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ABSTRACT

Documents announced with VT numbers only in the Fall 1971 issue (VT 014 129) of "Abstracts of Instructional Materials in Vocational and Technical Education" (AIM) are included in this microfiche set. The microfiche set is arranged in the following sequence: (1) a Vocational Technical (VT) number index to documents in the microfiche collection, (2) the subject and author index from AIM, and (3) the full text of documents listed in the VT number index. The texts are filmed continuously in VT number sequence. (CD)

ED0 56238

Microfiche Collection of Clearinghouse Documents

Reported in Abstracts of Instructional Materials

in Vocational and Technical Education

(AIM)

Compiled and Indexed by the ERIC Clearinghouse
on Vocational and Technical Education

FALL 1971

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ERIC Clearinghouse on Vocational and Technical Education
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1900 Kenny Road, Columbus, Ohio 43210

VT014237

INTRODUCTION

This collection of microfiche consists of the documents which are announced with VT number only in the Fall 1971 issue of Abstracts of Instructional Materials in Vocational and Technical Education (AIM). Microfiche availability is shown in the resume as MF AVAILABLE IN VT-ERIC SET. The documents are grouped in VT number sequence and filmed continuously as a microfiche set. These documents are not available on microfiche as individual items, but are obtainable only through purchase of this set, or from agencies who have this set and have the capability of reproducing microfiche. The microfiche set includes the following sections:

1. Vocational Technical (VT) Number Index to Microfiche Collection of Clearinghouse Documents Reported in AIM, Fall 1971.

2. Selected indexes from AIM, Fall 1971.

   a. Subject Index
   b. Personal and Institutional Author Index

   The documents identified in the indexes with an ERIC Document (ED) number are usually available as separate documents from the ERIC Document Reproduction Service (EDRS). Information about EDRS Service can be found in AIM or Research in Education (RIE).[1] Items not available through EDRS will include a source of availability. The page numbers shown in these indexes refer to the location of the abstracts in AIM, Fall 1971.

3. The full text of documents listed in the Vocational Technical (VT) Number Index to Microfiche Collection of Clearinghouse Documents Reported in AIM, Fall 1971.

[1] Research in Education is published 12 times a year. The first issue was no. 1, November 1966. Subscription: Domestic $21.00 a year; foreign $5.25 additional. Single copy: Domestic, $1.75. Send check or money order (no stamps) to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

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Missouri State Dept. of Education, Jefferson
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DESCRIPTORS - VOCATIONAL EDUCATION;
*COOPERATIVE EDUCATION; INDUSTRIAL EDUCATION;
*DISTRIBUTIVE EDUCATION; *GUIDELINES;
*PROGRAM PLANNING; PROGRAM DEVELOPMENT;
*PROGRAM EVALUATION; EDUCATIONAL FACILITIES;
YOUTH CLUBS; TEACHER CERTIFICATION

ABSTRACT - This manual should be of interest
to teachers and administrators when
developing vocational programs. Prepared
specifically for cooperative and distributive
education programs, the manual describes (1)
basic program plans, (2) certification
requirements, (3) facilities needed, (4)
youth organizations, and (5) program
reporting and evaluation procedures. (JS)

VT 001 128

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COOPERATIVE OCCUPATIONAL EDUCATION AND DISTRIBUTIVE EDUCATION HANDBOOK

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OFFICE OF EDUCATION
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STATE DEPARTMENT OF EDUCATION
Vocational Education Division
Jefferson City, Missouri

VT001128

COOPERATIVE INDUSTRIAL AND DISTRIBUTIVE EDUCATION

The Director of Cooperative Industrial and Distributive Education is responsible for part-time Cooperative Industrial Education programs. Preparatory and Cooperative Distributive Education programs, and combinations of these which are called Cooperative Occupational Education. These programs may be organized in high schools, area schools and junior or community colleges.

Cooperative Industrial Education

Instruction combined with part-time employment shall be designed to develop vocational competency for gainful employment in a trade or industrial occupation. These occupations are identified in the Dictionary of Occupational Titles as generally including, but not limited to, the classifications of skilled trades, or semi-skilled occupations which directly contribute to the designing, producing, processing, fabricating, assembling, testing, modifying, maintaining, servicing, or repairing of any product or commodity. Other occupations of technical or service nature usually regarded as trade and industrial may be included.

Instruction may be provided for persons over 14 years of age who have entered or agreed to enter a trade or industrial occupation. For those who have entered employment the instruction must be limited to vocational and technical subject matter related to the occupation or occupational field of employment. For those enrollees who have been identified as socio-economic or academically handicapped, basic general instruction can be provided to reduce the handicaps and to enable them to benefit from vocational instruction planned for them in a vocational program. This group can be served as potential enrollees of a Cooperative Industrial Education program.

Cooperative classes for industrial trainees may be offered to persons enrolled in high school by cooperative arrangements between the school and employers to combine supervised practical experience which is part-time employment with classroom instruction that is vocational, supplemental and related to employment. The arrangements between the school and employers shall be in writing. The employment of the student-learner shall conform with Federal, State and local laws and shall not result in exploitation of the student-learner for private gain. Schools granting a unit of high school credit for supervised occupational experience shall require a minimum of 15 hours per week for the school year. Suggested basic plans for related classroom instruction in part-time Cooperative classes for industrial trainees are as follows:

Plan A. Two years of one class period per day for vocational instruction that is limited to trade and industrial trainees.

Plan B. One year of two class periods per day for vocational instruction that is limited to trade and industrial trainees.

Plan C. One year of one class period per day for vocational instruction that is limited to trade and industrial trainees who have had or are currently enrolled in a course that makes a significant contribution to occupational competency such as those in home economics, agriculture, industrial, and technical education or a specific employment oriented course designed as pre-employment vocational instruction.

Plan D. A deviation from Plan A, B, and C such as:

a. In schools having too few twelfth grade applicants for economy of instruction, eleventh grade trainees may also be enrolled, but an adequate number of second year enrollees should be attracted to schedule them in a separate class period from first year student-learners.

b. In schools desiring to serve the socio-economic handicapped, the grade level, ages, and instruction time shall be based upon the needs of the group served.

Certification and/or approval of cooperative industrial education teacher-coordinators shall be based upon the qualifications for vocational instructional personnel written in the state plan as follows:

a. Occupational experience -- Three or more years of employment or other experience that contributes directly to the competency required in the occupations or occupational area to be taught. Such experience shall have been of such nature and quality as to give a recognized status in the occupation represented. Graduation from a four-year college with a major in the vocational area to be taught or completion of a two-year preparatory vocational or technical program in the occupational area to be taught may be considered as meeting one year of the above experience requirement.

b. Professional training for teaching -- A minimum of 20 semester hours of professional training for teaching, eight of which must be approved vocational teacher preparation. The foregoing must be appropriate to the level of instruction and to the occupation or occupational area to be taught.

c. Technical subject matter -- Individuals approved to teach vocational classes and/or coordinate vocational programs in these areas will be required to have a baccalaureate degree with a major appropriate to the vocational area to be taught.

More specifically stated the qualifications for cooperative industrial education teacher-coordinators are as follows:

a. A baccalaureate degree.

b. Twenty semester hours of professional education with eight semester hours of approved professional preparation in vocational education courses.

c. Twenty semester hours of approved subject-matter courses contributing to a background of knowledge for classroom instruction and employment supervision including appropriate courses in guidance, psychology, sociology, economics, business or industrial education.

d. Two years of approved occupational experience that is appropriate to the occupational field or area of responsibility for coordination and/or teaching assignment.

Cooperative and Preparatory Distributive Education

Instruction shall be designed to develop competency for gainful employment in distributive occupations. Distributive occupations are those followed by proprietors, managers, or employees engaged primarily in the marketing of goods and services. These occupations are commonly in business establishments engaged in retailing, wholesaling, manufacturing, storing, transporting, financing, and risk bearing. The program of instruction shall be derived from the functions of marketing and a knowledge of products and services. The functions of marketing are buying, selling, sales promotion, market research, operations and management. The instruction may also develop social competency and basic skills in communications and calculations associated with the competencies required for employment in distributive occupations.

This instruction may be provided for persons over 14 years of age who are preparing to enter or have entered a distributive occupation. A part-time program in distributive education shall require cooperative arrangements in writing between the school providing vocational instruction to student-learners in the classes and the employers providing on-the-job training through part-time employment of such student-learners. Such arrangements shall provide for employment in conformity with Federal, State and local laws and in a manner not resulting in exploitation of such student-learner for private gain and an organized plan for on-the-job training and supplemental vocational instruction in school. If school credit is granted, fifteen hours per week for a school year shall equal a unit of high school credit.

High school programs may be organized as a cooperative plan providing classroom instruction and supervised practical experience which is regular part-time employment. Programs may also be organized as a project plan for preparatory classes using participation activities supplemental to classroom instruction other than regular part-time employment. The project plan may consist of such courses as Merchandising, Salesmanship, Management and Marketing. A cooperative plan and a project plan may both be organized in the same school. A cooperative plan for part-time students employed in distributive occupations may be organized for classroom instruction as follows:

Plan A. Two years of at least one class period per day for vocational instruction that is limited to distributive trainees.

Plan B. One year of at least two class periods per day for vocational instruction that is limited to distributive trainees.

Plan C. One year of at least one class period per day for vocational instruction limited to distributive trainees: (a) who have completed one unit (two semesters) of preparatory distributive education subjects or (b) who are currently enrolled in an additional distributive subject or (c) who have completed at least two units (four semesters) of instruction in another program approved in the State Plan.

Plan D. A deviation from Plan A, B, and C such as:

a. A class organized specifically to serve academic socio-economic handicapped or potential dropouts may enroll youth over 14 years of age and adapt a work-study schedule to meet their needs.

b. A summer program with classroom instruction and employment hours approximately equal to a semester of Plan A may be organized if taught and coordinated by a qualified teacher-coordinator.

Project plans for preparatory classes utilizing participation activities as supplementary learning experiences, other than regular part-time employment, are as follows:

Plan E. Two school years of at least one period per day for vocational classroom instruction in distributive courses. Schools shall be approved for this plan only if currently providing a Plan A, B, C, or D cooperative plan. A series of semester courses with titles such as Marketing, Merchandising, Salesmanship and Management should begin in the 11th grade so that those completing the first year may enroll in a cooperative program and/or a second year of distributive courses during the 12th grade. Every student enrolled becomes a vocational trainee and should graduate with two or more units of credit to be adequately trained for the labor market.

Plan F. One school year of at least two periods per day for vocational classroom instruction in distributive courses. The two or more periods should be for juniors who will enroll in a cooperative program in the senior year or for seniors who will be seeking employment in a distributive occupation after graduation. The content shall develop competencies needed in distributive employment as indicated in the first paragraph of this section on Cooperative and Preparatory Distributive Education.

Certification and/or approval of distributive education teachers or coordinators shall be based upon the qualifications for all vocational instructors and specifically are as follows:

1. A baccalaureate degree

2. Twenty semester hours of professional education with eight semester hours of approved professional preparation in vocational education courses.

3. Fifteen semester hours of approved subject-matter courses that contribute to technical teaching competency from the area of Marketing and other appropriate business education courses.

4. Two years of approved occupational experience that is appropriate to the occupational field or area of responsibility for coordination and/or teaching assignment.

Plan G. One school year of at least one class period per day for vocational instruction enrolling only those who have a specific vocational objective for employment in an occupation requiring very limited skills and knowledge.

Evaluation of preparatory classes in Distributive Education shall be based upon the following criteria:

1. The number continuing training in the part-time cooperative program.

2. The number continuing training in the second year of preparatory instruction.

3. The number entering distributive occupations after graduation from high school.

4. The number enrolling in post-high school instruction which is related to the high school program.

Post Secondary preparatory classes for full-time students in area vocational schools and junior or community colleges may be organized for instruction that develops or improves the competencies for distribution occupations. A program of distributive education shall be not less than two courses per year for two years. Enrollment shall be limited to those with an occupational objective in distribution. Supervised practical experience as regular part-time employment shall be provided only to students enrolled in one or more distributive subjects.

Instructors in post-secondary programs for full-time students shall meet the requirements for certification and/or approval according to the qualifications for all vocational instructional personnel.

Special classes may be provided to meet the needs of academic socio-economic handicapped persons to secure gainful employment in distributive occupations. The program of instuuction may include cooperative arrangements with other vocational areas. The enrollees in a program designed to prepare for specific employment in a distributive occupation may also be provided general instruction that is necessary to enable the student to benefit from vocational instruction in the competencies required by the occupation.

Approval of teachers for special programs shall be by the State Department of Education and based upon qualifications appropriate for the specialized educational responsibility.

Physical facilities shall be provided that are adequate in size to allow space for instructional equipment that resembles a retail store. Instructional equipment should include a cash register, display cases, wrapping facilities, etc. Funds must be available for the purchase of up-to-date instructional materials to teach by the project method and provide participation activities that emphasize the vocational approach to learning. In other words, this must be more than a textbook course. The instruction must comply with current practices in distribution and develop decision making skills that contribute to competency in a distributive occupation. The preparatory courses demand equipment, references, and study guides appropriate for individual interests and abilities. These must be adequate to produce employable people and those entering the cooperative programs must continue to secure specific vocational instruction in the classroom. This calls for much individual study from guides and references designed for developing specific employment responsibilities.

Youth organizations shall be encouraged in local schools as chapters of the Distributive Education Club of America. A state advisor shall be provided and financial assistance shall be offered whenever it is legal or established state policy. Local clubs shall be expected to have an active local program and participate in the state-wide activities designed to provide desirable educational experiences for youth.

Cooperative Occupational Education

Cooperative Occupational Education designates a part-time cooperative training program that is a combination of Cooperative Industrial, Cooperative Distributive and in some instances Cooperative Office Education. The name of this program emphasizes the method of learning without identifying the subject matter, discipline, or occupational fields of training. The common significant feature is the use of supervised occupational experience to supplement vocational classroom instruction or the provision for in-school vocational instruction related to part-time employment.

Classes, enrollees and part-time employment must meet the general requirements for all vocational education under the 1963 Act, and the specific requirements for Cooperative Industrial Education and Cooperative Distributive Education. When supervised occupational experience in office occupations is included, the requirements for Business and Office Education shall be met.

This part-time cooperative program requires local schools to have cooperative arrangements in writing between the school providing vocational instruction to student-learners in the classes and the employers providing on-the-job training through part-time employment of the student-learners. Such arrangements shall provide for employment in conformity with Federal, State and local laws and in a manner not resulting in exploitation of the student-learners and shall provide for an organized plan of on-the-job experiences coordinated with supplemental vocational instruction in school. Regular part-time employment of fifteen hours per week for a school year shall be required for a unit of high school credit. The plans for classroom instruction of part-time cooperative enrollees are as follows:

Plan A. Two years of at least one class period per day for vocational instruction that is taught by a coordinator to separate class sections for distributive and industrial trainees.

Plan B. One year of at least two class periods per day for vocational instruction that is taught by a coordinator to separate class sections for distributive and industrial trainees.

Plan C. One year of at least one class period per day for vocational instruction that is taught by a coordinator to separate class sections of distributive and industrial trainees providing the distributive trainees have completed one full-year course of preparatory distributive education or are currently enrolled in a distributive subject and providing the industrial trainees have completed one full year or are currently enrolled in a course that makes a significant contribution toward occupational competency.

Plan D. A deviation from Plan A, B and C such as:

(a) In communities of less than 5,000 distributive and indusrtial trainees may be combined in the same class.

(b) In schools with too few trainees to have more than one class section distributive and industrial trainees may be combined in the same class.

(c) In schools with schedule conditions that can be justified as unsuited to separation of distributive and industrial trainees, they may be combined in the same class.

(d) For students classified as having acadmmic socio-economic handicaps, pre-requisite courses and classification of trainees by occupational experience may be disregarded and the length of instruction in years or periods may be provided to suit the needs of the students.

Certification of Cooperative Occupational Education (COE) teacher-coordinators is based upon some common qualifications required for the occupational fields that are combined. They must have a baccalaureate degree, and two years of occupational experience, but there should be a minimum of one year in each occupational field involved. The twenty hours of professional education courses, including semester hours of specific professional preparation in vocational education, is the same for each field. It is only in the technical subject matter background courses that there is a distinct difference. More specifically the combination or Cooperative Occupational Education (COE) teacher-coordinator certification requirements are:

(1) A baccalaureate degree

(2) Twenty semester hours of professional education with eight semester hours of approved professional preparation in vocational education courses.

(3) Twenty semester hours of approved courses contributing to a background of knowledge for classroom instruction and employment supervision. This shall include a minimum of six semester hours in Marketing, Retailing, Merchandising or Salesmanship for any responsibility of teaching student-learners classified as distributive trainees, and a minimum of six semester hours in industrial education for any responsibility of teaching student-learners classified as industrial trainees. The balance shall include appropriate courses in guidance, psychology, sociology, economics or business education.

(4) Two years of approved occupational experience that is appropriate to the occupational field or area of responsibility for coordination and/or teaching assignment.

Youth organizations identified as the Cooperative Occupational Education Club of Missouri shall be encouraged by providing a state advisor and financial assistance as established by state policy.

Procedure for Reporting and Evaluation

Evidence of local operations must be provided to the State Department of Education through periodic reports. In general, details can be given on printed forms that are provided. Details revealed by these reports shall include names of pupils enrolled, their ages, daily schedules, occupational objectives, and places of employment for cooperative and/or supplementary enrollees. The report shall give instruction personnel's daily schedule, total length of employment, contracted salary and certification status.

Local schools shall be expected to keep adequate records of students to make effective follow-up studies for evaluation of the vocational instruction. Specific evaluation reports shall be required and additional evaluations shall be based upon observations of state staff members during periodic visits of local programs.

Reimbursable programs must show evidence of value by the extent of placement and success of enrollees in gainful employment in the occupational field for which they were trained. Financial assistance shall be discontinued for programs failing to show satisfactory evidence of fulfilling this objective of vocational instruction.

The basic reports will be as follows:

1. A contract and budget of expenditures for a fiscal year due by July 30.

2. A semester enrollment report due the third week of each semester.

3. A summary or progress report of the program at the close of the school year.

4. Application for reimbursement on expenditures of salary for time devoted to vocational activities and purchases having prior approval.

5. A follow-up report on vocational students graduating in the spring and due November 1.

6. A follow-up report on vocational students five years after their graduation and due August 15.

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ABSTRACT - Developed by the Bureau of Secondary Curriculum Development for the New York State Education Department, this resource unit is for use in modifying industrial arts instruction in the secondary grades to provide for plastic instruction. These materials were developed with two purposes in mind: (1) To provide a guide for content and development of locally designed courses of study, and (2) To provide the most enriched and complete outside resource materials which could be identified. The contents have been arranged in 12 major units: (1) Orientation, (2) Molding and Forming, (3) Moldmaking, (4) Bonding, (5) Laminates, (6) Encapsulation, (7) Forms, (8) Coating, (9) Vinyl Dispersion-Thermofusion, (10) Decorating, (11) Materials, and (12) Guidance. Supply lists and sources of supplies are contained in the appendix. The bibliography is divided into three sections: (1) Basic Library References, (2) Supplemental Reference List, and (3) Free or Inexpensive References. (GEB)

VT 002 004

an EXPERIMENTAL
RESOURCE UNIT in

PLASTICS

for INDUSTRIAL ARTS

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THE UNIVERSITY OF THE STATE OF NEW YORK / THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT / ALBANY, 1966

an experimental resource unit in PLASTICS for INDUSTRIAL ARTS

Bureau of Secondary Curriculum Development

The State Education Department

THE UNIVERSITY OF THE STATE OF NEW YORK

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Arthur J. Dudley

FOREWORD

Today, our lives are increasingly affected by the acceleration of technical knowledge and technological skills.

The increasing complexity of this aerospace age demands that our schools assist youth and adults to keep abreast of current developments. Industrial arts education, within the context of general education, provides a unique practical arts approach. It capitalizes on a student's interest in making things. Industrial arts instruction introduces him to, and acquaints him with, many phases of his environment. These are presented best through direct experiences with tools, materials, and processes. In this way, industrial arts education provides a unique opportunity for young people to gain a general insight into modern industry and to relate their experiences to other educational disciplines.

This *Experimental Resource Unit in Plastics for Industrial Arts Education* is for use in the junior and senior high schools. As an integral part of industrial arts education, it provides unique and significant learning experiences within the context of a total educational program.

Gordon E. Van Hooft
Chief, Bureau of Secondary Curriculum Development

William E. Young
Director, Curriculum Development Center

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INTRODUCTION

This *Experimental Resource Unit in Plastics for Industrial Arts Education* was developed to fill an emerging need to interpret plastics as a contemporary industrial material, involving different processes and products. Enrichment and modernization of industrial arts education programs in the junior and senior high schools is made possible as current courses of study are modified to include the addition of meaningful instruction in plastics. This publication contains a suggested outline showing how industrial arts instruction in the junior high school may be modified to provide for plastics instruction.

As the result of a survey of the plastics industry in New York, manufacturers of plastic materials and products indicated an interest and willingness to make their facilities available for field visits of students in industrial arts programs. A guide to such possible field trips is contained in the Appendix.

There also is an equipment list, submitted by the committee preparing this publication, which provides detailed information relating to items, possible supplier, and approximate cost at the time of publication.

The Appendix further contains a detailed bibliography. The listed publications include those materials that should be provided as a *Basic Reference Library*. A *Supplemental Reference* list is contained as references for advanced study. Another important section is the *Free or Inexpensive Reference* list.

A two-fold purpose was kept in mind as this material was being developed:

- To provide a guide for content and development of locally designed courses of study
- To provide as enriched and complete outside resource materials as it was possible to identify

It was planned that instruction in plastics would become an integral part of the total program offered in both the junior and senior high schools. Schools are invited to request additional assistance from the Bureau of Industrial Arts Education when considering the addition of plastics instruction to the industrial arts education program.

C. Thomas Olivo
Director, Division of Occupational Education II

Joseph R. Strobel
Assistant Commissioner for Occupational Education

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TO THE INSTRUCTOR

The significant role of plastics as a material, and of plastics products, is vital to our industrial society. After considerable deliberation it was decided that resource materials should be prepared in a formal way in order to extend, improve, and emphasize the importance of this material and the accompanying processes and products. The content in this publication has been divided into twelve major units. These units have been arranged in a logical order and include from 1 to 11 lessons per unit. The resultant 50 lessons, including 23 demonstrations and 27 related lessons, comprise information appropriate for instructional purposes in industrial arts. The length of presentations should be determined by the teacher as the lessons have not been divided according to a time schedule. The outline technique which has been used lends itself to subdivision within lessons. Schools preparing for instruction in plastics should select units and lesson topics carefully in order to provide a logical teaching-learning progression.

Materials and product manufacturers in the plastics industry of this State are interested and willing to assist teachers in industrial arts education in several ways. Field trips may be planned to gain firsthand knowledge of this rapidly expanding field. A guide to such possible field trips is contained in the Appendix. Teachers should add to the list other industries within a reasonable radius of the local school system where field trips may be provided.

Helpful cooperation was received from the industry in identifying suitable equipment. At the time of publication the cost of basic equipment for instruction in plastics was identified. The prices which appear in the Appendix, therefore, are those that prevailed in 1965. Selection of appropriate equipment to meet local course needs may be determined easily by referring to this list. The necessary equipment for the introduction of plastics instruction may be added to the wood, ceramics and shop drawing instruction units of the junior high school program. It may be combined with equipment from one or more of the other areas of instruction at the senior high school level. It is anticipated that bench surfaces and certain small tools already available for other instructional areas will be used in the plastics activity.

The Appendix contains a supply list and sources of these supplies. No effort has been made to determine the necessary quantity of supplies, but the recommendation is offered that teachers procure suppliers' catalogues and that conservative requests be made for those items having a short shelf life.

The bibliography has been divided into three sections. The first section, entitled *Basic Reference Library*, consists of the publications to which the lessons have been keyed. When plastics instruction is added to the curriculum, this basic library should be included as essential for reference purposes, both for the teacher and the students.

The second section of the bibliography, the *Supplemental Reference List*, includes publications which have been used as references, usually of an advanced nature, in many of the lesson outlines. The references throughout the course of study which have been marked with an asterisk (*) appear on this list of Supplemental References.

The third section of the bibliography, is *Free or Inexpensive References*. Schools introducing plastics instruction should add some of these titles to their reference libraries. Some of the free and inexpensive materials will be found indispensable to the teacher. Terms used frequently throughout the course of study will be found in the *Glossary of Plastic Terms*, available free from Phillips Chemical Company and listed in the bibliography.

The Film Catalog of the Plastics Industry published by the Society of the Plastics Industry will be of value in the selection of audio-visual materials. The content of this catalog was considered to be comprehensive enough to make it unnecessary to include a list in this publication. The curriculum development group previewed approximately 50 films, most of which have been annotated in this SPI publication. All were found to be of high quality and acceptable for industrial arts study purposes.

As stated earlier, the publication was developed with two purposes in mind:

- To provide a series of resource instructional units from which certain units might be selected for instruction at both the junior and senior high school levels.

- To develop a publication containing necessary resource information for teachers unfamiliar with this material area.

Schools are invited to request additional assistance from the Bureau of Industrial Arts Education and to forward constructive suggestions on how this instructional area and the total instructional program may be improved.

Arthur J. Dudley
Chief, Bureau of
Industrial Arts Education

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This publication was developed during the 1964 summer session at the State University College at Oswego in a curriculum development workshop coordinated by Robert J. Ullery, Associate in Industrial Arts Education, Bureau of Industrial Arts, State Education Department. The facilities of the college were made available for this purpose through the courtesy of Paul DeVore, Director of the Division of Industrial Arts Education.

Technical advisers to the development team included Gerald Steele, of Minneapolis, Minn., and Maurice Keroack of the instructional staff at State University College, Buffalo. Editorial adviser to the group was James Crawford, department chairman, Monroe-Woodbury Central School, Central Valley. An opportunity was provided for the trial use of the instructional materials through the courtesy of Frank Robinson and William Todd at the State University College at Oswego.

The original lesson content was developed by a selected group of six industrial arts teachers including F. Dean Hansen, Burnt Hills-Ballston Lake Central School; Irwin S. Howard, Gates-Chili Central School; Robert Kindred, Niagara Falls Schools; Frank R. Manhardt, North Babylon Schools; Carl J. Marsden, New Rochelle Schools; and Vito Tisci, Ilion Schools.

The resource materials in this publication were prepared under the direction of Arthur F. Ahr, formerly Chief, Bureau of Industrial Arts Education, State Education Department, Albany. Final editing was performed by Robert J. Ullery of that bureau. Final copy was prepared for publication in the Curriculum Development Center by G. Earl Hay, Associate in Vocational Curriculum, Bureau of Secondary Curriculum Development.

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Several sources provided descriptive literature for review and study:

Allied Chemical, Plastics Division

Allied Resin Products Corp.

American Cyanamid Co., Plastics and Resins Division

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Avecor, Inc.

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Baum Chemical Corp.

Bee Chemical Co.

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Caco Pacific

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Canadian Aviation Electronics, Inc.

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DuraCote Corp.

Durez, Plastics Division

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Frye Plastics International, Inc.

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General Electric, Chemical Materials Dept.

General Tire & Rubber Co., Chemicals Division

Gering Plastics Co., Dept. of Monsanto

B. F. Goodrich Chemical Co.

Grace Plastics

Hastings Plastics, Inc.

Hinchman Manufacturing Co., Inc.

Rich, Hofheinz & Co.

Hofmann & Schwabe Co.

Injection Molders Supply Co., Inc.

Kamweld Products Co.

Killion Extruders, Inc.

Kingsley Machine Co.

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ACKNOWLEDGMENTS

Koppers Co., Inc., Plastics Division

Libby-Owens-Ford Glass Co.

Lionel Toy Corp.

Marbon Chemical Division, Borg-Warner

Mobay Chemical Co.

Monsanto Plastics

Murphy Paints, Inc.

National Board of Fire Underwriters, New York City

Naugatuck, Chemical Division

Newbury Industries, Inc.

Nixon Baldwin Chemicals, Inc.

Owens-Corning Fiberglas Corp., Reinforced Plastics Division

Penn Salt Chemicals Corp.

Philips Chemical Co.

Plastic Products Co. of Utah

Plextone Corp. of America

Polymers Dept., Hercules Powder Co.

Portage Plastics

Prodex Corp.

Pulverizing Machinery, Div. of Flick Corp.

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Shawinigan Resins Corp.

Shell Chemical Co., Plastics and Resins Division

Shore Instrument & Manufacturing Co.

Simplomatic Manufacturing Co.

Spencer Chemical Company

Stereotype Equipment Co.

Tabor Instrument Corp.

Testing Machines, Inc.

Thoreson-McCosh, Inc.

Union Carbide Plastics Co.

U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp.

U. S. Rubber Co.

Van Doren Iron Works Co.

Wayne Machine & Die Co.

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ACKNOWLEDGMENTS

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UNIT I

ORIENTATION

Lesson		Page
1	History and growth of the plastics industry	1
2	Applications of plastics products	5
3	Classification and identification of plastics	10

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UNIT I ORIENTATION

Lesson 1

Related Lesson: History and growth of the plastics industry

OBJECTIVES:

. To develop a knowledge of the history and growth of the industry

. To develop an understanding of the future potential of the industry

REFERENCES:

1.	Bakelite Co.	The ABC's of Modern Plastics	pp. 3-5
2.	Cherry, Raymond	General Plastics, Rev. Ed. 1964	
3.	*Cope, Dwight	Cope's Plastics Book	p. 9
4.	Dearle, Denis A.	Opportunities in Plastics Careers	pp. 9-15
5.	SPI	Plastics: The Story of an Industry	pp. 1-5
6.	SPI	Plastics Engineering Handbook	pp. 8, 22, 39, 45, 19, 23

FOR DISCUSSION:

. Common use of plastics in everyday life
. Interdependence of industries
. Development of processing machinery

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Compare the growth of the plastics industry to that of other industries.
. Investigate present use of different plastic materials.

LESSON OUTLINE:

I. Natural Resins

A. Rubber
B. Shellac

II. First Commercial Plastic Discovery in U. S. A

A. John Wesley Hyatt's discovery in 1868
B. Makeup of cellulose nitrate (celluloid)
C. Uses and molding techniques

III. Phenolic Resin Discovery, 1909

A. Search for synthetic shellac - Dr. Leo Henrik Bakeland
B. Developed molding techinques for phenolic
C. Properties and uses

IV. Up to World War II

A. Cold molded, 1909, Phenolics
B. Casein from cows milk 1919 - Adolph Spitteler
C. Cellulose acetate 1927; first injection molded plastic, 1929
D. Introduction of injection molding in USA, 1934
E. Polystyrene 1938

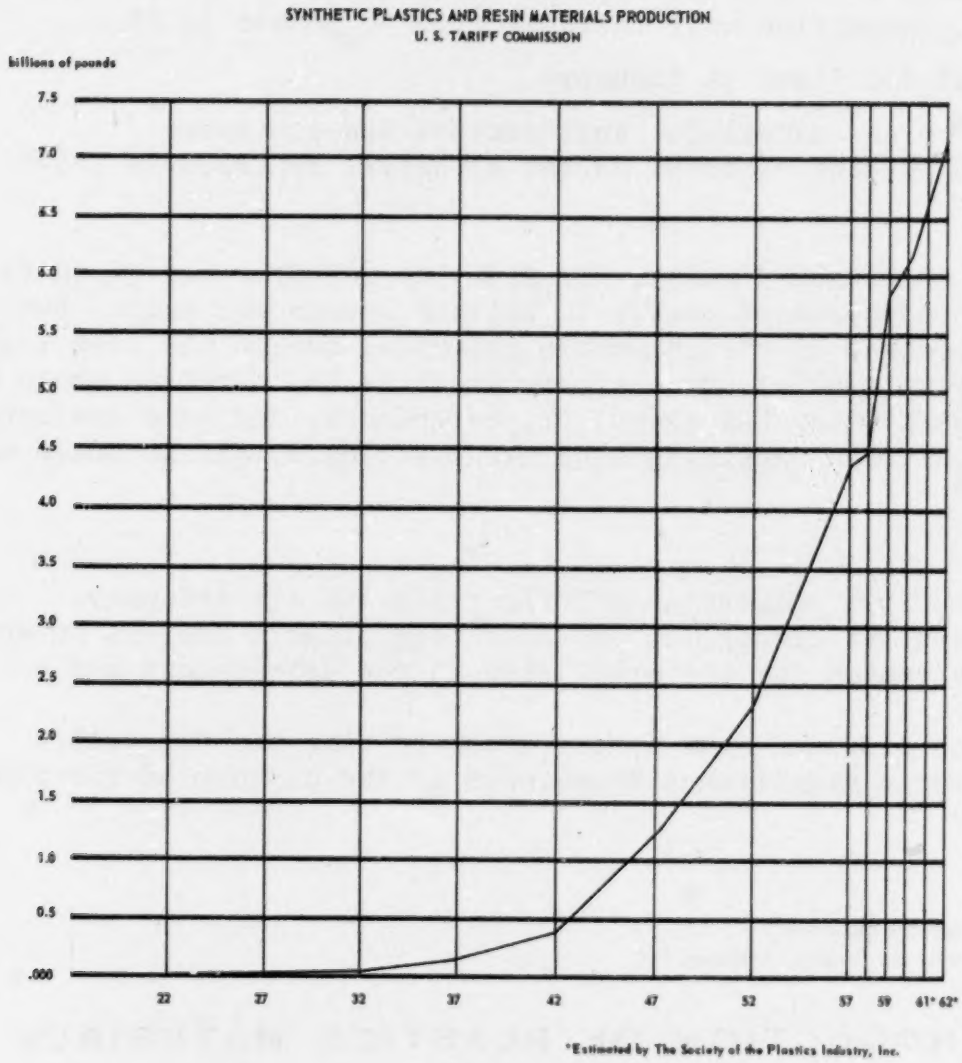

V. During World War II

A. Great need for substitutes due to material shortage
B. Need for new materials with new characteristics
C. Polyethylene 1942, made radar and television possible (flexible electrical insulator)
D. Polyester 1942, made fiber glass reinforced plastics possible

VI. After World War II

A. Slump in use of plastics following World War II
B. Great rise in use of plastics began about 1950
C. New plastics materials and processes developed

VII. Growth Curve of Plastics Production

A. Rapid growth
B. Increase in last 10 years
C. 1963 use, 9 billion pounds; 1964 use, 10 billion pounds

D. According to a study recently made by Corplan Associates, plastics will be second in importance only to steel as an industrial material, increasing from 8 billion pounds in 1963 to 15 billion in 1970. Per capita consumption will increase from 40 pounds to 68.

VIII. Future of the Plastics Industry

A. Unlimited new materials, applications and processes
B. About 3 percent of total market potential realized in 1964

SUMMARY:

In about one hundred years, the plastics industry has grown from discovery to production of nearly 10 billion pounds per year. Even at this rate, only 3 percent of the estimated potential market has been realized. Without plastics, many of our everyday products and services would be impossible. Such things as radar, TV, telephones, and home comforts such as foam cushion, food packaging, and new clothing materials would not be available.

QUESTIONS:

Q: Name the first commercial plastic resin and its inventor.
Q: Name the first commercial thermosetting plastic and its inventor.
Q: Give the reason for the great rise in the development and use of plastics.
Q: What need prompted John Wesley Hyatt to make his discovery?
Q: Name several significant milestones in the history of the plastics industry.

Introduction of Plastics Materials
courtesy of The Society of the Plastics Industry, Inc.

INTRODUCTION OF PLASTICS MATERIALS

DATE	MATERIAL	EXAMPLE
1868	CELLULOSE NITRATE	Eye Glass Frames
1909	PHENOL-FORMALDEHYDE	Telephone Hand Set
1909	COLD MOLDED	Knobs and Handles
1919	CASEIN	Knitting Needles
1926	ALKYDS	Electrical Bases (molded)
1926	ANILINE-FORMALDEHYDE	Terminal Boards
1927	CELLULOSE ACETATE	Toothbrushes, Packaging
1927	POLYVINYL CHLORIDE	Raincoats
1929	UREA-FORMALDEHYDE	Lighting Fixtures
1935	ETHYL CELLULOSE	Flashlight Cases
1936	ACRYLIC	Brush Backs, Displays
1936	POLYVINYL ACETATE	Flash Bulb Lining
1938	CELLULOSE ACETATE BUTYRATE	Irrigation Pipe
1938	POLYSTYRENE or STYRENE	Kitchen Housewares
1938	NYLON (POLYAMIDES)	Gears
1938	POLYVINYL ACETALS	Safety Glass Interlayer
1939	MELAMINE-FORMALDEHYDE	Tableware
1939	POLYVINYLIDENE CHLORIDE	Auto Seat Covers
1942	POLYESTERS	Interior Partitions
1942	POLYETHYLENE	Squeezable Bottles
1943	SILICONES	Motor Insulation
1943	FLUOROCARBONS	Industrial Gaskets
1945	CELLULOSE PROPIONATE	Automatic Pens and Pencils
1947	EPOXY	Tools and Jigs
1948	ACRYLONITRILE-BUTADIENE-STYRENE	Luggage
1956	ACETAL RESIN	Automotive Parts
1957	POLYPROPYLENE	Industrial Moldings
1957	POLYCARBONATE RESIN	Appliance Parts
1959	CHLORINATED POLYETHER	Valves and Fittings

UNIT I ORIENTATION

Lesson 2

Related Lesson: Applications of plastic products

OBJECTIVES:

- To show the importance of plastic products in society
- To acquaint the student with the industrial application of plastic products

REFERENCES:

1.	Breslom	Modern Plastic Encyclopedia	pp. 37-52
2.	SPI	Plastics - Story of an Industry	pp. 8-9
3.		Modern Plastics Magazine	Annual January Issue

FOR DISCUSSION:

- Various industrial applications of plastic products
- Number of plastic parts now used in major equipment

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Do individual research.
- Construct show case displays.
- Prepare wall charts.

Plastics Parts in Refrigerators

courtesy of The Society of the Plastics Industry, Inc.

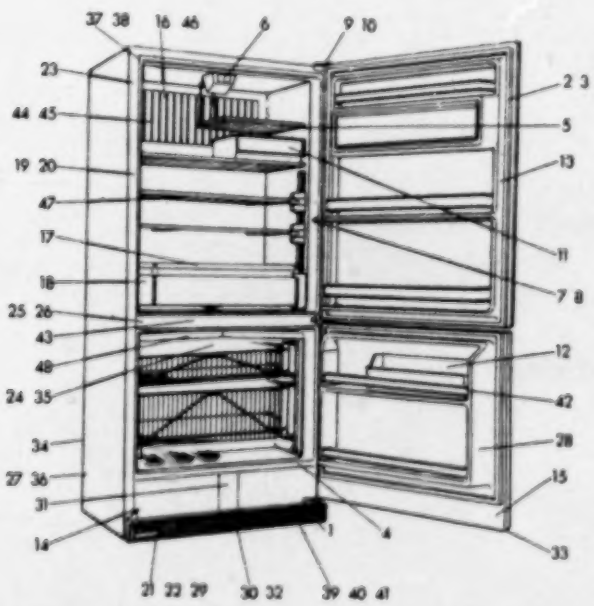

1 ROLLERS
2 DOOR GASKETS
3 GASKET MAGNETS
4 BREAKER STRIPS
5 SHELF SUPPORTS
6 LIGHT COVER
7 SWITCH PLUNGER
8 SWITCH CASE
9 HINGE SHIMS
10 HINGE BEARINGS
11 MEAT PAN
12 ICE BUCKET
13 DOOR PANS
14 PEDAL BUMPER
15 SYNTHETIC PAINTS
16 COIL COVER
17 VEG. PAN COVER
18 EGG STORAGE

HIDDEN PARTS

19 THERMO. KNOB
20 THERMO. INDICATOR
21 RELAY CASE
22 WIRE INSULATION
23 FOAM INSULATION
24 FAN GRILL
25 DRAIN PAN
26 DRAIN ELBOW
27 "WONDERWALL" LAMINATE
28 INSULATION BAGS
29 TIMER KNOB
30 TUBE GROMMETS
31 SUCTION LINE INSULATION
32 COMPRESSOR MOUNTS
33 SEALING PLUGS
34 WALL BUMPERS
35 FAN SUPPORTS
36 SEALING COMPOUND
37 LINER SUPPORTS
38 HEAT BREAKS
39 WATER PAN
40 VINYL TAPES
41 VINYL SLEEVES
42 RIVETS
43 DRAIN FUNNEL
44 TUBE COATING
45 COIL COVER PLATE
46 COIL SUPPORTS
47 MISC. BUMPERS
48 MISC. GASKETS

OTHER MODELS-

VEG. PAN
EVAP. DOOR
NAMEPLATES
SHELF SLIDES
BUTTER DOOR

EVAP. DOOR HINGES
CHILLER TRAY
ICE CUBE TRAY
ICE TRAY GRIDS

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BRIEF DESCRIPTION OF PROCESS:

Manufacturers in many material areas have found that plastics can be utilized to advantage in their products. New uses for plastic products are being found daily. The properties of plastics often make possible manufacturing procedures and products not possible with any other material.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Samples of products which utilize plastics
- Bleach bottles - blow molded
- Rain apparel - calendered film
- Food containers - vacuum formed
- Auto accessories - injection and compression molded
- Distributor caps - compression molded
- Wire insulation - extruded
- Other samples as available

LESSON OUTLINE:

I. Construction

A. Paneling - laminates
B. Counter tops - high pressure laminates
C. Insulation materials - foams
D. Paints - resins
E. Roofing
F. Vinyl tile - extrusion or calendering

II. Transportation

A. Brake Linings - compression
B. Truck and car bodies - reinforced plastics
C. Boats - reinforced plastics
D. Accessory knobs - injection or compression
E. Tires - vulcanizing

III. Farming

A. Greenhouse covers - calendering
B. Irrigation lines - extrusion
C. Baling twines - filament forming
D. Sheet covers to prevent weed growth - calendering

IV. Packaging

A. Bags - blown film
B. Thin wall containers - vacuum forming
C. Shrink pack - blown film
D. Cushioning - foams
E. Shipping drums - thermofusion
F. Lids or covers - injection molding

V. Aero space

A. Nose cones - filament winding or FRP (Fiberglas reinforced plastics)
B. Insulation - foams
C. Foam in place (shock absorption) - foams
D. Satellites
E. Control panels - extruded wire coating

VI. Electrical

A. Switches - compression
B. Terminal boards - lamination and electroplating
C. Circuit breakers - compression
D. Wire insulation - extrusion
E. Printed circuitry - electroplating

VII. Plumbing

A. Pipes - extrusion
B. Valve seats - injection
C. Pipe fittings - injection

VIII. Clothing

A. Synthetic fabric - filament forming
B. Water repellent clothing - coating
C. Insulated clothing - foams
D. Corfom shoes - foams

IX. Home consumer products

A. Measuring spoons - injection
B. Mixing bowls - injection
C. Dishpans - injection
D. Lamps - reinforced plastics
E. Ash trays - compression
F. Appliances - thermoforming and others
G. Teflon coated pans

X. Advertising

A. Counter displays - thermoforming
B. Metalized signs - metalizing
C. Novelty items - injection
D. Vacuum formed signs - thermoforming

XI. Metal Industries

A. Die facings - reinforcing
B. Bearings - injection
C. Drill bushings - injection
D. Inspection gauges

XII. Graphic Arts

A. Offset printing plates

SUMMARY:

In the United States today there are over 5,700 companies which make plastics their business. These companies may be divided into three main categories, having functions which sometimes overlap. These categories are (1) the plastics materials manufacturers which produce the basic plastic resin or compound, (2) the processors who convert the plastic into a solid shape, and (3) the fabricators and finishers who fashion and decorate the plastic. It is of this third category that other industries will make their demands on production in the plastic industries. The plastic material manufacturers estimate that 10 billion pounds of plastics will be used in 1965.

QUESTIONS:

Q: How important are plastics in the American industrial scene?
Q: What are some of the practical or obvious uses of plastic items?
Q: List some of the typical current uses of plastics.

Use of Plastics in Automobile Manufacturing
courtesy of The Society of the Plastics Industry, Inc.

PLASTIC COMPONENTS BODY AND ELECTRICAL

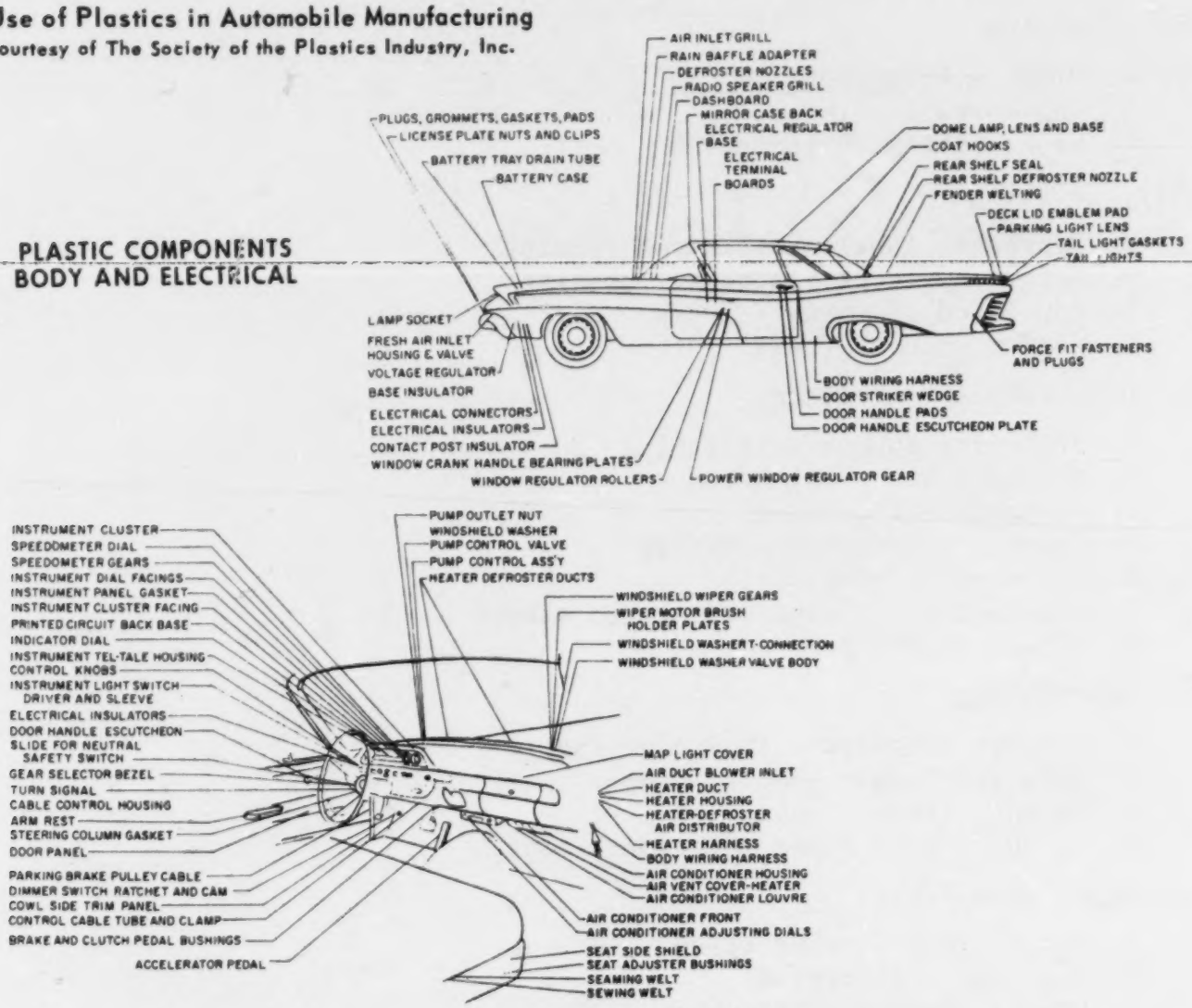

PLASTIC COMPONENTS CHASSIS

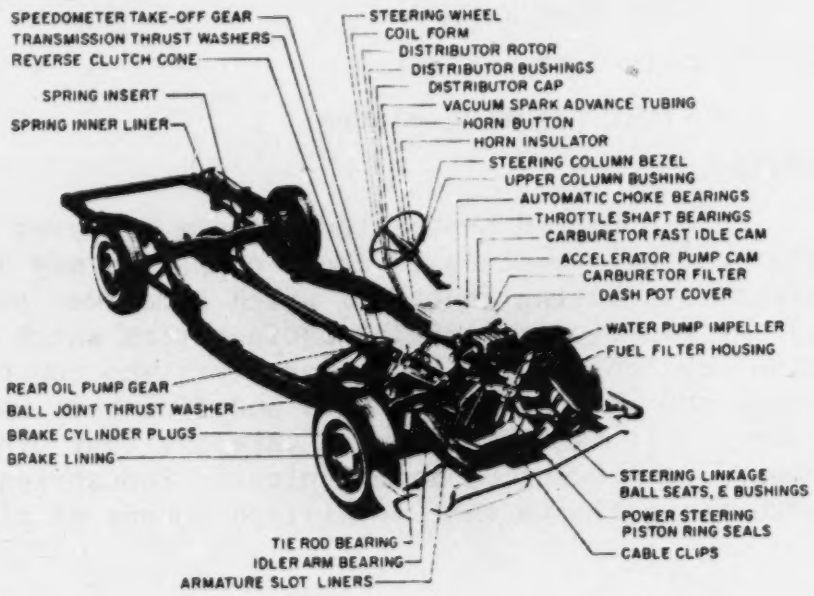

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Lesson 3

Related Lesson: Classification and Identification of Plastics

THERMOSETS

Chemical and Trade Names	Physical Characteristics	Typical Uses
1. EPOXY - Plastic Steel Metalfil, Araldite Epon	Low viscosity fluid to a brittle solid; very good adhesion qualities; weather resistant; high mechanical strength; good electrical properties; heat stable; good storage properties; easily colored	Laminating for nose cones, fuel tanks, auto and aircraft bodies, boat hulls (cast); in transformers, rotors, stators, circuit breakers; used for high-voltage low-current insulation, X-ray components, and battery cases
2. MELAMINE - Formaldehyde (Meline)	Strong; hard to scratch; withstands high heat and moisture; full range of colors; odorless, tasteless, nontoxic; oil resistant	Dinnerware; food service items; mixing bowls; table counter tops; auto ignition parts; hearing aid and shaver housings
3. PHENOLICS - Phenol formaldehyde (Phenolic), Bakelite	Strong; hard to scratch; good heat and electric insulation; high resistance to moisture	Flat iron handles; appliance bases; radio and T.V. cabinets; telephones; pot and utensil handles; light plugs and switches
4. POLYESTER - Mylar, Dacron	Strong; hard to scratch; unaffected by water; good resistance to chemicals and heat	Air-conditioner housings; chairs; light panels; bath tubs; skylights; luggage; boats; sleds; sport car bodies; patio roofing; fabrics
5. POLYURETHANE - Polyurethane Arothane, Cipfoam	Foamed plastic similar to rubber; very resilient, returns quickly to original shape after being wrung dry; light weight; heat resistant; good insulation qualities; easily molded; can be laminated	Used extensively as an insulation for refrigerators; pipes; trailers; trucks; panels for home construction; bridges; shelters; storage tanks; linings in clothing, bedding, cushions; cushioning in auto and furniture seats
6. SILICONE - Silastic RTV	Stable at high temperature and also at low temperature; resistant to weathering and oxidation; excellent electrical properties; water repellent; resistant to most gases, chemicals, and solvents	Water proof waxes and polishes; ball bearings; greases; defoamers; cosmetics; electrical insulators; release agents
7. UREA - Arodure, Resimene, Lauxite, Plaskon	Resists breaking and scratching; unaffected by common chemicals, grease, and oils; odorless, tasteless, nontoxic; good electrical insulator	Buttons; buckles; radio cabinets; clock cases; light reflectors; control knobs

Cherry, Raymond, General Plastics, 4th Ed.
Simonds, H. R. and Church, J. M., Concise Guide to Plastics
SPI, Plastics: Story of an Industry
____ Fire Hazards of the Plastics Industry
____ Lionel Plastics Engineering Manual
SPI, Plastics Engineering Handbook
Swanson, Robert, Industrial Plastics

For cost factor on above, see January, 1963, issue of Modern Plastics.

Lesson 3

Related Lesson: Classification and Identification of Plastics

THERMOPLASTICS

Chemical and Trade Names	Physical Characteristics	Typical Uses
1. A.B.S. (Acrylonitrile-Butadiene-Styrene) ABSON, Royalite, Cycolac	Extremely hard, also can be made flexible; will withstand abuse and pressure; wide temperature range; resistant to chemicals; good abrasion resistance; good impact and flexual strength; excellent thermal stability and hot strength; formable; easily colored	Pipe; luggage; refrigerator and appliance use; shoes; auto instruments; tote boxes; colored telephones; boats; safety helmets; sporting goods; typewriter and pump parts
2. ACRYLIC - Plexiglass, Lucite Orlon, Acrilan	Transparent; light diffusion; weather resistant; exceptionally formable; machinable; shatter resistant	Glazing; lighting; signs and displays; machine guards; models; lenses; coupling filters; textile fiber
3. POLYAMIDE - Zytel Nylon	Very strong; self lubricating; resilient, non-marring; machinable; unaffected by oil	Gears; bearings; wear strips; guides; rollers; stop pins; valve seats; gaskets; hydraulic lubricating lines; fabrics
4. CELLULOSICS - Cellophane, Cellulose Acetate, Rayon Cellulose Acetate Butyrate Cellulose Acetate Propionate	Strong; rough use; scratch resistant; good electric insulator; full range of colors; tasteless, non-toxic	Toys; lamp shades; tool handles; fish lures; ping-pong balls; eyeglass frames; fabrics
5. FLUOROCARBONS - TFE Teflon, (FEP) Teflon, Kel-F, Halon, Fluoride	Chemical resistance; high thermal stability; good dielectric; non-adhesive; low friction	Gaskets; seals; bearings; electronic components; coatings for fabric and metal; sheets; rods and tubing
6. POLYETHYLENE - Martex, Epon, Microthene	Impervious to water; lighter than water; tough; pliable; chemical resistant; dielectric; high frequency insulator	Moisture barrier, protective cover, gaskets, insulating parts, packaging, chemical pipe, high frequency insulators
7. POLYPROPYLENE - Escon, Pro-fax	Light plastic with low specific gravity; strong; good shock resistance; smooth surface; scratch resistance; resistant to acids, bases, and water; flexible; good tensile strength	Electric coffee pots; kitchen utensils; chairs; packaging fiber cloth; clothes; shoes; blankets; luggage; cameras; film
8. POLYSTYRENE - Orienated Styrene	Conventional; exceptional low temperature properties; transparent; brittle	Low temperature electrical parts; refrigerator linings; insulators; lighting panels
9. VINYL - Saran film, Plastisol, (PVC) Polyvinyl Chloride, Poly Vinyl Alcohol	Wear resistant; easy to form; printable; flexes without cracking	Splash aprons; gaskets; seat covers; chemical-beverage and laboratory piping; floor covering

For cost factor on above, see January 1963 issue of Modern Plastics.

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IDENTIFICATION TESTS

Plastic Name	Floatability in Water	Burns	Heating & Burning . color flame . odor	Spot Test & Solubility Acetone	Ethanol	Tearing - Bending Film Sheet	Bending Test	Plastic Name
A.B.S.	sinks	yes, slow	orange odorless (almost)	* S	I		flexible and holds part of curl	A.B.S.
ACRYLICS	sinks	yes, slow	yellow fruity smell	S	I	touch, hard to scratch	usually snaps back to orig. position	ACRYLICS
AMIDES	sinks	yes	blue burned wool	I	I	stiff and very strong	hard to curl	AMIDES
CELLULOSICS ACETATE	sinks	yes, slow	bluish acetic acid (vinegar)	S	SL	tears easily	bends, holds most of the curl	CELLULOSICS ACETATE
ACETATE BUTYRATE		slow	rancid butter				hard to bend	ACETATE BUTYRATE
NITRATE		rapid	camphor-like					NITRATE
EPOXY	sinks	yes, slow	orange to black sweet	I	I			EPOXY
FLUOROCARBONS	sinks	no	chars odorless	I	I	waxy, hard to tear	hard to bend	FLUOROCARBONS
MELAMINE	sinks	no	chars urea, ammonia & formaldehyde	I	I	tough, hard to scratch	will not bend or crack	MELAMINE
PHENOLICS	sinks	no	chars carbolic when filed	S	S	tough	will not bend	PHENOLICS
POLYESTER	sinks floats in hypo	no	amber fluid pleasant acid	I	I	tough	will not bend	POLYESTER
POLYETHYLENE	floats	yes, slow	clear to yellow waxy	I	I	tough, stretches feels waxy but is solid	will hold part of curl	POLYETHYLENE
POLYPROPYLENE	floats	yes	clear to yellow celluloid	I	I	hard to tear	curls and springs back to orig.	POLYPROPYLENE
POLYSTYRENE	sinks	yes, slow	orange flame marigolds	S	I	stretches before tearing	holds curl but cracks	POLYSTYRENE
POLYURETHANE	sinks	yes, fast	orange paper			hard to tear	will not bend	POLYURETHANE
SILICONE	sinks	no	odorless feels waxy	SL	SL	flexible and stretches		SILICONE
UREA	sinks	yes, v. slow		SL	SL			UREA
VINYL	sinks	yes	orange (copper rod) pungent-chlorine	SL	SL	strethces and tears ragged	easy to curl, springs back	VINYL

*CODE S - Soluble
SL - Slightly soluble
I - Insoluble

Identification References
Lionel Plastics Engineering Manual
Fire Hazards of the Plastics Industry, National Board of Fire Under.

UNIT II

MOLDING AND FORMING

Lesson		Page
4	Injection molding (related)	14
5	Injection molding - thermoplastics (demonstration)	18
6	Extrusion (related)	21
7	Principle of extrusion (demonstration)	24
8	Blow molding (related)	27
9	Blow molding (demonstration)	30
10	Compression molding (related)	33
11	Compression molding (demonstration)	38
12	Transfer molding (related)	41
13	Thermoforming (related)	45
14	Thermoforming (demonstration)	49

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UNIT II MOLDING AND FORMING

Lesson 4

Related Lesson: Injection molding

OBJECTIVES:

. To acquaint students with an industrial method of molding thermoplastics

. To show major types of equipment used in injection molding

REFERENCES:

1.	*Bernhardt, Ernest (*Suplementary Bibliography)	Processing of Thermo-Plastics Materials	
2.	Dearle, Denis A.	Opportunities in Plastic Careers	pp. 53, 99, 101-103
3.	Lewis, Alfred	The New World of Plastics	pp. 70-74
4.	Society of Plastics Industry	Plastics: The Story of an Industry	pp. 5-33
5.	SPI	Plastics Engineering Handbook	pp. 45, 52, 54

FOR DISCUSSION:

. The injection molding machine and its uses
. Employment opportunities and educational qualirications for employment in injection molding
. Injection molding thermoplastics in a closed mold

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Investigate an occupation in the plastics industry.
. Use the injection molder to mold an article.
. Explore the history of the injection molder or of one of the materials used.
. Experiment with mold-making using various types of materials for injection molding.

Injection Molding
courtesy of The Society of the Plastics Industry, Inc.

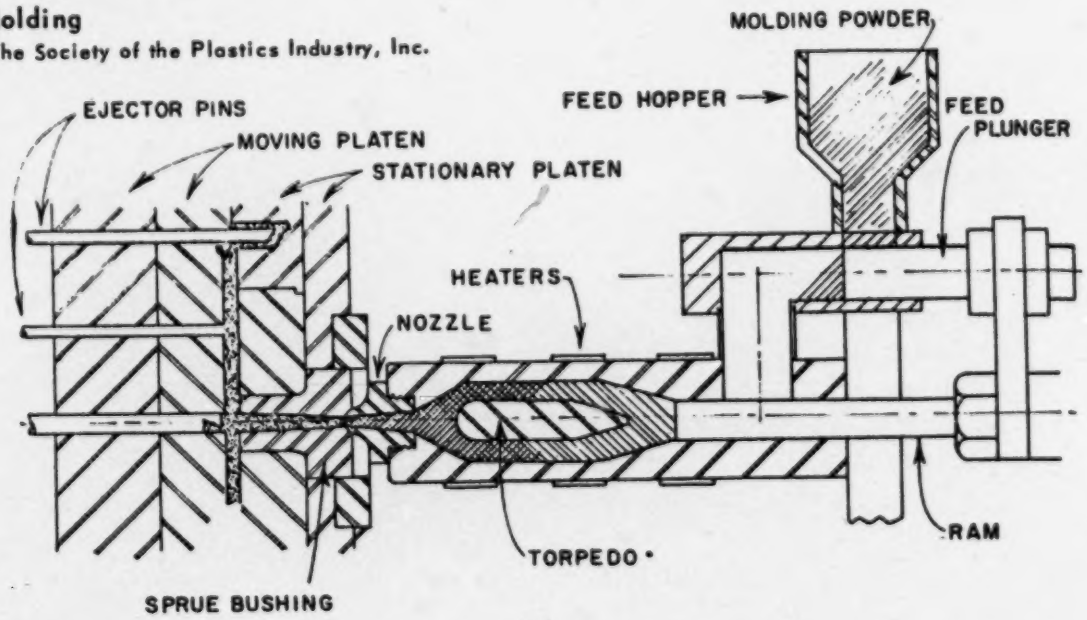

BRIEF DESCRIPTION OF THE PROCESS:

Injection molding is accomplished by forcing or squeezing a semi-fluid or plasticized thermoplastic into a mold cavity where it cools to form an article.

MATERIALS, EQUIPMENT AND TEACHING AIDS:

. Injection mold
. Samples of injection molded articles
  - Model airplane - family mold
  - Plastic bottle caps, polyethylene dish pans
. Pellets used in injection molding
. Chart showing section drawing of injection molder
. Chart showing historical development of plastics Ref No. 5 Page 5

LESSON OUTLINE:

I. Historical Development

A. Stuffing machine - 1872, forerunner of the injection molding machine, J. W. Hyatt
  - Heating cylinder-vertical-steam heat
  - Discharge nozzle
  - Hydraulic plunger
  - Used first as an extruder
  - Material used was cellulose nitrate
  - Mold was closed by hydraulics

B. Injection molding, 1919, adapted from die casting machine - Dr. A. Eichengrun
  - Closing mechanism taken from diecast machine
  - Clamping for various thicknesses of molds
  - Used geared mold closing
  - Spring return on plunger
  - Material used was cellulose acetate

C. Injection Molding, 1935 to present
Parallel development of machines and materials; machines modified to meet needs. Ref #5, Page 5
  - Cellulosics 1869
  - Vinyls 1919
  - Polyethylene 1930
  - Polystyrene 1938
  - Nylons 1938, as Filaments; after World War II as a molding plastic

II. The Injection Molding Machine

A. Basic machines contain
  - Mold clamping device which has
    a. A supporting frame to hold mold in place
    b. A clamping device which moves one platen, the other remaining stationary
      . Hydraulically operated
      . Mechanically operated
      . Hydraulic and mechanical
    c. Part removed by air or knockout pins

- Injection unit which has
  a. A supporting frame or base
  b. A feeding device - hopper which feeds by gravity; auxiliary equipment may be added to facilitate drying of the pellets
  c. An injection head which has either
     . A plunger or ram, to force material forward
     . A screw feed
     . A combination of screwfeed and ram called piggy-back
  d. An electrically heated cylinder
  e. A torpedo, for heat conduction
  f. A nozzle - restriction at end of cylinder to increase velocity
     . Single nozzle
     . Multiple nozzle injecting directly into cavity
     . Nozzle torpedo design sometimes varying with type of material used

B. Mold Considerations
- Mold affects quality of article
- Can cause defects in product
- Can increase or decrease production rate
- Molds can be made by casting of epoxies or machining of metal
- Have sprue, gates, and runners to transmit material
- Ejection of articles by pins, air pressure, or stripper plates
- Vents to allow trapped air to escape
- Multiple molding of pieces
  a. Family mold
  b. Multiple cavity mold
- Guide pins for alignment of mold parts
- Cooling of mold-cores or channels for water

III. Industrial Considerations

A. Economics of injection molding
- Short molding cycle
- Low labor costs
- High overhead cost
  . Equipment, from $295 for a 1/5 ounce capacity, to $280,000 for a 200 ounce capacity machine
  . Molds, several thousand dollars each
- Articles of complex design
  Produced more easily by injection molding than other methods
- Long runs necessary to pay for molds
- Low material cost in relation to sheet stock

B. Pressure
- Cylinder pressure from 10,000 to 20,000 psi (25 percent to 75 percent transferred to mold)
- Clamping pressure; mold must be held together or flashing will occur

C. Temperature
- Cylinder temperature higher than material measured with thermocouples
- The material temperature is determined by cylinder temperature and friction. Overheating can cause defects
- Mold temperature is controlled by water or air-cooling

IV. The Industry

A. Started on a large scale in 1930 because material development warranted it
B. Injection molding now the principle method of molding plastics (approximately 60 percent of the production of plastic resins are used for injection molding) Ref. No. 1
C. The average injection molding factory is worth $525,000. See Ref. No. 1

V. Guidance

A. Two types of injection molding establishments
- Custom molders
- Proprietary molders

B. Thousands of employees
- Press operators
- Granulators
- Set-up men and millwrights
- Plumbers
- Engineers

SUMMARY:

The injection molding process is the method by which many plastic articles may be produced. It can produce articles smaller than a golf tee or larger than a garbage can. It uses a variety of thermoplastics. The molding machine itself consists of a feed system, ram or injection section, heating section, and a clamping system which holds the mold.

QUESTIONS:

Q: What is meant by cycle time in injection molding?
Q: Name two plastics that may be injection molded.
Q: What function does the torpedo perform in the injection molder?
Q: Why is the process of injection molding used to produce many plastic articles?
Q: What are the channels called that carry material from the nozzle to the cavity?

UNIT II MOLDING AND FORMING

Lesson 5

Demonstration: Injection molding thermoplastics

OBJECTIVES:

. To acquaint the student with the injection molder

. To relate the safety factors involved in using the injection molder

. To further the students' knowledge of the injection molding process as used in industry

REFERENCES:

1. SPI	Plastics Engineering Handbook	p. 46
2. Redfarn and Bedford	Experimental Plastics	p. 77

FOR DISCUSSION:

. Dry coloring techniques
. Socio-economics and consumer values of injection molded articles

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Make a simple mold to be used on the injection molder.
. Injection mold an object with this mold.
. Evaluate the product from a design standpoint, surface quality, defects due to mold design.
. Run a cost analysis of the mold, time involved, product, and material.
. Experiment with color mixing and color blending.

BRIEF DESCRIPTION OF PROCESS:

In injection molding, a semi-fluid thermoplastic is injected under pressure into a mold where it cools to form an article.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Injection molding machine
. A mold
. Thermoplastic pellets
  - Polyethylene (easiest to use, good molding qualities)
  - Polypropylene (when a stiffer plastic is required)
  - Polystyrene
  - Nylon
  - Others
. Mold releases (silicon spray or wax)
. Information sheet giving terminology of machine in use, melting temperatures of various materials, and procedure for molding an article
. Chart. "Plastics Properties Chart, Modern Plastics Encyclopedia Issue" (A wall chart supplement to Modern Plastics Encyclopedia)
. Injection molded articles
  - Golf tees
  - Bottle caps

LESSON OUTLINE:

I. Terminology

A. Injection unit
- Hopper - material storage and feeding
- Cylinder - (material heating) pressure and heat applied here
- Ram - applies pressure to material
- Nozzle - reduces size of cylinder to increase velocity of material; feeds material into mold
- Source of feed pressure - lever, hydraulic, or air is used

B. Mold clamp or holding device
- Off center or eccentric - most lab machines
- Hydraulic has great holding power
- Platens - 2 aligned surfaces which hold mold together

C. Temperature - approximately 200 to 600 degrees F
- Electrically heated by heat bands around cylinder
- Thermometer - usually thermocouple type; gives cylinder temperature
- Mold temperature - usually room temperature or cooler

II. Process of Molding

A. Preparing plastics material for injection molding
- Bring temperature of cylinder to approximate melting point of desired plastic. (See "Modern Plastics Encyclopedia" Thermoplastics Chart)
- Load pellets into hopper. Note - store pellets in dry, clean place, and, for safety, keep pellets off the floor.
- Ram some pellets into cylinder
- Let plastic soak (heat through). Safety note - DO NOT TOUCH PLASTIC OR NOZZLE.
  a. Semi-fluid as it leaves nozzle
  b. Purge nozzle once or twice to change color; use temperature of material you wanted to remove
- Keep mold cool until material is injected

B. Making the shot
- Place mold against stationary platen
- Adjust clamping device to hold mold together
- Inject material into mold
  a. Pressure at nozzle is approximately 10,000 to 15,000 psi
  b. Stop pressure when resistance is met on hand-operated machine
  c. Stop pressure when plunger stops on air-operated machine
  d. Maintain pressure to allow material to cool under pressure (approx. 5 sec.)
- Release injection pressure
- Release mold pressure and remove mold. (Use caution. Material and nozzle are HOT.)
- Carefully remove object from mold when it is set. (Wear gloves.)

- Inspect for four defects:
  a. Sinking - Material flows away from mold surface; not enough initial pressure; material too hot; pressure not held
  b. Over packing - too much injection pressure; object loses shape when removed
  c. Short shot - too little pressure; material not fluid enough to fill mold; plugged nozzle
  d. Flashing - too much pressure; too little clamp pressure; too hot; ridge forms along parting line of object

C. Finishing
- Remove sprue and runners (diagonal cutters work well)
- Carefully touch rough surface to a soldering iron to smooth

D. Using different colors and materials
- Some machines have removable cylinders and nozzles
- Other machines must be purged (material removed); feed new material in after old is squeezed out at temperature of previous material
- Sprues, runners, and gates may be granulated or reground for reuse

SUMMARY:

Time, heat, and pressure are the three important variable factors in injection molding. There must be a balance of heat, pressure, and time. Various colors and types of materials can be molded by injection molding.

QUESTIONS:

Q: What are some of the causes for flashing on an injection molded product?
Q: How are color or material changes made on an injection molder?
Q: How does the temperature of the cylinder compare to the temperature of the material to be molded in injection molding?
Q: Which material is easiest to mold by injection molding?
Q: Name the three important variables in commercial injection molding.

UNIT II MOLDING AND FORMING

Lesson 6

Related Lesson: Extrusion

OBJECTIVES:

- To convey an understanding of the industrial method of molding plastic called "extrusion"
- To develop an insight into the industrial and consumer applications of extrusions

REFERENCES:

1. *Bernhardt, Ernest C.	Processing of Thermoplastic Materials	Chap. 5
2. *Eastman Chemical Products Inc.	Extrusion	pp. 1-30
3. Edwards, Lauton	Industrial Arts Plastics	pp. 32-33
4. *Griff, Allen L. (Reinhold Pub. Co.)	Plastics Extrusion Technology	pp. 1-288
5. Simonds and Church	Concise Guide to Plastics 2nd Ed.	pp. 165-170
6. SPI	Plastics: The Story of an Industry	pp. 34

FOR DISCUSSION:

- Types of dies used
- Materials adaptable to extrusion
- Industrial and consumer applications of extrusion
- Auxiliary extrusion equipment

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Compare extrusion with injection molding techniques.
- Examine commercial products made by extrusion.
- Build or devise a unit so extrusion may be done on an injection molder.

Extrusion Molding
courtesy of The Society of the Plastics Industry, Inc.

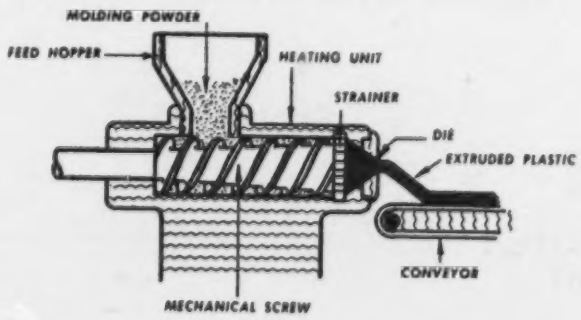

BRIEF DESCRIPTION OF THE PROCESS:

Extrusion molding is a process in which thermoplastic materials are formed into continuous sheeting, tubes, profile shapes, rods, film, filaments, or coatings for wire, cable, and cord. Hot plastic material is continuously forced through a steel die by a revolving screw to form these shapes.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Wall diagram of extrusion process
. Samples of extruded products
. Samples of raw materials used for extrusion

LESSON OUTLINE:

I. Applications

A. Rods (lawn furniture frames)
B. Tubing (fluid lines, electrical plug insulators, hose)
C. Sheeting (for vacuum forming, etc.)
D. Blow molding (parison)
E. Coating (wire, cable, cord)
F. Profile shapes (screw driver handles, jewelry)
G. Film (food coverings, seat cover materials, etc.)
H. Polyethylene (parison, the hollow plastic tube from which containers, toys, etc., are blow molded)

II. Materials used for extrusion

A. Styrenes (lawn, patio furniture frames)
B. Vinyls (trim moldings, wire coverings)
C. Nylons (tubes, rods)

III. Principle of extrusion

A. Outgrowth of injection molding
B. Types of extrusion
- Wet extrusion (plunger method, outdated)
- Dry extrusion (screw compacting method)

IV. Industrial equipment

A. Hopper (used to convey materials to cylinder; auxiliary equipment may be added to facilitate drying of the pellets)

B. Heating chamber
- Circulating oil
- Electric heaters

C. Heated screw (special screw for each type of material)

D. Forming dies
- Rod
- Sheet
- Tube, parison
- Coating wire

E. Conveyor (cooling)
- Speed control
- Air jet

V. Industrial production and future outlook

A. As of 1963, the largest number of processors to be found in the field of injection molding, about 20 percent do extrusion and calendering

B. Greater tonnage of thermoplastics processed by extrusion than all other methods of forming in the early sixties

C. Continuous operation extrusion is one of least expensive methods used per volume of material produced

D. Recent developments
- High speed extruder
- Blow molding process adopted by many large industries, thus creating greater demand for extrusion

SUMMARY:

Extrusion is one of the forming methods in plastics, and it is a rapidly growing branch of the industry. The four basic steps of extrusion are heating, compacting, forcing molten plastic continuously through a die under controlled temperature and pressure, and cooling. Thermoplastics materials such as polyethylene, styrene, vinyl, and nylon are those most commonly used for extrusion.

QUESTIONS:

Q: Compare injection molded products with extruded products, as to uses, cost, etc.
Q: What thermoplastic materials are best adapted to extrusion?
Q: What function does the screw perform in an extruder?
Q: Compare injection molding techniques with extrusion techniques.

UNIT II MOLDING AND FORMING

Lesson 7

Demonstration: Principle of extrusion

OBJECTIVE:

. To demonstrate the principles of continuous extrusion

REFERENCES:

1. *Bernhardt, Ernest C.	Processing of Thermo-Plastic Materials	Chap. 5
2. *Eastman Chemical Products, Inc.	"Extrusion"	pp. 1-30
3. Edwards, Lauton	Industrial Arts Plastics	pp. 32-33
4. *Griff, Allen L.	Plastics Extrusion Technology	pp. 1-288
5. Simonds and Church	Concise Guide to Plastics 2nd. Ed.	pp. 165-170
6. SPI	Plastics - The Story of an Industry	p. 34

FOR DISCUSSION:

. Types of dies used to extrude wire, tubing, and sheeting
. Thermoplastic materials adaptable to the process of extrusion
. Industrial methods (use charts and diagrams if an extruder is not available)

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Cut extruded forms to use in jewelry making area.
. Extrude and shape rods for chair frames, tool handles, molding, etc., if extruder is available.

Wire Coating
courtesy of Modern Plastics Encyclopedia

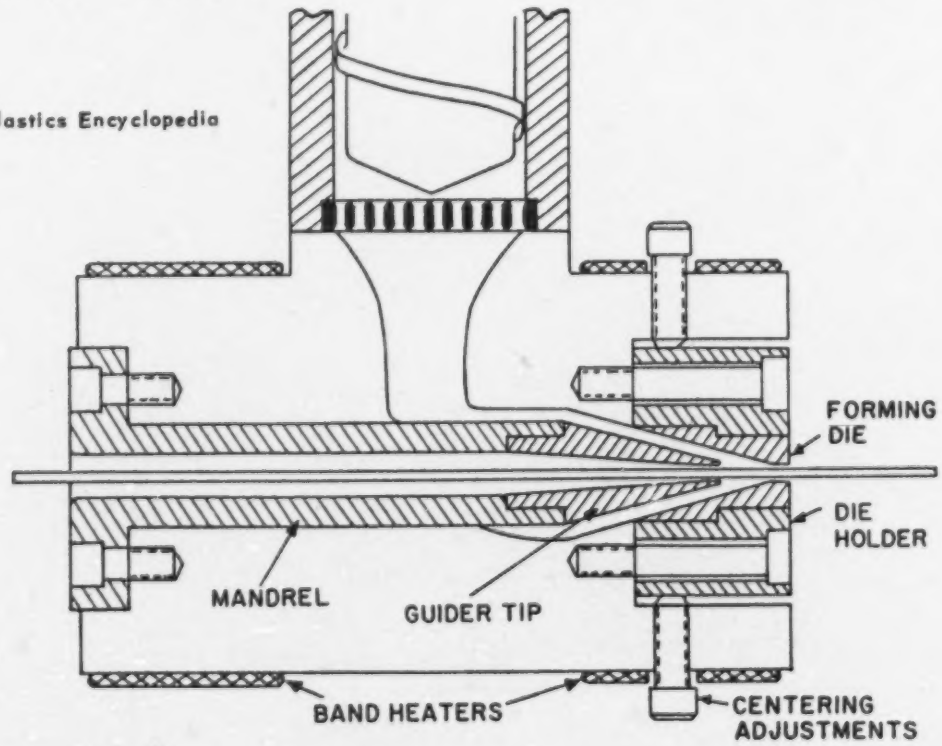

DESCRIPTION OF PROCESS:

Extrusion is a process whereby a thermoplastic material is forced through dies of specific shapes to form tubes, rods, film, and irregular profile shapes.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Extruder
- Cake decorator (in lieu of extruder)
- Tube of Polyseam Seal coating
- Thermoplastic pellets (polyethylene, polystyrene, vinyl)
- Plasticized clay (in lieu of pellets)
- Charts, diagrams
- Assorted dies for extruder
- Uncoated wire

LESSON OUTLINE:

1. Demonstration with commercial or laboratory extruder (if available)

   A. Select die and attach to machine

   B. Charge machine
      - Place dry pellets in hopper
      - Use polyethylene, polystyrene, or vinyl

   C. Heat Cycle
      - Adjust temperature of heating chamber to setting recommended for material

   D. Extrude part
      - Screw action of machine compacts material and forces it out of die
      - Part takes shape of die opening

   E. Cool material
      - Air or water can be used
      - Adjust speed of conveyor to regulate tension and size of product

II. Demonstration with cake decorator or cookie press (if regular extruder is not available)

   A. Prepare material to a flow state suitable to pass through die
      - Plasticized clay; play dough

   B. Attach forming die

   C. Feed into chamber (Compare with loading hopper of extruder)

   D. Apply pressure to plunger; refer to diagram in order to explain action of the screw and effects of heat on the pellets

   E. Extrude a part

   F. Dry product; relate to industrial drying methods; move conveyor device at same speed of extrusion

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III. Wire coating demonstration

A. Remove pouring spout from tube of Polyseam Seal plastic
B. Insert 6 inch length of uncoated wire into tube
C. Pass pouring spout over wire and screw into place
D. Squeeze tube to eject plastic while slowly withdrawing wire
E. Allow plastic coating to dry (approx. 1 hr.); compare with industrial cooling methods
- Conveyor speed
- Air jet

SUMMARY:

The basic principles of extrusion are heating, compacting, forcing molten plastic continuously through a die under controlled temperature and pressure; followed by cooling and conveying extruded material. Wire coating is one of the oldest applications of this process.

QUESTIONS:

Write the letter preceeding each term in the right hand column in the space next to each term in the left hand column which most nearly corresponds to the lettered term.

1. ( ) Hopper	A. Cooling
2. ( ) Take off conveyer	B. Drying
3. ( ) Die	C. Thermoset
4. ( ) Polyethylene	D. Thermoplastic
5. ( ) Heating chamber	E. Forming
6. ( ) Feed screw	F. Compacting
7. ( ) Phenolic	G. Reversal
	H. Plasticize

UNIT II MOLDING AND FORMING

Lesson 8

Related Lesson: Blow molding

OBJECTIVES:

. To explain the industrial process used for blow molding thermoplastic products

. To present the consumer applications of blow molding methods

REFERENCES:

1.	Edwards, Lauton	Industrial Arts Plastics	pp. 31-37
2.	*Jones and Mullen	Blow Molding	
3.	Simonds and Church	Concise Guide to Plastics 2nd Edition	pp. 180-182
4.	SPI	Plastics - The Story of an Industry	p. 33
5.	Swanson, Robert S.	Plastics Technology	
6.	Redfarn and Bedford	Experimental Plastics	p. 87

FOR DISCUSSION:

. Development of glass blowing techniques
. Dies and molds used for extrusion of parison
. Special technology
  - Coating
  - Special finishes
  - Food and Drug Administration regulations

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Compare methods of injection molding and extrusion in production of parison.
. Collect various products and determine what thermoplastic, blow molded products are most commonly used in the home.
. Make a blow mold; blow mold an article.

Schematic Illustration of Blow Molding Principle
courtesy of W. R. Grace & Co.

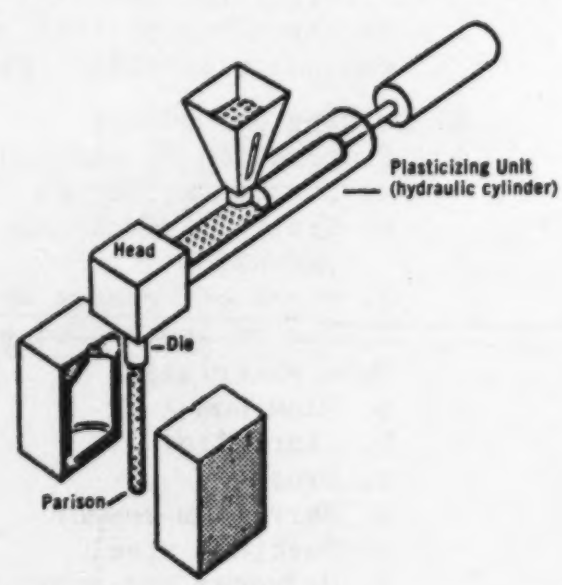

Basic Extrusion/Blowing Principle

BRIEF DESCRIPTION OF PROCESS:

The blow molding process involves the forming of a hollow tube of thermoplastic material, called a parison; by introducing air under pressure into the tube. The heated parison expands and takes the shape of the mold.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Sample products (bottles, containers, etc.)
. Wall chart illustrating parison suspended in mold

LESSON OUTLINE:

I. History

A. Early Egyptians and Babylonians
- Glass blowing

B. Prior to 1958, cellulose acetate
- An art rather than a science
- All equipment manufactured in Europe

C. 1960's, Technological advances
- Mass production methods (parison produced by extrusion)
- Thermoplastic materials
  a. Polyethylene
     - Accounts for 90% of all plastic blow molded products
     - Impervious to solvents
     - Easily molded; fine detail
  b. Polystyrene
  c. Cellulosics
  d. Polypropylene

II. Applications

A. Industrial (gasoline tank liners, glove compartment, containers, and ducts)

B. Home (bottles, lamp bases, and toys)

III. Blow molding process

A. Applications
- Thermoplastic materials (all types can be used)
- Plasticizing material (temperature must be controlled)
- In extruding parison; wall thickness of parison and ratio of expansion determine final thickness of product

B. Molding procedures
- Preparation of parison
  a. Extrusion; may be extruded directly into mold
  b. Gravity effect; the longer the parison the slower the rate of extrusion
  c. Pinch off occurs when mold closes on parison
  d. Use of stock tubing; (heated in an oven)
- Mold materials
  a. Aluminum
  b. Zinc alloy
  c. Brass
  d. Beryllium-copper
  e. Machined steel
  f. Hydrocal and epoxy for short runs

- Blowing method (air injection)
- Cooling (water zoned method)

IV. Industrial Considerations:

Advances in the blow molding process have resulted from refinement of existing techniques. Consolidation of other fabrication methods such as extrusion has caused the growth of blow molding production to rival the growth of the injection molding process since the late 1940s.

Blow molding is used to produce many products formerly produced by the vacuum forming method. The "no seam" construction, derived from the blow molding process, adds strength to the finished product.

V. Consumer Considerations:

Many articles formerly packaged in glass containers are now packaged in plastic containers. The blow molded containers may be reused for mixing and storing solutions, as buoys, etc. Certain solvents, however, will readily permeate the thermoplastic material, rendering the containers unsuitable for reuse.

SUMMARY:

Bottles, containers, etc. may be blow molded by introducing air into the center of a hot extruded tube or parison, causing it to expand and take the shape of the mold. Polyethylene resin accounts for 90 percent of the volume of material used in this rapidly growing area of the plastics industry.

QUESTIONS:

Q: What method is used to form the parison for blow molding?
Q: How is the thickness of a blow molded product controlled?
Q: Blow molding is a refinement of what ancient art?
Q: List several thermoplastic materials used to produce blow molded toys and containers.
Q: How can you identify a blow molded product?

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UNIT II MOLDING AND FORMING

Lesson 9

Demonstration: Blow molding

OBJECTIVES:

. To develop an understanding of the blow molding process

. To demonstrate one method of blow molding

REFERENCES:

1.	Edwards, Lauton	Industrial Arts Plastics	pp. 31, 37
2.	Simonds and Church	Concise Guide to Plastics	
3.	SPI	Plastics Engineering Handbook	p. 87
4.	SPI	Plastics: The Story of an Industry	p. 33
5.	Swanson, Robert	Plastics Technology	ch. 5

FOR DISCUSSION:

. The differences between heated tube blow molding and extruded parison blow molding
. The effects of blow molding on the economy of industry
. The different styles of extrusion machines as they apply to blow molding

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Develop methods and equipment for blow molding on a plunger type injection molding machine.
. Develop a transparent mold which can be used to show the blowing technique.
. Try slip casting molds.

Blow Molding
courtesy of The Society of the Plastics Industry, Inc.

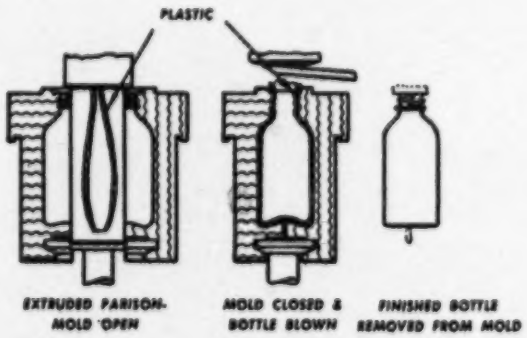

BLOW MOLDING

BRIEF DESCRIPTION OF PROCESS:

In the process of blow molding, a soft plastic tube (or parison) is placed between two female mold halves sealing one end, and air pressure is injected into the other end, blowing the soft plastic into the shape of the mold.

In this demonstration, a stock plastic tube is heated and placed between two mold halves and inflated. It can be called the "heated tube" method.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Stock plastic tubing, such as butyrate, polyethylene, vinyl, etc.
- Compressed air source
- Pair of female molds with aligning pins
- Clamping or holding device for molds
- Heater or oven, controllable to at least 450°F, for heating the plastic tube

LESSON OUTLINE:

I. Select and prepare the mold

A. Mold materials. A mold may be made from any material which will provide a suitable molding surface and will hold its shape under low heat and pressure. It should not break from clamping fixture strain. Four materials are most commonly used:
- Plaster or gypsum cement
- Wood
- Metal
- Reinforced plastics

B. Mold construction. Molds may be made similar to those used for ceramics slip casting or similar to the mold halves used for vacuum cavity forming. A wood flask or frame surrounding the plaster or gypsum cement will add strength and prevent chipping the edges. Hardware, such as that used on a suitcase, may be attached to facilitate rapid closing. Review the mold making lesson.

II. Prepare the materials

A. Preheat heating device

B. Cut plastic tubing to length

C. Air supply
- Build up air pressure
- Attach air hoses
- Attach air regulator and set to zero
- Attach air line adapter to plastic tube

D. Lay mold halves out face up next to each other

E. Adjust clamping devices to mold thickness

III. Procedure for molding

A. Heat plastic tube in oven or heater, rotating it as it is heated. (See manufacturer's specs. for proper temperature.)
B. Remove from oven or heater
C. Attach air hose to air adapter
D. Place heated tube over one mold half
E. Close mold and clamp securely
F. Adjust air regulator until plastic fills the mold; use as low a pressure as possible
G. Allow plastic to cool
H. Open the mold and remove blow molded part
I. Trim off flash and neck

IV. Alternate method (sheet plastic)

A. Construct molds as before
B. Cut two sheets of plastic to proper size (Develop a template pattern)
C. Heat plastic in oven
D. Place both sheets over one half of the mold
E. Insert a blowing tube between plastic sheets
F. Close and clamp mold
G. Blow the part
H. Cool, remove, and trim

SUMMARY:

Blow molded plastic products can be made by this method from simple, matched, gypsum cement molds. Caution should be exercised in aligning and clamping the molds to prevent misaligned parts.

QUESTIONS:

Q: How does the heated tube method of blow molding differ from extrusion blow molding?
Q: What is a simple alternate method to the heated tube blow molding method?
Q: Name several materials which can be used for mold making in heated tube blow molding.

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UNIT II MOLDING AND FORMING

Lesson 10

Related Lesson: Compression molding

OBJECTIVES:

- To develop a knowledge of the history and importance of compression molding
- To develop an understanding of the materials used in this process
- To acquaint the students with the products and occupational opportunities pertaining to this phase of the plastic industry

REFERENCES:

1.	Cope, Dwight	Cope's Plastics Book	pp. 25-26
2.	Dearle, Denis A.	Opportunities in Plastic Careers	pp. 56-57
3.	SPI	Plastic Engineering Handbook 3rd Edition	pp. 3-21
4.	SPI	Compression and Transfer Molding	pp. 1-15
5.	Vaill, E. W.	"Compression and Transfer Molding" Plastics Encyclopedia, Vol. 39 #1A	pp. 721-23
6.	Winding, Chas. Hiatt, Gordon	Polymeric Materials	pp. 115-16

FOR DISCUSSION:

- Compression molding's place in the total plastics industry
- Variables encountered in the process
- Compounds best suited for compression molding
- Consideration of machines and equipment, types, sizes, etc.

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Compare volume of materials used with that of other processes.
- Compare compression process with injection molding; note difference. Look up other job possibilities (other than those mentioned).

Compression Molding
courtesy of The Society of the Plastics Industry, Inc.

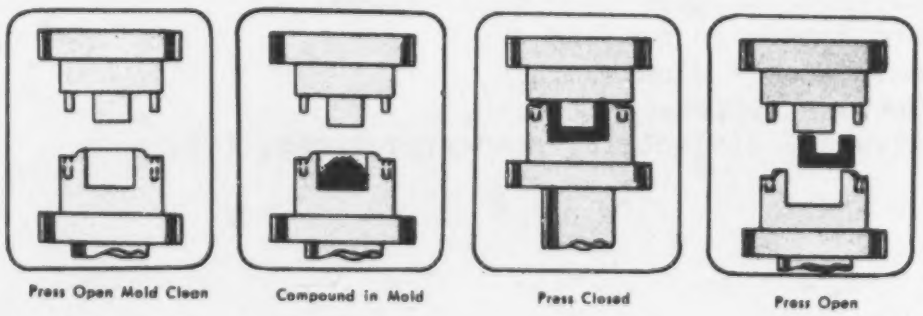

BRIEF DESCRIPTION OF PROCESS: (Ref. #5)

Compression molding is a technique of thermoset molding in which the molding compound (generally preheated) is placed in the mold cavity, the mold is closed, and heat and pressure are applied until the material has cured.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Simple mold drawing
. Chart showing halves of four molds and label
. Examples of products made by compression molding (distributor cap, dishes, electrical components)

LESSON OUTLINE:

I. History (Ref. #3)

A. The compression molding process was used for rubber molding by Thomas Hancock in the early 19th century

B. First patent on process issued to John and Isaiah Hyatt in the 1890's

C. Bakelite developed by Leo F. Baekeland
- Discovery of phenol-formaldehyde in 1908
- Need for further development

II. Material Properties

A. Thermosetting materials
- Heat of 300 degrees F (plus or minus 20 degrees) needed for curing
- Formaldehyde gas and water vapor given off

B. Size of product limited by size and tonnage of press (12 to 2000 tons)

C. Final product, a hard, heat-resistant material
- Chemical change takes place
- Cannot be replasticized by heat

D. Important variables
- Temperature of mold, material
- Pressure range
- Curing time (2-45 minutes)

III. Compounds: Resins and other materials (Ref. #2 and #3)

A. Resins
- Enough for flow and cementing (50%)
- Bulk factors (Determine by the ratio of the volume of the raw material to the volume of the cured material)
- Phenol-formaldehyde used first (1908)
- Others common to process
  a. Melamines - dinnerware
  b. Ureas - buttons
  c. Alkyds - dielectric, connector knobs, T.V.

B. Other materials
- Fillers
  a. Increase bulk, reduce cost, add heat resistance
  b. Types: wood flower, cut canvas, asbestos, shirt stock, glass fiber, thread, etc.
- Plasticizers
  a. Increase flow
  b. Change character of finished article
- Pigments add color
- Lubricants give release and flow qualities

C. Conditions of compound
- Granular or powdered
- Preforms (Measured amount of material compressed into a form on a separate machine)
- Preheated preforms (before compressing)
  a. Shortens cycle
  b. Larger articles; less pressure

IV. Presses (Ref. #2)

A. Types
- Vertical
  a. Automatic, semi-automatic, or hand
  b. Platen moves up or down on compression stroke
  c. Usually controlled electrically
- Rotary
  a. Automatic or semi-automatic
  b. Rotary movement of main parts

B. Power
- Pressure usually hydraulic - water or oil
- Heating - electrical or steam
- Controlled electrically

V. Molds (Ref. #5)

A. Material - high grade steel, for polishing and hardening

B. Types of molds
- Flash mold (widely used)
  a. Relief around cavity; lower and upper part
  b. Easy to open
  c. Easy to measure charges
  d. Lighter weight
  e. Less uniform pressure on material
  f. Needs low bulk-factor material
  g. Needs longer cure time
- Positive mold
  a. Uniform pressure on material, uniform product
  b. Uniform color of product
  c. Higher bulk-factor material can be used
  d. Shorter cure time required
  e. Requires more daylight
  f. Harder to open
  g. Heavier
  h. More accurately sized charges necessary

- Relief positive mold (landed mold)
  a. A positive mold which has been relieved to allow excess material to escape without loss in uniform pressure on material
  b. All advantages of positive mold
  c. Charges need not be weighed accurately
- Semi-positive mold (landed mold)
  a. A cross between the flash mold and positive mold
  b. Has the advantages of a positive mold except
     . Uses lower bulk-factor material
     . Uses higher flow number material
  c. Has advantages of flash mold except
     . More costly to make
     . Harder to open

C. Design considerations
- Freedom from undercut or reverse draft
- Sufficient draft on side walls
- Proper parting line
- Types of machine to be used on
- Stripper plates or ejection pins
- Temperature and pressure used in molding
- Provision to vent trapped air

VI. Consumer economic considerations

A. Compression molding about 15 percent of total plastics industry

B. Products
- Pot and pan handles - heat
- Electric iron handles - heat
- Distributor caps - electrical
- Dinnerware - durable
- Buttons - colorful, durable

C. List price on materials high
- Raw material cost high
- Production cost high

VII. Industrial considerations

A. Advantages
- Hard, dense product
- Heat resistant product
- High dielectric strength
- Relatively low cost of raw materials

B. Disadvantages
- High cost of molds
- Long cure cycle
- Material waste (cannot be reused as in injection molding of thermoplastics)

VIII. Guidance (Ref. #6)

A. Occupation - press operator
- No experience, training 2-3 weeks
- Physical - none
- Duties - vary with machine

- Working conditions - heat, noise
- Hazards - blowing excess materials; hot machines and materials
- Goggles are usually required

B. Accidents - very few disabling injuries

C. Pay scale, 1963
- Molder - $1.91 - $2.48
- Learner - $1.50 - $1.91
- Set up man - $2.00 - $2.20

SUMMARY:

In compression molding, thermosetting materials are generally used. The temperatures, pressures, and curing times depend largely upon the machinery available and upon the compounds used. The resulting product is hard, dense, and has heat resistant properties which cannot be obtained by other plastic molding methods.

QUESTIONS:

Q: What kinds of materials are used in compression molding?
Q: Why are filler materials used in the compound?
Q: What are compression molds made of?
Q: What are preforms, and why are they used?

Various Types of Compression Molds
From Polymeric Materials by Winding & Hiatt. Copyright 1961. McGraw-Hill Book Company. Used by permission.

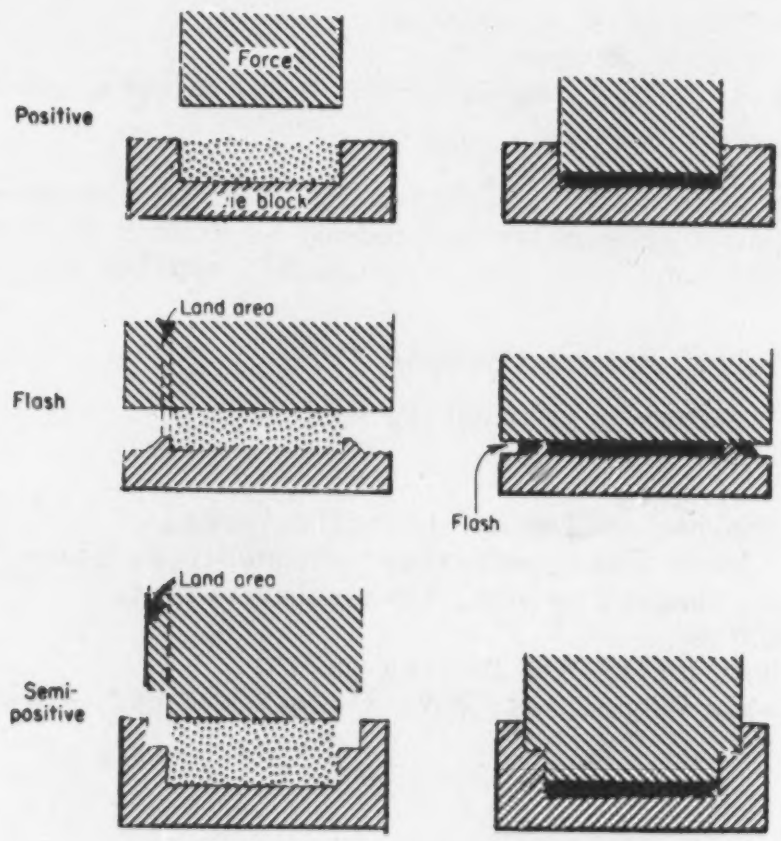

UNIT II MOLDING AND FORMING

Lesson 11

Demonstration: Compression molding

OBJECTIVES:

. To show the student the compression molding process
. To acquaint him with the machine and equipment used
. To develop further understanding of the materials used for compression molding

REFERENCES:

1. *Carver, Fred	Carver Press Booklet	All
2. SPI	Plastic Engineering Handbook	pp. 11-16
3. SPI	Plastics: The Story of an Industry	pp. 14-22
4. Phillips Chemical	Glossary of Plastics Terms	p. 7
5. *Winding, C. Charles	Polymerc Materials	

FOR DISCUSSION:

. Semi-automatic and automatic machines, and molds for these machines

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Mold a set of checkers or coasters.
. Fabricate a window scraper.
. Test materials, mold using different temperatures, pressures, and times.

BRIEF DESCRIPTION OF PROCESS: (Ref 2)

Compression molding is a technique of forming thermosetting materials. The molding compound (generally preheated) is placed in the mold cavity; the mold is closed, and heat and pressure are applied until the material has cured.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Compression molding or laminating machine
. Mold for desired article
. Materials
  a. Plastic resins: melamine, phenolic, urea
  b. Fillers: wood flour, asbestos, chopped rag, glass fibers, etc.
  c. Pigments: tempera colors, commercial colors
. Gloves, asbestos
. Spoon or other device for loading mold
. Chart: Plastic Properties, Part II, (thermoset), Modern Plastics Encyclopedia

LESSON OUTLINE:

I. Using a press for hand molds 10 to 30 tons (Ref 1)

A. Platens - Plates that squeeze mold halves together (horizontal member)
- Size varies with press
- Heating plates fastened to platens
- Bottom platens usually movable; top may be also

B. Ram - Transmits pressure from hydraulic mechanism (jack) to platens (Ref 2)
- Vertical movement
- Pressure is applied to either upper or lower plates (usually the lower plate)

C. Columns (Vertical Structural Members)
- Adjust for daylight between platens
- Platens to be in parallel alignment

II. Mold (See related lesson.)

A. Flash
B. Positive
C. Relief Positive
D. Semi-Positive

III. Materials

A. Resin
- Types - phenolic, urea, melamine
- Temperature range 275° to 350°
- Comprises 50% of total compound

B. Filler
- Types - glass fibers, wood flour, (from disc sander), asbestos, chopped rag
- Comprises about 45% of compound

C. Pigments about 5% - tempera color, etc.

IV. Preparation of compound

A. Measure and mix components
B. Prepare charge; measure correct amount

V. Molding operation

A. Preheat press platens to 300° F
B. Place mold on lower platen with upper mold or plunger removed
C. Allow molds to preheat
D. Place prepared charge in cavity
E. Place upper mold force in position and close press slowly, allowing gases to escape
F. Press pressure is determined by multiplying surface area in square inches by the proper compression molding pressure factor. This factor is given in pounds per square inch (psi) in the Modern Plastics - Plastics Properties Chart
G. Release molding pressure; remove mold; remove object from mold

VI. Finishing:

A. Remove flash by sanding, tumbling, or grinding, or break off by hand
B. Buff or polish if necessary

VII. Safety:

A. Wear gloves when near heated areas
B. Wear goggles during the compression holding cycle

SUMMARY:

A variety of articles can be produced by compression molding with a simple hand mold, a common thermosetting plastic material, and the proper application of heat and pressure. The machines and materials used in industry may vary considerably from the ones used in this demonstration, but the basic process of compression molding is the same. An industrial laboratory press works well.

QUESTIONS:

Q: What function do the platens serve on a compression molding press?
Q: What mechanical features are found on an automatic compression molding press which are not found on hand presses?
Q: Why are filler materials added to the resin for compression molding?
Q: What is the curing temperature range of most of the materials used for compression molding?

UNIT II MOLDING AND FORMING

Lesson 12

Related Lesson: Transfer molding

OBJECTIVES:

- To develop in the student an understanding of the transfer molding process
- To acquaint the student with the materials and equipment used in transfer molding
- To give the students an understanding of the relationship of transfer molding to compression and injection molding

REFERENCES:

1. *Gerbracht, and Robinson	Understanding America's Industries	p. 138
2. *Winding and Hiatt	Polymeric Materials	p. 119
3. Simonds and Church	Concise Guide to Plastics	pp. 117-172
4. SPI	Plastics Engineering Handbook	Chap. 4 p. 8

FOR DISCUSSION:

- Process description (no demonstration)
- Comparison with compression and injection molding
- Encapsulating process

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Show advantages of transfer molding over compression molding.
- List some common household products made by this process.
- Make a simple mold for use in a compression press.

Transfer or Plunger Molding
courtesy of The Society of the Plastics Industry, Inc.

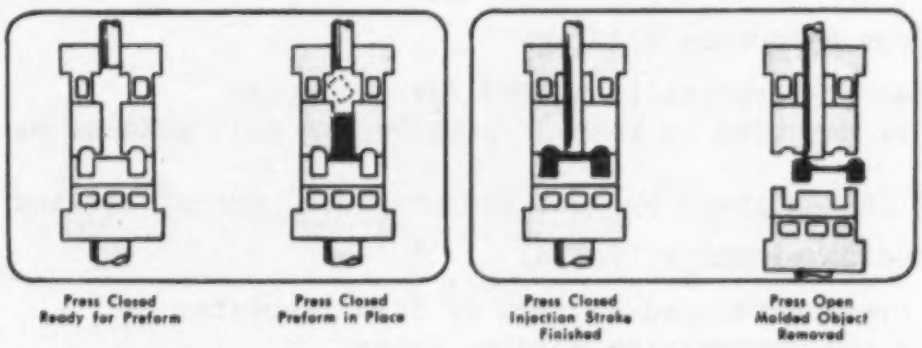

BRIEF DESCRIPTION OF PROCESS (Ref 2):

Transfer molding is a process whereby a dry, solid molding compound (thermoset) is heated in a separate chamber to the point of plasticity, and then forced (transferred) under pressure into a heated, closed mold, by means of an hydraulically operated plunger. (See third objective of this lesson.)

MATERIALS, EQUIPMENT, AND TEACHING AIDS:

. Blackboard drawing or chart of a pot-type mold and plunger mold
. Samples of products:
  - Distributor cap
  - Flat iron handles
  - Handles for pots and pans
  - Encapsulated electronic devices - Resistors

LESSON OUTLINE:

I. Limitations of compression molding precluded (Ref 4)

  A. Molding of articles with intricate sections
  B. Molding of articles with thin walls
  C. Molding articles with fragile inserts

II. Detailed description of process: (Ref 4)

  A. Types of transfer molding
    - Pot-type (Explain by using equipment)
    - Plunger (chart or board, Ref 1 & 2)

  B. Material in powdered or preformed condition

  C. Preheated (Radio frequency heating) to semiplastic state

  D. Introduced into pot chamber separate from mold cavity

  E. Material forced or transferred through orifice to heated, closed mold

  F. Allowed to cure in mold with heat and pressure

III. Differs from compression molding (Ref 3)

  A. Material is not loaded directly into mold cavity
  B. Material is forced into mold in semiplastic state
  C. Thorough preheating is necessary

IV. Differs from injection molding

  A. Only enough material is heated for one cycle
  B. Sprue is reversed to keep it attached to cull (excess material in pot)
  C. Curing is continued by heat and pressure, not by cooling

V. History and Development (Ref 4)

  A. First press developed in 1926 by Shaw Insulator Co.
    - Single ram compression molding press
    - Mold especially designed for pot-type transfer molding
    - Material was preheated in separate oven

B. Double ram presses
- Main ram attached to lower platen
- Auxiliary rams forced material into cavity (plunger molding)
- Rams could be side mounted

C. Introduction of new preheating methods
- Accelerated during and after World War II
- Steam and high frequency dielectrics used
  a. Speeds of cure increased
  b. Lower pressures for transfer and clamping resulted

D. New Automatic Presses 1956
- Horizontal, using loose powder and inexpensive molds
- Vertical press
  a. 400 ton clamping capacity
  b. Extremely fast
  c. Designed for preheated preforms

VI. Materials

A. Phenol-formaldehyde
  a. Flows easily in molding
  b. Forms dense molded articles
  c. Limited colors - blacks and browns

B. Melamine
  a. Requires some property change for best flow
  b. Good color - full range shades and colors
  c. More difficult to mold than urea and phenolic
  d. Ease in preheating
  e. Higher priced than phenolic; 15% more than urea

C. Epoxies
  a. Newest material used
  b. Ease of being formulated into semi polymerized stage

D. Urea
- Full color range; stable in sunlight
- Double the price of phenolic
- Requires 50 percent higher holding pressures than phenolic

VIII. Pressures for molding (Ref 3)

A. Mechanical pressure on molding material in psi

B. 10 to 15 percent more clamping pressure than transfer pressure, to prevent flashing

C. Pressures vary with design of mold and material used as in the following examples:
- Phenolic material preheated-8000 psi plunger type and 12,000 psi pot-type
- Fabric-filled phenolic materials, 50 percent increase in transfer pressure required

IX. Encapsulating (by transfer molding)

A. General definition of encapsulating - Enclosing an article (usually electronic components) in a closed envelope of plastic

B. Advantages over encapsulating by compression molding:
- Better density of finished product
- Greater mechanical strength
- Less waste due to breakage
- Faster than casting methods

X. Limitations of transfer molding

A. Cost of making molds many times higher than compression molds because of intricate detail

B. Loss of material in cull, gates, and runners; cannot be reused

C. Strength sometimes reduced

D. Temperature critical; must keep materials from total polymerization

SUMMARY:

Transfer molding is becoming very widely used for thermosetting plastic materials because more intricate, thin-walled articles can be made. Many products used in the electrical industry are now being encapsulated by the transfer molding process. With better thermosetting materials being made, the future of transfer molding looks bright.

QUESTIONS:

Q: What types of materials are used in transfer molding?
Q: Transfer molding is related to what two other molding processes?
Q: Why is it necessary to preheat the material for transfer molding
Q: What new material has very recently been successfully used for transfer molding?

UNIT II MOLDING AND FORMING

Lesson 13

Related Lesson: Thermoforming

OBJECTIVES:

- To acquaint the students with the thermoforming process
- To develop an understanding of the industrial uses of thermoforming methods
- To create an awareness of the many practical uses of the thermoforming methods of packaging and fabrication
- To convey to the student the impact thermoforming has had on industrial fabrication

REFERENCES:

1.	Butzko, R. L.	Plastics Sheet Forming	
2.	Cherry, Raymond	General Plastics Revised 1964	Ch. 19
3.	Edwards, Lauton	Industrial Arts Plastics	pp. 37-41
4.	Simonds and Church	Concise Guide to Plastics	pp. 1-12, 182-194
5.	SPI	Plastics Engineering Handbook	pp. 91-117
6.	Swanson, Robert	Plastics Technology	Ch. 8
7.	Vol 39 #1A	Modern Plastics Encyclopedia	pp. 737-39
8.	Wenberg	"Vacuum Forming Unit" School Shop, March 1963	

FOR DISCUSSION:

- The diversification of thermoforming methods
- The common applications of thermoforming methods
- What thermoforming has done to enhance other industries
- New developments in the thermoforming industry

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- List the uses of thermoformed products.
- Compare thermoformed products to similar products molded by other processes, including injection, rotational, and blow molding.
- Have students relate other possible uses for thermoformed products.
- Use various materials to make molds for vacuum forming and compare product quality.

BRIEF DESCRIPTION OF PROCESS:

Thermoforming is a method of forming plastic sheets which utilizes the ability of plastic to be shaped immediately after it has been heated to a plastic state. After the plastic sheet has been formed it is allowed to cool while it is still on the mold, thus retaining the shape of the mold.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Samples of thermoplastic sheets (polystyrene, cellulose acetate, polyvinyl chloride, ABS, cellulose acetate, butyrate, and others)
- Samples of thermoformed products (Bubble pack, free blow, skin package, etc.)
- Wall chart showing the different types of thermoforming
- Examples of different molds (cavity, drape, and stretch)

LESSON OUTLINE:

I. Thermoforming methods and Typical Applications

A. Vacuum cavity forming	Refrigerator door liners
B. Drape vacuum forming	Counter displays
C. Male form forced above the sheet	Deep draw trays
D. Vacuum snap back forming	Hobby horses
E. Plug and ring forming	Skylight domes
F. Air pressure forming	Candy dishes
G. Matched mold forming	Boat Hulls
H. Mechanical stretch	Stiff or thick sheets

II. Scientific principles in thermoforming

A. Vacuum forming. The removal of air from the mold side of the thermoplastic sheet causes atmospheric pressure (14 to 15 psi) to push the heated plastic against the mold. (air pressure differential)

B. Pressure or blow forming. Air pressure (also mechanical pressure, alone or in combination) is applied to the plastic on the side away from the mold to overcome the atmospheric pressure and force the plastic against the mold. (air pressure differential)

C. Heat effect on thermosplastic. Heat absorbed by the thermoplastic causes it to soften because the molecular bond within the plastic loosens (molecules become more active), allowing the plastic to become formable. Cooling the plastic tightens the bond (molecules become less active), making the formed plastic rigid.

III. Application

A. Packaging. Applications range from the vacuum forming of squeeze tubes for caulking compound to boilable bags for frozen foods.

B. Fabrication. The uses range from swimming pools to factory building panels.

IV. Advantages and disadvantages

Manufacturers have frequently found that for short production runs the thermoforming processes are practical. Large items that would be impractical to mold by other methods may be thermoformed. The cost of plastic sheet is high compared to the lower cost of the pellets for injection molding. When the job run is not long enough to pay for the necessary dies used for injection molding, thermoforming processes may be employed.

V. Industrial considerations

A. Appropriate use: Where short run or high mold costs dictate
B. Cost: High sheet cost; low mold cost
C. Change: Products Can be redesigned or revised as needed
D. Equipment: Lower cost fabrication equipment. Cost range for machine, $40 to $5,000 (Many custom built)
E. Personnel: Duration of training period varies with job

VI. Guidance

A. Rapid growth; since 1950, especially in the field of packaging of produce and other products
B. Sales managers - A good future in promotion and sales
C. Tool and die makers - high pay rate
D. Millwrights - high pay rate
E. Machine operators - Low pay rate due to minimal training required
F. Patternmakers - high pay rate

SUMMARY:

Thermoforming as a phase of the plastics industry has experienced a period of rapid growth. The great gains in this area seem to have come in the packaging industry. It has been found that thermoforming may be used economically for fabrication of short runs of unusual shapes.

QUESTIONS:

Q: What is meant by thermoforming?
Q: List the different methods of thermoforming.
Q: Why have the packaging industries turned to skin packing?
Q: Name the chief material used for the thermoforming process.
Q: What three scientific principles are involved in the thermoforming processes?

BASIC TECHNIQUES FOR THERMOFORMING SHEET

1. STRAIGHT VACUUM FORMING

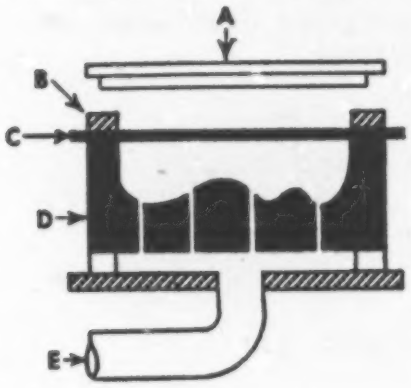

2. DRAPE VACUUM FORMING

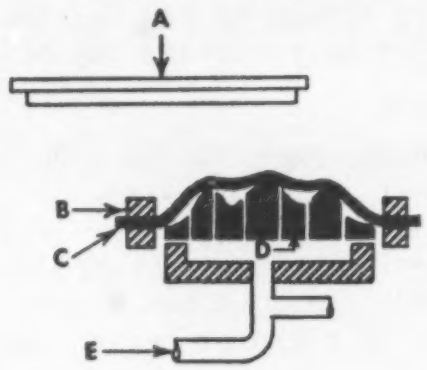

3. FORCE ABOVE SHEET

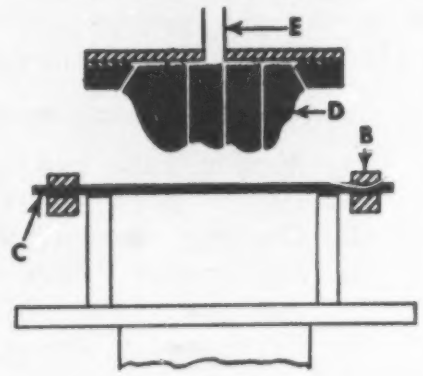

4. VACUUM SNAP-BACK FORMING

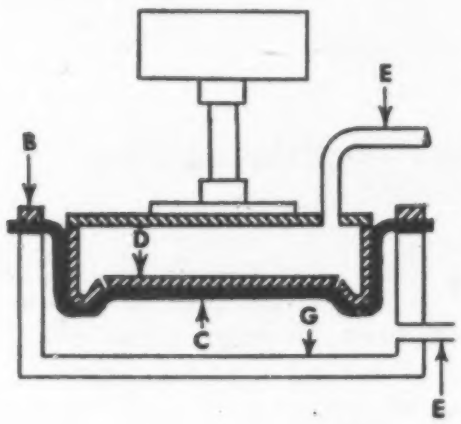

5. PLUG and RING FORMING

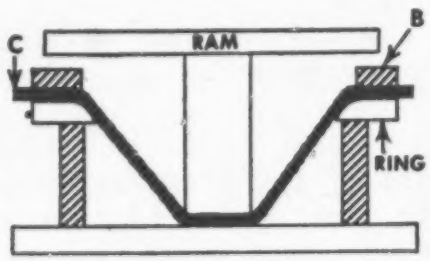

6. FORMING INTO FEMALE WITH HELPER AND AIR PRESSURE

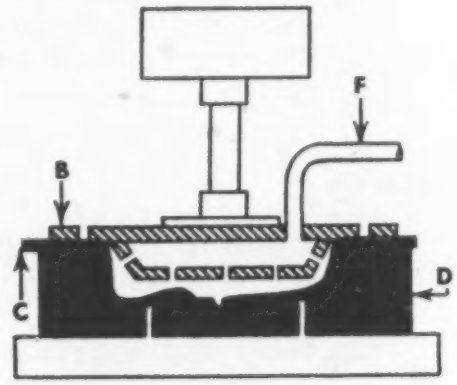

7. PRESSURE FORMING

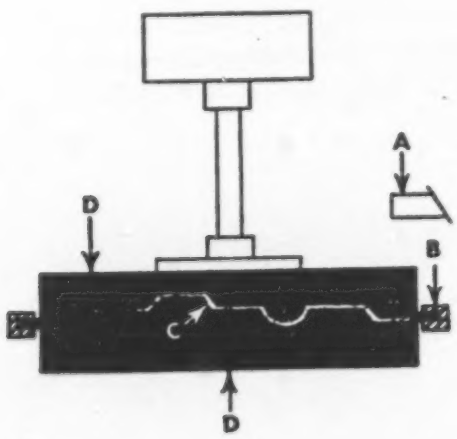

IN THESE SIMPLIFIED schematics of seven basic methods, letters indicate the following: A = Heater; B = Clamp; C = Plastic Sheet; D = Mold; E = Vacuum Line; and F = Air-Pressure Line. The methods (fully described in the text) are as follows: 1) Straight vacuum forming. Clamped in a stationary frame, the heated sheet is vacuum drawn into the mold. 2) Drape vacuum forming. Moveable frame or clamp drapes the sheet, softened by heat, over male mold before vacuum is pulled. 3) Force above sheet. Mold descends onto heated sheet, partially forming it; then the vacuum is pulled. 4) Vacuum snap-back forming. Vacuum is pulled, drawing pre-heated sheet into cavity G. Male plug moves down until it reaches a predetermined position. Vacuum is then applied through male plug. 5) Plug and ring forming. Heated sheet is placed over a ring and clamped down. Mold mounted on ram is forced into it. 6) Forming into female with helper and air pressure. As press closes, cored plug pushes heated sheet into cavity. Air pressure, introduced through plug, pushes sheet into female mold. Holes in mold let air escape. 7) Pressure forming. After heating, framed sheet is formed between matched male and female dies.

courtesy of Modern Plastics Encyclopedia

UNIT II MOLDING AND FORMING

Lesson 14

Demonstration: Thermoforming

OBJECTIVES:

. To demonstrate different thermoforming methods

. To create an awareness of the many practical uses of thermoformed products

. To develop safe working habits while in the thermoforming area

REFERENCES:

1.	Butzki, Robert	Plastics Sheet Forming	
2.	Cherry, Raymond	General Plastics Revised	Chap. 19
3.	Daines, "Vacuum Formed Name Plate"	Industrial Arts & Vocational Education June 1963	pp. 37-41
4.	Edwards, Lauton	Industrial Arts Plastics	pp. 37-41
5.	Simonds and Church	Concise Guide to Plastics	pp. 1-12, 182-94
6.	Swanson, Robert	Plastics Technology	Chap. 8
7.	Swanson and Schoenike	"Plastic Serving Tray" Industrial Arts and Vocational Education Nov. 1962	

FOR DISCUSSION:

. Various heat application methods
. Visual conceptions of thermoforming methods
. Practical applications of thermoformed products

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Have the students experiment with the different methods of thermoforming plastic.
. Have the student originate a project.
. Report on thermoformed products and their probable forming methods.

Straight Vacuum Forming
courtesy of Modern Plastics Encyclopedia

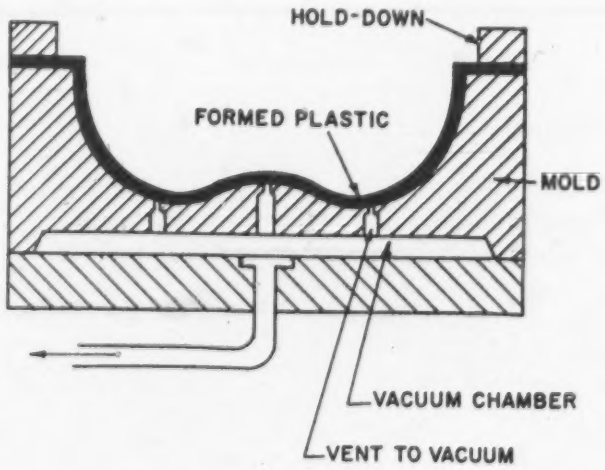

SSI 121

BRIEF DESCRIPTION OF PROCESS:

Thermoforming is any process of forming thermoplastic sheet which involves heating the sheet and stretching it to conform to a mold. After the plastic has been formed it is allowed to cool while it is still on the mold, thus retaining the shape of the mold.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Polystyrene, cellulose acetate, butyrate, ABS, and other thermoplastic sheets
- Cavity drape and/or blow molds (soap dish, wall plaque, planters, candy dishes, etc.)
- Vacuum and/or compressed air - source vacuum cleaner, air compressor, converted piston type refrigerator pump, milking machine vacuum pump, commercial vacuum units, etc.
- Heat source for plastic sheet (domestic baking oven, commercial oven, radiant heater, heat lamps, etc.)
- Thermoforming machine (commercial or teacher-made)
- Skin packaging card backs

LESSON OUTLINE:

I. Select material to be used

A. Polystyrene (preferred material, lowest cost)
B. Cellulose acetate
C. Cellulose acetate butyrate
D. ABS
E. Others

II. Prepare stock to be molded

A. Cut to proper size

B. Clamp in holding device

C. Heat to proper temperature for forming
- Set oven control to proper temperature
- Judge visually, by the amount of sag and/or the amount of smoke

III. Form the prepared plastic sheets

A. Vacuum cavity - apply vacuum
B. Drape - apply vacuum
C. Blow - start from zero pressure, apply pressure slowly

IV. Cool until rigid, cool to the touch

V. Finish

A. Remove from the mold

B. Trim off excess stock
- Jig saw or band saw
- Router, or a router blade in a drill press

C. Finished edges, if necessary, by filing, sanding, and/or buffing

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VI. Molding Tips

A. Be sure you have a good vacuum or pressure seal on mold and plastic

B. Check molds for damage or lack of preparation

C. Have the plastic sheets at the proper temperature before attempting to form them. (Check specifications)

D. When more than one item is to be formed on one sheet, be sure the spacing is correct. If the molds are too close together, a web will form between them.

E. If the first attempt at forming fails, remember that you are using a thermoplastic sheet. It may be reheated and reused.

VII. For safety, handle hot plastic with gloves

SUMMARY:

In the thermoforming processes, three scientific principles are involved. First, vacuum forming uses atmospheric pressure (14-15 psi) to press the plastic to the mold, after the pressure is decreased under the mold. Second, increased air pressure on one side of the plastic sheet overcomes the atmospheric pressure on the other side and forms the plastic onto the mold. Third, the application of heat causes the molecular bond within the thermoplastic sheet to loosen, allowing it to be formed. Cooling restores the original molecular bond.

QUESTIONS:

Q: How can you tell when the plastic sheet is ready to mold?
Q: What happens when there is a poor seal between the sheet and the mold?
Q: Must you scrap a sheet which is malformed on the first try?
Q: What is a web, and why does it occur?
Q: What is thermoforming?

MECHANICAL STRETCH FORMING

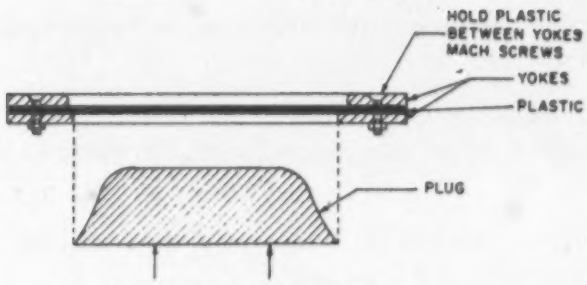

THE COMPONENTS FOR FORMING

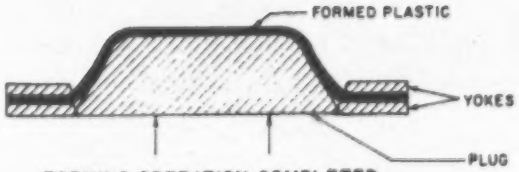

FORMING OPERATION COMPLETED

BLOW FORMING

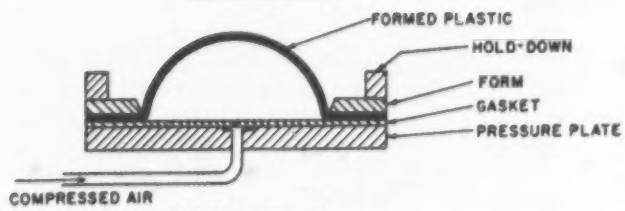

1. FREE BLOWING

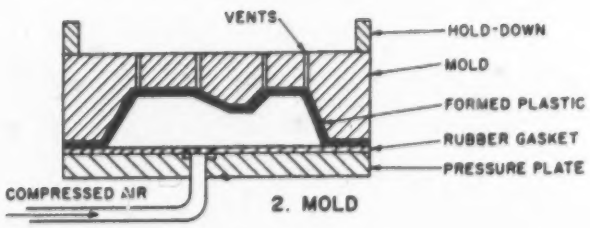

2. MOLD

courtesy of The Bruce Publishing Co.

CSP 124

UNIT III

MOLDMAKING

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UNIT III MOLDMAKING

Lesson 15

Related Lesson: Moldmaking

OBJECTIVES:

- To acquaint the student with procedure in moldmaking
- To develop an understanding of the importance of proper mold fabrication
- To explain the methods of fabricating gypsum cement, epoxy, and metal molds
- To explain the reasoning and methods used in arriving at the selection of certain types of molds

REFERENCES:

1.	Cherry, Raymond	General Plastics, Revised 1964	Ch. 24
2.	*Skiest, Irving	Epoxy Resins	pp. 18-20
3.	Steele, Gerald	Fiber Glass - Projects and Procedures	pp. 39,88,90
4.	SPI	Plastic Engineering Handbook	pp. 199-204,220
5.	Swanson, Robert	Plastics Technology	ch. 14

FOR DISCUSSION:

- Mold design considerations
- Mold making, the heart of the plastics industry
- Advantages of each type of mold
- Types of mold in relation to material to be molded
- Type of mold in relation to molding process

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Fabricate molds for vacuum forming, injection molding or compression molding.
- Repair damaged molds.
- Develop a chart for moldmaking showing different types of molds and their uses.
- Do research concerning moldmaking.

BRIEF DESCRIPTION OF PROCESS:

A mold is a device into which, or onto which, plastic materials are placed to cure or harden them by heat, cooling, and/or pressure, thus forming a molded part or article. Three materials often used for molds in the plastics industry are: gypsum cement, epoxy resins, and metals. Others would include plastics, wood, glass, and ceramics; however, these last four are in very limited use. The length of the production run, the pressures involved, the size of the molded product, and the heat required determine the design, method, and material for mold making.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

- Samples of different molds or patterns
- Gypsum cements, epoxies, and metal mold blanks
- Samples of molds made of different materials
- Wall charts of mold types

LESSON OUTLINE:

I. Mold design (refer to reference #3, pp. 88-90, and #5, ch. 14)

A. Terms to know about
- Male and female molds
- Matched molds
- Draft and undercuts
- Strength of materials used
- Finish
- Protective coatings

II. Gypsum cements molds

A. This type of mold is made of plaster or gypsum cement poured over a model or pattern of the desired shape
- Plaster, known as a "soft mold" in industry will not stand up to rough use but may be used for models or prototypes
- Super-strength gypsum cements have proved much more rugged in nature and will take more punishment

B. Application of gypsum cement molds
- Mass cast; material is poured over the object to form the basic shape
- Surface cast; material is applied to the surface of the model or pattern and backed up by a reinforcing material, such as, burlap, wire or other supportive materials
- Frame and wire; basic shape is formed by a gypsum cement. It is spread on, to give a finished shape (sometimes called "loft" method)

C. How gypsum cement molds are made (mass cast)
- Flask or form (wood or sheet metal frame)
- Pattern or model types
  a. Wood models (mold released)
  b. Vacuum formed sheet
  c. Metal objects
  d. Plaster models (mold released)
- Preparation of the mold
  a. Should be cleaned and/or polished
  b. A mold release agent must be used on porous surfaces and on aluminum

- Mixing gypsum cement; should add water until desired consistency is achieved
- Pouring gypsum cement; should be done at a steady, even rate so that there will be little or no air trapped
- Jiggling; done by gently shaking the form or flask
  This action releases any air bubbles that may have formed around the model or pattern

D. Industrial considerations (gypsum cement molds)
- Advantages:
  a. Easy to fabricate
  b. Fabrication cost is low
  c. Easily repaired
- Disadvantages:
  a. Short pot life
  b. Easily damaged
- Amount of use in industries:
  a. Limited at present
  b. Growing with experimental improvements

III. Epoxy resin molds

A. Epoxy resin is a clear liquid resin that is formed into a solid by a chemical reaction. The chemical reaction is caused by a hardener. Epoxy resins have high strength, heat resistance, shock resistance, and easily adhere to other materials.

B. How epoxy resins are used in moldmaking
- As a single material
- Combined with other materials such as metal, fiber glass, wood flour or chips, and other materials to take up volume
- Mixed with special materials to change strength and heat resistance
  a. Metal filled for increased shock resistance

C. How epoxy resin molds are made
- Mass cast. A model is either a male or a female form; epoxy resin is poured over it to form a die or mold.
  a. Use of mass cast dies. They may be used for drawing, forming, bulging, or injection molding.
  b. Mass casting procedure
     . Apply mold release to model or pattern
     . Mix epoxy resin with required hardener
     . Pour over the mold
     . Cure at room temperature or oven heat
- Surface casting. An epoxy resin surface is applied to a rough cast backing, using a model or mold to form the working surface
  a. Pour method. Core suspended over die mold and then sealed. Epoxy resins are then poured through the predetermined opening.
  b. Squash method. A paste of epoxy resin is placed on the die mold. The core is then placed on the material and allowed to settle to a predetermined position.
  c. Pressure pot method. Epoxy resin liquid is forced into a die that has been sealed. This is accomplished by forcing the material in at the low points and venting at the high points.

- Industrial considerations (epoxy resin molds)
  a. Technical advantages
     . Light weight and easily handled
     . Damage is easily repaired, thus lowering break down time
     . Bondable to almost any material
  b. Disadvantage: Limited to job runs of 50,000 items or less
  c. Cost
     . Reduces tooling time by 50 percent
     . Reduces delivery time for dies by 70 percent
     . Fabricated at one half of cost metal dies

IV. Metal molds

A. Types
- Machines. Fabricated from blocks of cold-rolled steel, tool steel, die steel, etc.
- Cast. From steel, aluminum etc.
- Spun. Generally from a non-ferrous metal
- Hobbed. Same material as machined molds
- Electroformed. Nickel the most popular material for this mold
- Low-melting alloys

B. Applications
- Machined molds for injection, compression, and transfer molding
- Cast molds for thermofusion, expandable beads, and rotational molding
- Spun molds for forming or bulging dies
- Hobbed for compression or injection molding
- Electrochemical machining for a wide variety of molding processes
- Low-melting alloys for prototypes

C. Fabrication of metal molds
- Machined. Using general tool room machinery
- Cast. Using general foundry procedure with special sand; also using pressure casting methods
- Spun. Using general rules of metal spinning
- Hobbed. Male die is pressed into mold blank under high pressure
- Electrochemical machining. Metal eroded by arc to duplicate carbon die
- Low-melting alloys. Softer material for short runs

D. Finishing metal molds
- Chrome plated and then polished
- Epoxy resin faced
- Teflon-coated working faces

E. Industrial considerations
- Machined molds. The most widely used because of durability and dependability
- Cast molds. A practical method for forming expandable beads
- Spun molds of limited use though not uncommon
- Hobbed molds
  a. Where multiple identical cavity molds needed
  b. Where internal milling is difficult but external milling is easier (small knobs, etc.)

OCL 129

V. Other methods of moldmaking

A. Wood forms
B. Ceramic molds
C. Reinforced plastic
D. Elastomer RTV

SUMMARY:

Moldmaking is said to be the heart of the plastics industry. The considerations in the fabrication and selection of molds are critical. The poor selection of a mold by a processor might prove costly to him. There are three main types of molds used in the plastics industry today. The plaster or soft molds, the epoxy resin molds, and the metal molds. Each has its own place and purpose in the plastics manufacturing industry of today.

QUESTIONS:

Q: What are the main considerations in mold design?
Q: What is a soft mold, and what are its basic material ingredients?
Q: What are epoxy resins?
Q: What is the most widely used mold material in the plastics industry?
Q: What types of materials require the use of mold release when you are making a mold?

Mold Design Considerations
courtesy of McKnight & McKnight Publishing Company from Fiber Glass Projects and Procedures by Steele, Gerald L.

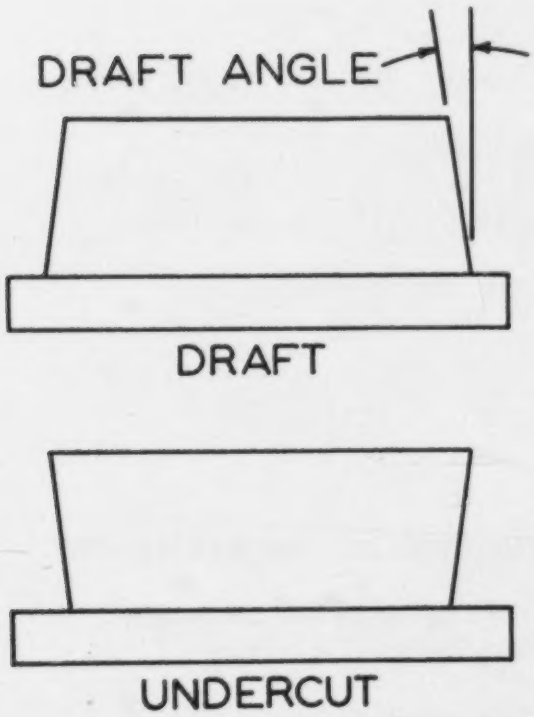

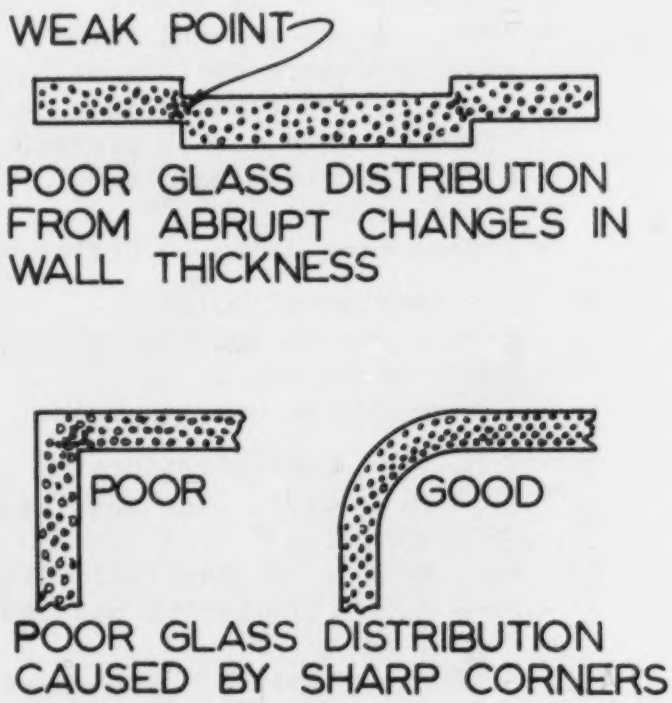

UNIT III MOLDMAKING

Lesson 16

Demonstration: Moldmaking

OBJECTIVES:

. To show the proper method of fabricating a gypsum cement mold

. To show the proper method of fabricating an epoxy resin mold

. To develop an appreciation of proper mold design

REFERENCES:

1. Cherry, Raymond	Gen. Plastics 4th Ed.	Chap. 24
2. *Skiest, Irving	Epoxy Resin	pp. 18-20
3. SPI	Plastic Eng. Hand Book	pp. 199-204,220
4. Steele, Gerald	Fiber Glass - Projects and Procedures	pp. 39, 88-90
5. Swanson, Robert	Plastics Technology	Chap. 13-14

FOR DISCUSSION:

. Considerations in mold design
. Determining the right mold for the job
. The importance of molds to the industry
. Advantages of each type of mold

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Design a model or pattern for a mold.
. Fabricate a mold from a students design.
. Repair a damaged mold.

BRIEF DESCRIPTION OF THE PROCESS:

Moldmaking is the heart of the plastics industry today. The success or failure of a job depends on the selection of the proper mold or die for the work to be done. Molds may be made of many different materials and by many different processes. High strength, gypsum cement and metal-filled epoxy molds are types which can be made in the school shop without extensive equipment. Yet these two materials provide opportunities for extensive moldmaking and for the investigation of many plastics processing methods.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Room-temperature and oven-curing epoxy resins, filled and unfilled types (Ren, Devcon, etc.)
. Plaster and gypsum cement (Hydrocal, ultracal, etc.)
. Models or patterns (wood, metal, plastic, glass, plaster, etc.)
. Flasks or forms (wood, metal, etc.)
. Scale (pounds and ounces)
. Mixing containers (paper cups, metal cans, etc.)
. Mixing sticks (coffee stirring sticks, tongue depressors)

LESSON OUTLINE:

I. Gypsum Cement Molds

A. Preparing flask
- Check for proper construction (reference #3, pp. 199-204, #5, Ch. 13-14)
- Seal the seams to prevent leaks

B. Preparing model or pattern
- Coat with a mold release (appropriate for mold material)
- Set the model in the proper position in the flask and secure it

C. Mixing gypsum cement. (Manufacturer's directions should be followed in attempting to mix gypsum cement; general procedure outlined below.)
- Water and plaster or gypsum cement are weighed separately before mixing to obtain correct consistency
- Sift the plaster or gypsum cement into the water. Allow to stand for 1 to 3 minutes; then mix thoroughly.
- Stir until mixture reaches a creamy state. Failure to mix properly will result in a dense mold face or pinholes. Avoid mixing air into the plaster.

D. Pouring
- Start pouring at one end of the flask and pour at a steady even rate until it flows into an even layer
- Draw a coarse file the wrong way over the edge of the flask. The gentle vibration will cause the entrapped air bubbles to rise to the surface. Tapping lightly will also assist in removing air bubbles.

E. Curing gypsum cement molds
- Allow 30 to 60 minutes for cement to set before removing the model or pattern. (See manufacturers instructions.)
- Allow the mold to thoroughly air-dry for at least 48 hours before use

F. Finishing. An appropriate finish may be applied to the surface, depending on the end use.
- Lacquer - vacuum or pressure forming
- Plastic resin - reinforced plastics
- Wax - most used

II. Epoxy resin molds (Read thoroughly the manufacturer's instructions for exact directions and proportions.)

A. Prepare flask or form
- Select either the flask or the form to be used. (Check reference #4, pp. 199-204, Ref #5, Ch. 14.)
- Coat with a mold release

B. Prepare model or pattern
- Model or pattern must be completely free of moisture
- Coat model or pattern with mold release
- Position model or pattern in desired place in flask
- Preheat model and flask to approximately 200° F. if an oven cured epoxy resin is used

C. Mixing epoxy resins (Use a resin appropriate to end use.)
- Measure and pour epoxy resin into a clean metal container and heat 212° F. (Direct heat is not recommended; use an oven or double boiler. (This step is necessary only when using an oven-curing epoxy resin.)
- Measure out the correct amount of hardener
- Add the hardening agent to the resin and stir well

D. Pouring
- Pour the resin into a corner of the flask slowly to prevent the trapping of air, allowing it to flow into an even layer
- Allow the mixture to cure either in the oven or at room temperature, depending on the resin type used

E. Remove the cured mold from the flask, and remove the pattern after the cure is complete

III. Metal molds

. For information on the fabrication of metal molds, refer to metal working text books and Reference #4
. See related Lesson 15 for metal mold information

SUMMARY:

The use of gypsum cement molds and epoxy molds is increasing in the plastics industry today. Advances in the development of these materials are broadening their use. These types of molds are becoming more appealing to manufacturers because of the great savings in time and money they offer, especially for short runs and/or low pressure molding applications.

QUESTIONS:

Q: What two methods may be used to cure epoxy resins?
Q: Why must gypsum cement be thoroughly mixed?
Q: Why must the containers used for mixing epoxy resin and the hardening agent be clean?
Q: Why is the use of gypsum cement and epoxy resin molds on the increase in industry today?

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UNIT III MOLDMAKING

Lesson 17

Related Lesson: Elastomers

OBJECTIVES:

. To acquaint pupils with elastomeric materials
. To develop an awareness of their industrial applications
. To convey to the students the occupational opportunities created by elastomers in relation to occupational opportunities in the plastics industry as a whole
. To classify several important elastomers

REFERENCES:

1.	Dow Corning Co.	What's a Silicone	
2.	Horsch, M. J.	Factory Magazine	Report No. 19
3.	Meals and Lewis	Silicones	
4.	SPI	Plastics Engineering Handbook	pp. 516-517
5.	Simonds and Church	Concise Guide to Plastics	pp. 61-63

FOR DISCUSSION:

. Some flexible foams which are elastomers
. Industrial trends of elastomers

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Make up a wall chart on elastomers.
. Make up a sample display board.
. Prepare handout sheet with list of major elastomers.
. Test various kinds of elastomers for stretch qualities.

BRIEF DESCRIPTION OF PROCESS:

Plastics are divided into two broad classifications: thermoplastics and thermosets. Some elastomers are considered thermosetting and some are considered thermoplastics. Elastomers may have some properties of both thermoplastics and thermosets, and some properties which do not fall into either of these classifications. An elastomer is a material which at room temperature stretches under low stress to at least twice its length and snaps back to the original length upon release of stress.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Samples of various elastomers
. Chart or list of elastomers
. Film entitled "You and the Silicones" (16 mm sound, color, 31 min.) by Dow Corning (SPI Film Catalog)

LESSON OUTLINE:

I. Usual characteristics of elastomers

A. Flexible at extremely high and low temperatures

B. Stretch under low stress at room temperature to at least twice their length and snap back to their original length

II. Specific elastomers and their properties

A. Acrylic rubber
- Oil resistance and great flex life
- High temperature (300° F to 400° F)
- Resist oxidation and sunlight

B. Butyl rubber
- Good mechanical properties
- Resistant to sunlight and hard weather
- Stiffens sharply at low temperatures

C. Chloroprenes (neoprenes)
- Substantial fire, oil, and abrasion resistance
- Not highly affected by oxygen, ozone, or sunlight
- Very resistant to chemical action

D. Fluoroelastomers
- A rigid fluorocarbon plastic
- Good high temperature performance

E. Silicone rubbers
- Well known for their ability to remain flexible
  a. Up to high temperature of 500° F
  b. Down to extreme low temperature of - 150° F
- Applications
  a. Calking and gasket material
  b. Water repellants, clothes, bricks, etc.
  c. Polishes and car waxes
  d. Release agents - for removing part from mold
  e. Lubricants - with ball bearings
  f. Retardants - to keep fluids from freezing
  g. Defoamers - for use in reducing foam in batch mixing
  h. Aircraft ignition sealants

III. Brief history of elastomers

A. Natural rubber was first known elastomer and is used as standard of comparison for elastomers

B. Silicone the first elastomer to be produced by reduction of silicon, an abundant material in earth's surface

C. Great accomplishment in experimentation by Swedish chemist - Johann Berzelius, 19th century

D. Now used commercially as a result of work done at the University of Nottingham, England - Dr. Kippling

E. In 1930's, further development led to discovery of many uses for silicones - Dr. Hyde

IV. Industrial Processing

A. Elastomers generally are mixed in large vats
- To change the characteristics of an elastomer, different ingredients are added, such as:
  . Solvents
  . Plasticizers
  . Varnishes
  . Color additives

B. Elastomers become products through:
- Metering elastomeric material into molds
- Vulcanizing at high temperatures
- Room temperature vulcanizing (RTV)

V. Industrial considerations

A. The production of elastomers comprises about one-fifth of the total production of plastic products

B. The cost of equipment and materials is relatively higher than that involved in other processes

VI. Consumer values

A. Elastomers provide longer service life than other materials

B. Elastomers are very adaptable to customers uses or to use as a part of a finished product

SUMMARY:

Natural rubber was one of the first known elastomers. It was found that natural rubber had a stretch factor, which is an important characteristic of elastomers. Recently, many modifications of elastomers have made this material useful in numerous industrial applications.

Silicone is one of the important elastomers. It is vital to many industrial operations and to the service industries due to its flexible characteristics.

QUESTIONS:

Q: What is an important characteristic of an elastomer?
Q: Which elastomer leads in industrial uses?
Q: Elastomers belong in which general classification of plastics?
Q: What was the first known elastomer?

PRINCIPAL PLASTICS FAMILIES

Their forms and applications

	Group	Sheet			Tubing				Foams				Coatings						
		Flexible	Rigid	Rod	Flexible	Rigid	Pipe	Fiber	Flexible	Rigid	In place	Sealants	Solvent	Latex	Catalyst-cured	Potting compound	Reinforced laminates	Adhesives	Fil
Acetals	TP	—	X	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Acrylics	TP	—	X	X	—	X	—	X	—	—	—	X	X	X	—	—	—	X	X
Acrylonitriles	TP	—	X	X	—	X	X	—	—	X	—	—	X	—	—	—	—	—	—
Alkyds	TS	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—	—	X	—
Butyls	E	X	—	—	X	—	—	—	X	—	—	X	X	X	—	—	—	—	—
Cellulosics	TP	X	X	—	—	—	—	—	—	X	—	—	X	X	—	—	—	X	X
Chloroprenes	E	X	—	—	X	—	—	—	X	—	—	X	X	X	X	—	X	X	—
Diallyl phthalates	TS	X	X	X	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—
Epoxies	TS	—	X	X	—	X	X	—	—	X	X	—	X	—	X	X	X	X	—
Fluorocarbons	TP	X	X	—	X	X	—	X	—	—	—	—	—	—	—	—	—	—	X
Melamines	TS	—	—	—	—	—	—	—	—	—	—	—	X	X	—	—	X	X	—
Nitrile rubbers	E	X	—	—	X	—	—	—	X	—	—	—	—	—	—	—	—	X	—
Phenolics	TS	—	X	X	—	X	—	—	—	X	X	—	X	—	—	X	X	X	—
Polyamides	TP	X	X	X	X	X	—	X	—	—	—	—	—	—	—	—	—	X	X
Polycarbonates	TP	X	X	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	X
Polyesters	TS	X	X	—	—	—	X	X	—	—	—	—	X	—	X	X	X	X	X
Polyethers, chlorinated	TP	X	X	X	—	X	X	—	—	—	—	—	—	X	—	—	—	—	X
Polyethylenes	TP	X	X	X	X	X	X	X	X	X	—	—	—	—	—	—	—	—	—
Polyethylenes, chlorosulfonated	E	X	—	—	X	—	—	—	—	—	—	X	X	—	—	—	—	—	—
Polypropylenes	TP	X	X	X	X	X	X	X	—	—	—	—	—	—	—	—	—	—	X
Polystyrenes	TP	X	X	X	—	X	—	—	—	X	X	—	X	X	—	—	—	X	X
Polysulfides	E	X	—	—	—	—	—	—	—	—	—	X	X	X	X	—	—	X	X
Polyurethanes	E	X	—	—	—	—	—	—	X	X	X	X	X	—	X	X	—	X	—
Polyvinyl acetates	TP	X	X	—	—	—	—	—	—	—	—	—	X	X	—	—	—	X	—
Polyvinyl chlorides	TP	X	X	X	X	X	X	—	X	X	—	—	X	X	—	—	—	X	X
Polyvinylidene chlorides	TP	X	X	—	—	—	X	X	—	—	—	—	X	X	—	—	—	X	X
Silicones	TS	—	X	X	—	X	—	—	X	X	X	X	X	—	—	X	X	X	—
Styrene-butadiene rubbers	E	—	—	—	—	—	—	—	—	X	—	—	X	X	—	—	—	X	—
Urea-formaldehydes	TS	—	—	—	—	—	—	—	—	X	—	—	X	—	X	—	—	X	—

KEY: TS—Thermosets, TP—Thermoplastics, E—Elastomers

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UNIT III MOLDMAKING

Lesson 18

Demonstration: Casting with silicone rubber

OBJECTIVES:

. To demonstrate to the student how to work with silicone elastomers

. To show how room temperature vulcanizing (RTV) materials can be used

REFERENCES:

1. *Dow-Corning	Silicones (pamphlet)	Dow-Corning Midland, Mich.
2. *Meals and Lewis	Silicones	
3. *Smith, H. A.	Making Flexible Molds (pamphlet)	Dow-Corning Midland, Mich.

FOR DISCUSSION:

. General applications of castings possible with RTV type silicones
. Future uses of this material in industrial arts
. The reason catalyst is used in RTV silicones
. The theory of cure RTV silicones

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Select a pattern for reproduction.
. Have the student make several molds, one requiring a one piece mold, one needing two piece mold, etc.

Mold Making with Silastic RTV Materials
courtesy of Dow Coming Corporation

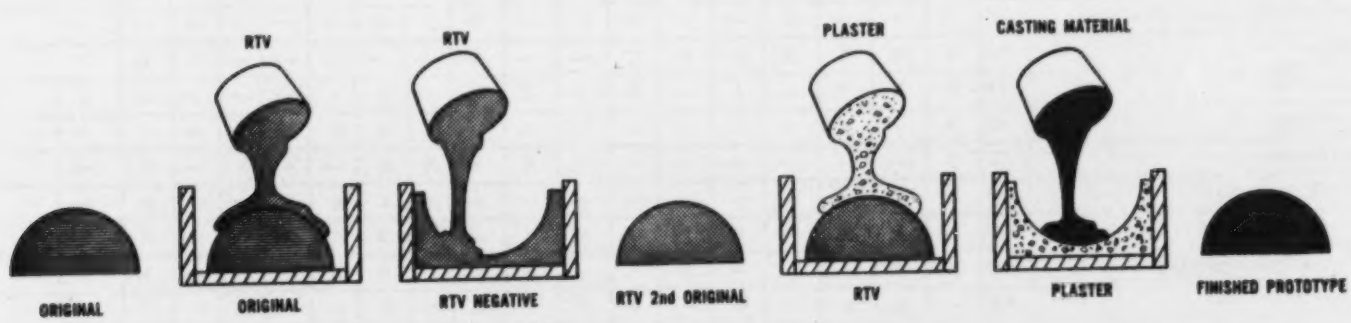

BRIEF DESCRIPTION OF PROCESS:

RTV silicone rubber is a plastic material which, with the addition of a catalyst, cures at room temperature to form an elastomer. It can be used to make flexible molds or mold copies of objects. These molds may then be used to make castings with other plastic materials or to make other molds from silicone RTV.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. RTV silicone rubber
. Catalyst for RTV
. Measuring containers and mixing sticks
. Beam scale
. Pattern
. Flask or form

LESSON OUTLINE:

I. The use of RTV silicone rubber

A. Easy and safe to use

B. Releases readily from most materials without use of release agent

C. Reproduces fine detail

D. Will not distort with casting temperatures up to 500° F

II. Preparing the pattern (i.e., radio dials, handles, novelties)

A. Original may be made of
- Wood
- Plastic
- Wax
- Soap
- Glass
- Metal

B. Clean grease, oil or burrs from surface

C. Make sure corners, crevices, and draws are free from foreign matter

D. Use release agent only if pattern has high details or large undercuts; use as spray or dip
- Silicone spray
- Solution of household detergents made up of 5 parts detergent to 100 parts water
- 5 percent solution of xylene

III. Preparing one-piece mold

A. Place pattern in retaining flask or form
B. Allow one-fourth to one-half inch clearance on all sides of pattern in flask
C. Use release agent if complex undercuts exist

IV. Preparation of silicone RTV for pouring (Read manufacturer's instructions carefully.)

A. Place measured amount of silicone rubber into mixing cup
B. Add one-half percent by weight of catalyst, according to directions. (Other percentages may be used according to need.)

C. Stir to mix thoroughly
D. Do not touch the liquid silicone

V. Pouring

A. Begin pouring from one corner of flask, allowing silicone rubber to flow around the pattern
B. When pattern is half covered, stop pouring until RTV has leveled off
C. Resume pouring until pattern is covered at highest point with one-half inch of silicone rubber
D. Let it set up until firm
E. No extra safety precautions are necessary

VI. Stripping model

A. Remove RTV mold from flask
B. Remove pattern from mold
C. Remove flash, if any

VII. To cast replicas of original

A. Place mold in the flask for support
B. Make solution of paraffin wax and xylene as release agent, and apply it
C. Prepare silicone rubber as before
D. Pour, cure, and strip from mold as before

VIII. Application to Industrial Arts

A. Casting a mold of silicone is one of the industrial processes, using silicones, that we can perform in the school shop
B. The versatility of this material makes it particularly suitable for use in industrial arts

SUMMARY:

Silicone rubber molds are especially suited for the high temperatures of many casting materials. This material, because of its flexible properties, is filling great industrial needs where speed and economy is important.

QUESTIONS:

Q: What is the function of a catalyst in silicone RTV rubber?
Q: Silicone rubber molds will stay rigid up to what temperature?
Q: If a silicone original is cast, is it usable again? Why?
Q: If a release agent for silicones can't be bought commercially, what workable substitute is available?

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UNIT IV

BONDING

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UNIT IV BONDING

Lesson 19

Related Lesson: Welding and cementing

OBJECTIVES:

. To introduce the student to methods of bonding thermoplastics

. To acquaint the student with the different welding processes

. To encourage interest in thermoplastic welding

REFERENCES:

1.	Cherry, Raymond	General Plastics, Rev. 1964 4th Ed.	Chap. 16
2.	*Hain and Zahn	Welding of Plastics	
3.	Kaminsky and Williams	Welding and Fabricating Thermoplastics	
4.	*Neuman and Brockhoff	Welding of Plastics	Chap. 1,2,5,6
5.	SPI	Plastics Engineering Handbook	
6.	Swanson, Robert	Plastics Technology	pp. 214-17

FOR DISCUSSION:

. Factors influencing the choice of welds used in manufacturing
. Use of welding as a repair technique

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Have the student experiment with different welding processes.
. Fabricate a project by welding pieces of thermoplastic together.
. Develop a wall chart on different welding methods.

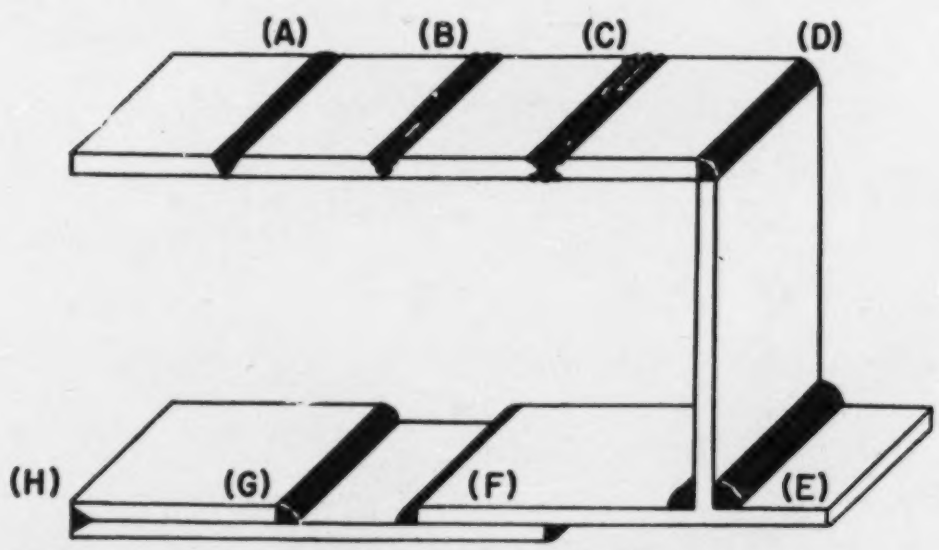

Eight basic weld types: *A) single-bead, single-V butt weld; B) multiple-bead, single-V butt weld; C) multiple-bead, double-V butt weld; D) corner weld; E) double fillet weld; F) and G) lap fillet welds; H) edge weld.* courtesy of Modern Plastics Encyclopedia

BRIEF DESCRIPTION OF PROCESS:

Cohesive bonding and adhesive bonding are two basic plastics joining processes. Cohesive bonding includes thermal welding and solvent cementing. Adhesive bonding involves the use of adhesive cements.

Thermal welding can be accomplished by use of: hot gas, high frequency, a heated tool, friction or ultrasonic waves.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Wall chart showing the basic methods of welding thermoplastics
. Samples of thermoplastic products that have been welded and cemented

LESSON OUTLINE:

I. Cohesive bonding. The molecular attraction by which the particles of two bodies are united and become one mass. Similar materials must be used for a cohesive bond. Two methods of achieving a cohesive bond are by thermowelding and solvent cementing.

A. Welding of Thermoplastics

- Hot gas welding. This is similar to gas welding of metal except that an open flame is not used (the high temperature oxidizing effects of an open flame will cause damage to plastic.) A stream of hot (425° F) compressed air or nitrogen gas is applied alternately to the material and a filler rod, causing them to melt. Moderate pressure is then applied to filler rod to complete the joint. This method is best suited to welding rigid sheets and pipes.
- Heated-tool welding. A heat source, such as a hot plate or heated knife, is used. The surfaces to be welded are melted or softened by the heated tool and butted together under pressure until the two edges bond to each other during the cooling period. This method is particularly applicable to welding of thin sheet or film.
- Friction welding (spin welding). This is done by rubbing mated parts together until the melting point is reached, at which point the rubbing is stopped. Pressure between the two parts is maintained until they have cooled, completing the bond. The rubbing action, which generates heat by friction, may be oscillating or rotational. Generally, the rotational method is the most convenient method. This type of welding may also be used to bond a thermoplastic to a thermoset plastic.
- High frequency welding (induction welding). High frequency waves or vibrations generated by a power source pass through electrodes that hold the thermoplastic materials together. These vibrations cause heat between the two plastic parts, and, when the correct temperature is reached, pressure is applied to complete the bond. This method is used for bonding thin sheets or films.
- Ultrasonic welding. This is achieved by pulsations from an ultrasonic generator which pass through the material to be welded. This hammering action generates heat, and the pressure from the holding device completes the bond.

B. Solvent cementing
- Solvent cements (ethylene dichloride, glacial acetic acid, etc.)
  a. Selected for specific plastic to be bonded
  b. Low-boiling solvents give fast setting action but may cause crazing in a short time
  c. Inexpensive method of cementing
- Dope cements
  a. Contain in solution a quantity of the same plastic which is being bonded
  b. Leave on drying, a film of plastic to aid in the bonding
  c. Are used for imperfect fits and where some filling is necessary
  d. Are easier to handle than regular solvent cements

II. Adhesive bonding. The adhering or sticking together of substances in contact with each other through the use of a sticky, glutinous substance.

A. The adhesive may be of a different chemical type than the plastic being bonded

B. Monomeric or polymerizable cements
- Consist of
  a. A reactive monomeric identical to, or compatible with, the plastic to be bonded
  b. A suitable system of catalyst and promoter
  c. Are polymerized at room temperature or at a temperature below the softening point of the plastics

C. Examples of adhesive bonding
- Bonding of thermosetting plastics with epoxy cements
- Plastic bonding cement used for model making

III. Techniques

A. Common joints used for bonding
- Lap joint
  a. Good appearance
  b. Good strength in many instances
- Butt joint
  a. Easiest type to provide for in molding
  b. Less contact area, weakening joint
  c. Unsightly bond lines
- Tongue-and-groove
  a. Self-positioning
  b. Amount of adhesive to be carefully controlled during application

B. Application methods
- Dip method
  a. One of the two parts dipped into the cement just enough so that the solvent will act on the desired area for maximum time
  b. Parts then assembled and held under light pressure for a short time
- Capillary method. Surfaces to be cemented are fitted closely, and cement is introduced into the edges of the joint and allowed to spread to the rest of the joint by capillary action

C. General technical considerations
- Clean surface on pieces to be bonded
- Proper contact of mating parts
- Care in application of adhesives to avoid disfiguration
- Enough clamping pressure on contacted surfaces where necessary

D. Industrial considerations: Basically, these methods can be used to bond plastics regardless of their shape; the intricacy of the shape and the material to be bonded will determine the method and the material to be used. Factors such as strength or appearance should be considered by the fabricator when deciding what method of cementing or welding should be used.

IV. Safety and hygiene

A. Work in a well ventilated room

B. Check volatility of material to be welded or cemented

C. Employ all general precautions used when working with hot plastics

V. Guidance - Jobs available

A. Welders

B. Layout men

C. Designers

D. Chemists

E. Engineers

VI. Science

A. Cohesive bonding - The molecular bond of the parent materials are loosened by heat or solvents. The two parent materials are put in contact with each other and when the solvent evaporates or the heat dissipates, the molecular bond is again strengthened causing the two parts to bond together.

B. Adhesive bonding - A sticky material which grips the parent materials when dried or cured, is placed between the two materials, holding them together by adhesion.

SUMMARY:

Welding thermoplastics has become an integral part of the plastics industry since 1940. Growth in size, technique, and understanding is still going on in this phase of the plastics industry. The future of welding and cementing plastics seems to be very good.

QUESTIONS:

Q: What are the five basic methods of welding plastics?
Q: Why can't an open flame be used for welding plastics?
Q: What is meant by spin welding?
Q: What are the industrial considerations for choosing a bonding method in plastics?
Q: What is the difference between adhesive and cohesive bonding?

Recommended methods of welding thermoplastics

Material	*Hot-gas welding*	*Heated-tool welding*	*Thermobande welding*	*High-frequency welding*	*Heat sealing*	*Friction welding*	*Flame welding*	*Ultrasonic welding*	*Solvent welding*
Polyacetals	A	—	B	—	—	B	—	—	—
Polyamides	A	A	B	C	—	A	—	C+	B
ABS copolymers	B	B	—	B	—	—	—	—	A
Polyacrylics	C	B	—	—	—	B	—	—	A
Polycarbonates	B	B	—	—	—	C	—	—	A
Polyester (Mylar)	—	—	—	—	—	—	—	A+	—
Chlorinated polyether (Penton)	A	B	B	—	C+	—	—	—	—
Polypropylene	A	B	B	—	—	B	—	C+	—
Polystyrene	B	B	—	—	—	B	—	—	A
Polyethylene (low-density)	A	B	A	—	A+	A	C+	—	—
Polyethylene (high-density)	B	A	A	—	A+	A	C+	—	—
PVC (rigid)	A	B	—	C	—	A	—	C+	A
PVC (plasticized)	A	A	C	A	C+	—	—	—	A
Polyvinyl fluoride	—	—	—	A	A+	—	—	A+	—
FEP (Teflon)	—	A	—	—	A	—	—	—	B

A=Applicable in most cases; B=second choice; C=In exceptional cases only; +=Indicates film or foil.

The Hot Gas Welding Process

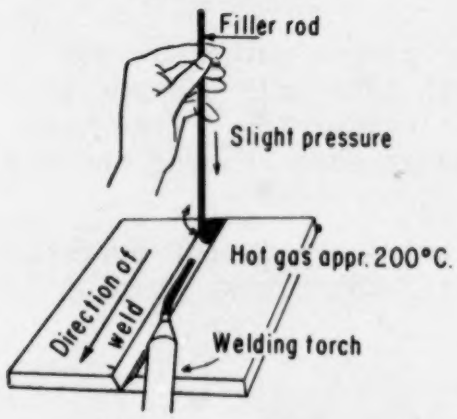

Friction Welding Process

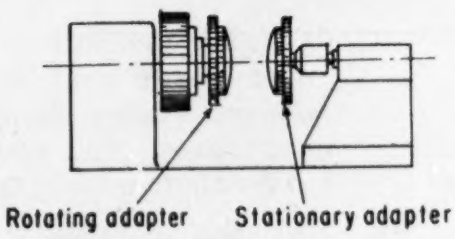

The High Frequency Welding Process

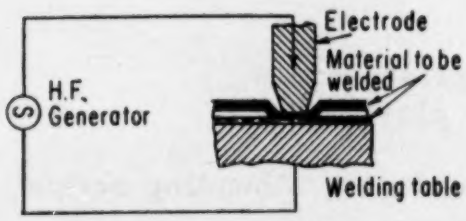

Heated Tool Welding

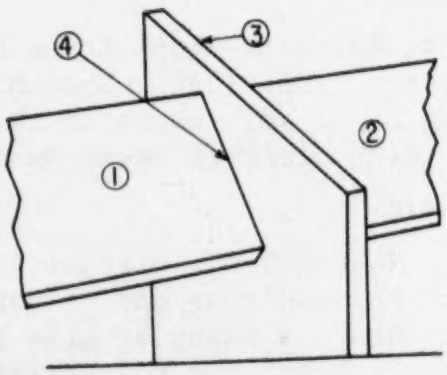

The material to be welded (1 and 2 in drawing above) are pressed against a heated surface (3) until they melt (4). The melted edges are then butted and held until the joint hardens. In production, holding jigs are used.

courtesy of Modern Plastics Encyclopedia

UNIT IV BONDING

Lesson 20

Demonstration: Welding

OBJECTIVES:

- To demonstrate the various methods of thermoplastic welding
- To acquaint the student with the safety precautions to be taken in connection with the welding processes
- To develop an appreciation for fabrication of plastics by welding methods

REFERENCES:

1.	Cherry, Raymond	General Plastics Revised 1964	Chap. 16
2.	Kaminsky and Williams	Welding and Fabricating Thermoplastics Material, Kamweld Prod., Co. Norwood, Mass.	
3.	*Hain, George and Zade, H. P.	Welding of Plastics	
4.	*Newman & Brockhoff	Welding of Plastics	Ch. 2,5,6
5.	Simonds and Church	Concise Guide to Plastics	pp. 183-6
6.	SPI	Plastic Engineering Handbook	pp. 501-7
7.	Swanson, Robert	Plastics Technology	pp. 214-15

FOR DISCUSSION:

- The five basic methods of thermoplastic welding
- The proper selection of a welding method for the job to be done
- The historical development of the plastic welding processes

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Practice welding samples of different types of thermoplastic materials.
- Discover and identify welds on commercial plastics products.
- Have the student fabricate a project using welding as a process.

BRIEF DESCRIPTION OF PROCESS:

Welding is a process of joining two or more items of the same material under the influence of heat and pressure. There is no problem of solvent evaporation or curing time as in the use of adhesives. A welded item may be handled in a reasonable amount of time. Time and money may be saved in the fabrication of thermoplastic products using these methods.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Wall chart depicting various processes of welding and general procedure for each (Modern Plastic Encyclopedia 1962, pp. 844-845)
- Thermoplastic rod and sheet of identical material (Kamweld Corp.)
- Heat source for heated tool method (Hot plate, heat-sealing tool, soldering iron)
- Drill press
- Available welding equipment for thermoplastics (Hot gas welder, plastics flow gun, electric soldering iron)

LESSON OUTLINE:

I. Hot gas welding

A. Secure objects to be welded so they will not move during welding operation. (Pin, tack, or tape to a solid surface.)

B. Check the heating element to be sure it is the proper one for temperature that will be needed. (Temperature needed varies with the material to be welded. See manufacturer's specs.)

C. Close the regulator before connecting the air or gas supply. After connecting the air or gas, adjust regulator for proper pressure (approx. 2-6 pounds on the gauge). Lowering the pressure will increase the heat.

Typical set-up *for hot-gas welding of thermoplastics materials, using an electrically heated gun. Welding rod used (far left) is of the same composition as the parts which are to be welded together*

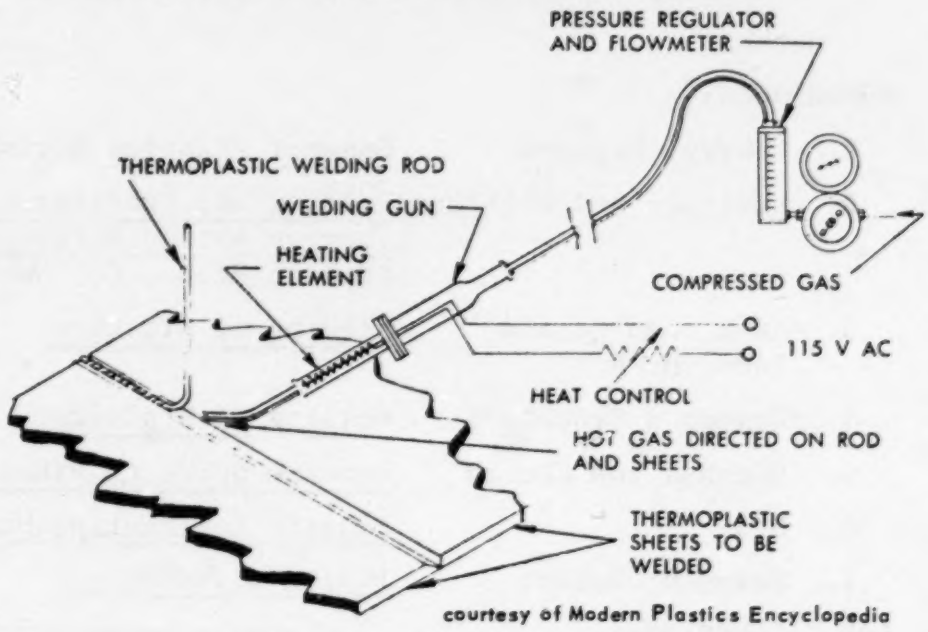

courtesy of Modern Plastics Encyclopedia

D. Connect to electric outlet

E. Allow about 3-4 minutes for warm up. The gas or air should flow through the barrel at all times to prevent the burning-out of the heating elements during preheat and welding.

F. Select the tip needed for the job to be done. Install by holding the tip with pliers to prevent burning of fingers or hands.

G. Select the filler rod (should be of same material as items to be welded; large diameter for thicker sheets, etc.)

H. Brush the stream of hot air or gas between the filler rod and material to be welded. When both the rod and the material become tacky, begin the welding process.

I. Hold the filler rod to material and feed the rod progressively as it and the material become tacky. Hot air stream should be directed so that 40 percent of it hits the filler rod and 60 percent hits the material to be welded. Continually move the air stream to produce an even weld.

J. When the weld is complete, filler rod may be twisted off while it is still soft

II. Heated-tool welding

A. Place joint edges on a heat source and hold until both edges reach the proper temperature. The temperature will vary with the type of material to be used. Use mold release on heat source to prevent sticking.

B. As soon as the materials are properly heat softened, remove them from the heat source and join them together quickly

C. Hold them together firmly until the melted material cools to form a strong joint

III. Friction welding

A. Mount a piece of round plastic filler rod stock in the drill press

B. Secure a piece of sheet of the same material as the filler rod to the drill press table

C. Start the drill and feed it down until the rod comes into contact with the sheet

D. Hold down with approximately 20 lbs. of pressure until contact points become heat softened

E. Stop the drill quickly and maintain pressure until the material cools to complete the bond

Spin welding *of locking button to knob of automobile window crank is accomplished with a special tool. (From a Du Pont sketch)*

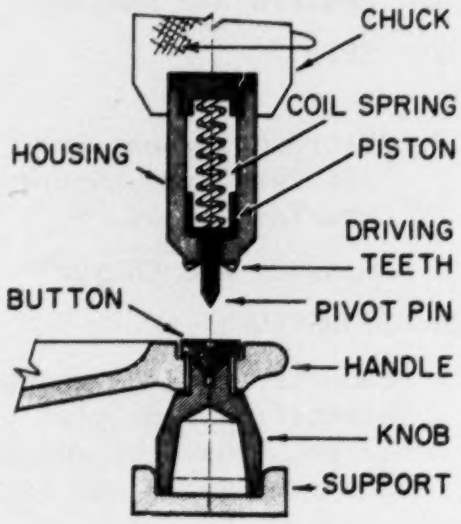

courtesy of Modern Plastics Encyclopedia

IV. Ultrasonic and high frequency welding. Refer to section on heat sealing (Lesson 21).

V. Safety

A. Never handle hot gas tips by hand
B. Never direct hot gas flow toward other people
C. Do not handle hot plastics without gloves
D. Check volatility of material to be welded
E. Work in a well ventilated room

SUMMARY:

Welding is the process of bonding two items of the same material under the influence of heat and pressure. Welding is being used more and more every day as an industrial fabrication process. It is fast, easy, and comparatively inexpensive. This makes it a practical industrial fabrication method.

QUESTIONS:

Q: Describe hot gas welding of thermoplastics.
Q: Should the heat source for the heated-tool method be coated with a lubricant or mold release?
Q: What types of motion can be used in friction welding?
Q: List 5 safety rules for thermoplastic welding.
Q: What is meant by volatility?

UNIT IV BONDING

Lesson 21

Related Lesson: Heat sealing

OBJECTIVES:

. To introduce the student to the heat sealing process.

. To point out the industrial uses of heat sealing.

REFERENCES:

1.	Redfarn and Bedford	Experimental Plastics	pp. 89-90
2.	SPI	Plastics Engineering Handbook	p. 501
3.	*Ultrasonic Seal Inc. 386 Park Ave., South New York 16, N. Y.	Solve Your Sealing Problems	pamphlet
4.	Simonds and Church	Concise Guide to Plastics	pp. 102-103

FOR DISCUSSION:

. Products in which industry employs the heat sealing process
. Scientific principles of heat sealing
. Equipment used by industry
. Materials which are heat sealable

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Heat seal a card holder for a wallet.
. Incorporate heat sealing in a class production problem.
. Make a simple heat sealer.

BRIEF DESCRIPTION OF PROCESS:

Heat sealing refers to the welding of thin, thermoplastic sheetings or films to the same type of plastic, or to other materials, by heating.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Chart of materials and temperatures for heat sealing plastics (see Ref. #2)
. Examples of heat sealed articles
  - Roll bags
  - Plastic baby pants
  - Plastic raincoat
  - Meat packages

LESSON OUTLINE:

I. Historical development

  A. Heat sealing has been used for many years
  B. Used extensively in packaging, clothing, upholstery
  C. New methods developed to do special jobs

HEAT-SEALING TEMPERATURE RANGES FOR PLASTIC FILMS

Film Type	Range (°F)
cellophane (coated)	200-350
cellulose acetate	400-500
CFE (chlorotrifluoroethylene)	415-450
polyester (coated)	490
polyethylene	250-375
polystyrene (oriented)	220-300
polyvinyl alcohol	300-400
polyvinyl chloride and copolymers nonrigid	200-400
polyvinyl chloride and copolymers, rigid	260-400
polyvinyl chloride nitrile rubber blend	220-350
polyvinylidine chloride	285
rubber hydrochloride	225-350
FEP (fluorinated ethylene-propylene copolymer)	600-750
TFE (tetrafluoroethylene polymer)	cannot be welded
CFE (chlorotrifluoroethylene polymer)	satisfactorily

courtesy of The Society of the Plastics Industry

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II. Methods of heat sealing

A. Electrical resistance sealing
- Jaws, rollers, metal plates or bands heated by electricity are in contact with materials to be sealed
- Material is touched by these heated jaws thus welding material together
- The following are the major materials which may be sealed:
  a. Cellulose acetate, cellulose butyrate (not sealable - cellulose nitrate and cellophane)
  b. Vinyls - saran for food packaging
  c. Polyethylene - dry cleaning bags; roll bags
  d. Polystyrene - card cases
  e. Materials which have been coated with heat sealable plastics

B. High frequency generation (Frequency near that of radio)
- Uses electrical properties of material (dielectric)
- Develops heat within film
- Vinyls such as those employed in the fabrication of raincoats and plastic boots seal best with this method
- Has limited use aside from vinyl

C. Ultrasonic generation (20 to 40 K.C.)
- Mechanical vibrations in sealing area develop heat losses which melt plastic surfaces causing seal
- Will seal through contaminates
  a. Printing on plastics
  b. Material contained in the package (frosting, etc.)
- Seals most plastic materials

D. Heat shrinking
- Plastic sealed around article being packaged
- Package heated with hot water or hot air
- Plastic shrinks and eliminates some of the air present
- Makes an attractive looking package

SUMMARY:

Heat sealing is used to advantage in many industries. It can be used to speed packaging operations and make the package more attractive. Heat sealing can give these articles waterproof seams that are as strong as the material itself.

QUESTIONS:

Q: Name some products heat sealed by the electrical resistance method.
Q: Heat sealing usually refers to the welding of what thicknesses of plastics?
Q: Is nitro cellulose a heat sealable plastic?
Q: What type or classification of plastic may be heat sealed? (thermoplastic or thermosetting?)
Q: Explain the theory by which the ultrasonic sealer works.
Q: Name some materials which can be sealed by high frequency generation.

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UNIT IV BONDING

Lesson 22

Demonstration: Heat sealing

OBJECTIVES:

. To show how heat sealing may be accomplished

. To demonstrate heat sealing as it is used by industry

REFERENCES:

1.	Redfarn and Bedford	Experimental Plastics	pp. 89-90
2.	SPI	Plastics Engineering Handbook	p. 501
3.	Simonds and Church	Concise Guide to Plastics	pp. 102-103

FOR DISCUSSSION:

. The temperatures involved in heat sealing
. Uses of heat sealing equipment
. Types of industrial heat sealing equipment

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Experiment with heat sealing on various plastic films.
. Make a kite using plastic film which can be heat sealed.
. Experiment with most common heat sealable plastics.

	Heat seal temperature
- Vinyl	200° to 400°
- Coated cellophane	200° to 350°
- Polyethylene	250° to 375°
- Cellulose acetate	400° to 500°
- Polystyrene	220° to 300°

See chart Related Lesson: Heat Sealing; also Ref. #3 above

BRIEF DESCRIPTION OF PROCESS:

Thermoplastic sheet (material thicker than 10 mils (.010) in thickness) or film (material thinner than 10 mils) may be bonded together by applying heat and pressure to a narrow strip of the materials so that they fuse or weld together.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Clothes iron, with temperature control
. Electric soldering gun or wood burning pen
. Variable transformer
. Commercial heat sealer
. Two-sheet metal strips 20 ga. x 1/8" x 10"
. Vinyl film
. Cellophane, coated
. Polyethylene
. Cellulose acetate
. Temperature chart
. Silicon spray (mold release)
. Newspapers
. Hair dryer
. 10" x 10" plastic sheet from meat market
. Small spring clamps

LESSON OUTLINE:

I. Heat sealing using clothes iron

A. Set temperature control to temperature required. (See heat chart.)
CAUTION: Do not touch the hot iron
B. Spray iron and sheet metal strips with silicon spray
C. Clamp double thickness of plastic between metal strips
D. Place iron on top strip until plastic softens slightly
E. Remove iron; unclamp; let cool

II. Using soldering gun or wood burning pen

A. Spray tip with silicon release
B. Turn on variable transformer
C. Check heat tip with thermometer to get correct heating temperature
CAUTION: Do not touch the tip
D. Place double thickness of plastic on stack of newspapers
E. Draw tip in straight line over surface of plastic
F. Let cool

III. Using commercial heat sealer (has rollers, strips, or clamps which come in contact with plastic. CAUTION: Do not touch the heated edges)

A. Preheat sealer to proper temperature
B. Heated strip is usually coated with nonstick material
C. Clamp plastic between jaws
D. Hold for approx. 30 seconds
E. Unclamp and allow to cool

IV. Heat shrinking plastic packages, using clothes iron and portable hair dryer

A. Use plastic from meat market (approx. 10" x 10" of film one side of which is coated with a sweet tasting coating which keeps food from spoiling)
B. Wrap plastic around crumpled newspaper, placing "sweet side" against paper
C. Heat seal on sole of clothes iron
D. Hold hair dryer approximately 10 inches from package
E. Heat surface until plastic shrinks and tightens around newspaper

SUMMARY:

Heat sealing is used to make many items from plastic film. It forms strong, waterproof joints or welds on the material sealed. Heat sealing is used extensively in packaging to make attractive, practical packages.

QUESTIONS:

Q: How does heat affect plastic in heat sealing?
Q: Why do we use pressure in heat sealing?
Q: Name some heat sealable plastics.
Q: Name three methods of heating sheets and films for heat sealing.

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UNIT V

LAMINATES

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23	Reinforced plastics (related)	84
24	Reinforced plastics (demonstration)	88
25	Low pressure laminating (related)	91
26	Low pressure laminating (demonstration)	93
27	High pressure laminating (related)	97
28	High pressure laminating (demonstration)	100

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UNIT V LAMINATES

Lesson 23

Related Lesson: Reinforced plastics

OBJECTIVES:

- To develop an understanding of industrial applications using hand layups of polyester and epoxy reinforced plastics
- To develop an appreciation for polyester reinforced projects as they might be used in the school shop
- To develop an understanding of the materials used in reinforced laminations

REFERENCES:

1. Bick, Alexander F.	Plastics: Projects and Procedures with Polyesters	p. 2
2. *Cleworth Publishing Company	Reinforced Plastics 1 River Road CosCob, Connecticut	Periodical
3. *Redfarn and Bedford	Experimental Plastics	pp. 28-30
4. *Sonneborn, Ralph	Fiberglass Reinforced Plastics	p. 27 and others
5. Steele, Gerald	Fiber Glass - Projects and Procedures	pp. 33-42 others
6. *Whitney Publishing Company	Industrial Design 18 E. 50th Street New York 22, N. Y.	Oct. '58

FOR DISCUSSION:

- Computing costs of glass fiber for hand layup
- Fillers and their purpose
- Mold designs for reinforced plastics
- Uses and types of plastic automobile body solders

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Make a model boat, car body, tray, etc., using the open mold process.
- Make a project utilizing the pressure bag method.
- Make a project utilizing male and female matched molds.
- Take a field trip to industry employing hand layup method of reinforced plastics.
- Experiment with various reinforcing materials.
- Mix a polyester resin and use in hand layup (Ref. #3).

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Flip chart, pictures, etc. of basic reinforcing methods
- Large photos or drawing of glass fiber to include cloth, mat, roving, chopped strands, fibers, and others
- Samples of reinforcing materials

BRIEF DESCRIPTION OF PROCESS:

By the addition of reinforcing materials such as glass fibers, asbestos, or sisal the shock resistance and strength of the plastic binder can be greatly increased.

Commercially large items are possible using dies or molds to shape the plastic. Boat hulls and large tanks are commonly made of reinforced plastics.

Hand layup is accomplished by applying a reinforcing material and a polyester resin in, on, or around a mold. The process is similar to pouring concrete around reinforcing steel except that plastic is used as the binder instead of concrete. The plastic requires special treatment for gelling, curing and specific pre coating and post coating operations.

The hand layup method affords definite advantages for the school shop since it utilizes a low cost polyester resin which will cure at the normal atmospheric conditions of the classroom.

LESSON OUTLINE:

I. History of reinforced plastics

A. World War II application
- Resin developed by early 1900's
- Glass fiber developed by Corning in late 1930's
- In 1940's great industrial stimulus provided by World War II needs such as
  a. Bullet resistant outershells for airplane gas tanks, bullet proof vests, landing boats, etc.
  b. Coating to prevent bullets shattering tank's inside liner

B. Post World War II use
- War applications cease; use of materials very limited
- Late 1940's, reinforcements are revived with great growth in numerous areas; little commercial coordination
- In 1950's, large growth of market application. (NOTE: see SPI Press Release 1964 for current history - See also current issues of Modern Plastics magazine)

II. Advantages of fiber glass reinforced plastics

A. Superior strength
- Impact
- Flexural
- Tensile
- Compression

B. Protective characteristics
- Electric arc resistance
- Chemical resistance

C. Versatility of application
- Low cost per item
- Fabrication of large items
- Simple moldmaking in comparison to injection or compression molding
- Simple hand tools needed
  a. Paint brushes, rollers, squeeges
  b. Parting agents, such as, carnauba wax or silicone

III. Materials

A. Polyester Resin
- What it is
- How it is made
- Theory of cure
  a. Mixture of components
  b. Resin activitated by exothermic heat to align molecules
  c. Long chain of molecules form gel state
  d. Cross linking occurs, solid state
  e. Resin locks around reinforcing material
- Thinning agents - styrene monomer
- Catalyst - MEK peroxide and others
- Color pigments - in suitable carrier
- Solvents - resin-out and acetone

B. Other Resins
- Epoxy
- Silicone
- Phenolic
- Melamine
- Thermoplastic

C. Types of reinforcements
- Glass fiber made from glass, processed into several forms
  a. Cloth
  b. Mat
  c. Roving
  d. Fiber
  e. Chopped strands
  f. Chips and/or ground fiber
- Minor types of reinforcements used
  a. Cardboard
  b. Asbestos
  c. Silica
  d. Others

IV. Sample products for school shop program

A. Flat tray-method, open mold
B. Dish-method, male and female mold
C. Boat hull-method, open or pressure bag mold
D. Others

V. Occupational-industrial potentials

A. Job shop
B. On the job repair and maintenance
C. Manufacturing of large items and small quantity production
D. Other areas where uniformity is not critical

SUMMARY:

Hand layup of polyester resin and reinforcements have the chief advantage of being applicable to short production runs where a strong article is desired. A minimum of equipment is necessary, and molds are relatively inexpensive. This material is easy to use in the shop because most of the work can be done with hand tools. The polyester resin, when combined with a reinforcement, provides a durable, lightweight, high strength product.

QUESTIONS:

Q: Describe the advantage of hand layup of polyester reinforced plastics in the small shop.

Q: Describe the types of glass fiber materials used in glass reinforcements.

Q: What chemical reaction takes place when MEK peroxide is mixed in polyester resin? Describe by drawing the four simplified diagrams of molecular states.

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UNIT V LAMINATES

Lesson 24

Demonstration: Reinforced plastics

OBJECTIVES:

. To show the procedure for a hand layup of polyester reinforced plastic

. To acquaint students with some techniques and visual checks in hand layup of polyester reinforced plastics

REFERENCES:

1.	Bick, Alexander F.	Plastics: Projects and Procedures with Polyesters	pp. 1-64
2.	Cope Plastics Hwy #100 Godfrey, Ill.	"How to Make Useful and Decorative Bowls with Fiberglass Cloth - Polyester Resin"	Information sheet
3.	*Sonneborn	Fiberglass Reinforced Plastics	General
4.	Steele, Gerald	Fiber Glass - Projects and Procedures	All

FOR DISCUSSION:

. The four stages of polyester resin
. Types of molds and how they are used
. Types of mold releases used
. Safety, room ventilation, eye protection, skin protection, necessary when using resins and catalysts

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Do a layup of an open mold (model boat hull, dish, etc.).
. Design, build mold and make project from original mold.
. Do a layup project using male and female mold, (dish, cup, etc.).
. Experiment with reinforcements other than glass fiber.

BRIEF DESCRIPTION OF PROCESS:

The hand layup procedure follow four general steps: (1.) preparation; (2.) mixing of gel coats and/or resin with catalyst; (3.) layup or application; and (4.) product finishing. (The process is written in general terms and should be supplemented with a specific reference to manufacturer's instructions. Specific reference is made to visual checks for students.)

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Polyester resin and catalyst
. Gel coat resin and catalyst
. Mold(s)
. Mold release
. Brush, roller, tin cans for washing, paper cups
. Acetone or lacquer thinner
. Shop apron, rags, disposable gloves
. Bench covering - newspaper, cardboard
. Reinforcement - fiber glass, mat, cloth, roving, etc.
. Scissors, knife

. Stirring sticks
. Fine sandpaper

LESSON OUTLINE:

I. Preparation

A. Materials and tools
- Cut reinforcement to mold shape allowing for slight waste
- Assemble resins, catalysts, acetone, mold releases, tools, etc., on bench
- Use small mouth can as container for acetone for easy rinsing of tools after resin application
- Wear shop apron and disposable polyethylene gloves
- Provide adequate air circulation (adequate size exhaust fan)
- Maintain room temperature at about 70-75 degrees F
- Lay cardboard on bench top

B. Mold(s)
- Clean mold surfaces using rag
- Apply mold release carefully to all surfaces; follow manufacturer's instructions. Use two coats.

II. Mixing of resin

A. Gel coat (if used). Follow instructions for proportions.
- Pour out desired amount in clean cup or can (approx. 1 oz. per square foot of surface)
- Add catalyst and stir thoroughly (usual percentage of catalyst is 1% to 2%; 4 to 8 drops per oz. of resin
- Brush or roll resin on to mold surfaces
- Clean tools with acetone rinse
- Allow to cure; sand surface thoroughly to remove any surface wax from cured gel coat

B. Polyester resin. Follow manufacturers instructions for proportions of resin and catalyst.
- Pour resin needed into clean cup or can
- Add catalyst (1% or 4 drops per oz.) and stir thoroughly; look for change in color from pink to amber. Resin is now in catalyzed stage and must be used within a short time.

III. Layup or resin reinforcement process

A. Apply resin with brush or roller; resin should coat all surfaces to be covered

B. Lay on reinforcement

C. Apply polyester resin and saturate reinforcement, bearing in mind the following techniques:
- Saturate all reinforcement in mold
- Use stipple effect of brush to work out air bubbles
- Keep reinforcement in place and use small scraps if extra strength is needed
- Apply more resin to high areas of mold. (Resin has tendency to run to low portion of mold.)
- Take care to avoid uneven saturation, resulting in resin rich areas and resin starved areas
- Assemble and put pressure on male mold (if used)

D. Rinse brush or roller in acetone

E. Clean area, including hands. (Wash hands with soap and water.)

F. Allow for complete curing of resin. Notice milky substance as resin gels; further gelling aligns molecular structure into 3-dimensional cross-linking, which is the cured stage of resin.

IV. Product Finishing

A. Parting from mold
- Check for and trim any hardened waste on edges
- Lift off evenly. (Slight prying may be needed.)

B. Cleaning up mold

C. Finishing product
- Trim edges with saw, sander, plane, etc.
- Remove release agent by wiping
- Proceed with assembly of product as necessary

SUMMARY:

The hand layup of polyester reinforced plastic is an excellent method for the making of limited or low production items. The reinforcement is thoroughly saturated with catalyzed resin, and the gelling-to-curing cycle is readily visable. Safety considerations in the use of the polyester resin are; ventilation, body protection, and equipment protection. The finished product is strong and has the advantages of low cost and high durability.

QUESTIONS:

Q: What are the four steps in the polyester resin molecular cycle?
Q: What are the four general areas of procedure in the hand layup method of reinforcing polyester resin?
Q: Describe the difference between a resin rich and a resin starved area as applicable to working with polyester reinforcements.
Q: What are the major safety factors involved in the use of polyester reinforcements during the hand layup procedure?

UNIT V LAMINATES

Lesson 25

Related Lesson: Low pressure lamination

OBJECTIVES:

To develop an understanding of the process of low pressure heat lamination

REFERENCES:

1.	Cherry, Raymond	General Plastics, 1964 Rev.	Chap. 20
2.	Duffin, D. J.	Laminated Plastics	
3.	Edwards, Lauton	Industrial Arts Plastics	Chap. 18
4.	Simonds and Church	A Concise Guide to Plastics	pp. 172-173
5.	SPI	Plastic Engineering Hand Book	pp. 495
6.	Warner Electric	(Company literature on laminating press)	Warner Electric Co. 1512 Jarvis Ave. Chicago 26, Ill.

FOR DISCUSSION:

. The use of lamination in all areas of plastics
. The types of laminate materials available and their intended uses

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Heat seal a photograph between sheets of acrylic plastic.
. Make a project with embedded articles, i.e., cuff links, broaches, etc.
. Experiment with different types of sheet plastic stock at varied temperatures and pressures.
. Laminate a social security card or other cards (after satisfactory results with practice cards).
. Laminate plastic to other materials (cloth, paper, leather).

BRIEF DESCRIPTION OF PROCESS:

Lamination is the process used to form a bonded product made up of several layers of plastic and other materials. Heat and pressure are used to bond the sandwich-like layers together.

Low pressure lamination is generally accepted as bonding accomplished below a pressure of 300 psi. Plastic sheets usually form the surface over objects such as cards, photos, and similar items.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Samples of low pressure heat lamination
. Samples of pressure sensitive lamination
. Diagram of the lamination process

LESSON OUTLINE:

I. Heat Lamination

A. Purpose
- To seal for protection (identification cards, etc.)
  a. Moisture
  b. Damage
- To beautify and decorate (cuff links, etc.)
  a. Embedding small items
  b. Vari-colored effects

B. Materials
- Low cost
  a. Acetate
  b. Butyrate
- High cost
  a. Acrylic
  b. Vinyl

C. Technical considerations
- Not larger than press platens
- Edge overlap to form seal, 1/8"
- Item embedded able to withstand 400° F

II. Pressure sensitive lamination

A. Purpose. To seal for protection
B. Materials. Plastic sheet with pressure sensitive adhesive on one side
C. Procedure. To be applied to the surface of the item to be protected after removing backing paper, pressing evenly

III. Industrial applications

A. Local job shops - diplomas, cards, photos, etc.
B. Specialty manufacturing
C. Industrial - identification cards, etc.

SUMMARY:

Low pressure heat lamination utilizing acetate, butyrate, acrylic, and vinyl sheet plastics is a simple process and serves a practical purpose in finished products. The items laminated are placed between two or more sheets of plastic and heated under pressure to seal or fuse the contacting sheet plastic around them. Pressure sensitive laminations may also be made. Occupational opportunities appear limited to job shop and similar situations.

QUESTIONS:

Q: Why are identification cards laminated with sheet plastic materials?
Q: Of what value, industrially, is low pressure heat lamination? Why?
Q: Describe the basic process of low pressure heat lamination.
Q: Describe pressure sensitive lamination.

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UNIT V LAMINATES

Lesson 26

Demonstration: Low pressure laminating

OBJECTIVES:

. To demonstrate the procedure for low pressure laminating

. To laminate an item with sheet plastic

REFERENCES:

1. Cherry, Raymond	General Plastics 4th. Ed. 1964	Chap. 20
2. *Duffin, E. J.	Laminated Plastics	General Info
3. Edwards, Lauton	Industrial Arts Plastics	Chap. 18

FOR DISCUSSION:

. Laminating temperatures of different thermoplastic sheet materials in relationship to each other

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Laminate plastic sheet over general organization card or student membership card.
. Test various plastics for laminating qualities.
. Develop a chart to give best heating ranges for different kinds of plastic in sheet form, thicknesses of sheet, and items to be laminated.
. Develop thicker laminations (over fishing flies, etc.).

BRIEF DESCRIPTION OF PROCESS:

The item to be laminated is sandwiched between two sheets of plastic stock and the sandwich is heated to a controlled temperature. Overlapping plastic sheets form around the item, creating an encased thickness slightly more than the original thickness of the items before lamination? Items are put under pressure, cooled under pressure, and trimmed. Pressure sensitive laminates may also be used for protecting items.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Thermoplastic sheet stock (acrylic, acetate, vinyl and others)
. Item to be laminated (social security card, fishing license, etc.)
. Laminating press to include two (2) slick facing sheets. (Capacity of press approx. 300 psi with 310° - 350° heat range)
. Carnauba wax to coat facing plates
. Scissors, tin snips, or other sheet cutting tools
. Fine sandpaper
. Water supply and drainage for cooling press

LESSON OUTLINE:

I. Selecting and cutting the sheet stock

A. Choose stock from one of the following stocks suitable for low pressure laminating
- Acrylics
- Acetates
- Vinyls (unplanished)

- Others (See manufacturers specs. for details on heat, pressure, and time cycles.)

B. Determine size
- Size and capacity of press (item not to exceed platen size)
- Size of item to be laminated, including thickness of item
- Overlap on items (rough 1/4" minimum overlap to get 1/8" minimum finished overlap)

C. Cut to measured size with snips, squaring shear, etc.

II. Preparation and press preheating

A. Preheat the press to desired temperature. (Check manufacturer's specifications of heat required for plastic stock being used.)

B. Clean and wax facing plates as necessary

C. Dry run the complete sandwich into the press opening to check for fit

D. Dry item to be laminated. Trapped moisture causes fogginess in the laminate

III. Operating procedure for laminating

A. Set up sandwich (in sequence)
- Back up plate
- Heat distribution or cushion sheets, blotters, etc.
- Slick facing sheets (chrome plated sheets and/or ferrotype plates)
- First plastic sheet
- Item to be laminated
- Second plastic sheet
- Slick facing sheet
- Heat distribution or cushion sheets
- Back up plate
- The above 9 items clamped together by the plates with vice grip, wrench, or "C" clamps

B. Heating cycle
- Insert clamped sandwich (1-9, above) in heated press and apply pressure, (Formula: total load lbs = psi required x sq. in. of surface area)
- For each laminated item in stack, add proportionate time to heating cycle, but do not add more pressure
- Release the pressure and remove the clamped stack
- Place stack in cooled portion of the press and apply same pressure for same time as for heating cycle
- Remove the cooled stack and unclamp the vise grips
- Label the press and hot items as "HOT"

IV. Trimming laminated items

A. Trim all edges to a minimum of 1/8" overlap all around

B. Sand or polish the sharp edges of the laminate

SUMMARY:

Low pressure laminating of sheet stock depends on the proper application of heat and pressure. The time cycle for heat fusing and cooling is equal. Pressure is maintained throughout the heating and cooling cycles.

The item laminated has a sealed edge around it and also has its surface covered with the plastic stock. The protective qualities conferred by this type of lamination are excellent for items handled repeatedly.

QUESTIONS:

Q: What are the requirements for a successful low pressure heat laminate?
Q: What condition causes fogginess under laminated sheet?
Q: How can fogginess be eliminated in low pressure heat lamination?

UNIT V LAMINATES

Lesson 27

Related Lesson: High pressure laminating

OBJECTIVES:

. To develop in the student an understanding of high pressure laminates

. To acquaint the student with the uses of this material

REFERENCES:

1. Cherry, Raymond	General Plastics, 4th Ed.	pp. 131-132
2. *Duffin, D. J.	Laminated Plastics	Chs. 4-5
3. *Gould, David F.	Phenolic Resins	Ch. 6
4. Hutchings and Lindbeck	Panelyte in the School Shop	pp. 1-6
5. Simonds and Church	Concise Guide to Plastics 2nd Edition	pp. 170-173
6. Redfarn and Bedord	Experimental Plastics	p. 73

FOR DISCUSSION:

. Types of laminates
  - Resins and fibrous materials used
. Coating or wetting process employed

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Make a list of the places where high pressure laminates are used in the home.
. Compare plastic laminated countertops and finished wood countertops.
. Make some high pressure circuit boards.

BRIEF DESCRIPTION OF PROCESS:

High pressure laminates are multilayer sandwich structures. They consist of sheets of various materials bonded with adhesive resins. After bonding they are molded and cured at pressures not lower than 1000 psi. Pressures of 1200 psi are commonly used. Formica and Micarta are common trade names.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Chart #1 showing laminate structure of solid sandwich
. Chart #2 showing preparation of fibrous sheets
. Formica counter top material of sandwich construction
. Printed circuit board of solid construction

High Pressure Laminate Construction
courtesy of Panelyte Division, St. Regis

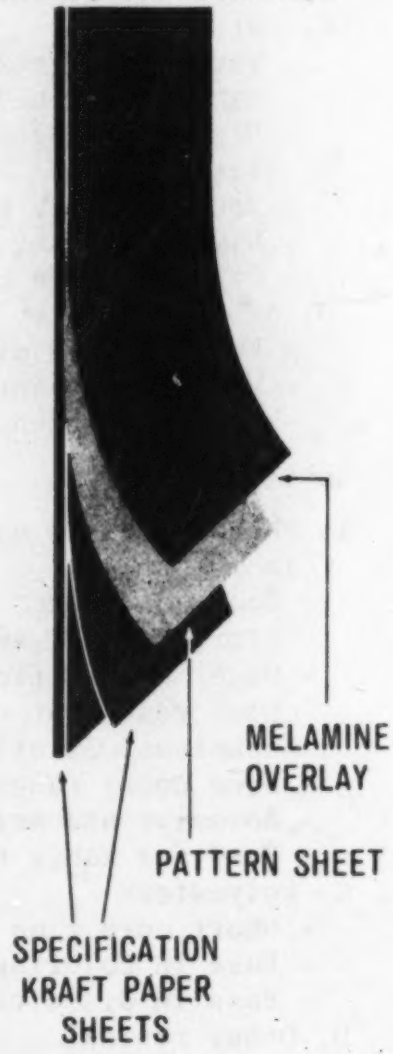

LESSON OUTLINE: (Ref. #5)

I. Development of high pressure laminates

A. Production low before World War I
B. Vulcanized fabric (rubber base) produced by Continental-Diamond in 1911
C. Resins for laminating became available in the 1930's
D. Phenolics first used for laminating resin

II. Structural types of high pressure laminates (Ref. #3)

A. Solid Construction. Multiple layers of fibrous sheets and resin binder are compacted into a homogeneous unit. Facing sheets may be of two different materials.
B. Sandwich construction. A construction involving the bonding together of a relatively thick, low density core and thin, high strength facing sheets.

III. The Fibrous materials used (Ref. #2)

A. Papers - Kraft, Alpha, Rag (cotton fibers)
- Quality desired in end product is the determining factor in choice of fiber material to be used
- Construction employed often uses core stock with decorative sheets overlayed
- Large quantities used for production of printed circuitry

B. Cotton cloth
- Various weights and weaves used in wide range of applications
- High strength obtainable through use of heavy fiber
- High impact strength possible for use in gears and pulleys

C. Glass cloth
- Becoming very popular
- High strength, chemically resistant
- Difficulty in wetting or soaking this cloth with resin

D. Asbestos felts, mats, papers
- Felts are 10 mils or under in thickness; Mats are over 10 mils
- May be purchased with or without resin binder
- Used with phenolic resin for high heat resistance

IV. Resins (Ref. #2)

A. Phenolic resin most common. 105 million pounds used for laminating in 1963
- Good adhesion
- Limited color selection
- Made in 16 different electrical grades
- Heat resistant up to 300-350° when combined with epoxy

B. Melamines. 32 million pounds used for laminating in 1963
- Wide color range
- Abrasive and acid resistant
- Used for table tops, counters

C. Polyesters
- Short cure time
- Ease in coloring
- Ease in dissolving for wetting process

D. Other resins
- Acrylics, fluorocarbons, epoxies, etc.

V. Preparation and function of materials and equipment (Ref. #4)

A. Resins
- Powder or pellets dissolved in solvent (ketones, alcohol, etc.)
- Also available in prepared liquid form

B. Coating process or wetting process (Use chart No. 1)
- Machine - coating and drying
- Wetting - coating material with resin
- Drying chamber - removes volatiles from resin
- Re-coating sometimes necessary

C. Patterned sheets-used in sandwich construction laminates
- Paper with high wet strength
- Printed if desired, coated with resin
- Transparent overlay - need a high percentage of resin

D. Facing sheets for solid construction laminates
- Copper, steel, aluminum alloys, cork and vulcanized fiber
- Sheets are treated on surfaces as needed for adhesion
- Films of polyester and cellulose acetate also used

VI. Laminating presses

A. Sheet stock press (Ref. #2)
- Vertical action with single or multiple platens
- Platens plated or highly polished
- Separate plates of stainless or chrome
- Very large platen sizes up to 80" long, 40" wide
- Platens heated with steam, electricity or water (under pressure)

B. Molding presses
- Shaped dies may be used in place of flat plates
- Used for intricate forms

C. Tube winders. Used to make tubes and rods

VII. Application of high pressure laminates (Ref. #1)

A. Automotive - timing gear
B. Electrical - printed circuits, switchboard panels
C. Home use - countertops and table tops

SUMMARY:

With the use of different combinations of fillers and resins, a wide range of high pressure laminates may be produced. The different combination will give the laminates different mechanical, electrical and chemical properties, tailor made for specific applications.

QUESTIONS:

Q: What is meant by high pressure laminating?
Q: What is the difference in solid and sandwich construction of high pressure laminates?
Q: What are some common fibrous materials used in high pressure laminating?

UNIT V LAMINATES

Lesson 28

Demonstration: High pressure laminating

OBJECTIVES:

. To give the students an understanding of how high pressure laminates are made

. To show the students some of the common materials used in this process

REFERENCES:

1. *Duffen, D. J.	Laminated Plastic	Chaps. 4-5
2. *Gould, David F.	Phenolic Resins	Chap. 6
3. *Hutchings and Lindbeck	Panelyte in the School Shop	Chap. 4-6
4. Simonds and Church	Concise Guide to Plastics	pp. 170-173
5. SPI	Plastics: The Story of an Industry	p. 36

FOR DISCUSSION:

. Factors determining choice of laminating resins
. Factors determining choice of laminating filler materials

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Projects: drum practice pad, printed circuit plates.
. Experiment by laminating different materials at different heats, pressures and times.
. Experiment by compounding different resins and fillers for making core stock.

High Pressure Laminating
courtesy of The Society of the Plastics Industry

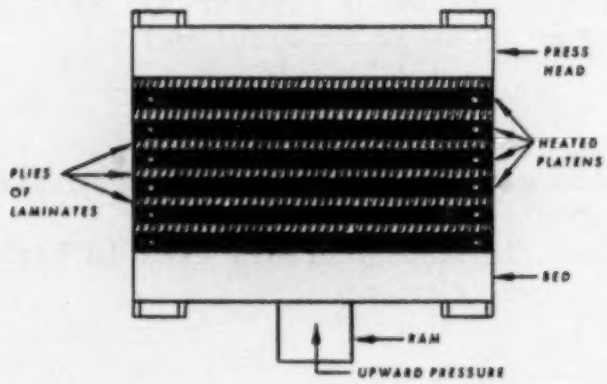

BRIEF DESCRIPTION OF PROCESS:

High pressure laminates are multilayer sandwich structures with sheets of the same, or various stocks, bonded with adhesive resins, molded and cured at pressures not lower than 1000 psi and more commonly in the 1200 psi range.

Formica, Panelyte, Micarta, Synthane, and Dilecto are some of the common trade names.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Laminating Press
. Polished Plates
. Materials - impregnated material available
. Pressure pads, kraft paper, blotter material
. Asbestos gloves
. Drawing or photograph of plastics laminating press

LESSON OUTLINE:

I. Machine description

A. Platens
- Heat source. Electricity, steam, or hot water
- Size. Laboratory models, 6" x 6" to about 10" x 12". Up to 40" x 80" in industry
- Ram connected at botton (force or chase)
- Adjustable - change daylight between platens

B. Columns
- Alignment - keeps platens parallel
- Allow for travel of platens

C. Press mechanism. On laboratory models, 10 to 30 tons; up to 200 tons and more on industrial types)
- Hydraulic jack
- Pressure measured in load pounds for vertical movement

II. Auxiliary equipment

A. Facing plates (placed next to material to give a good surface texture)
- Stainless steel or chrome plated
- Finishes vary
  a. High gloss
  b. Dull matt
  c. Embossed - special jobs

B. Pressure pads
- Unsaturated kraft paper or ink blotter material
- Purposes
  a. Cushions to minimize temperature and pressure differences
  b. Shields to protect plates, reduce wear

III. Materials used in process

A. Kraft paper impregnated with phenolic resins
B. Resins: polyester, melamine
C. Fibrous materials: cotton, asbestos, glass and fiber cloth

IV. Laminating process

A. Preheat pressure plates to 250° - 300°

B. Cut core and facing sheets to size for sandwich construction

C. Place facing sheet in place on top of sandwich

D. Apply mold release to plates

E. Place plates on top and bottom of materials

F. Position pressure pads on outside surface of top and bottom plates

G. Place pack between heated plates (285° - 300°)

H. Apply calculated pressure to plates
- Commonly about 1000 psi, occasionally up to 2000
- Pressure figured by load in pounds - no. square inch x psi recommended for material
- Allow continuous pressure for from 20 min. to 12 hours (depending on material used, as recommended by manufacturer)

I. Remove pack and disassemble

V. Safety

A. Wear gloves when handling hot plates and when working around heated press

B. Label hot materials and press

SUMMARY:

Good results from high pressure lamination depend on the use of proper temperatures, pressures, and curing time for materials being used. Careful control of these variables govern the quality of material produced.

QUESTIONS:

Q: What function do the polished plates serve in high pressure lamination?

Q: What purpose do the pressure pads serve in high pressure lamination?

Q: How would you figure load pounds for a given material to be used in high pressure laminating?

UNIT VI

ENCAPSULATION

Lesson Page

29 Casting and embedding (demonstration) 104

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UNIT VI ENCAPSULATION

Lesson 29

Demonstration: Casting and embedding

OBJECTIVES:

. To teach the student to case and embed materials in plastic resins

. To teach students to work with thermosetting plastic resins

REFERENCES:

1. Bick, Alexander F. — Plastics: Projects and Procedures with Polyesters
2. Castalite Co. — How to use Castalite
3. Holt, Elmer — Casting in Clear Plastic
4. *Harden, Cleo E. — How to preserve animal and Other Specimens in clear plastic
5. *Pearson, Hazel — Liquid Plastic Artistry
6. SPI — Plastics Engineering Handbooks

FOR DISCUSSION:

. Protection of electronic components by potting as protection from vibration and atmosphere
. Casting as an economical method of preserving biological specimens
. Theory of cure in polyester and other thermosetting resins
. Methods of determining specific gravity

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Select and embed a coin, stone or biology specimen.
. Arrange and embed shells and similar materials to form an artistic or decorative scene or form.
. Experiment with different resins, catalysts, and cure cycles to determine one with the least possible shrinkage.
. Demonstrate the cracking or crazing caused by rapid cure cycles.
. Measure the heat of cure for various cure cycles and conditions.

BRIEF DESCRIPTION OF PROCESS:

Embedding, often referred to as casting, potting, and/or encapsulation, is a process where by an object such as a coin, biological specimen, or electrical component is placed in a liquid plastic material and the material is polymerized.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Polyester casting resin and catalyst (non-air-inhibited)
. Molds (glass tumbler, commercial glazed ceramic mold or any nonporous surface)
. Mold release (carnauba wax or polyester mold release)
. Mixing cups and sticks (tongue depressors, paper cups)
. Specimens (coins, stones, shells, bugs, etc.)
. Eye dropper

LESSON OUTLINE:

A. Select and prepare the mold
- Select proper size and shape for item to be embedded
- Mold should have minimum draft of about 5°
- Apply mold release with a rag

B. Prepare a specimen
- Clean; be sure item is dry and grease free. (Buff or polish lightly. Shine with paste wax to remove buffing compound.)
- If biological specimens are desired, prepare in accordance with instructions furnished by several suppliers. (Reference No. 4)

C. Prepare the resin
- Measure a small quantity and pour in a paper cup. (An ordinary metal kitchen measuring spoon set is desirable. Clean with acetone after use.)
- Determine proper catalyst concentration
  a. Ratio determined by layer thickness
     Thicker layers require less catalyst
  b. Consult chart provided for resin being used
     One manufacturer recommends:

1/8" layer or less	8 drops per tablespoon resin
1/8" to 1/4"	6 drops per tablespoon resin
1/4" to 1/2"	4 drops per tablespoon resin
1/2" to 1"	2 drops per tablespoon resin

- Measure out and add catalyst; mix well
- Relate method of determining catalyst concentration. Tell how thick sections of layers can crack from use of too much catalyst. Relate how rapid cures cause excess shrinkage.

D. Pour base layer
- Partially fill mold to form base layer (1/8" to 1/2", depending on size and depth of mold). Agitate mold with vibrator tool.
- Allow to gel
- Describe theory of cure of polyester resins
  a. Catalyst oxidizes the accelerator
  b. Oxidation causes heat (exothermic)
  c. Heat causes the molecules of the resin to link together forming chains
  d. Chains crosslink with other chains to form a solid

E. Add specimen
- Coat specimen with catalyzed resin to seal out air bubbles
- Place on gelled base layer
- Cover with catalyzed resin. (Light weight specimens float. Pour a thin holding layer and allow to gel.)
- Relate specific gravity information effecting specimens. Compare specific gravities of materials.

F. Pour a cover layer
- Measure, catalyze and pour layer or layers and cure
- Relate how several thin layers cause less problems than thick layers
- Relate difference between air-inhibited and non-air-inhibited resin

G. Remove from the mold
- Show how shrink will pull large castings from the edges
- Show how hot and cold water baths help release small castings
- Show how air jets can release surface tension to help pull castings

H. Trim and buff
- File and/or sand surface exposed to air and corners
- Buff (as you would acrylic plastic) if desired
- Relate that buffing is actually an abrasive operation and how it creates heat

SUMMARY:

The casting or encapsulation with polyester resins consists of a simple and well planned sequence of measuring, catalyzing, and pouring of resins into a properly prepared mold. A specimen is added, if desired. When the resin has properly cured, it has undergone a chemical change (polymerization). This material cannot return to its original liquid form.

QUESTIONS:

Q: Why does the resin become hard when catalyzed?
Q: Might the resin be hardened without a catalyst? If so, how can this be done?
Q: How does layer thickness affect cure time? What compensation is made for layer thickness in catalyzation?
Q: What is exothermic heat? Endothermic heat?
Q: What material is added to polyester resins to make them non-air-inhibited?
Q: Why must specimens be clean, dry and grease free for use as embedments?

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UNIT VII

FOAMS

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31	Expandable bead foam molding (demonstration)	112
32	Expandable resin foams (related)	116
33	Expandable urethane foam molding (demonstration)	119

UNIT VII FOAMS

Lesson 30

Related Lesson: Expandable bead foam

OBJECTIVES:

. To obtain a knowledge of the development of polystyrene
. To introduce an understanding of the methods of molding foams
. To give students an insight into the many applications of the products in industry and the home

REFERENCES:

1.	Koppers Co., Inc.	Expandable Polystyrene	pp. 1-33
2.	SPI	Plastics: Story of an Industry	pp. 26-27
3.	Swanson, Robert	Plastics Technology	Chap. 10
4.	*Teach and Kiessling	Polystyrene	pp. 128-150

FOR DISCUSSION:

. Chemical and historical development
. Properties and characteristics of expandable polystyrene
. Compounding methods of the beads
. Industrial and consumer applications of expandable polystyrene

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Compare historical development of polystyrene with development of other plastic materials.
. Study various advantages, properties, and limitations of products made of polystyrene.
. Show various samples of objects molded from polystyrene heat-expanded beads.
. Experiment with the amount of expansion in various brands of polystyrene heat-expandable beads.

BRIEF DESCRIPTION OF PROCESS:

Polystyrene, in the form of foam materials, is a rapidly growing area of application in the plastics industry. Polystyrene heat-expandable beads are placed in a mold, subjected to heat, and expanded into a foam which has a closed cell structure.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Virgin beads
. Expanded beads
. Product samples - bottles, toys, sandwich panels, packing materials

LESSON OUTLINE:

I. Polystyrene chemistry

A. Production
- Coal tar and natural gas are distilled to form ethyl benzine
- Polymerization of ethyl benzine produces polystyrene

- An expanding agent is added to polystyrene beads. The styrene beads are manufactured by suspension polymerization wherein the necessary quantity of expanding agent is forced into the beads in a pressure vessel by one of a number of patented processes. The resultant product contains from 5 to 8 percent volatile material which, with the application of heat, will cause the polystyrene beads to expand to several times its original size.

B. Characteristics
- Thermal insulator. Very low thermal conductivity; (K factor examples: refrigerator parts, air conditioners)
- Water resistance. Low water absorption, less than 1% water absorption by volume. Examples: buoys, boats, buoyant chambers
- Shock resistance. Energy absorption of 61 lbs per sq. in. at a density of 1 lb per cubic foot
- Strong and lightweight. Lighter than cork and moldable at densities as low as 1 lb. per cubic foot, 1 cubic foot supporting over 60 lbs. in water

II. History

A. In 1839, the German scientist, Simon, develops styrol (little commercial value)

B. From 1839-1938, Experimentation indicated by patents issued shows that polystyrene was developed from styrol

C. In 1950's, Expandable beads are developed by large chemical companies in Germany

D. As of 1964, Expansion of use is projected in the area of automobile body construction and sandwich constructed building materials

III. Processing techniques

A. In large objects pre-expansion necessary to control density

B. Molding techniques:
- Steam chest autoclave (pressure cooker)
- Steam probe
- Conduction heating
- Radio frequency (as a source of heat, may become most popular industrial method)

C. Where pre-expansion is not necessary virgin or non-expanded beads are used

IV. Applications

A. Thermal insulation
- Refrigerator linings and storage units
- Rocketry
- Picnic coolers

B. Buoyance - boat construction

C. Core in sandwich construction - insulation, building materials

D. Low density filler - blocks, sheets, and loose fill used for packaging television tubes, meters, etc.

V. Industrial considerations

A. Production volume. Polystyrene accounted for 33 percent of the plastics volume used in 1964; an increasing amount of this volume is in the form of expanded beads

B. Industry is experimenting with auto body construction and building materials as new uses for expanded bead

VI. Consumer values

A. Picnic coolers. Thermal insulation bottles are inexpensive and lightweight with shock resistant qualities as well

B. Packaging with loose fill. Expanded polystyrene foam is more expensive than conventional materials, but the high shock resistance of the plastics material results in less breakage and lower final price to the consumer.

VII. Safety precautions

A. A low flash point creates a fire hazard. Some foams are specially compounded to be self-extinguishing.

B. Avoid breathing fumes. The blowing agent usually induced in the bead is a toxic gas. Store beads in airtight containers.

SUMMARY:

Expandable polystyrene is a thermoplastic that comes as small high density granules containing an expanding agent. When heated in a suitable mold the beads expand up to 45 times their size and fuse to form a strong, light weight plastic foam. The characteristic of the foam lends itself readily to a variety of uses.

Of the major basic materials of the plastics industry, one third of the volume is polystyrene (approximately 20 percent of polystyrene used for foams in 1963). Toxic gases and a comparatively low flash point warrant care when handling the heat expandable beads.

QUESTIONS:

Q: What impact has the development of foam had on the use of polystyrene in the plastics industry?
Q: Give five examples of articles manufactured from polystyrene heat-expandable beads.
Q: Give several reasons for the increased use of polystyrene expanded beads.
Q: What characteristics of the heat-expandable beads should be considered when handling?

UNIT VII FOAMS

Lesson 31

Demonstration: Expandable bead foam molding

OBJECTIVES:

. To introduce an understanding of the procedures followed when molding various objects by use of the steam chest method

. To acquaint students with characteristics of polystyrene heat-expandable beads

REFERENCES:

1.	Koppers Co., Inc.	Expandable Polystyrene	pp. 1-33
2.	SPI	Plastics: The Story of an Industry	pp. 26-27
3.	Swanson, Robert	Plastics Technology	Chap. 10
4.	*Teach and Kiessling	Polystyrene	pp. 128-150

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Mold from a cast or spun aluminum mold, using a pressure cooker.
. Mold from a thin walled mold immersed in boiling water.
. Mold from an aluminum foil mold, using a radiant heat source.

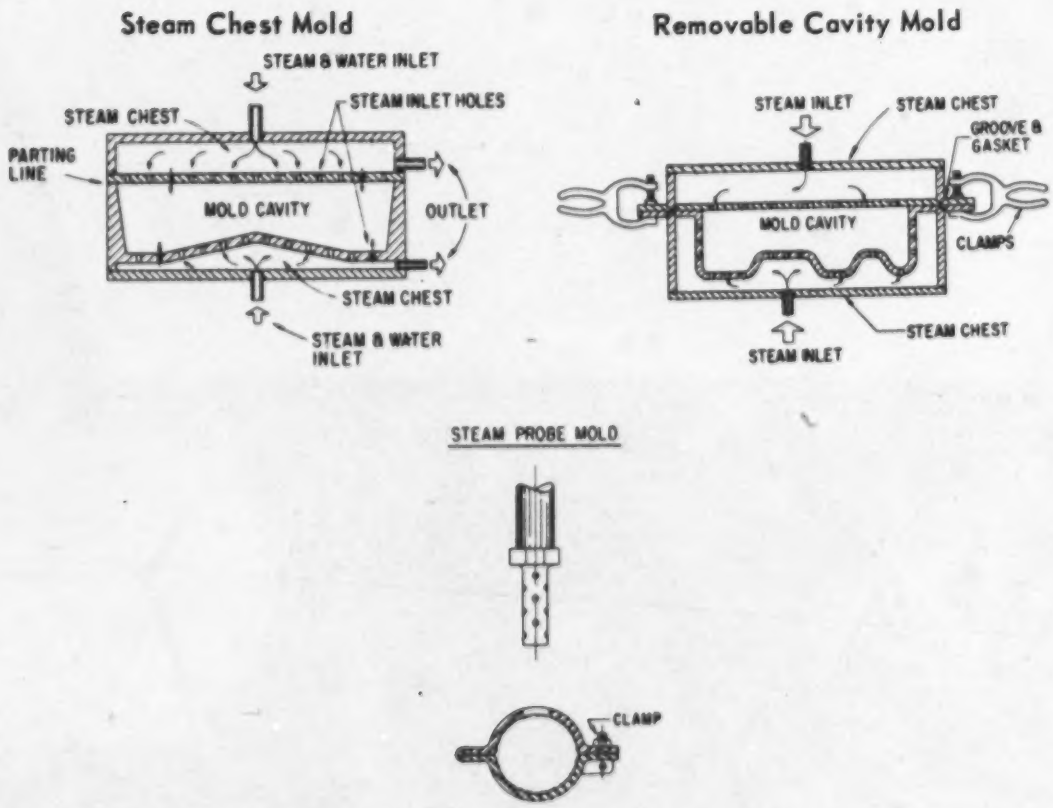

courtesy of The Dow Chemical Company

BRIEF DESCRIPTION OF PROCESS:

Foamed articles can be made quickly and easily using expandable polystyrene beads by heating the beads to cause expansion within a suitable confining mold.

The density of the molded article is governed by the pre-expansion of virgin beads in an unconfined manner, and careful measurement of material used to change each mold.

Steam heat is often used to further expand the beads within a mold which determines the shape and helps form a unicellular rigid foam.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Virgin beads
. Pre-expanded beads
. Mold release (spray or heat resistant wax)
. Devices to pre-expand the beads
  - Heat lamp - radiant heater
  - Boiling water
  - Sieve fine screen
. Molding unit
  - Pressure cooker
  - Pot of boiling water
. Molds
  - Cast
  - Spun
. Pail of cold water
. Safety goggles, asbestos gloves
. Tongs

LESSON OUTLINE:

I. Pre-expanding the beads. This process is used in industry to control density when using large molds

   A. Stir beads in boiling water (will float when expanded). Then allow to cool and dry before use.

   B. Heat with radiant heaters over a variable speed traveling belt, or vary the heat source over a constant speed traveling belt

II. Molds. Spun aluminum or cast aluminum

   A. Vent holes. Drill one for every two square inches of mold area, using a number 60 drill

   B. Mold release. Apply light coat of silicone spray to interior

III. Molding

   A. Prepare a mold
   - Filling:
     a. For a thin wall section part or where surface durability is desired, use raw or virgin beads (not pre-expanded). Fill mold one-half to three-fourths full. Object will be quite hard and dense.
     b. For thick wall section part or where light weight or low thermal conductivity is desired, use pre-expanded beads of the desired density. Fill mold full.

- Close mold and fasten top securely

B. Autoclave (pressure cooker)
- Add water. Observe safety limits for unit being used.
- Bring water to boiling point
- Place mold in steaming unit
- Secure top of pressure cooker, keeping safety valves open
- Close escape valves after top has been secured
- Raise steam pressure to 15-25 psi, or within limits prescribed for unit being used. (Steaming time will vary due to wall thickness of mold and steam pressure. Try 2 minutes time after pressure reaches 20 psi.)
- Open escape valves to release steam. (Wear asbestos gloves and safety goggles.)

C. Remove mold using tongs

D. Cool mold by placing in cold water for 5 minutes

E. Open mold, remove product. Use air jet on edges if removal is difficult.

IV. Alternate methods

A. Conduction heating method. This heat source may be used for thin molds in place of steam

B. Hot water method. Thin molds may be immersed in boiling water for expansion

C. Steam chest and steam probe. This method is used in industry for thick section

V. Safety precautions

A. In handling the beads
- Toxic vapors present a hazard when bead container is opened
- Beads have low flash point and represent a fire hazard
- Keep beads off floor to prevent slipping

B. In the use of steam equipment
- Secure top
- Add water each time pressure cooker is used
- Use asbestos gloves and safety goggles
- Follow operating instructions for steam equipment being used

SUMMARY:

Polystyrene heat expandable beads may be placed in a suitable mold and moved to an autoclave (pressure cooker) for a time sufficient to cause the blowing agent to expand the bead and produce a polystyrene foam product.

QUESTIONS:

Q: How is the density of a polystyrene expandable-bead product determined in our experiment?
Q: What methods are used in industry to produce polystyrene foam products?
Q: Why are polystyrene beads pre-expanded in industry?
Q: How may we pre-expand polystyrene beads in class?

TABLE OF PLASTIC FOAMS

Foam Name	History	Foaming Agent	How Foamed	Components	Open/ Closed	Rigid/ Flex.	*Fabrication FIP	Mold	**Ext.	Application	Toxic
CELLULOSE ACETATE	WW II ships-planes	Super heated solvent	Extruded	CA solvent	C	R			X	Structurals insulation panels Flotation	
EPOXIES (special equip. necessary)	1949 - Encapsulate Elect. parts	Polystrene Beads	Endothermic heat Exothermic heat	Epoxy - Catalyst exp. beads	O C	R	X	X	X	Insulation Electrical Acoustical Thermal	
PHENOLIC (special equip. necessary)	1945 - U. S.	Reaction between Phenol Formaldehyde or Hollow beads	Liberation of gas	Phenol Formaldehyde or Hollow beads Polyester Resin	C	R	X	X	X	Insulation Thermal Acoustical Electrical	X
POLYETHYLENE (special equip. necessary)	1944 wire insulation	Thermal Liberates inert gas	Extruded	Polyethylene Nitrogen gas	C	F	X		X	Wire Insulation	
POLYSTYRENE (may be used in school shop)	1952 Germany 1954 U. S.	Gas Heat Pressure	Extruded	Polystyrene Nitrogen gas	C	R	X	X	X	Packaging Flotation	
SILICONES (special equip. necessary)	1950 U. S.	Nitrogen when heated	Liberation of Nitrogen	Blowing agent Silicon catalyst	C	R F	X	X	X	Insulation Thermal Acoustical Electrical	
URETHANE (may be mixed by hand)	1930's Germany	Water and amine	Liberation of gas	B. agent Polyoly Isocyanate Water	O C	F R	X	X	X	Insulation Flotation Packaging Upholstery	X some
UREA - FORMALDEHYDE (special equip. necessary)	WW II Germany	Mechanical whipping of air, Hollow spheres are added to mix			O C	R	X	X	X	Thermal insulation Floral displays	
CELLULAR VINYLS (special equip. necessary)	WW II Germany	Mechanical Blowing			C C	F R	X	X	X		

*FIP - Foam in Place **Ext. - Extrude

UNIT VII FOAMS

Lesson 32

Related Lesson: Expandable resin foams

OBJECTIVES:

. To develop an interest in how industry uses resin foams

. To acquaint the student with various foams used by industry

REFERENCES:

1.	Lewis, Alfred	The New World of Plastics	p. 50
2.	Redfarn and Bedford	Experimental Plastics	
3.	SPI	Plastics Engineering Handbook	pp. 137-197

FOR DISCUSSION:

. The manufacture of foams
. The application or use of foams

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Foam in place a coaster for glasses.
. Identify some objects, common to the home, that are made of foam.
. Make some polyurethane foam from polyester resin.

BRIEF DESCRIPTION OF PROCESS:

Foam plastics are resin materials in cellular or sponge form. The foam may be flexible or rigid, the cells open or closed. Foams may be expanded in a mold, expanded in place, sprayed, or extruded to achieve the desired result.

MATERIAL, EQUIPMENT AND/OR TEACHING AIDS:

. Foamed articles - packing cases, ring buoy
. Chart of foams on handout sheet

LESSON OUTLINE:

I. Science

A. Open cell. A cluster of cells, some connected to each other; not separated by a wall of plastic

B. Closed cell. A cluster of cells each enclosed by a wall of plastic; non-interconnected

C. Expanded by adding a foaming agent or blowing agent to the plastic
- Gas is blown into mix or dissolved in mix
- Heat volatizes blowing agent
- Tiny beads of thermoplastic or thermosetting resin, expandable by heat, are put into mix

D. Uniformity of cell structure
- The blowing agent must disperse throughout the mix
- The release of gas over a period of time and range of temperature should be rapid but controllable
- Select a blowing agent that is non toxic, will not develop too much heat, and will not effect rate of cure
- Check manufacturer's recommendation in selecting blowing agent

E. Foam characteristics
- Usually good heat and electrical insulators
- May be flexible or rigid
- Flexible open cell will absorb water
- Flexible and rigid closed cells will float
- Structure of walls and cells give strength to the foam
- Density can be varied

F. Safety
- Store resin and blowing agent in cool place
  Refrigeration lengthens shelf life
- Keep away from fire and flame
- Have proper ventilation. (Essential do not inhale fumes).
- Keep containers covered
- Wear gloves (disposable type is best)

II. Urethene foam, it's composition, industrial use and application

A. Made by mixing a resin, water and a isocyanate catalyst

B. Varies from flexible to rigid and therefore lends itself to a wide range of uses

C. Processes of using urethane foam
- Batch mixed
  a. Material blended thoroughly
  b. Mixed until foaming begins
  c. Poured into cavity
- Continuous metering and mixing
  a. Separate pump handles components
  b. Enough of the components pumped to fill cavity
  c. A nozzle used to inject foam into a mold
  d. Foams in the cavity
- Spray application (for thin applications)
  a. External mix guns. Catalyst is mixed into resin as it issues from nozzle.
  b. Internal mix. Catalyst and resin are mixed together before spray.
  c. Reaction starts as compound leaves gun
- Slabs (flexible and rigid)
  a. Mixing head lays down a layer of mix on release paper
  b. Expand to desired thickness
  c. Thin sheets may be slit from large slabs
- Mold forming
  a. Measured amount of foam is injected into mold
  b. Foam expands to take shape of mold

D. Application
- Flexible
  a. Seat cushions and padding
  b. Shock proofing - dash boards
  c. Insulation - pipes, homes, etc.
- Rigid
  a. Floatation - boat hulls
  b. Insulation - buildings
  c. Structural - airplanes, boats, etc.

E. Consumer values
- Cost of plastic foams is less than that of foam rubber
- Plastic foams do not deteriorate as rubber foams do
- Fire hazard is greater in urethane foams than rubber foams

III. Other plastic foams
(See chart)

SUMMARY:

A wide variety of foams are available and used in our daily life. Chemicals may be compounded to form many basic foam resins. They are open or closed cell structure and either rigid or flexible. Foams are usually good heat barriers due to low density characteristics.

QUESTIONS:

Q: Identify names of foams.
Q: What is the difference between open and closed cell foams?
Q: Where are some major foams used in day to day living?
Q: What does a forming agent do in the forming of a foam?
Q: What role does the resin in a foam play?

UNIT VII FOAMS

Lesson 33

Demonstration: Expandable urethane foam molding

OBJECTIVES:

. To show the process used in making urethane foam products

. To introduce the student to materials used in foams

REFERENCES:

1.	Edwards, Lauton	Industrial Arts Plastics	P. 129
2.	Swanson, Robert	Plastics Technology	Ch. 1,3,18

FOR DISCUSSION:

. The uses of urethane foam
. Safety precautions to be employed in working with foam

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Foam in place around a thermos type bottle.
. Make a buoy for a swimming pool.
. Make some duck decoys (vacuum formed skin, foam in place core).

BRIEF DESCRIPTION OF PROCESS:

Urethane foam is made by mixing proper proportions of resin and blowing agent. The resulting expansion causes air cells to form in the resin, giving the material its light weight, buoyancy, and insulating properties.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Urethane foam components for either rigid or flexible products
. Electric hand drill with paint mixer paddle
. Acetone for cleaning
. Containers to mix in, such as paper cups, tin cans, etc.
. One pound capacity postal scale
. Small cups for weighing components
. Rubber gloves or disposable plastic gloves

LESSON OUTLINE:

I. Pouring and mixing

A. Measure by weight (proportions of components in product instructions, often 50/50)

B. Pour components together

C. Mix with electric drill for from 10 to 30 seconds. (Read instructions and experiment with each resin used.)

D. Pour into mold or form
. Let foam set for approx. 5 minutes
. Foam achieves full strength in approximately 24 hours

II. Safety

A. Work under exhaust fan. Avoid breathing vapors released during foaming.

B. Keep resins away from fire and flames

C. Wear rubber, or disposable plastic gloves

D. Wash foam off tools and hands before it sets, using acetone or lacquer thinner, followed by soap and water. (Acetone will dissolve foams after setting.)

SUMMARY:

Foams have opened new horizons; we may now add buoyancy, insulating, or cushioning qualities to products as needed.

QUESTIONS:

Q: Where can we use rigid urethane foam?
Q: Where is flexible urethane foam used primarily?
Q: What makes a plastic foam expand?

UNIT VIII

COATING

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UNIT VIII COATING

Lesson 34

Related Lesson: Coating processes

OBJECTIVES:

. To develop an understanding of coating processes in commercial use

. To investigate occupational-industrial potentials

. To develop an understanding of basic coating materials

REFERENCES:

1.	Bakelite	The ABC'S of Modern Plastics	p. 12
2.	Simonds and Church	Concise Guide to Plastics	pp. 66,83,87, 163,165,203,205
3.	*SPI	Plastic Engineering Handbook	pp. 250-270

FOR DISCUSSION:

. Major uses of plastic coated products
. Occupational industrial potentials of plastic coatings
. Products and respective coatings

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Dip coat a project (hot or cold).
. Upholster with vinyl fabrics.
. Take a field trip to a coating plant.
. Make a mock up of a coating mill.
. Try coating various kinds of cloth and assorted coating materials.

BRIEF DESCRIPTION OF PROCESS:

Coating processes are methods for applying a film or thin layer of plastic to an item. This covering serves three purposes:

- To protect
- To decorate
- To reduce vibrations (optional)

Which of the coating processes are to be used is determined by the following:

- Type of material or item to be coated
- Type of coating material to be used
- Equipment available and/or location of application

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Samples of as many coated products as are available
. Pictures and/or charts depicting coating principles

LESSON OUTLINE:

I. Definition and purpose of coating

A. Controlled application of a mobile film forming material
B. Protective, decorative, and vibration dampening

II. Coating developments

A. Coating applications developed during World War II to protect electronic components and wires in severe environmental conditions

B. Other developments in response to need for material protection from damage in handling, storage and in-motion vibration

III. Basic Materials Coated with Plastics

A. Paper - milk carton
B. Fabric - window shade
C. Metals - tool edges and high exposure products
D. Wood - paints

IV. Plastic Coating Resins

A. Melamine
B. Vinyl
C. Polyamide (Nylon)
D. Epoxy
E. Styrene
F. Polyethylene
G. Alkyds (major use is coating)
H. Polyesters (200 million lbs. used in 1961)
I. Phenolics
J. Ureas
K. Cellulosics
L. Acrylates
M. Silicones
N. Fluorocarbons
O. Polyurethane
P. Elastomers

V. Basic Coating Processes (see diagrams)

A. Painting - use of brush, roller or spray gun

B. Dipping
- Hot dipping - cushion grip on plier handles
- Cold dipping - protective coating on edge tools

C. Fluidized bed-coated - chain

D. Vacuum metallizing - dash board parts

E. Electroplating - light reflectors

F. Silk screening on package decoration

G. Calendering spread coating and roller coating-vinyl fabric, milk cartons, etc.

H. Flame spraying prototype work

I. Extrusion coating wire insulation

J. Calendering as a sheet forming process - flat sheet stock for vacuum forming, etc.

VI. Scope of plastic coating in industry

A. Approximately one fourth of all resins produced are for coating

B. Job opportunities
- In small business house painters, silk screening, etc.
- In major manufacturing
  a. Mostly semi-skilled labor
- Industrial development job potentials
  a. Substantial need for industrial research
  b. The major growth area in polyesters, the versatile unsaturated types in particular

SUMMARY:

Many manufacturers consider the final consumer product as their largest market area with great financial promise. Therefore, coatings which protect, reduce vibration and/or beautify the final product are given careful consideration. Often new processes have had to be developed to take full advantage of new materials brought about by chemical research. There is an opportunity for both large and small businesses to use plastic coatings.

The use of polyesters as a coating material appears to have great potential. Alkyds as used in paint are the dominant plastics used today. The use of new materials for new jobs keeps the market for coated materials expanding.

QUESTIONS:

Q: Describe what is meant by a plastic coating.
Q: List and describe the basic plastic coating processes.
Q: Why should we be informed as to the coating possibilities of each coating resin?
Q: Describe five products which are plastic coated, and tell why they are coated.
Q: Name five basic materials which are coated with plastics.

Cross-Head Die for Wire Coating

courtesy of Modern Plastics Encyclopedia

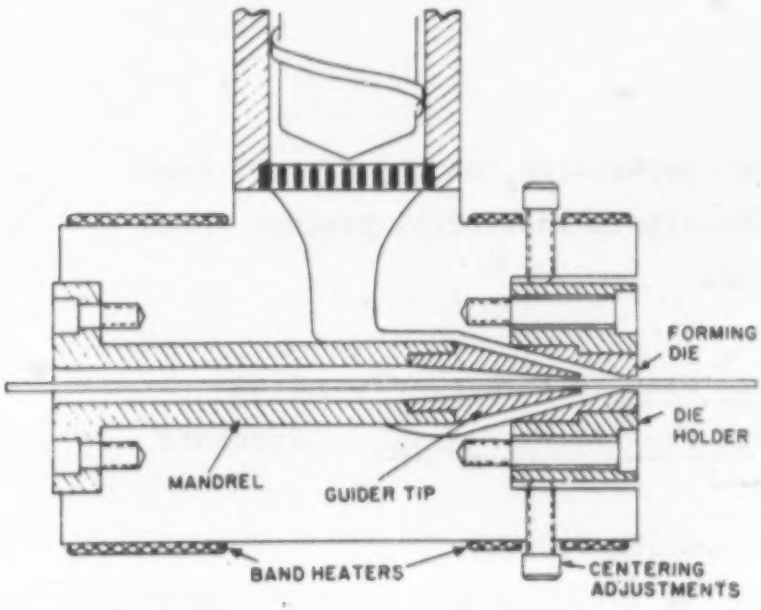

Continuous-Blanket Knife Coater

courtesy of The Society of the Plastics Industry

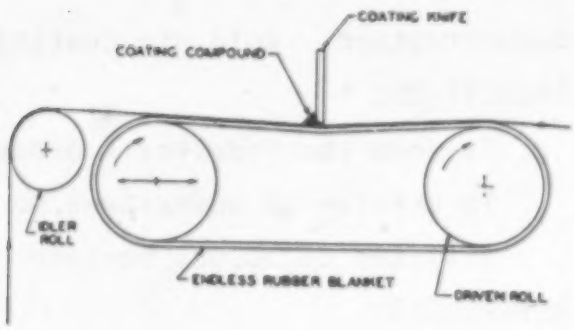

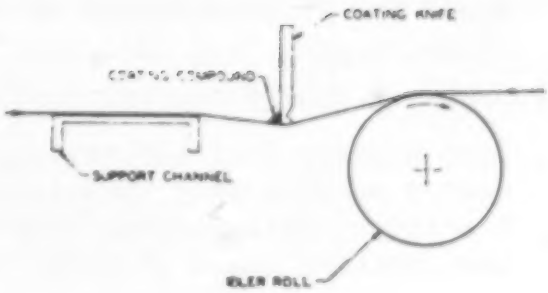

Reverse-Roll Coater

courtesy of The Society of the Plastics Industry

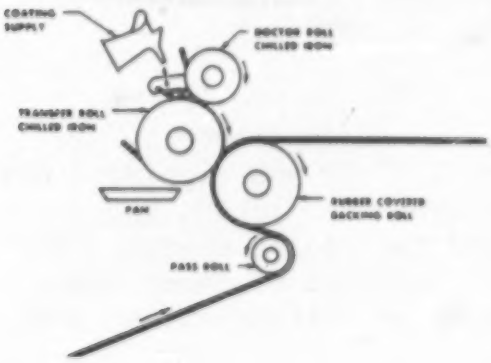

Calendering

courtesy of Modern Plastics Encyclopedia

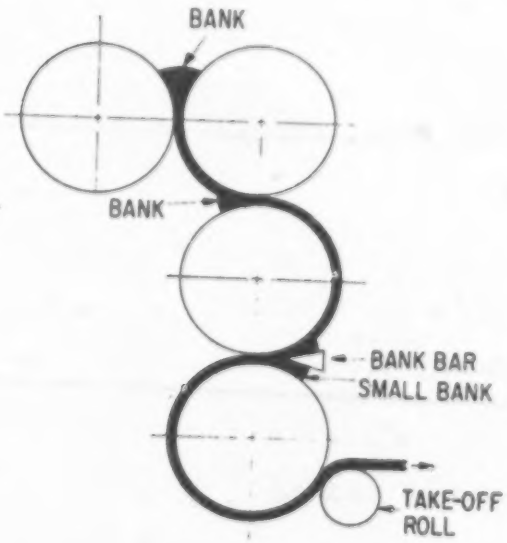

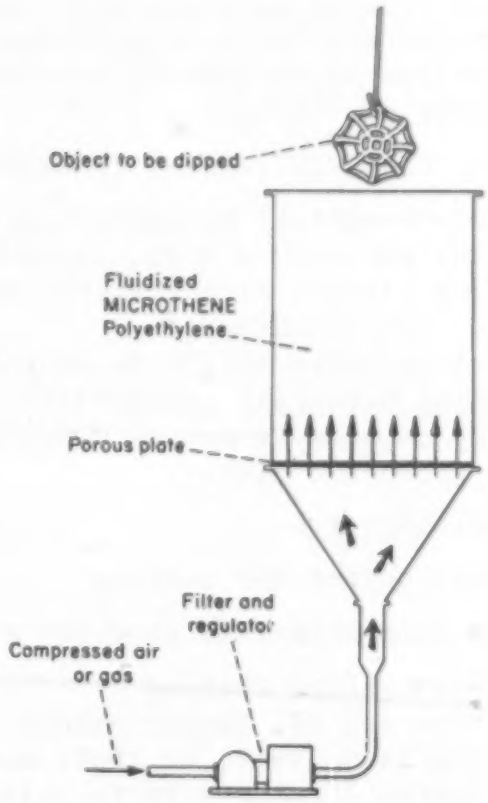

courtesy of U. S. Industrial Chemicals Co.

UNIT VIII COATINGS

Lesson 35

Demonstration: Cold dip coating

OBJECTIVES:

. To show the industrial process for protective coating of tool edges

. To develop an understanding of the simple industrial process which utilizes cellulose acetate butyrate

REFERENCES:

1. Eastman Chemical Co. "Peelable Plastic Packaging" Film
2. Eastman Chemical Co. "Peelable Plastic Packaging" Brochure

FOR DISCUSSION:

. World War II utilization of this coating process
. Products presently sold with this coating

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Coat a sharp tool cutting edge.
. Coat a machine part (possible student project).
. Experiment with varying temperatures for desired coating thickness.
. Coat cutting edges of shop tools at close of school year.

BRIEF DESCRIPTION OF PROCESS:

Cold dipping in cellulose acetate butyrate is accomplished by preheating the cellulose acetate butyrate (350° to 375° F) and dipping a metal object into the hot liquid. Remove the object from the liquid, and a coating of plastic material will solidify around the cooler object. The cellulose acetate butyrate provides protective qualities of three types: 1. lubrication of contacting surfaces; 2. masking of cutting edges; and 3. dampening of vibration.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Cellulose acetate butyrate dipping compound
. Heating pot (1/2 to 1 qt. capacity, minimum)
. Heating element with temperature control
. Probe type thermometer
. Chisel or other object to be coated
. Cleaning materials (greaseless solvent, steel wool, etc.)
. String or wire to use as dipping holder
. Shop apron and gloves

LESSON OUTLINE:

I. Prepare object for coating

A. Be sure object is properly made, sharpended, etc.

B. Clean before coating
- Wipe off all finger prints
- Dip in solvent, or steel wool the area to be coated
- Fasten dipping wire to object
- Suspend to keep clean

II. Set up coating equipment

A. Preheat pot of cellulose acetate butyrate to 350° F (Note: this is a thermoplastic material, and overheating may cause burning.)

B. Have work station clean; provide a dripping area for cooling

C. Protect clothing; wear apron and disposable gloves

III. Perform cold dip coating

A. Place clean tool (or portion thereof) in heated plastic

B. Agitate slowly to coat all areas

C. Remove slowly, drip excess in pot

D. Hang in a safe area to cool

IV. Complete coating process

A. Place drippings from floor back in hot pot

B. Turn off heating element

C. Label area as "hot"

V. Maintain safety precautions

A. Use electric heating element only (no open flames)

B. Ventilate area during process

C. Use extreme care in handling heated plastic

D. Protect clothes and hands from drippings or spills

SUMMARY:

The cold dipping process using cellulose acetate butyrate compound has the following characteristics:

- Completely seals surface from weather
- Lubricates metal surfaces coated
- Protects cutting edges and dampens vibration

This economical process, using low heat, lends itself to both large and small industrial applications. A major advantage is the characteristic of the cellulose acetate butyrate whereby it may be reheated many times. Product applications include coating machine tool edges or machined areas, parts and cutting edges, or as a substitute for masking tape when painting only a portion of a product.

QUESTIONS:

Q: What is the name of a plastic material used as the coating in the cold dip coating process?
Q: What are some practical applications of cold dip coating?
Q: Describe the procedure for cold dip coating.
Q: What safety precautions are to be taken in cold dip coating?

UNIT VIII COATING

Lesson 36

Demonstration: Fluidized bed coating

OBJECTIVES:

. To demonstrate the process known as fluidized bed coating

. To acquaint students with a hot dipping process

REFERENCES:

1.	Cherry, Raymond	General Plastics: (Revised 1964)	
2.	Simonds and Church	Concise Guide to Plastics	p. 325
3.	Swanson, Robert	Plastics Technology	pp. 322, 323
4.	U.S. Industrial Chemicals	Microthene Polyethylene Powder Info. sheet	Ch. 2A

FOR DISCUSSION:

. Factors involved in powder coating with various types of plastics
. Commercial products presently coated through fluidized bed process
. The kinds of material used for fluidized bed coating

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Coat a cold chisel, center punch, or other metal project.
. Test samples of coating materials using variables which might include:
  - Material to be coated
  - Coating material
  - Time required in fluidized bed
  - Time required to pre heat and post heat object
. Experiment with the use of different materials for the porous base plate of the fluidizing chamber.
  - Felt pad
  - Leather
  - Styrofoam
  - Cellulose sponge
  - Others

Fluidized Bed Coating

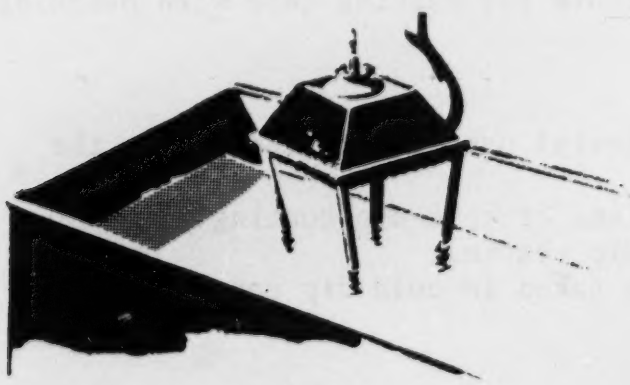

PRIME

PREHEAT

courtesy of Eastman Chemical Products, Inc.

BRIEF DESCRIPTION OF PROCESS:

Plastic coatings can be applied to other materials by dipping preheated objects into a bed of plastic powder made fluid by a flow of air. This process is called fluidized bed coating. The hot object (about 200° to 500° F) picks up a coating by partially fusing a powder on the hot surfaces. The coating is then post heated in order to smooth and completely fuse the plastic.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Heating device - hot plate, copper enamel kiln
. Thermometer (to 500° F)
. Clear or colored coating material - polyethylene or butyrate powder
. Fluidizing chamber (see sketch P. 3, microthene booklet)
. High volume, low pressure air source (2 to 5 psi. approx.) - compressor, vacuum cleaner, etc.
. Metal item to be coated
. Dipping wire
. Cleaning materials - steel wool, abrasives, solvents such as acetone, etc.

LESSON OUTLINE:

I. Purpose of coating

A. To protect from corrosion
B. To decorate
C. To reduce vibration

II. Advantages of fluidized bed process

A. It lends itself to production line work

B. Setup cost is low
- A controlled coating can be applied
- Coatings are durable and can be colored
- Coating has strong bond to object

C. Only material in contact with the job is used. No material is wasted.

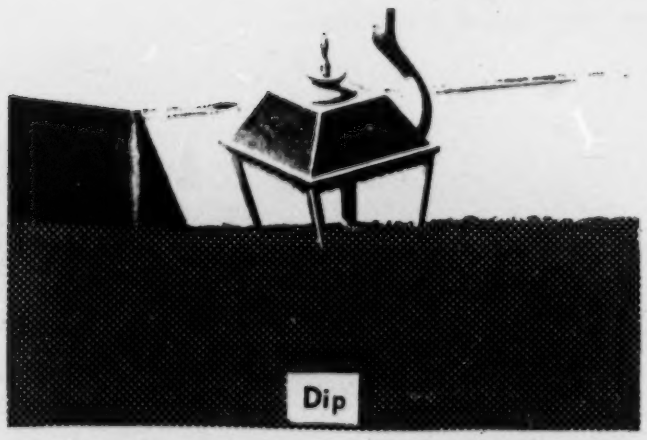

POSTHEAT

III. Process procedure (Check manufacturers specifications for exact instructions.)

A. Set up equipment
- Activate heating source (200° F to 530° F)
- Fill fluidizing chamber
- Open air supply valve until air bubbles are uniform in size
- Hook dipping wire to object

B. Preclean object
- Clean physically with steel wool
- Use a chemical cleaning agent and let dry

C. Preheat object
- Place over heat source or in oven
- Check temperature with thermometer until desired heat is reached

D. Coat object
- Carefully dip object in fluidized bed of powder
- Remove object for postheating

E. Postheat object to fuse
- Suspend coated object over heating source or in oven
- Watch for smooth flow of material on object
- Be careful not to overheat and burn coating

F. Clean up area
- Turn off heating element and label the area "hot"
- Place unused coating material in air-tight container

SUMMARY:

The fluidized bed coating process can be applied to any shape or size of object with a low initial setup cost.

A high quality, uniform finish, which is protective, decorative and vibration dampening is achieved on any object to be coated by the process. All objects coated must be able to withstand the pre-and-post-heating operations.

QUESTIONS:

Q: Describe the fluidized-bed coating process.
Q: What are the basic coating materials used in hot dipping, and describe their characteristics?
Q: Describe the advantages of the hot dip coating.
Q: Why does industry utilize the fluidized-bed process?
Q: What is the difference between hot and cold dipping?

UNIT VIII COATINGS

Lesson 37

Related Lesson: Vacuum metallizing of plastics

OBJECTIVES:

. To develop a knowledge of the vacuum metallizing process

. To show the student illustrations and examples of the process

REFERENCES:

1. Bee Chemical Co. "Why and How of Vacuum Metallizing" Finishing News Magazine, reprint

2. Gilbert, M. B. and Garwood, A. D. "Vacuum Metallizing" Modern Plastics Encyclopedia 1963 p. 859

3. Narcus, Harold Metalizing of Plastics

4. Thorson, M. L. "The Art of Plastics Decoration" SPE Journal, Vol. 17 Nov. 12 - Dec. 61

FOR DISCUSSION:

. Describe the previous uses of vacuum metallizing
. Give a brief description of the process as it exists today
. Illustrate some of its applications
. Illustrate some possible future uses of this process

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Make a large poster illustration of the process.
. Make a colorful display of vacuum metallized parts.
. Have students make up product folders on this process.

BRIEF DESCRIPTION OF PROCESS:

Vacuum metallizing is a process in which surfaces are thinly coated with metal by exposing them to a vapor of metal that has been evaporated under vacuum of one millionth of normal atmospheric pressure. The vaporized metal condenses on the surface of the plastic.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Flow chart of the vacuum metallizing process
. Picture of the process
. Samples of vacuum metallized plastics

LESSON OUTLINE:

I. The Process

A. Procedure
- Part to be coated is cleaned in a detergent
- Lacquer base coat is applied
- Parts are placed on a holding fixture and placed in a chamber
- The pressure is reduced in two stages
  a. Rough pumping of vacuum is brought down to 100 to 200 microns (0.1 to 0.2 MM mercury or .002 to .004 inches of mercury.)
  b. The diffusion pumping of vacuum is brought down to 0.3 or 0.5 microns (0.0003 to 0.0005 MM mercury or 0.000,007 to 0.000,001 inches of mercury), at this point 99.9999 percent of the air has been removed from the vacuum chamber.*
- The metal is heated an evaporation or vaporization takes place
- The metal condenses on the plastic part
- Atmospheric pressure is restored
- A final coat of lacquer is applied

B. Equipment
- Vacuum metallizers have four major components
  a. Vacuum chamber capable of being evacuated to a pressure of 0.5 micron or lower
  b. Pumping system having
     Roughing pump
     Holding pump
     Oil diffusion pump
     Pump cooling system
  c. Holding fixtures to go into chamber
  d. Heating device for evaporation of the metal
- Lacquering equipment to apply by spray, dip or brush
- Baking oven
- Cleaning equipment

C. The metals used and their vaporization temperatures under vacuum

Aluminum	1000°F
Copper	1270°F
Gold	1460°F
Silver	1050°F
Zinc	340°F

II. The Product

A. Types of objects metallized
- Molded parts use vacuum chamber method with a 10 to 20 minute cycle
- Films use continuous metallizers in which continuous web stock enters and leaves through vacuum seals

B. Selection of surface to be coated
- Front or outside surface least desirable. Can be scratched easily
- Underside of clear plastic preferred. Plastic protects the metallized surface from being scratched

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*1 micron = 0.001 MM mercury or 0.00002 inches of mercury

C. Advantages of vacuum metallizing
- Applies corrosion resistant surface
- Lengthens service life
- Decorates surface
- Makes undesirable colored plastics parts usable
- Utilizes scrap plastic
- Eliminates undesirable properties of certain plastics
- Has the inherent properties of the plastic plus the desired properties of the deposited metal

D. Disadvantages
- Industrial equipment costly. Need equipment for coating, lacquering and curing finished jobs
- Time, labor, materials and extra processes add to the cost
- Vacuum metallizing often jobbed out to specialty shops

III. Applications of vacuum metallizing

A. Present
- Plastic automotive fabrics
- Draperies
- Food preparation papers
- Papers for printing and publishing
- Electrical insulators (plated with copper, cadnium or lead)
- Printed circuits
- Aviation parts (retards vibrations)
- Resistors, condensers, and relays
- Ceramics, glass, quartz and other materials

B. Future
- Glare reducing coating on aircraft windshields
- Defrosting of aircraft windows
- Sun glasses (optional interference)
- Complex electronic circuitry

SUMMARY:

Vacuum metallizing is a process which is readily adaptable to mass production. It provides low cost parts which resemble those made from metal. It is a process which is finding a larger application in the plastics industry.

QUESTIONS:

Q: Why are plastic products vacuum metallized?
Q: What is the importance of rotating the plastic part during the metallizing cycle?
Q: Why is it more practical to metallize parts on the second surface than the first?
Q: Why must most plastics be lacquered before metallizing?

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UNIT VIII COATING

Lesson 38

Related Lesson: Electroplating plastics

OBJECTIVES:

- To develop an understanding of the process of coating a non-conductive plastic object with metal
- To present the industrial and consumer applications of metal plated plastics

REFERENCES:

1.	Narcus, Harold	Metallizing of Plastics	pp. 121-129
2.		Society of Plastics Engineers Journal Vol. 20, No. 4, Apr. 1964	pp. 305-310
3.		Plastics Design and Processing May, 1963	pp. 22-23
4.		Materials in Design Engineering Feb, 1962	p. 106
5.	*Schlabach and Rider	Printed and Integrated Circuitry (McGraw Hill)	pp. 141-144

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Compare electroplated samples with vacuum metallized products, and discuss limitations of each process.
- Discuss current and future applications of the electroplating process.

PLATING MARKETS FOR ABS - 1964

END USE	TOTAL ABS Millions of lbs.	PLATED ABS Millions of lbs.
Automotive	22	1.8
Appliance and business mach.	12	1.0
Other moldings	10	0.5

The above table reproduced from - S.P.E. Journal, April 1964, p. 309

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BRIEF DESCRIPTION OF PROCESS:

A process in which a conventional metal plating (chromium, copper) is applied to a plastics part, the surface of which must first be made conductive.

LESSON OUTLINE:

I. History

A. In the 1940's, plastic bottles, etc. first electroplated for the military

B. In the 1950's, metal covered fillers for costume jewelry and household gadgets were developed; there was also some unsuccessful experimentation with tetraflouroethylene resin (TFE)

C. In 1960's
- Decorated automobile parts
  a. Letter ornaments
  b. Turn signal handles
  c. Door lock buttons
- Printed circuitry - through-hole plating process

II. Materials adaptable to process

A. High impact polystyrenes
B. Acrylonitrile-butadiene-styrene (ABS) materials
C. Urea formaldehydes and phenol-formaldehydes
D. Others

III. Applications

A. Printed circuitry
B. Automotive-name plates, radio and clock cover plates, rear view mirror frames
C. Appliances - control knobs, vacuum cleaner heads, handles, buttons
D. Plumbing - faucet handles, drain flanges, plugs, sink strainers
E. Other home and industrial - false teeth, thumb tacks, pen barrels, marine hardware levers and handles

IV. Industrial plating process

A. Pretreatment and cleaning of the insulator surface with organic or detergent solutions by:
- Barrel tumbling - sand blast
- Flush method
- Ultrasonic method

Caution: Cleaning method used must not impair the insulating properties of the plastic when preparing printed circuit boards.

B. Sensitizing. (Process originated with silvering of mirrors.)
- This is a process whereby a very thin metallic film, which acts as a catalytic surface for the metal to be added, is placed on the plastic surface by means of bath or spray.
- Salts of tin, titanium, silver, gold and palladium formulations are the most widely used materials for sensitizing.

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C. Electroplating. Copper, nickel, gold or chromium may be used; follow conventional electroplating methods (demonstration)

D. Safety considerations
- Vapors from bath (insure proper ventilation). Do not inhale fumes.
- Electrical connections
- Wear rubber gloves, prevent contact with skin

V. Industrial outlook

In recent years the cost of electroplating has decreased due to refinements in sensitizing techniques. During the past year plastics have been used in many areas of automobile production.

It is estimated that 5 million pounds of ABS will be plated for automotive purposes in 1965. Refer to table on page 134.

VI. Guidance information

Electroplating of metals has been carried on as a separate operation in most large industrial firms for many years. Plastics may be plated by the same basic process with the addition of sensitizing equipment. No appreciable increase in occupational opportunities in this area in the near future is expected.

SUMMARY:

Electroplating is the electrochemical process of coating an object (in this case a non conductor) with metal. This method is another of the finishing and decorating approaches that a plastic customer may choose. Plastics electroplating is made possible by the use of a sensitizing operation in which an insulating material receives a conductive coating. In the electroplating of plastics, ABS plastics and high impact polystyrenes are the most common plastics materials coated.

QUESTIONS:

Q: Name three examples of electroplated plastic products.
Q: Why is sensitizing necessary when electroplating plastics?
Q: What plastic materials are best suited to the electroplating process?

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UNIT VIII COATING

Lesson 39

Demonstration: Electroplating plastics

OBJECTIVES:

. To demonstrate the process of applying an electroplated surface on a plastics product

REFERENCES:

1. *Marbon Chemical Div. Borg Warner	Plastics Memo #606A	
2. Narcus, Harold	Metallizing of Plastics	pp. 121-129
3. *Schlabach, and Rider Washington, W. Virginia	Printed and Integrated Circuitry (McGraw-Hill)	pp. 141-144
4. SPE	Society of Plastics Engineers Journal Vol. 20 #4, Apr. 1964	pp. 305-10

FOR DISCUSSION:

. Applications of electroplating in the automobile industry
. Limitations of electroplating process in the field of plastics

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Compare vacuum metallizing with the electroplating process.
. Electroplate ABS plastics products.

BRIEF DESCRIPTION OF PROCESS:

A very thin, fine grained, conductive film of copper is chemically deposited on, and bonded to, a plastic surface. This film provides a base upon which such metals as copper and chromium can be electroplated to form a protective, decorative finish.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Cleaner Solutions (Enthone) or equiv.
Follow manufacturer's directions carefully
. Activator Solutions (Actane, Enthone) or equiv.
. Sensitizer Solutions (Enplate) or equiv.
. Copper Bath (Enplate) or equiv.
. Disposable plastic gloves
. Electroplating Unit

LESSON OUTLINE:

I. Electroplating process

A. Surface preparation
- Immerse product in Enthone cleaner solution for 2-3 minutes
- Rinse with water
- Immerse in activator Actane solution for 15 seconds to 2 minutes

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- Rinse with water
- Immerse in Enthone solution for 1 hour at 145-150°F
- Rinse thoroughly with water

B. Surface activation
- Immerse in Enplate sensitizer solution for 1 minute
- Rinse with water until all of the sensitizer solution has been removed
- Immerse in Enplate solution for 30 seconds
- Rinse with water

C. Chemical deposition of copper
- Immerse surface activated ABS in Enplate solution for 20-40 minutes
- Rinse with water
- Transfer to electroplating bath immediately

D. Electroylic deposition of copper
- Immerse product in Enplate solution until desired thickness is obtained

E. Mechanical polishing
- Polish the soft copper film to a bright luster by wheel buffing
- Clean with Enthone to remove all traces of polishing compounds
- Rinse with water
- Dip in Hydrochloric Acid solution to remove copper oxides
- Rinse with water

F. Electrolytic deposition of metal finish
- Use conventional plating techniques, treating prepared plastic product as you would any other metallic material
- Follow directions prescribed for electroplating unit available

II. Safety precautions

. Wear disposable plastic gloves
. Check insulation on all electrical equipment used
. Check manufacturers' safety precautions for all chemicals and equipment being used

SUMMARY:

The plating process for ABS plastics requires special surface preparation and surface activation to make it a conductive surface before conventional electrolytic deposition of metal and buffing take place. Care must be exercised when handling chemical solutions and electrical equipment.

QUESTIONS:

Q: Why is a thin metallic film placed on any plastic prior to electroplating?
Q: List several metallic finishes that can be placed on plastics products by use of the electroplating process.
Q: List three safety precautions which should be followed when electroplating.

VOS 208

UNIT IX

VINYL DISPERSION - THERMOSFUSION

Lesson		Page
40	Vinyl dispersions and thermofusion (related)	140
41	Vinyl dispersions molding (demonstration)	145
42	Thermofusion molding (demonstration)	148
43	Rotational molding (demonstration)	151

OLS
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UNIT IX VINYL DISPERSION - THERMOFUSION

Lesson 40

Related Lesson: Vinyl dispersions and thermofusion

OBJECTIVES:

. To acquaint the student with powdered polyethylene and vinyl dispersions
. To illustrate the industrial methods of processing powdered polyethylene and vinyl dispersion

REFERENCES:

1.	Cherry, Raymond	General Plastics, 4th Ed.	Ch. 27
2.	*Johnson, Dale	Materials in Design Engineering	Feb. 1963
3.	*Johnson, Ira	"Rotational Molding" (IAVE)	Dec. 1963
4.	Redfarn & Bedford	Experimental Plastics	p. 83
5.	SPI	Plastics Engineering Handbook	pp. 223-236 275-280
6.	Zimmerman and Johnson	"Molding Powdered Polyethylene" Modern Plastics Encyclopedia 1963 issue	pp. 717-720

FOR DISCUSSION:

. Release papers used in sheet casting
. Equipment necessary for rotational molding

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Mold an article by rotational casting.
. Discuss the types of molds used for various processes involved.
. Slush mold an article.

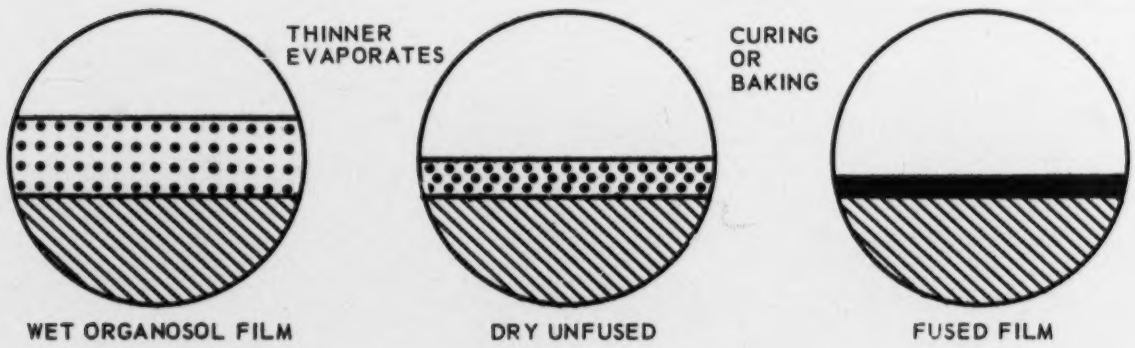

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BRIEF DESCRIPTION OF PROCESS:

Thermofusion involves the use of solid thermoplastic powders and/or molding granules. Vinyl dispersion resins are liquids with finely divided particles of the plastic in suspension in a plastisol or organosol.

Either material may be used for several molding methods described here.

Heat is used to cure the thermofusion powders, or to evaporate the plastisol or organosol leaving a molded part.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Molds for rotational, slush and closed molding. Consider use of metal cooking molds.
. Sample products formed by this process
  - Toys, balls, doll heads
  - Industrial chemical bottles
. Plastic materials
  - Vinyl plastisol
  - Vinyl organosol
  - Polystyrene granules and powder
  - Polyethylene granules and powder

LESSON OUTLINE:

I. Materials used

A. Vinyl dispersions. Vinyl resin is suspended in a non-water liquid which does not dissolve the resin at ordinary temperatures.
  - Vinyl plastisol. If the dispersing liquid consists only of a plasticizer, the dispersion is termed a plastisol. A plastisol, to be converted to a usable form, must be heated to fuse the resin and the plasticizer.
  - Vinyl organosols. If the dispersing liquid contains a volatile solvent, the dispersion is termed an organosol. An organosol, to be converted to a usable state, requires the evaporation of the solvent from the solution and the fusing of the resin with the plasticizer.

B. Polyethylene powders for thermofusion in rotational slush molding
  - Finely powdered polyethylene is successively plasticized, molded and then cured in the mold
  - Thermofusion powders are relatively low in cost
  - Equipment formerly used for plastisols can be employed
  - Products made with thermofusion powders offer high chemical, electrical and mechanical resistance

C. Polystyrene in finely powdered form produces clear moldings in thermofusion, as contrasted to milky colored moldings produced through use of polyethylene.

D. Polystyrene and polyethylene pellets or granules are used for solid castings. They are not suited to most rotational or slush moldings.

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II. Molds should be made of a heat conducting material such as copper or aluminum

A. Molds may be made by
- Electro-deposition
- Sprayed atomized metal
- Die cast metals
- Sand casting
- Metal spinning

III. Molding processes

A. Slush molding
- Open top mold filled with plastic material
- Heated mold causes thin layer of plastic to form next to wall of the mold
- Excess material not fused to wall of mold is poured out forming a hollow, thinwalled flexible object

B. Rotational molding by Engel Process (a slush technique)
- Closed molds are filled with polyethylene powder or vinyl dispersions
- Mold is closed with a thermo insulating lid
- Filled mold is placed in a heated oven
- Layer of material is formed next to wall of mold. The thickness is determined by the temperature of the oven, the heating time and special properties of the material
  . Polyethylene plasticizes
  . Vinyl dispersions fuse
- After heating cycle of 4 to 5 minutes the excess plastic is poured out
- Mold is returned to the oven to smooth insides
- After mold has cooled the product can be removed from the mold
- Industrial considerations
  . Product usually limited to open end type
  . Limited runs up to 8500 units are practical
  . Longer runs could be done less expensively by injection molding unless product is too large
- Consumer considerations. Tanks, bottles, toys and other flexible items are produced by this method.

C. Rotational method by the Heisler process (centrifugal hot mold method - a slush technique)
- Used to produce hollow objects with one or two open ends such as pipes or tubing
- Mold is preheated to 325 to 365 degrees F, and partially filled with plastic material
- The filled mold is rotated in an oven on a single axis or plane until material fuses and forms a shell on mold walls
- Excess material is poured out and mold is cooled before product is removed
- It is a slow process unless highly automatic techniques are adopted for high production

1212

D. Rotational molding using polyethylene powder
- Enough powder is placed in mold to coat sides to the desired thickness
- Mold is heated to 300 to 400 degrees F
- Mold is rotated on 2 planes or axes for approximately 5 to 10 minutes. The polyethylene powder plasticizes in this phase of the operation after which the mold is cooled and product removed.
- Rotational molding is a practical industrial process
  . There is little waste or scrap
  . There is no dumping of excess powders as in slush casting
  . The process is easily adapted to continuous high production methods
- Product characteristics
  . Has uniform wall thickness due to two plane rotation
  . Products strain free hollow parts

E. Rotational molding using vinyl dispersions
- Vinyl plastisols or organosol is used in similar manor for polyethylene powder
- Plastisols fuse at 300 to 375 degrees F
- Industrial and product considerations similar to powder rotational casting

F. Solid casting with either polyethylene powder or polystyrene powder
- Powdered material is placed in mold
- Decoration in form of glitter or tinsel can be added
- After resins are plasticized in hot oven the mold is removed and cooled before part is removed
- Equipment cost is low. Sheet metal or cast molds can be used.
- Intricate shapes can be molded with ease using a low cost thermoplastic material

G. Casting with vinyl dispersions
- Vinyl dispersions are measured on release paper then heated to 300 to 400 degrees F when dispersion fuses
- A flexible sheet of plastic is formed
- Used primarily to make experimental samples. Often laminated to cloth for clothing, coats, etc.

IV. Industrial considerations

A. Advantages of thermofusion and plastisol molding
- Large objects may be produced inexpensively
- Molds are inexpensive to make compared to injection molds and others used
- There is little waste of plastic materials involved in this process
- Materials cost less than those using sheet stock
- Hollow flexible objects may be molded in one or two pieces

B. Disadvantages of thermofusion and plastisol molding
- Long runs become more expensive due to labor. Extremely large items still cheaper.
- Only thermoplastic materials can be used
- Slush casting requires dumping excess material out of mold

C. Applications
- Slush casting (hollow articles with open end)
  . Tanks for chemicals
  . Sporting equipment
  . Toys
- Rotational molding (hollow, closed or open articles)
  . Industrial bottles
  . Toys - hobby horses
  . Doll heads
  . Balls
- Solid castings
  . Printing plates
  . Auto mats and arm rests
  . Decorations, craft items
  . Encapsulation of electrical parts

SUMMARY:

Thermofusion of powdered plastics and fusion of vinyl dispersions has opened new ways of producing a better product for a lower cost. New materials and new fabricating processes are making possible a variety of new products which are appearing on the consumer market almost daily. The product and its application govern whether the rotational, slush or solid molding technique will be used.

QUESTIONS:

Q: How do rotational, slush and solid molding differ?
Q: What is a vinyl dispersion?
Q: How do products made from vinyl dispersions differ from products made from polyethylene powders.
Q: Name two types of vinyl dispersions.
Q: Why are molds for rotational molding less expensive than molds for injection molding of the same hollow article?

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UNIT IX VINYL DISPERSION - THERMOFUSION

Lesson 41

Demonstration: The molding of a vinyl dispersion

OBJECTIVES:

. To demonstrate several techniques of molding with vinyl dispersions

. To show to the student applications of this process

REFERENCES:

1.	Howard and Markwood	"Cast in Textures for Vinyl" Reprint Modern Plastics	Nov. 1963
2.	SPI	Plastics Engineering Handbook	pp. 270-278

FOR DISCUSSION:

. The major methods used to mold parts through use of vinyl dispersions
. The variety of products available made from vinyl dispersions
. Possible future development of new products using vinyl dispersions

EXPERIMENTAL AND/OR PROJECT ACTIVITIES

. Prepare a display of products made from vinyl dispersions.
. Design and mold individual projects using a vinyl dispersion.
. Investigate the variety of differently shaped molds available and mold with them.

Schematic Diagram of a Conveyerized Slush-Molding Setup. Variable speed chain drive, oven thermostats, and cooling water controls are desirable.
courtesy of The Society of the Plastics Industry, Inc.

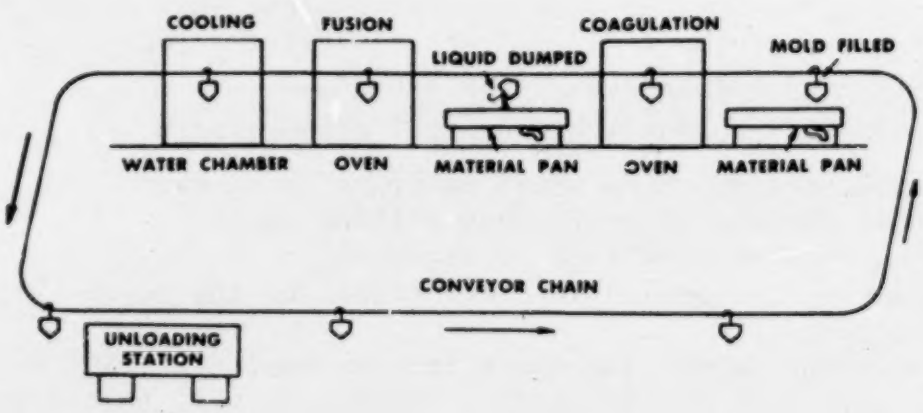

BRIEF DESCRIPTION OF PROCESS:

Molding with a vinyl dispersion changes a liquid to a solid material. Finely powdered vinyl is suspended in a plastisol or an organosol. Fusing the plastic with the plasticizer at about 350° F. causes the liquid to cure to a solid state. The molding processes used are similar to ones employed for the thermofusion of powdered polyethylene.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Compounded vinyl plastisol or organosol
- Mixing containers, (paper cups)
- Mixing spatula (coffee stirring sticks, etc.)
- Heating oven. An air circulating type such as a kitchen oven, commercial oven or infra-red heat lamps, etc. CAUTION: Do not use open flame.
- Various types and shapes of molds - jello molds, cookie tin, spun aluminum, machined aluminum molds, etc.
- Treated paper
- Heat insulating gloves
- Supporting sheet to transport mold
- Mold release - silicone spray or wax

LESSON OUTLINE:

I. Types of castings using vinyl dispersions

A. Slush molding produces a hollow shell of cured plastic next to the mold surface. Extra plastic material not fused is poured out of the mold when desired wall thickness is achieved.
B. Solid cavity molding can use mold similar to ones used for slush casting. Solid object is produced by fully curing plastic placed in the mold.
C. Sheet casting employs shallow or flat molds

II. Mold types and preparation

A. Molds may be thin walled metals like jello molds, cookie sheets, cookie molds or textured metals for leaves, etc.
B. Thicker walled molds, holding more heat can be made of cast or machined aluminum, ceramics or metals
C. All molds should be smooth and free of defects
D. Molds should be treated with a release agent such as silicone
E. The thickness of the mold, and its temperature govern the heat transferred to the plastic being formed

III. General molding procedures using vinyl dispersions

A. Place mold on supporting sheet to transfer to oven
B. Spray mold surface with silicone release agent
C. Stir the prepared plastisol or organosol
D. Start pouring dispersion into the corner of the mold. Fill to the proper level.
E. Place mold and supporting sheet in oven heated to 350° F
- Curing time will depend on mold thickness, wall thickness desired and type of product being made. See more specific instructions.
F. Remove mold from oven and allow to cool before stripping mold
- If part crumbles or tears easily, it has not cured sufficiently

IV. Slush molding special procedures

A. Prepare mold and dispersion
B. Cover top of mold with insulating lid. An asbestos sheet is satisfactory
C. After 1 or 2 minutes in oven, remove mold from oven and pour out uncured plastisol or organosol

D. Place mold (without cover) back in oven for final curing
E. Final cure has been achieved when plastisol appears glossy

V. Solid cavity molding special procedures

A. Prepare mold and dispersions, fill mold
B. Heat from 5 to 8 minutes. If article is not fully cured continue heating. Avoid over heating which causes scorching.

VI. Sheet casting

A. Prepare mold and dispersion. Treated papers can be used as mold
B. Place mold in oven for 3 to 4 minutes at 350° F. Thin sections require careful control of time and temperature

VII. Typical applications

A. Slush castings
- Movable parts for dolls
- Insert tank linings
- Electrical insulation
- Plier handles
- Gaskets for glass container covers
- Toys and boats

B. Solid Cavity Molding
- Bases such as flag standards
- Shock absorbing blocks
- Coasters for tumblers

C. Sheet Casting
- Leaves for planters
- Decorative articles
- Carpeting
- Coverings to protect finishes
- Coatings

SUMMARY:

Vinyl dispersions are easily handled and safe to work with. Only a small amount of inexpensive equipment is needed to produce numerous useful and decorative articles. Necessary molds are easily made. Economical use is made of an inexpensive material. The low cost of equipment and material necessary is usually passed along to the customer who gets a decorative item at a reasonable price.

QUESTIONS:

Q: What are the three major processes used in producing products from vinyl dispersions?
Q: Name a factor that determines the size of a part which can be made?
Q: Why are two heating cycles necessary with a slush casting?
Q: What are some similarities between molding process using vinyl dispersions and those using powdered polyethylene for thermofusion?
Q: How can one tell whether a molded part was cured if a temperature gauge was not available in the oven?

UNIT IX VINYL DISPERSION - THERMOFUSION

Lesson 42

Demonstration: Thermofusion molding

OBJECTIVES:

. To demonstrate the techniques of molding by the thermofusion of pellets or powdered polyethylene

. To give the student insight into possible other applications of this process

REFERENCES:

1.	Cherry, Raymond	General Plastics, 4th Ed.	Ch. 27
2.	Pearson, Hazel	Creating with Cooking Crystals	p. 717
3.	Redfarn and Bedford	Experimental Plastics	p. 64
4.	St. Louis Crafts, Inc. 15 W. Moody St. St. Louis, Missouri	Crafts-Maid Memos	

FOR DISCUSSION:

. Molding processes that can be accomplished in an industrial arts laboratory
. Materials used for thermofusion molding
. The use of polyethylene in combination with other materials

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Select and arrange samples made by the thermofusion process.
. Make up a display board showing a flow chart of the thermofusion process.
. Make up give aways for PTA's, etc.

BRIEF DESCRIPTION OF PROCESS:

Thermofusion of thermoplastic powders or pellets in various forms provides interesting applications in the industrial arts shop. In processing, pellets or powdered polyethylene are placed in a mold and set on a support (cookie sheet tin). The entire unit is placed in an oven and heated to the proper temperature. The fusion of the powder by application of heat will cause it to take the shape of the mold. Interesting projects of this kind can be done successfully in the shop.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Various types of molds - pizza pans, copper salad molds, cookie sheets, aluminum pans, gelatin molds, etc.
. Powders - clear and colored polyethylene
. An electric oven with a maximum temperature of 400° to 500°. An oven such as a commercial oven, domestic kitchen oven, roaster or infra-red oven could be used.

. Embedding materials - coins, metal parts, etc.
. Supporting tray - cookie sheet, metal tray, etc.
. Files and/or buffer
. Knife

LESSON OUTLINE:

I. Preparation of mold

. Select metal mold and desired polyethylene, powder or pellets
. Apply mold release (silicone spray or carnauba wax)
. Preheat oven to between 350° and 400°F
. Place mold on supporting sheet, making sure the mold is free from blemishes to insure a smooth surfaced product

II. Molding by thermofusion

A. General molding procedures
- Select and prepare mold
- Completely cover bottom of mold with a 1/8 inch thick layer of powder
- Place mold in preheated oven. Fusing time will vary depending on mold thickness and type of oven. Check frequently. Do not overheat.
- Correct heat and time are indicated when the plastic has fused together smoothly
  . A rippled effect is achieved by under fusing
  . For a smooth effect, heat longer
- Remove mold and cool in air or under a spray of water
- Rough edges should be smoothed using a fine file, sandpaper, jeweler's sanding wheel or a heated kitchen knife

B. Embedding articles in a mold
- When embedding, select items that will not melt at the fusing temperature of the plastic
- Prepare mold as before and preheat oven
- Place a 1/8 inch thick layer of clear powdered plastic in the mold
- Place material to be embedded over base layer as desired. Embedding material may be stones, glass, woodchips, metal, or colored plastic pellets.
- Place another layer of clear powdered plastic on top
- Place in oven to heat and cure as before

C. Adding color to plastic powder
- Break up colored chalk into bits
- Measure clear powdered plastic in another container, and add colored chalk to it
- Shake until color is evenly dispersed

III. Industrial and consumer considerations

A. Advantages
- Weight saving of material represent an economic saving of importance to the manufacturer
- The over-all cost of producing an article is 40% less by the thermofusion of polyethylene powders than it is by other mechanical molding techniques. The lower cost can be passed on to the consumer.

B. Disadvantages
- Uniform wall thickness is difficult to control
- Inside surfaces may be uneven

IV. Implications for industrial arts

- Products can be made in the shop in the same way they are made in industry
- Practical shop made projects include large sheets to be used for tray bases, using cookie sheets as mold, protective coatings and mounting for plaques, coasters for tumblers and tote boxes
- Materials and equipment are inexpensive

SUMMARY:

Thermofusion of plastic materials in powdered or pellet form is especially well suited for the industrial arts laboratory as it combines many materials that are basic to plastic work. Their use can be both pleasing and functional, as in decorative room dividers.

QUESTIONS:

Q: Why should molds used for thermofusion be free of blemishes?
Q: How may color be added to a project?
Q: Why is it necessary to carefully select materials to be embedded?
Q: What materials can be used for molds for thermofusion?

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ers

UNIT IX VINYL DISPERSION - THERMOFUSION

Lesson 43

Demonstration: Rotational molding

OBJECTIVES:

. To demonstrate the process of rotational molding

. To acquaint students with applications of this process in industry

REFERENCES:

1.	Johnson, Dale	"Materials in Designing" Engineering Magazine	Feb. 1963
2.	Johnson, Ira	"Rotational Molding" IAVE Vol. 52, Dec. 1963	pp. 31-33
3.	Zimmerman and Johnson	"Molding Powdered Polyethylene" Modern Plastics Encyclopedia-1963	pp. 717-720
4.	SPI	Plastics Engineering Handbook	p. 275

FOR DISCUSSION:

. Need for a low cost molding process
. Other applications of materials that are used in this process

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Make up a display board of several samples of products made by rotational molding.
. Make up a wall chart on the different types of molding processes.
. Make up give-away projects to promote interest in industrial arts.

BRIEF DESCRIPTION OF PROCESS:

Rotational molding or casting is a method of molding a hollow plastic product which is completely enclosed. The molding compound can be a liquid or a powder. The rotating device must be mounted so that it will permit the mold to revolve in two directions simultaneously in order to provide even distribution and heating.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. An electric oven
. Several casting molds
. Bi-directional rotating device
. A plastisol or organosol vinyl dispersion
. Polyethylene molding powder

LESSON OUTLINE:

I. Selection of the mold

A. The design of the mold may vary but should have a parting line and locking clamps
B. Avoid intricate cavities and large undercuts
C. A cast or spun aluminum mold

II. Preparation of the mold

A. Make sure both halves of the mold are clean
B. Spray mold with a high temperature type of mold release (silicone)

III. Molding

A. Fill mold half full. The wall thickness of the end product depends on the amount of material placed in the mold
B. Place upper half of mold on top of bottom half of mold
C. Lock clamping devices
D. Insert mold into rotating device

IV. Curing

A. Preheat the oven to proper temperature (about 350° F)
B. Slide rotating device into position in oven and start the rotation at a rate of from 5-15 RPM
C. Start timing at this point
D. Make sure no part on the mold will get closer to the heating element than another
E. Heat for approximately 5-8 minutes keeping rotation at an even rate

V. After curing

A. Turn off oven
B. Remove rotating device from oven, using gloves
C. Let mold cool in air for best results
D. If a faster cooling of the mold is desired, immerse in cold water
E. Unclamp the mold and remove the part

VI. Molding with vinyl dispersions

A. Use same steps as above with the noted exceptions
- Instead of using powdered polyethylene, use a vinyl plastisol or organosol
- Time of curing may vary with vinyl dispersions

SUMMARY:

Rotational molding is a process requiring special equipment for making hollow molded parts. It finds its major industrial application in the production of large hollow products in limited production runs.

QUESTIONS:

Q: Why is rotational molding an important process in the plastics industry?
Q: List 2 different materials which will work well with the rotational molding process?
Q: What determines the size of the mold in rotational molding?
Q: Why, in rotational molding, does the mold have to be in two pieces and not just one?
Q: What conditions determine wall thickness of the part in rotational molding?

TYPICAL SYSTEM USED TO OBTAIN
BIAXIAL ROTATION IN ROTATIONAL MOLDING

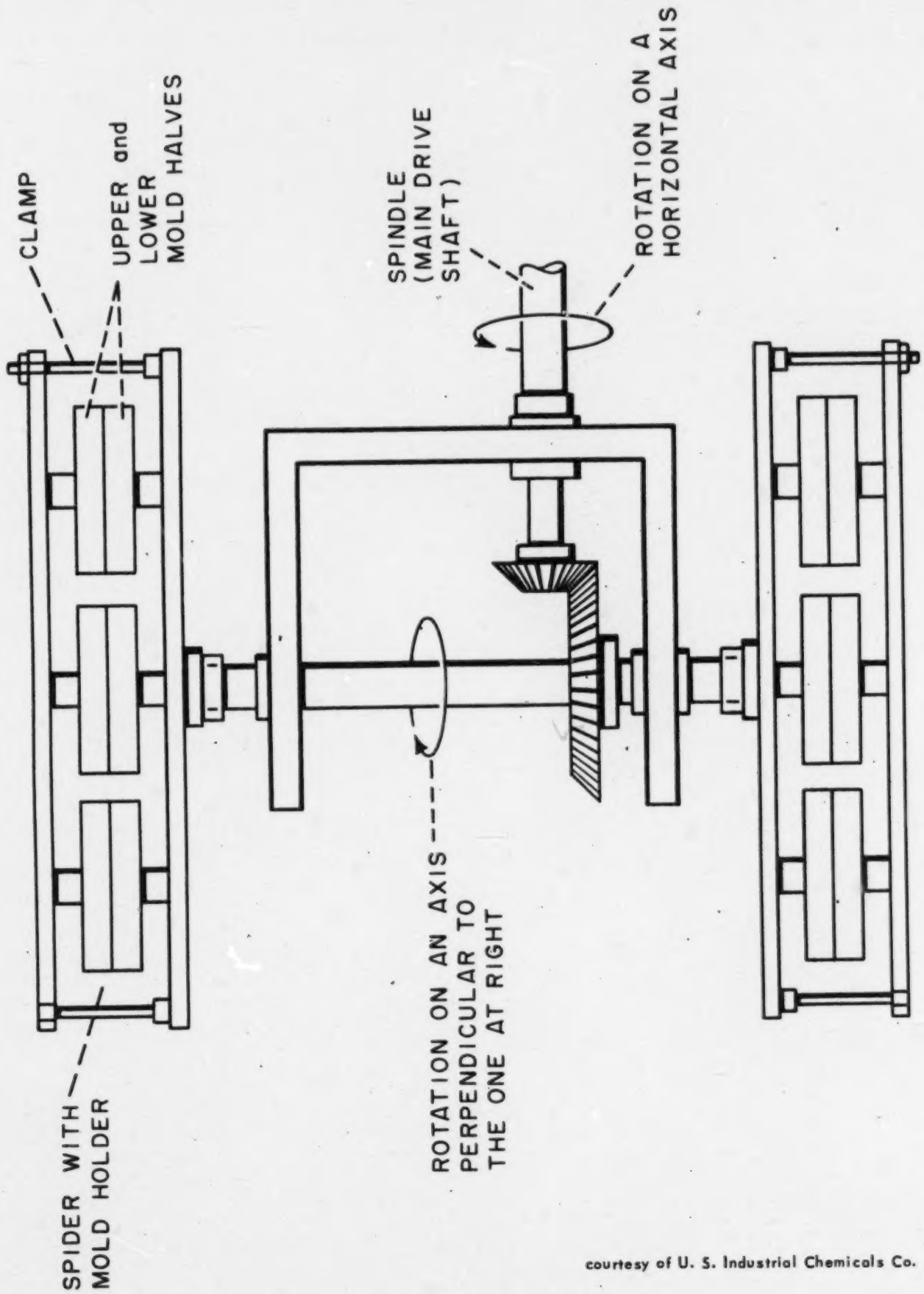

courtesy of U. S. Industrial Chemicals Co.

UNIT X

DECORATING

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45	Hot foil stamping (demonstration)	160
46	Machine engraving (related)	162
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UNIT X DECORATING

Lesson 44

Related Lesson: Decorating, coloring, and finishing

OBJECTIVES:

- To provide an overview of "why" and "how" plastics are decorated and colored
- To explain the basic procedures in choosing a colorant
- To describe methods of plastic finishing

REFERENCES:

1.	Bee Chemical Co.	Painting Plastics Manual	
2.	Edwards, Lauton	Industrial Arts Plastics	pp. 10,78,79
3.		Modern Plastics Encyclopedia	
4.	Redfarn and Bedford	Experimental Plastics	p. 56
5.	SPI	Finishing and Decorating Copyright 1959	
6.	SPI	Plastics Engineering Handbook	

FOR DISCUSSION:

- The shop use of dye colorants
- Correlation between decorating processes and coating processes

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Make a tumbler drum for dry coloring of plastics.
- Produce a fiberglass layup with material imbedded in outside layer.

BRIEF DESCRIPTION OF PROCESS:

The coloring, decorating, and finishing of plastics require methods, materials, and equipment designed specifically for the given case. The entire purpose of decorating or coloring is a more appealing end product. Colorants are in either dry or paste forms. Decorating materials run a wide range of types. Finishing materials have traits of their own, such as wheel speeds, at which they may best be used, abrasiveness, etc. For each type of plastic the manufacutrers have recommended methods of coloring, decorating, and finishing which should be followed.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Paste dyes, and dry powder dyes
- Simple drum tumbler and plastic beads. (Tin can with cover will do.)
- Buffing wheel and tape measure
- Inlay of plaid material in surface of fiberglass dish (optional)
- Chart with methods of coloring various types of plastics materials available in school shop

LESSON OUTLINE:

I. Coloring

A. Definition of colorant. A physical substance which modifies light waves striking it by absorbing some and reflecting others, thereby changing light energy composition. This altered light produces the effect called color.

B. Three types of colorants
- Dyes
  a. Chemical makeup
     1. Synthetic
     2. Natural organic
  b. Characteristics
     1. Good color strength
     2. Wide range of colors
     3. Poor resistance to heat
     4. Pronounced tendency to bleed or come to surface of plastic
- Organic pigments (divided into two classes called toners)
  a. Insoluble organic toners (usually salt free)
  b. Lake toners (quite pure, water insoluble, heavy metallic salts)
- Inorganic pigments (generally metallic oxides)
  a. Characteristics
     1. Weather resistant
     2. Heat and light stability
     3. Used in strong concentrations
  b. Miscellaneous group of inorganic pigments for special effects
     1. Metallic (powder)
     2. Pearlescent (flakes)
     3. Fluorescent (powder)
     4. Phosphorescent pigments
     5. Metallic flakes
     6. Color speckles

C. Methods of mixing
- Tumbler for dry powder dyes
- Vat and roller mixing for soluble dyes and colors
- Spray mixing in air before coating product in use of urethane foam

II. Types of processes for decorating

A. Inlay - for example, a print cloth under a clear polyester coating on tray

B. Printing - as seen on shampoo squeeze tubes, key tags, automobile decorations, etc.
- Silk screening
- Offset
- Gravure printing
- Letterpress
- Flexographic
- Photosensitive emulsion
- Hot stamping

C. Through the use of spray, roller, brush - Sample: soap bottle (spray)

D. Adhesion - the decorative labels on products

E. Plating; electro and vacuum metallizing - car dash parts

F. Calendering, embossing - textured vinyl fabric

G. Engraving - desk plates

H. Decalcomania - dinner ware

III. Finishing processes

A. Filing, sanding, buffing, polishing, and cutting

B. Air blasting and etching

C. Tumbling part against part (deflashing or with an abrasive)

D. Airless blast tumbling (deflashing)

E. Chemical solvent uses acetone, etc., to form a coating on surface

F. Flame polishing

SUMMARY:

Most basic plastics processes for fabrication have a finishing sequence, often called a secondary operation. Colorants are generally applied or infused during the fabrication of the article. The decorative materials and processes generally refer to coatings put on after the item is fabricated. The finishing processes are for surface clarity, texture, or the necessary cleaning after fabrication.

QUESTIONS:

Q: Describe five sample plastic products with decorative finishes and tell the decorative process for each product.

Q: When a plastics product is finished by the tumbling method, what is the abrasive used in the process?

Q: How does the chemical solvent affect the surface of a plastic product when it is used as a finishing solvent?

Q: What is the purpose of decorating a plastic product?

PROCESSING CONDITIONS AND SUITABLE COLORANTS FOR USE WITH VARIOUS COMMERCIAL PLASTICS

Plastic	Processing conditions and properties	Colorants
1 Phenol-formaldehyde molded laminates	Mildly alkaline reducing atmosphere Molding temperatures up to 170° C. Usually only moderate light fastness	Spirit and hydrocarbon soluble dyes Spirit soluble acid dyes Lakes and toners Organic pigments Inorganic pigments
2 Phenol-formaldehyde surface coatings and cast	Mildly acidic or mildly alkaline reducing atmospheres Long heating at moderate temperatures Better light fastness than for molded items	Spirit and hydrocarbon soluble dyes Spirit soluble acid dyes Phthalocyanines Lakes and toners Organic pigments Inorganic pigments
3 Urea and melamine-formaldehyde products	Mildly acidic reducing atmosphere for a short period Superlative light fastness	Selected water soluble dyes Inorganic pigments Vat dye pigments Phthalocyanine pigments Organic pigments, lakes, and toners
4 Casein products	Low mixing and extruding temperatures (approximately 100° C.) Acidic reducing conditions during formulation Moderate-good light fastness Must not bleed into the formulating solution	Water soluble acid and direct dyes Organic pigments, toners, and lakes Phthalocyanine pigments Inorganic pigments
5 Cellulose plastics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose, etc.)	Substantially neutral to mildly acidic atmosphere Mixing time on the order of 15 min. at 180° C. Short-time high injection temperature at 180 to 200° C. Moderate-good light fastness	Spirit and hydrocarbon soluble dyes Organic pigments (except those prone to bloom) Lakes and toners Dispersed dyes Basic dyes
6 Polyvinyl chloride and copolymers	Tends to become acidic during processing High temperature compounding up to 170° C. for long periods Very good light fastness High degree of dispersibility	Selected spirit and hydrocarbon soluble Vat dye pigments Organic pigments Inorganic pigments (except those prone to bloom and migrate) Lakes and toners Phthalocyanine pigments
7 Fluorocarbons	High heat stability Resistant to acids and alkalies High degree of dispersibility (very fine)	Inorganic pigments Phthalocyanines and selected organic pigments
8 Polyethylene	Neutral inert processing conditions High temperature processing and extruding depending on grade Very good fastness to light	Organic pigments (except those prone to bloom and migrate) Lakes Vat dye pigments Phthalocyanine pigments Selected hydrocarbon soluble dyes
9 High-density polyethylene	Neutral inert processing conditions Very high temperature processing conditions Very good light fastness and heat stability	Inorganic pigments Organic pigments Phthalocyanine pigments
10 Polymethyl methacrylate	Strongly oxidizing atmosphere during polymerization Moderate temperatures Very good light fastness	Selected hydrocarbon soluble dyes Selected vat dye and organic pigments Phthalocyanine pigments
11 Polyesters	Strongly oxidizing atmosphere during polymerization Very good light fastness High degree of dispersibility	Vat and other organic and inorganic pigments as flushed pastes Inorganic pigments Selected hydrocarbon soluble dyes as flushed pastes
12 Polyurethane foams	Inertness of colorant to catalytic effect and alkaline conditions Light fastness not of importance High degree of dispersibility	Water pulps and flushed pastes of inorganic and organic pigments Vat dye pigments Phthalocyanine pigments
13 Nylon	High heat stability Very good light fastness High degree of dispersibility Strong reducing action of nylon above 500° F.	Inorganic pigments Phthalocyanine pigments Selected anthraquinone pigments
14 Alkyds	Very good light fastness High degree of dispersibility Moderate temperature Bleed resistance	Selected vat dye and thioindigoid pigments Inorganic pigments Phthalocyanine pigments
15 Epoxies	Very good light fastness High dispersibility Moderately high temperature	Organic pigments Phthalocyanine pigments Inorganic pigments
16 Polystyrene	Processing conditions neutral but residual oxidizing catalyst may be present. High temperature processing and injection at 200° C. and above; good to excellent light fastness; high degree of dispersibility	Hydrocarbon soluble dyes Organic pigments Lakes Phthalocyanine pigments Inorganic pigments
17 Polypropylene	Neutral inert processing conditions Very high temperature Very good light fastness and heat stability	Inorganic pigments Organic pigments Phthalocyanine pigments
18 Silicones	Neutral inert processing conditions Molding temperature at 500° F. and above Excellent light fastness and heat stability	Inorganic pigments

UNIT X DECORATING

Lesson 45

Demonstration: Hot foil stamping

OBJECTIVES:

. To develop an understanding of the hot stamping process on plastics

. To show a method of applying a decorative foil surface to plastics

REFERENCES:

1. Coating Products — Literature on Films
   101 W. Forest Avenue
   Englewood, New Jersey

2. The Kingsley Machine Co. "Plastic Marking Machine" — Equipment Literature
   Hollywood, Calif.

FOR DISCUSSION:

. The industrial application of hot foil stamping on plastics
. The commercial potential in a home workshop

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Make key chain identification tag with students name.
. Experiment with different plastics.
. Produce name badges.

BRIEF DESCRIPTION OF PROCESS:

Hot foil stamping is a method of decorating plastic materials. Heated metal dies are pressed on to a plastic foil and against the object to be stamped. The color on the foil releases and adheres to the plastic.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Hot stamping machine
. Plastic item to be stamped (suggest a flat sheet item)
. Die, type, or other form for desired decoration (suggest standard type supplied with machine)
. Foil suitable for the plastic used (See foil literature for correct type(s).)

LESSON OUTLINE:

I. Description of hot stamping on plastics

   A. Die localizes heat and pressure on foil
   B. Plastic foil and material is heated under pressure
   C. The coating of foil heat-seals itself to the area of contact

II. Equipment, setup, and operation

   A. Press operation
      - Set up type, assemble die, etc.
      - Place in press and preheat
      - Install foil, printable side down, facing item; test sample impression on scrap plastic (same as item)

B. Item preparation and press run
- Clean surface of item carefully, using rag
- Insert in press in proper register with die
- Hot stamp the item(s)
- Turn off press and label "HOT"

III. Area clean up and safety

A. Remove type or die, using gloves
B. Allow to cool
C. Redistribute type or store die

SUMMARY:

When using a foil to hot stamp on plastics attention should be paid to five variables. The pressure applied to the foil, the type of foil used, the plastic used and the length of the cycle time will all effect the result produced. The size and type of die used is basically a problem of heat distribution.

The finished hot-stamped item has an attractive surface or detail. Color is varied according to the foil used and allows for a detailed metal-like appearance.

QUESTIONS:

Q: What are the purposes of hot stamping on plastics?
Q: What are the variables in hot stamping?

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UNIT X DECORATING

Lesson 46

Related Lesson: Machine engraving

OBJECTIVES:

. To acquaint the student with the machine engraving process

. To develop in the student an understanding of materials and equipment used in machine engraving of plastics

REFERENCES:

1.	Cherry, Raymond	General Plastics 1964 Revised	Chap. 29
2.	Edwards, Lauton	Industrial Arts Plastics	pp. 98-104

FOR DISCUSSION:

. Commercial use of machine engraving
. Types of plastic materials used
. Methods of machine engraving plastics

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Produce name plates and plaques.
. Experiment with different fillers when solid stock is engraved.

BRIEF DESCRIPTION OF PROCESS:

Machine engraving is one process of incising lines or designs in the surface of a plastic. The machine used is an accurate pantograph using a stylus following a line in a die to guide the rotary cutter engraving the plastic.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

. Pantograph (wood type) Definition: An instrument for copying a diagram to any predetermined scale. The pantograph consists of four light, rigid bars joined in the form of a parallelogram.
. Laminated blocks
. Products made by the engraving process - house numbers, name plates, desk signs, etc.

LESSON OUTLINE:

I. Other engraving processes

A. Earliest scratching on stone caves a forerunner of engraving

B. Highly developed hand skill used to engrave or cut away thin line of metal

C. Wood engraving used for early block printing

D. Machine process used on many materials. Used on plastics in the 1940's

II. Application

A. Commercial use: Signs, name plates
- Hospitals - x-ray room
- Hotels - check out time signs
- Banks - loan department signs
- Home and school - desk name plates, etc.

B. Industrial use
- Instruction plates and numbers
- Instrument panels and dials

III. Machines used for process (for flat, and 3 dimension stock)

A. Built around the use of the pantograph
- They reduce from master type to work
- For plastics the ratio range is 2:1 to 7:1

B. Power for cutting
- Electric motors run on 115V and produce 1/6 to 1/4 HP
- Speeds should be variable from 1200 - 3400 RPM

C. Cutting tool material
- High speed steel is the most common
- Tungsten carbide is also frequently used
- The tools are sometimes diamond tipped

D. Tracing stylus (follows master type in operation)
- Hardened steel is frequently used
- The stylus is often carbide tipped

E. Copy tables, to hold material to be traced, type or design

F. Work table, holds blank to be engraved

G. Depth control
- It is most commonly mechanical
- Pneumatic control used in some instances

H. Size of machine (varies with master type to be used. (Master type 1/16" - 7")

I. Cost of machines used for engraving plastics varies from $95 to $12,000

IV. Master type or copy

A. Standard
- Flat bottom grooved
- Vee grooved

B. Reverse lettering (used for transparent and translucent materials)

C. Two or three dimensional material may be used

D. Made usually from brass

E. Cost depends on style type used and size - relatively expensive for most copy

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V. Materials used for engraving

A. Laminated phenolics
- Surface 1/16, 1/8, 3/32 thick
- Engraving through top layer exposes core
- Colors
  a. Core - black, white, red
  b. Surface - many colors and designs, including wood grain

B. Acrylics
- Solid stock generally used with reverse type
- Colored, clear, opaque, and translucent

C. Other materials by trade name
- Gravoply - pliable
- Gravoflex - flexible
- Micro laminated stock
- Green laminated stock
- Formica, panelyte

VI. Basic methods of machine engraving

A. When using laminated material the top layer is cut through, resulting in permanent lettering on a contrasting background

B. When using solid opaque stock the engraved area is filled with wax crayon or other fillers such as paint or lacquer of contrasting color

C. When using solid transparent or translucent materials engraved on the reverse side, a reverse master type is used. The engraved area may be colored as in use of opaque solid stock.

VII. Consumer value

A. Wax filled engravings are less expensive than laminated stock. The quality of the engraving depends on the machines and the materials used.

VIII. Guidance

A. Small business opportunity

B. Custom shops, small job shops

SUMMARY:

In machine engraving, the size and type of machine, the plastic material, and the master copy may vary considerably. The quality of the end product depends largely upon the proper selection of the materials and master copy for the particular product desired.

QUESTIONS:

Q: What are some commercial uses of machine engraved plastics?
Q: What is the mechanical principle that engraving machines are based on?
Q: What are two types of plastics used in engraving?
Q: What are two methods of making engraved name plates on an engraving machine?

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UNIT X DECORATING

Lesson 47

Demonstration: Machine engraving

OBJECTIVES:

- To show students the process of machine engraving of plastics
- To develop in the student an understanding of the pantograph machine to be used
- To develop in the student an appreciation of the materials used for machine engraving

REFERENCES:

1.	Cherry, Raymond	General Plastics 1964 Revision	Ch. 29
2.	Edwards, Lauton	Industrial Arts Plastics	pp. 100-104

FOR DISCUSSION:

- Extensive use of machine engraving for metal
- Differences in machines used
- Differences in cutting tools used

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

- Produce name tags, desk name plates, plaques.
- Make high pressure plastic laminates (similar to formica) on compression press, and engrave a name plate or similar item.

BRIEF DESCRIPTION OF PROCESS:

Machine engraving uses a rotary cutter guided by a stylus in a template. The cutter and stylus are connected by a precision-type pantograph machine.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

- Engraving machine - trade names: Mico, H. D. Preis, Green Inc., Hermes
- Master type or templates - letters, numbers etc.
- Plastic engraving stock - laminated, solid
- Fill material - wax crayon, paint, or lacquer

LESSON OUTLINE:

I. Material used

A. Laminated phenolics
B. Solid stock (acrylic), colored or clear

II. Engraving process

A. Select letters or numbers (standard or reversed type)
B. Place master type in template on holding table
C. Center copy material in template
D. Open work vise on work table
E. Insert work to be engraved
F. Set pantograph arms for required reduction
G. Locate cutter in correct position, holding stylus on first letter
H. Turn motor on and adjust to correct speed

I. Follow letter patterns with stylus using three fingers of right hand to guide stylus. (Depress cutter handle with left hand.)
J. Complete engraving by following each letter or number
K. Bevel edges as desired
L. Turn off machine and remove engraved material
M. Fill engraved surface if laminated stock is not used

V. Industrial considerations

A. Advantages
- Process offers ease in setup of machine for short runs
- Precision machine produces an accurate detailed copy
- Plastic material is easily obtained

B. Disadvantages
- The process is not practical for long run jobs
- Cost of type and other copy material is high

SUMMARY:

To make an article on the engraving machine you must first select the master type and blank material to be used. The pantograph arms of the machine should then be adjusted to provide the proper ratio of master copy to the piece to be engraved. If care is taken during the engraving process, no additional surface finishing of the article is necessary.

QUESTIONS:

Q: How are different ratios of copy-to-work obtained with the use of the engraving machine?
Q: What type of motor is used for powering an engraving machine?
Q: From what type of steel are the engraving cutting tools made?

UNIT XI

MATERIALS

Lesson Page

48 Testing plastics materials (related) 168

49 Plastics chemistry (related) 172

TSS 236

UNIT XI MATERIALS

Lesson 48

Related Lesson: Testing plastics materials

OBJECTIVES:

. To acquaint the student with the main categories of testing

. To acquaint the student with the significance of each type of test

. To convey the importance of testing plastics materials

REFERENCES:

1.	ASTM	Plastic-Methods of Testing	Part 27
2.	Celanese	Standard tests on Plastics	
3.	SPI	Plastics Engineering Hand Book	pp. 541-550
4.	Swanson, Robert	Plastics Technology	pp. 12-31

FOR DISCUSSION:

. What testing signifies for the manufacturers
. Difference between "captive" and independent testing agencies
. The four main categories of testing plastic materials

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Develop testing equipment for plastics laboratory.
. Experiment in testing of different plastics materials.

BRIEF DESCRIPTION OF PROCESS:

The testing of the physical properties of items made of plastics is of paramount importance to manufacturers today. The purpose of such tests may be for quality control in production, as a check by the purchaser to see if the item meets specifications, or for the establishment of data for engineering and design. These tests fall into four main categories: mechanical properties; permanence properties; thermal properties; and flamability tests. Each of these four tests employs different means of checking a plastics material to see if it is the proper material to do the job.

MATERIALS, EQUIPMENT AND/OR TEACHING AIDS:

A chart listing the five main categories and subdivisions of tests.

LESSON OUTLINE:

I. Mechanical tests (Basic reference #3 pp. 541-44)

A. Purposes of mechanical tests
- Crushing tests are designed to check whether or not the article will stand up to compressional stresses that it may encounter when in customer service
- Wear tests are designed to find out how long an item made of plastic will withstand the usage to which it is subjected while in consumer use
- Fatigue tests are set up to check whether or not the item will fail after repeated loading to a stress less than its short time ultimate strength

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B. Strength. (Testing molded articles for physical properties)

- Falling weight test. This test is made by dropping an object of a given weight and dimension from a predetermined height on a specimen and examining the effect of the impact.

Impact Testing
courtesy of Celanese Plastics Company

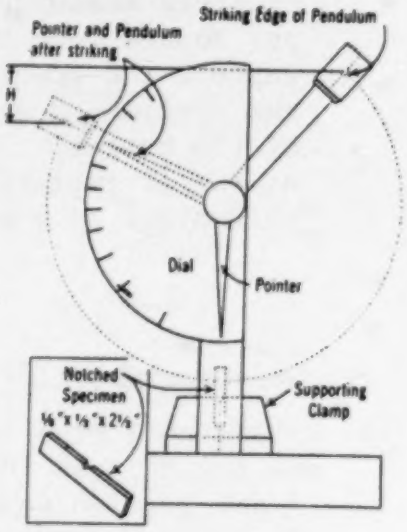

- Pendulum test (IZOD). The sample is clamped in a pendulum testing machine, and the pendulum is released so that it strikes the sample. The force required by the pendulum to break the sample is calibrated by the height which the pendulum reaches on the follow through.

- Tumbling impact test. Items of a known molded material are placed in a tumbling machine with the same amount of an unknown molded material. The items are tumbled for a specific length of time and then removed and inspected. The items made of the weaker molded material will show the greater amount of wear.

- Projectile impact test. A projectile is fired from a gas pressurized gun, and the impact strength of the specimen is calculated from the speeds of the projectile before and after impact as measured by photocells in circuit with electrical timing devices.

- Tensile strength. Tensile properties are the most important single indication of strength in a material. The force needed to pull the specimen apart is determined as well as how much the material stretches before breaking.

Tensile Testing Machine
courtesy of Celanese Plastics Company

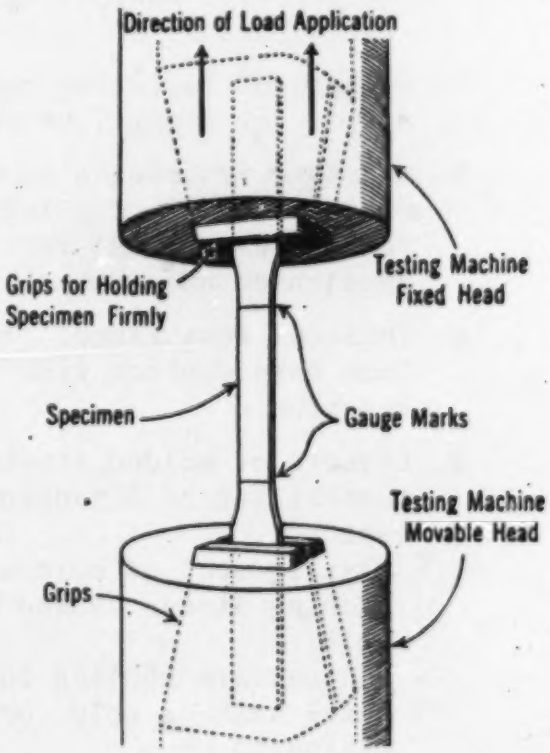

TENSILE TEST SPECIMEN

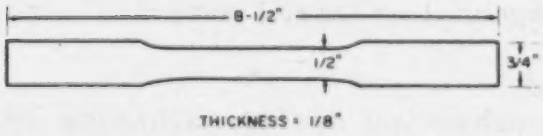

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- Compressive strength. The compressive strength of material is determined as a pressure measured in pounds per square inch required to rupture the specimen or deform the specimen a given percentage of its height. It may be rated as PSI at rupture, or at a given percentage of yield.

Compression Testing
courtesy of Celanese Plastics Company

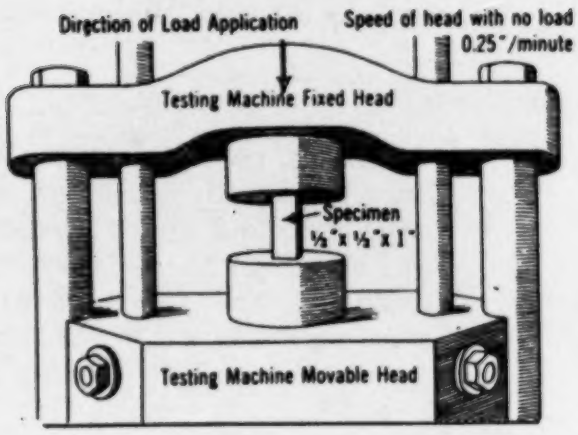

II. Permanence properties tests

A. Dimensional stability tests are designed to find out whether there are any changes in dimensions due to any of the following factors:
- A deformation under load known as cold flow
- Swelling or shrinking owing to absorption of moisture or drying
- Aging effects owing to cycles of absorption of moisture and drying
- Internal stress
- Change in temperature

B. Weathering tests. These arrive at an evaluation of the resistance of materials to outdoor exposure which may cause degradation, loss of original beauty, and, in some cases, complete erosion. This is generally accomplished by one of the following means:
- Weathering rack (sun, rain, snow, heat, cold, industrial acids in the air)
- Accelerated weathering machines (speed up weathering through artificial means)

C. Effects of radiation test. This is a check to see whether radiation causes any damage, or whether it may, in some cases, be beneficial.

D. Moisture resistance test. This involves a check of the physical properties directly influenced by the moisture content of plastics, such as electrical resistance, dielectric losses, mechanical strength, appearance and dimensions.

E. Chemical resistance. This test is necessary only when the item is to come into contact with water and solvents which may cause a chemical reaction.

F. Effects of molded stress. This is testing designed as a check on the possibility of dimensional changes caused by any of the following factors:
- Misalignment of molecules
- Packing stress caused by forcing unplasticized material into the mold
- Non-uniform cooling in the mold
- Quick heat or cold, or local overheating during machining or finishing

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III. Thermal property tests (Effect of temperature). These involve checking materials to see how they have been affected by heat and cold.

IV. Burning test

A. Heat is applied to a specimen, and if it does not burn, it will be classed "non-burning."

B. If it burns for four inches, it will be classified as "burning" by this test

C. If the flame goes out before it reaches four inches, the specimen is classified "self-extinguishing."

D. The length that it did burn is reported as the "extent of burning."

V. Specific gravity test. A piece of material is held by a fine piece of wire, weighed in air, and then submerged in water. While it is in water, it is weighed again. From the weight difference, the density is calculated. Specific gravity is the ratio of a given volume of material at 73.4°F to that of an equal volume of water at the same temperature. Density is the weight per unit volume of material at 73.4°F.

SUMMARY:

Many of these methods originated in the technology of metals; however, there is little doubt that future testing of articles made from plastics will depend on modifications of existing techniques or on new concepts arising from the unique needs of organic materials.

QUESTIONS:

Q: What are the four main categories of tests for plastics?
Q: Define each of the four main categories of tests for plastics.
Q: What two methods are used for weathering tests?

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UNIT XI MATERIALS

Lesson 49

Related Lesson: Plastics chemistry

OBJECTIVE:

. To acquaint students with the basic chemical background of plastics

REFERENCES:

1.	Bakelite Company	The ABC'S of Modern Plastics	pp. 1-22
2.	Cherry, Raymond	General Plastics, 4th Ed.	Ch. 1
3.	Fry Plastics International	Speaking of Plastics Series	
4.	Lionel Engineering Corp.	Plastics Engineering Manual	
5.	Redfarn and Bedford	Experimental Plastics	
6.	Simonds and Church	Concise Guide to Plastics 2nd Edition	pp. 1-75
7.	Swanson, Robert	Plastics Technology	pp. 3-7

FOR DISCUSSION:

. A comparison of organic and inorganic chemistry
. Characteristics of thermoset and thermoplastic materials

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Experiment 1.16 - Polyethylene, solution polymerization
  Ref. #5 Experimental Plastics p. 23
. Experiment 2.13 - cellulose acetate cast film
  Ref. #5 Experimental Plastics p. 51
. Experiment 2.12 - polyester dough molding material
  Ref. #5 Experimental Plastics p. 50

Polystyrene Origin and Resins
courtesy of The Lionel Corporation

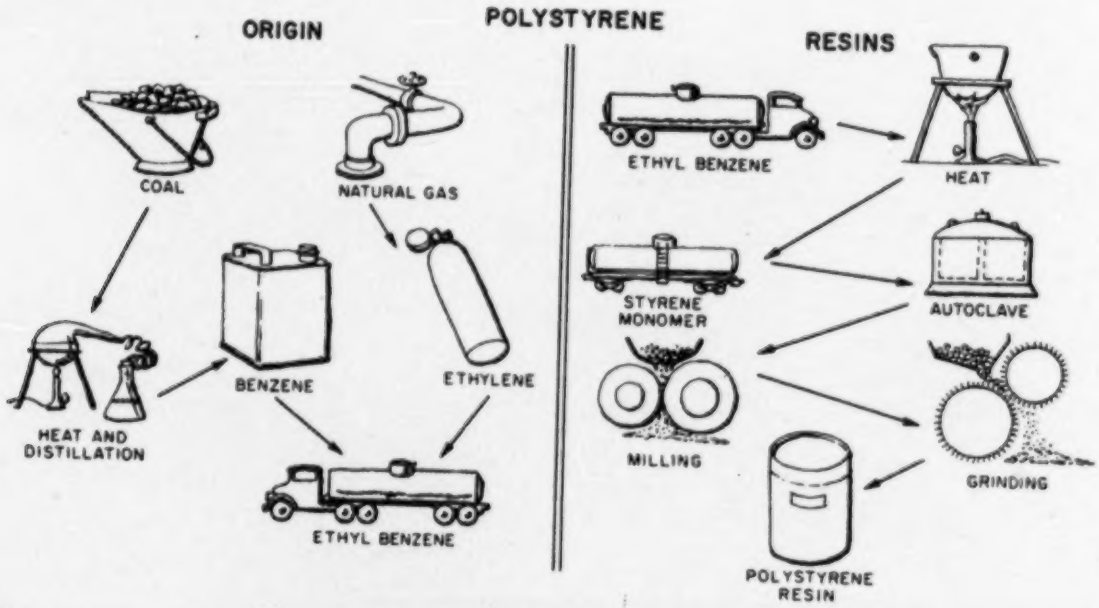

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OPS

BRIEF DESCRIPTION OF PROCESS:

Plastics are man-made materials. They may be any one of a large and varied group of materials consisting wholly or in part of combinations of carbon with oxygen, hydrogen, nitrogen and other organic and inorganic elements.

Plastics are solid in the finished state but at some stage in their manufacture they are made liquid and capable of being formed into various shapes. The application of heat or pressure or both usually causes the change of state.

MATERIALS, EQUIPMENT, AND/OR TEACHING AIDS:

. Samples of thermoset and thermoplastic products
. Samples of plastic pellets, sheet stock, and beads
. Wall charts
. Models indicating basic molecular structures

LESSON OUTLINE:

I. Historical origins and commercial background

A. Romans and Egyptians collected secretions of lac bug to form shellac sheets

B. Commercial development
- John Hyatt - cellulose 1868
- Leo Baekeland - phenolic (Bakelite) 1909

II. Four families of plastics

A. Natural - shellac, copal, resin, and pitch

B. Cellulose - treated cotton or pulpwood

C. Protein - soybean meal and the casein of milk

D. Synthetic - product built by using organic chemical building blocks, called atoms and molecules, starting from raw materials such as coal, petroleum, air, water

III. Branches of Chemistry

A. Inorganic chemistry. This is a branch of chemical science that deals with non carbon molecules.

B. Organic. This is a branch of chemical science that deals with the hundreds of thousands of known chemical molecules containing a large percentage of the element carbon in their makeup. Plastics is a branch of organic chemistry.
- Organic substances are large, complex, molecular structures
- In them, the carbon atom combines readily with other carbon atoms as well as atoms of other elements
- Their unstable molecular structure breaks up easily when heated

C. Polymer chemistry. This is a branch of organic chemistry
- The atom is the smallest particle of an element
- The molecule is the smallest portion of an element or compound which retains the chemical identity and properties of the substance mass. It is made up of atoms.

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- A monomer (Mono - single, Mer - part) is a one part, single molecular unit. Basic building blocks (molecules) joined end to end form polymers.

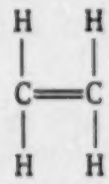

- A polymer (Poly - many, Mer - part) is a giant molecule made up of many parts (single molecules)
- Polymerization is the act of combining two or more molecules of a monomer into a single large molecule, thus creating a different substance called a polymer

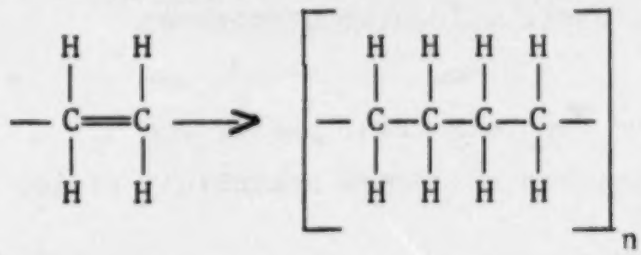

- A catalyst is a chemical substance which is used in assisting chemical reactions without combining chemically itself
  . It is sometimes used to speed up or start a reaction
  . It is at other times used to stop a reaction (inhibitor)

IV. Thermoplastics

A. The plastics of this group soften when heated. Molecules are thus loosened so that they may move freely.
B. They have a long chain-like molecular structure
C. They can be re-shaped
D. Examples - polystyrene, polyethylene, polypropylene, nylon

V. Thermoset plastics

A. The plastics in this group have a cage-like molecular structure
B. They are heated and formed permanently
C. Examples - melamine, polyesters, phenolics, ureas, epoxies

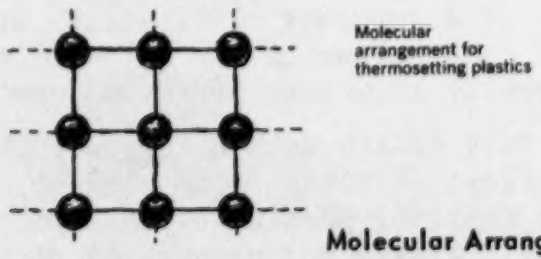

Molecular Arrangements for Thermosetting Plastics and for Thermoplastics
courtesy of The Lionel Corporation

SUMMARY:

All plastics are giant-molecule, high molecular weight materials. The broad field of study that has contributed the varied plastics materials is called organic chemistry. The number of monomers in a giant chain-like molecule and the nature of their arrangement in the plastic are important determinants of the physical and chemical properties of the plastic, which in turn determines the thermoset or thermoplastic qualities of the material.

QUESTIONS:

Q: What function does the catalyst fulfill when mixed with a polyester resin?

Q: How does the study of organic chemistry differ from the study of inorganic chemistry?

Q: Are plastics considered synthetic materials?

Q: Use two sketches to compare the molecular structure of thermoplastics and thermoset plastics.

UNIT XII

GUIDANCE

Lesson Page

50 Occupational Opportunities in Plastics (related) 178

UNIT XII GUIDANCE

Lesson 50

Related Lesson: Occupational opportunities in plastics

OBJECTIVES:

. To acquaint the student with possible employment opportunities in the plastics field

. To develop in the student an understanding of the education and training needed to qualify for employment in the plastics field

REFERENCES:

1. Dearle, Denis A.	Opportunities in Plastic-Careers Occupational Outlook	Total Content
2. *United States Dept. of Labor	Occupational Outlook Handbook (1961)	
3. *United States Dept. of Commerce	Statistical Abstract of the U. S. (1963)	pp. 232,784,221, 776-77
4. *State of N. Y. Dept. of Commerce	Industrial Directory of New York (1958)	
5. McGraw-Hill, Inc.	Modern Plastics Magazine	General

FOR DISCUSSION:

. Safety Hazards and Working Conditions
. Education and Training
. Interrelationships of occupations

EXPERIMENTAL AND/OR PROJECT ACTIVITIES:

. Investigate the specific duties of a setup man in an injection molding plant.
. Determine which high school courses should be taken to prepare for a chemical engineering career in plastics.
. Make an occupational analysis of one occupation in the plastics industry.

LESSON OUTLINE:

The plastics industry is expected to provide thousands of job opportunities for new workers during the late 1960's and the 1970's. The industry's work force is expected to increase at a faster rate than the nation's total labor force.

I. General employment outlook

A. Growth in number of workers through 1961 (Ref. 3)
- The number rose from 18,000 in 1940 to 86,000 in 1956 and to 152,000 in 1961
- The growth of the labor force is expected to continue at a faster rate than the increase of manufacturers in general
- Technical improvement has raised output per worker
- Improved materials and exploration in new fields has kept employment up

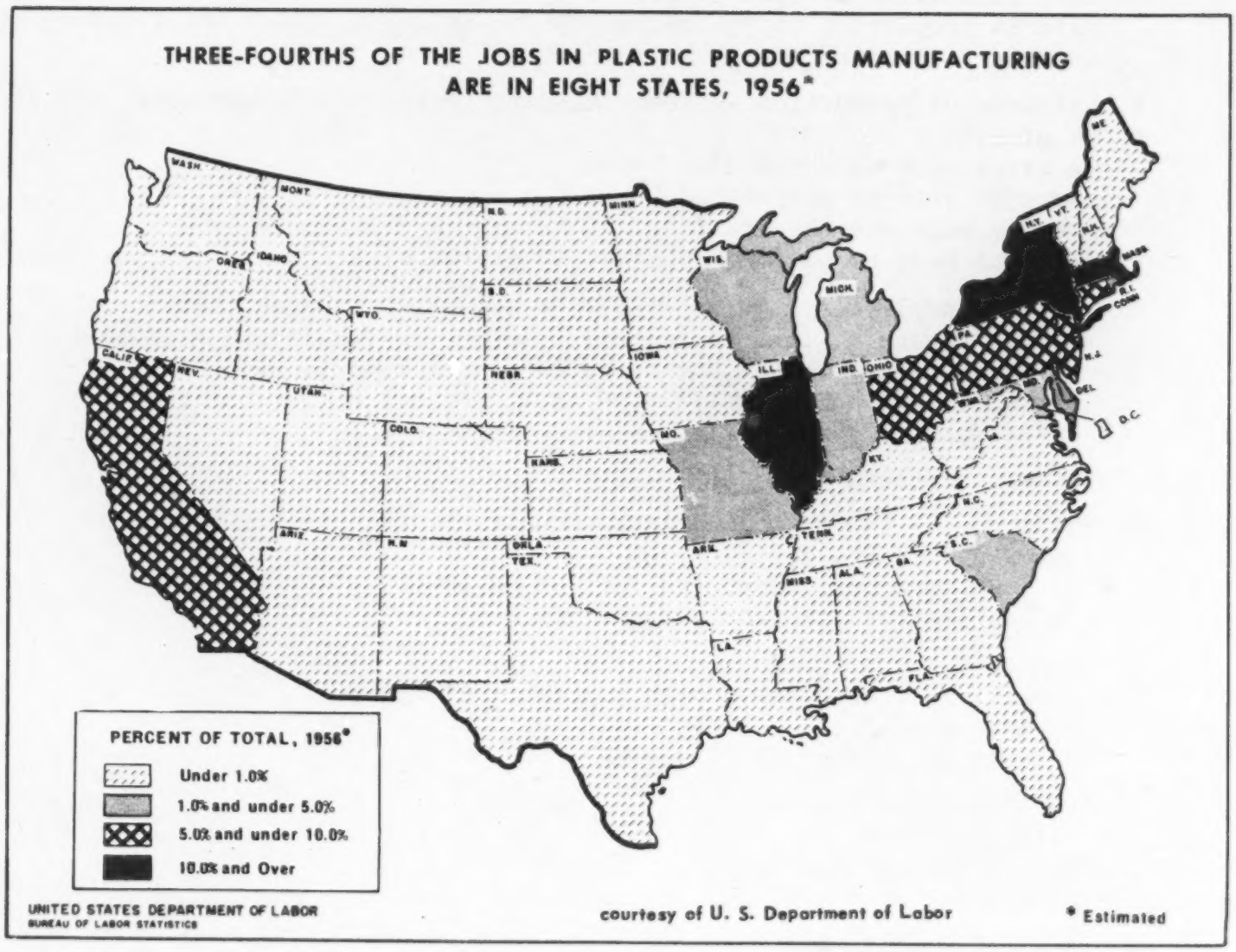

B. Distribution of workers as of 1961 (Ref. 2)
- Of the 152,000 workers, 103,000 were production workers
- Approximately 40 percent of the total number of workers were unspecialized
- About 25 percent were semi-skilled (largely machine operators)
- The number of skilled craftsmen and foremen comprised approximately 10 percent of total. (One-half of these workers were tool and die makers.)
- Professional and technical workers made up the remaining 25 percent of the workers. Because of a large number of small industries (50 workers or less) many of these professional workers were proprietors and managers.

II. Wage Considerations

A. Vary in accordance with particular job performed. The salaries are paid in proportion to the responsibilities involved and the training necessary to carry out these responsibilities.

B. Earnings of production workers (molders, setup men, inspectors, etc.) as of 1961
- Average work week was 41.6 hours
- Average rate of pay was $2.59
- Weekly wage average was $107.74
- Females made up one third of the labor force

C. Salaried employees earnings (molding material salesmen, plant production managers, cost estimators, product designers and engineers)
- Salaries range from $4,200 to $9,000 and sometimes beyond
- Increases are based entirely on merit and the ability of the individual to show results in his particular job

III. Working Conditions (Ref. 1)

A. Shift work. (Most large plants work around the clock.)
- Usually 3 shifts are in force
- 5 cents extra per hour paid for second shift.
- 10 cents extra paid for third shift

B. Vacations
- 1-week vacation granted with pay after one year
- 2-weeks paid after 5 years
- 3-weeks paid after 15-20 years

C. Other Benefits
- Life insurance
- Health and hospitalization
- Pensions

D. Physical conditions
- They are good compared with factory work in general
- Buildings are generally well lighted and adequately ventilated
- Noise and heat may prove to be a problem
- Odors and gases may cause health problems for some persons

IV. Education and Training (Ref. 2)

A. Unskilled and semi-skilled labor (molders, finishers, inspectors, set-up men, etc.)
- Training
  a. General practice is to hire inexperienced persons and train them on the job
  b. Training period varies with job. (Ranges from 3 days to several months or more.)
- Education. A high school education is preferred, but not always required.
- Extra education and training usually needed for advancement

B. Skilled Workers
- Tool and die makers and machinists generally serve an apprenticeship of 4-5 years, or attend trade school and shorter apprenticeship
  a. They work with experienced craftsmen
  b. They attend classes for instruction in related subjects
- Maintenance men generally learn from experienced craftsmen as helpers
- High school or vocational school education is necessary
- Tests for mechanical and mathematical aptitudes are sometimes given

C. Professional workers (engineers, mechanical, chemical, and sales engineers, technicans, cost estimators, etc.)
- College degree in chemistry, engineering, or special field is required for most professional and technical jobs
- Salesmen are also required to have some technical training to understand the nature of the product
- Technicians. 2 year technical degrees or graduation from community colleges is usually acceptable.

D. For information concerning schools of higher education in the plastics field, refer to (Ref. 1-pp. 140, 141, 31-32)

V. Plant Location (Refer to map)

A. New England area has largest number of plastics concerns
B. Metropolitan New York and parts of New Jersey have high concentration
C. Chicago and midwest area are next in industrial concentration
D. Ohio and California more recently have become sections with increased plastics activity commercially

VI. Future of the Industry (Ref. 1)

A. Barometer for future may be found in the rapid rise in resin production
- In 1950, 2 billion pounds of resin were produced
- In 1961, 6 1/2 billion pounds of resin were produced
- In 1964, nearly 10 billion pounds of resin were produced

B. Sales increased from 14 million dollars to almost 400 million dollars between 1946 and 1961. Many new products introduced.

C. Highly automated industry, so there is an expanding need for technically competent workers

D. Industry estimates that only 3 percent of potential market has been realized in 1963

SUMMARY:

The plastics industry is still a rapidly growing industry. Although the rate of employment is not expected to increase at the same rate as production, employment should increase at a steady rate as new markets and new materials are discovered.

Most of the new job openings will be for inexperienced persons who can be trained for production jobs, but there will be many openings for engineering, sales, and other technical and professional personnel.

QUESTIONS:

Q: Approximately how many workers were employed in the plastics industry in 1961?

Q: What are some of the semi-skilled jobs in the plastics industry?

Q: What type of education is necessary to become an engineer in the plastics industry?

Q: What are the future prospects for employment in the plastics industry?

APPENDIX

Seventh Year Outline. 184

Field Trip Directory (map & list of companies). 185

Suggested Equipment List for Plastics 190

List of Equipment Manufacturers and Distributors. 193

List of Supplies for Plastics 196

List of Materials Suppliers and Distributors. 198

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Seventh Year Outline

Plastics Area in General Industrial Arts

	Lesson	Unit	Content	Time
1	Injection Molding	II	Basic instruction related to heat, pressure and cycling time for process	15 min.
2	Compression Molding	II	Understanding scope of process application including variety of resins, filler materials, heat and pressure considerations	15 min.
3	Thermoforming	II	Blow forming, vacuum forming, mold design relationships, effect of heat and pressure on one or two common materials	15 min.
4	Mold Making	III	Simple hydrocal mold production and thermo-forming activity	30 min.
5	Bonding	IV	Cementing, heat sealing, and welding (optional)	20 min.
6	Laminating	V	Reinforced fiberglass	15 min.
7	Laminating	V	Low pressure and high pressure including biological specimens 2-dimensional and production of Formica type material	15 min.
8	Encapsulation	VI	Embedding 3-dimensional electronic, biological or other specimens in-cluding coins	15 min.
9	Foams	VII	Polystyrene bead expansion, rigid and flexible resin foams expansion	10-20 min.
10	Coating	VIII	Cold dip and fluidized bed - materials, application, technique	10 min.
11	Vinyl Dispersion and/or Rotational Molding	IX	Simple dip technique with organosols or plastisols	10 min.

A great deal of pupil project and/or experimental activity can be combined with woodworking and ceramics. For example: moldmaking which requires wooden flasks and gypsum casting.

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FIELD TRIP DIRECTORY

1 Allied Chemical Co., Plas Div.
2 Atlas Plastics Co.
3 Auburn Plastics Co.
4 Brenneman-Hartshorn, Inc.
5 Brighton Plastics Co.
6 Clarmont Polychemical Corp.
7 Consolidated Plastics Corp.
8 Crellin Plastics Corp.
9 Curbell Plastics, Inc.
10 Dismolding Corp.
11 Duramark, Inc.
12 Durez Plastics Div. Hooker Chem
13 Empire Brushes, Inc.
14 Fisher-Price Toys, Inc. Trinuld
15 Geigy Industrial Chemicals
16 General Products Corp.
17 International Business Machines Corp.
18 LeBarb, Inc.
19 Laminated Fiberglass Corp.
20 Lunn Laminates, Inc.
21 Norton Industries, Inc.
22 Nu-Process Plastics
23 Orangeburg Manufacturing Co.
24 Reichhold Chemicals Inc.
25 Russell Reinforced Plastics Corp.
26 Syracuse Ornamental Co.
27 Tufflite Plastics, Inc.
28 Pontasote Company
29 Dura Plastics of New York

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MAP CODE NO.	COMPANY AND ADDRESS	ACCOM. NO. STUDENTS	PLANT PROCESSES
1	Allied Chemical Co., Plas Div. 40 Rector Street New York 6, N. Y. Nicholas A. Dunn P. O. Box 70 Morristown, N. J.	24	Chemical Research
2	Atlas Plastics Co. 681 Seneca Street Buffalo, New York H. S. Nathan, President 716-856-5041	24	Laminating
3	Auburn Plastics Co. Auburn, New York Harold J. Hugg Personnel Director	12	Custom Molders
4	Breneman-Hartshorn, Inc. 8 East Utica Street Oswego, New York T. A. Beard, President 343-3660	12	Laminating Production
5	Brighton Plastics Company 21 Rutter Street Rochester 6, New York Frank Rohrbaugh General Manager C14-5775	10	Injection Molding
6	Claremont Polychemical Corp. 39 Powerhouse Road Roslyn Heights, L. I., N. Y. M. W. Neitlich Advertising Director 516-MA-1-8800	24	Production Packaging
7	Consolidated Plastics Corp. Conklin Avenue Binghamton, New York R. J. Coyne RA2-4288	24	Injection Molding Compression Molding Custom Molders Finishers
8	Crellin Plastics Corp. Chatham, New York John Devich Chatham 2-3221	12	Injection Molding Finishers
9	Curbell Plastics, Inc. 777 Hertel Avenue Buffalo, New York Leonard H. Leone TR 3-9540	10	Production Finishers Vacuum Forming

MAP CODE NO.	COMPANY AND ADDRESS	ACCOM. NO. STUDENTS	PLANT PROCESSES
10	Diemolding Corp. 125 Rasbach Street Canastota, New York Gerald S. Roach OW 7-2221	24	Pre Forming Finishers
11	Duramark, Inc. 2 Secatoag Avenue Port Washington, New York I. D. Wallach, President P. O. 7-3271	24	Finishers Laminating
12	Durez Plastics Div. Hooker Chem Walck Road North Tonawanda, New York N. J. McClellan, Manager 693-1860	24	Compression Molding
13	Empire Brushes, Inc. 200 William Street Port Chester, New York Miss Sappho Manos Employment Manager WE 9-6100	24	Injection Molding Packaging
14	Fisher-Price Toys, Inc. Trimold Edgewood Drive Holland, New York Charles Fay, Manager 537-2281	24	Injection Molding Packaging
15	Geigy Industrial Chemicals Saw Mill River Road Ardsley, New York Public Relations Dept. 914 - GR 8-3131, Ext. 2893	15	Chemical Research
16	General Products Corp. 107 Sales Street Union Springs, New York George P. Diehl, Jr. Manager Personnel Relations 889-7361	24	Custom Molders
17	International Business Machines Corp. 590 Madison Avenue New York 22, New York William O'Hare, Manager 212 Plaza 3-1900	24	Production
18	LaBarb, Inc. Armonk, New York John H. Dood, Personnel AR 3-3700	12	Injection Molding

MAP CODE NO.	COMPANY AND ADDRESS	ACCOM. NO. STUDENTS	PLANT PROCESSES
19	Laminated Fiberglass Corp. 1158 Broadway and 27th Street New York 1, N. Y. Moosa Haghand, President 212 MU 6-5340	24	Production Laminating
20	Lunn Laminates, Inc. Straight Path Road Wyandanch, New York James Lunn, President MI 3-8900	24	Production Vacuum Forming
21	Norton Industries, Inc. 520 Mill Street Lockport, New York Paul Palmer, Manager HF 3-6751	15	Compression Molding
22	Nu-Process Plastics Division Gutmann Plastics 79 Franklin Street Brooklyn, New York Stanley R. Sacks EU 3-4400	24	Chemical Suppliers
23	Orangeburg Manufacturing Co. Orangeburg, New York J. Mulhall, Personnel Manager EL 9-2721	24	Extrusion
24	Reichhold Chemicals Inc. Packard Drive Niagara Falls, New York Dr. R. McDonald Butler 2-2356	12	Chemical Suppliers Chemical Research
25	Russell Reinforced Plastics Corp. 521 West Hoffman Avenue Lindenhurst, New York Harry Friedman, Vice President TUrner 4-1700	24	Production Packaging
26	Syracuse Ornamental Co. State Fair Boulevard Baldwinsville, New York Paul Niles, Personnel Div.	24	Injection Molding Compression Molding
27	Tufflite Plastics, Inc. 19 Low Street Ballston Spa, New York Bayard L. Bowers 885-5321	24	Finishers Packaging
28	Pantasote Company 26 Jefferson Street Passaic, New Jersey John Ertel, Manager 777-8500	24	Production Chemical Research

MAP CODE NO.	COMPANY AND ADDRESS	ACCOM. NO. STUDENTS	PLANT PROCESSES
29	Dura Plastics of New York 303 Fifth Avenue New York 16, New York Plant located at: 49 Richmondville Avenue Westport, Conn. J. Layman	24	Fabricators

This is not a complete list of plastics companies willing to conduct field trips.

Check your local area for plastics companies and record the name of the person to contact in this space.

Suggested Equipment List for Plastics

24 Students

Junior and/or Senior High School

No.	Description	Cost
(2)	1/5 ounce or larger Injection Molding machines, Simplomatic PL-63 or equal - Jr. and Sr. High Sources: 5, 7, 22, 32, 38 @$300.00 *	$600.00
(4)	Mold blanks for above Injection Molder - Jr. and Sr. Sources: 5, 7, 22, 32, 38 @$10.00	40.00
(1)	12 ton or larger capacity, Compression/Laminating Press complete with heated and cooled platens, facing sheets for laminating, thermometers and 1 compression mold, etc. Carver Model 150 or Pasadena Hydraulics Labmaster or equal - Jr. and Sr. Sources: 5, 8, 12, 35a, 44	550.00
(1)	Vacuum former 7" x 7" with vacuum source and heating unit, Iasco 7" x 7" or equal - Jr. High Source: 24	80.00
(1)	Vacuum former 10" x 14" with vacuum source and heating unit, Orbit Model SA-2500 or equal - Jr. High Sources: 4, 5, 10, 24, 43	145.00
(1)	Portable Scrap Granulator 7" x 6 1/2" throat or larger capacity with 1 Hp motor and switch, Injection Molders Supply Co. Model M-1 or equal - Sr. High Source: 26	450.00
(1)	Vacuum, pressure and mechanical former 18" x 18" with heating unit, material clamping device, vacuum and pressure sources, DIACRO Model 18 with hinged clamp frame or equal - Sr. High Sources: 5, 14	875.00
(1)	Vacuum former, 10" x 14" with vacuum source and heating unit, Orbit Model SA-2500, or equal - Sr. High Sources: 4, 5, 10, 24, 43	145.00
(1)	Electric oven and burner unit, electric kitchen stove with large oven and four surface cooking units, 30" or 40" with wide oven or equal - Jr. and Sr. Source: Local hardware store	325.00
	OR	
(1)	Hot air oven, thermostatically controlled 450° or higher maximum temperature, interior minimum dimensions 26" wide by 20" high x 20" deep - Broadhead-Garrett Model 51-550 or equal - Jr. and Sr. High Sources: 1, 11, 13, 16, 19, 23, 24 AND	383.00
(1)	Electric hot plate, temperature controlled model HP-A8805B, Thermolyne Corporation, Duhugue, Iowa	17.00

* See Optional Equipment, page 192.

No.	Description	Cost
(1)	Strip heater 18" long or longer, Hotpack 18" or equal Sources: 5, 11, 23, 24 - Jr. and Sr.	$ 22.50
(1)	Heat Sealer, hand operated, Caig Lab. Model Ersa #50p, 150p or 50F or equal - Jr. and Sr. Sources: 6, 20, 37, 42, 48	15.00
(1)	Plastics Welding Unit, hand operated, kit with extra tips, etc. Kamweld 15 TM or equal - Jr. and Sr. Sources: 5, 7, 27, 48	105.00
(1)	Glue pot or bucket heater unit for cold dripping Sources: 5, 20 - Jr. and Sr.	25.00
(1)	Engraving machine, Micro Model or equal - Sr. High Sources: 18, 21, 31	150.00
(1)	Hot stamping machine, Kingsley or equal - Sr. High Sources: 2, 28, 30	295.00
(1)	Thermometer, 6" shank, dial face reading type 100°F to 600°F, Weston or equal - Jr. and Sr. Sources: 49	5.00
(1)	Power paint mixing paddle - Jr. and Sr. High Source: Local hardware store	1.00
(2)	Double wheel electric buffer, 6" wheel or larger, 1/2 Hp or larger, 1725 RPM - Sr. High Sources: 5, 11, 24 @$50.00	100.00
	Assorted molds, jello molds, muffin tins, glass tumblers, leaf molds, casting molds - Jr. and Sr. Sources: Local hardware store	25.00
(1)	Pressure cooker, 10 qt. or larger - Jr. and Sr. Source: Local stores	20.00
(3)	Air pressure regulators, 0 to 100 psi, single stage, spray painting type @$30.00 - Jr. and Sr. Sources: Local automotive supply stores etc.	30.00
(1)	Air compressor - capacity at least equal to the air consumption of two air operated injection molders with necessary valves, hose, quick connectors Sources: Local Jr. and Sr.	350.00
(2)	Air line oilers for injection molders - Jr. and Sr. Source: Local @$10.00	20.00
(1)	Postal scales, 2 lbs. capacity, spring type for weighing materials - Jr. and Sr. Source: Local	5.00
(1)	Electroplating unit, 5 amp. capacity or larger power unit and plating equipment and chemical set, Warner 5 amp. power unit #971 x plus plating outfit #3 - Jr. and Sr. Sources: 5, 35b	110.00

OPTIONAL EQUIPMENT

No.	Description	Cost
(1)	Extruder, laboratory type, 3/4" screw or larger - 20:1 screw dia. to screw length ratio - Wayne 3/4" table model or equal Sources: 29, 46	$825.00
(1)	Blow molding attachment for plastics extruder, hand or air operated, mold closure device Source: 29	250.00
(1)	Rotational molding machine, laboratory model Source: 9	1000.00
(1)	Set testing equipment - tests for tensile, compression, shear, transverse, hardness, modulus of elasticity Broadhead-Garrett, Model UTM-2B or equal Sources: 5, 36, 40, 47	1000.00
(1)	All materials spray gun, for spraying plaster, plastic resins and rubber, with extra nozzles, cups, lids and hose, R-2 all materials gun or equal Sources: 35c	80.00
(1)	Portable Plastics School consists of 14 volumes: Each volume contains raw materials and finished product samples held in place by flexible bands for removal and inspection. Multi-colored charts show the method of polymerization starting from the basic raw materials and also the various methods of producing finished articles. The Commentary volume gives a brief history of each material, raw materials production, production of the plastic material, properties, processing methods and applications. Source: 52	137.00
(1)	Honajector, plastic injection molder, Model 101. Including assortment of molds and accessories. Source: 53	325.00
(1)	Injection molder "wasp" Mini-Jector, Model 45 Source: 54	965.00

LIST OF EQUIPMENT MANUFACTURERS AND DISTRIBUTORS

The names of companies with their addresses of the main source of plastics equipment are given here. Complete listings of machine manufacturers can be found in the *Modern Plastics Encyclopedia*.

1. Acme Plastic Machinery
   500 Sawmill River Road
   Yonkers, New York

2. Admiral Coated Products Inc.
   20 Railroad Avenue
   Hackensack, New Jersey

3. American Handicrafts
   384 Fifth Avenue
   New York 1, New York

4. Auto-Vac Co.
   106 Meadow Street
   Fairfield, Conn.

5. Broadhead-Garrett Co.
   4560 East 71st Street
   Cleveland, Ohio

6. Caig Laboratories
   46 Stanwood Road
   New Hyde Park, L. I., N. Y.

7. Canadian Aviation Electronics, Ltd.
   Dept. FG-2 Box 2030 St. Laurent
   Montreal 9, Quebec, Canada

8. Carver, Fred S., Co.
   5 Chatham Road
   Summit, New Jersey

9. Akron Presform Mold Co.
   2038 Main Street
   Cuyahoga Falls, Ohio

10. Comet Industries
    1 N640 York Road
    Bensonville, Illinois 60106

11. Cope Plastics
    Highway 100
    Godfrey, Illinois 62035

12. Dake Corp.
    Grand Haven, Michigan

13. Despatch Oven Co.
    619 S. E. 8th Street
    Minneapolis, Minn.

14. DiAcro Corp.
    Lake City, Michigan

15. Entoleter Inc.
    Box 904
    New Haven, Conn.

16. Fisher Scientific
    633 Greenwich St.
    New York 14, N. Y.

17. Glenn Electric
    Heater Corp.
    Erie, Pennsylvania

18. Green Instrument
    295 Vassar Street
    Cambridge 39, Mass.

19. Grieve-Hendry Co.
    1358 N. Elston Ave.
    Chicago, Illinois

20. Hastings Plastics
    1704 Colorado Avenue
    Santa Monica, Calif.

21. Hermes Engraving Mach.
    154 West 14th Street
    New York, New York

22. Hinchman Mfg. Co., Inc.
    259 E. First Avenue
    Roselle, New Jersey

23. Hot Pack Co.
5083 Cottman Avenue
Philadelphia, Pa.

24. Industrial Arts Supply Co.
3002 Hennepin Avenue
Minneapolis 8, Minn.

25. Industrial Heater Corp.
417 Canal Street
New York 13, New York

26. Injection Molding Supply Co.
17601 South Miles Road
Cleveland 28, Ohio

27. Kamweld Products Co.
932 R Washington Street
Norwood, Massachusetts

28. Kensal-Olsen Mark Inc.
124-132 White Street
New York 13, New York

29. Killion Extruders, Inc.
56 Depot Street
Verona, New Jersey

30. Kingsley Machine Co.
850 Cahuenga
Hollywood, California

31. Micro Instrument Co.
80 Trawbridge Street
Cambridge, Maryland

32. Newbury Industries, Inc.
Newbury, Ohio

33. Ogden Manufacturing Co.
2520 W. Irving Park Rd.
Chicago, Illinois 60618

34. Pacific Plastics Machinery Corp.
228 San Lorenzo Street
Pomona, California

35. (a) Pasadena Hydraulics Inc.
1433 Lidcombe
El Monte, California

35. (b) Paxton/Patterson
45 Samworth Road
Clifton, N. J. 07012

(c) Plaster Supply House
Box No. 551
Chicago 90, Illinois

36. Research Products Co.
P.O. Box 1047
St. Petersburg, Florida 33731

37. Seal Inc.
Shelton, Conn.

38. Simplomatic Manufacturing Co.
4416 W. Chicago Avenue
Chicago 51, Illinois

39. South Bend Lathe
South Bend, Indiana

40. Testing Machines Inc.
72 Jericho Turnpike
Mineola, New York

41. Thermal, Inc.
9408 Robinson Road
Franklin Park, Ill.

42. Vertrod Corp.
2037 Utica Avenue
Brooklyn 34, N. Y.

43. Vac Form
5 North Water Street
South Norwalk, Conn.

44. Wabash Metal Products
1569 Morris Street
Wabash, Indiana

45. Watlow Electric Mfg. Co.
12001 Lockland Road
St. Louis 41, Mo.

46. Wayne Machine and Die
23-B Grand Street
Garfield, New Jersey

47. W. C. Dillon and Co.
14620 Kiswick Street
Van Nuys, Calif.

48. Weldotron Corp.
913 M Felinghuysen Ave.
Newark 14, New Jersey

49. Weston Instrument and
Electronics
Newark 14, New Jersey

50. Wiegand, Edwin L. Co.
7613 Thomas Blvd.
Pittsburgh 8, Pa.

51. Wing and Son Corp.
384 Broadway
Albany 1, New York

52. International Plastics Industry
Consultants, Inc.
P.O. Box 1324
Long Island City 1, New York

53. Nassau Manufacturing Company
923 Old Nepperhan Avenue
Yonkers, New York 10703

54. Newbury Industries, Inc.
Newbury, Ohio

LIST OF SUPPLIES FOR PLASTICS

This list includes most of those materials which are needed for the units in this course of study. Additional materials may be obtained from the suppliers listed here or from local sources. Numbers which appear after each material listed are the code numbers which correspond to the number preceeding each firm listed in the List of Material Suppliers and Distributors on page 198.

Materials	Supplier
A. B. S. sheet	32
acetate	6, 5
acetone	20, 6
acrylic	6, 7
adhesives	15
balls, styrene	11, 28
buffing	15, 20, 4, 7
butyrate peelable resin	18, 25, 10
butyrate powder	13
casting resins, clear polyester	15, 20, 29, 4, 7
catalysts	15, 20
cements	15, 20, 29, 7, 5
cobalt	6
color concentrates	37
colorants	15, 29, 4, 14
chrome plating chemicals	12
Devcon casting resins	5
dyes	20, 29, 7
elastomers, room temp. vulcanizing	15, 16, 1
epoxy resin	29, 5, 7, 34, 6, 31
electric chemicals	12
epoxy cement	20
engraving stock	7

Materials	Supplier
ethylene dichloride	5
fiber glass, cloth mats, roving	20, 29, 7, 6
film, polyethylene	15, 7
films, heat sealing	6
flourescent powders	15
fluidizing powder	10
foams, polyurethane	20, 7
foil, hot stamping	2, 22, 23
glass reinforcement, cloth mat, roving	20, 29, 7, 6
gloves	11
glues	29
gypsum cement	34
lacquers	34
laminating engraving stock	7
latex rubber	20
melamine, molding compound	3, 9, 26, 30
methylene dichloride	20
molecular modules, styrene balls	11, 28
mylar	15
nylon	6
organosols	20
parting compounds	34
phenolic molding compounds	3, 9, 26, 30

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Materials	Supplier
pigments	15, 29, 5
plastisol	20, 7
polishing compounds	15, 20, 27 4, 5
polyester resins	15, 20, 29, 27, 6, 7
polyester resin colorants	14
polyethylene, powder, pellets	5
polynopylene	5
polysean seal compound	13
polystyrene expandable beads	20, 24, 8, 33
polystyrene, pellets	5
polyurethane foams	20, 7
release paper	36
release sprays	7, 15, 17, 20, 21

Materials	Supplier
rubber, room temp. vulcanizing	1, 15
sealers	34
sheet, rod, tubes	6, 7, 15, 20, 29
solvents	5, 20
styrene monomer	6, 20
styrofoam	15, 20
tempera, powdered	4, 20
thickeners, polyester resins	19
thinners	6, 20
thread compound, high heat	21
tinsel	20
Ultracal 30, gypsum cement	34
urea molding compound	3, 9, 26, 30
urethane foams	7, 20
vinyl dispersions	7, 20

This does not represent a complete list of supplies available. Refer to supplier's catalog for complete list of materials which they can supply.

LIST OF MATERIAL SUPPLIERS AND DISTRIBUTORS

Plastics materials are available from many suppliers. A partial list of suppliers, and their addresses are given here. The code number in front of each supplier is used in the List of Supplies on page 196 to indicate a source. A complete list of manufacturers can be found in the *Modern Plastics Encyclopedia*.

1. Adhesive Products Corp.
   1660 Bonne Avenue
   Bronx 60, New York
2. Admiral Coated Products, Inc.
   20 Railroad Avenue
   Hackensack, New Jersey
3. Allied Chemical Corp.
   Plastics Division
   40 Rector Street
   New York 6, New York
4. American Handicrafts Co.
   18-20 West 14th Street
   New York 11, New York
5. Brodhead-Garrett Co.
   4560 E. 71st Street
   Cleveland, Ohio 44105
6. Cadillac Plastics
   2427 6th Avenue, South
   Seattle 4, Washington
7. Copes Plastics
   Highway 100
   Godfrey, Illinois 62035
8. Dow Chemical Co.
   Midland, Michigan
9. Durex Plastics Division
   Hooker Chemical Corp.
   8 Walck Road
   North Tonawanda, New York
10. Eastman Chemical Products Inc.
    Kingsport, Tennessee
11. Edmund Scientific Co.
    Barrington, New Jersey 08007
12. Enthone Incorporated
    442 Elm Street
    New Haven 8, Connecticut
13. L. W. Ferdinand and Co. Inc.
    Simsbury, Connecticut
14. Ferro Corp. - Color Division
    4150 East 56th Street
    Cleveland 5, Ohio
15. Fry Plastics
    8601 S. Figueroa Street
    Los Angeles 3, California
16. General Electric
    Silicone Product Dept.
    Waterford, New York
17. General Mills
    9200 Waycata Blvd.
    Minneapolis 26, Minnesota
18. The Glidden Co.
    3rd and Bern Street
    Reading, Pennsylvania
19. Godfrey Cabot Co.
    77 Franklin Street
    Boston 10, Massachusetts
20. Industrial Arts Supply Co.
    3220 Hennepin Avenue
    Minneapolis 8, Minnesota
21. Injection Molders Supply Co.
    17610 South Miles Road
    Cleveland 28, Ohio
22. Kensol-Olsenmark Inc.
    124-132 White Street
    New York 13, New York
23. Kingsley Machine Co.
    850 Cahuenga Street
    Hollywood, California
24. Koppers Co., Inc.
    Plastics Division
    Koppers Building
    Pittsburg 19, Pennsylvania
25. Lacquer Corp. of America
    857 Meeker Avenue
    Brooklyn, New York

26. Monsanto Chemical Co.
Plastics Division
800 N. Lindbergh Blvd.
St. Louis 66, Missouri

27. Natool Laboratory
P. O. Box 229
Redlands, California

28. Palsteel Corp.
26970 Princeton
Inkster, Michigan

29. Plastics Product Co. of Utah
P. O. Box 1415
Salt Lake City, Utah

30. Reichhold Chemicals
525 N. Broadway
White Plains, New York

31. Ren Plastics
5656 South Cedar Street
Lansing 9, Michigan

32. Royalite Plastics Products
Dept. S. C. - United States Rubber Co.
2638 North Pulaski Road
Chicago, Illinois 60639

33. United Cork Co.
Uni-Crest Division
28 Central Avenue
Kearny, New Jersey

34. United States Gypsum
Industrial Sales Division
101 S. Wacker Drive
Chicago 6, Illinois

35. USI Chemical Co.
99 Park Avenue
New York, New York

36. S. D. Warren Co.
89 Broad Street
Boston 1, Massachusetts

37. Wilson Products Inc.
Neshanic, New Jersey

BIBLIOGRAPHY

Basic Reference Library 201

Supplemental Reference List 202

Free or Inexpensive Reference 204

BIBLIOGRAPHY

Basic Reference Library

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VT 002 018
101 Teaching Suggestions for Stimulating Student Learning in Business Education.

New York State Education Dept., Albany. Bureau of Secondary Curriculum Development.
MF AVAILABLE IN VT-ERIC SET.
The Publications Distribution Unit, State Education Department, Albany, New York 12224 (single copies available).
PUB DATE - 65 65p.

DESCRIPTORS - *BUSINESS EDUCATION; *TEACHING TECHNIQUES; TEACHING METHODS; *STENOGRAPHY; OFFICE PRACTICE; *BOOKKEEPING; *TYPEWRITING; ECONOMICS; BUSINESS CORRESPONDENCE; RESOURCE MATERIALS

ABSTRACT - This document contains teaching techniques gathered from experienced teachers in many of the registered private business schools of the State of New York. All are techniques which have been used successfully and which may prove useful to other business educators. Teaching techniques are included for: (1) Typewriting, (2) Shorthand, (3) Transcription, (4) Secretarial Practice, (5) English for Business, (6) Economic Understanding, (7) Business Mathematics, and (8) Bookkeeping and Accounting. (JS)

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BUREAU OF BUSINESS AND DISTRIBUTIVE EDUCATION/ALBANY, NEW YORK/1965

101 TEACHING SUGGESTIONS

FOR

STIMULATING STUDENT LEARNING

IN

BUSINESS EDUCATION

The University of the State of New York
The State Education Department
Bureau of Secondary Curriculum Development
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FOREWORD

The effectiveness of a school program is determined by classroom teachers. While administrative leadership helps teachers by providing good classroom facilities and adequate instructional materials, the classroom teacher is still the key person in every school.

The teaching techniques contained in this brochure were gathered from experienced teachers in many of the registered private business schools of the State of New York. Private business schools have long been recognized as leaders in teaching methodology unusually well suited to individual student progress. The ideas incorporated in this publication reflect the strong interest of these business educators in the progress of every student and the desire to motivate students to their maximum achievement.

Here are more than one hundred classroom techniques that have been used successfully. Some may be considered unconventional and perhaps will not function equally well for another teacher. It is hoped, however, that many of the suggestions will serve to stimulate teachers in both public secondary schools and private business schools to experiment with new techniques that may improve instruction.

Appreciation is expressed to all those teachers listed on pages 58-60 who contributed to the development of this brochure. Raymond A. Light, Associate in Business Education, coordinated the project under the direction of John E. Whitcraft, Chief, Bureau of Business and Distributive Education. The final manuscript was processed by the Curriculum Development Center with the technical assistance of the Bureau of Publications.

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SUGGESTIONS FOR IMPROVING INSTRUCTION

IN

TYPEWRITING

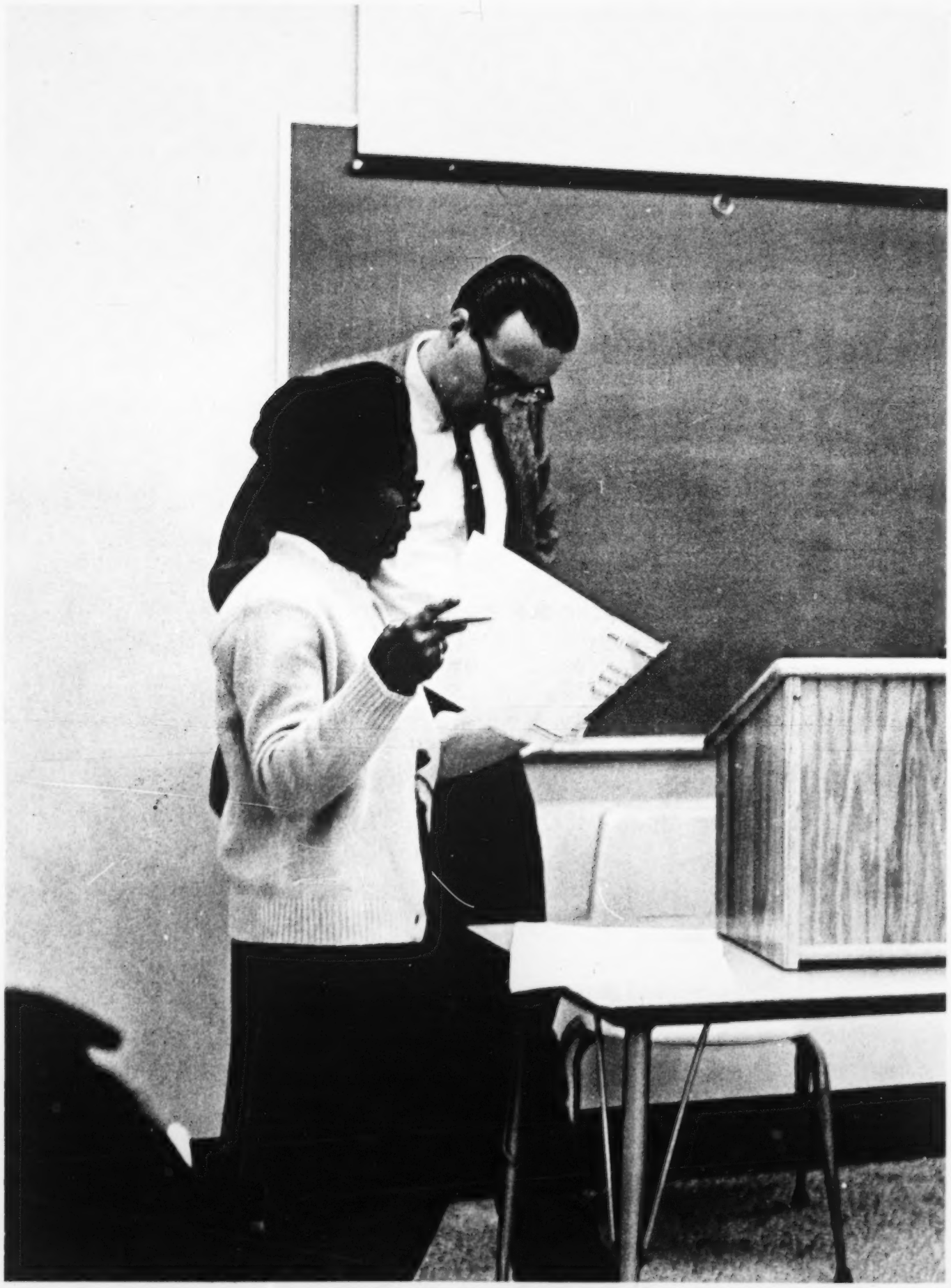

Good pupil-teacher relationships contribute
to the learning situation.

OBS 281
SCL

TYPEWRITING 1
(Beginning)

SENTENCE METHOD

Students in beginning classes typewrite a sentence the first day. Examples are: feed the deer; the deer feed, etc. Note that only the strong first and second fingers are used. The sentence method, with the emphasis on double-letter words, not only makes the student feel accomplished but makes him sound that way.

FINGERING

Students who have difficulty with keys jamming, faulty spacing, or squeezed letters, may benefit from being transferred to an electric typewriter.

ENCOURAGE

The most important period for the beginning typewriting student is during the first month of instruction. During this time, each student must be observed constantly. When proper posture, fingering, and technique are learned well at the beginning of the course, the student, and teacher, will "breeze" through the remainder of the year.

If a student seems to make little or no improvement in basic typewriting technique during the first six weeks, have him repeat the introductory lessons to the keyboard. It will be well worth the extra time expended. As a result of this fresh start, he will gain confidence and usually substantially improve his basic technique.

NUMBERS

Numbers are learned early. If a student can move his finger from j to u successfully, surely he can continue up to 7. Practice the figures in the current date each day. After the keyboard has been thoroughly covered, type the complete current date (month, day, year) each day.

STEPPING UP THE NUMBERS

"W E - 2 3 drills" notwithstanding, a slower approach to the reaches of the figure row tends to lead to a most unusual control. Students should be taught to feel their way up the banks of the keyboard, working from home row to top row and touching the middle row en route. This technique in learning the reaches to the figure row fosters greater accuracy and confidence.

In reaching to the 2, students will be instructed to reach from the s key, touch the w, and return to the s key after striking the 2. In reaching to 5, they are taught to touch the r, 4, and reach one key to the right. In reaching to 6, they touch the u, 7, and reach one

key to the left. This "feel and reach" technique also works miraculously when applied to the special characters and symbols.

Some teachers believe that most typewriting texts introduce numbers too soon, but with this approach even the slowest student is able to master the reaches to the numbers and special characters with a minimum of difficulty. While the typing of numbers will be slower at first, the greatly increased accuracy will prove to be worthwhile in the long run.

MOTIVATION

During each drill period, review the keyboard with special emphasis on a particular letter, number, or sign. Time the drill; conduct several short timings.

Raise such questions as:

"How many typed at least 15 words a minute?" (The rate should be low enough to include almost every student.)

"How many typed for one minute without error?"

"How many improved this time?"

Each student should raise his hand in answer to at least one of the questions.

Changing the class pace often will also motivate students. Changing pace prevents boredom.

SHORT TIMINGS

Short timings should begin very early in the course. During the first lessons, for instance, students may be timed to see how many correct "the's" they can type in a 10-second timing.

SPURT TO SPEED

The following type of one-minute speed drills has been highly successful in achieving speed <u>with</u> control: Duplicate (on one sheet of paper) a series of paragraphs graduating from 30 to 90 words. Each paragraph is to serve as the basis for a 1-minute timed writing. Students may be directed to start working on this drill copy as soon as the entire keyboard has been covered. The aim of the drill is to complete each paragraph in one minute without error. The student is instructed to proceed to the 40 word paragraph only after he has completed the 30 word paragraph without error. The teacher maintains a record of each perfectly completed paragraph.

Alternating 1-minute speed spurts--with perfect copy as the aim for the first timing, all-out speed as the aim for the second timing, and speed with control as the aim for the third timing--will stimulate the development of speed, and with control.

DON'T BE SATISFIED WITH LESS--SET STANDARDS

The teacher who is effective enough to demand high-quality work and to reject as unmailable (therefore unacceptable) any piece of work that fails to meet these high standards will receive quality work from her students. A teacher can stamp out strikeovers and other evidences of sub-standard work by refusing to accept an entire lesson where these faults occur.

CHALKBOARD QUOTATIONS

One variation that a beginning typewriting class will enjoy is the placing on the blackboard each day a quotation from poetry, philosophy, or folk sayings. This quotation is typewritten by each student at the top of the page before starting the day's work. After the keyboard has been covered, it is wise to use quotation marks around the quotation and identify the quotation as to source.

CHECK AND DOUBLE CHECK

To give proofreading a portion of its tremendous importance, penalize poor proofreading of 5- and 10-minute timings by deducting one additional error if any errors were not found and circled by the student.

CLASSROOM MANAGEMENT--EVER ON THE ALERT

Students are instructed to type selected drills for a specific purpose or are given directions for typing a particular type of application. They know that papers will be collected at the end of the daily typewriting class, but are unaware as to whether they will serve as a simple review practice or as a test to be recorded. Consequently, they put forth their maximum effort each day to complete every exercise in the allotted time and without wasting paper. The graded papers are returned to students when a particular typewriting practice was intended as a test.

CLASSROOM MANAGEMENT AND SPEED BUILDING

The following technique is an excellent procedure for getting the period off to a good start and for building speed:

Before the class enters the room, place on the chalkboard instructions for the day's practice drill. The class has previously been informed that the aim is to typewrite as many lines of the drill as possible in the allotted time. The five minutes allowed for this activity permits the teacher to complete the necessary preliminary work before the actual class begins. The number of lines finished by each student is recorded each day, thus providing purposeful drill as well as a record of attendance.

It is interesting to note the gradual increase in the number of lines finished as the days pass. Call attention to this increase frequently by listing on the bulletin board the names of the top three typists for the week.

IMPROVING TYPEWRITING SKILLS BY SETTING INDIVIDUAL GOALS

Every typewriting teacher is interested in having each student become an effective typist and meet the speed and accuracy requirements of the course. By giving each student an individual goal, and by periodically revising these goals, there will be few students who will not have reached the course requirements.

Some steps suggested for selecting these individual goals are as follows:

1. An individual progress card is kept for each student. This card provides space for recording the date, gross speed, net speed, number of errors, and general remarks. The card is ruled to accommodate 50 different timed writing scores as well as space for recording the student's beginning and ending typewriting scores. This card is also valuable as a source of information for a placement office.

2. During a student's first course in typewriting, a record is kept on the card of scores obtained on 1-minute, 2-minute, and 3-minute timed writings. At approximately the tenth week, the student should be given his first goal. The basis for arriving at this goal is described below.

    a. Based upon the student's speed and accuracy range as indicated by the progress card, the teacher projects the student's typewriting ability to the end of the first term. The teacher projects the student's achievement based on 3- or 5-minute timed writings, using net scores for comparison purposes.

    b. At this point, it becomes the teacher's responsibility to review the student's various habits which directly or indirectly will affect typewriting progress. These might include physical limitations, mental attitude, position at the typewriter, stroking ability, reading ability, and previous typewriting experiences--plus any other history which would alter the student's progress.

    c. The teacher will now decide on the student's final goal for the first term. This goal will be recorded on the progress card and a conference

planned with each student. During the conference the teacher should explain to the student why and how the goal was set. Some of the purposes of setting this goal are:

(1) To help the "late starter" reach the requirements of the course.

(2) To keep the student with apparent potential striving for more and more speed and accuracy.

(3) To make every student realize that the teacher is not satisfied with less than the student's best efforts in typewriting.

(4) To demonstrate to the student that the teacher has confidence in his abilities and that by following this advice will reach the goal that has been set.

During the conference it should be made clear that the student will be expected to practice until the goal is reached. If necessary, the teacher will conduct after-class lab periods and timed writings to help him reach his goal. It is important for the student to realize that the prime responsibility lies with him and that the teacher cannot do the work for him.

This process of goal setting is repeated for each semester that the student is enrolled in a typewriting course. During the closing weeks of a semester, the teacher must analyze and resolve the problems that occur in connection with any student's reaching the goal that has been set for him. A student who has not reached his goal must be given every opportunity to reach that goal, and the teacher's work is not done until each student has been given such opportunities to achieve his individual goal.

TYPEWRITING CHARTS--MOTIVATION

Keep two large charts that students can easily read.

Chart I. A permanent chart presented as a graph which shows highest speeds attained by students. Whenever possible have the students maintain the chart.

Chart II. A movable type progress chart which shows weekly speeds attained by each student. This variety of chart is often kept by typing student names on tags which can be pinned to a bulletin board.

MAKING CORRECTIONS

Students are apt to have difficulty realigning their papers for making a correction once the paper has been removed from the typewriter. Use as instructional material a paper for each student that the student has previously typed and which contains a spelling error. Require each student to erase the error, reinsert the paper into the typewriter, and type the correct letter.

The technique of using a paper containing an error that the student has previously typed is also effective for teaching the use of the half-space key or the technique of half spacing.

TYPEWRITING SPEED--USE OF DISPLAY

Many students learn the use of the typewriter in high school in the tenth year, with a minimum of subsequent practice. When they subsequently enter a course providing advanced typewriting instruction, they frequently attempt to type too rapidly in relation to their present skill.

A most successful remedy is to display perfect timed writings on the bulletin board so that all may see and check for themselves. In addition, any student whose paper is displayed may be given extra credit for his accomplishment. If, for example, he has a perfect paper on Thursday, a perfect writing may also be recorded for Friday. He thus receives double credit. It is interesting to observe the effect of this incentive on a class--errors soon begin to decrease and speed increases.

TYPEWRITING SPEED--THE RELAY TECHNIQUE

Classes like to typewrite in unison. They especially like the "Radio City Rockette" drills made up of sentences composed of three- and four-letter words. Drills of this variety give the student the opportunities for reaching to new speed accomplishment. One use of this type of drill is as follows: First, practice the sentences in unison to set a pace; one row of students is then instructed to type the drill as quickly as possible and upon completion to return the carriage with a quick flick of the wrist; as soon as the last student in the row completes the sentence, the next row immediately begins. This "relay team" technique provides an excellent incentive for speed development.

With a little practice, it will be found that a class will not only pick up considerable speed but will also enjoy the process.

COMPARE ACHIEVEMENT ON SPEED AND ACCURACY WRITINGS

To show the student where he is failing in speed development, give 3 one-minute takes for speed alone (no penalty for mistakes); then administer 3 one-minute takes emphasizing accuracy. Finally, ask each student to compare the results of the two series of timings. The student will soon discover either his own tendency toward error or his need for conscientious speed development.

AN INCENTIVE TO HIGHER SPEED--THE RAPID TYPIST CLUB

The first challenge that presents itself is eligibility for membership in the Rapid Typist Club. Once a week the student executes test drills. These tests start with three- or five-minute timed writings and increase to ten and possibly to fifteen minutes. The student's goal in the longer writings is to achieve 50 or more words a minute. Once a student attains this speed of 50 w.a.m. or more, she automatically becomes eligible for membership.

Club meetings are held once each month and as part of the club's activities a timed writing is administered and awards made based upon the results attained. The minimum requirement for receiving an award is the typing of 55 to 59 words a minute, allowing a maximum of 10 errors on a 15-minute writing. The next award category is 60 to 64 net words, followed by 65 to 69 net words, then 70 to 74 net words.

The awards for rapid typewriting consist of attractive gold pins with numerals which indicate the speed reached. The competitive spirit continues among club members to earn a special award of typewriting 75 net words or more during a 15-minute writing. This special award permits the student the choice of the most recent edition of the SECRETARY'S HANDBOOK or the latest COLLEGIATE DICTIONARY. It is presented to the successful candidate by the principal of the school.

SUGGESTIONS FOR IMPROVING INSTRUCTION

IN

SHORTHAND

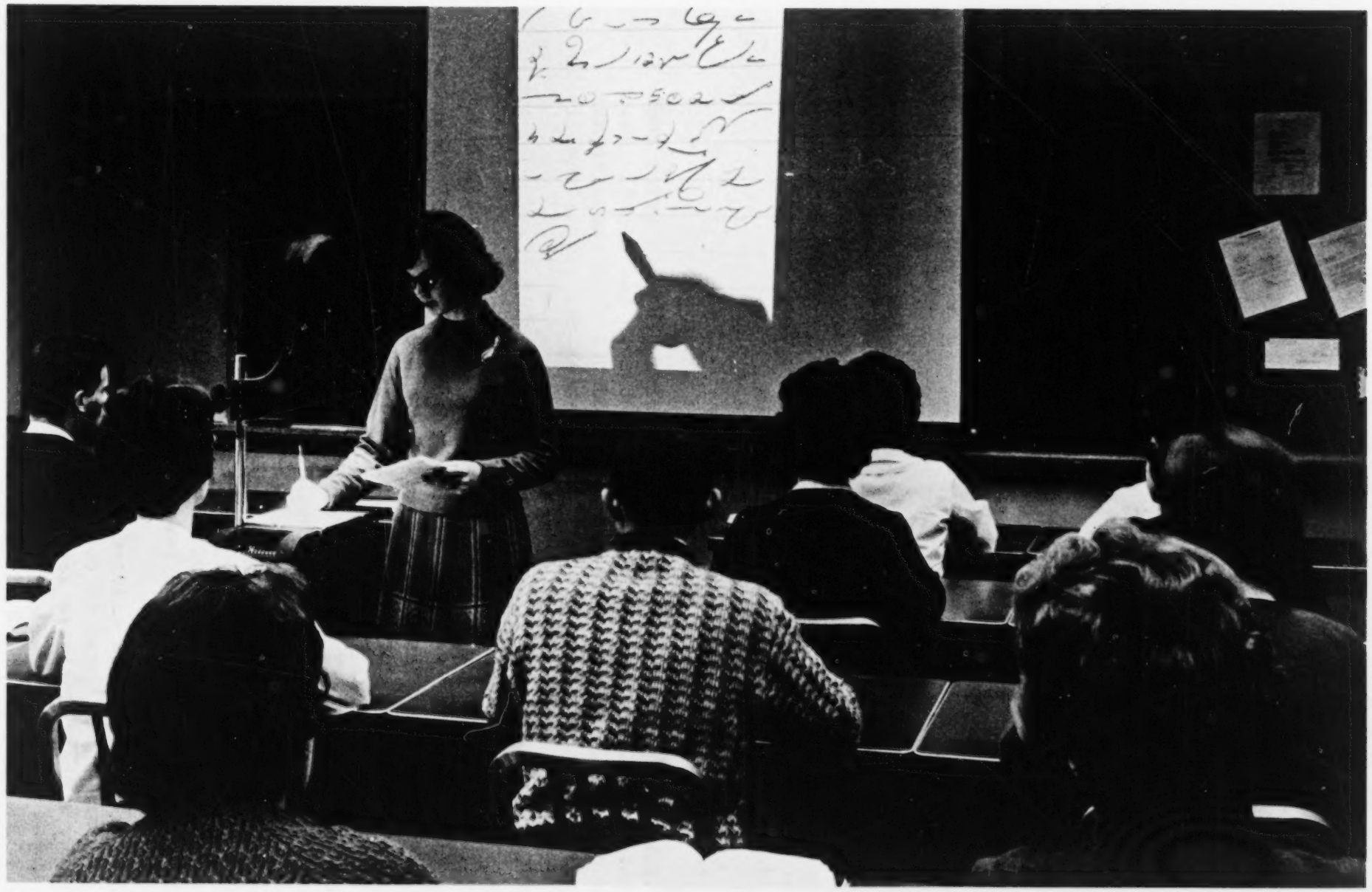

The overhead projector is an effective
teaching tool in many business education classes.

AN APPROACH TO EFFECTIVE STUDY OF SHORTHAND

Basic comprehension can be unlocked with three keys:

The Phonetic Key. Words are written exactly as sounded, and this key takes the word apart by sounding aloud each syllable--each outline--of the word.

The Image Key. Shorthand is a language of signs, and this key keeps inscribing these signs on the mind's blackboard, serving as a memorizer, reviewer, and constant giver of outlines.

The Correlation Key. There are interrelationships between outlines and this key systematically renders more dynamic and lasting memorizations of short forms, phrases, and basic rules of shorthand.

IMPORTANCE OF LEARNING BRIEF FORMS

Take three to five minutes each day to dictate the day's brief forms. Have the brief forms transcribed, checked by exchanging papers, and the perfect papers given to the teacher. (Perfect papers should be perfect both as to outlines and transcripts.) Students with other than perfect papers are considered not to have mastered that phase of the day's lesson.

PERMIT STUDENTS TO USE THE CHALKBOARD

Begin the first shorthand class by having students write the different shorthand characters as they are put on the board. When classes are small, the teacher may send students to the chalkboard (or overhead projector) to write. This enables her to see readily how well students are progressing.

KEEP THE INITIAL PACE SLOW

During the first two weeks of the term, a slow rate of presentation is set, usually a new lesson followed by a thorough review every third day. In other words, for the first eight sessions 3 or 4 lessons are taught. This will make it possible to give every student a thorough comprehension and "feel" of the phonetic basis of shorthand, proper penmanship, and correct size of outlines.

Beginning with the third week of the term, one complete lesson in the textbook is presented daily. Fortnightly tests are given either in the form of word dictation or mimeographed sheets. Corrected tests are returned to students and a remedial lesson follows.

Each class period is started with a dictation of the special vocabulary and short forms of the homework lesson. This dictation is followed by a short business letter of low syllabic intensity.

Constant emphasis is placed upon correct spelling, punctuation and paragraph structure in order to lay the foundation early for transcription.

Assignments for home practice are given each day. Two days prior to the formal mid-year examination, as well as before the final examination, a complete review is given.

As an additional incentive, students who are encountering difficulty are invited to meet the teacher periodically for extra help. This is especially beneficial to the student who has missed a lesson as a result of an absence.

To avoid monotony and to maintain a high level of interest on the part of students, the method of presentation should be varied through the use of the inductive, deductive, project, work sheet, and open textbook methods.

INTRODUCTIONS IN SHORTHAND

For interest development, introduce students to the class (via shorthand) as soon as principles governing the writing of their names have been presented. This procedure can be extended to faculty members, the administration, office staff, and other workers with whom students are associated daily.

USE THE CHALKBOARD FREELY

The chalkboard should be used constantly for illustrations of concepts that can be presented visually. Teach standing and let the chalkboard help to vitalize the lesson.

AIM TO BUILD VOCABULARY AND RELATED INFORMATION

Supplement lessons with valuable additions from a variety of supplementary sources of information. In this way students will learn not only shorthand but a wealth of related useful knowledge.

Students become dictionary users when the teacher is able to impress upon them the importance of vocabulary building. The teacher should make sure that every possible translation is given for an outline, including the brief forms, and should seek ways to foster the use of the dictionary for correct spelling and word meanings.

DICTATION

Teach advanced students how to use a stopwatch for dictation and give them the opportunity to work with slow or new students. In this way, advanced students are given the opportunity to dictate and take dictation from a number of different dictators.

PEP WITH PROMPTING

When a student is reading from shorthand plates in the textbook, overcome daydreaming and boredom of the other members of the class by asking the class to prompt the reader when necessary. The class then becomes more attentive and will follow the reader more closely.

DICTIONARY CLUB

Students experiencing difficulty with spelling may form a dictionary club. In reading new or alienated material in shorthand, when a student is "stumped" by a word, one of the members of the dictionary club is called upon to supply the word. This technique has proved effective for helping students who may be having difficulty reading fluently but who are able to grasp shorthand theory.

ENTHUSIASM--A COMMON DENOMINATOR FOR SUCCESS

The enthusiastic teacher keeps the shorthand class alive and alert; the class moves at a rapid pace and as a consequence, good learning results are usually obtained.

Give students the necessary confidence and encouragement. By constant challenge, keep students alert; by commendation and enthusiasm, keep them relaxed and cheerful.

RELYIN' ON RELAYIN'

If you can't read shorthand, you certainly can't write it! Students have a tendency, however, to tire of reading sessions because they do not realize that facility in reading from shorthand is not only beneficial but very essential to shorthand success.

Why not conduct races to keep students interested and motivated? Competition has always been the basis of success--shorthand being no exception.

Time students as they read, and record the top speed and student's name on the board. Encourage students to compete with themselves to better their own top record.

As an alternate procedure, organize the class into teams of four or five students and have each team read a selected passage under timed conditions. The team with the best timing wins the race.

The feeling of competition will increase reading speed which is the basis of speed in dictation. With a little competition this can be accomplished with genuine interest and enthusiasm--that all important element to success.

SCRAMBLE PERK-UPS

Many times a "blue Monday" falls on a day other than a Monday. On these days, students seem disinterested and unresponsive; the atmosphere prevailing is certainly not conducive to learning. One technique that will help to lift students' spirits is the use of scrambled sentences.

If today's lessons were 20 and 14, (Gregg Shorthand Simplified), for example, I might write in shorthand on the blackboard the following scrambled sentence comprised of words from these lessons:

meant mend to mother the leather brother for chair but she help waited to her.

Key: Mother meant to mend the leather chair, but she waited for brother to help her.

women examine editor wasted about many glad to the from the will be letter money the.

Key: Many women will be glad to examine the letter from the editor about the wasted money.

Scrambled sentences cause students to come "alive"; each student wants to be the first to unscramble the jumbled words. After two or three such sentences, a class will have lost its "blues" and be ready to go back to work.

VARY THE NATURE OF DICTATION MATERIAL

In your class dictation, avoid using for subject matter only business letters. Use a variety of articles taken from current literature. You may also dictate speed pointers and other tips for the beginning secretary.

Urge your students to use dictation records and tapes available at various dictation speeds for supplementary out-of-class dictation.

PROVIDING FOR INDIVIDUAL DIFFERENCES

Continually stimulate students to strive for greater shorthand speed by setting aside a few minutes of the class period, preferably at the end of the period, to dictate a series of letters (at least three) at gradually increasing speeds.

Students should be instructed to try to take each of the letters dictated and to hand to the teacher the letter dictated at the highest speed that they are able to transcribe (or write) in its entirety. This teaching technique enables each student to take dictation at his own best rate; at the same time, it provides for the varying abilities of your class.

USE OF TAPE RECORDER

Tape record several letters from your shorthand textbook for the use of students in developing speed. These tapes may then be used out of class for additional dictation practice.

The letters may be recorded at a variety of speeds--60, 80, 100, 120 words a minute--with a short preview before each take. Since students gain speed by taking dictation of easy, familiar material, the letters should consist of relatively simple content.

Students should be encouraged to practice individually with the tapes. They are familiar with the teacher's voice and seem to enjoy this opportunity for additional practice. Those students who have been absent have this opportunity to make up for lost class time.

TIPS ON METHODOLOGY

Theory. Teach all of the shorthand theory as soon as possible!

1. A new word injected into a sentence and its structure explained is more impressive and is apt to be remembered longer.

2. Instruct students to record in shorthand on homework papers turned in each day, the day and month of the year copied from the board. Constant usage in this manner improves the outlines and saves the teacher from devoting a complete lesson to the days and month of the year.

3. Correlate related theory when first presented. i.e., ing, ings, ingly.

4. Tie the varying uses of strokes together. When the use of ish for short and ship is presented, review all uses of ish. Follow this pattern for all strokes.

5. Provide constant drill on derivatives, especially brief form derivatives. This practice insures instant recall of the root word and increases the ability to recognize and execute known outlines in new words.

Penmanship. Emphasize that shorthand is written not for beauty but for ease of writing and transcribing.

1. As soon as students begin to write in sentences, guide penmanship. Dictate and permit students to copy from the textbook; call out such directions as "way up to the d--," "shave the initial 'a' on down strokes," "o--deep and narrow," etc.

Aes 295

2. During the first ten weeks, it is advisable not to insist, criticize, nor interfere in any way with the student's development of his own individual penmanship style.

Speed. Speed is worthless without readability.

1. A little trick for students who may be having difficulty acquiring dictation speed is the "backtracking for the forward push" technique. Use a short letter of between 60 and 100 words. (See letter 241 of the Gregg Shorthand Manual, Second Edition, as an example.) The letter might be dictated as follows: Dear Friend your--Friend your business--your business definitely--business definitely makes--and so on. The letter is then rewritten. Speed may be doubled in this manner.

A FEW WORDS OF ADVICE

1. Be calm and relaxed. Your class is a reflection of you.

2. Praise success; minimize failures or mistakes. Find something to praise every pupil for every day; the less a student has to praise, the more she needs it.

3. Realize that every skill learner is entitled to practice without criticism and observation.

4. Remember that a skill must be learned. You acquire technique from improved performance.

5. Dictate in such a way that any stranger would not know you are a teacher.

6. Keep students enthusiastic.

7. Teach students how to study shorthand theory and how to use the transcript.

8. Build speed on easy material.

9. Remind students to "keep writing" when working for speed.

10. Keep "speed takes" short.

11. Repeat "speed takes" over and over again.

12. Following every "speed take," be sure to drop back for control.

13. Leave writing habits alone.

14. Let students know what you have set as goals.

SUGGESTIONS FOR IMPROVING INSTRUCTION

IN

TRANSCRIPTION

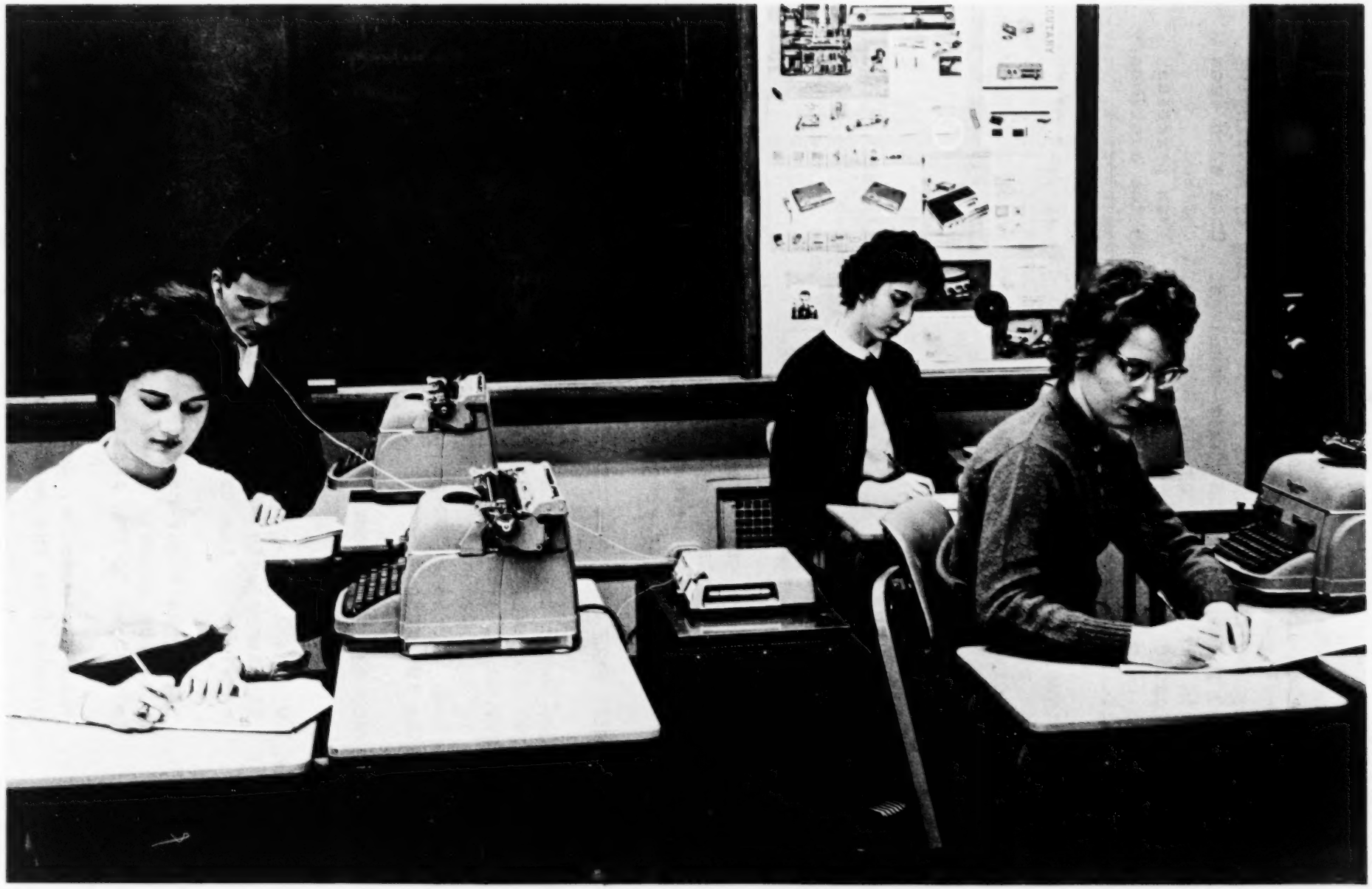

The voicewriter can be used effectively
for small group instruction in shorthand.

TEACHING IDEAS

Students must be constantly encouraged to check carefully for accuracy every piece of transcribed copy. New words encountered and words misspelled should, of course, be checked with a dictionary. Students will strengthen their vocabulary and spelling by developing a vocabulary list of these words and their meanings. Once each week the word lists should be collected by the teacher and checked against errors indicated in the student transcripts. This practice will cause students to proofread more carefully, to use the dictionary effectively, as well as serve to strengthen student vocabularies.

Another technique is to assign ten words each day as part of the regular homework for spelling, syllabication, word meaning, and correct shorthand outline. Give a test periodically on these words and provide extra credit for students who can handle these word lists without error.

THE SPIRIT OF EMULATION

When the instructor writes in shorthand on the chalkboard slowly, her students will follow the example. When the teacher writes her own shorthand fluently on the chalkboard, the class is more interested than when following the notes of the textbook.

Write slowly to explain, then repeat again at a faster rate. Give students the urge to write faster with repetition, thus learning by doing and seeing. Correct shorthand outlines are learned more readily by assimilation than by being memorized.

FOUR PROCEDURES THAT HELP INCREASE TRANSCRIPTION RATE

1. Use a stop watch to time the transcription period. Check individual students from the time the typewriter carriage stops because of a transcription "barrier" until the problem is resolved and the student continues on. This may also include carriage "stops" caused by the need for correcting an error.

2. Demonstrate the techniques of making an erasure easily and quickly:

    a. With the right hand, pick up the eraser. Simultaneously with the left hand, pull the carriage to the left or right.

    b. While the right hand is moving toward the cylinder with the eraser, the left hand should twirl the platen up to the erasing point.

    c. Make the erasure, carefully brushing the erasure crumbs from the machine.

d. As the right hand places the eraser back on the desk or in the desk drawer, the left hand should return the carriage to the typing point.

Have students practice the steps indicated above; practice at the count of 1, 2, 3, 4 many times. Follow this practice for one month and note the increase in the transcription rate.

3. Instruct each student to keep a list of all words misspelled during the period of a month. Words repeatedly misspelled should then be listed on 3 x 5 index cards which can be arranged alphabetically and kept near the typist as she transcribes.

4. When working for speed, push students several words a minute above the rate set as a transcription goal.

MAILABLE LETTERS

One of the prime achievements of a course in transcription is the mailable letter. Many factors contribute to this end. Prominent among them is the ability to erase and make corrections easily, good proofreading habits, reading shorthand notes for meaning of words in context, good vocabulary, spelling ability, and, of course, common sense.

In many offices there is no such thing as a correctable mistake. Employers in these offices expect such errors to be caught by the stenographer before any letter is presented for their signature.

In an effort to help students accomplish this end, letters are read back in class with all marks of punctuation designated even before actual transcription at the typewriter takes place. Thus, when the student actually starts the task of transcribing at the typewriter, he is thoroughly familiar with at least one major element--punctuation.

In order to produce an acceptable transcript in a short space of time, the student must have complete control of the typewriter and an adequate typewriting speed. Careless errors, poor erasures, and smudges must be eliminated in order to produce the desired objective--a mailable letter.

IMPROVING QUALITY OF DAILY TRANSCRIPTS

A simple technique for improving daily transcripts is to have unannounced daily tests. Rather than have students anticipate the test days, the teacher should collect the daily transcripts each day and announce the test only after papers have been turned in.

In this way each student does his best work each day, not knowing but that the day's work will be evaluated by the teacher as the weekly test. Not only does this practice tend to improve the daily transcripts,

but the student who is inclined to become upset at the announcement of a test, overcomes the nervous tension of a weekly or bi-weekly test.

SUGGESTIONS FOR IMPROVING INSTRUCTION

IN

SECRETARIAL PRACTICE

The atmosphere of any business classroom laboratory should approximate that of a well-run business office.

PRACTICAL OFFICE TRAINING

Your secretarial practice class may be made more practical and effective by supplementing the text with actual office tasks. Supplement your textbook with several work assignments of a type required in local business offices. These assignments may be prepared with the help of executives from several business organizations. Select the office tasks so that students are given an opportunity to work with many of the common office reference books and other materials encountered in modern business offices.

ORGANIZE THE CLASS AS AN ACTUAL OFFICE

Conduct the secretarial practice class periodically as an actual business office. Appoint one student as office supervisor. All completed correspondence should then be checked by the supervisor for accuracy and enclosures before giving her signature of approval. The letters are then returned to the "stenographers" where they are folded and inserted into the accompanying envelopes ready to be mailed.

No grades are assigned, but student stenographers understand that their rating as an employee of the office will depend upon the quality of their performance. Perfect work is considered to be "top" performance; mailable work with acceptable word substitutions and corrected errors, "average" performance. Work which includes any misspelled word, a bad erasure, an incorrect word division, or any other transcription fault is considered unmailable and must be retyped until acceptable.

START FILING INSTRUCTION EARLY

Although filing instruction may not be started until several weeks from the start of the school term, students may begin learning to file properly from the day school begins in the fall. As they are instructed to write their names on cards, surname first, comma, given name, etc., remind them that this preparation for later alphabetizing is called "indexing." As students assist in the collecting and arranging of cards in groups of A's, B's, C's, etc., remind them that what is really happening is that they are doing what the file clerk refers to as "rough sorting." If there are names with a prefix, such as Ellen St. Croix, the class is also given an opportunity to learn how such a name is correctly filed.

Another means of teaching filing in a practical way is to give students an opportunity to alphabetize papers that are collected in class. This makes it possible for students to be seated in other than alphabetic order and yet provide the teacher with an efficient means for handling homework papers.

When formal instruction in filing is begun, it is sometimes interesting to have members of the class exchange exercises that have been filed. This provides the opportunity to cross check upon the accuracy of one another in the class and emphasizes the importance of a uniform system of filing in any business organization.

WHAT'S MY NUMBER?

Let's be realistic in teaching Soundex filing! Use the names of students to illustrate the system used in the Social Security and Motor Vehicle files--two files in which most students' and parents' names will eventually appear.

IMPORTANCE OF GOOD TELEPHONE TECHNIQUE

In a modern business office a secretary must be of help to her employer through her efficient use of the telephone. Help your students to appreciate the importance of

1. a positive, pleasing telephone voice
2. asking questions; getting names and messages correct
3. leaving messages where they will be found immediately
4. memorizing telephone numbers, voices, and names that are frequently encountered
5. temperament and attitude. They show over the telephone.
6. having information at one's finger tips or where it can be quickly located
7. following through with any promises made during the telephone conversation
8. trying to be helpful to <u>every</u> caller

INITIATIVE AND ATTITUDE

There are many instances where a secretary, because she is a good one, actually runs a goodly portion of the activities of a business. Because she knows the business thoroughly, her employer does not hesitate to trust it to her care. Her attitude toward herself, her employer, the firm, and her associates will, however, often influence the degree of responsibility entrusted to her.

Help students to appreciate that initiative is basic to job success. Initiative is more than a quality to be talked about; it must be practiced. Ask students to look at the word <u>initiative</u> and observe the number of "eyes" that it contains. This implies the ability to see great detail. Stress that a good secretary is not afraid to make a decision or to take action on her own. Mistakes may be made, but employers like employees who shoulder a little responsibility.

Employers also like employees who grow with the business and who may some day be capable of becoming the head of a department, an office, or the entire organization. Naturally, every employee wants a

better job, but he must be prepared for it when the crucial time arrives. Stress with students that initiative involves planning on the job for jobs higher on the organizational ladder. Initiative involves planning, education, study, and forethought.

ACTUAL OFFICE EXPERIENCE

All secretarial students are required to work 36 hours at a reception desk which places them in an office-type atmosphere. To identify herself and her responsibility, the student places a placard on the desk which reads "Student Secretary for the Day, Miss Susan Brown."

Some of the duties for which she may be held responsible are:

1. Answering all incoming phone calls

    a. Recording messages
    b. Delivering messages promptly and correctly
    c. Screening calls to see that teachers are not interrupted unnecessarily

2. The sale of small supplies

    a. Making change
    b. Seeing that supplies are available for sale

3. Office dictation

4. Assistance to teachers

    a. Typing stencils
    b. Operating duplicating equipment
    c. Recording data in the proper record books

5. Assisting with office filing

6. Greeting visitors

Duties such as these will provide the opportunity for a student to demonstrate her initiative and good judgment as well as her office skills. Placement personnel will also welcome this opportunity to appraise a student's capabilities and be better prepared to recommend her upon graduation for a suitable position.

SUGGESTIONS FOR IMPROVING INSTRUCTION

IN

ENGLISH FOR BUSINESS

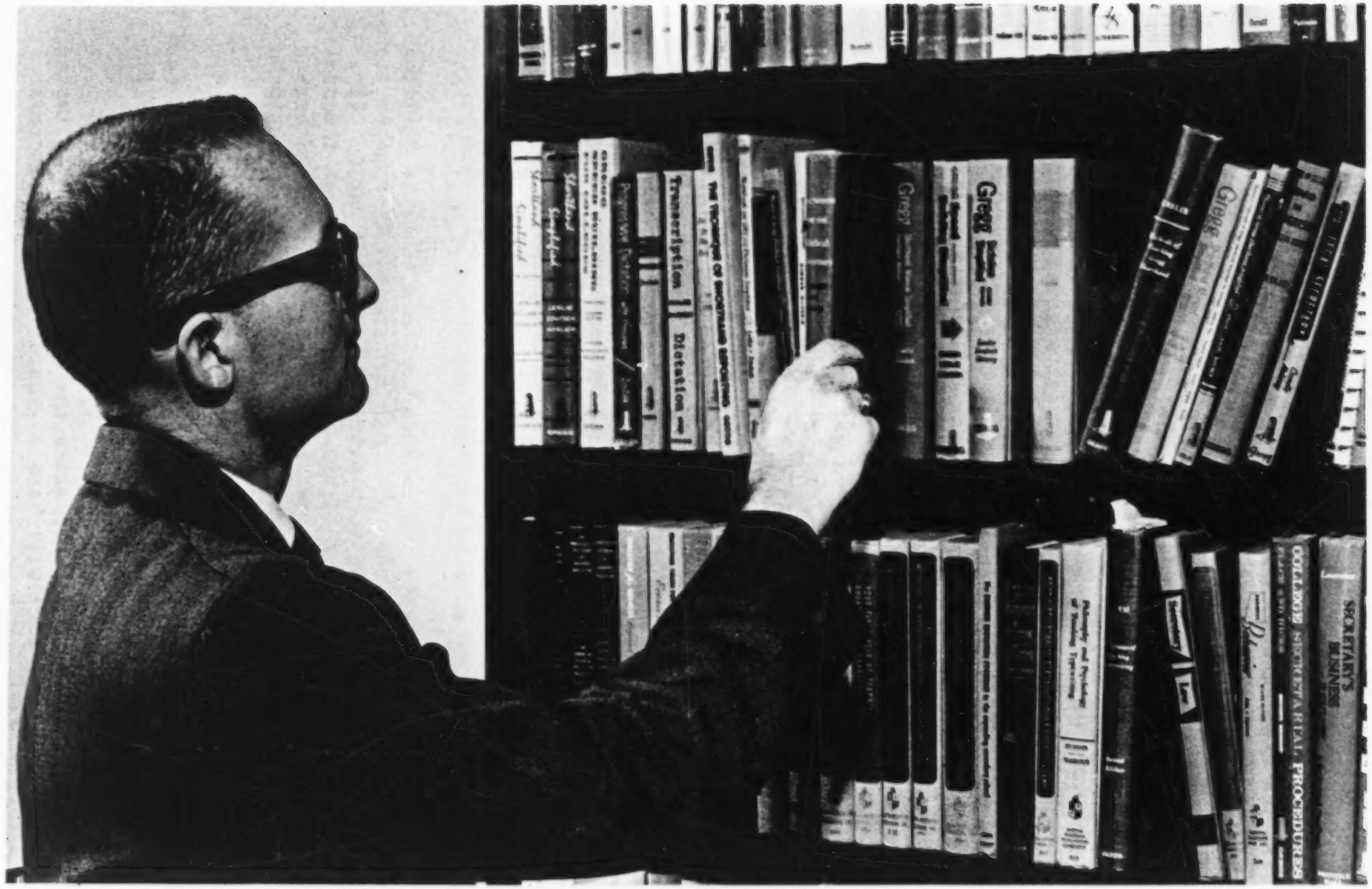

A variety of library resources should be available to the business student.

HELPFUL HINTS FOR TEACHING ENGLISH MECHANICS

The student who has studied English for many years frequently needs new directives and motivation for continuing the study of the subject. The right mental attitude must be formed before a teacher will receive the desired results.

The business student must realize that in order to succeed in many types of employment and particularly in office employment he must have a good command of the English language--accurate and action-producing. He must realize that he will be expected to be able to apply the fundamentals of English grammar he has learned; he must also appreciate the need for a clear but forceful writing style, powerful enough to impress the reader and stimulate him to the desired action.

In order to strengthen the foundations of sentence structure, the teacher should be sure that students can distinguish between a complete and an incomplete sentence. Considerable time must also be devoted to the re-teaching of the principal parts of speech and fundamentals of sentence structure. It is desirable for many students to keep a notebook of definitions of the parts of speech and sentence components. Students are apt to forget the difference between a phrase and a clause, between an object and a predicate nominative. Let it be emphasized, however, that the explicit meaning of terms is not nearly so important to the student as the understanding of how they are correctly applied. A program which combines the building and analyzing of sentences with the writing of business letters is therefore helpful.

Exercises which provide practice in such aspects of English grammar as agreement of subject and predicate and correct pronoun forms will strengthen the student's understanding of sentence structure. The principal parts of certain verbs are also troublesome to some students. Reciting these verb forms in unison is often helpful. If the student remembers that the past tense needs no helper but that the past participle does, he usually has less difficulty.

Students find it interesting to work together in class building sentences. The adding of words, phrases, and clauses to a given framework of a sentence can be made both profitable and enjoyable. If students have not been taught to diagram, there is often an immediate psychological block. However, since some students understand better when they can visualize, some form of sentence diagramming should be presented. A brief review of a few simple diagrams usually is sufficient for those who have been taught the process. The simple device of underlying the main elements of the sentence, and using parentheses to set off phrases, brackets for clauses, and arrows to show the relationship of modifiers also enables students to clarify the relationships of words in a sentence.

If students can be made to realize the importance of the letter in the business world, they will have a greater desire to improve their written English. Via the medium of composing carefully constructed

business letters, students will have an opportunity to demonstrate their facility with English grammar, sentence structure, punctuation, vocabulary and spelling. At the same time, the teacher will be able to discover the principal difficulties of each student, and both teacher and student can work together more easily toward the goal of perfect English.

PUNCTUATION AND CAPITALIZATION

Good punctuation and correct capitalization are made a practical reality by having the rules learned as applied and repeated as assignments are corrected. By learning WHY, often for the first time, students understand the importance and necessity of correct capitalization and punctuation and the definite use of each punctuation mark.

PENALTY FOR ERRORS

Every business teacher knows the feeling of frustration when a student is heard to break a basic rule of English grammar. Occasionally, when students are heard making such errors, try this little game. When a student is caught making an error in English, either in class or out of class by his fellow students, penalize him a penny. Encourage every member of the class to be alert to these infractions. Use the pennies collected for some worthwhile class activity.

THE DAILY SPELLING LIST

Dictate twenty-five words each day, but give credit to a student only for 100 per cent accuracy in the spelling of the words selected. A weekly spelling test may then be given covering the words included in the lists of the past week.

THE SCHOOL NEWSPAPER

The school newspaper provides a proving ground for most of the communication skills the student has been taught in his secretarial training. Gathering the newspaper content requires research; writing the copy requires a knowledge of English, spelling, punctuation, form of layout, and artistic talent; typing and stenciling for the project requires accuracy; painstaking proofreading is necessary at every point in the process. Complete knowledge of the operation of the mimeograph machine is essential. Collating, selling, and accounting for funds involved provide further experience in matters which may be of help in future office positions.

LOOK UP AND LEARN

As a means of building vocabulary, have your students read the editorials in one or more local newspapers. Request that new words encountered and their definitions be written by each student in a notebook. Shorthand students may also be instructed to write the shorthand outline for each new word.

11310

CLASSROOM TELEGRAMS

Teaching students to condense a message helps to strengthen their writing ability. For example, the teacher may either relate a story to the class or have students read an article from a specified business maga 'ne. Students are then requested to summarize the story or article in 10 to 15 words and to typewrite the "telegram" within 10 or 15 minutes, depending upon the length of the article.

DEMONSTRATE THE EFFECTIVENESS OF THE PERSONAL DATA SHEET

Many students lack confidence in their ability to compose a good business letter, particularly a letter of application. As the teacher knows, a personal data sheet with concise accompanying letter is frequently used with success.

Students must, of course, appreciate that a short, carefully written letter, whether it be a letter of application or an ordinary business letter, is essential today. Every business letter should adhere to the five C's of good letter writing--courtesy, conciseness, clearness, correctness, and completeness.

In order to prove to students the effectiveness of the personal data sheet in writing a letter of application, one teacher on several occasions has demonstrated its use to her class by answering a blind "help wanted" advertisement. The reply from the employer was then exhibited to her class.

This demonstration has emphasized dramatically to students the effectiveness of preparing a letter of application in this particular form. Students should also appreciate the wisdom of preparing such a letter with utmost speed. If possible, the letter should be completed within an hour from the time the advertisement first appears in the newspaper. For any local job opening, it should then be taken directly to the newspaper office rather than lose the time necessary for having the letter pass through regular postal channels.

MONITOR RADIO AND TELEVISION BROADCASTS

Interest in developing good grammar and a better vocabulary may be created through the technique of recording errors of this variety heard on radio and television programs. When each student is made responsible for one new word a week that is new to him, with its proper pronunciation, meaning, and use, or one grammatical error used in apparent good faith by a radio or television announcer, he is made aware of his own limitations in speech.

SUGGESTIONS FOR IMPROVING

ECONOMIC UNDERSTANDINGS

Everyone can profit from instruction in applied economics.

A HYPOTHETICAL INVESTMENT

Many students hold preconceived ideas and prejudices concerning various facets of economics. This is especially true of the student's ideas of the corporate structure and its financial implementation.

With a mythical cash outlay of $10,000 to be invested by each student and $50,000 by the class as a whole, the world of stocks and bonds can take on a personal meaning. The suggestion that this money be invested immediately will usually be disapproved by most students. They will ordinarily prefer to withhold making a stock or bond purchase until such time as they are more confident of the past history of the investment. Thus the framework is laid for a concentrated study of the corporate structure and of the factors that affect the value of a stock or bond on the market.

With encouragement, students will visit brokerage agencies, make a study of such financial ratings as Moody's Manuals or Standard & Poor's Standard Corporation Records, read the Wall Street Journal, examine prospectuses, and learn a variety of terms that afford a better understanding of stocks and bonds.

After making their investments, students enjoy following the activity of their investment via the newspapers. A chart kept on the progress of the class investment of $50,000 also serves to stimulate interest.

In addition to the increased class participation in the learning process, there is a noticeable change in the attitude of students toward stocks and bonds as a means of future investment for them.

INJECTING A PERSONAL POINT OF VIEW

Ask each student to consider as his salary what might be considered an average amount for a beginning office worker. With this amount, request each student to work out, according to the principles learned in class, a budget that will fit his own needs and desires.

SUGGESTIONS FOR IMPROVING INSTRUCTION

IN

BUSINESS MATHEMATICS

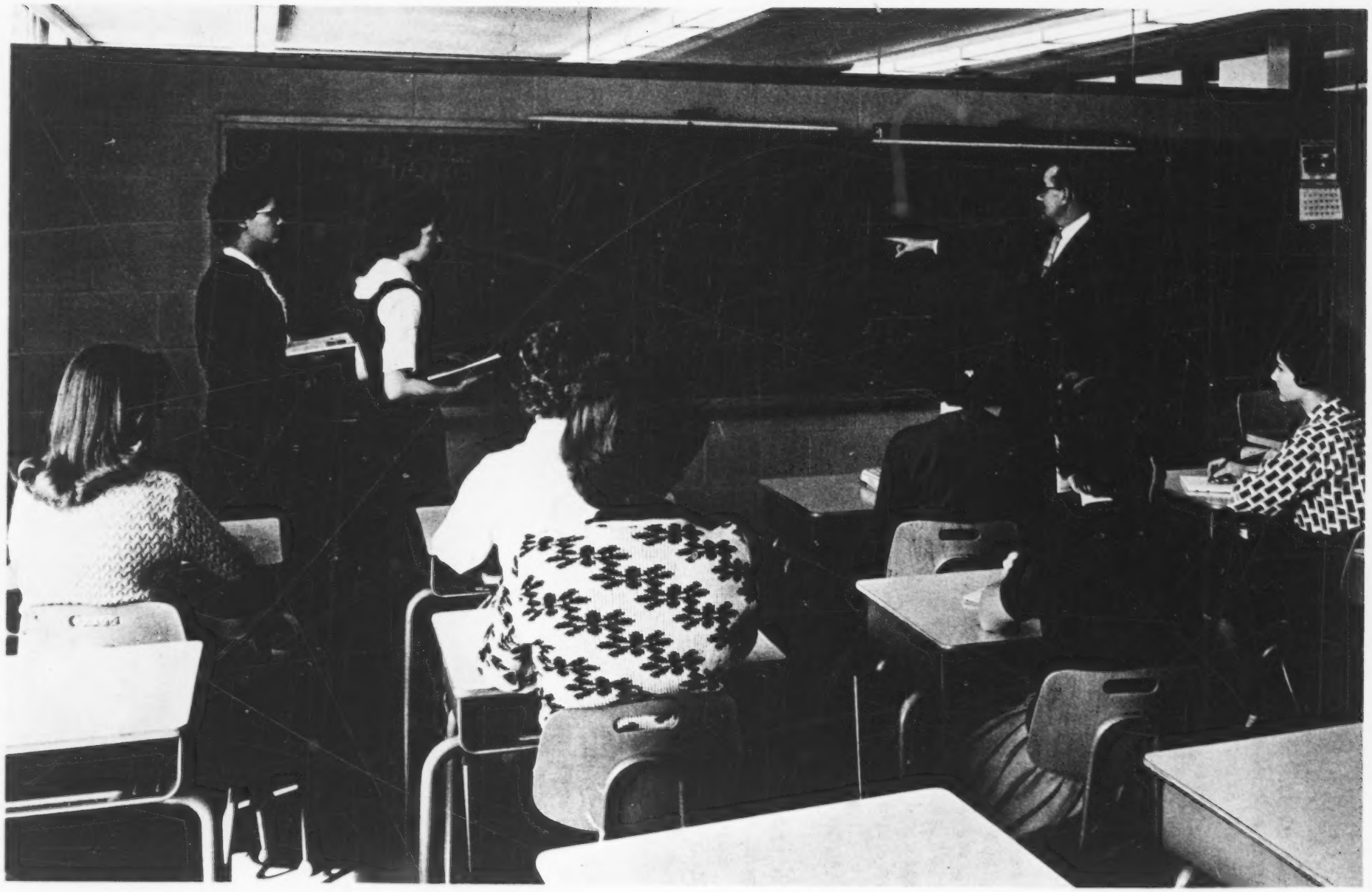

Related arithmetic should be
taught in connection with appropriate topics.

READ NUMBERS ALOUD

As an introduction to the course in business mathematics, provide practice in the oral reading of numbers. It is surprising to learn that when a number has more than three digits many students will hesitate or stumble.

Some practice can be given by reading numbers as a group or as a class. Particular attention must be given to the reading by individual students, however, if maximum benefit is to result.

PENMANSHIP

Instruction, as well as constructive criticism, in the formation of figures will benefit students. It is wise to point out that careless penmanship frequently leads to confusion of the figure 1 with the 7, 3 with the 5 or 8, 6 with 0, and 4 with 0. As a result of the poor construction of figures, there is apt to be poor alignment which is another cause of inaccuracy.

COMPETITION

In the early weeks of a course in business mathematics, it is important to stress arithmetic fundamentals. To hold attention and create interest in class drill on addition and subtraction, this technique is suggested: Dictate a checkbook beginning balance; then indicate the amount of a check drawn. After hesitating a moment, dictate the amount of another check, then a deposit, then another check or two. To stimulate competition, allow a show of hands for the first completed result. Competition proves to the student that he is rusty and that mental lubrication is very good medicine.

REVIEW TECHNIQUES

When reviewing multiplication and division, illustrate short-cut methods that can be used. This will stimulate interest in the review. Use sales tickets, invoices, customer accounts, and customer monthly statements to add realism. This will tend to relieve the monotony of the review.

COMMUNICATION

Appoint students to go to the chalkboard to illustrate their solution of assigned homework. Then allow each student to explain his work for the benefit of the class. This experience will emphasize the importance of being able to explain one's logic in a solution to others.

GARNER WITH HONOR

In business, honor is a prerequisite. To stress this objective more fully, make it possible for students to use the classroom as a

laboratory. An honor system can be initiated through a self-check point system. Points might be accumulated weekly for such activities as the following:

Quick quiz	-	10 points
Class participation	-	10 points
Homework well done	-	2 points
Answering a challenging question	-	2 points

The various means of accumulating points must, of course, be explained to the class. Deductions from the weekly total may also be made for such infractions as failure to complete homework, talking, lateness, etc. At the end of the week, each student accumulates the points he has earned and submits his score sheet in a style that will conform to the model outlined by the teacher. He may report his score for the week in terms of points earned or, if the teacher prefers, as a letter grade. A letter grade might be based upon a scale such as the following:

A - 70 points or more
B - 60-70 points
C - 50-60 points
D - 40-50 points
E - Below 40 - unsatisfactory

SCORE SHEET

Student's Name.....Week of.....

I, on my honor, submit the following points:

Total..... Grade.....

SIMPLE METHOD FOR CHANGING A DECIMAL TO A FRACTION

Example: Change .1263 to a common fraction.

First, place 1263 as the numerator of a fraction.

Second, put a zero for each decimal place in the denominator and place a "1" before the zeros.

This will supply the correct number of zeros in the denominator.

If necessary, reduce the fraction to simplest terms.

Answer: $\frac{1,263}{10,000}$

TEACHING MARKUP

The conventional method of presenting the topic of Markup in business arithmetic is to supply the student a formula, such as

$$\frac{\text{Principal}}{\text{Rate}} = \text{Base}$$

Using the above formula, the student then learns to determine the selling price when the markup is based on the selling price.

Another method which has proved to be successful will be illustrated through the following examples:

1. Determine the selling price of an article costing $4.14 if markup amounts to 25 per cent of the cost.

2. Determine the selling price of an article costing $4.14 if markup amounts to 25 per cent of the selling price.

The teacher must first impress upon the class that the base is equal to 100% and that the basic formula is as follows:

Cost + Markup = Selling Price

The class is then told that to find the selling price when markup is based on the selling price one must divide by the cost expressed as a per cent. If markup is based on the cost, multiply by the selling price expressed as a per cent to find the selling price in dollars.

The solution to problem 1 above might be illustrated through the following "T" arrangement:

Formula	%	$	
Cost	100	$4.14	
+	+		Multiply
Markup	25		by
=			125%
Selling Price	125		

The solution to problem 2 above might be illustrated through the use of a simple "T" and with the formula written at the left

Formula	%	$	
Cost	75	$4.14	
+	+		
Markup	25		Divide
=			by
Selling Price	100		75%

QUICK QUIZ

At the start of the period, administer a short quiz by placing on the chalkboard as many problems as there are rows of students in the classroom. In this way, there will be a different question for each row. The first student from each row who is finished will be given the chance to go to the chalkboard and place his solution to any problem other than the one assigned to his row. He will earn an additional 2 points if his solution is correct. The examples are then checked at the chalkboard by the teacher. Each student at his seat corrects his paper and places a score of "2" on the paper if his solution was correct and a score of "4" if he was one of the "winners."

MULTIPLICATION BY MACHINE

Multiplication by adding machine poses no problem for the mathematically minded, but for those students who have difficulty with arithmetic fundamentals it is often confusing. To facilitate the teaching of multiplication on an adding machine, first explain the process of multiplication without the use of a machine. Tell students to multiply 8.75 x 431 arithmetically, for example. When the work is completed, ask "What did you multiply by first?" After some discussion, the correct answer is identified as being "one." Then ask, "What did you multiply by next?" At this point, the correct answer is readily identified as being "three." Then point out that actually the multiplication in this case was by 30--the result of moving the product one column to the left instead of placing it directly beneath the product of 1 x 8.75. Again, ask "What did you multiply by then?" After receiving the reply, "four," remind the class that actually the multiplication was by 400--the result of moving the product one more place to the left.

Now, when the teacher instructs the class to "move the multiplicand one column to the left on the machine each time you multiply it by a number from the multiplier," it becomes clear that what has actually taken place is that the multiplicand (in this case) has been multiplied by 1, 30, and by 400.

SUGGESTIONS FOR IMPROVING INSTRUCTION

IN

BOOKKEEPING AND ACCOUNTING

The overhead projector facilitates
instruction in bookkeeping and accounting.

AN ANALOGY

It has been found helpful to students if the teacher presents the bookkeeping cycle as being analogous to the playing of a hand of cards.

The Analogy

A Hand of Cards	The Bookkeeping Cycle
1. A hand of cards is dealt, representing the potential of the player.	1. The original investment (Assets; or Assets and Liabilities) are indicative of the financial condition of the proprietor (Proprietorship)
2. Cards are played according to the rules of the game and the best judgment of the player.	2. During the fiscal period, business is transacted by the proprietor. The bookkeeper records these events first in the form of business vouchers from which journal entries are made. These entries are posted into the ledger from which a summary is drawn in the form of a trial balance.
3. As a result, the player may either add to or reduce his score.	3. From this summary or trial balance, adjusting and closing procedures take place and the proprietor is presented with his score.
4. For the card player, this is a time for analysis, comparison, and reflection. He is then ready for a new hand of cards.	4. A detailed explanation of the result of operations is prepared in the form of an income statement. A new hand of cards is dealt in the form of a balance sheet.

AN ORIGINAL PROJECT

Bookkeeping, which involves a maze of detail that is essentially recordative, has the distinct goal of providing summary data (trial balance, financial statements and endless reports that call for a recapitulation of the accumulated detail involved). Every bookkeeping teacher will agree that there is a great difference between teaching bookkeeping students to understand the mechanics of record keeping and getting them to be a "thinking" bookkeeper. The student who records business data without the insight necessary to see how the part which he

is recording fits into the bookkeeping cycle as a whole is working blindly. It is this type of blindness that explains many of the errors leading to imbalance of the records, not to mention other shortcomings of records maintained by bookkeepers who cannot see in their "mind's eye" the total recording picture.

Developing bookkeeping "insight" in students is difficult. The project described below is suggested as one means that can be used to develop bookkeeping awareness of how each entry in a set of books, regardless of their form, fits into the total bookkeeping cycle.

The Project. Each student is asked to choose a type of business he would like to work for as a bookkeeper during the final weeks of the first year of bookkeeping. The student selects a business with which he is familiar or in which he is interested. Students will typically select from such businesses as: gas stations, grocery stores, beauty parlors, restaurants, farms, etc. The best project submitted by a student to one teacher involved a hamburger stand. The type of business selected is not as important as the student's knowledge of, or interest in, the business.

After selecting a business for his project (with teacher approval), the following steps are taken by the student:

1. A hypothetical balance sheet is drawn up for the business.

2. Original records (form of journals) are drawn up.

3. Transactions of the business are written out for one month (number and diversity are based on student ability, interest and other factors).

4. Transactions are journalized; journals are completely posted to the ledger(s).

5. Trial balance is taken.

6. Financial statements are prepared.

Rewards of the Project

1. Student interest is stimulated. The opportunity to work in a business of his own choice arouses momentary excitement.

2. Originating the bookkeeping system brings to life much of what was mere bookkeeping theory.

3. Hypothecating business transactions brings into play related information that the student has learned from other business courses.

4. The projects are individualized; no two students are working with the same data. Competition occurs; students make their projects as extensive and qualitative as their individual ability dictates.

5. The project provides a complete view of the bookkeeping cycle and dramatizes each step in the process. The project is the student's own creation; he has supplied the materials and all details and is completely familiar with them; he understands the correlation of each part of the project with every other part. The student has been "thinking" bookkeeping instead of mechanically recording data.

TEMPORARY AND PERMANENT ACCOUNTS

When the Balance Sheet Approach is used, one teacher starts with the question, "What do you know about the Alps?" When the word permanent is introduced, the teacher compares the Alp(s) of business with the Alps of Switzerland. Assets, liabilities, and proprietorship are the permanent accounts of a business--those which comprise the balance sheet of a business.

The teacher may then liken the accounts of the Income Statement to ice. Like the melting characteristic of ice, the accounts which comprise the Income Statement are temporary in nature. The key words alp and ice help the student to visualize the nature of the accounts that appear on these two principal bookkeeping statements.

Another question to be raised is, "What accounts customarily have debit balances; which credit balances?" The key words ace and lip may be introduced to help the student identify these accounts.

RELATE INSTRUCTION TO STUDENT EXPERIENCES

When introducing a class to bookkeeping, it is important to incite their imagination by relating the hypothetical situation to experiences encountered in their everyday life. If students are able to visualize a situation and actually live the experience, the problem will become more meaningful and result in greater student interest.

In presenting the permanent accounts elements--assets, for example--use personal assets as illustrations. These might be such items as a student's wardrobe, his savings account, or his jewelry. Liabilities can be illustrated by his obligation to a clothing merchant for new clothing, an unpaid medical fee to the family physician, or a mortgage held by a bank on the family home.

Use this technique to chart the fundamental equation and illustrate to the student how his own proprietorship is determined. Having determined his own capital, then substitute the assets, liabilities and capital of a business in a similar equation.

When discussing a transaction, use a situation in which any student could actually have had a part. For example, the transaction might involve the boarding of a bus for transportation to school, buying the morning paper, or shopping at a local supermarket. Such illustrations permit the student to project himself into the situation and facilitates his understanding of the effect of the transaction on the accounting elements. Every new account that is introduced in a transaction is illustrated by a "T" account and its effect on the accounting equation is explained at that time. If diagramming is essential in teaching English grammer, "T" accounts are essential in bookkeeping.

MINIMUM OUTSIDE PREPARATION DURING THE FIRST MONTH

Very little independent written outside homework is required during the first month of bookkeeping instruction, other than the completion of work partially completed in class. During the succeeding class session, the completed assignment is then checked and individual questions answered before the class progresses to the next lesson. Use of this technique offers an opportunity for direct observation of the instruction given and its application by the student. When outside assignments are given, they can be devoted to textbook study and review of problems completed.

FACILITATING THE UNDERSTANDING OF THE WORK SHEET

Try illustrating the adjustments of the work sheet by comparing with student experiences. Office supplies (when used as an asset) are to the proprietor of a business what groceries are to the homemaker. The groceries when purchased are assets to the family until the first meal is served, then they become an expense.

Compare the adjustment column of the work sheet to a book of original entry where entries must be made involving changes in accounts so that the ledger can be brought up to date. The result of the procedure, of course, is the adjusted trial balance. The breakdown of the adjusted trial balance in the remaining four columns of the work sheet should then involve a review of the chart of ledger accounts and the classification of accounts as to their permanent or temporary nature.

THE BUSINESS REPORT CARD

Some textbooks refer to the Income Statement of a business as a "report card" presented to the proprietor of a business at the close of a particular fiscal period. Capitalizing on this statement, every student has had the experience of analyzing his own report card and this same situation can be used in explaining the Income Statement. If a profit is reported, the proprietor has "passed;" if a loss is shown, he has "flunked" for the period.

A SYSTEM OF THEIR OWN

In beginning bookkeeping classes, it is sometimes effective to provide students with a series of transactions with the instructions that they keep a record, in their own way, to determine the profit or loss of the venture. After several weeks, students are given the same series of transactions with the instructions that they be recorded in a set of books using the double-entry principle. Finally, the first papers collected are returned and a comparison made between the results obtained.

INDIVIDUALIZING INSTRUCTION

Teaching on an individual basis enables the average student to progress more rapidly and affords the instructor additional time to spend with the slow student. The personal contact of individualized instruction gives the instructor an opportunity to become better acquainted with the student, to help him develop proper attitudes toward his work, and to adjust to procedures that are demanded by business.

MORE ATTENTION TO THE SUBJECT OF TAXES

In this complex world of ours, we in business education often permit our students to graduate from school without a sufficient understanding of the various taxes and tax benefits typically encountered by most citizens. Instructors should be sure that the business curriculum gives adequate attention to this important topic. In the private business schools, this may involve the initiation of a course devoted exclusively to the topic.

The subject of taxation and tax benefits should include treatment of property taxes, Federal income taxes for the individual, Federal Old-Age and Survivors Insurance, Federal and State Unemployment Insurance, New York State Disability Benefits, State income taxes, sales taxes, and excise taxes. Of course, there are other taxes which might be included, but the instructor should seek to concentrate on those tax laws and benefits common to most individuals.

Students must fully appreciate and understand the benefits of taxation. Many of our citizens, for example, do not understand their rights or benefits under the Federal Old-Age and Survivors Insurance law and, as a result, lose benefits to which they are entitled. Far too many citizens also fear the thought of preparing a Federal or State income tax return. Perhaps business educators are to blame, in part, for they may fail to include enough instruction on the subject of taxation in the business curriculum.

The treatment of this topic must be both theoretical and functional, with most of the emphasis being placed on practical applications. The rules and regulations of the tax laws should be discussed fully and then applied to simple commonly encountered problems. Students

should be given the opportunity to work on the various tax forms which they will meet in business and personal life.

Give students an opportunity to prepare a tax form or solve a tax problem without any assistance. This will provide them the opportunity to apply the law as they understand it and to express, in writing, their interpretation of how the laws should be applied. After the form is completed or problem solved, the results may be compared with those arrived at by other members of the class. Students will then be able to observe where errors were made and take precautions to avoid such errors in other problems.

TIPS FOR TEACHING INCOME TAXES

It is stimulating to the beginning student if he is given an opportunity to actually visit the local office of the Director of Internal Revenue. On his visit he should attempt to obtain copies of tax forms that are used by individuals in the preparation of their tax returns. The booklet, Your Federal Income Tax, may also be purchased for a small fee.

In addition, the United States Treasury Department, Internal Revenue Service, will make available to schools a Teacher's Tax Kit and individual Student Handbooks for use in teaching the preparation of individual income taxes. Teachers will also want to have on hand one or more copies of Circular E, Employer's Tax Guide.

Because the student has personally visited the Office of Internal Revenue, his subsequent study of the subject seems to take on added meaning. It is possible that a group visit may also be arranged which will permit a more extensive explanation of the various activities of the office.

GENERAL TEACHING SUGGESTIONS

IN

BUSINESS EDUCATION

QUESTION AND ANSWER BOARD

For short reviews and a bit of fun in the teaching of English grammar, filing, or typewriting theory, a question and answer board provides an interesting diversion. To make such a board, one needs only a board, two dry cell batteries, wire, a few nails, and a very elementary knowledge of electricity. After a demonstration--usually not needed in this scientific age--students are readily able to use the board. The board is so constructed that by answering a question correctly, a light on the board will light up. Students can be seen before class, at noon, and even after school making the board light up with the correct answers. This is a favorite with the boys.

SPELLING CONTEST

A spelling contest based upon a weekly class test will stimulate pupil interest in the improvement of spelling skill. Some teachers require only half of the homework assignment over the weekend from those students who are able to pass the spelling test with a grade of at least 90 per cent.

For variety, if practical, have students use the typewriter for the spelling tests. If typewriters are used, the teacher should read each word twice and after a word is pronounced the second time, the student should then type the word.

INVESTMENTS

Each student may be asked to select a stock, check into the background of the issuing company, follow the progress of the stock as it is reported in a daily newspaper, and then make a decision (with reasons) as to whether a purchase should be made.

PERSONALITY DEVELOPMENT--"A WAY OF LIFE"

Personality development is considered to be so important that it is frequently offered as a special course in many private business schools. In its application, however, personality development is fostered every minute of every day. In one of those schools where personality development is taught as a formal course, the student is given four criteria by which to measure himself in the light of a plus personality. He asks himself (1) Am I physically fit? (2) Am I mentally and morally fit? (3) Can I speak, read and write correctly? (4) Can I reason?

At every opportunity, the point is stressed that the ability to reason is the basis of a positive personality. The student is told that if reasoning is applied in his daily living, he need have little worry with respect to the other yardsticks presented. In fact (and this statement is often startling to him), he is further told that any defect which he may encounter in life he may well lay at his own door--for lack of ability to reason.

This philosophy is put into practice in every phase of the school's activities. If a student is late, he is not merely penalized for his tardiness; he is told why, the effect it has upon the program for the day, and what everyone stands to lose as a result. This same technique is followed when his work is substandard, if it does not come in on time, or if he fails to conduct himself in a proper manner.

The business of finding out where we err and how proper reasoning can help to set us straight gets to be a game. When a student states that he is applying "reasoning" to out-of-school and home problems, then there is reason to believe that he is being prepared both for a job in the business world as well as for a WAY OF LIFE.

TAPE YOUR INTERVIEWS

Taped recordings of interviews conducted by members of the class or by previous classes with men and women active in the field of study serve as a valuable aid in many business classes. Such interviews might have been obtained with a local stock broker, corporation president or other officer, market research specialist, banker, director of an employment agency, management consultant, or other persons in the business community. In one instance, these recordings were the product of a weekly radio program created, directed and moderated by a faculty member over a local radio station.

DISCUSSION OF CURRENT EVENTS

A part of the class period of certain of the business subjects can be spent profitably in the discussion of current world happenings and their effect upon the business world. This practice stimulates students to do more reading of current news and to try to understand the inter-relationship of current events and the climate of the business world.

FACTORS THAT INFLUENCE STUDENT ACHIEVEMENT

Factors constantly to be kept in mind by both teacher and student if a high standard of achievement in shorthand and typewriting is to be attained:

1. Realization on the part of each student that he must arrive at the classroom punctually, regularly, and prepared to participate fully in the daily lesson.

2. Prompt start of the lesson. A maximum amount of typewriting and shorthand writing should be done by students during every class period. There should be a minimum of time lost in lengthy teacher explanations.

3. Establishment of a spirit of friendly cooperation between students and teacher--both working at full capacity.

4. Insistence on the part of the teacher upon high standards of performance--work that will be acceptable to the most careful and scrupulous business executive.

5. Realization on the part of students that in skill subjects such as shorthand and typewriting, a great amount of practice is essential. This will require not only the completion of each day's homework but, in addition, much unassigned home practice.

TIPS FOR TEACHERS

DO -- learn the name of each student the first day of class, and address the student by name

--to aid in personalizing class instruction;

--to let the student know that the teacher is taking an immediate interest in him as a unique person!

DO -- remember the need for and use of many phrases of approval. Make use of an extensive series of synonyms for "good," "fine," and "excellent":

--to avoid student irritation at hearing one phrase repeated day after day;

--to insure that you as a teacher retain the power to motivate your students through phrases of approval that are sincerely given, rightfully earned, and proudly received!

EFFECTIVE TEACHING PRACTICES

Plant Visitations. Provide opportunities for your classes to visit one or more local business organizations. If the class is studying stenography, try to arrange a visit to the stenographic pool. Afford students the opportunities to see as many phases of a stenographer's work as an organization of this size requires.

Visiting Lecturers. Supplement your own knowledge of the subject by bringing in an occasional "outside expert" to lecture on his field of specialization. Your students, you as a teacher, and the school will all benefit.

Records and Tapes. Make use of records and tapes to supplement your classroom instruction and permit the student to listen a second time to any points of information you wish to stress. In shorthand classes, recorded dictation will make it possible for the teacher to divide the class into groups and provide dictation for each group of varying difficulty and rates of speed. Recorded dictation will also supplement the classroom dictation by making it possible for students to have carefully prepared dictation that can be used at home.

The Overhead Projector. The overhead projector is a valuable teaching aid in almost any classroom, but it is especially useful to the teacher of bookkeeping and accounting. Business forms, problems, and solutions to problems can be placed before the class in a minimum of time; the chalkboard can then be kept free to supplement the projected material. Problems partially completed in one class period can also be placed before the class the next day with a minimum of effort on the part of the teacher.

Preparation of a Yearbook. As part of the classroom activities in Distribution, students develop a school yearbook. The class assists in the layout of the book and with the writing of copy in addition to being responsible for obtaining ads and sponsors to help finance the cost of the publication.

Word for the Day. A new word is posted each day either in one of the school corridors or in one of the business classrooms. In the English classes, the instructors reinforce the student's learning of the new word by asking the class its spelling and use.

INDIVIDUALIZING INSTRUCTION

In a system of individualized instruction as occurs in some private business schools, students are given the opportunity to progress in a subject entirely at their own rate. The teacher, furthermore, is readily able to gauge the learning strengths and weaknesses of each student. The teacher is frequently able to anticipate the errors a particular student is apt to make and help to prevent the errors by warning him in advance. The personal attention that the teacher affords each student also puts the student at ease so that problems can be discussed readily and without embarrassment.

Since it is recognized that there are marked differences in learning rates from one student to another, methods of instruction which permit individual student progress should be used more often in our secondary schools.

ESTABLISHING GOOD STUDENT-TEACHER RAPPORT

The teacher who has the good will of her students will usually get their best effort. It is important that a teacher show genuine and sympathetic interest in the problems of each student. A teacher will be most effective if she will make a practice of learning as much as she can about the problems of each of her students. She should encourage students to bring problems to her. The teacher who has the good will of her students will find that they will be reluctant to "let her down" by putting forth any less than their optimum effort.

TALK WITH CHALK

Using the chalkboard at every opportunity will help students to learn. Whenever possible, illustrate the point that you are trying to

impart by using the chalkboard. Students will benefit from the use of multiple-sense appeals. Hearing and seeing a point illustrated as it is being made by the teacher will frequently facilitate learning.

THE ANECDOTAL APPROACH

Vitalize your teaching by incorporating interesting, but relevant, stories into your classroom presentations. This teaching technique is particularly valuable in classes such as business law. Students retain subject matter longer when served in palatable morsels!

DEVELOP MODEL SOLUTIONS

Model solutions to problems which contain detailed marginal notations or explanations will enable a student who is encountering learning difficulty or the student who has been absent from class to work independently of the teacher and check his own solution. A carefully annotated model solution is equivalent to the help a student might derive from a private tutor.

BRIDGING THE GAP

For students of business, the classroom is the business office; and all training in business subjects should be provided with that principle in mind. Making the classroom closely relate to the atmosphere found in a business office will help business students bridge the gap between the school and the job.

The student must get the feeling that the classroom is a business. This must be instilled. It can be accomplished over a period of time with the patient effort on the part of the teacher and without the awareness on the part of the student that he is being indoctrinated.

To accomplish this objective, attention should be given to:

1. Developing self-discipline

   Most students, if kept busy, realize that they have a job to do and willingly accept the responsibility. The problem of discipline for the teacher is over. Self-discipline will result, therefore, if the teacher is able to provide each member of the class with meaningful tasks--learning experiences that the student feels he will profit by.

2. Courtesy

   Courtesy among members of a class is greatly stimulated by teacher example. The teacher must try to instill in the class the principle that courtesy is an expression of respect. Courtesy in business requires attention to good manners; courtesy also involves the knack of being pleasant and aware of opportunities to be of help to fellow employees.

3. Honesty

Few students would deny that lying is dishonest, that lost property should be returned, or that stealing is wrong. But it is the more subtle evidences of honesty that the student and office worker fail to recognize. It is sometimes difficult for the student to realize that he is being dishonest when he copies work from a fellow student, when he fails to report all of his homework errors, or when he makes indiscriminate personal use of school supplies.

4. Teacher-student relations

The relationship between student and teacher should approximate that of employer and employee or employee and supervisor. There must exist a feeling of mutual respect and understanding of the problems of the other. There must also be an atmosphere of friendly cooperation but respect.

5. Use of reference aids

Students must also become accustomed to using common general reference aids that will facilitate their work. Employers place a great deal of reliance on the ability of stenographers and typists to spell, to punctuate properly, and to supply a variety of information that can be found in good general reference books. Students should be given many opportunities to demonstrate their ability to use effectively such references as an abridged or unabridged dictionary, encyclopedia, Postal Manual, yearbooks, travel guides, books of quotations, directories and the like.

6. Use of realistic classroom materials

Wherever possible, supplement textbook materials with work assignments garnered from business. For the stenographer and typist, a variety of tasks are provided by business organizations through the FBE BULLETIN. Most business teachers are familiar with the materials entitled "A Typist's Day in the Office" and "A Secretary's Day in the Office" provided through the FBE BULLETIN to classroom teachers.

Dictation copy and copy for typewriting practice can also be taken from current periodicals and newspapers. This technique has the advantage of helping students to keep current with important happenings taking place daily in the world of business.

TEACHER FOR THE DAY

Permit selected students to "teach" for five or ten minutes on Friday of each week. This lesson will ordinarily be a review of material covered during the past week. The student should be assisted by the teacher in preparing the lesson and should be encouraged to make use of charts or other visual materials that will help to make the presentation effective.

STUDENT SPEAKS REPORT

Each week the teacher submits titles or topics to be used by a student as the basis for an oral and written report. The student volunteers for the task rather than being drafted by the teacher. Some of the topics could be: The Stock Market, Federal Reserve System, Bonds, Banks and How They Operate, Loans and Mortgages, Consumer Credit.

This is an opportunity for a student to demonstrate his initiative. Because the assignment is taken voluntarily, the teacher will probably want to provide "bonus credit" for a task well done. The finished report should be typed and given to the teacher after the student has had an opportunity to report orally before the class.

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ABSTRACT - Curriculum materials for teacher use in planning a 1-year high school Family Relations Course were developed by local home economics teachers and supervisors. The course is organized on a sequential basis, with each unit proceeding from the concepts, generalizations and understandings developed in earlier units. An introductory section discusses teaching methods. Each of the eleven units contains an overview, basic understandings, suggested experiences and activities, summary, evaluation and references. Subject matter covers: contemporary families, relationship with parents, maturation, marriage, problem solving, family finance, children, the elderly, community, and the projected family. Forms, charts, questionnaires, graphs, and a bibliography of professional resources and periodicals are included in the appendix. (FP)

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CURRICULUM GUIDE

for

FAMILY RELATIONS

Grade Twelve

SECONDARY CURRICULUM

BULLETIN NO. 153

KANSAS CITY, MISSOURI

PUBLIC SCHOOLS

1965

The design on the cover of this guide depicts ancient symbols of family life. Man , woman , man and woman united for procreation , the woman becomes pregnant , woman bears a child , the family .

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FOREWORD

September, 1965 - an era of space ships, complicated computations and plans for landing on the moon - cries aloud for an island of refuge from a pace more rapid and tense than ever the world has seen. Serious reflection suggests that the family unit can be our island of refuge and may meet our needs more basically than at any previous time. Creative family living which provides for the flowering of individual personality and, also, for harmonious and intimate group life, is essential to our sanity and national health. Accomplishing creative family living, however, is neither automatic nor mechanistic.

Experiences which guide us in getting along with and understanding ourselves and others are not easy to attain. The child learns from the time he arrives in the world. The home has the first fundamental responsibility for education in family living. The church and community also contribute. The school has a responsibility.

Students, by the time they reach their senior year in high school, have many questions about themselves, their relationships with their peers, moral standards and marriage. Frequently they are confused in their thinking about values and goals. They need opportunities to consider, in an objective atmosphere, some of their concerns with their peers and with well-informed, emotionally stable adults who may guide their reflections.

In Kansas City the schools have accepted responsibility for guiding youth in the area of family life education. The securing of pertinent information, the development of wholesome attitudes toward marriage and family life and the formulation of workable concepts and generalizations are emphasized in the course for seniors, entitled Family Relations.

This curriculum guide has been outlined for the use of administrators, counselors and family living teachers.

Grateful appreciation is expressed to all who have made the guide possible:

- The family living teachers have contributed generously of their time and from their rich experiences with many students. Without their assistance the guide would be meager, indeed.

- Miss Rosemary Beymer, Director, Art Education, Kansas City, Missouri, Public Schools, and her assistants have designed the attractive cover of the guide.

- Mr. Don Smith, Director, Audio-Visual Education, Kansas City, Missouri, Public Schools has assisted in bringing the Audio-Visual Instructional materials up-to-date.

- Dr. Gordon E. Wesner, Assistant Director, Secondary Curriculum, Kansas City, Missouri, Public Schools participated in the writing of the guide. Every page reflects his breadth of vision and extensive knowledge. His enthusiasm was a constant source of encouragement.

It is our hope that this guide will provide a functional blueprint for achieving the goals and purposes set forth.

Esther E. Prevey

Esther E. Prevey, Director
Family Life Education

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INTRODUCTION

Overview

Creative family life in which the principles of sound mental, emotional and spiritual health are basic is a precious possession. It is in the family that our foundations for living are laid. The infant comes to his home with potentialities but no attitudes or skills and few patterns of behavior. His day-by-day experiences play a large part in his growth. How his potentialities develop, what his attitudes are and how he behaves will depend first of all upon his mother and father, brothers, sisters and other relatives. As he grows older, the neighborhood, community, national and world factors will influence him. The family, however, is first.

There are no well-defined rules for building this creative type of family life mentioned above. There is, indeed, no one pattern. As we look around, we realize that there are many patterns and that diversity is to be prized. To encourage young people to give thoughtful attention to the essential elements involved in creative living in the family and how these elements may be evolved is, in broad terms, the goal for this high school course in marriage and family living for senior boys and girls.

General Objectives

Throughout the course, emphasis is given to guiding students to:

- Develop constructive attitudes concerning oneself, the family, family relationships and family-community relationships
- Gain useful knowledge, understanding and concepts about growth, relationships, values and value systems, change, creativeness and family living in general
- Learn to live more successfully personally and in their parental families
- Acquire a background, supplemental to that which they already have, which will be of value to them in establishing their own homes and families
- Believe in the dignity of man, the worth of the individual, the need for individual fulfillment on a moral basis and the need for working together in the family unit toward common goals.

Educational Planning by the Administrators and Counselors

Increasingly it is being recognized that the whole area of family life education is a real necessity as general education for our young people who are the future founders of families.

All about us we are conscious of:

- Early marriage
- Increasing divorce rate
- Spread of venereal disease among youth
- Downgrading of moral standards and values
- Increasing numbers of children in conflict.

These are factors which interfere with our national welfare and advancement. The content of the course, entitled Family Relations, contributes richly toward self understanding, appreciation of today's family and its place in our nation. Inasmuch as this is true, it would seem wise as we plan programs and guide boys' and girls' educational progress through the secondary school, that as many students as possible, have experience in family life education while they are in the high school. This course is useful to all - those with high ability as well as those with average or lesser abilities.

Family Relations is a developmental course which is organized on a sequential basis. Each unit proceeds from the concepts, generalizations and understandings developed in earlier units.

During the first semester, the foundation is laid. Basic knowledge is presented, concepts and primary generalizations are developed early in the school year. The emphasis is on the student developing understanding of himself, his relationships with his peers and his place in the parental family.

During the second semester, the emphasis is on the student's future family - its founding, its problems and adjustments in a rapidly changing world.

Understandings developed early in the year are essential to learnings later in the year. The students, therefore, must be in the course from its beginning in order to benefit adequately from class instruction and in order not to interfere with the progress of the other boys and girls.

It is hoped that school Administrators will find this Family Relations curriculum guide of assistance as they plan the educational program and determine the appropriate educational climate of the secondary school. The guide should give administrators ideas of how this course attempts to meet students' future needs in this broad and basic area of general education.

The Counselor understands the needs, interests and aptitudes of each individual student. Counselors, therefore, are encouraged to read and study the curriculum guide in order to recognize the importance of its content for completing the secondary education of boys and girls. Since this area is recognized to be such a vital part of general education, every attempt should be made to provide experience for each outgoing senior. Students from broken homes, especially, should be encouraged to enroll.

Accomplishing Goals - To the teachers

It is not too difficult to teach students certain subject-matter facts pertaining to marriage and family living. While factual information is helpful and necessary, attitudes, convictions, insight into problems, vision, basic understandings, concepts and emotional maturity are something quite different and infinitely more important. Our goals in this course must be, therefore, of two-fold nature: informational and attitudinal. They must involve feelings, understandings and motivations toward helpful ways of living. The effectiveness of this course will depend upon the quality of the person who teaches it, the techniques he uses and the involvement of the students.

The teacher is of first importance in accomplishing goals. The effective teacher of family living will:

- Be well-adjusted and mature emotionally
- Like and get along well with other people
- Be a person for whom the students have respect and in whom they trust
- Have a psychological - sociological orientation in his academic preparation
- Appreciate the values of home and family in encouraging optimum personality development
- Exercise good judgment in selection of subject matter, student activities and in class discussion
- Believe that there are many right patterns of family living and that no two families need to have the same pattern.

It is especially important, in a course concerned with human relationships, for the teacher to build a teacher-student relationship in which there is mutual respect and liking. The teacher's feeling about each student is fundamental. It needs to be remembered that every student, regardless of his degree of intellectual ability, is a potential homemaker and family member of the future.

The adequate teacher in family life education will not condemn or criticize a parent or parents in general. Also, he will not condemn students for their points-of-view on behavior. The teacher's task is to lead boys and girls to examine, analyze and criticize for themselves their goals,

ideas and behavior but he does not condemn them when they differ from him. This does not mean, of course, that teachers should not hold to high-quality standards or guide young people to determine their behavior on a moral basis.

The teacher, to be effective, needs to make himself available for individual conferences. Counseling, to be of real value, requires special skills, which means that teachers must prepare themselves for their counseling role. Reading, talking with others who have acquired a wholesome counseling philsophy and useful skills, enrolling in academic courses on counseling are some of the ways of developing competence. Advice-giving is natural to many people. Counseling and advice-giving are not synonymous.

Student participation is essential in promoting growth. Behavior and attitude changes are brought about by doing rather than by passive listening. Many different techniques will be used to fulfill individual needs. Some students learn by one method, some by another. Some devices are more suited to one area of discussion and some to another. If teaching is to be successful, techniques must be developed which will lead students to think through their interests and concerns, to analyze, ask why, develop ideas and make decisions.

The activities and experiences throughout the guide are suggestions only. Some will be suitable at one time and some at another time. The teacher may create more meaningful activities than any of those listed. These suggestions are not meant to be restrictive and certainly not stifling. They are a point of departure.

Since there are other courses in the high school curriculum in which there could be duplication of material involved (e.g. psychology, human science, home economics), it is wise for the teachers of these courses to plan together for a correlated approach. In this way various areas can be covered more thoroughly and from different points of view. The family living teacher should be the one to take the initiative in this matter.

The remainder of this Introduction is devoted to a short discussion of concepts, basic understandings, techniques and devices for stimulating learning. It is suggested that it be studied frequently.

Concepts and Basic Understandings

It is hoped that family living teachers will work toward encouraging students to understand concepts and basic understandings involved thus enabling our young people to function more adequately as individuals and as family members.

Before attempting to guide students in the development of their own concepts and generalizations, the teacher needs to have formulated some basic ideas along these lines. Following are a few hints that may be useful:

A concept is a mental image, a symbol or statement.

- A concept is a general notion about something. It grows as one learns more about it.
- One concept rests upon another. The meaning of a concept develops slowly out of many experiences.
- It is the teacher's job to provide as many experiences as possible which are vital to the area under consideration in order that the concept produced by the student may be as accurate and as meaningful as possible.
- Example - A certain mental image is brought forth when one sees the word "family". A two-year-old's image differs from a thirty-year-old's image.
- Concepts develop from concrete to abstract
  vague to clear
  inaccurate to valid
  incomplete to broad as the learners have experiences to develop them.

A generalization is an underlying truth or basic principle or basic understanding.

- It has an element of universality and frequently expresses relationships.
- To be able to formulate a generalization or basic understanding, a learner must be able to perceive two or more concepts and then to understand the relationship between them.
- Examples:

  Each stage of the family life cycle requires admustments.

  Marriage is more likely to succeed when there is similarity of backgrounds of marriage partners.

  Credit rating is established by one's performance in fulfilling credit contracts.

  A child in our culture who develops a positive attitude about the importance of work is more apt to succeed as an adult.

We cannot give a concept or a generalization to a student, he must develop his own through various experiences.

Concepts and generalizations are the subject matter aspects of the curriculum. Their relationship to the curriculum might be illustrated thus:

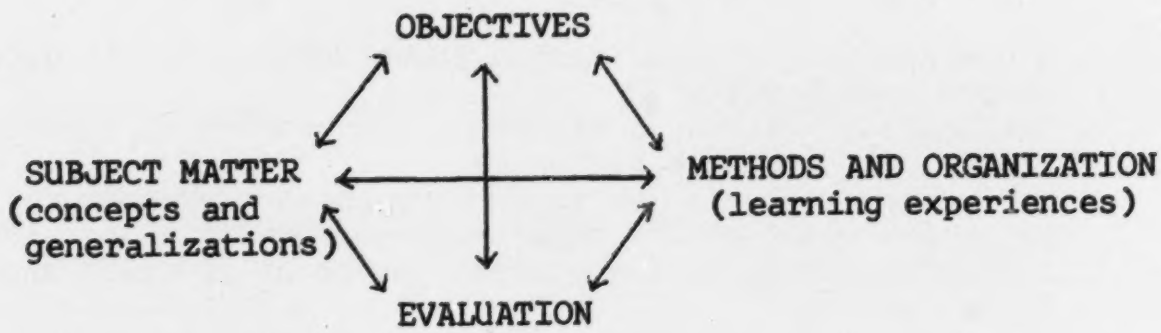

In a meaningful curriculum, according to Helen Westlake*, four questions must be asked:

- What is to be done
- What subject matter is to be used
- What methods and organization are to be employed
- How are the results to be appraised?

*Westlake, H. - "Teaching for Concepts and Generalizations in H.E. Education", American Vocational Journal, Dec. 1964, p. 17

In this curriculum guide some of the generalizations that seem to be outstanding are listed on the left hand side of the page as basic understandings. Others may need to be included according to the insight of the teacher and the students.

- Concepts are not identified. It is assumed the teacher will identify the concepts inherent within the basic understandings or generalizations.
- "Learning experiences should be planned which will enable students to locate, interpret, and evaluate supporting facts, participate in a variety of related experiences and finally apply learnings to new situations." *
- On the right hand side of the page, some suggested activities or learning experiences are outlined. The teacher and the class may devise other more meaningful activities which will help the students develop for themselves the basic understandings involved.

Techniques and Devices to Stimulate Learning

	Some Suggestions For Use
Reading	Reading is still the most important source of obtaining information for the high school student. It is the teacher's responsibility to provide reading material of various levels of difficulty. The use of the Public Library is imperative. Arrangements may be made with the librarian for books to be used in relation to the different units. Use some of the many books of fiction presenting family life situations.
File of Reading Cards	A file of reading cards (5 x 8) on which articles read may be summarized may be stimulating and useful.
Films	A film should be used only when it illustrates, clarifies or develops ideas, principles or facts that are being taught. It is a device to promote learning, not an end in itself. In almost every unit valuable films are available.

*Taken from "Thoughts For An Educator", by Dr. Barbara Osborn - Penney's Fashions and Fabrics, Spring/Summer, 1964, p. 12

Techniques	Some Suggestions For Use
	The teacher should preview each film and develop a film guide for the students which will give them some specific things to observe. Following the film there must be consideration, in some manner, of the principles, ideas and facts illustrated and their meaning or application.
Interview	Information may be secured and facts learned by having students interview other students in the school, faculty members or persons from the community. Adequate preparation before interviewing is essential not only to secure the desired information but also from a public relations standpoint. Adequate preparation includes having the questions about which information is to be secured clearly defined and understood by the student. An interview form or schedule of questions to be asked is useful. This should be compiled by the student and approved by the teacher especially if it is to be used with faculty or community persons. Before any interviewing is done, the teacher should discuss with the students the procedure for securing an interview, emphasizing the importance of explaining who you are, why you want an interview, what the interview is to be about and making a definite appointment. If the interview is to be with a community person, the first contact probably should be by a letter of explanation. This could be followed by a telephone call asking for an appointment. An interview with any adult should be followed with a letter expressing appreciation for the time and information given.

Techniques	Some Suggestions For Use
	Teachers should emphasize with students that information given must be treated with respect and in a confidential manner.
Guest speakers or resource persons	Resource persons should be chosen for their ability to give accurate information or to stimulate thinking.
	Persons invited need to be carefully briefed in regard to the exact subject matter to be included, time allotment, nature of the question and answer period, the hour to arrive and the place to report.
	Arrangements should be made for courteous reception in the school office and in the classroom. The principal should be informed.
	A note of appreciation is common courtesy and is a worthwhile student activity.
Panel Discussions	Panel discussions are often a helpful way to bring information to the class and to stimulate thinking.
	Panels may be composed of students, parents, community persons or any combination of these persons. When students are used in discussion, have them prepare themselves by reading or research.
	Assignments should be definite and limited. Avoid covering too large an area at one time.
Buzz Sessions	Sometimes discussion in small groups is valuable.
	Buzz groups are usually composed of three to five persons. Each group should have a leader who can be chosen by some objective method such as the one whose last name begins with "A" or closest to "A".
	Assignments need to be definite. Sometimes it is helpful to assign different questions to each small group.

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Techniques	Some Suggestions For Use
	Discussion periods should last about ten minutes. Follow with reports from each group to the class as a whole (made by each leader) and general discussion.
Brainstorming	In brainstorming a word or concept is set forth and each student is asked to write down quickly all the ideas it suggests to him. Allow a few minutes and follow with discussion.
Newspaper and Magazine Articles	Advertisements, newspaper and magazine articles referring to home, family life and personal development are often stimulating and help to keep course material interesting and up-to-date. These may be used to start a discussion and evaluation by considering fundamental principles involved, fallacies, advantages and disadvantages of the ideas expressed or facts stressed.
Charts, Notebooks, Posters and Projects	Students often are interested in developing charts, notebooks, bulletin boards, posters and other projects which represent certain concepts or display definite information. Most projects of this type involve facts and should be based on accurate information. This means that students must secure their data from reliable sources. Through these projects, boys and girls may learn that there are reliable and unreliable sources of information and that we must learn to discriminate. A notebook, to be valuable, must include some analysis, critical evaluation or pertinent remarks by the students. Merely pasting articles in a book, or copying materials is useless.

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Techniques	Some Suggestions For Use
Case Material	Case material may be secured from various books and articles, or it may be developed by the teacher or one of the more able students. A simple example would be "Harry is a boy with a fine physique. He is much interested in competitive sports and longs to be a member of one of the school teams. He is prevented from participation by extreme shortsightedness which requires him to wear thick glasses. How can he learn to live with his handicap?"
Skits or Role Playing	There are a number of short plays available which have been prepared with definite teaching purposes in mind. Some of the best of these are by the Theatre Guild and are known as "Mental Health Plays". More detailed information may be secured from the Director of Family Life Education. Such plays may be performed by the students and followed by discussion. Frequently it is helpful to have developed beforehand some very definite questions for the students to discuss. Simple plays may be developed by students with talent for this type of thing. Frequently, role-playing may be done on an unrehearsed basis, illustrating an idea. For example, four students could role-play a girl introducing her boy friend to her mother and father with several methods of approach. Several students could demonstrate how and how not to hold a telephone conversation with a friend. Useful situations are endless. Skits and role-playing should always be followed by discussion. They are not planned for amusement purposes only.
Surveys	Students, singly or in committees, may make surveys to discover certain definite facts. A review of printed materials in regard to a definite topic may be made.

Techniques	Some Suggestions For Use
	A survey may be an examination of conditions in a community of a study of peoples' points of view. Discussion and evaluation are an important part of a survey project.
Themes	Sometimes students learn by developing a theme on such a vital topic as: - How teen-agers can build better relations with their parents - What are some of the most important qualities needed for a successful marriage. Consult with English teachers concerning good standards for theme writing.
Pictures	May be used to stimulate discussion. Show a picture depicting family living situations and then ask such thought-provoking questions as: - What do you think is happening - What might have caused this situation - What do you think will follow?
Observation	Observation of children, adults and relationships may be helpful. Observation may be in a well-organized situation such as a school room or on an informal basis such as in the neighborhood, in the grocery store or bus. Many kinds of assignments may be made which will help students to understand growth behavior and relationships, for example: - Have the students observe a preschool child in a grocery store -- his mother's reactions -- discuss some possible reasons why they behave as they do. - Have students write down conversations between children of younger ages -- discuss and evaluate the meaning.

Techniques	Some Suggestions For Use
Evaluating Devices, Tests, Rating Sheets, Others	Essay and objective tests are useful to check information. Personality rating sheets and other check lists may be used to help students start to evaluate in various areas. These devices require thoughtful preparation by the teacher. They can be administered at various times throughout the year to show growth or change and may be used year after year with revision and refinement.
Statements from Books, Newspapers or Other Writings	Challenge and analyze these statements. Who said it? On what basis? Do we believe everything that is said or written?

The teacher in using any technique should ask:

- What do I expect to accomplish with this technique
- Why am I using this particular technique
- What will the students learn
- What subject matter will be presented?

Using This Guide

This guide on Family Relations for the Twelfth Grade has been compiled on the basis of knowledge gained by the teachers who have taught these classes over a period of many years, the Assistant Director of Secondary Curriculum and the Director of the Department of Family Life Education. The willingness, especially on the part of the teachers, to share experiences, joys and tribulations has made it possible to enrich the content in ways not originally contemplated.

As stated previously, this is a guide, not a rigid curriculum. Its purpose is to encourage teachers rather than to restrict, inhibit or leave them with feelings of frustrations. Many suggestions have been made. No teacher will include them all in his teaching. Additional ideas, activities and techniques suitable for particular needs will be developed by creative teachers who wish to make their family living classes a rich experience for their students. Some teachers may prefer to combine parts of one unit with some other unit. It is expected, however, that teachers in Kansas City will present the essentials of each unit in some way and will abide by the general underlying philosophy of the family living course as a whole.

The time suggested for each unit is the result of the combined judgment of the curriculum production committee. Naturally adjustments will have to be made to meet local needs. However, attention to the time suggested can help to insure each student the opportunity to benefit from the total course and prevent gaps in his experience.

It is imperative that each teacher exercise good judgment in his presentation of materials and in his use of activities and teaching methods in order that students may be given the opportunity to learn and grow in accordance with their age and needs. Ideas and methods for which students lack readiness and experience can be disturbing and harmful.

It is suggested that each year the teacher note in the guide, unit by unit, suggestions which will make his teaching more meaningful the following year.

* * * * * * *

KEYS TO GOOD TEACHING

Ask rather than answer.

Teach rather than preach.

Observe rather than look.

Interpret rather than judge.

Seek rather than accept.

Particularize rather than generalize.

Elizabeth Force

Teachers, help your students to spend themselves well.

UNIT I - The 20th Century Family in the United States

Suggested Time - 2 weeks

Overview

In this rapidly changing technological age, the family is our most precious possession since it is in this group that our foundations for living are built. The infant comes to his home with potentialities but no attitudes or skills, and few patterns of behavior. At every age, from infancy through the entire life cycle, relationships with others determine to a large degree the development of one's potentialities, attitudes and behavior patterns. These relationships begin in the family. They are nurtured in the family. They are enlarged in the community.

Children today grow up in a social situation in which changes in values, beliefs, expectations and conduct are taking place so rapidly that parents often are unable to understand how and why adolescents think and behave as they do. Family needs and interests frequently are sacrificed to social, economic and political situations within today's world. If satisfactory families are to continue as the fundamental units of society, young people must be guided in making lifetime decisions, with stress on the need for maturity and readiness to meet adult responsibilities. There must be emphasis on developing a value system which will encourage each person to function adequately as a moral being, living a creative life satisfying to himself and acceptable to society. There is no one recipe for building worthwhile, constructive family life. There is, indeed, no one pattern. There are many patterns, diversity or uniqueness is to be prized rather than discouraged. Specific details of pattern may vary, but fundamentally, constructive family life is concerned with enabling each family member to grow and develop in ways which permit him to: feel comfortable about himself, feel right about other people, and be able to meet the demands of life because he has matured and developed his capacities and abilities.

General goals or objectives of the course may be stated as guiding students to:

- Develop constructive attitudes and acquire useful knowledge and understandings about themselves, their own sex and the opposite sex, their peers and those older and younger than themselves

- Critically evaluate current behavior patterns, moral standards, cultural group values, individual value systems and present day customs as a background for formulating their own personal philosophies of living, including their own value systems, later to be used in rearing the next generation

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- Become acquainted with the concept of family growth and recognize the various stages in the family developmental cycle

- Acquire useful understandings in regard to values in constructive family living, as well as recognizing the necessity for constant change and how this can be a force for creativeness in family life, a quality characteristic of strong families

- Realize, at least to a degree, the impact which the community has on the home and to obtain knowledge of the resources available to families today and how these resources may be used effectively

- Develop understanding about the family's responsibility to the community

- Gain knowledge, attitudes and understandings which will be useful to them in establishing their own family units and in developing a democratic way of living

- Believe in the dignity of man, the worth of the individual, the need for individual fulfillment on a moral basis, the value of diversity in abilities and efforts and the need for working together in the family unit toward common goals.

Basic Understandings	Suggested Experiences & Activities
Most of their lives, people live in the small group situation of the family; hence, it is important to have a working knowledge of family organization, function and value.	This course may be initiated by asking the students to discuss such questions as: - Why have you enrolled in this course - What do you expect to study or learn - How would you define a family, a happy family? Is the term "happy" a good one or is there a more appropriate term? - How do you distinguish between a house and a home? Reference: - Hoeflin, R. - Essentials of Family Living, p. 2-19 The overall objectives of the course should be discussed, making clear that this is a course devoted to all aspects of family life.

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Basic Understandings	Suggested Experiences & Activities
	Have students make a list of the functions of the family today and yesterday - compare and point out the changes that have occurred. Discuss the meaning of these changes to each member of the family from the youngest child to the grandparents, as well as to other members of the larger family group.
As one becomes acquainted with many families, it is recognized that there are many ways of living together as a family. Uniqueness in families may be a great asset.	Have the students discuss the meaning of family pattern, family traditions, democratic family life, etc. Outline different, acceptable patterns which might be developed in a family. Compare in general our ways of family living with those of other cultures. Seek to discover some common factors in American family life. Consider how families of different origins may live together creatively in a community.
There is a growth pattern which families follow known as the family life cycle. This is a frame of reference for understanding family life.	Discuss the meaning of "family life cycle". Outline and discuss the stages in the family life cycle. Use a chart depicting the eight stages in the family life cycle. References: - Duvall, E. M. - Family Development, p. 7, 9, 13 - Hoeflin, R. M. - Essentials of Family Living, p. 88-102 - Appendix B Identify with the students the stages in the family "life cycle" in which their families are. This may be done by having each student develop a chart depicting his own family's growth. Develop an understanding that stages may overlap to a degree.

Basic Understandings	Suggested Experiences & Activities
	Help the students to see that the family life cycle is a dynamic, growing concept, with the family passing from one stage to the next.
At each stage in the family life cycle, there are family developmental tasks to be accomplished if the family is to function competently.	Present the meaning of developmental tasks as applied to the family. Reference: - Duvall, E.M. - Family Development, p. 27-51 Consider how these tasks, if accomplished, help the family to grow as a functioning unit. Identify the developmental tasks of the family in which there are persons ages 14 to 18. Reference: - Duvall, E.M. - Family Development, p. 288-331
For each member of the family there are individual developmental tasks to be accomplished.	Introduce the concept of individual developmental tasks as they relate to family developmental tasks. Have the students read and discuss briefly the developmental tasks to be accomplished during the teen years. This discussion should lead to the introduction of the next unit on the young person and his parental family and the study of personality development.

Vocabulary:

- attitudes
- behavior pattern
- competent
- cultural group
- developmental tasks
- evaluate

Basic Understandings	Suggested Experiences & Activities
family family development family life cycle matriarchal maturity patriarchal personality potentialities readiness role technological traditions uniqueness values	

Culmination and Evaluation

Several persons representing families at different developmental stages could be invited to discuss with the class their ideas of the characteristics of a successful family. Plan with the Parent Education Chairman of the PTA.

Have each student consider carefully:

- "What did we learn in this unit?"
- "What does it mean to me?"
- "Where can I use it again?"

The teacher may say to the students, "When we started this unit each of us had some ideas about family living. During these few weeks we have considered some different ideas. How has our discussion changed your thinking? Can you formulate any brief generalizations that may have come from our class work?"

Take part of a period to discuss the learning that has occurred.

Basic References

Duvall, E. M. - Family Development, 2nd Ed., Lippincott, 1962

Duvall, E. M. - Family Living, Rev. Ed., Macmillan Company, 1961

Duvall, E. M. & Hill, R. - When You Marry, High School Ed., D. C. Heath, 1962

Force, E. S. - Your Family Today And Tomorrow, Harcourt, Brace & Co., 1955

Hoeflin, R. M. - Essentials of Family Living, John Wiley & Sons, 1960

Landis, J.T. & M.G. - Personal Adjustment Marriage and Family Living, 3rd Ed., Prentice-Hall, 1960

Additional References

Cavan, R. S. - The American Family, 3rd Ed., Thomas Y. Crowell, 1963

Gardner, John W. -Excellence - Can We Be Equal and Excellent Too?, Harper & Row, Harper Colophon Books, 1961

President's Commission on National Goals - Goals for America, Spectrun Book, Prentice-Hall, 1960

Sirjamaki, John - The American Family in the Twentieth Century, Harvard University Press, 1964

Audio - Visual Instructional Materials

ASHA - Chart on the Family Life Cycle, $1.00
American Social Health Association, 1790 Broadway, New York, N.Y. 10019

Children Without	0X373
Family Life	0-538
Good Neighbor Family	00-44
Your Family	0-566

UNIT II - You and Your Parental Family

Suggested Time - 4 weeks

Overview

Developing personal adequacy and learning to live congenially and competently in one's own family are two of the major tasks which young people face in our culture. Therefore, early in a course in family relations it is appropriate to include a unit which considers personal development of the student and his place in his parental family.

Specific Objectives

This unit seeks to increase the young person's understanding of:

- Developmental tasks to be accomplished during the teen years
- Growth toward maturity, contributing factors
- Principles of good mental health
- His place in the parental family
- Developmental tasks of parents and the problems which they encounter
- Interpersonal competence with parents, brothers, sisters and other relatives in the family
- Basic needs of various family members, including his own.

Basic Understandings	Suggested Experiences & Activities
Personality development is a lifelong process with definite developmental tasks to be accomplished at each age level.	Discuss the meaning of the concepts involved in this basic understanding. References: - Duvall, E. M. - Family Living, p. 3-28 - Landis, J. & M. - Personal Adjustment Marriage and Family Living, p. 3-24 Have students outline the main developmental tasks of the teen years. Discuss.

Basic Understandings	Suggested Experiences & Activities
	Reference: - Duvall, E. M. - Family Living, p. 84-95
Accomplishment of these tasks requires developing degrees of maturity.	Discuss meaning of "maturity", "growth". Have students observe freshman boys and girls and compare their behavior, ideals, standards, values with those of senior year students. What has caused the change?
Teen-agers must grow toward individual maturity: - emotionally - socially - intellectually - spiritually - physically - sexually.	List and discuss the characteristics of each aspect of growth and point out their interrelationships. Invite a resource person such as the Director of the Kansas City Social Health Society to discuss sexual development. Have students cite examples of growth or lack of growth. Use personal growth rating charts - see Appendix B. Use charts showing the reproductive systems - see Appendix C.
Rate of growth and capabilities vary among people.	Read Menninger, Wm. C. - Understanding Ourselves. Discuss indications of mature behavior. Have each student list characteristics of a mature 18-year-old. Each student could rate himself in regard to his maturity. Use SRA Youth Inventory - (a commercial device) - see references at end of unit.
Growth is related to both heredity and environment.	Through reading and discussion, seek to establish understanding that hereditary factors and environmental experiences influence growth and behavior.

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Basic Understandings	Suggested Experiences & Activities
	Reference: - Schienfeld, A. - The New You and Heredity Construct a family tree of three generations. Trace several hereditary characteristics which seem to appear. Have each student write his biography. The teacher should keep these for reference.
There are certain fundamental needs to be satisfied during the teen years. These are basic to good mental health and influence the accomplishment of teen-age developmental tasks.	Discuss and list the fundamental needs of the teen years. Reference: - Duvall, E. M. - Family Living, p. 52-84
When basic needs are not satisfied we resort to various behavior mechanisms.	Play and discuss the Menninger Records, Meet Your Mind. Make practical applications of the behavior illustrated in the records. Have students write a list of behavior mechanisms which they use from time to time. Discuss. Discuss mature and immature behavior.
Developing a philosophy of living is an important aspect of the maturation process Philosophy of living includes formulation of: - goals - values - convictions - standards for behavior	Explore the meaning of "philosophy of living". Invite a resource person, such as a minister, to talk about philosophy of living. Discuss application to the 17 or 18-year-old of: - Knowing oneself - Facing reality - Right and wrong - Honesty - Personal responsibility

Basic Understandings	Suggested Experiences & Activities
	- Freedom - Self-control - Facing problems - Healthy ways of solving problem situations. Discuss how we arrive at personal values, goals, etc. Have students write briefly about their chief joys, satisfactions, worries, fears and what they want to be. Follow with discussion avoiding use of identifying materials of any kind. Show a picture representing a problem situation. Have students discuss: - What is happening? - What may have caused the situation? - Suggest possible solutions. Reference: - Alberty, H. - Helping Teen-agers Explore Values
Young people need to grow and to adjust satisfactorily in their parental family units.	Analyze, explore and discuss the basic understanding listed opposite. References: - Duvall, E. M. - Family Living, p. 99-138 - Force, E. - Your Family Today and Tomorrow, p. 37-54
There are many reasons for parents behaving as they do.	Discuss the main areas in which problems and conflicts arise between youth and parents today in family living. Arrange a parent panel to discuss youth-parent conflicts. Show and discuss the film - Parents Are People Too.

Basic Understandings	Suggested Experiences & Activities
	Have students list what they expect of parents and what parents should expect of their young people.
Parents have developmental needs and tasks.	List developmental needs and tasks of parents. Discuss how parents might seek to satisfy these needs and achieve these tasks. References: - Duvall, E. M. - Family Development, p. 389-434 - Hoeflin, R. M. - Essentials of Family Living, p. 208-220
Brothers and sisters have developmental needs and tasks.	Discuss how you can relate to brothers and sisters as they seek to satisfy their needs and achieve their developmental tasks. Show and discuss the film - Sibling Rivalries and Parents. Reference: - Force, E. S. - Your Family Today and and Tomorrow, p. 55-73
In any adjusted family where there is respect for individual personality, there will be some conflict.	Discuss the meaning of "respect for individual personality", "conflict" and "the adjusted family". References: - Jenkins, G. G. & Newman, J. - How to Live With Parents (SRA Booklet) - Ullman, E. - Getting Along With Brothers and Sisters (SRA Booklet)
Some procedures for solving family conflict will be more constructive than others.	Illustrate constructive and destructive ways of solving conflict in the family. Have class discussion of such practical questions as: - What privileges do I need or want and am I ready for the responsibility implied?

Basic Understandings	Suggested Experiences & Activities
	- How can the family car be shared? - How may "apron strings" be cut? - To what extent should parents be included in planning and executing parties or social plans?
	Have students list three things they could do to make their family life more pleasant and satisfying. Keep a notebook record for one week. Evaluate project at the end of the week.
Young people have a responsibility for developing their ability to communicate with other family members.	Discuss the meaning of communication, empathy.
	List some ways in which family members communicate. Evaluate.
	How may teen-agers improve communications?

Vocabulary:

adequacy
attitude
behavior
behavior mechanism
communication
compensation
competition
conflict
constructive
convictions
culture
defense mechanism
development
emotional
empathy
environment
extrovert
goals
gossip
gratitude
growth
heredity
inferiority complex
intellectual
interpersonal competence
introvert

Basic Understandings	Suggested Experiences & Activities
maturation	
maturity	
patterns for problem solving	
personality	
philosophy	
physical	
puberty	
rationalize	
reality	
responsibility	
siblings	
social	
spiritual	
traits	
values	

Culmination and Evaluation

Have each student write a short description of the kind of person he would like to be - now and ten years from now.

Have some students develop pictorial representations of the meaning of maturity as related to personality development.

Have each student outline what he has learned about himself, including his strengths, weaknesses, values, goals.

Have each student list three problems he has faced recently, describing how he solved each problem or how he might have solved them if he had been more mature.

Have each student describe the most interesting personality he knows. Why is this person the most interesting?

Invite a resource person to talk about working toward achievement of personal goals.

Discuss concepts which have been clarified in this unit, generalizations which have been developed, and the practical value of these concepts and generalizations.

Basic References

Alberty, H. - Helping Teen Agers Explore Values, Ohio State University Press, Columbus, Ohio, 1956 ($1.00)

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Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, 3rd Ed., Prentice-Hall, 1960

Scheinfeld, A - The New You and Heredity, Lippincott, 1961

Additional References

Avery, C. E. - "Sex Education Through Rose Colored Glasses", The Family Life Coordinator, 1964, October, No. 4, p. 83-90 (Teachers only)

Beery, H. - Manners Made Easy, 2nd Ed., McGraw-Hill, 1954

Boyer, D. A. - For Youth to Know, Laidlaw Brothers (Thacher and Madison, River Forest, Illinois), 1957

Call, Alice L. - Toward Adulthood, J. B. Lippincott, 1964, 96¢

Connecticut Mutual Life Insurance Co., Needlepoints and The Worry-Go-Round, Hartford, Connecticut, (free) - also additional materials. Write for list.

Craig, Hazel T. - Thresholds to Adult Living, Charles A. Bennett & Co., Peoria, Illinois, 1962

English, O. S. & Pearson, G. H. - Emotional Problems of Living, 3rd. Ed., W. W. Norton & Co., 1963 (Teacher's use)

Fedder, R. - A Girl Grows Up, 3rd Ed.,Whittlesey House, 1957

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Loeb, R. H. Jr. - She-Manners, Association Press, 1959

Mahoney, H. J. & Engle, T. L. - Points for Decision, Rev. Ed., Harcourt, Brace & World, 1961

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Menninger, W. C. - How To Be a Successful Teen Ager, Sterling Pub. Co., 1954

Pitzer, R. L. - Do Teenagers Need Families, University of Minnesota, Agriculture Extension Service, 4 HM-131, 1963 (15¢)

Science Research Associates, 259 East Erie Street, Chicago 11, Illinois

Alexander, F. - What Are You Afraid of?
Byrne, K. M. & Byrne, John - You and Your Abilities
Clark, T. B. - What Is Honesty?
English, U. S. & Foster, C. J. - Your Behavior Problems
Henry, W. E. - Exploring Your Personality
Hertz, B. V. - Where Are Your Manners?
Jenkins, G. G. & Newman, J. - How To Live With Parents
Menninger, W. C. - Understanding Yourself
- Enjoying Leisure Time
- Making and Keeping Friends
- Growing Up Emotionally
Neugarten, B. L. - Your Heredity
- Becoming Men and Women
Remmers, H. H. & Hackett, C. G. - What Are Your Problems?
Seashore, R. H. & Van Dusen, A. C. - How To Solve Your Problems
Smith, T. V. - Building Your Philosophy of Life
Ullmann, E. - Getting Along With Brothers and Sisters
Wrenn, C. G. - How To Increase Your Self-Confidence
Youth Inventories - Personal Audit -
7-211DR Test Booklets with Manual - $2.75 package of 20
7-221DR Test Booklets with Manual - $3.75 package of 20
7-218DR Review Set - $1.00 each, Hand scored.

Youth Inventory -
7-961DR - Test Booklets with Manual - $10.80 for 20
7-962DR - Answer Sheets - $5.00 for 100
7-966DR - Basic Difficulty Scoring Stencils - $2.50 per set of five, machine scored.

Smart, R. L. & M. S. - Living in Families, Houghton Mifflin, 1958

U.S. Government - The Adolescent In Your Family, Children's Bureau Publications, 347-1954, U. S. Department of Health, Education and Welfare

Van Heusen Corp., What Every Woman Should Know About Men's Fashions, Home Economics Service Bureau, Phillips Van Heusen Corp., 417 Fifth Ave., New York, N. Y. 10016 (free)

Audio - Visual Instructional Materials

Act Your Age	00-167
Are You Popular	0-23
Attitudes and Health	0-487
Boy to Man	00-836
Bully, The	0-654
Cheating	0-656
Control Your Emotions	00-416
Facing Reality	00-421
Family Life	0-538
Farewell To Childhood	00-285
Gossip, The	00-423
He Acts His Age	00-289
Human Growth	00-163
Human Heredity	00-446
Human Reproduction	00-52
Individual Differences	00-292
Make Way For Youth	00-66

Meaning of Adolescence	00-319
Older Teens and Family Relationships	FO-82
Palmour Street	OX-59
Parents Are People Too	00-400
Preface To a Life	OX-79
Sibling Rivalries and Their Parents	0-935
You and Your Parents	00-178
Your Family	0-567

Kansas City Social Health Society:

As Other See You

Home Ground

Is Your Home Fun

Stepping Out

You and Your Family

You and Your Friends

Mr. Finley's Feelings (free), order from Metropolitan Life Insurance Co., New York, N. Y. Order considerable time ahead of the time desired for showing.

Meet Your Mind - Wm. C. Menninger - (Secure from the Department of Family Life Education - reserve ahead) May be purchased from Lewellen's Productions, 400 Hill Avenue, Glen Ellyn, Illinois, price $12.50 (Records)

UNIT III - Growing Towards Maturity in Social Relationships

Suggested Time - 5 weeks

Overview

During the period of youth, establishing oneself with one's peer group is a major developmental task. Heterosexual relationships need to be established. Casual dating may lead to friendships which eventually lead to marriage. Social horizons widen and value patterns are established.

Specific Objectives

Goals in this unit are to enable young people to:

- Understand their own social growth and interests
- Develop acceptable social attitudes, behavior and skills which will be basic in their adult life
- Develop values and goals which will be useful to them now and later
- Be aware that their parents are responsibly concerned about their social growth and behavior.

Basic Understandings	Suggested Experiences and Activities
Social growth follows a pattern, the general sequence of which is similar for all young people. However, the rate of growth and specific details differ from person to person.	As a review of the social growth pattern presented in Unit II, plan panels on: - Environmental factors influencing social growth (home, school, community) - Mass media influences our social growth pattern (radio, television, advertising, newspapers, magazines) Reference: - Hoeflin, R. - Essentials of Family Living, p. 38-43
The teen years are a time for establishing many friendships - male and female.	Have the students bring articles, clippings, and advertisements relating to social acceptability. Critically

Basic Understandings	Suggested Experiences & Activities
To satisfy this interest, most youth strive to be acceptable to others.	evaluate these as a realistic basis for selection of friends. Discuss characteristics of a person who is apt to have friends. Socio-drama may be used to depict various stages of social maturity.
Dating requires social skills often spoken of as good manners.	Discuss the importance of manners. Study the skills needed in the following social situations: - Introductions - Eating - at home at school public place - Telephone calls - Entering a room - Going to a movie - Getting into a car - Timing the return home. Have the students develop standards for each of these occasions. Use role playing to demonstrate skills which are helpful in today's social life. Films: - Dating Do's and Don'ts - What About Dates References: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 45-57 - Duvall, E. M. - Family Living, p. 157-226 Develop, with the Home Economics Teacher, a cooperative project on setting a table, serving, correct table manners, how to invite a person to a social a affair, how to express your appreciation for entertainment, etc.

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Basic Understandings	Suggested Experiences & Activities
	Consider the real meaning of social courtesy.
Dating is an important part of the social life of young people.	Read and discuss - Force, E. - "Climbing the Dating Ladder", Your Family Today and Tomorrow, p. 106-112. Outline the developmental growth involved.
There is a developmental growth pattern of affectional feelings and attitudes in boy and girl friendships. This results in stages in dating.	Arrange panel discussions on: - Why dating is important - Becoming more datable - Social skills helpful in dating situations.
	Have foreign exchange students discuss social life in other cultures.
	Suggest readings portraying social life in other cultures, for example: - The Good Earth - Pearl Buck - The Red Chair Waits - A. M. Hudgins.
	References: - Anderson, W. J. - Design For Family Living, p. 67-82 - Duvall, E. M. - The Art of Dating
There are some concerns which high school students have in common during the dating years e.g. - When to begin dating - Who asks for the date - How to accept or refuse graciously and courteously - Responsibility for planning - What to do - Where to go - Who pays the expenses - Time to be home - How often to date	Provide students, in committees or individually, opportunities to read about and discuss each of these common concerns. Urge them to understand reasons for acceptable behavior and for recognizing their responsibility. Have students develop a code of dating behavior which they think is reasonable for them to follow. Discuss the problem of maintaining one's standards when others do not agree. Invite appropriate resource persons, use films, etc. to bring information to students.

Basic Understandings	Suggested Experiences & Activities
- Blind dating - Pick-up dating - Use of automobile - Automobile manners - Parking and petting - Appropriate gifts - Adult supervision - Some do not date - Smoking - Use of alcohol and narcotics - Venereal disease	Show films: - How Much Affection - Alcoholism - Dating Topics for Older Teens - Innocent Party - The Invader
One's dating behavior is determined by one's values and standards and what he wants from life.	Have students list some do's and don'ts in behavior and why standards are important to us. References: - Alberty, H. - Helping Teen-agers Explore Values - Ann Landers' newspaper column Show film: - Going Steady Follow with further study and discussion as necessary. Have students discuss: - What is popularity - Is popularity enough - Force's statement, "Learn to read the price tag on popularity. Can you afford to pay the price?" - Your Family Today and Tomorrow, p. 100 - How are personal values and standards developed - Should one change one's standards to suit the crowd? Have students rate themselves as a date - Refer to Appendix B
Sexual maturity is a part of growth which the young person must face realistically in his relationships with others.	Set up situations in which the student may consider such questions as: - Should there be a double standard in behavior for boys and girls

Basic Understandings	Suggested Experiences & Activities
	- Our culture has decreed that intimate relations are to be reserved for marriage. Is this pattern of behavior acceptable to young people? - What standards of behavior in relation to sex, should be developed by young people? Encourage students to raise related questions which arise out of changing cultural patterns. Have students write questions to be discussed in class. At the close of the discussion formulate with the class three or more broad generalizations that seem to indicate the more desirable standards of behavior in relation to sexual attitudes. Reference: - Duvall, E. M. - Why Wait Till Marriage
There is a developmental growth pattern involved in love and affectional life - self love - parental love - family love for its members - friendship - both sexes same sex opposite sex - love for marriage partner - love of children - love of mankind.	Study and discuss the meaning of each stage in this developmental growth cycle. References: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 170-179 - Cavan, R. S. - The American Family, p. 364-383 Have students evaluate the type of love depicted in movies, in selected literature, etc. Discuss such questions as: - How do I know when it is real love - Is love a two-way street - How does love change - Why do some not date - How can social needs be met, if one does not date?

Basic Understandings

Suggested Experiences & Activities

Films:

- Is This Love
- How Do You Know It's Love

Discuss meaning of romance, infatuation, puppy love, love and happiness, love on the rebound.

Write in a paragraph what you consider to be the component parts of love and suggest changes that may occur in home relationships with increasing age.

Vocabulary:

abortion
affectional feelings
animosity
belligerent
cervix
clitoris
code
coitus
conception
courtesy
egg cell or ovum
embryo
fallopian tubes
fertilization
fetus
heterosexual
hymen
illegitimate parents
infatuation
menstruation
ovaries
ovulation
peer group
penis
pituitary gland
placenta
popularity
pregnancy
puppy love
ramification
romance

Basic Understandings	Suggested Experiences & Activities
scrotum semen sperm cells testes umbilical cord uterus vagina venereal disease vulva	

Culmination and Evaluation

Have students review the basic understandings that have been developed in this unit.

Have them discuss what they learned from these understandings, what effect they have had on their thinking and behavior.

Give the students a test.

Have the students list the generalizations or principles that they recognize as considerations which they can use in their future plans.

Basic References

Alberty, H. - Helping Teen Agers Explore Values, Ohio State University Press, Columbus, Ohio, $1.00, 1956

Anderson, W. J. - Design For Family Living, T. S. Denison & Co., 1964

Cavan, R. S. - The American Family, 3rd Ed., Crowell, 1963

Duvall, E. M. - The Art of Dating, Association Press, 1958

Duvall, E. M. - Family Living, Macmillan Company, 1957

Duvall, E. M. - Love and the Facts of Life, Association Press, 1963

Duvall, E. M. - Why Wait Till Marriage, Association Press, 1965

Duvall, E. M. & Hill, R. - When You Marry, High School Ed., D. C. Heath & Co., 1962

Force, E. S. - Your Family Today and Tomorrow, Harcourt Brace & Co., 1955

Hoeflin, R. M. - Essentials of Family Living, John Wiley & Sons, 1960

Kansas City Social Health Society - Venereal Disease Education, Curriculum Guide for Teachers

Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, 3rd Ed., Prentice-Hall, 1961

Additional References

Armstrong, D. W. - Questions Boys Ask, E. P. Dutton, 1955

A.S.H.A. - Our Family Is Having a Blood Test (free)
Some Questions and Answers About VD
What Everyone Should Know About Syphilis & Gonorrhea (free)

Bush, P. S. - Venereal Disease A Teaching Reference Guide, Division of Curriculum and Instruction, Department of Education, State of New Jersey, Trenton, N. J. (free)

Call, Alice L. - Toward Adulthood, J. B. Lippincott, 1964

Children's Bureau - Smoking, Health and You, Children's Bureau, Publication Number 424-1964. Order from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 20402, 15¢

Craig, H. T. - Thresholds to Adult Living, Charles A. Bennett Co., 1962

Dickerson, R. - Into Manhood, Association Press, 1954

Division of Health, State of Missouri, Jefferson City - For Those Who Drink and A Boy Grows Up (free)

Duvall, E. M. & S. M. - Sense and Nonsense About Sex, Association Press, 1962

Duvall, E. M. & S. M. - Sex Ways - In Fact and Faith, Association Press, 1961 (for teacher's use)

Felsen, H. G. - Letters To a Teen-Age Son, Dodd, Mead & Co., 1961

Frank, L. K. - The Conduct of Sex, Morrow & Co., 1961 (for teacher's use)

Gottlieb, B. S. - What a Boy Should Know About Sex, Bobbs-Merrill, Co., 1961

Gottlieb, B. S. - What a Girl Should Know About Sex, Bobbs-Merrill, Co., 1961

Haupt, E. F. - The Seventeen Book of Etiquette and Entertaining, David McKay Co., New York, N.Y., 1963

Landers, Ann - Ann Landers Talks to Teen Agers About Sex, Prentice-Hall, 1963

Leverton, R. M. - A Girl and Her Figure, The Dairy Council of Greater Kansas City (free)

Loeb, R. H. - He-Manners, Association Press, 1954

Loeb, R. H. - She-Manners, Association Press, 1959

Manly, H. - A Curriculum Guide in Sex Education, State Publishing Co., Inc. St. Louis, Mo., 63136, 1965, $1.25

Menninger, W. C. - Blueprint for Teen-Age Living, Sterling Publishing House, 1958

Metropolitan Life Insurance Co., Your Teen Years (free)

Optimist International - A Boy Today - A Man Tomorrow, Optimist International, 4494 Lindell Bldg., St. Louis 8, Mo., 1 copy 35¢, 2-9 copies, 20¢

Powell, R. R. - Enjoy Your Parents, Abingdon Press, 1962

Public Affairs Pamphlets -

Barnouw, E & Clark, G. - Syphilis: The Invader, 24A
Blakeslee, A. L. - Alcoholism - A Sickness Which Can Be Beaten, F1 118 A

Public Affairs Pamphlets (continued) -

Brecker, R. & E. - Smoking, The Great Dilemma, FL 361
Eckert, R. G. - So You Think.It's Love, FL 161
Landis, P. - Coming of Age: Problems of Teen Agers, 234
McGrady, Pat - Cigarettes and Health, FL 220
Richman, T. L. - Venereal Disease: Old Plague - New Challenge, 292

Science Research Associates - Guidance Series -

Floyd, M. F. - Let's Talk
Hertz, B. V. - Where Are Your Manners?
Kirkendall, L. A. - Dating Days
McCarthy, R. G. - Facts About Alcohol
Menninger, Wm. - Making and Keeping Friends
Neff, M. V. - Ethics for Everyday Living
Neugarten, B. L. - Becoming Men and Women
Schacter, H. - Getting Along With Others
Stevens, P. - Guide to Good Grooming
Vogel, V. H. - Facts About Narcotics
Weitzman, E. - Growing Up Socially

Stephenson, M. & Millett, R. - Good Manners: The Magic Key, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1959

Vetter, M. & Vitray, L. - The Questions Girls Ask, E. P. Dutton, 1959

Whitman, Howard - The American Way of Love, Order from the Register and Tribune Syndicate, Box 957, Des Moines, Iowa 50304, 1961, 50¢

Audio - Visual Instructional Materials

Alcoholism	00-232
Dating Topics for Older Teens	F0-78
Going Steady	0-1166
How Do You Know It's Love	00-291
How Much Affection	00-496
Innocent Party	00-8
Invader, The	0X-226
Is This Love	00-497
Social Acceptability	00-510
What About Dates	F-2283

Drug Addiction - Order from Division of Health, State of Missouri, Jefferson City, Missouri

UNIT IV - Looking Toward Marriage

Suggested Time - 4 weeks

Overview

In our present day society where social mores and values are undergoing severe changes from the puritanical way of life to an exagerated emphasis upon freedom, family life education must establish some guide lines which will enable young people to choose wisely their life-time companion. This unit, therefore, should emphasize the basic concepts and understandings with which young adults need to be equipped when their thoughts turn to the serious consideration of marriage partners.

Specific Objectives

Goals in this unit are designed to help young adults to:

- Learn why people marry
- Gain an understanding of marriage responsibilities
- Recognize readiness for marriage
- Acquire knowledge of basic factors to be considered in choosing a marriage partner
- Recognize the value of the engagement period
- Learn of available community services for engaged couples
- Know how to plan and arrange an appropriate wedding.

Basic Understandings	Suggested Experiences & Activities
People marry for different reasons. It is important to understand motivating reasons.	List and discuss the many reasons that motivate people into marrying. Compare these with the reasons that were operative in the early days of our country. Determine which of the above reasons have a fair chance of resulting in a successful marriage. Why? Discuss why some of these reasons are almost certain to result in marriage failure.

Basic Understandings	Suggested Experiences & Activities
	Use case study references from library. Have one or two students bring in case reports. Reference: - Bernard, J., Buchanan, H. E. & Smith, W. E. - Dating, Mating and Marriage Film: - It Takes All Kinds Discuss the advantages and disadvantages of being married. Determine from vital statistics the number of persons who marry today. Compare with earlier times. Why the difference?
Understanding the meaning of present day concepts relating to marriage gives a background for wiser decisions on the part of young people. These concepts include: - Romantic complexes - Romance and love - Companionship - Happiness and well-being - Partnership - Promotion of personality growth.	List answers which students give to the question, "Of what do you think when you see the words: - marriage - romance - love - partnership - happiness and well-being - companionship - helping the other person to grow - improving one's marriage partner?" Discuss and evaluate. Have students examine ideas on romantic love presented by magazines, TV, etc. Discuss the degree to which these ideas represent a sound or misleading philosophy regarding marriage. Have students discuss, "When is love the kind of love upon which a real marriage may be built?" Discuss ideas or qualities that make for a lasting marriage.

Basic Understandings

Before becoming engaged, young people need to have an understanding of the responsibilities of marriage

- legal
- spiritual (sacredness)
- economic
- social
- procreative.

Suggested Experiences & Activities

Invite married individuals of long standing and of lesser standing to discuss the responsibilities which are assumed when

- a girl marries
- a boy marries.

Invite an older married couple to discuss with the class some of the advantages of being married

- for the woman
- for the man.

Develop with the students a questionnaire which they could use to obtain information relating to responsibilities that a boy and a girl assume when they marry. Have the students interview couples of different ages and different experiences.

Read the marriage vows, discussing the implications of each statement.

Discuss the meaning of "vow". Relate the word vow to contract or contractual agreement.

List and discuss the responsibility assumed in marriage by the man and the woman. Discuss the essential contributions which each should make to marriage.

Evaluate the phrase frequently heard, "I am not marrying the whole family".

Consider the implications of the phrase, "marrying into a family".

Reference:

- Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 149-150

Film:

- Early Marriage

Basic Understandings	Suggested Experiences & Activities
Being ready for marriage has many facets.	Outline and discuss the many facets of being ready for marriage. Formulate a list of maturity characteristics that make for marriage readiness. Reference: - Force, E. S. - Your Family Today and Tomorrow, p. 143-155 Discuss the implications of the phrase "emotionally and socially ready for marriage". Film: - When Are We Ready for Marriage Have students do library research on the divorce rate for early marriages as well as those contracted at a later age. Discuss. Refer to appropriate articles in current popular magazines. Start the students on a class card file summarizing current articles. Use 5" x 8" cards. Have the student list at the top of each card name of article, source, name of student, and summary of the main ideas of the article. Refer to this file for class use. Study and discuss, "How Do I Know When I Am Old Enough for Marriage?" as outlined in Landis, J. T. & M. G., Personal Adjustment Marriage and Family Living, p. 147-157 Discuss: - Marriage in high school - Marriage and military service. Have a R.O.T.C. officer or other service man give the point-of-view of the military toward marriage while serving.

Basic Understandings	Suggested Experiences & Activities
	Discuss: - Financial readiness for marriage - Elopement and secret marriages. Film: - This Charming Couple Discuss.
There are some background factors which tend to influence success in marriage. Knowledge of these factors may be guide lines for young people.	Have students discover the results of research studies which have been made on background factors that influence success in marriage. References: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 123-157 - Force, E. S. - Your Family Today and Tomorrow, p. 157-169 - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 113-131 In choosing one's lifetime companion discuss the relative importance of the following factors: - Age differences - Length of acquaintanceship - Attitudes, interests, standards, goals - Outstanding personality characteristics - Family and cultural backgrounds - Physical and mental health - Religious beliefs - Parents' attitudes and approval. Have each student outline and discuss: - The kind of marriage partner he would like to be - The kind of marriage partner he would like to find. See Appendix B.

Basic Understandings	Suggested Experiences & Activities
	Films: - Choosing for Happiness - Choosing Your Marriage Partner Have each person consider his own strengths and weaknesses in terms of characteristics outlined above. Have the students read about the importance of religion in choosing a life-time companion. Reference: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 177-188 Have a minister, priest and rabbi discuss with the class the importance of religion to marriage and family life. Discuss the concerns that parents have in the marriage of their sons or daughters.
The engagement period serves many useful purposes.	Have students list the purposes and values of the engagement period as they see them. Follow with reading and further discussion. Reference: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 159-170 A student panel could discuss the degree of agreement there should be on important purposes and goals of living before marriage. Reference: - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 87-110

Basic Understandings	Suggested Experiences & Activities
	Discuss the implications of widely varying attitudes on the part of husband and wife toward patterns of living involving money, in-laws, children, religion, recreation, work, etc. Have students develop some ways of reconciling these differences. Have students read and report on engagement and marriage customs of other cultures. Discuss the values recognized in these customs which differ from marriage customs in the United States. Discuss the meaning of: - Polygamy - Polygyny - Polyandry - Monogamy. Film: - Meaning of Engagement
The state government is related to the marriage of every person.	Have students obtain and discuss the most important laws pertaining to marriage in several states and the State of Missouri in particular. Reference: - Landis, J. T. & M. G. - Building A Successful Marriage, p. 259-279 Discuss state legal requirements for obtaining a marriage license. Have a lawyer explain changes in legal status of the man and the woman when marriage takes place. Study the brochure With This Ring, Missouri Bar Association.

Basic Understandings	Suggested Experiences & Activities
The engaged couple needs to be aware of community services available.	Have students list the services available to an engaged couple in an urban community. Discuss the advantages of using these services. Invite resource persons to discuss: - Premarital counseling - Premarital medical examination. Film: - Are You Ready For Marriage
Adequate knowledge about wedding plans and costs may help the young couple in planning more realistically the type of ceremony, reception and honeymoon which will be most appropriate for them.	Discuss the different types of weddings that may be planned. List the advantages of each type. Introduce the bride's book with directions for conducting a wedding. Outline in detail the necessary steps in arranging a simple or a more elaborate wedding. Consider: - Engagement announcements - Setting the date - Conference with the minister or the person who will administer the vows - Factors which will determine the type of wedding - Shower parties - Bachelor party - Responsibilities of the bride and groom and their families - Place to live - Furnishings. Evaluate the cost of a simple and an elaborate wedding in terms of permanent values. Outline plans for several different types of honeymoon. Discuss advantages of each type.

Basic Understandings	Suggested Experiences & Activities
	References: - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 134-165 - Anderson, W. J. - Design For Family Living, p. 99-104
There are times when it is wiser to break an engagement.	Discuss circumstances which might make it expedient to terminate an engagement. Consider how this might be done with the least damage to both parties. Reference: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 166-171
There are many reasons why some people do not marry.	References: - Force, E. S. - Your Family Today and Tomorrow, p. 128-134 - Landis, J. T. & M. G. - Building A Successful Marriage, p. 91-99 Invite a resource person to discuss reasons why some people do not marry. Consider: - responsibilities - careers - health - opportunities - disturbing experiences - parent-attachment. Outline ways a person, even though not married, may live a purposeful life. Reference: - Ogg, E. - Why Some Women Stay Single, Public Affairs Pamphlet

Basic Understandings	Suggested Experiences & Activities

Vocabulary:

affinity
community services
companionship
consanguinity
counseling
cultural background
elopement
engagement
honeymoon
legal status
marriageable
marry
monogamy
officiate
polyandry
polygamy
polygyny
premarital
procreative
readiness
romance
romantic complex
vital statistics
vows
wedding

Culmination and Evaluation

Administer an objective test covering the concepts and understandings which should have been gained from this study.

Use five-minute discussions on such topics as "My marriage readiness, plus or minus"; "When I am of age, I can choose a life-time partner", "I plan to be a bachelor, and so"; "Marry in haste, repent at your leisure"; "Johnnie married Susie, but he didn't intend to".

Have students write a paper on personal insights they have developed during the study of this unit.

Basic References

Anderson, W. J. - Design for Family Living, T. S. Denison & Co., 1964

Bernard, J., Buchanan, H. E. and Smith, W. E. - Dating, Mating and Marriage, Howard Allen, 1958

Duvall, E. M. & Hill, R. - Being Married, D. C. Heath & Co., 1960 (for teacher's use only)

Duvall, E. M. - Love and The Facts of Life, Association Press, 1963

Duvall, E. M. & Hill, R. - When You Marry, High School Ed., D.C. Heath & Co., 1962

Force, E. S. - Your Family Today and Tomorrow, Harcourt Brace & Co., 1955

Landis, J. T. & M. G. - Building A successful Marriage, 4th Ed., Prentice-Hall, 1963

Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, 3rd Ed., Prentice-Hall, 1960

Missouri Bar Association - With This Ring, Order from the Missouri Bar, 223½ East High Street, Jefferson City, Missouri 65102

Additional References

Bowman, H. A. - Marriage For Moderns, 4th Ed., McGraw-Hill, 1960 (for teacher's use only)

Craig, H. T. - Thresholds to Adult Living, Charles A. Bennett, Co., Peoria, Ill., 1962

Duvall, E. M. - Before You Marry, Association Press, 1949

Duvall, E. M. - Family Living, Rev. Ed., Macmillan Co., 1965

Kansas City Social Health Society - many inexpensive pamphlets

Kirkendall, L. A. - A Reading and Study Guide For Students in Marriage and Family Relations, Rev. Ed., Wm. C. Brown Co., 135 S. Locust, Dubuque, Iowa 62003, 1965 (for teacher's use)

Pitzer, R. L. - Engagement, Prelude to Marriage, H-H M-132, University of Minnesota Extension Service, 1964

Pitzer, R. L. - School Bells or Wedding Bells, H-H M-128, University of Minnesota Extension Service, 1963

Public Affairs Pamphlets

- Black, A. D. - If I Marry Outside My Religion, No. 204
- Eckert, R. S. - So You Think It's Love, No. 161
- Kirkendall, L. A. - Too Young To Marry, No. 236
- Ogg, E. - Why Some Women Stay Single, No. 177

Smart, M. S. & R. C. - Living In Families, Houghton Mifflin, 1958

Sorenson, H. & Malm, M. - Psychology For Living, 2nd Ed., McGraw-Hill, 1957

Sussman, M. B. - Sourcebook in Marriage and The Family, 2nd Ed., Houghton Mifflin & Co., 1963

Audio - Visual Instructional Materials

Are You Ready for Marriage	00-168
Choosing for Happiness - film	00-273
- film strip	F-708
Choosing Your Marriage Partner	00-734
Early Marriage	0X-236
Family Portrait	F-703
Future in Hand	F-704
How Do You Know It's Love?	00-291
It Takes All Kinds - film	00-274
- film strip	F-709
Meaning of Engagement	00-249
Seeing Double	F-706
This Charming Couple - film	00-276
- film strip	F-711
When Are They Ready For Marriage	F-1775
With This Ring	F-707

UNIT V - Marriage - A New Way Of Life

Suggested Time - 3 weeks

Overview

In a world of profound and accelerating change, the two people who unite together in marriage have much to learn about each other and what it means to be married. Building a lasting marriage is a life-long task; a good marriage doesn't accidentally happen! As the marriage relationship changes and grows, the will to succeed is of primary importance in the marriage way of life.

Specific Objectives

The goal of this unit is to develop an understanding of:

- The meaning of marriage
- The concept that building a successful marriage requires planning, time, effort and cooperation
- The fact that adjustments must be made to successfully resolve conflicts
- The principles involved in determining the pattern of living for the new family unit.

Basic Understandings

The image of a successful marriage will help determine, at least to a degree, the kind of marriage which is apt to be developed.

Suggested Experiences and Activities

Have a panel of students discuss their ideas of a successful marriage of the "good life" each would like for his marriage.

Film:

- Marriage Today

References:

- Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 215-230
- Force, E. S. - Your Family Today and Tomorrow, p. 236-264

Basic Understandings	Suggested Experiences & Activities

	List and discuss:
	
	- Characteristics that each student expects in a husband or wife
	- Role of the wife in a new family
	- Role of the husband in a new family
	- Factors that may contribute to a satisfactory marriage
	
	  - planning and working together
	  - common goals
	  - playing together
	  - flexibility.
	
	References:
	
	- Landis, J. T. & M. G. - Building A Successful Marriage, p. 281-305
	- Anderson, W. J. - Design For Family Living, p. 107-114
	
	What can a wife do to keep the respect and affection she has won?
	
	What can a husband do to keep the respect and affection he has won?
	
	What is housekeeping? Homemaking?

The new family must learn to think, act, feel and plan as a couple. They must build the "we" philosophy of life.	Have students interview parents, teachers, ministers, business or professional people of various ages to acquire information about living as couples. Reference: - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 245-260 Have students develop a Family Responsibility Inventory. Discuss. See appendix B
The new family must share common interests, develop common goals and build new traditions.	Consider the value of traditions. List and discuss traditions which may be established during the early years of marriage.

Basic Understandings	Suggested Experiences & Activities
	Films: - Marriage Is a Partnership - This Charming Couple (if not used previously)
Adequate personality growth requires the development of individual interests and goals, on the part of both the husband and the wife.	Discuss the relationships of individual interests and goals to personality development and sound mental health. Consider how individual interests and shared interests can be harmonious. Discuss ways that married people can help themselves and one another fulfill their basic personality needs.
Since marriage is the most intimate and demanding of all human relationships, adjustment and conflict are inescapable parts of its nature.	Analyze the terms "conflict", "adjustment". References: - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 199-217 - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 215-240 List and discuss some methods of resolving conflicts. Which are satisfactory, which unsatisfactory? Why? Six reasons for conflict are: - Process of living, growth and change - Fatigue and illness - Differences in values, goals and standards - Personality differences - Immaturity, jealousy - Unrealistic objectives. Discuss these reasons. Divide class into six groups. Have each group prepare a skit, using one of the six reasons for conflicts. Discuss possible solutions.

Basic Understandings	Suggested Experiences & Activities
	Bring clippings or articles to class showing differences in goals affecting married harmony. Discuss. Film: - Who's Boss
Every couple needs to learn and develop techniques for handling conflict situations	Discuss constructive and destructive ways of handling conflict or differences of opinion. References: - Bernard, J., Buchanan, H. E. & Smith, W.M. - Dating, Mating and Marriage, p. 258-294 - Force, E. S. - Your Family Today and Tomorrow, p. 204-219 - Landis, J. T. & M. G. - Building A Successful Marriage, p. 281-305 Developing an understanding of different methods of managing conflicts. Three of these methods are: - Domination by one person - Compromise-bargaining - Democratic planning. Through role playing, show different methods of managing conflict over one or more specific problems. Discuss such statements as: - "There are times when we should admit that we are wrong" - "I didn't have all the facts and need to reconsider" - "I'm sorry, I made a mistake". Films: - Jealousy - Handling Marital Conflicts

Basic Understandings	Suggested Experiences & Activities
Ability to communicate is basic in solving conflicts and releasing tensions in the new family.	Discuss the meaning of communication. List ways of communicating one with another. Which of these are helpful in developing understanding of each other. Review the importance of empathy in communication. Reference: - Anderson, W. J. - Design For Family Living, p. 138-140
Day by day, month by month the marriage relationship should continue to develop, grow and improve.	Discuss Duvall's concept of developmental stages in relationship to marriage. Emphasize year by year growth. Reference: - Duvall, E. M. - Family Development, p. 123-156 Have students interview adults who have been successfully married 5, 10, 30, 40 years to gain some information about husband and wife relationship changes and growth: - In companionship - In romantic ideas - In activities together and apart - In feelings of affection.
When a family cannot develop satisfactory ways of solving conflict there are sources of help in the community.	Invite guest speakers to discuss some of the resources in Kansas City available to the family. List sources of help and develop an understanding of the functions of: - marriage counseling agencies - family agencies - ministers - doctors - competent family members.

Basic Understandings	Suggested Experiences & Activities
	Discuss the importance of distinguishing between a bona-fide resource and quackery. Reference: - Where To Turn For Health and Welfare Services, Greater Kansas City Area, 1963

Vocabulary:

adjustment
bona-fide
catastrophe
code
compromise
controversial
depreciation
disillusioned
eugenic
harmonious
martydom
panacea
patterns
philosophy
prestige
quackery
reconcile
rigid
socio-economic
statistical
status
techniques
tension

Culmination and Evaluation

Have the students formulate the basic understandings which have been developed in this unit. Determine whether or not the following understandings have been included:

- Marriage is a way of living
- Marriages go through developmental stages
- Each marriage partner has a contribution to make to the personality development of his mate and to the development of a shared life

- If the marriage relationship is a dynamic one, differences of opinion and some conflict are bound to occur making adjustments necessary
- There are constructive as well as damaging ways of making adjustments.

Have each student describe in written form the personal growth he thinks would be necessary for him to make if he were to be married within the next year.

Have the class list problems which might be common to most marriages today. Use this as an introduction to Unit VI, entitled, Special Problems of Today's Family.

Basic References

Anderson, W. J. - Design For Family Living, T. S. Denison, 1964

Bernard, J., Buchanan, H. E. & Smith, W. R. - Dating, Mating and Marriage, Howard Allen, 1958

Duvall, E. M. - Family Development, 2nd Ed., J. B. Lippincott & Co., 1962

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Force, E. S. - Your Family Today and Tomorrow, Harcourt, Brace & Co., 1955

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Landis, P. H. - Making The Most Of Marriage, 2nd Ed., Part V, Appleton-Century-Crofts, 1955 (for teacher's use only)

Missouri Bar Association - With This Ring I Thee Wed, Order from the Missouri Bar, 223½ East High Street, Jefferson City, Missouri 65102

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Additional References

Bee, Lawrence S. - Marriage and Family Relations, Harper & Brace, 1959 (for teacher's use only)

Blood, R. O. - Marriage, The Free Press of Glencoe, Illinois, 1962

Bossard, J. H. & Boll, E. - Ritual In Family Living, University of Pennsylvania Press, 1950

Bossard, J. H. & Boll, E. - Why Marriages Go Wrong, The Ronald Press, 1958

Cavan, R. S. - The American Family, 3rd Ed., Thomas Y. Crowell Co., 1963

Crabtree, A. P. - You and The Law, Holt, Rinehart, Winston, Inc., 1964

Craig, H. T. - Thresholds to Family Living, Charles A. Bennett Co., 1962

Denton, W. - What's Happening To Our Families, The Westminster Press, 1963 (for teacher's use only)

Duvall, E. M. & Hill, R. - Being Married, D. C. Heath, 1960 (for teacher's use)

Gruenberg, S. M. & Krech, H. S. - The Many Lives of Modern Woman, Doubleday, 1952

Mace, D. R. - Marriage: The Art of Lasting Love, Doubleday, 1952

Mace, D. R. - Success in Marriage, Abingdon Press, 1958

Public Affairs Pamphlets:

- Mace, D. R. - What Makes Marriage Happy, FL 290
- Duvall, E. M. - Building Your Marriage, FL 113
- Duvall, E. M. - Saving Your Marriage, FL 213

Regional Health and Welfare Council - Where To Turn For Health and Services, Regional Health and Welfare Council, 320 E. 10th Street, Kansas City, Missouri 64106, 1963

Sirjamaki, J. - The American Family in the Twentieth Century, Harvard University Press, 1964 (for teacher's use only)

Steiner, R. M. - Where Do People Take Their Troubles, Houghton Mifflin, 1 1945

Whitman, Howard - Making Marriage More Rewarding, 1962, Order from the Register and Tribune Syndicate, Des Moines 14, Iowa, 50¢

Audio - Visual Instructional Materials

Family Life	0-538
Handling Marital Conflicts	
Jealousy	00-819
Marriage is a Partnership	00-216
Marriage Today	00-275
This Charming Couple	00-276
Who's Boss	00-277
Your Family	0-538

UNIT VI - Problem Solving For Today's Family

Suggested Time - 2 weeks

Overview

In today's family, there is emphasis on development of a group life which is satisfying in itself and at the same time contributes to each individual's growth. Growth on both an individual and a group basis in our fast moving society necessarily poses many problem solving situations. Finding solutions sometimes is difficult, often calling for consideration of new patterns of action in resolving conflict.

Specific Objectives

The function of this unit is to examine some of the problems which families face and some possible solutions.

The goal of this unit is to learn to:

- Recognize and identify problem situations in family relations
- Explore differential facts and opinions which are operative
- Examine and develop procedures for the logical consideration of facts and affective opinion looking toward formulation of possible solutions
- Select an appropriate solution and try it out
- Evaluate findings and decisions as they affect the family unit
- Seek a new solution when the previous solution has proved unsatisfactory.

Basic Understandings	Suggested Experiences & Activities
Husbands and wives, mothers and fathers need to consider periodically the areas in which there are apt to be differences of opinion.	List problem areas where differences of opinion are apt to occur, such as: - Social and recreational activities, individual, group - Work of the husband - Work of the wife, at home, away from home - In-laws · Sex behavior Children

Basic Understandings	Suggested Experiences & Activities
	- Religion - Emotional Needs and responses - Living quarters and conditions - Use of TV, radio - Freedom and responsibility of family members - Money management. References: - Mace, D. R. - Success In Marriage, p. 47-76, 111-129 - Anderson, W. J. - Design For Family Living, p. 107-148
The development of patterns of living in areas where there is apt to be differences of opinion is necessary.	Outline and discuss some of the possible patterns of living that might be developed in the previously mentioned areas. List advantages and disadvantages of these possible patterns. Invite resource persons to assist with the discussion. Discuss such ideas as: - "Marriage changes the social rules for each of the marriage partners" - "When or why should wives be employed outside the home" - "The wife contributes to her husband's success in his work" - "Take time to be a family" - "Men and women both should be interested in their community" - "Each member of the family sometimes should be alone."
There are many problems to which the family must give special attention.	Have the students read current library materials and discuss such problems as: - Suburban living - Mobility of the family - Human relations - The impact of mass media on family life - Housing - Automation.

Basic Understandings	Suggested Experiences & Activities
	Outline the factors involved in each of these problems. How do these apply to: - The newly established family - The family with preschool children - the family with elementary school children - the family with high school youth - the contracting family. Discuss implications of such ideas as: - "On the average, the modern family uproots itself every five years" - "Youth of today will probably have to train themselves to be competent in four or five different vocations before they reach retirement age" - "Mass media is an important factor in developing our ideals, standards of behavior and values" - "Suburban living turns mother into a chauffeur."
Decision making is a significant factor in family living today.	Have the students consider how decisions are made, who makes them, why they are important to today's family. References: - Duvall, E. M. - Family Living, p. 339-352, 369-396 - Sussman, M. - Sourcebook in Marriage and Family Living, p. 144-156 Emphasize with the students the role of each parent in decision making. Strive to develop the following concepts: - Parents are in the family for a real purpose - Growth is gradual from dependency to independency - The individual never becomes completely independent of his family unit - Respect for individual family members in decision making is a significant part of today's living.

Basic Understandings	Suggested Experiences & Activities
There are crises in every family. The family must find ways to meet these crises without disintegration of the family unit.	List the crises which are apt to be a part of family life such as: - Hospitalization - Loss of a family member - Separation - Disgrace, delinquency, crime - Infidelity - Non-support - Relatives moving in - Desertion - Loss of job - Mental illness - Venereal disease - Alcoholism - Illegitimacy References: - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 219-242 - Bernard, J., Buchanan, H. E. & Smith, W. R. - Dating Mating and Marriage, p. 353-391 Films: - Is There a Typical Family - Your Family Discuss: - The effect of these crises on family life - Family attitudes towards these problems - How can these experiences be used positively or to strengthen the family unit - What are the best ways to avoid total disintegration (think, plan, experience and maintain individual integrity).
Management of time and energy is an important aspect of today's living.	Have a homemaker, a business man or a professional person discuss management of time and energy.

Basic Understandings	Suggested Experiences & Activities
	Students may interview homemaker, business or professional person, if more convenient, and bring reports to class. Discuss. Have students do some scheduling of time and energy. Discuss implications of time and energy schedules to each family member. Discuss, "When time and energy are saved, what will be done with the concerned time and energy." Reference: - Smart, M. S. & R. C. - Living in Families, p. 311-328

Vocabulary:

contracting family
delinquency
democratic
desertion
disgrace
disintegrating
expanding family
family crisis
hospitalization
human relations
illegitimacy
infidelity
living quarters
management - time
energy
money
mass media
mobility of the family
pattern of living
privacy
schedule
sex behavior
social rules
suburban living
validity

Culmination and Evaluation

Have the students formulate the basic principles underlying this unit.

Discuss the importance of recognizing the rapidity of change which is occurring in our world and the impact which it is making on family life.

A panel may discuss how these changes may make for interesting and stimulating family living for each individual and for the group as a whole.

Basic References

Bernard, J., Buchanan, H. E. & Smith, W. M. - Dating Mating and Marriage, Howard Allen, 1958

Duvall, E. M. - Family Living, Rev. Ed., Macmillan, 1955

Duvall, E. M. & Hill, R. - Being Married, D. C. Heath & Co., 1960 (for teacher's use only)

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Mace, D. R. - Success in Marriage, Abingdon Press, 1958

Sussman, M. E. - Sourcebook in Marriage and the Family, 2nd Ed., Houghton Mifflin & Co., 1963

Additional References

Anderson, W. J. - Design For Family Living, T. S. Denison, 1964

Nye, F. I. & Hoffman, L. W. - The Employed Mother in America, Rand McNally & Co., 1963

President's Commission on The Status of Women - American Women, 1963, single copy free from Women's Bureau, Department of Labor, or Superintendent of Documents, Washington D. C. 20402, $1.25

President's Commission on The Status of Women - Home and Community, 1963, single copy free from Women's Bureau, Department of Labor or purchase from Superintendent of Documents, Washington D. C. 20402, $1.25

Public Affairs Pamphlets -

Black, A. - If I Marry Outside My Religion, No. 204
Blakeslee, A. L. - Alcoholism - A Sickness That Can Be Beaten, No. FL 118A
Block, I. - How To Get Good Medical Care, FL 368
Butcher, R. L. & Robinson, M. O. - The Unmarried Mother, No. 282
Doyle, K. C. - When Mental Illness Strikes Your Family, No. 172
Duvall, E. & S. - Saving Your Marriage, No. 213
Gruenberg, S. M. & Krech, H. S. - The Modern Mother's Dilemma, No. 247
Lawton, G. & Steward, M. S. - When You Grow Older, No. 131
Ogg, E. - When A Family Faces Cancer, No. 286
Ogg, E. - When Parents Grow Old, No. 208
Osborne, E. - When You Lose A Loved One, No. 269
Thorman, G. - Broken Homes, No. 135
Thorman, G. - Family Therapy, FL 356
Wolf, A. W. & Stein, L. - The One-Parent Family, No. 287

Smart, M. S. & R. C. - Living In Families, Houghton Mifflin & Co., 1958

Audio - Visual Instructional Materials

Is There a Typical Family	F-1772
Your Family	0-566

UNIT VII - Family Finance

Suggested time - 3 weeks

Overview

Developing a constructive philosophy about family finances and learning to adequately manage money are important factors in family life and in building a satisfactory marriage. In a very few generations the family has changed from being primarily a production unit to a consuming unit. This basic change leads to the importance of understanding money management.

Specific Objectives

The goals of this unit will emphasize:

- Understanding that there are basic principles involved in sound financial management of the family income
- Recognizing that family needs, values and desires determine the use of the family income
- Budgeting or planning use of income
- Learning how to evaluate consumer services and goals
- Developing resistance to sales pressure and false advertising.

Note - It is suggested that in this unit attention be given to specific materials relating to finance in order that the students will gain definite information about budgeting, credit, insurance and principles of consumer buying.

Basic Understandings

Good management of finances helps a family to live better on the income they have.

Suggested Experiences & Activities

Have students discuss meaning of:

- management
- plan or budget
- finances
- income.

References:

- Duvall, E. M. - When You Marry, High School Ed., p. 175-197
- Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 253-266

Basic Understandings	Suggested Experiences & Activities
	Have students write the ideas immediately suggested when the term "money" is mentioned. Follow with discussion of values and goals as relating to money.
Understanding personal finance is preliminary to managing family finance.	Have students develop and keep an accounting record for personal expenditures - relate to their actual income. Have them develop a personal budget for a specific period of time.
In any expenditure of money a fundamental question is, "Can we afford it?" Probably the first "afford" question is "Can we afford to get married?"	Divide the class into couples as far as possible. Have each group calculate cost of establishing a place for living (apartment, house, furnished or unfurnished). Consider the standard of living in their community, different age groups and salary levels. Reference: - Anderson, W. J. - Design For Family Living, p. 118-122 Discuss: - Amount of income which is desirable before marriage - The income which is necessary to establish minimum living quarters - Immediate financial responsibilities - The cost of future needs, wants and aspirations.
Adequate use of money requires planning - budgeting. Planning requires knowledge of the expenditures which most frequently occur. Planning also requires setting of goals and determination of values - immediate and long range.	Films: - Home Management - Why Budget Have the students discuss: - Why budget - What is a budget - How to use a family budget - Importance of relating expenditures to income.

Basic Understandings	Suggested Experiences & Activities
Categories which need to be considered are: - Shelter - Food - Clothing - Utilities - Transportation - Taxes - Insurance - Personal expenses - Recreation & education - Savings - short time goals, long time goals - Contributions - Gifts - Advancement or personal growth	Have committees set up operating family budgets for simple establishments for a definite period of time. Use catalogs, newspaper prices, store prices, etc. Consider and discuss the various items and ways of providing for both immediate and long range values and goals. Discuss how democratic principles of living may be applied to money matters in today's family as it changes, grows and matures. Films: - Home Management: Buying Food - Dollar Series filmstrips, Institute of Life Insurance. References: - A Date With Your Future, Institute of Life Insurance (free) - Craig, H. T. - Thresholds for Adult Living, p. 346-368 - Money Management Series - Household Finance - A Guide to Budgeting For the Young Couple - U. S. Dept. of Agriculture, Home and Garden Bulletin, No. 98.
Income is an important part of family finances.	Have class read appropriate references from books, magazines, newspapers. Reference: - Duvall, E. M. - When You Marry, High School Ed., p. 187-189 Discuss such topics as: - Sources of income - Whose income - Reasons for married women being employed outside the home - Who handles income - Who makes decisions about expenditures?

Basic Understandings	Suggested Experiences & Activities
	Reference: - Peterson, E., "Working Women" - Daedalus, Spring, 1964, p. 671-699
Every family needs to establish a credit rating.	Use student reports, committees or resource persons to consider and discuss: - Meaning of credit rating - Its value - How established - Kinds of credit - Institutions which loan money - Installment buying - Charge accounts - Banking arrangements - Loan sharks - The pitfalls of "Too easy credit". Films: - The Wise Use of Credit - How Banks Serve - Using Bank Credit References: - Phillips, E. B. & Lane, S. - Personal Finance, p. 53-84 - Using Our Credit Intelligently, National Foundation for Consumer Credit - Phelps, C. W. - Using Installment Credit - Force, E. S. - Your Family Today and Tomorrow, p. 314-315
The family needs to understand that taxes are necessary to help pay for the many services we enjoy.	Have the students make a list of the tax-supported services the family enjoys. Discuss taxes with the students - Federal - State and local - Social Security

Basic Understandings	Suggested Experiences & Activities
	Calculate the taxes which a family pays. References: - Teaching Taxes, U. S. Government, Dept. of Internal Revenue - Your Social Security - secure from Social Security office - If You Become Disabled - secure from Social Security office. Use resource persons from local Social Security office.
In today's world an insurance program is beneficial to the family.	Discuss factors which determine the kind of insurance - Life insurance, objectives, types of policies, premiums - Health insurance, objectives, types, how purchased - Car insurance, coverage - Property insurance, personal property, mortgage insurance, types of policies, coverage - Family plans for comprehensive coverage. Invite a resource person to discuss different kinds of insurance. Consider, "Can a family be over-insured? under insured?" References: - Craig, H. T. - Thresholds to Adult Living, p. 386-398 - Family Guide to Property and Liability Insurance - Insurance Information Institute - Phillips, E. B. & Lane, S. - Personal Finance, p. 374-420

Basic Understandings	Suggested Experiences & Activities
	Film Strips - Institute of Life Insurance: - How Life Insurance Began - How Life Insurance Operates - How Life Insurance Policies Work - Planning Family Life Insurance.
Before buying the family should consider the type of house, how it will be financed, and what the upkeep will cost.	Study and discuss factors involved in deciding whether or not the family should buy a house. If the decision is "yes", study factors involved in selecting the type to buy, where to secure loan, cost of the loan, etc. Use resource persons (Mr. J. D. Farmer, Home Savings Association). Film: - How to Buy a House (from Home Savings Association) References: - Craig, H. T. - Thresholds to Adult Living, p. 369-384 - U. S. Savings & Loan League - Safeguards of Freedom (secure from Home Savings Association).
There are ways to increase the family's real income even when the money income is not increased.	Have the students interview a number of homemakers to determine the ways by which their real income is increased. Have the students make a study and discuss the values in carefully planned buying and avoidance of high-priced luxury items. Develop some principles of consumer buying which enable money to be well spent. Discuss the meaning of impulse buying. Have the students make a study of the many ways in which waste may occur. Discuss unnecessary spending as waste.

Basic Understandings	Suggested Experiences & Activities
	Discuss the effect of high pressure salesmanship through mass media on family and personal buying and waste. Compare cost of expenditures for items such as bakery goods, simple sewing, etc., when produced at home from basic materials and purchased ready-to-use from the store. Do the same for simple house repairs done by the family or done by outside service persons. Discuss the creative values involved when family members produce at home. Resource persons: - University of Missouri, Extension Service, Mrs. Lois Harrison (on good buys) - U. S. Pure Food and Drugs, Mrs. Lorena Meyers (on quackery).
As the family becomes established financially, thought should be given to a savings and investment program.	Consider with the class the following types of savings and investments for different types of families: - Buying a home - Government bonds - Other types of bonds - Mutual funds - Stocks, preferred, common - Savings accounts. Discuss the need to develop a plan for investments which will provide income for the contracting family. . . when retirement from active earning occurs. Consider: - Social Security - Annuities - Stocks, bonds. Accumulation of property through investment makes it important to provide for its disposal at the time of death. Discuss the legal involvement and the necessity for wills. Invite a lawyer as a resource person.

Basic Understandings	Suggested Experiences & Activities
	References: - Craig, H. T. - Thresholds to Adult Living, p. 398-410 - Crabtree, A. P. - You and The Law, p. 165-176, 125-138
In today's world there are a number of places in which the family may keep their money.	List the places where the family may keep its money, such as: - At home - Banks - Savings and loan companies - Credit unions. Discuss the advantages and disadvantages of each.
As the family grows and matures, financial plans need to be revised.	Have the students revise their plans made at the beginning of the unit, including ideas learned during the past few weeks. Have them outline a family budget which would include the cost of the first baby from the beginning of pregnancy until the baby is six months old.
When a family has money problems, psychological problems are apt to develop.	Discuss the tensions, irritations and other psychological problems that are apt to be related to money problems of the family. What does "keeping up with the Joneses" mean? When is it wise or unwise to do installment buying? Reference: - Hoeflin, R. - Essentials of Family Living, p. 244

Vocabulary:

abstract
annuity policy
automobile insurance
- bodily injury liability
- collision
- comprehensive physical damage

Basic Understandings	Suggested Experiences & Activities
- medical payments - property damage liability - protection against uninsured motorists	
bonds budget charge accounts check commission common stocks confidence games consumer economics consumer price index convertible co-signer credit credit unions deed default depreciation dividends equity endorsement endowment policy fraud group insurance health and accident insurance home-owners liability coverage	
- comprehensive personal liability - medical payments - physical damage to property of others	
home-owners policy hospitalization insurance income installment buying interest limited payment life policy medical insurance mortality rate mortgage mutual funds preferred stock premium promissory note	

Basic Understandings

repossess
revolving charge account
savings and loan
straight life insurance
term insurance

Culmination and Evaluation

Have the students outline briefly the different times in the family cycle when revision of the family financial plan is likely to be necessary, indicating the changes that would need to be made and the reasons why.

Have a panel discussion on "Ways in which our concepts of family finance have been changed by this unit".

Basic References

Anderson, Wayne J. - Design for Family Living, T. S. Denison & Co., 1964

Crabtree, A. P. - You and the Law, Holt, Rinehart & Winston, 1964

Craig, H. T. - Thresholds To Adult Living, Charles A. Bennett Co., 1962

Duvall, E. M. & Hill, R. - When You Marry, High School Ed., D. C. Heath & Co., 1962

Hoeflin, R. M. - Essentials of Family Living, John Wiley, 1960

Insurance Information Institute - A Family Guide to Property and Liability Insurance - Educational Division, 110 William Street, New York, N. Y. 10038

Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, 3rd Ed., Prentice-Hall & Co., 1960

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Additional References

Black, H. - Buy Now, Pay Later, William Morrow, 1961

Cheyney, W. J. - Using Our Credit Intelligently, Rev. Ed., National Foundation for Consumer Credit, 1959

Cohen, J. B. - Decade of Decision, Educational Division, Institute of Life Insurance, 1961

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Force, E. S. - Your Family Today and Tomorrow, Harcourt, Brace & Co.,1955

N. E. A. - Taxes Are Good, Committee on Educational Finance, 1201 16th St., N.W., Washington 6, D. C.

Neisser, E. G. - The Many Faces of Money, Human Relations Aids, 1958, 104 East 25th Street, New York, N. Y. 10010, 25¢

Petersen, E. - "Working Women", Daedalus, Spring 1964, Journal of the American Academy of Arts and Sciences, 280 Newton Street, Brookline Station, Boston 46, Mass., $2.00

Phelps, C. W. - Using Installment Credit, Commercial Credit Company

Public Affairs Pamphlets -

Cole, G. H. & Margolius, S. - When You Gamble, No. 354
Margolius, S. - A Consumer's Guide to Health Insurance Plans, No. 325
Margolius, S. - Guide to Consumer Credit
Margolius, S. - How to Pay For Your Child's College Education,No. 342
Margolius, S. - How to Stretch Your Money Dollar, No. 302
Stewart, M. S. - Investing For Income and Security, No. 317
Stewart, M. S. - The Taxes We Pay, No. 289
Stewart, M. S. - When You Invest, No. 221
- How to Finance Your Home - FL 360

U. S. Department of Agriculture - A Guide To Budgeting For the Young Couple, 1964, Home and Garden Bulletin, No. 98, 10¢. Order from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402

U. S. Department of Agriculture - Helping Families Manage Their Finances, 1963, 40¢. Order from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402

U. S. Treasury - Income Tax Forms and Instructions, U. S. Treasury, Washington, D. C., free

Magazines

Articles on family finance and the teaching of family finance appear periodically in:

Finance Facts - National Consumer Finance Association, Educational Services Division, 701 Solar Building, 1000 16th Street, N. W., Washington, D. C. 20036, a monthly publication, free

Journal of Home Economics - American Home Economics Association, 1600 20th Street, N. W., Washington, D. C. 20009

Newspapers

Popular Magazines - Ladies Home Journal, Better Homes and Gardens, etc.

Practical/Forecast For Home Economics, Teacher Ed., 900 Sylvan Ave., Englewood Cliffs, New Jersey 07362, $4.50 per year, 9 issues

Tips and Topics. Order from School of Home Economics, Texas Technological College, Lubbock, Texas, 1 yr. subscription, $2.00

What's New In Home Economics - Circulation Department, 466 Lexington Ave., New York, N. Y. 10017, $6.00 per year, 10 issues

Audio - Visual Instructional Materials

Distribution of Foods	0-105
Driving Economically	00-185
Fred Meets A Bank	0-147
Home Management: Buying Food	0-628
Home Management: Why Budget	0-845
How Banks Serve	0-815
Pay To The Order Of	0-817
Search for Security	00-104
Sharing Economic Risks	0-367
Too Good To Be True	00-832
Using Bank Credit	0-818
Using The Bank	0-432
Wise Use of Credit	00-757
Work of the Stock Exchange	00-139
Your Family Budget	0-567

Household Finance Money Management filmstrips, free loan or purchase $6.00 each.

Institute of Life Insurance, Dollar Series filmstrips, free loan or purchase $3.00 each.

Other Resources for Teaching Aids

*Better Business Bureau, 400 Title Building, 112 East 10th Street, Ha 1-8188

Commercial Credit Company, Educational Division, Baltimore, Md.

*Dairy Council of Greater Kansas City, 5200 East 45th Street, Kansas City, Missouri 64130, Un 1-5300

*Home Savings Association, 1000 Grand Avenue, Mr. J. D. Farmer, Ba 1-7100

Household Finance Company, Prudential Plaza, Chicago 1, Illinois

National Foundation For Consumer Credit, 1411 K. Street, N. W., Washington 5, D. C.

New York Life Insurance Company, Box 90, Madison Square Station, New York, N. Y. 10010

Sears, Roebuck & Company, Consumer Education Division, Chicago 7, Illinois (series of pamphlets on Hidden Values)

Institute of Life Insurance, Educational Division, 277 Park Avenue, New York, N. Y. 10017

Insurance Information Institute, 110 William Street, New York, N. Y. 10038

*U. S. Government, Pure Food and Drug Administration, Mrs. Lorena Meyers, Ba 1-7000, Ext. 3271

*University of Missouri Extension Service, Mrs. Lois Harrison, Vi 2-2268

UNIT VIII - Children Are Added To The Family

Suggested Time - 6 weeks

Overview

Parenthood, a challenge, responsibility and a privilege, comes to the majority of young married couples within the first few years of marriage. Rearing children with reasonable success should bring real satisfaction and personality growth to both parents.

Specific Objectives

This unit aims to develop an understanding and appreciation of:

- Parenthood, its satisfactions and responsibilities
- Adjustments which must be made as children are added to the family
- Growth, behavior and principles for guidance of children
- Adjustments when there are no children.

Basic Understandings	Suggested Experiences & Activities
To introduce the unit the teacher may wish to post appropriate pictures, cartoons, a birth certificate and/or baby pictures of students (without names) on the bulletin board.	
The miracle of birth - a new baby grows for nine months before it is born into the world.	A young couple with their first baby may be invited to visit the class. Have the mother and father discuss the meaning of this experience to them. Assist the students in acquiring pertinent facts about the miracle of prenatal growth and the growth process. This may be achieved by showing films, reading and discussion.

Basic Understandings	Suggested Experiences and Activities
	Films: - Biography of the Unborn - Human Reproduction - Human Growth - Before Baby's Birth Day References: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 301-308 - Duvall, E. M. - When You Marry, High School Ed., p. 272-284 - Duvall, E. M. & Hill, R. - Being Married (teacher's use) p. 353-372 - Anderson, W. J. - Design For Family Living, p. 171-179 - Duvall, E. M. - Love and The Facts of Life, p. 123-137 - U. S. Dept. of Health, Education & Welfare - Prenatal Care - Lerrigo, M. O. & Senn, M. - Parents' Privilege. Discuss with the students "We Are Pregnant".
Each baby comes into the world with an inheritance, a product of both father and mother.	Discuss with the class hereditary factors and their application. References: - Anderson, W. J. - Design For Family Living, p. 151-170 - Duvall, E. M. & Hill, R. - When You Marry, High School Ed. p. 263-272 - Duvall, E. M. - Love and The Facts OF of Life, p. 137-143. Films: - Human Heredity Discuss, "From whom does the baby inherit his characteristics?"

Basic Understandings	Suggested Experiences & Activities
The prenatal period gives time for prospective parents to develop new understandings and make certain adjustments.	Invite a new mother and father to discuss necessary understandings and adjustments that have to be accomplished during the prenatal period. Have students interview new parents whom they know and bring to class new ideas concerning understandings and adjustments that need to be made by prospective parents. Have students consider the expenses that will be incurred and discuss necessary adjustments in the budget.
Medical care during the prenatal period is important to the health of the mother and the baby.	Have a nurse discuss with the class the importance of early selection of a doctor and the health care of the mother. Reference: - Anderson, W. J. - Design For Family Living, p. 176-177, 185
When the baby and mother come home new learnings must take place. An important area will be that of physical care and feeding of the baby.	Have a nurse discuss with the class the physical care of the infant. Have her demonstrate with a large doll how to bathe, hold and feed a baby. Films: - Caring For the Baby - Baby Meets His Parents - Protecting Baby From Infection References: - U. S. Dept. of Health, Education & Welfare - Prenatal Care, p. 63 - Shuey, R. M., Woods, E. L. & Young, E. M. - Learning About Children, p. 125-141 - Graves, J. - Right From The Start, Public Affairs Pamphlet Discuss the relationship between the baby's physical care and feeding and the development of feelings of security

Basic Understandings	Suggested Experiences & Activities
New parents need to give thought to their roles as parents in building effective male and female parental images within the evolving family.	Have the students discuss such ideas relating to parenthood as: - Establishing lasting images - The role of parenthood - New adjustments with a new baby recognizing dependency and developmental stages of growth - The essential qualities of a good home - New relationships when there are three instead of two - How parents can maintain husband-wife identity in the midst of parenthood. References: - Anderson, W. J. - Design For Family Living, p. 189-191 - Duvall, E. M. - Family Development p. 192-195, 196-201 - Force, E. S. - Your Family Today and Tomorrow, p. 265-285, 236-254 Develop a series of generalizations which indicate the kind of parents we should like to become.
Grandparents may be an asset to the child.	Discuss the contributions which grandparents may make to the child. References: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 364-365 - Force, E. S. - Your Family Today and Tomorrow, p. 297-299
Children grow and develop according to a pattern. If the parent is to fulfill his role as a guidance counselor he must have some knowledge of the developmental cycle and the orderly process of growth.	Have the student discuss the meaning of developmental cycle, developmental pattern, growth and guidance. Outline and discuss the main developmental tasks to be accomplished at each developmental stage.

Basic Understandings	Suggested Experiences & Activities
	References: - Duvall, E. M. - Family Development, p. 35-43 - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 302-303 - Duvall, E. M. - Family Living, p. 307-312 - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 309-322 - Shuey, R. M., Woods, E. L. & Young, E. M.-Learning About Children, p. 142-164 Consider how parents provide for the growth needs of the child - emotionally, physically, spiritually, intellectually, socially. Reference: - Hoffman, M. L. & L. W. - Child Development Research, Vol. I Film: - Preface To A Life Study and discuss the following: - All behavior is caused - Dependence gives way to independence - Building self-confidence and self-image - Developing a feeling of trust - Promoting friendliness - Developing responsibility and problem solving ability - Establishing values and goals - Building respect for order and law - Encouraging initiative, curiosity, creativeness, sincerity and integrity - The whole personality must grow - The parental love for the child. Have a panel of young parents discuss privileges and responsibilities of parents in guidance of children.

Basic Understandings	Suggested Experiences & Activities

Have several young children brought to the classroom for visiting and observation.

Have students observe children of different ages in different situations in the community comparing behavior patterns and maturity levels.

Films·

- Ages and Stages Series
- Early Social Behavior
- Posture and Locomotion

References:

- Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 24
- Duvall, E. M. - Family Development, p. 228-287
- Craig, H. T. - Thresholds To Adult Living, p. 253-274
- Shuey, R. M., Woods, E. L. & Young, E. M. - Learning About Children, p. 31-52.

Have students develop a chart using the following column headings:

Age of Child	Developmental Characteristics	Behavior Problems	Controls & New Learning
2 yrs			
3 yrs			
5 yrs			

Reference:

- Spock, B. - Baby and Child Care, p. 346-396

Organize a panel discussion on:

- "It's the mother's job to rear the children and the father's job to earn the money"

Basic Understandings	Suggested Experiences & Activities
	- "Every child should be treated equally" - "Discipline is making children behave". List some common problems in child rearing which parents usually face. Have committees discuss possible solutions. References: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 323-332 - Shuey, R. M., Woods, E. L. & Young, E. M.-Learning About Children, p. 181-186 - Stoops, E. - Here's How - Craig, H. T. - Thresholds to Adult Living - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 299-302 - Loeb, R. H. - Manners For Minors - Anderson, W. J. - Design For Family Living, p. 227-247
	Consider the kind of sex education that the parents should provide for preschoolers, elementary children, high school youth. References: - Anderson, W. J. - Design For Family Living, p. 197-226 - Shuey, R. M., Woods, E. L. & Young, E. M. - Learning About Children, p. 275 - Christopher Records - Spock, B. - Baby and Child Care, p. 372-380
Parents will be more adequate in their jobs if they learn about child growth, behavior and relationships.	Review the need for learning about growth and behavior.

Basic Understandings	Suggested Experiences & Activities
	List the available resources in the community and discuss how they may be used. Acquaint the students with the parent education program promoted by the Department of Family Life Education, Kansas City, Mo. Public Schools.
New relationships and new problems develop when other children are added to the family.	Discuss ways and means of helping each child to adjust as the family circle expands. Film: - Sibling Rivalries and Parents Reference: - Puner, H. W. - Helping Brothers and Sisters Get Along, SRA booklet Have students discuss jealousy, rivalry, and other emotional problems which develop when there is more than one child in the family. Have students who are the oldest, youngest and middle children report on problems which they faced because of their special place in the family. Formulate possible aids to adjustment. Have students who are only children discuss some of their problems of adjustment. References: - Spock, B. - Dr. Spock Talks With Mothers, p. 59-94 - Puner, H. W. - Helping Brothers And Sisters Get Along, p. 15-23, SRA booklet
In today's society many mothers find it necessary to be employed outside the home.	Discuss with the students the reasons why mothers may be employed outside the home.

Basic Understandings	Suggested Experiences & Activities
	References: - Duvall, E. M. - Family Living, p. 257-258, 273-275, 341, 344, 355 - Shuey, R. M. , Woods, E. L. & Young, E. M - Learning About Children, p. 54-55 - Daedalus - The Woman In America, p. 671-709 Consider with the class the arrangements that may be made for adequate care of the children. Have the students discuss, "Adequate Care". Discuss with the class the adjustments that may need to be made by family members when the mother is employed. Have the students list the extra expenses that may be incurred when the mother is employed outside the home. Does the salary earned compensate for these extra expenses? Discuss the need for women to be full-time mothers when children are young.
As boys and girls grow older new child-parent relationships evolve which call for new family patterns of living and communications. Here, parents seek to guide the child as he or she approaches adjustments for more adult behavior and responsibilities.	Discuss the importance of maintaining friendly and cooperative communication in the family through the teen-age and young adult period of growth. Have students indicate and discuss areas of concern which call for thoughtful understanding on the part of both parents and teen-agers. Discuss the importance of: - mutual respect for the individual - compromising - personal honesty - respect for opinion and rights of others - sharing. Relate this discussion not only to their relationship with their parents, but, also, to their responsibilities later as parents.

Basic Understandings	Suggested Experiences & Activities
	References: - Neisser, E. - How To Live With Children, p. 41 - Osborne, E. - Democracy Begins In The Home, Pub. Affairs Pamphlet, p. 13 - Anderson, W. J. - Design For Family Living, p. 250-257 - U. S. Government - The Adolescent In Your Family, p. 57
As the children become young adults, the family becomes a launching center.	Have the students read and discuss the meaning of "launching center". Discuss relationships between parents and their adult children. References: - Anderson, W. J. - Design For Family Living, p. 283-287 - Craig, H. T. - Thresholds To Adult Living, p. 245 - Duvall, E. M. - Family Development, p. 335-388 - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 309
Childless couples who wish children may satisfy their need in different ways.	Discuss with the class the question of whether or not the home can be satisfying without children. If so, under what conditions? Consider the various ways of satisfying one's need for children when a couple is childless, for example: - Foster care - Adoption - Interest in other people's children - Church and Sunday School work - Community activities. Discuss relative merits of each.

Basic Understandings	Suggested Experiences & Activities
	Invite a guest speaker from a social agency to discuss foster care and adoption and the responsibility which one assumes in either plan. Have this speaker outline procedure for becoming a foster parent, an adoptive parent. Reference: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 347-352
Special kinds of adjustment are necessary when the home is broken by death, separation, desertion, divorce.	Brainstorm the class on the kinds of family adjustments that may or must be made when there is: - sudden death - separation - family desertion - divorce. References: - Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, p. 285-300 - Sussman, M. B. - Sourcebook in Marriage and the Family, p. 440-483 - Duvall, E. M. - Family Living, p. 233-237, 341-342 - Force, E. S. - Your Family Today and Tomorrow, p. 346-358 - Craig, H. T. - Thresholds to Adult Living, p. 200-203, 234 - Duvall, E. M. & Hill, R. - When You Marry, High School Ed., p. 219-241 - Hoeflin, R. - Essentials of Family Living, p. 247-250 - Anderson, W. J. - Design For Family Living, p. 143 (reference on brainstorming)

Vocabulary:

adoption
birth certificate
discipline
family circle

Basic Understandings	Suggested Experiences & Activities
flexibility	
forceps	
foster parents	
fraternal twins	
identical twins	
incubator	
infant	
inflexible	
jealousy	
labor	
multiple birth	
obstetrician	
parental role	
parenthood	
pediatrician	
prenatal	
preschool child	
prospective parents	

Culmination and Evaluation

Review the book Angel Unaware by Dale Evans Rogers. Compare adjustments made to the normal child with those which must be made to the handicapped child.

Administer an objective test on facts presented.

If not done earlier in the unit, have each student write an essay on the kind of parent he would like to be and what steps he could take now and in the future to help him become this kind of parent.

Have students write a review of their own progress and development during the unit.

Basic References

Anderson, W. J. - Design For Family Living, T. W. Denison & Co., 1964

Craig, H. R. - Thresholds to Adult Living, Charles A. Bennett Co., Inc., 1962

Daedalus - The Woman In America, Spring, 1964, Vol. 3, No. 2, Proceedings of the American Academy of Arts and Science, 280 Newton Street, Brookline Station, Boston, Mass. 02146

Duvall, E. M. - Family Living, Rev. Ed., Macmillan Co., New York, N.Y. 1961

Duvall, E. M. - Love and The Facts of Life, Association Press, 1963

Duvall, E. M. & Hill, R. - Being Married, D. C. Heath & Co., 1960 (for teacher's use)

Duvall, E. M. & Hill, R. - When You Marry, High School Ed., D. C. Heath & Co., 1962

Force, E. S. - Your Family Today and Tomorrow, Harcourt, Brace & Co., 1955

Hoeflin, R. M. - Essentials of Family Living, John Wiley & Sons, 1960

Hoffman, M. L. & L. W. - Child Development Research, Vol. I, Russell Sage Foundation, 1964

Landis, J. L. & M. G. - Personal Adjustment Marriage and Family Living, 3rd Ed., Prentice-Hall, Inc., 1960

Lerrigo, M. O. & Senn, M. - Parents' Privilege, 1955, Order from N. E. A. 35¢

Loeb, R. H. - Manners For Minors, Association Press, 1964

Shuey, R. M., Woods, E. L. & Young, E. M. - Learning About Children, Rev. Ed., Lippincott Co., 1964

Spock, B. - Baby and Child Care, Rev. Ed., Pocket Book, 1957

Spock, B. - Dr. Spock Talks With Mothers, Pocket Book, 1964

Stoops, E. - Here's How, Crusader Life Insurance Co., 847-A Minnesota Avenue, Kansas City, Kansas

U. S. Dept. of Health, Education & Welfare -

Prenatal Care, No. 4
Infant Care, No. 8
Your Child from One to Six, No. 30
Your Child From Six to Twelve, No. 324
The Adolescent in the Family, No. 347

Order from Health Education Services, Division of Health, Jefferson City, Missouri

The Abused Child, Children's Bureau, 1963

Order from Superintendent of Documents, U. S. Government Printing Office, 0-691-402, 1963, Price 10¢

Additional References

Arnstein, H. S. - What To Tell Your Child, Bobbs-Merrill Co., 1960

Bossard, J. H. S. & Boll, E. S. - The Sociology of Child Development, Harper & Brothers, 1960

Grams, A. - Children and Their Parents, T. S. Denison & Co., 1963

Gruenberg, S. M. - The Encyclopedia of Child Care and Guidance, Rev. Ed., Doubleday, 1963

Gruenberg, S. M. - The Wonderful Story of How You Were Born, Doubleday, 1952

Harris, I. D. - Normal Children and Mothers, The Free Press of Glencoe, 1959

Hymes, J. L. - The Child Under Six, Prentice-Hall, 1964

Langdon, G. - Children Need Toys, American Toy Institute (free)

Langdon, G. - How To Choose Toys, American Toy Institute (free)

Nye, F. I. & Hoffman, J. - The Employed Mother In America, Rand-McNally & Co., 1963

Public Affairs Pamphlets -

Burgess, H. S. - How To Choose A Nursery School, No. 310
Butcher, R. L. & Robinson, M. O. - The Unmarried Mother, No. 282
Carson, R. - Having A Baby, No. 178
Carson, R. - So You Want To Adopt A Baby, No. 173
Carson, R. - Your Child May Be A Gifted Child, No. 291
Dietrich, H. F. - Your Child's Safety, No. 225
Frank, J. - Children and TV, No. 323
Graff, J. R. - Parents' Guide To Better Vision, No. 339
Graves, J. - Right From The Start, No. 350
Gruenberg, S. M. & Krech, H. S. - Your Child's Friends, No. 285
Guttmacher, A. F. & Gould, J. - Why Can't You Have A Baby, No. 309
Hart, E. - How Retarded Children Can Be Helped, No. 288
Hymes, J. L. - Enjoy Your Child, Ages 1, 2, 3, No. 141
Hymes, J. L. - How To Tell Your Child About Sex, No. 149
Hymes, J. L. - Three to Six: Your Child Starts to School, No. 163
Lambert, C. - Understanding Your Child, 6 to 12, No. 144
LeShaw, E. J. - The Only Child, No. 293
LeShaw, E. J. - You and Your Adopted Child, No. 274
Milt, H. - Young Adults and Their Parents, No. 355
Neisser, E. - Making The Grade As Dad, No. 157
Neisser, E. - Your Child's Sense of Responsibility, No. 254

Public Affairs Pamphlets (continued)

Osborne, E. - Democracy Begins At Home, No. 192
Osborne, E. - How To Teach Your Child About Work, No. 216
Ross, H. - The Shy Child, No. 239
Thorman, G. - Broken Homes, No. 135
Wolf, A. W. M. - Your Child's Emotional Health, No. 264
Wolf, A. W. M. & Stein, L. - The One-Parent Family, No. 287

Raines, M. - Managing Livingtime, Charles A. Bennett Co., Inc., 1964

Scheinfeld, A. - The New You and Heredity, J. B. Lippincott, Co., 1961

Science Research Associates - Better Living Booklets

English, Spurgeon - Emotional Problems of Growing Up
English, O. S. & Foster, C. J. - A Guide To Successful Fatherhood
Escalona, S. - Understanding Hostility In Children
Foster, C. J. - Developing Responsibility In Children
Jenkins, G. G. - A Guide For Family Living
Kehm, F. - Your Child and The People Around Him
Krug, O. & Beck, H. L. - A Guide To Better Discipline
Leonard, C. W. - Why Children Misbehave
Levine, M. - Helping Boys and Girls Understand Their Sex Roles
Mohr, A. J. - When Children Force Crises
Montagu - Helping Children Develop Moral Values
Neisser, E. - How To Live With Children
Olson, W. - How Children Grow and Develop
Puner, H. W. - Helping Brothers and Sisters Get Along
Ridenhour, H. - Building Self Confidence in Children
Ross, H. - Fears of Children
Strang, R. - Helping Children Solve Problems
Van Riper, C. - Helping Children Talk Better
Weitzman, E. - Guiding Children's Social Growth

Wolf, A. W. - The Parents Manual, 2nd Ed., Rev., Frederick Ungar Publishing Co., 1962

Magazines

The PTA Magazine, published by the National Congress of Parents and Teachers, 700 North Rush Street, Chicago 11, Illinois, 10 issues per year, price $1.50 per year

Popular magazines as Ladies Home Journal, McCalls, etc. have articles by recognized authorities - also Kansas City Star

Journal of Home Economics, published by American Home Economics Association, 10 issues per year

Pamphlet Resources

American Toy Institute, 200 Fifth Avenue, New York, N. Y. 10010

John Hancock Mutual Life Insurance Co., Boston, Mass.

Kansas City Social Health Society, 406 W. 34th St., Suite 412, Kansas City, Missouri 64111

Metropolitan Life Insurance Co., One Madison Ave., New York, N. Y. 10010

University of Missouri Extension Service, Columbia, Missouri

Audio - Visual Instructional Materials

And So They Grow	OX-94
Ages and Stages Series:	
- Terrible Two's and Trusting Threes	00-309
- Frustrating Fours and Fascinating Fives	00-287
- From Sociable Six to Noisy Nine	00-397
- From Ten to Twelve	OX-123
Answering the Child's Whys	00-208
Baby's Day at 48 Weeks	0-30
Baby Meets His Parents	0-489
Before Baby's Birth Day	F-2773
Caring For the Baby	F-2774
Children's Emotions	00-348
Early Social Behavior	0-111
Family Life	0-538
Fears of Children	OX-57
He Acts His Age	00-289
Helping Johnny Remember	0-1006
Helping The Child Face The Don'ts	0-499

Helping The Child To Accept the Do's	0-498
Human Growth	00-163
Human Heredity	00-446
Human Reproduction	00-52
Individual Differences	00-292
Learning and Growth	0-234
Life With Baby	00-63
Life With Junior	00-295
Meeting The Emotional Needs of Childhood	0X-58
Mike Makes His Mark	0X-383
Palmour Street	0X-59
Preface To A Life	0X-79
Protecting Baby From Infection	F-2775
Sibling Rivalries and Parents	0-935
Social Development	00-256
Young Teens and Family Relationships	F0-83

Audio-visual materials also may be obtained from the Health Education Services, Division of Health, Department of Public Welfare, Jefferson City, Missouri.

Records

Christopher records on Sex Education may be borrowed from Family Life office (reserve in advance) or may be purchased from The Christophers, 18 East 48th Street, New York, N. Y. 10017, Price $3.50

UNIT IX - The Older Generation In the Family

Suggested Time - 2 weeks

Overview

The "empty nest" era in a couple's life often presents completely new problems and opportunities. The ability to recognize each situation for what it is and to live accordingly may be the key to maintaining good mental health.

Numerous families are finding the approach of the retirement age either interesting or frightening. The relatively new concept of retirement from the working force in the early sixties leaves many couples in a dilemma not easily resolved. In addition, many families have older parents for whom they must plan. The increased life expectancy should urge us to consider, investigate and evaluate the role these people play in both the family and community life.

Specific Objectives

The goals of this unit are to learn to:

- Recognize the importance of planning for retirement and post retirement years of the life cycle
- Appreciate emotional aspects and attitudes relating to the empty nest
- Develop satisfying and creative use for new found leisure time
- Accept the physical changes which occur as we grow older
- Understand adjustments needed when husband or wife is left alone
- Acquire techniques and develop creative ideas for continuing social and civic responsibilities in the community.

Basic Understandings	Suggested Experiences & Activities
Since people are marrying at younger ages, many mothers and fathers find that they reach the "empty nest" stage at an age when they are still vigorous and alert. This stage brings new challenges, new relationships, new problems - a new way of living.	Review the family life cycle identifying the "empty nest" stage. Discuss the implications of this stage and the developmental tasks to be accomplished.

Basic Understandings	Suggested Experiences & Activities
	Discuss how women may spend their time and energy which was once used in rearing children. Evaluate these different ways in terms of promoting individual personality growth and in providing further integration of mother and father as a couple. References: - Duvall, E. M. - Family Development, p. 389-407 - Anderson, W. J. - Design For Family Living, p. 283-303 - Craig, H. T. - Thresholds To Adult Living, p. 245-246 - Duvall, E. M. - Family Living, p. 358-360 - Duvall, E. M. - When You Marry, High School Ed., p. 310-311 - Cavan, R. S. - The American Family, p. 482-496 - Whitman, H. - Your Middle Years
Parents frequently become grandparents, a status which calls for new adjustments and relationships.	Invite several grandparents to discuss with the class how they conceive the role of grandfathers, grandmothers. Discuss, "Grandparents are valuable people". Consider with the class the responsibilities and privileges of being a grandparent. Discuss how the younger family and especially grandchildren can make life better or worse for the grandparents. Use buzz sessions to help find suggestions for living with grandparents. References: - Landis, J. T. & M. G - Personal Adjustment Marriage and Family Living, p. 364-366

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Basic Understandings	Suggested Experiences & Activities
	- Cavan, R. S. - The American Family, p. 504-505, 404-405 - Duvall, E. M. - Family Development, p. 407-430, 462-464 - Hoeflin, R. - Essentials of Family Living, p. 90, 153-154 - Duvall, E. M. - Family Living, p. 150-152, 279 - Stern, E. M. - A Full Life After 65, Public Affairs Pamphlet
Scientific and medical advances have made it possible for people to live longer.	Have the students develop individual charts, graphs or posters which help analyze statistical materials concerning older population groups on city, state and national levels. The same may be done for the numbers of various age groups in our total population. References: - Use the public library as a pivot of reference - include Statistical Abstracts of the United States, World Almanac, Population Perspectives and other current reference materials.
With advancing age, there are physical, emotional and spiritual changes.	Have resource persons discuss some of these changes and their meaning or have the students read in this area. Consider physical limitations, health, emotional and social problems. Have the students discuss the question, "What is meant by the aging process?" Have the students make a study of ways that some of the emotional needs of older people might be met. Reports might be made on Golden Age Clubs, Service Corps for Senior Citizens, etc.

Basic Understandings	Suggested Experiences & Activities
	References: - Hart, E. - Making The Most of Your Years, Public Affairs Pamphlet - Anderson, W. J. - Design For Family Living, p. 296-303 - Metropolitan Life Insurance Company, When Our Parents Grow Old - John Hancock Life Insurance Company, Growing Old Gracefully - Jacobs, H. L. - Youth Looks at Aging - Lawton, G. & Stewart, M. J. - When You Grow Older, Public Affairs Pamphlet - Cavan, R. S. - The American Family, p. 500-504
	Discuss with the students the pros and cons about relocation of residence for older persons - Within the community - In a warmer climate - In a village or apartment for older people.
	Have the students discuss the financial and other responsibilities that should be assumed by grown children for one or both parents when their income or Social Security may not be sufficient to meet the necessary expenses of old age.
	The teacher may need to point out the reciprocal responsibilities which grown children assume as they become the independent members of the family and their parents become the dependent ones.
When it becomes impossible for older people to maintain their own home or be cared for by their grown-up children, there are supplementary services available.	Have students discuss possible health insurance plans and their cost, cost of nursing home care and private home care. Discuss licensing for nursing homes in Missouri (Information may be secured from the Division of Health of Missouri)

Basic Understandings	Suggested Experiences & Activities
	Assign students to report on current articles dealing with care of older persons.
Widowhood is a state through which many must pass.	Discuss with the students preparation for widowhood including learning to live again on a single basis.
	Invite a minister, priest, or rabbi to discuss the function of the church in relation to older widows or widowers.

Vocabulary:

- empty nest
- golden age clubs
- launching center
- licensing
- medicare
- nursing home
- population groups
- retirement age
- senior citizens
- widowhood

Culmination and Evaluation

Have a panel discuss "Mental health and happiness in older age are determined by the kind of life one lives before he reaches the status of older age", and "Whether one is happy or sad depends upon whether one is at peace, not merely with the world, but with himself".

Have another panel discuss the responsibility of those in their teens, 20's, 30's, 40's and 50's for taking the loneliness out of old age.

Basic References

Anderson, W. J. - Design For Family Living, T. S. Denison & Co., 1964

Cavan, R. S. - The American Family, 3rd Ed., Thomas Y. Crowell, 1963

Craig, H. T. - Thresholds To Adult Living, Charles A. Bennett Co., 1962

Duvall, E. M. - Family Development, 2nd Ed., J. B. Lippincott, 1962

Duvall, E. M. - Family Living, Rev. Ed., Macmillan, 1960

Duvall, E. M. & Hill, R. - When You Marry, High School Ed., D. C. Heath, 1962

John Hancock Insurance Company - Boston, Massachusetts

Foes After Forty (free)
Growing Old Gracefully (free)

Hauser, Phillip - Population Perspectives, Rutgers University Press, New Jersey, 1961, $3.50

Hoeflin, R. - Essentials of Family Living, John Wiley & Sons, 1960

Jacobs, H. L. - Youth Looks at Aging, University of Iowa, Institute of Gerontology, Division of Extension and University Services, Iowa City, 1964, $1.00

Landis, J. T. & M. G. - Personal Adjustment Marriage and Family Living, 3rd Ed., Prentice-Hall, 1962

Metropolitan Life Insurance Company -

When Parents Grow Old (free)
Your Future And You (free)

Public Affairs Pamphlets -

Close, K. - Getting Ready To Retire, No. FL 182
Greeley, O. - Private Nursing Homes, Their Role in the Care of the Aged, No. 298
Hart, E. - Making The Most of Your Years, No. FL 276
Lawton, G. & Stewart, M. - When You Grow Older, No. 131
Milt, H. - Middle Age - Threat or Promise, No. 294
Neisser, E. - How To Be A Good Mother-in-Law and Grandmother, No. 171
Ogg, E. - When Parents Grow Old, No. FL 208
Stern, E. M. - A Full Life After 65, No. 347

Whitman, Howard - A Brighter Later Life, Prentice-Hall, 1961

Whitman, Howard - Your Middle Years, The Register & Tribune Syndicate, Des Moines 4, Iowa, Boc 957, 50¢

Additional References

Albrecht, R. E. - Aging In A Changing Society, University of Florida Press, Gainsville, Florida, 1962

Buckley, J. C. - The Retirement Handbook, 2nd Rev. Ed., Harper and Brothers, 1962

Christiensen, H. T. - Marriage Analysis, 2nd Ed., Ronald Press, 1958

Crowe, C. M. - Getting Ready For Tomorrow, Abingdon Press, 1959

Greene, T. - How To Enjoy Retirement For the Rest of Your Life, Exposition Press, 1957

Martin, A. R. - Leisure Time A Creative Force, The National Council On The Aging, 49 West 45th St., New York, N. Y. 10036

National Association For Mental Health - Series of leaflets entitled Notes After Fifty, order from Kansas City Association For Mental Health, 417 East 13th Street, Kansas City, Missouri 64106, $1.00

Rose, A. M. - Aging In Minnesota, University of Minnesota Press, Minneapolis, 1963

Sussman, M. B. - Sourcebook in Marriage and The Family, Houghton-Mifflin Co., 1963

Tibbitts, C. - Handbook of Social Gerontology, University of Chicago Press, Chicago, Ill., 1960

U. S. Department of Health, Education & Welfare -

Looking Forward To The Later Years, Public Health Service Publication, No. 116, 15¢

The Older Person In The Home, Public Health Service Publication, No. 542, 20¢

U. S. Social Security Administration -

Now That You Are Retiring, OASI-853, 15¢. Order from Superintendent of Documents, U. S. Government Printing Office.

Audio - Visual Instructional Materials

Family Life 0-538

UNIT X - The Individual and The Family Live in the Community

Suggested Time - 2 weeks

Overview

In our society, the family and community are interrelated and each is responsible, one to the other. The family depends upon the community for many supportive services. The community, on the other hand, is made up of individual families, each of which has responsibility to the whole. Young people today stand at the threshold of another cycle.

Specific Objectives

This unit will emphasize:

- The contribution which a community makes to its families
- The responsibilities each family has to contribute adequately to the neighborhood, city, state, nation and world.

Note: Some teachers prefer to cover this material in the previous units rather than to devote a separate unit to it. If this has been done adequately, there is no need for repetition. It is organized here, however, for the use of teachers presenting it as a separate unit and to serve as suggestions for content and activities when it is incorporated into other units.

Basic Understandings	Suggested Experiences & Activities
We cannot take advantage of the opportunities provided by the community, if we are unaware of community services.	Ask the students the question, "How much do you know about your neighborhood and Kansas City, Missouri?" Survey the neighborhood and city for the services provided for families and family members. Make notes on the values of each service - also approximate expense involved in utilizing these services. Investigate such services as: - Protective services - Public utilities - Cultural and recreational opportunities

Basic Understandings	Suggested Experiences & Activities
	- Health and welfare - Character building Have a resource person discuss services provided and how a person avails himself of these services. Have students write term papers or give reports concerning findings. Reference: - Where To Turn For Health and Welfare Services - Greater Kansas City Area, 1963
Every city has forces and conditions which are not helpful to the development of healthy personalities or wholesome family life.	Have students discuss some of the detrimental influences which they recognize in their community. Discuss how individuals and/or families may counteract such influences. Have a panel discuss services and community influences on the basis of "Youth wants to know".
The individual and the family, if each is to benefit from the community, must also contribute positively to the community.	Have the students present reports on: - "How we as individuals can contribute to healthy community development" - "The responsibility of each family to its neighbor and to the community". Have a panel discussion on the kind of family our neighbor would like to have living next door. (Students may interview several families for data.) Discuss family responsibility for supporting: - the church - the laws - youth programs - governmental and political activities - education - cultural activities - welfare programs - taxes, etc.

Basic Understandings	Suggested Experiences & Activities
	Develop an understanding of the full meaning of the term "support" (time, energy, money). References: - Duvall, E. M. - Family Living, p. 39 - Cavan, R. S. - The American Family, p. 511-533 - Force, E. S. - Your Family Today and Tomorrow, p. 361-390 - Craig, H. T. - Thresholds to Adult Living, p. 290-304
Youth needs to have an understanding of the inner city plight and the influence of economic deprivation on individual and family development.	Have students investigate this basic understanding in relation to Kansas City. Use resource persons to help clarify the picture. Evaluate the progress being made in our city. Resource persons: - Mr. Jim Reefer, Director of City Welfare, Kansas City, Missouri - Mr. Robert MacNeven, Special Consultant, Commission on Human Relations, 16th Floor, City Hall, Kansas City, Missouri. Film: - Children Without
Vocabulary: character building services community counteract cultural deprivation health services influences inner city protective services support supportive services welfare services	

Culmination and Evaluation

Invite a well-informed person to give a summary discussion on the responsibility of the family to the community and vice versa.

Have students write a report on practical steps which they themselves can take to better their neighborhood.

Basic References

Cavan, R. S. - The American Family, 3rd Ed., Crowell Publishing Company, 1963

Craig, H. T. - Thresholds to Adult Living, Charles A. Bennett & Co., 1962

Force, E. S. - Your Family Today and Tomorrow, Harcourt Brace & Co., 1955

Greater Kansas City Area Regional Health and Welfare Council - Where To Turn For Health and Welfare Services, Regional Health and Welfare Council, 320 East 10th Street, Kansas City, Missouri

Additional References

Duvall, E. M. - Family Living, Rev. Ed., Macmillan Company, 1960

Feldman, F. L. - The Family In a Money World, Family Service Association, 1957

President's Commission on the Status of Women - Home and Community, Women's Bureau, Department of Labor, Washington, D. C., 1963

Public Affairs Pamphlets -

Dach, Ed. - Your Community and Mental Health, No. 263
Deutsch, A. - What We Can Do About The Drug Menace, No. 186
Doyle, K. C. - Homes For Foster Children, No. 223
Mace, D. R. - What Is Marriage Counseling, No. 250
Neuberger, R. L. - Our National Resources and Their Conservation, No. 230
Ogg, E. - Getting Together For Community Service, No. 277
Ogg, E. - Your Nursing Services Today and Tomorrow, No. 307
Osborn, F. - This Crowded World, No. 306
Puner, H. W. - Children In Court, No. 207
Stewart, M. S. - That No Man Shall Hunger, No. 304
Stewart, M. S. - The Poor Among Us, No. FL 362
Stewart, M. S. - The Taxes We Pay, No. 289
Yahraes, H. - Making Medical Care Better, No. 283

Strong, R. - Facts About Juvenile Delinquency, Science Research Associates

Zelomek, A. W. - A Changing America - At Work and Play, John Wiley & Sons, 1959 (Public Library)

Audio - Visual Instructional Materials

Children Without	OX-373
Make Way For Youth	OO-66

Division of Health of Missouri, Health Education Services -

A Family Affair - Help from trained caseworker with a family and a son who resists authority

Again Pioneers - Community attitudes toward a migrant family

A Place For Growing - Boys' Club

Children Without

Community Health in Action - Work of Public Health Department

Leaders for Leisure - Recreational

V for Volunteers - Participation on volunteer basis in a community

UNIT XI - The Family, 1965-1975 Style

Suggested Time - 1 week

Overview

This unit should serve as a summary for the Family Relations Course. It gives an opportunity to review, to clarify, to enlarge upon and to emphasize some of the most important basic principles and learnings that have been established throughout the school year.

This course has sought to help the student:

- See himself as an individual, understand the growth or developmental process as it applies to him, and accept for himself the goal of furthering his own fulfillment. Students need to have developed the concept that each individual is unique. This uniqueness must be developed in a way satisfying to the individual and to society

- Understand the great importance of the family in the United States of America, its functions, developmental cycle, the principles of democratic living as applied to the group as a whole, and the values in uniqueness in patterns of family living

- Realize the importance to our national life of fulfillment for each individual, and how the family may contribute to the furtherance of learning and personality growth at every age

- Grasp the idea of the rapidity of change in the modern world and the inherent creative possibilities in change. If the concept of constant change can be accepted, the individual may act more effectively in determining his own life pattern, and in becoming a positive force in the community and in the nation.

Suggested Activities and Evaluation

Have the students project goals for family life looking toward the year 2000. *Use "Population Perspectives" as a point of reference. Imagine yourself in 2000. Will your homes be different - families - schools - churches? What part do you plan to play in progress?

Have the students write a paper on one of the following:

- The most meaningful experiences of the year and why (one method would be for the student to write to an imaginary friend in another location telling this friend why a high school senior should take this course)
- How their ideas, values, and goals have changed
- Why it is important to know one's values. In the paper they might outline their value system.
- Student chosen topic related to a unit studied this year (with teacher approval).

Ask the students to suggest course changes or topics which would have been beneficial to them.

* Hauser, Phillip - Population Perspectives, Rutgers University Press, New Jersey, 1961, $3.50

APPENDICES

APPENDIX A STYLE SHEET FOR WRITTEN WORK

I. FORM FOR WRITTEN WORK

A. Use blue or black ink or double-spaced typing for the finished copy of a composition.

B. Capitalize all words in a title except conjunctions (and, but, or, nor, etc.), prepositions of four letters or fewer (for, in, on, of, to, etc.), and articles (a, an, the.) Capitalize these also, if they are first or last in the title.

C. Write the title on the first line. Put no period after it. Put no quotation marks around it.

D. Leave space of one line below the title.

E. Indent about one inch for the beginning of each paragraph.

F. Start the first paragraph on the third line.

G. Leave one-inch margins on both sides of your paper and one and one-half inches at top and bottom.

H. Use only one side of the paper for the finished copy of a written composition. Use unruled paper, regulation theme-size.

I. Endorse the outside paper in the following form:

Jack Taylor
Subject
Hour
September 9, 1962

J. Fold lengthwise. (Optional)

II. CAPITALIZATION

A. CAPITALIZE

1. The first word of every sentence, direct quotation, topic of an outline, and line of poetry. (Modern poetry is not included.)
2. Languages, but not other subjects unless accompanied by a designation. (I take algebra and world history. I take Algebra 2 and World History I.)
3. Names of the month, days of the week, holidays, but not seasons.
4. All words in the salutation of a letter except Dear when used with my - - My dear Sir: Capitalize only the first word in the complimentary close of a letter.
5. Only names of particular buildings, business houses, churches, clubs, colleges, highways, lakes, mountains, oceans, organizations, parks, rivers, schools, seas, societies, streets. (Northwest High School.)
6. Names of cities, constellations, continents, countries, departments of government, historical events, nationalities, persons, places, states, steamships. (Indian; Battle of Bunker Hill.)
7. All words in a literary title except conjunctions (and, or, but, nor, etc.), prepositions of four letters or fewer, (for, in, on, of, to, etc.), and articles (a, an, the.) Capitalize these also, if they are first or last in the title.
8. The word Bible, the books of the Bible, and all words referring to God and the Deity. (But not the word god, if it means a pagan deity.)
9. Terms of relationship like Mother, Father, Grandmother when used without a modifier or before a person's name. (I saw Mother and Uncle John.) (See II., B., 3.)

10. North, South, East, and West when they are used as names of sections of the country, but not when they are used as names of directions. (The North defeated the South. Turn north now.)
11. Titles of office only when they precede a person's name - - Mayor Bartle. One exception is the President of the United States.
12. Commercial trade names - - Eversharp pencil, Boeing plane, Crosley radio.

B. DO NOT CAPITALIZE
1. Names of animals, birds, flowers, games, insects, and trees.
2. Class names like freshman, sophomore, junior, senior.
3. Mother, father when preceded by modifier, like my mother, her father.

III. PUNCTUATION

A. USE A PERIOD
1. At the end of every declarative and imperative sentence.
2. After initials of names.
3. After accepted abbreviations.
4. After numbers and letters used in numbering exercises or the topics of an outline.

B. DO NOT USE A PERIOD
1. After the title of a composition.
2. After the topics of an outline unless it is a sentence outline.
3. After your name when you sign a letter or note.

C. USE A QUESTION MARK - After every direct question.

D. USE AN EXCLAMATION POINT - To indicate strong or sudden feeling.

E. USE COMMAS
1. To set off all items, after the first, of a date.
2. To set off all items, after the first, in an address.
3. After Oh, Yes, No, Well, when they introduce a sentence.
4. To set off a noun of direct address.
5. To separate words, phrases, and clauses in series.
6. To separate parallel adjectives.
7. To set off words in apposition unless they are closely related to words they explain - - Ellen, my sister, - - my sister Ellen.
8. Before expressions like can't you, didn't she, doesn't he, don't they, hasn't he, haven't you, isn't she, won't you when they come at the end of a sentence.
9. To set off parenthetical words and phrases like as usual, by the way, however, nevertheless, no doubt, on the other hand, of course, etc.
10. To set off most direct quotations from the rest of the sentence.
11. After the salutation (greeting) of a friendly letter and after the complimentary close of all letters.
12. Before the conjunctions and, but, for, nor, or when they join unpunctuated independent clauses.
13. After an introductory adverbial clause. Seventeen commonly used subordinate conjunctions that introduce adverbial clauses are: after, although, as soon as, because, before, if, since, though, unless, until, when, whenever, where, wherever, while, why, as.
14. To set off nonrestrictive clauses - - Mr. Smith, who is sick, is our friend.
15. To set off all introductory participial phrases, or phrases containing participles that turn or delay the thought - - A flock of ducks, flying very high, passed over our blind.

F. USE AN APOSTROPHE

1. To form the possessive case of nouns and indefinite pronouns.
2. To indicate the omission of a letter or of a syllable in a contraction.
3. To form the plural of figures, letters, signs, and of words when the latter are spoken of as words: 1's, L's.

G. USE QUOTATION MARKS

1. To enclose the words of a speaker in a direct quotation.
2. To indicate the titles of articles, chapters, short stories, and single poems when quoted from a publication.
3. To indicate titles of movies, radio, and television programs.
4. To indicate foreign phrases not italicized.

H. USE AN UNDERLINE

1. Under each separate word of titles of books, magazines, and newspapers, long poems, plays, musical works, planes, ships, and trains.
2. Under letters, figures, and words used in sentences as letters, figures, and words - - Dot your i's and cross your t's. Can you spell Mississippi?

I. USE A SEMICOLON

1. To separate independent clauses not joined by coordinate conjunctions in a compound sentence - - Classes start at eight o'clock; a warning bell rings five minutes before the hour.
2. Between long independent clauses joined by co-ordinating conjunction when either clause is punctuated by commas - - Jones was chosen; but, I believe, Smith is the better man.
3. To separate terms of a series if commas are used within the terms - - The main characters are Tom Sawyer, a mischievous boy of eleven; Huck Finn, his pal; Sydney, his younger brother; Becky, his girl friend.

J. USE A COLON

1. After the salutation (greeting) of a business letter.
2. After such expressions as the following and as follows.
3. Before a long, formal quotation (but not if single spaced, and indented farther than the rest of your typewritten material.)

V. GOOD SENTENCE STRUCTURE - ESSENTIALS

A. PROPER RELATION OF IDEAS.

A simple sentence develops only a single idea. Complex or compound sentences contain a central thought and related ideas. Related ideas are expressed either in phrases or in subordinate clauses.

B. UNITY OF THOUGHT IN THE SENTENCE

1. Separate sentences should be used for ideas not closely related in thought.
2. Clauses in compound sentences should be of equal rank both in meaning and form. The complex sentence should be used when clauses are of unequal rank.
3. A series of short statements closely related in thought should be combined into one sentence.
4. A phrase or a dependent clause cannot be used as a complete sentence.

C. CLEARNESS OF THOUGHT IN THE SENTENCE

1. Place modifiers, such as adjectives, adverbs, phrases, and clauses, near the words they modify.
2. Make the reference of each participle and of each pronoun definite.
3. In general, keep the same number, the same tense, and the same voice throughout the sentence.
4. Use connectives that express exactly the desired relations between parts of complex and compound sentences.

D. EMPHASIS IN THE SENTENCE

1. Ideas placed at the beginning or at the end of a sentence receive emphasis.
2. Emphasis is secured by arranging words, phrases, or clauses in the order of increasing importance.
3. Emphasis is increased by omitting unnecessary words.
4. Emphasis is secured by using words that show exact distinctions.

V. PARAGRAPH STRUCTURE

A. A paragraph is a group of properly related sentences that develop a single topic. A topic sentence aids in the logical development of a paragraph. The following sentences are examples:

1. A city administration may be economical and not efficient.
2. A very common method of judging the efficiency of municipal government is to compare the cost of a given service in one city with the cost of the same service in another city.

B. A paragraph should concern itself with one and only one topic or main thought. Each sentence in the paragraph should contribute directly to the development of the paragraph topic. Close a paragraph with a sentence that summarizes, concludes, or emphasizes the topic, if added force is needed.

VI. THE OUTLINE

The following outline form will contribute to orderly thinking:

I. . . . . .
  A. . . . . .
    1. . . . . .
    2. . . . . .
      a. . . . . .
      b. . . . . .
  B. . . . . .
II. . . . . .

(The following points should be stressed in the making of outlines:

1. There cannot be a break into fewer than two parts. Consequently, in an outline, there cannot be a I. without a II., an A. without at least a B., a 1. without at least a 2., etc.
2. Entries under the parts of an outline must be parallel in importance as well as in form. For instance, if A. is "The uses of a slide rule" then B. cannot be something like "Advanced problems," even though the material is presented in that order in the book. B. might be something like "The advantages of a slide rule.")

APPENDIX B

Rating Charts, Inventories and Questionnaires

Item 1 - How Old Am I?

	Today	End of Semester	End of School Year
When someone disagrees with me			
When someone pokes fun at me			
When I want attention			
When I am confused			
When I don't get what I want			

Have rating computed in years. Example: 10 years old, 14 years old, etc.

Ask students to make three or more copies of chart and have the following persons rate them - a parent, a friend and themselves. Keep these for comparison at end of year.

Item 2 - Check List for Self-Understanding*

Check those items to which you could or would answer "Yes"

I. Accepting One's Physique

1. I think I am too big.
2. I think I am too tall.
3. I am smaller than most people in my class.
4. My clothes don't look as well as my classmates' clothing.
5. I don't like to fit patterns in class.
6. I think I'm well proportioned.

II. Learning New and More Mature Relations with Age Mates of Both Sexes

7. I enjoy dating.
8. I have many friends.
9. I like to go to parties.
10. I do not like to go to parties.
11. I enjoy mixed parties.

III. Acquiring Emotional Independence From Parents and Other Adults

12. I can make my own decisions.
13. My parents approve of my judgment.
14. My parents dictate to me.
15. I do not like to be corrected.
16. We often disagree at home.
17. My parents have confidence in me.

IV. Selecting and Preparing For an Occupation

18. I know what I am going to do for a living.
19. I want to do the same kind of work my father does.

* Courtesy of Home Economics Education Classes, University of Missouri.

20. I don't want to do the same kind of work my father does.

21. I want to work and earn a lot of money.

22. I want to be a doctor or a lawyer.

23. I wish I knew what I wanted to do for a living.

V. Acquiring Skills and Concepts Necessary For Civic Competence

24. I like to work with groups.

25. I would rather work alone.

26. I'm proud of my community.

27. My community needs to be improved.

28. I like to be a leader.

29. I would rather be a follower than a leader.

VI. Desiring and Achieving Social Responsibility of Behavior

30. I like to give parties.

31. I like to go to teas.

32. I like to plan teas.

33. I like to meet people.

34. Making introductions is fun.

35. I do not like to meet new people.

VII. Building Values in Keeping With an Adequate World Picture

36. We are all created equal.

37. I enjoy my grandparents.

38. To travel is fun.

39. Everyone has a right to his own religion.

40. We all have a right to our personal opinions.

41. Customs of other families and races are interesting.

VIII. Achieving Assurance of Economic Independence

42. I enjoy making my own money.

43. I believe a family should save.

44. I believe every family member of age should work.

45. My father doesn't earn enough money for us all.

46. Most of my friends have more than we can afford.

47. I'll be glad when I can earn my own money.

Item 3 - When Is A Person Grown Up?*

Read the sentence below. If you agree that what is said indicates being grown up, place a check beside the sentence under TRUE. If you think the sentence does not describe what it is to be grown up, check the FALSE column. If you are undecided, check the third column.

You are grown up when you:	TRUE	FALSE	UNDECIDED
1. start dating			
2. are twenty-one			
3. are willing and able to take responsibility for your acts			
4. are given a latchkey by your parents			
5. get a driver's license			
6. try to understand your parents and get along with them			
7. don't lose your temper if you do not get your own way			
8. live within your allowance			
9. vote for the first time			
10. begin to earn money			
11. see the other person's point of view			
12. don't cheat even if others do			
13. begin to "go steady"			
14. are willing to change your attitude after thoughtful deliberation			
15. learn to face up to problem, to solve it or learn to live with it			
16. can argue with your parents and win your point			

* Permission granted by Rev. Elton Smith, St. George's Episcopal Church.

Item 4 - Family Responsibility Inventory*

FAMILY RESPONSIBILITY INVENTORY

Encircle the symbol that represents the person or persons you expect will perform each task in your future family. Encircle H for husband, B for both husband and wife, and W for wife.

H	B	W	1. Doing the weekly grocery shopping.
H	B	W	2. Entertaining the children in late afternoon and early evening.
H	B	W	3. Managing the family's money matters.
H	B	W	4. Washing the car.
H	B	W	5. Bathing and dressing the children.
H	B	W	6. Being concerned with politics and world affairs.
H	B	W	7. Making repairs on household equipment.
H	B	W	8. Feeding the children.
H	B	W	9. Deciding where the family will live.
H	B	W	10. Doing the laundry.
H	B	W	11. Spending time with the boys in the family.
H	B	W	12. Preparing the meals.
H	B	W	13. Paying the bills.
H	B	W	14. Doing the vacuuming.
H	B	W	15. Choosing where we will go and what we will do when we go out for fun.
H	B	W	16. Planning the meals.
H	B	W	17. Staying home with the children during part of the weekend.
H	B	W	18. Doing the ironing.
H	B	W	19. Deciding on types of insurance policies for the family.
H	B	W	20. Doing the dusting.
H	B	W	21. Guiding the children's play activities.
H	B	W	22. Keeping clothes in repair.
H	B	W	23. Managing and planning for spending money.
H	B	W	24. Scrubbing and waxing floors.
H	B	W	25. Spending time with the girls in the family.
H	B	W	26. Drying dishes.
H	B	W	27. Decisions affecting the family as a whole, such as when meals are served and when television is turned on.
H	B	W	28. Washing dishes.
H	B	W	29. Babysitting in the evenings.
H	B	W	30. Selecting furniture for the house.
H	B	W	31. Setting social dates with other couples.
H	B	W	32. Washing windows.
H	B	W	33. Caring for the children when they are sick.
H	B	W	34. Serving meals or keeping the house orderly when we have guests.
H	B	W	35. Decisions concerning the children, such as where they will go and what they may do.
H	B	W	36. Rearranging the furniture.
H	B	W	37. Disciplining the children.
H	B	W	38. Buying gifts for holidays and birthdays for the children, relatives, and friends.
H	B	W	39. Deciding the place for the family vacation.
H	B	W	40. Cleaning up after guests have left.
H	B	W	41. Shopping for clothes for the children.
H	B	W	42. Emptying the garage.
H	B	W	43. Gardening or other lawn work.
H	B	W	44. Keeping informed and active in the work of the community.
H	B	W	45. Selecting small kitchen appliances.

* Permission to reproduce this Inventory granted by The National Council on Family Relations.

Item 5 - A Test On "Mate Selection"*

A student teacher at Texas Tech recently made many discoveries about her students when she used the following questions as a test over the unit of "Mate Selection":

How can happiness "run in families?" Is it inheritable" Explain and illustrate.

If one comes from an unhappy home, is he doomed to an unhappy future home? Is he doomed to an unhappy marriage? Explain.

What is the best guarantee that a couple will enjoy their leisure time activities together after they marry? Explain and illustrate.

"Marriage is no better than the material that goes into it." Explain.

What is your understanding of the term "mixed marriage"? Illustrate.

Many men protect their egos by dating and marrying those who are younger and who have the same or less education then they have. Discuss.

Determine the four most important characteristics which you could not tolerate in a marriage partner and give the reasons for your choice.

Do you consider this statement to be true?: "It is more important to be the right person than to find the right person." Why or why not?

* Tips and Topics in Home Economics - Vol. IV, No. 2, December 1963, p. 8 - Permission to reprint this material granted by the School of Home Economics, Texas Technological College, Lubbock, Texas.

Item 6 - Questionnaire on Marriageability

Questions which each partner should be able to answer in the affirmative before marriage.

1. Are we both mature enough so that personality needs will not greatly change in the next few years?

   Between the years of 17 and 24 most people change greatly. The person one loves at 17 might not suit at all five years later.

2. How many important interests do we have in common? Do we both genuinely enjoy the same kind of books, some of the same activities or sports? Or is one of us bored by many of the things that seem enjoyable to the other? Do we see humor in the same situations? Or is one of us serious and intense about something that seems funny to the other?

3. Are our backgrounds similar enough so that we could understand each other readily in marriage? (The importance of difference in religion, race, and other factors has been discussed in another chapter)

4. What about the family of the person I love? Are they a happy, congenial family? If he (she) comes from an unhappy family, has it marred his personality?

5. What do my family and friends think of him? If he embarrasses me around them, is it because I am overly sensitive, or is it that he (she) really does not fit in with the other people I care for?

6. Do we quarrel? A few quarrels may occur in almost all courtships, but many quarrels mean that there will be many quarrels in marriage. Many quarrels must be recognized as a sign that something is wrong, a danger signal warning that trouble is ahead if these two people marry each other.

7. Am I confortable around this person? That is, can I be my real self or do I feel that I must work hard to live up to some of the expectations he (she) has for me? Do I feel that I must try to appear to be different from what I am?

8. How well do we agree on roles of men and women? Does one of us believe in equality and the other believe in the male-superior and female-inferior pattern in life? That kind of a difference does not help love to grow later.

9. Have we been acquainted long enough to know how well we agree on important matters, or have we been so busy making love that we just assume that we agree on everything?

10. How much do we confide in each other? People who confide in each other are establishing a good pattern for their future happiness.

11. Would I want to change this person if I married him (her)? It probably cannot be done.

12. Do I respect his (her) judgment? Are there many occasions when it seems to me that he makes the wrong decisions or choices?

13. How mature are we both? Have we learned the differences between love and physical attraction? Can we look at marriage objectively, or are we basing our ideals and expectations upon romantic stories or movies?

14. Do we have the same goals in life? Are we going in the same direction, so that we can happily strive for the same things?

Item 7 - The Family Life Cycle*

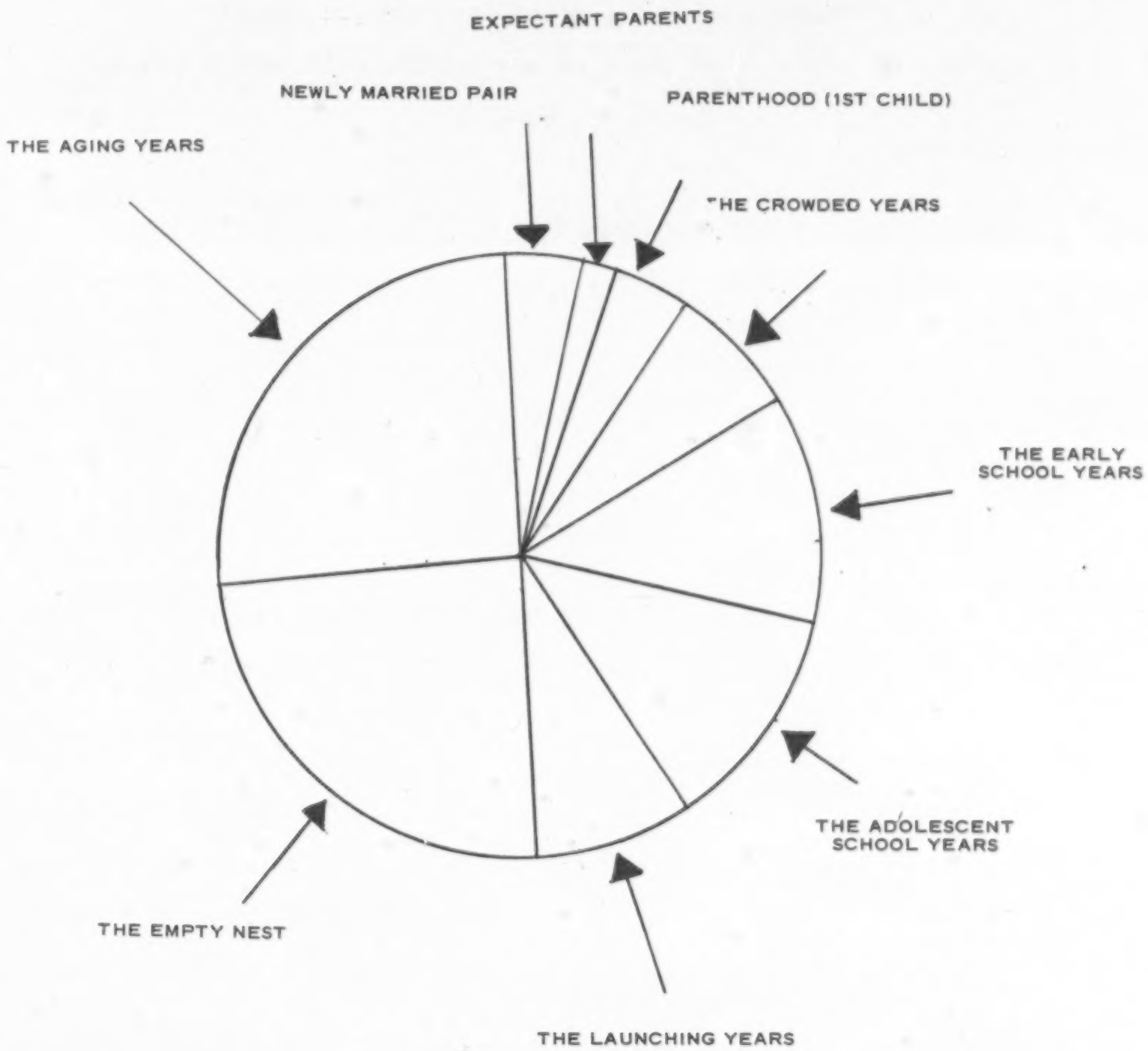

* Permission to reproduce this chart granted by the American Social Health Association.

Item 8 - The Family Cycle*

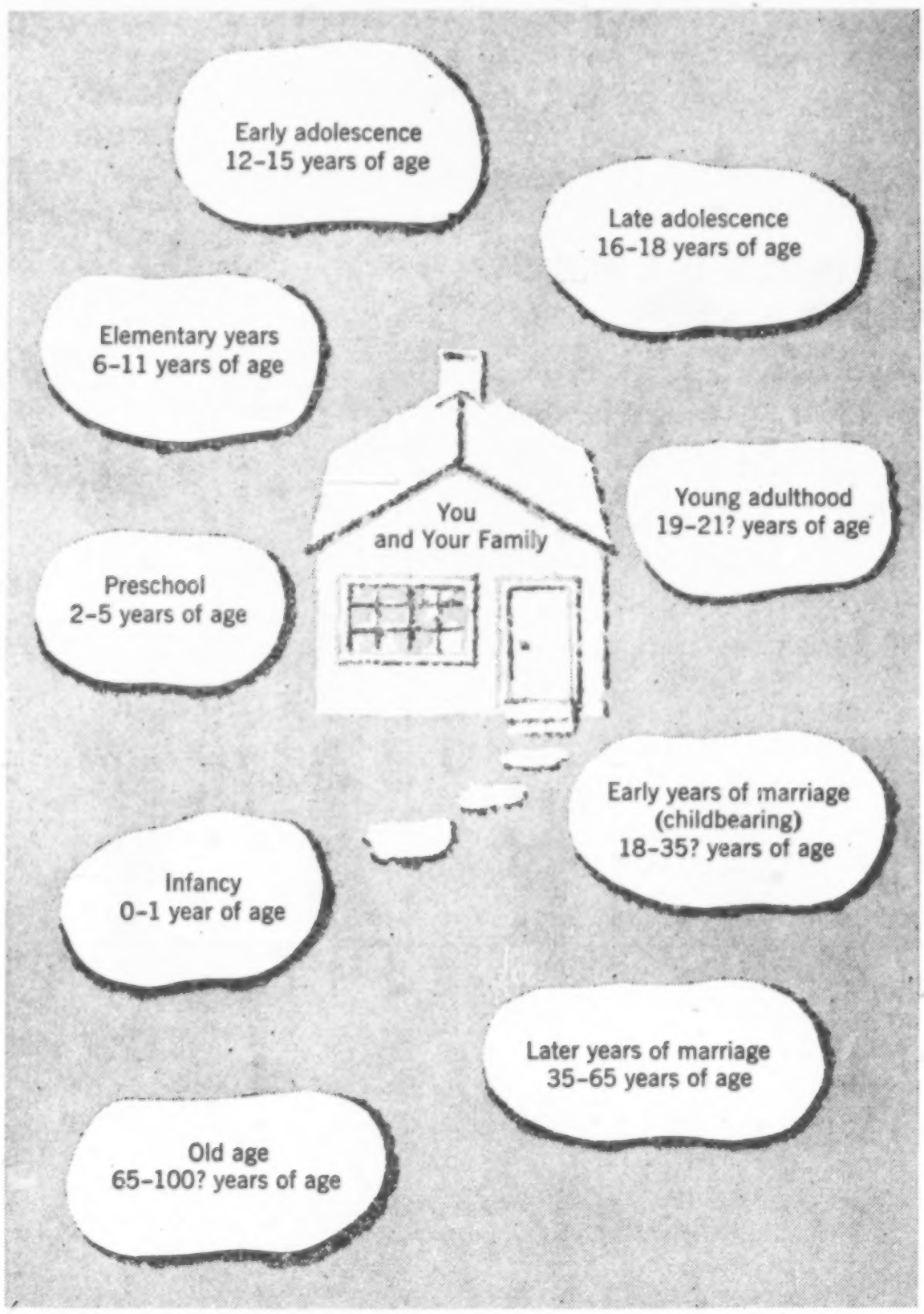

* Hoeflin, R. M. - Essentials of Family Living, p. 91. Permission to reproduce this chart granted by John Wiley & Sons.

Item 9 - Every Third Worker Is a Woman*

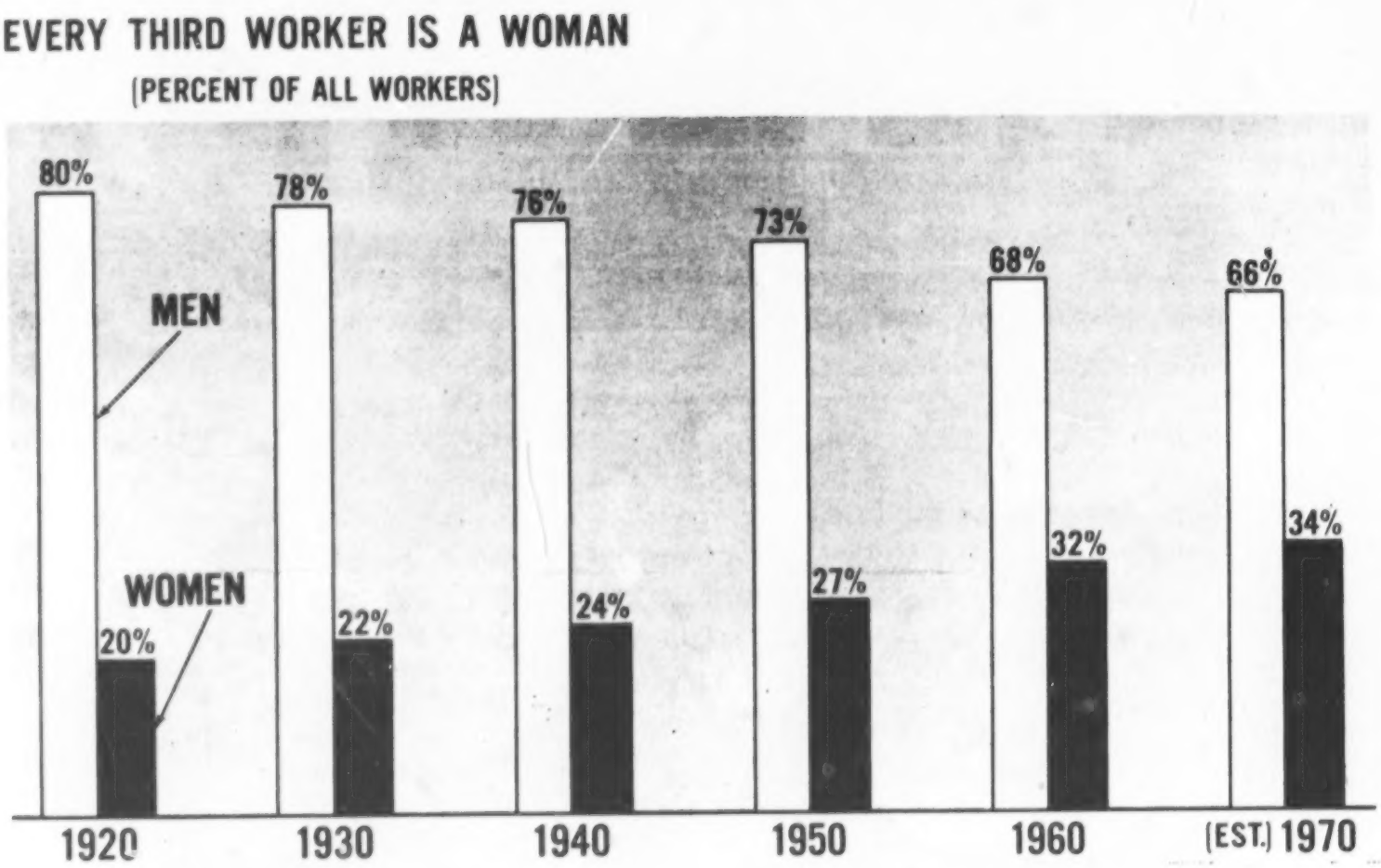

* President's Commission on The Status of Women - American Women, Women's Bureau, Department of Labor, Washington, D. C., 1963, p. 28

Item 10 - Most Women Who Work Are Married*

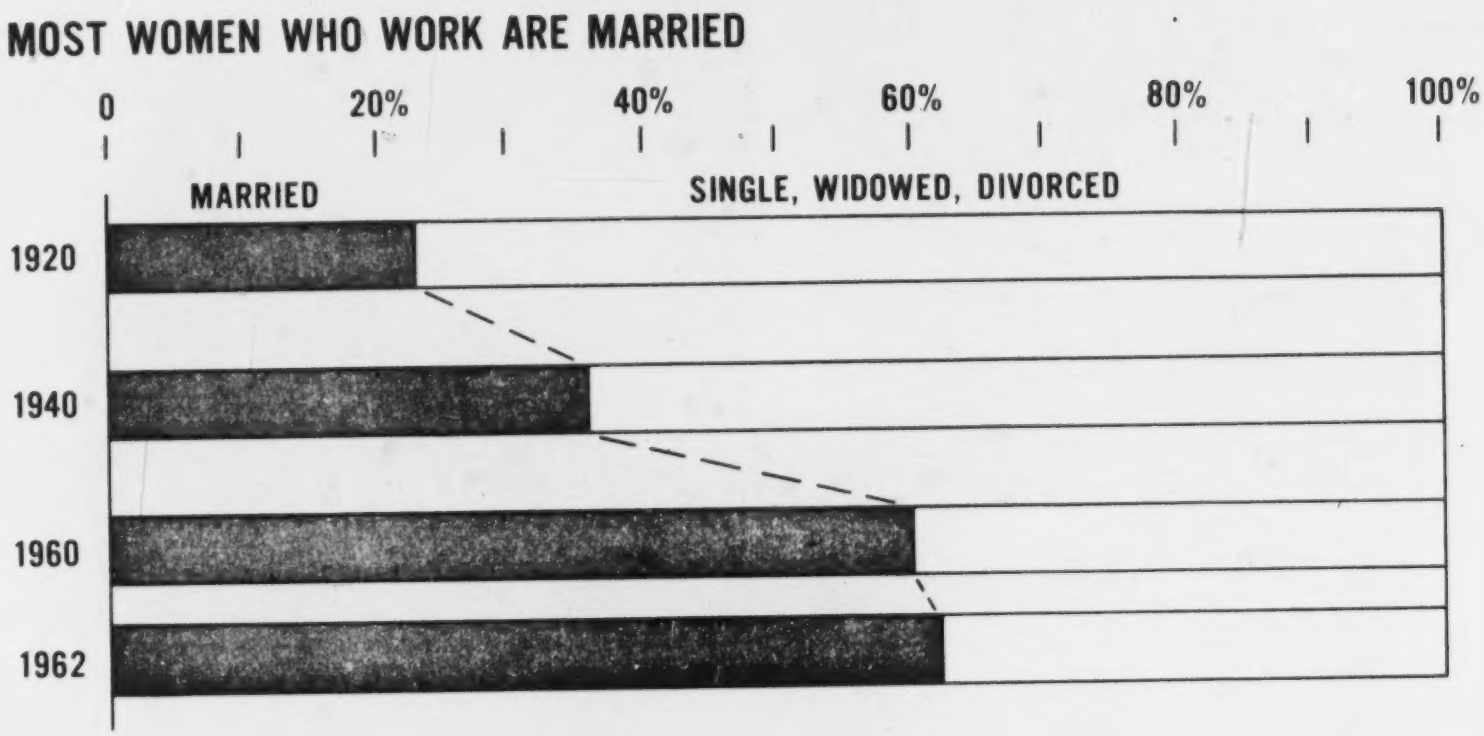

* President's Commission on The Status of Women - American Women, Women's Bureau, Department of Labor, Washington, D. C., 1963, p. 29

Item 11 - Too Many Children Lack Good Care*

TOO MANY CHILDREN LACK GOOD DAY CARE

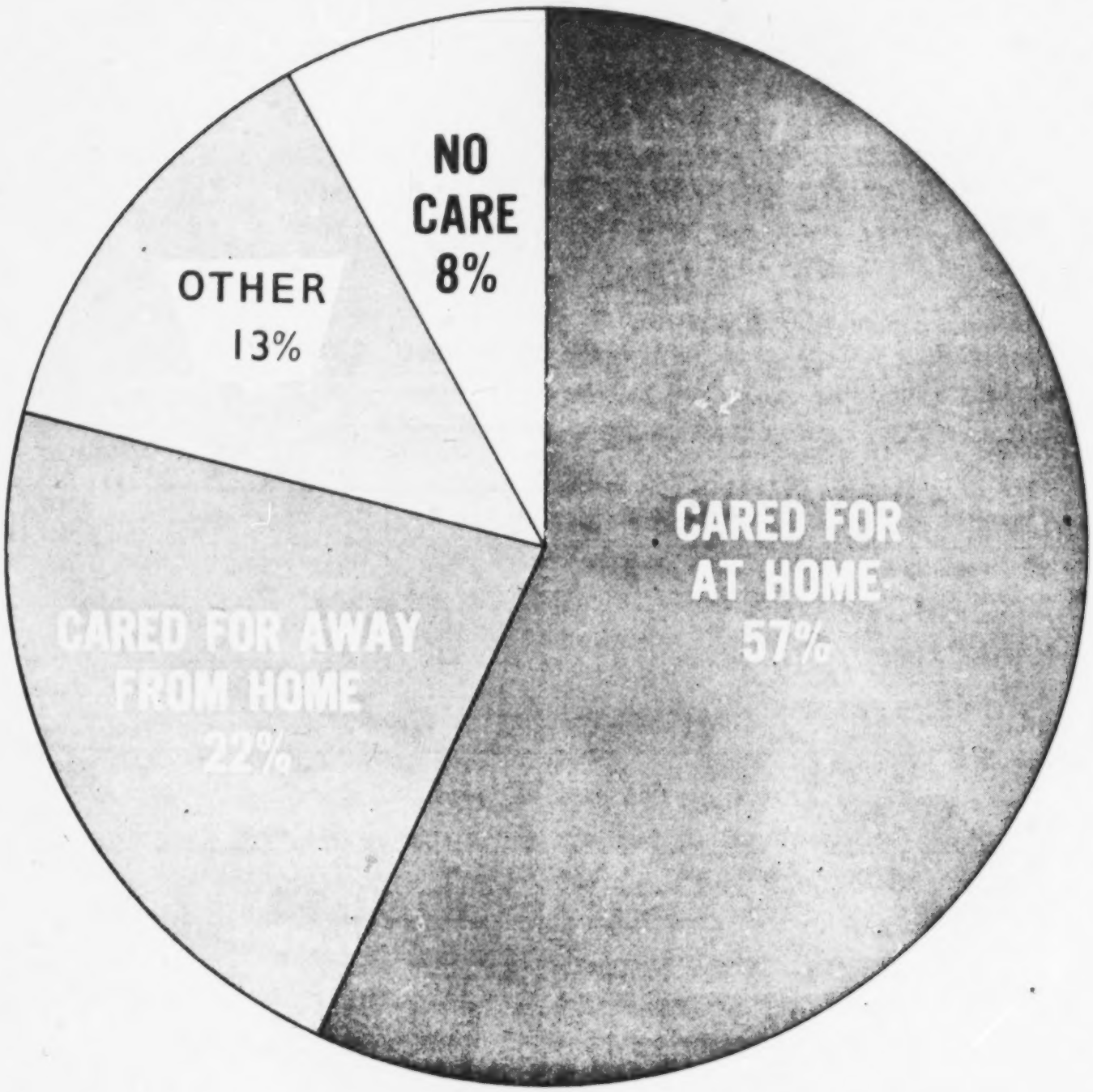

* President's Commission on The Status of Women - American Women, Women's Bureau, Department of Labor, Washington, D. C., 1963, p. 21

Item 12 - Births Out of Wedlock Are Increasing*

BIRTHS OUT OF WEDLOCK ARE INCREASING

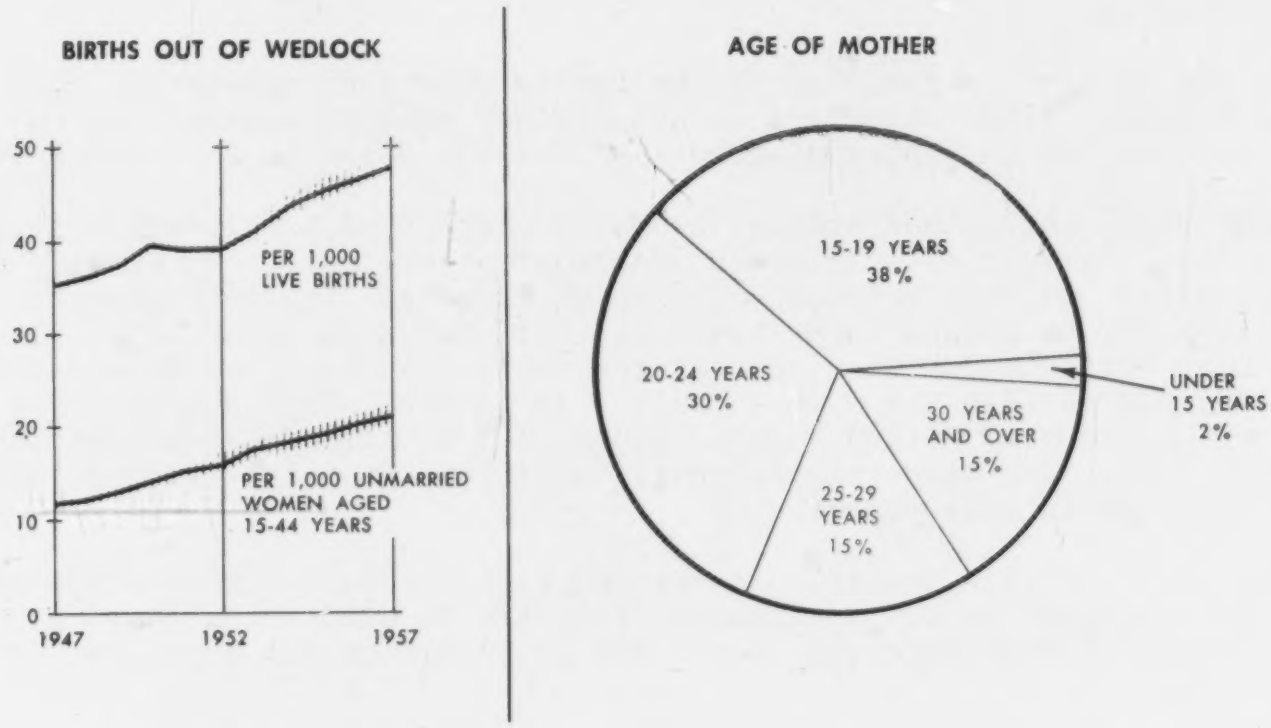

Among the 202,000 babies born out of wedlock in 1957 there were about 81,000 whose mothers were teenagers, about 5.2 percent more than the number born out of wedlock to teenage mothers in 1956. But this does not mean that illegitimacy among teenage girls is increasing disproportionately. While the numbers of teenage marriages and teenage mothers increased, the proportion of teenage girls bearing children out of wedlock remained the same for 1956 and 1957. This is a significant fact since this is the first time since 1940 that there has been no increase in the rates of births out of wedlock to teenage girls.

About 40 percent of all mothers of illegitimate babies are under 20 years of age, about 2 percent are under 15 years. While the proportion under 15 years has not changed significantly since 1938, there is a trend toward smaller proportions for the 15 to 24 year old group and correspondingly larger proportions for those 25 years and older.

* 1960 White House Conference on Children and Youth - Children In A Changing World - a book of charts, p. 22

Item 13 - Letter Which Is Mailed Early in the School Year to Parents of Students Enrolled in Family Relations

SCHOOL DISTRICT OF KANSAS CITY, MISSOURI
DIVISION OF INSTRUCTION
DEPARTMENT OF FAMILY LIFE EDUCATION

October, 1965

Dear Parents:

Your boy or girl is enrolled in the family relations course in your high school. Since this is a relatively new area of instruction in our schools, we thought you would like to know a little more about it.

Almost every individual spends the major portion of his lifetime living in a family situation. It seems important, therefore, that we give our young people as much help as possible to live well in their parental families and to create happy homes of their own at a later date. It was with this thought in mind that the course entitled Family Relations was introduced into our high schools. In general, this course seeks to foster good mental health, sound values, and to strengthen and enrich family life. Enclosed is a brochure outlining the units of study which are included in this course.

A fee of $1.00 each semester is charged each student. Since students are not required to buy a textbook, this fee is used to purchase a variety of reading materials which are available to all enrollees in the class.

The family relations class meets daily for the entire school year. It is open to senior students.

Any time that you would like to know more about this class, you are invited to consult with your family relations teacher, your school principal, or you may call Dr. Esther E. Prevey, Director of Family Life Education, School District of Kansas City, Missouri - Ba 1-7565, extension 233.

We hope this class will prove beneficial and interesting to your son or daughter.

Sincerely,

Family Relations Teacher

APPENDIX C

Biolgocial Charts and Statistics

Item 1 - Female Pelvic Organs - Chart A

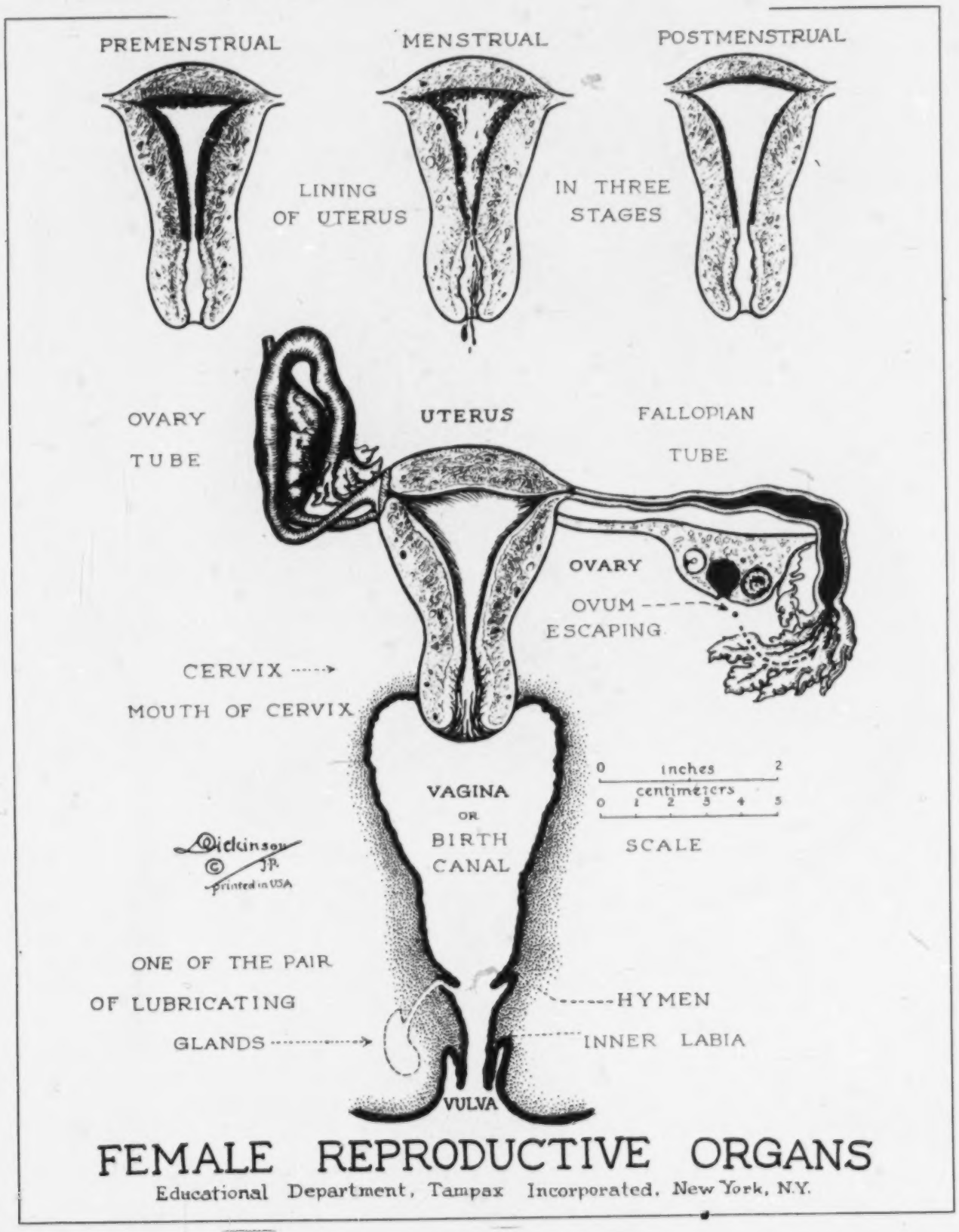

*Permission to reproduce these charts granted by Tampax, Inc.

Female Pelvic Organs - Chart B

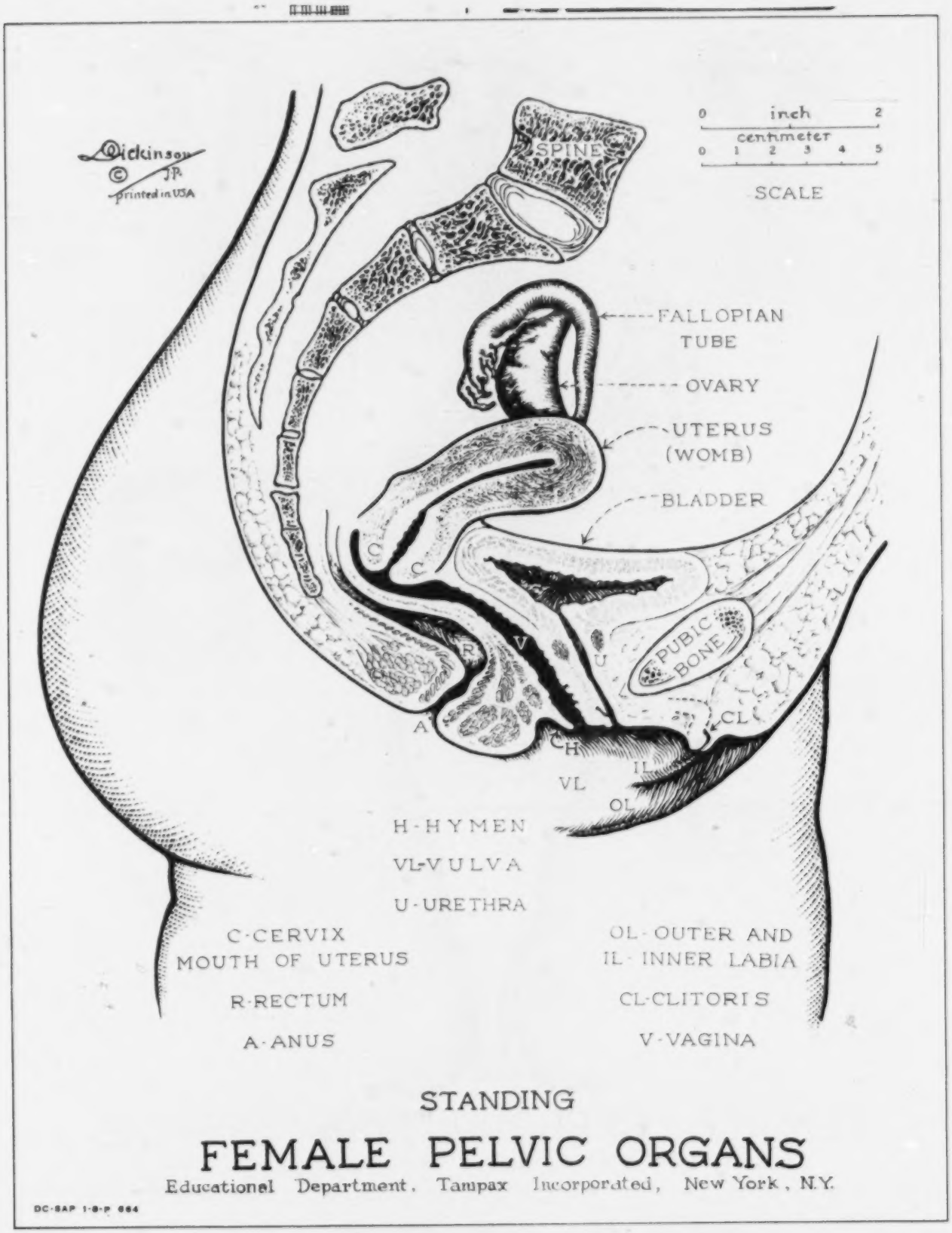

Item 2 - The Male Reproductive System

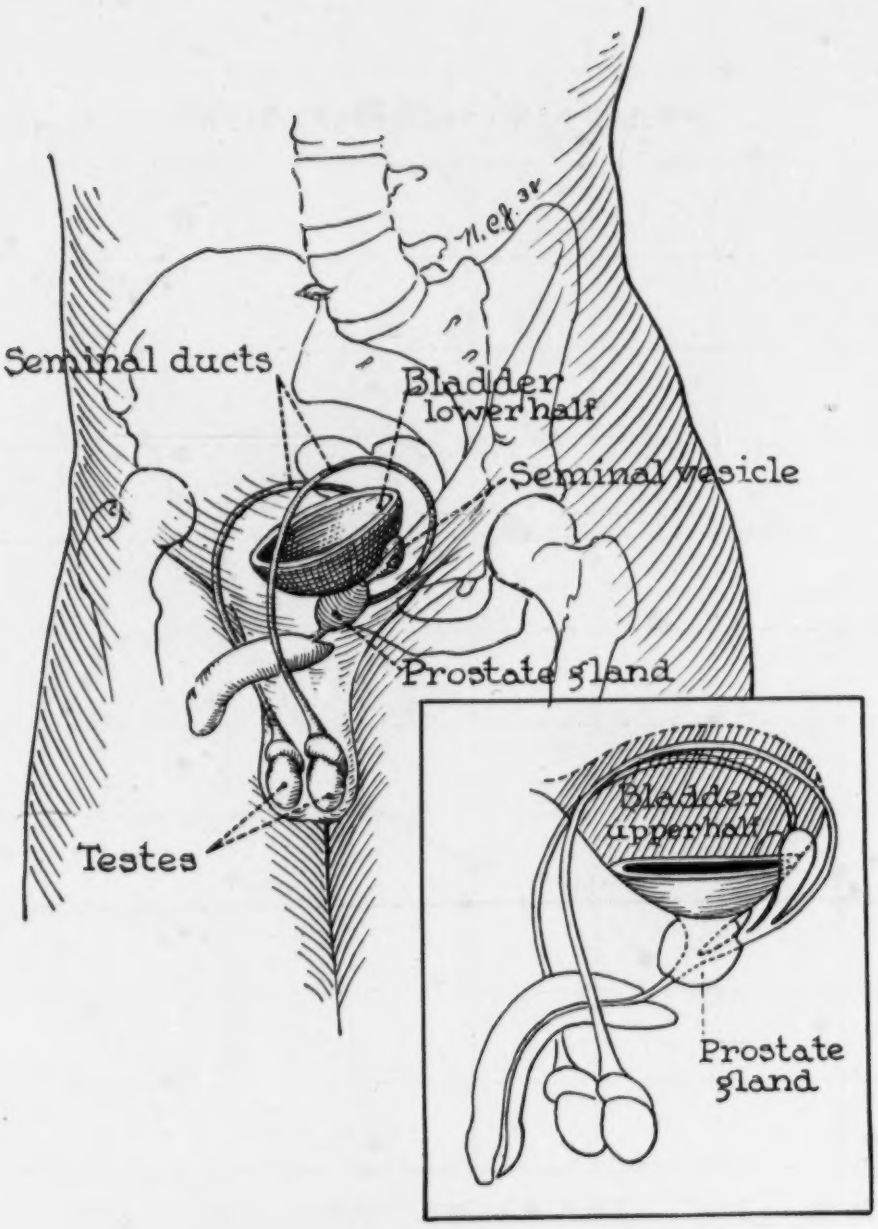

Male Reproductive System

Reported Infectious Syphilis Cases—1954-1964

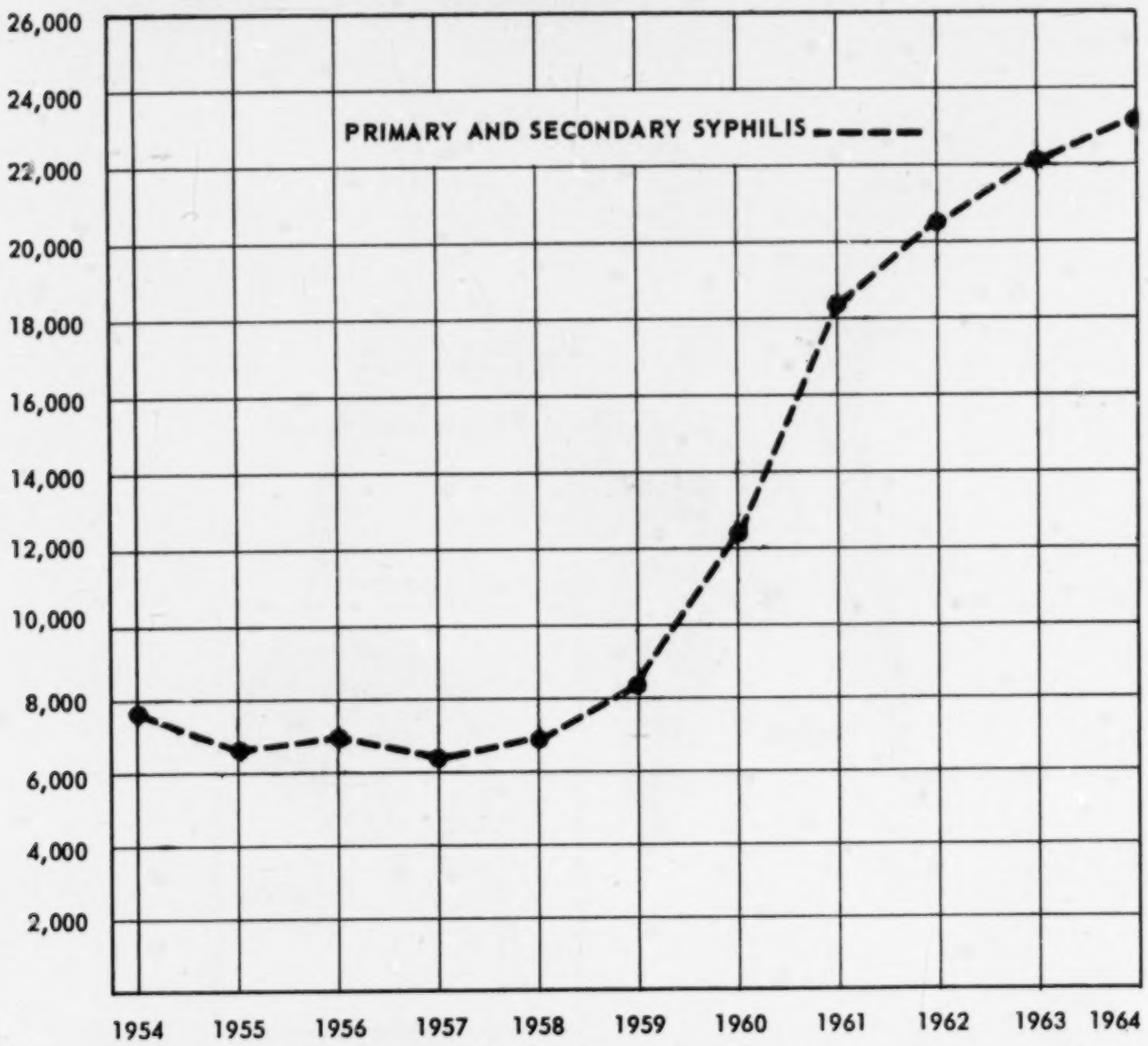

Reported primary and secondary (infectious) syphilis increased again in fiscal 1964 to 22,733 cases, a rise of 3.6 percent.

* American Social Health Association - Social Health News, Vol. 40, No. 1, Jan. 1965, p. 2. Permission to reproduce this chart granted by the Association.

APPENDIX D

Professional Resources

Item 1 - National Agencies and Organizations

American Social Health Association - 1790 Broadway, New York, N. Y. 10019

Child Study Association of America, Inc. - 9 East 89th St., New York, N. Y. 10028

The Christophers - 18 East 48th Street, New York, N. Y. 10017 (Christopher records on sex education)

Connecticut Mutual Life, Human Relations Program - Hartford, Conn. 06115

Gerber's Baby Foods - Department of Nutrition, Fremont, Michigan

The Hogg Foundation for Mental Health - The University of Texas, Austin 12, Texas

Household Finance Corporation - Prudential Plaza, Chicago 1, Illinois

Human Relations Aids - 104 East 25th Street, New York, N. Y. 10010

Institute of Life Insurance - Educational Division, 277 Park Avenue, New York, N. Y. 10017

Insurance Information Institute - 110 William St., New York, N. Y. 10038

Metropolitan Life Insurance Company - School Health Bureau, 1 Madison Ave., New York, N. Y. 10010

Missouri Bankers Association - 25 South 8th Street, Columbia, Missouri

Missouri Bar Association - The Missouri Bar, 223½ East High Street, Jefferson City, Missouri 65102

Missouri Consumers Finance Association - 225 South Meramec Ave., Room 828T, Clayton, Missouri 63105

State of Missouri, Division of Health, Health Education Services, State Office Building, Jefferson City, Missouri

Narcotics Education, Inc. - P. O. Box 4390, Washington D. C. 20012

National Consumers Finance Association - 1000 16th Street, N. W., 701 Solar Bldg., Washington, D. C. 20006

National Council on Family Relations - 1219 University Ave., S. E., Minneapolis, Minn. 55414 - Publishes Marriage and Family Living - quarterly, $12.50 per year includes membership dues.

National Education Association - 1201 16th St.,N. W., Washington, D. C., 20036
A - Department of Home Economics
B - Secondary Principals Association

Play Schools Association - 41 West 57th Street, New York, N. Y., 10019

Public Affairs Pamphlets - 381 Park Avenue, South, New York, N. Y. 10016

Science Research Associates - 259 East Erie St. Chicago, Illinois, 60611

United States Treasury Department - Internal Revenue Service, "Teaching Taxes" material - write to Director, Training Division, Internal Revenue Service, Washington, D. C. 20024

University of Missouri - Cooperative Extension Program, Columbia, Missouri, or 23rd floor, City Hall, 414 East 12th Street, Kansas City, Missouri 64106, Vi 2-2268

Item 2 - Local Agencies and Organizations

Better Business Bureau - 400 Title Building, 112 East 10th Street, Kansas City, Missouri 64106, Ha 1-8188

Dairy Council of Greater Kansas City - 5200 East 45th Street, Kansas City, Missouri 64130, Un 1-5300

Family and Children's Services of Kansas City, Missouri - Suite 600, 417 East 13th Street, Kansas City, Missouri 64106, Vi 2-0988

Home Savings Association - 1000 Grand Avenue, Kansas City, Missouri, Mr. J. D. Farmer, Ba 1-7100

Jackson County Welfare Office, Missouri Division of Welfare - 313 East 16th Street, Kansas City, Missouri, Mr. Edward Dunkin, Ha 1-3816

Jewish Federation and Council of Greater Kansas City - Community Relations Bureau, Room 425, 20 West 9th Street Building, Kansas City, Missouri 64106, Ha 1-5808

Kansas City Association for Mental Health - 417 East 13th Street, Kansas City, Missouri 64106, Gr 1-8122

Kansas City Health and Welfare Council - 320 East 10th Street, Kansas City, Missouri 64106, Gr 1-8030

Kansas City Social Health Society - 406 West 34th Street, Suite 412, Kansas City, Missouri 64111, Je 1-7272

Missouri Department of Revenue - Income Tax Division, Railway Exchange Building, 7th and Grand, Kansas City, Missouri 64106, Vi 2-3686

Item 3 - Periodicals

American Vocational Journal - Published 10 months per year by American Vocational Association, 1010 Vermont Avenue, N. W., Washington, D. C. 20005, Non-members $3.00 per year

Childhood Education - Published 9 months per year by Association for Childhood Education International, 3615 Wisconsin Avenue, Washington, D. C. 20016, Non-members $5.50 per year

The Family Life Coordinator - University of Oregon, Department of Sociology, Eugene, Oregon 97403, $3.00 per year

Journal of Home Economics - Published 10 times per year, official organ of American Home Economics Association - Non-members $10.00 per year

National Parent-Teacher - National Congress of Parents and Teachers, 700 North Rush Street, Chicago, Illinois 60611, $1.50 per year

Practical/Forecast For Home Economics - 900 Sylvan Avenue, Englewood Cliffs, New Jersey 07632, published 9 months per year, $4.50 per year

Tips and Topics - Published 4 times per year by School of Home Economics, Texas Technological College, Lubbock, Texas 79409, $2.00 per year

What's New In Home Economics - Published 10 months per year, 466 Lexington Avenue, New York, M. Y. 10017, $6.00 per year

Teacher's Notes and Suggestions

VT 005 246
Bernstrom, Hal, And Others
Introductory Business for Everyday Living.
What Business Does and Can Do for You.
Learning Activity Package No. 1.

Hughson Union High School, Calif.
MF AVAILABLE IN VT-ERIC SET.

PUB DATE - Jul67 33p.

DESCRIPTORS - *BUSINESS EDUCATION; SECONDARY EDUCATION; *CONSUMER ECONOMICS; STUDENT EVALUATION; *INDIVIDUALIZED INSTRUCTION; SELF EVALUATION; *MANUALS; EDUCATIONAL OBJECTIVES; WRITING EXERCISES; *TEACHER DEVELOPED MATERIALS; INSTRUCTIONAL MATERIALS; PROGRAMED MATERIALS; RESOURCE MATERIALS
IDENTIFIERS - *LEARNING ACTIVITY PACKAGES; LAPS

ABSTRACT - Three high school instructors prepared this learning activity package to help students understand basic business terms and ideas as they apply to consumers and producers. Useful for individualized instruction, these materials include: (1) a student evaluation chart, (2) a pretest, (3) instructional objectives, and (4) student activities. Also included in this color-coded material are several illustrations and the answers to the pretest. (JS)

VT 005 246

ED0 56238

VT (1)

INTRODUCTORY BUSINESS
for Everyday Living

What Business Does and Can Do For You

"Learning Activity Package #1"

3 Week LAP

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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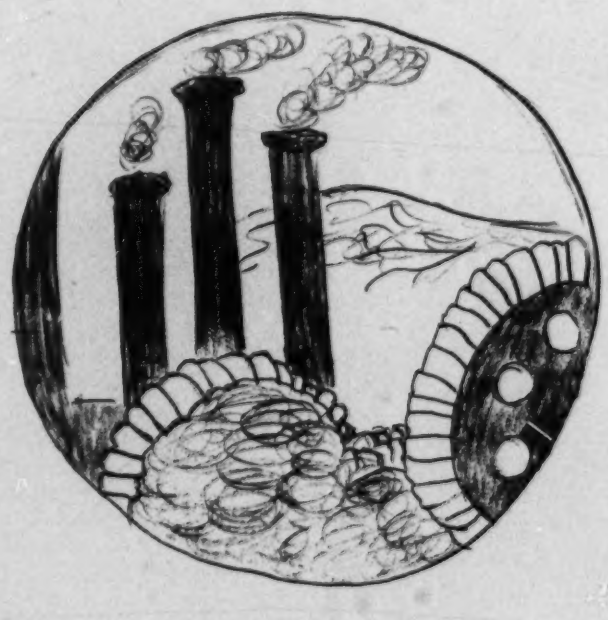

By Hal Bernstrom
Shirley Glenn
Gloria McGill
of the
Business Department

To be used at--
Hughson Union High School
Hughson, California
July, 1967

STUDENT NAME _____

VT005246

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INTRODUCTORY BUSINESS FOR EVERYDAY LIVING

This is a learning activity package to help you understand basic business terms and ideas as they apply to consumers and producers.

Rationale (Why Study This?)

The purpose of this Learning Activity Package is to expose you to business and economic affairs that will affect your everyday life and well-being. It will enable you to develop an understanding of our economic society. Our purpose will be accomplished through direct, clear, accurate, and lively presentations in which business principles and basic economic ideas are explained by relating them to experiences we have in living and working in America today.

This study will lead us to units concerning money, finance, insurance, law, and economic factors operating in our business world.

Primary Idea

The main idea you should obtain from this study is "What Business Can Do and Does For You." This information will come from the secondary ideas that follow.

Secondary Ideas

1. You Live in a Business World.
2. Business Satisfies Your Wants Through Production.
3. Business Markets Your Goods.

Instructional Objectives (or Goals)

To help you find the information the work is divided into smaller objectives (goals) and activities. Below is a list of these:

I. The student will domonstrate his understanding of the selected business terms by being able to:

   A. Define each term in his own words
   B. Relate each term to given business situations
   C. Apply the use of these terms to given business situations

II. Given knowledge of the basic business terms, the student will demonstrate the way in which the production of goods and services satisfies our needs and wants by ability to:

   A. Explain relationship of goods and services to production
   B. Give examples of the factors of production
   C. Explain the effect of production on the standard of living

III. The student will demonstrate his knowledge and understanding of the three steps in marketing goods by his ability to:

   A. Define each step in his own terms
   B. Give examples of each step
   C. Explain the relationship of marketing to production and consumption

HOW TO USE THIS LAP!

STOP, LOOK, AND LISTEN! ! ! Then follow these directions. This LAP is an introductory LAP. It is divided into three segments. Each segment is divided into three steps.

1. The Instructional Objective: What we expect of You. This tells you what skill or idea you will be expected to know or obtain from each segment.

2. The Activities: FUN, FUN, FUN !!!
   Required : These are activities all students must complete.

   Optional : These are activities any of the students may complete to learn more about the objective. (Extra Credit will be given for the GO-GETTER who completes one or more activity successfully.)

Exemption Procedures (How Do You Skip a Segment?)

After looking at and reading the content and objectives of this LAP, you may want to by-pass (Exempt) the unit. In this case:

1. Take the pretest. If you pass with 5 errors or fewer you may proceed with the exemption.

2. See the instructor for an exemption evaluation consisting of:

   A. An oral exam on content
   B. An evaluation of the content

3. If you are successful, proceed to the next LAP or complete parts of this LAP that interest you.

Required Activities

All nonexempted students will complete the required activities in their numerical order. Papers are to be handed in to the instructor as soon as they are completed and you go on to the next activity. The papers will be evaluated and returned. Some required activities are labeled a or b or c or d. This means that you may choose any one of them or all if you so desire.

Optional Activities

These activities are designed to provide greater understanding for those who wish to learn more about the unit. Extra Credit will be given on the unit grade. When you have finished your Optional Activities be sure to turn them in to the instructor for evaluation.

STUDENT EVALUATION CHART

Inst. Objective #	"Should Time"	Time Taken	Optional Activities Completed	Extra Credit	QUANTITY	QUALITY	TEACHER TEST	FINAL AVERAGE
							Total of Averages Score	
							# of Sub Units	
							Final Average	

PRETEST

Everyone takes the pretest. Check your answers with answers on page 32 of this LAP. If you miss only 5, you can take the teacher test. If you miss more than 5 questions, you must start activities on page 10 of the LAP.

		True or	False
1.	Satisfying just one person's needs may require the efforts of many people.	T	F
2.	Farming is no longer the largest single industry in the U.S.	T	F
3.	Competition may exist even between different types of business.	T	F
4.	Over the years, man's wants and needs have decreased.	T	F
5.	One of the easiest decisions consumers have to make is how to spend money.	T	F
6.	All businesses in this country (a) are interdependent (b) require raw materials (c) require machinery (d) are successful.	_____	
7.	Competition forces businesses to (a) pay high wages (b) expand (c) advertise (d) be efficient	_____	
8.	Define: goods		
9.	Define: consumer		
10.	A bank is an example of a service type business.	T	F
11.	A free-enterprise system discourages competition.	T	F
12.	Consumers determine the kinds of things our business system porduces.	T	F
13.	A nation's standard of living depends on its population.	T	F

14. Fewer people earn a living by working for someone else than by operating businesses of their own. T F

15. Efficient production is as important to workers as it is to the owners of business. T F

16. The amount of goods and services a worker can obtain in exchange for one hour of labor has been steadily decreasing. T F

17. Production is the result of combining labor with natural resources and (a) technology (b) advertising (c) capital (d) specialization. _____

18. Define: producer

19. All businesses engage in manufacturing. T F

20. Today practically no one produces all the things that he needs. T F

21. The process of getting goods from producers to consumers is marketing. T F

22. One marketing function that is required for all production is (a) storage (b) packaging (c) processing (d) transportation _____

23. Converting raw materials into finished products is called (a) marketing (b) specialization (c) division of labor (d) manufacturing _____

24. Define: 3 functions of marketing

25. Define: marketing

Now grade your test. Answers on page 31 of LAP

INSTRUCTIONAL OBJECTIVE #1 TIME: 4 days

The student will demonstrate his understanding of the selected business terms by being able to:

A. Define each term in his own words.
B. Relate each term to given business situations.
C. Apply the use of these terms to given business situations.

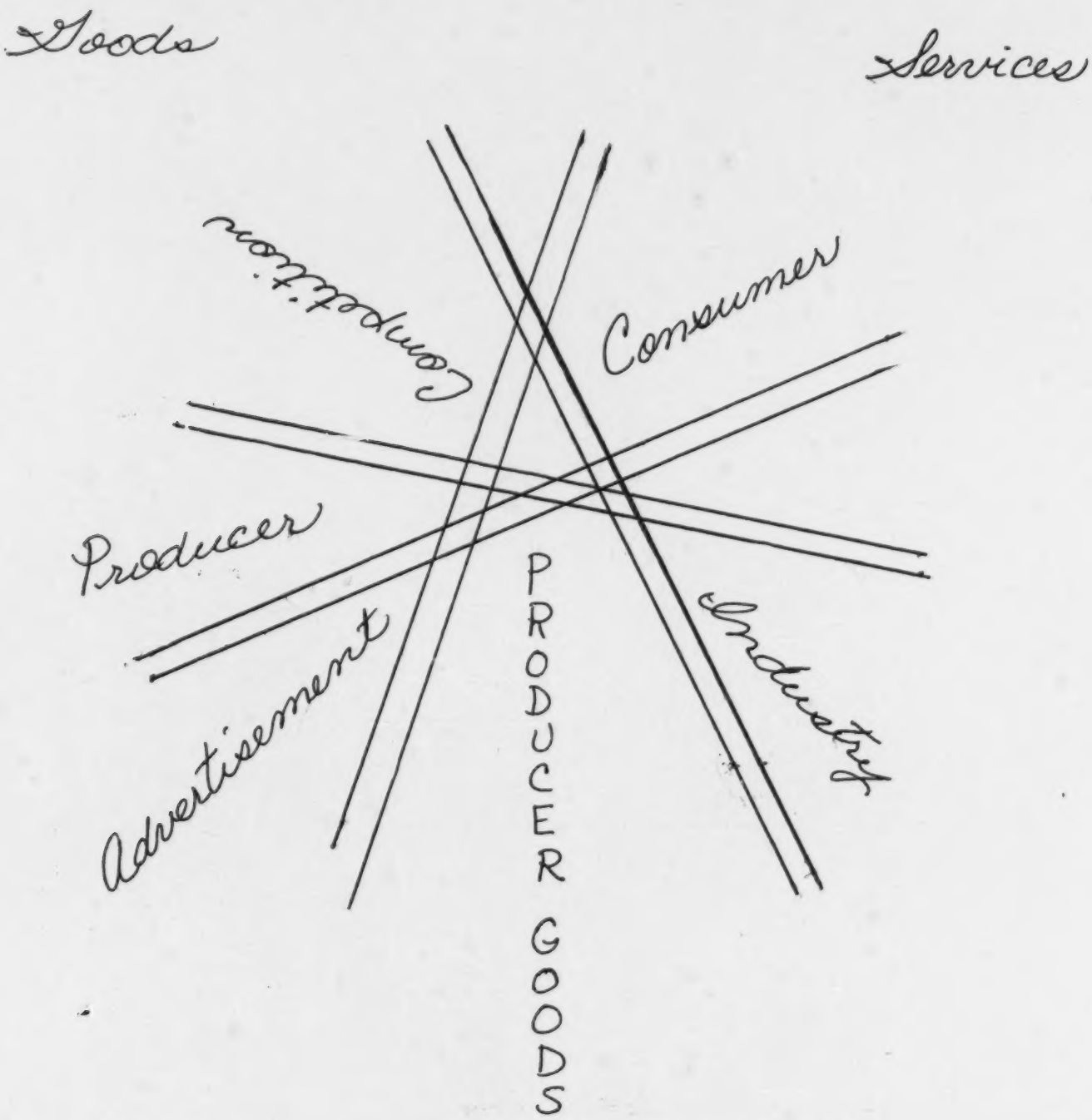

TURN TO NEXT PAGE

Required Activities

Complete #1 and #2, then the balance in any order you desire. Remember * is in Quality Score, page 6 of LAP 1.

1. Write a two paragraph paper on what you expect to gain from this course.

2. Read on of the following (or both for additional information.)
   a. Pages 4-16 in GENERAL BUSINESS, 2nd Edition
   b. Pages 1-7 in GENERAL BUSINESS, 3rd Edition

Special Everyone view "A Better Way." (Time and place to be announced.)

*3. Complete Vocabulary and Understanding on page 13.

*4. Complete Projects and Problem #1 on page 14.

*5a Alone or with some other student write the answers to Sharing and Discussing Your Problems on page 15.

OR

5b Sign up for and attend a small group discussion to discuss Sharing and Discussing Your Problems, page 15 in LAP 1.

Optional Activities

Complete as many of these in any order as you wish.

1. Business information is often presented by means of tables, charts, or graphs in order to show comparisons or relationships. For example, the table below shows five of the largest companies in the U.S., measured by the number of employees.

Company	# Employees
Ford Motor Company	160,181
United States Steel	225,081
General Motors	595,000
Standard Oil Company of NJ	140,000
General Electric Co.	250,621

a. List the companies in order of their size as measured by employees. Begin with the largest.
b. Find the total number of people employed by these companies.
c. The average number employed by these companies was _____ (Number employed by all - number of companies = average # employed)

2. Read or reread pages 12-16 in GENERAL BUSINESS, 2nd Edition and complete Learning by Doing on pages 17-18, Parts 2 and 3 in text.

Vocabulary and Understanding

Vocabulary

Select from the column that term best suited for the statement and write it in the appropriate blank.

goods	producer	consumer
industry	services	luxuries
	producer goods	

1. Material objects, such as books or cameras. _____
2. Things others do for us, like cutting our hair or repairing our cars. _____
3. A group of business enterprises that produce similar products or provide similar services, _____
4. A person or enterprise that makes goods or provides service. _____
5. Goods used to produce other goods or services. _____
6. Goods and services that give pleasure but are not considered necessities. _____
7. Anyone who uses the goods and services of business. _____

Understanding

For each of the questions, indicate your answer by checking Yes or No.

	Yes	No
1. Do most persons today produce the goods they consume?		
2. Are there more farms in the United States than any other type of business?		
3. Is every employed person a producer?		
4. When we say that businesses are interdependent do we mean that they are not dependent on one another?		
5. Do most people depend on business for employment?		
6. Is the primary purpose of business to satisfy our needs and wants?		

		Yes	No
7.	Do most stores produce goods?		
8.	Could only one business satisfy all our wants?		
9.	Could our business system thrive without consumers?		
10.	Does the demand for business products and services increase as our population increases?		
11.	Does what consumers select in the way or products and services have little effect on our business system?		
12.	Is it easy for consumers to decide how to spend their money, since business produces so many goods and services?		

Projects and Problems #1

For each item listed below indicate by a check mark in the appropriate column whether it is a good or a service.

	Goods	Services		Goods	Services
Clothing			Insurance		
Electric Power			Air Transportation		
Gasoline			Telegraph Message		
Hotel Accomodations			Truck Repair		
Hair Cut			Desk Lamp		

List five businesses in your community that produce goods. For each company, list one item it produces. Indicate in the appropriate columns whether the items are made for consumers, producers or both.

Name of Business	Item Produced	For Consumer	For Producer
Example: Roger's Dairy	Milk and cream	X	X
1.			
2.			
3.			
4.			
5.			

Name five types of businesses--either manufacturing or service--on which each of the businesses listed below depends. For example, restaurant depends on such businesses as food supplier, furniture manufacturers, etc.

Filling Station	Barber Shop	Grocery Store	Lumber Yard
1.			
2.			
3.			
4.			
5.			

Sharing and Discussing Your Problems

1. Food is not the only product of our farms. Can you think of other ways in which our farms contribute to production?

2. Does consume mean the same thing as use? Explain.

3. Do you think people can learn to be good consumers?

4. Relate a personal experience in which satisfying one need gave rise to other needs, such as the example of buying a phonograph.

5. Carefully examine this textbook and name at least three different kinds of businesses that might have helped to produce it.

6. Give example of articles that may be either consumer goods or producer goods.

7. Bill Wright maintains that people were more independent in earlier times than they are today. Do you agree? What do you think he means?

8. Primitive man satisfied his wants in a direct manner. Today people satisy their wants in an indirect manner. Explain.

Self-Evaluation

See instructor to go over required activities and those optional activities completed by you, and record on STUDENT EVALUATION CHART.

Complete the following STUDENT SELF-TEST. If you complete 4 out of 5 accurately and to your satisfaction, go on to Instructional Objective #2. If you feel you need additional work on the objective, see the instructor.

Student Self-Test

Write at least one paragraph for each of the following.

1. Business is a means of satisfying our wants and needs. What does business do for you?

2. Why are consumers important in our business system?

3. Give examples of how one business depends on other businesses.

4. Explain the difference between goods and services.

5. What caused farming to become a business today?

INSTRUCTIONAL OBJECTIVE #2 TIME: 4 days

Given knowledge of the basic business terms, the student will demonstrate the way in which the production of goods and services satisfies our needs and wants by ability to:

A. Explain relationship of goods and services to production
B. Give examples of the factors of production
C. Explain the effect of production on the standard of living.

Required Activities

Special! Everyone view a film on "What is Business." This film will be shown during large group activity. (Time and place will be announced.)

1.a Read "Business Satisfies Your Wants Through Production" in GENERAL BUSINESS FOR EVERYDAY LIVING.
Pages 19 to 24 in the 2nd Edition
Pages 10 to 14 in the 3rd Edition

OR

1.b Listen to a tape recording of pages 10 to 14 from GENERAL BUSINESS FOR EVERYDAY LIVING, 3rd Edition. Follow along in your textbook as the information is being read.

*2. Complete the vocabulary and understanding activity pages 20 and 21 of this LAP. You are welcome to use the textbook. Do you remember what * means? Why not find out on page 5 of LAP 1.

*3.a Explain the statement that "All Businessmen Engage in Production" orally to your instructor.

OR

3.b Write a short paper (two or three paragraphs) explaining how a nation's standard of living is closely related to its gross national product.

4.a Sign up and attend a small group discussion on the topics listed on page 22 of LAP 1.

4.b Individually, or with another student, write a brief reply to each of the topics listed on page 22 of LAP 1.

Optional Activities

1. Select an article manufactured in your community and list the raw materials needed to produce it.

   Example: Raw materials needed to produce shirts
   1. cotton cloth

   Raw materials needed to produce_____

_____ _____

_____ _____

_____ _____

2. List six types of production being carried on in your community by young people about your age.

_____ _____

_____ _____

_____ _____

_____ _____

3. Make a list of capital goods that might be used by one of the following kinds of business enterprises: clothing store, shoe-repair shop, railroad, mining company.

   Example: Capital goods required for a clothing store
   1. display cases

   Captial goods required for a _____

_____ _____

_____ _____

_____ _____

4. List goods and services you believe a family must have in order to have a high standard of living.

GOODS AND SERVICES NEEDED FOR A HIGH STANDARD OF LIVING

_____ _____

_____ _____

_____ _____

_____ _____

Vocabulary and Understanding #2

Vocabulary

Read the statements below; then for each statement, select the term that best matches it in meaning. Write this term in the space provided.

capital	mass production
demand	natural resources
division of labor	producer
factors of production	production
gross national product	profit
income	specialization
labor	standard of living
	technology

1. Changing the form or location of natural things to satisfy human wants ___. _____

2. Every businessman expects to earn a fair ___ on his business. _____

3. Natural resources, labor, and capital. _____

4. Things in existence that man did not produce, such as timber, oil, and iron. _____

5. We manufacture hundreds of automobiles daily. This is called ___. _____

6. The human effort that goes into production. _____

7. When an article is produced by many workers who each do only one part of the job, it is __. _____

8. Man-made things used in production. _____

9. A way of dividing production, so that each worker performs only one job. _____

10. When a knowledge of science is applied to production, we call it ___. _____

11. Money received by business from the sale of goods and services. _____

12. The amount of a good or service that will be bought at a particular price. _____

13. Mr. Jones manufactures plastic toys; Mr. Abel sells them, each is a ___. _____

14. The total amount that a nation produces in a year. _____

15. The way a family or the people of a nation live. _____

Understanding

Understanding directions. Each of the following statements is either true or false. If the statement is true, circle the "T" at the right; if false, circle the "F".

1.	Doctors and lawyers cannot be called producers, since they perform only services.	T	F
2.	Production is a minor function of business.	T	F
3.	Production includes not only making goods but transporting and selling them as well.	T	F
4.	A free-enterprise system permits you to select your own occupation.	T	F
5.	Goods used up in production, like office supplies and fuel, are called working capital.	T	F
6.	The term capital goods refers to the money needed to obtain goods used in production.	T	F
7.	Although mass production provides more goods, it increases their cost.	T	F
8.	Some things are produced without capital.	T	F
9.	Production is the result of combining labor with natural resources and capital.	T	F
10.	Iron and coal are natural resources.	T	F
11.	Specialization is a division of labor.	T	F
12.	Income is the result of production.	T	F
13.	Gross National Product is always expressed in dollars.	T	F
14.	The more workers specialize, the more dependent they are on one another.	T	F
15.	A nation's standard of living depends on its population.	T	F

When you have completed this activity test, check with your instructor. He will check your answers so that you may know how well you did.

Sharing Your Opinion and Experience

1. Joan Wilson earns extra spending money by baby-sitiing after school and on week-ends. Is Joan engaged in production? Why?

2. Why is farm land considered a natural resource?

3. What experience have you had as a producer?

4. Explain the statement, "Today production is based on teamwork."

5. How would you describe your community? Is it known as an agricultural area, a trade center, or a manufacturing center?

6. Give two or three examples of how weather influences what people buy.

7. Give some examples of goods that are not mass-produced.

Self-Evaluation

When you have finished the required activities and those optional activities you wish to do, check your progress by answering the following questions. Understanding these guide-posts gives you command to move on to Instructional Objective #3. If you are not comfortable with these ideas, see your instructor for some help.

1. People who make goods or provide services for others are known as producers. Explain how providing services can be called production.

2. The factors of production are natural resources, labor, and capital. Explain or give an example of each factor.

3. What do we mean by "Standard of Living" and how do we measure it?

4. What is production? Why is it the principal function of business?

? ? ? Have you been keeping your Student Evaluation Chart up-to-date ? ? ?

INSTRUCTIONAL OBJECTIVE #3 TIME: 4 days

The student will demonstrate his knowledge and understanding of the three steps in marketing goods by his ability to:

A. Define each step in his own terms
B. Give examples of each step
C. Explain the relationship of marketing to production and consumption

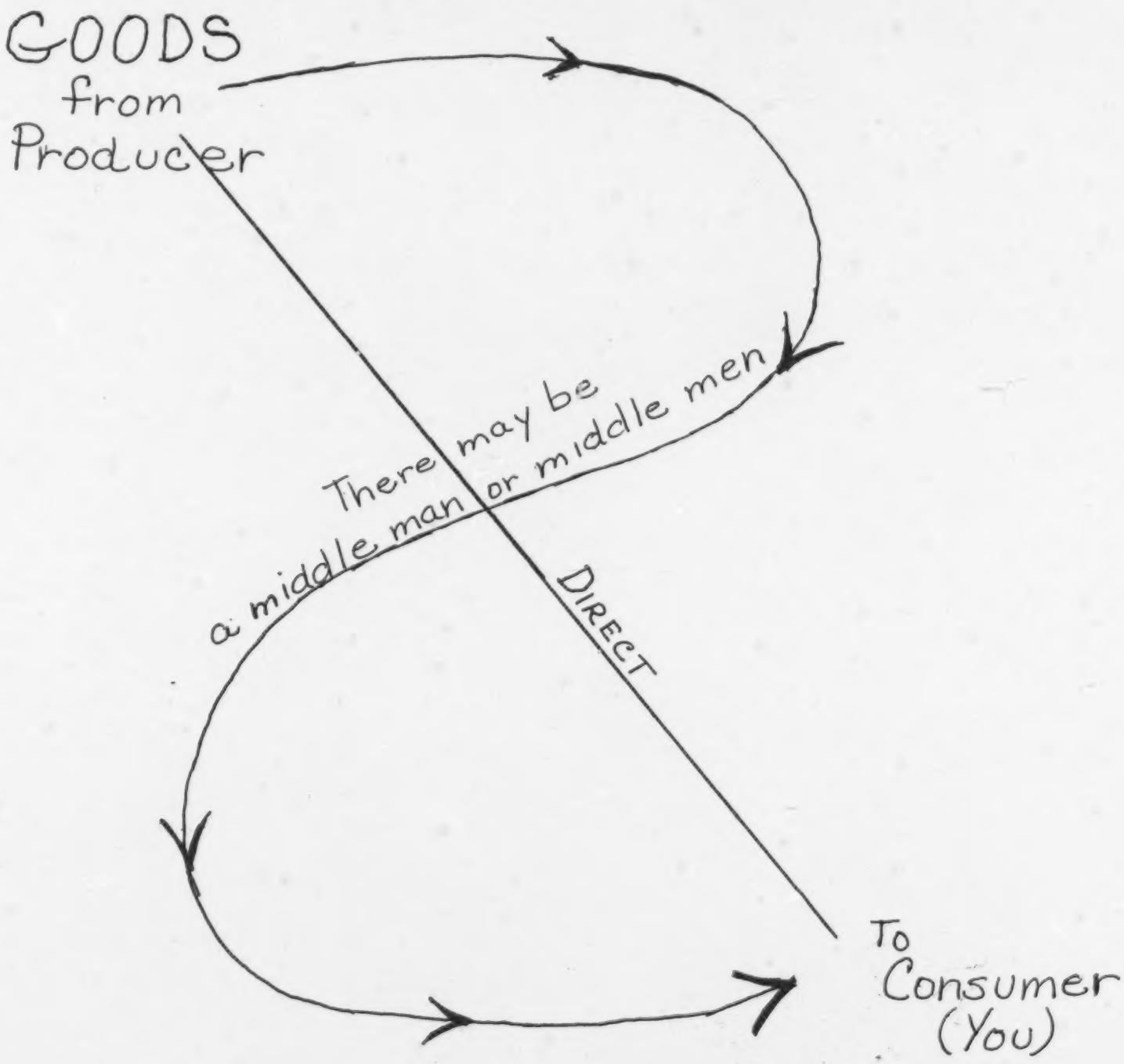

Required Activities

SPECIAL! Everyone attend film "The Making of Life."
This film starts in the forest and ends in pages of Life magazine. (Time and place will be announced.)

1.a Read pages 17-21 in GENERAL BUSINESS FOR EVERYDAY LIVING, 3rd Edition

OR

1.b Read pages 27-32 in GENERAL BUSINESS FOR EVERYDAY LIVING, 2nd Edition

OR

1.c Listen to tape of Chapter 3, Third Edition.

When you have finished this page, turn to page 26 of this LAP.

More Required Activities

You have read or heard a lecture about business markets goods. Now you do two of the following on this page. As soon as you finish one, go on to the next one. Do not wait.

*2.a Write answers to all thirteen questions of the Vocabulary and Understanding on page 28 of LAP 1. Don't forget to hand paper to teacher when you get all thirteen questions answered.

OR

*2.b Orally discuss all ten questions on Checking Your Reading Questions on page 29 of LAP 1 with one classmate. When you finish, record this on your Student Evaluation Chart.

OR

*2.c Sign up for and attend a small group discussion to discuss the following questions. Be ready to contribute information and not noise. Teacher will grade you on class participation.

Give examples of simple forms of distribution.

What determines the cost of marketing different items?

Which do you think would cost more to distribute--goods or services?

What are some of the ways consumers add to the cost of distribution?

What does * mean? Read page 6 of LAP 1 again for answer. Turn to page 27 for optional activities.

Optional Activities

Choose and do two of the following.

*1. Find pictures in magazines or draw pictures of six products and make a poster. Under each picture write why they would not have been advertised 15 years ago. Put on bulletin board in Room ____.

2.a Sign up for small group discussion. We will discuss:

Explain why the process of marketing is sometimes called distribution.

Why do you think retailers and wholesalers are called middlemen?

What reasons can you give for the fact that the marketing costs for food have been rising at a faster rate than for most other products?

Self-service markets are one example of how businessmen have attempted to reduce marketing costs. Explain.

OR

2.b Write the answers for 2.a Have one classmate read your answers and write his opinion of how clear and accurate you answered each question. Have him sign his name at the bottom of your last page. Hand it to the teacher after classmate has signed it.

*3. Make a list of ten articles found in your home that you probably could not have if it were not for our system of distribution. After each one, explain why it would have been difficult for you to obtain it. Present this at a small group discussion as an oral report.

4. Record on tape Chapter 4, third edition of the textbook. (Instructions for using tape recorder will be explained by teacher.)

Now turn to page 29 of LAP 1.

Vocabulary and Understanding #3

Vocabulary

Do all thirteen questions on this page. Match sentences and words. Write answer in blank at right.

wholesaler	retailer	peddler
producer	middleman	functions of marketing
distribution		marketing

1. The process of getting goods from producers to consumers is ? . _____

2. A retailer is sometimes called a ? . _____

3. A business enterprise that sells directly to consumers is a ? . _____

4. A merchant who buys goods in large quantities and resells them in smaller lots is a ? . _____

5. Tasks that middlemen perform in the process of moving goods from the original producer to the point of final sale are ? . _____

6. ? is the process of getting goods from those who produce to those who buy. _____

Understanding

Answer the following with a check in the column.

	Yes	No
7. Is distribution an essential part of our business system?		
8. Is the process of distribution sometimes called marketing?		
9. Are manufacturers middlemen?		
10. In business, does a market involve both a buyer and seller?		
11. Would our standard of living be as high as it is without our system of distribution?		
12. Do most producers of goods sell them directly to consumers?		
13. Is the principal function of wholesalers to sell directly to consumers?		

Checking Your Reading

Read each question and discuss what you think is the best answer for each. If you do not agree, try to find correct answers.

1. Explain why marketing is a part of production.

2. What is the simplest form of marketing?

3. What determines how a particular product is marketed?

4. What determines the cost of marketing a particular item?

5. Name five functions of marketing.

6. Why do business enterprises advertise?

7. How is marketing related to our standard of living?

8. As a rule, what kind of products cost the most to market?

9. What is the simplest form of distribution?

10. How does a wholesale merchant differ from a retail merchant?

Self-Evaluation

Time to check your progress by answering the following questions. Write your answers. Do you need any help? If you do, see the teacher. If not, check the box below.

1. Unsually food products are more expensive to distribute than manufactured articles. Why?

2. Some goods are sold direct from producer to consumer. Name some goods and the reasons why they can be sold direct.

3. Is it necessary to have middle men today?

4. Explain this sentence. In some ways, our standard of living depends as much on the distribution of goods as it does on the production of them.

IF YOU . . .

scored low on first part of pretest, pages 8 & 9 of LAP 1, review Instructional Objective #1 on page 10 of LAP 1.

scored low on middle part of pretest, pages 8 & 9 of LAP 1, review Instructional Objective #2 on page 17 of LAP 1.

scored low on last part of pretest, pages 8 and 9 of LAP 1, review Instructional Objective #3, page 24 of LAP 1.

scored low on all of pretest, review all of LAP 1.

Now turn the page and find out what to do next.

Teacher Evaluation

You are now ready for the teacher test. Ask teacher for this. You need only a pencil or pen. Conference will be held when you hand in your test. Good luck.

89-80% correct for 4.9 - 3.0

100-90% correct for 6.0 - 5.0

79-70% correct for 2.9 - 1.0

69 or less recycle as directed by teacher

Did you have a conference (talk) with the teacher after you finished the teacher test? Do not go on until you do.

Pretest Answers

1. T
2. T
3. T
4. F
5. F
6. (a)
7. (d)
8. The products of business.
9. Everyone who uses the goods and services of business.
10. T
11. F
12. T
13. F
14. F
15. T
16. F
17. (c)
18. Persons who make goods or supply services.
19. F
20. T
21. T
22. (d)
23. (d)
24. Transportation, packaging, processing, storing, advertising.
25. The process of distribution.

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Plastics Education Guide.

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ABSTRACT - This guide was prepared by the Committee on Plastics Education of the Society of the Plastics Industry to assist and encourage educational institutions on all levels and firms in the plastics industry in preparing and presenting planned programs of study on plastics. Contents are: (1) Educational Levels and Course Outlines, (2) Reference Sources, (3) Trade and Professional Associations, and (4) Eyuipment and Supplies. The reference sources section presents a listing of numerous books, trade publications, and industry literature. (GB)

VT 005 291

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PLASTICS EDUCATION GUIDE

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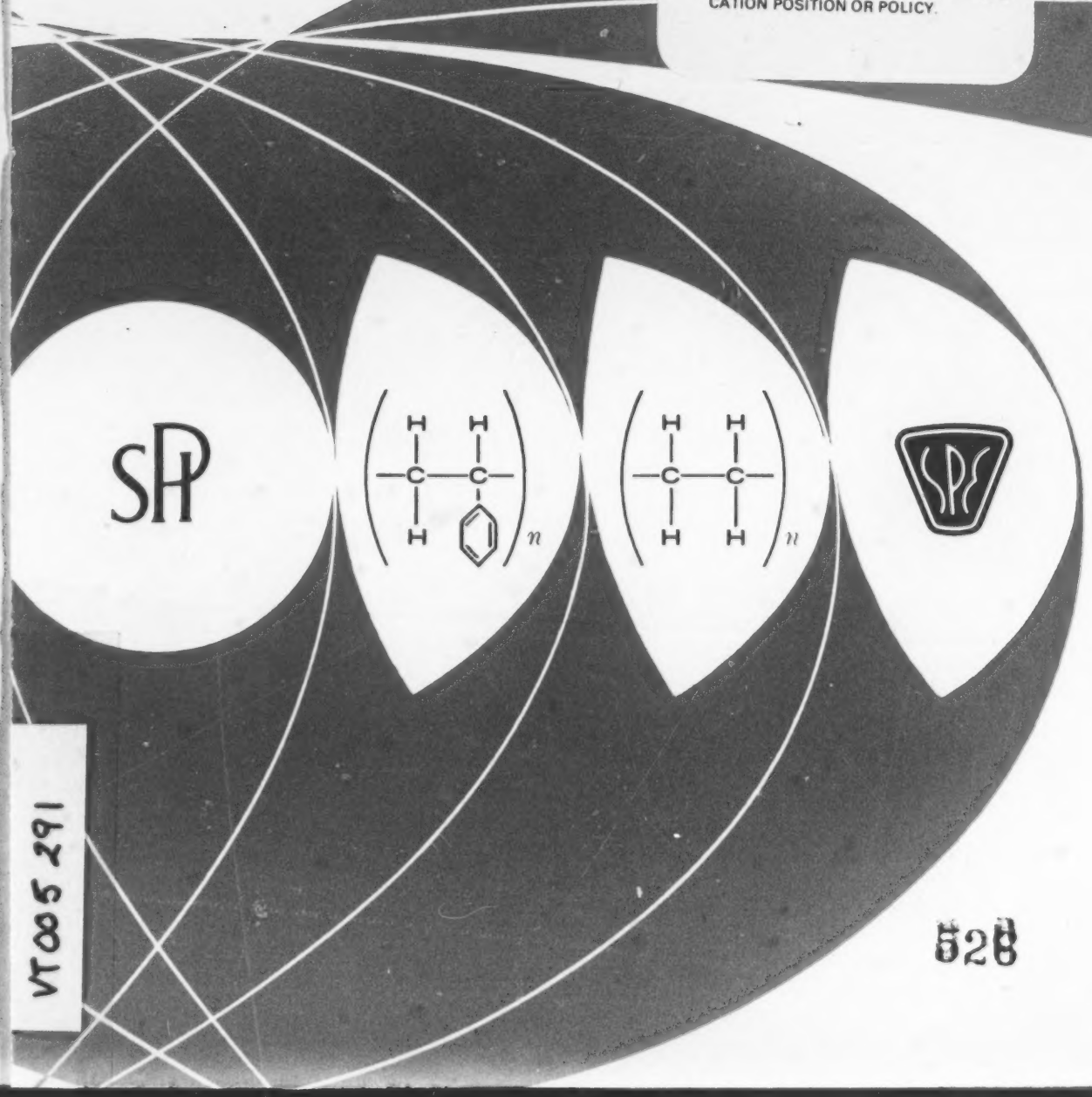

VT005 291

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PLASTICS EDUCATION GUIDE

prepared by the

Committee on Plastics Education
THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

revised by the
PLASTICS EDUCATION FOUNDATION

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The Plastics Education Foundation is a tax exempt corporation co-founded by The Society of the Plastics Industry and The Society of Plastics Engineers. The Plastics Education Foundation has as a primary purpose the promotion of plastics education programs. The activities of the Plastics Education Foundation are carried on by a variety of committees including the following: Industrial Arts Committee, Teacher Education Committee, Scholarships and Grants in Aid Committee, Vocational and Technical Education Committee, College Committee, Equipment Committee, Career Guidance Committee. A Board of Directors representative of both SPI and SPE governs Plastics Education Foundation activities and programs.

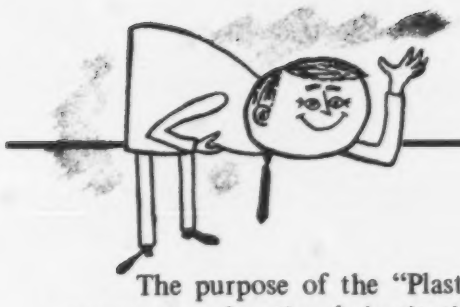

Foreword

The purpose of the "Plastics Education Guide" is to assist and encourage educational institutions on all levels and firms in the plastics industry in preparing and presenting planned programs of study in plastics. It is an attempt to bring together a wide variety of information and put it in one convenient reference guide.

The following pages will provide the reader with an indication of the various levels at which plastics can be taught, furnish a comprehensive list of reference sources, describe the trade associations that can be of specific assistance in presenting programs, list laboratory/testing and production equipment and finally supply a representative list of visual aids that can be used in presenting plastics courses. The manual was started in the summer of 1963 and is the first one of its kind. It is intended to be a guide rather than a compendium of detailed information.

We would like to take this opportunity of thanking the two editors of the guide, Mr. W.W. Rogers of the State University Agriculture and Technical College, Farmingdale, N.Y., who drew up the initial plan for the Guide and accumulated a great deal of material for eventual editing and arranging, and Mr. Anver S. Suleiman of International Plastics Industry Consultants, Inc., New York, N.Y., who carried out extensive editing and put the Guide into its final form. We are indebted also to Committee members for furnishing the material used. The Committee also thanks the Education Committee of the Society of Plastics Engineers for its great help and full cooperation in the preparation of this guide.

It is hoped that educators will find this publication of help in their various educational activities and that they in turn will aid us by their criticisms and suggestions. This information will assist us to keep the Guide up to date by the issuance of new editions.

Robert J. Ullery
Education Director
Plastics Education Foundation

Dr. Vivian T. Stannet, Chairman
SPI Committee on
Plastics Education - 1966

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INTRODUCTION

Why Teach Plastics?

Education institutions at both the secondary and post-secondary levels should consider the advisability of developing plastics education programs. The need for trained plastics personnel occupationally has been established clearly as a result of a 1968 nationwide manpower study by the plastics industry. This study revealed a continuing need in the foreseeable future for large numbers of entry level employees at the semi-skilled, skilled, technician and engineering levels in the United States. The industry has professed its willingness to be helpful in the establishment of programs and also to pay substantially higher starting wages to persons employed subsequent to having had special plastics studies in their preparation.

The plastics industry has grown dramatically in the last several decades. Such growth has averaged 15% per year, four times that of the Gross National Product. In 1983, it is estimated that the volume of plastics used for all purposes will exceed the volume of metals. Already production of plastics materials exceeds that of non-ferrous metals. Continued growth of plastics as an engineering material, both independently and as a part of the growing appliance industry, building construction, in electronics, in packaging, and in automotive applications assures ready employment for trained persons in the future.

The Plastics Education Foundation has as a primary purpose the development of improved educational opportunities for persons interested in a career in plastics.

Educators wishing to consider the development of plastics training programs are encouraged to take advantage of services of the Foundation early in planning stages. The Foundation can be particularly helpful in the identification of advisory committees and in many other ways on a regional basis.

Please let the Plastics Education Foundation assist in the development of your educational program for the future in an exciting area, Plastics!

Robert J. Ullery
Education Director
Plastics Education Foundation

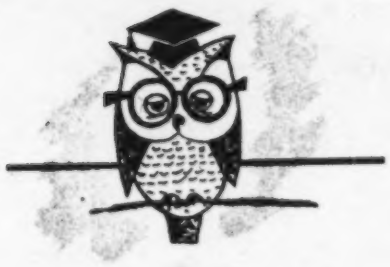

I. Educational Levels and Course Outlines

Starting in elementary school, continuing through high school and college, and into industry, education is imperative in every field of endeavor. Plastics is no exception. The needs at these different levels vary as do the types of materials and methods of presentation. In the following section there will be an attempt to classify these various levels and provide an indication of the goals and type of training required. Of course, there will be some overlapping based on the practices of educational institutions, industry, and state requirements, but the principles can be applied readily by the thinking educator.

A. LEVELS AND OBJECTIVES

1. Secondary education...

a. **Industrial arts**, as a school subject, is the broad study of the materials, organization, tools, processes, products, jobs and the human problems of industry. It is developed through the planning and construction of projects of interest to students, and by discussions, observations and readings related to industry. It is taught through grade 12.

b. **Vocational training** is designed primarily for those students who may not go on to college and it prepares the individuals for specific roles in industry. Vocational training is education for advantageous employment in a specific occupation and is generally presented in grades 9 through 14.

c. **Technical training** provides extensive knowledge of a field of specialization and is usually offered in a post-high school institution. The curriculum consists of mathematics, sciences, and engineering processes as related to the specific field.

2. College and University...

a. **Associate degrees** (two years) are designed to develop the skills, basic knowledge, proper attitude, and appreciation for successful entrance and advancement in the field as a technician.

b. **Bachelor's degrees** (four years) can be obtained in the engineering, science or technology areas.

c. **Graduate degrees**, either master's or doctoral, are extensions in specialization of the type of training received at the undergraduate level. It includes the successful completion of an independent piece of research in the chosen field.

3. **Company training programs...**

   Every raw material supplier, most of the equipment suppliers, and many of the molders and users of plastics have developed internal training programs devoted either wholly or partly to plastics. These programs which vary in degree of formality and specialization are geared to a wide range of employee levels.

4. **Industry training programs...**

   This category includes short courses, seminars, conferences, etc. offered by universities, professional corporations, and trade associations.

5. **Correspondence courses...**

   This type of training is starting to develop in the plastics industry.

B. REPRESENTATIVE COURSE OUTLINES

1. Secondary Education

a. Industrial Arts - The increase in plastics courses in industrial arts education during the last decade has been significant. Concurrent with the offering of such courses has been the development of course outlines and other curriculum materials. One of the first such outlines was developed in the State of New York by the Bureau of Industrial Arts Education. This outline has been reprinted by the Plastics Education Foundation. The publication is entitled, An Experimental Resource Unit in Plastics for Industrial Arts.

Data concerning curriculum materials available from State Education Departments has been outlined below:

Title:	*Industrial Arts for Iowa Schools - 1969*
Cost:	$1.00
Order From:	State of Iowa Department of Public Instruction Information and Publications Service Grimes State Office Building Des Moines, Iowa 50319
Title:	*Plastics for Industrial Arts*
Cost:	Gratis to schools
Order From:	State Department of Education 120 E. Tenth Street Topeka, Kansas 66612
Title:	*Industrial Arts Handbook*
Cost:	Gratis
Order From:	James H. Disney, Supervisor Industrial Arts State Department of Education State Office Building Frankfort, Kentucky 40601
Title:	*Minnesota Industrial Arts Plastics Guide*
Cost:	$2.50
Order From:	Documents Section Room 140 Centennial Building St. Paul, Minnesota 55101
Title:	*Plastics Guide*
Cost:	
Order From:	W.D. Smith State Supervisor of Industrial Arts State Department of Education Santa Fe, New Mexico 87501

Title: *An Experimental Resource Unit in Plastics for Industrial Arts*
Cost: 74¢
Order From: Publications Distribution Unit
New York State Education Department
Albany, New York 12224

Title: *North Carolina Industrial Arts Guide*
Cost: Gratis
Order From: Consultant, Industrial Arts Education
Department of Public Instruction
State of North Carolina
Raleigh, North Carolina

Title: *Plastics as an Area of Industrial Arts Instruction*
Cost:
Order From: Mr. Earl R. Zimmerman, Coordinator
Division of Industrial Arts
Department of Education
Box 911
Harrisburg, Pennsylvania 17126

Title: *Plastics Education Guide*
Cost: $1.00
Order From: Utah State Board of Education
136 E. South Temple
1300 University Club Building
Salt Lake City, Utah 8411

Title: *Plastics Education Guide*
Cost: Gratis
Order From: State Department of Education
Cheyenne, Wyoming

Title: *Vermont Plastics Guide*
Cost: Gratis
Order From: Vermont Department of Education
Montpelier, Vermont

Title: *Plastics Guide*
Cost: Gratis
Order From: Idaho Department of Education
518 Front Street
Boise, Idaho 83702

Title: *Plastics Guide*
Cost: Gratis
Order From: Industrial Arts Education Service
State Department of Education
Richmond, Virginia 23216

b. Occupational Education Including Vocational Training, Technical Training and Two-Year College Programs - Although a certain body of content would be suitable for occupational educational programs on a universal basis, such programs should be geared directly to the needs of nearby industry within which the graduates are most likely to become employed. For this reason, educators are urged to consider seriously the advisability of developing program content through the assistance of an industrial advisory committee. The Plastics Education Foundation and local sections of the Society of Plastics Engineers can be most helpful in the identification of persons for service on such a committee. Educators considering the development of plastics education programs for occupational training purposes may solicit the helpful assistance of both the Society of Plastics Engineers and the Plastics Education Foundation by communication to 656 West Putnam Avenue, Greenwich, Connecticut 06830.

A number of course outlines from both secondary and post-secondary institutions are on file with the Plastics Education Foundation and may be obtained for review by educational institutions contemplating the development of a plastics education program.

Several institutions conduct a variety of short term courses geared to the specific needs of individuals and industry. Short term courses are also provided by proprietary schools, one of which is International Plastics Industry Consultants, Inc., P.O. Box 1324, Long Island City, New York 11101.

International Correspondence Schools, Scranton, Pennsylvania 18515, also offers a plastics technician course.

2. **College and University – Teacher Education**

The Society of Plastics Engineers Education Committee conducts a periodic survey of college level course offerings in the field of polymeric materials and has compiled a list of schools with such offerings. The 106 schools surveyed constitute the complete Engineers' Council for Professional Development list of accredited chemical engineering curricula plus several additional schools known to offer polymer courses. The complete survey of university instruction in polymeric materials may be obtained directly from the Society of Plastics Engineers.

An additional source of information relative to course offerings at the collegiate level is the annual listing of such programs in the Modern Plastics Encyclopedia. This listing includes teacher education programs as well as chemical

engineering programs and two-year college programs.

Graduate level courses in cooperation with Stevens Institute of Technology are operated by the Plastics Institute of America, a non-profit educational and research organization. Additional details concerning the Plastics Institute of America may be obtained through correspondence with the Institute at Stevens Institute of Technology, Hoboken, New Jersey 07030.

The following institutions have specially designed courses to prepare industrial arts teachers to teach plastics. In some cases, these courses would be appropriate to persons aspiring to teach plastics at occupational education levels. Interested persons are encouraged to inquire of the college or university regarding such appropriacy.

Ball State University
Industrial Arts Division
Muncie, Indiana

Industrial Arts Division
State University College
1300 Elmwood Avenue
Buffalo, New York 14222

Department of Vocational Education
New York University
Barney Building
26-36 Stuyvesant Street
New York, New York 10003

Division of Industrial Arts & Technology
State University College
Oswego, New York 13126

Department of Industrial Arts
San Diego State College
San Diego, California 92115

Department of Industrial Education
Southern Illinois University
Carbondale, Illinois 62901

Iowa State University
Ames, Iowa 50010

Morehead State University
Morehead, Kentucky 40351

Murray State University
Murray, Kentucky 42071

Department of Industrial Education & Technology
Gorham State College
Gorham, Maine 04038

Montclair State College
Upper Montclair, New Jersey 07043

Trenton State College
Trenton, New Jersey 08625

Stout State University
Menomonie, Wisconsin 54751

Wisconsin State University - Platteville
Platteville, Wisconsin 53818

Industrial Arts Division
Kearney State College
Kearney, Nebraska

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American Elsivier Publishing Co., 52 Vanderbilt Avenue, New York, N.Y. 10017
American Technical Society, 848 East 58th Street, Chicago, Ill., 60637
Bennett, Chas. A. Co., Inc., 809 W. Detweiller Drive, Peoria, Ill., 61614
Bill Publications Inc., 630 Third Avenue, New York, N.Y. 10017
Butterworth & Co. (Publishers) Ltd., 88 Kingsway, London, W.C.2
Chemical Publishing Co., Inc. (Orders to: Tudor Publishing Co., 572 5th Avenue, New York, N.Y. 10036
Heath, D.C. & Co., 2700 N. Richardt Avenue, Indianapolis, Inc., 46219
Iliffe (See Butterworth)
International Textbook Co., Scranton, Pa., 18515
Interscience Publishers, Inc., 605 Third Avenue, New York, N.Y. 10016 (See Wiley, John & Sons, Inc.)
Lake Publishing Corporation, 311 East Park Avenue, Libertyville, Illinois 60048
Macmillan Co., 866 3rd Avenue, New York, N.Y. 10022
McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York, N.Y. 10036
McKnight & McKnight Publishing Co., 29 E. 10th Street, New York, N.Y. 10003
Oxford University Press, 200 Madison Avenue, New York, N.Y.
Penton Publishing Co., Penton Building, Cleveland, Ohio 44113
Pitman Publishing Corp., 6 E. 43rd Street, New York, N.Y. 10017
Reinhold Book Corp., 430 Park Avenue, New York, N.Y. 10022
St. Martin's Press, Inc., 175 Fifth Avenue, New York, N.Y. 10010
Technomic Publishing Co., Inc., 750 Summer Street, Stamford, Connecticut 06901
Temple Press Books, Hamlyn House, 42 The Centre, Feltman, Middlesex, England
Van Nostrand, D. Co., Inc., (See Reinhold)
Western Business Publications, 274 Brannon Street, San Francisco, California 94107
Wiley, John & Sons, Inc., 605 Third Avenue, New York, N.Y. 10016

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B. TRADE PUBLICATIONS

Adhesives Age, 101 West 31st Street, New York, N.Y. 10001
Canadian Plastics, 1450 Don Mills Road, Don Mills, Ont., Canada
Chemical Engineering, 330 West 42nd Street, New York, N.Y. 10036
Chemical & Engineering News, 1155 16th Street, N.W., Washington, D.C. 20036
Chemical Processing, 111 East Delaware Place, Chicago, Illinois 60611
Chemical Week, 330 West 42nd Street, New York, N.Y. 10036 (McGraw-Hill Publication)
Design News, Cahners Building, 270 St. Paul St., Denver, Colorado 80206
Electro-Technology, 80 Park Avenue, New York, N.Y.
Industrial & Engineering Chemistry, 733 Third Avenue, New York, N.Y. 10017
Insulation/Circuits Magazine, Box 159, 700 Peterson Road, Libertyville, Ill. 60048
Insulation/Circuits Directory/Encyclopedia, Box 159, Libertyville, Ill. 60048
Journal of Cellular Plastics, 750 Summer Street, Stamford, Conn. 06902
Machine Design, Penton Building, Cleveland, Ohio 44113
Materials Engineering, 600 Summer Street, Stamford, Conn. 06904
Modern Packaging, 1301 Avenue of the Americas, New York, N.Y. 10019
Modern Packaging Encyclopedia, 1301 Avenue of the Americas, New York, N.Y. 10019
Modern Plastics Magazine, 1301 Avenue of the Americas, New York, N.Y. 10019
Modern Plastics Encyclopedia, 1301 Avenue of the Americas, New York, N.Y. 10019
Plastics Design & Processing, Box 159, 700 Peterson Road, Libertyville, Ill.
Plastics Technology, 630 Third Avenue, New York, N.Y. 10017
Plastics Week, 221 Columbus Avenue, Boston, Mass. 02116
Plastics World, Cahners Building, 270 St. Paul St., Denver, Colorado 80206
Product Engineering, 330 West 42nd Street, New York, N.Y. 10036
Progressive Plastics, 481 University Avenue, Toronto 2, Ont., Canada
SPE Journal, 656 W. Putnam Avenue, Greenwich, Conn. 06830
Trends in End-Use Markets for Plastics, DeBell and Richardson, Inc. Hazardville, Connecticut 06036
Western Plastics, 274 Brannan Street, San Francisco, Calif. 94107
Western Plastics Directory, 274 Brannan Street, San Francisco, Calif. 94107 ($7.50/copy)

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C. INDUSTRY LITERATURE

There is a wealth of valuable information available from raw materials supplier and equipment manufacturers in the form of company literature. Trade and professional associations, listed in Section III of this guide, are another excellent literature source.

The following listing indicates the wide range of data available from some of the companies in the plastics industry and is not intended to be complete or represent every possible category. Most of this literature is available free of charge.

THE ABC's OF MODERN PLASTICS (35 pages)
Union Carbide Corporation
Plastics Division
270 Park Avenue
New York, New York 10017

Describes basic plastics materials, their sources and applications.

THE ANATOMY OF PLASTICS
Science & Technology
205 E. 42nd Street
New York, New York

BLOW MOLDING - AN OPERATING MANUAL (72 pages)
U.S. Industrial Chemicals
99 Park Avenue
New York, New York 10016

Describes the blow molding process, particularly with polyethylene emphasizing start up and shut down of operations as well as specific problem areas.

BLOW MOLDING FORTIFLEX POLYETHYLENE, BULLETIN 3PC (32 pages)
Celanese Plastics Company
550 Broad Street
Newark, New Jersey 07102

BLOW MOLDING OF ALATHON POLYOLEFIN RESINS (29 pages)
Polyolefins Division
Plastics Department
E.I. DuPont de Nemours Company
Wilmington, Delaware 19898

BLOW MOLDING OF BAKELITE POLYETHYLENES (28 pages)
Union Carbide Corporation
Plastics Products
270 Park Avenue
New York, New York 10017

BLOW MOLDING POLYETHYLENE (24 pages)
Dow Chemical Company
Plastics Department
Midland, Michigan

CELLULOSE ACETATE BUTYRATE FOR PROTECTIVE COATINGS
Eastman Chemical Products, Inc.
Kingsport, Tennessee 37662

COLORING PLASTICS (40 pages)
Ferro Corporation
4150 East 56th Street
Cleveland, Ohio 44105

A compilation of a number of articles prepared on the subject of coloring all types of thermoplastic and thermosetting materials.

DESIGN GUIDE
Security Plastics, Inc.
4297 E. 11th Avenue
Hialeah, Florida 33013

DESIGNING WITH RIGID VINYL
B.F. Goodrich Chemical Company
3135 Euclid Avenue
Cleveland, Ohio 44115

DUPONT MAGAZINE
Editor
DuPont Magazine
Wilmington, Delaware 19898

ENGINEERING PLASTICS AND DESIGN, BULLETIN G1B
Celanese Plastics Company
550 Broad Street
Newark, New Jersey 07102

ENGINEERING WITH SILASTIC SILICONE RUBBER

Dow-Corning Corporation
Midland, Michigan 48640

ENJAY MAGAZINE
Enjay Chemical Company
60 W. 49th Street
New York, New York 10020

EXTRUSION, BULLETIN N3A and BULLETIN A3C
Celanese Plastics Company
550 Braod Street
Newark, New Jersey 07102

C552

A FACTORY ENGINEERING AND TECHNOLOGY REPORT
PLASTICS #19
Readers Service Department
Factory
330 W. 42nd Street
New York, New York

FIBERGLAS REINFORCED PLASTICS
Owens-Corning Fiberglas Corporation
Appliance Materials Division
Industrial Materials Division
Toledo, Ohio 43602

FILAMENT WINDING WITH EPOXY RESIN SYSTEMS
CIBA Products Company
Division of CIBA Corporation
Fairlawn, New Jersey

FOURTEEN NEW DESIGNS IN SHELL PLASTICS AND RESINS
Shell Chemical Company
Plastics and Resins Division
110 W. 51st Street
New York, New York

GLOSSARY OF PLASTICS TERMS (36 pages)
Phillips Petroleum Company
Chemical Department - Plastics Division
Bartlesville, Oklahoma 74004

A glossary of terminology used in the plastics industry.

HOW TO CHOOSE AN EXTRUDER (107 pages)
Prodex Corporation
Fords, New Jersey 08863

Indicates important criteria in selecting an extruder with a basic description of the extruder and its component parts.

INJECTION MOLDING TECHNOLOGY (12 pages)
The Dow Chemical Company
Plastics Division
Midland, Michigan 48640

Describes injection molding, the machine and the problems.

"INPLANT TRAINING BOOKLETS"
The Society of the Plastics Industry
250 Park Avenue
New York, New York 10017

Pocket size booklets give sound "how to" information on operating plastics machinery and other subjects. Basic data useful for students and new employees.

- Compression and Transfer Molding (20 pages)
- Extrusion
- Injection Molding (15 pages)
- Finishing and Decorating (35 pages)

S 553

THE MARBON FAMILY OF ABS DESIGN ENGINEERING MATERIALS
Marbon Chemical Company
P.O. Box 68
Washington, West Virginia 26181

MATERIALS NEWS FROM DOW-CORNING
Dow-Corning Corporation
Midland, Michigan 48640

PAINTING PLASTICS MANUAL (77 pages)
Bee Chemical Company
2700 East 170th Street
Lansing, Illinois 60438

A comprehensive manual describing a variety of decorating, finishing and marketing operations.

PETROTHENE POLYOLEFINS (a processing guide) (140 pages)
U.S. Industrial Chemicals Co.
99 Park Avenue
New York, New York 10016

A guide to processing of polyolefins describing molecular porperties of resins, additives, and the techniques of processing including extrusion, calendering, injection molding, blow molding, thermoforming, and compression molding.

POLYETHYLENE EXTRUSION COATING - AN OPERATING MANUAL
U.S. Industrial Chemicals Company
99 Park Avenue
New York, New York 10016

STANDARD TESTS ON PLASTICS (61 pages)
Celanese Plastics Company
744 Broad Street
Newark, New Jersey

Describes the significant tests performed on plastics and their importance.

THE STORY OF THE PLASTICS INUDSTRY
The Society of the Plastics Industry
250 Park Avenue
New York, New York 10017

Provides basic information (in layman's language) about the history of plastics, industry's growth, plastics raw materials - typical end used with illustrations, properties, methods of processing and fabricating.

THERMOFORMING (24 pages)
Celanese Plastics Company
744 Broad Street
Newark, New Jersey

Analyzes the basic thermoforming techniques available to the processor with advantages and disadvantages as well as problem solving sections.

ULTRASONIC ASSEMBLY
Branson Sonic Power Company
Danbury, Connecticut

UREA AND ALKYD MOLDING COMPOUNDS (46 pages)
Allied Chemical Corporation
Plastics Division
P.O. Box 365
Morristown, New Jersey

A description of compression and transfer molding with emphasis on the amino plastics.

D. OTHER SOURCES

Title: *A Resource Unit for Teaching Plastics Technology at the Collegiate Level*
Author: James R. Harty, 460 36th Avenue, San Francisco State College, San Francisco, California

Title: *A Guide to Plastics in the Industrial Arts Program of the Academic High Schools of New York City*
Author: Arthur E. Golomb
Publisher: Dissertation abstracts, Volume XXIV, No. 4, 1963, order 635374, University Microfilms, Inc., 313 North 1st Street, Ann Arbor, Michigan, 48103

Title: *A Study of the Industry and Field of Plastics as a Creative Medium*
Author: Robert Lloyd Cantor
Publisher: Order 5412, University Microfilms, Inc., 313 North 1st Street, Ann Arbor, Michigan 48103
Description: Doctoral thesis

Title: *Plastics Technology and Its Reflection in Industrial Arts Teacher-Education Programs*
Author: James J. Runnals
Publisher: University of Missouri, University Terrace, Columbia, Missouri
Description: Doctoral dissertation

III. Trade and Professional Associations

There are a number of trade associations and professional/technical societies in the plastics and related industries. Some of these are listed below and can provide the educator with a wealth of information.

American Chemical Society
1155 Sixteenth Street, N.W.
Washington, D.C.

American Institute of Chemical Engineers
345 East 47th Street
New York, New York 10017

American Petroleum Institute
1271 6th Avenue
New York, New York

American Society of Tool and Manufacturing Engineers
10700 Puritan Avneue
Detroit, Michigan

Manufacturing Chemists' Association
1825 Connecticut Avenue, N.W.
Washington, D.C.

National Association of Plastic Fabricators
1108 Standard Building
Cleveland, Ohio

Plastics Education Foundation
656 W. Putnam Avenue
Greenwich, Connecticut 06830

Society of Plastics Engineers, Inc.
656 W. Putnam Avenue
Greenwich, Connecticut 06830

The Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

The Society of the Plastics Industry (Canada), Inc.
600z Eglinton Avenue, East
Toronto, Ontario, Canada

The Society of the Plastics Industry, Inc.
Western Section
611 South Catalina Street
Los Angeles, California 90005

Technical Association of The Pulp and Paper Industry (TAPPI)
360 Lexington Avenue
New York, New York 10017

Vinyl Fabrics Institute
60 East 42nd Street
New York, New York 10017

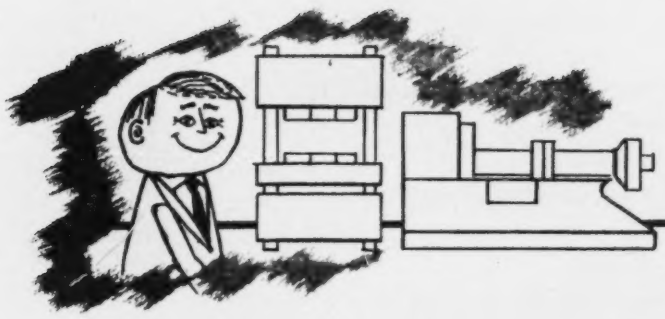

IV. Equipment

Equipment used in the presentation of plastics courses can be classified as either laboratory/testing or production equipment. The companies listed in this section are in part those which is response to a questionnaire from the SPI, indicated they have equipment which may be used in the educational field. However, there are other machinery manufacturers listed in the SPI Membership Directory and other reference sources which should be contacted for details on their equipment as well as prices.

Pages 44 - 45 list equipment which the University of the State of New York suggests for industrial arts courses.

Consultant assistance relative to equipment selection is available upon request to the Plastics Education Foundation.

A. LABORATORY/TESTING EQUIPMENT

ABRASION TESTING EQUIPMENT

Taber Instrument Company
111 Goundry Street
North Tonawanda, New York 141514151

GEL TIMER

C.W. Brabender Instruments, Inc.
50 East Wesley Street
South Hackensack, New Jersey 07606

Mol-Rez Division - Sub. of Whittaker Corp.
American Petrochemical Corporation
3134 California Street, N.E.
Minneapolis, Minnesota 55418

MELT INDEXER

D & R Plastic Welders, Inc.
Box J
Hazardville, Connecticut

Custom Scientific Company
541 Devon Street
Kearney, New Jersey 07032

F.F. Slocomb Corporation
100 Poplar Street
P.O. Box 1591
Wilmington, Delaware 19899

PHYSICAL PROPERTIES TESTING EQUIPMENT

American Chain & Cable Company, Inc.
Wilson Mechanical Instrument Division
230 Park Avenue
New York, New York 10017

D & R Plastic Welders, Inc.
Box J
Hazardville, Connecticut

C.W. Brabender Instruments, Inc.
50 East Wesley Street
South Hackensack, New Jersey 07606

W.C. Dillon & Co., Inc.
14620 Keswick Street
Van Nuys, California 91405

Instron Engineering Corporation
2500 Washington Street
Canton, Massachusetts 02021

Tinius Olsen Testing Machine Company
500 North 12th Street
Philadelphia, Pennsylvania 19123

VISCOSITY MEASURING DEVICES

C.W. Brabender Instruments, Inc.
50 East Wesley Street
South Hackensack, New Jersey 07606

Brookfield Engineering Laboratories, Inc.
240 Cushing Street
Stoughton, Massachusetts 02072

The Martin Sweets Company, Inc.
3131 West Market Street
Louisville, Kentucky 40212

WEATHERING EQUIPMENT

Atlas Electric Devices Company
4114 North Ravenswood Avenue
Chicago, Illinois 60613

D & R Plastic Welders, Inc.
Box J
Hazardville, Connecticut

B. PRODUCTION EQUIPMENT

BLOW MOLDING EQUIPMENT

Beloit Corporation
Washington & Green Streets
Downington, Pennsylvania 19335

Farrel Canada Limited
280 Belfield Road
Rexdale, Ontario, Canada

Farrel Co. - Division of USM Corp.
Plastics Molding Machinery Division
565 Blossom Road
Rochester, New York 14610

Improved Machinery, Inc. - Sub. of Ingersoll-Rand Co.
150 Burke Street
Nashua, New Hampshire 03060

Modern Plastic Machinery Corporation
64 Lakeview Avenue
Clifton, New Jersey 07015

Stokes Division
Pennsalt Corporation
5500 Tabor Road
Philadelphia, Pennsylvania 19120

Strong Plastics, Inc. - Sub. of Republic Corp.
700 Lamport Street
Elsegundo, California 90245

Technical Machinery Corporation
68 Newton Plaza (Engineers Hill)
Plainview, L.I., New York

Waldron-Hartig Division
Midland-Ross Corporation
P.O. Box 791
New Brunswick, New Jersey 08903

CALENDERING EQUIPMENT

Adamson United Company
Sub. United Engineering & Foundry Co.
730 Carroll Street
Akron, Ohio 44304

Canada Machinery Corporation Limited
19 Concession Street
Galt, Ontario, Canada

0561

Farrel Canada Limited
280 Belfield Road
Rexdale, Ontario, Canada

Farrel Corporation
Ansonia, Connecticut 06401

COMPRESSION AND LAMINATING PRESSES

Fred S. Carver Hydraulic Equipment
5 Chatham Road
Summit, New Jersey 07901

Dake Corporation
641 Robbins Road
Grand Haven, Michigan 49417

Farrel Canada Limited
280 Belfield Road
Rexdale, Ontario, Canada

Farrel Co.- Div. of USM Corp.
Plastics Molding Machinery Division
565 Blossom Road
Rochester, New York 14610

HPM Division
Koehring Company
820 Marion Road
Mount Gilead, Ohio 43338

C.A. Litzler Co., Inc.
4800 W. 160th Street
Cleveland, Ohio 44135

Pasadena Hydraulics, Inc.
200 N. Berry Street
Brea, California 92621

Stokes Division
Pennsalt Corporatin
5500 Tabor Road
Philadelphia, Pennsylvania 19120

CONVEYORS AND DRYERS

Ball & Jewell Company, Inc.
Division of Beloit Eastern Corporation
22 Franklin Street
Brooklyn, New York 11222

Conair, Inc.
Conair Building
Franklin, Pennsylvania 16323

Foremost Machine Builders, Inc.
23 Spielman Road
Fairfield, New Jersy 07006

Vac-U-Mac
227 Main Street
Belleville, New Jersey 07109

Whitlock, Inc.
23231 Industrial Park Drive
Farmington, Michigan 48024

CUTTING EQUIPMENT

Foster & Allen, Inc.
26 Commerce Street
Box 466
Chatham, New Jersey 07928

Viking-Chase Ltd., Inc.
36th Street and A.V.R.R.
Pittsburgh, Pennsylvania 15201

ELECTRONIC HEATERS

W.T. LaRose & Associates, Inc.
Box F, Lans Station
Troy, New York 12182

Votator Division
Chemetron Corporation
P.O. Box 43
Louisville, Kentucky 40201

ELECTROSTATIC EQUIPMENT

The Simco Company, Inc.
920 Walnut Street
Lansdale, Pennsylvania 19446

ENGRAVING EQUIPMENT

New Hermes Engraving Machine Corp.
154 West 14th Street
New York, New York 10011

EXPANDABLE POLYSTYRENE MOLDING EQUIPMENT

Conair, Inc.
Conair Building
Franklin, Pennsylvania 16323

Crown Machine & Tool, Co.
840 Great Southwest Parkway
P.O. Box 610
Arlington, Texas 76011

EXTRUSION EQUIPMENT

A-Be Industries, Inc.
16633 Minnesota Avenue
Paramount, California 90723

Barnett J. Danson & Associates Limited
33 Railside Road
Don Mills, Ontario, Canada

Beloit Corporation
Washington & Green Streets
Downington, Pennsylvania 19335

The Black Clawson Company
Plastics Department
Extrusion Equipment
2nd & Vine Streets
Hamilton, Ohio 45011

C.W. Brabender Instruments, Inc.
50 East Wesley Street
South Hackensack, New Jersey 07606

David-Standard
Division of Crompton & Knowles Corporation
U.S. Route 1
Pawcatuck, Connecticut 02891

Egan Machinery Company
36 South Adamsville Road
Somerville, New Jersey 08876

Gatto Machinery Development Corporation
134 Rome Street
Farmingdale, L.I., New York 11735

Killion Extruders, Inc.
56 Depot Street
Verona, New Jersey 07044

Miller Industries
Div. The Elkhart Bridge & Iron Company
1227 W. Beardsley Avenue, P.O. Box 823
Elkhart, Indiana 46514

Modern Plastic Machinery Company
Sub. of Savoy Ind., Inc.
64 Lakeview Avenue
Clifton, New Jersey 07015

NRM Corporation - Sub of AMK Corp.
47 West Exchange Street
Akron, Ohio 44308

564

Rainville Co. Inc. (The)
200 Clay Ave.
Middlesex, N.J. 08846

Reifenhauser U.S. Sales Corp.
535 N. Midland Avenue
Saddle Brook, New Jersey 07662

Francis Shaw (Canada) Ltd.
1393 Grahams Lane - P.O. Box 158
Burlington, Ontario, Canada

Sterling Extruder Corporation
901 Durham Avenue
So. Plainfield, New Jersey 07080

Stokes Division
Pennsalt Corporation
5500 Tabor Road
Philadelphia, Pennsylvania 19120

Technical Machinery Corporation
68 Newton Plaza (Engineers Hill)
Plainview, L.I., New York

Waldron-Hartig Division
Midland-Ross Corp.
P.O. Box 791
New Brunswick, New Jersey 08903

Welding Engineers, Inc.
P.O. Box 391
Norristown, Pennsylvania 19404

EXTRUSION ACCESSORY EQUIPMENT

A-Be Industries, Inc.
16633 Minnesota Avenue
Paramount, California 90723

Conair, Inc.
Conair Building
Franklin, Pennsylvania 16323

Gatto Machinery Development Corporation
134 Rome Street
Farmingdale, L.I., New York 11735

FOAM DISPENSING EQUIPMENT

Admiral Equipment Corp.
305 W. North Street
Akron, Ohio 44303

Binks Manufacturing Company
3114 West Carroll Avenue
Chicago, Illinois 60612

Finn and Fram, Inc.
8400 San Fernando Road
Sun Valley, California 91352

Glas-Craft of California - Div. of Republic Corp.
9145 Glen Oaks Boulevard
Sun Valley, California 91352

Lemco-Jennings
3252 Monroe Street
Toledo, Ohio 43606

The Martin Sweets Company, Inc.
3131 West Market Street
Louisville, Kentucky 40212

Park-Hannesson Ltd. - Div. of MIA Chemical Co.
813 Henry Avenue, P.O. Box 862
Winnipeg, Manitoba, Canada

Sealzit Division
The Flintkote Company
4075 Main Street, Suite 600
Riverside, California 92501

Viking-Chase Ltd., Inc.
36th Street and A.V.R.R.
Pittsburgh, Pennsylvania 15201

FILAMENT WINDING EQUIPMENT

McClean-Anderson, Inc.
120 West Melvina Street
Milwaukee, Wisconsin 53212

GRANULATING & PELLETIZING EQUIPMENT

Cumberland Engineering Company, Inc.
P.O. Box 6065
Providence, Rhode Island 02904

Entoleter, Inc. - Sub. of American Mfg. Co., Inc.
251 Welton Street
Hamden, Connecticut 06511

Flinchbaugh Products, Inc.
Div. Gulf & Western Ind. Inc.
P.O. Box 127, Redco Avenue
Red Lion, Pennsylvania 17356

GRINDING EQUIPMENT

Ball & Jewell Company, Inc.
Division of Beloit Eastern Corporation
22 Franklin Street
Brooklyn, New York 11222

Foremost Machine Builders, Inc.
23 Spielman Road, P.O. Box 644
Fairfield, New Jersey 07006

HOT STAMPING PRESS

The Acromark Company
60 Locust Avenue
Berkeley Heights, New Jersey 07922

Apex Machine Company
3000 N.E. 12th Terrace
Fort Lauderdale, Florida 33308

Franklin Manufacturing Corporation
692 Pleasant Street
Norwood, Massachusetts 02062

Howmet Corporation
Roll Leaf Division
4511 New York Avenue
Union City, New Jersey 07887

Kensol-Olsenmark, Inc.
30 Melville Park Road
Melville, L.I., New York 11746

INJECTION MOLDING EQUIPMENT

Barnett J. Danson & Associates Limited
1840 Birchmount Road
Scarborough, Ontario, Canada

Battenfeld Corporation of America
7301 North Monticello Avenue
Skokie, Illinois 60613

Beloit Corporation
Washington & Green Streets
Downington, Pennsylvania 19335

Farrel Canada Ltd.
280 Belfield Avenue
Rexdale, Ontario, Canada

Farrel Co. - Div. of USM Corp.
Plastics Molding Machinery Division
565 Blossom Road
Rochester, New York 14610

Flinchbaugh Products, Inc. - Sub. of Gulf & Western Ind. Inc.
P.O. Box 127, Redco Avenue
Red Lion, Pennsylvania 17356

Hinchman Manufacturing Company, Inc.
259 East First Avenue
Roselle, New Jersey 07203

HPM Division
Koehring Company
820 Marion Road
Mount Gilead, Ohio 43338

Husky Manufacturing & Tool Works Ltd.
200 Bentworth Avenue
Toronto, Ontario, Canada

Improved Machinery, Inc. - Sub of Ingersoll & Rand Co.
150 Burke Street
Nashua, New Hampshire 03060

Lombard Industries, Inc. - Sub. of USM Corp.
50 Main Street
Ashland, Massachusetts 01721

Modern Plastic Machinery Corporation - Sub. of Savoy Ind., Inc.
64 Lakeview Avenue
Clifton, New Jersey 07015

Nassau Manufacturing Co., Inc.
923 Old Nepperhan Avenue
Yonkers, New York 10703

The New Britain Machine Company - Div. of Litton Ind.
Plastics Machine Division
South Street
New Britain, Connecticut 06050

Newbury Industries, Inc.
10975 Kinsman Road
Newbury, Ohio 44065

Polymer Machinery Corp.
Plastic Processing Equipment
60 Woodlawn Road
Berlin, Connecticut 06037

Reed-Prentice Division
Package Machinery Company
330 Chestnut Street
East Longmeadow, Massachusetts 01028

Simplomatic Manufacturing Company
4416 West Chicago Avenue
Chicago, Illinois 60551

Standard Tool Company
217 Hamilton Street
Leominster, Massachusetts 01453

Stokes Division
Pennsalt Corporation
5500 Tabor Road
Philadelphia, Pennsylvania 19120

Trueblood, Inc.
6891 Cobaugh Road
Tipp City, Ohio 45371

MILLING EQUIPMENT

The Black Clawson Company
Hamilton Division
Plastics Department
2nd & Vine Streets
Hamilton, Ohio 45011

MIXING

Adamson United Company - Sub. of United Engineering & Foundry Co.
730 Carroll Street
Akron, Ohio 44304

Canada Machinery Corporation, Ltd.
19 Concession Street
Galt, Ontario, Canada

Barnett J. Danson & Associates Limited
1840 Birchmount Road
Scarborough, Ontario, Canada

Farrel Canada Limited
280 Belfield Avenue
Rexdale, Ontario, Canada

Farrel Co.
Ansonia, Connecticut 06401

Francis Shaw (Canada) Limited - Sub. of Francis Shaw & Co.
1393 Grahams Lane, P.O. Box 158
Burlington, Ontario, Canada

Sealzit Division
The Flintkote Company
Main Street, Suite 600
Riverside, California 92501

Welding Engineers Inc.
P.O. 391
Norristown, Pennsylvania 19404

MOLD BASES

D-M-E Corporation - Sub. of VSI Corp.
29111 Stephenson Highway
Madison Heights, Michigan 48071

Flinchbaugh Products, Inc. - Div. of Gulf & Western Ind., Inc.
P.O. Box 127, Redco Avenue
Red Lion, Pennsylvania 17356

OVENS

American Instrument Company
8030 Georgia Avenue
Silver Spring, Maryland 20910

C.W. Brabender Instruments, Inc.
50 East Wesley Street
South Hackensack, New Jersey 07606

Precision Scientific Company
3737 West Cortland Street
Chicago, Illinois 60645

Viking-Chase Ltd., Inc.
36th Street and A.V.R.R.
Pittsburgh, Pennsylvania 15201

PLASTICS WELDING EQUIPMENT

D & R Plastic Welders, Inc.
Box J
Hazardville, Connecticut

Kamweld Products Company, Inc.
742 Providence Highway, P.O. Box 91
Norwood, Massachusetts 02062

PRINTING

Apex Machine Company
3000 N.E. 12th Terrace
Fort Lauderdale, Florida 33308

Lembo Corporation
235 McLean Boulevard (Route 20)
Paterson, New Jersey 07504

PROCESS COOLING EQUIPMENT

Mayer Refrigerating Engineers, Inc.
9 Chapel Hill Road
Lincoln Park, New Jersey 07035

ROTATIONAL MOLDING EQUIPMENT

McNeil Corporation - McKeil Akron Div.
96 East Crosier Street
Akron, Ohio 44311

SEALING EQUIPMENT

Sealomatic - Div. of Solidyne, Inc.
75 Scott Avenue
Brooklyn, New York 11237

Thermatron
Electronics Division of Willcox & Gibbs
44-16 23rd Street
Long Island City, New York 11101

SONIC WELDING EQUIPMENT

Branson Sonic Power Co. - Sub. of Smith, Kline & French
Eagle Road
Danbury, Connecticut 06810

SPRAY-UP EQUIPMENT

Glas-Craft of California - Div. of Republic Corp.
9145 Glen Oaks Boulevard
Sun Valley, California 91352

Park-Hannesson Ltd. - Div. of MIA Chemical Ltd.
813 Henry Avenue, P.O. Box 862
Winnipeg, Manitoba, Canada

TEMPERATURE CONTROL EQUIPMENT

Alnor Instrument Company
420 North LaSalle Street
Chicago, Illinois 60610

C.W. Brabender Instruments, Inc.
50 East Wesley Street
South Hackensack, New Jersey 07606

Capitol Temptrol Corp.
555 South Fulton Avenue
Mount Vernon, New York 10550

Sterling, Inc.
5200 West Clinton Avenue
Milwaukee, Wisconsin 53223

Thermolator Co. - Div. of Van Dorn Co.
1523 East Epler Avenue
Indianapolis, Indiana 46227

West Instrument Corporation
3860 North River Road
Schiller Park, Illinois 60176

THERMOFORMING EQUIPMENT

AAA Plastic Equipment Company
P.O. Box 11512
Fort Worth, Texas 76110.

Atlas Vac-Machine Corporation
70 Panorama Creek Drive
Rochester, New York 14625

Auto-Vac Company
P.O. Box 557
Tabor City, N.C. 28463

Brown Machine Company
Beaverton, Michigan 48612

Comet Industries, Inc.
1320 N. York Road
Bensenville, Illinois 60106

WATER CHILLING AND RECOVERY EQUIPMENT

Application Engineering Corporation (Affil. of Whitlock, Inc.)
850 Pratt Boulevard
Elk Grove Village, Illinois 60007

C. REPRESENTATIVE SCHOOL EQUIPMENT

Suggested for Junior and Senior High School
Industrial Arts Courses
by
The State Education Department
Bureau of Industrial Arts Education
Albany, New York 12224

Description	
1/5 ounce or larger injection molding machines	Jr. & Sr. High
12 ton or larger capacity, compression/laminating press complete with heated and cooled platens, facing sheets for laminating, thermometers and 1 compression mold, etc.	Jr. & Sr. High
Vacuum former 7"x7" with vacuum source and heating unit	Junior High
Vacuum former 10"x14" with vacuum source and heating unit	Junior High
Portable Scrap Granulator 7"x6½" throat or larger capacity with 1 Hp motor and switch	Senior High
Vacuum, pressure and mechanical former 18" x18" with heating unit, material clamping device, vacuum and pressure sources	Senior High
Vacuum former, 10"x14" with vacuum source and heating unit	Senior High
Electric oven and burner unit, electric kitchen stove with large oven and four surface cooking units, 30"x40" with wide oven or equal OR	Jr. & Sr. High
Hot air oven, thermostatically controlled, 450° or higher maximum temperature, interior minimum dimensions 26" wide by 20" high by 20" deep - Model 51-550 or equal	Jr. & Sr. High
Heat Sealer, Hand Operated	Jr. & Sr. High
Plastic welding unit, hand operated, kit with extra tips, etc.	Jr. & Sr. High
Engraving machine	Senior High
Hot stamping machine	Senior High
Thermometer, 6" shank, dial face reading type 100°F to 600°F	Jr. & Sr. High
Pressure cooker, 10 qt. or larger	Jr. & Sr. High

Air pressure regulators, 1 to 100 psi., single stage, spray painting type	Jr. & Sr. High
Air compressor - capacity at least equal to the air consumption of two air operated injection molders with necessary valves, hose, quick connectors	Jr. & Sr. High
Air line oilers for injection molders	Jr. & Sr. High
Postal scales, 2 lbs., capacity, spring type for weighing materials	Jr. & Sr. High
Electroplating unit, 5 amp. capacity or larger power unit and plating equipment and chemical set	Jr. & Sr. High

OPTIONAL EQUIPMENT

Extruder, laboratory type, ¾" screw or larger 20:1 screw dia. to screw length ratio	Senior High
Blow molding attachment for plastics extruder, air operated, mold closure device	Senior High
Rotational molding machine, Laboratory model	Senior High
Set testing equipment - tests for tensile compression, shear, transvers, hardness, modulus of elasticity	Senior High
All materials spray gun, for spraying plaster, plastic resins and rubber, with extra nozzles, cups, lids and hose	Senior High
Portable Plastics School consists of 16 volumes: Each volume contains raw materials and finished product samples held in place by flexible bands for removal and inspection. Multicolored charts show the method of polymerization starting from the basic raw materials and also the various methods of producing finished articles. The Commentary volume gives a brief history of each material, raw materials production, production of the plastic materials, properties, processing methods and applications.	Senior High

D. TEACHING AIDS

A variety of teaching aids have become available in the recent past. Many of these are applicable to industrial arts and occupational education programs at both the secondary and post-secondary educational levels.

The Thiokol Chemical Company, which had contracted with the Office of Economic Opportunity, Job Corps, for the operation of a Job Corps Center in the State of Utah, has developed a number of teaching aids originally for use in a plastics training program at that Center but now to be distributed nationally. Teaching aids include working plastic models of processing equipment. Additional details may be obtained from Thiokol Chemical Company, Clearfield, Utah.

The PLASTICS SCHOOL, a description of which is contained in the optional equipment listing on page 45, can be obtained from Brodhead-Garrett Company, 4560 E. 71st Street, Cleveland, Ohio 44105, or Cope Plastics Illinois, Inc., 1111 West Delmar Avenue, Godfrey, Illinois 62035.

A programmed instruction book entitled, *Fundamentals of Plastics,* obtainable from the Penton Education Division, Penton Publishing Company, Cleveland, Ohio 44113.

Transparencies - A series of Plastics processing and basic chemistry transparencies can be obtained from DCA Educational Products, 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.

Films - A number of industry produced films are available for educational purposes on a loan basis. A convenient guide to such films is the SPI Film Catalogue available from The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017.

Career Film - The Plastics Education Foundation has produced a career guidance film, How to Crack the Establishment, suitable for use at the secondary school level. Distribution of this movie through the Plastics Education Foundation.

A number of film strips and accompanying records suitable for use at early secondary or secondary school level can be obtained from the Henry Company, Kitco Division, 6405 E. Kellogg Street, Wichita, Kansas.

SELECT-A-BOX is a kit containing samples of a variety of plastics materials in several forms together with accompanying data concerning the suitability of a variety of plastics to particular applications. Advantages as well as disadvantages are listed for each material. This kit may be purchased from Edison Technical Services, Inc., 70 Riverside Drive, New York, New York 10024.

Films - Closed loop, single concept, 8mm films, Sterling Educational Films, Inc., 241 E. 34th Street, New York, New York 10016.

Plastic Education System: includes
- student experiment workbook
- teacher guide
- student tests
- course outline
- filmstrips correlated with lessons
- reference lists
- hardware
- supplies

one week teacher education workshop may be purchased from PLASTIK-LABS, Post Office Box 18011, Wichita, Kansas 67218

E. SUPPLY SOURCES

The following firms currently list supplies and/or equipment appropriate to industrial plastics instruction at secondary or post-secondary levels in both industrial arts and occupational education programs.

Brodhead-Garrett Company
4560 E. 71st Street
Cleveland, Ohio 44105

Cope Plastics Illinois, Inc.
1111 West Delmar Avenue
Godfrey, Illinois 62035

Plastic Products Company of Utah
P.O. Box 1415
Salt Lake City, Utah 84110

Industrial Arts Supply Company
1408 West Lake Street
Minneapolis, Minnesota 55408

Hastings Plastics
1704 Colorado Avenue
Santa Monica, California 90404

The Henry Company
Kitco Division
6405 E. Kellogg Street
Wichita, Kansas

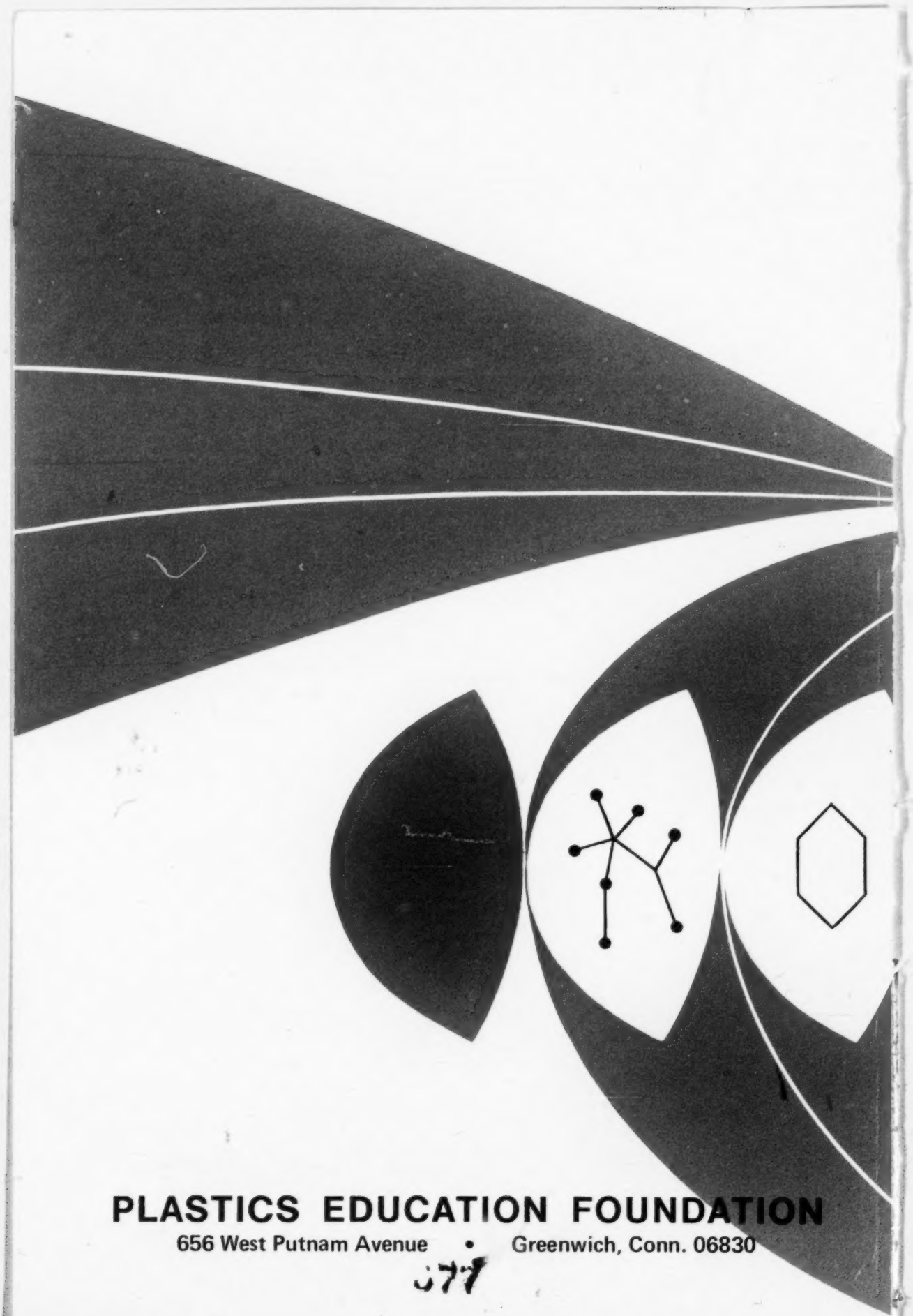

PLASTICS EDUCATION FOUNDATION

656 West Putnam Avenue • Greenwich, Conn. 06830

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ABSTRACT - Developed as a reference manual for both instructor coordinators and administrators, this handbook presents ideas regarding the aims, policies, organization, and operation of local programs in distributive education (DE). Among the 12 sections of this handbook are the following: (1) Types and Operation of DE Programs, (2) Methods In Selection of Student-Learner, (3) Advantages and Values of The Cooperative Part-time Program, (4) Duties and Functions of a DE Coordinator, (5) The Local Advisory Committee, (6) Criteria for Evaluating a Distributive Education Program, and (7) Distributive Education Forms. This handbook should be of interest to those planning and evaluating DE programs as well as to those operating existing programs. (JS)

VT 006 162

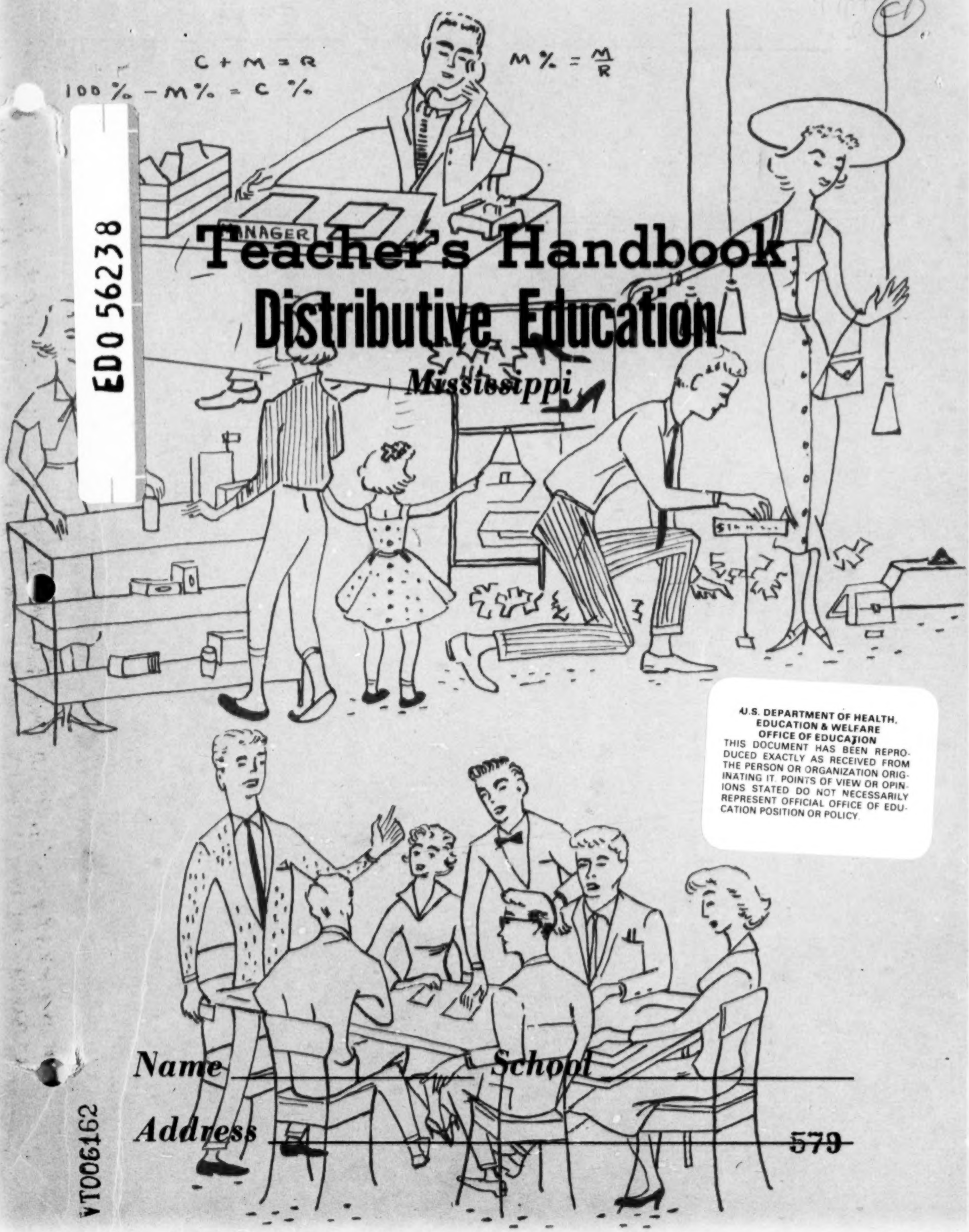

Teacher's Handbook
Distributive Education

Mississippi

ED0 56238

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FOREWORD

The primary purpose of this publication is to serve as a reference for both the new and experienced teacher-coordinator in solving many of their problems in the Distributive Education program. It may prove most helpful as other means of presenting the "Distributive Education Story".

This publication was prepared also to meet the continued demand from school administrators and from people in the field of distribution for statements regarding the aims, policies, organization, and operation of local programs of distributive education.

Grateful acknowledgement is given to former graduates and Mr. E. F. Mitchell, Head, Industrial Education, in the preparation of this publication. It is hoped that this information will assist those who wish to further expand opportunities in their communities for training both high school students and adults for occupations in the fields of marketing and distribution.

Jewel E. Burgess, Supervisor
Distributive Education

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PART I

Philosophy of Distributive Education

Distributive Education, a reimbursable program in Vocational Education, is designed to prepare students for employment in the field of marketing and distribution. The scope is broad including areas in the fields of retail, wholesale, and service areas.

Distributive Education came into existence with the passage of the George-Deen Act in 1936, and received further support from the George-Barden Act of 1946. Under the provisions of this Act, Distributive Education courses in the part-time cooperative and evening classes must be of such a nature as to:

1. Increase the skills, knowledge, and ability of trainees who are employed in a apecific distributive occupation.

2. Prepare trainees in a distributive occupation for changing to a related kind of experience in another distributive occupational level.

Part-time Distributive Education classes are organized and conducted on a cooperative basis - school and business. Entrance into classes giving instruction in distributive education is confined to persons who want, need, and can profit by it through special aptitude, skills, and interest. The student who enrolls must be at least sixteen years of age or older.

Distributive Education, a vital part of the total program, makes a worthwhile contribution toward the development of good citizens, including economic, cultural, and social interests.

Although Distributive Education classes primarily terminal in nature, the student is well qualified to enter college to further his career.

With the awareness on the part of school administrators of the vast number of people employed in marketing and distribution, and its demand for better trained distributive workers, we can look to the future with greater satisfaction that progress shall continue in the Secondary Schools of Mississippi. We can be assured also, that such schedule and curriculum adjustments that are necessary, both in the educational training and laboratory experience, shall be made.

PART II

Occupational Levels of Jobs Which May Be Included In Distributive Education

1. Distributive Occupations Defined.

Distributive occupations are those followed by workers directly engaged in merchandising activities, or in contact with buyers and sellers when:

a. distributing to consumers, retailers, jobbers wholesalers and others the products of farm and industry, or selling services.

b. managing, operating or conducting a retail, wholesale, or service business.

This training applies to training given to in-school youth and to adults eligible for training in distributive education.

2. Potentials In Occupational Objectives.

One interpretation is that there should be opportunity for advancement within the firm considered as a training establishment. Another interpretation is that the training provided by the firm under consideration should develop the student's potential ability to a point where he would be occupationally competent in that particular field of distribution, even though the manager might not be able to employ the student full time after graduation.

3. Job Training Requirements.

Not only should the student's classroom experience but the on-the-job training should be of sufficient stature to justify two credits per year. Some jobs, though distributive, are <u>not</u> important or complex enough to provide sufficient training opportunities.

Example: In variety stores the type of limited "work experience" can seldom, if ever, justify classroom training or supervision. Male students' opportunities far exceed the female student in this area. Male trainees often become managers and regional managers.

Distributive Education is not a "work" program - it is an educational training program.

4. Work Environment.

The coordinator should always be alert to the environment in which the student is placed. The business should be a distributive and reputable one, the management should be respected, and the moral climate should be good. The coordinator should assure himself that working conditions are satisfactory, and good atmosphere for training does exist.

5. Progression and Rotation.

In a training program, the student-learner progresses from simple jobs to more difficult ones, this should certainly be true in a distributive occupation training program. The idea of progression must be sold to insure job potentials for the student and to insure good training. Example: In a men's department store, rotations could mean the student starts work in receiving and marking, progresses to selling men's furnishings, progresses to selling men's shoes, progresses to other departments, and then, perhaps, to some junior executive level.

There follows a listing of training establishments which normally provide good training possibilities:

1. Shoe Store
2. Women's Specialty Shop
3. Furniture Stores
4. Department Stores
5. Dry Goods - General Mdse. Stores
6. Family Clothing Stores
7. Women's Ready-To-Wear
8. Infant's Wear Shop
9. Household Appliance
10. Floor Covering, Drapes, Glassware
11. Music Stores
12. Grocery
13. Auto Accessory
14. Lumber Yard - Building Material
15. Heating, Plumbing, Paint, Glass, Wallpaper Supplies
16. Meat Markets
17. Fruit Stores
18. Hardware
19. Farm Implement
20. Jewelry
21. Hay, Grain, Seed
22. Farm - Garden Supplies
23. Drug Stores
24. Book - Stationery
25. Newspaper Circulation
26. Gift Shop
27. Office Supply
28. Camera - Photo Shop
29. Sporting Goods
30. Florist
31. Other Retail Stores
32. Wholesale Outlet in any of the above.

PART III

Types and Operation of Distributive Education Programs

High School

Cooperative part-time programs consist of students who spend part of the day in the secondary school and a part of the day in a selected distributive occupation, thereby learning a vocation through the cooperative effort of the school and community.

Post High School

The scheduling of this program is the same as the high school program, except the student, usually, is preparing for mid-management or supervision in the field of marketing and distribution.

Adults

Adult classes are those conducted during the non-working hours of the enrollees. Persons enrolled in such classes must be employed in a distributive occupation. Instruction in such classes must be supplementary to the daily employment of those enrolled.

Operation

The co-operative part-time program may be set up to offer either two (2) years training with one (1) hour per day devoted to related instruction or one (1) year of training with two (2) hours per day devoted to related instruction. Student-learners will be employed a minimum of three (3) hours per day and not less than fifteen (15) hours per week. A training agreement between the school and employer and a detailed schedule of processes based on an analysis of the occupation are required for each student.

General Areas of Instruction

A cooperative Distributive Education program involves a variety of instruction. The organized classroom instruction, on-the-job experiences, and D. E. Club activities provide opportunities which enable the student

to channel his efforts toward the accomplishment of his ultimate goal. The program develops a well adjusted individual who recognizes his responsibilities. Individual instruction in school and on-the-job is most important in developing a strong Distributive Education Program.

Group instruction involves broad general content including: a study of the social and economic changes in the local community; a study of the kinds of organizations which perform distributive functions; a study of the process of getting goods from the producer to the consumer; a study of marketing, including buying, selling, pricing, wholesaling and retailing; a study of population changes, international problems, and government regulations; a study of financial aspects of distribution including records, customer service, advertising, display, and a study of the consumer in relation to the marketing process.

PART IV

Methods In Selection of Student-Learners

1. Information on Student and his Potentials.

Determining the ability of each enrollee in the Distributive Education program is not the sole responsibility of the teacher-coordinator. The assistance of the guidance counselor, school principal, and possibly members of the advisory committee can be most helpful, all of them should be in accord with the local policy on selection of students. Students must be legally employed in the distributive occupation for which training is provided. The Memorandum of Training service as evidence of legal employment.

Through a battery of tests much information can be gathered and should be carefully analyzed relative to:

a. interest
b. ability to learn
c. aptitudes
d. personality

A student in Distributive Education must be in good physical condition which may be determined by an interview, observation, school records, and conferences with parents, teachers, and physicians.

Past achievements of the students are of special significance in the development of any and all talents which lead to well-rounded, well-adjusted citizens of the community.

There is no factor in the student's life that plays a more vital part in the student's progress and achievement than his home life. It is one of the duties of the teacher-coordinator to visit the student's home before approving his application in order that he may thoroughly understand the home environment and conditions.

A. Matching the Student to the Job.

The coordinator in search for the opportunity which will result in a successful career for the student realizes that the interest of the employer and

the student are the same. The employer is looking for a student who will be successful in the job he has to offer. The student is looking for that job in which he can succeed.

Matching a student and a job is most important!

2. Locating Training Placements

The coordinator may have difficulty in determining proper placements, particularly if he is not acquainted with the local establishments which can provide acceptable distributive education training. He may study the classified section of the telephone directory, consult the Chamber of Commerce and tour the city or consult the advisory committee.

PART V

Advantages and Values of the Cooperative Part-Time Program

To the Student

Acquires knowledge needed for good job performance

Learns as he earns

Learns to work with people and for people

Learns to assume many responsibilities

Gains poise

Develops own cultural values

Develops leadership for tomorrow

To Management or Employer

Obtains trained new workers who have chosen retailing as a career

Increases sales at lower instructional cost

Has an opportunity to work with coordinator in developing the student's work and behavior habits

Offers opportunity in training for future full time employees

Participation in the planning for better instruction of students

To the School

Offers opportunities of projecting the school into the community

Interests business leaders in the school

Helps to prevent drop-outs

Has advantage of advisory committee composed of prominent community leaders.

PART VI

Qualifications of Teacher-Coordinators

Professional preparation in distributive education:

The teacher-coordinator shall be approved under one of the following plans:

Plan I.

The teacher-coordinator shall be a graduate of an approved teacher-training program in distributive education and hold a Class A secondary teacher's certificate.

Plan II.

A one (1) year Class A permit and vocational license may be issued to holders of Class A secondary certificate upon completion of six (6) semester hours or eight (8) quarter hours of credit earned from any of the courses required for a standard coordinator's certificate. He may continue to be approved as a teacher-coordinator each succeeding year upon completion of six (6) semester hours in distributive education as approved by the state supervisor until such time he meets requirements to be certified as a distributive education teacher-coordinator.

A minimum of twenty-seven (27) semester hours or forty (40) quarter hours in specialized education courses shall be reequired for a Class A secondary teacher's certificate for all distributive education teacher-coordinators.

Technical Preparation in Distribution:

Fifteen (15) semester hours in technical courses chosen from the following areas: marketing, accounting, economics, business law, merchandising and management. Ten (10) of the fifteen (15) semester hours will be required from the area of marketing.

Experience in distributive occupations: He shall have had two (2) years of practical experience as a wage earner in business or in a distributive occupation. One (1) year of which shall have been full time employment.

Duties and Functions of a Distributive Education Coordinator

A complete list of duties performed by coordinators would be infinite in length, therefore, this list should only serve as a guide and provide suggestions to the coordinator in performing his duties. The following list of duties is considered essential to the operation of a complete distributive education program in Mississippi:

1. Organization and Promotional Activities.

   a. Make survey of school and community distributive occupational needs.
   b. Counsel with prospective students and with parents of prospective students.
   c. Contact employers and explain the distributive education program.
   d. Recruit, select, and enroll students in D. E. program.
   e. Select and maintain functioning advisory committee.
   f. Make talks before business, civic and school groups to explain the program.
   g. Publicize the accomplishments of the program.
   h. Establish rules and regulations for the operation of the program.

2. Classroom Instruction.

   a. Instruct Distributive Education classes consisting of one or two hours in school each day.
   b. Instruct or supervise students in study of information directly related to their occupation.
   c. Instruct students in information indirectly related to their occupation designed to increase the student's personal development into a more proficient citizen.
   d. Correlate the laboratory experience of students with classroom instruction.
   e. Obtain, prepare, and maintain current and valid instructional aids in accordance with class needs.

3. Coordination-Supervision.

   a. Secure quality placements for students and set up training stations and training agreements.
   b. Plan a schedule of rotated experiences with employers on the Memo of Training Form then agree on a system of supervision.
   c. Arrange students schedule of school and training.
   d. Place students in training stations according to their interest, aptitudes, and abilities.
   e. Carefully follow-up students periodically to carry out Memo of Training Plan and check progress of experience.

f. Use grade sheets to obtain ratings from employers on student progress and ability.
g. Adjust problems of students with employers, school, parents, or others concerned.
h. Visits in homes with parents of students.
i. Works with faculty for general improvement of program.
j. Works closely with businesses of community in satisfying their training needs.

4. Follow-up and Evaluation.

a. Make periodic visits to trainees on the job and to employers.
b. Aid students in making additional adjustments for better progress in chosen occupations.
c. Confer frequently with individual students on personal achievement and training progress, and make recommendations when needed for improvement.
d. Counsel with former trainees to secure information for improvement of program and to follow-up with additional training through the adult program.

5. Related Activities

a. Sponsor local club chapter.
b. Keep records of trainees and work experiences.

6. Establish Relationships

a. Maintain close working relationship with business on employer-employee level.
b. Work to provide better school-community relations by striving to meet distribution training needs in the community.
c. Take an active part in professional activities such as civic groups. parent organizations, faculty meetings, teacher organizations, and merchant organization.
d. Attend extra-curricular activities and functions of the school.
e. Maintain continued publicity designed to educate the public on D. E., it's goals, it's achievements, it's merits, and it's services.

7. Adult Work.

a. Survey community for adult educational needs in distribution.
b. Organize courses.
c. Secure information and instructional materials for adult group needs.
d. Obtain instructors proficient and experienced in areas of courses taught.
e. Release publicity on courses offered.
f. Supervise all D. E. adult courses and instructors.

PART VIII

Organization and Promotion of Adult Evening Classes In Distributive Education

Administration of Adult Evening Classes In Distributive Education

a. Secure an adequate budget for adult classes through the school, making certain that the request is made in sufficient time to permit the school administration to approve it before the beginning of a new fiscal period.

b. Make arrangement for suitable space, either at the high school or some centrally located facility that meets the needs of a particular group or class.

c. Ascertain if an instructor is available to teach the particular class or series of related classes that are to be offered.

d. Promote the enrollment of adults in the class through one or more of the following organizations. (These are not necessarily listed in the order of their particular value, as this may vary somewhat from community to community.

1. Chamber of Commerce
2. Retail Merchants' Association
3. Newspaper, Radio, T. V.
4. Civic Clubs
5. Trade Associations
6. Direct Mail
7. Personal Solicitation
8. Poster Cards in Store Windows
9. Business Management Groups
10. Itinerants (State Department of Education)
11. A Representative Advisory Committee

Suggested Classes That May Be Offered

This is simply a cross section of classes that are approved to be offered in an adult evening program in distributive education. Others may require correspondence with the state supervisor to make certain that it meets the legal requirements for a reimbursable class.

For Management Personnel:	Personnel management, Legal aspects of business, Sales promotion, Record Keeping, Financial Management.
For Supervisory Personnel:	How to train an employee, how to supervise an employee, how to conduct group meetings, how to buy, creative thinking, rapid reading.
Sales Personnel:	Salesmanship, Stockkeeping, Human Relations, Display, Effective Speech, Retail Arithmetic, Credit and Collection.
Specialized Areas:	Interior Decorating, Textiles, Food Service Selling, Service Station Selling, Hardware Product Information, Furniture Sales Training, and many others.

Suggestions in Securing Instructors for Adult Evening Classes

a. Make certain that instructors are qualified in the field in which they are to teach. The local advisory committee should be of value to you in this regard.

b. It is also important, if the instructor is to be a local person that he has sufficient prestige to draw people into the class and to sell his services sufficiently well to have the enrollees want to come back to every class.

c. A lot of good potential instructors need help in putting their knowledge across to students. It is the job of the distributive education coordinator to serve as a teacher-trainer to the instructor.

d. Itinerant instructors are available through the Distributive Education Division of the State Department of Vocational Education. These instructors are available to the local school without cost. Write to the State Supervisor of Distributive Education for the names of these instructors and the classes that they teach.

e. Trade and civic organizations may be used in securing names of potential adult class instructors.

f. Certain trade groups such as the local association of furniture stores, department stores, variety stores, service stations, etc., are sometimes able and willing to bring in outside experts in their particular fields to instruct specialized classes for their specific and related groups.

g. Members of the faculty of your high school and any local college may make excellent instructors in their particular field of study.

h. Promotion of adult evening classes is one of the most important duties of the coordinator who realizes, however, that unless he has a good cooperative program he possibly will not be as successful in organizing adult evening classes. Both should be given their fair share of promotional and supervisory time.

Procedures in Securing Approval for Adult Evening Classes

a. Approval must be secured in advance of the opening of adult evening classes in order to be eligible for reimbursement of the instructor's salary.

b. An Application For Approval In Advance Form must be completed in duplicate, an Outline of the Course to be offered attached to it and signed by the superintendent or someone authorized by him to sign, before it is sent in to the state supervisor of distributive education.

c. When the class is organized an initial report is sent in signed by both the instructor and the coordinator. This report should be sent in as soon as the class becomes stablized in number.

d. A minimum of ten students are required for reimbursable classes. A minimum of fifteen should be enrolled in order to allow for possible drop-outs.

e. Instructors should keep up-to-date and adequate records of attendance for students enrolled in the class.

f. The coordinator should check the classes progression in order to see if it is being conducted in line with the policy for adult evening classes.

g. Coordinators should realize that reimbursement is only on the instructor's salary and cannot be used for any other purpose.

h. Visitations to the classes should be recorded on the Activity Report, as well as number of class members talked with.

Cost of Instruction

a. One of the best public relations aspects of a distributive education program, as far as business people are concerned, is a good adult program for management, sales workers, department heads, supervisors and non-selling personnel.

b. A budget can pay big dividends in engendering goodwill in the community through programs that meet the needs of workers in marketing, distribution and service establishments.

c. At the present time, the State Department of Vocational Education will reimburse two-thirds of the teacher's salary for conducting approved adult classes in distributive education. It may be possible, under certain conditions, to secure 100% reimbursement on certain classes. A small registration fee may be charged for teaching aids and supplies that may be applied to the local costs of the class where no local funds are available.

d. A budget of $1,000.00 should be adequate to pay teacher salaries for twenty-five classes of ten hours each, enrolling probably a minimum of three hundred seventy-five students, with possibly a great many more being enrolled. Note: Four dollars an hour was used as a basis of instructor salary. Note: One-third of above would be local funds.

e. On the basis of the above projections, the value to the community and its' tax payers and voters through the benefits derived through these classes would be most worthwhile both economically and in the general welfare of the trade territory.

<u>Supervision of Adult Evening Classes by Distributive Education Coordinator</u>.

a. It is the local school's responsibility to provide the supervision of adult evening classes. The coordinator of distributive education is trained and qualified to handle this responsibility and should be expected to do so. In larger areas or communities he may require assistance in order to keep him from neglecting his cooperative program on account of a large adult evening program.

b. The coordinator should be aware that the following reports are required on any reimbursable classes:

1. Initial Report; at the beginning of each class
2. Monthly Activity Report
3. Final Report; shortly after the class is completed.

c. All standard report forms are supplied through the state supervisor of distributive education. These may be ordered when supplies become depleated.

d. All approved adult evening classes completed during a semiannual period should be reported for reimbursement.

PART IX

The Local Advisory Committee

a. A local advisory committee is most important and necessary to the successful operation of a good adult evening school program.

b. The coordinator should realize that the advisory committee's function is solely advisory in nature, and involves no administrative responsibilities or authority.

c. Outstanding local business leaders and employees serving on the advisory committee should serve as a most helpful group in keeping the distributive education coordinator and the school informed on local needs and problems which might be alleviated through efforts of the distributive education department in cooperation with local business leaders and organized groups.

d. The advisory committee should be composed of an equal representation of employers and employees. Strong representation from the Chamber of Commerce and the Retail Merchant's Association, should be included in the membership. The coordinator is an ex officio member of the group and should act as secretary.

e. The possible membership should be discussed with the superintendent of schools and preferably a letter be sent out over his signature notifying the individual members of their appointment to the advisory committee. (The coordinator should have previously talked with each individual to ascertain their willingness to serve).

The advisory committee provides a link between the school and community through which their activities can be coordinated. Its use is highly recommended. There must be a constant exchange of information in order to keep the program of distributive education realistic and to satisfy the changing needs of the community.

Purposes and Functions of Advisory Committee:

Advise on course of study.

Planning group for program expansion.

Assists in creating good will.

Help in creating prestige for school, community, and program.

Assist in surveys.

Aid in development of standards.

Help insure a realistic and practical program.

Guide in wage and hour problem.

Assist in promoting adult classes.

Help select adult teacher-coordinator.

Help evaluate all phases of activities.

PART X

Future Leaders in Marketing and Distribution

Distributive Education Clubs of America is a youth activity program which is designed for boys and girls enrolled in part-time cooperative programs in the field of marketing and distribution. It is organized on local, state, and national levels to provide incentives and recognition for D. E. students. It encourages the value of the club as a vital part of the total program.

Aims and purposes of D. E. C. A.

Broadens ecnomic understanding.

Increases knowledge of distribution.

Maintains an inquity attitude toward techniques used in distribution.

Increases abilities in citizenship activities.

Develops an understanding of the social and economic responsibilities of those engaged in distribution.

<u>Importance to the Student</u>

D. E. C. A. provides opportunities for service to the school, community, and nation in the following areas:

Educational activities

Professional activities

Civic activities

Social activities

Benevolent activities

PART XI

Criteria For Evaluation of a Desirable D. E. Program

Organization

1. Is this program in Distributive Education based upon findings of surveys of employment opportunities in marketing and distribution in the area served by the local school?
2. Is an advisory board or planning committee, representing both school and business leaders, used in organizing this program?
3. Is classroom instruction correlated with laboratory training?
4. Do students receive credit toward graduation for both classroom instruction and laboratory training?
5. Do D. E. students spend minimum 15 hours a week with an approved laboratory training agency?
6. Are all state and federal laws adhered to in the operation of this program?
7. Are students enrolled on a basis of need, interest, and ability as a result of proper tests and interviews?
8. Are D. E. students permitted to participate in club activities in the field of distribution?
9. Does this present program meet the career objectives of each student?
10. Is there a detailed training plan contributing to the career objective a matter of record for each student?

Nature of the Curriculum

1. Is the D. E. instruction based on career objectives in marketing and distribution, and basic needs of the community?
2. Does this D. E. Curriculum include the marketing and distribution process?

3. Does this D. E. Curriculum provide for subject areas in addition to the areas of distribution?

4. Is there adequate supervision given to the laboratory training?

5. Is there a definite understanding of the responsibilities in a competitive economic system in the areas of distribution?

Physical Needs

1. Are the following items of equipment available for classroom and laboratory instruction:
   1. Cash register.
   2. Filing cabinet.
   3. Wrapping counter with a variety of supplies.
   4. Wall cases with mirrors.
   5. Models and mannequins.

2. Is there sufficient space provided to meet curricular and enrollment needs?

3. Is the teacher coordinator equipped with a desk and files for counseling with students?

4. Are movable tables and chairs provided to facilitate use of reference materials?

5. Is there convenient storage space provided for materials and equipment not in frequent use?

6. Is the classroom conveniently located near a building entrance?

Cognizant

1. Is the instructional material kept up to date?

2. Does the teacher coordinator maintain sufficient supplementary instructional materials?

3. Are adequate reference materials available?

4. Are self-study materials available for specific instruction?

5. Are there appropriate audio-visual aids available?

6. Does the instructor have a plan of instruction to follow?

Instructional Activities

1. Does the instruction in D. E. contribute to the school's objective?
2. Is instruction directed toward career objectives?
3. Is there evidence of careful planning and preparation for classroom work on the part of the teacher coordinator?
4. Are business resources of the local community used in instruction?
5. Do students assist in planning classroom activities?
6. Are job descriptions prepared for laboratory experiences?
7. Are the laboratory experiences used to develop an understanding of the theory presented in the classroom?
8. Does the instruction include the basic concepts of distribution in addition to specific specialization?
9. Does the teacher coordinator visit in the home of each student?
10. Does the teacher coordinator visit the student's laboratory agency regularly?
11. Is the laboratory training correlated with the student's aptitudes, interests, and abilities?
12. Is a positive approach instilled in the student's attitude of personal responsibility toward the laboratory training?
13. Is there provision for teaching the economics of distribution?
14. Is there provision for teaching management concepts?

Instructional Staff

1. Is each member of the D. E. staff prepared in the subject matter field?
2. Has each member of the staff received training in methods of teaching DE?
3. Has each member of the D. E. staff had wage-earning experience in the field of marketing and distribution?
4. Has each member of the D. E. staff had sufficient preparation in related areas in the field of distribution?

5. Has each member of the D. E. staff developed good relations with the business community?

6. Has each member of the D. E. staff maintained an interest in the activities of the business organizations in the local community?

7. Has each member of the D. E. staff maintained an active interest in the professional organizations?

8. Has each member of the D. E. staff maintained active participation in in-service education through formal and other professional activities?

9. Does each member of the D. E. staff maintain proper lines of communication?

Methods of Evaluation

1. Are the evaluation activities an integral part of the classroom instruction?

2. Is individual progress recorded and used for guidance and instructional purposes?

3. Is the laboratory experience training used as a basis of student education as well as the classroom proficiency?

4. Is the student's evaluation of laboratory training made jointly by the employer and teacher coordinator?

5. Is the student's evaluation made in terms of needs of the laboratory experience of the student as well as in terms of career objectives?

6. Is there sufficient follow-up surveys conducted to evaluate the student's educational outcomes?

Achievements

1. Do students show sufficient signs of improvement in skills and attitudes necessary for the distributive occupations?
2. Do the students show sufficient knowledge and understanding necessary for success in the distributive occupations?
3. To what extent are students developing moral and ethical standards related to distributive occupations?
4. Are students being informed about the varied opportunities in the field of distribution?

Form DE-1

PROPOSED BUDGET AND APPLICATION FOR AID IN DISTRIBUTIVE EDUCATION CLASSES

For the Fiscal Year Beginning July 1, 19____, and ending June 30, 19____.

(Due in State Office on or before June 15—Submit 3 copies)

From:.....School Board, Post Office.....

To: Mississippi State Vocational Board
Box 771
Jackson, Mississippi

County of.....

Gentlemen:

We are submitting herewith for your information and approval our estimated budget for the vocational Distributive Education classes, both white and colored, and the part-time and evening classes that we hope to have in operation in this.....

.....school system during the fiscal year, 19.....-19.....

(State whether consolidated, separate district or county agricultural)

1. List Your "In-School" Program by Type Class to Be Operated.

Name of Instructor	Race	Course to be Taught	Number Months Employed	Yearly Salary	% Time Voca-tional	Vocational Cost	Estimated Reimbursement		
							Salary	Travel	Total

Schedule of Teachers Time	1st Period	2nd Period	3rd Period	4th Period	5th Period	6th Period	7th Period
	From—To	From—To	From—To	From—To	From—To	From—To	From—To

2. Other Classes to be organized during year on basis of needs in the Distributive field.

For "Out-of-School" Students

TYPE OF CLASS	Estimated No. Classes	Estimated Enrollment	Local Funds Set Aside for These Classes	Total Cost for These Classes	Estimated Reimbursement
Part-time (W.)					
Part-time (C.)					
Evening Classes (W.)					
Evening Classes (C.)					

B. The following amount of local funds has been included in our budget to be used for equipment and instructional supplies,

Distributive Occupations $.....

We, the undersigned local school authorities do hereby certify that the foregoing statements and budgets for vocational distributive education are true and correct to the best of our knowledge and belief. We hereby pledge our full cooperation with the State Vocational Board in maintaining these vocational classes so as to comply with all requirements for state and federal aid as provided by law.

We are submitting herewith 3 copies of this budget for vocational education and trust the State Vocational Board can give its approval of same and return one approved copy to the undersigned County Superintendent of Education or City Superintendent of Schools.

Approved By:

_____
(State Supervisor of Distributive Education)

_____
(State Director Vocational Education)

Date:_____

Respectfully submitted,

Signed:_____
(President or Secretary, Board of Trustees)

Approved By_____
(County Superintendent of Education or City Superintendent of Schools)

Date:_____

Form DE-2

MEMORANDUM OF TRAINING PLAN

(Due in State Office not later than end of first school month)

This memo is for the purpose of outlining the agreement between the school and the employer on the conditions of training to be given a student while on the job. It, therefore, should not be interpreted by either agency as a legal document or any form of binding contract.

The _____ will permit _____
(Training Agency) (Trainee)

Sex_____ Age_____ Grade_____

to enter their establishment for the purpose of gaining knowledge and experience as_____

_____ _____ _____
(Occupation)

(It is understood that the occupation in which training is herewith being offered is one in which provisions of the wage and hour law **is** or **is not** applicable)

1. This course of training is designed to run for a_____year period with a minimum of FIFTEEN hours per week required for the work experience and at least _____period(s) in each school day required for the supervised and directed study of technical and auxiliary related subjects.

2. The outlines of the processes to be learned on the job and of related subjects to be taught in the school is presented on the reverse hereof and constitutes the major portion of the training program of this learner.

3. The student will not be permitted, in the process ot gaining occupational experience, to remain in any one operation, job, or phase of the occupation beyond the period of the time that is necessary for him to become proficient in that occupation.

4. The student while in the process of training will have the status of a non-competitive worker neither displacing a regular worker now employed nor substituting for a worker needed by the training agency.

5. The following schedule of compensation shall be paid the trainee for the school year.

   Amount per hour_____, and per week_____.

6. All transfers, withdrawals, or dismissals shall be made jointly by the Coordinator and by the employer.

_____ _____
School Employer

_____ By_____
Supt. or Prncipal

Date_____

DISTRIBUTION: Copies to—Employer, School Superintendent, State Supervisor and Coordinator

This section should be filled in by the coordinator in conference with the employer of the student.

OUTLINE OF JOB PROCESSES	OUTLINE OF RELATED SUBJECTS
NAME OF TRAINEE	

Form DE-3

ORIGINAL

Code_____

INITIAL REPORT

on

D. E. Classes

City_____ County_____ Date _____

I hereby submit the following initial report on_____

Subject

_____, organized at_____School. This class began

_____19____with_____ pupils enrolled, as follows:

NOTE: This form should be filled in listing each student enrolled in the class and mailed in at least by the third week of operation of the class.

NAME OF STUDENT	Age	Sex		Grade Level	OCCUPATIONAL OBJECTIVE	EMPLOYED BY:
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						

Signed:_____

Superintendent of school

_____

Signature of Teacher

Form DE-3

DUPLICATE

Code_____

INITIAL REPORT

on

D. E. Classes

City_____ County_____ Date _____

I hereby submit the following initial report on_____
Subject

_____, organized at_____School. This class began

_____19____with_____ pupils enrolled, as follows:

NOTE: This form should be filled in listing each student enrolled in the class and mailed in at least by the third week of operation of the class.

NAME OF STUDENT	Age	Sex		Grade Level	OCCUPATIONAL OBJECTIVE	EMPLOYED BY:
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						

Signed:_____
Superintendent of school

_____
Signature of Teacher

Form DE-3

ORIGINAL

Code_____

Race_____

INITIAL EVENING REPORT

on

D. E. Evening Classes

City_____ County_____ Date_____

I hereby submit the following initial report on the evening class in_____
Subject

_____, organized at_____School. This course began

_____ 19_____with_____ Pupils enrolled, as follows:

NOTE: This form should be filled in listing each student enrolled in the class and mailed in at least by the third week of operation of the course.

NAME OF STUDENT	Age	Sex	Year in this work	Grade Level	OCCUPATIONAL OBJECTIVE	EMPLOYED BY:
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						

Signed_____
Superintendent or Local Supervisor

_____
Signature of Teacher

Form DE-3

DUPLICATE

Code_____

INITIAL EVENING REPORT

on

D. E. Evening Classes

Race_____

City_____ County_____ Date_____

I hereby submit the following initial report on the evening class in_____
Subject

_____, organized at_____School. This course began

_____ 19_____with_____ Pupils enrolled, as follows:

NOTE: This form should be filled in listing each student enrolled in the class and mailed in at least by the third week of operation of the course.

NAME OF STUDENT	Age	Sex	Year in this work	Grade Level	OCCUPATIONAL OBJECTIVE	EMPLOYED BY:
1.						
2.						
3.						
4.						
5.						
6.						
7.						
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21.						
22.						
23.						
24.						
25.						

Signed_____
Superintendent or Local Supervisor

_____
Signature of Teacher

Form DE-4

ORIGINAL

APPLICATION FOR APPROVAL IN ADVANCE

FOR

STATE AND FEDERAL AID

FOR

Part-Time Extension and Evening Classes in Distributive Education

_____County

_____City

_____Date

To: State Board for Vocational Education
Jackson, Mississippi

The School Board of_____being desirous of establishing a vocational class as described below hereby makes application for approval of such under the provisions of the federal vocational educational act and the state plan for vocational education. It is understood and agreed that the local school board will pay the entire cost of instruction and will receive reimbursement from the State Vocational Board for _____% of this cost. The total cost of instruction for this class will probably be $_____.

Signed:_____Superintendent

CLASS:
Occupation for which instruction is to be given_____

Subjects_____

White or colored_____Probable enrollment: M_____ F_____

Class will meet: Place_____ Time: From_____ To_____ Days_____

Class will start_____ Will continue_____weeks

TEACHER:
Name_____

Employed by_____ Occupation_____

Years of experience_____ Age of Teacher_____ M_____ F_____

Years Schooling_____ H. S._____ College_____ Graduated_____

Vocational Certificate_____ (yes, no) No._____

Teacher's salary for this class $_____per_____Total salary $_____

ATTACH TO THIS APPLICATION outline of course to be given.

Approved:

STATE VOCATIONAL BOARD

By:_____
State Supervisor, Distributive Education.

Note: This form is to be submitted in duplicate and approval received before the first meeting of the class is held.

Form DE-4

DUPLICATE

APPLICATION FOR APPROVAL IN ADVANCE

FOR

STATE AND FEDERAL AID

FOR

Part-Time Extension and Evening Classes in Distributive Education

_____County

_____City

_____Date

To: State Board for Vocational Education
Jackson, Mississippi

The School Board of_____being desirous of establishing a vocational class as described below hereby makes application for approval of such under the provisions of the federal vocational educational act and the state plan for vocational education. It is understood and agreed that the local school board will pay the entire cost of instruction and will receive reimbursement from the State Vocational Board for _____% of this cost. The total cost of instruction for this class will probably be $_____.

Signed:_____Superintendent

CLASS:
Occupation for which instruction is to be given_____

Subjects_____

White or colored_____Probable enrollment: M_____ F_____

Class will meet: Place_____ Time: From_____ To_____ Days_____

Class will start_____ Will continue_____weeks

TEACHER:
Name_____

Employed by_____ Occupation_____

Years of experience_____ Age of Teacher_____ M_____ F_____

Years Schooling_____ H. S._____ College_____ Graduated_____

Vocational Certificate_____ (yes, no) No._____

Teacher's salary for this class $_____per_____Total salary $_____

ATTACH TO THIS APPLICATION outline of course to be given.

Approved:

STATE VOCATIONAL BOARD

By:_____
State Supervisor, Distributive Education.

Note: This form is to be submitted in duplicate and approval received before the first meeting of the class is held.

Standard Form No. 223C
Form prescribed by
State Auditor
July, 1956
For 12 mos. voc.
teachers.
H. B. 942, Regular Session 1956

Voucher For Reimbursement of Expenses Incident To Official Travel

STATE BOARD OF EDUCATION
VOCATIONAL EDUCATION DIVISION

Vou. No._____

File_____

RECORD OF PAYMENT

Date_____

Req. No._____

Check No._____

Fund_____

_____
Official Duty

TO_____

Address_____

Monthly Report On Activities for the Month of_____

Item	Totals
1. Number of contacts made with employers	
2. Number of meetings with employer and/or employee organizations	
3. Number of coordination contacts with cooperative students	
4. Number of calls on parents of students	
5. Number of cooperative part-time students in classes	
6. Number of part-time and evening classes in operation	
7. Number of part-time and/or evening classes supervised during month	
8. Number of confs. with teachers of evening or part-time classes for impv. of instr.	
9. Number of advisory committee meetings during month	
10. Number of student clubs attended	
11. Number of civic-professional clubs attended	
12. Number of promotional contacts	
Miscellaneous	

PENALTY FOR PRESENTING FRAUDULENT CLAIM.—Fine of not more than $250.00; civilly liable for full amount received illegally; and in addition, removal from the office or position held by the person presenting such claim. (See Section 10 of H. B. No. 223, Miss. Laws of 1950.)

Subject to any differences determined by verification, I certify that the amount claimed by me for travel expenses for the period indicated on the reverse side is true and just in all respects, and that payment for any part thereof has not been received.

Approved for payment:

_____
County or Separate School Supt.

Payee_____
(Signature of Vocational Teacher)

Verified by_____
School Superintendent

AMOUNT CLAIMED			AMOUNT DUE (As Per Office Verification)		
FOR	Dollars	Cents	FOR	Dollars	Cents
Travel					

(DISTRIBUTION: White copy to Administrative Superintendent, pink copy to State Vocational Board, Green copy to Local School Supt., and yellow copy for Vocational Teacher)

MONTHLY STATEMENT OF OFFICIAL LOCAL TRAVEL

SCHOOL_____ COUNTY_____ _____
(Name of Teacher)

For mileage for privately owned motor vehicle used by me for transportation in the discharge of official duty from_____ 19_____, to_____ 19_____, as per itemized statement within.

DATE	SUPERVISION OF INSTRUCTION			TOTAL MILES	AMT. @ 6¢ PER MILE
	INDIVIDUALS	GROUP	PURPOSE OF VISIT		

Standard Form No. 223C
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Vou. No._____

File_____

RECORD OF PAYMENT

Date_____

Req. No._____

Check No._____

Fund_____

STATE BOARD OF EDUCATION
VOCATIONAL EDUCATION DIVISION

_____ Official Duty

TO_____

Address_____

Monthly Report On Activities for the Month of_____

Item	Totals
1. Number of contacts made with employers	
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5. Number of cooperative part-time students in classes	
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Payee_____ (Signature of Vocational Teacher)

Verified by_____ School Superintendent

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FOR	Dollars	Cents	FOR	Dollars	Cents
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(Name of Teacher)

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DATE	SUPERVISION OF INSTRUCTION			TOTAL MILES	AMT. @ 6¢ PER MILE
	INDIVIDUALS	GROUP	PURPOSE OF VISIT		

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VOCATIONAL EDUCATION DIVISION

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File _____

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County or Separate School Supt.

Payee _____
(Signature of Vocational Teacher)

Verified by _____
School Superintendent

AMOUNT CLAIMED			AMOUNT DUE (As Per Office Verification)		
FOR	Dollars	Cents	FOR	Dollars	Cents
Travel					

(DISTRIBUTION: White copy to Administrative Superintendent, pink copy to State Vocational Board, Green copy to Local School Supt., and yellow copy Vocational Teacher)

620

MONTHLY STATEMENT OF OFFICIAL LOCAL TRAVEL

SCHOOL_____ COUNTY_____ _____
(Name of Teacher)

For mileage for privately owned motor vehicle used by me for transportation in the discharge of official duty from_____ 19_____, to_____ 19_____, as per itemized statement within.

DATE	SUPERVISION OF INSTRUCTION			TOTAL MILES	AMT. @ 6¢ PER MILE	
	INDIVIDUALS	GROUP	PURPOSE OF VISIT			

Standard Form No. 223C
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H. B. 942, Regular Session 1956

Voucher For Reimbursement of Expenses Incident To Official Travel

STATE BOARD OF EDUCATION
VOCATIONAL EDUCATION DIVISION

Vou. No._____

File_____

RECORD OF PAYMENT

Date_____

Req. No._____

Check No._____

Fund_____

_____
Official Duty

TO_____

Address_____

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Item	Totals
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7. Number of part-time and/or evening classes supervised during month	
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Subject to any differences determined by verification, I certify that the amount claimed by me for travel expenses for the period indicated on the reverse side is true and just in all respects, and that payment for any part thereof has not been received.

Approved for payment:

_____
County or Separate School Supt.

Payee_____
(Signature of Vocational Teacher)

Verified by_____
School Superintendent

AMOUNT CLAIMED			AMOUNT DUE (As Per Office Verification)		
FOR	Dollars	Cents	FOR	Dollars	Cents
Travel					

(DISTRIBUTION: White copy to Administrative Superintendent, pink copy to State Vocational Board, Green copy to Local School Supt., and yellow copy for Vocational Teacher)

MONTHLY STATEMENT OF OFFICIAL LOCAL TRAVEL

SCHOOL_____ COUNTY_____ _____
(Name of Teacher)

For mileage for privately owned motor vehicle used by me for transportation in the discharge of official duty from_____ 19____, to_____ 19_____, as per itemized statement within.

DATE	SUPERVISION OF INSTRUCTION			TOTAL MILES	AMT. @ 6¢ PER MILE
	INDIVIDUALS	GROUP	PURPOSE OF VISIT		

VT 006 625
Christensen, Howard H.; Lee, Ivan E.
Handbook for New Vocational Teachers.

Nevada Univ., Reno. Max C. Fleischmann Coll. of Agriculture.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 81p.

DESCRIPTORS - *VOCATIONAL EDUCATION; *VOCATIONAL EDUCATION TEACHERS; *INSERVICE TEACHER EDUCATION; *TEACHER ROLE; *MANUALS; TEACHER EDUCATION; TEACHER ORIENTATION; BEGINNING TEACHERS; STUDENT TEACHERS

ABSTRACT - This handbook has been prepared for the vocational education major, student teacher, new teacher, and the adult teacher with limited teaching experience. Designed to highlight the simple but necessary tasks of successful teaching, one page is used for each main idea, supplemented by line drawings. Chapters include: (1) Characteristics of Successful Teachers, (2) Local Policies and Regulations, (3) Planning the Instructional Program, (4) Writing Lesson Plans, (5) Preparation for the Class, (6) How to Teach the Class, and (7) Evaluation and Testing. (CH)

VT 006 625

HANDBOOK FOR NEW VOCATIONAL TEACHERS

ED0 56238

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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CHRISTENSEN and LEE

VT006625

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HANDBOOK

FOR

NEW VOCATIONAL TEACHERS

by

HOWARD H. CHRISTENSEN, Ph. D.
TEACHER-EDUCATOR IN AGRICULTURE
Max C. Fleischmann College of Agriculture
University of Nevada
Reno Nevada

and

IVAN E. LEE, M. S.
TEACHER-EDUCATOR, VOCATIONAL
Technical and Industrial Education
College of Education
University of Nevada
Reno, Nevada

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ACKNOWLEDGEMENTS

Much valuable assistance was received from Dr. Harlan E. Ridenour, Director of Ohio Vocational Agriculture Material Service, Ohio State University.

Credit is also given to the teacher-educators and state staff in Ohio for their excellent ideas for Trade Extension teachers.

Assistance also was given by Professor T. A. Butler, Dr. L. P. Herndon, Agricultural Education and Mechanics Department, University of Nevada. Mr. J. R. Peddicord, State Supervisor of Agricultural Education and Harvey G. Thiel, Trades and Industrial Education Supervisor, State Department of Education, Carson City, Nevada.

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PREFACE

This book has been prepared for the Vocational Education major, student teacher, new teacher and the adult teacher with limited teaching experience. The purpose is to show the beginner the role of the teacher and illustrate the simple but necessary things that should be done to make his teaching a success. This is also meant to be used by the veteran instructor as a reminder of the basic fundamentals of teaching.

It is believed that most of the failures and poor teaching result from lack of doing the things listed in this small book.

It is also believed that most discipline problems, bad school and public relations problems can be prevented by mastering the fundamentals listed.

It is conceded by the authors that many practices and methods used by successful teachers are not included in the text, but those that are listed are essential to the vocational teachers' success.

The handbook is designed to hit only the highlights. For this reason one page is used for each main idea.

It is hoped that all new teachers will seek more complete references for greater detail on ideas suggested in this manual.

The Authors

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CHAPTER I

CHARACTERISTICS OF SUCCESSFUL TEACHERS

INTRODUCTION

The art of successful teaching can be mastered by practically all normal, well trained individuals who strive to develop the characteristics described in this section.

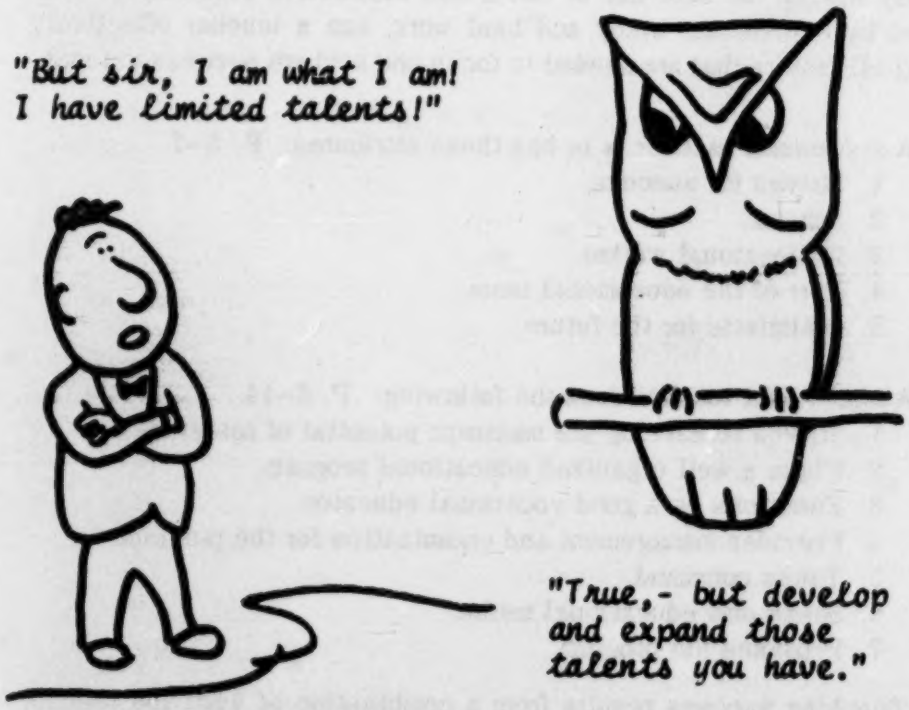

Teaching is not a "fixed" skill but one where the teacher "practices" his profession. Classes and individual students vary from year to year. They have different needs; also our society and "world of work" is not static but constantly changing. For these reasons the teacher must constantly adapt and improve to best meet the changing times.

The assumption is that successful teachers in general act in a similar manner; but have developed their own peculiar personality and style to best use their own God-given talents.

By making the best use of one's own distinctive personality, tempered by experience, study and hard work, can a teacher effectively bring all factors that are needed in focus and achieve success in teaching.

A successful teacher **is** or has these attributes: P. 3–7

1. Strives for success.
2. Scholar.
3. Professional worker.
4. Part of the educational team.
5. Optimistic for the future.

A successful teacher *does* the following: P. 8–14.

1. Strives to develop the maximum potential of his students.
2. Plans a well organized educational program.
3. Functions as a good vocational educator.
4. Provides management and organization for the program.
5. Takes command.
6. Seeks new educational media.
7. Promotes his program.

Teaching success results from a combination of what the teacher *is* and what he *does*. Each is equally important for teaching success. It is important to note they are not identical. In the observation of successful teachers, it is usually more difficult to see and explain what a teacher does than it is to identify teacher attributes. Learn the earmarks of quality teaching.

THE SUCCESSFUL TEACHER STRIVES FOR SUCCESS

The goal of the new teacher should be to assume the characteristics of the successful teacher.

Becoming a successful teacher requires a long period of hard work and experience. Students are not perfect and have great differences and great needs. The rewards that come to the teacher are few and hard to define. A successful teacher believes that the primary hope for the future lies in education.

He is an alert, aggressive, dynamic individual who will spend the time needed to make his program a success.

He is creative, imaginative, optimistic and is opportunistic in making the most with what he has to work.

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THE SUCCESSFUL TEACHER IS A SCHOLAR!

Each teacher is in the lifelong business of self improvement!

1. Has a satisfactory scholastic record.
2. Reads worthwhile publications in the vocational, business and education fields.
3. Is a keen observer of his students, successful operators and employers.
4. Knows how to relate technical knowledge to actual problems of students.
5. Participates in workshops, seminars and professional and technical areas of knowledge.

Outcome or results

His students, through their work and accomplishments, exemplify good scholarship.

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THE SUCCESSFUL TEACHER IS A PROFESSIONAL WORKER

1. Organizes and manages his own program under the supervision of others.

2. Supports and promotes his profession and is loyal to his colleagues.

3. His appearance, actions and manner are geared to meet the best interests of the profession.

4. Answers correspondence, completes reports and becomes a part of the total educational team, local and state.

ECG 632

THE SUCCESSFUL TEACHER IS A PART OF THE EDUCATIONAL TEAM!

1. Promotes the entire school program.
2. Cooperates with school administration.
3. Carries his fair share of the "extra duties" associated with teaching.
4. Works with parents.
5. Cooperates with state supervisors, teacher educators and others in the development of the total program.
6. Joins and takes an active part in professional educational organizations – local, state, national.

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THE SUCCESSFUL TEACHER IS OPTIMISTIC FOR THE FUTURE.

1. Believes in the future.

2. Believes in the worth of people and has faith in the youth and adults of his community.

3. Sees the good side of things.

4. Is able to pass his enthusiasm on to others.

5. Believes in the worth of vocational education and has faith in his program.

THE SUCCESSFUL TEACHER STRIVES TO DEVELOP THE MAXIMUM POTENTIAL OF HIS STUDENTS.

He works with guidance counselors and others to understand his students.

1. Tries to determine vocational and scholastic goals of his students.

2. Tries to develop in his students a love for learning and their creative talents.

3. Assists students to discover knowledge as well as the world of work and to finally become a well adjusted citizen.

PCA 635

THE SUCCESSFUL TEACHER PLANS A WELL ORGANIZED EDUCATIONAL PROGRAM.

1. Plans a curriculum for his department based on the vocational objective of his students.

2. Uses an advisory council, successful individuals, and his observations of the "world of work" in planning his instructional program.

3. Plans a meaningful educational program for his students.

4. Plans for supervised work experience programs for his students.

5. Develops educational objectives that may be observed and measured.

6. Plans to evaluate his educational program in terms of his educational objectives.

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THE SUCCESSFUL TEACHER FUNCTIONS
AS A GOOD VOCATIONAL EDUCATOR.

1. His lessons have utility.

2. His instructional program is aimed to develop vocational competence in his students.

3. Assists students to find employment and become successful workers.

4. Knows the needs of parents, employers and the self-employed in his service area.

5. Relates classroom teaching to occupational work experience programs.

6. Supports the principles of vocational education.

Outcome or results:

The value of his program can be measured by the occupational success of his students.

THE SUCCESSFUL TEACHER PROVIDES
THE MANAGEMENT AND ORGANIZATION FOR THE PROGRAM.

1. Determines the most effective use of his own time.

2. Wholesales his own time by determining job priorities, group activities and various methods of teaching that will bring the greatest results according to effort expended.

3. Develops and uses student leaders. He authorizes, deputizes and supervises students and others.

4. Plans varied and adequate work that provides meaningful learning experiences for all.

5. Organizes his teaching materials, the facilities and classroom for best results.

THE SUCCESSFUL TEACHER TAKES COMMAND.

1. Has a high concept of his own worth.
2. Provides leadership.
3. Determines educational objectives.
4. Determines learning activities of his students – assignments, practice, projects, reports, etc.
5. Sets standards.
6. Gives directions.
7. Evaluates progress and determines grades.

THE SUCCESSFUL TEACHER CONTINUALLY SEEKS NEW EDUCATIONAL MEDIA FOR USE IN TEACHING.

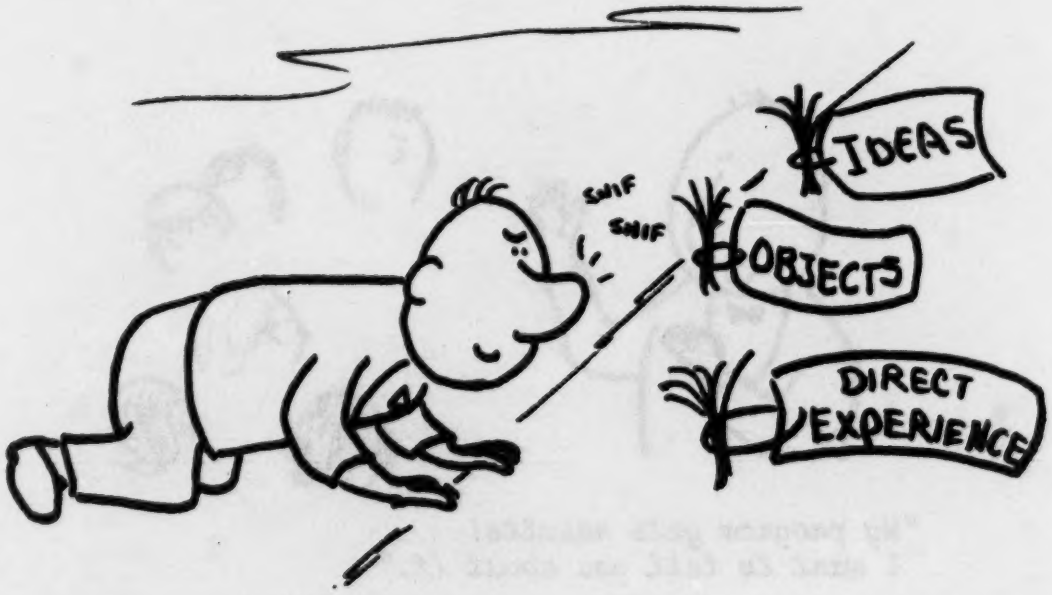

1. Has the nose of a bird dog to find new ideas, innovations, resource materials, and educational media.

2. Makes his instruction interesting, dynamic and vital.

3. Collects actual objects to enrich lessons.

4. Is constantly improving his library.

5. His curricula planning includes plans for educational media to be used in teaching.

THE SUCCESSFUL TEACHER PROMOTES HIS PROGRAM.

"My program gets results!
I want to tell you about it."

1. Never misses an opportunity to inform school administrators of the results of his program.

2. Informs his students of the accomplishments of his department.

3. Works with lay individuals, successful operators and community leaders.

4. Has an organized public information program. Uses mass media.

5. Shows appreciation for those who assist and support program.

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CHAPTER II

LOCAL POLICIES AND REGULATIONS

INTRODUCTION

"Sir, before starting, I have a few questions."

The new teacher should be knowledgeable on all points listed in this section before starting to teach. After employment he should be constantly aware of policy changes.

Many failures and difficulties have arisen because the new teacher did not become informed on the important points in this chapter. He must take the initiative to make himself informed.

The problem for the new teacher is *where* and *how* to get the information.

Suggestions:

1. Ask the prospective employer about these basic points before signing a contract.

   The student teacher should ask questions on these points before or as soon after he starts his student teaching as possible.

2. After employment have frequent talks with the school administrators.

3. Ask questions from teachers in the department.

4. Review school policy manuals.

5. Make careful observations.

6. Learn sources of funds and procedures of finances.

Request information from the State Supervisor on availability and use of vocational funds.

GENERAL SCHOOL REGULATIONS AND POLICIES
AND
INFORMATION NEEDED BY THE NEW TEACHER.

Don't be in the dark about these!

NATURE OF THE SCHOOL

ORGANIZATION AND ADMINISTRATION

SCHOOL POLICIES AND REGULATIONS

DEPT. POLICIES

CLASS SCHEDULE

STUDENTS:
NO. AND TYPE

COMMUNITY:
SOCIAL AND ECONOMIC

WORK EXPERIENCE STATIONS

FACILITIES

INVENTORY

DO YOU HAVE AN ADEQUATE BUDGET FOR THE VOCATIONAL PROGRAM PLANNED?

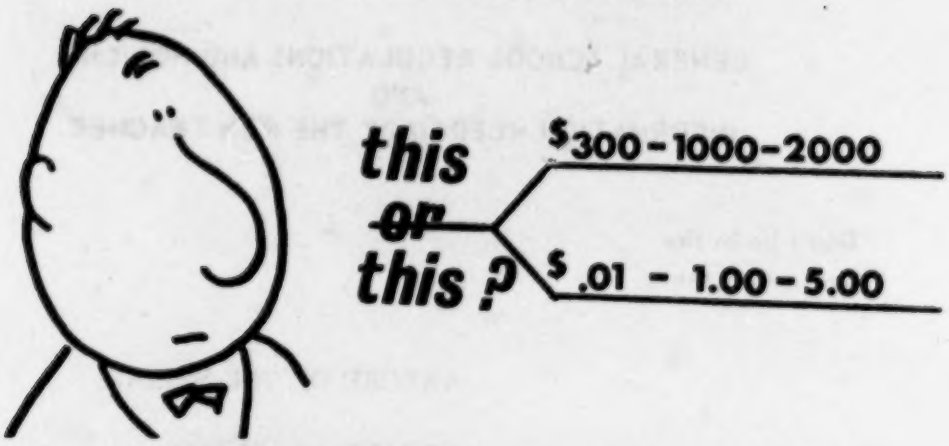

There should be an adequate budget for the instructional program and student activities planned.

Equipment _____

Supplies _____

Tools _____

Books _____

Visuals _____

References and
Periodicals _____

Adult classes _____

Travel _____

Special Student
Activities _____

WHAT RECORDS AND REPORTS AM I RESPONSIBLE FOR?

Attendance? _____

Grading? _____

Projects? _____

Youth Organizations? _____

_____

Travel? _____

WHAT IS THE POLICY REGARDING:

Home Assignments? _____

Loaning Tools? _____

Use of Classroom and Shop?

_____

Field Study? _____

Faculty Meetings? _____

Breaks? _____

Smoking? _____

First Aid Equipment? _____

Emergencies? _____

WHAT MUST I DO ABOUT SECURITY, PURCHASING, STORAGE, MAINTENANCE?

Student Projects? _____

Machinery? _____

Tools and Equipment? _____

Supplies? _____

Cleanup? _____

Heating? _____

Lights? _____

Locking? _____

Use of Building at Night? _____

Books? _____

Miscellaneous Materials? _____

CHAPTER III

PLANNING THE INSTRUCTIONAL PROGRAM

INTRODUCTION

Teaching success depends upon the efficiency and skill demonstrated by the teacher in performing the five functions listed below.

1. The quality of the instructional plans made in advance of the class. Chapter III.
2. Concise and meaningful written lesson plans. Chapter IV.
3. The extent immediate preparation is made to insure readiness for the class. Chapter V.
4. The skill and efficiency displayed in teaching. Chapter VI.
5. Evaluation of the instructional program. Chapter VII.

In planning the instructional program for vocational technical type programs, the teacher is concerned with providing training that makes the student employable. He functions as a vocational educator described on p. 10 in order to obtain a high degree of employability and other outcomes described on p. 26. The teacher must *plan, organize, manage* and *administer* the program to see that it adjusts and keeps in step with the advancements as they are made in the occupation. If this is accomplished, the following essentials are necessary.

1. The program is directly related to employment opportunities, determined by cooperation with occupationally concerned and competent individuals and groups.
2. Courses are up-dated on the basis of advancements in the occupation.
3. Facilities and equipment used in instruction are comparable to those found in the particular occupation.

4. Adequate instruction *time* is provided to accomplish the objectives.

5. Vocational guidance is effective to *enroll* and *place* those students who can profit from the instruction.

6. Provision is made for supervised occupational experience programs.

7. The teachers are competent in occupational and teaching skills. The teacher studies and observes methods used by successful employers and workers in the world of work. He also improves himself by added professional training.

In planning the instructional program, the teacher must be aware of the factors which influence the quality of the instructional program. The final outcomes and results measured in terms of student accomplishment are largely determined by three factors:

1. The quality and quantity of the students themselves.

2. The quality of the total educational program provided by the school. This includes school support, as well as factors listed on p. 17.

3. The quality of the teacher. What he *is* and what he *does*. pp. 3-14.

The above points are discussed more completely in Chapter VII, Evaluation and Testing.

Page 24 represents an overview of the total plans for a department. Program plans include all of the course plans for the department. Course plans include all of the unit or major jobs in sequence. Unit or major job plans include lesson or operation plans. Objectives and evaluation are needed for each of the above divisions of the instructional program.

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PLANNING IS A DECISION MAKING PROCESS.

The teacher uses all available help from outside sources to develop his instructional program, but in the final analysis the decision is his.

The instructional program must be planned well in advance of the class so a "good" start can be made. Adjustments can be made as the course proceeds.

Definitions

Unit or job: The subdivision of a course.

Lesson or operation: The subdivision of a unit or job.

Examples:

Course: Welding
Unit or job: Acetylene welding
Lesson or operation: Weld two pieces of metal in flat position

Course: Animal science
Unit or job: Sheep production
Lesson or operation: Fattening show lambs

PLANNING THE TOTAL INSTRUCTIONAL PROGRAM

Know what you are going to do and how you are going to do it.

1. Program plans – includes plans for all of the courses or years that a typical student is in the department.

2. Course plans – units in proper sequence – for a year or semester.

3. Unit plans – special subject matter areas – typically 4 to 8 weeks.

4. Lesson plans for each session – typically from 1 to 3 days. All plans should be written on a standard form. Organize for class room use – 3 ring binder or book.

DECISIONS ARE YOURS
IN PLANNING THE INSTRUCTIONAL PROGRAM.

1. What long time results should I expect from my teaching? P. 26.
2. What are the needs of my students? P. 27.
3. What is my teaching situation? P. 28.
4. What subject matter can be taught as part of the adult program, on the job, and by the other departments in the school. P. 29.
5. What are my objectives? P. 30–32.
6. What shall I have my students do? P. 33.
7. What books, bulletins, charts or films shall I use? P. 34–36.
8. Which teaching method will get me the greatest results? P. 37–41.

WHAT LONG TIME RESULTS SHOULD I EXPECT FROM MY TEACHING?

1. A high percentage of students are:
   a. effective leaders in related organizations;
   b. gainfully employed;
   c. effective workers in industry, agriculture and business.

2. The results of the instructional program should be reflected in improvement in economic efficiency, productivity, organization and management of the farms, firms and industries within the service area of the schools.

3. Students are assisted to meet educational and employment goals and assume their roles in society.

WHAT ARE THE NEEDS OF MY STUDENTS?

1. Home background – social and economic.
2. Interests, likes, dislikes.
3. Initiative.
4. Potential.

HOW DETERMINED?

Home visits.

Standard tests.

Individual conferences.

Observation on the job.

Class record.

Guidance counselors.

WHAT IS MY TEACHING SITUATION?

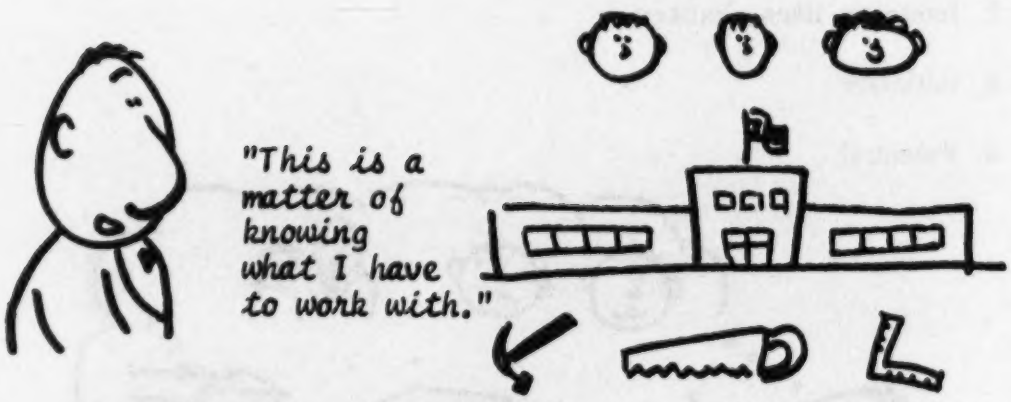

The teaching situation is the quality and quantity of *what is there* which has a direct bearing on teaching.

1. School – financial support, organization p. 17.
2. Students – abilities, background – The new teacher must determine where the students are in the instructional program before he can make teaching plans.
3. Time available for instruction.
4. Teaching resources – facilities, references p. 18.
5. Resources of the school service area.
6. Distances – businesses – availability of supplies, etc.
7. Other programs – adult, out of school youth and types of other classes within the school.

Can the instruction be taught in a real situation in the natural surroundings, using methods, tools, etc., as found in the occupation?

WHAT SUBJECT MATTER CAN BE TAUGHT AS PART OF THE ADULT PROGRAM, ON THE JOB, AND BY OTHER DEPARTMENTS IN THE SCHOOL?

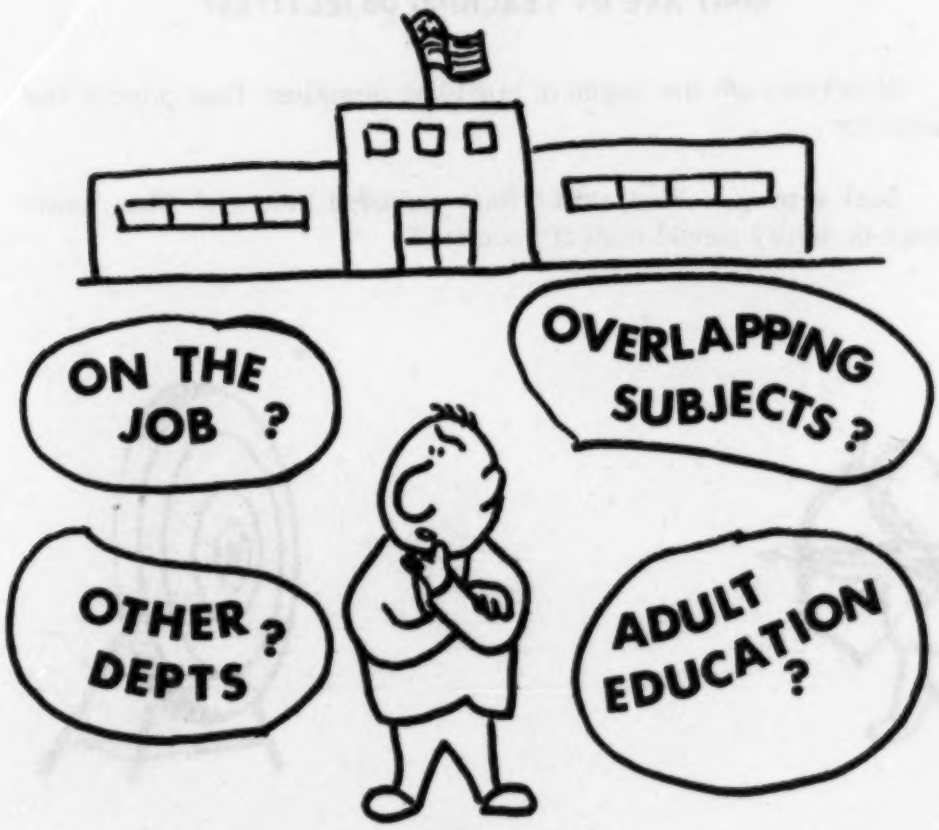

"I can't run the whole show."

Some jobs are too complicated or time consuming to fit into the high school program. These should be delayed for post high school or adult programs.

The teacher's problem is to determine what he can adequately teach with the time and resources available. Direct duplication in teaching subject matter should be avoided in the high school as far as the same students are concerned.

WHAT ARE MY TEACHING OBJECTIVES?

Objectives are the means of providing direction! They provide the basis for –

Goal setting – What skill? What approved practice? What knowledge or ability should students acquire?

Evaluation – To what degree did my lesson hit the target?

In writing objectives think in terms of the specific changes that result in the student by having studied the lesson. He should be a changed person by having learned this particular lesson.

Objectives assist the teacher to limit, to be specific, to determine importance and what is essential.

IN DETERMINING OBJECTIVES, FOCUS ON

STUDENT LEARNING EXPERIENCE

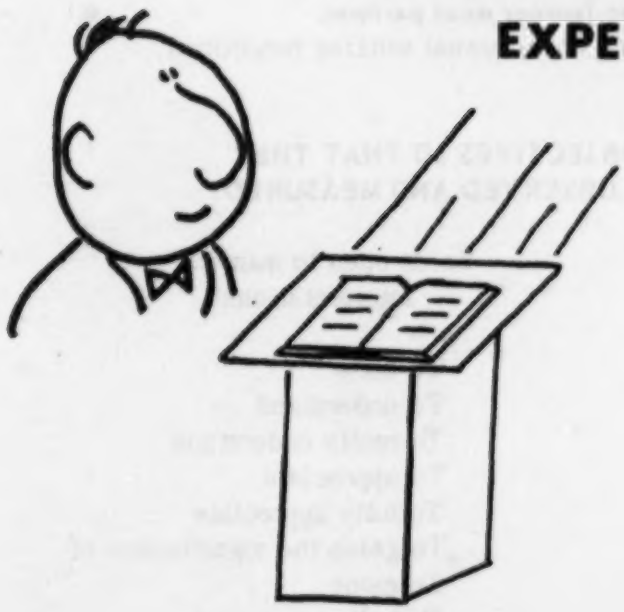

NOT ON

TEACHER ACTIVITY

STEPS TO TAKE IN WRITING OBJECTIVES

1. **Name the terminal behavior.**
   Develop the ability to measure machine efficiency.

2. **Describe the conditions under which the learning will be taking place.**
   Determine engine operating efficiency under normal operating conditions.

3. **Describe how well the learner must perform.**
   Make final adjustments under actual working conditions.

WORD OBJECTIVES SO THAT THEY MAY BE OBSERVED AND MEASURED.

Words open to fewer interpretations	Words open to many interpretations
To write	To know
To recite	To understand
To identify	To really understand
To differentiate	To appreciate
To solve	To fully appreciate
To construct	To grasp the significance of
To list	To enjoy
To compare	To believe
To contrast	To have faith in.
To demonstrate	
To apply	
To rank	
To do.	

The left hand column above is *preferred* because the outcomes can be observed and measured.

WHAT SHALL I HAVE THE STUDENTS DO?

The teacher must determine specific operations or lessons in order of difficulty. The student must learn the objective for the total job or unit. Each operation should be evaluated. The student must successfully do each operation before going on to the next. As soon as the student completes the required operations or lessons he should go on to practical jobs that apply the information learned.

Example: Unit in arc welding.

Operation	Joe x	Rex x
Equipment set up	1	2
Run straight beads	2	2
Flat butt weld	1	4
Flat edge and lap weld	3	2
T weld flat and vertical	2	5
T weld – overhead	4	3
Extra activities		

x Student grades on each operation.

WHAT BOOK, BULLETIN, CHART OR FILM SHALL I USE?

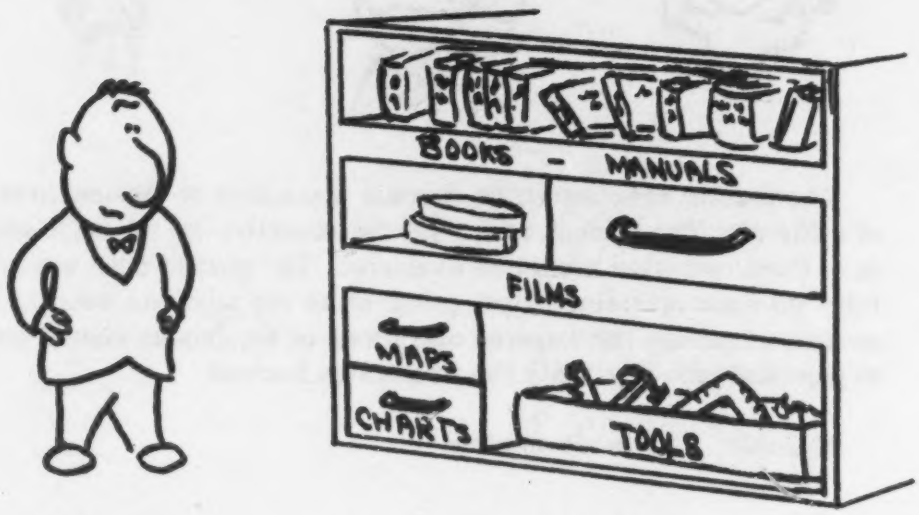

1. What is available? How many?
2. What can I order?
3. What can I prepare myself?
4. Which contains the subject matter content I wish to teach?
5. Is it timely, up-to-date and is the content of critical significance?
6. Can I use it within time and conditions for use?
7. Will it make best use of my time and the student's time?
8. Does it help in student practice or assignments?
9. Which can *I* use most effectively?

ROLE OF EDUCATIONAL MEDIA IN THE TEACHING LEARNING PROCESS

"I use them because they help!"

1. Stimulate interest.
2. Provide concrete basis for development of understanding.
3. Supply basis for developmental learning.
4. Offer a reality of experience which stimulates the learner.
5. Motivate student to investigate and discover.
6. Increase retention.
7. Teach the poor readers and keep them involved in the class.
8. Keep the attention of the class focused on the things the teacher wants the students to learn.

Educational media are excellent means for imparting information, and are especially useful where a complex mechanism is to be explained, to show relationships, or to present a sequence of procedure.

How does your educational media rate? P. 36.

FACTORS THAT INFLUENCE THE SELECTION OF EDUCATIONAL MEDIA

	Must apply to lesson	Time allotment	Student participation	Attention demanding	Technical accuracy	Easily constructed	Flexibility	Versatile	Economic	Availability	Simple in design
Motion pictures											
Slides or film strips											
Opaque projections											
Transparencies											
Pictures, flip charts											
Blackboard											
Printed materials											
Models or mock up											
Actual objects											
Recordings											
Field trips											

In the selection of a **certain** educational media there are many factors that influence your choice. Across the top of this chart are some of the most common factors.

WHICH TEACHING METHOD WILL GIVE ME THE BEST RESULTS?

"The method I use depends upon...:"

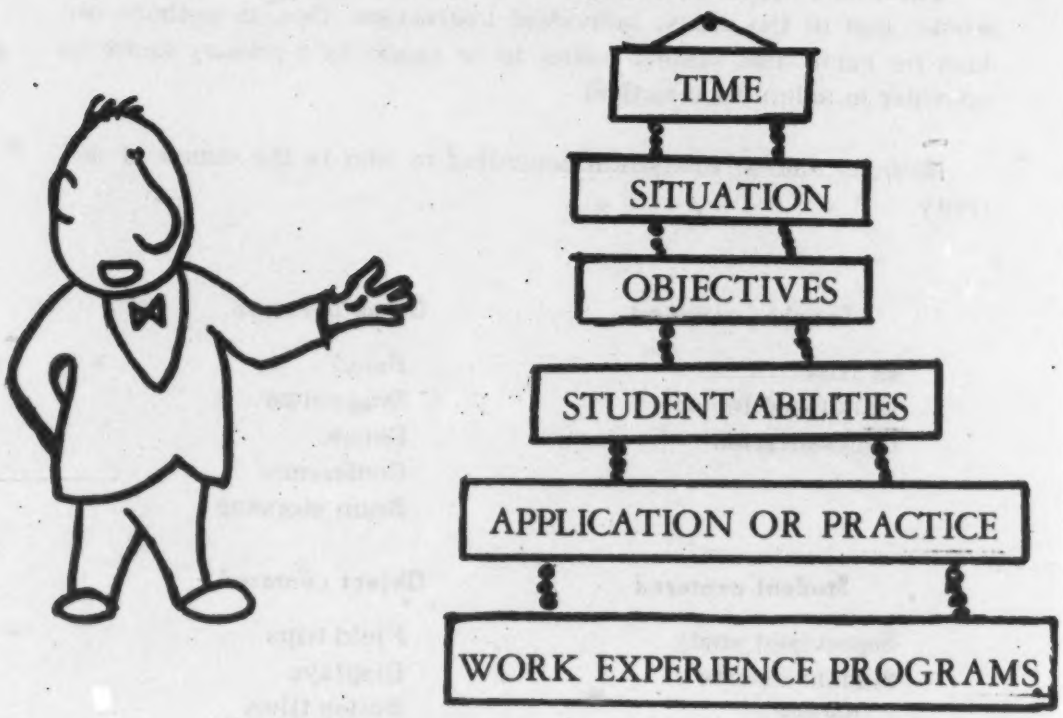

Good teachers use a variety of methods. In all methods the teacher is still in charge and provides leadership. His role varies with the method used.

Student involvement is an important factor in selecting all methods.

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THE SELECTION OF A METHOD DEPENDS UPON THE LESSON OBJECTIVE AND THE TEACHING SITUATION.

The instructional program should include teaching the class as a whole, part of the class, individual instruction. Certain methods are best for each. The subject matter to be taught is a primary factor to consider in selecting a method.

Methods can be classified according to who is the center of activity.

Teacher centered

Lecture
Illustrated lecture
Demonstration

Group centered

Panel
Symposium
Debate
Conference
Brain storming

Student centered

Supervised study
Student reports
Laboratory
Study guide
Programmed instruction

Object centered

Field trips
Displays
Motion films
or machine

Usually in a given lesson one method is predominately used; however, good results may be obtained by using several methods. Different teachers will effectively use the same general method in different ways.

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LECTURE METHOD

Use: In situations where the subject is complex and there is a limited amount of time, also where the instructor has superior knowledge.

Introduce new material or give instructions.

To be used sparingly. Transfer problems from instructor to student as quickly as possible. Students are passive.

ILLUSTRATED LECTURE METHOD

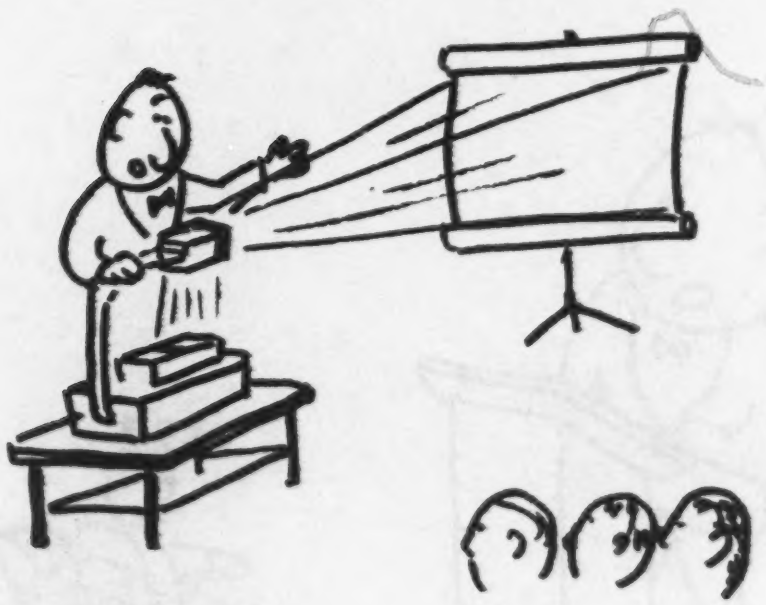

Use: It provides insight or depth into a problem. Teacher shows as well as explains subject matter.

One of the most effective methods when used with slide set, flip charts, actual objects, etc.

Teacher involves students, reviews, questions and tests as lesson proceeds.

Students are usually passive.

DEMONSTRATION METHOD

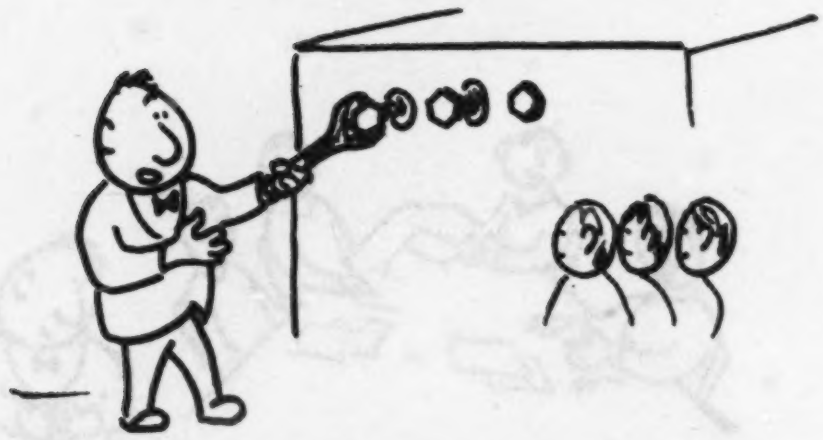

Use: To teach manipulative type jobs where the end product is for the student to be able to build or make an object or perform an operative function in a specific manner. The objective is to show *how* and the correct *sequence* in which the job is done.

Procedure:

Prepare: (teacher)
- motivation for the student to receive instruction and
- reasons for the job and importance.

Present: (teacher)
- carefully and completely
- give steps and key points or information with each step.

Try out: (students)
- have students do work under supervision
- correct mistakes.

Testing or follow up:
- put him on his own
- return to normal supervision.

PANEL OR GROUP CENTERED METHOD

Advantage: Burden is on the group rather than the teacher. Provides various opinions.

Use: Students have had prior study or have special knowledge.

Types of lessons:

1. To solve a particular problem.
   Example: How can we improve our chapter?

2. Role playing.
   Example: Selling of an object or business.

3. Use of a particular thing.
   Example: The use of a cooperative selling or buying organization.

Teacher role: At start introduce topic and set ground rules, and define audience participation. When needed may act as a stimulator, questioner, interpreter. At end with class make summary.

SUPERVISED STUDY METHOD

Use: Gain information to solve a problem, background, or special reports and projects. Students study under teacher supervision.

PROCEDURES

Determine educational objectives.

Develop a good set of study questions.

Provide each student with adequate references and note book.

After study period, discuss questions and develop a summary or list of approved practices.

Prepare a short written test, based on objectives, on the material studied.

PROBLEM SOLVING METHOD

Use: Managerial or decision making lessons.

PROCEDURE

Outline the situation.

Identify the problem.

Determine the factors bearing on the problem.

Determine the pertinent information
from student experience,
through student study assignments,
through observation,
through teacher presentation.

Assist students in seeing the relationship of one list of information to another.

Assist students in generalizing and forming conclusions.

Form and try trial solutions.

Select most appropriate solution and apply to life situation.

FIELD STUDIES

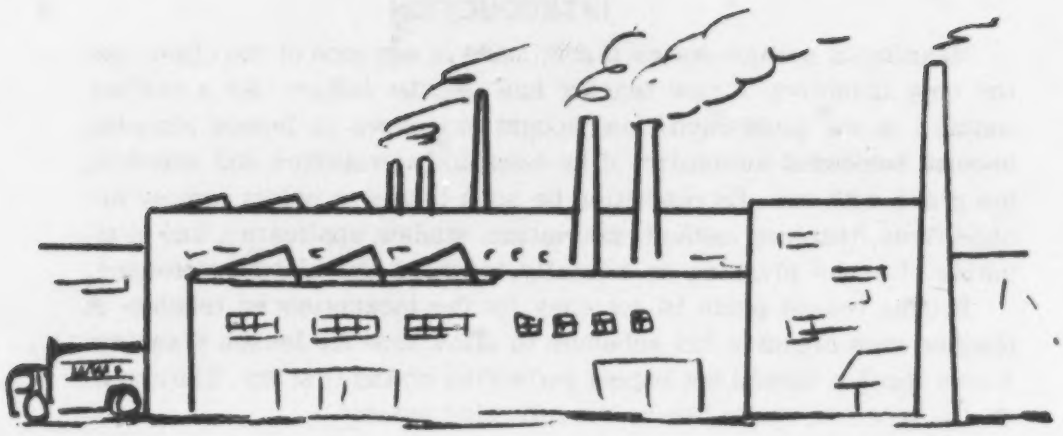

Types

1. Outstanding farms or ranches.
2. Superior businesses.
3. Specific type jobs.

Cautions

1. Determine specific aims.
2. Select industry or job that best fits.
3. Prepare students for trip. Suggest questions for students to ask.
4. Make student assignments for trip.
5. Require report after trip.

It is necessary to plan carefully each step of a field trip. The success or failure of a field trip is in direct ratio to the amount and caliber of this groundwork.

Teacher role at the location

Introduce owner.
May act as a group leader.
Ask questions, if needed, to bring out important points.
Thank owner at end.

CHAPTER IV

WRITING LESSON PLANS

INTRODUCTION

Meaningful written lesson plans, made in advance of the class, are the best insurance a new teacher has against failure. As a teacher matures in the profession, his thought processes in lesson planning become somewhat automatic, if he constantly evaluates and improves his plans with use. By repetition he soon learns to select rapidly his objectives, teaching method, motivation, student application and evaluation. Lesson planning is mentally teaching the class beforehand.

Writing lesson plans is not easy for the inexperienced teacher. A teacher must organize his schedule to allow time for lesson planning. A new teacher should not expect perfection on the first try. The teacher, for success, must observe the following points:

1. *Lesson plans must be written.* Thinking through how the lesson is to be taught is necessary, but this is not enough. The writing of the lesson plan forces the teacher to be specific and answer the questions on p. 48.

2. Lesson planning should be done in rather large units and all planning should be developed to fit into the total plan p. 24. In writing any given lesson plan, a teacher must be fully aware of both the lessons to be taught *before* and *after* it is to be used.

3. The plan should be written in a manner so that the teacher can use it teaching the class, and also be used by the substitute teacher.

4. The plan should be realistic. Only include *what* and *how* you actually plan to teach.

5. The educational media to be used in teaching the lesson should be listed in the lesson plan. Lesson planning should be done prior to ordering educational media. The best teaching can be done where the lesson plans, filing systems, and "hardware" for showing educational media are all well organized and coordinated.

6. The lesson plan should include how the new knowledge is going to be used on the job, as well as the testing and evaluation of student learning.

7. Lesson plans must be *revised* with use.

8. There must be an orderly method of *storing* and *using* them. A large 3-ring binder is recommended for each course. Lesson plans should be numbered and arranged in the proper sequence in the units that make up the course.

9. All lesson planning should not originate with the teacher. Usually he can adapt the work of others to his own particular situation. He should always be looking for improved ways of doing things p. 13.

FORMS FOR WRITING LESSON PLANS

There are many types and forms of lesson plans but most lesson plans include the following:

1. Name of the unit or enterprise.

2. Name, number, and amount of time for the lesson.

3. Situation. May not be written but is considered in the formulation of the objectives.

4. Objectives.

5. Method or procedure.

6. References and materials to be used.

7. Introduction or motivation – why or reasons for lesson.

8. Presentation – basic information, steps, procedures, etc.

9. Application – period of tryout, correction of procedures.

10. Testing and follow-up work on an actual job, summary, use of knowledge.

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THE WRITTEN LESSON PLAN IS THE ROAD MAP FOR THE CLASS

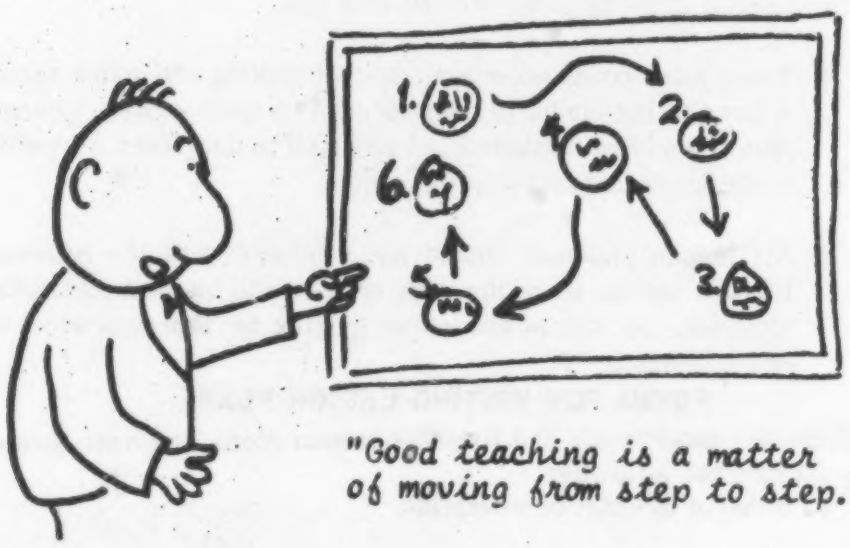

"Good teaching is a matter of moving from step to step."

There are three important questions in lesson planning.

1. What do *I need to do?* (teacher)
2. What do the *students need to do to learn?*
3. What should be done to meet my goals with my means in this particular situation?

The plan answers the following questions:

1. *What* I plan to do.
2. *How* I plan to do it.
3. Does it list the *teaching resources or materials* to be used?
4. Will techniques listed motivate students?
5. Is the presentation *dynamic, vivid* and *vital?*
6. Will the student learning activities get the desired results?
7. Is the material taught measurable and useful on the job?

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TYPES OF LESSONS

In writing lesson plans, it is important to keep in mind the outcomes or results expected. These can, in most cases, be classified into three distinct types as follows:

(a) Managerial or decision making.
(b) Manipulative – the mastery of a specific skill(s).
(c) Informational – new knowledge, appreciation and understanding.

In practically all lessons, a part of each of the above are included. In spite of this, however, the major outcomes are distinctive enough that lessons can be classified according to one of the three major types.

The lesson plan for each type follows the same general format. Note in this chapter the discussion and examples for managerial, manipulative, and informational lesson plans. If a new teacher can use and prepare lesson plans for these three general type lessons, he should not have difficulty with writing any lesson plan and should become more effective in his teaching.

MANAGERIAL OR DECISION MAKING LESSONS

These are mainly mental. They require a knowledge of factors important to the decision. They are concerned with what, when, where, costs, amounts to use, alternatives or choices.

Managerial type jobs are most important in teaching vocational education. They should make a substantial part of the course because they are a means to teaching students to think.

"The first fruits of all true education is the ability to think."

The success of any business is dependent upon making the correct decisions. For this reason the teacher should strive to help a student analyze jobs so he will ask the right questions to get the facts, evaluate the validity of informational sources and plan a course of action to meet the problems in his situation.

Methods used in teaching managerial type lessons.

Problem solving.	Supervised study.
Debate and/or interviews.	Field trips.
Conference.	

MANAGERIAL LESSON IN PROGRESS

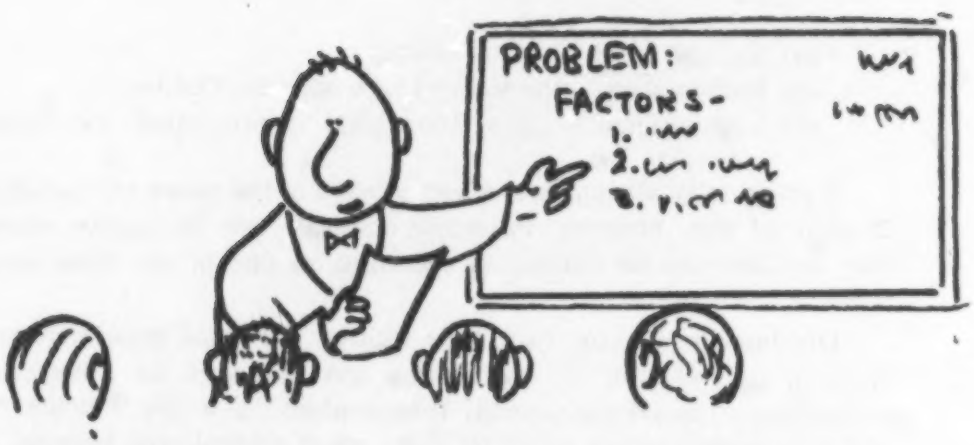

Teacher with help of students develop important factors and information needed in making a decision or developing a plan for action.

Practically all managerial type lessons fall into either of the two categories.

1. Should I buy new, replace, repair, remodel, construct, rent, lease, etc.

2. What type business or effort shall I go into – potential income, expense, volume, overhead costs? What are the hidden or added expenses, such as taxes?

The objective of managerial type lessons is for the student to make the correct decision or know the factors to consider in making the decision. They can be evaluated by the quality of decisions made by the student; also by the degree of insight displayed by the student in arriving at the decision and the inclusion and weight given to all important factors. These can best be evaluated on the farm or job as part of the directed work experience program.

Managerial Type Lesson (example)

Lesson: What kind of machine shall Joe buy?

Step I – Preparation or introduction
Give examples of how large amounts of money are lost due to lack of care in the selection of machines.

Step II – Presentation

Factors	Information Needed
1. Use	1. How much and what kind of work will be done?
2. Kinds and types available	2. What kinds and types of machines are commonly used in the area?
3. Service	3. Services provided by the distributor?
4. Cost	4. What is the cost of several types of machines?
5. Other factors	5. What other factors are important?
6. Suggested plan for action.	6. List justification for decision.

Step III – Application or try out
Students in supervised study find answers to questions listed in information needed.

Step IV – Testing or follow-up
Short written test on lesson.
Assist student to implement the plan.

MANIPULATIVE TYPE LESSONS

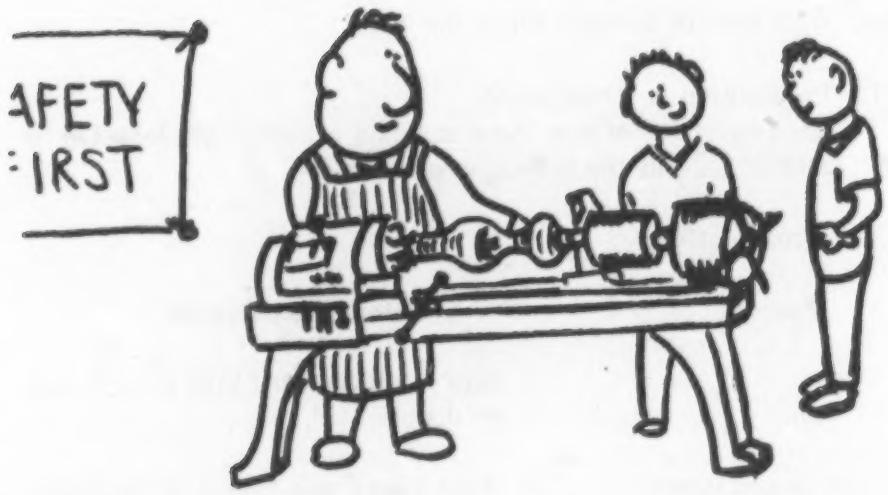

Manipulative type jobs include the broad area of skills or performance of tasks with the hands. The end result is for the student to be able **to do** an operation and proceed in definite steps. Examples: to type, to weld, to operate a machine, etc.

Steps in writing lesson. Determine the following:

1. Teaching situation.
2. Objective or skill to be learned.
3. Equipment and materials needed.
4. List the steps in the order in which the operation is done. For each step list the critical information or key points which if not done or known will cause the job to fail.

The evaluation is best done by a performance test. Can the student do the job as demonstrated and get the expected results? If he cannot, either the teacher gave a faulty demonstration or the student failed to learn.

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Manipulative Lesson Plan (example)

Operation: Start a car.

Situation: Car has automatic transmission.

If car had a standard shift the plan would be changed. Students have had no experience, but want to learn.

Step I – Preparation and Introduction

Explain briefly how car runs and why correct starting procedures are important.

Step II – Presentation – Operation Breakdown

Steps	Key Points
1. Place shift in park.	1. Safety – Read symbols P.R.D.
2. Turn on key.	2. Types starting systems.
3. Depress gas feed.	3. Slight – avoid racing engine.
4. Start engine.	4. Check – gauges working.

Step III – Application or try out

Students explain each step and why as they start car.

Step IV – Checking and Testing.

INFORMATIONAL LESSONS

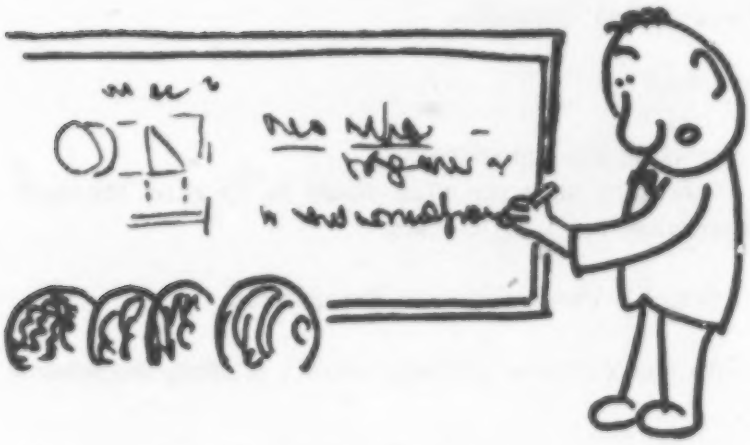

Informational type lessons are for greater appreciation, understanding and background. They have a limited place in vocational education unless tied to a management type job. A small percentage of lessons in Vocational Education should be of this type.

Method:

Lecture or illustrated lecture.
Study questions.
Motion films.

Examples of informational type lessons.

1. Types of materials and use.
2. History of the FFA or related organizations.
3. Keeping up-to-date with advanced information.

The success of the lesson is evaluated by the degree to which the student knows the basic information. It is usually evaluated by a written test.

Information Type Lesson (example)

Lesson: History of the FFA

Motivation: Teacher shows film on national organization. After this he explains the organization and how it functions.

Supervised Study Period: Students have official manuals and resource material. The student writes the answers to the questions in his note book.

1. *Rank* the purposes of the FFA in the order you think are most important.

2. *List* three awards that you may earn in the FFA.

3. *Describe* in your own words conditions at the time the FFA started.

4. *Draw* the FFA emblem and label the purpose of each symbol on your drawing.

5. *How do* the state and national officers assist the local chapters?

Class Discussion: Each question is discussed by the class.

Evaluation: Written test.

Note: Each question requires that the student apply or interpret information read rather than merely copying from the book.

CHAPTER V

PREPARATION FOR THE CLASS

COUNT DOWN! There is no substitute for a good start!

"She'll go if all is ready."

Minutes of preparation before the students arrive prevents frustration.

Have materials ready before class starts.

All visual materials, tools, equipment, actual objects, blackboard, chart stand, film projector should be ready for use.

Check in advance to see that they function. Practice before class on unfamiliar jobs.

START CLASS ON TIME

The class should always be started on time. Get the students in the habit of being on time. Have a definite starting time and stick to it. Expect them to be on time and they will be.

CHECK PHYSICAL FACILITIES

This is particularly important with adult classes. Adults are more aware of heating, lighting and their physical surroundings than younger students. They usually come to class after a hard day's work. Make the room as comfortable as possible.

Watch students for signs of sleepiness – open windows, turn down heat, etc.

CHAPTER VI

HOW TO TEACH THE CLASS

INTRODUCTION

If a teacher has done a careful and complete job of planning, and has made the immediate preparation for the class, the actual teaching should be easy. All of the ideas previously given in this book are worthless if the teacher doesn't follow through in the actual teaching process.

The teacher must keep these questions in mind – What is the maturity, ability and background of the student as it relates to the lesson I am teaching? Have I discovered what the student knows and then teach accordingly? Am I proceeding in a dynamic and interesting manner? Am I flexible enough to adjust to vital teaching situations that may arise, yet follow a teaching plan?

When the teacher signs his contract, he declares himself to be for beneficial learning and against sloppiness, indifference and unemployment. The stakes are high, dear teacher, read on!

A great teacher once said, "Good teaching requires three things. First a teacher who knows his *subject matter*. Second, he knows *how* to teach. Third, he is a *Ham*."

Usually the inexperienced teacher will spend a disproportionate amount of his time in trying to master the subject matter. Knowledge of subject matter is important, but preparation does not stop with it. He must also plan how to teach and follow the suggestions in this chapter on teaching. The teacher should not forget his role as an actor. He tries to hold attention and create interest.

Learning is an active process. We learn by doing. This means we learn to think by thinking. We learn to do a manipulative type operation by actually performing the process. We learn to make decisions by making decisions. We learn to be creative by being creative. Often well meaning teachers make their classes sterile by too much structuring including determining *what* and *how* things are to be done. Thus they limit discovery and stifle initiative.

In the same terms *teaching is an active process.* It requires action on the teacher's part to get the learning process within the student in motion. This is not done haphazardly, but requires concerted effort on the teacher's part in order for the *teacher-learning* process to be most effective.

The teacher should recognize there is a certain amount of annoyance in learning. Most students are mentally lazy. There appears to be a resistance to learning in most students. The teacher in a class is competing for the student's attention. His teaching must literally "tune out," for example, thoughts of love, home and job in the student's mind. This requires positive, deliberate action. As we move into individualized instruction by the use of varied means such as programmed instruction, uni-packs, machines, etc., it will require greater effort and ingenuity to offset student indifference and mental laziness. Students respond to guidance, direction and leadership.

The role of the teacher in teaching classes generally proceeds in the order listed below:

1. Motivate and engage the student in the learning process.
2. Vividly present the concepts and principles to be learned. Use educational media when beneficial.
3. Involve the students by asking challenging, meaningful questions. Force them to think and participate. Learn to use *silence* as a technique.
4. Direct learning by supervising student practice or application. Correct mistakes and wrong conceptions as they arise. Solve student learning problems.
5. Involve students in activities that will challenge their imagination, initiative and creativity. Make the student an active partner in determining what *he will do to* learn.
6. Evaluate learning and progress. Diagnose student learning problems and prescribe appropriate learning experiences.
7. Develop ways and means for assisting the student to use the knowledge learned at school, on the job or in daily life.

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8. Up date the course content and evaluate course materials. Select and use course content that is pertinent to the world of work.

It is impossible to cover all of the facets and innovations and concepts in teaching in this small book. It is important that the new teacher study these and become familiar with them. The authors have tried to include only the basic fundamentals of teaching. It is important that the new teacher first get a good grasp on techniques and fundamentals included in this book. After that he can handle practically any teaching situation that develops. Due to the limited space only the J.I.T. (Job Instructional Training) method will be discussed. It consists of four steps on how to teach pp. 67-70. This is as efficient a pattern of teaching vocational classes as has been devised.

THE TEACHER SHOULD MAKE USE OF STUDENT INTERESTS AND NEEDS

If the teacher knows his situation and plans his program accordingly, teaching becomes not only easier but more effective. The student who has a need and a desire to learn a skill is easier to teach that skill. The student who plans to make a decision for example, to buy or sell a specific object, is naturally motivated for the lesson and much easier to teach. For this reason, the teacher attempts to gear his instructional program, as far as feasible, to the interests and needs of his students. The time of year and the general order that certain jobs are done in industry should influence when and how jobs are taught.

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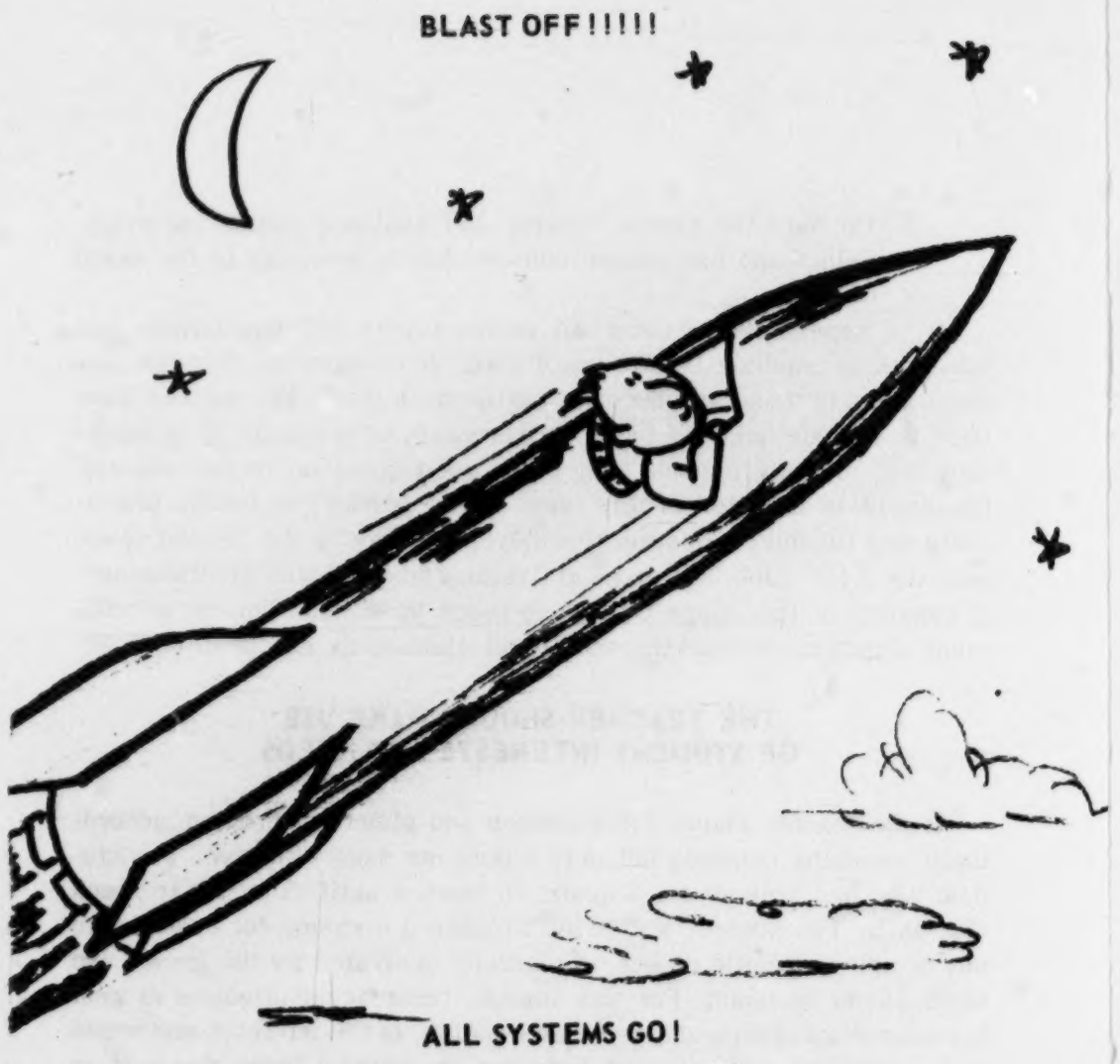

Relaxed.

Confident.

Alert.

Prepared.

THE START IS THE FIRST STEP TO SUCCESS.

1. Be on time! Start on time!

2. Demand attention.

3. Insist on routine in handling books. tools. seating. etc.

4. Curtail preliminaries to the essentials. Get with the lesson.

5. Let students know *objectives* and the *why* of the lesson and what is expected of them.

6. Involve students.

FOLLOW YOUR PLAN!

The means of hitting the home run and touching all of the bases –

1. Have in front of you – try to stick to it.

2. It should be a road map for the lesson. Be cautious about detours.

3. If followed the student should hit the high lights and know at the end what he should have learned.

4. It should lead to a natural summary – approved practices, skills, abilities and knowledge learned.

5. Continual evaluation and revision for later use is necessary.

OBSERVE YOUR STUDENTS

Watch students closely. An alert teacher can determine the following by observation of his class:

How fast to proceed.

Whether or not students are learning.

Fatigue.

Physical conditions of the room.

If directions or assignments are being followed.

Interest or lack of interest.

Special student problems.

Students' reactions help a teacher make certain responses in his own behavior – as loudness of voice, repeat questions or directions, etc.

MAKE MAXIMUM USE OF TIME!

Plan activities on basis of available time.

Plan time for:
.... Class, group, and individualized instruction.
.... Motivational and interest promotion.
.... Summary, testing and evaluation.
.... Next assignments and future activities.

Save teacher and student time by:
.... Formulating with the class, group, or individual – goals, ways and means that activities are to be accomplished.
.... Giving needed instruction before an activity.
.... Developing time schedules for completion of progressive steps and final completion of the project.
.... Providing superior demonstrations, supervision, and evaluation of student work.

The master teacher never seems to have enough *time* – the inferior teacher has too much. The master teacher provides *leadership* and *anticipates problems*. The inferior teacher runs late and spends his time in correctional measures.

STEP I

PREPARATION OR INTRODUCTION STEP

Step 1

Prepare the Learner

Put him at ease.

Find out what he already knows about the lesson at hand.

Get him interested in learning the lesson.

Place learner in correct position to receive instruction.

Explain the value or worth that new knowledge or skill will be to the learner.

HOW TO TEACH

STEP II

PRESENTATION STEP

Step 2

Present the Lesson (following the "Lesson Breakdown and Plan Sheet.")

Tell, show, illustrate, and question carefully and patiently.

Stress key points.

Instruct clearly and completely, taking up one point at a time – but no more than can be mastered.

HOW TO TEACH

STEP III

APPLICATION OR TRY-OUT STEP

Step 3

Application or try out

Test learner by having him present the lesson.

Have learner tell and show you.

Have learner explain key points of the lesson.

Ask questions and correct errors.

Continue until you know HE knows.

HOW TO TEACH

STEP IV

CHECKING, TESTING, and FOLLOW-UP STEP

Step 4

Checking, Testing, and Follow-up

Put him on his own.

Check frequently.

Designate to whom he goes for help or source to get help.

Encourage questions.

Get him to look for key points as he progresses.

Taper off extra coaching and close follow-up.

CHAPTER VII
EVALUATION AND TESTING

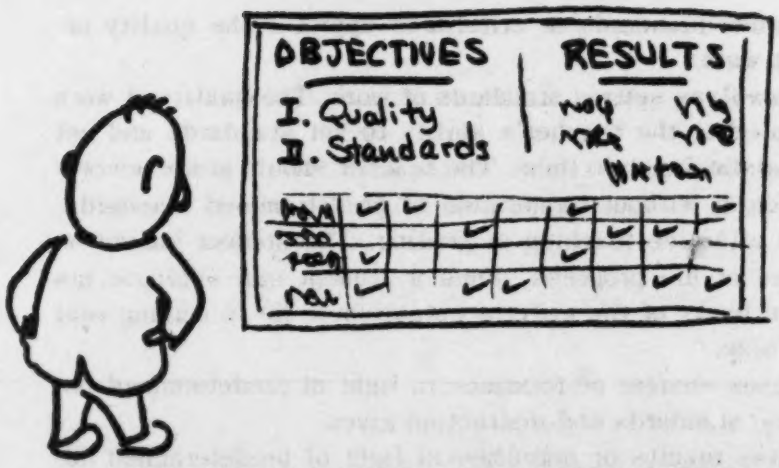

EVALUATION OF THE INSTRUCTIONAL PROGRAM

Evaluation is simply an appraisal of outcomes and results in terms of objectives planned. An activity or accomplishment must have happened prior to an evaluation. It is a means of determining the following:

a. Student grades.
b. Teaching effectiveness.
c. Instructional program effectiveness.

Systematic evaluation of pupil progress is an essential part of the teaching-learning process pertaining to any educational objective. Evaluation is most effective when many procedures and devices are used to obtain objective evidence of changed behavior on the part of the learner.

The process leading to the eventual determination of outcomes and results should proceed in about the following steps. The teacher:

1. Determines objectives.

The teacher should evaluate each lesson or each operation to determine the amount of student learning. In order to do this, the objectives must be known. Objectives should be stated as end products. What skill, ability, or knowledge was the student to have learned from the class. The objectives should be worded so they may be observed and measured. Review pp. 30-32. Teaching effectiveness can be measured by the quantity and quality of student learning.

2. Determines standards or criteria to appraise the quality of student work.

Evaluation involves setting standards of work. The quality of work obtained is related to the teacher's ability to set standards and get students to understand and do them. The teacher should grade according to the standard. Without formulation of predetermined standards, there cannot be effective teaching or grading. The student should be constantly aware of his progress. When a student can evaluate his own work on the basis of the criteria established, he is making real progress in learning.

3. Supervises student performance in light of predetermined objectives, standards and instruction given.
4. Evaluates results or outcomes in light of predetermined objectives and standards.
5. Takes action. The following may result: (1) Grades or a rating may be assessed and recorded. (2) Activities may be revised, abandoned or continued.

The most reliable criterion for evaluating vocational education is accomplishment on the job. Where the student cannot perform under actual job conditions, the skilled teacher can simulate most actual job situations in the school.

Teacher effectiveness can be measured by pre-testing and post-testing. This procedure will give the teacher a basis for determining what the students have learned from a unit or course.

Many types of programmed instructional units have been recently developed which provide a means of pre-testing and post-testing. These tests can be of great assistance to the teacher in teaching certain units. Another value of pre-testing before teaching a unit will assist the teacher in planning the instructional program so he will spend time on the subject matter that students do not know. Constant appraisal of teaching procedures will assist the teacher increase his effectiveness. Thus he can eliminate those methods which do not get results.

In determining student grades, the teacher should use a variety of written tests. Usually short tests given once a week are more effective than term tests. The questions should measure a student's ability to think and make judgments rather than straight recall. Test questions should be formulated with a specific objective in mind. The student's response should indicate the degree of understanding of the principle tested. If the objective of the test is to evaluate student learning, it should do just that. The teacher should study student test scores on each question and eliminate those questions which do not measure student learning. Questions that all students get perfect scores on or all students miss should usually be eliminated.

For best results test questions should be completed when the lesson plan is written. This will assist the teacher predetermine what is most important. It will help the teacher measure student learning on the basis of predetermined objectives. All types of tests have value, but multiple choice type tests usually have most of the qualities desired. Well thought out test questions should be saved and used from year to year.

EVALUATION OF A DEPARTMENT

An evaluation can be made on the department as a whole or on one activity.

An evaluation of a vocational department can be best done by using qualified outside individuals to help the teachers in the department. Frequent *self evaluation* is also necessary. If properly done an evaluation can be a powerful "tool" for upgrading teacher and departmental efficiency. It is a "tool" to find strengths and weaknesses. To make

an evaluation is to make a judgment. One cannot make a valid judgment unless he has the facts. These facts must be considered in full knowledge of the limitations and strengths of the school as a whole, and the department. There are many factors, such as school support, which directly influence quality teaching. Teachers can only be held responsible for those factors which fall under their control and they can directly influence. For this reason, a department evaluation is more than an evaluation of the teacher.

In making an evaluation, the following steps should be followed:

1. Review teacher objectives, plans and program.
2. Make a study of the situation p. 28. This should include the quality and quantity of the "inputs" that are fed into the school and the "fixed" factors in the school district that have a direct bearing on the quality of the outcomes.
3. Make a critical study of the school as it is related to the department. Teacher preparation, activities, and performance should also be studied. Pages 17 and 18 list some very important factors to be considered in the evaluation.
4. Make a study of the "outputs" or the long time results of the teaching program p. 26. The facts can be best obtained by talking directly to the students and employers, as well as parents, school administrators, and others who observe, over a period of time, the results of the department.

By weighing the facts determined above in light of established criteria for similar successful departments, a reasonably accurate appraisal of the department can be made. After the evaluation, if progress is to be made, changes must be made by the teachers, school administrators and others responsible for the program.

TEACHER RATE YOURSELF

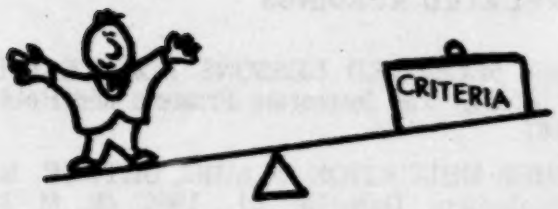

Did you select and use effectively:

___ Lesson plan.

___ Best resource material available.

___ Blackboard, chart stand, etc.

Did you properly:

___ Select your objective for the lesson.

___ Select the most productive method.

___ Give specific instructions.

___ Stress key points.

___ Summarize your lesson.

Do you have a program to:

___ Keep all students productively busy.

___ Use your tools, equipment and facilities for maximum efficiency.

___ Evaluate and record student work.

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ABSTRACT - Intended for enlisted personnel of the U.S. Navy and Naval Reserve who are preparing for advancement to AT1 and ATC, this training course on aviation electronics was prepared by the U.S. Navy Training Publication Center, Memphis, Tennessee. Topics are: (1) Aviation Electronics Technician Rating, (2) Aircraft Maintenance Organization, (3) Technical Drawings and Publications, (4) Aviation Supply, (5) Avionics Maintenance Supervision, (6) Maintenance Procedures, (7) Test Equipment, (8) Infrared Detection, (9) Magnetic Amplifiers, (10) Aircraft Computer Applications, (11) Antennas and Propagation, (12) UHF and Microwave Techniques, (13) UHF Communications, (14) Special Circuits, (15) Principles of Radar, (16) Radar Circuits, and (17) Radar Indicators. A film list, electronics symbols, Greek alphabet, and formulas are appended, and a subject index is included. (GB)

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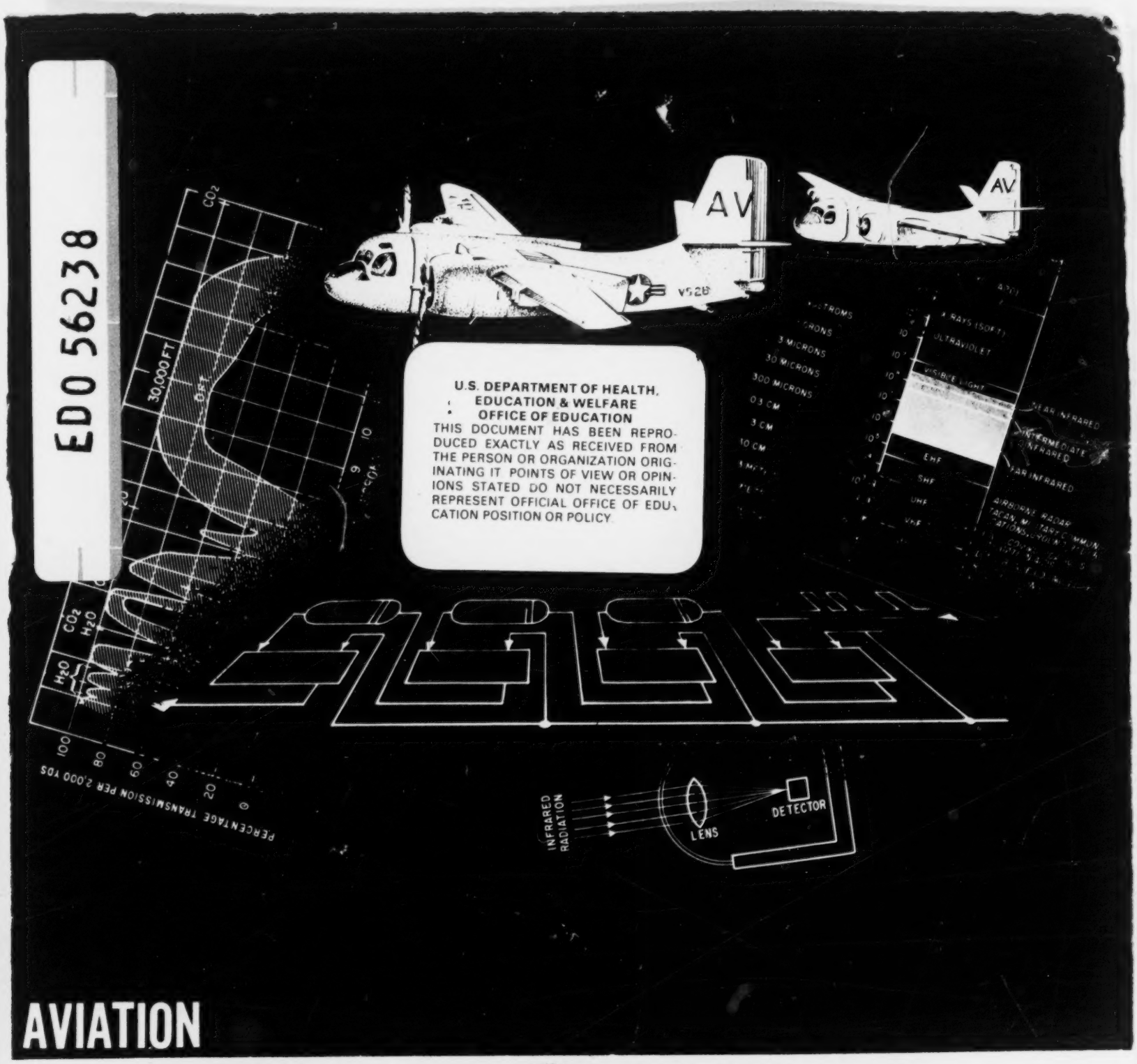

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AVIATION
ELECTRONICS TECHNICIAN 1 & C

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE

NAVPERS 10318-C

PREFACE

This Navy Training Course is one of a series of training courses prepared especially for enlisted personnel of the U.S. Navy and Naval Reserve who are preparing for advancement to AT1 and ATC.

The Manual of Qualifications for Advancement in Rating, NavPers 18068-B (revised), has been used as a guide in the selection of content for this training course. Trainees should become familiar with the qualifications for advancement in rating prior to starting work on this course.

Of the 17 chapters in this training course, 16 are concerned with the technical aspects of the AT rating. Chapter 1 contains introductory information with which the trainee should familiarize himself before studying the other chapters.

Basic Electricity, NavPers 10086 (current edition), and Basic Electronics, NavPers 10087 (current edition), contain essential background information for the AT rating.

This training course has been prepared by the United States Navy Training Publications Center, Memphis, Tennessee, for the Bureau of Naval Personnel. Credit is given to the Naval Air Technical Training Center, located at Memphis, Tennessee, the Naval Examining Center, Great Lakes, Illinois, and to the Naval Air System Command, for technical reviews.

1968 Edition

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THE UNITED STATES NAVY

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CHAPTER 1

AVIATION ELECTRONICS TECHNICIAN RATING

This training course is designed to aid the AT2 in preparing for advancement to AT1 and the AT1 in preparing for advancement to ATC. It is based primarily on the professional requirements or qualifications for AT1 and ATC, as specified in the Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series). In preparing for advancement-in-rating examinations, this course should be studied in conjunction with Military Requirements for Petty Officers 1 & C, NavPers 10057 (Series). The latter covers the military requirements for all senior petty officers.

It should be kept in mind that any changes in the professional qualifications occurring after the change 2 revision of the "Quals" Manual may not be reflected in the information given in this course.

In preparing this training course, every effort has been made to cover professional matters adequately and yet within reasonable bounds. It has been designed to give the prospective AT1 or ATC a good working knowledge of all subjects covered by the professional qualifications for advancement. It includes a great deal of new material required as a result of new equipment and new or revised maintenance programs.

Chapter 2 discusses organizational structure, starting at the Department of Defense level and working down to the maintenance department of aviation squadrons. This chapter is primarily concerned with relationships and responsibilities of commands concerned with naval aircraft maintenance.

Chapters 3 through 17 discuss the technical aspect of the rating. Refer to the table of contents for title and sequence of material in these chapters.

The remainder of chapter 1 is devoted to information which should be helpful in preparing for advancement in rating. It is strongly recommended that this material be studied carefully before beginning intensive study of the remainder of the course.

ENLISTED RATING STRUCTURE

The present enlisted rating structure includes two types of ratings: general ratings and service ratings.

GENERAL RATINGS are designed to provide paths of advancement and career development. A general rating identifies a broad occupational field of related duties and functions requiring similar aptitudes and qualifications. General ratings provide the primary means used to identify billet requirements and personnel qualifications. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Subdivisions of certain general ratings are identified as SERVICE RATINGS. These service ratings identify areas of specialization within the scope of a general rating. Service ratings are established in those general ratings in which specialization is essential for efficient utilization of personnel. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

AT RATING

The AT1 and ATC ratings are general ratings and are included in Navy Occupational Group IX (Aviation).

The Aviation Electronics Technician rating, at pay grades E-4 and E-5, comprises the two service ratings ATN and ATR. At pay grades E-6 through E-8, there is a single general rating, AT. At pay grade E-9 the Aviation Electronics Technician rating loses its identity; personnel of pay grade E-8 in this rating, along

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with AECS, AQCS, and AXCS, advance to Master Chief Avionics Technician, AVCM. Figure 1-1 illustrates all paths of advancement for an Airman Recruit to Master Chief Avionics Technician (AVCM), Chief Warrant Officer (W-4), or to Limited Duty Officer (LDO). The advancement paths through the AT ratings are emphasized in the figure. Shaded areas indicate career stages where qualified enlisted men may advance to Warrant Officer (W-1), and selected Warrant Officers may advance to Limited Duty Officer. Personnel in enlisted rates and warrant ranks may advance only as indicated by the lines.

The Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series), states that AT's are responsible for the inspection and maintenance of aviation electronics equipment, except ASW equipment, including the following:

1. Detection, reconnaissance, identification, communication, navigation, display, and special purpose equipment.
2. Target drone and pilotless aircraft equipment.
3. Related equipment and test equipment.

In addition to these duties, the AT's responsibilities include the operation of airborne CIC equipment.

When advanced to AT1 or ATC, even more responsibilities are to be yours. As a senior petty officer, you must possess more than technical knowledge. You must assume greater responsibility not only for your own work, but also for the work of others who serve under you. The AT1 and ATC must be a supervisor, inspector, and instructor, as well as an accomplished military leader. Senior petty officers should therefore be vitally concerned with the Naval Leadership Program.

As a result of the Naval Leadership Program, a considerable amount of material related to naval leadership for the senior petty officer is available. Studying this material will make you aware of your many leadership responsibilties as a senior petty officer and will also be of great help in developing leadership qualities. It will not in itself, however, make you a good leader. Leadership principles can be taught, but a good leader acquires that quality only through hard work and practice.

As you study this material containing leadership traits, keep in mind that probably none of our most successful leaders possessed all of these traits to a maximum degree, but a weakness in some traits was more than compensated for by strenth in others. Critical self-evaluation will enable you to realize the traits in which you are strong, and to capitalize on them. At the same time you must strive to improve on the traits in which you are weak.

Your success as a leader will be decided, for the most part, by your achievements in inspiring others to learn and perform. This is best accomplished by personal example.

Since the AT rating includes service ratings at the AT3 and AT2 levels, it is necessary to consider the transition from service ratings to the general rating. This is important from the following two points of view:

1. Personnel going from a service rating to the general rating must broaden the scope of their knowledge. For example, an ATN2 cannot advance to AT1 without learning the duties of the ATR2.
2. The AT1 and the ATC have responsibilities for cross-training personnel seeking advancement from a service rating to the general rating.

BILLETS AVAILABLE TO THE AT1 AND ATC

A wide variety of assignments is available to the AT1 and ATC. In addition to the various types of maintenance activities to which lower rated personnel are assigned (discussed in AT3 and 2, NavPers 10317-C), the AT1 and ATC are eligible for assignment to instructor duty as well as a number of other desirable shore billets. Most of these billets are under the management control of BuPers and are directly associated with training. Others are associated with research, testing, or evaluation. Some of the more desirable billets to which the AT1 and ATC may be assigned are described in the following paragraphs.

Instructor duty is available to both the AT1 and the ATC at the Naval Air Technical Training Center, Memphis, Tennessee, in the following schools:

1. Avionics Fundamentals School (Class A).
2. Aviation Electronics Technician School (Class A).
3. Aviation Electronics Technician School (Class B).
4. Aviation Officers School (Class O).

In addition to the above listed instructor billets, the AT1 and ATC may be assigned to instructor duty with a Naval Air Maintenance Training Detachment (NAMTD). NAMTD's are located at shore stations on both coasts. Personnel assigned to this duty are first sent to

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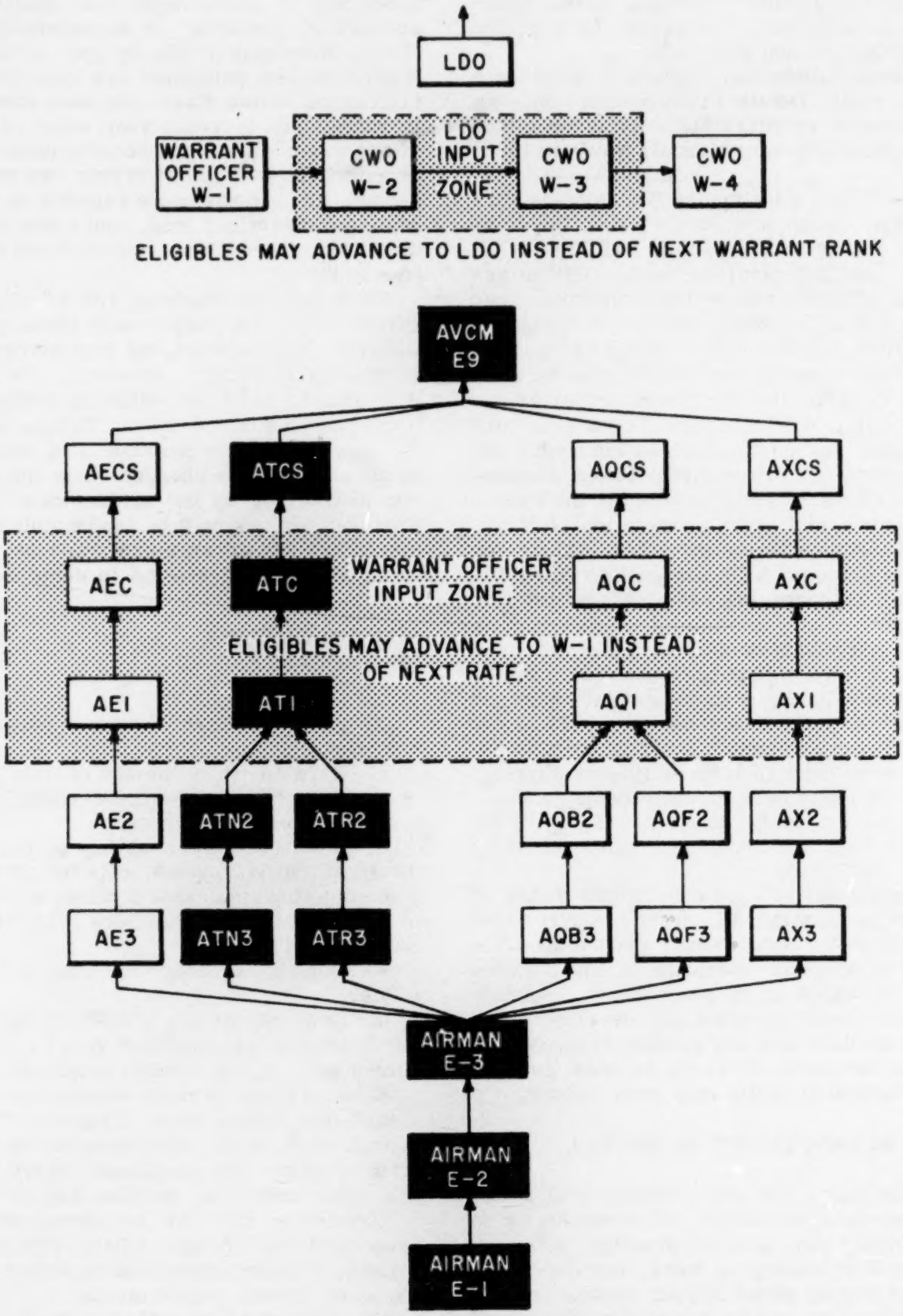

Figure 1-1. —Paths of advancement.

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Naval Air Maintenance Training Group headquarters at Memphis, Tennessee, for a period of indoctrination and instruction.

Instructor billets are normally filled on a voluntary basis. Detailed information concerning assignment to instructor duty is contained in the Enlisted Transfer Manual, NavPers 15909 (Series).

Chief Aviation Electronics Technicians are eligible for assignment to duty with the Navy Training Publications Center (NTPC), NAS, Memphis, as Technical Writers. CPO's assigned to NTPC assist in the preparation and revision of Navy Training Courses for the Group IX (Aviation) ratings. AT's assigned to these billets assist in preparing and/or revising Navy Training Courses for the avionics ratings.

Chief Aviation Electronics Technicians are also eligible for assignment to duty with the Naval Examining Center, Great Lakes, Illinois, as Item Writers. CPO's assigned to the Examining Center assist in the preparation of Navy-wide advancement-in-rating examinations for enlisted personnel. AT's assigned to these billets assist in preparing examinations for the AT ratings.

There are a number of special programs and projects to which enlisted personnel may be assigned. For a listing of these special programs and projects, reference should be made to the Enlisted Transfer Manual. Others are also announced from time to time in BuPers Notices.

Personnel may indicate their desire for assignment to a specific program or project by indicating it in the "remarks" block of their Rotation Data Card.

As a petty officer, you are already aware of the importance of the AT rating to naval aviation. Pilots and aircrewmen depend upon the AT for the efficient operation of the avionics system for which he is responsible. As improved electronic systems are developed, the AT's job involves new and greater responsibilities; from the lowest level up, he must possess greater technical skills than ever before.

ADVANCEMENT IN RATING

By this time, you are probably well aware of the personal advantages of advancement in rating—higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen career. By this time, alsc, you have probably discovered that one of the most enduring rewards of advancement is the training you acquire in the process of preparing for advancement.

The Navy also profits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating, you increase your value to the Navy in two ways: First, you become more valuable as a technical specialist in your own rating; and second, you become more valuable as a person who can supervise, lead, and train others and thus make farreaching contributions to the entire Navy.

Since you are studying for advancement to PO1 or CPO, you are probably already familiar with the requirements and procedures for advancement in rating. However, you may find it helpful to read the following sections. The Navy does not stand still. Things change all the time, and it is possible that some of the requirements have changed since the last time you were going up for advancement in rating. Furthermore, you will be responsible for training others for advancement, and so will need to know the requirements in some detail.

HOW TO QUALIFY FOR ADVANCEMENT

To qualify for advancement in rating, a person must:

1. Have a certain amount of time in grade.
2. Complete the required military and professional training courses.
3. Demonstrate the ability to perform all the PRACTICAL requirements for advancement by completing applicable portions of the Record of Practical Factors, NavPers 1414/1 (formerly NavPers 760).
4. Be recommended by his commanding officer.
5. Demonstrate his KNOWLEDGE by passing a written examination on (a) military requirements, and (b) professional qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-2 gives an overall view of the requirements for advancement of active duty personnel; figure 1-3 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

When you are training lower rated personnel, it is a good idea to point out that advancement

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	# E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3. AME 3, HM 3			Class B for AGC MUC, MNC.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
\# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

Figure 1-2.—Active duty advancement requirements.

INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam	Standard Exam or Rating Training.	Standard Exam required for all PO Advancements.		Standard Exam, Selection Board. Also pass Mil. Leadership Exam for E-4 and E-5.			
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center		Bureau of Naval Personnel			

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-3.—Inactive duty advancement requirements.

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in rating is not automatic. Meeting all the requirements makes a person ELIGIBLE for advancement, but it does not guarantee his advancement. Such factors as the score made on the written examination, length of time in service, performance marks, and the quotas for the rating enter into the final determination of who will actually be advanced.

HOW TO PREPARE FOR ADVANCEMENT

Preparation for advancement in rating includes studying the qualifications, working on the practical factors, studying the required Navy Training Courses, and studying any other material that may be specified for the rate and rating. To prepare for advancement yourself or to help others prepare for advancement, you will need to be familiar with (1) the "Quals" Manual, (2) the Record of Practical Factors, NavPers 1414/1, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052 (Series), and (4) Navy Training Courses. The following sections describe these materials and give some information on how to use them to the best advantage.

"Quals" Manual

The Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications. Military requirements apply to all ratings rather than to any one rating alone. Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups. Then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS.

The qualifications for advancement in your rating and a bibliography of study materials are available in your educational services office. The "Quals" Manual is changed more frequently than Navy Training Courses are revised. By the time you are studying this training course, the "quals" for your rating may have been changed. Never trust any set of "quals" until you have checked the change number against an UP-TO-DATE copy of the "Quals" Manual.

In training others for advancement in rating, emphasize these three points about the "quals":

1. The "quals" are the MINIMUM requirements for advancement to each rate within the rating. Personnel who study MORE than the required minimum will have a great advantage when they take the written examinations for advancement.
2. Each "qual" has a designated rate level—chief, first class, second class, or third class. You are responsible for meeting all "quals" specified for the rate level to which you are seeking advancement AND all "quals" specified for lower rate levels.
3. The written examinations for advancement in rating will contain questions relating to the practical factors AND to the knowledge factors of BOTH the military requirements and the professional qualifications.

Record of Practical Factors

A special form known as the Record of Practical Factors, NavPers 1414/1, is used to record the satisfactory performance of the practical factors. This form, which is available for all ratings, lists all the military and all the professional practical factors. Whenever a person demonstrates his ability to perform a practical factor, appropriate entries must be made in the DATE and INITIAL columns. As a PO1 or CPO, you will often be required to check the practical factor performance of lower rated personnel and to report the results to your supervising officer.

As changes are made periodically to the "Quals" Manual, new forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the "Quals" Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement. Keep this in mind when you are training and supervising other personnel. If a person demonstrates proficiency in some skill which is not listed in the "quals" but which is within the general scope of the rating, report this fact to the supervising officer so that an appropriate entry can be made in the Record of Practical Factors.

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When you are transferred, the Record of Practical Factors should be forwarded with your service record to your next duty station. It is a good idea to check and be sure that this form is actually inserted in your service record before you are transferred. If the form is not in your record, you may be required to start all over again and requalify in practical factors that have already been checked off. You should also take some responsibility for helping lower rated personnel keep track of their practical factor records when they are transferred.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-3 through E-8 for his personal record and guidance.

NavPers 10052

Training Publications for Advancement in Rating, NavPers 10052 (Series) is a very important publication for anyone preparing for advancement in rating. This publication lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 (Series) is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE you have the most recent edition.

The required and recommended references are listed by rate level in NavPers 10052 (Series). It is important to remember that you are responsible for all references at lower rate levels, as well as those listed for the rate to which you are seeking advancement.

Navy Training Courses that are marked with an asterisk (*) in NavPers 10052 (Series) are MANDATORY at the indicated rate levels. A mandatory training course may be completed by (1) passing the appropriate Enlisted Correspondence Course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the mandatory training course; or (3) in some cases, successfully completing an appropriate Navy school.

When training personnel for advancement in rating, do not overlook the section of NavPers 10052 (Series) which lists the required and recommended references relating to the military requirements for advancement. Personnel of all ratings must complete the mandatory military requirements training course for the appropriate rate level before they can be eligible to advance in rating. Also, make sure that personnel working for advancement study the references which are listed as recommended but not mandatory in NavPers 10052 (Series). It is important to remember that ALL references listed in NavPers 10052 (Series) may be used as source material for the written examinations, at the appropriate levels.

Navy Training Courses

There are two general types of Navy Training Courses. RATING COURSES (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the professional qualifications of ONE rating. SUBJECT MATTER COURSES or BASIC COURSES give information that applies to more than one rating.

Navy Training Courses are revised from time to time to bring them up to date. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether a Navy Training Course is the latest edition by checking the NavPers number (and the letter following the number) in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061 (Series).

Navy Training Courses are designed for the special purpose of helping naval personnel prepare for advancement in rating. By this time, you have probably developed your own way of studying these courses. Some of the personnel you train, however, may need guidance in the use of Navy Training Courses. Although there is no single "best" way to study a training course, the following suggestions have proved useful for many people:

1. Study the military requirements and the professional qualifications for your rating before you study the training course, and refer to the "quals" frequently as you study. Remember, you are studying the training course primarily to meet these "quals."

2. Before you begin to study any part of the training course intensively, get acquainted with the entire course. Read the preface and the table of contents. Check through the index. Thumb through the course without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

3. Look at the training course in more detail, to see how it is organized. Look at the

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table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book.

4. When you have a general idea of what is in the training course and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

5. In studying each unit, write down questions as they occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

6. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill, or a situation, ask yourself some questions. Does this information tie in with past experience? Or is this something new and different? How does this information relate to the qualifications for advancement in rating?

7. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Without looking at the training course, write down the main ideas you have learned from studying this unit. Do not just quote the book. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

8. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Navy Training Courses or other appropriate texts. As mentioned before, completion of a mandatory Navy Training Course can be accomplished by passing an Enlisted Correspondence Course based on the training course. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master the information given in the training course, and also gives you an idea of how much you have learned.

INCREASED RESPONSIBILITIES

When you assumed the duties of a PO3, you began to accept a certain amount of responsibility for the work of others. With each advancement in rating, you accept an increasing responsibility in military matters and in matters relating to the professional work of your rating. When you advance to PO1 or CPO, you will find a noticeable increase in your responsibilities for leadership, supervision, training, working with others, and keeping up with new developments.

As your responsibilities increase, your ability to communicate clearly and effectively must also increase. The simplest and most direct means of communication is a common language. The basic requirement for effective communication is therefore a knowledge of your own language. Use correct language in speaking and in writing. Remember that the basic purpose of all communication is understanding. To lead, supervise, and train others, you must be able to speak and write in such a way that others can understand exactly what you mean.

Leadership and Supervision

As a PO1 or CPO, you will be regarded as a leader and supervisor. Both officers and enlisted personnel will expect you to translate the general orders given by officers into detailed, practical, on-the-job language that can be understood and followed by relatively inexperienced personnel. In dealing with your juniors, it is up to you to see that they perform their jobs correctly. At the same time, you must be able to explain to officers any important problems or needs of enlisted personnel. In all military and professional matters, your responsibilities will extend both upward and downward.

Along with your increased responsibilities, you will also have increased authority. Officers and petty officers have POSITIONAL authority—that is, their authority over others lies in their positions. If your CO is relieved, for example, he no longer has the degree of authority over you that he had while he was your CO, although he still retains the military authority that all seniors have over subordinates. As a PO1, you will have some degree of positional authority; as a CPO, you will have even more. When exercising your authority, remember that it is positional—it is the rate you have, rather than the person you are, that gives you this authority.

Training

As a PO1 or CPO, you will have regular and continuity responsibilities for training others.

Even if you are lucky enough to have a group of subordinates who are all highly skilled and well trained, you will still find that training is necessary. For example, you will always be responsible for training lower rated personnel for advancement in rating. Also, some of your best workers may be transferred; and inexperienced or poorly trained personnel may be assigned to you. A particular job may call for skills that none of your personnel have. These and similar problems require that you be a training specialist—one who can conduct formal and informal training programs to qualify personnel for advancement in rating, and one who can train individuals and groups in the effective execution of assigned tasks.

In using this training course, study the information from two points of view. First, what do you yourself need to learn from it? And second, how would you go about teaching this information to others?

Training goes on all the time. Every time a person does a particular piece of work, some learning is taking place. As a supervisor and as a training expert, one of your biggest jobs is to see that your personnel learn the RIGHT things about each job so that they will not form bad work habits. An error that is repeated a few times is well on its way to becoming a bad habit. You will have to learn the difference between oversupervising and not supervising enough. No one can do his best work with a supervisor constantly supervising. On the other hand, you cannot turn an entire job over to an inexperienced person and expect him to do it correctly without any help or supervision.

In training lower rated personnel, emphasize the importance of learning and using correct terminology. A command of the technical languages of your rating enables you to receive and convey information accurately and to exchange ideas with others. A person who does not understand the precise meaning of terms used in connection with the work of his rating is definitely at a disadvantage when he tries to read official publications relating to his work. He is also at a great disadvantage when he takes the examinations for advancement in rating. To train others in the correct use of technical terms, you will need to be very careful in your own use of words. Use correct terminology and insist that personnel you are supervising use it too.

You will find the Record of Practical Factors, NavPers 1414/1, a useful guide in planning and carrying out training programs. From this record, you can tell which practical factors have been checked off and which ones have not yet been done. Use this information to plan a training program that will fit the needs of the personnel you are training.

On-the-job training is usually controlled through daily and weekly work assignments. When you are working on a tight schedule, you will generally want to assign each person to the part of the job that you know he can do best. In the long run, however, you will gain more by assigning personnel to a variety of jobs so that each person can acquire broad experience. By giving people a chance to do carefully supervised work in areas in which they are relatively inexperienced, you will increase the range of skills of each person and thus improve the flexibility of your working group.

CROSS-TRAINING.—Preparing men in service ratings for advancement to the general rating is an important part of your training job. As noted before, the ATN2 cannot advance to AT1 without learning the duties of the ATR2. Similarly, the ATR2 must learn the duties of the ATN2 before he can advance to AT1.

The first step in setting up a program of cross-training is to make a careful study of the qualifications. Suppose, for example, that you are going to train an ATN2 for advancement to AT1. First of all, you know that he will have to be trained in all areas indicated by the qualifications for advancement to AT1. In addition, you will have to make sure that he is trained in all qualifications required for ATR3 and ATR2.

In some cases, of course, third class and second class qualifications are common to both service ratings. For example, "Test, select, and replace circuit parts" is a requirement for advancement to ATN3 and ATR3; consequently, you know that the ATN2 has already been checked out on this qualification. However, the qualification "Energize radar equipment, set indicator controls, and adjust magnetron and crystal current" is required for advancement to ATR3 but is not required for ATN3. Therefore, the ATN2 who wants to advance must learn to adjust radar components.

After you have listed all the ATR3 qualifications that the ATN2 must now learn to meet, group these qualifications into logical units of work or study. Some of the material can be learned by study of the appropriate training course. Other subjects can only be learned by practical experience. Whenever possible, use

regular working situations as training situations. When formal training is required, plan it all out in advance so that you will be able to make the best use of the available time.

Working With Others

As you advance to PO1 or CPO, you will find that many of your plans and decisions affect a large number of people, some of whom are not even in your own rating. It becomes increasingly important, therefore, for you to understand the duties and the responsibilities of personnel in other ratings. Every petty officer in the Navy is a technical specialist in his own field. Learn as much as you can about the work of other ratings, and plan your own work so that it will fit into the overall mission of the organization.

Keeping Up With New Developments

Practically everything in the Navy—policies, procedures, publications, equipment, systems—is subject to change and development. As a PO1 or CPO, you must keep yourself informed about changes and new developments that affect you or your work in any way.

Some changes will be called directly to your attention, but others will be harder to find. Try to develop a special kind of alertness for new information. When you hear about anything new in the Navy, find out whether there is any way in which it might affect the work of your rating. If so, find out more about it.

SOURCES OF INFORMATION

As a PO1 or CPO, you must have an extensive knowledge of the references to consult for accurate, authoritative, up-to-date information on all subjects related to the military and professional requirements for advancement in rating.

Publications mentioned in this chapter are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to revision, make sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made.

A list of training courses and publications that will be helpful as references and for additional study in preparing for advancement is included in the reading list at the beginning of this text. Additional training courses applicable to the rating are available through your educational services officer.

In addition to training courses and publications, training film furnishes a valuable source of supplementary information. A selected list of training films that may be useful appear in the appendixes of this training course. Other films that may also be helpful are listed in the U.S. Navy Film Catalog, NavAir 10-1-777.

ADVANCEMENT OPPORTUNITIES FOR PETTY OFFICERS

Making chief is not the end of the line as far as advancement is concerned. Proficiency pay, advancement to Senior (E-8) and Master (E-9) Chief, and advancement to Warrant Officer and Commissioned Officer are among the opportunities that are available to qualified petty officers. These special paths of advancement are open to personnel who have demonstrated outstanding professional ability, the highest order of leadership and military responsibility, and unquestionable moral integrity.

PROFICIENCY PAY

The Career Compensation Act of 1949, as amended, provides for the award of proficiency pay to designated enlisted personnel who possess special proficiency in a military skill. Proficiency pay is given in addition to regular pay and allowances and any special or incentive pay to which you are entitled. Certain enlisted personnel in pay grades E-4 through E-9 are eligible for proficiency pay. Proficiency pay is allocated by ratings and NEC's, with most awards being given in the ratings and NEC's which are designated as critical. The eligibility requirements for proficiency pay are subject to change. In general, however, you must be recommended by your commanding officer, have a certain length of time on continuous active duty, and be career designated.

ADVANCEMENT TO SENIOR AND MASTER CHIEF

Chief petty officers may qualify for the advanced grades of Senior and Master Chief which are now provided in the enlisted pay structure. These advanced grades provide for substantial

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increases in pay, together with increased responsibilities and additional prestige. The requirements for advancement to Senior and Master Chief are subject to change but, in general, include a certain length of time in grade, a certain length of time in the naval service, a recommendation by the commanding officer, and a sufficiently high mark on the Navy-wide examination. The final selection for Senior and Master Chief is made by a regularly convened selection board.

Examination Subjects

Qualifications for advancement to Senior Chief Petty Officer and Master Chief Petty Officer have been developed and published in the Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series). They officially establish minimum military and professional qualifications for Senior and Master Chief Petty Officers.

Training Publications for Advancement in Rating, NavPers 10052 (Series) contains a list of study references which may be used to study for both military and professional requirements.

The satisfactory completion of the correspondence course titled Navy Regulations, NavPers 10740-A, is mandatory for advancement to E-8, and the course titled Military Justice in the Navy, NavPers 10993, is required of all personnel advancing to E-9.

In order to be certain you have the latest "quals," the current NavPers 10052 (Series), and the schedule of advancement examinations, you should visit your educational services office for the latest information.

ADVANCEMENT TO WARRANT AND COMMISSIONED OFFICER

The Warrant Officer program has been revitalized in revised form in the Regular Navy and the Naval Reserve, and is being phased in at this writing (1967). After fiscal 1968, the only rates eligible for advancement to Warrant rank will be E-6's and E-7's. The E-6's must have passed examinations for E-7 prior to selection. After fiscal 1968, enlisted men will have to decide at E-6, or not later than E-7, whether they wish to follow the Warrant or the E-8/E-9 path of advancement.

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CHAPTER 2

AIRCRAFT MAINTENANCE ORGANIZATION

In order to maintain increasingly complex aircraft in their operating prime, various aircraft maintenance organizations and procedures have been employed throughout the Navy. Prior to and during World War II, it was a general practice for every operating activity to have its own maintenance spaces, equipment, and a complement of maintenance personnel to accomplish all maintenance except overhaul. Due to variance in workload between squadrons, some shops were idle at times and could have been used by maintenance personnel from other squadrons on the same station to accomplish their work.

A combining of talents, efforts, facilities, and equipments for the accomplishment of common tasks was indicated. Through the process of evolution, combining of naval aircraft maintenance personnel and consolidation of maintenance facilities were effected on a Navy-wide basis when the Naval Aircraft Maintenance Program (NAMP) was established.

NAVAL AIRCRAFT MAINTENANCE PROGRAM

The Naval Aircraft Maintenance Program was designed to insure maximum utilization of manpower, material, and equipment and establish standard maintenance procedures and organizations for the accomplishment of maintenance on naval aircraft and associated equipment. The adoption of standard organizations and procedures promotes a high degree of uniformity among all activities in the methods that are used to manage and utilize maintenance personnel, material, and facilities. It results in a decrease in time required to indoctrinate recently assigned personnel.

The improvement of aircraft readiness is of utmost importance; costly, complex weapons systems and spares demand maximum command attention to the repair of critical items to enable aircraft to be in a ready status. It is therefore mandatory that all maintenance personnel have a thorough knowledge of and abide by the established procedures.

LEVELS OF MAINTENANCE

The task of maintaining naval aircraft in an operationally ready condition ranges from a few minutes of squadron servicing to months of overhaul in a depot level maintenance activity. To more efficiently accomplish maintenance on military aircraft the present concept is to divide the maintenance functions into three distinct levels—depot, intermediate, and organizational. The determination of what maintenance will be performed at each level is governed primarily by the availability and distribution of maintenance equipment and facilities.

Each command and support agency is responsible for continually reviewing the distribution of equipment and facilities to insure that the amount of maintenance performed at the lowest levels is consistent with available skills and personnel.

Organizational Maintenance

Organizational maintenance is the type of work performed by the operating squadron or unit on a day-to-day basis in support of its own operations. Maintenance performed at this level includes (1) inspection, (2) servicing, (3) handling, (4) "on-aircraft" corrective maintenance, including removal and installation of parts and components, (5) complying with technical directives (when prescribed), and (6) the necessary recordkeeping and reports peculiar to organizational maintenance.

Organizational maintenance in an operating activity is performed by permanently assigned personnel who are not responsible for intermediate maintenance. Organizational maintenance at shore stations (on aircraft assigned to the station) normally is a function of the Operations Maintenance Division (OMD). The OMD also provides organizational maintenance and such other assistance to transiting aircraft as may be directed by higher authority.

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Intermediate Maintenance

Intermediate maintenance is that type of work performed in centrally located facilities for the support of operating activities within a designated geographical area, at a particular base or station, or aboard aviation ships. This level of maintenance is assigned for performance to such units as Station Aircraft Maintenance Departments (AMD's), Marine Headquarters and Maintenance Squadrons, Marine Aircraft Maintenance Squadrons, Aircraft Intermediate Maintenance Department (AIMD, afloat), etc. Typical of the work performed at this level is shop type repair and test work on aircraft components and equipment from the supported units. Technical assistance, when required, is furnished by personnel of the intermediate maintenance facility to the supported operating activities.

Intermediate maintenance activities are normally manned by a nucleus of permanently assigned personnel and certain designated intermediate maintenance personnel temporarily assigned from the on-board tenant squadrons. When these squadrons deploy from their home stations, their intermediate maintenance personnel accompany them, and are then temporarily assigned to the AIMD if afloat or to the AMD at their new station.

Depot Maintenance

Depot maintenance is that type of work normally accomplished in an industrial type facility (Naval Air Rework Facilities or contractors' plants.) This level includes overhaul and major repair or modification of aircraft, components, and equipments. It also includes the manufacture of specified aeronautical parts to be stocked as spares and the manufacture of kits for the accomplishment of aircraft and equipment modification. Installation of these spare-parts kits may be done at this or a specific lower level of maintenance.

Navy Depot maintenance activities are manned primarily by civilians. However, some military personnel are usually assigned and assist with the intermediate and organizational type work necessarily connected with the depot facility.

It can be seen from the foregoing that the three aircraft maintenance levels or categories provide for an orderly separation of the various maintenance tasks. The bases for the separation are complexity of the task, equipment and space requirements, the skill level of assigned personnel, and the scope of support responsibility.

FUNCTIONS RESPONSIBILITIES

Functions relate only to the maintenance level authorized to perform the task and have no bearing on the rating or skill required. Some levels will require more than one skill or rating to accomplish its task. Allowance lists for support equipment, tools, and material reflect these maintenance level assignments. The depth and complexity of the specific function will vary with the number and type of aircraft involved.

The Chief of Naval Operations assigns maintenance responsibilities to the operating forces, and the Naval Air Systems Command assigns maintenance responsibilities to the activities ashore under its control. Some activities may be assigned intermediate level maintenance responsibility for an entire logistic area if requested by the cognizant controlling custodian. Specific activities designated to perform intermediate maintenance are authorized to perform higher level maintenance on systems and equipment unique to the assigned mission, and certain other organizational level activities are authorized to perform selective functions in partial intermediate support of their own operations.

SHORE STATIONS

Navy activities ashore assigned intermediate level maintenance responsibilities establish an Aircraft Maintenance Department, usually referred to an AMD. Those activities with assigned aircraft establish a maintenance division within the operations department to perform organizational maintenance on assigned aircraft and on transit aircraft. Intermediate level maintenance activities perform maintenance in support of station aircraft and tenant squadrons and units. The intermediate activity also provides facilities and equipment for tenants to accomplish organizational maintenance. Tenant activities aboard shore stations furnish personnel to the intermediate activity for the accomplishment of its responsibility, and the personnel are used only in the normal spectrum of their individual rate or rating.

All Naval Air Reserve Training Units (NARTU's) and Naval Air Reserve Maintenance Units (NARMU's) are responsible for intermediate and organizational maintenance on their assigned aircraft; however, the supporting activity is responsible for logistic support. Naval and Marine air reserve squadrons are responsible for organizational maintenance on their

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assigned aircraft while on active duty or assigned to a fleet unit. During regular scheduled drill periods, maintenance is performed according to the training requirements.

SHIPS

For discussion purposes this topic includes aircraft carriers and other aviation ships (AV's, ARVA's, and ARVC's).

Aircraft Carriers

The need for establishing an Aircraft Intermediate Maintenance Department was recognized by CNO and supported by fleet commanders. Therefore, this department is being established in all aircraft carriers (less the one operating with NATRACOM), assigning intermediate maintenance responsibilities afloat to the AIMD instead of the Air Wing/Group Commanders. (See fig. 2-1.) This action dissolves the V-6 division, assigning those functions not directly related to intermediate maintenance to appropriate departments. Squadron maintenance personnel will be assigned to the AIMD as for the AMD previously discussed.

Other Aviation Ships

These ships are responsible for performance or organizational maintenance on assigned aircraft. If aircraft are operated from the ship, intermediate level maintenance facilities are provided air groups, squadrons, and units. Aircraft repair ships (ARVA/ARVC) are assigned intermediate level maintenance responsibility.

INTERMEDIATE LEVEL MAINTENANCE ACTIVITY ORGANIZATION (AFLOAT)(5)

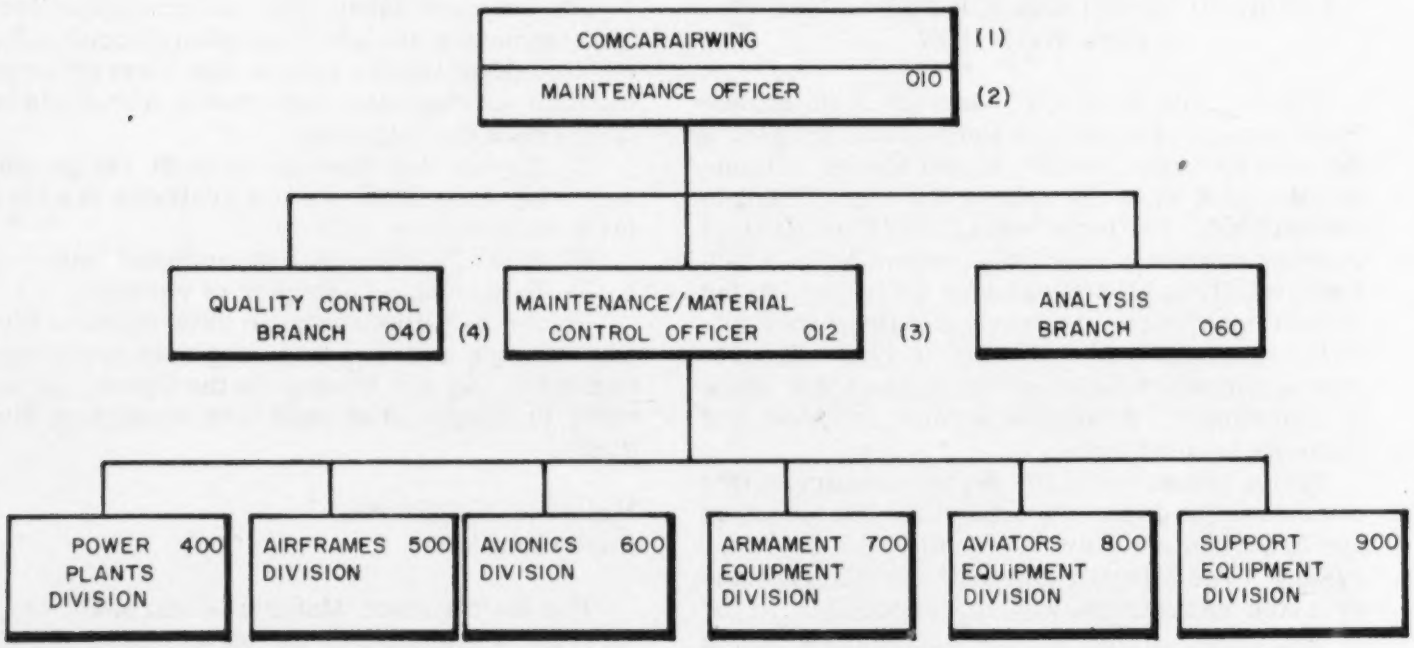

NOTES: (1) WHEN EMBARKED.

(2) AND (3) THE AIRCRAFT MAINTENANCE DEPARTMENT OFFICER (AFLOAT), DEPENDENT UPON HIS SENIORITY, WILL BE ASSIGNED AS EITHER THE INTERMEDIATE MAINTENANCE OFFICER OR MAINTENANCE/MATERIAL CONTROL OFFICER FOR CUSTODY/CONTINUITY PURPOSE UPON DEBARKATION OF THE AIR WING.

(4) BRANCH OFFICERS WILL BE TAD FROM AIR WING/GROUP THE IMA FOR MANAGEMENT RESPONSIBILITIES.

(5) APPLICABLE UNTIL ESTABLISHMENT OF AIMD DIRECTED BY CNO MESSAGE 151806Z MAY 1967

Figure 2-1.—Intermediate level maintenance activity organization, afloat.

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Nonaviation ships operating or tending aircraft are not assigned maintenance responsibility; however, they provide intermediate and organizational maintenance facilities, support equipment, and material for embarked units.

SQUADRONS

Navy squadrons and units are responsible for performing organizational maintenance on assigned aircraft, with the exception of VRF squadrons. The station supporting activity performs their organizational and intermediate maintenance. All squadrons are required to provide personnel for temporary assignment to the station aircraft maintenance department responsible for squadron support; or if the squadron is deployed aboard ship, the personnel are assigned temporarily to the AIMD, who is responsible for intermediate maintenance support.

AIRCRAFT MAINTENANCE DEPARTMENT ORGANIZATION

The organization for Aircraft Maintenance Departments provide firm lines of authority from the maintenance officer to personnel accomplishing the work for which the department is responsible. The term "department" used in this training course is used as a general term which applies fully to all maintenance activities having a department head. In cases of maintenance activities assigned as divisions to other departments, the next echelon (division) is used in place of department. Branches become sections, and sections become units.

Major segments of the department are called divisions. Divisions are subdivided into branches and branches are subdivided into sections if necessary. The aircraft maintenance officer manages the department and is responsible to the commanding officer for the accomplishment of the department's mission.

The Aircraft Maintenance Department supports naval operations by the upkeep of assigned and supported aircraft and associated support equipments to the level and depth of maintenance assigned. Specific functions include the following:

1. Periodic maintenance and routine inspection and servicing of aircraft, associated support equipment, and aeronautical material and components including the necessary disassembly, cleaning, examination, repair, modification test, inspection, assembly, and preservation.
2. Special work in compliance with technical directives or local instructions.
3. Correction or discrepancies.
4. Assurance of high quality of all work.
5. Maintenance of records and technical publications.
6. Maintenance and custody of tools and other organizational equipment.
7. Training of assigned personnel.
8. Conduct maintenance and ground handling safety programs.

INTERMEDIATE LEVEL ACTIVITY

The primary purpose of this level maintenance is to support and supplement the work of organizational maintenance activities. These functions are normally performed in centrally located areas for the support of operating aircraft on a shore station, aboard a ship, or within a designated area.

The responsibility for intermediate level maintenance is assigned to station aircraft maintenance departments ashore and aircraft intermediate maintenance departments afloat and encompasses the following:

1. Repair and test of aircraft components requiring shop facilities not available in a lower level maintenance activity.
2. Aircraft changes and modifications.
3. Reporting and keeping of records.

Figure 2-2 illustrates an intermediate level maintenance activity, including work center code numbers. As can be seen in the figure, the activity is composed of staff and production divisions.

Maintenance/Material Control Officer

The Maintenance/Material Control Officer is directly responsible to the Maintenance Officer for the management of the overall productive effort of the department. His general responsibilities include but are not limited to the following:

1. Scheduling, coordinating, and monitoring the workload of the department.
2. Maintaining liaison with supported/supporting activities and the local supply department to insure material requirements are fulfilled in order to keep productive capacity compatible with workload requirements.
3. Coordinating the order, receipt, and delivery of material, the administrative screening,

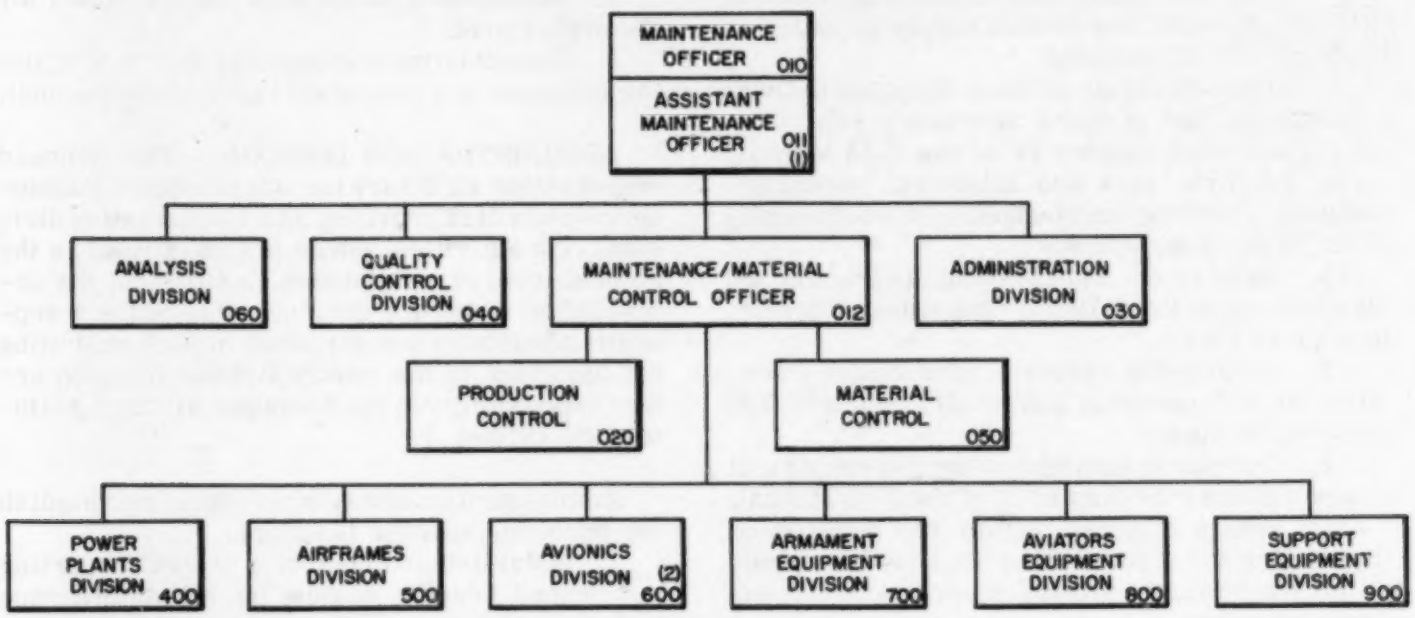

NOTES: (1) WHEN ASSIGNED

(2) QUALIFICATION WILL BE PERFORMED BY THE TEST EQUIPMENT BRANCH OF THE AVIONICS DIVISION.

(3) WORK CENTERS WILL BE ESTABLISHED IN ACCORDANCE WITH APPENDIX "D" OF THE 3-M MANUAL.

Figure 2-2.—Intermediate maintenance activity, ashore.

scheduling, and control of processed components, and the control and usage of funds provided the department.

In discharging the duties of production control, the Maintenance/Material Control Officer will perform the following:

1. Plan and schedule the workload so as to insure maximum utilization of personnel, material, and resources.
2. Coordinate the actions of the production divisions to insure prompt movement of components through the department.
3. Assign production control numbers, work priorities, due-in and due out dates to the various work centers, and establish maintenance control procedures in order to effectively monitor the daily workload requirements.
4. Maintain technical directive control procedures for the department.
5. Review and approve work requests from supported activities.
6. Maintain files of completed maintenance action forms and work requests (6 months).
7. Maintain the Intermediate Maintenance Control Register.
8. Recommend and control cannibalization in accordance with applicable directives.
9. Submit reports as applicable.
10. Analyze daily and monthly maintenance data reports to ascertain effective utilization of personnel resources.

An assistant to the Maintenance/Material Control Officer will discharge the duties of material control by performing the following:

1. Plan, requisition, and expedite materials to enable the department to perform its mission quickly and effectively.
2. Pass all requirements for material for support of weapons system maintenance to the supporting SSC (Supply Support Center), and maintain a material control register for these items.
3. Establish delivery-pickup points for all material as mutually agreed upon by the Supply and Maintenance Officers. Insure that material received is expeditiously routed to the applicable work center.
4. Furnish technical advice and information to the supply activity on the identity and quantity of supplies, spare parts, and materials required for maintenance actions.
5. Establish procedures to insure the periodic inventory of tools and the adequate accountability of material and equipment.

6. Initiate surveys in the event of loss, damage, or destruction of accountable material.

7. Keep the Maintenance/Material Control Officer advised of the overall supply situation as it affects the department.

8. Verify Aircraft on Work Stoppage (AOWS) requisitions and prepare necessary reports in accordance with chapter IV of the 3-M Manual.

9. Perform cost and allotment record accounting, charting, and budgeting of costs applicable to the department.

10. Monitor the operation of toolrooms and maintain an updated IMRL (Individual Material Readiness List).

11. Arrange for return of prospective F condition or R/S material and locally repaired RFI material to supply.

12. Operate an administrative screening unit in accordance with chapter IV of the 3-M Manual.

13. Retain material within the department that is in AWP status until such time the requisition is filled and continually ascertain followup status on same.

Staff Division

Staff divisions are incorporated into the framework of aircraft maintenance activities for the purpose of providing services and support to the production divisions. A discussion of some of the more important functions of the staff divisions is contained in the following paragraphs:

ANALYSIS DIVISION. — The Analysis Division provides qualitative and quantitative analysis information to the Maintenance Officer in order to enable him to continually review the management practices within his organization by accomplishing the following functions:

1. Managing, coordinating, and monitoring the MDCS (Maintenance Data Collection System) for the department.

2. Reviewing MDR (Maintenance Data Reports) to discover and point out workload inequities, personnel inequities, and resource inequities.

3. Collecting, reviewing, and delivering source documents to data services for processing. Picking up complete data reports and disseminating throughout the organization.

4. Maintaining an adequate supply of manuals, source documents, registers, etc., on hand to insure continuity in the MDCS.

5. Developing an analytical plan which encompasses all maintenance functions to provide periodic audits of work center performance.

6. Developing charts, graphs, and displays for command presentations.

7. Maintaining an updated master roster for the department.

8. Coordinating and insuring that 3-M training services are provided to assigned personnel.

ADMINISTRATION DIVISION. — The standard organization structure for intermediate maintenance activities provides an administration division. (In activities where organizational is the highest level of maintenance performed, the organization structure does not provide for a separate administration division. In such activities the functions of the administration division are the responsibility of the Assistant Aircraft Maintenance Officer.)

Administration division personnel accomplish the following specific functions:

1. Establish and control a central reporting and record keeping system for all maintenance reports and correspondence.

2. Implement all directives concerning distribution, retention, and disposition of records and reports.

3. Provide clerical and administrative services for the department.

4. Reproduce as necessary and distribute incoming messages and other data.

5. Supervise and coordinate department administrative responsibilities with other departments/divisions as required.

6. Conduct liaison with the Activity's Administration Department regarding department personnel matters.

7. Safeguard and distribute personal mail to department personnel, when appropriate.

8. Make proper distribution of all nontechnical information and publications.

9. Distribute approved locally issued maintenance instructions, reports, and studies.

10. Control classified material (excluding technical manuals and letter type directives) required by the department.

11. Establish and coordinate the department training requirements. Obtain necessary school quotas to support these requirements.

12. Determine requirements for and insure establishment of proper transportation and communication systems to provide complete support of the workload.

13. Assign spaces to the various divisions and establish the responsibility for security and cleanliness of such spaces.

14. Assume responsibility for the cleanliness and security of vacant or unassigned aircraft maintenance spaces.

15. Arrange department participation in joint inspections of facilities assigned to tenant activities especially incident to the departure of a tenant activity.

QUALITY CONTROL DIVISION. —The quality control division provides the department head with the quality status of work accomplished, points up areas that need particular attention, and develops more realistic inspection requirements. Primary functions performed by this division are as follows:

1. Review all incoming technical publications and directives affecting the department to determine their application to quality control.

2. Prepare or assist in the preparation of maintenance instructions to insure that proper direction and emphasis is given to implementing quality control.

3. Maintain the master technical library for the department, including letter type technical directives and control classified technical publications for the department. Insure that each division/branch receives all publications applicable to its work areas and that these are kept current and complete. Where applicable, maintain the Reader-Printer and associated equipment for aircraft models supported.

4. Establish qualification requirements for Quality Control Inspectors and Collateral Duty Inspectors. Review the qualifications of personnel nominated for these positions and endorse nominations to the Commanding Officer via the department head. Maintain a current record of all designated inspectors. Periodically promulgate a list of all designated inspectors by TIMI or command notice.

5. Obtain and utilize appropriate inspection equipment such as lights, mirrors, magnifying glasses, dye penetrant kits, pressure gages, etc. Insure that productive personnel have such equipment available and in use.

6. Periodically accompany Collateral Duty Inspectors on assigned inspections and recheck their qualifications.

7. Insure all work guides, checkoff lists, checksheets, maintenance requirement cards, etc., used to define or control maintenance operations are completed and current prior to issuing to crews/individuals.

8. Review all UR entries, explanations and descriptions to insure they are accurate, clear, concise and comprehensive prior to mailing. Additionally, either Quality Control or Maintenance Officer will sign all UR's.

9. Cause to be inspected all equipment received for use, returned for repair, or held awaiting repair to insure its material condition, identification, packaging, preservation, and configuration are satisfactory and, when applicable, that shelf life limits are not exceeded.

10. Perform inspections of maintenance equipment and precision measuring equipment to insure compliance with calibration and safety instructions.

11. Perform technical inspections of all maintenance equipment and facilities.

12. Provide for the continuous on-the-job training of all inspectors in the techniques and procedures pertaining to the conduct of inspections.

13. When directed or required, provide technical task forces to study trouble areas and submit recommendations for corrective action.

14. Maintain adequate records and data on discrepancies to enable establishment of trends with the specific objective of determining when discrepancies in any area are ascending.

15. Maintain liaison with contractor, NAESU, NavAirSysComRep's, and other available field technical services. Establish and maintain liaison with other maintenance activities and rework points in order to obtain information on ways for improving maintenance techniques, quality of workmanship and quality control procedures.

16. Review maintenance data reports and note unnecessary and/or recurring discrepancies requiring special action.

17. Insure that established standard procedures are observed by production personnel for conducting bench check, test, and repair of components including engines. Periodically check the performance of this work to insure the desired quality level is obtained.

18. Insure the configuration of aircraft components and support equipment is such that all essential/applicable modifications have been incorporated. This necessitates the review of appropriate records.

Production Divisions

The standard organization for intermediate level maintenance activities provides six production divisions. These divisions perform maintenance on aircraft components and equipment for supported activities. The responsibilities and functions of these divisions are described in the following paragraphs.

Functions of Production Divisions.—Power Plants, Airframes, Avionics, Armament Equipment, and Aviators Equipment Divisions will:

1. Perform intermediate level maintenance functions for tenant squadrons/detachments/units and station assigned aircraft.
2. Continuously review the intermediate level shop facilities for adequacy and make necessary recommendations to the Maintenance/Material Control Officer.
3. Initiate requests to Maintenance/Material Control Officer for production control numbers and material.
4. Nominate qualified individuals for designation as Collateral Duty Inspectors when required.
5. Maintain work center registers and master rosters.

The Support Equipment Division will:

1. Initiate action to obtain the authorized allowance of support equipment, including those items which will be subcustodied to tenants.
2. Nominate qualified individuals for designation as Collateral Duty Inspectors when required.
3. Perform intermediate maintenance on all support equipment, including repair of gas turbine powered equipment engines. Avionics support equipment will be maintained by that division.
4. Administer the program for subcustody of support equipment to other divisions of the maintenance department, Operations Maintenance Division and tenant activities. Periodically inspect subcustodied equipment, in conjunction with organizational activities, to insure proper maintenance, operation and use (except for avionics support equipment).
5. Initiate requests to Maintenance/Material Control Officer for production control numbers and material.
6. Maintain work center registers and master rosters.

ORGANIZATIONAL LEVEL ACTIVITY

The responsibility for organizational level maintenance is assigned to operating units on a day-to-day basis—to support their own operations. Maintenance performed at this level includes aircraft servicing, aircraft inspections, minor adjustments, removal and replacement of defective parts and components, limited aircraft changes and modifications, recordkeeping, and reports. Figure 2-3 illustrates an organizational level maintenance activity, including work center code numbers.

Maintenance/Material Control Officer

The Maintenance/Material Control Officer performs the following functions:

1. Scheduling, coordinating, and monitoring the workload of the department.
2. Maintaining liaison with the supporting activities and the local supply department to insure material requirements are fulfilled in order to keep productive capacity compatible with workload requirements.
3. Coordinating the ordering, receipt, and delivery of material, the administrative screening, scheduling, and control of processed components, and the control and usage of funds provided the department.

In discharging the duties of production control (work center 020), he will:

1. Plan and schedule the workload so as to insure maximum utilization of personnel, material, and resources.
2. Assign job control numbers for each reported discrepancy.
3. Maintain the organizational maintenance control register (3 months).
4. Maintain an up-to-date status board.
5. Provide the Operations Department with required aircraft status and configuration information.
6. Maintain technical directive control procedures.
7. Relay discrepancies to work centers with complete information as to status, by the fastest method (i. e., telephone, intercommunications, etc.).
8. Review and approve work requests to the supporting activity. (Maintain completed files.)
9. Recommend and control cannibalization in accordance with applicable directives.
10. Submit reports as required.
11. Receive certain completed source documents from work centers and:
    a. Update aircraft and equipment logs, accessory record cards, configuration forms, and associated documents.
    b. Forward completed forms to data analysis.
12. Receive completed source documents from data analysis after processing and file for historical records.
13. Conduct monthly maintenance meetings and publish a monthly maintenance plan.

ORGANIZATIONAL LEVEL MAINTENANCE DEPARTMENT ORGANIZATION

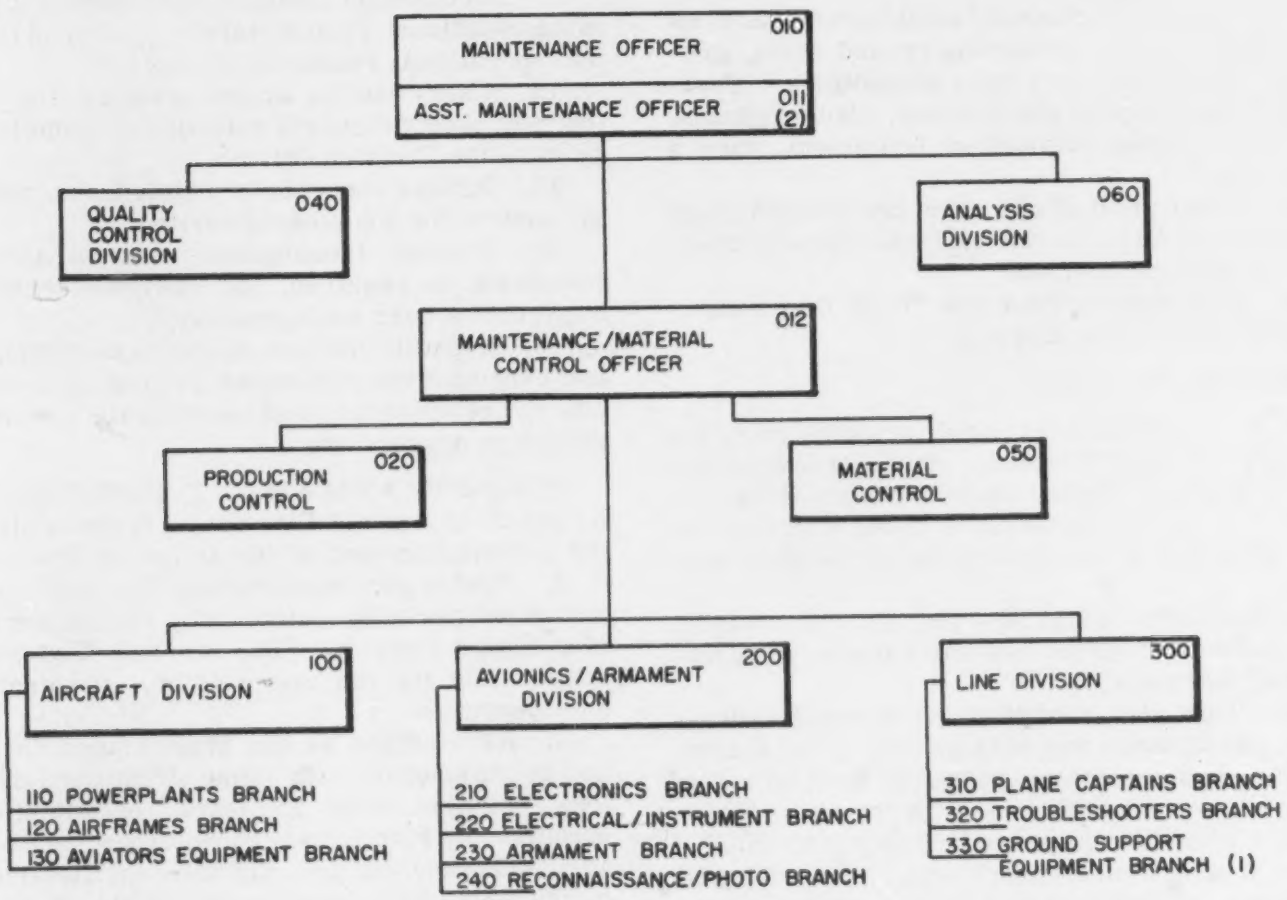

NOTE: (1) When responsibilities relative to operation and maintenance of ground support equipment are extensive, the Commanding Officer will establish a Ground Support Equipment Branch under the Line Division to coordinate and/or carry out organizational maintenance functions on assigned support equipment.

(2) When assigned.

Figure 2-3.—Organizational maintenance activity.

14. Schedule all periodic and special inspections and insure maintenance test flights are conducted in accordance with applicable instructions.

In discharging the duties of material control (work center 050), he will perform those applicable functions specified under intermediate level maintenance as well as the following:

1. Prepare documents for material required for operational support of weapon systems (i.e., material chargeable to BRAVO funds such as fuel, oil, and flight clothing, etc.) and material carried in SERVMART/JETMART outlets.

2. Verify NORSAIR (Not Operationally Ready Supply Aviation Item Report) requisitions and maintain (by BUNO) current NORSAIR status records.

3. Inventory aircraft upon receipt and transfer. Insure inventory logs entries are updated, authenicated, and corrected.

Staff Divisions

The organizational level activity has only two staff divisions, having no administration division as explained under the intermediate level. The analysis division is the same for both activities; therefore, it is not discussed here. The quality control division is the same as discussed for the intermediate level with the following additions:

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1. Review "yellow sheets," maintenance data reports, periodic inspection records and note unnecessary and/or recurring discrepancies that may require special action.

2. Insure that standard established practices are observed for conducting ground tests, preflight, postflight, and daily inspections. Periodically accompany check crews, plane captains, or pilots during inspection (minimum, once a quarter).

3. Insure that pilots/crew are briefed prior to each test flight so that purpose and objectives are clearly understood.

4. Maintain current the Type Commander Maintenance Index Record.

Production Divisions

The organizational level activity provides three production divisions, which are subdivided into branches. Each of these branches/divisions performs many maintenance tasks in order for the operating unit to accomplish its assigned mission.

AIRCRAFT DIVISION.—The Aircraft Division is responsible for the accomplishment of the following functions:

1. Supervise, coordinate, and complete periodic maintenance and inspections. (Check crew leaders and such other personnel authorized by the Maintenance Officer will be permanently assigned.) Additional personnel required to perform periodic maintenance and inspections will be made available as required from other production divisions. The Maintenance/Material Control Officer is responsible for insuring that divisions assign qualified personnel for the completion of scheduled maintenance and inspections.

2. As directed by the Maintenance Officer and in conjunction with other production divisions, perform those applicable organizational maintenance functions in those areas relative to assigned branches; i.e., Airframes, Power Plants and Aviators Equipment.

3. Continuously advise the Maintenance/Material Control Officer of the status of work in progress.

4. Insure cleanliness of hangar and assigned spaces.

5. Nominate personnel for assignment as collateral duty inspectors.

6. Initiate requests for maintenance material.

7. Assume custody for tools and support equipment assigned to the Aircraft Division.

8. Interpret applicable directives and prepare, in draft form, maintenance instructions to implement such directives.

9. Recommend changes in techniques to promote maximum ground safety, safety of flight, and operational readiness of aircraft.

10. Carry out an active program for FOD (foreign object damage) control, as established by the Line Division Officer.

11. Initiate requests to maintenance/material control for job control numbers.

12. Provide troubleshooters and aircrew members, as required, and exercise technical supervision over such personnel.

13. Expedite the accomplishment of assigned work through the continuous evaluation of methods and procedures, and incorporate new techniques as appropriate.

AVIONICS/ARMAMENT DIVISION.—The Avionics/Armament Division is responsible for the accomplishment of the following functions:

1. Assign personnel required to accomplish scheduled periodic maintenance and inspections of assigned aircraft. (The Aircraft Division is responsible for the supervision, coordination, and inspections.)

2. As directed by the Maintenance Officer and in conjunction with other production divisions, perform those applicable organizational maintenance functions in those areas relative to assigned branches, i.e., Electronics, Electrical/Instrument, Armament, and Reconnaissance/Photographic.

3. Continuously advise the Maintenance/Material Control officer of the status of work in progress.

4. Insure cleanliness of assigned spaces.

5. Assume custody and accountability for assigned tools and support equipment.

6. Initiate requests for maintenance material.

7. Nominate qualified individuals for assignment as collateral duty inspectors.

8. Interpret applicable directives and prepare, in draft form, maintenance instructions to implement such directives.

9. Recommend changes in methods and techniques to promote maximum ground safety, safety of flight, and operational readiness of aircraft.

10. Initiate requests to maintenance/material control for job control numbers.

11. Provide troubleshooters and aircrew members, as required, and exercise technical supervision over such personnel.

12. Expedite the accomplishment of assigned work by continuous evaluation of methods and procedures and incorporate new techniques as appropriate.

LINE DIVISION.—The Line Division is responsible for the accomplishment of the following functions:

1. Assign personnel, as required, to accomplish periodic maintenance and inspections of assigned aircraft. (The Aircraft Division is responsible for the supervision, coordination, and completion of periodic maintenance and inspections.)

2. As directed by the Maintenance Officer and in conjunction with other production divisions, perform those applicable organizational maintenance functions in those areas relative to assigned branches; i. e., plane captains, troubleshooters, and ground support equipment (when established).

3. Coordination and direction of troubleshooters. Although troubleshooters will normally be assigned from other divisions on a daily basis, the Maintenance Officer may assign personnel permanently to a Troubleshooter Branch of the Line Division. A troubleshooter should accomplish correction of minor discrepancies.

4. Initiate requests to maintenance/material for job control numbers.

5. Provide to pilots/aircrews records of aircraft discrepancies and corrective actions for the preceding 10 flights of the aircraft.

6. Administer the plane captain program.

7. Nominate qualified personnel as collateral duty inspectors.

8. Participate in an active FOD (Foreign object damage) prevention program.

9. Initiate requests for maintenance material.

10. Insure the cleanliness of assigned aircraft and spaces.

11. Assume custody and accountability for tools and aircraft maintenance support equipment assigned to the division/branch.

12. Insure the security and proper ground handling of aircraft and associated support equipment.

13. Recommend changes in methods and techniques to promote maximum ground safety, safety of flight, and operational readiness of assigned aircraft and associated support equipment.

NAVY MAINTENANCE AND MATERIAL MANAGEMENT (3-M) SYSTEM

The 3-M system is a program to insure the highest state of aircraft readiness and reliability at the lowest cost in men, money, and material. In accomplishing this, it must insure that maintenance personnel, equipment, and facilities are utilized to the fullest extent in the performance of maintenance and not wasted in other functions not requiring highly trained maintenance skills nor specialized and expensive maintenance equipment and facilities.

All aircraft weapon systems must be maintained to the maximum extent possible to perform 100 percent of the functions for which they were designed and to accomplish the assigned mission. Anything short of this goal is considered a compromise to readiness which cannot be afforded.

By analyzing maintenance costs and devising techniques to reduce cost wherever and whenever possible, many procedures and unnecessary actions can be minimized or eliminated entirely. Therefore, by doing away with the unnecessary, effort can be concentrated on increased readiness. The 3-M system embraces two broad areas—a Planned Maintenance System, and a Maintenance Data Collection System.

PLANNED MAINTENANCE SYSTEM

The Planned Maintenance System (PMS) is a system of maintenance planning and control that provides for the uniform accomplishment of planned preventive, rather than corrective, maintenance in all aircraft squadrons. A set of Maintenance Requirement Cards (MRC's) is provided for each type of aircraft, based on information in the Periodic Maintenance Requirements Manual (PMRM). The MRC's tell what inspections are to be performed, when and how they are to be performed, the skills, tools and equipment needed, the safety precautions to be observed, and the inspection sequence.

Many separate but interrelated functions and tasks combined to make up the maintenance workload that is required for support of modern aircraft. The times allocated and available for the accomplishment of this maintenance does not allow for all of these tasks to be considered, planned, and performed on an individual basis; therefore, it is necessary that they be combined, sequenced, and phased in the proper order if the overall task is to be accomplished in the most

efficient manner. The best possible use of allocated time, manpower, materials, and funds is mandatory if the maximum potential weapons system availability and utilization are to be realized.

Operating aircraft are subject to a variety of stresses, strains, vibrations, and environments. If not inspected regularly for all defects, the aircraft would soon become inoperable. The correcting of discrepancies and timely lubrication are performed in conjunction with inspections and enable the aircraft to be flown safely until the next inspection.

The most frequent types of inspections which are performed by activities responsible for the maintenance of naval aircraft are described in the following paragraphs.

Daily Inspection

Daily inspections are accomplished between the last flight of the day and the next scheduled flight, if no more than 72 hours elapse between the inspection and the next scheduled flight. If more than 72 hours elapse between the inspection and the next flight, the inspection must be repeated. This inspection is basically a combination of requirements for checking equipment that requires a daily verification of satisfactory functioning, plus requirements that prescribe searching for and correction of relatively minor problems to prevent their progress to a state that would require major work to remedy. Other items which require inspection at intervals more frequent than prescribed for calendar inspections are also included on the daily inspection and are accomplished along with the daily inspection on the day they become due.

Preflight Inspection

A preflight inspection is performed prior to each flight. This inspection consists of checking the aircraft for flight readiness by performing visual examinations and operational tests to discover defects and maladjustments that, if not corrected, would cause accidents or aborted missions. It also includes a check to determine that the aircraft has been properly serviced for the next flight.

Postflight Inspection

A postflight inspection is performed on aircraft at the termination of the flight. This inspection includes the following:

1. Inspecting critical areas of the aircraft for obvious damage.
2. Servicing the aircraft with fuel, oil, oxygen, etc., to help maintain the aircraft in a ready-for-flight condition.
3. Installing of safety devices such as ejection seats and canopy safety pins, landing gear safety pins, and jury struts to maintain the aircraft in a safe condition.
4. Securing the aircraft after the last flight of the day. This includes installing all protective covers and plugs such as intake and exhaust covers, refrigeration and pressurization plugs, pilot covers, static vent plugs, etc.

NOTE: This inspection is no longer accomplished except where locally authorized to satisfy specific requirements.

Calendar Inspection

The calendar inspection is a thorough and searching inspection of the aircraft. It consists of visual and operational checks of sufficient depth of uncover discrepancies or progressive deterioration within the aircraft that could affect safety of mission accomplishment. This type of inspection is divided into two categories—an ODD calendar and an EVEN calendar inspection—and consists of basic requirements plus additional items scheduled for compliance at less frequent intervals.

Most of the items to be inspected at less frequent intervals are divided evenly so that approximately half of the items are checked on the first (ODD) calendar inspection and the remainder are checked at the second (EVEN) inspection. Subsequent inspections repeat the same ODD-EVEN cycle.

Under this system, the appropriate inspection is conducted at the expiration of a specified number of calendar weeks. Figure 2-4 illustrates a squadron inspection interval.

The Calendar Inspection System is an efficient system from a maintenance management standpoint. When aircraft are inspected under this system, the workload planning operation is simplified and the schedule maintenance in process is automatically stabilized.

The first inspection interval subsequent to Navy acceptance of a new aircraft under this inspection system commences on the date or at the time of the acceptance test flight. The first calendar inspection is performed at the completion of this first interval with subsequent inspections performed in sequence as previously mentioned.

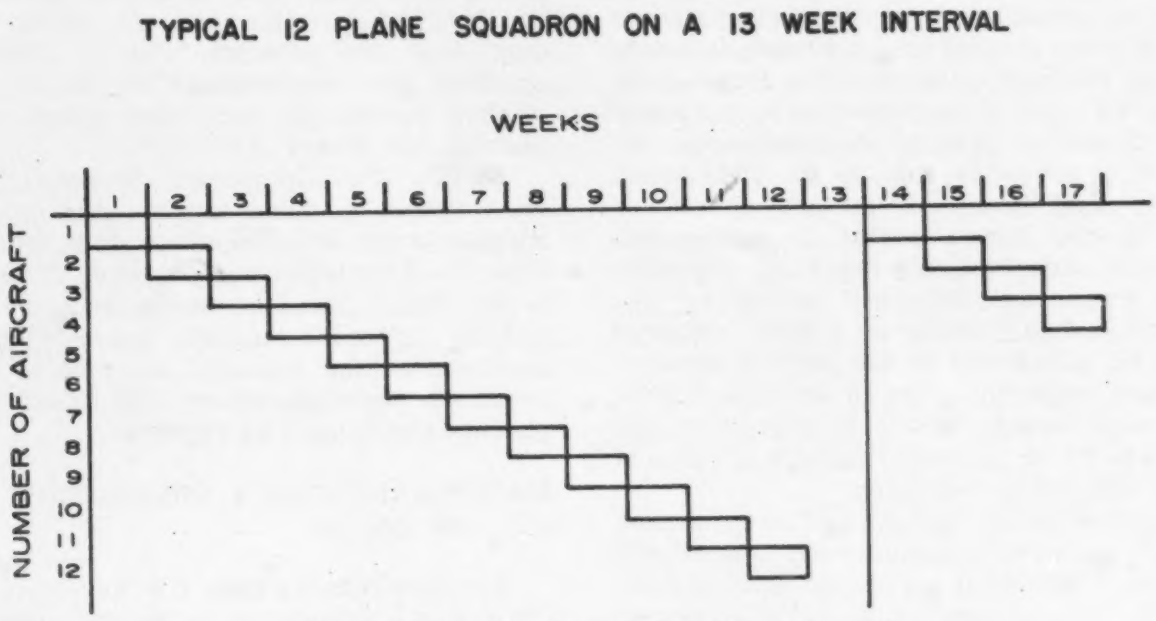

Figure 2-4.—Squadron inspection interval.

The first inspection interval subsequent to standard rework commences on the date entered in the Aircraft Logbook by the rework activity certifying accomplishment of the equivalent calendar inspection. The next calendar inspection due is performed at the completion of this first interval and subsequent inspections are in sequence.

During special rework, the rework activity accomplishes all inspections falling due while the aircraft is in custody of the rework activity. Calendar inspections subsequent to special rework, therefore, continue in sequence. All calendar inspections accomplished by rework activities are noted in the Aircraft Logbook and the Aeronautical Equipment Service Record.

CALENDAR INSPECTION PROCEDURES.—Aircraft are inspected on the calendar interval established by current NavAir Instructions or on an adjusted interval as specified by the controlling custodian. Normally, calendar inspections are programed in multiples of calendar weeks, computed from induction date to induction date, irrespective of days consumed performing the individual inspection. Therefore, an aircraft assigned a 17-week interval would be inducted into the next calendar inspection 17 weeks after the original induction day of the week.

The Calendar Inspection System is placed into operation by dividing the number of aircraft in the aircraft allowance into the calendar inspection interval (for example, 13, 17, 21, or 22 weeks) and programing scheduled maintenance inspection requirements accordingly. Activities responsible for the maintenance and upkeep of large numbers of aircraft group them into multiple units for programing purposes.

To meet unusual situations, a plus or minus 1 week, or portion thereof, may be applied to the authorized calendar inspection interval. To enable a ferry flight to the home ship or station after an away-from-home grounding discrepancy of such duration that the calendar interval expired, necessary additional days may be added. However, in each instance each deviation must be approved by the commanding officer or officer in charge, not delegated, and applies only to the immediate inspection due. If unusual circumstances dictate deviations of succeeding calendar inspections, each is computed from the date on which the inspection would have been due if the preceding deviation had not been granted.

To eliminate peaks and valleys in the workload, the overall pattern of inspections of all aircraft should be one of alternating odd calendars and even calendars. Induction of new and reworked aircraft into an established calendar inspection schedule may require repeating or performing an otherwise unnecessary inspection to insure that the scheduled workload pattern remains one of alternating types of inspections. Newly received aircraft are required to be firmly established in the calendar inspection schedule

within a period not to exceed one inspection interval.

Reporting custodians (operating activities) are authorized under current instructions to increase the depth of any inspection but not to decrease it. Whenever the depth of an inspection is increased to meet unusual or special circumstances, the inspection is recorded only as the type which was due in accordance with the programed sequence. Special inspections to an appropriate depth may be ordered by the reporting custodian whenever excessive utilization during the operating interval is considered to have impaired the material reliability or integrity of the aircraft. Such inspections are in addition to programed requirements and in no way affect the requirement for the accomplishment of the next regularly scheduled inspection.

Special inspections specified in the applicable PMRM are performed concurrently with scheduled calendar inspections when the time authorized for the special inspection is not exceeded. When the time interval will be exceeded during the calendar period inspection interval, the special inspection is accomplished as part of the scheduled daily inspection falling nearest to the requirement.

Scheduled replacement of components with stated operating limitations is normally accomplished during the calendar inspection falling nearest the hourly limitation. To facilitate maximum replacement in accordance with the foregoing, a plus or minus 10 percent of the stated operating time is permissible. When the hourly limitation plus or minus 10 percent does not coincide with a calendar inspection, the replacement is usually accomplished during the scheduled daily inspection nearest the hourly limitation.

NOTE: The Component Removal/Replacement Schedule, found in the applicable PMRM, contains a list of components which must be removed and replaced periodically. This section of the PMRM contains the nomenclature, part number or stock number, quantity, technical justification for removal, corrective action required, and replacement schedule of the components which must be replaced.

MAINTENANCE DATA COLLECTION SYSTEM (MDCS)

The Maintenance Data Collection System (MDCS) is a system for collecting, processing, and analyzing maintenance and material data and distributing information to line commanders and material commands to enable them to carry out management functions in support of the operating forces. This system is also referred to as the management system. The primary purpose of this system is to insure that basic data generated by maintenance personnel are recorded only once. This system provides information from the following categories: manhour

accounting, maintenance data reporting, and aircraft statistical data.

Manhour Accounting

The effective use of available manpower is an important function of maintenance management. Manhour accounting is an important part of the MDCS. The purpose of collecting manhour data is to provide management with essential information necessary to more efficiently plan and direct the distribution of assigned personnel.

The Manhour Accounting System is based upon the "exception" principle; that is, only the deviations or exceptions from normal are reported. Through the use of master rosters, electric accounting machine cards, and machine processed reports, the system provides summaries of the hours expended by maintenance personnel during the normal working day or in an overtime status. Basically, the system is designed so that the normal working hours for each person assigned to the maintenance activity are allotted or assigned to work centers by types of labor at the beginning of each reporting period. Exceptions from these normal working hours, or labor types, are reported by use of Manhour Accounting Cards. Data processing machines add or subtract the exceptions reported on the Manhour Accounting Cards from the initial manhour allotment. These exceptions and the working hours allotted at the beginning of the period serve as the basis for the daily and monthly manhour accounting reports mentioned in the foregoing. These reports are forwarded to the maintenance officers and supervisors for validation and utilization. Each supervisor and worker must thoroughly understand the importance of the system, its operation, and the need for continual accuracy.

At the beginning of each reporting period, generally the first of the calendar month, manhours are assigned to every work center to which personnel are assigned. These manhours are based on an 8-hour workday 5 days per week for every person assigned. Not included in these "original assigned manhours" are any hours for work on Saturdays, Sundays, or holidays during the month. If every person assigned to the work center could be continuously employed throughout the month during all the time available for work, there would be no need for manhour reporting, as the time would be accounted for on the various maintenance data collection forms. Since continuous employment is not possible, each worker must report what he did when he was not working during any period in excess of 20 minutes, or approximately three-tenths of an hour.

Maintenance Data Reporting

This category of data embraces the widest range and most complex types of information involved in the Aviation 3-M System. The scope of the data collected is indicated by the descriptive titles of the data collection forms which are used. These data collection forms are commonly called "source documents." These source documents include the Support Action Form (SAF), Maintenance Action Form (MAF) (single and multicopy), Technical Directives Compliance Form (TDCF), and Configuration Control Form (CCF).

Most of these source documents are originated and completed by the production divisions; however, maintenance control personnel assist in the preparation of some of them.

The Maintenance Data Reporting (MDR) system is designed so that each worker, when accomplishing a job, converts a narrative description of the job into codes and enters the coded information on standard source documents. These source documents are collected and forwarded to the data services activity where the information is transferred onto Electric Accounting Machine (EAM) cards. Data services then uses these EAM cards to produce periodic machine reports listing and summarizing the submitted data. These reports are supplied to maintenance supervisors to provide assistance in planning and directing the maintenance effort. In addition, the information on the EAM cards is forwarded to the Central Data Processing Facility which provides data to satisfy the management requirements of type commanders, system commands, and other managers.

The MDR system provides a valuable tool for use by maintenance managers. It was not designed to replace management or supervision. It was designed to assist management, and to achieve this purpose requires strict attention from the worker to the commanding officer. As with the entire MDCS, the key to an effective MDR system is the work center supervisor. This supervisor must understand the system, the proper procedures for using the source documents and registers, and the information he collects from the machine reports. He must assure complete

and accurate documentation and also insure that assigned personnel have received proper training and motivation. It is well to remember that a product from MDR is only as good as the input information, and the input is used to provide management products for the highest levels of Navy Management.

Aircraft Statistical Data

Management control of an operating unit is furnished inventory, flight, and readiness information by this system. Selected information for each aircraft in the inventory of a reporting custodian is prepared and forwarded to Data Services, and this information is used to establish an accurate master file of inventory data within the local Data Services activity. When the master file is established, it is kept current by the submission of Equipment Statistical Data (ESD) Cards, which are the source documents for this system. Figure 2-5 illustrates the Equipment Statistical Data Card reporting flight data. An ESD card is utilized to report inventory information when an aircraft is gained or lost and when there is a change in the reporting status of the aircraft.

Data Services provides various reports containing inventory, readiness, and flight data. Compilation of selected elements or data in a specified format will aid in the preparation of maintenance information and will allow similar type organizations to compare statistics and equipment.

The following paragraphs provide the description of the report to be made.

The Aircraft Master List, ASD-00, is a monthly report reflecting the true inventory condition of assigned aircraft as of 0001 hours the first day of each month. The report lists the permanent unit code, type equipment code, and the assigned aircraft hours for the appropriate NOR (Not Operationally Ready) reporting status for each aircraft. This report provides a means of verifying and/or correcting data contained in the local inventory data bank.

The report is checked for accuracy and completeness using local records of aircraft inventory change transactions which occurred during the previous month. Erroneous or incomplete data should be corrected and the local inventory data bank corrected in accordance with locally established procedures.

The Daily Flight Report, ASD-1, is a detailed listing of all aircraft flight data submitted on ESD cards during the previous working day. The report may contain data for more than 1 day due to extended flights or flights on weekends or holidays. It indicates flight data collected during shipboard operations and shows landing data, departure and arrival times, date, and the duration and purpose of each flight conducted by each aircraft.

This report provides a means of verifying and correcting information in Data Services files. It also provides maintenance managers with a means of monitoring aircraft utilization on a daily

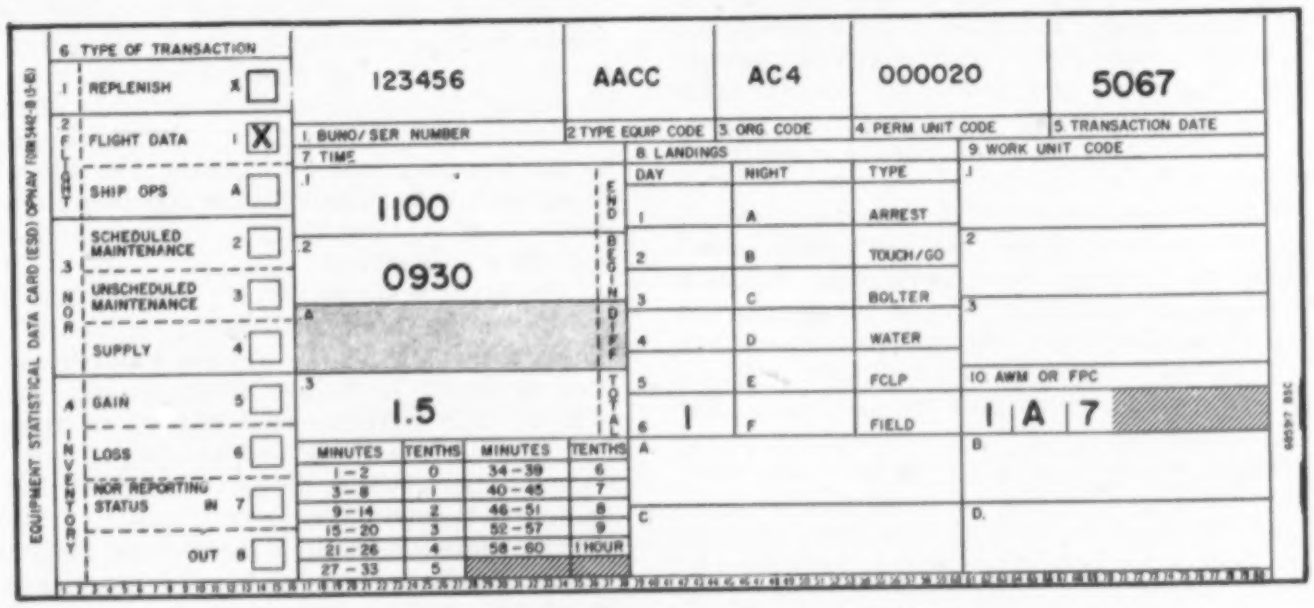

Figure 2-5.—ESD Card (flight data).

basis and can be used as a measure of accomplishment of the previous day's schedule. The report is checked daily for accuracy and completeness by maintenance control personnel. Erroneous entries should be lined out and the correct data inserted, in red, directly above the lined out entry. After correction the report is forwarded to the Data Services activity.

The Daily Aircraft Readiness Report, ASD-2, is a detailed listing of all aircraft NOR and inventory data submitted on ESD cards during the previous working day. Like the ASD-1, it may contain data for more than 1 day. The ASD-2 shows not ready conditions and inventory changes by bureau number. When an aircraft is reported as NOR more than once during the same day, the data for this aircraft is listed in the order the NOR times began.

This report provides a means of verifying and correcting information in Data Services files. It also provides maintenance managers with a means of monitoring operational readiness on a daily basis.

Maintenance managers use this report to identify specific problem areas that degrade the overall readiness condition. The nature of the problem areas identified may determine what action is necessary to improve readiness. Further, this report provides the means of identifying specific aircraft that detract from overall readiness, measuring the impact of scheduled maintenance, unscheduled maintenance, and supply support on readiness, identifying potential ready hours lost to the awaiting maintenance category, identifying systems or components that contribute to NOR conditions, and computing cumulative readiness rates. The report is checked daily for accuracy and completeness, and any erroneous data corrected in the same manner as the ASD-1.

The Monthly Aircraft Readiness and Flight Report, ASD-3, is a summary of all flight and NOR ESD cards submitted during the reporting period. It shows a summation, by bureau number and type equipment, of hours assigned "IN" or "OUT" of a NOR reporting status, NOR hours by category, total flights and flight hours, and flights and flight hours during shipboard operations.

The report aids maintenance managers in their efforts to maintain optimum aircraft readiness and utilization. The format used lends itself to quick analysis of factors that affect aircraft readiness and utilization. This report provides a means to identify the operationally ready rate, not ready hours by reason, awaiting maintenance hours, aircraft lost to an "OUT" of a NOR reporting status, aircraft that continually account for a large portion of NOR hours, the hours flown by each aircraft, the average flight duration, and flights and hours accumulated during shipboard operations.

NOTE: An aircraft is "IN" a NOR reporting status when the status code of the aircraft is A1 through A8, AJ, and AK; B1 through B8, BJ, and BK; and C1 through C8, CJ, and CK, Not Operationally Ready reporting is required only on aircraft "IN" a NOR reporting status. An aircraft is "OUT" of NOR reporting status when the status code of the aircraft is other than listed above. Aircraft are not reported as NOR when "OUT" of a NOR reporting status.

In addition to these standard reports, Reporting Custodians may request special reports from data services. It should be remembered that any information known to exist in ASD files can be obtained in the form of special reports. However, if the information desired is already available in another report, a special report should not be requested. Special reports should not be used indiscriminately because of the additional, and often excessive workload imposed on Data Services personnel and machines.

MAINTENANCE FORMS AND RECORDS

Effective accomplishment of aircraft maintenance requires thorough familiarity with numerous maintenance forms and records. Some of these are discussed in other chapters of this text. Those discussed in the following paragraphs are aircraft status boards and test flight forms used in postmaintenance flight tests.

AIRCRAFT STATUS BOARD

This board is maintained to provide a visual presentation of current status information on all aircraft assigned to an activity. The aircraft status board, such as the one depicted in figure 2-6, should be of suitable size and material to display sufficient information so that interested personnel can quickly ascertain the essential facts.

The size and location of the board will vary with the employment and operating conditions of the particular activity; however, it remains the responsibility of the maintenance control office to maintain the board in a current and up to date status. Additional columns and subcolumns for

AIRCRAFT STATUS BOARD (Sample)

SQUAD. NO.	MODEL	BUNO	UP or DOWN	STATUS CODE	ENGINE HOURS (since overhaul)	ENGINE HOURS (since check)	A/C HOURS (since check)	NEXT PERIODIC INSPECTION		MONTHS IN SERVICE	REMARKS
								TYPE INSPECTION	DUE DATE		
LN-1	P3A	151351	↑	A1	250.6	8.3	8.3	088	1MAR	3	SAR STBY

HELICOPTER STATUS BOARD (Sample)

NEXT CALENDAR INSP. DUE (DATE AND TYPE)	STATUS	TIME THIS MONTH	NEXT CHECK DUE (TYPE)	TIME SINCE CHECK	IN COMM	OUT COMM	MONTHS IN TOUR	BUNO	SQUADRON NUMBER	CREW CHIEF	TIME THIS TOUR	FAN	CLUTCH	LFT LATERAL	RT LATERAL	FORE & AFT	MAIN SERVOS	TAIL ROTOR	BLACK	BLUE	YELLOW	RED	ROTOR BLADES	ROTOR HUB	AFT	MID	MAIN	TRANS-MISSION	ENGINE
3 Tour Extn	UP	3.7	NA	NA	✓		13	123456	HL3	DME	520	50	37	28	25	38	840	24	840	42	48	33	840	480	800	720	480	480	600

Figure 2-6.—Aircraft status boards.

rapid reference may be employed to indicate the status of selected components and functional systems as well as replacement times or dates on selected items. When items which have established replacement intervals are selected for the status board, the time at which replacement is required can be effectively displayed by entering in the component column the replacement interval (or the time remaining on the item) plus the aircraft or engine time when the item was installed. Thus, replacement is required when the aircraft or engine time equals the time entered in the component column. For a more effective display, the figure in the component column may be entered in red as the replacement time or date approaches.

POSTMAINTENANCE FLIGHT TESTS

The control and accomplishment of test flights may be a necessary and integral part of a maintenance process. Test flights are those flights performed to determine if the airframe, powerplant, accessories, and items of equipage are functioning in accordance with predetermined requirements while subjected to the intended operating environment. Such flights are conducted when it is not feasible or possible to determine safe and/or required functioning by means of ground or shop tests. (Refer to NavAir Instruction 4700.2 (latest series) for a listing of conditions that require flight tests.)

LOGS AND RECORDS

All activities which have reporting custody of Navy or Marine Corps aircraft have the responsibility to maintain the Aircraft Logbook and associated records for their assigned aircraft in a proper and up-to-date status.

The actual responsibility for the maintenance of the Aircraft Logbook and its associated records have been recently assigned to the Aviation Maintenance Administrationman (AZ) rating. However, since the technician must supply information for many of the entries which are made in the Aircraft Logbook, it is necessary that he be familiar with it.

AIRCRAFT LOGBOOK

The Aircraft Logbook is the record in which all data concerning the aircraft are posted. Information gathered in this log is used to determine the aircraft condition for planning its rework. Accident investigating boards determine

the compliance with directives from it. It reflects a history of all significant events occurring to the airframs, its components, and accessories. It is a legal document of investigations.

NOTE: The Aircraft Logbook has recently been revised and the NavWeps 13090 forms are being replaced by NavAir Forms. Some of the old forms will continue to be used until present stocks are depleted.

The Aircraft Logbook is a hard cover, looseleaf ring binder containing separators and page insert forms. Each separator and page insert is identified by individual slash numbers.

AERONAUTICAL EQUIPMENT SERVICE RECORD

The Aeronautical Equipment Service Record is a nine-part looseleaf log contained within a separate cover and punched for insertion in the Aircraft Logbook ring binder. This record is prescribed for use with aircraft powerplants, propellers, and airborne auxiliary powerplants. When used as a propeller log, it is prepared using the propeller hub as the basic equipment and must accompany the hub throughout its service life.

The Aeronautical Equipment Service Record is initiated by the activity originally accepting the equipment for the Navy. This record is subsequently maintained by the activity having custody of the equipment. Maintenance of this record is similar to that required for the Aircraft Logbook. Although the record is maintained in the Maintenance Control Office, much of the information that must be incorporated comes from the individual shops. General familiarity with the contents of the log and the record by chief and first class petty officers in all aviation ratings is a valuable aid in the development of the spirit of cooperation so vital to the overall maintenance effort.

The Aeronautical Equipment Service Record consists of the following:

1. The cover (NavAir Form 13090/20).

2. Part I - Guarantee Information and Basic Information (NavWeps Form 13090/21A). This part contains information similar to that contained in the first two sections of the Aircraft Logbook.

3. Part II - Custody and Transfer Record.

4. Part III - Equipment Operating Log. This form is generally self-explanatory; however, a few remarks may be helpful as an aid in preparation and maintenance. For instance it should be remembered that "Military" time refers to reciprocating engines and "Afterburner" time refers to gas turbine engines. The form provides for logging of equipment operating time on a preflight, daily, weekly, or monthly basis except that ferry and test flight times are logged separately. This form provides an additional column without a heading which may be used for logging any special information.

Part IV - Inspection Record. The discussion of this form in the section on Aircraft Logbooks also applies to the preparation and maintenance of the form when used as Part IV of the Aeronautical Equipment Service Record.

6. Part V - Record of Rework. This is also a dual usage form and is to be maintained in accordance with those instructions which apply to the Aircraft Logbook.

7. Part VI - Technical Directives. The recording of technical directives in the Aeronautical Equipment Service Record is largely limited to "bulletin" type publications. Separate pages are used for each type directive and all applicable directives are recorded.

8. Part VII - Preservation- Depreservation Record. This part of the Aeronautical Equipment Service Record is another of the forms that is also used in the Aircraft Logbook. The purpose and the maintenance of this form when used as part of this record are basically the same as for the Aircraft Logbook.

9. Part VIII - Miscellaneous. Part VIII is used in the Aeronautical Equipment Service Record for recording pertinent information for which no other place has been provided. Such information includes special test data, abnormal characteristics of equipment, significant damage and/or repair, and authorization for extension of operating intervals.

10. Part IX - Replacement of Assemblies, Accessories, and Major Components. Part IX is another of the forms that is also used in the Aircraft Logbook. This part of the record is screened for information and discarded at time of rework, and a new Part IX is initiated.

AIRCRAFT INVENTORY

In order to maintain an unbroken chain of custodial responsibility incident to the transfer and acceptance of naval aircraft, the Standard

Inventory Log was developed to be used as an instrument of transfer. In the interest of standardization among the Armed Services, the Aircraft Inventory Record has been designed by the Department of Defense for this purpose. Records are being prepared, instead of Logs, for future new production aircraft.

With remote exceptions, no aircraft may now be transferred or accepted without an Inventory Log or Record. On these occasions an inventory of the aircraft and its equipment must be accomplished, based on the items of equipment and material contained in the applicable Log or Record.

Although the Log and Record serve the same purpose, there are some minor differences in their format and categorical listings. In general, the determination as to whether items are, or are not, subject to listing in these publications without regard as to whether they are Contractor or Government furnished and Contractor or Service installed, is governed by the following:

1. Items essential to the execution of the designated missions of the aircraft, such as armament, electronics, photographic equipment (excluding cameras other than for primary missions), and special instruments, are included.

2. Items of equipment which are rigidly fixed and considered to be a basic or integral part of the airframe, such as engines, propellers, wheels, tires, and brakes, are excluded. In the case of the Aircraft Inventory Record, standard instruments are also excluded.

3. Special equipment items essential to the safety or comfort of the crew, such as bedding, life rafts, Thermos bottles, crash axes, and portable fire extinguishers, are included. Comparable items which are personal issue or furnished on squadron allowances are excluded.

4. Loose equipment delivered with the aircraft, such as covers, mooring kits, and jack pads, for which stowage provisions have been incorporated in the aircraft, are included.

5. Items subject to pilferage or readily convertible to personal use, such as clocks, Thermos jugs or bottles, bedding, and first aid kits, are included. Comparable items which are personal issue or furnished on squadron allowances are excluded.

The Standard Inventory Log is subdivided into groups of equipment (e. g., instrument and navigation equipment, armament equipment, and electronic equipment). The components are listed in alphabetical sequence and according to their location in the aircraft, with the exception of the electronics equipment, in which case all components of an equipment are listed in one place regardless of their location in the aircraft. Stock numbers are also supplied for individual items, and are used for ready reference when replacements are required.

The Aircraft Inventory Record includes a sectional breakdown diagram of the applicable aircraft. This diagram consists of a side elevation and/or the plan view of a wing, or in the case of twin-boomed or flying wing aircraft, the perspective view.

To facilitate inventorying, the sections of the diagram are identified by letters, the letter "A" being assigned to the foremost section, "B" to the next, and so on, generally to the rear of the aircraft. The letter "R," as part of the item number, denotes items mounted on the exterior of the fuselage, and the letter "F" denotes items to which access is gained from the fuselage. Subdivisions of sections may be identified by a lowercase letter, such as "Aa," "Ac," etc.

The equipment list portion of the Record is divided into sections, each of which lists the items pertaining to a particular section of the aircraft, as indicated on the sectional breakdown diagram. Within each section, individual items are numbered as nearly as possible in the sequence of their physical location in the aircraft without regard to their relation to specific equipment. Stock numbers are not supplied as part of the equipment listing in Inventory Records.

One Standard Inventory Log in general is issued as applicable to one aircraft model and designates material and equipment peculiar among the various applicable versions and bureau numbers. The Aircraft Inventory Record is issued as applicable to one aircraft for a specific bureau number.

Blank columns are provided on the inventory pages of the Log and Record, in order that transferring and receiving activities may jointly inventory and indicate the quantity of each item ascertained to be on board the aircraft at the time of transfer. A "Receipt Endorsement Log" in the Standard Inventory Log and a "Certificate and Record of Transfer" in the Aircraft Inventory Record are provided so that transferring and receiving activities may sign, indicating by column applicability, the items on board the aircraft.

Upon the transfer of an aircraft, representatives from the transferring and receiving activities jointly inventory and record, in the appropriate column, the quantity of each item which

is ascertained to be on board the aircraft at the time of transfer. When a ferry pilot or a naval vessel is involved in the transfer, two inventories are made, one prior to the ferry flight or embarkation, and one upon completion. In the former instance the ferry pilot or vessel is to be considered the receiving activity, and in the latter instance the transferring activity.

A Report of Inventory Form supplied with the Standard Inventory Log, or the Shortages Form (DD 780-2) in the Aircraft Inventory Record, is generally prepared in triplicate, listing missing items with appropriate remarks. The original signed copy of the form is retained by the transferring activity and filed as a permanent record of transfer.

The second copy of the form is left in the Standard Inventory Log or Aircraft Inventory Record, as the case may be, and delivered along with the Log or Record to the activity receiving the aircraft.

A third copy of the report or shortages form is forwarded to the cognizant major operating command of the transferring activity for information and any appropriate action deemed necessary.

In the case of missing items, the transferring activity makes every effort to locate the missing items or to withdraw from store the replacement items necessary to complete the inventory. If it is impossible to locate or supply the missing items, the notation "Missing items are not available" is placed in the Report of Inventory Form in the Standard Inventory Log or the Shortages Form in the Aircraft Inventory Record. An explanatory statement signed by the transferring representative is placed within this form, indicating the authority for these shortages. On the basis of this statement, the receiving activity may fill the shortages from stock and account for them in the normal manner.

When an aircraft is abandoned or disposed of by scrapping, the inventory log or record may be destroyed by the activity disposing of the aircraft. When the aircraft is transferred to other U. S. agencies, the log or record is transferred also. When sold to a private party, the inventory log or record is forwarded to the Naval Air Systems Command immediately after consummation of the sale and should include the signatures of the last custodian (seller) and the purchaser. In order to provide the buyer with inventory information, the log or record may be duplicated, provided that it includes no classified information.

CHAPTER 3

TECHNICAL DRAWINGS AND PUBLICATIONS

DRAWINGS AND SCHEMATICS

As a senior AT, you will find a twofold use for your ability to properly interpret schematics and drawings. The need to interpret drawings and schematics will continue to be a part of accomplishing your maintenance tasks. In addition you will be required to assist the less experienced men in interpreting schematics. Often when working with the less experienced men, the need for simplified versions of these schematics and drawings will arise.

INTERPRETATIONS

Instruction manuals used by the AT may contain diagrams of various types; among these are schematic diagrams, block diagrams, wiring diagrams, interconnecting cable diagrams, mechanical drawings, and combinations of some of these types. These diagrams are normally used to present a great deal of information in a small space or to clarify complex and detailed written explanations. Your ability to correctly interpret these diagrams will, to some extent, determine the level of technical knowledge and understanding you can achieve.

Schematics

Electrical and electronic schematics will comprise a large portion of the diagrams the technician uses. Symbols are the building blocks of the schematic. The technician should be familiar with the basic symbols from past experience. The increasing use of semiconductors has added new symbols, and future developments will undoubtedly add more. A study of new symbols and a review of the older standard symbols should be helpful to the AT. A list of standard symbols can be found in Military Standard Graphical Symbols for Electrical and Electronic Diagrams, MIL-STD-15-1.

Another basic consideration in schematic interpretation is recognizing specific type circuits. Here again it may be advisable for the AT to review the basic circuits using electron tubes, semiconductors, or the two in combination. The basic training courses (Basic Electricity, NavPers 10086-A, and Basic Electronics, NavPers 10087-B offer one source of review material for these circuits. In addition, two manuals showing preferred military circuits are listed later in this chapter under miscellaneous publications.

Drawings

Included in the drawings used by the AT are block diagrams, signal flow charts, wiring diagrams, and mechanical drawings. As with schematics, the technician will be familiar with some of these drawings from past experience. The use of block diagrams and signal flow charts to present the overall picture of equipment function is widespread. Although these do not contain the details so often needed in accomplishing your maintenance tasks, they are of great value in fulfilling your training responsibilities and in providing overall continuity when working with partial schematics.

Wiring diagrams, especially in some modern aircraft and equipments, have become quite complex. With the emphasis now placed on integrated electronic systems, a review of wire and cable identification markings and symbols used to show the interconnection of units should be useful to most technicians.

The use of mechanical drawings and the inclusion of mechanical functions on electronic diagrams is increasing. This is due, in part, to the increased use of computers and automatic devices (electronically controlled and mechanically operated).

The technician must understand mechanical symbols and basic mechanical principles in

order to correctly interpret these drawings. The basic training courses comprise a source of some useful information in this field.

MAKING SIMPLIFIED VERSIONS

Making simplified versions of drawings is not as new to the AT as some may think. Each time you have drawn a circuit to explain a point about a large schematic, you were in fact making a simplified version of the schematic. The technician may make simplified versions of drawings for various reasons: to explain a portion of the drawing while working with someone; in connection with the formal training program; or quite often as a means of better understanding a complicated drawing himself.

When making a simplified version of a drawing, use standard symbols, especially in drawings used for training.

There are many possible ways to simplify a drawing. The AT must determine why the diagram needs simplification; this reason may indicate how to go about making the simplified version.

Section IV of the Service Instruction Manual for each electronic equipment contains schematics of circuits or sections of the equipment. These are simplified versions of parts of overall schematics which have been redrawn in order to group components of a particular circuit or circuits to facilitate understanding. While simplification is usually thought of as reducing the whole into parts, there are cases where combining drawings makes them more easily understood. In working with inexperienced men it may be necessary to redraw a circuit to more closely resemble the basic circuit of this type.

PUBLICATIONS INDEX

The publications index, as discussed in this section, is composed of the following separate lists and indexes: Navy Stock List of Forms and Publications, NavSup 2002, Section VIII, Parts C and D; and Naval Aeronautic Publications Index, NavAir 00-500A, B, and C. These lists and indexes will provide the AT with a listing of all available aeronautical publications distributed by Naval Air Systems Command. Within the different sections of the index, the AT will find numerical listings as well as cross-reference indexes. Supplements are published to keep the index current.

NAVSUP 2002, SECTION VIII, PARTS C AND D

Part C of this stock list contains a numerical listing, by code number, of available aeronautic technical manual type publications. In addition to the code number, the publication title, security classification, and date of issue or date of latest revision are given. The instructions for using the stock list include an explanation of the code number system used to identify the manuals by subject group. Also included in this section is information on ordering and methods of procurement of publications. Another section of the stock list is devoted to a cross-reference index of Air Force, NavShips, and NavOrd publication numbers to the NavWeps publication numbers.

Part D of the stock list contains a listing of the letter type technical directives. These are grouped by subject matter and, in addition to the same information that is listed for manuals in part C, an effective date is included if applicable.

All titles of publications listed in these stock lists are unclassified unless marked "1" (Confidential) in the column headed SC (security classification). However, this marking is not classification authority. The bimonthly supplement contains information pertaining to changes in classification action on a when occuring basis. This supplement, in itself, is authority for making classification changes on NavWeps publications.

Parts C and D are distributed semiannually—in September and March. A supplement to these stock lists is issued bimonthly. This supplement is cumulative, so the preceding supplements may be destroyed upon receipt of the latest issue. Included in the supplements are lists of new manuals and letter type publications, lists of canceled publications, lists of interim revisions issued, and special notices and corrections to the basic stock list.

NAVAIR 00-500A

Naval Aeronautic Publications Index, NavAir 00-500A, Equipment Applicability List, contains a listing of aircraft components and related equipment (by model, type, and part number) in alphabetical and numerical sequence, with the applicable publications shown in appropriate columns. This index includes both manual type publications and letter type technical directives.

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the index includes an explanation of the numbering and grouping system used for both types of publications.

The equipment applicability list is issued twice annually—in March and September. Monthly cumulative supplements are issued to provide a listing of new publications distributed during the interval between reissues of the index.

NAVAIR 00-500B

Naval Aeronautic Publications Index, NavAir 00-500B, Aircraft Application List, contains a listing of aeronautic technical publications with respect to their applicability to a specific aircraft. For example, under the heading S-2D every manual type publication pertaining to the aircraft or any piece of equipment installed in the aircraft is listed numerically.

NavAir 00-500B does not list any letter publications. It lists technical manuals dealing with electronics, armament, instruments, accessories, powerplants, aircraft, and certain general publications. The manuals listed in this index are identified by publication code number only. For titles or other information on special publications, refer to NavSup 2002, Section VIII, Part C.

NavAir 00-500B is also issued and distributed twice annually—in March and September.

NAVAIR 00-500C

NavAir 00-500C, Directive Application List by Aircraft Configuration, contains a listing of the active BuWeps Technical Directives with respect to their applicability to an aircraft.

NavAir 00-500C is published twice annually, in January and July. No supplements are issued to this publication.

USE OF PUBLICATIONS

As a first class or chief, your responsibilities in connection with installing, adjusting, maintaining, and testing electronic equipment will be much greater than they were when you were a lower rated petty officer. You will be required to have quick and accurate answers to many questions. Since there is a wide variety of complex equipment, you cannot expect to have a ready answer to all questions. However, you will become familiar with the published materials that contain the answers, and by so doing you will be able to take positive action.

MAINTENANCE INSTRUCTIONS MANUAL

A Maintenance Instructions Manual is distributed for each type of aircraft. Recent manuals are issued with the sections as separate volumes to facilitate the use of the manual by the different shops. The sections concerning electric and electronic systems maintenance and wiring data are of prime interest to the AT.

Location of components and instructions for removal and installation are included in the manual. The wiring diagrams, power distribution charts, and drawings showing the location and connection of fuses and circuit breakers are valuable to the technician while troubleshooting in the aircraft.

Information on electronic equipment maintenance is also included. The amount of this information or the depth of maintenance discussed will vary from one manual to another and also between equipments within a given manual. Included in some manuals for organizational maintenance are operational and functional checks, trouble isolation charts, and adjustment charts. The intermediate maintenance section may contain information for bench checks, troubleshooting, disassembly, repair and parts replacement, and assembly instructions. If special support equipment is needed to accomplish the maintenance described, a section on use and maintenance of this support equipment may be found in the volume on electronic maintenance. These manuals, when used in conjunction with the Service Instruction Manual for the electronic equipment, furnish the technician with information needed to properly maintain the equipment.

OPERATION AND SERVICE INSTRUCTION MANUALS

The Naval Air Systems Command procures Operation and Service Instruction Manuals for various avionics equipments. The Operation and Service Instruction Manuals may be issued as one combined manual or as separate manuals. In some cases, where the equipment is installed in only one aircraft, the Maintenance Instructions Manual for that aircraft will contain the information normally found in the Operation and Service Instruction Manual.

Aviation Electronics Technician 3 & 2, NavPers 10317-C, lists the subject content of each

section of this manual. The discussion in this course will be limited to a few of the items contained in the manual.

Performance Specifications

As a senior AT, your responsibilities for inspecting the work of others will increase. The Operation and Service Instruction Manual contains charts or sections on standards the equipment should meet if it is to be considered as performing satisfactorily. The use of this information to determine the quality of your own work or the work of some other AT is recommended. The preflight checks given in the manual usually give only an indication of overall system operation and do not indicate how much above minimum standards each section is operating. There are some equipments that utilize line testers for this check; line testers quite frequently are of the GO, NO-GO type. This is the most basic of the performance standards the equipment must meet.

The preliminary or preinstallation inspection is normally a bench test procedure for equipment received from the supply system or from an intermediate maintenance activity. Normally, this is also a check for overall operation of the equipment and is not designed to check the equipment for specific circuit performance.

The portion of the manual that gives the performance standards for the individual sections of the equipment is titled "Minimum Performance Checks" or "Specifications." These standards are shop procedures used to check the individual sections of the equipment against the acceptable performance levels. In addition to listing the minimum acceptable performance levels, this section gives procedures for setting up the equipment for test, the test equipment to use, and the adjustments required to bring the equipment up to standard.

The specific checks given will vary with the type of equipment—communications, navigation, or radar. Some checks of the type found in this category are as follows:

1. Receiver sensitivity.
2. Transmitter power output.
3. Signal-to-noise ratio.
4. Bearing or range accuracy check.
5. Receiver recovery time.
6. Frequency tolerance.

Where the equipment fails to meet minimum performance standards, a malfunction is indicated. Trouble analysis charts and alinement procedures are included in the manual to assist the technician in locating and correcting the malfunction.

Adjustments

The Operation and Service Instruction Manual contains charts and instructions for adjusting the equipment. One of these charts will be found in the organizational maintenance section of the manual. The information given will concern minor repairs and adjustments.

The adjustments given in the field maintenance section are more extensive than those in the section on organizational maintenance. Normally included in this section are the complete alinement procedures for each section of the equipment. The instructions include the step by step procedures and give the test equipment setup required.

Special Tools

The Operational and Service Instruction Manual furnishes a list of special tools required for maintaining the specific equipment. The technician should check the applicable allowance list to determine whether the tools are available to his unit as organizational property or if it will be necessary to procure them on custody from the supporting activity.

FILING AND MAINTAINING PUBLICATIONS

A steady stream of technical correspondence, directives, and publications is received by the Avionics Division. A system for filing this paperwork and disseminating the useful information must be established if full value of these sources is to be realized. In order for the information to be of value to the division, it must be brought to the attention of the people in the shop. A routing system within the shop will provide for the dissemination of the information to all personnel concerned.

There is a great deal of technical information received concerning the many pieces of equipment. The file location of this information must be known and accessible, so that the individual assigned to repair or test the equipment will have all the necessary information available.

The avionics shop should establish and maintain a technical library. The shop's technical

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library should consist primarily of a complete and current set of letter publications and technical manuals which are pertinent to equipments and aircraft serviced by the shop. In addition, it should contain a file of the Digest of U.S. Naval Aviation Electronics, NavAir 08-1-503, and other material of informative or training nature.

The technical library should be kept in an orderly fashion, and its facilities made readily available to all personnel. General and little used material should be filed in the division or shop office, and the manuals should be filed in the shop.

For larger activities, or those where many people utilize the same technical library, it is imperative that a checkout system be instituted for certain publications. This system will enable an interested individual to locate needed publications on board and will also aid in maintaining a complete and current library.

A custody card or logbook system can be developed at the discretion of the Avionics Officer. Regardless of which system is chosen, it should provide information regarding the home unit of the borrower, the date and time of loan, and the security classification of the publication.

Maintaining the manuals in good condition and up to date is very important. If the manuals are abused or mishandled, it is easy to lose pages or otherwise decrease the usefulness of the available information. All revisions should be incorporated as soon as received in order to keep the information correct and current.

MISCELLANEOUS PUBLICATIONS

There are a great number of technical publications, other than the maintenance and service instructions, that the AT will find useful in performing his job. This section lists and describes briefly a few of these publications. By including this type of publication in the shop technical library, the supervisor will be providing information that should increase the efficiency of the shop.

Handbook of Installation Practices for Aircraft Electrical and Electronic Wiring, NavWeps 01-1A-505

This manual was written for the following purposes:

1. To bring together under one cover the recommended practices and techniques to be used for installing, repairing, and maintaining aircraft electric wiring.
2. To standardize these techniques and methods so that electrical/electronic installations are performed in a uniform manner.
3. To indoctrinate all personnel with the importance of good workmanship.
4. To point up the failures which may result from poor workmanship.
5. To promote safety by pointing out and prohibiting unsafe practices.

The information contained in the manual represents the best current knowledge and practice in the avionics field. It has been compiled with the cooperation and assistance of leading airframe manufacturers, airline operators, and military overhaul and repair bases. Many of the illustrations have been provided by the manufactures of electrical accessories used in aircraft.

The following topics are covered:

1. Wire and cable preparation.
2. General purpose connectors.
3. RF connectors and cabling.
4. Solderless terminations and splicings.
5. Thermocouple wire soldering and installation.
6. Bonding and grounding.
7. Bus bar preparation.
8. Conduit fabrication.
9. Installation of bus bars, conduit, junction boxes, protective devices, and terminal strips.
10. Electrical wiring installation.
11. Lacing and typing.
12. Safety wiring.
13. Emergency repairs.

This manual can be of much assistance to the leading petty officers because it contains the answers to many questions. Also, it is an excellent teaching aid in carrying out your on-the-job training duties.

Reduction of Radio Interference in Aircraft, NavAer 16-1-521

The purpose of this manual is to present information which will serve as a guide to the aviation industry and to naval aircraft maintenance activities for reduction of radio interference in naval aircraft. It may be used as a guide to enable you to determine the type of interference, to locate its source, and to provide a means for its elimination or suppression.

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The information is presented under the following headings:

1. Purpose.
2. Types and effects of radio interference.
3. Sources of radio interference.
4. Interference coupling.
5. Basic installation planning for radio interference control.
6. Radio interference reduction components; their selection, application, and installation.
7. Bonds and bonding.
8. Shields and shielding.
9. Testing for radio interference.
10. Maintenance aspects of radio interference.

Handbook of Test Methods and Practices, NavShips 900, 000. 103

This manual is written to meet the technician's need for convenient reference on the fundamentals of testing electronic equipment. The wide scope of information, covering both theory and practice, makes the manual equally valuable for the beginning technician and the technician who has much experience. The manual has been reviewed by technicians in shops and in schools in order to make it as effective as possible. It is presented in five sections as follows:

Section 1, Testing in General, discusses the importance and functional divisions of testing, along with some associated testing information, and explains the need for various types of measurements and tests.

Section 2, Test Equipment and Measurements, provides the technician with a background in test equipment circuit theory. With this background he will be better able to select the most suitable test equipment for a particular job and to interpret correctly the data received. In addition he will be qualified in the use of both general and specialized test equipment. All of these abilities are important requirements for efficient performance testing and troubleshooting.

Section 3, Testing Techniques and Practices, covers in detail the specific procedures used in testing equipments. In this section the selection of test points, the correct interpretation of tests, and the selection of suitable test equipments are stressed as important requirements for efficient testing.

Section 4, Care and Repair of Test Equipment, deals with both preventive maintenance and repair of test equipment. Preventive maintenance procedures, care of accessories and cables, proper storage of equipment, and periodic inspections are all considered important parts of the technician's job.

Section 5, Reference Data, contains data such as a list of the terms used in this manual, tables of radiofrequency classifications, letter coded radar bands, and Smith charts.

Periodic Maintenance Requirements Manual

This manual contains the planned scheduled maintenance requirements for the aircraft concerned and is the controlling document for the planning and accomplishment of the related work tasks through all levels of maintenance.

The maintenance requirements contained in this manual specify the equipments to be inspected or examined and the required conditions. It does not contain instructions for repair, adjustments, or troubleshooting, as this type of information is found in the Maintenance Instructions Manual for the particular aircraft.

The planned maintenance requirements prescribed by the Periodic Maintenance Requirements Manual are considered to be the minimum necessary under any conditions to assure timely discovery and corrections of defects. The listed designated calendar intervals are the maximum authorized based on aircraft class and planned Navy-wide utilization. Due to varying operational requirements, climatic or environmental conditions, squadron commanders may increase the scope or frequency of material inspection or examination as required to properly and safely carry out assigned missions.

Part I of this manual contains sections on maintenance management, definitions, preflight, daily and calendar inspection procedures, and references.

Part II contains fleet maintenance requirement data for daily, calendar, special, and preflight inspections.

Part III includes the requirements for progressive aircraft rework. The first section of Part III contains instructions on squadron responsibility and rework activity responsibility. The rest of the sections are a listing of the systems of the aircraft.

Part IV contains the component removal and or replacement schedule. The replacement time intervals are indicated in operating hours, calendar time, or PAR periods as appropriate. Components are arranged according to systems.

Part V is a listing of the components by part number and nomenclature which require accessory card entry into the appropriate logbook.

Department of the Navy
Safety Precautions for Shore
Activities Nav So P-2455

The purpose of this manual is to present the safety precautions applicable to Navy shore activities including shore (field) activities of the operating forces and fleet schools. The safety precautions given in this manual are of necessity basic and general in nature and are not inclusive of all conceivable operations and functions involved in the great variety of shore activities. In many instances references are made to other publications for detailed safety precautions applicable to specific operations.

The senior AT should become very familiar with the contents of this manual. It is the responsibility of supervisory personnel to see that safety precautions are strictly adhered to. Continuous cooperation and vigilance of all personnel are needed to see that all operating procedures and work methods do not unnecessarily expose personnel to injury or property to loss or damage.

Index of Safety Precautions
OpNav Notice 5100

OpNav Notice 5100 is an index of Navy Department documents containing safety precautions applicable to the operating forces.

The manual, "United States Navy Safety Precautions" (OpNav 34P1), is no longer in use. To assist commanders in the operating forces in carrying out their responsibilities in the area of safety, the Chief of Naval Operations has revised the index of publications, pamphlets, periodicals, and directives, issued by commands and offices of the Navy Department, which address themselves to safety precautions applicable to the operating forces.

Instructions and procedures pertaining to aspects of safety are contained in general and specific manuals such as NavShips 250-000, Naval Ship Systems Command Technical Manuals, Volumes I, II, and III. The safety precautions listed in OpNav Notice 5100 are not intended to replace the instructions in manuals but only to supplement by providing specific safety precautions in certain categories where they have been changed or have been implemented. When the listed precautions references have been included in manuals, they will be deleted from the index. It behooves the senior AT to review this index and to study sections applicable to his activity. As stated previously, it is the responsibility of supervisory personnel to ascertain that all safety precautions, as cited in OpNav 5100, are rigidly enforced.

Aviation Electronics Officer's
Guide, NavAer 00-80T-64

This publication is issued by the Office of the Chief of Naval Operations, Aviation Training Division. It is a compilation of information prepared primarily to assist the naval aircraft electronics officer in the performance of his technical and administrative duties. Since some of the duties of the ATC and AT1 closely parallel those of the electronics officer, this publication can be of use as an excellent source of information.

The major sections of the publication are as follows: introduction to naval aeronautics aeronautics organization; safety; technical duties; reports, records, local directives, and memoranda; supply; publications; education and training; security; and technical reference material.

Handbook Preferred Circuits
NavWeps 16-1-519

This publication is designed primarily for engineering standardization. It does, however, contain information of interest to the AT. Another publication in this category is the Guide Manual of Cooling Methods for Electronic Equipment, NavShips 900, 190.

Semiconductor Device Replacement
Guide, NavWeps 16-1-530

This publication contains replacement technical, and mechanical information on all semiconductor devices listed in the Navy Supply System.

SECURITY OF CLASSIFIED PUBLICATIONS

Security is one of the chief responsibilities confronting the Avionics Division. Although security is the duty and responsibility of all hands, security rests very heavily upon

electronics supervisors because of the classification of the equipments, systems, and publications with which AT's work.

Department of the Navy Security
Manual for Classified Information
OpNavInst 5510-1 (Series)

The objective of the orders and instructions contained in this publication is to establish a coordinated policy for the maintenance of the security of all matter classified in the interest of national defense. The United States Navy Regulations, the Espionage Act, and Atomic Energy Act, executive orders, and other legally established directives form the basis for this publication. These regulations do not restrict the mature judgment of individuals in the proper application of initiative, and local commands may issue additional security instructions as necessary to meet local situations. However, this manual contains detailed procedures and outlines basic responsibilities of the security system. Reference to this manual will provide methods of implementation of the security system for most encountered circumstances. The senior AT should be familiar with this publication.

SECURITY RESPONSIBILITY

Commanding officers are directly responsible for safeguarding all classified matter within their commands and are responsible for instructing their personnel in security practices and procedures. Security consciousness is the duty and responsibility of ALL Navy personnel. As a senior PO, you have the added duty and responsibility to insure that all avionics personnel become security conscious, and that this consciousness be maintained by repeated instructions in matters of security.

HANDLING AND STOWAGE

Handling and stowage procedures concerning classified publications are dependent upon both the classification and the quantities of the particular material to be stored. However, rarely should the Avionics Division maintain in private files any publications classified Top Secret or Secret. When such occurs, strict attention to instructions for handling and stowage of Top Secret and Secret material should be observed.

A checkout system utilizing logbooks or custody cards MUST be maintained for the proper handling of classified publications.

KEYS AND COMBINATIONS

It is essential that combinations or keys be accessible only to those personnel whose official duties demand access to the container involved. The combination to a security container should be changed whenever one of the following conditions occurs:

1. When the combination lock is received.
2. When a person having knowledge of the combination leaves the organizational unit.
3. When there is reason to believe the combination has been compromised.
4. When the lock has not been changed in a 12-month period.

PERSONNEL SECURITY CLEARANCES

Any person having access to classified matter must have a security clearance. NEVER assume the security clearance of anyone regardless of rank or rating or previous activities. Always demand valid proof of entitlement to classified information. Limit access to classified information, and to the files, to a "need to know" basis (information necessary for the performance of the individual's duties). On the other hand, remember that avionics personnel, due to the nature of their ratings and the continual need for updating their education on the latest avionics system, should be properly cleared and have assess to material relevant to the duties of their ratings. Leading petty officers should take the lead in establishing the right balance in this area.

CHAPTER 4

AVIATION SUPPLY

A Chief or First Class Technician, especially if in a supervisory billet, will find himself increasingly involved in the details of supporting the man on the job. One of these detail areas is in the field of aviation supply.

Aviation supply personnel are vital members of the aircraft maintenance team; and the technician as well as the other aviation maintenance ratings must work in close harmony with them if successful teamwork is to be achieved. The team must work so that a flow of parts is maintained from the manufacturer to the man on the job—quite possibly a technician doing repair work on the other side of the world. A correct concept of supply's relationship to the entire organization is essential in the supervision of aircraft maintenance functions.

ORGANIZATION AND FUNCTION OF NAVAL SUPPLY

The command exercising management control over the policies and procedures of the aviation supply organization is the Naval Supply Systems Command. The Commander of the Naval Supply Systems Command is usually a rear admiral who is appointed by the President for a term of 4 years with the advice and consent of the Senate. He works with the delegated authority of the Secretary of the Navy and all orders emanating from him have the full force and effect of SecNav orders.

To better understand the relationship of the Naval Supply Systems Command to the Aviation Supply System it might be well to quickly review the development of the Navy Supply System. Prior to 1842 the commanding officers of ships and stations were responsible for the procurement of their own supplies. They were furnished funds for this purpose by the Navy Department and were required to account for all expenditures. In addition to creating an intolerable burden of paperwork on the Navy Department this procedure had the effect of forcing prices upward, especially when two commanding officers were bidding for some scarce commodity.

In 1842 Congress approved the establishment of a Bureau of the Navy to take cognizance over all matters of naval supply. The primary responsibilities of this infant supply bureau were the procurement, maintenance of custody, and issuance of naval material. They are the primary responsibilities of the Naval Supply Systems Command today. Every function of the Naval Supply Systems Command is directly related to one or more of these responsibility areas.

In the early years of naval aviation when the Navy had few aircraft, the procurement of spare parts was much like the old system whereby commanding officers dealt directly with the sellers to fill the needs of each command. The pioneer naval aviation project directors had to deal directly with the manufacturers as parts were required.

By 1917 the Naval Aircraft Factory (NAF) in Philadelphia had come into existence and was assigned responsibility for the procuring of aircraft and spare parts. Other responsibilities assumed by NAF included the repair of aircraft, the manufacture of some spare parts, and eventually the manufacture of complete aircraft. There are still many aviators around today who earned their Navy wings in the old N3N, built by NAF.

In 1921 the Bureau of Aeronautics (BuAer) came into being and assumed the responsibility of procuring aircraft and aircraft engines. The responsibility for procuring spare parts and other aeronautical material remained with NAF, which until 1941 was the aviation supply center of the Navy.

The Aviation Supply Office (ASO) was established in 1941 under the technical control of BuAer and the management control of BuSandA. The function of ASO was the procurement, custody, and issuance of aeronautical spare parts and technical material. This is essentially the

function of ASO today under the technical control of the Naval Air Systems Command. Management control is still vested in the Naval Supply Systems Command.

RESPONSIBILITIES OF THE NAVAL SUPPLY SYSTEMS COMMAND

The general functions of the Naval Supply Systems Command within its areas of responsibility include many that are not of primary interest to aviation personnel in that they are not related to aircraft maintenance. Listed below are some of the more important general functions of the Naval Supply Systems Command.

1. Supervises the procurement, receipt, custody, warehousing, and issuance of Navy supplies and materials, exclusive of ammunition, projectiles, mines, explosives, and medical supplies.
2. Supervises and directs the operation of the supply phases of the Navy Supply System and administers the redistribution program of excess personal property within the Department of Defense and the sale of Navy surplus property.
3. Authorizes and supervises the transportation of Navy Property.
4. Prepares budget estimates and administers funds for the supply distribution system.
5. Renders an annual report to the Congress of money value of supplies on hand at the various stations at the beginning of each fiscal year, the disposition thereof, purchase and expenditure of supplies for the year, and balance on hand.
6. Coordinates the compilation and arranges for the printing of the Catalog of Navy Material.

Some additional functions of the Naval Supply Systems Command that are of interest to naval aviation maintenance personnel are the general functions of ASO. These include the following:

1. Responsibility for overall determination of requirements, procurement, and distribution of standard aeronautical materials. (Certain materials excepted; e. g., complete aircraft and engines, complete electronic equipment, major photo equipment, nonstandard and experimental aerological equipment, and items of naval weapons ordnance equipment.)
2. Maintenance of a complete file of ASO and Naval Air Systems Command contracts, letters of intent, amendments, extensions, and change orders, and distribution of copies of documents necessary to Navy field activities.
3. Stock control of aeronautical materials at all aviation supply facilities, including control of packing, preservation and distribution of material under ASO cognizance to, from, and between aviation supply facilities and major supply points.
4. Maintenance of complete records of material on order and followup procedure necessary to effect timely deliveries for all material under ASO cognizance.
5. Maintenance of up-to-date records of existing storage facilities at depots, major supply points, and operation stations for aeronautical materials, and control of influx of materials in aviation supply channels so as not to exceed existing storage facilities.
6. Determination and disposition of obsolete and excess aeronautical material under the Naval Air Systems Command cognizance.
7. Preparation and distribution of the Navy Stock List of the Aviation Supply Office, including interchangeability data.
8. Compilation and distribution of some allowance lists subject to approval by the Naval Air Systems Command.
9. Compilation of lists of spare parts to be salvaged from surveyed aircraft.
10. Followup on delivery, stock recording, reallocating as necessary, and distributing change material promulgated by the Naval Air Systems Command.
11. Establishment and maintenance of a statistical unit which assembles, compiles, and analyzes usage data.
12. Maintenance of a representative at each aircraft manufacturer's plant who keeps ASO fully informed, as requested, as to all changes which affect spare parts under procurement.
13. Establishment of an inspection service which inspects aviation supply activities within established naval districts.

APPROPRIATIONS

At one time or another, almost everyone has had the frustrating experience of not being able to draw from supply some item that he thought necessary to have immediately; the usual reason given being, "We don't have any money left." It takes only a short time to realize that the Navy does not operate with unlimited funds. This section and the following section, titled "Allotments," are presented to further an understanding of the system whereby funds are made available at the user activity level for operating expenses.

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The main money pool of the government is the General Fund of the Treasury. Funds come into the General Fund from such sources as income taxes, excise taxes, import-export taxes, etc. The only way for money to be expended from the General Fund is by congressional action, which has to be approved by the President. A bill passed by Congress which includes the expenditure of funds from the General Fund is called an appropriation.

An estimate of the amount of money required for the operation of the Defense Department during a given fiscal year is prepared by Department of Defense fiscal experts well in advance of the beginning of the fiscal year. The Congress studies the proposed budget in the light of world affairs, the current domestic economy, and such other considerations as they see fit, then acts upon it. They may increase the amount requested, decrease it, or pass it as is. After presidential action is completed, the money is made available to the Department of Defense to be spent during a specified year. This is known as an "annual" or "1-year" appropriation.

Congress and the President may also approved "no-year" appropriations for special projects such as large construction over an unspecified length of time. Another form of appropriation is the "multiple-year" appropriation for projects which will be completed in a predictable length of time. An example of this type of appropriation might be the money appropriated to cover the expenses of the NROTC college programs for the next 4 years.

The appropriation by which the technician is most affected is the current year appropriation. After the appropriation or expenditure authorization is received in the Department of Defense, it is prorated among the services as a percentage of their previously submitted budget estimates. The Navy's share is prorated among the various bureaus and commands in essentially the same manner; that is, as a percentage of their estimated requirements for the coming fiscal year. The money to be spent for naval aviation is made available to the Naval Air Systems Command. Here, part of the money is allocated to ASO for the purchase of aircraft spare parts in quantities which past usage data has indicated will probably be sufficient for the coming year. These spare parts are furnished to the operating activities at no cost, since their usage has been anticipated and the items paid for in advance. The account from which money was spent to buy these items is known as the Appropriation Purchase Account. Material received in the user activities from this account is known as APA material.

Another part of the Naval Air Systems Command funds is made available to the operating activities in the form of allotments.

ALLOTMENTS

Allotments concerning naval aviation are authorizations by the Naval Air Systems Command to the user activities to spend a certain amount of money during a given length of time for specific purposes. User activities are shore commands which operate aircraft, and the major air type commanders. Major air type commanders are Commander, Naval Air Force, Atlantic (ComNavAirLant); Commander, Naval Air Force, Pacific (ComNavAirPac); Chief of Naval Air Training (CNATra); and Chief of Naval Air Reserve Training (CNAResTra). Operating funds for squadrons and units are apportioned to them by their type commander as an Operating Target (OPTAR). Routine nonaviation expenses for operating squadrons and units are absorbed by the ship or station to which assigned.

There are three types of allotments—operation and maintenance, operation and line maintenance of aircraft, and aviation fleet maintenance. These three allotments are of particular concern to the technician and are discussed further.

Operation and Maintenance Allotment

Funds in this allotment are made available to commanders of the shore establishment to pay their operating expenses, exclusive of aircraft operating expenses. This money is used to pay civilian labor, buy office supplies, and to pay for all other upkeep and housekeeping supplies. Squadrons aboard the station have no allotment of this type and are dependent on the station for their support. A segment of the station's allotment is allocated to the squadrons for their nonaviation routine expenses. Funds from this source are generally scarce, but it is possible by careful management to make them last through the specified spending period. Shore commanders, in some cases, may elect to provide basic supplies in limited amounts to the tenant activities without providing any funds which the squadron or unit can spend as needed.

Operation and Line Maintenance of Aircraft Allotment

Major air type commanders and shore commands which operate aircraft are furnished this allotment by the Naval Air Systems Command. The OPTAR provided to fleet squadrons and units by their type commanders is usually a monthly segment of these funds. Unused funds revert to the control of the type commander as each new OPTAR is authorized. Type commanders provide OPTAR's to all squadrons and units under their operation control, whether or not the user activity is based ashore. Shore station commanders have no responsibility for providing money for the operation and line maintenance of aircraft of tenant fleet activities.

Funds allotted for the operation and line maintenance of aircraft may be used to buy any type material as long as the material is used for the purpose of the allotment. By far the greatest expenditures against this account are for fuel and oil. Other materials that may be purchased with this allotment include rags, aircraft paints, preservatives, crewmen's flight clothing, or anything else that is consumable due to its use on or about the aircraft.

Aviation Fleet Maintenance Allotment

Air type commands are furnished this allotment by the Naval Air Systems Command, then the Air type command will furnish funds to ships by OPTAR, and fleet support stations are funded by suballotment. These funds are provided to finance the cost of Intermediate and Organizational levels of maintenance. These costs include the following:

1. Technical repair parts, common hardware, lubricants, cleaning agents, cutting compounds, metals, etc., incorporated into or expended in the performance of aviation maintenance of aircraft, aircraft engines, aeronautical components and subassemblies, and Navy maintenance of the Naval Air Systems Command authorized maintenance support equipment.
2. Fuels and lubricants consumed by aircraft engines in the performance of complete section repair.
3. Preexpended, consumable maintenance material.
4. Replacement of consumable/expendable allowance list items (Material Accountability and Recoverability Codes "B" and "C").

DISTRIBUTION SYSTEM

The aviation supply distribution system consists of reserve stock points, primary stock points, secondary stock points, and satellites. These are discussed briefly in the following paragraphs.

1. RESERVE STOCK POINTS carry reserve and backup stock for the aviation supply system. The range and quantity of stock are determined by the Aviation Supply Office. Reserve stock points provide storage facilities for bulk material.
2. PRIMARY STOCK POINTS carry stock for their own consumption. They may be designated as support activities for secondary stock points, for fleet units, and/or yard and district craft in the area.
3. SECONDARY STOCK POINTS carry stock for their own consumption as well as stock for aircraft and assigned yard and district craft.
4. SATELLITES are aviation activities which are dependent for support on a primary or secondary stock point. Satellites are usually minor activities and normally receive their supply support on a retail issue outlet basis.

As far as the consumers are concerned, they may be assigned to any of the primary, secondary, or satellite stock points for supply support. The same basic principles will affect your supply support. (Hereafter in this training course, they are referred to as field supply points.)

MATERIAL IDENTIFICATION

As aviation maintenance personnel, we will be working closely with the aviation storekeepers in keeping aircraft in an "up" status. In order to obtain replacement parts as rapidly as possible, we must know how to determine the source of supply of different items. For example, we may waste many hours trying to find out that the item is to be manufactured within our own activity. Also, it is important to know the correct stock number and cognizance symbols used to requisition items from supply.

The cataloging system developed by the Department of Defense is such that it identifies with one name and stock number any item of supply that is carried in any or all government agencies. In the procurement of material it is normally necessary to identify your material requirement in the medium understandable to the supply system.

FEDERAL STOCK NUMBERS

Prior to 1952 each of the services had its own numbering system for identifying, cataloging, stocking, and issuing items of military supply. It was not unheard of that one service would be negotiating on the open market for an item that was held in surplus by another service under its own stock number. This confusion resulted in the passage in 1952 of the Defense Cataloging Standardization Act.

The implementation of this Act has resulted in a reduction of item duplication between the services by providing for one Federal Stock Number (FSN) for each item, regardless of the use of the item or the using activity.

Coded Federal Stock Number

The federal stock number consists of an 11-digit number. The Aviation Supply Office uses federal stock numbers with prefixes composed one, two, or three symbols, and suffixes composed of four characters which may be all letters or a combination of letters and numbers. When the prefixes and suffixes are used, the federal stock number becomes a coded federal stock number. A coded federal stock number and its breakdown is shown in figure 4-1.

If a 1-symbol prefix is used, it designates the command or office having control or cognizance of a particular item. Listed below are some of the more common cognizance symbols, together with the type material controlled and the name of the cognizant command or office.

SYMBOL	COGNIZANT ACTIVITY	MATERIAL CONTROLLED
2R	Aviation Supply Office	Aeronautical material
2V	Naval Air Systems Command	Major aeronautical equipment
1N	Electronics Supply Office	Electronic assemblies and repair parts
1W	Fuel Supply Office	Fuels, lubes, and gases
1I	Navy Supply Depot, Philadelphia	Forms
0I	Navy Supply Depot, Philadelphia	Publications

Many variations of coded stock numbers will be encountered in field maintenance work. These variations indicate material management responsibilities for the item; flag certain items as recoverable, consumable, high value, etc.; and identify the condition of the material if it is not ready for issue. Some of the more common codes that a technician is likely to encounter include the following:

RH—a recoverable aeronautical component of high value.

2RHF—a recoverable aeronautical component of high value that is not ready for issue.

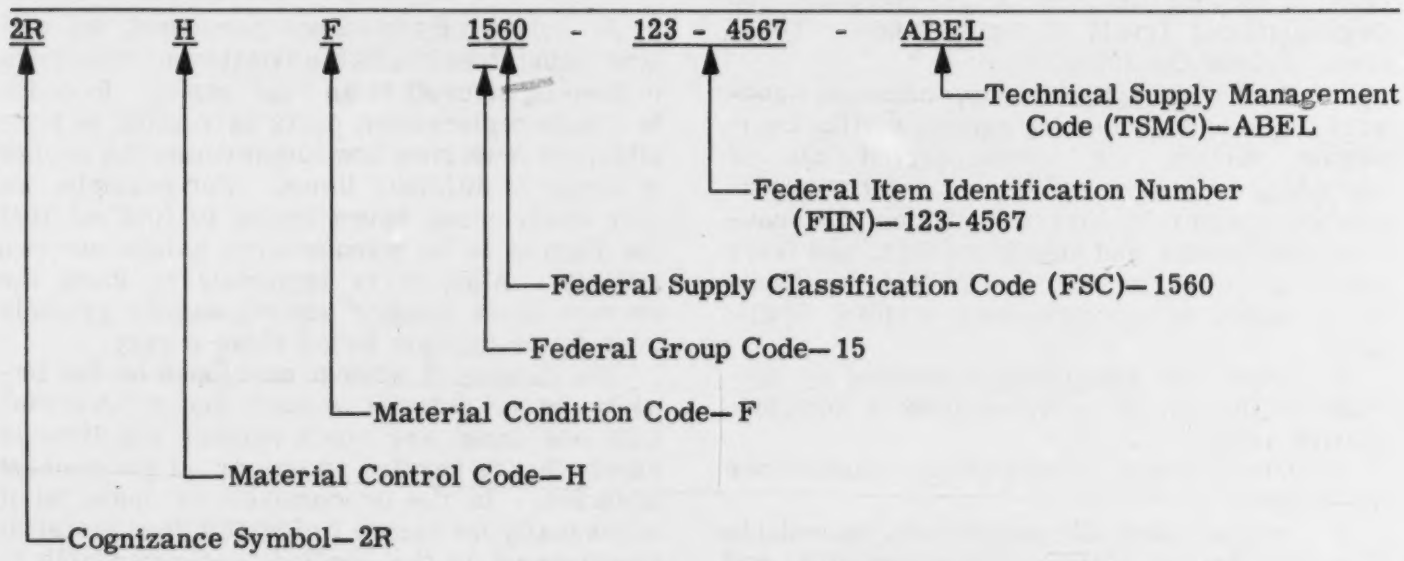

Figure 4-1.—Breakdown of Coded Federal Stock Number.

Because the variety of codes is so extensive and the trend to single service management of items has caused so many changes in recent years, a list of codes that might be prefixed or suffixed to a stock number would not be appropriate for this course. The primary things to keep in mind are that the basic stock number, consisting of three groups of numerals, identifies the item from a technical point of view and that the other codes identify material management characteristics.

With the advent of the single manager concept many items formally carried in the individual Navy Stock Lists are cataloged in the Federal Supply Catalog For General Supplies. The complete catalog consists of many sections and is arranged by federal supply classification class.

MATERIAL IDENTIFICATION AIDS

There may be times when a part or some technical material is needed and the stock number is unknown. At other times some material may be on hand and its identity is not positively known. A knowledge of the several methods by which material may be identified is very helpful in speeding the completion of a maintenance task. There are many ways in which material may be identified. Certain data may be available which does not identify an item but may lead to positive identification. An aircraft part has a part number. The part number may be looked up in the IPB and identified by nomenclature and often by the stock number. If the stock number is not furnished in the IPB, it may be found by referring to the Cross-Reference Section C0006 of the Navy Stock List of ASO.

Some equipments have attached nameplates which provide such information as the manufacturer's name, make or model number, serial number, size, voltage, phase, etc. Identification data taken from the nameplate of the old part can be very helpful in procuring a replacement.

When only the description of the item is known, the best source for identification is the descriptive sections of the various Navy Stock Lists.

Various publications used in identifying material are described in the following paragraphs.

NAVSUP PUBLICATION 2002, SECTION VIII, PARTS C and D, contains a complete numerical listing of all available naval aeronautic publications distributed by Naval Air Systems Command. This stock list is supplemented by and should be used in conjunction with NavAir 00-500A, Equipment Applicability List, and NavAir 00-500B, Aircraft Application List. These lists are handy references to publications that should assist you in the identification of material.

ILLUSTRATED PARTS BREAKDOWN (IPB) lists are probably the most important tool for the identification of aeronautical material. As a senior Petty Officer, you are undoubtedly familiar with them. However, due to the importance attached to them as a material identification source, they are discussed briefly in the following paragraphs.

IBP's are compiled by the manufacturer for each aircraft model in naval use. IPB's, as discussed here, encompass IPB's for aircraft, IPB's for aircraft engines, and IPB's for individual accessories and equipments.

Although slight variations in format exist among the various IPB's, each normally includes the following major sections:

I. TABLE OF CONTENTS—This section shows the breakdown of the catalog into sections and furnishes a cross-reference between the various assemblies and figures where they are illustrated. The section also cross-references assemblies and pages where they are broken down into subassemblies and parts.

II. INTRODUCTION—This section includes general information and instructions for using the publication. Because variations between IPB's do exist this section should be referred to prior to using an IPB with which you are not thoroughly familiar.

III. GROUP ASSEMBLY PARTS LIST—This section is the main text of the publication. It consists of a series of illustrations and parts lists in which all parts of the aircraft/engine/equipment are shown in assembly breakdown order. The illustrations and parts lists are keyed to each other by means of figure and index numbers. Each assembly included in the parts lists is followed immediately by its component parts properly indented to show their relationship to the assembly. The group assembly parts list is subdivided into groups such as wing group, tail group, and fuselage.

IV. NUMERICAL INDEX—This section lists all parts in alphanumerical order, and each part is cross-referenced to the figure and index number where it is illustrated. This list also shows the official source code of each part listed in the applicable IPB.

Source codes are codes which indicate to a consumer a source for a part required in the maintenance or repair of an aeronautical article. They are provided in six series—P, M, A, N, X, and U.

The REFERENCE DESIGNATOR INDEX, normally the last section of the IPB, is a listing of reference designators (C104, R603, K202, etc.) used on the electrical and electronic wiring diagrams. The reference designator index will aid in the location of parts where only the reference designation number is known.

Source code P series parts are parts of supply system stock which are purchased.

Source code M series applies to parts which are not purchased but are capable of being manufactured at Navy fleet or overhaul activities (MF, MO, or MOA).

Source code A series applies to assemblies which are not purchased.

Source code N applies to nonstock items which are purchased on demand.

Source code X applies to main structural members or similar parts which, if required, would suggest extensive repair. The need for a part or parts coded X normally results in a recommendation for complete overhaul or retirement of the equipment from service.

Source code X1 applies to items for which purchase of the next larger assembly, source coded in the P series, is justified.

Source code X2 is applied to items which are not purchased for stock, but may be acquired for use through salvage or one-time purchase. Activities requiring such items should attempt to obtain them from salvage; if not obtainable from salvage or readily manufactured, such items may then be requisitioned through normal supply channels with supporting justification. Repeated requisitions could justify a change to the P series code.

Source code U applies to parts which are not of supply or maintenance significance, such as installation drawings, diagrams, instruction sheets, etc.

Within each of the source code series listed above there are one or more subcodes identified by a letter or number appended to the basic code letter. These subcodes provide detailed information concerning the procurement or manufacture of various parts within the scope of the particular code series. The introduction section of the applicable IPB provides a ready reference for each of the codes and subcodes as required.

Aeronautical Allowance Lists

Aeronautical allowance lists as used in this course include NavAir Allowance Lists, NavAir Initial Outfitting Lists, and NavAir Tables of Basic Allowance.

Aeronautical allowance lists are lists of equipment and material, known or estimated to be required, to place and maintain aeronautical activities in a material readiness condition. These lists contain substantially all items used with sufficient frequency to justify their issuance to all activities maintaining aircraft or equipment for which the lists are designed. They also contain information concerning stock number, nomenclature, interchangeability, and supersedures. These publications are further defined in subsequent paragraphs. Keep in mind that allowance lists normally contain support equipment allowed to maintenance personnel consistent with their assigned level of maintenance. Initial outfitting lists contain material of a spare parts nature required for maintenance of aircraft/equipments. Materials listed in the initial outfitting lists normally are held in supply stocks and under most conditions are not authorized shop spares.

Allowance lists indicate the range and quantities of support equipment considered necessary for maintenance support of assigned and/or supported aircraft. Generally, these items are in-use items required for daily or continual use, such as handtools and avionics test equipment.

Initial outfitting lists (IOL's) are publications which indicate the range and quantities of maintenance spare parts considered necessary to support various aeronautical articles. This material is provided to vessels or activities and is firm only at the time of initial outfitting. Increases and decreases in both range and/or quantities of material are based upon the experience (demand history) of each activity concerned. Each series list is designed to support an aircraft, electronic equipment, or some other aeronautical article. The allowances of material are established for various articles for a 90-day period. All items capable of replacement by a maintenance activity are not listed, but rather, only those that are expected to be used at least once in 9 months.

Publications listing equipment and material required for performance of specific functions are known as Tables of Basic Allowance. They contain both shop equipment and common supporting spare parts. They cover allowances

of tools and equipment required for use by such activities as Fleet Marine Force squadrons and guided missile activities.

Initial Outfitting Lists and Allowance Lists are identified by the publication number NavAir 00-35Q series, while Tables of Basic Allowance are identified by the publication number NavAir 00-35T series. Those allowance lists of primary interest are listed in the following paragraphs:

Section "A" Initial Outfitting List (NavAir 00-35QA-1)—Lists standard aeronautical and Navy stock account material common to the designated aircraft classes.

Section "B" Initial Outfitting List (NavAir 00-35QB)—Series lists peculiar maintenance parts (airframe, engine, accessories) required for support of specific aircraft models. (Includes lists for certain target aircraft and guided missiles.)

Section "BR" Initial Outfitting List (NavAir 00-35QBR)—Series lists peculiar maintenance parts (airframe, engine, accessories, electronics) required for support of concerned target aircraft model, drone helicopter, or guided missile. (Prepared in lieu of separate Section "B" for airframe, engine, accessories, and Section "R" lists for electronic parts due to limited installation of electronic equipment.)

Section "G" Allowance List (NavAir 00-35QG)—Series lists general maintenance support equipment and handtools required for intermediate and organizational levels of maintenance support of aircraft.

Section "R" Initial Outfitting List (NavAir 00-35QR+4)—Lists general aeronautical electronics material common to and required for maintenance of avionics equipment and systems.

Section "R" Allowance List (NavAir 00-35QR-5)—Lists avionics support equipments required for maintenance of installed avionics equipment and systems. A confidential supplement to NavAir 00-35QR-5 is issued as a separate publication.

Section "R" Initial Outfitting List (NavAir 00-35QR-5A)—List peculiar parts required for maintenance of electronic test equipments authorized in NavAir 00-35QR-5.

Section "R" Initial Outfitting List (NavAir 00-35QR-6)—Lists aeronautical electronic accessories common to designated aircraft classes.

Section "R" Initial Outfitting List (NavAir 00-35QR-7)—Lists electron tubes required in the maintenance of aeronautical equipment utilizing such tubes.

Section "R" Initial Outfitting List (NavAir 00-35QR-30)—Series lists peculiar parts, spare components, assemblies, and subassemblies required for maintenance of appropriate aeronautical electronic equipments.

Section "T" Allowance List (NavAir 00-35QT)—Series lists special maintenance support equipment required for intermediate and organizational levels of maintenance of airframes, powerplants, accessories, avionics equipment, and/or aircraft model to which the list applies.

Section "X" Initial Outfitting Allowance List (NavAir 00-35QX-30)—Series lists peculiar parts, spare components, assemblies, and subassemblies required for maintenance of the armament, fire control, instrument, or electrical system to which the list applies.

Section "Z" Initial Outfitting List (NavAir 00-35QZ)—Series lists peculiar parts for electric powerplants, special and general aircraft, and guided missile support equipment.

Tables of Basic Allowances (NavAir 00-35T)—Series (T-37-1, T-37-2, T-37A, T-38, T-39, T-40, and T-41) lists equipment and material required by activities to which the list applies for performance of assigned mission. Lists presently in effect relate to the following activities:

T-37-1, T-37-2..	Fleet Marine Force Aviation Units.
T-37A	Fleet Marine Force Aviation Units (Supply Officers' material and equipment).
T-38.....	Target Pilotless Aircraft Activities; Drone Aircraft Catapult Control Craft; Navy Tactical Control Squadrons.
T-39.....	Regulus Guided Missile Activities.
T-40.....	Air-Launched Guided Missile Activities.
T-41.....	DASH Weapons System Operational and Maintenance Activities.

Stock Catalogs

Stock catalogs provide information necessary to procure items for operation and maintenance

of activities afloat and ashore. The stock catalogs commonly used by aviation maintenance personnel are the Federal Supply Catalog for General Supplies and the Navy Stock List of ASO for aeronautical material.

The Navy Stock List of ASO is divided into four parts, each consisting of several volumes. Many of these stock list sections are designed for supply management purposes and have very little significance to maintenance personnel. The sections normally utilized by maintenance personnel include the following:

1. Sections C0006 and C0009 are cross-reference sections. The section C0006 is used to cross-reference a manufacturer's part number to a federal stock number. The section C0009 is used to cross-reference a federal stock number to a manufacturer's part number. These are multiple volume sections and are not normally available in individual shops, but may be available in a centralized area for use by several shops. These sections are published annually with cumulative supplements being issued monthly.

2. Parts list sections provide supply data to supplement information contained in the Illustrated Parts Breakdown. These sections contain valuable information relative to application and interchangeability. Parts list sections are set up by TSMC. Each section contains an application checkoff list, a listing of repairable assemblies, and a listing of supporting spare parts.

3. Descriptive sections are used when only the item nomenclature and physical characteristics are known. Illustrations are provided to aid in the identification of items that cannot be defined by words. The descriptive sections are established by federal supply classification class.

MATERIAL REQUISITIONING

Maintenance personnel are apt to encounter a variety of local requisitioning channels; all designed to present a demand for an item to the supporting supply department. Assigned levels of maintenance, geographical location of shops relative to supply facilities, and mission of activities requiring support all influence the local requisitioning channels. Local instructions normally promulgate detailed procedures for submitting your demand to the appropriate supply point.

SUPPLY ACTIVITY

The mission of the supply activity is to support the operational and maintenance efforts of the activity/ship. Stocks of aviation oriented material carried are tailored and replenished to this end. Positioning, replenishment, and control of stocks of material in maintenance areas are carried out as a result of joint decisions by the Supply and Maintenance Officers concerned. They determine the range, depth, and related procedures. The Navy Maintenance and Material Management System (Aviation) requires that the cost of material used in maintenance be determined and accumulated in such manner and detail that weapons system costing can be measured. Usage is finely defined as to stock number, within component, within equipment/weapon/aircraft, in a particular squadron, located in a specific operational area, at a definite point in time. These data are used as an inventory management tool to determine geographic and strategic distribution of stock of material. In addition, the data will be invaluable in establishing the material portions of work standards in maintenance.

Supply Support Center

Maintenance organizations have one single point of contact with the supporting supply activity. This single supply contact point is the Supply Support Center (SSC) which responds to all material requirements of the maintenance organizations. The SSC is an internal organization of the local supply activity. It is made up of three sections—the Supply Response Section (SRS), the Component Control Section, (CCS) and the Supply Screening Section (SSS).

Supply support is available consistent with the operating hours of the maintenance activities supported. If maintenance is being performed 24 hours a day, then supply support is available 24 hours a day.

The supply support center maintains rotatable pool material which consists of repairable ready-for-issue items reserved primarily to satisfy the requirements of Organizational level maintenance. Items maintained in the pool are capable of being repaired by the local Intermediate maintenance activity, have application relationship to weapon systems supported by local Intermediate maintenance activities, and have an average Organizational maintenance level removal rate of at least one per month.

Defective components are turned in to Intermediate level maintenance for repair. The defective components repaired to an RFI condition are then returned to the rotatable pool to replace the components previously issued.

Low value, fast moving consumable items are preexpended from supply. Such materials are located in the maintenance area. The establishment, maintenance, and replenishment of preexpended bins are the responsibility of the supply organization.

SUPPLY RESPONSE SECTION.—The Supply Response Section (SRS) is responsible for preparing all necessary requisitions (DD Form 1348) and related documents required to obtain material for local maintenance use in direct support of weapon system maintenance. The maintenance organization verbally notifies the supply organization of the need for such material. When material is available locally, the time frame for processing and delivery is as follows:

Priority	Process/Delivery Time
1-3	1 hour
4-8	2 hours
9-20	24 hours

Otherwise, the time frames as noted in table 4-1 will apply.

The SRS is responsible for receipt, storage, and issuance of all ready-for-issue pool components. It is responsible for physical delivery of RFI material to maintenance organizations, and the pickup of defective components from the Organizational maintenance activity and subsequent delivery to the Intermediate maintenance activity. Actual maintenance personnel are not involved in the physical movement of material between organizations.

This section also performs technical research in regard to completion of requisition documents as well as determining the status of outstanding requisitions and relaying this status to the customer upon request.

COMPONENT CONTROL SECTION.—The Component Control Section (CCS) accounts for all components being processed in the Intermediate maintenance activities. This section also maintains records on the status of all rotatable pool components.

SUPPLY SCREENING SECTION.—The Supply Screening Section (SSS) is responsible for initiating disposition action on components that cannot be repaired by the local Intermediate maintenance activity. Using listings and directives from inventory managers, screening personnel determine disposition of components in question, including prospective consignee and packaging and preservation requirement prior to movement of material.

Table 4-1.—Processing time frames.

Issue group	Issue priority designator range	Supply source processing	CONUS on station time	Overseas on station time
1	1-3	24 hours 24-hour day 7-day workweek	120 hours	168 hours
2	4-8	72 hours 24-hour week 7-day workweek	8 days	15 days
3	9-15	10 days 5-day workweek 8-hour day	20 days	45 days
4	16-20	12 days 8-hour day 5-day workweek	50 days	60 days

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MATERIAL CONTROL OFFICER

The Material Control Officer in a maintenance activity is an assistant to the Maintenance/Material Control Officer, and as such provides support and services to the production divisions. Material control exists for the primary purpose of insuring that maintenance requirements for parts and materials are made known to the supply organization in a timely manner in order to prevent work stoppages and grounding aircraft. Material control insures that parts and materials made available to maintenance are systematically utilized and not allowed to accumulate or to become depleted. It serves as the single point of contact within the maintenance organization for the conduct of business with the supply organization.

Material Control provides material support to their cognizant organization by accomplishing the following general functions:

1. Pass all requirements for material required for direct support of weapon system maintenance to the SSC. A material control register is maintained for these items.
2. Prepare documents for materials required for indirect support of weapon system maintenance. Examples of materials for which documents are to be prepared are aviation fuels and lube oils, rags, and flight jackets. A separate requisition record log is maintained for these items.
3. Maintain liaison with the supporting SSC on maintenance material matters to insure that material needs of the organization are satisfied.
4. Establish delivery points for all material and insure that material received is expeditiously routed to the applicable work center.
5. Furnish technical advice and information to the supply activity on the identity and quantity of supplies, spare parts, and materials required for maintenance actions.
6. Establish procedures to insure the periodic inventory of tools and the adequate accountability of material and equipment on custody to the cognizant organization.
7. Initiate surveys in the event of loss, damage, or destruction of accountable material.
8. Keep maintenance control advised of the overall supply situation as it affects the activity.
9. Perform cost and allotment record accounting, charting, and budgeting of cost applicable to the cognizant organization.
10. Monitor the operation of toolrooms and maintain support equipment allowance lists.
11. Maintain inventory control of authorized allowances of material.

The material control is responsible for the coordination of material ordering, receipt, and delivery. This is done in such a manner as to insure that the correct material is ordered and that it reaches the work center within the specified time frame.

The foregoing functions of the material control division apply to both Organizational and Intermediate level activities. Some of the functions which are applicable to one level only are listed in the following paragraphs.

Intermediate Level

An Administrative Screening Unit has been established in Material Control of Intermediate maintenance activities. This screening unit does the following:

1. Positively identifies material and determines if it is within the repair capability of the Intermediate Maintenance Activity (IMA).
2. Insures that all required documentation is affixed to the component (i. e., logs, records, MAF, etc.).
3. Notifies maintenance control of the receipt of defective components for scheduling into the IMA.
4. Transfers the defective components to the appropriate work center when directed by maintenance control.

All components received in the IMA material control receive screening to determine if the item is within the check, test, or repair capability of the IMA. As a result of this screening, components requiring maintenance within the IMA capability are reported to maintenance control as ready for induction. Items beyond IMA capabilities are returned to the Supply Support Center with appropriate recommendations for disposition. When work on components in the IMA has been completed, the components, together with required records, are returned to material control for appropriate routing.

Organizational Level

In addition to the general functions, material control in Organizational level activities is responsible for the following:

1. Verification of NORS (Not Operationally Ready Supply) requisitions and maintain current NORS status records.

2. Inventory of aircraft upon receipt and transfer and maintenance of inventory records.

When removed components are generated as a result of the maintenance effort, material control insures that the SSC is notified to make a pickup. These components must be accompanied by record cards and logs, when applicable, plus the number two, three, and four copy of the MAF.

Material Control Register

The Material Control Register is used by Intermediate and Organizational level activities to record all materials requested from the supply support center in direct support of weapon system maintenance. Space is provided to record essential information considered necessary to monitor OPTAR funds. This information includes part number, priority, quantity, price, date, and time ordered, and date and time received. Maintenance control uses the time ordered and time received to help determine NORS time used in fulfilling readiness reporting requirements.

When a defective repairable item is turned in, the following forms are required: copies two, three, and four of the multicopy MAF and the Accessory and Component Service Record (NavWeps Form 13090/29), when applicable. The supply department uses copy two of the MAF for bookkeeping purposes. Copies three and four of the MAF accompany the item to the IMA. When repair is completed by the IMA, copy four of the MAF is attached to the RFI item and the item is returned to the supply system.

If material being turned in is no longer required and is RFI, a Single Line Item Release/Receipt Document (DD 1348-1) is submitted with the item. RFI means ready for issue in all respects—preservation still intact and item in original or reusable container with seals unbroken.

MILSTRIP

The Military Standard Requisitioning and Issue Procedure (MILSTRIP) and Uniform Material Issue Priority System were developed by the Department of Defense to provide a common supply language and more effective supply system operations within the military establishment. This system standardizes forms, formats, codes, procedures, and the priority system.

MILSTRIP employs two forms for the requisitioning and issuing of material. The Single Line Item Requisition Document (Form DD 1348) is the basic request document submitted to the applicable supply echelon for material requirements. The issue document is the Single Line Item Release/Receipt Document (Form DD 1348-1). Form DD 1348-1 is also used to return RFI material to the supply system. These forms will be prepared by the Supply Response Section of supply for all material requested in direct support of weapon system maintenance and by the material control for material requested in indirect support of weapon system maintenance.

Under the MILSTRIP priority system there is no decision to be made in assigning priorities. The urgency of need combined with the unit's military importance when applied to the priority number chart (table 4-2) indicate the proper priority number and no deviation is allowed.

There are two allowable exceptions to the force/activity designator governed priority number system.

Priority 3 will be used by all activities for *Medical or Disaster supplies.*

Priority 6 will be used by all activities for individual and organization clothing required to fill a minimum of essential clothing in the event an individual is without the clothing required.

Every activity is assigned 1 of 5 force/activity designations according to their military importance. These designators are as follows:

I - COMBAT—The highest order of military importance. This designator is not used in peacetime unless approved by the President or the Joint Chiefs of Staff.

II - POSITIONED—U. S. Forces positioned and maintained in a state of readiness for immediate combat or direct combat support.

III - READY—U. S. Forces maintained in a state of readiness to deploy for combat.

IV - RESERVE AND SUPPORT—U. S. active and selected reserve forces planned for employment in support of approved joint war plans. This category includes training units and units in training for scheduled deployment.

V - OTHERS—All units not otherwise assigned.

Force/activity designators are assigned by the Secretary of the Navy, the Chief of Naval Operations, and Commanders in Chief of Fleets. Authority to make assignments may be delegated

Table 4-2. —Priority number chart.

Designator	A Unable to perform	B Impairs capability	C Other than routine	D Routine
I Combat	1	4	11	16
II Positioned	2	5	12	17
III Ready	3	6	13	18
IV Reserve and support	7	9	14	19
V Others	8	10	15	20

to Fleet Commanders with the exception of I - COMBAT.

The urgency of need for an aircraft spare part or aeronautical material may be determined in accordance with the following designators:

A - Material and equipment for immediate installation or use to effect emergency repairs or replacement for an aircraft mechanically incapable of flight, or an aircraft incapable of performing its primary mission.

B - Material required to effect emergency replacement or repairs without which the operational capability of the activity will be impaired and decrease effectiveness and efficiency in accomplishing assigned operational missions and tasks will result.

Material required to effect emergency replacement or repairs without which the activity can operate only temporarily as an effective unit in performing its assigned operational mission and tasks. This includes material required for aircraft overhaul work stoppage.

C - Material required for emergency repairs or replacement of specific units of inoperative equipment or systems not essential to the operational effectiveness or safety of the force/activity.

Material required for scheduled deployment.

D - Material required in preparation for operational readiness.

Material required for scheduled maintenance of a specific aircraft or system.

Material required for initial outfitting and filling of allowances.

All stock replenishment actions other than previously prescribed.

If a squadron or unit has been assigned force/activity designator III and a branch supervisor determines that a part of some material is needed which if not received will impair the capability of the aircraft to perform its assigned mission, then the priority assigned must be number 6. The only other priorities available to force/activity designated III units or squadrons are 3, 13, and 18.

PARTS KITS

Parts kits contain supporting items and material for the maintenance, repair, and rework of selected aeronautical repairable type items and will be procured, stocked, requisitioned, accounted for, and used on a kit basis as one line item.

A parts kit consists of a group of maintenance or overhaul parts that are bought, packaged, and stocklisted as a single item regardless of classification that may be included therein. Normally, these parts have either a very low unit cost or have a high replacement rate in overhaul or repair of the next higher

assembly. Depending on the complexity of the end item, there can be one or more kits needed for its repair. Parts kits are designed to serve three separate requirements as described in the following paragraphs.

C KIT (CURE-DATED OR SOFT GOODS). This kit provides cure-dated items such as diaphragms, packings, and O-rings. The C kit may also contain soft goods not subjected to age control such as gaskets and seals, plus metallic items such as screws, nuts, and washers required to be removed when cure-dated or soft goods type materials are replaced. Any metallic item placed in the C kit is not duplicated in the D kit. When mixed categories or cure-dated parts are packaged in a single container, the control or cure-date of the package must be that of the oldest cure-dated part contained therein. If cure-dated kits become overaged due to the expiration of the storage limitations, the kit must be administratively disposed of as excess material.

D KIT (OVERHAUL). This kit provides hard good spare parts required for overhaul of equipment by depot level maintenance. This kit does not contain cure-dated parts.

F KIT (FIELD). This kit provides those items that are required to be replaced at intermediate and organizational maintenance levels. These parts are normally items not requiring special tools or equipment. This kit does not contain cure-dated parts.

Part numbers for applicable parts kits for intermediate and organizational levels of maintenance are listed in the Illustrated Parts Breakdown and the Maintenance Instructions Manual. Components of kits are additionally identified in the Illustrated Parts Breakdown by a footnote and a symbol appearing to the right in the part number column and indicating which items are furnished in the kit. The Maintenance Instructions Manual utilizes a symbol keyed to the illustration to indicate parts furnished in the kit.

Presence of a new part in an applicable parts kit eliminates the necessity of cleaning, inspection, or rework of the equivalent part removed from the assembly being repaired. Removed parts in this category must be administratively condemned. Removed parts not supplied in applicable kits must be handled in accordance with instructions contained in the Maintenance Instructions Manual.

Detailed instructions on parts kits are contained in BuWeps Instruction 4423. 2.

PREEXPENDED BINS

A preexpended bin is one which contains low cost, high usage items which have already been charged to final expenditure. Many items of small dollar value are used repetitively in the aircraft maintenance program. The accepted practice is to stock these repetitively used items in the immediate maintenance area in a semi-controlled preexpended bin. Preexpended bins are normally established by the supply department in consort with the maintenance activity and are labeled, stocked, and replenished by the supply department. The normal responsibilities of maintenance personnel in this are:

1. Recommending items to be stocked.
2. Supervising the use of the bins to prevent waste, pilferage, and deterioration of the contents to a scrap heap.
3. Insuring that preexpended bins are separate and distinct from the normal "salvage" boxes located in most shops.

Preexpended bins provide repetitively used items to maintenance personnel with the minimum of effort. The material is immediately available to all shop personnel. The bins also provide the supply department with a constant and realistic demand history.

Nonstandard and/or Navy manufactured items may at times be required. These are normally obtained through the normal supply channels as outlined in local directives.

Manufactured items are those items which are source coded in the M series in applicable illustrated parts breakdown lists. Request documents submitted for manufactured items should contain additional reference data such as, part number, drawing number, and publication reference, or any other information which would be advantageous in the acquisition of the material.

Nonstandard material (material requiring open purchase) may not be procured when standard stock items are available except when the nonstandard material is considered to be indispensable. When the procurement of nonstandard material is considered essential, the originating request document must contain the following information:

1. A certification that no standard stock material is suitable.
2. A justification for the procurement of the nonstandard material.

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ROTATABLE POOLS

Rotatable pools consist of a range of selected components maintained by a specific maintenance activity, on custody from the supporting supply department. The items generally carried in the pool are those required to sustain operations where immediate availability is essential. Aircraft wheels, tires, avionics assemblies, propellers, and carburetors are examples of items that might be included in the pools. The range and quantity of items to be carried in the pool are subject to the recommendations of the maintenance activities. The supply department establishes the rotatable pool stock and prescribes detailed procedures for operation and control of the pool.

ACCOUNTING FOR MATERIAL IN USE

Accounting for material does not cease when it is withdrawn from the supply department. It is at this point that the accounting responsibility passes to the applicable maintenance personnel.

AIRCRAFT PARTS

Normally, the accounting for aircraft parts drawn to replace similar defective parts is satisfied when the part is installed on the aircraft. No further custodial records are required. The accounting for materials drawn for general maintenance is satisfied when the material is consumed in the authorized maintenance work. In these cases it is actually the removed defective material that requires additional action to insure its accountability from the time it is removed unitl it is returned to the supply department.

The degree of accountability required for aeronautical material may be ascertained by the material accountability recoverability codes (MARC). Material accountability recoverability codes are a part of the source, maintenance, and recoverability codes which are assigned provisioned items as required by current ASO and BuWeps/NavAir directives. The MARC's appear in the descriptive sections and parts lists sections of the ASO Navy Stock List, NavAir Allowance Lists, and may appear in such other publications as directed by NAVAIRSYSCOM. These codes aid personnel to determine the proper method of:

1. Requisitioning material.
2. Accounting for material while in use.
3. Turn-in or disposition of material.
4. Repair or overhaul of material.

The following list defines the various material accountability codes.

B - Exchange Consumables. Code B is applied to items which are consumable or expendable but normally require item-for-item exchange for replacement. Such items may contain precious metals, may be highly pilferable, or may be high cost items.

C - Consumables. Code C is applied to all other consumable or expendable items which do not require item-for-item exchange for replacement.

D - Equipage, Support Type. Code D is applied to end items of support equipment which are economical and practical to repair on a scheduled basis through a major rework activity. Code D items are maintained on a custodial basis and normally require item-for-item exchange for replacement.

E - Equipage, Locally Repairable, Support Type. Code E is applied to end items of support equipment which are to be repaired locally by the using or fleet support activity within their assigned maintenance responsibility. Code E items are maintained on a custody basis and normally require item-for-item exchange for replacement.

R - Equipage. Code R is applied to repairable (except end items of support equipment) items which are economical and practical to repair on a programed basis through a major rework activity. Code R items are maintained on a custody basis in some cases, depending upon the use of the item. These items normally require item-for-item exchange for replacement.

L - Equipage, Locally Repairable. Code L is applied to repairable (except end items of support equipment) items which are to be repaired locally by the using or fleet support activity within their assigned maintenance responsibility. Code L items are maintained on a custody basis in some cases, depending on the use of the item. They will normally require item-for-item exchange for replacement.

Some allowance lists may still be in use which utilize a different accountability code system than MARC. The following equivalents may apply, pending issuance of new publications

using the latest material accountability recoverability codes:

MARC	INTERIM	OLD
D	A	A
D	O	A
D	E	AX
R	R	X
B	D	NONE
C	C	C
E	NONE	NONE
L	NONE	NONE

As is apparent upon reviewing the material accountability recoverability codes, the disposition of defective material is largely dependent upon its potential repairability. Codes D, E, R, and L signify that the item is repairable and is required to be returned to the supply system even though it is not RFI. The need for the expeditious handling of prospective repairable material cannot be over-emphasized. The repair program is the prime source of supply for many critical high value items. Code C items are normally consumed or are not of a repairable nature and do not require turn-in if non-RFI.

An aeronautical material screening unit is established by all activities assigned the responsibility to perform intermediate level maintenance. The basic responsibility of the screening unit is to screen all defective aeronautical material generated on the station by tenant squadrons and station operating units prior to further processing of the material by the supply system or higher echelons of maintenance. The screening unit determines if such material is within the repair responsibility of local intermediate maintenance activities and, if so, initiates action to effect its local repair.

Normally, the following sequence of events should be followed in the repair of aeronautical material:

1. The using activity should repair the defective item without removal from the aircraft.
2. The using activity should remove the defective item from the aircraft, check, test, and repair it within their assigned responsibilities and replace it on the aircraft.
3. In the event the item requires repair and the time involved is excessive from the operational or readiness point of view, the using activity may draw a replacement item from supply. The defective item should be forwarded to the supporting intermediate maintenance activity's screening unit.
4. This screening unit determines if the item is within the repair responsibility of the intermediate maintenance activity, and, if so, the item is repaired and forwarded to supply as RFI. If not, the item is forwarded to supply as prospective repairable material.

The basic form used in the reporting of failures, deficiencies, or malfunction of aeronautical material is the Unsatisfactory Material Condition Report (UR), NavWeps 13070/5. It is designed so that certain copies may also be used for custodial purposes of the defective material including its return to the supply department.

AIRCRAFT MAINTENANCE SUPPORT EQUIPMENT

Developing and supervising proper procedures to insure the maintenance and accountability of aircraft maintenance support equipment (AMSE) is normally a prime administrative function of the senior technician. Unlike most aircraft parts, AMSE requires the maintenance of custodial records and periodic physical inventories throughout its in-use life.

Aircraft maintenance support equipment as discussed in this chapter applies to all accountable type support equipment listed in NavAir Allowance Lists, Sections "G," "O," "R5," "T," and "TBA's." Accountable AMSE items are those assigned material accountability recoverability codes "D" and "E." These items are assigned material control code X which appears as part of the federal stock number identification.

Because stocks of AMSE are so limited, issues are strictly controlled to insure proper program support. After initial outfitting, AMSE items are issued on an item-for-item exchange basis. When an AMSE item is lost, missing, or beyond economical repair, and replacement is required, approval of the replacement item is granted only when accompanied by a copy of the survey document. Aircraft maintenance support equipment is issued by the supply activity to the end user only upon approval by the following:

1. The cognizant type commander or his designated representative for fleet and training command activities.
2. The cognizant NavAirSysComRep for Naval Air Rework Facilities (NARF's) and shore activities.
3. ASO for special programs, bailment programs, military aid programs (MAP), etc.

Aircraft maintenance support equipment includes such items as test stands, lubricating guns, special wrenches, drills, compass testers, and voltmeters as listed in the Allowance Lists mentioned above. These equipments are made available as organizational property or custody/subcustody from supporting station/squadron/vessel dependent upon the characteristics of the equipment and the assigned maintenance, operational, and/or logistics responsibilities. Except for vessels, equipments required are authorized through the application of appropriate allowance lists as shown in enclosure (2) to BuWeps Instructions 04700. 3. This enclosure consists of an allowance list applicability chart (ALAC) for each activity of the naval shore establishment indicating the equipment by allowance list category authorized to specific activities. Actual equipment authorized for naval vessels may be determined from BuWeps Instruction 4423. 3 (Series).

Under the aircraft maintenance material readiness list (AMMRL) program all applicable intermediate and/or organizational maintenance support equipment listed in the various allowance lists are consolidated into one individual material readiness list (IMRL) for each aircraft maintenance activity. Each IMRL is approved by the cognizant fleet or training command and is used as the firm mandatory material readiness list of the activity to which the list applies.

All aircraft maintenance support equipment must receive continued accountability while in use. The activity having prime custody of the support equipment is considered to be the accountable activity. Equipment furnished as organizational property is accountable activity. Equipment furnished as organizational property is accounted for by the holder of such equipment. Equipment furnished or received on subcustody is accounted for by the supporting activity.

The department head is held responsible for the maintenance support equipment in his department. Senior Petty Officers normally are required to receipt on subcustody for all the AMSE in their shops. Periodic inventories are required to ascertain if material for which you are responsible is actually on hand. Material which cannot be accounted for must be surveyed.

An annual inventory of in-use aircraft maintenance support equipment is required to provide ASO and Naval Air Systems Command with an accurate assessment of the quantity and condition of this support equipment in the possession of custodians in order that sound decision can be made concerning the procurement of new and replacement equipment. Type commanders or the NavAirSysComRep forwards to all activities having reportable items of support equipment a deck of EAM cards and/or an EAM listing indicating those items of support equipment requiring inventory. Care should be taken to insure that items held or issued on a custody basis are reported only by the controlling custodian.

Transaction reporting of selected AMSE items is sometimes required. Type commanders or NavAirSysComRep selects the items of AMSE desired to be reported on a transaction basis and publish appropriate instructions for reporting. Upon receipt or transfer of an item of AMSE (subject to transaction reporting) on a permanent basis, or when the condition or status of equipment changes, activities are required to submit a transaction report.

HIGH VALUE ASSET CONTROL SYSTEM

The high value asset control system (HIVAC) is the result of SecNav Instruction P4440. 29 (Series). This instruction prescribes a Navy-wide high value item management program. The purpose of the program is to achieve inventory economies without impairing combat readiness. In the past the military services have been criticized for management deficiencies which led to accumulation of costly excess stocks.

The need for specialized, intensive management attention to a relatively small percentage of items can be better understood when considering the ever-increasing costs of weapon systems and the increase in the costs of the major supporting spares and components for these systems. These costs have had an impact on the national economy approaching that of military expenditures of World War II.

By using the best techniques in the management of high value items, which represents approximately 40 percent of the annual procurement dollar expenditure, inventories and procurement investments can be reduced considerably and still maintain an acceptable level of readiness.

High value items, as described in BuSandA Instruction 4440. 105 (Series), and identified by a specific material control (fraction) code on all supply documents as follows: Repairable items with a unit cost of $1, 000 or more

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are assigned Material Code "G." Consumable items with a unit cost of $1,000 or more are assigned Material Code "J." There are control codes assigned to items other than those mentioned, but these two require worldwide movement accounting.

Although the technician is not directly involved in the program, he is involved at fleet level in that some of these items will be installed in aircraft or held in rotatable pools for which he may be required to assume responsibility. The major responsibility of fleet personnel is supply discipline, since supply discipline in the fleet is an especially critical aspect of the high value program. This is because of the greater difficulty of maintaining accountability under the pressure of operating conditions. Also, prompt action on the part of fleet personnel to expedite handling of high value items is essential to the program. For complete and detailed information concerning the HIVAC system, refer to the instruction previously mentioned in this section.

SURVEYING ACCOUNTABLE MATERIAL

When property must be reevaluated or expended from the records due to loss, damage, deterioration, or normal wear a survey must be made to obtain proper authority to write this material off the books. The survey request provides a record showing the cause, condition, responsibility, recommendation for disposition, and authority to expend material from the records. Think of a survey as being an administrative examination into the cause of material being lost to use. A survey may be either informal or formal, depending on the circumstances.

A formal survey is required for those classes of materials or articles so designated by the bureaus, commands, or offices concerned, or when specifically directed by the commanding officer. A formal survey is made by either a commissioned officer or a board of three officers. At least one of the board members must be a commissioned officer. The commanding officer appoints those who serve on the survey. Neither the commanding officer, the officer on whose records the material being surveyed is carried, nor the officer charged with the custody of the material being surveyed, may serve on a survey board.

An informal survey is made by the head of the department having custody of the material to be surveyed. Informal surveys are used in all cases when a formal survey is not required or directed by the commanding officer.

Preparation of Request for Survey

You will not have the responsibility of preparing final survey forms; however, as a first class or chief, you are apt to be required to provide your division officer with certain information when he is making a survey. Because of this, you should be familiar with the general procedures that are followed.

A request for survey may be originated by a department, division, or section head or a designated subordinate as prescribed by local regulations. Normally, requests for survey are originated in the department having custody of the material being surveyed. The initial survey request is made on a rough copy of S. and A. Form 154. A statement by the originator is placed on or attached to the request for survey relative to the condition of material; cause of condition surrounding the loss, damage, deterioration, or obsolescence of material; responsibility for cause or condition of material or reason why responsibility cannot be determined; and recommended disposition of material or action to be taken.

Upon receipt of the rough copy, the designated group or section prepares a sufficient number of smooth copies of the request for distribution in accordance with local regulations. The smooth survey request is filled out down to the caption Report. It is then forwarded to the commanding officer who will determine whether the survey will be formal or informal. If formal, the survey request is forwarded to the designated surveying officer(s); if informal, it is forwarded to the head of a department for survey action.

The statement by the originator as to cause, condition, etc., is attached to the smooth request for survey for evaluation by the surveying officer(s). After the survey has been completed by the head of a department or surveying officer(s), it is returned to the commanding officer for review and action. After approval by the commanding officer, the survey request is forwarded to the cognizant command for final review and approval when so required.

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CHAPTER 5

AVIONICS MAINTENANCE SUPERVISION

The job of supervising the operation of a division or shop is a many sided task. Some of the techniques will have been learned through past experience. Others may be learned from self-study courses and technical publications. Still other techniques will have to be learned during the actual supervision of the division or shop. The purpose of this chapter is to acquaint the new supervisor with some of the more important aspects of shop supervision.

OBJECTIVES OF SUPERVISION

Briefly, the objectives of supervision are as follows:

1. To operate with maximum efficiency and safety.
2. To operate with minimum expense and waste.
3. To operate free from interruption and difficulty.

While these are the primary objectives of shop supervision, it is well for the man who may be assigned these duties to keep in mind the fact that his new assignment is important to him personnally, since it affords him in an excellent opportunity to gain practical experience toward future promotions.

OPERATION WITH MAXIMUM EFFICIENCY AND SAFETY

The operational efficiency of a shop is dependent to a large extent upon how conveniently the work spaces and equipment are arranged in the shop and upon the extent to which the shop, files, and equipment are maintained. Equipment in good working order, tools in good shape and of the proper type and quantity, and an up-to-date file of applicable publications are all important factors toward a smoothly running aircraft maintenance shop.

As some equipment becomes obsolete and new equipments and new models of equipment are phased into the shop inventory, the efficiency will increase to a certain extent, but may still be short of the full potential. Making a drastic rearrangement to improve the utilization of a single piece of equipment may not be economically feasible; however, a drastic change which results in improved utilization of several equipments may be worthwhile. The new shop supervisor will want to make an evaluation of the existing shop layout to assure himself that he has the most efficient arrangement possible.

The shop functions may be further smoothed by the judicious delegation of authority. The delegation of authority does not relieve the supervisor of the final responsibility for work accomplishment. It is primarily a means of relieving the supervisor of details. A supervisor who allows himself to become too involved with details loses his effectiveness as a supervisor.

A supervisor should know his men's limitations and capabilities in order to get the most work out of them. He should exploit the capabilities of his best men in a twofold manner. If at all possible he should assign a well-qualified man to do a certain job and add to the team other individuals who are less qualified but who are professionally ready for advanced on-the-job training.

The supervisor must anticipate the eventual loss of his most experienced workers through transfers, discharges, etc., and offset this by the establishment of an effective and continuing training program. In addition to raising the skill level of his division, the training program will insure that personnel, otherwise qualified, will be ready for the advancement in rating examinations.

A shop safety program must be organized and administered if the shop is to function efficiently. Current Navy directives and local policies are quite specific as to the establishment of safety training programs. A worker

is not much good to anyone if he is laid up in the sickbay.

The keeping of accurate and complete records is another factor in the efficient operation of a shop. The most efficient recordkeeper is one who has enough records without having his files bulging with useless and outdated material.

A knowledge of the principles of man-hour accounting is necessary in the efficient utilization of the manpower available. The supervisor should schedule his workload in such a way that planned absences of key workers will not unduly interrupt the daily routine. When scheduling the workload, he should keep in mind the skill level required for the various tasks and assign individuals to jobs in such a way that the work may still progress if any worker is unexpectedly absent.

OPERATION WITH MINIMUM EXPENSE AND WASTE

The efficiency of any operation is directly related to the expense involved. The shop supervisor has responsibility for ordering and accounting for parts and materials. He must impress upon his men the need for being thrifty in the use of these materials. There are many ways to economize, and the supervisor and his senior petty officers should always be on the alert for opportunities to point out these ways to the less experienced individuals.

Methods of avoiding waste and unnecessary expense should be included in the shop training program.

PROVIDING FOR INTERRUPTION

During an average workday, occasions will arise when personnel have to leave their working spaces for one reason or another, thereby delaying the scheduled work. Some delays can be anticipated; some cannot. Among the delays that can be anticipated are training lectures, immunization schedules, flight schedules, rating examinations, meals, and watches and other military duties.

Before making personnel work assignments the supervisor should determine what delays can be anticipated. It may be possible to arrange assignments so that work interruption is held to a minimum. When estimating the completion time of an aircraft maintenance task, the supervisor should allow for these predictable delays.

UNFORESEEN DIFFICULTIES

Some difficulties are impossible to predict. The weather, for instance, cannot be relied upon for full cooperation in the maintenance effort. The supervisor must have a flexible schedule planned to provide for such events if he expects to contribute maximum support to his unit. The flight schedule itself is seldom ever completed without a few changes. Usually these changes will involve a rearrangement of previously planned maintenance tasks. Again the supervisor must be as well prepared for such interruptions as possible and be able to reassign his men, if necessary, with the least amount of confusion and loss of time.

SHOP ORGANIZATION

A well-organized shop will provide a safe and comfortable working area, allow for maximum use of space available, and produce the most toward the maintenance effort.

SHOP LAYOUT

The average Chief or First Class Petty Officer may never have the opportunity of planning the layout of an Avionics shop in a new facility. In almost every case, the new supervisor will take charge of an already functioning division or, when his squadron or unit moves to a new base, he and his crew will usually be assigned to spaces already basically equipped. In either case, a reevaluation of the shop's layout is indicated. This reevaluation should include checking the most recent applicable allowance lists to see if the shop equipment allowances have been changed in any way. There is no use relocating equipment which involves rewiring work if improved replacement models are authorized and available.

A change in assigned aircraft model designation may call for a reevaluation of the shop layout.

When planning for new installations, the supervisor should utilize the Design Guide for Avionics Shop Power Distribution, NavWeps 01-1A-512.

The ideal setup contains enough space to have all the avionics shops in separate spaces in a centrally located area. Since this is not always possible, the supervisor must decide what shops are to be combined, if any, and in what areas of each space the appropriate equipment is to

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be installed. This decision should be based on factors of safety, economy, functional compatibility, and convenience.

The shop layout plan should make provisions for an information or bulletin board upon which may be posted safety posters, maintenance posters, instructions and notices, plans-of-the-day, and such other information as is appropriate from time to time. The bulletin board should be located in a prominent place in the shop, preferably near the entrance where everyone asigned will have to pass at some time or another during the day. Material on the bulletin board should be changed frequently, expired notices promptly removed, the current plan-of-the-day posted early, and other posters and materials rotated periodically. If the same material is presented in the same format every day, it will not be long before the men begin to ignore the bulletin board and purposes for having it are defeated. New arrangements are noticed and interest is stimulated with variety.

BENCH ARRANGEMENT

Following the determination of what shops are to occupy what spaces or areas within a space comes the arrangement of furniture and equipment for the various shops.

The arrangement of the shop furnishings should be made on the basis of utility rather than appearance. Moving an item of equipment into an out-of-the-way corner may greatly improve the appearance of the shop but at the same time reduce the efficiency of personnel using the equipment and may possibly create a safety hazard. A good rule to follow is to locate equipment where it can be safely used by the greatest number of people with a minimum of effort in the least amount of time.

In view of the fact that standard avionics workbenches are normally used in shops where actual maintenance and testing of equipments are accomplished and that these benches usually become fixed in their position (due to test harness and cabling arrangements) there will be few benches or worktables to consider. Worktables or workbenches that are not permanently installed should be positioned with respect to fixed equipment so that they can be safely, quickly, and easily reached when work is being performed that requires their use. In an area where intricate maintenance functions are to be performed, such as disassembly and repair of miniature components, consideration should be given to special interference-free type lighting.

If a separate shop space is not provided for classified equipments, then placement of these equipments in a section of the shop where the physical arrangement provides limited or controlled access is desired.

SAFETY

Operational readiness of a maximum number of aircraft is necessary if naval aviation is to successfully perform its mission. Keeping its aircraft in top operating condition is the principal function of naval aviation maintenance personnel. It is essential that maintenance work be performed with a minimum of injury to personnel and damage to equipment and aircraft.

Aircraft maintenance is, to some extent, naturally hazardous due to the nature of the work, the equipment and tools involved, and the variety of materials required to perform many repairs and maintenance functions. Factors which can function to increase or decrease these hazards are (1) the experience levels and mental attitudes of assigned personnel, and (2) the quality of supervision of the maintenance tasks. Thorough indoctrination of all personnel is the most important single step in maintaining safe working conditions.

The concept of aircraft maintenance safety should extend beyond concern for injury to personnel and damage to equipment and aircraft. Safe work habits go hand-in-hand with flying safety. Tools left in aircraft, improper torquing of fasteners, and poor housekeeping around aircraft can cause conditions which may claim the lives of flying personnel as well as cause strike damage to aircraft. Safety on the ground is equally as important as safety in the air.

A recent type commander letter states in part, "While the increased complexity of our modern aircraft is a factor, it is noted that a large number of maintenance-error-caused accidents and incidents are due, not to complexity of equipment, but to lack of supervision and technical knowledge. Many mistakes are simple ones in routine maintenance."

Safety in aircraft maintenance depends largely upon the supervisory personnel. The standards of quality which they establish are directly reflected in the quality of the aircraft maintenance. The primary duty of the senior petty officers

is to supervise and instruct others rather than to become totally engrossed in actual production. Attempts to perform both functions invariably result in inadequate supervision and greater chance of error. Supervisors must exercise mature judgment when assigning personnel to maintenance jobs. Consideration must be given to each man's experience, training, and ability.

Sometimes overlooked in a maintenance program are the considerations generally grouped under the term "human factors." These factors are important in that they determine if an individual is ready and physically able to do work safely and with quality. Supervisory personnel should be constantly aware of conditions such as general health, physical and mental fatigue, unit and individual morale, training and experience levels of personnel, and other conditions which can contribute in varying degrees to unsafe work. Not only is it important that proper tools and protective clothing and equipment are available for use, but also the insistence by maintenance supervisors that they are used is of increasing importance with modern high performance aircraft. For example, maintenance personnel are sometimes negligent in the wearing of protective hearing devices in high noise areas.

There are several areas in which the shop supervisor can effectively work to minimize accidents incident to aircraft maintenance. Among these are continuing inspections of work areas, tools, and equipment; organization and administration of safety programs; correct interpretation of safety directives and precautions; and energetic and imaginative enforcement of them.

Technical knowledge also plays a large part in a good maintenance safety program. The complexity of our modern equipment demands the attention of well-informed and expert maintenance personnel; otherwise, our weapons system cannot be operated and maintained. Technical knowledge is a function of education and training which, incidentally, does not end with graduation from school. Graduation is only the beginning. Any technician worthy of his rating is continually training and learning through self-study and application, and through a personal desire for proficiency and self-betterment. But technical knowledge by itself is not sufficient unless it is coupled with an old-fashioned craftmanship that receives gratification and keen satisfaction in doing any job well. The man who wishes to contribute to safety and reliability improvement must know his job and must develop professional pride in the quality of his work.

It is a continuing duty of every person connected with aircraft maintenance to try to discover and eliminate unsafe work practices. Accidents which are caused by such practices may not take place until a much later date and their severity cannot be predicted. The consequences may range from simple material failure to a major accident resulting in serious injuries or fatalities.

ELIMINATION OF HAZARDS

Most accidents which occur in noncombat operations can be prevented if the full cooperation of personnel is gained and vigilance is exercised to eliminate unsafe acts. The supervisor should diligently inspect work areas, tools, and equipment to detect potentially hazardous and unsafe conditions and take appropriate corrective action. Since maintenance personnel will be working in the shop, in the hangar, and on the line all of these areas should be included in the supervisor's inspection. He should check for explosion or inhalation hazards due to improper ventilation of working spaces, or careless handling of materials.

Spilled oil, grease, and chemicals should be wiped up promptly, and all rags used should be disposed of in covered metal containers.

Handtools should be in good shape, of the proper type, and used only for the purpose for which they were designed.

Fire hazards present another serious problem. "No Smoking" rules should be strictly enforced. Ground wires should be installed on every aircraft during maintenance to eliminate dangerous static electrical buildups.

GROUNDING

Grounding power tools and other equipment is a must and the supervisor is the man to see that this is done. It should not be necessary for a technician to be killed to once again emphasize the absolute necessity that portable power tools and other equipment be properly grounded. The importance of installing safety grounds to the cases of power tools or equipment must be stressed as a case of life or death-that is exactly what it is.

Another aspect of this problem, which deserves attention in a poor safety ground or one that is wired incorrectly. This may be more dangerous than no ground at all. A poor ground is dangerous because it does not offer full protection, yet it lulls the user into a false sense of security. The incorrectly wired ground is a hazard because transposing one of the line wires and the safety ground makes the shell of the tool "hot" the instant the plug is connected. Thus the unwary user is trapped unless, by pure chance, the safety ground is connected to the grounded side of the line on a single-phase grounded system. In this case, the user again goes blithely along using the tool until he encounters a receptacle which has its wires transposed.

The need for a safety ground is not hard to realize when you know that a few years ago statistics showed that, over a given period, 50 percent of the deaths in the Navy due to electric shock were caused by 115-volt electric potentials.

The reason for this high percentage is as follows: When the current through the body nears 100 milliamperes, death is almost certain. The body resistance, assuming dry skin, varies from about 1,000 to 500,000 ohms. With a 115-volt potential, a body resistance as low as 1,150 ohms can produce the necessary 100 milliamperes. With perspiration or water on the victim's hands, the body's resistance can go as low as about 300 ohms, resulting in a current of 384 milliamperes, which is normally lethal.

Portable power tools afford you an excellent opportunity to become part of a circuit. For example, if the motor winding is shorted to the case, the case will be at the same potential as the power applied. Then the path of least resistance may be you.

These facts caused SecNav to formulate the policy of grounding any exposed, noncurrent-carrying parts of electrically operated equipment powered from supply circuits of more than 50 volts. Several safety measures have been adopted to implement this policy.

In an effort to make certain that a safety ground is used, a requirement has been established for a 3-wire, color-coded cord with a polarized plug having a ground pin.

Since the polarized plug can be connected only to a mating receptacle, the user has no choice but to use the safety ground. (Adapters to change three-prong plugs to two-prong plugs are sometimes furnished, but they should never be used with power tools.) Supervisors should insure that the ground pin is not removed from the polarized plug. The color coding has been standardized to conform with the National Electric Code. All new tools which are properly connected use a green wire as the safety ground. The wire is attached to the metal case of the tool at one end and to the grounding pin in the connector at the other end. It normally carries no current, being used only when the tool insulation fails to bypass the current around the user to ground. Black and white leads are used as the current-carrying conductors: the white lead is the power ground of a single-phase system, and the black lead is hot.

The three-pin plugs and their receptacles have been designed to minimize the possibility of incorrect wiring. Looking at the end of a plug, you will notice that the pins are constructed so that they can be put into the receptacle in only one position. The ground pin is the longest and therefore will mate first and break last, insuring that the safety ground is connected at all times when power is applied to the circuit. In addition, the plugs are usually color coded. The three-prong plugs ordered under FSN N5935-280-2380 (Connector Plug, Electrical) have color-coded screws: The terminal screw on the safety ground prong is painted green; the neutral prong and screw are silver; and the terminal screw on the hot pin is brass. Thus, there should be no confusion when installing this type of plug.

One fact must be kept in mind when installing safety ground hardware. Although all portable power tools need this feature, some items of sensitive test equipment should not have their cases grounded. Grounding the case of some VTVM's, for instance, creates a possible ground loop which will support spurious signals, thereby hindering measurement accuracy.

If a cable requires replacing, be certain to replace it with the proper color-coded cord; and make sure that the green conductor is connected to the shell of the equipment. If the shell consists of more than one piece, make sure that all pieces are connected. Clean off any paint, and scrape the metal beneath it to make a clear, clean surface at the point of connection.

When it is necessary to use an extension cord, use only the type that has a grounded

plug attached to one end and a grounded receptacle (suitable for connecting to the grounded tool plug) on the other.

If the tool or equipment is adequately grounded through a supporting bracket or bulkhead fastener, you need not use the ground cable. For your own protection, however, you should check the resistance to ground with a low-reading ohmmeter to be certain that the grounding is adequate (less than 0.1 ohm is acceptable). If the resistance indicates greater than 0.1 ohm, use either a separate ground strap or a three-wire cord; and check the ground connection to be certain of a good contact.

When installing a new cord or checking the tool for safety, examine the cord connections carefully. The cable wires should terminate in a standard crimped or solder type lug or connector; or, if stranded wire is used without a lug, the ends should be solder dipped. Form the wire into a loop (in the direction of the screw rotation) around the connecting screw; and make absolutely certain that no loose, fine strands of the flexible wire cord protrude to cause an accidental contact with the shell of the tool, receptacle, or plug.

High Voltage

All radars employ voltages which are dangerous and may be fatal if contacted. Practical safety precautions have been incorporated into every radar system; however, when the most basic rules of safety are ignored, the built-in protection becomes useless.

The following rules are basic and should be followed at all times by all personnel when working with or near high voltage circuits:

1. CONSIDER THE RESULT OF EACH ACT—There is absolutely no reason for individual to take chances that will endanger his life or the lives of others.
2. KEEP AWAY FROM LIVE CIRCUITS—Do not change tubes or make adjustments inside the equipment with high voltages on.
3. DO NOT SERVICE ALONE—Always service equipment in the presence of another person capable of rendering assistance or first aid in an emergency.
4. DO NOT TAMPER WITH INTERLOCKS—Do not depend on interlocks for protection; always shut down equipment. Never remove, short-circuit, or tamper with interlocks except to repair the switch.
5. DO NOT GROUND YOURSELF—Make sure you are not grounded when adjusting equipment or using measuring equipment. Use only one hand when servicing live equipment.
6. Do not energize equipment if there is any evidence of water leakage; repair the leak and wipe up the water before energizing.

These rules, teamed with the idea that "voltage is not a respecter of persons" and that personal caution is your greatest safeguard, may prevent serious injury or even death.

ORGANIZATION AND ADMINISTRATION OF SAFETY PROGRAMS

In accordance with the Navy policy of conserving manpower and material, all naval activities are required to conduct effective and continuous accident prevention programs. The organization and the administration of a safety program are part of the requirements of the supervisor. The safety program must be in accordance with local instructions and based on information contained in the Navy safety precautions manuals which are presently undergoing a revision. Work methods must be adopted which do not expose personnel unnecessarily to injury or occupational health hazards. Instructions in appropriate safety precautions are required to be given and disciplinary action taken in case of willful violations.

The shop safety program will generally involve three areas of attention—the posting of the most important safety precautions in appropriate places, the incoporation of safety lessons in the formal training program, and frequent checks for understanding during the day-to-day supervision of work.

Posted safety precautions are more effective if they may be easily complied with; for example, a sign on the electronic test bench reads "ground high voltage of terminal before working on or near video indicator." Thus, a high voltage grounding probe should be installed in a convenient location.

Fixed posters and signs should be renewed frequently and not allowed to become rusty, faded, or covered with dust and dirt. General safety posters on bulletin boards and other places should be rotated often to stimulate interest. Appropriate safety posters may be obtained from the squadron or unit safety officer.

The formal safety training sessions should utilize films, books, visual aids, or any other

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suitable technical material. The men should be told more than just what or what not to do. Each safety subject should be explained in detail. The results of unsafe acts are usually the most dramatic and easiest remembered. Causes of accidents and contributing factors should be reviewed and analyzed. Many good ideas for accident prevention have been developed in training sessions.

An extensive series of lessons may be developed over a period of time as latent hazards are recognized, and this will aid in keeping the sessions interesting while avoiding too frequent repetition.

It may be well to mention the new man in the shop at this point. A separate safety indoctrination lesson which covers all the major hazards of the shop should be given the new man as soon as he reports for work. The supervisor with an effective safety program and an excellent shop safety record will take steps necessary to make sure that the new man is properly instructed, so as to prevent his being hurt.

In the third area of safety program administration—followup, the supervisor will do well to delegate authority to his subordinate petty officers to assist him in monitoring the program. Also included in the followup area is a responsibility of the shop supervisor to inquire as quickly and thoroughly as possible into the circumstances of accidents and reports of unsafe practices and take action or make recommendations.

Safety precautions are designed to cover usual conditions in naval activities. Commanding officers and others in authority are authorized to issue special precautions to their commands to cover local conditions and unusual circumstances. The shop supervisor will have to apply both sets of rules in the administration of his shop safety program.

Safety directives and precautions should be followed to the letter in their specific application. Should any occasion arise in which any doubt exists as to the application of a particular directive or precaution, the measures to be taken are those which will achieve maximum safety.

When new safety posters or precautions are posted, it is the responsibility of the shop supervisor to correctly interpret their application to his men. In this way he will be able to achieve a unity of thought and action in the observance of the required safety rule.

The organization's safety officer is available to assit in interpreting and suggesting ways of implementing various safety directives and precautions. Current directives require that a safety officer or safety engineer be assigned as head of the safety department, division, branch, or section, whichever is applicable, at all shore stations.

In most instances the hazards involved and the applicable precautions for a given type of work are the same whether the work is done afloat or ashore.

RADIOACTIVE TUBES

Radioactive material is used in quite a number of spark gap, TR, glow lamp, and cold cathode tubes.

In many cases the personnel charged with maintenance of equipment that contains radioactive material are not aware that they are handling radioactive matter. Even if they do know, they are quite likely to take the matter too lightly.

Radioactive materials are intentionally added to the tubes to produce a continuous supply of ionized particles in the tubes. This assures that the tubes will always operate at the same voltage.

The radioactive material causes the tube to produce a continuous supply of ionized particles whether the tube is in storage, in transit, in the equipment, or in disposal containers. The general concept is that ionization occurs only when the keep-alive voltage is applied to the tube. This is fallacious, since the voltage only increases the rate of ionization; it does not affect the rate of decay of the radioactive material.

Radiological Hazards

Radioactive tubes, as normally used and stored aboard stations and ships, do not subject personnel to a dangerous amount of external radiation. As long as the radioactive tubes are not broken, the hazard is slight; but as soon as the tubes are broken, the hazard is increased because internal radiation is then possible by inhalation of radioactive materials. However, they should be handled very carefully to prevent breakage; also, it is recommended that technicians do not remove radioactive tubes from cartons until they are ready to be used. This will preclude the possibility

of the accumulation of unpacked tubes and help prevent accidental breakage.

Handling Broken Tubes

When a radioactive tube has been broken, it is advisable to observe the following rules, which apply when any material is contaminated by radioactivity:

1. Contact a medical officer.
2. Never permit any material contaminated by radioactivity to come in contact with any part of the body at any time. Wear rubber or plastic gloves at all times when it is necessary to handle radioactive wastes or broken radioactive parts.
3. Do not bring food or drink into the contaminated area or near any material that is radioactive.
4. Immediately after leaving the contaminated area, if you have handled radioactive material in any way, remove any clothing which might have become contaminated, and wash your hands and arms thoroughly with soap and water, especially before eating, drinking, or smoking.

Disposal

In order that the Atomic Energy Commission (AEC) shall have cognizance of all disposal areas, amounts deposited in each area, and disposal procedures, SecNav Instruction 4555.1 directs that all naval activities shall dispose of radioactive waste by transferring them to an activity licensed by the AEC or to an AEC land disposal site, except in certain cases which are described in the instruction.

In general, radioactive electron tubes should not be disposed of individually, but should be collected in a designated container with a tight-fitting lid and suitable markings until a reasonable quantity for disposal has been gathered.

Tube and Container Markings

There are two types of marking or labeling of commodities and their containers, based on the level of activity of the radioisotope contained. Detailed information concerning the requirements of these markings and a list of the radioactive isotopes can be found in MIL-M-1959OC.

Type I or type II markings must be placed on the radioactive source enclosure and on each surrounding container so that the presence of the radioactive material can be readily recognized and its location determined.

The color of both type I and type II symbols and the words "DANGER" and "CAUTION" will be magenta (purplish red) on a yellow background. Type I marking is as shown in figure 5-1. The words "controlled disposal required" mean that, as directed by SecNav Instruction 4555.1, naval activities must dispose of radioactive wastes through organizations licensed by AEC or through AEC land disposal sites whenever practicable. AEC controls the disposal locations and the amount of radioactive material deposited at each location in order to reduce potential hazards to the public.

Type II marking is shown in figure 5-2. The words "accountability required" means that each organization that uses and/or stocks radioactive tubes must keep records showing the receipt, transfer, export, and disposal of such items in accordance with existing instructions. For special instructions concerning type II markings, refer to MIL-M-1959OC.

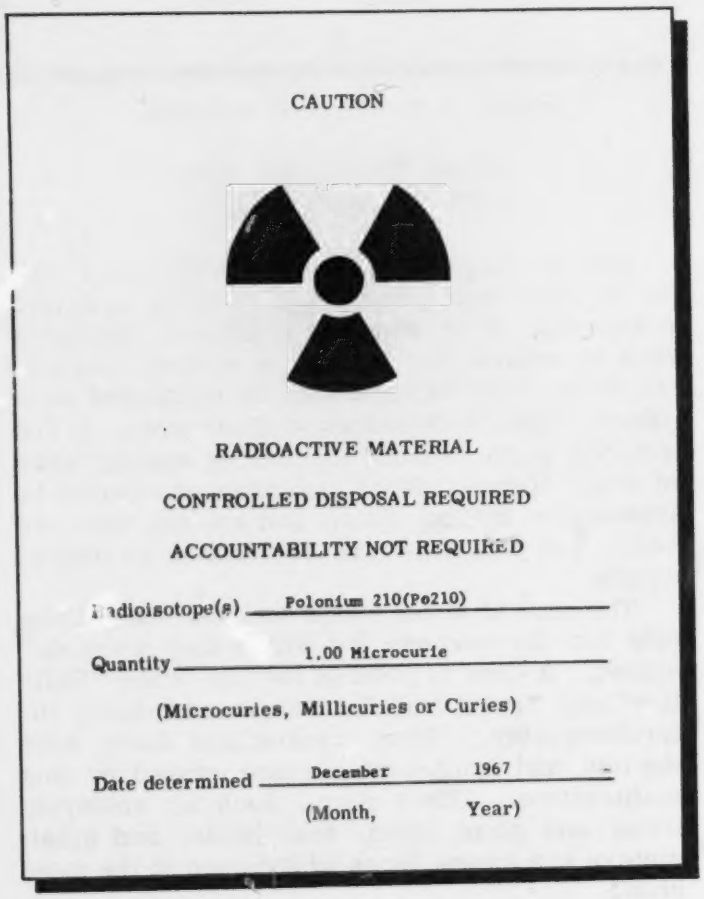

Figure 5-1.—Type I marking.

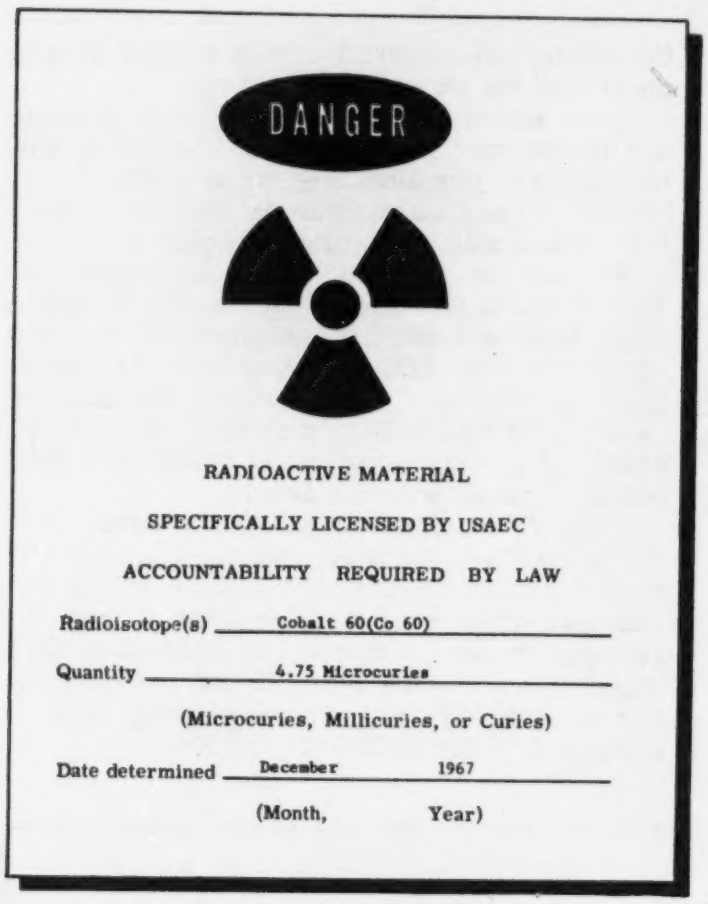

Figure 5-2. —Type II marking.

CARE OF TOOLS AND TEST EQUIPMENT

One of the problems of the supervisor will be the care and proper use of tools and test equipment. It is sometimes difficult for some men to realize the need of a special effort in the care of the tools and other equipment necessary in the performance of their work. There are two main reasons for taking special care of these items: First, maintenance would be impossible without them; and second, they are costly and therefore are sometimes in limited supply.

The care of these items includes using them only for the purpose for which they were designed. A case in point is the use of the "Phillips" and "Reed and Prince" screwdrivers interchangeably. Most technicians have seen the tool and equipment damage caused by this malpractice. Other items such as soldering irons and guns, files, test leads, and small meters are among those which receive the most abuse.

Test equipment is expensive and delicate; therefore, the care and proper use of this equipment will be of great concern to the supervisor. If the care of such equipment is not emphasized, it will soon deteriorate to a point where it is useless and, in fact, may even become dangerous. Meter leads must be properly stowed to prevent loss or damage; and if a cover is provided, it should be installed when the meter is not in use.

A system of stowing tools and other equipment must also be devised. The place for all tools should be marked, and everything not being used should be returned to its proper place. Toolboxes issued to shop personnel should contain a duplicate inventory list of tools issued with the box. The original should be kept in the shop files. Periodic inventory of these toolboxes is necessary since it is impossible to operate without an occasional loss or damage of tools.

TRAINING OF PERSONNEL

Training of personnel is a necessary function and one of the most important responsibilities of the supervisor. Even if a supervisor is fortunate enough to have a group of men who are highly skilled and well trained, he will find that training is still necessary. For example, the training of strikers and lower rated men for advancement in rating examinations is a continuing, never-ending process. The Navy rotation policy being what it is, all men will eventually be transferred and replacements will be received aboard. The replacements will, in most instances, require training before they can be relied on to take their places as effective members of the shop organization. These and similar problems require the supervisor to be well versed in the several aspects of training—able to set up as well as conduct an effective training program for assigned personnel.

ORGANIZING A TRAINING PROGRAM

Organizing a shop training program involves such considerations as determining objectives of the training program, selecting and qualifying instructors, making arrangements for classroom space, phasing the training program with the scheduled workload, procuring training aids, and determining teaching methods for each lesson or lesson series.

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The subject matter areas to be included in the shop training program are (1) material relating to maintenance of aircraft supported, (2) general material required by the men for advancement in rating examinations, and (3) material relating to safety. In most cases lessons will fall under more than one of the subject areas.

Once it has been determined what publications will adequately cover the subject areas, the material must be divided into lessons, and lesson guides prepared. It will be very helpful to assign numbers to the lessons and provide a personnel training progress record for each individual. These will provide a handy index to the state of training of the shop personnel as a whole.

Whether the shop supervisor teaches the lessons himself or assigns other petty officers to conduct them depends on the state of training of his first and second class petty officers. A requirement for advancement for third class petty officers and nonrated personnel is satisfactory completion of the correspondence course based on Military Requirements for Petty Officer 3 & 2, NavPers 10056-B. Chapter 9 in that text book sets forth some of the basic principles of training in general and teaching in particular.

An advancement requirement for second and first class petty officers is satisfactory completion of the correspondence course based on Military Requirements for Petty Officer 1 & C, NavPers 10057-B. The latter test expands and amplifies training theory and introduces job analysis, training aids, and testing. For the first time in his career the prospective First Class Petty Officer is required to demonstrate his ability to formally teach, use various training aids, and prepare and administer written tests. In order to demonstrate correct instructional techniques the shop supervisor may elect to teach certain lessons himself or assign them to a competent instructor for the same purpose. Later he may assign less proficient petty officers as instructors so that they may acquire the experience necessary for completing their practical factors for advancement.

If at all possible, training sessions should be conducted at the same time of day and on a regular schedule. Factors to consider when scheduling lessons are usual flight schedules, meal hours, watches, availability of classrooms, and aircraft inspection schedules.

Some lessons are better suited for one type of instructional technique than others. The type of presentation for each lesson should be planned in advance. This will also facilitate the rotation of the lessons among the petty officers who require experience in teaching.

The effectiveness of aviation technical training is greatly enhanced by the use of training aids. The shop supervisors should always be on the alert for material that can be utilized as training aids. He must be aware of the existence of applicable training films and, if they are available, schedule them for showing in conjunction with specific lessons. The squadron or unit training officer may usually be depended on to supply training aids in support of shop safety presentations.

When planning a training program, the supervisor should decide where the classroom sessions should be conducted. The space selected should preferably be in a quiet area or at least one with a minimum of noisy distractions. The area should be large enough to accommodate the expected student load and be well lighted. Adequate ventilation will help keep the men awake and interested in the presentation. Convenience is another factor in the selection of classroom space. Some of the desirable space characteristics may, on occasion, have to be sacrificed in order to find a classroom nearer to the working area.

Training procedures are of two general types—formal training which can be scheduled, and informal training which cannot be scheduled.

Formal Training

Formal training is normally conducted in the classroom through lectures, supplemented by required reading and implemented by the use of all available visual aids. The schedule is prepared and published periodically by the maintenance officer. It lists the time of the training, the location of the classroom, names of the men who are to attend, subject of the lesson, and the name of the instructor.

Lesson guides are prepared by the division officer and chief or first class petty officers who are qualified to do so. The lesson guides should contain the title, objective(s), time to be consumed in presenting the lesson, list of instructional aids, list of references, outline for presentation, and a summary of the lesson.

When a petty officer has been assigned to instruct a given lesson, it is his responsibility

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to procure a copy of the lesson guide and from it prepare his lesson plan. Lesson plans are prepared by each individual instructor, based on the lesson guide; and though they may differ from instructor to instructor, they must adequately cover the subject.

SPECIALIZED TRAINING.—At most major naval air stations there will be a Naval Air Maintenance Training Group which offers courses of varying lengths on specific aircraft and systems. These courses are normally made available through the replacement air wing training division.

Some Naval Air Rework Facilities offer special courses on repair of certain electronic equipments. These, as well as other C-type courses, provide the supervisor with a source of specialized formal training that the man may attend on a returnable basis.

In addition to the courses mentioned previously, engineers of the Naval Aviation Engineering Service Unit are ready, willing, and able to assist in training of maintenance personnel. These people usually have the latest "Hot Dope" and should be consulted at frequent intervals.

Informal Training

Informal training is the practical instruction of men in the performance of maintenance tasks by means of demonstration and imitation under personal supervision in the shop or on the operating line. Nearly every maintenance task that is undertaken presents an opportunity for on-the-job training. The experienced men of the division are utilized as fully as possible in demonstrating and imparting their skills to the less experienced.

Under this system, the trainee has the opportunity to actually do the job under the supervision of an experienced petty officer. The only equipment necessary is the job itself. It is necessary, of course, that the instructor have an interest in the job and the skill to do it well. The striker or trainee will learn by seeing the job performed, and he will gain experience by having a chance to participate in the accomplishment of the job.

The nature of informal training makes regular scheduling impracticable. Actually, it is done at every opportunity. A training syllabus is prepared under the guidance of the maintenance officer, with content and scope corresponding with practical factor requirements of the personnel. On-the-job training is reported by the leading petty officer instructors and shop supervisors to the division officers on the training syllabus at regular intervals so that a close watch may be made on individual progress. The records are for review by higher authority and will point out the need for training in special areas as well as certain practical factors. The degree of success in on-the-job training depends on the degree of recognition by each individual of his responsibility to his outfit to impart his skill and knowledge to the man who is trying to learn.

TRAINING RECORDS

Since all men are not present at each unscheduled training period nor do they attend the same scheduled classes, it is apparent that they will become trained to different levels on different equipment. Obviously the supervisor must see that a record is carefully kept on each man, with an entry made each time he undergoes instruction.

Methods of recordkeeping are many and varied, but it is best to keep them in the most simple and easy-to-read form. The more elaborate the system, the more difficult it is to maintain. There are standard forms available which can be used for planning as well as for record purposes. These forms are designed to reduce recordkeeping to a minimum. Detailed information concerning recordkeeping methods can be found in Military Requirements for Petty Officer 1 & C, NavPers 10057-B.

JOB PRIORITY

Determining which jobs are to be performed first is one of the major responsibilities of the supervisor. This is an important phase of the maintenance operation because it will determine the use of facilities, men, material, and other equipment. The two major factors to consider when determining which job should come first are time and personnel required to complete the job.

Probably the most important single aid in estimating time and personnel requirements for aircraft maintenance tasks is the Periodic Maintenance Requirements Manual with its related cards, charts, and forms. Extensive time and motion studies of the various inspection requirements have been made and completion times are furnished in man-hours or man-minutes. These times also reflect routine

maintenance, adjustment, and replacement if required in connection with the aircraft inspection. They are calculated on the basis that the most efficient number of men are continuously employed and that all necessary equipment, tools, and parts are immediately available. The supervisor must consider all these factors from the knowledge of his individual personnel, supply, and equipment situation, together with an accurate determination of the extent to which the maintenance task at hand exceeds the inspection requirements if he is to reliably predict the completion time. While this procedure may seem rather involved at first, the new supervisor will find that it is based on sound management principles and that, with experience, his ability to accurately predict time and personnel requirements will speedily improve.

SCHEDULING

If possible, the supervisor should avoid scheduling several jobs that may require identical tools and equipments to be performed at the same time. This often results in confusion and loss of time.

It is also important to schedule activities so that work is accomplished in the proper sequence. This is especially important if men are working on several different phases of the same job.

Time must be allowed in the schedule for assignment of future routine work. This may make it necessary to rearrange the present schedule to insure that special jobs will not interfere with the accomplishment of this work.

ASSIGNMENT OF PERSONNEL

Work assignments should be rotated so that each man will have an opportunity to develop his skills in all phases of the work. When assignments are rotated, the work becomes more interesting for the men. Another good reason for rotating work assignments is that if one highly skilled man performs all the work of a certain type, the supervisor and the shop would be at a great disadvantage in the event the man is transferred from the shop. Less experienced personnel should be assigned to work with him in order to become proficient in his particular skill. Also, in order to broaden his knowledge of his rate, the expert on one job should be rotated to other tasks when there is no immediate need for his particular skill.

Strikers should be assigned to various tasks so that they will acquire experience on all kinds of jobs. A special consideration for the assignment of strikers to jobs is that they should be assigned progressively to jobs of ascending levels of difficulty. A striker may be a useful assistant on a complicated job, but he may not understand what he is doing unless he has worked his way up from basic tasks.

CHECKING PROGRESS AND EVALUATING PROCEDURES

The assignment of work is only the beginning of job processing. The man in charge must know his men and have a fairly good idea of each man's skills and abilities. He must also be aware of each man's knowledge regarding the operation of equipment and the accomplishment of repair work.

The best way in which the supervisor can obtain this knowledge is to make frequent inspections and check the progress of work being performed. In that way he will have a good idea as to which jobs, or which men, will require the most supervision.

When checking the progress of work, the supervisor should make sure that the men are observing proper safety precautions in regard to themselves and the equipment they are operating. In addition, he should see that each man is using the proper tools, and note the quality of the work being performed.

In case of any doubt, he should check to see that his instructions are understood and that the work is being performed correctly. If necessary, he should provide additional instructions to give a better understanding of the job or to improve workmanship. By frequently talking to the men and answering their questions, the supervisor can prevent time and material waste, as could be the case if he were not available to give the correct details.

Complications may develop on some repairs which may require additional planning and revised repair procedures. By observing the progress of various jobs, and whether they are ahead or behind the planned schedule, the supervisor will be able to change the schedule in order to prevent any major work stoppage.

INSPECTING COMPLETED WORK

When a job has been completed, the man in charge is responsible for inspecting and approving the work. Inspection is necessary to

insure that the repair job or the replacement parts will be satisfactory. A thorough inspection normally requires that it be accomplished both visually and by means of measuring instruments. In addition, specific operational tests are performed to check the condition of repaired equipment.

The supervisor is responsible for determining whether the repair job, including replacement parts, meets the following standards:

1. Have the repair parts been correctly installed in accordance with instructions?
2. Is the repaired item or replacement part free from defects in material and workmanship?
3. Have all parts or accessories to the repaired equipment been replaced or reinstalled correctly?
4. Has the proper replacement part been used in making repairs?
5. Has the part or item been properly checked and certified ready for service?

The existence of a properly functioning quality control division in no way decreases the responsibility of the shop supervisor for the quality of work accomplished. Since the work was performed by shop personnel under the direct supervision of the senior man, the quality of the work is fundamentally a shop responsibility.

CHANGES AND BULLETINS

Changes and bulletins are eventually issued to the shop responsible for the subject equipment in the form of maintenance instructions. These instructions prepared by the division officer with the aid of the division or shop supervisor, are an interpretation of the directive. It then becomes the responsibility of the supervisor to instruct and supervise the installation, marking, and recording.

ACQUIRING AND INSTALLING CHANGE KITS

Change kits are not normally ordered directly by the shop concerned. When a directive is received requiring a change kit, maintenance control or designated personnel of the maintenance division, with the assistance of the shop supervisor, if requested, will order the kit.

Installation of change kits is governed by the directive concerning the change or bulletin. Some must be installed immediately in the event safety is involved. Others have specified time periods allowed as determined from the directive. In any case they should be installed as soon as practicable so as to take advantage of the new configuration. The supervisor must insure that workmanship is of the highest caliber that accepted electrical and electronic installation practices are adhered to, and that detailed instructions, when included, are followed precisely.

MARKING EQUIPMENT AND RECORDING

Change kits are normally ordered and issued against an aircraft bureau number. This means that marking the equipment and keeping complete and up-to-date records is necessary to prevent confusion and loss of time. If correct marking and recording of equipment changes are not kept current, it could affect aircraft availability and scheduling.

Information concerning the type and manner of marking equipments in which a change has been installed is described under the directive heading "identification." In some cases the directive refers to Electronic Material Bulletin 1-54 as the source of information for identification markings. In all cases marking must be accomplished at the time the change has been installed.

If a change is made to plug-in assemblies or subassemblies which are interchangeable between equipments, the identification marking must be applied to the chassis of these assemblies or subassemblies. In addition, this identification marking is also to be placed on the front panel of the equipment.

No markings are to be applied to dust covers, cases, mounting bases, etc., unless a change is made to these specific items. A material marking kit for use by maintenance activities may be obtained through normal supply channels, although most change kits include the necessary equipment for marking.

After the change has been correctly installed and the equipment properly marked, records must be made to reflect the change. Recording is accomplished by the use of history cards, file copies of maintenance instructions (SAMI, CAMI, etc.), and aircraft logbooks.

If the equipment has a history card, this card should be kept current. History cards can be used as a quick reference to equipment configuration; however, if history cards are not required and not used, the file copy of the maintenance instruction will serve the same

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purpose. When directives require a logbook entry, these entries are recorded by the persons in maintenance control assigned this responsibility.

The main thing for the supervisor to keep in mind is that a record of these changes must be kept, for without them there will be nothing but confusion.

CHAPTER 6

MAINTENANCE PROCEDURES AND SPECIAL PROBLEMS

The term "testing," as used in this chapter is considered to consist of measurements, tests, and checks. When these measurements, tests, and checks are applied to electronic equipments (or systems), they may provide information which establishes an acceptable condition, or they may provide information of undesirable conditions which exist in these equipments.

In the former instance, the testing (and inspection) proves that the equipments are operating within tolerances, and results in establishing a form of maintenance which is preventive in nature. In the latter instance, the testing (and inspection) exposes conditions which are undesirable, and which must be corrected if the equipments are to perform as designed. The result of this testing establishes another form of maintenance which is corrective in nature.

By applying both preventive and corrective maintenance, electronic equipments are kept in continuous service at optimum or peak performances that are reasonably close to the standards set by the manufacturing specifications.

Senior technicians should study and constantly refer to the available maintenance publications covering the equipments used by their activity. They should stand ready to answer questions about equipments, and to outline the various steps necessary to correct possible troubles.

MAINTENANCE PROCEDURES

Performance testing data, along with other maintenance information, is covered in the Service Instruction Manual for each particular equipment. This information has been written to enable the technician to make an intelligent evaluation of the operating capabilities of that equipment; at the same time the data serve as a gage for the measurement of equipment efficiency. The standards are designed to insure that equipments operate at maximum efficiency at all times, and to reveal any change from this optimum performance, thus indicating the need for corrective measures.

The information presented in these manuals gives the technician a step by step performance check with all the test connections and test equipment clearly indicated for each step. Performance testing is discussed to show the relationship between that type of testing and preventive maintenance, as a means of emphasizing the final results may indicate the need for corrective maintenance. Both preventive maintenance and corrective maintenance are discussed in the following paragraphs. Troubleshooting—considered as the principal form of corrective maintenance—is analyzed in detail.

PREVENTIVE MAINTENANCE

The best maintenance work is preventive in nature, potential failures being detected and corrected before they have a chance to develop. Preventive maintenance is defined as those measures taken periodically, or when needed, to achieve maximum efficiency in performance, to insure continuity of service, and to lengthen the useful life of the equipment or system. This form of maintenance consists principally of cleaning, lubrication, and periodic inspections aimed at discovering conditions which, if not corrected, may lead to malfunctions requiring major repair.

Performance Testing

A performance test is an operational check of equipment in which the performance specifications set by the manufacturer are carefully observed. It should be a part of an overall program of inspections and tests in which accumulative data on each equipment is systematically compiled.

Inspections fall into two main categories. First, there is the regular visual inspection of

the mechanical aspects of the equipments. This is conducted for the purpose of finding dirt, corrosion, loose connections, mechanical defects, and other sources of trouble. Second, there are functional inspections that are accomplished through periodic tests and through less frequent bench tests. To realize the most effective results from the regular functional inspections, a careful record of the performance data on each equipment must be kept.

The value of performance data records is demonstrated in a number of ways. Comparison of data taken on a particular equipment at different times reveals any slow, progressive drifts that may be too small to show up significantly in any one test. While the week to week changes may be slight, they should be followed carefully so that necessary replacements or repairs may be made before the margin of performance limits is reached. Any marked variations should be regarded as abnormal, and should be investigated immediately.

Another advantage in keeping systematic records of performance and servicing data is that maintenance personnel develop a more rapid familiarization with the equipment involved. The accumulated experience contained in the records furnishes a guide to swift and accurate troubleshooting.

Test Methods

The actual work of testing and servicing, as well as that of recording performance data, should be done systematically. While a logical sequence of steps is required, this does not imply the rigid necessity of making only a step by step progression. Working within the overall pattern of procedure, maintenance personnel should analyze the results obtained to eliminate unnecessary steps.

GENERAL RECEIVER TESTING. —Receivers are composed of a series of selective circuits, each stage of which is designed to refine and amplify the output of the preceding stage. The lowered efficiency of any one tube usually results in lowered overall efficiency of the receiver. The sensitivity of the receiver may also be decreased by the misalinement of the successive circuits, each of which may function in a suitable manner as a unit.

The function of a receiver is to receive (in a selective manner) a weak signal; therefore, an objective overall test on sensitivity is the most significant single check that can be made of the condition of a receiver.

Some receivers are provided with a built-in output meter, and others have an output meter equipped with a cord and plug to facilitate testing. The only other requirement for a sensitivity check is a suitable standard signal for the excitation of the receivers on the various bands. This signal may be provided by a calibrated signal generator with a dummy antenna coupled directly to the receiver input.

Any decrease in sensitivity should be corrected as soon as possible by following the appropriate remedial procedures. When using this method, use a megger before starting the tests to check for proper operation of both the radiating and the receiving antennas.

In addition to periodic checks on sensitivity, routine physical inspections must be made of the receiver and accessory units. Lubrication and cleaning schedules recommended by the manufacturer should be followed. Tubes should be tested sparingly, because frequent insertion and removal weakens socket contacts and causes noisy (or intermittent) operation.

Electron tube life extends to several thousand hours. Therefore, in equipment which is continuously operated and on which periodic sensitivity tests (or operation records) are made, tubes should be checked only when poor performance indicates such a need. When tubes are replaced in RF circuits, the circuit should be checked and, if necessary, realined to achieve normal sensitivity. Before new tubes are used, it is a good practice to check them on a tube tester of the transconductance type.

GENERAL TRANSMITTER TESTING. — In some transmitters, tube currents are automatically measured by self-contained instruments. If these readings are periodically recorded, the cumulative record bears the same relationship to the transmitter as a sensitivity check does to the receiver. When the emission of a large tube falls to 80 percent of normal rating, it should be replaced.

Ventilation and dust conditions present a greater problem in transmitters than they do in receivers, principally because there is more heat to be dissipiated. Because dust forms a film which absorbs moisture, the insulation resistance is lowered to a point at which flashover (arcing) can occur. Therefore, cleaning periods must be initiated and regularly followed. These periods will vary for different locations.

Insulators must be wiped, corroded metal parts cleaned, and arc-overs repaired. It is

possible to detect poor contacts by inspecting for evidences of local overheating (or arcing). Such contacts must be thoroughly cleaned and tightened. Likewise, it is important that the antenna connections be regularly inspected and cleaned.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of the location and correction of troubles whenever an equipment or system fails to function properly. Location of the trouble includes the activities of evaluating reported discrepancies and troubleshooting.

The trouble may be corrected by mechanical or electrical adjustments, or it may be necessary to replace one or more parts.

Evualuation of Reported Discrepancies

When a discrepancy is turned in either by crew debriefing or on a "gripe sheet," the first thing to determine is whether the system or equipment is actually faulty. A mistake which is often made is removing the equipment from the aircraft before checking it.

The supervisor should have a prescribed procedure for technicians to follow in checking a discrepancy on equipment installed in an aircraft. Some suggested procedures that will aid in evaluating discrepancies are as follows:

1. Visual inspection. A visual inspection of the equipment in the aircraft may disclose frayed or broken wiring, loose connections (electrical and mechanical), or open circuit protectors, which could cause the malfunction.
2. Operational check. An operational check of the system can aid in analyzing the discrepancies and pinpointing the trouble to a particular unit. In some cases, it may disclose improper operating procedures—especially with newer type equipment or new personnel.
3. Performance checks. The use of portable test equipment, built-in meters, and special test equipment installed in some types of aircraft, will aid in making a performance test of the system in the aircraft. Performance testing, mentioned in the first part of this chapter, should be of great help in localizing the discrepancy to a particular unit which can be removed from the aircraft for repair, or in some cases, repaired in the aircraft.
4. Quality control inspections. Highly qualified senior technicians should be provided to conduct thorough inspections on all equipments prior to their installation in the aircraft. This quality control inspection should be a combination of the visual inspection, operational check, and performance check. This inspection will ascertain that each equipment is in proper operating order and completely mission ready.

Troubleshooting

Corrective maintenance is, for the most part, concerned with troubleshooting, which can be further divided into two phases. The first phase is system troubleshooting. It is based on the starting procedure, and is designed to isolate the malfunction to the unit in which the trouble exists.

The second phase is unit troubleshooting, and is designed to locate the trouble in the unit in which it occurs. In rare cases it is possible to determine which unit is at fault without following the system troubleshooting method to isolate the unit. However, most of the time it is impossible to determine which unit is at fault until the system method has been employed in whole or in part.

TROUBLE ISOLATION. —When abnormal operation has been traced to a particular stage or to a functionally related group of stages, its cause must be further isolated and identified as due to a particular faulty component or group of components. To do this it may be necessary to disassemble the equipment, either in whole or in part. After disassembly, the trouble may be immediately apparent through a mere visual inspection, whereupon the trouble should be corrected by repair or replacement.

If the trouble is not immediately apparent, a more detailed procedure should be followed to isolate and repair or replace the actual circuit component responsible for the failure. This procedure consists of tube checks, voltage and resistance checks, waveform analysis, and finally, repair or replacement of the defective component.

Supervisory personnel should insure that detailed trouble isolation procedures are in accordance with the applicable current Service Instruction Manual for the equipment being repaired.

TUBE TESTING. —Electron tube failures are responsible for a large percentage of troubles that occur in equipment or systems. However, if a particular system uses a great number of tubes, it is obviously impractical, and not good policy, for a technician to attempt to locate faults by general tube checking. Only when

the fault has been traced to a particular stage should any tubes be tested, and then only those associated with the improperly functioning circuits.

When replacing a tube in a circuit, the technician should note and record the positions of the equipment controls before changing the setting of any of them. If adjusting the controls with the new tube in place does not correct the abnormal condition, the controls should be returned to their original positions. Unless a reliable tube tester shows the original tube to be defective, the old tube should be returned to the original circuit.

After placing a new tube in a circuit, the technician must decide whether or not to discard the old tube. Certain types of tubes are capable of performing over a wide range of frequencies and driving voltages, so that their poor performance in one circuit does not necessarily preclude their use in another, less demanding circuit.

If a bin of used tubes is kept, each tube should be carefully labeled with a tag showing what circuit the tube was removed from, thus avoiding attempted reuse of the tube in the same type circuit. The tag should also indicate the operating conditions under which the tube "failed."

CAUTION: Steps should be taken to insure that no used tube is ever placed in a circuit whose failure would constitute a safety hazard or cause an aborted combat mission.

Any proposed procedure for reuse of old tubes should be submitted to the avionics officer for his review and approval.

In many high frequency equipments, the interelectrode capacitance of a tube is a significant portion of a tuned circuit; therefore, when tubes are changed, the tuning of the circuits may be upset. Thus, if too many tube substitutions are made, the unit may become misalined.

VOLTAGE MEASUREMENTS.—Since many troubles encountered in equipments and systems either result from abnormal voltages or produce abnormal voltages, voltage measurements are considered an indispensable aid in locating troubles. Testing techniques that utilize voltage measurements also have the advantage that circuit operation is not interrupted. Point to point voltage measurement charts which contain the normal operating voltages encountered in the various stages of the equipment are available to the technician. These voltages are usually measured between the indicated points and ground unless otherwise stated.

When making voltage measurements, it is good practice to set the voltmeter on the highest range initially so that any excessive voltage in a circuit will not damage the meter. To obtain increased accuracy, the voltmeter may then be set to the designated range for the proper comparison with the representative value given in the voltage charts.

If the internal resistance of the voltmeter and multiplier is approximately comparable in value to the resistance of the circuit under test, it will indicate a considerably lower voltage than the actual voltage present when the meter is removed from the circuit. The sensitivity (in ohms per volt) of the voltmeter used to prepare the voltage chart is always given on the charts. Therefore, if a meter of a similar sensitivity is available it should be used so that the effects of loading will not have to be considered.

When checking voltages, it is important to remember that a voltage reading can be obtained across a resistance, even if the resistance is open. The resistance of the meter and the multipliers forms a circuit resistance when the meter prods are placed across the open resistance. Thus the voltage across the component may appear to be normal when the meter is connected, and abnormal when it is disconnected. If the voltages appear normal on a faulty stage, the next step would be to perform a resistance check of that stage.

NOTE: Certain precautions are presented in Basic Electricity, NavPers 10086-A, as general safety measures pertinent to the measurement of voltages. Supervisors should ascertain that these precautions are adhered to by all personnel who are responsible for the maintenance of electronic equipment.

RESISTANCE MEASUREMENTS.—Defective components can usually be quickly located by measurement of the d-c resistance between various points in the circuit and a reference point or points (usually ground). This is true because a fault will generally produce a change in resistance values. Point to point resistance charts can be used advantageously at this time. The values given, unless otherwise stated, are measured between the indicated points and ground.

Before making resistance measurements, the technician must be sure that the power to the equipment under test has been turned off.

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Since an ohmmeter is essentially a low range voltmeter and a battery, an ohmmeter connected to a circuit which already has voltages in it may be seriously damaged. The pointer may be deflected off scale, and the meter movement may be permanently damaged.

Filter capacitors must be discharged before making resistance measurements. This is extremely important when testing power supplies that are disconnected from their loads. If a capacitor discharges through the meter, the surge may burn out the meter movement. Furthermore, contact with a circuit containing a charged capacitor may endanger the life of the person making the test.

WAVEFORM COMPARISON. —The measurement and comparison of waveforms are considered to be very important parts of the circuit analysis used in troubleshooting. In some circuits (for example, pulse circuits) waveform analysis is indispensable. Waveforms may be observed at test points, shown in the waveform charts which are part of the maintenance literature for the equipment. It should be noted that the waveforms given in the instruction books are often idealized and do not show some of the details which are normally present when the actual waveform is displayed on an oscilloscope.

By comparing the observed waveform with the reference waveform, faults can be localized rapidly. A departure from the normal waveform indicates a fault that is located between the point where the waveform is last seen to be normal and the point where it is observed to be abnormal. (For example, if a waveform is observed to be normal at the grid circuit and abnormal at the plate circuit of the same stage, this indicates that the trouble lies in that stage or possible the input of the following stage.)

When waveforms associated with a multivibrator, a blocking oscillator, or a similar circuit are observed to be abnormal, replace the associated tube before making further tests. If the replacement tube does not provide the correct waveform, reinsert the original tube.

If there is no trouble present in an equipment or system, a waveform observed at a point in the equipment should closely resemble the reference waveform given for that test point. The reference waveforms supplied with maintenance literature are the criteria of proper equipment performance. However, test equipment characteristics or usage can cause distortion of the observed waveform, even though the equipment or system is operating normally. Several of the most common causes of these conditions are summarized as follows:

1. The leads of the test oscilloscope may not be placed in the same manner as those used in preparing the reference waveforms, or the lead lengths may differ considerably. This is particularly significant in the case of shielded test leads, where the capacitance per unit length is a factor.

2. A type of test oscilloscope having different values of input impedance, different sweep durations, or different frequency response may have been used.

3. The equipment operating (and servicing) controls may not have settings identical to those used when the reference waveforms were prepared. This condition is normally to be expected when servicing adjustments are made in terms of their effect on the shape and amplitude of an observed waveform.

4. The vertical or horizontal amplitudes of the reference and test patterns may not be proportional. This will produce apparent differences between the waveforms when actually there is no difference.

Whether or not a minor waveform discrepancy may be disregarded depends upon the type of circuit being traced. A minor discrepancy is not regarded as significant unless the nature of the discrepancy indicates faulty operation of the equipment. In general, time should not be wasted in searching for faults when relatively minor differences are detected between the reference waveforms and those obtained by test.

Modular Units

The demand for small, maintainable circuitry in military equipment has led to many different construction techniques. One of the most popular is modular construction. Since modular assemblies incorporate several subminiaturized features not found in conventional equipment, some specialized knowledge and tools are required for efficient repair and maintenance.

A few definitions are helpful in understanding the terms involved. A module is defined as "a unit or standard of measurement; a fixed dimension." A modular assembly has outline dimensions which are multiples of a module. An equipment which consists of replaceable assemblies (any type) is said to be of unitized construction. Modular construction, then, is a

type of unitized construction consisting predominantly of modular assemblies.

For example, think of a carton of cigarettes. If each pack were a modular assembly, the carton would represent an equipment of modular construction. Notice that the packs can be arranged differently without changing the outside dimensions of the carton. Although the cigarette packs are all the same size, the assemblies in many equipments are not.

The original concept of many modular assemblies was that they should not be maintained in the field. The intention was to replace the assembly and ship it back to some repair facility. As assemblies became more complex, the point was soon reached where the extensive supply system required for the replacement concept was too costly. Many equipments built during this initial stage were potted with some special ingredient to discourage maintenance personnel from tampering with the components contained within the black box.

When the Navy reassessed this concept, realizing that the Fleet must maintain every thing it could, most of the equipment manufacturers began to make components accessible. However, many technicians are still convinced that modular assemblies are impossible to repair. This conviction may stem from a lack of experience in working with the printed circuits and the other components in modular assemblies. While it is true that special tools and techniques are required, it is also true that satisfactory repairs can be made to any printed circuit by using just a little care and common sense. Actually, with a little experience, repairs can be made as easily as in conventional assemblies; sometimes more easily, because of improved accessibility.

Repair of Defective Components

One of the time-consuming elements of troubleshooting is the identification of specific components. In conventionally wired equipment, components are not always easy to locate; even the circuitry in the chassis can become confusing since related components are often positioned in decentralized areas of the chassis.

In equipment which includes printed circuit boards, identification of circuitry and components may be relatively simple. This type of circuit construction allows uniform placement of components and complete sectionalization of related circuitry. Just a quick, once-over glance of such circuitry is often all that a technician requires to formulate the overall layout of the chassis in his mind and quickly focus his attention on the area of particular concern.

Many of the commercial manufacturers have developed methods of quick identification. One of the most common ways is to impose a grid over a drawing of the board, and then furnish a table which lists the part location. Another technique is to number points of interest on the schematic, then provide a pictorial guide to locate the points on the board.

Circuit tracing of the printed wiring board may be simpler than that of conventional wiring, due to increased uniformity. If the wiring board is translucent, a 60-watt light bulb placed underneath the side being traced will facilitate circuit tracing. Test points can be located in this manner without viewing both sides of the board.

Resistance or continuity measurements of coils, resistors, and some capacitors can be made from the component side of the board. In some cases, a magnifying glass will help in locating very small breaks in the wiring. Voltage measurements can be made on either side of the board. However, a needlepoint probe is needed to penetrate the protective coating on the wiring. Hairline cracks can be located by making continuity checks.

A number of general precautions are necessary when working with modular assemblies. Supervisory personnel should take steps to insure that the technician in their shop or maintenance crew know and understand the rules set forth in the following paragraphs:

1. Observe power supply polarities when measuring the resistance of the circuits of modular assemblies containing transistors, or other semiconductors. Such parts are polarity- and voltage-sensitive. Reversing the plate voltage polarity of a triode vacuum tube will keep the stage from operating, but generally will not injure the tube. However, reversing the voltage applied to a transistor, or other semiconductor, could destroy it very quickly.

Since transistors and similar components require different power supply connections, the personnel who work with these parts must always be alert in connecting test equipment. Make sure that the correct polarity and range are observed. Recheck your work before turning on the power—the wrong polarity will destroy the part.

2. Avoid applying a-c power operated test equipment or soldering iron without first making certain that powerline leakage current is not excessive. It is a good precaution to use an isolation transformer with all test equipment and soldering iron operated on a-c power, unless it has been determined that the equipment contains a transformer in its power supply or shows no current leakage. With all test equipment (whether transformer-operated or not), it is good practice to connect a common ground lead first from the ground of the circuit to be tested, and then to the test equipment ground.

3. Avoid application of too high a pulse from test equipment. The safest procedure is to start with a low output signal setting, and then proceed to apply the required signal levels. Be sure that the signal applied is below the rating given for the circuit under test. Relatively high current transients can occur when test equipment is connected to a circuit where low-impedance paths exist.

4. Avoid moving loose connections, disconnecting parts, inserting or removing transistors or similar components, and changing modular units while the equipment power is on or while the circuit is under test. Moving a loose connection, or any of the actions mentioned, will cause an inductive kickback. This can be prevented by being sure that all parts in the circuit are secure before starting the test or turning on the equipment power. Be sure to remove all possible capacitance charges from parts and test equipment before applying them to a modular assembly. When changing modular assemblies, be sure the equipment power is off.

SPECIAL MAINTENANCE PROBLEMS

The effect of environmental conditions upon the operation of electronic and electrical equipment has greatly increased the maintenance problems of the technician. These conditions may be grouped under the major headings of altitude, temperature, and humidity. At the extremes of these conditions special maintenance and operating procedures are required. Equipments required to function at these extremes frequently fail due to the effect of decreased air density, radical temperature changes, and moisture.

Other special maintenance problems are introduced by the effects of radio noise interference. Among the types of radio noise interference discussed in the following paragraphs are atmospheric interference, effects of rotating and switching devices, effects of nonlinear circuit elements, and interference fr m a-c power sources. Also discussed are methods of suppressing radio noise interference.

HIGH ALTITUDE

As the ceiling for aircraft on extended flights has been raised higher and higher, many new types of operating and maintenance problems have developed. Some of the various types of equipment involved are generators, voltage regulators, electric motors, and solenoids. Electric brushes on generators, inverters, electric motors, and other rotating electrical machinery wear away very rapidly at high altitude. Special brushes have been developed that have longer life at high altitude. Thus, it is advisable to use the proper type brushes and to check them more frequently when high altitude flying is being performed.

While most switches will break a circuit safely at sea level, their contacts may burn and in some cases even melt at high altitude. It has been found that double-break contact switches somewhat alleviate this fault. Since electric and electronic systems use specially designed switches for high altitude operation, it is necessary to take special precautions to insure that the proper type is used by personnel making a replacement.

Other items that often fail during high altitude flights are electrical plugs and receptacles. A voltage breakdown occurs between the pins and shell along the surface of the insulating material. The result is a burned plug. This happens because the breakdown voltage is less at high altitude. For example, the breakdown voltage for a 1/4-inch airgap is about 3.7 times greater at sea level than at 40,000 feet.

This condition may be overcome by sealing the connector with a potting compound. This reduces the probability of arc-over between pins. or between pins and the shell of the electric connector since the dielectric characteristics of the connector are improved. This sealing compound will also protect the connectors from corrosion or contamination by excluding metallic particles, moisture, and aircraft liquids.

Pressurization

Airborne electronic equipment used at high altitudes is usually pressurized for the following reasons.

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1. To prevent high-voltage arcing and resultant wear on brushes and relay contacts.

2. To prevent RF voltage breakdown in waveguides.

3. To eliminate the problems of condensation and corrosion in the equipment which result from "breathing."

Pressurized equipments are sealed with gaskets to make an airtight and moistureproof seal. Pressurization can be accomplished by using a combination dehydrator-hand pump, as is done with the UHF transceiver discussed in chapter 13 of this course. Some equipments have an electric compressor-dehumidifier built in.

The hand pump is used to pressurize some equipments with 18 to 20 psi absolute or 3 to 5 psi gage. Compressors that are installed in the aircraft with equipment such as radar are used to pressurize various units of the system with 30 to 34 psi absolute at all altitudes.

HUMIDITY

Continuous damp, warm air causes condensation of atmospheric moisture within equipment unless units are hermetically sealed or the interiors are maintained at a temperature higher than surrounding atmospheric temperatures. Condensed moisture forms electrical leakage paths and causes corrosion. These climatic conditions also promote rapid fungus growth which in itself has a corrosive effect on materials, such as wire, switch contacts, and other metal parts.

Humidity is a term describing the amount of water vapor in the air. It is usually expressed as a percentage of the total amount of water the air can hold at a given temperature. Thus, 50 percent relative humidity means the air contains one-half the total water it can hold, and 100 percent means it contains all it is capable of holding. Air can hold more water as its temperature increases. In tropical areas the humidity varies between 60 and 100 percent.

High humidity accounts for the condensation of moisture, or sweating, on various parts of electronic equipments when they undergo temperature changes. Condensed moisture on insulating materials reduces their insulating qualities and results in arc-overs and shorts between terminals. The water vapor also penetrates into the body of insulation, is absorbed, and causes similar effects. High humidity also causes corrosion of metals. Other sources of moisture which cause deterioration include fog, salt spray, and rain.

TEMPERATURE

In general, equipment may encounter extreme temperatures, ranging from minus 65° F to a maximum of 135° F, under various climatic conditions of high humidity, fog, rain, salt spray, salt air, cold, insects, fungi, and dust. High temperature and moisture vapor cause rapid corrosion. Fungus and bacterial growths, which thrive in warm temperatures, produce acids and other products which speed corrosion, etching of surfaces, and oxidation. This interferes with the operation of moving parts, screws, and so forth, and causes dust between terminals, capacitor plates, and other parts, which produces noise, loss in sensitivity, and arc-overs.

Variations of temperature cause moisture to be breathed through any small cracks, pinholes, or vents in the equipment. As the temperature rises, the air inside a piece of equipment expands and it is expelled, in part, through the openings and vents. When the temperature falls, the air inside the equipment contracts and outside air is admitted through all openings and vents. The moisture which is breathed destroys the insulating qualities of dielectrics and corrodes metals.

FUNGUS

Fungus is a form of plant life which feeds on materials of vegetable and animal origin including paper, cotton, and so forth, and such things as dead insects and other fungi. These may be spread by wind, dust, dirt, and insects, such as ants, flies, and mites. Growth may take place on materials other than those of organic origin if a spot of dust or other nutrient substance is present.

Fungus growth causes decay, accelerates the deterioration of insulating materials, and short circuits items such as relays, jacks, and keys. The inclusion of a fungicidal compound in the manufacture of the equipment retards the growth of these fungi.

Most new equipment is given a climatic deterioration prevention treatment which provides a reasonable degree of protection against fungus growth, moisture, corrosion, salt spray, insects, cold, desert heat, and so forth. The treatment involves the use of a lacquer or varnish coating material applied with a spray gun or brush. Detailed instructions dealing with this treatment may be found in Climatic

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Deterioration Prevention Treatment Electronic Test and Communications Equipment, AN-16-1-41.

CORROSION

Modern high speed aircraft are dependent on the operational and structural soundness of metals (basically high strength aluminum alloys) which make up the largest percentage of their thousands of parts. With higher strength demands being made on aircraft metals and the closer tolerances of flight safety which accompany high performance aircraft, these aircraft would rapidly become inoperative without regular anticorrosion maintenance.

In the past, aircraft have remained longer in overhaul activities than was desirable, due to requirements for corrosion removal and surface refinishing. This situation, which adversely affects the Navy's goal of maximum utilization of all available aircraft, has been the subject of much discussion by persons responsible for aircraft maintenance policy. The results of these studies have pointed out the need for ever-increasing emphasis on corrosion control at all maintenance levels. The senior technician may be attached to a unit which has a fully developed corrosion control program in operation and in this case he need only familiarize himself with the program and with his responsibilities in making the program a successful venture.

If no corrosion control program exists on squadron or department level, the senior technician should give consideration to establishing such a program on a shop, division, or other level where his supervisory reponsibilities lie. This course will point out briefly some of the dangers of corrosion and will list some of the information sources to which the senior technician can refer for detailed information on corrosion control.

Corrosion can cause eventual structural failure if left unchecked. The appearance of the corrosion differs with the particular metal involved. On aluminum alloys and magnesium it will appear as surface pitting and etching, often combined with a gray or white powdery deposit. On copper and copper alloys, corrosion forms a greenish film; on steel a reddish rust.

When the gray, white, green, or red deposits are removed, each of the surfaces may appear etched or pitted, depending upon the length of exposure and the severity of the attack. If these surface pits are not too deep, they may not significantly alter the strength or ductility of the metal; however, even here the pits may become sites for crack development on parts which are critical stress members. Some types of corrosion can travel beneath the surface coatings and can spread undetected until they perforate the coating or the part fails.

A thorough comprehension of the dangers of corrosion, the ability to recognize the various types of corrosion, and the development of the skills necessary to cope with them should be included in the objectives of the training program. The technician will find that aircraft corrosion control aboard ship frequently turns out to be an all-hands evolution. In his day to day work he can improve the quality of corrosion control by observing precautions and initiating proper maintenance procedures.

Water and spray containing salt combine with oxygen in the atmosphere to form the main source of corrosion in aircraft. Therefore, naval aircraft operating in a marine environment are particularly susceptible to corrosive attacks. The corrosion problem for the technician is compounded when one considers that many equipments have components which are mounted in positions which can act as traps for salt spray or sea water vapor.

The senior technician should be familiar with publications which contain valuable information concerning corrosion control. In addition to local directives on this subject the technician will find that complete technical information for specific application may be obtained from the following:

1. Corrosion Control for Aircraft, NavWeps 01-1A-509.

2. Aircraft Maintenance Cleaning Manual, NavWeps 01-1A-506.

3. Preservation of Naval Aircraft, NavWeps 15-01-500.

In addition to the formal manuals listed above, the supervisor will find information on this subject in various manufacturer's instructions furnished with equipments. Another source available to the supervisor when searching for information on this subject, or almost any subject relevant to electronics, is the Digest of Naval Aviation Electronics (NAESU Digest), NavAir 08-1-503.

RADIO NOISE INTERFERENCE

Radio noise interference is a problem of first importance to maintenance personnel. The problem has increased in proportion to the complexity of both the electric system and the electronic equipment. Almost every component of the aircraft is a possible source of radio interference, which is one of the main factors in preventing the operation of receivers at full sensitivity. All personnel concerned should be familiar with the problem of radio noise and how to eliminate it.

The overall effect of radio interference of any kind is to impair or deteriorate the performance and reliability of radio and electronic sets or systems. The interference may act directly by actual deterioration of the equipment response, or indirectly by wearing down the patience and tolerance of the human operator. Either way, the result is the same, since combat efficiency is materially reduced.

The technician should know the following:

1. What radio interference is.
2. Where the interference originates.
3. How it gets into equipment.
4. How to identify it.
5. How to suppress it at its source.
6. How to segregate its path of entry into a receiver
7. How to prevent its entry into a receiver.
8. What considerations enter into the design of an interference-free equipment.
9. How to position and install electrical and electronic devices.

This information is presented in detail in the publication, Installation and Maintenance Practices for Reduction of Radio Interference in Aircraft Electronics, NavAer 16-1-521. Some of the more important of this information is presented briefly in the following pages.

Atmospheric and Precipitation Static

Atmospheric static is a burst of RF energy caused by electrical discharges in the atmosphere. Although the frequency spectrum of atmospheric static is very wide, only frequencies in and below the high frequency band propagate far enough to be very troublesome at long distances from the electrical disturbance. Therefore, UHF and VHF receivers are seldom troubled by atmospheric static. Reduction of such static is obtained by use of frequency modulation, directional antennas, and noise limiter circuits. Frequency modulation is not used extensively in aircraft radio communications because of the bandwidth requirements.

Precipitation static is caused by the development of large static charges on the aircraft when it is flown through snow, rain, ice crystals, or dust clouds. An aircraft can build up a charge of several hundred thousand volts in a few seconds. The resulting high voltage gradients at extremities and sharp points exceed the breakdown strength of air and cause noisy corona discharges.

The conventional radio antenna, which must stand away from the body of the aircraft to be of effective height, is exposed to high electric fields. This means that corona discharges occur first in the antenna system, the very place that is most sensitive to noise. Precipitation static is reduced by using a completely insulated antenna system—that is, by using wire with high voltage insulation instead of bare wire, and by insulating all connections and supports for the antenna wire.

Precipitation static is reduced also by eliminating all sharp metal projections from the aircraft and by installing dischargers, which quietly discharge accumulated static charges at a high rate. A discharger consists of silver-impregnated cotton wicking encased in a flexible plastic tube with an aluminum mounting lug. The many fine high resistance fibers provide a multitude of discharge points. The resulting discharges are quiet unless the current is very high. For detailed information on precipitation static refer to NavAer 16-1-518, Installation and Maintenance Instructions, Anti-Precipitation Static System.

The effect of precipitation static is a loud hissing or frying noise from the speaker or headset of radio equipment and interference (grass) on the picture tube of visual output receivers. As a technician you should be concerned with precipitation static since it is produced only when the aircraft is flying. Also, the preventive measures that are taken are among the primary responsibilities of your rating. You should be aware of its characteristics for there is the probability that you will have to correct for radio interference that is caused by precipitation static.

Manmade Radio Noise

Manmade radio noise is caused by electrical transients which occur during the operation of electrical or electronic equipment. In brief, manmade radio noise will be generated whenever an electrical circuit is open or closed abruptly, such as by a relay, commutator, or other make and break devices. A similar condition exists when large amounts of current are periodically and abruptly started and stopped, as in radar circuits. An electric spark is a generator of electrical disturbances which appear to cover the entire radiofrequency spectrum.

ROTATING ELECTRIC MACHINES.—The types of interfering voltages generated by d-c machines are:

1. Switching transients as the brush moves from one commutator bar to another. This is usually called commutation interference.
2. Random transients caused by varying contact between brush and commutator. This is usually called sliding contact interference.
3. Audiofrequency hum (commutator ripple).
4. Radiofrequency and static charges built up on the shaft and rotor assembly.

Direct-current motors used in aircraft systems are of three general types: series wound, shunt wound, and permanent magnet field. The field windings of both series- and shunt-wound motors afford some "padding" or filter action against transient voltages generated by the brushes. The permanent-magnet motor's lack of such inherent filtering makes it a very common source of interference.

It must be emphasized that the size of a d-c motor has little effect upon its interference generating characteristics. The smallest motor aboard may well be the worse offender.

The output of an ideal a-c generator is a pure sine wave. A pure sine wave voltage is incapable of producing interference except at its basic frequency. However the ideal waveform is difficult to produce, especially in small machines.

Practically all types of a-c power generators currently used in naval aircraft have proved to be potential sources of interference at other than the output power frequencies. This interference is produced in the following forms:

1. Harmonics of the power frequency, caused by poor waveform.
2. Commutation interference (series-wound motors).
3. Sliding contact interferences (a-c generators and series-wound motors).

It should be noted that a-c motors that do not use brushes are almost never sources of interference.

SWITCHING DEVICES.—Abrupt changes in electric circuits occur when switching takes place. Such changes are accompanied by transients capable of interfering with the operation of radio and electronic systems. The simple manual switch is of little consequence as a source of interference because its frequency of operation is usually not great. Example of frequently operated switching devices capable of appreciable or serious interference are relays, vibrators, and thyratrons.

Since relays are used almost exclusively to control large amounts of power with relatively small amounts of power, they are always potential interference sources. This is especially true when they are used to control inductive circuits. Relay actuating circuits should not be overlooked as interference sources, because even though the actuating currents are small, the inductances of the actuating coils are usually quite high. It is not unusual for the control circuit of a relay to produce more interference than the circuit which it controls.

Induction vibrators are essentially double-pole, double-throw relays which operate at a constant rate. As in any induction type switch or relay, there are two sources of switching transients: the inductive field contacts and the switching contacts. The output waveform of the vibrator is essentially rectangular at some audiofrequency. Its harmonic content is high and filtering is difficult.

Because of its interfering capabilities, the vibrator is seldom used as a radiopower source in naval aircraft except for certain commercially available radio equipments found in small auxiliary aircraft. (Vibrators are used as d-c choppers in some servosystems.)

Thyratrons are gas filled, grid controlled, electronic switching tubes which are used for many purposes. Among the most common uses are keyer tubes in radar modulators, rectifiers in regulated power supplies, rectifiers in servosystems, and relay applications. The current flow in a thyratron is either all on or all off; there is no in-between. Since the time required to turn a thyratron on is only a few microseconds or less, current waveforms in

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thyratron circuits always have steep fronts. As a result, they are rich in radio interference energy (transients).

NONLINEAR CIRCUIT ELEMENTS.—A conductor or semiconductor whose resistance or impedance varies with the voltage applied across it is a nonlinear element. Nonlinear elements that may cause radio interference in aircraft, in the order of their frequence, are overdriven vacuum tubes, oxidized or corroded joints, cold solder joints, and unsound welds. In the presence of strong signals a nonlinear element behaves as a detector or mixer, producing harmonics and sum and difference frequencies from signals applied to it.

A-C POWER SOURCES.—Radio interference of a broadband nature is produced by a-c power sources. In a-c powered equipments, a-c hum may appear at the power frequency or at the rectification ripple frequency. The ripple frequency of a full-wave rectifier is twice the power frequency times the number of phases. Normally, aircraft systems utilize only single- and 3-phase sources at 400 cps. Full-wave rectification of single-phase, 400-cps power gives a ripple frequency of 800 cps; a 3-phase source yields 2,400 cps. This ripple can produce interference varying from annoyance to complete unreliability of equipment, depending on its severity and its coupling to susceptible elements.

SUPPRESSION METHODS.—Suppression of radio noise has advanced to the point where the proper application of available techniques will insure that receiving equipment installed in aircraft will operate at optimum efficiency. Four types of suppression techniques are involved.

Isolation is the easiest and most practical method of radio noise suppression and revolves around the possibility of separating the source of radio noise from the input circuits of the receiving equipments affected. As every man-made radio noise source can be considered a small transmitter, it is obvious that the radio noise source and leads carrying radio noise energy should be kept as far away from receiver antennas or lead-ins as possible.

In many cases, the radio noise in a receiver may be entirely eliminated simply by moving the antenna lead-in wire just a few inches away from the source of radio noise. The value of sufficient separation between sources of radio noise and receiver input circuits is not apt to be overemphasized. The isolation method of radio noise suppression is very popular as it has the advantages of not requiring any additional material or adding any additional weight.

Bonding is a very important means of radio noise control. It provides grounding of all insulated conducting objects on the exterior of the aircraft. When conducting objects are not grounded, flight through precipitation causes high voltage charges to build up on those objects. Repeatedly, the voltage gets high enough to spark over to an adjacent ground member or the object discharges to the surrounding air by corona conduction. Either mode of discharge causes considerable radio noise.

Other important functions of bonding are:

1. To protect the aircraft and personnel from lightning discharges by equalization of potentials which might cause arcs and sparks in the aircraft structure.
2. To provide a homogeneous counterpoise for radio transmission and reception.
3. To provide power current return paths.
4. To provide a short path bypassing RF noise.

All electronic equipments should be ground to the aircraft structure. This is done by using short bond straps or sheets of high conductivity (copper or aluminum) metal where it is impossible to use a short bond strap. No bond strap should be more than 4 inches in length.

Shielding is one of the most effective methods of suppressing radio noise. The primary object in shielding is to electrically "bottle up" the radiofrequency noise energy. In practical application, this means that the radio noise energy must be kept flowing along the inner surface of the shield. The use of good shielding is particularly effective in situations where filters cannot be used. A good example of this is where radio noise energy radiates from a radio noise source and the radiated energy is picked up by the various circuits that eventually connect to the receiver input circuits. It is obvious that it would be impractical to filter a number of leads or units that are influenced by the radio noise energy; hence, the application of effective shielding at the noise source itself is advisable for it will eliminate the radiated portion of the radio noise energy by confining it within the shield at its source.

Radio interference as radiated or conducted from a source may be of a single frequency or may cover an extended band of frequencies. When bonding, shielding, or isolation of the source proves ineffective as a means of reducing radio interference, it becomes necessary

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to employ filters to accomplish this reduction. A filter is defined as a selective network which transmits freely electric waves having frequencies within one or more frequency bands and which attenuates substantially electric waves having other frequencies.

The size of a filter may vary widely, depending on the voltage and current requirements as well as the degree of attenuation desired. Filters are usually incorporated in equipment known to generate radio interference, but these filters are often inadequate, and in many cases it is necessary to add filters external to these equipments. This is especially true if the source of interference is coupling interference to paths of entry to a receiver other than the powerline.

The types of filters used in the reduction of radio interference vary with the application, but each of the general filter types may be found to be particularly adaptable to some specific situation. Most of the electrical devices connected to powerlines require, for their operation, features which are conductive to the generation of radio interference.

The interference generated by these devices, unless properly attentuated, is impressed upon the power lines and conducted to the receivers. It may also be conducted into the receivers by inductive coupling to other wiring associated with the receivers. This interference, unless attenuated by means of filters, is then transmitted along these powerlines, entering the receivers at the powerline input; or this interference may be radiated somewhere along the powerlines and enter the receiver by means of the antenna system.

Filters are of four kinds and are identified as follows:

1. The low pass filter, which introduces negligible attenuation at all frequencies below a certain frequency, called the cutoff frequency, and relatively high attenuation at all higher frequencies.

2. The high pass filter, which introduces negligible attenuation at all frequencies above a certain frequency, called the cutoff frequency, and relatively high attenuation at all lower frequencies.

3. The bandpass filter, which introduces negligible attenuation at all frequencies within the range between two frequencies, and relatively high attenuation at all other frequencies.

4. The band elimination filter, which introduces negligible attenuation at all frequencies outside a certain range, and relatively high attenuation at all frequencies inside that range.

For information that covers the theory of operation of these filters, refer to chapter 4 of Basic Electronics, NavPers 10087-B.

The normal characteristics of a filter are obtained only when the filter is properly terminated in its characteristic impedance.

A wave trap is a filter or network especially designed to reject certain frequencies, or bands of frequencies. Networks of this type may be installed at the antenna of the transmitter or receiver in order to attenuate frequencies outside of the assigned frequency range of the equipment. All such networks must have low insertion loss, or attenuation, for the pass frequencies. In the design and construction of wave traps, the insertion loss is usually below 2 db.

There are two basic circuit configurations for filter networks, the pi-section and the T-section. Each may be broken down into half section which have an inverted L-shape and are known as L-section filters. If a number of pi- or T-sections are connected in series to form a filter, the resultant network is called a ladder network. Any of the above circuit configurations may be used for radio interference elimination.

In general, the use of simple capacitor filters is to be preferred over that of the more complicated network filters in cases where this type of filter provides the required degree of radio interference attenuation. In this method, the radio noise energy passes through the capacitor to ground. This sort-circuiting effect is due to the fact that the capacitor offers a very low impedance path across the noise source terminals.

A given capacitor is effective in bypassing only a limited range of radio interference frequencies because of its internal inductance and the inductance of the connecting leads. The inductance of the capacitor depends upon its capacity, the material of which it is fabricated, and the length of the connecting leads.

The capacitor leads are the major contributors to the inductance of capacitors. Therefore, small mica capacitors, with short leads are more effective as filters at high frequencies than large paper capacitors with normally long leads. Electrolytic capacitors should never be used as filters because of the danger of dielectric breakdown.

The popularity of the capacitor type filter is due to the fact that the current used for operation of the radio noise source does not have to pass through the filter. The only energy passing through the filter is the radio noise energy. The most important limiting factor in the choice of a capacitor type filter is the breakdown voltage rating of the capacitor. It must be well above the voltage used to operate the source of radio noise to be filtered. For example, where a 24-volt source of noise is to be bypassed with a capacitor, the working voltage of the capacitor should be at least 50 volts.

CHAPTER 7

TEST EQUIPMENT

For effective operation of an avionics system, it is imperative that the electronic equipments operate at maximum effectiveness within the designed limits. To accomplish this, the technician must employ the best maintenance techniques and he must utilize the test equipment to the utmost.

The following discussion on the operation and circuitry of various test equipments is designed to aid the AT in furthering his knowledge of these test equipments and their use in effective maintenance of avionics equipments. The technician should bear in mind that this discussion is not a substitute for the test equipment's Operation Instruction or Service Instruction Manual, which should be consulted before operating any type of test equipment.

OSCILLOSCOPE

Oscilloscope AN/USM-140A, which is discussed in the following paragraphs, is a high speed precision instrument utilizing plug-in units for maximum accessibility and flexibility. The vertical deflection amplifier bandpass is designed for operation from d. c. to 30 mc, and the temperature range is from minus 28°C to plus 50°C. The sweep generator which is part of the horizontal deflection system provides a variable range of sweep times. This range is from 0.1 μ sec per cm to 5 sec per cm.

FUNCTIONAL DESCRIPTION

The functions of the AN/USM-140A may be divided into six major sections. Each section is vital to the purpose of the instrument, which is the production of transient and graphic displays of electrical waveshapes on the face of a cathode-ray tube. Figure 7-1 shows the six major sections, with dotted lines to indicate d-c voltage distribution. The solid arrows show signal paths. The calibrator is not shown in the block diagram because it is a convenience, not vital to the functions of the oscilloscope.

The preamplifier receives the vertical signals and provides the required amplification. It then applies those signals (individually, alternately, or chopped) to the main vertical amplifier. To do this, an electronic switch is provided as a part of the plug-in unit.

The main vertical amplifier is a wideband circuit which raises preamplifier input signal voltage to deflection plate requirements. It provides impedance matching for the preamplifier and for the CRT deflection plates, with frequency compensation to well above 30 mc. Some of the signal is applied to the sweep generator for internal triggering. The large output of the main vertical amplifier drives the CRT deflection plates.

The sweep generator is the source of sawtooth horizontal deflection voltages for the CRT. Highly linear waveforms are available over a wide range of frequencies and they are calibrated in time. Sweep signals may be triggered by the vertical signal, internal or external a-c sources, or by external d. c. Free-running sweep may be used if desired. Additional controls are provided by plug-in units.

The horizontal amplifier has two inputs; it may receive sweep generator output, or it may receive external sweep voltages through the input jack. It amplifies these low-level signals and applies them to CRT deflection plates in push-pull circuitry.

The low voltage power supply provides all a-c and d-c voltage requirements for the oscilloscope from the a-c power line. Solid state rectifiers and voltage regulators are used throughout. Except for filament and fan supplies, all voltages are regulated. Five fuses protect the power supply; a sixth fuse protects the fan and d-c filament supply.

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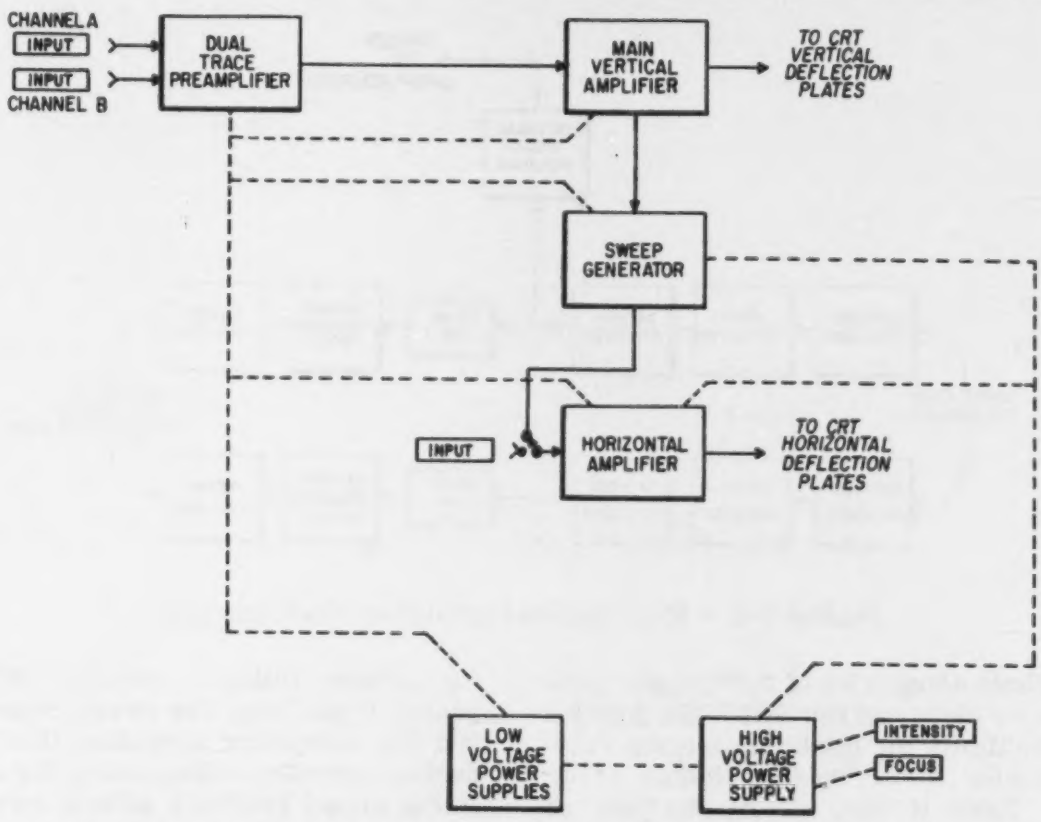

Figure 7-1. —Oscilloscope block diagram.

The high voltage power supply provides all the accelerating anode and focus voltages for the CRT. It also provides matrix circuitry for blanking and unblanking voltages, alternate switching signals, and intensity modulation.

MAIN VERTICAL AMPLIFIER

The main vertical amplifier comprises two identical d-c amplifiers, arranged for balanced push-pull operation. Figure 7-2 shows a block diagram of those circuits. The cathode follower stages provide good impedance transformation and circuit isolation between stages. The trigger sample is taken off after the second cathode follower and ahead of the delay line. A 0.20-μsec delay is included so that trigger signals may start the sweep before the vertical signal is applied to the CRT. The high frequency response is adjusted in the cathode follower driver output. The output amplifier stage has four dual triodes connected in push-pull-parallel for good driving power with low noise factor. One section of the BEAM FINDER switch limits the gain of the output stage to limit deflection.

Sweep Generator

The sweep generator is shown in block diagram form in figure 7-3. The heart of this unit is the gate generator. It produces a square wave gate signal which is then integrated to form a sawtooth sweep voltage. Cathode followers provide power output and generator isolation to four outputs. Stop and start of the gate generator is controlled by bias control and trigger signal.

Trigger Amplifier and Generator

The trigger signal, selected at the TRIGGER SOURCE switch, is applied to the TRIGGER SLOPE switch. From there, the signal enters the trigger amplifier V101, according to polarity selected. The amplified signal is then applied to a Schmitt trigger circuit, V103. This circuit, discussed in more detail later in this chapter, is a bistable multivibrator which produces spike pulses precisely timed by the trigger signal. The voltage spikes are added to the d-c level from the bias controls (V113A and B) and this composite voltage is then applied to the gate generators (V104 and V105A).

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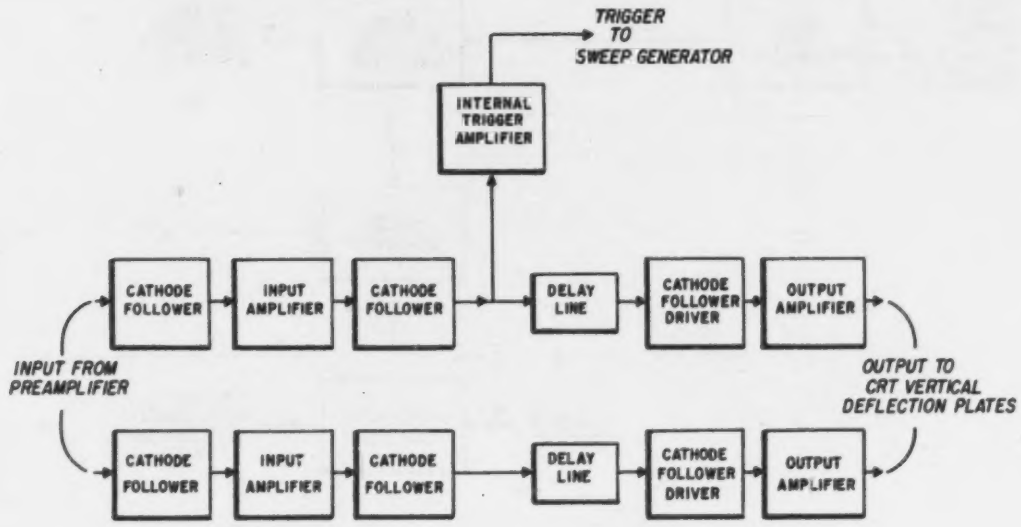

Figure 7-2. —Main vertical amplifier block diagram.

The threshold sensitivity of the trigger amplifier is set by bias from the TRIGGER LEVEL control. This limits the minimum trigger voltage and permits lower noise voltages to be eliminated. Since it also affects the gain of V101, it governs the amplitude of the trigger voltage at the V103 input. Thus it affects triggering sensitivity. The TRIGGER SLOPE switch permits phase inversion in V101A for positive-going signals. For negative-going signals, it uses V101B to apply cathode drive to V101A, eliminating phase inversions. The TRIGGER SLOPE switch thus determines whether the sweep starts on negative or positive triggers.

GATE AND INTEGRATOR CIRCUITS

The gate generator is a Schmitt trigger, designed for square wave output in bistable operation. Tube V113 holds gate bias near a critical firing point between sweeps. In this condition, V104A is on (saturated conduction) and V105A is off (nonconducting). Diode switch CR104 is held on by positive gate voltage of V105A, clamping the integrator input. No sweep occurs in this phase.

Trigger generator V103 produces reduced positive and large negative pulses. The positive pulses have no effect, but the first negative pulse causes the gate to switch, turning V104A off and V105A on. The large negative gate voltage at V105A opens the diode switch CR104, freeing the integrator input. Simultaneously, the gate generator supplies positive gate voltage for cathode follower outputs. With the integrator input free, the sweep capacitor charges and the integrator amplifies this signal, producing a positive voltage ramp for sweep output. Ramp signal feedback affects sweep capacitor charging to produce a highly linear sweep signal.

Sweep feedback through V114A and V113B triggers V104A on, resetting the gate and ending gate pulses. Positive gate to CR104 again turns on the diode switch. Clamp V105B then discharges the sweep capacitor, and the integrator amplifies this retrace voltage. Clamp action assures that all sweeps start at the same level, about -50 volts. Capacitive action in the holdoff circuit prevents retrace overshoot which might trigger the gate prematurely, before other circuits has stabilized. Note that the SWEEP TIME switch changes the sweep resistor and capacitor and the holdoff capacitor.

SCHMITT TRIGGER CIRCUIT

A Schmitt trigger is a form of bistable, cathode coupled multivibrator. Figure 7-4 is a simplified schematic of a Schmitt circuit with corresponding waveforms. Tubes V1 and V2 operate alternately so that V2 is conducting when V1 is cut off, and vice versa. As input to V1 becomes more positive, it reaches the predetermined level A of figure 7-4 (B). Then the trigger flips, V1 starts conducting, and V2 is cut off. When the input voltage begins to go negative, the grid of V2 becomes more positive. When it reaches the second predetermined level B of figure 7-4 (B), V2 once again conducts and

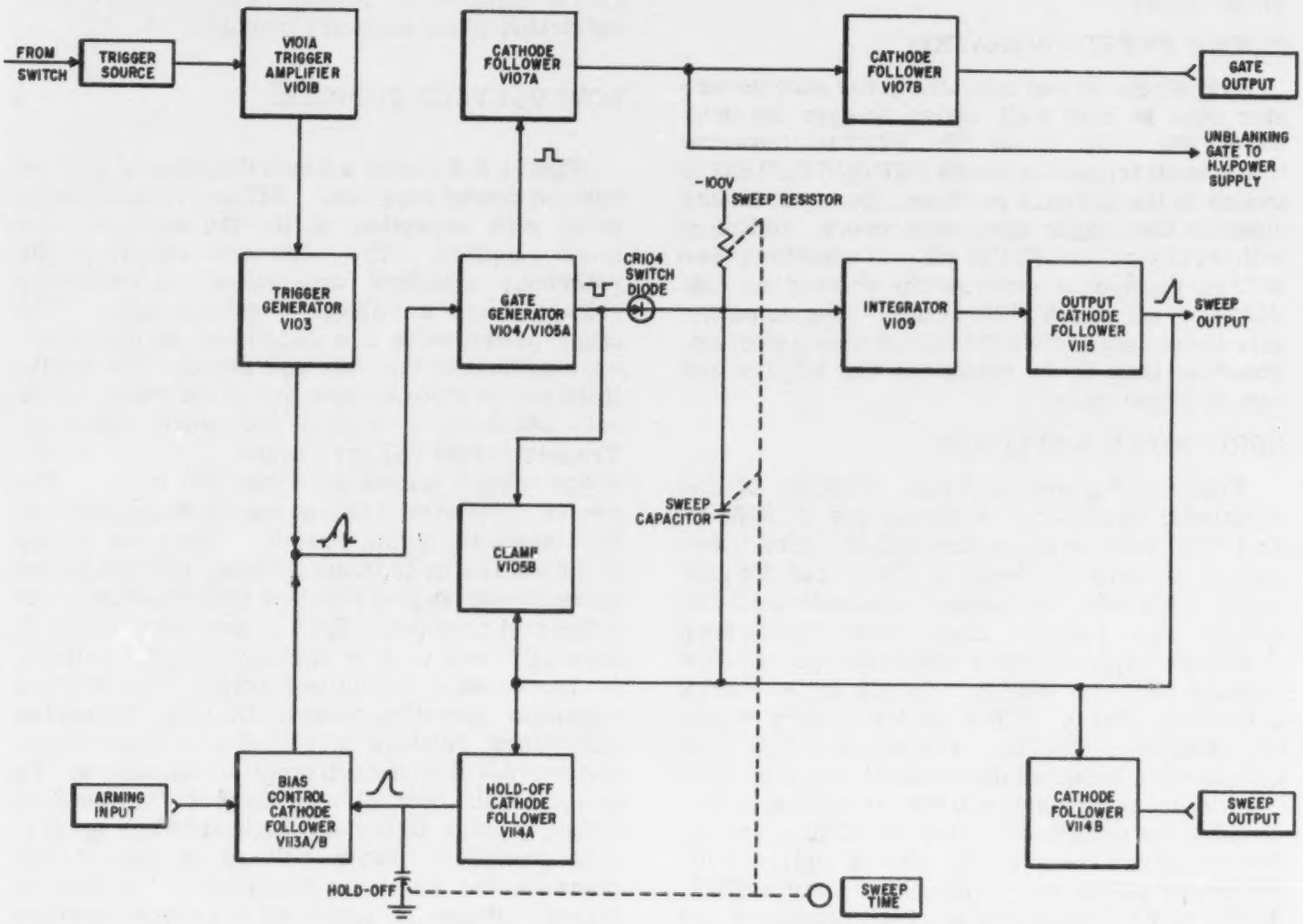

Figure 7-3. —Sweep generator block diagram.

V1 is cut off. Figure 7-4 (B) shows the relationship between the input and output of the Schmitt circuit. Points A and B are the voltage limits at which the trigger switches. The output of V2 is a square wave. Notice that the trigger will not switch unless the input signal is

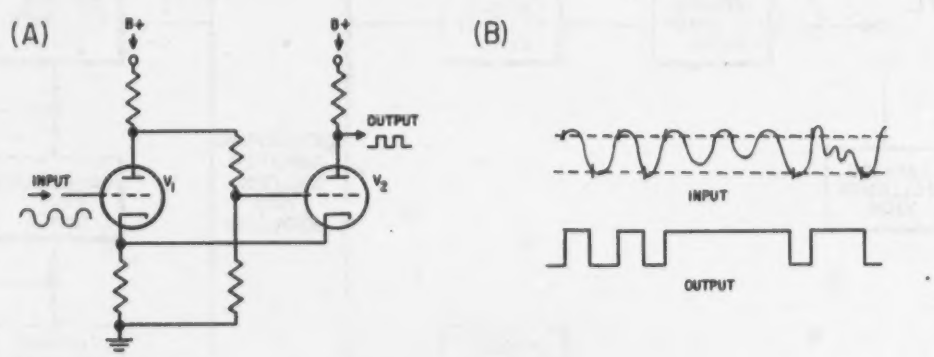

Figure 7-4. —Schmitt trigger circuit. (A) Simplified schematic; (B) waveforms.

large enough to cross both the upper and the lower limit.

SINGLE SWEEP OPERATION

For single sweep operation, the gate generator bias is held well above trigger level by V113B (fig. 7-3). To do this, V113 is converted to a Schmitt trigger by the SWEEP OCCURRENCE switch in the SINGLE position. Sweep feedback controls the trigger after each sweep, setting it with V113A on and V113B off. A positive pulse is then applied to reverse the trigger so that V113A is off and V113B is on. This arms the gate according to SWEEP MODE bias selection. Thus the gate is in readiness for trigger and can fire just once.

HORIZONTAL AMPLIFIER

Figure 7-5 shows a block diagram of the horizontal amplifier. Although the HORIZONTAL DISPLAY switch is simplified in this drawing, it governs the input of V201A and the gain of the horizontal amplifier. Cathode follower V201A may receive input from the sweep generator or it may take external input through cathode follower V201B. Output from V201A drives the grid of V202A, which in turn drives the cathode of V202B. Transistors Q201 and Q202 form a balanced differential amplifier with transistor driver stage V202, providing a balanced drive to cathode followers V206A and B. Power output from V206A and B drives CRT deflection plates and capacitance driver V207. Action of V207 improves the high frequency deflection waveform by effectively reducing capacitive reactance of the deflection plates. The plate resistance of V207 is effectively in parallel with deflection plate capacity. Its plate current is adjusted for leading phase, aiding during deflection plate capacity charge.

LOW VOLTAGE SUPPLIES

Figure 7-6 shows a block diagram of the low voltage power supplies. All are voltage regulated with exception of the fan and a-c filament supplies. The -100 volt supply is the reference standard and takes its reference voltage from a voltage regulator tube. The other power units are dependent on the reference voltage of the -100 volt supply. The rectifiers are bridge circuits except for the 6.3-volt unit which is a simple full wave rectifier. Transistorized voltage regulators maintain average ripple output to 6 mv/100 volts. The series regulator transistors are mounted in heat sinks in the fan shroud. Each d-c supply is protected by individual fuses, and the power transformer is protected by both line fuses and a thermal breaker. Each power supply may be manually set to the desired output voltage.

The voltage regulators follow conventional regulator operating theory. Briefly, the series regulators produce a variable voltage drop, under control of the differential amplifiers. To produce this control, the amplifiers compare output voltage to the standard -100 volt supply. Any change in output voltage is sensed and counteracted by those amplifiers. A drop in output voltage is offset by a reduced voltage drop across the series regulators. If output voltage starts to rise, an increased voltage drop occurs across the series regulators.

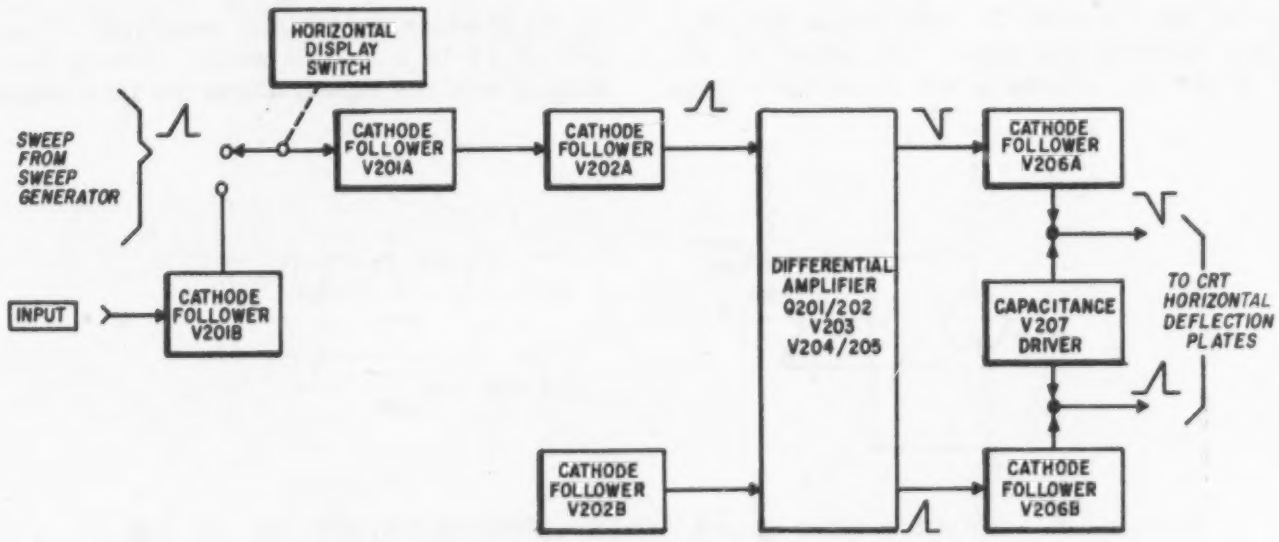

Figure 7-5. —Horizontal amplifier, block diagram.

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HIGH VOLTAGE SUPPLIES

Figure 7-7 shows a block diagram of the high voltage supply for the CRT. V304 and the primary of the high voltage transformer form a Hartley oscillator. The 50-kc output in the primary is stepped up in the secondary windings to supply the rectifiers with high voltage

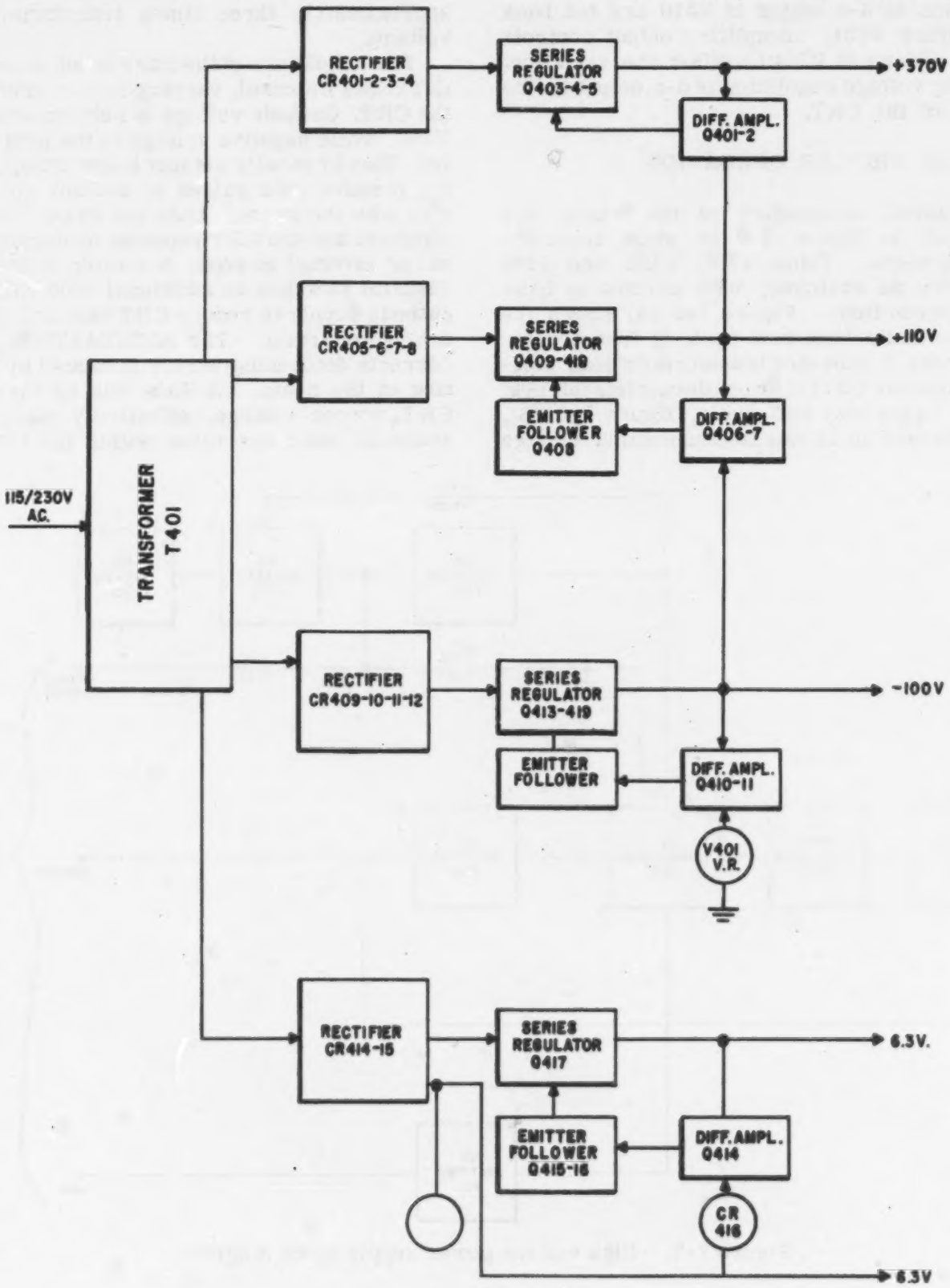

Figure 7-6.—Regulated power supply block diagram.

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a.c. V310 and V311 are simple half-wave rectifiers which supply intermediate high voltage d.c. to the cathode and grid of the CRT. V307, V308, and V309 form a voltage tripler which provides high voltage d.c. for the CRT anode. Variations in d-c output of V310 are fed back to amplifier V301. Amplifier output controls screen voltage of V304 to offset the variation, providing voltage regulation of d-c output to the cathode of the CRT.

VOLTAGE TRIPLER OPERATION

Simplified schematics of the tripler are presented in figure 7-8 to show capacitor charging steps. Tubes V307, V308, and V309 are shown as switches, with arrows to indicate electron flow. Figure 7-8 (A) shows the condition on the first half-cycle of transformer a.c. where E indicates transformer peak voltage. Capacitor C311 charges during this interval to 1E. In the next half-cycle, figure 7-8 (B), C309 charges to 2E due to transformer voltage added to that of C311. In figure 7-8 (C), the next half-cycle again charges C311, and polarity is such that V307 conducts, charging C310 to 2E. Since the voltage of C310 is 2E and that of C311 is 1E, the output voltage is 3E, or approximately three times transformer peak voltage.

The brightness of the trace is adjusted by the INTENSITY control, varying the d-c grid bias of the CRT. Cathode voltage is held constant from V310, while negative voltage to the grid is varied. Bias is usually set just below cutoff, allowing positive gate pulses to unblank the CRT in step with the sweep. Gate and sweep times are identical and the CRT remains on during internal or external sweeps. A section of the BEAM FINDER switches an additional -100 volts in the cathode supply to reduce CRT bias and produce a brighter trace. The ASTIGMATISM control corrects defocusing errors produced by deflection of the beam. It does this by varying the CRT screen voltage, effectively changing the shape of beam apertures within the CRT.

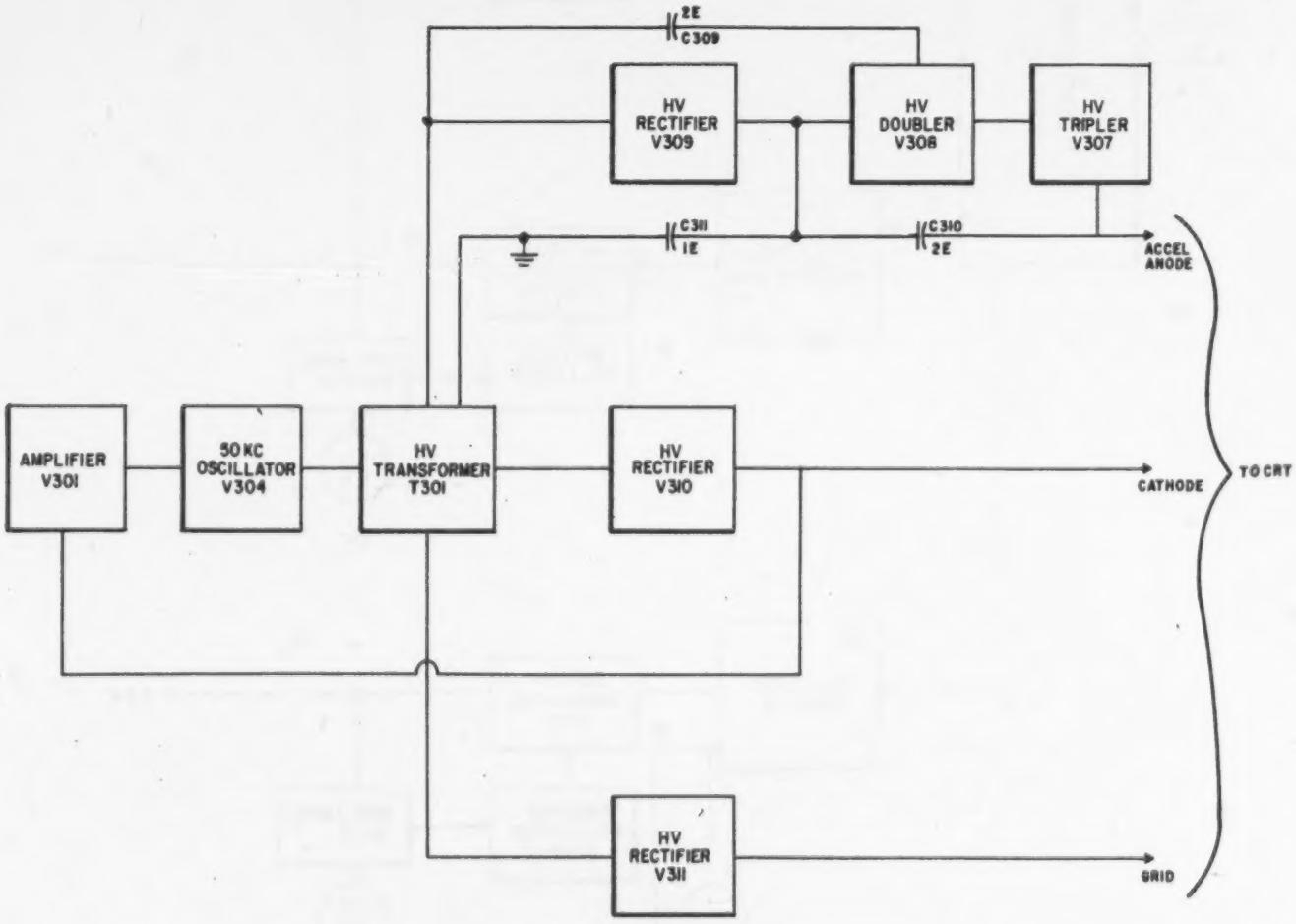

Figure 7-7. —High voltage power supply block diagram.

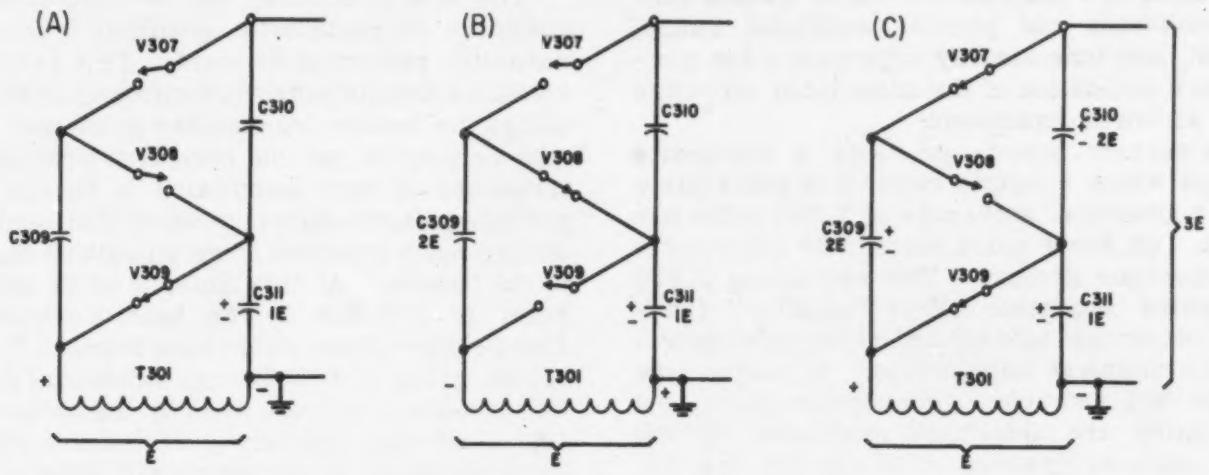

Figure 7-8. —Voltage tripler.

CALIBRATOR

The calibrator consists of a plate and cathode coupled multivibrator with a free-running frequency of 1 kc. Its output is clipped on positive and negative peaks at zero and +110 volts. The square waves produced are applied to an attenuator for pulse output calibrated in millivolts and volts. A calibrated 5-ma current output is available between the volt and millivolt jacks when the CALIBRATOR switch is set to CURRENT. No adjustments are required in this circuit.

MAINTENANCE

Maintenance of the AN/USM-140A oscilloscope does not require special procedures. Test equipment maintenance of a general nature is covered in the last section of this chapter.

TACAN BEACON SIMULATOR

This equipment is a test set designed to produce simulated TACAN surface beacon signals and other signals for testing airborne TACAN equipment.

The TACAN Beacon Simulator, Radio Test Set AN/ARM-22, can simulate fixed or variable ranges from 0 to 198 miles, all bearings from 0° to 360°, and tone signals for the operation of the identity circuits of the airborne receiver-transmitter. The test set can transmit these simulated signals to the equipment being tested on any one of 126 preselected channels.

When used in conjunction with Test Set Indicator AN/ARM-31, the capabilities of the equipment are increased. The simulator information sent to, and then processed by, the equipment being tested may be displayed by the test set indicator. This enables the operator to test individual components of the aircraft TACAN equipment.

The AN/ARM-22 is usable at shore station maintenance facilities as well as aboard ship.

OPERATING PROCEDURES

The Operation Instruction Manual, NavAer 16-30ARM-22-501, is supplied for use with Radio Test Set AN/ARM-22. Instructions contained in this manual should be followed when operating the test set.

In addition to the step by step operating instructions, the manual contains operating checks and adjustments, operating precautions, listings of equipment furnished and equipment needed, and general information on the AN/ARM-22.

THEORY OF OPERATION

This section covers the theory of operation for Radio Test Set AN/ARM-22. A discussion of the TACAN system and surface beacon is included to familiarize the maintenance technician with the overall system tie-in.

TACAN System

The test set provides simulated TACAN surface beacon facilities for conducting preflight tests of airborne TACAN receiver-transmitters.

These tests are carried out under closed circuit conditions and provide artificial range, azimuth, and tone identify information for performance evaluation of the associated circuitry in the airborne equipment.

The surface beacon provides a composite envelope which consists entirely of pulse pairs that are generated at the rate of 3,600 pairs per second. Of these pulse pairs, 900 are repetitive reference groups. The remaining 2,700 pulse pairs constitute fill-in "squitter" (randomly occurring pulses) and reply pulse pairs. used for distance information. In conjunction with the 900 reference group pulse pairs, all pulse pairs are amplitude modulated by the beacon antenna rotation, at 15 and 135 cps, for azimuth information.

To obtain distance information, the aircraft transmitter radiates a series of interrogation pulse pairs. These pulse pairs are picked up by the receiver portion of the surface beacon and, following a fixed delay of 50μ sec, retransmitted to the aircraft as an identical series of reply pulse pairs. The time interval between interrogation signal transmission, beacon reply, and pulse reception by the receiver portion of the aircraft equipment, is a function of the distance between the aircraft and the beacon. This interval is directly translated into terms of distance and is displayed on a suitable indicator in the aircraft. Other aircraft, which use the same surface beacon, employ the same operating frequency. However, the pulse repetition frequency (PRF) of the interrogating signal has random pulse spacing and is different for each aircraft. The beacon transmitter replies with a PRF identical to those transmitted and the aircraft receiver circuits ignore PRF's which are not identical to those originally transmitted. This method permits the simultaneous use of the same beacon by as many as 100 aircraft.

Azimuth information is transmitted by amplitude modulation at 15 and 135 cps. It is necessary, therefore, to insure that in the absence of sufficient interrogation, the pulse output is maintained at an average of 2,700 pulse pairs per second plus the reference pulse groups which preserve the complete modulation envelope. This is done by supplementing the interrogating pulse pairs by sufficient squitter pulse pairs. When interrogation pulse pairs are received, a sufficient number of squitter pulses will be eliminated to keep the rate constant at 2,700 pulse pairs per second.

The beacon antenna has an omnidirectional radiation characteristic modified by a rotating parasitic reflecting element. This produces a rotating cardioid pattern which sinusoidally modulates the beacon transmitter pulse pair output with respect to any one reception position. The frequency of this modulation is 15 cps. The positive going crossover point of this modulation occurs when received from a position due south of the beacon. At this time, a north reference burst is radiated by the beacon transmitter. The relative phase difference between this reference group and the 15-cps sinusoidal modulation waveform is translated by the airborne receiver circuits into terms of bearing information for display by an instrument in the aircraft.

To increase the accuracy of the bearing information, the RF pulse output from the beacon antenna is also modulated at a frequency of 135 cps by the use of nine additional parasitic reflectors. The reflectors introduce a superimposed 135-cps sine wave component on the 15-cps cardioid pattern. Corresponding auxiliary reference bursts are provided in the transmitter output. They are phased so that the positive going crossover point of the 135-cps modulation will coincide with the 135-cps reference burst, with respect to a reception position due south of the beacon. The 135-cps reference bursts and complete cycles of 135-cps modulation repeat at angular intervals of 40°, with respect to the rotary 15-cps cardioid pattern. This improves the accuracy of the obtained bearing.

For purposes of beacon identification, the random squitter pulses are periodically replaced at 740μ sec intervals by pulse pairs spaced 100μ sec apart. These evenly spaced groups form a 1,350-cps tone which is phase locked to the auxiliary bursts and keyed with the beacon identification signal in Morse code.

Radio Test Set AN/ARM-22

Radio Test Set AN/ARM-22 provides range and bearing signals, identical to those of the surface beacon except for tone coding, for preflight testing of airborne TACAN equipment. The test set consists of the following four major units:

1. Range and Azimuth Simulator SM-142/ARM-22.
2. Pulse Generator SG-317/ARM-22.
3. Signal Generator SG-318/ARM-22.
4. Power Supply PP-2110/ARM-22.

A functional block diagram of the test set is shown in figure 7-9.

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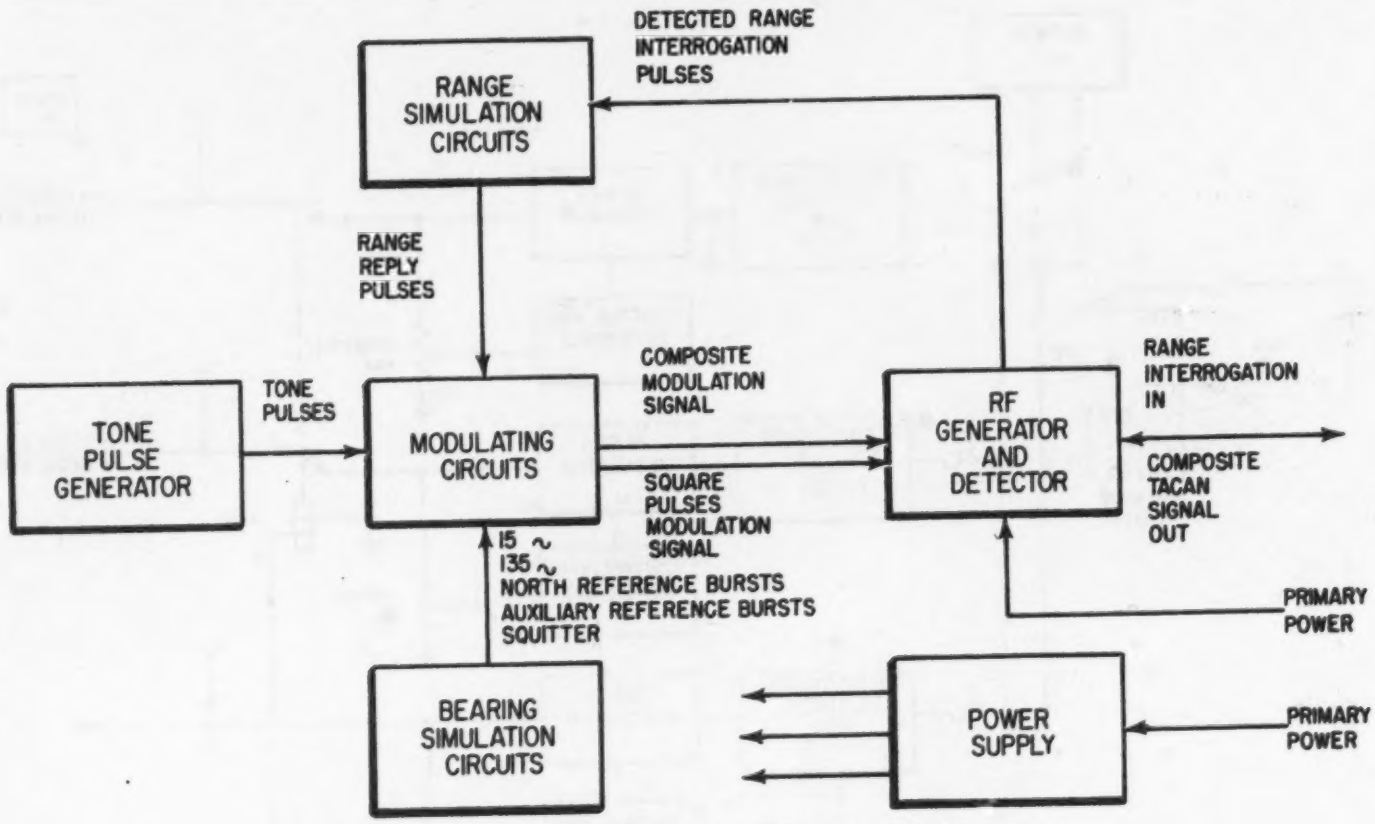

Figure 7-9. —AN/ARM-22 functional block diagram.

The power supply provides regulated voltages for the range and azimuth simulator and the pulse generator. The signal generator contains its own power supply circuitry.

The range and azimuth simulator simulates range and bearing information and uncoded tone pulses for the identity tone signal. Bearing information consists of a north reference trigger, auxiliary reference triggers, and 15-cps and 135-cps variable phase sine waves. Range information consists of suitably delayed range reply triggers.

The range, bearing, and tone information developed in the range and azimuth simulator is supplied to the pulse generator. The pulse generator circuits develop the correct spacing between pulses of groups, code and shape the output pulses, generate squitter signals, and modulate the pulse output at 15 and 135 cps. Controls are provided so that range and bearing signals may be made available individually, or combined with squitter signals. The output of the pulse generator, which consists of signals selected by the operator, is then applied to the signal generator. The pulse generator circuits also supply square pulses to the signal generator. These square pulses are synchronized with the shaped video pulses. The square pulse train is identical to the shaped pulse train but is not sine wave modulated. These pulses key the RF generating stages in the signal generator prior to modulation by the pulses.

The signal generator generates crystal controlled RF signals for each of the 126 channels. Channels 1 through 63 operate in a frequency range from 962 through 1,024 mc; channels 64 through 126 operate in a frequency range from 1,151 through 1,213 mc. The desired composite video signals from the pulse generator are applied to the signal generator where they are used to modulate RF signals. The signals may be amplitude controlled and applied to the airborne receiver-transmitter under test. When the function selector switch is placed in the PULSE OUT position, the signal generator output is in the form of pulse modulated RF power, thus simulating the beacon output in space. A CW RF output signal is obtained when the function selector switch is placed in the CW OUT position.

POWER SUPPLY. —The power supply unit, shown in block diagram form in figure 7-10, furnishes regulated d-c voltages at +250v,

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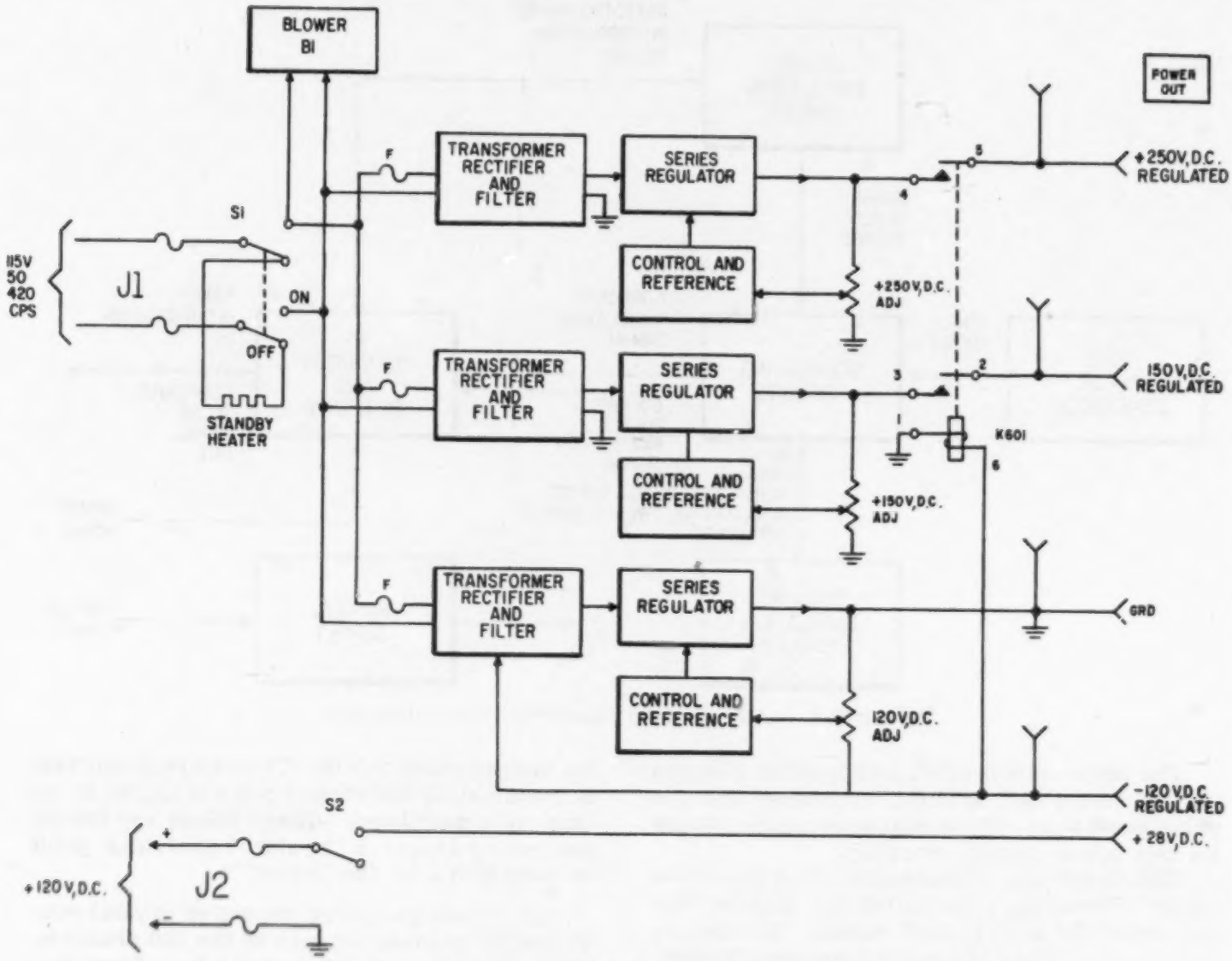

Figure 7-10. —Power supply, block diagram.

+150v, and -120v, and an unregulated d-c voltage at +28v to the range and azimuth unit and the pulse generator.

Primary a-c power is supplied through jack J1. With the a-c power switch S1 in the OFF position, power is supplied to the standby heaters in the three units. When S1 is energized, the heaters are cut off and power is applied to blower B1 and to three separate power supplies. Each power supply employs standard rectifier and filter circuits and a series regulated output circuit, which is controlled by a gas filled reference tube and a control tube.

Relay K1 protects circuits in the range-azimuth and pulse generator units by preventing application of plate voltages until the bias supply is operating. Controls and monitoring jacks on the front panel permit adjustment of each of the regulated voltages.

Primary d-c power at 28v is supplied through jack J2 and controlled by switch S2.

All power outputs are available at the power output jacks. Each input power line and power supply is separately fused by front panel fuses.

RANGE AND AZIMUTH UNIT. —The range and azimuth unit (fig. 7-11 and fig. 7-12) provides appropriately delayed range reply trigger pulses, north and auxiliary reference burst triggers, simulated bearing signals, 1,350-cps tone triggers, and a 4,046-cps test signal.

Range interrogation pulse pairs from the radio set under test are decoded in the signal generator and fed to the simulated range reply circuits. The range decoder circuit decodes range interrogation pulse pairs into a single pulse delayed about 11 μ sec. Each of these

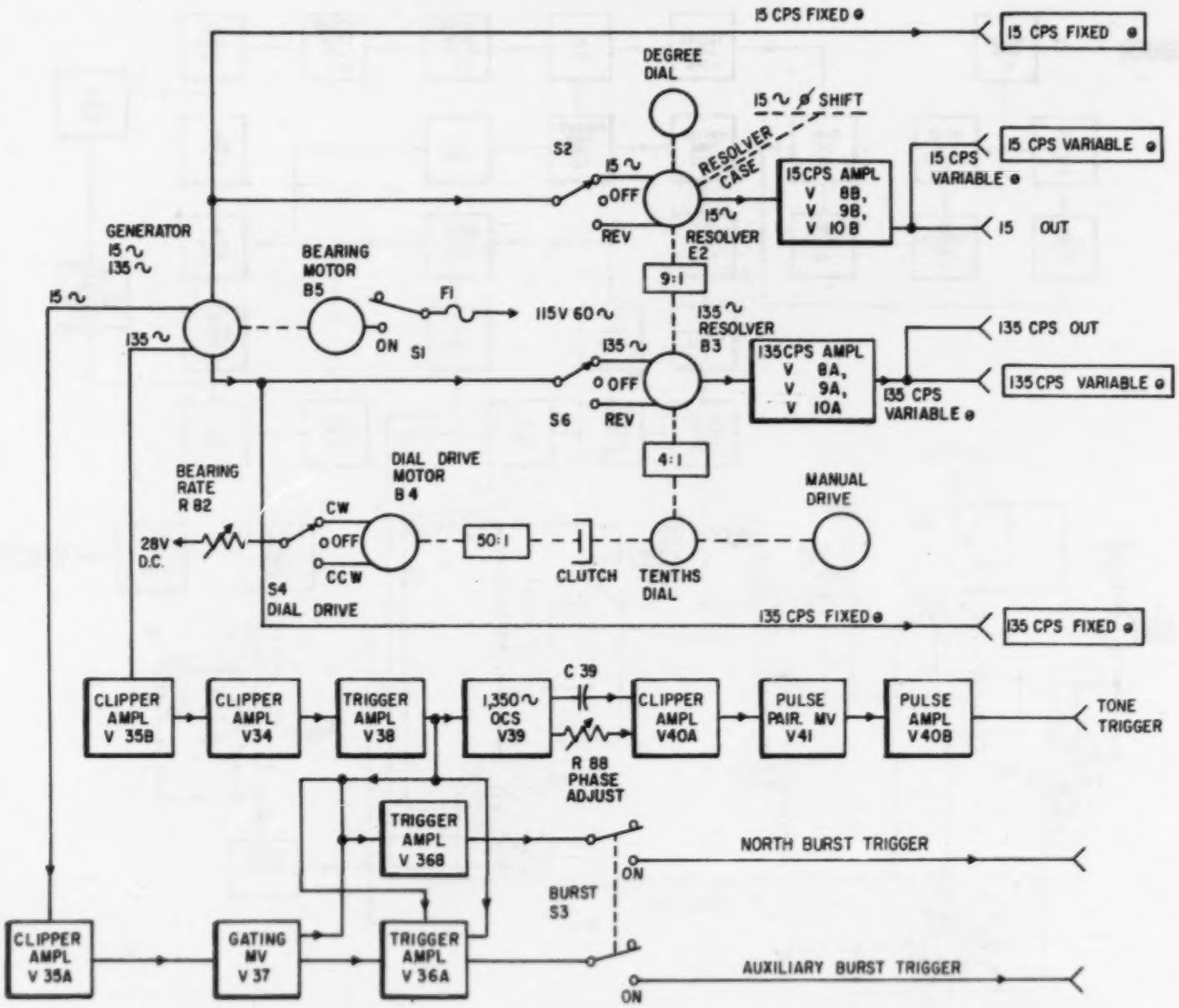

Figure 7-11.—Range and azimuth unit, bearing and tone circuits, block diagram.

pulses is used by the pulse train generator circuit to produce a pulse train 3,000 sec long, with individual pulses spaced at 222.2-μsec intervals corresponding to 18-mile separation between pulses. A five-position switch selects the mode of operation of the range reply circuits by selecting the proper range selector circuit.

The variable range rate circuit utilizes a motor driven potentiometer to produce a range sweep at a predetermined rate. Each range sweep covers fixed limits, according to the setting of the switch. In the variable position of the range switch, a manually operated potentiometer permits continuous variation of range simulating signals from 0 to 195 miles. In the fixed position of the range switch, fixed range steps are available, from 0 to 198 miles, in 18-mile increments.

Each range selector position selects a positive bias, which is fed to the bootstrap delay circuit. In the bootstrap delay circuit, this bias and a pulse from the pulse train generator produce a delayed signal which operates a range gating circuit. In the fixed position of the range switch, the range gate produces a fixed delay gate which opens the coincidence gate to permit the passage of the appropriate pulse from the pulse train. The variable delay range pulses from the range gate, or the fixed delay range pulses from the coincidence circuit,

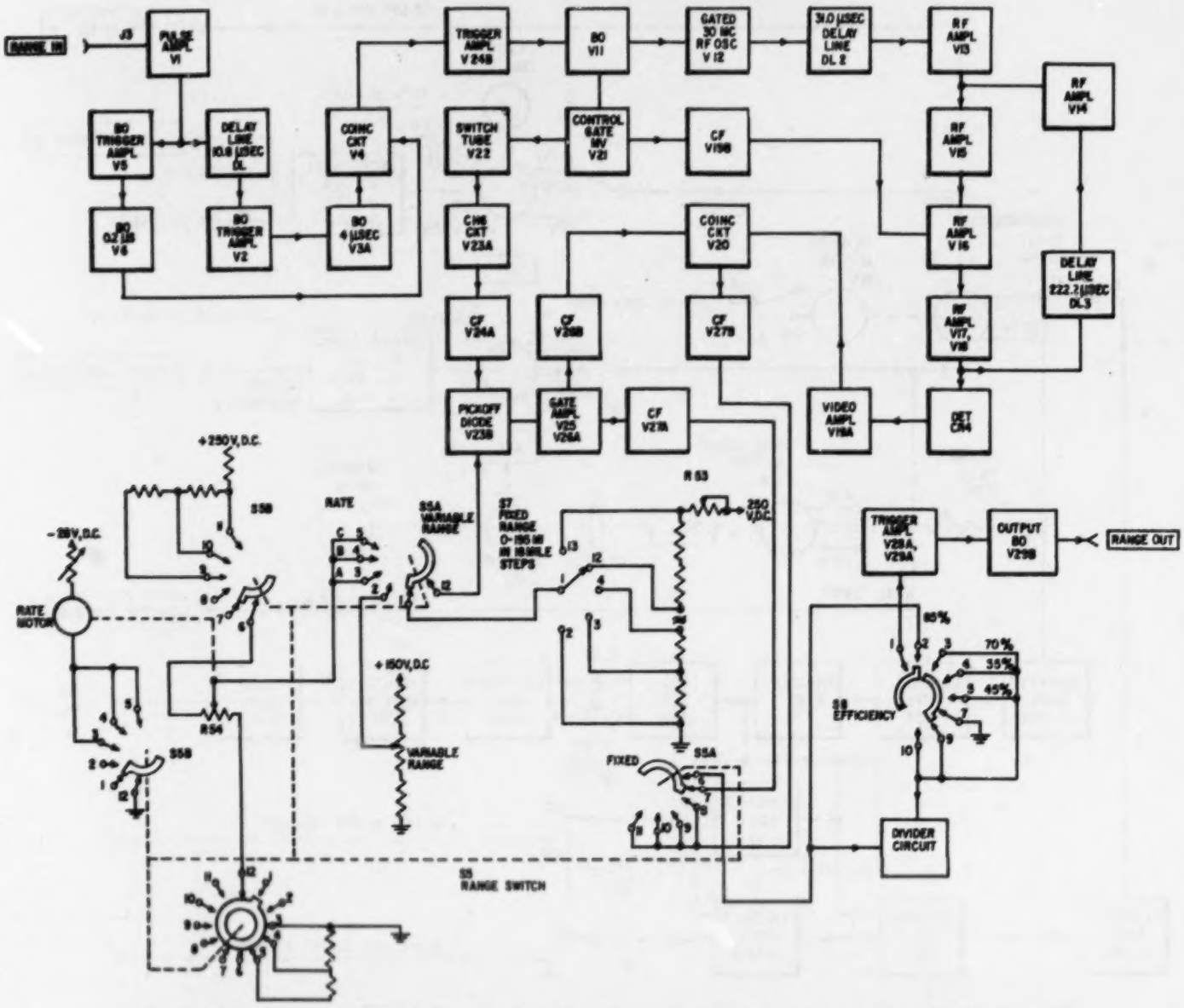

Figure 7-12. —Range and azimuth unit, range circuits, block diagram.

are fed to the efficiency circuit, which divides the pulse count so that only the indicated percentage of appropriately delayed reply pulses is fed to the output circuit. The output circuit converts each range reply pulse to a pulse trigger fed to the pulse generator unit.

A 15-cps and 135-cps generator provides the basic signals used by the unit for producing simulated bearing signals. The separate synchronous 15-cps and 135-cps sine waves from the generator are fed, respectively, to north reference burst and auxiliary reference burst circuits. The north burst circuit produces a pulse which serves as the north burst trigger. The auxiliary burst circuit produces eight equally spaced pulses between each pair of north burst trigger pulses.

Separate 15-cps and 135-cps sine waves from the generator are fed to phase shift resolvers. These resolvers shift the phase of the 15-cps and 135-cps sine waves, with respect to the north and auxiliary triggers, to simulate bearing information.

A 4,046-cps oscillator in the range and azimuth unit provides a 4,046-cps signal for testing range circuits in the airborne receiver-transmitter.

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A tone pulse circuit produces 1,350-cps tone trigger pulse groups.

PULSE GENERATOR UNIT.—The pulse generator unit utilizes the tone, range, and bearing signals from the range and azimuth unit for the following purposes:

1. To produce coded pulse groups.
2. To generate random squitter pulses.
3. To combine all outputs to form a properly sequenced coded pulse train for use by the modulating circuits in the signal generator.

The tone trigger, simulated range trigger, and a squitter signal (generated within the pulse generator unit) are fed to the tone squitter circuits. A switch allows selection of separate signals or of a combined squitter-range signal, and permits the tone-range-squitter circuits to produce a properly sequenced pulse train which is fed to the burst mixing and gating circuits. The north and auxiliary trigger pulses are fed to separate reference burst circuits.

Each reference burst circuit produces properly spaced pulse groups for each trigger signal. The north reference burst consists of 12 pulses, spaced at 30-μsec intervals, and occurring at a 15-cps rate. The auxiliary reference bursts consists of 6 pulses, spaced at 24-μsec intervals, and occurring at a 135-cps rate. Since auxiliary bursts are blanked during the occurrence of north bursts, the combined reference burst signals are fed to the burst mixing and gating circuits without interfering with each other. In the mixing and gating circuits, the inputs are combined to form a properly sequenced series of pulses. These sequenced pulses are fed to the pulse coding circuit, where the spacing between pulses of a pair can be varied.

The coded, sequenced pulses are fed to the pulse generator and shaper circuits. In these circuits each pulse is used to produce a pair of 3.5-μsec pulses, spaced 12-μsec apart. All of these pulses are of equal amplitude and are fed to the modulator circuits. The variable phase 15- and 135-cps sine waves, conveying the bearing information, are fed to the modulator driver circuits and may be used to amplitude modulate the pulse pairs. The output is fed to the signal generator and is also available at a monitor jack for test purposes.

SIGNAL GENERATOR UNIT.—The signal generator unit (fig. 7-13) utilizes the output of the pulse generator to amplitude modulate any one of 126 output frequencies. This action produces an output signal which consists of RF pulses containing the range, tone, squitter, and reference bursts, all of which are amplitude modulated by the simulated bearing signals at 15 cps and 135 cps.

Any one of 42 separate crystals selected by the channel selector controls a primary crystal

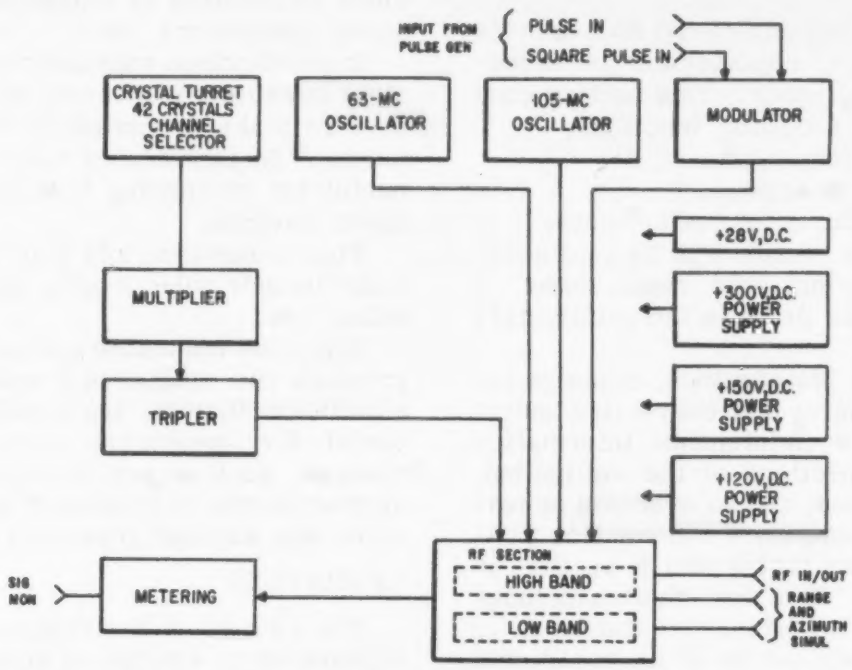

Figure 7-13.—Signal generator, simplified block diagram.

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oscillator. The signal from the primary crystal oscillator, after being multiplied and properly combined with the output of a crystal controlled 105-mc or 63-mc oscillator, provides the 126 radiofrequencies. The unit may also be used at these frequencies as a CW generator.

The composite modulating signals from the pulse generator unit enter the modulator drive circuits. After amplification, they are used to modulate various RF stages when the unit is switched to the pulse operation position. The RF signal from the output cavity is fed through a variable attenuator to an RF filter assembly. Then, via a piston attenuator, the RF signal is fed to the receiver-transmitter under test. When the receiver-transmitter under test transmits range interrogation pulses, the coupling circuit directs them to a detector which detects the interrogation pulse pairs and feeds them to the range and azimuth simulator.

The signal generator also contains circuits for measuring the transmitter output power of the receiver-transmitter under test, calibrating the level of the pulsed or CW RF output, and monitoring the various signals.

MAINTENANCE

Instructions for maintaining the TACAN beacon simulator are contained in the Service Instruction Manual, NavWeps 16-30ARM22-502, sections V and VI.

Section V, titled Organizational Maintenance is limited to service, replacement of subassemblies, and minor repair. This section contains tables for the following functions:

1. Preliminary inspection.
2. Cable interconnections.
3. Check procedures of major units.

Minor repairs in this section will be confined to the cleaning, repairing, and replacement of only those components listed in the preliminary inspection list.

Section VI, Field Maintenance, contains instructions for preventive and corrective maintenance. Preventive maintenance information covers periodic inspections of the equipment, lubrication instructions, and an overhaul schedule. Corrective maintenance information provides trouble analysis tables and a section on equipment alinement. This section also includes tables of minimum performance standards to insure that the equipment is at an acceptable performance level.

FREQUENCY METER

Frequency Meter AN/USM-26 is a precision instrument that measures frequencies to 10 megacycles automatically and displays its answers in digital form on an eight-place panel indicating system. With the use of the plug-in unit Frequency Meter Subassembly MX-1637/U (supplied as part of USM-26), the range is extended to 100 megacycles. With the use of the Frequency Converter Group AN/USA-5 (not supplied), the frequency range may be extended to 220 megacycles. In addition to making direct measurements of frequency, the set also measures period (time of one cycle of a periodic wave), time intervals, frequency ratios, and total events. It may also be used to count random events, such as those encountered in nuclear work.

PURPOSE

Because of the accuracy with which it measures frequencies, the equipment can be considered to be a new type of secondary frequency standard that replaces more elaborate installations of conventional precision frequency measuring equipment. For example, the meter has been found particularly useful for frequency measurements in quartz crystal grinding work as well as for general laboratory quality frequency measurements. Other typical frequency measuring applications for the equipment include calibration of transmitters, oscillators, signal generators, etc.

In combination with tachometer generators or other suitable transducers, the equipment can be used to make precision tachometry measurements. In tachometry work it is particularly useful for measuring the performance of high speed devices.

Time measurements that the equipment will make include pulse length, pulse interval, time delay, etc.

Since the indicating system in the equipment presents the measured frequency in up to eight significant figures, the equipment is especially useful for measuring very small frequency changes, such as are encountered when making measurements of frequency stability of oscillaators and similar frequency generators.

OPERATION

The circuit of the frequency meter can be considered to consist of seven basic sections. These are:

1. The input section, where input signals are amplified and shaped before they are fed into the counters and the control circuits. Trigger circuits in this section assure that strong, sharp triggering pulses are always supplied to the high speed circuits.

2. The time base section, which supplies the internal standard frequencies for the frequency meter. This unit consists of a 100-kc crystal oscillator and frequency multiplier and divider circuits.

3. The gate section, which opens and closes the signal path to the counter. The circuit also controls the display time and resets the counter to zero.

4. The counter section, which consists of eight cascaded scalers, each with an indicating system.

5. The frequency converter, a front panel plug-in unit which extends the basic frequency measurement range of the frequency meter from 10 mc to 100 mc.

6. The time intervals unit, also a front panel plug-in unit, which contains the adjustable threshold input channels (START INPUT and STOP INPUT) that are used for measuring the time between two electrical events.

7. The power supply, which develops all of the necessary operating potentials for the frequency meter circuits.

Time Base Section

The 100-kc internal standard frequency is controlled by a low temperature coefficient crystal, Y1. Frequency accuracy of two parts per million per week or better is obtained by maintaining the 100-kc crystal at a uniform temperature in a heater oven. The crystal oven, Z35, is wired into the primary power circuit and is on as long as the instrument is connected to the power source. A panel mounted thermometer provides a continuous indication of crystal temperature which is nominally 65°C. Oven heater circuits are shown in the power supply schematic. Figure 7-14 shows a block diagram of the complete time base.

CRYSTAL OSCILLATOR. —The 100-kc crystal oscillator (V34) in figure 7-15 is a modified Pierce circuit. Frequency can be changed ±2 cps by adjusting the capacity across the crystal. This change is made by screwdriver adjustment of capacitor C94, located at the

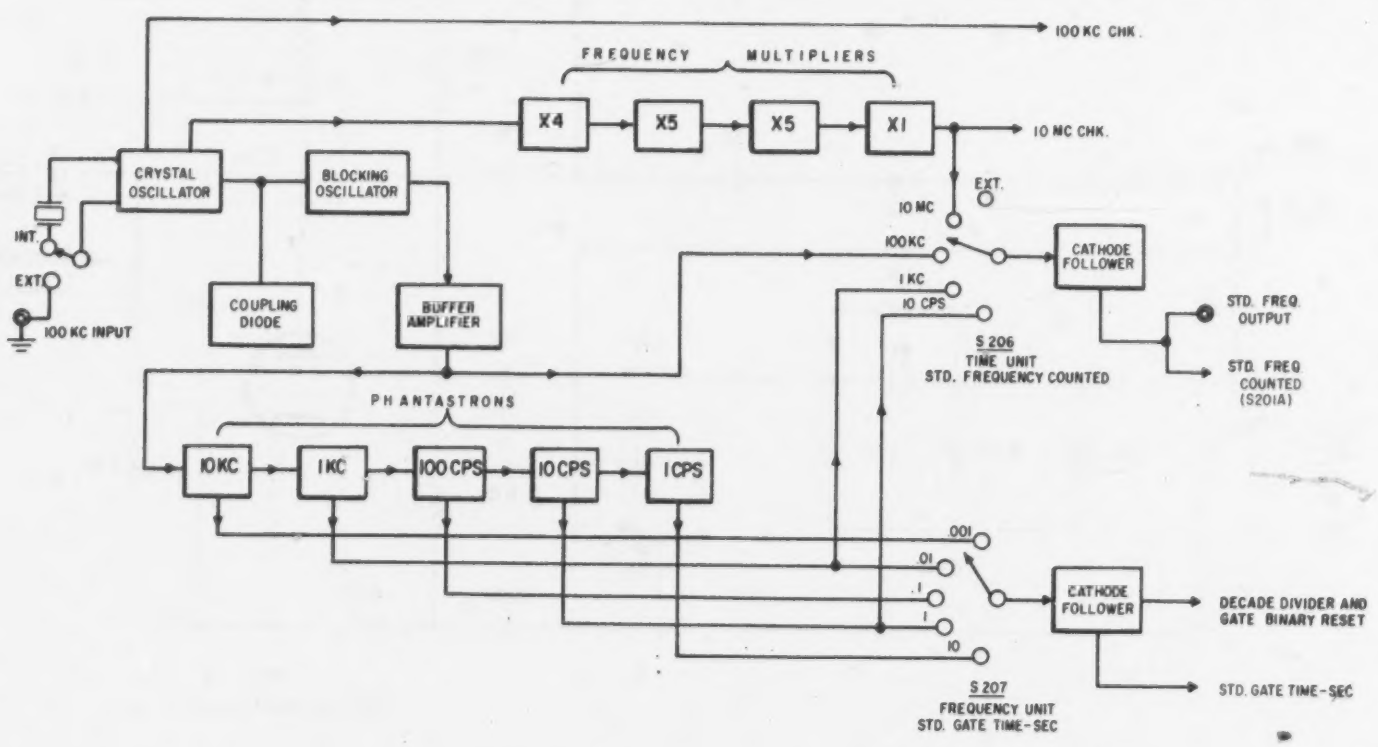

Figure 7-14. —Block diagram of the time base.

lower left corner on the front panel of the instrument. Larger changes can be made by adjusting capacitors C95 and C96 located on the deck behind the crystal oven.

The output from the crystal oscillator drives blocking oscillator V36A. The output voltage is also fed to the FUNCTION SELECTOR switch (S1A) for self-check operation.

EXTERNAL STANDARD FREQUENCY.—Where a primary frequency standard is available, an external 100-kc standard frequency may be connected to the 100-kc INPUT, with switch S5 in EXT position. V34 is converted to amplifier operation as shown in figure 7-15.

BLOCKING OSCILLATOR.—To reduce the loading and provide isolation from the remaining circuits, blocking oscillator V36A follows the crystal oscillator. This oscillator drives itself beyond cutoff within one cycle of operation. The action is initiated by the output signal from the 100-kc crystal oscillator (V34) and results in a sharp output pulse accurately repeated at a repetition rate of 100 kc per second. A simplified schematic of the blocking oscillator is in figure 7-16. It consists of V36A, a special iron core transformer T2, and associated components.

Gating Section

The function of the gating section is to open and close the signal path from the input amplifiers and triggering circuits to the counters by means of an electronic gate. This section also controls the display time and supplies the reset pulse to clear the previous count from the counters before the gate opens. A block diagram of the gating section is shown in figure 7-17.

BINARY GATE AND DIODE GATE.—The binary gate (V6 and V7 of fig. 7-18) is a modified Eccles-Jordan flip-flop circuit. It has the function of furnishing the signal gate with the

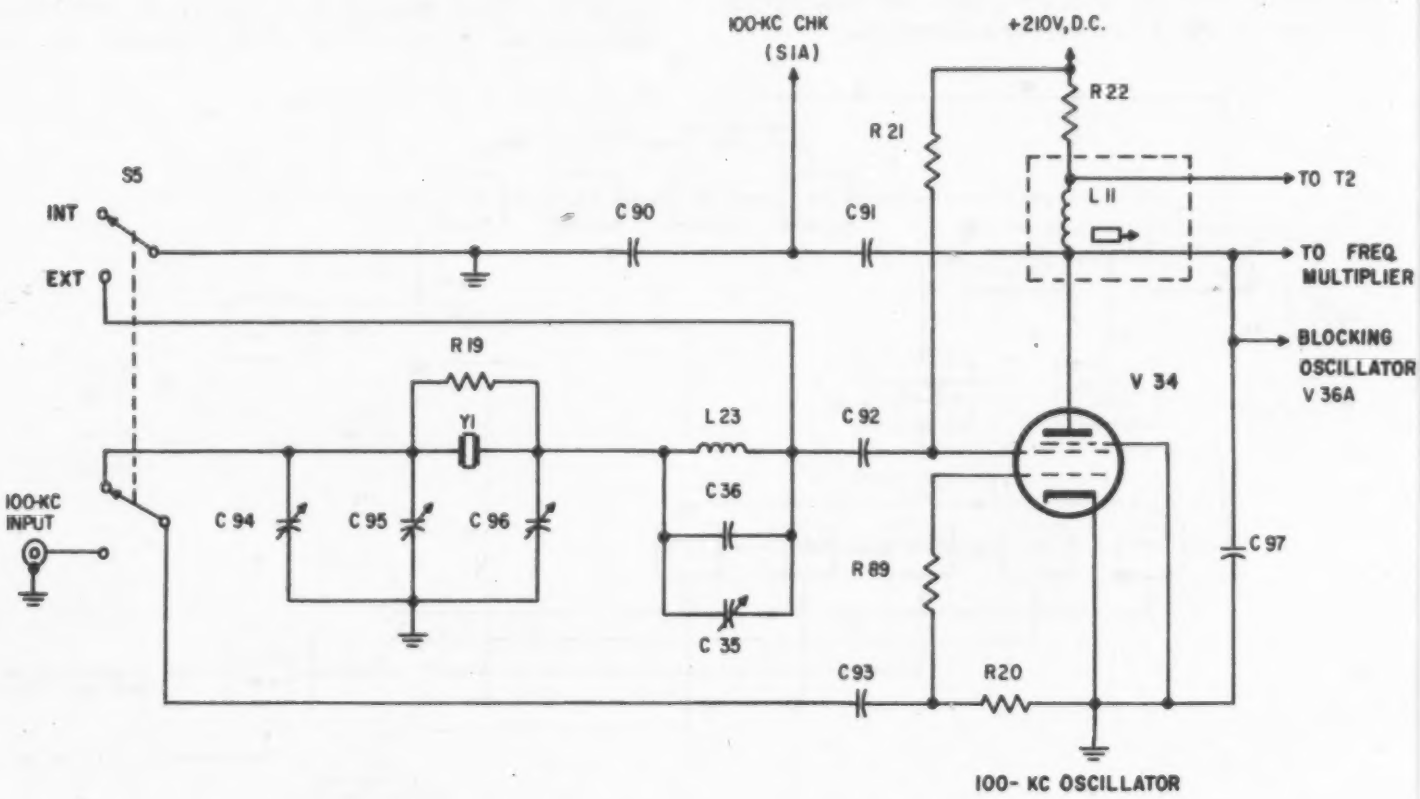

Figure 7-15.—Schematic of crystal oscillator.

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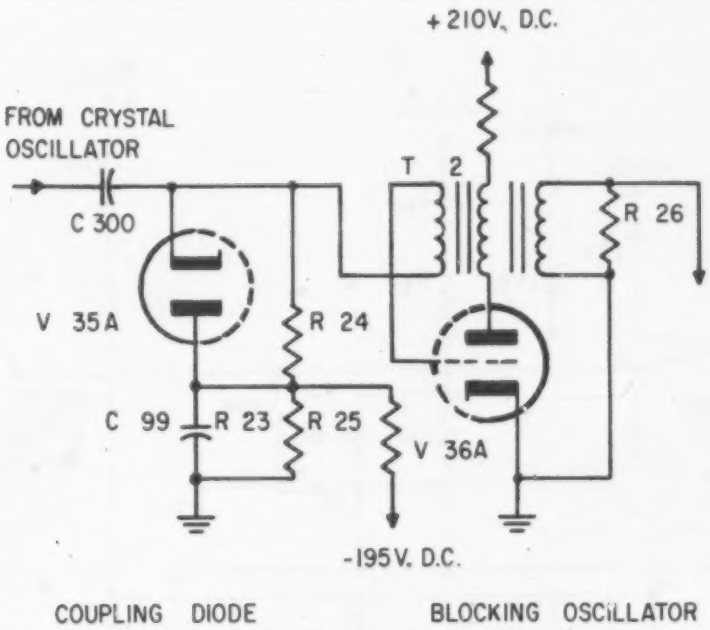

Figure 7-16. —Schematic of blocking oscillator.

proper voltage to hold it open for a time interval between the two negative input pulses (start and stop) to the binary. The diode gate (CR5), which is controlled by the display time circuits, prevents the binary gate from being retriggered during the display time. This isolation of the binary gate is accomplished by blanking any negative triggering pulses with a high back bias placed on CR5 by the display time control tube V4. The bias is removed at the end of the display time and the system is ready to start the new count. A simplified schematic of the binary gate and diode gate is shown in figure 7-18.

To insure positive operation of the binary gate by any of the several types of driving pulses, the basic binary circuit is modified by use of R51, R52, R67, and R68. These resistors form two voltage dividing networks that apply back bias to the grid crystal CR5 or CR10 (whichever tube is cut off) and zero bias to the grid crystal of the conducting tube. Due to this bias, triggering pulses reach only the grid of the conducting tube, the back bias absorbing those that would be applied to the grid of the cutoff tube.

Each triggering of the binary gate shifts the bias so that the back bias always shields the cutoff half of the gate from any triggering pulse. The shift (due to stray capacity) takes approximately 0.7 microseconds, or somewhat longer than the 0.1 microsecond shift time of the flip-flop. This delay allows lengthy triggering pulses to die down and eliminates possible erratic triggering of the binary gate.

The source of the negative input pulse to the binary gate depends on the measurement function performed by the instrument. For period

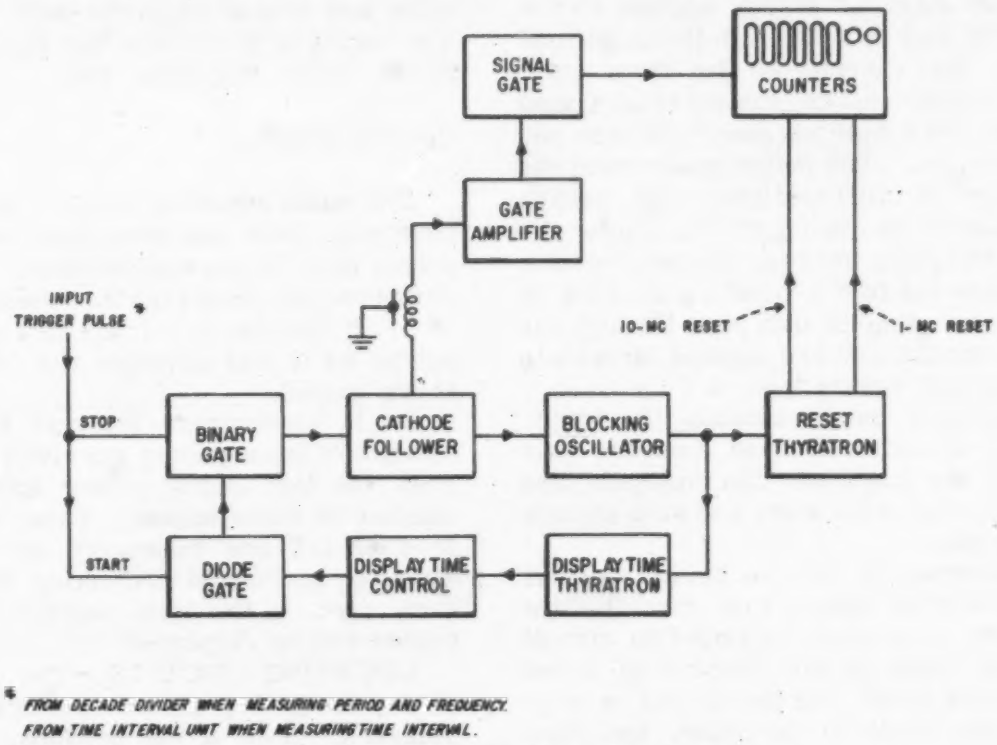

Figure 7-17. —Gating section, block diagram.

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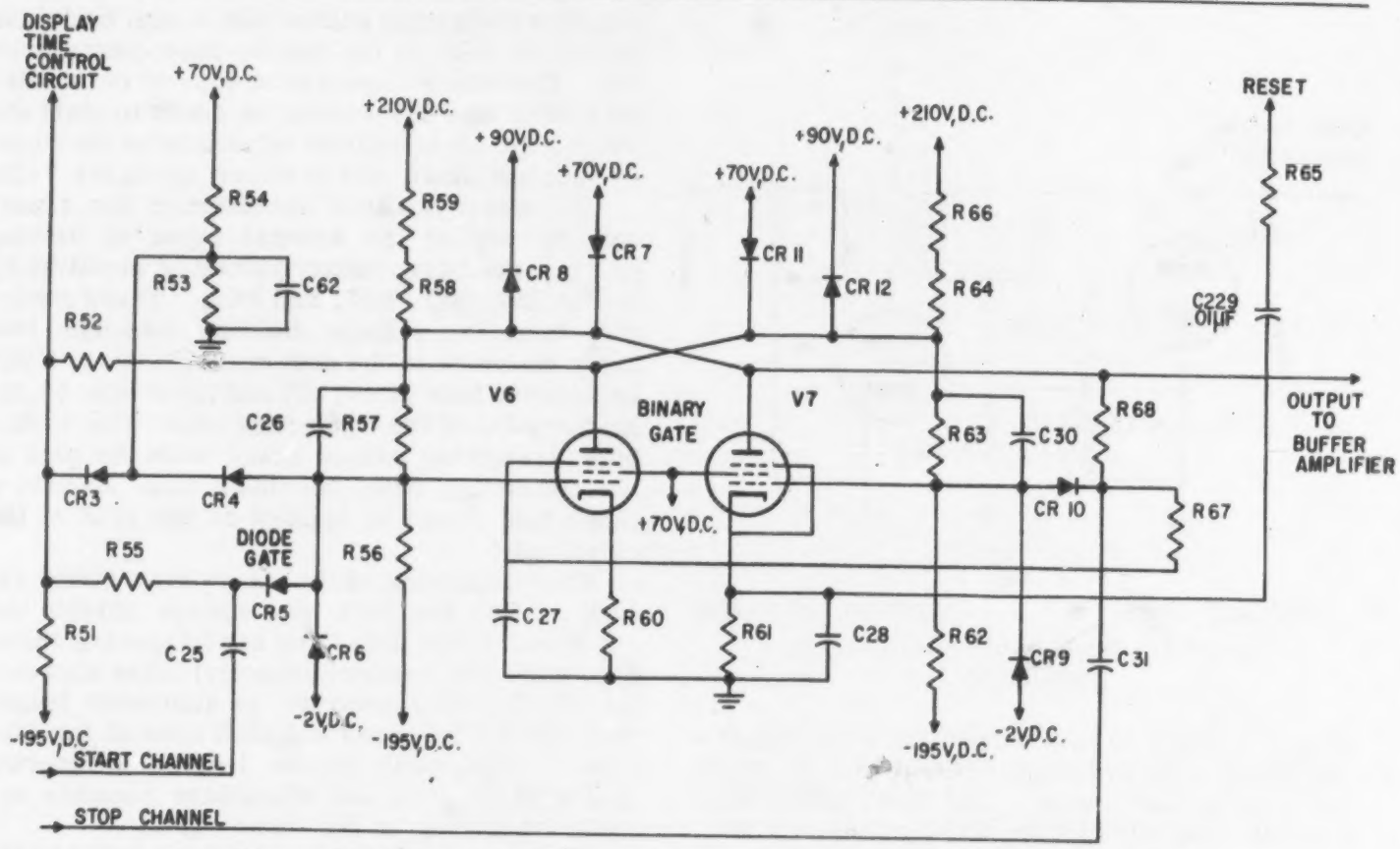

Figure 7-18. —Simplified schematic of binary gate and diode gate.

measurements, the input trigger pulse is obtained from an external signal applied to the SIGNAL INPUT and goes through the amplitude discriminator (Z2) directly to the diode gate. In 10 period measurements, the external signal passes through the amplitude discriminator and the decade divider. The output pulse from the decade divider is differentiated and passes through the open diode gate (CR5) to trigger the binary gate. For time interval measurements, external signals fed to the input connectors of the time interval plug-in unit pass through the waveshaping circuits and are applied directly to the diode gate and binary gate.

During frequency measurements, the internal standard frequencies derived from the time base are fed to the amplitude discriminator and decade divider to provide start and stop signals for the binary gate.

Since the accuracy of the gate period depends upon the speed with which this circuit flips from one state to another, a flip-flop circuit similar to that found in the 10-mc high speed decade counter is used. As the circuit is triggered from one state to the other, the plate voltage of V6 is switched from +70 to +90 volts, with the plate of V7 always in the opposite state. The gate is open when the plate of V7 is at +70 volts and closed when the plate is at +90 volts. The output is taken from the plate of V7 and fed to the buffer amplifier V8A.

Counter Section

The pulse counting circuit consists of decade counters, such as those used in digital computers and nuclear instruments. Each counter performs the following two functions:

1. It divides the frequency of the incoming pulses by 10 and presents the lower frequency at its output.
2. It remembers (stores) indefinitely the number of input pulses received since it delivered the last output pulse, and displays this number by some means. Thus, when a number of counters are connected in cascade, each dividing by 10 and indicating the remainder, each digit in the total number of pulses received will be displayed.

COUNTING CIRCUITS. —The counter section of the frequency meter employs eight decade counters. Two of the decades, the 1-mc decade and the 10-mc decade, display the residual counts on meters. The six remaining decade

counters are plug-in units. Five of these (Z5 through Z9) are decade counters with a maximum counting rate of 30 kc. One counter, Z4, has a top frequency of 100 kc. The residual counts of these decades are displayed by means of neon lamps.

BASIC BINARY SCALER.—Since counters must be usable over wide frequency ranges, counting circuits must be nonperiodic. This requirement has led to the use of the Eccles-Jordan trigger circuits or flip-flops and a binary system for counting purposes.

For convenience of use, it is desirable that a counting device divide by a factor much larger than two. Therefore, several flip-flops are usually connected in cascade in a circuit such as that of figure 7-19 where four stages divide in a binary manner by a facotr of 16. That is, every 16th pulse applied to the input flip-flop results in a single output pulse from the output flip-flop, as illustrated in figure 7-20.

DECADE COUNTERS.—Because of the wide preference for decimal rather than binary dividing ratios, compounded binary systems such as that in figure 7-19 are often modified by means of a feedback circuit so as to recycle after the 10th applied triggering pulse. This operation is best described by reference to figures 7-21 and 7-22.

Starting with the output plate (pin 6, fig. 7-22) of each of the flip-flops in a low state (conducting), the plates would be as shown at position 1 in figure 7-21. If it were now possible to cut off plate current in tubes V20 and V21 (represented by waveforms B and C), their plates would go to the high state (+200 volts). This change to +200 volts would correspond to skipping from a place just after the eighth input pulse (position 1) over to a place just following the 14th input pulse (position 2) in the straight binary system (see trigger pulses opposite 4 in figure 7-21). The six plate voltage states corresponding to input pulses 8, 9, 10, 11, 12, and 13 in the straight binary system would thus be skipped. From this point, two more input pulses (trigger pulses 9 and 10 opposite 5) would return all four plates to the low (conducting) state from

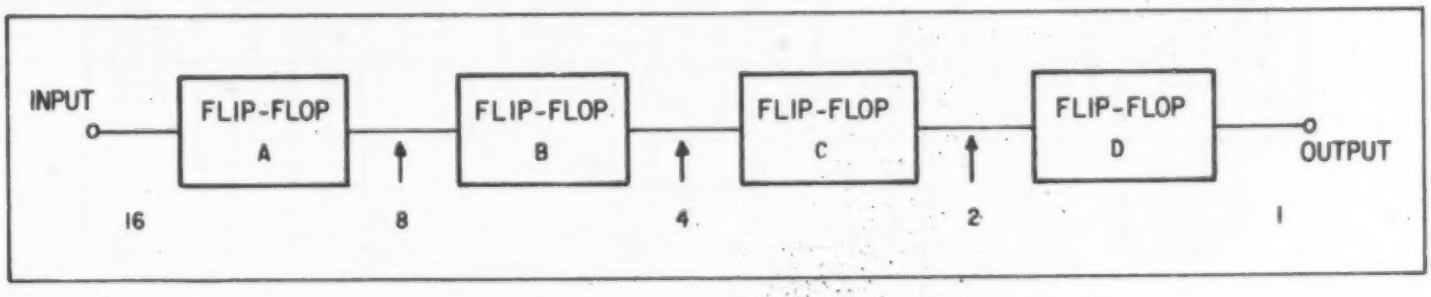

Figure 7-19.—Flip-flop chain used in scale-of-16 circuit.

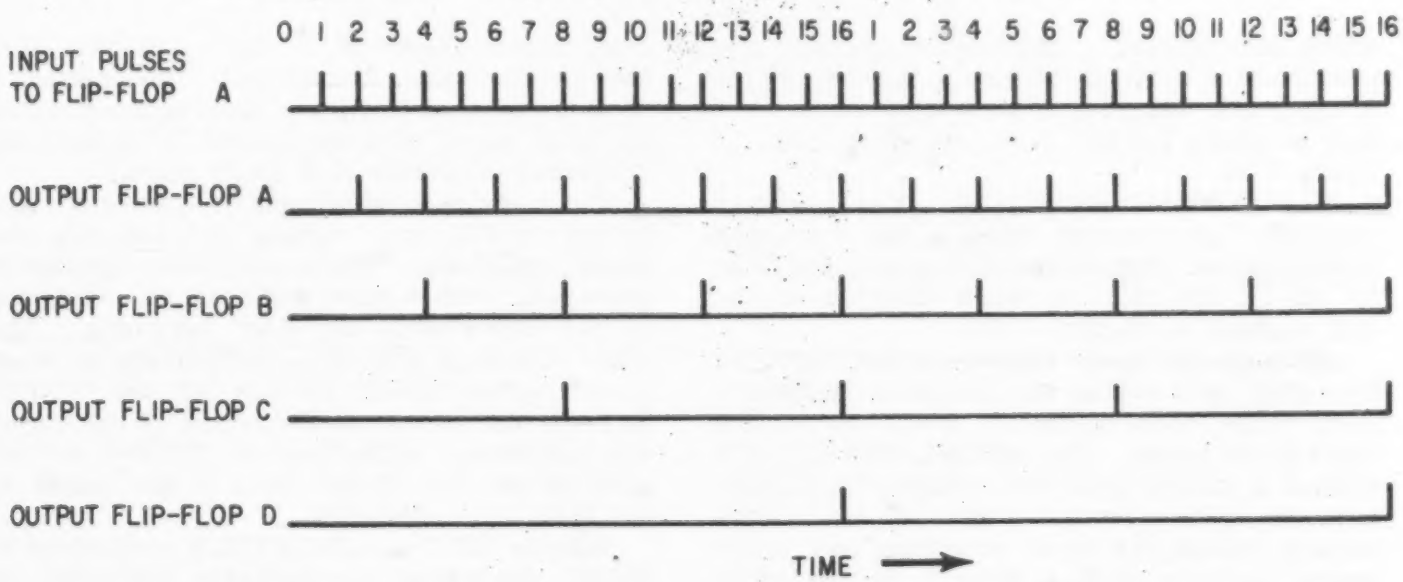

Figure 7-20.—Schematic representation of operation of scale-of-16 circuit.

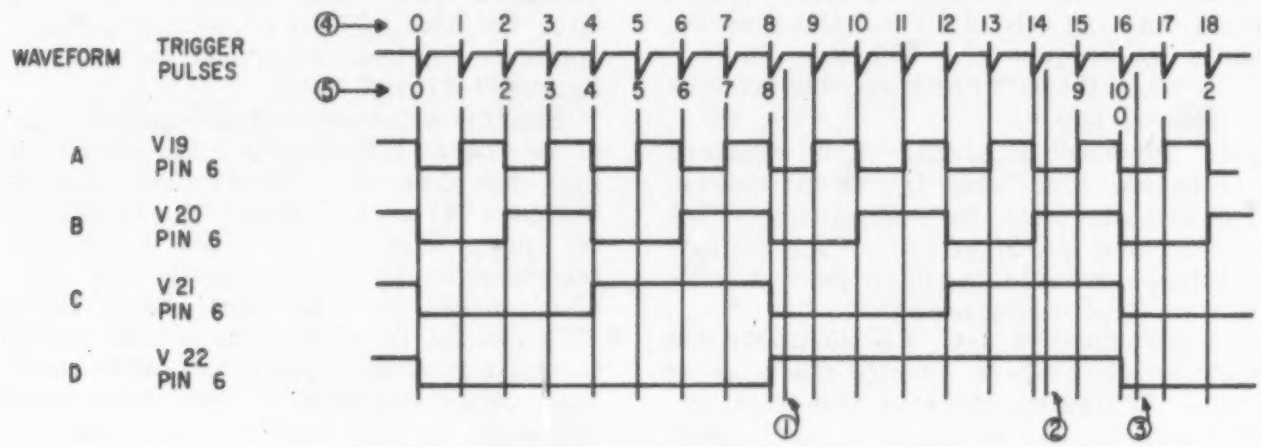

Figure 7-21. —Waveforms of a 4-stage binary counter.

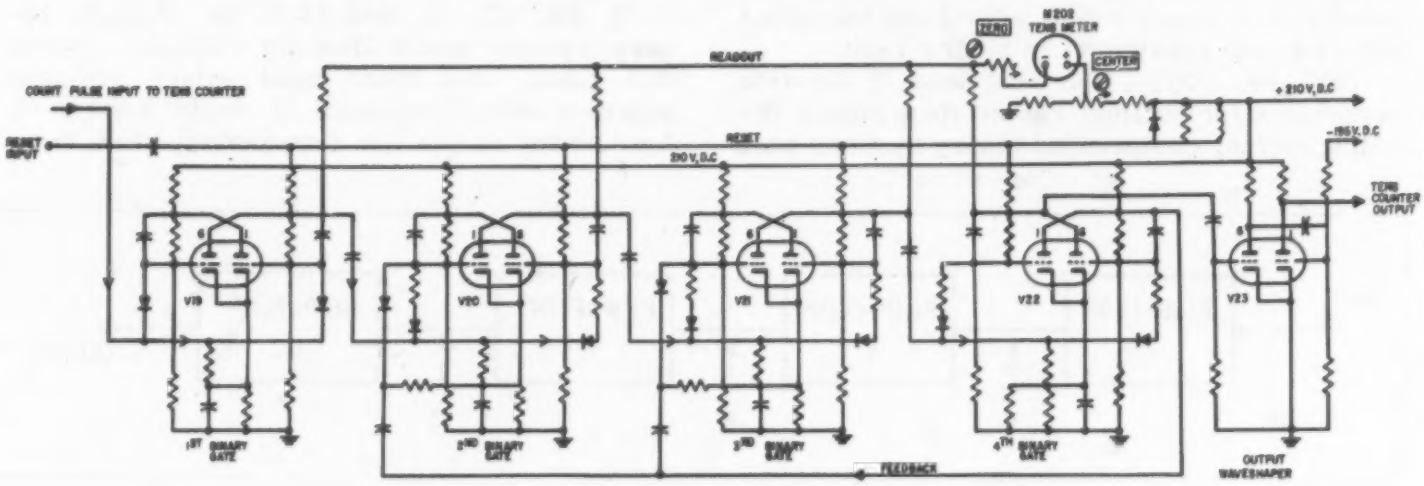

Figure 7-22. —Decade counter, schematic diagram.

which they started. The four stages have now completed a cycle in 10 counts instead of 16. A schematic diagram of such a feedback circuit is shown for the 1-mc decade counter in figure 7-22.

FREQUENCY CONVERTER. —The frequency converter plug-in unit extends the frequency measurement range of the frequency meter from 10 mc to 100 mc. A block diagram of the unit appears in figure 7-23.

Although the basic purpose of the frequency converter is to extend the frequency measurement range, measurement of lower frequencies can still be made. The MIXING FREQUENCY control is placed in the zero position for measurement of frequencies below 10 mc. Input signals bypass the tuned amplifier and mixer stages and are applied directly to the video amplifiers. Because of the additional gain (due to the video amplifiers), the frequency measurement sensitivity of the frequency meter up to 10 mc is increased about 20 db when the frequency converter unit is in place.

For measurement of input frequencies from 10 mc to 100 mc, signals are fed into the tuned amplifiers. These amplifiers operate in push-pull, with a tuned plate circuit consisting of two capacitors and four inductors. The plate circuit of the tuned amplifiers is tuned by setting the TUNING RANGE-MC and TUNING controls for maximum deflection of the tuning eye indicator. Adjusting the TUNING control also adjusts the 10-mc trap in the output of the frequency converter.

With the MIXING FREQUENCY control set to TUNE, the tuning eye indicator will close as

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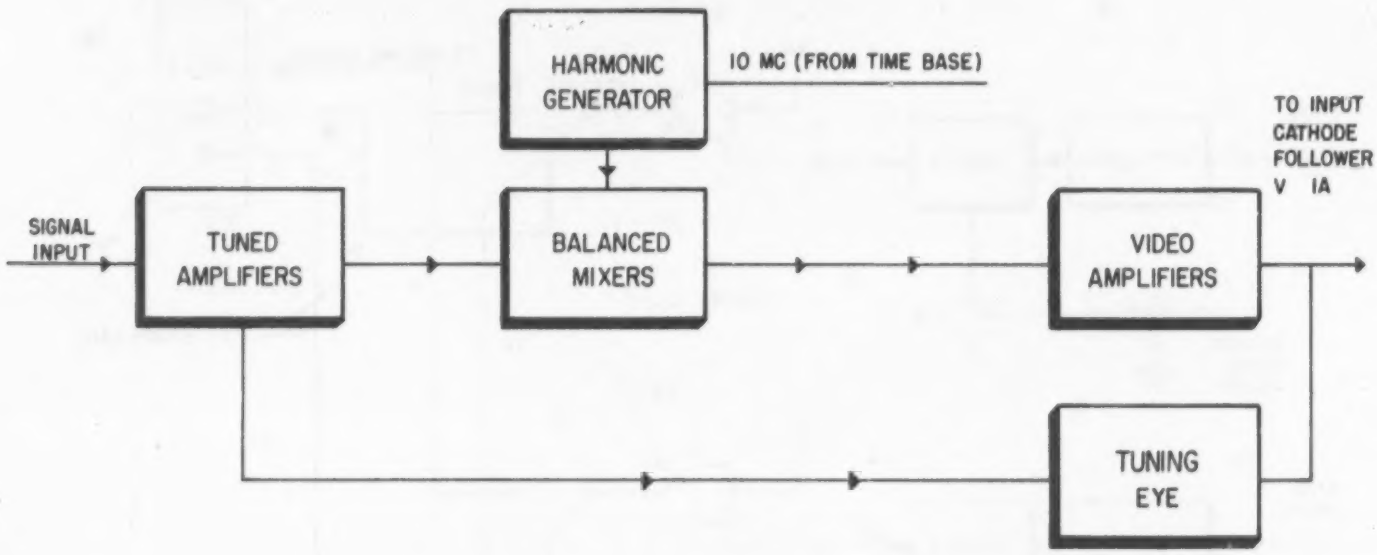

Figure 7-23. —Block diagram of frequency converter unit.

the unknown frequency is located. If the eye overlaps in closing, the input signal should be reduced with the GAIN control (the grid bias resistor) to protect against overloading the tuned amplifiers. If the eye does not close with maximum gain, the amplitude of the input is too small for accurate counting. The output voltages from the plates of the tuned amplifiers are applied to the grids of the balanced mixer.

The mixer tubes are dual control RF pentodes. The input signal is applied to the first control grid, while the mixing signal is applied to the second control grid. The BALANCE ADJ capacitor balances the drive from the tuned amplifiers to the balanced mixers. The BALANCE ADJ capacitors should be set to minimize the 10-mc carrier frequency at the output of the video amplifiers in the unit.

The variable cathode resistor for the balanced mixers balances the transconductance of the mixer tubes. Two capacitors neutralize the inputs to the balanced mixers.

The MIXING FREQUENCY control is now set to the frequency indicated by the dial of the TUNING control. The MIXING FREQUENCY control selects the proper frequency from the harmonic generator by switching in appropriate tuned circuits. The harmonic frequency is applied to the suppressor grids of the balanced mixer tubes where the signal is mixed with the input frequency applied to the control grids. The difference frequency, obtained at the parallel plates of the mixer tubes is fed through the video amplifiers to the counting circuits.

The total count is obtained by adding the MIXING FREQUENCY figure and the displayed count. The MIXING FREQUENCY figure is always megacycles and the displayed count is kilocycles.

The harmonic frequency generator is a sharp cutoff RF pentode. The control grid is driven by a 10-mc signal from the time base. Operating as a class C amplifier, the plate current has a high harmonic content (harmonics of the exciting voltage applied to the control grid).

TIME INTERVAL UNIT. —A block diagram of the time interval unit is shown in figure 7-24. This unit provides circuits that enable the frequency meter to measure time intervals from a minimum of 1 microsecond up to 10 million seconds with a high degree of accuracy. The time is displayed on the counters and may be read directly in seconds, milliseconds, or microseconds, as indicated in the TIME UNIT control.

Two separate circuit input channels are provided. One accepts a start signal and the other accepts a stop signal which opens and closes the electronic gate in the frequency meter. Special threshold selecting controls are provided for the trigger circuits in both the start and stop channels so that they will be actuated only by signals of predetermined amplitude, slope, and polarity. The trigger circuits shape the input waveforms into suitable start and stop trigger pulses for the binary gate. (See fig. 7-24.) TRIGGER LEVEL VOLTS switches S1 and S3 select the voltage at which the channel will trigger. These

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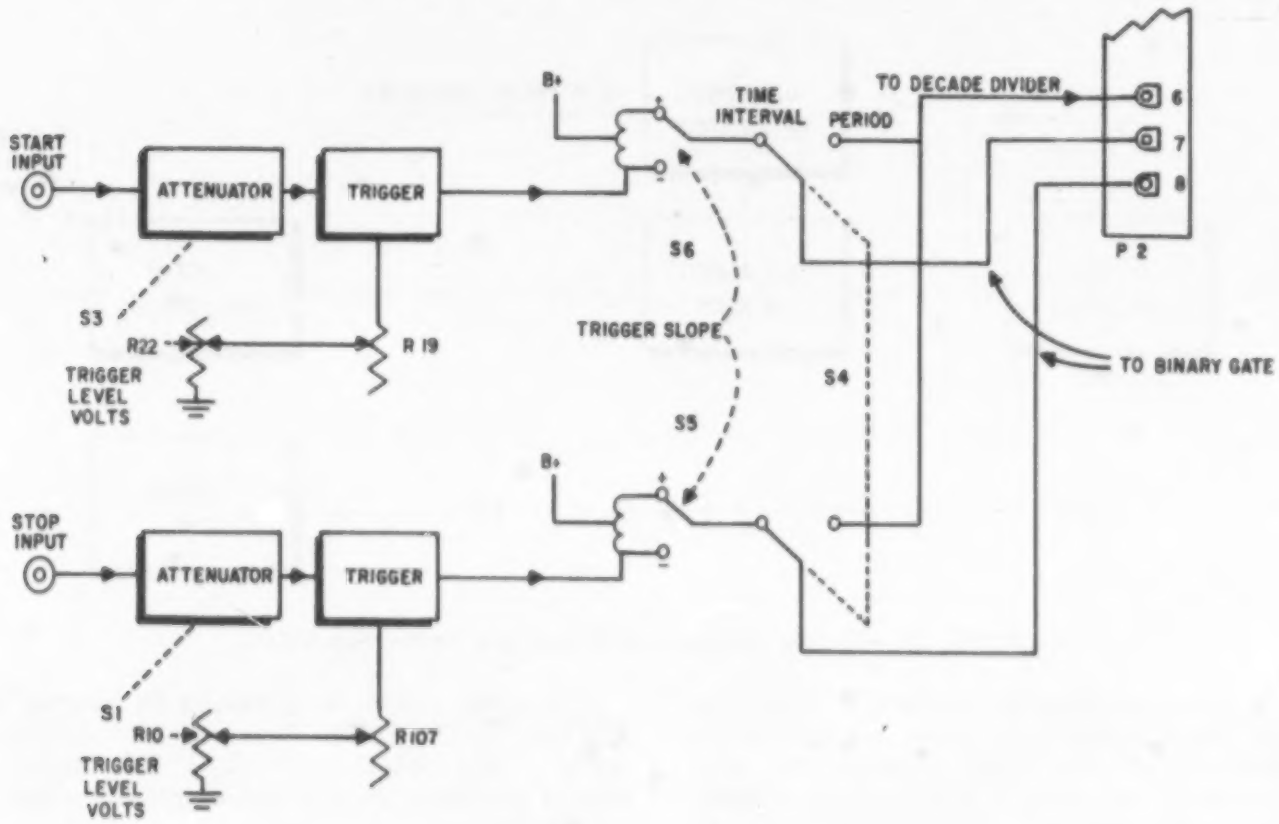

Figure 7-24. —Block diagram of time interval unit.

controls are calibrated from +192 to -192 volts.

TRIGGER SLOPE SWITCHES S5 and S6 prepare the channels to trigger only from the positive or only from the negative slope of the waveform. The two controls permit each channel to be triggered by any one of the following four combinations of slope and polarity: Positive or negative slopes of positive voltages, and positive or negative slopes of negative voltages. For each of these combinations, the voltage at which triggering occurs is adjustable from approximately 1 to 192 volts. The COM-SEP switch (not shown) is provided so that the start and stop channels can be operated from the same input (COM position) if desired. The slope and level controls for each channel remain operative, permitting measurements to be started and stopped from different portions of the signal.

POWER SUPPLY. —The power supply is designed to supply all of the operating potentials required for the frequency meter. The unit provides regulated d-c voltages at +210v, +90v, +70v, and -195v, and an unregulated d-c voltage of +300v. Full wave rectifier circuits are employed with electronic regulation. The power supply also provides all of the filament power required by the vacuum tubes in the instrument.

Two separate full wave rectifier circuits are used; one supplies the positive voltages, and the other supplies -195v d. c. Electronic regulation makes the output voltage substantially independent of the load impedance. Screwdriver adjustments are provided to set all regulated voltages.

MAINTENANCE

Test equipment maintenance is covered later in this chapter. Additional details may also be found in the Service Instruction Manual for the equipment.

RADAR TEST SET AN/UPM-32

Radar Test Set AN/UPM-32 is a portable test set designed primarily for use with radar sets operating in the frequency range of

8,500 to 10,500 mc. It combines in one test set all the functions of a power meter, a frequency meter, a spectrum analyzer, a signal generator, and a general purpose synchroscope. Figure 7-25 illustrates the AN/UPM-32, indicating all of its front panel controls.

PURPOSE

The general applications of the test set are as follows:

1. Measurement of power, frequency spectrum, and frequency pulling of conventional and multipulsed radar transmitters.
2. Measurement of sensitivity and bandwidth of a radar receiver.
3. Measurement of the frequency and spectrum of a radar receiver local oscillator.
4. Adjustment of a radar receiver local oscillator.
5. Measurement of TR recovery time.
6. Observation of video signals.
7. Furnishing pulsed, FM, or CW microwave signals.

From the preceding list of applications it should be obvious that the AN/UPM-32 is a very versatile test set.

OPERATING PROCEDURES

Through the use of the master function selector switch (number 9, fig. 7-25), the internal circuits may be switched into the desired operation to perform any of the functions previously mentioned.

Power Meter Operation

When it is desired to use the test set as a power meter, input signals from a radar transmitter pass through a calibrated variable attenuator to a temperature compensated power monitor, illustrated in figure 7-26 in block form. The power monitor is composed of a bridge circuit and a power level indicating meter calibrated in milliwatts and dbm (decibels relative to one milliwatt).

Frequency Meter Operation

When the frequency meter function of the test set is used, an absorption type frequency meter is tuned to resonance. (See fig. 7-26.) The resonant frequency meter cavity causes a reduction of the power level in the microwave section at the frequency to which the cavity is tuned. This reduction of power, at the resonant frequency, appears as a dip on the power monitor meter or on the screen of the synchroscope. The resonant frequency (in megacycles) is indicated directly on a front panel counter (22, fig. 7-25) which is geared mechanically to the tuning mechanism of the cavity. The power meter and frequency meter portions of the AN/UPM-32 closely resembles the TS-147 frequency-meter test set in construction and operation. Therefore, with an understanding of this portion of the AN/UPM-32 the technician should have little trouble in the operation and use of the TS-147 if the AN/UPM-32 is not available.

Spectrum Analyzer Operation

For the spectrum analyzer function, the test set's klystron oscillator is frequency modulated by the sawtooth output of a sweep generator. (See fig. 7-27.)

The radar transmitter signal to be observed and the klystron oscillator signal are combined in a mixer to produce heterodyne frequencies which are fed to an IF amplifier. For each radar transmitter pulse, a frequency component of the pulse beats with the klystron oscillator signal to produce a 45-mc IF signal. For successive radar transmitter pulses, a different frequency component causes the 45-mc beat frequency to appear because the klystron oscillator is frequency modulated. The detected IF signals are amplified and applied to a cathode-ray tube. Since the horizontal deflection system of the cathode-ray tube is driven by the same sawtooth used for klystron modulation, the CRT pattern is a plot of frequency versus relative power for the input signal.

The test set also includes a gating circuit which permits the observation of the spectrum of any pulse in the output of a multipulsed radar transmitter. For this operation, the radar synchronizer is used to feed a pretrigger to the test set gating circuit to avoid triggering on the wrong RF pulse. This circuit, in turn, generates a pulse which gates the IF amplifier so that any signals applied during the gating period pass through the amplifier. The gating period is long enough to permit only the frequency samples from one radar transmitter pulse to pass through the IF amplifier. The gating pulse may be delayed relative to the pretrigger for the desired pulse selection.

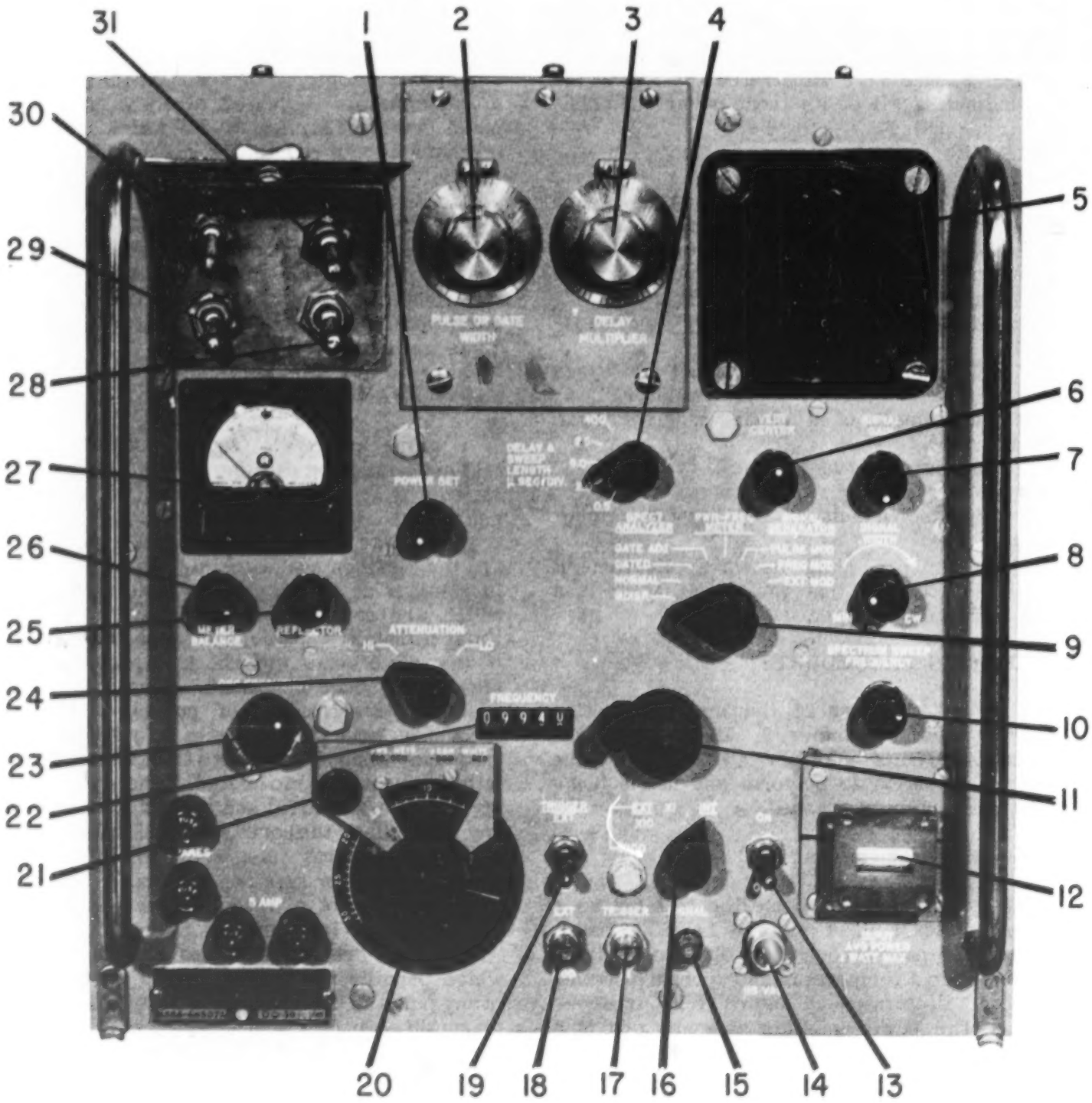

Figure 7-25. —Radar Test Set AN/UPM-32, front panel controls.

This portion of the AN/UPM-32 closely resembles the operation of the Sepctrum Analyzer TS-148 with the exception of the gating circuit function used for testing multipulsed radar transmitters. This feature is not available with the TS-148. However, with an understanding of the AN/UPM-32 spectrum analyzer operation, the AT should have little trouble understanding and operating the TS-148 for spectrum analyzation if the AN/UPM-32 is not available.

Signal Generator Operation

When the test set is used as a signal generator, it supplies FM, pulse modulated, externally modulated, or CW microwave signals. This portion of the AN/UPM-32 is illustrated in block form in figure 7-28.

For the FM and pulse modulated signals, internal circuits provide the modulating waveforms, but a trigger must be provided by an

Nomenclature for figure 7-25

1. POWER SET control.
2. PULSE OR GATE WIDTH control.
3. DELAY MULTIPLIER control.
4. DELAY and SWEEP LENGTH switch.
5. Cathode-ray tube.
6. VERT CENTER control.
7. SIGNAL GAIN control.
8. SIGNAL WIDTH control.
9. Function selector switch.
10. SPECTRUM SWEEP FREQUENCY control.
11. Frequency control.
12. RF connection.
13. ON-OFF switch.
14. 115 VAC connector.
15. SIGNAL connector.
16. SIGNAL switch.
17. TRIGGER IN connector.
18. EXT MOD connector.
19. TRIGGER switch.
20. DBM control.
21. Indicator light.
22. FREQUENCY counter.
23. OSC FREQUENCY control.
24. ATTENTUATION switch.
25. REFLECTOR control.
26. METER BALANCE control.
27. Power meter.
28. ASTIG control.
29. MODE GAIN control.
30. FOCUS control.
31. INTENSITY control

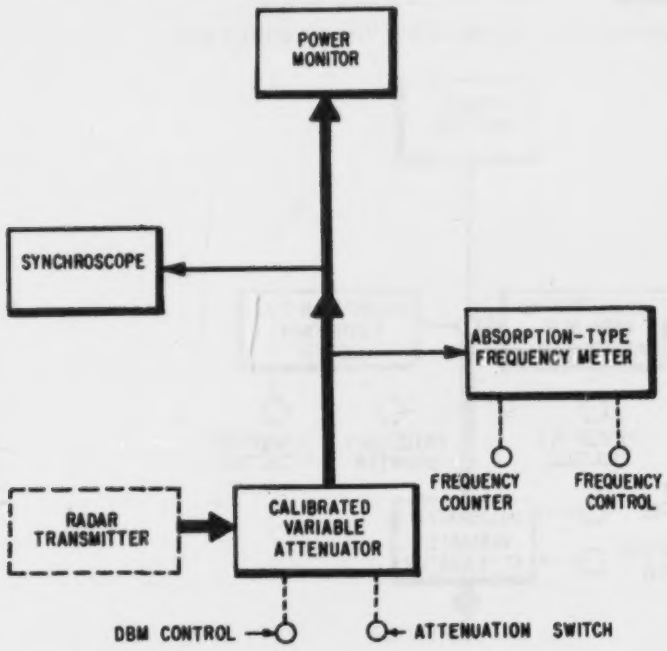

Figure 7-26.—Power meter and frequency meter operation, simplified block diagram.

external source. Any desired type of modulation waveform can be applied to the klystron osicllator, and the test set will provide correspondingly modulated RF signals. The power level and frequency of all output signals are adjustable to the desired level within the limits of the test set.

Synchroscope Operation

When the test set is operated as a general purpose synchroscope, a video signal is applied to the video amplifiers. The amplified signal is applied to the vertical deflection circuit of the cathode-ray tube as illustrated in block form in figure 7-29.

This video signal can be externally applied, or it may be an internal signal taken from the mixer crystal (detector). The sweep generator, which drives the horizontal deflection system of the cathode-ray tube, must be triggered and synchronized with the video signal, either by an external trigger source associated with the video signal or by the detected RF pulse from the radar transmitter.

Microwave Assembly

The microwave assembly makes possible the measurement of the power level and frequency of input and output signals. The assembly consists basically of a block containing waveguides and attenuating sections. Within the assembly both the klystron signal and RF input signals are mixed to obtain a spectrum pattern. Signal flow in the assembly depends upon the setting of the function selector switch to the desired mode of operation.

With the function selector switch on MIXER position, energy flow in the assembly is illustrated in figure 7-30. The power set attenuator adjusts the power level of the klystron signal. Because the klystron oscillator is sawtooth modulated by the sweep generator circuits (fig. 7-27), its output frequency varies linearly during the sawtooth excursion. Therefore, if the frequency meter is tuned to a frequency within the range covered by the klystron output, a sharp reduction in power level occurs at this

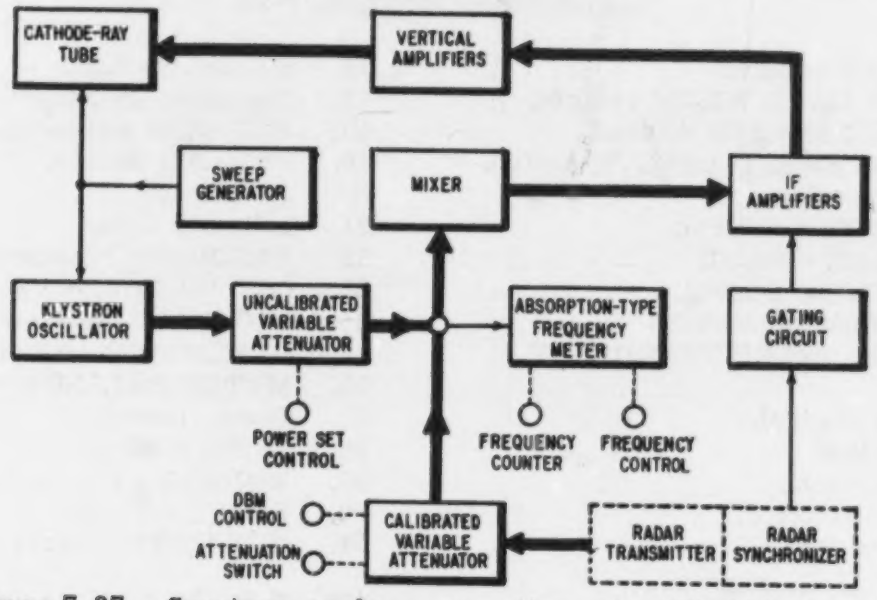

Figure 7-27. —Spectrum analyzer operation, simplified block diagram.

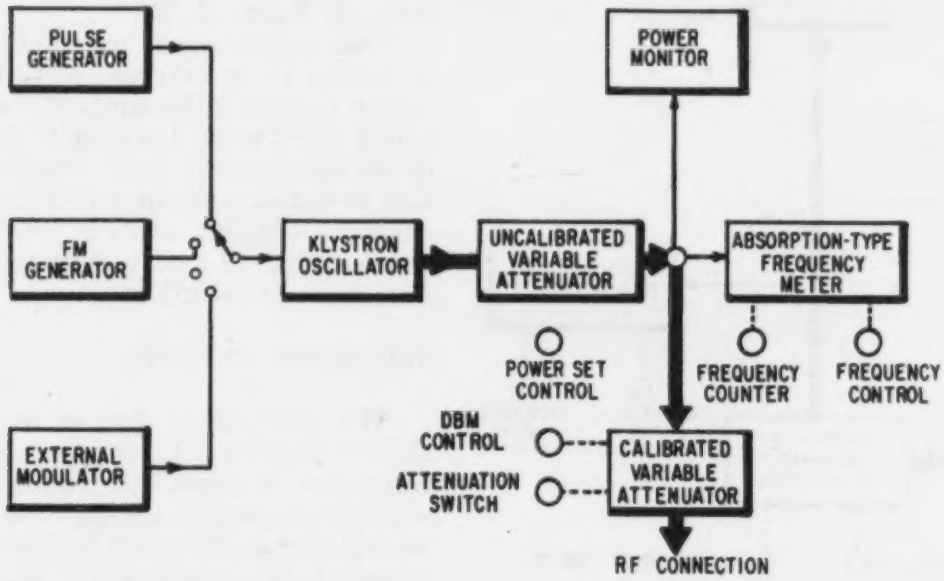

Figure 7-28. —Signal generator operation, simplified block diagram.

particular frequency. This reduction appears as a dip in the pattern displayed on the CRT indicator. The frequency of the klystron may then be read directly, in megacycles, from the frequency meter Z304.

With the function selector switch in the NORMAL or GATED position, two signals are present in the microwave assembly. (See fig. 7-31.) The klystron signal and the transmitter signal are mixed in the mixer crystal which produces heterodyne frequencies. The 45-mc component appearing during each radar output pulse passes through a tuned filter network to the IF amplifier stages. Because of the linear sawtooth modulation applied to the klystron, the klystron signal beats with a different frequency component of the radar output during each transmitted pulse interval to produce this 45-mc beat frequency. Hence, the amplitude of each 45-mc pulse is a measure of the power contained in the particular magnetron frequency component producing it. The magnetron spectrum is thus produced and appears on the CRT indicator. The importance of this presentation lies in the fact that with it a radar transmitter can be tuned to give a spectrum in which the greatest possible portion of the high power frequency components falls within the pass band of the radar receiver.

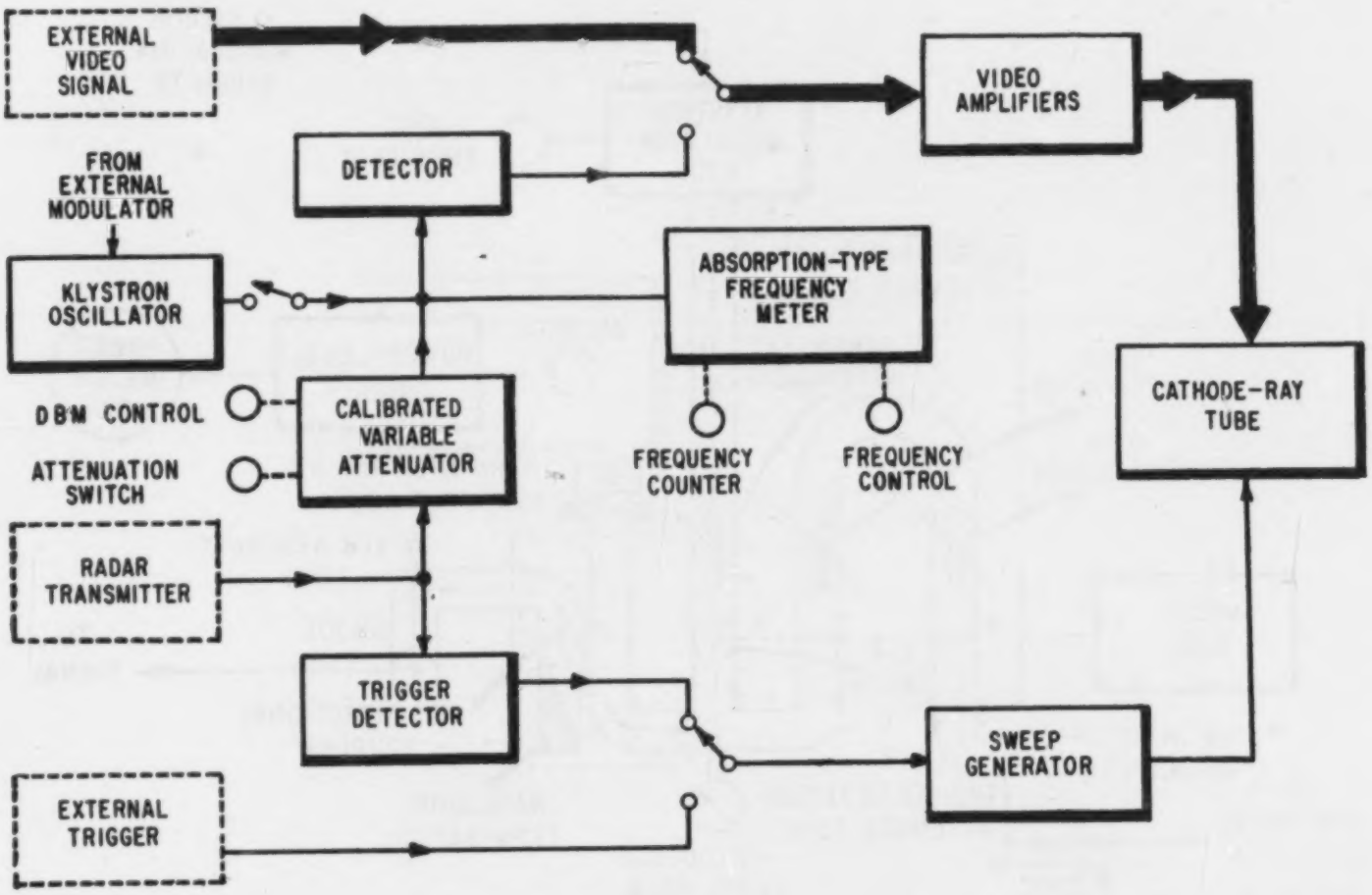

Figure 7-29. —Synchroscope operation, simplified block diagram.

When the function selector switch is placed in the PWR-FREQ METER position, the radar transmitter power is fed through the microwave assembly as shown in figure 7-32. The RF switch is closed; hence there is no power division at the tee junction nor can any klystron power reach the thermistor mount. This permits measurement of the power level of the incoming signal. The step attenuator should be at its minimum (LO) position.

For the PULSE MOD, FREQ MOD, and EXT MOD positions of the function selector switch, signal flow is shown in figure 7-33. The power level of the klystron RF signal is set by the power set attenuator. The frequency of the signal is indicated by the frequency meter which is used in conjunction with either the power level indicating meter or the synchroscope pattern on the CRT. Since there is an equal division of power in the tee junction following the RF switch, the reading of the power level bridge meter, as modified by the DBM attenuator dial reading, gives an accurate indication of the power level of the test set output signal. The signal reaching the mixer crystal is detected, and the signal, which is the modulation waveform, can be viewed on the CRT by setting the signal switch at INT if desired.

Trigger Detector Assembly

The trigger detector assembly (Z303, fig. 7-33) consists of a removable mount attached to the rectangular waveguide section at the input of the microwave assembly. The mount contains a crystal rectifier element (CR302) and functions as a fixed tuned detecting section. Isolation from the main waveguide is provided by an iris which attenuates the energy from the main waveguide about 35 db to protect the crystal from burnout.

DBM Attenuator

The DBM attenuator consists of a rectangular glass vane coated with a resistive material. The vane is mounted inside the waveguide parallel to the narrow wall, and its position is continuously adjustable (by the DBM control) from

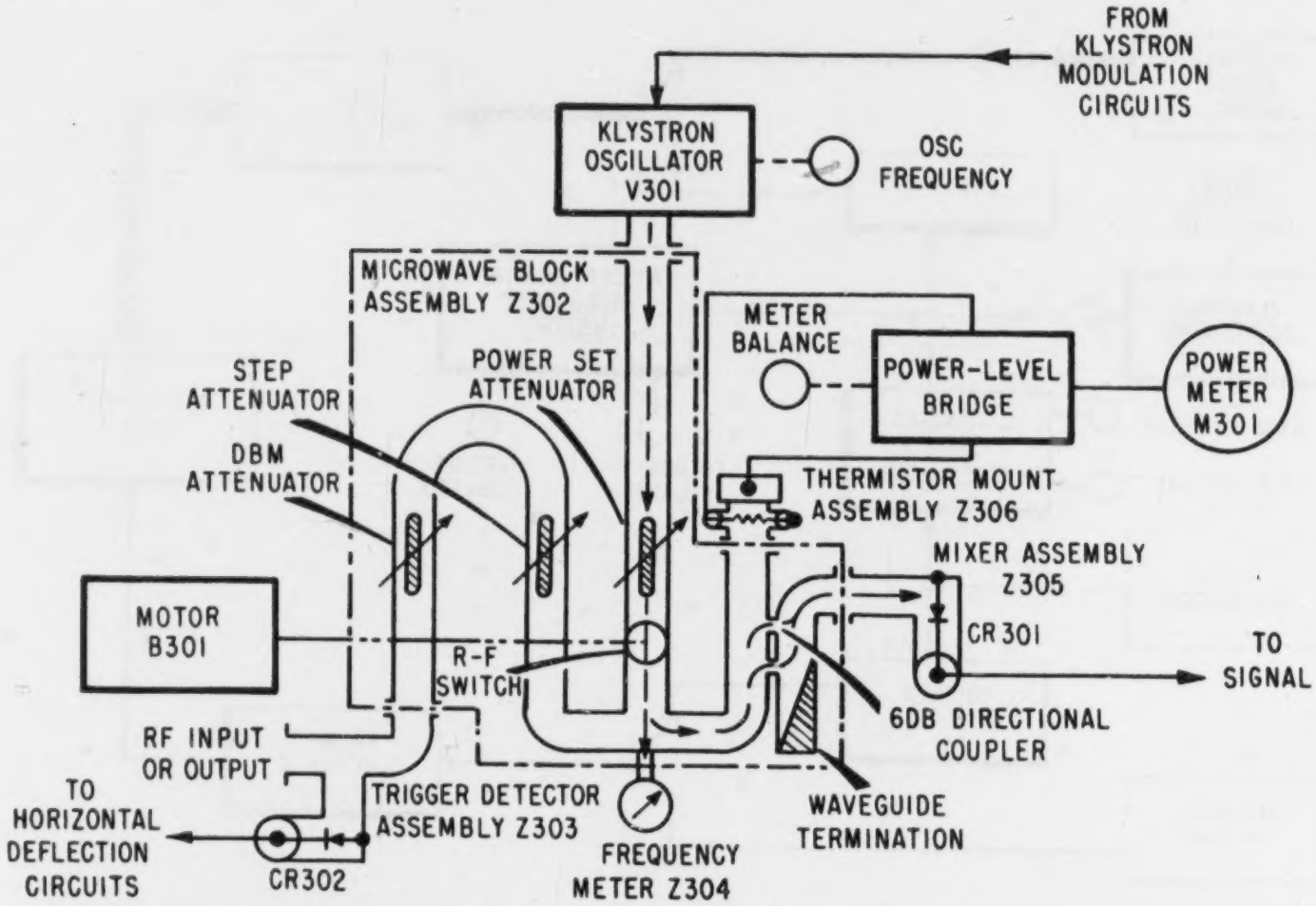

Figure 7-30.—Energy flow in microwave assembly, function selector switch at MIXER.

the narrow wall toward the center of the waveguide. The maximum attenuation introduced by the vane (near the center) is approximately 50 db. The calibration of the DBM dial accounts for this attenuation and the known losses in the microwave block.

Step Attenuator

The step attenuator is constructed in the same manner as the DBM attenuator. The step attenuator is controlled by the ATTENUATION switch, which has two settings, HI and LO. In the HI position, the vane is near the waveguide center; in the LO position, it is adjacent to the narrow wall. For the HI position of the switch, the step attenuator introduces about 50 db of attenuation in the waveguide run.

RF Switch

The RF switch consists of a cylindrical element which closes off the waveguide leading to the klystron when the function selector switch is on the PWR-FREQ METER position. The axis of the switching device is paralled to the broad walls of the waveguide. The device has a rectangular hole through it, which lines up with the waveguide for the open position and rotates through a quarter turn to close off the waveguide run to the klystron. A metallic window which projects part way across the guide opening inside the device serves as an impedance matching device for the waveguide tee.

RF Oscillator

The microwave oscillator tube (V301) used in the test set is a reflex klystron which operates on the principle of velocity modulation. The klystron may be tuned either mechanically or electrically. Mechanical tuning is accomplished from the top of the klystron by the OSC FREQUENCY control. Electrical tuning is accomplished by the modulation sawtooth from the modulation sweep generator circuits and by the REFLECTOR control.

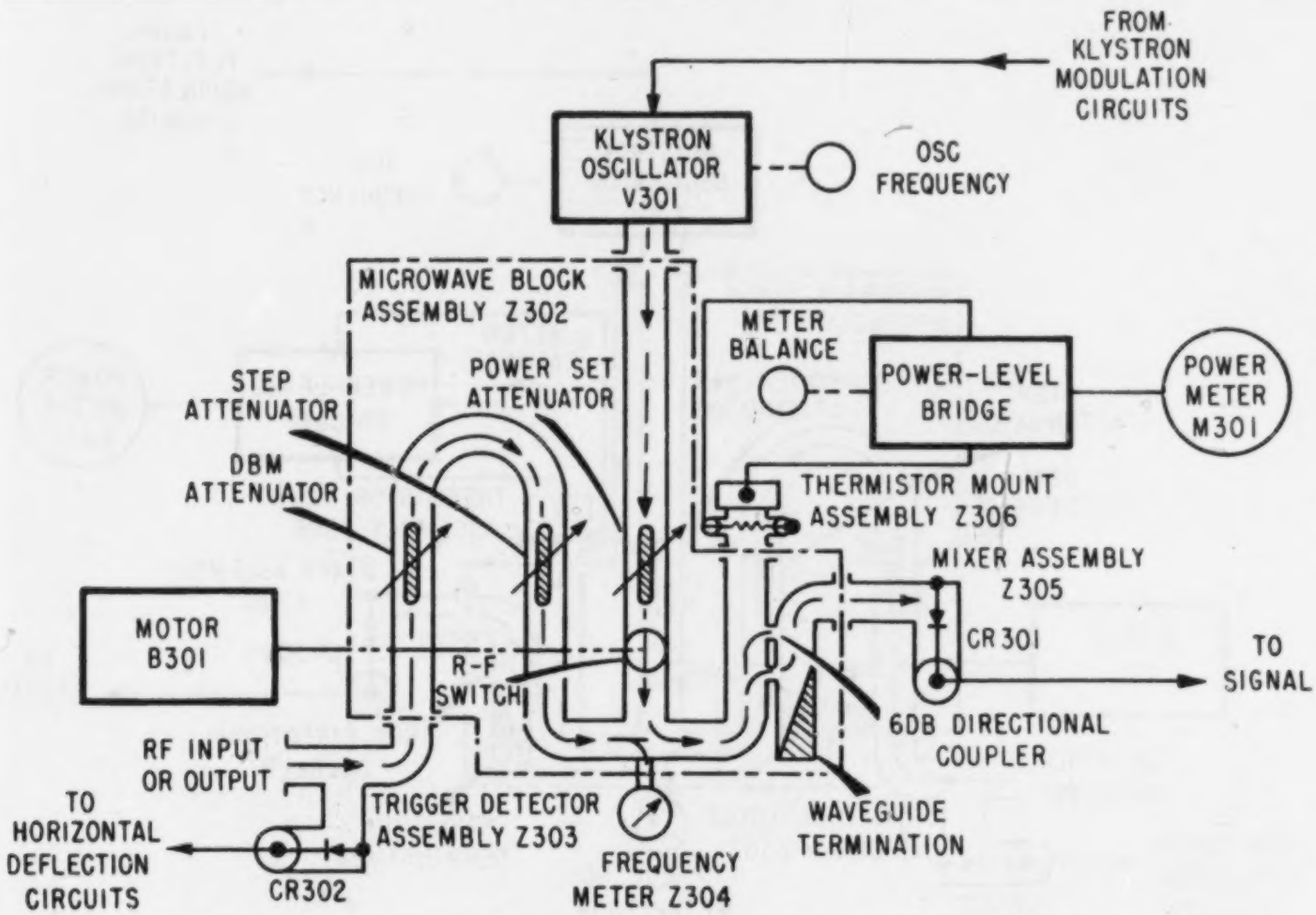

Figure 7-31. —Energy flow in microwave assembly, function selector switch at NORMAL or GATED.

NOTE: A detailed discussion on the operation of the reflex klystron is given in chapter 12 of this course.

Power Set Attenuator

The power set attenuator consists of a small rectangular glass vane coated with a resistive material. The adjustment of the vane position within the waveguide is continuous, but the assembly is not calibrated. For the maximum attenuation position near the waveguide center, the attenuator decreases the level of the klystron output signal by 20 to 25 db.

Frequency Meter

The frequency meter (Z304) consists of a circular high-Q cavity with a movable concentric tuning plunger. The frequency meter is fitted into the microwave assembly and coupled to the waveguide by means of a circular iris, and the entire assembly is hermetically sealed. The tuning plunger mechanism is geared to the frequency counter which indicates the resonant frequency of the cavity in megacycles.

Thermistor Mount Assembly

The thermistor mount assembly (Z306) is comprised of a short waveguide section terminated in a housing which contains a thermistor bead. The bead is sensitive to microwave energy, and its resistance changes in proportion to the level of energy in the waveguide. The assembly is mounted to the microwave section and fixed tuned at the factory. A cylindrical subassembly is located on one side of the thermistor mount assembly to hold a disk thermistor. This thermistor has a negative temperature coefficient of resistance. The resistance changes in the disk thermistor compensate the power level bridge circuit for the effects that changes in the ambient temperature produce in the resistance of the thermistor bead.

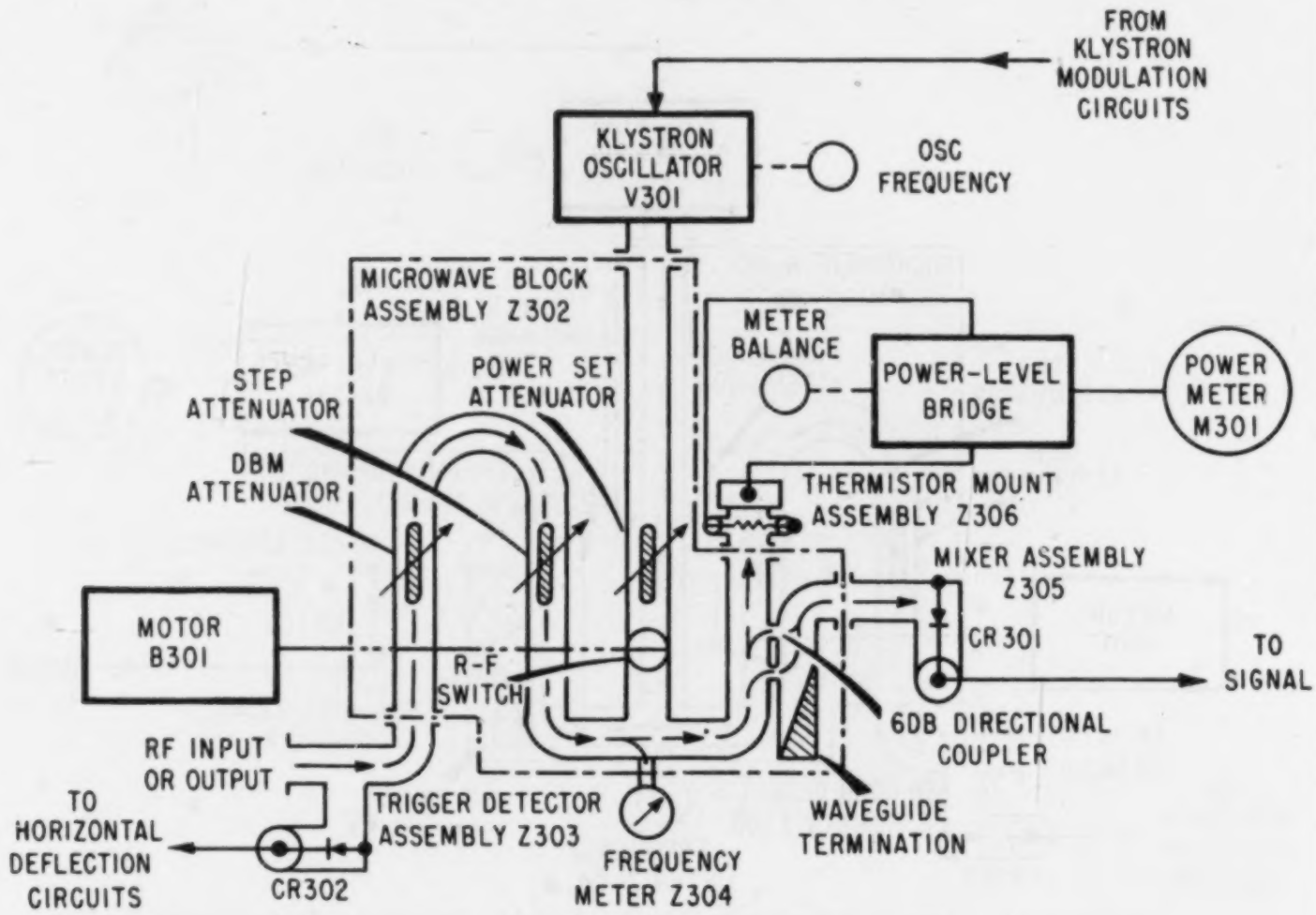

Figure 7-32.—Energy flow in microwave assembly, function selector switch at PWR-FREQ METER.

Mixer Assembly

The mixer assembly (Z305) is similar in construction to the trigger detector assembly (Z303), and it contains the same type crystal cartridge. When the function selector switch is on the MIXER, PWR-FREQ METER, GATE ADJ, PULSE MOD, EXT MOD, or FREQ MOD position, the mixer crystal acts as a simple RF detector. For operation in the NORMAL and GATED positions of the function selector switch, the radar transmitter signal and the klystron signal are both present, and the output of the mixer contains beat frequencies because of the nonlinear detection characteristic of the crystal. The mixer assembly also contains a 3-db isolation pad which is adjusted when installed and must not be disturbed by the field maintenance technician.

MAINTENANCE

The information presented in this section is intended to aid the Aviation Electronics Technician in the prevention and correction of troubles in the Radar Test Set AN/UPM-32.

The technician should bear in mind that the operation of this equipment involves high voltages which are dangerous to life. Maintenance personnel must observe safety regulations at all times.

No maintenance should be attempted on the equipment without the test set's Service Instruction Manual for ready reference. Section V of this manual lists in table form the minimum performance standards of the test set. It includes the purpose of the check, procedure, normal indications, and a list of possible causes of abnormal indications. Section V of the Service Instruction Manual also lists a step by step procedure for isolation of a trouble to a faulty circuit, group of circuits, or part. A system of symbols is used in the check charts for indicating in the equipment where test connections are made for measuring or observing electrical data. The symbols are divided into three classes: major, secondary, and minor

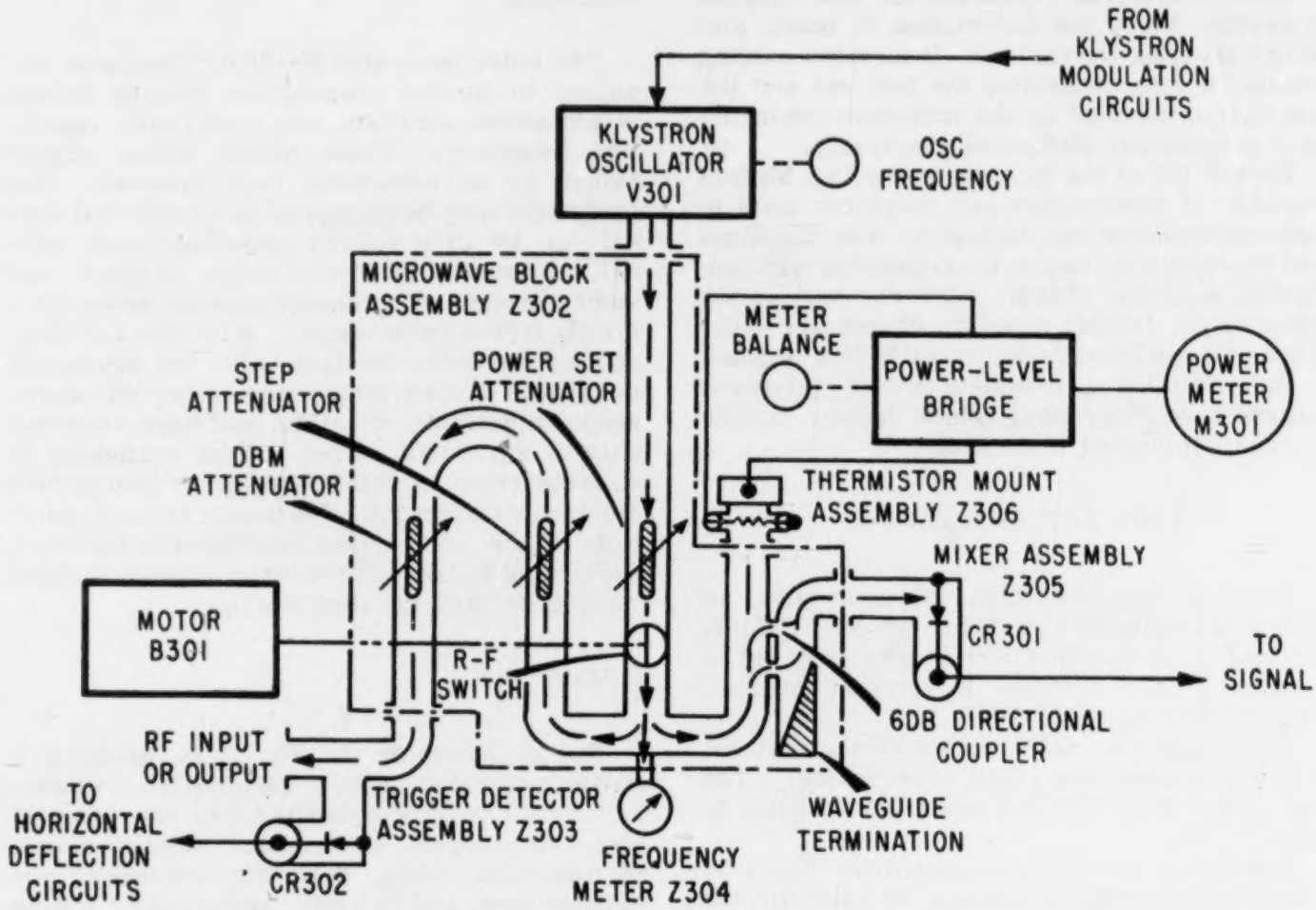

Figure 7-33.—Energy flow in microwave assembly, function selector switch at PULSE MOD, FREQ MOD, or EXT MOD.

test points. The major test points are assigned to critical points in circuits interconnecting assemblies or at input/output connections. These points are used to localize a trouble to a particular assembly or group. Secondary test points are generally assigned to critical points between circuits within an assembly. These points are used in localizing trouble to a particular circuit of the assembly. Minor test points are assigned to points within circuits bracketed by secondary test points. These are used to isolate the trouble to a particular stage of the circuit.

Section V of the Service Instruction Manual also lists in detail the removal and replacement instructions for assemblies, subassemblies, and parts which might be found faulty in the performance and trouble analysis checks. It lists the step-by-step procedure for minor repairs and adjustments necessary after the replacement of parts for the test set to meet the minimum performance standards.

Calibration

The complete procedures for alinement and adjustment of the test set are contained in section VI of the Service Instruction Manual. The control or adjustment described in the manual need only be checked occasionally or whenever a tube or detail part is replaced in the circuitry directly associated with any given control.

Section VI lists the detailed procedures for alining the following:

1. IF amplifier assembly.
2. Video amplifiers.
3. Pulse generator assembly.

It also lists in table form a complete schedule for maintenance inspections, listing the item to be checked, inspection required, and the time interval between inspections. (NOTE: The test set should be turned in to the activity's overhaul center after each 2,000 hours of operating time.)

Another important maintenance aid included in section VI is the description of bench test setups utilizing the test set. It includes cabling details for interconnecting the test set and the test equipment used in the minimum performance procedures discussed previously.

Section VII of the Service Instruction Manual consists of information and diagrams used in both maintenance and alinement. The diagrams will be especially useful in conjunction with the trouble analysis charts. All the test points noted in the trouble analysis charts are indicated on the schematic diagrams in this section. It also contains a complete set of waveform diagrams (photographs) which appear at the various designated test points.

TEST SET AN/UPM-44C

Radar Test Set AN/UPM-44C is supplied as associated equipment to Radar Set AN/APS-82. A complete description of the radar test set is covered in the Service Instruction Manual, NavAer 16-30UPM-44-502.

The radar test set consists of the test set assembly transit case, and accessories. The front panel of the test set assembly is shown in figure 7-34.

The test equipment is designed for use with S-band radar systems and may be used for the following purposes:

1. Measure receiver bandwidth sensitivity, recovery time, and local oscillator frequency.
2. Measure transmitter power and frequency.
3. Tune local oscillator.
4. Test and tune duplexers, AFC systems and rotating joints.
5. Provide visual indication of the magnetron and local oscillator spectra.
6. Observe magnetron pulling.
7. Visual indication of video signals.

With the expection of frequency coverage, the UPM-44C is similar to the UPM-32. Therefore, further detailed coverage is not presented here.

PULSE GENERATOR

The equipment discussed in this section is a combination pulse generator and synchroscope. It is capable of furnishing, displaying and measuring pulse test signals.

PURPOSE

The pulse generator SG-30/UP has been designed to furnish rectangular voltage pulses of adjustable duration, amplitude, and repetition frequency. These pulses follow trigger pulses by an adjustable time interval. The equipment may be triggered by an external signal, or by an internally generated audio signal. Internally generated pulse, trigger, and audio signals are made available at output terminals on the front panel. With the synchroscope provided in the same unit, the equipment is capable of accurately determining the waveshape, amplitude, duration, and time relationship of the output pulses. This equipment is suitable for use in maintaining airborne or ground electronic equipment. The design and construction of the unit makes it adaptable for work performed in laboratories or maintenance shops located on land or aboard ships.

OPERATION

Pulse Generator SG-30/UP is basically a pulse generator and a quantitative cathode-ray synchroscope combined into one compact unit. It produces rectangular voltage pulses of adjustable width, duration, amplitude, repetition rate, and polarity, and provides means by which these characteristics may be observed and accurately measured. A simplified block diagram (fig. 7-35) shows the interrelationship of the various circuits employed.

The rectangular voltage pulses, generated by the pulse generator, are available at the PULSE OUTPUT terminal for coupling to the equipment under test. Polarity is selected by manipulation of the PULSE POLARITY switch.

Triggering of the pulses may be accomplished either by means of the output of the RC oscillator or by external signals coupled to the SYNC INPUT terminals. These excitation (triggering) signals are coupled to the trigger generator which converts them into sharp trigger pulses. The output of the trigger generator is coupled to both the pulse generator and the sweep generator through separate variable delay circuits, allowing the pulse and sweep circuits to be started independently of each other. The triggers are also made available at the TRIGGER OUTPUT terminals for use in external circuits.

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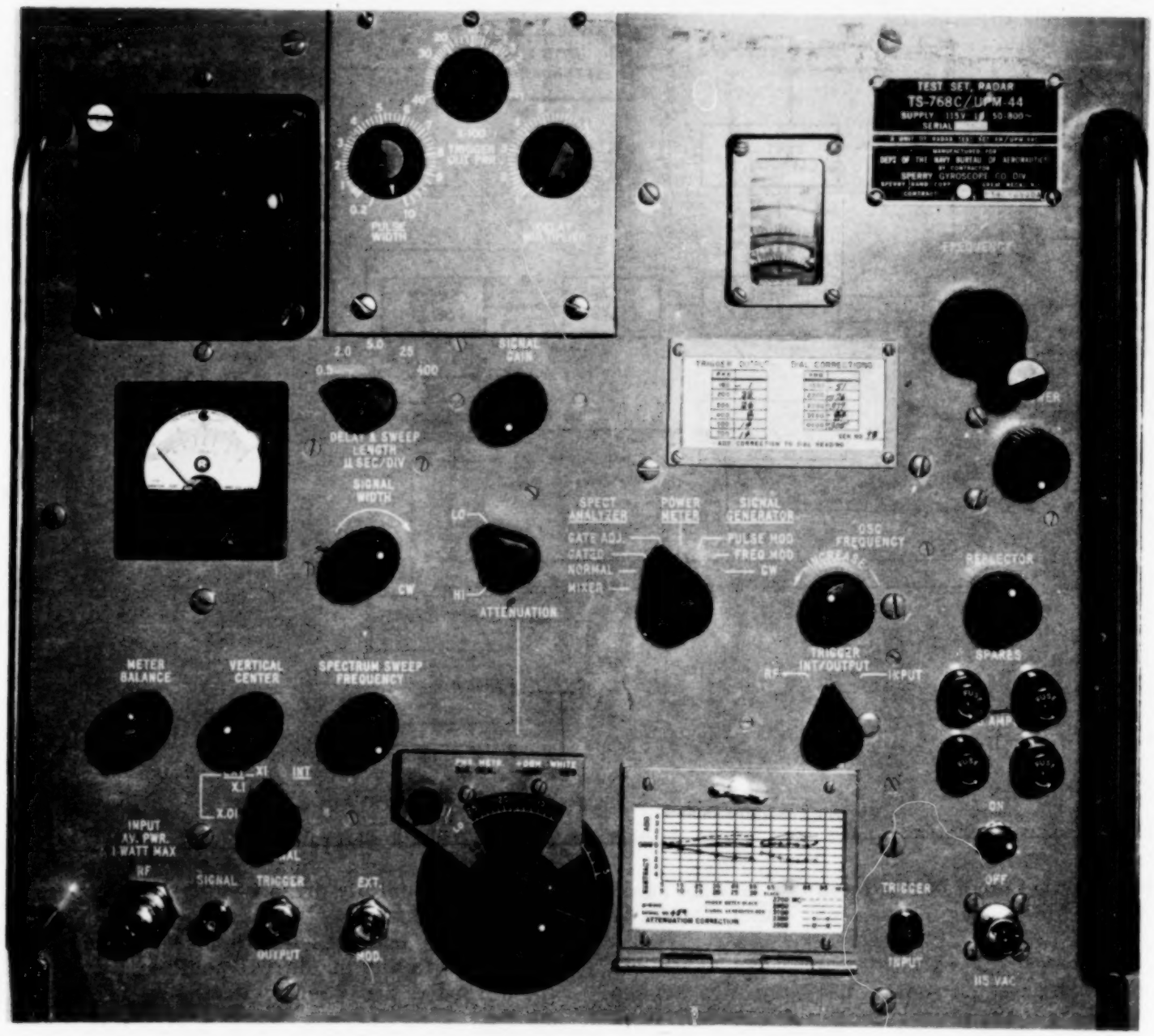

Figure 7-34.—Radar Test Set AN/UPM-44C.

Since both the pulse generator and the sweep generator receive the same triggering signal, synchronization of pulses and sweep is automatic for internally generated pulses. For externally generated pulses it is necessary to adjust the TRIGGER RATE and TRIGGER RATE MULTIPLY by controls to obtain the proper trigger rate for synchronization.

The output of the RC oscillator is a sine wave whose frequency may be varied between 20 and 20,000 cycles per second. Since this is used for excitation of triggering signals, it provides for variation of the pulse repetition rate between 20 and 20,000 pulses per second. In addition to providing excitation for the trigger generator, the output of the RC oscillator is also made available at the AUDIO OUTPUT terminals for external applications.

Signals which are to be observed and measured are coupled to the vertical amplifier by means of the VERTICAL INPUT SELECTOR switch. The signal may be any of the following:

1. The positive or negative pulse from the pulse generator.

2. An external signal coupled to the VERTICAL INPUT terminals.

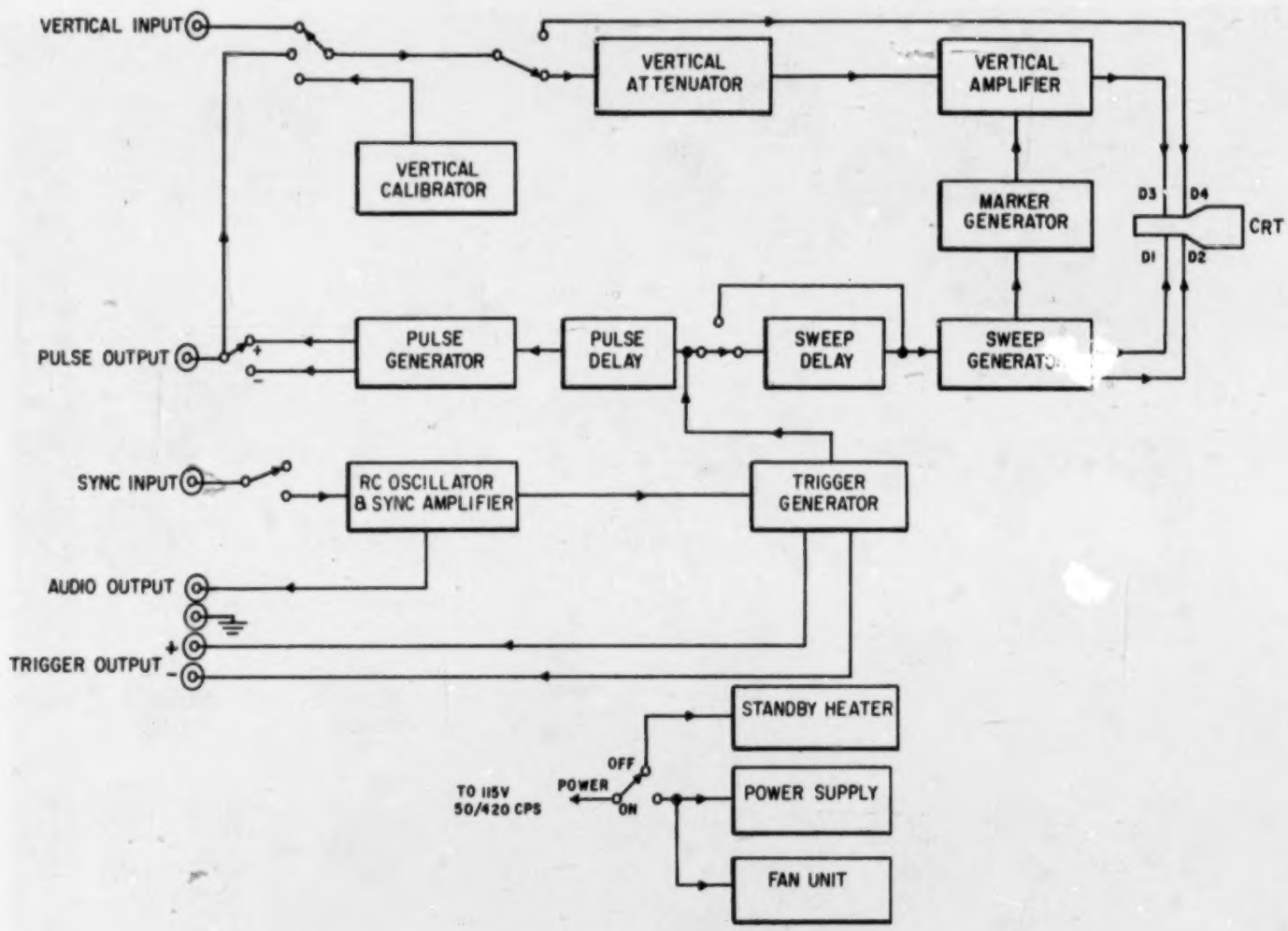

Figure 7-35.—Pulse generator, overall block diagram.

3. The output signal from the vertical calibrator for making voltage amplitude measurements.

The vertical calibrator provides two horizontal traces on the cathode-ray tube screen with vertical spacing which indicates the peak to peak voltage at the vertical input connection. The front panel allows selection of voltages at 0.5, 5, and 50 volts with an accuracy of ± 5 percent.

The marker generator produces pulses of accurately determined frequencies which are mixed into the vertical amplifier. These pulses are presented on the cathode-ray tube screen as pip type markers to provide for time calibration of the trace.

The standby heater, energized when the POWER switch is in the OFF position, raises the average temperature of the set to a minimum of 6° C above the ambient temperature with the equipment out of its transit case. This provides protection from harmful effects under high humidity or extremely low temperature conditions.

The fan operates continuously when the POWER switch is in the ON position. It provides forced air cooling during operation of the set.

MAINTENANCE

Refer to the section on test equipment maintenance later in this chapter, for a discussion of typical maintenance procedures applicable to the pulse generator. Additional details may also be found in the Service Instruction Manual for the equipment.

INSULATION TEST SET

The ohmmeter ZM-14A/PSM-2 is designed to measure insulation resistance from 0 to 1,000 megohms utilizing a testing voltage of 500 volts d.c. The unit consists principally

of a hand cranked a-c generator; a terminal board assembly containing a rectifier, resistors, a capacitor, and neon glow lamps; and a meter. These major component parts are housed in a die cast aluminum alloy dust and moisture resistant case provided with a removable bottom plate. On the outside of the case are a crank, two indicator buttons, two binding posts, a semicircular opening through which the meter is read, and a meter adjustment screw cover. Turning the crank in either direction until the indicator buttons glow steadily red, generates 500 volts d.c. testing voltage which is available at the binding posts. When testing insulation, the meter pointer will indicate the resistance in megohms.

OPERATING PROCEDURES

Before attempting to connect the insulation test set, be sure that the line, apparatus, or circuit to be tested is disconnected from its power supply in accordance with safety instructions. Ground the line, apparatus, or circuit to be tested to discharge any capacitors connected to it.

To measure resistance, perform the following steps:

1. Connect the side spade type terminal lug (black) of the test lead to the GND binding post on the ohmmeter.
2. Attach the alligator clip (black) of the test lead to the insulation or side of the circuit nearest ground potential.
3. Connect the other side spade type terminal lug (red) of the test lead to the L binding post on the ohmmeter.
4. Attach the other alligator clip (red) of the test lead to the conductor to be tested.
5. Turn the crank in either direction at the minimum speed required to provide steady illumination of the indicator buttons. (See fig. 7-36.)

NOTE: Do not turn the crank faster than necessary to keep buttons illuminated as the output from the voltage regulator will be greater than required.

6. Read the resistance (in megohms) offered by the material being tested on the indicating meter. If the resistance is more than 1,000 megohms the meter pointer will stay at rest over the infinity mark(∞) indicating that the resistance of the insulation being tested is beyond the range of the meter.

THEORY OF OPERATION

The activating force for the ohmmeter is supplied by manually turning the crank. The crank is connected through the gear train to the rotor of the a-c generator G101. (See fig. 7-37.)

The generated a-c voltage is converted to a d-c voltage by the rectifier CR101. The d-c output of the rectifier is filtered through capacitor C101 to minimize the line ripple which exists as a result of converting a-c voltage

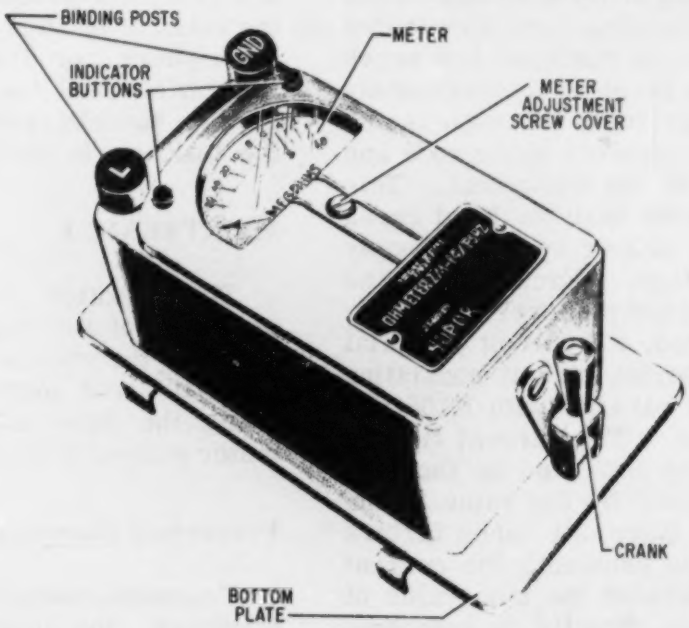

Figure 7-36.—Ohmmeter ZM-14A/PSM-2.

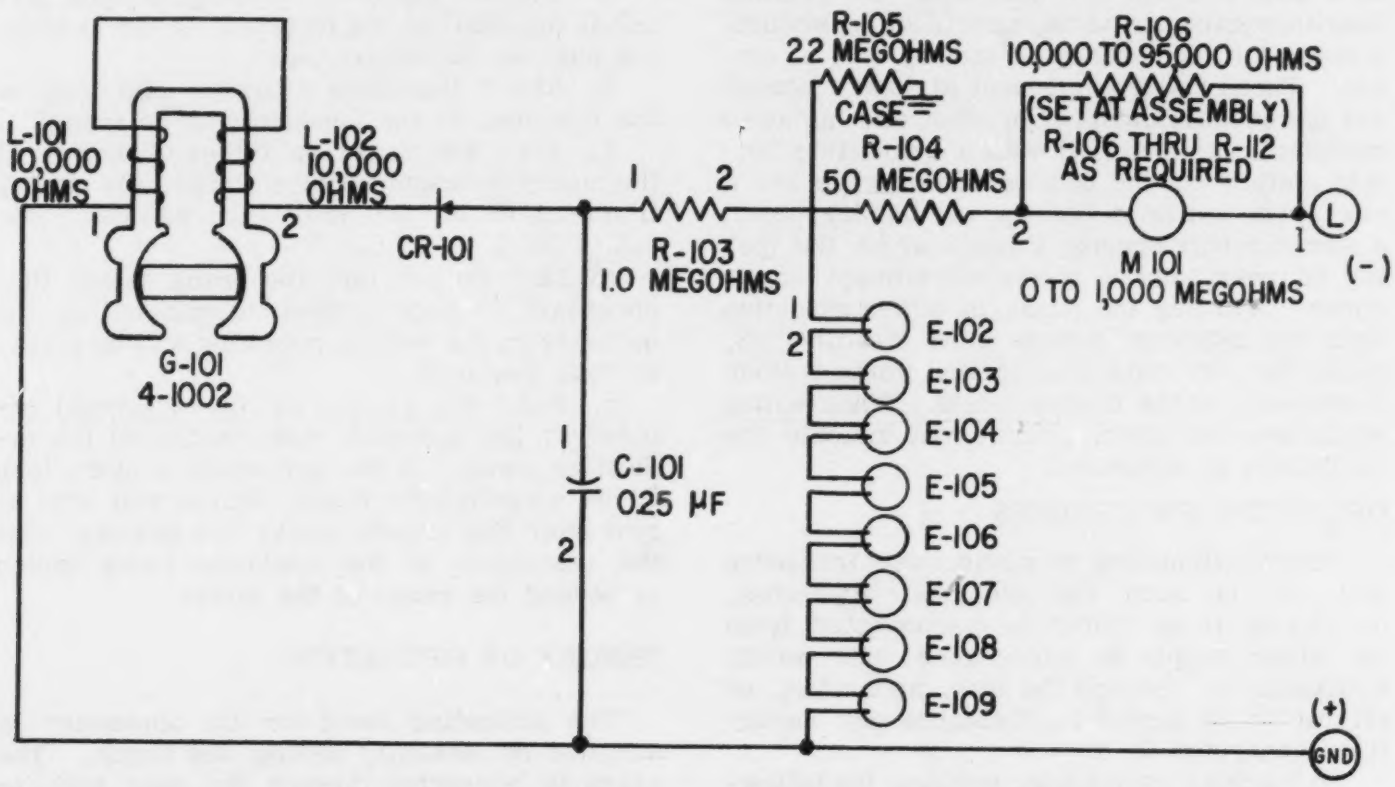

Figure 7-37. —Schematic wiring diagram of ZM-14A/PSM-2.

to d-c voltage. Resistor R103 operates in conjunction with the neon lamps to regulate the d-c output voltage of the rectifier as required to assure maximum performance from the neon lamps. Eight neon lamps, E102 through E109 inclusive, connected in series, are illuminated by the d-c voltage from the rectifier and serve to control the output voltage at approximately 500 volts d. c. The light from the neon lamps is transmitted through two clear lucite rods and is visible on the front of the equipment. This provides visual indication that the hand crank is being turned at the proper speed to supply the required test voltage. Excessive crank speed produces only a slight rise over 500 volts. As the crank is rotated, a 500-volt potential is applied across a series circuit consisting of R104 and M101 in parallel with R106 and the unknown resistance. The current flowing in this series circuit, as indicated by the meter M101, is determined by the value of the unknown resistance. Since all other factors in the series circuit are constant, the current through the meter indicates the true value of the unknown resistance directly in megohms as determined by the relationship known as Ohm's law.

One adjustment and a guard circuit for the indicating meter are provided to insure correct readings. The external infinity adjustment screw provides a mechanical means of setting the pointer in relation to the infinity mark. Resistor R105 is connected between the case and the line (L) side of the circuit and acts as a protective or guard circuit. In the event of leakage due to high humidity, salty atmosphere, or the like, the leakage would pass back into the circuit in advance of the meter, thereby preventing an error, due to the leakage, in meter reading.

MAINTENANCE

The operator should check the initial adjustments of the ohmmeter. This consists of checking the voltage output of the a-c generator G101 and adjusting if necessary. Also check the zero and infinity positions of the meter pointer and adjust if necessary.

Preventive Maintenance

To insure continuity of service at peak performance, the following maintenance procedures and electrical checks should be performed:

1. Monthly. Perform the initial adjustments of the ohmmeter. These are the zero and infinity adjustments.

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2. Semiannually. Check the voltage output of the ohmmeter by connecting an electronic voltmeter (0 to 1,000-volt d-c range) across the output terminals L and GND. Turn the crank at the operating speed. The output voltage should be 480 to 520 volts d.c.

3. Annually. Remove the generator G101 and oil the permanent magnet rotor shaft bearings with lubricating oil. To prepare for oiling, operate the generator at operating speed for approximately 5 minutes to warm the bearings. Then, holding the generator with the bearing on the crank side uppermost, apply three drops of oil to the bearing adjacent to the shaft, using a toothpick or similar means to control its placement. Continue, a few drops at a time, until the bearing is saturated.

Apply the same amount of oil to the bearing on the gear train side of the generator. Apply oil between the pinion and the thrust washer. Wipe up any surplus oil. No lubricant is to be applied to the gears.

Corrective Maintenance

To locate troubles, repair, or adjust the ohmmeter the methods outlined later in this chapter under Test Equipment Maintenance should be used. A troubleshooting guide is given in the Service Instruction Manual for finding the trouble. After locating the trouble, use the appropriate section of the manual for its correction.

The calibration procedure for this equipment is the same as that in the initial adjustment section mentioned under preventive maintenance.

The ZM-14A/PSM-2 is being replaced by the ZM-14B/PSM-2. This unit has a black bakelite case and its external appearance is somewhat different from that of the ZM-14A/PSM-2. However, the operating range and basic functions of these two units are identical.

RF SIGNAL GENERATOR

Signal Generator AN/USM-44A is the nomenclature assigned to the TS-510A/U signal generator and its assessories. This equipment is complete, self-contained, and transportable. It includes, in addition to the signal generator itself, the following accessories: A watertight transit case, power and RF cables, connector adapters, and an output fuse holder for protection of the RF output attenuator.

PURPOSE

The AN/USM-44A is a general purpose test equipment capable of furnishing accurately adjustable radio frequency signals from 10 to 420 megacycles. The instrument may be amplutude modulated by internally generated sine waves, or by externally applied sine waves or pulses. The set includes a built-in cyrstal controlled heterodyne calibrator which permits the operator to adjust the output frequency to a high degree of accuracy. The instrument features direct reading meters and controls throughout.

OPERATING PROCEDURES

The Operating Instruction Manual for the AN/USM-44A outlines step by step procedures for operating the equipment in each of the following modes of operation:

1. Continuous wave.
2. Internal sine wave modulation.
3. External sine wave modulation.
4. External pulse modulation.

The manual also furnishes the operator with instructions for using the frequency calibrator and contains a section on signal generator loading considerations.

THEORY OF OPERATION

The signal generating circuits are shown in block diagram form in figure 7-38. The unit contains a regulated power supply which is not shown in the block diagram.

The RF oscillator generates a variable frequency RF signal which is fed through a buffer and power amplifier to the output circuit. The oscillator is of the Colpitts type, and is carefully designed for high stability.

The buffer isolates the oscillator from the power amplifier and minimizes interaction between the two circuits.

The RF power amplifiers receives both the RF and the modulation signals and amplifies the RF energy for application to the output attenuator. The RF amplifier receives variable bias from the modulator which permits adjustment of the power level fed to the output attenuator.

The power monitor samples the RF energy fed to the output attenuator and indicates the power and voltage level on a front panel meter. The output attenuator obtains the monitored

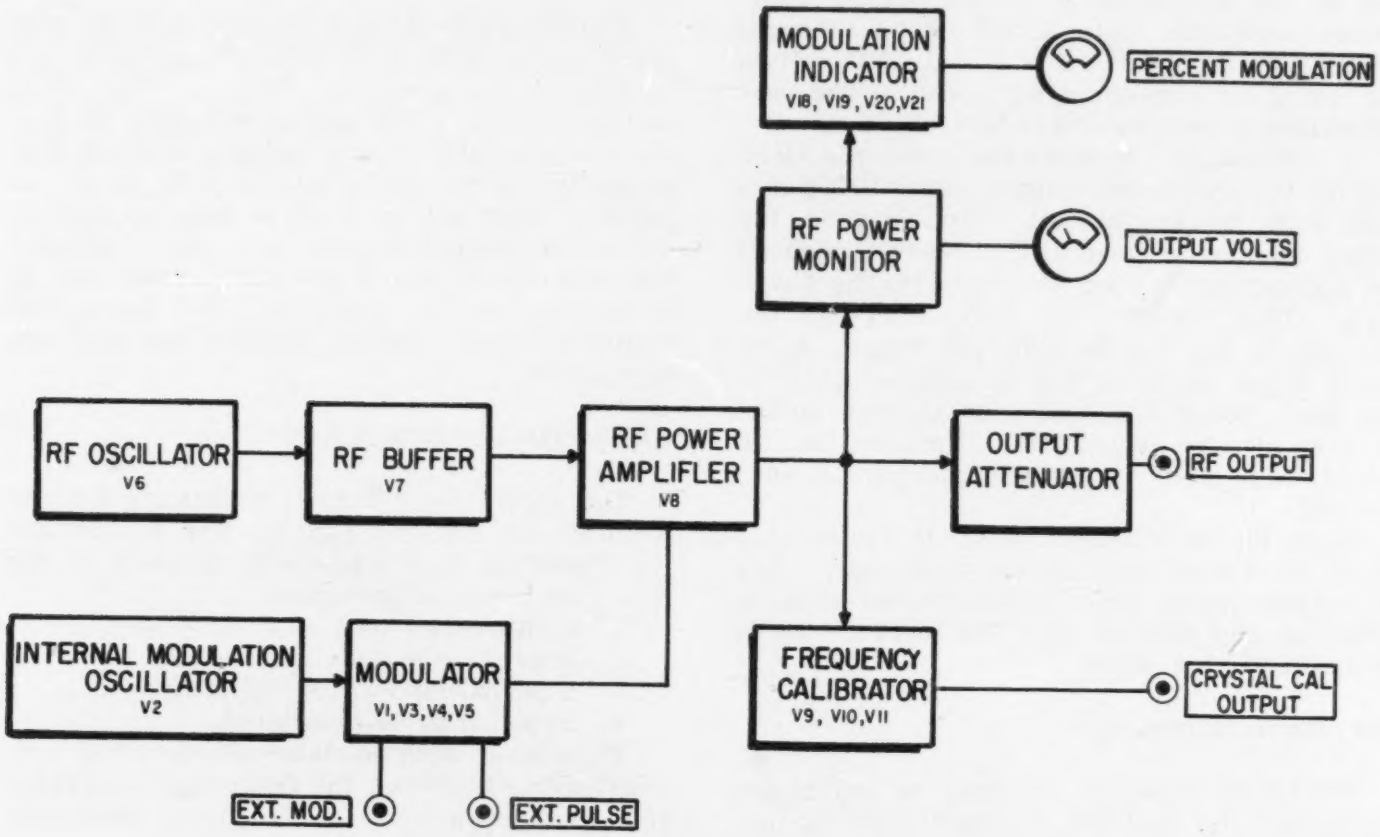

Figure 7-38. —Signal circuit block diagram.

RF energy from the power amplifier, applies the selected degree of attenuation, and conducts the energy to the front panel output jack.

The beat frequency calibrator generates harmonics of the 5-mc signal obtained from the crystal, as well as harmonics of the 1-mc signal obtained from a tuned circuit and mixes these harmonics with the RF output signal coupled from the RF amplifier. The resultant beat frequency signal is amplified and fed to the front panel headphone jack.

The internal modulation oscillator generates either a 400- or 1,000-cps sine wave for application to the modulator. The modulator receives all modulation signals for application to the RF power amplifier and also supplies variable bias to the amplifier for control of the RF output power level.

The modulation measuring circuits receive detected modulation from the RF power monitor, amplify and rectify it, and indicate the modulation percentage directly on a front panel meter.

RF Oscillator

The RF oscillator generates a sine wave signal from 10 to 420 mc in 5 frequency bands. The Colpitts oscillator circuit is tuned by a precision split stator capacitor and 5 separate RF transformers. The tuned circuit components are specially constructed for high stability.

RF Buffer

A loosely coupled secondary winding on each of the RF oscillator coils couples RF energy from the oscillator to the buffer stage. The buffer stage is connected as an untuned grounded grid amplifier and serves to isolate the oscillator circuit from the effects of the modulation signal at the cathode of the power amplifier circuit. The use of the buffer reduces incidental frequency modulation to an extremely small value.

RF Power Amplifier

The RF power amplifier amplifies the energy received from the buffer for application to the RF output attenuator. The circuit is connected as a grounded grid, cathode modulated amplifier. The plate circuit is tuned in the same manner as the oscillator, with a similar split stator capacitor and five coils. The amplifier

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capacitor is provided with a mechanical linkage, controlled from the front panel, that allows the rotor plates to be shifted from their normal tracking position. This control allows the amplifier tuning to be separately adjusted for maximum output at all frequencies.

Output Attenuator and RF Power Monitor

A piston attenuator is used to control the power obtained from the RF power amplifier. The housing for the attenuator projects through the rear of the RF generator housing and terminates, open ended, close to the RF amplifier plate circuit inductor. The nonresonant, single turn pickup loop at the end of the attenuator probe couples energy to an impedance matching network, then through a section of double shielded coaxial cable to the RF OUTPUT jack. The probe has a movable sleeve in the probe body which allows minor adjustments of the internal impedance of the generator so that a minimum standing wave ratio is obtained when the output jack is terminated in a 50-ohm resistive load.

The RF power level which is fed to the attenuator is sampled and continuously monitored. This power level is indicated in both volts and decibels over a limited range, on the front panel power level meter. A calibration mark on the meter establishes a predetermined amount of power fed into the attenuator for direct reading of the output attenuator dial calibrations.

Frequency Calibrator

The frequency calibrator consists of a crystal controlled oscillator, a mixer, and a 75-db resistance coupled amplifier. The accuracy of the crystal oscillator allows the frequency dial calibration to be set very accurately at the checkpoints. The calibrator is turned on as long as the signal generator is turned on.

Modulator Section

The purpose of the modulator section is threefold: To generate 400-cps and 1,000-cps sine waves for internal modulation of the generator; to amplify all modulation signals for application to the RF power amplifier; and to control the power level obtained from the RF amplifier for all types of operation by varying the bias on the RF amplifier. The modulator consists of a Wein bridge type oscillator, a limiter, amplifiers, a cathode follower output stage, and an output level control tube.

Modulation Measuring Circuits

The modulation measuring circuits indicate the degree of sine wave modulation of the RF output signal directly in percentage between 0 and 100 to an accuracy of 10 percent or better. These circuits consist of a stabilized wideband amplifier and a bridge type meter circuit. The circuit amplifies the detected modulation from the RF power monitor circuit, rectifies it, and applies the resultant d-c voltage to the meter bridge. Being a peak reading instrument, the meter indicates the modulation percentage of most waveforms that are applied to the EXT MOD jack. The meter is calibrated to indicate the percent modulation of a given amount of RF carrier power.

Power Supply

The power supply for the signal generator consists of two electronically regulated high voltage supplies, one providing -165v d.c., the other providing +225v d.c. Each regulator is supplied from a full wave bridge type selenium rectifier. The power transformer supplies a-c heater voltage for all tubes except the RF oscillator and power amplifier. These tubes receive constant heater voltage from a separate circuit.

MAINTENANCE

The Service Instruction Manual for the AN/USM-44A contains detailed maintenance information. Sections V and VI of this manual are devoted to maintenance at different levels.

Preventive Maintenance

The AN/USM-44A signal generator requires no special preventive maintenance other than a general alertness for the effects of misuse, loose controls, condition of cables and connectors, and possible damage that may be evident in the general appearance. The attenuator and frequency drive mechanisms should be inspected every 6 months for dryness of lubrication. Avoid overlubrication. If the signal generator

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has been subjected to unusual conditions, excessive moisture, dust, heat, vibration, etc., the instrument should be removed from the cabinet and inspected for dirt or moisture accumulation, loosened components, or any possible sign of damage. Refer to the Service Instruction Manual for specific lubrication points and recommended lubricants when servicing the equipment.

Corrective Maintenance

As previously mentioned, the Service Instruction Manual contains two sections on maintenance. Section V is the organizational maintenance section and contains information and maintenance charts for use by squadron personnel. The only adjustments listed for accomplishment at this level are the power supply voltage adjustments and the modulation meter zero set.

The instructions in Section VI are an extension of those listed in Section V. These instructions include tube replacement, component replacement, calibration procedures and complicated tests which require greater skill and more precise instruments than those described in Section V. Replacement procedures are grouped at the beginning of the section followed by recalibration and test procedures for the individual sections of the equipment.

SYNCHRO ALIGNMENT SET

Synchro Alignment Set TS-714/U (fig. 7-39) is a portable, general purpose test set used to check the alinement of synchros or resolvers. It can be used to aline any 400-cps synchro or resolver. In addition to its high sensitivity, the test set has an additional advantage in that it can also supply excitation voltage for the synchro or resolver being alined.

The test set basically consists of a bandpass amplifier and power supply, a synchro or resolver excitation supply with outputs from 3 to 115 volts rms, and switching circuits. The output voltages from the synchros or resolvers are applied to the amplifier, the output of which is fed to a phase sensitive detector circuit. The detector's output is metered by the microammeter. A meter switch selects the meter sensitivity from 300 volts full scale to 0.1 volts full scale, plus a calibrate and off position.

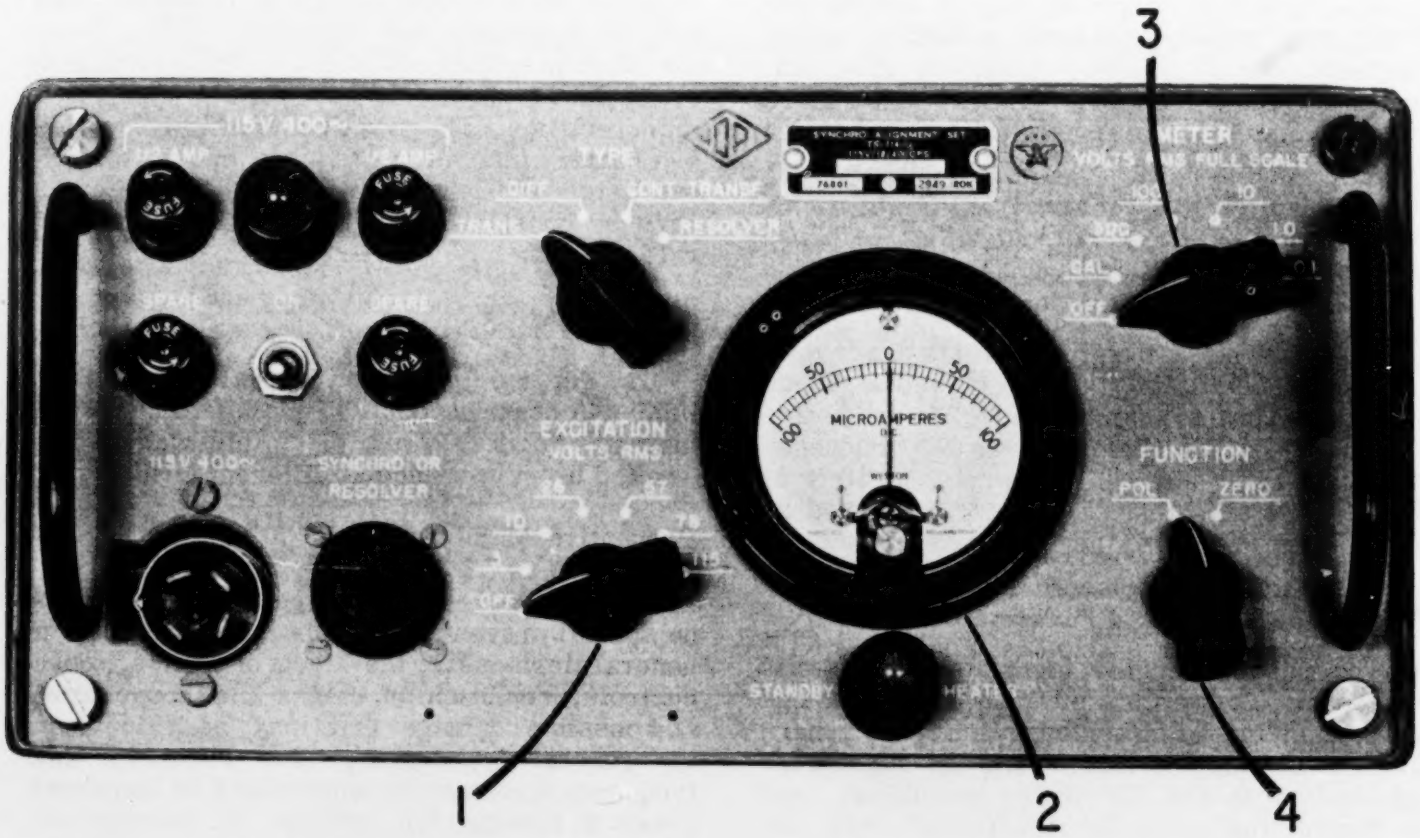

1. Excitation switch. 2. Microampere meter. 3. Meter switch. 4. Function switch.

Figure 7-39. —Synchro Alignment Set TS-714/U, front panel.

The meter has a zero center scale and indicates zero when the synchro or resolver is adjusted to either of its two nulls. The synchro or resolver is adjusted to a null position with the function switch in the ZERO position. When the null is reached, the function switch is switched to the POL position and note is taken of the meter reading. Then the function switch is returned to ZERO position and the synchro is rotated 180° to its opposite null. When the opposite null is reached, the function switch is again switched to the POL position and a note made of the reading. The correct null will be the one indicating the lowest reading with the function switch in the POL position. When the synchro is adjusted to this null, it is electrically zeroed with the correct polarity.

For more detailed instructions on the use of the TS-714/U, consult the Operation and Service Instruction Manual.

Maintenance procedures for the test set follow the general outline presented in the following section under the heading Test Equipment Maintenance.

TEST EQUIPMENT MAINTENANCE

Some of the test equipments discussed in this chapter require special maintenance techniques. These have been mentioned as a part of the detailed coverage for the specific equipments to which they apply. In the following paragraphs a more general discussion of test equipment maintenance, applicable to most test equipment is, discussed.

TYPES OF MAINTENANCE

Maintenance personnel must be prepared to repair and adjust certain types of test equipment should it fail in operation. The trouble must be located, and after repairs or replacements have been made, the equipment must be tested and adjusted to conform to the original system specifications. Maintenance personnel must endeavor to find the source of the trouble that causes equipment failure, particularly when the trouble is a recurrent one. The recurrence of a fault usually indicates that the effect, not the cause, has been remedied.

As with the other kinds of electronic equipment, the two basic types of maintenance for test equipment are preventive maintenance and corrective maintenance.

Preventive Maintenance

Preventive maintenance, as performed on the organizational maintenance level, is of major importance. Preventive maintenance is a systematic series of operations that can be performed on all electronic equipment at regular intervals. The purpose of this maintenance is to eliminate, whenever possible, major breakdowns and unwarranted interruptions in service. Through careful and conscientious efforts it is possible to keep this equipment operating at top efficiency at all times. By preventing breakdowns, valuable time can be saved at the field and depot levels of maintenance. The importance of this type of maintenance cannot be overemphasized. Electronic test equipment can only be utilized when the equipment is functioning normally and at maximum efficiency. It is vitally important that electronic maintenance men maintain this equipment properly.

These instructions have been compiled to serve as a guide for a properly organized approach to preventive maintenance. It is suggested that the general techniques outlined in the following paragraphs be utilized whenever possible.

FEEL.—The feel operation is utilized to check rotating machinery and parts that either radiate heat or normally vibrate. This is a check for overheating as well as for parts that are not working.

NOTE: It is important that the feel operation be performed as soon as possible after equipment shutdown. This operation is always performed before attempting any other maintenance work.

INSPECTION.—This is the most important operation in the preventive maintenance program. An untrained observer will have a tendency to overlook minor troubles. It is entirely possible that these troubles may not cause equipment failure at the time when they are first noticed, but after long hours of operation may be the cause of major breakdowns. The service technician should make every effort to become familiar with the complete operating system and the indications of normal functioning of the equipment.

Inspection of the equipment should consist of carefully observing all parts associated with the equipment, noticing their color, placement,

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state of cleanliness, etc. When performing this operation, look carefully for the following conditions:

1. Overheating. This is indicated by discoloration, blistering, or bulging of the parts. Leakage of chemical compounds from containers such as electrolytic capacitors gives warning of future breakdown.

2. Placement. Careful observation as to the position of all leads and cables should be made. The original position of all parts and interconnecting leads is shown pictorially in the manual for the equipment.

3. Cleanliness. Careful examination of all corners and recesses in the equipment for the accumulation of dust should be made. All parts, electrical connectors, and soldered joints should be free of foreign matter.

4. Tightness. All connections, mechanical or electrical, should be checked carefully for tightness.

CLEAN, ADJUST AND TIGHTEN. —These operations are considered to be self-explanatory. Familiarity with the equipment and the service manual will facilitate these operations.

VACUUM TUBES. —The technician should inspect all glass and metal tube envelopes for accumulation of dust and signs of corrosion. When such signs exist, a potential danger point also exists.

Inspection of the tubes' physical seating within their sockets should be made. This inspection is made by pressing the tubes into their respective sockets. Do not perform this check by withdrawing or rotating the tube forcibly within its socket. Such movements tend to weaken both mechanical and electrical connections associated with the tubes.

All connections to tube sockets should be clean and tight. If the connections show signs of dirt or corrosion, clear them; also tighten them when necessary. Whenever stranded wire is used for electrical connections, observe carefully, using a small mirror when necessary, the placement of each strand of wire. It is possible for single strands to become misplaced, causing external shorts across tube elements.

Periodic cleaning of all vacuum tubes is essential. Do not permit dust or dirt to accumulate on either the tubes or their respective sockets. Remove all dust and dirt from the glass or metal envelopes with a clean, lint-free cloth. When absolutely necessary, it is permissible to remove corrosion, oxidation, or foreign matter from the tube sockets using very fine sandpaper. Never use emery paper.

Examine all tube clamps, caps, and supporting parts to assure a tight fit. These parts are made of heavy gage metal which can withstand the application of pressure.

CAPACITORS. —Inspection of the terminals of all capacitors for corrosion, loose connections, cracks, or signs of breakage should be made. Capacitor mountings should be carefully inspected to discover loose mounting screws, studs, or brackets. Leads must be examined for signs of poor insulation or cracks, and for signs of decay. Frayed strands on the insulation should be cut away.

Variable capacitors should be inspected for any signs of foreign matter lodged between the plates. The operation of the capacitor may be checked by rotating the movable plates.

It is recommended that the plates of variable capacitors be cleaned with a small brush. In no case should the technician use an object that may vary the spacing between the plates.

RESISTORS. —All resistors should be checked for signs of blistering, breaking, chipping, and discoloration. Carefully inspect resistor leads for signs of corrosion, dust, or foreign matter. Resistor leads may become broken at the point of contact with the resistor body. Careful examination will reveal this trouble.

Resistors may be cleaned with a soft brush or a clean, dry cloth. When foreign matter is unusually hard to remove, a suitable authorized solvent may be used. Do not attempt to remove foreign matter from a resistor body by scraping.

FUSES. —Inspect all fuses and fuse holders for evidence of heat and arcing. Usually, burning or overheating will take place when the fuse does not make tight contact with its holder. While fuses are removed, check for signs of corrosion, dirt and foreign matter. When replacing the fuse in the holder, check for loss of tension on replacing the fuse holder cap. Check all wire connections to the fuse holder for tight mechanical and electrical joints.

SWITCHES. —Inspect carefully the mechanical and electrical action of each switch. This is best accomplished by placing the switch in different positions while using your sense of touch, sight, and hearing. Note the freedom of movement and the amount of switch tension in each case. Carefully examine multiple section switches to determine if the contacts are touching and clean. Never attempt to pry wafer

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contacts apart. All rotary members should make good contact with stationary members on each switch.

Carefully clean all rotary switches with a small brush. Authorized cleaning solvents may be used on contact points when necessary.

POTENTIOMETERS.—Inspect all potentiometers for cleanliness and mechanical action. Potentiometers are protected with dust covers. Do not remove these covers. When evidence indicates that foreign matter exists within the potentiometer structure, send the equipment to a field maintenance activity for replacement activity for replacement of the potentiometer. Examine the potentiometer structure for loose connections and mounting nuts. Use a soft brush or a dry cloth to remove dust and dirt from around the potentiometer.

TERMINAL BOARDS.—Inspect all terminal boards for signs of cracks, dirt, breakage, and loose connections. Check the mounting hardware for the terminal boards. Tighten the mounting hardware securely; when tightening, do not exert too much pressure.

Clean terminal boards with a soft brush. Do not disturb electrical connections unless visual checks show cause.

Check conditions of each wire lead attached to the terminals in the terminal boards. Tighten mechanical connectors and good electrical contact should result.

CONNECTORS AND ADAPTERS.—Inspect the exterior and interior of each connector and adapter. Look for any signs of breakage or cracking. Clean each connector and adapter with a dry, clean cloth.

CABLES AND CORDS.—Inspect carefully all cords and cables for cracked or deteriorated insulation. Frayed or cut insulation around connecting and supporting points is a common type of failure. Examine all insulation for signs of oil and grease.

Clean all dust, dirt, and foreign matter from all cables and cords. Dust and dirt commonly hide defects in cable and cord insulation.

PILOT LAMPS.—Inspect pilot lamp assemblies for loose lamps, loose or dirty connectors, and loose mounting nuts. Inspect the pilot lamp for looseness of the glass envelope. Tighten loose lamps in sockets and clean electrical connections to the pilot lamps socket.

TERMINALS.—Inspect terminals periodically for cleanliness and tightness. When replacing faulty terminal lugs, use only an exact replacement. Clean terminals with a stiff brush; when corrosion is present, use crocus cloth.

CABINET AND CHASSIS.—Inspect the interior of the cabinet for cleanliness. Check the control panel for loose knobs and tighten all loose set-screws on control knobs. Wipe all dust, dirt and foreign matter from the exterior and interior of the cabinet with a clean, dry cloth.

GEARS.—Inspect gear teeth on switch drive mechanisms for cleanliness and ease of operation. Clean drive mechanisms with a small brush. If dirt accumulation is great, use an authorized cleaning solvent.

Corrective Maintenance

Corrective maintenance is performed when an actual trouble exists on the equipment. After the repair has been accomplished, calibration of the equipment is necessary.

The technician is limited to some extent in the corrective maintenance that he is able to perform on test equipments (and still have them function accurately and reliably), principally because he does not have the tools and equipment, and sometimes the spare parts, necessary for this specialized form of maintenance.

REPAIR AND CALIBRATION OF TEST EQUIPMENT

The technician should realize the limitations imposed upon the repair of certain test equipments, and in no case should he attempt repairs until the applicable

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Service Instruction Manual has been thoroughly read. Particular note should be made of possible circuit misalinement or need for recalibration resulting from parts replacement. In the corrective maintenance section of the test equipment instruction manuals, troubleshooting charts are provided for the localization of trouble. When charts are supplied, they should be utilized for the correction of any trouble.

REPAIR

In repairing a piece of equipment a few preliminary tests, along with a logical procedure, often serve to locate the source of trouble without the use of extensive test equipment. In many cases, the reported symptoms along with a few astute observations will indicate the type and probable location of the trouble. Make observations carefully, and keep the symptoms constantly in mind.

The use of the senses of smell, sight, hearing, and touch often localize the source of trouble rapidly. Note unusual odors, such as sealing compound, which would indicate an overloaded transformer; scorched paint, which could indicate an overheated resistor; and burning rubber, which might point to defective insulation. If any component emits any unusual odor, the trouble might be in that part or in the associated circuit. Examine for smoking parts or sparking. Notice whether wax impregnated capacitors have lost any wax—that is usually indicative of a defective capacitor. Hum, scratch noises, and other odd sounds should have special meaning for the technician, depending upon the type of test equipment that is faulty.

NONSCHEDULED REPAIR OF TEST EQUIPMENT

Naval Air Rework Facilities of naval and Marine Corps Air stations provide a source for "call" type rework or repair to meet nonscheduled requirements. Consequently, depot maintenance activities are prepared to manufacture M series source coded items to satisfy replacement needs for operating units. They are also prepared to perform rework of specific items urgently needed to meet immediate demands where other sources are unable to provide support (usually parts not available or not in stock in supply channels). This type of support is classified as "customer service." Operating activities are encouraged to apply to NARF's in accordance with local command directives for assistance whenever normal support channels have demonstrated an inability to meet demands. Because the capacity for this type of support, in particular, is severely limited by manpower, material, and funds available, units requesting customer service should exercise thorough self-discipline to insure that normal support channels, including the capability of lower levels of maintenance in repair or manufacturing, have been exhausted prior to applying to the depot maintenance facility for assistance. On the other hand, because the capability of each depot maintenance activity is so varied and extensive, it is better to err on the side of requesting service for which no capability exists than to assume noncapability when the service could be performed.

Other support includes disassembly inspections to determine cause for failure or unsatisfactory performance of an individual item and the resultant disassembly inspection reports (DIR's), preservation, in-service repairs, in-service modifications, and related work. This support is controlled by the Naval Air Systems Command Representatives (NavAirSysComRep) within funding and man-hour limitations established by NavAirSysCom.

CALIBRATION POLICY

It is the policy of the Naval Air Systems Command that all test and measuring equipment under its cognizance be calibrated periodically and that participation in the established calibration program is mandatory for all Naval Air Systems Command managed activities and Navy inspection activities.

Fleet, Reserve, and training units, to which NavAirSysCom test equipment is provided for determination of operability and performance of NavAirSysCom material, have the responsibility of insuring that such test equipment is calibrated within the specified periods or exchanged for calibrated equipment. Each NavAirSysComRep provides for scheduling weapon system test equipment, including ready-for-issue avionics test sets, into Navy calibration laboratories under his cognizance. Also NavAirSysComRep stock and issue labels, tags, and

information pertaining to their use and other technical data on the NavAirSysCom calibration program. For further details on the NavAirSysCom calibration program, refer to current instructions.

Complete recalibration of test equipment should not be attempted by the technician. For the most accurate calibration of test equipment, precision meters, frequency standards, etc., must be used. These precision equipments are not usually found in a shop where maintenance of aircraft equipment is performed. Accurate calibration of the equipment requires the more complete testing and calibrating instruments which are available at a test equipment repair facility.

CHAPTER 8

INFRARED DETECTION

Infrared, or IR as it is sometimes called, is assuming increasing importance in missile guidance, target detection, fire control, communications, and mapping. Like radar, infrared was developed and used for military purposes during World War II. Unlike radar, however, the use of infrared has received little publicity. In some military applications, infrared energy has advantages over radar. Infrared, used as a medium of communications, is usually less susceptible to counterdetection and interference than is radar or visible light. Infrared equipment is generally less complex than radar equipment used for similar tasks.

ELECTROMAGNETIC SPECTRUM

IR is a form of electromagnetic energy, with certain characteristics identical to those of light and RF waves. Among these characteristics, some of the more important ones are reflection, refraction, absorption, and speed of transmission. Infrared waves differ from light, RF, and other electromagnetic waves only in wavelength and frequency of oscillation.

The frequency of IR ranges from approximately 300,000 megacycles to 400 million megacycles. Its place in the electromagnetic spectrum (fig. 8-1) is between visible light and the microwave region used for high definition radars. This part of the spectrum is usually discussed in terms of wavelength, and it is generally accepted that the IR spectrum lies between .72 and approximately 1,000 microns (1 micron equals 0.0001 centimeter).

The IR portion of the electromagnetic spectrum is frequently divided into three parts:

1. The near infrared which extends from the visible region out to around 1.5 microns.
2. The intermediate infrared which extends 1.5 to 5.6 microns.
3. The far infrared which extends from 5.6 microns to microwave frequencies.

Some confusion in terminolgy exists because infrared energy is so close to the visible range of wavelengths in the electromagnetic spectrum. Thus it is not uncommon to hear references to "infrared light," although the term is inaccurate. Infrared waves are also loosely referred to as heat waves, because of the well-known fact that a solid object subjected to radiation by infrared energy undergoes an increase in temperature. Heat differs from infrared waves in much the same way that electricity differs from radio waves.

INFRARED RADIATION

All objects above absolute zero (0° K or -273° C or -460° F) emit infrared radiation. Radiation from any given object is emitted over a wide range of wavelengths, but it peaks at one particular wavelength. This point is of considerable interest in military applications, as will be shown later. Detection of infrared energy depends on the contrast between IR from the source under consideration and the radiation emitted by the background. A cold object with a warm background has just as good target definition as a warm object with a cold background.

There are a number of advantages in using IR for target detection rather than some other form of electromagnetic transmission. Among these are:

1. IR systems are passive.
2. Although IR systems can be confused, complete jamming is just about impossible.
3. Military targets are usually good sources of IR.
4. IR systems may be made smaller, lighter, less complex, and less expensive than other comparable systems.
5. IR systems have higher resolution.

EMISSIVITY

One of the most useful concepts employed when working with IR is the "black body." A black body is defined as an object which absorbs

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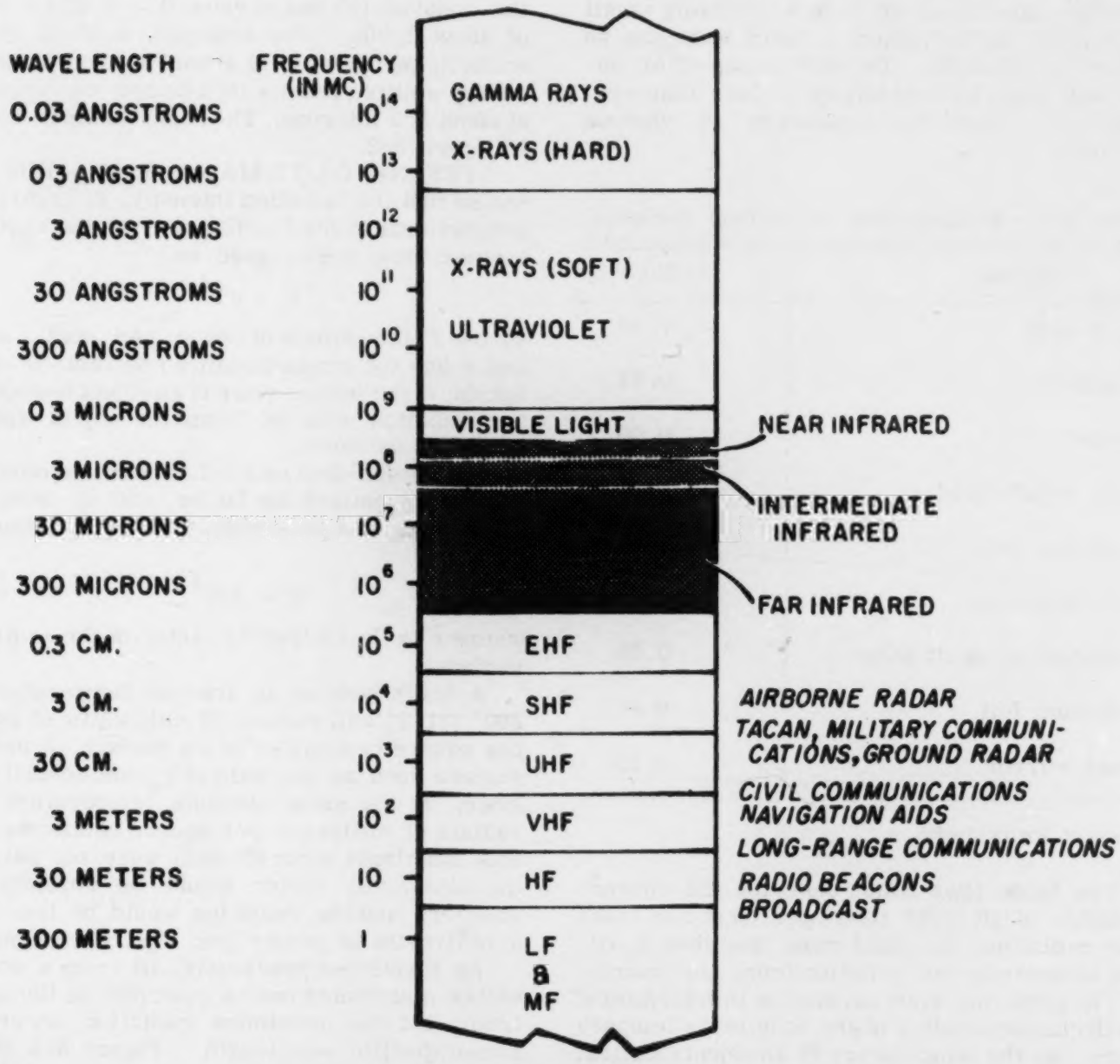

Figure 8-1.—Electromagnetic spectrum, showing different wavelength units used in different bands of the spectrum.

all radiation incident on it. Conversely, the radiation emitted by a black body is the maximum possible for any given temperature. This black body is then a perfect absorber and radiator of IR at all temperatures and for all wavelengths.

In order to compare the radiation emitted by an actual source with that of a perfect radiator, the concept of emissivity is employed. Emissivity is defined as the ratio of the total radiation emitted by any object at a temperature T to the total radiation which would be emitted by an ideal black body at the same temperature. The emissivity of any object depends on the amount of energy its surface can absorb. If the surface absorbs most of the IR striking it,

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then it will emit a relatively high amount of radiation, and the emissivity of the object will be comparatively large. By the same reasoning, if the surface reflects most of the incident radiation, the object will have a relatively small emissivity. By definition, a black body has an emissivity of unity. Therefore, any other object will have an emissivity of less than one. Table 8-1 shows the emissivity of various surfaces.

Table 8-1.—Emissivities of various surfaces.

Surface	Emissivity
Black body	1.00
Lampblack	0.95
Painted	0.90
Steel, cold-rolled	0.60
Aluminum paint	0.25
Steel, stainless	0.09
Aluminum aircraft skin	0.08
Aluminum foil	0.04
Silver mirror	0.02

Laws of Emissivity

The basic laws which describe the characteristics of IR were developed first for black body radiation, the ideal case, and then modified to describe the radiation from any source.

The most important parameter in determining the IR characteristics of any body is its temperature. As the temperature of an object changes, two specific changes in the IR characteristics take place: The wavelength where peak radiation occurs is shifted, and the total energy radiated varies with the fourth power of the temperature. These fundamental relationships are given by two laws which are discussed in the following paragraphs.

WIEN'S DISPLACEMENT LAW.—This law states that the wavelength at which maximum radiation occurs, λ_m is inversely proportional to the absolute temperature of the body. This can be expressed by

$$\lambda_m = \frac{K}{T}$$

where the wavelength is given in microns, and the constant (K) has a value (for a black body) of about 2,900. For example, a block of ice emits its peak energy at about 10 microns, while energy emitted from a jet aircraft engine peaks at about 3.5 microns. The relationship is shown in figure 8-2.

STEFAN-BOLTZMANN LAW.—This law states that the radiation intensity, E, is directly proportional to the fourth power of the absolute temperature, experessed as

$$E = \sigma T^4$$

where E dimensions of power per unit area, and σ has the proportionality constant. In other words, if the temperature of an object is doubled, the radiation emitted from the object will be 16 times as much.

The Stefan-Boltzmann Law can be modified to include emissivity factor, and by using the right units, the total radiation can be obtained by

$$E = \epsilon \sigma T^4$$

where ϵ is the emissivity factor of the radiating surface.

A black body at an absolute temperature of 300° (81°F) will radiate 46 milliwatts of power per square centimeter of its surface. A painted surface such as the skin of a commercial airliner, at the same absolute temperature will radiate 41 milliwatts per square centimeter. If this aluminum aircraft skin were not painted, the emissivity factor would be considerably smaller, and the radiation would be less than 4 milliwatts of power per square centimeter.

As mentioned previously, IR from a source will be distributed over a good part of the spectrum, but the maximum radiation occurs at some specific wavelength. Figure 8-3 shows the distribution of energy radiated from a black body at various temperatures.

As an example, IR from jet and rocket engine exhaust plumes is primarily due to the molecular excitation of water vapor and carbon dioxide which are characteristic byproducts of combustion. This molecular radiation peaks at 2.7 microns (due to water vapor and carbon dioxide) and 4.3 microns (due to carbon dioxide alone). In a practical situation, however, more usable radiation is obtained from the hot tailpipe and other heated surfaces.

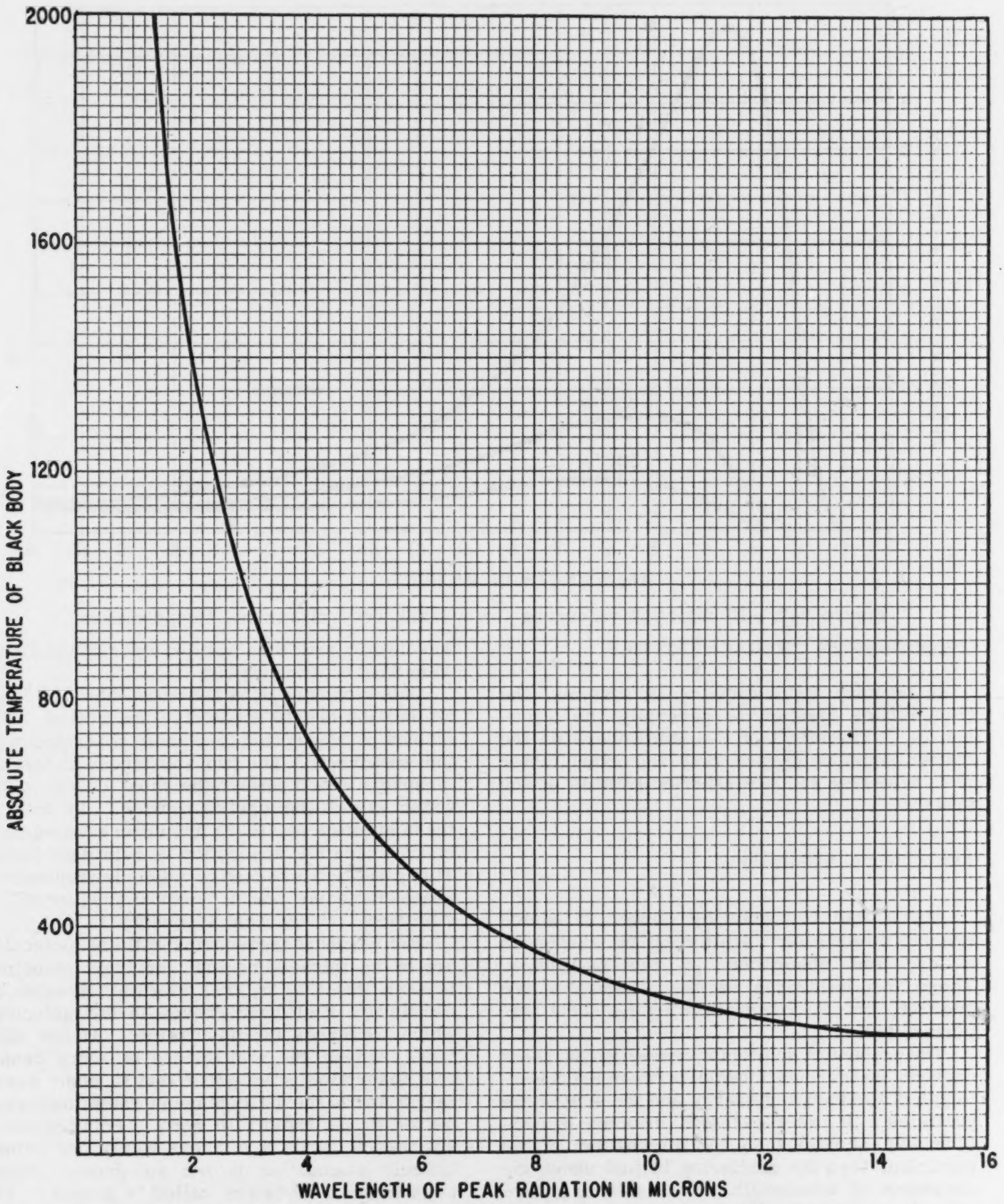

Figure 8-2. —The wavelength of the peak radiation from a black body in relation to its temperature.

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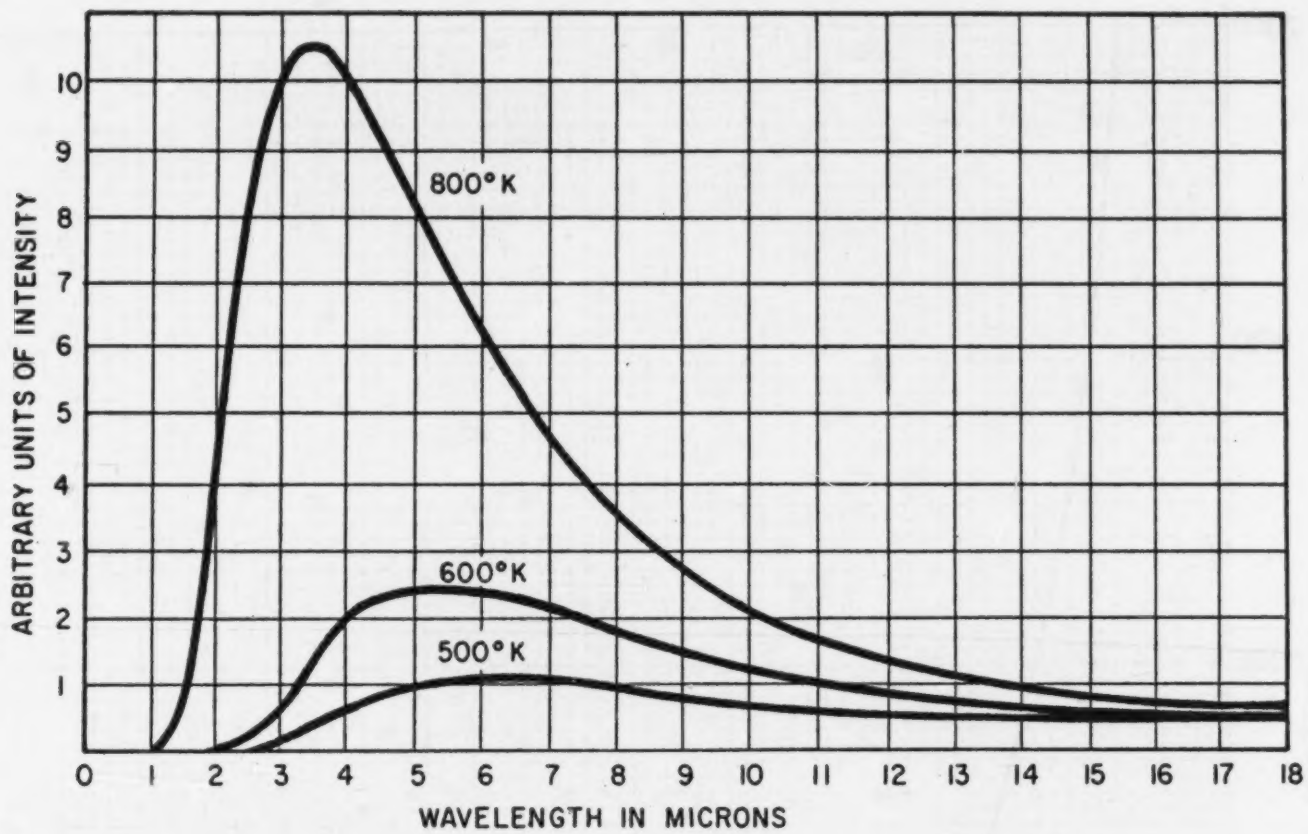

Figure 8-3.—IR distribution curves for a black body at various temperatures.

TRANSMISSION CHARACTERISTICS

In military applications of IR systems, the transmitting medium is generally the atmosphere. The effect of the atmosphere on the transmission of IR is a very important factor in considering the overall effectiveness of the system.

Atmospheric Absorption

There are two primary causes of atmospheric attenuation: scattering by suspended solids, and absorption by free molecules. These two influences on the attenuation are additive, but the absorption is the most important factor.

The amount of scattering caused by particles depends on the relationship between the wavelength of the radiated energy and the size of the particles. If the wavelength involved is considerably shorter than the dimensions of the particles, then the scattering is just about independent of wavelength. Since this is generally the case in the IR spectrum, the attenuation due to scattering can be measured at one wavelength and then applied over a relatively wide band of wavelengths.

This technique does not work, however, with attenuation due to molecular absorption. The amount of absorption is closely connected with the wavelength. The two substances in the atmosphere which absorb the most radiation are water vapor and carbon dioxide. In both of these substances, there are several wavelength bands where the absorption is relatively large. This condition is caused by molecular resonance. (Each molecule has a "natural frequency" of vibration, or resonant frequency.)

The resonant frequencies of these molecules are in the infrared region, and their structure is such that this natural vibration creates an oscillation of electric charge in the molecules which increases the absorption. At low altitudes, where the atmosphere is more dense, this absorption is so great that in some wavelength bands the percentage of radiation transmitted drops rapidly to zero. Between these absorption bands are areas where the atmospheric attenuation is not so great. These transmission bands are called "windows." The transmission windows in the atmosphere are approximately as shown in table 8-2.

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Table 8-2.—Wavelength limits of IR transmission windows in the atmosphere.

0.95	-	1.05	microns
1.2	-	1.3	microns
1.5	-	1.8	microns
2.1	-	2.4	microns
3.0	-	5.0	microns
8.0	-	12.0	microns

Figure 8-4 shows the transmission characteristics of the atmosphere at two different altitudes. It will be noted by reference to figure 8-4 that the 2.7 and 4.3 micron radiation readings from a jet exhaust plume occur at frequencies of high absorption. The radiation resulting from hot tailpipe surfaces is a function of tailpipe material and temperature, usually peaking at about 3.5 microns. This frequency is in the region of an atmospheric window or low absorption band. It will also be noted that the absorption bands are much narrower at high altitudes due to the thinner atmosphere. These absorption bands will, therefore, be of lesser consideration in the design of high altitude systems.

Optics

Optical devices based on equipment similar to that used in visible light systems are employed to collect and focus IR on a detector. A simplified focusing system, as shown in figure 8-5, would consist of a protective housing, an IR dome, and a lens. The housing is used to protect the detector and optics from the weather. The radiation enters through the dome, which is a hemispherical continuation of the protective housing. The dome must be transparent to IR. Materials such as optical glass, quartz, synthetic sapphire, rock salt, germanium, and silicon are used in making the dome. (Ordinary window glass is opaque to waves in the far infrared region.)

There are a number of problems involved in the design of IR optical systems. The material used must match the wavelength to which the detector will respond. Optical materials are generally weak physically, and many have a low resistance to high temperature and thermal shock. Chemical reactions and pressure will change the properties of some materials.

Another vital problem is that of system heating. If any part of the system becomes heated by energy is has absorbed, this energy will be reradiated at wavelengths that differ from those of the original radiation. If the detector is sensitive to these new wavelengths, this source

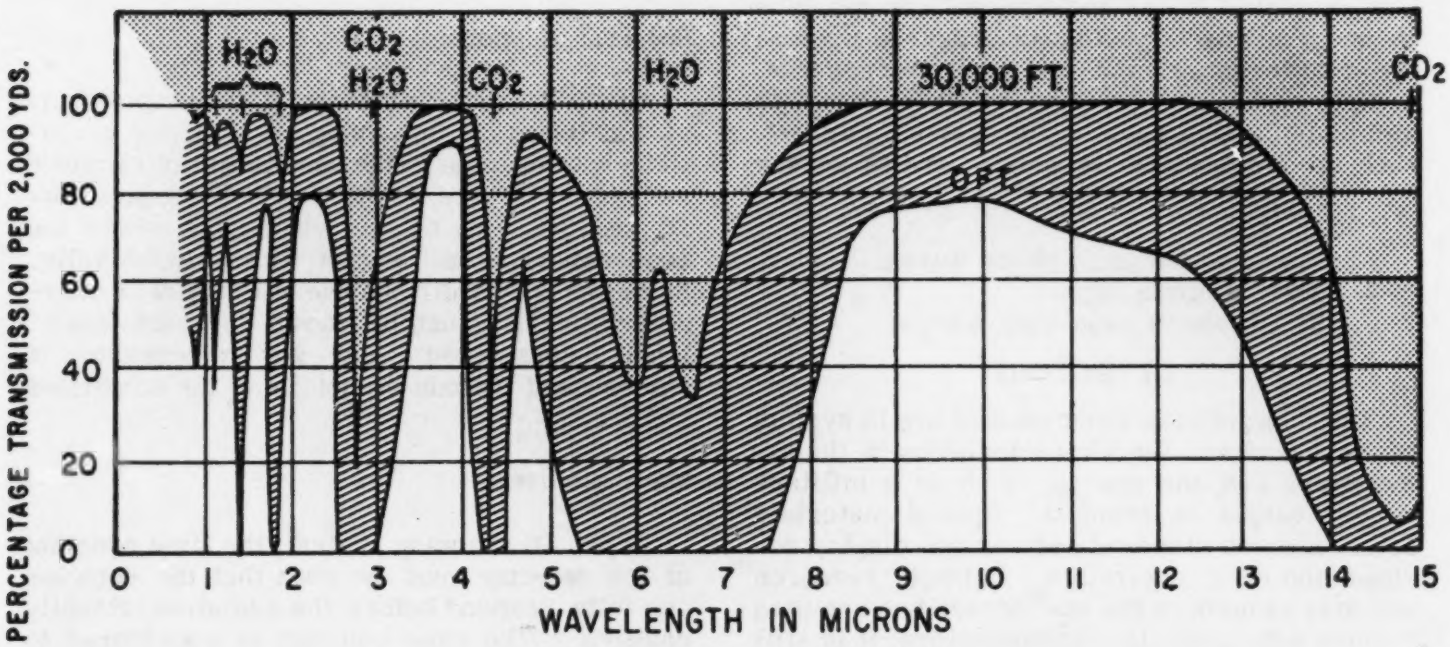

Figure 8-4.—Atmospheric transmission characteristics.

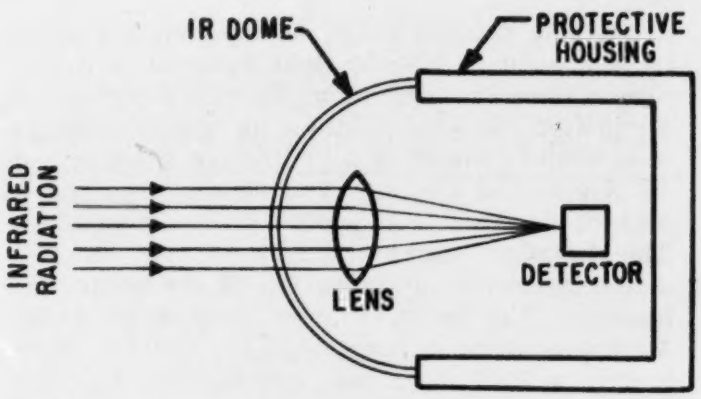

Figure 8-5.—A simple IR optical system.

which is much closer than the target will obscure the target or cause "ghost" images.

Attenuation in optical materials is primarily due to two things: surface reflections, usually overcome by antireflection coatings; and attenuation by the material. The latter is the more serious problem.

IR systems often have a chopping reticle in the principal focal plane. The chopper is generally a rotating disk with some clear and some opaque areas. Although a chopper is not absolutely necessary in a search system, it has several useful properties. The chopping rate furnishes a conveniently high carrier frequency for the electronic amplifiers. The reticle pattern can operate as a discriminator or filter. For example, it can be designed for the type of backgrounds expected in order to provide better differentiation of target and background.

Optical filters are used in IR instruments to isolate certain wavelength regions of interest, such as atmospheric windows, and to screen out undesired wavelengths. Three general types of filters are:

1. Those which pass short waves.
2. The bandpass type.
3. Those which pass long waves.

DETECTORS

The most critical component of any IR system is the detector. The characteristics of the atmosphere and the source, if it is a military target, cannot be changed. Optical materials are somewhat standardized, as are display devices and control circuits. Although research and development in the last decade has resulted in some very good all-round detectors, it is still necessary to use care in choosing the proper one for a particular application.

Many variables must be considered in the choice of a detector. The characteristics of the radiation involved will determine which type of detector will best fit the need of the system.

DETECTOR CHARACTERISTICS

In order to compare the relative merits of different detectors in different situations, it is necessary to introduce several parameters of detector operation. These parameters make it possible to discuss the characteristics of a particular detector in terms which can be applied to any detector.

Responsivity

When IR strikes a detector material, either photoelectric or thermal, a change takes place which produces an electrical output signal, indicating that the material has been irradiated. The amount of signal produced by each unit of input radiation intensity is called the responsivity of the detector, and is expressed as

$$R = \frac{\text{output}}{\text{input}}$$

generally in volts per watt. Many factors influence the responsivity, such as temperature of the detector and source, detector area, spectral distribution of the radiation, detector time constant, etc.

Spectral Response

One important influence on the responsivity of a detector is the change in detector sensitivity with changes in the wavelength of received radiation. The spectral limit of responsivity is considered to be the wavelength where the responsivity is half that of its maximum value. Since the spectral response is a nonlinear characteristic, it must be known for each wavelength considered, and any discussion of values must include the details of the conditions involved.

Time Constant

In any IR scanning system, the time constant of the detector must be such that the detector can fully respond before the radiation intensity changes. The time constant is considered to be the time required for the detector to develop 63 percent of its maximum output signal. The

maximum scanning rate is dependent upon this time constant.

Noise

Many different types of noise are generated within IR systems. Among these, the most important are:

1. Current noise, caused by bias currents within the detector.
2. Johnson (thermal) noise, caused by thermal fluctuations in the detector material.

At low bias voltages, current noise is negligible and the output noise voltage consists almost entirely of Johnson noise. The current noise increases linearly with bias voltages and may eventually become the primary source of noise.

NOISE EQUIVALENT POWER. —Another useful and important detector parameter is the noise equivalent power (NEP) of a detector. NEP is the radiation power in watts which must strike a detector to produce a signal response from the detector equal to the noise output (in other words, signal to noise ratio of 1) over a reference bandwidth.

When comparing two different IR detectors, the one with the lower NEP has the higher useful sensitivity. Since this tends to be confusing, another parameter is used: the detectivity. This figure is simply the reciprocal of the given NEP of a detector, so that the higher detectivity a cell has, the higher is its useful output. For example, a detector with an NEP of 4.0×10^{-9} will have a detectivity of 2.5×10^{-8}.

The best IR detector would be one having the greatest possible responsivity, the widest possible spectral response within the frequency band of interest, and the lowest possible NEP (or highest possible detectivity). A properly chosen detector, with the necessary operating conditions, might have a maximum range of 90 miles with a signal to noise ratio of 5 from a 1 square meter target at 300 degrees Kelvin. This range is equivalent to an ability to detect IR emitted by a cubic inch of ice at 3 miles.

PHOTODETECTORS

The three major types of photodetectors are photoconductive, photovoltaic, and photoemissive detectors. Signal to noise ratio of the detector is the limiting factor in determining its effectiveness. These are used in the near infrared spectrum.

Photoconductors use a semiconductor crystal that absorbs the photon energy from the radiation which strikes the surface of the crystal, changing its resistance or conductivity. Quite a number of materials have been used for this type of photodetector, including lead sulfide, lead telluride, lead selenide, cadmium sulfide, and many others. Gold-doped germanium has been established as a good detector material, but some difficulties, such as the long time constant, must be considered.

Photovoltaic cells are similar to solar cells. These are semiconductors with a high resistance photosensitive barrier between the two layers. When exposed to IR this cell builds up a potential difference between the two layers.

Photoemissive cells operate on the principle that electronic emission is caused by exposing the cathode to IR. In this type of emission, the number of electrons emitted depends on the intensity of the IR striking the cathode.

THERMAL DETECTORS

Thermal detection is accomplished by sensing the change in temperature of the detector material as a result of IR striking its surface. There are three different types of sensing elements employed in modern detectors to sense this temperature change. These are as follows:

1. The thermopile, which is a series combination of several thermocouples.
2. Bolometers, which sense the change in resistance of the detector material.
3. Pneumatic cells, which use the expansion of a gas as an indicator.

Thermocouple

One of the basic heat detectors is the thermocouple. When two dissimilar metals such as iron and copper are joined together and heat is applied to the junction, a measurable voltage will be generated between them. Figure 8-6 shows a basic thermocouple.

The voltage difference between two metals is quite small, but the sensitivity can be increased to a point at which the thermocouple becomes useful as a detector of IR. The increase in sensitivity is obtained by connecting or stacking, a number of thermocouples in series, so that they form what is known as a thermopile. The complete thermopile action is similar to that obtained when a number of flashlight cells are connected in series. That

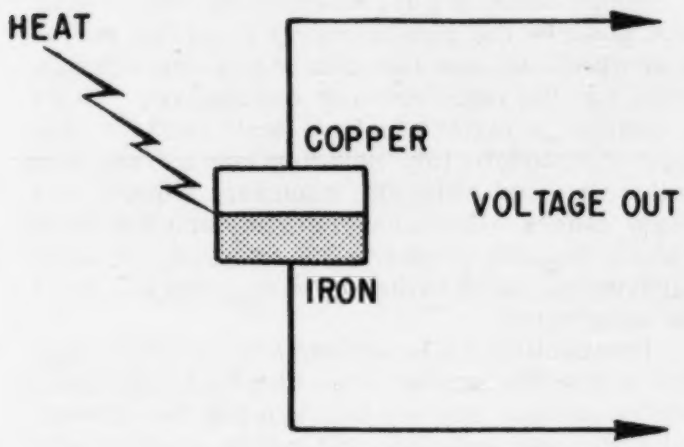

Figure 8-6. —Thermocouple.

is, the output of each individual thermocouple is added to the output of the others. Thus, ten thermocouples, with individual output voltages of 0.001 volt, would have a total output of 0.010 volt when connected in series.

The effecitve sensitivity of a thermopile can be further increased by mounting it at the focal point of a parabolic reflector. When this method is used, IR given off by the target is focused on the thermopile by the reflector.

Bolometers

A bolometer is a very sensitive material whose resistance will vary, depending on the amount of IR to which it is exposed. There are two main classes of bolometers—barretters and thermistors.

A barretter consists of a short length of very fine wire (usually platinum) which has a positive temperature coefficient of resistance. (A resistance has a positive temperature coefficient if its value increases with temperature, and a negative coefficient if its value decreases with an increase in its temperature.)

The thermistor is a type of variable resistor made of semiconducting material, such as oxides of manganese, nickel, cobalt, selenium, and copper. The thermistor has a negative temperature coefficient of resistance. Thermistors are made in the form of beads, disks, rods, and flakes, some of which are shown in figure 8-7.

The heat sensitive materials of thermistors are mixed in various proportions to provide the specific characteristics of resistance versus temperature necessary for target detection.

Figure 8-8 shows the change in resistance which can be produced in a typical thermistor material and in a barretter. This comparison shows that the thermistor has the steeper temperature coefficient of resistance curve, and therefore is the more sensitive of the two sensors.

One simple type of infrared detector consists of two thin strips of platinum which are used to form two arms of a Wheatstone bridge. To increase the thermal sensitivity of the strips, each is blackened on one side. The IR to be measured is applied to one of the strips, and is absorbed by its blackened surface. As the strip absorbs heat, its resistance changes and unbalances the bridge. The imbalance causes a change in the current produced by an external voltage applied to the input terminals of the bridge.

A device of this kind is shown in figure 8-9. It consists of four nickel strips supported by mounting bars, which have electrical leads attached to them. A silvered parabolic reflector (mirror) is used to focus the IR on the nickel strips. The change of resistance in the strips produces unbalanced conditions in the bridge circuit which can be used to produce correction signals.

Pneumatic Cell

Another unique infrared detector is the pneumatic cell or GOLAY detector shown in figure 8-10. This detector is actually a miniature heat engine.

Infrared energy entering the window causes expansion of a volume of gas located between the reflecting diaphragm and the window. The lamp at the after end of the detector emits a light beam which is focused by the lens and then passes through the grid and onto the reflecting diaphragm. The expansion and contraction of the gases between the window and diaphragm will cause the diaphragm to change its shape in response to changes in the amount of infrared energy entering the window.

Changes in shape of the diaphragm will cause its light-reflective properties to vary accordingly, modulating its light output. The light reflected from the diaphragm will then pass back through the grid which is designed to intensify the variations of the reflected light. After passing through the grid, some of the light strikes the mirror and is reflected to a photocell of high sensitivity (not shown in the

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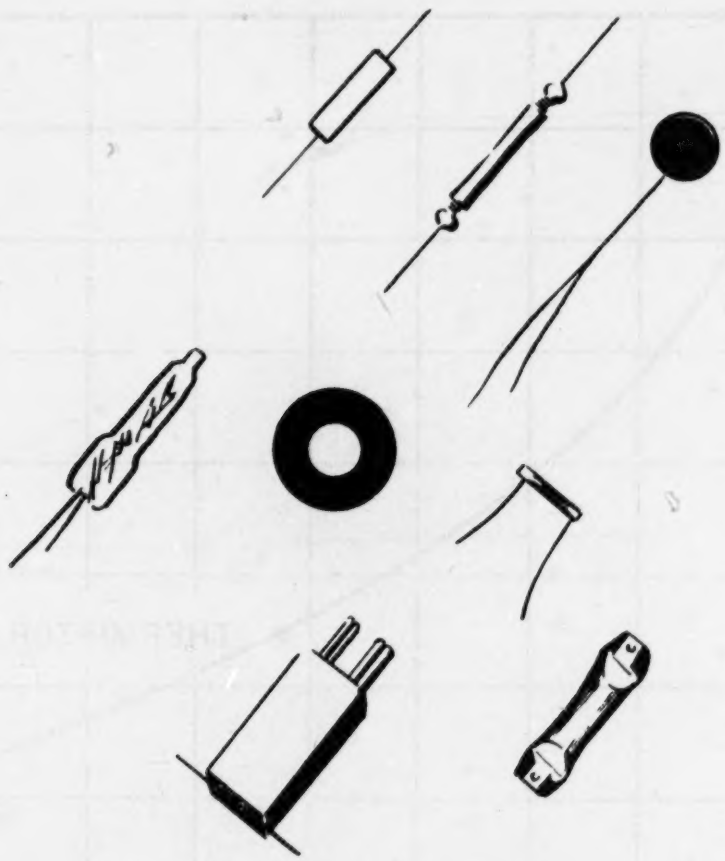

Figure 8-7. —Various thermistors.

figure). The modulated output of the photocell is a voltage proportional to the intensity of the IR entering the window.

The Golay detector has the most rapid response of any infrared detector, but it can operate only when radiant heat is received intermittently. An optical chopper may be used to interrupt the flow of IR to the cell periodically. Another advantage of the Golay detector is its extremely wide bandwidth, making it a very good choice for use in IR spectrum analysis.

APPLICATIONS

Military and industrial applications of IR have grown in number considerably in the last decade. A complete discussion of all applications would be beyond the scope of this course. However, some of the systems and concepts applicable to military situations are discussed in the following paragraphs.

MILITARY USES OF INFRARED

Infrared devices found their first military uses during World War II as a snooperscope which operated in total darkness and outlined enemy troops by the heat radiated from their bodies. A rifle with a device known as the sniperscope made it possible to see a target in total darkness and fire with normal accuracy without the enemy's becoming aware of one's presence.

Since infrared is invisible but behaves much like visible light, that is, it can be reflected and controlled in a beam pattern, it has served as a means of communication for specific wartime purposes. Development of equipment which would receive the invisible light was the foundation for the design and successful use of some highly important weapons. Infrared, when used for short-range communication between sea-level stations, such as ships, affords excellent security. Infrared rays are limited to line of sight, and are rapidly attenuated at sea level; thus, IR acts in favor of security for short-range communications. Military use of infrared for communications therefore requires a powerful source that can be modulated, and sensitive receivers for detecting the modulated source. Such sources and receivers have been developed for near infrared energy.

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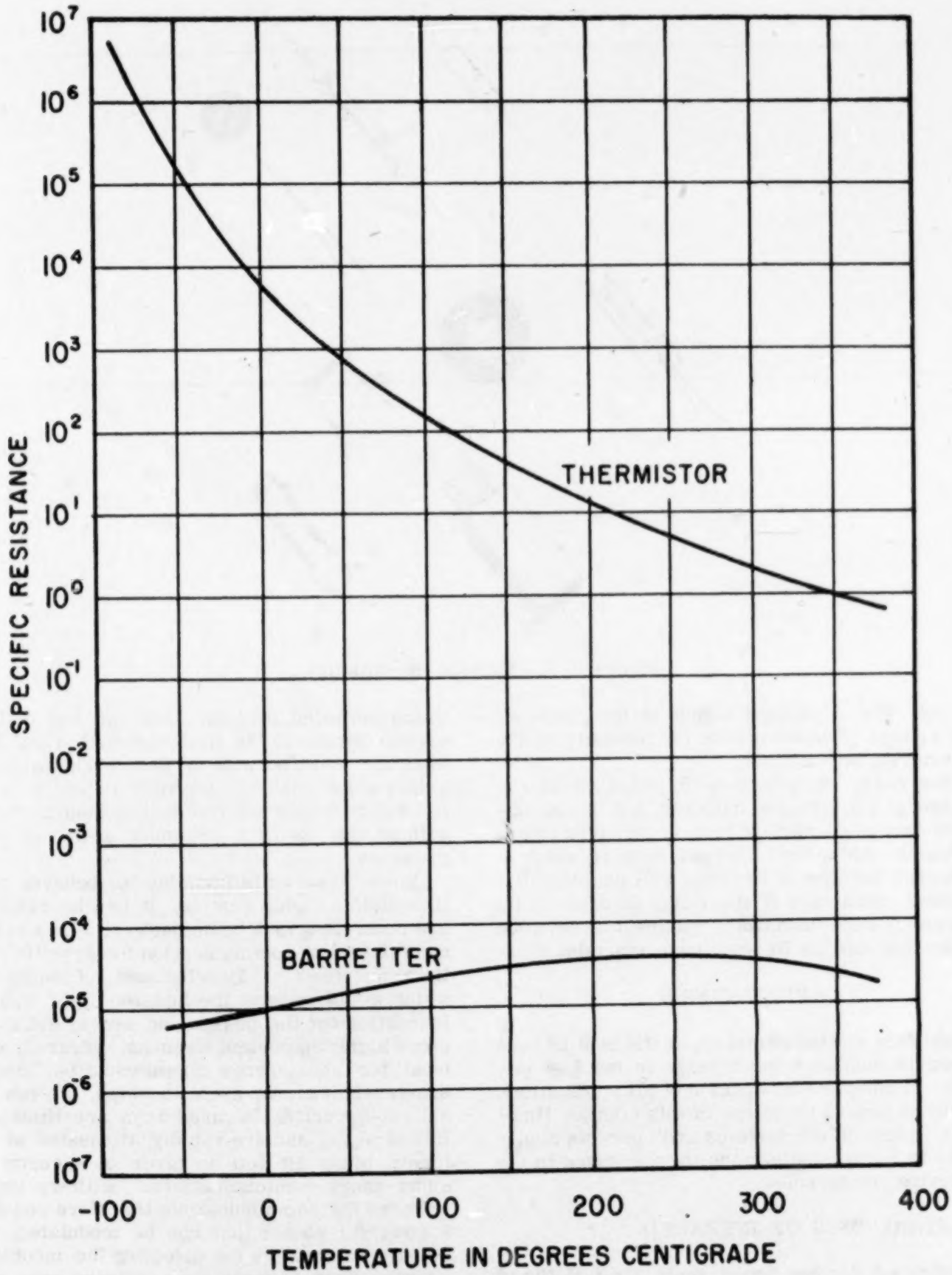

Figure 8-8.—Comparison of thermistor and barretter sensitivity.

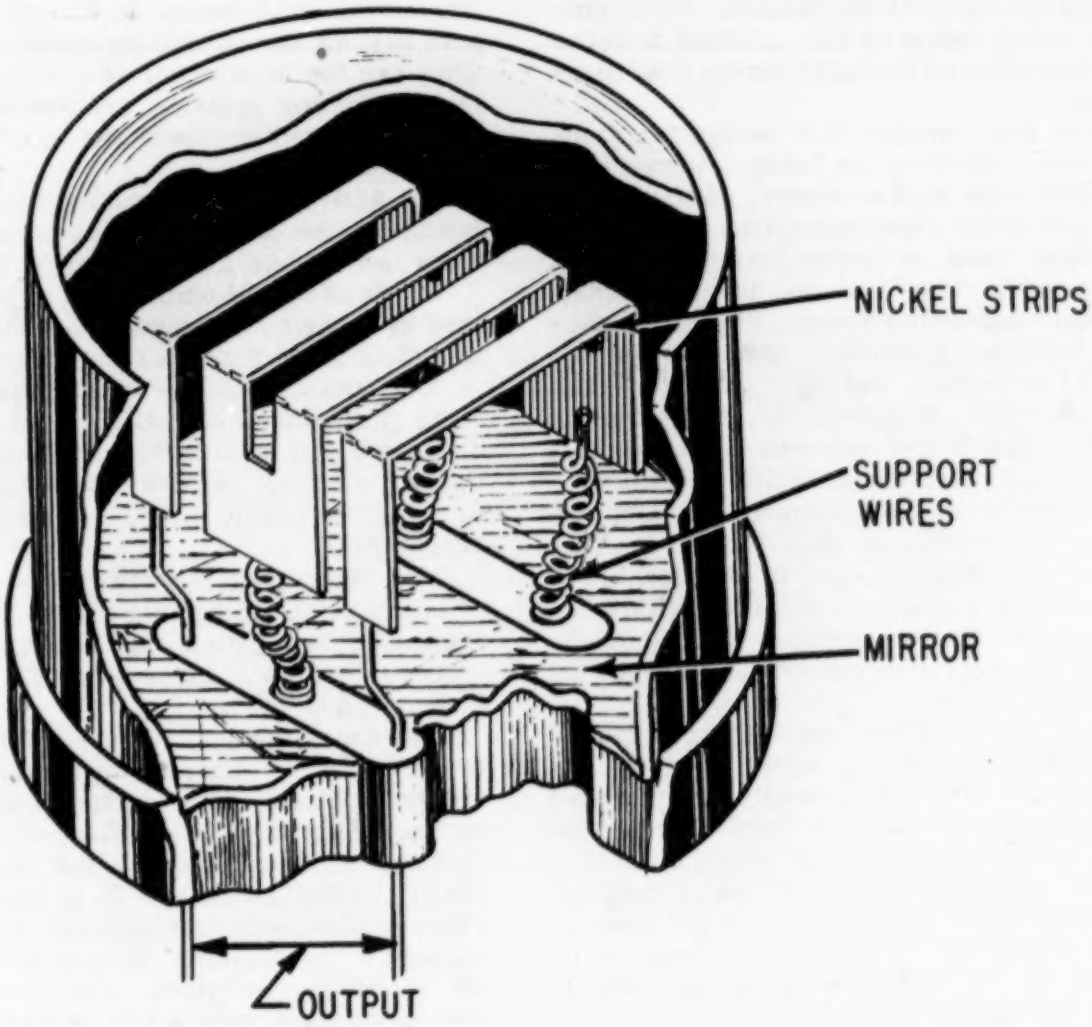

Figure 8-9. —Infrared detecting device.

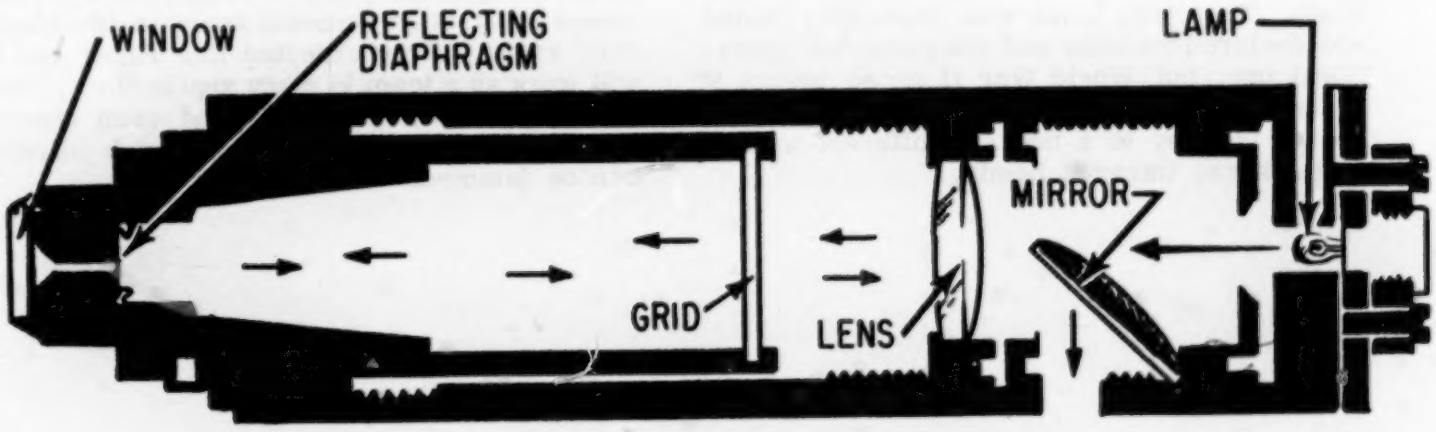

Figure 8-10. —Golay detector.

Infrared is used in photography as it is effective against camouflaged targets. Night photography using infrared can produce a better visual presentation of terrain than the best mapping radar.

Infrared has invaded the navigation field. Groundspeed indicators are being developed that will compete with Doppler radar. Anticollision circuits are under experimentation.

IR is also used in image forming devices, thermal or ship detection, and infrared radar. The portable infrared detector (PND) is a passive far infrared equipment used for the detection of personnel, vehicles, tanks, small boats, and ships. It detects the difference in temperature between a body and its immediate background and provides an audible signal output. A larger far infrared system for ship detection is the stabilized ship detector. This provides a permanent record of the true bearing of all targets that are detected within the angle scanned. Infrared radar uses a pulsed IR source and receives reflected IR energy as in microwave radar.

Infrared has excellent application to guided missiles. Military targets, such as ships, factories, and aircraft, are normally warmer than their surroundings. The presence of these targets may be detected by the heat radiation they emit. The radiation of heat at lower temperatures is particularly important in the passive detection of surface targets, since there is no economical way by which the enemy can camouflage his self-radiated heat.

The Felix bomb was the first guided missile to utilize IR. It was automatically guided by an infrared homing device in the nose of the bomb. The Felix bomb was thoroughly tested and declared reliable and adequate for operational use, but World War II ended before it could be used under combat conditions. This opened the way to a new and different method of guidance, infrared homing.

Homing guidance systems control the path of the missile by a device in the missile that reacts to some distinguishing feature of the target. They are the most accurate of all guidance systems. Homing systems are divided into three types, depending upon the source of target radiations:

1. Active homing—both the source which illuminates the target and the receiver which detects the echoes are carried in the missile.
2. Semiactive homing—the target is illuminated by some source outside the missile and the missile receiver utilizes the target reflections.
3. Passive homing—the missile receiver detects the natural radiation of the target.

Active and semiactive types generally use radar, whereas passive types use heat, light, or in some cases, home on a radio or radar transmitter.

The Sidewinder is probably the simplest and cheapest of all guided missiles. It uses an infrared homing system and is designed to destroy high-performance aircraft from sea level to about 50,000 feet.

The experimental Midas satellite, which was launched by the United States, employs infrared principles. It is equipped with an infrared scanning device capable of instantaneous spotting and reporting of the launching of a hostile ballistic missile. It is expected to provide complete and constant scanning of the earth's surface. By flashing the alarm of the blast-off of enemy missiles, they would give the United States 30 minutes to prepare for nuclear bombardment.

While it is unlikely that radar will ever be entirely replaced by IR, it is already an established fact that IR possesses certain advantages over radar. It is expected that radar and IR will work as a team in many applications, such as fire control, guidance, and even search. There is no known method by which infrared can be jammed.

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CHAPTER 9

MAGNETIC AMPLIFIERS

The magnetic amplifier combines many of the advantages of both the vacuum tube and the thyratron and in addition contributes several of its own characteristics to advantageous uses in handling large amounts of power. Although its ability to control large amounts of power is an important feature, it is also well suited and frequently used in devices involving signal or voltage amplification. It is usually necessary or desirable to add control currents from several different sources. This is easily accomplished by putting additional windings on the magnetic amplifier core.

Many different trade name devices, such as self-saturating magnetic amplifiers, Magamps, Transductors, and Amplistats, have been used to identify the more elaborate saturable reactor circuits. However, the term magnetic amplifier is used in this chapter to identify all amplifying systems which utilize the saturation of a magnetic core for the purpose of control, It is felt that this is the most popular of all terms used at the present time.

The advantage of the magnetic amplifier is principally based on the fact that it is a completely static device. With the exception of the rectifiers used, its mechanical construction is comparable to that of an iron core transformer. There are no contacts, moving parts, filaments, or other features which account for most of the failures associated with other types of amplifiers (except for those using transistors). The need for frequent inspection and maintenance is cut to a minimum. The life of the magnetic amplifier is more or less indefinite, and it is especially suited for aircraft installation where there are adverse operating conditions such as vibration and shock.

In order to understand the theory of magnetic amplifiers, a knowledge of magnetism and magnetic circuits is necessary. This information may be found in chapter 7 of Basic Electricity, NavPers 10086-A. In addition, chapter 18 of Basic Electricity discusses the basic principles and materials found in magnetic amplifier usage. These subjects are reviewed here only to the extent necessary for continuity. It is the intent of this discussion to build upon these basic considerations and develop the subject of magnetic amplification in greater detail.

BASIC MAGNETIC AMPLIFIER

The basic circuit for controlling the load power by means of a control winding is illustrated in figure 9-1. Both windings are on a common core; the primary is usually referred to as the control winding.

The primary winding is supplied with a d-c source for control purposes. A potentiometer is connected in series with this circuit and is used to control the amount of current flow.

This current will establish a unidirectional flux in the core at a level depending upon the amount of d-c magnetizing force. The second winding is connected in series with an a-c source and the load, which is shown as a lamp.

Changes of current through the control winding correspond to variations in magnetic field intensity (ampere turns). (See fig. 9-2.) These variations over the portion of the curve between the origin and point a will produce little or no change in inductance or permeability due to the nearly straight characteristic of the curve. In order for these changes in current to produce changes in inductance, they must take place on the curved portion, or knee of the curve. This means that sufficient current must flow through the control winding to place the operating point at the knee, such as at point c. This is very similar to setting the operating point of a vacuum tube by means of bias.

With the coil operating on the knee of the magnetization curve, a small increase of current through the control winding will lower the inductance of the coil, or permeability of the

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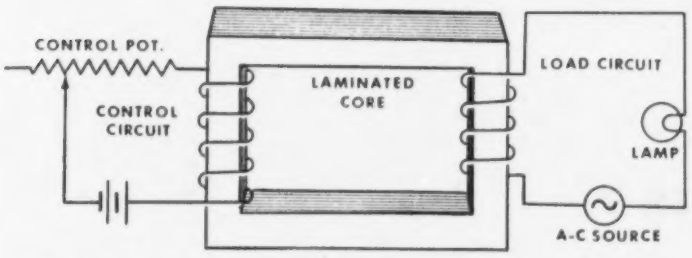

Figure 9-1. —A basic magnetic amplifier.

core, because the magnetization curve's slope is moving toward a horizontal direction. As a result, the a-c reactance of the load winding is decreased. The decreased impedance of the load circuit will then allow a larger current to flow, thereby increasing the power developed across the load. With the core completely saturated, the load winding reactance drops to nearly zero, leaving only the resistance of the copper wire to impede the flow of current. Under this condition, the maximum supply voltage will be applied to the load; thus the lamp will be brightest. Conversely, decreasing the current through the control winding will increase the reactance of the load coil, thereby decreasing the power developed across the load.

In the region between the origin and point a on the curve in figure 9-2, the core permeability (hence coil inductance) is maximum, resulting in minimum load current and, consequently, minimum output power. Since the reactance of the load coil winding has been changed by varying the degree of core saturation, the device is referred to as a saturable reactor. The following rule will apply to any saturable reactor or magnetic amplifier: A control current which tends to saturate the core will increase the output of the amplifier.

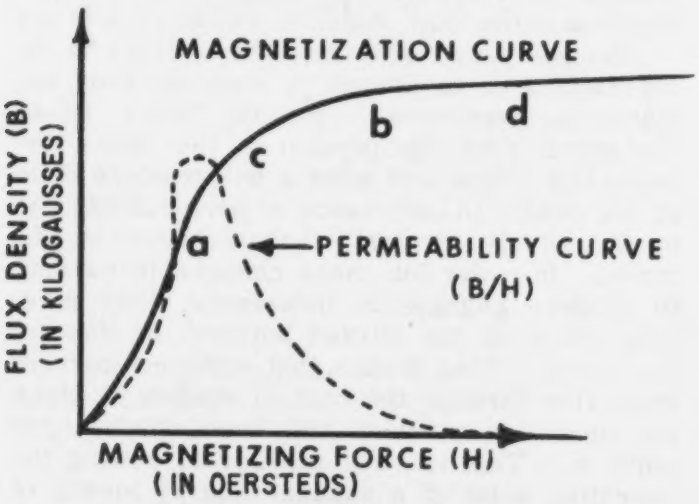

Figure 9-2. —Magnetization and permeability curves.

IMPROVED MAGNETIC AMPLIFIER

The basic magnetic amplifier circuit shown in figure 9-1 is very inefficient because of transformer action between the two windings. The alternating flux from the secondary will induce a voltage into the primary control winding. If the control winding has a large number of turns, the voltage may become excessive and may even break down the insulation.

Another reason why this form of magnetic amplifier is seldom used is the fact that the control winding would act as a short circuited secondary. This would dissipate a considerable amount of a-c energy that is applied to the control winding. It is possible to prevent this loss by inserting an isolating impedance, in the form of an inductance, in series with the control winding. Another method of preventing this loss is by utilizing a three-legged core. This and other circuit improvements are discussed in the following section.

BASIC CIRCUITS

The transformer action previously mentioned would also cause an oscillating flux in the core and the usual B-H hysteresis loop of the core material would be traced out during one full-cycle of the a-c source voltage as in transformer operation. In order for this circuit to function as an amplifier, sufficient d-c magnetizing force is required to counteract the a-c flux, and an additional amount of d-c magnetizing force is needed to set the operating point.

THREE-LEGGED CORE

A much more satisfactory arrangement for a saturable reactor is shown in figure 9-3. This figure shows a three-legged core having an a-c winding on each outer leg connected in series and the d-c control winding on the center leg. In the center leg of a saturable reactor of this type, any alternating flux produced by one of the a-c coils is balanced by the flux produced by the other a-c coil. This is true only when both a-c coils have an equal number of turns and are connected either in series or parallel

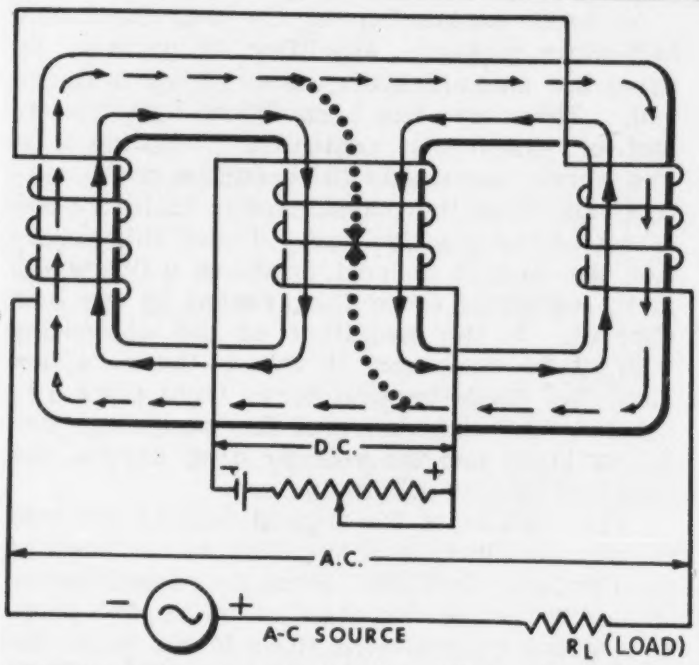

Figure 9-3. —A magnetic amplifier with three-legged core.

such that the flux fields produced by the two coils oppose each other through the center leg. This is shown by the dotted lines in figure 9-3.

Since these forces are opposite and equal, they do not pass through the center leg but join in a common path through the outer legs of the core. This is shown by the broken lines in figure 9-3. The figure also shows that the current through the d-c winding on the center leg of the core produces a magnetic flux as indicated by the arrows on the solid lines. The flux lines are caused by the direct current flow in two paths, as shown, and magnetize the entire core. Although the d-c coil is used to magnetize the cores of the a-c coils, no a-c voltage is induced into the control coil when a three-legged reactor is used.

During operation, variation of current in the control coil will vary the magnetization of the core. As has been shown previously, when the magnetizing force is altered, the permeability of the core is varied and, in turn, the inductance of the a-c coils is also varied. In other respects the three-legged magnetic amplifier functions similar to the basic circuit.

As mentioned previously, the a-c coils can be connected either in series or parallel. The series connected a-c coils offer the advantages of higher voltage gain and faster response characteristics. The parallel connected a-c coils are capable of handling loads with medium to high current consumption as may be required by large servomotors. The time of response is longer for the parallel windings.

Half-Wave Amplifier

Another improvement to the basic magnetic amplifier is the use of half-wave rectifiers. Chapter 18 of Basic Electricity, NavPers 10086-A, contains a circuit which includes their application. However, the discussion which follows is fundamental to magnetic amplifier circuits as found in aviation electronic equipment.

The type of magnetic amplifier shown in figure 9-1 is relatively inefficient. This is true because the load supply voltage, which is alternating, will create a sinusiodally varying flux which will flow through the core in one direction during one-half of the cycle and in the opposite direction during the other half. Thus, half of the time the flux created by the load current will impede the d-c control winding flux and the other half of the time it will aid this flux. This will shift the operating point of the amplifier from the origin (fig. 9-2) to a point of the curve whose abscissa (horizontal coordinate) corresponds to the peak value of ampere turns, back to the origin, and along a similar curve in the negative direction. In other words, the operating point of the amplifier will trace out a hysteresis curve such as is shown in figure 9-4. Because the amplifier cannot operate in this manner, the oscillating flux must be bucked or counteracted and then a directional flux must be added to partially saturate the core or place the operating point on the desired portion of the magnetization curve.

In order to produce sufficient flux to balance out the oscillating flux caused by the alternating current in the load winding, the ampere turns applied to the control winding would have to equal the ampere turns of the load winding. Then sufficient extra ampere turns would have to be applied to the control winding to set the operating point at the desired place on the magnetization curve. It is obvious then that this would be a very inefficient amplifier because the ampere turns required by the control loop would be greater than the ampere turns in the load circuit.

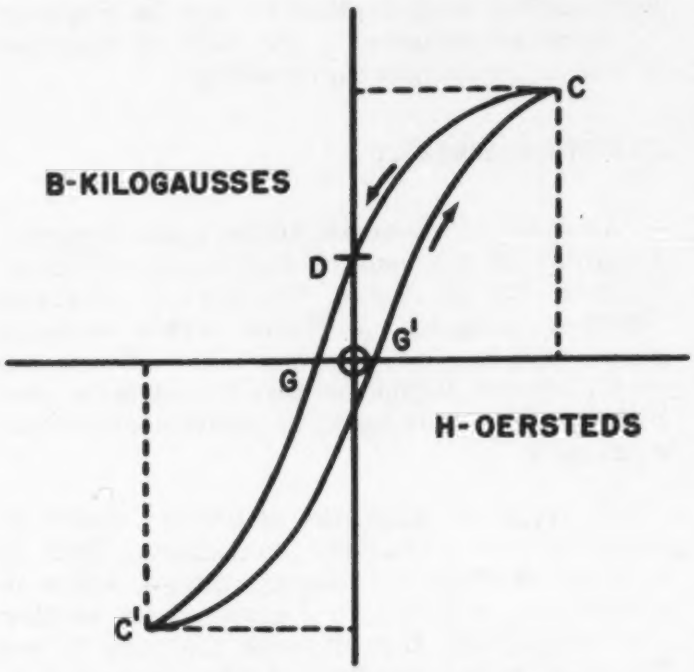

Figure 9-4. —Hysteresis loop.

A more efficient magnetic amplifier utilizing internal feedback is shown in figure 9-5. A half-wave rectifier has been inserted in the load circuit allowing current to pass in one direction only. This unidirectional load current eliminates the oscillating flux caused by the alternating current in the load circuit. Thus, the load current assists the control winding current in saturating the core. A more efficient amplifier is thus provided since less control power is needed for a given amount of control. In this figure the control circuit is so arranged that the magnetic flux resulting from the control current may either aid or oppose that resulting from the load current.

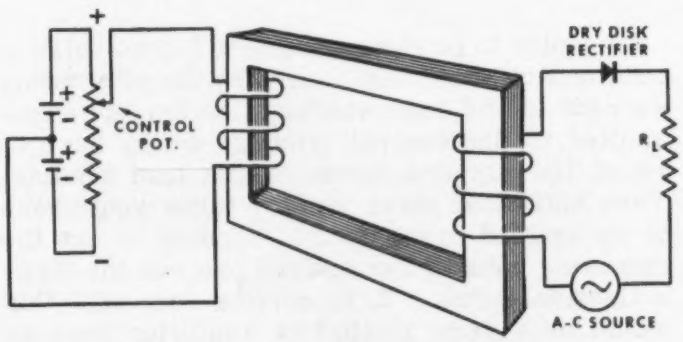

Figure 9-5. —Magnetic amplifier with half-wave rectifier.

A brief explanation of the self-saturating half-wave magnetic amplifier is possible by using the magnetization curve shown in figure 9-6. This curve has been drawn with the effect of hysteresis neglected. Position a on this curve represents the condition of the control flux when the potentiometer in figure 9-5 is set at the positive end. Under this condition the control current produces a flux which is in opposition to the flux created by the load current. If the amplitude of the alternating current is such that it varies the core flux along the magnetization curve from point a to point d, the impedance of the secondary remains large and the voltage drop across the load will be approximately zero.

The relation of the applied voltage and load current for this type of operation is represented by a in figure 9-6 (B). When the potentiometer is moved toward the negative end to the position where current still flows in the same direction but of less amplitude so that the control flux is at point b on the curve, the rectified alternating current will now vary the core flux from point b to point e. Under these conditions partial saturation of the core is achieved, resulting in a low voltage waveshape as shown at b in figure 9-6 (B). As the potentiometer is moved further toward the negative end, the initial flux density in the core (no load winding flux) is nearer saturation so that the inductance of the controlled winding is reduced earlier in

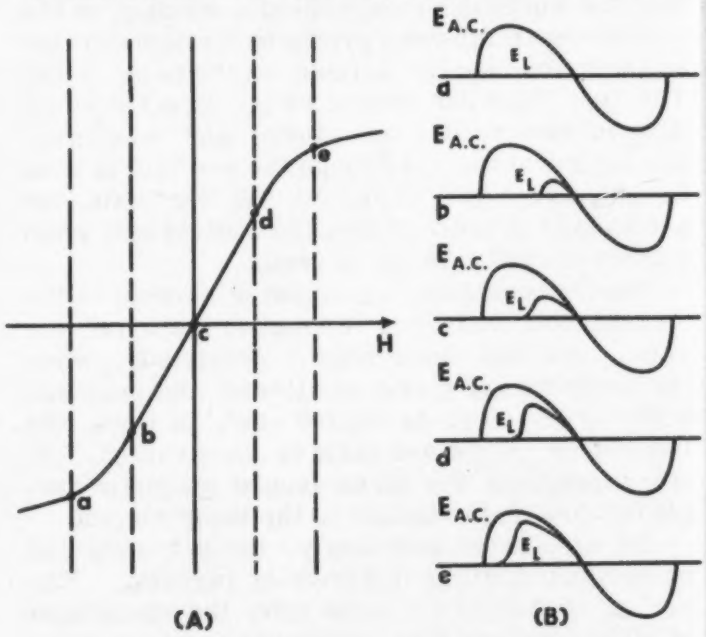

Figure 9-6. —Operation of a self-saturating magnetic amplifier.

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the half-cycle and larger values of load current flow. This is shown by c, d, and e in figure 9-6 (B).

Using Bias for Flux Reset

When the core material possesses hysteresis properties that produce a rectangular shaped B-H curve, it may be necessary to bias the core in order to retain control. This is accomplished by allowing a bias current to flow either through the control winding or through a separate bias winding. This bias current provides a means of resetting the flux to the initial operating point during the control period. Thus, no control current is necessary to reset the flux. Figure 9-7 shows a separate bias winding wound on the center leg of a three-legged core.

The core is usually biased so that with zero control current the load winding flux saturates the core midway in the operation cycle. This bias setting enables the control current to either advance or delay the point of saturation. In other words, if the polarity of the control current is such that the flux produced by it adds to the bias flux, the point of saturation will be delayed. (Control and bias flux are in opposition to load winding flux.) A control current of opposite polarity will produce a flux that opposes the bias flux and this will advance the point of saturation.

The bias may be either alternating or direct current. In most cases the polarity of d-c bias is such that it opposes the load current flux. The magnitude of the bias might be such that it would reset the flux to a point between a and c figure 9-2. There are some applications where the opposite is true: in these applications the purpose of the bias is to provide an initial d-c saturation in the core in order to obtain greater amplification of weak signals.

Full-Wave Amplifier

The magnetic amplifier that has already been discussed produces a pulsating or half-wave output. In most applications of magnetic amplifiers, full-wave operation is more desirable for it is more efficient since the load is energized during both halves of the a-c cycle. Full-wave operation may be obtained by using a pair of simple half-wave magnetic amplifiers operating in parallel. A typical circuit arrangement is shown in (A) of figure 9-8.

The load current is controlled by means of two control windings connected in series. Each amplifier unit contains a rectifier so that load current flows alternately in the two amplifiers. As one conducts, the core of the series coil in the other is being set by the action of the control current. And with each amplifier conducting during approximately one-half of each cycle of load current, the output variations are full-wave in nature.

Output waveforms for two different control currents are shown in (C) and (D) of figure 9-8. The waveform in (C) is produced when the control current biases the core near the point of saturation. In this condition, saturation of the magnetic cores of the amplifiers is reached

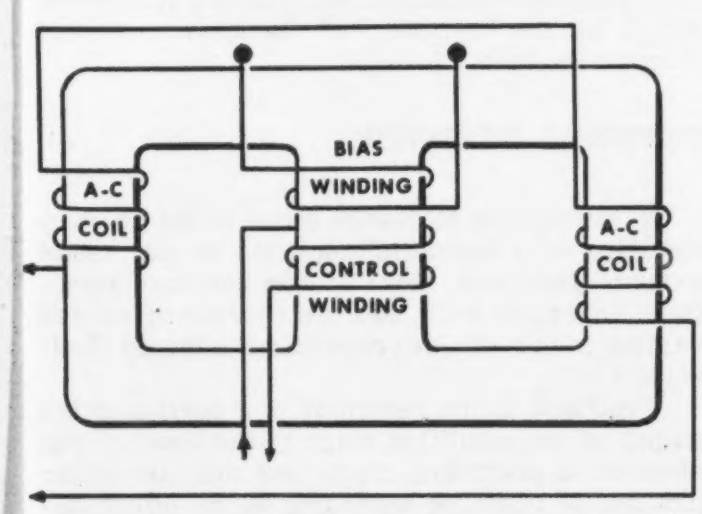

Figure 9-7. —Bias winding.

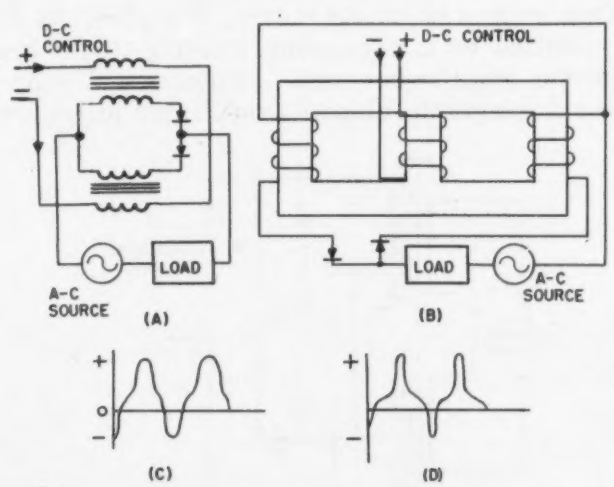

Figure 9-8. —Full-wave magnetic amplifier and output waveforms.

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early in each half-cycle, and the resulting output current variation are almost sinusoidal in shape.

When the current in the control winding biases the core in such a way as to produce the waveform of figure 9-8 (D), the average value of load current is considerably less than when the control current biased the core to near saturation. Thus, as in the half-wave circuit, the output power developed in the load can be varied by controlling the load current. The output that is developed is an alternating current and is in phase with the source voltage. Figure 9-8 (B) shows a magnetic amplifier that functions similar to the one shown in (A). The major difference is that the two cores shown in (A) have been combined to form a three-legged core.

CROSSOVER WINDINGS

In discussing the theory of operation of the full-wave magnetic amplifier circuits shown in figure 9-8, it was assumed that the rectifiers have zero forward resistance and infinite back resistance. In actual practice this assumption is not valid since rectifiers do not have infinite back resistance. It should be apparent that any back current flowing through the rectifiers shown in figure 9-8 (A) during their nonconducting half-cycle, will produce a magnetic flux which will tend to drive the core out of saturation. During the conducting half-cycle, a part of the load current would be absorbed in bringing the core back to the point of saturation, thus reducing the gain of the amplifier.

One method of counteracting this effect is by the addition of a crossover winding to the two magnetic amplifier cores. Figure 9-9 illustrates a magnetic amplifier utilizing full-wave rectification and crossover windings. It should be noted that this circuit is similar to the circuit shown in figure 9-8 (A) with the addition of the crossover windings.

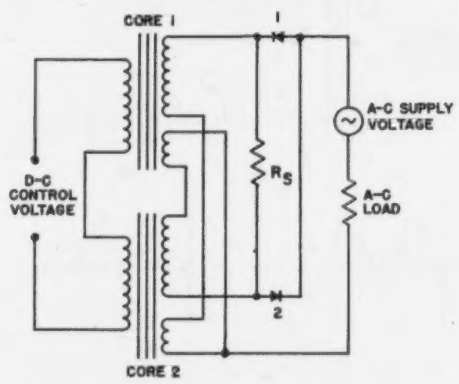

Figure 9-9. —Full-wave magnetic amplifier utilizing crossover windings.

The crossover winding consists of a few turns which produce a magnetic field in a direction opposite to that produced by the backward current through the load winding. Referring to figure 9-9, consider the action of the load and crossover windings on the two cores. Assume that during the first half-cycle of the a-c supply voltage, rectifier 1 is conducting in the forward direction. The heavy current, flowing through rectifier 1 and the load winding on core 1, also flows through the crossover winding of core 2. During the same half-cycle a small backward current is flowing through rectifier 2, the load winding on core 2, and the crossover winding on core 1. This small backward current, flowing through the large number of turns in the load winding, produces a magnetic field that is canceled by the heavy current flowing through the small number of turns of the crossover winding on core 2. A similar cancellation is achieved on the second half-cycle of the a-c supply voltage by the other crossover winding.

Since the back resistance of the rectifiers will vary with temperature and applied voltage, some means must be provided to insure cancellation of the field resulting from the backward current at all times. A small constant resistance, R_S, is connected in parallel to the high, but variable, back resistance of the rectifiers. Each rectifier is shunted during its nonconducting half-cycle by the series combination of R_S and the conducting rectifier. The variations in the back resistance will now have no noticeable effect on the quantity of backward current through the load windings.

EXTERNAL FEEDBACK

It is possible to change some of the characteristics of a magnetic amplifier by the use of external feedback. (NOTE: The action of rectifiers in series with the load current discussed earlier in this chapter constitutes internal feedback.)

Feedback is the returning of a portion of the output of an amplifier stage to the input of that stage or a preceding stage and may be either positive or negative depending on the effect desired. It has the effect of adding to or subtracting from the flux density created by the control

circuit current. Regenerative or positive feedback, which increases the control circuit flux density, makes the circuit more sensitive to changes in control current; thus, the power gain of a single stage may reach 40 to 50 db. However, this type of feedback has two disadvantages for it increases the time lag characteristics of the amplifier, and may also cause instability. Degenerative or negative feedback reduces the gain of the amplifier by decreasing the flux density created by the control winding current; however, it increases the linearity of the magnetization curve and reduces the time lag characteristics of the amplifier.

The curves in figure 9-10 illustrate the effect of both positive and negative feedback on load current as a function of input control current. It should be noted that the same amount of direct current is needed to saturate the core regardless of the amount of feedback provided. However, when using positive feedback, less input control current is required to saturate the core since the feedback current aids the control current toward this end. The gain characteristics of magnetic amplifiers with positive and negative feedback may be compared by studying the curves shown in figure 9-10. The following should be concluded:

1. Output current is the same when saturation is attained regardless of feedback.
2. Linearity and stability improve with degenerative (negative) feedback.
3. Gain improves with regenerative (positive) feedback.

A schematic diagram of two magnetic amplifier circuits utilizing external feedback is shown in figure 9-11. Feedback is provided by an additional winding on the center leg of each core. The direct current flowing through the feedback

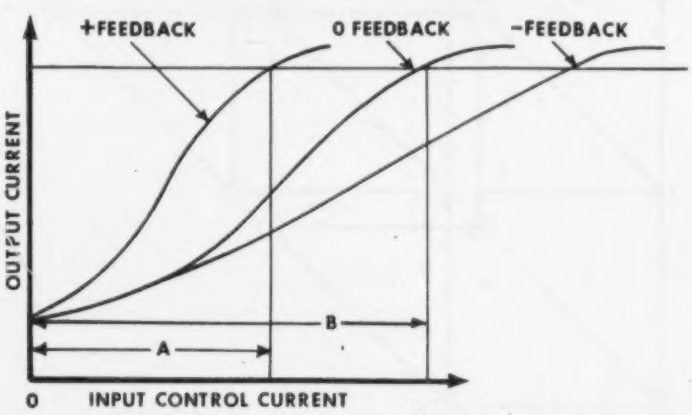

Figure 9-10. —Effects of external feedback.

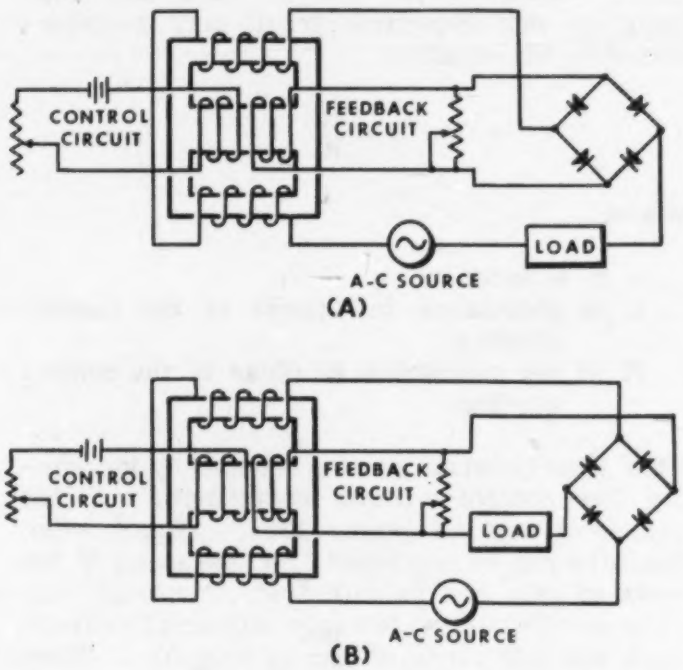

Figure 9-11. —Magnetic amplifiers using external feedback.

winding creates a magnetic field which either aids or opposes the magnetic field created by the control current.

In (A) of figure 9-11 the a-c load current is rectified prior to being fed through the feedback winding. It should be noted that the feedback current consists of the total load current and it will always flow in the same direction regardless of the input signal. To change the feedback from regenerative to degenerative or vice versa, the feedback winding connections must be reversed.

Figure 9-11 (B) illustrates the use of external feedback in a magnetic amplifier supplying a d-c load. The amount of feedback is controlled in both circuits by setting of the potentiometer paralleling the feedback winding.

Earlier in the discussion it was mentioned that the time of response of a magnetic amplifier was affected by feedback. Since this characteristic largely determines their application, let us discuss this aspect further. The ordinary saturable reactor type, or saturable transformer, requires a certain time for a control action to take effect since the action is applied to an LR control circuit. The time of response is usually proportional to the time constant of

the d-c input control circuit. The time constant for this inductive circuit may be determined by the equation

$$t = \frac{L}{R}$$

where

t is in seconds.
L is inductance in henrys of the control winding.
R is the resistance in ohms of the control winding.

This time constant may be reduced by increasing the control circuit resistance, but this causes a control power loss. Degenerative feedback can be employed to do the same if the reduced gain can be tolerated. A normal arrangement would be to apply degenerative feedback and add more stages in cascade. When stages are cascaded, a d-c output of the first stage is applied to the control winding of the next stage, and so on.

SELF-SATURATING MAGNETIC AMPLIFIER

In order to understand the workings of magnetic amplifiers in general, a brief review of magnetics is in order. More specifically, the discussion at this time will deal with the special magnetic properties that are peculiar to magnetic amplifiers. These properties are generally referred to as "nonlinear magnetics."

NONLINEAR MAGNETICS

This category covers such subjects as voltage to time relations and voltage to flux relations. The first case is the much used volt-second concept and is of primary importance in an analysis of magnetic amplifiers.

From the continuity standpoint, the next logical step is to apply the above acquired knowledge to analysis of the operation of the basic magnetic amplifier. As will be explained shortly, the basic amplifier to be studied is of the self-saturating type. These devices are relatively new to industry in this country, and as the field has expanded, it has become evident that the self-saturating magnetic amplifier is increasingly dominating the field.

Domain

For the purposes of this course, the domain is considered as being an area within a ferromagnetic material, where the spin magnetic moments are alined in such a manner that the area itself is magnetized to saturation, giving a resultant field to the area.

Crystal Structure

A crystal is simply an orderly arrangement of atoms, sometimes referred to as a lattice. The pattern repeats itself regularly, as shown in figure 9-12.

This particular diagram shows only three cubic crystals. A ferromagnetic core will normally contain millions of these crystals and is called a polycrystalline substance. Each crystal itself may be composed of a great many domains and each domain may contain many atoms. This is not meant to infer that a crystal must always have many domains; a crystal may contain only one domain, and as conditions change, a domain can contain a great many crystals.

The single crystal has some important qualities that may be explored at this time. The first of these is the arrangement of the domains within the crystal. Figure 9-13 shows four possible arrangements. It must be realized that there are many possible arrangements and they are generally much more complex than those shown.

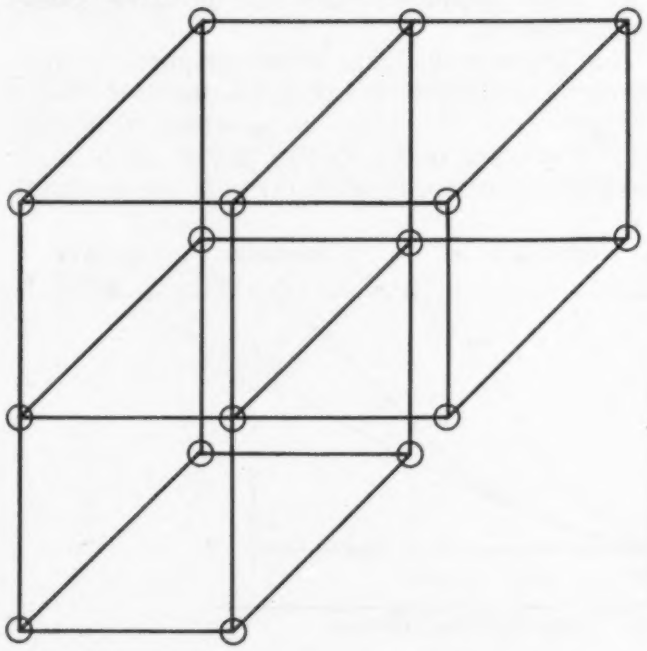

Figure 9-12. —Crystal structure.

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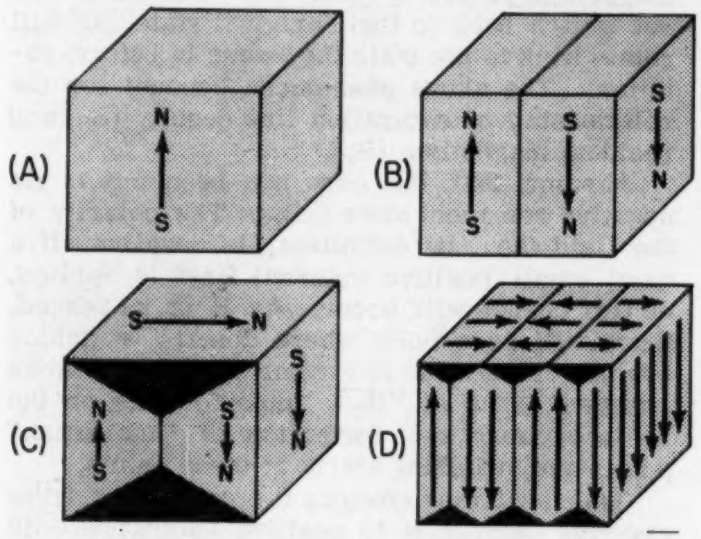

Figure 9-13.—Possible domain configuration.

A study of these cases will reveal the fact that in all cases but one, the resultant field of the crystal is zero. This one exception occurs when the crystal contains only one domain.

Figure 9-14 (A) shows the Miller indices of a unit crystal. Because a crystal is easier to magnetize in some directions than others, it was found that a system of indexing was needed. This resulted in the Miller indices. As shown, each index lies in a plane with one of the dimensions of the crystal. The (100) index lies along the cube edge. The (110) index lies in a line that runs from corner to corner across the cube face, and the (111) index goes from corner to corner through the center of the cube. It has been found that an iron crystal will magnetize in the (100) plane with less energy applied than in either of the other two planes. The (110) plane is the next easiest direction of magnetization and the (111) the hardest. This is graphically shown in figure 9-14 (B).

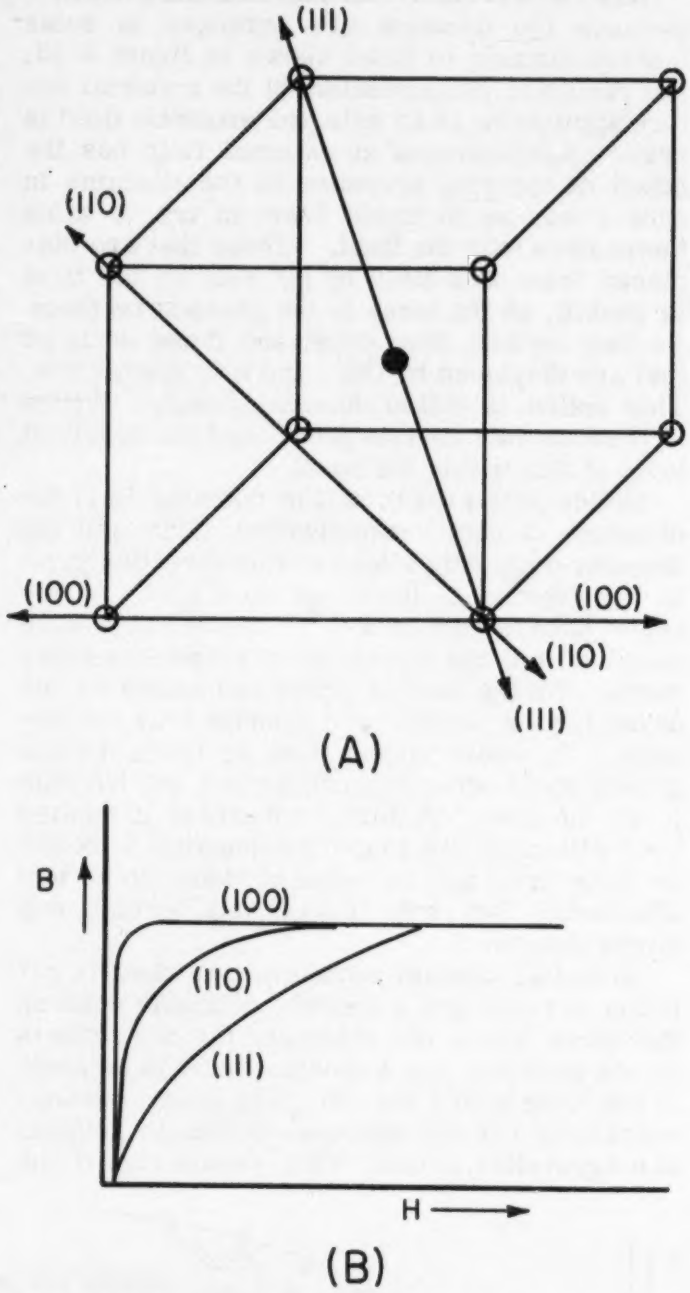

Figure 9-14.—Magnetization in an iron specimen. (A) Miller indices; (B) ease of magnetization.

Magnetization

The core materials used in magnetic amplifiers are usually magnetized by a process called grain orientation (sometimes referred to as domain orientation).

GRAIN ORIENTATION.—Grain orientation is accomplished during the rolling and drawing process in the manufacture of tapes that are later wound into cores, similar to a roll of movie film on a bobbin. During this rolling and drawing process, the material is heated to a temperature above the Curie point and rolled thin through steel rollers. Throughout the rolling process, the material is under the influence of a strong magnetic field and the temperature is gradually lowered through the Curie point. This alines each grain or crystal so that its (100) index is alined with the applied field. When the tapes are wound on bobbins, the grains are alined with the direction that the externally applied field will follow.

APPLICATION OF AN EXTERNAL FIELD.—Because the domains are arranged in some fashion similar to those shown in figure 9-13, the resultant magnetization of the material before application of an external magnetic field is zero. Application of an external field has the effect of applying pressure to the domains in such a way as to cause them to try to aline themselves with the field. Those that are displaced from this field by 90° will be the first to switch, as the force is the greatest on them. As they switch, they unbalance those domains that are displaced by 180°, and they also switch. This action is called domain growth. Figure 9-15 shows this domain growth and the resultant level of flux within the core.

Notice that growth of the domains is in the direction of easy magnetization (100) and the domains originally alined in this direction grow at the expense of those not so alined. At the upper knee of the curve, all the domains have switched and the individual crystals are saturated. As the domain grows and saturates the crystal, each crystal will contain only one domain. It would appear that no more domain growth could occur from this point on, but this is not the case. A further increase in applied field will cause the individual domains to rotate on their axes and as some of these come into alinement, they will merge and become one larger domain.

Actually, domain switching and domain rotation overlap and a clearly definable point on the curve where one stops and the other starts is not possible. An important point to be made at this time is that the switching process is nonreversible but the process of domain rotation is a reversible action. This means that if the magnetizing force is removed, the domains will not switch back to their original state, but will rotate back to the state they were in before rotation. The above phenomena account for the relationship of saturation flux density (B_S) and residual magnetism (B_r).

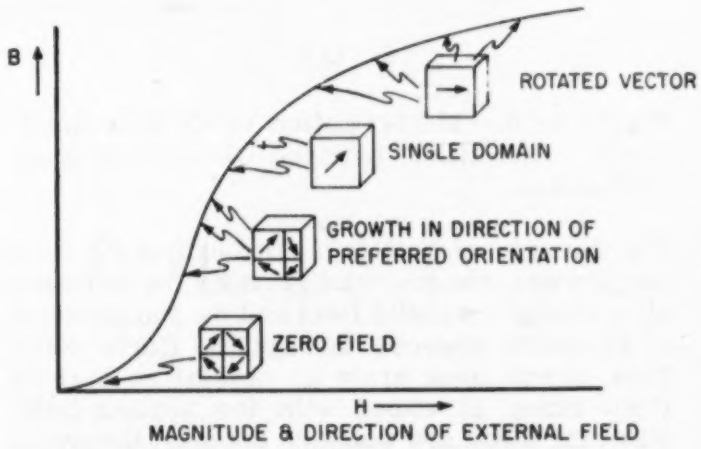

Figure 9-15.—Domain growth.

Assume that the core has been left in its negative remanent state ($-B_r$). The polarity of the field then, by definition, is negative. If a very small positive external field is applied, no flux change will occur. As H is increased, there will be a point where domain switching begins. This value is commonly referred to as coercive force or "H_c". Imperfections on the surface cause the formation of "nucleation" points and switching starts at these points.

This switching changes the core state from negative saturation to positive saturation with a very minute addition of H beyond H_c. If the ratio of domain rotation to domain switching is small, the B-H loop will have very square corners. Applying the above theory to transformer cores in general, it can easily be shown that the nonoriented materials used in linear transformers would yield a B-H loop with less slope and rounder corners.

B-H LOOP TERMINOLOGY.—Figure 9-16 shows a typical B-H loop with symbols designating significant portions of the loop. The meanings of these symbols are listed as follows:

B_S is saturation flux density.

B_r is residual magnetism (remanence).

B_m is the maximum flux swing between $+B_S$ and $-B_S$; it is equal in magnitude to $2B_S$.

AT_1, AT_2, and AT_c designate loop width.

Volt-Second Concept

A clear understanding of the relationship between flux and voltage across a transformer can best be achieved through a study of Faraday's law. This law states that the rate of change of flux with respect to time is directly proportional to the amplitude of the applied voltage. From this relationship, it can be shown mathematically that the AMOUNT of change of flux density (rather than the rate of change) is directly proportional to the product of voltage multiplied by time. This is the volt-second concept.

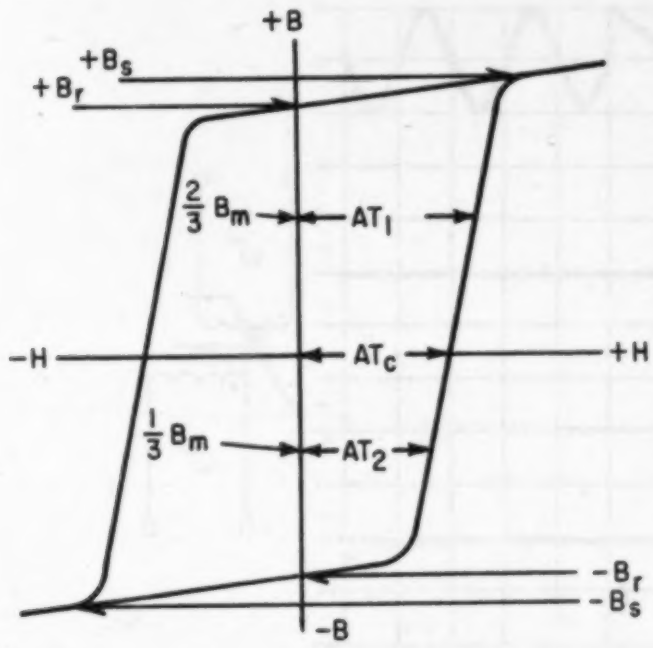

Figure 9-16. —B-H loop terminology.

In the simplified situation just discussed, it is assumed that there is no limitation on the amount of flux change which might occur. That is, the core is not saturable. This is the situation shown in figure 9-17. Notice that the output is directly proportional to the input; each change of voltage in the primary winding (E_p) is duplicated by a change of voltage in the secondary winding (E_s). The core flux level (core ϕ) fluctuates but does not stabilize because the core is not saturable.

Figure 9-18 shows a saturable transformer and waveforms. In this arrangement, the same linear relationship exists between input and output as in figure 9-17, until saturation occurs (time T_2). After saturation, the relationship becomes very nonlinear, with positive excursions of E_p having no effect on E_s during saturation of the core. When E_p goes negative, the core becomes unsaturated and E_s is affected by both negative and positive changes in E_p. When the core reaches positive saturation again (time T_3) it holds E_s at zero again, as long as the E_p excursions remain above zero.

If a sine wave of voltage is applied to the input of the saturable transformer of figure 9-18, the waveforms will be as shown in figure 9-19. The assumptions are that the input is sufficient in amplitude to saturate the core at $+B_s$ and the core was set at an initial value of $-B_s$. Notice that $E_p = E_s$.

Either winding can support only so much voltage before core saturation occurs. When the core saturates, the impedance of the windings decreases to some low value and the device can no longer support the voltage on either winding. Also of primary interest is the area of the waveforms. Notice that the area of the output is the same as the area of the input. If the input is increased in amplitude, as shown to the right of the vertical dotted line, the core will saturate sooner and the output will also be higher in amplitude but of shorter time duration. If the input is reduced in amplitude, it will take longer for the core to saturate and

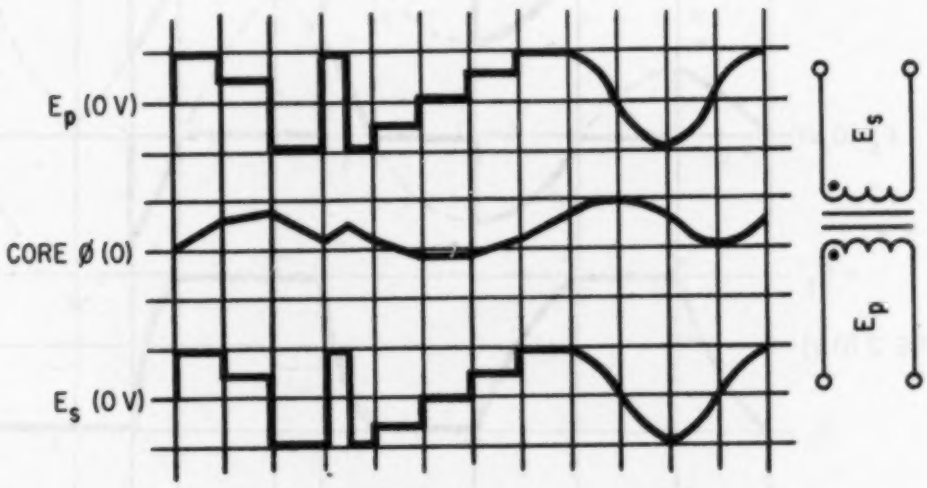

Figure 9-17. —Transformer and waveforms.

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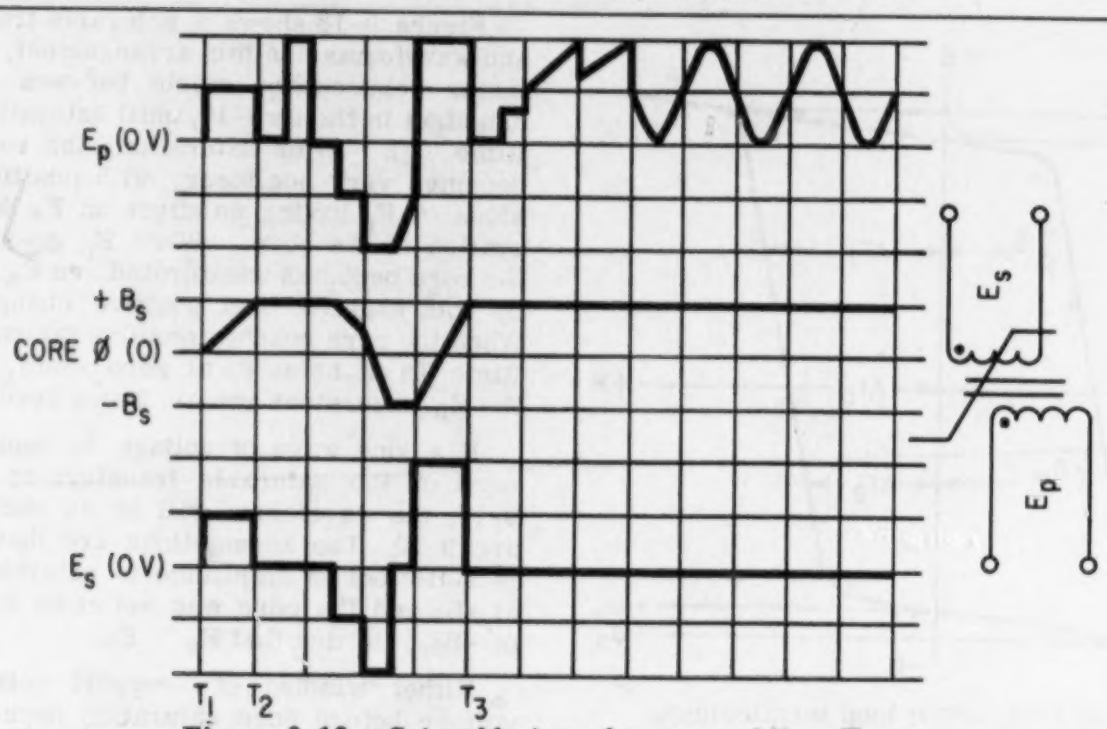

Figure 9-18. —Saturable transformer and waveforms.

consequently the output will be of longer duration, but of lower amplitude.

The important thing to realize here is that in all three conditions, the areas of the waveform remained constant. Now, if the d-c average of the output were measured, it would be found that the d-c component of the output remains constant; for the average output of a waveform is a function of the ratio of areas of the waveform. This is a very important point

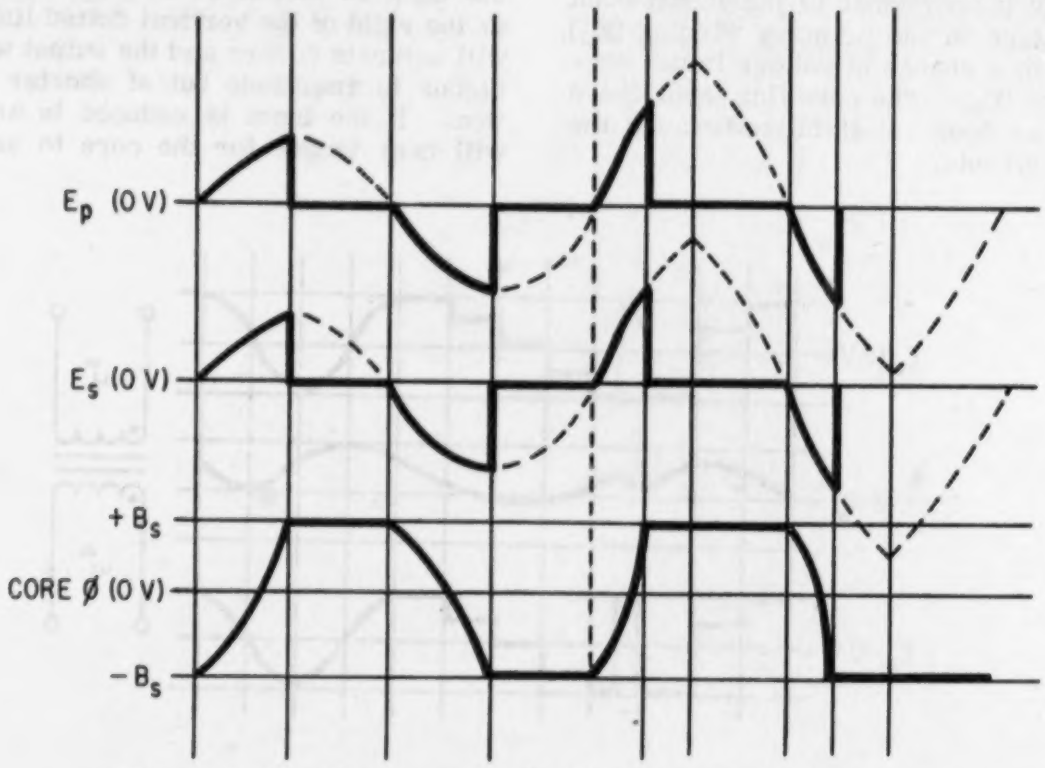

Figure 9-19. —Sine wave applied to saturable transformer.

in respect to all magnetic amplifiers and will hold true as long as the core saturates for some portion of the cycle of operation.

The volt-second-area (VSA) relationship may be more easily understood if one assumes an applied square wave, rather than the sine wave in the preceding case. Refer to figure 9-20 for the analysis. From time T_0 to T_1, a square wave of amplitude e_1 is applied to the primary of a saturating transformer. The rate of change of flux is shown directly below. The resultant secondary voltage is seen at the bottom of the figure.

If the amplitude of the pulse applied to the primary is decreased, the rate of change of flux will decrease accordingly, as is shown in the second condition (T_2 to T_3). As a consequence, the support voltage (e_2) will be of a greater time duration. From the relative amplitudes and time bases, one can more easily detect the constant supported VSA with changes in amplitude of the applied voltage.

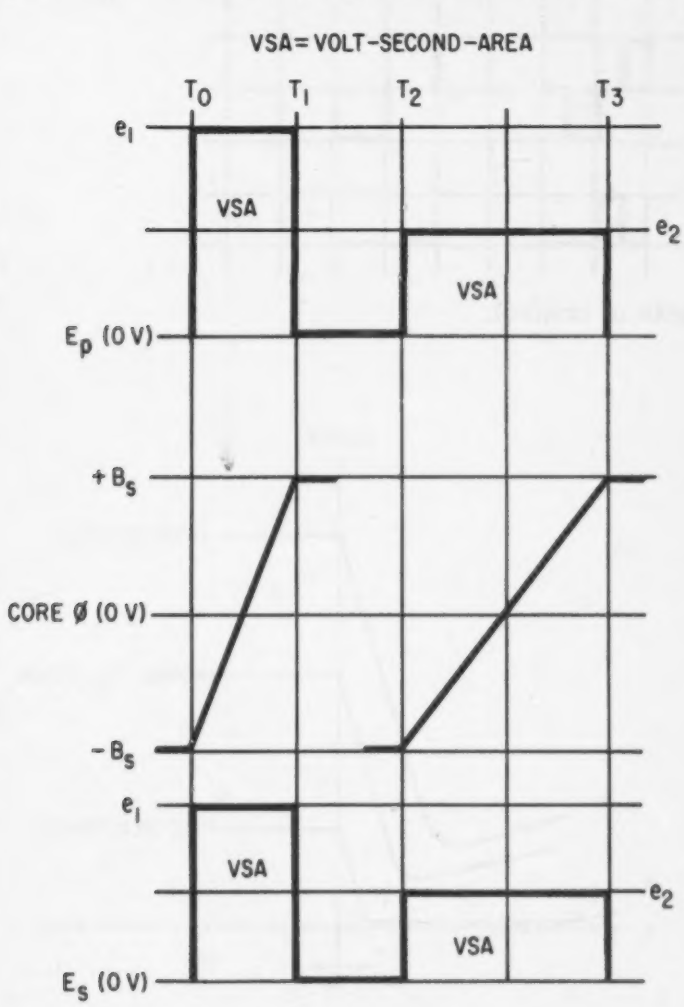

Figure 9-20.—Application or square wave.

THEORY OF OPERATION OF THE SELF-SATURATING MAGNETIC AMPLIFIER

The basic self-saturating magnetic amplifier is shown in figure 9-21. The symbols used in the figure are as follows:

E_c—Control voltage (d. c.).
i_c—Control current.
R_c—Control circuit resistor.
N_c—Control winding.
N_g—Gate winding.
E_g—Gate voltage (developed across N_g).
E_a—Applied signal voltage.
R_L—Load resistor.
E_o—Output voltage.

Condition I in figure 9-21 (zero control current) yields a maximum output. This is because the rectifier allows current to flow in only one direction through the gate windings. If the first pulse drives the core into positive saturation, then there will be no back voltage on the following half-cycle (due to rectifier action) to reduce the core flux. If the core flux cannot change, the winding can support no voltage, hence E_o is maximum.

If d-c control current is now added in such a direction as to reduce the core flux while gate current is being blocked, then the flux must change back to positive saturation on the following half-cycle. This is shown in II. Notice that the core flux waveform is shown at a reduced level slightly ahead of the start of cycle II. This change in flux allows the gate winding to support voltage until the core is again saturated. Because N_g and R_L are in series, the voltage seen across N_g must subtract from E_o.

As control current is increased (III), the reset flux increases and the gate can support a progressively longer pulse. Therefore, the output decreases accordingly until finally (IV), the windings are able to support the full supply and E_o drops to its minimum value. Thus, by the use of a d-c control current, it is possible to control the average output current.

Excitation Voltage

Excitation is the result of applying the supply voltage to the circuit. There are three conditions of excitation: namely, exactly excited, overexcited, and underexcited. Each of these conditions is utilized to some extent in the circuitry.

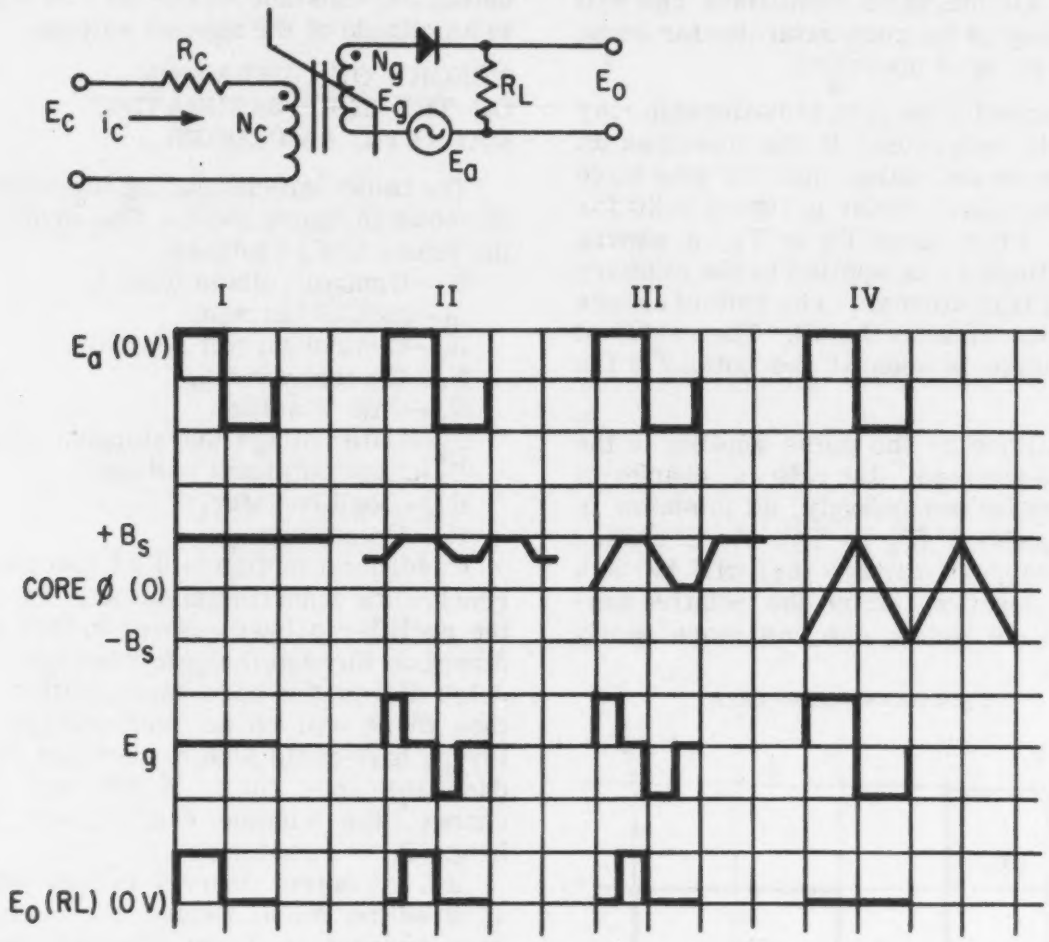

Figure 9-21. —Effects of control.

First, consider the condition of exact excitation or normal excitation. If the supply voltage is of such a magnitude as to cause the core flux to swing just below the value of B_m ($2B_s$), the device is operating with normal excitation. To determine the amount of supply voltage to use with a given number of gate windings, Faraday's law can be used. If the supply voltage is known, the gate turns may be determined by manipulating the mathematical formula which expresses Faraday's law. By transposing the formula, an increase in voltage or decrease in turns gives a condition of overexcitation. Reversing the changes gives a condition of underexcitation.

The three conditions of excitation can be shown on the control characteristics curve. Refer to figure 9-22.

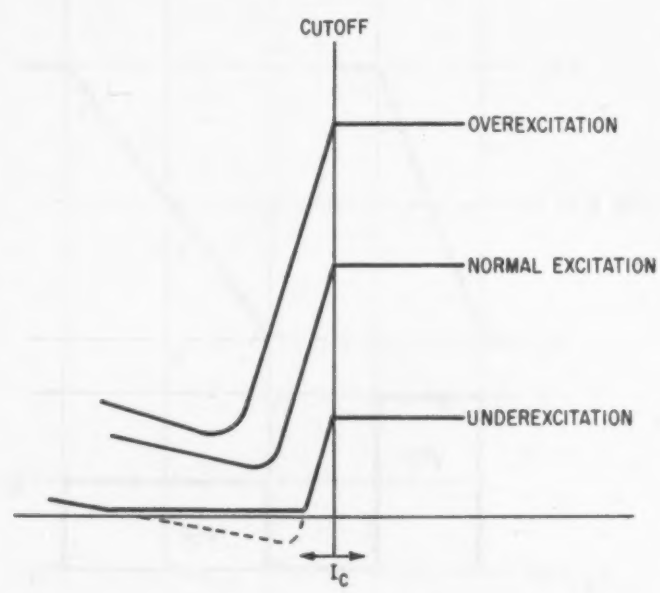

Figure 9-22. —Effect of excitation voltage.

Hysteresis Effect

Up to this point, in order to simplify the introduction to magnetic amplifiers, the effect

of hysteresis has been neglected. In order to fully understand the operating characteristics of magnetic amplifiers, it is important to know how these characteristics are affected by the shape of the hysteresis loop.

The curve in figure 9-23 (A) represents a typical rectangular shaped B-H curve; the curves in (B), (C), and (D) show the operation for various amounts of control action.

Further use of the circuit in figure 9-21 is made in explaining the effects of hysteresis. This circuit actually has two distinct periods of operation. The period during which the rectifier conducts is known as the "operating period"; the other half-cycle of the alternating current is known as the "control period."

In the explanation of the effect of the hysteresis loop of figure 9-23 (A), assume that control current is zero and that the load winding current is of such amplitude that it will saturate the core during peak conduction. During the first operating period, conduction through the load winding will cause the core flux to build up along the dotted line from the point of origin, o, to the point of saturation, a. At the end of this period, the flux level in the coil returns to point b rather than to zero because of the retentivity of the core. This is called the remanence point in magnetics and leaves the core in a magnetic state, similar to a permanent magnet. Thus, with no control current the core flux will remain at point b and during each positive half-cycle the core will saturate immediately. Under this condition the load current will be maximum, for no control is exercised.

Figure 9-23 (B) shows the action when a small control current is added. The operation during the first half-cycle is similar to that just described in connection with figure 9-23 (A), but during the second half-cycle (control period), the flux will reset from point b to point c. This occurs because the direction of the control flux in the core is opposite to that of the operating flux.

This positioning of the residual flux is called "resetting." During the next half-cycle the flux starts increasing from point c in the figure and a small period of this half-cycle is used before the flux reaches saturation at point a. At this point the core is saturated and the rectifier is in maximum conduction for the remaining part of this half-cycle. At the end of the operating period the flux returns to point b where the control period starts and resets to point c where the cycle starts repeating itself. The output for this condition is shown as the shaded portion of the waveform of figure 9-23

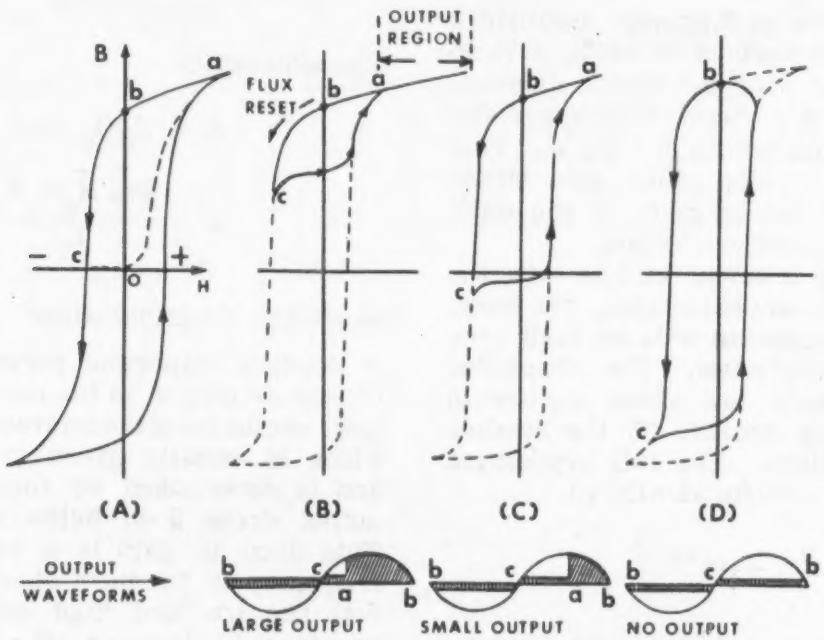

Figure 9-23. —Operation of a magnetic amplifier showing effects of hysteresis.

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(B). Figure 9-23 (C) and (D) shows the operation for increasing amounts of control action. The operation in each case is basically the same as for figure 9-23 (B).

It may be seen that the action described in the analysis mentioned above in similar to that of a thyratron. The control signal sets the point of amplitude at which the source voltage causes saturation of the core and reduces the impedance in series with the load winding to a very low value. In the thyratron, the control signal on the grid sets the point of amplitude at which the source voltage causes the tube to ionize, which results in a decreased impedance. The term firing, as it relates to the thyratron, is frequency used in connection with magnetic amplifiers interchangeably with the term saturation.

PERFORMANCE CHARACTERISTICS

This discussion of magnetic amplifiers has been limited, up to this point, to the mechanics of operation of the self-saturating magnetic amplifier. No mention has been made regarding such parameters as gain, bandwidth, etc. These topics are discussed in the following paragraphs.

Gain

Most manufacturers of magnetic amplifiers list the gains of their devices as being a ratio of the output voltage to the control current. This ratio is called the transresistance of the amplifier and is formulated as $A = E_o/i_c$. This ratio may easily be transformed into either voltage, current, or power gain, if the input and/or output resistances are known.

In order to obtain a better insight into the factors that affect the amplifier gain, the basic formula for transresistance will be built upon with the aid of Faraday's law. The simplified statement of Faraday's law given earlier in this chapter does not include N, the number of turns in the windings. The full expression of the law reduces mathematically to

$$e = \frac{N\phi}{t} \times 10^{-8}$$

It t represents the period of the output voltage E_o, then 1/t is the frequency of the signal being amplified. Therefore,

$$E_o = N\phi\ f \times 10^{-8}$$

This expression shows that the voltage gain (E_o) during one cycle is directly proportional to the number of turns (N), the flux (ϕ), and the frequency.

The number of parameters which affect the gain will be easier to see by analyzing the quantity ϕ. It can be shown mathematically that

$$\phi = \frac{4\pi\mu\ N_c N_g i_c A_c}{L_c}$$

where

μ = B/H.

N_c = Number of turns in control winding.

N_g = Number of turns in gate winding.

i_c = Control current.

A_c = Cross sectional area of the core in centimeters.

L_c = Length of the core in centimeters.

Therefore

$$E_o = \frac{4\pi\mu\ N_c N_g i_c A_c f}{L_c} \times 10^{-8}$$

The expression

$A = E_o/i_c$ then becomes

$$A = \frac{4\pi\mu\ N_c N_g A_c f}{L_c} \times 10^{-8}$$

Bandwidth Considerations

Another important parameter in the design of any amplifier is the bandwidth of the amplifier, exclusive of the interstage circuitry. Bandwidth is usually given in cycles per second and is determined by the point at which the output drops 3 db below midfrequency value. This drop in gain is a result of varying the frequency of the input signal and may occur at both the low and high ends of the frequency spectrum. However, the magnetic amplifier is capable of responding to a d-c signal without any attenuation of the output. Therefore,

the bandwidth of the magnetic amplifier will be determined by the upper frequency point.

Because the control circuit is basically an L/R circuit, it will be these values that will determine the bandwidth of the amplifier. However, this is not a simple first order time constant circuit, as the output voltage fluctuations will in most cases affect the input inductance. Therefore, the values of resistance and inductance that will be used are the EFFECTIVE values.

For any time constant circuit, the cutoff frequency (f_c) may be determined by the formula:

$$f_c = \frac{1}{2\pi T_c},$$

where T_c is the time constant. The control circuit time constant of the magnetic amplifier is determined by the above formula, where T_c is the ratio of the effective inductance of the control circuit to the effective resistance of the control circuit. The resistance is referred to as "effective" because the effective control loop resistance may be changed, without changing the actual resistance of the loop. This is one of the effects of feedback.

Feedback

To discuss the effects of feedback, first consider the action of the amplifier with a total lack of feedback. In comparing the action of the saturable reactor with the basic half-wave self-saturating magnetic amplifier, we need only remove the diode from the circuit of the self-saturating amplifier and we have the basic saturable reactor. We will make this comparison because the self-saturating amplifier has an inherent feedback that is exactly analogous to adding feedback to the basic saturable reactor.

To understand why this is referred to as feedback, consider the action of the control current. We know, from the mechanics of operation, that the control current resets the core flux during the time that the diode is blocking the supply current in the gate circuit. Therefore, the control current does not have to oppose the gate current to reset the flux level to some value on the control half-cycle. If we remove the diode from the gate circuit, the control current must oppose the action of the gate current in order to reset the core flux. Consequently, more control current is needed to achieve the same effect as with the diode present. This means that there must be more control current to accomplish the same gate voltage excursion, and when relating this to gain, one can see that the amplifier without the diode would have the lower gain.

External feedback, as applied to magnetic amplifiers, may be divided into two basic categories, these being magnetic and electric. These types may be used individually or in combination, depending on the results desired, and also that distinctly different effects can be had from each type. Further, in most cases, the magnetic feedback is a built-in feature of the amplifier, whereas the electric feedback may be applied to any amplifier.

MAGNETIC FEEDBACK.—Magnetic feedback is accomplished by feeding back a portion or all of the output current in such a fashion as to directly affect the core flux. This is not, however, referred to as current feedback. Magnetic feedback is achieved by forcing feedback current through a tertiary winding placed on the core. If the output of the amplifier is d.c., then this current may be fed to the feedback winding directly without the need of rectification. If, however, the output of the amplifier is a.c., then the current must first be rectified, and then applied to the feedback winding. The feedback current will then be a direct current, proportional to the load current. This current may be applied in such a fashion that it is either regenerative or degenerative, depending on the action of the generated flux in respect to the circuit action. Figure 9-24 shows the basic doubler circuit with external magnetic feedback applied.

The amount of feedback is a function of the relation between the flux generated by the gate winding and that generated by the feedback winding. This ratio is a function of the ampere-turns ratio of the feedback circuit to gate circuit. The ampere-turns of the feedback circuit may be controlled by external means, either by controlling the current flowing through the winding or by adjusting the number of turns, as with an adjustable tap.

Magnetic feedback is considered to be external feedback, where the self-saturating magnetic amplifier is considered as employing a comparable inherent feedback. It should be realized at this point that both internal and external feedback may be applied to the same

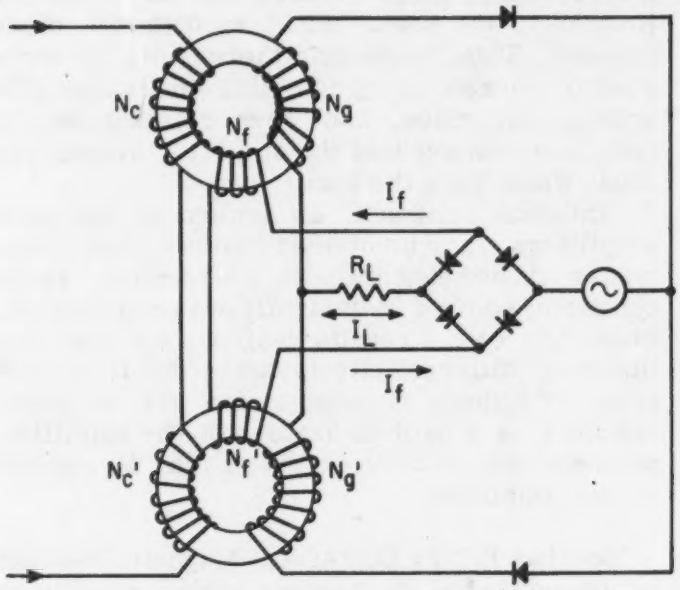

Figure 9-24. —Full-wave doubler with external magnetic feedback.

amplifier. As was previously mentioned, magnetic feedback is one of the basic types of feed back, the other type being electric. It is not uncommon to encounter an amplifier employing both internal, magnetic, and electric feedback.

ELECTRIC FEEDBACK. —This type of feedback may be further divided into two classes, these being voltage and current. Both types are accomplished by forcing all or a portion of the output to flow in the control circuit in such a manner as to influence the signal applied to the control winding. The feedback circuitry is completely external to the amplifier proper; as a consequence, it does not affect the gain of the amplifier proper, but does affect the stage gain.

The characteristics of the voltage feedback circuit are as follows:

1. Output appears as a constant voltage source.
2. Output voltage is insensitive to load fluctuations.
3. Output voltage remains relatively constant.
4. Output appears as a low impedance source.

Current feedback has the following characteristics:

1. Output appears as a constant current source.
2. Output current is insensitive to load fluctuations.
3. Output current remains relatively constant.
4. Output appears as a high impedance source.

The feedback circuit in figure 9-25 consists of the voltage divider network composed of R2 and R1. Notice that these resistors are in parallel with R_L, and the voltage seen across R_L will also be felt across R2 and R1. The voltage across R1 will also be present in the control loop, composed of the signal source (E_S), the source resistance (R_S), the control winding resistance, and R1. The signal voltage will be divided across R_S, the control winding resistance, and R1, all in series. The current that will flow in the control winding will be a result of the algebraic sum of the voltage drops around the loop. Because of the polarities involved, the voltage dropped across R1 will oppose the signal voltage; hence, the feedback is degenerative. This is most generally the case when electric feedback is employed.

Figure 9-26 shows the basic current feedback circuit. Note that the load current flows through the resistance R1 in such a fashion as to oppose the input signal. Again, the feedback is degenerative. The amount of feedback in this case is a function of the value of the feedback resistance, R1. The improvements realized by the application of current feedback are

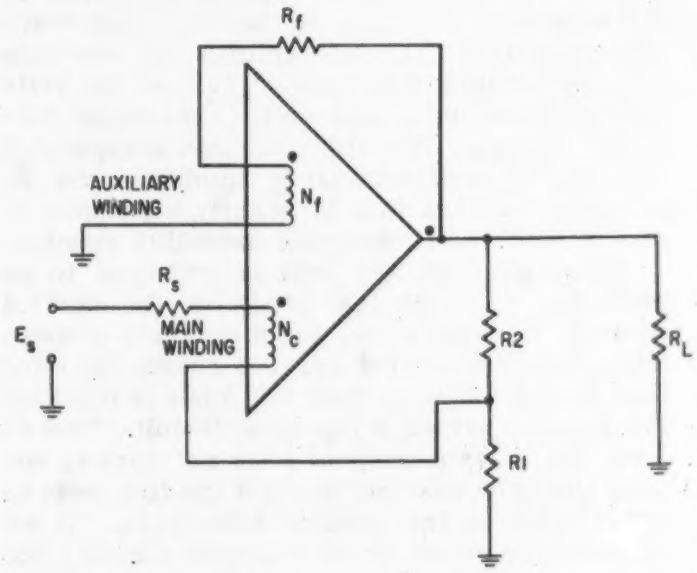

Figure 9-25. —Voltage feedback.

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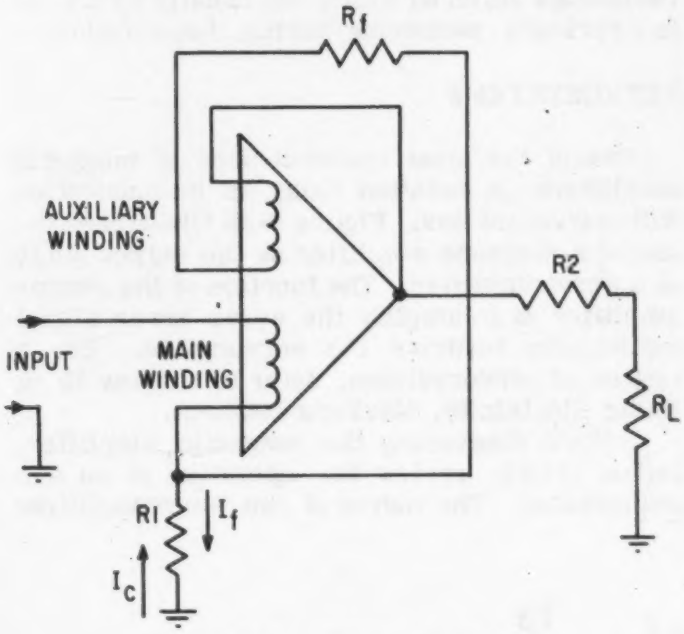

Figure 9-26. —Current feedback.

comparable to those realized by using voltage feedback, and the characteristics are those listed in the first portion of the analysis of electric feedback.

In summation, the basic amplifier employing no feedback is seldom encountered in the modern circuitry. The amplifiers in use today will almost invariably employ some form of feedback. The type used will be determined by the application of the amplifier.

APPLICATIONS OF MAGNETIC AMPLIFIERS

The magnetic amplifier has found application in almost all circuits which use vacuum tubes and many which do not. They may be found in such circuits as audio amplifiers, voltage regulators, servoamplifiers, computer counting and dividing circuits, and many high frequency circuits. However, the Aviation Electronics Technician will be mainly concerned with their application in servosystems and in the various operations of computers.

ELECTRONIC POWER SUPPLY REGULATOR

Many aviation electronic equipments contain voltage regulated power supplies. The accuracy of the voltage produced by these supplies is important insofar as proper operation and maximum life of the equipment are concerned. Present day electronic equipments contain many timing, waveshaping, and other critical circuits that require a constant d-c voltage source.

Figure 9-27 (A) shows a power supply which used a magnetic amplifier to regulate the d-c output voltage. In this circuit the conventional filter choke has been replaced by a saturable reactor, T2. The voltage regulator (VR) tube (V1) produces a constant reference voltage across coil B and acts as a current amplifier for the control winding, A. Coils A and B control the saturation of T2, hence the inductance of the load winding. This action effectively transfers filter capacitor C to

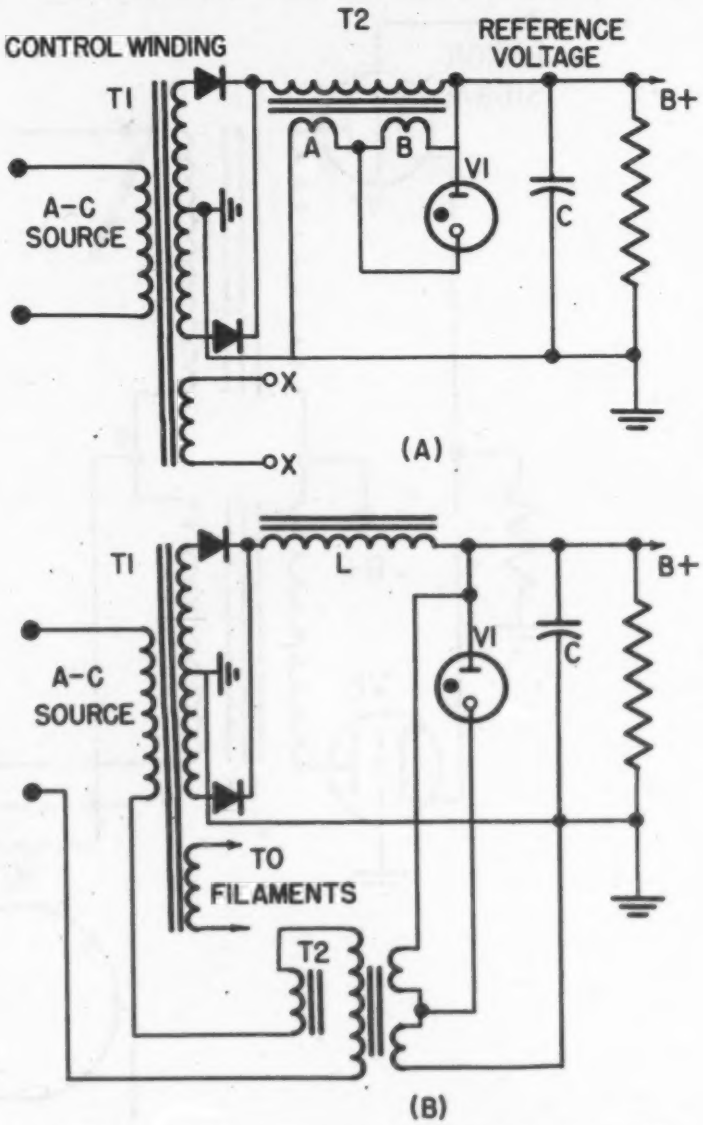

Figure 9-27. —Power supply using magnetic amplifier voltage regulator.

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the other side of the choke when the core is saturated. The end result is that the power supply alternates between a choke input and a capacitor input type of supply; thus a constant voltage output is produced.

Figure 9-27 (B) shows a variation of figure 9-27 (A) in which saturable reactor T2 is connected in series with the primary of power transformer T1. An advantage of this circuit arrangement is that a regulated filament voltage is also produced.

The significance of constant filament voltage is appreciated when it is realized that the incidence of failure rises rapidly when the cathode or filament temperature exceeds optimum. This does not include transformer, choke, and resistance failures which can usually be traced to overloads occurring during these failures.

SERVOSYSTEMS

One of the most common used of magnetic amplifiers in aviation today is in connection with servosystems. Figure 9-28 illustrates the use of a magnetic amplifier as the output stage of a servoamplifier. The function of the servoamplifier is to amplify the servo error signal sufficiently to drive the servomotor. For a review of servosystems, refer to chapter 19 of Basic Electricity, NavPers 10086-A.

Before discussing the magnetic amplifier, let us briefly review the operation of an a-c servomotor. The output of the servoamplifier

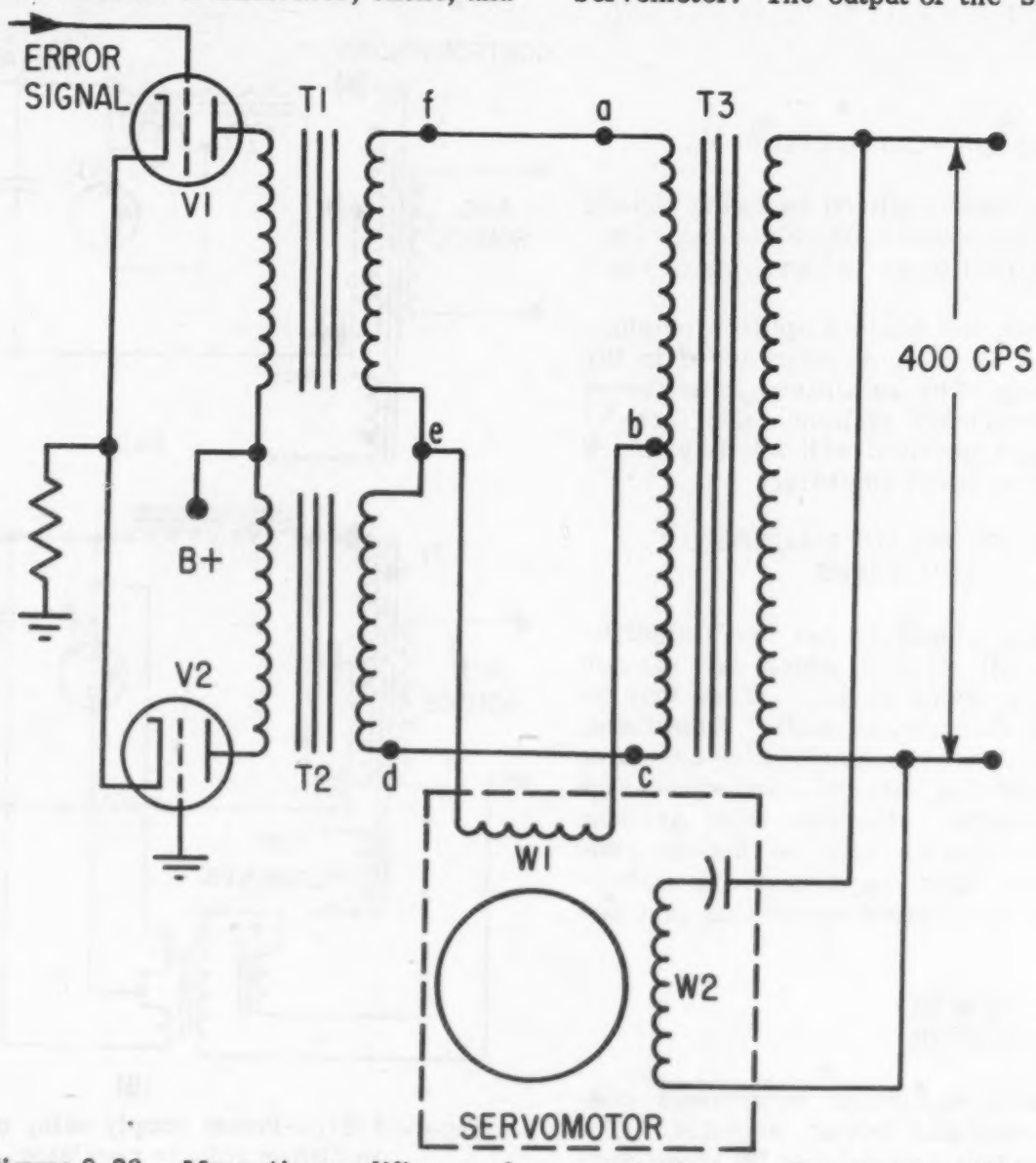

Figure 9-28. —Magnetic amplifier used as an output stage of a servoamplifier.

is connected to one of the motor windings (controlled winding W1) while the other winding (uncontrolled winding W2) is connected across the a-c source in series with a capacitor. The capacitor provides the required 90° phase shift necessary to cause motor rotation. The phase relationship of the current through the two windings determines the direction of rotation of the servomotor.

The input to the amplifier shown in figure 9-28 is a d-c error signal and is applied to the grid of V1. Tube V1 and V2 constitute a cathode-coupled paraphase amplifier working into two saturable reactors (magnetic amplifiers). The secondaries of the two saturable reactors and the two halves of the secondary of T3 form an a-c bridge circuit. The motor winding (W1) is connected across the bridge as shown. With a zero error signal applied, both tubes draw equal amounts of plate current partially saturating T1 and T2. Since the degree of saturation of the two saturable reactors is equal, the bridge circuit is still balanced and no current will flow in W1.

When a positive error signal is applied, V1 will conduct heavily while V2 will be near cutoff. At this time the secondary inductance of T1 will be practically zero. Motor winding W1 will be effectively connected across points a and b of T3 and supplied with an a-c source. Also at this time the secondary inductance of T2 will be very large (effectively an open circuit).

In a similar manner, when V2 conducts heavily, V1 will be near cutoff, the secondary inductance of T2 will be near zero, and the secondary inductance of T1 will approach maximum. Under these conditions, motor winding W1 is now effectively connected between points b and c of T3 and is supplied an a-c voltage that is 180° out of phase with the previous condition.

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CHAPTER 10

AIRCRAFT COMPUTER APPLICATIONS

Automatic computers are becoming increasingly common as a part of the electronic installations in naval aircraft. Present and future technicians will be faced with a collection of electronic equipments which use computers as integral portions of the overall system. To understand the operation of the system in general, and the computer portion in particular it is necessary to have a basic understanding of computer functions, circuitry, terminology, and applications. Basic Electronics, NavPers 10087-B, chapter 16, presents a basic coverage of the purpose, operation, and theory of computers, together with some of the terminology peculiar to them. In addition, chapters 14 and 15 of Aviation Electronics Technician 3 & 2, NavPers 10317-C, present coverage of some of the basic circuits of computers. Review and study of these basic coverages will aid in understanding the material covered in this chapter.

REVIEW OF COMPUTER PRINCIPLES

A COMPUTER is any device capable of accepting information, applying mathematical operations to that information, and obtaining the results of these operations. From this definition, it is obvious that any computer must have three fundamental components—input, processing, and output.

Computers in use today are performing many functions, among which are the following:

1. Solving design problems of many different types.
2. Solving problems in personnel, fiscal, and stock control management.
3. Processing information from missile ranges and tracking stations.
4. Automating processes.
5. Training by simulation.
6. Forming a part of complex military systems and operations on land, at sea, and in the air.

As a part of naval aircraft systems, computers are used in connection with AEW, ECM, ASW attack, reconnaissance, intercept, and command missions. They perform such functions as communications link and relay, navigation, fire control, tracking, strategy, tactics, logistics, selection and identification of targets, etc. It is obvious that computers, with such wide and diverse usage, will form a considerable part of the technical responsibility of the AT as well as personnel from other ratings.

Basically, computers are divided into ANALOG and DIGITAL types, but many actual equipments are combinations of the two. The combination is called a HYBRID computer. The basic difference between the analog and the digital computer is not in the type of problem solved, but in the manner of representing the quantities involved in the solution. Analog quantities are usually represented by magnitude or angular displacement signals; digital quantities are usually represented by encoded "binary words."

A SPECIAL PURPOSE computer is one designed for a specific type calculation, such as navigation. A simple computer may be able to calculate ground track (ground velocity and direction). By proper selection and interconnection of units, it is possible to have a computer that will indicate the present position of an aircraft, course and distance to a preselected target, course and distance to home, estimated time of arrival at either or both, and whether sufficient fuel is available for the flight. As the problems become more and more complicated, so does the overall equipment. However, even the most complex equipment is made up of many relatively simple components.

By increasing the number of computing units and making the interconnection of these units sufficiently flexible, the computer may be used to perform almost any type computation. A computer of this type is called a GENERAL PURPOSE computer. There are very few

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general purpose analog computers, most general purpose computers being digital. Because of the necessary complexity, general purpose computers are too large and heavy for airborne use; their use is normally limited to shore-based activities, or to the larger ships. Nearly all airborne computers are of the special purpose type.

To be of any practical value, the computer must be properly organized. Proper organization of a computer requires the following characteristics:

1. The computer must be supplied with the information upon which its computations are to be based. This is called the INPUT.

2. The inputs must be applied in the proper manner, to the proper circuit element, at the proper time, and in the proper sequence. This requirement holds true for each step in the overall solution process.

3. Each circuit must be capable of perforing the steps required of it, within the required degree of accuracy. It must also be properly interconnected to deliver its partial solution to the circuit which is to perform the next step of the problem.

4. A conversion unit must be provided to change the data measured or calculated into a form usable by the computing circuit, and the scale factor of this conversion must be one which the computer can use.

5. Some method must be provided for checking the accuracy of calculations. In addition, some means of adjustment must be included to compensate for changes in the operation of the equipment to manintain this accuracy.

NOTE: Items 2 through 5 of this listing are frequently grouped and referred to as the PROCESSING function.

6. The overall result of computer operation (the answer) must be presented in a manner that is useful to the operator. This is called the READOUT of the computer.

DIGITAL COMPUTER PRINCIPLES

Digital computers are finding increasingly wide application in Navy aircraft. Some aircraft now operational, and others that will become operational in the near future, have computers installed as integral parts of the electronics system. Among the more common applications in Navy aircraft at present are the navigation weapons delivery systems, tactical communications systems, ASW and ECM systems, and automatic flight systems.

The ability to make calculations is built into the computer by proper combinations of relatively simple circuits. A computer also has the ability to retain information by storing it in memory banks. This information, fed to the computer by an operator, is available whenever the operator calls for it. In most airborne computers, information is stored in the form of magnetic charges, and is stored for varying periods of time—from a few milliseconds to years—depending upon what use is to be made of it.

When a computer performs an operation, it does so by comparing quantities representing data that have been placed into it. Its output consists of data that must be "read" and automatically translated into some form of understandable language.

Since the airborne digital computer performs all of its functions by using coded numbers, it follows that any information to be fed to the machine must be transposed from plain language into the proper coded number form.

The type of coding normally used in digital computers is based on the binary number system, as explained in chapter 16 of Basic Electronics, NavPers 10087-B. Chapter 2 of Mathematics, Vol. 3, NavPers 10073, also contains information on the binary system as well as other number systems which are of interest to the AT in a study of digital computers.

MAJOR UNITS

Digital computers contain blocks of circuits and machinery that can be broadly broken down into the input-output unit, the memory unit, the arithmetic unit, and the control unit. (See fig. 10-1.)

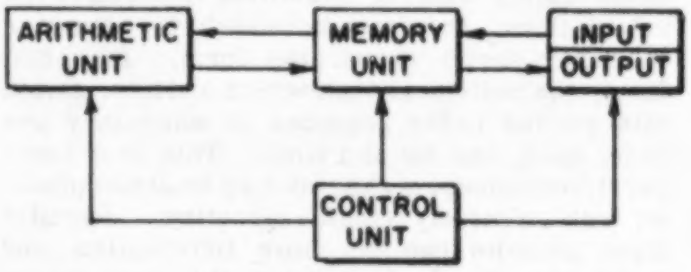

Figure 10-1.—Fundamental units of a digital computer.

Input-Output

The input-output unit is just what the name implies; that is, it is the unit into which information is fed, and from which information is taken out. Information may be supplied to a computer by any of several means, a few of which are as follows:

1. Punched cards (most Navy paychecks have perforations which, when fed into a computer, identify the check with the issuing activity and with the person to whom the check was issued).
2. Magnetic tape (similar to the tape used in common tape recorders).
3. Received pulses of radio transmission.
4. Modified or converted data read from aircraft or other instruments.
5. Telephone line or keyboard.

All of these and many others may be fed individually (or in combinations) to a computer which is built to accept that type input. They all do the same thing—feed pertinent data to the computer so that a logical solution to the problem may be obtained.

The output unit translates the result of the computer's operations into a visual indication, or into some other form that is readily usable. The output of a computer may operate a relay or a light, or it may be used to position some mechanical device (such as a pointer, a rudder, or a dial). In large computers, the output may operate an electric typewriter.

Memory

The memory unit stores information until it is needed. Data fed to the computer will be directed to the memory unit. Such data includes INFORMATION and INSTRUCTIONS. Instructions tell the computer what operations to perform, the order in which to perform them, and what to do with the results. Information deals mainly with the quantities involved in the calculations. Data may be fed into the computer in either serial or parallel form. In serial form, the individual instruction and information bits are fed in the sequence in which they are to be used, one bit at a time. This is a comparatively slow process, but may be accomplished with relatively simple circuitry. Parallel input permits two or more information and instruction bits to be fed into the computer at the same time, resulting in a much faster rate. More complex circuitry is required for parallel inputs. In a practical computer, instructions and information may be fed into the computer at the rate of 3 million bits per second, using the parallel input. With serial feed, rates as high as 50,000 bits per second are common.

Arithmetic Unit

The arithmetic unit is the calculating unit. It contains circuits that are simple in both theory and operation. It performs mathematical operations—addition, subtraction, multiplication, and division—by performing logical operations. It must be remembered that all mathematical calculations dealing with numbers take some form of one or more of these basic operations. For instance, squaring a number is merely a special form of multiplication; extracting a square root involves all four operations in a special order. Similarly, an exponential curve is simply the result of many instantaneous values computed by arithmetic means.

By comparing data quantities against each other, the arithmetic unit is able to make logical decisions. For example, it is able to determine the proper bomb release point by considering aircraft speed, windspeed and direction, drift, ballistics information regarding the particular bomb, altitude, and other factors that have been fed to it, and then to provide a "yes or no" answer to specific questions. The solution to a given problem is sent from the arithmetic unit to the memory unit where it remains in storage until needed for further calculations, or until otherwise routed by the control unit.

Control

The control unit of a computer ties all parts of the computer together, causing them to function as an integrated system. Its functions are the same as for the control unit of any system, in that it maintains complete control over every operation the computer performs.

Computer Logic

Digital computers are used to make logical decisions (but not to reason) about matters which can be logically decided. Some logical decisions that a computer may be required to make are when to perform an operation, what operation to perform, and how (of several ways) to perform it. Keep in mind that digital computers

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never reason why or think out an answer. They operate only on instructions prepared by a man who has applied the thought process to a problem and has reduced the problem to a point where logical decisions can deliver the correct answer. The rules for the equations and manipulations employed by the computer differ in many cases from the familiar rules and procedures of everyday mathematics. For this reason, the AT should have an understanding of the basic concepts involved in computer logic.

Many logical truths are used by people in everyday life without their realizing it. Most of the simple logical patterns are distinguished by words such as AND, OR, NOT, if, else, and then. Once a verbal reasoning process has been completed and the results put into statements, there are laws of logic which can be used to evaluate the process. Although simple logic operations can be performed by manipulating the verbal statements, the structure of more complex relationships can more usefully be represented by the use of symbols. Thus the operations are expressed by what is known as symbolic logic.

The symbolic logic operations utilized in digital computers are based on the investigations of George Boole, and the resulting algebraic system is called Boolean algebra. It is similar in some aspects to the algebra with which the AT is familiar; however, it follows different laws and rules.

Truth Tables

A truth table is a chart used in connection with logical circuits to illustrate the states of the inputs and outputs of a given stage under all possible signal conditions. It provides a ready reference for use in analyzing the operating theory of the circuit, and is useful in developing the overall signal flow diagram.

In devising the truth table, it is necessary to know the number of inputs and their polarity. All possible states of the input are listed in column form, with a separate column for each input line. Then the output for each of the possible input states is determined and noted in an output column. In logic circuits employing bistable devices, the number of possible input combinations in the truth table will be 2^n, where n = number of input lines.

For example, a truth table constructed for a conventional pentode coincidence amplifier would be as shown in table 10-1. The circuit constructed in such a manner that an output occurs only when an input is applied simultaneously to the control grid and suppressor grid.

In constructing table 10-1, all possible input combinations were placed in column form, and the output for each combination was determined and noted. In this particular example, the number of possible inputs also follows the rule for bistable devices; that is, with two inputs the table contains 2^2 or 4 combinations.

In computer logic circuit truth tables the column headings will normally contain letter designation for the input and output. Also, the "Yes and No" will be replaced by symbols to denote the state of the inputs and outputs. The symbols which the AT will encounter include binary 1's and 0's, plus and minus signs, or H and L (High and Low). Using symbols to construct the truth table for the coincidence amplifier, it would appear as in table 10-2.

The meanings of the symbols in table 10-2 are as follows:

A = Control grid input.
B = Suppressor grid input.
Z = Output signal.
1 = Signal present.
0 = No signal present.

Some truth tables will be presented later in this chapter in the discussion of Boolean algebra and logic circuits. The truth table shown in the previous example is actually the truth table for a two-input AND gate. The coincidence amplifier is one of the standard electronic circuits which can also be used as a logic circuit.

Table 10-1. —Coincidence amplifier truth table.

Control grid input present	Suppressor grid input present	Output signal present
NO	NO	NO
NO	YES	NO
YES	NO	NO
YES	YES	YES

Table 10-2—Truth table symbols for coincidence amplifier.

A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1

When plotting a truth table for a circuit involving a large number of inputs, a convenient method of getting all possible inputs listed is to start with all zeros and then count in binary sequence until the correct number of combinations has been listed. The last binary number listed in the input side of the table will be one less than the number of required inputs. Note in table 10-2 that there are 4 input combinations, and the last input is 11 or binary 3.

Boolean Algebra

The objective of using Boolean algebra in digital computer study is to determine the "truth value" of the combination of two or more statements.

Due to the fact that Boolean algebra is based upon elements having two possible stable states, it becomes very useful in representing switching circuits. The reason for this is that a switching circuit can be in only one of two possible stable states at any given time; that is, the state of being open or the state of being closed. These two states may be represented as 0 and 1, respectively.

Since the binary number system consists of only the symbols 0 and 1, we employ these symbols with the Boolean algebra and it can be thought of as binary Boolean algebra.

In the mathematics with which the AT is normally concerned, there are four basic operations—addition, subtraction, multiplication, and division. In Boolean algebra there are three basic operations—AND, OR, and NOT. If these words do not sound mathematical, it is only because logic began with words, and not until much later was it translated into mathematical terms. The basic operations are represented in logical equations by the symbols in table 10-3.

The OR operation is indicated by the addition symbol, while the AND operation is indicated by the multiplication symbol. In addition to the dot, parentheses and other multiplication signs may be used. The negation function may also be indicated by A' instead of $\overline{A}$. Some examples of combinations of these symbols are given in table 10-4.

The basic logic operations and some combination logic operation will be presented in this section. In addition to the Boolean expression and an explanation for each operation, a truth table, equivalent switching circuit, and logic diagram symbol will be given.

THE "AND" OPERATION.—The truth table of an AND operation (fig. 10-2(A)) can be understood if one thinks of the logic involved. If either A or B (or both) take the condition of 0, then AB is equal to 0. When both A and B take the condition of 1, then AB is equal to 1.

The switch circuit in figure 10-2(B) is an equivalent circuit for the AND operation. Inspection of the switch arrangement shows that the resulting circuit will be completed only if both A and B are closed (that is, equal to 1). If either switch is open (equal to 0), the resulting circuit will not be completed. This allows us to define an AND circuit as follows: In an AND circuit the output is 1 only when all of the inputs are 1's.

In any digital computer equipment, there will be many of the circuits which perform the logical operations. In order to analyze the operating principles of a computer without extensive electronic circuit tracing, a group of logic diagram (block diagram) have been devised. The standard computer logic symbols are included in the appendix to this course which

Table 10-3.—Logic symbols.

Operations	Meaning
$A \cdot B$	A AND B
$A + B$	A OR B
$\overline{A}$	A NOT or NOT A

Table 10-4. —Combinations of logic symbols.

Operations	Meaning
(A + B) (C)	A OR B, AND C
AB + C	A AND B, OR C
$\overline{A} \cdot B$	A NOT, AND B
A + B′	A OR B NOT

lists electronic symbols. The logic diagram for the AND circuit is shown in figure 10-2 (C). This diagram means that there are two inputs, A and B, into an AND operation circuit producing the output in Boolean form of AB. Such diagrams simplify equipment circuits by indicating operations without drawing all the circuit details.

THE "OR" OPERATION. —The truth table for the OR operation is shown in figure 10-3 (A). This truth table bears out the following definition of an OR circuit: The output of an OR circuit will be a 1 when any one (or more) of the inputs is 1. Since the OR circuit reresents the logical concept of "one or more" and thus expresses inclusion, a more precise name for it is "INCLUSIVE OR." Although this name is seldom used, the distinction between inclusion and exclusion is made by giving the name EXCLUSIVE OR to the circuit which represents the logical concept of "one and only one." The EXCLUSIVE OR circuit is discussed later in this chapter.

The switching circuit (fig. 10-3(B)) shows that the circuit would be completed if either A or B were closed. The logic diagram for the OR circuit is shown in (C) of the figure. This diagram shows an output of A + B which is the Boolean expression for the output of an OR gate.

THE "NOT" OPERATION. —The NOT operation in logic is the negation function. Figure 10-4 (A) shows the truth table for the NOT function while the switching circuit and logic diagrams are shown in (B) and (C), respec-

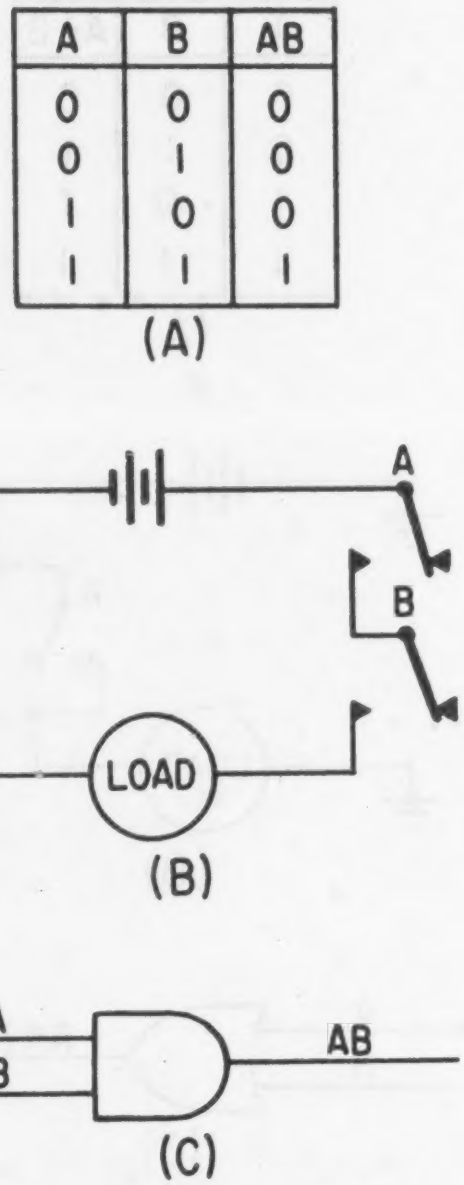

Figure 10-2. —The AND operation.

tively. The requirements of a NOT circuit are as follows:

1. A signal injected at the input must produce the complement (opposite or inverted signal) at the output.

2. The presence of the complement of the signal at the input must produce the signal at the output.

In the switching circuit, when switch A is closed (equal to 1) the relay opens the circuit to the load and the output is the complement of the input or 0. When switch A is open (equal to 0), the relay completes the circuit and the output is the complement of the input or 1. The two logic diagrams employing

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

(A)

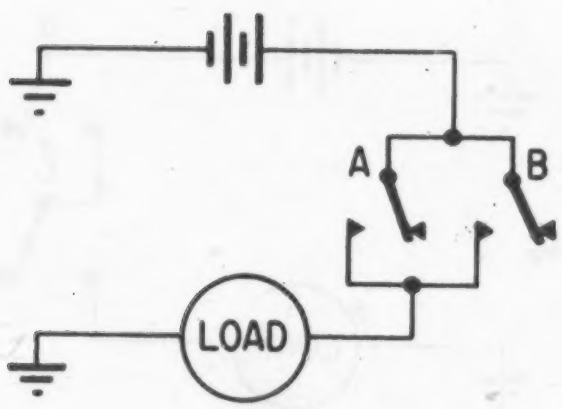

(B)

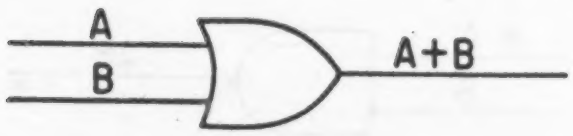

(C)

Figure 10-3.—The OR operation.

the standard inverter amplifier symbol depict both of the conditions of the truth table. The small circle on the triangle (amplifier block diagram symbol) indicates the low level side of the inversion circuit. The third symbol, the circle enclosing an I, is another symbol sometimes utilized to show the NOT (inversion) operation.

THE "NOR" OPERATION.—The truth table for the NOR operation is given in figure 10-5 (A). The table shows that if either A or B is 1 then the output $\overline{A + B}$ is 0. Furthermore, if both A and B are 0, the output is 1.

The NOR operation is a combination of the OR operation and the NOT operation. The

A	$\overline{A}$
1	0
0	1

(A)

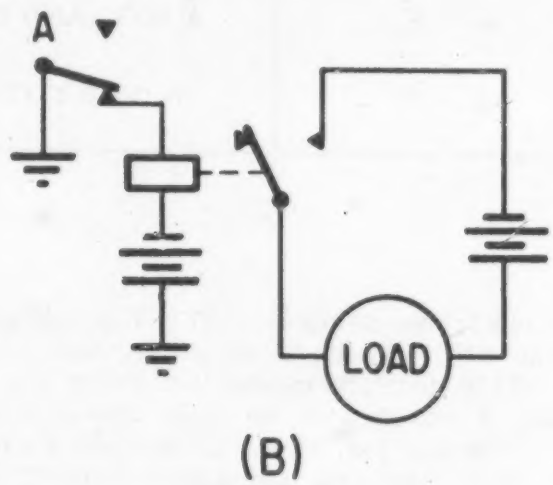

(B)

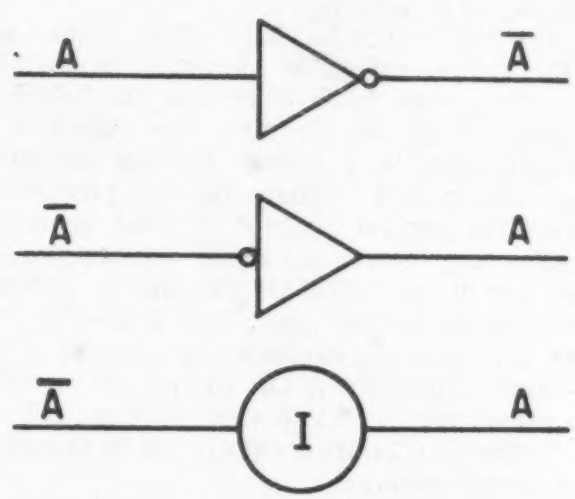

(C)

Figure 10-4.—The NOT operation.

NOR switching circuit (fig. 10-5 (B)) is the OR circuit placed in series with the NOT circuit. If switch A, or switch B, or both are in the closed position (equal to 1), then the circuit is not completed. If switches A and B are both open (equal to 0), then the circuit is completed. The logic diagram for the NOR operation is shown in figure 10-5 (C); A +

A	B	A+B	$\overline{A+B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

(A)

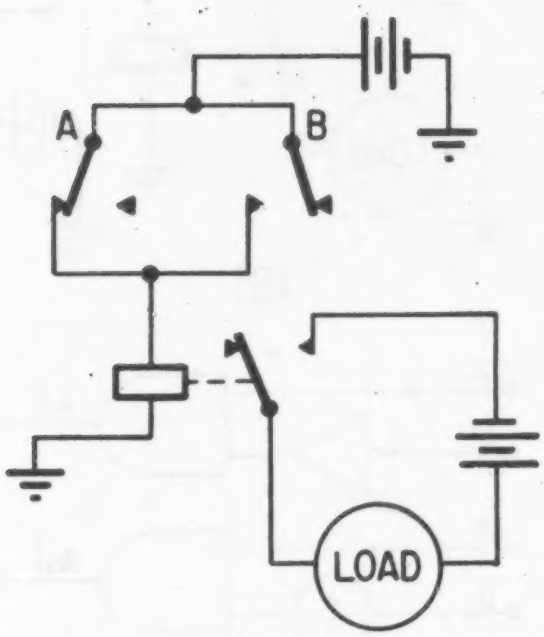

(B)

Figure 10-5. —The NOR operation.

A	B	AB	$\overline{AB}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

(A)

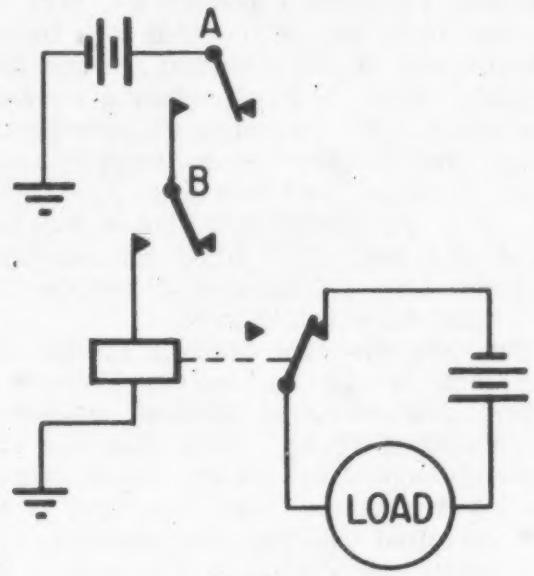

(B)

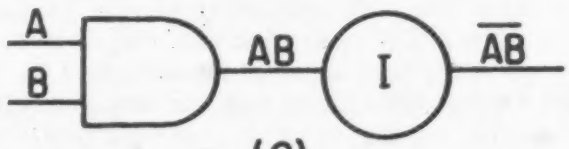

(C)

Figure 10-6. —The NAND operation.

B is the output of the OR gate portion and $\overline{A + B}$ (A OR B negated) is the output of the complete operation. Note that the entire quantity is complemented and not the separate variables.

THE "NAND" OPERATION. —The NAND operation is a combination of the AND operation and the NOT operation. The truth table for this function is given in figure 10-6 (A). When A and B equal 1, then the output is 0. In all other cases the output is 1.

The switching circuit in (B) of the figure shows the AND circuit placed in series with the NOT circuit. If either switch A or B is open (equal to 0), the relay will not energize and the output circuit is completed. If both of the switches are closed (equal to 1), the relay energizes and the output circuit is opened.

Figure 10-6 (C) shows the diagram for the NAND operation. The logic diagrams for both the AND and the NOT operations are used to show the NAND operation. There are two inputs, A and B, into an AND gate producing an output of AB. This quantity is the input to the NOT circuit which gives an output, in Boolean form, of $\overline{AB}$. This is spoken as "AB

negated" or "A and B quantity notted." In the NAND operation, as in the NOR, it is important to note that the entire quantity is complemented and not the separate variables.

THE "INHIBIT" OPERATION.—A circuit which performs the INHIBIT operation is a combination of an AND circuit and a NOT circuit, with the NOT circuit placed in one input leg of the AND gate.

The truth table, switching circuit, and logic diagram symbols for the INHIBIT operation are depicted in figure 10-7 (A), (B), and (C), respectively. In this explanation the NOT function is placed in the B leg of the AND gate. In actual computer circuitry the NOT operation can be in any of the AND gate input legs.

Inspection of the truth table shows that the circuit's output is 1 only when A equals 1 and B equals 0. The switching circuit diagram indicates that the circuit is complete only with switch A closed and switch B (the inhibit input) open. An INHIBITOR circuit will have an output of 1 only when all of the regular input terminals have an input of 1 and the input at the inhibit terminal is zero.

The logic diagram symbols for the INHIBITOR show two inputs, one fed through an inverter, and an output Boolean expression of $A\bar{B}$ (A AND NOT B). Note that one variable is complemented and not the entire expression. The lower diagram, with the input to the inhibit terminal showing the inversion function by a small half-circle, is the most commonly used symbol for an INHIBITOR.

THE "EXCLUSIVE OR" OPERATION.—The EXCLUSIVE OR operation (fig. 10-8 (A)) differs from the OR operation shown in figure 10-3. In the OR operation, an output of 1 occurs when either or both inputs are 1's. The EXCLUSIVE OR circuit has an output if either one of the inputs is a 1, but not when both are 1's. Switch A or B could be closed to complete the circuit, but not both.

The logic diagram symbol for the EXCLUSIVE OR circuit is shown in figure 10-8 (B). The (C) and (D) portions of figure 10-8 show two of the possible logic circuit combinations which will produce the EXCLUSIVE OR operation; the figure also shows truth tables for these diagrams.

The (C) portion of the figure is a combination of an AND gate and an OR gate feeding an INHIBITOR, with the AND gate connected to the inhibit terminal. The circuit in (D) consists of two INHIBITORS feeding an OR gate. In one of the INHIBITORS, the A input is connected to the inhibit terminal; in the other, the B input is connected to the inhibit terminal. The Boolean expression for each of these circuits is shown on the figure. The truth tables show that the EXCLUSIVE OR circuits have an output if either one of the inputs is present, with no output if both are present.

A	B	$A\bar{B}$
0	0	0
0	1	0
1	0	1
1	1	0

(A)

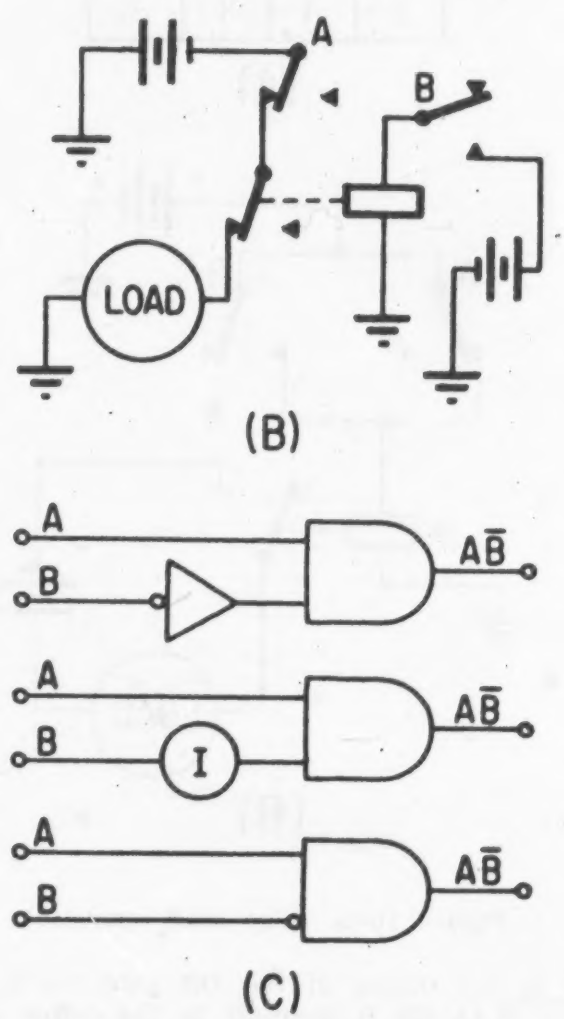

Figure 10-7.—The INHIBIT operation.

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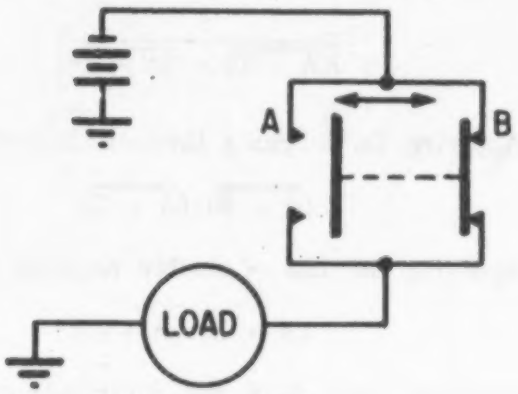

(A)

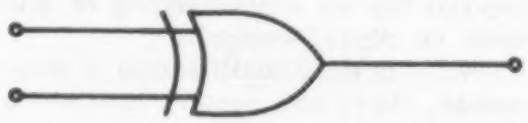

(B)

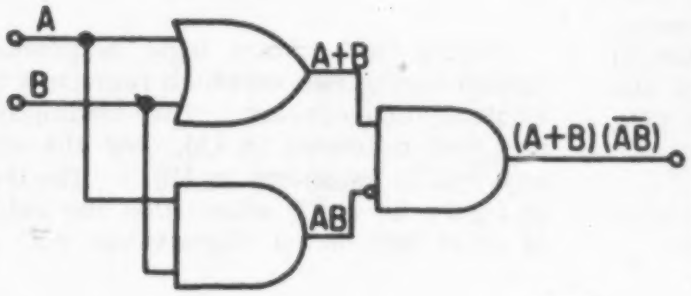

A	B	A+B	AB	(A+B)(AB)
0	0	0	0	0
0	1	1	0	1
1	0	1	0	1
1	1	1	1	0

(C)

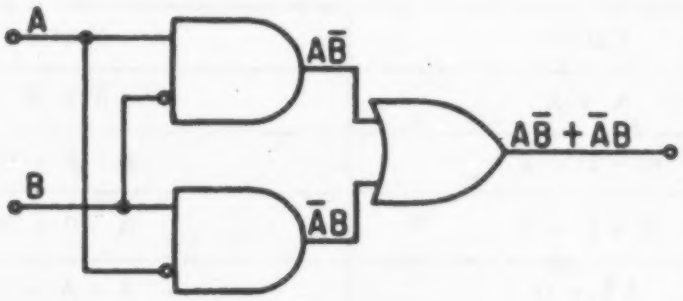

A	B	AB	AB	AB+AB
0	0	0	0	0
0	1	0	1	1
1	0	1	0	1
1	1	0	0	0

(D)

Figure 10-8.—The EXCLUSIVE OR operation.

Simplification of Boolean Expressions

The preceding section of this chapter introduced the logic operations and the Boolean expressions which describe the various operations. These operations, and the corresponding Boolean expressions, are relatively simple when taken individually. However, when computer circuitry is designed to include all of the functions required, the logic diagrams are very complex. Through the use of Boolean algebra, these complex circuits can be modified and simplified witnout changing the logic of the original circuit.

Some of the reasons for simplification of computer circuitry are as follows:

1. Reduce cost by reducing number of components.
2. Simplify the actual circuit operation.
3. Reduce percentage of breakdowns, and consequently reduce time and money spent for repairs.
4. Economize by reducing power consumption.

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The actual process of simplification of computer circuitry is a design process. However, the AT should have a knowledge of Boolean algebra and the simplification process as a foundation for understanding digital computer theory. This foundation of basic knowledge will be essential for an understanding of any advanced texts on digital computers.

BASIC LAWS. —In the simplification of Boolean expressions, there are certain laws which must be followed, just as there are laws and postulates in ordinary algebra. The laws of Boolean algebra are listed in table 10-5. Any changes in Boolean expressions based on the listed fundamental identities represents a physical change in the electrical network without a change in relationship between input and output signals. Boolean algebra provides a means for making changes in a logical diagram in the search for a more desirable network for a given expression. The most desirable network usually is that which requires the smallest number of components.

An example of simplification utilizing a few of the laws is given in the problem below.

Simplify the expression

$$\left[\overline{(\overline{A + B}) + (\overline{A + C})}\right]$$

Applying DeMorgan's theorem produces

$$(\overline{A + B}) \cdot (\overline{A + C})$$

Applying the law of double negative produces

$$(A + B)\ (A + C)$$

Applying part 2 of the distributive law produces

$$A + BC$$

Figure 10-9 shows logic diagrams of the circuit configurations which represent these two Boolean expressions. The unsimplified expression is shown in (A), and the simplified expression is shown in (B). The truth table in figure 10-9 (C) shows that the relationship of input and output signals has not changed,

Table 10-5. —Laws of Boolean algebra.

Law	Part 1	Part 2
Identity	$A = A$	$\overline{A} = \overline{A}$
Intersection	$A \cdot 1 = A$	$A \cdot 0 = 0$
Union	$A + 1 = 1$	$A + 0 = A$
Complementary	$A\overline{A} = 0$	$A + \overline{A} = 1$
Idempotent	$AA = A$	$A + A = A$
Commutative	$AB = BA$	$A + B = B + A$
Associative	$A(BC) = ABC$	$A + (B + C) = A + B + C$
Distributive	$A(B + C) = AB + AC$	$A + (BC) = (A + B)\ (A + C)$
Absorption	$A(A + B) = A$	$A + (AB) = A$
Dualization (DeMorgan's theorem)	$\overline{AB} = \overline{A} + \overline{B}$	$\overline{A + B} = \overline{A} \cdot \overline{B}$
Double negative	$\overline{\overline{A}} = A$	

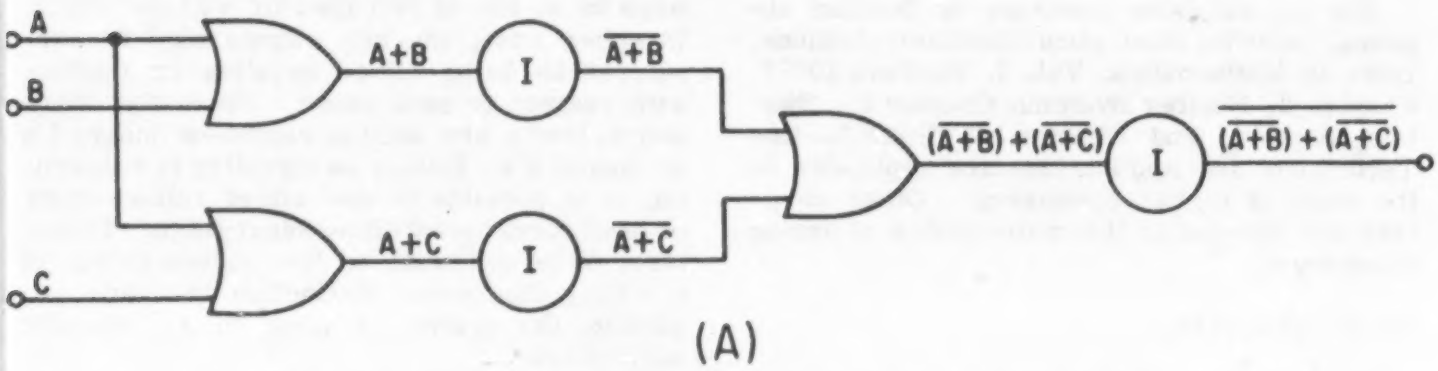

(A)

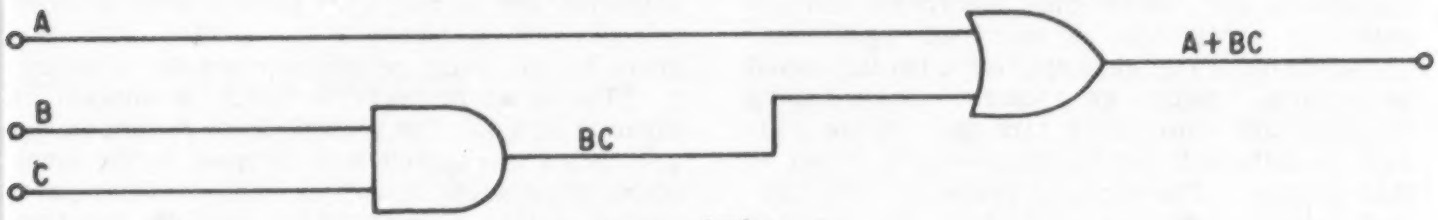

(B)

TRUTH TABLE

INPUTS			INTERMEDIATE OUTPUTS OF (A)					FINAL OUTPUT OF (A)	INTERMEDIATE OUTPUT OF (B)	FINAL OUTPUT OF (B)
A	B	C	A+B	A+C	$\overline{A+B}$	$\overline{A+C}$	$(\overline{A+B})+(\overline{A+C})$	$(\overline{A+B})+(\overline{A+C})$	BC	A+BC
0	0	0	0	0	1	1	1	0	0	0
0	0	1	0	1	1	0	1	0	0	0
0	1	0	1	0	0	1	1	0	0	0
0	1	1	1	1	0	0	0	1	1	1
1	0	0	1	1	0	0	0	1	0	1
1	0	1	1	1	0	0	0	1	0	1
1	1	0	1	1	0	0	0	1	0	1
1	1	1	1	1	0	0	0	1	1	1

EQUAL

(C)

Figure 10-9. —Simplification of expressions.

while the simplification has changed the physical appearance of the electrical network. The final outputs of the two expressions, (A) and (B), are equal, using the same inputs.

For an extensive coverage of Boolean algebra, including other simplification techniques, refer to Mathematics, Vol. 3, NavPers 10073. Chapter 2, Number Systems; Chapter 3, Boolean Algebra; and Chapter 4, Simplification Techniques and Applications are applicable to the study of digital computers. Other chapters are devoted to the mathematics of analog computers.

BASIC CIRCUITS

Many of the basic circuits used in digital computers are conventional electronic circuits generally applicable to electronic equipment. These circuits include amplifiers, timing signal generators, pulse generators, waveshaping circuits, and time delay circuits. These general circuits will not be discussed in detail in this chapter. The circuits presented are limited to those logic circuits which are peculiar to digital computers.

These logic circuits are the high speed electronic switching circuits that perform the functions of storing information signals and of performing logical operations on these signals. The storage circuits are discussed in a later section of this chapter. The circuits which perform the logical operations previously discussed sense the input conditions and provide an output only if certain input conditions exist. They can be classified generally as gate circuits, which may employ vacuum tubes, diodes, transistors, tunnel diodes, semiconductor rectifiers, or magnetic cores.

By opening some gates and closing others, a signal may be routed over a predetermined course. The computer, when reading input data and performing its operation, is concerned only with the arrangement of pulses of voltage or current. This is the method that designers have employed to cause the computer to perform predetermined operations, and also the method by which the computer performs those operations. The control unit determines the sequence in which the gates are to be operated, and it receives its instructions from the input data. The input data, in turn, is supplied by the programer.

The circuits discussed in this chapter are logic circuits which may be utilized to provide a "yes or no" or "true or false" answer to specific questions. These bistable circuits may be gates which are either conducting or cut off, or they may be circuits that will always be at one of two specific voltage levels. In either case, the two outputs may be considered as being either negative or positive with respect to each other. Normally, these output levels are used to represent binary 1's or binary 0's. Insofar as circuitry is concerned, it is possible to use either voltage state or level to represent either binary digit. Therefore, it is essential to the understanding of circuitry that some distinction be made regarding the system of logic in any specific application.

The term POSITIVE LOGIC is used to denote circuitry in which the voltage level utilized to represent a binary 1 is positive with respect to the level which represents a binary 0. The term NEGATIVE LOGIC is applied to circuits in which the voltage level representing a binary 1 is negative with respect to the level which represents binary 0. The circuits presented in this course which employ negative logic will be specifically identified as negative logic circuits.

Another convention which is sometimes used defines positive and negative logic in terms of the voltage level used to activate the gate circuits.

NOT Circuits

The NOT circuit, also known as an inverter, is nothing more than a normal gate amplifier stage that produces an inversion (negation) of the input signal and has unity gain. Figure 10-10 illustrates two NOT circuits. The waveforms and logic diagram symbols for these two circuits are given.

In the vacuum tube circuit shown in (A), the triode is biased beyond cutoff with no signal applied. A positive pulse input causes the tube to conduct, and the output voltage level changes to a relatively negative value. (A vacuum tube NOT circuit using negative logic in the same configuration would be biased for heavy conduction when no signal is applied, and negative inputs would cut the tube off.)

In the PNP transistor circuit shown in (B), the transistor is biased to cutoff by the divider (R2 and R3), making the base positive with respect to the emitter. The input signal is divided by R1 and R2 to make circuit gain

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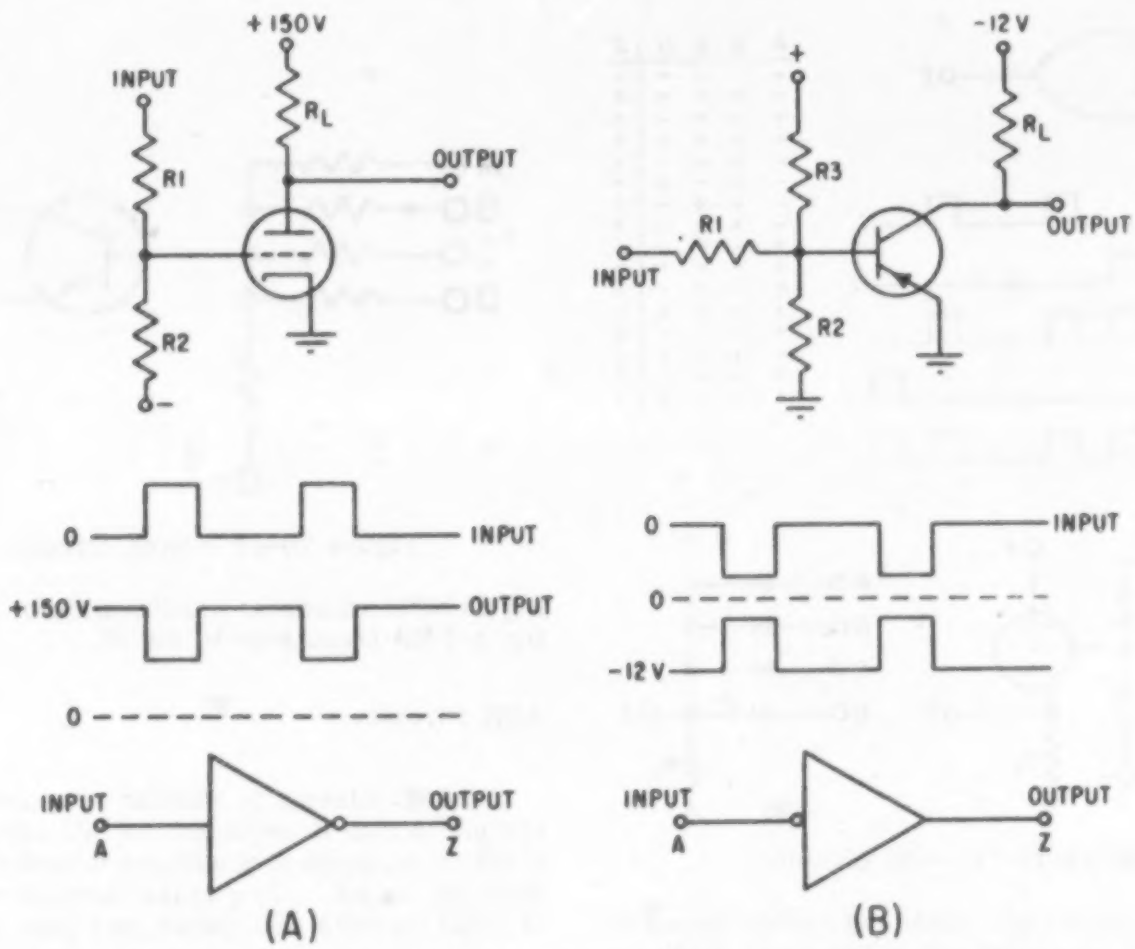

Figure 10-10.—NOT circuits. (A) Vacuum tube circuit; (B) transistorized.

unity. Note that the input signal must be negative to cause conduction; therefore, this circuit represents a negative logic NOT circuit. The logic symbols presented here indicate, by the use of a small circle on the triangle, the low level or negative state; that is, in (A) the inversion is from a positive going to a negative going signal, while in (B) the reverse is true.

It should be noted at this time that any circuit which inverts the signal and produces unity gain falls under the definition of a NOT circuit. One common device used in this manner is the unity transformer.

OR Circuits

An OR circuit is the logic circuit having two or more inputs and producing an output if any one or more (or all) of the inputs are placed in the required signal state. Figure 10-11 shows two types of OR circuit.

In the block symbol, four inputs are illustrated. This is not necessary—many OR circuits are used which have only two inputs. In an OR circuit, any practical number of inputs may be used. The truth table in this figure also illustrates that a two-level gate with 4 inputs may have 16 different input signal combinations ($2^4 = 16$). The waveform drawing does not show all possible input combinations, but enough combinations are shown to convey the idea that with any positive input, a positive output will result.

The vacuum tube in the circuit shown in (A) is biased to cutoff when there is no signal applied. The inputs are each fed through a resistor to the grid of the tube. The resistor in the signal path decreases the interaction between the individual input lines. A positive signal applied to any one or more of the input leads causes the tube to conduct, and (by cathode follower action) a positive signal is taken from the cathode.

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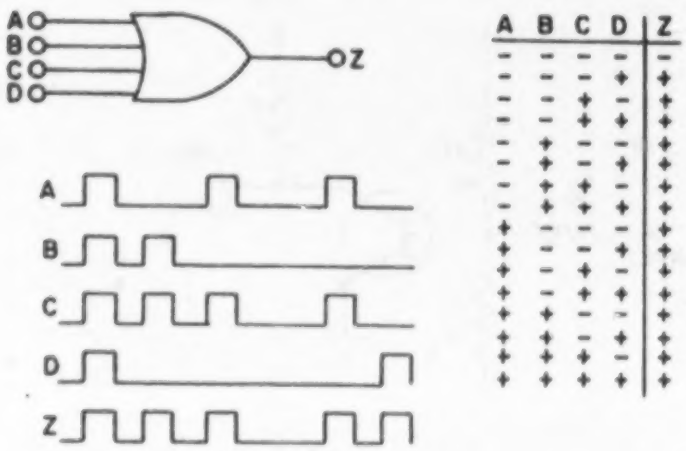

A	B	C	D	Z
−	−	−	−	−
−	−	−	+	+
−	−	+	−	+
−	−	+	+	+
−	+	−	−	+
−	+	−	+	+
−	+	+	−	+
−	+	+	+	+
+	−	−	−	+
+	−	−	+	+
+	−	+	−	+
+	−	+	+	+
+	+	−	−	+
+	+	−	+	+
+	+	+	−	+
+	+	+	+	+

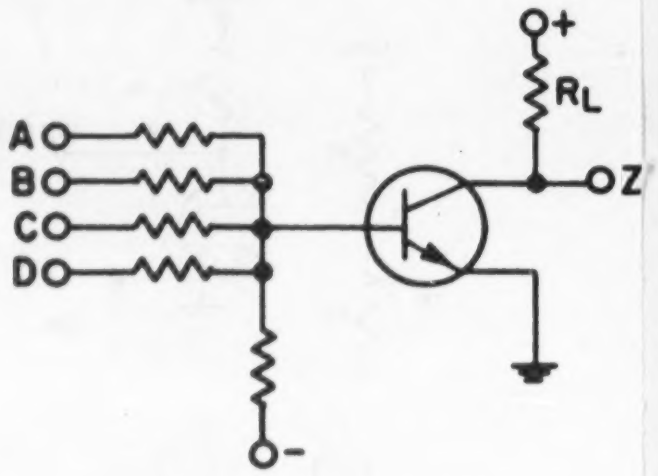

Figure 10-12. —NOR circuit.

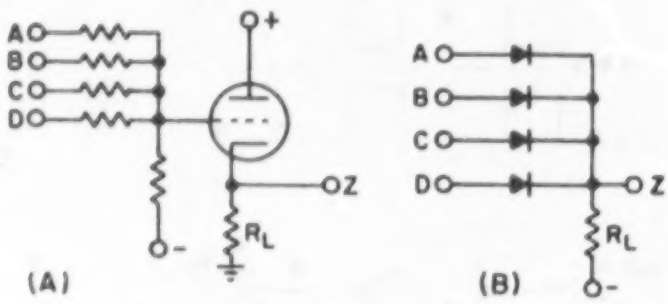

Figure 10-11. —OR circuits.

The positive logic diode OR circuit shown in (B) can be examined using the truth table as shown. When any one or more of the inputs receive a positive signal, the diode receiving that input conducts. A signal is impressed accross R_L, resulting in a positive going waveform at the output.

NOR Circuits

Figure 10-12 shows a transistor type OR circuit which also includes the negation function of the NOT circuit. A circuit that performs both of these logic functions is called a NOR (NOT OR) circuit, as explained in the previous discussion of logic operations.

With no input signal applied, the NPN transistor is biased to cutoff by the reverse bias between the emitter and base. A positive input pulse causes saturation conduction of the transistor, producing a negative going output pulse at the collector. The triode in figure 10-11 (A) could be changed to a NOR circuit by replacing the cathode output with an output from a plate load resistor. Similar circuits could be arranged for negative inputs by biasing an NPN transistor to saturation or by biasing a PNP transistor to cutoff.

AND Circuits

An AND circuit is similar to a coincidence circuit in that it requires that all inputs meet a set of prescribed conditions in order to produce an output. Two transistorized versions of AND circuits are shown in figure 10-13.

In figure 10-13 (A), two PNP transistors are connected together at the collectors and emitters to form an emitter follower type circuit. There are two separate input terminals for the base signals. Initially both transistors are biased to saturation conduction, and nearly all of the collector voltage is dropped across R_L. Positive signals fed to the base of each transistor will cut off the respective transistors, but both transistors must be cut off in order to produce an output. When both of the transistors are cut off simultaneously, the output terminal voltage will go in a positive direction.

The circuit shown in figure 10-13 (B) is a negative logic AND circuit. With no signal applied, each transistor is cut off. During operation, all transistors must be activated together. If any one or more of the transistors remain cut off, there is no current path through the series connected emitter collector circuits. If all transistors are driven into conduction (by negative signals applied to the bases), the output at the emitter terminal will increase in a negative direction.

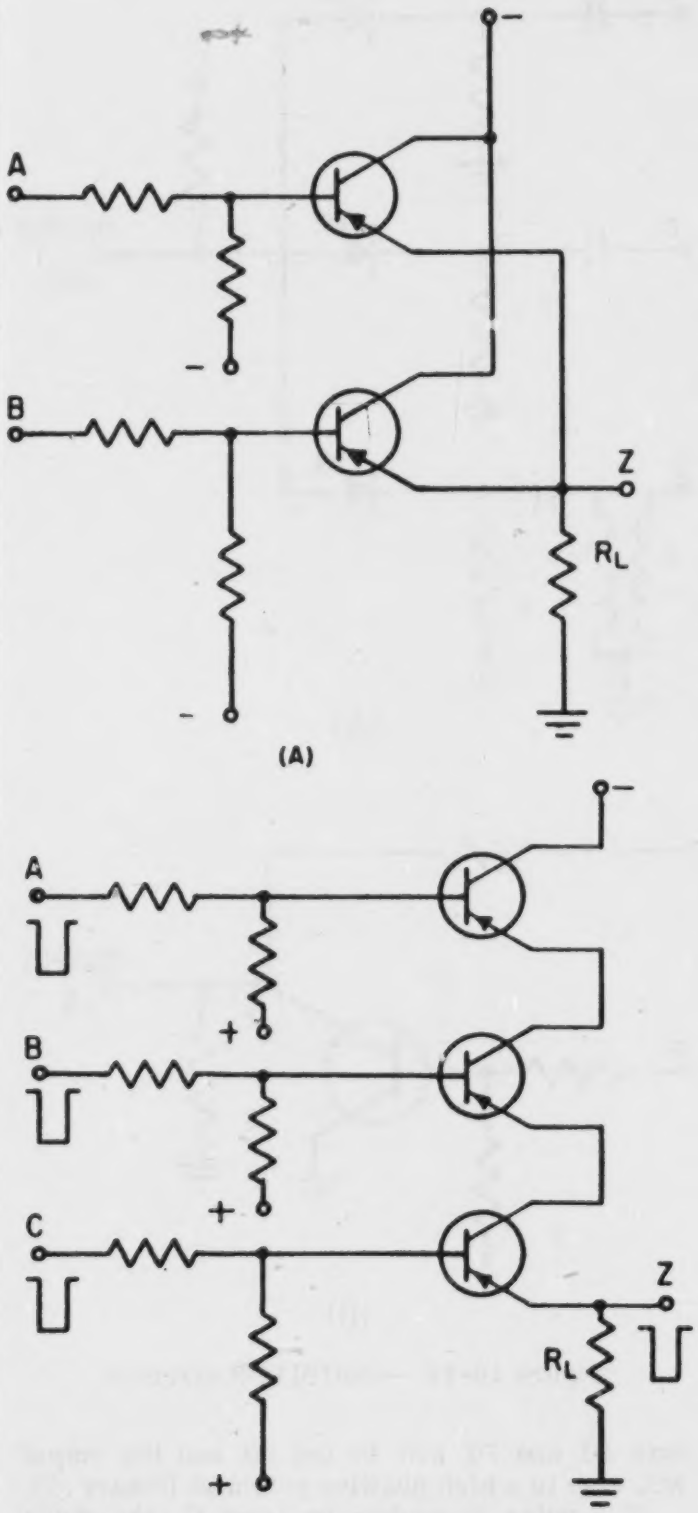

Figure 10-13. —AND circuits. (A) Positive logic; (B) negative logic.

NAND Circuits

The NAND (NOT AND) circuits are shown in figure 10-14. Both of these circuits combine the AND function and the NOT function.

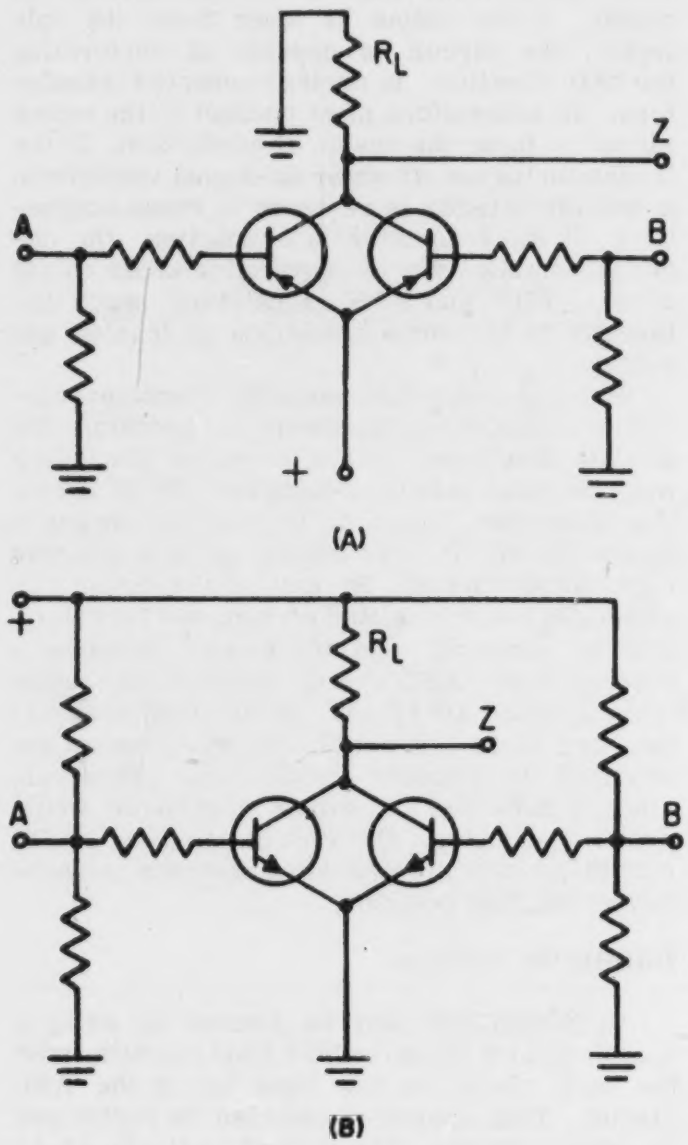

Figure 10-14. —NAND circuits.

In (A) the PNP transistors are biased for saturation conduction in the absence of signals. If positive signals are applied simultaneously to both bases, both transistors will be cut off (the AND function). When cutoff occurs for both transistors, the collector voltage (output) goes relatively negative. This signal inversion is the NOT function.

In (B) the NPN transistors are also statically biased for saturation conduction. When both transistors are cut off by coincident negative signals, the output voltage from the collector is relatively positive. This is a negative logic NAND circuit.

Comparison of these circuits will illustrate the similari[illegible]d the differences between

positive and negative logic circuits, and the AND, OR, and NOT functions. In transistor logic circuits, if the output signal is taken from the emitter, there is no inversion of the signal; if the output is taken from the collector, the circuit is capable of performing the NOT function. In series connected transistors, all transistors must conduct if the output signal is to be the result of conduction. If the transistor is cut off under no-signal conditions, a definite polarity is required to cause conduction; if the transistor is conducting, the opposite polarity input is required in order to cut it off. PNP and NPN transistors react differently to the same conditions of biasing and signal.

When studying any specific computer circuitry to determine the theory of operation, the factors discussed in the previous paragraph must be taken into consideration. To illustrate this statement, refer to the circuit shown in figure 10-14 (A). As shown, it is a positive logic NAND circuit. By moving the output resistor (R_L) to the emitter circuit, the NOT function is removed, and the circuit becomes a positive logic AND circuit similar in operation to figure 10-13 (A). If the PNP transistors are biased at cutoff, negative inputs are required to produce conduction. However, since conduction of either transistor would produce an output, the circuit becomes an OR circuit (or a NOR, depending upon the connection of the load resistor).

INHIBITOR Circuits

An INHIBITOR may be formed by using a combination of any of the NOT AND circuits, with the NOT circuit in one input leg of the AND circuit. This operation can also be performed by other circuits. The circuit in figure 10-15 (A) provides the inversion (NOT function) by placing a transformer in the input leg of diode D3.

Diodes D1 and D2 are forward biased, allowing them to conduct. This places the output voltage at a low level (binary 0). Diode D3, however, is biased so that the diode is cut off with no signal applied to input C. With a signal applied to either input A or B, either D1 or D2 will be cut off; however, the other will continue to conduct, holding the output at a low potential.

When inputs A and B both have a signal applied, with no signal applied to input C, both D1 and D2 will be cut off and the output will rise to a high positive potential (binary 1).

If a pulse is applied to input C, the pulse will be inverted across the transformer. This will overcome the bias on D3, allowing it to conduct, holding the output to a low level regardless of the state of the other inputs.

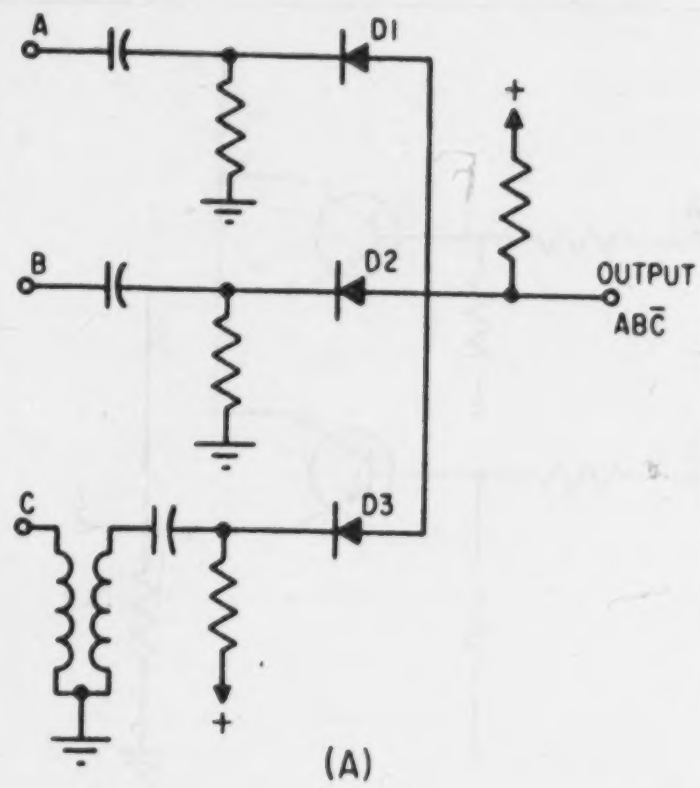

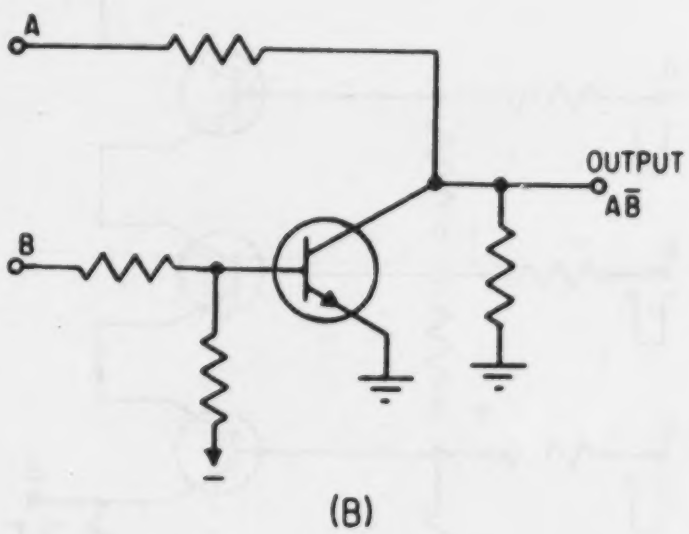

Figure 10-15. —INHIBITOR circuits.

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Another circuit which will perform the INHIBIT operation is shown in figure 10-15 (B). The circuit employs an NPN transistor with the emitter grounded. Note that the emitter base circuit is biased in the reverse direction; therefore, the transistor will be normally cut off.

If a positive pulse is applied to input. A, current flow through the load fresistor will produce a corresponding signal at the output terminal, when no input is present at input terminal B.

If, however, a positive pulse appears at input B at the same time there is one present at input A, this input would overcome the reverse bias and the transistor would conduct to saturation. When at saturation, the transistor is effectively a short circuit and the input pulse at A would be effectively lost; thus it would not appear in the output. In this fashion, a pulse applied to input B INHIBITS the appearance of a pulse at the output terminal.

ARITHMETICAL FUNCTIONAL CIRCUITS

The circuits previously explained as individual circuits are all combined in the computer to operate as an integrated system. Each circuit on a schematic is normally shown in symbol form. As yet there is no universally used system of symbols for computer block diagrams. The symbols given in MIL-STD-806B are the ones used in this chapter. In the inhibitor circuit, note that one of the inputs is terminated in a small half-circle instead of an arrowhead. This symbol indicates that inhibitor pulses are applied to the circuit.

Adders

Adders in digital computers use combinations of AND, OR, NOT, and INHIBITOR circuits to perform the functions of addition. When adding numbers, it is often necessary to CARRY a number to the next column. For example,

$$\begin{array}{r} ① \\ 45 \\ +\,19 \\ \hline 64 \end{array}$$

It is the carry function of arithmetic (the 1 encircled) that necessitates complex circuits in computers. Were carries not needed, a simple OR circuit could easily add numbers, for it has an output pulse whenever pulses appear at either or both inputs. Figure 10-16 shows the OR circuit and block diagrams of two other circuits which are used in construction of an adder. All of the circuits shown could perform the addition function, were a carry not required.

A binary word appears as a train of pulses with spaces to indicate 0's. In an adder, a pulse train applied to one input will be added to a pulse train applied to another input. In figure 10-16 (A) the OR circuit has produced an output pulse each time a pulse appeared at either or both of the input lines. However, the output word of the two binary inputs is not the correct sum. The pulse train at input 1 is a binary 0101101 (45 in decimal notation); at input 2 the binary word is 0010011 (decimal 19). Adding these two inputs should give binary 1000000 (decimal 64). The actual output word is 0111111, which is 63 in decimal notation. The error is caused by the fact that this circuit cannot carry a digit.

The quarter adder (EXCLUSIVE OR circuit) shown in figure 10-16 (B) is another of the circuits which can generate the sum of two inputs but cannot perform the carry operation. With the circuit inputs as shown in (B), both inputs to the AND circuit receive a 1 as the first digit applied. This results in a 1 in the output. This pulse is applied to the inhibitor as an inhibiting pulse and prevents an output when the first 1 pulse from the OR circuit is applied. In this case the output of the quarter adder is 100. This is not the correct sum of the inputs (101 and 001), as is shown in the example below.

Binary addition is performed as follows when a carry is involved:

$$\begin{array}{r} ① \\ 001 \\ \underline{101} \\ 110 \end{array}$$

In the first column a 1 is to be added to a 1—the sum is 0 with a 1 carry. The 1 carry is shown encircled over the second column; adding the 1 carry to the two 0's in the second column produces a sum of 1, with no carry; in the third column a 1 added to a 0 produces a sum of 1. Thus, 110 is the correct sum of the two inputs to the half adder; but because the inhibiting pulse of the

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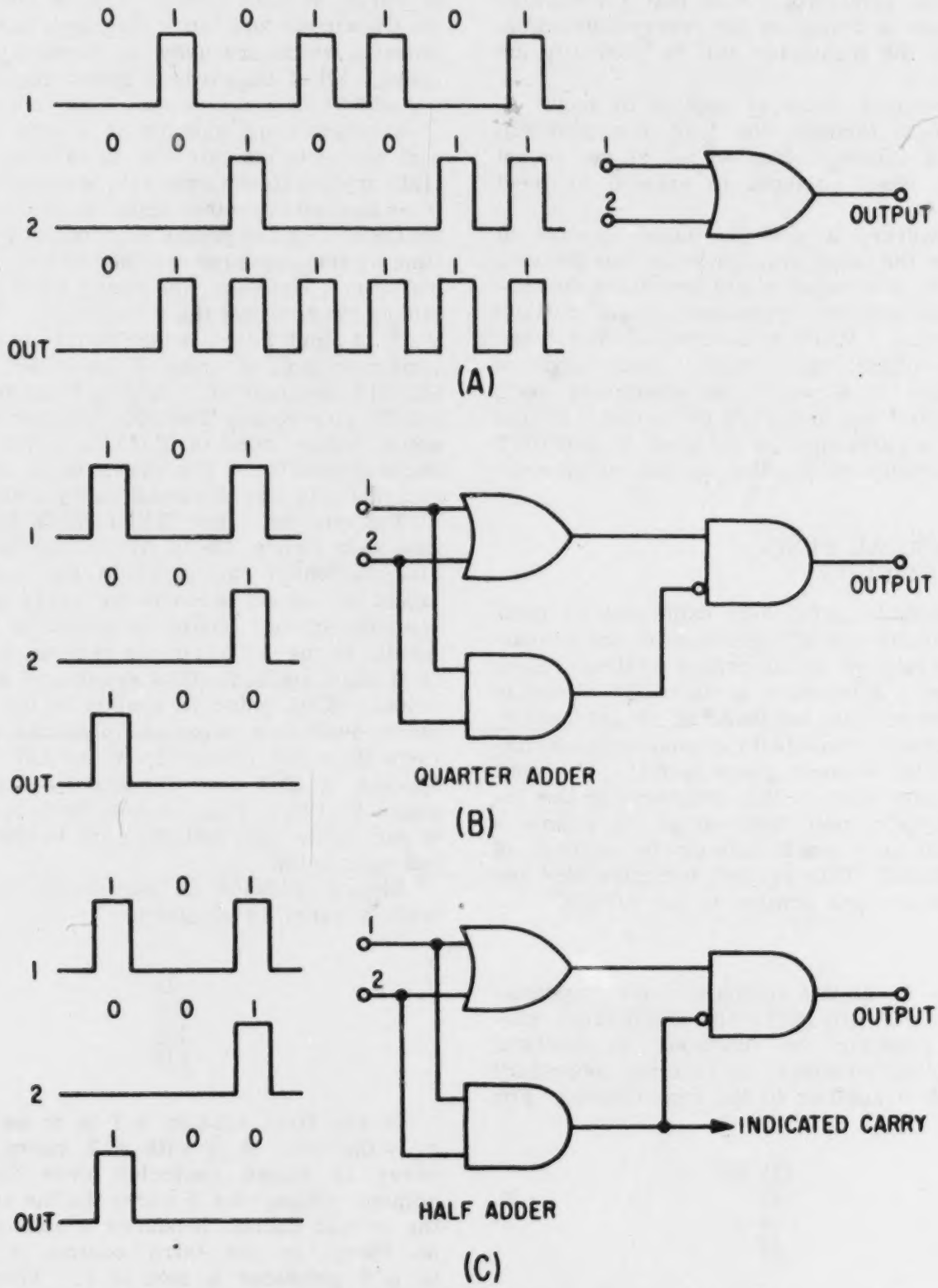

Figure 10-16. —Adder circuits with no carry.

carry is in the first place instead of the second place, a false sum of 100 is produced.

A half adder is shown in (C). It utilizes the same circuit configuration as the quarter adder, with an additional output line. This second output (from the AND gate) is the carry output. The difference between the quarter and half adder is the carry output of the latter. NOTE: The half adder is not capable of performing addition involving the carry function. It only generates the carry output which is utilized by additional circuitry to perform the complete addition function.

One of the circuits that must be discussed in connection with adders is the delay circuit. The delay circuit functions much like a conventional delay line. It delays a pulse train for the duration of one pulse; that is, all the pulse in a train advancing from left to right are moved one place to the left. Thus, the binary number 001 applied to a delay circuit becomes 010 in its output. The delay circuit permits the carry function of arithmetic in adders. It is used with a combination of OR, AND, and NOT circuits to make up a full adder circuit. A full adder consisting of two half adders and a delay line is shown in figure 10-17.

The inputs to the adder in figure 10-17 are the binary numbers 0011 and 0101, and the correct sum of these two numbers is binary 1000. The circuit operation to perform this addition is described in the following paragraphs.

For ease of explanation we will call the pulse sequence time 1, 2, 3, and 4, starting with the least significant bit (digit farthest to the right). Recall from the previous discussion that the output of the half adder will be a 1 on the sum line (total) and a zero on the carry output line when only one input is present. If both inputs are present the output will be a zero on the sum line and a 1 on the carry line.

The inputs shown to the first half adder give the outputs 0110 and 0001, as shown in the figure. The output train on the A line (0110) is the A input to the second half adder. The delay line, however, causes the B input of the second half adder to differ from the B output of the first half adder as shown in figure 10-17.

The second half adder inputs at time 1 are 0 on the A line and 0 on the B line, due to the delay line. The sum and carry outputs are both 0 at this time. At time 2 the A input is 1, the B input is the delayed 1, and this gives a sum of 0 and a carry of 1. At time 3 the A and B inputs are again 1 and the outputs are the same as for time 2. At time 4 the A input is 0 and the delayed B input is 1. This gives an output sum of 1 and a carry of 0, for the correct sum to the addition problem.

Subtraction in Computers

Subtraction in computers is performed by employing the same circuits that have been discussed; namely adders, inhibitors, and delay lines. They are not connected the same as when used in adders; however, each circuit performs its operation in exactly the manner that has been described. The following discussion is a simplification used for illustration.

Figure 10-18 (A) shows the basic subtractor circuit. It is shown only for the purpose of illustrating the subtraction principle; this circuit must be combined with adders and delay lines (as shown in (C)) in order to function as a subtractor and give true answers. In (A) the inhibitor produces a true remainder when no "borrow" is necessary. In (B) however, the remainder is false because the basic circuit cannot perform the necessary borrow

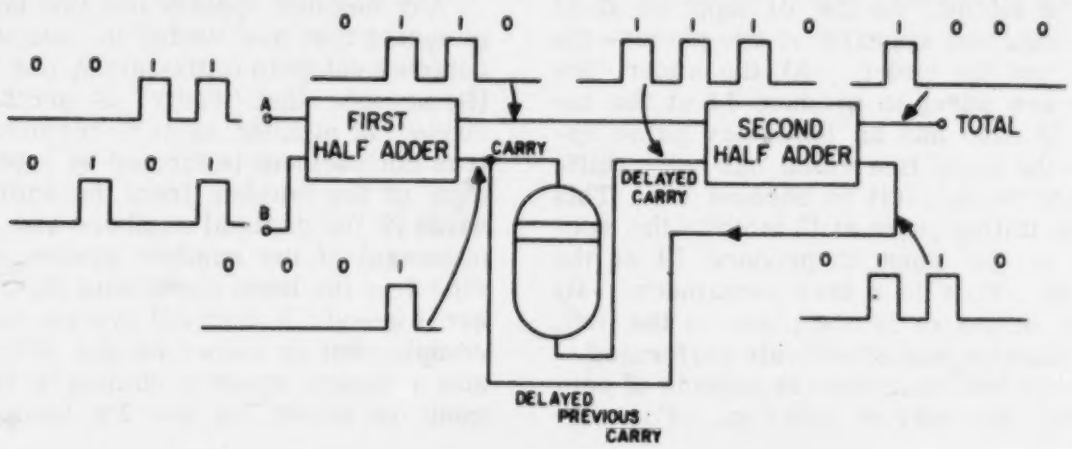

Figure 10-17.—Full serial adder.

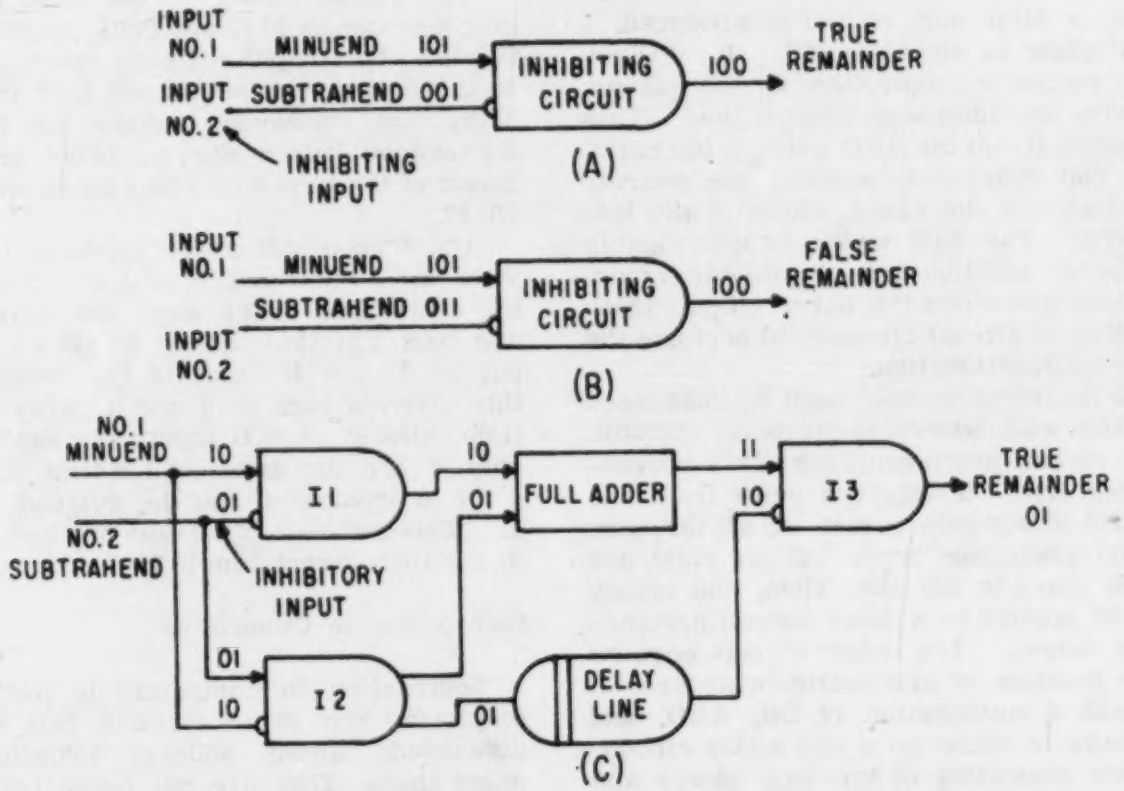

Figure 10-18.—Binary subtraction circuits, block diagram. (A) Basic—no borrow needed; (B) basic—borrow needed but not provided; (C) subtractor that borrows.

function. The subtracting circuit in figure 10-18 (C) shows the arrangement necessary to perform a borrow function.

In this circuit it is desired to subtract 01 from 10. At I1 (inhibitor No. 1), the inhibiting pulse in the subtrahend arrives when there is no pulse in the minuend to inhibit, so the 10 passes through the inhibitor to the adder. I2 has the same inputs applied, except that they are reversed so that the minuend (10) becomes the inhibiting input. Here again, the inhibiting pulse arrives when there is no input pulse to inhibit, so the 01 input at I2 is passed through and appears at two places—the delay line and the adder. At the adder, the two inputs are added to produce 11 at the input to I3. I3 also has an inhibitory pulse applied from the delay line which has been shifted one place to the left to become 10. This time the inhibiting pulse at I3 inhibits the second pulse of the input to produce 01 at the output of I3. This is a true remainder. By shifting the output of I2 one place to the left, a borrow function was effectively performed.

The circuit just described is capable of performing only one borrow function. For subtraction involving multiple functions of borrow, additional adders and delay circuits must be incorporated, or the more practical shift register may be used to shift the necessary pulses as required.

SUBTRACTION WITH COMPLEMENTS.—Another method of subtraction widely used in digital computers involves complementing the subtrahend and adding the numbers. The main advantage gained by using this system is that computers can perform both addition and subtraction with the same arithmetic circuits.

Any number system has two types of complements that are useful in computers—a true complement and a radix-minus-one complement. (Remember that "radix" is another word for "base" in number system terminology.) The true complement is formed by subtracting each digit of the number from the radix-minus-one value (9 for decimal numbers and 1 for binary numbers) of the number system and then adding 1 to the least significant digit of the number formed. A decimal system number's true complement is known as the 10's complement, and a binary system number's true complement is known as the 2's complement. As

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an example, find the 10's complement of the decimal number 13:

```
  99
 -13
  86
 + 1
  87
```

Therefore, 87 is the 10's complement for the decimal number 13. The 2's complement of a binary system number, such as 10101, is found by subtracting each digit from 1, which is the radix-minus = one value, and adding 1 to the number formed. The 2's complement of the binary number 10101 is:

```
  11111
 -10101
  01010
 +    1
  01011
```

However, it can be accomplished faster by changing each 1 to a 0 and each 0 to a 1, and adding a 1. Such an operation in a digital computer is usually accomplished by inverting all the pulses, or lack of pulses, in a pulse train that represents the number, and adding a pulse that represents a 1.

The radix-minus-one complement of a number is formed by subtracting each digit from the radix-minus-one value, but a 1 is not added to the least significant digit of the number formed. The radix-minus-one complement of the decimal number 13 is 86, and 01010 is the radix-minus-one complement for the binary number 10101. These are known as the 9's and 1's complements, respectively.

Since the digital computer uses binary representation of quantities, the use of only the 2's and 1's complements will be illustrated. Decimal numbers are converted into binary numbers before operations are performed by the arithmetic circuits.

Subtraction using the 2's complement involves forming the 2's complement of the subtrahend and then adding this true complement to the minuend.

Normal binary	2's complement
1101	1101
-1011	+0101
0010	10010 = 0010
	(Drop the 1 on the left, which is the carry.)

The answers, after dropping the 1 in the answer of the complemented case, are identical.

Subtraction with the 1's complement is very simple because the 1's complement is easier to form than the 2's complement.

Normal binary	1's complement
10110	10110
-01011	+10100
01011	101010
	+1
	01011
	(Add the 1 on the left, which is the carry, to the other five digits.)

Again, in this case by adding the carry of 1, the answers are the same. Note that subtraction with the 1's complement in this example is much easier than normal binary subtraction. Also, note that only an inverter stage is necessary to form the 1's complement of the subtrahend electronically.

Counting by Flip-Flop

The modified Eccles-Jordan multivibrator is the circuit used, in conjunction with other circuits, for counting. It is a two-state oscillator that remains in either of its two conditions until a pulse is received to flip it to the opposite condition. The output, if taken from the plate of one tube, will be a positive voltage representing a 1 in one condition and a low voltage representing a 0 in the other condition. Each pulse input to the stage will flip it to the opposite condition, so two pulses are required at the input to produce one pulse at the output.

The simplified flip-flops (FF's) in figure 10-19 are arranged to show the basic arrangement of counters. Should you require a refresher on the theory of the plate coupled multivibrator, refer to Basic Electronics, NavPers 10087-B.

Counting by FF is possible because of the characteristic that requires two pulses in to produce one pulse out. In the figure, note that the input to the counter chain is on the right side of the figure. This arrangement is used because the indicator lamps of each stage will be read as binary numbers. If the lamp in the second stage is lighted and the lamp in

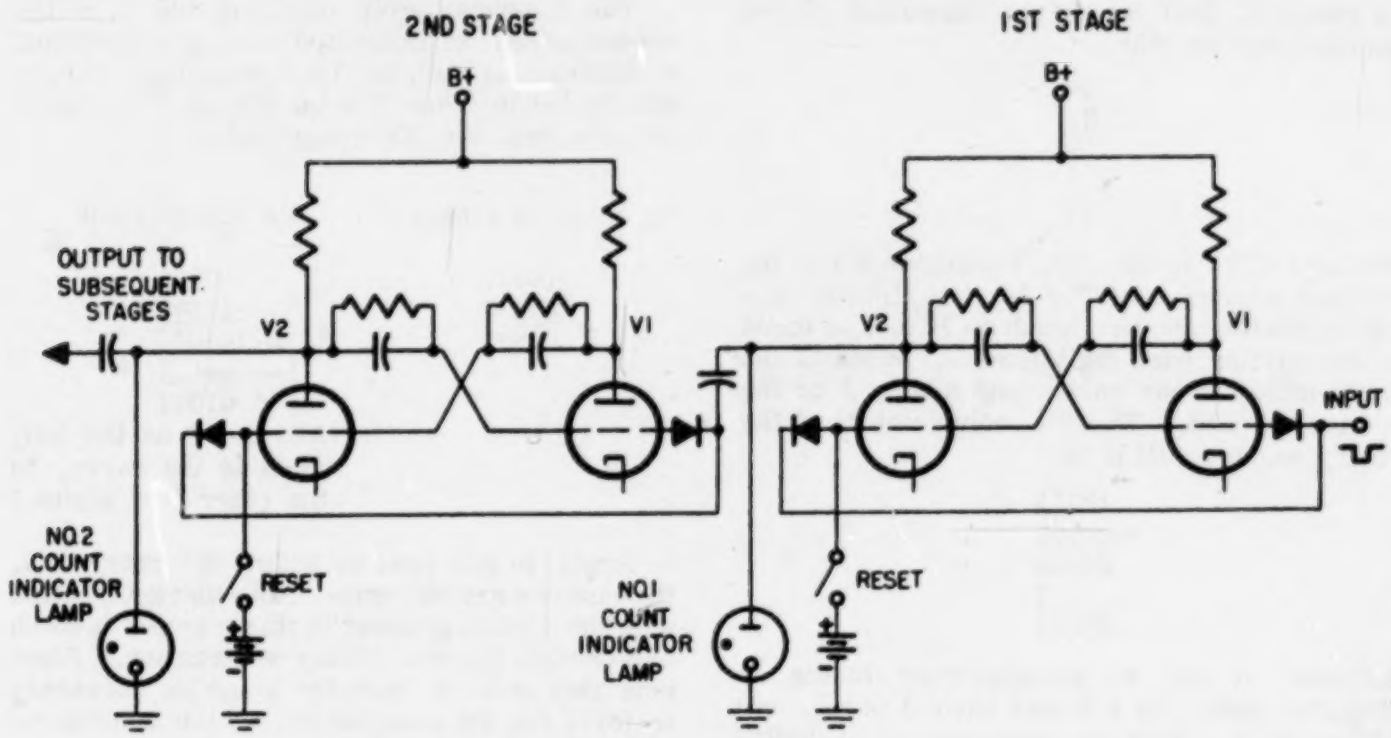

Figure 10-19.—Basic counter.

the first stage is not lighted, the binary indication is 10, or decimal 2. If both lamps are lighted, the binary number is 11, or decimal 3. Additional stages are necessary to count a higher number than three, and each of these additional stages from the input represents a power of two.

Note also that the grid of each tube labeled V2 has a reset provision with a positive voltage that is applied by closing the switch. Before any counting is begun, all the V2 tubes in the chain are caused to conduct by a momentary closing of the reset switch, and all indicator lamps register 0. This is the reset condition.

The grids of both tubes in each stage are tied together so that any negative signal applied appears on both grids simultaneously. The diodes in the grid inputs prevent a positive signal from reaching the grids. They respond only to negative pulses.

Assume that the circuit has been reset so that all V2 tubes are conducting. In this state the plate voltage is too low to light the neon lamp, and all lamps register 0. The first negative pulse applied to the inputs of both tubes of the first stage flips the circuit to the opposite condition; V1 now conducts, V2 cuts off, and its plate voltage rises and lights the lamp to indicate 1. The positive rise of voltage is capacitively coupled to the second stage, but the diodes prevent the positive pulse from having any effect. Reading the two indicator lamps after the first pulse has been applied produces binary 01, meaning a count of 1. The second negative pulse that arrives causes the first stage to flop back to the reset state; V1 cuts off; V2 goes into conduction, its plate voltage drops, its lamp goes out; and the negative pulse is coupled to the second stage. This negative pulse flips stage No. 2 to its opposite state and lights its lamp. The lamps now register binary 10, which is decimal 2. Note that two pulses were required at the input to produce one pulse out.

In late-model computers, the FF circuits use transistors, and a long chain of such stages can be built into a small space. Each additional stage makes provision for a higher counting capability. Each succeeding countdown circuit, as the FF is sometimes called, "counts" in the same manner, or scales by two. Each additional stage also scales by two; a two-stage FF, as shown in the figure, scales by four; a three-stage unit will scale by eight; a four-stage unit will scale by 16; etc.

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The same circuit, with only slight modification, could be used to count positive inputs.

Accumulator

The accumulator of a computer is the unit in which storage operations are performed. Basically, it consists of a memory section called a register (discussed later in this chapter) and is used in connection with an adder. The register is a group of FF and memory elements that route and store data. The adder has been explained previously. The A-register performs two functions: it furnishes the stored augend to the adder and stores the sum of an addition operation. (See fig. 10-20.)

In this connotation, the "augend" is the subtotal. In each progressive addition, the total of the previous addition is fed to the adder (as the augend), and is then combined with the new data to furnish a new total which is stored in the A-register. For example, the A-register holds a number, say 4, and it is to be added to another number, say 3; then both the 4 from the A-register and the 3 from the addend register are sent to the adder. The sum of the addition, 7, is sent to the A-register and remains until more data is to be added to it. The A-register accumulates data for arithmetic operations.

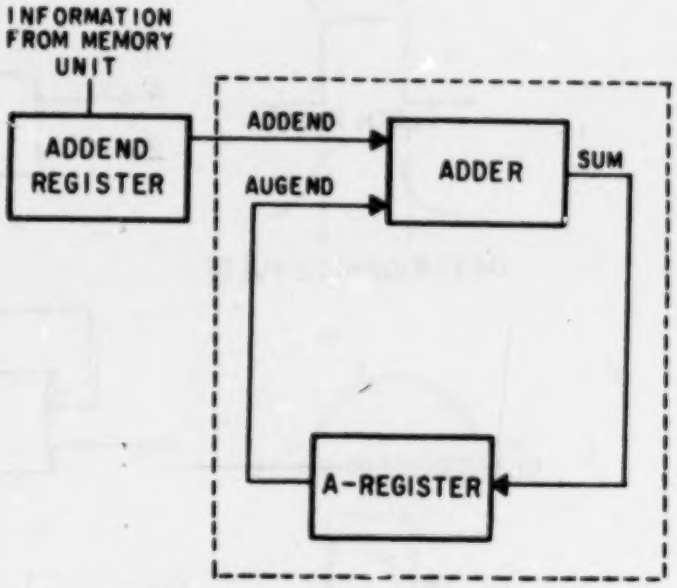

Figure 10-20.—Accumulator.

Clock Pulses

An idea which is basic to most digital computers is that of a uniform rate of counting (synchronous operation). To provide for this feature, a CLOCK, or master timer, is employed. This circuit produces or controls the rate of timing pulses. The interval between the pulses determines the period of time during which an event can occur. If a signal is delayed for a number of pulse intervals and then fed back to the input of an AND circuit, that signal will be continuously regenerated, and may be used to store data bits (binary digits) according to the length of the delay. Since the AND circuit will produce an output only when both input signals are present, the repetition of the pulse permits the transfer of data during that interval. The delay may be of any convenient length, and may be used to store any number of digits. Therefore, such an arrangement is entirely practical.

PULSE RESHAPING.—In addition to serving as the master timer for the computer, the clock pulses are also used in pulse reshaping circuits.

As pulse trains pass through various circuits of a computer, the rise and fall times of the pulses usually increase; the amplitude may decrease; and the pulses are delayed in time as they move through circuits. The clock pulses, which are usually available at several points in the computer and have a choice of pulses that are shifted in time by 1/4 cycle, are used with a reshaping circuit to restore the shapes of numerical or instructional information pulses within the computer.

If the information pulses to be reshaped occur at the same time as an available clock pulse, a simple AND circuit can be used to reshape the pulse. Figure 10-21 (A) shows clock pulses and deteriorated pulses applied simultaneously to terminals A and B, respectively, of an AND circuit. In a properly designed circuit, the output is produced only during the time interval t_1 to t_2. The rounded top of the output pulse can be clipped in a succeeding amplifier stage.

Instances will occur where the deteriorated pulses to be reshaped are no longer in time synchronization with the clock pulses. In these cases, the circuit shown in figure 10-21 (B) can be used to reshape the pulses.

The deteriorated pulses and clock pulses are applied to terminals A and B, respectively. The deteriorated pulses pass through the OR circuit and, together with the clock pulses,

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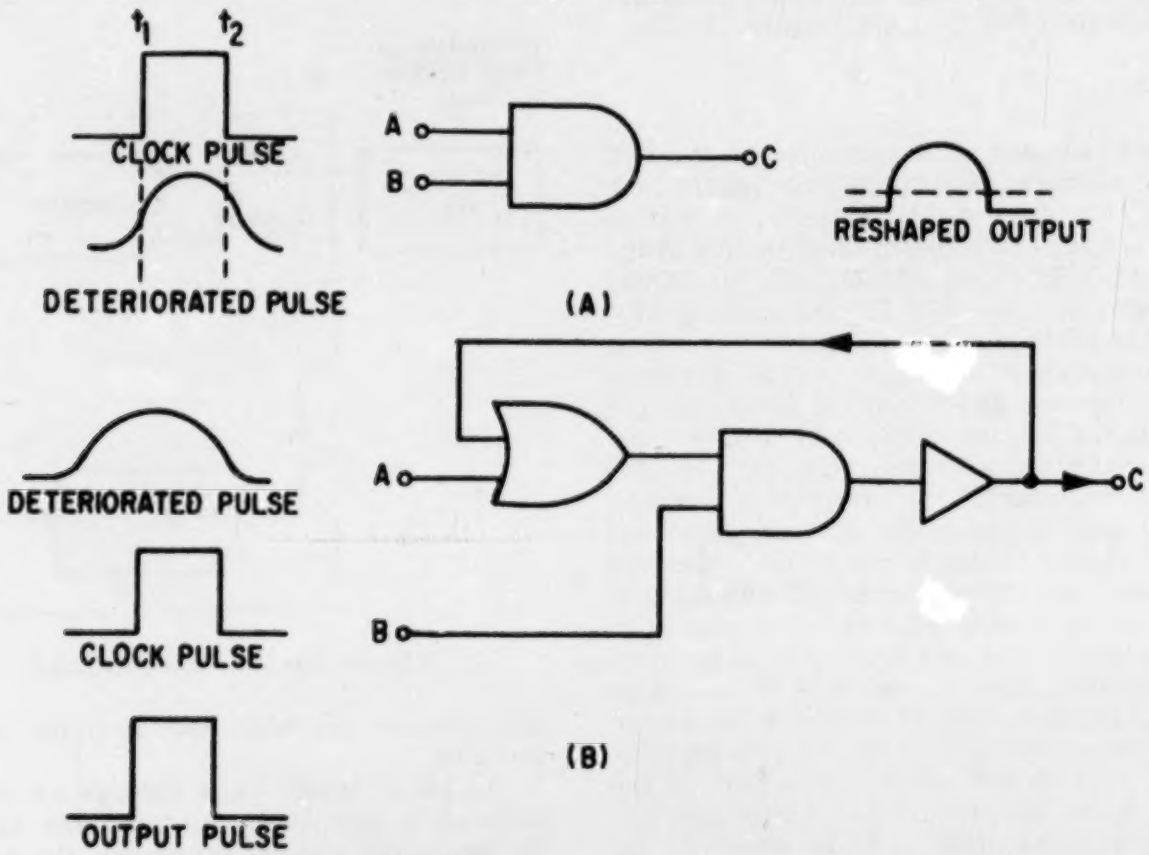

Figure 10-21.—Reshaping circuits.

cause an output from the AND circuit during the portion of the time that they occur simultaneously. Now, if there were no regenerative (positive) feedback from the amplifier output, the output would be representative of only the overlap time of the deteriorated and clock pulses. However, the positive feedback and the clock pulse keep the AND circuit functioning, producing an input to the amplifier until the clock pulse ends. This produces an output pulse that is identical to the clock pulse. This circuit allows a pulse that is not in time sequence with a clock pulse to be reshaped, but there must be some overlap in the duration of the two pulses.

STORAGE (MEMORY)

Although there are many different systems for data storage used in digital computers, this discussion will be limited to some of the more common magnetic systems and the shift register. The magnetic systems employed are DYNAMIC; that is, the stored information must be moving in order to be used. For this reason it becomes necessary to recirculate the signal over a given path. If the signal were not recirculated, the end of the storage medium could be reached before the complete data storage process was completed. Recirculation is accomplished by rotating a closed loop, and will be clarified later in this section.

Since many computers require the storage of (and access to) more bits of information than can be accommodated in a single unit, the use of multiple memory units has become a common practice. The use of more than one memory unit requires that inputs be supplied directly to each unit. Items that are to be stored periodically (or items that are time dependent) are supplied to the circulating memory under the control of the internal program.

Magnetizing the Memory Unit

The magnetization curves of those ferrite materials which are commonly used in computer memories are essentially square, as shown in figure 10-22 (A). However, the heavy line

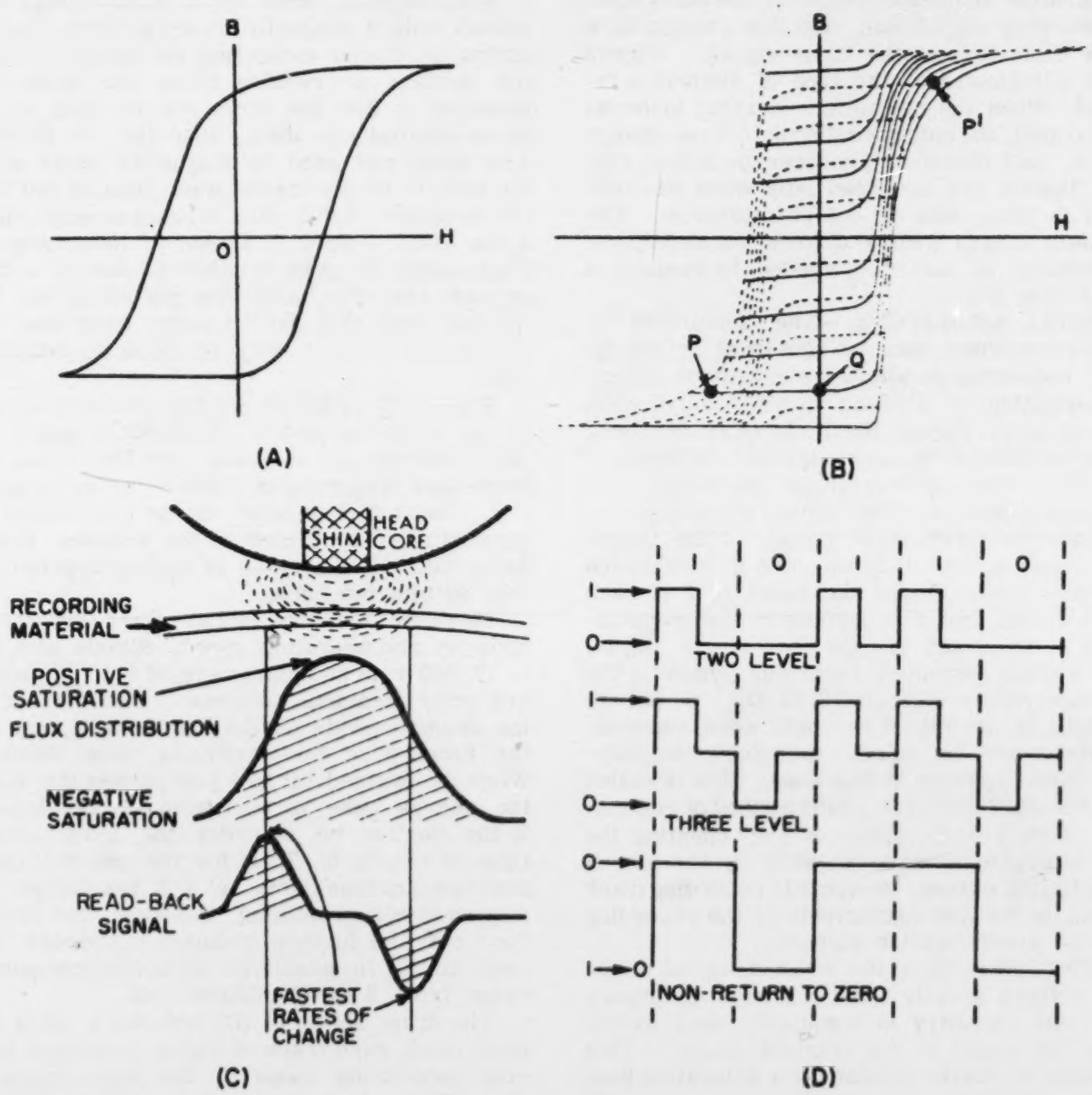

Figure 10-22.—Magnetizing ferrite materials. (A) Idealized B-H curve; (B) more realistic representation; (C) recording method, showing distortion; (D) recording levels.

which indicates the loop represents the ideal case of a symmetrical magnetizing force. This situation does not apply in computers. A more realistic representation of the hysteresis loop is shown in (B). A complete representation of the magnetizing process would show that successive B-H loops do not exactly close; but each time a new loop is formed, it more closely approaches the ideal loop, until the difference becomes undetectable after a few cycles.

RECORDING.—The process of recording a 0 or a 1 on a magnetic medium involves two opposing problems:

1. To obtain the highest practical packing density (storage of the maximum number of items in the minimum space).

2. To maintain reliability (ability to recognize and use the stored data).

In order to obtain the highest packing density, considerable distortion must be tolerated.

A saturation amplitude signal is normally used in recording digital data, and this results in a gross distortion of the input signal. Figure 10-22 (C) illustrates the type of distortion involved. When the magnetic recording material is saturated, the output winding detects no change in flux, and therefore produces no output signal. Signals are produced only when the material is going into or out of saturation. The magnetic airgap (shim) dimensions determine the amount of material needed to record a single data bit.

SIGNAL AMPLITUDE.—The amplitude of signals recorded may be two-level or three-level, depending on whether a condition of zero magnetization is allowed to exist other than momentarily. Figure 10-22 (D) is an idealized representation of the binary number 10110 (decimal 22). The top waveshape represents the two-level signal, and the center waveshape represents the three-level signal. In the three-level system, note that the zero magnetization condition exists during the latter half of each data bit, and that the polarity of the magnetization is reversed for the 0 or the 1 digits.

In a third system of recording (shown in the bottom waveform of figure 10-22 (D)), no change of output is permitted to occur when succeeding digits are the same; therefore, no playback signal appears at this time. This is called the NON-RETURN-TO-ZERO method of recording. With a long series of 1's, counting the time intervals is made possible by the use of clock timing pulses. A separate recording track is usually devoted exclusively to the recording of these synchronizing signals.

READOUT.—Since the readout signal waveform differs greatly from the reading signal, additional circuitry is frequently used to restore the signal to its original shape. This circuitry normally consists of a saturation amplifier and clippers, or reshaping circuits such as those discussed earlier.

Memory Drum

Since many computers have magnetic memory units that move under heads, the information stored in the various channels can be changed as an operation progresses; that is, during the time that a problem is being solved—such as the bomb release point—some of the items of data will be varying and must be changed as the problem progresses. The heads of pertinent channels will be used to erase and rewrite information in those channels as required.

The magnetic drum is an aluminum cylinder coated with a magnetic material arranged in strips or tracks encircling the drum. Heads for writing or reading from the drum are mounted so that the drum rotates past and in close proximity to them. (See fig. 10-23 (A).) The heads are used to magnetize spots along the surface of the tracks when data is fed into the computer, and to pick off data as magnetized spots cause a pulse to appear at their outputs. This action is quite similar to that of a tape or wire recorder, since the portion of the revolving drum that passes under each head can be thought of as a ring or band of magnetic tape.

Figure 10-23 (B) shows how channels appear on the magnetic drum. In order to place the maximum number of heads over the drum, the heads are staggered in position as indicated in (C). Each pickup head can be considered as representing a channel of the rotating drum. Each channel is capable of storing approximately 80 bits per inch.

Magnetic memory drums vary greatly in capacity and operating speed. Speeds of 3,000 to 17,000 rpm and diameters of 4 to 12 inches are quite common. Access to data stored on the drum depends on the rotational speed and the location of the particular data desired. When the desired bit has just passed the head, the access time is maximum (1 revolution). If the desired bit is under the head, access time is nearly 0. Thus for the general case, average accesss time is 1/2 revolution. By improved programming methods, this access time may be further reduced. Average access times in practical airborne computers range from 2 to 10 milliseconds.

The drum shown in (D) includes a quick access band, each track of which comprises several circulating loops of the type shown in (E). These loops waste that portion of track (if any) which is not between the two heads which comprise a loop.

Each channel on the drum is identified, and the location (address) of each bit or word is identified. The channel may be thought of as resembling a motion picture film, with block separations to locate a specific word or bit. The address of a specific binary word is identified as to its channel, block and location within the block. The blocks will, of course, be very small as compared with the film.

Many bits are recorded in each block of each channel; and since the bits pass under

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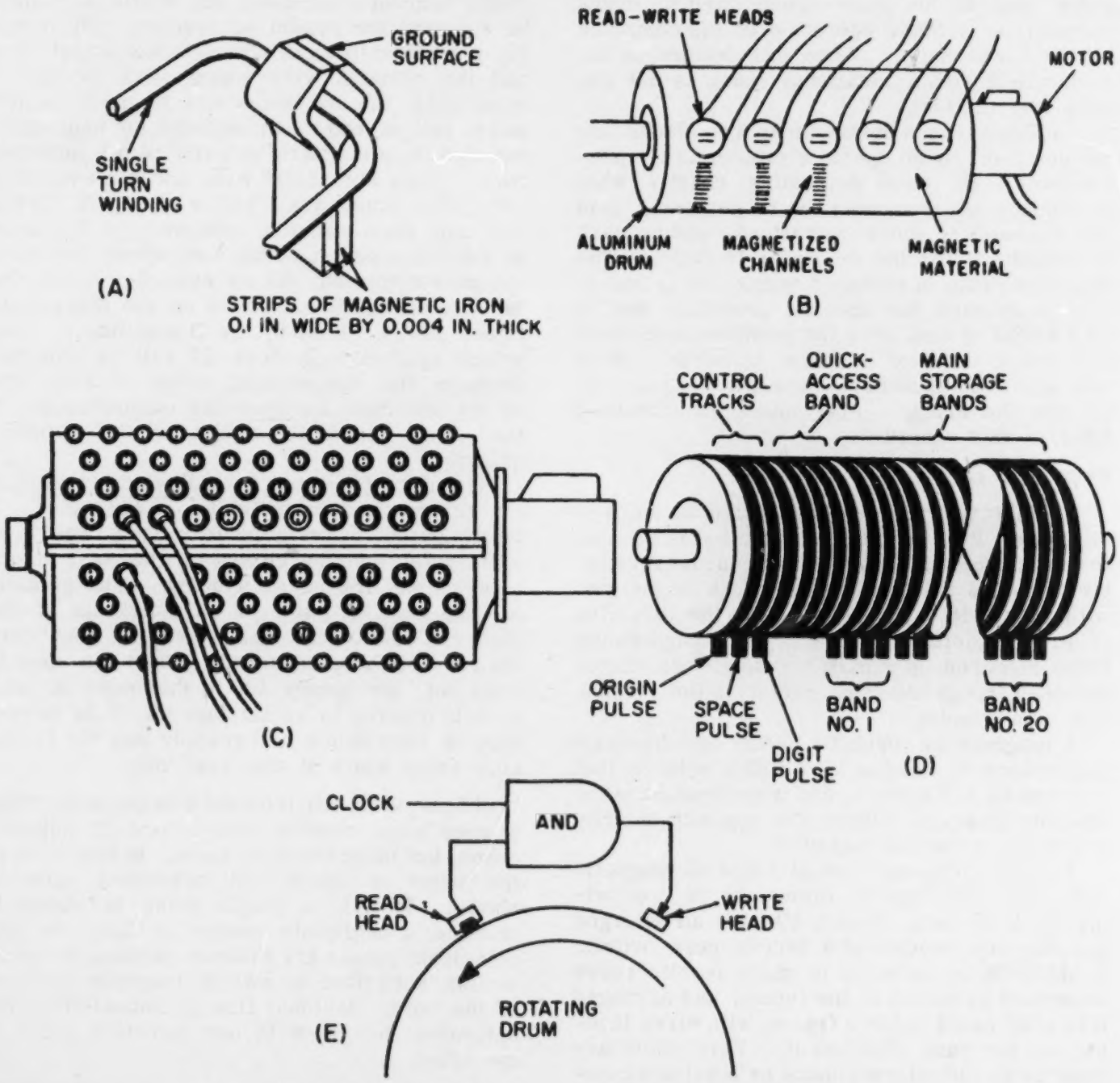

Figure 10-23.—The magnetic memory drum unit. (A) Read-write head; (B) magnetic drum; (C) arrangement of heads on drum; (D) arrangement of tracks on drum; (E) read-write circuit, block diagram.

the head one at a time, some method of identifying the start of a word must be provided. The first channels of the drum have magnetized sectors that provide for positive location of a word or digit within a word. These sectors usually contain pulses used for timing, location of words or word groups, word separation, and bits within a word. The timing pulses synchronize the actions of the other channels. In this manner, all the data on all

channels is in synchronism with the timing pulse; and if the drum speed varies, every calculation or other operation of the computer varies accordingly. When this feature is incorporated, drum rotational speed is not excessively critical.

Information and instructions are placed into the computer by an operator (known as the programer). He must determine exactly what operations the computer is to perform, plan the sequence of these operations, and prepare a PROGRAM for the computer to follow. The magnetic drum in airborne computers is normally programed for specific problem, and is CLEARED of data after the problem is finished and before the next problem is begun. Each new problem requires that new data be programed into the drum. Programing is discussed later in this chapter.

Ferrite Core Memory Element

Another type of memory device is the ferrite core. Its principle of operation is similar to that of magnetic amplifiers (discussed in chapter 9 of this course), in that it is magnetized with a polarity corresponding to the direction of the magnetizing force. The magnetizing force required is small; a single conductor passing through the core performs the function of a winding.

A magnetizing force applied in one direction magnetizes the ferrite core with a polarity that represents a binary 1, and when applied in the opposite direction causes the opposite polarity which represents a binary 0.

Ferrite cores are small rings of magnetic material, with typical diameters of approximately 0.05 inch. Figure 10-24 is an enlarged drawing of a section of a ferrite core matrix. A MATRIX is made up of many ferrite cores connected as shown in the figure, and arranged it in a flat panel inside a frame, with wires leading out for easy attachment. Very short access times (10 microseconds or less) are common, because modern high speed semiconductor switches make parallel access practical.

The arithmetic and memory units of a general purpose computer contain many of these matrices. Each core is capable of storing only 1 bit, so a matrix of 250 cores can store only 250 bits. Mutliplying the number of matrices by the number of cores per matrix gives the number of bits that a computer can handle.

In the figure, each core has three "windings." The wires that cross at right angles are used to magnetize the core, Using coincident current techniques, any single core may be selected for readin or readout. By passing a current through both the horizontal wire and the vertical wire which pass through a given core, the two fluxes may be made to add and to just exceed the threshold value necessary for switching magnetic polarity of the selected core. Each horizontal wire and each vertical wire pass through an entire string of cores. The only core affected, however, is the core at the intersection of the two wires that have the pulses applied. As an example, locate the junction of line B and line 2 on the diagram in figure 10-24. If both line B and line 2 have pulses applied, only core B2 will be affected, because the magnetizing effect of only one is not sufficient to cause the magnetization of the other cores to switch to the opposite polarity.

The use of a third (sense) winding permits the sensing of the switching of the core. If interrogated by coincident pulses, the core will switch and the change of flux will induce a pulse into the sense winding. The polarity of this induced pulse is an indication of the binary 1 or 0 that was stored in that core before switching occurred. When the core is read out, the binary bit in that core is lost. If it is desired to retain that bit, it is necessary to recirculate and reapply that bit to the core from which it was read out.

Single pulses will frequently be passed through a core when reading into or out of adjacent cores, but these cause no harm. In figure 10-25 the effect of single and coincident pulse is shown. In (A), a single pulse is shown to produce a negligible change in flux; in (B), coincident pulses are shown to produce a change in flux sufficient to switch magnetic polarity of the core. Residual flux is indicated by the saturation levels, N in one direction and S in the other.

TESTING.—A testing waveform of current may be used to determine the effect of repeated single pulses on a given core. In the ideal situation, a single pulse will have no effect, but this is not necessarily true in practice. To determine the effect of many single pulses on a given core, the waveform shown in figure 10-25 (C) is applied to the core to be tested. A pickup winding is used to sense the response of the core to the testing waveform, and the output of the pickup winding is applied to an

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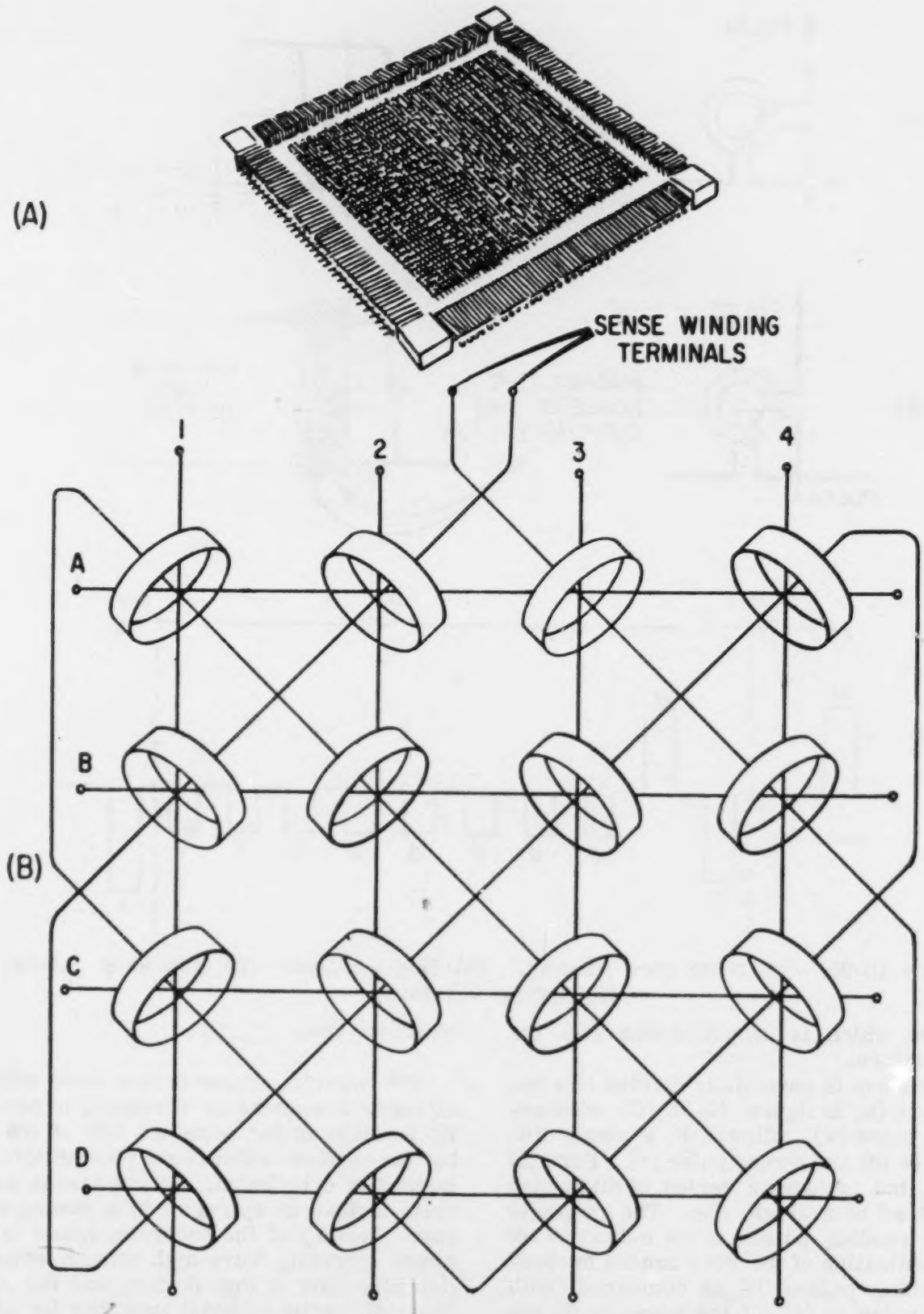

Figure 10-24.—Ferrite core memory. (A) Memory frame as it appears in the computer; (B) schematic representation showing wiring detail.

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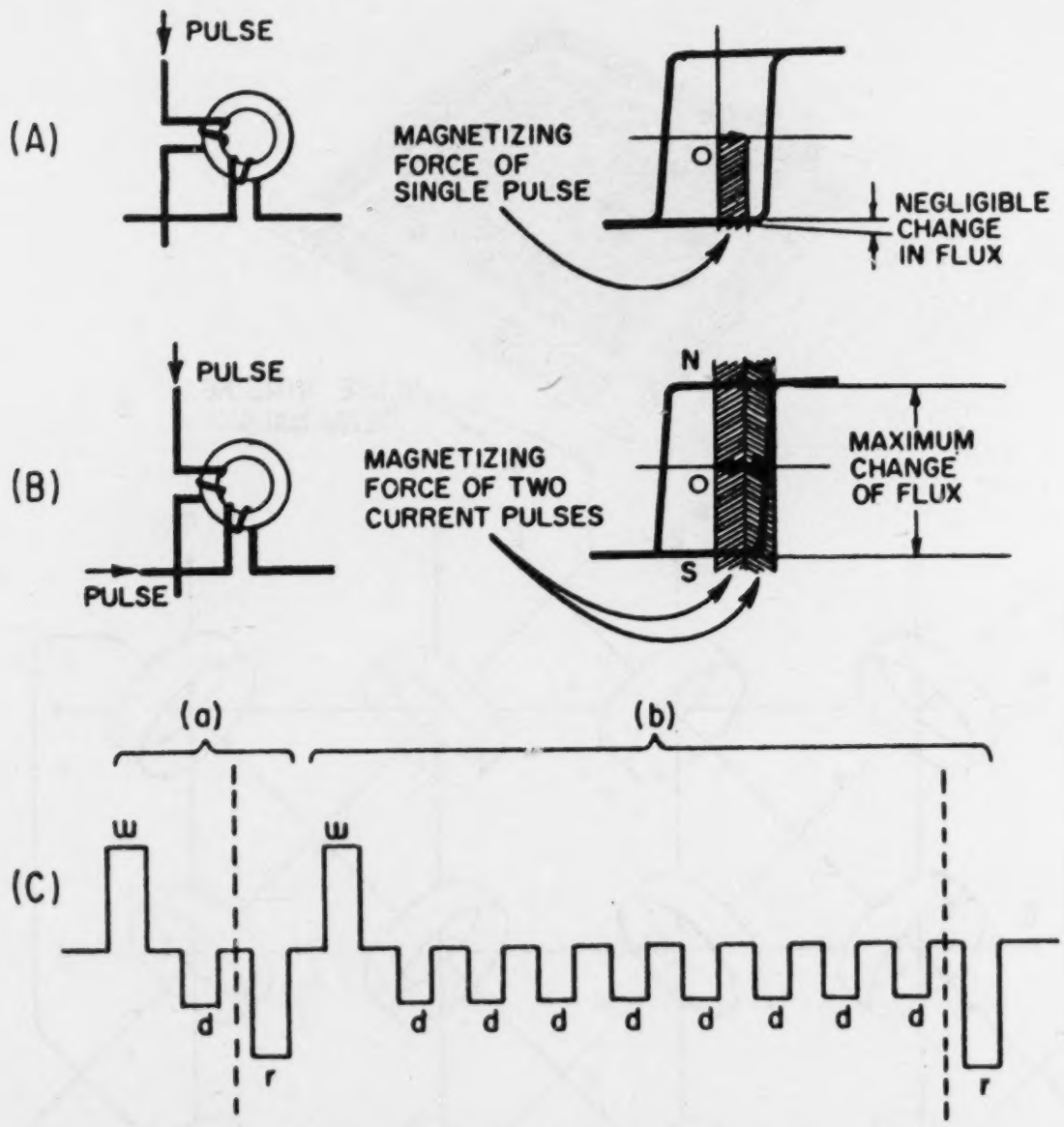

Figure 10-25.—Switching core polarity. (A) Single pulses; (B) coincident pulses; (C) testing waveform.

oscilloscope which is synchronized with the testing waveform.

The waveform is essentially divided into two parts. Part (a) in figure 10-25 (C) consists of a write pulse (w), followed by a single disturbing pulse (d) and a read pulse (r). Part (b) is similar, but includes a series of disturbing pulses instead of a single one. The response of the two reading pulses is an indication of the demagnetization of the core caused by several disturbing pulses (b) as compared with the single pulse in (a). If the response to the disturbing pulses is excessive, the core must be rejected.

Magnetic Disk

The rotating magnetic disk used with some airborne computers is increasing in popularity. Its function is the same as that of the drum, but the surface is flat like a phonograph record instead of cylindrical, and the tracks are circular instead of spiral as in a phonograph record. Spacing of the recording heads is maintained constant. Very high storage capacity is characteristic of this device, and the low mechanical inertia makes it appealing for airborne applications. Disk storage units have been built with 100 concentric tracks on each side of

each disk. Figure 10-26 indicates the construction of the disk type magnetic storage unit.

Magnetic Tape

Perhaps the most "familiar" type of storage is magnetic tape. The materials used for recording may be the same as those used for audio recording, except that a very high quality tape is required to avoid missing an occasional bit. Seven-channel tape (common in computer work) is usually 1/2 inch wide, and has a recording density of 100 to over 500 bits per inch. A 2,400-foot roll can store about 3 to 16 million characters. (This is less than the apparent maximum, because the gap between recorded sections of tape may be from 1/2 to 2 1/2 inches.) The tape must be brought up to operating speed before reading or writing is begun. Actual tape speed may be as high as 240 inches per second.

Since input and output devices are generally mechanical, it may be advantageous (both for speed and economy) to record the computer output at its optimum speed on tape, and later play it back at any convenient speed into the appropriate terminal unit. Similarly, a separate tape track may carry other data essential to the evaluation of the tape. Thus a flight performance monitor may furnish a complete log of equipment operation and performance, from preflight to postflight. In this instance, a low speed would be required, with data being fed into storage at regular intervals during the flight.

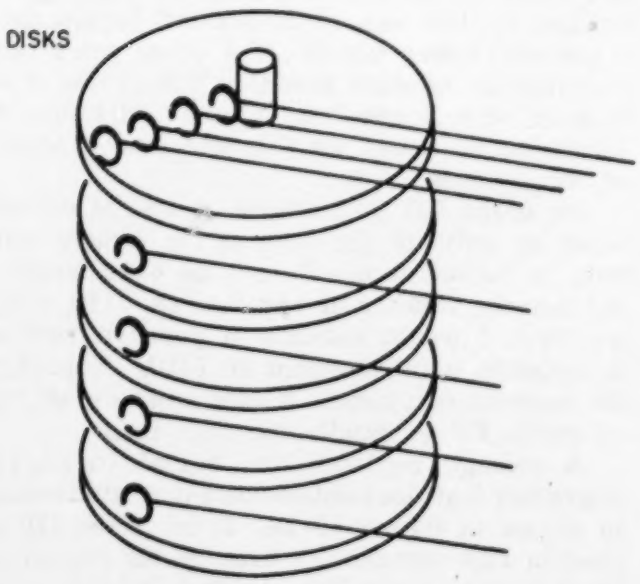

Figure 10-26.—Magnetic disk storage device.

Tapes produced by computers are used extensively for controlling other processes. Since the data is digital, it can be operated at various speeds, and even stopped, with no loss or distortion of data while other operations are performed.

Many techniques are available to overcome random data acquisition on tapes. These include use of multiple tracks, multiple read heads, etc. The chief advantage of magnetic tape is its ability to store millions of data bits inexpensively. Under ordinary operating conditions, magnetic tape is usable up to 50,000 times. Data on a used tape may be transferred to a new one. Temperature and humidity must be controlled, as variations may cause the oxide surfaces to crack. Since dust may cause a signal to be missed, extreme care in manual handling is necessary. Oil or moisture from manual handling may encourage the collection of dust.

Other Magnetic Devices

A readout device with characteristics similar to those of the ferrite core, but whose stored data is not destroyed in the reading process, is called the TRANSFLUXER. Figure 10-27 (A) shows that a second, smaller aperture is used to permit sampling and possible switching of only that portion of flux which exists around the small hole. During readout, this device does not switch all the flux contained in the core. The transfluxer may also be used for storing analog quantities.

The THIN FILM DOT ARRAY memory device (shown in fig. 10-27 (B)) promises very fast, compact, and inexpensive switching. Access time of 0.2 microsecond has been demonstrated. The magnetic characteristics of this thin magnetic surface are directional in nature; the film is easy to magnetize in one direction, but hard in a direction at right angles to that direction. The magnetization characteristic in the direction of difficult magnetization is essentially without hysteresis (instead of a B-H loop, it collapses into a line), but the B-H characteristic in the direction of easy magnetization is the familiar square loop.

Register

A registers is a device that provides temporary storage of a binary word during computation. Registers are composed of flip-flops

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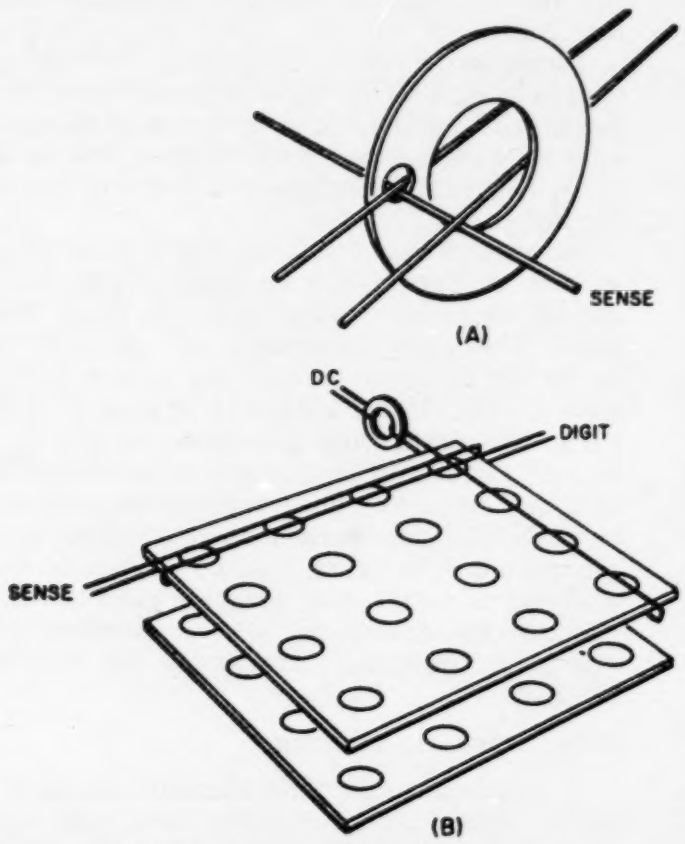

Figure 10-27.—Magnetic memory devices. (A) Transfluxer; (B) thin film dot array.

(FF's) and are generally found in the control and arithmetic units of digital computers. There may be several in a large computer; however, a simple arithmetic unit may contain only one or two. The number depends on the amount and variety of other storage facilities that are included. It is also somewhat dependent upon the speed with which the computer is designed to operate. A relatively long time is required for readout of a word from a magnetic drum memory; a shorter readout time is possible with magnetic core matrix type memory units. Generally, one or more arithmetic registers can be used to advantage in speeding up the computation.

Remember that a word is a group of pulses; each pulse, or lack of one, represents a bit; each bit represents binary digit whose value is 1 or 0. The chair of bits can be of almost any length. This group of pulses at the input unit can represent instructions, constants, and/or variables for the problem. In the actual arithmetic circuits, the pulse chains that represent the constants and variables for the problem are present. The instruction portion of the word is used to program the computer.

STORAGE REGISTER.—A storage register is used to store a word temporarily. Storage registers consist of a group of FF's capable of storing the maximum word length expected; they operate in the same fashion as counter FF's. Figure 10-28 represents a storage register which is capable of handling a four-bit word. The lower group of FF's comprise the register, and the upper group form and associated counter. Between the two is a group of AND circuits. (Note that the input to the counter is in serial form and the input to the register is in parallel form; therefore, it also forms a serial to parallel converter for the word. The counter is included in the set because of this function as a converter.) First, the word is applied to the counter. Later a read pulse is applied to the AND circuits. If the read pulse and the voltage at the 1 output of a particular counter FF agree in voltage levels, a 1 pulse is transmitted to the corresponding register FF. No signal is transmitted to a register FF if the 1 output of the corresponding counter FF is at a 0 voltage level or, in any case, until there is a read pulse applied.

Each register FF can store a single bit, representing a 1 or 0. Note that at the same time a 1 is represented by a 1 level of voltage at the 1 output terminal, a 0 voltage level is represented by the 0 output terminal. The output from the lower FF's (fig. 10-28) might be applied to the augend or addend terminals of a parallel adder circuit, the other word being supplied by similar means. If both the 1 and 0 leads are connected to other circuits, the condition is known as "double lead transfer" of information.

An extra bit is included in an information word to indicate the sign of the binary number. A three-bit word such as +110 would be fed into the counter or register as 0110, where the first 0 would indicate a positive number. A negative number would be 1110. Therefore, the circuits that handle signed words must have an extra FF to handle the sign bit.

A storage register and serial to parallel converter that does not use an associated counter is shown in figure 10-29. Delay lines (D) are used in this instance to provide the conversion from serial to parallel. Each delay line introduces a delay equal to one input pulse spacing,

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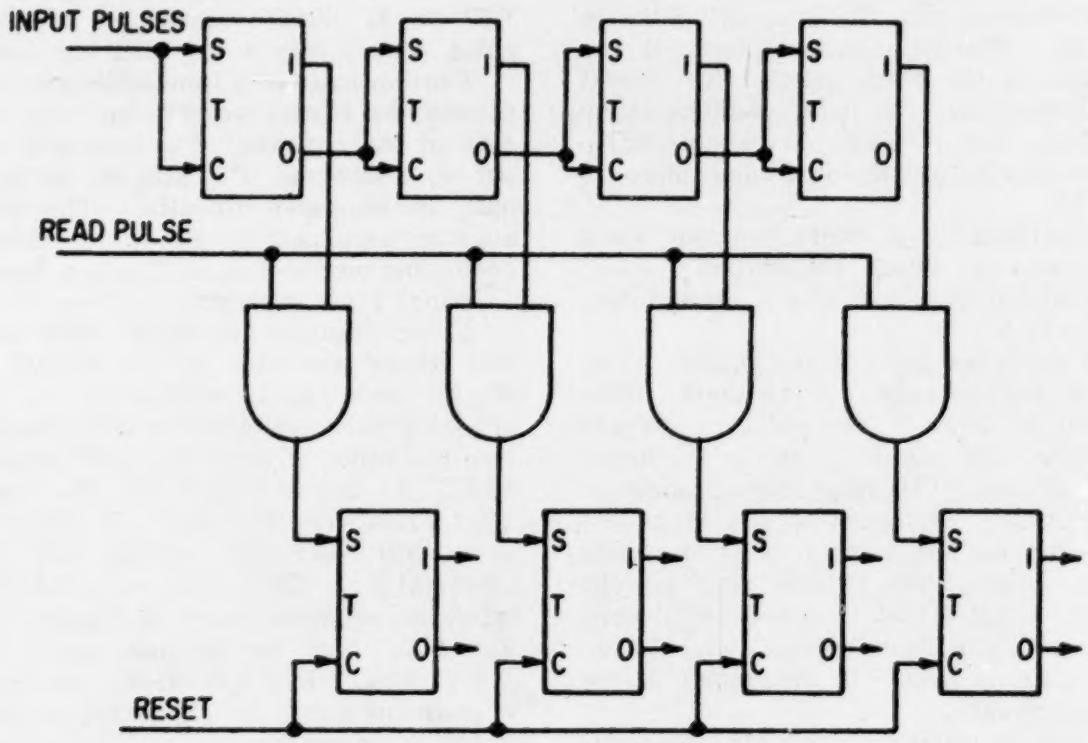

Figure 10-28. —A four-bit register and associated counter.

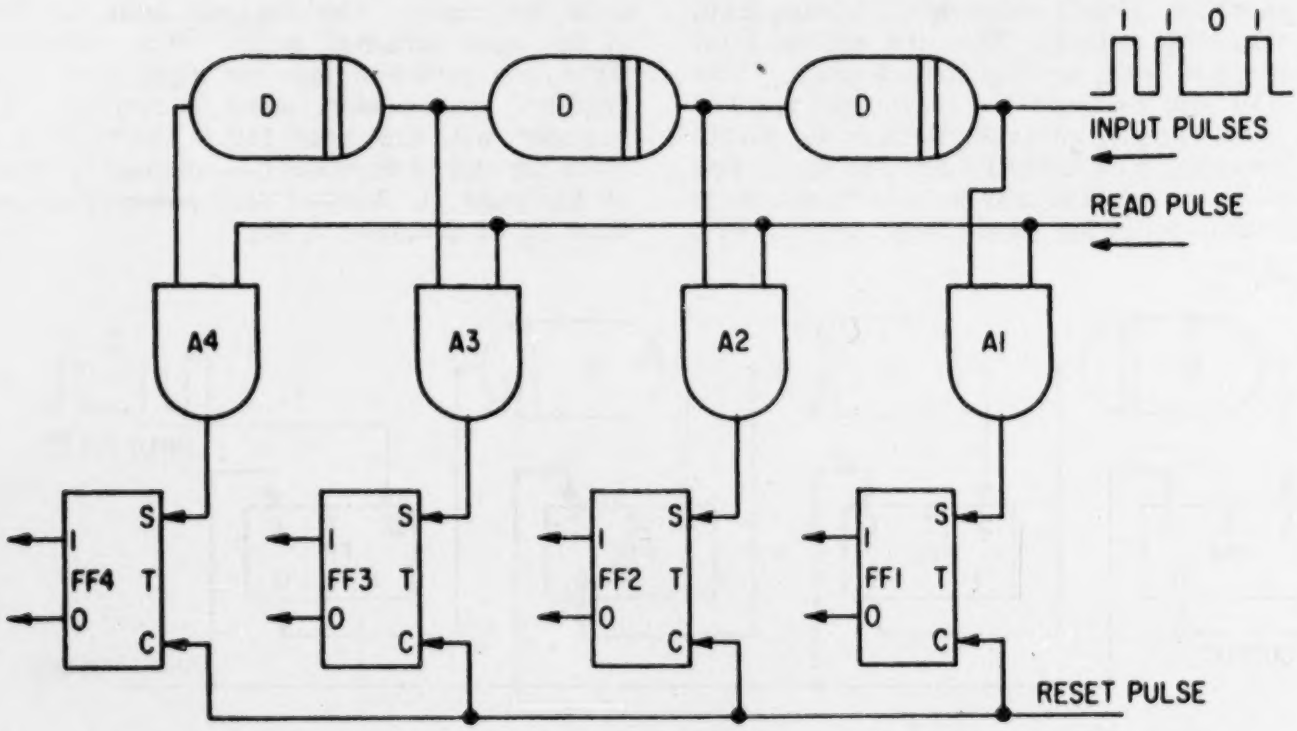

Figure 10-29. —Storage register using delay lines.

Therefore, the first input pulse (the one shown at the left in the pulse train) arrives at A4 at the same instant that the last bit pulse is applied at A1. The input pulse spacing is the same as that of the clock pulses for serial form. Therefore the read pulse could be taken from the clock, but it must not be applied to the AND circuits before the last input pulse is applied to A1.

SHIFT REGISTER.—A shift register is a storage register in which the stored number can be shifted left or right with a shift pulse. (See fig. 10-30.)

The shift pulse are applied continually, using the same spacing as the bits of the word. Since the FF would be upset if two pulses occurred simultaneously, the shift is applied midway between bit pulses. The stages are coupled so that any particular FF is set to a 1 state only if the preceding one was reset to 0 by the shift pulse. The delay lines (which may be RC circuits) have a delay that is only a small portion of the spacing between pulses. The operation of the shift register is discussed in the following paragraphs.

Assume that the binary word 1101 (decimal 13) is to be stored and that all FF's have been reset to 0. The first 1 bit is applied and sets FF1 to 1. This does not affect FF2. A shift pulse then occurs that resets FF1 to 0; and FF2 receives, after a short delay, a pulse from FF1 that sets it to 1. Then the second 1 bit is applied to FF1, setting it to 1 again. Now both FF1 and FF2 are set to 1; and another shift pulse occurs, resetting them to 0. Shortly thereafter, FF2 and FF3 are set to 1. The next bit in the word is a 0 and has no effect on FF1. The following shift pulse resets FF2 and FF3 to 0; later FF3 and FF4 are set to 1. FF1 and FF2 now read 0. The last bit sets FF1 to 1. Shift pulses are stopped at this point, and binary word 1101 has been stored.

The application of four additional shift pulses causes the stored word to be read out the left side of the register. The contents can be read out to additional FF stages, to the memory unit, or to adder circuits. The output might also be returned to the input, through pulse reshaping amplifiers, to form a dynamic (circulating) type register.

If the register contains many more stage than there are bits in the stored word, the stored word can be shifted to the left and its changing value doubled by each successive shift. For example, if the word 1101 (decimal 13) is shifted to the left by 1 bit, the register will read 11010 (decimal 26). If 11010 is shifted to the left again, the register will read 110100 (decimal 52). Therefore, each left shift multiplies the register word by binary 10 (decimal 2). Note that the decimal point location in the register does not shift. In this case, it remains at the input terminal, or the right of the last stored bit.

Additional stages have to be switched into the right-hand side of the register before the word 1101 can be shifted to the right. Assume that 1101 is stored and it is desired to shift it to the right. The decimal point is fixed at the input terminal point. Now, additional FF's are switched into the right side of the register, and a shift pulse is applied. The register will now read 110.1 (decimal 6.5). Thus the stored word has been divided by binary 10 (decimal 2). Another shift pulse would produce 11.01 (decimal 3.25).

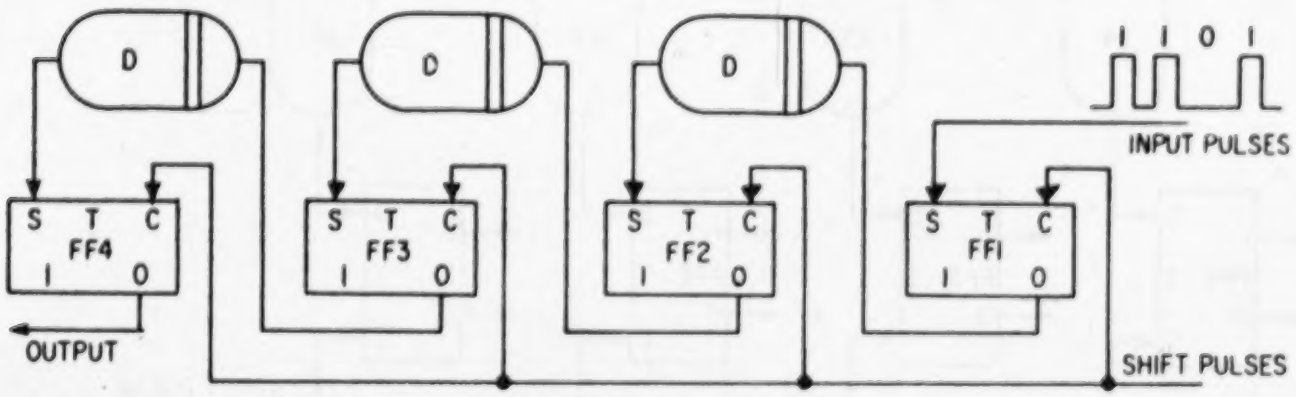

Figure 10-30.—Shift register.

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ACCUMULATOR.—Of the various types of register found in an automatic digital computer, the type which has the capacity to store a word, then receive additional words and sum the total, is the most important. A register with these features is defined as an accumulator. It will most likely also incorporate left and right shifting features and be capable of dynamic operation. It will be able to provide this additional feature while handling the maximum computer word length. Figure 10-31 presents a simplified block diagram of a serial arithmetic unit and indicates the importance of the accumulator. The accumulator can receive or send information to the memory unit; the stages of the shift register can be added to the accumulator to form a double-length accumulator during multiplication and division; and the complement register can be complemented and its contents added to the contents of the accumulator.

PROGRAMING

A digital computer can add or subtract almost indefinitely, and with lightning speed. For this speed to produce meaningful results, the computer must be supplied with complete instructions before each operation. The speed, accuracy, and versatility of the computer are determined by the type of instructions provided and the manner in which they are given. These instructions will at times be specific information, such as a number that represents some item of data, and at other times will be a number that represents an instruction. For instance, the program may instruct the computer to carry out a sequence of operation as follows:

1. Select a specific item from a specific location of a channel and transfer it to the arithmetic unit.
2. Select another item from some other channel and transfer it to the arithmetic unit.
3. Compare the two numbers.
4. Place the larger of the two numbers in a specified address on a specified channel.

The program portion just described is a simple example used to show how a programer talks to a computer. The programer may not be concerned with the actual answer to the problem, but only that an answer will be produced and placed in the memory unit at a specified address. The computer may be instructed to perform the same operation over and over; and if any of the data changes, the solution will also change. The solution to this problem will probably be used in other calculations required in the overall operation.

The programer for a computer does not necessarily need to know the mechanical or electronic theory of a computer, but he does

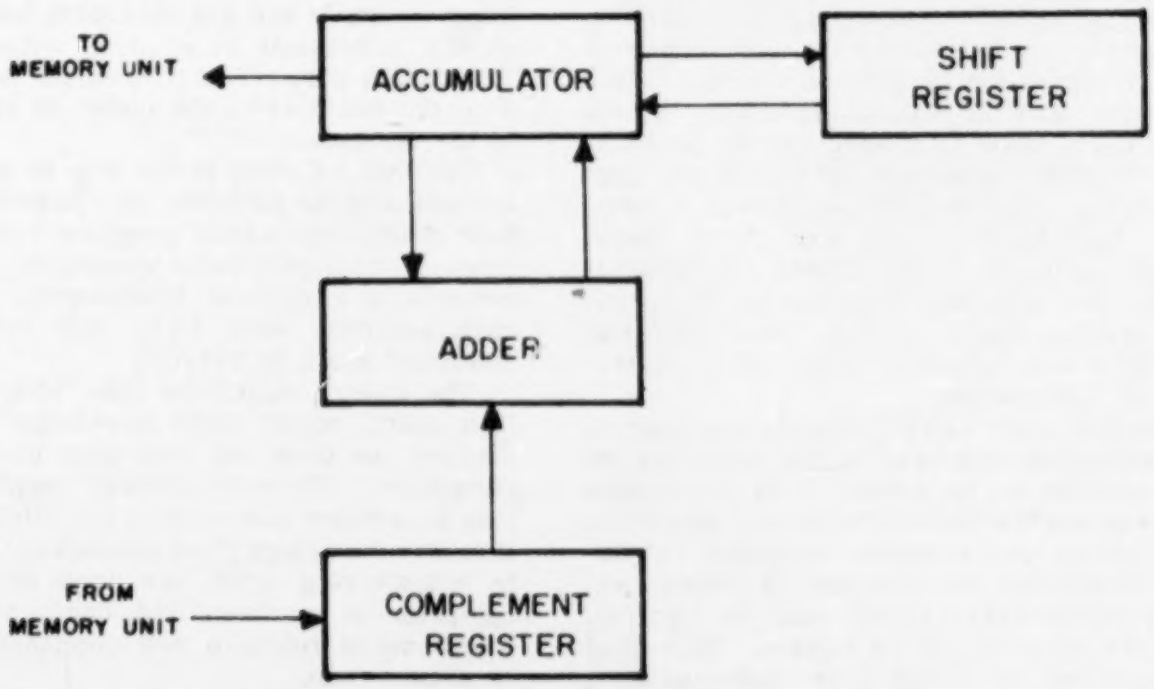

Figure 10-31.—Simple serial arithmetic unit.

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need to know its maximum capabilities, number of words per block, number of bits per word, number of channels, and access time.

The switching or routing system of signals in computers can be compared to a huge railroad yard where many trains are being routed through a maze of tracks. All the trains are controlled from a central point and move as directed by the controller. A train is formed by directing an engine to move through the maze of tracks in the yard, picking up one or more cars at designated points. The completed train then moves out of the yard as an integral unit.

The paths followed in forming the train were predetermined and directed in sequence by the controller. In a similar manner, the control unit of a computer will be the controlling device that does the switching, and the courses taken by the binary bits will resemble the tracks of the yard. In the output of the computer, the completed data will be analogous to the train.

The Program

When the programer makes a program for a computer, he determines the sequence of operations necessary for the solution of a problem. Many automatic functions are built into the computer, such as switching, counting, arithmetic operations, and others involving the special mechanics of arithmetic employed by computers. A program may be set up in such a manner that each operation is given a coded number designation, and the programer merely inserts the coded numbers as instructions to the computer. Programing is technically only one part of preparing a problem for solution by a computer. Actually there are four major steps, as shown in figure 10-32. These are numerical analysis, planning the sequence of operations, (programing), coding, and checking. These jobs are frequently referred to collectively as "programing."

NUMERICAL ANALYSIS.—Numerical analysis is the definition, in proper mathematical terms, of the problem to be solved. It is the science of reducing real problems into terms, quantities, and equations that a digital computer can accept. In all but the simplest problems, extensive numerical analysis may be required before the program can be written. How does one represent an integral or differential, a cosine, or a quality? Numerical tricks, approximations, and even arbitrary values must be used in order to translate these concepts into the discrete, numerical values required by the computer.

PROGRAM PREPARATION.—Normally problems are too long and too complex to encode directly from the mathematical analysis. Programing provides the shorthand, or guide, which makes it possible to translate the mathematical operations into the step by step operations required by the specific computer to be used. Programing is primarily the task of drawing flow charts, or block diagrams, and planning memory allocations.

A flow chart (illustrated in (B) of fig. 10-32) is essentially an annotated block diagram and is an organizational convenience. In addition to depicting the overall system logic, it shows the sequence of logic operations, the result of each choice, and the time and entrance point of all new data.

Although it is intended principally as an aid in writing the computer code, the flow chart is also an excellent troubleshooting and testing device. It has symbols to describe the various functions to be performed, to indicate a logical choice or optional sequence, and to show when a sequence is changed by new or modifying instructions. Additional symbols and conventions are generally used to simplify the diagram and to make it a more complete instrument for aiding the man writing the code. These symbols are not standard, but they are usually consistent in a given set of charts. Their main purpose is to transfer information from the designer to the coder or other users of the computer.

CODING.—Coding is the step by step transformation of the problem, as mapped out by the flow chart, into a final program written in the language of a particular computer. Coding is essentially a precise bookkeeping operation; each address, each digit, and every single command must be correct.

The coder, unlike the man who writes the flow chart, needs little knowledge of mathematics; he does not even need to understand computers. The only absolute requirement is that he adhere inflexibly to the rules as established by the design of the computer. Generally, in transferring from one type or model of computer to another, the coder must learn a new set of rules, a new computer language, or a new code.

CHECKING.—Checking, or verifying, is the final step in the preparation of a particular

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(A) NUMERICAL ANALYSIS

PROBLEM: DETERMINATION OF POSITION

$$P = at^2/2 + bt + P_o$$

a = ACCELERATION
b = VELOCITY
P_o = POSITION AT t=0
t = TIME

(B) PROGRAMING

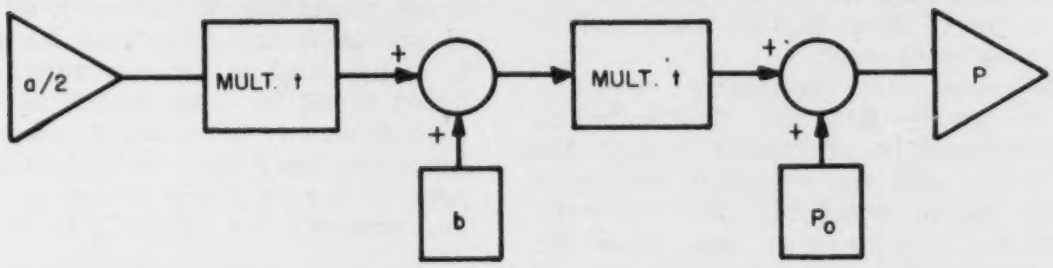

(C) CODING

INST. NO.	INSTRUCTION
1	READ IN a/2
2	MULTIPLY BY t
3	ADD b
4	MULTIPLY BY t
5	ADD P_o
6	READ OUT

(D) CHECKING

INST. NO.	
1	a/2
2	at/2
3	at/2 + b
4	$at^2/2 + bt$
5	$at^2/2 + bt + P_o$

$$P = at^2/2 + bt + P_o$$

Figure 10-32.—A simple program for a digital computer.

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computer problem. It is frequently performed automatically. The sole purpose of this step is to insure that the coder has made no errors. The coded program may be stored internally or externally. Storage will be semipermanent or permanent, depending upon the purpose and application of the computer.

INPUT AND OUTPUT METHODS

The primary application of plug-in units in large digital computers is to supply multiple input and output devices capable of being individually and/or collectively coupled to the computer. Numerous devices have been developed to take advantage of the speed of the computer; a few of these devices are described in the following paragraph.

All converters are essentially counting, weighing, or reading devices. The output of the converter should be compatible in form and time availability with the computer that is to use it. The speed, precision, and accuracy required of the measurement determine the type converter used. Since the majority of inputs to airborne computers are available in analog form, the analog to digital converter type input is used extensively. Devices of this type are available to convert most analog inputs to digital form with almost any desired degree of accuracy.

In the sample program just discussed, the values of a, b, and P_0 are variable (and possibly constantly varying) quantities which are available in analog form from aircraft instruments or from computer sections. The following paragraphs discuss briefly each of the quantities, fixed or variable, included in the problem:

1. Acceleration (a) is available from an accelerometer in some form such that the output of the device is proportional to (analogous to) the acceleration. It represents a change in velocity.

2. Velocity (b) represents the resultant of the combined airspeed and wind vectors, such as the AN/ASA-47 calculations discussed later in this chapter. Since velocity is variable during the flight, this quantity may be available directly from the computer, or it may be stored in an easily erasable memory circuit and corrected as the occasion demands.

3. The time interval (t) is determined by clock timing pulses. The shorter the time interval (and the more nearly constant the clock PRF), the more accurate the possible computations.

4. Position at time zero (P_0) indicates the position at the beginning of the time interval. At the beginning of the solution, this position may be inserted manually, or it may be made available to the computer from an automatic navigation system.

5. Present position (P) represents the solution to the problem, and is the usable output of the computer. Since this data is continually being revised each time the computer cycles through the program, it is stored in an easily erasable address.

If it were necessary to determine each of these quantitites, to convert it into digital form, to encode it and determine the program, and to apply these to the computer, the computer speed would be of no significant value in one-time solution. The value of computers in actual flight situations lies in the automatic and repetitive nature of the computer. Specifically, this includes the following abilities:

1. To accept the required data automatically, provided only that it be included in the program and that it be in the proper form for use by the computer.

2. To perform the programed computations with great speed.

3. To perform the same computations over and over.

4. To make corrections during each computation cycles, as the situation requires, reflecting any change in values that may have occurred since the last previous cycle.

5. To store the result of the last previous calculation for use in the next computation.

In the problem under current consideration, refer to figure 10-32. The program is built into the computer; all required data is immediately available from aircraft instruments or other computers, or it is stored in the storage unit of the computer. In connection with the solution of this particular problem, certain pertinent factors must be considered.

If the aircraft is flying at a constant velocity, the acceleration is zero, and the preliminary solution to "at/2 + b" is simply "b." The value of b from the previous cycle of computation is stored at a specified address in the memory unit; when needed, b is applied to the computer input and used in the new solution.

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If the aircraft changes velocity, an accelerometer is used to sense and evaluate the acceleration taking place. Any increase in velocity represents a positive acceleration, whereas a decrease indicates negative acceleration. The computer must be capable of distinguishing between the two, and must be able to make the computation for either.

Multiplying the average value of acceleration during the time interval (at/2) determines the change in velocity which has occurred since the previous computation cycle. Adding this correction to the former value of b results in a new velocity, which is used in the present cycle and then stored in the memory unit at the b address for use in the next solution.

Multiplication of the new value of b by the time interval determines the change of position that has occurred since the last cycle, and indicates the correction that must be added to the last known position (P) in order to determine the new P.

P_0 represents the last known position, and is stored information. Adding the correction to the last previous result provides the computer with a new value of P which is the usable output of the computer. This information then becomes the P_0 for the next computation cycle.

If it is desired that a computer should continually calculate the course and distance from the present position to the point of origin, another section of the computer could be programed to perform the computations involved. This would require a permanently stored reference position, and additional circuitry to compare the two positions and to compute the course and distance between them. Readout of this information could be made continuous, or it could be made available upon demand. If the solution is required only upon demand, no storage is needed; if it is to be continually computed, storage should be in an easily erasable form, since it is continuously changing.

Analog to Digital Converters

During a flight, the variable quantities just mentioned probably originate in analog computers. Since a digital computer accepts only binary quantities, the analog data must be routed through a converter and changed into digital form for insertion into the computer.

Another problem involving changing quantities is the question whether the remaining fuel is sufficient to allow the aircraft to reach a given destination. Almost all factors of such a problem are variable—time, fuel, airspeed, groundspeed, drift, altitude, fuel consumption rate, etc. Analog computers determine the present value of each quantity and supply it to the converter, which then converts the data into digital form. The computer may have a program outlined by which all the variables are considered in calculations that finally result in a YES or NO answer. The YES answer might cause a green indicator to light, and NO might cause a red indication. The computer may cycle the program continually, correcting the various quantities as needed, and temporarily storing the rate of change of each quantity, as well as the value of the latest computed quantity. With this arrangement, computations based on latest available data can continue in the event of interruption of operation, and the margin of error is decreased in that event.

The limit of accuracy of a computer is the least significant digit. There is no advantage in having an analog device more accurate than the control data available to it. As an example, a servo positioned by a five-digit binary control signal can indicate no closer than 1/32 (2^5 = 32) of a revolution, or approximately 11.3° regardless of the precision of the servomotor itself. The precision of output devices should be matched to the stored data, or at least to the level of accuracy required in the output application.

Angular converter outputs may be matched in reference to a defined 0° reference, or in reference to the last previously indicated angle. Many analog to digital converters utilize a wheel, a ring, or a spiral shaft encoder which is electrically or mechanically positioned by the quantity being measured. Several general types are discussed below.

SIMPLE BINARY WHEEL.—The binary wheel is a flat disk composed of concentric circles with each ring divided into twice as many sectors as the adjoining inner ring. Thus a properly coded wheel divides a circle into sectors, with the number of rings determining the accuracy of the device. Figure 10-33 (A) shows a five-bit shaft encoder of the general type just discussed.

Instead of the concentric rings, parallel bands on the wheel perimeter could be marked, and used to perform the same function. Coding could then be based on conducting and nonconducting layers, magnetic and nonmagnetic segments, transparent and opaque segments, or

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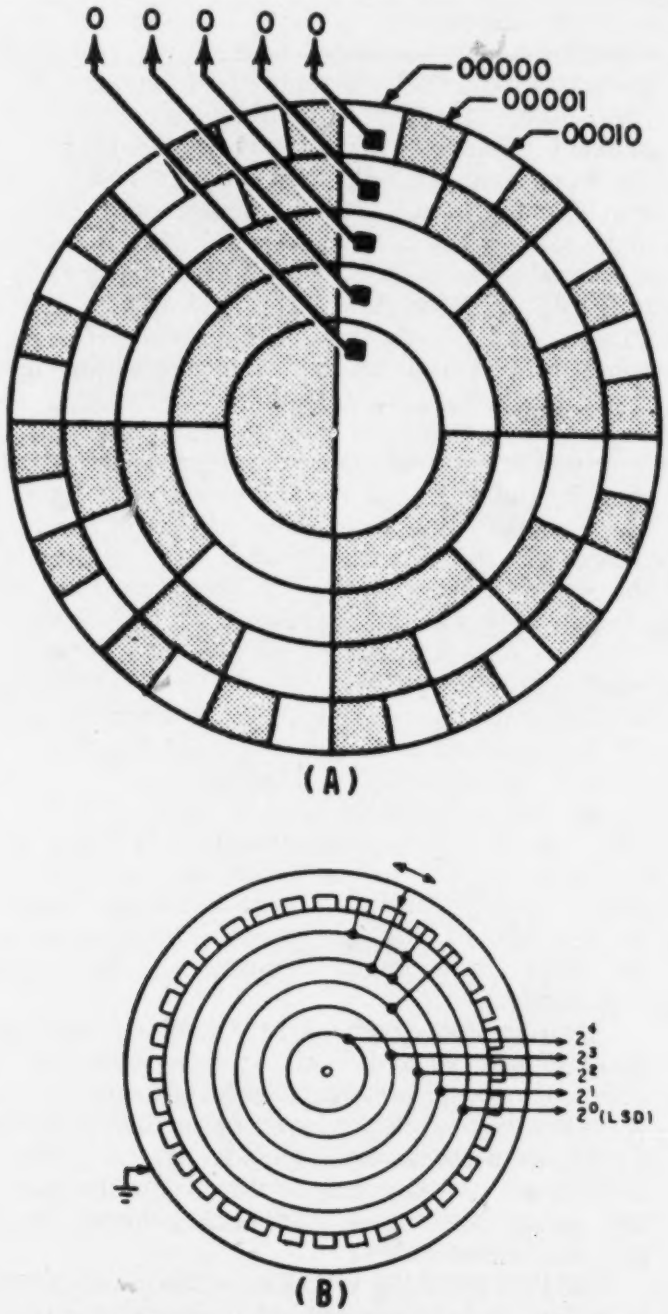

Figure 10-33.—A simple five-bit shaft encoder. (A) With five output requirements; (B) With a single output required.

raised and lowered segments which operate to open and close electromechanical switching devices. (See fig. 10-33 (B).)

SINGLE BRUSH SHAFT ENCODER.—A modification of the shaft encoder consists of a single brush on the shaft, making contact with multiple tabs on the perimeter of a wheel. These tabs are connected to buses in a nonrepeating binary code. Since the tabs are all on the perimeter of the wheel, only one brush is required, regardless of the number of points which are to be indicated. This results in the following three major advantages.

1. The rings need not be concentric or coplanar, but simply electrically insulated.
2. Identical printed wafers with distinctive tab codes could be stacked to form the switch.
3. A 14-digit encoder could be built using the same size case, housing, etc., as a five-bit unit.

GEAR DRIVE SHAFT ENCODER.—Most angular to linear conversion devices introduce a positional uncertainty which must be eliminated, either by limiting the permissible angle or by using two conversion units. The gear drive does not have this problem; it may be designed to represent any angle. The limits imposed are the minimum angle resolution and the maximum permissible size of the components. The minimum angular resolution is determined by the number of teeth per revolution. (See fig. 10-34.)

LINEAR POTENTIOMETER.—A potentiometer may be used with its two ends connected to fixed reference potentials. The angular position of the slider may be represented by the unloaded voltage at the slider. Any variation in the reference voltage, or any current in the sensed voltage, can introduce errors into the reading. The voltage can be used directly (analog), or it may be supplied as a scaled voltage to the converter. For digital applications, a tapped rather than continuous potentiometer may be used, with the output then encoded to binary form for input to the computer.

VOLTAGE TO NUMBER CONVERSION.—Electrical analogies (analogs) of most measurable quantities have been developed, with most instrumentation presenting its output as a scaled voltage (1 volt = 100 miles, 1 volt = 1,500 gallons, etc.). It is necessary to convert both the voltage level and the scale factor into terms usable by the computer. It is not always necessary that the scale factor be inserted, as long as the computer has it stored at a unique address.

Examples of voltage to number converters are the digital voltmeter and the self-centering potentiometer used in angle to number conversion.

VOLTAGE TO TIME TO NUMBER CONVERSION.—A coverter of the voltage to time to number type, in its simplest form, is very useful in scale systems. The converter may require clock pulses, a linear sawtooth of

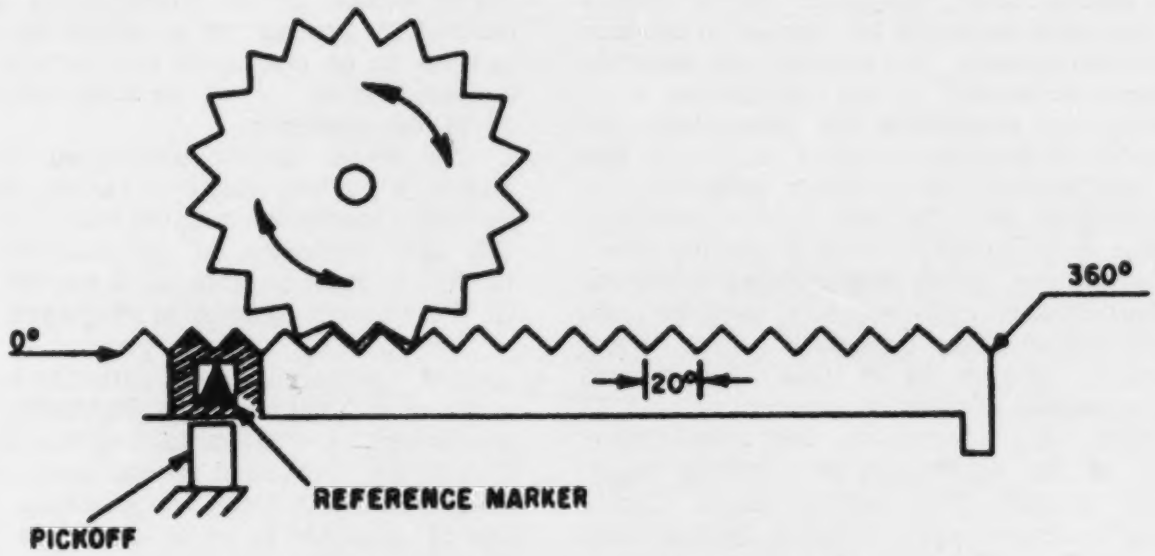

Figure 10-34.—Gear drive shaft encoder.

voltage (ramp), a voltage comparison circuit, and a voltage that is to be measured.

Digital conversion is provided by starting a digital counter that has been synchronized with the sweep, and stopping it when the sweep voltage and the unknown voltage are equal. The clock pulses are counted, and the voltage change per unit time factor is applied, so that the output reading is converted into a number. There is one counter output for each sweep as long as the unknown voltage is within the calibrated range of the sawtooth.

Accuracy of this system is limited by the slope of the sawtooth, by the accuracy of the timing system, and by the precision of the voltage equality determining system. Making the same measurement concurrently (using two or more converters) and averaging the results decrease the inaccuracies of the system.

The system indicates an instantaneous value; nothing is shown concerning the behavior of the input voltage before or after its intersection with the sawtooth. The sawtooth need not be linear, provided that its voltage as a function of time is known and used in the calculation.

SELECTIVELY ADD-SUBTRACT SYSTEM.—The operating principle of this system is the same as that of an equal arm balance, where an unknown weight in one pan is balanced by selectively adding or subtracting known weights in the other pan. The limit of accuracy, disregarding friction, is ±1/2 the smallest balance weight available. Similarly, a voltage balance analog system, selectively adding or subtracting scaled resistors until balance is obtained, may be used. The advantage of this system is that the voltage may be larger or smaller than the reference voltage. A simple example is a balanced bridge with binary adjustments. The system may start from a fixed point or from the last used point, with switching automatically sequenced and controlled by the computer.

Digital to Analog Converters

It is often necessary for the digital output to be converted to analog quantities in order to actuate a servo or some other device of an analog nature. Again, a converter is required; but in this case, it must be a digital to analog converter.

Practically any encoder (analog to digital converter) can be used as a decoder (digital to analog converter), either directly or in combination with a null-seeking driver. Frequently the only modification required is reversing the input and output functions of the device.

Readout Devices and Methods

Symbolic displays are generally employed for immediate use. The display system (matrix) may be formed by an array of individual lights; at may be based on variations of intensity or color on a CRT; or it may represent the locus of points on an X-Y plotter or on

a DRT plotter table. Computer output voltage levels and data rates can be adapted to produce any of these displays. The specific type selected will depend primarily on the application.

Timing and retentivity (or recording) may be selected to provide a display similar to that of an oscilloscope, of a radar indicator, or of a television set. The data can be arranged in alphanumeric, graphic, or photographic form. Multiple displays, using combinations of several individual display systems, are used in most airborne and military computers, both digital and analog. Figure 10-35 illustrates several common readout devices.

LIGHTS. —Each individual light may be considered as the equivalent of a binary stage: ON—true or one; OFF—false or zero. Lights are used to display such discrete data as fail-safe, on-off, and warning. They may be used in groups and in conjunction with ring counters to form binary to decimal conversion displays. Each individual light is sequenced and illuminates the appropriate digit when switched by the counters. (See fig. 10-35 (A).)

MULTIFILAMENT LIGHTS. —These lights may display numbers, letters, symbols, or combinations of these. Filaments may "edge light" lucite cards to illuminate engraved symbols, or may actually be shaped in the form of the symbol and glow when switched on. (Note fig. 10-35 (B) and (C).)

Lights require appreciable current—greater than that which is normally available directly from the computing circuits. Therefore, a buffer or amplifier stage is usually required to furnish the additional current. Since a single display illuminates multiple symbols and requires at least one terminal for each, it may require its own counter circuits to convert from binary code to the display code, or it may share a common converter with several other circuits. On the other hand, the individual filaments may be prewired to a printed circuit board, and the appropriate display selected and switches by computer circuitry.

The value or quantity being measured may be represented by a positioned display of multiple filament lights. The digital voltmeter is a fairly common example of the use of these lights.

WHEEL DISPLAYS. —Any one of the angle to number converters previously described can be connected as an output device, either to furnish an angle signal or display (pointer or servo signal) or to mechanically position a particular symbol on a wheel display. The symbol to be displayed can be any arbitrary number, letter, word, or other symbol selected by the designer.

The wheel can be positioned by a servomotor, by a step counting switch, by a digital to analog converter coupled with a motor, etc. The only limitation on the positioning system is that it must be able to drive the wheel until the correct symbol is displayed.

The display may be generated by wheels geared together in a fixed ratio (as in an odometer) or with each wheel individually driven and positioned. A disadvantage of the second system is the increased frontal area required to accomodate the drive mechanisms. The number of symbols to be displayed is limited by the size of the wheel and by the number of discrete positions that can be selected. (See fig. 10-35 (D) and (E).)

TAPE DISPLAYS. —Rather than increasing the size of the wheel to increase positional accuracy and to increase the number of symbols that can be displayed, tape displays are frequently used. The small wheel simply acts as an idler wheel for a tape bearing a large group of symbols. This system has several advantages, but the primary advantage is that it provides a clearly legible (precise) display in a minimum of space.

Many "games" can be played with the tape system to increase packing density. The digits of several tapes may be alined and projected. The depths of the tapes can be staggered, making it possible to package the drive mechanisms in line with the tapes. The tape can be coded and may actually carry the control wiring for its own positional drive motor, simplifying external wiring.

The tape (if of a sufficient free length-to-width ratio) may be formed into a "Möbius band," permitting doubling the number of symbols on a band of given length and/or permitting staggering the symbols so they can be transilluminated (projected). (See fig. 10-35 (F).)

PLOTTERS. —Digital computers frequently use plotters to represent two properties of a variable: latitude and longitude, altitude and bearing, amplitude and time, etc. Most digital plotters are simply plotters which already exist for analog systems, with the computer merely furnishing signals through digital to analog converters as the input signals.

The plotter may be either of the recording or the nonrecording type. The digital data

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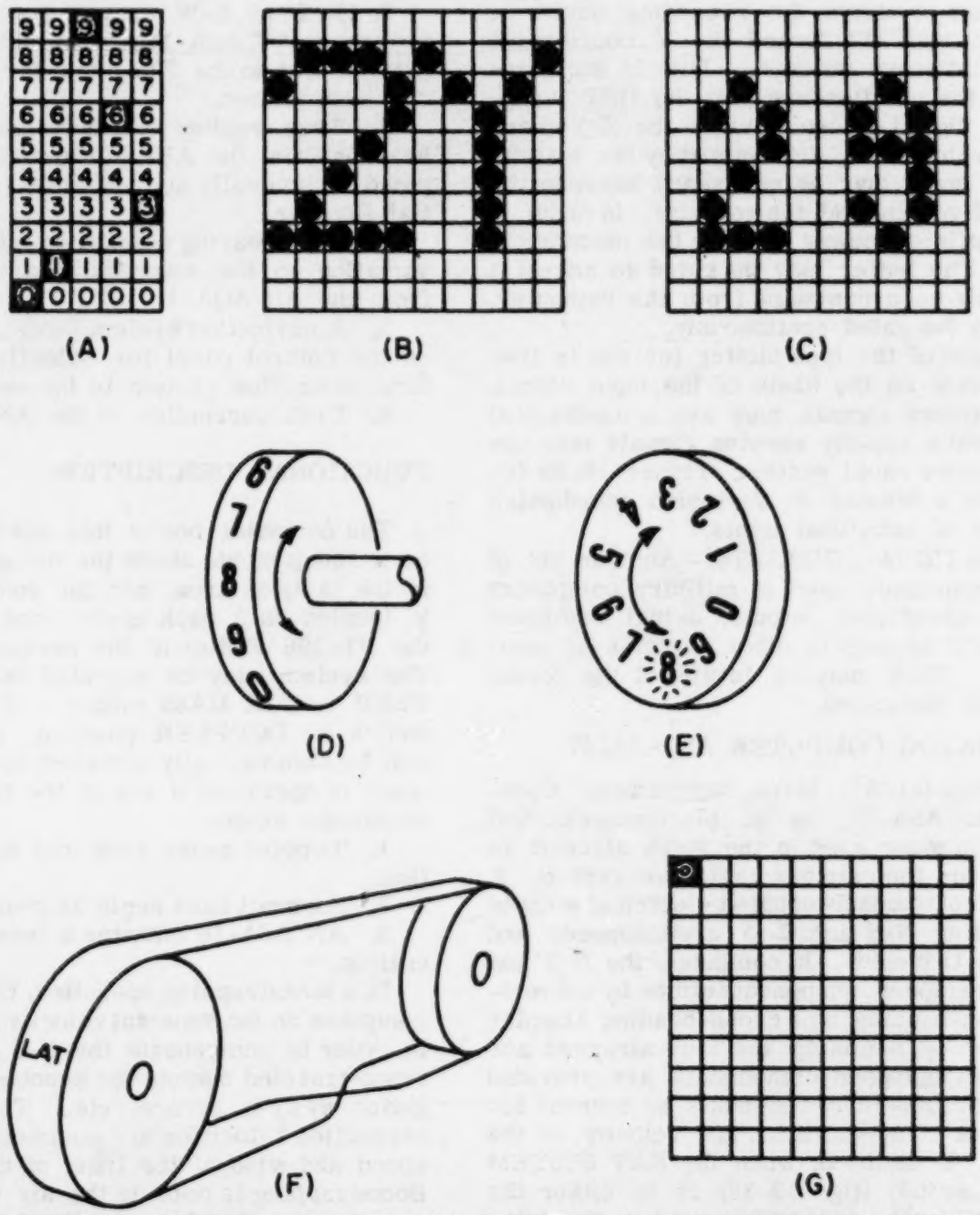

Figure 10-35.—Readout display matrices. (A) Positional illuminated display; (B) 5 x 7 alphanumeric display; (C) 3 x 6 dot display; (D) side display; (E) perimeter display; (F) tape display; (G) Cartesian coordinates display.

displayed (plotted) are a series of discrete values. If the points are readily distinguishable from each other, more than one curve may be plotted at one time. The plot is affected by the number and type of recording heads, the speed of response, and the rate of travel. Since it requires no motion, the nonrecording CRT is one of the fastest plotting systems, and is one of the most common used.

Another common system, the moving ribbon recording oscillograph, uses pencil or pen on regular or graph paper, pressure-sensitive paper, electrosensitive paper, Xerography, photography, or waxed paper. The motion of the paper generates one dimension (generally the time, control, or X coordinate), while the lateral motion of the recording device generates the second dimension.

In other systems the recording device is moved in both the X and the Y coordinates over a stationary surface. This is the principle of the oscilloscope and the DRT table. A direct digital control divides the X-Y plane into discrete points, determined by the matrix. A buffer stage may be necessary between the measured voltage and the coverter, in order to insure sufficient power to drive the mechanical device. The buffer may be gated to accept a signal only upon command from the computer, or it may be gated continuously.

Selection of the type plotter for use is frequently made on the basis of the input signal. Slowly varying signals may use a mechanical device, while rapidly varying signals may require a more rapid system. Figure 10-35 (G) illustrates a display of Cartesian coordinates by means of individual lights.

OPERATIONAL CIRCUITS.—Another set of outputs commonly used in military computers are the operational outputs, actual command and control signals to other systems or subsystems. They may be in any of the forms previously discussed.

ANALOG COMPUTER AN/ASA-47

The Doppler/Air Mass Navigational Computer, AN/ASA-47, is an electromechanical analog computer used in the P-3A aircraft as a backup for the primary navigation system. It provides continuously updated electrical outputs representing N-S and E-W groundspeeds and distances traveled. It computes the N-S and E-W groundspeed components either by converting the on-heading and cross-heading Doppler inputs, or by summing the true airspeed and wind. Groundspeed components are provided to the AN/ASN-12 continuously to correct for the effects of acceleration and velocity on the platform. In addition, when the NAV SYSTEM selector switch (fig. 10-36) is in either the AN/LN-2C or the AM/AHRS position, the ASA-47 furnishes N-S and E-W velocity components to the AN/ASA-16.

The Doppler/Air Mass Navigational Computer consists of a computer and control indicator (figs. 10-36 and 10-37) and a mount. A simplified block diagram is provided in figure 10-38. The equipment supplies the following:

1. N-S and E-W distance-traveled outputs to using equipment by intergrating either Doppler radar or true airspeed-plus-wind velocities.
2. N-S and E-W aircraft groundspeed components to AN/ASA-16 for aircraft course computation and to the ID system for vehicle velocity corrections.
3. True heading output by adding magnetic heading from the AHRS to automatically computed or manually set variation from the inertial Doppler.
4. True bearing outputs by adding magnetic variation to the magnetic bearings received from the AN/AQA-1.
5. A navigation system mode select switch on the control panel for selection of the tactical navigation system to be used.
6. Drift correction to the AN/ASA-16.

FUNCTIONAL DESCRIPTION

The computer box of this system is located on a shock mount above the navigator's station in the tactical area, and the control indicator is located in a rack above, and outboard of, the PT-396 Plotter at the navigator's station. The system may be operated in either DOPPLER or AIR MASS modes. With the mode switch in DOPPLER position, the computer will be automatically switched to the air mass mode of operation if any of the following three conditions exists:

1. Doppler radar goes into memory operation.
2. Aircraft bank angle is greater than 30°.
3. AN/ASA-16 initiates a bootstrapping operation.

In a bootstrapping operation, the AN/ASA-16 computes an incremental velocity that is needed in order to compensate the N-S and E-W distance-traveled outputs for sonobuoy drift, navigation system errors, etc. The AN/ASA-16 correction velocities are summed with true airspeed and wind at the input of the integators. Bootstrapping is done in the air mass mode of operation as Doppler velocity signals are subject to errors and memory operation during maneuvers. Provisions have been made to allow bootstrapping, in Doppler mode if future improvements result in better Doppler information during maneuvers.

In the Doppler mode of operation, V_h and V_d from the Doppler radar are resolved with true heading input to obtain N-S and E-W aircraft velocity components for the inertial navigator, groundspeed and drift angle indicator, and AN/ASA-16. Resolved true airspeed is compared with resolved Doppler velocities to

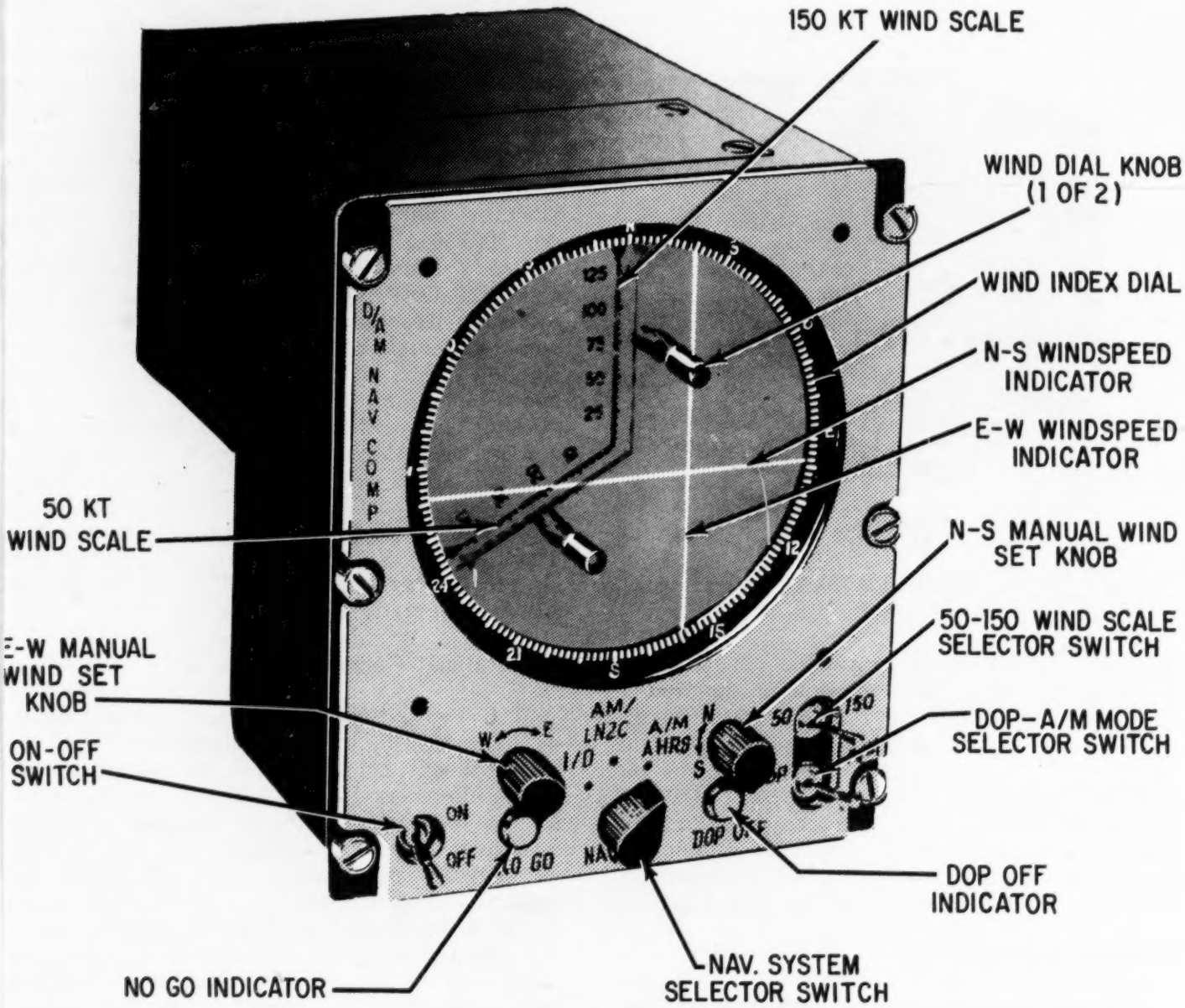

Figure 10-36. —ID-995/ASA-47 position indicator.

obtain N-S and E-W wind as an electrical output to the AN/ASA-16 and as a visual readout on the control indicator. Wind may be read out in either Cartesian or polar coordinates on the display. N-S and E-W components of Doppler velocities are integrated to obtain distance traveled as synchro outputs to the PT-396 and PT-434 Plotters, ID-888/U LAT-LON Indicator, AN/APA-125 Radar Indicator, and AN/ASA-16 Tactical Display.

In the air mass mode of operation, resolved true airspeed is added to last computed or manually set wind to obtain velocity outputs for the inertial navigator, GSDA, and AN/ASA-16, and integrated to obtain distance-traveled output for using equipment listed above. Manually set or last computed wind components are also supplied to the AN/ASA-16.

Integrataion in air mass mode does not occur unless true airspeed is greater than 100 knots. This feature is necessary to prevent integration prior to takeoff because the TAS Computer has a minimum output of 70 knots. A ground signal is supplied to the inertial navigator whenever true airspeed is greater than 100 knots to indicate that the DOP/AM computer is functioning and that the inertial

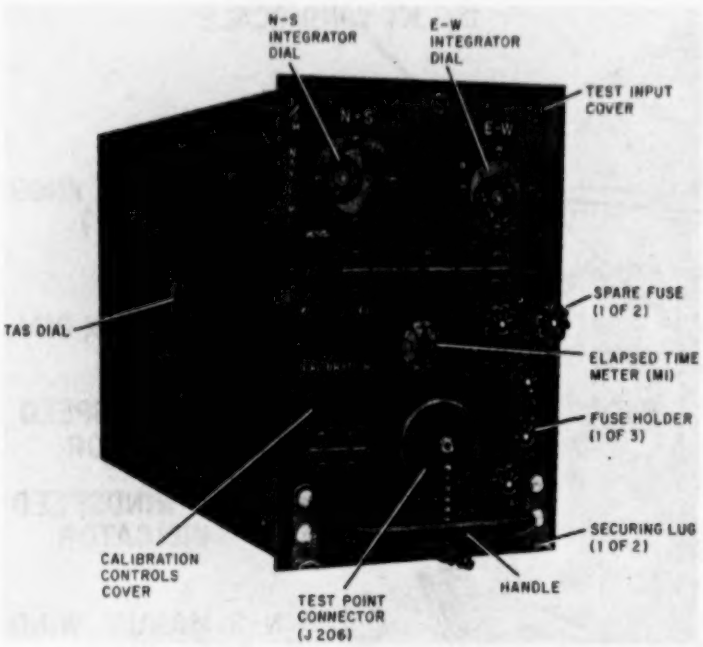

Figure 10-37.—CP-640/ASA-47 navigational computer.

navigator can rely on groundspeed being supplied to it. Magnetic variation is supplied to the equipment by the inertial navigator to allow conversion of magnetic heading from the AHRS to true heading for system use in the AM/AHRS Navigation mode. The DOP/AM Computer also converts two sonobuoy magnetic bearing signals from the AN/AQA-1 Indicator Group to two true bearing signals which are displayed on the AN/ASA-16 Tactical Display.

Position Indicator

The Position Indicator, ID-995/ASA-47 (fig. 10-36) sometimes called the control indicator, contains all normal operating controls for the computer, the windspeed indicator, and the wind computation servos. The unit consists of various assemblies mounted on a frame. The indicator assembly is at the front; electrical components, including the power transformer, are at the rear. The power transformer is enclosed in a mu-metal shield. At the top are four plug-in amplifiers which are accessible when the cover is removed. These are sealed units not repairable in the field. To prevent improper installation, each type of amplifier throughout the AN/ASA-47 is keyed by the arrangement of its connectors and mounting pins. All other electrical components are mounted either directly to the frame or on component boards which are then secured to the frame. All connections to the position indicator are made through two receptacles mounted on the lower rear of the unit. A door on the top of the unit can be opened to make adjustment.

The front panel controls and indicators include the ON-OFF switch, the NAV SYSTEM selector switch, the DOP-A/M mode switch, the 50-150 knot wind scale switch, the N-S and E-W manual wind input knobs, the NO GO and DOP OFF indicator lamps, and the wind indicator assembly. The wind indicator assembly consists of a clear plastic dial, a wind heading index, and an N-S and an E-W windspeed indicator or cursor. The dial has a 50-knot and a 150-knot scale engraved on it and can be rotated by two plastic knobs mounted directly on the dial face. The wind heading index, around the wind indicator dial, provides compass wind heading in 1° increments. The N-S and E-W wind cursors are engraved on plastic curtains which are visible through the clear plastic dial.

Navigational Computer

The Navigational Computer, CP-640-ASA-47 (fig. 10-37), which is mounted on the resilient mount, contains all of the required computing elements except for the two wind servos. On the front panel of the navigational computer are three active fuse holders and two spares; an elapsed time meter, M1; and a test receptacle. Two hinged doors on the front panel cover screwdriver calibration controls and a test input panel. The N-S and E-W integrator dials, which are part of the corresponding integrator modules mounted inside the navigational computer, can be viewed through windows on the test input door. The true airspeed dial, which is mounted on the true airspeed module, is visible on the left side of the computer.

Mounted on the left side of the main frame of the navigational computer are five modules: Ground Speed Module 2A2, True Airspeed Module 2A3, True-Heading Module 2A4, Variation Module 2A5, and N-S Integrator Module 2A6. Also mounted on the left side of the unit at the rear bottom are the Doppler reference transformer and the N-S groundspeed output transformer. Two relay sockets, into which are plugged crystal-case relays, are mounted on the left side of the frame. Five electrical connectors are located on the rear of the frame.

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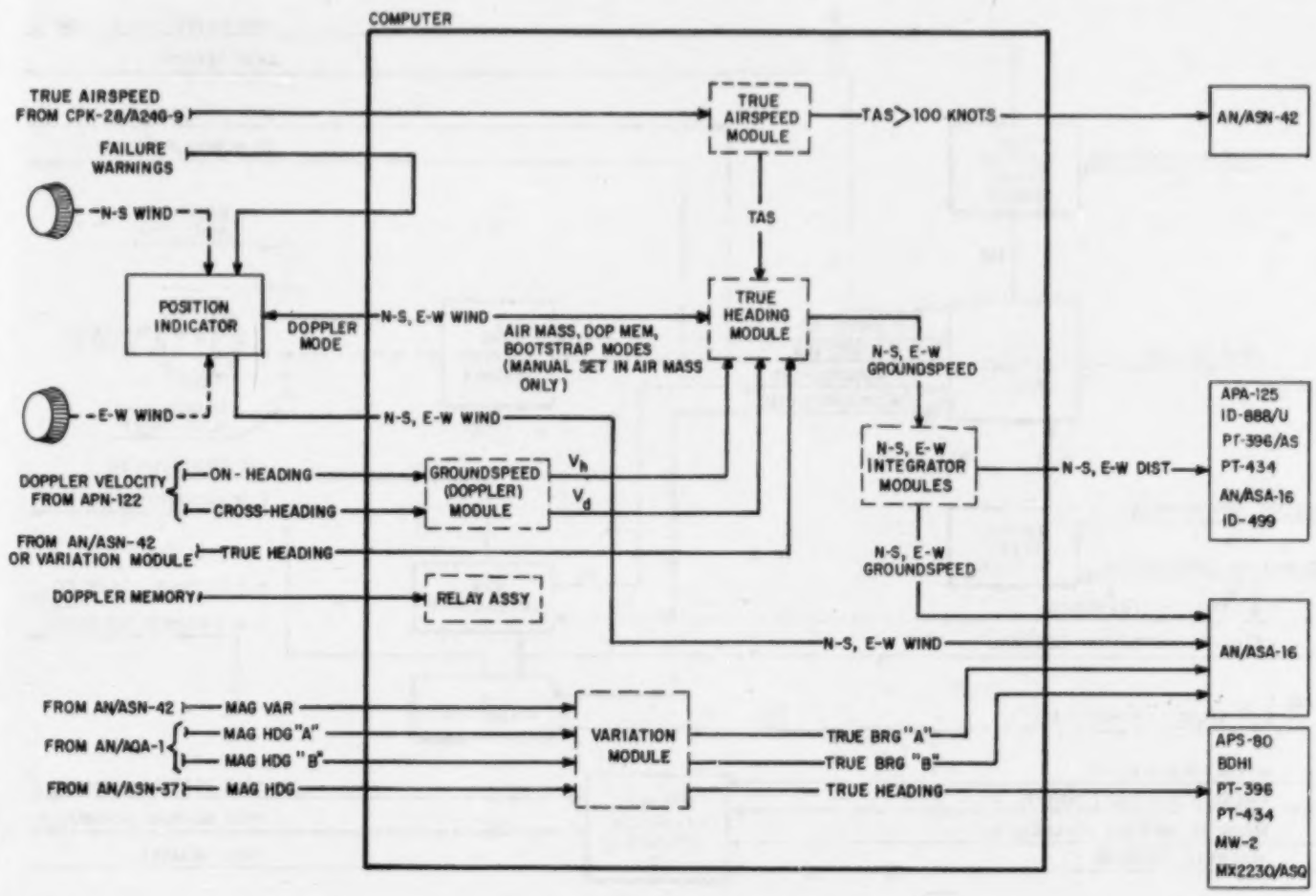

Figure 10-38.—Doppler/Air Mass Navigation System block diagram.

The E-W Integrator Module 2A7 and the crystal-case plug-in relays are mounted on the right side of the frame. Signal reference transformer, E-W groundspeed output transformer, and linear transformers are also located here.

THEORY OF OPERATION

The Doppler/Air Navigation Computer, AN/ASA-47, performs several functions in the operation of the P-3A navigation system. Figure 10-39 shows the computer in a simplified block diagram. The AN/ASA-47 computes groundspeed and ground track in the N-S and E-W components. The wind velocity is computed in the Doppler mode of operation; but in the air mass mode, the value last computed is remembered or wind is manually inserted. The computer also adds variation corrections to magnetic heading and magnetic bearing to provide true bearings. Outputs of true heading and true bearing; the components of groundspeed, ground track, and wind velocities; and electrical ground signal when true airspeed exceeds 100 knots, are provided to other elements of the navigation system.

As shown in figure 10-39, the computer has seven functional modules. Six of these modules, True Airspeed, True Heading, Groundspeed, N-S Integrator, E-W Integrator, and Magnetic Variation are in the computer unit. The seventh module, Wind Solution, is an integral part of the indicator unit.

Doppler Mode

In the Doppler mode of operation, the computer receives inputs of true airspeed (TAS), V_t; true heading, H_t; on-heading groundspeed, V_h; and cross-heading groundspeed (drift), V_d. The Doppler mode of operation is also known as the groundspeed mode, since groundspeed is received directly by the computer. A prime function in this mode is to compute the rectangular components of windspeed.

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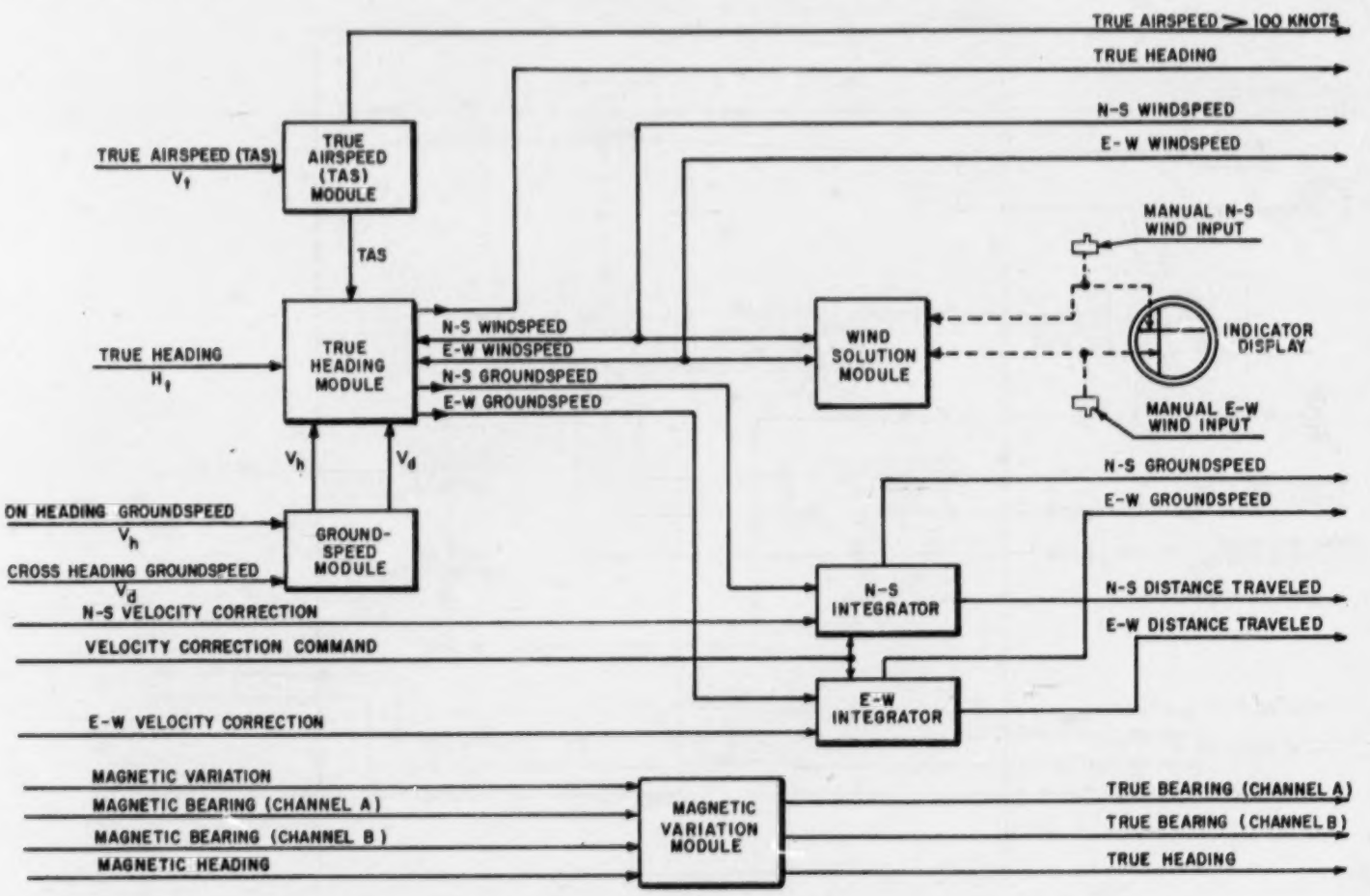

Figure 10-39.—Doppler/Air Navigational Computer simplified block diagram.

Windspeed is the vectorial difference between true air velocity and ground velocity; that is, windspeed is the speed of the aircraft with respect to the ground because of the effects of the wind. If the direction and magnitude of both the airspeed and groundspeed are known, the corresponding value of windspeed can be determined. In the AN/ASA-47, the windspeed is found in terms of its rectangular, or N-S and E-W components.

TAS is received as a synchro signal by the true airspeed module, which converts it into a form more usable in the computer. This value is then fed to the true heading module, which also receives the true heading, H_t, either from the AN/ASN-42 or from the output of the variation module of the AN/ASA-47, depending on the position of the NAV SYS mode switch. TAS is resolved into its N-S and E-W components by multiplying V_t by the cosine and sine, respectively, of the true heading angle, H_t as shown in figure 10-40.

On-heading groundspeed, V_h, and cross-heading groundspeed, V_d, are received by the groundspeed module as separate 400-cycle

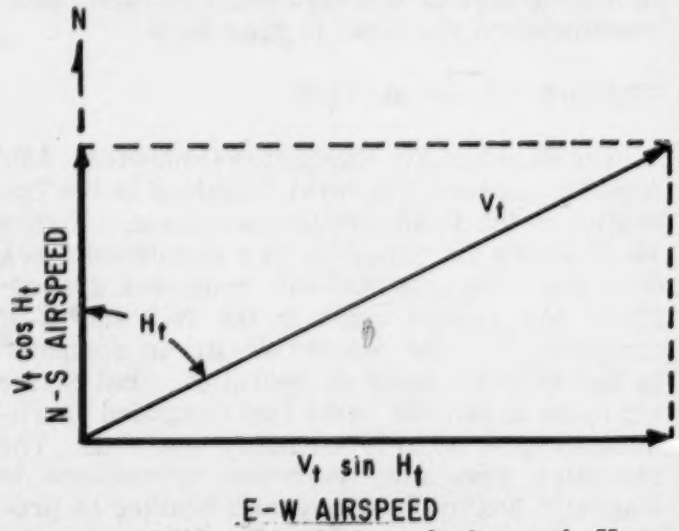

Figure 10-40.—Resolution of airspeed, V_t, into rectangular coordinates.

input signals from the Doppler Radar AN/APN-122. Each is converted into the proper form and fed to the true heading module. In this module, each value is separately resolved into its N-S and E-W components, as shown in figure 10-41; and the corresponding rectangular coordinates are algebraically summed to obtain the N-S and E-W components of groundspeed. The N-S airspeed is algebraically added to the N-S groundspeed to find the N-S windspeed. The two wind components are transmitted as 400-cycle signals to the wind solution module in the position indicator unit and to the other elements of the navigational system.

The N-S and E-W components of groundspeed are applied as 400-cycle input signals to the two integrator modules. The N-S and E-W integrator modules are identical. Each integrator receives its corresponding groundspeed signal and a 400-cycle velocity correction signal. When a velocity correction command signal is received from the AN/ASA-16, computation automatically transfer to the air mass mode. The velocity correction signal is summed with the groundspeed signal to produce a correct N-S or E-W groundspeed signal (depending upon the integrator module). The groundspeed signal is applied to other elements of the navigational system as a 400-cycle signal voltage. The signal voltage is also integrated to find the distance traveled over the ground, which represents the change in position in a N-S or E-W direction.

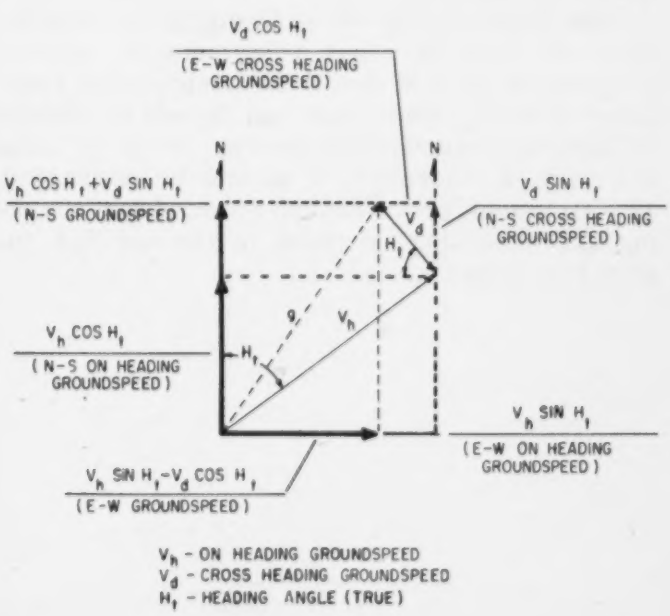

Figure 10-41.—Resolution of groundspeed, V_g, into rectangular coordinates.

The distance traveled outputs are provided as synchro signals.

The wind solution module contains servos which utilize the two windspeed component signals for mechanically positioning the indicator unit display crosshairs. By rotating the scale to intersect the point of intersection of the crosshairs, the navigator can read the windspeed and direction.

The magnetic variation modules receives a magnetic variation signal from the AN/ASM-42 (ID), two separate magnetic bearing signals from the AN/AQA-1, and a magnetic heading signal from the AN/ASN-37 (AHRS). These are all synchro signals. A servo in the module provides a shaft position proportional to magnetic variation. Each synchro is positioned by the variation correction shaft to provide two separate true bearing signals and a true heading signal. These outputs are all in synchro signal form.

The true heading module also provides a true heading synchro signal to other elements of the navigational system. The true airspeed module provides a signal (contact closure) to the rest of the navigational system when the true airspeed exceeds 100 knots.

Air Mass Mode

In the air mass mode of operation, which is also known as the airspeed-wind mode, groundspeed is not known and must be calculated before the N-S and E-W components of distance traveled can be found. However, since windspeed, obtained from another source or estimated, can be inserted manually into the computer and true airspeed is known, the computer can calculate groundspeed. Except for the groundspeed, wind solution, and true heading modules, the functional modules in the computer operate in the same manner in the air mass mode as they do in the Doppler mode.

The groundspeed module does not have any effect on the air mass mode, groundspeed, and distance traveled computations. The wind solution module acts as a signal converter, providing 400-cycle N-S and E-W speed signals proportional to the manual input values to the true heading module. The windspeed signals are also transmitted to other elements of the navigational system.

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The operation of the true heading module is essentially the same in the air mass mode as it is in the Doppler mode, except that the equations being solved are slightly different in form. In the Doppler mode, the N-S and E-W groundspeed components are found by resolving the on-heading and cross-heading groundspeed about the heading angle. In the air mass mode, the groundspeed is found by adding the respective components of windspeed and air speed. (See fig. 10-42.) In the Doppler mode, the windspeed components are found by algebraic addition of airspeed and groundspeed. In the air mass mode, windspeed is a preset input.

Automatic Mode Switching

The AN/ASA-47 system automatically switches to the air mass mode of operation when the Doppler information becomes unreliable. A signal from the AN/APN-122 Doppler causes the computer to operate with the last computed and remembered windspeed components as input values. When the Doppler information again becomes reliable, the computer reverts to the Doppler mode, again computing the wind solutions.

As mentioned previously, a similar action takes place when a velocity correction command is received. In this case, the AN/ASA-16 supplies a signal which switches the computer to air mass mode. The windspeed components become remembered values, and the groundspeed velocity correction is applied. When the velocity correction command is removed, the computer reverts to normal Doppler mode operation. Normal control of mode of operation is maintained by a front panel switch on the computer. Either a Doppler unreliable or a velocity correction relay signal overrides the Doppler mode switch position, causing the system to compute in the air mass mode.

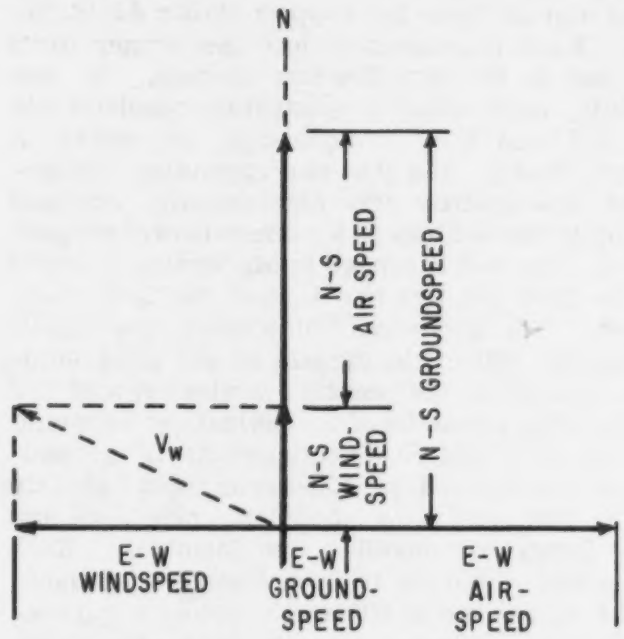

Figure 10-42.—Solution of windspeed by algebraic addition.

ALINEMENT, CALIBRATION, AND MAINTENANCE

A complete set of schematic diagrams, wiring diagrams, alinement procedures, list of test equipment required, and other maintenance information can be found in the appropriate service manuals.

The Doppler/Air Mass Navigation Computer must be kept in close alinement to operate properly as part of the P-3A navigational computer system. The alinement should be checked after 20 operational hours; if it is found to be out of tolerance, it should be corrected. The alinement procedure to be used for checking and resetting is given in the service instruction manual.

CHAPTER 11

ANTENNAS AND PROPAGATION

After an RF signal has been generated in the transmitter, there must be a means of radiating the RF energy into space, and a means by which this signal may be intercepted (picked up) for the receiver. The device which fulfills both of these requirements is the ANTENNA. The major purpose of a transmitting antenna is to convert the transmitter's RF power into radiated energy as efficiently as possible; the major purpose of a receiving antenna is to absorb as much of this radiated energy as possible.

The process by which the RF electrical energy is converted into electromagnetic waves and radiated into space is called PROPAGATION. Certain basic concepts of propagation and antennas are included in Basic Electronics, NavPers 10087-B. These basic concepts should be thoroughly reviewed at this time to insure a full understanding of the fundamentals of propagation, prior to completing the work on this chapter.

This chapter is a continuation of the material covered in Basic Electronics, and in addition covers sections on antenna arrays and typical airborne antennas. The aim of this chapter is to more fully acquiant the AT with the mechanics of propagation, the results of irregularities in the atmosphere, the consideration required in the selection of the proper frequency for specific purposes, and the operational characteristics of the various types of antennas and arrays.

In the study of this chapter, it should be kept in mind that the subject matter field is broad and no attempt at complete coverage is made. Rather, only such background information as will be of help to the AT is included. In many instances, the AT will have the assistance of field engineers, or will at least have specific instructions on how to perform many jobs. He therefore will, in practice, need much of the information contained in this chapter only as a necessary background.

When considering the energy radiated from an antenna, an important concept is the DIRECTIVITY of the antenna. The directivity of an antenna is a measure of its ability to radiate energy in the desired direction (or directions) and to suppress the radiation in other directions. The same is true of a receiving antenna; in this case, signals from the favored direction (or directions) are received more easily than those from other directions.

The RADIATION PATTERN, which is a good indication of the directivity of an antenna or antenna array, is usually plotted on polar graph paper. It should be emphasized that when polar coordinates are used, the resulting curve is NOT an actual picture or outline of the energy radiated by the antenna. It is rather an indication of the relative amount of energy delivered to points on an imaginary circle a certain distance from the antenna, which is usually located at the center. The points where the measurements are taken are usually spaced 10° or more apart. Thus, the polar plot is a good picture in two dimensions of how directive the antenna is. (See fig. 11-1 (A).)

It should be emphasized also that the pattern is three dimensional, although the plot is commonly given only in the horizontal or vertical plane. The rounded projections of the polar pattern are called LOBES and the indented portions, representing minimum energy pickup in the test antenna, are called NULLS.

REVIEW OF PROPAGATION PRINCIPLES

From your study of Basic Electronics, NavPers 10087-B, you will recall that a radio-frequency current flowing in a wire of a finite length can produce electromagnetic fields that may become disengaged from the wire and set free in space. The principles of the radiation of electromagnetic energy are based on the laws that a moving electric field creates

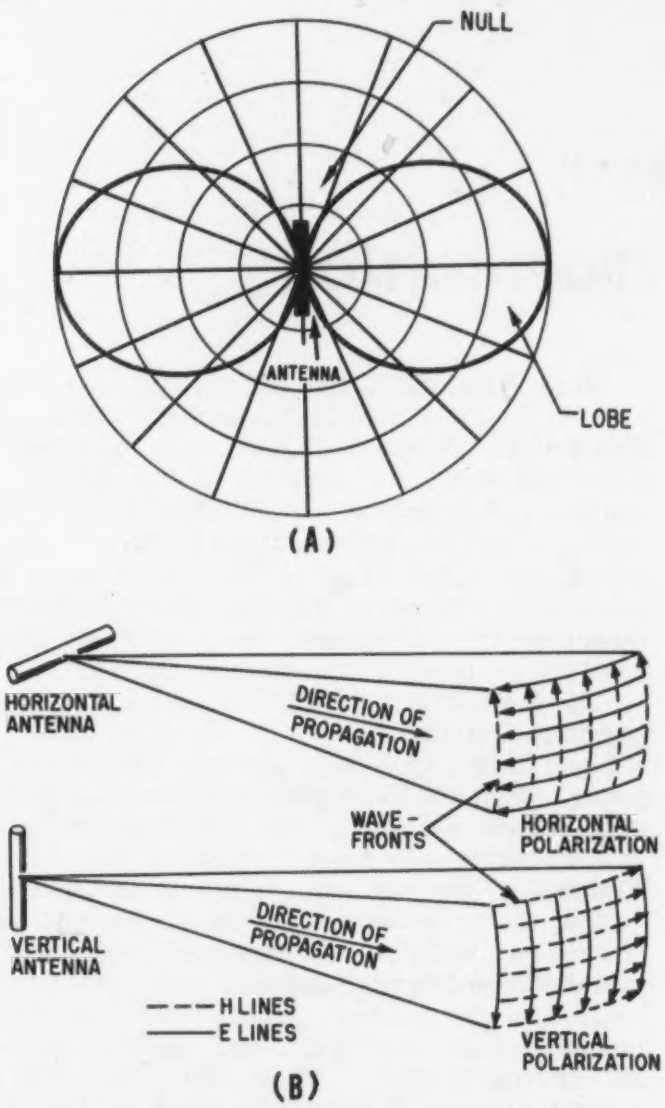

Figure 11-1.—Antenna radiation. (A) Radiation pattern; (B) wavefronts.

a magnetic field, and (conversely) a moving magnetic field creates an electric field. The created field (either electric or magnetic) at any instant is in phase in time with its parent field, but is perpendicular to it in space. These laws hold true whether or not a conductor is present.

ELECTROMAGNETIC FIELDS IN SPACE

The E- and H-fields are mutually perpendicular to each other and to the direction of travel. These fields, traveling through space together, form a radio wave. The frequency of the radio wave is the same as the frequency of the RF current which produced it. Radio waves are radiated into space at the speed of light, 186,000 miles (or 300,000,000 meters) per second. This velocity is constant, regardless of frequency. Because of this constant velocity, it is possible to establish the relationship between the frequency and the wavelength. This relationship is expressed as

$$\lambda = \frac{300}{f} \text{ or } f = \frac{300}{\lambda}$$

where λ is the wavelength in meters, f is the frequency in megacycle, and 300 is the velocity of travel in millions of meters per second.

Wavefronts and Polarization

Energy from the transmitting antenna moves outward in ever-expanding spheres. A small portion of one of these spheres is called a WAVEFRONT. As indicated in figure 11-1 (B), the H-lines are perpendicular to the E-lines, and both are perpendicular to the direction of propagation. A right-hand rule that ties these three quantities together is given in Basic Electronics, NavPers 10087-B.

HORIZONTAL POLARIZATION means that the electric lines are horizontal with respect to the earth, and VERTICAL POLARIZATION means that the electric lines are vertical with respect to the earth. The choice of the electric field as a reference field results from the practice of measuring radio wave intensity in terms of electric field intensity (for example, microvolts per meter).

Reflection, Refraction, and Diffraction

When one is considering the movement of electromagnetic fields through space, it is very important to understand clearly what is meant by reflection, refraction, and diffraction. Because radio waves of short wavelengths act somewhat like light waves (both of which are electromagnetic radiations), it is well to consider these effects from the point of view of light waves, which may be more readily observed.

A basic coverage of the reflection and refraction of light is to be found in chapter 4 of Aviation Electronics Technician 3 & 2, NavPers 10317-C. A review of these principles at this time will be of great help in understanding the action of radio waves in space.

Reflection takes place only when the reflecting surface is large compared to one-half the wavelength of the incident wave, and smooth for an appreciable portion of one-half wavelength. Under these circumstances, the angle of incidence is equal to the angle of reflection. When these conditions are not met, scattering will occur. Scattering is a common occurrence. As a matter of fact, FORWARD SCATTER of radio waves in the troposphere and ionosphere (because of irregularities in density) is an important method of radio wave propagation.

The INDEX OF REFRACTION is a term used to describe how much bending will take place as electromagnetic waves pass through a given substance. The higher the index of refraction, the more the bending. The index of refraction is the ratio of the velocity of light waves in a vacuum to the velocity of light in the substance being considered.

In the case of radio waves being refracted in the ionosphere, the path is gradually curved because there is no sharp point of transition between layers of different densities. Those rays that make a large angle with respect to the horizontal along the earth may be refracted a small amount and pass on through the ionosphere to outer space; those that make a smaller angle will travel a greater distance in the ionosphere and may be bent to such an extent that they will return to earth. The net result is as if the wave had been REFLECTED back to earth. A simplified illustration of ionospheric refraction is given in figure 11-2. A certain amount of refraction also takes place in the troposphere (below the ionosphere) because of the proximity of warm and cold air masses.

Diffraction of light occurs when a beam of light passes over the edge of an opaque object. The energy is bent, or diffracted, around the edge of the object, as indicated in figure 11-3. Instead of a sharp outline being formed, the shadow will be blurred because of the bending of the light around the object. Red light (long wavelength) is bent into the shadow more than violet (short wavelength).

Low frequency radio waves bend around natural obstructions, such as mountains, in much the same way that light does. At the higher frequencies, the bending is much less apparent.

Although these effects (reflection, refraction, and diffraction) have been listed separately, it is not uncommon for them to occur simultaneously. In addition, there are other factors, such as energy loss due to absorption, changes in polarization, and reinforcement or cancellation due to variations in signal path lengths. Therefore, it is frequently difficult to discover exactly what has happened to the radio wave during its passage from the transmitter to the receiver.

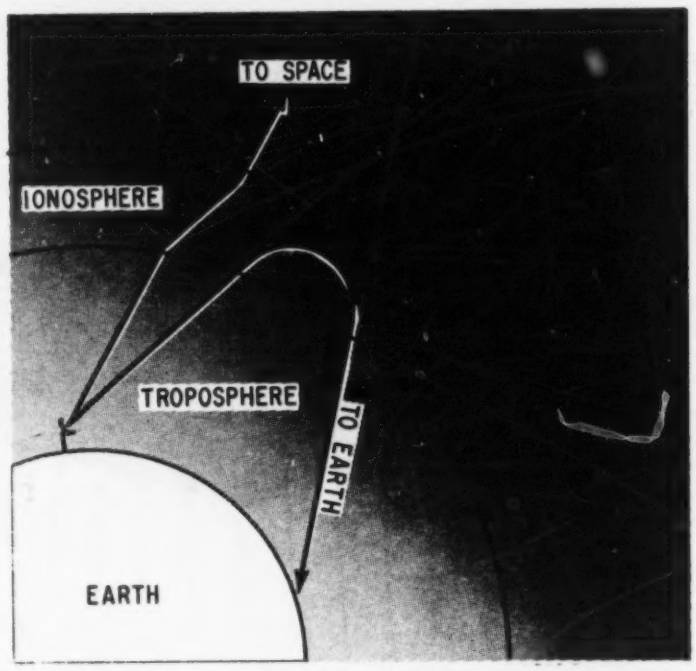

Figure 11-2. —Refraction in ionosphere.

Forward Scatter of Radio Waves

Much research is being conducted at present to determine the practical use to which the phenomenon of FORWARD SCATTER may be put.

Forward scatter is believed to be due to small variations in the composition of the atmosphere. This lack of homogeneity may be created by such irregularities as the ionization left by meteor trails, ionospheric winds, auroral effects, tropospheric turbulence, variation of the refractive index, etc. The net effect is a scattering of radio waves in all direction, especially in the forward direction of travel. By the use of powerful transmitters, highly directional antennas, and light-gain receivers, scatter signals from the troposphere may be received up to 600 miles and scatter signals from the ionosphere may be received at distances of 600 to 1,200 miles. For tropospheric scatter, frequencies between

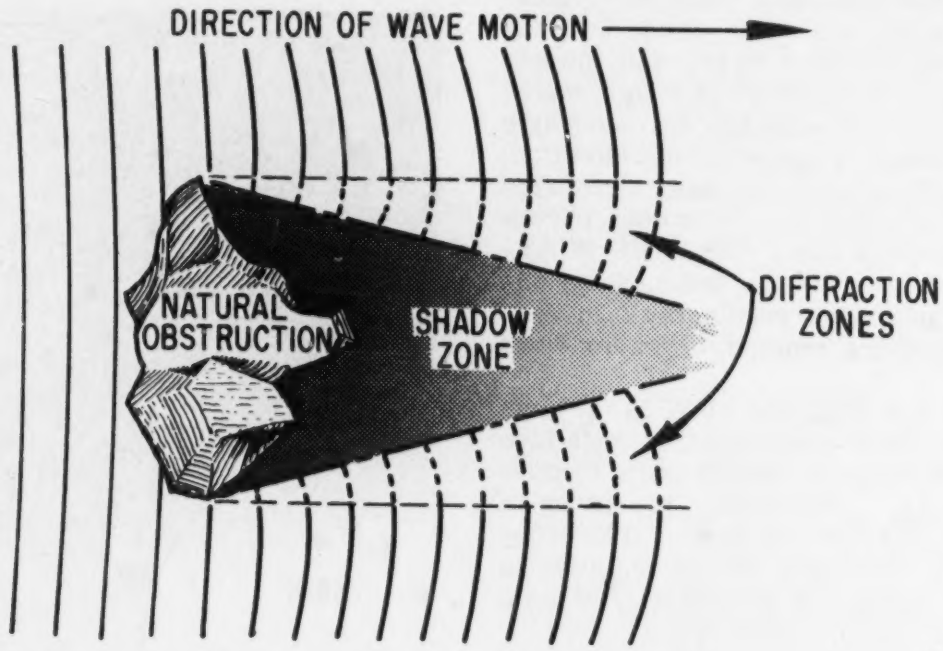

Figure 11-3. —Diffraction.

100 mc and 10,000 mc have been used; for ionospheric scatter, frequencies between 25 mc and 60 mc have been used.

Although much work remains to be done in this field, it seems probable that VHF frequencies will become increasingly important in long range communications. For ranges up to 600 miles where tropospheric scatter is effective, the useful frequency range probably will be greatly extended.

IONOSPHERIC VARIATIONS

Variations in the ionosphere greatly affect the propagation of certain radio waves. It is therefore necessary to include a brief treatment of the variations that take place in the ionosphere. Although a degree of irregularity is characteristic of all ionospheric variations, nevertheless it is convenient to subdivide them into both irregular and regular variations.

Irregular variations cannot be accurately predicted in advance; regular variations follow a general pattern, and therefore may be predicted with some degree of accuracy.

Certain basic information on the ionosphere is given in Basic Electronics, NavPers 10087-B and should be reviewed at this point.

Irregular Ionospheric Variations

SUDDEN IONOSPHERIC DISTURBANCE.—This type of disturbance in the ionosphere is caused by radiation from solar flares that produce intense ionization in all layer of the ionosphere in daylight areas.

Frequencies above 1 or 2 mc (depending on the intensity of ionization) are largely absorbed in the heavily ionized D layer. Higher frequencies may be used for short distance communications, and lower frequencies (which do not penetrate the D layer) may be used for long distance communications.

IONOSPHERIC STORMS.—These magnetic disturbances occur about 18 hours after solar flares. The upper ionosphere expands and becomes diffused, the effects being more severe near the poles and less severe near the Equator.

Ionospheric storms may last from a few minutes to several hours; the intensity then diminishes, and the effects disappear in a few days. During the peak of the storm and for a period thereafter it may be necessary to use lower than normal frequencies, especially in high latitudes.

SPORADIC DISTURBANCE IN THE E LAYER — Frequently, "clouds" of abnormal ionization occur at the approximate altitude of the E layer. The occurrence is spotty both in time and place. This results in excellent reception within the normal skip distance, and occasionally long distance communication may be obtained above 60 mc The frequency may have to be lowered to maintain communications over short skip distances.

SCATTERED IRREGULARITIES IN THE IONOSPHERE.— Scattered irregularities in ion density may cause scattered reflections and

resultant signal fading. This is due to varying phase relations resulting from variation in signal path lengths. It is a situation that must be tolerated.

EFFECT OF METEORITE TRAILS. — Large numbers of meteorites enter the upper atmosphere during the course of a day. A portion of the energy released as these particles are slowed down is utilized in ionizing the atmosphere. The volume of the atmosphere ionized by one of these particles is very large, considering the size of the particle. It may be several feet in diameter and perhaps a mile or more in length. Even though recombination of the ions occurs very rapidly, nevertheless ionization often lasts long enough to cause radio stations to be heard that would not normally come through.

Research is currently being done in this field, and perhaps the effect of meteorite trails on propagation may, in time, be used to great advantage.

Regular Ionospheric Variations

ELEVEN-YEAR SUNSPOT CYCLE. —Periods of maximum sunspot activity occur 11 years apart. For example, the last period of maximum activity was during 1958-1959; the next one will be 1969-1970.

During these periods, the F1 and F2 layers, especially, increase in density and height. In general, higher operating frequencies are necessary for long distance communications.

SEASONAL VARIATIONS. —During the summer months the height of the F2 layer is increased, and during the winter months it is decreased. During the winter months the ionization density rises earlier in the day, and reaches a higher value than in the summer months; the predawn ion density reaches a lower value. The F1, E, and D layers reach lower maximum densities in winter.

Medium high frequencies are used for long distance, winter communication; the lower high frequencies are used for medium distance communication.

TWENTY-SEVEN-DAY SUNSPOT VARIATIONS. —These disturbances accompany sunspot activity that occurs every 27 days. This interval is the time required for the sun to complete one revolution about its axis. The effect on radio transmission is essentially the same as that of sudden ionospheric disturbances.

DIURNAL (DAILY) VARIATIONS. — During the daylight hours the density of the F layers increases; the thickness of these layers also increases during this time. During the course of the day, the F layer splits into the F1 and F2 layers. The ion density of the F1 layer varies with the vertical angle of the sun, and the ion density of the F2 layer increases to a peak somewhat later in the day.

The ion density of the E layer varies with the vertical angle of the sun, and the height remains approximately constant; the E layer is much weaker at night.

The D layer appears after dawn, and the ion density varies with the vertical angle of the sun; it dissapears at night. The D layer is located between 40 and 50 miles above the earth's surface.

CHOOSING THE PROPER FREQUENCY

The frequencies with which the AT normally works range from about 15 cps or less up to about 300 gigacycles (300,000,000,000 cps) or higher. For convenience, these frequencies are divided into BANDS. Audiofrequencies extend from about 15 cps to about 15,000 cps, and embrace those frequencies that are audible to the normal human ear. These frequencies are not normally connected with radiation and antennas.

The classifications of the various bands in the RF spectrum are shown in table 11-1.

The frequencies included in the UHF and the microwave ranges are usually considered as 225 mc through 30 gigacycles, indicating that there are some areas of overlapping in this type breakdown. In order to prevent confusion and to further break these important bands into smaller divisions, the system of classification shown in table 11-2 has been adopted.

Figure 11-4 shows the frequency distribution in the RF spectrum. The figure also indicates the uses to which portions of the RF spectrum are put. For example, the radar bands extend from the VHF to the EHF band; the commercial television channels cover portions of the VHF and UHF bands; and communications make use of all of the bands except the EHF. Newer developments indicate that even the EHF band will be used in the near future. The approximate distances covered are also indicated, as well as the types of transmission lines commonly used and the types of interference commonly experienced.

Table 11-1. —Radiofrequency classifications.

Band	Frequency spectrum (kc)	Wavelength in meters
VLF (Very Low)	10 - 30	30,000 - 10,000
LF (Low)	30 - 300	10,000 - 1,000
MF (Medium)	300 - 3,000	1,000 - 100
HF (High)	3,000 - 30,000	100 - 10
VHF (Very High)	30,000 - 300,000	10 - 1
UHF (Ultrahigh)	300,000 - 3,000,000	1 - 0.1
SHF (Superhigh)	3,000,000 - 30,000,000	0.1 - 0.01
EHF (Extremely High)	30,000,000 - 300,000,000	0.01 - 0.001

Sky-Wave Propagation Versus Frequency

As has been stated, the higher the frequency of transmission the lower must be the angle of radiation for effective transmission. This results from the fact that high frequency radiation passes through into space and is effectively lost when the angle of radiation is high. Low frequency radiation may be returned to earth even if it is radiated vertically upward. (As a matter of fact, the effective height of the ionosphere can be determined by directing low frequency pulses vertically upward toward the ionosphere and measuring the time lapse between the transmitted pulse and the echo. Knowing the velocity of radio waves, it is relatively easy to compute the effective distance.)

If the frequency is increased while the height measurements are made, it will be found that above a certain frequency (the CRITICAL FREQUENCY) echoes are not returned to earth. However, if the radiation angle is reduced sufficiently, echoes will be returned to earth at some distance from the antenna. The distance depends on the height and density of the ionosphere.

For the E layer, the critical frequency is from 1 to 4 mc, depending on the ion density of the E layer. For the F2 layer (daytime), the critical frequency is approximately 2.5 mc, and for the F layer (night), it is approximately 12.5 mc.

MAXIMUM USABLE FREQUENCY. — Because less energy is absorbed out of high frequency radiation during transmission, it is desirable to know the maximum usable frequency (MUF) that may be employed in transmission. Higher frequencies will pass through the ionosphere and will be lost to the communication circuit, and lower frequencies will be seriously attenuated in the ionosphere.

Data on the maximum usable frequency is collected by the National Bureau of Standards and is made available to the Navy in the publication, Basic Radio Propagation Predictions.

LOWEST USEFUL FREQUENCY. — As the radiated frequency is reduced below the MUF,

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Table 11-2.—Radar frequency band code letters.

Band P		Band L			Band S			Band X			Band K			Band Q			Band V		
Freq	λ	Sub	Freq	λ	Sub	Freq	λ	Sub	Freq	λ	Sub	Freq	λ	Sub	Freq	λ	Sub	Freq	λ
0.225	133.3	P	0.390	76.9	E	1.55	19.3	A	5.20	5.77	P	10.90	2.75	A	36.00	0.834	A	46.00	0.652
0.390	76.9		0.465	64.5		1.65	18.2		5.50	5.45		12.25	2.45		38.00	0.790		48.00	0.625
		C	0.465	64.5	F	1.65	18.2	Q	5.50	5.45	S	12.25	2.45	B	38.00	0.790	B	48.00	0.625
			0.510	58.8		1.85	16.2		5.75	5.22		13.25	2.26		40.00	0.750		50.00	0.600
		L	0.510	58.8	T	1.85	16.2	Y	5.75	5.22	E	13.25	2.26	C	40.00	0.750	C	50.00	0.600
			0.725	41.4		2.00	15.0		6.20	4.84		14.25	2.10		42.00	0.715		52.00	0.577
		Y	0.725	41.4	C	2.00	15.0	D	6.20	4.84	C	14.25	2.10	D	42.00	0.715	D	52.00	0.577
			0.780	38.4		2.40	12.5		6.25	4.80		15.35	1.95		44.00	0.682		54.00	0.556
		T	0.780	38.4	Q	2.40	12.5	B	6.25	4.80	U	15.35	1.95	E	44.00	0.682	E	54.00	0.556
			0.900	33.3		2.60	11.5		6.90	4.35		17.25	1.74		46.00	0.652		56.00	0.536
		S	0.900	33.3	Y	2.60	11.5	R	6.90	4.35	T	17.25	1.74						
			0.950	31.6		2.70	11.1		7.00	4.29		20.50	1.46						
		X	0.950	31.6	G	2.70	11.1	C	7.00	4.29	Q	20.50	1.46						
			1.150	26.1		2.90	10.3		8.50	3.53		24.50	1.22						
		K	1.150	26.1	S	2.90	10.3	L	8.50	3.53	R	24.50	1.22						
			1.350	22.2		3.10	9.68		9.00	3.33		26.50	1.13						
		F	1.350	22.2	A	3.10	9.68	S	9.00	3.33	M	26.50	1.13						
			1.450	20.7		3.40	8.83		9.60	3.13		28.50	1.05						
		Z	1.450	20.7	W	3.40	8.83	X	9.60	3.13	N	28.50	1.05						
			1.550	19.3		3.70	8.11		10.00	3.00		30.70	0.977						
					H	3.70	8.11	F	10.00	3.00	L	30.70	0.977						
						3.90	7.69		10.25	2.93		33.00	0.909						
					Z	3.90	7.69	K	10.25	2.93	A	33.00	0.909						
						4.20	7.15		10.90	2.75		36.00	0.834						
					D	4.20	7.15												
						5.20	5.77												

(Frequencies are shown in gigacycles, wavelengths in centimeters.)

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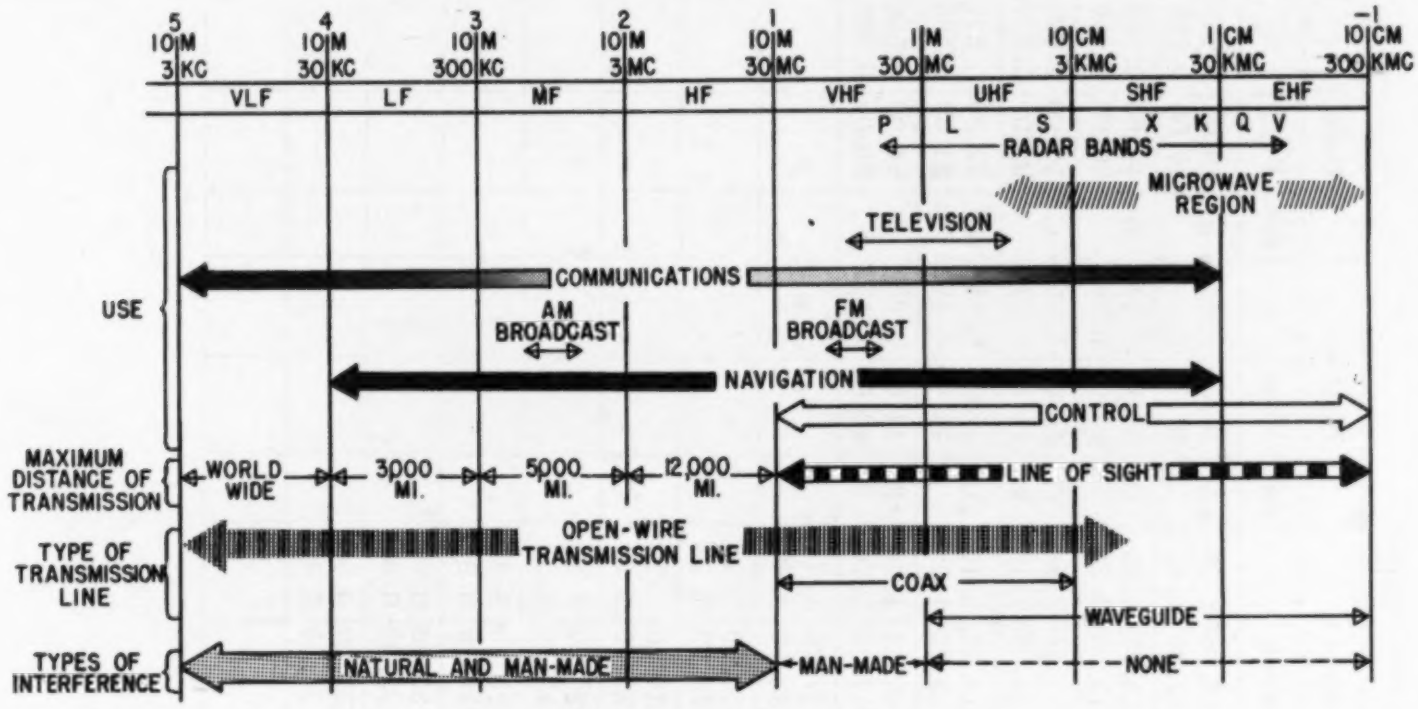

Figure 11-4.—RF spectrum.

more and more energy is absorbed from the wave and is lost, as far as communication is concerned. This absorption occurs principally in the D and E layers, which are maximum during the daylight hours, especially for frequencies between 500 kc and 2,000 kc. At the lowest useful frequency (LUF) the signal strength reaching the receiver barely overrides the background noise. Frequencies below this cannot override the noise and therefore serve no useful purpose.

OPTIMUM WORKING FREQUENCY. — Because both the height and the density of the various layers of the ionosphere may change from hour to hour, it is not possible to predict the exact MUF for each hour. Predictions are based on averages made over a long period of time. Therefore, it is necessary to choose an operating frequency that will not shift above the MUF when sudden changes in ionosphere occur. This frequency (15 percent below the MUF for F2 transmission) is called the optimum working frequency. When the lowest usable frequency is only slightly below the maximum usable frequency, the 15 percent figure may not apply.

EFFECT OF ANTENNA SITE

Should you be required to set up a VHF or UHF communication station at a forward base or at some training location, careful attention should be given to antenna location. In general, the following rules apply:

1. Locate the antenna as high from the ground as is practical.
2. In VHF installations locate away from manmade noises.
3. Locate on the highest ground in the area.
4. If possible, choose a site that is flat (that is, no hills or forests).

However, as with most general rules, there are exceptions. One factor that should be taken into serious consideration in the selection of the antenna site is the possibility of using the phenomenon known as OBSTACLE GAIN. Experiments with long range VHF transmission in mountainous regions have demonstrated the possibility of using knife edge obstacles as a means for increasing the received signal energy. Indications are that the disadvantages normally attributed to the transmission of very high frequencies (30 to 100 mc) among high mountain ridges can actually become powerful aids for reducing both transmission loss and tropospheric fading. The results of these obstacle gain experiments may have a deciding influence on the choice of sites for transmitting and for booster station installations. For example, it may prove more

advantageous to locate stations at lower elevations a short distance away from the mountains, rather than on the foothills right up against very high mountains.

The theory upon which obstacle gain transmission is based states that the transmission of VHF over a knife edge type obstacle should be considered as a combination of reflection, diffraction, and atmospheric refraction. Thus, if a transmitter and receiver are separated by a mountain, the radio waves would be received by means of the following mechanisms:

1. Diffraction at the top of the obstacle.
2. Reflection from the ground between the transmitter and the obstacle, and then diffraction over the obstacle.
3. Diffraction over the obstacle and reflection from the ground between the obstacle and the receiver.
4. A combination of the two ground reflections, with diffraction over the obstacle.

One requirement for use of the obstacle gain method for increasing signal strength is that the height of the obstruction must be greater than that of the common horizon.

Radio waves transmitted over the theoretically smooth, spherical earth are considered to arrive at points within the radio horizon by virtue of a normal diffraction process, and by scattering from the turbulet atmosphere. The turbulence, which is greatest near the earth's surface and decreases with increasing height into the upper atmosphere, is also considered responsible for the relatively weak and fading signals normally observed at distances well beyond the horizon. The obstacle gains associated with a properly situated knife edge ridge have been found to be large enough to reduce the transmission loss accompanying the reception of these signals beyond the horizon, thereby effectively eliminating the fading associated with the atmospheric scattering process.

A mountainous obstacle extending well above both the transmitting and receiving antennas requires the radio waves to pass through the most turbulent and disturbing regions of the atmosphere at relatively high grazing angles. With these large grazing angles, the amount of energy received from the highly turbulent regions in the screened lower portion of the atmosphere is effectively eliminated and so, in turn, is most of the tropospheric fading which normally exists on a nonobstructed path.

ANTENNA ARRAYS

The fundamental principles of antennas for use at UHF and microwave ranges are the same as those for use at lower frequencies. These principles have been covered in Basic Electronics, NavPers 10087-B, and will not be included in this chapter. It is advisable that you become thoroughly familiar with the material in the basic course, for without such information you will probable experience a great deal of difficulty in understanding this chapter.

In order to increase the effectiveness of the antenna system, several elements are often combined to form an array.

The simple half-wave dipole may be used in a variety of combinations to provide directive radiation patterns, with a signal increase in some directions, but reduction in others.

The antenna array to be used will be determined by the requirements of the equipment and the particular purpose of the transmission. UHF directive arrays containing several parasitic elements may be built into a very small space. Likewise, directive arrays with parabolic and horn type reflectors which would be too bulky for use at the lower frequencies become very practical at microwave frequencies because of their small physical size.

Directional arrays are more widely used with radar than the simpler vertical or horizontal antennas because of the increased gain due to the concentration of energy.

DRIVEN ARRAY

In the driven array, each of the individual wires which comprise the array receives its energy from the transmitter. Driven arrays may be divided into three basic types—the broadside array, the end-fire array, and the collinear array.

Broadside Array

When two half-wave elements are placed one-half wave apart, parallel to each other and excited in phase, most of the radiation takes place in a direction perpendicular to a plane through the elements. The arrangement and radiation pattern of such an array, called a broadside array, are shown in figure 11-5.

The antenna elements are mounted one-half wavelength apart to simplify the problem of

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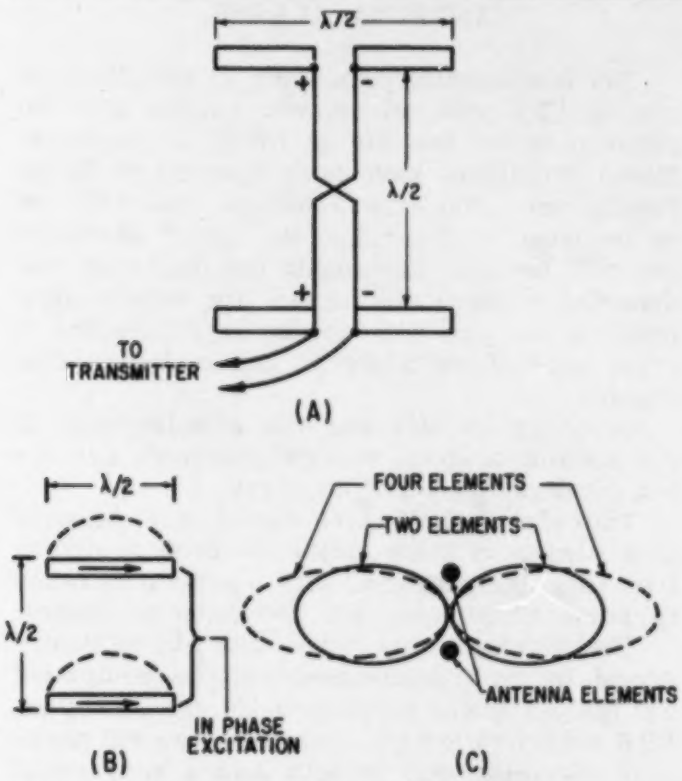

Figure 11-5. —Broadside array.

feeding the array with a single transmission line. In one-half wavelength, voltage and current polarities reverse. Therefore, by reversing the connections between the antenna elements (as shown in fig. 11-5 (A)), all the elements in a vertical line may be fed in phase.

Because of the vertical mounting or stacking of the radiating elements, and because of the phasing of the currents and voltages, the vertical radiation from the array is small. Most of the energy is concentrated in the horizontal plane, and by using more elements in the array, this horizontal directivity can be further sharpened, as shown in 11-5 (C). This increased directivity is shown by the dotted lines.

End-Fire Array

When two elements are spaced a certain fraction of a wavelength apart and are excited out of phase by the same fraction of a cycle (as shown in fig. 11-6), the radiation is directional in the plane of the array and perpendicular to the elements. It is directional from the end of the array that has the most lagging current. If the spacing in an end-fire array, for example, is a half wavelength, the

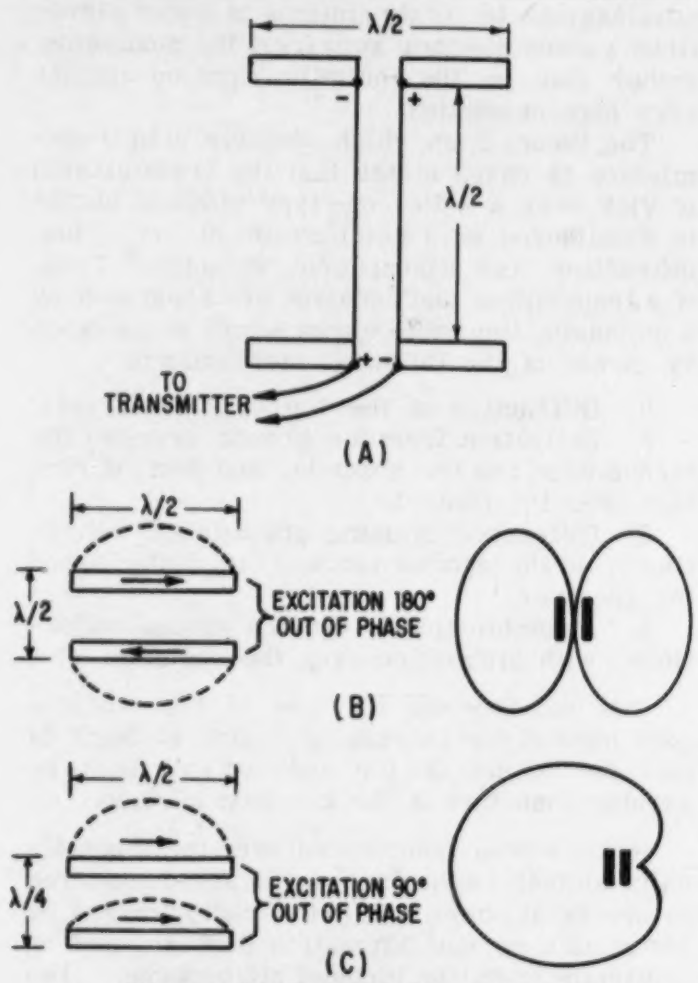

Figure 11-6. —End-fire array.

two elements are excited a half cycle or 180° out of phase. This causes the bidirectional pattern shown in 11-6 (B). A unidirectional cardioid pattern can be obtained with a quarter wavelength spacing and a quarter cycle (90°) phase difference in excitation, as shown in 11-6 (C).

Collinear Array

A collinear array is formed when two half-wave elements are placed end to end and excited in phase. In a collinear array there is no directivity in the plane perpendicular to the antenna, but there is a sharp pattern in any plane containing the antenna. As with any of the other arrays, increasing the number of half-wave elements increases the directivity of the pattern. This array is shown in figure 11-7.

If radiation in only one direction is desired (and this is true in most radar installations) a metal screen is mounted behind the radiating

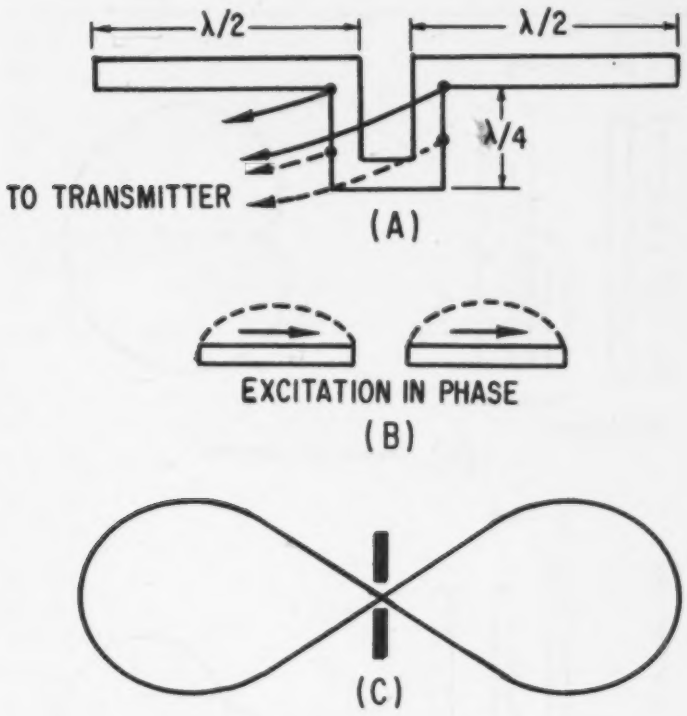

Figure 11-7. —Collinear array.

antennas. The unit now is a combination driven and parasitic array. This is a common procedure in the use of driven arrays, producing better directivity (and more antenna gain) than is possible with the driven array alone.

Interconnection of Elements in Arrays

There are several ways to connect the elements in an antenna array to obtain the required phase of excitation. The most convenient method to change the phase from one element to another element when they are a half wave apart is with an RF line. In the broadside array shown in (A) of figure 11-5, one element is excited directly from the transmitter. This element is connected to the other element by a half wavelength of RF line. The phase of the voltage along the RF line is shifted 180° for each half wavelength. The leads to the second driven element are reversed. This causes a reversal of polarity similar to that resulting from another 180° phase shift. The second element is then excited in the same phase as the first.

In the end-fire array in (A) of figure 11-6, the elements are also interconnected with RF lines. But instead of reversing the leads to the elements, they are connected directly to take advantage of the phase shift. With half-wave spacing, the interconnecting line will be one-half wave long and provide a 180° phase shift. If quarter-wave spacing is used, the interconnecting line will be one-quarter wave long; this arrangement produces a 90° shift.

The usual method for providing the correct phase in a collinear array is shown in (A) of figure 11-7. Since the current direction changes for each half wavelength of an antenna, it is not possible to connect the half-wave sections together directly. Instead, the half-wave section which carries the current in the wrong direction is folded to form a quarter-wave section of RF line. This brings together the ends of the sections in which current flows in the same direction. In other words, in terms of voltage it is necessary that the two antenna sections have voltages which are opposite in polarity at the open end. Further, note how the line to the transmitter is connected in the figure. The connection is made at a point of very high impedance. This requires the use of a resonant line. If a nonresonant line is to be used, it must be connected as shown by the dotted lines. In the diagram the connections near the closed end of the quarter-wave section are at a point of low impedance.

It is possible to connect any number of elements in this manner. Increasing the number of elements makes the array more directional.

PLANAR ARRAY

A planar array is a two-dimensional configuration of elements arranged to lie in a plane. (A linear array consists of elements arranged in a straight line in one dimension.) The two-dimensional planar array is probably the array of most interest in radar applications since it is fundamentally the most versatile of all radar antennas.

Radar beams can be rapidly scanned without any mechanical movement of antennas. Also, several independent beams can be generated simultaneously from the same antenna structure. When the array is mounted as a broadside array, the radiation pattern will be bidirectional and perpendicular to the plane of the array; with a reflector screen located a λ/4 behind the elements, the radiation pattern is undirectional. When the array is mounted as an end-fire array, the radiation pattern will be bidirectional and parallel to the plane of the array.

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A rectangular aperture can produce a fan shaped beam. A square or a circular aperture produces a pencil beam. The array can be made to simultaneously generate many search and/or tracking beams with the same aperture (with the use of phase shifting devices).

PARASITIC ARRAY

A parasitic array is an antenna system which consists of two or more elements in which not all of the elements are driven. The other elements are excited by induction and radiation fields which are produced by the driven element. With parasitic arrays it is possible to obtain highly directional patterns. The action in a parasitic array is analogous to the action in a transformer in which the primary induces a current in the secondary and the current in the secondary produces a magnetic field which, in turn, induces current back into the primary. The phase relationship between elements in an array varies according to the spacing between elements. The elements are usually spaced an appreciable fraction of a wavelength apart.

Antenna with Reflector

In the two-element array shown in figure 11-8 (A), the DRIVEN ELEMENT is cut at the center for connecting a low impedance feed line. The length of the driven element is a half wavelength. This makes it self-resonant. A parasitic element (called the REFLECTOR) is located 15 percent of a wavelength in space from the driven element, and is about 5 percent longer than the driven element.

If the polar diagram is plotted for two elements spaced 0.15 wavelength apart and excited out of phase, the curve shown in (A) results. This shows that most of the radiation is on the side of the driven element which is away from the parasitic element, while very little occurs on the side of the reflector.

Another point is that the field passing from the reflector cuts the antenna (driven element) and induces a voltage in it. This voltage changes the input current. The input impedance, which is a function of this current, is about 50 ohms as compared to 73 ohms for the antenna alone.

Antenna with Director

A parasitic element becomes a director when it is made shorter than the antenna element. In a director most of the energy is sent in a direction from the antenna element to the parasitic element. To see what takes place, note

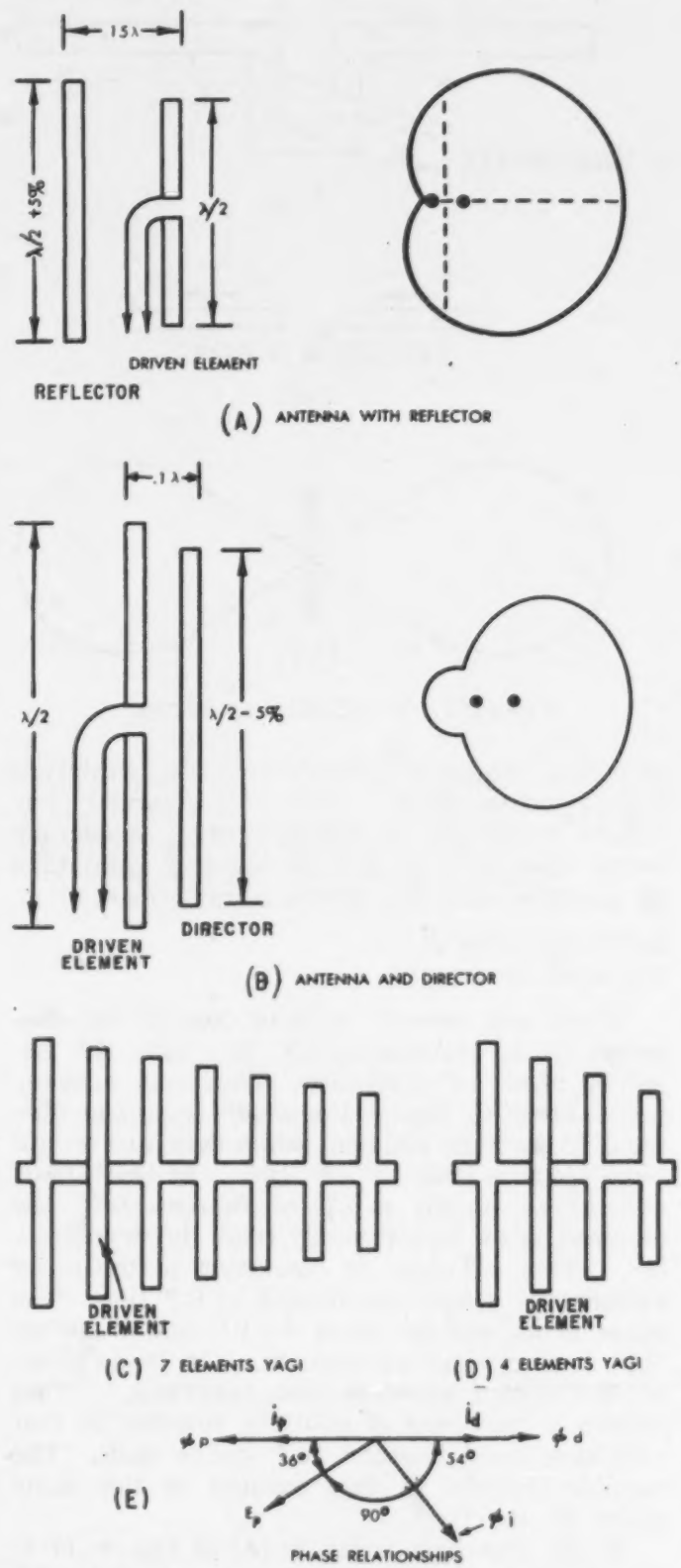

Figure 11-8.—Parasitic antennas and arrays.

the radiation pattern and the arrangement of the array in the diagram in (B) of figure 11-8. The director is usually about 5 percent shorter and about 0.1 wavelength from the antenna. Sometimes the impedance is reduced to 20 ohms at the driven element in this array.

Multielement Yagi

Notice the element array called a Yagi antenna in (C) of figure 11-8. In it the antenna or driven element is insulated, but the reflector, and all directors are welded to a piece of tubing which runs parallel to the direction of propagation. The beam width of this array is about 19°. The four-element Yagi shown in (D) is constructed similary to the one in (C) and has a beam width of about 50°.

Phase Relationships

Figure 11-8 (E) shows the phase relationship in the parasitic array vectorially. Vector i_d, which represents the current in the driven element, is in phase with the H-field. The part of the H-field that cuts the parasitic element lags the field which leaves the driven element by 0.15 of a cycle. (This is the time lapse during the travel between elements.) The lag is equivalent to 54°. The flux at the reflector is shown by vector ϕi. It lags i_d by 54°. The voltage induced by the field is 90° out of phase with the field. This voltage is represented by the vector E_p. If the parasitic element were resonant, the current in it would be in phase with E_p, but the reflector is longer than the resonant half wavelength. A long antenna is inductive and the current in this element will lag the voltage by 36° if it is approximately 5 percent longer. The radiated field will be in phase with this current. In summary, the field starting out from the parasitic element will be 180° out of phase with the field leaving the driven element.

Directivity

The conventional method for describing the directivity of an antenna array is in terms either of the ratio of the power in the best lobe to the power radiated by a simple half-wave antenna (antenna gain), or the ratio of the power in the direction of the best lobe to the power in the opposite direction (front to back ratio). The direction of the best lobe is usually called FORWARD direction, while that in the opposite is called the BACKWARD direction. In other words, this ratio is the power in the forward field to the power in the backward field. For example, the front to back ratio of the antenna array illustrated in (B) of figure 11-8 is about 5:1. In decibels, this represents approximately a 7-db gain. The ratio between forward power and power from a single half-wave antenna is about 4 db.

Comparison between the more directive types of arrays are made in terms of the beam angle. This angle is the angle between half-power points in the main lobe (radiation curve). In arrays the half-power points are the points where the electric field strength (volts per meter) is 0.707 times as great as that along the axis of the beam. Figure 11-9 shows the beam angle for a radiation pattern. In this illustration the angle between points A and B (angle ϕ) is the beam angle. At each of these points the signal strength is 70.7 percent of its value at point C. At A and B the power radiated is one-half the value as at C; thus these points are also known as half-power points.

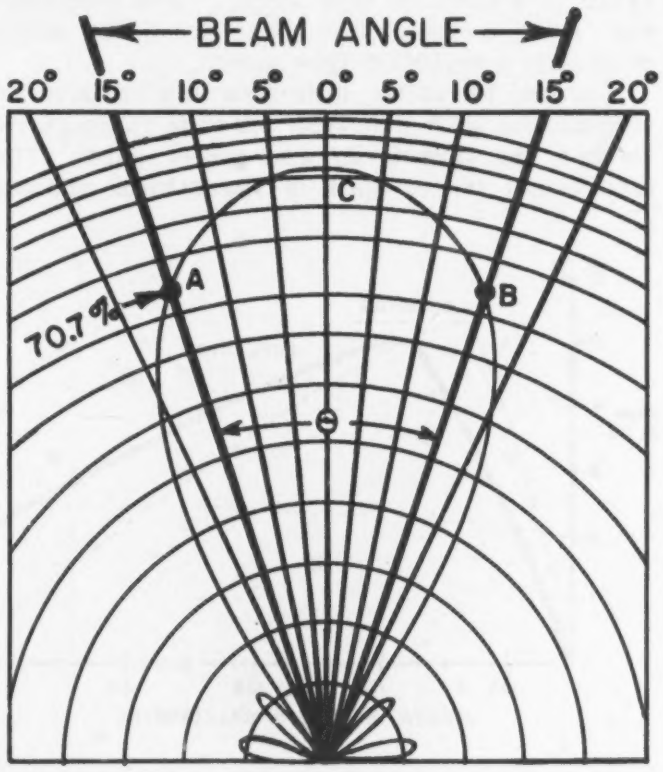

Figure 11-9.—Beam angle.

Power Gain

Figure 11-10 shows the effect of the element spacing on the power gain of an array as compared to the field strength of a half-wave antenna alone. Curve A shows the power gain for director spacings in wavelengths between a half-wave director and the driven half-wave radiator. Curve B shows the power gain for half-wave reflector spacings between the reflector and the driven half-wave radiator.

The graph shows that when a single parasitic element is used, there is little difference in the gain of the array if the parasitic element employed is used either as a reflector or as a director. When the parasitic element is tuned to work as a reflector, the spacing which gives maximum gain is about 0.15 wavelength and this maximum gain peak is fairly broad. The director will give slightly more gain than the reflector, but the difference between the two is less than 0.5 db. Consequently, on the basis of gain, there is little choice between the two types of operation. The broader curve of the reflector does offer a distinct advantage in that the spacing is less critical. Similarly, a small error in reflector spacing will reduce the gain of the array less than the same spacing error in a director type array. For this reason, when a single element is used, the array is usually a reflector type array.

Several parasitic elements can be used in conjunction with a driven antenna to increase further the directivity and power gain. The theoretical power gain of directional antenna arrays composed of an excited element and various numbers of parasitic elements is given in table 11-3.

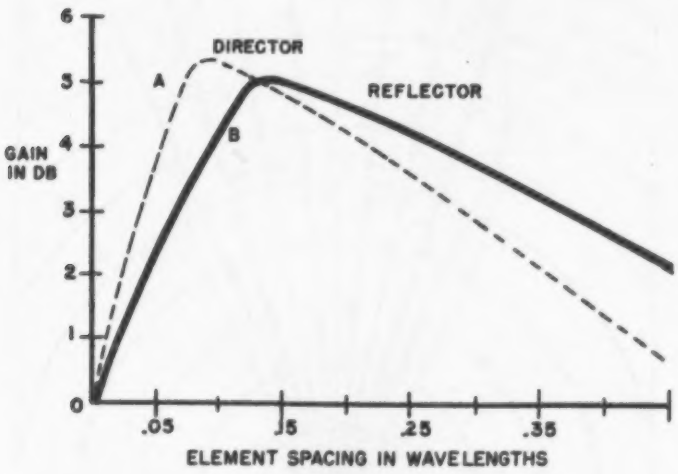

Figure 11-10. —Relative power gain for parasitic elements.

Impedance Considerations and Matching

In multielement arrays the input impedance drops as low as 15 ohms. In these arrays special matching devices are needed for matching this low impedance to the higher impedance of most RF lines.

One method for making the match is to use the delta matching system in which the end of the transmission line that is to be connected to the antenna is spread apart (fanned out) before being connected. The section of the line that is spread apart has a continuously increasing characteristic impedance. The impedance of a half-wave radiator increases from 73 ohms in the center to about 2,500 ohms at the ends. Thus, the impedance at any point is determined by the distance from the center. Two points can be found on the radiator where the impedance equals that of the fanned section of the transmission line. The connections are made at these points.

Another method, the one most often employed, uses the folded dipole as shown in figure 11-11.

A folded dipole is a full wavelength conductor which is folded to form a half-wave element. (A better description is that it consists of a pair of half-wave elements connected together at the ends.) In it the voltage at the ends of each element must be the same. In operation, the field from the driven element induces a current in the second element. This current is the same as the current in the driven element.

An ordinary dipole with a given current, I, produces a certain field intensity in space. Due to this field, there is also a certain power density per square meter in space. This power

Table 11-3. —Theoretical power gain.

Number of elements	Power gain
2	2.5 (4.0 db)
3	3.6 (5.6 db)
4	5.0 (7.0 db)
5	6.4 (8.1 db)

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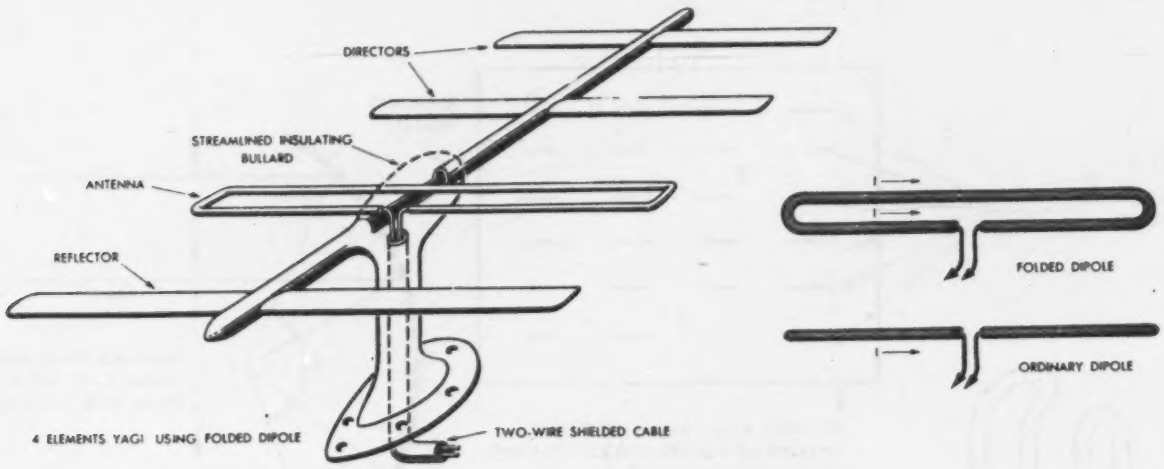

Folded Dipole

Figure 11-11. —Folded dipole antenna array.

density is produced by the input power, P. The relationship between the input resistance, the current, and the input power is expressed by the equation,

$$R = \frac{P}{I^2}$$

With the folded dipole, the same current, I, exists at the input terminals; but this same current flows in both sections of the antenna, and consequently, the field strength in space is doubled. This causes the power density per square meter to increase to four times the previous value when the current at the input remains unchanged. In turn the input power must be four times as great. In this case, to balance the equation, it is necessary to multiply R by 4 as follows:

$$\frac{4P}{I^2} = 4R$$

So long as each section of a dipole has the same diameter, the input resistance is four times that of the simple half-wave dipole. Increasing the diameter of one section makes the increase in impedance still greater. The input impedance to the driven element of a parasitic array drops to about a fourth of the value of the coaxial cable impedance, but the use of a folded dipole increases the impedance by about four times. In this way a good impedance match is achieved.

PARABOLIC REFLECTOR

When a multielement broadside array is excited, the E-field which exists in front of the antenna will be a single plane, as shown in (A) of figure 11-12, rather than in an arc as is the case in a single half-wave element. The larger the dimensions of this plane in terms of wavelengths, the greater is the directivity of the antenna system, and the narrower the radiated beam.

Although a multielement broadside array gives good results, it is quite complicated in structure. In it every element must be driven and all spacings and dimensions must be quite exact. A much simpler device for producing an electric field in a single plane is the parabolic reflector. As shown in (B), the parabola has its focal point at F. If a single antenna is placed at F and caused to radiate a field, the electric field will leave the antenna in all directions at the same rate in the form of an arc as indicated at point A. As each part of the wavefront reaches the reflecting surface, it is shifted in polarity and sent outward at an angle of reflection that is equal to the angle of incidence. All parts of the field will arrive at line BB' at the same time after reflection because all paths from F, to the reflector, to line BB' are equal in length. Thus, with only one antenna and a specially shaped reflector, it is possible to produce a large electric field in a single plane. Or, looking at it another way, all parts of the field travel in parallel paths after reflection from the para-

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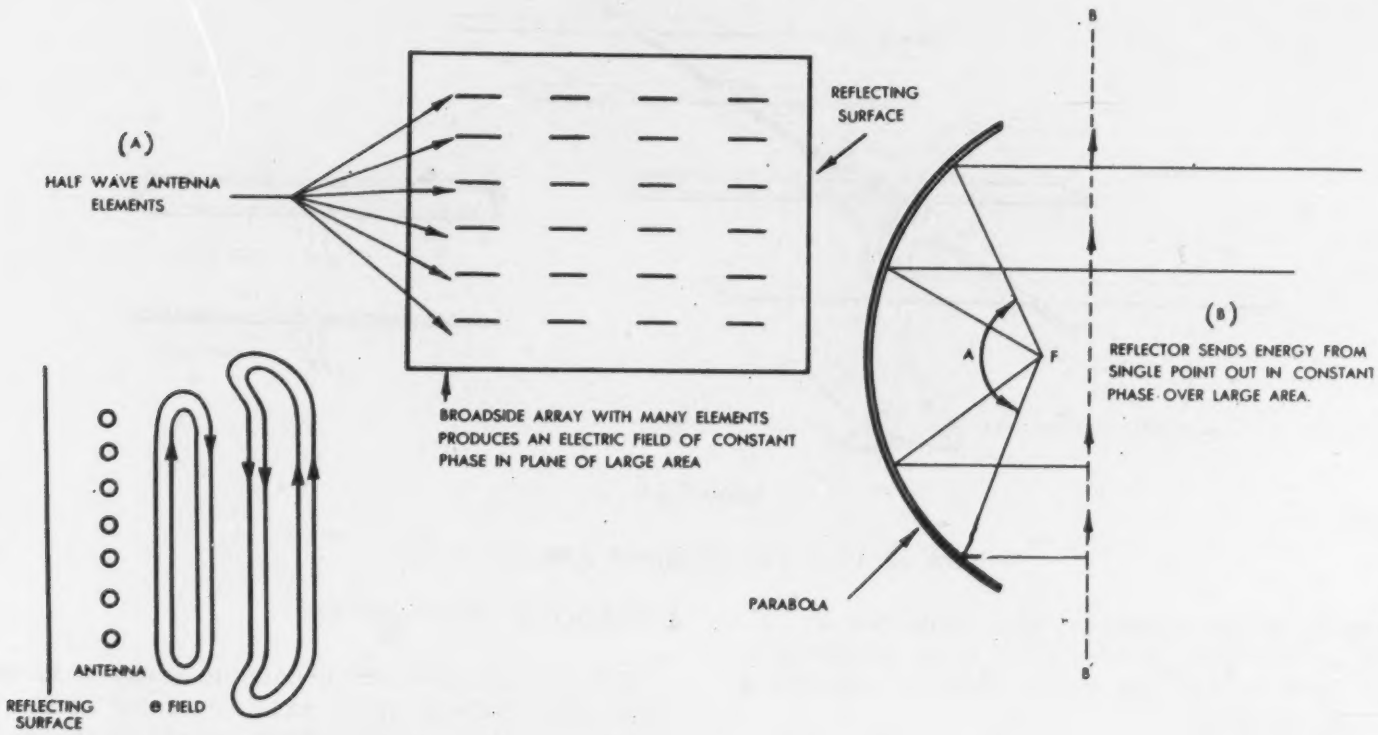

Figure 11-12.—Directional radiation by means of reflectors.

bola in such a way that the rays are focused like the headlight beam from an automobile.

Like the broadside array, high directivity is not obtained until the diameter of the parabolic reflector is made many wavelengths long. This prohibits the use of the parabolic reflector at low frequencies, but for 3-centimeter and 10-centimeter radar equipment these reflectors are very practical.

Feed Systems

In figure 11-13 (A), showing the exciting antenna for a parabolic reflector, the half-wave dipole is mounted a quarter wave back from the short on the coaxial line. To sharpen the focal point, the antenna is made physically less than a half wave long. However, the balls at the end make it electrically a half wave long. This broadens the band of frequencies it will handle. The airtight cylinder in which the antenna is enclosed permits the coaxial line to be pressurized. The inner surface of half the cylinder on the side away from the parabolic reflector, is coated with a reflecting foil. This reflecting surface directs energy from that side of the antenna into the large reflector. Without this reflector, the antenna radiation would be nondirectional.

The natural directivity of a dipole causes the pattern from a parabolic reflector to be somewhat sharper in the plane containing the dipole than in the other plane. For this reason, the dipole is erected horizontally for maximum azimuth accuracy in radar systems. If vertical accuracy is of primary importance, the dipole is mounted vertically.

Other methods of preventing the direct forward radiation use a parasitic reflector with the half-wave dipole, and a disk which is placed in front of the dipole.

A waveguide can be used to bring energy to the parabolic reflector by placing the mouth of the guide at the focal point of the parabola and positioning it so that the energy strikes the parabolic reflector. A typical application is shown in (B). The most easily constructed waveguide feed is simply an open-ended waveguide. The energy from the transmitter comes streaming down the guide, passes out through the open end and, if this is facing the parabolic reflector, strikes the reflecting surface. Sometimes the end of the waveguide is tapered, so that the energy may be distributed horizontally or vertically to produce a desired pattern after it is reflected by the paraboloid. By modifying the shape of the feeding waveguide, this energy can be concentrated in one direction

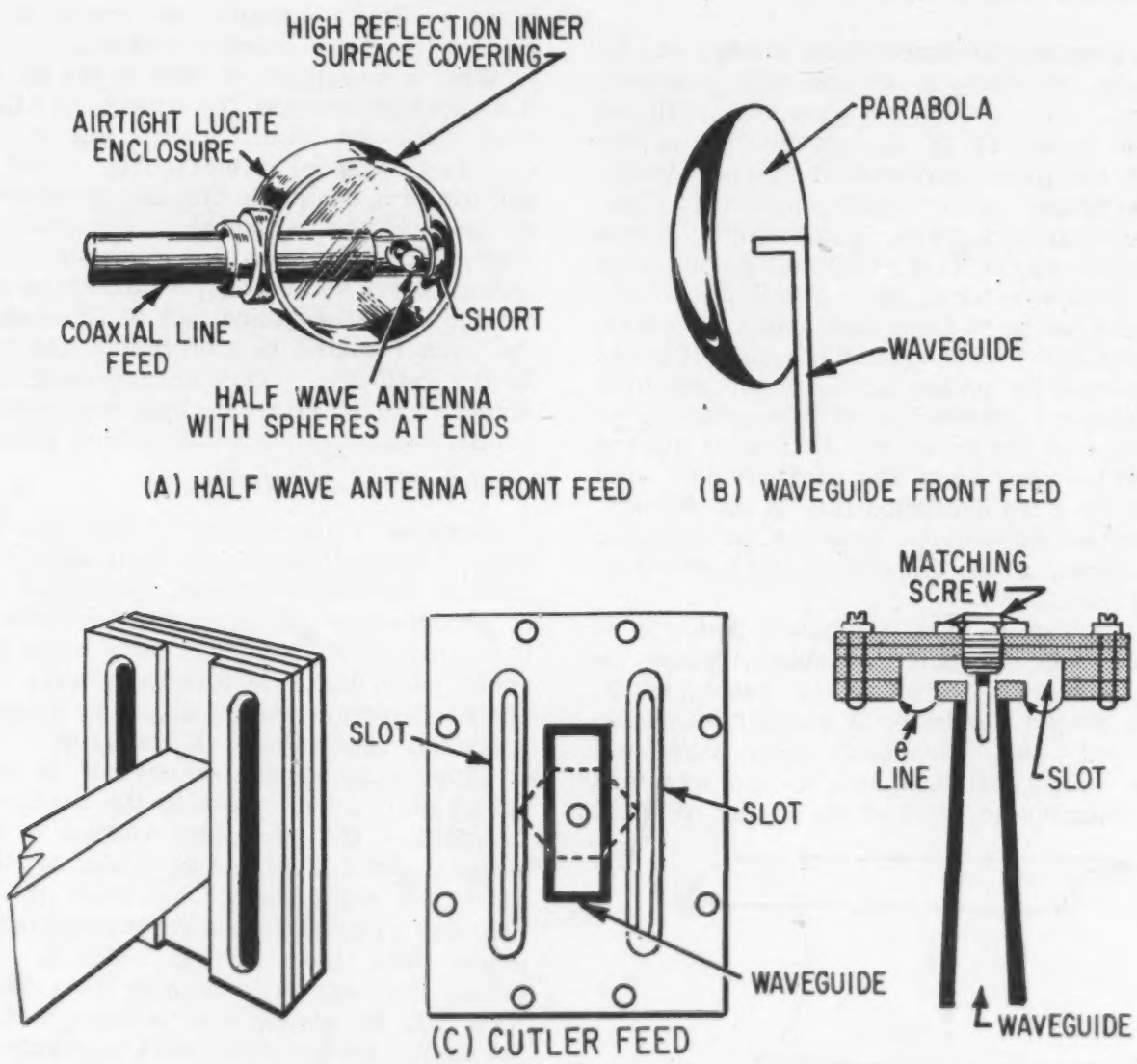

Figure 11-13.—Feed systems for parabolic reflectors.

and, in conjunction with the parabolic reflector, achieve a desired radiation pattern.

One difficulty that is encountered when using waveguides to feed energy to parabolic reflectors is the fact that the guide, passing in front of the reflector, tends to block part of the energy reflected by the paraboloid. To avoid this difficulty, several rear feeds have been developed. In this form of feed, the waveguide passes through the vertex of the paraboloid and extends to the focus, at which point the energy is redirected back to the reflecting surface of the paraboloid and then radiated in the forward direction. The most widely used and most successful of these "rear-feed" arrangements is the Cutler feed shown in (C).

The waveguide is terminated in front of the reflector in a Cutler feed radiator, which in reality is a cavity at the end of the waveguide. It can be considered as two small waveguides formed as a result of dividing the main wave into two halves, and bending each half through 180°. The fields emerge from openings or slots that are a half wave apart as shown in the drawing. The waveguide is tapered in the noncritical dimension to fit between the slots. The cavity impedance is matched to the waveguide by the matching screw. This adjustment is made at the factory and soldered in position. The radiated field is horizontally polarized. The design of the cavity is such that the energy striking the reflector decreases sinusoidally from the center toward each edge.

Variation of Parabolic Reflectors

It is possible to concentrate energy in one plane only, by using a section of a parabolic reflector. Thus, with the parabolic cylinder shown in figure 11-14 (A), directivity is obtained in the plane perpendicular to the length of the cylinder. In the figure, this would mean sharp vertical directivity. Parabolic cylinders do not have single focal points as paraboloids do, but rather a focal line. Small dipole antennas are mounted along this line, the useful energy radiating back toward the reflector and then forward by reflection from the surface. The horizontal directivity of this reflector is determined by the number of half-wave dipoles used and the phasing of the currents and voltages fed by a transmission line to the dipoles. The greatest directivity, however, is obtained in the vertical plane and this is determined by the parabolic surface.

Another section of a paraboloid which is of interest is the truncated paraboloid shown in (B) of figure 11-14. This is energized by either a single dipole or a waveguide placed at the focal point. Directivity in the horizontal plane is essentially the same as that obtained from a paraboloid; directivity in the vertical plane is not quite as good. This type of antenna would be suitable for ground to air or ground to ground surface search.

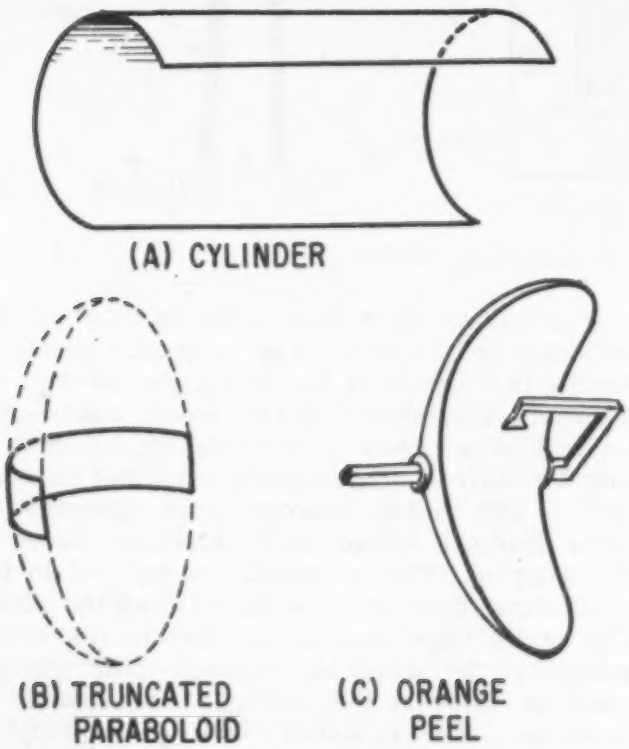

Figure 11-14. —Variations of the parabolic reflector.

When a waveguide is used in the RF system, it is possible to send the energy into the parabolic reflector with a horn radiator. In this case an orangepeel reflector (fig. 11-14 (C)), or section of a complete circular paraboloid may be used as the reflector. The feed is by a waveguide and a horn type radiator. The horn type radiator and orangepeel parabola are constructed so that almost all of the energy that the horn radiates is intercepted and reflected by the reflector. This arrangement is highly directive in the vertical plane and is used principally to determine the altitude of aircraft.

Cosecant-Squared Reflectors

Because of the variety of the applications of radar, widely different requirements must be met by different antennas. Antennas designed to produce special polarization effects or pattern shapes may differ greatly from those already described. In airborne radar sets that are designed for use in scanning a large area, a special beam shape is required.

This beam should be narrow in the horizontal plane, but broad in the vertical plane. In addition, the particular section of the area being scanned must not be uniformly illuminated by the radar beam. Instead, the objects near the aircraft should be illuminated by less power than those farther away in the same sector, because echo signals from nearby objects will be strong due to their closeness to the plane. On the other hand, a greater amount of power should fall on more distant objects in this sector, since they would normally produce the weakest echoes. Thus, the radiated field of the beam should increase in intensity at the greater distances. Figure 11-15 (A) shows some trigonometrical relationships of this situation.

If the aircraft is at point A in figure 11-15 (A), and the target is at point B, then the slant range (straight-line distance from A to B) can be represented in terms of the aircraft altitude (h) and the angle of depression (θ) of the target as seen from the aircraft:

$$\frac{h}{r} = \sin\theta; \quad r = \frac{h}{\sin\theta}; \quad r = h \csc\theta$$

Thus the slant range is proportional to the cosecant of θ.

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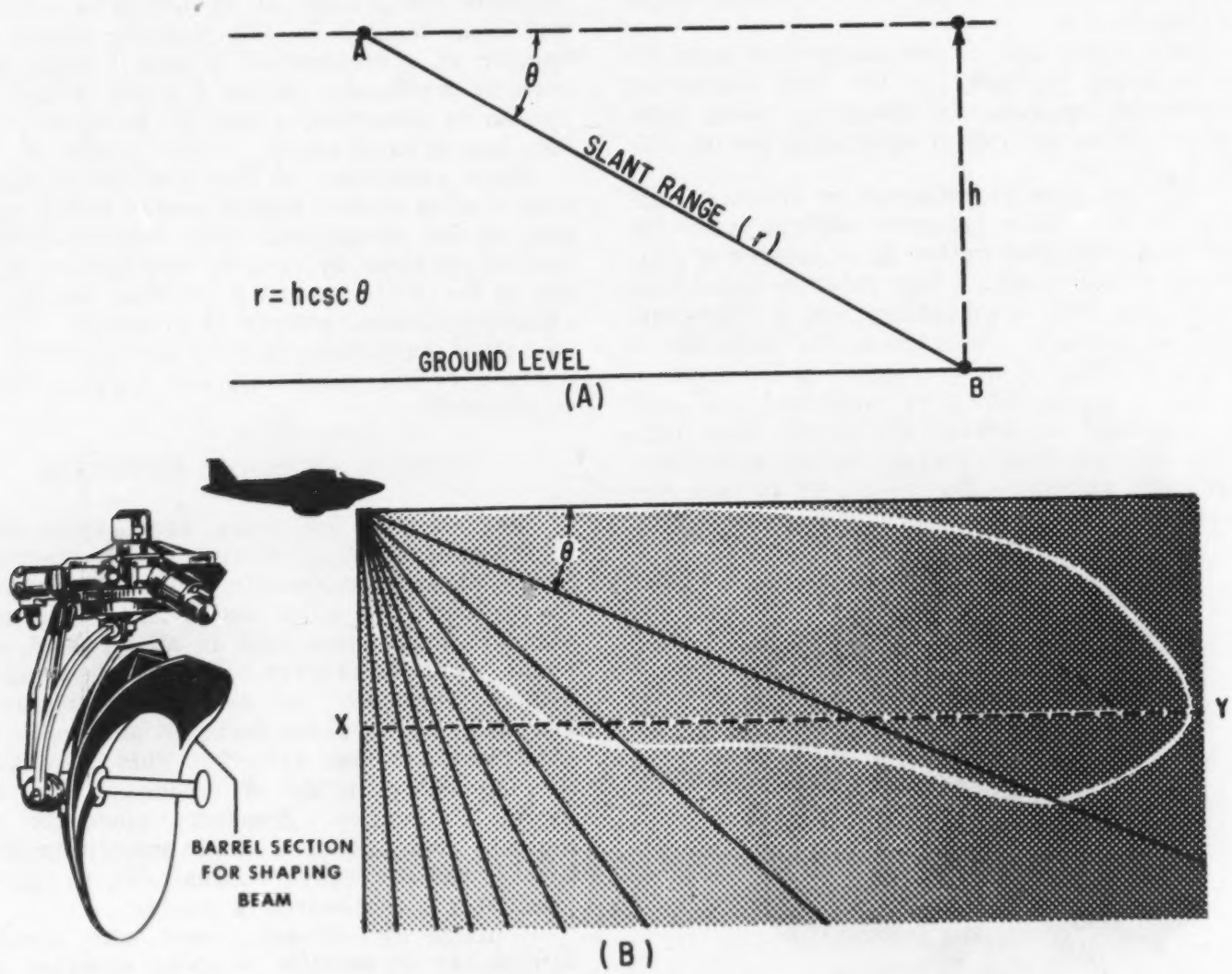

Figure 11-15.—Cosecant-squared antenna and pattern.

An antenna has been designed so that the field intensity pattern is also proportional to cosecant θ; this antenna lays down a uniform electric field which causes the echo response of a nearby target to be approximately equal to that of a distant target having the same radar cross section (reflectivity). The equality of response is based on the concept of power density; research has shown that power density is proportional to the square of field intensity. This particular antenna, therefore, produces an electrical field whose power density is proportional to the square of cosecant θ.

Recalling from a review of Basic Electronics, NavPers 10087-B, that RF signal strength is inversely proportional to the square of the distance from the source, note that a balance of signal loss against signal gain is utilized in this antenna. As the slant range r (fig. 11-15 (A)) increases, θ decreases and csc θ increases. The signal strength (power density) is inversely proportional to the square of h csc θ because the wave is RF energy; at the same time, the signal strength is directly proportional to the square of csc θ because of the antenna design. (Assume that h is constant.) The result is a net change of zero (theoretically) in the signal strength up to the maximum range of the transmitter. The antenna design which produces this result is called the cosecant-squared antenna.

Figure 11-15 (B) shows the special paraboloid reflector, in which the top portion is bent forward to produce the cosecant-squared pattern. Also shown is the pattern itself. Notice that this antenna produces a field of constant signal strength (bounded by the white line)

at ground level (line XY) over a broad range of values of θ.

This same type of antenna is also used (in an inverted position) on the land based and shipboard systems for obtaining equal indications from aircraft at equal altitudes but different ranges

Another type of reflector is shown in figure 11-16. This reflector differs from the one just discussed in that it is capable of producing either a pencil type (narrow beam both vertically and horizontally) or a cosecant-squared pattern. Mounted on the reflector is a rod grating, roughly shaped in the form of a barrel stave, which is polarized and acts as a spoiler to deform the pencil beam pattern into an equal energy return (cosecant-squared) pattern. The choice of pattern desired may be obtained by rotating the entire reflector and grating 90° by means of a motor and gear train. In the position where the spoiler is nonreflective, a pencil beam pattern is produced. In the position where the spoiler is reflective, a narrow, blade-like pattern having equal energy return results.

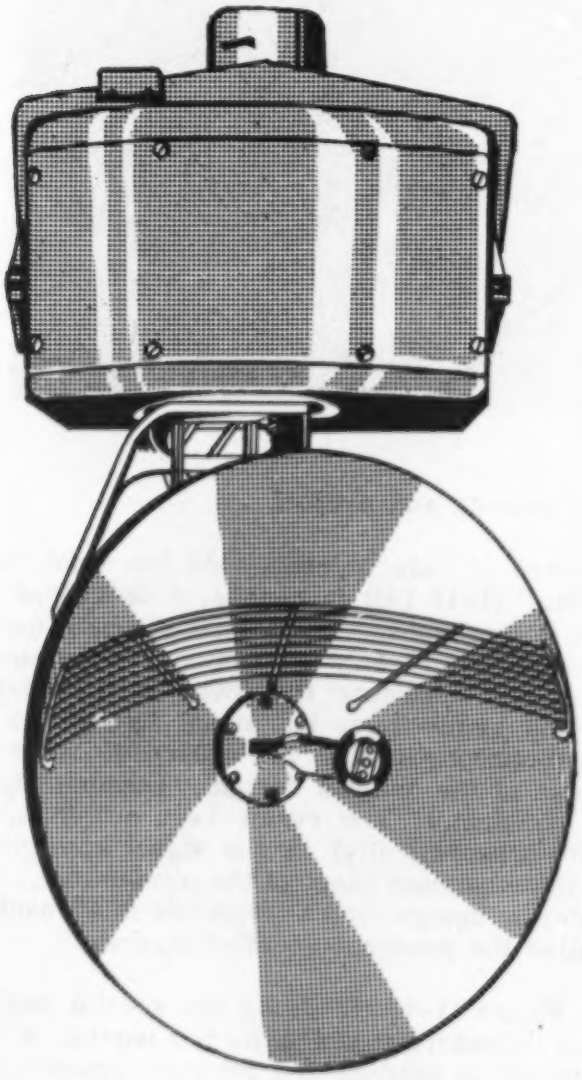

Figure 11-16.—Parabolic antenna with spoiler.

Some reflectors of this type are equipped with a solid spoiler that is hinged to the upper part of the paraboloid. The desired pattern may be obtained by causing this spoiler to tilt out of the reflector to a position where the cosecant-squared pattern is produced. In the retracted position the spoiler is flush with the surface of the paraboloid and a pencil beam is produced.

TYPICAL AIRBORNE ANTENNAS

Until the past few years, the antennas used in airborne electronics were fairly standard. For a transmitter operating within a given frequency band, the same antenna was used as a standard installation item in all types of aircraft. With the modern concept of the weapons system, however, the electronic equipments and their antennas are designed along with the individual weapons system. This eliminates the interchangeability of antennas from one system to another. However, since the antenna is designed for a single specific application, it has decreased considerably in importance as a major source of trouble.

Although the antennas used with specific equipments in specific weapons systems are somewhat different from one another, they have certain basic similarities. There are general classes of antennas used, each for its own specific purpose. The various antenna components of the electronic packages are merely modifications of these basic types. The remainder of this chapter is devoted to a discussion of these types; some specific examples are mentioned, along with some of the new developments in antenna design.

The location of the antenna will vary depending upon the specific problems of the installation. It is extremely important to know that at all frequencies, especially UHF and microwave, it is possible to reduce the efficiency of an installation through the use of excessive antenna cable lengths and connectors. Antenna runs should be kept to a minimum length. In most cases the Service Instruction Manual will specify maximum lengths. It is also important that either the designated type or a

lower loss cable be used in all installation work.

A helpful publication, Index of RF Transmission Lines and Fittings, MIL-HDBK-216, is available upon request. This publication contains charts of attenuation versus frequency for various types of transmission lines, assembly data for connectors, waveguide data, and other information. The charts will be helpful in determining attenuation losses for an antenna cable at a particular frequency. An example of attenuation loss is as follows: RG8/U cable has an attenuation of 9 db per 100 feet at 1,000 megacycles. If a 1,000-watt transmitter is connected to an antenna with 33 1/3 feet of cable, the power at the antenna will be only 500 watts; thus, half the power is dissipated by the cable. It is also possible to increase the losses of the system by using older type high loss connectors. Even with the newer type low loss connectors, it is advisable to use as few as possible. This may be partially accomplished by using a minimum of right angle connectors and as few as possible of the type that connect through the bulkhead. Adaptors should also be used sparingly.

GROUND-PLANE ANTENNAS

A vertical quarter-wave antenna several wavelengths above ground produces a high angle of radiation which is very undesirable at the VHF and UHF frequencies. An effective means of obtaining a low angle of radiation from this type antenna is to work it against a simulated ground (called a GROUND PLANE). The simulated ground may be made from a large sheet of metal, or from several wires or rods protruding from the base of the radiating element of the antenna. In another type, the outer conductor of a coaxial antenna may be flared out. An antenna so constructed is called a ground-plane antenna. The most noticeable difference between the ground-plane antenna and the reflector type antenna is the relative positions of the elements. In the reflector type antenna, the reflector element is mounted parallel with the driven element; while in the ground-plane antenna the ground plane is mounted perpendicular to it.

Several types of ground-plane antennas are shown in figure 11-17. The radius of the ground sheet or the length of the rods used should be one-quarter wavelength or longer. The function of a ground plane corresponds to that of a counterpoise used with low frequency vertical antennas.

This type antenna is frequently used with VHF and UHF communications equipment in aircraft. The skin of the aircraft serves as the ground plane. When this type antenna is used with a ground installation, it is necessary to employ a ground plane as illustrated. Without the use of the ground plane, it is impossible to obtain proper loading and efficient radiation.

Since there are no ordinary transmission lines having a characteristic impedance low enough to permit a direct connection to the 20- to 36-ohm impedance of the ground-plane antenna, a quarter-wave matching section may be used to obtain an acceptable match.

If it is desired to avoid the use of a matching section with its accompanying power losses and bandwidth limitations, the radials can be arranged to slope downward in the manner of an inverted cone as shown in (C). The impedance increases as the angle between the radials and the horizontal plane increases. This method can be used to secure a suitable match to a 52-ohm transmission line. It is possible to use the rods or cables in the multiple capacity of a ground plane and as guy wires for mechanical support, while at the same time changing the impedance to obtain a proper match.

The impedance can be increased further to match a 72-ohm line by bending the radials down parallel to the transmission line, or by supporting the shaft as shown in (D).

SLEEVE ANTENNAS

The sleeve antenna is basically a vertical omnidirectional antenna developed from the ground-plane antenna by folding the ground plane back over the radiator (to form a sleeve) before flaring it out. This helps to minimize radiation from the feeder line. One type coaxial radiator is one-half wavelength long, with the top half a thin whip or rod, and the bottom half a comparatively large hollow metal tube or cylinder. The coaxial feed line is run up through the sleeve radiator or cylinder, as shown in (A) of figure 11-18. The center conductor of the coaxial line connects to the whip radiator, and the outer conductor connects to the sleeve radiator. Since there is no RF field within the sleeve, interaction between the radiator and the coaxial line is minimized.

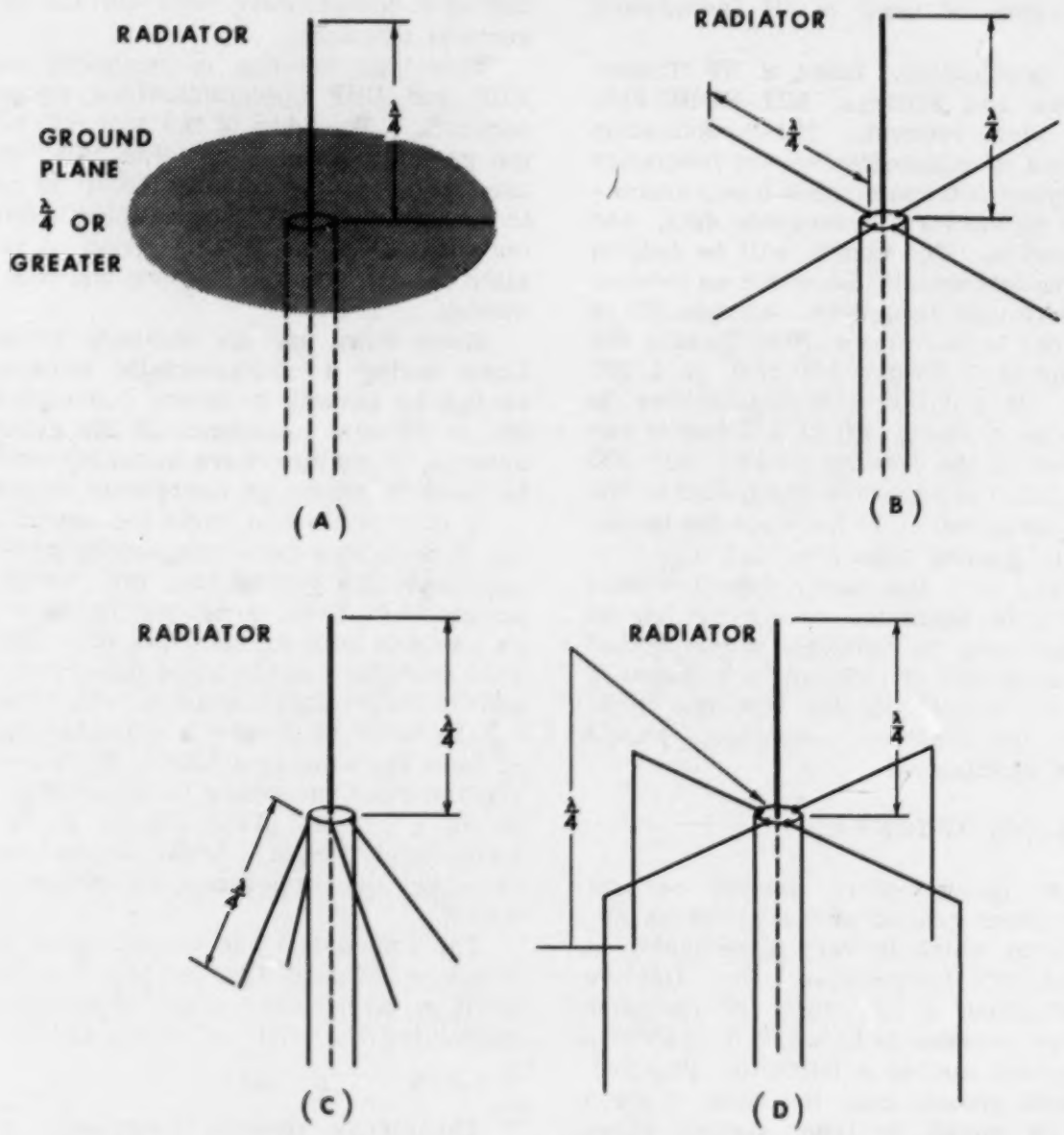

Figure 11-17. —Ground-plane antennas.

The section of transmission line within the sleeve acts in conjunction with the sleeve to form a short circuited concentric line which has an extremely high impedance across the open end. This high-Q parallel resonant circuit minimizes coupling between the sleeve radiator and the transmission line or hollow supporting mast. Although the sleeve effectively decouples the section of line within it from the sleeve radiator itself, as well as from the upper radiator, there will still be some coupling between radiators and the section of transmission line or mast immediately below the sleeve. This coupling causes some radiation from the vertical portions of the line and/or mast, and as a result, some power is wasted in high angle radiation.

Radiation can be eliminated from the feeder and mast by placing a quarter-wave detuning sleeve below the sleeve radiator as shown in (B). The detuning sleeve is mounted with its open end facing upward, one-quarter wavelength below the bottom of the sleeve radiator. Its closed end is connected to the mast, or to the outer conductor of the coaxial feed line.

Inasmuch as the coaxial antenna is effectively a vertical, center fed, half-wave radiator, its center impedance is approximately 70 ohms. A 70-ohm feed line provides the most efficient match, but lines up to 120 ohms can be used without serious mismatch. It is possible to maintain a uniform impedance over a larger frequency band by increasing the diameter of

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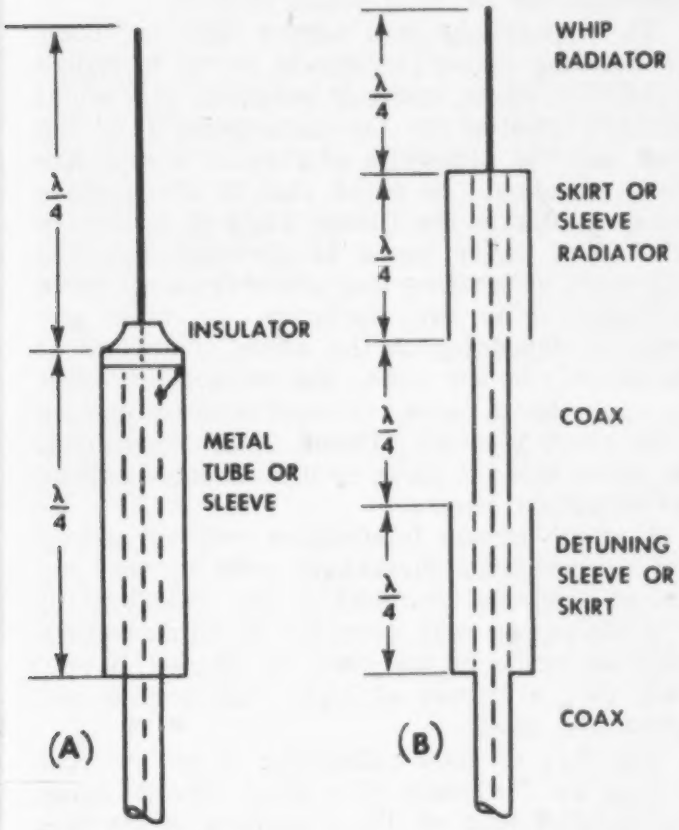

Figure 11-18.—Sleeve antennas.

the dipole, or by using a dipole constructed in the shape of a cone or cylinder.

CORNER REFLECTOR

When a unidirectional radiation pattern is desired, such a characteristic can be obtained by the use of a corner reflector. A corner reflector antenna is a half-wave radiator with a reflector consisting of two plane metal surfaces meeting at an angle immediately behind the radiator. In other words, the radiator is set in the plane of a line bisecting the corner angle formed by the reflector sheets. The construction of a corner reflector is shown in figure 11-19 (A).

Corner reflector antennas are mounted with the radiator and the reflector horizontal when horizontal polarization is desired. In such cases, the radiation pattern is very narrow in the vertical plane, with the maximum signal being radiated in line with the bisector of the corner angle. The directivity in the horizontal plane is approximately the same as for any half-wave radiator having a single-rod

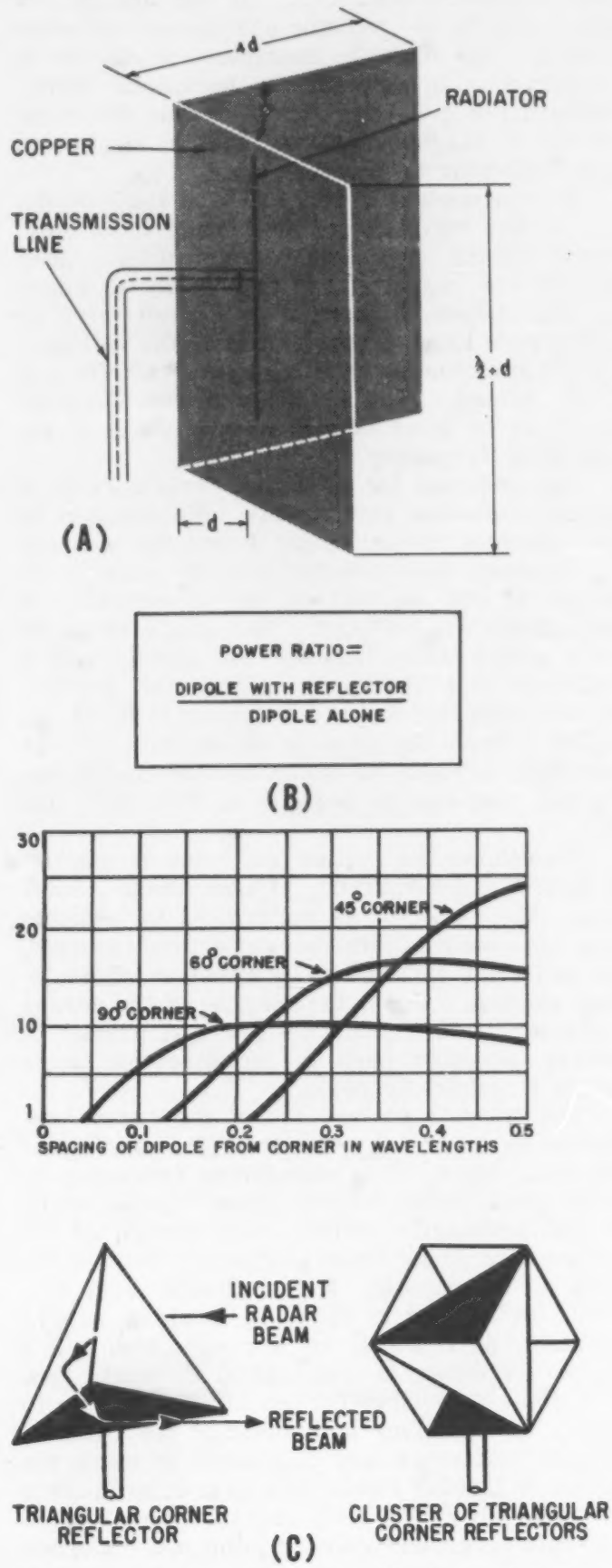

Figure 11-19.—Corner reflector antenna.

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type reflector behind it. If the antenna is mounted with the radiator and corner reflector vertical (as shown), maximum radiation is produced in a very narrow horizontal beam. Radiation in a vertical plane will be the same as for a similar radiator with a single-rod type reflector behind it.

At frequencies in the VHF and UHF bands, the corner reflector is often made from solid metal sheets. At lower frequencies, such sheets are massive and are easily damaged by high winds. Therefore, screen wire or metal rods located in the plane of the reflector sheets and running parallel to the radiator are used instead. The spacing between the rods must not be more than 0.06 wavelength at the operating frequency.

The gain and the radiation resistance of a corner-reflector antenna are both affected by the reflector corner angle Φ and the spacing, d, between the radiator and the corner as shown in (A), as well as the construction of the antenna and reflector. The gain (expressed as a power ratio between the dipole with a reflector and the dipole alone) for several corner-reflector antennas is shown in the graph in (B). Here the gain is shown for various spacings between the dipole and the corner reflector, and for an angle Φ of 90°, 60°, and 45°.

Sometimes the corner reflector is used as a PASSIVE RADIATOR. Under these conditions, the reflector is not excited by a dipole that is mounted with the reflector. Instead, the reflector is acted on by a distant transmitting antenna. Here, the purpose of the corner reflector is to return the greatest amount of energy possible back in the direction from which it originally came.

The most important use of the corner reflector as a passive radiator is in radar applications. Here, it is sometimes necessary to make good radar targets from objects which do not ordinarily reflect back enough of the transmitted radar beam to disclose their presence. For example, it is normally very difficult for a search radar to locate a rubber liferaft, particularly in a rough sea. If a corner reflector is installed on the raft, then it becomes possible for an aircraft radar to detect the raft over a distance of many miles. Corner reflectors are also used to mark the edges of landing fields or a particular runway so as to provide a well marked point for the aircraft or ground radar equipment. Corner reflectors are frequently installed on important buoys or strategic points of land which would otherwise not be good radar targets.

The appearance of a corner reflector used for marking radar targets is shown in figure 11-19(C). Three mutually perpendicular metal surfaces similar to the arrangement of the floor and two sidewalls at a room corner are used. It should be noted that in the passive corner reflector the corner angle Φ is always 90°. If a radar beam is directed into the reflector, reflections may occur from all three surfaces, from two surfaces, or from one surface, depending on the angle of arrival of the beam. In any case, the reflections cause the radar beam to be returned in the direction from which it came. Under these conditions, the radar antenna picks up the reflected energy and detection occurs.

A single corner is effective only for energy that arrives from directions covering one octant of a sphere centered at the reflector. If it is desired to have coverage in all directions (such as would be the case for liferaft detection), then a cluster of eight such corner reflectors is used.

The size of such reflectors is not critical so long as the length of a short side is many wavelengths long at the frequency of the detecting radar. The corner reflector cluster which is included as part of the emergency rescue equipment on liferafts is a collapsible structure made of screen and measuring 2 feet on a short side. The reflector is mounted about 4 feet above the raft.

SLOT ANTENNAS

Slot antennas are adaptable for the VHF and UHF ranges. Their most important practical advantage is that the feed section which energizes the slot may be placed below the large metal surface in which the slot is cut. Thus, nothing need protrude from the surface. In addition, the slot itself may be covered by a section of insulating material so that the opening is closed. As a result, no air resistance occurs. This is particularly important in the case of high speed aircraft where the vibration problems and drag that would be introduced by conventional antennas cannot be tolerated.

When a slot antenna is installed on an aircraft, particular attention should be paid to the slot location with respect to large protuberances.

Wings, fuselage, or engine will act to cut off a large portion of the energy radiated from a slot if these objects are located between the slot and the receiving location. Optimum locations for slot antennas on aircraft include the leading edge of the wing and the side of the nose.

Basic Slot Antenna and Its Complementary Dipole

The slot antenna consists of a radiator formed by cutting a narrow slot in a large metal surface. Such an antenna is shown in figure 11-20. The slot length is a half-wave while the width is a small fraction of a wavelength. Such an antenna is frequently compared to a conventional half-wave dipole consisting of two flat metal strips whose sizes are such that they would just fit into the slot cut out of the large metal sheet. This type is called the COMPLIMENTARY DIPOLE. This comparison is made since the radiation pattern produced by the slot antenna when cut into an infinitely large metal sheet and that of the complementary dipole antenna are the same.

It is of interest to note several important differences between the slot antenna and its complementary antenna. First, the electric and magnetic fields are interchanged. In the case of the dipole antenna shown, the electric lines are horizontal while the magnetic lines form loops in the vertical plane. With the slot antenna, the magnetic lines are horizontal and the electric lines are vertical. The electric lines are built up across the narrow dimension of the slot. As a result, the polarization of the radiation produced by a horizontal slot is vertical. If a vertical slot is used, the polarization is horizontal.

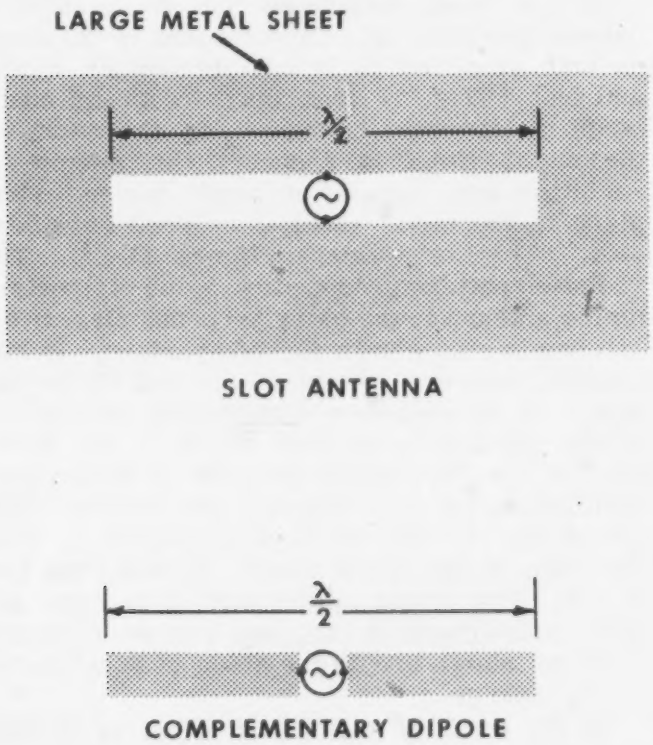

Figure 11-20.—Slot and complementary dipole antennas.

A second difference between the slot antenna and its complimentary dipole is that the direction of the lines of electric and magnetic force reverse abruptly from one side of the metal sheet to the other. In the case of the dipole, the electric lines have the same general direction while the magnetic lines form continuous closed loops.

When energy is applied to the slot antenna, currents flow in the metal sheet. These currents are not confined to the edges of the slot but rather spread out over the sheet. Radiation then takes place from both sides of the sheet. In the case of the complementary dipole, however, the currents are more confined, so a much greater magnitude of current is required to produce a given power output.

From this it may be seen that the current distribution of the dipole resembles the voltage distribution of the slot, and conversely. The edges on the slot have a high voltage concentration and relatively low current distribution; the complementary dipole has a quite high current concentration and relatively low voltage.

Coaxial Feed of the Slot Antenna

A coaxial line is frequently used to feed the slot antenna. The outer conductor of the feed line is bonded to the metal sheet while the inner conductor is connected to the opposite side of the slot as shown in figure 11-21. Note that the coaxial line is not connected at the center of the slot length since a severe impedance mismatch would occur.

The impedance at the center of a slot whose electric length is a half wave is 530 ohms. This impedance is reduced to a lower value as the input connection is moved toward the end of the slot. At a point about one-twentieth of a wavelength from either end, the input impedance falls to about 50 ohms. A coaxial

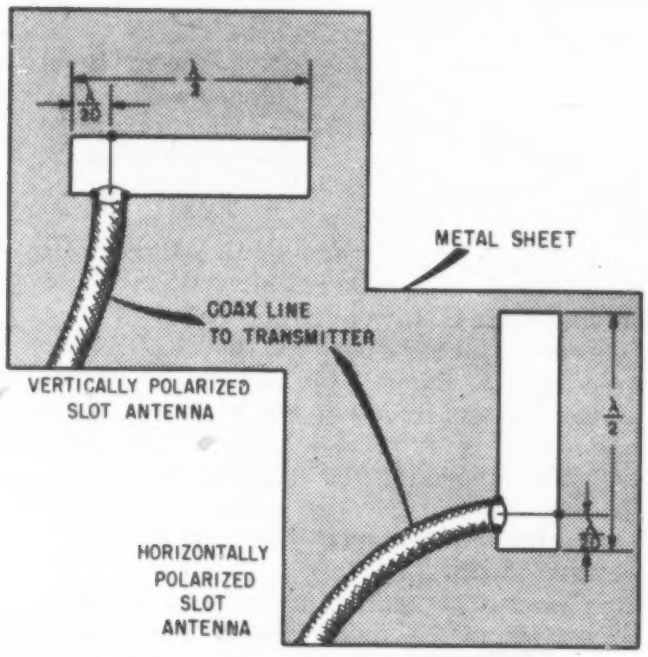

Figure 11-21.—Feeding slot antenna with coaxial line.

line may thus be connected here without serious mismatch. The slot length may be increased to a full wave if it is desired to connect the coaxial line to the center of the slot. With a full wave slot, the input impedance at the center of the slot is 50 ohms.

Boxed-in Slot Antenna

Frequently, it is desired to produce radiation from only one side of the metal sheet in which the slot is cut. This is conveniently arranged by boxing in the slot with a section of waveguide. If the depth of the waveguide is a quarter wave (fig. 11-22), then the waveguide will introduce no reactance. Under these conditions, the input impedance at the center of the slot is about 1,000 ohms and the impedance at a point about one-twentieth of a wavelength from either end is about 100 ohms.

Waveguide-Fed Slot Antenna

Another convenient method of making a slot antenna radiate from only one side of the metal sheet in which it is cut is to energize the slot by means of a waveguide as shown. This does away with the coaxial feeder altogether.

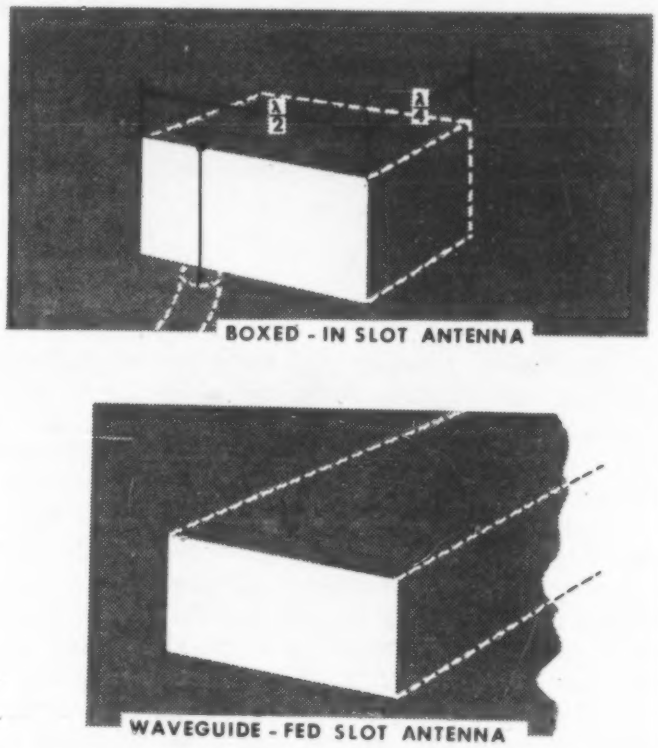

Figure 11-22.—Unidirectional slot antennas.

Radiation Patterns.

It has been mentioned that the radiation pattern produced by a slot antenna is the same as that produced by a complementary dipole antenna. This is true only if an infinitely large metal sheet is used. As the width of the metal sheet is reduced, the amount of radiation that occurs at small angles to the plane of the metal sheet is reduced considerably. This is shown in figure 11-23. The radiation pattern produced by a complementary dipole antenna in the plane perpendicular to the antenna is also shown for comparison. In this pattern, you are looking at the end of the dipole. If all radiation disappeared to the left of the vertical centerline shown in the illustration, then you would have the radiation pattern produced by a boxed-in slot antenna. (See (A) of fig. 11-23.) Here you are looking along the edge of the metal sheet in which the slot is cut. The length of the slot is at right angles to the plane of the page and the radiation patterns shown are in the plane of polarization of the energy.

If the width of the metal sheet is a little over 5 wavelengths, then the scalloped pattern shown in (B) results. As the width of the sheet is further reduced to slightly over 2 1/2

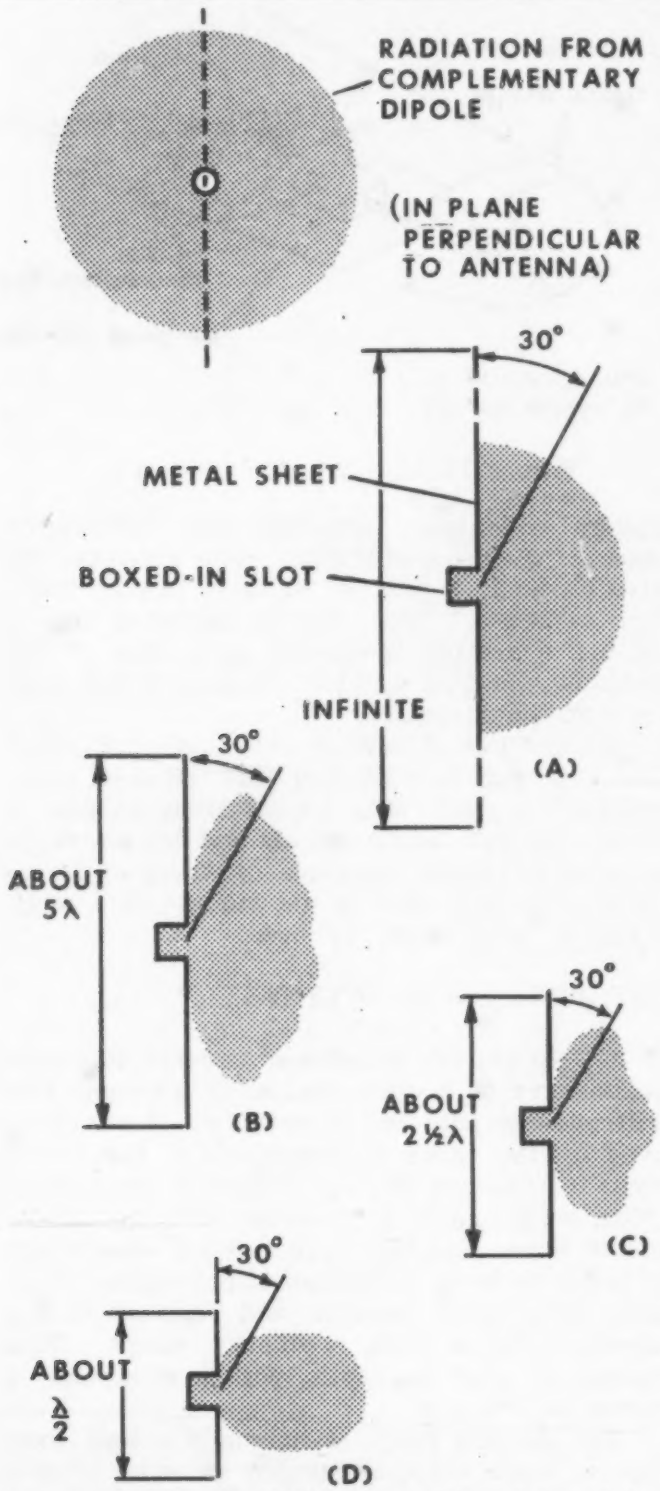

Figure 11-23.—Radiation from boxed-in slot antenna.

wavelengths, fewer irregularities appear in the pattern, as shown in (C). Also note the reduced radiation at a fixed angle (say 30°) with respect to the metal surface. At a width of only about a half wavelength, the pattern shown in (D) bears only a little resemblance to that shown in (A). The radiation produced at an angle of 30° is further reduced. In practice, since the size of the metal surface in which the slot is cut is usually quite large (compared to a wavelength), radiation patterns having a form somewhere between that shown in (A) and (B) are common.

T-Fed Slot Antenna

A type of slot antenna which was developed for use over a very wide frequency band and which could be fed by coaxial line is shown in figure 11-24. With the compensating bar (providing capacitive loading) and stub as shown, this antenna has a standing wave ratio of less than 2 to 1 over a frequency range from about 30 percent below to about 30 percent above the design center frequency when fed with 50-ohm coaxial cable. Such an antenna may be constructed in a large flat metal surface or it may be made to conform with a curved metal

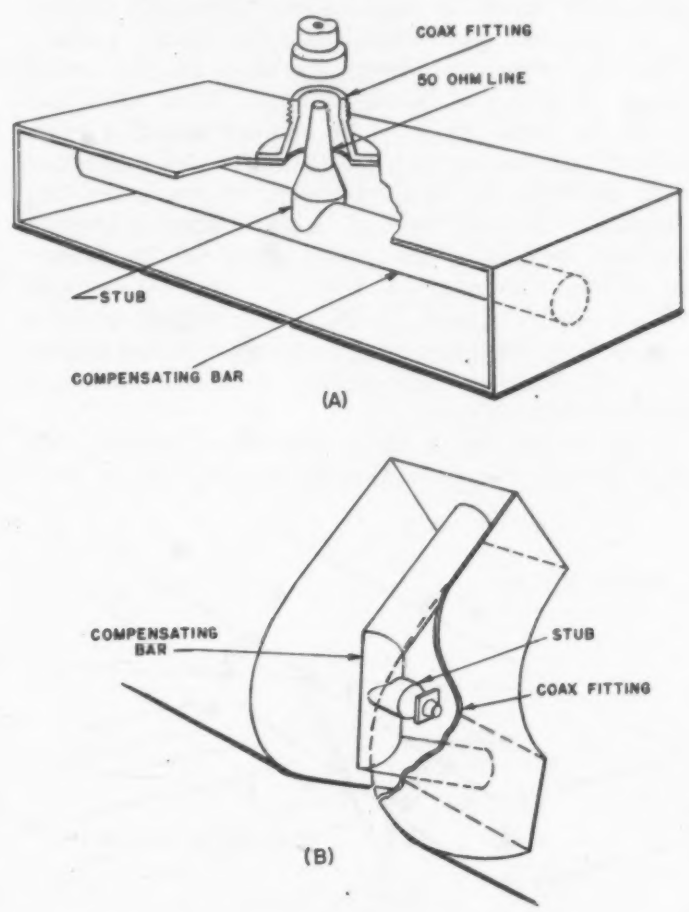

Figure 11-24.—T-fed slot antennas.

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surface. For example, the curved slot antenna shown in (B) can be installed in the leading edge or tip of an aircraft wing. With such a severely curved large metal surface, the radiation pattern produced is quite different from that produced with a slot in a flat surface. The extent of the curvature has considerable effect on the radiation produced.

Slot Array

Still another form of the slot antenna is shown in figure 11-25. Here the large metal sheet is eliminated completely. Instead, an array of diagonal slots is cut into a length of waveguide. The slots are spaced at intervals along the waveguide so that they are excited in phase. Maximum radiation takes place in the direction indicated.

SKIN ANTENNA

A skin antenna is a type of flush mounted antenna used in aircraft. Such antennas are generally used in high speed aircraft where it is necessary to eliminate the speed reducing aerodynamic drag produced by the usual types of antenna installations. The skin antenna is made by electrically isolating a portion of the metal skin of the aircraft and using this section as the radiating surface of the antenna. In one type of installation, a plastic section insulates the metal skin at the wingtips from the rest of the skin of the aircraft as shown in figure 11-26. The wingtip section connects to the receiving and transmitting equipment through an impedance matching network and coaxial cable.

The range of a skin antenna approximates that of fixed wire antennas for the same frequency coverage. Although the illustration shows a wingtip installation, skin antennas can also be made a part of suitable tail or fuselage surfaces. The radiation patterns depend on the operating frequency, the size of the radiating surface, and the location of that surface on the aircraft.

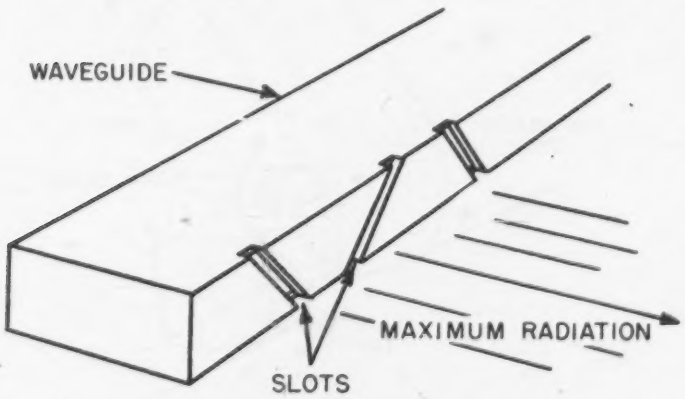

Figure 11-25. —Slot array.

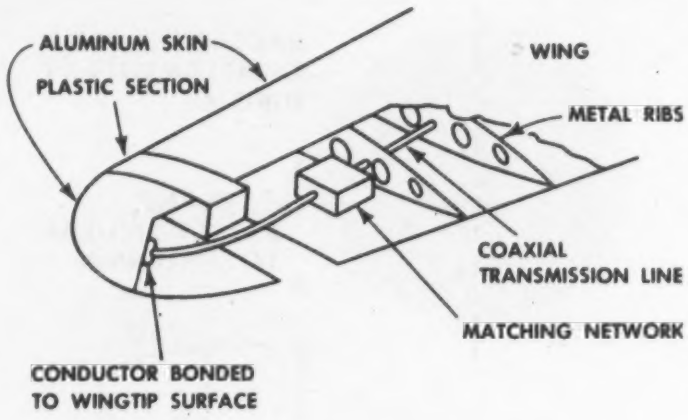

Figure 11-26. —Wingtip antenna.

Other types of flush mounted antennas which find wide use in VHF and UHF aircraft communications and radar installations consist of loops, dipoles, and parasitic and driven arrays encased in plastic housings or canopies forming the tip or a part of the surface of a wing, elevator, stabilizer, or nose.

UHF BROADBAND ANTENNAS

The so-called "broadband antenna" is a representative of a class of low-Q antennas that will operate with fairly constant effectiveness over a wide range of frequencies. Electronic countermeasures (ECM), frequency modulation (FM), pulsed radar altimeters, and other equipments have used this type antenna effectively. In order to be of maximum effectiveness, passive ECM must receive and respond to any signals over a wide frequency range. This reception must be rapid, with a minimum of tuning adjustment.

The antenna itself is normally a half-wave dipole, made thick and stubby in order to give the antenna a low inductance, a low L-to-C ratio, and the low Q that results from these. Being a tuned circuit, the antenna will have a wider frequency response with less gain than an equivalent antenna with a higher Q. Another factor that will add to the wide uniform response is the method of support. Normally this support will be a quarter wave shorted

section of transmission line. In addition to the insulating qualities of the transmission line section, the support may be used as an impedance matching device, and also as a tuning stub.

Since the antenna acts the same as an open-ended quarter-wave section of transmission line, any increase in frequency will tend to cause the antenna to become inductive, and the support to become capacitive. This opposing action results in the antenna appearing resonant over the wider frequency range. Lowering the frequency will cause opposite actions, and broader response.

The assembly will normally include built-in impedance matching devices which are relatively insensitive to frequency variations.

The antenna itself may be a half-wave dipole, of which there are many types. The type that provides the ultimate in broadband response is the flared coaxial antenna of the type shown in figure 11-27 (A). The inner and outer conductors are both flared, but in order to maintain a constant impedance throughout the full range of frequencies, the ratio of the inner to outer diameter is maintained constant. The more gradual the flare of the diameters, the less reflection of mismatched impedances, and the more constant the efficiency of the antenna.

By folding the outer conductor of the coaxial antenna to form a ground plane, and shaping the inner conductor to a teardrop configuration (as in (B)), an antenna is obtained that has a frequency response nearly as good as the original broadband type discussed above.

The actual radiator of the broadband antenna may take any of several shapes, depending on the desired broadness of the band, directional characteristics, impedance, etc. In general, the greater the thickness of the radiating element, the broader the pass band. Thus, radiators having conical or cylindrical shape are less broad than those previously discussed, while the thin stub (or whip) is even more narrow in its frequency response.

In the coaxial feed and antenna system, the ratio of diameters (outer to inner) is sometimes changed. When this is done, the resulting impedance mismatch reflects energy back down the line. This mismatch may be fairly abrupt, being more so as the antenna is made thinner or as the change in the ratio is made more abrupt. The frequency band is determined by those frequencies at which the impedances are sufficiently matched and the reflection cancel.

The antenna required for a broadband response could also be developed from the two-wire transmission line (as shown in (C) of figure 11-27), but the frequency response is not quite so broad as for the equivalent coaxial antenna.

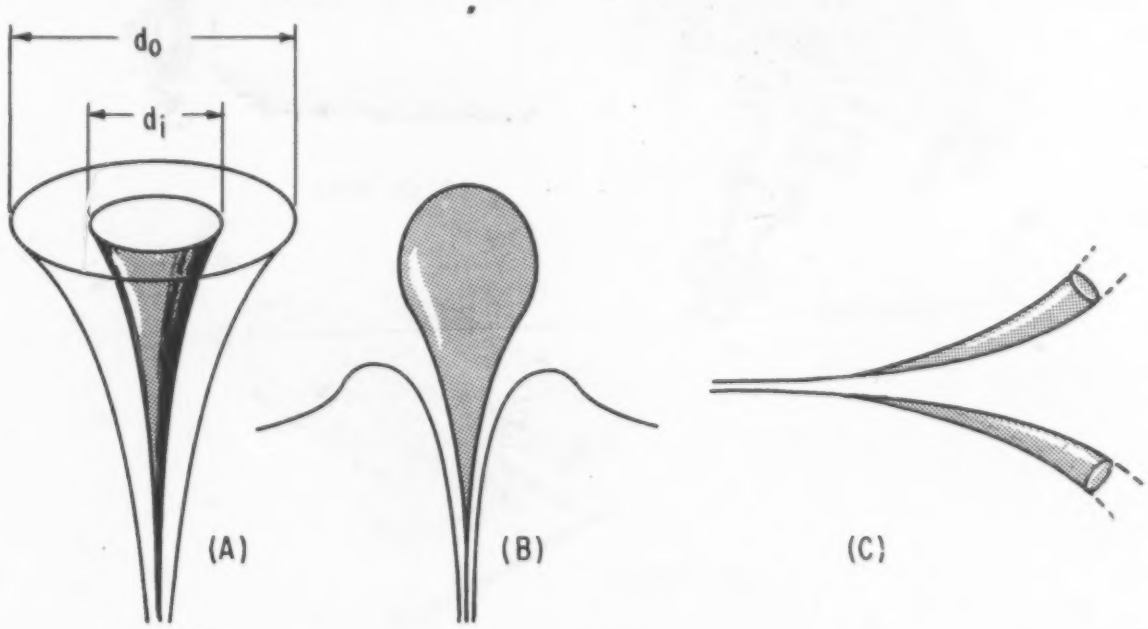

Figure 11-27.—Broadband antennas.

Blade Antenna

An ultrahigh frequency, streamlined, blade shaped broadband antenna for general purpose use over the 225- to 400-megacycle range is shown in figure 11-28 (A). An antenna of this shape may consist essentially of a near quarter-wave stub fed through the base, or it may be a sleeve type antenna. It is designed for mounting on the exterior skin of the aircraft, and so it is streamlined for high speeds. Its cross sections take the form of ellipses on the leading half of the body, and of parabolas on the trailing half. The resulting form has minimum drag effect.

This antenna is usually a single self-contained unit. No accessories are required other than those for mounting and connecting.

A single broadband antenna of this type may be connected to two or more pieces of equipment operating on different frequencies within the range of the antenna. When this is done,

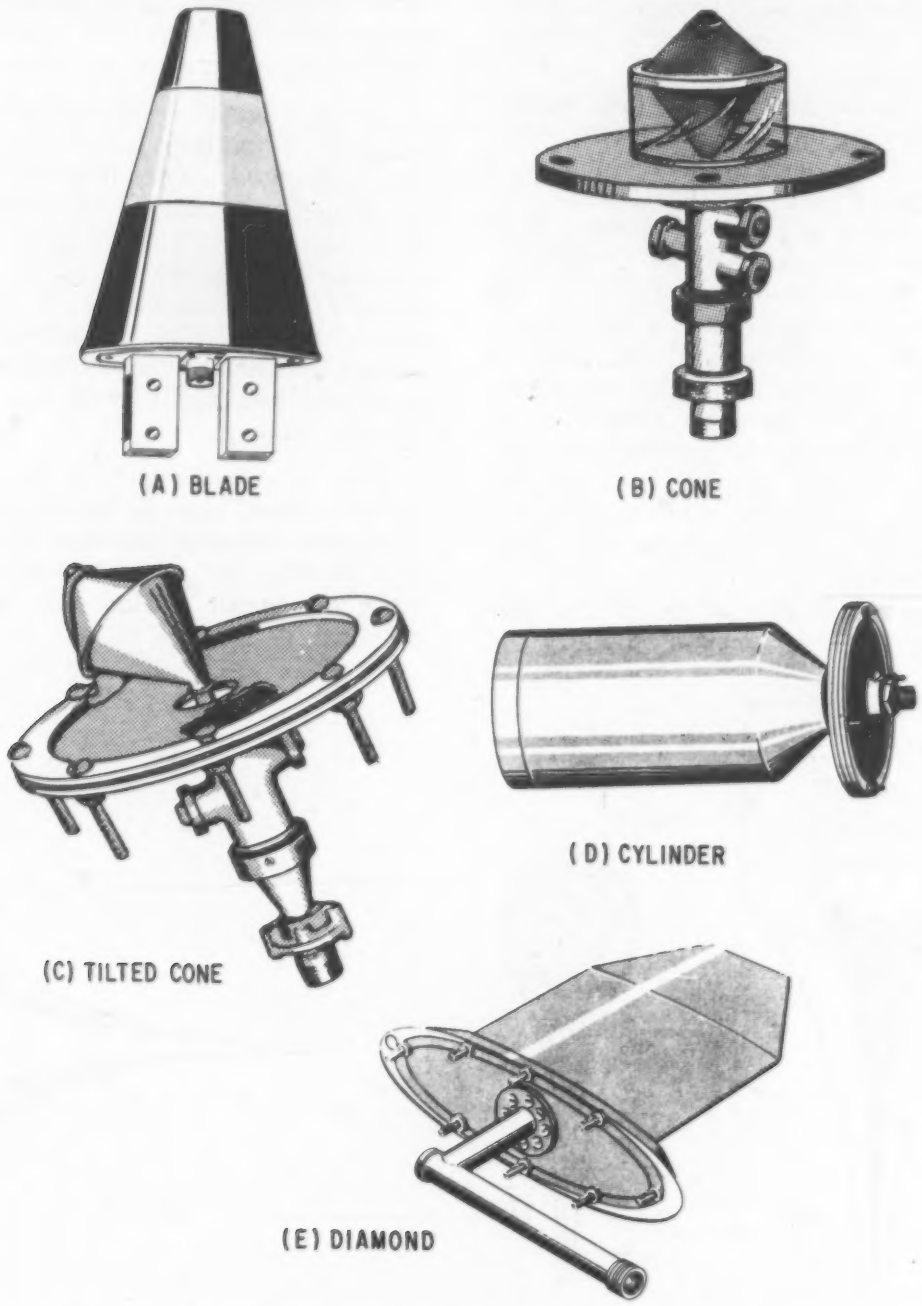

Figure 11-28.—Typical aircraft antenna assemblies.

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it is necessary to use bandpass filters in series with the antenna cables to isolate the equipments.

Cone Antenna

It frequently becomes desirable for a transmitting or receiving antenna to operate over a wide band of frequencies. This is especially true in electronic countermeasures and airborne communication equipment. In order to operate over a wide band, it is necessary that the characteristics of the antenna system be such that the radiation pattern is not appreciably changed over the frequency range involved. It is also necessary that the standing wave ratio be held to a minimum in order to prevent excessive losses.

The impedance of resonant wire antennas will vary with frequency, thus they will function adequately over only a narrow frequency band. As previously stated, it is possible to maintain a uniform impedance over a wider frequency band by increasing the diameter of the antenna elements. This increase in diameter reduces the Q of the resonant system and this in turn causes a reduction in the reactive energy stored in the E and H fields adjacent to the antenna.

A cone antenna is a good example of increasing the diameter in order to obtain wideband operation. The bandwidth of this type antenna can be further increased by the use of compensating reactances. By the use of these series and shunt reactances, it is possible to increase the operating frequency range of the antenna as much as six times.

Figure 11-28 (B) and (C) show two cone type high frequency antennas for use with ECM equipment. In each of these, the electrical connections are brought to a receptacle at the bottom of the antenna. The antenna flange is designed to be mounted flush with the skin of the aircraft. A Plexiglass dome or blister is used to cover the antenna in order to afford protection and to reduce wind resistance.

The antenna illustrated in (B) should be mounted vertically to receive vertically polarized waves and horizontally to receive horizontally polarized waves. The antenna in (C) is similarly constructed except that the conical pickup element is mounted at an angle of 45° to the mounting flange. This permits reception of either horizontally or vertically polarized waves for a single mounting position.

Some antennas of this type have a high-pass filter incorporated in their assembly to attenuate all frequencies below their designed operating range. Signals below the operating range are filtered out and do not reach the equipment. It is important when selecting antennas of this type (especially for ECM equipment) that a close check be made, since an antenna that is equipped with this type filter will pick up a negligible amount of energy below its operating range.

CYLINDRICAL. — A modified cone antenna is shown in figure 11-28 (D). This assembly consists of a cylindrical antenna with an inverted cone shaped base fitted into a mounting flange. It is designed as a jamming transmitter antenna and covers the frequency range of 200 to 550 megacycles.

DIAMOND. — Another variation of the cone antenna is illustrated in figure 11-28 (E). It is a flat, diamond shaped metal plate enclosed in a streamlined plastic housing and is omnidirectional.

An antenna of this type, when operated at about 1,000 megacycles, will provide efficient operation over a bandwidth of approximately 200 megacycles. Since this antenna is made of a flat piece of metal, it may be mounted in an airfoil type plastic housing that offers little wind resistance. This is especially desirable for high speed aircraft.

The radiator is made diamond shaped, in order to obtain broadband frequency characteristics, and is vertically polarized. Since it is end fed, its impedance is comparatively high (140 ohms) and a matching section of transmission line is used to match this impedance to the 51 ohm transmission line. This section, which is a three-quarter-wave line, properly matches the impedances of the antenna and the antenna cable, and provides a low standing wave ratio along the cable. The antenna requires no adjustment.

Polyrod Antenna

Figure 11-29 shows a polyrod antenna that consists of a slender, tapered rod of special plastic. This rod is cemented to a piece of standard waveguide that is flared to match the square dimension of the large end of the rod. The principal mechanical features of this antenna are its streamlined aspect, its small size, and light weight.

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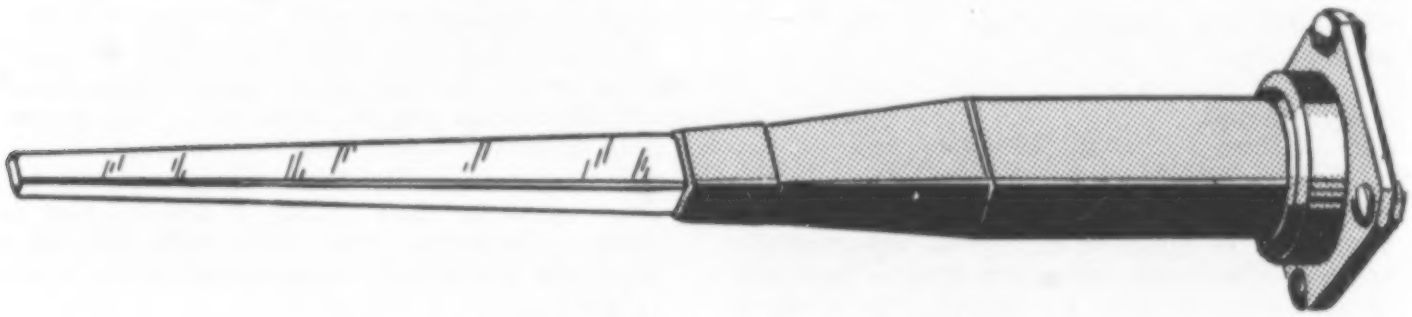

Figure 11-29. —A polyrod antenna.

It can be shown experimentally that very high frequency radio energy can be made to travel along a rod made of material having good dielectric properties in much the same way as light travels along a lucite rod. Some of the light traveling along the lucite rod is emitted from its longitudinal surfaces. Similarly, some of the radiofrequency energy traveling along the dielectric rod is radiated from its longitudinal surfaces.

By appropriately tapering the rod, the amount of energy radiated per unit length may be made approximately the same throughout the length of the rod. In doing so, an end-fire antenna is created which is roughly analogous to a linear array of dipoles spaced a quarter wavelength apart and fed at successive 90° intervals. For such an antenna array, the net energy radiated broadside to the rod will be a minimum. The rod, as seen from a point in a forward direction, will appear to be radiating a cigar shaped beam of energy.

HORN ANTENNA

The horn antenna provides a method of matching the impedance of waveguides to free space, and at the same time providing desired beam characteristics. Normally, the radiation pattern of an open-ended waveguide is broad in both the vertical and the horizontal planes. It is also an inefficient radiator system because of the mismatch between the waveguide antenna and free space. The evolution of the horn came about as a result of the effort to minimize the reflections that occur when a straight piece of waveguide radiates into space. By flaring the open end of the waveguide, the RF energy in the guide does not encounter such an abrupt impedance change when it reaches the end of the guide; hence, reflections and standing waves are minimized.

If the waveguide is flared out at a gradual angle, a horn antenna is obtained. The flare must be gradual so as to permit a better match between antenna and free space. At the same time, a sharper beam is obtained when a flared horn is used.

The horn is very practical at microwave frequencies since at these frequencies its physical size is not prohibitive. Since a resonant element is not involved, this type antenna is capable of wideband operation. Horn antennas used in aircraft installations produce beam patterns that are not highly directive. In order to produce a highly directive beam at lower frequencies, the antenna would have to be longer than practical for aircraft.

The horn antenna may be used with either circular or rectangular waveguides, and the same general considerations will apply: the longer the flare of the horn, the higher the gain and the narrower the beam width. For both circular and rectangular horns, the flare angle for the narrowest beam is between 40° and 60°. Generally speaking, the gain of a horn is less than that of a parabolic antenna. In order for the horn to have the same gain as a parabolic antenna, the horn must be much longer, which soon proves to be a big disadvantage.

A sectoral type horn antenna is illustrated in figure 11-30 (A). Its field distribution is spherical in shape and depends upon the mode of operation of the waveguide feeding it and the flare angle of the horn. The spherical shape of the wavefront becomes flatter (elliptical) as the flare angle of the horn decreases. This horn has the greatest degree of directivity in the plane of the widest dimension.

Two other types of horns to which the principles just described apply are shown in (B) and (C). The pyramidal horn (B) has equal directivity in both the vertical and horizontal plane.

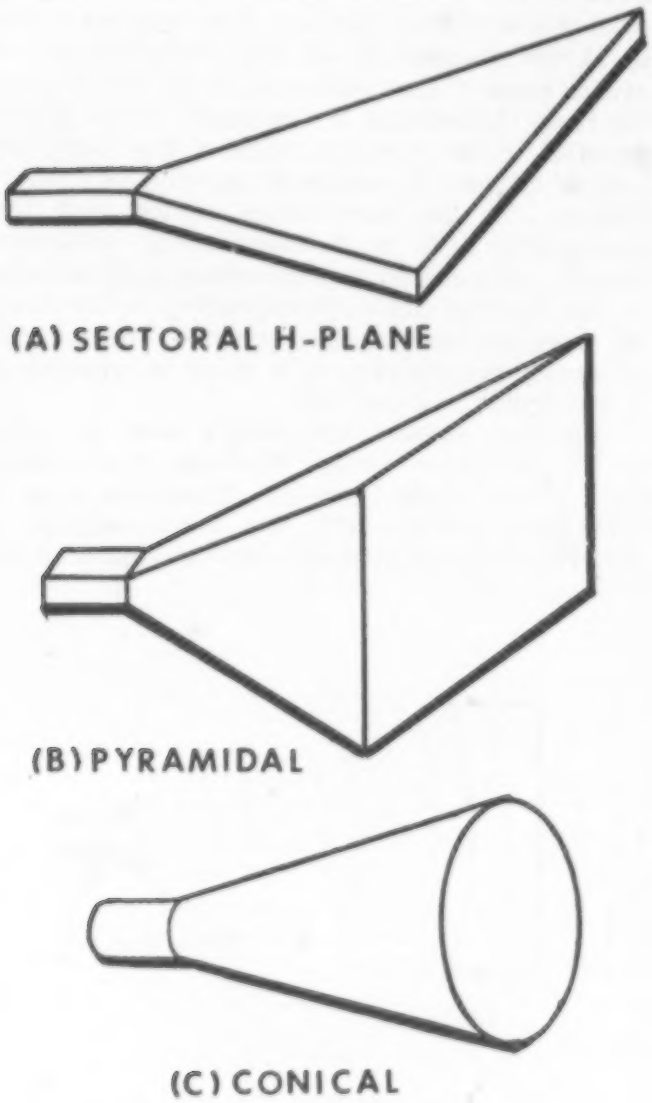

Figure 11-30.—Horn antennas.

The conical horn (C) produces a conical beam pattern.

For horn antennas (as well as for dipole arrays and reflectors), a rule that may be kept in mind is that the larger the aperture of the waveguide or the larger the area of the array, the greater will be the gain and directivity. Since a large aperture is desired at the mouth, the length of the horn may become unwieldy if the gradual flare requirement is to be incorporated in the design.

However, a recent development in antenna design has made possible the use of horn antennas having a much larger equivalent size than was formerly practicable. This new type antenna has been called the JELLY-ROLL ANTENNA, due to its configuration. Effectively, it is the same as a conventional horn antenna rolled from the feed end toward the aperture end like a jelly roll. The resulting cylindrical shape uses less space than the conventional horn with the same size feed, the same angle of flare, and the same size aperture. Therefore, this saving in size could be used to good advantage by increasing the size of the aperture, with the resultant increase in directivity and gain.

Another method of improving the directivity and gain of a horn antenna is by the use of electromagnetic lenses to focus the beam in much the same manner that the light beams are focused by an optical lens.

MICROWAVE LENSES

A lens is a structure substantially transparent to microwaves, but which inserts a phase change over the cross section of the exit side of the lens to make the microwaves coverage or diverge. The lens is placed in front of a point source of RF energy, such as a feedhorn. The feedhorn is located at the focal point of the lens, and radiates spherical waves which are concentrated into a beam as they pass through the lens.

The focusing action of the lens is due to its ability to take the spherical wavefront of the energy transmitted by the horn and transform it into a plane wavefront. This is accomplished by changing the velocity of portions of the wavefront producing a flat wavefront. A wavefront that is flat will possess extremely good directivity. The lens may be made of plastic or it may consist of conducting strips of metal.

The explanation of microwave lenses can be better understood if we first consider a little background information. Then we will see that the microwave lens and its principles of operation are not strangers to us. Microwaves are similar to light in that both (like many other types of energy) travel in waveform. Consequently, both obey the physical laws of wave transmission. Although the primary purpose of an RF transmission line is to guide the transfer of energy from one place to another, in so doing the transmission line has other characteristics which may be useful in certain cases. For example, if a voltage is applied to the input terminals of a line, a definite amount of time passes before the voltage appears at the output terminal. In other words, the line has the ability to delay the transmission of voltages and currents. The time delay

is determined by the length of the line and its characteristics, R, L, and C. The time delay of a transmission line has many applications in radar timing. The artificial transmission lines used in radar employ this factor.

However, there is nothing in the physical laws of microwave transmission that says we must have a material conductor. The same laws apply to propagation of RF waves in air or in a vacuum. The velocity of wave propagation is determined by the characteristics of the medium through which it travels.

Microwave lenses are of two basic types. One type is the waveguide, or conducting type, shown in figure 11-31 (A). The other type is the dielectric, or delay type shown in figure 11-31 (C).

A sectoral horn with a conducting-strip lens is shown in figure 11-31 (A). This type accelerates wave transmission as it passes through the lens. It consists of flat metal strips placed parallel to the electric field of the wave and spaced slightly in excess of one-half of a wavelength. To the wave these strips look like waveguides with each hypothetical waveguide having a dimension in a direction perpendicular to the electric field corresponding to the spacing between the parallel strips. The velocity of phase propagation of a wave is greater in a waveguide than in air.

As you can see, the strips near the sides of the horn form longer sections of waveguide than those in the center. Since the lens is effectively concave (B), the phase velocity is progressively increased from the center of the

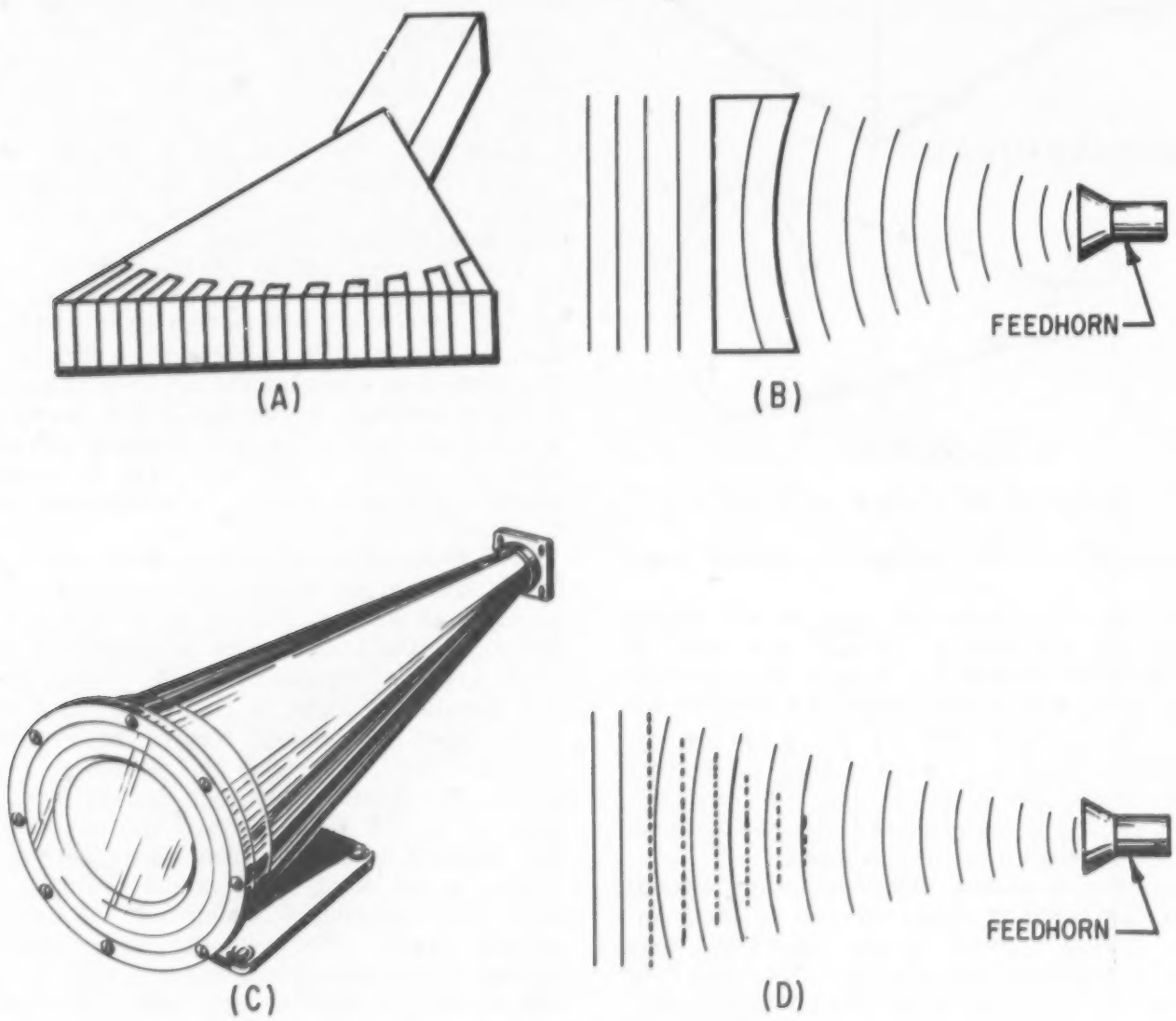

Figure 11-31.—Microwave lenses.

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horn toward the sides as the lengths of the individual waveguide sections increase. The outer portions of the transmitted spherical wavefront are accelerated for a longer period of time than the inner portion. Therefore, this wavefront will emerge at the exit side of the lens aperture as a flat-fronted wave. This waveguide type lens is frequency sensitive (because of the change in phase velocity of waves in a waveguide with a change in frequency), so frequency stability of the transmitter is an important consideration in equipments where it is to be used.

A dielectric or delay type lens is shown in (C) of the figure. The delay lens, as its name implies, slows down the phase propagation as the wave passes through the lens. This lens is convex, and consists of dielectric material. The delay in the phase of the wave passing through the lens is determined by the dielectric constant (or refractive index) of the material. In this case, the inner portion of the transmitted wave is decelerated for a longer interval of time than the outer portions. (See fig. 11-31 (D).)

Many lenses of this type use artificial dielectrics consisting of conducting rods or spheres that are small compared to the wavelength. Artificial dielectrics, or conducting insulators, are covered in Basic Electronics, NavPers 10087-B.

In a lens antenna the exit side of the lens can be regarded as an aperture across which there is a field distribution. This field acts as a source of radiation just as fields across the mouth of a reflector or horn. For a returning echo the reverse effects take place in the lens.

It can be seen that the reflector uses the law of reflection while the lens uses the law of refraction. The rear feed arrangement of the lens antenna eliminates spillover radiation in the backward direction. Also, this arrangement puts the radiator out of the path of the beam, thus reducing shadows.

The plastic type lens, shown in figure 11-31 (C), is affixed to a conical horn type antenna. This particular antenna produces a beam width of 18° at half-power points and has a gain of approximately 100. The lens is effective in reducing the sidelobe intensity by retarding the phase of the energy leaving through the center of the lens. This causes the energy to leave the horn in a plane of constant phase.

While the two types of lens produce the same results they operate in somewhat opposite manner. The plastic lens retards the phase of the energy at the center and the conducting-strip lens accelerates the phase of the energy at the edge.

It is interesting to compared the characteristics of this antenna with those of the polyrod shown in figure 11-29. While the half-power beam width of the horn is 18°, that of the polyrod is 25°. However, the spurious radiation from the polyrod is of greater magnitude than that from the horn. These factors cause the polyrod to be less efficient than the horn, but nevertheless, in some applications, it is more desirable because of its mechanical features.

MONOPULSE ANTENNA

The methods of radar scanning covered in Basic Electronics (NavPers 10087-B) and Aviation Electronics Technician 3 & 2 (NavPers 10317-C) are sometimes called sequential lobing, because target information must be gathered from a series or sequence of pulses. The high speed response and fine degree of accuracy required of tracking radars in modern high speed weapons systems have made this system unsuitable for some applications. Another scanning technique, called MONOPULSE or simultaneous lobing, can obtain information on target range, bearing, and elevation from a single pulse. This system is presently used in some of the newer type fire control and tracking radars.

For target tracking, the radar discussed here produces a narrow circular beam of pulsed RF energy at a high pulse repetition rate. Each pulse effectively is divided into four signals which are equal in amplitude and phase. The four signals are radiated at the same time from the four feedhorns as indicated in figure 11-32.

The radiated energy is focused into a narrow beam by a microwave lens. Energy reflected from the target is refocused by the lens into the feedhorns. The total amount of energy received by each feedhorn is determined by the position of the target with respect to the center of the beam. This is illustrated for four targets at different positions with respect to the beam axis. Notice that a phase inversion takes place at the microwave lens similar to the image inversion in an optical system.

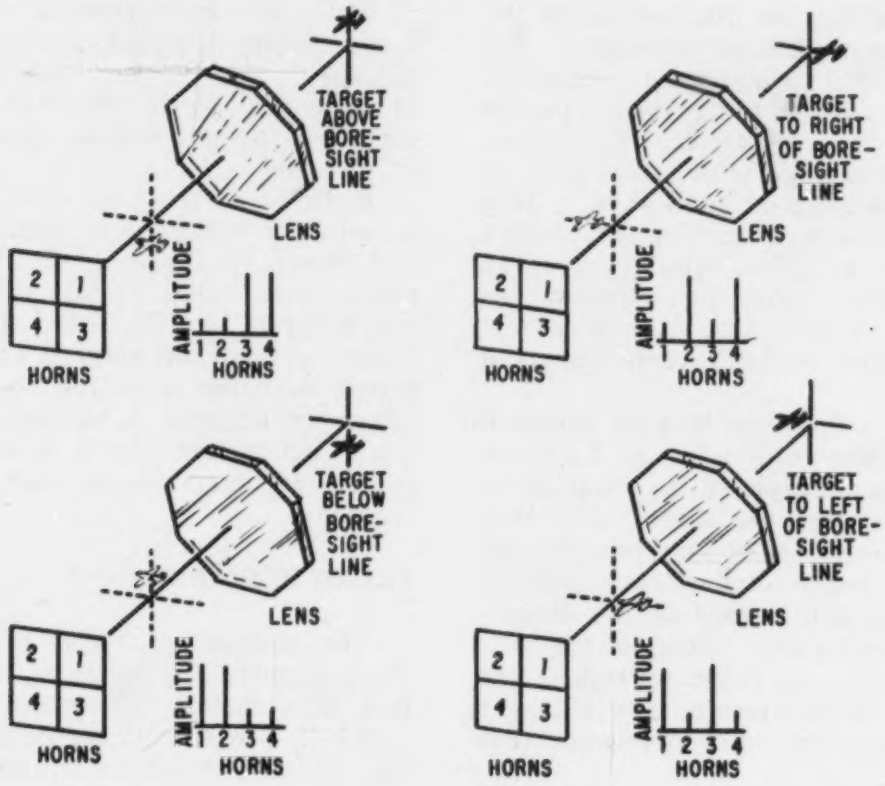

Figure 11-32.—Monopulse technique.

The amplitude of returned signals received by each horn is continuously compared with those received in the other horns, and error signals are generated which indicate the relative position of the target with respect to the axis of the beam. Angle servocircuits may be used to receive these error signals and correct the position of the radar beam to keep the beam axis on target.

The BEARING (azimuth) signal is made up of signals from horns 1 and 3 (added)and from horns 2 and 4 (added). By waveguide design the sum of 2 and 4 is made to have a 180° phase relation with the sum of 1 and 3. These two sums are combined, and the bearing signal is the difference of (1+3) — (2+4). Since the horns are positioned as shown in the figures, the relative magnitudes of the horn signals give an indication of the bearing error.

The ELEVATION signal consists of the signals from horns 3 and 4 added (with 180° phasing) to 1 and 2; i.e., (1+2) — (3+4) (The 180° phasing accounts for the negative sign.)

The RANGE (sum) signal is composed of signals from all four feedhorns addedtogether in phase. This range signal is also used as a reference signal for the bearing and elevation error signals. The bearing and elevation error signals are compared in the radar receiver with the reference (range) signal. The output of the receiver may be positive or negative pulses, depending on direction of error, with a magnitude proportional to the angle between the boresight (beam) axis and a line drawn to the target. Of course, if the target is directly on the boresight line, the output of the receiver is zero, and no angle tracking error is produced.

In the monopulse system, certain problems are inherent, and suitable provision must be made for their solution. Among the most important of these problems are:

1. A single magnetron output must be fed to all four antenna feedhorns, and these must be in phase and of equal magnitude.

2. Echo signals received by the feedhorns must be fed to the receiver channels with the proper phasing and magnitude.

3. Range (reference) signals are to consist of the echoes from all four horns, added in phase.

4. Elevation angle error signals must reflect the difference in magnitude and the polarity of the difference in the sums of the signals from horns 1 and 2 and from honrs 3 and 4, added in phase.

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5. Bearing angle reference signals must reflect the difference in magnitude and the resulting polarity of the sums of the echoes from horns 1 and 3 and from horns 2 and 4, added in phase.

These problems are solved in part by the use of the MAGIC-T COUPLER.

Magic-T Coupler

As shown in figure 11-33 (A), a magic-T coupler consists of four energy paths with a common junction. For the following discussion, assume that the magnetron's output is fed through a TR/ATR duplexer to path 3, and that the return echo signals present in path 3 are fed through the same duplexer system to a reference channel in the receiver. Further assume that paths 1 and 2 are fed to two of the antenna feedhorns, and that path 4 is fed into another channel of the receiver (either elevation or bearing).

Transmitted energy in path 3 (fig. 11-33 (A)) is propagated in equal amounts in paths 1 and 2. None is propagated in path 4 since no field strength difference exists across its face (which is at right angles to the transverse electric mode). Target returns appearing at paths 1 and 2 in equal field strengths are therefore propagated in path 3 but not in path 4 since, again, no field strength difference exists across its face. However, if the received signals appearing at paths 1 and 2 are not of equal field strength, a potential difference does exist across the face of path 4, and energy is propagated into this waveguide in an amount proportional to the difference in field strengths between paths 1 and 2; that is, a potential difference must occur across the face of path 4 in order for energy to be propagated in this path. A potential difference will occur across the face of path 4 when there is an imbalance between the signal strength from path 1 and path 2. The amount of energy propagation in path 4 is dependent upon the magnitude of this imbalance in signal strength between path 1 and path 2.

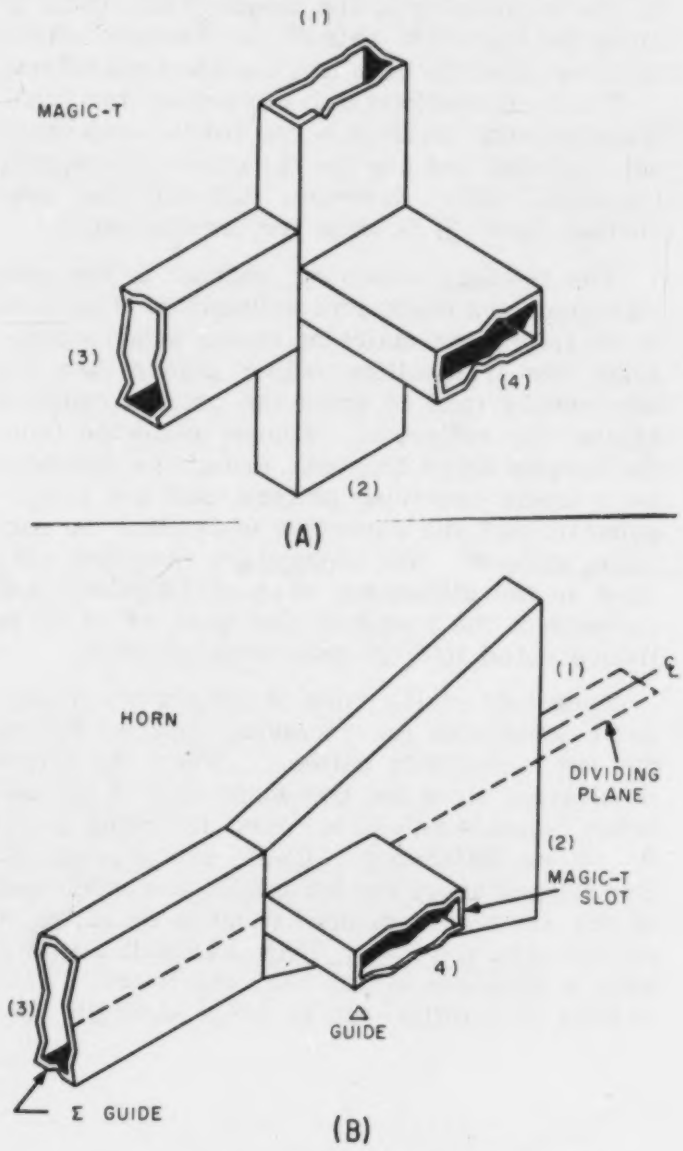

Figure 11-33. —Magic-T coupler, basic drawings.

If there is energy propagated in path 4, its phase relationship to the reference (sum) signal is determined from which path (1 or 2) the greatest signal is supplied and by the construction of the magic-T coupler.

In airborne radar systems, it is frequently necessary to develop an error signal in only one geometric plane — either bearing or elevation. Figure 11-33 (B) illustrates the principle applied in one typical height finding (elevation) application. Note that a single horn radiator is used to effectively produce both the up and the down signals. Although there is no physical surface separating the paths 1 and

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2, the positioning of the magic-T slot (path 3) along the boresight axis of the feedhorn effectively divides the horn into two identical halves.

The feedhorn effectively comprises two functional antenna sections — one for the sum channel (Σ guide) and one for the difference channel (Δ guide). Note, however, that only the sum channel (path 3) is used for transmission.

The primary receiving channel is the sum waveguide and feedhorn combination. The horn is an impedance matching device used to propagate the transmitter output pulses into the atmosphere (and to shape the pattern radiated against the reflector). Echoes reflected from the targets enter the open end of the feedhorn as a single receiving pattern, and are propagated through the waveguide to produce the sum video signals. The secondary receiving element is the difference channel (Δ guide) and consists of the magic-T slot (path 4) which is incorporated into the horn configuration.

Each half of the horn is effectively a separate waveguide (or receiving antenna) having its own sensitivity pattern. When the target is situated along the boresight axis of the antenna, equal sensitivities exist for paths 1 and 2, so no difference signals are propagated. For targets above the boresight, the upper half of the antenna is somewhat more sensitive to echoes than the lower half, and will respond with a stronger signal than the lower. This results in a difference in field strength between the signals in paths 1 and 2 of the magic-tee.

Because of the difference in these field strengths, a potential difference exists across the Magic-T slot (path 4), and a small amount of energy is propagated in the guide. The amount of energy so propagated is directly related to the difference of the field strengths in the input arms.

When a target is located below the boresight axis of the feedhorn, the lower half of the antenna is more sensitive to radar echoes than the upper half.

The phase relation of the difference and sum signals is determined by the physical position of the magic-tee slot with respect to the opening into the sum channel waveguide. The antenna configuration is chosen so that a difference signal, which is caused by greater energy in one channel, is in phase with the sum channel reception, while the reverse energy condition results in the opposite phase. Only a small portion of the total received energy is coupled to the difference channel; the major portion is propagated in the sum channel, and is used as the target display in the indicator.

There are numerous variations of nonpulse radar systems in use in naval airborne electronics applications. For specific details on the peculiarities of an actual type equipment, consult the applicable Maintenance/Service Instructions manual for that equipment or aircraft.

CHAPTER 12

UHF AND MICROWAVE TECHNIQUES

The increase in congestion of the communication channels below 30 mc and the special advantages of the shorter wavelengths in the very high and ultrahigh frequency bands have led to increasing use of these parts of the RF spectrum.

The upper limit for radio signals that can be returned effectively to the surface of the earth by the ionosphere is about 30 mc. Therefore, 30 mc was chosen as the low frequency limit of the VHF band. This 30-mc dividing line is not an abrupt one, because there is no abrupt change in the avility of the ionosphere to return the waves to earth as the frequency is increased. The change of behavior of the ionosphere takes place over a region of the frequency spectrum with its center at about 30 mc. The band of frequencies in which the ionosphere behavior changes may occasionally move higher or lower by considerable amounts.

The 300-mc dividing line between the VHF and UHF bands and the 3,000-mc upper limit of the UHF band likewise are more or less arbitrary and are agreed upon for convenience. Again, these dividing lines are not abrupt. The limits should be thought of as transition regions, centering on those frequencies.

Communication equipments below 225 mc in the VHF range are not used extensively any more, because most tactical voice circuits now operate in the UHF band. Limited installations of VHF equipment are retained, principally for communication with allied forces who have not yet converted to UHF equipments.

Transmitters and receivers installed in naval aircraft cover only parts of the VHF and UHF bands. VHF equipments cover the range of frequencies from 115 to 156 mc. UHF transmitters and receivers are designed for 225- to 400-mc operation. Although this frequency range includes the upper portion of the VHF band, the equipments are commonly referred to as UHF equipments.

It must be understood that the behavior of radio waves at VHF, UHF, and microwave frequencies is very different from their behavior at lower frequencies, and the differences are extremely important. For this reason, this chapter begins with information on the fundamental differences of radio waves in this frequency range and the reasons for the differences.

The distributed properties of inductance, capacitance, and resistance associated with any conductors are discussed first, because their effects must be understood before the action of electronic circuits at these frequencies can be comprehended. In particular, the effects of these distributed properties in the connecting leads in electronic circuits are presented. These effects comprise the principal reason for the physical differences between equipment operating in this frequency range and the more familiar circuits used at lower frequencies.

It is also necessary to understand the changes that occur in the behavior of lumped-property components, such as inductors, capacitors, and resistors, when they are operated in the VHF/UHF/microwave region. The differences in design of components meant for operation in these frequency bands are compared with the more familiar lower frequency components.

The purpose of this chapter is to acquaint the AT with oscillators and amplifier circuits employed at UHF and microwave frequencies. Also, information dealing with the pulsing techniques used in RF generators of this frequency range is presented. Specifically, it discusses problems involved in generating high frequency signals, explains the theory and operation of a number of oscillators, amplifiers, and other microwave circuits employed at these frequencies, and describes various methods for pulsing oscillators.

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ADVANTAGES OF USING HIGH FREQUENCIES

At 30 mc and above, the ionosphere does not return radio waves to the surface of the earth very effectively, except under rather unusual conditions. This limits the effective range of radio communication and radar coverage in these frequency bands to points not far beyond the optical horizon as seen from the transmitting antenna. At first this was considered a serious limitation because most of the emphasis was on long distance communication, far beyond the horizon. It soon was realized, however, that the shorter wavelengths could be used for covering relatively local areas. This made some additional lower frequencies available for long distance communication.

Because propagation of these shorter radio waves does not reach points on the surface of the earth beyond the horizon, stations can operate on the same assigned frequency without interference, if they are separated far enough geographically. This provides reliable short range communication and is widely used in naval operations at sea, for convoy communications, for communication between ships and aircraft, and for communications between aircraft.

A second effect of the decrease in wavelength as the frequency is increased is related to the phenomenon of radio wave reflection. All electromagnetic waves, such as radio, light, and infrared radiation, can be reflected but how well they are reflected depends on a number of different factors. One factor is the relationship between the length of the wave and the physical size of the reflecting object. The AT needs to concern himself with this phenomenon because it is one of the basic principles on which radar operates, and its importance can hardly be exaggerated.

Another factor directly related to wavelength is the physical size of the equipment used to generate the RF energy, and the antenna needed to radiate it effectively. Both of these factors can be made smaller in direct proportion as the wavelength is made shorter. Obviously, equipment for the shorter wavelengths can be made smaller and more compact because of this relationship between physical size and wavelength.

Aside from the factors of size and weight, these frequencies are highly applicable to radar equipment for they produce better target echoes and make possible the detection of smaller targets. The size of the target that radar can detect depends mostly on the frequency. In general the higher the frequency, the smaller the target that the radar can detect. A target gives the best echoes when its size is about one-half the wavelength (or some multiple on the wavelength) at the frequency being transmitted. If the target is much smaller than a wavelength, the intensity of pulse that it reflects is low. However, as the operating frequency is increased, the wavelength becomes smaller making it possible to detect smaller targets.

DISTRIBUTED PROPERTIES

Distributed properties may be defined as the inductance, capacitance, and resistance uniformly spread along each unit length of any circuit element, plus the inductance, capacitance, and resistance existing from each conductor to ground and to other objects. For example, a 1/4-inch rod of copper, 4 inches long, placed in free space where no outside influence could act upon it, would be found to possess small but definite values of inductance, capacitance, and resistance. If the conductor were cut in half, each part would possess exactly half the values previously found. In other words, the distributed properties are uniform as long as the conductor itself remains uniform in cross sectional size, shape, and conductivity, provided that no external influences exist. If the conductor is not uniform, the distributed properties still exist, but their distribution is not uniform.

When a conductor is placed in an actual circuit, it possesses these self-contained distributed properties, and may or may not possess additional distributed properties caused by its proximity to ground and to other components in the circuit. Distributed properties exist in all conductors and conducting surfaces, even in the leads and other parts of the lumped-property circuit elements (capacitors, coils, resistors), which are manufactured to provide definite amounts of the properties. When used in practical circuits at VHF/UHF/microwave frequencies, however, the distributed properties of inductance, capacitance, and resistance in a given conductor actually are not fixed amounts or constants, but slowly change in value as the frequency changes.

At frequencies below 30 mc it is practicable to ignore distributed, or stray, circuit properties, except in circuits such as resonant sections of transmission lines or antennas. Above 30 mc, the effects of distributed properties upon practical circuits can no longer be neglected, because of the relationship between the physical size of the circuit components and the wavelengths. At 3 mc, for instance, one wavelength is 100 meters long, in comparison with which a 6-inch length of wire is very short. When the wavelengths become relatively short, as the frequency increases, it becomes physically impossible to scale down the parts of the electronic circuit and keep them small in relationship to wavelength. Even where such a size reduction is possible, the power handling ability of the circuit is reduced in proportion. As a result, much of the usefulness of the device is lost.

When the operating frequency increases, the various losses that reduce circuit efficiency increase, making it desirable to use circuit arrangements and elements that have lower built-in losses. So far it has been found impossible to construct lumped-property elements that are pure and do not contain small distributed values of the other two properties. As the working frequency increases, the effects of the unwanted distributed properties cause increased losses, with the result that the efficiency drops. In circuits utilizing distributed properties, losses are lower than in the same circuits constructed of lumped-property elements, because it is possible to use conductors of proper size and shape to minimize RF resistance and because the dielectric is usually air. The result is that better circuit stability and efficiency are achieved by using the distributed properties.

Distributed Inductance

The term "distributed inductance" refers to the self-inductance distributed along the length of any type of conductor, whether it is or is not meant to act as in inductor. Inductance, as defined in Basic Electricity, NavPers 10086-A, is the property of a conductor that tends to oppose any change of electron flow (current) through the conductor. Inductance reveals itself only when current is varying in the conductor; a back emf (electromotive force) is induced in a direction that tends to oppose the change in current flow. It is apparent that even a very short section of straight wire possesses self-inductance. The conductor does not have to be wire, however; it can be any conductor, any shape or size.

Usually, the actual amount of self-inductance is small, but its effect becomes important at frequencies above 30 mc. The effect may be desirable or unwanted, but it cannot be ignored. A complex equation is needed to find the actual value of self-inductance, but the important point here is that the value depends directly on the number of lines of flux surrounding the conductor. Self-inductance is highest at the center of any conductor carrying alternating current, and tapers off toward the outside surface. This is the cause of skin effect, explained later.

UNDESIRABLE EFFECTS.—The property of distributed inductance can cause serious RF losses if leads and connecting linkages are not kept as short as possible. Figure 12-1 demonstrates how this loss takes place. The plate tank circuit (A) is designed to operate at a frequency of 4 mc. The inductor is connected to the tube plate by a wire having a self-inductance of approximately 0.1 microhenry (μh).

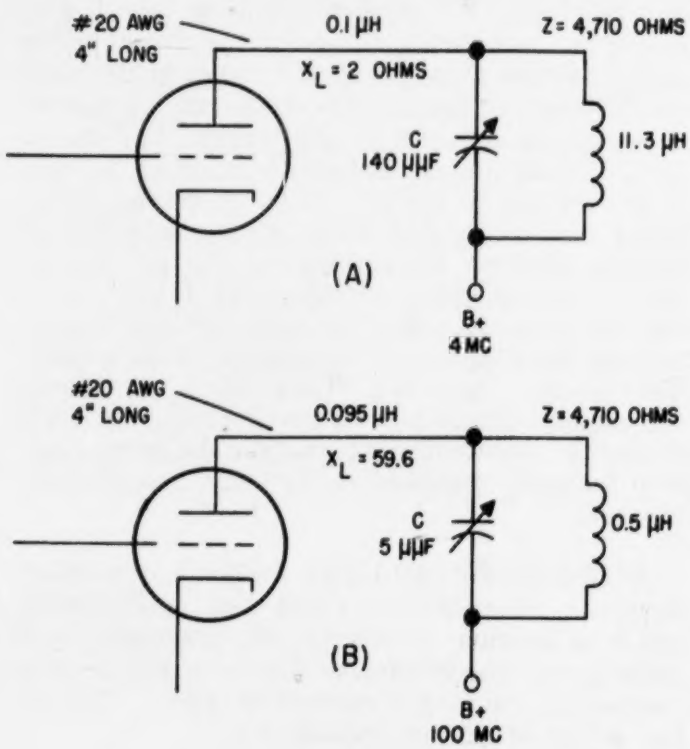

Figure 12-1.—Effect of distributed inductance at higher frequencies.

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Ignoring loading and other factors; calculation shows that the resistive impedance offered by the tank circuit at resonance is 4,710 ohms, where the inductive reactance ($X_L = 2\pi fL$) of the connecting wire is approximately 2 ohms, and is so small in proportion to 4,710 ohms that it can be neglected at this low frequency.

When the operating frequency is raised to 100 mc (fig. 12-1 (B)), the inductance of the tank coil must be reduced to resonate at the higher frequency. At 100 mc, the self-inductance has decreased slightly but the increase in frequency raises the inductive reactance of the plate lead to 59.6 ohms. The resistive impedance of the of the tank circuit is still 4,710 ohms at resonance. A voltage divider effect occurs, which prevents the entire RF signal output of the tube from being impressed across the tank circuit and results in a loss of gain. In addition, the introduction of an inductive component causes a phase lag that is undesirable in certain applications. At higher frequencies, the effect becomes even more pronounced, introducing larger losses.

DESIRABLE EFFECTS. —In certain circuits, a condition of series or parallel resonance is desired, and the property of distributed inductance, distributed capacitance, or a combination of both, may be used to achieve this. For example, to provide a bypass for signal voltages from the low-impedance end of an IF tank circuit back to the cathode of the tube, a series resonant circuit offers the lowest impedance path. When the IF frequency is above 30 mc, it is possible to get the effect of series resonance by cutting the leads of the capacitor to lengths offering the necessary series inductance. This is shown in figure 12-2 (A). Note that the capacitance is lumped, but the inductance is the distributed inductance of the capacitor leads. (See fig. 12-2 (B).) However, the signal voltage sees a certain value of each property, regardless of whether the properties are lumped, distributed, or any combination thereof.

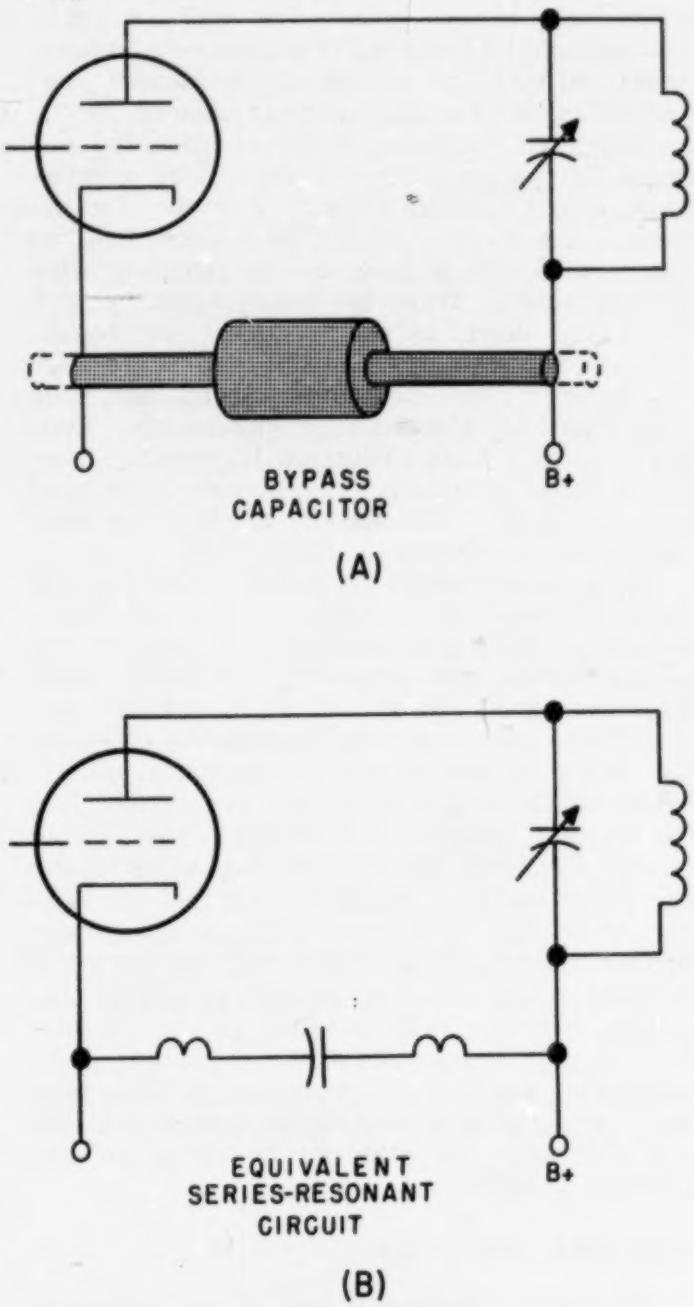

Figure 12-2. —Series resonance; lumped capacitance and distributed inductance.

INDUCTIVE COUPLING. —When a conductor carrying alternating current runs sufficiently close to another conductor, its magnetic field induces an electromotive force in the second conductor, causing a current to flow. This is the effect of mutual inductance.

The study of mutual inductance and coupling at lower frequencies usually is restricted to coils and transformers, but above 30 mc the effect of coupling between two conductors—even two straight pieces of wire—becomes important. This is true because the amount of coupling or mutual reactance between two inductors increases as the frequency is increased, if the physical relationship remains the same.

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Some effects of coupling between distributed inductances are undesirable. For instance, if the grid and plate leads of a single-tube amplifier stage are permitted to run close to each other, signal energy from the plate circuit may be coupled back to the grid, causing either regeneration or degeneration. Distributed capacitance also is present, but only the inductive coupling effect is considered at this time. As another example, a current carrying wire may be too near a tube shield, inducing an emf that causes current to flow in the shield. This current flow through the shield is a power loss that can be supplied only from the current carrying wire.

When inductive coupling causes circuit imbalance or power loss, it usually is spoken of as stray coupling. The amount or degree of coupling depends directly on the relative positions of the conductors as well as their distance from each other. Figure 12-3 shows the effect of physical position on the degree of coupling. In (A) the coupling is loose, inasmuch as the leads are crossing at right angles, and the least mutual inductance results. The coupling between the wires (B) and (C) increases because of the greater amount of mutual inductance. Practical circuits are laid out with the shortest possible leads, well separated from one another and distance from the chassis and shields. If two wires must cross, they should cross at right angles, because in this manner the smallest mutual inductance results.

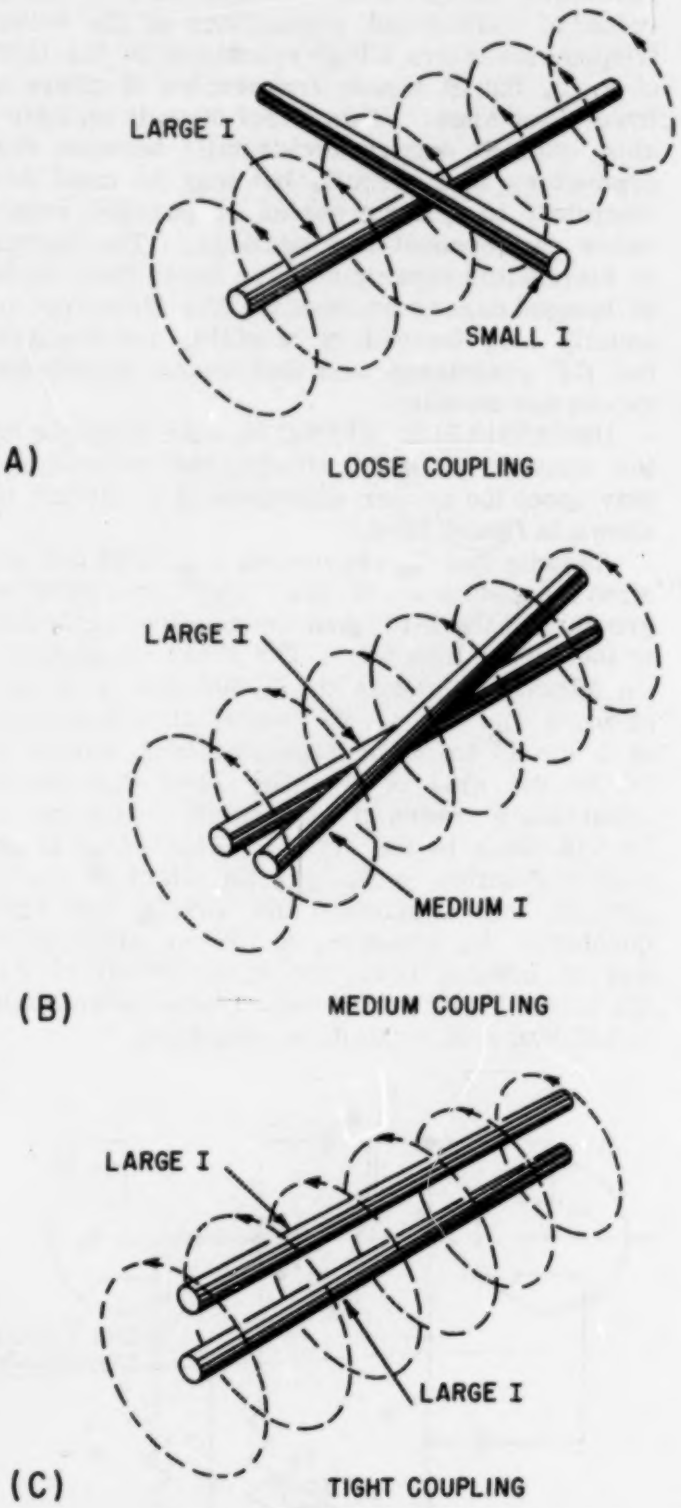

Figure 12-3.—Inductive coupling effects at higher frequencies.

Distributed Capacitance

The term "distributed capacitance" refers to the capacitance between any point on a conductor and all surrounding objects. Capacitance exists between any two points that are at different electrical potentials. This is true whether the points of different potential are in different conductors or in the same conductor. Although the self-capacitance of a conductor is of relatively little importance, except in special circuits, the effect of the capacitance between two conductors must be taken into consideration at VHF/UHF/microwave frequencies. This is because of the distributed capacitance that exists between the parts of circuit elements and the electrodes of electron tubes. as well as between leads and switch contacts.

The actual value of distributed capacitance changes only slightly with frequency, but the reastance changes greatly. The formula for capacitive reactance ($X_C = \frac{1}{2\pi fC}$) shows that, if the value of capacitance remains the same, increasing the frequency causes the capacitive

reactance to decrease. Therefore, a small value of distributed capacitance at the lower frequencies offers a high reactance to the flow of a.c., but at higher frequencies it offers a lower reactance. This effect often is undesirable when it occurs accidentally between two conductors in a circuit, but may be used deliberately to achieve series or parallel resonance in resonant line sections. The losses in distributed capacitance are lower than those in lumped capacitors because the dielectric is usually air, instead of a solid, and because the RF resistance and distributed inductance values are smaller.

UNDESIRABLE EFFECTS.—An example of the manner in which distributed capacitance may upset the proper operation of a circuit is shown in figure 12-4.

Assume that C_d represents a distributed, or stray, capacitance of 1$\mu\mu$f appearing between ground and the lead from the coupling capacitor to the grid of tube V2. The stray capacitance C_d effectively shunts the 5,000-ohm grid impedance Z_g. If an RF signal at a frequency of 2 mc is traveling from the tank circuit of V1 to the grid of V2, the 1$\mu\mu$f distributed capacitance offers a capacitive reactance of 79,618 ohms to the signal. This value is so high in relation to Z_g that its effect is negligible at this frequency and similar low frequencies. If, however, a 100-mc signal voltage is coming from the tank circuit of V1, the same 1-$\mu\mu$f stray capacitance offers only 1,592 ohms of capacitive reactance.

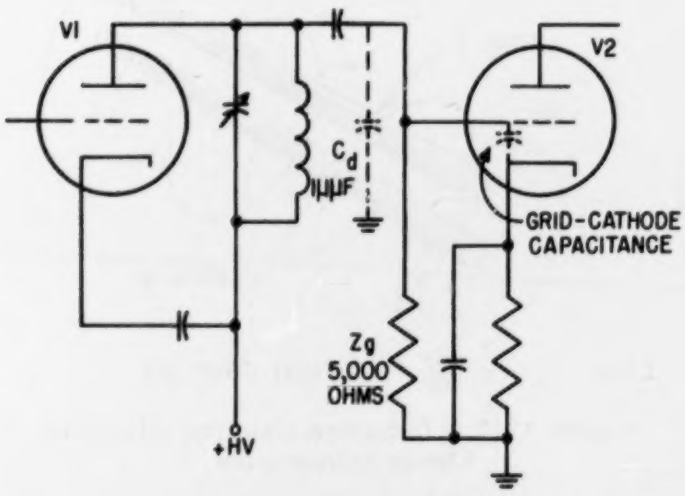

Figure 12-4.—Effect of distributed capacitance at higher frequencies.

Now the signal voltage sees a relatively low impedance path across the stray capacitance, offering less than one-third the opposition of the grid impedance Z_g. Therefore, more than two-thirds of the signal voltage is shunted across this path and lost. If the frequency of the signal voltage is increased to 400 mc, the reactance drops to 398 ohms, and only a very small amount of the signal voltage reaches the grid impedance.

To keep the stray capacitance at a minimum, the circuit wiring is kept well spaced with short leads that run at right angles to one another whenever possible.

DESIRABLE EFFECTS.—For certain applications, such as IF amplification, a parallel LC (inductance-capacitance) circuit, resonant at a single frequency, is useful. A simple way of achieving this is to wind a coil in such a manner that the total distributed capacitance is used to make the coil self-resonant at the desired frequency.

Part (A) of figure 12-5 shows the distributed capacitance that exists because of the difference of potential between adjacent turns of any coil. The sum of these small values is shown in part (B) as an effective value of capacitance in parallel with the lumped inductance of the coil. Although most inductors are wound to minimize the distributed capacitance, some are designed to offer the necessary capacitance to provide a desired L/C ratio. This offers an advantage because the response of the tuned circuit can be made sharper than would be possible with lumped-property coils and capacitors.

Distributed Resistance

The term "distributed resistance" seldom is used, because it is necessary to distinguish between the resistance offered to d.c. and low-frequency a.c. and the resistance offered to RF currents at the higher frequencies.

Depending on the conductivity of the metal or alloy, all conductors have d-c resistance. It is distributed uniformly along conductors that are uniform in cross sectional area, shape, and conductivity. Resistance to RF, however, is caused by d-c resistance plus the effect of self-inductance, which is greater at the center of a conductor than at the surface. At the lower frequencies, this self-inductance has little effect on the flow of current because the values of inductive reactance are extremely small.

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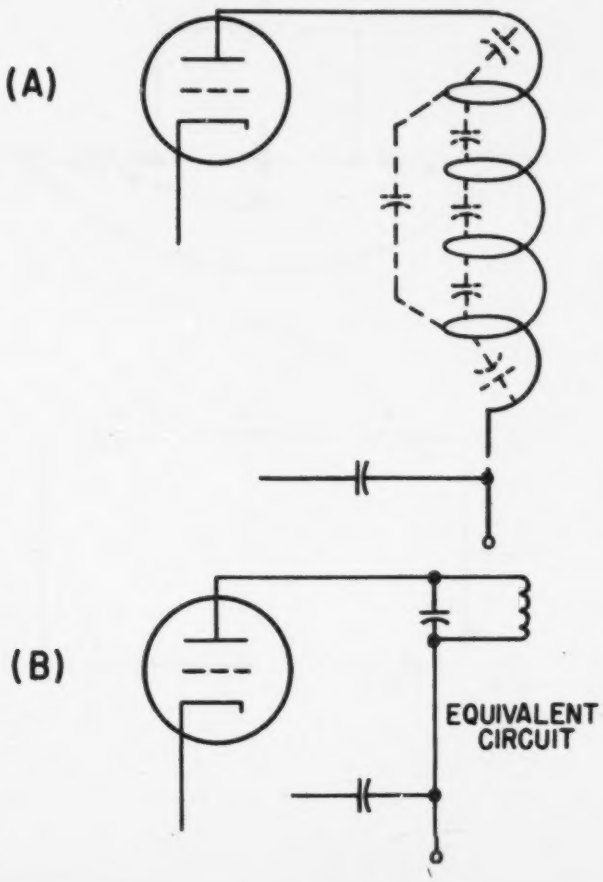

Figure 12-5.—Parallel resonance; lumped inductance and distributed capacitance.

As the operating frequency increases, the inductive reactance at the center of the conductor becomes higher, and the current seeks the lower reactance path toward the surface, resulting in a current distribution that is not uniform.

This tendency of the current to flow on or near the surface of a conductor is called SKIN EFFECT. As the frequency increases, less current flows in the center of the conductor and more flows on the surface. The result is that more current is forced through less conductor material, with higher losses and more heating. Because the center of the conductor is not carrying current, the effect is the same as using a smaller conductor. The RF resistance at higher frequencies can amount to several times the d-c resistance of the same conductor.

MINIMIZING SKIN EFFECT.—Skin effect takes place regardless of the shape of the conductor, but it causes less RF resistance in conductors having rectangular cross sections than in those that are circular. Flat copper strips are sometimes used, but are more expensive and not easy to work.

Litz wire, as it commonly is called, is made up of many strands of very fine enameled wire woven together. The current is divided among the strands, and the skin effect on any single conductor is extremely small. Litz wire is comparatively expensive, however, and is not widely used.

Probably the best method of avoiding losses from RF resistance is by silver plating the conductors. This does not eliminate skin effect, but takes advantage of it. When the plated conductor carries RF current, skin effect takes place as usual. Now, however, the current is flowing in the silver plating, which has less d-c resistance than ordinary conductors; therefore, the RF resistance is reduced considerably. In practice, plating is expensive, limiting its use.

The most common means of reducing RF resistance is to use a hollow conductor or one of larger diameter. Again, this does not eliminate skin effect. The depth to which the current penetrates is affected only by the frequency and the conductor material; consequently, when the diameter is increased, the current layer has the same thickness but more cross sectional area in which to flow. This reduces the effective RF resistance.

LUMPED-PROPERTY COMPONENTS

A lumped-property component is an electronic part in which a definite amount of capacitance, inductance, or resistance exists, usually with relatively little of either or the other properties present. Capacitors, coils, and resistors used in radio equipment operating at frequencies below 30 mc generally a lumped-property components.

As the frequency of operation is raised, the electrical loss in lumped-property components increases, until a frequency is reached where this increasing loss cannot be tolerated. The increased loss is actually a combination of three distinct effects—dielectric loss, RF resistance loss, and radiation loss.

Loss in even the best dielectric materials increases with frequency, because a definite amount of applied electrical energy is lost in each cycle, and the more cycles that occur in a unit of time, the more heat is generated in the dielectric.

The RF resistance loss also increases with increasing frequency, because of skin effect.

Radiation loss occurs in any RF circuit because of direct radiation from the parts. This loss is usually negligible, so long as the circuit is not more than about one-tenth of a wavelength in any physical dimension. With increasing frequency, however, it becomes impossible to scale the components down in physical size in proportion to the decreasing wavelength, and radiation losses increase. The addition of RF shielding around the circuit also causes energy to be lost in heating the shield, rather than by radiation.

Capacitors

All capacitors, of any size, type, or construction, have characteristics that cause them to behave in a way unlike the theoretical ideal capacitor, which would have pure capacitance, and no inductance or resistance. Practical capacitors actually have some series inductance because of their leads and internal metallic foil plates. This inductance is effectively in series with the actual capacitance as shown in the approximate equivalent circuit of figure 12-6 (A) where C represents the actual capacitance, L the inductance of each lead, and R the effective RF series resistance of the leads and foils. Losses in the dielectric are represented by the shunt conductance, G. Below 10 mc, dielectric losses are seldom serious, even in ordinary paper capacitors, and in high quality mica and ceramic units it has no serious effects at the highest frequencies.

Since capacitors have a small (but significant) amount of inductance in series with the actual capacitance, there is a resonant frequency at which the reactances of the inductance and capacitance become equal, and cancel each other. The reactance becomes capacitive below series resonance, and grows larger as the frequency decreases. The opposite effect takes place above resonance, where the reactance is inductive, and grows larger with increasing frequency.

The common types of electrolytic, mica, paper, and ceramic capacitors are subject to increasing losses as the operating frequency is increased. In electrolytic capacitors, these losses and the inductance of the leads and internal foil strips that form the plates make them practically ineffective as capacitors at frequencies above a few megacycles. Even in equipment operating below 30 mc, electrolytic capacitors usually are shunted with a paper of mica capacitor of suitable value, which bypasses the higher frequency currents around the electrolytic unit.

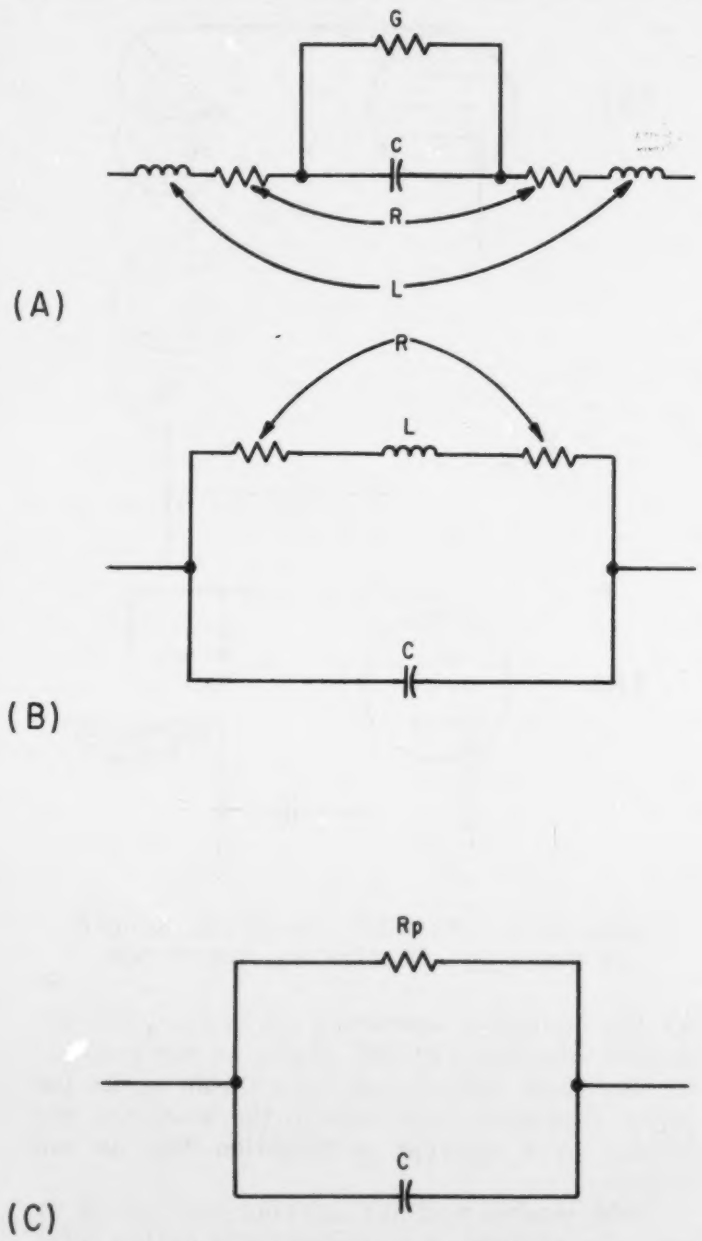

Figure 12-6.—Equivalent high frequency circuits.

Paper capacitors also are subject to serious losses as the frequency is raised, but not to the same severe extent as in electrolytic units. The series inductance of paper units is large, and causes them to become series-resonant at frequencies ranging from 1 to 10 mc, depending on the capacitance and lead length.

Mica capacitors, because of their lower losses and smaller series inductance, have an extended range of usefulness. Average types become series-resonant at frequencies from 10 to 100 mc, depending on the capacitance value and lead length.

Ceramic capacitors are a more recent development and have improved properties in certain respects. Their losses are lower than those of mica units, and their design permits a much lower series inductance. As a result, their series resonance may be as high as 400 or 500 mc and this, together with their stability and low losses, makes them preferred in many VHF/UHF/microwave applications.

IMPROVEMENTS IN CAPACITORS.—Changes in the materials and design of capacitors have been made to adapt them for more effective performance at frequencies above 30 mc. In general, since capacitors do not behave as capacitors above their own resonant frequency, most of the improvements have been made with a view to raising the resonant frequency. The greatest improvement resulted from the development of ceramic materials that made possible ceramic-dielectric capacitors with only two plates, as compared with the many interleaved foils necessary in paper and mica units. Ceramics also made possible capacitors with various temperature coefficients which can be used to improve the stability of critical circuits.

Various ceramic materials, such as barium and strontium titanates, have been found to have high dielectric constants and good dielectric strength. By plating or firing silver electrodes directly on thin plates of this dielectric material, air and moisture are prevented from getting between the plates of the capacitor. This results in greatly improved stability. By varying the mixture of the ceramics, the temperature coefficient of the capacitor can be made negative, zero, or positive, as desired. Ceramic capacitors then can be used to compensate for frequency drift caused by changes in other components with changes in temperature. Skin effect is reduced by using short, heavy leads, and losses caused by surface leakage and humidity are minimized by sealing the surface with baked silicon lacquer. A similar process of plating or coating the silver electrode on mica also has been developed for the manufacture of mica capacitors, with considerable improvement in their stability and high-frequency performance.

Inductors

All inductors have some distributed capacitance between turns, which appears as a small capacitance in parallel with the external circuit. When the applied frequency is increased to a point where the distributed capacitance of the coil resonates with the inductance, a new effect appears. The coil becomes a parallel-resonant circuit (fig. 12-6 (B)) to the external circuit connected to its terminals. The resistance in this equivalent circuit represents the losses incurred in practical coils. This self-resonant characteristic is used in many applications in VHF/UHF/microwave receivers. The inductor is made to resonate with its own self-capacitance, plus the tube input and stray circuit capacitance. This eliminates the need for a separate tuning capacitor and provides the highest possible inductance-capacitance ratio, the largest load impedance, and the greatest stage gain.

Self-resonant inductors are often used in the IF amplifiers of communications receivers. If adjustable tuning is required, it is accomplished by varying the inductance either by a switching arrangement or with an adjustable core (slug) of plastic impregnated with iron powder.

In transmitter circuits, the inductor must handle considerable power without serious heating. This requires a coil of larger physical size, and usually makes the use of iron powder cores impractical because such cores tend to saturate magnetically and lose efficiency as the power level increases. Inductors in transmitter circuits thus are usually of the air wound, self-supporting type.

Resistors

The effects of increasing frequency on the performance of some types of resistors are such that the resistors cannot be used efficiently at frequencies of 30 mc and upward. Wire wound resistors that are used at low frequencies become useless above this range because of unavoidable inductance and capacitance, which introduce unwanted reactive or resonant effects. Therefore, composition resistors made of finely divided carbon in a suitable binder are most commonly used in this frequency range.

For practical purposes, the simple equivalent circuit shown in figure 12-6(C) illustrates the effective impedance of a composition resistor at high frequencies. This equivalent

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circuit generally is used in the design of VHF, UHF, and microwave circuits. R_p is the reciprocal of the conductance and is referred to as the parallel resistance. The total effective capacitance, C, is caused by the capacitance between the leads and the distributed capacitance.

Resistors made by depositing a thin layer of pure, finely divided carbon or a carbon and boron mixture on the surface of a ceramic or glass tube provide improved performance characteristics at all frequencies. They are particularly stable, and they show less change in impedance with increasing frequency.

FREQUENCY LIMITATIONS OF CONVENTIONAL OSCILLATORS

The principal factors which limit the frequency of the ordinary type oscillator are the construction of the tube and the external circuits which connect to the tube.

Although the basic principles of vacuum tube operation are unchanged, certain factors that can be disregarded in tube operation below 30 mc become important at higher frequencies. The inductances of the electrode leads and the capacitances between electrodes are very small, but at higher frequencies their reactances become significant. In addition, electrons do not travel instantaneously from the cathode to the plate, but require a TRANSIT TIME. This causes an in-phase grid current to flow, even though the grid is negative, and results in a loading effect across the input that reduces overall gain in all classes of tube operation.

Skin effect in the electrodes and electrode leads causes the RF resistance to increase with frequency. Dielectric losses in the insulating electrode supports are increased, and some power is lost by direct radiation from the electrodes and their leads. The effect of these factors is to cause tube efficiency to become progressively lower as the operating frequency is increased. For example, a tube operated as an amplifier at 50 mc gives less output for a given signal input than at 5 mc, even if the external circuits are equally efficient at both frequencies. Also, because these losses increase with frequency, there is a practical upper frequency limit beyond which the tube is not useful as an amplifier. If the same tube is operated as an oscillator, the high frequency limit of operation will be about two-thirds to three-fourths that of the limit as an amplifier, because the tube no longer can supply sufficient output to make up the increased losses and still provide a useful output signal.

These effects are always present in a vacuum tube; no matter what the operating frequency. As the frequency is raised, the effects increase and become so large that they place an effective upper limit on useful operation. Although it is not necessary to learn new operating principles, it is important to understand how and why these characteristics that previously were disregarded become major limitations at frequencies above 30 mc.

TUBE CONSTRUCTION FACTORS

As the wavelength is made shorter, it becomes comparable in length to the physical length and spacing of tube electrodes and leads. The apparent solution to this difficulty is to scale down the entire tube structure. There is a practical limit, however, governed by the power handling capacity required. New tube designs have been developed that successfully overcome one or more of the limitations without requiring a drastic size reduction. For further details on tube design, review chapter 1 of Basic Electronics, NavPers 10087-B.

Interelectrode Capacitances

As has been pointed out in Basic Electronics, NavPers 10087-B, a small but significant value of capacitance must exist between any element of an electron tube and each of the other elements. Additional capacitances exist between the leads, particularly in those tubes in which the leads are brought out through a common stem to the base. When the tube is operating with normal voltages applied, the effective capacitances between electrodes are different from the capacitances when the cathode is not emitting. These differences are caused partly by expansion of the parts when the tube heats and partly by the electron stream.

When the tube is cold, the dielectric between electrodes is mostly vacuum, but in operation this vacuum is partially filled with a stream of electrons, resulting in a change in the dielectric constant. Naturally, this changes with variations in the electron stream. The normal capacitance values are measurable, and are listed in tube characteristics tables.

The discussion of interelectrode capacitance in Basic Electronics, NavPers 10087-B, establishes the relationship between operating frequency and capacitive reactance within electron tubes. A good point to remember is that the higher the frequency (or the larger the interelectrode capacitance) the higher the current flow through this capacitance. In most UHF oscillators employing ordinary tubes, interelectrode capacitance currents are much greater than the power currents supplied by the tube. These higher currents cause power losses in the resistance in the oscillatory circuit.

Since interelectrode capacitances are effectively in parallel with the tuned circuit, they affect the frequency at which the tuned circuit resonates. In the circuit illustrated in figure 12-7, the plate to cathode capacitance is in parallel with the series combination of the plate to grid capacitance and the grid to cathode capacitance. All these capacitances together form a part of the total capacitance of the plate's tuned circuit. Their total capacitance is calculated by the formula,

$$C_t = C + C_{pk} + \frac{C_{gk}\,C_{gp}}{C_{gk} + C_{gp}}$$

Not only does interelectrode capacitance limit the frequency by establishing a minimum value below which it is impossible to go, but it also varies with the applied voltages and with the loading of the oscillator. This causes frequency instability, particularly when the interelectrode capacitance forms a large part of the tuning capacitance.

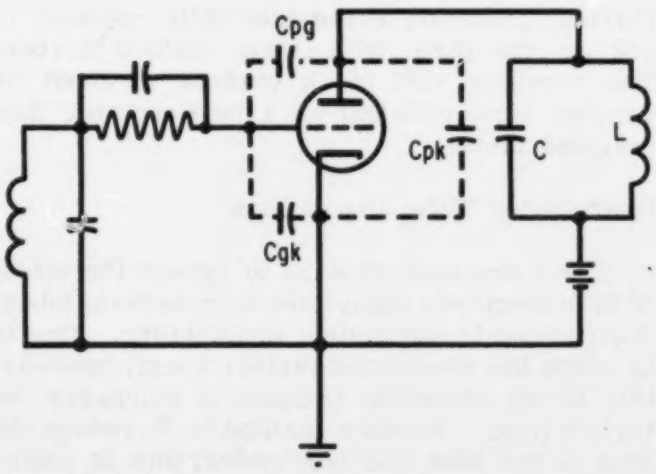

Figure 12-7.—Effect of interelectrode capacitance on frequency of tuned plate, tuned grid oscillator.

Inductance of Leads

Another frequency limiting factor is the inductance of the lead to each tube element. Because any conductor possesses self-inductance, the internal leads to the tube elements and the elements themselves, as well as the tube pins, have some inductance. For example, within a tube operating above 30 mc, circuit calculations must take into consideration the effective values of inductance. This inductance is in series with the plate, grid, and cathode, and although the actual inductance of a lead is usually small, the reactance offered at frequencies of several hundred megacycles becomes appreciable.

While these inductances do not necessarily impair the efficiency of the oscillator, they may represent a major portion of the inductance of the tuned circuit and limit the frequency by setting a minimum limit on the inductance. Furthermore, since the cathode lead is frequently common to both plate and grid circuits, feedback may take place through it and produce an additional loss of efficiency.

Transit Time

The importance of transit time at UHF and higher frequencies is mentioned in Basic Electronics, NavPers 10087-B. Further details are presented in the following paragraphs.

The effect of transit time is of special concern in connection with the input impedance of the tube. The signal applied to the grid causes a flow of electrons past the control grid, which in turn causes a current to be induced into the grid. This induced grid current may flow either into or out of the grid, depending on the relative grid voltage at the time. Part of the current flowing in the grid is the current which charges the grid to plate capacitance (C_{pg}, fig. 12-7). The voltage which produces this current is the vector sum of the input voltage (grid to cathode) and the output voltage (across the plate load).

Grid current flow absorbs power from the input signal, even though the grid is always negative, and has the same effect as if a shunt resistance and a shunt capacitance were connected across the grid and cathode terminals of the tube. The loss of signal energy brought

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about in this manner is the most important effect of transit time, and the loss increases as the frequency increases.

At lower frequencies with a resistive load, the input and output voltages are (for practical purposes) 180° out of phase and add algebraically to determine the charging current for the grid to plate capacitor. This current is 90° out of phase with the input voltage. However, at higher frequencies where transit time is an important factor, the plate current lags appreciably behind the input voltage. At these frequencies, the plate voltage is less than 180° out of phase with the input voltage, and the voltage across the capacitor lags the input voltage slightly. As a result, the charging current is no longer 90° out of phase, but now has an in-phase component. The in-phase current results in power being consumed in the grid circuit. The consumption of power is effectively the same as adding a high resistance between the grid and cathode, with the resistance decreasing as the frequency is increased.

REDUCING TRANSIT TIME EFFECTS.— Transit time effects can be minimized by scaling down tube dimensions and increasing operating voltages. Miniaturization is utilized widely. Amplifiers designed for use above 30 mc usually have close interelectrode spacing. Many transmitting tube types are very small in proportion to their power ratings, and require cooling by forced air draft.

Where close spacing is utilized, the distance from the cathode to grid is particularly important. Preventing the electrons from leaking from cathode to plate around the ends of the control grid supports is important, because such leakage would result in increased transit times.

Screen grid tube types have naturally shorter transit times than triodes, and are used in many VHF/UHF/microwave equipments to reduce transit time effects.

Miscellaneous Effects

Other effects on electron tubes at the higher frequencies are caused by grid gas current, grid emission, and heat radiation.

In any electron tube there are always some molecules of gas, because it is impossible to produce a perfect vacuum. When electrons collide with these molecules, positive ions are created and are attracted to the negative control grid. This causes a grid current to flow when the grid is negative. The grid current thus produced is small but has the effect of making the grid less negative, which is undesirable in view of the effects of input resistance in this frequency range.

Any metal emits electrons if heated sufficiently, although some are much more efficient in this respect than others. In miniature tubes suitable for use at frequencies higher than 30 mc, the grid is subjected to heating by the nearness of the cathode as well as by the in-phase grid currents. Some electrons strike the grid even though it is negative, causing the possibility of secondary emission. As a result, there is a possibility of both primary and secondary emission from the grid. This adds to the space charge and is undesirable because it varies erratically. The effect can be reduced by plating the grid with a metal that does not emit electrons easily. Gold is particularly effective and is used where the type of operation is critical enough to warrant the expense. Another method, somewhat less effective, is spraying the grid with finely powdered boron carbide.

The radiation of heat from the plates of air-cooled tubes becomes a factor of importance because the tube efficiency is reduced as the frequency is raised. For a given power input, a reduction of efficiency causes higher plate dissipation. This means that the input power must be reduced to keep the plate dissipation from going above the rated value and causing serious overheating. When the input power is decreased, however, the useful output power drops.

The most common method of improving the thermal radiation of the tube plate consists of coating the plate with finely divided carbon. The resultant dull black surface is about 60 percent more efficient as a heat radiator than polished metal.

Overcoming Tube Limitations

There are several ways to reduce the effect of interelectrode capacitances in vacuum tubes, though none is completely satisfactory. One is to move the electrodes farther apart; however, this is not desirable because it increases the transit time. Another method is to reduce the size of the tube and electrodes; this is satisfactory except for one ill effect. It decreases the power handling ability of the tube, varying directly with the square of the factor by which

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the electrodes are reduced. Another method is to separate the leads and to bring them out of the envelope at the point nearest the electrode; this results in a slight decrease in the capacitances.

Similarly there are several ways to reduce the inductances of the leads. Bringing out electrode leads through the envelope at the nearest point decreases the inductances of the leads as well as the capacitances. Another method is to make double connections to the electrode. This makes two parallel inductances, thus cutting the lead inductance in half. Another method is to arrange the leads as extensions of the external transmission lines which are the resonant elements of the circuit. Thus the interelectrode capacitances and lead inductances are incorporated as part of the tuned circuit. (See fig. 12-8.)

It is possible to minimize the inefficiency previously mentioned by using a tube that has two separate external cathode connections.

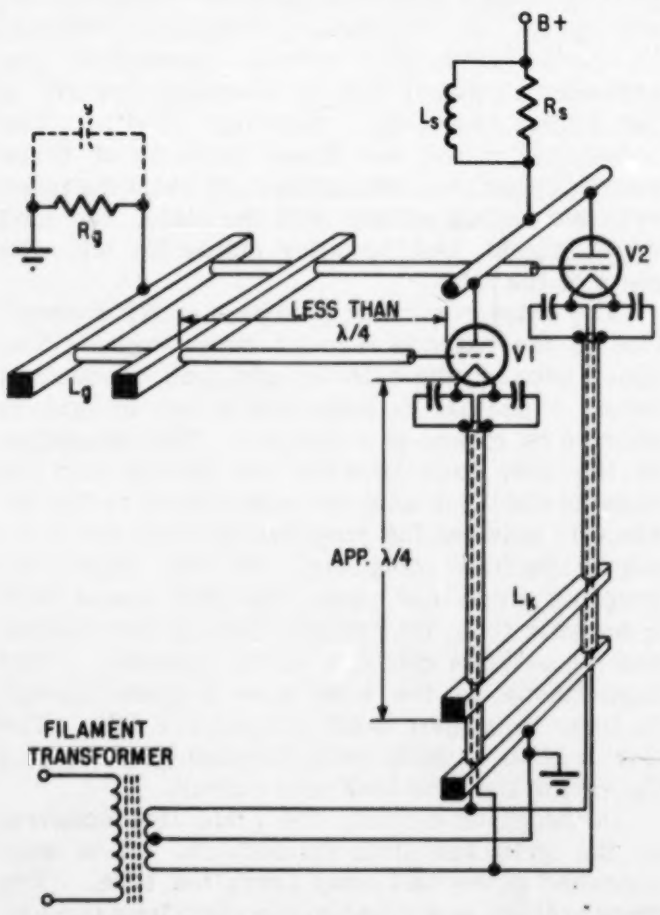

Figure 12-8.—Tuned grid, tuned cathode oscillator.

When one cathode lead is used for the grid return and the other for the plate circuit, the unwanted feedback is prevented since the grid and plate currents do not flow in a common lead inductance.

For reducing transit time, closer spacing of the electrodes may be employed. Closer spacing of electrodes, however, causes higher interelectrode capacitances. Therefore, it can be used only when the electrodes are made smaller.

Transit time may also be reduced by the use of higher plate voltages. For this reason UHF oscillators operate at very high plate voltage. The fact that a radar and other pulsed transmitters do not operate continuously is an advantage in that high enough voltages may be used to reduce transit time without exceeding the maximum power rating of the tube. Operating with high voltages does, however, necessitate some precautionary measures (such as separating the leads to avoid the presence of excessive voltage gradients in or on the surface of the glass envelope, and avoiding sharp projections on the high voltage leads or electrodes to prevent arcing).

LIMITATIONS DUE TO EXTERNAL CIRCUITS

In addition to the limitations placed on the operating frequencies of oscillators by the tubes themselves, additional limitations are imposed by the external circuits. An increase in frequency causes a rather rapid increase in power losses in the external oscillatory (tank) circuit. These losses are due, primarily, to the skin effect of current in conductors, and to radiation from the conductors.

Skin Effect

Skin effect causes a considerable increase in the resistance in an electron tube circuit. This results in a lower Q and increased I^2R losses. To prevent skin effect losses, conductors are made large in size and tubular in shape since current flows only in the surface at and above UHF frequencies. In addition they may be plated with silver, since it has a higher conductivity than copper. At microwave frequencies current flow will be in the silver plating.

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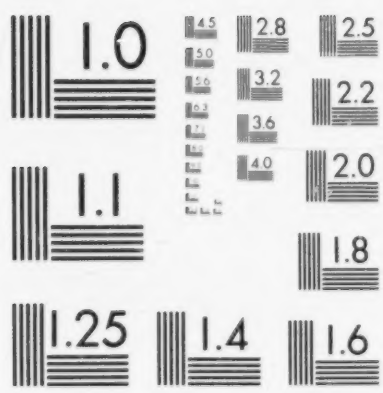

MICROCOPY RESOLUTION TEST CHART
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or $\frac{2\pi r^2}{2}$, or πr^2. This is the most commonly used formula for the area of a circle.

An ellipse is shown in figure 2-20. The longer axis AB is called the major axis, the shorter axis CD the minor axis. Call the length of the major axis a and that of the minor axis b. The area equals the product of half the major axis times half the minor axis times π; or $A = \frac{a}{2} \times \frac{b}{2} \times \pi = \frac{\pi ab}{4}$.

Areas of irregular figures which are drawn to scale may be determined by use of an instrument called a planimeter. The planimeter is described in chapter 3.

Solid Figures

Solid figures are three-dimensional; that is, they have length, width, and height. Figure 2-21 shows various common solid figures; refer to the illustration as you study the following definitions and statements concerning solid figures.

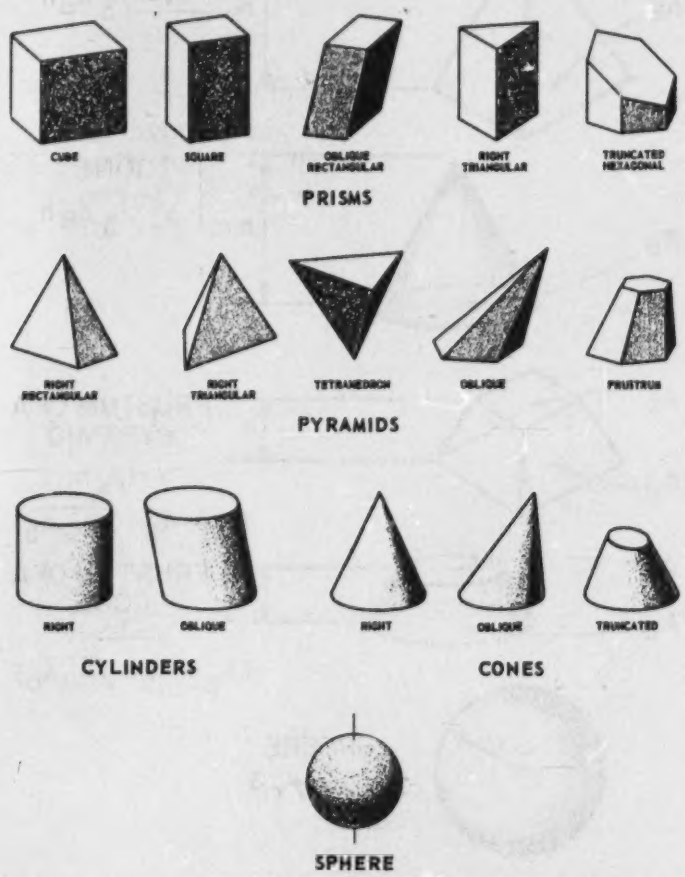

Figure 2-21.—Three-dimensional shapes.

The portions of planes which form solid figures are called faces.

Faces which are the top and bottom of the figures (as usually depicted) are called bases.

The sides are called lateral faces or faces.

Lateral edges are formed by the intersection of lateral faces.

A prism is a figure whose bases are similar polygons and whose faces are parallelograms.

A pyramid is a figure whose base is a polygon and whose sides are triangles.

A circular cylinder has circular bases.

A circular cone has a circular base: the lateral surface is formed by a line which moves around the circle from a fixed point.

Prisms and pyramids are square, rectangular, triangular, hexagonal, and so on, according as their bases are squares, rectangles, triangles, hexagons, and so on.

The lateral edges of a right prism or right cylinder are perpendicular to the base; the vertex of a right pyramid or a right cone falls on a line perpendicular to the center of the base; an oblique prism or pyramid or cylinder or cone does not meet these requirements—that is, it slants.

A truncated prism or pyramid or cylinder or cone is the portion of the figure between the base and a plane which cuts the figure oblique to the base.

The frustum of a pyramid or cone is the portion of the figure between the base and a plane which cuts the figure parallel to the base.

A tetrahedron is a figure with four faces.

A cube is a prism whose six faces are square.

A sphere is a solid bounded by a surface all points of which are equally distant from a point inside called the center.

Volumes

The formula for finding the volume of a rectangular solid is $V = \ell wh$, or the volume of a rectangular solid is equal to length times width times height. Since ℓ times w is the area of the base, you may let A_B stand for the area of the base and express the volume another way: $V = A_B h$, or volume is equal to area of the base times height. When you use a formula for the volume of a solid, like $V = \ell wh$, the length, width, and height must be expressed in the

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same unit of measurement, and the volume, V, will be expressed in terms of the cube of this unit. For example, refer to figure 2-22 which represents a rectangular prism with a base 2 ft by 2 ft and a height of 3 ft; there are 12 cubic feet in the solid.

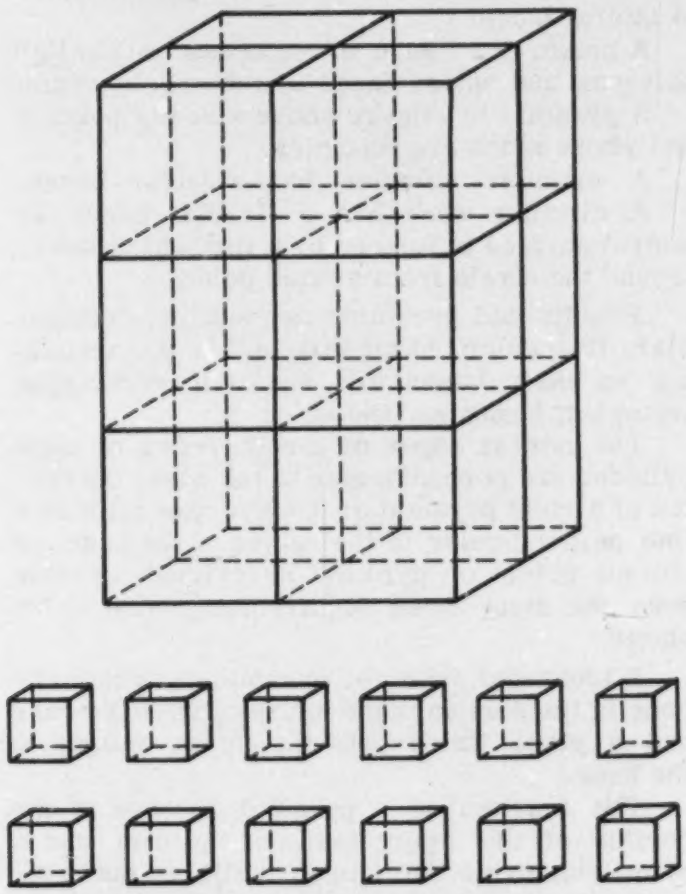

Figure 2-22.—12 cubic feet in rectangular solid.

In the case of a cube, remember that there is a difference between, for example, 2 cubic feet and a 2-foot cube. Two cubic feet may be represented by two of the little cubes in figure 2-22. But a 2-foot cube is a block which measures 2 ft on each edge and has a volume of 8 cubic feet.

For the volume of any prism, then, you simply determine the base area (rectangle, square, triangle, or whatever) by the appropriate method and then multiply the base area by the height. In the case of an oblique prism, the height is the perpendicular distance between the bases and not the distance along a sloping edge (called the slant height).

From the standpoint of volume calculation, the only difference between a cylinder and a prism lies in the fact that the base of a cylinder is a circle rather than a polygon. Therefore, the volume of a cylinder is again equal to the product of the base area times the height. But you determine the base area from the formula πr^2.

The best way to approach the problem of determining volume of a cone or pyramid is on the basis of the fundamental fact that the volume of a cone equals one-third of the volume of the corresponding cylinder, while the volume

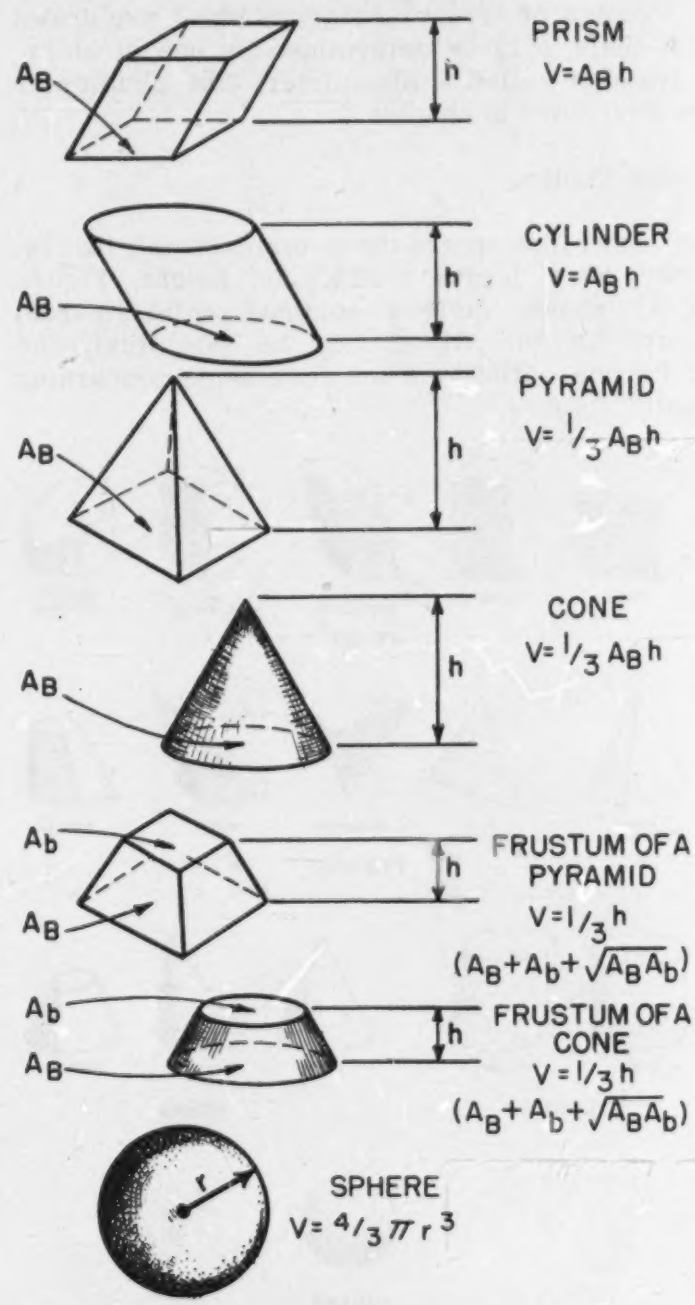

Figure 2-23.

of a pyramid equals one-third of the volume of the corresponding prism. Therefore, for any of these solids, volume equals base area times height divided by 3.

The formulas for the volumes of frustums of pyramids and cones involve the areas of both the upper and lower bases. The formula for the volume of a sphere involves π and the radius of the sphere. These formulas together with the formulas discussed in the preceding paragraphs are summarized in figure 2-23.

TRIGONOMETRY

Trigonometry is that branch of mathematics which deals with the relationships among the sides and angles of triangles and especially with methods of deducing required parts from other given parts.

Trigonometric functions are various ratios whose values vary with the size of angles. The functions of angles can best be illustrated by means of a "circle of unit radius" like the one shown in figure 2-24. A grid coordinate axis is inscribed within the circle. Angles are generated by the motion of a point P counterclockwise along the circumference of the circle. The initial leg of any angle is the positive leg of the x axis, that is, line OC in the illustration. The other leg is the radius r, at the end of which the point P is located; this radius always has a value of 1. Because the positive and negative legs of the axes also have a value of 1,

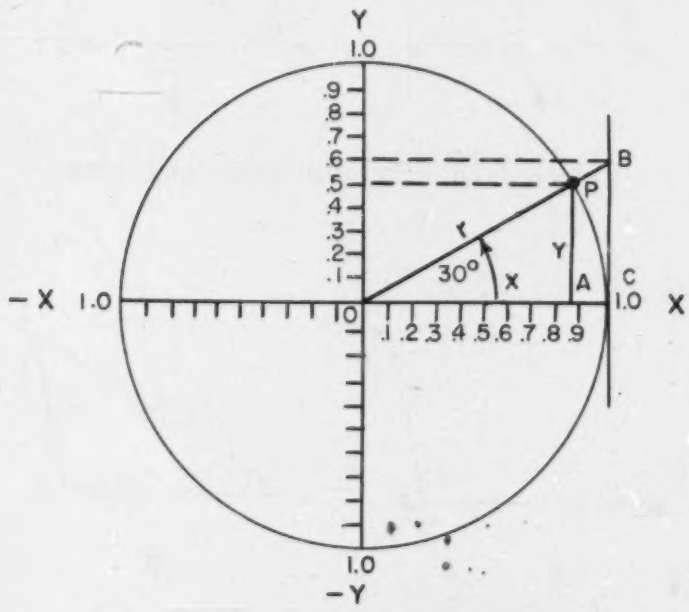

Figure 2-24.—Circle of unit radius.

TRIGONOMETRIC FUNCTIONS

(Natural)

Angle	Sine	Cosine	Tangent	Angle	Sine	Cosine	Tangent
0°	0.000	1.000	0.000				
1°	.018	1.000	.018	46°	0.719	0.695	1.036
2°	.035	.999	.035	47°	.731	.682	1.072
3°	.052	.999	.052	48°	.743	.669	1.111
4°	.070	.998	.070	49°	.755	.656	1.150
5°	.087	.996	.088	50°	.766	.643	1.192
6°	.105	.995	.105	51°	.777	.629	1.235
7°	.122	.993	.123	52°	.788	.616	1.280
8°	.139	.990	.141	53°	.799	.602	1.327
9°	.156	.988	.158	54°	.809	.588	1.376
10°	.174	.985	.176	55°	.819	.574	1.428
11°	.191	.982	.194	56°	.829	.559	1.483
12°	.208	.978	.213	57°	.839	.545	1.540
13°	.225	.974	.231	58°	.848	.530	1.600
14°	.242	.970	.249	59°	.857	.515	1.664
15°	.259	.966	.268	60°	.866	.500	1.732
16°	.276	.961	.287	61°	.875	.485	1.804
17°	.292	.956	.306	62°	.883	.470	1.881
18°	.309	.951	.325	63°	.891	.454	1.963
19°	.326	.946	.344	64°	.899	.438	2.050
20°	.342	.940	.364	65°	.906	.423	2.145
21°	.358	.934	.384	66°	.914	.407	2.246
22°	.375	.927	.404	67°	.921	.391	2.356
23°	.391	.921	.425	68°	.927	.375	2.475
24°	.407	.914	.445	69°	.934	.358	2.605
25°	.423	.906	.466	70°	.940	.342	2.747
26°	.438	.899	.488	71°	.946	.326	2.904
27°	.454	.891	.510	72°	.951	.309	3.078
28°	.470	.883	.532	73°	.956	.292	3.271
29°	.485	.875	.554	74°	.961	.276	3.487
30°	.500	.866	.577	75°	.966	.259	3.732
31°	.515	.857	.601	76°	.970	.242	4.011
32°	.530	.848	.625	77°	.974	.225	4.331
33°	.545	.839	.649	78°	.978	.208	4.705
34°	.559	.829	.675	79°	.982	.191	5.145
35°	.574	.819	.700	80°	.985	.174	5.671
36°	.588	.809	.727	81°	.988	.156	6.314
37°	.602	.799	.754	82°	.990	.139	7.115
38°	.616	.788	.781	83°	.993	.122	8.144
39°	.629	.777	.810	84°	.995	.105	9.514
40°	.643	.766	.839	85°	.996	.087	11.43
41°	.656	.755	.869	86°	.998	.070	14.30
42°	.669	.743	.900	87°	.999	.052	19.08
43°	.682	.731	.933	88°	.999	.035	28.64
44°	.695	.719	.966	89°	1.000	.018	57.29
45°	.707	.707	1.000	90°	1.000	.000	∞

Figure 2-25.—Trigonometric functions.

the value of each of the 10 subdivisions shown is 0.1. For any angle the point P has three coordinates: the x coordinate, the y coordinate, and the r coordinate (which always has a value of 1). The functions of any angle are, collectively, various ratios which prevail among these coordinates.

Three of these functions are called the sine, the cosine, and the tangent. The numerical values of these three functions for angles from 0° to 90° are shown in the table of trigometric functions in figure 2-25.

The ratio between y and r (that is, $\frac{y}{r}$) is called the sine of the angle. In figure 2-24 the y value of point P is 0.5; therefore the sine of 30° is $\frac{y}{r} = \frac{0.5}{1} = 0.5$. In the table in figure 2-25 you can

see that the value of the sine of 30° is 0.500. Graphically, the sine is indicated in figure 2-24 by line AP.

The ratio between x and r (that is, $\frac{x}{r}$) is called the cosine of the angle. In figure 2-24 the x value of point P is about 0.87; therefore the cosine of 30° is $\frac{x}{r} = \frac{0.87}{1} = 0.87$ In the table in figure 2-25 you can see that the cosine of 30° is 0.866. Graphically, the cosine is indicated in fiugre 2-24 by line OA.

The ratio between y and x (or $\frac{y}{x}$) is called the tangent of the angle. The tangent of 30°, then, is $\frac{y}{x} = \frac{0.500}{0.866} = 0.578$, which agrees with the value shown in the table in figure 2-25. The tangent is indicated graphically by the line CB, drawn tangent to the circle at C and intersecting the extended r at B. As you can see by the line projected from B to the ordinate, the y value of CB is, by scale, about 0.58.

The three functions illustrated in figure 2-24 are called the "direct" functions. For each direct function there is a corresponding "reciprocal" function--meaning, a function which results when you divide 1 by the direct function. You know that the reciprocal of any fraction is simply the fraction inverted. Therefore, for the direct function "sine", which is $\frac{y}{r}$, the reciprocal function (called the "cosecant") is $\frac{r}{y}$. For the direct function "cosine", which is $\frac{x}{r}$, the reciprocal function (called the "secant") is $\frac{r}{x}$. For the direct function "tangent", which is $\frac{y}{x}$, the reciprocal function (called the "cotangent") is $\frac{x}{y}$.

For a detailed discussion of trigonometry, refer to chapter 6 of Mathematics, Volume 2, NavPers 10071-A.

MECHANICS

Mechanics is the oldest and simplest branch of physics. It deals with the motion of bodies and the equilibrium of forces. Before studying this section of this chapter, you should study chapters 1 through 9 of Basic Machines, NavPers 10624-A. That text covers simple machines—the lever, block and tackle, wheel and axle, inclined plane and wedge, and the screw. The concepts of work, power, force, energy, and pressure are also covered.

Force is an action upon a body which tends to set it in motion or to change its state of motion. Where there is an equilibrium of forces, no change occurs, but each force must be balanced by one or more other forces acting in the opposite direction.

Work is done when a resistance is overcome by a force acting through a measurable distance. Therefore, in mechanics, work is a measurable quantity based on resistance (a measurable quantity), force (a measurable quantity), and distance (a measurable quantity). The measurement of quantities is basic to all physics.

Vectors

All quantities can be classified in one of two groups--scalar quantities or vector quantities. A scalar quantity can be specified by magnitude alone, for example, quantities of money, wheat, books, etc.

There are certain types of quantities which we must deal with in physics and mathematics which cannot be completely specified by magnitude alone, but which involve also the idea of direction. These quantities are called vector

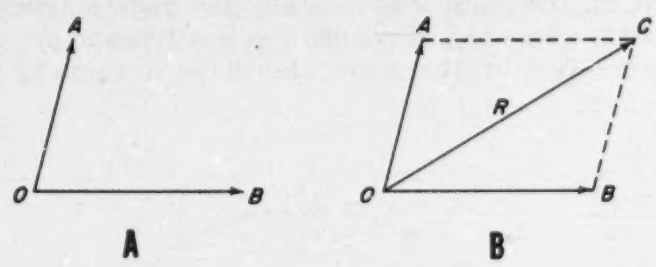

Figure 2-26.—Parallelogram of forces.

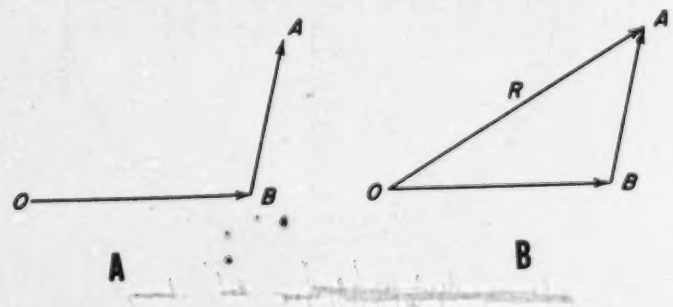

Figure 2-27.—Triangle of forces.

quantities. Examples are displacement, velocity, acceleration, and force. They can be represented and analyzed graphically by means of lines of appropriate length and direction, called vectors.

For example, a force can be represented by a straight line. One end of the line represents the point at which the force is applied. The direction of the line, indicated by the arrowhead, represents the direction in which the force is applied. The number of units in the length of the line represents the number of units of force.

Suppose that two forces are acting on a particle from different directions, and you wish to know the total effective force being exerted on the particle. This force which represents the total of two or more forces is called the resultant. You can find this resultant by drawing a diagram representing the two forces acting on the particle as shown in figure 2-26A. Then complete the diagram by drawing dotted lines parallel to the lines of the forces to form a parallelogram. The diagonal of this parallelogram is the resultant of the two forces, as shown in figure 2-26B. That is, force OA and force OB cause the same result on the particle as force OC.

In figure 2-26, the spatial relationship of the forces in relation to their point of application is maintained. The same resultant can be found by constructing a triangle, as shown in figure 2-27. You can start with either of the forces and add the second at its end, being careful to preserve the length and direction, as shown in figure 2-27A. Now, the third side of the triangle is the resultant. Notice, that it is the same length as the diagonal in figure 2-26.

This is the same as adding distances and directions. For example, if a man walks 3 miles east and then turns and walks 4 miles north, and you wish to find the distance in a straight line between the point where he started and the point that he finally reached, you can add the displacements by drawing a triangle as shown in figure 2-28. You can find the length of the third side by measuring it directly, or by mathematics if greater accuracy is desired.

Figure 2-28.—Adding directions of quantities.

In adding vectors graphically, the added quantities are placed tail to head. The sense of the resultant will be from the tail of the first vector toward the head of the last vector.

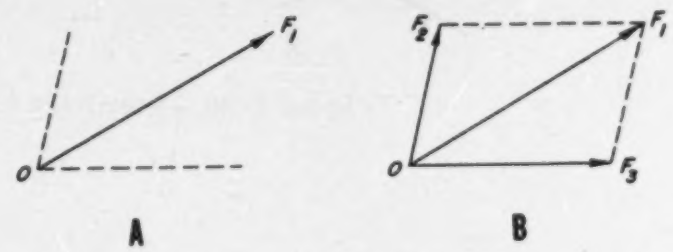

Figure 2-29.—Finding two components of a force.

Just as it is possible to find the resultant vector when the component vectors are known, it is likewise possible to break down a known resultant into any number of desired components. In figure 2-29A, the resultant and the lines of action of the two components are given. When the parallelogram is completed with lines parallel to the two forces, the component forces are defined, as shown in figure 2-29B.

In figure 2-30, the force of the wind against the sail of a sailboat, represented as the force vector R, has been resolved into components. For simplicity, the sail is considered to be flat in this illustration. In figure 2-30A, R has been resolved into components A and B. A, parallel with the sail, produces little effect, but B acts on the boat through the mast. However, to find the force effect of B on the movement of the boat through the water, it is resolved, in figure 2-33B, into the components C, parallel with the keel of the boat, and D. D produces very little motion because the boat is not built to move sideways in the water. The component C represents the force producing forward movement of the boat by a wind blowing in the direction of the force vector R.

Polygon of Forces

Up to this point, the effect of only two forces acting at a single point has been considered. Suppose that more than two forces are involved.

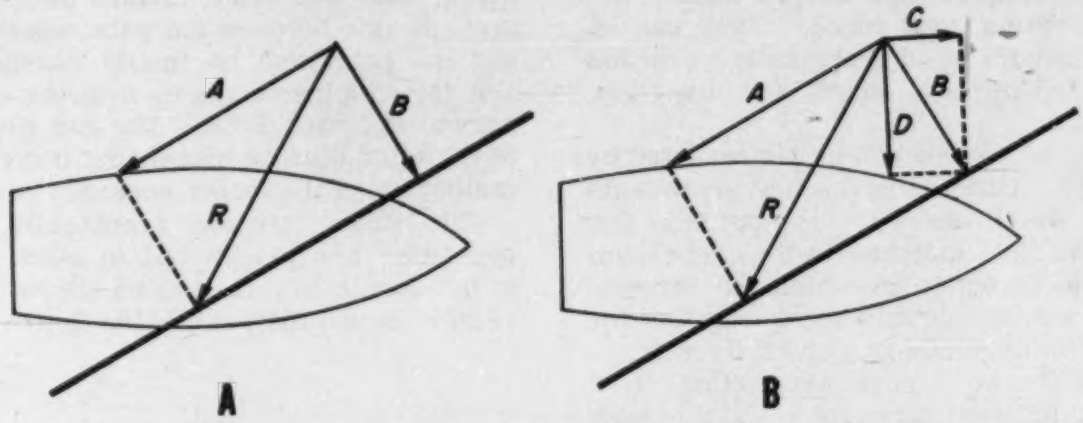

Figure 2-30.—Resolving a force vector into components.

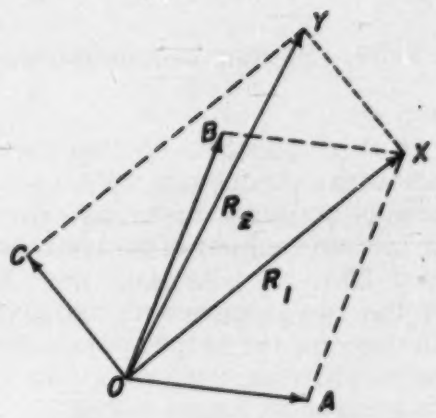

Figure 2-31.—Using the parallelogram construction to find the resultant of more than two forces.

The resultant of more than two forces can be found by finding first the resultant of two forces and then using it with another component force to find another resultant, etc. For example, in figure 2-31, forces OA and OB yield the resultant OX. Then a parallelogram is constructed using OX and force OC, which yields the resultant OY. Thus, OY is the resultant of OA, OB, and OC.

However, as the number of forces increases, this method becomes increasingly complex. In its place, a polygon of forces is used. For example, take the three forces shown in figure 2-32 and, placing them tail to head, construct an open polygon, as shown in figure 2-32B. The arrow which closes this polygon, as shown in figure 2-32C, is the resultant of the forces in its proper length and direction.

Note that the resultant in figure 2-32 has its arrow pointing in the direction around the poly-

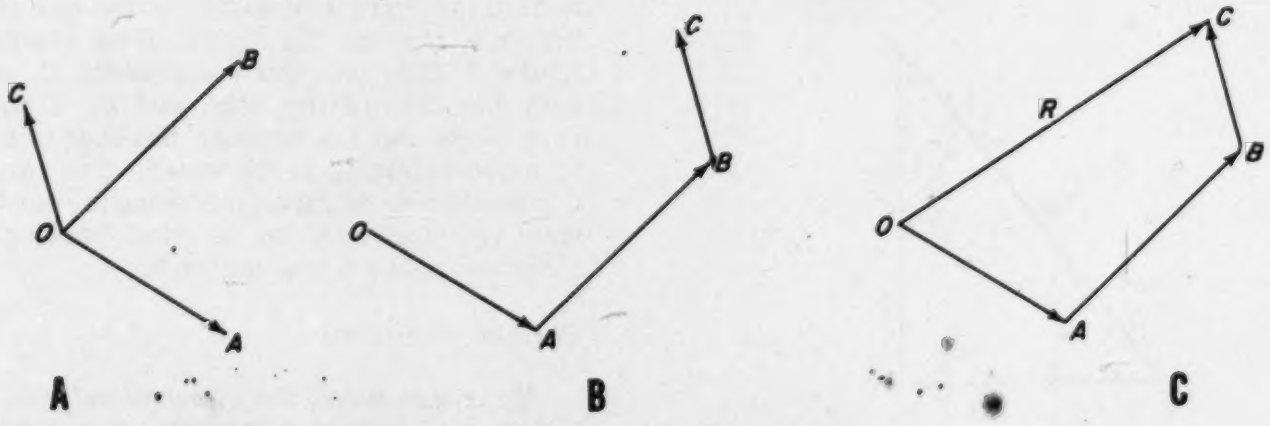

Figure 2-32.—Polygon of forces.

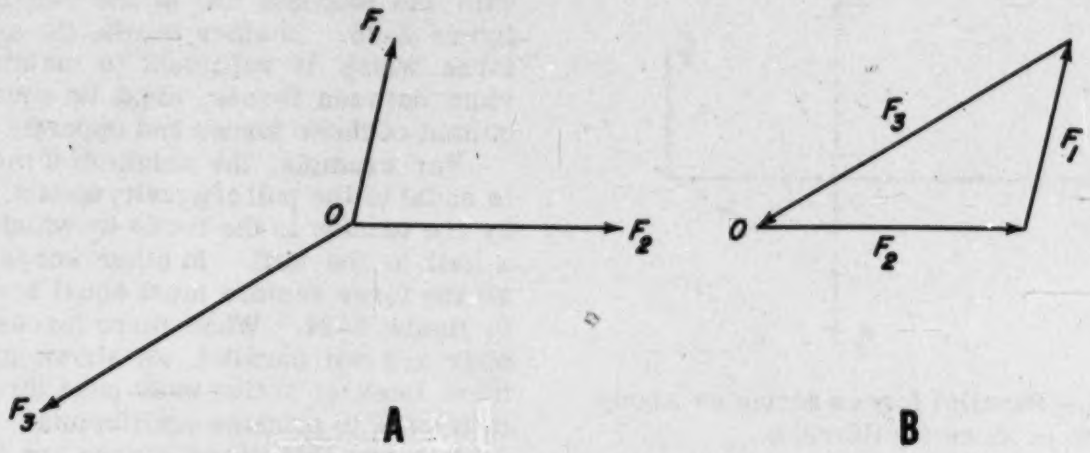

Figure 2-33.—Three forces in equilibrium.

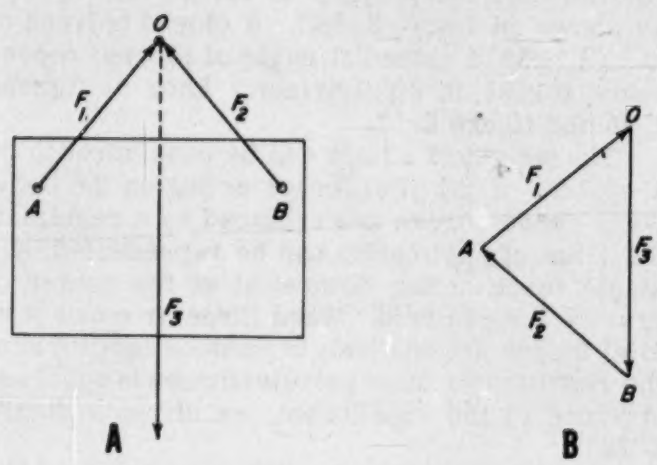

Figure 2-34.—Three nonparallel forces acting on a body to produce equilibrium.

gon opposed to that of the given forces. A force parallel and equal to this arrow acting at O represents the resultant in position, as well as in length and direction, as shown in figure 2-32C.

A problem in vectors can be solved graphically if it contains not more than two unknowns. These unknowns may be:

1. The magnitude and direction of one vector.
2. The magnitude of one vector and the direction of another.
3. The magnitude of two vectors.
4. The direction of two vectors.

Conditions of Equilibrium

Statics is that branch of mechanics which is the study of the equilibrium of forces. It is concerned with bodies at rest and the forces

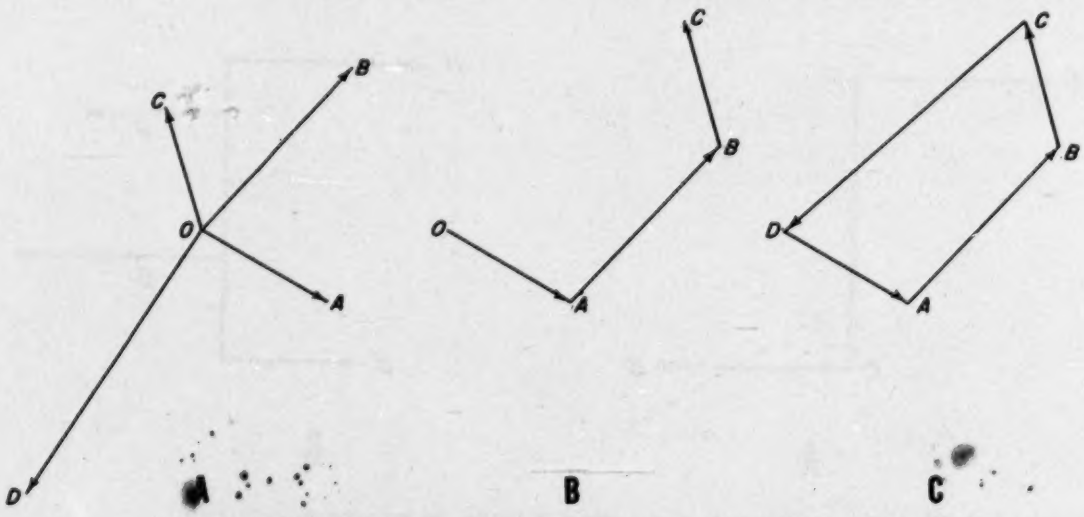

Figure 2-35.—Polygon of forces in equilibrium.

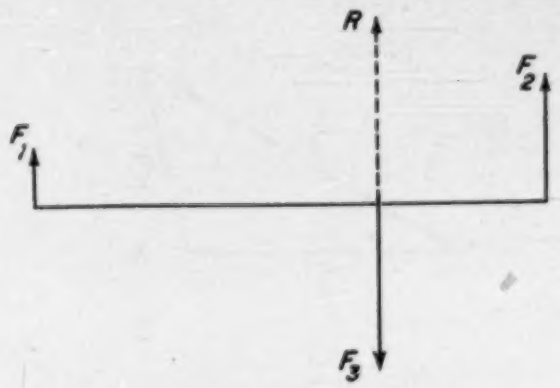

Figure 2-36.—Parallel forces acting on a body to produce equilibrium.

which keep them at rest. When an unbalanced force acts on a stationary object, the object will move, but that does not mean that there is no force involved when the body is stationary. Instead it means that the forces acting on the body are in balance. A picture hanging on the wall is stationary, but there are a number of forces acting upon it.

Suppose you are dealing with a structure in which the forces are in equilibrium. How would you represent these forces? Suppose that at one point on a stationary body three forces are applied as shown in figure 2-33A, and these forces are in equilibrium. That is, they cause no movement at the point of application of the forces.

You can solve this problem by drawing a triangle of forces, as shown in figure 2-33B. Since the forces are in equilibrium, force F_3 must be equal to forces F_1 and F_2, and the triangle must be a closed triangle. Now look at the side F_3 with side OA in figure 2-27 and with the diagonal OC of the parallelogram in figure 2-26. In other words, the equilibrant, a force which is sufficient to maintain equilibrium between forces, must be equal to the resultant of these forces and opposite in direction.

For example, the weight of a picture, which is equal to the pull of gravity upon it, is balanced by the tension in the cords by which it hangs on a nail in the wall. In other words, the sum of all the force vectors must equal zero, as shown in figure 2-34. When three forces acting on a body are not parallel, as shown in the figure, their lines of action must pass through a common point to produce equilibrium.

If more than three forces are involved, the force polygon may be used. If the forces act at O as shown in figure 2-35A, and they are in equilibrium, the polygon of forces will appear as shown in figure 2-35C. A closed polygon of forces, like a closed triangle of forces, represents forces in equilibrium. Look at figures 2-35 and figure 2-32.

The weight of a body can be considered to be a system of parallel forces acting on the body. When these forces are replaced by a resultant, the point of application can be represented by a single force acting downward at the center of gravity, or centroid. When three or more parallel forces act on a body to produce equilibrium, the resultant of these parallel forces is equal and opposite to the equilibrant, as shown in figure 2-36.

However, the forces acting on a body may be parallel, equal, and opposite, and still fail to produce equilibrium. In this case, the forces are acting at different points on the body. Such forces, producing a rotary motion, are called

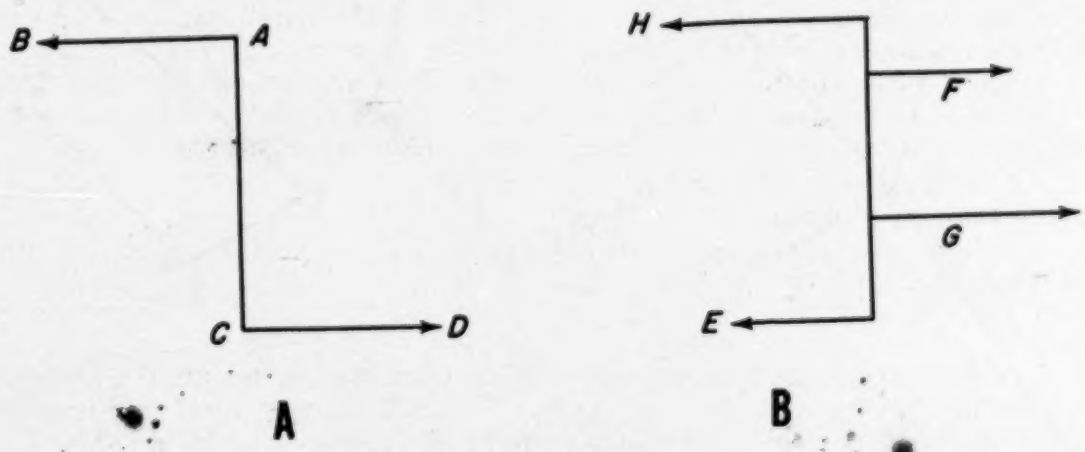

Figure 2-37.—A. A couple acts upon a body to produce rotation.
B. Two couples acting upon a body may produce equilibrium.

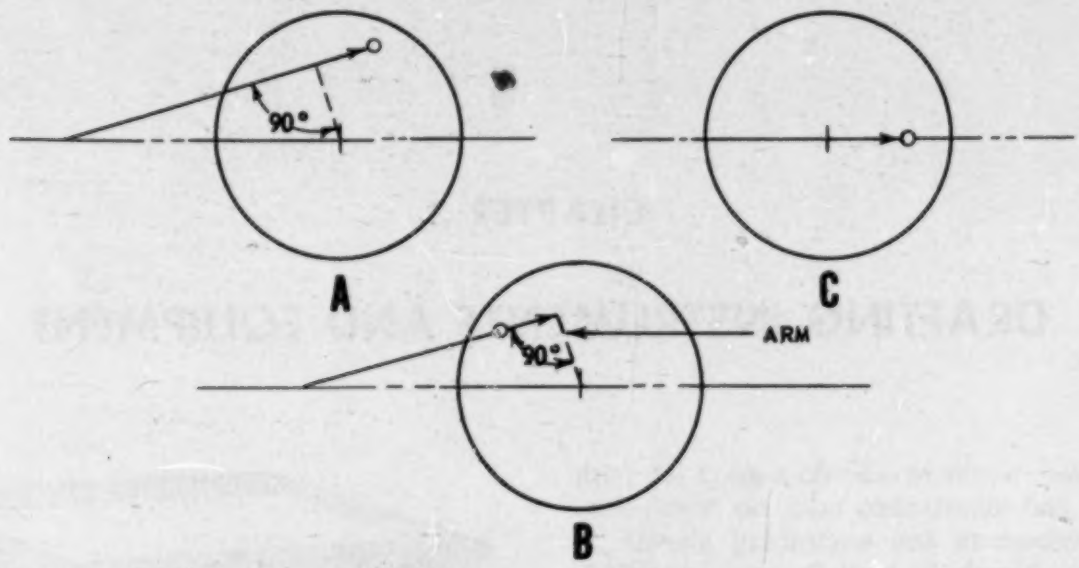

Figure 2-38.—A. The line of the moment, or torque, of a force is always perpendicular to the line of action of the force.
B. Maximum moment.
C. Minimum moment.

a couple. (See fig. 2-37A.) The tendency to produce rotation is called the moment of the couple, and it is measured by taking the product of one of the forces multiplied by the distance between the two, or the arm of the couple.

In order to maintain equilibrium when a couple is acting upon a body, a second couple, consisting of two other equal and opposite forces, is required. The moments of the two couples must be equal and they must tend to rotate the body in opposite directions. (See fig. 2-37B.)

Conditions for Stability

As has been stated, when forces act at different points on a body instead of at one point, they tend to cause rotation of the body. The tendency toward rotation caused by any force is equal to the force multiplied by its distance from the center of rotation. The center, or axis, of rotation may be a stationary fulcrum as in the case of a lever, prybar, or seasaw, or it may be the center of gravity of the object, as in the case of the roll and pitch of a ship or airplane.

This product of force times distance from the axis is called moment or torque. It must be remembered that the moment arm is not necessarily measured from the point of application of the force but is always measured perpendicularly to the line of action of the force. (See fig. 2-38.)

For a body to remain in a stable condition, the sum of all horizontal forces must equal zero, the sum of all vertical forces must equal zero, and the sum of all moments must equal zero. Thus,

$$\Sigma H = 0,$$
$$\Sigma V = 0,$$
$$\Sigma M = 0,$$

in which the Greek capital sigma (Σ) represents the term SUM OF, H represents the horizontal forces, V represents the vertical forces, and M represents the moments. These three formulas may also be written

$$\Sigma F_x = 0,$$
$$\Sigma F_y = 0,$$
$$\Sigma M_O = 0,$$

in which F_x represents the X forces and F_y the Y forces in a system of rectangular coordinates, and M_O represents the moments.

Radiation

Radiation, the other cause of power loss, is due to incomplete cancellation of electromagnetic fields in the region surrounding the circuit. When the frequency is low enough so that the spacing between two parallel conductors equals only a very small fraction of a half wavelength, there is almost complete cancellation of fields in all directions. At higher frequencies, however, the same spacing would represent a larger fraction of a half wavelength. This means less cancellation. In extreme cases (for example, where the spacing is a half wavelength) the fields add in the direction of the plane containing the two conductors. This causes the tuned circuit to radiate energy like an antenna. Therefore, as the frequency increases, it is necessary to reduce the spacing between the parallel elements. However, there is a limit; too close spacing will result in arcing of the tank circuit. Another means of eliminating radiation is the use of concentric lines instead of open wire line. This eliminates radiation entirely, since the outer conductor acts as a shield which prevents the electromagnetic field from expanding into space.

Limits of Inductance and Capacitance

At UHF frequencies and above, it is necessary that the inductances and capacitances in the oscillatory circuit be very small. The lower limit of capacitance is the sum of the interelectrode capacitances and the distributed capacitance of the leads. The lower limit of inductance is the lead inductance plus the inductance necessary to connect the tube electrodes externally. UHF oscillators approach both these limits; the only capacitance in the tank circuit often is a small trimmer capacitor for fine tuning adjustments, and the inductance often is the shortcircuited transmission line less than one-quarter wavelength long. (See fig. 12-9.)

To obtain smaller values of inductance, the length of the line is decreased. Frequently the tank circuit is located near a flat surface and parallel to it. The flat surface acts as a shield and, while it does not affect the electrical length of the line, it does lower the characteristic resistance of the line.

At microwave frequencies, even the small amounts of inductance and capacitance mentioned above prove to be excessive, so that at microwave frequencies the resonant cavity is almost exclusively used as the oscillatory circuit.

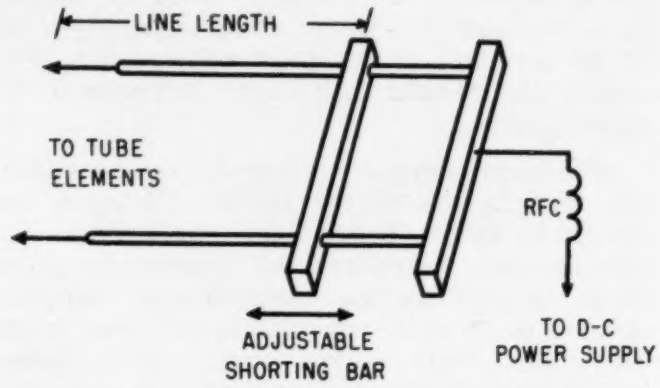

Figure 12-9. —Parallel wire resonant circuit.

LIGHTHOUSE TUBE OSCILLATOR

The lighthouse tube oscillator is a single tube oscillator used in test equipment and low power transmitters. The lighthouse tube, which gets its name from its peculiar construction, will operate at frequencies as high as 4,000 mc. Its plate, grid, and cathode connections are arranged so that it may be mounted directly in the tuning assembly. (See fig. 12-10.) The component called the tuner consists of three coaxial cylindrical conductors, of which the inner cylinder makes contact with the plate, the next with the grid, and the outer conductor with the shell of the tube.

The outer conductor provides an RF connection to the cathode through capacitance. The space between the cathode and grid conductors forms a coaxial cathode line which in turn is shorted by means of a plunger. The insulation at the tube base between the cathode and the cathode shell (or external connection) is the dielectric between the rings which form the cathode capacitive coupling. If this capacitive coupling were not used, the grid would have a d-c path from its cylinder through the plunger and the cathode cylinder to the cathode. This capacitance in the tube base is great enough to form a virtual short circuit for RF. The d-c grid to cathode path consisting of R_g and C_g forms the grid leak bias circuit.

In the plate circuit, the plate line consists of the grid and plate conductors. It is open circuited at the end away from the tube. The plate voltage is applied to the plate lead through the plate tuning rod at the point where the plate line is shorted. This point is one-quarter

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CHAPTER 3

DRAFTING INSTRUMENTS AND EQUIPMENT

Few skilled workers can do a good job with poor tools, and draftsmen are no exception. Drafting instruments and equipment should be well made and should be kept in good condition. If a man is a poor draftsman, the best instruments in the world will not make him a good draftsman. On the other hand, a good competent man will do better work if he is furnished good instruments and materials, and since he knows the importance of good equipment, such a competent man will make every effort to keep it in good condition. Each instrument and piece of equipment was designed to do a certain job. Learn what that job is, and use your tools to do the job for which they were designed. A good set of drafting instruments will last a lifetime if given proper care.

Observe these rules:

1. Have a place for each piece of equipment and keep it there when you are not using it.

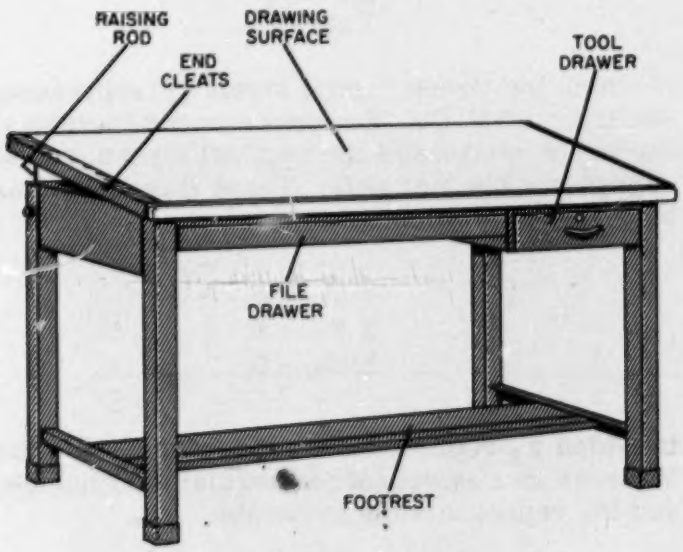

Figure 3-1.—Drafting table.

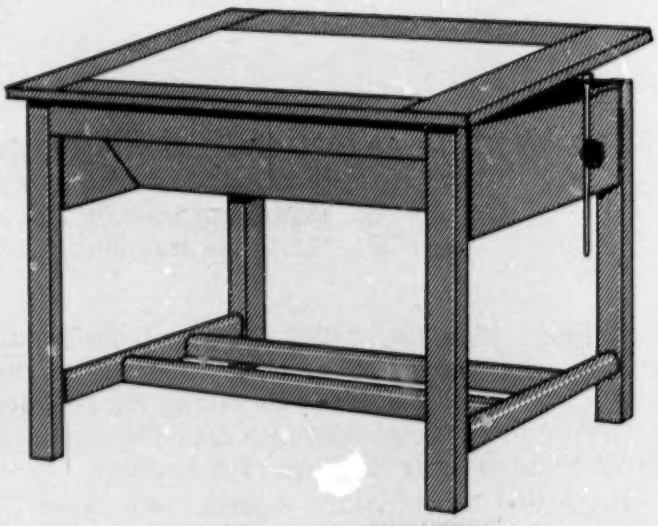

Figure 3-2.—Light table.

2. Keep your instruments in their case when they are not in use.
3. Keep your pens clean.

The basic equipment for a simple drafting assignment consists of a drawing board with a straight working edge on at least one side, a T-square, a set of triangles, scales, pencils, ink, a protractor, an eraser, curves for drawing irregular curved lines, and a set of drafting instruments. Your instrument set should include ruling pens, compasses, and dividers. Special instruments will be required for more complicated drawings.

This chapter covers the nomenclature, use, care, and maintenance of the basic equipment, the basic instruments, and some of the special instruments. This chapter does not include coverage of lettering pens and pen points, lettering guides, or mechanical lettering devices. These items are covered in chapter 9, an entire chapter devoted to lettering.

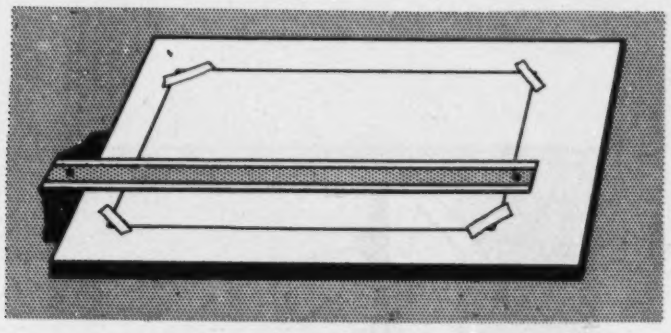

Figure 3-3.—Drawing board with T-square and drawing paper in place.

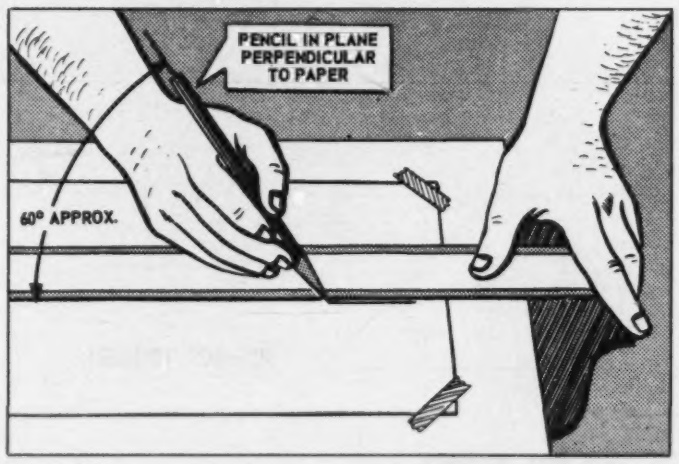

Figure 3-4.—Drawing horizontal lines with a T-square.

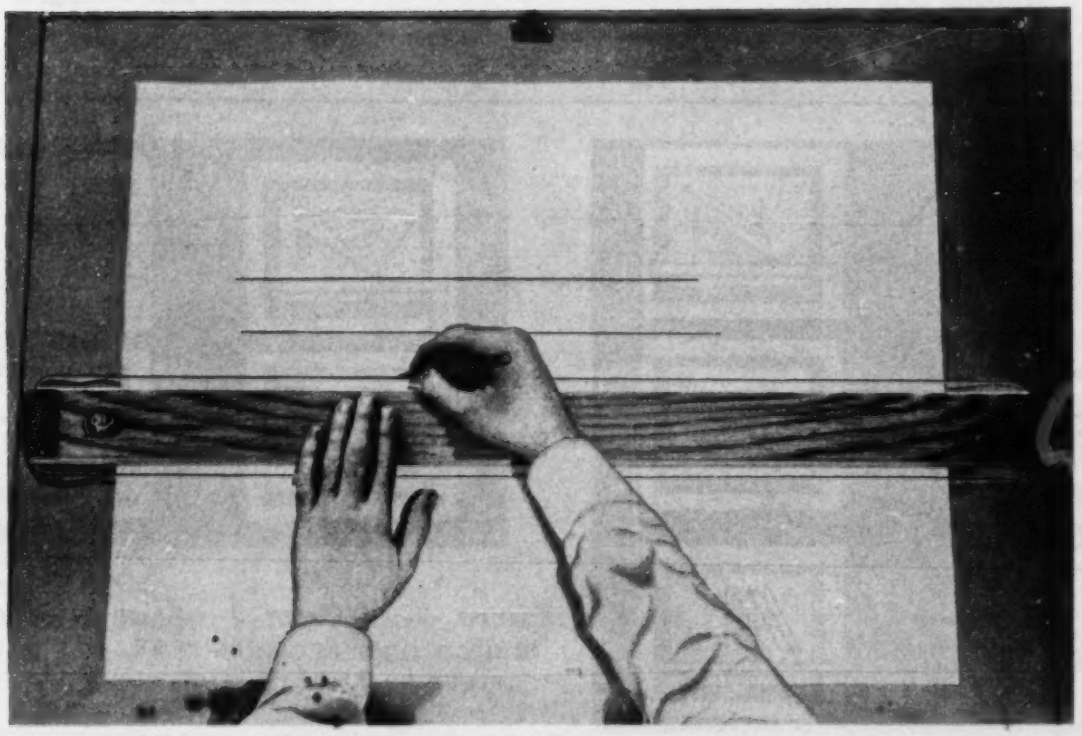

Figure 3-5.—Parallel straightedge.

Figure 3-6.—Steel straightedge.

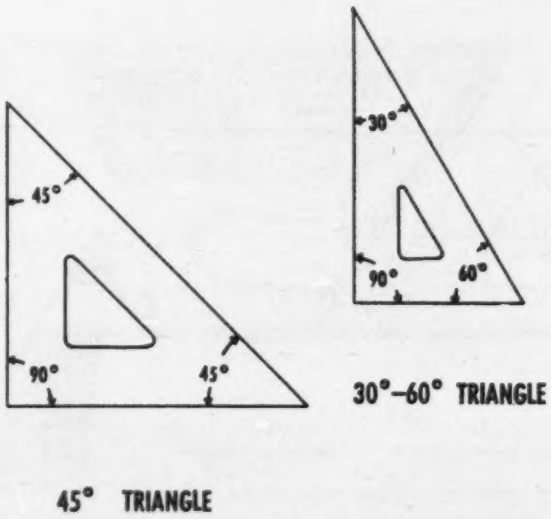

Figure 3-7.—45-degree and 30-60 degree drafting triangles.

Figure 3-8.—Drawing a vertical line with T-square and triangle.

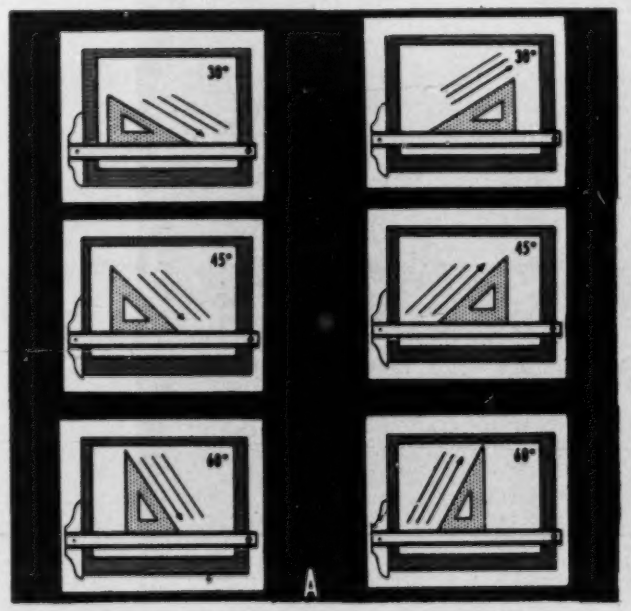

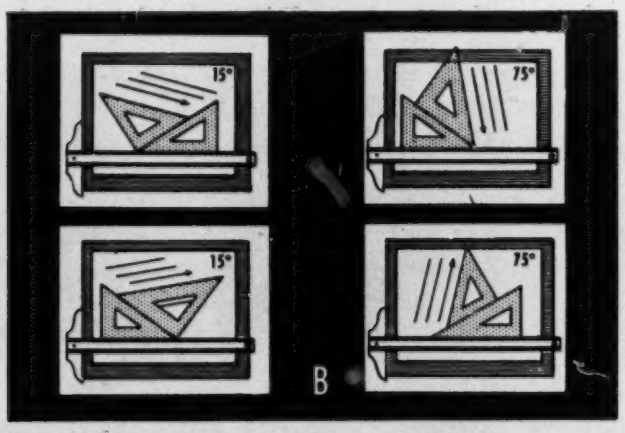

Figure 3-9.—Using T-square and triangle(s) to draw lines at angles of 15, 30, 45, 60 and 75 degrees to the horizontal.

DRAWING TABLES AND BOARDS

Navy drafting rooms are generally equipped with drafting tables such as the one shown in figure 3-1. The top of the table is, in effect, a drawing board. The board can be adjusted to various angles to suit the man using the table. Various other features are pointed out in figure 3-1 by the manufacturer of this particular table.

Drafting tables are available in various sizes and styles and with various arrangements of drawers. One type of drafting table which is of great convenience in the drafting room is the light table or tracing table such as the one shown in figure 3-2. A light table has a glass working surface with fluorescent lights underneath. This arrangement greatly facilitates the tracing of prints, soiled tracings, or other relatively opaque drawings.

When a drafting table is not available, draftsmen use a drawing board which is generally made of white pine, basswood, or of some other soft wood. It should have a smooth top surface and a straight working edge at the side. A typical drawing board is shown in figure 3-3.

Sometimes a drawing board is raised on wedges placed under the board so that, when the board rests on a table, the drawing surface slopes toward the draftsman. A recommended maximum slope is 1 vertical to 8 horizontal.

It is common practice to cover drawing boards, especially the larger and more expensive ones, to ensure cleanliness, to protect them against nicks and scars, and to provide a resilient surface for pencil drawings. A desirable drawing board cover is made of some material that will lie flat with a minimum of puckers. It should have enough body to provide protection; it should not be too hard or too soft; and it should be strong enough to withstand considerable use before being renewed. If it is too hard, the compass needle point will not penetrate it, and the compass will not hold its position. If it is too soft, it will become grooved and scarred quickly. Manila paper is commonly used to cover drawing boards. There are, however, papers on the market with a high gloss waterproof finish on one side which will withstand many cleanings. Also, some grades of linoleum have been found satisfactory; the sheet of linoleum may be applied to the board with linoleum paste.

More light is required for drafting than for normal administrative office work. If overhead lighting is insufficient, lamps should be obtained. The most popular drafting lamp is the floating-arm type of fluorescent fixture which clamps onto the desk or drafting table.

T-SQUARES AND STRAIGHTEDGES

The T-square gets its name from its shape. It consists of a long, straight strip, called the blade, which is mounted at right angles on a short strip, called the head. The head is mounted under the blade so that it will fit against the edge of the drawing board while the blade rests on the surface as shown in figure 3-3. T-squares vary from 15 inches to 72 inches in length, with the 36-inch length the most common.

The T-square is used for drawing horizontal lines (see fig.3-4), and it serves as a base for the triangle when vertical and inclined lines are drawn. Always draw lines along the upper edge of the blade. Move the T-Square up or down to position by sliding the head along the edge of the drawing board with your left hand.

Handle your T-square carefully. If dropped, it may be knocked out of true and become useless. The T-square blade should not be used as a guide for the knife in cutting paper.

Before beginning a new job, you should test the top edge of your T-square for warp or nicks. Draw a sharp line along the top of the blade. Turn the T-square over and redraw the line with the same edge. If the blade is warped, the lines will not coincide.

If the blade swings when the head is held firmly against the edge of the drawing board, the blade may be loose where it is joined to the head, or the edge of the T-square head or of the drawing board may be warped. You can usually tighten a loose blade by adjusting the screws which connect it to the head, but if it is out of square or in bad condition you should select a new T-square.

To keep a good T-square true, hang it up or lay it on a flat surface when you are not using it. Hang the T-square up by the hole in the end of the blade, and not by the head.

For large drawings, many draftsmen prefer a parallel straightedge to a T-square. As shown in figure 3-5, the parallel straightedge is permanently attached to the drawing board by a system of cords and pulleys so arranged as to give exact parallel motion to the straightedge as it is moved over the board.

The parallel straightedge has two fundamental advantages over the T-square: supported at both ends, it maintains parallel motion automatically; it may be moved up or down the board with pressure at any point along its length. These advantages become particularly significant when you are working on large drawings, because a T-square tends to become unwieldy and inaccurate when you work near the blade end of a long T-square.

Steel straightedges (fig. 3-6) are used for drawing long straight lines. Sometimes a long T-square blade is used as a straightedge, but the steel straightedge is superior because its heavier weight helps you keep the straightedge exactly in position. Putting tape at both ends of the straightedge greatly reduces unwanted movement. Using the beveled edge for inking reduces the chance of ink running under the straightedge.

TRIANGLES

Right-angle triangles are used in combination with the T-square or straightedge to draw vertical and inclined lines. Plastic triangles are preferable to wooden ones because they are transparent and you can see the work underneath. The most common triangles are the 45° and the 30°-60°, shown in figure 3-7. You will note that both have one 90° angle, or right angle, and that one has two 45° angles while the other has one 60° and one 30° angle. Another triangle sometimes used is the 22 1/2°-67 1/2° triangle.

Vertical lines are drawn by using the T-square as a base for one of the triangles. With the T-square in position, place one edge of the triangle against the blade and draw the vertical line along the vertical edge, as shown in figure 3-8. (Left-handed draftsmen reverse the triangle.)

You can use the same method to draw lines at an angle of 30, 45, and 60° to the horizontal T-square. When you reverse the triangle, you can draw the same angle in the opposite direction. (See fig. 3-9A.)

These angles may be referred to the vertical as well as to the horizontal, because the difference between the horizontal and vertical is 90°. You merely subtract the degrees of a horizontal angle from 90° to find the degree of the vertical angle corresponding to it. For example, an angle 30° from the horizontal will automatically be 60° from the vertical.

Now suppose you want to draw a line that forms an angle of 75° with the horizontal or 15° with the vertical. You can do this by using both the 45° triangle and the 30-60° triangle with the T-square. Rest the side of the 30-60° triangle against the T-square and set the 45° triangle above it, as shown in figure 3-9B. The 30° angle and the 45° angle add up to 75°. You can get the opposite result, or 15° to the horizontal, by readjusting the triangles.

Parallel vertical or inclined lines are drawn by sliding the triangle along the blade of the T-square. (See fig. 3-10.) You can draw a line parallel to any given line by placing the side of the triangle flush with the line, and fitting the T-square or straightedge along the base. Then slide the triangle to any desired point and draw a line.

A line perpendicular to another line can be drawn by using the adjacent sides of the 90° angle. If one side is parallel with a line, the adjacent side will be perpendicular to it. Place the long side of the triangle against the straightedge. Draw a line along one side. Then slide the triangle along the straightedge until the adjacent side is perpendicular to the drawn line. (See fig. 3-10.)

The techniques in the preceding paragraphs are the same if a straightedge other than a T-square is used. Other straightedges could include a parallel straightedge, a steel straightedge, or the side of a large triangle.

Like other drafting equipment, triangles must be kept in good condition. To prevent warping, you should always lay them flat or hang them up

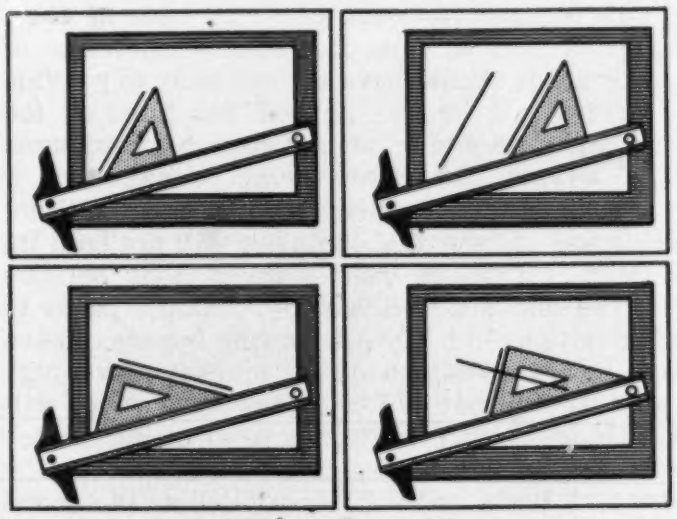

Figure 3-10.—Drawing parallel perpendicular lines.

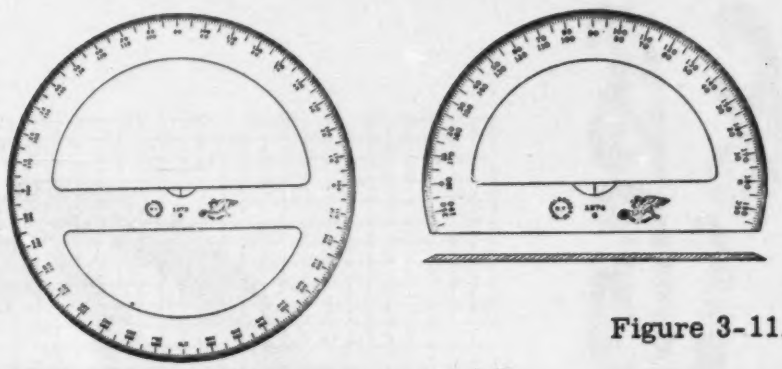

Figure 3-11.—Types of protractors.

when they are not in use. Since there is seldom enough drawer space available to permit laying triangles flat without their being thrown around with drawings and other triangles, it is best to develop the habit of hanging triangles up.

If plastic triangles are dropped, their tips may be damaged. Also, triangles may warp so that they do not lie flat on the drawing surface, or the edge may deviate from true straightness. If the tips are bent, use a sharp knife to cut off the damaged part. If the triangle warps out of flat, you may be able to bend it back by hand. If this does not straighten it, leave the triangle lying on a flat surface with weights on it, or hold the triangle to the opposite curvature with weights. If the triangle warps so that the drawing edges are curved or the angles are no longer true, throw it away and get another.

PROTRACTORS

Protractors are used for measuring and laying off angles. They may be circular or semicircular as shown in figure 3-11. The protractors commonly used in drafting rooms are graduated in degrees and divided to 1/2°. With care, angles can be protracted to about 1/4°. The numbering arrangement varies. Semicircular protractors are generally labeled from 0 to 180° in both directions. Circular protractors may be labeled from 0 to 360° both clockwise and counterclockwise or they may be labeled from 0 to 90° in four quadrants.

To measure an existing angle, place the center mark of the protractor at the point of the angle, with the 0° line along one leg. Then note the degree mark which falls on the line of the other leg. To locate the second leg of an angle you are to draw, position the protractor in the same way and use a needle point or a sharp pencil to mark the desired angular value.

Using only the three points on the protractor as described above may result in considerable inaccuracy, particularly if the lines of an angle are to be extended for some distance beyond the protractor. A refinement of the procedure is indicated in figure 3-12. Suppose angle BOA is to be measured. Extend line AO on to C; extend line BO on to D. When you set the center of the protractor at O, make sure that both points c and a are on line AC. Take your reading at point d as well as at point b when you measure the angle. If you are laying off the angle BOA, protract and mark point d as well as point b; this gives you three points (d,0, and b) for establishing line DB. If you are using a semicircular protractor you can't, of course, locate point d; but your accuracy will be improved by lining up c, 0, and a before you measure or lay off the single angle BOA.

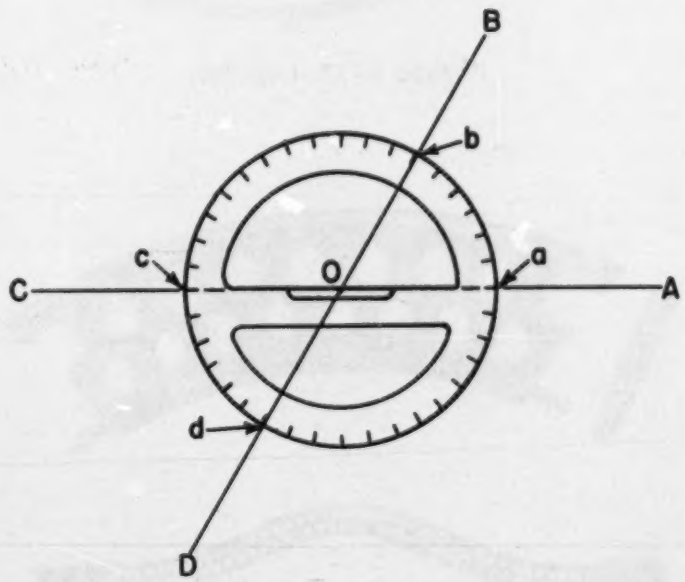

Figure 3-12.—Protracting an angle.

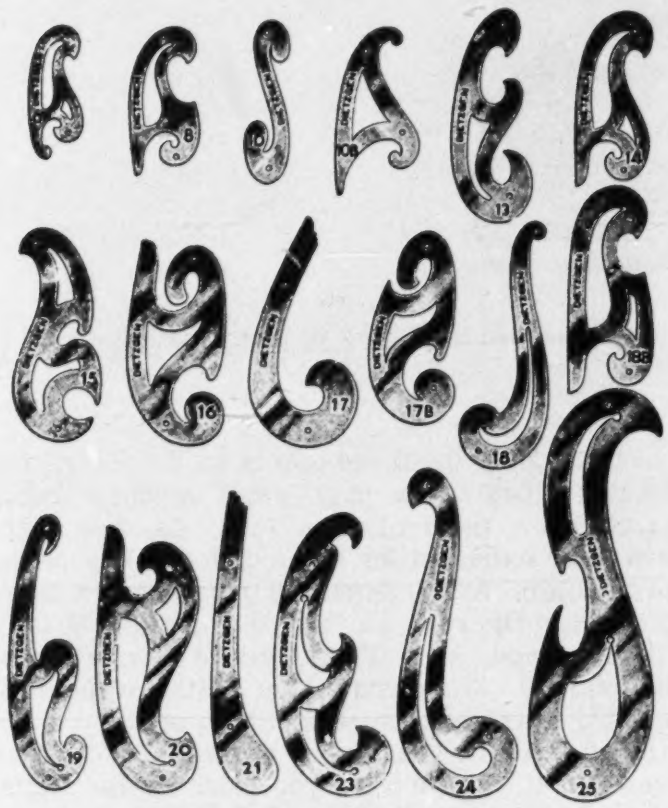

Figure 3-13.—French curves.

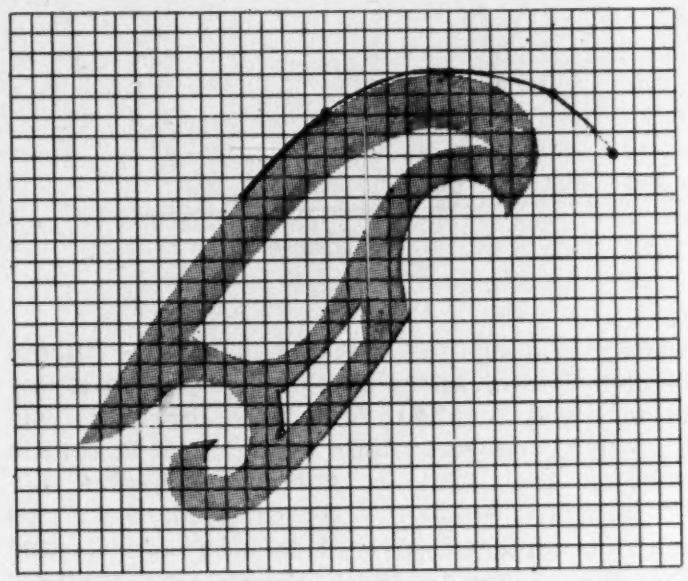

Figure 3-14.—Using a french curve to draw a curved line through plotted points.

Figure 3-15.—Spline.

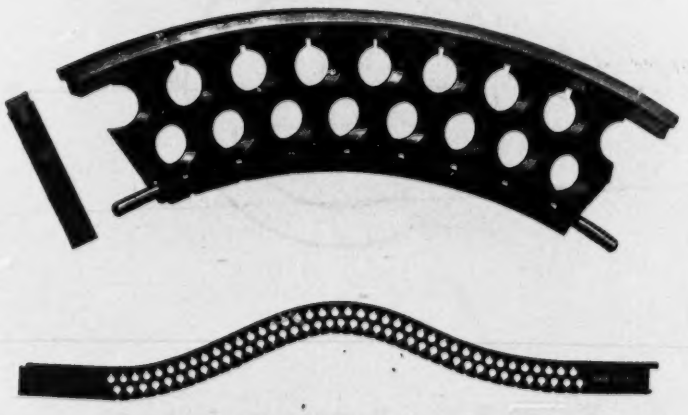

Figure 3-16.—Flexible curve rule.

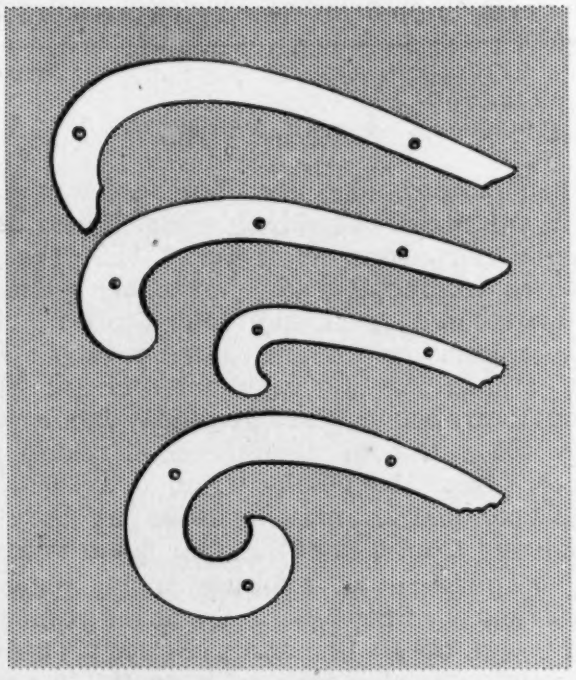

Figure 3-17.—Ship curves.

CURVES

When you must draw smooth curved lines which are not arcs of circles, you cannot use a compass. For drawing these lines special guides—French curves, splines, and ship curves—are available. Other guides, such as radius curves, may be used instead of a compass when drawing arcs of circles.

French curves come in a variety of shapes and sizes and are made of transparent plastic. (See fig. 3-13.) They are used to draw non-circular curves, such as ellipses, spirals, and parabolas. These curves are usually plotted carefully on a drawing and then the lines are drawn through the plotted points.

When drawing a curve through plotted points:

1. Sketch a light freehand line smoothly through the points.
2. Select a section of a French curve that matches at least three points. Always make sure that the curvature indicated by the plotted points and the curvature of the French curve increase in the same direction. (See fig. 3-14.)
3. Draw the curve between the first points but not to the last point. If you stop short of the last point that matches the French curve, your lines will blend smoothly.
4. Move the French curve to the next position and extend the drawing of the curve, again stopping short of the last point.
5. Continue using this method until you have completed the line.

Splines (fig. 3-15) are used to make long, smooth, irregular curves. They are made of flexible strips of wood, plastic, or metal that can be bent to fit almost any long curve or bend. Metal weights, called ducks are used to hold this spline in place while the line is being drawn.

Flexible curve rules (fig. 3-16) are made of rubber and metal and have a clear plastic ruling edge. They can be bent to a radius of 3 inches and may be adjusted to fit more than three plotted points of a curve.

Ship curves (fig. 3-17) are used primarily for drawing curves peculiar to ship construction. They are made of plastic or wood and come in sets. One curve is usually sufficient to draw the entire curved line, but sometimes several of them must be fitted together to complete the curve.

Another set of irregular curves is called mechanical engineers curves. These curves are similar to some of the French curves and some of the ship curves.

Radius curves may be used instead of compasses to draw arcs of circles. A radius curve is a flat, narrow sheet of plastic curved to conform to the arc of a specific circle. Stamped on each curve is the size of the radius of the circle to which its arc corresponds or some other method of indicating the degree of curvature. These curves are called railroad curves, highway curves, or simply radius curves, all depending on the intended use which is reflected in the method of identifying the curvature. These curves are available in dozens of sizes ranging from 1 1/2-inch radius to 1000-inch radius. Some radius curves are curved throughout as shown in figure 3-18; others have a length of tangent as shown in figure 3-19.

Arcs of long-radius circles may also be drawn with the aid of various adjustable-radius

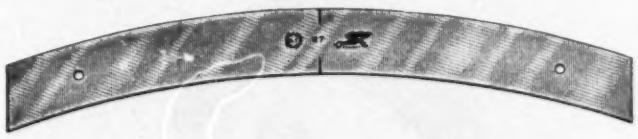

Figure 3-18.—Radius curve without tangent.

Figure 3-19.—Radius curve with tangent.

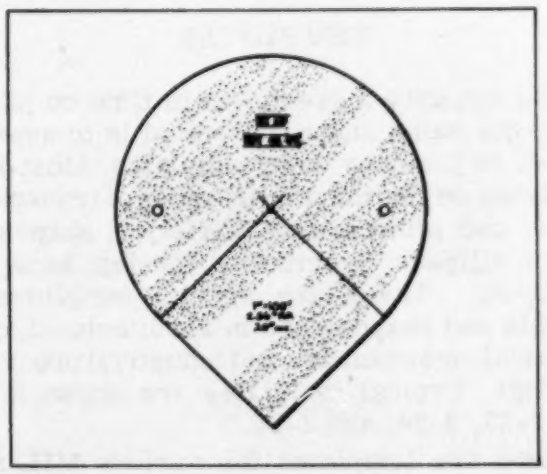

Figure 3-20.—Tear drop radius curve.

curve devices currently on the market. These instruments are made of metal and plastic and have clear plastic ruling edges. Some of these devices have coil springs to achieve the proper tension; others make use of the flexibility of

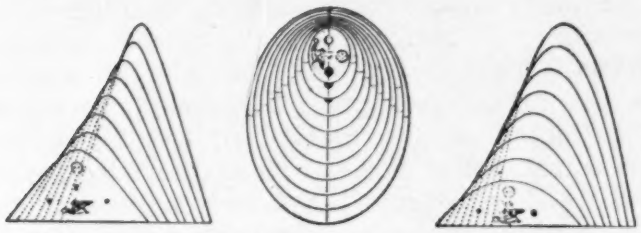

Figure 3-21.—Curves for ellipses, hyperbolas, and parabolas.

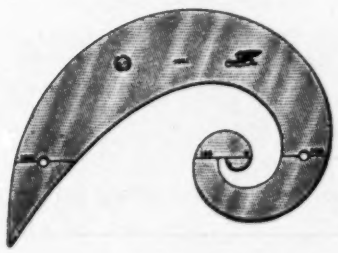

Figure 3-22.—Logarithmic spiral curve.

plastic to permit adjustment to the indicated radius.

Other types of regular curves include tear drop radius curves (fig. 3-20), conic section curves (fig. 3-21), and logarithmic spiral curves (fig. 3-22).

TEMPLATES

You can save a great deal of time on jobs on which the same shape or symbol is to appear a number of times by using templates. Most of the templates on the market are made of transparent plastic and offer a wide variety of shapes, including ellipses, hyperbolas, circles, hexagons, and arcs. There are special templates for symbols and shapes used in architectural, civil, electrical, mechanical, and industrial processes drawings. Typical templates are shown in figures 3-23, 3-24, and 3-25.

There are templates for various MIL-STD (military standard) symbols; for example: electrical and electronic symbols, dimensioning and tolerancing symbols, fluid connections symbols, and so on. If the shape you need is not available, it may be worth your while to take time to make your own template from cardboard, plastic, lead, or some other sheet metal.

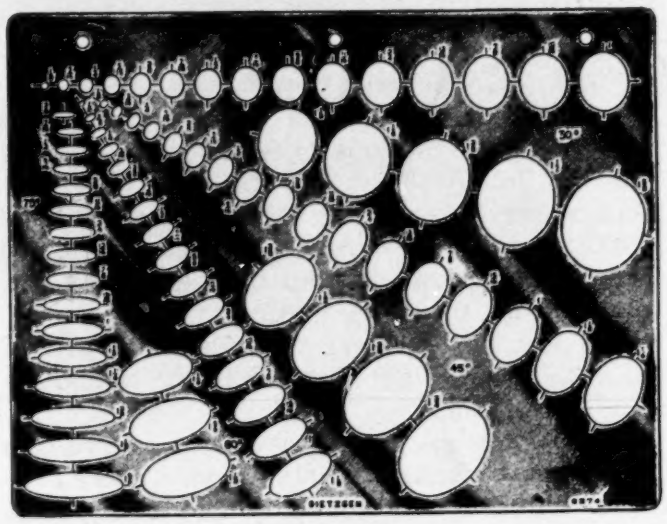

Figure 3-23.—Ellipse template.

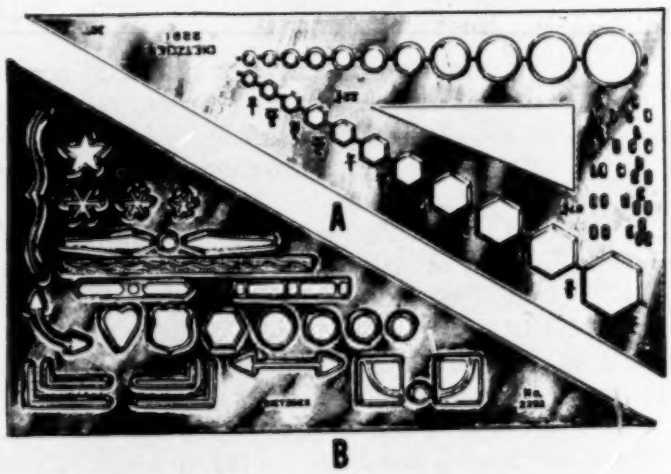

Figure 3-24.—A. Engineer's triangle.
B. Design triangle.

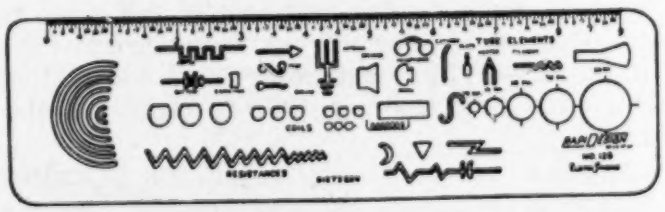

Figure 3-25.—Electrical symbol template.

SCALES

The importance of scales to the draftsman and the mathematical significance of scales were stressed in chapter 2. Once the ratio between the size of the object being drawn and the size of the object as depicted on the drawing has been determined, you will use drafting measuring scales to measure distances on the drawing. Since almost every line on the drawing must be of measured length, measuring scales are in constant use in the drafting room.

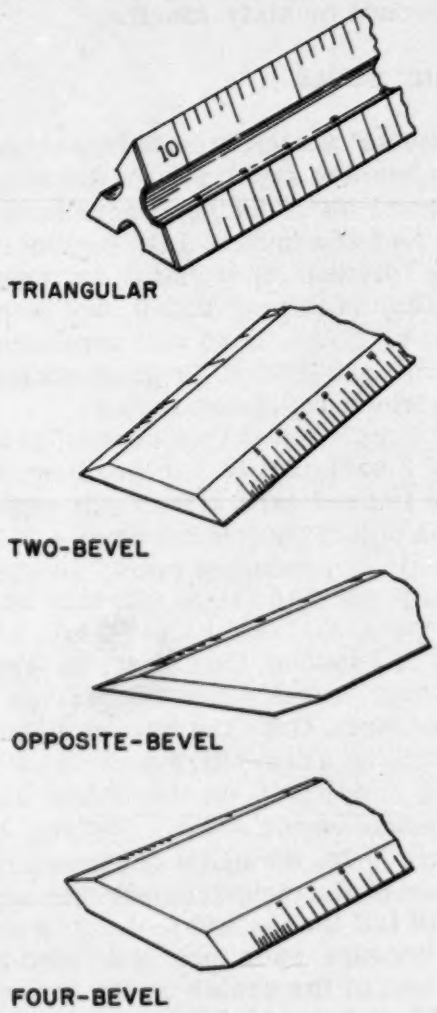

Figure 3-26.—Shapes of scales.

Scales vary in scale graduation, style of division, shape, and materials of construction. The most inexpensive scale is made of yellow hardwood—this type of scale is generally used by students in mechanical drawing classes. The scales usually used in drafting rooms are made of plastic or high grade boxwood. The plastic scales, while less expensive than boxwood scales, have clear, accurate graduations. The boxwood scales have white plastic scale faces which are permanently cemented to the boxwood. The boxwood scales are engine divided—that is, the graduation lines are cut by a highly accurate machine.

Various shapes of scales are shown in figure 3-26. The triangular scale provides six scale faces on one rule. The two-bevel scale provides a wide base; the scale faces are always visible. The opposite-bevel scale is easily lifted from the drawing board by tilting it. The four-bevel scale provides four scales on one small rule—this shape is usually used for pocket rules which are 6 inches long. The other shapes of scales are used for rules 12 inches long—the size generally used in drafting rooms.

As to style of division, scales may be open divided such as the 3/16 and 3/32 scales on the architects' scale in figure 3-29. Open divided means that only the main divisions are marked throughout the length of the rule; the extra unit on the end is fully subdivided. Scales may be fully divided such as the engineers' scale shown in figure 3-31. All of the units are fully subdivided throughout the length of the scale. Scales may be double numbered such as the mechanical engineers' scales shown in figure 3-28. This arrangement makes it convenient to measure from right to left as well as from left to right.

The types of scale graduations most often used in drafting rooms in the Navy are the architects' scale, the mechanical engineers' scale, and the civil engineers' scale. The mechanical engineers' scale is often called the mechanical draftsmen's scale to distinguish it from the civil engineers' scale which is fre-

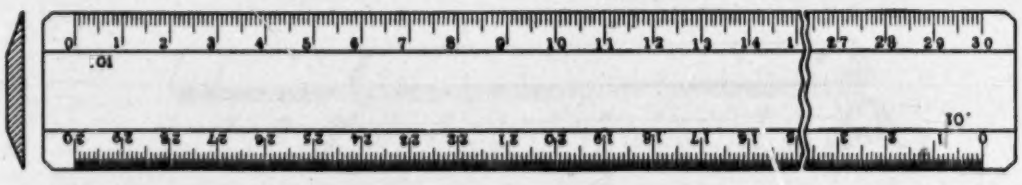

Figure 3-27.—Metric scale.

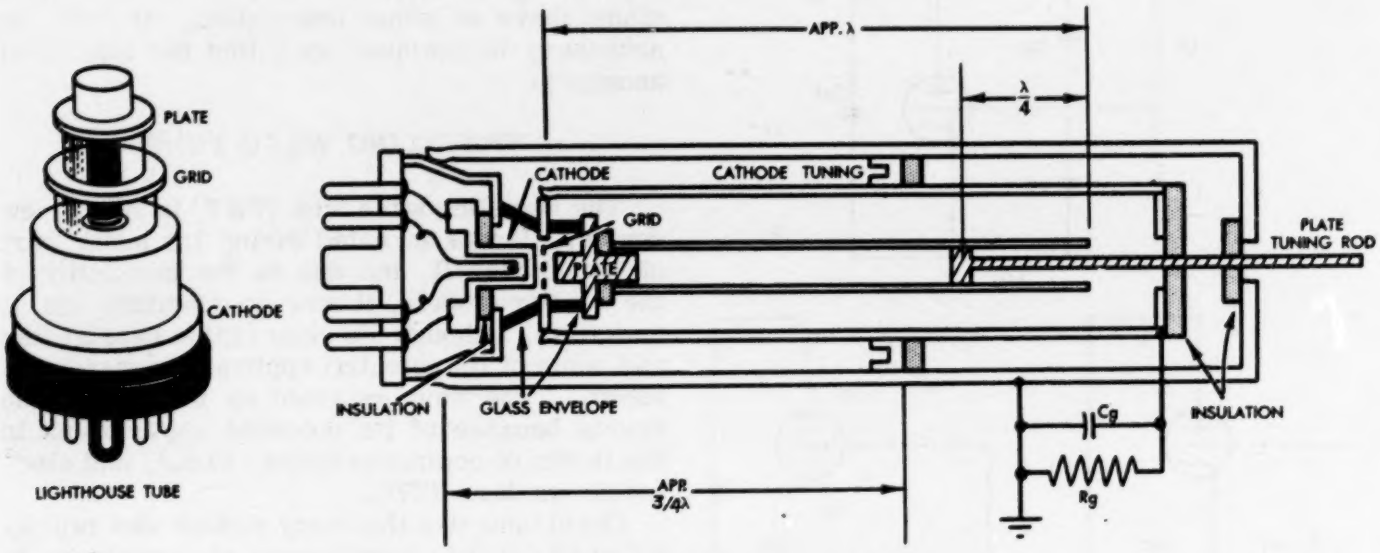

Figure 12-10.—Lighthouse tube oscillator.

wavelength from the end. This quarter-wave section (which is shorted at the point where B-plus is applied) presents a high impedance to RF from the open ended plate line, and therefore prevents RF from flowing into the power supply.

EQUIVALENT CIRCUITS

The equivalent circuits in figure 12-11 show the evolution of the lighthouse tube oscillator. In (A), the components L_k and L_p represent the inductances of the shorted cathode line and the open circuited plate line respectively. This is a true representation of the actual circuit provided that the cathode line is less than three-quarters of a wavelength long and provided that the plate line is less than a full wavelength long. (The three-quarter wavelength and full wavelength were chosen for this circuit rather than the one-quarter and one-half wavelength due to the fact that at the frequency of operation the latter fractions of a wavelength are inconveniently short.) However, keep in mind that if the cathode line is slightly less than one-quarter wavelength, it acts like an inductance; and if the plate line is slightly less than one-half wavelength, it acts like an inductance. There is no lead inductance shown in the circuit since the lines connect directly to the electrodes. The interelectrode capacitances complete the equivalent circuit.

In (B), the parallel combination of L_p and C_{gp} are represented by X2 and the parallel combination of L_k and C_{gk} by X1. Obviously the reactances X2 and X1 along with C_{pk}, which can be considered as unknown reactances, must form a resonant circuit. The reactance X1 forms a voltage divider circuit along with C_{pk}. Since the voltage across X1 is the voltage fed back to the grid, it must be 180° out of phase with the plate voltage (which can happen only if X1 is a capacitive reactance). This condition leads to the third equivalent circuit, (C), in which the reactance X1 is represented by a capacitor.

An oscillatory circuit requires at least one inductance; therefore X2 must be an inductive reactance. Hence, in (C), the reactance X2 is shown as the inductance L. This circuit is representative of the oscillator circuit only at the resonant frequency. On examining this circuit, notice that basically it is that of a Colpitts oscillator. If X1 is capacitive, C_{gk} must conduct more heavily that L_k; therefore the oscillator frequency must be above the resonant frequency of L_k and C_{gk}. Likewise, for X2 to be inductive the oscillator frequency must be below the resonant frequency of L_p and C_{gp}. Thus the oscillator frequency is between the resonant frequencies of the plate circuit and the cathode circuit.

FEEDBACK

In this oscillator, the amount of feedback depends upon the size of C (fig. 12-11(C)) in relation to C_{pk}. This is a function of the

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quently called simply the engineers' scale. The latter is also sometimes called the chain scale. But these three scales, while the most common, are by no means the only types of scale graduations available. There are scales graduated in terms of miles to the inch and rods to the inch. There are metric scales such as the one shown in figure 3-27. This rule is divided into centimeters (about 3/8 inch) reading to millimeters on one scale face and centimeters reading to half-millimeters on the other face.

Mechanical Engineers' Scales

Mechanical engineers' scales are used in drawing machine parts and other objects which do not need to be greatly reduced. On these scales, each unit, a fraction of an inch in length, represents a full inch on the object to be drawn. These units are numbered 1, 2, 3, 4, 5, etc., beginning with 0. (See fig. 3-28.)

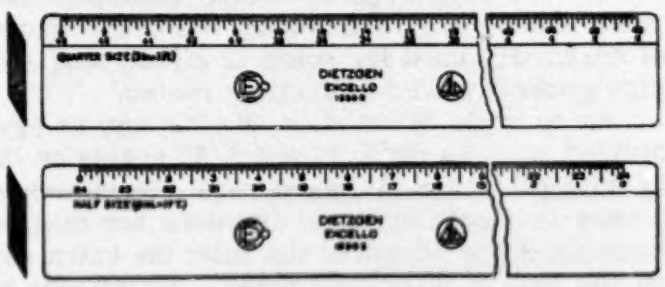

Figure 3-28.—Mechanical engineers' scales.

The different scales are labeled to indicate the ratio. Sometimes they are marked half size, quarter size, etc., and sometimes they are marked 6 inches = 1 foot, 3 inches = 1 foot, etc., which mean the same thing. On the half-size scale, 1/2 inch is the unit representing 1 inch; on the quarter scale, 1/4 inch is the unit representing 1 inch; on the eighth scale, 1/8 inch is the unit; on the sixteenth, 1/16 inch is the unit. When you have determined the proper reduction for a drawing, select the scale marked with that reduction and, from then on think in terms of big inches on the object and small inches on the drawing.

Usually, mechanical engineers' scales are full divided, with the subdivisions between units indicated by graduations on the entire length of the scale. The subdivisions represent the fractions of an inch as they appear on the regular full-sized scale of a ruler. In other words, the units are divided into halves, fourths, eighths, sixteenths, just as inches are divided on a ruler. Sometimes the subdivisions are carried to thirty-seconds or sixty-fourths.

Architects' Scales

Architects' scales are used for many types or drawings besides architectural drawings. They are designed as reducing scales for measurements in feet and inches. Like engineers' scales they are divided into units by graduations. These units, beginning with 0, are numbered 1, 2, 3, 4, 5, 6, 7, etc. Each unit represents a foot and may be subdivided by graduations into 12 divisions which represent inches.

For example, on the architects' scale which is labeled 3, each unit is 3 inches long, and when this scale is used each 3-inch unit represents 1 foot on the object you are drawing. A 3-inch unit on this scale is graduated into 12 divisions, each of which represents an inch. On other scales, the unit may be 3/32, 3/16, 1/8, 1/4, 3/8, 1/2, 3/4, 1 inch, or 1 1/2 inches. On any of the architects' scales, a unit on the scale represents 1 linear foot on the object. Once you have selected a scale to use in making a drawing, you can think in terms of full feet and inches on the object and small feet and inches on the scale. (See fig. 3-29.)

In figure 3-29, the scale on the upper edge is the common scale measurement that appears on rulers with full inches and feet. It is called the 16 scale because each inch is divided into sixteenths. One of the scales on the lower edge in figure 3-29 is labeled 3/16, which means that 3/16 of an inch on this scale represents 1 foot.

Figure 3-29.—Architects' scale.

Architects' scales are usually open divided. That is, the scale is divided into the units for a foot, and an extra unit preceding the 0 on the scale is subdivided for use in drawing inches to that scale

Figure 3-30 shows the first few units of the 3/4 architects' scale. Let's see how it is used. Remember, on this scale, a unit of 3/4 inch represents 1 foot. Suppose you wanted to measure a distance of 3 feet 10 1/2 inches on this scale. You would first count off the 3 feet on the major graduations. Next count off the 10 1/2 inches on the small graduations which represent inches and fractions of inches and precede the 0 on the scale. This illustrates how all open divided scales are used.

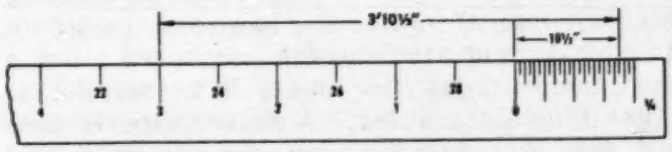

Figure 3-30.—Measuring distance with the architects' scale.

Look again at figure 3-30. You will notice other numbered graduations between the graduations of the 3/4 scale. This is a reverse scale. Since each of these numbers represents two units, this second scale with units half as large as those on the 3/4 scale is a 3/8 architects' scale with 3/8 of an inch representing 1 foot.

When you are drawing an object and are asked to use full scale, half scale, quarter scale, or eighth scale, you will have to think twice before selecting one of the architects' scales. Suppose you want to make a half-scale drawing using the architects' scale. You will have to use the full-size or 16 scale and divide each measurement by 2. Don't use the 1/2 scale, which is intended for drawing each foot on the object as 1/2 inch. To make a quarter-scale drawing with an architects' scale, use the 3 scale, since 3 inches is 1/4 of 1 foot.

Civil Engineers' or Chain Scales

Civil engineers' or chain scales are used in making survey maps and charts and in making machine drawings when the dimensions are given in decimal fractions of inches or feet, rather than in common fractions. The chain scale takes its name from the steel tape which a civil engineer uses. In the past, civil engineers used a real chain, instead of the steel tape they now use, and the name was carried over

An inch on the chain scale is divided by 10, 20, 30, 40, 50, or 60 graduations. The scale is labeled with a large number which indicates the graduations to the inch. Look at the lower scale shown on the instrument in figure 3-31. The large 50 at the end indicates that there are 50 graduations to the inch on that scale. But the graduations themselves are grouped in tens.

The loop attached to the top of the scale in figure 3-31 is made of metal and is called a triangular scale clip. This clip covers the scale faces which are not in use so that your attention is quickly drawn to the scale face in use when the scale is on the drawing board.

Since the civil engineers' scale is decimally divided, it is a very convenient scale to use when plotting charts or graphs. You can select a scale of convenient ratio to fit your paper and let 10 on the scale face be 1 or 10 or 1000 or a billion or whatever tens group you need for the graph.

When you use the chain scale in drawing a map, an inch on the scale represents a specific number of feet on the map. For example, the chain scale labeled 20 has 20 graduations to an inch. When you use this scale, an inch on your

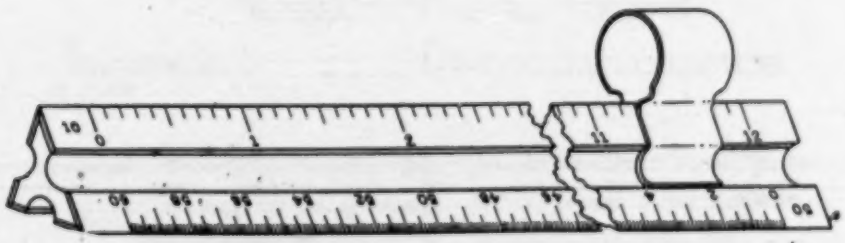

Figure 3-31.—Engineers' scale.

drawing may represent 20 feet. Then one graduation will represent 1 foot. But, an inch on your drawing may also represent 200 feet on this scale, and one graduation will then represent 10 feet. Similarly an inch on the 20 scale may represent 2,000 feet or 20,000 feet or even 200,000 feet.

Taking Measurements From the Scales

To measure accurately with a triangular scale, lay it on your drawing parallel to the line on which the measurement is to be made. The farther edge of the scale should be on the line. Now look down over the scale at this farther edge. Notice that the graduations on the scales are really groves in the surface that are only partially filled with ink. Slide a needle point, or a very sharp pencil, carefully down the groove of the graduation until it touches the drawing paper. (See fig. 3-32.)

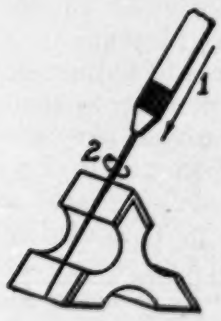

Figure 3-32.—Taking a measurement. with a triangular scale.

When you use a needle point, remember that a deep prick mark that breaks the paper is less accurate than a light dent made with the very tip of the needle point. When you use a pencil be sure that it is very sharp. Twirl it in the groove in the scale before removing it, in order to reinforce the pencil dot on the paper.

If a series of distances are to be set off, move the scale only when you have reached the end of it and have more distances to mark. Don't move it for each measurement or you may get a cumulative error which will spoil the drawing.

Note that your pencil touches the scale only for the purpose of marking a point on the paper. Never use a scale as a straightedge for drawing lines. A typical office ruler has a metal edge—it is a scale and straightedge combined. But a draftsman's measuring scale is for measuring only—it is not a ruler. A scale properly used will last for decades, but a scale used as a straightedge will soon have the graduations worn away.

Indicating Scale on a Drawing

There are many ways of indicating the scale on a drawing. Among these are the fractional method, the equation method, and the graphic method.

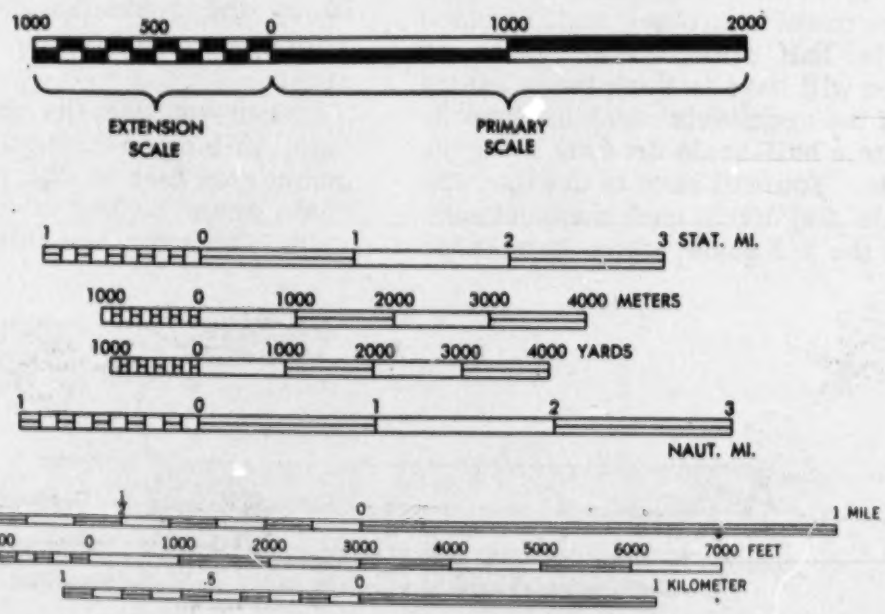

Figure 3-33.—Graphic scales.

In the fractional method, the scale is indicated as a fraction or a ratio. A full-size scale is indicated as 1/1; enlarged scale as 10/1, 4/1, or 2/1; and reduced scale as 1/2, 1/4, 1/10, etc. Notice that the drawing unit is always given as the numerator of the fraction and the object unit as the denominator. On maps, the reduced scale fraction may be very large (for example, 1/50,000) as compared with the typical scales on machine drawings. On maps, the scale is frequently expressed as a ratio such as 1:50,000.

In the equation method, a certain number of inches on the drawing is set equal to a certain length on the object. Symbols are used for feet (') and inches ("). On architectural drawings a certain number of inches on the drawing is set equal to one foot on the object. A full-size scale is entered as 12' = 1' -0"; and enlarged scale, as 24" = 1' -0"; and a reduced scale, as 1/8"= 1' -0". On civil engineering drawings, one inch on the drawing is set equal to a certain measurement on the object: 1" = 5', 1" = 100', 1" = 1 mile.

In the graphic method, an actual measuring scale is shown on the drawing. Typical graphic scales are shown in figure 3-33.

DRAFTING MACHINES

The drafting machine (fig. 3-34) combines the functions of a parallel ruler, protractor, and scale. Any drafting operation requiring straight parallel lines may be performed advantageously with a drafting machine.

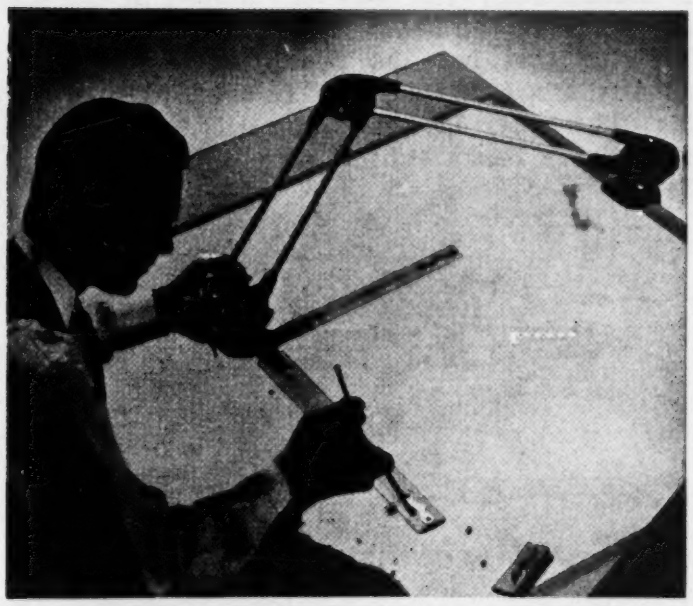

Figure 3-34.—Drafting machine.

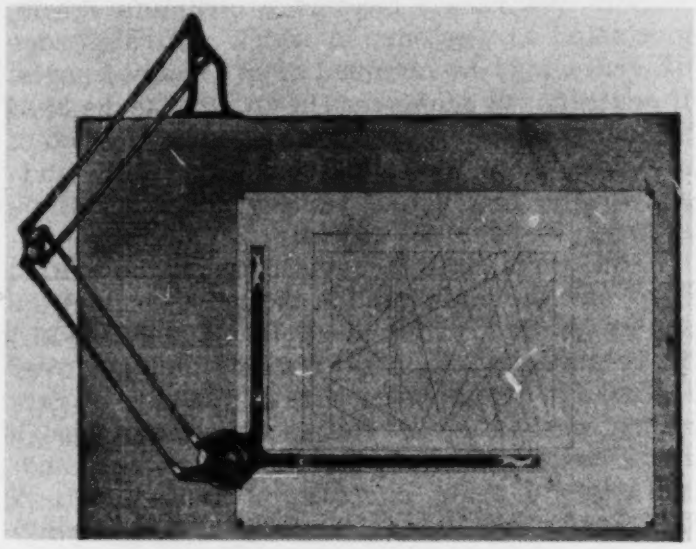

Figure 3-35.—Drafting machine with rigid arms.

The majority of drafting machines are constructed so that a protractor head may be moved over the surface of a drafting table without change in orientation by means of a parallel motion linkage consisting of two sets of double bars. The type illustrated in figure 3-35 has rigid metal connecting links or arms, called pin-joint linkage. On the better quality machines of this type, the bearings will have a means of taking up wear.

However, the type of drafting machine shown in figure 3-36, in which the linkage is provided by two steel bands working against one another, is superior to that with pin-joint linkage, because there is less lost motion. The machine in figure 3-36 has steel bands enclosed in tubes, although this type may also have the bands without the tubes. If these bands become loose through wear or expansion, the tension may be increased on them, although this is seldom necessary.

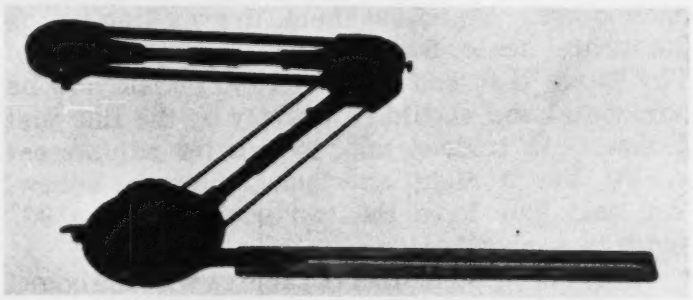

Figure 3-36.—Drafting machine with enclosed steel bands.

The protractor head is a complete circle, graduated in degrees, to which a straightedge or scale may be clamped at any desired angle. If desired, two scales may be attached to the head at right angles to each other. The method of attaching these scales has been fairly well standardized so that a wide variety of scales can be attached or removed as desired. Tapered, dovetailed fittings, with the female part on the control head and the male part on the rule, connect the scales to the drafting machine. (See fig. 3-37.) To remove a scale, a key is used which fits over the head of the adjusting screw. The key, by cam action, pushes the dovetailed fittings far enough apart so that the scale can be removed by hand. To insert a scale, carefully slide the dovetails into place and tighten them by tapping lightly with the palm of your hand.

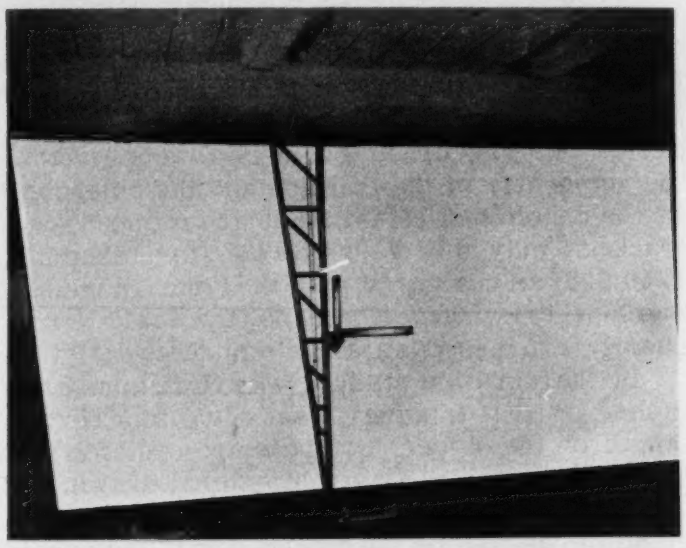

Figure 3-38.—Roller-type drafting machine.

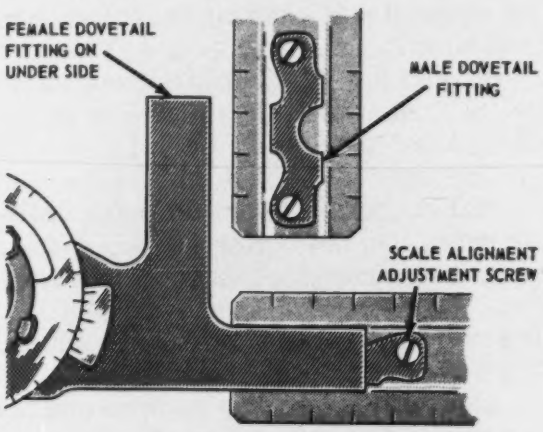

Figure 3-37.—Fittings for attaching the scale to the drafting machine.

One of the screws holding the fittings to the scale passes through an elongated slot, which allows for some angular adjustment of the scale. This adjustment is for truing the two scales with each other. To adjust them, draw a line by the horizontal scale. Swing the scales 90° clockwise. The scale that had been vertical should now be horizontal and should fit exactly by the line just drawn. If it does not, loosen its adjustment screw, set it right, and then tighten the screw. You will then have the two scales set at a 90° angle to each other.

Correct alignment of the scales with the board is usually accomplished by some adjustment in the control head or linkage of the machine. Any major repairs or adjustments on a drafting machine should be done by an instrument repair man and not attempted in the drafting room.

Figure 3-38 shows a type of drafting machine in which the scales are moved horizontally or vertically by means of rollers or tracks. This type of machine has special advantages when it is used on extra large drawing boards. Angular adjustments can be made to within 1 minute on some of these machines.

COMPASSES

The compass is used for drawing circles or circular arcs. The large compass usually found in a set of drawing instruments is about 6 inches long. The legs are hinged at the top so that they can be set in any desired position. The leg that has the pencil or pen attached usually has a hinged joint in the middle of the leg. The other leg containing the needle point sometimes has a similar hinged joint. (See fig. 3-39.)

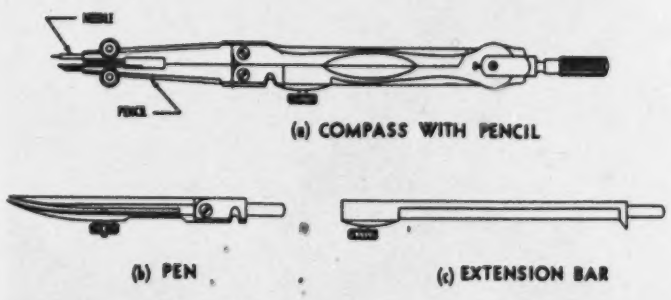

Figure 3-39.—Pivot joint compass.

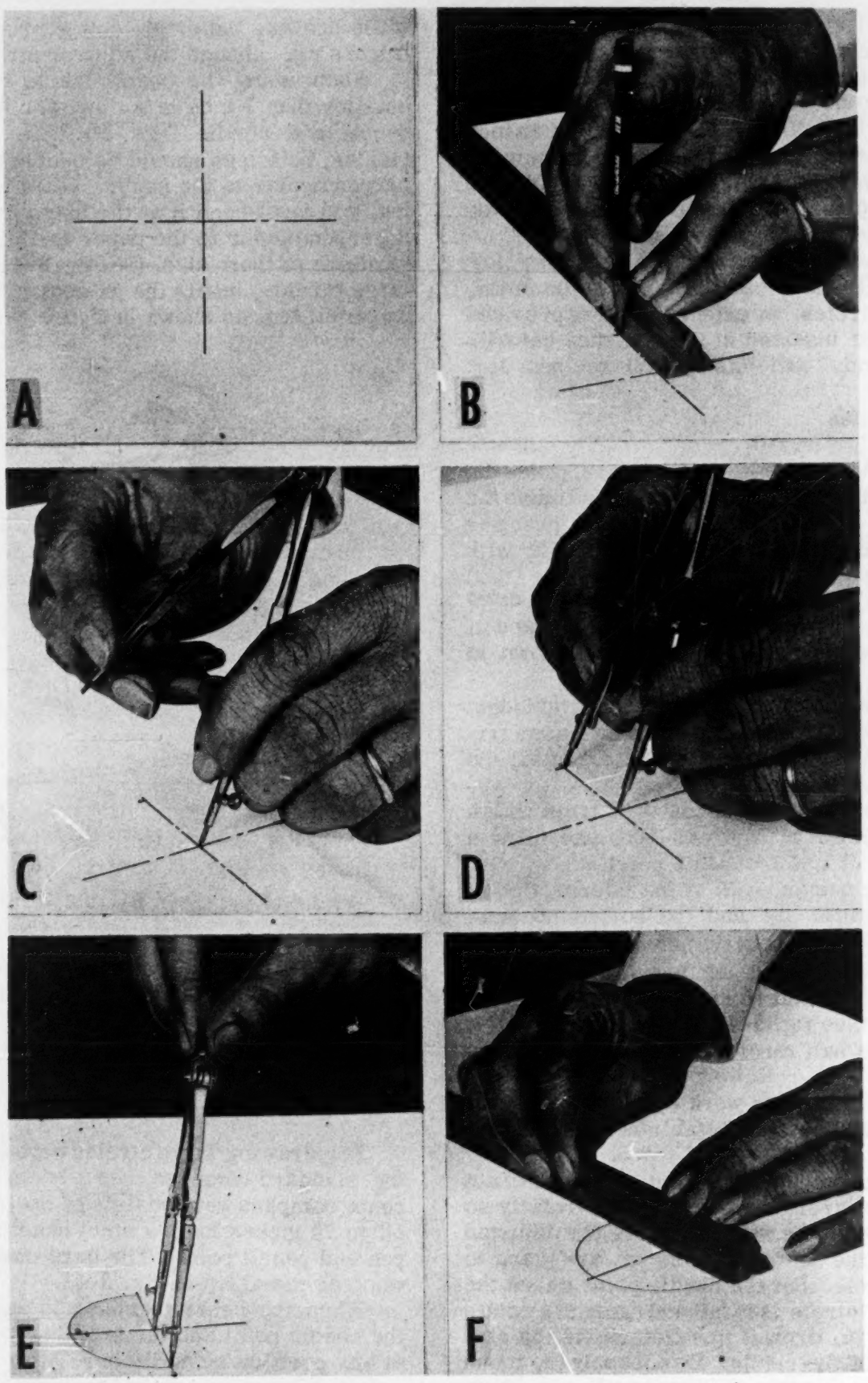

Figure 3-40.—Drawing a circle of given diameter in pencil.

The pencil and pen are interchangeable so that the same compass can be used for either pencil or ink drawings. When the compass is prepared for use, the needle point should be adjusted so that it projects about one sixty-fourth of an inch beyond the pencil lead or ink point. A compass can be obtained with a shoulder on the needle point which prevents the point from sinking too deeply into the drawing surface.

The 6-inch compass is satisfactory for drawing circles to about 12 inches in diameter. For larger circles, an extension bar is provided which may be inserted in the compass between the main body and the pencil or pen leg.

Drawing Circles

To draw a circle with the compass, press the needle point into the drawing paper and move the marking leg around it. After a little practice you will find that you can do this easily with one hand. (See fig. 3-40e.)

When you wish to set the compass to draw a circle of a given diameter, use a piece of scratch paper and follow the steps shown in figure 3-40.

1. Draw a horizontal line with a straightedge.
2. With the straightedge as a base, use a triangle and draw a vertical line intersecting the horizontal line. (See fig. 3-40a.)
3. Measure the radius of the circle with a scale, as shown in figure 3-40b, and draw a second vertical line from this point.
4. Set the needle point at the intersection of the first vertical line and the horizontal line. (See fig. 3-40c.) This is the center of the circle.
5. Set the marking leg to fall on the intersection of the second vertical line and the horizontal line. (See fig. 3-40d.)
6. Draw a half circle with the compass. (See fig. 3-40e.)
7. Now check your work by measuring with the scale the diameter established by this half circle. (See fig. 3-40f.)

Once the compass has been set to the exact radius of the circle, handle it very carefully so as not to disturb the setting. Move the adjusted compass to the drawing where you are going to make the circle. Set the needle point where the center of the circle is to fall and carefully rotate the compass to draw a line describing the circumference of the circle. Do not apply too much pressure on the needle point or it will bore a hole in the paper and you will lose the accurate center mark. Do not hold the legs of the compass while drawing the circle or the pressure of your fingers may change the adjustment.

When using the pencil leg to draw circles smaller than 1 inch in radius, you may keep the pencil and needle legs straight. For larger circles, both legs should be bent so that they are perpendicular to the paper. When using the pen leg, you must bend it at the hinge joint and keep it perpendicular to the paper for all circles, regardless of their size. (See fig. 3-41a.) To draw large circles, insert the extension bar in the pen or pencil leg, as shown in figure 3-41b.

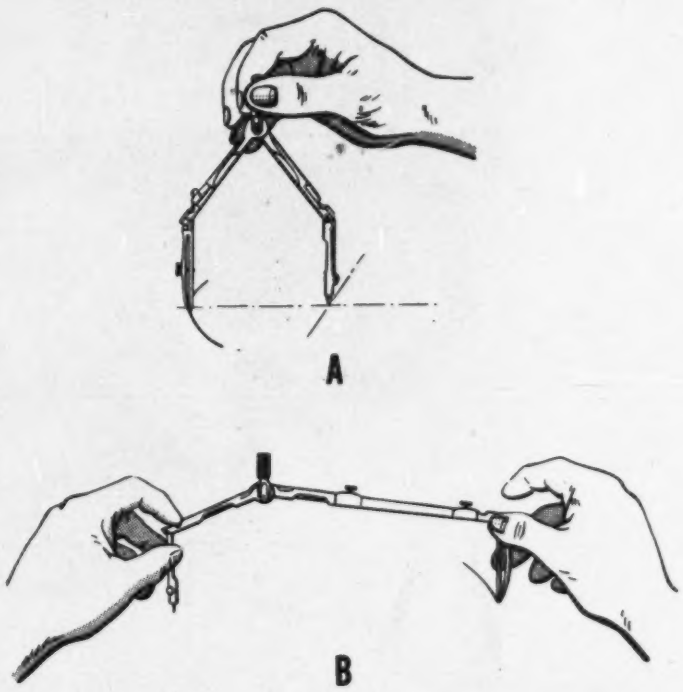

Figure 3-41.—(A) Compass with legs perpendicular to drawing. (B) Compass with extension bar attached.

Beam Compass

For drawing large circles beyond the range of the standard compass, use a beam compass. A beam compass set consists of one or more bars 18 to 70 inches long, a steel needle point, and a pen and pencil point. The bars may be of hardwood or metal. (See fig. 3-42.)

When the beam compass is assembled both the needle point and the marking point can be set at any position along the bar. After setting these points in approximately the correct position on the beam, you can make a final adjustment by means of a small screw on one of the points.

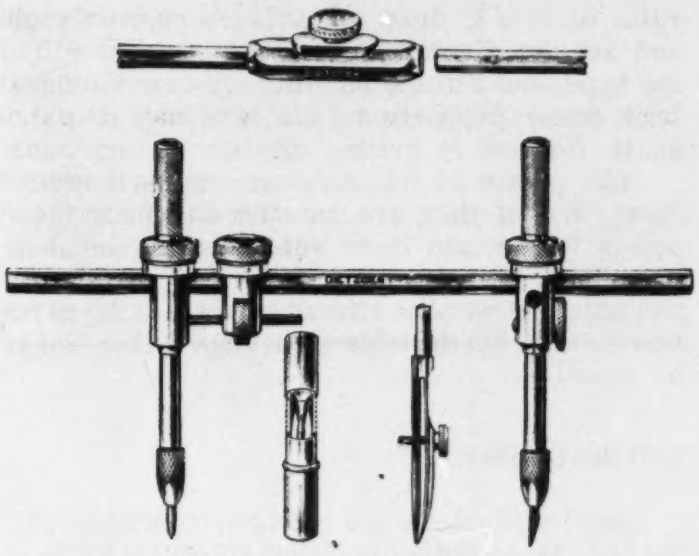

Figure 3-42.—Beam compass.

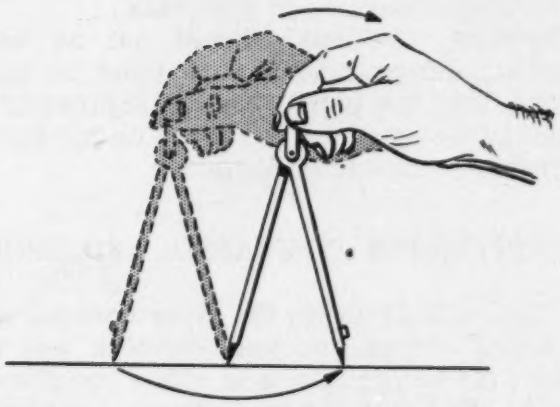

Figure 3-43.—Stepping off a series of equal distances on a line with the dividers.

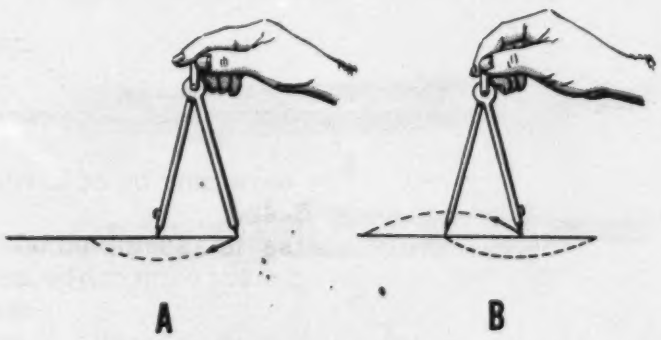

Figure 3-44.—Dividing a line into three equal parts.

DIVIDERS

Dividers are similar to compasses, except that both legs are provided with needle points. They are used for transferring measurements and for dividing lines into a number of equal parts.

To lay off distances on a drawing, set the dividers to the correct distance, then transfer the measurements to the drawing by pricking the drawing surface very lightly with the points of the dividers.

To measure off a series of equal distances on a line, set the dividers to the given distance. Then step off this distance as many times as desired by swinging the dividers from one leg to the other along the line. (See fig. 3-43.)

Dividing a given line into equal parts is slightly more complex. For example, figure 3-44 shows how a line is divided into three equal parts. First, set the dividers to a distance approximately one-third the length of the line. Then step off this spread three times. If the three stepped-off distances do not equal the length of the line, increase or decrease the setting of the dividers by one-third the error. Continue this trial-and-error method until the three steps equal the line.

Proportional Dividers

Proportional dividres are convenient for transferring measurements from one scale to another when drawings are to be made to a larger or smaller scale. (See fig. 3-45.) They can also be used to divide lines or circles into equal parts or to get some special ratio such as $1:\sqrt{2}$ or feet to meters.

They consist of two legs of equal length, pointed at each end and held together by a movable pivot. By varying the position of the pivot, the lengths of the legs on opposite sides of the pivot may be adjusted so that the ratio between them is equal to the ratio between two scales. Therefore, a distance spanned by the points of one set of legs has the same relation to the distance spanned by the points of the other set as one scale has to the other.

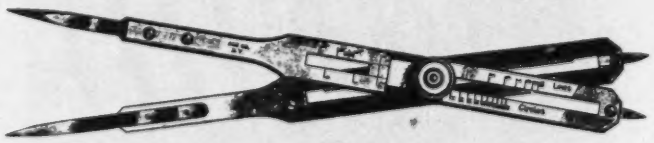

Figure 3-45.—Proportional dividers.

A thumb nut moves the pivot in a rack-and-gear arrangement. When the desired setting is reached, a thumb-nut clamp on the opposite side of the instrument locks the pivot in place. A scale and vernier are provided on one leg to facilitate accurate setting. The dividers may be set by reference to the table of settings which is furnished with each pair; they will accommodate varying ranges of scales up to 1 to 11.5. However, it is better not to depend entirely on the table of settings. You can check the adjustment by drawing lines representing the desired proportionate lengths and then applying the points of the instrument to them in turn until by trial and error the correct adjustment is reached.

To divide a line into equal parts, set the dividers to a ratio of 1 to the number of parts desired. For instance, to divide a line into 3 parts, set at 3 on the scale. To use the dividers to transfer measurements from feet to meters, draw a line 1 unit long and another line 3.28 units long and set the dividers accordingly. To get the ratio of 1: $\sqrt{2}$, draw an isoceles right triangle and set the dividers to a ratio of the length of the hypotenuse to the length of either of the equal legs. Some proportional dividers have an extra scale for use in getting circular proportions.

The points of the dividers are of hardened steel, and if they are handled carefully these points will retain their sharpness during long use. If they are damaged, they may be sharpened and adjusted without affecting the accuracy of the instrument, but the table of settings will no longer be exact.

Figure 3-46.—Spacing dividers.

Spacing Dividers

Spacing dividers are constructed with multiple legs arranged so that they subdivide the total distance spanned into a number of equal parts. (See fig. 3-46.) The size most frequently used is about 6 inches long and contains 11 points numbered consecutively from 0 to 10. With these dividers, distances up to 9 inches in length may be divided into 10 equal intervals.

Spacing dividers should not be handled roughly, and particular care must be taken to ensure that the points are not injured or bent. If the pivot becomes too loose or too tight, the instrument should not be used.

MAINTAINING COMPASSES AND DIVIDERS

Figure 3-47 shows the three common shapes in which compasses and dividers are made. They may be purchased in either the round, the flat, or the bevel shapes. When you select compasses and dividers, test them for alignment by

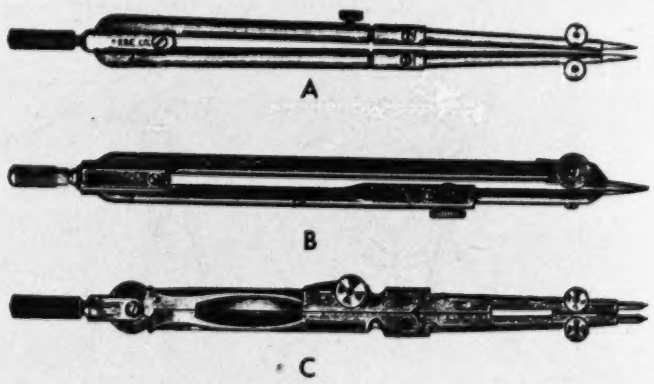

Figure 3-47.—Shapes of compasses and dividers. A. Round. B. Flat. C. Bevel.

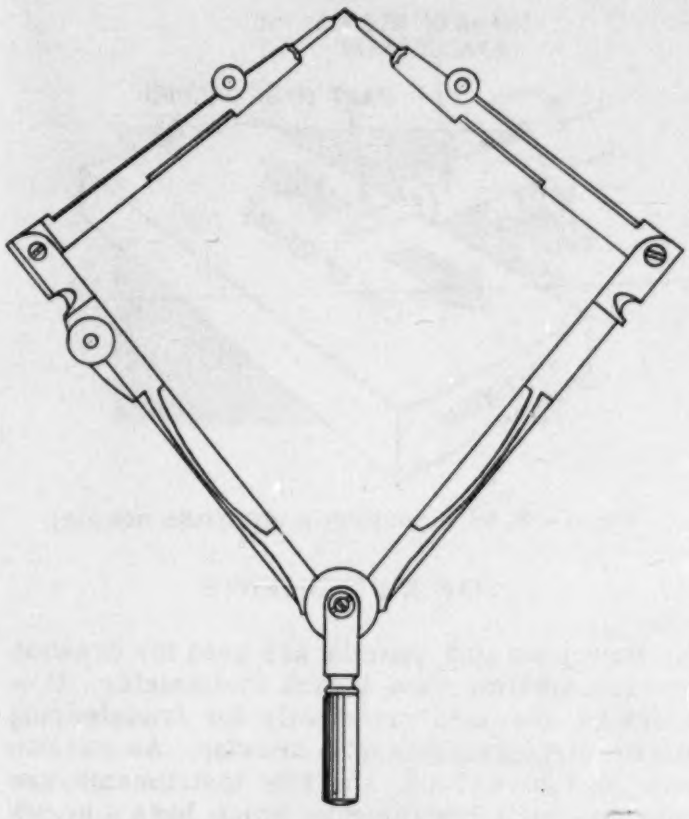

Figure 3-48.—Testing pivot joint compass for alignment.

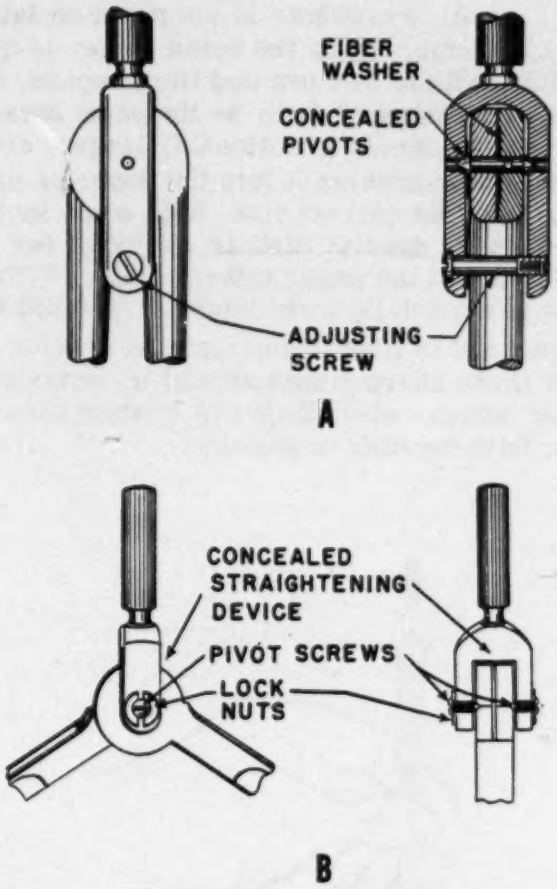

Figure 3-50.—Sections of pivot joints.

bending the joints and bringing the points together as shown in figure 3-48.

Older compasses and some cheap modern ones have a tongue joint. (See fig. 3-49.) Because there is no way to tighten this type of joint after it becomes worn, modern pivot joints are more satisfactory. Figure 3-50 shows types of pivot joints found on compasses and dividers.

Dividers should be adjusted so that they may be set without undue friction. They should not be so rigid that their manipulation is difficult, nor so loose that they will not retain their setting. Hairspring dividers are set for the correct friction by skilled instrument makers, and it is inadvisable to attempt adjustments in the drafting room, since a special wrench is needed which is ordinarily not available.

Figure 3-49.—The tongue joint.

Divider points should be straight and free from burrs. When the dividers are not in use, the points may be protected by sticking them into a small piece of soft rubber eraser or cork. When points have become dull or uneven in length, make them even by holding the dividers vertically, placing the legs together, and grinding them lightly back and forth against an oilstone. (See fig. 3-51A.) Then hold the dividers horizontally and sharpen each point by whetting the outside of it back and forth on the stone, while rolling it from side to side with your fingers. (See fig. 3-51B.) The inside of the leg should remain flat and should not be ground on the stone. Neither should any part of the outside of the point be ground so that a flat surface results. In shaping the point, be careful to avoid shortening the leg.

Needles on bow instruments and compasses should be kept sharpened to a fine taper. When they are pushed into the drawing, they should

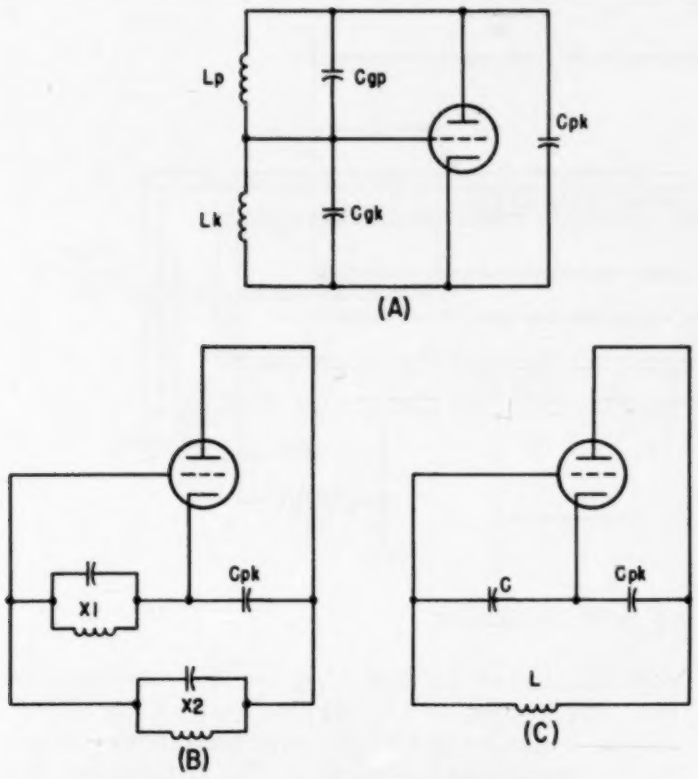

Figure 12-11.—Evolution of equivalent circuit of lighthouse tube oscillator.

tuning of the cathode line; the cathode tuning serves principally to control the amount of feedback. If feedback is too small, oscillations are weak and may cease completely; if feedback is too great, power consumption in the grid circuit becomes too large. This results in a decrease in output of the oscillator. The value of C (hence of the cathode tuning) has some effect on the frequency of oscillations, but since C and C_{pk} are in series, and C is usually much larger than C_{pk}, C must be changed considerably to appreciably affect the frequency.

TUNING

Since the tuning of the plate line determines the resonant frequency of the plate circuit, which in turn determines the amount of inductance represented by the plate circuit at the oscillator frequency, the plate tuning is the chief control of the oscillator frequency. It has a secondary effect of feedback since C is determined by the relative frequencies of the cathode circuit and of the oscillator. Thus the plate line is tuned to give the correct frequency and the cathode line to adjust feedback for maximum output from the oscillator; but, since there is some interaction, it will be necessary to readjust each line for maximum accuracy.

TRAVELING WAVE TUBE

The traveling wave tube (TWT) is not a new device. It was invented during the latter part of World War II, but due to the instability of the earlier models, it saw no practical use at that time, although its remarkable capabilities and some of its potential applications were well known. The Navy retained an interest in the device because of its potential applications in the fields of communications, radar, and electronic warfare (EW).

Development of the early radars was rapidly followed by the development of techniques to deceive and jam them. The evolution of radar has been partially the result of a continuing need to stay ahead of any new countermeasure tactics which might compromise the radar's effectiveness.

The trend in search radars has been toward higher power and toward electronic counter-countermeasures (ECCM) techniques that will increase visibility despite jamming. A good antijamming radar must be able to shift frequency quickly (and, if possible, over a wide bandwidth) to avoid the jammer's frequency. Similarly, the trend in EW has been toward wide bandwidth capability, where the jammer amplifies wideband noise or may deceptively retransmit the radar pulse to offset the radar's frequency shift tactics.

Since wide frequency bandwidths are essential to the employment of such tactics, an amplifying device capable of broad operating ranges with sufficient output power and efficiency was needed. The TWT appeared to offer promise in these areas; and the Navy has been responsible for many of the primary advancements in the development of equipment to fulfill this promise.

PRINCIPLES OF OPERATION

Figure 12-12 is a simplified sketch of one type TWT structure. At the left of the diagram is the electron gun assembly. The cathode, when heated, emits a continuous stream of electrons. These electrons are drawn through the anode, focused into a tight, narrow beam, forced to travel the length of the

1982

leave a small, round hole in the paper no larger than a fine line. Since the same center is often used for both the bow pen and the compass, it is best that needles on both be the same size. If the compass needle is noticeably larger, either use it without pushing it into the paper or grind it until it is the correct size. With some instrument sets, a special disk is provided for use when a hole in the paper at the center of a circle or ark is especially undesirable. This disk may be composed of plastic and metal or of bone, and it has three sharp points around its outside diameter which, when they are pushed into the paper, hold the disk in position.

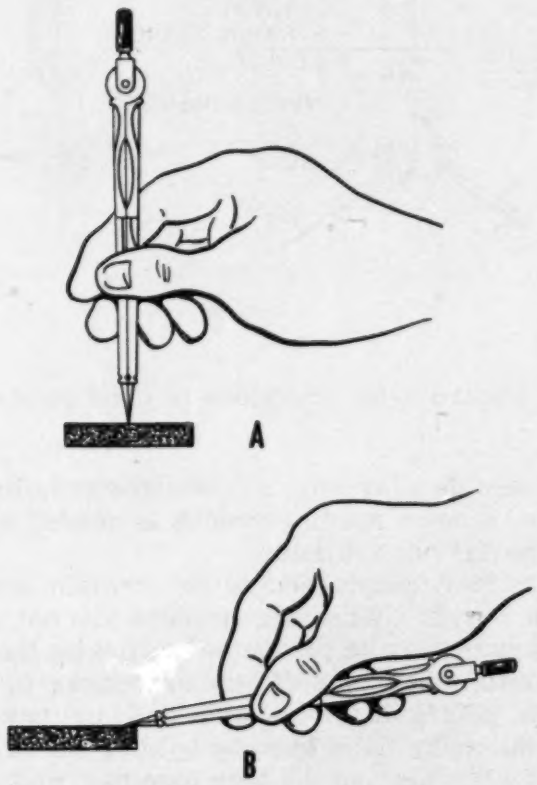

Figure 3-51.—(A) Evening legs of dividers. (B) Sharpening divider needle points.

To make a compass needle smaller, wet one edge of the oilstone and place the needle with its shoulder against this edge. Then grind it against the oilstone, twirling it between your thumb and forefinger. (See fig. 3-52.) Test it for size by inserting it in a hole made by another needle of the correct size. When it is pushed as far as the shoulder, it should not enlarge the hole.

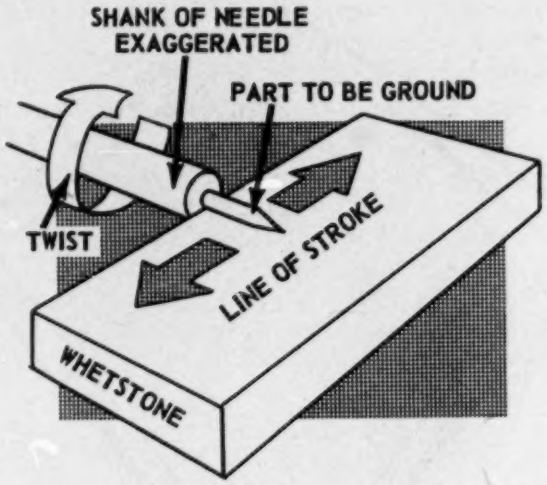

Figure 3-52.—Shaping a compass needle.

BOW INSTRUMENTS

Bow pens and pencils are used for drawing circles smaller than 1 inch in diameter. Bow dividers are used principally for transferring small measurements on a drawing. As you can see in figure 3-53, the bow instruments are merely small instruments which have a screw acting against a spring for adjusting the spread of the legs. These instruments are used in the same manner as the compasses and dividers previously described.

The screw threads on bow instruments are delicate, and care should be taken never to force them. When you increase the spread of the legs, hold them together lightly to release the tension on the setscrew and to decrease the wear on the threads. Take care to keep the threads free from rust or dirt.

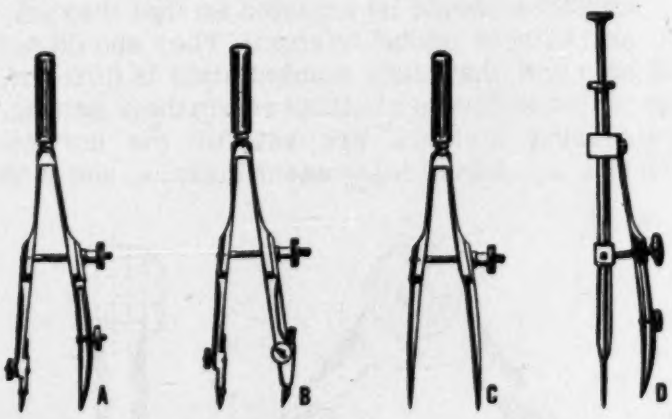

Figure 3-53.—Bow instruments: (A) bow pen; (B) bow pencil; (C) bow dividers (D) drop bow pen.

The drop bow pen (fig. 3-53D) is not one of the standard instruments. However, for some jobs it it essential. It is used to draw small circles with diameters of less than a quarter of an inch, such as rivet holes on structural drawings. As the name indicates, the pen assembly is free to move up or down and to rotate around the main shaft. Holding the pen in the raised position, adjust the setscrew to give the desired radius. Then gently lower the pen to the paper surface and draw the circle by rotating the pen around the shaft. These instruments are generally used for drawing a large number of small identical circles. They are also available as a combination drop bow pen and pencil.

RULING PENS

It requires far more experience to do a professional job in ink than it does to do one in pencil. An apprentice draftsman starts with a pencil. After he has learned to draw with a pencil, using the T-square, triangles, curves, and compass, he can begin to use pens.

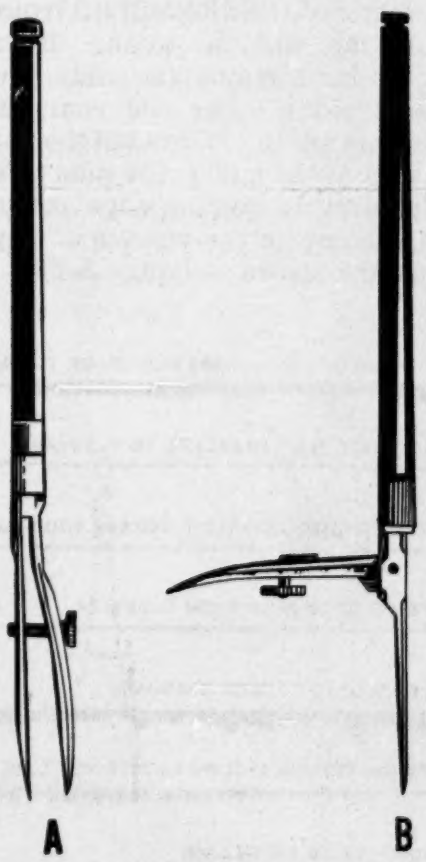

Figure 3-54.—Ruling pens: (A) spring type; (B) hinged-blade type.

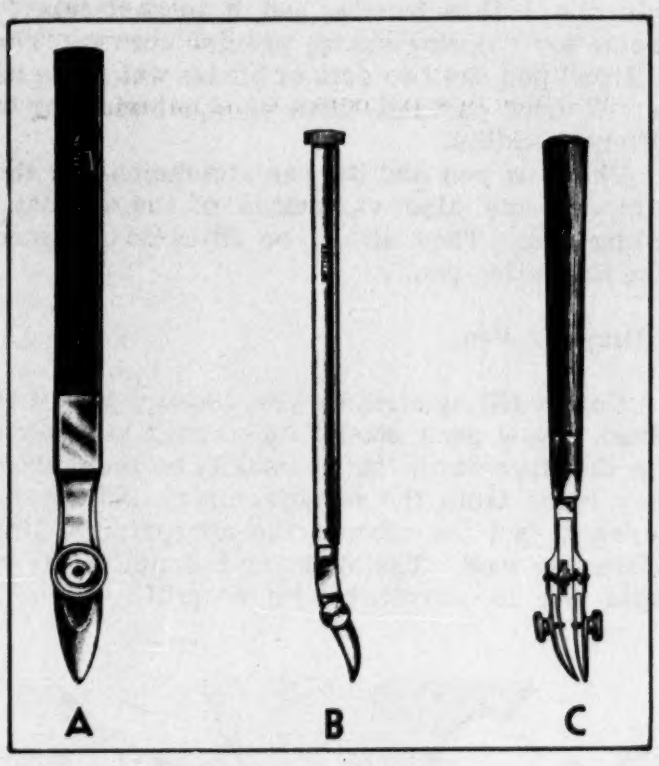

Figure 3-55.—Special varieties of the ruling pen: (A) detail pen; (B) contour pen; (C) railroad pen.

The ruling pen is used for ruling lines of uniform width with the T-square, triangles, or other guides. It should not be used for freehand work. It consists of two steel blades, called nibs, attached to a handle. The blades are of equal length, narrowed at their tips. (See fig. 3-54.) A setscrew is used for adjusting the distance between the nibs at the tip to correspond to the width of line desired. Tightening the screw brings the nibs closer together so that the pen makes a thinner line.

The standard ruling pen has an adjustable spring blade, limber enough to permit opening it wide to clean the inside of the nibs. Another type has a hinged blade, which allows the pen to be opened, cleaned and snapped back in place with the nibs the same width apart. This is convenient if you have to do a long piece of work which requires many lines of the same width.

There are several useful variations of the standard ruling pen. (See fig. 3-55.) The detail or Swede pen is similar to the standard pen except that the blades are wider and have a greater ink capacity. It can be used for very heavy ink lines as well as for light lines. The contour pen has blades attached to a shaft which rotates in-

side the hollow handle, and it is particularly useful for drawing sharp, precise curves. The railroad pen has two sets of blades which can be set to draw parallel lines of equal width or of different widths.

The bow pen and the pen attachment for the compass are also variations of the standard ruling pen. They should be filled and cleaned like the ruling pen.

Filling the Pen

Before filling a ruling pen, be sure that it is clean. New pens should be washed to remove the thin film of oil that is usually on them when they come from the manufacturer. Adjust the screw to set the nibs to the approximate line width you want. The ordinary 2-ounce bottle of India ink is provided with a quill, which is

Figure 3-56.—Using ink-bottle quill to fill a ruling pen.

fastened to the stopper, for use in filling a ruling pen. Figure 3-56 shows how the quill from the ink bottle is used to fill the pen. Insert it between the nibs of the pen until the ink rises to about 3/16 of an inch from the tip. If you do not have a quill attached to the cork, an ordinary writing pen dipped in ink and passed between the blades of the ruling pen will fill it satisfactorily. Overloading will cause a blot or an uneven line.

Before you start to draw with the ruling pen, carefully remove any ink from the outside of the blades and test the width of the line on a scrap of your drawing paper. If the line is not the right width, make a final adjustment of the setscrew.

Drawing Lines

When drawing, hold the ruling pen with the setscrew pointed away from you. Be sure that both nibs touch the paper. The pen should be almost upright, with a slight tilt in the direction in which you are drawing. (See fig. 3-57.)

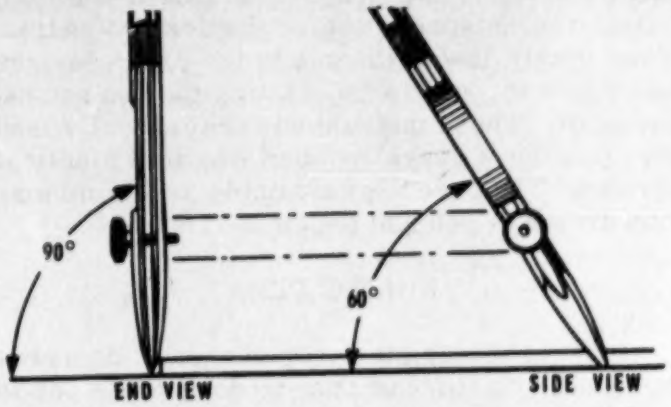

Figure 3-57.—Drawing lines with a ruling pen.

To draw clean, uniform lines, you must hold the pen properly. If the handle is tilted toward the guide, one of the nibs will lift from the paper and your line will be weak. If the nibs are pressed too hard against the guide, you will force one closer to the other and your line will not be uniform in width. If you tilt the handle of the pen away from the guide, the nibs will be thrown in contact with the guiding edge and ink may run under it. Some of the results of improper use of the pen are shown in figure 3-58.

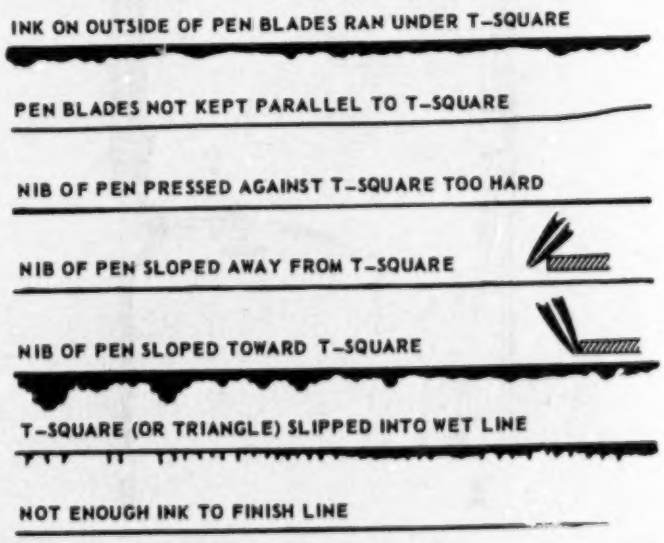

Figure 3-58.—Defective ink lines and their causes.

When you use a ruling pen with a T-square or straightedge, make long lines with a whole-arm movement by sliding your pen hand along the blade, while you keep the straightedge steady with your other hand. Just before reaching the end of a line, slow down and finish with a finger movement to keep from overrunning the line. For greater control in stopping, draw short lines and the ends of long lines with a finger movement. When the end of a line is reached, lift the pen vertically, and carefully remove the guide.

Draw horizontal lines from left to right, starting at the top of the drawing and working down. (If you are lefthanded, you will, of course, draw these lines from right to left, and similarly reverse many of the directions given in this book.)

Vertical lines are usually drawn in an upward direction and from left to right. However, when you have to draw a number of vertical lines or lines slanted in the same direction, how you draw them will be governed by the source of your light and the way you have found that you can draw vertical lines with greatest control.

Let the first lines dry before starting to draw any intersecting lines. Watch carefully when you draw one line across another line. If the ink starts to run down the dry line under your straightedge, lift the pen quickly from the drawing and move the straightedge carefully.

If the ink is stubborn and refuses to flow, draw the pen tip quickly over a piece of scratch paper. If it is still sluggish, examine your pen to see if it needs cleaning or if it is worn.

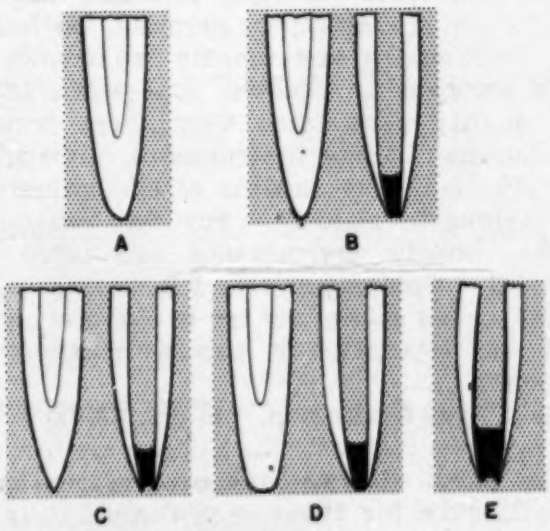

Figure 3-59.—Shapes of ruling pen nibs. (A) worn; (B) correct; (C) too pointed; (D) too rounded; (E) too curved.

Caring for the Pen

Clean your pen by dipping the tip in water or in water with a little ammonia in it or in a pen-cleaning solution. Then wipe the blades thoroughly, inside and out, with a soft, lintless cloth.

You will have to wipe your pen several times during the course of a few hours of work, because ink hardens in the pen very rapidly. Don't subject your pen to unnecessary wear by stroking it too often on scratch paper when the ink fails to flow easily; clean it instead. Always put it away clean, with its blades well separated to release the tension on the steel.

Sharpening the Ruling Pen

High quality is especially desirable in a ruling pen. If the nibs are of low quality steel, it will be more difficult to keep them sharp. A good pen will usually be sharp when it comes from the manufacturer, but a cheap pen may need sharpening before it is used.

When you start having difficulty drawing fine lines or getting the ink to flow from your pen, check it for signs of wear. Hold the nibs toward you in a good light, and if they are worn, you will see a bright spot on the tip of each nib which is not present on a sharp pen. This spot indicates a flat surface that has been formed by wear. (See fig. 3-59A.)

A ruling pen that has become dull may be sharpened on a fine oilstone if extreme care is

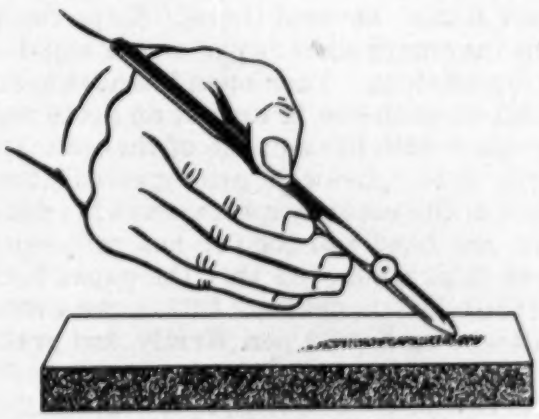

Figure 3-60.—Shaping a ruling pen.

used. To restore the nibs to their original parabolic shape, hold the pen in a vertical plane and bring the blades into light contact with the stone. Then whet the pen back and forth through an angle of about 120 degrees. (See fig. 3-60.) To sharpen each nib of the pen, hold the outside surface nearly flat on the surface of the oilstone and whet with a rotary motion to conform to the shape of the nib. (See fig. 3-61.)

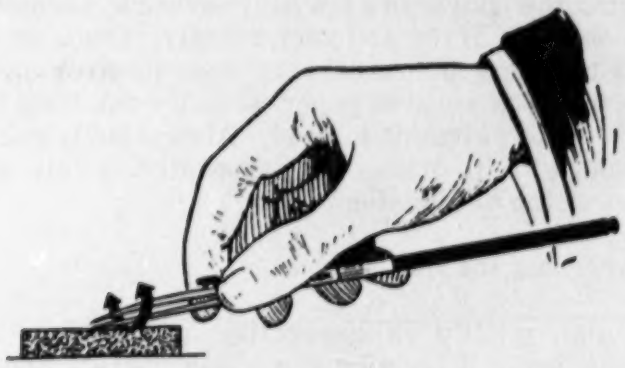

Figure 3-61.—Sharpening a ruling pen.

Take care not to alter the parabolic shape of the ends. The edges should not be too sharp or they will cut the paper when the pen is used. Any burr should be removed from the inside of the blades with a piece of leather or emery paper. The inside surface should never be stoned, since stoning may give it a slight convexity, which is very undersirable.

There is another method of sharpening ruling pens which requires less skill. Place a fine grain emery paper on a base of sponge rubber or a towel folded several times. Shape the ruling pen on the emery surface just as you would shape it on an oilstone. Then open the nibs and place the back of each one in turn at an acute angle in full contact with the surface of the emery paper. (See fig. 3-62.) Draw the pen repeatedly over the surface of the emery paper, always in a direction toward the handle of the pen and with sufficient downward pressure so that the paper becomes depressed into a channel fitting the contour of the nibs. Hold the pen firmly and prevent it from turning, so that the edges of the nibs are in equal contact with the paper. When the nibs are sharp enough, grind the inside surface lightly with the emery paper to remove any burrs that may have formed.

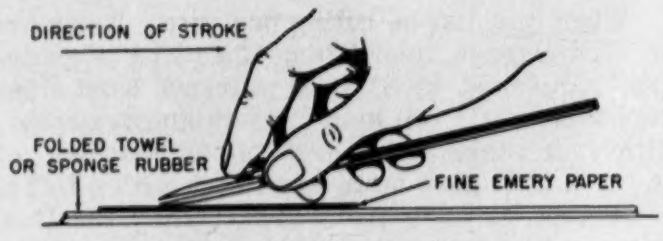

Figure 3-62.—Sharpening the nibs of a ruling pen on emery paper.

CARE OF CASED INSTRUMENTS

Your instruments may be issued to you one by one or as a set in a case. If possible, it is best to keep them in a case, since the case protects them from falls or unnecessary pressures. Then, too, the lining of the case is usually treated with a chemical which helps prevent the instruments from tarnishing or corroding.

To protect instruments from rusting when they are not in use, clean them frequently with a soft cloth and apply a light film of oil to their surface with a rag. Joints on compasses and dividers should not be oiled. A knife edge or an abrasive should never be used to clean instruments, since, when the surface finish is worn or scarred, they are more subject to corrosion.

It is sometimes difficult to judge the quality of drafting instruments by appearance alone. Often their characteristics become evident only after they are used. Usually, cheap quality instruments have a mass-production appearance, with little machine finishing and with designs that permit rapid assembly. On the other hand, high quality instruments are usually correctly sharpened, adjusted, and packaged in a good quality case when they come from the manufacturer. Some instruments, although accurately made and capable of fine adjustment, are lacking in rigidity. For this reason, the simple, sturdy instruments are often most practical. Before you select instruments, look for the brand name and try to learn something about the reputation it has with experienced draftsmen.

As a Navy draftsman, you are not expected to buy your own instruments. These are furnished by the Navy. If you have professional pride, you will care for them as you would your own. However, when an instrument is defective or worn beyond repair, do not hesitate to ask that it be replaced. Remember that the quality of your work is of first importance.

PENCILS

The selection of a grade of pencil lead is to some extent a matter of a particular draftsman's personal preference. The 18 grades of pencil lead from 9H (hardest) to 7B (softest), may be broadly divided into three general categories as follows:

9H to 4H . . . . . hard
3H, 2H, F, HB . . . . . medium
B to 7B. . . . . soft

In general, the soft lead is used more for illustrative than for technical drafting. The medium lead is used for general-purpose work, for tracing, and for lettering. The softer hard lead is used for line work in machine drawing, the harder hard lead for graphs, charts, or diagrams requiring a high degree of accuracy in the drawing.

The standard leads described above are used primarily on paper and linen, although they may be used on film. However, there are now leads on the market designed specifically for use on drafting film. The grade designations vary with the manufacturer; three of these are K1 through K5, 2S through 6S, and E1 through E5.

If you want to keep your drawing clean, do not use leads that are so soft that they smear easily. Use a very sharp point when you point off directions with the scale. Try to select a pencil which will make a good line on the particular surface you are using. With such a pencil, it should not be necessary to put so much pressure on it that it makes a dent in the paper. On most fine tracing paper, H to 3H pencils are best.

In drawing with a pencil, the width of the line you make depends on the sharpness of your lead, not on the pressure you put on it. If the tip of the lead is very sharp, you can draw a thin, black line or a thin, gray line, depending on the pressure of your pencil on the paper. If the tip is slightly duller, you can draw a medium black line or a medium gray line. Wide lines are drawn with pencils with blunt tips.

Drafting room pencil sharpeners cut the wood away from the lead without cutting the lead and leave about 3/8" of the lead exposed as shown in figure 3-63. If no such sharpener is available, use a knife or a razor blade to cut the wood away from the pencil lead. A pencil should always be sharpened at the unlettered, never at the lettered, end. The reason is, of course, to preserve the symbol which indicates the grade of the pencil.

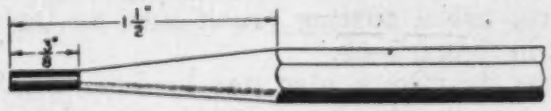

Figure 3-63.

Many draftsmen prefer lead holders, which are mechanical clutch-type pencils in which you may insert any grade of lead.

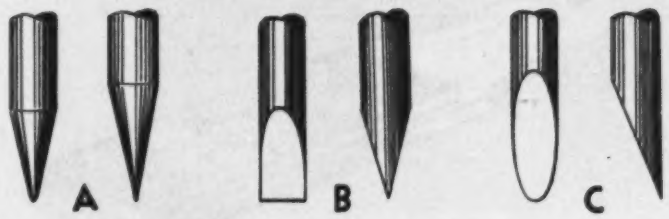

Figure 3-64.—a. Conical point.
b. Chisel point. c. Elliptical point.

The lead exposed in either a wooden pencil or a lead holder must be dressed, or pointed, before it can be used. The conical point shown in figure 3-64 is most commonly used. However, many draftsmen claim that if you draw a long line with the narrow part of the chisel point the lead does not wear down as rapidly and the line is more even. (See fig. 3-64B.) Others maintain that pencil leads, as manufactured, are harder on the outside and that the elliptical point takes advantage of the hardest part of the lead. These draftsmen use the elliptical point, which is normally used in the bow pencil, in doing other drawings.

If you use a lead with either a chisel or an elliptical point, you must keep the pencil from shifting in your hand as you draw. If the pencil shifts so that the wide part of the point slants across the line, the line will vary in width. Since this is not easy to prevent, it is better for the beginner to work with a conical tip.

When you are making mechanical drawings in pencil, hold the pencil in an almost vertical position, just as you would hold a pen. Press the lead against the guiding edge only enough to hold the lead in contact with it. When you are using a lead with a conical tip and must draw a long line with it, revolve the pencil slightly as you draw and the lead will wear evenly, producing a more even line.

Keep a pad of sandpaper by your drawing table. These come with the sheets of sandpaper

lightly glued together at the edges and attached to a small wooden paddle. (See fig. 3-65.) Some draftsman tack their sandpaper pad to some steady surface within reach, so that they need not use their hands to steady it. This eliminates the chance of their getting loose graphite dust on their fingers. If you want a clean drawing, keep your hands clean.

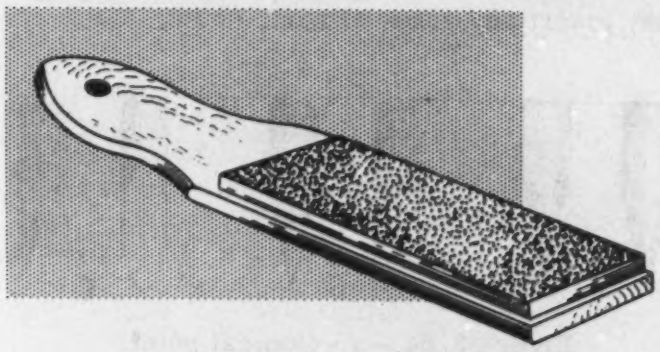

Figure 3-65.—Flat sandpaper pad with wooden handle.

To sharpen a lead to a conical point, rotate the pencil as you rub the tip on the pad. This keeps the abrasive action of the pad even on all sides of the lead. (See fig. 3-66.)

There are presently on the market various mechanical pencil pointers which create a conical point. These are rotating devices, some of which clamp to the table, which contain either metal file blades or sandpaper to cut the lead.

To sharpen a lead to a chisel point, hold the pencil on one side as you rub it on the pad until the lead is worn halfway through at the tip. Then turn it over and sharpen it the same amount on the other side. Many draftsmen who use the chisel point make a couple of final rubbings on the sandpaper pad to cut off the corners of the chisel and to narrow it so that it is easier to handle.

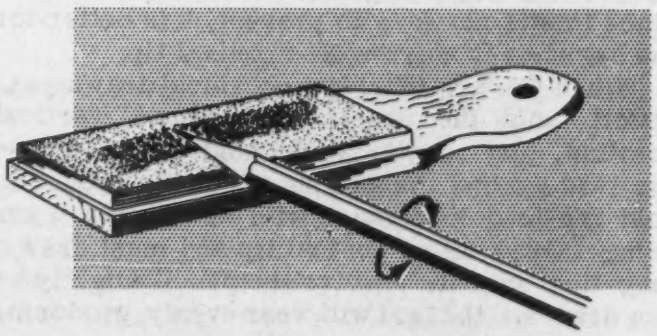

Figure 3-66.—Sharpening a lead to a conical point on the sandpaper pad.

When you want to sharpen a lead to an elliptical point, the exposed lead must be at least 3/8 of an inch long. Rub the lead on the sandpaper pad on one side only, holding the pencil at an oblique angle to the pad.

Before you start to draw with a newly sharpened lead, test it on a small piece of scratch paper. Use a piece exactly like the paper on which you are drawing.

ERASERS

Figure 3-67 shows just a few of the many types of erasers available. The first is a rubberless vinyl eraser for use on films and cloth. The next is a plastic eraser for use on film, cloth, and paper. The third is typical of the more ordinary pencil and ink erasers for use on linen and paper; these vary in softness—the softest are usually pink, the intermediate erasers are usually red, and the hardest are usually white. The last two are gum cleaning erasers. To clean finger marks or smudges from the surface

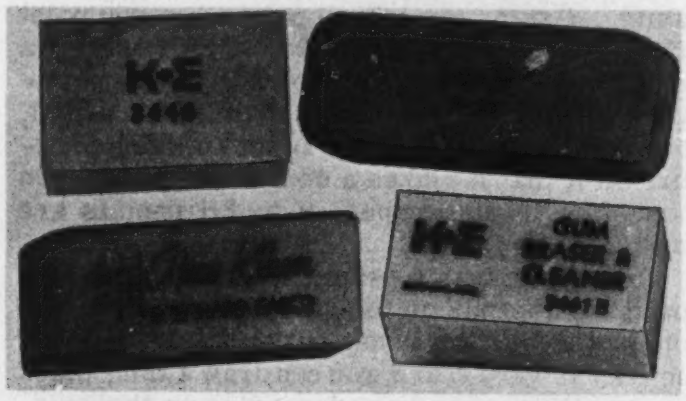

Figure 3-67.—Erasers.

of the drawing paper, use the artgum eraser. When you erase pencil lines, be careful not to use to hard an eraser, since such an eraser will damage the surface of the paper. To remove eraser crumbs from the drawing after each erasure, use a dusting brush such as the one shown in figure 3-68.

Many draftsmen also use kneaded erasers. These are made from snythetic rubber or plastic and may be kneaded in the bands to form a fine point. They have the advantage of leaving

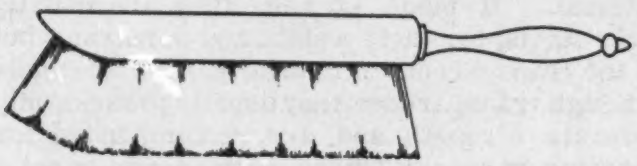

Figure 3-68.—Dusting brush.

few crumbs on the drawing and can be used to pick up graphite dust, rather than to rub it off.

An electric erasing machine such as the one shown in figure 3-69 is a timesaver when there is much erasing to be done, but it is hard to use on paper without damaging the surface. It has a hard eraser at its tip, which revolves very rapidly when the machine is turned on. To use it, touch it gently to the line to be erased. Any undue pressure on the eraser will cause it to bite into the surface.

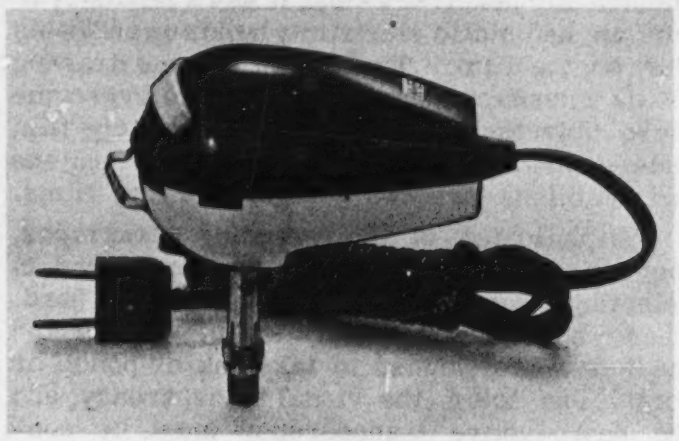

Figure 3-69.—Erasing machine.

An erasing shield (see fig. 3-70) is a small plate of thin spring steel with holes of various shapes having been punched out. The open holes in the shield make it possible to remove unwanted lines while leaving other work untouched. Further, the sharp edge of the metal cuts away the smudged exterior of the eraser, permitting a clean portion of the eraser to rub against the surface of the drafting media.

In addition to artgum erasers, cleaning compounds include pulverized gum eraser particles which may be squeezed onto the drawing from a plastic squeeze bottle. Gum eraser granules are also packaged in cloth bags made of a soft mesh. The granules sift through the bag as it is rubbed over a drawing. The eraser pad is also

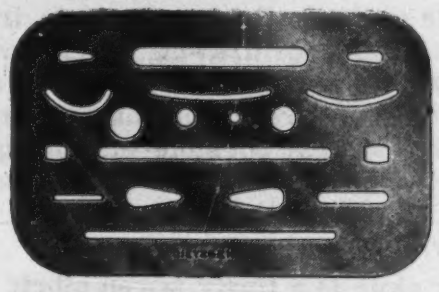

Figure 3-70.—Erasing shield.

excellent for precleaning to prevent later soil buildup.

Frequently, ink may be removed more easily from drafting media, especially linen, by scraping rather than rubbing. This procedure is facilitated by careful use of a steel eraser such as the one shown in figure 3-71.

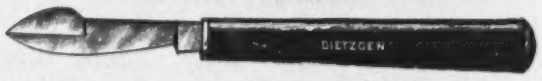

Figure 3-71.—Steel eraser.

DRAFTING MEDIA

The quality of drafting media is very important. As with any other artist, draftsmen using good materials may not always produce top-notch work, but draftsmen using poor materials will never produce good work. For practice you may use inferior paper, since the drawing does not have to be duplicated, but never try to do a finished piece of work on paper with a grain in it. The grain will show up on contact prints of the drawing, and drawings are generally duplicated by contact printing methods. Drafting media in general use are described in the following paragraphs.

Detail paper is a heavy weight, opaque paper which is usually either buff or neutral green in color. It takes pencil well, but pencil lines on it are difficult to erase because a hard, sharp pencil makes impressions in the paper's heavy texture. When drawings are made on detail paper, they must be traced before blueprints or other duplicates may be made by contact printing methods, since detail paper is to opaque to be

used for this purpose. Due to changes in drafting practices, the need for drawing papers today is limited to the two extremes in the quality scale: the very highest grade, permanent drawing papers with the best possible erasing quality for maps or master drawings which are later photographed, and at the other extreme inexpensive school type of papers.

Tracing cloth is a finely woven fabric which is coated heavily with a starchlike compound and rolled to produce a glossy surface on one side and a dull surface on the other. The glossy surface is the one which was originally intended for use. Ink lines on it have a sharper edge, and it is easier to erase on that side without damaging the cloth. However, the dull side is now intended as the working side, because it takes ink more readily, and it can be worked on with a pencil when changes in the drawing are necessary. Cloth combines the advantages of transparency, surface quality, strength, and permanence. It can withstand repeated erasures without major loss of surface quality, and aging does not materially affect its drawing and reproduction qualities. Though paper may exceed cloth in one or more of these characteristics, it does not equal its combined advantages. The so-called linen cloth is actually cotton, sized with starch to give a surface that takes pencil and ink, and by penetrating the voids between the cellulose fiber, makes the cloth transparent for tracing and reproduction purposes.

Tracing paper, sometimes called tracing vellum, is white or slightly tinted more-or-less transparent paper which may or may not be especially prepared. The more transparent papers are used as tracing papers. Formerly, they were used almost exclusively for the ink tracing of pencil drawings made on opaque papers. Transparency was the prime requirement. Today, the usual drafting practice is to develop the master drawing directly on transparent paper from which reproductions can be made, thereby saving the time, expense, and checking involved in the tracing process. This practice means that, in addition to good transparency, the modern high-grade tracing paper must be able to withstand repeated erasures, have good pencil take, and be strong enough to withstand considerable handling. The paper should retain these qualities for a long period of time to avoid the eventual necessity of redrawing, either manually or photographically. Natural tracing papers have properties which depend on weight, method of manufacture and raw material. If made of rag, they are usually fairly strong for their weight and permanent but not too transparent. If natural papers are made with high transparency they usually possess only moderate strength and are recommended for sketching purposes where permanency is not a factor. Transparentized or prepared tracing papers answer the problem of how to combine strength plus transparency, for the added thickness that gives paper its strength usually reduces its transparency. This problem has been solved by means of a solid, stable, synthetic resin which is permanently impregnated into the thicker paper to give it high transparency.

The most recent of drafting media is film. The base material for drafting film is the DuPont polyester film called Mylar. Raw Mylar has natural dimensional stability, great tearing strength, high transparency, high age and heat resistance, and nonsolubility and waterproofness. However, raw Mylar is not a satisfactory surface for pencil drawing; it has a tendency to curl up; and static electricity builds up and holds dust on the film. Therefore, various drafting media manufacturers treat Mylar to overcome these objections and market the drafting film under trade names other than Mylar. Herculene and Stabilene are two popular drafting films.

As indicated in the foregoing paragraphs, there are many qualities to be considered in selecting a drafting medium for the job at hand. These include a consideration of whether the medium was designed to take ink or pencil or both. The color, the visual transparency, and the reproductive transparency must be considered. Also the strength, erasability, and permanence. And, most important for some engineering drawings, the dimensional stability under varying conditions of temperature and humidity.

Drafting media are available in rolls, in sheets, and in pads. Typical roll lengths are 20 yards and 50 yards and typical widths vary from 24 inches to 54 inches in 6-inch increments. Sheets are generally cut to order by the supplier, but stock of some popular sheet sizes are often kept on hand. The following sizes (in inches) are typical: 8 1/2 x 11, 11 x 17, 12 x 18, 17 x 22, 18 x 24, 22 x 34, and 24 x 36. Pads of tracing paper may also be prepared to order, but stocks are often maintained of pads of 25, 50, and 100 sheets of some sheet sizes of which the following are typical: 8 1/2 x 11, 11 x 14, 11 x 17, 14 x 17, 18 x 24.

All of the drafting media are available plain without any preprinting. But some drafting shops find it convenient and economical to order sheets with preprinted borders and, sometimes, title blocks. Sheets, rolls, and pads preprinted with nonreproducible or fade-out grid lines or guide lines are popular. The cross-section lines are printed in a special nonreproducible ink and these grids will not appear when the drawing is reproduced by diazo or photographic methods. Rolls, sheets, and pads of paper, and rolls of film, are stocked by most suppliers. Grids available include the following number of lines to each square inch: 4 x 4, 5 x 5, 8 x 8, 10 x 10, and 20 x 20.

DRAFTING ROOM SUNDRIES

Most of the basic equipment and materials used in a drafting room have been mentioned thus far in this chapter. However, there are a few common items which have not been covered.

Drafting tape, similar to masking tape, is used to attach drawings to the board. Paperweights are convenient, particularly for use on the light table or when an edge of the tracing paper must be frequently lifted to read faint lettering on a drawing being traced. Leather bags filled with lead shot are popular paperweights.

Transparent mending tape is used to repair tears in tracings and to patch holes which resulted from your leaning too heavily on the electric erasing machine. Never use cellophane tape—it shows up on the prints.

Various kinds of sharp-bladed knives and paper cutters are sometimes used in drafting rooms. The old-fashioned 14-inch or 16-inch paper shears, however, are probably best for cutting paper.

Preparations similar to talcum powder come in shaker-top containers with a felt pad on top. This powder is used to prepare the surface of cloth before it is drawn on with ink. Sprinkle the powder on the linen, rub it with the felt pad, and then shake off the excess powder.

Rubber cement is frequently used in drafting rooms to make a mosaic of work prints when the overall drawing consists of more than one sheet.

SPECIAL INSTRUMENTS

There are a number of drafting instruments which are not always required but which are very useful, and at times indispensable, for certain types of work. Some of these are used only in one highly specialized field of drafting. Others are used in several fields, and since a general knowledge of these are of value to every draftsman, their use and care are discussed in this section.

Meter Bar

The meter bar, so-called because its graduated scale is one meter in length, is the standard scale for all measurements used in constructing projections or other operations involving comparatively long distances. It is made of german silver and graduated by machine with great precision, on one side at a scale of 1:10,000 and on the reverse at a scale of 1:20,000. (See fig. 3-72.)

The bar may be used for other scales by applying a simple ratio to the distance to be scaled. For example, a 10,000-meter distance on a 1:40,000 scale will equal 5,000 meters on the 1:20,000 scale of the meter bar; or similarly, 2,500 meters on the 1:10,000 scale.

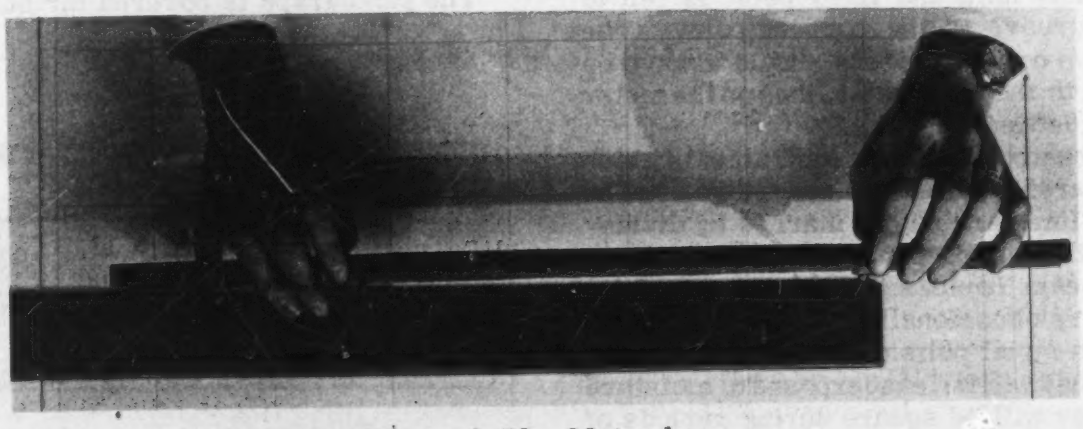

Figure 3-72.—Meter bar.

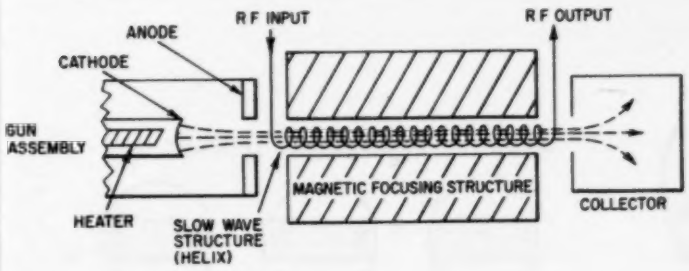

Figure 12-12.—Schematic view of helix type traveling wave tube.

tube, and eventually dissipate in the collector in the form of heat.

At the same time the electron beam is moving through the tube, the desired RF signal is fed into a slow-wave structure consisting (in this case) of a tightly wound wire called a HELIX. The phase velocity of the RF wave (or the speed at which the wave is moving forward) is made synchronous with the velocity of the electron beam.

An interaction is created between the electron beam and the RF signal. This interaction is such that the electrons in the beam are slowed by the RF field, and move down through the helix in bunches. As the electrons are slowed, they surrender energy to the RF field, resulting in great amplification of the RF signal by the time it reaches the output.

COMPONENTS

Basically, all traveling wave tubes consist of the same components, although there are many variations of each of these. These components are:

1. Electron gun, to produce the electrons and to shape them into a beam.
2. Slow wave structure, to propagate a microwave signal in such a manner as to permit interaction between the signal and the beam.
3. Collector, to absorb and eliminate the unused energy from the beam upon completion of its travel.
4. Input and output coupling devices for the transfer of energy into and out of the tube.
5. Attenuator, to isolate the input and output sections of the tube, so as to prevent undesirable oscillations.

These components and some of their variations are discussed in this section.

Electron Gun

The electron gun is the source of electrons for the beam, and is similar to the lens in a projector. Its main objective is to get as much electron current to flow in as small an area as possible, without distortion or fuzzy edges. A wide variety of gun designs have been developed in an effort to improve gun optics and to provide better beams.

Different types of cathode materials have been used as electron emitters. Two types have become generally standard: The oxide type, which has a nickel base with a barium-strontium coating; and the L-type (or dispenser) cathode which has an emitting surface consisting of porous tungsten through which barium atoms are dispensed from a chamber containing barium-strontium-oxide crystals. In addition, two other dispenser types, the pressed cathode and the impregnated cathode, are also used.

Recently a number of TWT's using control grids have been developed. This innovation permits turning the electron beam on and off rapidly with a smaller voltage swing than is required with cathode modulation of the tube without the grid.

Methods of Focusing

All TWT's require some method of holding the electron beam together as it travels through the interaction structure of the tube, because the beam tends to disperse (or spread out) as a result of the mutually repulsive forces between electrons. An electrostatic field or a magnetic field of the proper magnitude is used to confine the beam in the pencillike cylindrical shape it must maintain. The three principal types of magnetic focusing discussed here are shown in figure 12-13.

SOLENOID.—Solenoid focusing is still considered as one of the best means of obtaining a narrow, pencillike beam of electrons in an electron tube. The magnetic lines produced by the solenoid are parallel to the direction of travel of the electrons, and the solenoid can be alined accurately with the beam. This type focusing continues to be used in cases where the maximum power is required from the tube, and the physical size and weight of the tube and associated circuitry are not critical. However, in airborne equipments, the solenoid type focusing has been supplanted by other means.

The allowable error on a meter bar is 0.1 mm. for any distance. A copy of the calibration test for a bar will usually be found inside the cover of the box in which the meter bar is furnished. Older bars, for which there are no data as to accuracy, should be carefully verified before use by comparison with a standard of known accuracy.

The length of a meter bar is divided into spaces representing 100 meters each at the scale of the bar. The width of the bar is divided into 10 equal spaces by numbered parallel lines. (See fig. 3-73.) At the left end of the bar, one 100-meter space is subdivided by 10 parallel diagonal lines in such a way that distances to tenths of a meter may be scaled as illustrated in figure 3-73.

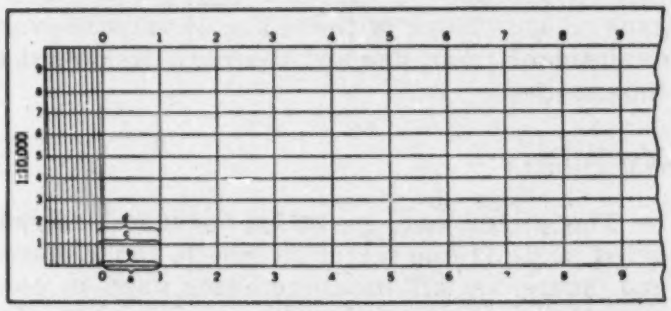

Figure 3-73.—Metric scale: a = 100.0 meters; b = 110.0 meters; c = 111.0 meters; d = 111.5 meters.

In setting a distance on the meter bar with the beam compass, place the point of the leg containing the slow-motion screw on the appropriate 100-meter vertical division line and bring the fixed point to the approximate setting at the left end of the bar. Then, holding the fixed point in your left hand, move the slow-motion screw with your right hand until the fixed point is felt to engage the groove at the correct point. The compass beam or the dividers should always be held parallel to the horizontal lines on the meter bar during a setting.

Meter bars are expensive instruments which should be carefully handled and stored. The finely ruled lines are easily marred by divider points. For this reason, take particular care to handle the beam compass or dividers lightly. Clean the bars occasionally with a soft rag and a nonabrasive metal polish. On board ship, store them where they will be least exposed to moisture and where they will be secure during periods of rough weather.

Quarter-meter scales, similar to the meter bar but only a quarter meter in length, are available at scales of 1:10,000 and 1:20,000. These should be compared with a meter bar of known accuracy before they are used.

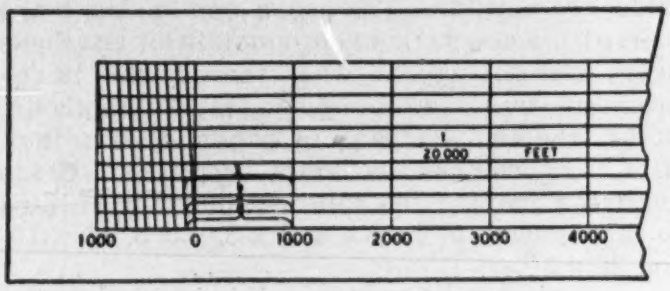

Figure 3-74.—Foot scale: a = 1100.0 feet; b = 1110.0 feet; c = 1125.0 feet.

Foot scales are similar to meter bars in construction and use, but the lengths and values of the subdivided spaces differ. (See fig. 3-74.) The smallest direct reading is 10 feet, but 1-foot distances can be interpolated between the parallel horizontal lines as illustrated. These scales are used in plotting control points or other data where coordinates are in feet.

Pantograph

The pantograph is an instrument for copying drawings to the same, a larger, or a smaller scale. There are a number of different types of pantographs, but the principle governing them all is the same. It consists essentially of a system of bars pinned together in parallelogram form. (See fig. 3-75.) Holes are provided in the arms at certain measured intervals so that the instrument can be set to give a ratio of reduction or enlargement.

The pantograph is covered further in chapter 17.

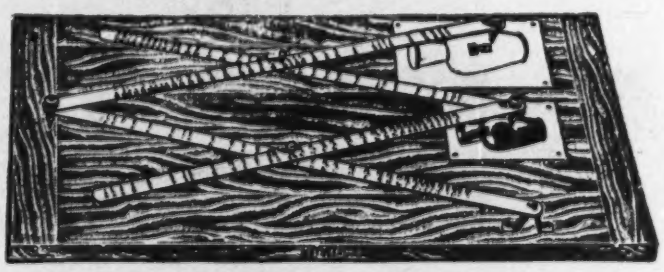

Figure 3-75.—A pantograph.

Planimeter

Planimeters are designed to make measurements of irregular boundaries from which the number of square units of the areas inside these boundaries can be determined. (See fig. 3-76.)

After the tracing arm of the planimeter is set to the desired scale, the tracing point is placed at any convenient point on the boundary of the area to be measured. The tracing arm contains a vernier which is read and recorded. Then the tracing point is carefully guided around the entire boundary of the area to the starting point where it is reread and the reading recorded. The difference between the two readings determines the area of the traverse or other figure with an irregular boundary. This difference is used in computations to give the number of square units in the area. When the work requires special accuracy, several measurements may be taken and the average of differences used as the figure in the computations.

Some planimeters may be set so that the figure representing the area may be read directly. It is customary to make two or three readings with such instruments, using the average of the results as the figure for the number of square units in the area.

Calipers

To make a working sketch directly from a machine part, you will need special instruments to measure the part. The drafting scales are too delicate to use on machinery. If the measuring edge of the drafting scale is nicked, any measurements taken from it when you are drawing may be inaccurate.

In measuring parts of machines, a steel machinists' rule is useful. For cabinet work, use a carpenters' rule. Calipers are invaluable for making accurate measurements of machinery or tools. (See fig. 3-77.) The curved legs of the outside calipers make it possible to reach places where the rule cannot be used. Inside

Figure 3-76.A planimeter.

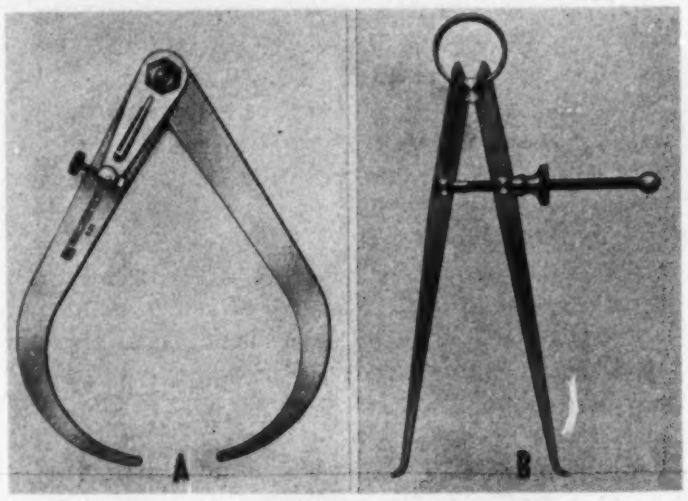

Figure 3-77.—Calipers for measuring machinery. a. Outside calipers. b. Inside calipers.

the calipers are adapted to measuring width of holes or gaps.

Calipers can be used for taking measurements which are accurate to within 1/64 of an inch. It takes some practice, however, to develop the right "feel" required for taking measurements this accurate. When measurements of a cylindrical piece are taken with outside calipers, the calipers should just touch the piece but be free to slide over it under their own weight. (See fig. 3-78a.) When you measure holes with inside calipers, be sure the measurement is taken in a plane exactly perpendicular to the axis of the holes. (See fig. 3-78b.)

For measurements which are accurate to less than 1/64 of an inch, a micrometer caliper is best. Figure 3-79a shows a 1-inch micrometer which will take measurements of dimensions up to 1 inch and which are accurate to within .001 of an inch. Figure 3-79b shows an enlarged view of the scales. The scale running lengthwise along the barrel has divisions representing .025 of an inch; the scale around the thimble had divisions representing .001 of an inch. To take a reading, look at the scale on the barrel first and then add to the figure there the reading on the thimble scale. It is a simple procedure, but it requires a little practice. The beginner usually has a tendency to bring the instrument into too tight contact with the object he is measuring. To prevent this, some micrometers are provided with a friction slip on the thimbles so that they cannot be tightened beyond the correct pressure.

Description and use of simple calipers, caliper squares, vernier calipers, and micro-

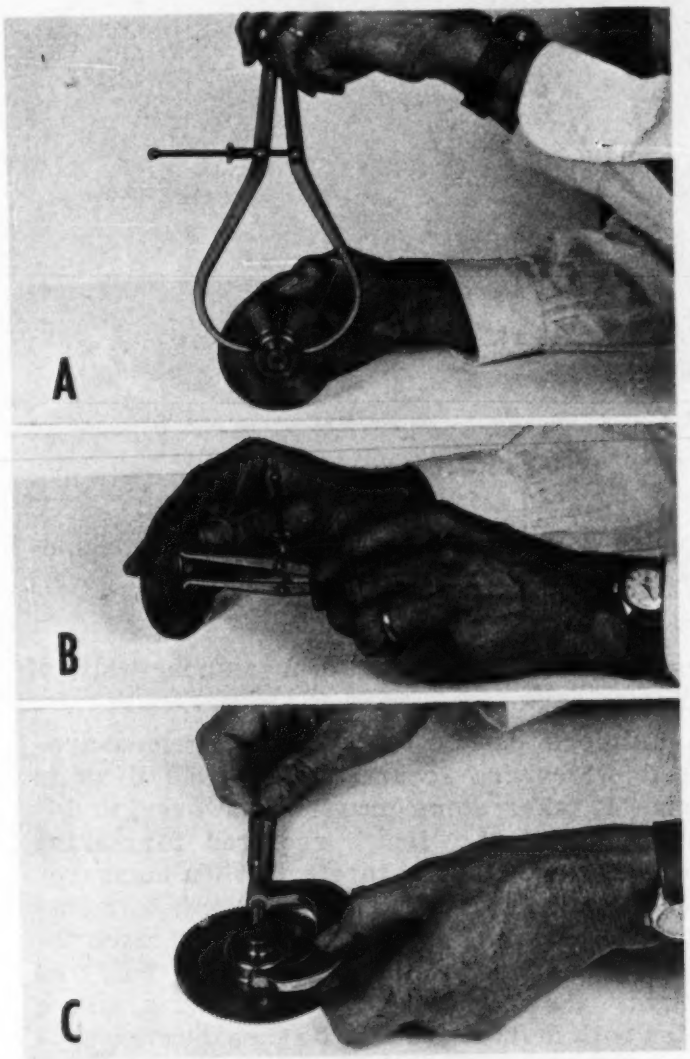

Figure 3-78.—Taking measurements with calipers.

meter calipers are covered in great detail in Part I Section 1 of Basic Handtools, NavPers 10085-A. The maintenance and care of the instruments are also covered in detail.

CARE OF EQUIPMENT

This chapter opened with the presentation of rules concerning the care and stowage of instruments and equipment. Throughout the chapter information relating to care, maintenance, and adjustment has been presented with coverage of both individual items and groups of items of equipment. The subject is so important, however, that it is appropriate to close the chapter on the same note.

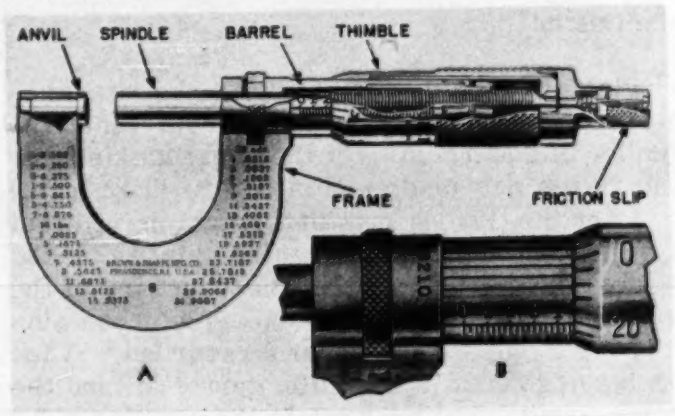

Figure 3-79.—a. Sectional view of 1-inch micrometer. b. Enlarged view of scales.

Some people seem to have the attitude that straightedges, triangles, curves, protractors, and scales are consumables like pencil leads and erasers and that you have to expect to replace them frequently. This attitude has no merit. Properly used, handled, and stowed, these items will last for decades. Don't pound on the board with your scale when you want to emphasize a point or vent your frustration at having made an ink blot. Don't throw a triangle across the room when someone asks to borrow it. In your eagerness to knock off at the end of the day don't shove the equipment off the board and into the drawer in one great sweeping motion. Hang things up. Handle them carefully. And remember, don't use your scale as a straightedge.

Instruments can last a lifetime. Keep instruments, large and small, in their cases. Always carefully preserve the manufacturer's manual which comes with such items as the planimeter or the pantograph. It's not overdoing it to keep the cased instrument and the manual in the cardboard box in which they came from the supplier. That way your successors can find the manual. Keep track of the little containers of extra screws, points, and so on, which are sometimes furnished with instruments. These will permit you, using the manual if necessary, to make minor repairs. If wear or damage cannot be rectified by adjustment or minor repair in the drafting room, the instrument should be replaced or returned to the supplier if repair is economically feasible. Procedures for obtaining repairs and replacement items were covered in chapter 1.

CHAPTER 4

GENERAL DRAFTING PRACTICES

This chapter opens with an explanation of drafting symbols. The next topic includes the techniques of laying out and finishing drawings using the equipment and materials described in chapter 3. The conventional symbols for the lines on a drawing are discussed. The use of instruments and equipment to draw geometrical figures and curves is covered next. The dimensioning of drawings follows. The chapter presents next the types of projections and views which go to make up engineering and architectural drawings. The chapter closes with brief coverage of technical sketching.

SYMBOLS

Symbols are a part of the language of engineering drawings. Spoken languages are living things in the sense that the meaning of words may change; some words fall out of use; new words are introduced, particularly when the technology is rapidly expanding. Similarly, drafting symbols change; some are deleted; many new ones are introduced.

As a Navy draftsman you are required to use symbols which are set forth in the military standards. The standards are presented in an ever-changing series of documents which are identified by the term MIL-STD followed by a number. When you start a new project, make sure that you have the current MIL-STDs needed for the job. Check for the latest MIL-STD editions in the Department of Defense Index of Specifications and Standards, which is issued as of 31 July of each year. Also check the supplements to the Index; supplements are issued every two months between the annual editions. The Index and its supplements are issued in two parts: an alphabetical listing and a numerical listing. It is usually more convenient to use Part II—the numerical listing. Look on the table of contents of Part II for the heading "Military Standards." Your drafting symbol MIL-STDs will be, generally, at the beginning of the list of MIL-STDs. Some are as follows (these are current at the time of preparation of this book and where there have been changes issued the date shown is the date of the latest change):

Number	Title	Date
MIL-STD 1B	General drawing practice	9 Jul 63
MIL-STD-2C Change 1	Engineering drawing sizes and formats	19 Mar 64
MIL-STD-7A	Types and definitions of engineering drawings	18 Feb 64
MIL-STD-8C	Dimensioning and tolerancing	16 Oct 63
MIL-STD-9A	Screw thread conventions and methods of specifying	26 May 60
MIL-STD-10A Change 2	Surface roughness, waviness, and lay	25 Nov 63
MIL-STD-12B	Abbreviations for use on drawings	18 May 59
MIL-STD-14A	Architectural symbols	3 Sep 54
MIL-STD-15 Part No. 1	Graphic symbols for electrical and electronics diagrams part 1A	22 May 63
MIL-STD-15 Part No. 2	Electrical wiring equipment symbols for ships plans part 2	30 Oct 61

MIL-STD-15 Part No. 3	Electrical wiring symbols for architectural and electrical layout drawings part 3	30 Oct 61
MIL-STD-16C	Electrical and electronic reference designations	4 Dec 61
MIL-STD-17B Part No. 1	Mechanical symbols	23 Jan 63
MIL-STD-17B Part No. 2 Change 1	Mechanical symbols for aeronautical, aerospacecraft, and spacecraft use	23 Feb 65
MIL-STD-18A	Structural symbols	12 Aug 53
MIL-STD-20	Welding terms and definitions	14 Dec 49
MIL-STD-21	Welded-joint designs, armored-tank type	5 Oct 61
MIL-STD-22A	Welded joint design	24 Oct 56
MIL-STD-24B	Revision of drawings	28 Jun 63
MIL-STD-25 Change 1	Nomenclature and symbols for ship structure	14 Jun 56
MIL-STD-25 Change Notice 1	Nomenclature and symbols for ship structure	14 Jun 56

Many drawings continue in use for years. Therefore, you will have occasion to work with drawings which contain obsolete symbols. Also, architectural and engineering consulting firms which prepare drawings for the Navy have not always adhered closely to MIL-STD symbols. Look for a legend on the drawings; it should help you in the reading of any symbols with which you are not familiar. If there is no legend, study the drawing carefully and you should be able to deduce the meaning of unfamiliar symbols and abbreviations. MIL-STD symbols, current at the time of preparation, were used in the drawing of the illustrations for this book. However, subsequent changes in the MIL-STDs will render some of these symbols obsolete. This is exactly what you can expect to find on the drawings which you will see in practice.

LAYING OUT THE DRAWING

Before you start drawing, put all the materials and equipment you may need, such as pencils, sandpaper pad, erasers, triangles and curves within easy reach. If you are not using a lead holder, you would do well to sharpen a number of pencils so that you will not have to stop work often later to sharpen pencils.

You can do better work in pencil if your drawing board is covered with a drawing board covering as described in chapter 3 or a sheet of firm paper which serves as a backing for your drawing sheet. When you mount this covering sheet on your drawing board, be sure it does not stick out over the edge on which your T-square slides nor interfere in any way with the free action of the T-square.

Keeping a Clean Drawing

When you start a drawing, remember that there is no excuse for sloppy work and dirty drawings. To keep your drawing clean, you need only observe a few simple rules as you work.

1. Before you begin a drawing, dust your T-square, especially the under side of the blade, dust your drawing board, and wipe off your instruments.
2. After any erasure, dust the eraser crumbs from the board and wipe the under side of the T-square. These crumbs may become charged with electricity and cling to surfaces, deflecting the pencil and keeping the T-square or the triangles from lying flat on the paper.
3. Never use a lead pencil softer than a 2H on a mechanical drawing, because soft leads smudge easily.
4. Keep your hands clean.
5. To protect a drawing from dust or injury when you are not working on it, cover it with a cloth or a sheet of clean paper.

Drawing Sheet Sizes

In the Navy, engineering drawings are made in certain standard sizes, which are given in Military Standard Drawing Sizes and Formats, MIL-STD-2C. Each of these sizes is designated by a letter. Table 4-1 lists these sizes by letter. The size of the sheet you use for each drawing will probably be governed by drafting room practice in any command to which you are assigned.

Drawing Sheet Format

The drawing sheet format has been standardized, as well as the size. The distance between the border line which you draw and the actual cut line or margin of the finished drawing may vary a specified amount, depending on whether

Table 4-1.—Finished format sizes (inches).

FLAT SIZES				ROLL SIZES				
SIZE DES (LTR)	X (WIDTH)	Y (LENGTH)	Z (MARGIN)	SIZE DES (LTR)	X (WIDTH)	Y MIN (LENGTH)	Y MAX (LENGTH)	Z (MARGIN)
A(HORIZ)	8.50	11	.25&.38*	G	11	42	144	.38
A(VERT)	11	8.50	.25&.38*	H	28	48	144	.50
B	11	17	.38	J	34	48	144	.50
C	17	22	.50	K	40	48	144	.50
D	22	34	.50					
E	34	44	.50					
F	28	40	.50					

*HORIZONTAL MARGINS .38-INCH, VERTICAL MARGIN .25-INCH, SEE FIGS. 1 & 2

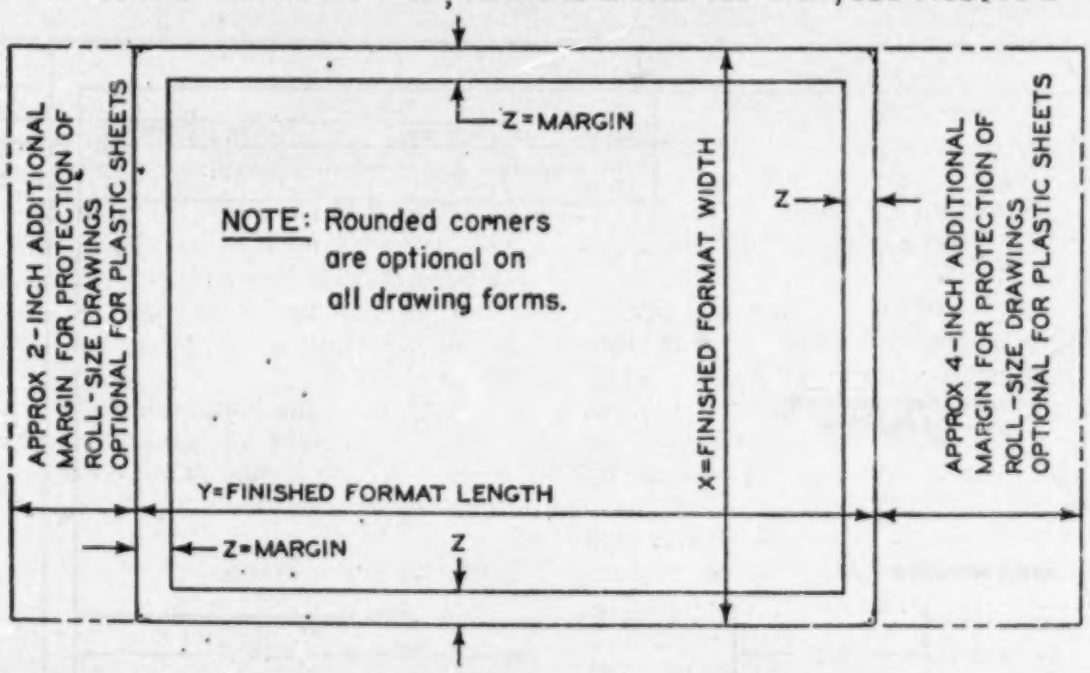

the drawing is to be bound. There is a specified place for the title block, the revision block, and the drawing number which is entered in the official records and which is used in filing. The dimensions of the margins and the various blocks are specified in detail in MIL-STD-2C. Figure 4-1 is typical of the drawings in MIL-STD-2C. In figure 4-1 the letters A through N refer to the following:

A — Record information block
B — Drawing title
C — Design activity identification
D — Design activity approval
E — Approval by activity other than design activity
F — Code identification number
G — Drawing size
H — Drawing number
J — Scale
K — Reference to a specification or report, etc.
L — Multisheet numbers
M — Dimensional notes
N — Material, finish, treatment, etc.

On some drawings, it is necessary to add other elements to the format, such as a block for dimension notes, a block for the description

of material used (bill of material), or a usage block for identifying elements in the drawing with other drawings containing these same elements by drawing numbers. There may also be a block for a complete material record or list and a block for listing physical properties. The security classification block should be included only on those drawings that are classified as Top Secret, Secret, or Confidential. The type and number of these special blocks depends on the purpose of the drawing. MIL-STD-7A lists the definitions and requirements for 28 different types of engineering drawings and shows a sample drawing of each type. Examples of the different types of drawings are: assembly drawing, control drawing, detail drawing, diagram drawing, erection drawing, installation drawing, and matched parts drawing.

In some drafting rooms, the work is so standardized that the drawing sheets used are printed with the border line, the necessary blocks, and even some of the lettering. This saves the individual draftsman the time he would spend laying out the format of a sheet. In other places, each drawing is so different that it requires a different format, and the draftsman must be prepared to execute the necessary format.

Fastening the Drawing Sheet

Fastening a drawing sheet to the drawing board seems like a very simple operation. However, you will find that unless you do it properly, a perfectly smooth, flat surface on which to draw is difficult to obtain. To properly

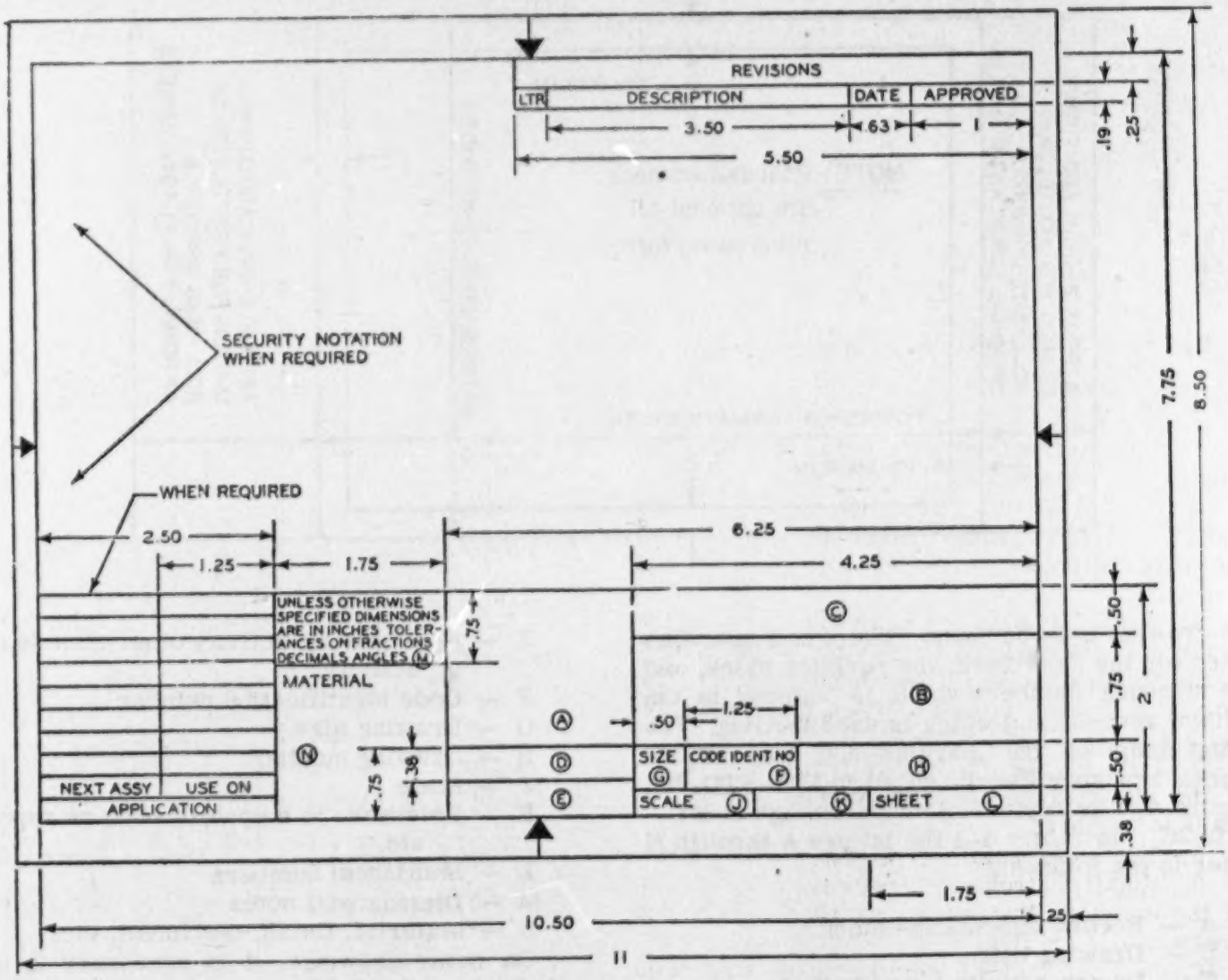

Figure 4-1.—Horizontal format for A size drawings.

fasten the drawing sheet to the board, follow these steps:

1. Wipe the drawing board and T-square free of all dust.
2. Place the paper in position near the upper left hand corner of the board as shown in figure 4-2. See that the upper edge of the paper is parallel with the upper edge of the board.
3. Place the T-square in position with its head held firmly against the left edge of the board.

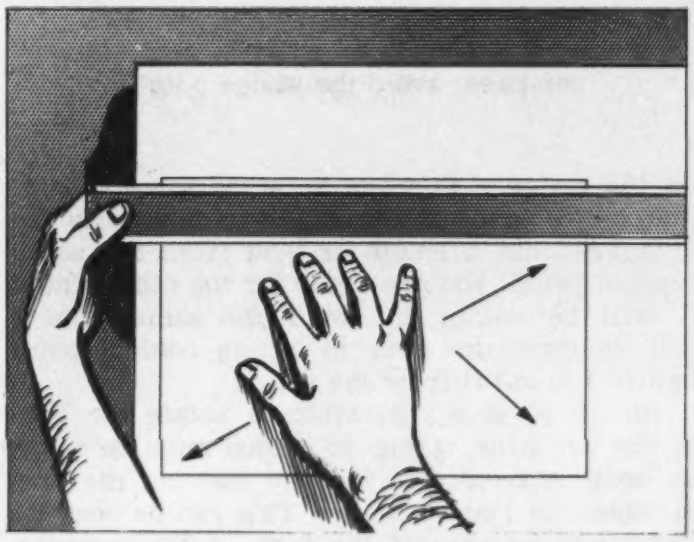

Figure 4-2.—Fastening the drawing sheet.

4. Place tape lightly in the upper left hand corner of the paper.
5. With your left hand, slide the head of the T-square into position. Make the top edge of the paper parallel with the top edge of the T-square.
6. With the palm of your hand stroke the paper so that it adheres smoothly to the board, working from the upper left hand corner to the lower right hand corner. Then place tape on the lower right hand corner.
7. Now stroke the paper from the middle of the sheet to the upper right hand corner and place tape there.
8. Test the position of the paper again.
9. Finally, stroke the paper from the middle of the sheet to the lower left hand corner and press tape down firmly.
10. Be sure that all the tape has been pressed down firmly so that the T-square can be moved easily over it.

Order of Penciling

When your paper is firmly mounted on the board, draw the cutting line, or margin line, to the standard size which has been selected for the drawing. Then draw the border line, the title block, and any other blocks you may need.

You may find it a help to make freehand sketches on a piece of scratch paper of the various views you expect to show, before you start to lay out your drawing. Then cut them out and place them on the sheet in correct order and approximate location. Don't forget to allow space for notes and dimension lines.

In making a view drawing, follow this order of penciling:

1. Draw all center lines. Symmetrical parts should be marked by center lines. In views that are not symmetrical, select a large plane face as a base line. (See fig. 4-3a.) On the center lines, point off the over-all dimensions.

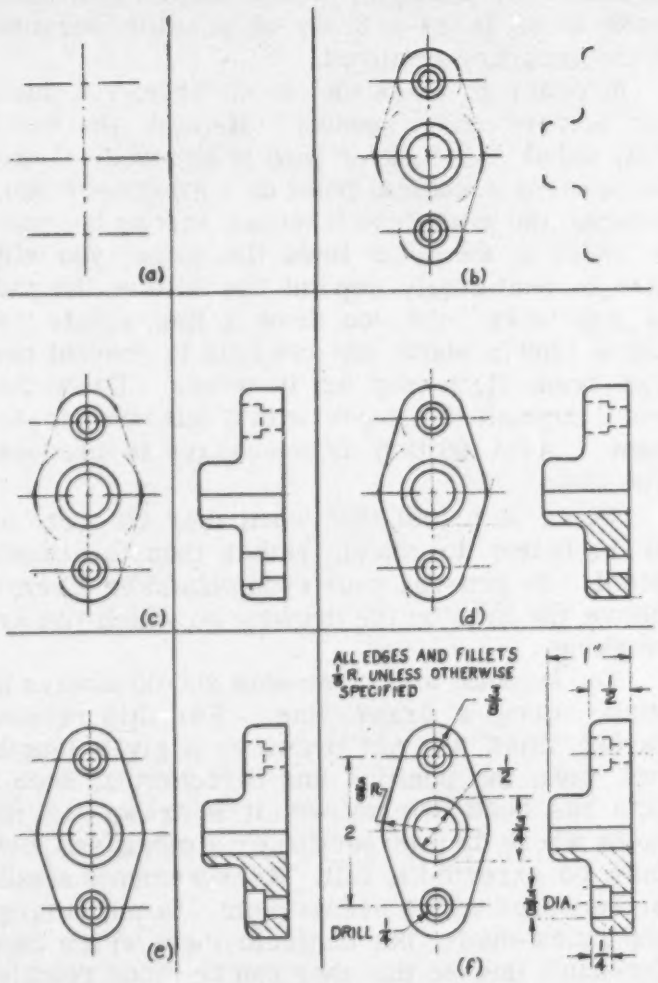

Figure 4-3.—Order of penciling a drawing.

2. Draw the chief circles, arcs, and fillets. These circles, as shown in figure 4-3b, often project to another view, and if you draw them first you save yourself the trouble of making the measurements for this other view.

3. Draw the principal horizontal and vertical lines in the views. (See fig. 4-3c.)

4. Draw the slant lines. (See fig. 4-3d.)

5. Clean up the drawing, erasing construction lines and any excess lines. (See fig. 4-3e.)

6. Draw extension lines, dimension lines, and leaders. (See fig. 4-3f.)

Precision Drawing

Actually all detail drawings should be made with as great a precision as possible, because a good drawing inspires confidence and the workman using it will be more likely to do good work on the part he makes with the incentive supplied by a good drawing. However, there are certain techniques which are specifically applicable to layouts. For example, layouts should always be made to as large a scale as possible because of the accuracy required.

In order to make the layout lines, you must use a very sharp pencil. Remove the wood until about 1/2 inch of lead is exposed. Grind the lead to a conical point on a sandpaper pad, rotating the pencil as it moves across the pad. In order to keep the lines the same, you will have to continually repoint the lead on the pad as you work. As you draw a line, rotate the pencil slowly about its own axis to prevent the lead from flattening as it wears. Draw the pencil across the paper with a full arm movement. Arm motion is necessary to produce true lines.

Some men feel that when they do a layout, it is better to stand, rather than to sit on a stool. In general your eyes should be directly above the area on the drawing on which you are working.

On layouts, measurements should always be made along a drawn line. For this reason, layout lines are not drawn to a given length, but when the position and direction of such a line has been determined, it is drawn past the point where an intersection or a measured point may be expected to fall. Measurements should be recorded with a needle point. Do not enlarge the holes made, but encircle them with a light freehand line so that they can be found readily.

When you use a compass, it is necessary to use the same lead you use for the other lines on the layout if they are to be the same weight. Instead of using the leads that come with the compass, cut a length of lead from the same type of pencil you are using for the other lines. It will be easier to obtain the same point if you sharpen the lead to a long conical point before you cut it from the pencil.

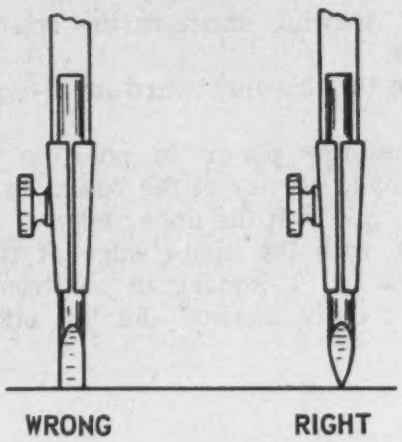

Figure 4-4.—Sharpening the lead for the compass; avoid the wedge point.

Since it is not possible to rotate the lead in the compass, some provision must be made to keep it from wearing and causing the line to widen as you draw it. This can be done by flattening the side of the lead. A broad wedge shape, however, should be avoided. (See fig. 4-4.) Remember that you will have to keep continually repointing the lead as you work.

FINISHING THE DRAWING

In making a finished drawing for reproduction, it is often wise to follow the drawing procedure just outlined and make a rough but accurate drawing first. Then you can trace a more finished drawing from this. Complete the drawing by lettering dimensions and notes, and hatching any cross sectioning. Finally letter the title, drawing number, and any other information required in the blocks of the drawing format.

If you are required to make a change in a pencil drawing, place a sheet of tracing paper over the drawing sheet and draw your change on it, connecting the lines with enough lines traced from your original drawing to make it easy to position it on the drawing. Then make any erasures necessary on the original drawing and, slipping the piece of paper with the

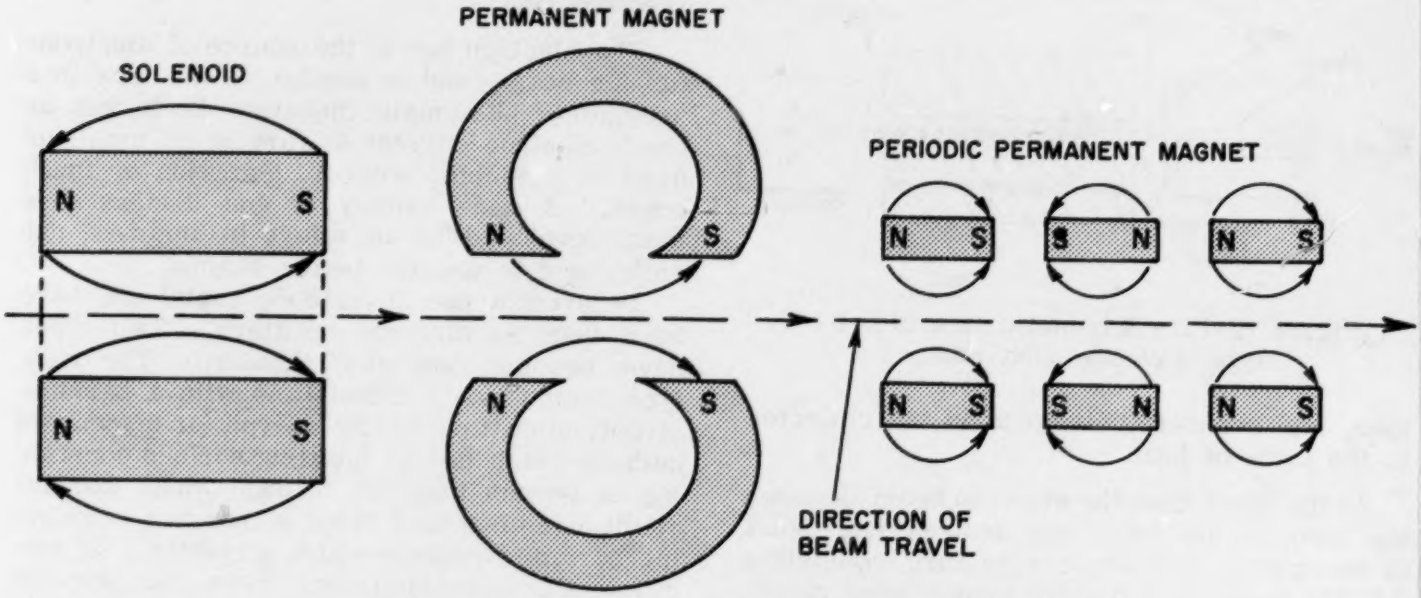

Figure 12-13.—Types of magnetic focusing.

PERMANENT MAGNET.—Permanent magnet focusing is frequently used in tube structures where the interaction space is short. Extremely powerful magnets are required for this application, and the weight and physical size must not be excessive if the tube is to be used in airborne applications.

PERIODIC PERMANENT MAGNET.—Periodic permanent magnet (PPM) focusing is perhaps the most important new development in the evolution of beam control methods. In this method, small but powerful permanent magnets are placed at regular intervals along the slow wave structure of the tube. As the electron beam travels along the interaction space, it is acted upon by the magnetic fields which periodically focus it into a sharp beam. Figure 12-14 illustrates the construction and arrangement of this type focusing system.

This lightweight focusing method fills a great need in the high power systems where the focusing solenoids formerly required for the high density electron beam were too large and too heavy for many of the airborne and space applications. The tube shown in figure 12-14 (A) is a high power X-band TWT. The tube is a metal-ceramic type using the coupled cavity interaction space (discussed later), and weighing only about 15 pounds complete. Its magnetic structure is composed of round disks represented in the cross section by the black vertical areas at the ends of the interaction structure. These magnets are separated by the lighter-colored iron pole pieces, which not only act as magnet separators but also form the interaction structures of the tube.

A helix type TWT using PPM focusing is shown in (B) of figure 12-14.

ELECTROSTATIC.—Electrostatic focusing systems have been used with low power and medium power traveling wave tubes, but some difficulty has been encountered at the high power levels. The electrostatic focusing system requires no magnetic field, and it is considered practical to make it even lighter and smaller than the PPM focusing system. However, in the present state of development, it has not yet reached that point.

Slow Wave Circuits

Basically, there are two types of slow wave circuits used in traveling wave tubes. These are the HELIX and the FILTER TYPE. Each of these types has several variations, and each has its advantages and disadvantages. The particular circuit used is determined by the function of the tube and its associated circuitry.

THE HELIX CIRCUIT.—The helix circuit gets its name from the fact that the structure which comprises the slow wave circuit is a coil of wire wound in the shape of a helix, or coil spring. The helix is considered to be the most efficient slow wave circuit for TWT applications. It is capable of producing wider bandwidths than any of the newer versions, but its use is limited by power output restrictions.

The helix is normally made of tungsten or molybdenum, and is wound to extremely accurate dimensions. The fields associated with

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prefer to ink all horizontal lines, shifting the set of the ruling pen. Others prefer to ink first all the horizontal lines of one weight, then all the horizontal lines of another weight and so forth. Still others prefer to ink the horizontal visual lines as shown in figure 4-7b and go on to ink other visual lines before inking lines of any other weight.

3. Next ink vertical lines, as shown in figure 4-7c.

4. Ink slant lines as systematically as possible. (See fig. 4-7d.)

5. If only visual lines have been inked first, ink other line weights in the same order, including the cross hatching. (See fig. 4-7e.)

6. Finish the drawing by inking all lettering. (See fig. 4-7f.)

Tracing on Cloth

If you are assigned to make an ink tracing on tracing cloth, first check carefully for accuracy the pencil drawing from which you are to make the tracing. Errors in ink on tracing cloth are hard to erase. Since tracing cloth is not completely transparent, you may go over the lines of the pencil drawing with an H pencil to darken them and save yourself eyestrain. Use a needle point to prick the centers of all circles and arcs or draw a small dark circle around the centers. This makes it possible for you to see the centers through the cloth.

On the dull surface of tracing cloth as it comes from the manufacturer, there is a greasy film that repels ink. Remove this film by dusting

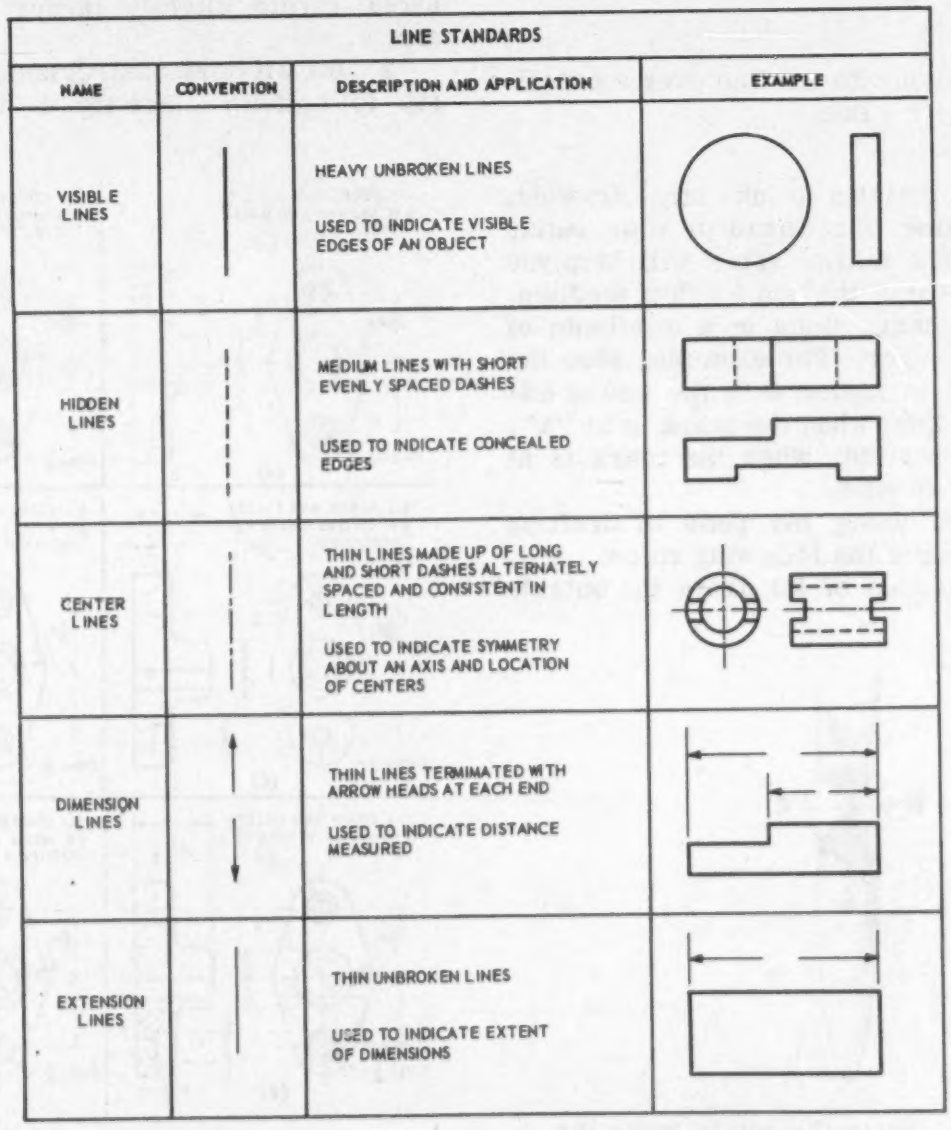

Figure 4-8.—Line characteristics and conventions.

a prepared powder, called pounce, on the cloth and rubbing it in with a cloth or with your hand. After the excess pounce has been brushed off, the cloth will take ink.

Do not use water on tracing cloth, and be sure the cloth is kept in a dry place. Since the preparation used to surface the cloth has a starch base, water will destroy the surfacing of tracing cloth and wash out the drawing.

Order of Tracing on Cloth

In tracing the order of inking previously discussed is followed, with one important exception. Since tracing cloth changes shape with changing atmospheric conditions, ink only a section of the drawing which you can finish at one sitting. Do not ink the circles for the entire sheet if you can finish only part of it during the day. If you ink all the circles, you may find that the circles have shifted slightly from their centers by the next morning.

Erasures on Tracing Cloth

Use an ink eraser to erase errors in ink lines on tracing cloth. It requires skill to make

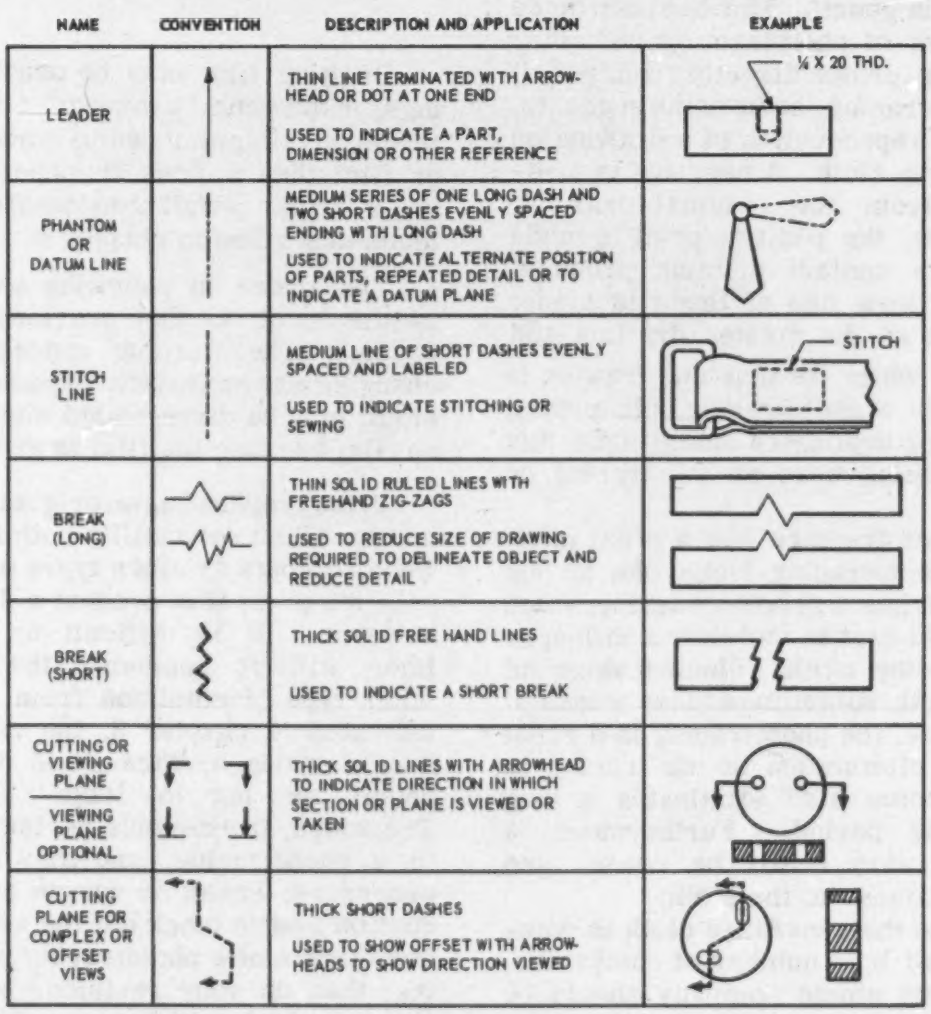

Figure 4-8.—Line characteristics and conventions—continued.

an erasure without laying bare the threads of the cloth. If the threads are laid bare, fresh ink from ink lines drawn over the threads will spread into them just as ink spreads in any cloth, and an ugly blot, impossible to erase, will be formed.

When threads are laid bare, they have to be especially treated before ink lines can be drawn over them. Soapstone is used to resurface the threads. The soapstone can be rubbed on directly, or powdered soapstone can be scraped on with a knife. Rub it in with your finger and polish it briskly with the back of a fingernail.

Do not use a knife to cut out an error if you are planning to ink over the spot. However, after a drawing has been finished, you may use a very sharp knife to cut off excess lines.

Phototracings

In the last few years, more and more drafting rooms have adopted the practice of making their finished drawings in pencil. This has been made possible by the use of phototracings and other methods of making prints directly from pencil drawings. A phototracing, as its name suggests, is a photographic reproduction of a drawing on a sensitized tracing cloth. A negative is made photographically from the original drawing. From this negative, the positive print is made on the cloth by a contact printing process. Usually no more than one of these is made, and it is marked as the master drawing and kept in the files, while the original drawing is destroyed. From a phototracing, blueprints, vandykes, and other duplicates can be made, just as if the phototracing were an ink tracing on tracing cloth.

The use of phototracings has a great many advantages. A phototracing looks like an ink tracing. The cloth has a gelatine backing which makes it more resistant to moisture and longer wearing than tracing cloth. Since making an ink tracing on cloth sometimes takes weeks of a draftsman's time, the phototracing is a great timesaver. The elimination of ink tracing in many drafting rooms also eliminates a long apprentice-training period. Furthermore, a phototracing can very easily be erased and redrawn without damage to the cloth.

However, since the sensitized cloth is commercially prepared by a number of companies, a sample from any single company should be tested before the cloth is used for reproducing drawings. Poor phototracing cloth will stretch or shrink out of shape in the drying process and drawings reproduced on such cloth will become badly distorted.

To erase the lines of a phototracing, use a wet ink eraser. Then you can redraw a portion of the drawing just as if you were working on ordinary tracing cloth but without worrying about exposed threads.

The use of phototracings has made the technique of pencil drawing far more important. A pencil drawing must be good if a good phototracing is to be made from it, and even a good drawing will sometimes reproduce with a few uneven lines or indistinct details.

Touch up a phototracing as you would ink a drawing, following the procedures under the section on order of inking. Touching up a phototracing is never so arduous as making a complete tracing on tracing paper or cloth.

Working on Film

Drafting film may be used for pencil drawings, inked pencil drawings, tracings, or phototracings. Regular pencil smudges more easily on film than it does on paper or pencil cloth; use a harder pencil than usual or use the special leads described in chapter 3.

The order of penciling and inking on film is the same as that previously described for paper. The warning concerning the shape-changing characteristic of paper and, especially, cloth, may be disregarded when you are working on film because the film is exceptionally stable.

Film prepared as an original drafting medium has excellent erasability both for pencil and ink. Phototracings or other types of duplicate originals made on film present a different problem, however. It is difficult to erase duplicated lines without removing the photographic or other type of emulsion from the film, and, as indicated in chapter 3, the raw Mylar is not a good drawing surface—it is difficult to get the pencil or ink to "take" on the raw film. Therefore, if extensive revisions must be made to a phototracing, you may use the following procedure: erase or cut out or have the reproduction people block out the area to be removed; then have a new phototracing made of the drawing; then do your revisions on the new phototracing which will have a usable emulsion over the plastic.

LINE CONVENTIONS

In drawing an object, a draftsman not only arranges the different views in a certain manner, but he also uses different types of lines to convey information. Line characteristics, such as width, breaks in the line, and zigzags, have meaning. Figure 4-8 shows the different types of lines which should be used on engineering drawings as they are given in MIL-STD-1B.

Types of Lines

Often the first lines a draftsman draws on his drawing sheet are the center lines of the views. Center lines are composed of long and short dashes, alternately and evenly spaced, with a long dash at each end. They are used to indicate the center of a symmetrical object. A base line instead of a center line is used for an unsymmetrical view. A center line is also used to indicate the center of a circle or arc on a view. (See fig. 4-9.)

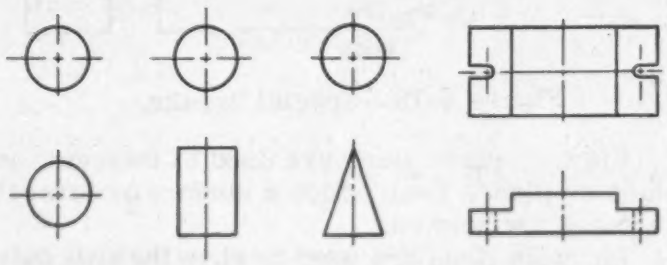

Figure 4-9.—Use of center lines.

A very short center line may be drawn as a single dash if there is no possibility of confusing it with other lines. Center lines may also be used to indicate the travel of a moving center.

The visible lines of the views are drawn as solid, thick lines. These include not only the outlines of the view, but lines defining edges which are visible within the view. (See fig. 4-10.)

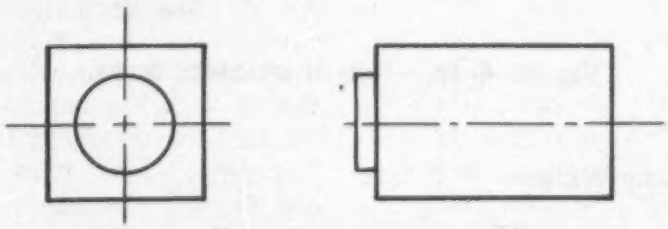

Figure 4-10.—Use of visible lines.

Hidden lines are drawn with short dashes and are used to show the hidden features of an object. A hidden line should begin with a dash in contact with the line from which it starts, except when it is the continuation of an unbroken line. (See fig. 4-11.)

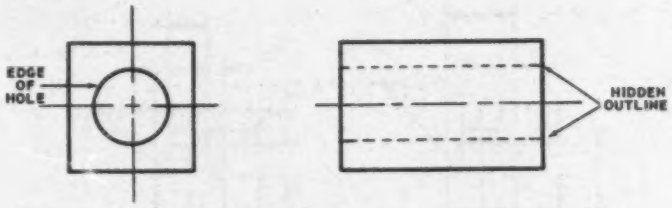

Figure 4-11.—Use of hidden lines.

Extension lines are used to extend dimensions beyond the outline of a view so that they can be read easily. These thin, unbroken lines are started about 1/16 of an inch from the outline of the object and extend about 1/8 of an inch beyond the dimension line. They are drawn parallel to each other and perpendicular to the distance to be shown. (See fig. 4-12.)

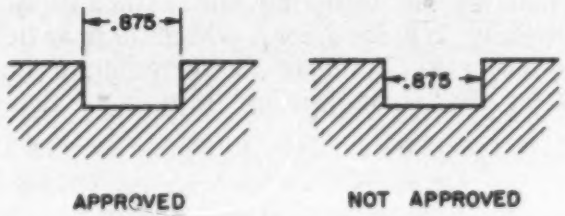

Figure 4-12.—Use of extension lines.

As far as practicable, avoid drawing dimension lines directly to the outline of an object. When it is necessary for extension lines to cross each other, they should be broken, as shown in figure 4-13.

A dimension line, terminating at either end in a long, pointed arrowhead, is inserted between each pair of extension lines. It is a thin line, and except in structural drafting, it is usually broken to provide a space for the dimension numerals. Occasionally, when the radius of an arc is to be indicated, there is an arrow at only the end of the line which touches the arc. The other end, without an arrow, terminates at the point used as the center in drawing the arc.

A leader is a line with an arrowhead which touches the surface to which the leader refers

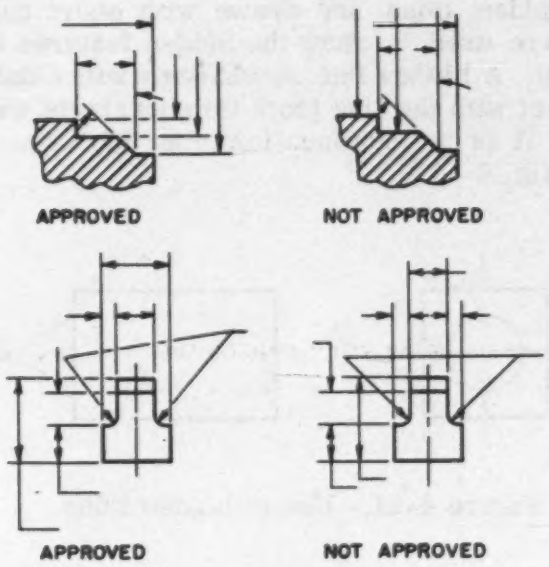

Figure 4-13.—Breaking extension lines and leaders at points of intersection.

or an extension line to that surface. Leaders are used to connect numbers, references, or notes to the appropriate surface on the drawing. These lines are drawn at an angle to show their difference from other lines. Leaders should terminate at the lettering end with a line approximately 1/8 inch long which is parallel to the construction lines of the lettering and centered on the first line of letters. (See fig. 4-14.)

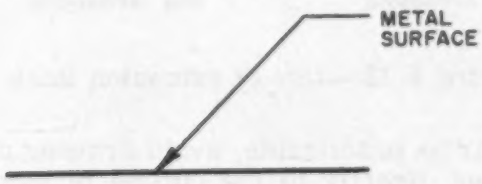

Figure 4-14.—A leader.

Break lines may be used to save space when an extended part of an object has the same continuous shape and size. For instance, they may be used when the details of a piping system are to be shown. Drawing space can be saved by "breaking" the line representing a pipe and leaving an unimportant part out of the drawing. Long break lines are drawn as thin, zigzag lines; short break lines are drawn as thick, wavy lines.

For drawings made to a large scale, special conventions are used that apply to drawing breaks in such things as metal rods, tubes, or bars. The methods of drawing these breaks are shown in figure 4-15.

Cutting plane lines are used to indicate a plane or planes in which a sectional view is taken. For a more complete discussion and illustrations of the use of these lines, see "Sectioning Techniques" in this chapter.

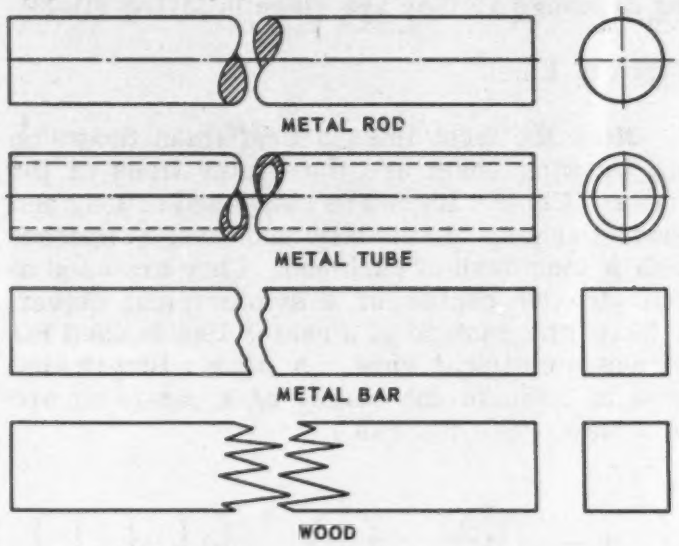

Figure 4-15.—Special breaks.

Viewing plane lines are used to indicate the plane or planes from which a surface or several surfaces are viewed.

Phantom lines are used to show the alternate position of movable parts or repeated details, or the position of some related part that is absent. (See fig. 4-16.)

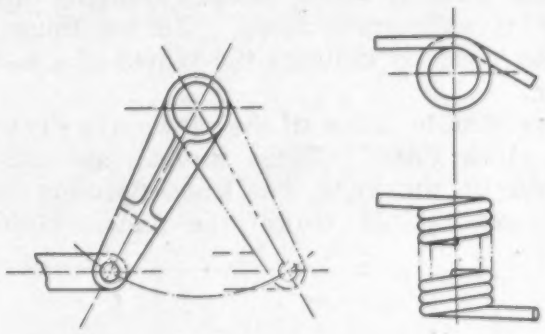

Figure 4-16.—Use of phantom lines.

Line Widths

The widths of the various lines used in making a drawing are important in interpreting

the drawing. MIL-STD-1B states that in inked drawings three widths of line should be used; thin, medium, and thick. The actual width of each type of line should be governed by the size and the style of the drawing.

On pencil drawings, the width of lines cannot be controlled as well as can the width of lines drawn with a ruling pen and ink. Pencil lines should be opaque and of uniform width throughout their length. Cutting plane and viewing plane lines should still be the thickest lines on the drawing. Lines used for outlines and other visible lines should be thick enough so that they can be differentiated from hidden, extension, dimension, or center lines.

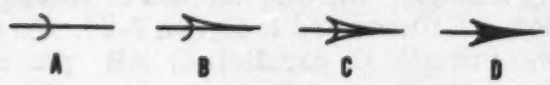

Figure 4-17.—Method of drawing an arrowhead.

Drawing the Arrowhead

The arrowhead on a dimension or leader line is an important detail of a drawing. If these arrowheads are sloppily drawn and vary in size, the drawing will not look finished and professional. The size of the arrowhead used on a drawing may vary with the size of the drawing, but all arrowheads on a single drawing should be the same size, except occasionally when a space is very restricted.

The arrowheads used on Navy drawings are usually solid, or filled in, and are between one-eighth and one-fourth of an inch long, with the length about three times the spread. (See fig. 4-17.) When many arrowheads of one size are to be drawn, it may save time to cut a template, or pattern, of the arrowhead in a sheet of plastic. Such a template is easy to use when the drawing is in pencil. When you are using ink, much more care is necessary to keep the ink from running under the edge of the plastic and spoiling the drawing.

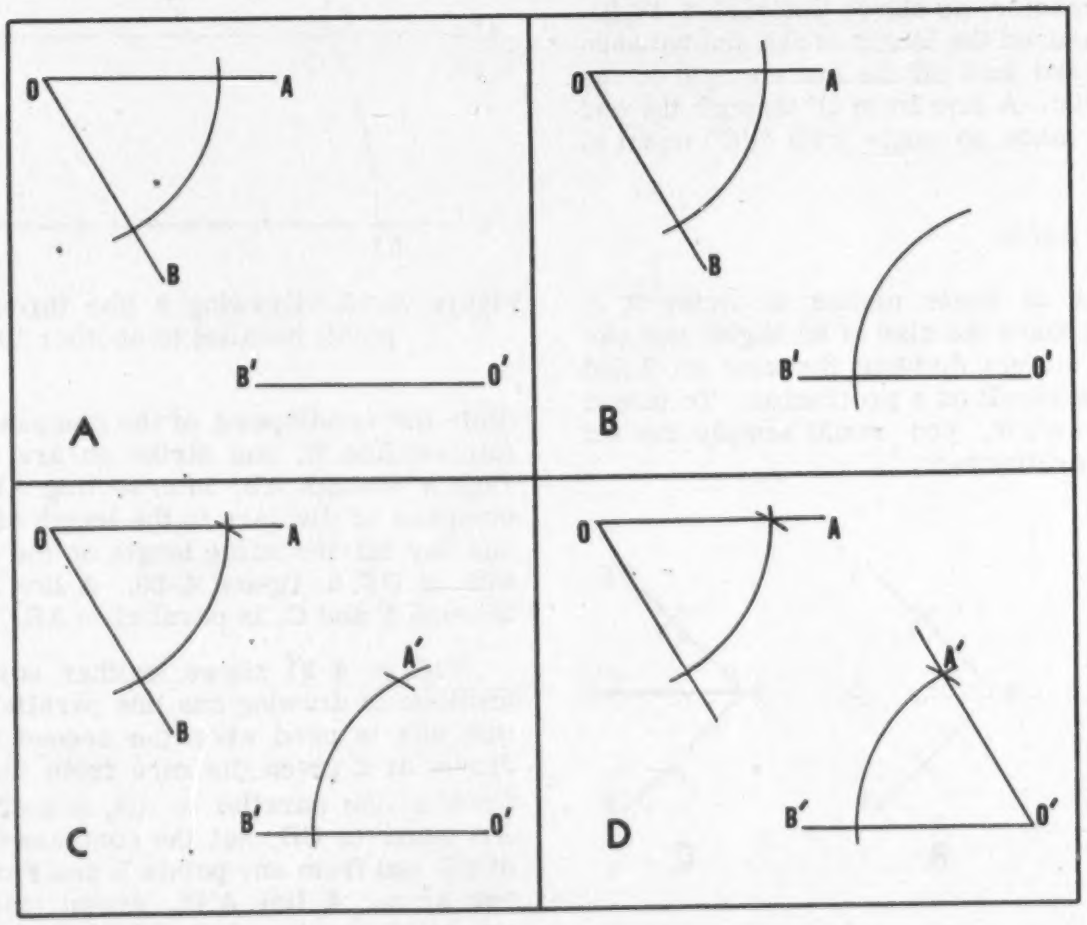

Figure 4-18.—Transferring an angle.

With a little practice, you can learn to make good arrowheads freehand. First, define the length of the arrowhead with a short stroke, as shown in figure 4-17a. Draw the sides of the arrowhead as shown in figure 4-17b and c. Then fill in with ink the area enclosed by the lines, as shown in figure 4-17d.

GEOMETRIC CONSTRUCTIONS

CONSTRUCTIONS INVOLVING ANGLES

Transferring an Angle

There is a geometric construction for laying off, on another part of the same drawing or on a different drawing, an angle equal in size to one which is already drawn. This procedure (which is called transferring the angle) is illustrated in figure 4-18. Here the draftsman desired to lay off from O' a line which would make an angle with B'O' equal to angle BOA. He drew an arc through OB and OA, with O as a center, as shown in figure 4-18(A). He then drew an arc of the same radius from B'O', with O' as a center, as shown in figure 4-18(B). Next he measured the length of the arc between OB and OA and laid off the same length on the arc from B'O'. A line from O' through the end of this arc made an angle with B'O' equal to angle BOA.

Bisecting an Angle

To bisect an angle means to divide it in half. If you know the size of an angle, you can bisect it by simply dividing the size by 2 and laying off the result on a protractor. To bisect a 45-degree angle, you would simply lay off 22.5° on the protractor.

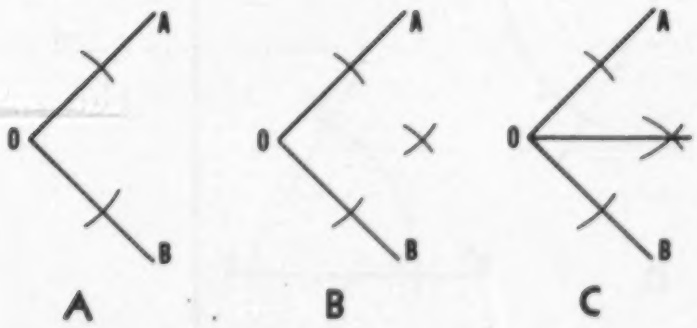

Figure 4-19.—Bisecting an angle.

Geometric construction for bisecting an angle is shown in figure 4-19. To bisect the angle AOB, the draftsman first laid off equal lengths from O on OA and OB (fig. 4-19A). From the ends of these lengths, he laid off equal, intersecting arcs (fig. 4-19B). A line from O through the point of intersection of the arcs bisects angle AOB (fig. 4-19C).

CONSTRUCTIONS INVOLVING STRAIGHT LINES

Parallel Lines

In the preceding chapter you learned how to draw a line through a given point, parallel to another line, by the use of a straightedge and a sliding triangle. Another method of solving this problem is illustrated in figure 4-20. To draw a line through C parallel to AB, place the needlepoint of a compass at any point D on AB, and strike arcs through C and through AB.

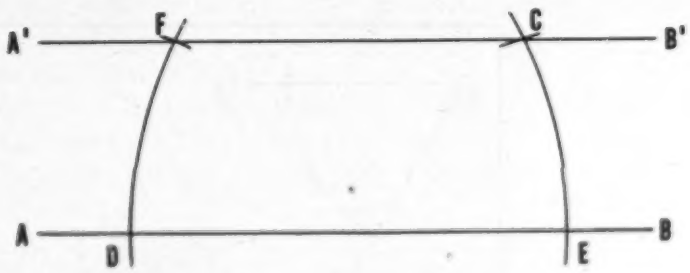

Figure 4-20.—Drawing a line through a given point, parallel to another line.

Shift the needlepoint of the compass to point of intersection E, and strike an arc of the same radius through AB, intersecting AB at D. Set compass or dividers to the length of the arc CE, and lay off the same length on the arc from D; this is DF in figure 4-20. A line A'B', drawn through F and C, is parallel to AB.

Figure 4-21 shows another solution to the problem of drawing one line parallel to another; this one is used when the second line is to be drawn at a given distance from the first. To draw a line parallel to AB, at a distance from AB equal to CD, set the compass to the length of CD and from any points E and F on AB strike two arcs. A line A'B', drawn tangent to (just touching, as shown) the arcs is parallel to AB, at a distance equal to CD.

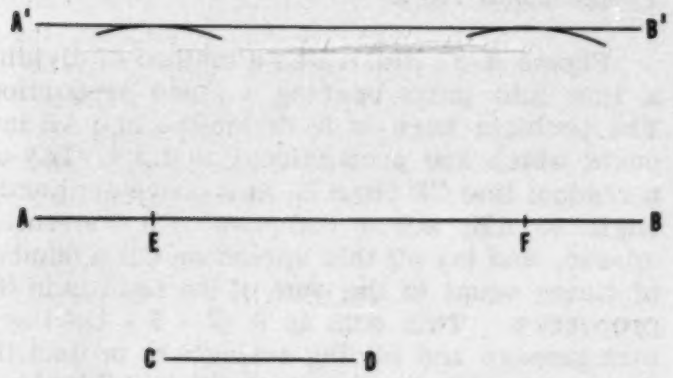

Figure 4-21.—Drawing parallel line at a given distance from another line.

Perpendiculars

In the preceding chapter you learned how to draw a line perpendicular to another by the use of a straightedge and a sliding triangle. Other methods of solving this problem are as follows.

Figure 4-22 illustrates a method of dropping a perpendicular from a given point to a line. To drop a perpendicular from point P to AB, set the needlepoint of a compass at P and strike an arc intersecting AB at C and D. With C and D as centers and any convenient radius larger than one-half of CD, strike arcs intersecting at E. A line from P through E is perpendicular to AB.

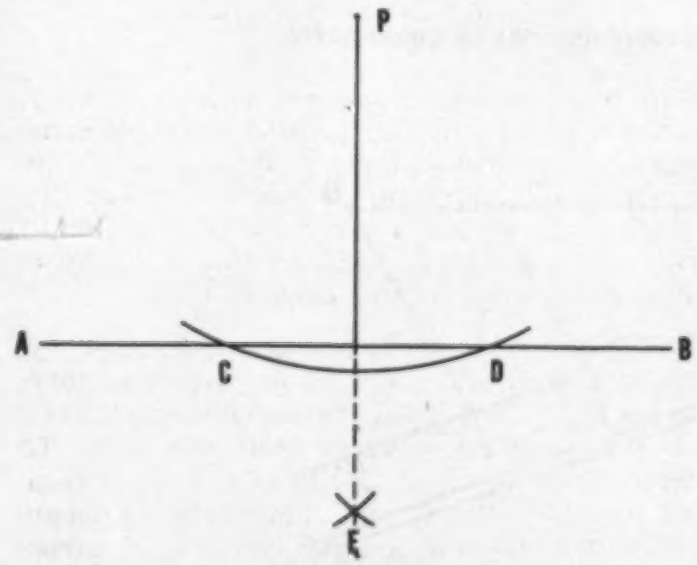

Figure 4-22.—Dropping a perpendicular from a given point to a line.

Figure 4-23 illustrates a method of erecting a perpendicular from a given point on a line. To erect a perpendicular from point P on line AB, set a compass to any convenient radius and strike arcs intersecting AB at C and D. With C and D as centers and any convenient radius larger than CP, strike arcs intersecting at E. A line from P through E is perpendicular to AB.

Bisecting a Line

A line can be bisected by trial-and-error with the dividers—that is, by setting the dividers to various spreads until you get a spread which comes to exactly one-half of the length of the line.

Another solution of the problem of bisecting a line is illustrated in figure 4-24. To bisect the line AB, use the ends of the line as centers,

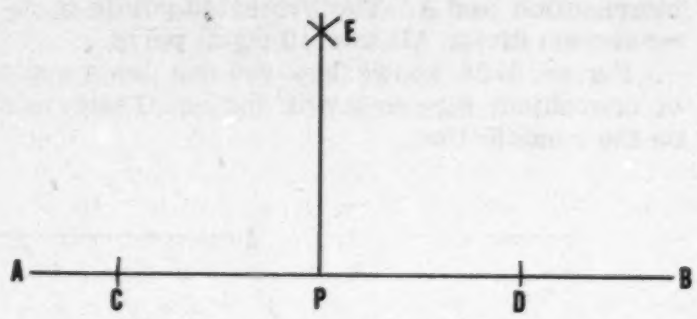

Figure 4-23.—Erecting a perpendicular from a given point on a line.

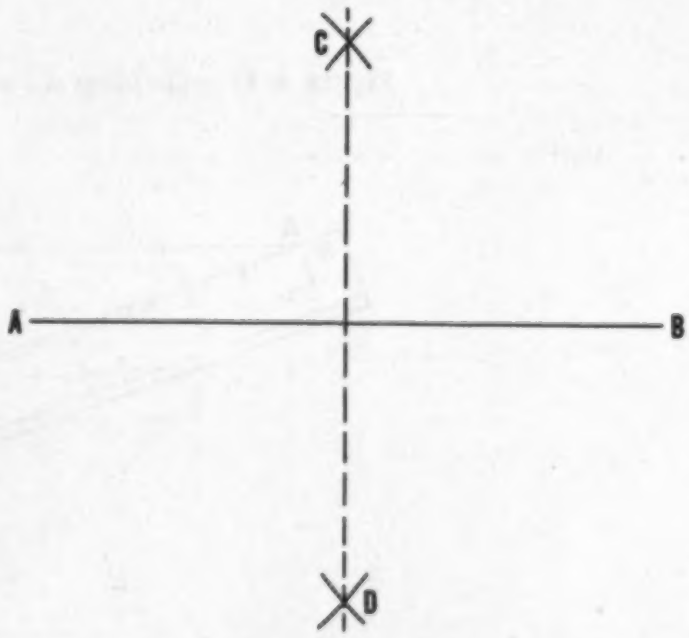

Figure 4-24.—Bisecting a line.

set a compass to any convenient radius which is more than one-half the length of AB, and strike arcs intersecting at C and D. A line drawn through C and D bisects AB.

More Than Two Equal Parts

A line may be divided into more than two equal parts by trial-and-error with the dividers, as described for bisecting a line. Another method of dividing a line into any number of equal parts is illustrated in figure 4-25. To divide AB into 10 equal parts, draw random line CB from B, at a convenient acute angle to AB. Set a compass to a spread less than one-tenth of the length of CB, and lay off this spread 10 times from B on CB. Project the intermediate points of intersection on CB to AB by lines parallel to the line between the 10th point of intersection and A. The projected points of intersection divide AB into 10 equal parts.

Figure 4-26 shows how you can use a scale of convenient size to lay off the equal intervals on the random line.

Proportional Parts

Figure 4-27 illustrates a method of dividing a line into parts bearing a given proportion. The problem here is to divide the line AB into parts which are proportional as 2:3:4. Lay off a random line CB from B, at a convenient acute angle to AB; set a compass to a convenient spread, and lay off this spread on CB a number of times equal to the sum of the figures in the proportion. This sum is 9 (2 + 3 + 4). Use a straightedge and sliding triangle to project the 2nd and the 5th intercepts on CB to AB by lines parallel to 9A. These projected intercepts divide AB into segments which are proportional as 2:3:4. Here again you could use a scale of convenient size to lay off the equal intervals on CB.

Parts With a Given Ratio

You may be required to divide a line into parts in such a manner that the ratio between the whole line and one of its segments is the same as that between two other lines. A solu-

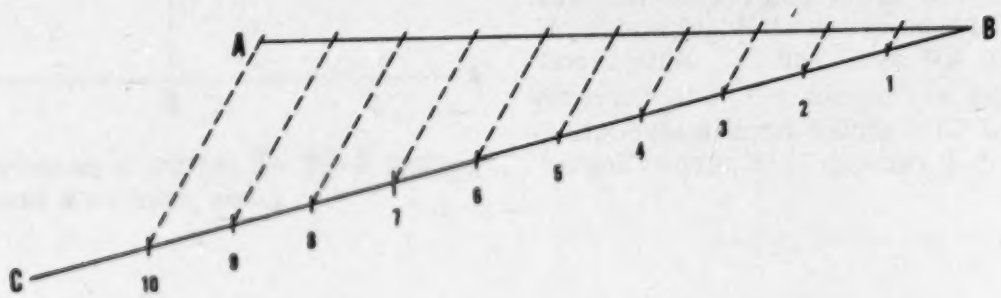

Figure 4-25.—Dividing a line into any number of equal parts.

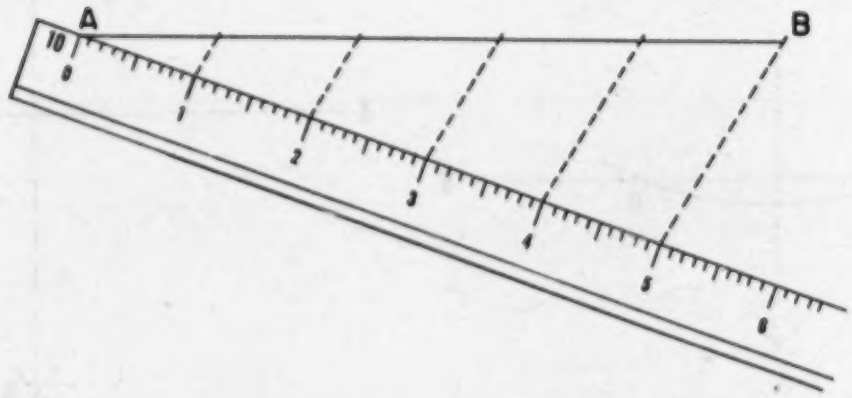

Figure 4-26.—Using a scale to lay off equal intervals on random line.

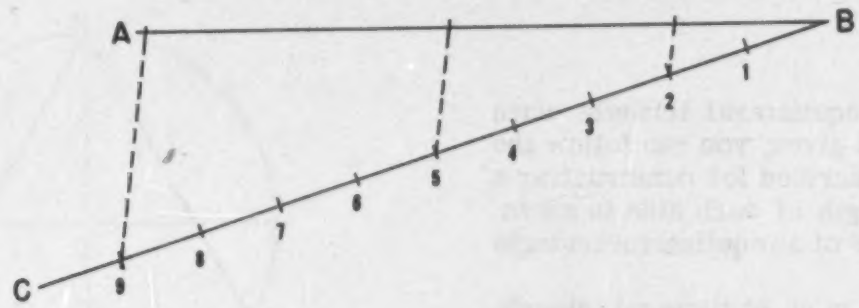

Figure 4-27.—Dividing a line into proportional parts.

tion to this problem is illustrated in figure 4-28. Here it is required that AB be divided so that the ratio between AB and a segment of AB is the same as the ratio between CD and EF. From A draw a random line AG, at a convenient acute angle to A, and lay off AH equal to EF and AI equal to CD. Use a straightedge and sliding triangle to project H to AB on a line parallel to the line from I to B. The ratio of AB to AJ is the same as the ratio of CD to EF—that is, (AB:AJ):(CD:EF).

CONSTRUCTIONS INVOLVING PLANE FIGURES

Triangle: Three Sides Given

To draw a triangle with three sides given, draw a straight line AB, equal in length to one of the given sides. With A as a center, strike an arc with radius equal to the given length of the second side; with B as a center, strike an intersecting arc with radius equal to the length of the third side. Draw lines from A and B to the point of intersection of the arcs.

Right Triangle: Hypotenuse and One Other Side Given

Figure 4-29 illustrates a method of drawing a right triangle when the hypotenuse and one of the other sides are given. The line labeled H in the figure is the given hypotenuse; the line labeled S is the given shorter side. To construct the triangle, draw AB equal to H. Locate the center of AB, by bisecting AB, and with one-half of AB as a radius, draw a semicircle around AB as shown. Set the compass to the length of S and with A as a center strike an arc intersecting the semicircle at C. Draw AC and CB.

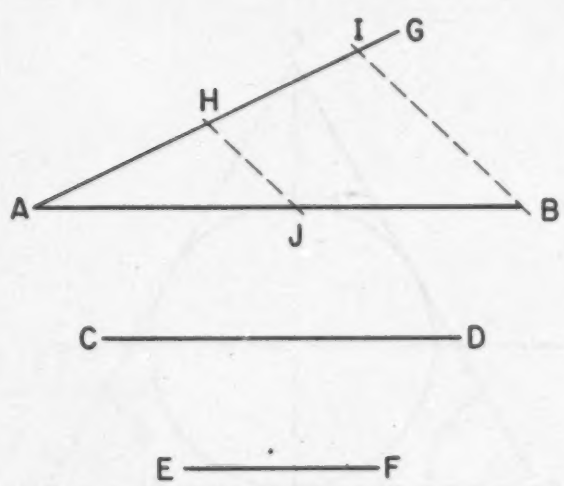

Figure 4-28.—Dividing a line into parts with a given ratio.

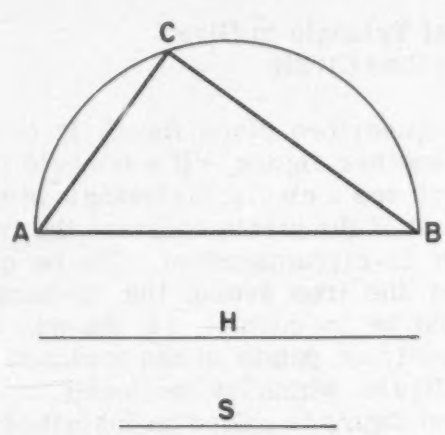

Figure 4-29.—Constructing a right triangle with hypotenuse and one of the other sides given.

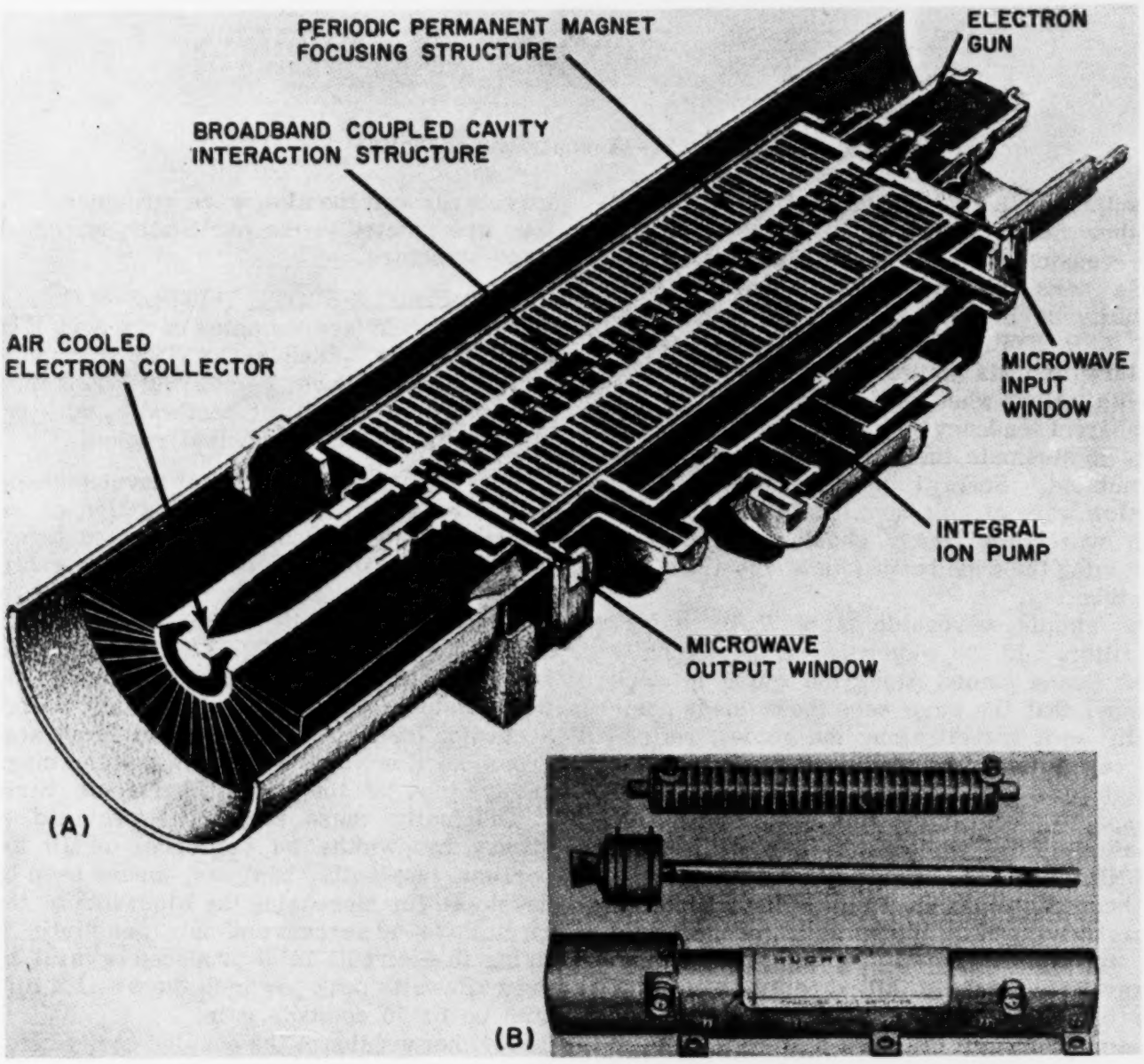

Figure 12-14.—TWT's using PPM focusing system.

the "slow waves" they carry must travel at the same axial speed as the stream of electrons emitted from the cathode. For example, in a 1,500-volt electron beam, the axial speed at which the electrons travel is one-thirteenth the speed of light. Since the RF signal is carried along the wire from which the helix is wound at about the speed of light, the resulting linear ratio of the helix length to the beam length must be 13:1 in this example.

A number of configurations using the basic helix structure have been tested in an attempt to increase the power output capabilities of the tube. The CONTRAWOUND HELIX structure uses two helices wound in opposite directions, and effectively increases the power output capability of the tube to a moderate degree. The RING-BAR shown in figure 12-15 is one version of the contrawound helix.

One disadvantage of the helix circuit has been the fragile glass vacuum envelope which encloses the tube parts; however, such glass structures are sufficiently well supported to withstand almost any environment and can tolerate very high shock and loads. Recently a means of adapting metal and ceramic materials for use in the place of glass in the manufacture of TWT's has been developed. These tubes

Equilateral Triangle: Length of Side Given

To construct an equilateral triangle when the length of a side is given, you can follow the method previously described for constructing a triangle when the length of each side is given. As you know, the sides of an equilateral triangle are equal in length.

You also know that in an equilateral triangle each of the angles measures 60°. You can apply this fact to the problem of constructing an equilateral triangle when the length of a side is given by following the procedure illustrated in figure 4-30. Draw one side, AB, to the correct given length, and use a straightedge and a sliding 30-60 degree triangle to erect lines from A and B at 60° to AB.

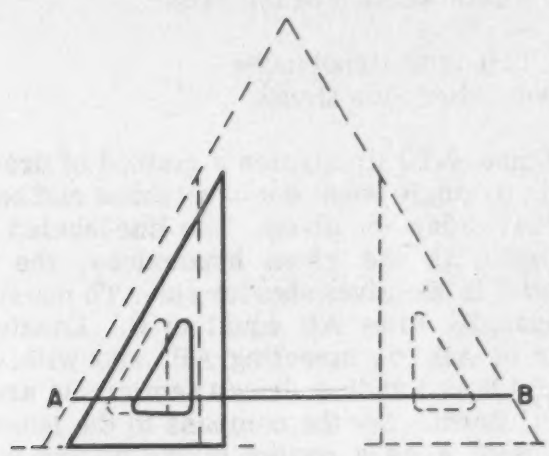

Figure 4-30.—Equilateral triangle with length of side given.

Equilateral Triangle in Given Circumscribed Circle

A circumscribed plane figure is one which encloses another figure. If a triangle (for example) encloses a circle, the triangle is circumscribed; but if the circle encloses the triangle, the circle is circumscribed. To be circumscribed in the true sense, the circumscribed figure must be in contact, all the way around, with the outlying points of the enclosed figure. A plane figure which is enclosed by a circumscribed figure is called an inscribed figure.

Figure 4-31 shows you how to draw an equilateral triangle within a given circumscribed circle. Draw a vertical center line through the circle, intersecting the circumference at A and B. With B as a center and the radius of the circle as a radius strike arcs intersecting the circumference at C and D. A, C, and D now divide the circle into 3 equal arcs. Lines connecting A, C, and D will form an equilateral triangle. If you desire to have the triangle inverted (pointing down instead of up), use A as a center for striking the arcs, and connect the arc intercepts with B.

Figure 4-31.—Equilateral triangle in given circumscribed circle.

Equilateral Triangle on a Given Inscribed Circle

Figure 4-32 illustrates one method of circumscribing an equilateral triangle on a given inscribed circle. Draw AB parallel to the horizontal center line of the circle and tangent

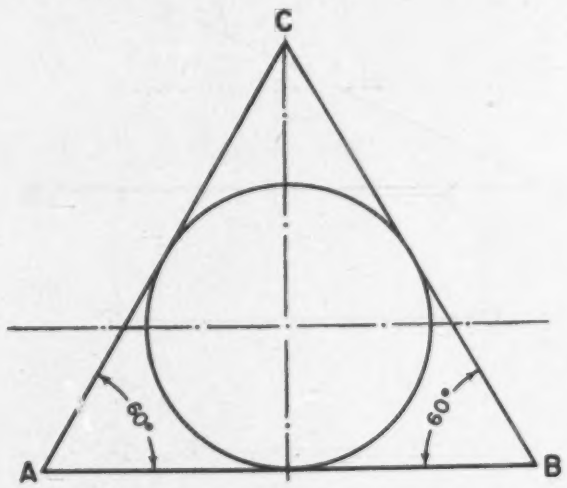

Figure 4-32.—Equilateral triangle on given inscribed circle: one method.

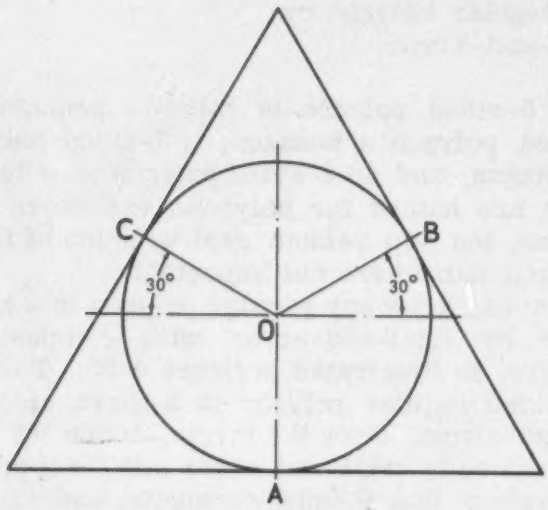

Figure 4-33.—Equilateral triangle on given inscribed circle: another method.

to the circumference. Then use a straightedge and sliding 30-60 degree triangle, as illustrated in figure 4-30, to draw AC and CB, tangent to the circumference of the circle and at 60° to AB.

Another method of circumscribing an equilateral triangle on a given inscribed circle is shown in figure 4-33. Divide the circumference of the circle into three equal arcs, as shown in figure 4-31. Another way to do this is to draw two radii, OC and OB, at 30° from the horizontal center line as shown in figure 4-33. The third intercept is the vertical center line intercept at A. You now have three radii: OA, OC, and OB. Draw each side of the triangle tangent to the circumference of the circle and perpendicular to the relevant radius.

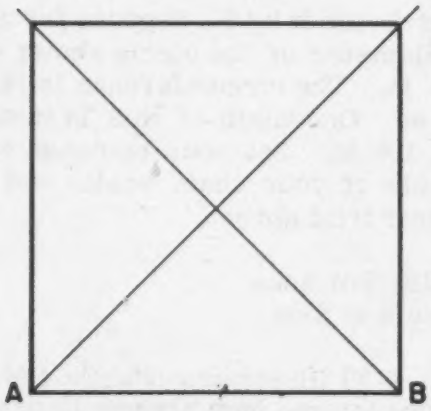

Figure 4-34.—Constructing a square by use of diagonals.

Rectangle: Given Length and Width

To construct a rectangle with given length and width, draw a horizontal line AB with the T-square, equal to the given length. With T-square and triangle, erect perpendiculars from A and B, equal to the given width; and connect the ends of the perpendiculars.

Square: Given Length of Side

You can construct a square with a given length of side by the method described for constructing a rectangle. Another method is illustrated in figure 4-34. Draw a horizontal line AB with the T-square, equal to the given

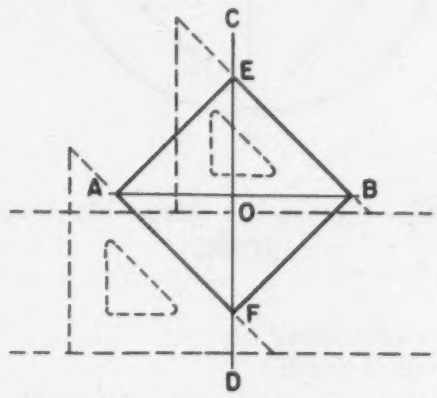

Figure 4-35.—Square with given length of diagonal.

length of side. With the T-square and a 45-degree triangle, draw diagonals from A and B at 45°. Erect perpendiculars from A and B, intersecting the diagonals, and connect the points of intersection.

Square: Given Length of Diagonal

Figure 4-35 illustrates a method of constructing a square with a given length of diagonal. Draw a horizontal line AB, equal in length to the given length of diagonal; let this be one diagonal of the square. Locate O, at the center of AB, and lay off CD through O, perpendicular to and slightly longer than AB. Use a T-square and 45-degree triangle to draw AF and EB at 45° to AB. Connect AE and FB.

Square in Given Circumscribed Circle

Figure 4-36 shows a method of drawing a square in a given circumscribed circle. Draw the diameters AB and CD at right angles to each other, and connect the points where the diameters intercept the circumference of the circle.

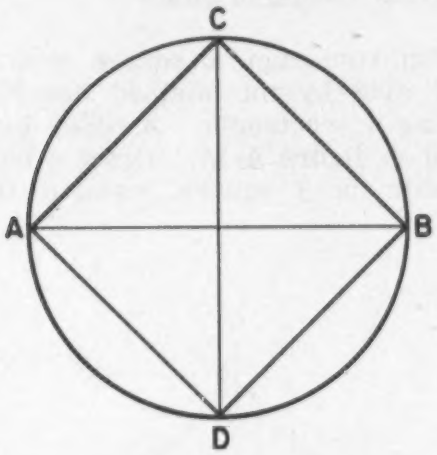

Figure 4-36.—Square in given circumscribed circle.

Square Circumscribed on Given Inscribed Circle

Figure 4-37 illustrates a method of circumscribing a square on a given inscribed circle. Draw the diameters AB and CD at right angles to each other. Then draw each side of the square tangent to the point where a diameter intersects the circumference of the circle, and perpendicular to the diameter.

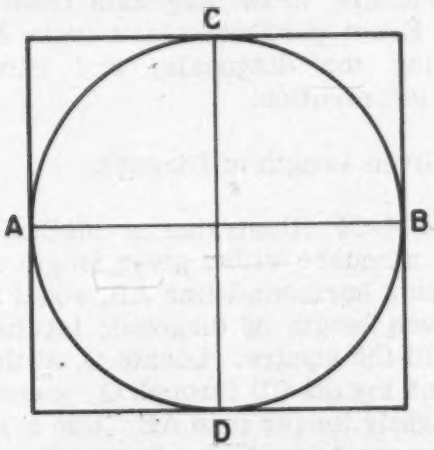

Figure 4-37.—Square on given inscribed circle.

Any Regular Polygon by Trial-and-Error

A 5-sided polygon is called a pentagon, a 6-sided polygon a hexagon, a 7-sided polygon a heptagon, and an 8-sided polygon an octagon. There are names for polygons with more than 8 sides, but you seldom deal with any of these and their names are not important.

You can draw any regular polygon in a given circle by trial-and-error with compass or dividers, as illustrated in figure 4-38. To draw a 9-sided regular polygon in a given circumscribed circle, draw the circle, divide the circumference by trial-and-error with the compass or dividers into 9 equal segments, and connect the points of intersection. To get a trial spread to start with, compute the circumference of the

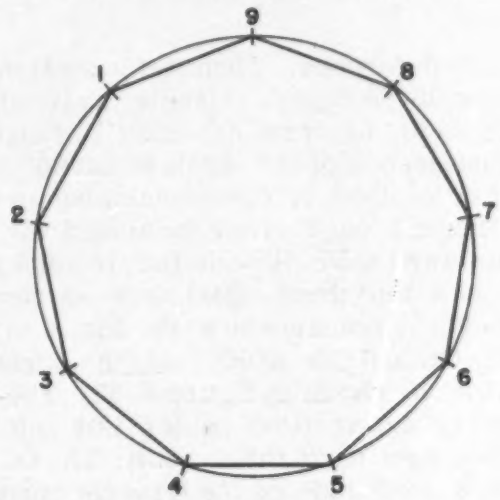

Figure 4-38.—Any regular polygon by trial-and-error with compass or dividers.

circle and divide it by 9. Suppose for example, that the diameter of the circle shown in figure 4-38 is 4 in. The circumference is (4 x 3.14), or 12.56 in. One-ninth of this is just a shade less than 1.4 in. Set your compass to this on the 10 scale of your chain scale, and use that as your first trial spread.

Any Regular Polygon, Given Length of Side

Figure 4-39 illustrates a method of drawing any regular polygon with a given length of side. To draw a 9-sided regular polygon with length of side equal to AB, first extend AB to C, making CA equal to AB. With A as a center and

AB (or CA) as a radius, draw a semicircle as shown. Divide the semicircle into 9 equal segments from C to B, and draw radii from A to the points of intersection. The radius A2 is a second side of the polygon.

Draw a circle through points A, B, and D. You do this by erecting perpendicular bisectors from DA and AB; the point of intersection of the bisectors is the center of the circle.

This circle is the circumscribed circle of the polygon. To draw the remaining sides of the polygon, extend the radii from the semicircle as shown, and connect the points where these radii intersect the circumscribed circle.

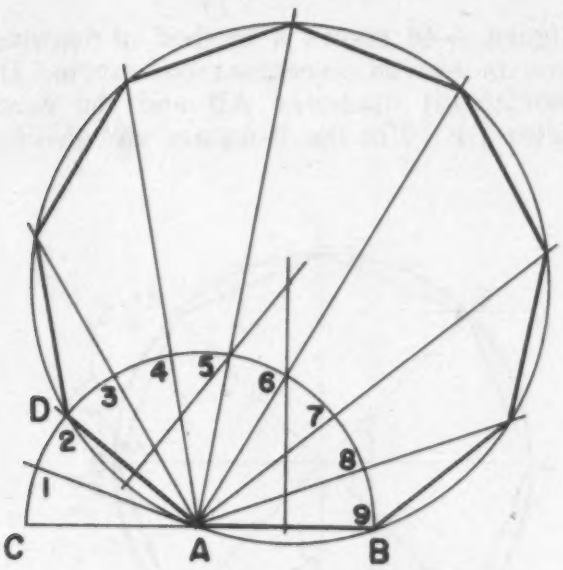

Figure 4-39.—Any regular polygon with given length of side.

Regular Pentagon in Given Circumscribed Circle

Besides the methods described for drawing any regular polygon there are particular methods for drawing a regular pentagon, hexagon, or octagon.

Figure 4-40 illustrates a method of drawing a regular pentagon in a given circumscribed circle. First draw a horizontal diameter AB and a vertical diameter CD. Locate E, the midpoint of the radius OB. Set a compass to the spread between E and C, and with E as a center strike the arc CF. Set the compass to the spread between C and F, and with C as a center strike the arc GF. The straight line G to C is one side of the pentagon. Set the compass to the length of GC, lay off this spread from C around the circle, and connect the points of intersection.

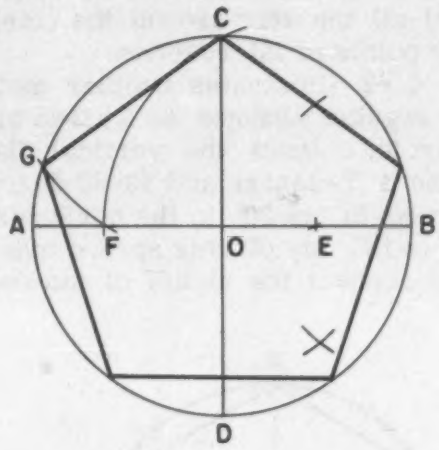

Figure 4-40.—Regular pentagon.

Regular Hexagon in Given Circumscribed Circle

A great many bolt heads and nuts are hexagonal (6-sided) in shape; you will therefore be often required to draw a regular hexagon.

Figure 4-41 illustrates a method of drawing a regular hexagon when the circumscribed circle is given. The diameter of the circumscribed circle has the same length as the long diameter of the hexagon. The radius of the circumscribed

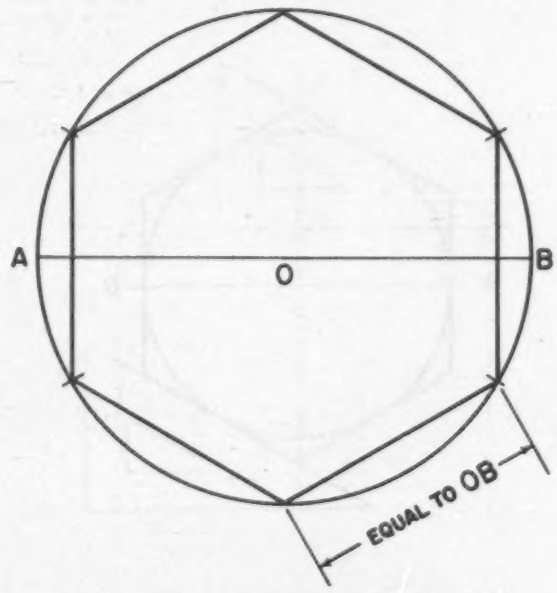

Figure 4-41.—Regular hexagon in given circumscribed circle: one method.

circle (or one-half the long diameter of the hexagon) is equal in length to the length of a side. Lay off the horizontal diameter AB, set a compass to one-half of this or OB, lay off this spread all the way around the circle, and connect the points of intersection.

Figure 4-42 illustrates another method of drawing a regular hexagon in a given circumscribed circle. Draw the vertical diameter AB, and use a T-square and 30-60 degree triangle to draw BC to 30° to the horizontal. Set a compass to BC, lay off this spread around the circle, and connect the points of intersection.

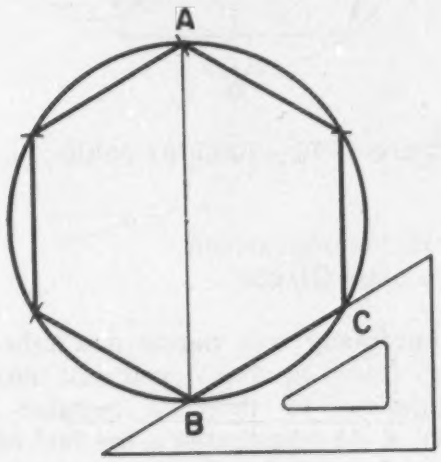

Figure 4-42.—Regular hexagon in given circumscribed circle: another method.

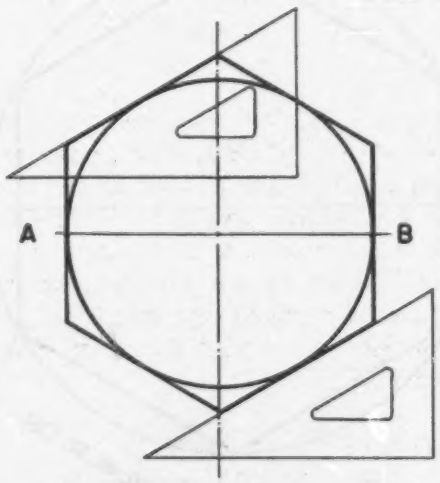

Figure 4-43.—Regular hexagon on given inscribed circle.

Regular Hexagon in Given Inscribed Circle

Figure 4-43 shows a method of drawing a regular hexagon around a given inscribed circle. Draw the horizontal diameter AB and the vertical center line as shown. Draw perpendiculars to AB at A and B, tangent to the circle. Use a T-square and 30-60 degree triangle to draw lines at 30° to the horizontal between the perpendiculars and the vertical center line, tangent to the circle.

Regular Octagon in Given Circumscribed Circle

Figure 4-44 shows a method of drawing an octagon in a given circumscribed circle. Draw the horizontal diameter AB and the vertical diameter CD. Use the T-square and 45-degree

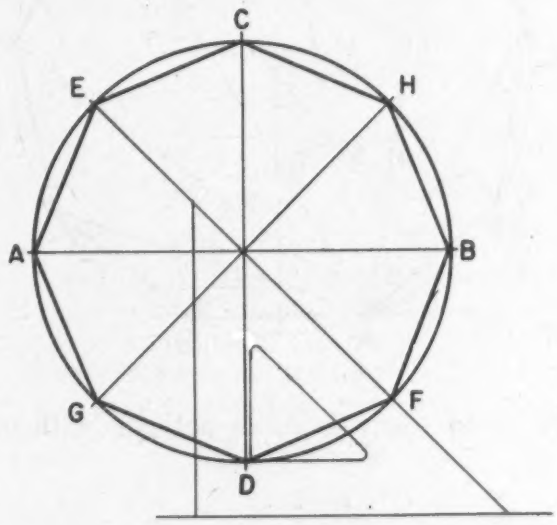

Figure 4.44.—Regular octagon in given circumscribed circle.

triangle to draw additional diameters EF and GH at 45° to the horizontal. Connect the points where the diameters intersect the circle.

Regular Octagon on Given Inscribed Circle

Figure 4-45 shows a method of drawing an octagon around a given inscribed circle. Draw the horizontal diameter AB and the vertical diameter CD. Draw perpendiculars at A, B, C, D, tangent to the circle. Then use a T-square

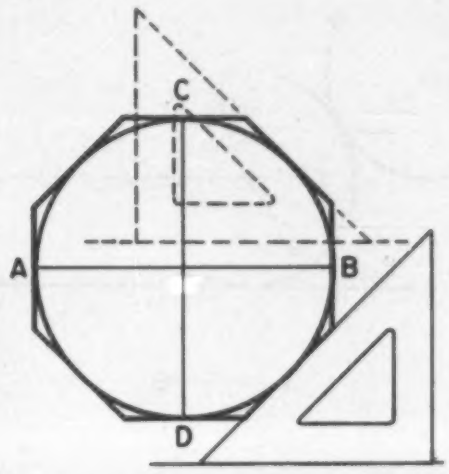

Figure 4-45.—Regular octagon on given inscribed circle.

and triangle to draw lines at 45° to the horizontal, tangent to the circle and intersecting the perpendiculars.

CONSTRUCTIONS INVOLVING CIRCULAR CURVES

Circle Passing Through Three Points

In figure 4-46, the problem is to draw a circle (or a circular arc) which passes through points A, B, and C. Connect the points by lines, and erect perpendicular bisectors from the lines as shown. The point of intersection of the perpendicular bisectors is the center of the circle or arc which passes through the points.

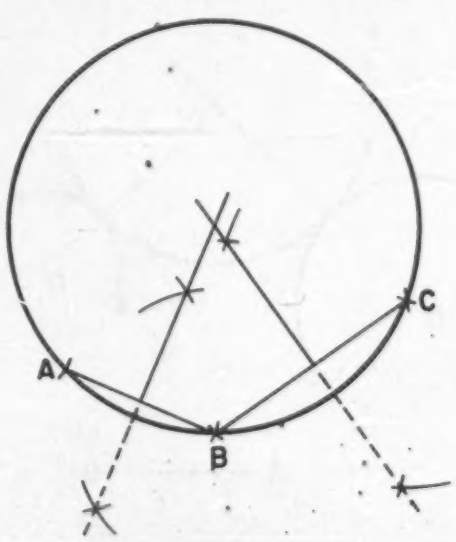

Figure 4-46.—Circle or arc passing through three points.

Line Tangent to a Circle at a Given Point

A line which is tangent to a circle at a given point is perpendicular to the radius which intersects the point. It follows that one method of drawing a line tangent to a circle at a given point is to draw the radius which intersects the point and then draw the line touching the circle at the point of intersection and perpendicular to the radius.

Another method is shown in figure 4-47. To draw a line tangent to the circle at P, set a compass to the radius of the circle and, with

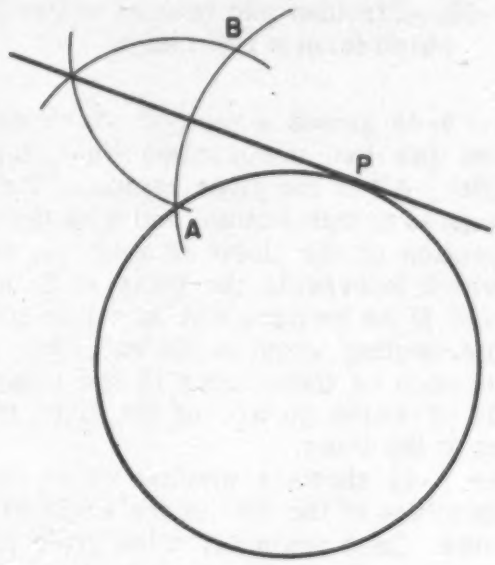

Figure 4-47.—Line tangent to given point on a circle.

P as a center, strike an arc which intersects the circle at A. With the compass still set to the radius of the circle, use A as a center and strike an arc which intersects the first arc at B. With B as a center and the compass still set to the radius of the circle, strike another arc. A line through the point of intersection of the last-drawn arcs and through P is tangent to the circle at P.

Circular Arc of Given Radius Tangent to Two Straight Lines

The problem of drawing a fillet or a round (explained in a previous section) comprises the problem of drawing a circular arc of given radius which is tangent to two non-parallel lines.

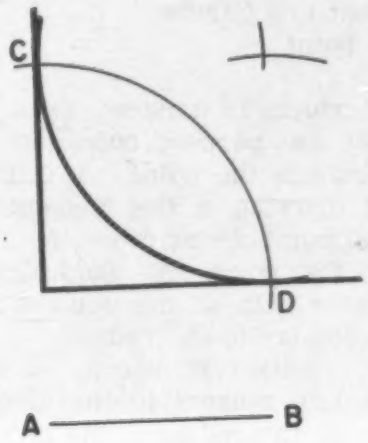

Figure 4-48.—Circular arc tangent to two lines which form a right angle.

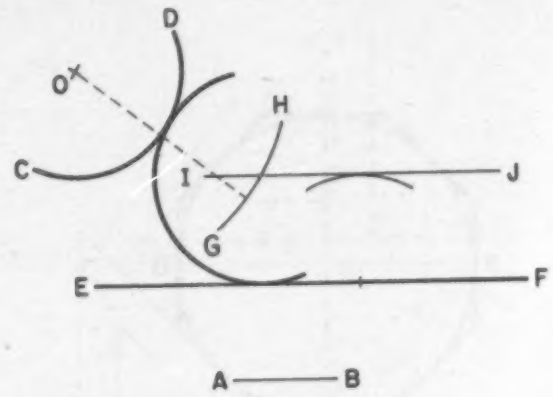

Figure 4-50.—Circular arc tangent to a straight line and to another circular arc.

Figure 4-48 shows a method which can be used when the two nonparallel lines form a right angle. AB is the given radius of the arc. Set a compass to this radius, and with the point of intersection of the lines as a center, strike an arc which intersects the lines at C and D. With C and D as centers and the same radius, strike intersecting arcs as shown. The point of intersection of these arcs is the center of the circle of which an arc of the given radius is tangent to the lines.

Figure 4-49 shows a method which can be used regardless of the size of the angle formed by the lines. Once again AB is the given radius of the arc, and the problem is to draw an arc of that radius, tangent to CD and EF. Draw GH parallel to CD, and at a distance from CD equal to the given radius of the arc. Draw IJ parallel to EF, also at a distance equal to the given radius of the arc. The point of intersection between GH and IJ is the center of the circle of which an arc of the given radius is tangent to CD and EF.

Circular Arc of Given Radius Tangent to Straight Line and to Another Circular Arc

The problem in figure 4-50 is to draw a circular arc with radius equal to AB, tangent to the circular arc CD and to the straight line EF. Set a compass to a radius equal to the radius of the circular arc CD plus the given radius AB (this radius is indicated by the dotted line shown), and with O as a center strike the

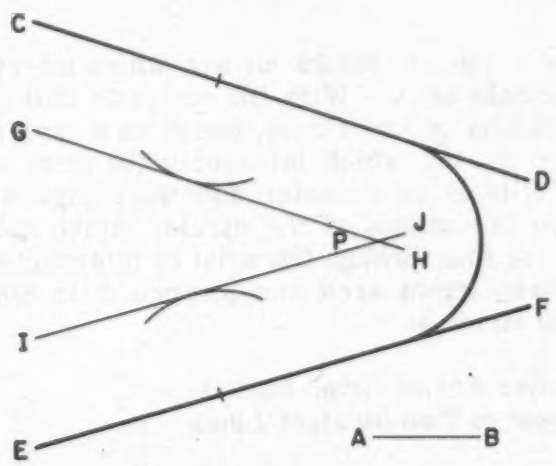

Figure 4-49.—Circular arc tangent to two lines which form any angle.

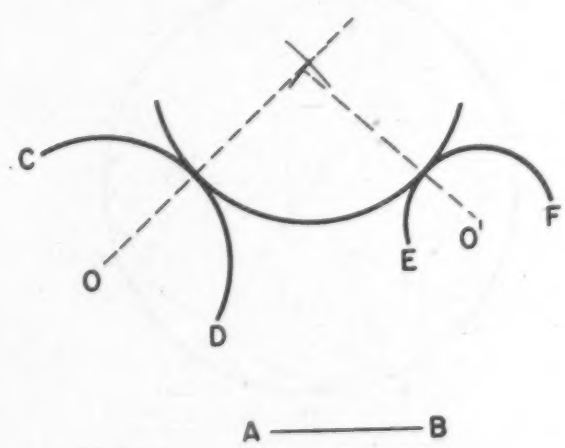

Figure 4-51.—Circular arc tangent to two other circular arcs.

arc GH. Draw a line IJ parallel to EF, at a distance from EF equal to AB. The point of intersection between GH and IJ is the center of the circle of which an arc of the given radius is tangent to CD and EF.

Circular Arc of Given Radius Tangent to Two Other Circular Arcs

The problem in figure 4-51 is to drawn an arc with radius equal to AB, tangent to the circular arcs CD and EF. Set a compass to a spread equal to the radius of CD plus AB (indicated by the left-hand dotted line), and with O as a center strike an arc. Set the compass to a spread equal to the radius of EF plus AB (indicated by the right-hand dotted line), and with O' as a center strike another arc. The point of intersection between these two arcs is the center of the circle of which an arc of given radius is tangent to CD and EF.

In figure 4-51, the circular arcs CD and EF curve in opposite directions. In figure 4-52, the problem is to draw an arc with radius

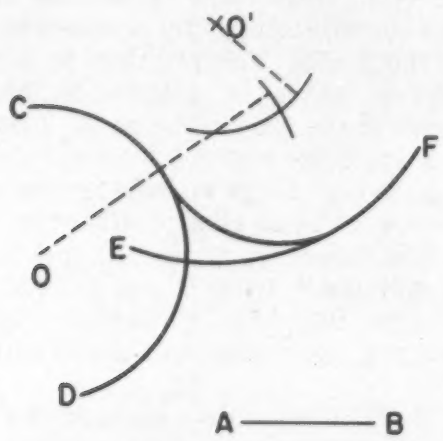

Figure 4-52.—Circular arc tangent to arcs which curve in the same direction.

equal to AB, tangent to two circular arcs (CD and EF) which curve in the same direction. Set a compass to a radius equal to the radius of CD plus AB, and with O as a center, strike an arc. Set the compass to a radius equal to the radius of EF less AB, and with O' as a center, strike an intersecting arc. The point of intersection between these two arcs is the center of the circle of which an arc of the given radius is tangent to CD and EF.

When a circular arc is tangent to another, it is commonly the case that the two arcs curve

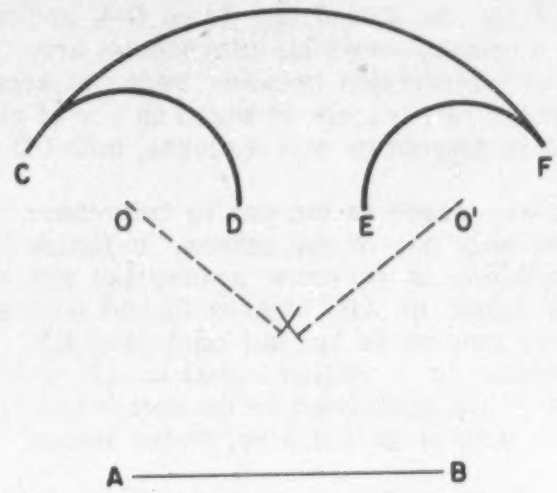

Figure 4-53.—Circular arc tangent to, and enclosing. two other circular arcs.

in opposite directions. However, an arc which is tangent to another may be an arc which curves in the same direction as the other. When this is the case, the tangent arc is said to enclose the other arc.

An arc which is tangent to two others may enclose one or both of the others. In figure 4-53, the problem is to draw a circular arc with radius equal to AB, tangent to, and enclosing, both CD and EF. Set a compass to a radius equal to AB less the radius of CD (indicated by the dotted line from O), and with O as a center, strike an arc. Set the compass to a radius equal to AB less the radius of EF (in-

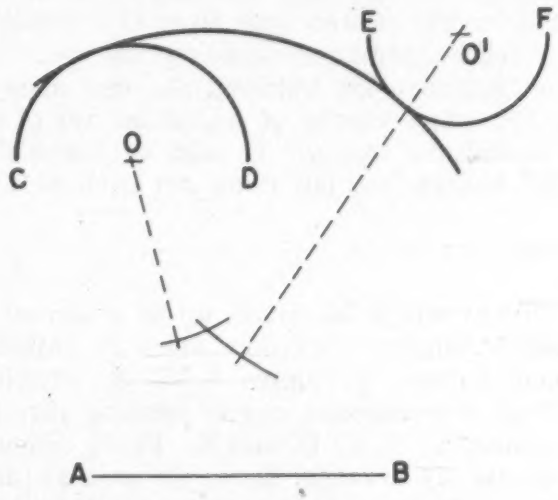

Figure 4-54.—Circular arc tangent to and enclosing one arc, and tangent to but not enclosing another.

dicated by the dotted line from O'), and with O' as a center, strike an intersecting arc. The point of intersection between these two arcs is the center of a circle of which an arc of given radius is tangent to, and encloses, both CD and EF.

An arc which is tangent to two others may enclose only one of the others. In figure 4-54 the problem is to draw a circular arc with radius equal to AB, tangent to and enclosing CD, and tangent to but not enclosing EF. Set a compass to a radius equal to AB less the radius of CD (indicated by the dotted line from O), and with O as a center, strike an arc. Set

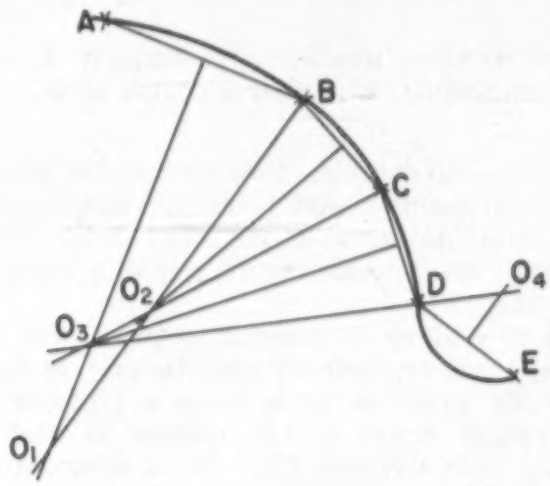

Figure 4-55.—Curve composed of a series of consecutive tangent circular arcs.

the compass to AB plus the radius of EF (as indicated by the dotted line from O'), and with O' as a center, strike an intersecting arc. The point of intersection between the two arcs is the center of a circle of which an arc of the given radius is tangent to and encloses CD, and also tangent to, but does not enclose, EF.

Compound Curve

A curve which is made up of a series of successive tangent circular arcs is called a compound curve. In figure 4-55, the problem is to draw a compound curve passing through given points A, B, C, D, and E. First, connect these points by straight lines; the straight line between each pair of points constitutes the chord of the arc which passes through the points.

Erect a perpendicular bisector from AB, select an appropriate point O_1 on the bisector as a center, and draw the arc AB. From O_1 draw the radius O_1B. From BC erect a perpendicular bisector. The point of intersection (O_2) between this bisector and the radius O_1B is the center of the arc BC. Draw the radius O_2C, and erect a perpendicular bisector from CD. The point of intersection (O_3) between this bisector and the extension of O_2C is the center of the arc CD.

It is obvious that to continue the curve from D to E you must reverse the direction of curvature of the arc. Draw the radius O_3D, and erect a perpendicular bisector from DE on the opposite side of the curve from those previously erected. The point of intersection between this bisector and the extension of O_3D is the center of the arc DE.

Reverse or Ogee Curve

A reverse or ogee curve is a curve composed of two consecutive tangent circular arcs, one of which curves in the opposite direction to the other.

Figure 4-56 illustrates a method of connecting two parallel lines by a reverse curve tangent to the lines. The problem is to draw a reverse curve which is tangent to the upper line at A and to the lower line at B. Connect A and B by a straight line AB. Select a point C on AB, this being the point where you want to have the reverse curve change direction. Erect perpendicular bisectors from BC and CA, and erect perpendiculars from B and A. The points of intersection (O_1 and O_2) between the perpendiculars are the centers of the arcs BC and CA.

Figure 4-57 illustrates a method of drawing a reverse curve tangent to three intersecting straight lines. The problem here is to draw a reverse curve tangent to the three lines which intersect at points A and B. Select on AB a point

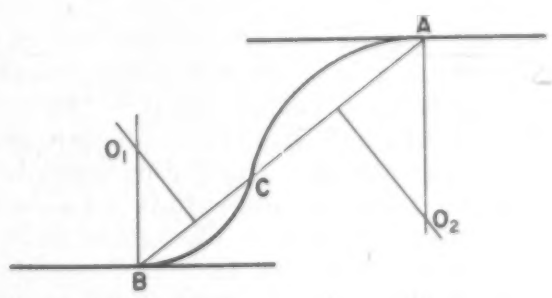

Figure 4-56.—Reverse curve connecting and tangent to two parallel lines.

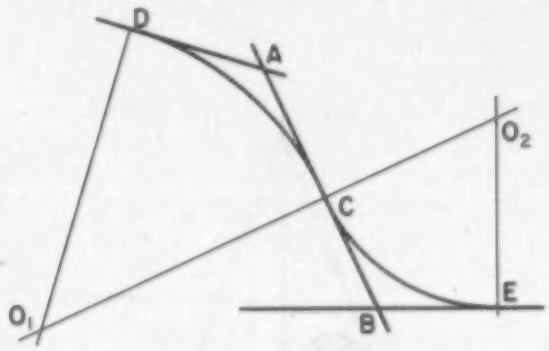

Figure 4-57.—Reverse curve tangent to three intersecting straight lines.

C, this being the point where you want the reverse curve to change direction. Lay off from A a distance equal to AC to establish point D. Erect a perpendicular from D and another from C. The point of intersection of these perpendiculars (O_1) is the center of the arc DC.

Lay off from B a distance equal to CB to establish point E. Erect a perpendicular from E, and extend O_1C to intersect it. The point of intersection (O_2) is the center of the arc CE.

Rectifying a Circular Arc

To rectify a circular arc means to ascertain its straight-line length—that is, to determine what the length of the arc would be if it were converted to a straight line.

Figure 4-58 illustrates a graphic solution called rectifying an arc on its tangent. The problem here is to rectify the arc AB. Draw the radius OB and erect a tangent from B. Draw the chord AB, and extend it to C, making CB equal to one-half of AB. With C as a center and AC as a radius, strike an arc intersecting the tangent at D, DB is very slightly shorter than the arc AB. For an arc which subtends a 45-degree angle, the difference is about 1 unit in 2866 units meaning that if the arc AB were 2866 ft long, DB would be 2865 ft long.

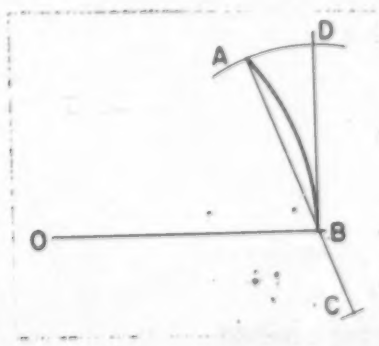

Figure 4-58.—Rectifying a circular arc.

Laying Off a Given Length on a Circular Arc

Figure 4-59 illustrates a method of laying off a given length on a circular arc. The problem is to lay off, on the arc shown in the figure, a length equal to AB. Draw the radius OC, and draw a tangent CD equal to AB. Extend OC to the left to E, making EO twice as long as OC. Connect E and D by a straight line which intersects the arc at F. The arc FC is very slightly shorter than the tangent CD. For a subtended angle of 30° the difference in length would be 1 in 2326, for 45° it would be 1 in 420; and for 60° it would be 1 in 132.

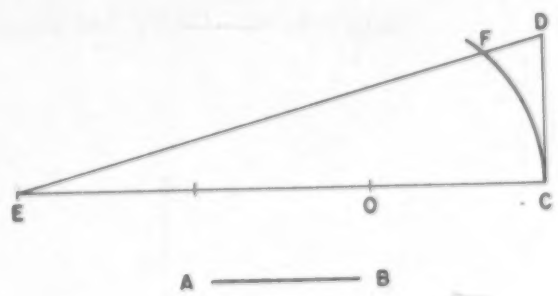

Figure 4-59.—Laying off a given length on a circular arc.

This method can also be used for rectifying a circular arc. It is slightly less accurate than the method illustrated in figure 4-58.

CONSTRUCTIONS INVOLVING NON-CIRCULAR CURVES

The basic uniform noncircular curves are the ellipse, the parabola, and the hyperbola. These curves are called conic sections, because they are curves of the type which would be formed if a cone were cut by planes as illustrated in figure 4-60. The circle (not shown) is also a conic section.

Ellipse by Pin-and-String Method

The dimensions of an ellipse are given in terms of the lengths of the major (longer) and minor (shorter) axis. Figure 4-61 illustrates a method of drawing an ellipse which is called

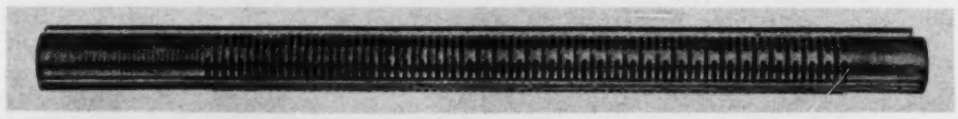

Figure 12-15.—A contrawound helix.

can withstand higher loads and can be fired at higher temperatures than before; this assures considerably better "cleanup" of undesirable gases trapped in the tube, and improved reliability at higher operating temperatures.

FILTER TYPE CIRCUITS.—The basic helix structure and its major variations have two main limitations when used at high power levels: the inherent tendency to oscillate, and the inability to dissipate the large quantities of heat accumulated. Several versions of the filter type slow wave circuit have shown great promise in overcoming these shortcomings, while maintaining the wide bandwidth of the traveling wave tube.

The simple waveguide is basically a high pass filter. If the waveguide is periodically loaded (loads placed along the guide in such a manner that the wave sees these loads periodically as it travels along the guide), reflections result from the loading devices. Thus, the high pass filter becomes a bandpass filter with specific characteristics which depend on the nature of the periodic loading utilized.

FUNDAMENTAL FORWARD WAVE circuits have been developed in which a disturbance of the basic waveguide mode is introduced at a point where the phase and group velocities of the wave are in the SAME direction. One of these circuits, the CLOVERLEAF (so called because the circuit couplers are connected so as to resemble a four-leaf clover), has achieved up to 2 megawatts peak power at S-band frequencies, over a 10-percent bandwidth, with gains on the order of 20 to 30 decibels.

Another broad group of filter type slow wave circuits, called SPATIAL HARMONIC FILTERS, uses a coaxial mode which is distorted by the waveguide wall. The fundamental wave in these circuits has its phase and group velocities in OPPOSITE directions. Therefore, a harmonic (usually the first) is used. These circuits are used as BACKWARD WAVE AMPLIFIERS or as BACKWARD WAVE OSCILLATORS. Spatial harmonics should not be confused with frequency harmonics. Spatial harmonics are all approximately the same frequency, but are developed at different times as the electron bunch travels through the slow wave structure. Thus, they are related to the periodicity of the slow wave structure.

The SINGLE-SLOT, DOUBLE-SLOT, and DRIFT TUBES are examples of the spatial harmonic circuits. Double-slot TWT's have been built which produce 1 megawatt peak power output over a 9-percent bandwidth, with gains also in the 20- to 30-decibel region.

One of the most significant developments in recent years has been the utilization of basic waveguide mode resonators, coupled together by means of capacitive or inductive apertures, to provide either a fundamental forward or a backward wave circuit. This device is known as the COUPLED CAVITY CIRCUIT. It is also known as a FOLDED WAVEGUIDE circuit, since its structure resembles a waveguide folded in accordion fashion. Figure 12-16 illustrates a cross section view of a high power, coupled cavity tube of the spatial harmonic variety.

Originally these structures provided frequency bandwidths on the order of 10 to 15 percent. Recently, however, means have been developed for increasing the bandwidth of these circuits to 40 percent and more; and tubes utilizing this circuit have produced several hundred kilowatts peak power in the S and X bands, with up to 50 decibels gain.

Another version of the coupled cavity circuit, the interdigital line, has found extensive use in low and medium power amplifiers ranging in power output up to 1 kilowatt peak, with gains of about 30 decibels.

The Collector

The only function of the collector is to dissipate the energy of the electrons in the form of heat as they emerge from the slow wave structure. This is usually accomplished by conduction to a colder outside surface, where the heat is absorbed by circulated air or liquid. The collector size is determined by the method of cooling used and by the amount of energy which must be released.

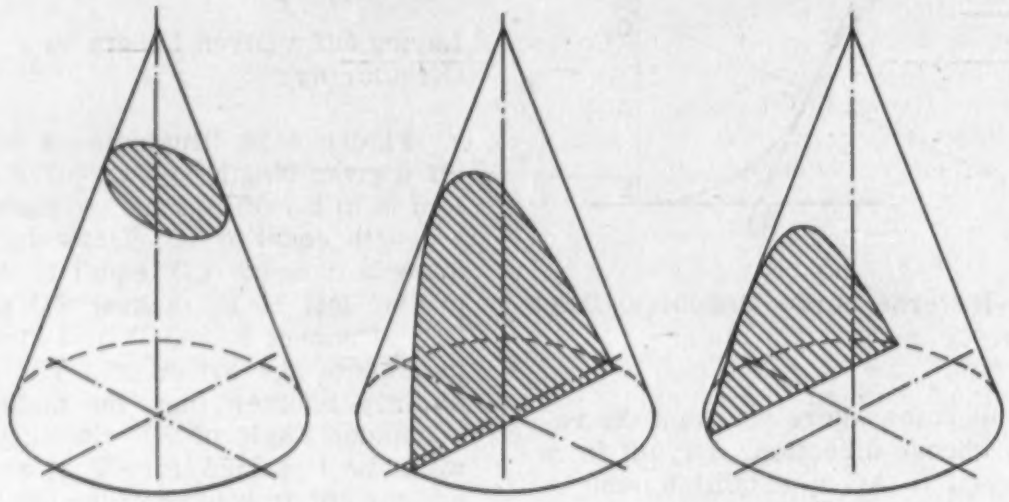

Figure 4-60.—Conic sections: (A) ellipse; (B) parabola; (C) hyperbola.

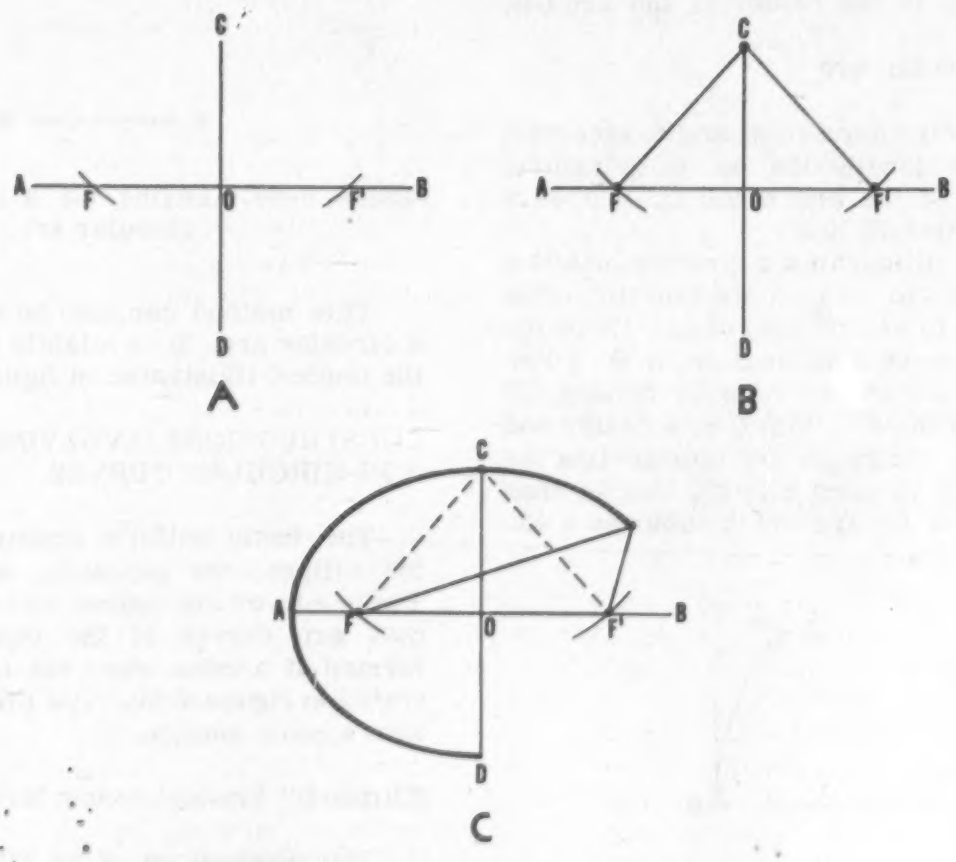

Figure 4-61.—Ellipse by pin-and-string method.

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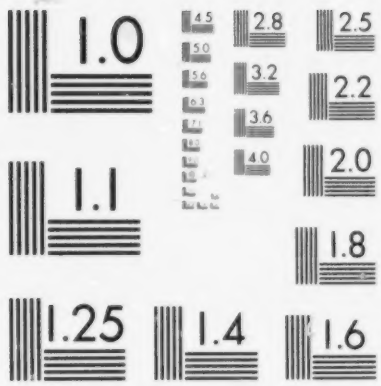

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

the pin-and-string method. The problem is to draw an ellipse with major axis AB and minor axis CD. Set a compass to one-half the length of AB, and with C as a center strike arcs intersecting AB at F and F'. Set a common pin at point C, another at F, and a third at F'. Tie the end of a piece of string to the pin at F, pass the string around the pin at C, pull it well taut, and fasten the other end to the pin at F'. Remove the pin at C, place the point of the pencil in the bight of the string, haul out the slack in the string, and draw the ellipse as shown in the third view, keeping the string taut all the way around.

Ellipse by Trammel Method

Another method of drawing an ellipse, called the trammel method, is illustrated in figure 4-62. In this method you plot a series of points along the ellipse by the use of a marked

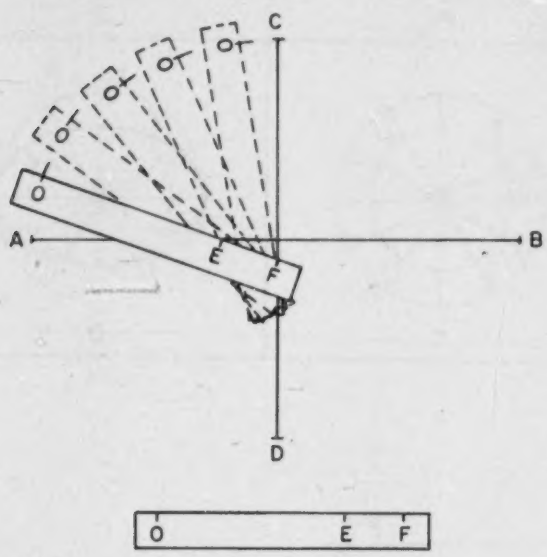

Figure 4-62.—Ellipse by trammel method.

straightedge called a trammel. A strip of paper, cardboard, or plastic, or the edge of a triangle, will serve the purpose. On the edge of the trammel lay off OE equal to one-half of the minor axis CD and OF equal to one-half of the major axis AB. If the trammel is set on the axes so that E is constantly on the major axis AB and F constantly on the minor axis CD, O will always be on the ellipse, regardless of the angle of the trammel. This being the case, you can use the trammel in the manner illustrated, to plot a series of points along the ellipse. You can then fair a line through the points with a french curve.

Ellipse by Foci Method

Another method of drawing an ellipse is the fOCI method illustrated in figure 4-63. In this method you plot a series of points along the ellipse by drawing a series of intersecting arcs, using two points on the major axis as centers. These points are the fOCI. To locate the foci (F and F' in fig. 4-63), set a compass to one-half of the major axis and, with C as a center, strike arcs intersecting the major axis. Lay off from O toward F a series of at least 5 equal intervals on the major axis. To plot point 1 on the ellipse, set the compass to A1 and with F' as a center strike an arc; then set the compass to B1 and with F as a center, strike an intersecting arc. To plot point 2 on the ellipse, set the compass to A2 and with F' as a center, strike an arc; then set the compass to B2 and with F as a center, strike an intersecting arc. Proceed in this manner to plot 5 points on the ellipse between C and B. To plot 5 points between C and A, proceed in the same manner, but reverse the foci in drawing the arcs. To plot 5 points between B and D, use the foci as you used them in plotting the points between C and B. To plot 5 points between A and D, use the foci as you used them in plotting the points between C and A. After you have learned the method, you can plot the points in the right-hand half of the ellipse in a single operation, and the points in the left-hand half in another single operation.

Ellipse by Concentric Circle Method

Figure 4-64 illustrates the concentric circle method of drawing an ellipse. With the point of intersection between the axes as a center, draw two concentric circles (concentric circles are circles having the same center), one with diameter equal to the major axis and the other with diameter equal to the minor axis, as shown in 4-64 (A). Draw a number of diameters as shown in 4-64(B). From the point of intersection of each diameter with the larger circle, draw a vertical line; and from the point of intersection of each diameter with the smaller circle, draw an intersecting horizontal line, as shown in 4-64(C). The points of intersection between these lines lie along the ellipse, as shown in 4-64(D).

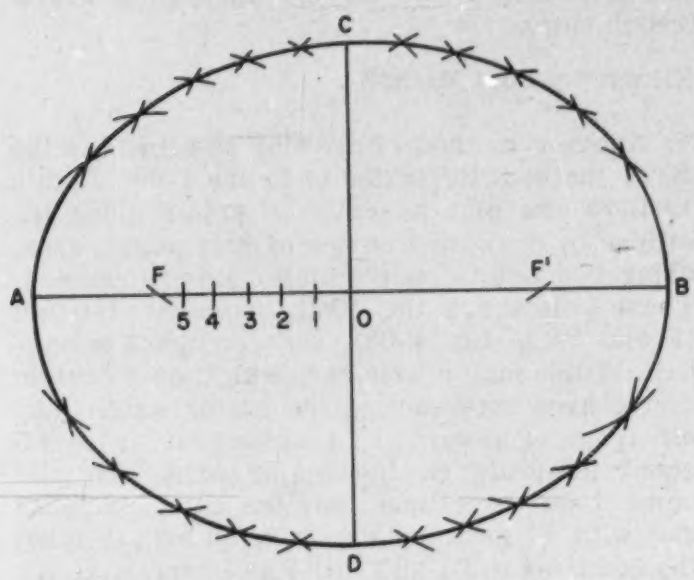

Figure 4-63.—Ellipse by foci method.

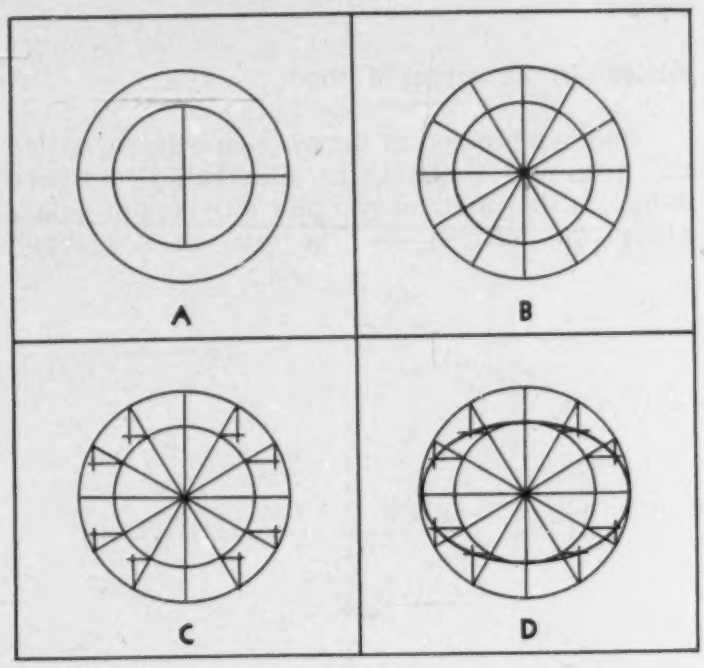

Figure 4-64.—Ellipse by concentric circle method.

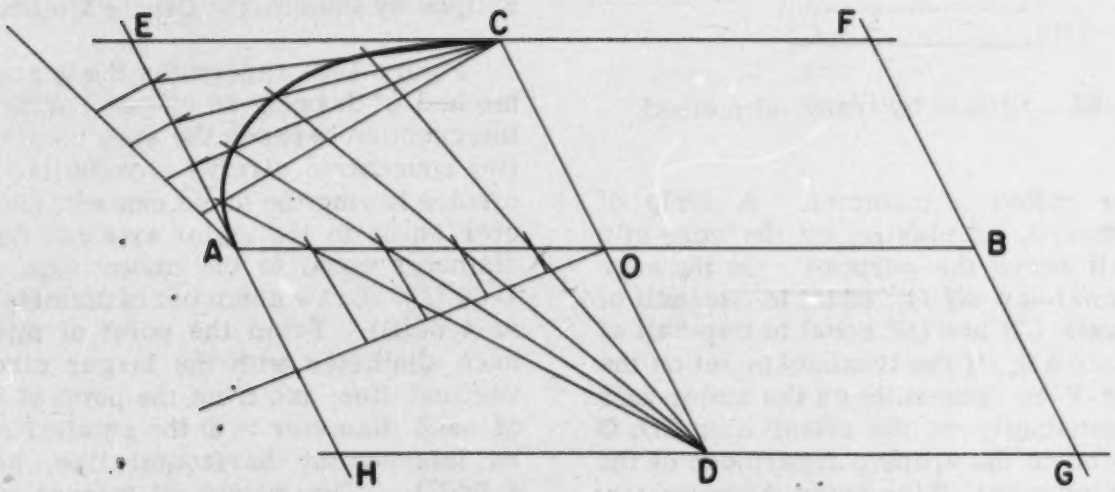

Figure 4-65.—Ellipse with given conjugate diameters.

Ellipse, Given Conjugate Diameters

Each of the ellipses discussed in the previous sections has been given in terms of a horizontal and a vertical axis, one of which is perpendicular to the other. An ellipse may also be given in terms of conjugate diameters. Two diameters of an ellipse are conjugate when each is parallel to the tangents at the ends of the other. One of a given pair of given conjugate diameters is, as a rule, not perpendicular to the other.

Figure 4-65 shows the parallelogram method of drawing an ellipse with given conjugate diameters AB and CD. Draw the circumscribing parallelogram EFGH. Divide EA and AO into the same number of equal intervals. Draw lines

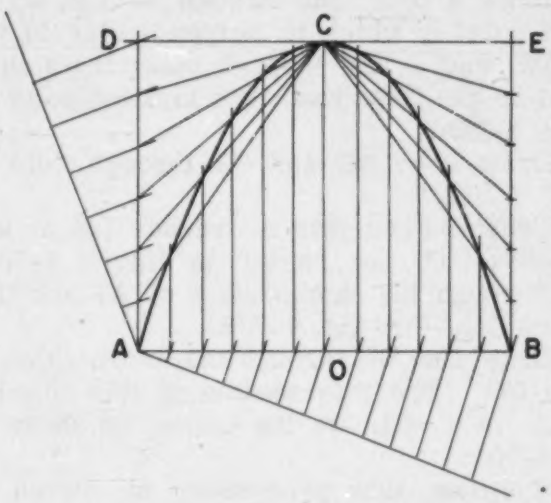

Figure 4-66.—Parabola.

from D passing through the intervals of AO, the lines from C to the intervals of EA. The points of intersection of these lines lie on the ellipse.

Parabola

Figure 4-66 illustrates a method of drawing a parabola. The problem is to draw a parabola which starts at A, ends at B, and has CO as an axis. Draw AD, DE, and BE, creating the rectangle ADEB. Divide AD and BE into a number of equal intervals, and divide AB into twice that number of equal intervals. Draw lines from C to the intervals along AD and BE, and erect perpendiculars from the intervals along AB to intersect these lines. The points of intersection lie along the parabola.

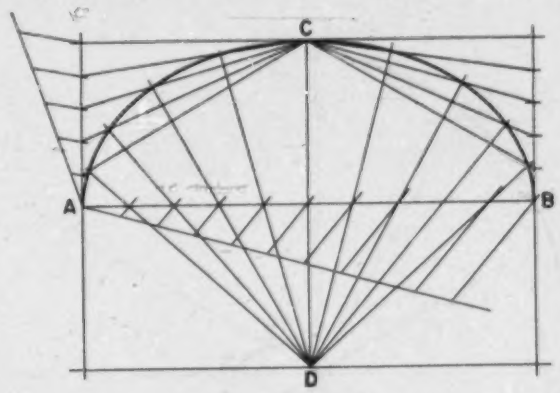

Figure 4-67.—Ellipse by general method for drawing conic sections.

This method is a general method which can be used to draw any conic section. Figure 4-67 illustrates the use of the method in drawing an ellipse with major axis AB and minor axis CD. The use of the method in drawing an ellipse with given conjugate diameters is illustrated in figure 4-65.

Hyperbola

Figure 4-68 illustrates the use of the general method for drawing a hyperbola. The problem here is to draw a hyperbola which starts at A, ends at B, and has CO as a vertical axis (AB is the transverse axis). Draw AD, DE, and BE, creating the rectangle ADEB. Divide AD and BE into a number of equal intervals,

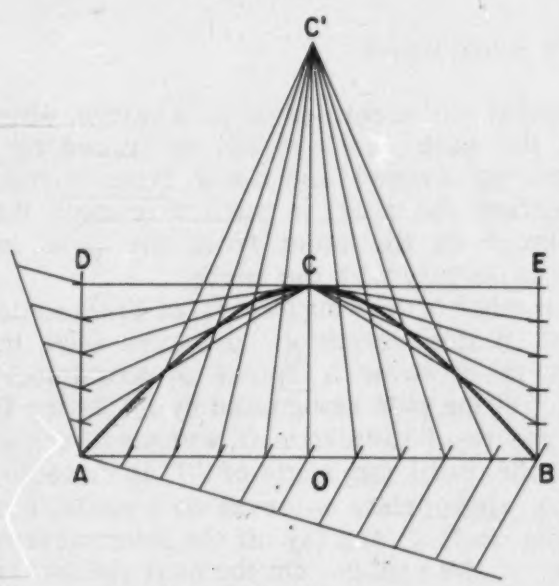

Figure 4-68.—Hyperbola.

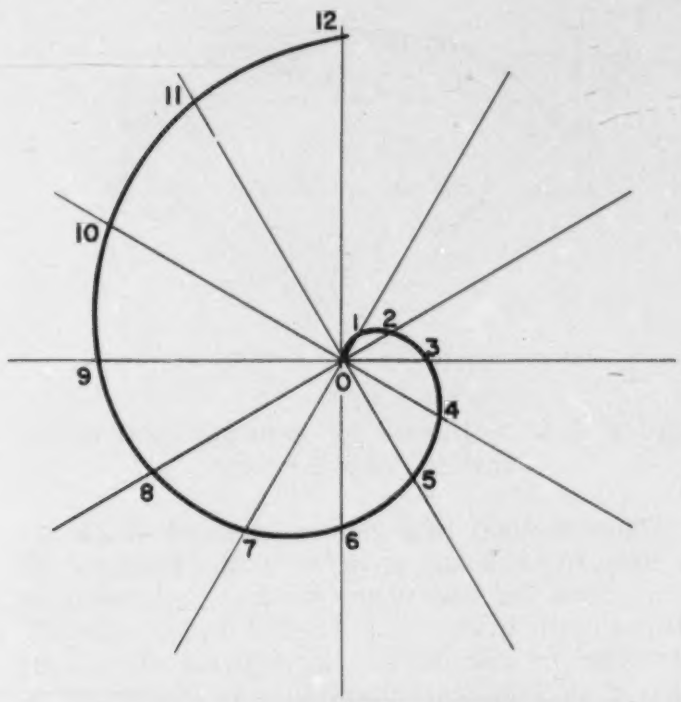

Figure 4-69.—Spiral of Archimedes.

and divide AB into twice that number of equal intervals. Extend OC to C'. The amount you extend it depends upon how sharp you want the curve of the hyperbola to be. The longer you make C'O, the flatter the curve will be.

Draw lines from C to the intervals along AD and BE, and lines from C' to the intervals along AB. Points of intersection between these lines lie on the hyperbola, as illustrated.

Spiral of Archimedes

A spiral of archimedes is a curve which follows the path which would be traced by a point moving around and away from a fixed point (called the pole) in such a manner that the distance of the point from the pole increases uniformly with the angle.

The method of drawing a spiral of Archimedes is based on this definition. In figure 4-69, the problem is to draw a spiral of Archimedes beginning at the pole designated by the letter O. Draw a series of radii from O, with equal angles between the radii (an angle of 30° is suitable). Select an appropriate interval on a scale, pick a starting radius, and lay off the interval from the pole on the radius. On the next radius, lay off twice the interval; on the next, three times the interval, and so on. This will produce the series of numbered points shown in the figure. Draw a line through the points with a french curve.

CONSTRUCTING FAIRED CURVES

In general, a curve is considered smooth or faired if a draftsman using a normally straight spline with ducks can make it lie on all points of the curve without forcing it. If any of the ducks, except one at an end, is lifted, the spline should not spring away from its position. That is, the curve should be perfectly smooth with no slight reverse curves in it.

Figure 4-70 illustrates a method of constructing a faired curve geometrically when only three points on the curve are known:

1. Locate the points for clearance, shown as A, O, and B in figure 4-70.
2. Draw a base line through point A, a line through point A which is perpendicular to the base line, and a line through point B which is parallel to the base line, thus locating point C. (See fig. 4-70A.)
3. Draw lines AD and BE through point O. (See fig. 4-70A.)
4. Draw AF so that it crosses BE at any point above O, as shown in figure 4-70B.
5. Through the intersection of AF and BE, draw line CG. (See fig. 4-70B).
6. Draw line BH through the intersection of AD and CG. The intersection of this line BH with AF is a point on the curve, as shown in figure 4-70B.
7. Continue this procedure, as shown in figures 4-70C and 4-70D, until as many points on the curve as are desired have been located.

DIMENSIONING

Since an engineering drawing is made to be used in producing or constructing something, the dimensions on the drawing must be drawn and lettered accurately. In drawing extension and dimension lines and in lettering dimensions, keep in mind the man who has to read the drawing and make something from it. All the dimensions a workman will need should be included on the drawing. It should never be necessary for him to stop his work to make mathematical computations that should have been given to him. In MIL-STD-8C, Dimensioning and Tolerancing, the general rules which are followed throughout the Defense Department are discussed at length.

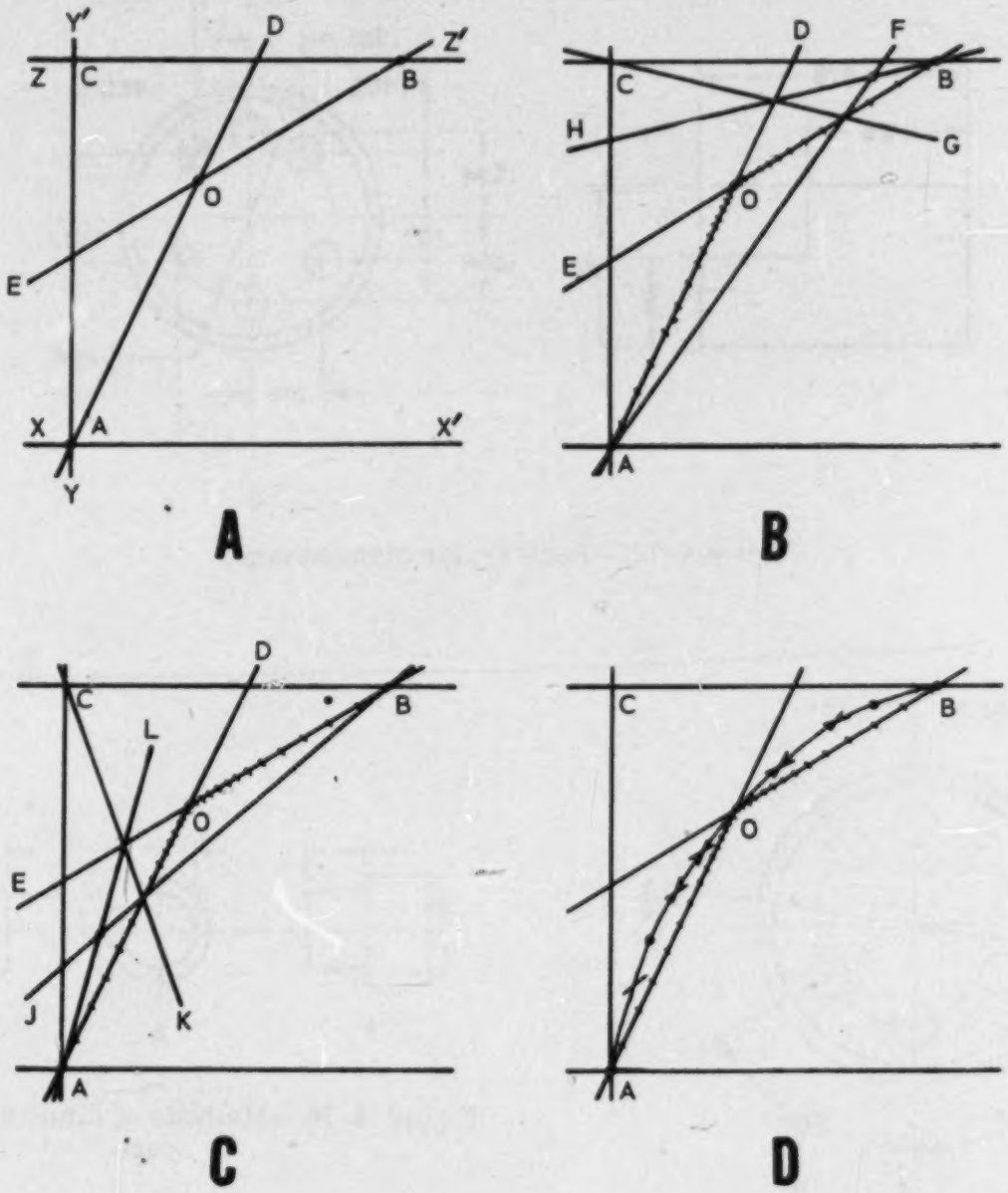

Figure 4-70.—Layout for a faired curve through a set of points.

Placing Dimensions

Place as many dimensions on the principal view as you can without crowding them. Dimensions of surfaces which show on the outlines of two views should be placed between these views. On views other than the principal view, show dimensions only for those features which do not have their true shape on the principal view. Dimensions should be placed outside the view whenever possible. If you can avoid it, do not dimension to hidden lines.

Two systems are used in dimensioning. The rectangular system is shown in figure 4-71, and the angular system in figure 4-72. In the rectangular system, horizontal or vertical dimension lines are drawn parallel to the distance to be dimensioned, with any necessary extension lines drawn perpendicular to that distance. In the angular system, the position of a point, line, or surface is shown by means of angles and linear dimensions at an angle other than 90°.

When a number of distances that are side by side on a drawing are to be dimensioned, place the dimension lines and figures in line where space permits. (See fig. 4-73a.)

Dimension lines should not cross other lines. The dimensions should be grouped with

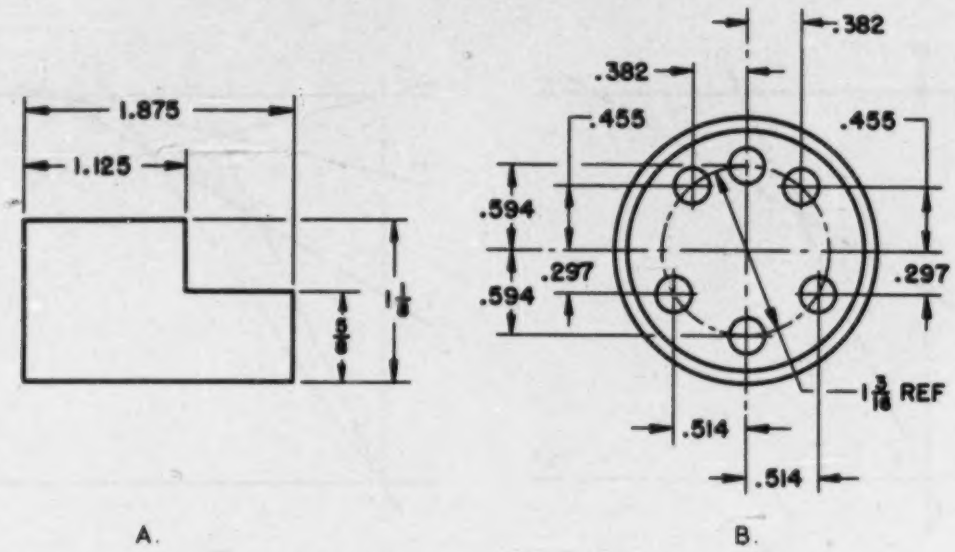

Figure 4-71.—Rectangular dimensioning.

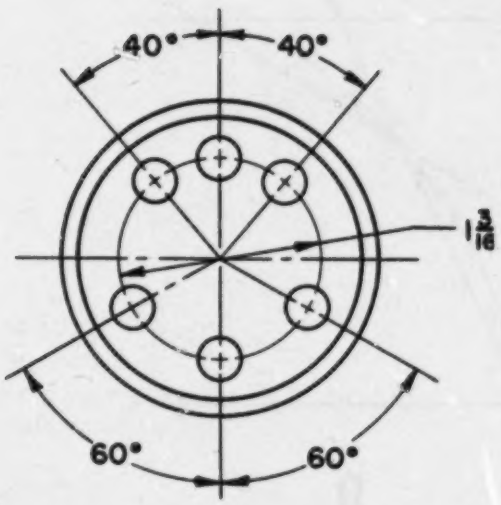

Figure 4-72.—Angular dimensioning.

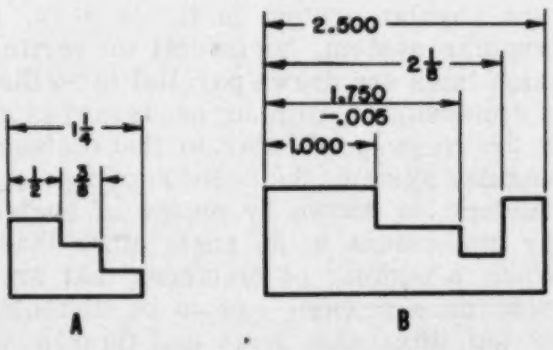

Figure 4-73.—a. Placing dimensions.
b. Staggering dimensions.

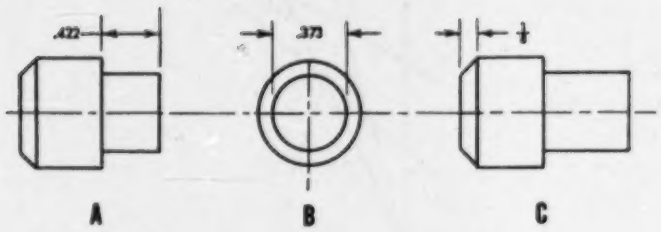

Figure 4-74.—Methods of dimensioning a small space.

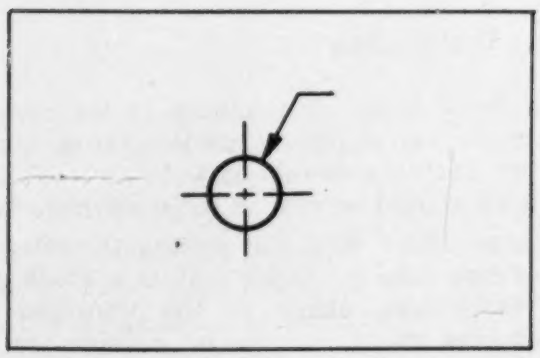

Figure 4-75.—Leader used in dimensioning small circles.

the smallest dimension closest to the outline of the view and the larger dimensions stepped out at equal distances. (See fig. 4-73.) When it is impossible to avoid drawing leader lines across a dimension line, break the leaders. Avoid crowding dimension lines. The lines should be spaced at least 3/8-inch from the view and at least 3/8-inch apart when the dimensions are stepped out from the view.

Where the space to be dimensioned is small:

1. The dimension line with arrows may be drawn inside the space between extension lines and a line drawn leading to the figure outside. (See fig. 4-74a.)

2. The figure may be placed in the space between extension lines, aligned with arrows pointed toward it from outside the lines, as shown in figure 4-74b.

3. The arrows may be trained on the space, which is left blank, and the dimension lettered at the end of one of the arrows. (See fig. 4-74c.)

In the dimensioning of small circles, leaders are used as in figure 4-75. The abbreviation DIA should follow the diameter dimension unless it is clearly a dimension figure as shown by a dimension line drawn inside the circle at an angle to represent the diameter or by a note such as drill.

In the dimensioning of larger circles, the rectangular system may be used; or a dimension line may be drawn as a slanted diameter to the circle and an extension line exactly like a leader, but without an arrow, drawn to the dimension numeral, as in figure 4-72.

In the dimensioning of arcs of circles, a leader defining the radius is used, with its

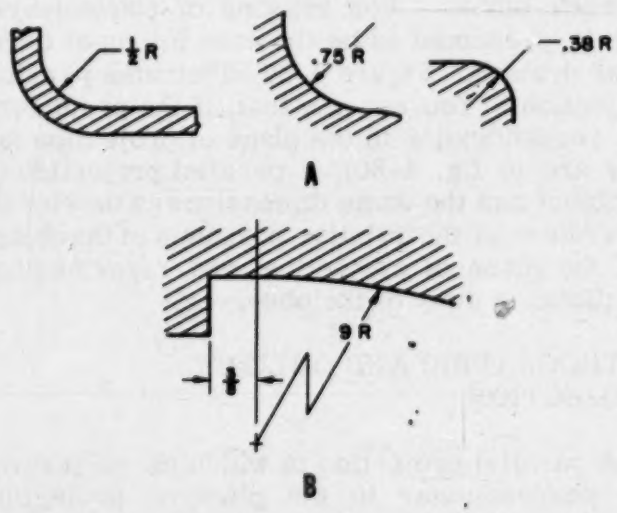

Figure 4-76.—Dimensioning arcs.

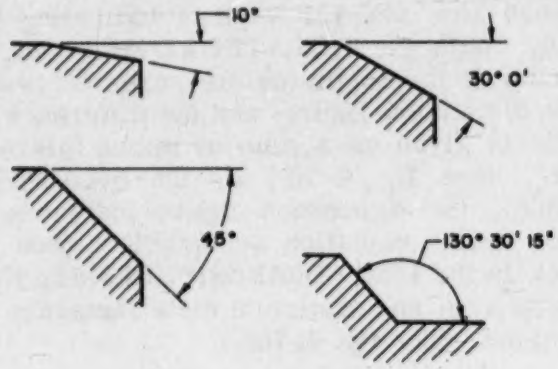

Figure 4-77.—Dimensioning angles.

arrowhead terminating in contact with the arc. (See fig. 4-76a.) On large arcs, where the center of the circle would fall off the drawing, a long break, or zigzag, is drawn in the leader line, and the dimension is placed between the zigzag and the arrowhead. (See fig. 4-76b.) The letter R should always follow the dimensions of a radius.

In the dimensioning of angles, the dimension lines are drawn as arcs. (See fig. 4-72.) The position of the dimension figure will vary according to the size of the angle, as shown in figure 4-77.

Dimension Numerals and Letters

It is important to leave enough space between letters and figures in order to prevent their becoming blurred when your drawing is reproduced to a smaller scale. Decimal points should be slightly heavier than the lines in the lettering and should be spaced carefully.

All letters and numerals should be so placed on a drawing that they are easy to read without turning the drawing. On one drawing they may all be placed in a horizontal position. On another, the vertical and angular dimensions may be placed in such a manner that they may be read from the right-hand side of the drawing.

Tolerance figures on mechanical drawings represent the amount a part can be allowed to vary within a dimension when the part is made. When no tolerance is given with the individual dimensions, there should be a general tolerance note on the drawing. When there is no general note, tolerance figures may be placed either just to the right of the dimension or directly beneath the dimension. The numerals are placed in a break in the line or, if the tolerance figure is below the dimension, the line may pass between them.

There are several ways of indicating tolerance. With the UNILATERAL METHOD, the minimum or the maximum measurement is used as the dimension figure, and the difference allowable is given as a plus or minus tolerance figure. (See fig. 4-78.) In the BILATERAL METHOD, the dimension figure indicates the plus or minus variation acceptable. (See fig. 4-78b.) In the LIMIT DIMENSIONING METHOD, the maximum and minimum measurements are both stated. (See fig. 4-78c.)

THEORY OF PROJECTION

CENTRAL PROJECTION

Projection is done, in theory by extending lines of sight (called projectors) from the eye of the observer through lines and points on the object to the plane of projection. If this procedure were literally followed, the result would always be the type of projection illustrated in figure 4-79. This type is called central projection, since the lines of sight or projectors converge at a single central point—the eye of the observer.

You can see that the projected view of the object varies considerably in size, according to the relative positions of the object and the plane of projection. It would also vary with the distance between these two, and with the distance between the observer and the object and between the observer and the plane of projection. For these and other reasons, central projection is seldom used for the projection of technical drawings.

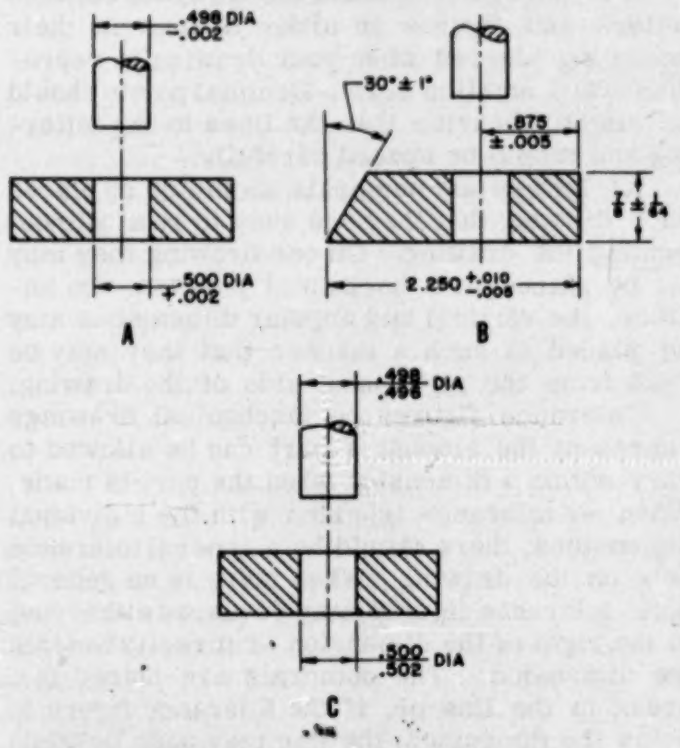

Figure 4-78.—Methods of indicating tolerance.

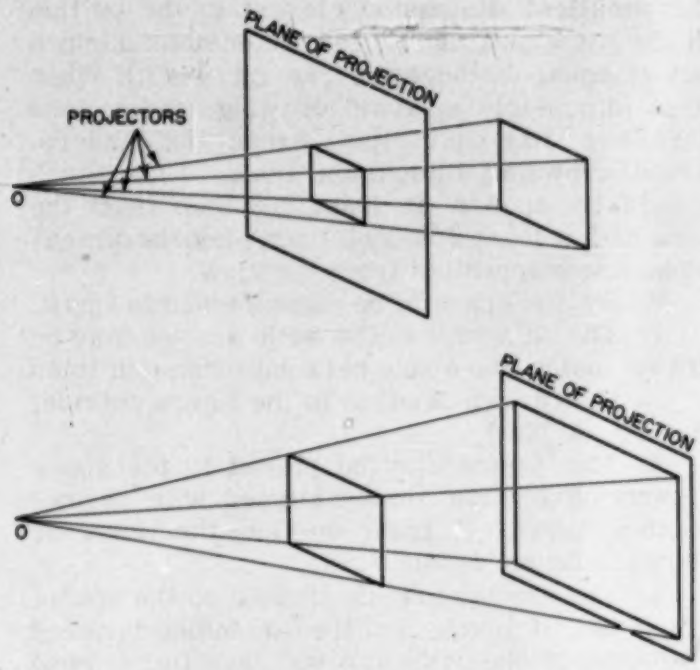

Figure 4-79.—Central projection.

PARALLEL PROJECTION

If the observer were located an infinite distance away from the object and its plane of projection, the projectors, instead of converging together to a point, would be parallel to each other. For reasons of convenience, this is presumed to be the case for most technical drawing. Figure 4-80 illustrates parallel projection. You can see that, if the projectors are perpendicular to the plane of projection (as they are in fig. 4-80), a parallel projection of an object has the same dimensions as the object, regardless of the relative positions of the object and the plane of projection, and regardless of the distance away of the observer.

ORTHOGRAPHIC AND OBLIQUE PROJECTION

A parallel projection in which the projectors are perpendicular to the plane of projection (as they are in fig. 4-80) is called an orthographic projection. One in which the projectors

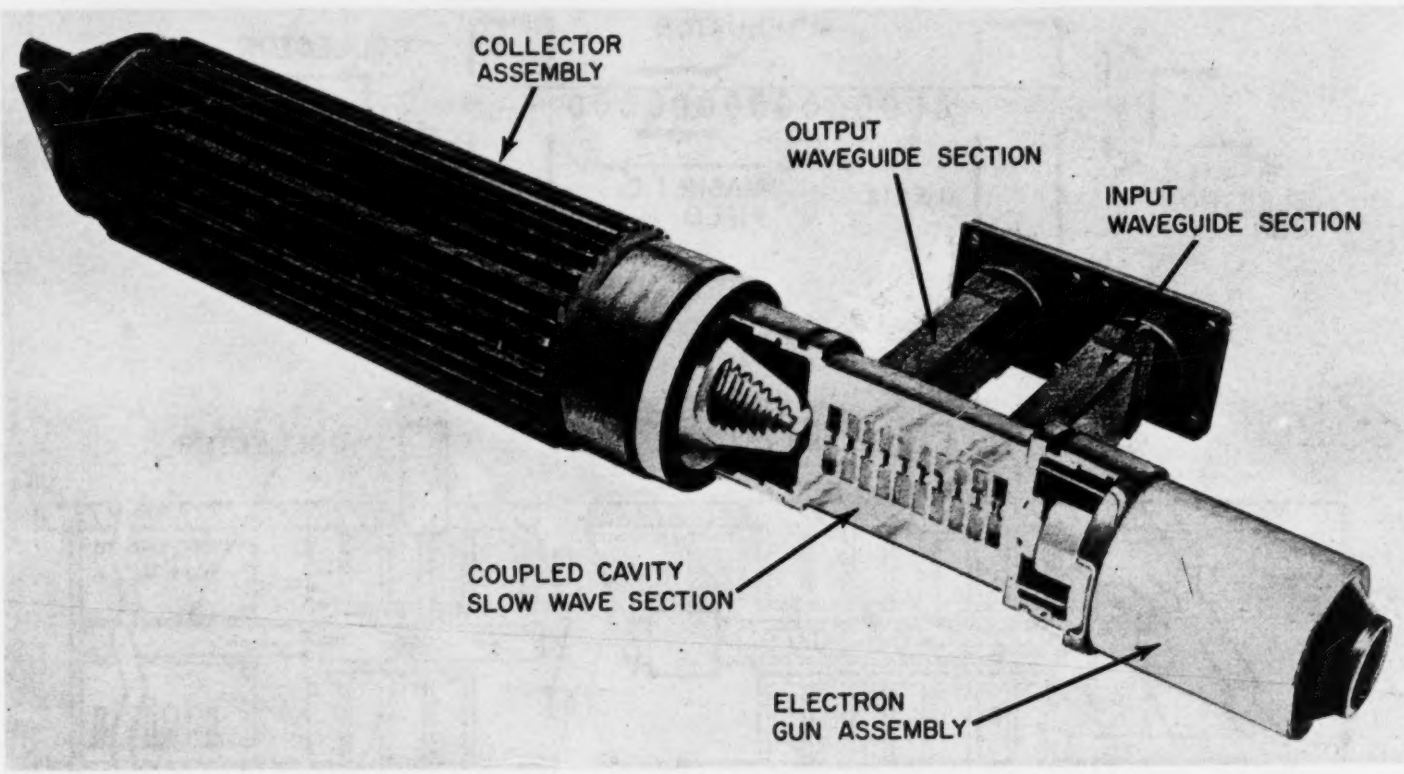

Figure 12-16.—High powered coupled cavity TWT.

Coupling and Attenuation

Input and output coupling methods, and the means of attenuating signals in the TWT circuits, are generally of the same types discussed in chapter 9 of AT 3 & 2, NavPers 10317-C in connection with waveguides and cavity resonators. A review of these coupling and attenuating methods may be of some help at this time.

APPLICATIONS

The traveling wave tube has proved itself a very versatile device. Among the applications to which it has been put are:

1. Amplifiers—tunable and fixed frequency; input and IF; amplitude, phase, pulse, and frequency modulated; and phase and frequency shifters.
2. Limiters and automatic gain control devices.
3. Microwave frequency generators—fixed frequency, narrowband or wideband, or tunable; frequency multipliers.

Some of these applications will be discussed in the following paragraphs, along with details of construction and variations of the tubes and circuit functions.

Amplifier

The most noteworthy characteristic of the traveling wave tube is its ability to amplify microwave signals through a wide band of frequencies. This amplification is obtained through the use of the interaction circuit. This circuit is basically a transmission line, and usually does not contain a resonant circuit of any kind. By avoiding the use of resonant circuits, the TWT is not subject to the normal gain-bandwidth formula (which states that as the bandwidth is increased, the gain decreases, and vice versa). To date, the TWT is the only amplifying device used at microwave frequencies that does not use resonant cavities for amplification. The gain-times-bandwidth product of the TWT may be in the order of 10^{13}. TWT's have been constructed to operate in frequency bands from 100 mc to 50,000 mc.

In the helix type slow wave circuit (fig. 12-17), this gain takes place as described in the following paragraphs.

The electron beam is injected into the interaction region at the electron gun end of the slow wave structure. The velocity of the beam

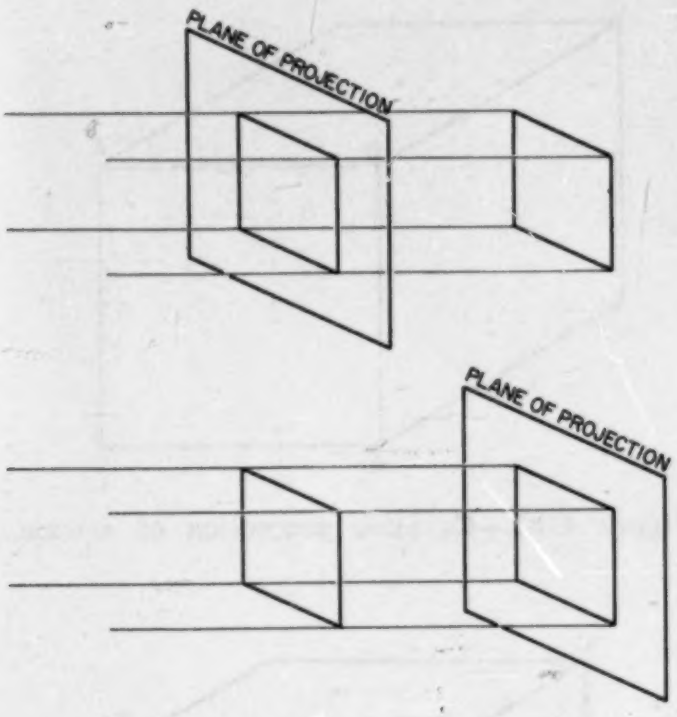

Figure 4-80.—Parallel projection.

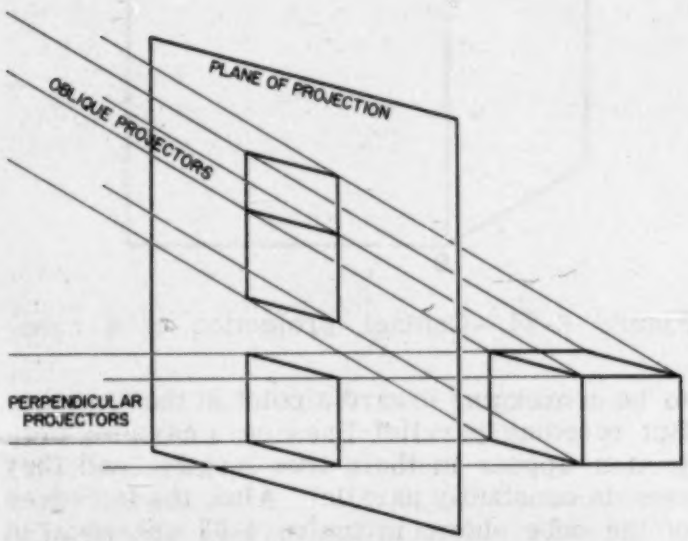

Figure 4-81.—Oblique and orthog aphic projections of the same object.

are oblique (other than perpendicular) to the plane of projection is called an oblique projection.

Figure 4-81 shows the same object by both orthographic and oblique projection. The block is placed so that its front surface (the surface toward the plane of projection) is parallel to the plane of projection. You can see that the orthographic projection shows only this surface of the block. The oblique projection, on the other hand, shows the front surface and also the top surface. The orthographic projection shows only two dimensions of the block, the length and the width. The oblique projection shows three, the length, the width, and the thickness. Oblique projection, then, is one method by which an object can be shown, in a single view, in all three dimensions.

SINGLE-PLANE PROJECTION

A projection which shows an object in all three dimensions is called a single-plane projection, because only a single plane of projection is required to show all three dimensions. A single-plane projection may be either an oblique or an axonometric projection.

OBLIQUE SINGLE-PLANE PROJECTION

The two most commonly used types of oblique single-plane projection are the cavalier projection and the cabinet projection.

Cavalier Projection

Cavalier projection is a form of oblique projection in which the projectors are presumed to make a 45-degree vertical and a 45-degree horizontal angle with the plane of projection. Assume that in figure 4-82 the line XX' represents a side-edge view of the plane of projection, and that the square ABCD represents a side of a cube, placed with its front face parallel to, and its top face perpendicular to, the plane of projection. You can see that the projected lengths of AB and AC are the same as the actual lengths.

Now assume that the line XX' in figure 4-82 represents a top-edge view of the plane of projection, and that the square ABCD represents the top of the cube. You can see again that the projected lengths of AB and AC are the same as the actual lengths of AB and AC.

In a cavalier projection, then, any line parallel to or perpendicular to the plane of projection is projected in its true length. Figure 4-83 shows a cavalier projection of the cube shown in figure 4-82. You start by drawing the axis, which consists of the front axes OA and OB and the receding axis OC. The front axes are always perpendicular to each other; the receding axis may be drawn from

O at any convenient angle. All three are equal in length, the length being the length of an edge of the original cube (which may be scaled down or up, of course, if the drawing is made other than full scale). After you draw the axis, complete the projection by drawing the required parallel lines. All the edges shown in the projection are, like the edges on the original cube, equal in length.

Cabinet Projection

The first thing you notice about the cube shown in figure 4-83 is the fact that it doesn't

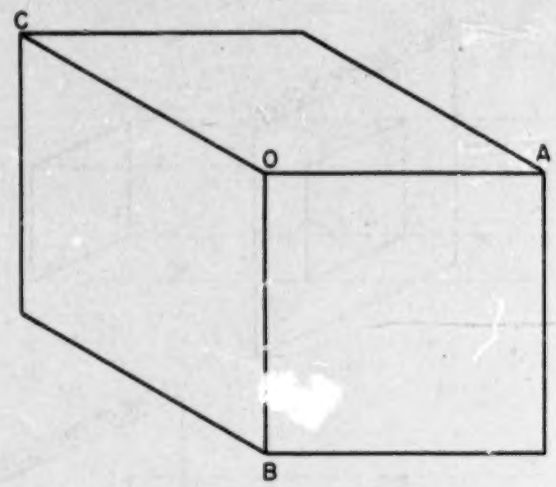

Figure 4-83.—Cavalier projection of a cube.

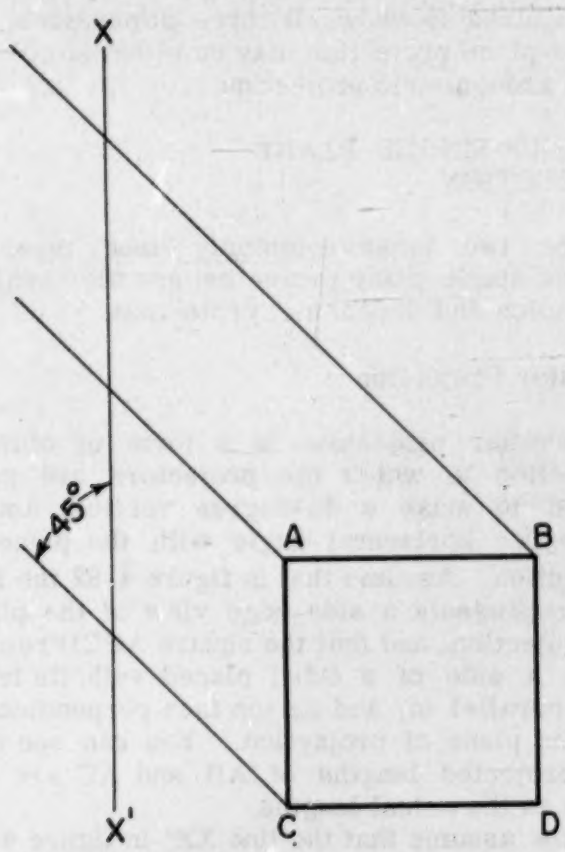

Figure 4-82.—Angle of projectors in a cavalier projection.

look like a cube, because the depth dimension appears to be longer than the height and width dimensions. The reason for this is the fact that a cavalier projection corrects a human optical illusion—the one which causes an object to appear to become smaller as its distance from the eye increases. This illusion in turn causes receding parallel lines to appear to the eye to be shorter than they really are, and also

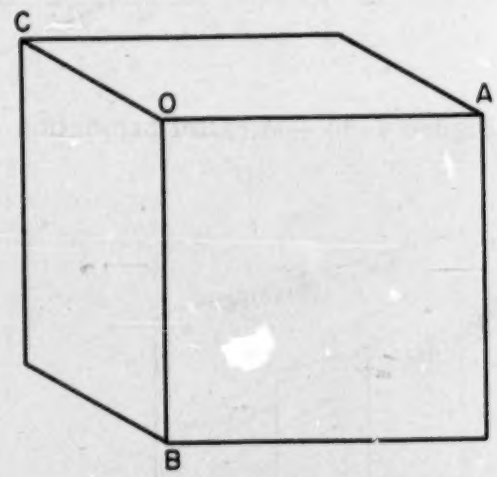

Figure 4-84.—Cabinet projection of a cube.

to be converging toward a point in the distance. But receding parallel lines on a cavalier projection appear in their true lengths, and they remain constantly parallel. Also, the far edges of the cube shown in figure 4-83 are equal in length to the near edges.

The apparent distortion in figure 4-83 is only apparent, but the eye is so accustomed to its illusions that it is sometimes desirable in pictorial drawings, to reduce the appearance of distortion. This can be done in an oblique projection by reducing the length of the receding axis (OC in fig. 4-83). This axis can be reduced by any desired amount, but it is customary to reduce it by one-half. When the receding axis is reduced by one-half, the projection is called a cabinet projection. Figure 4-84 shows a cabinet projection of a cube. The length of the

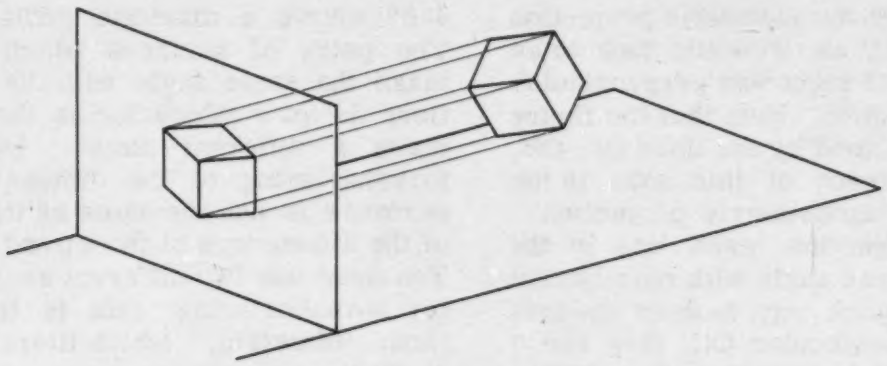

Figure 4-85.—Isometric projection of a cube.

receding axis OC has been reduced by one-half. As you can see, the eye is much more satisfied with this representation of a cube.

PROJECTION AXONOMETRIC SINGLE-PLANE

AXONOMETRIC single-plane projection is another way of showing an object in all three dimensions in a single view. Axonometric projection is orthographic projection—meaning that in axonometric projection the projectors are perpendicular to the plane of projection. It is the object itself, rather than the projectors, that is inclined to the plane of projection.

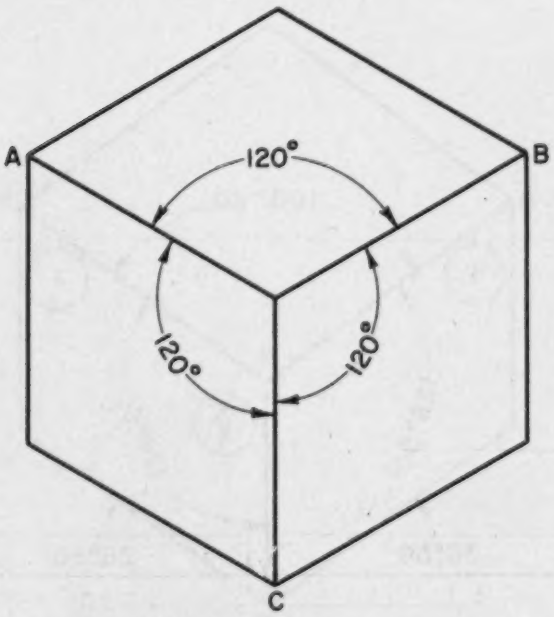

Figure 4-86.—Isometric axis.

Isometric Projection

Figure 4-85 shows a cube projected by isometric projection, the most frequently used type of axonometric projection. The cube is inclined so that all of its surfaces make the same angle (35° 16′) with the plane of projection. As a result of this inclination, the length of each of the edges shown in the projection is somewhat shorter than the actual length of the edge on the object itself. This reduction is called foreshortening. The degree of reduction amounts to the ratio of 1 to the cosine of 35° 16′, or 1/0.8165. This means that if an edge on the cube is 1 in. long, the projected edge will be 0.8165 in. long. As all of the surfaces make the same angle with the plane of projection, the edges all foreshorten in the same ratio. Therefore, one scale can be used for the entire layout; hence the term "isometric," which literally means "one-scale."

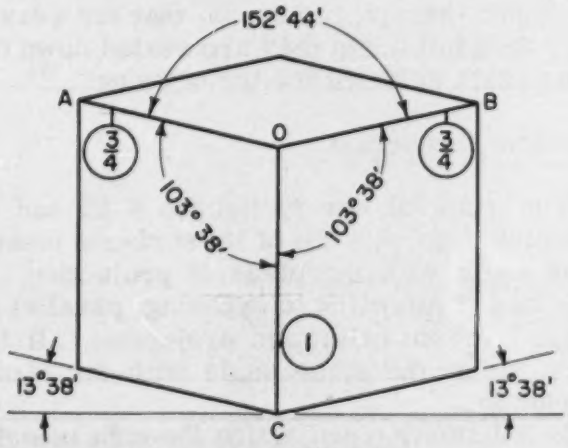

Figure 4-87.—Dimetric projection of a cube, showing a practical dimetric axis.

Figure 4-86 shows the isometric projection shown in figure 4-82 as it would look to an observer whose line of sight was perpendicular to the plane of projection. Note that the figure has a central axis, formed by the lines OA, OB, and OC. The existence of this axis is the origin of the term "axonometric projection." In an isometric projection, each line in the axis forms a 120-degree angle with the adjacent line, as shown. A quick way to draw the axis is to draw the perpendicular OC, then use a T-square and 30-60 degree triangle to draw OA and OB at 30° to the horizontal. Since the projections of parallel lines are parallel, the projections of the other edges of the cube will be respectively parallel to these axes.

Isometric Drawing

Assume that the projection shown in figure 4-86 is a projection of a cube measuring 1" x 1" x 1". If you drew this cube to full scale, each line in the isometric projection would be 0.8165 in. long.

Now, if you made each line in the drawing 1 in. long instead of 0.8165 in. long, the drawn figure would be slightly larger, but there would be no perceptible difference in its appearance otherwise. The proportions of the figure, with relation to each other, would be the same. Consequently, in practical draftsmanship it is often the case that an isometric drawing, rather than an isometric projection, is made. In full-scale isometric projection, dimensions are scaled down to the scale of 0.8165 (which comes to about 4/5 scale, or about 9.6" = 1 ft), to allow for foreshortening. In an isometric drawing foreshortening is ignored, and the dimensions on the drawing are the same as those on the object—except, of course, that for a drawing other than full scale they are scaled down or up to the scale selected for the drawing.

Dimetric Projection

The cube shown in figures 4-85 and 4-86 is inclined so that all of its surfaces make the same angle with the plane of projection. The cube has three pairs of opposing, parallel surfaces. In an isometric projection, all three pairs make the same angle with the plane of projection.

In a diametric projection the cube is inclined so that only two pairs of surfaces make the same angle with the plane of projection, while the third pair makes a different angle. Figure 4-87 shows a dimetric projection of a cube. The pairs of surfaces which form the sides make the same angle with the plane of projection; the pair which forms the top and bottom make a different angle. Consequently, the foreshortening of the dimensions of the side surfaces is not the same as the foreshortening of the dimensions of the top and bottom surfaces. You must use two different scales to scale down for foreshortening; this is the origin of the term "dimetric," which literally means "two-scale."

The axis of an isometric projection of a cube always consists of three lines at a 120-degree angle to each other, as illustrated in figure 4-86. The similar axis on a dimetric projection of a cube is variable, according to the angle of inclination of one pair of surfaces of the cube to the plane of projection. However, there are three axes which are suitable for almost any practical dimetric projection or drawing. One is the axis shown in figure 4-87. You can draw this one by drawing the perpendicular OC and using a protractor to draw OA and OB from O at 13° 38' to the horizontal. If you use this axis, the scale of foreshortening is 3/4 for OA and OB to 1 for OC. You can ignore the foreshortening of OC—that is, you can make OC the length of the original (to scale, of course, if the drawing is not being done full-scale). This means that you are making a dimetric drawing, rather than a dimetric projection.

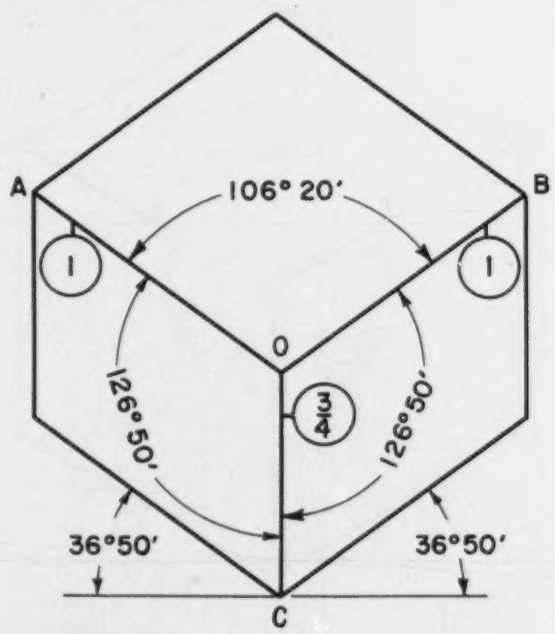

Figure 4-88.—Another practical dimetric axis.

Another practical dimetric axis is shown in figure 4-88. You can draw this one by drawing the perpendicular OC and then drawing OA and OB from O at 36° 50' to the horizontal. If you use this axis, the scale for foreshortening is 3/4 for OC to 1 for OA and OB.

In the dimetric projection shown in figure 4-89, it is the top and bottom pair of surfaces and one pair of side surfaces that make the same angle with the plane of projection; the other pair of side surfaces make a different angle. A practical dimetric axis for a cube in this position is shown in the figure. You can draw this one by drawing the perpendicular OC, then drawing OA from 0 at 7° 10' to the horizontal and OB from 0 at 41° 25' to the horizontal. If you use this axis, the scale for foreshortening is 1/2 for OB to 1 for OA and OC.

Trimetric Projection

In a trimetric projection the cube is inclined so that all three pairs of surfaces make different angles with the plane of projection. Figure 4-90 shows a trimetric projection of a cube. The foreshortening is different for each of the three pairs of surfaces; therefore, three

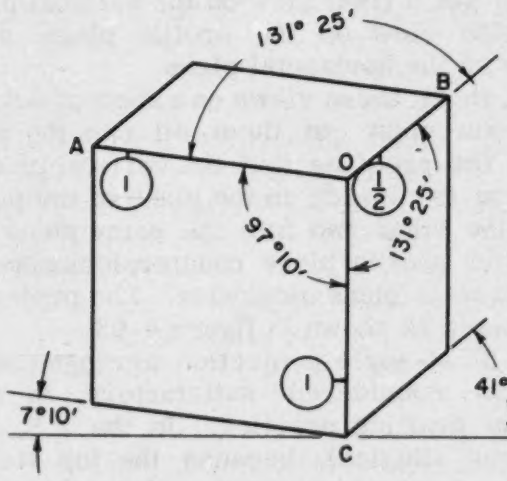

Figure 4-89.—Practical axis for cube placed in different dimetric position.

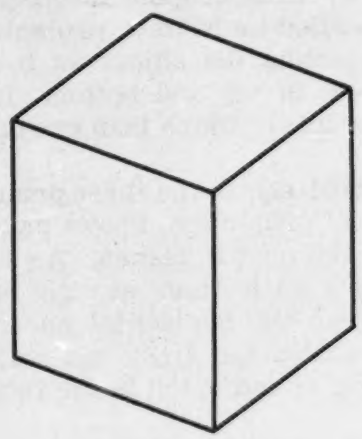

Figure 4-90.—Trimetric projection of a cube.

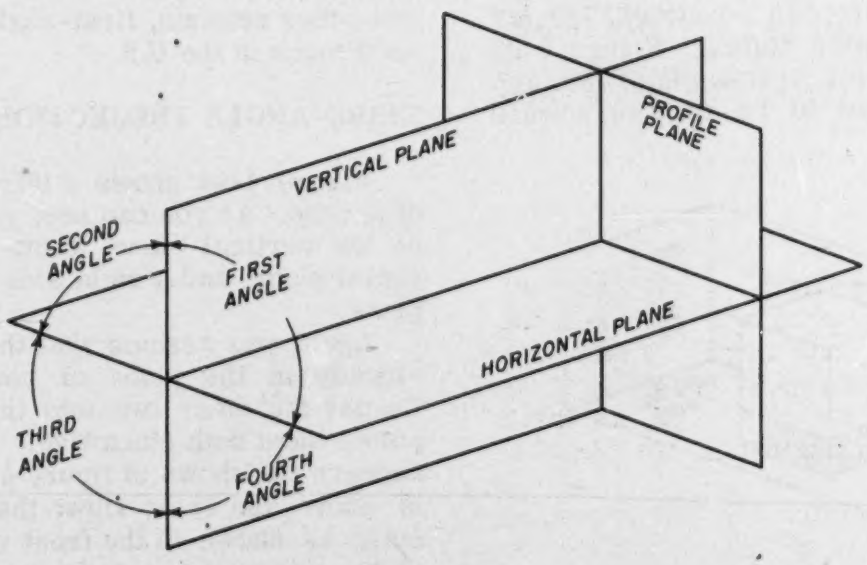

Figure 4-91.—Multiview planes of projection.

different scales would be required to scale down for foreshortening. This is the origin of the term "trimetric," which literally means "three-scale."

Trimetric projection is much more difficult than isometric or dimetric projection, and it has few, if any, advantages over either of these other methods. Trimetric projection is therefore seldom used in actual practice.

MULTIVIEW PROJECTION

Oblique and axonometric projections are known as single-plane (or single-view) projections, because only a single view of the object is presented. Most technical drawings, however, are made by orthographic multi-plane, more commonly called multiview, projection. In this type of projection the object as it appears on all sides, and in top and bottom views, can be shown by the use of more than one plane of projection.

Figure 4-91 shows the three principal multiview planes of projection, known as the vertical, horizontal, and profile planes. As you can see, they intersect each other at right angles. The angles between the horizontal and the vertical planes are called the first, second, third, and fourth angles, as indicated in the figure.

FIRST-ANGLE PROJECTION

You could place the object to be projected in any one of the four angles. For technical reasons, second-angle and fourth-angle projections are not used. First-angle projection is used in most European countries, but not used much in the United States. Figure 4-92 shows a cube placed for first-angle projection. The cube is supposed to be fronting toward the vertical plane of projection. As you can see, you get a front view on the vertical plane, a left-side view on the profile plane, and a top view on the horizontal plane.

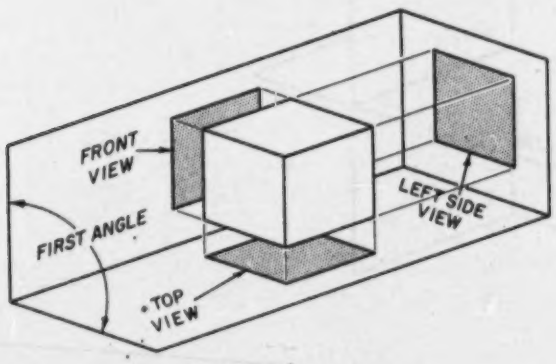

Figure 4-92.—First-angle projection of a cube.

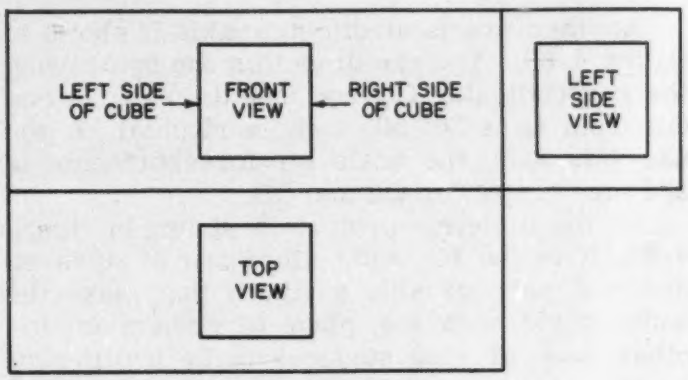

Figure 4-93.—First-angle projection brought into a single plane.

Now, to put these views on a sheet of drawing paper, you must get them all into the same plane. You presume that the vertical plane of projection is already in the plane of the paper. To get the other two into the same plane, you rotate the profile plane counterclockwise and the horizontal plane clockwise. The projection now appears as shown in figure 4-93.

This first-angle projection arrangement of views is considered satisfactory in most European drafting practice. In the U.S. it is considered illogical, because the top view is below the front view; because the right side of the object, as shown in the front view, is toward the left-side view of the object; and because the bottom of the object, as shown in the front view, is toward the top view of the object. For these and other reasons, first-angle projection is not used much in the U.S.

THIRD-ANGLE PROJECTION

Figure 4-94 shows a third-angle projection of a cube. As you can see, you get a front view on the vertical plane, a top view on the horizontal plane, and a right side view on the profile plane.

Again you assume that the vertical plane is already in the plane of your drawing paper. To get the other two into the same plane, you rotate them both clockwise. The projection now appears as shown in figure 4-95. The top view is above the front view; the right side of the cube, as shown in the front view, is toward the right side view; and the top, as shown in the front view, is toward the top view.

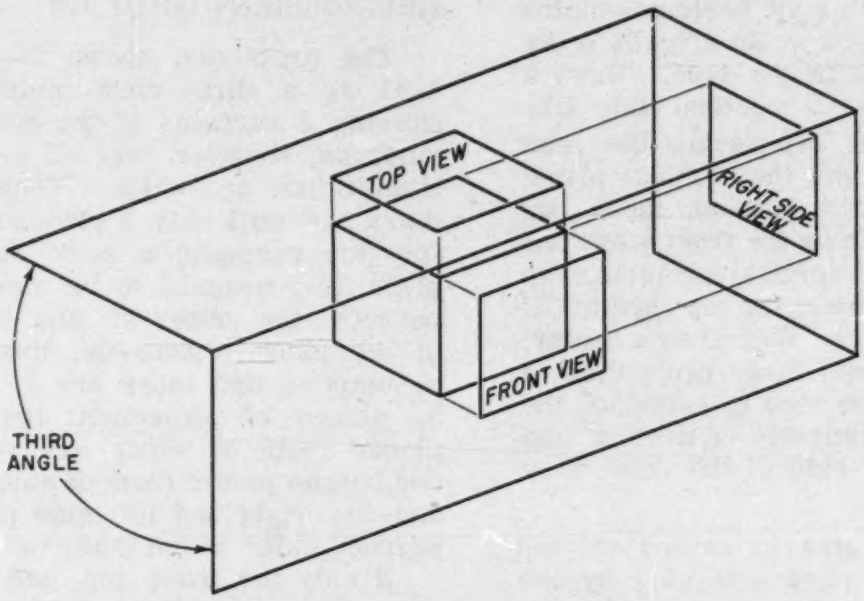

Figure 4-94.—Third-angle projection of a cube.

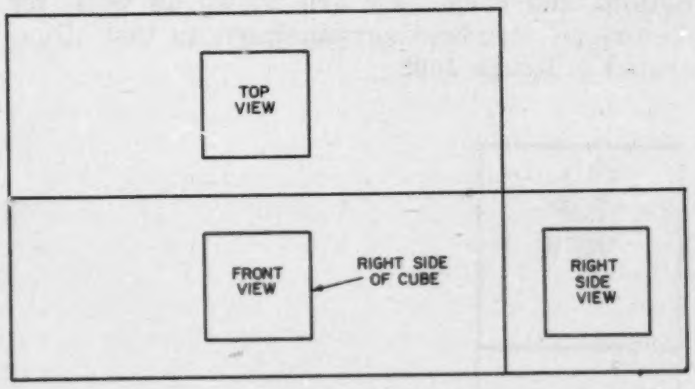

Figure 4-95.—Third-angle projection brought into a single plane.

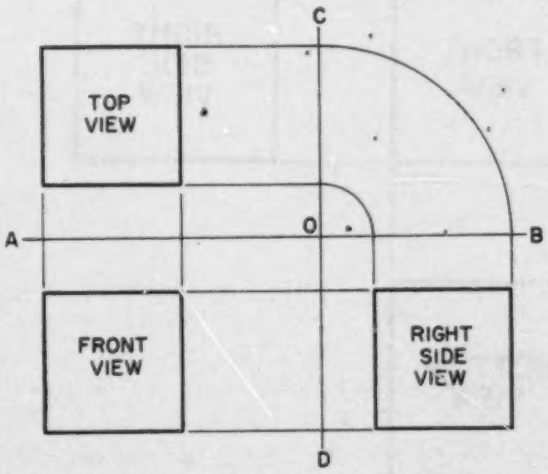

Figure 4-96.—Method of making a third-angle projection.

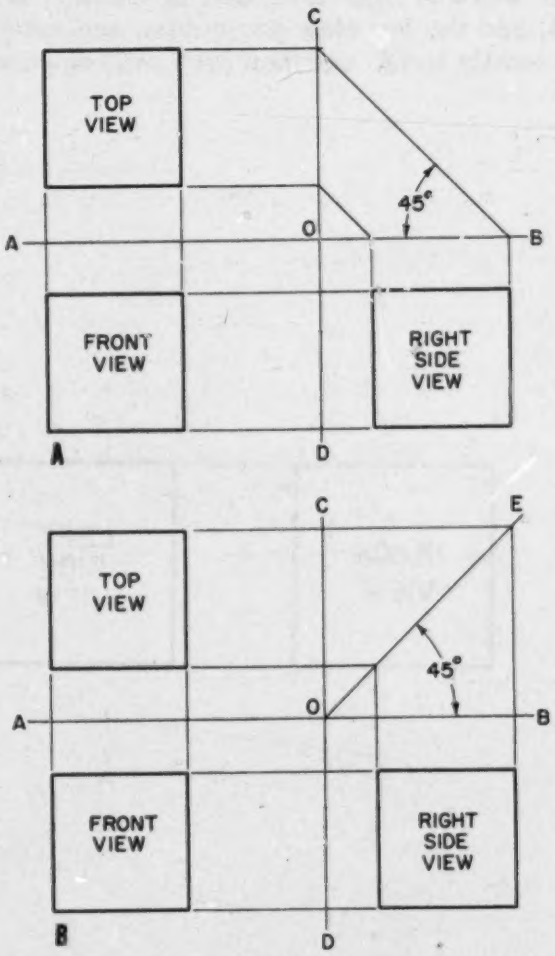

Figure 4-97.—Alternate methods of extending top view projectors.

Figure 4-96 illustrates the basic principles of the method by which you would actually make the projection shown in figure 4-95. Draw a horizontal line AB and a vertical line CD, intersecting at O. AB represents the joint between the horizontal and the vertical plane; CD represents the joint between these two and the profile plane. Draw the front view, and project it upward with vertical projectors to draw the top view. Project the top view to CD with horizontal projectors. With O as a center, use a compass to extend these projectors to AB. Draw the right side view by extending the projectors from AB vertically downward, and by projecting the right side of the front view horizontally to the right.

Many draftsmen prefer to extend the top view projectors to the right side view by one of the methods illustrated in figure 4-97. In figure 4-97(A) the projectors are extended from CD to AB by lines drawn at 45° to AB. In figure 4-97(B) the line OE is drawn at 45° to AB, and the top view projectors are extended horizontally to OE and then vertically downward.

ARRANGEMENT OF VIEWS

The projection shown in figure 4-96 and 4-97 is a three-view multiview projection, showing 3 surfaces of the cube. A cube has 6 surfaces, however, and all 6 can be shown in a multiview projection. Technically speaking, there are still only 3 planes of projection, but for (for example) a back view, the vertical plane is presumed to be moved to a position between the observer and the back surface of the block. Actually, this amounts to the assumption that there are 6, rather than only 3, planes of projection: the front and back planes (both of which are vertical), the top and bottom planes (both of which are horizontal), and the right and left side planes (which are perpendicular to the other two pairs of planes).

If only the front, top, and right side views are shown, the standard American arrangement of views is the third-angle arrangement shown in figure 4-96 and 4-97. If a left side, bottom and back view are shown as well, the American standard arrangement is that illustrated in figure 4-98.

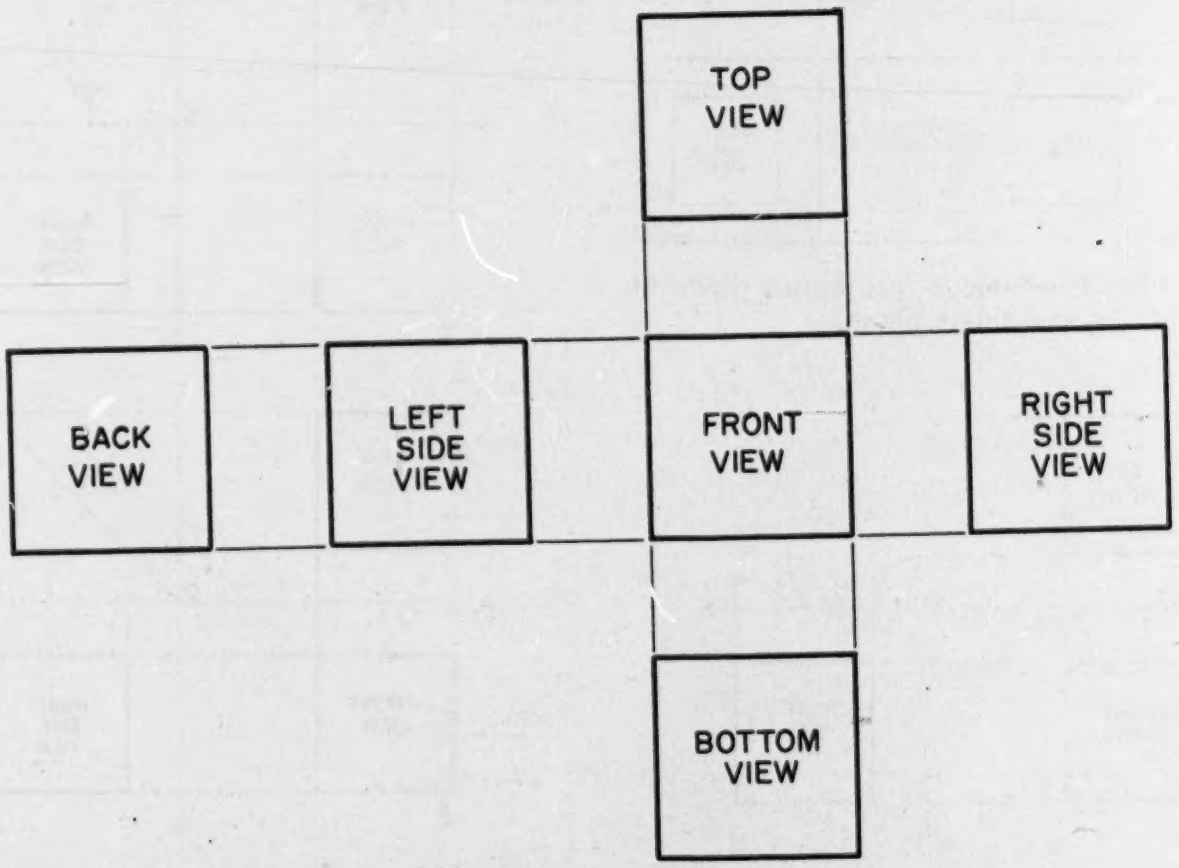

Figure 4-98.–American standard arrangement of views in 6-view third-angle multiview projection.

In architectural drawings, a top view is called a plan, and a front, back or side view an elevation. A top view of a house, for instance, is a plan; a floor plan shows a top view of the house as it would look if it were cut away at the level of that particular floor. A front view of a house is a front elevation, a back view is a rear elevation, and a right side view is a right side elevation. The terms plan and elevation apply principally to architectural drawings, but they are often applied to drawings of other than architectural objects.

VIEW ANALYSIS

You must be able to analyze a multiview projection—meaning, to determine what each line in a particular view represents. In this connection, it is helpful to remember that in a third-angle projection the plane of projection is always presumed to be between the object and the observer, regardless of which view you are considering. This means that, in a third-angle projection, each view of a surface of an object is a view of that surface as it would appear to an observer looking directly at it.

Figure 4-99 shows a 6-view multiview third-angle projection of the block shown in cabinet projection in the upper left corner of the figure. You don't have any trouble analyzing the front view; you know that the top is up, the bottom is down, the left side is to the left, and the right side is to the right.

In the top and bottom views it's easy to see that the right-hand vertical line represents the right side and the left-hand vertical line the left side. But you might have to think a minute to realize that the upper horizontal line in the top view represents the back face of the block, while the upper horizontal line in the bottom view represents the front face of the block. Note, also, that there is a line which appears as a visible line in the top view and as a hidden line in the bottom view.

In the right side and left side views, you can readily see that the upper horizontal line represents the top of the block and the lower horizontal line the bottom. But you may have to think a minute to realize that the left-hand vertical line in the right-side view represents the front face of the block, while the left-hand vertical line in the left side view represents the back face. Again there is a line which appears as a visible line in the right side view and as a hidden line in the left side view.

In the back view the block is shown reversed, so that the cut-away part which appears

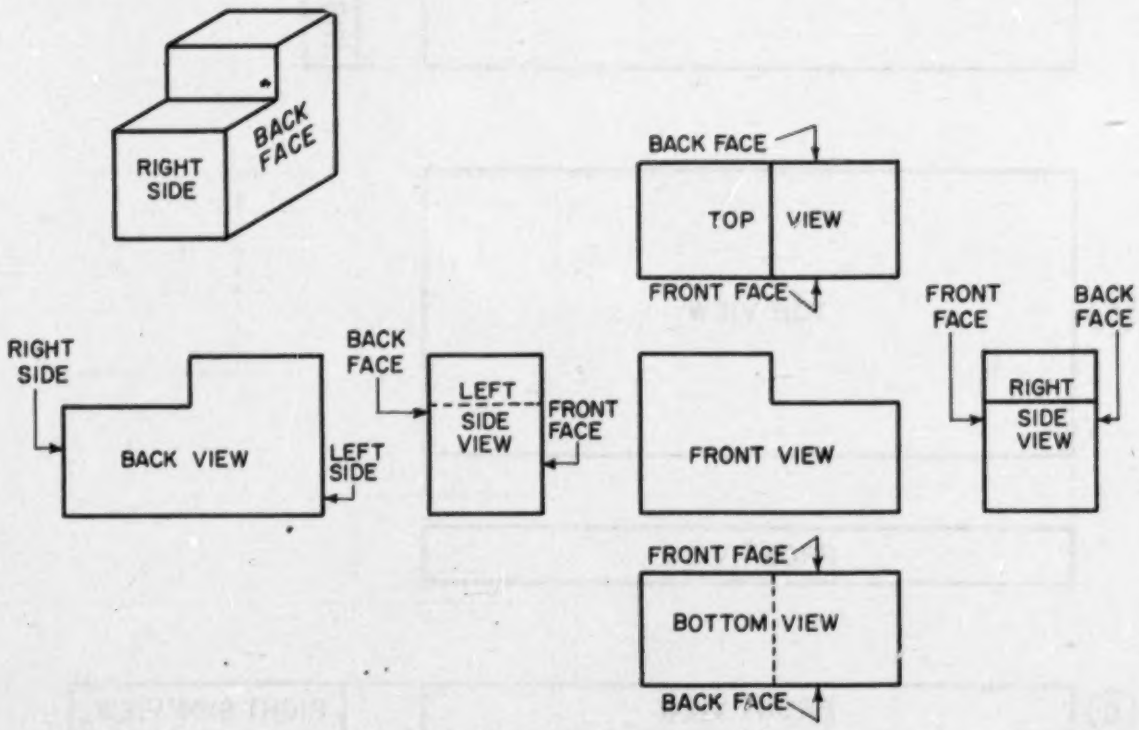

Figure 4-99.—Multiview view analysis.

to the right in the front view appears to the left in the back view. Similarly, the right-hand vertical line in the front view represents the right side of the block, while the corresponding line in the back view represents the left side.

As a general observation, it is helpful in view analysis to note that in the top, bottom, and side views the line which represents the front face of the block faces toward the front view of the block. Similarly, in the back view the line which represents the left side faces toward the left side view of the block. All this applies to third-angle projection only.

CHOICE OF VIEWS

A multiview projection should contain only as many views as are required to describe the object fully. If you refer back to figure 4-99, you can see at once that the back view does not convey any information which is not available in the front view; the back view is therefore superfluous and should be omitted. The same applies to the bottom view, which conveys no information not available in the top view. Likewise, the left side view conveys no information not available in the right side view.

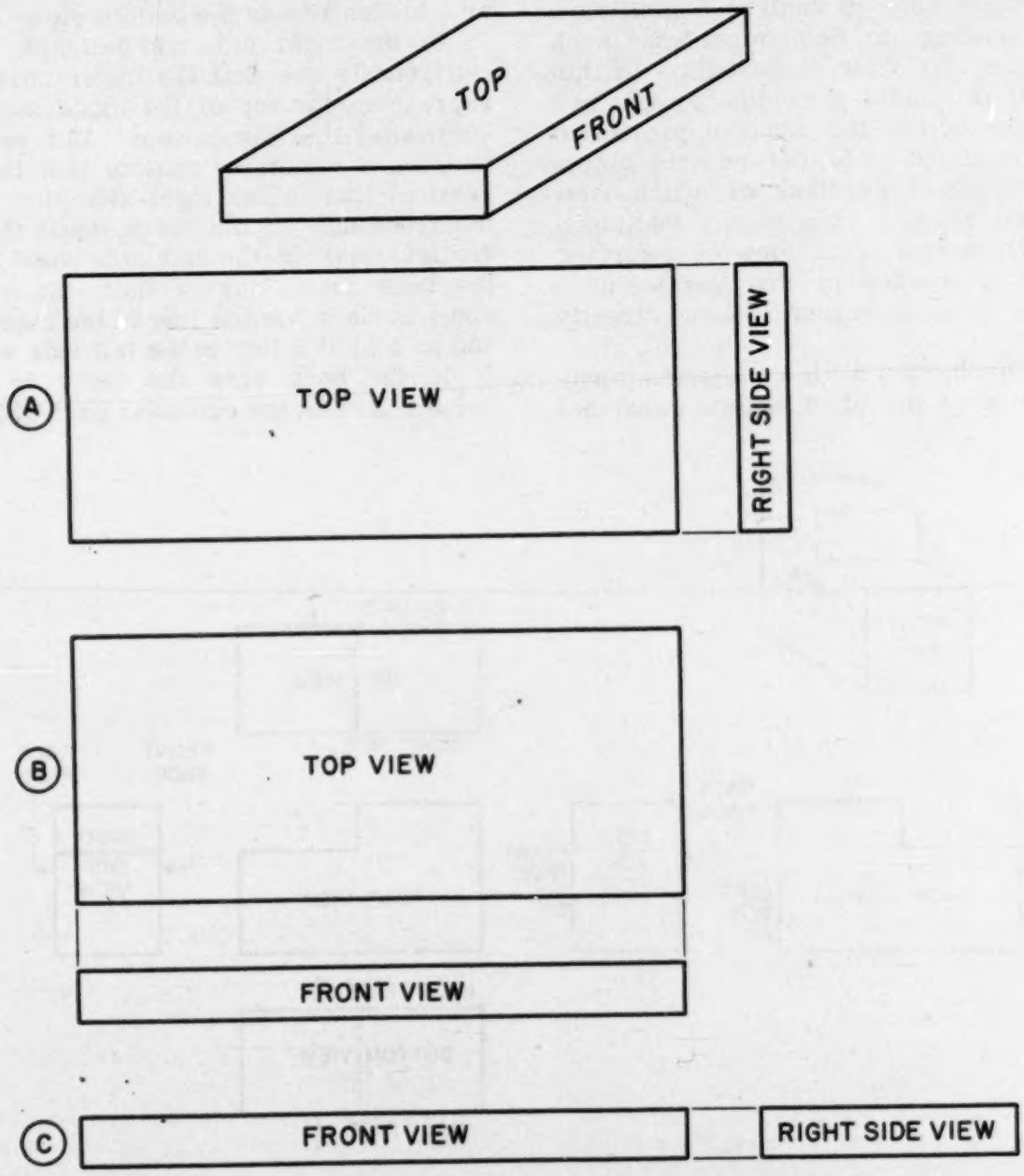

Figure 4-100.—Two-view multiview projections.

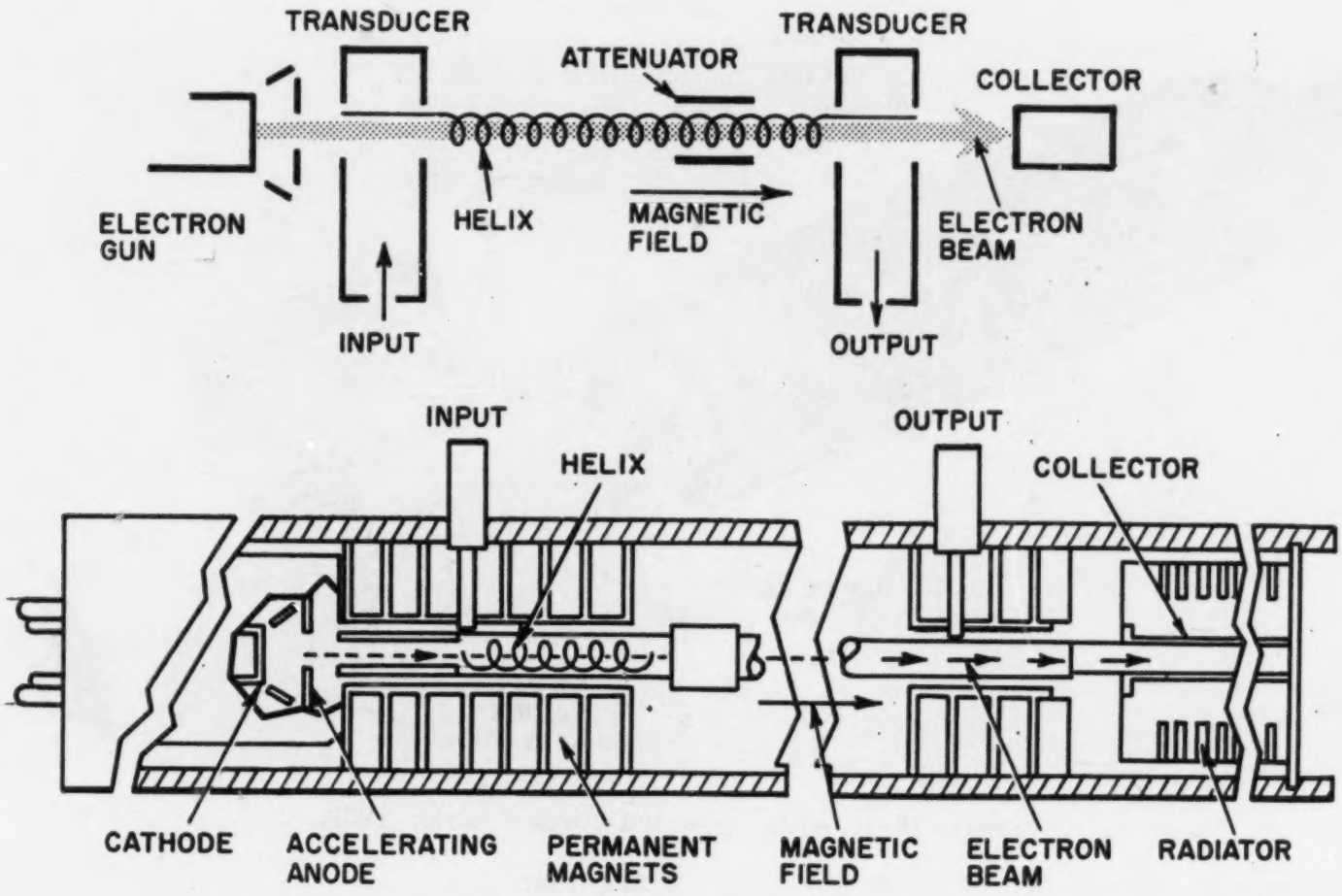

Figure 12-17. —Helix type TWT amplifier.

is determined by the d-c potential between the slow wave structure and the cathode of the gun. The beam is focused, by the focusing device, into a cylindrical beam whose diameter is approximately the same as the diameter of the inside of the slow wave structure.

An electromagnetic wave is injected into the same region at the gun end, and travels along the circumference of the slow wave structure at nearly the velocity of light. Due to the physical construction of the slow wave structure, the electron beam (in its direct path) and the electromagnetic wave (in its longer path) travel together along the slow wave structure at approximately the same forward velocity. The beam accelerating potential is adjusted so that the beam velocity is slightly greater than the wave velocity.

As in the magnetron, interaction of the RF electric field upon the electron beam will result in the acceleration of electrons in certain regions, and deceleration of other electrons in other regions. As the beam progresses along the slow wave structure, the decelerating action becomes predominant, and d-c energy from the electron beam is transferred to the RF electric field, resulting in amplification of the RF input signal.

Saturation may occur in a TWT, as in other types of electron tubes. In the TWT, this condition results from the RF field becoming excessive, due to either too large an input or too much gain. This represents the maximum power output of the tube for a given value of beam current. An increase in beam current will permit a further increase in output power, but the increases are not linear functions. For low input levels the gain is nearly constant, while the gain becomes less at higher input levels. Increasing the input beyond the saturation point results in decreased power output.

Maximum gain that can be realized from a TWT circuit is dependent on, and limited by, the following conditions:

1. The beam current value at which the tube will oscillate.

You have the choice of omitting either the top or bottom view and either the right side or left side view. One general rule in this instance is that a top view is preferable to a bottom view and a right side view to a left side view; another rule is that a view with a visible line is preferable to a view with the same line shown as a hidden line. Both rules apply here to eliminate the bottom and the left side views. All you need here is a three-view projection, showing the top, front, and right side views.

It is often the case that a two-view projection is all that is required. Figure 4-100(A) shows a cabinet projection of a board. It is obvious that a top view of this object tells you everything you need to know except the thickness; a right side view tells you everything you need to know except the length; and a front view tells you everything you need to know except the width. All you need to do, then is to select a particular view and couple it with another view which gives you the dimension which is missing in the first view. There are three possible two-dimension projections of the board, illustrated in (A), (B), and (C). In the selection of one of these three, everything else being equal, the balance of the drawing would be the deciding factor. Either (A) or (B) appears better balanced than (C), and between (A) and (B), (A) would look better on a long oblong sheet of paper and (B) better on a shorter oblong sheet.

The object shown in figure 4-100 has a definitely designated top and front; it follows that the right and left sides are also definitely designated. This is the case with many objects; you have no choice, for example, with regard to the top, bottom, front, and back of a house. Many objects, however, have no definite top or bottom, or front or back—many types of machine parts, for example. With an object of this kind, you can select a surface and call it the front, select another and call it the top, according to convenience. However, it is a general rule that an object should be shown in the position it customarily occupies. Suppose that the board shown in figure 4-100 is a floor board. Then the top would be as indicated in the figure. If it were a wall board, however, one of the long narrow edges would be the top, and one of the wide faces would be the front.

SPACING VIEWS

Views should be spaced on the paper to give the appearance of a balanced drawing. Figure 4-101 shows two-view drawings properly spaced on size A (8 1/2" x 11"), size C (17" x 22"), or size E (34" x 44") drawing paper. Marginal distances should be equal as indicated; distance B should be equal to, or slightly less than, distance A.

An easy way to determine the length of distance A in the upper drawing shown in figure 4-101 is as follows. Set a compass to the length plus the thickness of the object and

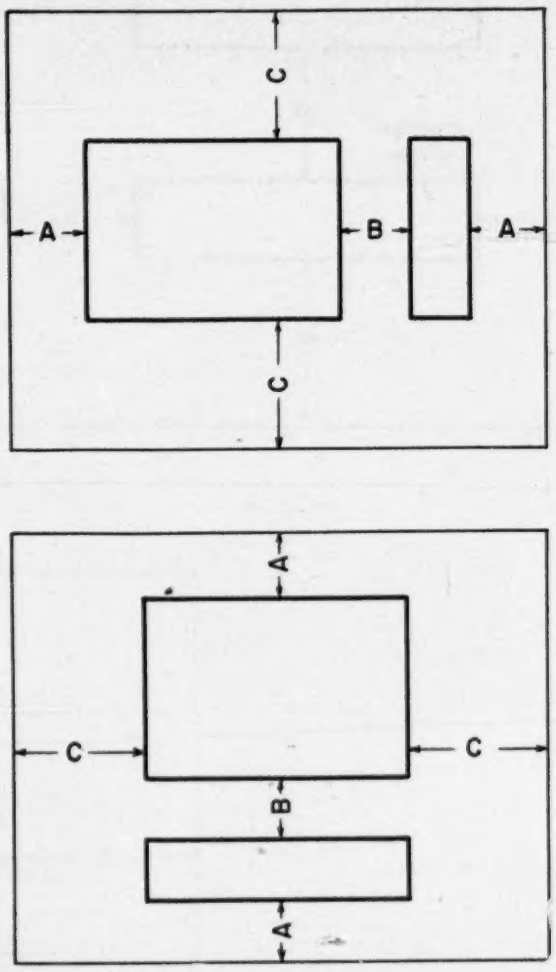

Figure 4-101.—Proper spacing of views on a 2-view projection.

lay off this distance from one end of one of the horizontal margins of the drawing. One-third of the length of the remaining segment of the margin is the length of distance A. To determine the length of distance C in the same drawing, set a compass to the width of the object and lay off this distance from one end of one of the vertical margins of the drawing. One-half of the length of the remaining segment of the margin is the length of distance C.

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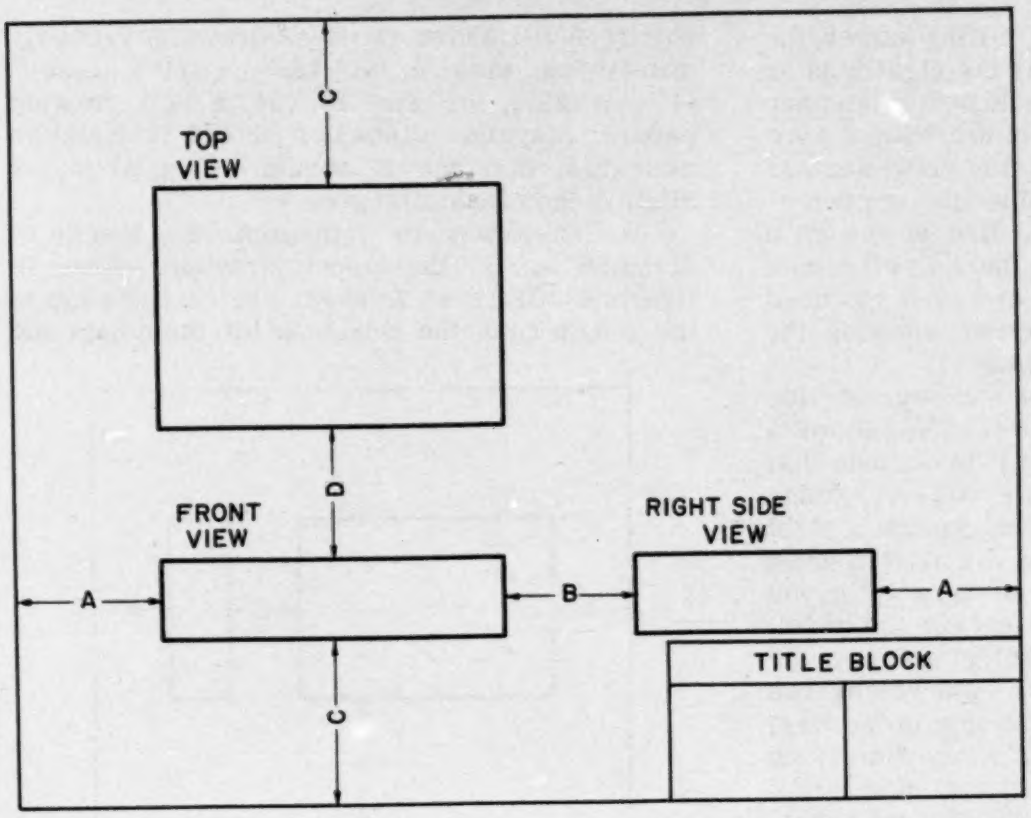

Figure 4-102.—Proper spacing of views on a 3-view projection.

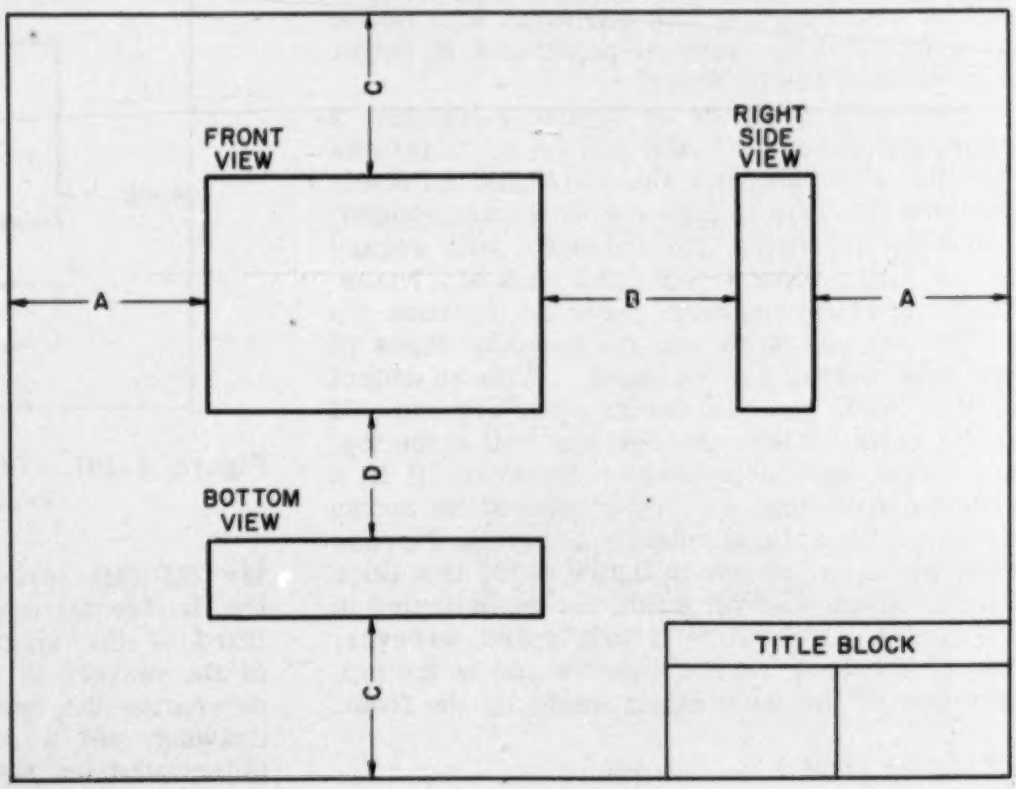

Figure 4-103.—Improved spacing for 3-view projection of object shown in figure 4-102.

Proper spacing of a three-view drawing is shown in figure 4-102. As you can see, the principle is the same as that applied in spacing a two-view drawing. Distances are again equal as indicated, with distance B equal to, or slightly less than, distance A, and distance D equal to, or slightly less than distance C.

While the spacing of views in figure 4-102 is technically correct, the drawing has an unbalanced appearance, because of the large area of empty space in the upper right corner, and because the right side view crowds the title block. If the drawing will contain a sizeable bill of materials in the upper right corner, this spacing will be satisfactory. If not, it should be improved, if possible.

If the object is one which allows an arbitrary choice with regard to the designation of surfaces as top, front, and so on, the spacing can be improved by changing the designation shown in figure 4-102, and projecting the object as shown in figure 4-103. What appears as the top in figure 4-102 you can now call the front; it follows that what appears as the front in figure 4-102 appears as the bottom in figure 4-103. Again the right side view appears, but it now appears in the upper rather than the lower right corner, and vertically rather than horizontally.

Spacing views in a drawing of a circular object is like spacing letters—you try to equalize the areas of the spaces around and between the views. Figure 4-104 shows properly spaced two-view drawings of a perforated disk. For the views which are horizontally in line, you locate the horizontal center line midway between the horizontal margins; for the views which are vertically in line, you locate it midway between the vertical margins. The other spacing is as indicated. To determine the lengths of distances A and 2/3 A in the upper drawing, set a compass to the diameter plus the thickness of the disk, and lay off this distance from one end of one of the horizontal margins. Then divide the remaining segment of the margin into three intervals, two of them being equal, and the third one and one-half times as long as each of the others.

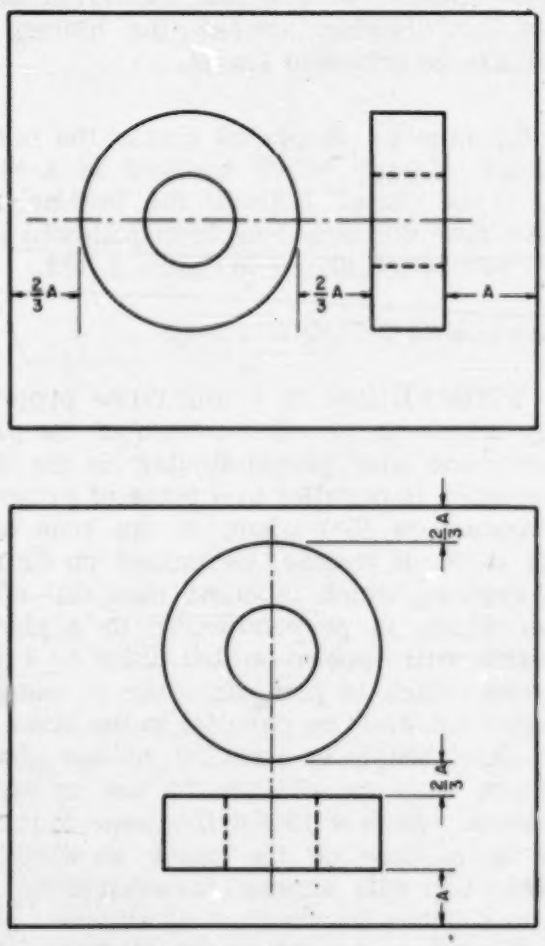

Figure 4-104.—Spacing of views of a circular object.

HIDDEN LINE TECHNIQUES

To prevent confusion in the interpretation of hidden lines, you must apply certain standard techniques in drawing these lines. A hidden line which is supposed to join a visible or another hidden line must actually contact the line, as shown in the upper views of figure 4-105; the incorrect procedure is shown in the lower views.

Figure 4-106 shows an intersection between a hidden line and a visible line. Obviously, on the object itself the hidden line must be below the visible line. You indicate this fact by drawing the hidden line as shown in the upper view

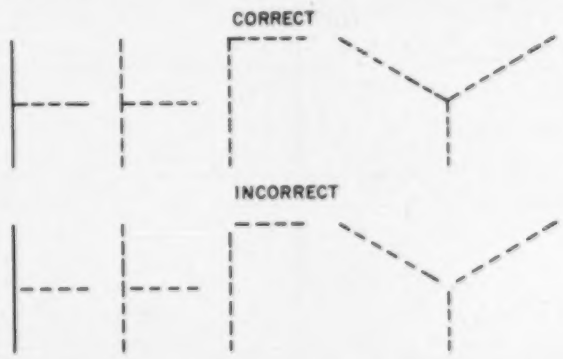

Figure 4-105.—Correct and incorrect procedures for drawing adjoining hidden lines.

of figure 4-106. If you drew it as indicated in the lower view, the hidden line would appear to be above, rather than beneath, the visible line.

Figure 4-107 shows an intersection between two hidden lines, one of which is beneath the other on the object itself. You indicate this fact by drawing the lines as indicated in the upper view of figure 4-107. If you drew them as indicated in the lower view, the wrong line would appear to be uppermost.

NUMBERING CORNER POINTS

A point which constitutes a corner on an object may be numbered, to facilitate interpretation of drawings of the object. A corner point may be hidden or visible in a particular view of the object. See figure 4-108, for example. In the upper left corner of this figure there is a cavalier projection of a block. You can see that point 2 on this block would be visible in a top, back, or right side view of the block, but hidden in a bottom, front, or left side view.

The rule for corner-point numbering is that for a point which appears as a hidden point the number is placed inside the outline, while for a point which appears as a visible point, it is placed outside the outline. You can see how the rule has been followed in the 6-view projection shown in figure 4-108.

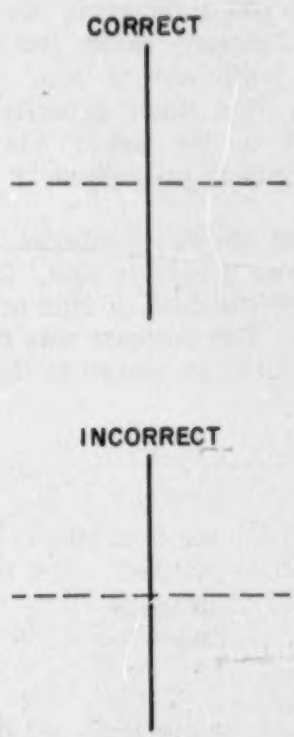

Figure 4-106.—Correct and incorrect procedures for drawing hidden line which intersects visible line.

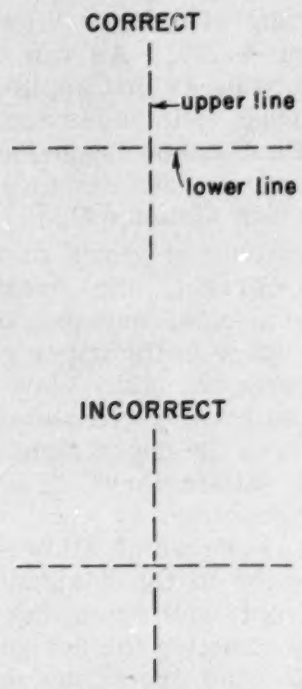

Figure 4-107.—Correct and incorrect procedures for drawing intersecting hidden lines which are on different levels.

NORMAL AND OBLIQUE LINES

A NORMAL line in a multiview projection is one which is parallel to two of the planes of projection and perpendicular to the third. A line which is parallel to a plane of projection will appear on that plane in its true length (which may, of course, be scaled up or down for a drawing which is other than full-scale). A line which is perpendicular to a plane of projection will appear on that plane as a point.

A line which is perpendicular to one plane of projection must be parallel to the other two. But a line which is parallel to one plane of projection may be oblique to one or both of the others. Such a line will appear in its true length in a view on the plane to which it is parallel, but will appear foreshortened in a view on a plane to which it is oblique. A line may, of course, be oblique to all three planes of projection, in which case it will appear foreshortened in all regular views of the object.

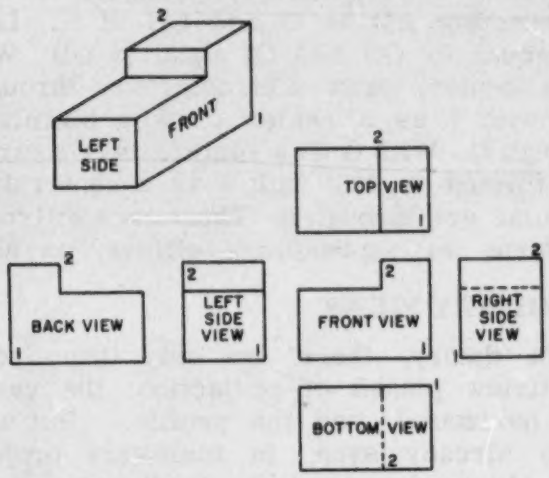

Figure 4-108.—Procedure for numbering hidden and visible corner points.

Consider figure 4-109, for example. In the upper left corner there is a cavalier projection of a block. This block is placed with its front parallel to the vertical plane, bottom parallel to the horizontal plane, and right side parallel to the profile plane. Then the line AB is parallel to the vertical plane, but oblique to both the horizontal and the profile planes. In the multiview projections shown in the same figure, you can see that it is only in the front and the back views (which are views on the vertical plane, to which AB is parallel) that AB appears in its true length. In all the other views (which are views on planes to which AB is oblique), AB is foreshortened. But you will note that you do not need to concern yourself with the amount of this foreshortening, since it works itself out as you project the various views.

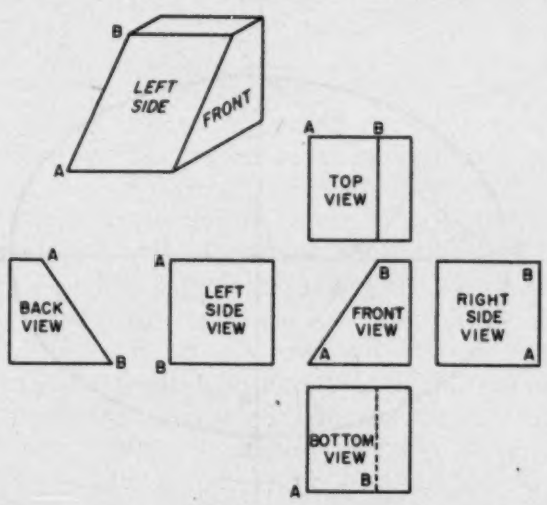

Figure 4-109.—Foreshortening of a line in a multiview projection.

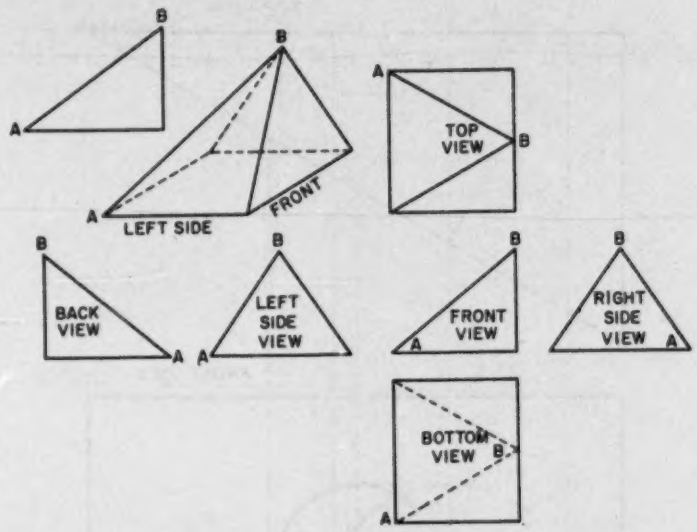

Figure 4-110.—A line oblique to all planes of projection is foreshortened in all views.

In the upper left of figure 4-110 there is a cavalier projection of a triangular block. The right side is presumed to be parallel to the profile plane of projection, the bottom to the horizontal plane. The line AB is oblique to all three planes.

The true length of AB is shown in the small triangle to the left of the cavalier projection; it is the length of the hypotenuse of a triangle with altitude equal to the vertical height of the block and base equal to the length of AB as it appears in the top view multiview projection. You can see that AB is foreshortened in all of the multiview views. Once again, however, the amount of foreshortening works itself out as you project the views.

CIRCLES

In a multiview projection, a circle on a surface which is parallel to the plane of projection will project as a circle. One on a surface which is oblique to the plane of projection will project as an ellipse, as shown in figure 4-111. The upper view of this figure is a top view of a wedge-shaped block, the block having a circular hole bored through it perpendicular to the inclined face. The outline of this hole on the front face of the block projects as an ellipse in the front view of the block. You get the minor axis of the ellipse by projecting downward, as shown. The length of the major axis is equal to the length of the diameter of the hole.

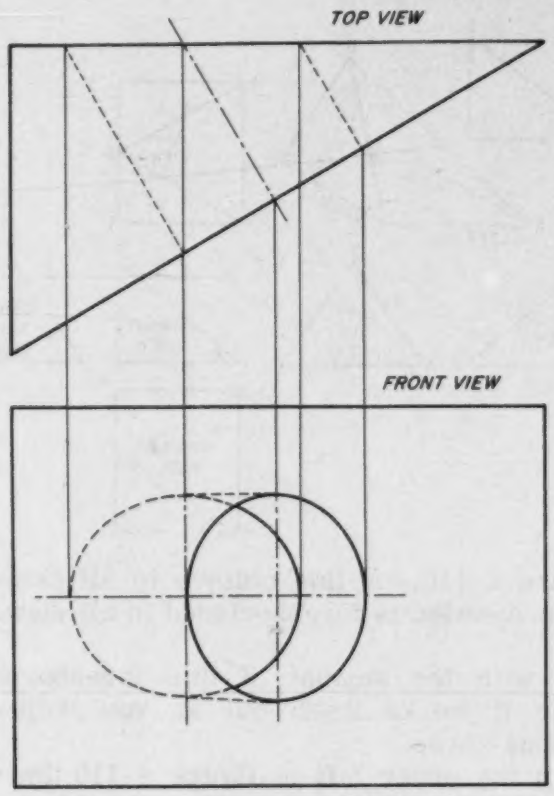

Figure 4-111.—A circle on a surface oblique to the plane of projection projects as an ellipse.

There is another ellipse in the front view: the partly hidden and partly visible outline of the hole as it emerges through the back of the block. This outline, too, is elliptical, because the hole, though it is circular, is bored obliquely to the back surface of the block. Since the vertical plane is parallel to the back surface of the object, this outline gives the true shape of the hole as it emerges from the back of the block. You get the major axis for this ellipse by projecting downward, as shown. The length of the minor axis is the same as the length of the diameter of the circular hole.

To draw these ellipses you may use any of the methods of drawing an accurate ellipse explained earlier. However, in a case of this kind an approximate ellipse, which can be quickly and easily drawn with a compass, is usually satisfactory. A method of drawing an approximate ellipse is illustrated in figure 4-112. The major axis is AB, the minor axis CD. Set a compass to the length of AO, and with O as a center, strike an arc intersecting OC (extended) at E. Draw the straight line AC, set the compass to the length of EC, and with C as a center, strike an arc intersecting AC at F. Draw a perpendicular bisector from AF, intersecting AO at G and OD at H. Lay off OJ equal to GO and OI equal to OH. With H as a center, draw a circular arc through C, and with I as a center draw a circular arc through D. With G as a center, draw a circular arc through A, and with J as a center draw a circular arc through B. These arcs will connect to form an approximate ellipse, as shown.

AUXILIARY VIEWS

In theory, there are only three regular multiview planes of projection: the vertical, the horizontal, and the profile. But as you have already seen, in multiview projection the plane of projection is always presumed to be between the observer and the object. This means that the vertical plane (for example) is presumed to be in one place for a front view and in a different place for a back view. Theoretically, it is the same plane; actually, however, there are two vertical planes—one the front view plane, the other the back view plane. It follows that, for a 6-view projection there are 6 regular planes: the front view and back view planes, the top view and bottom view planes, and the right side and left side view planes.

An auxiliary view is any view which is projected on a plane other than one of the regular 6. Refer back to figure 4-110. You recall that the line AB is oblique to all of the regular planes of projection, and therefore appears foreshortened in all 6 views. This

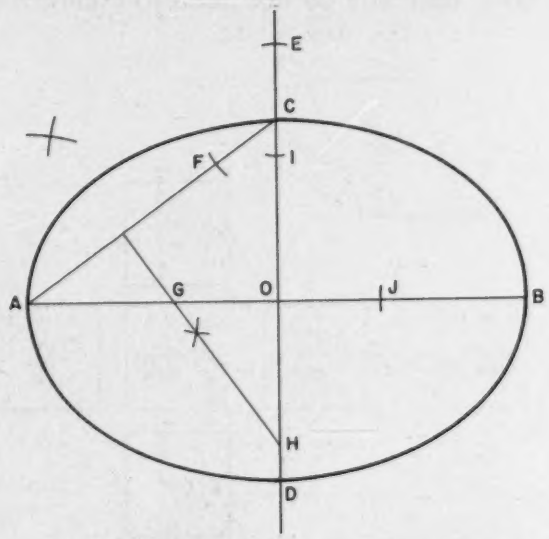

Figure 4-112.—Method of drawing an approximate ellipse with a compass.

means that the left side of the block cannot be shown in its true dimensions in any of the 6 regular views. To show the left side in its true dimensions, you would have to project it onto an auxiliary plane, parallel to the left side of the block.

Figure 4-113 illustrates the method of doing this. You select two adjacent views, one of which shows the edge of the surface which is to be projected in the auxiliary view, the other of which shows a dimension which will be required to lay out the auxiliary view. In this case, the front view and the left side view are the appropriate views.

You want to project the left side in its true dimensions; therefore, the projectors must be perpendicular to the left side, as indicated by the arrow. The auxiliary plane of projection must in turn be perpendicular to the projectors. The line marked "auxiliary plane and reference plane" represents an edge view of the auxiliary plane of projection. In theory, the projection is made on this plane, and then brought into the plane of the paper by rotation. You can draw the auxiliary plane and reference line any convenient distance away from the line AB.

You get the height of the auxiliary view by projecting points A and B, as shown. You get the width of the base by laying off this distance, as obtained from the left side view, from the reference plane line. You get the location of point B by measuring distance BO in the left side view, and laying this same distance off from the plane of reference, along the projector from B, in the auxiliary view.

The auxiliary plane line represents the edge of the auxiliary plane; the reference plane

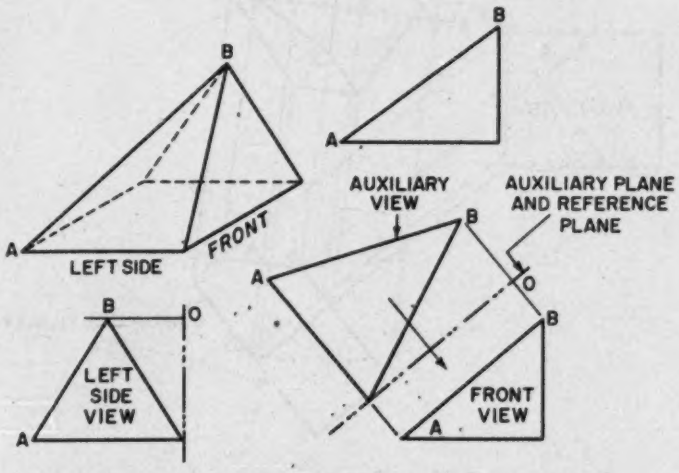

Figure 4-113.—Projecting an auxiliary view.

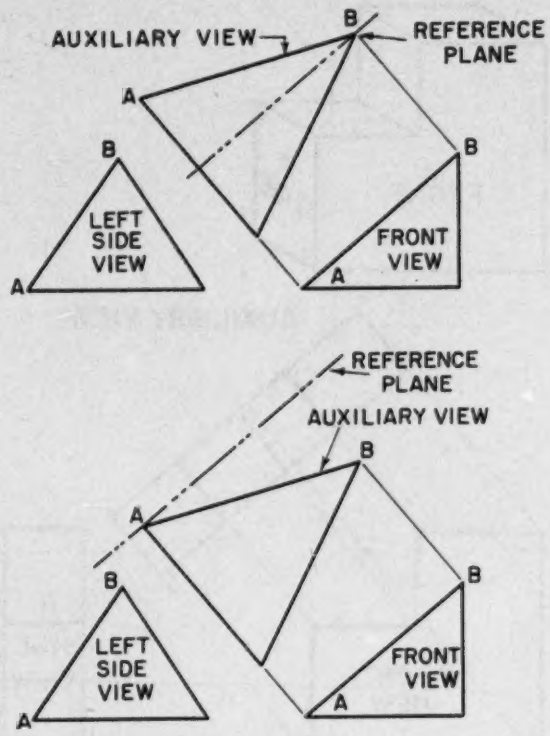

Figure 4-114.—Alternative locations of reference plane line.

line represents the edge of the plane from which distances (as, in this case, the width of the block and the distance of B from the reference plane) are measured. In figure 4-113, the auxiliary plane line and the reference plane line coincide. This is not necessarily the case, however. You might have found it more convenient to locate the reference plane line as it is placed in the upper or the lower projection of figure 4-114. In both of these projections the auxiliary plane is located between the front view and the auxiliary view. These planes are not shown, and it is unnecessary to draw them.

The purpose of the auxiliary view shown in figures 4-113 and 4-114 is to show the left side of the block in its true dimensions. An auxiliary view may be required, however, simply to show how an object looks from a given angle of observation—and this angle may be any angle. In the upper left corner of figure 4-115 there is a cavalier projection of a block. It is desired that the right side of this block be shown as it would appear from the angle of observation indicated by the arrow. The right side as it would thus appear is shown in the auxiliary view. You can see that, while the thickness dimensions in the auxiliary view are true, the vertical

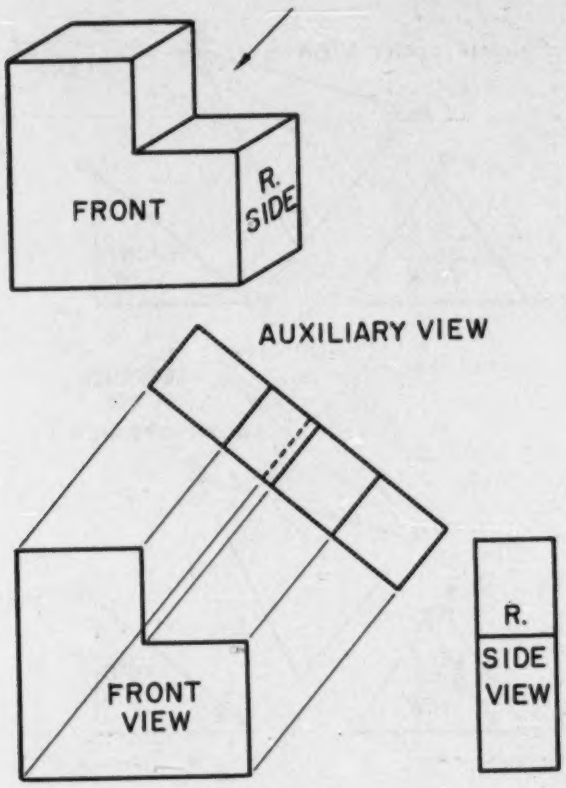

Figure 4-115.—Auxiliary view, showing object as seen from a particular angle of observation.

dimensions and the horizontal dimensions are all foreshortened. Once again, the amount of foreshortening works itself out as you project the auxiliary view.

DOUBLE AUXILIARY VIEWS

In figure 4-113 you were able to show the left side of the block in its true dimensions by making a single auxiliary projection. The reason you could do this was the fact that the surface you desired to project happened to be perpendicular to one of the three planes of projection (the vertical plane). Consequently, there was one multiview view (the front view, projected on the vertical plane) in which this surface appeared as a straight line. A single auxiliary view, projected from the surface as it appeared in the front view, showed the surface in its true dimensions.

In the upper left corner of figure 4-116 there is a cavalier projection of a block. The surface marked A is oblique to all three planes of projection. To show this surface in its true dimensions, you must first construct a primary auxiliary view, in which the surface appears as a straight line; and then from this view project a secondary auxiliary view, in which the surface appears in its true dimensions.

To construct the primary view, you must project the block onto a plane which is perpendicular to surface A. The reference line XX, shown on the front view, is drawn perpendicular to the line 1-3; it is therefore an edge view of a plane which is perpendicular to surface A. If you project the front view onto an auxiliary plane parallel to XX, you get a primary auxiliary view on a plane perpendicular to surface A.

In this primary view, surface A appears as a straight line. If you project the primary view onto a plane parallel to surface A, you will get a secondary view in which A appears in its true dimensions. The reference plane line X'X' in the secondary auxiliary view is drawn parallel to surface A as it appears in the primary view. You project the secondary view from the primary view by projectors drawn perpendicular to X'X'. You locate points on these projectors above and below X'X' by measuring the corresponding distance above and below XX in the front view from which the primary view was projected.

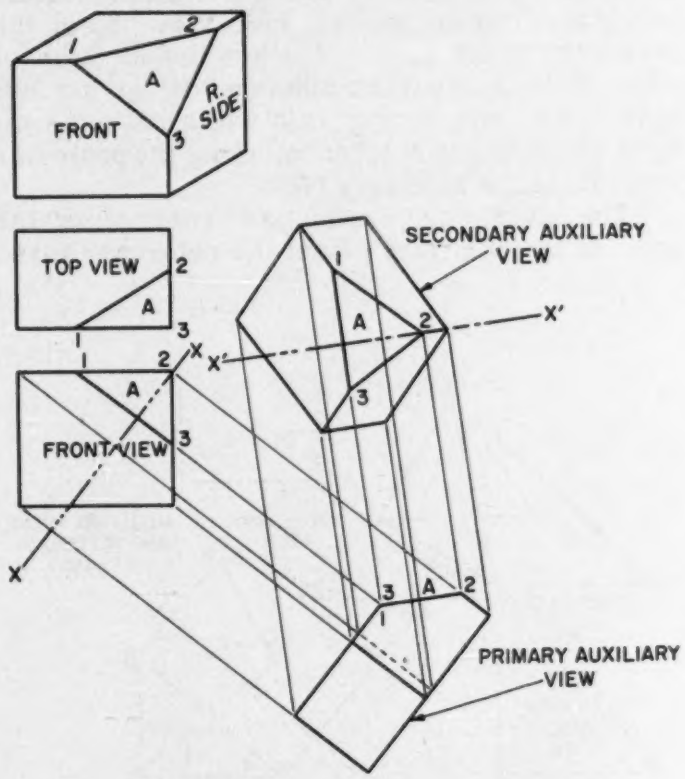

Figure 4-116.—Double, or primary and secondary, auxiliary views.

TRUE LENGTH OF A LINE BY AUXILIARY VIEW

The foregoing discussion has demonstrated the application of a basic rule to the effect that, if a line is parallel to a plane of projection, it will appear in its true length in a projection made on that plane. This rule may often be applied to determine the true length of a line which, because of the fact that it is oblique to all three of the standard planes of projection, appears foreshortened in all of the standard multiview views.

This method is illustrated in figure 4-117. In the upper left corner of this figure there is a cavalier projection of a triangular block. The line AB is oblique to all three of the regular planes of projection, and will therefore appear foreshortened in all of the regular multiview views. The true length of the line is shown in the small triangle at the upper right. It is the length of the hypotenuse of a triangle of which the length of the base is the length of AB as it appears in the top multiview view, and the altitude is the vertical distance of A above the lower horizontal line in the front multiview view.

The line AB is one of the edges of the surface ABC. You can get the true length of AB by projecting a partial auxiliary view of this surface from the view in which the surface ABC appears as a straight line. This view is the front view. You use an auxiliary plane parallel to the surface as it appears in the front view. The reference plane line X'X' is thus parallel. A line parallel to this one, located between the auxiliary view and the front view, would represent the edge of the auxiliary plane. There is no need to draw in the line.

The reference plane line X'X' represents the reference plane XX shown in the top view. Point A in the auxiliary view is located at the point of intersection between X'X' and the projector from A in the front view. Point B in the auxiliary view is located on the projector from B in the front view, at a distance from X'X' equal to the distance from B to XX in the top view. The line AB appears in its true length in the partial auxiliary view.

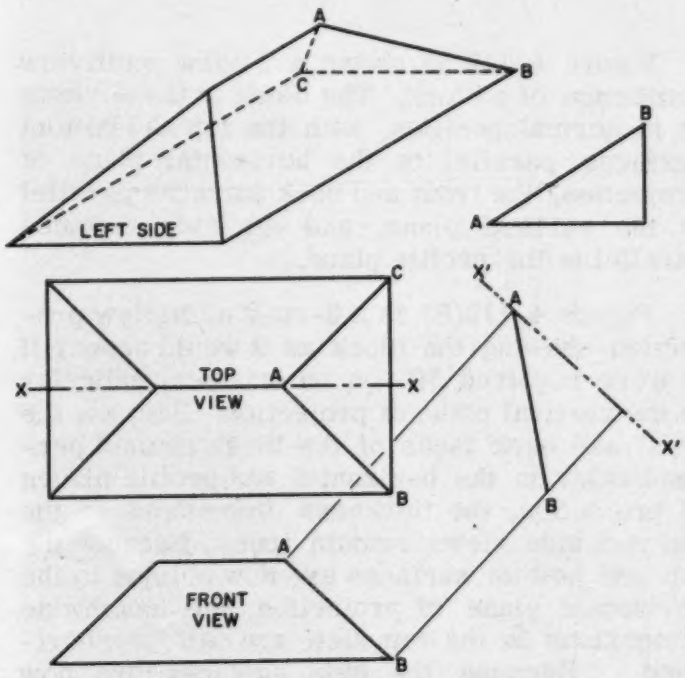

Figure 4-117.—Projecting a partial auxiliary view to get the true length of a line.

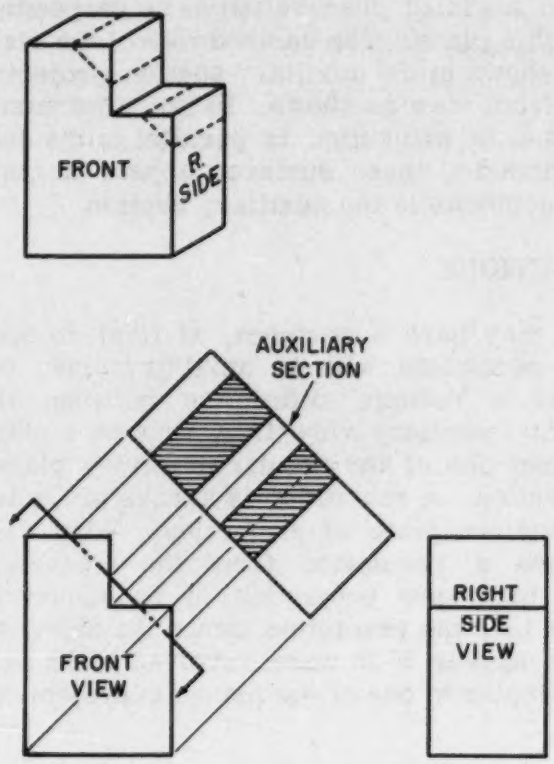

Figure 4-118.—Auxiliary section.

AUXILIARY SECTIONS

An auxiliary view may be a sectional rather than a surface view. In the upper left corner of figure 4-118 there is a cabinet projection of a block. It is desired to show the right side of this block as it would appear if the block were cut away on the plane indicated by the dotted

line, the angle of observation to be perpendicular to this plane. The desired view of the right side is shown in the auxiliary section, projected from a front view as shown. Because the auxiliary plane of projection is parallel to the cutaway surfaces, these surfaces appear in their true dimensions in the auxiliary section.

REVOLUTIONS

You may have a tendency, at first, to confuse a revolution with an auxiliary view, but there is a definite difference between the two. An auxiliary view is a view on a plane other than one of the regular multiview planes of projection. A revolution is always projected on a regular plane of projection. What distinguishes a revolution from the equivalent normal multiview projection of an object is the fact that the revolution shows the object as it would appear if it were revolved on an axis perpendicular to one of the planes of projection.

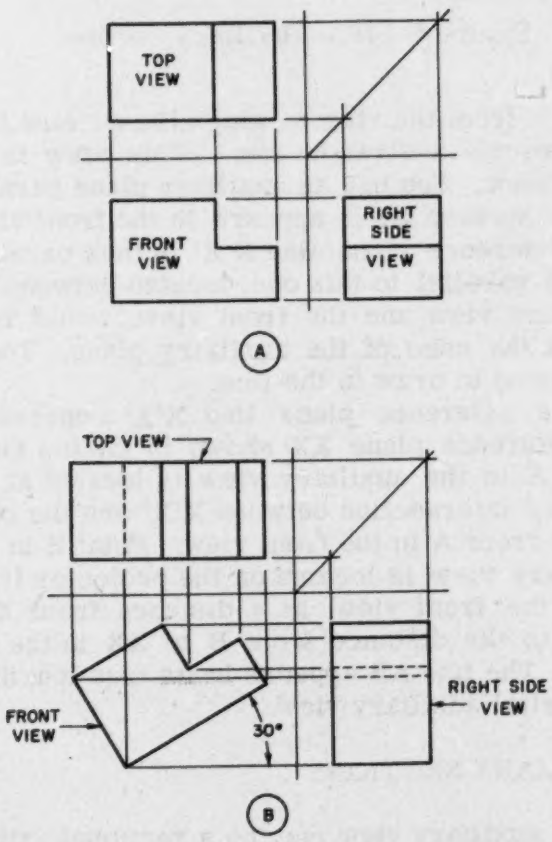

Figure 4-119.—(A) Multiview view of block in position. (B) Multiview view of block revolved 30°. on axis perpendicular to vertical plane.

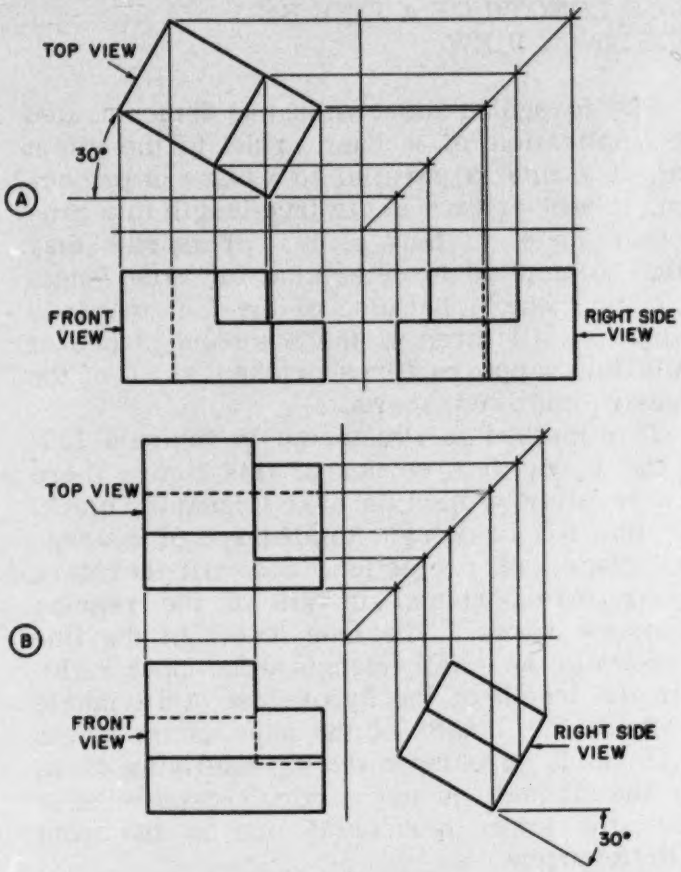

Figure 4-120.—(A) Revolution on axis perpendicular to horizontal plane. (B) Revolution on axis perpendicular to vertical plane.

Figure 4-119(A) shows a 3-view multiview projection of a block. The block in these views is in normal position, with the top and bottom surfaces parallel to the horizontal plane of projection, the front and back surfaces parallel to the vertical plane, and the side surfaces parallel to the profile plane.

Figure 4-119(B) is a 3-view multiview projection showing the block as it would appear if it were revolved 30° on an axis perpendicular to the vertical plane of projection. Because the front and back faces of the block remain perpendicular to the horizontal and profile planes of projection, the thickness dimensions in the top and side views remain true. Because the top and bottom surfaces are now oblique to the horizontal plane of projection, the lengthwise dimensions in the top view are all foreshortened. Because the side surfaces are now oblique to the profile plane of projection, the vertical dimensions in the right side view are

2. The maximum emission limit of the cathode.

3. The maximum beam current that can be focused without excessive heating of the tube elements due to the currents into these elements.

TUNABLE AMPLIFIER.—Using the TWT, it is possible to obtain high values of gain over a broad tuning range by varying the slow wave voltage. Use of a narrowband TWT decreases the danger of oscillation and permits greater gain to be obtained, but over a restricted frequency range. The wideband TWT permits high values of gain to be obtained over a greater range of frequencies, but the danger of oscillation is increased.

IF AMPLIFIER.—All pulse amplifiers require wide bandpass characteristics, and the more narrow the pulse, the wider the passband required of the amplifier. The TWT seems to be especially well adapted for use in this type circuitry, and has been used successfully as an IF amplifier at 3,000 megacycles, replacing the complex (and frequently troublesome) assemblies normally used for that purpose.

INPUT AMPLIFIER.—When used as the input amplifier of a radar receiver, the TWT must be able to respond linearly to input power levels over a wide range. Due to the limiting action of the TWT, however, modulated inputs with high power levels result in distortion. This disadvantage may be decreased by use of a varying helix voltage which extends the saturation point beyond the largest anticipated input. (This method is not applicable to phase sensitive radar systems.)

Low noise TWT's are especially useful in the input circuits of radar receivers because of the low noise figure throughout the life of the tube, and the additional protection of the crystal mixer following the TWT.

MODULATION.—In traveling wave tubes operating under CW conditions, the broadband circuit has an essentially constant phase angle. Since the interaction circuit is electrically quite long (usually at least 10 wavelengths), a slight variation in beam velocity can produce an appreciable variation in phasing at the output end of the structure. This is known as PHASE MODULATION. The allowable limits of variation are determined by the circuit.

AMPLITUDE MODULATION of the TWT may be accomplished by merely varying the potential applied to the electrode which controls the beam current. Generally, high percentages of modulation may be obtained from this method.

PULSE MODULATION is accomplished by pulsing the beam accelerating potential, or by pulsing the cathode with respect to the other electrodes. Pulsed tubes normally operate at the same potentials as would be used for the same tube operating under CW conditions. Peak power output in pulsed circuits may be increased only by increasing beam current, but this is practical only through comparatively narrow limits.

SAWTOOTH PHASE MODULATION results from applying a sawtooth wave to the slow wave element. The phase of the signal is continuously advanced, simulating an increase in frequency. This method is effectively the basis of single sideband modulation. It may also be used to simulate Doppler effect.

FREQUENCY SHIFTING.—This is accomplished in the same manner as phase modulation, the only difference being in the application and output circuitry. If the slow-wave-to-cathode impedance is low at the desired shift frequency, it may be possible to drive the cathode along in order to obtain the required output. Additional changes in phasing result from these variations in beam current.

DYNAMIC PHASE SHIFTING in the TWT occurs whenever amplitude or pulse modulation is the result of changing the beam current, the slow wave circuit voltage, or the anode voltage.

STATIC PHASE SHIFTING may occur as a result of differences in the effective lengths of the slow wave circuits or of the input and output coupling devices.

LIMITING.—Due to the saturation characteristics of the TWT, relatively constant output power may be obtained over a wide range of input power levels. By a slight modification of the basic TWT, this limiting action may be significantly increased. Use of two TWT's connected in cascade permits the level of output power to be held constant within 0.5 db over a 50-db range of input power and a 25-percent frequency variation.

AUTOMATIC GAIN CONTROL (AGC).—The limiting action of the traveling wave tube may be enhanced by the use of a feedback voltage applied to the electrode which controls beam current. Such a configuration is called an automatic gain control circuit, and is used when a constant power output level is required.

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all foreshortened. Again the amount of foreshortening works itself out as you project the views.

For the revolution shown in figure 4-119(B), you revolved the object on an axis perpendicular to the vertical plane of projection. You could have revolved it on an axis perpendicular to the horizontal plane, which would have resulted in the revolution shown in figure 4-120(A); or you could have revolved it on an axis perpendicular to the profile plane, which would have produced the revolution shown in figure 4-120(B).

REVOLVED SECTIONS

A common use of the revolution is the revolved section illustrated in figure 4-121. At the top of this figure there is a cabinet projection of a triangular block. You can show everything that needs to be shown about this block in a 2-view multiview drawing, by including a revolved section in the front view, as shown. You first assume that the bar is cut by a plane perpendicular to the long axis; you then revolve the resulting section 90° on an axis perpendicular to the horizontal plane of projection.

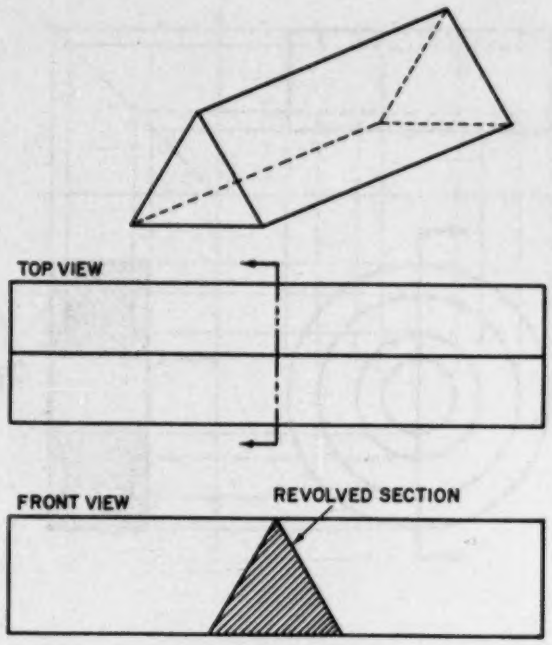

Figure 4-121.—Revolved section.

SECTIONING TECHNIQUES

Hidden and Visible Lines

A section view is called for when the internal structure of an object cannot be satisfactorily shown in a surface view by means of hidden lines. In the upper part of figure 4-122 there is a cabinet projection of a pulley. The same object is shown below in a 2-view multiview projection. The internal structure of the pulley is shown by the hidden lines in the top view, but these lines do not present a very clear picture.

You can show the internal structure much more clearly by projecting a section view, as shown in figure 4-123. Note that hidden lines behind the plane of projection are omitted in the sectional view. These lines are omitted by general custom, the custom being based on the fact that the elimination of hidden lines is the basic reason for making a sectional view. However, lines which would be visible behind the plane of projection must be included in the section view.

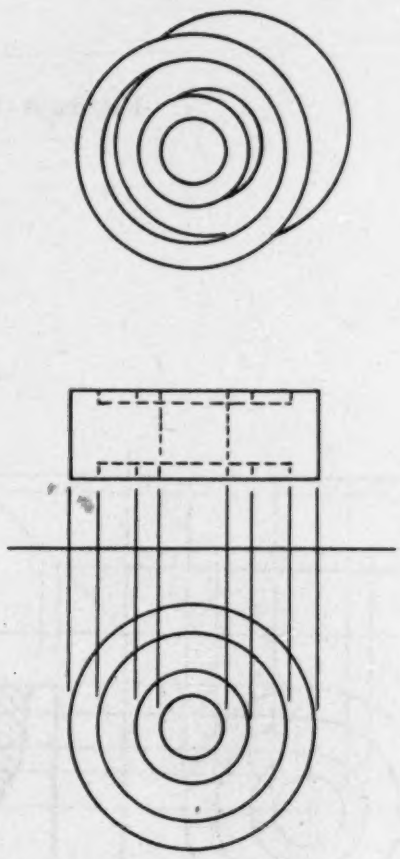

Figure 4-122.—Internal structure shown by hidden lines.

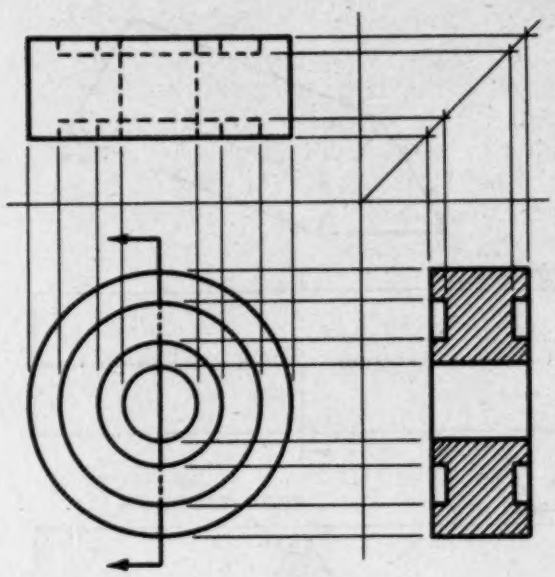

Figure 4-123.—Internal structure shown more clearly by section view.

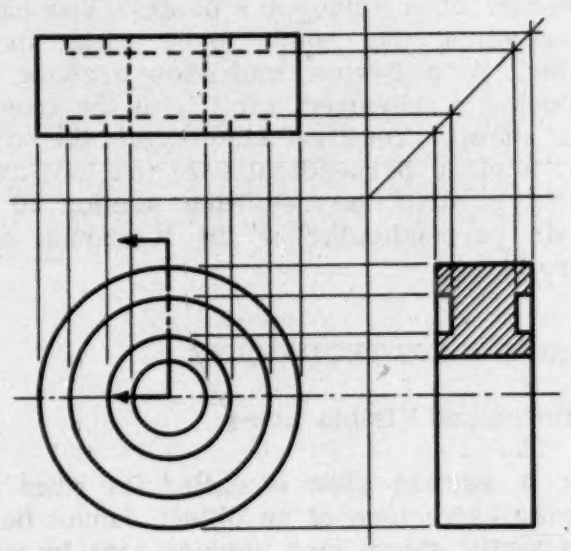

Figure 4-124.—Half section.

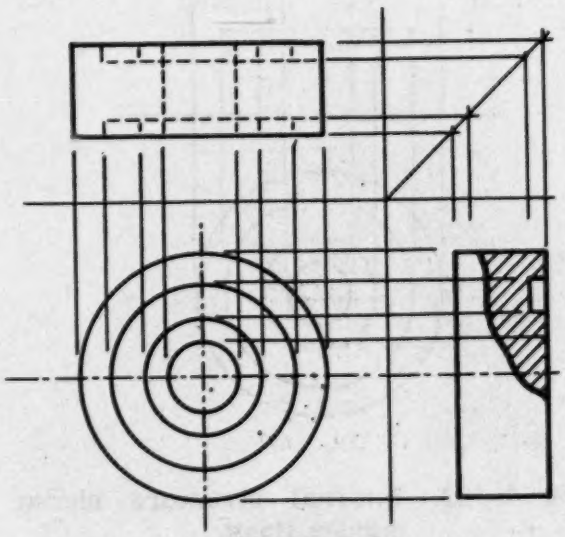

Figure 4-125.—Partial or broken section.

Full and Half Sections

The section shown in figure 4-123 is called a full section, because the cutting plane passes entirely through the object and divides the object into two equal halves. Now, the object shown in figure 4-123 is a symmetrical object, meaning that one-half of the object is identical with the other. This being the case, you could have used a half section like the one illustrated in figure 4-124. This half section consists of one-half of a full section. Because the other half would be identical, it is unnecessary to include it.

Note that you use the horizontal center line, rather than a visible line, to indicate the dividing line between the sectioned and the unsectioned part of the section view. If you used a visible line, the line would indicate an edge which is nonexistent.

Partial Sections

A section which consists of less than a half section is called a partial section. A partial section is illustrated in figure 4-125. Note that here you use a break line to indicate the dividing line between the sectioned and the unsectioned part. For this reason a partial section is often called a broken section.

Section Lining Techniques

The lines drawn on a sectional surface always serve one purpose: to indicate the limits of the sectional or cutaway surface. They may serve another purpose as well: to indicate the kind of material of which the object is made. For the second purpose, a specific type of section lining is used.

If the section lining is intended to indicate type of material, a series of parallel lines, drawn at a 45° angle to the horizontal and about 1/16 in. apart, indicate cast iron. On drawings on which the section lining is not intended to indicate type of material, however, the symbol for cast iron is used for all section lining. The symbol, called diagonal hatching, is shown at the left in figure 4-126.

Figure 4-126 shows a set of simplified sectioning symbols, as prescribed in MIL-STD-1B.

Angle of Diagonal Hatching

On a normal multiview section view, diagonal hatching should be drawn at a 45-degree angle to the horizontal, as shown in figure 4-127(A). If two adjacent surfaces are shown, the hatching should be inclined in opposite directions, as shown in figure 4-127(B). If still a third surface is included, it should be hatched at an angle of 30°, as shown in figure 4-127(C).

Note that the hatching lines on one surface are not permitted to meet those on an adjacent surface.

Diagonal hatching on an auxiliary section should be drawn at a 45-degree angle to the horizontal as the horizontal exists in that particular view. In the upper part of figure 4-128 there is a cavalier projection of a block. Below there is an auxiliary section showing the block as it would appear if it were cut along the plane indicated by the dotted line, the angle of observation being perpendicular to the plane. With regard to the auxiliary section, the horizontal is indicated by the projectors. You therefore draw the diagonal hatching at 45° to the projectors.

Figure 4-126.—Section conventions.

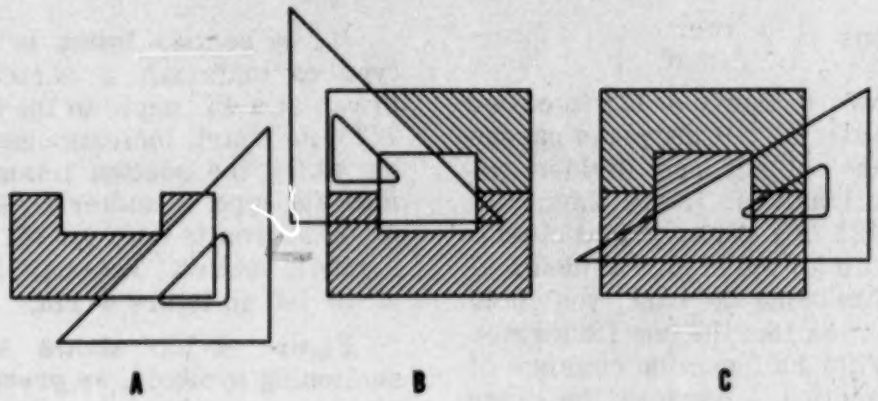

Figure 4-127.—Diagonal hatching on separate sectional surfaces shown in normal position.

In a revolution or other view of an object in other than normal position, diagonal hatching should be drawn at a 45-degree angle to the horizontal or vertical axis of the object as it appears in the drawing. In the upper part of figure 4-129 there is a cabinet projection of a block. Below there is a 3-view multiview projection of the block revolved 15° on an axis perpendicular to the horizontal plane of projection. The top view is a section view; the diagonal hatching is drawn at 45° to the horizontal axis of the drawing.

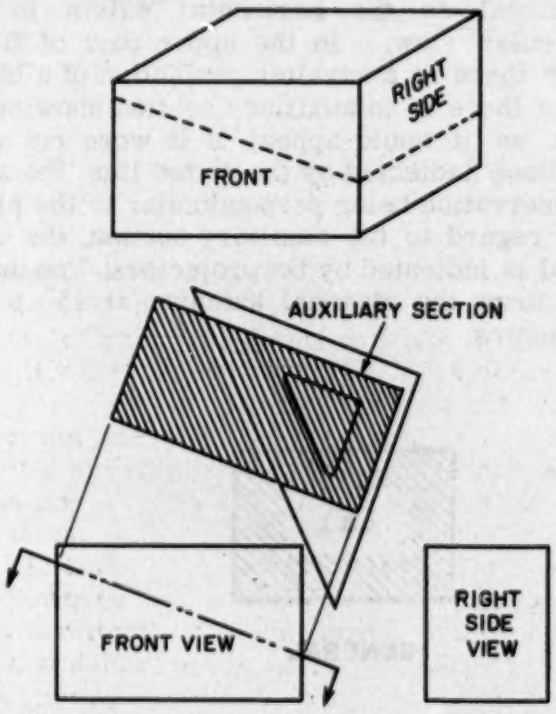

Figure 4-128.—Angle of diagonal hatching on auxiliary section.

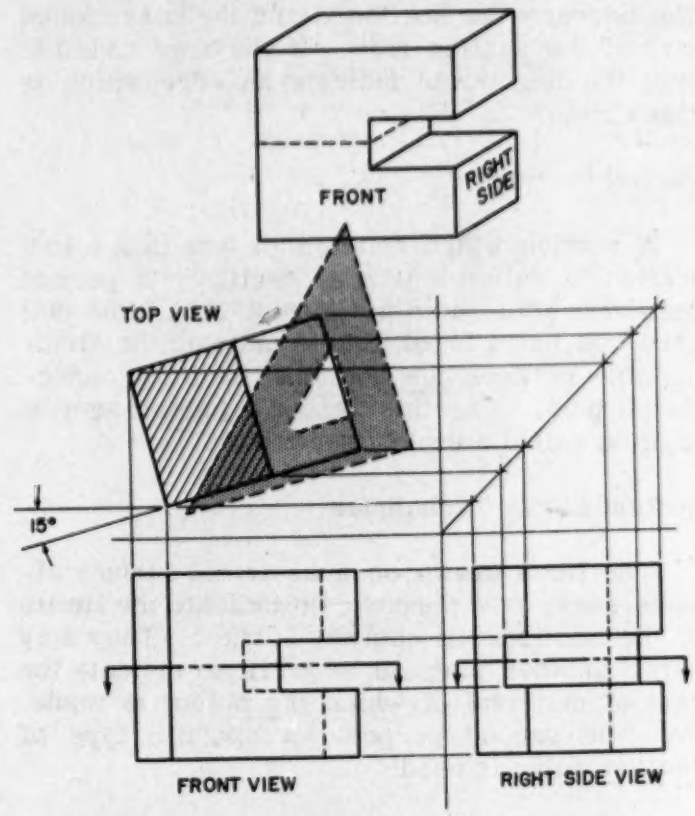

Figure 4-129.—Angle of diagonal hatching on a revolution.

ISOMETRIC DRAWING TECHNIQUES

BOX CONSTRUCTION

A rectangular object—that is, one on which all the surfaces are rectangular, with each surface perpendicular to the adjacent surfaces—can be easily drawn in isometric by the procedure known as box construction. In the upper part of figure 4-130 there is a 2-view normal

multiview projection of a rectangular block. An isometric drawing of the block is shown below. You can see how you build the figure on the isometric axis, and how you lay out the dimensions of the object on the isometric drawing. Because you laid out the identical dimensions, it is an isometric drawing rather than an isometric projection. To make an isometric projection, you would reduce each dimension to the scale of 0.8165:1, or about 4/5.

NONISOMETRIC LINES

Each line in the isometric drawing shown in figure 4-130 is equal in length to the same line as it appears in the normal multiview projection. The reason is the fact that each line in the isometric drawing is an isometric line—meaning, a line that forms the isometric angle (35° 16') with the plane or projection. Any isometric line will appear in its true length in a full-scale isometric drawing. In a full-scale isometric projection, it will appear scaled down to about 4/5.

If you examine the isometric drawing, you will note that each line in the drawing is parallel

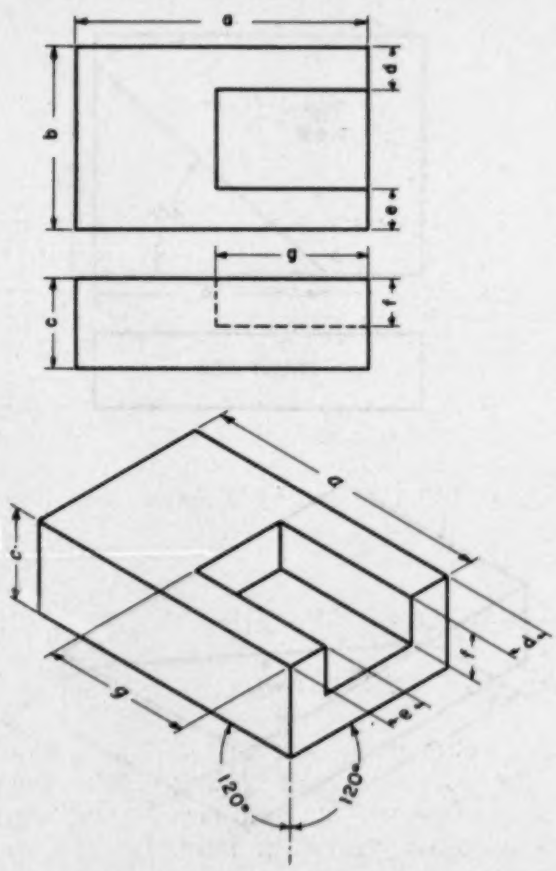

Figure 4-130.—Box construction.

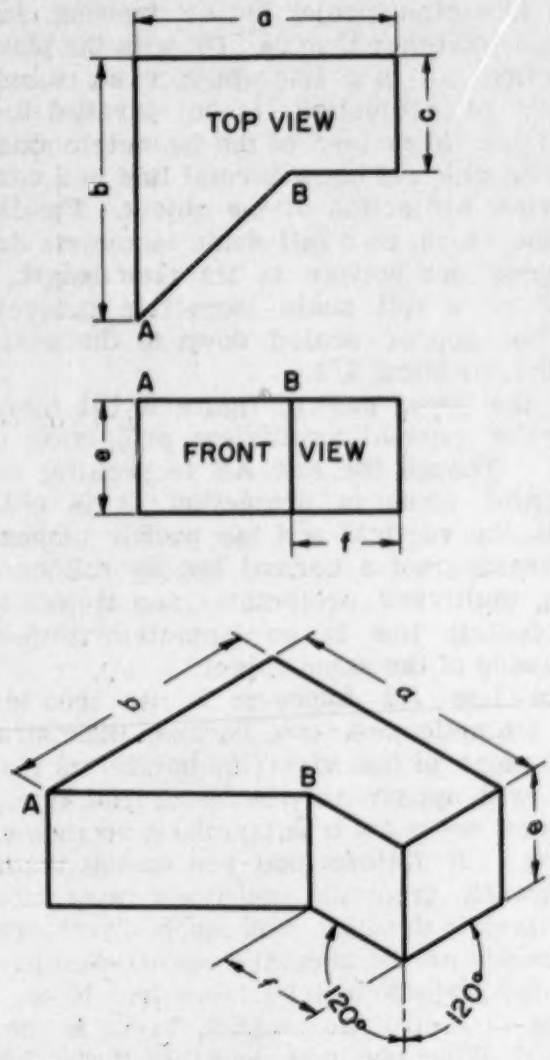

Figure 4-131.—The line AB is a nonisometric line.

to one or another of the legs of the isometric axis. An alternate definition of an isometric line, then, is a line which, in an isometric projection or drawing, is parallel to one of the legs of the isometric axis.

You will also notice that each line in the isometric drawing is a line which is a normal line in the normal multiview projection. A normal line, you recall, is a line which, in a normal multiview projection, is parallel to two of the planes of projection and perpendicular to the third. Still another definition of an isometric line, then, is a line which is a normal line in a normal multiview projection of the object.

From these definitions of an isometric line, the definition of a nonisometric line may be constructed. A nonisometric line is a line which,

in an isometric projection or drawing, forms an angle of other than 35° 16' with the plane of projection. It is a line which, in an isometric drawing or projection, is not parallel to any one of the three legs of the isometric axis. It is a line which is not a normal line in a normal multiview projection of the object. Finally, it is a line which, on a full-scale isometric drawing, does not appear in its true length, and which, on a full scale isometric projection, does not appear scaled down to the scale of 0.8165:1, or about 4/5.

In the upper part of figure 4-131 there is a 2-view normal multiview projection of a block. Though the line AB is parallel to the horizontal plane of projection, it is oblique to both the vertical and the profile planes. It is therefore not a normal but an oblique line in the multiview projection, and it will be a nonisometric line in an isometric projection or drawing of the same object.

The line AB appears in its true length in the top multiview view, because it is parallel to the plane of that view (the horizontal plane). But it will appear as a nonisometric line, and therefore not in its true length, in an isometric drawing. It follows that you cannot transfer AB directly from the multiview projection to the isometric drawing. You can, however, transfer directly all the normal lines in the multiview projection, which will be isometric lines, appearing in their true lengths, in the isometric drawing. When you have done this, you will have constructed the entire isometric drawing, exclusive of line AB, and of its counterpart on the bottom face of the block. The end points of AB and of its counterpart will be located, however, and it will only be necessary to connect them by straight lines.

ANGLES IN ISOMETRIC

In a normal multiview view of an object an angle will appear in its true size. In an isometric projection or drawing, an angle never appears in its true size. Even an angle formed by normal lines, such as each of the 90-degree corner angles of the block shown in figure 4-131, appears distorted in isometric.

The same principle used in transferring a nonisometric line is used to transfer an angle in isometric. In the upper part of figure 4-132 there is a 2-view multiview projection of a block. On the top face of the block the line AB makes a 40-degree angle with the front edge. The line AB is an oblique (that is, not normal) line, which will appear as a nonisometric line in the isometric drawing. You locate the end points of AB on the isometric drawing by distances measured along normal lines on the multiview projection, and laid off along the corresponding isometric lines on the isometric drawing. The ange which measures 40° on the top multiview view measures only about 32° on the isometric drawing. Note, however, that it is labeled 40° on the isometric drawing. This is because it is, actually, a 40-degree angle, as it would look on a surface placed at the isometric angle of inclination.

CIRCLES IN ISOMETRIC

A circle which appears in a normal multiview view will appear as an ellipse in an isometric drawing of the same object. This is illustrated in figure 4-133. The circle which appears in the top multiview view appears as an ellipse in the isometric drawing. The top view intersecting vertical and horizontal diameters form the conjugate axes of the ellipse in the isometric drawing.

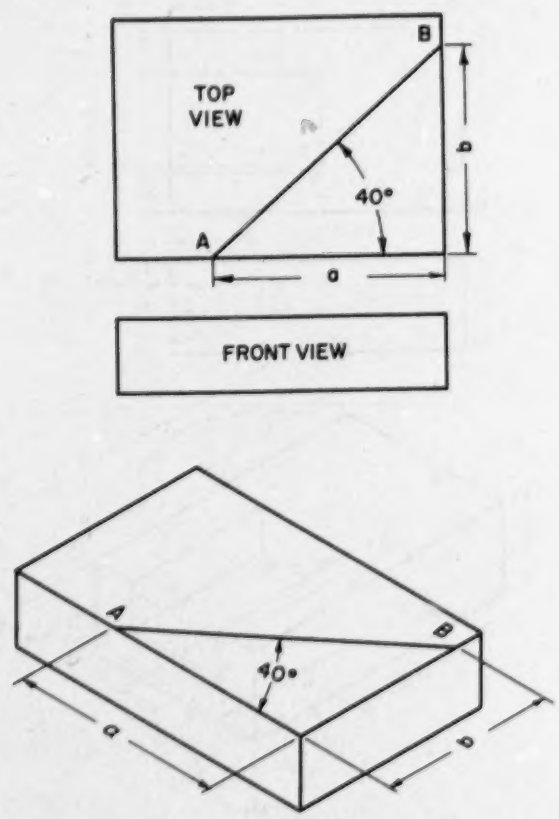

Figure 4-132.—Drawing an angle in isometric.

If an accurate ellipse is required you can draw the ellipse by the conjugate-axis method described earlier. However, in a case of this kind, an approximate ellipse, drawn with a compass, is usually satisfactory. Notice first, in figure 4-133 that the intersecting conjugate axes of the isometric ellipse always parallel two of the legs of the isometric axis. To draw an approximate isometric ellipse, first draw the circumscribing parallelogram ABCD, by drawing lines at the ends of each conjugate axis, parallel to the other axis, as shown in figure 4-134. Then draw the approximate ellipse as follows.

Draw the diagonal AC. Draw straight lines from the midpoint of AB and the midpoint of BC to D. The points of intersection (0 and 0') between these lines and the diagonal AC are centers for the end arcs of the approximate ellipse. Points B and D are centers for the intermediate arcs.

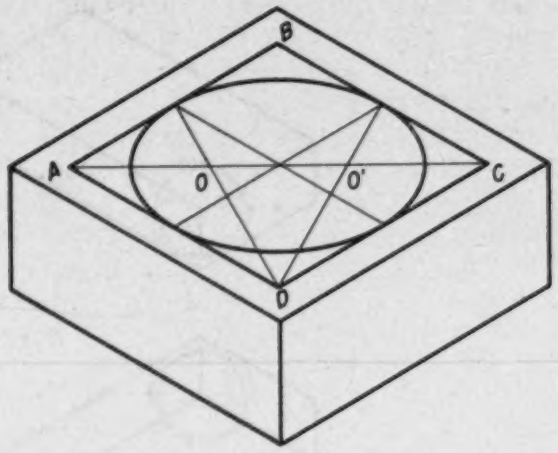

Figure 4-134.—Method of drawing approximate ellipse on isometric conjugate axis.

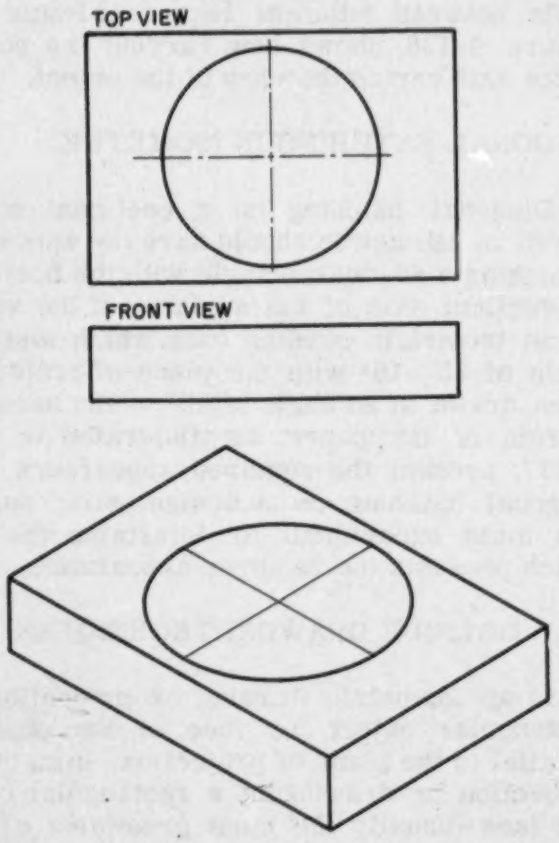

Figure 4-133.—Circle on a normal multi-view view appears as ellipse in isometric drawing.

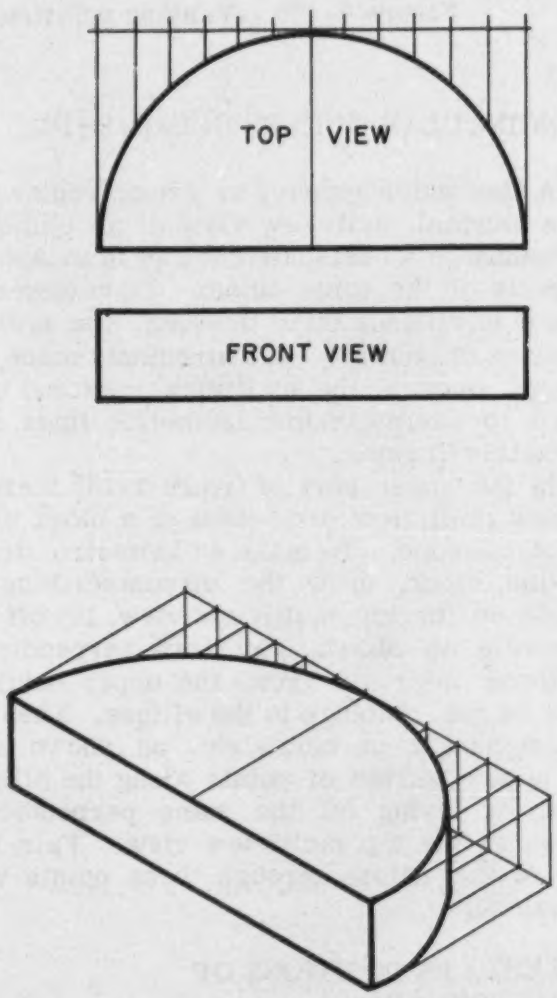

Figure 4-135.—Method of drawing a noncircular curve in isometric.

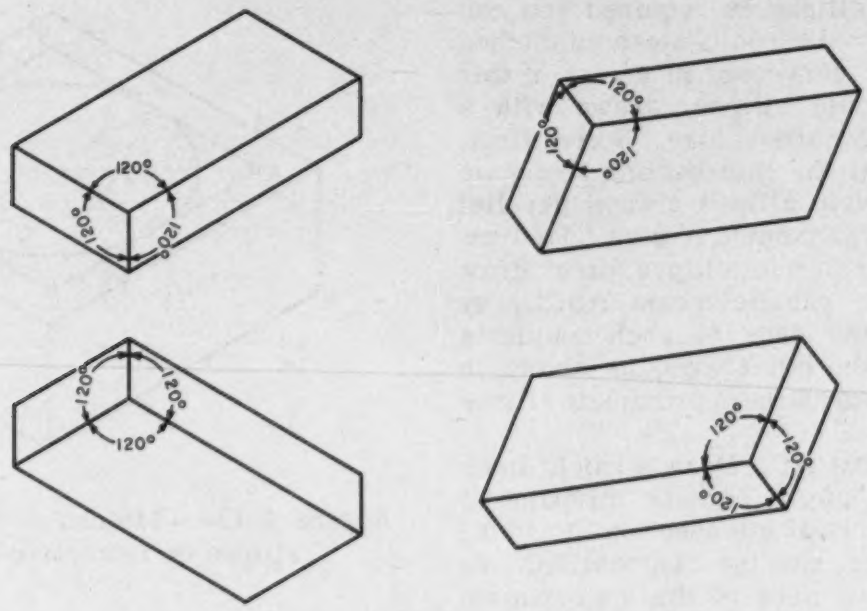

Figure 4-136.—Varying position of isometric axis varies view of the object.

NONCIRCULAR CURVES IN ISOMETRIC

A line which appears as a noncircular curve in a normal multiview view of an object will obviously be a nonisometric line in an isometric drawing of the same object. To transfer such a line to an isometric drawing, you must plot a series of points by measurements made along normal lines in the multiview view and transfered to corresponding isometric lines in the isometric drawing.

In the upper part of figure 4-135 there is a 2-view multiview projection of a block with an elliptical edge. To make an isometric drawing of this block, draw the circumscribing rectangle on the top multiview view, lay off equal intervals as shown, and draw perpendiculars at these intervals from the upper horizontal edge of the rectange to the ellipse. Then draw the rectangle in isometric, as shown below, and plot a series of points along the elliptical edge by laying off the same perpendiculars shown in the top multiview view. Fair in the line of the ellipse through these points with a french curve.

ALTERNATE POSITIONS OF ISOMETRIC AXIS

Up to this point the isometric axis has been used with the lower leg vertical. The axis may, however, be used in any position, provided the angle between adjacent legs is always 120°. Figure 4-136 shows how varying the position of the axis varies the view of the object.

DIAGONAL HATCHING IN ISOMETRIC

Diagonal hatching on a sectional surface shown in isometric should have the appearance of making a 45-degree angle with the horizontal or vertical axis of the surface. If the surface is an isometric surface (one which makes an angle of 35° 16' with the plane of projection), lines drawn at an angle of 60° to the horizontal margin of the paper, as illustrated in figure 4-137, present the required appearance. For diagonal hatching on a nonisometric surface, you must experiment to determine the angle which presents the required appearance.

OBLIQUE DRAWING TECHNIQUES

In an isometric drawing or projection of a rectangular object, no face of the object is parallel to the plane of projection. In an oblique projection or drawing of a rectangular object, one face (usually the most prominent or most important) is parallel to the plane of projection. Consequently, the axis for an oblique drawing has two legs (called the front axes) perpendicular to each other, and a third (called the receding axis) which may be drawn at any convenient angle.

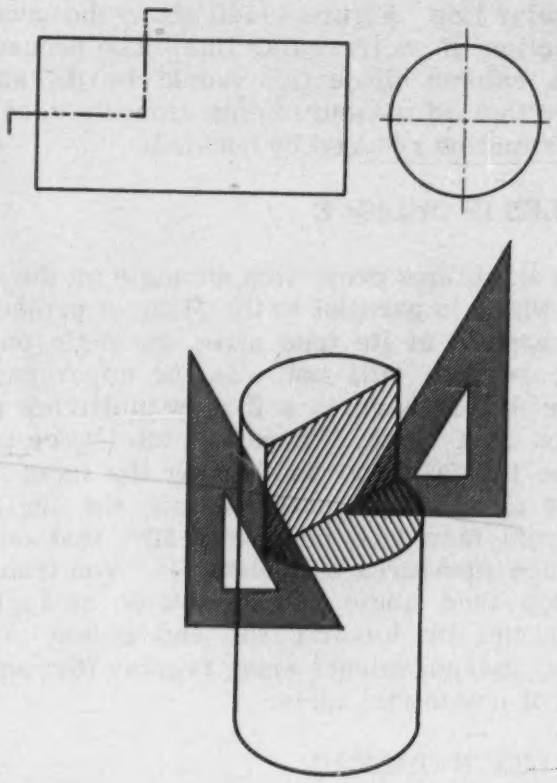

Figure 4-137.—Diagonal hatching in isometric.

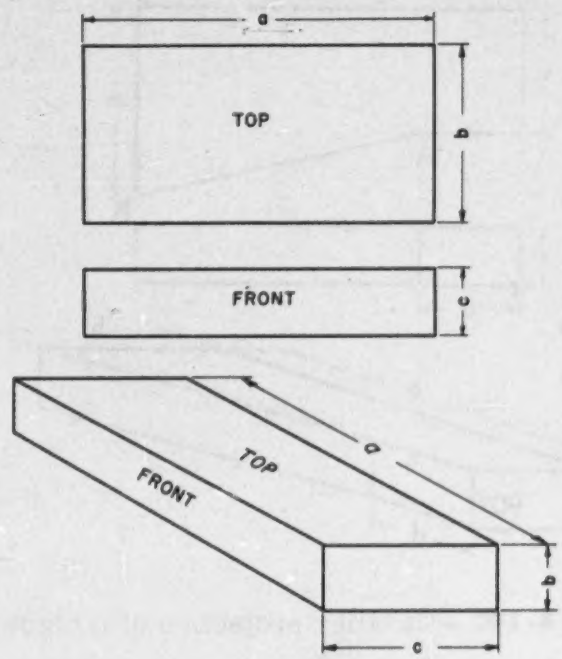

Figure 4-138.—Cavalier projection. Distances along front axes and along receding axis are all true.

TRUE AND FORESHORTENED DIMENSIONS

In the upper part of figure 4-138 there is a 2-view multiview projection of a rectangular board. Below there is a cavalier projection of the same board. The figure is built on the indicated axis, two legs of which are perpendicular to each other. Distances along the front axes and the receding axis are all true, as indicated.

The figure shown in cavalier projection appears to be elongated along the receding axis. In figure 4-139, the same object is shown in cabinet projection. In this projection the appearance of distortion along the receding axis is reduced by reducing measurements along this axis by one-half, as shown. Distance along the front axes are true.

IRREGULAR LINES

An irregular line in an oblique drawing is a line which would be an oblique line in a normal multiview projection, or a nonisometric line in an isometric drawing, except that in an oblique drawing there are no irregular lines

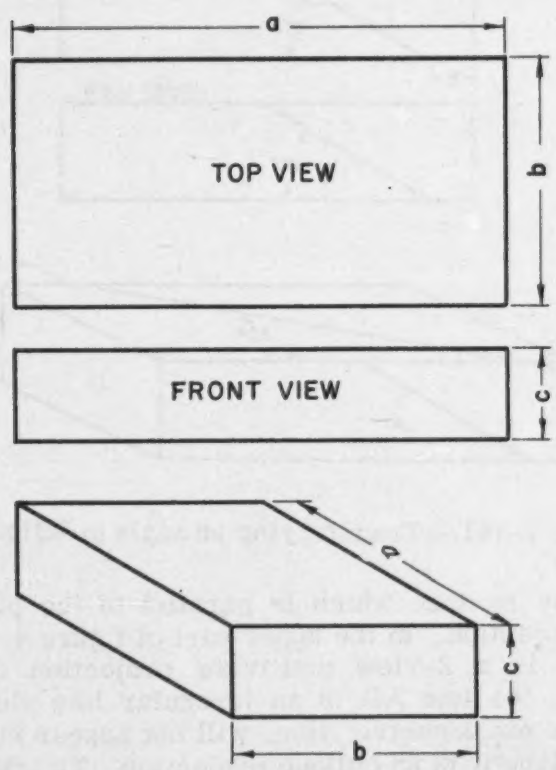

Figure 4-139.—Cabinet projection. Distances along front axes true; distances along receding axis reduced by one-half.

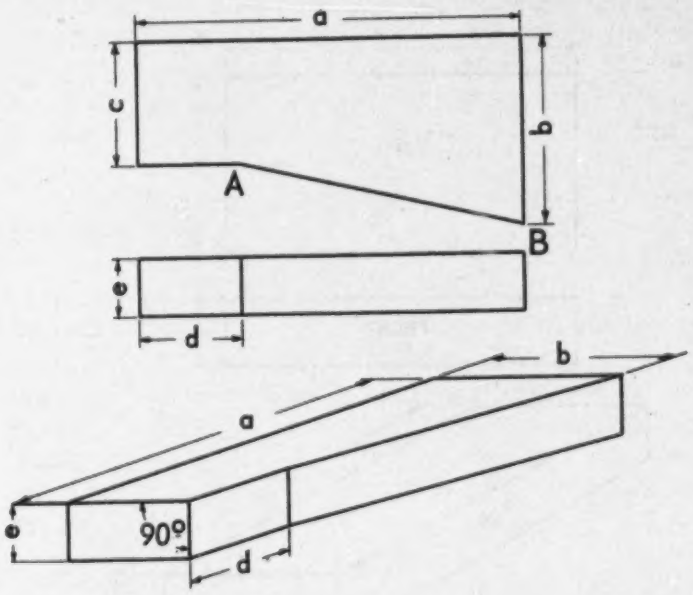

Figure 4-140.—Cavalier projection of irregular line.

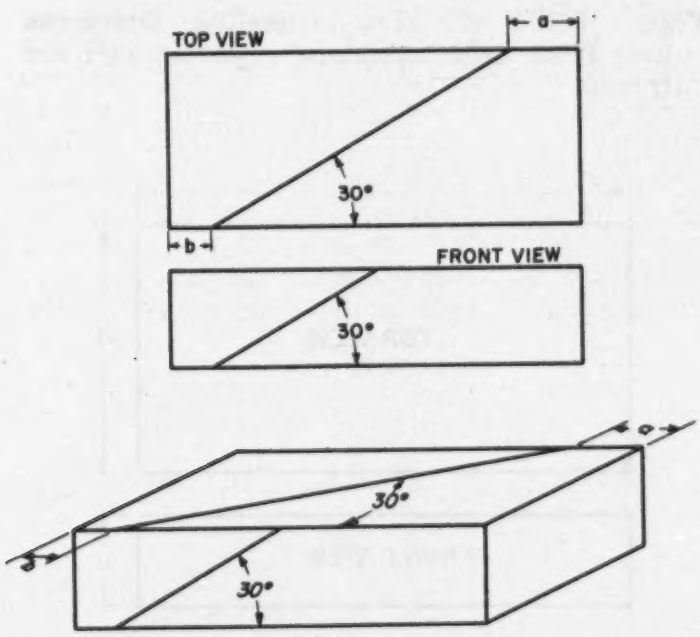

Figure 4-141.—Transferring an angle in oblique.

on the surface which is parallel to the plane of projection. In the upper part of figure 4-140 there is a 2-view multiview projection of a block; the line AB is an irregular line which, like a nonisometric line, will not appear in its true length in an oblique projection. To transfer the line you proceed just as you do with a non-isometric line: you draw the projection by transferring measurements taken along regular lines, and this locates the end points of the irregular line. Figure 4-140 shows the cavalier projection of an irregular line. The procedure for a cabinet projection would be the same, except that all measurements along the receding axis would be reduced by one-half.

ANGLES IN OBLIQUE

In an oblique projection an angle on the surface which is parallel to the plane of projection will appear in its true size; an angle on any other surface will not. In the upper part of figure 4-141 there is a 2-view multiview projection of a block. There is a 30-degree angle on the top face and another on the front face. In the cavalier projection below, the angle on the front face still measures 30°; that on the top face measures only about 9° You transfer the top face angle just as you do an angle in isometric: by locating the end points of the line by measurements along regular (the equivalent of isometric) lines.

CIRCLES IN OBLIQUE

In an oblique projection, a circle on the surface parallel to the plane of projection will appear as a circle. A circle on any other surface will appear as an ellipse, as illustrated in figure 4-142. In the upper part of this figure there is a 2-view multiview projection of a block with

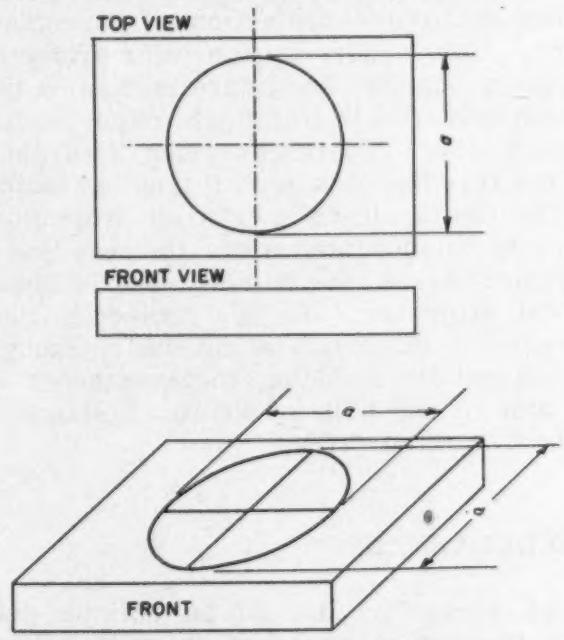

Figure 4-142.—Cavalier projection of a circle on a receding surface.

Microwave Frequency Generators

If a small part of the output is fed back to the input (through a directional coupler, a resonant cavity, and a phase shifter), stability of an oscillator can be improved. The total RF phase shift must be controlled so as to assure regenerative phasing at the input, and loop loss must be controlled in order to provide the proper magnitude of feedback signal. These requirements may be met by incorporation of a variable phase shifting network and a variable attenuator.

Phase shifting in the circuit may result from any of the following (or any combination of them):

1. Transmission line delays. These include phase shifts due to the length and the distributed constants of the transmission line system, the helix structure, the couplers, etc.
2. Resonant cavity or filter delays.
3. Electronic phase shifting resulting from any changes in the potentials applied to the electrodes.

Use of a filter having a wide bandwidth and low losses allows electronic tuning by merely varying the helix voltage. If the filter is of a narrowband type, tuning may be done manually.

As the output of a TWT approaches its saturation point, frequency harmonics are produced. Conversion gains of about 10 db can be obtained when the tube is used as a frequency doubler, with somewhat less gain for higher order harmonics.

BACKWARD WAVE OSCILLATOR

The "M" type backward wave oscillator (M-BWO) is a wideband, high powered, highly efficient and reliable source of microwave power. It offers high speed, half-octave electronic tuning by variation of a single control voltage. Its most extensive application to date has been in ECM barrage and spot noise jamming.

During World War II, the magnetron, with mechanical tuning, was the workhorse of the microwave electronic warfare equipment. However, because wide and rapid tuning requirements began to develop for both radar and countermeasures, wideband electronic tuning of high powered microwave oscillators became desirable.

The development of the voltage tunable magnetron and the principle of traveling wave interaction in linear beam tubes stimulated work on crossed field traveling wave devices. This led to the development of the CARCINOTRON and M-BWO.

The M-BWO has become an excellent microwave ECM transmitter tube because of the following characteristics:

1. The advantage of the M-BWO's voltage tuning over mechanical tuning.
2. The tube's high power and efficiency.
3. Its versatility.
4. Its economy of size and weight.

APPLICATIONS

Noise jamming is a brute force method of jamming which supplies sufficient noise to radar receivers to make it difficult to distinguish target echoes. The noise RF power is obtained by frequency and/or amplitude modulating the M-BWO with a noise source and a sine wave source. The noise bandwidth can be varied about the operating frequency, thus providing a high degree of flexibility in terms of watts per megacycle versus bandwidth. The two basic modes of operation are spot or narrowband jamming, and barrage or wideband jamming.

BASIC PRINCIPLES

The M-BWO is a voltage tunable microwave power generator using the interaction of a ribbon beam traveling near a frequency selective delay line. Electric and magnetic fields are maintained at right angles to each other and to the direction of the beam. The beam velocity is substantially the same as the phase velocity of a wave component traveling along the delay line. By this means, energy is transferred from the static field to the RF field. In the M-BWO, the RF energy travels in a direction opposite to that of the electron beam.

In most practical tubes, the interaction space is ring shaped. Figure 12-18 (A) shows a cross section of a typical tube and shows the path of the electron beam and the RF energy under oscillating conditions. Figure 12-18 (B) illustrates a three-dimensional cross sectional view of an earlier M-BWO.

The M-BWO is a member of the traveling wave tube family described earlier in this chapter, having in common with it the slow wave device, or delay line, and the bunching of electrons in the beam. The M-BWO differs from the TWT in several ways, including the use of the crossed magnetic field. You will probably recall that crossed magnetic fields are also used in the magnetron.

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a circle on its upper face. Below there is a cavalier projection, in which the circle appears as an ellipse. Each of the conjugate diameters of the ellipse is equal to the diameter of the circle.

Here again an approximate ellipse, drawn with the compass, is generally considered satisfactory. You cannot use the method used for drawing an approximate ellipse in isometric (fig. 4-134), however, because that method can be used only when the conjugate axes of the ellipse are parallel to two legs of the isometric axis.

Figure 4-143 shows a method of drawing an approximate ellipse in cavalier projection. Draw the circumscribing parallelogram ABCD by drawing lines at the ends of each axis, parallel to the other axis. Erect perpendicular bisectors from AB, BC, CD, and DA. These bisectors intersect each other at X and X' and at Y and Y' X and X' are centers for the interemdiate arcs of the approximate ellipse; Y and Y' are centers for the end arcs.

The method (called the four-center method) is basically the same as that illustrated in figure 4-134. It happens, however, than in an isometric circumscribing parallelogram perpendicular bisectors from the sides always intersect at corners of the parallelogram. This is not usually the case in a cavalier parallelogram.

The situation is a little different in a cabinet or other oblique projection in which measurements along the receding axis are reduced to lessen the appearance of distortion. In the upper part of figure 4-144 there is a 2-view multiview projection of a block with a circle on the right side. Below there is a cabinet projection, in which the circle appears as an ellipse. Note here, however, that the horizontal conjugate diameter of this ellipse is only one-half the length of the vertical conjugate diameter. For this reason, you must draw this ellipse by the method described earlier for drawing an ellipse on conjugate diameters. The four-center method of drawing an approximate ellipse (used in isometric drawing, fig. 4-134 and cavalier projection fig. 4-143) will work only on an ellipse with conjugate diameters which are equal in length.

PERSPECTIVE PROJECTION

Perspective drawings constructed by perspective projection are one-view drawings. While they do not show the object in its true shape and dimensions, they do show how the object looks to an observer and, as a consequence, they are easier to comprehend at a glance than drawings made according to orthographic projection. For this reason, perspective projection is often used for exploded views of objects to show all the different parts and their relationship to each other. Perspective projec-

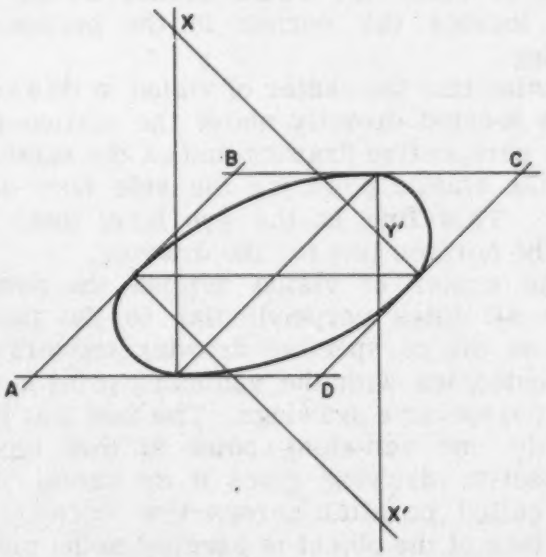

Figure 4-143.—Method of drawing approximate ellipse for cavalier projection of a circle on a receding surface.

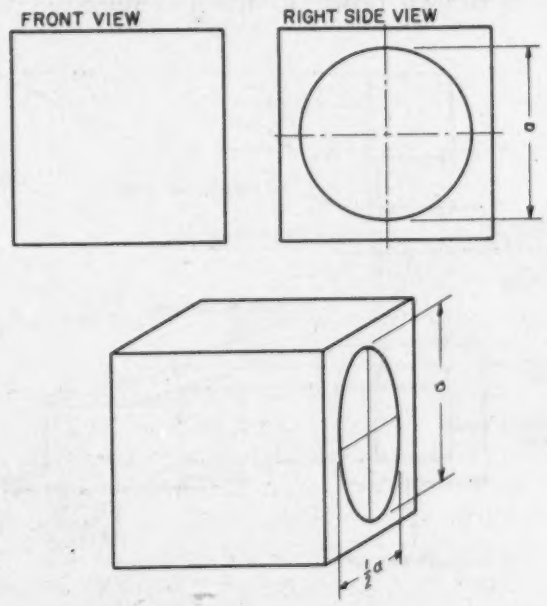

Figure 4-144.—Circle on receding surface shown in cabinet projection.

tion is also sometimes used for architectural renderings of proposed structures to show how the structures will look when they are completed.

Perspective projection drawings requiring very accurate projection are usually done by working from orthographic views of the object. For purposes of illustration, however, this type of painstaking projection is not necessary. Many illustrators do not use the methods of perspective projection at all, making their perspective drawings by approximating the positions of various planes. But, unless you are a very keen observer and have had considerable practice, you are likely to commit some rather ridiculous errors if you try to draw perspective illustrations by guesswork alone. A few simple rules and a few pains taken in constructing a scene or an object will help you make better drawings.

ONE-POINT PERSPECTIVE

Figure 4-145 is a one-point perspective projection of a cube from a top and side view in orthographic projection. The technical terms which will be used in discussing perspective projection are illustrated in the figure.

Notice that the picture plane becomes a line in the top and side orthographic views. Projectors from the corners of the top view are drawn converging toward the station point but, from the points where the projectors, or visual rays, pierce the picture plane, parallel projectors are drawn down to the perspective view.

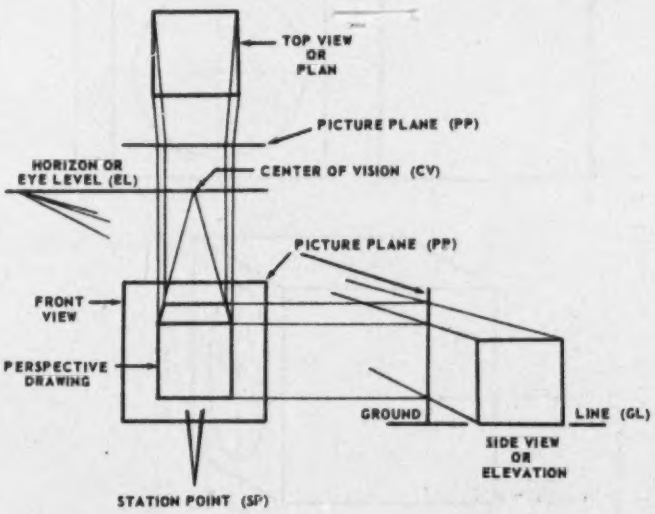

Figure 4-145.—One-point perspective drawing obtained from orthographic views.

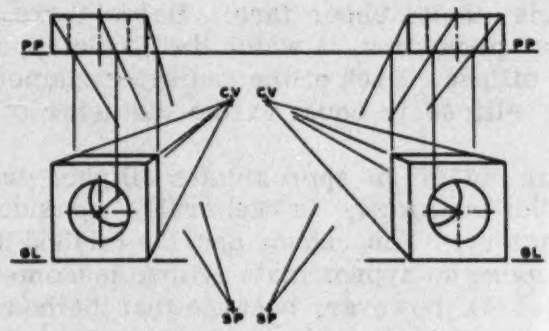

Figure 4-146.—Position of the station point at right or left of center in parallel perspective drawings.

The station point for the side view is actually the same station point as that shown for the top view. It is, therefore, the same horizontal distance from the cube, but its elevation shows the height of the station point above the level of the cube. The picture plane in the side view is also the same distance from the cube as in the top view, and the ground line in this view, on which the picture plane rests, defines the ground line of the picture plane in the perspective drawing.

In the side view, projectors are drawn converging to the station point, and at their piercing points on the picture plane, parallel horizontal projectors are drawn to the perspective drawing. The intersection point of a projector from a corner of the cube in the top view with the projector from the same corner in the side view locates the corner in the perspective drawing.

Notice that the center of vision in this drawing is located directly above the station point in the perspective drawing and on the same line with the station point for the side view of the cube. This line is the eye level line. It is also the horizon line for the drawing.

The center of vision defines the point at which all lines perpendicular to the picture plane in the perspective drawing converge. It also coincides with the vanishing point in one-point perspective drawings. The fact that there is only one vanishing point in this type of perspective drawing gives it its name. It is also called parallel perspective because the front face of the object is parallel to the picture plane.

In parallel perspective drawings, the center of vision is not necessarily centered on the object. It may fall to one side or the other as

shown in figure 4-146. However, when the front face is parallel to the picture plane and the center of vision is at one side of the drawing, there will necessarily be some distortion. Actually, the drawing becomes an oblique projection and not a true perspective drawing. Notice that in order to make such a drawing, the object must be considered as resting with its front face against the picture plane. If this were not so, converging projection lines from the corners of the front face would alter its appearance so that it would no longer appear to be parallel with the picture plane. In fact, as you will see, it would then become a two-point, rather than a one-point, perspective drawing.

TWO-POINT PERSPECTIVE

Two-point perspective is the most commonly used method for making perspective drawings. In two-point, or angular perspective, the object is considered as sitting at an angle to the picture plane. In the perspective drawing of such an object, there are 2 sets of horizontal edges converging toward 2 different vanishing points on the eye level or horizon line. The parallel lines which slope to the right will vanish at a point in the distance called the right vanishing point (VPR) and those that slope to the left at a point called the left vanishing point (VPL). (See fig. 4-147.)

In the figure, the top orthographic view of the block was drawn first. The position of the picture plane was then determined.

When the corner of the object rests against the picture plane, the vertical line representing the corner in the perspective drawing will be full size. In one-view perspective, the front face is full size in the perspective drawing if it rests against the picture plane. In any perspective drawing, the comparative sizes will be reduced proportionately as the distance is increased between the picture plane and the object.

Once the picture plane was established, the station point for the top view in figure 4-147 was located approximately opposite the center of the block. The distance from the station point to the object should not be less than twice the width of the object.

When this rule is neglected, a distorted appearance may result in the perspective drawing. There is a cone of about 30° in which the human eye sees clearly. For this reason, the angle formed by the lines of sight from the sides of the object to the station point should not exceed 30°. In no case, even when the

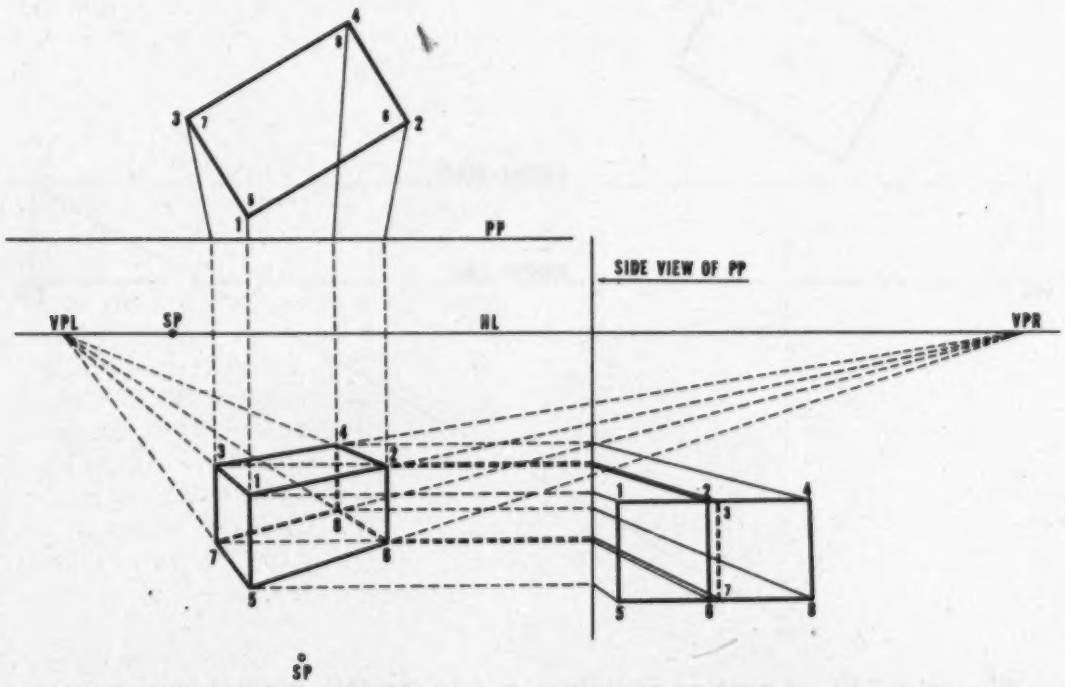

Figure 4-147.—Two-point or angular perspective.

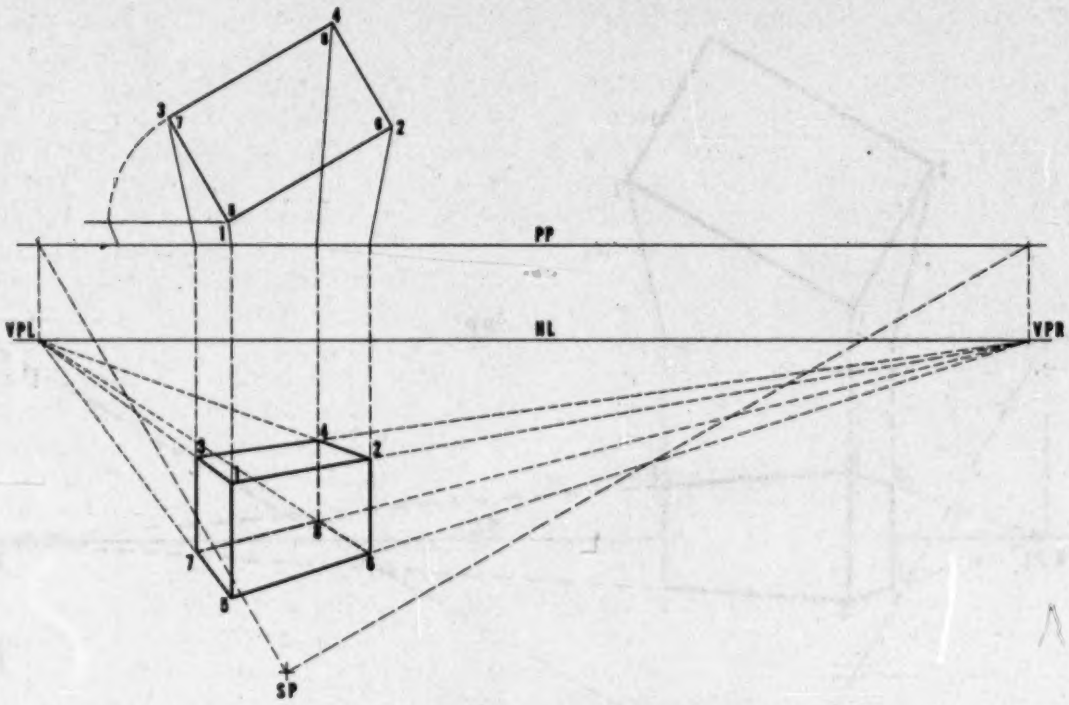

Figure 4-149.—Two-point perspective drawing made without using an elevation of the object.

elevation is not used, the various heights cannot be found directly. However, the bottom of the block may be located, as shown in figure 4-149 by drawing lines to the vanishing points from the point selected as the near corner.

Now if the perspective height of any one vertical line can be determined, the height of the other verticals can be found automatically. This is easy to do when one edge of the object rests against the picture plane. This edge will then appear in its true height in the perspective view. If you have the dimension for this height in the orthographic projection, you can transfer that dimension directly to the perspective view. Lines drawn to the vanishing points from this top corner will locate the top of the two sides, and lines drawn to the vanishing points from the far corners on these sides will complete the drawing of the block.

When the front edge of the subject does not rest against the picture plane, it is necessary to use some other dimension. Since the end of the block is square it is possible to find the perspective length of a horizontal line and use this dimension for the edge of 1-5. This is done, by drawing a line parallel to the picture plane from 1, measuring a length of this line equal to 1-3, and drawing a line converging on the station point to the picture plane from the end of this line.

This length can then be transferred to the front edge of the perspective view and the view completed as shown in figure 4-149. To check the accuracy of this method, compare figure 4-149 with 4-147. You will find that, since the station point, horizon level, and the bottom of the cube correspond, the two perspective views are similar. It is possible to make them correspond exactly.

In figure 4-149 the bottom of the front edge of the block has been placed autocratically at a certain point. Actually it could have been placed on the vertical projection from the cube at any desired point. Thus, the perspective view may be drawn below the eye level, or it may be drawn at eye level or above it, as shown in figure 4-150.

However, if the object is placed too high above the eye level or too low below it, the effect will be one of distortion. A block drawn in these positions will cease to look right as shown in figure 4-151. When the station point is too close to the object, there will be a similar distortion. The angle indicated in the figure should never be less than 90° and preferably not less than 100°.

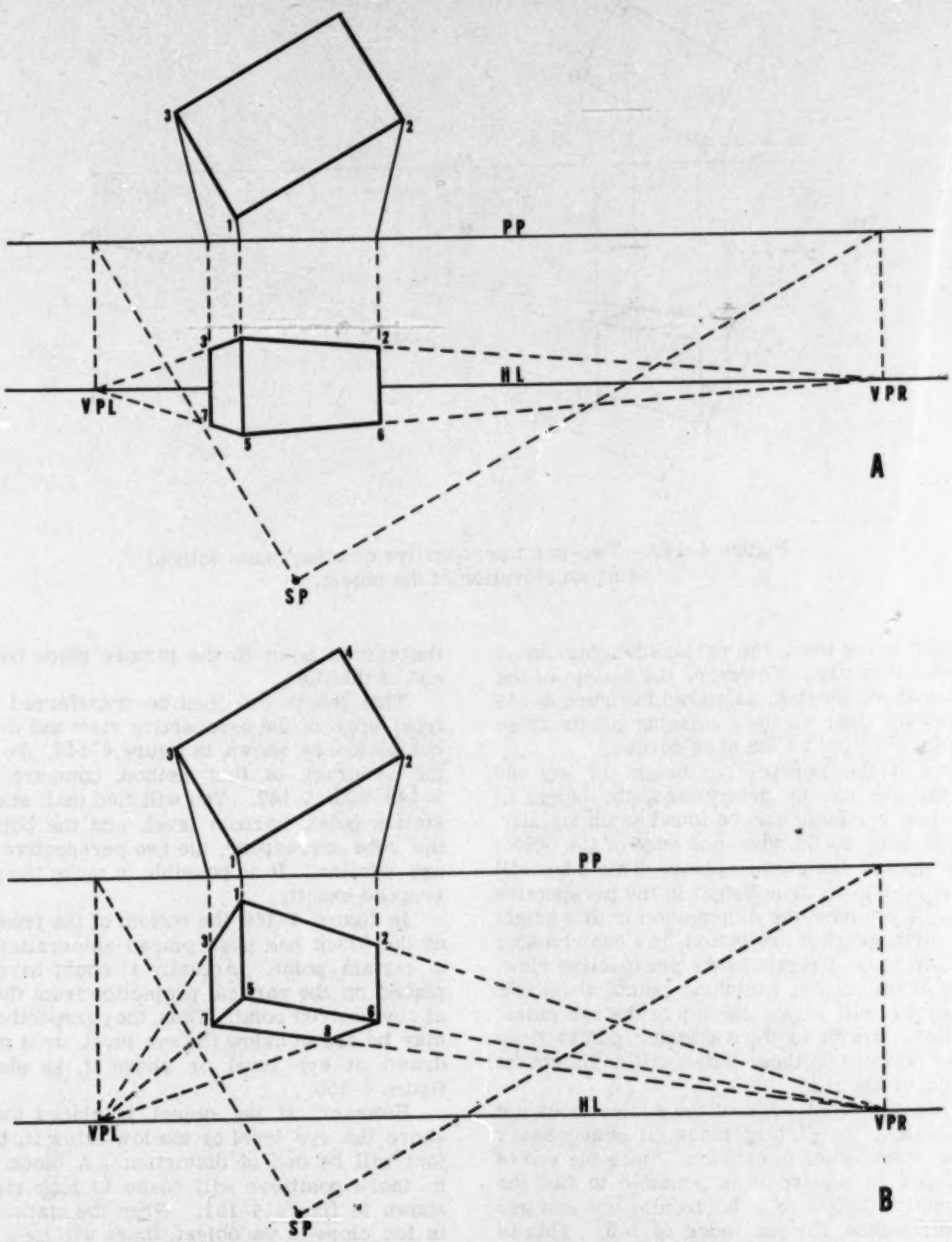

Figure 4-150.—A. Object on eye level. B. Object above eye level.

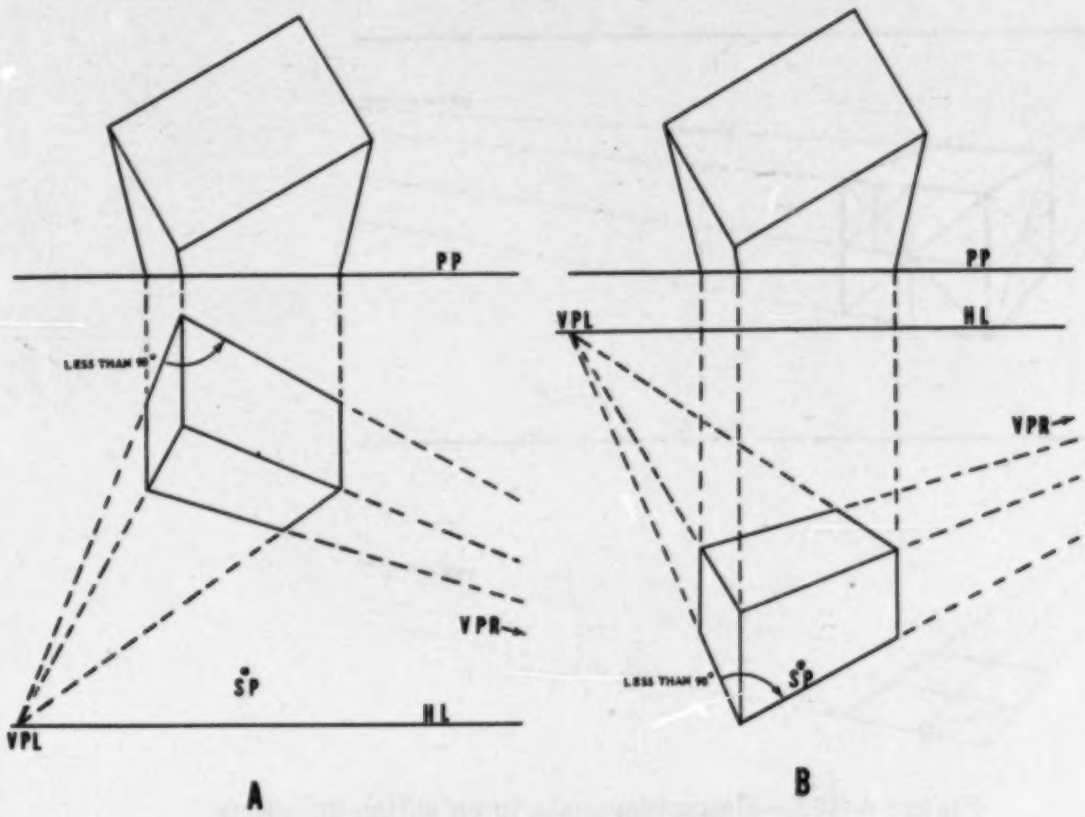

Figure 4-151.—A. Object placed too high above eye level.
B. Object placed too low below eye level.

To overcome distortion such as that illustrated in figure 4-151, the station point may be moved further from the object or the picture plane may be tilted so that a third vanishing point is needed for the third set of parallel lines in the drawing.

MEASUREMENTS IN TWO-POINT PERSPECTIVE

In drawing objects with compound shapes, a series of cubes may be used. If you draw a cube in two-point perspective, you can easily divide the perspective views of the sides of the cube into halves and again into quarters by using diagonals, as shown in figure 4-152A.

The diagonals of the square sides establish the centers of these sides. Verticals erected through each center, divide the side into halves. In order to divide the squares into quarters, find the center of a vertical side and draw lines from this point receding toward the vanishing points. This establishes the centers of the vertical edges. Now draw a diagonal in one of the quarters so established. This diagonal will cross the diagonal of the large square. Finally erect a vertical through the point established by the intersection of these two diagonals. As you can see, this process of division can be carried on as far as necessary to establish the required division points on a horizontal edge or within the square itself.

It is also possible by using diagonals to add to the sides of the cube in multiples of 2, 4, 8, etc., as shown in figure 4-153. First, the center of the square side is found and a vertical and horizontal are drawn through this center. The horizontal is extended beyond the side of the cube toward the vanishing point and the horizontal edges of the side are also extended toward this point, as shown in figure 4-153A.

A diagonal drawn from the center point on the lower horizontal edge of the square through the center point on the far edge will intersect the extension of the top edge as shown in figure 4-153B. A vertical dropped from this intersection will add the equivalent of a half to that side. As you can see, this process can be continued as many times as necessary, and the sections so established can be divided in turn.

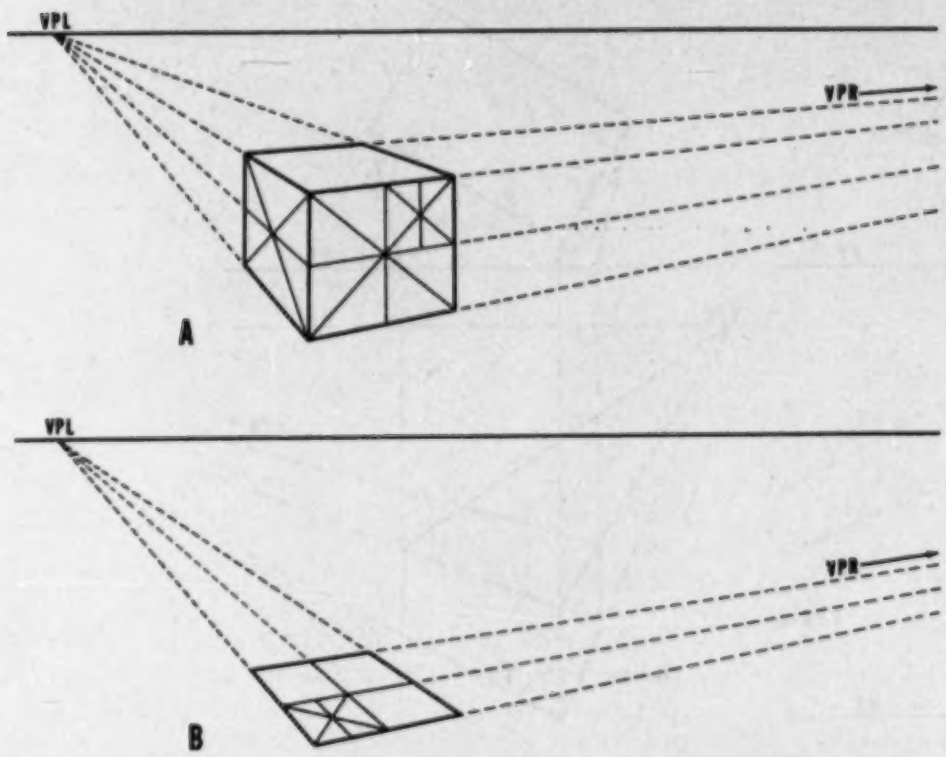

Figure 4-152.—Using diagonals to establish divisions on a line or a plane in perspective.

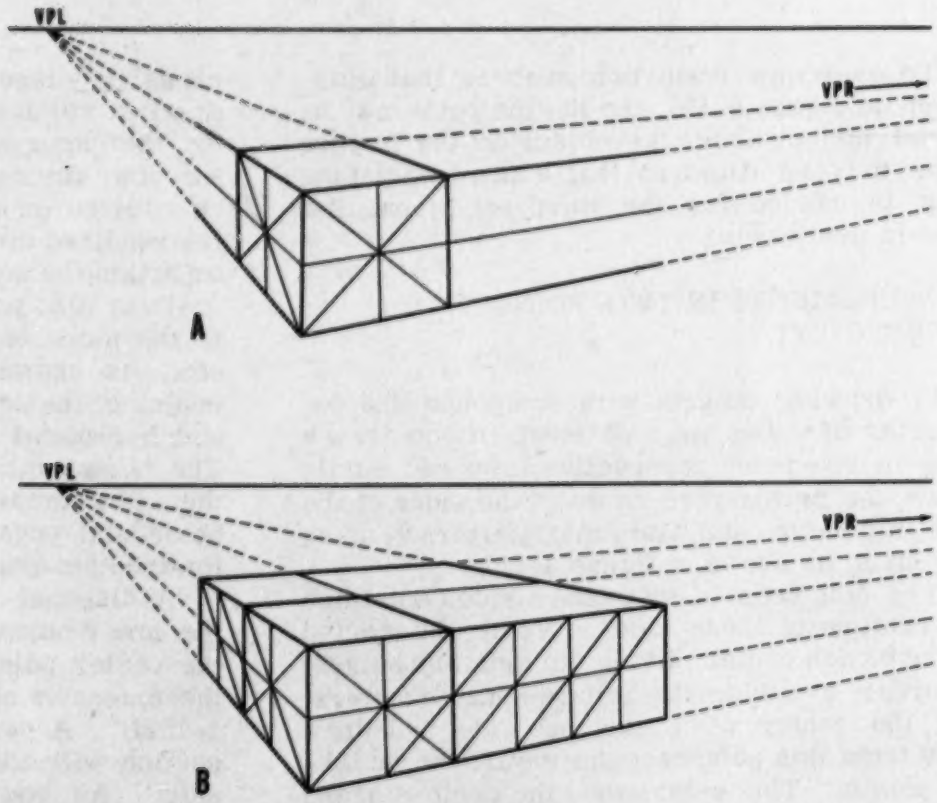

Figure 4-153.—Using diagonals to multiply areas.

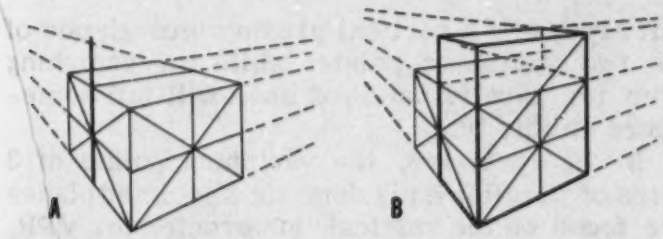

Figure 4-154.—Finding the outside dimensions of a bookcase in perspective.

Now suppose you are asked to draw in perspective a bookcase 36 inches high, 24 inches wide, and 12 inches deep. Since the 36 inches can be divided into 18 inches or 9 inches but not into 24 or 12, it will be better to make the basic cube 24 inches, which can easily be divided into 12 inches and to which 12 inches can be added. In figure 4-154B, these dimensions have been established. Note that the same method used for multiplying areas in a horizontal direction, shown in figure 4-153, may be applied to multiplying them in a vertical direction.

Suppose that the bookcase is constructed of boards which are 1 inch thick. The top shelf is 8 inches high—that is, the upper front edge is 9 inches from the top of the bookcase, and the lower shelves are 12 inches high—that is, 13 inches including the width of one shelf—with the lowest shelf resting on the floor. Notice that 9 inches is one-fourth of the total height of the bookcase, which should make it easy to find this dimension. A diagonal may be used to create a 36-inch square, as shown in figure 4-155A, and diagonals may be used to locate the top shelf, as shown in figure 4-155B.

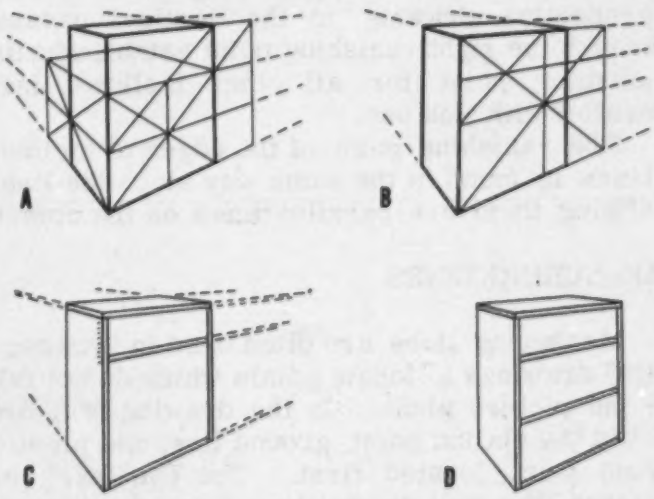

Figure 4-155.—Locating the shelves of the bookcase.

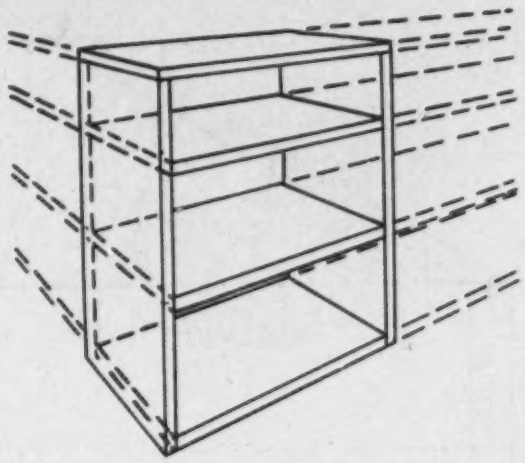

Figure 4-156.—Locating the rear edges of the shelves.

If either of the verticals bounding this shelf can be easily divided into nine of some convenient unit, such as an eighth of an inch, the width of the board can be found for that vertical, as shown in figure 4-155C. Since the bottom of the front edge of the second shelf is one-half the remaining distance, this dimension may be located by using dividers. The width for the horizontal shelf boards may be easily estimated. (See fig. 4-155D.)

Next work out the rear edge of each shelf, starting by finding the front edge of the backboard. This will be one inch from the rear edge of the bookcase itself. The measurement may be approximated. Mark a point one inch from the back of the bookcase on each of the lines. From these points, draw lines toward the right vanishing point to define the rear edges. (See fig. 4-156.)

To define the inside edges of the shelves at the right side of the bookcase, draw lines toward the left vanishing point from the points where the top edges of the front of the shelves meet the right side of the bookcase. Where these two sets of lines intersect, erect a vertical.

When the problem consists of finding equal division points of a plane in perspective, such as a line of telephone poles along a road or equally spaced divisions on a wall or a floor, and the spacing of these points is known, the problem may be solved as shown in figure 4-157. Since the points are parallel on the object, they will have a common vanishing point. If the plan view is used, the points may be projected to the picture plane in that view as shown in figure 4-157A. Then they are

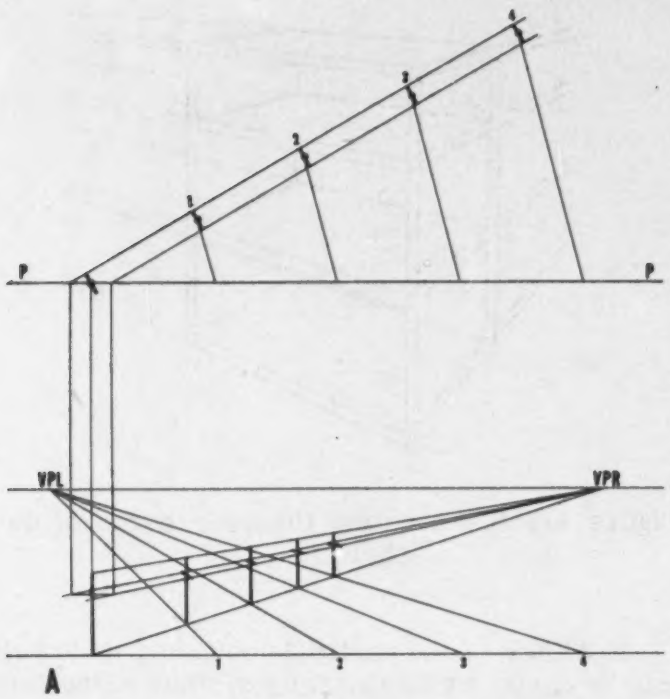

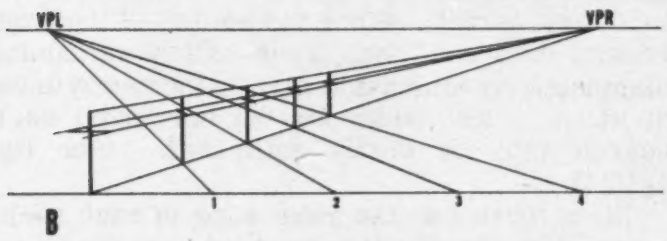

Figure 4-157.—Measurement of horizontal points that are equally spaced.

projected to the picture plane in the perspective view, and lines are drawn toward the vanishing point.

If no plan view is used, a horizontal line is simply drawn, as shown in figure 4-157B and the points spaced off on this line. Notice that this method of finding the position of equally spaced points on a line is very much like the common method of dividing a line into equal spaces.

VANISHING POINTS FOR INCLINED LINES

Just as horizontal planes vanish at the horizon line and horizontal lines vanish at a point on the horizon line, so inclined planes will vanish on a line and inclined lines which are parallel on the object will vanish at a point on this line. The vanishing line for inclined planes will always be a vertical passing through one of the two vanishing points, while the vanishing point for parallel inclined lines will fall somewhere on this line.

In figure 4-158, the vanishing points of 3 pairs of parallel lines defining 3 inclined planes are found on the vertical line erected for VPR. In the drawing, a plan view of the object was used and the station point was located. Then the vanishing points were found by the method shown in figure 4-148.

Points on horizontal and vertical planes can then be found by methods previously described. That is, lines are drawn converging on the station point from these points in the plan view to the picture plane and from the picture plane they are projected to the perspective view. Since the front edge of the plan view rests against the picture plane, the length of this edge is the same as it is in the orthographic drawing and can be projected directly from the elevation at right. From this edge, lines can be drawn converging on the left and right vanishing points.

However, the points on the inclined planes are not so easily found. In order to locate point A, it can be assumed to be moved forward to the picture plane, as shown by faint crosses; and measuring lines drawn down from the picture plane. The true height can then be projected from the elevation to intersect these lines. Lines are drawn from these points to the vanishing points. Point A is then established for the perspective drawing as the point where these receding lines cross. The other points in question can be found in the same way.

A line drawn from A' through A in the perspective drawing to the vertical passing through the right vanishing point establishes the vanishing point for all other inclined lines parallel with this one.

The vanishing point of the edges of inclined planes is found in the same way since the lines defining them are parallel lines on the object.

MEASURING LINES

Measuring lines are often used in architectural drawings to locate points which do not fall in the picture plane. In the drawing in figure 4-159 the station point, ground line, and picture plane were located first. The eye level, or horizon line was drawn about 5 feet 6 inches on the selected scale above the ground line, and the vanishing points were located on it.

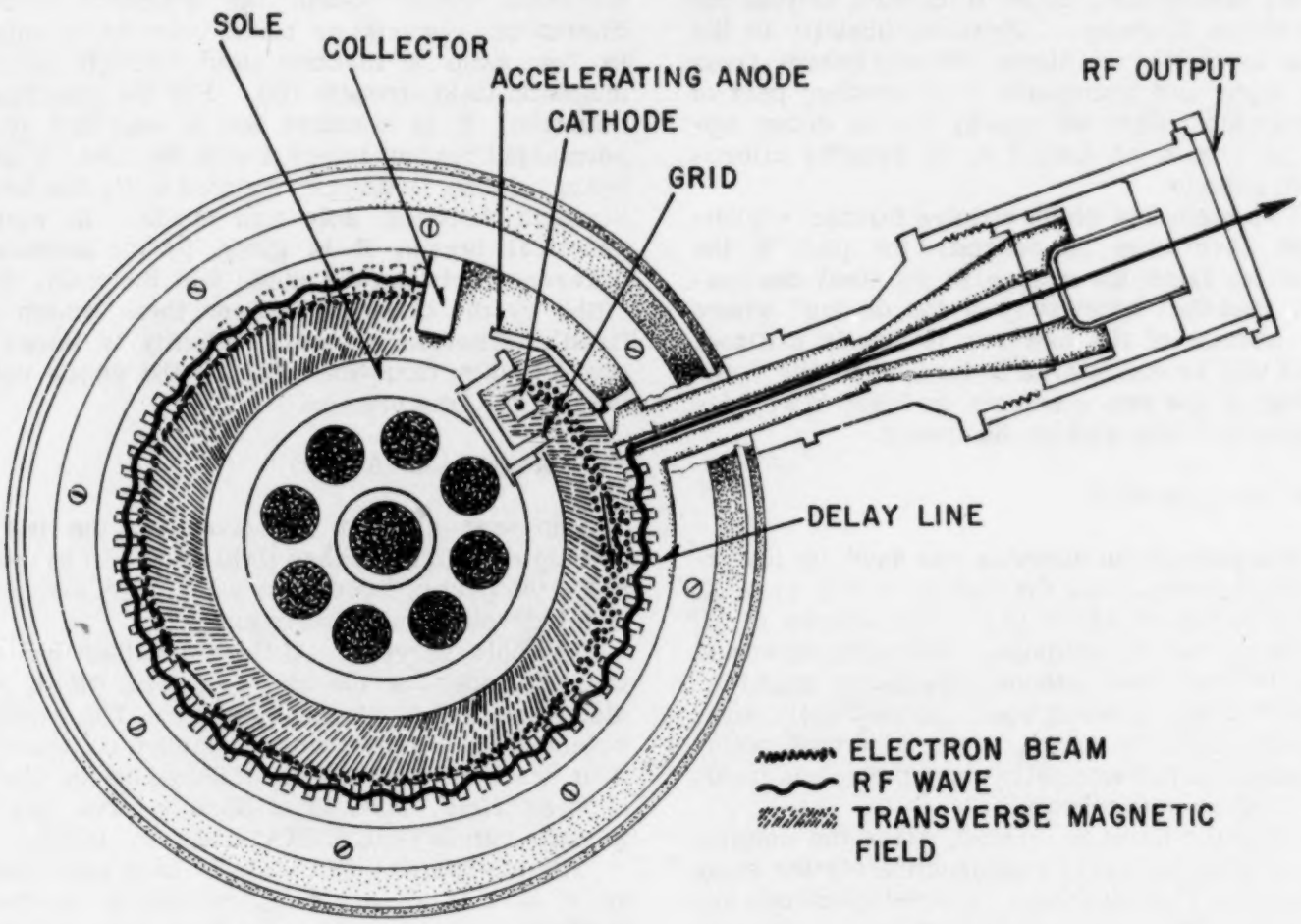

(A)

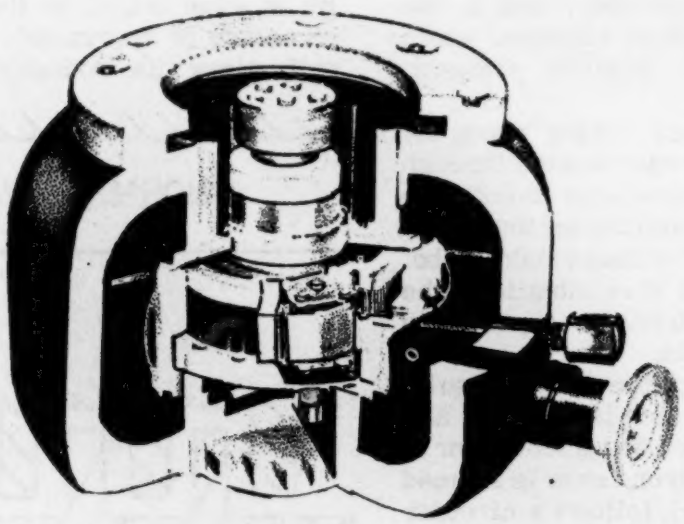

(B)

Figure 12-18.—Typical M-type backward wave oscillator.

The principle of traveling wave interaction is basic to all crossedfield devices. The major objective is to convert electrical energy from static (d-c) form to electromagnetic energy in extremely rapid (microwave frequency) alternating form. The electron is used for this

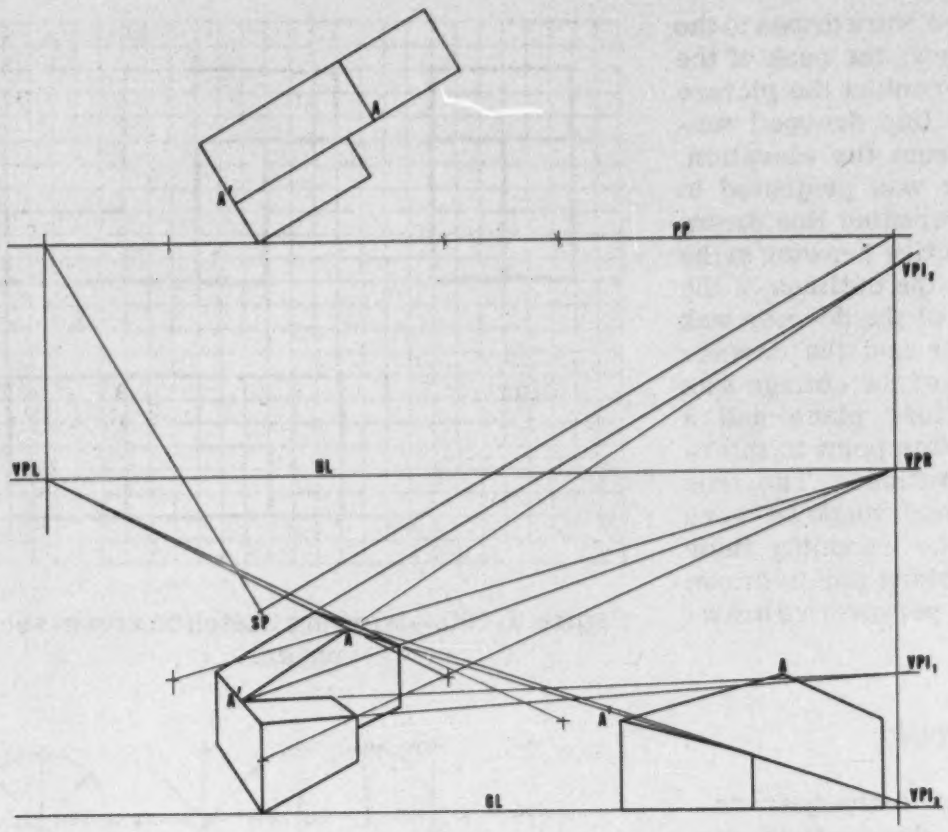

Figure 4-158.—Finding the vanishing point of inclined lines.

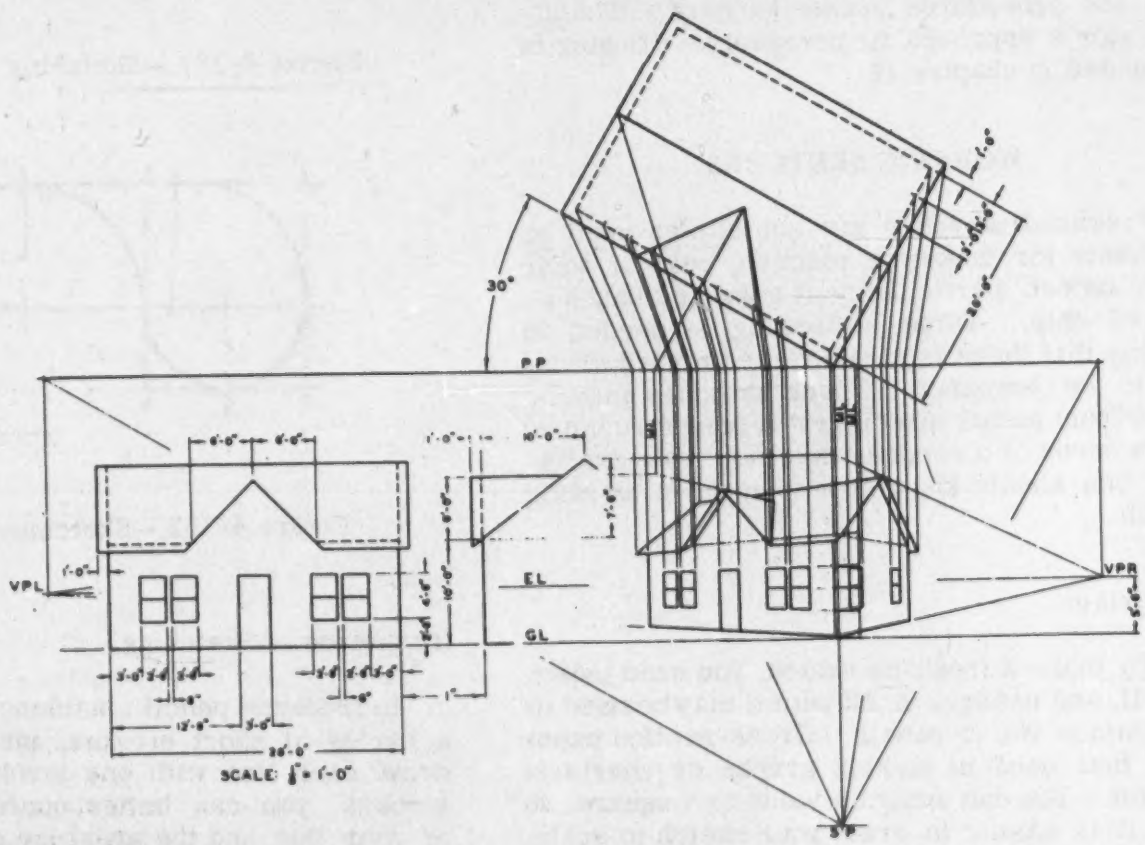

Figure 4-159.—Measuring lines in two-point perspective drawings.

Next the plan and elevation were drawn to the same scale. In the plan view, the peak of the roof was moved forward to contact the picture plane and then a measuring line dropped vertically from this point. From the elevation, the true height of the peak was projected to this measuring line and a receding line drawn from this point in the perspective drawing to the right vanishing point. Then the outlines of the roof were drawn. The peak of the dormer was located in the same manner and the dormer drawn. Next the right edge of the cottage was moved forward to the picture plane and a measuring line drawn from this point to intersect the line from the elevation. The true heights of the wall, door, and windows were marked on this line, and the receding lines from these marks to the vanishing points drawn to locate these features in the perspective drawing.

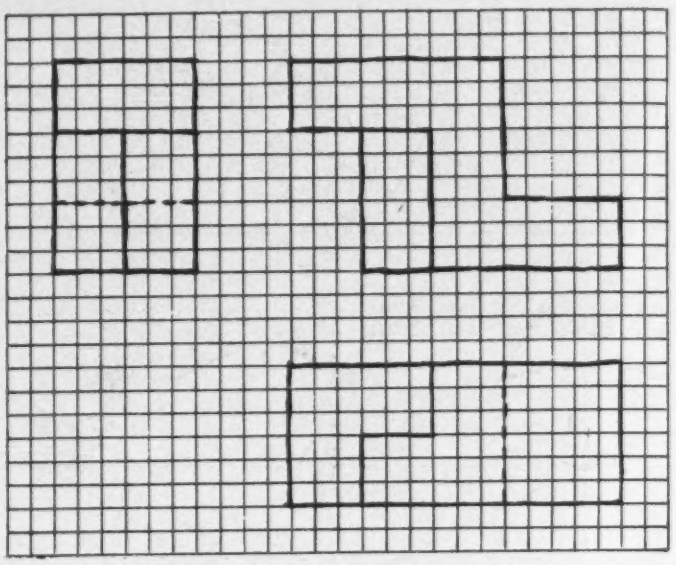

Figure 4-160.—Working sketch on cross-section paper.

PERSPECTIVE IN ILLUSTRATING

The perspective projection techniques described in this chapter are those which are generally used by the architectural draftsman. The illustrator customarily takes some liberties with the procedures presented here. The illustrator's approach to perspective drawing is presented in chapter 14.

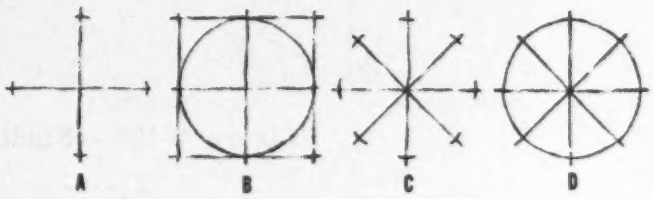

Figure 4-161.—Sketching circles.

WORKING SKETCHES

Freehand sketches are sometimes used as the basis for making a machine part or some other object, particularly at advanced bases or aboard ship. Often a drawing is needed so quickly that there is no time for a finished drawing to be prepared. These sketches may be made from actual machinery or from structures at the scene of a construction job. As a draftsman you should know how to make a working sketch.

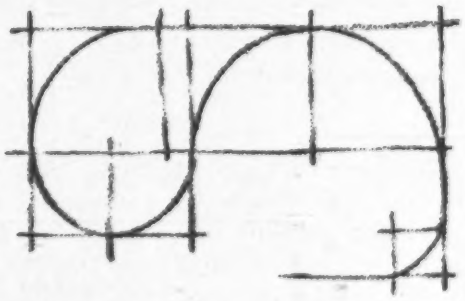

Figure 4-162.—Sketching curves.

Materials

To make a freehand sketch, you need paper, pencil, and eraser. A 2H pencil may be used or a common No. 2 pencil. Cross-section paper like that used in making graphs or charts is helpful. You can assign a value to a square, so that it is easier to draw your sketch to scale. (See fig. 4-160.)

Technique of Sketching

In freehand pencil sketching, draw lines with a series of short strokes, instead of trying to draw each line with one stroke. Using short strokes, you can better control the direction of your line and the pressure of your pencil on the paper.

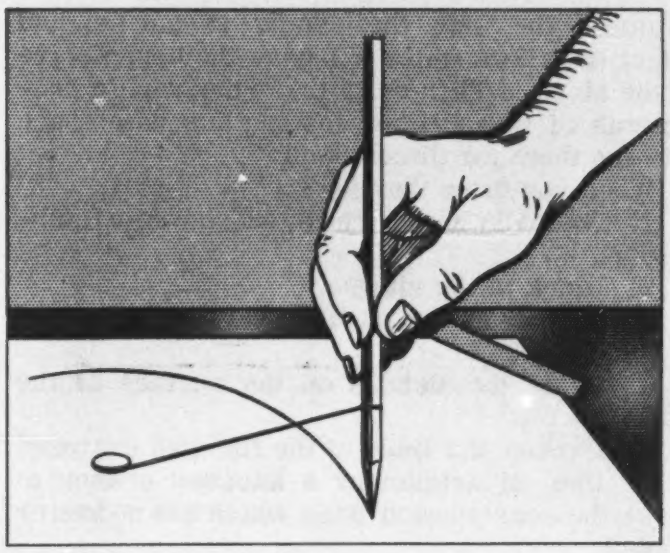

Figure 4-163.—Using a pencil and string as a substitute for a compass.

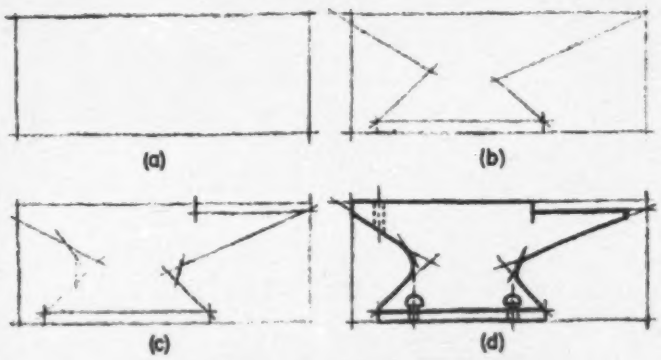

Figure 4-164.—The use of construction lines in sketching an object.

In sketching lines, swing your hand in the direction your line should go and back again a couple of times before you touch your pencil to the paper. In this way, you get the feel of the line. In sketching long lines, place a dot where you want the line to begin and one where you want it to end. Then use these dots to guide your eye and your hand as you draw the line.

Keep your freehand sketch neat. To do this, sketch your lines lightly first. Lines which are not essential to the drawing can be sketched so lightly that it is not necessary to erase them. Essential lines can be darkened by running the pencil over them with more pressure after they have been drawn lightly first.

Perfectly round circles are one of the most difficult things to draw freehand. Figure 4-161 shows methods of drawing circles and curves using straight lines as construction lines. First draw two straight lines crossing each other at right angles, as in figure 4-161A. The point where they cross will serve as the center of the circle. The four lines radiating from this center will serve as the radii of the circle. You can use a piece of marked scrap paper to measure an equal distance on each radius from the center. Sketch a square, with the center of each side passing through the mark defining a radius. (See fig. 4-161B.) Now sketch in your circle, using the angles of the square as a guide for each arc.

In figures 4-161C and 4-161D, four lines, instead of two, are sketched crossing each other. The radii are measured as in constructing the other circle, but the square is not added before the circle is drawn.

Figure 4-162 shows a convenient way of sketching arcs, tangent arcs, and curves by blocking them in with straight lines.

You can make a substitute for a compass with a pencil, a piece of string, and a thumbtack. Tie one end of the string to your pencil near the tip. Measure the radius of the circle you are drawing on the string, and insert your tack at this point. Then push the tack in hard at the center of the circle. Now swing your pencil in a circle, taking care to keep it vertical to the paper. (See fig. 4-163.)

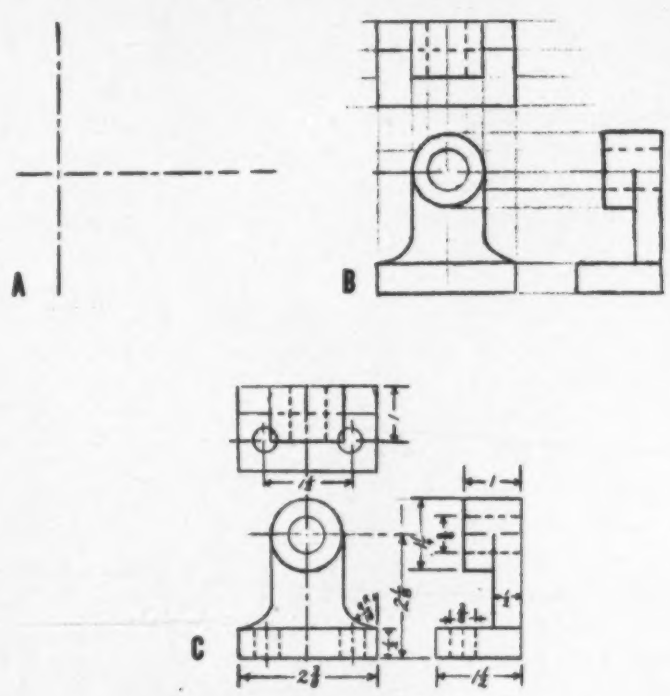

Figure 4-165.—Progress of a working sketch.

Construction Lines

When you are drawing a part, such as that shown in figure 4-164, don't start at one corner and draw it detail by detail and expect it to come out with the various elements in correct proportion. It is better to block in the over-all shape of the object first. (See fig. 4-164a.) Then draw light guide lines at the correct angle for the various outlines of the object. (See fig. 4-164b and c.)

Finish the sketch, by first making an outline of the object, and then drawing in the details, as shown in figure 4-164d.

Order of Working

If you are assigned to make a working sketch from a machine part or a model, first choose a clean sheet of paper, either plain or ruled. Estimate the size the sketch should be, and select the views which will give the best picture of the object. Then draw the orthographic projections of these views, leaving adequate space between them for dimensions.

When you draw the views:

1. Sketch in center lines, as shown in figure 4-165A.
2. Block in the views.
3. Sketch in the outlines, aligning them as in figure 4-165B.
4. Draw the details on the surface of the views.
5. Darken the lines of the finished drawing.
6. Use an artgum or a kneaded eraser to erase the construction lines which are no longer needed.
7. Draw all necessary extension and dimension lines.
8. Letter in the dimensions. (See fig. 4-165C.)

CHAPTER 5

DEVELOPMENT OF SURFACES

A surface has two dimensions—length and width. It is bounded by lines which are either straight or curved. The surface itself may be plane, plane-curved as the peripheral surface of a cylinder, warped as the surface of a screw thread, or double curved as the surface of a sphere. A plane surface is flat. A plane curved surface can be unrolled and laid out flat; a three-dimensional figure made up of plane surfaces can be unfolded as shown in figure 5-1. This unfolding or unrolling is called developing the surface. A warped surface or a double-curved surface cannot be developed except approximately. The term development is applied to the procedure for constructing the unfolded figure, to drawings as a whole which include the views necessary to construct the unfolded figure, and more specifically to the view which represents the unfolded figure. This latter view is also called a stretchout.

In figure 5-2, a number of three-dimensional figures are illustrated. Try to form a mental picture of what would happen if the surfaces of these figures were unfolded or unrolled and laid out in a flat plane. The polyhedrons, of course, would be merely a system of connected squares, triangles, or other polygons. A cylinder with parallel ends would unroll into a parallelogram. A cone would unroll into a section of a circle. However, warped surfaces could not be made to lie flat, and double-curved surfaces present a similar problem.

USES OF DEVELOPMENTS

In the Navy, developments are used for many types of sheetmetal work, such as ducts for heating, ventilating, and air conditioning systems. Also for flashing, valleys, gutters, and downspouts for buildings. Developments are used for the fabrication of parts for boats, ships, and airplanes, and structural features involving the use of sheetmetal or metal plates. Even though the metal sheets used for some of this work are thicker and heavier than the material usually used in a sheetmetal shop, the same principles are applied in constructing the developments.

In the usual sheetmetal fabrication shop, the required shapes may be formed by rolling, folding, and crimping. However, warped and double-curved surfaces can be produced in sheetmetal only through the application of pressure in such a way as to cause a flow of metal sufficient for the shape to be retained after the pressure is released. For example, automobile fenders and body sections are made in this way. Concentric articles, like metal bowls, can be spun from flat sheetmetal on a lathe. Pressure is applied with tools made for the purpose while the metal is spinning.

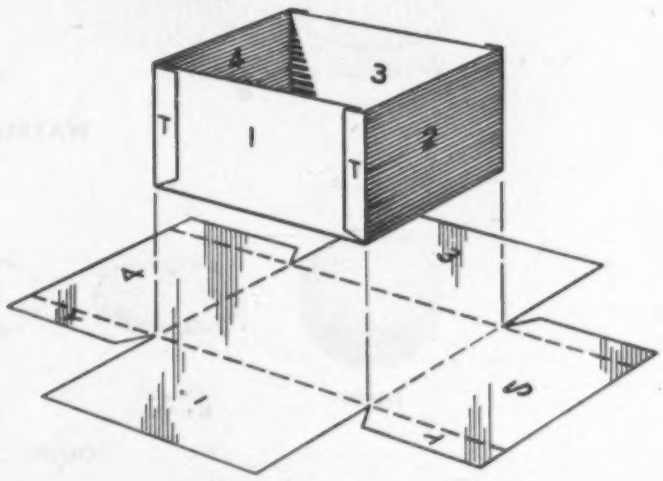

Figure 5-1.—A rectangular pan.

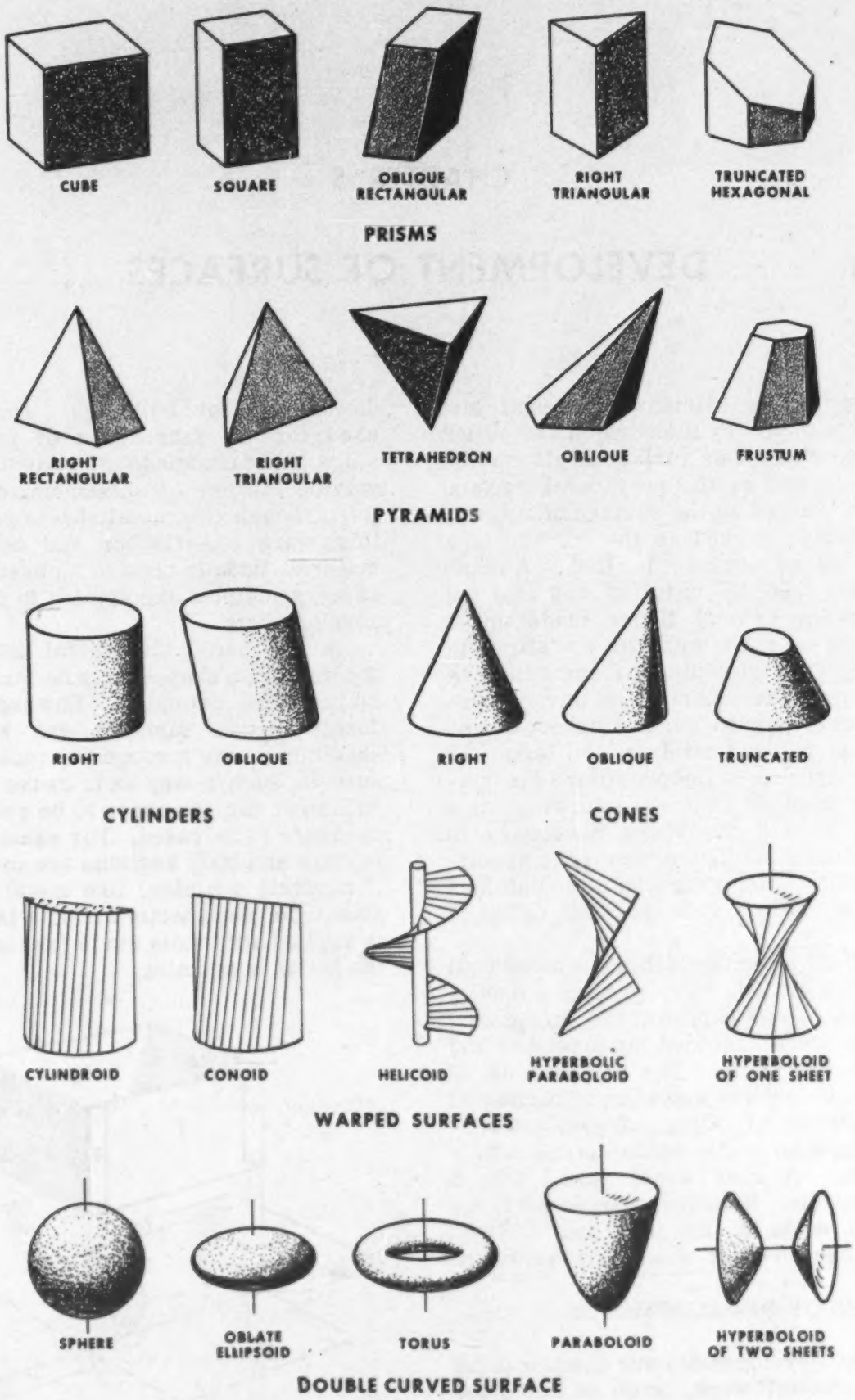

Figure 5-2.—Three-dimensional shapes.

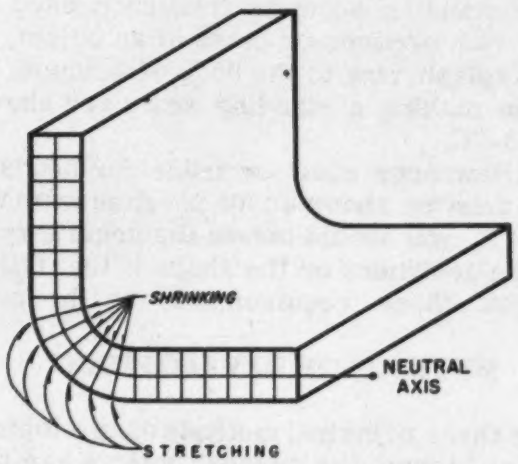

Figure 5-3.—What happens at a bend.

A development may be drawn directly on the metal or a paper pattern may be made. For repeated usage, a template may be made from the drawing. To withstand the wear and tear of shop use, templates are usually made of sheet steel.

BENDS AND SEAMS

The developments worked out in this chapter do not include allowances for bends or seams, because these vary according to the material used and its thickness. Considerable knowledge of shop work is necessary in order to allow for bends and to choose the best type of seam for any particular piece and in order to cut the development out of the metal without errors and waste. Note that most of the developments in this chapter provide for the seam to fall on the shortest side when there is a choice. When a number of pieces of similar shape are to be cut from one sheet of metal, the seam may be alternated from side to side in order for the pieces to fit together without much waste metal between them.

Bend allowance is the amount of material consumed in making the bend. The bend allowance is affected by the shrinking and stretching of the metal at the bend. This varies with the differend bend radii, the thickness of the metal used, the type of metal, and its temper. Metallurgists have developed methods for determining the bend allowance and have found, by actual bending, the effect of the factors just mentioned. When metal is bent, the outside of the bend is stretched or lengthened, while the material on the inside is forced to shrink or shorten as shown in figure 5-3. When the sheet is being bent, the metal along a line through the middle of the thickness of the sheet is a neutral zone, where neither shrinking or stretching occurs, but retains the same length. It is along this neutral axis that bend allowance is computed.

Illustrated in figure 5-4 are some of the more common joints, seams, finished edges, and connectors used in sheetmetal work.

The place where two sheets of metal are joined together is called a seam. The three most common types of seams used in sheetmetal work are the lap, grooved, and the standing seam.

The lap seam is the least difficult to fabricate. In making this seam, the pieces of stock are merely lapped one over the other as shown in figure 5-5A, and secured either by riveting, soldering, spot welding, or by all three methods, depending on the nature of the job.

A grooved seam is used in the construction of cylindrical objects, such as funnels, pipe section, containers, and so on. The steps in forming a grooved seam are shown in figure 5-5B.

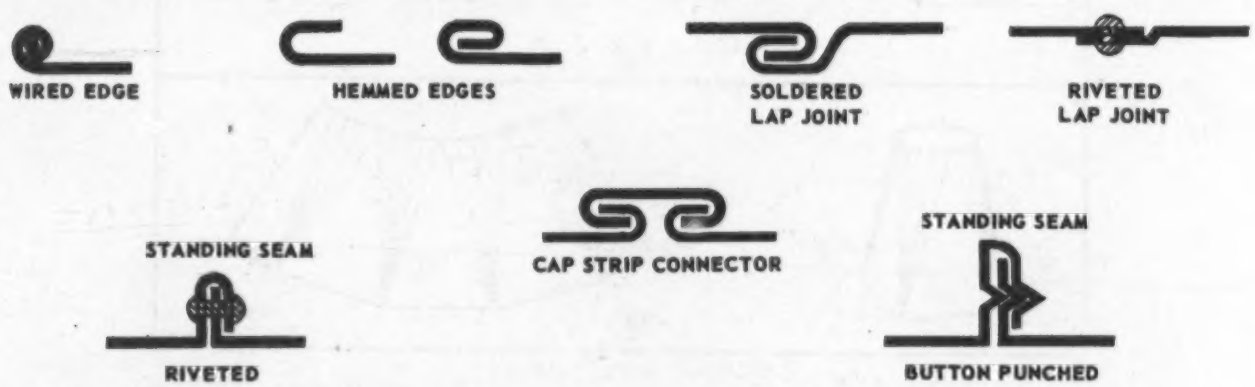

Figure 5-4.—Some common sheetmetal joints, seams, finished edges, and connectors.

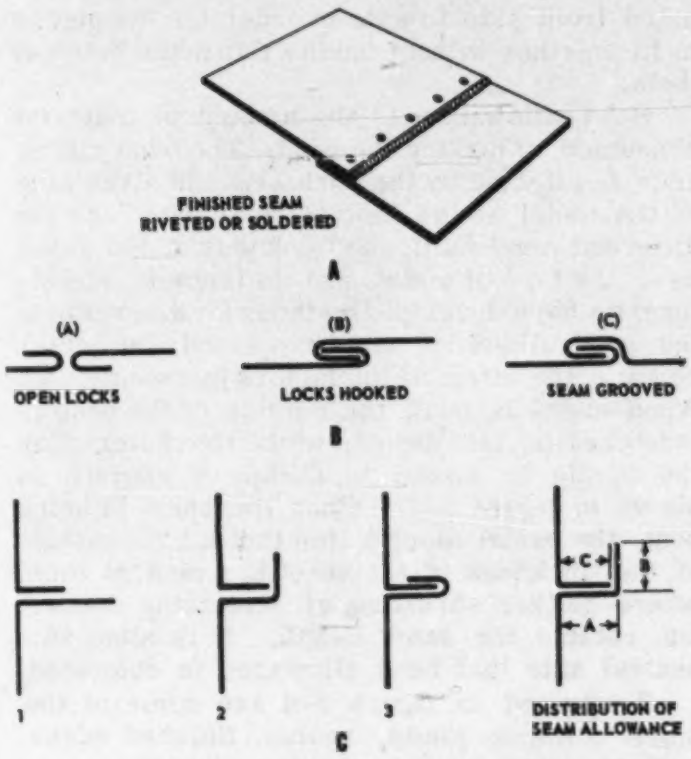

Figure 5-5.—Lap, groove, and standing seams.

The standing seam is frequently used when joining two sections or parts of an object, such as the splash ring to the body of a funnel. The steps in making a standing seam are shown in figure 5-5C.

If allowances must be made for bends, and seams must be shown on the developments which you draw, you should obtain the necessary data from the designers or the shops if they failed to give you these requirements at the outset.

METHODS OF DEVELOPMENT

The three principal methods of developing the surface of three-dimensional objects are called parallel development, radial development, and triangulation. Parallel development is used for surfaces such as those of prisms or cylinders. (See fig. 5-6A.) Radial development is used for surfaces such as those of cones and pyramids, which may be said to be generated by a line of which one end remains fixed while the other end rotates about it. (See fig. 5-6B.) Triangulation is used for surfaces which do not lend themselves to either of the other two methods and to approximate the development of warped surfaces. (See fig. 5-6C.)

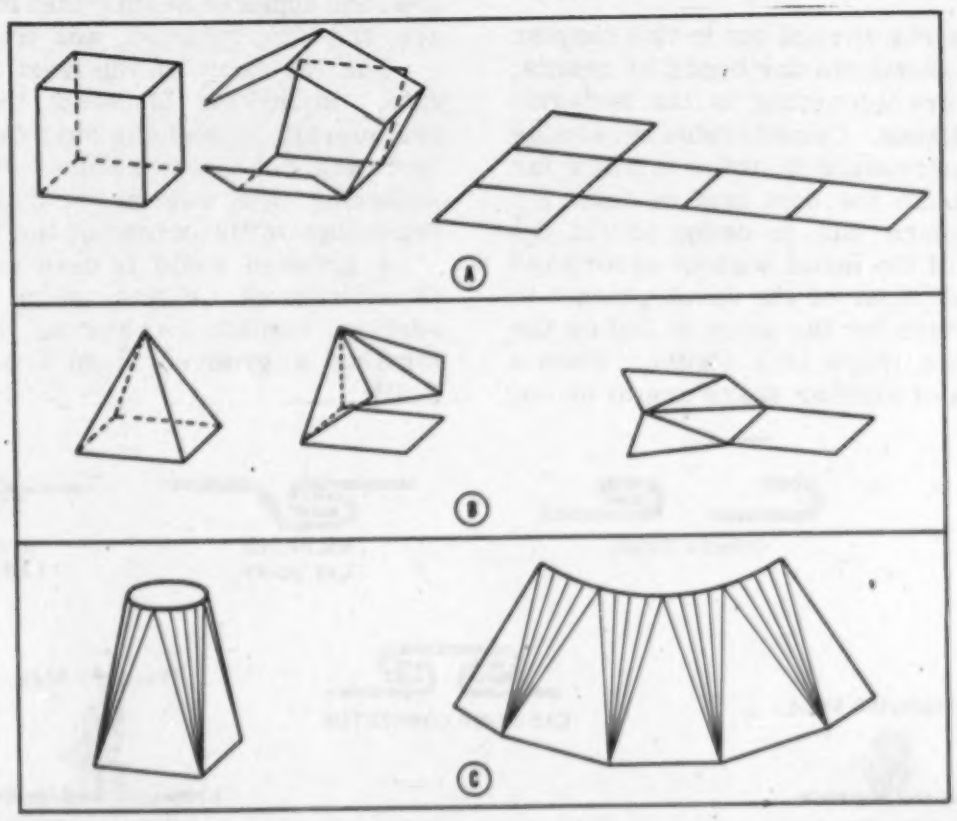

Figure 5-6.—A. Parallel development. B. Radial development. C. Development by triangulation.

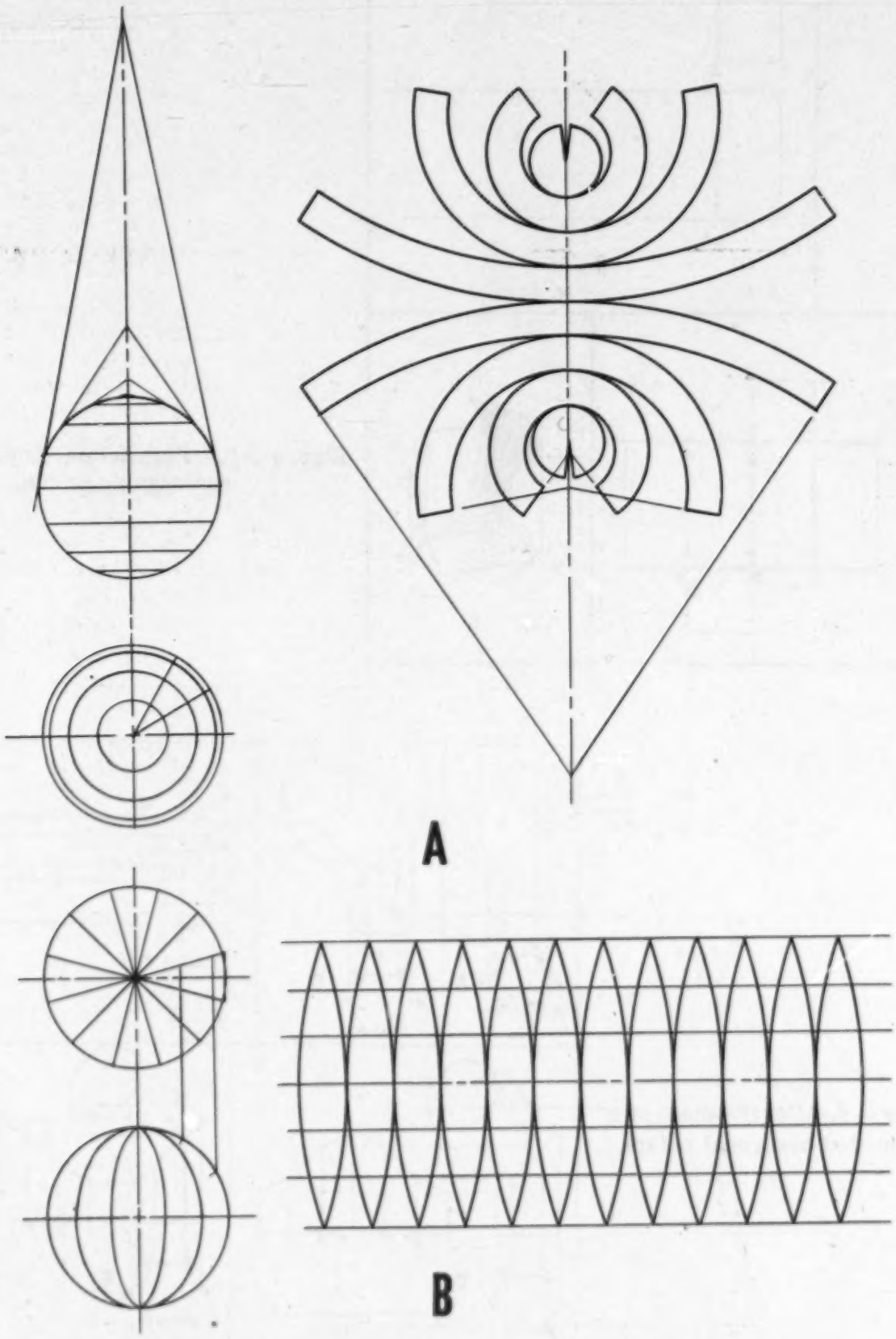

Figure 5-7.–Development of double-curved surfaces.

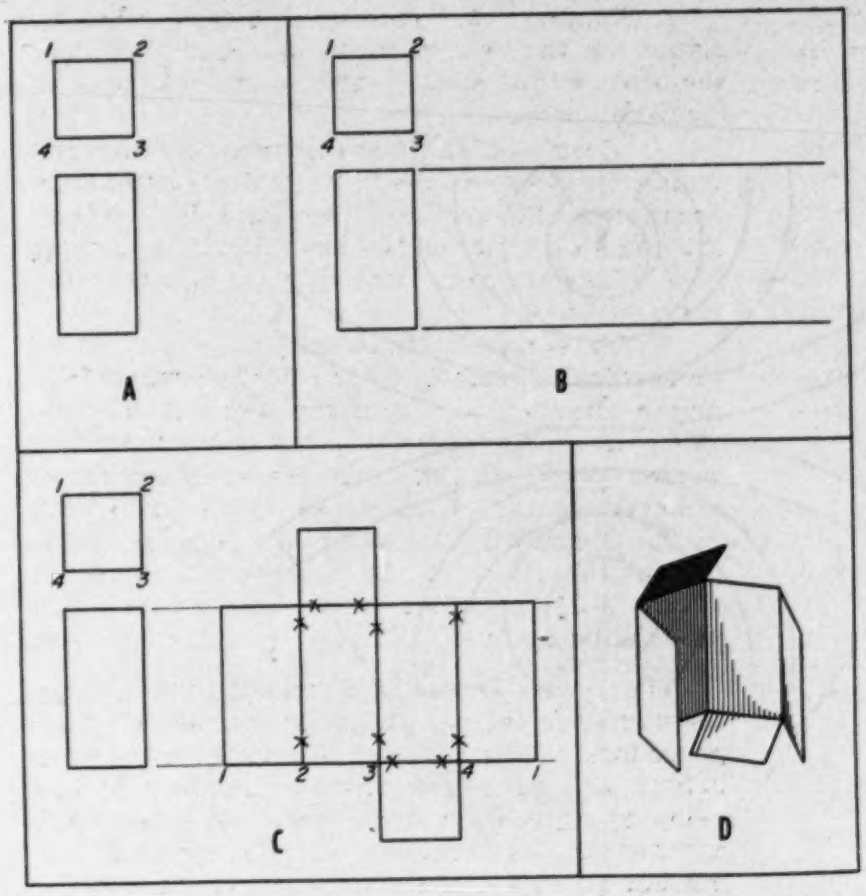

Figure 5-8.—Parallel development of a rectangular prism.

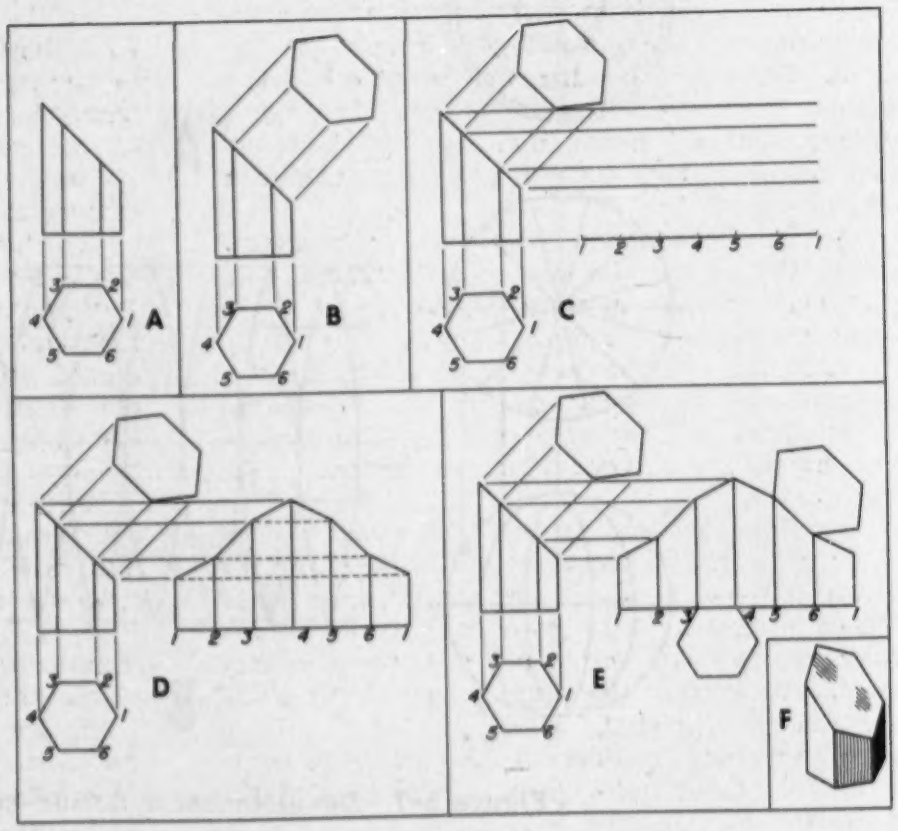

Figure 5-9.—Development of a truncated hexagonal prism.

power conversion, since it is able to link the two forms of energy. Reacting initially to the input or static conditions, it takes energy from the input and transports it to another part of the device. Here the energy can be drawn upon to create an output or to amplify microwave signals.

Two elements which require further explanation have been introduced: the path of the electron from its source to its final destination, and the "other part of the device" where the energy of the electron is finally utilized. Each will be considered in turn; then the combining of the two elements to form a working microwave tube will be discussed.

The Electron Path

The path of the electron can best be understood by considering the forces acting upon it. Refer to figure 12-18 (A). The source of all electrons is the cathode. Properly designed and located, the cathode supplies a unidirectional stream of electrons. Immediately after the electrons are emitted, the combined action of magnetic and specially shaped electric fields forms them into a beam.

After the beam is formed, all of the component electrons travel at approximately the same velocity. The negatively charged electrons are injected into an electric field which is perpendicular to their forward motion. (This field arises from voltages applied between opposed elements, the anode and the sole, and in the absence of other forces a given electron would soon be "collected" by the positive element, the anode.)

However, a second force acting upon the electron arises from its forward motion through a magnetic field oriented crosswise to both the electron path and the previously described electric field; hence, the term "crossed field" tube. By the conventional rule for this situation, the resultant force on the electrons is opposite to the force of the electric field.

Appropriate adjustment of the fields results in a controlled beam path which is circular and terminates at an element called a collector.

To summarize, the electron beam is formed at the electron gun (cathode), follows a circular path between the anode and the sole, and terminates at the collector.

When the forces acting on the beam are expressed in standard electrical terms and equated for the controlled beam condition, the electrical force equals the magnetic force. Therefore, electron or beam velocity is equal to the ratio of electric field strength (E) to magnetic field strength (B). For the practical situation, B is constant and is supplied by a permanent magnet integral with the tube. Thus, beam velocity is directly related to E, the field strength between sole and anode. In more practical terms, E is given by the potential difference between the anode and the sole, divided by the distance between them (which is fixed). Therefore, beam velocity is linearly controlled by variation of either the anode voltage or the sole voltage.

The Delay Line (Anode)

The next step in understanding the basic principles of the crossed field device is to consider the part of the device where the electron beam develops microwave energy.

The sole serves as little more than one of the electrodes for the static electric field, as discussed in the previous section. The anode, however, is a much more complex component than has been suggested. The anode in many crossed field tubes is of such a form that it is called an INTERDIGITAL DELAY LINE.

The interdigital delay line is best described as a normal waveguide transmission medium in which opposing walls have been extended towards one another in alternately spaced fingers or digits, as shown in figure 12-19. The velocity of wave travel in the resulting interdigital structure is decreased, because of the longer path along its boundaries. In effect, such a

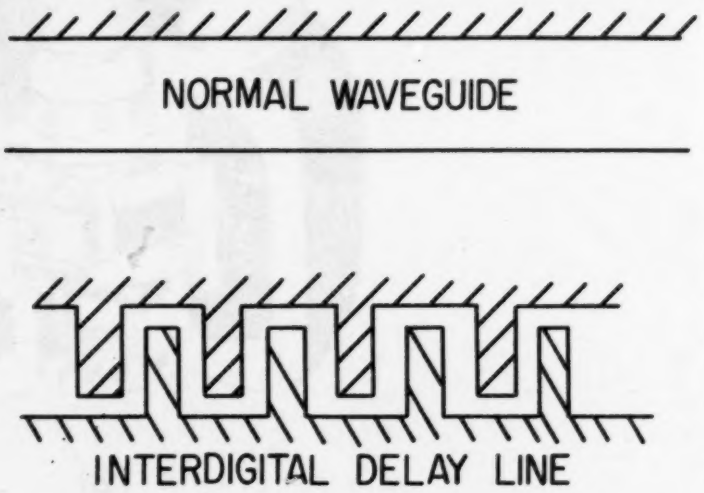

Figure 12-19. —Interdigital delay line compared with a normal waveguide.

Double-curved surfaces, such as the surface of a sphere, may be developed approximately by several methods which you will probably never have occasion to use in the Navy but which are interesting in that the identical methods are applied in various map projections. See chapter 12 of Blueprint Reading and Sketching, NavPers 10077-B for elementary information on map projections. A sphere may be cut into horizontal sections, or zones, which may be considered, and developed, as frustums of cones, as shown in figure 5-7A. A sphere may also be cut into equal meridian sections, called lunes, and these developed as if they were sections of cylinders. (See fig. 5-7B.)

PARALLEL DEVELOPMENT

The surfaces of prisms and cylinders are made up of parallel elements or of elements that can be treated as parallel elements. For example, in figure 5-8, the steps in developing a rectangular prism are illustrated.

1. In order to determine the length of all the edges of the prism, draw the front and top views in orthographic projection. (See fig. 5-8A.)
2. Draw the development to one side of the front view so that the dimensions of vertical elements on that view can be projected to the development as shown in figure 5-8B.
3. Transfer the dimensions of other elements from the top view. (See fig. 5-8C.) Notice that all bend lines are marked with crosses near their ends to distinguish them from outlines.
4. To check the drawing, measure the lines of edges which are to be joined as illustrated in the pictorial drawing in figure 5-8D. Such edges must correspond exactly.

In figure 5-9, the steps in the development of a truncated hexagonal prism are illustrated.

1. Draw a front view and a bottom view of the prism in orthographic projection. (See fig. 5-9A.)
2. Since the true shape of the slanting plane and the length of the lines of its edges are not shown in these views, draw an auxiliary view as shown in figure 5-9B. Note that it is not necessary to draw the entire prism in the auxiliary view, since only the dimensions of the plane surface are required.
3. Project the lines of the front view horizontally as the first step in constructing the development. (See fig. 5-9C.)
4. Number the points of intersection of planes on the bottom view, and mark off line segments of the same length on the base line of the development.
5. Erect vertical lines from these numbered points to intersect the lines projected from the front view of the prism. (See fig. 5-9D.) These intersections mark the corners of the prism.
6. Connect the intersection points with straight lines.
7. To complete the development of a closed three-dimensional figure, draw the bottom of the prism attached to one of the sides at the base line. Draw the slanting plane at the top of the prism, as it is shown in the auxiliary view, attached to one of the sides. (See fig. 5-9E.)
8. Check all measurements of edges to be joined as shown in the pictorial drawing in figure 5-9F, in order to be sure that they will coincide exactly.

The development of a truncated cylinder, illustrated in figure 5-10, follows a very similar procedure. The cylinder is considered to be a prism with an infinite number of sides. In developing a cylinder, the number of sides must necessarily be limited, but the greater the number of sides, the more accurate the development will be.

1. To develop one-half of a two-piece elbow, first draw a front and bottom view of that piece in orthographic projection. (See fig. 5-10A.) Since the elbow does not require an end piece, it is not necessary to draw an auxiliary view showing the true shape of the ellipse formed by cutting plane at the top of the cylinder.
2. Divide half of the circumference of the circle into a number of equal parts (fig. 5-10A.) The parts should be small enough so that, when a straight line is drawn between division points, it will approximate the length of the arc. Project lines from these points to the front view, as shown in figure 5-10B. The resulting parallel lines on the front view are called elements.
3. Lay off the base line, called the stretchout line, of the development. The length of this line may be calculated as π times the diameter of the cylinder (3.1416 x D).
4. Divide the stretchout line into twice the number of equal parts as the number on the half circle of the orthographic view. (See fig. 5-10C)
5. Erect perpendiculars at each point, as shown in figure 5-10C.
6. As shown in figure 5-10D, project lines horizontally onto the stretchout from the points

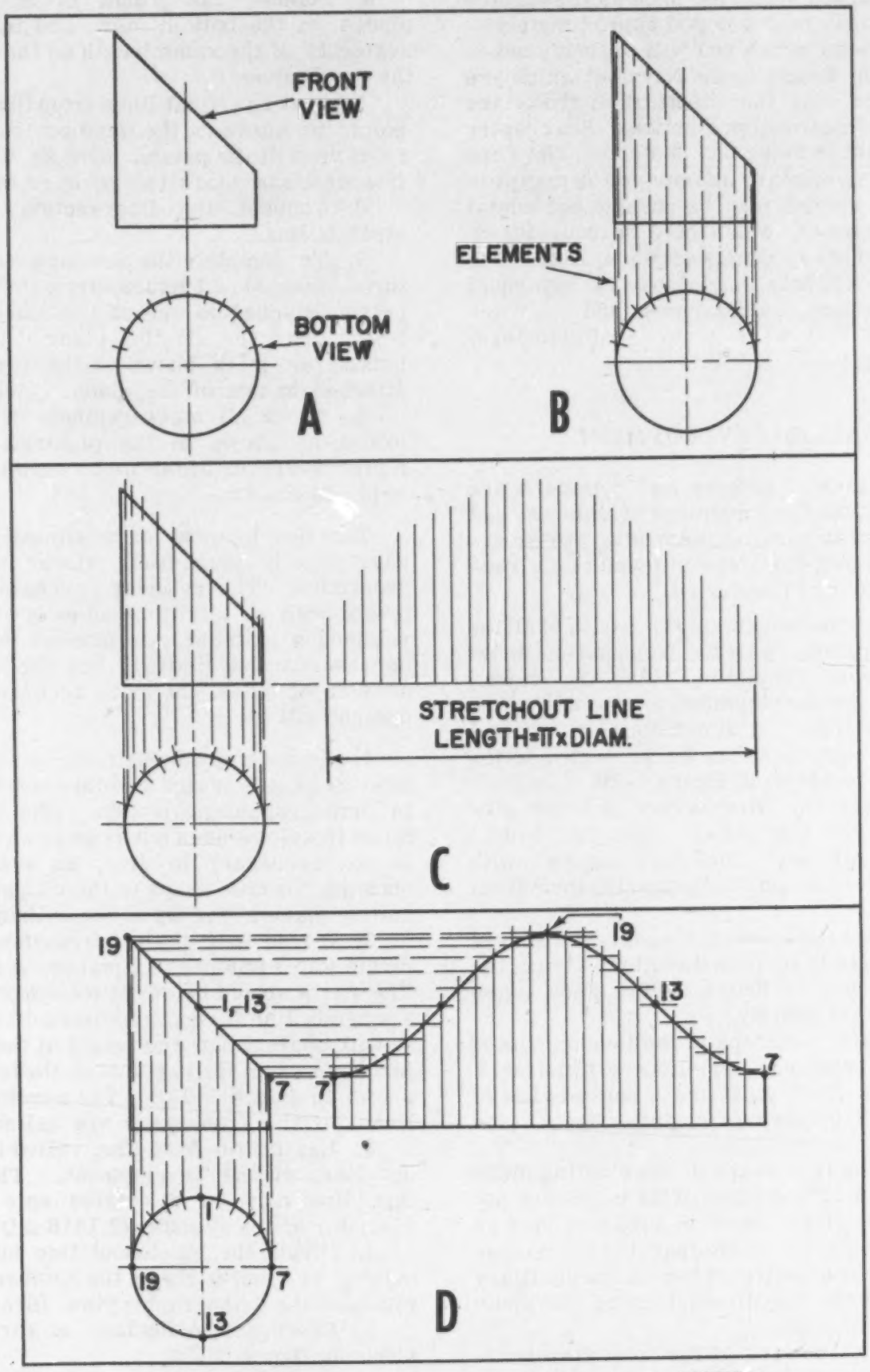

Figure 5-10.–Development of a truncated cyclinder.

of intersection of the elements with the top of the cylinder.

7. Using a curve, join the resulting points of intersection in a smooth curve. With points numbered around the bottom view as shown in figure 5-10D, corresponding points are located on the top of the cylinder as shown in the front view—point 13 is behind point 1. With the stretchout to be rolled up toward the viewer, the corresponding points are located as shown in the developed view.

When the two pieces of the elbow are identical, it is only necessary to make one pattern.

When a four-piece elbow is to be drawn, the same steps are followed to produce as many developments as may be required. The orthographic view may be drawn of the whole elbow and the developments drawn beside each separate piece, as illustrated in figure 5-11. Here only one end and one middle development are drawn, since the other two pieces are identical with these.

INTERSECTIONS

When two pieces, such as two cylinders or a cylinder and a prism, intersect, it is necessary to determine the exact points of intersection in order to make developments for the pieces that will fit together without gaps or unnecessary overlaps. These intersections are determined by carefully drawing the elements intersecting on orthographic views and then projecting or transferring these intersection points to the developments. In figure 5-12, for example, the steps in making developments for a T-joint are illustrated. The T-joint consists of two cylinders with equal diameters which intersect at right angles.

1. As shown in figure 5-12A, draw a front view and a side view of the T-joint. A bottom view representing the open end of the other cylinder might also be drawn. However, since this cylinder is circular and therefore symmetrical, a semicircle may be drawn attached

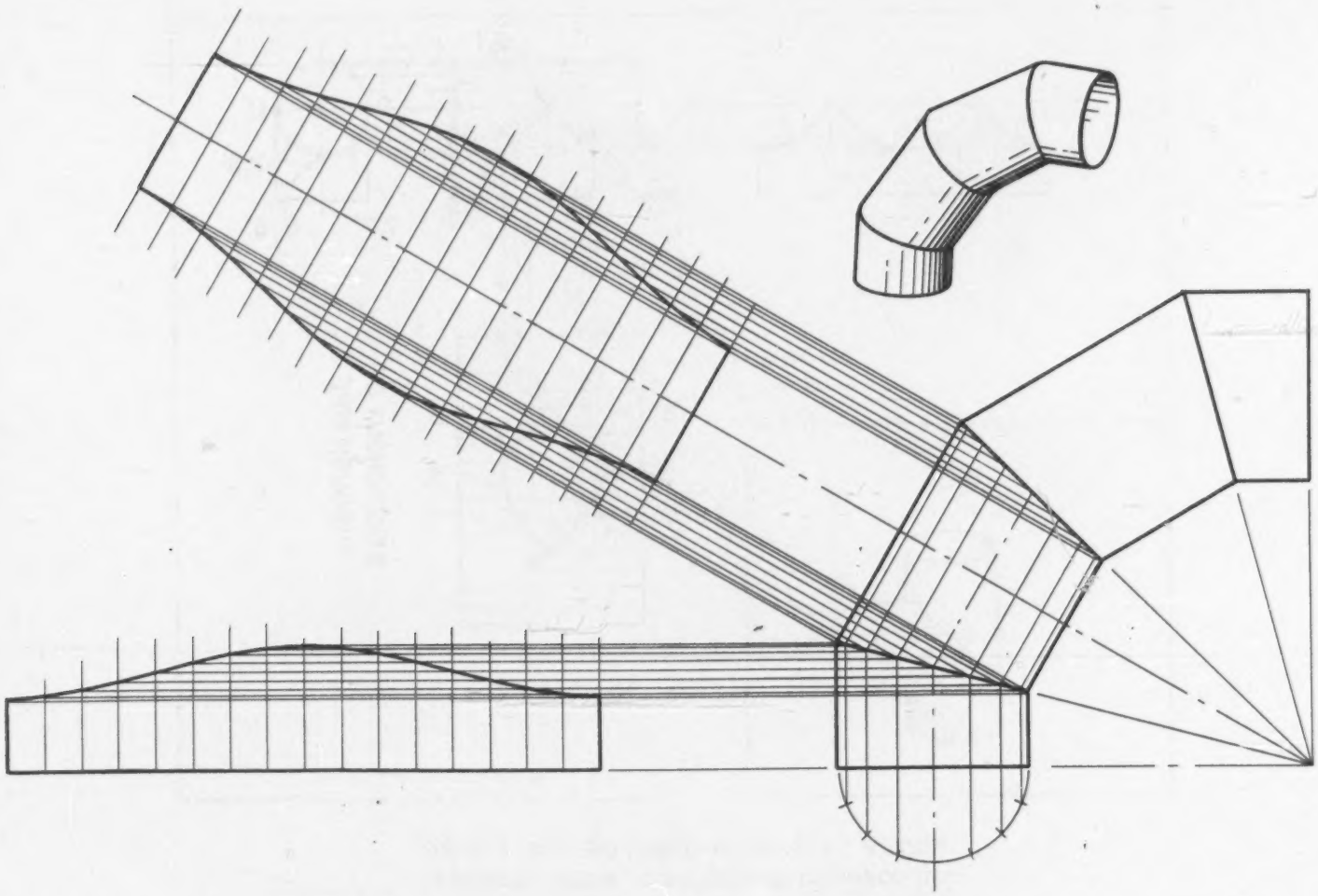

Figure. 5-11.—Developments for a four-piece elbow.

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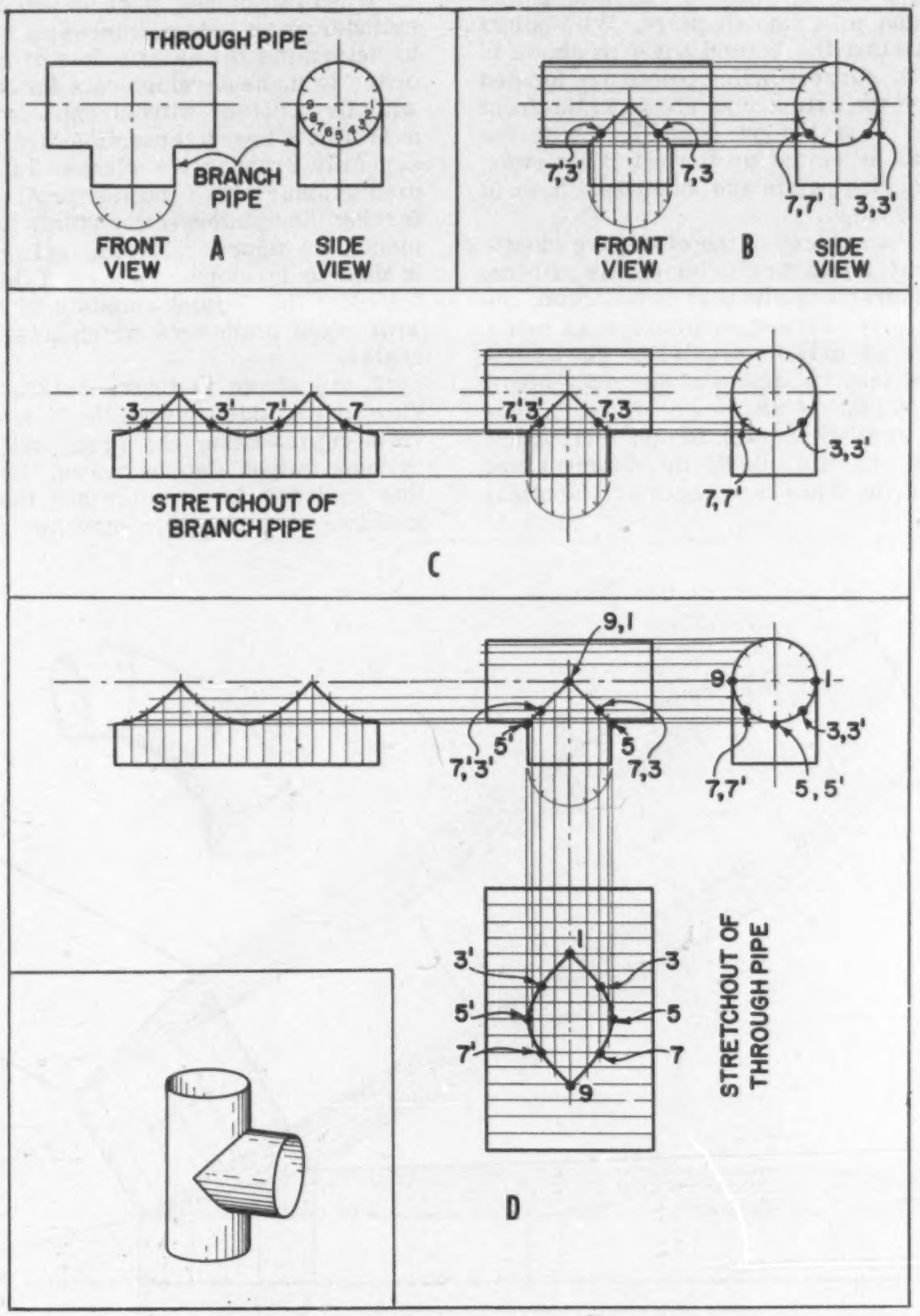

Figure 5-12.—Development of a T-joint composed of cylinders of equal diameter.

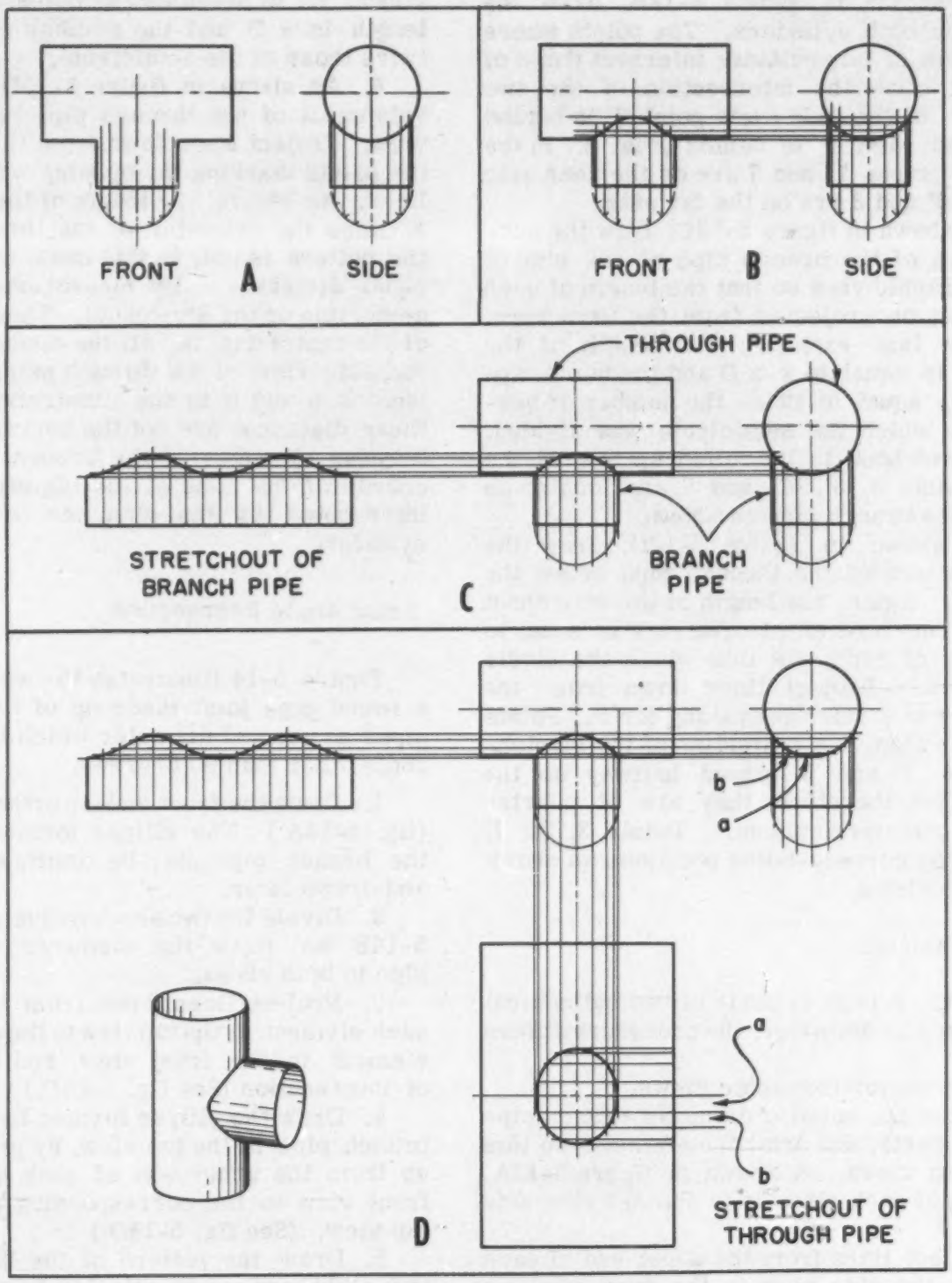

Figure 5-13.—Development of a T-joint with two cylindrical pipes of unequal diameter.

to the front view and the division points for the elements located on it. Also divide the through pipe in the side view into equal segments. The points are numbered (fig. 5-12A) for purposes of explanation in the following paragraphs.

2. As shown in figure 5-12B, draw the elements on both cylinders. The points where the elements of one cylinder intersect those of the other define the intersection of the two cylinders. In the side view point 7' is behind point 7' and point 3' is behind point 3. In the front view points 7' and 7 are on the near side and points 3' and 3 are on the far side.

3. As shown in figure 5-12C, draw the surface pattern of the branch pipe at one side of the orthographic view so that the length of each element can be projected from the front view. As in the last example, the length of the stretchout is equal to $\pi \times D$ and the number of divisions is equal to twice the number of segments into which the semicircle was divided. With a stretchout to be rolled up toward the viewer, points 3, 3', 7', and 7 are located on the top of the branch pipe as shown.

4. As shown in figure 5-12D, draw the surface pattern of the through pipe below the front view. Again, the length of the stretchout is π D. The number of divisions is equal to the number of segments into which the circle was divided. Project lines down from the branch pipe to locate the opening for it. Points 5 and 5' are along the centerline of the stretchout; points 1 and 9 extend halfway up the through pipe—therefore they are at quarter points on the development. Points 3, 3', 7, and 7' occupy corresponding positions as shown in the three views.

Unequal Diameters

When the T-joint is made of two cylindrical pipes of unequal diameter, the procedure differs slightly.

1. Draw the orthographic views.

2. Divide the smaller diameter branch pipe into equal parts, and draw the elements on this pipe in both views, as shown in figure 5-13A. The length of each element is shown in the side view.

3. Project lines from the upper end of each element in the side view to the front view, as shown in figure 5-13B. The intersections of these lines with the vertical lines drawn on the branch pipe define the intersection of the two pipes.

4. Draw the line of intersection on the front view

5. As shown in figure 5-13C, draw the surface pattern of the branch pipe to the left, continuing the projection lines from the other views. As in previous examples, the stretchout length is π D and the number of divisions is twice those of the semicircle.

6. As shown in figure 5-13D, draw the development of the through pipe below the front view. Project lines down from the branch pipe; the points marking the opening will fall on these lines. As before, the length of the stretchout is π times the diameter of the through pipe; but the pattern is not, in this case, marked off into equal divisions. By measurement locate the centerline of the stretchout. Then, on both sides of the centerline, lay off the distances picked off the side view of the through pipe; for example, lengths a and b in the illustration. Note that these distances are not the horizontal intervals between elements of the branch pipe; they are chords of the arcs of the big circle which are intercepted by the elements of the smaller cylinder.

Acute Angle Intersection

Figure 5-14 illustrates the steps in drawing a round pipe joint made up of two cylindrical pipes of unequal diameter which intersect at an angle other than 90 degrees.

1. Draw the front and top orthographic views (fig. 5-14A.) The ellipse formed by the top of the branch pipe may be omitted at this point and drawn later.

2. Divide the two semicircles shown in figure 5-14B and draw the elements on the branch pipe in both views.

3. Project lines down from the left end of each element in the top view to the corresponding element in the front view, and draw the line of intersection (See fig. 5-14C.)

4. Draw the ellipse formed by the end of the branch pipe in the top view, by projecting lines up from the upper end of each element in the front view to the corresponding element in the top view. (See fig. 5-14D.)

5. Draw the pattern of the branch pipe to the right and perpendicular to the pipe as it appears in the front view, as shown in figure 5-14E. The length of the stretchout is π D; it is divided into 16 equal parts because the semicircle was divided into eight parts.

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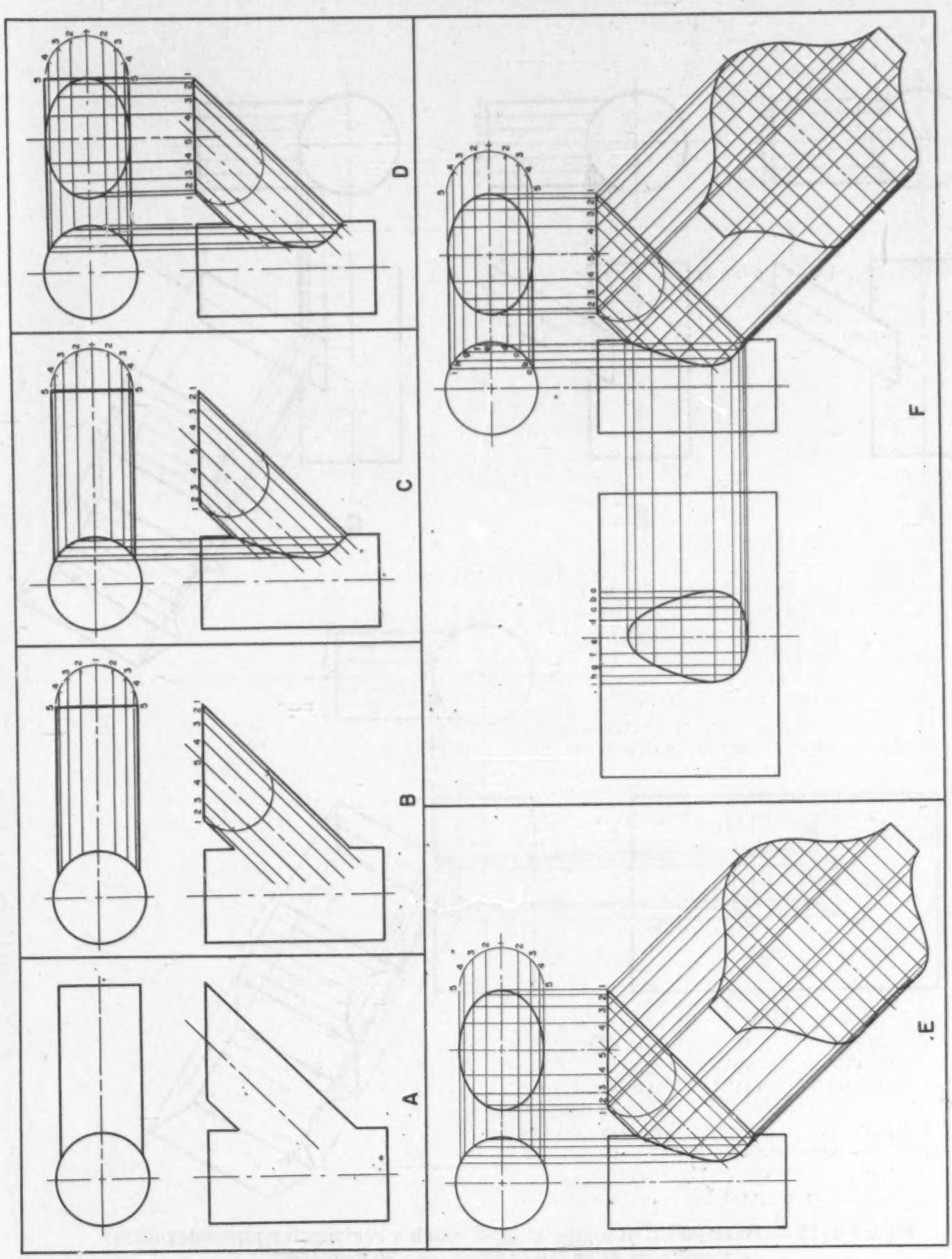

Figure 5-14.—Development of a round pipe joint made of two cylindrical pipes of unequal diameter intersecting at an angle other than 90 degrees.

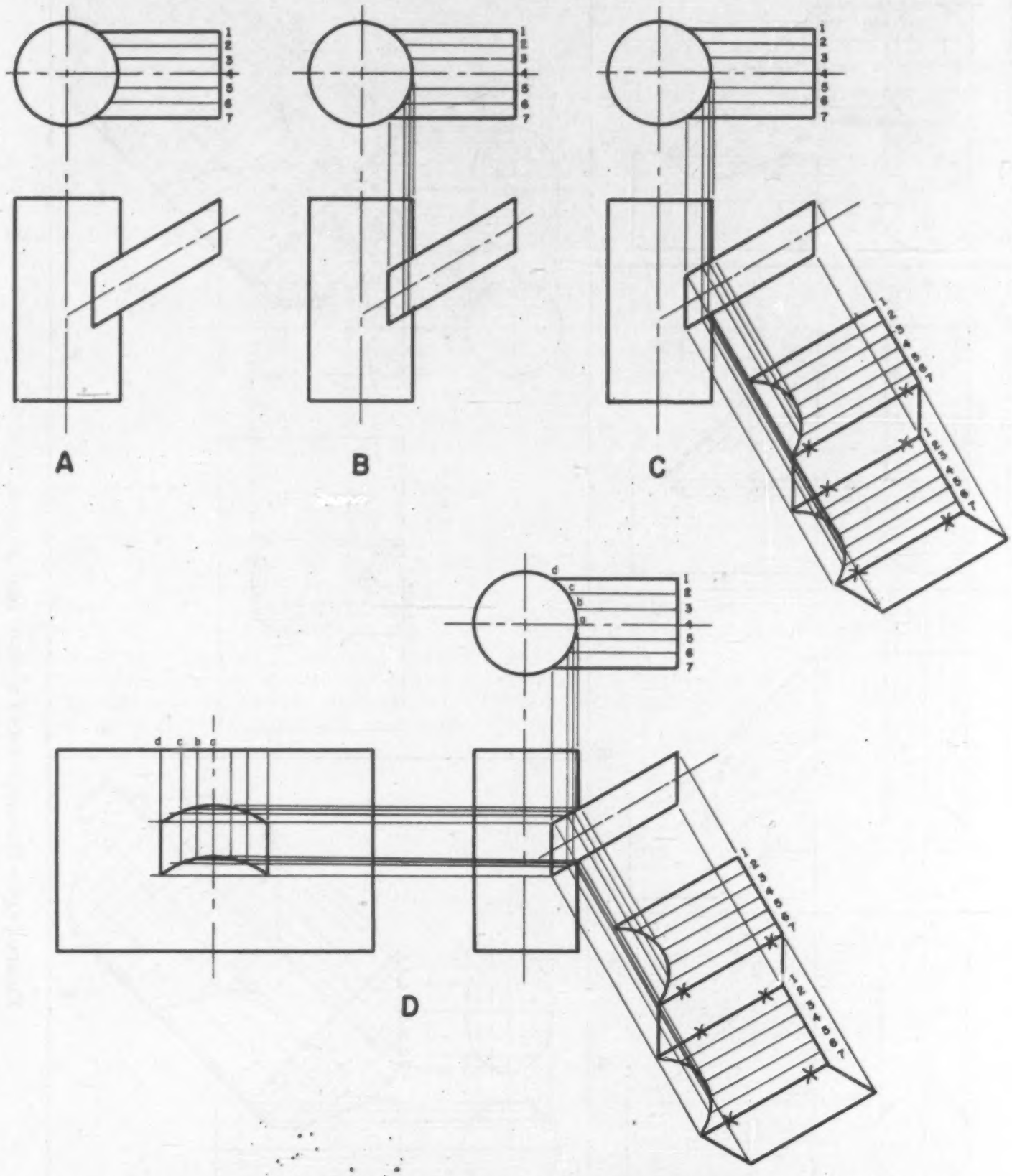

Figure 5-15.—Development of a pipe joint in which a rectangular pipe intersects a round pipe at an angle other than 90 degrees.

6. Draw the pattern for the main pipe to the left, with lines projecting from the intersection of the two pipes on the orthographic view to locate the opening for the branch pipe. (See fig. 5-14F.) The length of the stretchout is π times the diameter of the larger, vertical, pipe. The divisions laid off on either side of the centerline (e to d, d to c, etc.) are the distances along the arc of the larger circle which are created by the intersection of the elements of the smaller circle.

Rectangular and Round Pipes

When a pipe joint consists of a rectangular pipe intersecting a round pipe at an angle other than 90 degrees, the procedure is similar.

1. Draw the orthographic views, as shown in figure 5-15A, dividing the upper surface of the rectangular pipe in the top view by equally spaced elements.
2. The points of intersection of these lines with the circle are then projected down to the upper and lower surfaces of the branch pipe in the front view. (See fig. 5-15B)
3. Develop the surface pattern of the rectangular pipe perpendicular to it in the front view, as shown in figure 5-15C
4. Draw the surface pattern of the round pipe, with the opening for the rectangular pipe, to the side of the front view, as shown in figure 5-15D. The distances a to b to c to d are the lengths of arc intercepted by the elements of the rectangular pipe.

RADIAL DEVELOPMENT

The sides of a pyramid and the elements of a cone meet at a point called the vertex or apex. These same lines meet at a point in the development of a pyramid or cone and are said to radiate from this point. Consequently, the method of developing pyramids or cones is called radial development.

In radial development, the same general procedures are followed as those used in parallel development, except that since the slanting lines of pyramids and cones do not always appear in their true lengths on the orthographic views, certain other procedures must be followed in order to determine these true lengths. To find the true lengths of these edges, the pyramid may be rotated so that some of the edges appear in their true lengths in the views, as shown in figure 5-16B. In this case, the lines which appear as horizontal lines in the top view are shown in outline and in their true-length in the front view. In other words, when a line appears as horizontal or as a point in the top view, the corresponding line in the front view is its true length. Conversely, when a line appears as horizontal in the front view, the corresponding line in the top view is its true length.

Usually, instead of rotating the whole pyramid, the line of the edge itself may be simply rotated into the horizontal on a conventional orthographic view. For example, in figure 5-16C, the line of an edge from apex to base as it appears in the top view is used as the radius

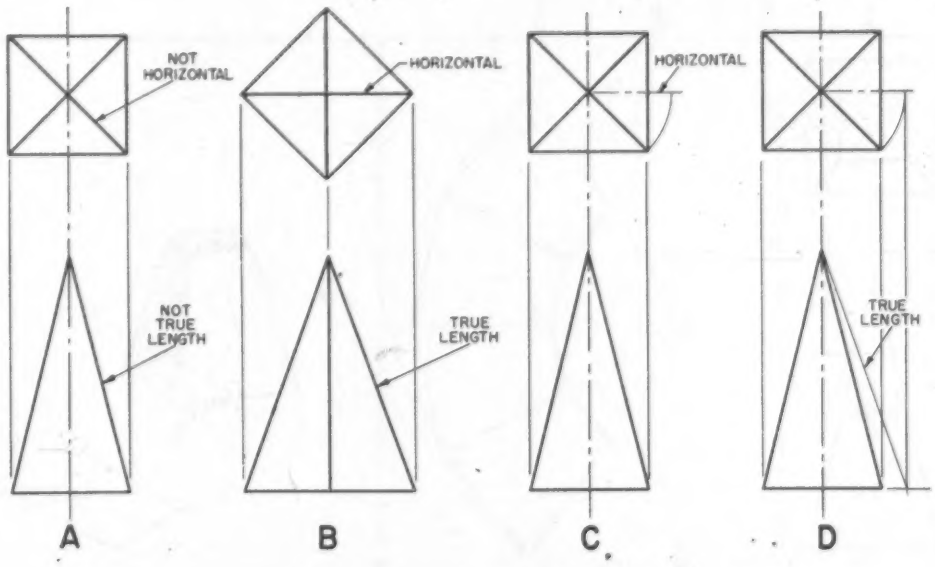

Figure 5-16.–Methods of finding the true length of a line in radial development.

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for an arc to the horizontal. The point of intersection of the arc with the horizontal is projected to the front view and a true-length line for that edge drawn, as shown in figure 5-16D.

The steps for developing a truncated pyramid are illustrated in figure 5-17. This is a trasition piece for connecting a large square pipe with a smaller one. Normally the square ends would be terminated in square collars which would also be developed.

1. Draw the orthographic views, completing the lines of the sides to the apex.

2. Rotate the line of one edge in the top view to the horizontal and project it to the front view. (see fig. 5-17B.).

3. Draw an arc with a radius equal to the length of this true-length line plus its extension to the apex of the pyramid, and a second arc defining the upper limit of the true-length line, as shown in figure 5-17C.

4. Step off lengths along these arcs equal to the sides of the pyramid. (See fig. 5-17D.)

5. Connect these points successively with each other and also connect them by light lines with the vertex, as shown in figure 5-17D. Heavy up the portions of these rays which are the sides of the pyramid and mark them as bend lines.

PENTAGONAL PYRAMID

To develop a truncated pentagonal pyramid like that shown in figure 5-18, the same general steps are followed. However, since one lateral edge appears in its true length in the front view, the limits of the other edges may be projected

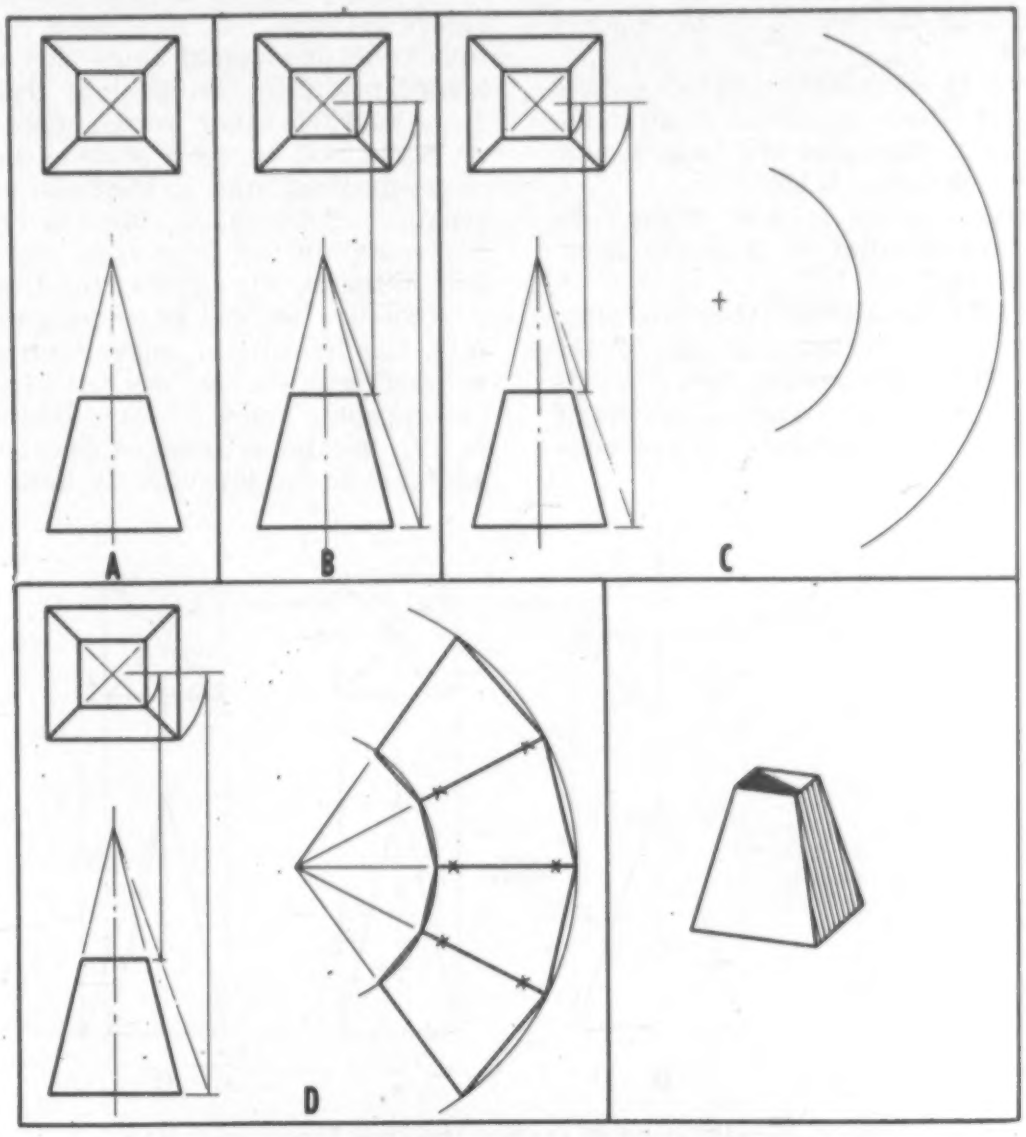

Figure 5-17.—Development of a truncated pyramid.

structure develops a series of space harmonics whose summation is seen as microwave energy propagated at the delayed or reduced rate.

(One type of magnetron, called the INTERDIGITAL MAGNETRON, uses the interdigital transmission line as the interaction space in the generation of RF power. The action of that device is more or less a combination of the conventional magnetron and the backward wave oscillator.)

A particular delay line can be designed for either forward wave or backward wave propagation. The distinction between the two arises from comparison of the direction of the dominant space harmonic with the direction of the energy which sustains it.

The amount of delay is established by adjusting various dimensions within the line. As with the more familiar waveguide, the delay line is a broadband device capable of transmission over a considerable frequency range. Its physical shape is a matter of convenience and, in this case, it is circular.

Production of the space harmonics is the same as in any oscillator, starting with noise and leading to generation of usable frequencies. These frequencies are determined by the fields of the device in a manner similar to the action of a magnetron.

In brief, the electrons serve as a link between the externally applied input energy and the microwave output energy. The electrons determine, by their velocity, the output frequency in an oscillator (and the optimum frequency for an amplifier). At the same time, they determine by their quantity (beam current magnitude) the power output level.

In contrast with magnetrons, the use of a beam in crossed field tubes eliminates cathode back bombardment, thus increasing emission life. In comparison with linear beam devices such as a traveling wave tube, where beam velocity (and therefore tube frequency) are functions of the square root of the tuning voltage. BWO's provide a very nearly linear relationship between tuning voltage and tube frequency.

Interaction

As the electron beam travels in a circular path between the sole and the anode (delay line), electrons of the beam pass near the fringe fields of the noise generated space harmonic waves on the delay line. For electrons of a given velocity, as determined by the externally applied delay line voltage, space harmonics of synchronous phase velocity result. Whether these are forward or backward waves is determined by the design of the delay line. In either case, since phase velocity of space harmonic waves is, in general, a function of frequency, it is the velocity of the electrons that determines the operating frequency.

The total field in this case is a combination of the externally applied fields and the internally developed space harmonic field. By following the laws governing electron motion in crossed electric and magnetic fields, electrons drift in a direction perpendicular to the space harmonic fields. This drift is such that they congregate in bunches, one bunch per space harmonic wavelength.

In the bunches, electrons work their way across from the original beam position to the slow wave structure (delay line), staying locked in synchronism as they do so. Their direction of motion is such that they give up to the RF field the energy acquired from the d-c source, thus causing the space harmonic wave to grow.

PHYSICAL AND ELECTRICAL CHARACTERISTICS

The basic elements of the M-BWO together with the usual polarities of applied d-c voltages, are indicated in figure 12-20. The arrangement of the basic elements can be separated into three regions as follows:

1. The gun region, including the cathode, grid, and accelerator.
2. The interaction space, including the delay line and the sole.
3. The collector element and the sole.

In practical tubes, the collector and the delay line are integral parts of the tube body and are maintained at ground potential. An exception is that the "beam miser" (to be discussed later in this chapter) places the collector at cathode potential.

The electron gun comprises a heater, cathode, control grid, and accelerator anode. The control grid is operated at zero potential or slightly negative with respect to the cathode. The accelerator electrode is maintained at a positive potential with respect to the cathode. The sole electrode is negative with respect to the cathode, and the delay line (commonly referred to as an anode) is positive with respect to the cathode.

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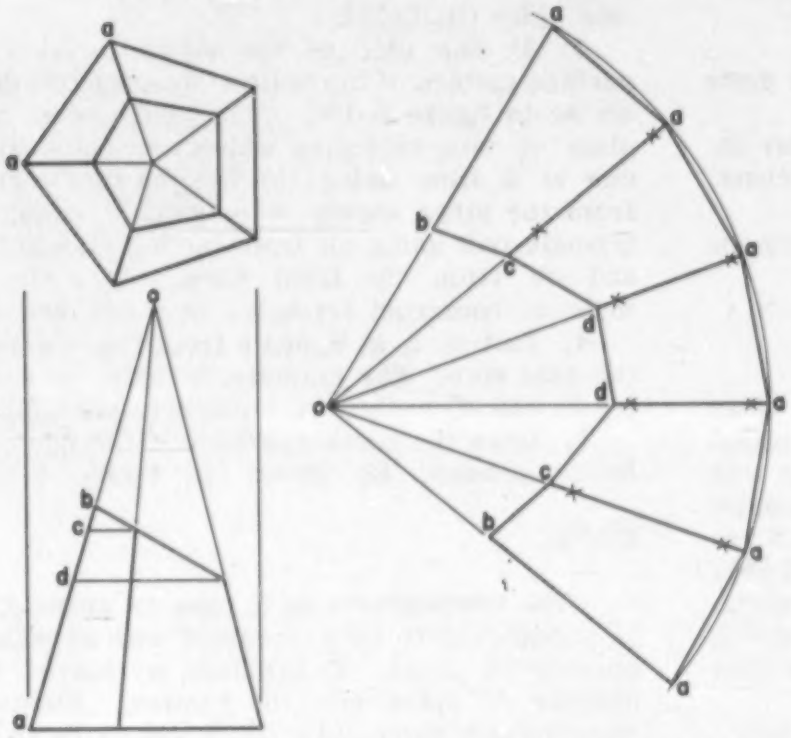

Figure 5-18.–Development of a truncated pentagonal pyramid with the upper corners cut by a slanting plane.

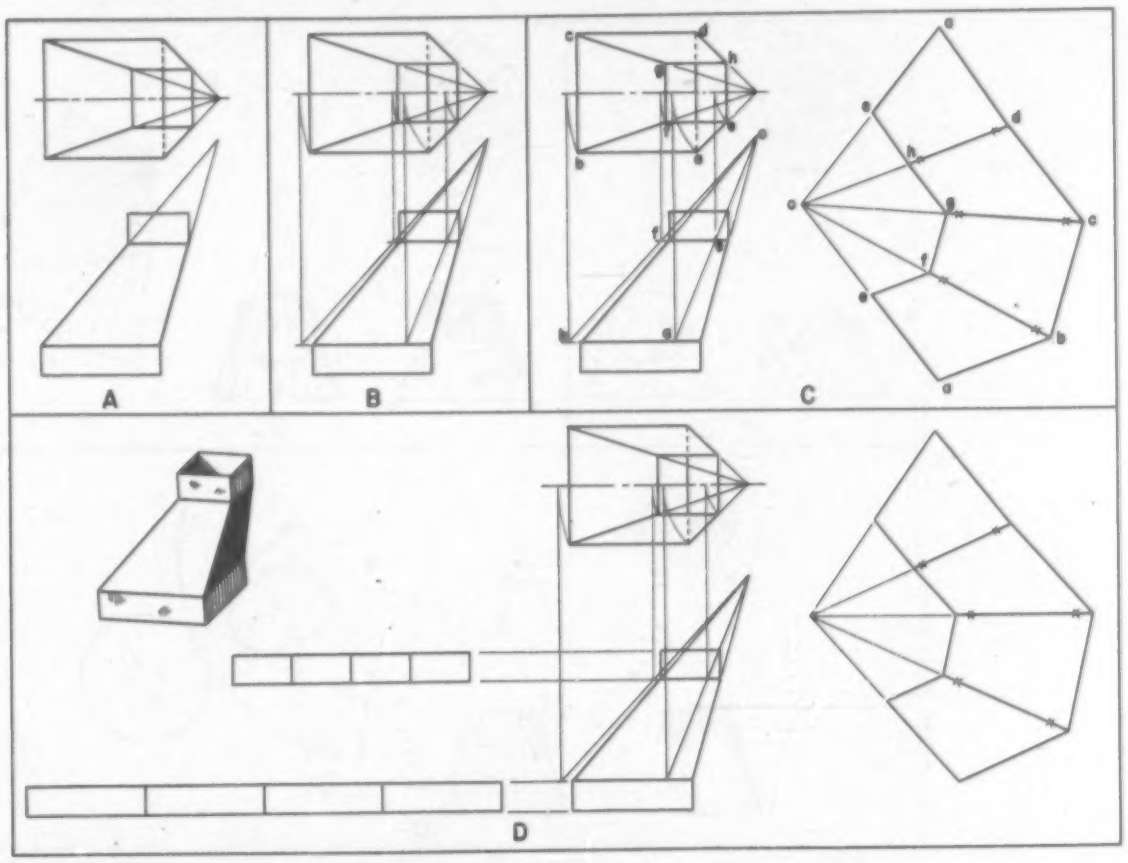

Figure 5-19.–Development of an offset transition piece.

onto the line of this edge in order to determine the true lengths.

1. Swing arc oa.
2. Step off the five distances aa and draw rays from points a to o.
3. Transfer distances ab, ac, and ad (or ob, oc, and od) from the front view to the stretchout.
4. Connect bcddcb.
5. Heavy up the pattern lines and mark the bend lines.

OFFSET TRANSITION

Figure 5-19 shows the development of an offset transition piece. It is called offset because the center of one end is not in line with that of the other end. The three parts consist of an upper section and a lower section, which are truncated rectangular prisms, and a third section, which is a truncated oblique pyramid.

1. Draw the orthographic views, extending the lines of the sides of the pyramid to its apex in both views.
2. Rotate the lines of the sides to the horizontal in the top view, project the points thus located to the front view, and draw the true-length line. (See fig. 5-19B.)
3. At one side of the views, develop the surface pattern of the oblique square pyramid as shown in figure 5-19C. The development consists of four triangles which are constructed one at a time using the lengths of the sides from the other views. For example, construct triangle oab using ab from the top view and oa and ob from the front view. In a similar manner, construct triangles boc, cod, and doa.
4. Plot e, f, g, h, and e from the lengths in the side view. For example, transfer ae and bf (or oe and of) to the development to establish ef.
5. Draw the surface patterns of the upper and lower prisms, as shown in figure 5-19D.

CONE

The development of a cone is similar. It is considered to be a pyramid with an infinite number of sides. In practice, of course, the number of sides must be limited. Elements representing these sides are drawn on the orthographic views and projected to the development.

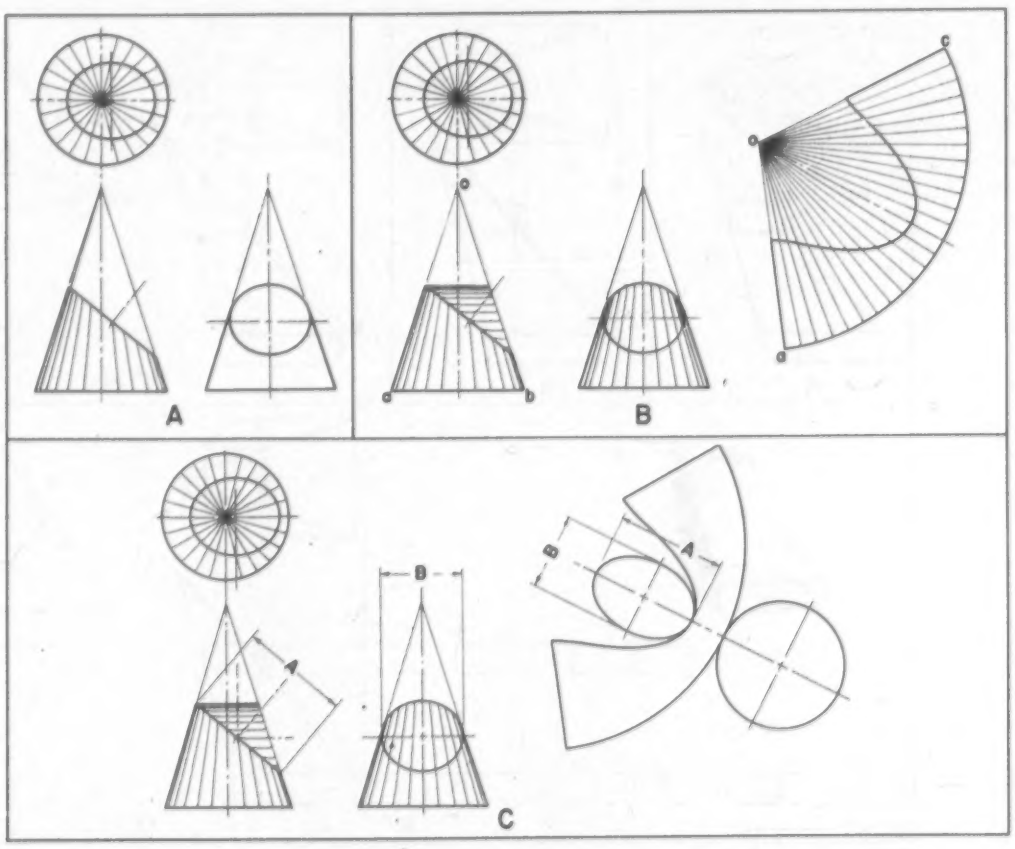

Figure 5-20.—Development of a truncated right cone.

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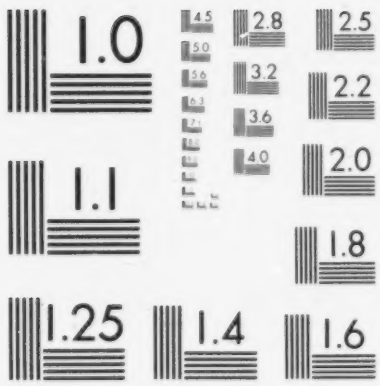

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The steps in developing a truncated right cone are illustrated in figure 5-20.

The right cone has a centerline which is perpendicular to its base. Thus the elements on a right cone are all the same length. The true length of these elements is shown by those which fall to the extreme right and left in the front view, since these elements are horizontal lines in the top view. The cone in figure 5-20 is cut by a slanting plane. Therefore the termination points of the elements between the two outside elements must be projected to one of the outside lines in order for their true length to be determined.

1. Draw the orthographic views, including either a side view, as shown in figure 5-20A, or an auxiliary view of the ellipse which is formed by the slanting plane. Note that the center of the ellipse must be determined since it does not fall on the centerline of the cone. This center point is projected to the side view and defines the length of the minor axis (length B in 5-20C) of the ellipse. The length of the major axis (length A in 5-20C) is defined by the length of the slanting line in the front view.

2. Develop the surface pattern of the cone (fig. 5-20B), using the length oa from the apex to the base as a radius for drawing the arc. Step off on this line the equally spaced divisions of the base. The angle aoc, the total arc ac, and the arc length of each division may be computed for use in constructing or checking the development. For example, let ab = 5.5 in. and let oa = 9.0 in. Arc ac is equal to the circumference of the base of the cone; therefore arc ac = π x diameter = π x 5.5 in. = 17.28 in. Since there are 24 divisions along arc ac, each division equals 17.28 in. ÷ 24 = 0.72 in. Angle aoc is part of a whole circle for which the circumference is 2π x radius = 2π x 9.0 = 18.0π. Angle aoc relates to 360° in the same ratio that arc ac relates to the whole circle:

$$\frac{\text{angle aoc}}{360^\circ} = \frac{\text{arc ac}}{\text{whole circle}} = \frac{5.5\pi}{18.0\pi} = \frac{5.5}{18.0} = 0.036$$

angle aoc = 360° x 0.306 = 110°

3. Measure each element individually (the true length as projected on line ob) and transfer this measurement to the development. The ends of each of these elements define the curve of the upper edge of the peripheral surface. (See fig. 5-20B.)

4. To complete the development of a solid figure, draw the circle of the surface of the base and the ellipse of the top surface attached to the peripheral surface as shown in figure 5-20C.

TRUNCATED INVERTED CONE

In figure 5-21, the pouring lip on the round measure is a truncated portion of an inverted cone. The lower end is cut by a plane parallel to the base and the upper end is cut by a slanting plane. The same procedures may be used to find the elements on this lip as those described in connection with the truncated cone shown in figure 5-21. However, a shorter method may also be used to develop the surface pattern of the lip.

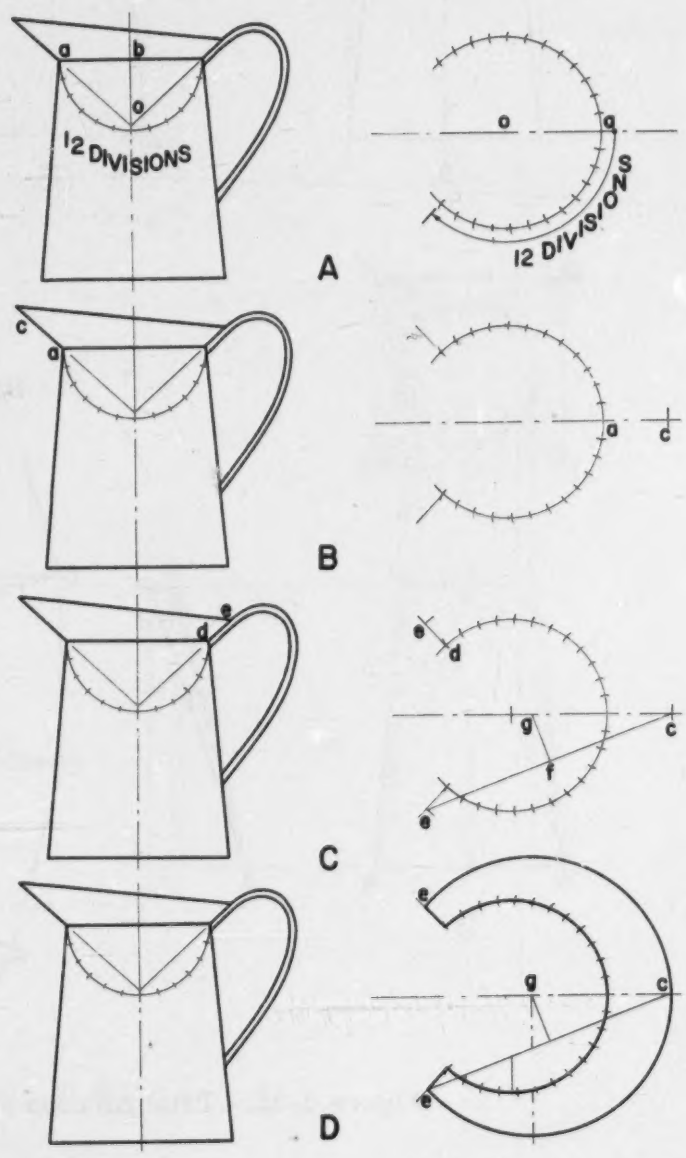

Figure 5-21.—Development of a pouring lip.

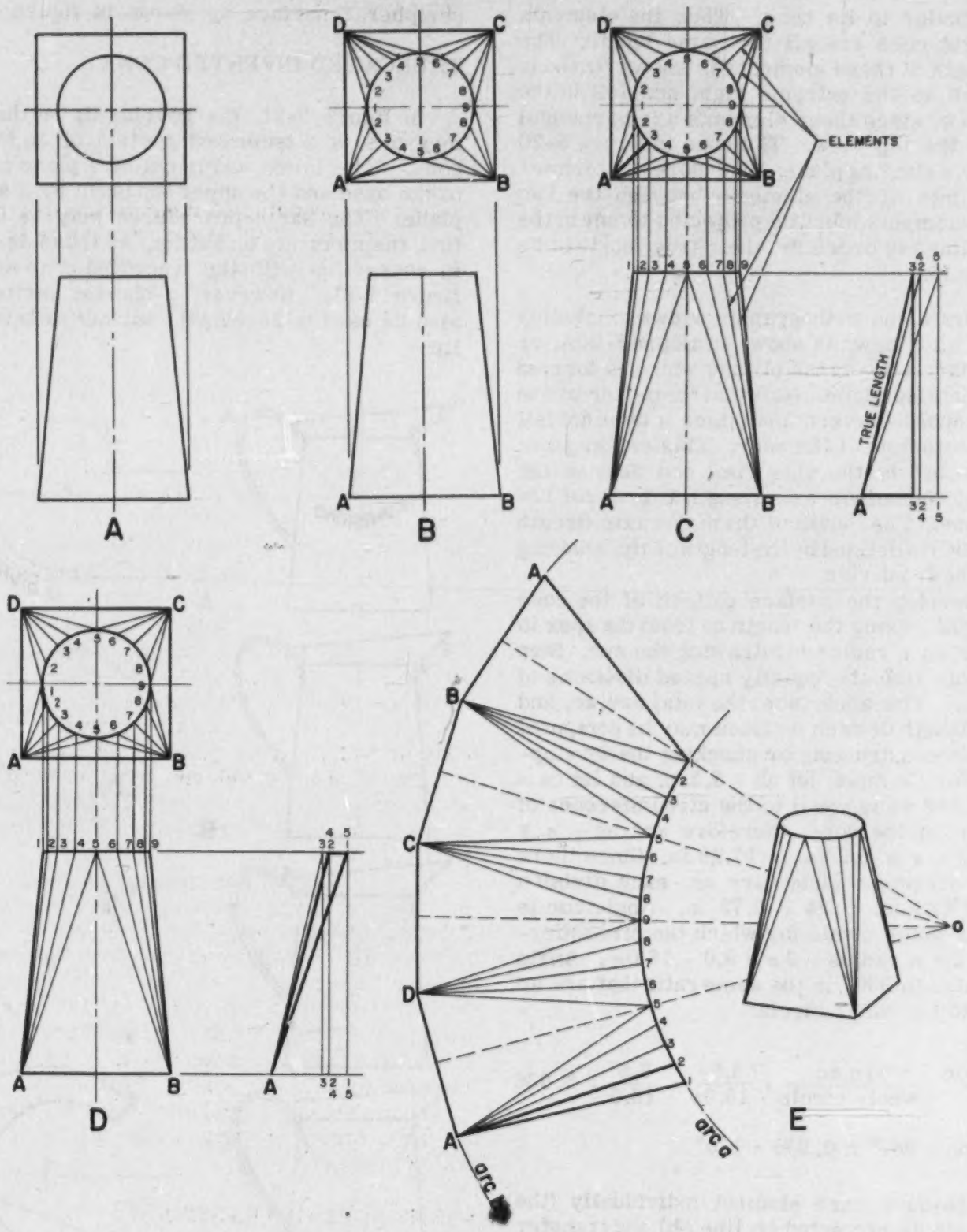

Figure 5-22.—Triangulation development of a transition piece.

1. Draw an orthographic view, and locate the apex of the inverted cone (o in fig. 5-21A).

2. Draw a semicircle (radius ba) attached to the lower edge of the pouring lip, and divide this into equal spaces; 12 divisions are used in the illustration.

3. As the first step in developing the surface pattern, draw an arc with a radius oa equal to the line from the apex o of the angle to the lower edge of the lip a along one of the true-length lines (See fig. 5-21A.)

4. Draw a centerline through this arc, and step off the same number of equal spaces on each side of this line as appear on the semicircle in the front view (12 divisions in the example).

5. From the final steps on each side, draw lines the distance of the short side de of the lip, as shown in figure 5-21B and C, and also locate a point c beyond the arc on the centerline at a distance equal to the long side ac of the lip in the orthographic view.

6. Draw a line from this point c to the outer edge of the lip e at the seam as shown in figure 5-21C.

7. Bisect this line ce, and draw a line fg perpendicular to ce which intersects the centerline at point g.

8. With this intersection g as the center and with a radius gc equal to the distance from this center to the points c and e already located on the outer edge of the lip, draw an arc describing this outer edge. (See fig. 5-21D.)

TRIANGULATION

Triangulation is slower and more difficult than parallel line or radial development, but it is more practical for many types of figures. Also it is the only method by which the developments of warped surfaces may be approximated. In development by triangulation, the piece is divided into a series of triangles as in radial development. However, there is no one single apex for the triangles. The problem, therefore becomes one of finding the true lengths of the varying oblique lines. This is usually done by drawing a true-length diagram.

Figure 5-22 illustrates the steps in the triangulation of a warped transition piece joining a large square pipe and a smaller round pipe.

1. Draw the top and front orthographic views (fig 5-22A).

2. Divide the circle in the top view into a number of equal spaces and connect the division points with the corners of the square, as shown in the top view in figure 5-22B.

3. Transfer the division points down to the front view, and draw the elements from the numbered points to corners A and B as shown in figure 5-22C.

4. Now the true length of each of these elements may be found by drawing a right triangle (A33 in fig. 5-22C, for example) with a base (3A) equal to the length of an element (3A) on the top view and with an altitude (33) equal to the altitude of the corresponding element on the front view. The hypotenuse (3A) of the triangle is the true length of the element. In figure 5-22C, the true-length diagram consists of only three right triangles. Since the piece is symmetrical, a number of the elements are the same length.

5. To draw the surface pattern, construct one triangle at a time; for example, triangle A21 in figure 5-22E. Draw line A1 using the length from the true length diagram in 5-22D. From point A, swing an arc of radius length A2 taken from the true length diagram. From point 1 swing an arc of radius length 12 taken from the top view of figure 5-22D. The intersection of the arcs establishes point 2 and completes triangle A21.

6. Using lengths from 5-22D, build triangles A23, A34, and A45 onto triangle A21.

7. To set point D in the development, swing length D5 (which is the same length as A5) from point 5 and swing length AD (taken from the top view of 5-22D) from point A. This completes one-fourth of the development; since the piece is symmetrical, the remainder of the development may be constructed using the lengths from the first part.

8. It is difficult to keep the entire development perfectly symmetrical when it is built up from small triangles. Therefore, you may check the overall symmetry by constructing perpendicular bisectors of AB, BC, CD, and DA (fig. 5-22E) and establish point O. From point O swing arcs a and b. Arc a should pass through the numbered points and arc b should pass through the lettered points. Further, the length of arc a should be equal to π times the diameter of the circular opening in the top of the transition piece.

RECTANGULAR TRANSITION

Figure 5-23 shows the steps in developing a rectangular transition piece which is not true pyramid because the extended lateral edges

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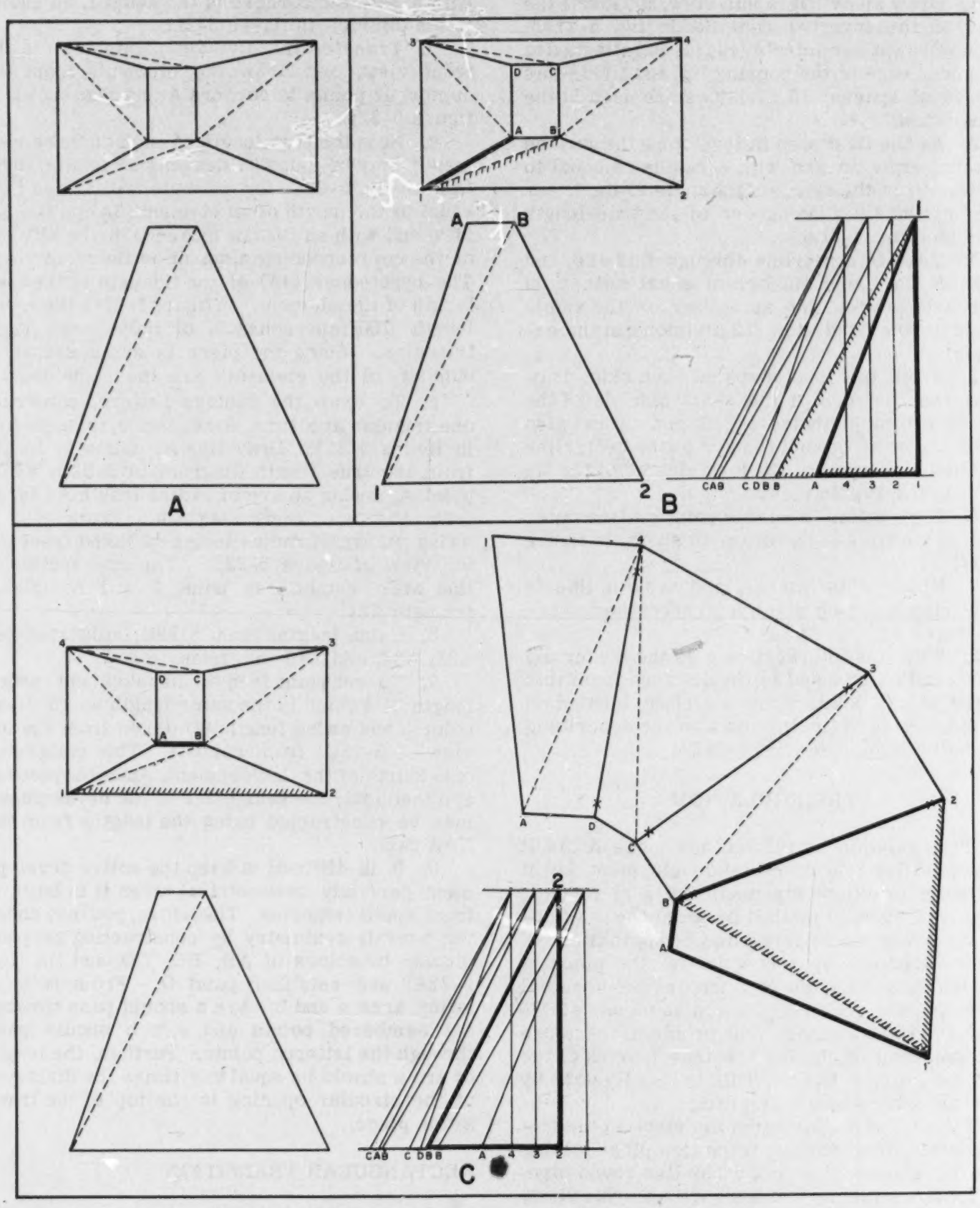

Figure 5-23.—Development of a rectangular transition piece which is not a true pyramid.

would not meet at a common vertex. This may best be developed by drawing diagonals which split the sides into two triangles. These diagonals are usually drawn as dotted lines to differentiate them from other elements. Then the true length of each element is found, and the surface pattern developed by constructing each triangle in turn. To find the true-length lines, a true-length diagram is drawn.

1. As shown in figure 5-23A, draw the orthographic views and the diagonals.

2. Draw the true-length diagram as shown in figure 5-23B. The altitude of the triangles in the diagram is the height of the piece. The base A1 of triangle A11 is length A1 taken from the top view; the hypotenuse A1 is the true length. Similarly, length B1 from the top view is the base of triangle B11; hypotenuse B1 is the true length.

3. Construct the development (fig. 5-23C) one triangle at a time. For example, construct triangle A1B using true lengths A1 and B1 from the diagram and length AB from the top view. To add triangle 1B2, use length 12 from the top view and length B2 from the true-length diagram. Build the remaining triangles onto these in similar fashion.

WARPED TRANSITION

The fitting in figure 5-24 has a warped surface. Its base is round and its top is oblong.

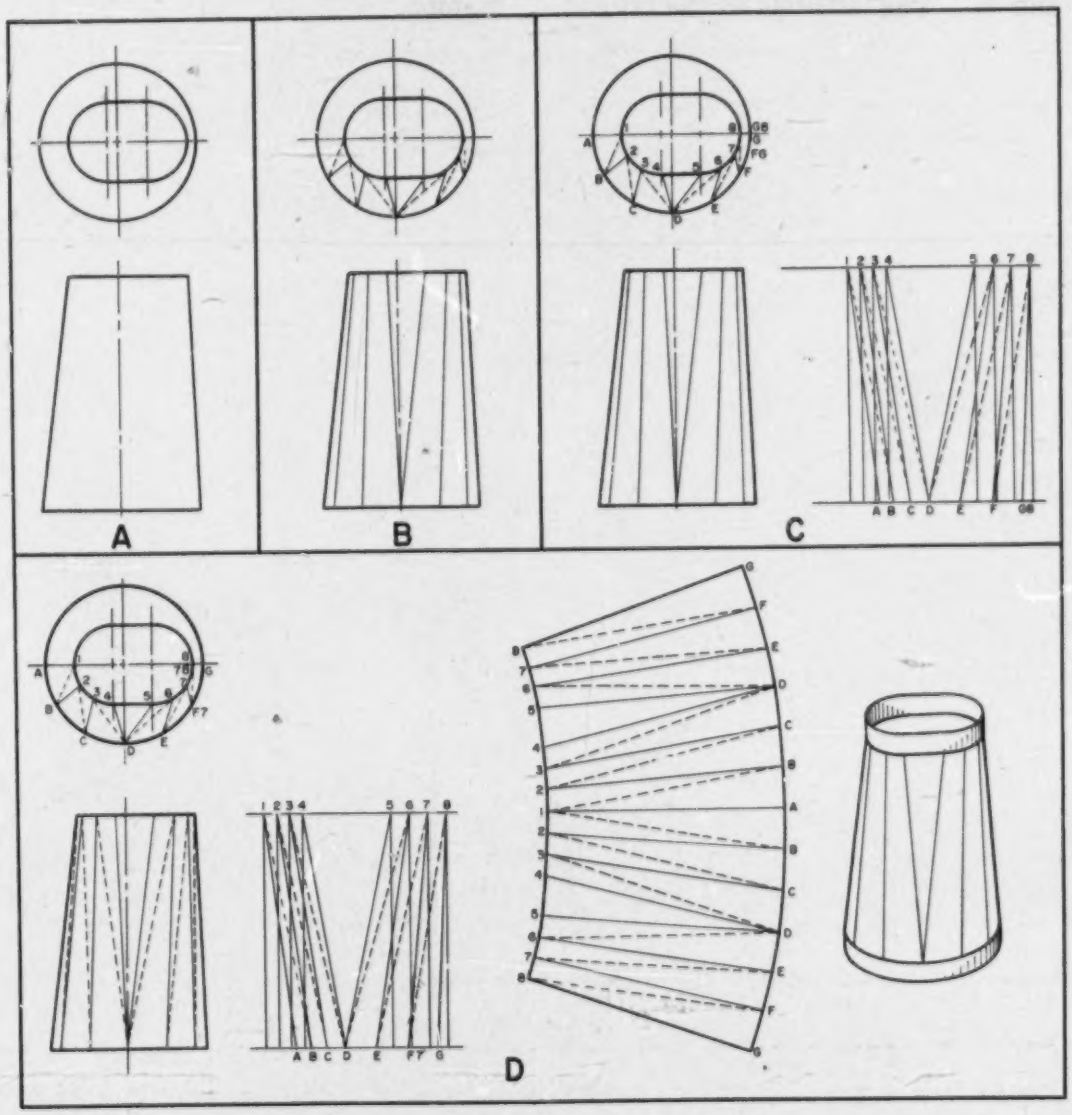

Figure 5-24.—Development of a warped transition piece.

The method for development consists of dividing the surface into quadrilaterals of approximately the same size, and then drawing a diagonal across each of these to produce two triangles. When the true lengths of these elements have been found, the surface pattern may be drawn, triangle by triangle.

1. Draw the front and top orthographic views as shown in figure 5-24A.

2. As shown in figure 5-24B, divide the circle of the base into equal parts (six divisions of the semicircle are shown). Divide the arcs on the oblong into equal divisions (three on each quarter-circle are shown).

3. Project the division points to the front view and draw the elements in both views. Draw diagonals using dashed lines.

4. Draw a true-length diagram as shown in figure 5-24C and D. The altitude of the true-length triangles is the height of the transition piece. The first small triangle on the right of the diagram has a base G8 the length of which is taken from the top view as indicated in 5-24C; the hypotenuse G8 is the true length. Another example is the bold triangle FG8 in 5-24C: the base FG is taken from the top view; the hypotenuse F8 is the true length. In the bold triangle in 5-24D, the base F7 is taken from the top view; again, the hypotenuse F7 is the true length.

5. Construct the development (fig. 5-24D) a triangle at a time. For triangle 8FG, the lengths G8 and F8 are taken from the true-length diagram and FG is taken from the top view. For the next triangle, length F7 is taken from the true-length diagram and length 78 from the top view. The entire development is constructed by building the triangles one upon another in similar fashion.

CHAPTER 6

MACHINE AND STRUCTURAL DRAWINGS

As an Illustrator Draftsman, you may be assigned to a repair ship or a tender. Most of the drawings with which you will be concerned will be adaptations of existing drawings. You will have access to prints of manufacturers' drawings and BuShips drawings. However, when a part is broken, it may be necessary to make a drawing so that the part may be rebuilt. Also, various minor modifications or repairs to structures or machinery may require that drawings be prepared locally. The draftsman making detail or assembly drawings should know something about materials and the different terms used in connection with them. He should also have an acquaintance with shop work and the fabrication of metal and plastic products. He should be familiar with the nomenclature of ships and aircraft so that he can relate the various drawings to the appropriate portion of the structure.

MACHINE DRAWINGS

When a complex piece of machinery is to be made, whether it will be produced as a single unit or in quantity, the problems involved in producing it are worked out on the drawing board. First, a design drawing is made by an engineer, engineer officer, or a well-trained and experienced draftsman working from sketches made by an engineer. Then detail drawings of each part are made from this design drawing. Finally, an assembly drawing is drawn to show how the machine is assembled. Often a mistake in a detail drawing shows up on the assembly drawing which, therefore, also serves as a check on the earlier work.

The detail drawings and assembly drawings of a machine comprise the working drawings, from which the machine is made, as distinct from the design drawing or such drawings as display drawings intended for other purposes. The working drawings of a piece of machinery tell what manufacturing processes and materials are used, and how the different parts are finished, as well as the dimensions of the parts.

METALS

Metals are divided into two general types—ferrous and nonferrous. Ferrous metals are those whose major proportion is iron. Iron is the basis for all steels. Nonferrous metals are those whose major proportions are not iron, although they may contain a small amount of iron as an impurity.

Iron

Molten iron from the blast furnace may be further refined before it is allowed to cool, or it may be cast into shapes of approximately 80 pounds which are called pigs. In either case the product of the blast furnace is called pig iron. Pig iron is remelted with certain proportions of scrap to provide the desired chemical properties of iron for the manufacture of cast iron. Because of its brittleness and low tensile strength, cast iron is limited in use.

When pig iron is further refined through a process known as puddling, wrought iron is obtained. This iron is used in the manufacture of pipes, nails, and rivets.

Steel

Steel is made from molten iron from the blast furnace or from remelted pig iron by bringing it into contact with a liberal supply of oxygen which consumes the excess carbon and

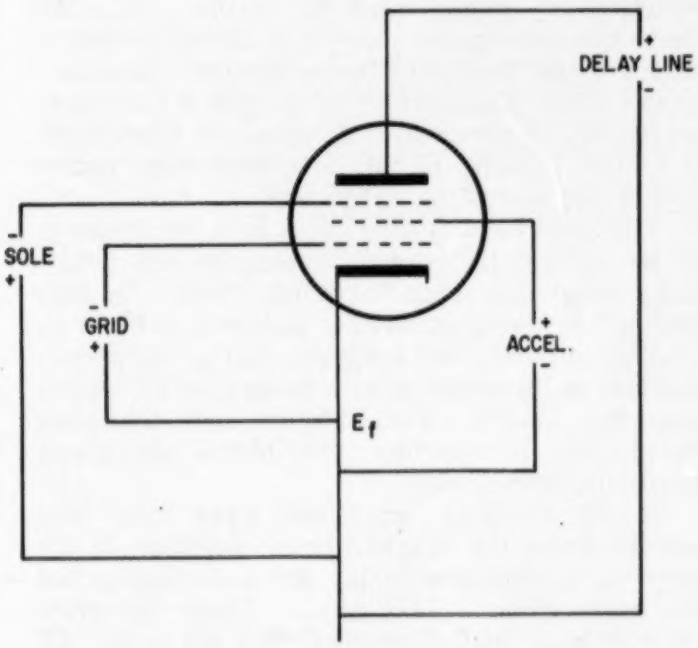

Figure 12-20.—Schematic equivalent of an M-BWO.

With appropriate values of applied potentials and appropriate value and direction of magnetic field, the electron beam is formed in the gun regions, passes through the interaction region, and is collected at both the delay line and the collector.

In backward wave oscillators there is no RF input, and a portion of the delay line adjacent to the collector is modified to assure absorption of any power reflected from the output.

The principal projections from the main tube body are the RF output connector and the HEADER, through which the electrode leads are brought out to external terminals. A doughnut shaped magnet is used, since this form combines high internal magnetic field strength with excellent external magnetic self-shielding properties.

FREQUENCY TUNING AND MODULATION

The oscillator can be tuned through the designed range of frequencies by varying the delay line-to-cathode or sole-to-cathode potential. This can be done statically or dynamically at rates limited chiefly by modulating power and interelectrode capacitances.

The average rate of tuning for a given tube design will be nearly linear throughout the range and very similar from tube to tube. The sensitivity differs in present tubes of different frequency ranges from approximately 0.13 mc per volt at L-band frequencies to approximately 1.0 mc per volt at X-band frequencies. The sole potential can be varied for frequency modulation with the advantage of requiring less modulating power. Since frequency is determined by the anode-to-sole potential, both sole and anode (delay line) tuning sensitivities are essentially the same. Sole modulation is limited to one-half of the complete tuning range of the tube, due to tube electronic characteristics.

Amplitude Modulation

Amplitude modulation is accomplished by varying the accelerator potential, since this electrode controls delay line current. Accompanying the amplitude modulation is an inherent frequency modulation resulting from frequency pushing. (Frequency pushing is defined as an RF frequency variation due to a variation in anode current.) Pushing is not linear over either the frequency range or the current range. Amplitude modulation linearity is good, but may be limited at low modulation frequencies by cathode fatigue during high current peaks. The grid electrode should not be utilized for amplitude modulation purposes. A d-c potential on the grid may be required for optimum tube efficiency.

Pulse Modulation

Although these tubes have been designed primarily for CW operation, it is possible to pulse the accelerator electrode and obtain peak power output considerably in excess of the CW power. Some delay line current is present even at zero accelerator potential. In some cases, therefore, it may be desirable to bias the accelerator negatively to obtain complete cutoff, and pulse positively from the level of cutoff bias.

INSULATION AND COOLING

Normal heat dissipation, principally at the delay line and collector, usually requires that external liquid cooling be provided to this region. A coolant channel, an integral part of the delay line, serves this purpose, with coolant being provided through external connections.

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some other impurities. Alloying elements are also added to steel to produce desired qualities.

Nonferrous Metals

One of the most important nonferrous metals is copper. Copper is an excellent conductor of electricity and has excellent resistance to salt-water corrosion.

Zinc is used as an alloying ingredient in making brass and some bronzes. It is also often used as a protective coating on steel sheets, which are then called galvanized sheets.

Tin is seldom used except as an alloying ingredient. Alloyed with lead, it makes a soft solder, and alloyed with copper, it produces bronze.

Aluminum is used extensively because of its light weight, easy workability, good appearance, high resistance to corrosion, and other desirable properties. When alloying elements such as magnesium, copper, nickel, and silicon are added, an alloy stronger than low carbon steel can be produced.

Nickel is a hard, malleable, and ductile metal. It is resistant to corrosion and is therefore often used as a coating on other metals. Combined with other metals, its effect is to make the alloy hard, strong, and ductile. It also imparts greater resistance to oxidation and corrosion.

True brass is an alloy of copper and zinc. Complex brasses are those containing additional alloying agents, such as aluminum, lead, iron, manganese, or phosphorus.

Bronze made of copper and tin was the best metal available for a great many uses before steelmaking techniques were developed.

Copper-nickel alloy is found extensively aboard ship because of its high resistance to the corrosive effect of salt water.

Monel contains nickel, copper, and small percentages of iron, manganese, and cobalt. In appearance, monel resembles stainless steel. In fact, it has many of the qualities of stainless steel. It has a very high resistance to corrosion.

K-monel is a special improved type of alloy that is stronger and harder than ordinary monel.

Inconel is a nickel alloy containing nickel, chromium, iron, and about 1 percent other elements. It has great resistance to corrosion and retains its strength at high temperatures. Exhaust systems of engines are often made of inconel.

Heat Treatment

Metals are heat treated to produce changes in their structure and physical properties. These changes are produced by variations in the temperature to which the metal is heated, the rate of heating, the time the metal is kept at the correct or critical temperature, the furnace atmosphere, and the cooling process and medium. There are several forms of heat treating. The most common for ferrous metals are annealing, normalizing, hardening, tempering, and case-hardening.

Hardness Tests

The property of hardness may be defined as the ability of a material to resist penetration. Because there are several methods of measuring hardness, the hardness of a material is always specified in terms of the particular test that has been used to measure this property, such as the Rockwell or Brinell. For example, R_c 44-48 means that the hardness of the metal part is between 44 and 48 on the C scale of the Rockwell Hardness Test.

Methods of Shaping Metals

Metals are often classified as being either cast metals or worked metals, depending upon the method used to shape them. Note, however, that even worked metals must first be cast into some sort of a shape such as an ingot. Mechanical working improves certain properties of the metal. Cold working, in particular, tends to improve strength and hardness and to produce a smooth surface. Hot working improves strength and toughness.

PLASTICS

Plastic materials are being increasingly used aboard ship. In some respects, they tend to surpass structural metals; plastic has proved to be shock resistant, not susceptible to salt water corrosion, and in casting, it lends itself to mass production and uniformity of end product.

MACHINE SHOP WORK

Machine finishing may be done by either cutting or grinding the metal or plastic away. Grinding produces a smoother surface and is

usually used only after a cutting process. The mass production of machine parts can be held within .001 in. accuracy, or even closer if necessary. Thus, a repair part for any machine fits and operates just as well as the original part. The most common cutting operations consists of turning, planing, milling, and drilling.

MACHINE DRAWING CONVENTIONS

The importance of the MIL-STDs has been indicated in both chapters 1 and 4. The MIL-STDs 1B, 2C, and 7A apply to all types of engineering drawings including machine drawing. Three of the MIL-STDs which have a more specific application to machine drawings are MIL-STD-8C Dimensioning and Tolerancing, MIL-STD-9A Screw Thread Conventions and Methods of Specifying, and MIL-STD-10A Surface Roughness, Waviness, and Lay. Some representative standards from these publications are included in some of the following sections.

Designating Materials

The typical machine detail drawing includes a material block and perhaps various notes which indicate the types of material to be used and their characteristics and quality.

Materials are usually specified by Federal or Military specification numbers. For example, the coupling on a particular oil burner is identified as "cast steel, class B, MIL-S-15083" and a lever on a particular safety valve is identified as "tool steel, MIL-S-15046," a clamp screw on a certain return flow burner is to be made of "brass, MIL-W-1165," or a washer in a certain safety valve assembly is to be made of "rolled corrosion-resisting steel, MIL-S-853."

In some cases, however, the materials are specified according to the SAE (Society of Automotive Engineers) system, according to the ASTM (American Society for Testing Materials) system, the AISI (American Iron and Steel Institute) system, or according to other metals classification systems.

For all practical purposes the AISI and SAE numerical designators for steel have the same meaning. AISI also has a letter prefix which indicates the method used in manufacturing the steel. Letters used as prefixes are:

A—open hearth alloy steel
B—acid Bessemer carbon steel
C—open hearth carbon steel
D—acid open hearth carbon steel
E—electric furnace steel

The SAE uses a four-digit identification number for steels. For the simpler alloys, the first digit indicates the alloy type; the second digit, the approximate percentage of the predominant alloying element; the last two digits, the carbon content in hundredths of 1 percent.

The first digit number and alloy types they represent are as follows:

1—plain carbon steel
2—nickel
3—nickel-chromium
4—molybdenum
5—chromium
6—chromium-vanadium
8—(was used to indicate national-emergency steel during World War II)
9—silicon-manganese

Nonferrous metals may be identified by their alloying elements. Examples are brass, bronze, coppernickel, and nickel-copper. Specific designations of an alloy are described by the amounts and chemical symbols of the alloying elements. For example, a copper-nickel alloy might be described as copper-nickel, 70 Cu-30 Ni. The 70 Cu represents the percentage of copper, and the 30 Ni represents the percentage of nickel.

Common alloying elements and their chemical symbols are:

Aluminum	Al
Carbon	C
Chromium	Cr
Cobalt	Co
Copper	Cu
Iron	Fe
Lead	Pb
Manganese	Mn
Molybdenum	Mo
Nickel	Ni
Phosphorus	P
Silicon	Si
Sulphur	S
Tin	Sn
Titanium	Ti
Tungsten	W
Vanadium	V
Zinc	Zn

In addition to the type of designations previously described, a trade name (such as Monel or Inconel) is used sometimes to designate certain alloys.

In addition to a material identification number, the material block on the drawing may include a "physical condition" and quality designation—that is, the designation of temper or other physical condition approved by a nationally recognized technical society or industrial association such as the American Iron and Steel Institute. Some of the physical condition and quality designations for various iron and steel products are listed here:

CR. . .	cold rolled	AQ. . .	aircraft quality
CD. . .	cold drawn	CQ. . .	commercial quality
HR. . .	hot rolled	DQ. . .	drawing quality
ANL. .	annealed	ERW .	electric resistance weld
NORM	normalized	S. . . .	seamless
EXTR.	extruded	AW . .	arc weld
NT. . .	normalized and tempered	BW . .	butt weld
QT. . .	quenched and tempered		

On the drawing, the heat treatment for a part may be indicated in several ways. A general note may list the steps, temperatures, etc. A hardness-test number or the tensile strength (psi) required for the part may be given.

Parts lists

A parts list may be required on a machine drawing. Such a list is usually placed on an assembly drawing and gives the name, quantity, material, stock size or weight, stock number, or drawing number of each part. A column may be added for remarks. Usually the larger or more important parts are listed first and the smaller or standard parts, such as screws, last.

When you make such a list, it is very important that you include every part. It is best to work out a system for taking the parts from the drawing and then later arrange the parts in order for the parts list. It is always wise to have your takeoff checked by someone else, since another man is less likely to make the same mistakes.

Gears

Though gears appear frequently on machine drawings, you usually do not have to draw the teeth in detail except for a few to indicate the proper dimensions.

The nomenclature of gears is illustrated in figure 6-1; the definitions of terms follow.

PITCH DIAMETER (PD).—Diameter of the pitch circle (or line) which equals the number of teeth divided by the diametral pitch.

NUMBER OF TEETH (N).—The diametral pitch multiplied by the diameter of the pitch circle (DP x PD).

DIAMETRAL PITCH (DP).—The number of teeth to each inch of the pitch diameter or the number of teeth divided by the pitch diameter. Diametral pitch is usually referred to simply as PITCH.

ADDENDUM CIRCLE (AC).—The circle over the tops of the teeth.

OUTSIDE DIAMETER (OD).—Diameter of the addendum circle.

CIRCULAR PITCH (CP).—Length of the arc of the pitch circle between the centers or corresponding points of adjacent teeth.

ADDENDUM (A).—The height of the tooth above the pitch circle or the radial distance between the pitch circle and the top of the tooth.

DEDENDUM (D).—The length of the portion of the tooth from the pitch circle to the base of the tooth.

CHORDAL PITCH.—The distance from center to center of teeth measured along a straight line or chord of the pitch circle.

ROOT DIAMETER (RD).—The diameter of the circle at the root of the teeth.

CLEARANCE (C).—The distance between the bottom of a tooth and the top of a mating tooth.

WHOLE DEPTH (WD).—The distance from the top of the tooth to the bottom, including the clearance.

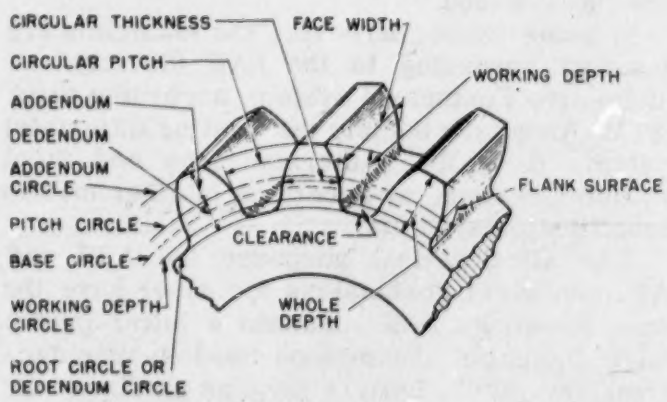

Figure 6-1.—Gear nomenclature.

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FACE.—The working surface of the tooth above the pitch line.

THICKNESS.—The width of the tooth, taken as a chord of the pitch circle.

CIRCULAR PITCH is the distance in inches measured from the intersection of the face and flank of one tooth to the same point on the adjacent tooth. That is, it is equal to $\frac{PD}{N}$ or $\frac{\pi}{DP}$ On a rack, it is called linear pitch.

PITCH CIRCLE.—The circle having the pitch diameter.

WORKING DEPTH.—The greatest depth to which a tooth of one gear extends into the tooth space of another gear.

RACK TEETH.—A rack may be compared to a spur gear that has been straightened out. The linear pitch of the rack teeth must equal the circular pitch of the mating gear.

Although it is seldom necessary for the draftsman to draw gears in detail, he should know how to draw at least one form of gear with the teeth. For this reason, instructions on drawing an involute tooth form on a wheel and rack are included here. The diameter of the pitch circle (PD) on the wheel is given as 12 inches and the number of teeth (N) as 36.

1. Calculate the values in inches, to three decimal places when necessary, for each of the following dimensions:

DP (pitch) = $\frac{N}{PD}$.

WD (working depth of teeth) = $\frac{2}{DP}$.

A (addendum) = $\frac{WD}{2}$.

OD (outside diameter) = PD + 2A.

D (dedendum) = A = $\frac{WD}{2}$.

RD (root diameter) = PD - 2D.

CP (circular pitch) = $\frac{3.1416}{DP}$.

T (thickness of teeth) = $\frac{CP}{2}$.

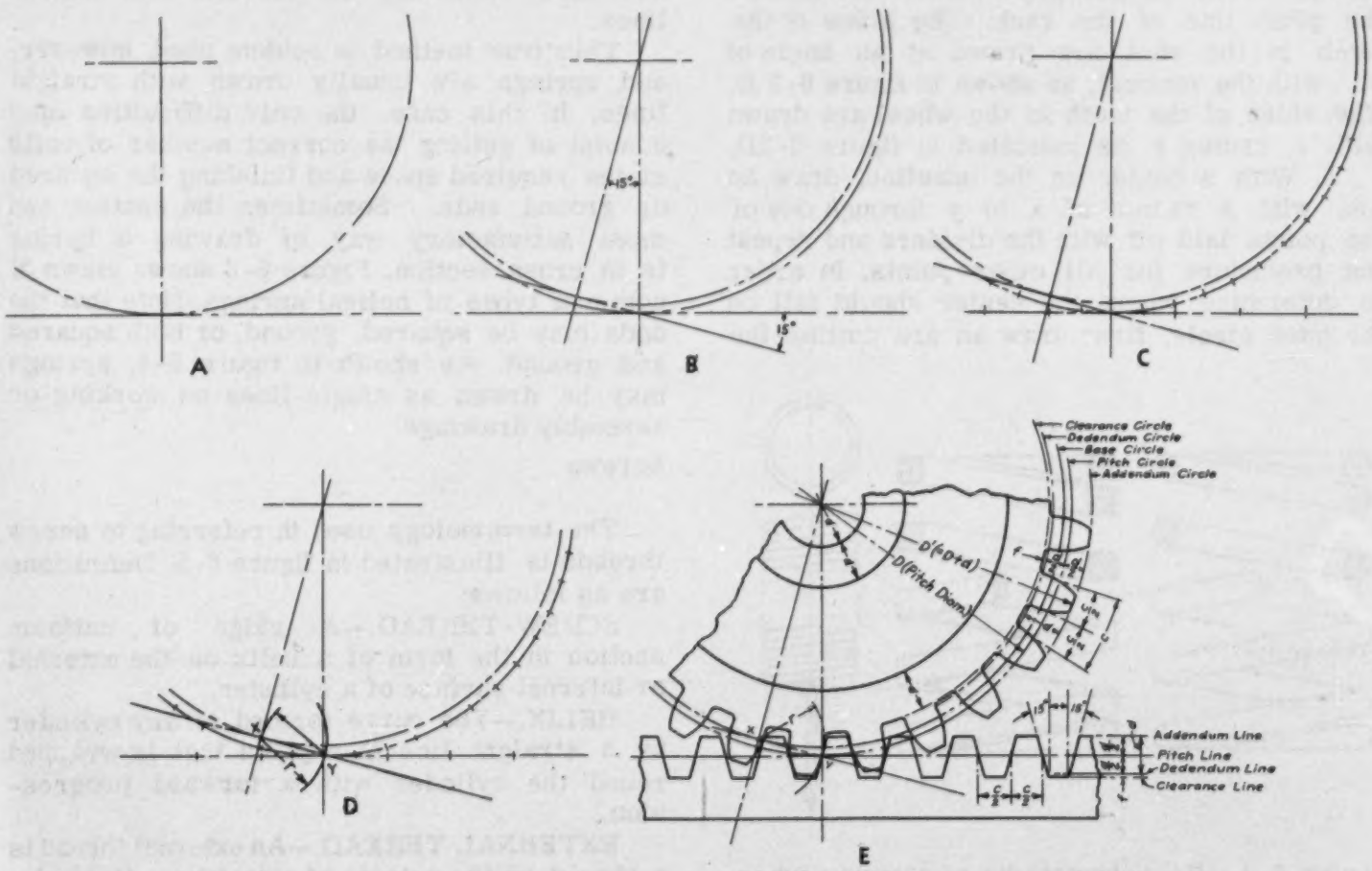

Figure 6-2.—Approximate method of drawing teeth on a wheel and rack.

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2. Locate the center of the wheel and draw the pitch circles with a radius of 1/2 the pitch diameter. Draw the center lines of the wheel, and at the point where the vertical centerline intersects the bottom of the pitch circle, draw a horizontal line to represent the pitch line of the rack. (See fig. 6-2A.)

3. In order to draw the teeth by the approximate method given here, a circle called the base circle, which falls between the pitch circle and the root circle, must be drawn. In order to locate this circle, draw a line inclined at an angle of 15° through the intersection of the vertical center line and the pitch circle, and a second line from the center of the wheel inclined at an angle of 15° to the vertical centerline. (See fig. 6-2B). The distance from the intersection of these two lines and the center of the wheel is the radius for drawing the base circle. Fifteen degrees was selected because it is a convenient angle to draw and closely approximates the 14 1/2° pressure angle of the teeth.

4. Set the small dividers at a distance equal to the thickness of the teeth and lay off the teeth on the pitch circle and then on the pitch line of the rack. The sides of the teeth in the rack are drawn at an angle of 15° with the vertical, as shown in figure 6-2 E. The sides of the teeth in the wheel are drawn with a radius r as indicated in figure 6-2D.

5. With a center on the baseline, draw an arc with a radius of x to y through one of the points laid off with the dividers and repeat the procedure for all other points. In order to determine where the center should fall on the base circle, first draw an arc cutting the base circle with a center on one of the points on the pitch circle. Both sides of the teeth may be drawn by this method. (See fig. 6-2 D.)

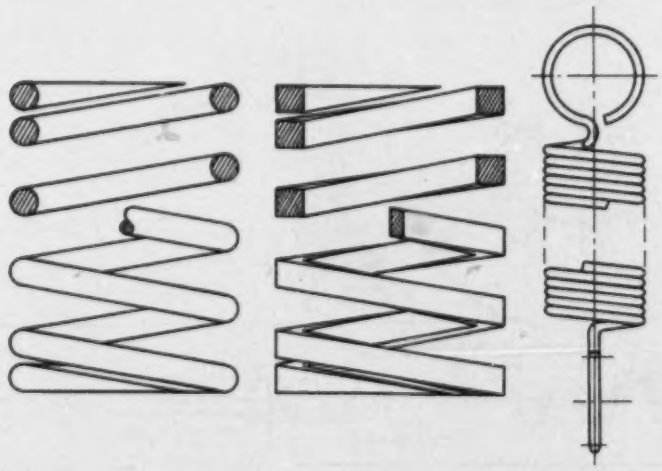

Figure 6-3.—Representations of common types of helical springs.

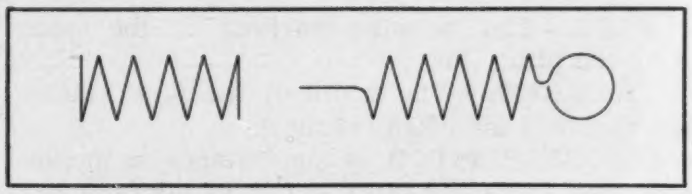

Figure 6-4.—Single line representations of springs.

6. In completing the teeth of the wheel, draw fillets with a radius of 1/16 inch connecting the sides of the teeth with the clearance circle. There are no fillets in the rack shown in this drawing. (See fig. 6-2D.)

Helical Springs

A true orthographic projection of a helical spring would be drawn by first laying out a true helix as a center line of the spring, then drawing circles of the diameter of the wire, and then enclosing the circles with curved lines.

This true method is seldom used, however, and springs are usually drawn with straight lines. In this case, the only difficulties may consist of getting the correct number of coils in the required space and finishing the squared or ground ends. Sometimes the neatest and most satisfactory way of drawing a spring is in cross section. Figure 6-3 shows views of common types of helical springs. Note that the ends may be squared, ground, or both squared and ground. As shown in figure 6-4, springs may be drawn as single lines on working or assembly drawings.

Screws

The terminology used in referring to screw threads is illustrated in figure 6-5. Definitions are as follows:

SCREW-THREAD.—A ridge of uniform section in the form of a helix on the external or internal surface of a cylinder.

HELIX.—The curve formed on any cylinder by a straight line in a plane that is wrapped round the cylinder with a forward progression.

EXTERNAL THREAD.—An external thread is a thread on the outside of a member. Example, a thread on a bolt.

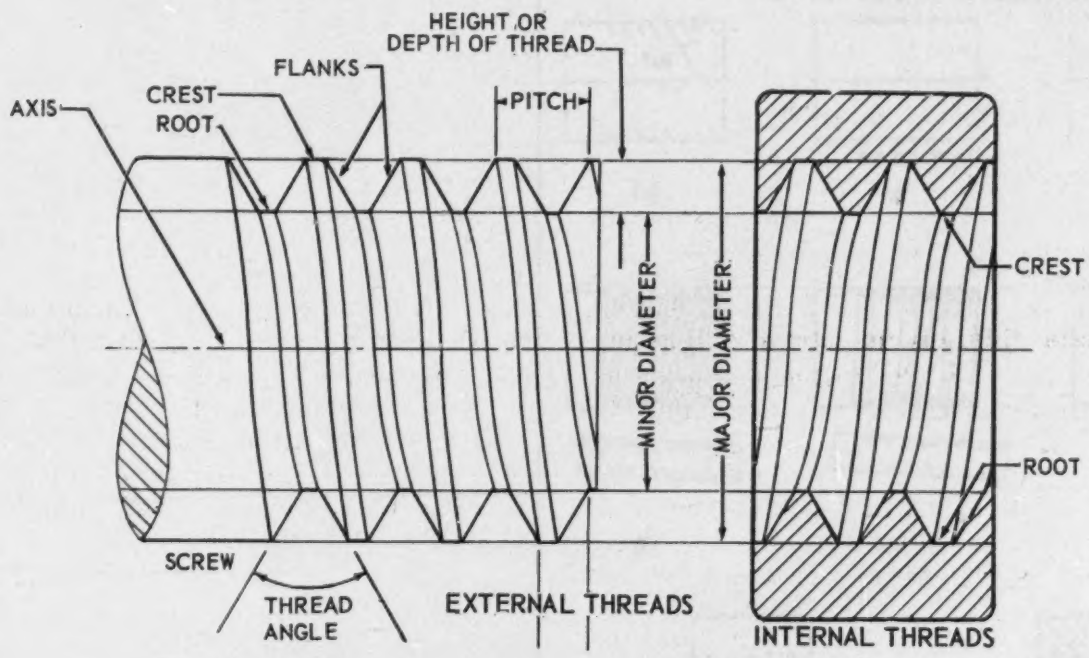

Figure 6-5.—Screw-thread terminology.

INTERNAL THREAD.—A thread on the inside of a member. Example, the thread inside a nut.

MAJOR DIAMETER.—The largest diameter of an internal or external thread.

AXIS.—The center line running lengthwise through a screw.

CREST.—The surface of the thread corresponding to the major diameter of an external thread and the minor diameter of an internal thread.

ROOT.—The surface of the thread corresponding to the minor diameter of an external thread and the major diameter of an internal thread.

DEPTH.—The distance from the root of a thread to the crest, measured perpendicularly to the axis.

PITCH.—The distance from a point on a screw thread to a corresponding point on the next thread, measured parallel to the axis.

LEAD.—The distance a screw thread advances in one turn, measured parallel to the axis. On a single-thread screw the lead and the pitch are identical; on a double-thread screw the lead is twice the pitch; on a triple-thread screw the lead is three times the pitch.

It would often take days of a draftsman's time to draw the screw threads for one drawing if he followed strict orthographic projection as shown in figure 6-5. In actual practice the threads are drawn as straight lines, rather than as the curve formed by a helix, or they may be further simplified. Semiconventional thread drawings are shown in figure 6-6. Figure 6-7 shows regular thread symbols, and figure 6-8 shows simplified thread symbols.

To draw semiconventional external screw threads:

1. Draw the center line and draw lightly the lines defining the major diameter of the threads. (See fig. 6-6a.)

2. On the upper line, mark off spaces the width of the pitch. If there are 8 threads to an inch, the pitch will be 1/8 inch on a full-size drawing. (See fig. 6-6b.)

3. On the lower line, mark off one space which is 1/2 the pitch; then mark off the pitch for the rest of the threads. (See fig. 6-6b.)

4. From each pitch point on both upper and lower lines, draw short lines which slope 60° from the center line. (See fig. 6-6c.)

5. Then turn your triangle over and draw line sloping at 60° to meet with the other 60° lines thus completing the outline of the threads. (See fig. 6-6d.)

6. Connect the crests of the threads as shown in figure 6-6e.

7. Connect the roots of the threads in the same manner (See fig. 6-6f.)

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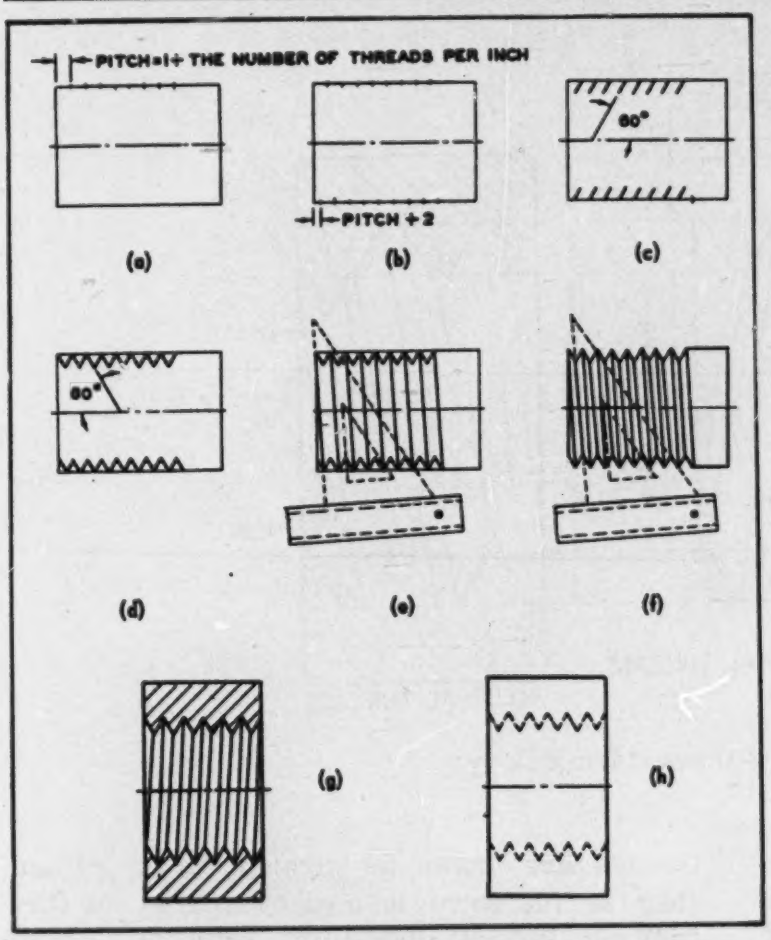

Figure 6-6.—Drawing semiconventional internal and external threads.

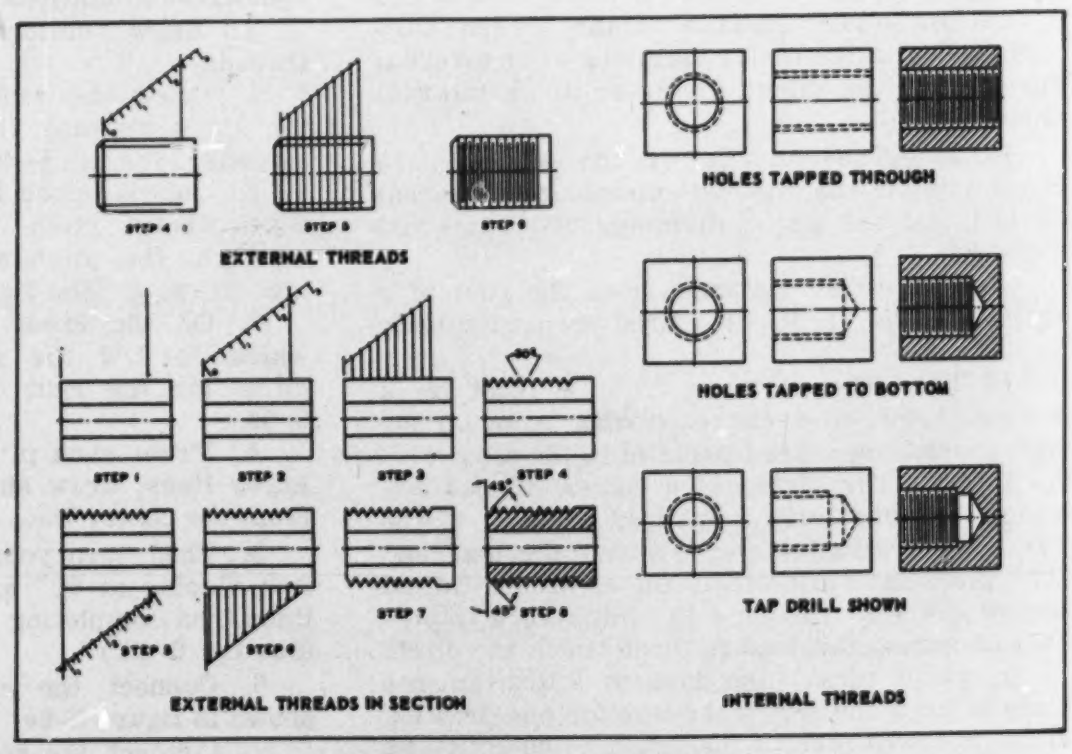

Figure 6-7.—Regular internal and external thread symbols.

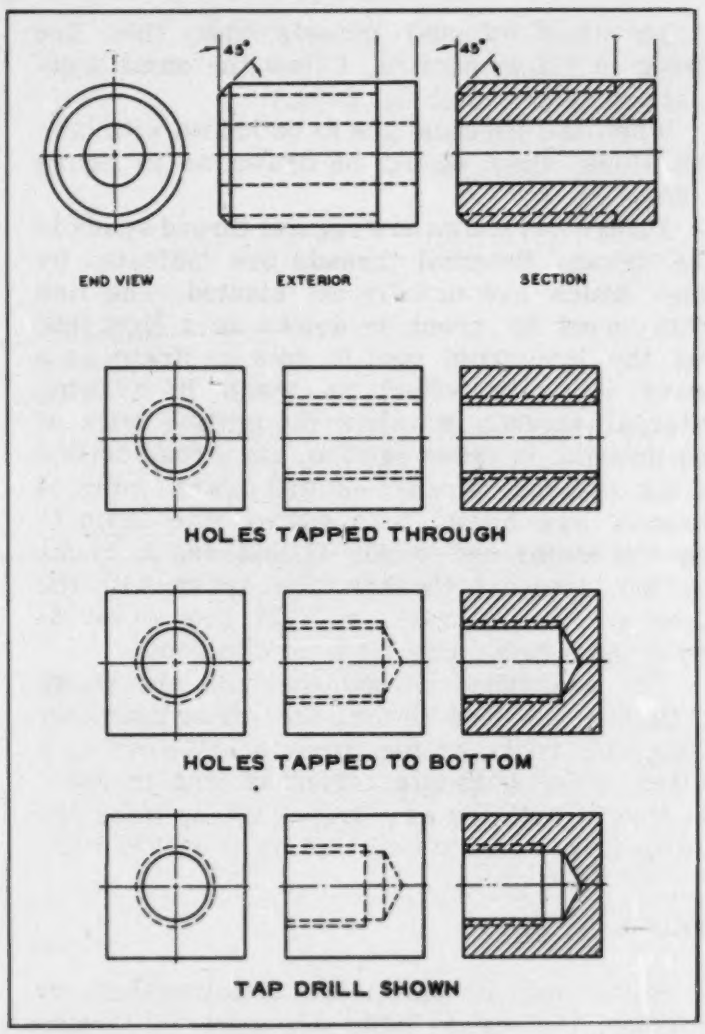

Figure 6-8.—Simplified external and internal thread symbols.

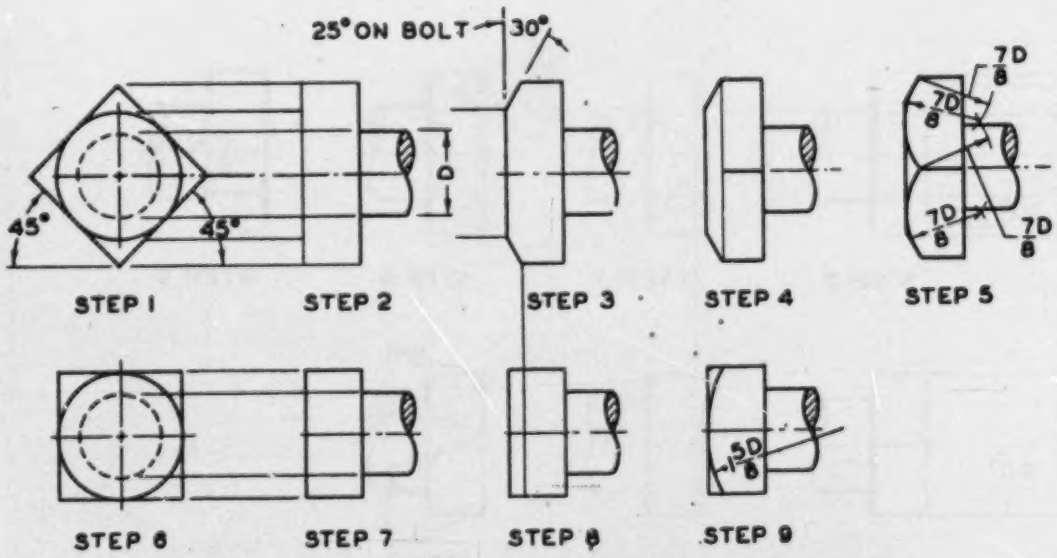

Figure 6-9.—Steps in drawing an unfinished square bolt head.

To draw internal threads when they are shown in cross section, follow the same general procedure. (See fig. 6-6g.)

When the threads are to be shown with hidden lines, they should be drawn as in figure 6-6h.

Figure 6-7 shows how regular thread symbols are drawn. External threads are indicated by lines which are usually not slanted. The line from crest to crest is drawn as a light line and the line from root to root is drawn as a heavy line. No effort is made in drawing external threads to show the outline form of the threads. In cross section, the thread outline of the external threads is still drawn. Internal threads are drawn with dotted line indicating the major and minor diameters. In cross section, internal threads are drawn with the lines of the threads, a light line crest to crest and a heavy line from root to root.

The simplified thread symbols are shown in figure 6-8. The line of the minor diameter along the roots of the threads is shown as a dotted line on both internal and external threads. No thread cutlines are drawn and no lines are drawn from crest to crest or from root to root.

Bolts and Nuts

Bolts may be unfinished, semifinished, or finished. Unfinished bolts are made by forging and rolling processes. On semifinished bolts, the surface under the bolt head is machine finished to provide a washer-faced bearing surface. This means that a round raised surface which has a diameter approximately equal to the width across flats in machined on the bearing surface, or the corners of the under face are chamfered. Finished bolts are machined all over to serve some purpose or to improve their appearance.

Although a draftsman is seldom called upon to make detailed drawings of standard bolts, he is very often required to make a drawing of a special bolt which may have a standard head or a standard shaped nut. Figure 6-9 and figure 6-10 illustrate the steps in drawing bolt heads. Nuts are drawn the same way. The nut for a bolt of a particular size is usually larger than the bolt head.

The tops of wrench-head bolts are chamfered at the corners. On the bolt this chamfer is at an angle of 25° to 30° and for convenience it is always drawn at an angle of 30°. The bearing surface may be unfinished, finished with a raised washer face, or finished by chamfering the corners. On the thread end, bolts are chamfered at an angle of 45° to the depth of the thread.

Finish Marks

The military standards for finish marks are set forth in MIL-STD-10A. Many metal surfaces must be finished with machine tools for various reasons. The acceptable roughness

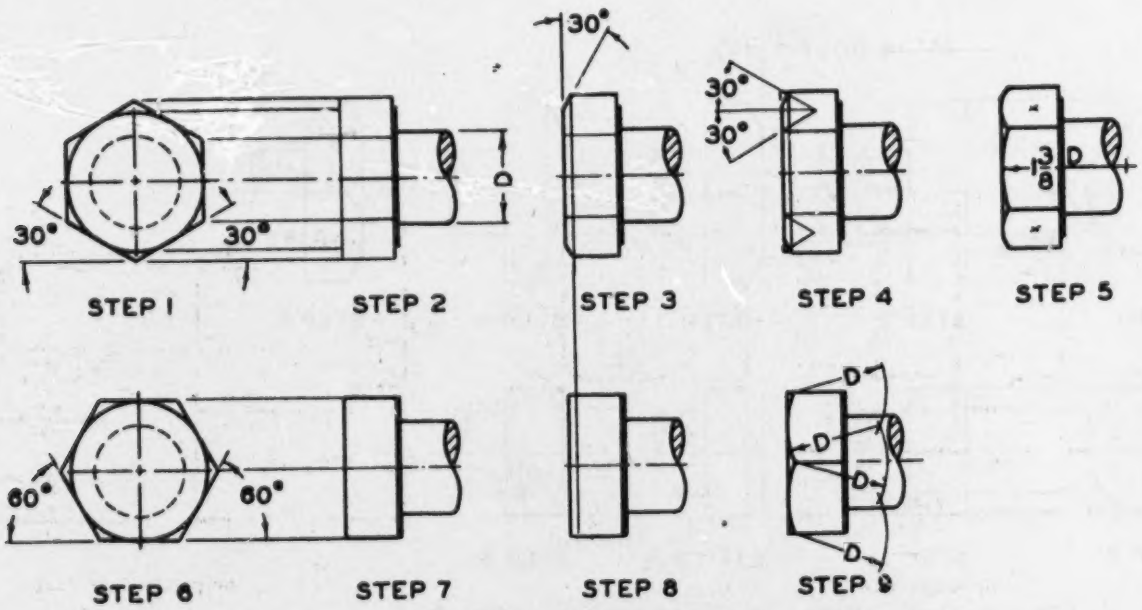

Figure 6-10.—Steps in drawing a semifinished hexagonal bolt head.

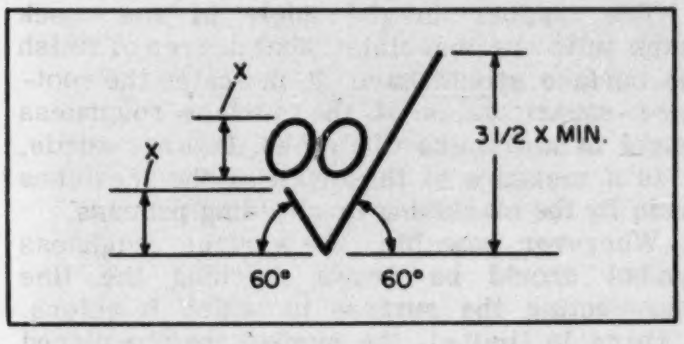

Figure 6-11.—Proportions for basic symbol.

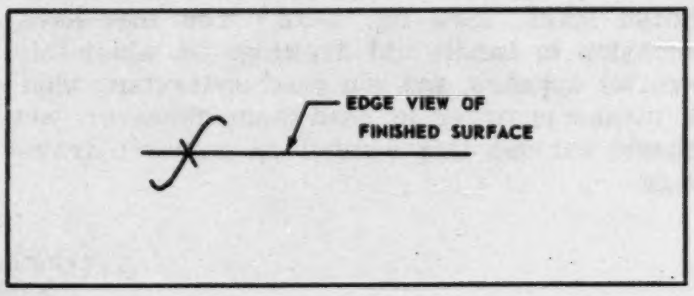

Figure 6-12.—The old finish symbol.

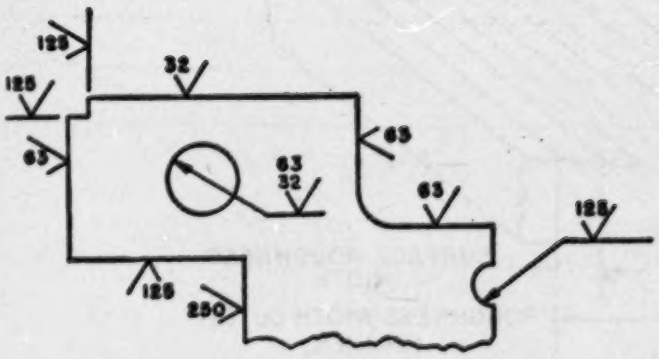

Figure 6-13.—Methods of placing surface roughness symbols.

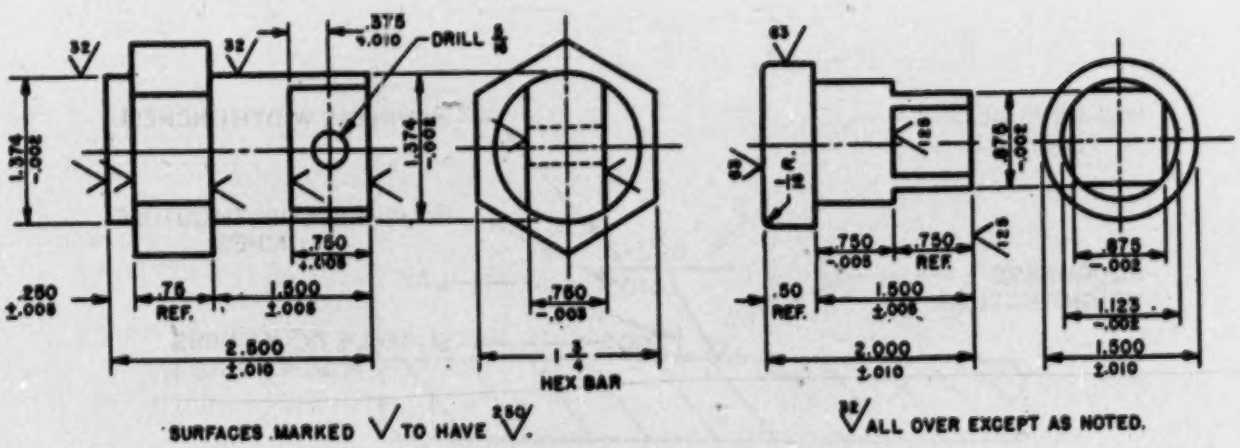

Figure 6-14.—Typical examples of symbol use.

The coolant generally used is Dow Corning 200 silicone oil, a thermally stable oil with a high resistance to change in temperature. For high altitude operation, the input bushing can be pressurized or immersed in an insulating liquid. In some applications, the tube is operated with the cathode at ground potential. When this method is used, primary to secondary high voltage insulation of the various supply transformers is unnecessary; but high voltage isolation of the RF output connector is necessary and additional safety precautions are required.

SPECIAL CONSIDERATIONS

Most microwave tubes have characteristics which limit their use or which require special consideration in their use. The following is a list of these factors, which the designer must bear in mind as he uses the tube in a system and which are also of interest to the operator:

1. Voltage tuning sensitivity at X-band frequencies is approximately 1 mc per volt. Thus, for a CW signal, the power supply must be well regulated, with a low ripple factor. Although the average tuning sensitivity is nearly linear over the frequency range, there are variations in sensitivity for small frequency changes.

2. The sole current changes in magnitude with frequency tuning, and it can be in either direction.

3. Frequency pushing results from variations of other tube parameters. This may or may not be significant.

4. Interelectrode leakage current of a small value exists in tubes of present design.

5. A small amount of frequency pulling is a characteristic of the M-BWO. These tubes are, therefore, somewhat susceptible to load VSWR (voltage standing wave ratio) variations. Generally, load isolators are not required when load VSWR's are equal to or less than 1.5 to 1.

6. After full beam current has been established, stabilized frequency will be reached in 2 minutes or less.

7. Interelectrode capacitances must be considered as modulating frequencies are increased.

8. Power output varies over the tuning range primarily due to the necessary change in input power when tuning. Therefore, a 3-db power variation may be encountered over the tuning range.

THE BEAM MISER

The BEAM MISER is a unique type of depressed collector utilized in the beam type, crossed field traveling wave tubes. It permits significant increase in efficiency and power with no additional external connections or other changes in tube or circuit. The depressed collector is one which operates at a lower voltage than the anode or delay line, rather than at the same voltage.

The beam miser consists of a collector internally connected to the cathode and consequently at cathode potential. Thus the anode current is reduced for a given beam current, or the beam current is increased for a given anode current. In an analogous sense, the beam miser has some of the advantage of a reentrant electron beam in crossed field tubes. A considerable part of the spent beam which is unused can be returned to the cathode instead of being wasted by normal collection at anode potential.

The use of a beam miser in standard M-BWO's has permitted increases of power of the order of 30 percent for normal operating anode currents. It has also permitted suitable operation of one tube at several power levels; that is, multiple operating current capability. A tube with a beam miser requires no external mechanical changes or additional electrical input connectors and is, therefore, directly replaceable in the same socket as a standard tube not having a beam miser.

PARAMETRIC AMPLIFIER

The parametric amplifier, or reactance amplifier, is a device capable of low-noise amplification in the UHF and microwave regions of the electromagnetic spectrum. Seldom has a device gone so rapidly from the laboratory into operation. The low-noise amplification afforded by these devices offers phenomenal radar range improvements on existing equipments with minimum cost and maximum economy.

The parametric amplifier increases the power level of a signal by means of the variation of an energy-storage parameter. An everyday example is that of a child on a swing. The oscillation is maintained by "pumping"; that is, the child lowers his center of gravity on the downswing and raises it on the upswing. For maximum oscillation, the pumping takes place at twice the frequency of oscillation.

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of a surface depends upon the use to which the part will be put. Sometimes only certain surfaces need to be finished. To indicate these surfaces and to specify the degree of finish desired, a modified V symbol is used with a number or numbers above it. On a drawing, this symbol touches the line which represents the surface to be finished. The proportions of the surface roughness symbol are shown in figure 6-11. On small drawings the symbol should be proportionately smaller.

In the past, an inclined f crossing the line that represented a surface was used as a finish mark. (See fig. 6-12.) You may have occasion to handle old drawings on which this symbol appears, and you must understand what it means in order to read them. However, you should not use this symbol on your own drawings.

The number in the angle of the check mark tells the machinist what degree of finish the surface should have. It indicates the root-mean-square value of the surface roughness height in millionths of an inch. In other words, it is a measure of the depth of the scratches made by the machining or abrading process.

Wherever possible, the surface roughness symbol should be drawn touching the line representing the surface to which it refers. If space is limited, the symbol may be placed on an extension line from that surface or on the tail of a leader with an arrow touching that surface. (See fig 6-13.)

When a part is to be finished to the same roughness all over, a note on the drawing should include the direction FINISH ALL OVER, along with the finish mark and the proper number. For example, FINISH ALL OVER 125√. When

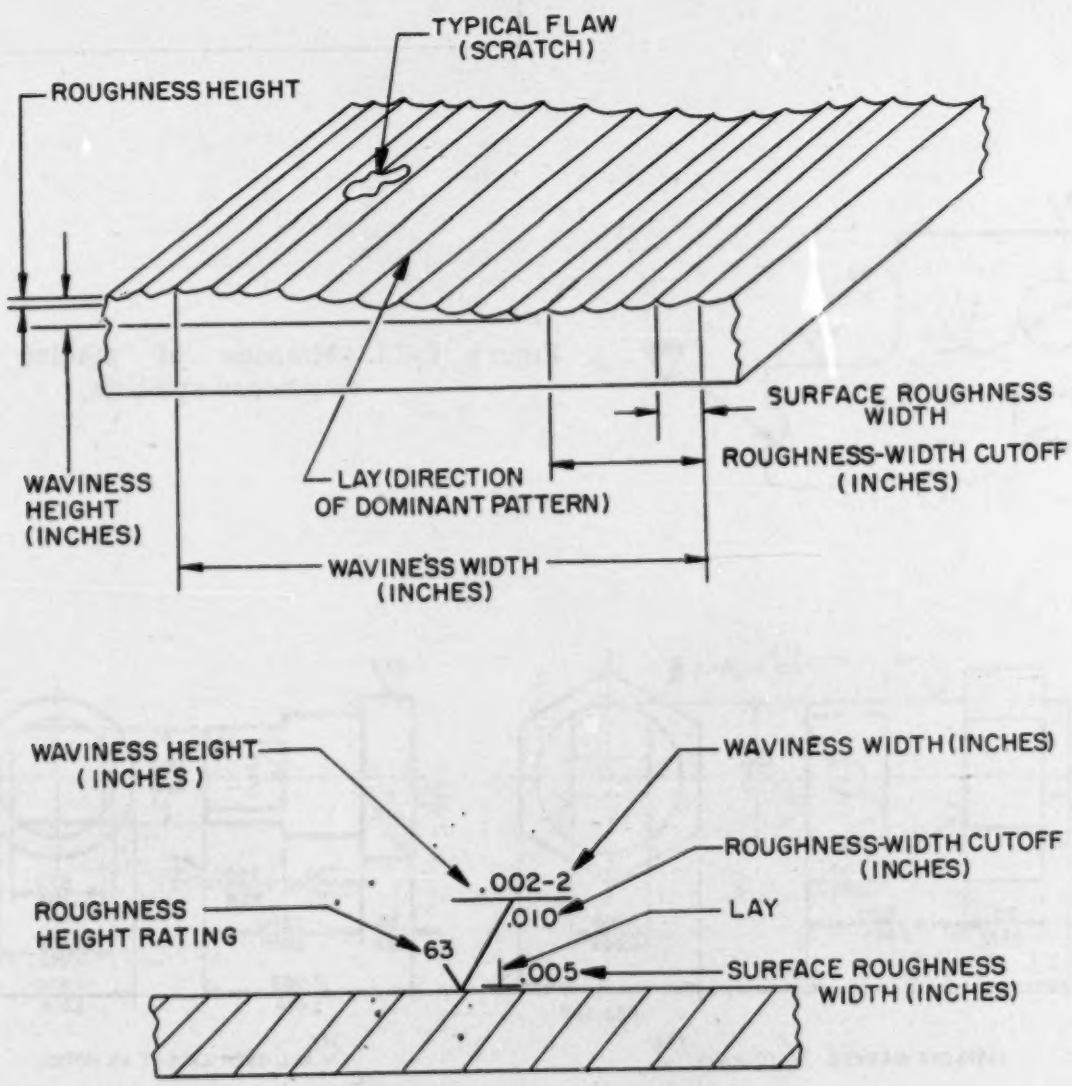

Figure 6-15.—Relation of symbols to surface characteristics.

a part is to be finished all over but a few surfaces vary in roughness, the surface roughness symbol and number or numbers should be applied to the lines representing these surfaces and a note on the drawing should include the surface roughness symbol for the rest of the surfaces. For example, 125√ ALL OVER EXCEPT AS NOTED. (See fig. 6-14.)

The machining operation to be used in finishing a surface is not usually specified. A good machinist will use the best machining operation he can for any given surface. However, certain surfaces can be obtained only by operations such as buffing, lapping, scraping, and honing, and these should have the surface roughness specified by the surface roughness symbol and number, followed or preceded by a notation of the required operation. For example, 4√ LAP.

In addition to surface roughness, the waviness and lay may be indicated on the drawing. As shown in figure 6-15, surface roughness has a width, which is the distance between successive peaks or ridges which constitute the predominant pattern of the surface roughness. Waviness is irregularities which are of greater spacing than the roughness. Lay is the direction of the predominate surface pattern produced by tool marks or grain of the surface. Typical symbols for lay and waviness are shown in figure 6-15; the lay symbol shown means that the lay is to be perpendicular to the boundary line representing the surface to which the symbol applies. Other lay symbols are described in MIL-STD-10A.

Dimensions and Tolerances

As explained in chapter 4 and mentioned earlier in this chapter, MIL-STD-8C covers in detail the conventions for dimensioning and tolerancing drawings. The following paragraphs contain information which is typical of that presented in MIL-STD-8C.

Limits are the maximum and minimum values prescribed for a specific dimension. A tolerance represents the total amount by which a specific dimension may vary. As mentioned in chapter 4, tolerances may be shown on drawings by several different methods. In the unilateral method (A of figure 6-16), the minimum or the maximum measurement is used as the dimension figure, and the difference allowable is given as a plus or minus tolerance figure. In the bilateral method (B of figure 6-16), the dimension figure indicates the plus or minus variation that is acceptable. In the limit dimensioning method (C of figure 6-16), the maximum and minimum measurements are both stated.

The surfaces being toleranced have geometrical characteristics such as roundness, or perpendicularity to another surface. Typical geometrical characteristic symbols are shown in figure 6-17. A datum is a surface or line or point from which a geometric position is to be determined or from which a distance is to be measured. Any letter of the alphabet except I, O, and Q may be used as a datum identifying symbol. A feature control symbol is made of geometric symbols and tolerances. As shown in figure 6-18, the feature control symbol may also include datum references.

The following are typical of the hundreds of abbreviations contained in MIL-STD-12B:

DIA	Diameter
GR	Gear
HDN	Harden
HT	Heat
PD	Pitch Diameter
REF	Refer or Reference
TIR	Total Indicator Reading
TOL	Tolerance

These abbreviations together with many of the previously discussed symbols and designations may be seen on the typical drawing in figure 6-19.

Round holes are dimensioned in various ways, depending on design requirements and manufacturing methods. The dimensioning methods in figure 6-20 are common machine drafting practice.

Countersinks for flat head screws, rivets, and similar items are specified on drawings as shown in figure 6-21. The linear dimension used for the specification is the diameter of the top of the countersink. The abbreviation CSINK indicates shape only and does not restrict the methods used to produce this shape. The dimensions of the countersink are determined by the dimensions of the screw or other part which is to fit in it. The angle indicated is the interior angle between the sloping faces of the countersink.

Counterbores are for recessing round-head screws and the like below the level of the main surface. Counterbores are dimensioned by a leader note giving the abbreviation CBORE

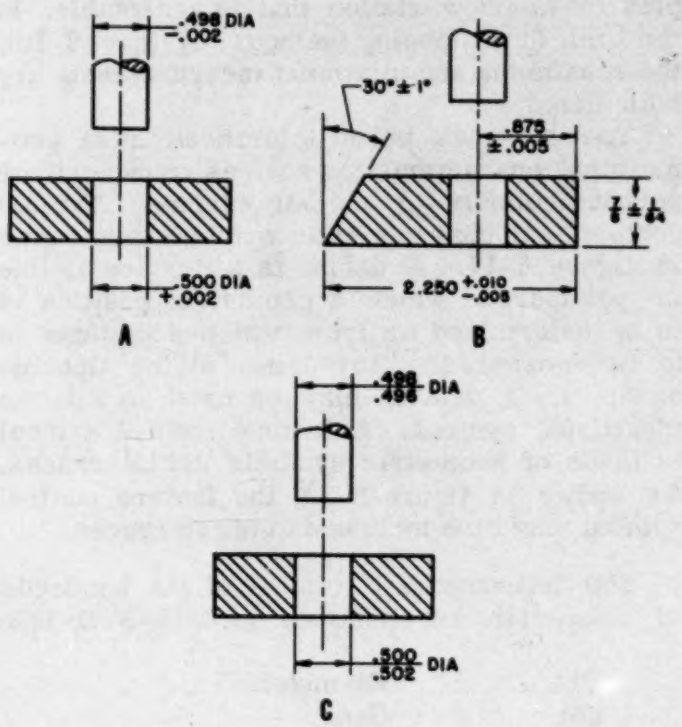

Figure 6-16.—Methods of indicating tolerance.

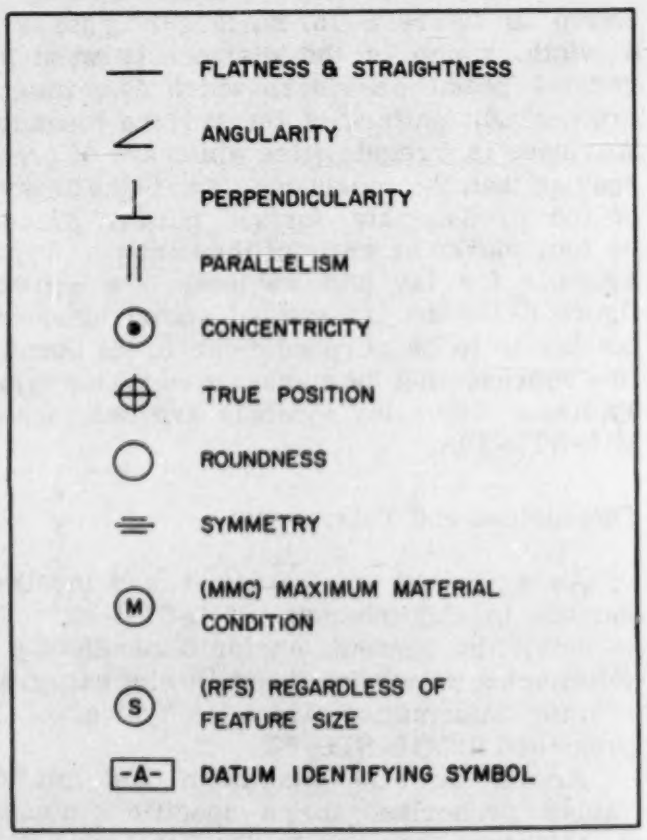

Figure 6-17.—Geometric characteristic symbols.

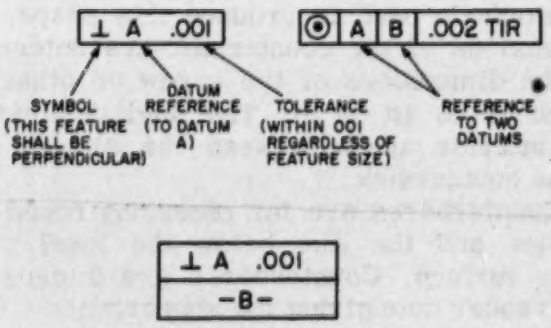

Figure 6-18.—Feature control symbol incorporating datum reference.

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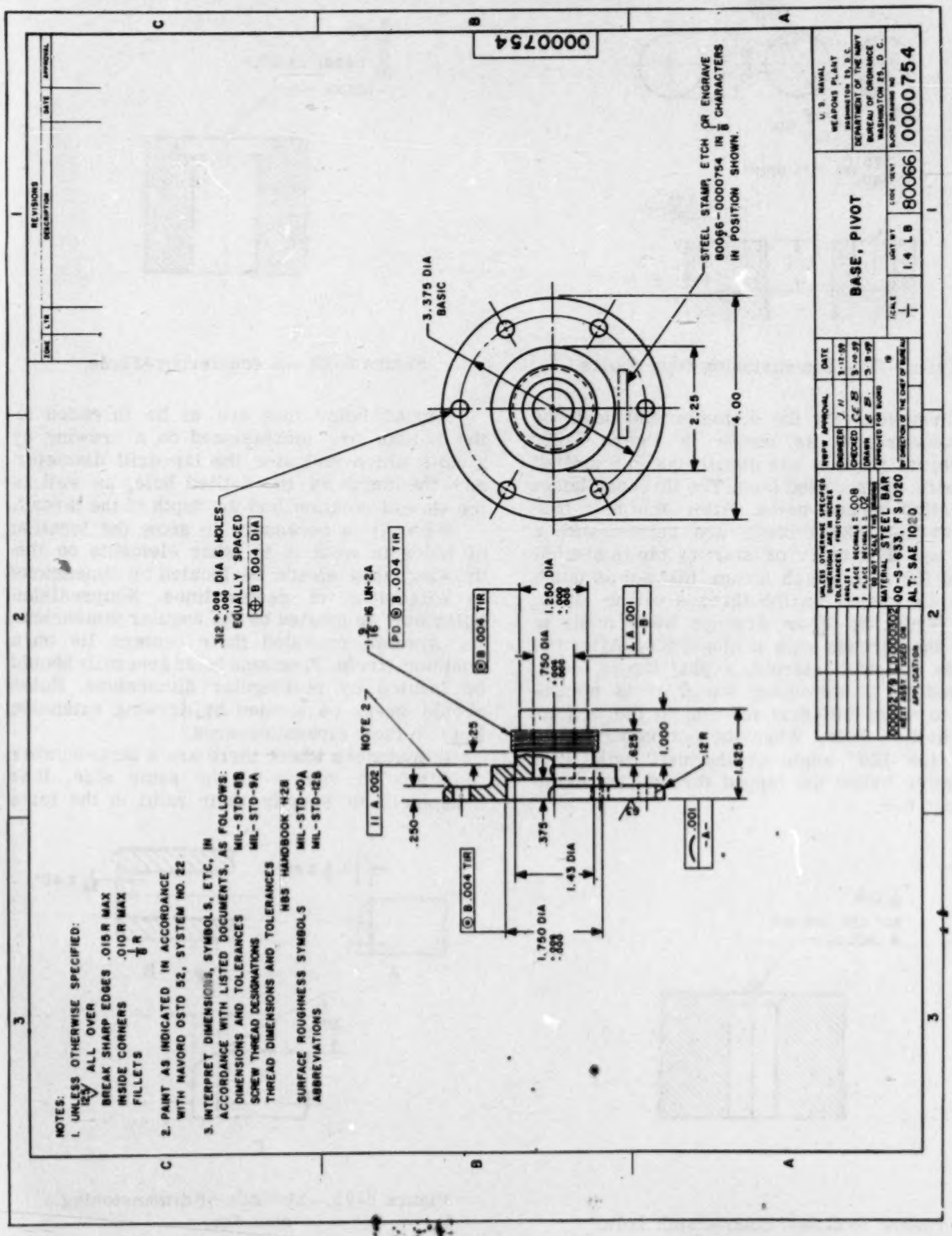

Figure 6-19.—Detail drawing of a base pivot.

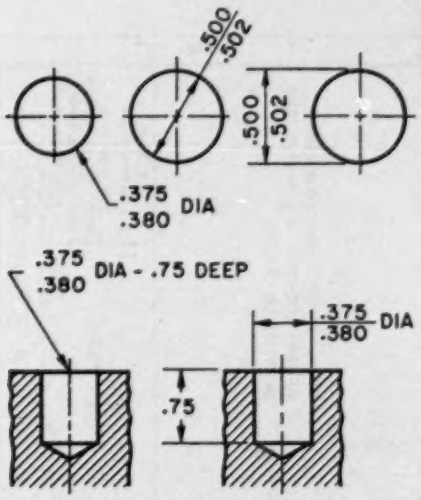

Figure 6-20.—Dimensioning round holes.

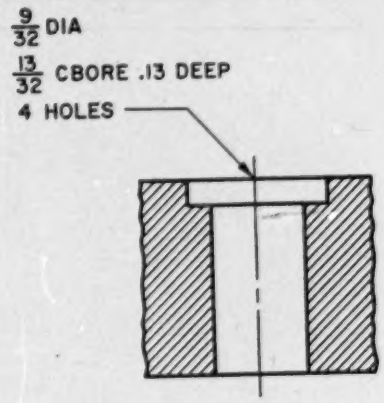

Figure 6-22.—A counterbored hole.

and dimensions for the diameter and depth of the counterbore, as shown in figure 6-22.

Internal threads are usually cut in a drilled hole with tools called taps. The threaded holes are called tapped holes. After the hole has been drilled, the threads are started with a taper tap. The taper or starting tap is slanted toward the end, which means that not as much strain is placed on the threads of the tap as there would be if an attempt were made to finish the threads with a single tool. After the threads are well started, a plug tap is used, followed by a bottoming tap if it is necessary to make full-size threads to the bottom of a drilled hole. When the bottoming tap is used, the 120° angle of the drill will still be visible below the tapped threads as shown in figure 6-8.

Tapped holes that are to be threaded to the bottom are dimensioned on a drawing by a note which indicates the tap drill diameter and the depth of the drilled hole, as well as the thread notation and the depth of the thread.

When it is necessary to show the location of holes in relation to other elements on the drawing, they should be located by dimensions to extensions of center lines. Nonprecision holes may be located by the angular dimensioning system, provided their centers lie on a common circle. Precision holes generally should be located by rectangular dimensions. Holes should never be located by drawing extension lines to their circumferences.

In instances where there are a large number of fillets or rounds of the same size, it is acceptable to specify their radii in the form

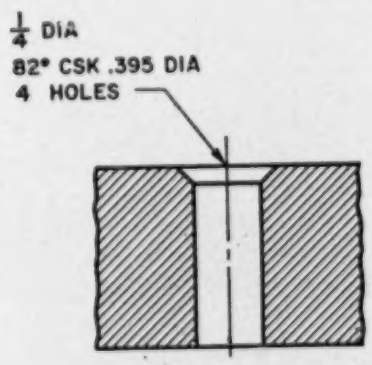

Figure 6-21.—A countersink hole.

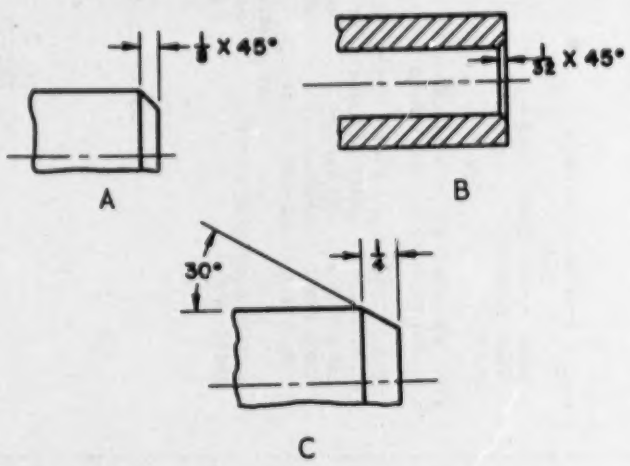

Figure 6-23.—Methods of dimensioning a chamfer.

of a note instead of specifying each individual radius. The following notes, with radius indicated in the blanks, may be used where they are appropriate and may be combined when necessary.

ALL EDGES - - - - - R UNLESS OTHERWISE SPECIFIED.
ALL FILLETS- - - - R UNLESS OTHERWISE SPECIFIED.

When the thickness of a curved wall is uniform, specify the radius on the inside or on the outside, but not on both sides of the same wall.

A spot-face is an area around a hole which is machined sufficiently to provide a seating surface for a bolt head, nut, washer, or similar item. It is not necessary to show a surface roughness symbol for a spot-face. A spot-face is specified by a leader to the surface to be spot-faced, with a note including the abbreviation SFACE and the minimum diameter. This leader and note may be combined with the leader and note used to specify the diameter of a concentric hole.

A chamfer is simply a bevel where a sharp angle of two adjoining surfaces has been removed, and this occurs in many places on machines and machine tools. A chamfer on a screw head which is to fit in a countersunk hole is dimensioned with a note giving the angle. Forty-five degree chamfers are dimensioned as shown in figures 6-23a and 6-23b. Other chamfers are dimensioned by giving the length and the angle as shown in figure 6-23c. It is unnecessary to use the word chamfer on the drawing.

Slots with rounded ends should be dimensioned by giving the over-all length of the slot together with the width and the radius as shown in figure 6-24.

External surfaces with rounded ends should be dimensioned by specifying the over-all length and width of the piece and the radius of the ends as shown in figure 6-25. Holes or other features should be dimensioned as shown in figure 6-26.

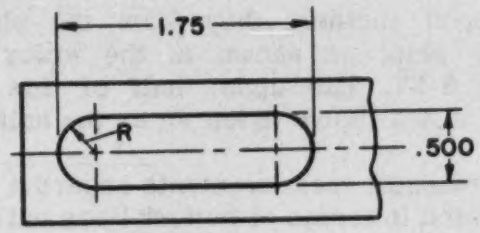

Figure 6-24.—Dimensioning a slot with rounded ends.

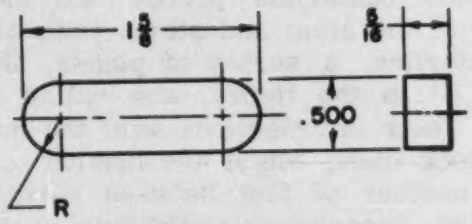

Figure 6-25.—Dimensioning external surface with rounded ends.

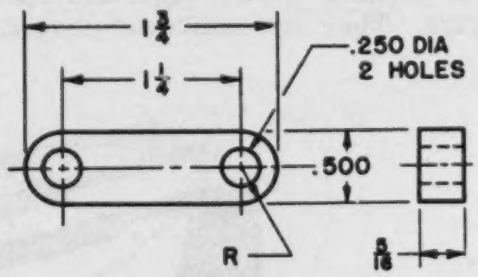

Figure 6-26.—Dimensioning external surface with rounded ends and holes.

SHIP STRUCTURAL DRAWINGS

Because of the shape of a naval vessel, the usual plan and elevation drawings are inadequate for the purpose of locating all points and defining all structures. Instead a system of fundamental lines and sections are used. The hull of a ship is considered to be cut by a series of horizontal, vertical, and transverse planes, with a result similar to the subdivision of an egg crate or an ice cube tray.

All vertical measurements aboard a ship are calculated from the plane of the base line (BL). The base line plane extends horizontally from an established point at the bottom of the ship, usually along the top of the flat keel. For convenience in measuring above the base line, a series of waterlines (WL) are established. Each waterline is a certain number of feet from the base line. In figure 6-27, the water lines are shown at the intersection of the horizontal planes 1, 2, and 3 with the hull. When these waterlines are superimposed

one upon another, they form the plan view of the ship, as shown in the lower part of figure 6-27. The upper half of this plan as shown in the figure is known as the half breadth plan.

Horizontal measurements aboard a ship are calculated in terms of buttock lines and stations. Transverse measurements are calculated from the centerline. In figure 6-28, the vertical plane A passes through the exact fore-and-aft centerline, and is termed the vertical centerline plane of the ship. Its intersection with the hull shows the centerline profile and the exact contour of the stem and stern. Outboard from the centerline, a series of planes, shown by B and B' in the figure, are called buttock planes. Their intersections with the hull form the buttock lines, which are labeled according to the number of feet between each and the centerline. Superimposing the buttock lines one upon another gives the sheer plan of the ship, as shown in the lower part of figure 6-28.

In order to show the complete shape of the ship, another set of lines, called frame lines are used between the forward and after perpendiculars. They are numbered progressively

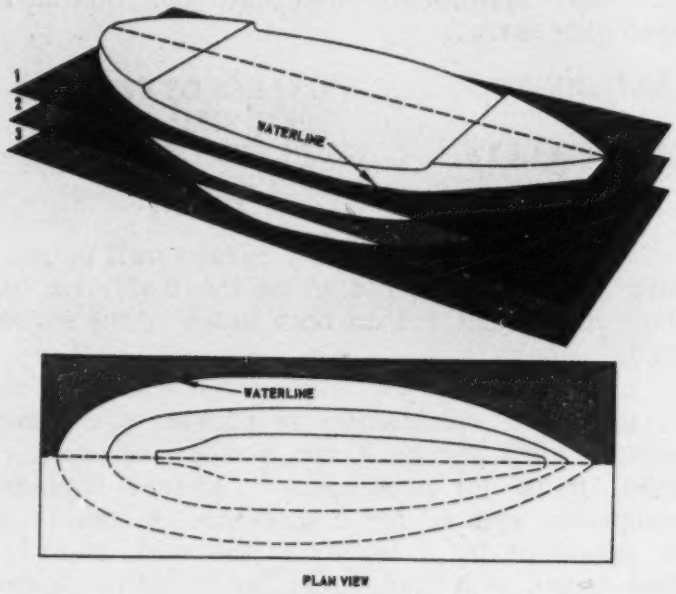

Figure 6-27.–Drawing showing horizontal planes and half-breadth plan.

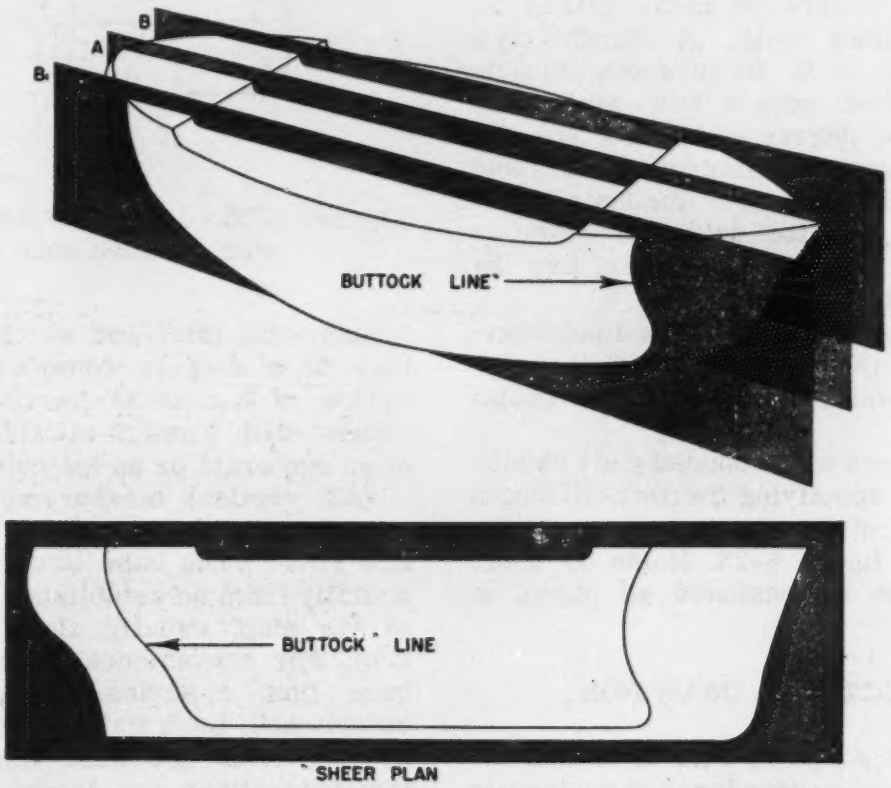

Figure 6-28.—Vertical centerline plane, buttock planes, and sheer plan.

from fore to aft. The distance between each of these lines varies with the different types of ships. These lines are defined by the intersection of transverse planes with the hull of the ship, as shown in figure 6-29. Such an intersecting plane is called a station. The outline of the hull as intersected by a station is a section. If the frame lines are shown superimposed one upon the other as in the lower portion of figure 6-29, the resulting drawing is called the body plan of the ship.

Some ship hulls are symmetrical with respect to the vertical centerline plane, only one side of the waterlines (port or starboard) need be shown to give the full shape of the hull. Therefore, only half of the plan view, or the half-breadth plan, is ordinarily used. (See upper sketch of fig. 6-30.) Since there is the same symmetry in the body plan, the right half of this plan shows the successive frame lines from the midship section forward, and the left hand side shows the frame lines from the midship section aft. This combination, shown in the middle of figure 6-30 makes for clarity, requiring fewer lines to represent the hull sections. The lower view of figure 6-30 shows the plan with the buttock lines in their true shape.

An additional set of planes is sometimes used, as shown in figure 6-31. These planes are perpendicular to the stations, intersect the

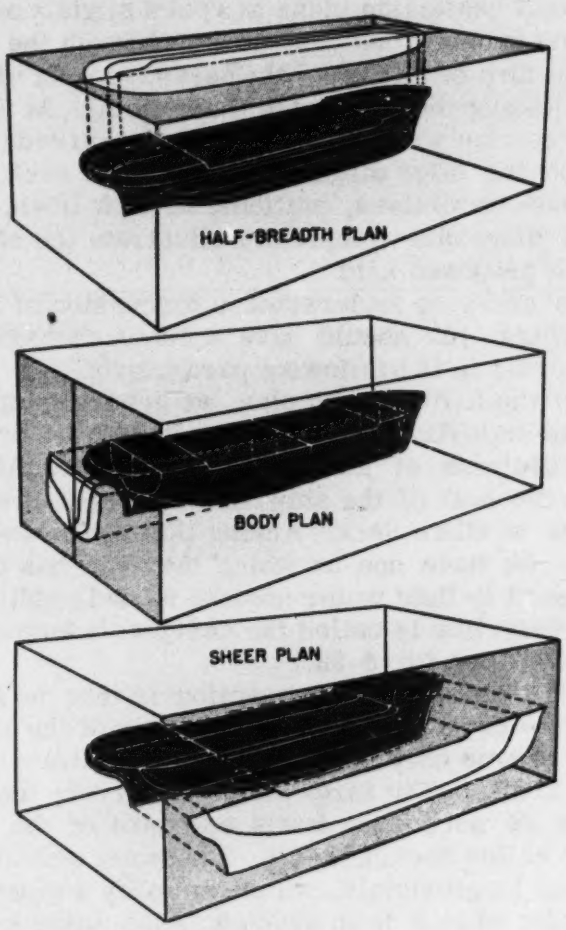

Figure 6-30.—Projection of half-breadth plan, body plan, and sheer plan.

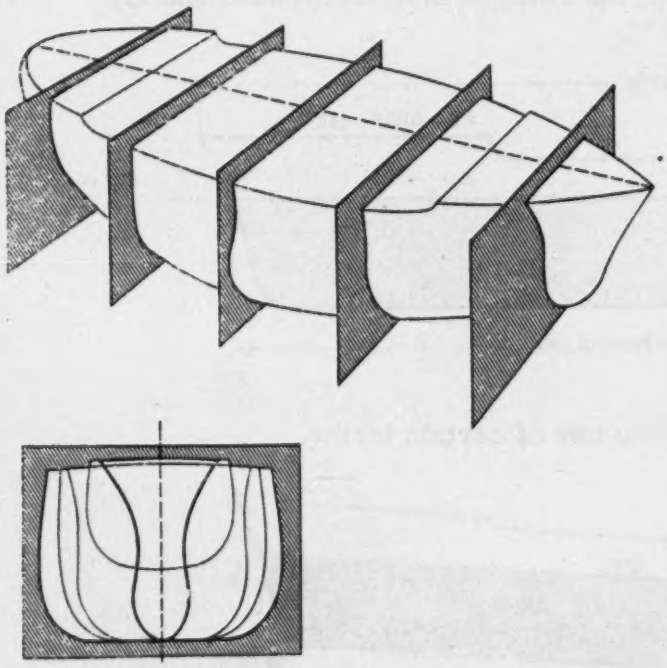

Figure 6-29.—Drawing showing transverse planes and body plan.

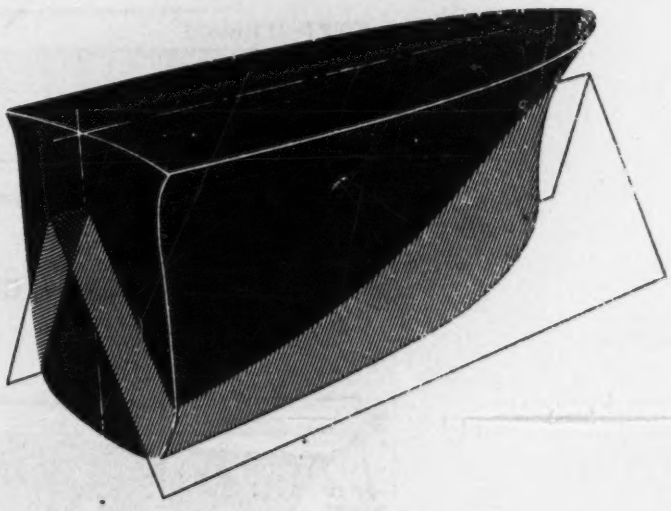

Figure 6-31.—Drawing showing projection of the bilge diagonals.

vertical centerline plane at a point slightly below the main deck, and extend out through the hull at the turn of the bilge (the curved section of the hull joining the sides with the bottom). At their intersection with the hull, they form curved lines called the bilge diagonals. As can be seen, the various waterlines, stations, buttock lines, and bilge diagonals completely illustrate the shape of the proposed ship.

In order to understand a discussion of ship drawings, you should have a comprehension of the terms in the following paragraphs.

In the half-breadth plan, we generally speak of the waterlines as the lines developed by the intersections of successive horizontal planes with the hull of the ship, from the keel upward to the weather deck. Among this set of waterlines we have one at which the ship has been designed to float under normal loaded condition. The waterline is called the designer's waterline (DWL). (See fig. 6-32.)

One common misconception is that the keel extends downward from the bottom of the ship. This is true only in the case of small boats with bar keels. On large ships, however, use is made of secondary keels outboard of the flat keel, called docking keels. These are relatively strong longitudinals, which simplify support of the ship when it is in drydock. Also, bilge keels are present on many larger ships. These are triangular or flat plate keels projecting from the hull at the turn of the bilge, running fore-and-aft for approximately two-thirds the length of the ship, and serving to help reduce the roll of the ship in a seaway.

Length of a ship is expressed in two ways: length over-all and length between perpendiculars. In the first case, the length is measured from the extreme forward end to the extreme after end of the ship. The length between perpendiculars extends from the forward perpendicular (FP) to the after perpendicular (AP), the perpendiculars being vertical lines passing through the line and the designer's waterline at its intersection with the bow and stern of the vessel in the sheer plan. Length between perpendiculars is sometimes called waterline length. (See fig. 6-32.)

Draft, or vertical distance from the surface of the water to the bottom of the ship's keel, is measured at the bow and at the stern by scaled markings on the hull. Draft, then, is generally spoken of as draft forward and draft aft. The average of these two readings is known as mean draft.

Trim is defined as the angle to the horizontal at which a vessel floats. In general, this is the angle between the designer's waterline and the actual waterline at which the ship is floating. If the draft forward is greater then the draft aft, the trim of the ship is changed, the numerical value of this change is the algebraic difference of the changes in draft forward and aft.

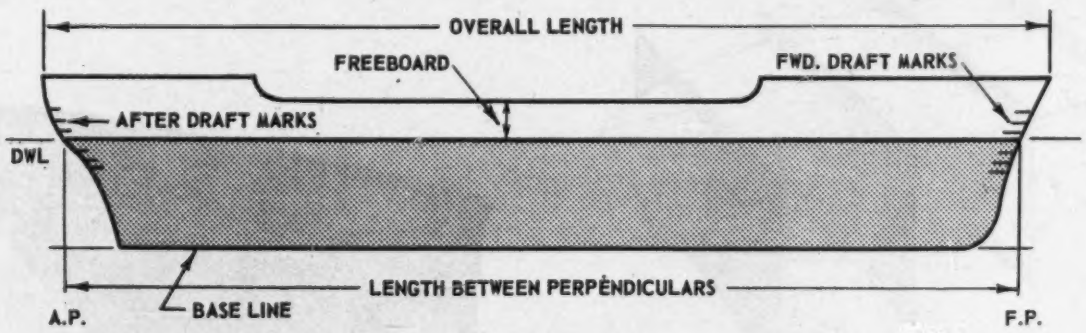

Figure 6-32.—Drawing illustrating use of certain terms.

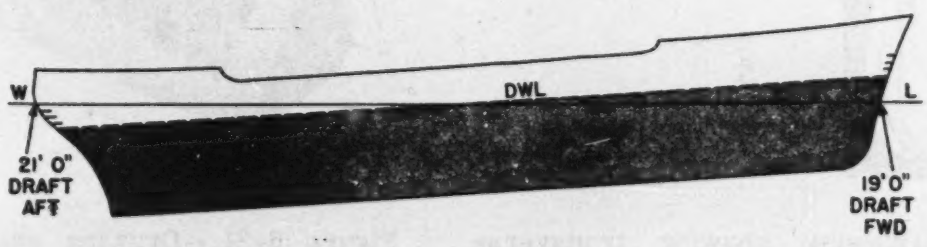

Figure 6-33.—Draft of a ship.

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As an example of the above statements: if a ship is trimmed so that she draws 21 feet 0 inches aft and 19 feet 0 inches forward, she is down by the stern and her mean draft is 20 feet 0 inches. By thus changing the trim, we have decreased the draft forward by 12 inches, and we have increased the draft aft by 12 inches. Thus, the change of trim is a plus 12 inches aft minus a negative 12 inches forward which equals 24 inches, as illustrated in figure 6-33.

Frequently, a ship's characteristics are improved if she has a slightly greater draft aft. When a ship is so designed, she is said to have been designed with a drag.

Dealing with measurement of the above-water portion of the ship's hull, we have freeboard, or the vertical distance from the water to the weather-deck edge at any point. Sheer is the excess of freeboard forward or aft over the amidships.

One never speaks of a ship's width, but rather of her breadth, or beam, which is the athwartship measurement taken at the broadest point of the hull.

When a ship is first floated, it will sink to a draft at which it displaces a weight of water equal to the weight of the ship. Therefore, we speak of a ship's weight as its displacement in tons. Displacement is always measured in long tons; that is, 1 ton equals 2,240 pounds.

The basic structural component of a warship is flat steel used to form the shell, decks, and bulkheads of the ship. Such pieces are subdivided into two types: sheets and plates. Those having a weight of 5 pounds per square foot of surface or less are known as sheets. Those having a weight of over 5 pounds per square foot of surface are known as plates.

The major parts of the structural steel used in ship construction is plating which usually comes in rectangular shapes. The shell of the ship is made up of fore-and-aft rows of plating known as strakes. The junction of plates within a strake is a butt, while the connection between the plates of adjacent strakes is called a seam. These plates are fastened together to form seams and butts by means of riveting or welding.

In general, three types of plates are used in ship construction:

1. Flat plates, which are the most common type on the sides, bottom, bulkheads, and decks of a vessel.

2. Rolled plates are those having curvature in one dimension only. The most common uses are at the turn of the bilge. They are formed cold on a roller in a shop.

3. Furnaced plates are those plates having curvature in two or three dimensions. It is necessary in this case to heat the plate and shape it while hot. The plates around the outboard propeller shaft bearings, which are called boss plates, are usually furnaced because of the large amount of shaping necessary. The plates in the lower section of the bow are also usually furnaced plates.

The common structural shapes used in ship construction are shown in figure 6-34. Of these, the I-beam and T-bar are most widely employed. These shapes are rolled to size and form in the steel mills and are delivered ready for use. Shapes similar to those shown in figure 6-34, but of larger than normal manufacturing size are built up from plates and angles, as shown in figure 6-35.

The keel (K) of a ship is frequently referred to as the backbone of the hull. It is a built-up girder consisting of the central vertical keel (CVK), the dished or flat keel plate, and the rider plate or keelson plate. The flat keel or central bottom strake is always of

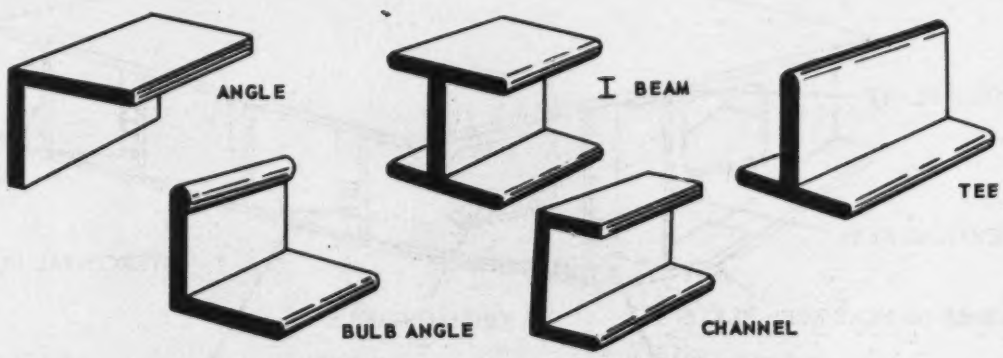

Figure 6-34.—Common structural shapes used in ship construction.

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The principle of operation can be illustrated by an L-C resonant circuit in which the spacing of the capacitor plates is varied cyclically by a "pump" at a frequency twice the signal frequency which is identical to the resonant frequency of the circuit. (See fig. 12-21.)

The circuit has a resonant frequency f as indicated by the capacitor voltage as a function of time. Imagine that the capacitor plates can be physically separated and returned to the original separation. If the capacitor plates are separated at A when the voltage is at maximum, there is a decrease in capacitance and a corresponding increase in voltage. (Since E = Q/C, the total charge Q on the capacitor must remain what it was when the voltage reached its peak value.) Work is done when the plates are pulled apart to separate the charge. The total energy in the system has been increased by the source which separated the capacitor plates. The energy transfer is referred to as pumping, and the source supplying the energy is referred to as the pump.

From point A, the capacitor begins to discharge and the energy which was stored in the electric field between the capacitor plates is converted into energy in the magnetic field surrounding the inductance L. If the plates of the capacitor are returned to their original separation at B when the voltage goes through zero and there is no charge on the plates, no work is done and the voltage is unchanged. If the capacitor plates are separated when the voltage is at the maximum negative point C, additional energy is supplied to the system.

In order to obtain maximum amplification, the plates must be separated at the precise maximum positive and negative points (A and C), and they must be returned to their original position B at the precise instant when the voltage is zero between the capacitor plates.

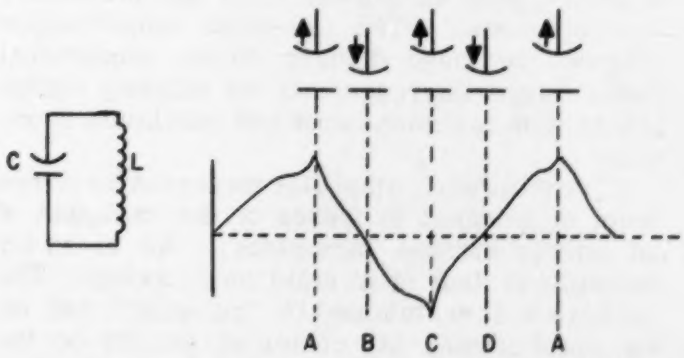

Figure 12-21. —Capacitor plates varied by a pump.

The frequency of the pumping source is twice the resonant frequency of the tank circuit. If the phase of the pump input and the resonant frequency of the tank circuit are not correct, the resultant gain will be somewhat less than achieved under a phase-locked condition.

In a practical case, the separation of the signal frequency and the pump frequency cannot be conventiently maintained constant, but will drift in and out of the optimum condition periodically, resulting in modulation of the signal frequency. Thus, the output will contain the pump frequency, signal frequency, and the pump frequency minus the signal frequency. (The latter is called the idler or image signal.)

Several devices may be used to provide operation in the parametric mode. One is the silicon diode which is used as a silicon capacitor since it has low-noise and high frequency characteristics. Another device is the reactance tube which can provide the pump action by periodically, varying the capacitance in response to an input signal. By the use of the nonlinear characteristics of ferromagnetic and ferroelectric materials, parametric amplification can also be achieved.

There are three basic configurations of the parametric amplifier. (See fig. 12-22.) They are as follows:

1. Two-port sum-frequency (or upper sideband) up-converter.
2. Two-port difference-frequency (or lower side-bank) down-converter.
3. One-port difference-frequency parametric amplifier.

In the two-port sum-frequency arrangement, the overall noise figure is higher than other modes of operation, and the amplifier has only moderate gain due to the restrictions placed upon the varactor at maximum pump frequency. However, it does have a wide bandwidth. In the two-port difference-frequency mode of operation, the amplifier has a relatively narrow bandwidth, high gain, and a low-noise figure.

In the one-port difference-frequency mode, the parametric amplifier has the lowest noise figure. It is also fail-safe in that the system would continue to operate with near the same noise figure if the pump were to fail. However, a circulator must be used to separate the amplified output from the incoming signal; this also aids in maintaining amplifier stability

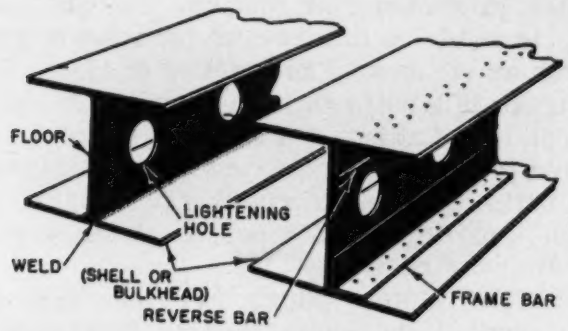

Figure 6-35.—Examples of built-up shapes; diagram on the left shows welded construction diagram on right shows riveted construction.

extra strength although of less than standard breadth. Joining the flat keel is the bottom plating. Figure 6-36 illustrates the structure of a typical keel.

Members extending to the sides of the vessel and joined perpendicularly to the central vertical keel are called floors. Floors may be closed and watertight, or they may be open. (See fig. 6-37.) Extending the length of the vessel are other members called longitudinals. The floors and longitudinals divide the bottom of vessels into compartments. Steel plating over the floor and longitudinals forms the inner bottom, which may also be called the tank deck. On cargo ships, frames are installed on the sides as continuations of the floors. On cruisers, floors run up to the lowest complete deck, and above this deck, web frames are installed.

The outside plating of the ship is called the shell plating. The entire vessel may be considered a horizontal box girder, and shell plating contributes greatly to the strength of that girder. Figure 6-38 illustrates the types of strakes used in building up the shell. Each strake is lettered alphabetically, starting on each side of the keel and continuing to the sheer of the ship. The letter I is usually omitted to avoid its being confused with J. The A strakes, joining the flat keel, are called garboard strakes. The final strake at the edge of the deck is called the sheer strake because it follows the sheer or longitudinal curve of the ship's profile.

An important strength function of decks is the support against racking (twisting) that they give to the ship. Certain decks are designed

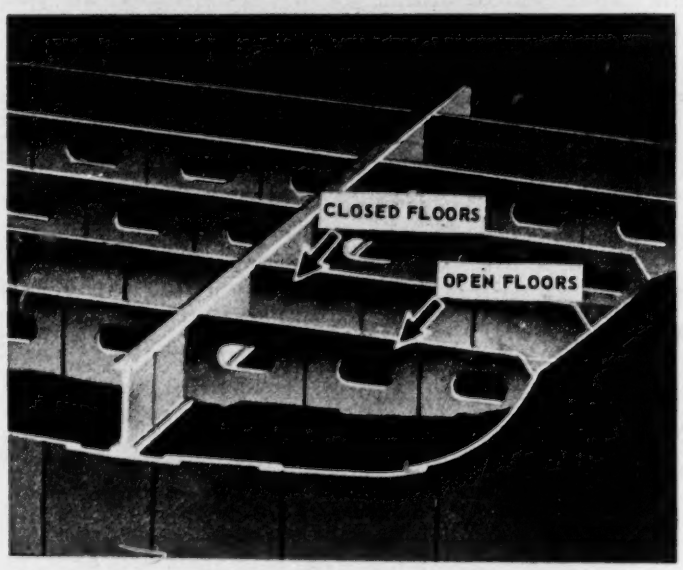

Figure 6-37.—Open and closed floors.

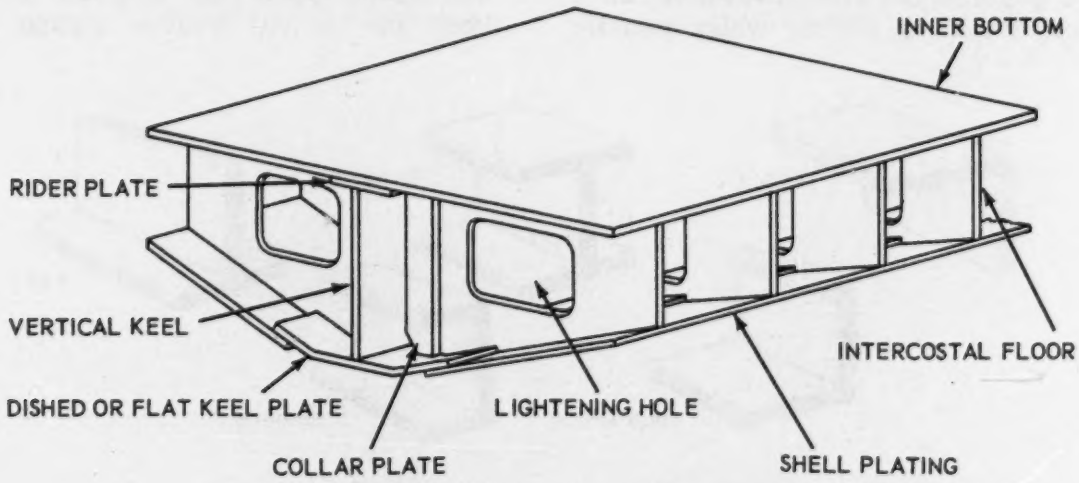

Figure 6-36.—Keel structure.

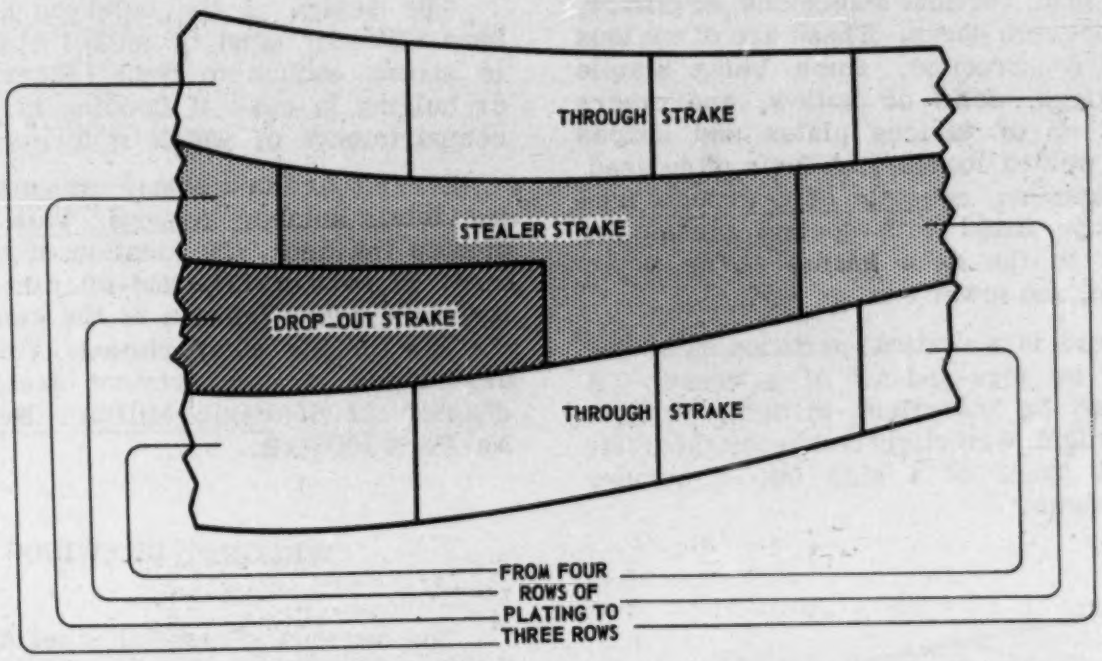

Figure 6-38.—Diagram showing types of strakes.

for protective purposes against plunging shell fire or aerial bombardment. These decks are designated as ballistic decks, or protective or splinter decks, and are fitted with plating of extra strength and thickness.

In warship construction all decks are watertight. They generally extend the full width of the ship but not necessarily the full length. A complete deck is one which extends the full length of the ship. A deck which does not extend the full length is known as a partial deck. The main deck is always a complete deck. The first complete deck below the main deck is called the second deck. Where there are several complete decks below the main deck, they are known as the second deck, the third deck, etc. A partial deck which is above the lowest complete deck is known as a platform. Where there are two or more partial decks below the lowest complete deck, they are known as the first platform, the second platform, etc. A deck which is laid a small distance above the inner bottom in the machinery spaces is known as a flat, and has no camber. The flats in the machinery spaces are not watertight, and ordinarily are composed of separate plates which are easily removable.

A deck which has more than ordinary sheer is known as an inclined deck. The relationship of decks are shown in figure 6-39.

In order to reinforce the deck beams and relieve the deck beam brackets and side frames

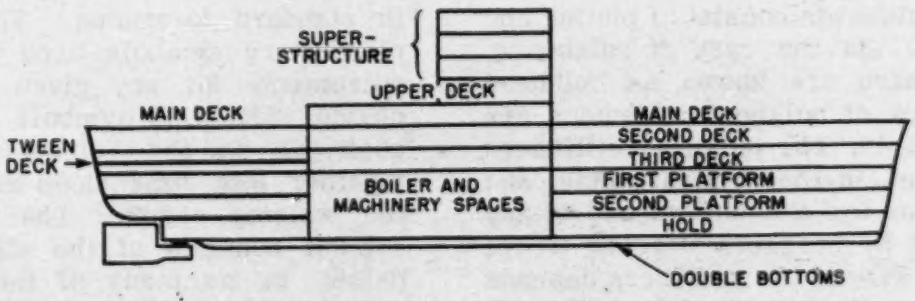

Figure 6-39.—Composite diagram showing the relationships of decks.

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of the total load, vertical stanchions, or pillars, are fitted between decks. These are of various sizes and construction, some being simple round sections, solid or hollow, and others being built up of various plates and shapes riveted or welded together. A form often used, the pipe stanchion, consists of a wrought iron or steel tube fitted with special pieces for securing it to the deck beams at its upper end, or head, and lower end, or heel.

A bulkhead is a vertical partition extending athwartship or fore-and-aft of a vessel. A bulkhead may be watertight, oiltight, airtight, or nonwatertight. Watertight bulkheads subdivide the internal space of a ship into a number of compartments.

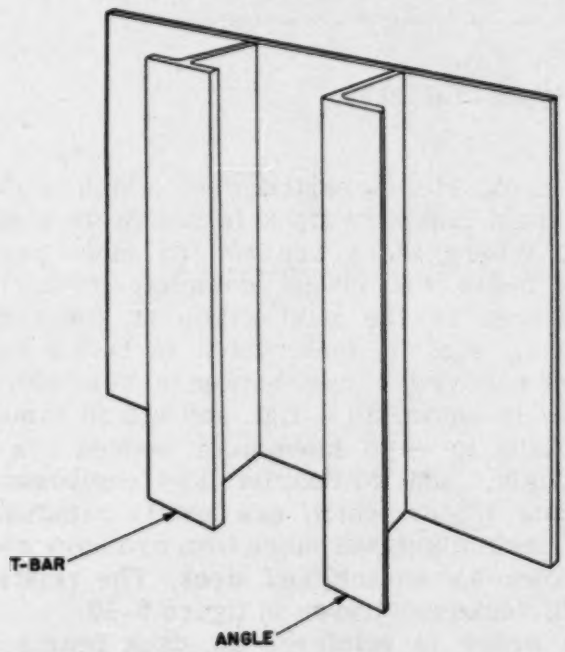

Figure 6-40.—Types of bulkhead stiffeners.

Like decks, bulkheads consist of plating and reinforcing bars. In the case of bulkheads, the reinforcing bars are known as bulkhead stiffeners. Types of bulkhead stiffeners are shown in figure 6-40. The bulkhead stiffeners usually are placed in the vertical plane, and are secured at the top and bottom and to any intermediate deck by brackets attached to the deck plating. The size of the stiffeners depends upon their spacing, the height of the bulkhead, and the hydrostatic head which the bulkhead is intended to withstand.

The design of the bulkhead and the bulkhead stiffener must be such that the structure is strong enough to resist excessive bending or bulging in case of flooding in either of the compartments of which it forms a boundary.

Every space in a ship is assigned an identifying letter-number symbol. This symbol indicates the deck, the location of the compartment in both a fore-and-aft direction and in its athwartship relation to the centerline, and the use of the compartment. For a detailed description of compartment designation, see chapter 11 of Basic Military Requirements, NavPers 10054-B.

WELDING DRAWINGS

The various structural steel shapes which make up the structure of a ship are generally connected together by welding, which is the process of fusing the parts into one body by the application of heat. The heat source may be burning gas or electricity. There are numerous processes of welding. There are various types of welded joints such as butt joints, corner joints, lap joints, tee joints, and so on; the name of the joint is descriptive of the positioning of the members to be joined. There are many types of welds such as bead welds, fillet welds, groove welds, and so on. All of these elements plus much additional detail may be shown on drawings by means of welding symbols and weld symbols.

For BuShips applications, the welding symbols to be used are set forth in American Welding Society Standard AWS A2.0-58. Typical symbols are shown in figures 6-41, 6-42, and 6-43. Figure 6-41 shows the welding symbol with the weld arrow. The arrow serves as a base on which all symbol information is placed in standard locations. The basic and supplementary symbols used to denote weld requirements for any given weld are also included. The weld symbols in their respective positions on the reference line and arrow, together with dimensions and other data, form the welding symbol. The assembled welding symbol consists of the eight elements listed below, or as many of them as are necessary to show the requirements of a given weld. Finish symbols indicate the method (C = chipping, M = machining, G = grinding)

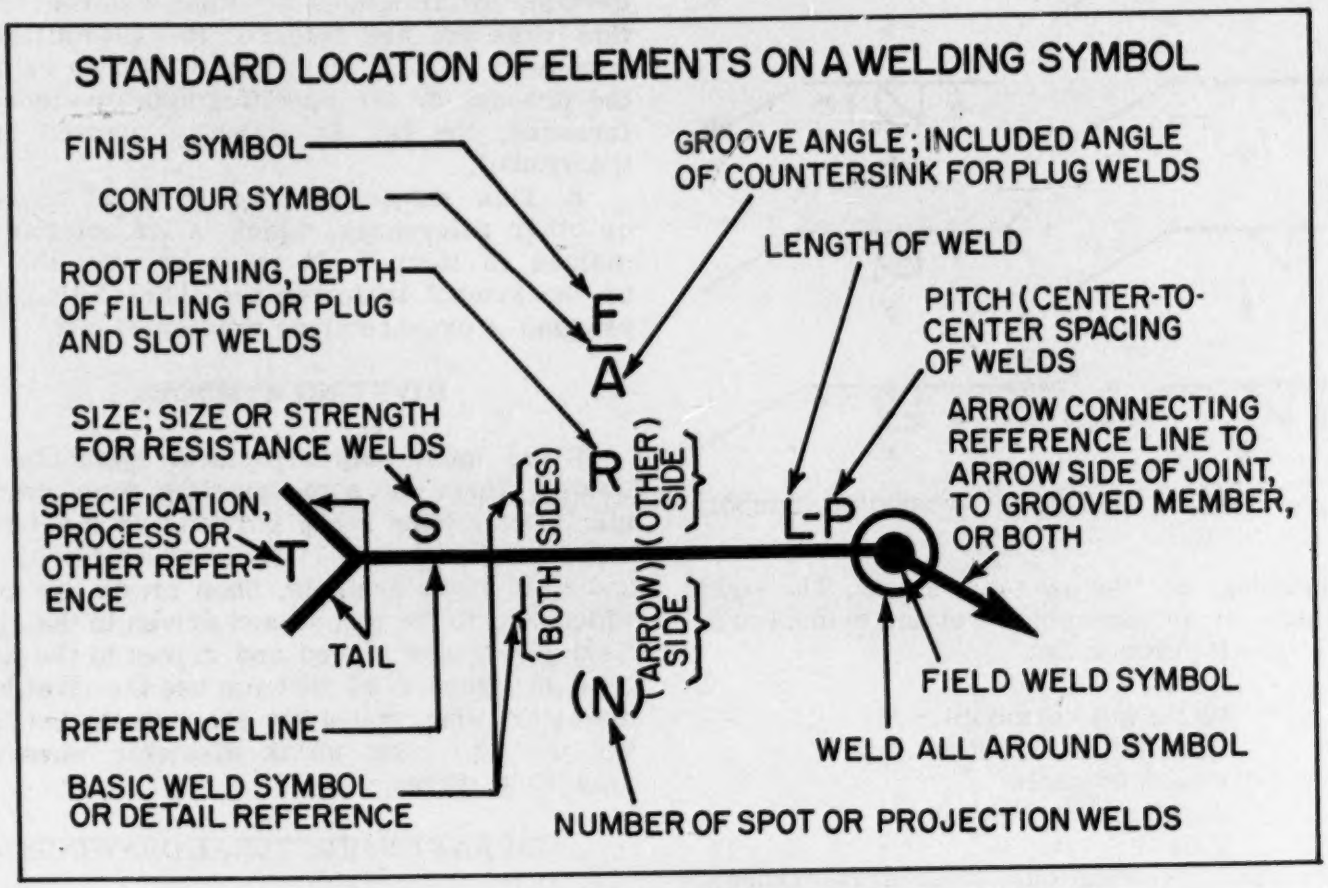

BASIC ARC AND GAS WELD SYMBOLS							
BEAD	FILLET	PLUG OR SLOT	GROOVE				
			SQUARE	V	BEVEL	U	J

BASIC RESISTANCE WELD SYMBOLS				SUPPLEMENTARY WELD SYMBOLS			
SPOT	PRO-JECTION	SEAM	FLASH OR UPSET	WELD ALL AROUND	FIELD WELD	CONTOUR	
						FLUSH	CONVEX

Figure 6-41.—Standard location of elements and types of welding and weld symbols.

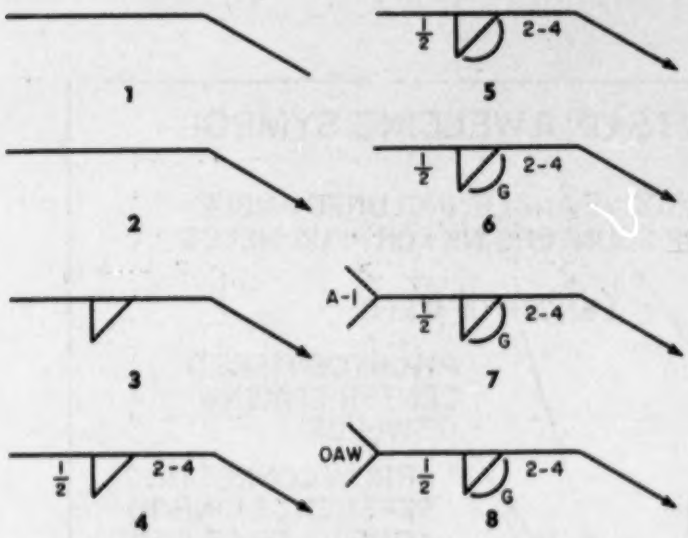

Figure 6-42.—Elements of a welding symbol.

of finishing, not the degree of finish. The eight elements of an assembled welding symbol are:

- Reference line
- Arrow
- Basic weld symbols
- Dimensions and other data
- Finish symbols
- Supplementary symbols
- Tail
- Process specifications, or other references.

To help clarify the reading of the eight elements of a welding symbol, refer to figure 6-42; each element is illustrated separately. The following is an explanation of each portion of figure 6-42.

1. This shows the reference line.

2. This shows the arrow. The arrow points to the location of the weld.

3. This shows the basic weld symbols. In this case it is to be a fillet weld and it is to be located on the arrow side of the object to be welded (explained in figure 6-43.)

4. This shows the dimensions and other data. The dimensions here indicate that the weld is to be 1/2 inch thick and 2 inches in length (L = length of weld, figure 6-41), and that the center to spacing (P = pitch of weld, figure 6-41) of the welds is to be 4 inches.

5. This shows the supplementary symbols (fig. 6-41). The supplementary symbol here indicates that the weld is to be convex.

6. This shows the finish symbol. The finish symbol illustrated here is G, which indicates that the weld will be finished by grinding.

7. This shows the tail. The tail is only used to set off symbols which indicate that you are to use a certain process or to follow certain specifications or other references; in this case you are referred to a specification numbered A-1. If there is no need to indicate the process or the specifications or other references, the tail is normally omitted from the symbol.

8. This shows the specifications, process, or other references, which is the notation explained in item 7. In this example, the tail of the symbol indicates the abbreviation of a process — oxy-acetylene welding (OAW).

RIVETING SYMBOLS

While most ship structural elements are welded, there is some riveting done—particularly in joining some portions of the superstructure. Figure 6-44 shows conventional shop and field rivet symbols. Shop rivets are those which are to be placed and driven in the shop; field rivets are placed and driven in the field. Note in figure 6-44 that you use the rivet head diameter when you draw shop rivets but that you use the rivet shank diameter when you draw field rivets.

AIRCRAFT STRUCTURAL DRAWINGS

Although aircraft drawing follows, in general, the procedures of other engineering drawing, it presents some problems rarely encountered elsewhere. Airplane drawings made by the Navy consist principally of drawings of rework, repair, and modifications to be made by the service activities for existing aircraft.

To learn the structural methods and principles applied to modern aircraft is made difficult by the fact that in aviation, design and structural methods are constantly changing.

An understanding of geometry is important, as well as skill in both orthographic and pictorial drawing and in development as applied to sheet metal work. It is often more convenient to determine measurements graphically, rather than mathematically. This requires precise measurements of the known distances and angles, care in transferring the measurements, and ability to draw smooth lines which meet accurately at points of intersection.

In addition to the drawing standards set forth in the MIL-STDs, there are usually additional standards set up by individual activities to meet their needs. When drawings are to be

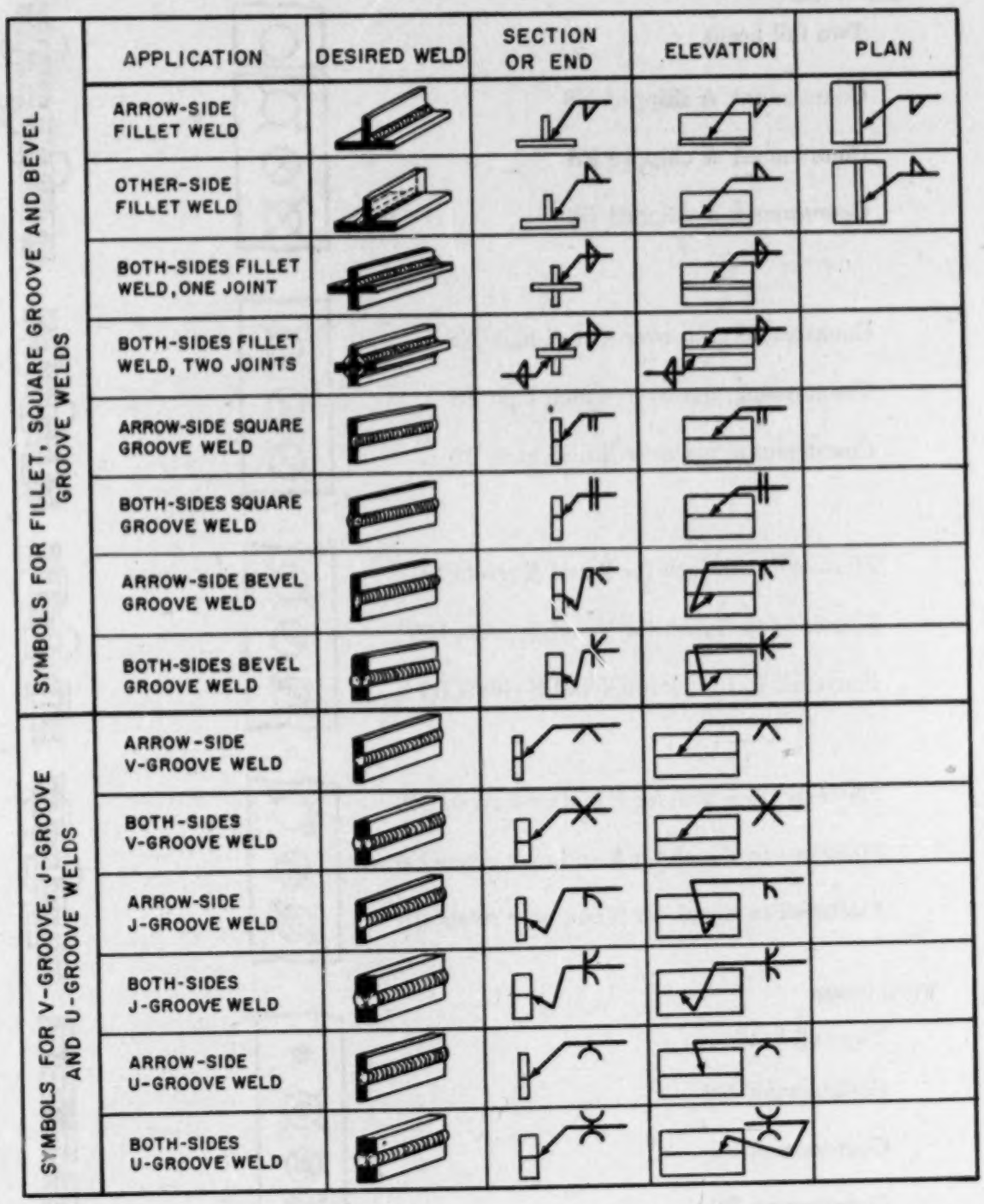

Figure 6-43.—Application of welding symbols.

Description	*Symbol* — *Plan*	*Section*
Shop rivets		
Two full heads		
Countersunk & chipped NS		
Countersunk & chipped FS		
Countersunk & chipped BS		
Countersunk, not over ⅛ inch high NS		
Countersunk, not over ⅛ inch high FS		
Countersunk, not over ⅛ inch high BS		
Flattened to ¼ inch for ½ and ⅝ rivets NS		
Flattened to ¼ inch for ½ and ⅝ rivets FS		
Flattened to ¼ inch for ½ and ⅝ rivets BS		
Flattened to ⅝ inch for ¾ and over rivets NS		
Flattened to ⅝ inch for ¾ and over rivets FS		
Flattened to ⅝ inch for ¾ and over rivets BS		
Field rivets		
Two full heads		
Countersunk NS		
Countersunk FS		
Countersunk BS		

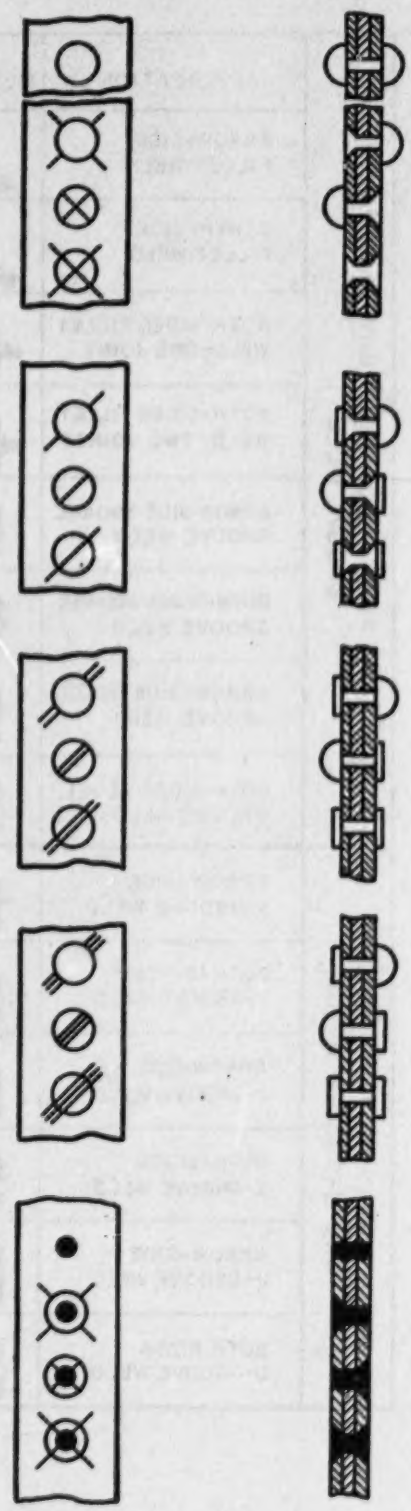

Notes:
NS-near side.
FS-far side.
BS-both sides.

Figure 6-44.—Riveting symbols.

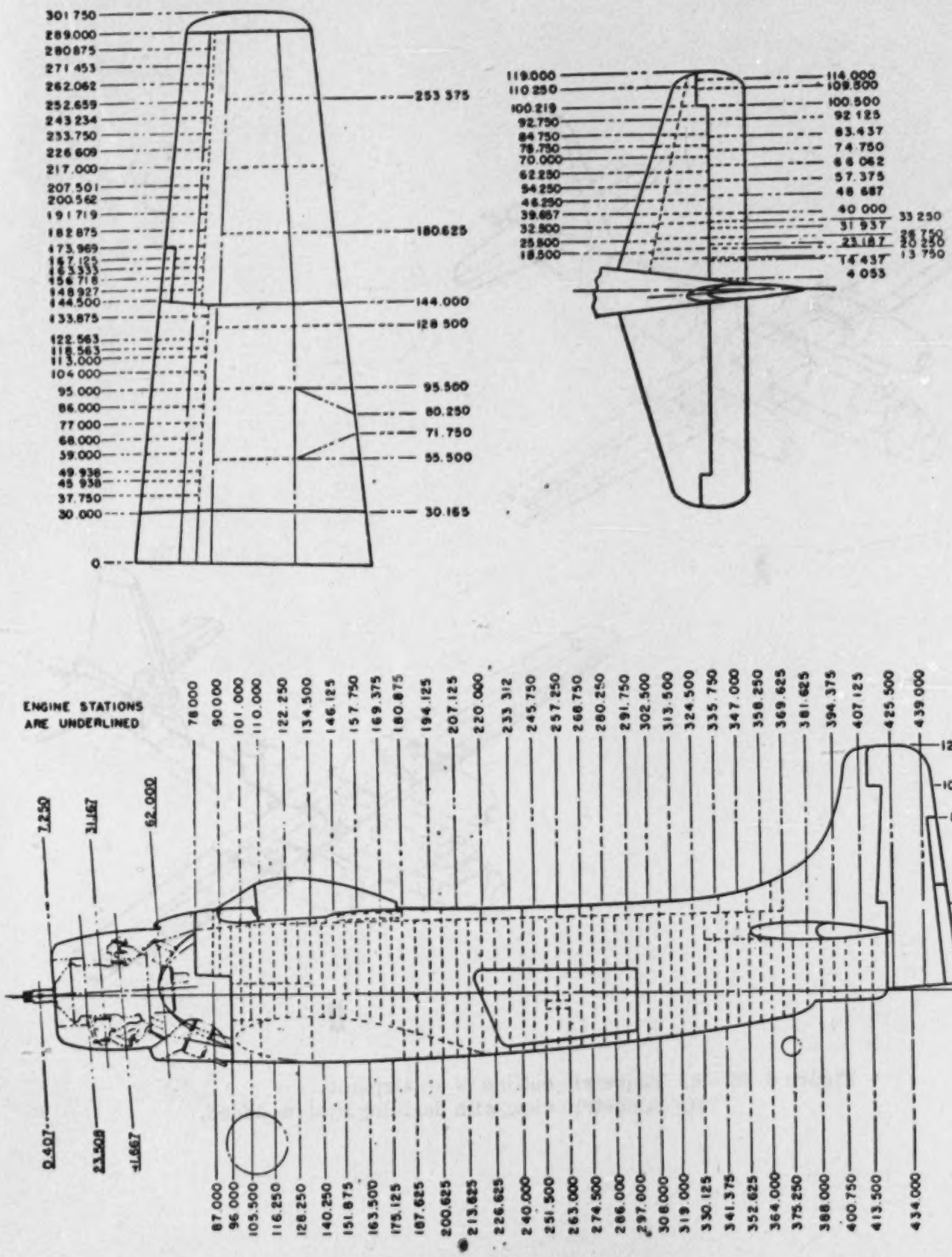

Figure 6-45.—Station marking.

made for a particular airplane, the drawing practices followed by the manufacturer of that plane will also serve as a guide.

As a general rule, detail and assembly drawings are made actual size. This necessitates the use of drawing sheets of greater width and sometimes of great length. It is desirable however, that the length should not exceed 144 inches. On large-sized drawings, horizontal and vertical zoning may be used as an aid to the location of items when the drawing is read. The approved method of zoning is described in MIL-STD-2C, Engineering Drawing Sizes and Formats.

Large detail, assembly, and installation drawings may be drawn to a reduced scale in information can be clearly shown in all respects. In order to do this, section or partial views may be drawn actual size where necessary. Draftsmen should bear in mind that the purpose of reducing the scale of a drawing is to reduce the size of the sheet to be handled and to avoid wastage of drawing and blueprint paper and file space. Therefore, as small a sheet should be used as practicable without crowding the drawing. Enough space should be left so that sectional views, notes, or tabulations can be added if these become necessary during the life of the drawing.

It is customary for every airplane part to have a number which corresponds with its detail drawing number. If more than one part is shown on one detail drawing, further identification may be accomplished by dash numbers. Thus, two parts shown on a single drawing may be numbered 34105—1 and 34105—2. On the drawing, the dash number preceeded by the dash should be placed in a small circle near the part it identifies. An arrow drawn from the circle should touch the outline of the part.

Sometimes, dash numbers are also used to distinguish between right-hand and left-hand parts which are mirror images of each other. In this case, the left-hand part may be shown and the right-hand part indicated by a note.

Draw only as many views in third-angle orthographic projection as are needed to clearly illustrate the part to be made. It is customary for principal views to be taken from the left side of the airplane with the nose pointed toward the left border of the drawing sheet. Partial views and sections may be used to illustrate certain features, thus making a greater number of complete views unnecessary.

One view may be used, for example, in drawing in a stud if the diameters are clearly marked as diameters. One view of a detail should correspond to the position of the view as shown on its next assembly drawing whenever possible. However, a part which is shown in an angular position when it is assembled should not be drawn in an angular position as a detail.

Sections should be projected directly if space permits, but if it is limited, a section view may be placed elsewhere on the sheet or on a separate sheet. Views which are not projected directly should be clearly marked to indicate the location from which they were taken and the direction in which they are viewed.

Various systems of station marking are used on aircraft drawings. For example, the center line of the airplane on one drawing may be taken as the zero station, and objects to the right or left of center along the wings or stabilizers may then be located by giving the number of inches between them and the center line zero station. On other drawings, the zero station may be at the nose of the fuselage, at a firewall, at the leading edge of a wing, or at some other location, depending on the purpose of the drawing and the custom concerning the particular part or assembly. (See fig. 6-45.)

Isometric, perspective, or orthographic views may be employed under some conditions where one of these types of drawing more clearly depict the article than the conventional ortographic projection. These drawings are of particular advantage when it is necessary to illustrate the installation of plumbing, wiring, or control linkage. However, with the curving lines and lack of parallelism, aircraft drawing is not considered easy even in orthographic projection, and the problems can be greatly magnified when an attempt is made to work in three dimensions. When three-dimensional drawings must be made, time can be saved and the work made easier if portions of new drawings, especially outlines, can be traced from other drawings and the appropriate additions drawn in. (See fig. 6-46.) A file of isometric outline drawings may be kept in the drafting room for this purpose.

Because of the large size of many drawings, dimensions should be made to read from the bottom. Dimensions are usually given in inches although some over-all dimensions, such as

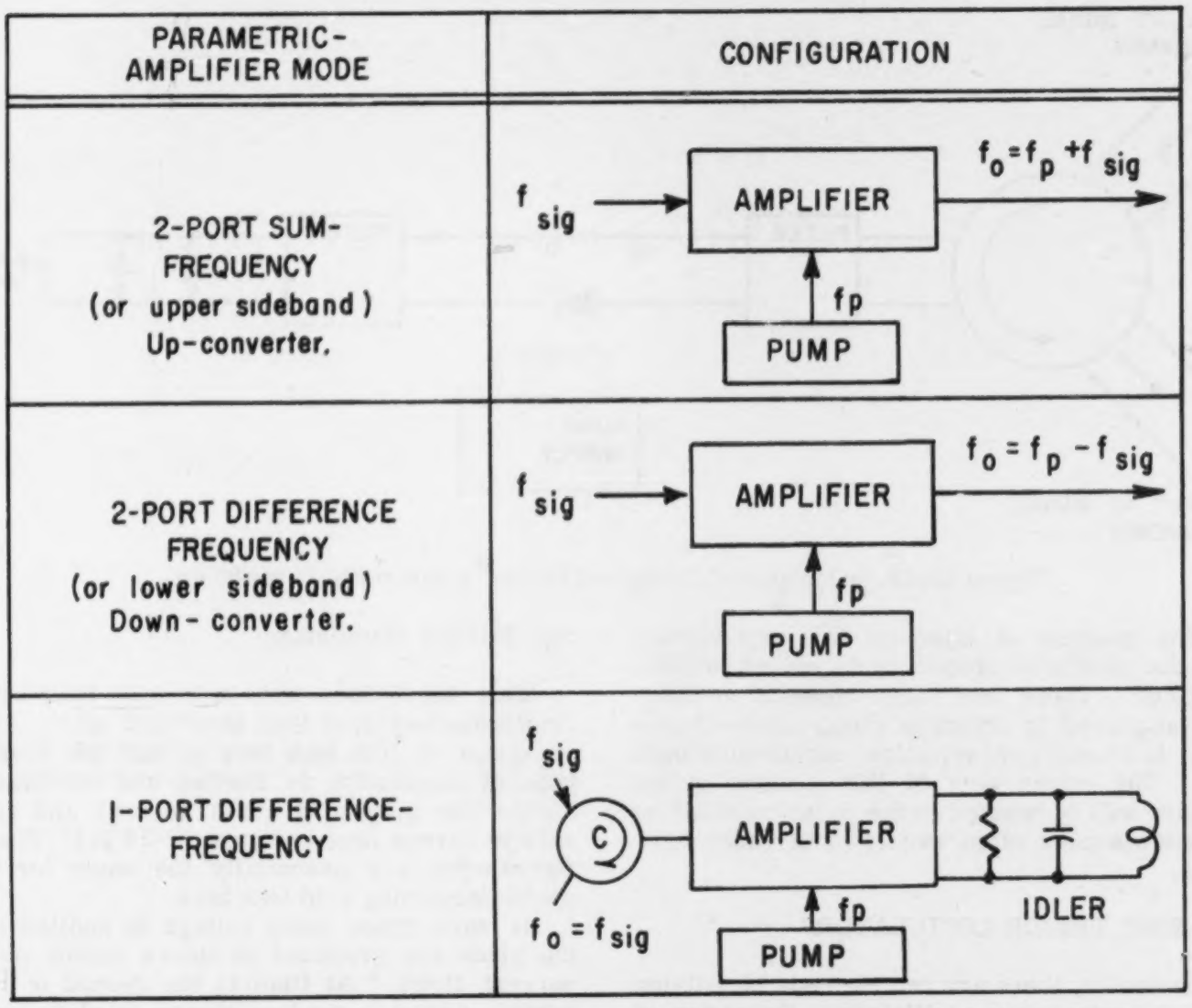

Figure 12-22.—Basic configuration of the parametric amplifier.

because it is sensitive to source impedance changes. The operation of the one-port difference-frequency parametric amplifier for the achievement of low-noise amplification (fig. 12-23) is as follows:

The varactor D (variable-capacitance diode) must couple together all the resonant sections at three frequencies—signal, idler, and pump. For amplification to occur, the sum of the idler and signal frequencies must equal the frequency of the pump. The signal frequency must be much lower than the idler frequency to achieve low noise. However, due to the imperfect nature of the varactor, there is an upper limit for the idler frequency at which noise will increase. The capacitance of the varactor will be varied at the pump frequency rate by power from the pump. Some of this power is transferred and added to the signal when the two frequencies are mixed, resulting in power amplification. The output signal is then taken from the circulator, which separates the input and output signals.

MODULATING OSCILLATORS

Oscillators are an indespensable part of most electronic equipments. However, in order to make the most use of the oscillator, it is necessary to insert some form of signal waveform that is used to convey information, messages, timing data, or whatever intelligence must be transferred from the transmitter to the receiver. Without this added information, the oscillator would in most cases be of no value.

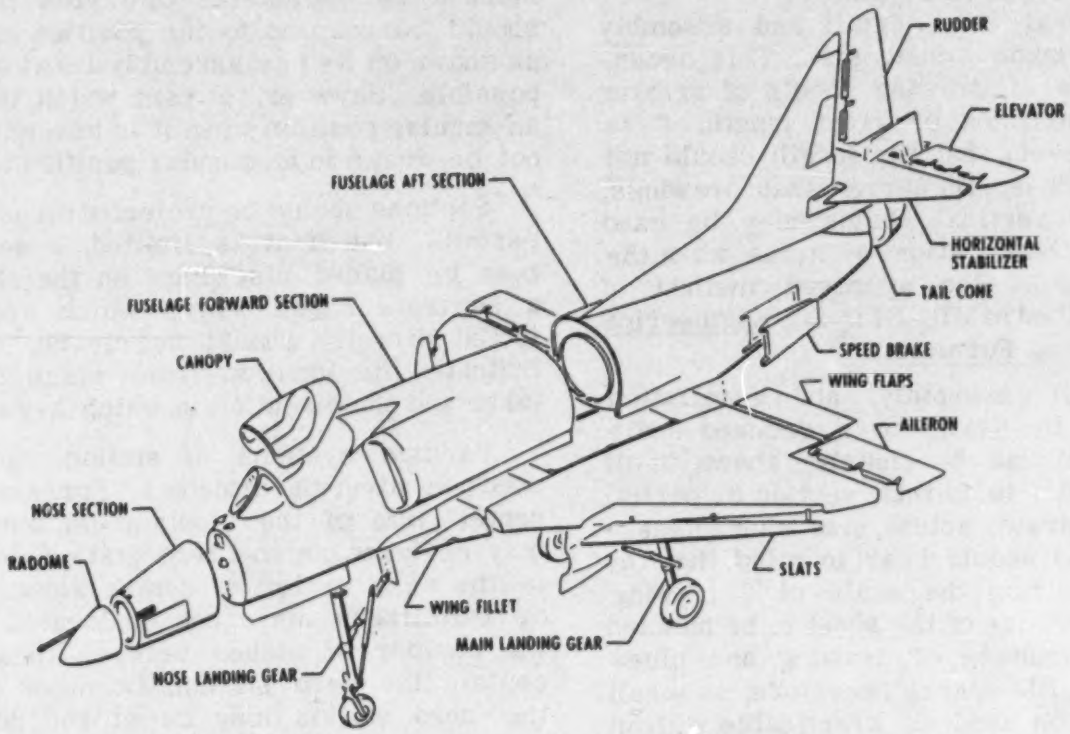

Figure 6-47.—Airplane nomenclature.

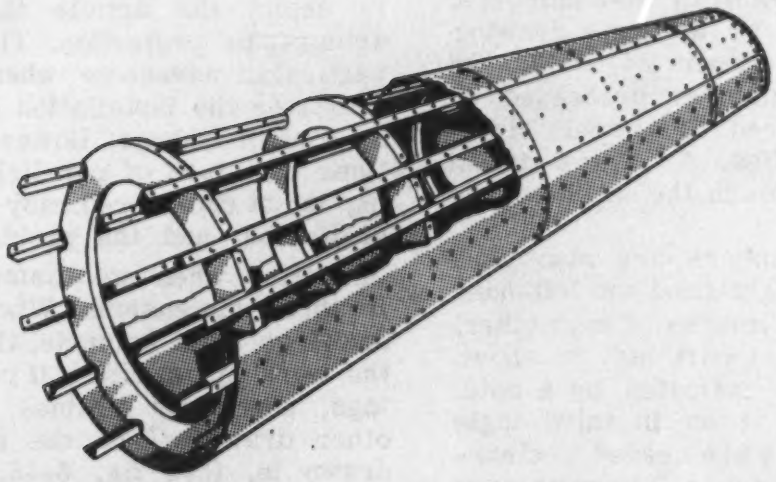

Figure 6-48.—Semimonocoque fuselage.

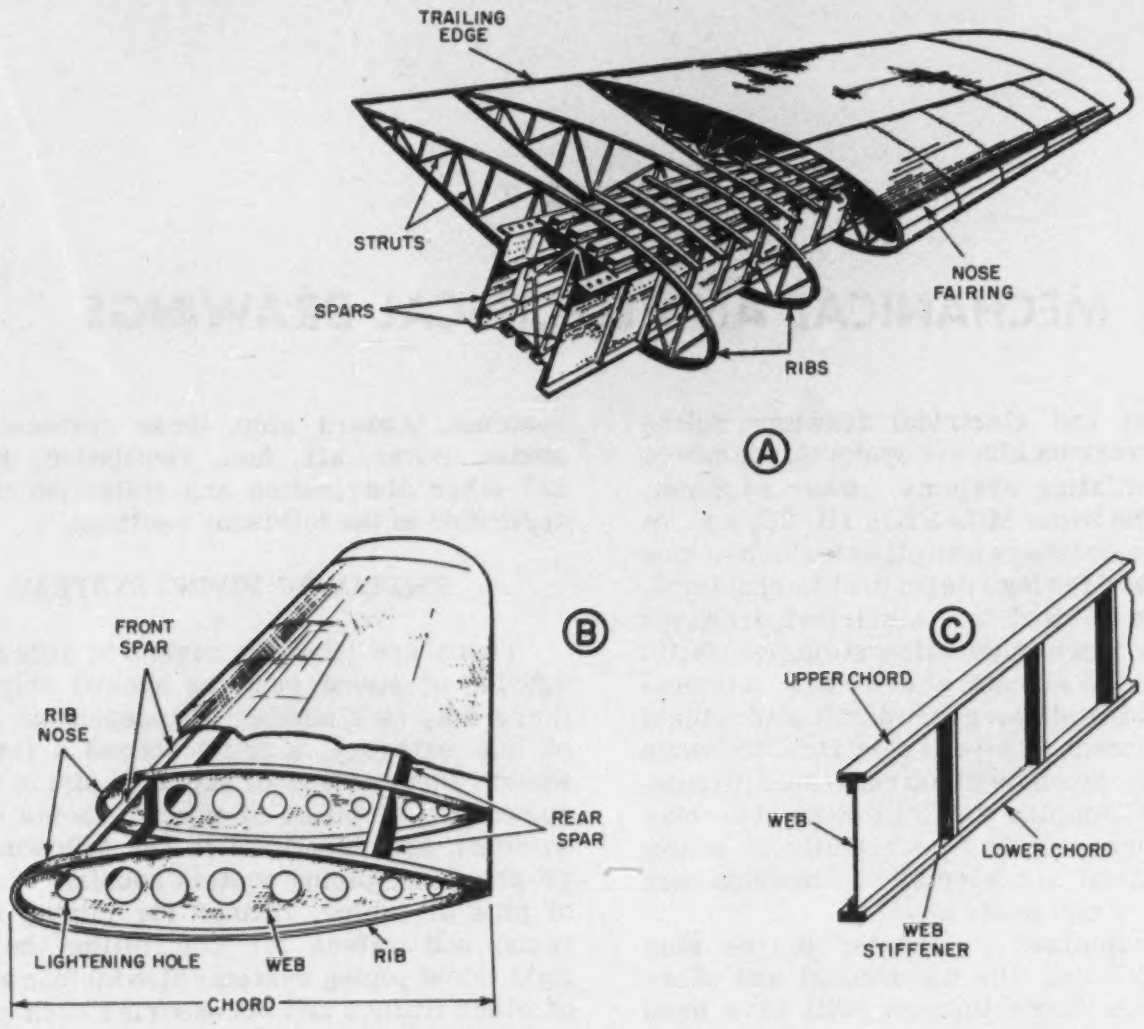

Figure 6-49.–Aircraft wing construction.
(A) Two-spar wing construction with strut support.
(B) Two-spar wing construction with web support.
(C) Detail of a spar.

wing span, are sometimes given in feet. In many activities, it is preferred that all dimensions be given in decimals instead of in common fractions.

A study of figure 6-47 will serve to refresh your memory with the names of the important parts of a typical airplane. The main structural unit is the fuselage, and other units are attached directly or indirectly to it.

Most military aircraft have what is known as semimonocoque construction. In this type, part of the stress is borne by the shell and part by lengthwise members, called stringers. (See fig. 6-48.)

Typical wing structures are illustrated in figure 6-49. Illustrated in figure 6-49A is a pictorial drawing showing the construction of a two-spar aircraft wing, using struts to brace the upper and lower chords of the rib. Figure 6—49B illustrates another two-spar wing construction using a web with lightening holes, (to decrease the weight) to support the upper and lower chords of the rib. Figure 6-49C is a detail drawing of a spar construction.

CHAPTER 7

MECHANICAL AND ELECTRICAL DRAWINGS

Mechanical and electrical drawings relate primarily to various kinds of systems; plumbing systems, ventilating systems, power systems, and so on. The basic MIL-STDs 1B, 2C, and 7A apply to these drawings as well as to the machine and structural drawings described in chapter 6. However, mechanical and electrical drawings are generally more schematic and diagrammatic than machine and structural drawings. A typical machine drawing shows every detail of the object depicted, but mechanical and electrical drawings may show only symbols which represent fittings, fixtures, or a complex item of machinery. Machine drawings are drawn carefully to scale; some mechanical and electrical drawings may not be drawn to any scale at all.

As was explained in chapter 6, the ship drawings, including the mechanical and electrical systems shown thereon, will have been prepared under the direction of BuShips. Any extensive revisions to the drawings will be made by shipyard or BuShips personnel. However, as with machinery or structural changes or repairs, it is possible that minor modifications to or extensions of mechanical and electrical systems may require that drawings be prepared locally. The draftsman who makes revisions to the ships drawings should know enough about the various mechanical and electrical systems so that he can distinguish one from another on the plans and be able to follow verbal instructions relating to the revisions. He should also have some knowledge of piping, cable, fittings fixtures, and appurtenances so that he can indicate the correct material designations and select the appropriate standard symbols for the drawings.

MECHANICAL DRAWINGS

As used here, mechanical drawings include the drawings of all kinds of piping and ductwork systems. Aboard ship, these systems include steam, water, air, fuel, ventilation, drainage, and other distribution and collection networks described in the following sections.

SHIPBOARD PIPING SYSTEMS

There are literally dozens of different categories of piping systems aboard ship. Since there may be a number of independent systems of one category, a count aboard a large ship would reveal scores of separate piping systems consisting of miles of piping. Some of these systems are identified in the following paragraphs. Each piping system consists of sections of pipe or tubing, fittings for joining the sections, and valves for controlling the flow of fluid. Most piping systems also include a number of other fittings and accessories such as vents, drains, traps, strainers, relief valves, and gages and instruments. Some of the following brief descriptions include a mention of various items of machinery or equipment related to or served by the system. On mechanical drawings, these items of equipment may be shown by a symbol, a block containing an abbreviation or words to identify the item, a rather symbolic outline conforming to the general shape of the item, or a pictorial representation of the item. Which of these methods of indicating machinery and equipment is to be used on a specific drawing depends on the scale and purpose of the drawing. The following descriptions also mention some of the materials of which the piping is made. This is generally indicated on the drawing in a material block, but it may also be shown adjacent to the line representing the pipe. Further, the type of material of which the pipe is made is closely related to the types of joints or connections used; and the type of connection (screwed, welded, soldered, and so on) is frequently shown on a mechanical drawing at each fitting and connection.

STEAM SYSTEMS

The main steam system is a comparatively short system but a very important one. Steam is generated in the boiler, then routed to the propulsion turbines, to the turbogenerators, and to the soot blowers via lines that are made of alloy steel tubing.

Auxiliary steam systems are either high pressure or low pressure, depending upon the units which they serve. The high pressure auxiliary steam system serves fire and bilge pumps, various service pumps, and fuel oil heaters. The piping and tubing is of the same material as that used in the main steam system. The low pressure auxiliary steam system is used for steam heat and for air ejectors in the distilling plant; seamless steel or copper pipe or tubing is used. The auxiliary steam system is routed in the form of a loop, with cross connection at suitable intervals; branch lines serve the various units of auxiliary machinery.

Service steam systems are low pressure systems which serve compartment heating units, galley equipment, fresh water heaters, and laundry equipment. Service steam systems are either constant service or intermittent service systems. Constant service systems are those in use the year around. Intermittent service steam systems are for heating services not required except in cold weather. Constant and intermittent service lines are usually cross connected.

WATER AND DRAINAGE SYSTEMS

Generally speaking, there are two classes of water: fresh water and sea water. The term fresh water is used on board ship to refer to potable water, feed water, reserve potable water, and reserve feed water. Potable water is water known to be of drinking water quality, while feed water is water known to be suitable for use in the ship's boilers.

Feed Water System

The condensate system and the boiler feed system, together, are frequently referred to as the feed water system.

The condensate system includes all the apparatus and piping used to collect and condense steam. The condensate system includes the main and auxiliary condensers, a pump or a combination of pumps, and the piping required to carry the condensate from the condenser to the deaerating feed tank. The main and auxiliary condensers recover feed water by condensing exhaust steam from propulsion turbines, generator turbines, and various auxiliary machinery units.

The boiler feed water system includes the deaerating feed tank, the feed booster pump, the main feed pump, and the piping required to carry the feed water from the deaerating feed tank to the boilers.

Steam and Fresh Water Drains

Most of the feed water in a shipboard steam plant is recovered so that it can be used over and over again for the generation of steam. As steam is condensed in the main and auxiliary condensers, the condensate is returned to the feed system. Also, the steam exhausted from auxiliary machinery is collected in the auxiliary exhaust system and is returned to the feed system. But steam is used throughout the ship in a good deal of machinery, equipment, and piping which does not exhaust either to a condenser or to the auxiliary exhaust system. Therefore, steam and fresh water drain systems are provided so that water can be recovered and put back into the feed system after it has been used (as steam) in fuel oil heaters, distilling plants, steam catapult systems, water heaters, whistles and sirens, and many other units and systems throughout the ship. The systems of piping which carry the water to the feed system, and also the water carried in the system, are known as drains.

There are five steam and fresh water drain systems on ships built to Navy specifications: (1) high pressure drainage systems, (2) service steam drainage systems, (3) oil heating drainage systems, (4) fresh water drain collecting systems, and (5) contaminated drainage systems. Most drain lines are fitted with steam traps to keep steam from passing into the drain systems.

High pressure drains generally include drains from superheater headers throttle valves, main and auxiliary steam lines, steam catapults (on carriers), and other steam equipment or systems which operate at 150 psi or above. High pressure drains are returned to the feed system by way of the deaerating feed tank.

The service steam drainage system collects drains from low pressure (below 150 psi) steam piping systems and steam equipment outside of

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the machinery spaces. On some ships, these drains discharge into the most convenient fresh water drain collecting tank; on other ships, particularly on large combatant ships such as carriers, the service steam drains discharge to two special service steam drain collecting tanks located in the machinery spaces—one in a forward machinery space, and one in an after machinery space. The drains are returned from the service steam drain collecting tanks to the feed system.

The oil heating drainage system collects drains from the steam side of fuel oil heaters, fuel oil tank heating coils, lubricating oil heaters, and other steam equipment that is used to heat oil. Since leakage in the heating equipment could cause oil contamination of the drains, these drains are collected separately and inspected before they are discharged to the feed system.

The fresh water drain collecting system (sometimes called the low pressure drain system) collects drainage from various piping systems, machinery, and equipment which operate at steam pressures of less than 150 psi.

Fresh water drains are collected in fresh water drain collecting tanks located in the machinery spaces. The contents of these tanks are discharged to the feed system.

A contaminated drainage system is installed in each main and auxiliary machinery space where dry bilges must be maintained. It collects oil and water from machinery and piping which normally has some leakage, and drainage from any other services which may at times be contaminated. The contaminated drains are collected in a bilge sump tank located in the same machinery space. The contents of the bilge sump tank are removed by the bilge drainage system.

Fresh Water Systems

Practically all fresh water used aboard ship is made by boiling sea water in the evaporators and condensing the resulting vapor. Water for general use is stored in peak tanks, or in other tanks at a distance from the machinery spaces; water intended for boiler use is stored in feed tanks located in the double bottoms or in wing tanks adjacent to the machinery spaces.

In the system which supplies hot and cold fresh water to scuttlebutts, sinks, showers, scullery, and galley, normal operating pressure is from 35 to 50 psi. This pressure is maintained by automatic electric pumps which take suction on the storage tank and discharge to fresh water pressure tanks.

Electronics Cooling Water System

Cooling water systems are now provided on most ships to cool electronics equipment. In this system, fresh water is usually circulated through the electronics equipment to carry away the heat generated during operation.

Firemain System

The firemain system aboard naval ships is a system of piping that receives water pumped from the sea and delivers it to fireplugs and sprinkler systems. It has certain additional functions, such as supplying water to flushing systems and supplying cooling water to auxiliary machinery; in certain installations it serves other purposes as well.

The type of firemain system installed on naval ships is governed by the physical characteristics and functions of each ship. The firemain may be a single main, a horizontal loop, or a vertical loop system.

Regardless of the type, the whole firemain system is so designed that a damaged section can be isolated, thus preventing loss of pressure in the remainder of the system.

In ships built to Navy specifications, the firemain material is required to be copper-nickel alloy with copper-nickel or bronze fittings and bronze valves. There are, however, a number of older ships that have the firemain system constructed of ferrous material.

Sprinkling Systems

Sprinkling systems are installed aboard ship in magazines, turret handling rooms, hangar decks, missile spaces, and other spaces where flammable materials are stowed. Water for these systems is supplied from the firemain through branch lines.

Most sprinkling systems aboard ship are of the dry type—that is, they are not charged with water beyond the sprinkling control valves except when they are in use. Sprinkling systems in magazines which contain missiles are of the wet type. The sprinkling control valves in magazine sprinkling systems are operated automatically by heat-actuated devices. Other sprinkling control valves are operated manually or hydraulically, either locally or from remote

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stations. In those areas of the ship in which major flammable liquid fires could occur, such as in aircraft hangars, foam sprinkling systems are provided.

Piping material used in sprinkling systems is copper-nickel.

Washdown Systems

Washdown systems are installed aboard ship for the purpose of removing radioactive contamination from topside surfaces of a ship.

Essentially, the washdown system is a dry-pipe sprinkler system, with nozzles specially designed and installed so that they will throw a large spray pattern on all weather decks.

Flushing System

The flushing system is supplied with sea water by a branch from the firemain or by a separate sanitary and flushing pump taking suction from the sea. When this system is supplied from the firemain, the branch is taken as near the top portion of the main as possible so that sediment from the firemain will not enter the flushing system. Since the firemain pressure is too high for a flushing system, the water is led through a strainer to a reducing valve which reduces the pressure to 35 psi.

Waste Drainage Systems

The drainage system aboard ship is divided into two parts: the main and secondary systems, which pump waste from the bilges and other spaces, and the plumbing and deck drains. Between them, these systems collect and dispose overboard all the shipboard waste fluids.

The main drainage system consists of piping installed low in the ship, with suction branches to spaces to be drained and direct connections to eductors or drainage pumps. This system generally serves the main machinery spaces and a few other spaces.

The secondary drainage systems supplement the main drainage system wherever the main drainage system cannot be extended because of interference of spaces through which the passage of piping is prohibited, or because the length of piping would be too great for efficient drainage. Each secondary drainage system is independent of the main drainage system and has its own pumps or eductors and its own sea connections.

Plumbing and deck drains are divided into two classes—A and B. Drains from water closets, urinals, and sick bay fixtures are class A drains; all other plumbing drains are class B.

Since shipboard flushing systems use salt water, the class A drainage piping is usually copper-nickel alloy. Class B drains are made up of brass or copper.

FUEL OIL SYSTEMS

The fuel oil system is arranged so as to allow the transfer of fuel oil from fueling connections to storage tanks, from storage tanks to service tanks, and from service tanks to the burners at the boiler. It also allows the transfer of fuel oil from one storage tank to another; these transfers are made with pumps, manifolds, and sometimes sluice valves which permit gravity flow from one storage tank to another.

The filling and transfer system usually consists of two large lines, one on each side of the ship, running fore and aft. Cross-connections join these mains to the fuel oil booster and transfer pumps. Risers are provided fore and aft for taking on or delivering fuel.

DIESEL OIL AND JP-5 SYSTEMS

Diesel oil systems are found even on steam-driven ships. Ships that carry large supplies of diesel oil have fairly complex diesel oil systems which are quite similar to the boiler fuel oil systems already described.

On aircraft carriers, JP-5 aviation fuel can also be used as boiler fuel in case of emergency. The JP-5 system is separate from the boiler fuel oil system but can be connected so as to discharge JP-5 to the fuel oil service system.

LUBRICATING OIL SYSTEMS

The lubricating oil system serves to supply clean, cool oil to machinery bearing surfaces. Lube oil is routed from the filling connection to the storage or sump tank located beneath the engine room; from this tank it is pumped through a series of strainers, coolers, and meters to the bearing surfaces. Used oil is routed to a settling tank, then through purifiers, and back to the sump tank.

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HYDRAULIC SYSTEMS

Hydraulic systems operate remote control valves for flooding, counterflooding, and ballasting. Other examples of the transmission of power aboard ship by hydraulics are the operation of steering gear, small hydraulic presses in the shop, and hydraulically operated pipe benders.

COMPRESSED AIR SYSTEMS

Compressed air systems are fabricated from brass and copper piping materials, bronze silver-brazed fittings, and bronze valves. Moisture and oil must be kept out of compressed air systems. Oil and moisture separation filters and air dryers are provided to remove these contaminating substances from the system.

The high pressure air system is designed to provide air for services such as counterrecoil, diesel engine starting, gas ejection, torpedo charging, and torpedo workshops.

The ship's service air system is a low presure compressed air system installed on practically all surface ships. The ship's service air system supplies air at required pressures for the operation of pneumatic tools, the operation of oil-burning forges and furnaces, the charging of pump air chambers, the cleaning of equipment, and many other uses.

Gas ejecting systems, where required, are provided for supplying air at the required pressure to the breeches of guns for removing gases and unburned solid matter.

A starting and control air system for diesel engines is installed on each vessel that requires air for diesel engine starting and the control of equipment such as clutches, engine selector valves, turning gear, and propeller brake.

A compressed air system is installed on some steam-driven ships to provide air for the automatic combustion control system on the boilers.

REFRIGERATION SYSTEMS

Mechanical cooling is provided in submarines and very often in certain spaces on surface ships where it is of importance for the comfort, health, and alertness of personnel or for the preservation of equipment.

The principal components of the system are the compressor, the condenser, the receiver, and the cooling coils (evaporator). Additional equipment required to complete the system includes piping, pressure gages, thermometers, various types of control switches and control valves, strainers, relief valves, sight-flow indicators, dehydrators, and charging connections.

PIPING AND TUBING

The Bureau of Ships defines piping as an assembly of pipe or tubing, valves, fittings, and related components forming a whole or a part of a system for transferring fluids (liquids and gases).

It is a little harder to define pipe and tubing. In commercial usage, there is not clear distinction between pipe and tubing, since the correct designation for each tubular product is established by the manufacturer. If the manufacturer calls a product pipe, it is pipe; if he calls it tubing, it is tubing.

In the Navy, however, a distinction is made between pipe and tubing. This distinction is based on the way the tubular product is identified as to size.

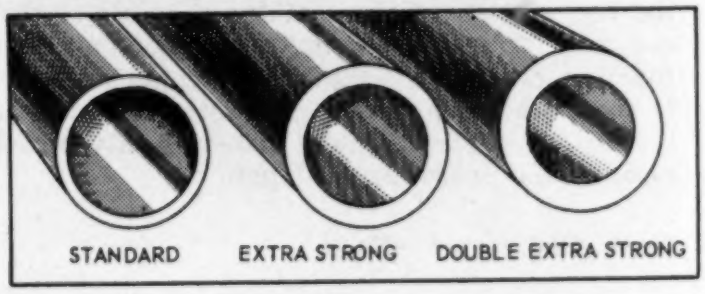

Figure 7-1.—Wall thickness designations.

There are three important dimensions of any tubular product: outside diameter (OD), inside diameter (ID), and wall thickness. A tubular product is called tubing if its size is identified by actual measured outside diameter (OD) and by actual measured wall thickness. A tubular product is called pipe if its size is identified by a nominal dimension called iron pipe size (IPS) and by reference to a wall thickness schedule designation.

Pipe is sometimes identified as standard (Std), extra strong (XS), or double extra strong (XXS), according to wall thickness. Figure 7-1 shows the relative wall thicknesses of pipes having the same nominal (OD) pipe size. As you can see, the inside diameter is reduced as the wall thickness is increased.

The terms standard, extra strong, and double extra strong do not identify any one actual wall

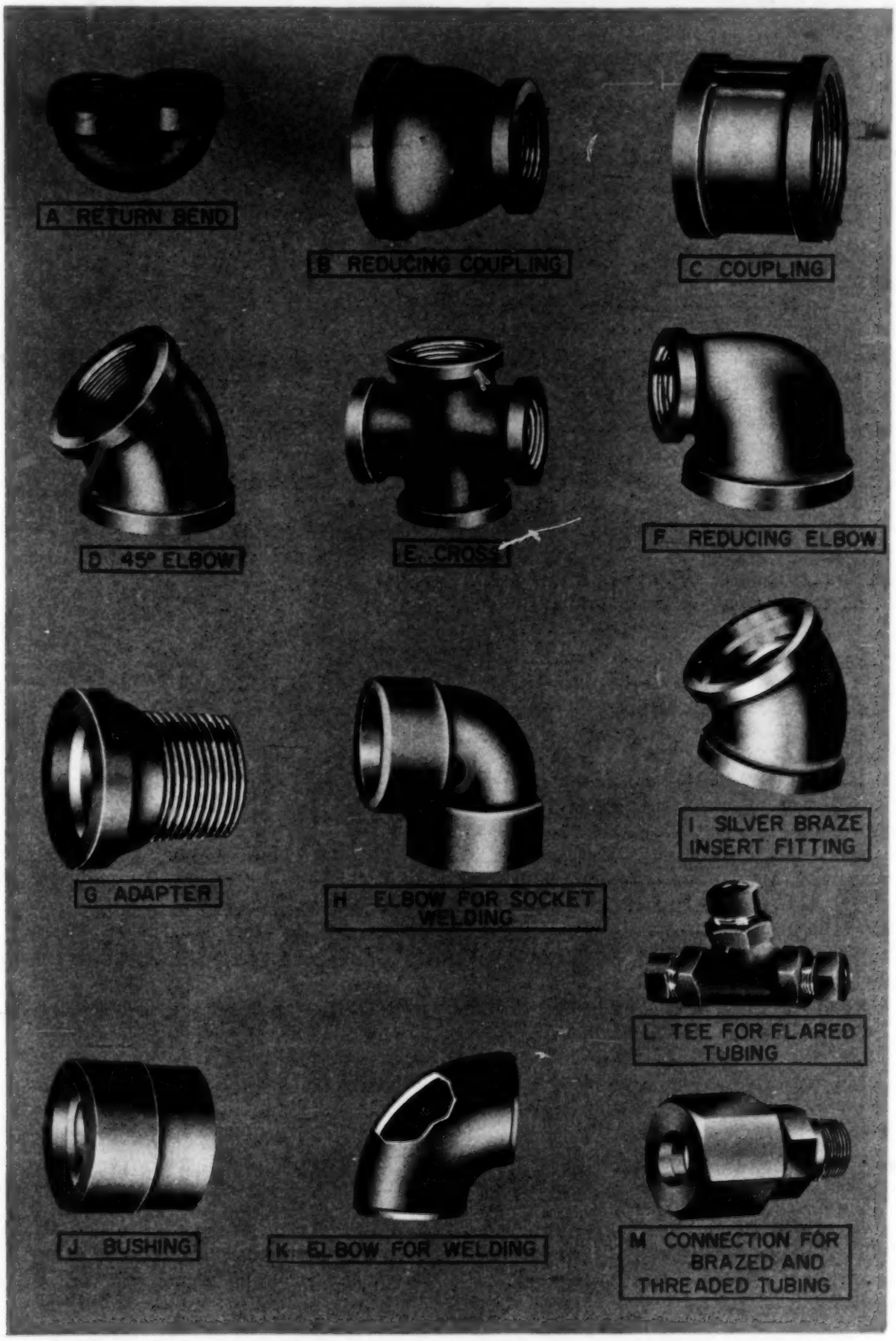

Figure 7-2.—Typical pipe fittings.

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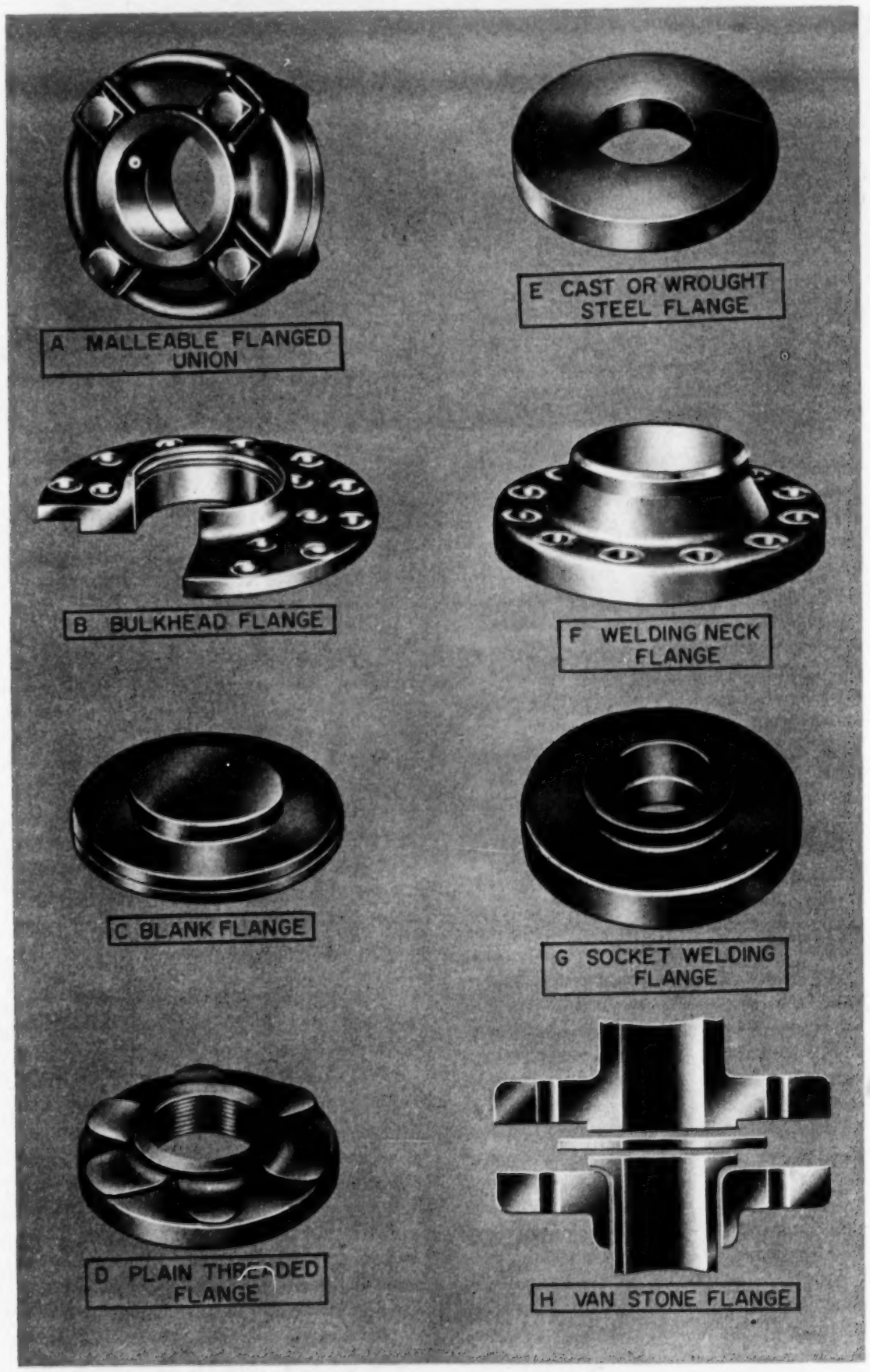

Figure 7-3.—Flanges.

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thickness of pipe. For example, a 3-inch OD pipe would be designated as double extra strong if it has a wall thickness of 0.600 inch, while a 4-inch OD pipe would be designated as double extra strong if it has a wall thickness of 0.674 inch.

Since pipe is manufactured in a number of different sizes, some pipe does not fit into the standard, extra strong, or double extra strong designations. The wall thickness of such pipe may be stated in decimal parts of an inch (as 0.120 inch wall) or it may be designated by reference to schedule numbers established by the American Standards Association (ASA). For example, a reference to "Schedule 40" for a pipe of 3-inch OD would indicate a wall thickness of 0.216 inch. The wall thickness of a schedule 40 pipe of 4-inch OD is 0.237 inch. These and many other values can be found in pipe tables in most engineering handbooks.

Some of the descriptions of piping systems in the previous section of this chapter included a mention of the pipe materials. The following paragraphs describe the piping and tubing used most frequently aboard ship.

Seamless steel pipe is available in standard and extra strong wall thicknesses in lengths from 12 to 22 feet. Seamless steel pipe is used aboard ship for diesel exhaust systems, overflow lines, sounding tubes, vents and air intake systems.

Welded steel pipe, either galvanized or ungalvanized (black), is available in standard and extra strong wall thicknesses.

Welded steel pipe is used primarily for general service such as plumbing drain lines aboard ship.

Seamless steel tubing is used in oil, steam, and water lines operating at 775° F and below. Different types of this tubing are available for use, according to the working pressure that will be maintained in the lines.

Welded steel tubing is available in two types, for use as follows:

Type A is used in steam or oil lines where maximum working pressure is 150 psi and in water or gas lines operating at a maximum working pressure of 225 psi.

Type B is used in steam lines operating at a maximum working pressure of 300 psi; in oil lines operating at a maximum working pressure of 350 psi; and in water or gas lines operating at a maximum working pressure of 400 psi.

Seamless chromium-molybdenum alloy steel tubing is used in high pressure steam lines at working pressures of 1201 to 1500 psi and operating temperatures of 1000° F. This tubing is furnished in lengths of 12 to 24 feet.

Several types of seamless aluminum alloy tubing are available. Tubing made of aluminum alloy 6061 is used primarily for dry lines in magazine sprinkling systems and for some structural applications. Tubing made of aluminum alloy 5052 is used for bilge and sanitary drain systems.

Seamless brass tubing (semiannealed and light annealed) is available in types and sizes suitable for operating pressures ranging from 200 psi to 4000 psi. It is used in systems which must resist the corrosive action of salt water, fresh water, or other fluids; it is a possible substitute for copper tubing aboard ship. Seamless hard drawn brass tubing is used for voice and pneumatic tube installations.

Seamless copper tubing suitable for pressures up to 6000 psi is covered by specification MIL-T-873. This material is intended for general use aboard ship; when not threaded, it may be joined by flanged joints, soldered joints, or flared fittings. Other types of copper tubing are available for refrigeration installations, plumbing and heating systems, gasoline systems, lubrication systems, and other shipboard uses.

Copper alloy tubing is available in composition 70-30 (70 percent copper and 30 percent nickel) and in composition 90-10 (90 percent copper and 10 percent nickel). Both seamless tubing and welded tubing are available in each composition. The 70-30 composition has been used for some time in shipboard piping systems and heat exchangers.

Every shipboard piping system includes a variety of fittings made from a number of different metals and alloys, and available in the same size range as the pipe and tubing used in the systems. Some typical fittings are shown in figure 7-2. In addition to illustrating some of the different shapes of fittings, this figure also indicates various methods of making connections: screwing, welding, and brazing. Pipes and fittings are also connected by means of flanges (see fig. 7-3). Flanges can be attached to pipes and tubing by welding, brazing, rolling, flaring, or (in some low pressure systems) with screw threads.

Every piping system must have some means of controlling the amount and direction of the flow of liquid or gas through the lines. This is

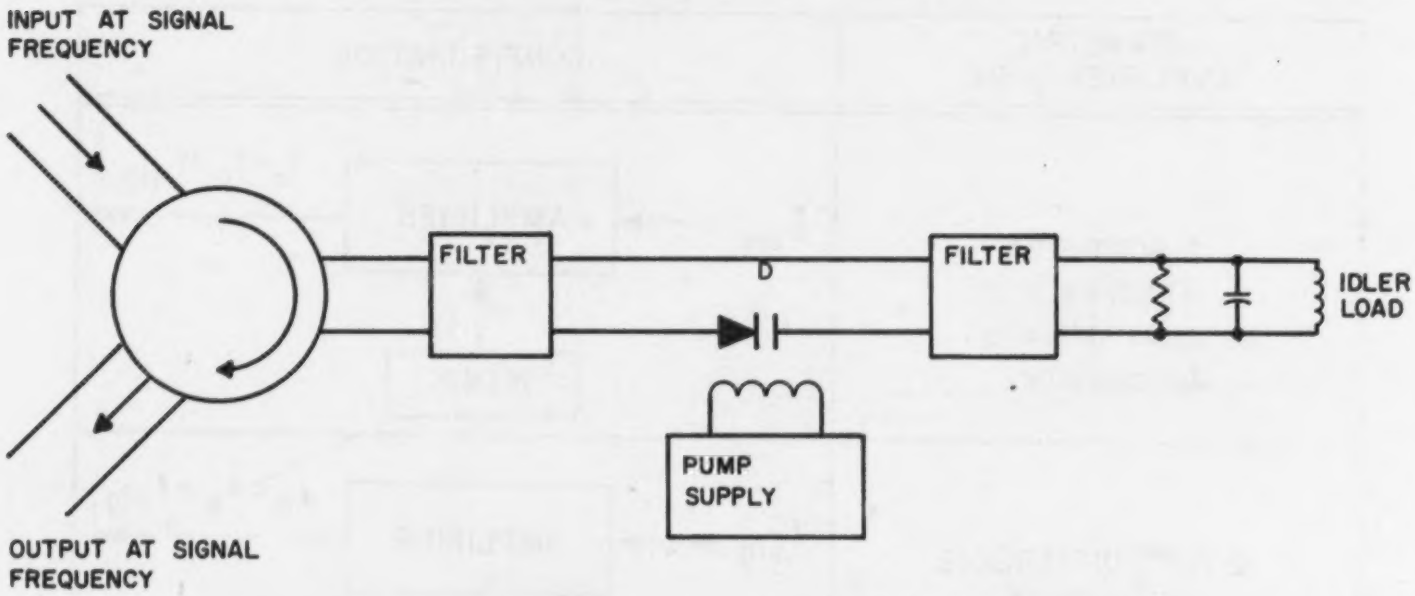

Figure 12-23.—One-port difference-frequency parametric amplifier.

The process of injection this intelligence into the oscillator frequency is called MODULATION. There are many types of modulation employed in airborne electronics—amplitude, frequency, phase, pulse, single-sideband, etc. The major part of this portion of the chapter will be devoted to the pulse modulation techniques most often employed in radar systems.

PULSING TRIODE OSCILLATORS

Basically, there are two methods of pulsing UHF and microwave oscillators. Operation of normal oscillators is discussed fully in chapter 8 of Basic Electronics, NavPers 10087-B. A thorough review of the basic principles of oscillators at this time may prove valuable for the understanding of the following discussions of the methods of modulating oscillators.

The first method to be discussed is that used in the self-pulsing oscillator, which contains within itself the circuitry needed to permit oscillation for a period of time, and to quench oscillation periodically. This ON-OFF action results in pulses of energy in the form of radiofrequency oscillations for a period of time, followed by no oscillation.

The second important method of modulating UHF and microwave oscillators incorporates the use of separate modulator circuits to trigger the oscillator into its ON-OFF states of operation.

Self-Pulsing Oscillators

Most oscillators use grid leak bias or a combination of grid leak and fixed bias. One advantage of grid leak bias is that the amplitude of oscillation is limited and stabilized. Notice the graphs of plate current and grid voltage versus time in figure 12-24 (A). These waveshapes are essentially the same for all oscillators using grid leak bias.

At zero time, plate voltage is applied but the grids are grounded so that a steady plate current flows. At time t_1 the ground is removed, and any random change in plate current will cause a change in voltage in the plate tank circuit, a portion of which is fed back to the grid circuit. Since this feedback is in the right phase and amplitude, the oscillations will grow in amplitude. Each time the grid goes positive, grid current flows and charges the grid leak capacitor more negatively so that on each successive oscillation the average grid voltage (the bias) goes more negative.

This continues until a balance is reached, and just enough grid current is drawn to replace the charge which leaks off through the grid leak resistor during the remainder of the cycle. As the average grid voltage becomes more negative, the plate current flows for a shorter portion of each cycle until the flow is just sufficient to replace the energy lost in the tank circuit and to supply feedback to the grid circuit.

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accomplished by the installation of valves, which can be opened or closed as required.

Valves are usually made of bronze, brass, cast or malleable iron, or steel. Steel valves are either cast or forged, and are made of either plain steel or alloy steel.

Many different types of valves are used to control the flow of liquids and gases. There are two main groups of valves. Stop valves are those which are used to shut off (or, in some cases, to partially shut off) the flow of fluid; these valves are controlled entirely by the movement of the valve stem. Check valves are used to permit the flow of fluid in only one direction; these valves are controlled by the movement of the fluid itself.

Valve designs vary greatly, due to the varying demands of service. You will find some valves which are combinations of the more or less basic types just mentioned; and others (such as reducing valves) which must be considered as special valves, bearing only slight resemblance to the basic types. Typical valves are shown in figure 7-4.

Traps are used to remove various undesirable materials from piping systems. In air lines, a trap is installed to remove water which is usually present. In steam lines, traps are

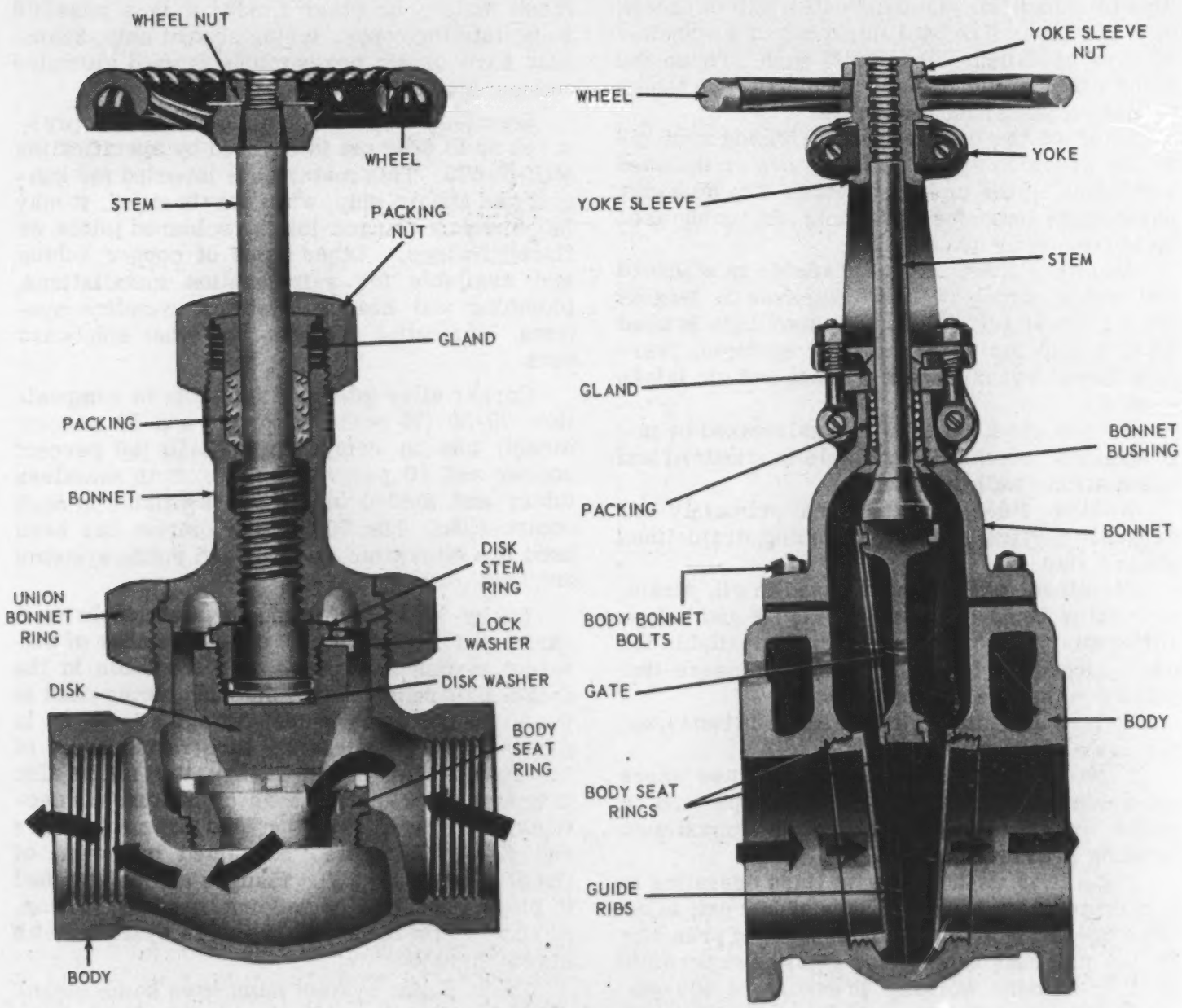

Figure 7-4.—Globe and gate valves.

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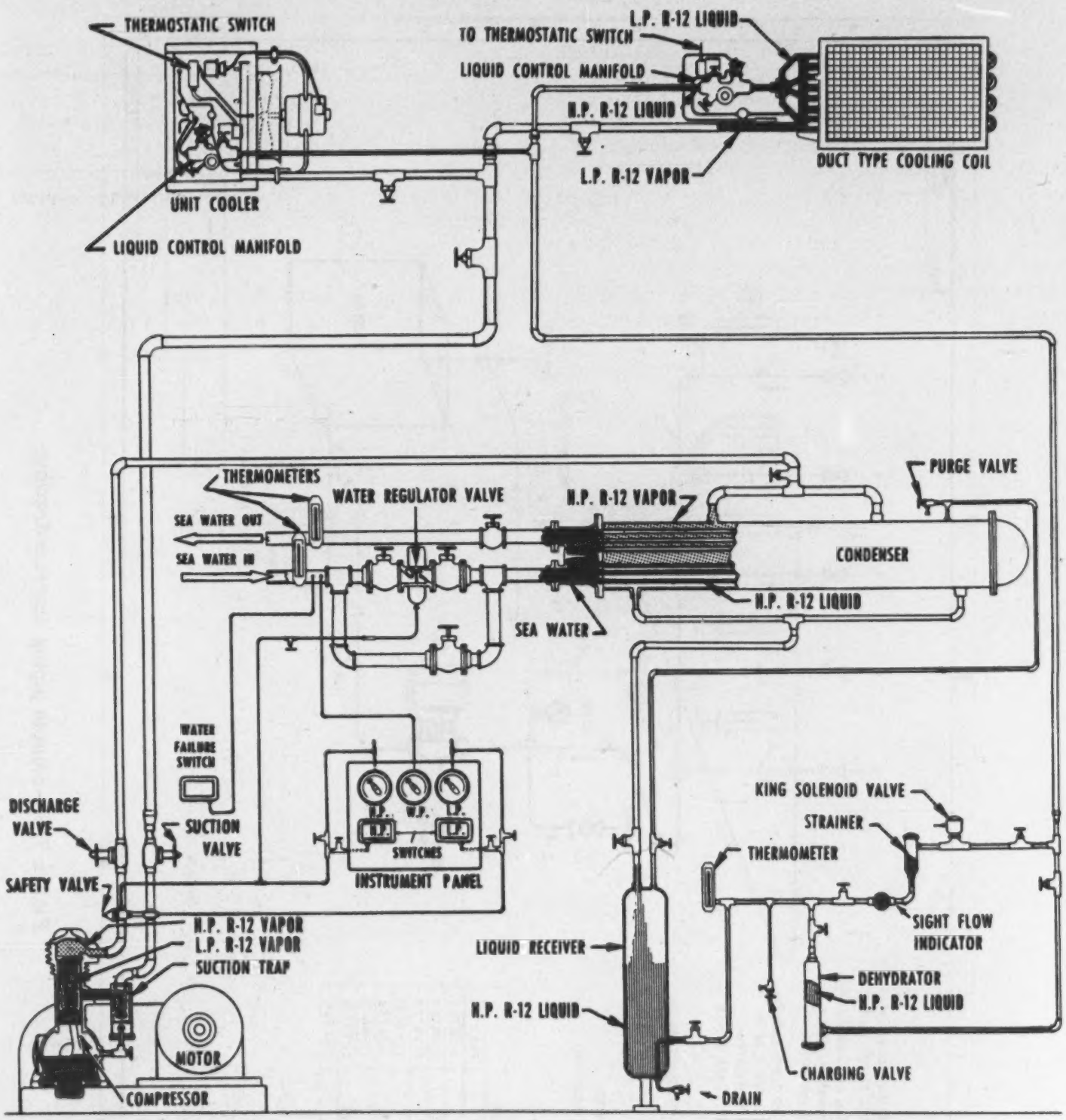

Figure 7-5.—Typical shipboard refrigerant circulating air conditioning system.

installed to remove condensate. Essentially, any steam trap consists of a valve and some device or arrangement which will cause the valve to open and close, as necessary to drain condensate from the lines without allowing the escape of steam.

Strainers are located in all piping lines to prevent the passage of foreign matter. In some locations, duplex strainers are used so that the flow of fluid through the system need not be interrupted when one element is removed for cleaning.

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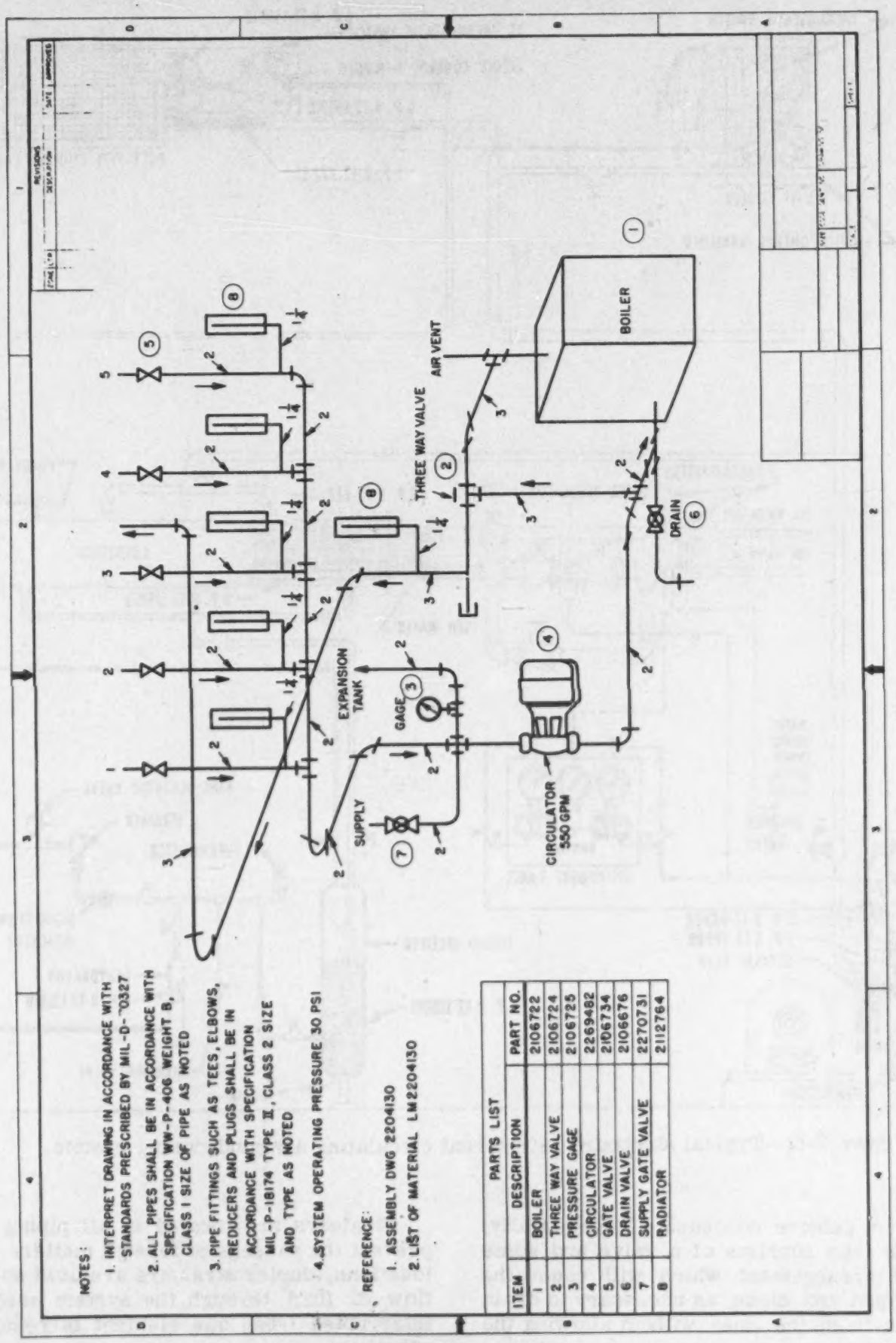

Figure 7-6.—Sample piping diagram drawing.

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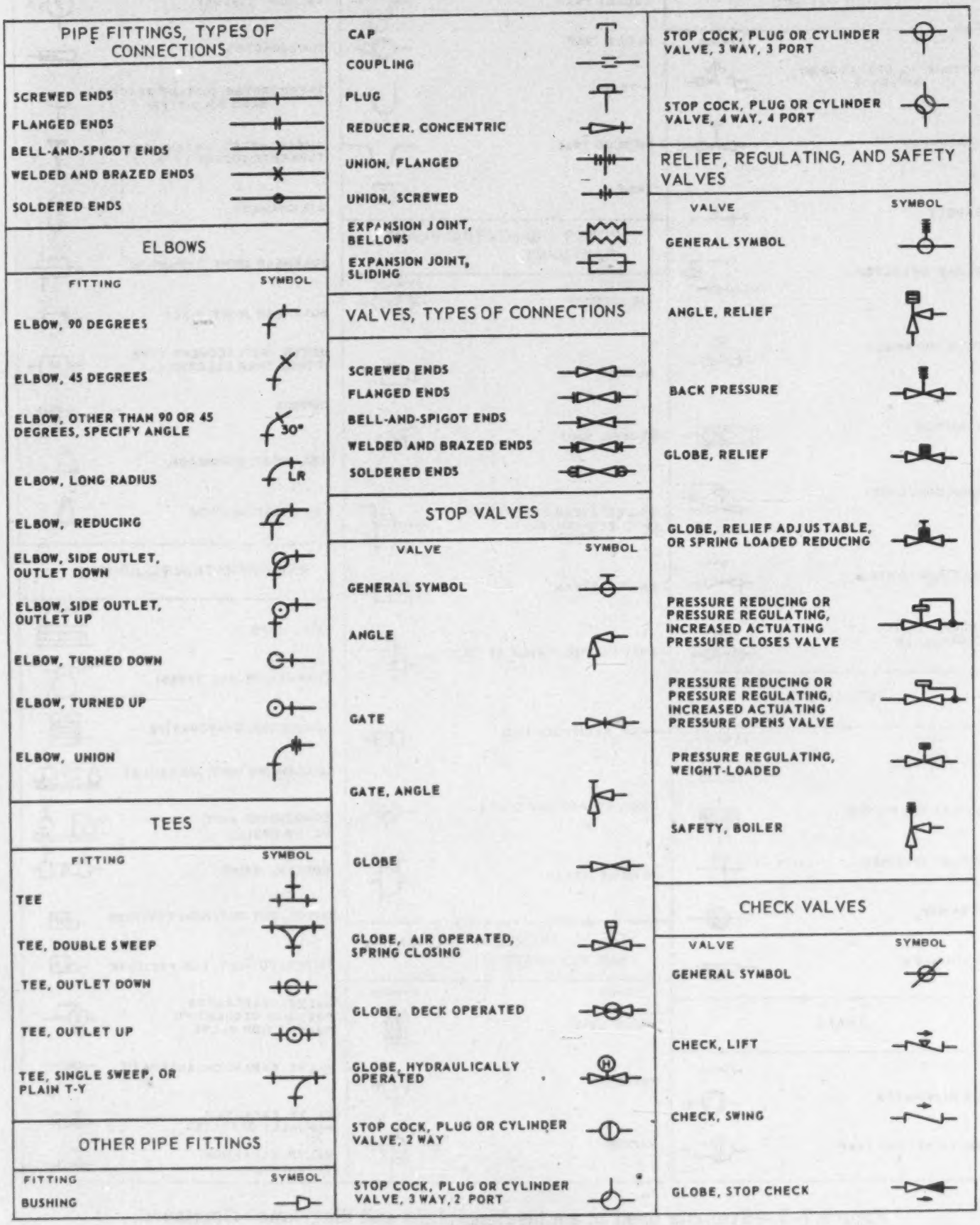

Figure 7-7.—Symbols used in engineering plans and diagrams.

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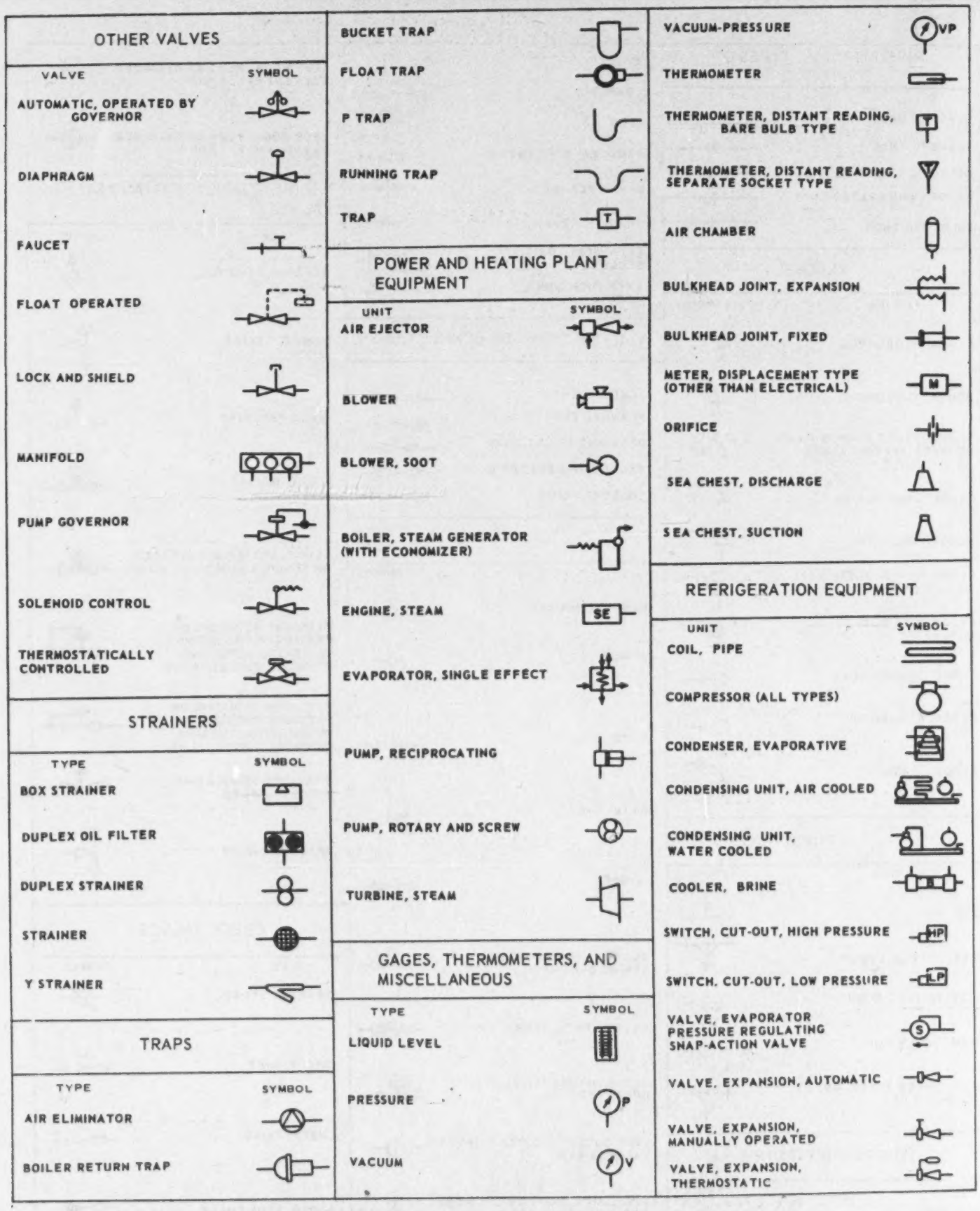

Figure 7-7.—Symbols used in engineering plans and diagrams—Continued.

NOTE: WHERE LINE SYMBOLS ON ANY ONE DRAWING ARE DUPLICATES OF ANOTHER SERVICE LETTER SYMBOLS MAY BE ADDED.

AIR CONDITIONING

BRINE RETURN	— — —BR— — —
BRINE SUPPLY	———B———
CIRCULATING CHILLED OR HOT-WATER FLOW	———CH———
CIRCULATING CHILLED OR HOT-WATER RETURN	— — —CHR— — —
CONDENSER WATER FLOW	———C———
CONDENSER WATER RETURN	— — —CR— — —
DRAIN	———D———
HUMIDIFICATION LINE	— - —H— - —
MAKE-UP WATER	— - — - — - —
REFRIGERANT DISCHARGE	———RD———
REFRIGERANT LIQUID	———RL———
REFRIGERANT SUCTION	— — —RS— — —

HEATING

AIR-RELIEF LINE	— ——— — ——— —
BOILER BLOW OFF	—— —— —— ——
COMPRESSED AIR	———A———
CONDENSATE OR VACUUM PUMP DISCHARGE	—o— —o— —o—
FEEDWATER PUMP DISCHARGE	—oo— —oo— —oo—
FUEL-OIL FLOW	———FOF———
FUEL-OIL RETURN	— — —FOR— — —
FUEL-OIL TANK VENT	— — —FOV— — —
HIGH-PRESSURE RETURN	— // — // — // —
HIGH-PRESSURE STEAM	—— // —— // —— // ——
HOT-WATER HEATING RETURN	— — — — — —
HOT-WATER HEATING SUPPLY	———

Figure 7-8.—Pipe line symbols.

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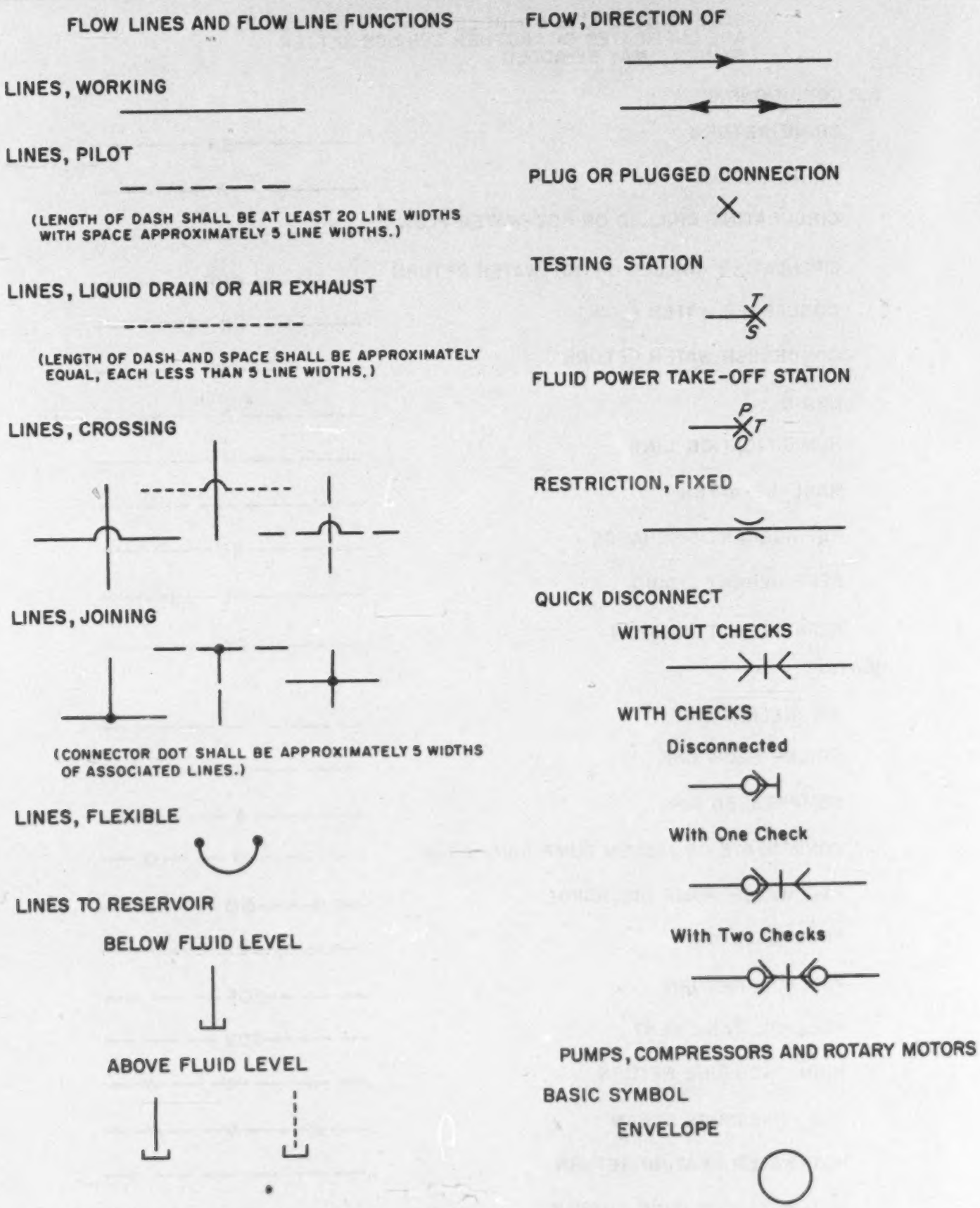

Figure 7-9.—Fluid power diagram symbols.

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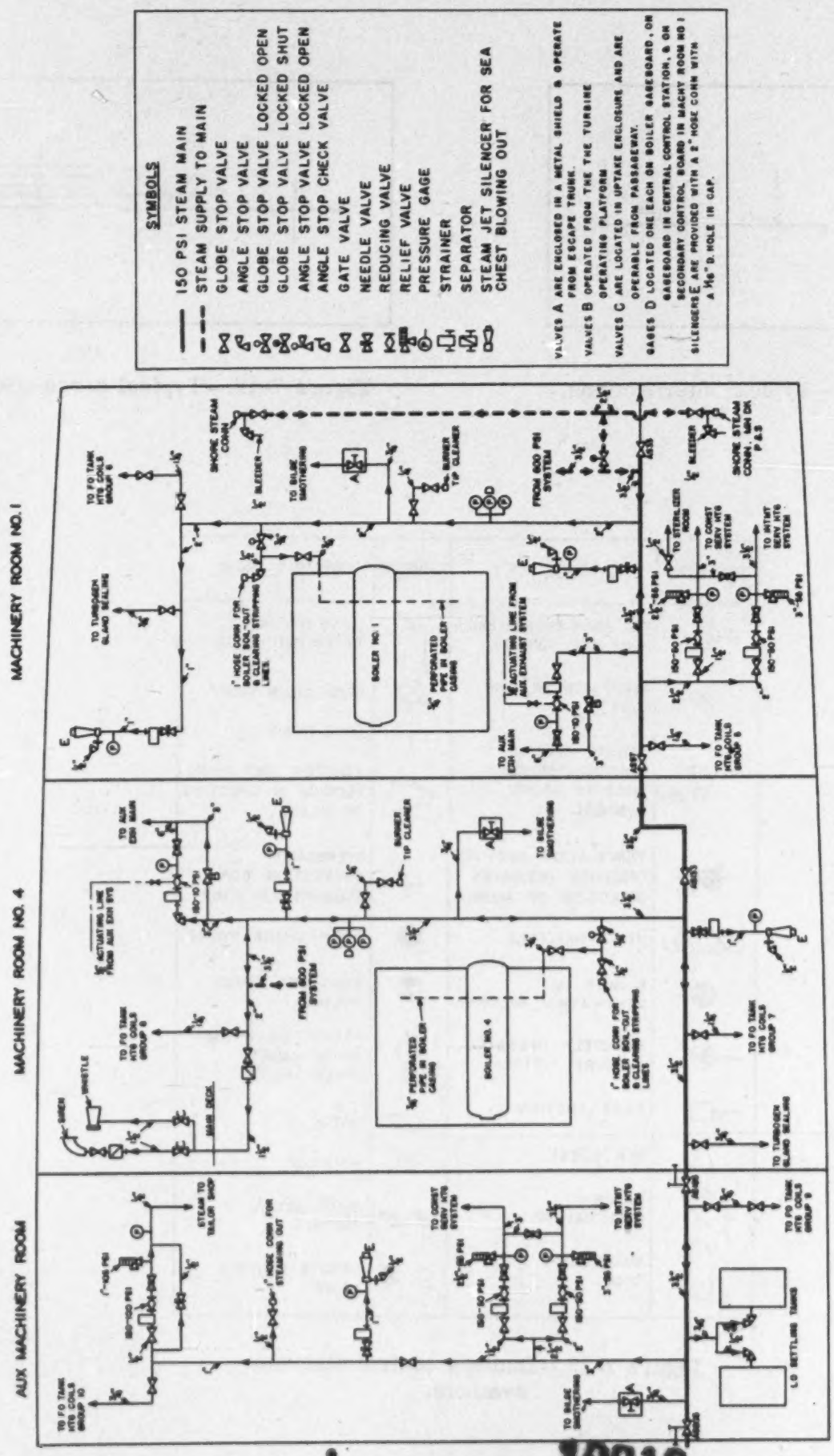

Figure 7-10.—Part of 150-psi auxiliary steam system, CA 139 class.

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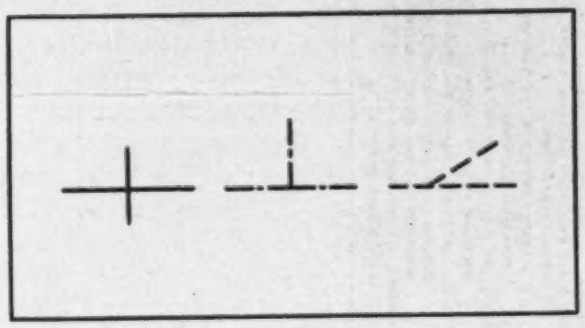

Figure 7-11.—Typical intersections.

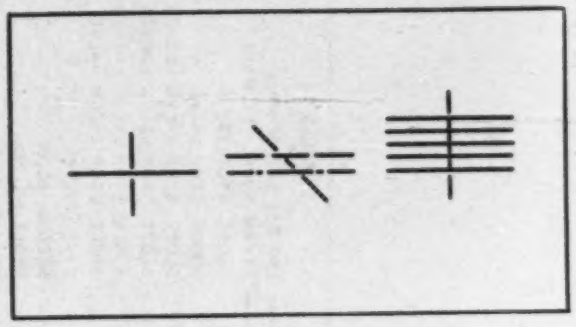

Figure 7-12.—Typical cross-overs.

SYMBOL	SYMBOL KEY	SYMBOL	SYMBOL KEY
	FOG FOAM PROPORTIONER PUMP AND CONTROL		QUICK-ACTING WATERTIGHT DOOR
	HOSE STOP OR FIRE PLUG		DECK DRAIN VALVE
			DECK DRAIN
6 7-79-1	REMOTE CONTROL STATION (FIGURES INDICATE VALVE NUMBER)		EDUCTOR (JET PUMP) FLOW IS IN DIRECTION OF FLARE
3-7	VENTILATION CLOSURE (POSITION INDICATES DIRECTION OF FLOW)		OVERBOARD CONNECTION FOR SUBMERSIBLE PUMP
	VALVE MANIFOLD		STOP-CHECK VALVE
	BLOWER IN VENTILATION SYSTEM		STOP-LIFT CHECK VALVE
	REMOTELY OPERATED CLOSURE FITTING		RELIEF VALVE OR SPRING-LOADED CHECK VALVE
	BILGE SUCTION		HATCH
	SEA CHEST		MANHOLE
	BULKHEAD PENETRATION		QUICK-ACTING SCUTTLE
	WATERTIGHT DOOR		REMOTE CONTROL VALVE

Figure 7-13.—Damage control diagram symbols.

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PIPING DRAWINGS

As we stated at the beginning of this chapter, the method of drawing piping, fittings and equipment depends on the scale and purpose of the drawing. Some drawings used in operation and maintenance manuals are quite pictorial—each fitting and item of equipment may be drawn in some detail. Figure 7-5 is an example of this kind of drawing.

Most piping drawings, however, are more schematic. Figure 7-6, which is taken from MIL-STD-7A, is a typical piping diagram. Note the use of symbols, notes, and a parts list.

Military Standard Mechanical Symbols, Part 1, MIL-STD-17B-1, establishes an approved list of mechanical symbols. These symbols have been adopted, by permission of the American Standards Association and the American Society of Mechanical Engineers, from various American Standards. Some of these symbols are shown in figure 7-7. Note that symbols may indicate types of connections (screwed, flanged, welded, and so on) as well as various fittings, valves, gages, and items of equipment. When a symbol is needed for an item not covered in the standards, a suitable symbol should be designed by the activity concerned. A new symbol should not duplicate any symbol in the standards, should be clearly understandable, and should be explained by a note on the drawing.

Figure 7-8 shows a few of the many pipe line symbols set forth in MIL-STD-17B-1. Since one drawing may contain a number of separate piping systems of the same kind, additional letter symbols should be added to differentiate the separate networks.

MIL-STD-17B-1 permits, in lieu of the types of symbols shown in figures 7-7 and 7-8, the use of special fluid power diagram symbols. Figure 7-9 shows typical symbols of this type. Component symbols can be devised for any fluid power component by combining basic symbols. Notes regarding pressure, flow rate settings, and other characteristics are added to the symbols when they are used to make up a fluid circuit diagram.

Figure 7-10 shows a typical drawing which makes use of the basic symbols shown in figure 7-7. Note that the drawing includes a legend. MIL-STD-17B-1 requires that each drawing or one sheet of each set of drawings show a legend. But then MIL-STD-17B-1 goes on to state that reference to the MIL-STD or American Standards may be used in lieu of a legend. In spite of this, a legend should be used whenever possible because it is of great assistance to anyone who is not completely familiar with the symbols.

Since symbolic representation does not usually involve exact or scale layout or the actual run or leads of piping, the same symbol should be used for all projections of the system (plan, elevations, and sections).

Some piping diagrams, particularly those at a small scale, do not include symbols for fittings and types of connections.

On those drawings where symbols for pipe fittings are not used in the diagrammatic representations, the intersection of any two piping runs is represented by showing the pipe symbols in contact. (See fig. 7-11.)

Cross-overs where there is no connection between piping runs are represented by a break in one of the lines. (See fig. 7-12.)

Not all of the piping drawings which you may draw or revise will make use of the MIL-STD-17B-1 symbols. A typical example of these exceptions is shown in figures 7-13 and 7-14. Note that there are some small differences between the symbols in figure 7-13 and the legend in figure 7-14. This, again, emphasizes the importance of the inclusion of a legend on piping drawings.

SHIPBOARD VENTILATION

The main difference between the ventilation systems of ships and the hot air heating systems which are popular in houses is the watertight and airtight construction of the ducts on a ship. Also, shipboard equipment will, in many cases, be of sturdier and more costly construction, since its proper functioning and reliability are of vital importance.

To preserve the watertight integrity of a vessel, shipboard ventilation is divided into many small systems. Some of these systems are for supply and others for exhaust. Figure 7-15 shows the general characteristics of one supply system and one exhaust system.

A supply ventilation system is designed to serve a group of compartments and spaces with an adequate amount of fresh air. The air enters the system through some type of waterproof ventilation intake located on or above the main deck or in a deckhouse bulkhead. From the intake, the air for the lower deck compartments ordinarily passes through a vertical duct, known as a trunk, which is usually built as part of the ship's structure. An air preheater with a con-

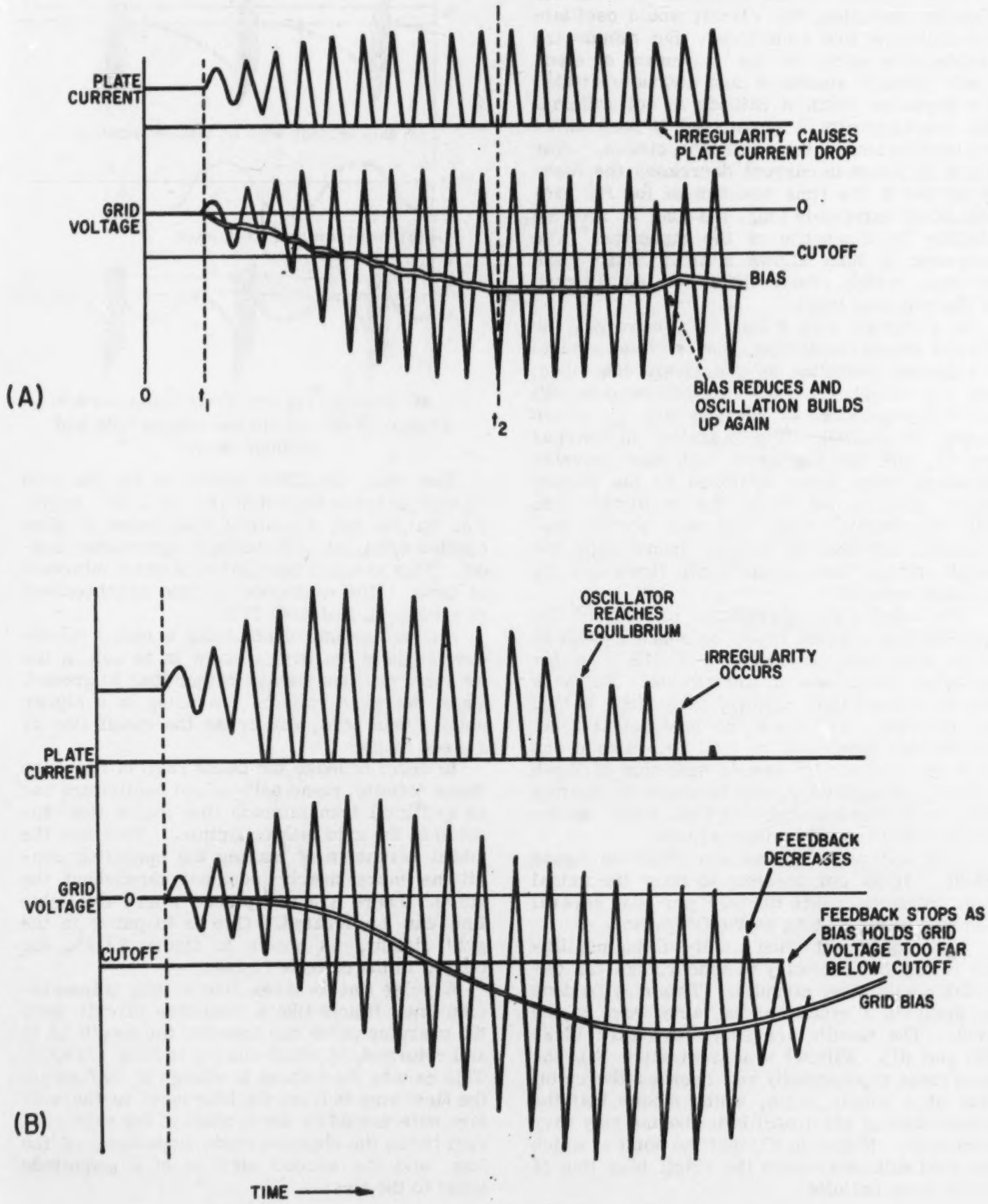

Figure 12-24.—Plate current and grid voltage versus time.

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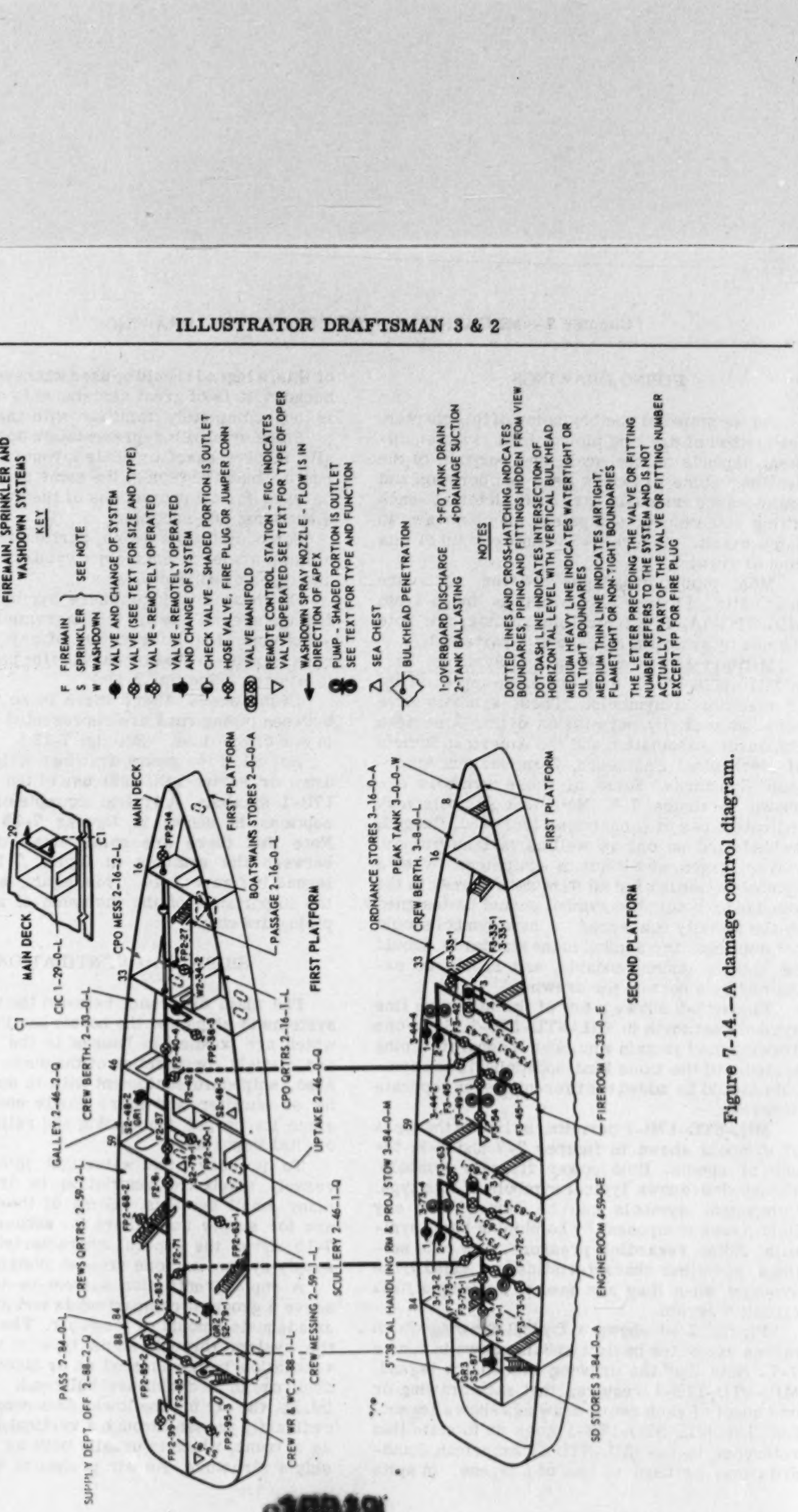

Figure 7-14.—A damage control diagram.

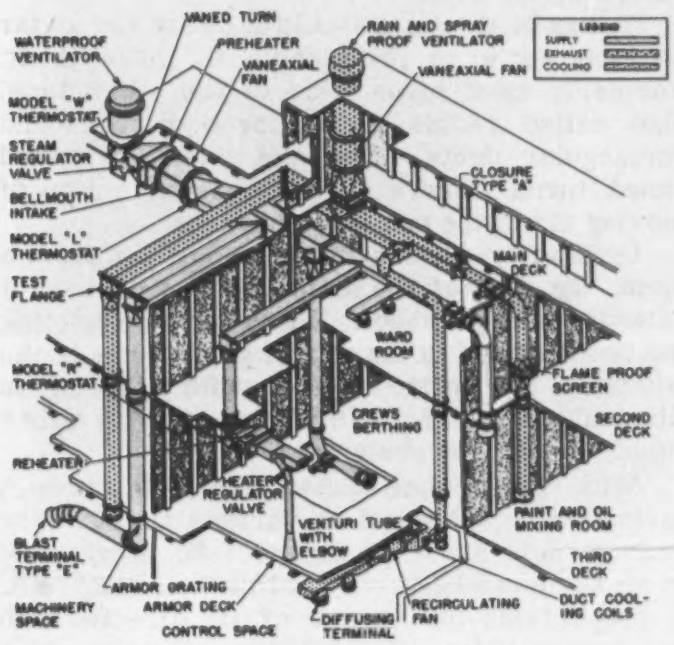

Figure 7-15.—Shipboard ventilation systems.

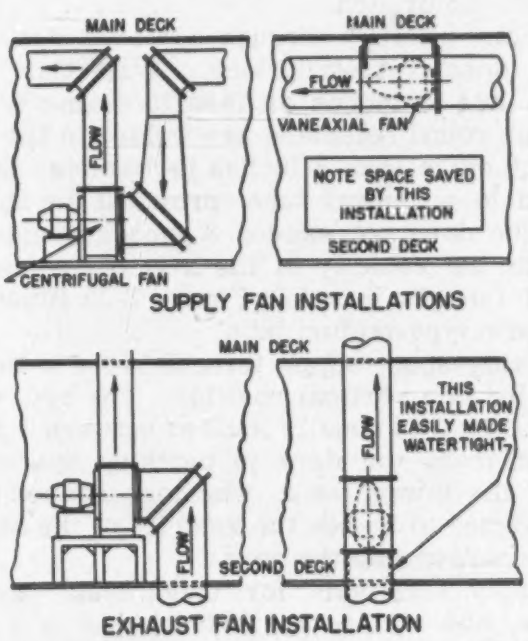

Figure 7-16.—Fan installations.

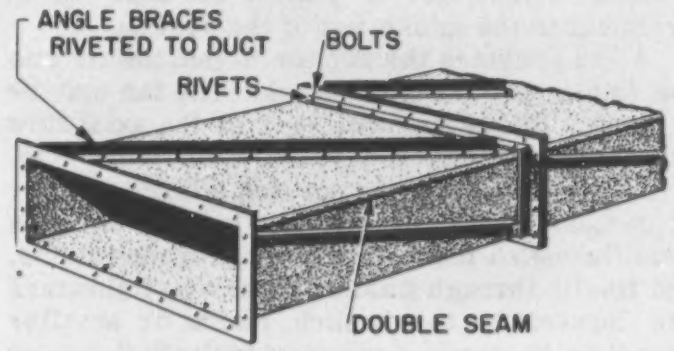

Figure 7-17.—Installation of large rectangular duct stiffeners.

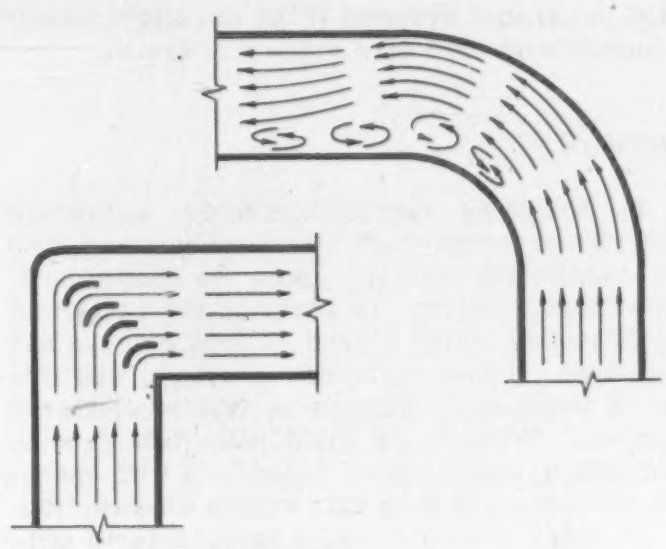

Figure 7-18.—Action of air currents in turns.

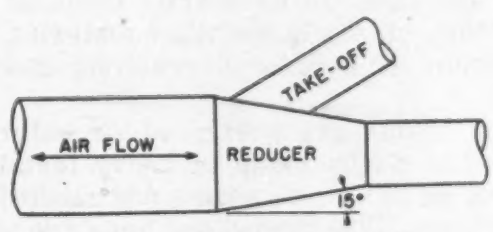

Figure 7-19.—Concentric reducer with takeoff.

trolling thermostat is placed as near as is practical to the intake end of the system.

A fan provides the suction to pull the air into the intake and down the trunk. The fan may be of either the centrifugal type or the axial flow type. Note the differences shown in figure 7-16.

In an intake system serving a large number of compartments, the air leaving the fan goes first through a main, then through branch mains, and finally through smaller branches. Reheaters are located in the branch mains or smaller branches to serve a group of individual spaces or compartments. At the end of the line, air is delivered through end openings known as supply terminals. In some types of terminals, dampers are installed which can be manually operated.

Ordinarily one exhaust system serves the same spaces and compartments that are served by one supply system. Axial flow fans are never used in exhaust systems if the air might contain flammable or explosive vapors or fumes.

Ductwork

In designing ventilation ducts, watertight integrity of compartments and spaces served by the ventilation system must be maintained. Watertight integrity is particularly important for branches which extend to lower decks and platforms. Penetration of watertight and armored decks and bulkheads is avoided whenever possible. When ducts must pass through such boundaries, they must be watertight with specified closures and fittings of welded construction.

In order for air to move through ducts efficiently with minimum friction loss from seams, joints, turns, and fittings, the interior of ducts must be streamlined. Also, in order that excessive noise be avoided, seams, splitters, dampers, vanes, and terminals should be carefully designed so that air can flow quietly over and around them.

Duct sections are ordinarily made of galvanized steel, unless some other material, such as aluminum or corrosion-resisting steel, is specified.

Welded seams are preferred for watertight ducts. Round ducts made of heavy metal are sometimes lapped at the seams and riveted with tinner's rivets. The lapped surfaces are tinned before riveting and then sweated together after riveting.

Stiffeners are used to minimize vibration of the walls of large rectangular ducts. They are usually made of lightweight angle bars and riveted to the outside of the ducts, as shown in figure 7-17. No stiffeners of any kind are to be placed inside a duct.

Turns in air ducts should be as few and as far between as it is practicable to make them. Formerly most turns were of the elbow type, also called radius turns, for both round and rectangular ducts. Now the trend is toward vaned turns. Figure 7-18 shows the action of moving air in the two types of turns.

Ordinarily when a branch takes off from a main, the size of the main is reduced where it extends past the takeoff. The reducer connecting the two sections is the proper place to locate the takeoff. A concentric reducer, with a takeoff, is illustrated in figure 7-19. It is used with either supply or exhaust systems.

With appropriate vaned turns, the branch main can be taken off at various angles. The branch main shown in figure 7-20 is taken off at an angle of 90 degrees. Notice the SPLITTER. It proportions the amount of air directed into the branch main. The splitter is usually made so that it is adjustable, but after its correct location is determined, it is riveted in place.

Small round branches are sometimes taken off branch mains, as illustrated in figure 7-21. Notice the SCOOP, which can be used to feed air into the branch.

Ducts passing through armored decks require special installations. Watertight ducts which are 8 inches or less in diameter pass through round holes and are welded to the deck. A duct more than 8 inches in diameter is connected to a venturi tube, provided the hole for the tube does not exceed 8 inches in diameter or that the velocity of the air will not exceed 10,000 feet per minute. Figure 7-22 illustrates an elbow-type venturi tube.

Living-space supply terminals are ordinarily installed in a vertical position. The open end of the terminal is usually located between 9 and 18 inches from the deck in berthing spaces and below the lowest bunk. The cone-shaped outlet is designed to lessen the velocity of the air that is discharged into the space.

Supply terminals for magazines, handling rooms, and staterooms are located in a horizontal position near the overhead. The design of various terminals is shown in figure 7-23.

Adjustable supply terminals are used in hot spaces, such as engine and machinery rooms, radio and sound rooms, workshops, laundries, and turrets. Adjustable slip sections provide a

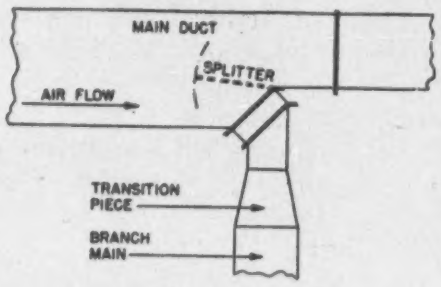

Figure 7-20.—Takeoff from rectangular duct.

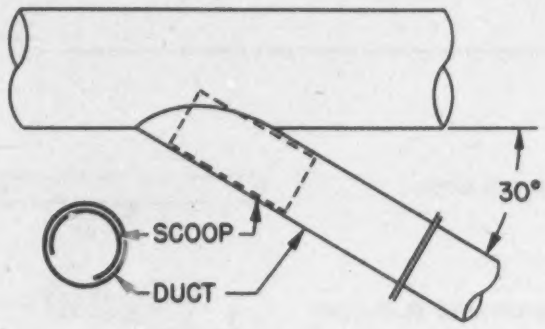

Figure 7-21.—Thirty-degree branch takeoff with scope.

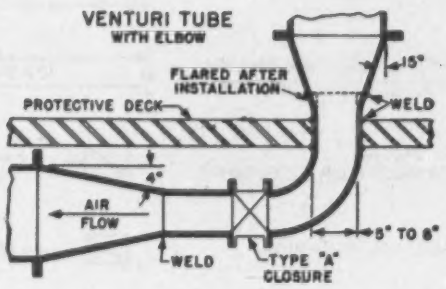

Figure 7-22.—Venturi tube in armored deck.

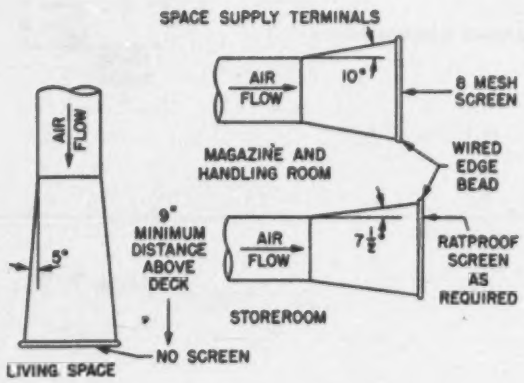

Figure 7-23.—Standard space supply terminals.

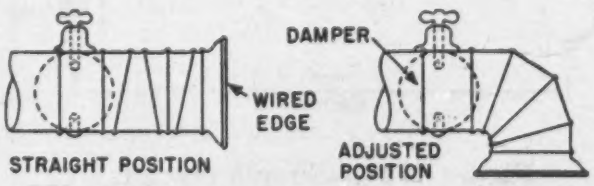

Figure 7-24.—Adjustable supply terminal.

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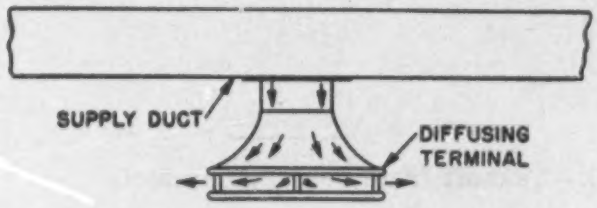

Figure 7-25.—Diffusing terminal.

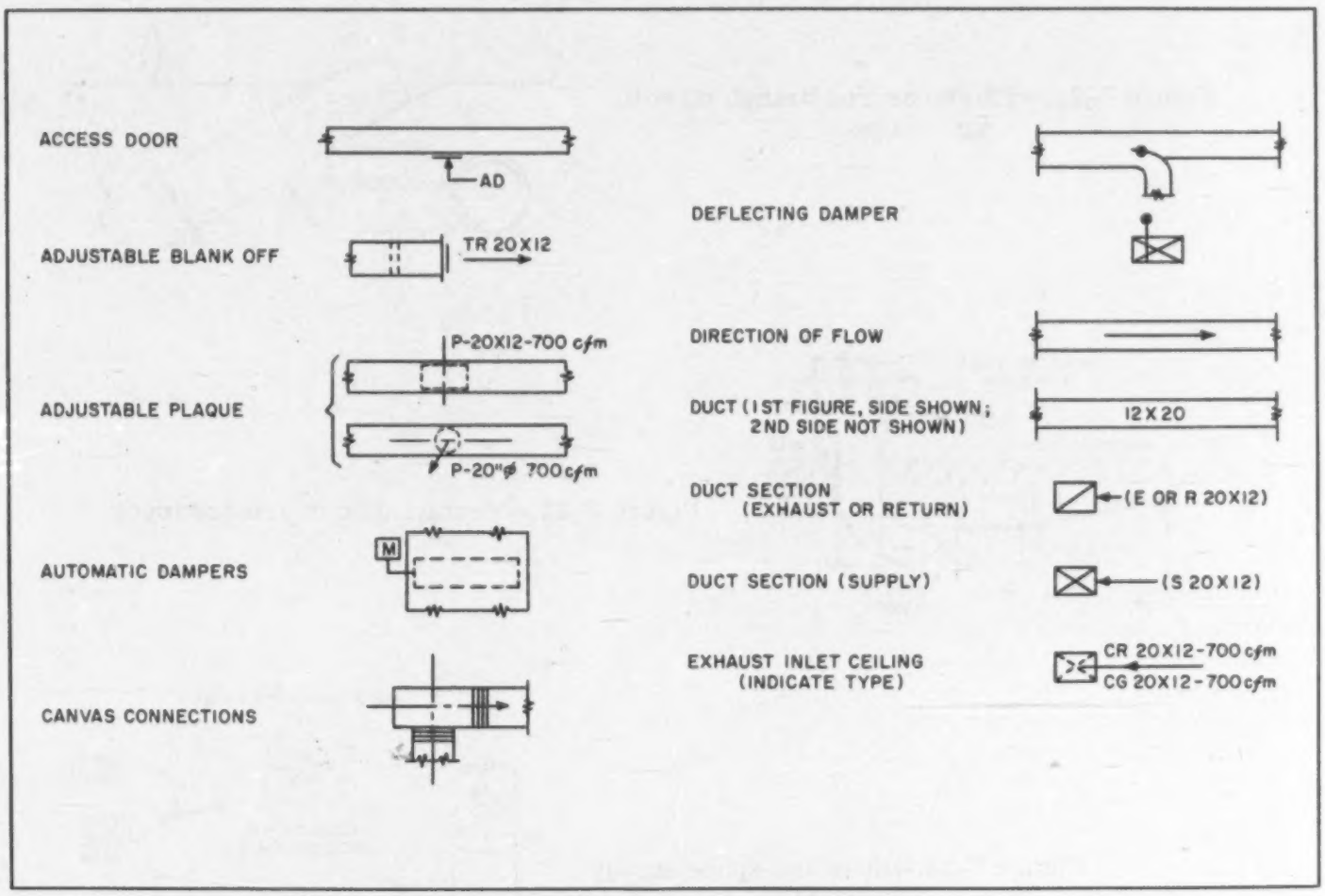

Figure 7-26.—Typical ductwork symbols.

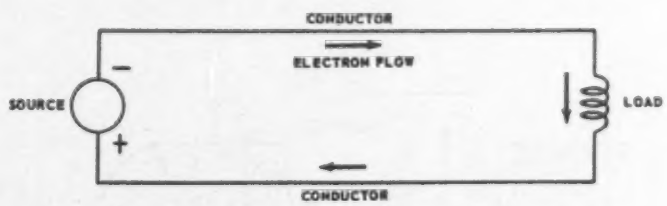

Figure 7-27.—Simple circuit.

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means of controlling air direction. (See fig. 7-24.) Air can thus be discharged directly in the vicinity of most of the personnel.

Navy standard diffusing terminals are used in offices, staterooms, wardrooms, mess rooms, and in spaces which have air conditioning. A standard diffusing terminal is installed in a duct as shown in figure 7-25.

Access plates are placed in ducts to provide an easy means of inspection and to facilitate assembly and cleaning. An access plate is ordinarily round and is closed with a cover plate. A collar is fitted to the opening in the duct and flush riveted into place.

Ducts are covered with insulating material whenever it is necessary to prevent condensation or objectionable gain or loss of heat. Ventilation heaters are insulated to keep in the heat and to protect personnel from burns.

Symbols for Drawings

The general information given previously concerning piping drawings applies also to ventilation drawings. Again, MIL-STD-17B-1 provides standard symbols for the drawings. Figure 7-26 shows some typical ductwork symbols from MIL-STD-17B-1.

ELECTRICAL DRAWINGS

As used here, electrical drawings includes the drawings relating to shipboard electrical wiring systems. In addition to various power distribution systems, the electrical wiring networks aboard ship include announcing and intercommunicating systems, alarm and warning systems, ship control order systems, and many others.

ELECTRICITY

Electric current consists of a flow of electrons along a conductor, usually copper wire. The flow is very similar to the flow of water in a pipe. Metallic atoms give up the electrons to other atoms very easily. Since electric current, according to theory, consists of a flow of electrons from atom to atom, metals make good conductors of current.

Some materials, unlike metals, require a very great force before electrons can be detached from their atoms. These materials are good insulators and are used to insulate conductors so that the electric current flowing in them is kept within bounds.

In its simplest form, an electrical circuit consists of the power source, which may be a battery or generator, the load, which is the device which consumes the electrical power and transforms it into useful work, and the conductor carrying current from the source to the load and from the load to the source. (See fig. 7-27.)

Electric current flows out of the negative terminal, around the circuit through the load, returning to the positive terminal at the source.

The generator or battery furnishes the electrical force which appears as a difference in potential across the positive and negative terminals of the circuit. This difference in potential between the two terminals is called the source voltage. So long as the circuit is unbroken and the battery or generator is functioning, electrons will flow from the negative terminal through the load and return to the positive terminal.

Direct current (d-c) flows through a circuit in one direction only. It may be a constant or a pulsating d-c, but the direction of flow never changes. Alternating current (a-c), which is the current commonly used in power circuits, especially for long distance transmission, flows first in one direction through a circuit and then is reversed, flowing in the opposite direction.

Constant direct current builds up to a peak of current flow for a given load and maintains that peak. Pulsating d-c rises and falls, as its name indicates. Alternating current rises and falls in one direction; then reverses and rises and falls in the other direction. The specified cycles of an alternating current mean the number of times this happens in 1 second. For example, 60 cycle current means there are 60 cycles to a second.

The rate of current flow in a circuit is measured in amperes. The amount of current flowing in a circuit depends on two things: (1) electromotive force (voltage or potential difference) and (2) resistance.

Resistance is measured in ohms. The resistance of a conductor depends upon a number of things. Of first importance is the material of which it is made. If a conductor is made of a material composed of atoms which lose their electrons very easily, it will provide less resistance to current than if its atoms require more force before their electrons are detached. Also, the diameter of the conductor is important. Like a pipe carrying water, it offers less resistance to current if its diameter is large than

it does if its diameter is small. A third factor in resistance is the length of the conductor. The longer the conductor, the greater will be its resistance. A fourth factor is temperature. The resistance of most material increases slightly with a rising temperature; the resistance of some remains about the same; and that of some decreases with a temperature rise.

The potential difference across the input terminals of a circuit is supplied by the electromotive force (emf) of the generator or battery. This electric force is measured in VOLTS. It takes one volt to establish a current flow of one ampere in a circuit possessing a resistance of one ohm. This is a statement of Ohm's law. Expressed as a formula, $E = IR$, with E standing for emf in volts, I standing for current in amperes, and R for resistance in ohms. As you will notice, this formula can also be written

$$I = \frac{E}{R} \text{ or } R = \frac{E}{I}$$

Thus if two factors of Ohm's law are known, the other is easily computed.

Power may be defined as "work per time." There is a constant relationship between the electromotive force (E), the current (I), and the power consumption (P) in a circuit. This relationship is expressed in the formula $P = IE$, from which it follows that $I = \frac{P}{E}$, and $E = \frac{P}{I}$. P is measured in units called "watts", a watt being defined as the work done in 1 second when 1 ampere flows under an electromotive force of 1 volt.

Suppose, now, that you have a 110-volt circuit in your home. The constant E of this circuit, then, is 110-volts. In the circuit there is probably a 15-ampere "fuse." This is a device which will open the circuit (usually by "burning out") if the current in the circuit exceeds 15 amperes. The reason for the existence of the fuse is the fact that the wiring in the circuit is designed to stand safely a maximum current of 15 amperes. A current in excess of this amount would cause the wiring to become red-hot, eventually to "burn out," and perhaps to start an electrical fire.

Suppose you light a 60-watt bulb on this circit. Your E is 110 volts. By the formula $I = \frac{P}{E}$, you know that the current in the circuit with the 60-watt bulb on is $\frac{60}{110}$, or about 0.54 amperes, which is well within the margin of safety of 15 amperes.

But suppose now that you cut in on the same circuit an electric toaster taking about 1500 watts (electrical devices are usually marked with the number of watts they consume) and an electric clothes dryer taking about 1200 watts. The total P is now 60 + 1500 + 1200, or 2760 watts. The current will now be $\frac{2760}{110}$, or 25 amperes. Theoretically, of course; because before it reaches this point the 15-ampere fuse will burn out and open the circuit.

The "work per time" definition of power can be applied to mechanical power as well as to electrical power. Work may be defined as a force acting through a distance and expressed: work = force x distance. If you lift a 30-pound weight a distance of 2 feet, the work you have done may be expressed thus: work = 30 pounds x 2 feet = 60 foot-pounds. Now suppose it took you 2 seconds to lift the weight. We have said that power is work per time; therefore, the power that you have exerted is 60 foot-pounds per 2 seconds, or 30 foot-pounds per second. In engineering, a larger unit power is used: the horsepower, which is 550 foot-pounds per second.

Since power may be expressed in either watts or horsepower, you may convert from one unit to the other. One horsepower is equal to 746 watts. Therefore:

$$\frac{\text{number of watts}}{746} = \text{number of horsepower}$$

or number of horsepower x 746 = number of watts.

For further detail on electricity, refer to Basic Electricity, NavPers 10086-A. For additional information on mechanical work and power, see Basic Machines, NavPers 10624-A.

ELECTRICAL CABLE AND APPARATUS

There are many different types of electrical cables installed to suit the varying conditions of heat, cold, dryness, dampness, vibration, flexibility, and shock found on naval vessels or at shore bases.

The types of electric cable used by the Navy for shipboard wiring are identified by a standard system of lettering and numbering which gives a more detailed breakdown than do conventional stock numbers used by supply services. The letters and numbers tell exactly the kind of cable used on the run. Note the typical type and size designations in figure 7-28. The first letters tell how many conductors are in the cable.

Cur Dis Obs	Type & Size	No of Cdrs	Strands Per Cdr	Diam Copper Cdr	Area Cdr	Outside Diam Cable Max	Stuffing Tube Size: Deck and Bulkhead	Stuffing Tube Size: Equipment	Maximum Rating: Voltage	Maximum Rating: Ambient Temperature 40°C	Maximum Rating: Ambient Temperature 50°C	Min Radius of Bend	Est Wt Per Ft	Federal Stock No
				Inch	Cirmils	Inch			Volts rms	Amperes		Inch	Lbs.	GX6145
						LIGHTING AND POWER—Cont.								
C	DSGA-400*	2	127	.742	413,600	2.119	V	8	1000	492	453	13.0	4.28	184-5897
D	DHFA-400*	2	127	.742	413,600	2.508	Y	9	600	492	453	15.5	4.75	192-7195
O	DHFA-400	2	127	.742	413,600	2.508	Y	9	600	492	453	15.5	4.75	192-7221
O	DLPA-400	2	127	.742	413,600	2.514	Y	9	600	329	251	15.5	4.52	
O	DFPA-400	2	127	.742	413,600	2.508	Y	9	600	579	452	15.0	4.75	
C	TSGA-3*	3	7	.060	2,828	.461	B	2	1000	11	10	3.0	.127	542-6910
D	THFA-3*	3	7	060	2,828	.560	C	4	600	11	10	3.5	.171	190-7489
O	THFA-3	3	7	.060	2,828	.560	C	4	600	11	10	3.5	.171	
C	TSGA-4*	3	7	.076	4,497	.499	C	2	1000	18	17	3.0	.156	542-6903
D	THFA-4*	3	7	.076	4,497	.812	F	4	600	18	17	5.0	.334	190-7488
O	THFA-4	3	7	.076	4,497	.812	F	4	600	18	17	5.0	.334	190-7486
D	FHFA-9*	4	7	.108	9,016	.920	G	5	600	38	35	6.0	.475	299-4429
C	FSGA-23*	4	7	.171	22,800	.890	G	5	1000	61	57	5.5	.525	643-1225
D	FHFA-23*	4	7	.171	22,800	1.130	K	5	600	61	57	7.0	.746	184-1091
C	FSGA-50*	4	19	.254	49,080	1.100	K	5	1000	95	89	6.5	.995	643-1224
D	FHFA-50*	4	19	.254	49,080	1.410	N	6	600	95	89	8.5	1.31	184-1093
C	6SGA-100*	6	61	.363	99,060	1.650	R	7	1000	272	250	10.0	2.74	
C	6SGA-125*	6	61	.407	124,900	1.840	S	8	1000	299	275	11.5	3.37	
C	6SGA-150*	6	61	.457	157,600	2.010	T	8	1000	326	300	12.0	4.17	
C	6SGA-200*	6	61	.514	198,700	2.250	W	9	1000	369	340	13.5	5.19	

Maximum ratings for 6SGA cables are for 400 cycle power circuits only.
*Watertight Construction

Figure 7-28.—Cables for nonflexing service.

"S" stands for single conductor, "D" for double conductor, "T" for triple conductor, "F" for four conductors, and "M" for multiple conductors to the cable.

In the 6 SGA designations, the 6 means six conductors. The other letters in the designations are the first letters of words which describe the cable further:

SGA—Shipboard General use, Armored
HFA—Heat and Flame resistant, Armored
LPA—Lighting and Power, Armored
FPA—Flame Proof, Armored.

The numbers following the letters may indicate one or more of the following:

1. Cross sectional areas of the conductor in thousands of circular mils.
2. Number of conductors.
3. Stranding of conductors.
4. Number of twisted pairs.

Two systems of cable marking (the old and the new) may be found aboard naval vessels. The old system used the color of the tag to denote cable classification and the following letters to designate power and lighting cables for the different services:

C—Interior communications
D—Degaussing
F—Ship's service lighting and general power
FB—Battle power
G—Fire control
MS—Minesweeping
P—Electric propulsion
R—Radio and radar
RL—Running, anchor, and signal lights
S—Sonar
FE—Emergency light and power

Other letters and numbers were used with these basic letters to further identify the cable and complete the designation. Typical marking of a power system for successive cables from a distribution switchboard to load would be as follows: feeder, FB-411; main, 1-FB-411; submain, 1-FB-411A; branch, 1-FB-411A1; and subbranch, 1-FB-411-A1A. The feeder number, 411, is indicative of the system voltage. The feeder numbers for a 117- or 120-volt system would range from 100 to 199; for a 220-volt system, from 200 to 299; and for a 450-volt system, from 400 to 499. The exact designation for each cable is given on the electrical wiring plans of each vessel.

The new system for marking power and lighting cable indicates the source and, where practicable, the destination of the cable. Therefore, a thorough knowledge of the system for numbering electrical machinery and equipment aboard ship is necessary to fully understand the new system of cable marking. The general rule for numbering machinery and equipment is used for numbering similar units of electrical machinery or equipment.

The general rule for numbering machinery and equipment states, in effect, that:

1. All similar units in the ship comprise a group, and each group is assigned a separate series of consecutive numbers beginning with 1.
2. Numbering begins in the lowest foremost starboard compartment, and the next compartment selected is to port of the first if it contains similar units; otherwise the next aft on the same level.
3. Proceeding from starboard to port and from forward to aft, continue the numbering procedure until all similar units on the same level have been numbered; then continue on the next upper level, and so on, until all similar units on all levels have been numbered.
4. Within each compartment, the numbering of similar units proceeds from starboard to port, forward to aft, and from a lower to a higher level.

Switchboards or switchgear groups supplied directly from ship's service generators are designated 1S, 2S, and so on as necessary to designate all ship's service switchboards. Switchboards supplied directly by emergency generators are designated 1E, 2E, and so on, as necessary to designate all emergency switchboards. Switchboards for special frequency (other than the frequency of the ship's service system) a-c generators are designated 1SF, 2SF, and so on, as necessary to designate all special frequency switchboards. Switchboards for coolant-pumping power generators are designated 1SC, 2SC, and so on, as necessary to designate all such switchboards. These designations are used only where the coolant-pumping power generators are separate from the ship's service generators.

Sections of a switchgear group other than the generator section are designated by an additional suffix letter starting with the letter, A, and proceeding in alphabetical order from left to right (it is assumed that the viewer is facing the front of the switchgear group). See switchgear group Nos. 4S and 6S (figs. 2-21 and 2-22), respectively.

Some large naval vessels are equipped with zone control, a system of ship's service distribution wherein the ship is divided into areas generally coinciding with fire zones, as dictated by the damage control plan of the ship. Power is distributed within each zone from load center switchboards located within the zone. Load center switchboards and miscellaneous switchboards for ship's service distribution systems on vessels with zone control are given identification numbers, the first digit of which indicates the zone and the second digit the number of the switchboard within that zone, determined in accordance with the general rule for numbering machinery.

The Bureau of Ships has adopted the channel method of illustrating cable diagrams. This method eliminates the use of individual lines to represent each cable and instead employs a heavy line to illustrate more than one cable, with the cables fanned out and identified at terminating points. The method reduces drafting time and also the size of drawings.

A few types of electrical apparatus are described in this section. To supplement this reading, take every opportunity to gain a first-hand acquaintance with electrical equipment and devices.

A generator transforms mechanical energy into electrical energy. It contains stationary field coils and a rotating element, also containing coils, which is called the armature. The rotation of the armature causes the conductors in the coils to cut through a magnetic field set up by the field coils, thus generating an emf. The emf causes an electric current to flow through the circuit of which the generator is a part. It may be built to generate either an a-c or a d-c current.

A battery sets up an emf by chemical action on metallic plates. Some batteries, such as common dry cells for flashlights, cannot be recharged and are thrown away when their chemical energy is spent. Storage batteries, however, with proper care, can be recharged and used many times.

In construction, an electric motor is very similar to a generator, but its use is to take power from the circuit and transform it into mechanical energy. Motors, like generators, have varied types of windings and mechanical features.

Transformers are used in a-c circuits to increase or decrease the voltage. They have a primary coil, energized by a generator, which sets up a constantly varying magnetic field and this serves to induce a current in the secondary coil. The voltage is increased or decreased in proportion to the number of turns in the primary coil to the number of turns in the secondary coil. For example, if the primary has 1,000 turns and the secondary has 100 turns, the secondary voltage will be approximately one-tenth of the primary voltage; if the primary coil has 100 turns and the secondary 1,000, the secondary voltage will be about 10 times that of the primary.

Switches are the control valves for electric current. A switch in a position of contact is said to be closed and, since the circuit is continuous, current can flow. A switch in an open position breaks the circuit and, when a circuit is not continuous, current cannot flow.

Central points in an electrical system, such as a power station or the generator room on a ship, usually have switchboards or control panels. Mounted on these are all the necessary devices for measuring and regulating the flow of current into various branches of the circuit.

A relay is a type of switch which is not operated by hand but by some force such as an electromagnet or a heating element. The purpose of a relay is to perform its switching operation at a location remote from the operator or, if a heating element is involved which trips the relay, as a protective device against too much current flowing on the line. When the relay is used as a protective device, it is usually called a circuit breaker.

ELECTRIC POWER SYSTEMS

Electric power furnishes the numerous services that are indispensable to the operation of a modern naval vessel. Because of the extensive and highly diversified use of electricity aboard ship, the electric system comprises a great many different items of equipment for the generation, distribution, and utilization of electric power.

The type of ship determines whether the electric power system is an a-c or a d-c system. The general practice is to install a-c systems in a new construction cruisers, aircraft carriers, destroyers, escort vessels, submarine chasers, and numerous auxiliary vessels.

D-c systems are used in numerous vessels converted for Navy use, and in cruisers, destoyers, and other vessels built before the general adoption of a-c ship's service systems.

The ship's service electric plant comprises the ship's service generator sets, which are driven by steam turbines, diesel engines, or gas turbines. These generator sets supply power to the ship's service power distribution system, which is the normal source of power to the ship's electrical equipment and machinery.

The emergency electric plant comprises the emergency generator sets, which are driven by diesel engines or gas turbine engines. If power is not available from the ship's service generators, the emergency generators supply a limited amount of power to the vital auxiliaries through the emergency power distribution system.

The power distribution system is the connecting link between the generators that supply electric power and the electrical equipment that utilizes this power to furnish the various services necessary to operate the ship. The power distribution system comprises the (1) ship's service power distribution system, (2) emergency power distribution system, and (3) casualty power distribution system.

Ship's Service Power Distribution System

The ship's service power distribution system is the electrical system that normally supplies electric power to the ship's equipment and machinery. The switchboards and associated generators are located in separate engineering spaces to minimize the possibility that a single hit will damage more than one switchboard.

The ship's service generator and distribution switchboards are interconnected so that any switchboard can be connected to feed power

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With perfect circuit elements and smooth electron emission, the circuit would oscillate indefinitely at this amplitude. But minute irregularities occur in the movement of electrons through resistors and conductors; also the emission from a cathode is not uniform. The nonuniformity is slight, but it does affect the equilibrium in the oscillator circuit. Any slight decrease in current decreases the feedback; and if the time constant of the RC circuit is not extremely long, the bias is reduced slightly by discharge of the capacitor. The decrease in bias allows a little more plate current, which reestablishes the equilibrium at the previous level.

In a circuit with a long RC, however, the circuit starts oscillating, then settles down to a balanced condition as previously described, but any slight decrease in plate current will not be compensated by lowered bias (as shown in fig. 12-24 (B)). The capacitor discharges slowly, and the continued high bias prevents feedback from being restored to the proper level. After a few cycles the oscillation dies out completely. The capacitor slowly discharges, and when its voltage drops below the cutoff voltage, the current again flows and the process repeats.

For continuous operation, the RC of the self-biasing circuit must be short enough to allow automatic adjustment of the bias for changing conditions in the circuit. To make the circuit oscillate briefly, then stop, a long RC is used. The time the tube remains cut off depends upon both the grid capacitance and grid resistance. By proper selection of these values, the oscillator may be made to operate for 1 or 2 microseconds and then cease operation for 500 to 1,000 microseconds.

Grid voltage variations are shown in figure 12-25. It is not possible to show the actual time relations, since the OFF period is several hundred times as long as the ON period.

In an equipment using a self-pulsing oscillator it may be necessary to synchronize the oscillator with other circuits. This may be done by applying a synchronizing sine wave to the grid. The results are shown in figure 12-25 (B) and (C). Without synchronization (A), the grid rises exponentially and crosses the cutoff line at a small angle, which means that the actual time at which oscillation begins may vary somewhat. Notice in (C) that the point at which the grid voltage crosses the cutoff bias line is much more definite.

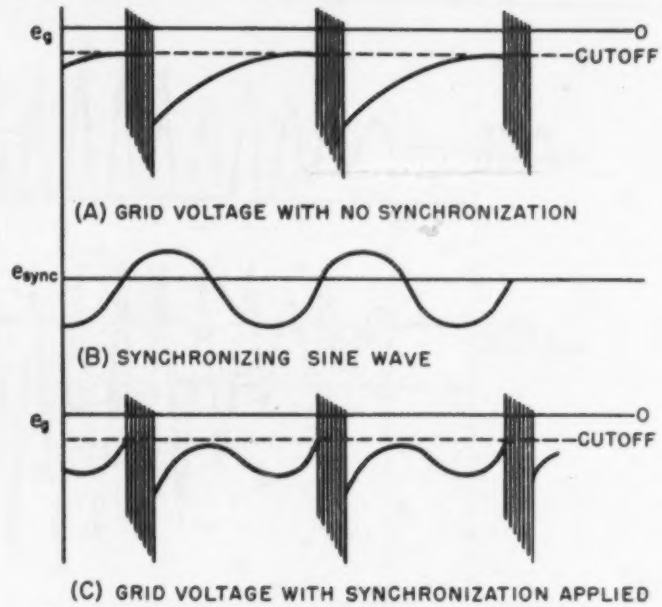

Figure 12-25.—Grid waveshape with and without sync.

The ideal condition would be for the grid voltage to cross the cutoff line at a 90° angle. For that reason, a positive going pulse is often applied when the grid voltage approaches cutoff. This assures oscillation at exact intervals of time. The oscillator is then synchronized to produce a desirable PRF.

Another means of obtaining a sharp crossover angle of the grid voltage is to return the grid to a positive voltage rather than to ground. Thus the grid voltage, in rising to a higher voltage than zero, will cross the cutoff line at a steep angle.

In order to make the DURATION of the pulse more definite, some self-pulsed oscillators use an artificial transmission line (pulse line) instead of the grid leak capacitor. This has the added advantage of making the operating conditions more nearly constant throughout the pulse. There are two places where the pulse line can be located. One is to put it in the grid circuit, as shown in figure 12-26, the other, in the cathode circuit.

A pulse line behaves like a long transmission line. It acts like a resistive circuit until the charging pulse has traveled the length of it and returned, at which time it is fully charged. This causes the voltage to change in two steps; the first step is from the bias level to the voltage determined by the product of the grid current times the characteristic impedance of the line, and the second step is of a magnitude equal to the first.

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from its generators to one or more of the other switchboards.

Emergency Power Distribution System

The emergency power distribution system is provided to supply an immediate and automatic source of electric power to a limited number of selected vital loads in the event of failure of the ship's service power distribution system. The system, which is separate and distinct from the ship's service power distribution system, includes one or more emergency distribution switchboards. Each emergency switchboard is supplied by its associated emergency generator. The emergency feeders run from the emergency switchboards and terminate in manual or automatic bus transfer equipment at the distribution panels or loads for which emergency power is provided.

The emergency generators and switchboards are located in separate spaces from those containing the ship's service generators and distribution switchboards.

Casualty Power Distribution System

The casualty power distribution system is provided for making temporary connections to supply electric power to certain vital auxiliaries if the permanently installed ship's service and emergency distribution systems are damaged.

The casualty power system includes portable cables, bulkhead terminals, risers, switchboard terminals, and portable switches. Portable cables in suitable lengths are stowed throughout the ship in convenient locations.

I.C. SYSTEMS

Alarm and Warning Systems

Alarm and warning systems are provided in naval vessels to indicate abnormal or dangerous conditions that may cause casualties to machinery and personnel.

The various alarm and warning systems used aboard ship are usually the simplest types of I.C. circuits. The majority of these systems consists of one or more switches that complete an electric circuit to various types of audible and visible alarm equipment. There are many kinds of switches in use and the type depends upon the circuit in which it is installed. Relays are used in alarm and warning systems to open and close circuits that may operate indicating lights, annunciator drops, and/or audible signals. Audible signal devices include bells, horns, buzzers for quiet spaces, and sirens for noisy spaces or to sound very urgent alarms.

Visual signals are used in a great many alarm and warning systems to provide an additional means of identifying the alarm being sounded. Audible and visual signals are often used together. In many instruments the same audible device is used in combination with several visual indicators. The principal types of visual signals are lamp-type indicators and annunciators.

Announcing and Intercommunicating Systems

Shipboard announcing and intercommunicating systems serve the general purpose of transmitting orders and information between stations within the ship by amplified voice communication. This function is accomplished by either (1) a central amplifier system, or (2) an intercommunicating system.

Each announcing and intercommunicating system installed aboard ship is assigned an I.C. circuit designation in the MC series. Authorized I.C. announcing circuits are numbered 1MC through 34MC. These systems, however, are not all installed in any one ship.

The central amplifier announcing system is designed to furnish amplified voice communications and alarm signals to the various loud speaker groups aboard ship. The system provides for transmitting the spoken word or signal at any one of several stations, amplifying this signal from a number of loudspeakers.

An intercommunicating system consists of a number of identical, permanently located stations. Each station contains all the necessary components to provide two-way amplified voice communication, supplemented by signal lamps, between any two stations or from one station up to four other stations simultaneously.

Supplementary Communication Systems

The sound-powered telephone amplifier system provides a method of amplifying one-way communication (incoming speech) in a two-way sound-powered telephone communication system. The equipment is designed to amplify voice signals so that the reproduced message will be clear and understandable at locations aboard ship where the noise level is high (gun positions

or machinery spaces). When the amplifier is turned off, the system functions normally for two-way communication at the sound-powered level.

The dial telephone system is primarily an administrative circuit that provides complete selective telephone communication throughout the ship. This system is also used to supplement other communication facilities for ship control, fire control, and damage control. The capacity of the system varies with the size and needs of the particular ship.

Television is becoming increasingly important in Navy applications. Present applications are limited to closed circuit television. In the closed circuit systems, signals are sent between the camera and the receiver through cables instead of through the air.

Ship Control Order and Indicating Systems

Ship control order and indicating systems include among others the engine order system, propeller order system, rudder order system, and rudder angle indicator system. These systems comprise units that pertain to ship control orders and indications.

Ship's Metering and Indicating Systems

Ship's metering and indicating systems include the shaft propeller revolution indicator systems, wind direction and speed indicator system, salinity indicator system, underwater log system, and many others.

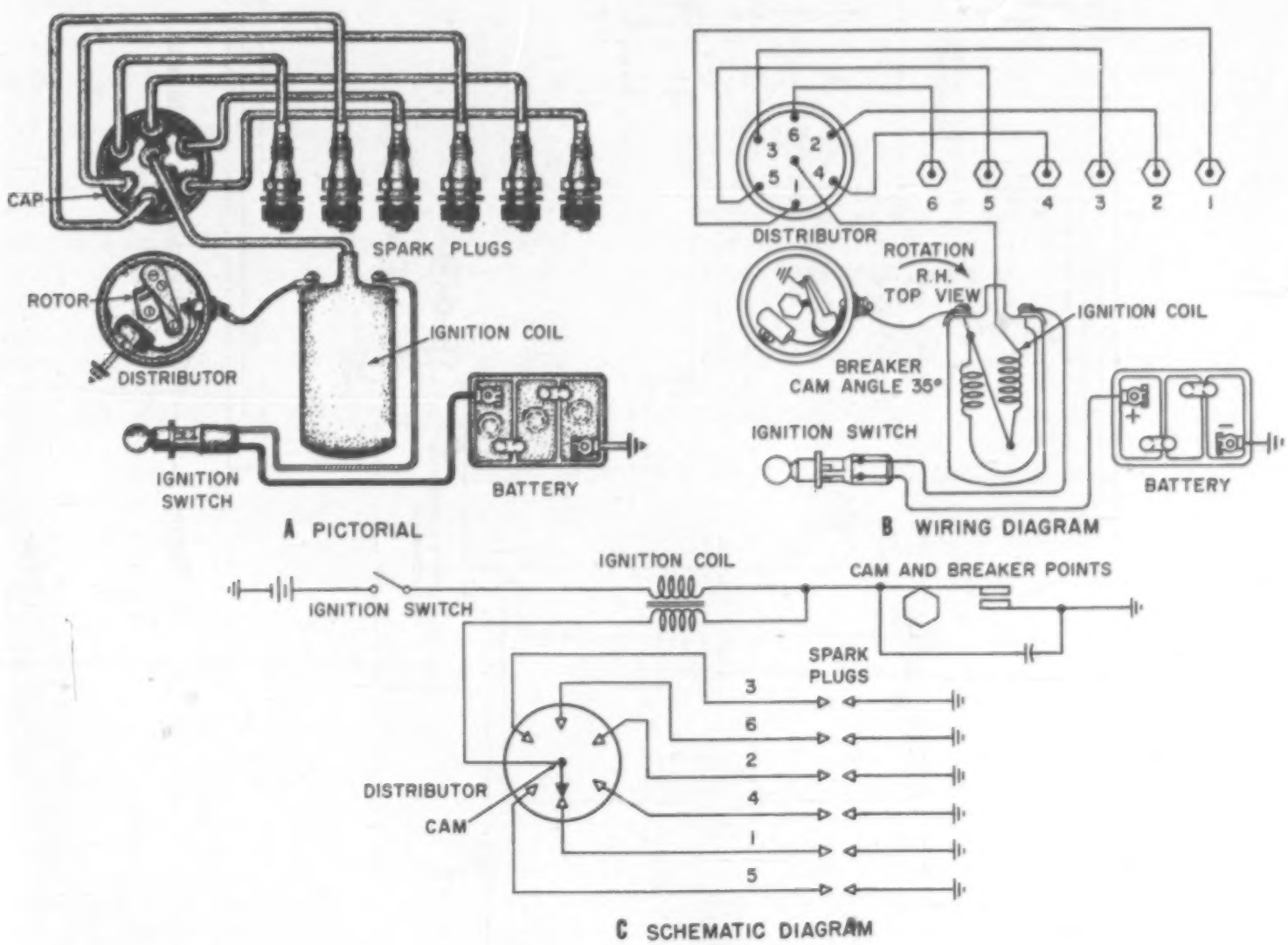

Figure 7-29.—An ignition system.

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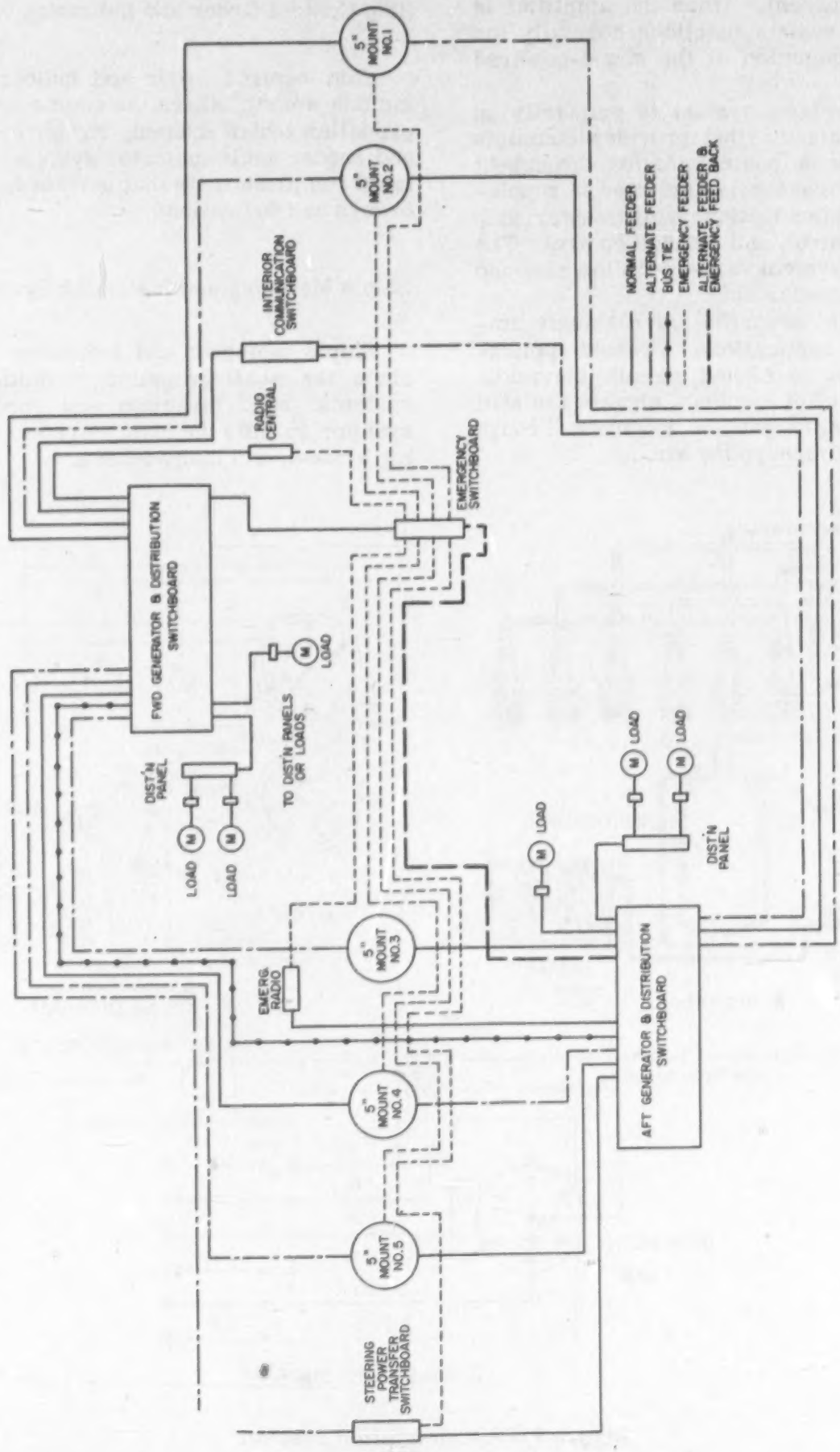

Figure 7-30.—Power distribution system in a destroyer.

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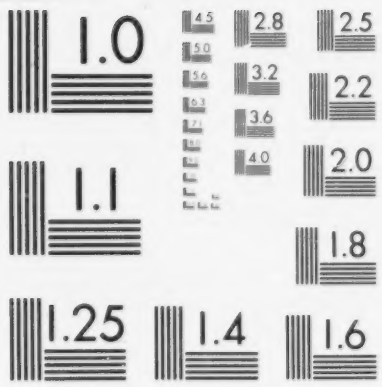

MICROCOPY RESOLUTION TEST CHART

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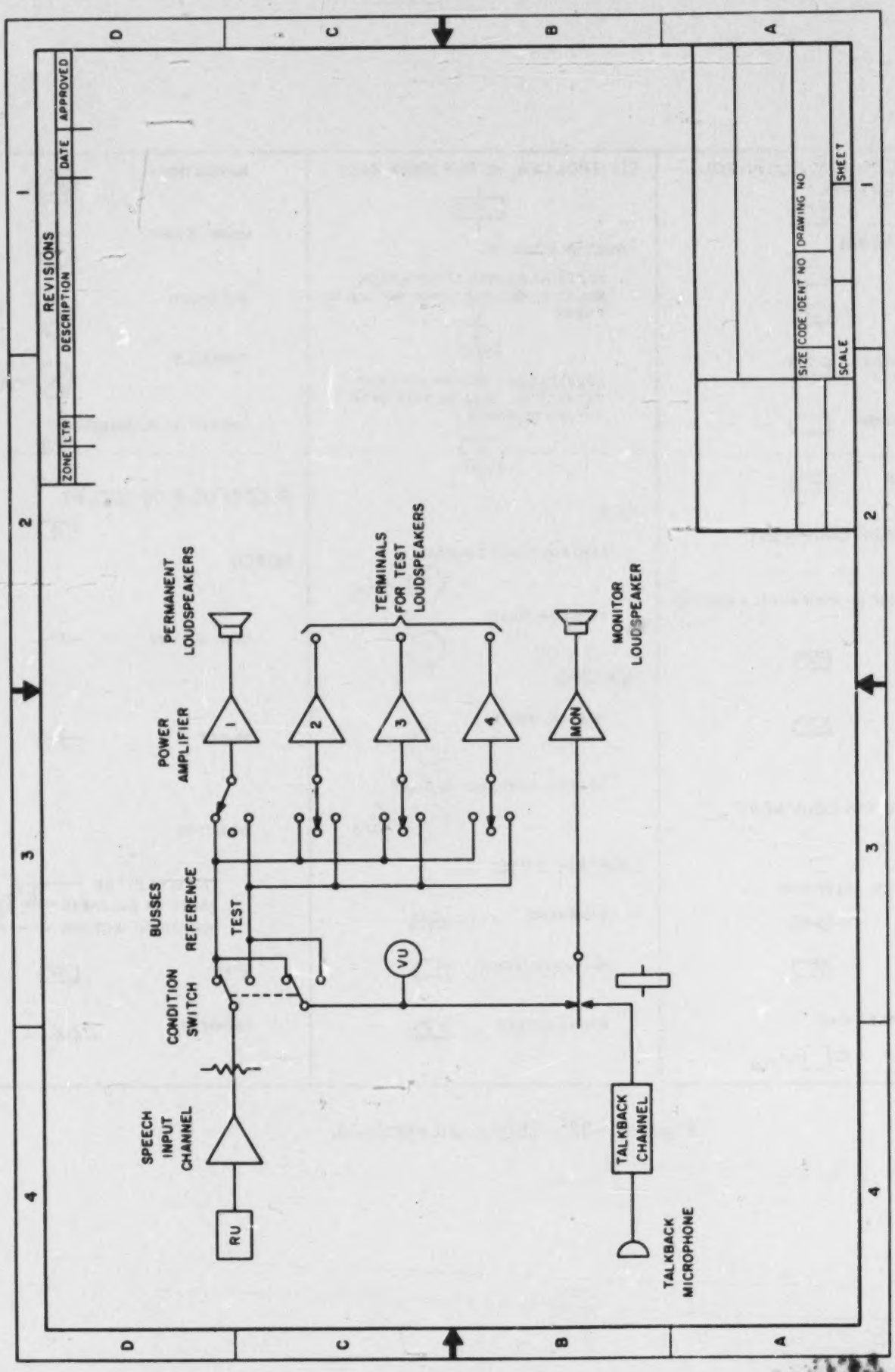

Figure 7-31.—Sample single line diagram drawing.

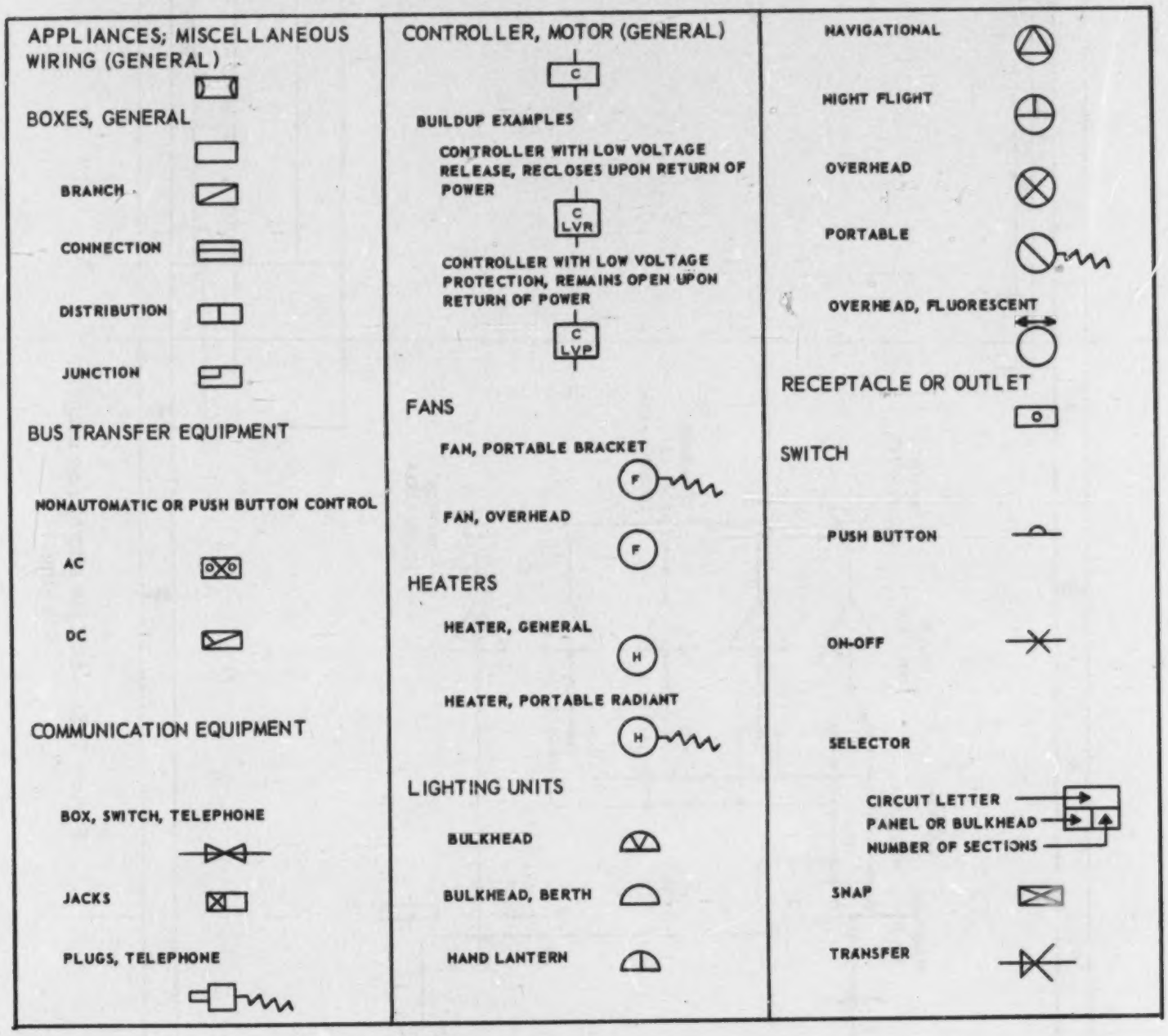

Figure 7-32.—Shipboard symbols.

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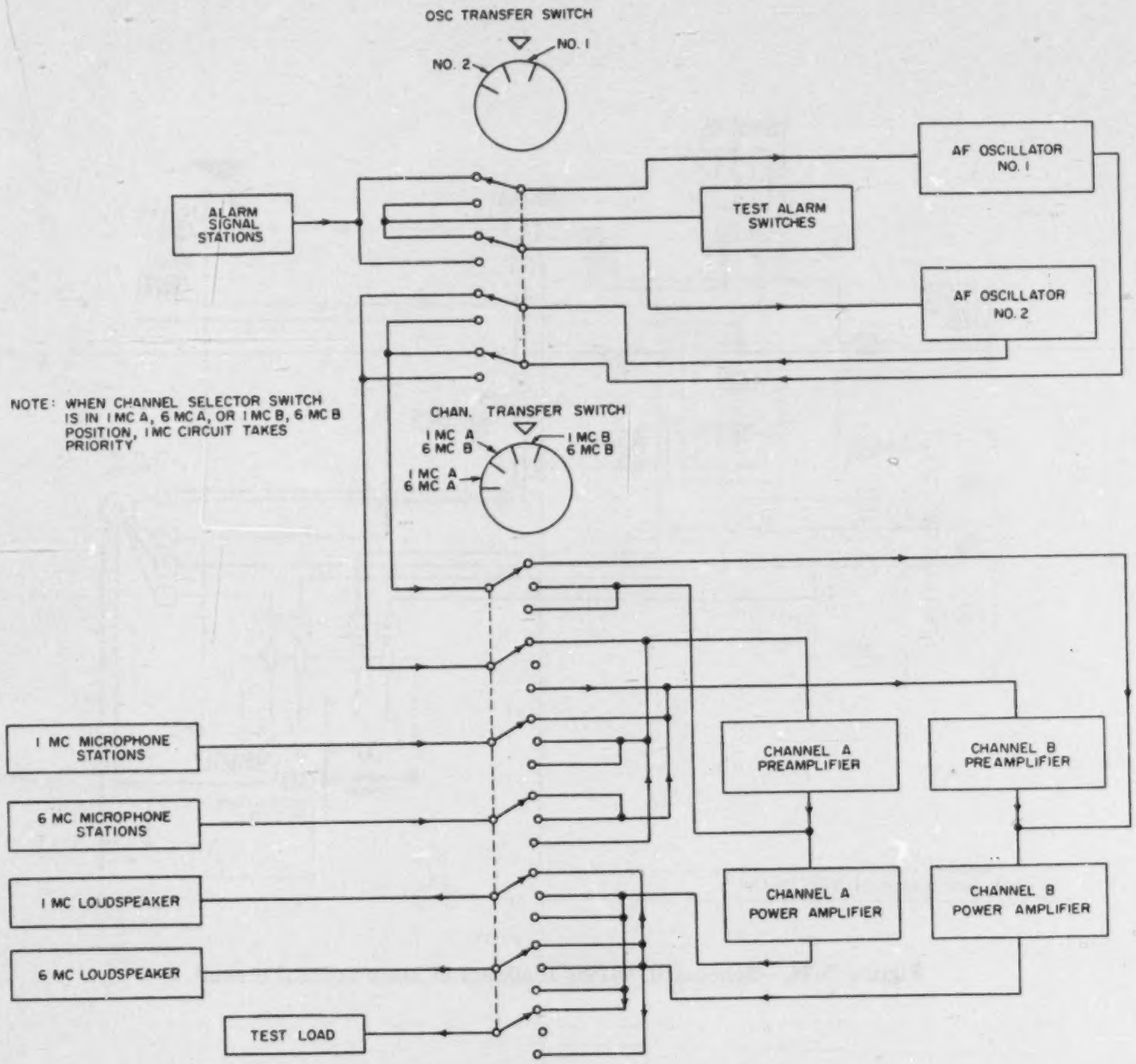

Figure 7-33.—Block diagram of an announcing system.

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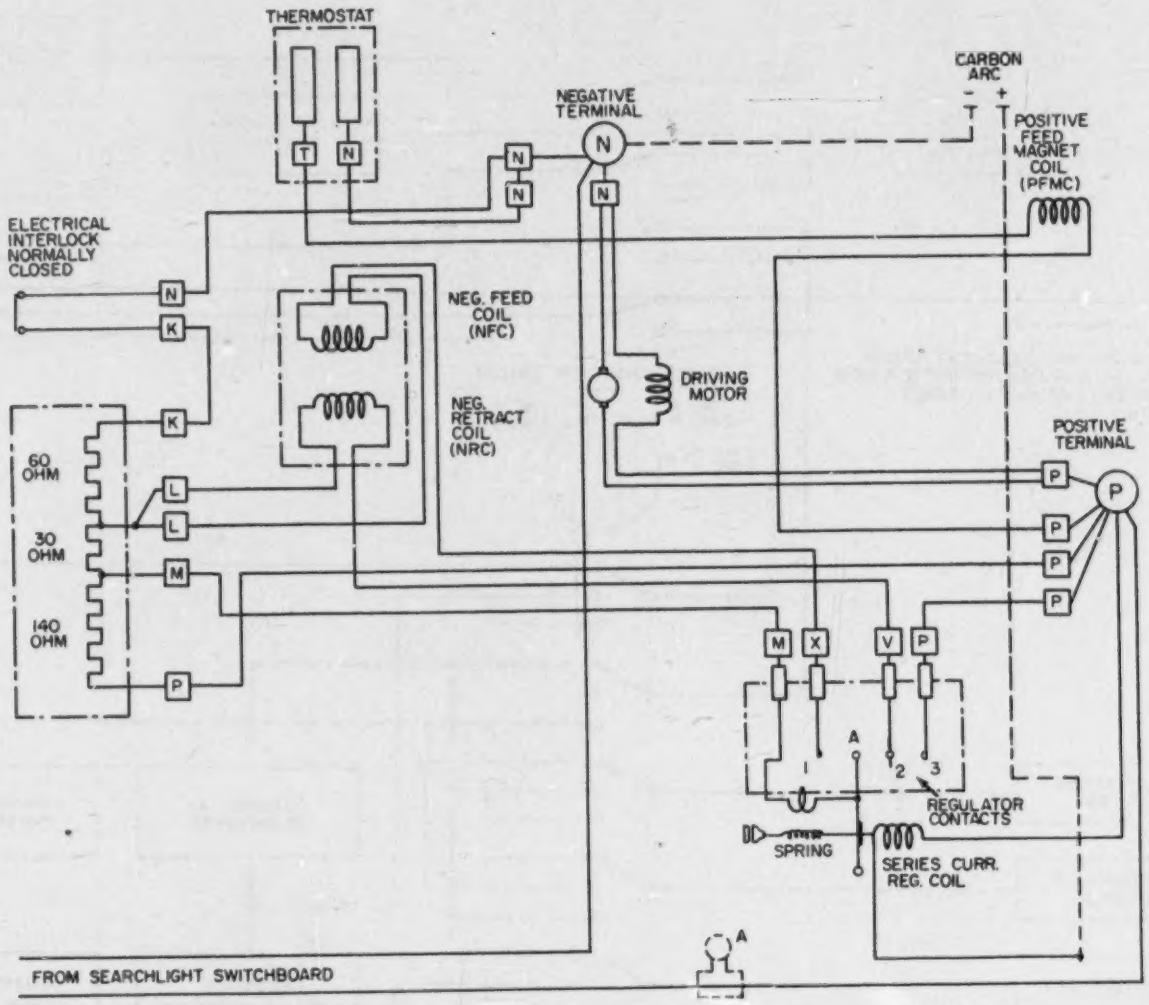

Figure 7-34.—Schematic wiring diagram of lamp control circuit.

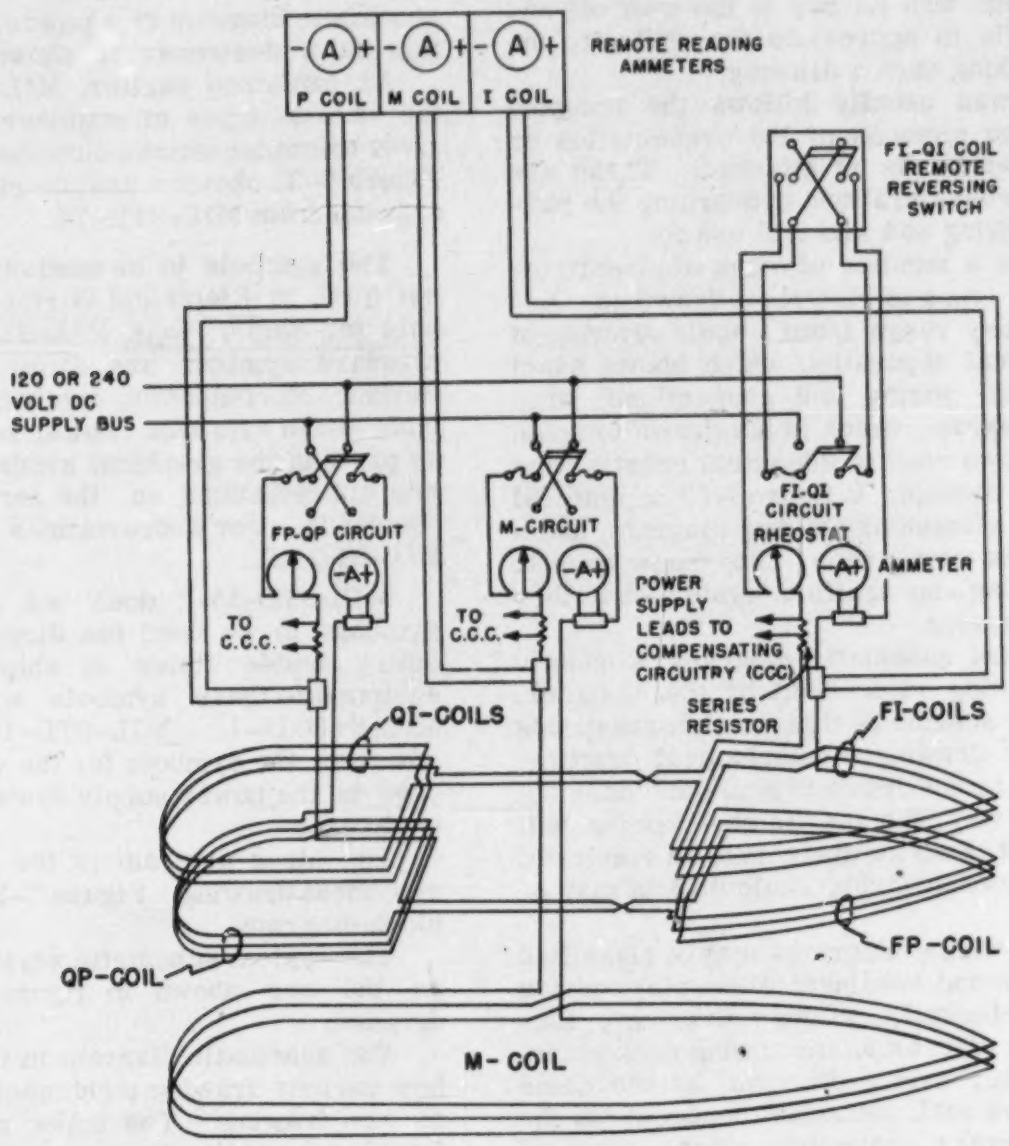

Figure 7-35.—Schematic diagram of a degaussing installation.

DRAWINGS AND SYMBOLS

Electrical diagrams may seem less difficult to draw than complex projections of machine parts or structural drawings. The standard symbols used on electrical diagrams consist of simple shapes: lines, circles, squares, rectangles, and letters. But try to read an electrical diagram with no key to the symbols and you will begin to appreciate the difficulty involved in making such a drawing.

A draftsman usually follows the accepted standards and methods of the organization or activity to which he is attached. These are governed by considerations concerning the purpose of a drawing and who will use it.

There are a number of ways of classifying the different types of electrical drawings. Actually they may range from a scale drawing of some electrical apparatus, which shows exact location of all wiring and connections, to a schematic diagram, which is not drawn to scale and which shows none of the actual construction details of the system. In figure 7-29, a pictorial drawing, and elementary wiring diagram, and a schematic are compared. They show exactly the same thing—an ignition system—but they look quite different.

Actually the schematic diagram is usually the first drawing worked out by the designer. It denotes the scheme of things. It corresponds to the design drawing of mechanical drafting, except that it is not drawn to scale and does not look in any way like the finished wiring will look. From it, a wiring diagram or an electrical layout with accompanying scale details may be drawn.

Shipboard wiring diagrams may be classified under four general headings: elementary wiring diagrams, schematic wiring diagrams, isometric wiring diagrams, and wiring deck plans. The elementary wiring diagram, as the name implies, shows each individual conductor in the circuit and every connection made. Most of these diagrams do not show the fixtures or cable runs, and for this reason they are not drawn to scale. What they show are the structural parts of the circuit. An elementary diagram would be used to check proper connections in a circuit or to make the initial hook-up.

Schematic wiring diagrams, on the other hand, would show the order in which parts of the system are connected but would not show each individual conductor. An example of a schematic diagram of a power distribution system in a destroyer is shown in figure 7-30.

As explained earlier, MIL-STD-7A defines the various types of engineering drawings and gives examples which follow the standard format. Figure 7-31 shows a sample single line diagram drawing from MIL-STD-7A.

The symbols to be used on ships' plans are set forth in Electrical Wiring Equipment Symbols for Ship's Plans, MIL-STD-15-2. Typical standard symbols are shown in figure 7-32. Buildup, or composite, symbols can be contrived from basic symbols. Letter combinations used as parts of the graphical symbols do not constitute abbreviations as the term is used in the standards. For abbreviations as such, refer to MIL-STD-12.

MIL-STD-15-2 does not cover all of the symbols to be used for diagrams of the circuitry inside items of shipboard electronic equipment—these symbols will be found in MIL-STD-15-1. MIL-STD-15-2 does cover, however, the symbols for the wiring appliances used in the power supply systems of electronic equipment.

The block diagram is the simplest type of electrical drawing. Figure 7-33 shows a typical block diagram.

The typical schematic wiring diagram, such as the one shown in figure 7-34, is more detailed.

The schematic diagram in figure 7-35 shows how various drawing techniques can be combined on one drawing. The upper part is a conventional schematic diagram. The lower part, however, is an oblique drawing of the cables which follow the outline of the hull of the ship.

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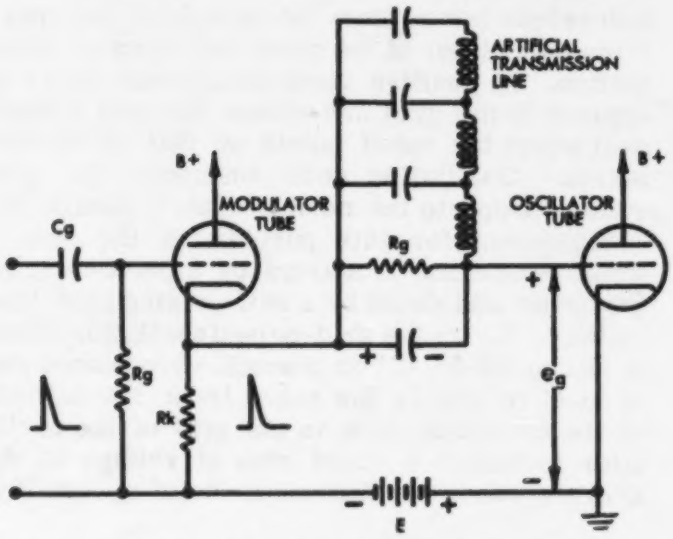

Figure 12-26.—Oscillator, with plause line in grid circuit.

The PRF is controlled by the synchronizing pulses, but the discharge of the pulse line through the grid resistor must be such that the grid voltage approaches the cutoff point by the time the next synchronizing pulse comes in. The discharge of the line is in steps, as shown in figure 12-27, which is the diagram of the grid waveshape of a line controlled, self-pulsed oscillator. The magnitude of the discharge voltage is determined by the relative values of the grid resistance (R_g) and the characteristic impedance of the line. R_g is usually much larger, hence the steps are small. These steps follow the general path of the exponential discharge curve with time constant R_gC_o, where C_o is the capacitance of the pulse line.

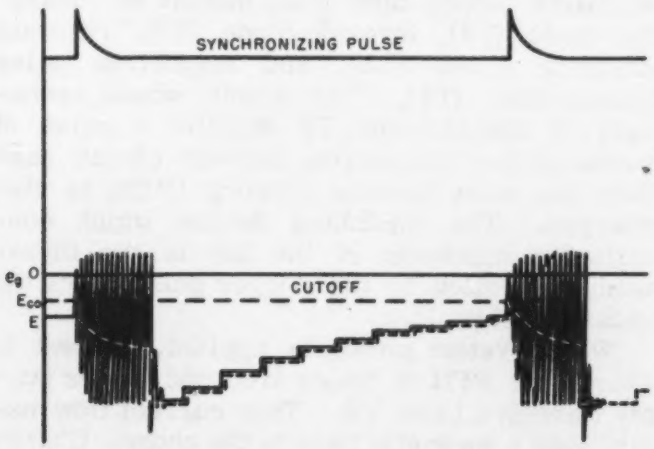

Figure 12-27.—Grid waveshape of a line controlled, self-pulsed oscillator.

Separate Modulators

As previously mentioned, some triode UHF oscillators are not self-pulsed, but employ separate modulators. These modulators are very much like those used with magnetron oscillators, which are discussed later in this chapter. Here merely note that the oscillator may be plate modulated, grid modulated, or cathode modulated.

PLATE MODULATION.—Figure 12-28 (A) shows a circuit for plate modulation in which short positive rectangular pulses applied to the grid of the modulator tube result in a negative going pulse at the plate.

Plate voltage is applied to the oscillator tube or tubes in short rectangular pulses. RF components for the oscillator are not shown in the diagram. The transformer must be specially constructed so that it passes the rectangular pulse without undue distortion. Since one purpose of the transformer is polarity inversion, the question arises as to why negative going pulses are not applied to the grid of the modulator tube to cut it off and obtain a positive going pulse at the plate for use in modulating the oscillator. This would require that the modulator tube, or tubes, conduct heavily during all the cycle except during the pulse, and would result in excessive waste of power.

The grid capacitance C_g of the oscillator is quite small, usually consisting of only the capacitance to ground of the grid tuned circuit. If made too large, C_g might cause the oscillator to be self-pulsed and cut itself off before the modulator pulse is over. C_g and R_g have values that would cause continuous wave operation if plate voltage were applied all the time. The modulator pulse is most effective in controlling the output pulse. Oscillations must build up rapidly so that the leading edge of the output pulse will be as steep as possible. The plate voltage of the oscillator must remain constant throughout the pulse.

CATHODE MODULATION.—A cathode pulsed (modulated) oscillator does away with the necessity of inverting the pulse, hence no transformer is required. (Refer to fig. 12-28 (B).) The charging diode serves to recharge the coupling capacitor C between pulses. The capacitor must have a large capacitance, so that it will not discharge appreciably during the pulse and thereby lower the plate to cathode voltage.

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CHAPTER 8

OFFICE MACHINES AND EQUIPMENT

In most every graphic art shop there is an assortment of machines and equipment used daily in the production or reproduction of illustrative material. It may also be a command instruction that a DM be the projector operator when the command gives its presentations. This chapter covers only a few of the many different types of equipment available; and, because of the almost constant changes and improvements in office reproduction equipment, the equipment in your office may be far in advance of that covered here, or it may be quite obsolete compared to the equipment mentioned here. The one thing any operator of any piece of equipment should always do is to study the manufacturer's instruction book which comes with his particular machine. This is the most practical method of learning the operation, maintenance, and safety precautions pertaining to any specific machine.

PROJECTORS

OVERHEAD PROJECTOR

The overhead projector is used to project images from either transparencies or slides. Light from a 500 or 1000 watt projection lamp is reflected upward toward the projection stage. Supported centrally over the stage is the projection level. Light leaving the lens along a vertical axis is deflected toward the screen. Figure 8-1 depicts the nomenclature of the overhead projector and shows the path of light being projected.

The projector can be set up on either side of the screen. For classroom use, it is more effective for it to be located in front of the screen to allow the instructor to operate it while he is instructing his class. The instructor can face his class continuously and can time his demonstrations during the class period to maintain greater trainee attention.

For command briefings, the projector is usually placed behind the screen so that it offers no interference to the audience.

There are projectors which project transparencies of 5 x 5 inches, 7 x 7 inches and even 12 x 15 inches, but the projector most commonly used has a 10 x 10 inch aperture.

In addition to projection capability, mechanical simplicity is a great advantage. It has the lamp (easily replaced) and a small blower for cooling, but no gears, wheels or dials. Turn on the lamp and it's ready for projection.

Lantern Slide Attachment

The attachment (fig. 8-2) is designed for the projection of standard lantern slides (3 1/4 x 4 in.). It consists of a collar, slide platform, auxiliary lens assembly and auxiliary lens. To mount the slide platform, remove the tube from the projector and slide the platform onto the tube from the bottom up until it approximately touches the rack. Tighten the clamping screw slightly. Slide the collar onto the tube so that the raised side of the collar comes in contact with the platform to serve as a stop. Tighten the clamping screw. Reinsert the tube into the projector and clamp it. Swing the platform until it is approximately centered over the projection stage. Mount the auxiliary lens as shown in figure 8-2. Push the clamping ring over the bottom of the lens so that the bottom edge of the lens and ring are even. Carefully tighten the clamping screw.

Turn on the projection lamp. Swing the platform from side to side until the bottom edge of the screen image is parallel to the floor. Rotate the collar until the vertical projecting edge

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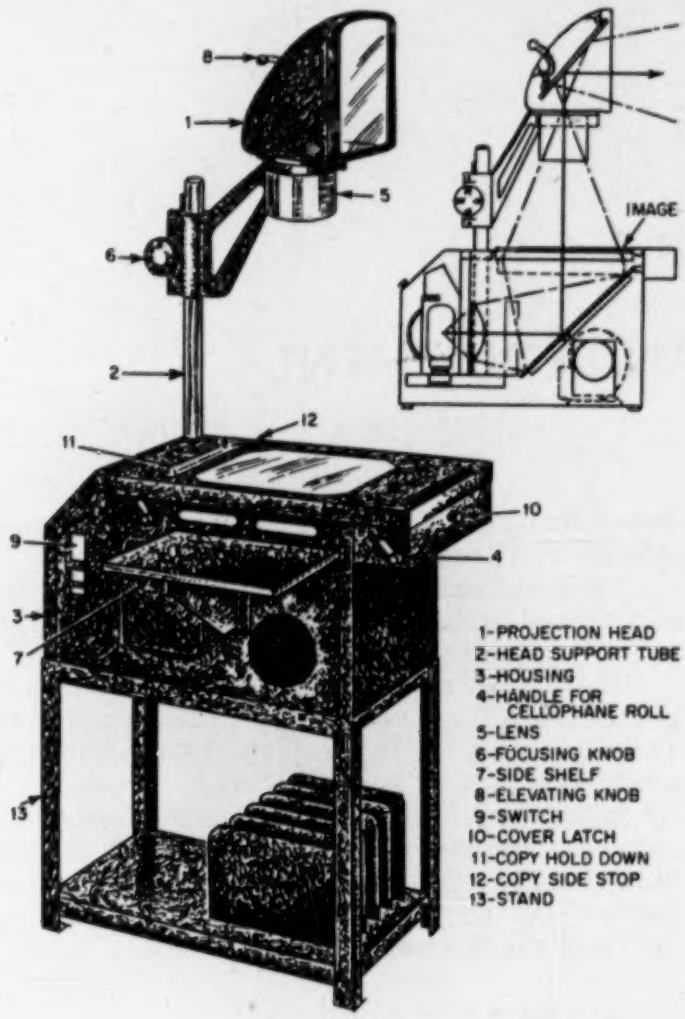

Figure 8-1.

comes up against the platform casting. Clamp the collar in this position. This serves as a stop so that the platform can be swung in and out of the projection position instantly. The auxiliary lens is also pivoted so that it can be swung in and out of operation position instantly.

To project slides, place the auxiliary lens and platform into projection position. Focus the image with the focusing knob. While one slide is being projected the next slide can be placed in the channel beside the first one. The slides are changed by sliding the second slide into projection position. This enables uninterrupted projection without light flashes on the screen.

Lantern Slide and 2" x 2" Slide Attachment

The lantern slide attachment (fig. 8-3) is designed for the projection of lantern slides (3 1/4" x 4") and 2" x 2" slides. It consists of a collar, a platform, a platform for 2" x 2" slides and an auxiliary lens assembly consisting of a clamping ring, lantern slide auxiliary lens, and 2" x 2" slide auxiliary lens.

Note: The lantern slide attachment in figure 8-2 can be converted into the lantern slide and 2" x 2" attachment by the addition of the 2" x 2" auxiliary lens and the 2" x 2" slide platform.

To mount the attachment, follow the instructions given for the lantern slide attachment shown in figure 8-2. Mount the 2" x 2" slide platform by hooking it over the shoulder rivets on the lantern slide platform. Figure 8-3 shows the unit set up for the projection of 2" x 2" slides. To project standard slides, remove the 2" x 2" platform and swing the 2" x 2" auxiliary lens to one side.

A HEAT ABSORBING FILTER is required for the projection of 2" x 2" slides and 35mm film strips. It is furnished mounted on a plate and is inserted into the projector by simply sliding it into the channels. (See fig. 8-4.) Although the heat absorber must be used, even with the 500-watt lamp, when projecting 35mm film strips and 2" x 2" slides, it is not normally required

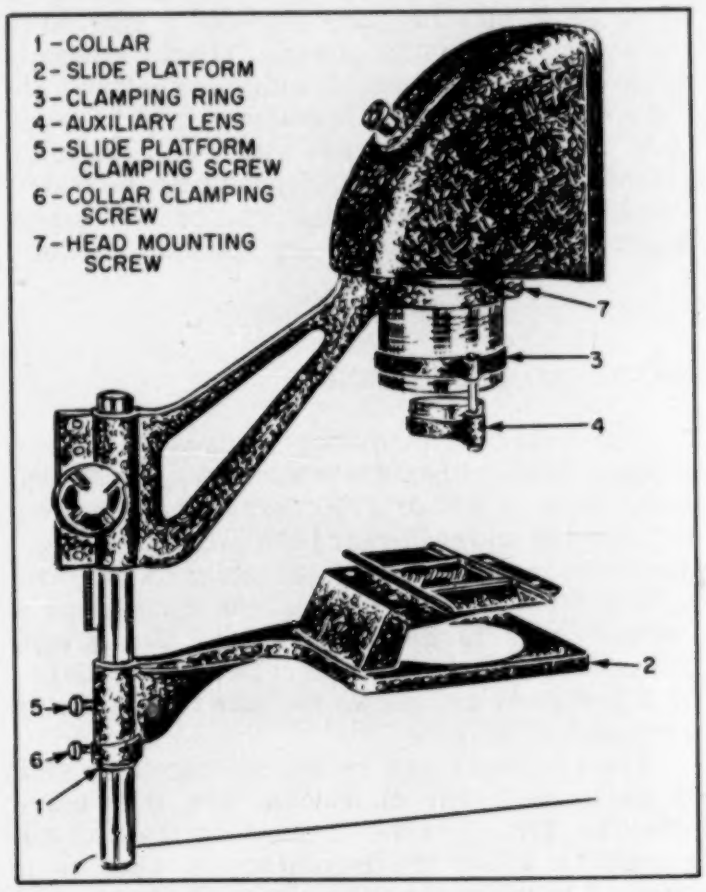

Figure 8-2.

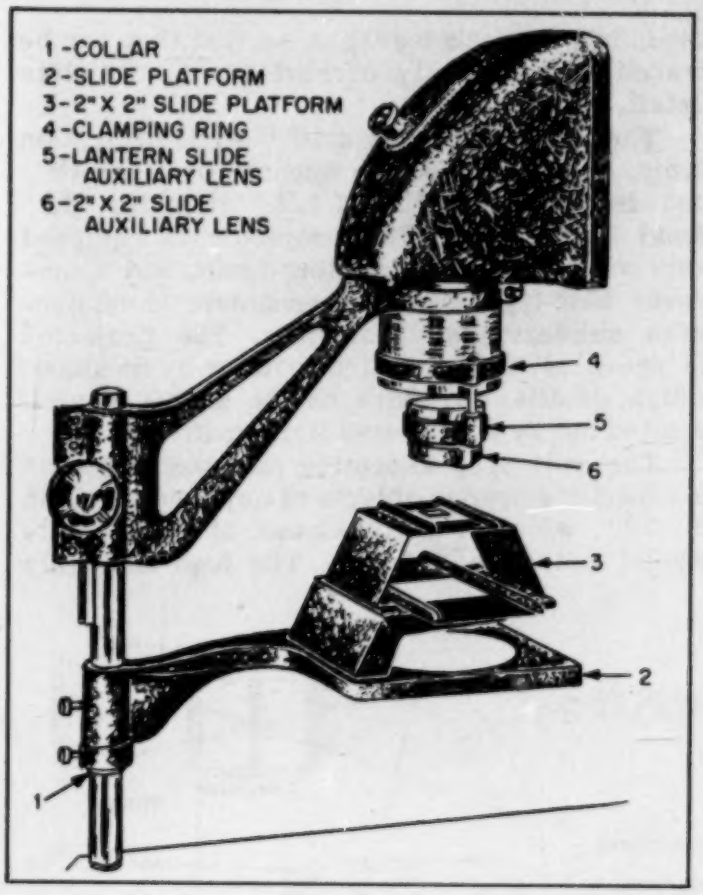

Figure 8-3.

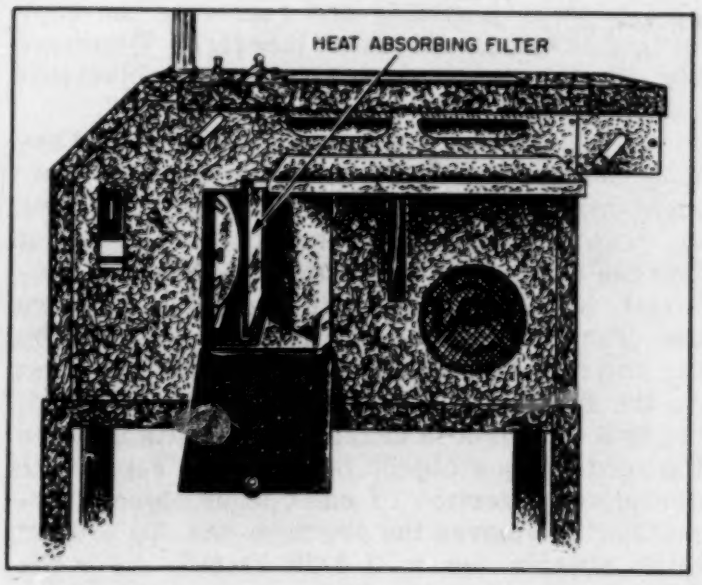

Figure 8-4.

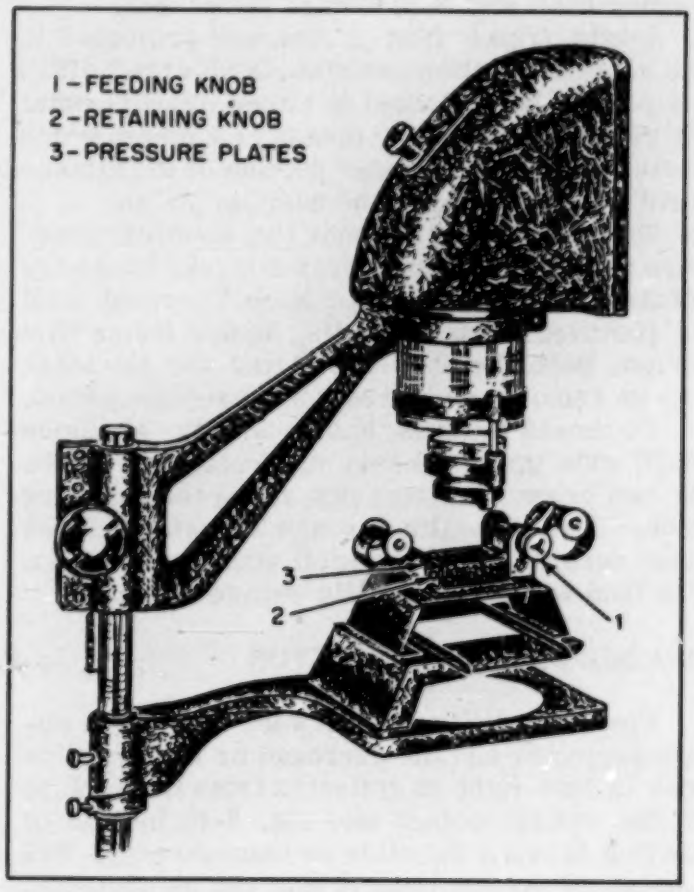

Figure 8-5.

for other types of projection, even with a 1000-watt lamp, unless the transparency being projected is very dense. In this case, most of the energy in the beam of light is arrested and converted into heat, making the heat absorber necessary.

35mm Film Strip Attachment

Projection of 35mm single and double frame film strips is accomplished by means of the film strip attachment used in conjunction with the Standard Slide and 2" x 2" Attachment.

This attachment is mounted in place of the 2" x 2" slide platform. It is placed with the feeding knob (fig. 8-5) toward the screen.

Single frame film strips are projected in the vertical position as shown. Double frame film strips may be projected in either the horizontal or vertical position by means of a turret which permits turning the upper portion of the attachment perpendicular to the position shown.

The attachment includes two identical pressure plates and a single frame mask. These are located above the retaining knob. The mask must be removed when projecting double frame film strips. Both the aperture plates and the mask can be removed by depressing the retaining knob.

To thread the film, hold it with the emulsion (dull) side up and insert the front end between the two pressure plates just above the retaining knob. Push the film through and at the same time turn the feeding knob counterclockwise. The film will automatically engage itself.

OPAQUE OBJECT PROJECTOR

The basic difference between the opaque object projector and the overhead or film or slide type is that light is reflected from the surface of the opaque object (see fig. 8-6) instead of passing through the slide or transparency. Examples of opaque objects that can be projected with this device are a page of a magazine or book, photographs, pictures in full color, charts and diagrams. Also, relatively flat physical objects such as small machine parts, cams, gears, coins, etc., can be projected. No special preparation of the opaque objects is necessary in order to project them.

The opaque object projector can be used as a visual aid in teaching and briefing, for the presentation of progress charts and similar data and for the comparison of small physical objects. It is extremely useful to enlarge drawings, maps or photographs so that they can be traced proportionally correct and in complete detail.

The projector uses a 1000-watt projection lamp, has a projection opening of 10" x 10", and is equipped with a 4 1/2" diameter, 22" focal length lens. The projector is equipped with an opaque object holding device and a conveyor belt type loading mechanism which permits uninterrupted projection. The projector is provided with an optical pointer by means of which details anywhere on the screen can be pointed out by a projected light spot.

The roll feed assembly provides a means for handling opaque objects of any length and up to 10" wide. The thickness of the objects should not exceed 1/32". The feed assembly

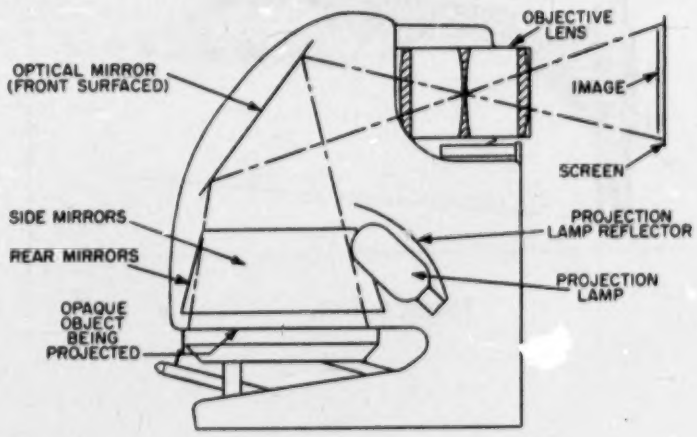

Figure 8-6.

also permits inserting and removing the copy without lowering the platen (see fig. 8-7) assembly. The maximum size of the opaque object that can be projected at one time is 10" x 10".

To operate the roll feed assembly, stand behind the projector and hold the crank in your right hand. Hold the copy in the left hand, face up, bottom edge toward the screen and feed it into the left side of the projector. When the material is inserted approximately 1 1/2", turn the crank clockwise. The pressure created by the impelled air will hold the opaque object flat on the feed belt and when the crank is turned, the opaque object is carried into position. When the next opaque object is inserted, repeat the operation. Insertion of one opaque object automatically removes the previous one. To project thick objects (up to 1 1/2" thick), lower the platen assembly to the locked position and remove the roll feed assembly by lifting it off.

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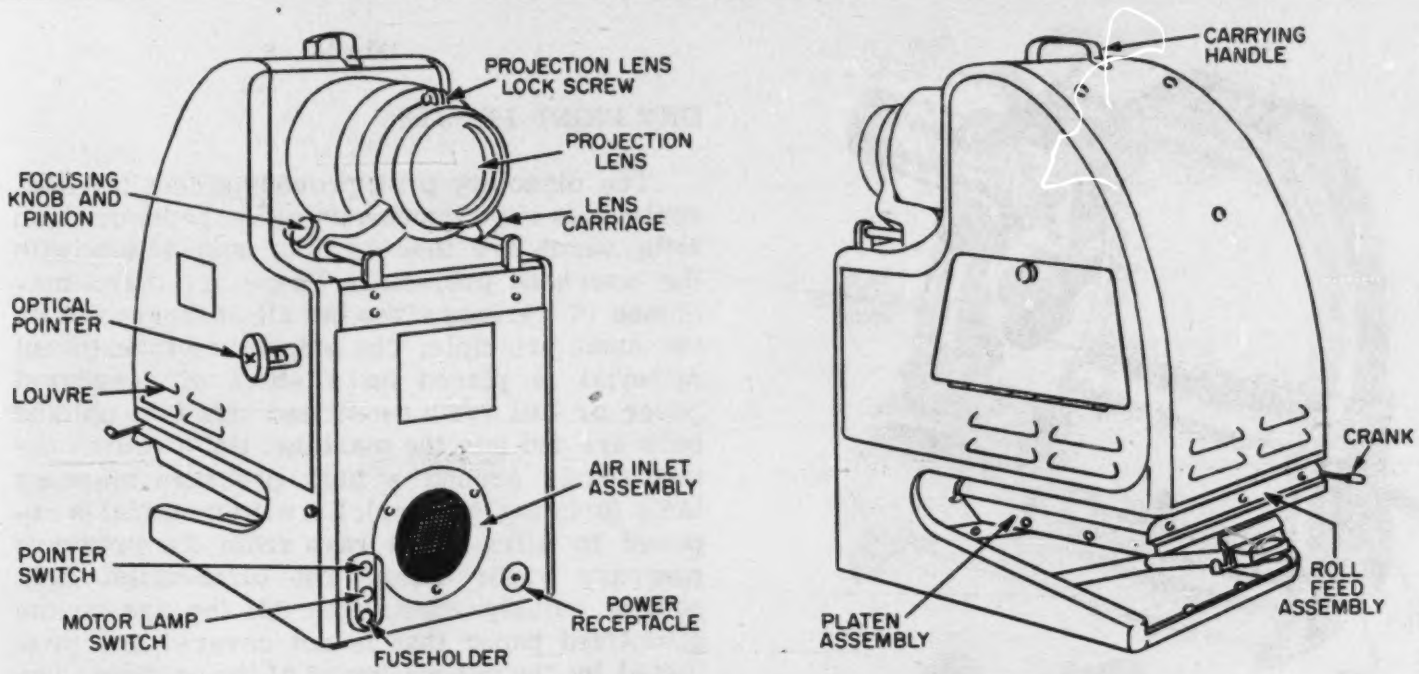

Figure 8-7.

Place the opaque object upon the platen assembly and let it rise as far as it will go. Apply a continuous pressure downward on the platen handle to prevent the platen assembly from snapping upward when you release the lock.

Although thick physical objects (not lying in one plane) can be projected, only one plane of the object can be brought into focus at one time. Other planes can be brought into focus by rotation of the focusing knob. However, when an object is not too thick, good definition can be obtained over its entire thickness.

Set the projector on a suitable table in the projection room. The table should be high enough to project the image over the heads of the audience. Do not use a low table which requires excessive extension of the elevating legs as this will produce a distorted screen image which will be impossible to focus sharply. With the opaque projector, the screen illumination obtained is not great and it is necessary to use a dark room for satisfactory projection.

LANTERN-SLIDE PROJECTOR

The lantern-slide projector is specifically designed for auditorium and theater projection of standard 3 1/4" x 4" lantern slides, 2 3/4" x 2 3/4" slides, and 2" x 2" slides. Some models of this type of projector have built-in optical pointers. The projector uses a 750-watt lamp, is blower cooled and has an extremely wide range of objective lenses available. Figure 8-8 shows the standard lantern-slide projector.

35MM STRIP FILM AND 2" x 2" SLIDE PROJECTOR

The film strip is projected through the projector, frame after frame, by turning the film advance knob (fig. 8-9) counterclockwise. The strip film attachment assembly is designed to automatically transport and index into position each single or double frame. The framing mech-

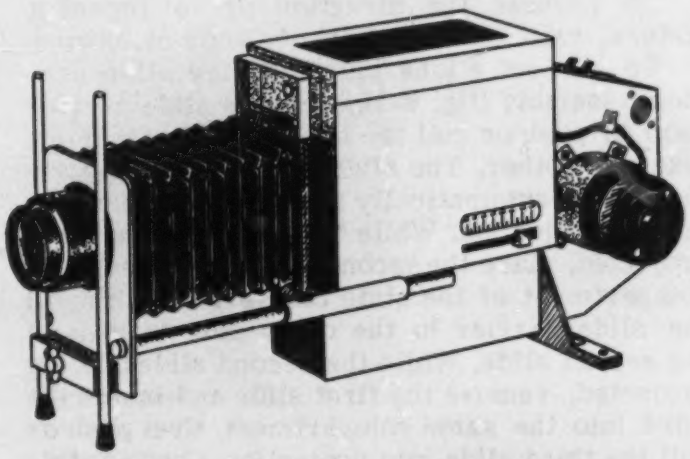

Figure 8-8.

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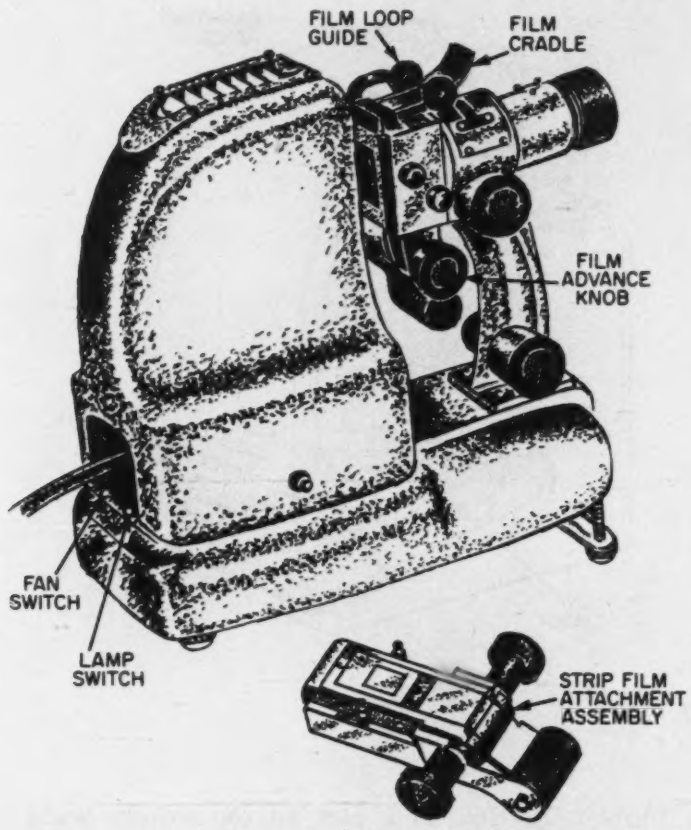

Figure 8-9.

anism is arranged so that 1/4 turn (1/4 of a full revolution) of the film advance knob transports and indexes one complete single frame, and 1/2 turn (1/2 of a full revolution) of the film advance knob transports and indexes one complete double frame. In either case, the film advance knob tends to carry through the necessary movement to index the strip film in the proper frame position. It is best for the operator to turn the film advance know several times before the presentation begins in order to get the feel of the knob.

To reverse the direction or to repeat a picture, turn the film advance knob clockwise.

To project slides placed in the slide carrier assembly (fig. 8-10), use the slide carrier knob to push or pull the slide carrier from one side to another. The slides, in either compartment, are automatically indexed in position for proper projection. While the first slide is being projected, place the second slide into the exposed compartment of the slide carrier. Push or pull the slide carrier to the other side to project the second slide. While the second slide is being projected, remove the first slide ~~and insert the~~ third into the same compartment, then push or pull the third slide into projection. Continue this procedure until all slides have been projected.

DIAZO

DRY PRINT PROCESS

The diazo dry print process allows for fast, continuous reproduction on either paper or clean foils which are then used in conjunction with the overhead projector. There are diazo machines of various sizes but all of them work on the same principle. The original or translucent material is placed on a sheet of sensitized paper or foil (with sensitized side face up) and both are fed into the machine. Belts convey the two sheets around a high pressure mercury lamp (printing cylinder). Here the material is exposed to ultra-violet rays from the pressure mercury vapor lamp. The ultra-violet light source quickly inactivates all the dye on the sensitized paper that is not covered and protected by the opaque image of the original. The printing speed depends on the translucency of the original and the density of the lines, and on the type of sensitized materials used. With some machines, after the exposure is made, the ma-

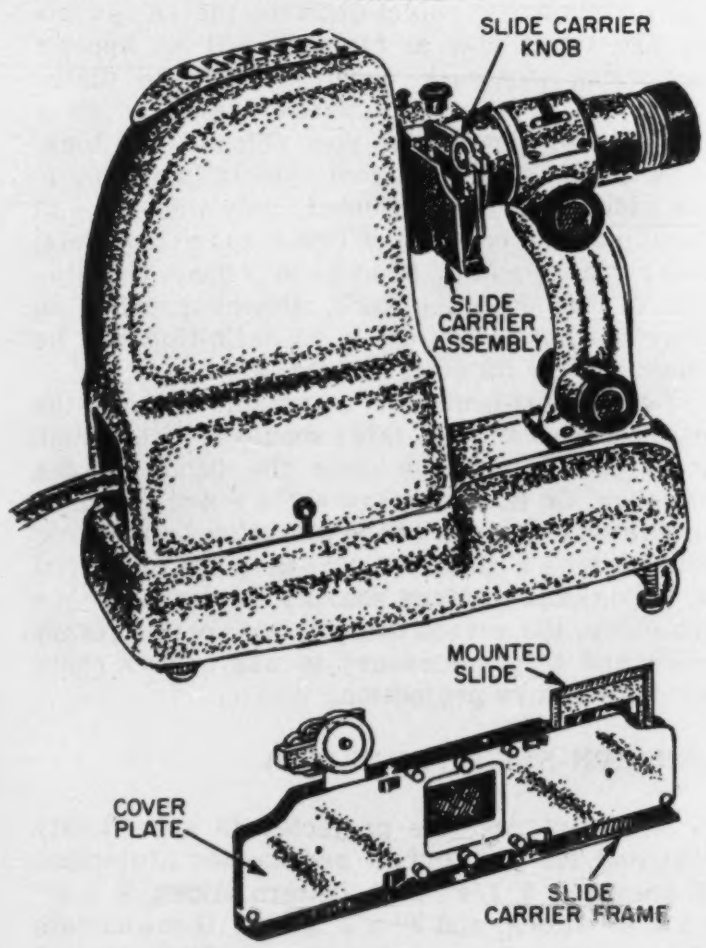

Figure 8-10.

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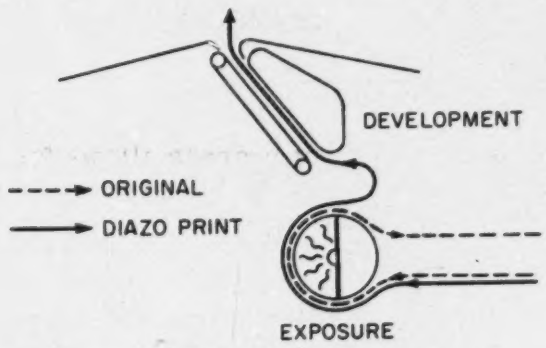

Figure 8-11.

terials are picked off the cylinder and guided to separation devices. At this point the print and original are automatically spearated and the print is conveyed to the developer section. The original is returned to the tracing receiving tray by a rubber disk ejection roller.

After exposure, the sensitized sheet contains only the exact image of the original. It is now conveyed across ammonia vapor, which develops the image and makes it as permanent as the paper itself.

The ammonia solution is heated to generate ammonia vapors that serve as the developing agent.

The print may have blue, black, red, or sepia lines. It may be on several grades or weights of white paper or on blue, pink, yellow, or green paper, or on film, cloth, or plastic-coated paper. Completely dry, it is ready for immediate use. Chapter 19 contains more information on the assortment of papers, foils and material available and how to use them. Figure 8-11 shows a diagram of the diazo process.

OTHER EQUIPMENT

It will be seldom that any of the graphic art shops in the assorted commands will have the same office machines and equipment. The machines just covered will be found in nearly all graphic art shops and some commands will have more, while some will have less. Some of the machines are the THERMOFAX, VERIFAX, ZEROX, PHOTOCOPIER, and several more. Some of these machines are very new in development and are constantly being improved and modified. As has been stated and now reemphasized, the only way anyone can truly learn the equipment he is to be associated with is to study the instruction books for the particular machines which are usually prepared by the manufacturer and contain information on how to operate and maintain the machines. They also explain safety procedures and replacement of parts. You should never operate any machine before you become thoroughly familiar with it. This is for your safety and for the safety and protection of the machine.

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CHAPTER 9

LETTERING

Lettering has often been called AN ART IN ITSELF. As an art, handlettering requires many hours of study and practice. It is extremely important for you to perfect your hand lettering if you are to become a qualified Illustrator Draftsman. You must know what makes one alphabet easier to read than another, what gives one alphabet more beauty and character than another, and you must be able to visualize appropriate letter forms in your mind.

An understanding of the letters and the ability to visualize them can be accomplished by the practice of drawing them until the muscles of your hand are accustomed to the pattern of the strokes which makes up the letters. You should be able to draw good letters without consciously thinking of this pattern. So, in order to letter well and use lettering effectively in your work, good taste in selecting the proper alphabet for the job, an ability to visualize, and highly trained hand muscles are needed.

As an Illustrator Draftsman, you will be required to do lettering for official publications, posters, placards, and do display lettering as well as doing the lettering on technical drawings.

The illustrative lettering can be accomplished freely, limited only by the dictates of good taste and suitability of the particular lettering style. Within these limitations, you are free to use originality and imagination; whereas, on the technical drawings, you are required to follow definite lettering specifications.

When you are lettering, regardless of type or purpose, the one rule you must always follow is to make your letters legible. Letters that are legible make it easier for the reader to understand the message before him.

When lettering, you may take your choice of a number of different materials, and it is your business to know which materials to use when you wish to draw a particular kind of letter. The materials necessary to do layout lettering are paper and pencils.

The most useful paper used in layout lettering is the visualizing paper. It is transparent enough to see through to the tracing beneath. Layout lettering is usually done directly on the visualizing paper pad.

The type of pencil used is a matter of personal choice; however, you should have at least a soft and a medium grade sketching pencil. A carpenter's pencil with its broad flat lead is a favorite of many illustrators when they are lettering. Layout pencils are used for medium size letters and regular drawing pencils of various degrees of hardness are used for smaller letters.

The layout should be true and accurate in size and shape. If available, a good steeledged T-square and a triangle should be used to keep the layout as square as possible.

A printer's ruler is used to indicate size when the drawings are to be reproduced. The printer's ruler is graduated in picas and half picas, having 6 picas to the inch. More precise rulers have the pica graduated in points, having 12 points to a pica. A printer's rule is shown in figure 9-1.

A pair of dividers used for spacing the letters and erasers such as artgum, ruby, and especially kneaded erasers are a must when doing layout lettering. When a lettering job is completed, it is cleaned, then sprayed with a fixative to keep it from smudging.

In the graphic arts and printing practices, a short word for alphabet is FACE, and we will use it from now on.

Everyday we can see seemingly countless styles of lettering in every direction we turn. In reality, all of these many styles have a great deal in common. Almost all faces are variations

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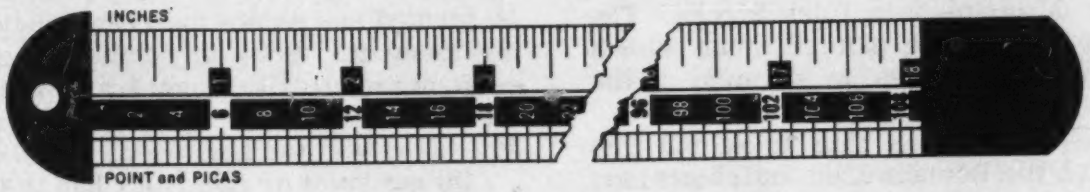

Figure 9-1.—Printer's rule.

of one simple face which is called the BASIC FACE. This face is composed of 26 capital letters, 26 small letters and the numbers 0 to 9. The term CAPS is used professionally for the capital letters and the term LOWER CASE is used to specify the small letters.

All letters are made of one or more parts called STROKES. In the roman face, some strokes are thick and some strokes are thin. With the gothic face, all strokes are of about the same thickness.

THE BASIC FACE

All of our many roman and gothic faces are represented by the basic framework of the basic face. The letters in figure 9-2 have been stripped down to their essential elements. None of the letters can be constructed in a more simplified style than that which is shown. Each of these letters, caps, lowercase, and numbers, should be studied until its construction is known by heart.

The first step in drawing the basic face in figure 9-2 is to establish the height of the letters to be drawn, then draw light parallel guidelines with your pencil. Normally, the main body of the lowercase letters is about two-thirds the height of the caps.

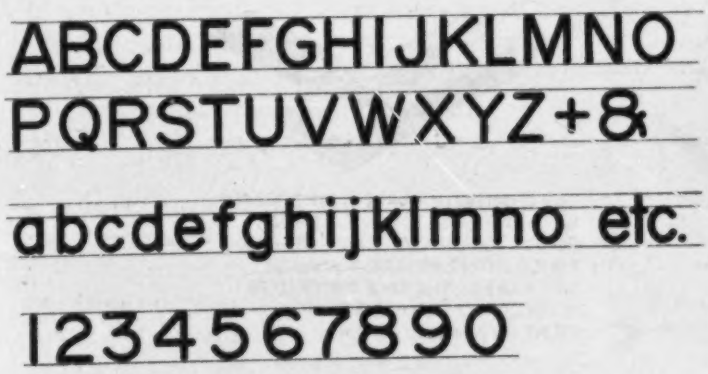

Figure 9-2.—Basic lettering.

THE ROMAN FACE

Our capital letters come to us from the ancient Romans who developed and perfected them. The ancient artists carved their letters in stone, and as a guide, they first painted the letters on with a flat brush, which was always held at the same angle. When the brush was

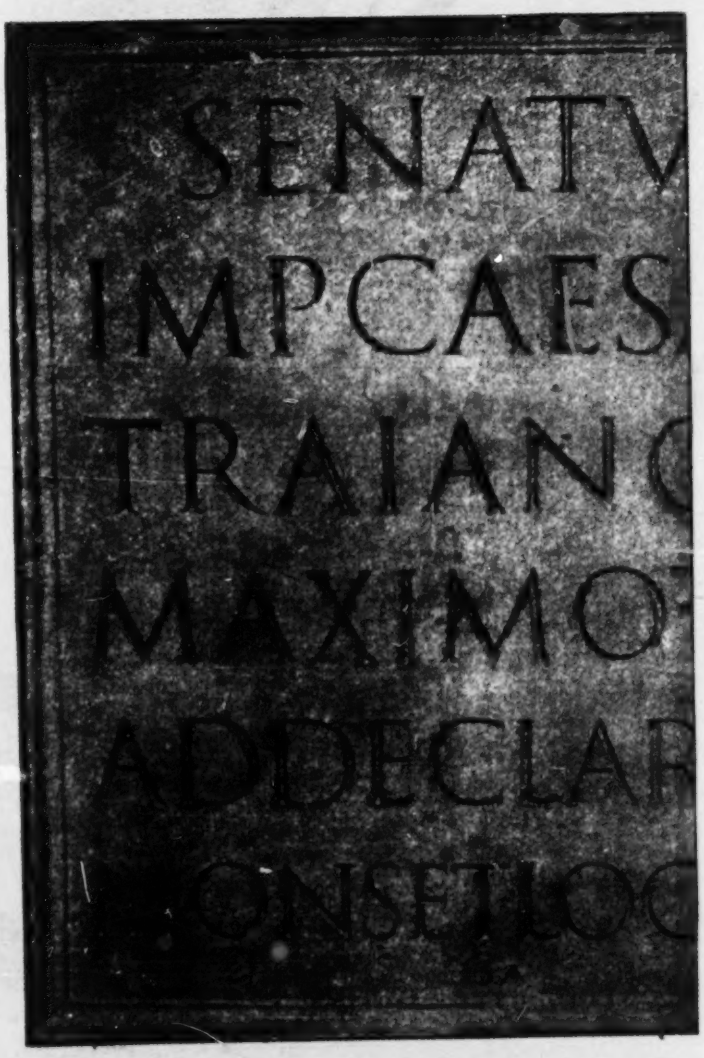

Figure 9-3.—Portion of an inscription on base of Trajan Column, Rome, circa 114 A.D.

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moved sideways, it made a thin stroke, and when moved up or down, made a thick stroke. The artist then cut away the painted stone with a chisel. Figure 9-3 shows an example of the ancient Roman's lettering.

Figure 9-4 illustrates this thick and thin principle which the Romans used, and shows four of the most commonly used flat lettering tools.

A square chisel point on a carpenter's pencil is the ideal tool to use when drawing the roman face. You can LET THE TOOL FORM THE LETTER. Figure 9-5 shows how the chisel point is formed and shows the recommended position for using it. Your thick and thin strokes will come automatically if you train yourself to hold the pencil so that the chisel point forms about a 30° angle with the horizontal guidelines.

Figure 9-4.—Four common lettering tools.

Do not twist or turn your hand as the strokes turn, but hold your pencil at the same angle at all times. You will find it necessary to re-sharpen your pencil often in order for your strokes to all have the same sharp edges.

To work well, sit comfortably with your work directly in front of you. Don't lean over too close to your work. You want to be able to see all of your work in order to relate each letter to the entire layout. Except when touching up, always keep your pad straight on the drawing board.

THE THICK AND THIN ROMAN FACE

At this point you should have pretty well mastered drawing the Basic Face, so now we are ready to learn the basic strokes of the thick and thin roman face.

To draw the thick and thin roman face in figure 9-6, you draw the same basic face as in figure 9-3 except you use a chisel-pointed pencil. In figure 9-6, number arrows indicate the sequence and direction in which each stroke is to be made.

A general rule to follow when lettering is to draw two guidelines indicating the height of the caps. If you are combining lower case with the caps, a third line is added so that the lowercase letters are about two-thirds as high as the caps. The height of the lowercase letters will vary with the different faces, but for general purposes, the use of the 2/3 to 1 scale is a good practice.

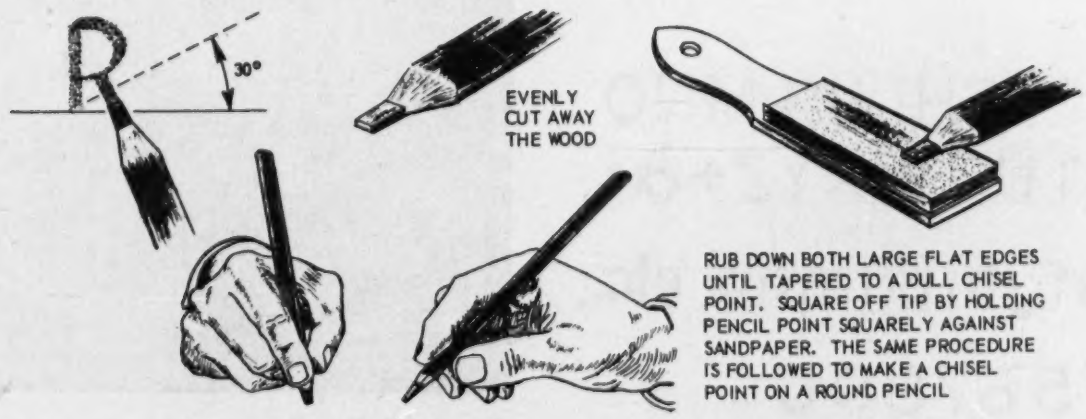

Figure 9-5.—Chisel point lettering.

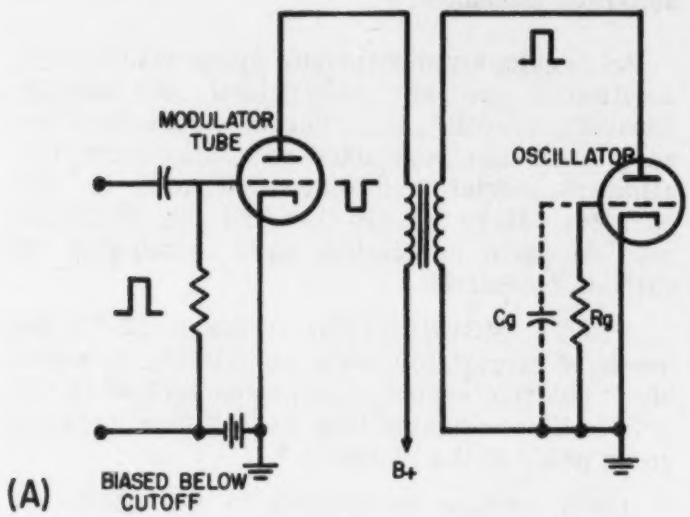

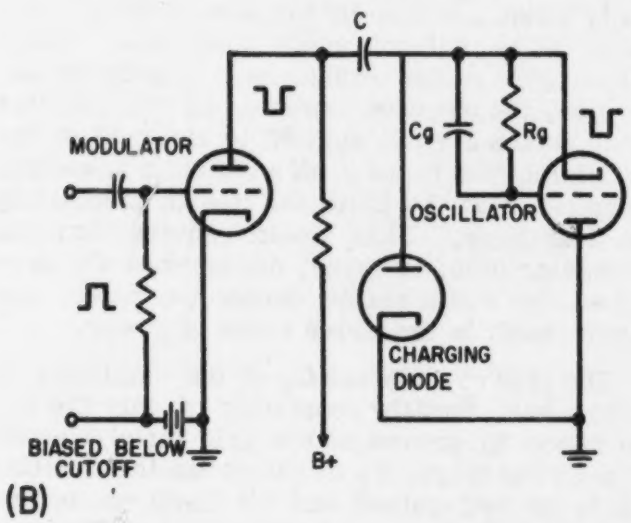

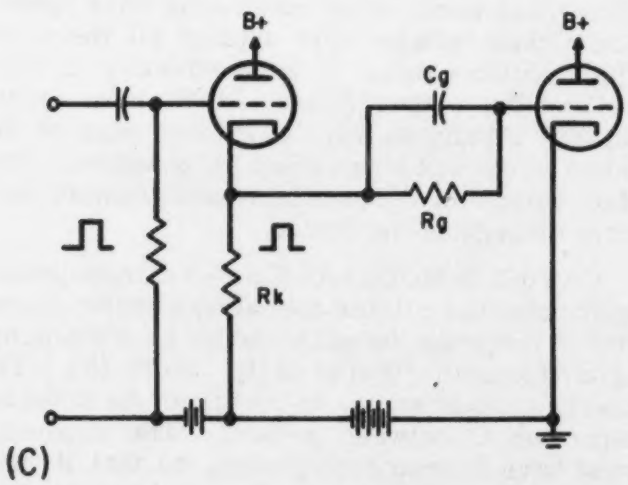

Figure 12-28.—Pulse modulation systems.

GRID MODULATION.—Grid modulation requires less power from the modulator for operation than either of the other two types of modulation. A positive going rectangular pulse is applied to the grid and raises the grid voltage well above the cutoff points so that oscillation starts. Oscillation ends whenever the grid voltage drops to the normal bias. Usually the arrangement for this purpose is the one in which oscillation is started by a positive trigger pulse and ended by a self-pulsing grid bias voltage. C_g in the grid-pulsed oscillator shown in figure 12-28 (C) is a small capacitance and is used to couple the pulse from the cathode of the modulator tube to the grid of the oscillator to insure a rapid rise of voltage at the grid and cause oscillations to build up quickly.

MODULATING THE MAGNETRON OSCILLATOR

The modulation circuit for the magnetron serves a double purpose—it determines the waveform of the output pulse, and it stores energy between pulses and releases it through the magnetron during the pulse. A typical circuit of a modulator and magnetron is shown in figure 12-29. This discussion will explain the theory of operation of the line pulsing modulator, and will also explain and/or summarize the functions of the various components.

The pulse forming network undergoes a charge-discharge cycle at a rate (PRF) which is established by the master trigger generator, and which is consistent with the pulse width in use and with the maximum power capabilities of the transmitter. The modulator consists of an artificial line pulse forming network (Z1), thyratron switch tube (V1), holdoff or charging diode (V2), inverse diode (V3), resonant charging choke (L1), and magnetron pulse transformer (T2). The double wound secondary of transformer T2 supplies a pulse of power to the magnetron cathode circuit each time the pulse forming network (PFN) is discharged. The switching device which controls the discharge of the line is the thyratron, controlled by the trigger pulse from the radar synchronizer.

When system power is applied, current to charge the PFN is drawn from the power supply through L1 and V2. This current flow establishes a magnetic field in the choke. Charging is rapid until the charge on the PFN is nearly equal to the peak power supply voltage.

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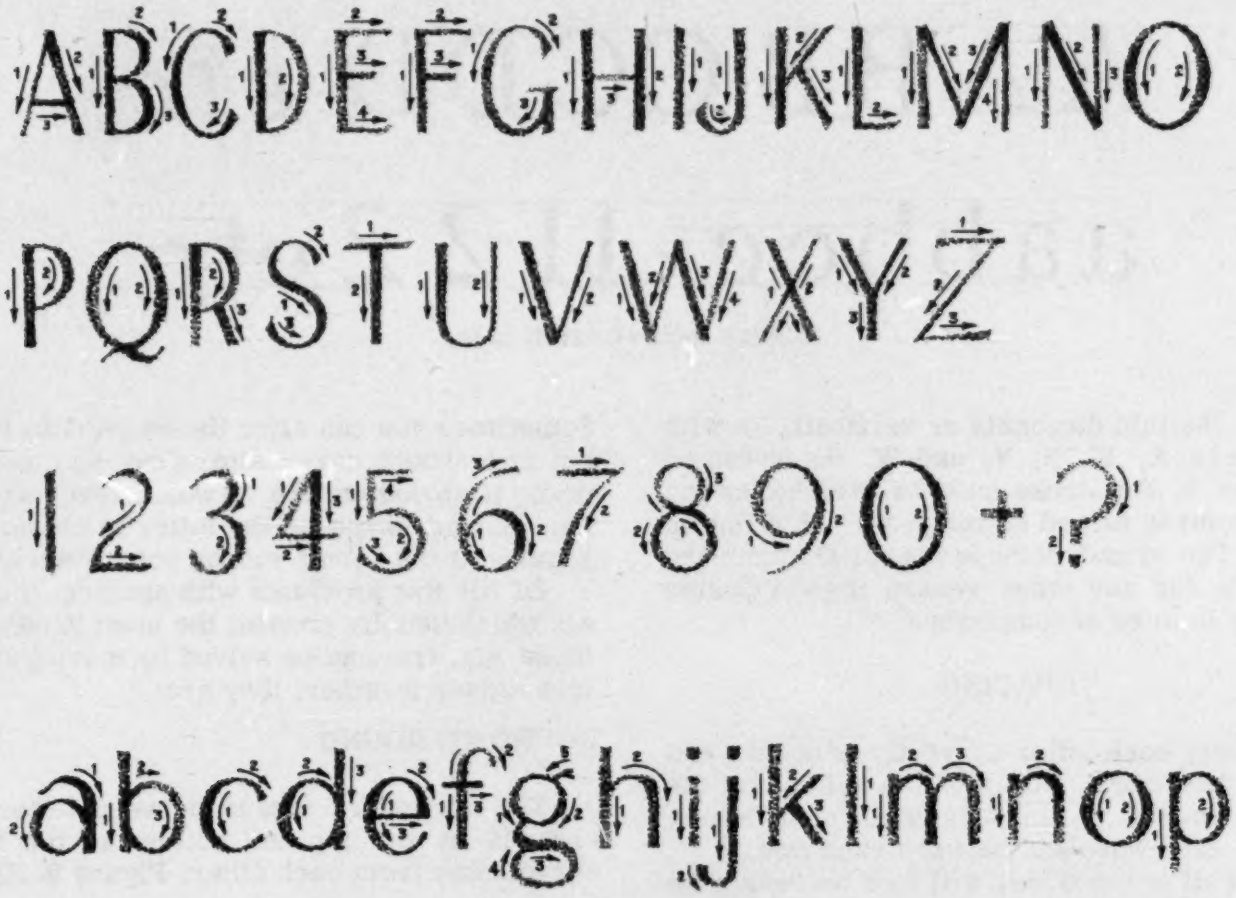

Figure 9-6.—Basic Roman face.

The ascender is the part of the lowercase letter that extends above the body of the letter. Except for the letter t, all extenders are as high as the caps. The descender is the part of the lowercase letter that extends below the body of the letter, about the same distance as the ascender raises above the letter.

Figure 9-7 illustrates the six basic strokes of the roman face. Practice these individually and in combination with each other.

CASLON FACE

With the addition of serifs, which are small strokes at the end of the main strokes, you can make thick and thin letters into the Caslon style roman shown in figure 9-8. Caslon has been selected for instruction not only because it is the most widely used, but also because it conforms most closely to the thick-and-thin style just discussed.

The Caslon face is also the most commonly used with other roman faces because its serifs are not extreme, but are average in thickness, pointedness, and length.

The Caslon letters are drawn with the same sequence of strokes as the chisel point thick and thin roman letters in figure 9-6.

Figure 9-8 shows finished Caslon letters and, beside them, the chisel point interpretation. Do not attempt to copy the finished letters in detail, but try only to show the character of the letter with the minimum of work, which is what a layout calls for.

There is one exception to the rule of holding the chisel point at the 30° angle. When you are

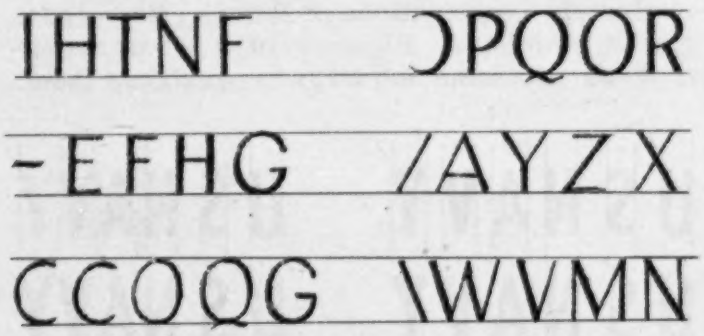

Figure 9-7.—Six basic strokes of the Roman face.

AABBCCDD etc

aabbcc-1122etc

Figure 9-8.—Caslon face.

drawing the thin diagonals or verticals, as with the letters A, M, N, V, and W, the unwanted thickness in the stroke must be avoided, so the chisel point is turned so that a very thin line is made. The chisel point is not turned from the 30° angle for any other reason if good Caslon lettering is to be accomplished.

SPACING

Drawing each letter correctly is not the end of good lettering. You must be able to put the correct amount of space between each letter, between each word and between each line.

The well lettered line will look as though the same amount of space appears between each of the letters, avoiding holes caused by too much space between letters and dark areas caused by a lack of space between letters. When correctly spaced, a line will have an overall uniform pattern.

Your only real guide in proper spacing is your eye, and, because letters are not uniform in shape, your artictic talents must guide you in your spacing.

Figure 9-9 illustrates mechanical spacing and the proper optical spacing.

COMMON PROBLEMS WITH SPACING

Certain combinations of letters often create spacing problems. Figure 9-10 illustrates some of these problems and ways to overcome them.

Figure 9-9.—Mechanical and optical spacing.

Sometimes you can alter the shape of the letters, but you should never alter them so much as to make it obvious to the viewer. Never sacrifice the desired shape of the letter to obtain better spacing if the result will be poor lettering.

Of all the problems with spacing, there are six which usually present the most problem. Of these six, five can be solved by moving the letters closer together; they are:

ROUND TO ROUND

The air space (space between letters) increases at the top and bottom as the letters curve away from each other, Figure 9-10A.

ROUND NEXT TO SLANT

The same as round to round; the air space is increased by the slant of one letter and the slope of the round letter, Figure 9-10B.

VERTICAL NEXT TO SLANT

The slant of the letter increases the air space, when the letters are moved closer together; it is sometimes impossible to keep their serifs from joining, Figure 9-10C.

SLANT NEXT TO SLANT

When the slants are parallel to each other, the space is about the same as for two verticals. When they slant toward each other, they will or will nearly touch, Figure 9-10D.

ROUND NEXT TO VERTICAL

The air space increases as it did in round to round, Figure 9-10E.

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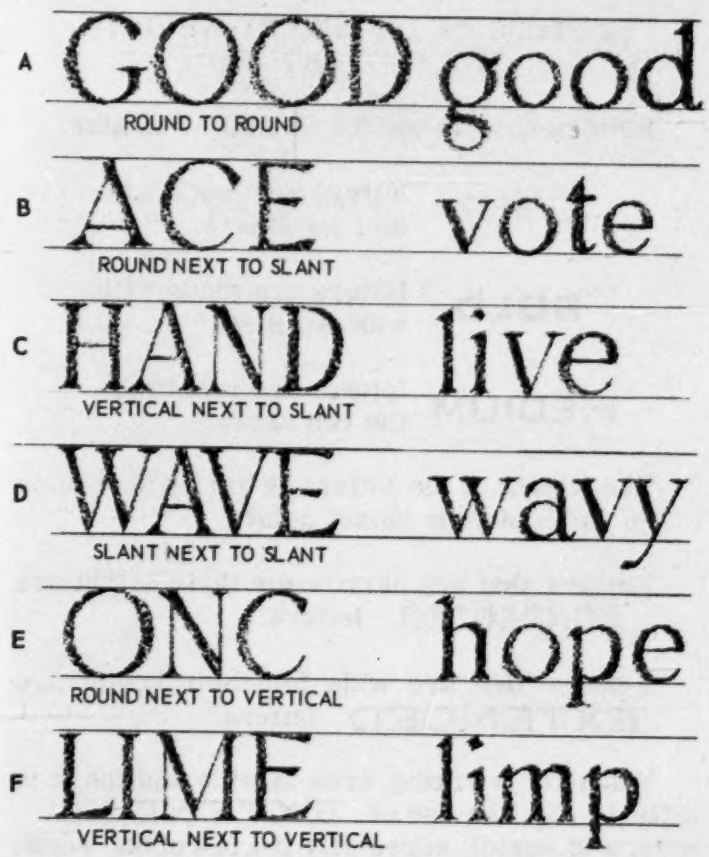

Figure 9-10.—Common spacing problems.

VERTICAL NEXT TO VERTICAL

The last remaining problem is solved by adding more air space when possible. This is when, there is no white area cutting in to make the space look wider, Figure 9-10F.

WORD SPACING AND LINE SPACING

When a person reads a line of type, he can tell where one word ends and the next one begins because of the space left between them. When there is not enough space, the words run together; when there is too much space, they appear unrelated and difficult to read.

In addition to the spacing between letters and words, the spacing between lines of lettering adds to the readability of the lettering. Again your eye and your artistic ability must be your guide. Except when you are trying for a special effect, you should have enough air space between the lines to make it easy for the reader to see what he is reading.

LAYOUT LETTERING

The most important part of layout lettering is to obtain as nearly as possible a perfect final tracing. The number of preliminary tracings you will need to accomplish this will vary according to your ability. Sometimes you may need only one preliminary tracing, or you may need four or five or more. Regardless of how many you find you will need to do, you must work until you have the best tracing possible. The tracing is very important in determining the artistic quality of your finished layout.

You may use a T-square on the vertical and horizontal lines to get good crisp, straight lines. This is especially good on the finished layout. By using the T-square, you can give your lettering the neat, craftsman-like appearance of roman lettering. You work with your T-square on the

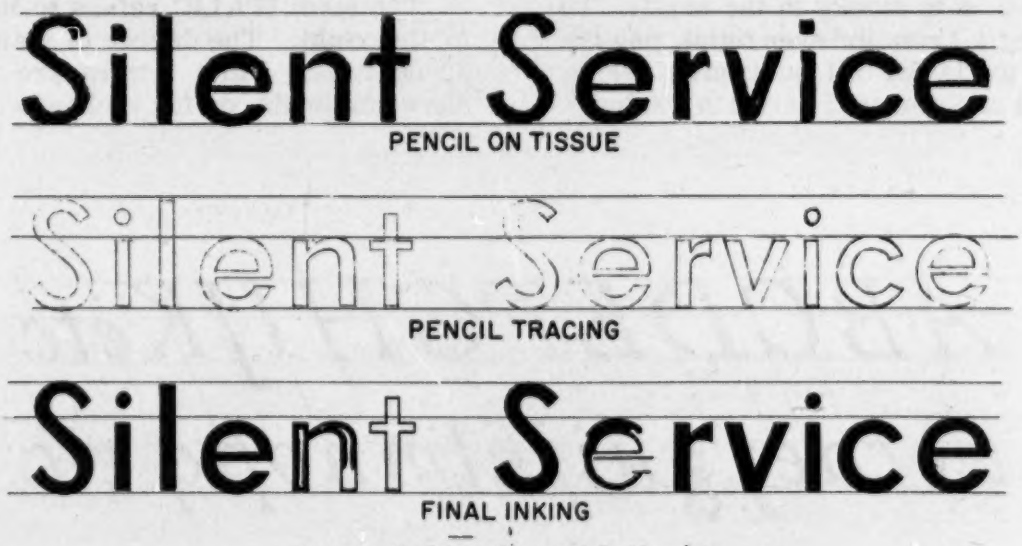

Figure 9-11.—Layout lettering.

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working edge of your drawing board only and turn the drawing paper to draw the vertical lines. Never use your T-square on any edge other than your working edge.

With your well sharpened chisel pointed pencil, you can draw every stroke needed, but never hesitate to make adjustments with a pointed pencil. Figure 9-11 illustrates the steps in doing layout lettering.

Rule guidelines using a T-square and a sharp HB pencil. Rough in the letters lightly, with no attempt at refinement at this stage. The object now is to fit the letters properly to the line. With the chisel pointed pencil, letter over the light guidelines and try to have the lettering come out even in the space allowed for it.

Remove the rough sheet and insert it under a clean sheet of paper. Now try to improve your proportions and shapes; repeat the process again. If it appears you are going to run over, do not tighten up the spacing or the width of the letters; this is to be done in the next tracing.

Repeat step 2 by inserting the second tracing under another clean sheet of paper. You should be able to easily draw and space the letters to fill the line exactly this time.

Remove the third tracing and place it under the top sheet of your layout pad. Draw your guidelines lightly and, using your T-square, draw all vertical strokes with the chisel pointed pencil.

Draw the horizontal strokes using the T-square. Either freehand or using a triangle, draw in the diagonal strokes.

Draw in the curves freehand. Keep the chisel point at a 30° angle to the horizontal line. Strive for accuracy and any slight imperfection in the curves will not be very noticeable.

The last step is to stroke in the serifs. To give the lettering a crisp and even finish, use the T-square as a guide for all horizontal serifs. Add the vertical and diagonal serifs in freehand.

LETTERS OF DIFFERENT WEIGHTS AND PROPORTIONS

Letters vary in weight as well as in size.

LIGHT letters are made with thin strokes.

BOLD letters are made with wide strokes.

MEDIUM letters are in between the two above.

The weight of the letters is varied according to the width of your chisel point.

Letters that are narrow for their height are CONDENSED letters.

Letters that are wide for their height are EXTENDED letters.

When the working area is wide and there is little to say, the use of EXTENDED letters is useful, especially if a few of the words are to be given prominent display.

When a lot is to be said in a limited space, the use of CONDENSED letters is useful.

When you are practicing lettering, practice drawing letters of different sizes, using harder pencils as the sizes get smaller.

ITALIC LETTERS

The term ITALIC refers to letters that slant to the right. The degree of slant is from 10 to 30 degrees. Italic letters are widely used to show emphasis, or for a change of pace.

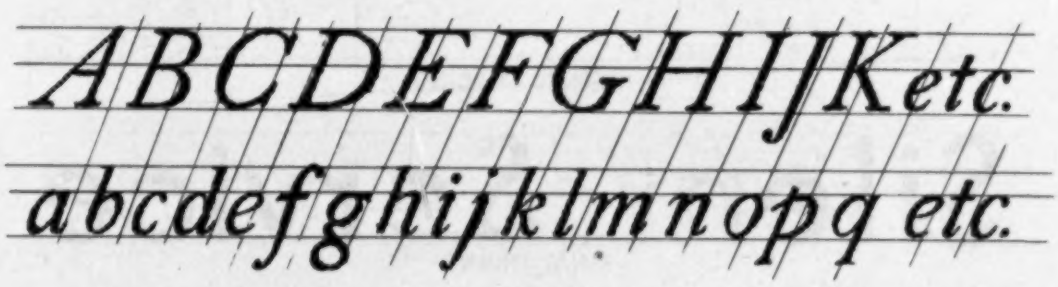

Figure 9-12.—Italic lettering.

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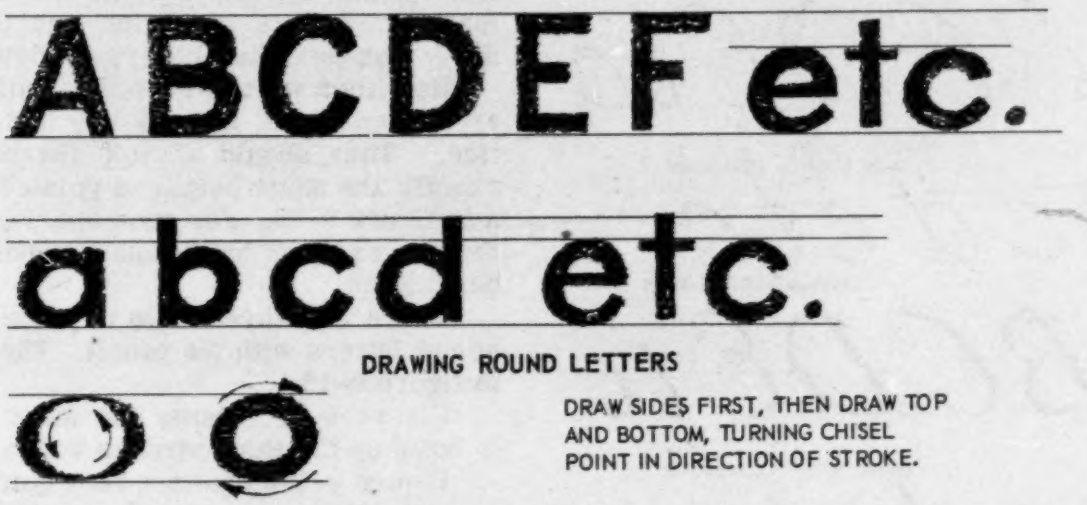

Figure 9-13.—Gothic face.

There is an italic version for almost every type face. The same sequence and manner used to make the roman caps are used to make the italic caps. The italic lowercase letters differ greatly from the roman lowercase letters. Instead of the serifs having curved hairlines, the ascenders of the italic lowercase have horizontal serifs, as shown on the letters b, d, h, k, and l in figure 9-12. Note how smoothly the thin lines and the hairline serifs flow into the main stems of the letters a, b, d, and q, giving the body of the letter an oval-like shape on its inside.

When you draw your horizontal guidelines, draw in your parallel diagonal lines as a guide to follow. Not all of the letters will be slanted exactly to these diagonal guidelines, but all of the letters should appear to have a uniform slant.

GOTHIC LETTERS

The GOTHIC face is constructed of strokes of equal or near equal widths. Gothic letters do not have serifs and are sometimes referred to as block letters.

The gothic face has the same structure as the basic face. Gothic faces can be bold, medium, or lightface; they can be condensed, normal, or extended, and can be italic.

There are many uses for the gothic faces. They are excellent when bold impact is desired because they can be made extremely heavy or condensed without becoming difficult to read. In contrast, the light face gothic can be used to express great delicacy and restraint.

When drawing gothic letters, the chisel point must be turned in the direction of the stroke ensuring the same width of letter throughout its construction, as shown in figure 9-13.

As you can see, this is quite a different procedure than the one used in making the thick and thin roman face.

When drawing the gothic face, follow the same steps of procedure as done in figure 9-11 Use the T-square as a guide for making the verticals and horizontals. Draw the curved strokes freehand.

When doing gothic lettering strictly by freehand, rule vertical guidelines on your final run through. These guidelines showing through the visualizing paper will help you keep your vertical strokes uniform.

The curved stroke is generally drawn thinner where it joins the straight stroke, otherwise, a dark spot develops where the two heavy strokes join. Figure 9-14 shows a variation of the gothic face.

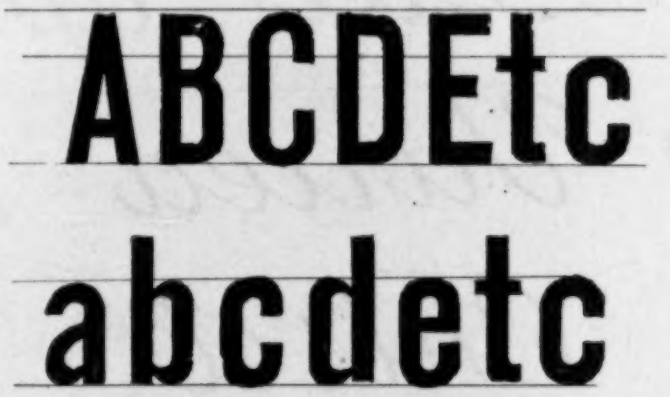

Figure 9-14.—Headline gothic.

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Figure 9-15.—Script lettering.

SCRIPT LETTERS

SCRIPT letters are based on our handwriting style. To get the feel of the basic strokes, it is best to write with a flexible pen that will make hairline strokes when light pressure is applied, and wide strokes when heavy pressure is applied.

There are many styles of script, but we shall concentrate on just two styles, the BASIC script and the FORMAL script; thick and thin versions are shown in figure 9-15.

Formal script gives the impression of elegance, dignity, and refinement, and is very easy to read. With a good understanding of the Basic and Formal script, you will be able to create many variations of script, and thus meet the many requests for this type of lettering.

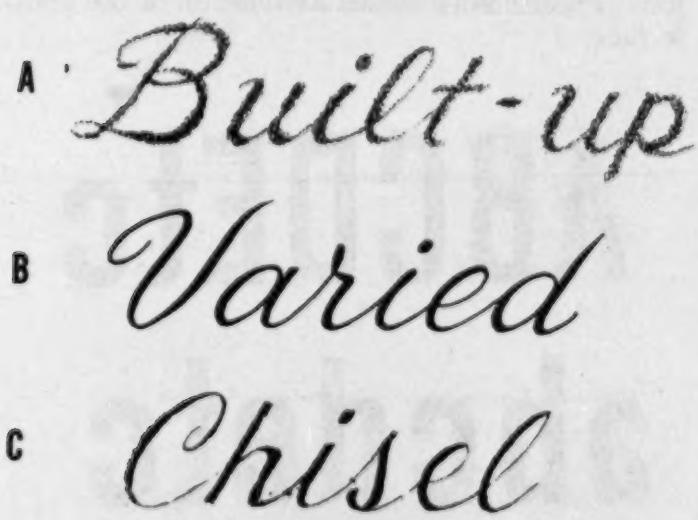

Figure 9-16.—Constructing script lettering.

Hairlines which sweep up to join main stems are called kerns, and must be uniform in direction. They should all join the main stems at exactly the same height as pointed out by letter a in figure 9-15. For good spacing, the width of the curves made by the upsweep hairlines should be uniform.

There are three ways to properly construct script letters with the pencil. These are shown in figure 9-16.

Figure 9-16a shows the most accurate way to build up the thick strokes with a pencil.

Figure 9-16b shows a very quick way to indicate small script. As the strokes are drawn, heavy pressure is applied to make the thick lines, and very light pressure is applied to make the hairlines.

Figure 9-16c shows the third method, a useful and quick way to make large letters. The thick strokes are rendered with a chisel point and the hairlines are made with either the corner of a chisel point or with a pointed pencil.

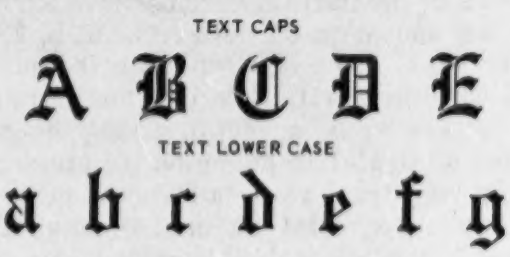

Figure 9-17.—Text face.

TEXT LETTERS

You may know this face simply as OLD ENGLISH. Text was among the first face styles used in printing because Gutenberg (inventor of the printing press) worked almost exclusively with this style of letter. Although it is still used frequently, it is generally limited to a few lines of copy. It should be reserved for something religious or formal, such as prayer books, programs, invitations or other similar purposes. Figure 9-17 shows the basic construction of text.

DISTORTIONS AND OPTICAL ILLUSIONS IN LETTERING

The eye is often bothered by certain distorting effects that occur in lettering designs. Many of

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Figure 9-18.—Optical illusions.

these effects are of great concern to us, especially the illusion that makes certain forms of the same height appear quite different in height when placed beside each other.

A good example is when triangles, circles, and rectangles of the same height are placed together. The triangles and circles never look as tall as the rectangles. When you draw or design letters with these shapes, you must make corrections so that these disturbing effects are offset and your letters appear correct and consistent.

In figure 9-18 we see a triangle, a rectangle and a circle of exactly the same height. Due to an optical illusion, however, the triangle and the circle look shorter than the rectangle. To correct this illusion and make all three appear to be of the same height, the point of the triangle is extended above the guideline while the circle is extended beyond both the top and bottom guidelines.

Using the letter A to represent the triangle, the letter E the rectangle, and the letter O the circle, we can see that the letters A and O must be enlarged in order for all the letters to appear to have the same height.

The same considerations apply to the lowercase letters and similar adjustments are necessary in every face if the letters are to appear uniform in height.

When drawing the gothic faces, the heavy strokes that join other strokes must be thinned down to avoid the effect of these strokes appearing even bigger than they actually are. This is true in both the caps and the lowercase of this face. Figure 9-19 shows the correct method to make these adjustments. Though slight, these changes are very important to the proper construction of this face.

Figure 9-19.—Adjustments to letters.

OVERLAPPING LETTERS

When designing overlapping letters, care must be taken that they are not overlapped to such an extent that their form or their negative space is greatly distorted. The letters in figure 9-20 are properly overlapped because there is enough of each letter remaining so that your eye

Figure 9-20.—Overlapping letters.

can fill in the missing parts. Also, the identifying negative spaces have not been destroyed, as you can easily see in figure 9-20 by the blackest areas around the letters.

IDENTIFYING AND DRAWING THE DIFFERENT TYPE FACES

The different type faces can be identified by their serifs, their thick and thin strokes, their curves and their general silhouette. Once you have learned the identifying features of a few key characters of any face, you will be able to readily recognize the face and will know what characteristics and features to look for and stress when drawing the letter.

Figure 9-21 shows the comparison of the six main classes of type. Study the basic differences carefully and memorize those features which are related solely to one particular face.

ROMAN

Roman faces are often divided into two classifications: modern and oldstyle. The chief difference between the two is found in the construction of the serifs. Compare the two letters shown in figure 9-22. You will notice that the oldstyle letter has soft, rounded serifs, while the

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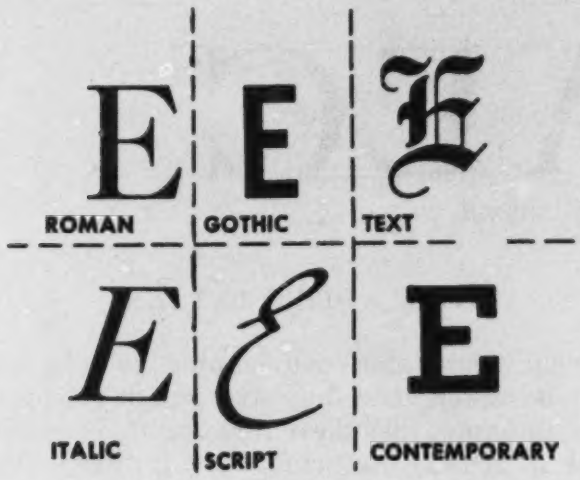

Figure 9-21.—Six main classes of type.

Figure 9-22.—Old and modern Roman face.

modern letter has heavier shadings and thin, clean-cut hairlines. Bodoni is typical of the modern style and Caslon is a good example of the oldstyle. Roman faces can be used for a variety of work, but printers try to avoid mixing the oldstyle with the modern faces. Figure 9-23 shows a few of the roman type faces.

GOTHIC

Figure 9-24 shows a few of the gothic type faces. Many of these faces are drawn or constructed in italics. The sans-serif included in the illustration is an up-to-date style of gothic. However, because of its modern design, it is generally grouped with the contemporary type faces.

As you can well see in figure 9-24, there are many kinds of gothic type faces. Each has its place in modern printing and lettering. Alternate and Copperplate Gothics have a wide use in Standard Navy forms. Copperplate Gothic is

BINNEY Old Style
BODONI Bold
BODONI Book
BODONI Bodoni
CASLON, True-Cut
CASLON Old Style
CASLON Bold
CASLON Old Style
CASLON No. 113, Condensed
CASLON Bold Condensed
CASLON Caslon
CENTURY Expanded
CENTURY Expanded Bold
CENTURY Schoolbook
CENTURY Schoolbook
CHELTENHAM Cheltenham
CHELTENHAM Bold Extra Condensed
CHELTENHAM Bold
CHELTENHAM Old Style
CHELTENHAM Wide
CLOISTER Bold Condensed
CLOISTER Oldstyle
CLOISTER Bold

Figure 9-23.—Roman type faces.

CONDENSED TITLE GOTHIC NO. 11
BANK GOTHIC CONDENSED BOLD
FRANKLIN Gothic Extra Condensed
POSTER GOTHIC
FRANKLIN Gothic Condensed
RAILROAD GOTHIC
BANK GOTHIC CONDENSED MEDIUM
NEWS Gothic
GOTHIC NO. 520 TO 526
LINING Gothic No. 545
ALTERNATE Gothic No. 1
ALTERNATE Gothic No. 2
ALTERNATE Gothic No. 3
NEWS Gothic Extra Condensed
SANS Serif Bold
COPPERPLATE GOTHIC BOLD NO. 132
GOTHIC No. 544
NEWS Gothic Condensed
GOTHIC No. 3 Gothic No. 3
COPPERPLATE GOTHIC NO. 342, HEAVY
LINING PLATE GOTHIC, HEAVY

Figure 9-24.—Gothic type faces.

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Bernhard Cursive Bold
Bernhard Cursive
Kaufmann Bold
Kaufmann Script
Typo Upright Bold
Typo Script
Signal Medium
Signal Black
Gillies Gothic Light
Gillies Gothic Bold
Commercial Script
Bank Script
Trafton Script
Bulletin
Ariston Bold
Gloria
Brush
Greyds

Figure 9-25.—Script type faces.

generally used for letterheads, envelopes, cards, announcements and many other kinds of office forms.

News Gothic is another serviceable face. It may be used as a body type for titles and headings. Franklin Gothic, Alternate Gothic, and Poster Gothic are chiefly used for display work. They are very popular for posters and headings.

SCRIPT

Script faces are extremely suitable for announcements and invitations. They may also be used to impart an air of elegance and charm in displays. Figure 9-25 shows a few script type faces. You will notice that some of the faces shown are contemporary styles used in modern display work.

TEXT

Samples of text type faces are shown in figure 9-26.

Engravers Old English Bold
Engravers Old English Open
Engravers Old English
Engravers Text
Wedding Text Shaded
Wedding Text
Inland Copperplate
Tudor Black No. 2
Typo Text
Cloister Black
Modern Text
Shaw Text
American Text
WEDDING TEXT *

*Words set in text caps are almost illegible.

Figure 9-26.—Text type faces.

BENEDICTINE Book Italic
FUTURA Bold Condensed Oblique
FUTURA Medium Oblique
STYMIE Black Italic
SPARTAN Medium Italic
GARAMOND Bold Italic
GOUDY Handtooled Italic
COPPERPLATE GOTHIC ITALIC
BOOKMAN Old Style Italic
CHELTENHAM Bold Italic

Figure 9-27.—Italic type faces.

ITALICS

There is an italic style for nearly every roman, gothic and contemporary type style in use. Since italic lettering is hard to read when set in lengthy articles, the practice has been to use italics only to show emphasis or to create a contrast in the lettering. Figure 9-27 shows some of the italics in use today.

CONTEMPORARY

The past 30 to 40 years have been truely significant in lettering and typographic history. The

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old gothics have had their faces lifted and everywhere new streamlined faces have appeared. Naturally many of these modern faces are fads. Their style and usefulness will be short-lived. Out of it all, however, have come a few serviceable type faces that will take their places alongside the old standbys we have just discussed.

Leading the contemporary field are two distinctly new styles: the sans serif and the square serif.

Sans Serif

Sans serif is actually a kind of gothic type. It has the same even strokes as gothic and it has no serifs. But, unlike its gothic ancestors, it has such perfect geometric propostions that it is generally classified with the contemporary type faces.

Study the Futura type faces shown in figure 9-28 for a moment. Notice that the letters seem to be constructed from squares, rectangles and other geometric forms. This type face is the last word in simplicity, yet it is one of the most serviceable of all the type faces the modern printer and illustrator has at his disposal. It can be used for almost any printing or lettering job.

SANS Serif Extra Bold
SANS Serif Extra Bold Condensed
SANS Serif Medium Condensed
SANS Serif Light
SANS Serif Medium
20th CENTURY Ultrabold
20th CENTURY Extra Bold
20th CENTURY Ultrabold Condensed
20th CENTURY Extra Bold Condensed
20th CENTURY Medium Condensed
20th CENTURY Bold
20th CENTURY Medium
FUTURA Bold Oblique
FUTURA Display
FUTURA Bold
FUTURA Demibold
FUTURA Bold Condensed
FUTURA Medium
FUTURA Medium Condensed
KABEL Light
KABEL Medium
KABEL Bold

Figure 9-28.—Futura type faces.

STYMIE Light
STYMIE Extra Bold
STYMIE Bold
STYMIE Medium
STYMIE Extra Bold Condensed
BAUER BETON OPEN
BAUER Beton Bold
GIRDER Heavy
KARNAK Medium

Figure 9-29.—Square Serif type faces.

Square Serif

Square serif is little more than sans serif with serifs added. It has the same even strokes and the same perfect geometric proportions. Square serif type originated in Europe shortly after the sans serif faces made their appearance. It became popular in the United States in the early 1930s. Some people think it is an offspring of the old Egyptian alphabet. Others believe it was inspired by typewriter type which was widely employed by advertisers of that period. As you can see in figure 9-29, Stymie is a typical example of this type.

Lydian Cursive
BALLOON BOLD
OFFENBACH MEDIUM
VALIANT Valiant
ONYX Onyx
CARTOON BOLD
PLAYBILL
LYDIAN Bold
FLASH Bold
Dom Casual
Trend
Studio
Venus X-B Extend.

Figure 9-30.—Contemporary type faces.

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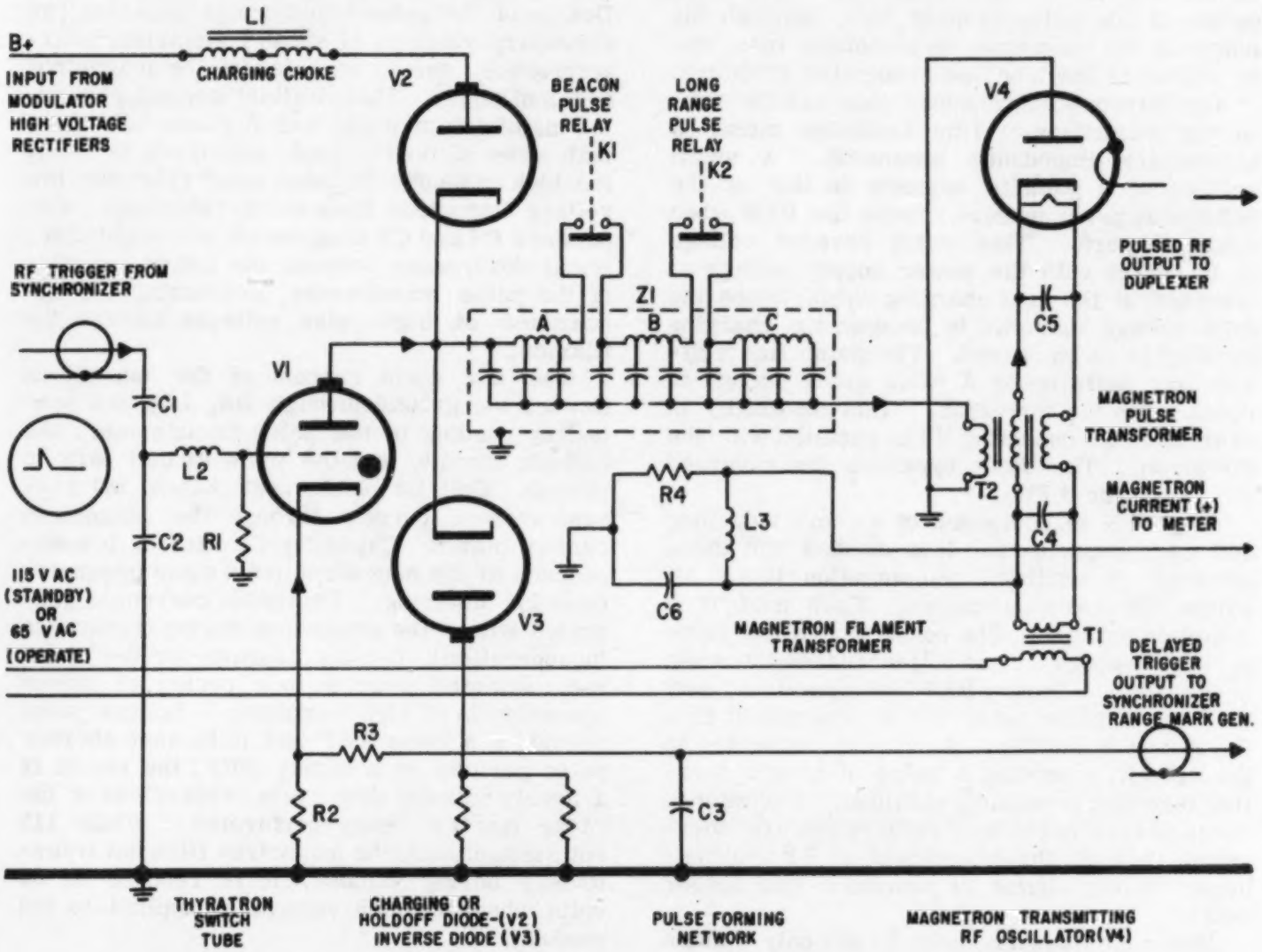

Figure 12-29.—A typical line-pulsing modulator and magnetron circuit.

When this point is reached, the rate of charge decreases rapidly, and the magnetic field around the choke collapses. By self-inductance, a voltage approximately equal to twice the power supply peak voltage is rapidly established. The resonant charging choke has an inherent tendency to oscillate, but this tendency is halted abruptly at its first positive peak by the rectifying action of the charging diode. The PFN is held at this high potential. Discharge of the PFN capacitors is prevented by the charging diode V2. The inverse diode and the thyratron are inoperative; hence they appear as infinite impedances and do not provide a discharge path for the network.

The master trigger generator in the synchronizer unit supplies a trigger voltage to the grid of the thyratron through the d-c blocking capacitor C1. When triggered, the tube ionizes and provides a closed circuit for discharging the PFN. Discharge continues for a definite period of time, at a rate determined by the constants of the PFN. A negative square shaped pulse is impressed across the primary winding of the magnetron pulse transformer. The width of the transmitter pulse varies in a manner determined by the number of sections of the PFN in use at the time.

Since the primary of transformer T2 is matched with the surge or characteristic impedance of the PFN, there is an equal division of voltage between these two units. The power supply peak voltage is impressed on the primary, and the turns ratio of the transformer results in a voltage step-up; thus a negative pulse of much greater magnitude is impressed

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Contemporary display faces is a classification which includes hundreds of modern type faces used in display work today. There are so many of them, that it would be difficult to try to list them all. There a number of scripts and italics, for example, which can be identified by their streamlined appearance. The Kaufman shown in figure 9-25 is one of these modern scripts. Others include Brush and Gillies Gothic.

There are also a number of tall, thin types, such as Onyx and Spire. Then there are wide, bold faces, such as Broadway and Neon. And, in between, there are medium faces, such as Lydian and Goudy Hand-Tooled. These types are used chiefly for display composition and some are shown in figure 9-30. More coverage is given this style under the topics of broad pen lettering and creative lettering.

FINISHED LETTERING

So far in this chapter you have learned the construction of the six basic faces. Now you will learn the proper procedure used to carry your work to its final stage, the finished lettering ready for reproduction.

The tools and materials needed to do finished lettering include a good pen with a flexible point and a pen with a very rigid point. Flexible pens should be used only on a hard surface paper, otherwise, the pen may catch on the paper and cause rough edges. A penholder of about the same thickness as a pencil will be the easiest to work with. A good ruling pen or a good Rapidograph pen is a must. A good quality No. 2 or No. 3 red sable brush is needed for retouching; when retouching, use a good opaque white.

Finished lettering is usually done on kid-finished Strathmore Bristol Board, or on a paper of like quality. Many kinds of paper are available; experiment and find the one that is most suitable to your needs.

Finished lettering is usually drawn one-half larger than reproduction size. Some illustrators prefer to enlarge the lettering to twice the size, Figure 9-31. Step one is to scale up your layout lettering. The easiest and fastest way is to use proportional dividers or a projector.

Adjust the dividers so that it gives a ratio of 1:2 or to whatever proportions you desire.

Now place your scaled up lettering under the top sheet of visualizing paper. Using a chisel point, or a B or 2B pencil, stroke in the letters until you have the correct weight and proportions for the letters. You can, by sliding the under tracing back and forth, align the letters as you want them. Check your lettering to see that the spacing and weight of the letters are uniform; if not, make another tracing. You may have to make several tracings before you have a satisfactory piece of lettering. Looking at the line of lettering from the back of the visualizing paper often shows up mistakes not otherwise noticeable.

Now do a final tracing. By building up your letters freehand, you can see what adjustments are needed, if any, in the width of spacing of the letters. You should have eliminated every problem of design on this tracing.

Turn your tracing over and blacken the back of it with an H or 1H pencil. This will give you a clean, firm, light line tracing when drawn. Attach the paper for your finished lettering to your drawing board. Tape the tracing to the top of the

Figure 9-31.—A method of enlarging lettering

drawing paper and, with a T-square, make two sets of register marks. Now you will be able to remove your tracing anytime you wish and still be able to correctly align it to your drawing paper.

With a 3H or harder pencil, a T-square and a triangle, trace all of the horizontal and vertical lines. Now loosen the drawing paper from the board, with the tracing paper still attached to it and turn the paper to whatever angle you desire and trace in the curves freehand. Always keep your pencil sharp while you work.

Frequently lift your tracing paper to avoid missing any lines, and to see if your transfer lines are sharp. You must make firm lines, but do not apply pressure so hard that you make furrows in the paper.

Remove the tracing from the finish sheet and with your pen, T-square, and triangle, ink all of the horizontal and vertical outlines.

Arrange your paper as before in the direction you most prefer and ink in the curved lines, using short strokes. Draw the edges smooth and sharp. They must be consistent with the edges of the horizontals and verticals. Keep your pen clean by wiping it frequently on a cloth or on scrap paper. This aids the ink to flow freely.

Do not correct any mistakes until you are completely finished with the job. If the ink has gone over the proper limits of a letter, use white opaque to cut it back. Any large corrections in black should be made with lampblack rather than india ink which may chip off of the large areas.

With an artgum eraser, carefully and gently erase any pencil marks or smudges. Examine your finished job carefully and make any final corrections or even up any ragged edges with a very fine brush.

BROAD-PEN LETTERING

Until printing was invented, all books had to be lettered by hand and the tool most often used was a broad flat pen. This broad-pen lettering continues to be useful in this modern era where the artist is required to do such work as posters, signs, certificates, charts, displays and countless other areas of freehand lettering work.

The broad-pen is a highly creative tool because of the various pen points available to choose from. A wide variety of novel and exciting lettering effects can be created with the broad-pen style of lettering. The term "broad-pen" includes the use of brushes because they can be used in the same manner as the pens.

To select the proper pen width for the lettering size desired, the rule of five times the width of the nib of the pen for lowercase letters and eight times the width of the nib for the caps is most often used by professional illustrators.

When using a broad-pen, light but firm pressure is all that is needed for the ink to flow freely. It is possible to draw many letters without lifting the pen from the paper because a good pen will work well regardless of which direction it is pushed or pulled.

MAKING BRUSH SCRIPT

Recalling the discussion on script lettering, you are now going to learn a more casual, spontaneous version of script: brush script. Brush script has a unique freshness, bounce and vitality and is widely used. You will have to try many different styles of writing with the brush to achieve the effect you want. To practice this style of lettering, you will need a bottle of ink, a supply of paper and a No. 2, No. 3 or No. 4 sable brush. Figure 9-32 shows the usual three to five steps taken to do brush script.

Step 1: Write the copy over and over until you get the desired effect.

Step 2: Select the word or parts of words or letters which you feel has the character of the style you are seeking. The parts you select should be easy to read, consistent in character, size and weight.

Step 3: Cut out the sections you have selected. Paste them down with rubber cement. Before the cement dries, you can move the sections around to get the proper spacing and alignment. Clean away any surplus cement and make any additions or adjustments with brush and ink.

Step 4: When you want a more exacting job, you can make a negative, paint out the section lines, and make any final changes you find necessary.

Step 5: Have a glossy positive made from the retouched negative. This will be the finished art. If necessary, you can still make improvements directly on the photostatic positive.

BRUSH GOTHIC

The procedure just covered can also be used to make the animated styles of separated letters

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often called brush gothic. You can create an almost unlimited variety of letters with this technique.

Forget about guidelines when drawing the casual animated letters, but keep in mind that your letters should always be of uniform height.

When drawing light letters, your brush should be pointed; use very little ink. Hold the brush almost vertical to the paper and allow only the point to touch the paper.

When drawing heavy letters, a worn or blunt pointed brush, or one with the tip cut away is best. Load the brush with ink and hold it at a close angle to the paper. This will make a wide stroke.

With proper practice, you will be able to create a wide variety of letters using both brush script and brush gothic as formats.

SHOW-CARD LETTERING

Show-card lettering is often referred to as "show-card writing," for an experienced letterer of show-cards is so skillful and fast that he seems to literally write his signs.

Show-cards are varied in their requirements. This will afford you ample opportunity to experiment with the designs of the different kinds of letters and layouts. This experimentation is an excellent way for you to develop and apply your ability to create new lettering forms and effects.

There are two favorite types of brushes preferred for show-card lettering. They are the rigger brush, a red sable brush with a round ferrule available in sizes from a No. 1 (very small) to a No. 12 (large), and the single stroke red sable brush with a flat ferrule which comes in varying widths from 1/8 of an inch to 1 1/2 inches. After using these brushes, wash them thoroughly and dry them with a dry rag.

Paper for show-card lettering comes in a great variety of surfaces. One of the most commonly used is a white cardboard which is available in 22 x 28-inch sheets, 30 x 40-inch sheets, and 28 x 44-inch sheets. It is also available in a wide variety of colors. Rolls of 10 to 100 yards in length are available for doing large signs or banners.

The pen most commonly used is the Speedball and it comes in a wide variety of pen tips, including round, square, oblong, and oval.

Show-card paints, often referred to as poster paints, come in a wide variety of colors and sizes. These paints often dry out as moisture evaporates when the lids are not kept tight. Water can be added to bring the paint back to its proper consistency. For use in lettering pens, the paint can be diluted, or ink, especially made for lettering pens, can be used.

Gothic or variations of gothic faces are the most widely used style of letters in show-card lettering. The brush is first dipped into the paint, then worked to a chisel point before it is applied to the drawing surface. The hand movement is kept free; the actions of the fingers, wrist and arm move, keeping the strokes flowing freely at all times.

Figure 9-33 shows how the vertical and curved brush letters are made.

Step 1: Draw the vertical strokes.

Step 2: Turn the brush sideways and square off the top and bottom of the vertical strokes.

Step 3: Make the left half of the curve. Hold the ferrule of the brush between the thumb and forefinger, and twirl the brush in the motion indicated by the arrow in the illustration.

Step 4: Connect the curve as needed to finish the letter.

CREATIVE LETTERING

As an Illustrator Draftsman, your imagination and sensitivity to the design of lettering should be as free as that of the commercial artist. You may not have the opportunity to do fashion layouts using the delicate lettering on a feminine subject, but you must have the ability to create a delicate style of lettering in the event you are ever called upon to do so.

You will most often be striving to create a coarse, heavy lettering, one which expresses a strong, dramatic theme of action, heroics, and all the other actions signifying the Navy as a man's organization. In creating this dramatic style of lettering, your first concern should be that your letters fully express the mood and character of the subject matter.

Your lettering should also be related to the other design elements of the layout or provide a contrast or a relief from the other elements. More often than not your decision as to style will be aided by your leading petty officer or the originator of the job itself.

Figure 9-34 gives a few examples of how words can be treated. As an Illustrator Draftsman, you will have much creative freedom in approaching most of your lettering assignments. This does not mean, however, that you are to lessen the emphasis that has been placed on the

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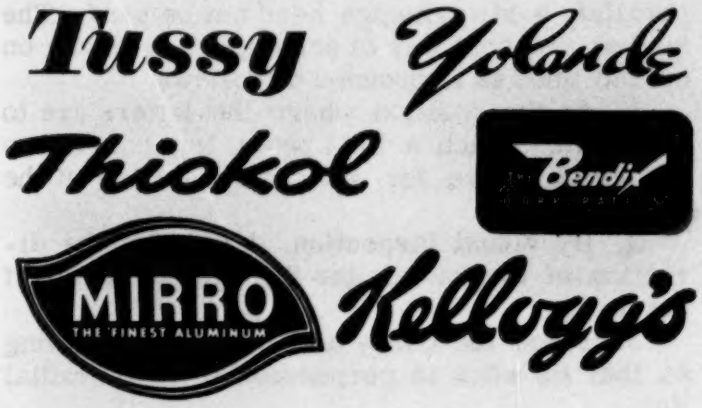

Figure 9-34.—Creative lettering.

need of your thoroughly understanding the fundamental letter forms, or the principles of correct letter, word, and line spacing.

Before you take any creative liberties in lettering, you must have a complete understanding of the basic fundamentals that have been provided. Success will not come until you do.

LETTERING GUIDES

Lettering guides, such as Leroy and Wrico sets, have the advantage of ensuring that letters and figures made with them will be absolutely uniform. By using these guides instead of working freehand, you can do lettering which is more professional in appearance. However, even someone who has developed maximum skill in the use of these guides cannot letter as rapidly as a proficient freehand letterer. Also, when you use these lettering guides, you must still determine the spacing between letters and words. Remember that a line of lettering will not look professional unless it is properly spaced.

LEROY LETTERING SET

In addition to the case, Leroy lettering sets consist of five components parts: a number of guides or templates in which the lines of the letters are indented, a three-legged scriber, a number of inking pens of varying sizes with cleaning pins, a penholder with a special Leroy penholding attachment and a special penciling attachment for the scriber. Figure 9-35 shows the scriber and the template in working position. The legends name the various parts.

One leg of the scriber holds the pen or pencil, and the other two legs terminate in tracer points. One tracer point or tail pin moves in a long, straight groove on the template. The other moves in the depressed letters on the template. When this latter point is moved around the contour of a letter, the entire scriber hinges on the tail pin in the groove and the pen or pencil traces the letter on the drawing paper.

Alongside the penpoint, there is a rest, adjustable in height, which prevents the pen from resting heavily on the drawing. This must be carefully adjusted because the pen will make a satisfactory line only when it is in very light contact with the drawing. You should experiment to find the exact point to adjustment.

The pens are vertical, with a reservoir for ink, and have a steel wire or cleaning pin running down into the opening at the bottom to keep the ink from clotting in the point. The pens are held in the scriber by means of a clamping screw.

In straight-line lettering, the spacing between letters can be determined by the eye before inking each succeeding letter. The space-area between all letters of a word are to be made equivalent; that is, in order that the word may have the appearance of having uniformly spaced letters, the areas between the letters, rather than the distances between them, must be made about equal as in figure 9-36. The area between adjacent letters depends upon the shape of the letters. Straight-sided letters such as H and I, I and K, M and N, or N and B, are drawn farther apart than round letters like O and Q, O and C, or C and G, and slant-sided letters in combination with open letters such as A and L, L and A, or V and J, are drawn with less space between them than the round letters. Where letters such as L and T, L and V, or A and V come together, they may have to overlap in

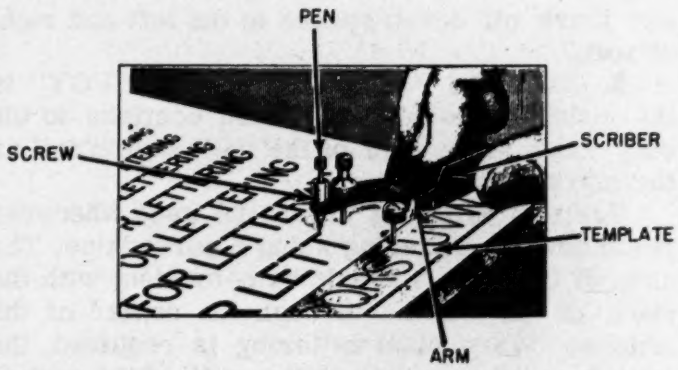

Figure 9-35.—The Leroy scriber and its operation.

order that the word does not appear to be broken into two or more words.

As in freehand lettering, the space between words should be made about equal to either the width or height of the letters, and the succeeding words should be drawn at the same spacing.

When lettering has to be centered above a certain part of a drawing or within the center of a certain space, the scales along the bottom edges of the templates aid in the centering of a

Figure 9-36.—Spacing.

line of lettering. Each space on the scale represents the center-to-center distance of normal-width letters. For example, to center the words "LEROY LETTERING" above a certain line, proceed as follows:

1. Count the letters in the words and the words and the spaces between them. Result: 15.

2. Considering the letter "I" and the spaces between the words as half value each, reduce the total by one (1). Result: 14.

(NOTE: If there are an odd number of half values, take the next lower even number and allow more space between words than normally required.)

3. Divide the result of No. 2 above by 2. Result: 7.

4. Set the zero of the scale at the vertical line about which the lettering is to be centered and mark off seven spaces to the left and right of zero.

5. Start the "L" of the word "LEROY" in the title at the left mark and continue to the end. The right edge of the "G" should fall on the mark to the right.

Vertical lettering should be used whenever possible when lettering along a curved line. The axes of the letters should be coincident with the radii of the curves through the center of the letters. When slant lettering is required, the letters are drawn so that the radii of the curves run through the center of the bottom of the letters. Since the axes of the letters will not be parallel, a straightedge need not be used. The fastest and best way to accomplish lettering on curved lines is to proceed as follows:

1. At the position where the letters are to be drawn, sketch a light pencil line parallel to the given curve for the bottom or top of the lettering.

2. By visual inspection, determine the direction of the radial line through the center of the letter.

3. Place the Leroy template on the drawing so that its edge is perpendicular to the radial line.

4. Insert the tail pin of the scriber in the straight-guide groove of the template, and the tracer pin at the bottom or top of the required letter.

5. Move the template and scriber as a unit to the left or right and up or down as required, keeping the template parallel to its original position, until the tip of the pen is at the correct position.

6. Trace the character.

7. Repeat the preceding steps until the lettering is completed, effecting equivalent spacing between succeeding letters and words.

(NOTE: If the degree of the curve is known and a template of that degree is available, it may be used to guide the Leroy template.)

Any drawing can be neatly completed with lettering of uniform slant, height, and thickness of strokes with the use of the Leroy set by taking the following steps:

1. Select the template with the letters of the desired height.

2. Lay the template along the top of a T-square or the straightedge of a drafting machine.

3. Using the table shown in figure 9-37, select the proper pen to give a well proportioned letter.

On drawings with a great deal of lettering, the recommended combinations may be altered, either one pen-size under or over the recommended size for variation and appearance.

4. Insert the selected pen into the socket of the scriber arm until the shoulder of the pen rests on the scriber arm.

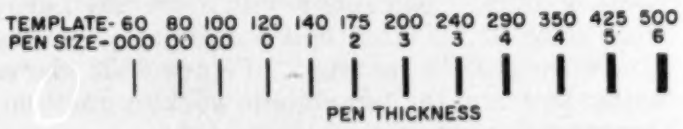

Figure 9-37.—Table for selection of proper Leroy pen.

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5. Tighten the screw on the side of the scriber arm.

6. Loosen the locknut on the adjusting screw in the scriber arm.

7. Set the tail pin of the scriber in the straight guide groove of the template.

8. Set the tracer pin of the scriber in the groove of a character.

9. Lower the pen gently to the surface of the drawing paper.

10. Raise or lower the scriber arm by turning the adjusting screw until the tip of the cleaning pin within the pen just touches the drawing surface. Tighten the locknut when the desired height is reached.
(NOTE: To prevent blotting, this adjustment is made before ink is put into the pen.)

11. Remove the scriber from the template.

12. Remove the cleaning pin from the pen.
(NOTE: When using Leroy pens No. 4 and larger, the cleaning pin should not be removed from the pen. This prevents the ink from flowing straight through the pen.)

13. Fill the reservoir of the pen with drawing ink.
(NOTE: The Leroy pen is filled with ink in the same manner as any common drafting inking instrument.)

14. If the cleaning pin was removed, insert it back into the pen.

15. Wipe the lower tip of the pen with a cloth to remove any excess ink that may have been pushed through by the cleaning pin.

16. Gently lower the pen to the drawing surface after inserting the tail and tracer pins into their proper grooves.

17. Proceed with the lettering by moving the tracer pin in the grooves of the characters, keeping the tail pin in the straight-guide groove.
(NOTE: If the ink does not flow properly, turn the cleaning pin within the pen, and make any minor adjustment to the adjusting screw to allow the ink to flow properly. Tighten the locknut. It is suggested that during short intervals of nonuse that occur when lettering, that the tip of the pen, while still in the socket of the scriber arm, be placed on a piece of moist cotton. This will prevent the ink from drying around the opening and will help the ink to flow properly when used again. To also prevent drying of the ink at the tips of the pen, wipe them frequently while lettering. A clean tip will produce strokes of uniform width.)

Wash each pen carefully after it has been used. Do not hold the pens under running water when you wash them, since they are so small they can easily be dropped down the drain. Use a syringe to rinse the pens if you have one. The manufacturer of the Leroy lettering set offers a special pen-cleaning fluid which is excellent for washing pens or for soaking off dried ink.

WRICO LETTERING SET

The Wrico lettering set contains a vertical penholder for various penpoints and a number of templates. Each template contains a number of differently shaped perforations from which letters in one size and style can be stenciled.

When you use the Wrico lettering set, align the bottom of the letter shapes in the template with the bottom guideline on your paper, resting the template against a straightedge. Since you will need to slide the template back and forth to draw different letters, it is a good idea to tape the straightedge in place. A shift button is provided at the right end of the template to make it easier to shift from one perforation to another when two must be used for a single letter shape. Be certain an ink line is dry before you shift the template, otherwise you may smear the ink.

The Wrico pen is vertical with a reservoir for ink. It is equipped with a plunger which keeps the point of the pen from becoming clogged with drying ink. For maximum performance, the Wrico pen should be kept clean. However, it is not a good practice to leave the pen soaking in water or a solution when it is not in use.

VARIGRAPH

The Varigraph, shown in figure 9-38 is another mechanical lettering device that operates with template and scriber. There are two sets of adjustments on the varigraph which permit the user to adjust height and slant of the lettering while using one template. There are no templates of varying sizes as with the Leroy or Wrico lettering sets.

MECHANICAL AIDS FOR LETTERING

HEADLINER

An Illustrator Draftsman may be called upon to use a photographic process lettering machine such as the Headliner. The Headliner produces positive copies on 35 mm film or on 35 mm plastic finished paper. The processing is

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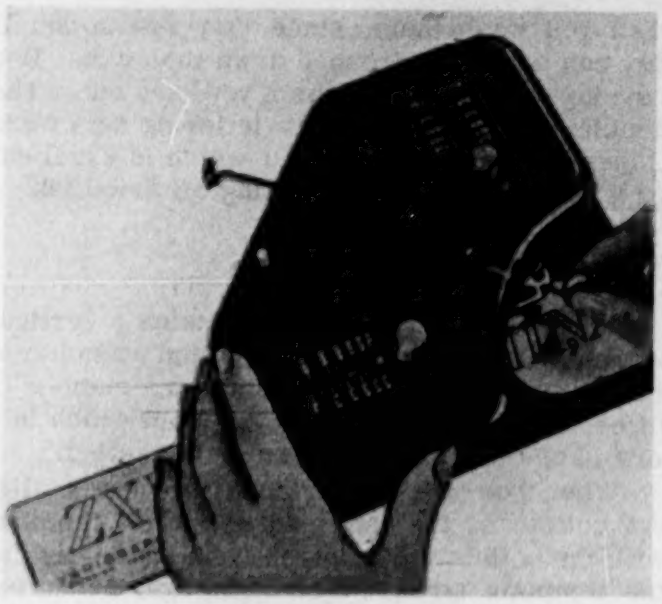

Figure 9-38.—Varigraph.

similar for both the film and the paper. The films may be used in preparing transparencies for reproduction on diazo foil transparencies. Since paper positives are generally preferred for design paste-up purposes, this discussion will center on them.

The type master, letter (Q) in figure 9-39B consists of a plastic disk with transparent (reverse) characters. Many type faces are available in sizes from 12 to 72 point, but a separate disk must be used for each size and style. This disk fits on a turntable located just under the top of the machine, also indicated by letter (Q) in figure 9-39B. The movement of the turntable is synchronized with the movement of the knob (J). (See fig. 9-39A). Turn the knob to move the desired character under the indicator (F), and then make the exposure by pressing the print bar (B).

The proportional spacing of the letters is controlled by the depth of slots cut for each letter in the edge of the type disk. There are deep grooves for wide letters like "M" and "W" and shallow grooves for narrow letters like "j" and "i."

To space between words, press the space bar (C). The word spacing knob (L) is used to adjust the spacing between words. To set the spacing, turn this knob until the reading on dial (M) corresponds to the point size of the type being used. You can adjust the machine for closer or wider spacing between the letters in the words by turning the spacing knob (K) to move dial (N).

When you have finished a line, turn the paper advance knob (G) forward three or four revolutions. This moves the photographic tape forward and allows for plenty of space between the end of one line and the beginning of the next.

The line length indicator (D) shows the amount of paper that has been used in setting the line. The automatic developing mechanism will not work unless at least 8 inches of paper have been advanced into the machine. Turn this dial manually to zero before beginning a new line.

Once the line has been set and the paper has been advanced properly, raise lever (S) see figure 9-39C and do not release it until a red light comes on at the front of the machine. This lever cuts the paper and starts it through the automatic developing unit. Developing operations are entirely automatic. The tape is carried first through a developing solution; then through a fixing solution; and finally, through plain water before it is forced from the machine.

The finished print should be dried before being used. Sanding the glossy covering from the back of the tape makes it adhere better when used with rubber cement.

Since the emulsion on the 35 mm tape is fairly slow, the tape can be handled safely for short periods of time in moderately bright light. However, if the light is too bright or the light source too close the tape may fog or turn gray. The use of a yellow or a red light during loading and threading operations will ensure relative safety.

Since the width of letters vary from one type style to another, it is necessary to adjust the lighthouse opening by moving the lever (P) when switching from a small to a large type face and vice versa. The setting for the lighthouse is printed on each type master. The exposure time can be adjusted if necessary by turning the knob (T).

The machine shown in figure 9-39A prints only one line of type on the tape. The Multi-Line model shown in figure 9-40 will produce one, two, or three lines of copy on the tape depending on the type master used. To produce three lines of copy, it is necessary to use a master with three rows of characters. You adjust the opening in the lighthouse so that only the characters in the top row will be exposed when the first line is printed, then turn the paper back to the starting point, reset lighthouse opening and print the second line. Repeat this same procedure for the third line.

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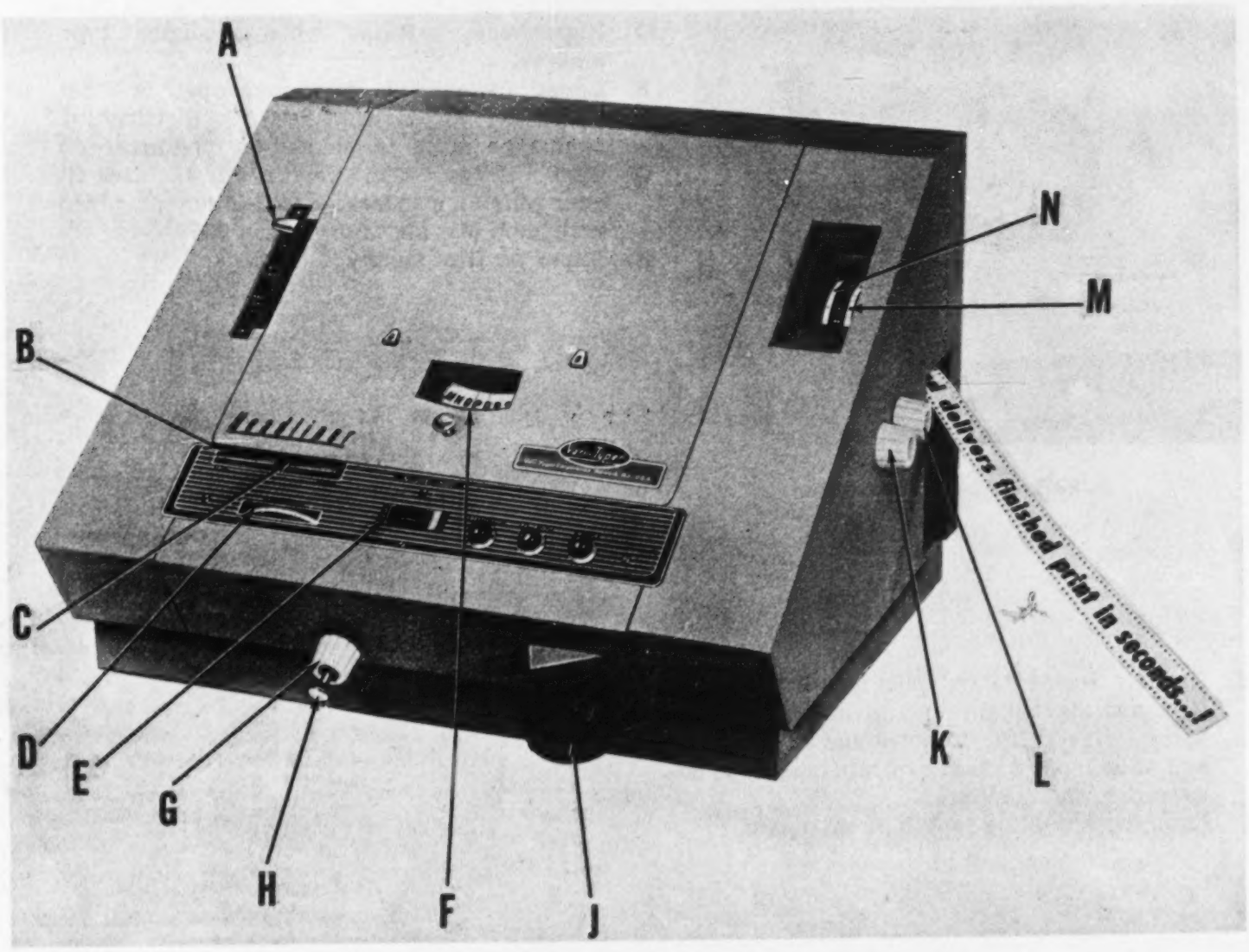

A. Space lever. Set at full font if type and lower case letters are on same type master; set at half font if caps are on separate master.
B. Print key. Press down to make exposure.
C. Space key for spacing between words.
D. Line length indicator. Move to zero by hand when starting new line.
E. Switch.
F. Character indicator. Turn knob (J) to bring desired letter into position.
G. Paper advance knob. When plunger (H) is pulled out, line length indicator will register, but paper will not advance in machine.
H. Plunger.
J. Knob used for turning type master to bring desired letters into position under indicator (F).
K. Knob for adjusting spacing between letters in word.
L. Wordspacing knob used to adjust spacing between words.
M. Wordspacing dial. To set, turn knob (L).
N. Letterspacing dial. To set, turn knob (K).

9-39A.—The Headliner.

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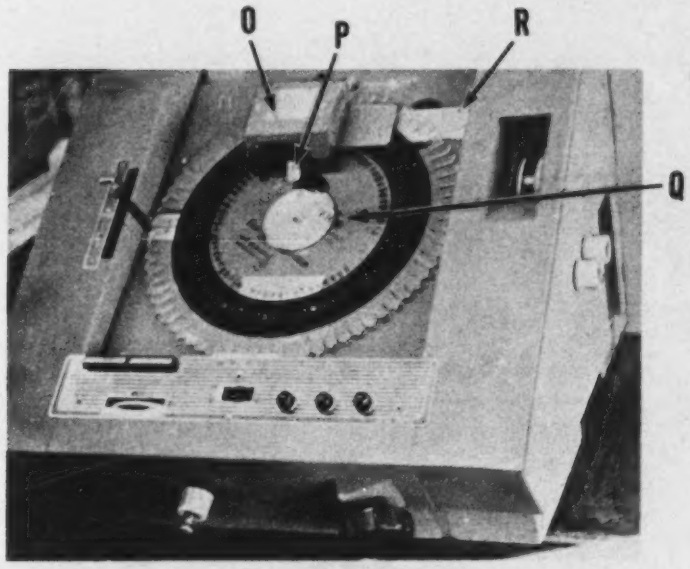

9-39B.—The typemaster.

O. Lighthouse. Raise when changing type master.
P. Lever for setting lighthouse opening. Set according to width of letter. (Setting for each type style is marked on type master.)
Q. Type master. The apertures in the disk fit over pins on a turntable that is synchronized with knob (J), shown in figure 9-39A.
R. Paper or film supply.

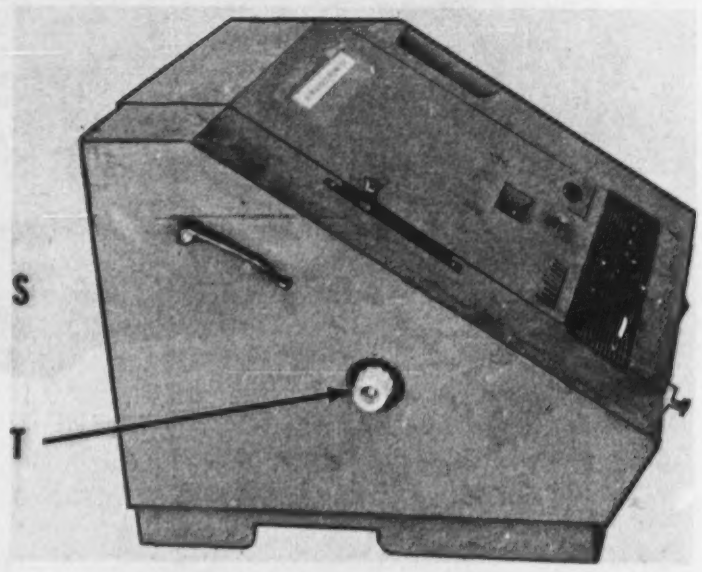

9-39C.—Operating controls on left side of headliner.

S. Lever. Raise to cut photographic tape or film and start it through developing unit. If lever will not lift; do not force it. Check to see if at least 8 inches of tape has been advanced in the machine.
T. Knob for adjusting length of exposure.

Since larger type faces require more space than the smaller ones, it is not possible to make more than one or two lines when these large faces are used. In some cases, it is also necessary to use two type masters; one for the lowercase, and one for the caps. When two masters are used, lever (A), figure 9-39A is moved to the half-font position.

Except for the multi-line feature, the operation of the model shown in figure 9-40 is similar to the one shown in figure 9-39A.

LETTERING ON NAVY DRAWINGS

In the Navy, single-stroke commercial gothic lettering is used on construction and production drawings. Inclined lettering and vertical lettering should not be used on the same drawing. Lowercase letters are never used on production drawings. However, lowercase letters may be used on construction drawings except in titles which should always be lettered with capitals. These rules, of course, do not apply to the lettering on illustrations which appear in publications.

Lettering on maps and charts is ordinarily quite different from the lettering on engineering drawings—mechanical, electrical, or structural. Instead of being hand lettered, such lettering is often type-set and the reproduction proofs pasted in place on a map or overlay. The lettering on maps and charts is discussed later.

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on the cathode of the magnetron. The peak power of this pulse is quite high, although the output of the magnetron is somewhat less, due to losses in the tube and associated circuitry.

Gas bursts (arcing) occur occasionally within the magnetron. This condition causes a momentary impedance mismatch. A small voltage of a polarity opposite to that of the modulator pulse appears across the PFN when arcing occurs. This small reverse voltage is in series with the power supply voltage at the start of the next charging cycle; hence the total voltage available to produce the charging oscillation is increased. The pulse line voltage may build up to a value great enough to break down the thyratron. This possibility is overcome by connecting V3 in paralled with the thyratron. The diode bypasses the reversed charge of the PFN.

The PFN is composed of aircore inductors and mica capacitors. It is divided into three sections of artificial transmission line, all within the same container. Each part is a complete network. The connection of the three parts (by relays K1 and K2) increases the width of the pulse. During BEACON operation, only the beacon pulse relay K1 is energized; thus the A and B sections of Z1 are connected in the circuit, providing a pulse of longer duration than that previously obtained. During long range search operation, both relays are energized; thus all three sections of Z1 are connected in the circuit to provide a still longer pulse.

Resonant charging choke L1 not only doubles the pulse system voltage before firing, but it effectively isolates the power supply from the rest of the modulator during the relatively short periods of pulse duration. It also prevents the power supply from shorting through the switch tube during de-ionization.

Resistor R1 functions as a grid leak for the thyratron switch tube. Capacitor C2 and choke L2 form a filter network to prevent reflection of the switch tube transients into the synchronizer. Switch tube current, flowing through the cathode resistor R2, generates a trigger pulse which may be used for synchronizing the rangemark start-stop multivibrator (located in the synchronizer unit). Resistor R3 and capacitor C3 improve the trigger shape by removing ripple at the top of the pulse.

The cathode of the magnetron is internally connected to one side of the filament line. Input to the magnetron is supplied by the modulator through the magnetron pulse transformer. Design of the pulse transformer provides two secondary windings of similar electrical characteristics, one in each leg of the magnetron filament supply. This "bifilar" secondary winding maintains an equal and in-phase voltage on both sides of the filament, effectively isolating the high voltage modulator pulse from the low voltage magnetron filament transformer. Capacitors C4 and C5 compensate for slight electrical differences between the output windings of the pulse transformer, preventing the appearance of high pulse voltages across the filament.

The d-c plate current of the magnetron flows from ground through R4, L3, and secondary winding of the pulse transformer, the cathode circuit, and the plate circuit back to ground. Coil L3 blocks peak pulses, but passes average current through the magnetron current meter. Capacitor C6 offers a low impedance to the magnetron pulses and integrates them for metering. Negligible current is generated within the magnetron during quiescence (nonoperation), but the average (or d-c) current summed over a long period of pulsed operation is of high magnitude. Longer pulse periods at a lower PRF tent to balance shorter pulse periods at a higher PRF; the result is a nearly uniform duty cycle, regardless of the radar function being performed. While 115 volts is applied to the magnetron filament transformer during standby, it is reduced to 65 volts when the high voltage is applied to the modulator.

VELOCITY MODULATED TUBES AS LOCAL OSCILLATORS

Most radar receivers use an IF frequency of 30 or 60 mc, which is usually only a small fraction of the transmitter frequency; therefore, stability of the local oscillator is a prime factor in receiver operation. For example, in a radar receiver which receives a frequency of 3,000 mc, a frequency shift in the local oscillator as much as 0.1 percent would be a 3-mc frequency shift. This is equal to the bandwidth in most receivers and would cause a considerable loss of amplification in the receiver.

Another consideration in radar is a receiver which uses a crystal diode mixer. In this receiver the power required of the local oscillator is small, being only 20 to 50 milliwatts

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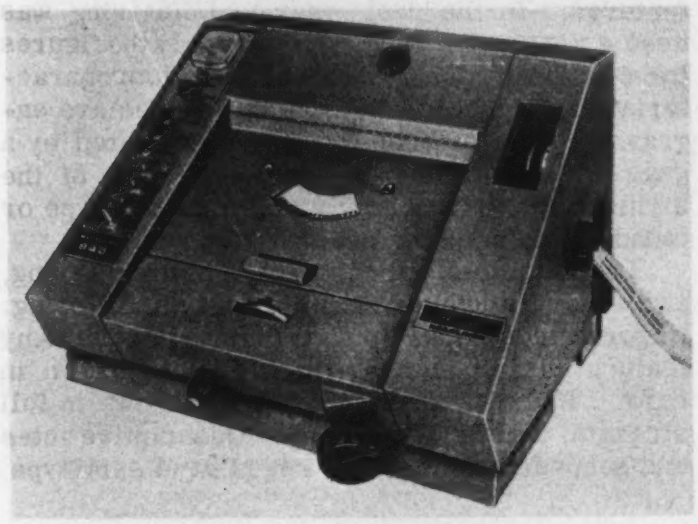

Figure 9-40.—Multi-line model headliner.

RECOMMENDED SIZES OF LETTERS

Because many mechanical drawings are now reduced to a small size when they are reproduced, or are photographed on microfilm and then enlarged, the lettering on drawings must be large enough to remain legible. MIL-STD-1B, 9 July 1963, shows the effect of reduction of lettering. See figure 9-41.

In the absence of factors making larger lettering desirable, the following sizes (shown in fig. 9-42) for lettering on Navy drawings are recommended.

When commercial lettering guides are used, sizes that correspond to the sizes given in figure 9-42 are acceptable. When typewriters or lettering machines are used, nothing smaller than the standard pica, or 12-point, type should be used.

REDUCTION GUIDE FOR LETTERING		
16 NOM RED. RATIO A,B,C, DRAWING SIZES	24 NOM RED. RATIO "D" DRAWING SIZES.	30NOM RED. RATIO ROLL SIZE DRAWINGS
ACTUAL SIZE OF LETTERING	2/3 SIZE REDUCTION	1/2 SIZE REDUCTION
ABCDEFGHIJK abcdefghijklmno 1234567890°."	ABCDEFGHIJK abcdefghijklmno 1234567890°."	ABCDEFGHIJK abcdefghijklmno 1234567890°."

Figure 9-41.—Reduction effect on lettering.

On large drawings, the size of the lettering should be governed by the amount of reduction necessary and by the minimum size of 3/64 of an inch after reduction.

	Inch
Drawing and part number	.20
Title	.12
Subtitle	.12
Letters and figures for body of drawing.	.12
Fractions and tolerances	.12
Designation of section and detail views:	.12
"Section"—"Detail"	.12
"A-A"—"B"	.18

Figure 9-42.—Minimum letter size.

CHART LETTERING

Lettering plays such an important role in the finish of charts and maps that the need for perfection in this element of their construction can hardly be overstressed. The lettering on a chart does much to establish the initial impression of the work. Slight imperfections that might not mar the symbols on a chart are quickly detected in the lettering.

There are several factors which enter into the production of superior lettering and topography. The aim must always be toward letters which are appropriate to the purpose. Type and lettering highly effective in advertising, book, or decorative work might be an unfortunate choice for serious charts and maps.

Letter styles on charts should be sufficiently restrained to avoid calling attention to their design. They must be legible, open enough to reproduce well by the lithographic process, yet not so bold as to kill adjacent type or to cause spottiness in the chart. They should blend in reasonable harmony when mixed.

Introducing types of widely divergent design, such as sans serif and roman, in a single work is unavoidable when clear-cut distinctions must be made among the various elements of a chart. To be considered for adoption, a style usually should be available in light, medium, and bold, with italics to match, but, this is not always possible. Different types which give similar effects may be used instead. Some good styles are not sufficiently economical of space to be practical for all work. Condensed or contracted forms must be resorted to and should be available.

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OCEANOGRAPHIC OFFICE CHARTS

Navy Department charts, including aeronautical charts and the charts in the Seaplane Pilot's Handbook or the Seaplane Route Manual, are produced at the Oceanographic Office. The lettering on aeronautical charts is similar to that on navigational charts, but the lettering on seaplane route charts is different in that only sans serif types are used.

The Oceanographic Office has established certain rules concerning lettering on charts. The purpose of these is chiefly to ensure the use of different types to indicate differing features. In the past, engraved lettering was used extensively. Now, however, only the figures for soundings, abbreviations for bottom characteristics, symbols, and standard notes are engraved. The size of these are indicated by a gage number which refers to the size of the stylus used by the engraver. Foundry type or monotype is used for other lettering.

Land features are shown in vertical lettering, and water features are shown in slanted lettering. Important features are shown in caps. Any feature larger than 12-point type is shown in caps. Place names are generally shown in full strength, that is, roman type. Descriptive notes and secondary names are set in sans serif type.

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CHAPTER 10

THE ILLUSTRATOR'S FOUR BASIC MEDIUMS

This chapter is essentially a handbook of four basic mediums: pencil, ink, ink washes, and opaque paints. The beginner is not expected to become a master technician with all or any one of these mediums at the start. However, during the span of your Navy career as an Illustrator Draftsman, you will often use these basic artist's tools and materials, so a thorough knowledge of them is a must if you are to become proficient in this rating.

PENCIL DRAWINGS

THE PENCIL

The pencil is the most valuable tool you will ever use as an Illustrator Draftsman. Regardless of what medium your drawings will be done in, you will do the planning with a pencil. The pencil is the most versatile of all drawing tools; you can create a range of values from the subtlest gray to the richest black, and create the thickest and thinnest lines. In addition, when you want to make a change to the preliminary drawing, the pencil lines can be erased.

Figure 10-1 shows 16 grades of pencils commonly used. Nine are hard: from H, slightly hard, to 9H, extremely hard. Six are soft: from B, moderately soft, to 6B, extremely soft. Between the two is a medium HB pencil. The softer the pencil, the thicker the lead and the broader the line drawn with it. Soft pencils need frequent sharpening, while the harder pencils retain their fine points for a longer time. When you are drawing and need a darker line, don't bear down on a hard pencil because this will cause grooves in the paper; instead, use a softer pencil to achieve the darker tone.

ERASERS

Of the erasers introduced in chapter 3, those most used by the illustrator are the kneaded eraser, the art gum eraser, and the flexible soft eraser.

The kneaded eraser picks up and absorbs pencil lead without leaving any rubber particles on the drawing. It can be molded to a point to clean the smallest area on your drawing and is especially good for bringing out highlights on pencil drawings. The kneaded eraser may be used to remove smudges without erasing the drawing by gently rubbing it over the drawing surface. Because it is soft, it will not erase heavily drawn lines.

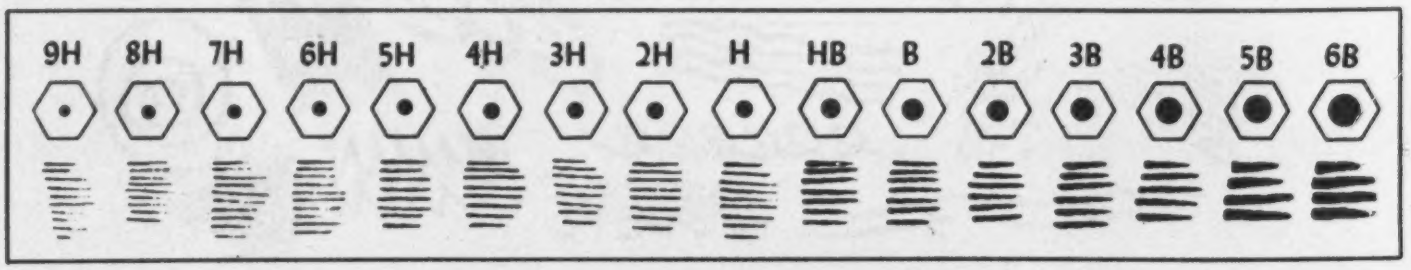

Figure 10-1.—Grades of pencils.

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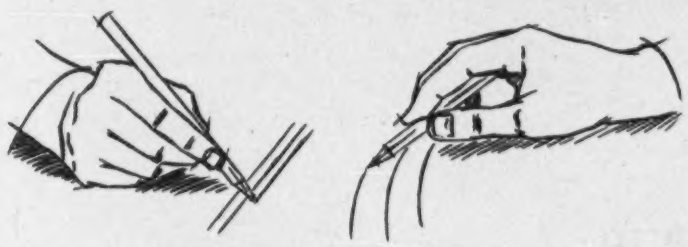

Figure 10-2.—Two ways of holding the pencil.

The art gum eraser is the favorite of most illustrators for cleaning a drawing after it is finished. It is especially good for removing pencil lines after a pen and ink or a brush and ink drawing is finished.

The flexible soft eraser is a rubber eraser similar to the one found on the end of a pencil. Its main purpose is to erase lines made with heavy pressure.

Erasing must be done slowly and carefully, using a gentle circular motion. Eraser particles from either the art gum eraser or the flexible soft eraser should be removed from the drawing surface with a small CLEAN desk brush.

HANDLING THE PENCIL

Hold your pencil comfortably and naturally. Grip the pencil lightly. When drawing light lines, press the pencil lightly; when drawing heavy lines, apply a little more pressure.

Figure 10-2 shows two ways of holding the pencil. Position #1 is good when drawing lines that must be carefully controlled and precise. Position #2 is good when working large areas such as outlines or shading in large areas.

CREATING VARIETY OF EFFECTS WITH PENCIL

Figure 10-3 shows a small portion of the many different effects and indicates the wide variety of movements possible with the pencil. These are not just doodlings. Practice of these movements will help to acquaint you thoroughly with the range of possibilities of this versatile tool.

THINKING IT OUT WITH A PENCIL

When you are planning a picture, you must put your thoughts down on paper. Small rough sketches done as easily and quickly as possible are best. The pencil is a thinking tool. With it you can speedily indicate the many ideas racing through your mind and then use combinations of these rough sketches to design your final picture. This way you can speedily create many different effects in a short amount of time.

Figure 10-4 shows how a final picture was created from many ideas roughed out in quick sketches.

INK DRAWINGS

Drawings made with pen and brush are called line drawings. With line drawings there are no grays, only solid black lines or black areas. Gray tones can be made by drawing many fine black lines close together giving a gray effect. The closer the lines are drawn, the darker the gray area will appear to be.

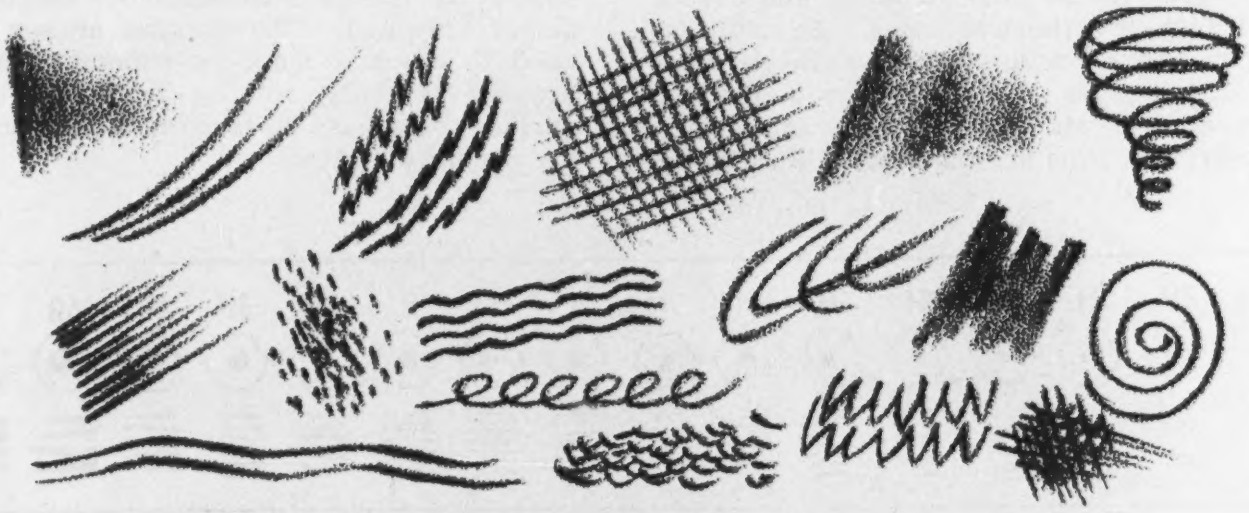

Figure 10-3.—Various movements possible with the pencil.

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A wide variety of lines can be created with the pen or brush, from a smooth line like the softness of a girl's cheek, to a rough line like the bark of a tree.

Moving the flexible pen across the paper, you can make a thin line by easing the pressure on the pen, or you can make a thicker line by applying more pressure to the pen, giving more variety and character to your line.

Line drawings are reproduced more easily and more inexpensively than any other type of drawing. They print well on all types of paper, where pencil, wash, or opaque drawings cannot. There is almost no limit to the uses for line drawings. So, throughout your career, your ability as a line artist will be one of your most valuable assets.

PEN AND INK

Pens

Pens are classified according to the thickness of the lines they form. A broad thick line is made with a coarse pen. A thinner line is made with a medium pen and a fine line is made with a fine pen. A crowquill pen is especially good for drawing very fine lines. Some pens are flexible, others are stiff. When a pen is flexible, a little pressure on it will result in a much broader line.

Many manufacturers make excellent pen points. Each of these manufacturers gives his pen points a different number. There is very little difference in the performance between two of the same style. There is also little difference in which brand you use; it is how you use it that counts.

Use a pen holder that feels comfortable. One that is about the same thickness as a pencil is preferred by most. A special holder is made for the smaller crowquill pen.

Ink

A black, opaque ink should be used. If the ink is too thin, it will look gray and not reproduce well. Light blue ink will not readily

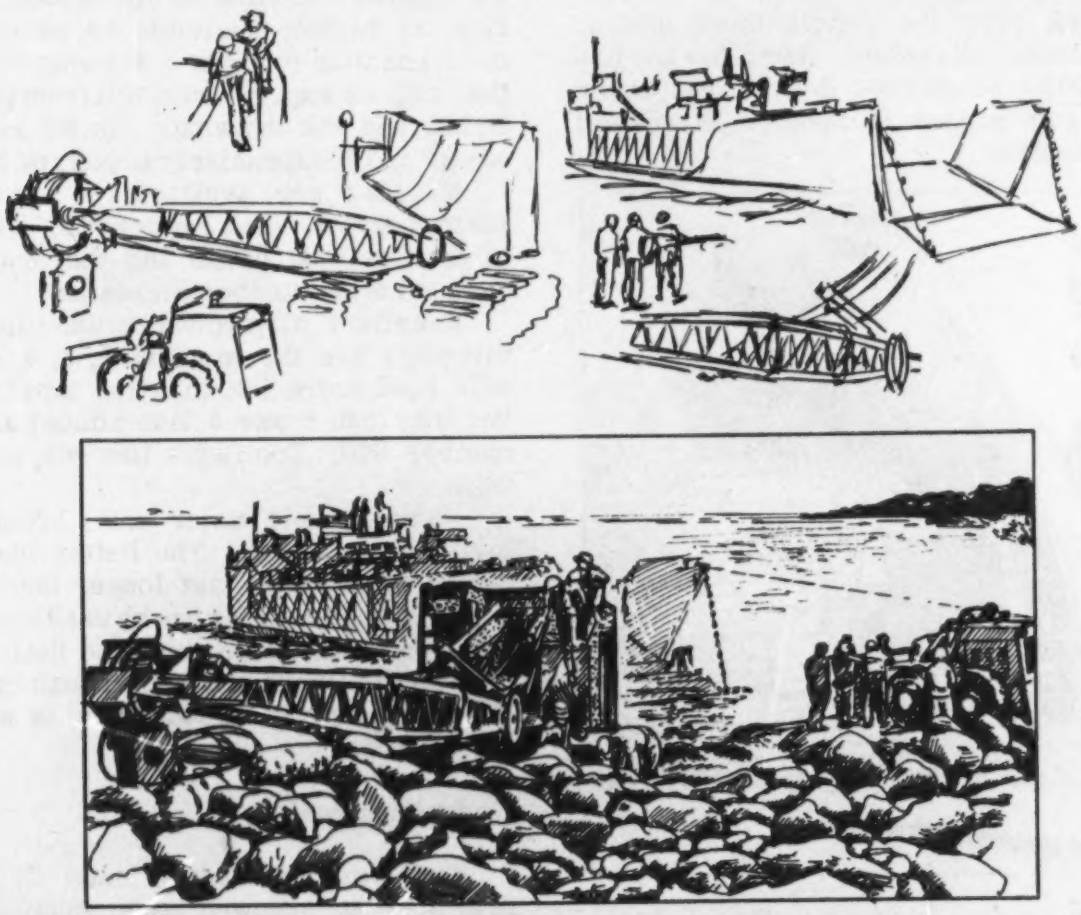

Figure 10-4.—Creating a picture from rough sketches.

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reproduce on photo-lithographic Diazo equipment. A good waterproof ink will not run if you paint over it. Ink can be applied straight from the bottle. Ink will thicken and not flow properly if the top has not been kept well closed when not in use. If this happens, thin it with a few drops of water.

Using the Pen

When using a pen point, dampen it on your lips and wipe it dry. This often helps the point hold the ink and makes the ink flow better.

Never dip your pen too deep in the ink. You may pick up too much ink and it will blot and spoil your drawing. Whenever ink begins to cake on your pen, wipe it clean with a soft rag. You will find it beneficial to wash your pen points after using them.

Do not handicap yourself with defective or worn out pen points; replace them.

Pen Drawings

When making line drawings, you can draw your picture in pencil directly on the drawing paper and ink over the pencil lines, adding texture and tones as needed. After the ink has thoroughly dried, erase over the entire drawing with an art gum eraser to remove any pencil lines and smudges.

Figure 10-5.—Shows how a well planned pencil drawing is inked in.

Another method is to work out your drawing in pencil on tracing paper and then blacken the back of the tracing and transfer it to the drawing paper. Ink in and clean the picture the same as before. Figure 10-5 shows how a well planned pencil drawing is inked in.

Creating Textures with a Pen

You can create many varied effects with the different pen points. Figure 10-6 shows just a few of the many effects possible. Notice the length, width, and direction of the strokes and the amount of white space between them. When drawing crosshatched lines, you must let the first set dry before you cross them with the second set or the intersections will become large blobs of ink.

BRUSH AND INK

Brushes

The brush is soft and flexible, and answers to the slightest pressure. Any kind of line, from the lightest hairline to the widest rough heavy line, is readily available by using the brush. It is possible to make a drawing with the brush that only an expert could tell from pen drawings. Brush and ink drawings can be reproduced as easily and inexpensively as pen and ink drawings.

Brushes are available in a wide range of sizes, styles, and materials. Number 000 is the smallest brush and the brush sizes increase as the number increases.

Excellent all-around brush sizes for line drawings are the numbers 2, 3, 4, and 5. They will hold more ink than the smaller brushes, yet they can make a line almost as fine as the number 000. Too fine a line will not reproduce well.

Pointed sable water-color brushes are best for line drawings. The better ones will give better effects and last longer than the cheaper ones. A softer paper can be used than that which was used with the pen because the brush will not pick up the fibers and cause rough lines or blots. Black waterproof drawing ink is excellent for brush work.

Using the Brush

The same procedure used in pen and ink drawings is followed when making brush and ink drawings. Lightly trace lines from the

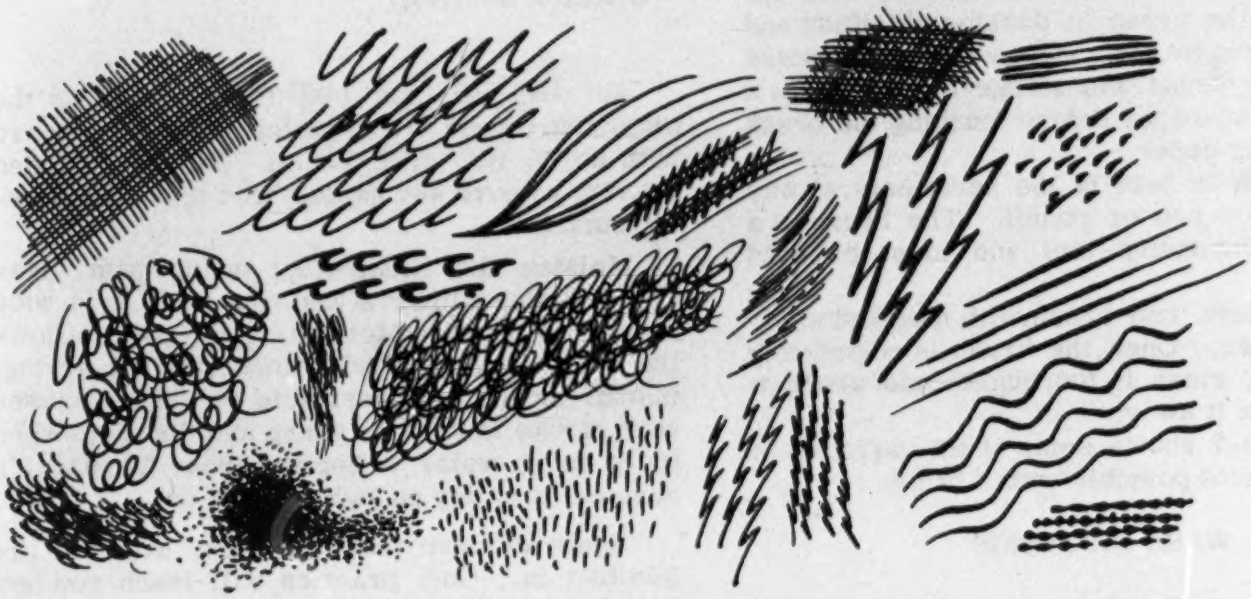

Figure 10-6.—Varied effects with the different pen points.

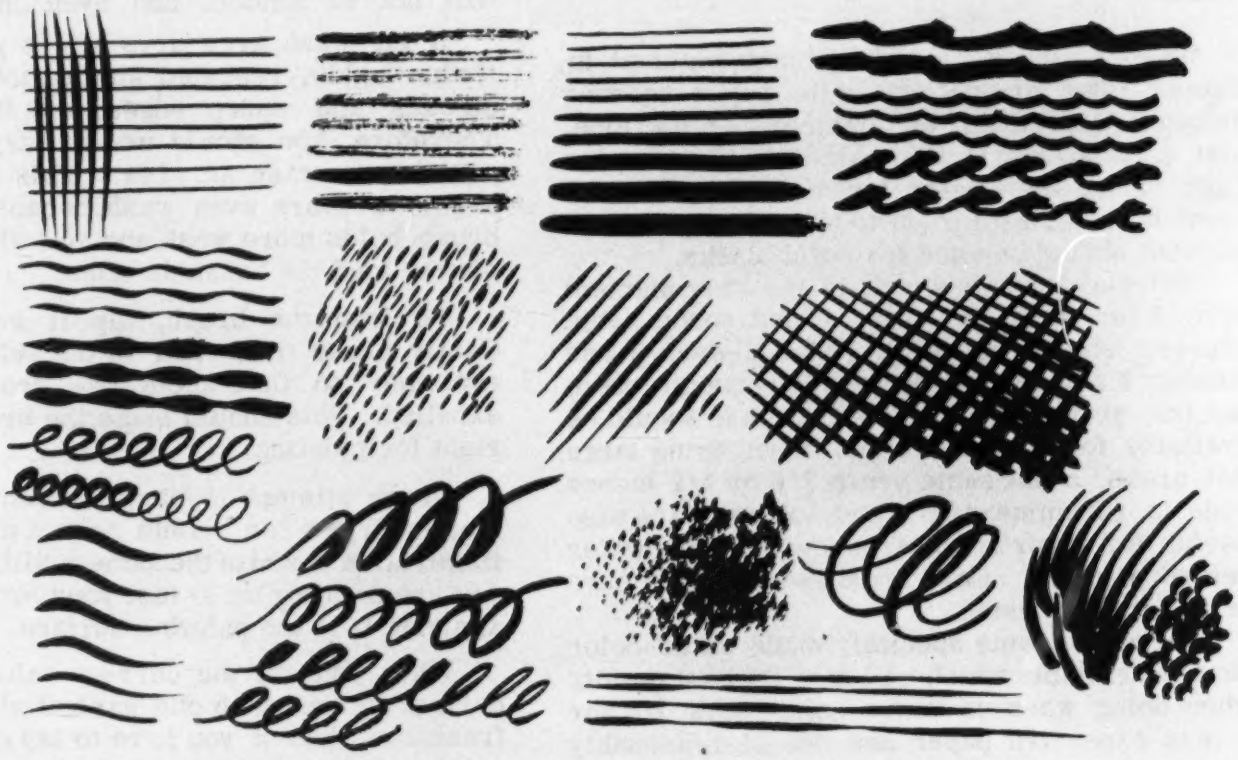

Figure 10-7.—Varieties of lines and effects possible with a brush.

preliminary sketches and ink directly over the lines. Use the brush to develop the lines and create line character. Always remove excess ink from the brush and stroke the brush on a piece of scrap paper before touching the brush to the drawing paper.

The brush is held in the same natural way you hold your pen or pencil. The brush is a sensitive, responsive tool and must be held lightly.

Always clean your brush with soap and water after each use. Once the brush is completely clean of ink, rinse it thoroughly and shape it before putting it away.

Figure 10-7 shows some of the varieties of lines and effects possible with a brush.

WASH DRAWINGS

A full range of values, from a solid black to the white of the paper is available with wash drawings. A wash may be used for every degree of finished drawing: from a flat decorative effect to a realism that is hard to distinguish from that of a three-dimensional photograph.

WASH

Wash is made by adding black pigment to water. The amount of white paper showing through determines the lightness of the tone. Add a relatively larger amount of water for light tones, less water for medium tones and very little water for dark tones. Pure black pigment should be used for solid blacks.

Water-color lampblack is the only pigment needed for wash drawings. Good round sable brushes should be used. The number 3 and number 5 are the brushes most frequently used, but one or two larger sized brushes should be available for occasional use. When doing large flat areas, a flat sable brush 3/8 or 1/2 inches wide is recommended. Wide brushes are also useful for moistening areas with clean water before painting. Good brushes well taken care of are a prime asset.

There are some specially made water-color papers available which will give the best results when doing wash on water-color work, but for a less expensive paper and one of reasonably good quality you will find that illustration board is the best general type of paper to use. It is available in three surfaces: smooth, medium, and rough. These are referred to as hot pressed, cold pressed, and rough.

WORKING IN WASH

As with pen and ink, the outlines of the picture are first drawn on the illustration board with an H, HB, or B pencil. With the kneaded eraser, remove any excess lead from the drawing surface.

Moisten the illustration board with clear water, using either a wad of cotton or a wide flat sable brush. Moistening the paper allows the wash to be applied without instant drying; instant drying is undesirable because it causes each stroke to become sharp and distinct. When there is no water reflecting from the paper's surface, it is dry enough to work on.

Again moisten that particular area you are painting in. Only practice will teach you how moist you will want the surface to be in order to create different effects.

Mix your washes. Always mix more tone than that which you think you will need because if you run short while you are working, you cannot stop and mix more wash to match the one you started with. When this happens, the tone will not be smooth and even on your paper.

If the wash area drys before you can cover it thoroughly, repeated applications will cause streaks and sharp edges, as stated before. Therefore, you should use as large a brush as possible to wash an area. This also helps to create a more even wash because the larger brush holds more wash and you will not have to stop to load the brush as often.

To load the brush, dip it into the wash. Gently press the brush on the side of the wash container so that about one drop of wash is expelled. This should make the brush just about right for painting.

Never attempt to paint a wash with a brush that is dry. You should have a piece of scrap illustration board of the same quality as the board you are painting on to test your brush on before applying it to the painting surface.

When you get the correct value of light or dark in an area with one wash, it will have more freshness than if you have to lay one tone over another to get the desired shade.

The three basic qualities of wash are: (1) it is transparent, (2) it blends natrually from one moist tone to another, and (3) the tones are built up from light to dark.

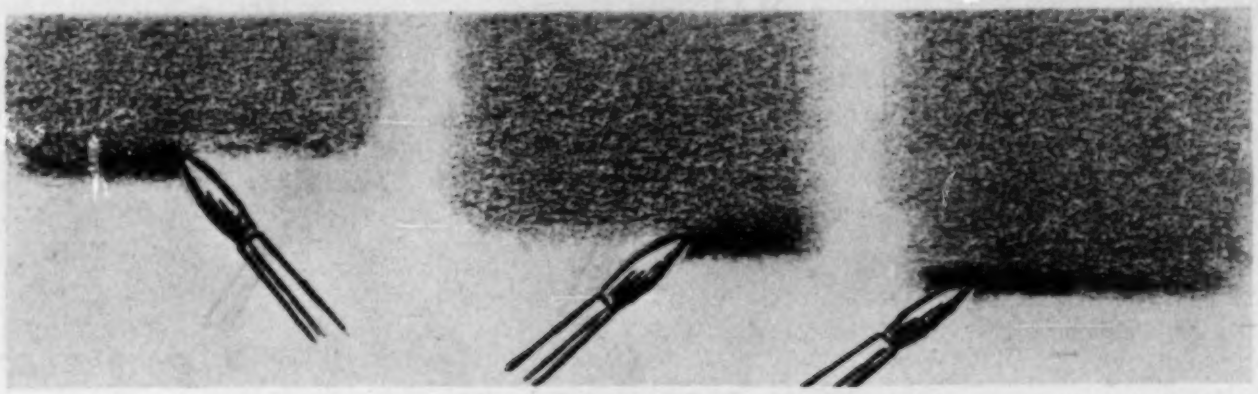

Figure 10-8.—Applying the wash.

FLAT AND GRADED WASHES

Painting a Flat Wash

Moisten the paper with clean water and allow time for the water to be absorbed into the paper until no water reflects from the paper's surface. The drawing board should be slightly tilted so wash will flow toward the bottom of the paper.

Apply the wash at the top of the paper, working first from the top left to the right as shown in figure 10-8. Once you have started, don't stop and don't work back into painted areas.

Work your loaded brush back and forth across the paper, keeping the brush loaded with wash. When you reach the bottom, dry your brush and soak up the puddle of wash left there. Your painting should dry smooth and flat. Results will improve with practice.

Painting a Graded Wash

There are two ways of painting a graded wash: from light to dark or from dark to light as shown in figure 10-9. When starting, prepare your drawing board as you did for the flat wash. For a light to dark wash, start with clean water at the top left and add a little darker tone as you progress downward. Further down, add an even darker tone than the first and finish up by removing the puddle at the bottom.

For the dark to light tone, prepare your paper as before. Start at the top left with a dark tone and work downward. Add touches of a lighter tone as you progress downward. Near the bottom you should be using clean water. Pick up the puddle at the bottom as before.

CREATING EFFECTS WITH WASH

Indefinite Blending

Indefinite blending creates many interesting effects and this technique is especially good for creating soft edges for fleecy clouds, furs, or water.

First, float clean water or a wash over the entire area to be painted. Into this wet area, paint one or more dark tones. These will blend into the wet surface and produce an indefinite

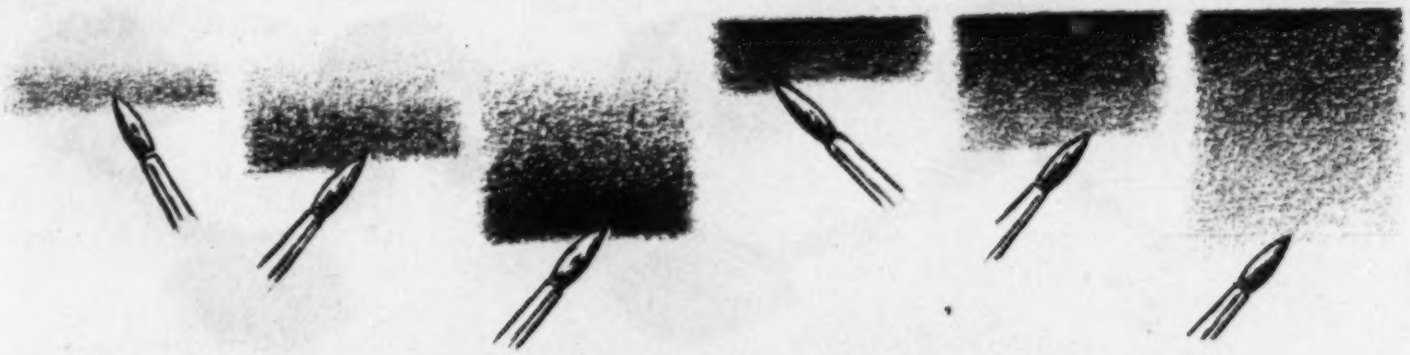

Figure 10-9.—Painting a graded wash.

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Figure 10-10.—Indefinite blend.

blend as shown in figure 10-10. The tone you add to a wet area should be darker than the final tone desired because the tone is lightened considerably as it blends with the wash or water already on the board.

OPAQUE DRAWINGS

The widely used medium called opaque watercolors can be readily changed because it is of a fast drying quality and is easily controlled.

MATERIALS

For working in black and white, a set of prepared opaque grays, brushes, paper, a large water bowl, and a rag for cleaning the brushes are all that's needed.

The number 3 and number 5 sable brushes you used for transparent wash are used again with the same principle of brush sizes; large brushes for large areas and small brushes for small areas.

Paper with a slight grain or tooth to hold the paint is best for opaque drawings. Illustration board is good because it is heavy enough not to buckle when moist.

When something is opaque, you cannot see through it; nothing of the working surface shows through. When you did wash drawings, you added more water to lighten the tone. In opaque drawings, you add white paint to lighten the tone. You never add water to lighten the tone when working with opaque paints. You do add water, but only to aid the paint in spreading smoothly with the brush.

When preparing to work in opaque paints, the first step is to arrange a series of opaque paints, from white to black, on your palette similar to that shown in figure 10-11. When you need an in-between tone, simply mix two adjacent tones to get the third desired tone.

Opaque greys come prepared, but you may mix your own if you prefer. Simply mix opaque white with varying amounts of opaque lampblack. This mixture will have a slightly bluish cast.

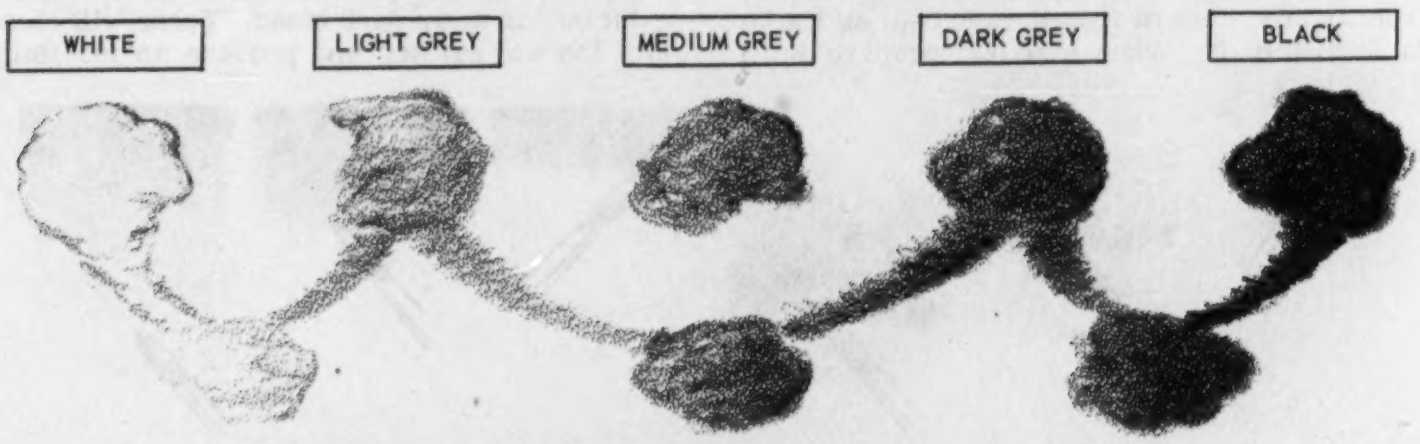

Figure 10-11.—Arranging a series of opaque paints on a palette.

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in the 3,000-mc region. Due to the very loose coupling, only about one milliwatt actually reaches the crystal.

A third requirement of a local oscillator is that it must be tunable over a range of several megacycles. This is to compensate for changes in the transmitted frequencies and in its own frequency.

In order to obtain a receiver IF signal of unvarying frequency it becomes necessary to vary the frequency of the local oscillator. The local oscillator must be caused to change its frequency by the same amount that the received signal changes, thereby maintaining a constant IF frequency. The frequency changing of the local oscillator should occur automatically as the received signal frequency changes occur.

In cases where the RF units are located in a remote position, it is desirable to mount the converter section of the receiver remotely also. This insures that the IF frequency (rather than the transmitted frequency) is cabled back to the receiver, but makes it necessary that the local oscillator be tuned from a position some distance away, preferably by varying the voltage applied to it.

The reflex velocity modulated tube (klystron) meets all these requirements very well, and is at present used in most microwave radar receivers. The klystron is also used in Microwave frequency generators or in other applications where a source of low power microwave energy is required. Although the klystron may some day be replaced in many applications by the traveling wave tube, the backward wave oscillator, or the magnetron amplifier, it will probably continue to be an important part of radar receivers for many years to come.

THEORY OF OPERATION

In the circuit diagram of the reflex klystron oscillator (fig. 12-30 (A)), note the arrangement of the electrodes, and the voltages involved in the operation of the oscillator.

Electrons emitted by an indirectly heated cathode are attracted by the cavity grids (buncher grids) G1 and G2, which are positive with respect to the cathode by a voltage E_a. The control grid, situated between the cathode and the cavity grids, controls electron flow. The control grid also has a positive potential (usually about 200 to 300 volts with respect to the cathode. Electrons travel from the cathode toward the cavity grids at a velocity primarily

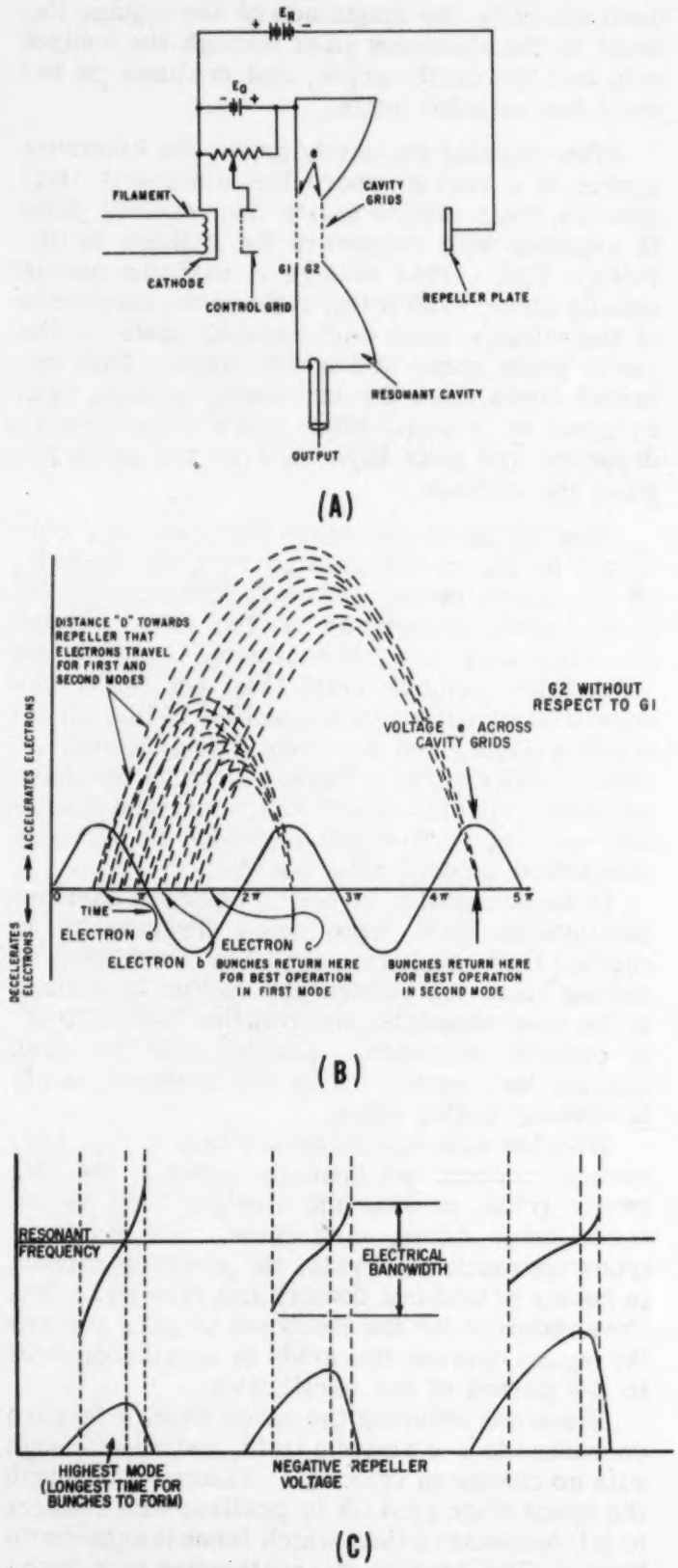

Figure 12-30.—Reflex klystron oscillator. (A) Schematic diagram; (B) and (C) electrical characteristics

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This is unimportant except when the picture is to be reproduced. It is then necessary to add a small amount of yellow ochre or burnt umber to the mixture which will nullify the bluish cast.

WET BRUSH AND DRY BRUSH BLENDING

Wet Brush Blending

Wet brush blending is accomplished by working different values of opaque grays together as shown in figure 10-12. When wet, opaque paint looks different than when dry. Let the paint dry before you rework it if in doubt about a value.

The selection between wet brush and dry brush blending is the illustrator's preference. Both give about the same finished effect.

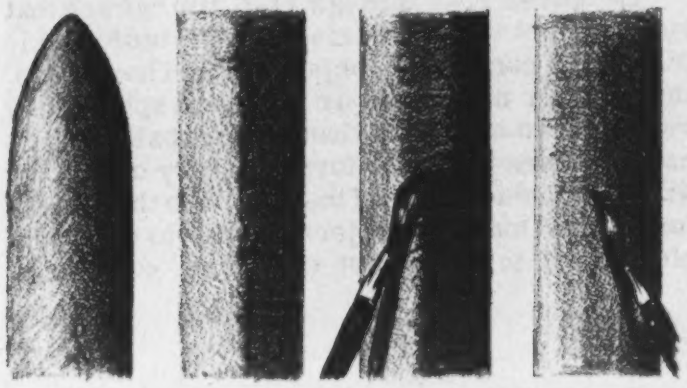

Figure 10-12.—Wet brush blending.

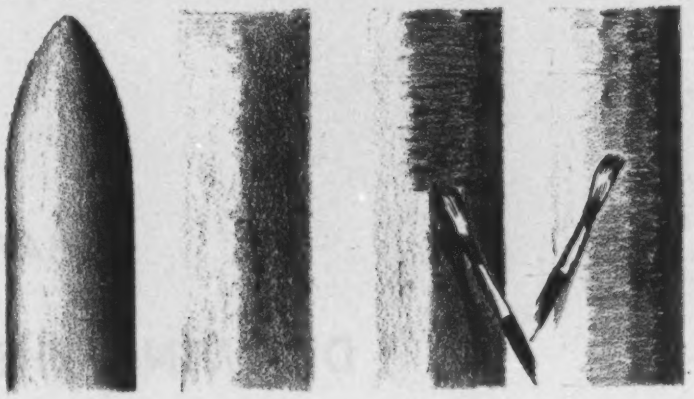

Figure 10-13.—Dry brush blending.

Dry Brush Blending

Dry brush blending is accomplished by mixing one or two tones halfway between the two tones to be blended. With a dry brush, apply this third tone over the hard edges of the two original tones as shown in figure 10-13.

MIXING MEDIUMS

Although each of the four basic mediums just covered is usually used by itself, many illustrators mix or combine them in a drawing.

Which medium to combine and the amount of combination is determined by the results the illustrator is trying to achieve.

CHAPTER 11

DRAWING THE BASIC FORMS

Form is the basis of all design. All objects consist of form and are three-dimensional in structure, having height, width and depth, and occupying space. We must remember this principle when we portray a three-dimensional object on a two-dimensional sheet of paper. We must create in the viewer's mind the illusion that the drawn object is real and has depth.

All designs, regardless of how complicated they may appear to be, can be reduced to one of or a combination of the four basic forms: the CUBE, the CONE, the SPHERE, and the CYLINDER.

FOUR BASIC FORMS

To draw the forms so that they look real, as in figure 11-1, you will find that by drawing through the object you will obtain the best results; that is, to outline the object both inside and out as if it were transparent. This will enable you to set the object correctly on the paper. Otherwise, you may have the object flat or lopsided or draw two objects which occupy the same space in the drawing. Drawing through the object is illustrated in figure 11-2.

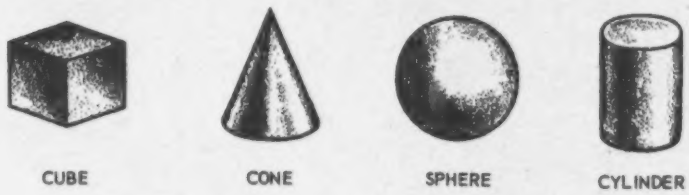

Figure 11-1.—Four basic forms.

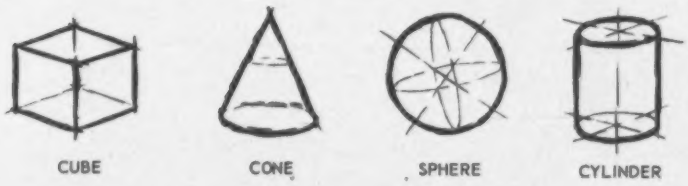

Figure 11-2.—Drawing through objects.

In figures 11-3 through 11-6, you can see that every object is not a perfect duplicate of a basic form. The cone in one object may not have a tip, the cylinder may curve or taper, the sphere may resemble an egg more than a round ball, but you can also see the basic form in every one of the designs. Reducing all of the objects to their basic forms has made the objects easier to draw and also aided in laying out the object correctly.

SPHERE

To lay out a sphere, as in figure 11-3a a simple circle is drawn with a line around the center to help construct its depth or thickness. Shading is added to suggest light and the basic sphere is modified slightly until it resembles an egg.

Sometimes the sphere is cut in two as in figure 11-3b to form such objects as cups or domes or, by elongating the circle into an ellipse, a saucer for the cup to sit on.

CUBE

In laying out a shape based on the cube, the main lines are drawn first as in figure 11-4a. Next, the slant on the front of the turret is drawn, along with the placement of the gun, the observation bubbles, and the circular base. Then, by establishing light and shade areas, we emphasize the form.

Following the same procedure as that used to draw the gun turret, the basic form of the landing craft shown in figure 11-4b is drawn first, then refined as design is added along with

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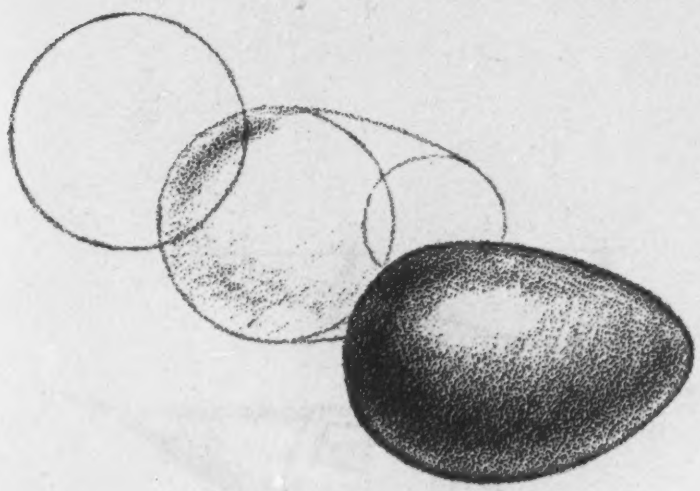

Figure 11-3.—A. Laying out a sphere.

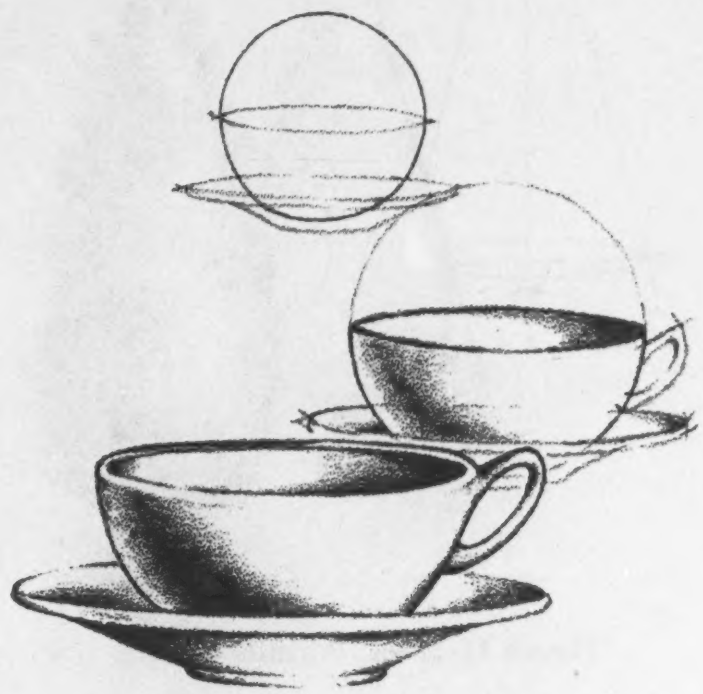

Figure 11-3.—B. Sphere cut in two.

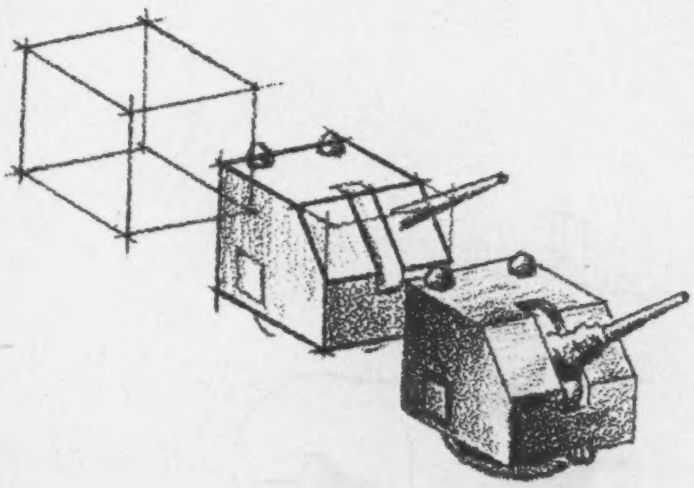

Figure 11-4.-A. Forming an object from a cube.

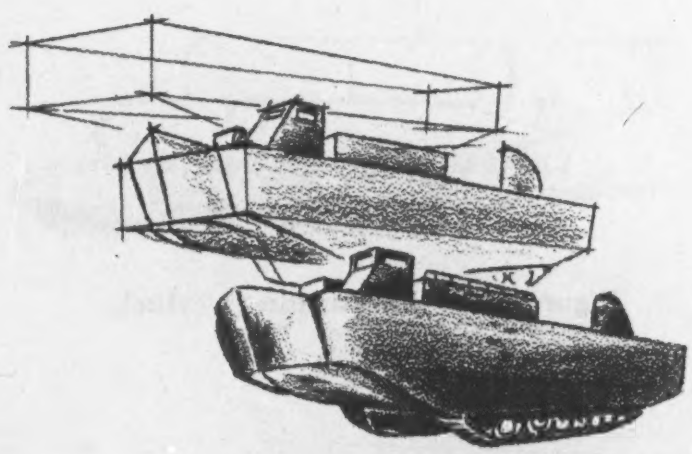

Figure 11-4.-B. Forming an object from an irregular solid.

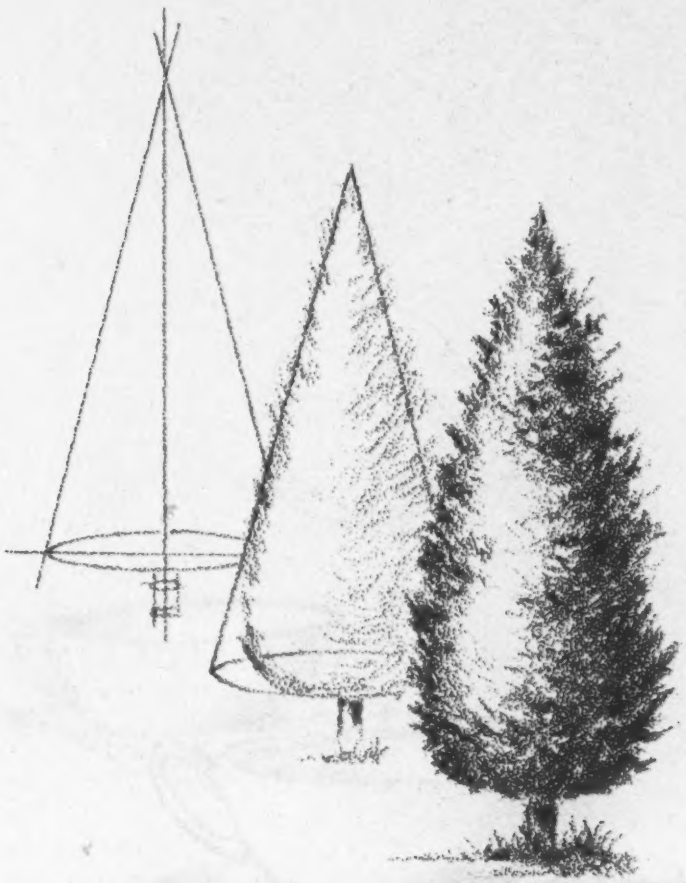

Figure 11-5.—A. Forming a cone.

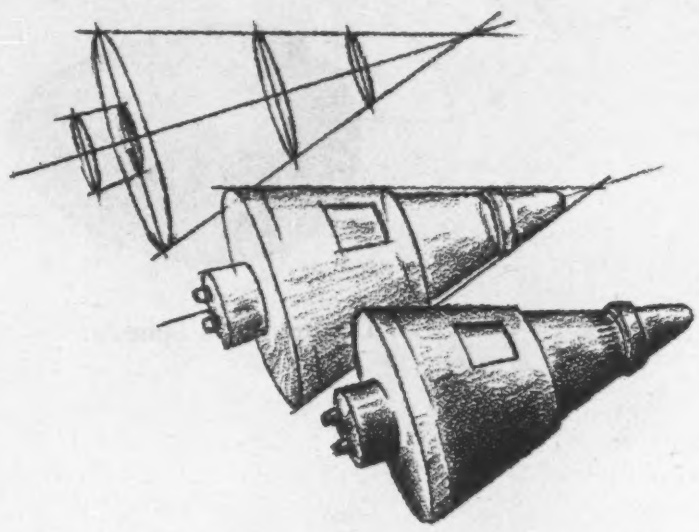

Figure 11-5.—B. A cone with cylindrical shapes added.

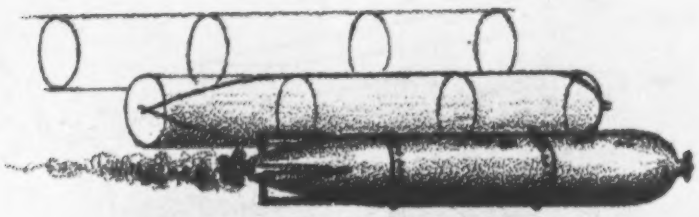

Figure 11-6.—A. Forming a cylinder.

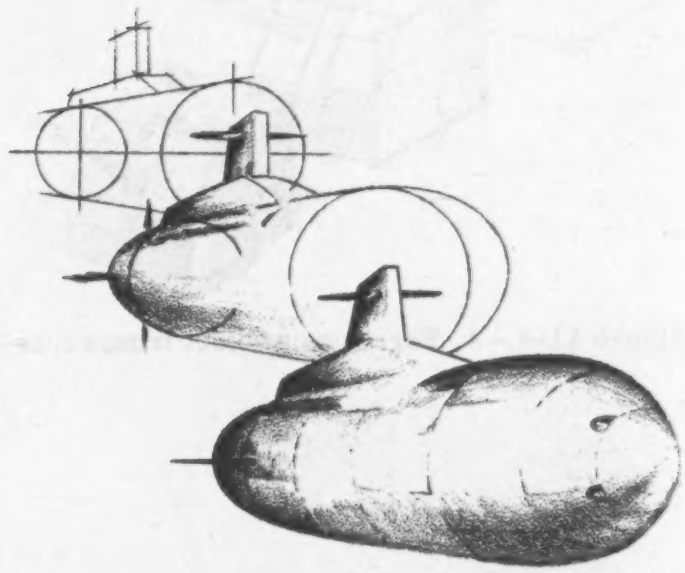

Figure 11-6.—B. Design formed from cylinder.

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light and shadow. As a last step, the details are drawn in to complete the drawing.

CONE

The basic form of the "poplar tree" is a cone as shown in figure 11-5a. By drawing a line down the center of the cone, we locate the main stem of the tree. The use of shade and suggestive modeling further establishes the design. To complete the drawing, we add more detail to the design.

The "Mercury Capsule" shown in figure 11-5b is constructed primarily as a cone with small cylindrical shapes added. When cylinders are seen in perspective, they tend to appear as cones.

CYLINDER

The torpedo shown in figure 11-6a is a cylinder, so the basic cylinder is drawn as the first step in its construction. The tail of the torpedo is constructed from a cone and the nose is constructed as a rounded cylinder. Shadow and light are established and details are added as a final step.

The submarine in figure 11-6b is also a cylinder. By adding design and establishing good light and shadow patterns, the drawing quickly takes on a realistic appearance. Details, as always, are kept for last.

COMBINING THE BASIC FORMS

All of the objects in your surroundings are composed of a combination of the four basic forms. Regardless of how complicated the objects may appear to be, the objects are combinations of the basic forms. You should train yourself to see all objects in their simplest form.

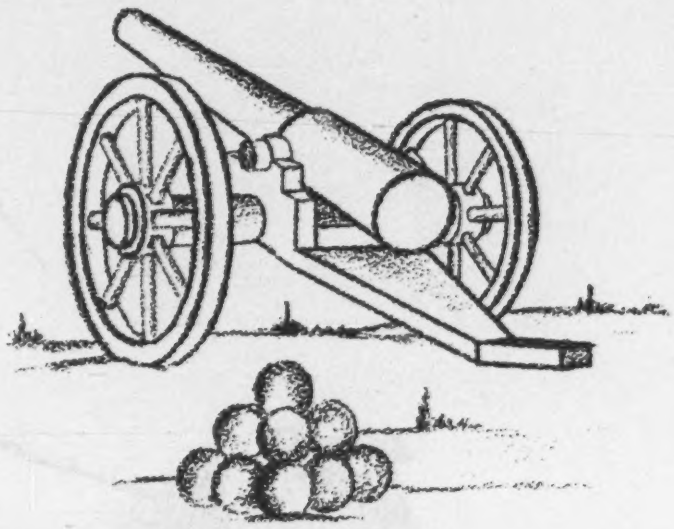

Figure 11-8.—Design formed by combining cylinders and cubes.

Always lay out your drawings using the basic forms and draw through the objects. By doing this, you will be able to correctly lay out any picture you desire to construct. Remember to keep your drawings simple and free of unnecessary lines when laying them out.

The earthmover in figure 11-7 is constructed basically from combinations of cubes with some cylinders such as the tires, and exhaust stack.

The civil war cannon in figure 11-8 is constructed from a combination of cylinder and cubes. The cannon balls are spheres.

The bald eagle shown in figure 11-9, which appears to be very complicated, can be broken down to a combination of cylinders and spheres. The head and body consist of spheres and the legs and neck of cylinders. The feathers are laid out next, but avoiding any detail work until the overall design is complete.

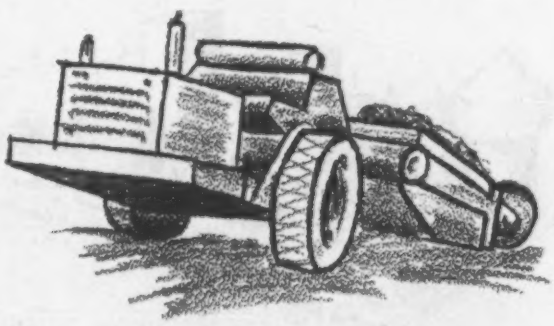

Figure 11-7.—Design formed by combining cubes and cylinders.

Figure 11-9.—Complicated form reduced to basic forms.

Figure 11-10.—Form emphasized by use of light and shade.

FORM REVEALED BY USE OF LIGHT AND SHADE

Light and shade are used to reveal and emphasize the forms of the objects in a picture. As an illustrator, you have the license to arrange the light source to come from the direction which is most beneficial to the effect you desire to create. When there is a light shining upon an object, the object will have a shaded area. Even if the light source is dull, the shaded areas will be there, although they may be harder to distinguish.

When you have a good basic drawing that is correctly constructed, the addition of light and shade will make the drawing more convincing, but no amount of shading will save a poorly constructed drawing. Figure 11-10 shows two well constructed subjects which have been shaded to emphasize their forms.

FORM IN SPACE

You have now learned the four basic forms and how, by reducing your subjects to their basic forms or combinations of the basic forms, you can draw the subjects convincingly on paper. You have seen that with careful placement of light and shade, you can make the subjects even more real and convincing. Now take the basic forms and put them together in a single drawing.

Since each of the forms occupies space and there is space around each of the forms, drawing through each of the objects will help to correctly place them in a drawing so that each occupies only its own space and does not take up the space of any forms near it.

If we were to construct a miniature city block similar to the one in figure 11-11, with its various combinations of forms, we would get a

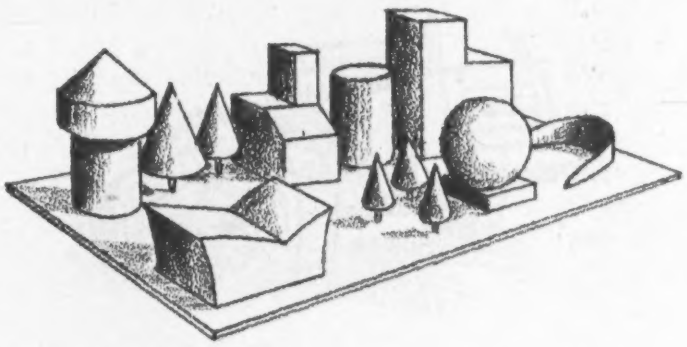

Figure 11-11.—Layout of forms.

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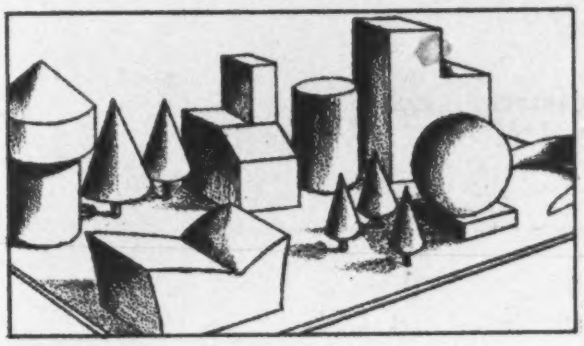

Figure 11-12.—Layout of forms in picture area.

realistic layout of forms, with each form being solid and occupying space, and space filling the area around every form. When the subjects of figure 11-11 are drawn on a sheet of paper, as in figure 11-12, we want to retain that feeling of space and solidness and its three-dimensional appearance. We must remember that space exists in all directions, and many objects, although solid in construction, hold other objects within themselves as shown in figure 11-13.

Each object within or on top of the bookcase takes up a definite space. To draw the entire design correctly, you must allow space for each object, and by drawing through each of the many components of the design, you can accomplish this and make a convincing drawing.

FORM FROM DIFFERENT EYE LEVELS

Different eye levels change the appearance of all objects. If we were to look at a profile of a missile, we would see a cylinder topped with a cone, but if we were to look at the same missile coming toward us, the appearance would be more of two cones end to end as in figure 11-14. You will find that anytime the view of a cylinder is changed to a great degree, it will assume the appearance of a cone. FORMS ALWAYS CHANGE IN APPEARANCE WHEN VIEWED FROM DIFFERENT EYE LEVELS.

We can take our miniature city block and view it from three different angles as in figure 11-15, and see that each of the basic forms appear different in each of the views. You may see a certain object in one view and possibly not at all in another view.

PERSPECTIVE AND FORM

The more distant an object is from the viewer's eyes, the smaller it will appear to be. This

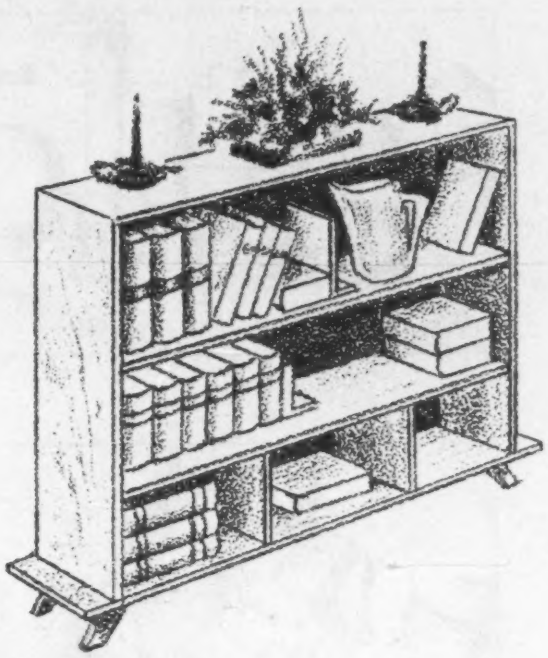

Figure 11-13.—Form within form.

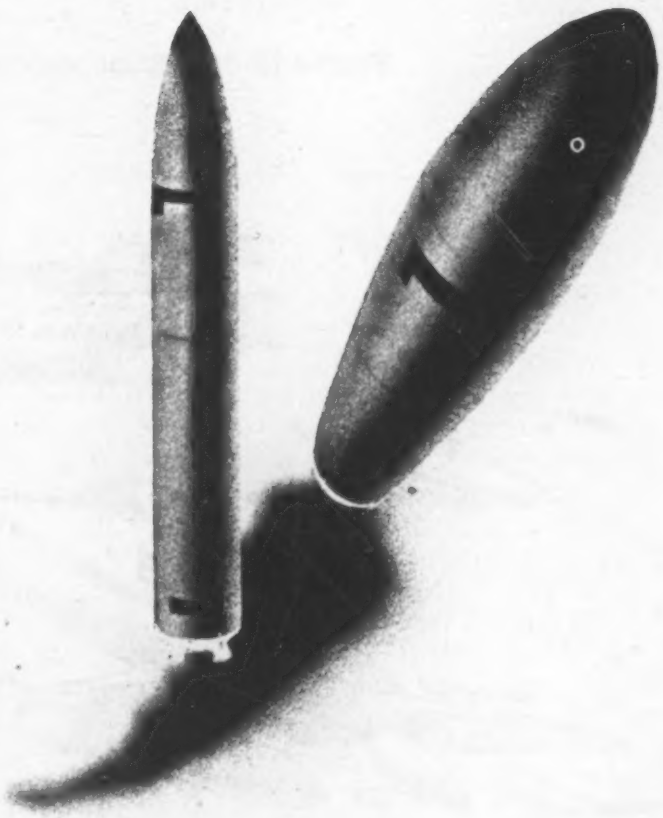

Figure 11-14.—Appearance of form changed by changes of eye level.

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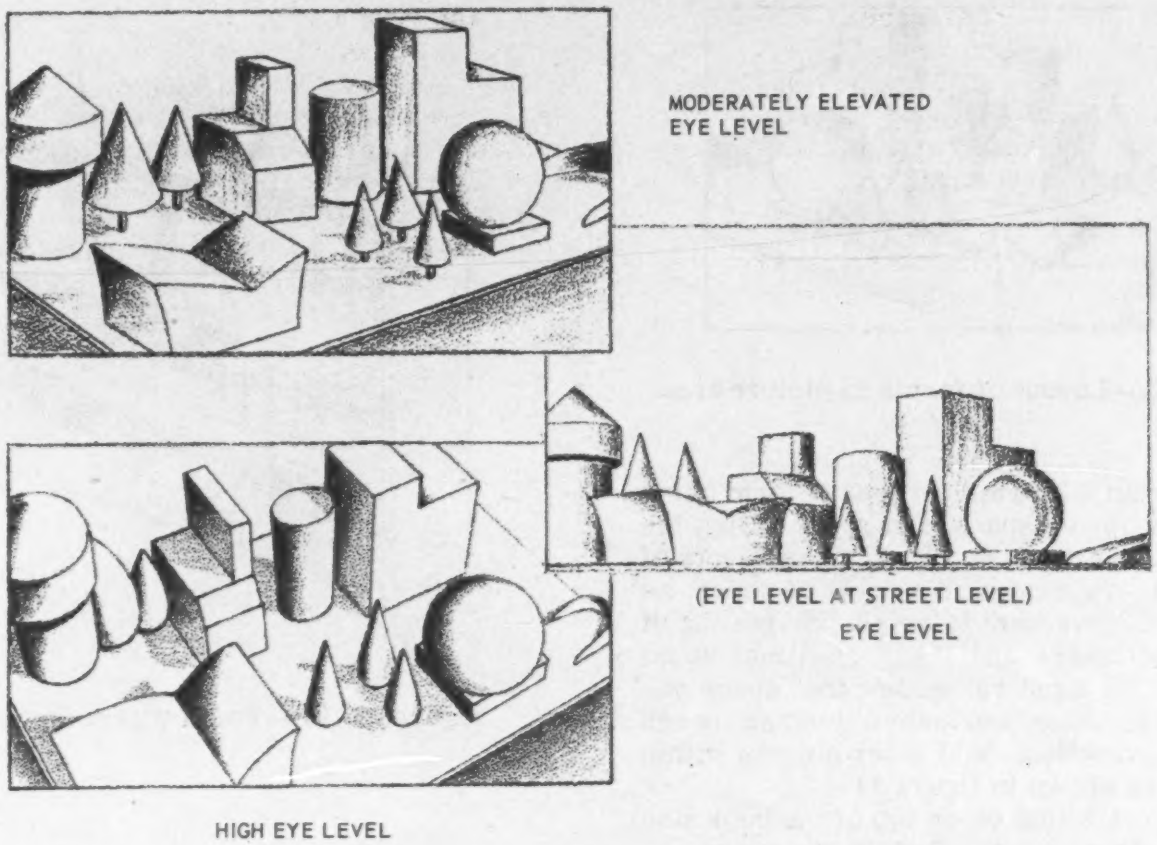

Figure 11-15.—Same view seen from three different angles.

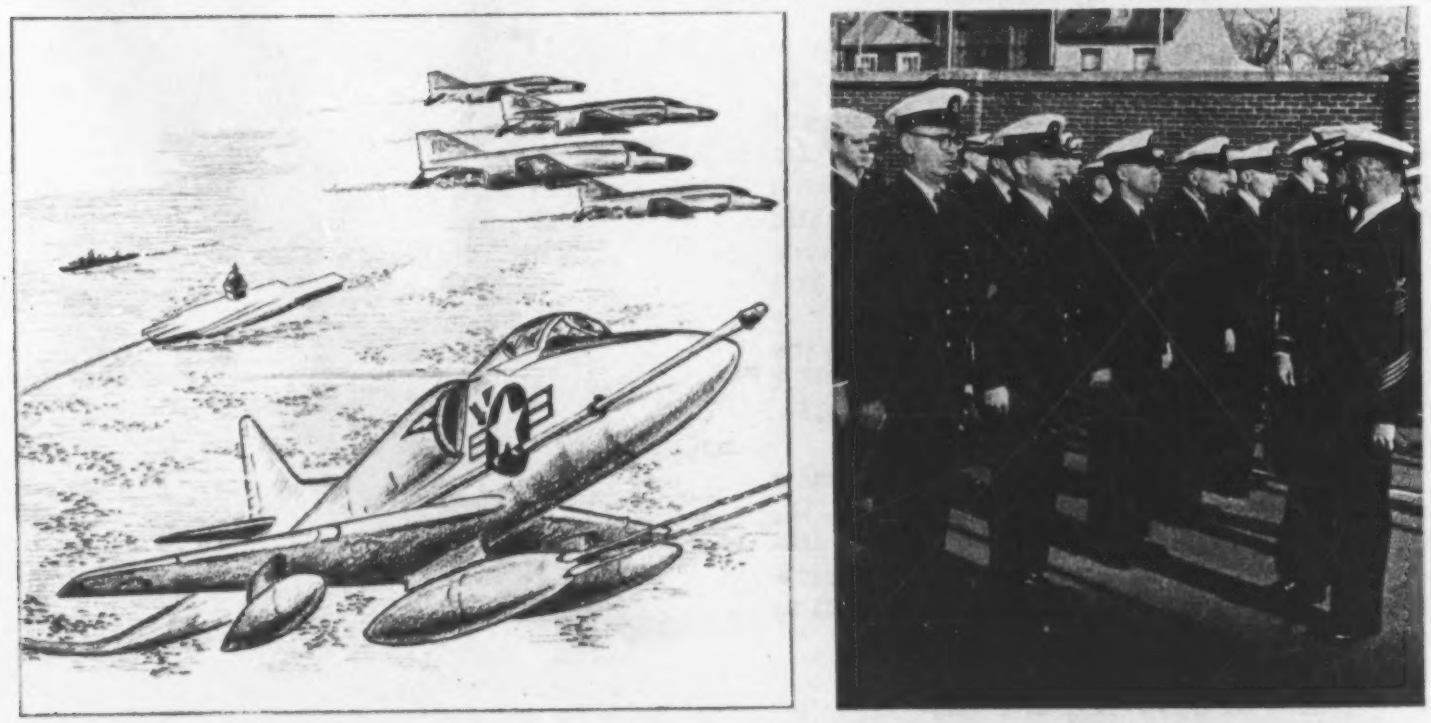

Figure 11-16.—Form in perspective.

is the main principle of perspective and everything conforms to this principle. The whole object will appear smaller and smaller as the distance increases and all parts of the object —height, width, thickness and detailed clearness—are reduced proportionately.

As all objects decrease in size in perspective, the area of space around the objects decreases. In figure 11-16, the space between each of the men in uniform is the same, but will appear to be less and less as we look toward the end of the line. The details of the jet in the foreground are easy to see, but of the four jets and aircraft carrier in the distance, we see only enough to recognize the larger shapes.

As the subjects in a picture decrease in size at a distance, they converge toward a definite line in the picture, which is the horizon. The line where the sky and earth meet is the most common of horizons, but, as an illustrator, your eye level makes the true horizon. The true horizon will change everytime you move yourself to a higher or lower position. You are looking at a true horizon when you look straight ahead without moving your head up or down. Another true horizon is where the sky and water meet.

When parallel lines are horizontal, or are level, they appear to converge toward and meet at a definite point on the horizon. This point is called the VANISHING POINT. The vanishing point may be on any point along the horizon. The convergence of horizontal parallel lines is easier to see for large objects, but the same convergence takes place with all level parallel lines regardless of their length.

ONE POINT PERSPECTIVE

For one point perspective, all parallel lines should converge on a single vanishing point as shown in figure 11-17.

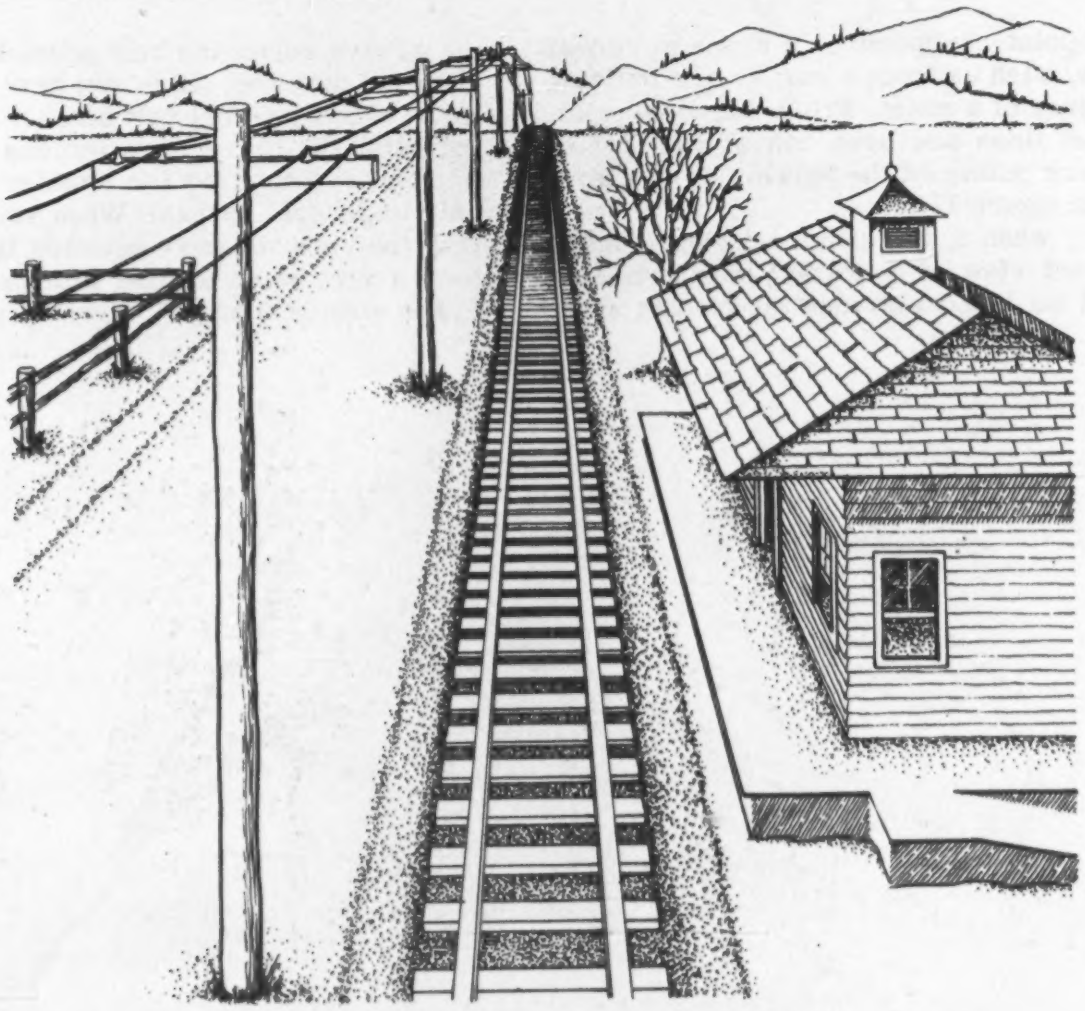

Figure 11-17.—One point perspective.

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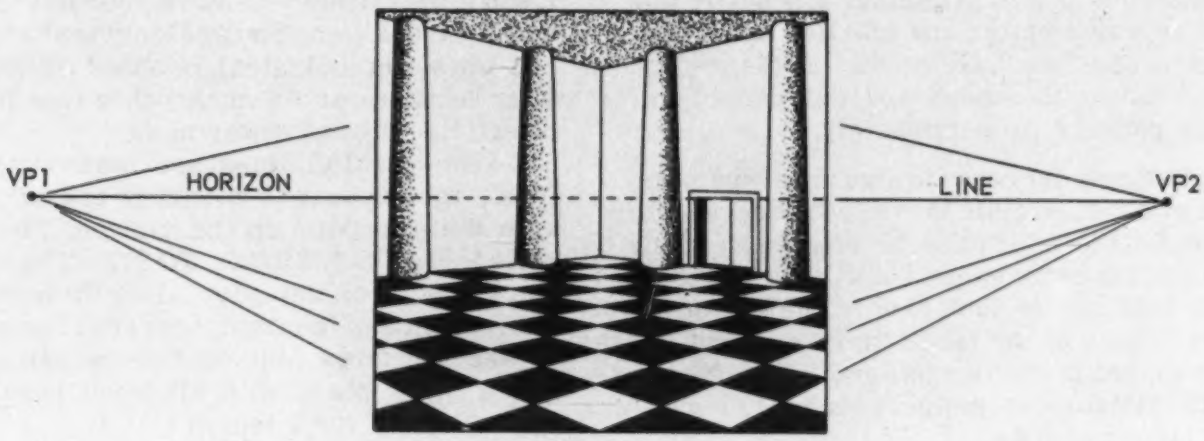

Figure 11-18.—Two point perspective.

TWO-POINT PERSPECTIVE

In two-point perspective, a scene is viewed at an angle, such as from a corner of a building or the corner of a room. From this view point, all parallel lines are seen converging toward two vanishing points on the horizon or eye level as shown in figure 11-18.

Usually, when a two-point drawing is made with a direct view of a corner, both vanishing points will be located outside the picture area.

DRAWING FORM STEP BY STEP

Always select the best possible point of view for your pictures. After you have decided on the view which you feel will make the best picture, establish the correct proportions for the larger objects, and then for the smaller objects. Work only in general shapes. When you are convinced that the view you have selected is best, and you have a very rough outline with the larger objects drawn proportionately correct, you should re-

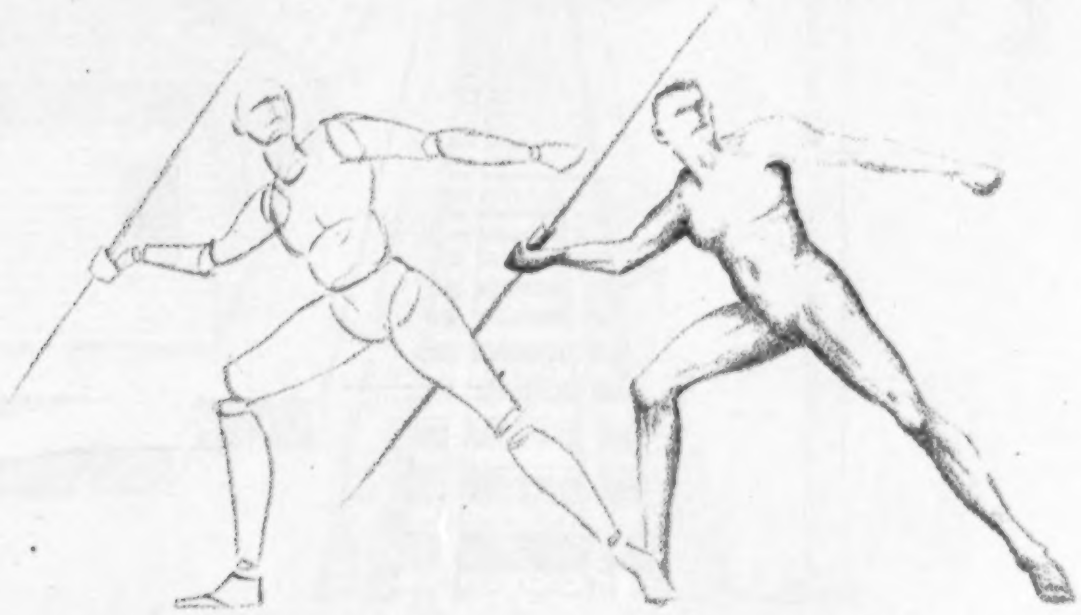

Figure 11-19.—Drawing form step by step.

determined by the magnitude of the voltage E_a. Most of the electrons pass through the control grid and the cavity grids, and continue on toward the repeller plate.

After passing the cavity grids, the electrons approach a region where the electrical field opposes their motion (since the repeller plate is negative with respect to the cathode by the voltage E_R). This voltage is variable and is usually about -100 volts, making the magnitude of the voltage from the repeller plate to the cavity grids about 300 to 400 volts. This potential slows down the electrons, causing them to come to a stop, after which they reverse direction and pass back through the grids toward the cathode.

Most of these returning electrons are collected by the cavity grid nearest the cathode, by the accelerating (control) grid, or by the metal shell (envelope) of the tube. Those electrons that are not collected continue on toward the cathode until they are again reversed in direction by the action of the accellerating field, and are sent back through the cavity a third time. These electrons that have not been collected cause improper tube operation—an undesirable feature which is partially eliminated through tube design.

In most circuits involving resonant cavities, oscillations start from some irregularity in current flow—such as a transient condition resulting from the sudden application of voltage to the tube elements, or from the "shot effect" of cathode emission. Keeping this in mind, assume that oscillation in the resonant cavity is already taking place.

With the tank circuit oscillating, a high frequency voltage (e) appears between the two cavity grids, causing the electric field to reverse twice during each cycle. As the electrons approach the grids, the electron stream is nearly of uniform density and velocity. The time required for the electrons to pass through the space between the grids is small compared to the period of the oscillation.

Electrons entering the space when e is zero encounter no a-c electric field, and pass through with no change in velocity. Electrons entering the space when grid G2 is positive with respect to G1 encounter a field which tends to accelerate them. (The amount of acceleration is a function of the magnitude of e.) Electrons entering the space when e is of the opposite polarity are decelerated.

The change in velocity due to acceleration and deceleration is small in comparison with the original velocity. The electrons which are accelerated most travel farther toward the repeller plate before being turned back, while those that are decelerated most are turned back sooner. With proper magnitudes of e, E_a and E_R, electrons returning to the cavity grids may be made to arrive in "bunches."

Figure 12-30 (B) shows the relative position of electrons in the tube at various times during their transit. The zero distance position, taken as the baseline of the graph, is midway between the cavity grids.

Electron a, which arrives when G2 is positive, is accelerated and travels farthest before being turned back; electron b is unaffected; electron c is decelerated and turns back after a short excursion. Hence, in the diagram these electrons (and the ones passing through at intermediate times) are shown as arriving back at the grids at the same time.

This is the ideal situation, but in actual operation electrons return to the grids in a stream that varies in intensity at the frequency of the oscillations. The tube is called a REFLEX velocity-modulated tube, because the electrons reverse direction and travel through the interelectrode space twice.

On the return trip the electric fields set up by the voltage e again act upon the electrons. Since they are now traveling in the opposite direction, they will be decelerated if they return when G2 is positive and accelerated if they return when G2 is negative. When an electron is accelerated by an electric field, its kinetic energy increases; this additional energy is taken from the electric field. On the other hand, an electron which is decelerated gives up energy to the electric field.

If the bunches of electrons can be made to return when G2 is positive, they will give up energy to the alternating field. For maximum transfer of energy the returning bunches must arrive when G2 is maximum positive. The question arises as to where this energy originates. Remember that if the electron stream from the cathode is uniform, some electrons are accelerated and some are decelerated on the outbound trip by the electric field of e. On the average, as many electrons absorb energy from the field as give up energy to it.

duce all of the objects to their basic forms. Remember to draw through the forms to establish a convincing likeness of the object and their existence in space, and also to place them in space correctly.

You should then add the light and shadow patterns to emphasize the forms and strengthen the appearance of the three-dimensional forms. When you have reached this point, you are ready to add detail. You should overcome the tendency to add details immediately, and save them for the last step, as shown in figure 11-19.

ARRANGING FORMS IN SPACE

The arrangement of forms in space, the use of perspective, and space itself contribute greatly to the impact of the picture. Although many objects and details are to go into a picture, primary establishment of these forms and their setting must take place before attention is turned to the details. Figure 11-20 illustrates the steps which should be followed for a well-constructed picture.

EVERYWHERE - THE VARIETY OF FORM

Every object is different, in some respect, from every other object. This difference in objects, even those of like construction, is what makes the object interesting. The difference also enables us to separate things and identify them.

As an illustrator, it is your job to train yourself to observe these differences so that you can use them in a picture. You should form an interest in the great variety of forms in order to recognize those differences which make every form unique. Figure 11-21 shows the profile of three human heads, and although they are constructed around the same basic structure, the skull, each has its own personal identity which is different from every other head in the human race.

TEXTURE BY REPEATED FORMS

Whenever a form is repeated often enough, a new texture will result. The new texture is not achieved simply by multiplying the original form, because in nature, no two objects are exactly the same, but the repetition of the original shape in varying size will blend to form an overall tone and texture design. Figure 11-22 shows three distinct forms, the leaves on the tree, the bricks of the fence and the grass, which are repeated to form a pattern.

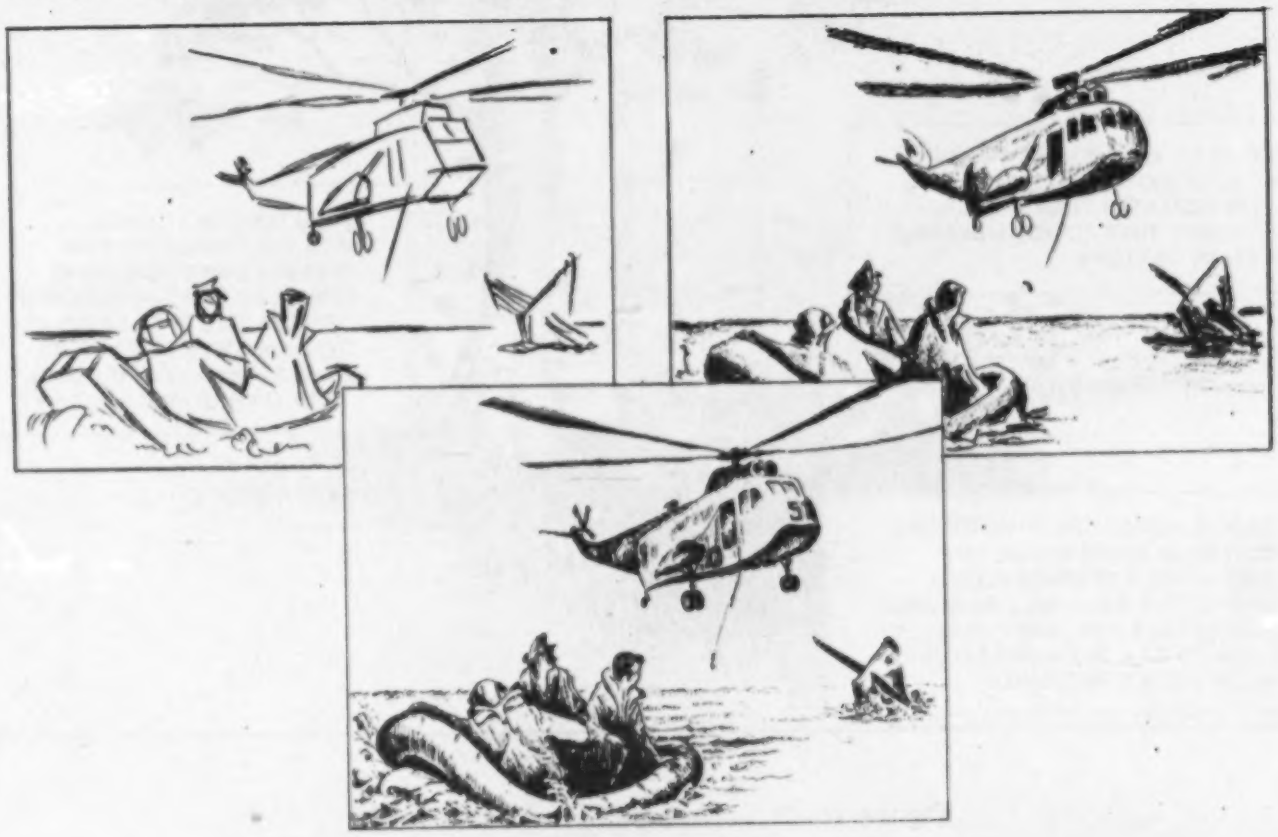

Figure 11-20.—Arranging form in space.

Figure 11-21.—Difference in form of the human head.

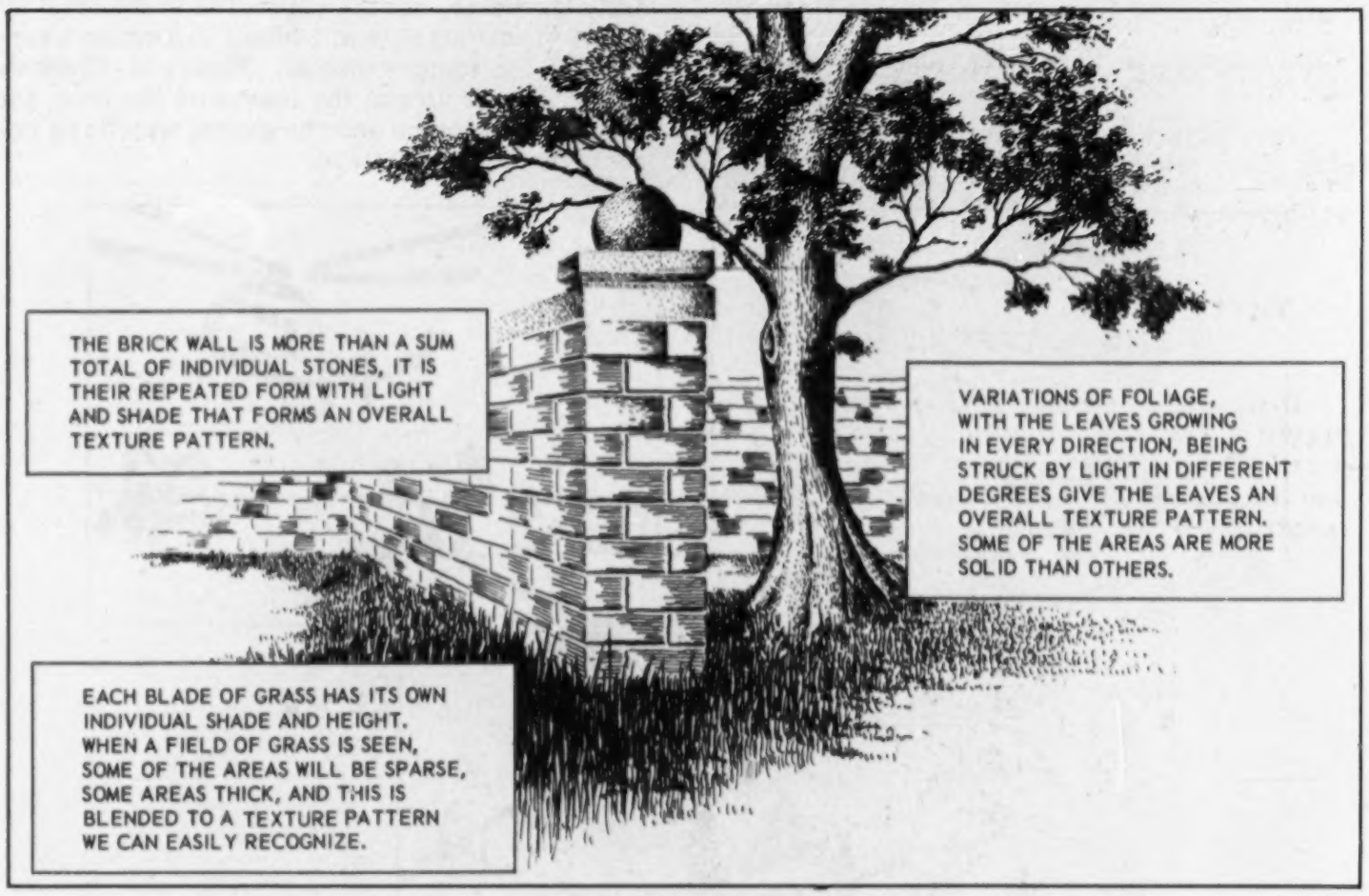

Figure 11-22.—Texture by repeated form.

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Figure 11-23.—Variety of textures.

VARIETY OF TEXTURES

We can readily recognize an object not only by its form, but also by the texture of its surface. An object can be smooth or rough, soft or hard.

In your pictures, you must capture the illusion of surface textures for objects. To do this, you should know the identifying characteristics of the object thoroughly.

It is sometimes helpful to think of how the object feels to the touch, then decide how it could best be rendered. Figure 11-23 shows a number of objects which illustrate this principle.

TEXTURES AND DETAILS AFFECTED BY DISTANCE

Distance, as we said when dealing with perspective, has a great influence on textures and details. When we see an object close up, we can see the texture of the object and the details of its construction quite easily, but, as we introduce distance between the object and our eyes, we will see less of the objects texture and fewer of its details.

If you take a quick look around at your surroundings, you can easily see all the details and texture of the objects which are close to you. But, look across the room. How well can you see details of those more distant objects? When you are constructing a drawing, you want to capture this sense of depth in order to give realism to the drawing. By following the principle that less texture and fewer details are seen as distance is increased between you and the object, you will be able to create realistic drawings.

The fact that you know the texture of a distant object does not mean you can really see the texture, and when you are drawing realistically, you draw the object as it is seen in reality. Objects in the background should be less well defined than those in the foreground. Figure 11-24 shows the same subject at three different distances from the viewer. You can easily see the application of this principle in the illustration.

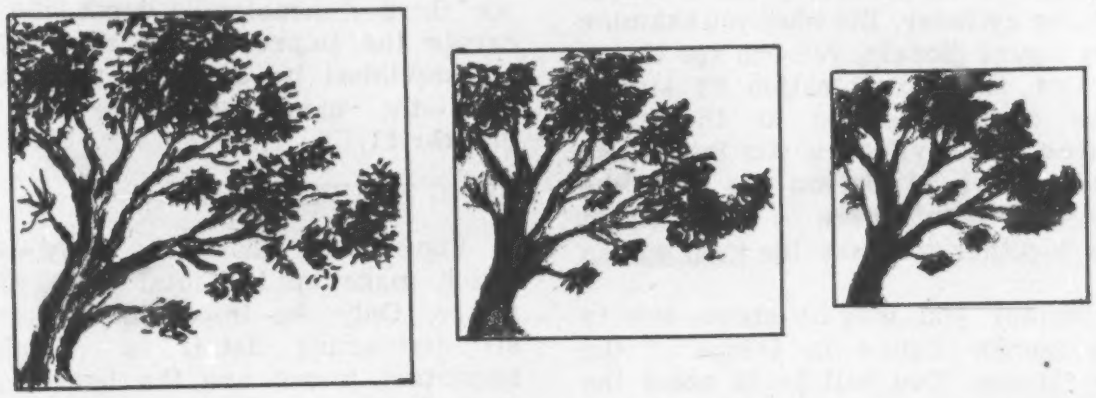

Figure 11-24.—Textures and details reduced by distance.

CHAPTER 12

DRAWING HUMAN FIGURES

In some of your work you may be called upon to draw human figures. This is one of the most difficult skills to be acquired in the field of illustrating, and this chapter can only cover some of the general principles to follow and some basic techniques to use in drawing human figures.

The principal reason most beginners have trouble drawing the human form is that they want to immediately start drawing a fully clothed subject in a complicated pose. The beginner may also spend a great deal of time concentrating on details of features, anatomy, and drapery at the expense of the whole. In his concern for details, he loses his sense of proportion and construction, and, most important of all, the figure's form loses its solid appearance.

There is only one sound approach to drawing the human figure: begin by having a very clear concept of the figure's basic form. The human figure is the same as the basic forms explained in chapter 11 in that it is a three dimensional object—a solid object with bulk and weight.

The human figure appears to be a highly complex form. It is obviously not a single sphere, cube, or cylinder. But when you examine this complex figure closely, you can see that it may be drawn as a combination of simple forms—forms closely related to the basic spheres, cubes, and cylinders you learned to construct in chapter 11. If you can draw the basic forms, you should have no difficulty in putting them together to make the total human form.

In this chapter you will be shown how to analyze the human figure in terms of the single basic forms. You will learn about the proportions of the component forms in relation to the total form, and about the ways these component forms are joined and how they move. You will be shown how to draw the basic human forms in various positions both at rest and in motion. You will also see how the form changes as a person grows from a child to an adult.

Be sure to master the figure's basic form before attempting detailed illustrations. Practice drawing the basic form in as many positions and attitudes as possible. Use photographs, paintings, and the people around you as models. If you wish to become more proficient in figure drawing, you should then study one of the commercially published books on the subject—one which covers artistic anatomy and the special problems encountered in drawing the individual parts of the body.

THE HUMAN FIGURE—A SOLID FORM

The human figure is a solid form; it has depth as well as height and width; it exists in three dimensions. Whether the artist forms the figure out of clay or stone or draws it on paper, he must think of it as a three dimensional object. Since the flat surface of the paper lacks the third dimension of depth, the artist must create the impression of depth. This is best accomplished by drawing through the solid form—the same procedure you learned in chapter 11.

BASIC FIGURE FORM

Figure 12-1 shows the simple basic forms which make up the total form of the human figure. Only the important forms are shown; all distracting detail is eliminated. The important forms are the head and neck, the upper and lower torso, the upper and lower arms, the upper and lower legs, and the hands

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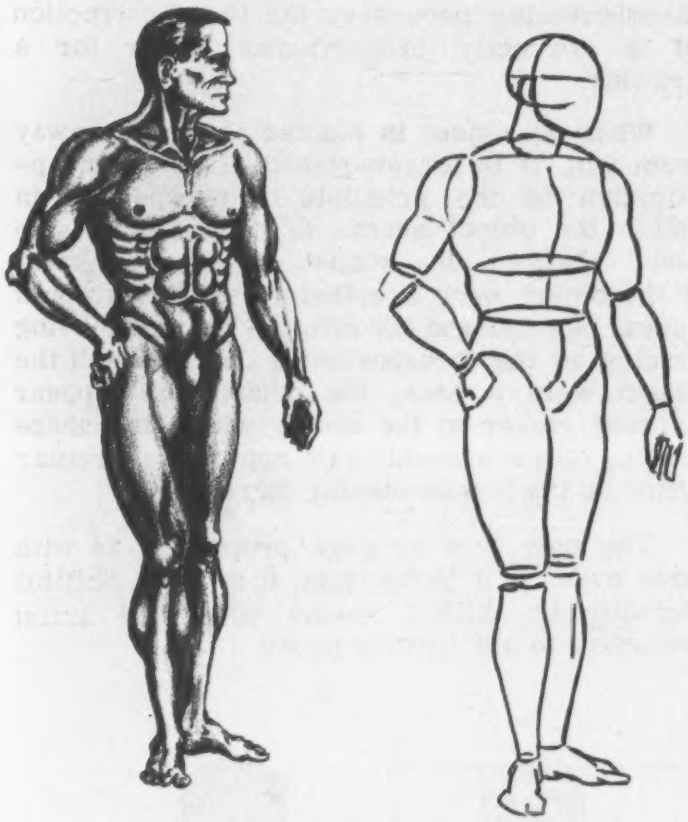

Figure 12-1.

and feet. You can see in both the model and the form drawing that the neck, arms, legs, and torso are essentially modified cylinders, the head is basically a sphere, the hands are cube forms, and the feet are a combination of cones and cubes.

FIGURE PROPORTIONS

The human head is used as the BASIC UNIT OF MEASUREMENT for proportioning the entire human body. The vertical height of the head from the chin to the top of the skull is used for all vertical measurements, while the width of the head is used for making all horizontal measurements. For example, the shoulders of the illustrated body are approximately three head widths across.

The average human figure is 6 1/2 heads high, but the ideal height of the illustrated figure is eight head units high. After the height of the figure has been decided, it should be divided into eight equal parts. After drawing the head, you should draw the other parts of the body along the vertical axis. The illustrated figure is slightly taller and slimmer than a person of average height and build.

As shown in figure 12-2, the eight head units of height are divided as follows: the head itself is "one head unit"; about 1/3 of a head unit is allowed for the neck; and 2 2/3 head units are allowed for the torso (from the bottom of the neck down to the crotch). This totals half of the figure's height. Of the four head units remaining, two units are used to measure the upper leg to the area just below the knee, and the remaining two head units indicate the height measure from below the knee down to the soles of the feet. Although the male figure is usually taller than the female and has a different outline, the same eight head units of measurement should be used for both male and female proportions. The head unit cannot be stated in a specific number of inches; each figure must be measured in terms of its own head size.

For correct proportions, you must rely on your visual perception. The use of the head as a unit of measurement is convenient and helpful while you are first learning figure proportions, but only when the figure is standing upright can you actually measure the body in terms of head units. Most of the time, you will find that the figure or parts of it are foreshortened as shown in figure 12-3. Only with your own eyes can you determine the

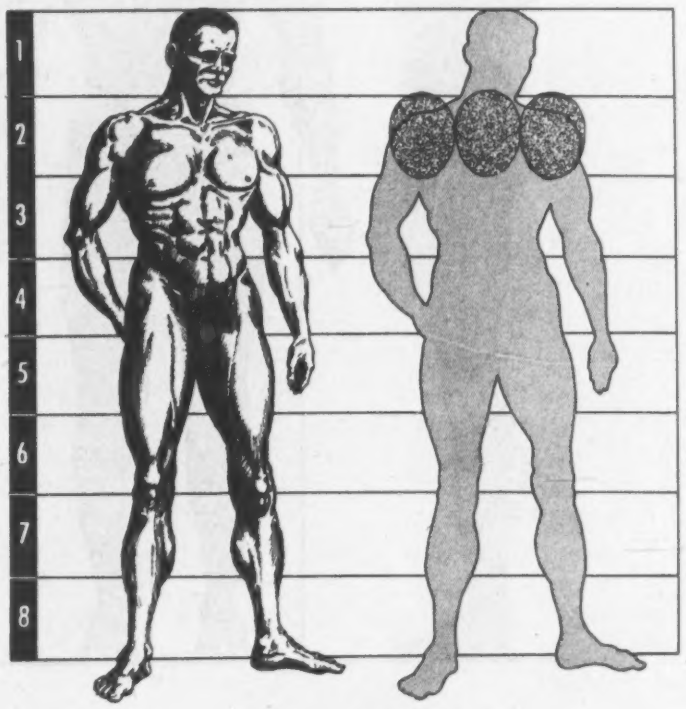

Figure 12-2.

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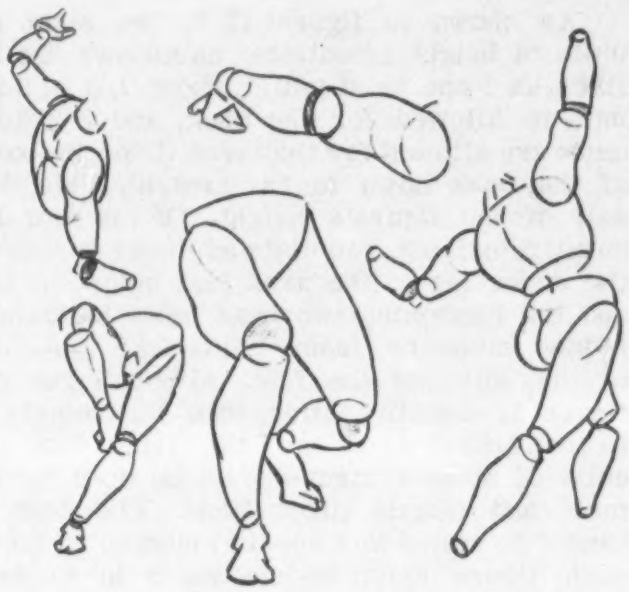

Figure 12-3.

foreshortening necessary for the construction of a correctly proportioned figure for a drawing.

When an object is slanted toward or away from you, it is foreshortened. This is an application of the principle of perspective in which the object seems to diminish in size and change in shape as it goes back. If the object were a cylinder, the sides would appear shorter and the ellipses nearer to being circles as the foreshortening increases. If the object were a cone, the point would appear to rest closer to the center within the shape and the ellipses would again approach a circular shape as the foreshortening increased.

The only way to gage proportion is with your eyes. If it looks right, it is right. Skillful drawing is skillful seeing which the artist transfers to his drawing paper.

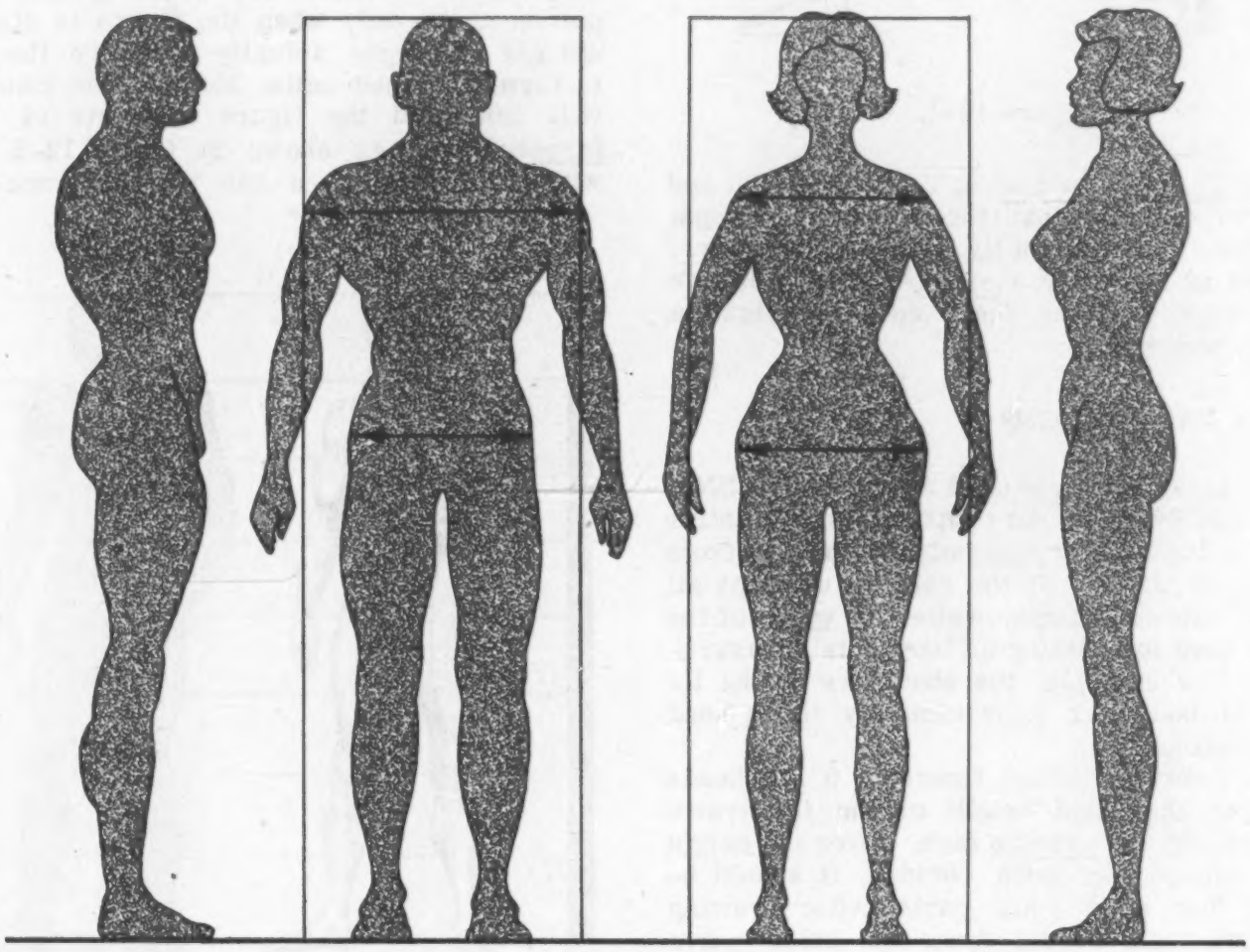

Figure 12-4.

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Structural Differences in the Male and Female

Figure 12-4 shows the differences between the average male and female illustrated forms. You can see that the male's shoulders are a full three heads wide, but his hips are much narrower than his shoulders. The female's shoulders are narrower than those of the males, but the female's hips are about the same width as her shoulders. Also, the female's shoulders are more tapered than the male's, and her arms, wrists, and fingers are smaller and thinner than the male's. The female's lower legs taper to thinner ankles and smaller feet than do the male's.

Changing Proportions at Various Ages

At birth, a baby's head is quite large compared to the rest of his body. At the age of about one year, the body from neck to feet is about three and one-half times the length of the head. The overall height is four and one-half heads as shown in figure 12-5a. The center of the body at one year is at a line drawn across the the stomach.

At the age of eight years, the center of the body has moved down to a line above the hips as shown in figure 12-5b. The arms and legs have become longer and the head is somewhat larger. The overall height of the body is approximately 6 and 1/4 heads.

At the age of twelve, the overall figure is seven heads high, and, as shown in figure 12-5c, the center line is now at the crotch, which is the dividing point of the average human body. From this age on, the body broadens out, becomes taller, and assumes

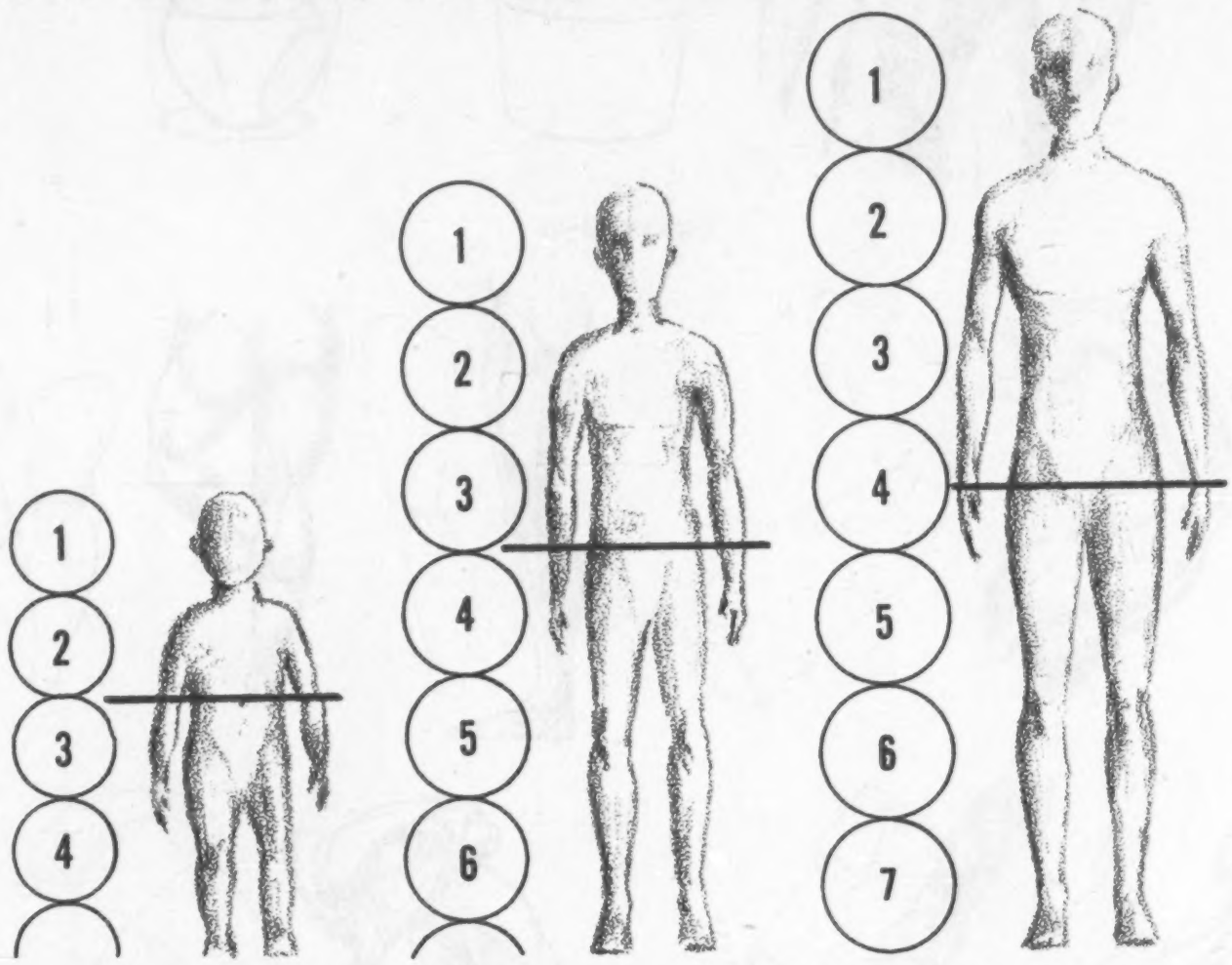

A. ONE YEAR B. EIGHT YEARS C. TWELVE YEARS

Figure 12-5.

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the characteristics of the typical male or female form.

CONSTRUCTING THE FIGURE

For the purpose of constructing a drawing, the human figure may be divided into five components: torso, arm, leg, hand and foot, and head. Each of these components, in turn, may be considered to consist of the basic forms explained in chapter 11.

THE TORSO

The easiest way to visualize the human torso is to reduce it to two cylinders. The upper cylinder is twice the height of the lower cylinder as shown in figure 12-6.

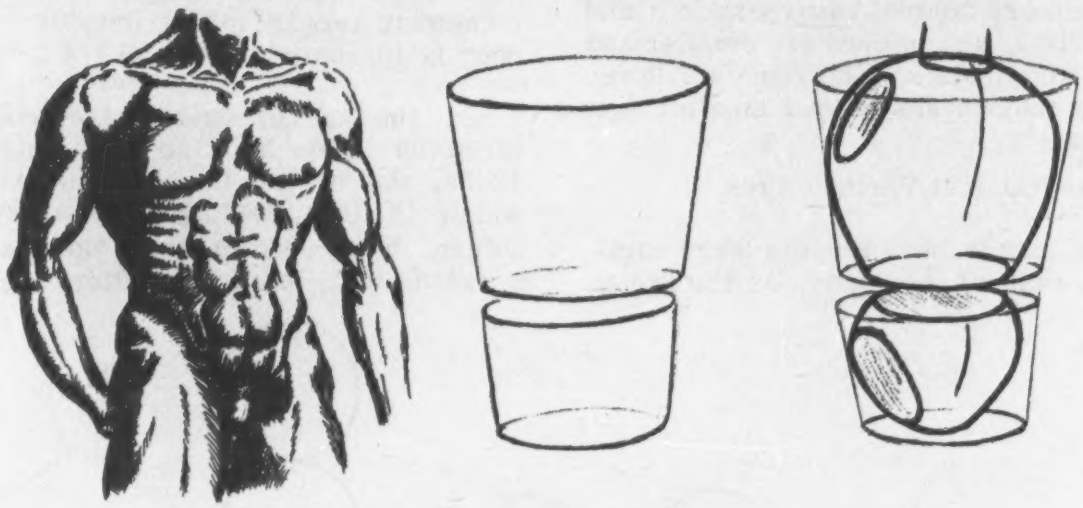

Figure 12-6.

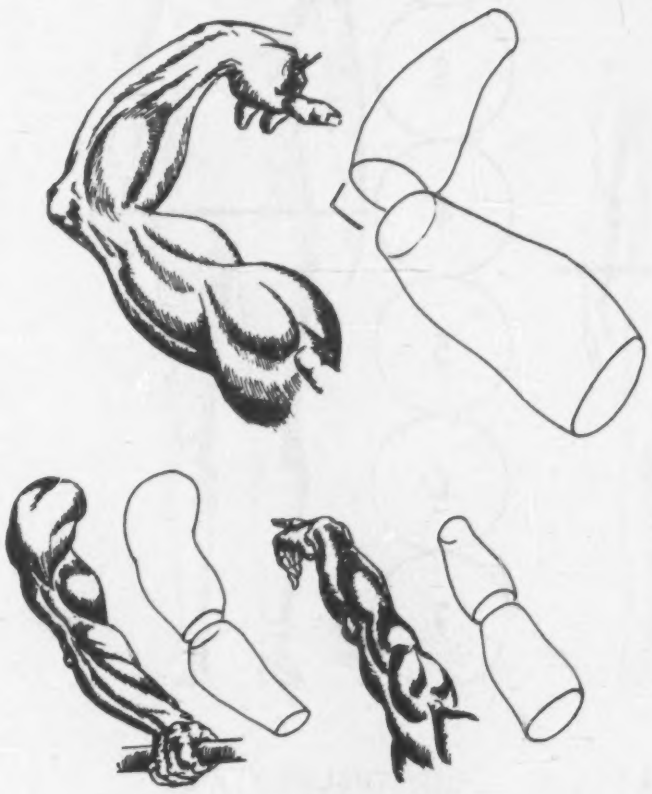

Figure 12-7.

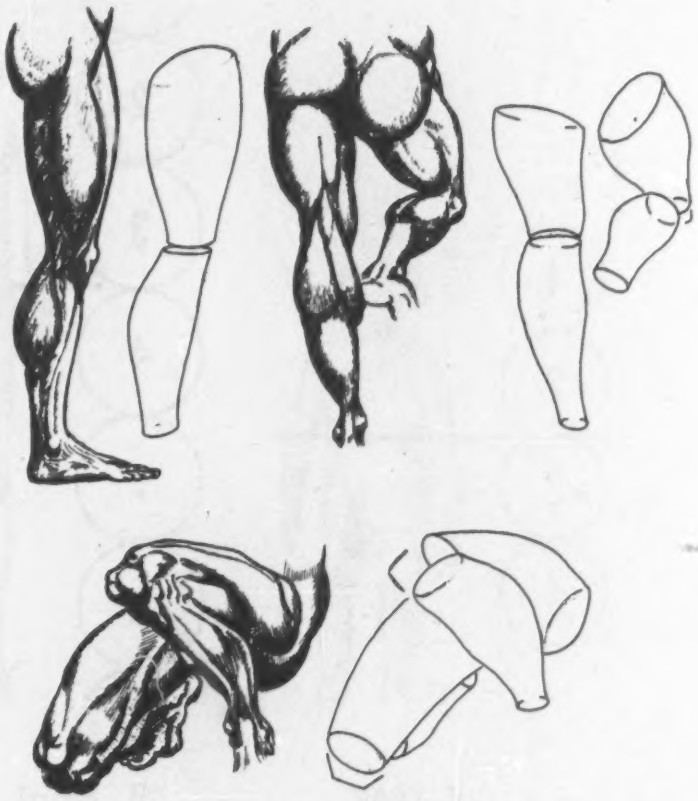

Figure 12-8.

THE ARM

The upper and lower arms are modified cylinders of approximately equal lengths as shown in figure 12-7. The cylinders for the arms are very much like the cylinders used for the construction of the torso, only much narrower. The cylinders forming the arms may be drawn at a much greater angle than the cylinders forming the torso because the arm bends much more than the torso.

THE LEG

The upper and lower legs are also modified cylinder forms of approximately equal length as shown in figure 12-8. The two sections of the leg are joined at the knee and are designed to bend in the opposite direction to the arm.

THE HAND AND FOOT

The hand and the foot are not as easily reduced to basic forms as are the three parts of the body described previously. They can, however, be shown as a combination of simple forms which represent them with reasonable accuracy. Figure 12-9 shows how a combination of a cube and a wedge shape will represent the hand. The cubic form symbolizes the palm of the hand while the tapering wedge represents the mass of fingers. The finger wedge is about the same size as the cubic area of the palm. The hand can also be represented by joined planes.

The upper portion of the foot may be reduced to a cone with the point cut off. This cone is not symmetrical in shape; the back rises almost straight up while the front is rather slanted as depicted in figure 12-10. The form of the toes and the entire sole are best shown as a very thin cubic form.

These basic approaches are enough for you to learn as a beginning. Later, you will learn more about the form, structure and anatomy of the hands and feet of the human figure.

THE HEAD

The basic form of the head is a modified sphere, very much like the shape of an egg.

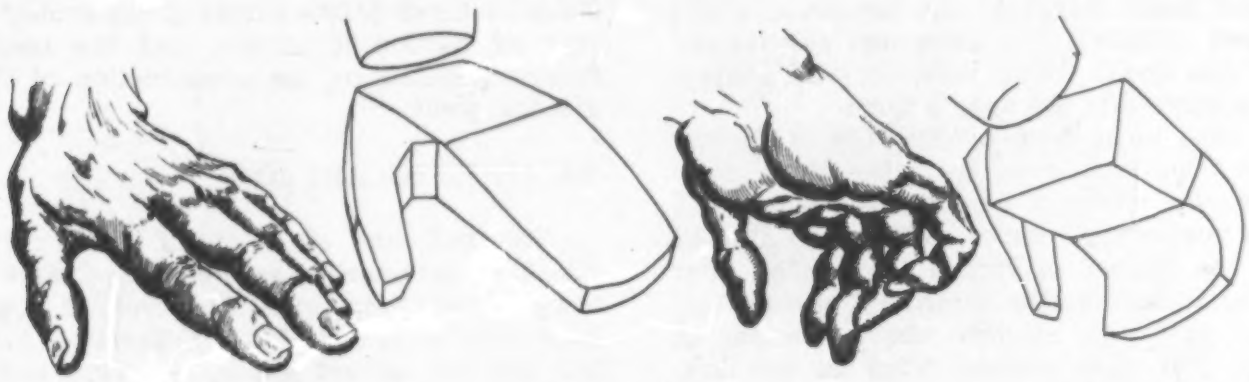

Figure 12-9.

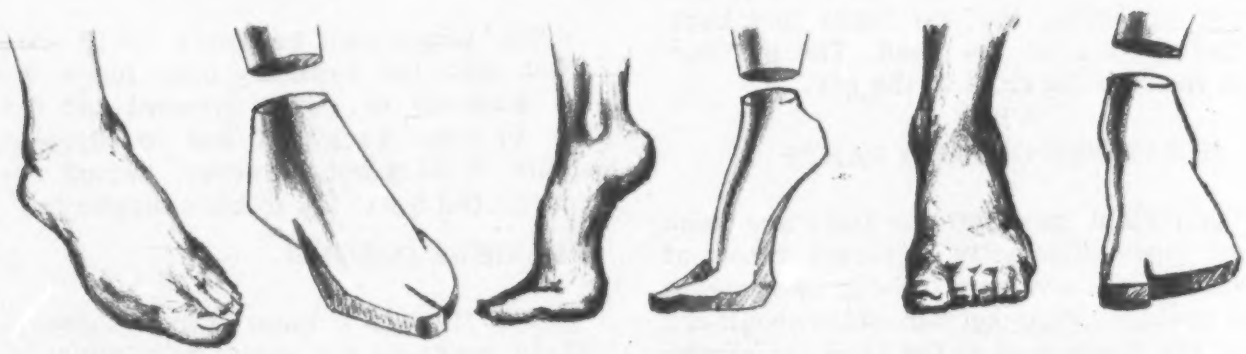

Figure 12-10.

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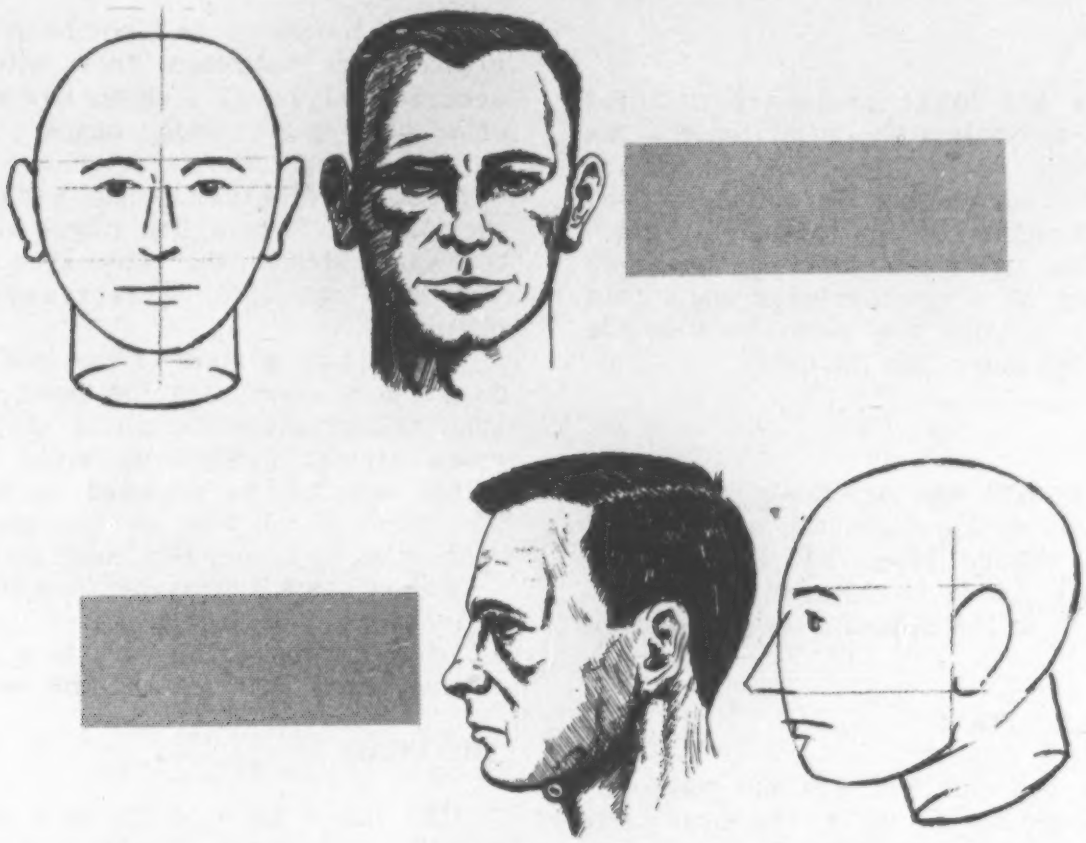

Figure 12-11.

The head rests securely on the neck, which is a short cylinder. The nose and ear are not part of the basic form; they actually project from the surface of the head's form.

The head seen from a side view is slightly different than when seen from the front view. From a side view, it can be seen tilted with the neck toward the rear of the head and slanted forward as shown in figure 12-11. The eyes should be located on the horizontal center line, with the eyebrows slightly above the line of the eyes. The nose extends from the eye line, halfway down to the chin. The top of the ears line up with the brows and the bottom of the ears line up with the bottom of the nose. When seen from the side, the ear rests just back of the center line of the head. The jaw line curves down from the front of the ear.

MOVEMENT OF BODY PARTS

The individual parts of the body are connected by three distinctly different types of joints which make a variety of body movements possible: the ball and socket joint at the shoulders and hips; the hinge joint at the knee and elbow; and the flexible column of the spine and neck. Each of these joints varies considerably in the type of motion it allows, and the amount of motion depends on the construction of the individual joint.

BALL AND SOCKET JOINT

The ball and socket joint shown in figure 12-12 is extremely flexible. Those parts of the body constructed with this type of joint can be rotated in practically any direction. Although not ball and socket joints, the wrist and ankle joints permit similar rotary movement.

HINGE JOINT

The hinge joint in figure 12-13 works very much like the ordinary door hinge. It allows the forearm to swing forward and the lower leg to bend backward and to straighten out again. It does not, however, permit the forearm or the lower leg to bend sideways.

FLEXIBLE COLUMN

The flexible column (spine) shown in figure 12-14 connects the upper and lower halves of the body. The upper most portion of the spine

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Hence, very little net energy is taken from the oscillating circuit during the bunching process.

The average kinetic energy of the electron is that imparted to it by the d-c voltage E_a. Thus some of the energy taken from the d-c electric field is transferred to the a-c field to sustain the oscillations. The power output is taken from the klystron with an inductance loop located inside the resonant cavity.

Modes of Operation

It is not necessary that the bunches of electrons return to the grids on the first positive swing of G2. Figure 12-30 (B) indicates that if the bunches arrive on the second positive swing, the net result is still the same. The time in transit for the average electron (b) is 3/4 cycle, 1 3/4 cycles, 2 3/4 cycles, and so forth. In actual practice there are three or four "modes" in which oscillation is possible. The darker lines in the illustration indicate paths of electrons operating in the first mode, while the lighter lines indicate paths of electrons operating in the second mode. The third mode is possible when the average transit time is 2 3/4 cycles.

The following explanation shows how transit time is controlled to produce the oscillations in different modes. Since the original velocity of an electron depends on the d-c voltage E_a, and since the distance that the electron travels before turning back and the speed with which it returns depend upon the difference between E_a and E_R, it is possible to adjust the two voltages E_a and E_R for any of the modes.

The voltage E_a is usually fixed in magnitude. Varying it would change the initial velocity, which would in turn vary the excursion and the return velocity. E_R is made variable, since it is not feasible to vary E_a. For operation in the first mode, the round trip must be completed in the shortest time. This is accomplished by making the repeller plate highly negative. For longer time in the interelectrode space, the repeller plate is made less negative.

Figure 12-30 (C) shows power output and frequency as functions of the repeller voltage for three modes of operation. Notice that the frequency at the point of maximum output is the same for all three modes, and is the resonant frequency of the cavity. Note also that the power outputs of the various modes at the resonant frequency are not the same, and that the output is least in the highest mode. This may be explained by examining the factors which limit the amplitude of the oscillations, and which in turn limit the power output.

Power and amplitude limitations are due to "overbunching" as well as to the usual losses in the oscillatory circuit. Overbunching occurs in the following way: As oscillations build up and e becomes greater, the amount of acceleration and deceleration increases. This causes bunching to occur within a shorter period of time; that is, before the electrons reach the grids on the return trip. This tends to reduce the magnitude of oscillations. In the higher modes of oscillations where the bunches are formed more slowly, the electrons are more susceptible to overbunching. The magnitude of e which results in overbunching is therefore lower and oscillations are limited by this action to a lower amplitude than in the lower modes of operation.

As shown in figure 12-30 (B), the frequency of oscillations in a reflex klystron is variable to a limited degree in any of the modes of operation by means of varying the repeller voltage. When the repeller voltage is varied, it causes a bunch to return a little sooner or a little later than normal. Off resonance, the amplitude of oscillations decreases by an amount which depends on the Q of the cavity. The tuning range is small in comparison to the frequency of oscillations and varies somewhat from one mode to another, being greatest in the highest mode. This can be explained from the fact that in the highest mode, bunching and debunching take place at a slower rate and that greater variation from the ideal time of return is possible without debunching, causing the amplitude of oscillations to drop below this usable output level. Another way to look at it is that in the highest mode the interval between leaving the grids and returning is greater, and the change in period represented by a given change in frequency is a smaller portion of the interval.

Operation Characteristics

The band of frequencies which can be obtained by varying the repeller voltage lies between the half-power points shown in figure 12-30 (C). This range of frequencies is known as the ELECTRICAL BANDWIDTH. The output curves of the bandwidth are unsymmetrical about the maximum output points. This results from

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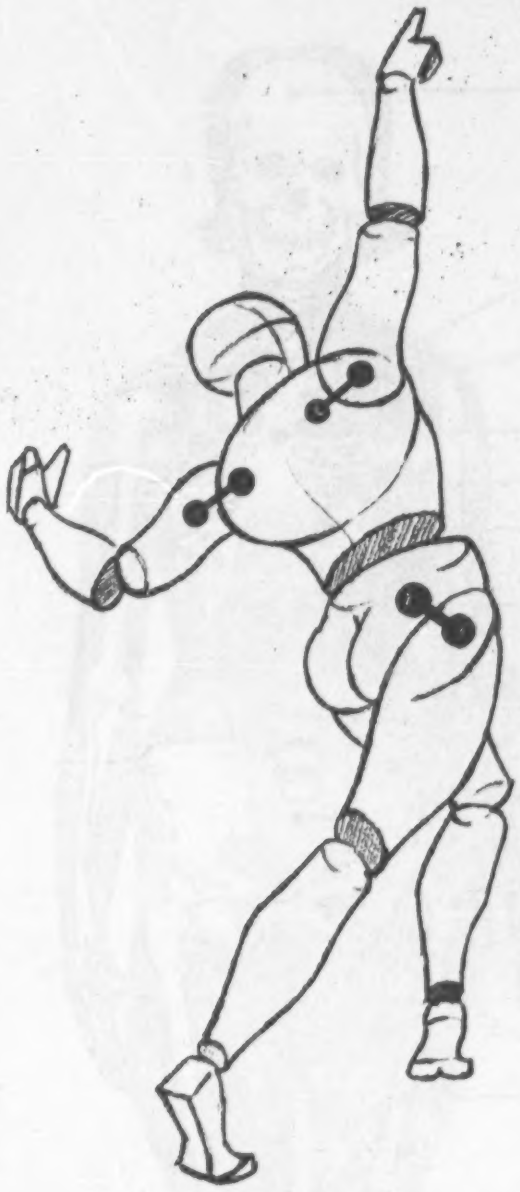

Figure 12-12.

is the neck which connects the head to the upper part of the body and controls all movement of the head. The spine is involved in all actions which require shifts in weight such as walking, running, or jumping. The spine is highly flexible and not only allows turning motions in all directions, but also permits a twisting motion throughout its entire length.

BONES AND MUSCLES IN FIGURE DRAWING

Bones and muscles have a distinct bearing on the outward appearance of the body and on the actions that the body can perform. After starting with the basic figure, you can use the bone and muscle structure to refine the simple basic forms and make them more life-like. In doing so, remember that the bones and muscles are not flat

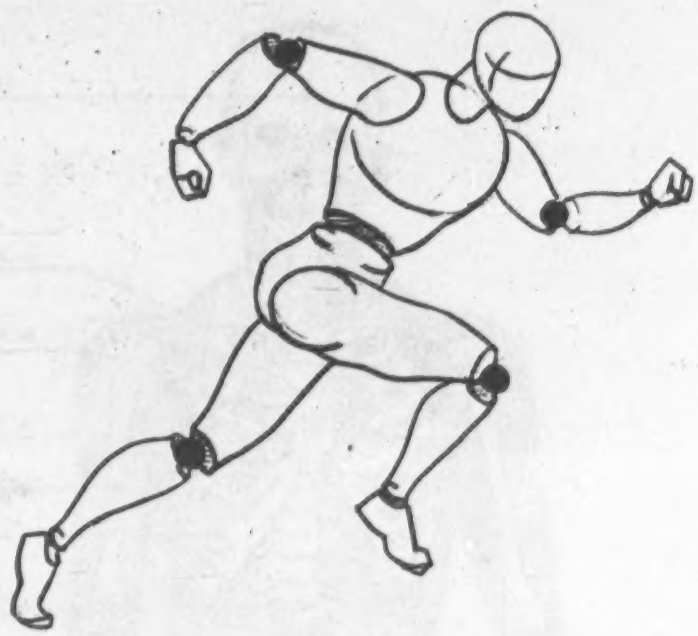

Figure 12-13.

bands or lines beneath the skin; they are solid forms that protrude from the surface of the figure or cut back into it.

Do not think that putting more bone and muscle into a drawing will make it appear more realistic. You will endup with a medical chart instead of a figure drawing. Time and effort can be well spent in studying and drawing the forms and actions of the bones and muscles as they affect the outward appearance of the figure.

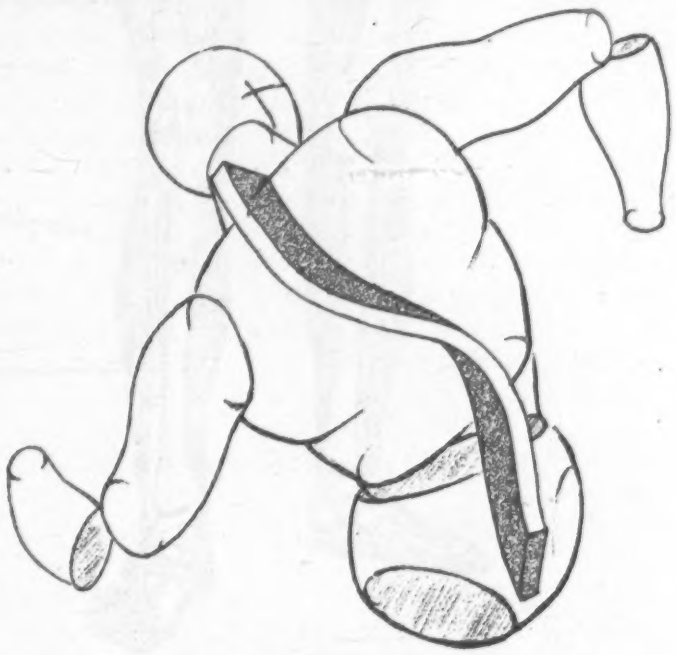

Figure 12-14.

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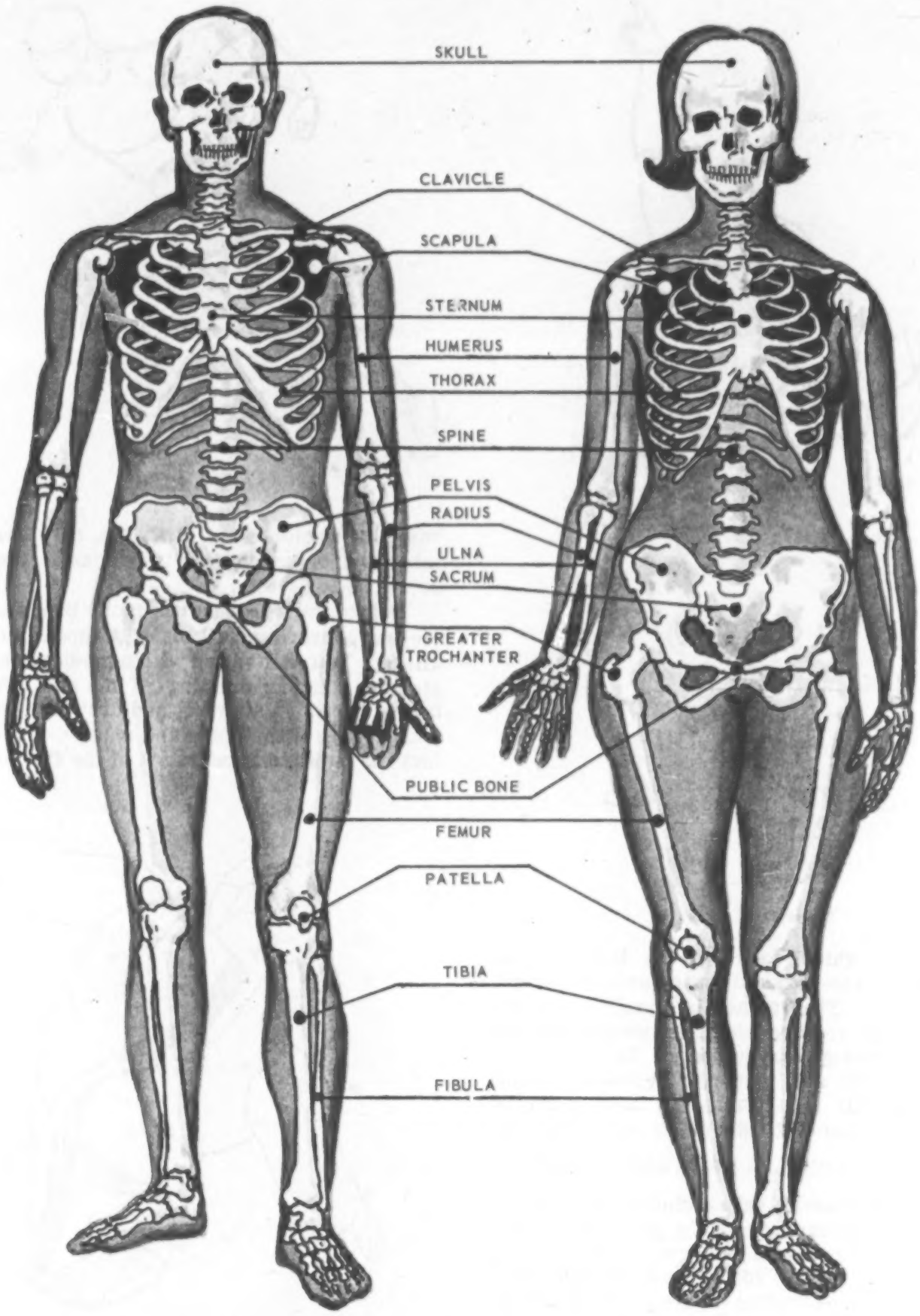
SKULL
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STERNUM
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THORAX
SPINE
PELVIS
RADIUS
ULNA
SACRUM
GREATER TROCHANTER
PUBLIC BONE
FEMUR
PATELLA
TIBIA
FIBULA

Figure 12-15.

BONE AND MUSCLE IN THE MALE AND FEMALE

Figure 12-15 shows the major differences of the bone and muscle structure of the male and female figures. While the female has the same bones and the same muscles as the male figure, the female's bones are smaller and smoother, and her body is heavily covered with fatty tissue, especially thick over the thighs, hips, and buttocks. Female muscles are almost always less developed than male muscles. The heavy covering of fatty tissue over the female's body causes the bones to be less apparent on the surface.

The breastbone or "sternum" in the male is longer and less curved than in the female. The male's hip section or "pelvis" is narrower and deeper, about the same width as his rib cage, while the female's pelvis is proportionally wider than her rib cage, giving her much wider hips. In the male, the distance from the pelvis to the rib cage is shorter, causing the length of the male torso to be proportionally shorter than the female torso. In the male figure, the legs are proportionally longer than the female's legs.

Having a shorter, straighter collar bone causes the female to have narrow, sloping shoulders and a longer neck than the male figure. In proportion to the trunk (torso), the male's arms are longer than the female's. Because of the longer "humerus", or upper arm bone, the male's elbows are lower than the female's elbows. The male skull is usually larger than the female skull.

CONSTRUCTING THE HEAD

When constructing the head, some important points to remember are (1) the nose is an

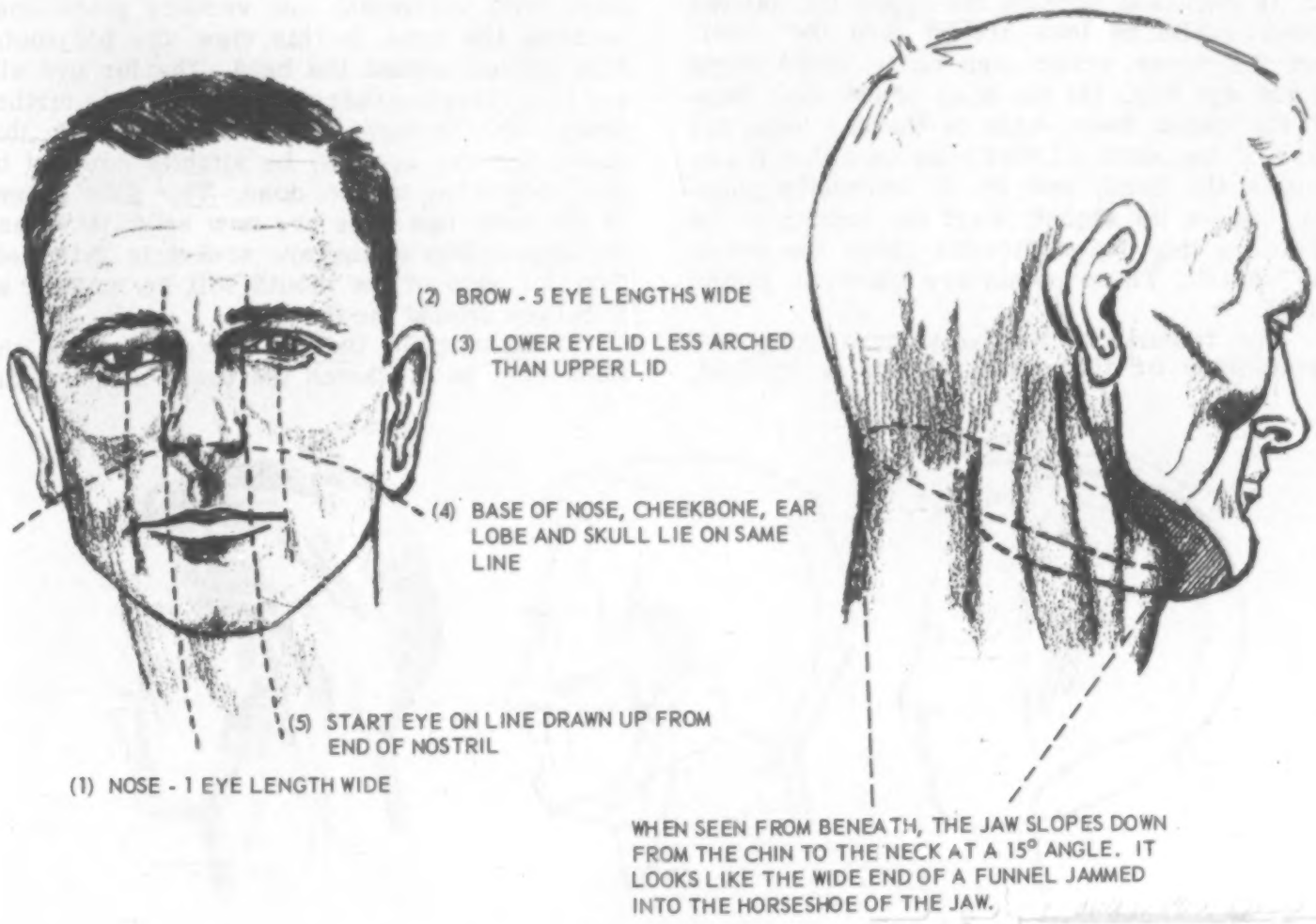

Figure 12-16.

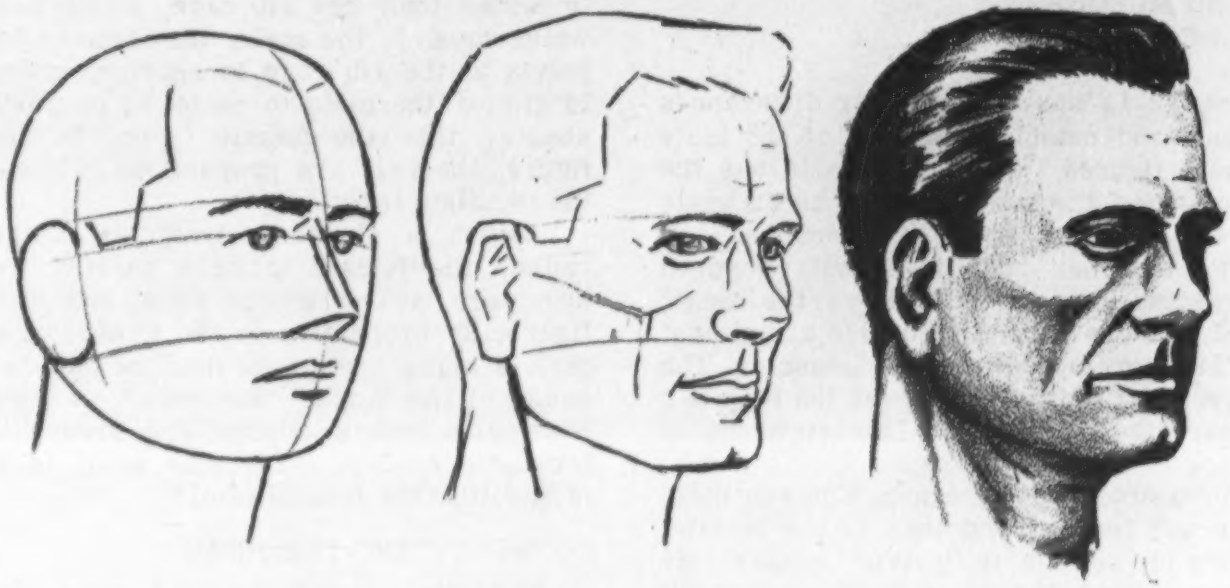

Figure 12-17.

eye length wide, (2) the front of the head at the brow is 5 eye lengths across, (3) the lower lid is recessed beneath the upper lid, (4) the lower eyelid is less arched than the upper, and the upper eyelid lies on a wider curve of the eye ball, (5) the base of the nose, base of the cheek bone, base of the ear lobe, and base of the skull ALWAYS lie on a line drawn across the head, and (6) to correctly place the eye in its socket, start the corner of the eye on a line drawn directly above the end of the nostril. These points are shown in figure 12-16.

The features of the facial area change in appearance or the viewing angle is changed. In the three quarter front view shown in figure 12-17, the basic shape of the head is sketched first with horizontal and vertical guide lines locating the eyes. In this view, the horizontal line curves around the head. The far eye will not be as large as the near one since it is further away. The features are located next. In this view, the far eye will be slightly covered by the projection of the nose. The side planes of the head and nose are now established and the depression of the eye socket is indicated. The far side of the mouth will be smaller as it curves around the face.

In drawing the three quarter back view, the first step is to sketch the basic shape of the

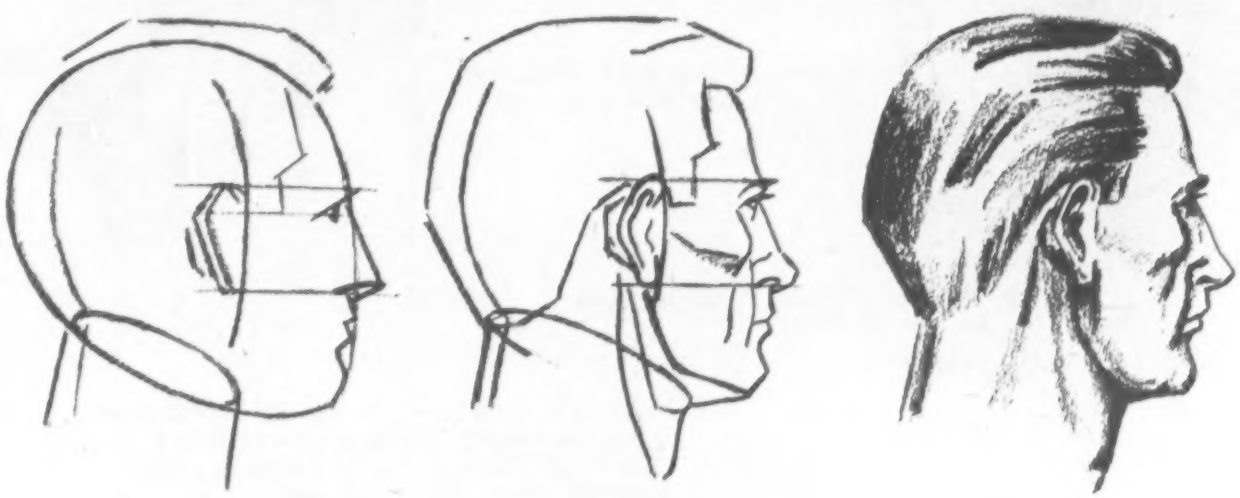

Figure 12-18.

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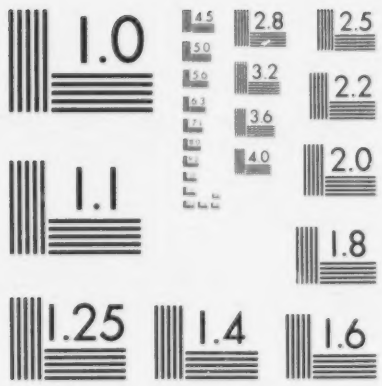

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

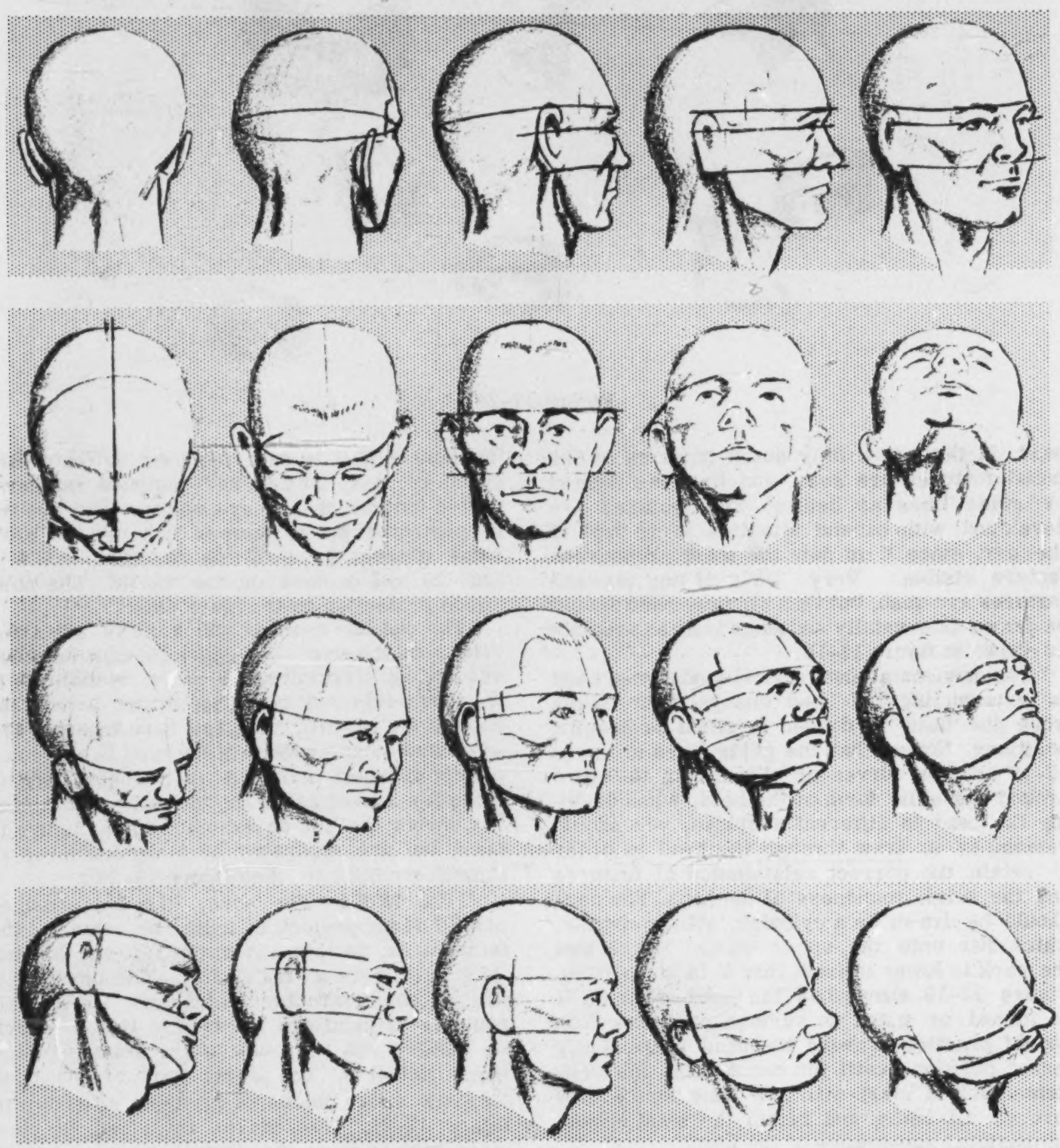

Figure 12-19.

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Figure 12-20.

head. In this view, only small portions of the facial features are seen, and they are located by guide lines as before. The features are developed with careful attention being paid to the ear, since it is now the most pronounced feature visible. Very little of any forward features are seen, but that which is seen should be drawn as carefully and accurately as possible as shown in figure 12-18.

The horizontal and vertical guide lines used in constructing the head change their shape when the head is drawn in tilted or leaning positions. Notice that the guide lines in figure 12-19 become curves or ellipses as they turn around the solid form of the head. When drawing the head in different attitudes, you should remember to draw through the head in order to retain the correct relationship of features and the solid, roundness of the head. The neck should be drawn as a cylinder, without details, which fits onto the upper torso. Notice that the neck is lower in front than it is in the back. Figure 12-19 shows how the head looks as it is turned or tilted in various positions. You should practice drawing the head in these different positions until you can do each one well. Remember to start with the basic form; draw through all lines; and retain the solid three-dimensional appearance of the head.

Facial Details

THE EYE.—The eyeball, about the size of a golf ball, is the most expressive feature of the face, but it is also the most delicate. Because of this, nature has designed extensive protection for it—the eye socket. The eyeball is protected by structures of bone: the brow ridge (frontal bone of the forehead) on top, and the cheek bone on the bottom. The nose offers protection on the inner side.

The eye has two lids which curve like short visors on the eye. The upper lid curves wider across the circumference of the eyeball while the lower lid turns on a shorter arc around the base of the eyeball. Both lids have lashes. The inner and outer corners of the eyelids are completely different in design. At the outer corner, the upper lid overhangs the lower lid. At the inner corner the lids do not touch when the eye is open, but are separated by a narrow area of pinkish membrane. (See figure 12-20).

THE NOSE.—The nose, the long wedge-shaped form projecting from the center of the facial area, is thin and narrow at the top and thick and wide at the bottom. The upper half has a bony structure while the lower half consists of cartilage (an elastic tissue) which is flexible and responds to the actions of the facial muscles. The lower part of the nose consists of five pieces of cartilage as shown in figure 12-21. Two pieces form the tip, one piece each to form the nostrils, and one piece forms the hook of the nose to separate the nostrils. The hook of the nose descends lower than the nostrils.

The nostril cavities are triangular in shape and vary according to individual size of the

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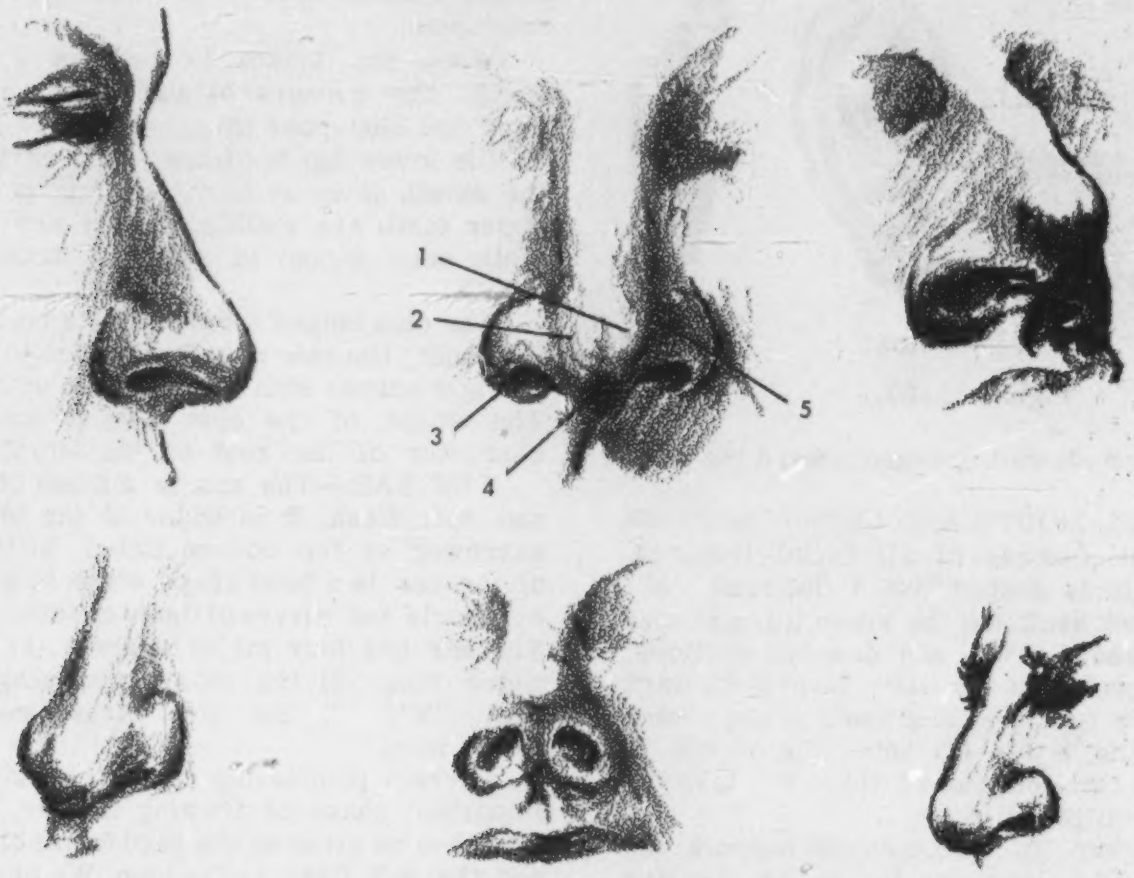

Figure 12-21.

Figure 12-22.

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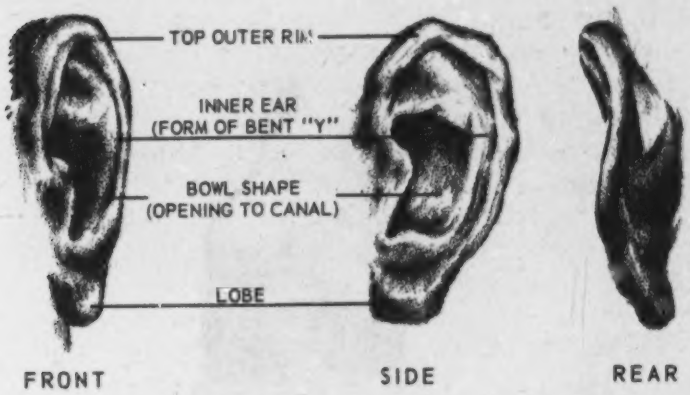

Figure 12-23.

nose; they are slanted outward toward the back of the nose.

THE LIPS, MOUTH AND CHIN.—The mouth is the most flexible of all facial features. The upper lip is shaped like a flattened "M" and has three sections; the lower lip is shaped like an extended "W" and has two sections. The center section of the "M" thrusts forward like the prow of a ship and rests in the center groove of the lower lip when the mouth is closed. The two sections of the "W" take the form of two elliptical lobes.

The lower lip is recessed beneath the upper lip and, when seen in profile, the lips are located on a line sloping backward from near the tip of the nose to the furrow at the top of the chin. This can be seen in figure 12-22.

There are slight depressions or hollows where the corners of the mouth meet the lower cheek. This is usually more pronounced in the male face.

When the mouth is seen in a smile or laugh, the corners of the mouth are pulled back and the upper lip appears to be straighter as the lower lip becomes more curved. When the mouth is in an open, smiling position, the upper teeth are visible. Rarely are the lower teeth seen except in extreme actions of the mouth.

The chin bulges forward at its center. From the front, the chin usually appears to be nearly straight across with a depression in the center. The shape of the chin usually matches the character of the rest of the facial features.

THE EAR.—The ear is a mass of cartilage and soft flesh. It is wider at the top rim and narrower at the bottom (lobe). In the middle of the ear is a bowl shape which is surrounded by whorls and curves of flesh-covered cartilage. The ear has four major shapes: (1) the outer wider rim, (2) the inner rim, shaped like a bent "Y", (3) the bowl area, and (4) the fleshy lobe.

Correct positioning of the ear is the most important phase of drawing the ear. Emphasis may then be given to the hard forms of cartilage and the soft flesh of the lobe. We have already mentioned that the top of the ear is on a line with the eyebrow and the bottom on a line with the base of the nose.

When seen in profile, the ear is located halfway between the front and the back of the

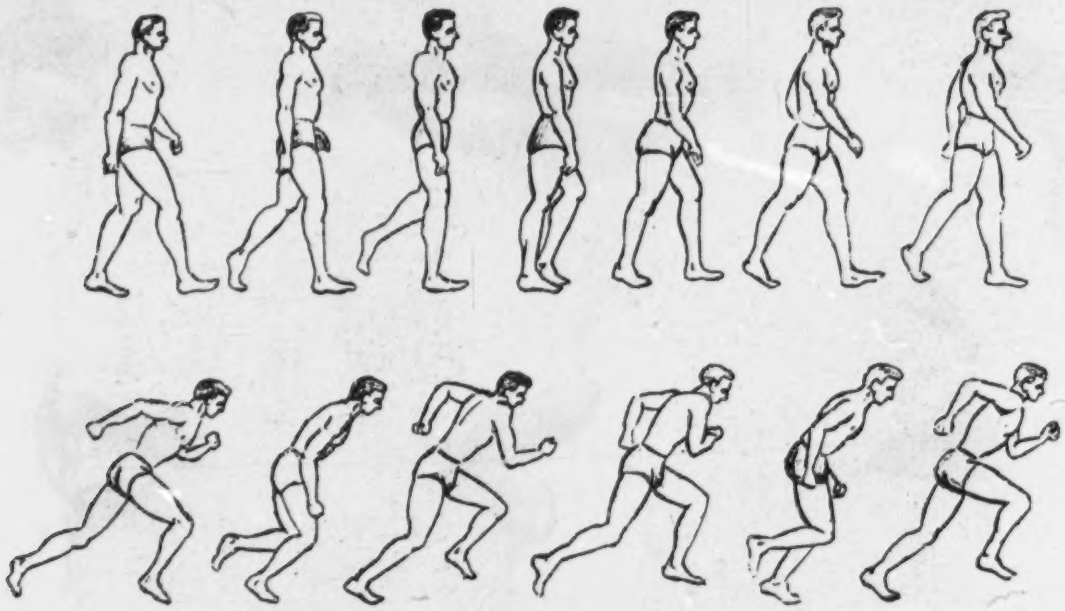

Figure 12-24.

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head location. When seen from the front, the ear slants downward and parallel to the side planes of the head as seen in figure 12-23.

WALKING AND RUNNING

When a person walks, the body shifts its weight alternately from one leg to the other, and the center of gravity passes through the foot on the ground. When the figure is running, the body leans in the direction of movement, ahead of the center of gravity. The faster the speed, the more the body leans. The figure in both walking and running attitudes is shown in figure 12-24.

CLOTHING THE FIGURE

The folds formed on a clothed figure are controlled by three factors: the shape of the figure, the action of the figure, and the cut of the garment. The folds formed primarily by the law of gravity are supported by the shoulders for the shirt, blouse and coat and by the waist for the trousers or skirt. These folds are usually long and flowing. The main points for folds formed by tension are at the shoulder-arm junction, the elbow, the waist, the leg-torso junction, and the knee. When the arm, torso, or leg is bent or changes direction, the cloth slackens on the opposite side of the tension. The cloth on a figure does not change in amount, but it is condensed. As it is condensed, it creates folds in different shapes and in different places. The shape, place, and direction that the fold takes is determined by gravity, tension, support, and action.

Figures 12-25 through 12-27 show examples of folds in male clothing; figures 12-28 through 12-31 show examples of folds in female clothing.

Figure 12-25.

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the fact that if E_R is increased, not only does the bunching voltage e decrease and cause bunches to form at a later time, but the repeller voltage causes a quicker return and the effects of the two actions add to cause poor bunching at the time the electrons return, resulting in a rapid drop in output on the high side of the hump. At lower voltages (even though the bunching voltage e decreases and causes slower bunching) the decreased repeller voltage causes a later return to the grids. The two effects are counteracting and a greater change in repeller voltage is possible before the output drops below the usable level.

The choice of the point and mode of operation is a compromise among several factors. There are several modes which have the necessary power output. It would seem that the correct choice would be the highest mode, for it gives the largest tuning range. The highest mode, however, is too sensitive to a change in voltage to be well regulated. A change of 1 volt may cause a change of 0.5 mc in the 3,000-mc oscillator. Since the humps are unsymmetrical, the point of operation is usually chosen a little below the frequency of maximum output. This makes it possible to tune above the operating frequency by a greater amount than if the maximum point were used.

REFLEX KLYSTRON

In a radar set, the reflex klystron is usually used in conjunction with an automatic-frequency-control circuit; a circuit which frequently is used to control the repeller voltage to maintain the correct intermediate frequency. Keep in mind that the frequency of oscillation is primarily determined by the dimensions of the cavity, and that the repeller voltage is effective in making small changes in frequency. Hence, in most reflex klystrons there is a coarse frequency adjustment which varies the cavity size, and the repeller voltage is the fine frequency adjustment. The dimensions of the cavity are changed (fig. 12-31 (A)) by a mechanical adjustment.

It is true that the klystron frequency is primarily determined by the size of the cavity. However, once built, the spacing between grids G1 and G2 (fig. 12-30 (A)) is the controlling factor, and a mechanical adjustment is provided which physically controls their spacing. Moving the grids closer together increases the capacity between them and consequently reduces the output frequency. Although this adjustment may also reduce the overall size of the resonant cavity, that effect is small as compared to the effect of the change of capacitance.

KLYSTRON THERMAL TUNING

It has been found advisable in the later types of equipment to operate the klystron local oscillator at a point of maximum output (klystron tuned for maximum crystal current). This is necessary because the noise output of the local oscillator is at a minimum at this point. Maximum output is obtained when the klystron cavity is resonant to the output frequency. In order to accomplish this in a practical installation, it is necessary to use a tuning mechanism that permits remote control of the cavity dimensions of the klystron.

One method of accomplishing this is through the use of a remotely controlled cavity tuning motor. In another method of remotely tuning the klystron cavity, the tuning mechanism is a part of the klystron. In one tube of this type the upper section contains a triode. (See fig. 12-31 (B).) The plate of the triode changes in length in accordance with the temperature of the plate, which in turn varies with plate current.

The variations of the triode plate length are impressed through mechanical linkage on the cavity of the klystron. Thus, by controlling the grid voltage of the trode (and its plate current), it is possible to vary the dimensions of the cavity in the klystron. This is known as THERMAL TUNING.

In some tubes the triode is replaced by a diode. This diode has a control tube connected in series with it and a B supply. By varying the bias on the control tube it is possible to control the diode plate current, which varies the dimensions of the klystron cavity.

INPUT CIRCUITS OF UHF RECEIVERS

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Proper selection of the input circuits to UHF and microwave receivers is a design consideration. Proper functioning of these circuits is an important operating and maintenance

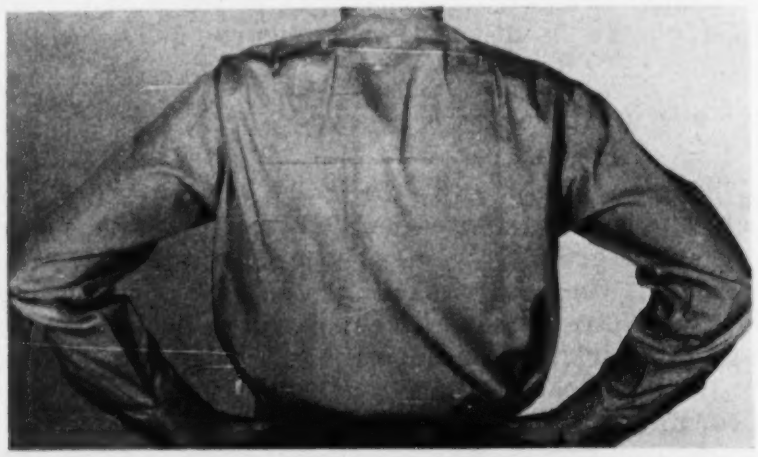

Figure 12-26.

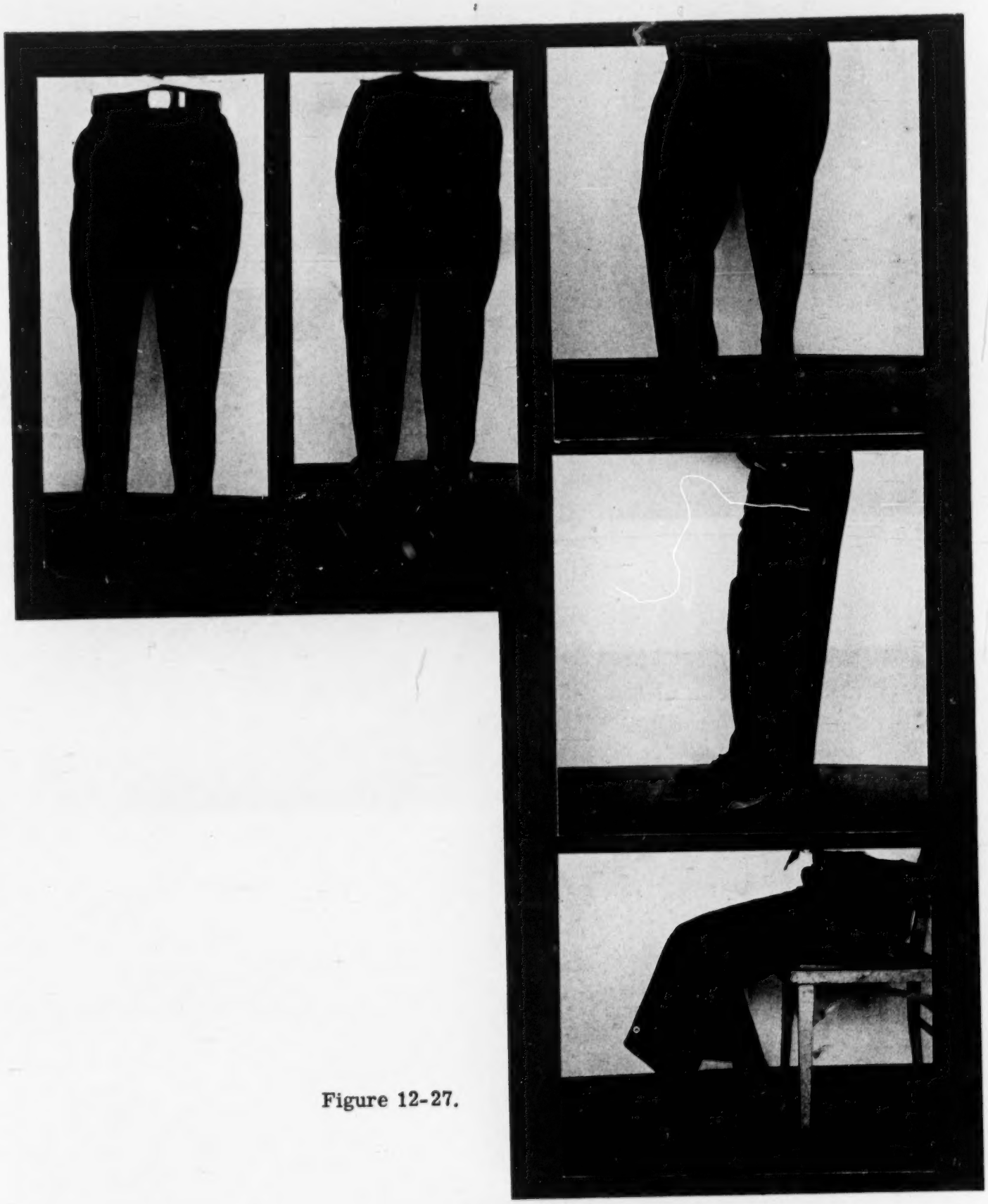

Figure 12-27.

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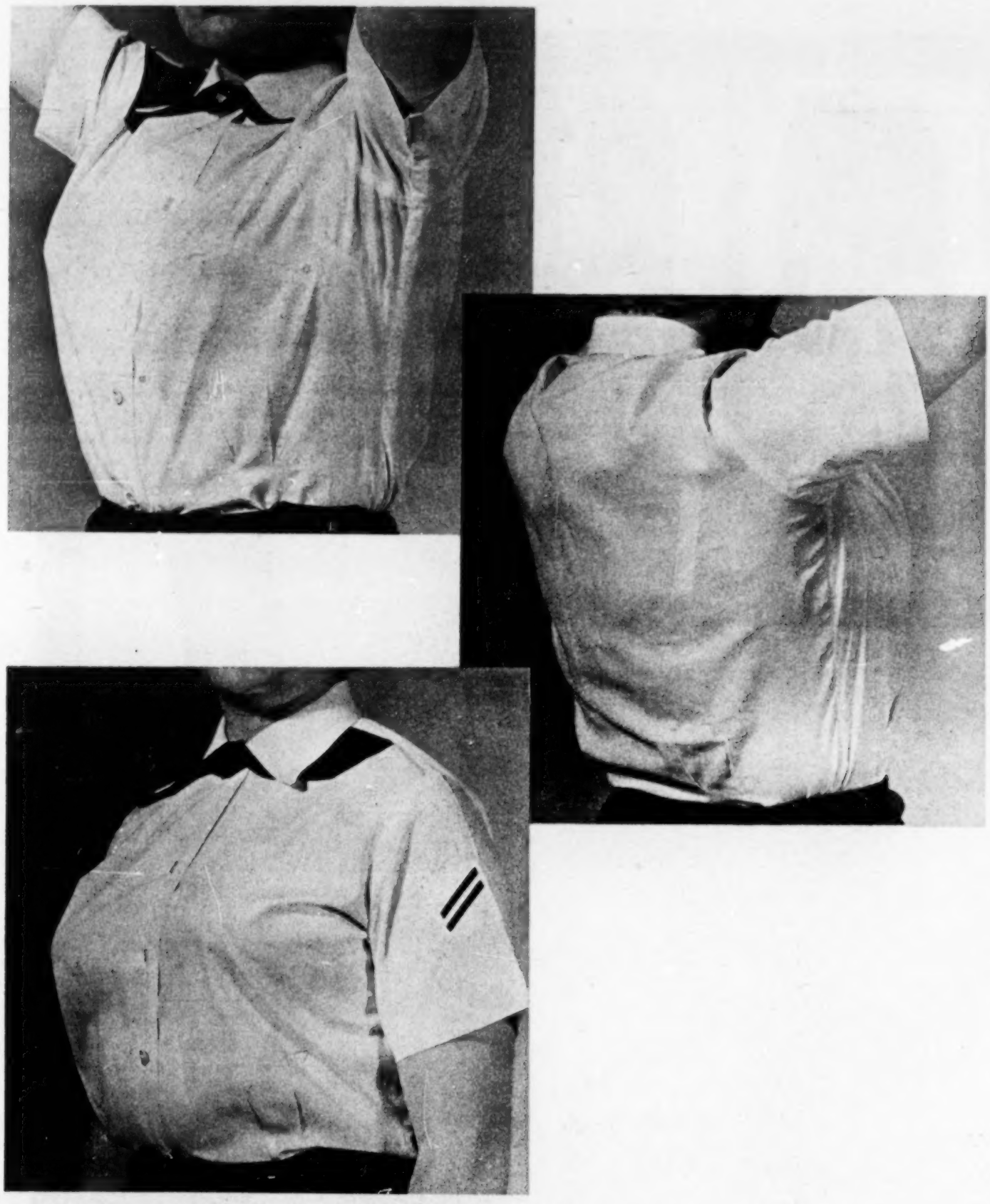

Figure 12-28.

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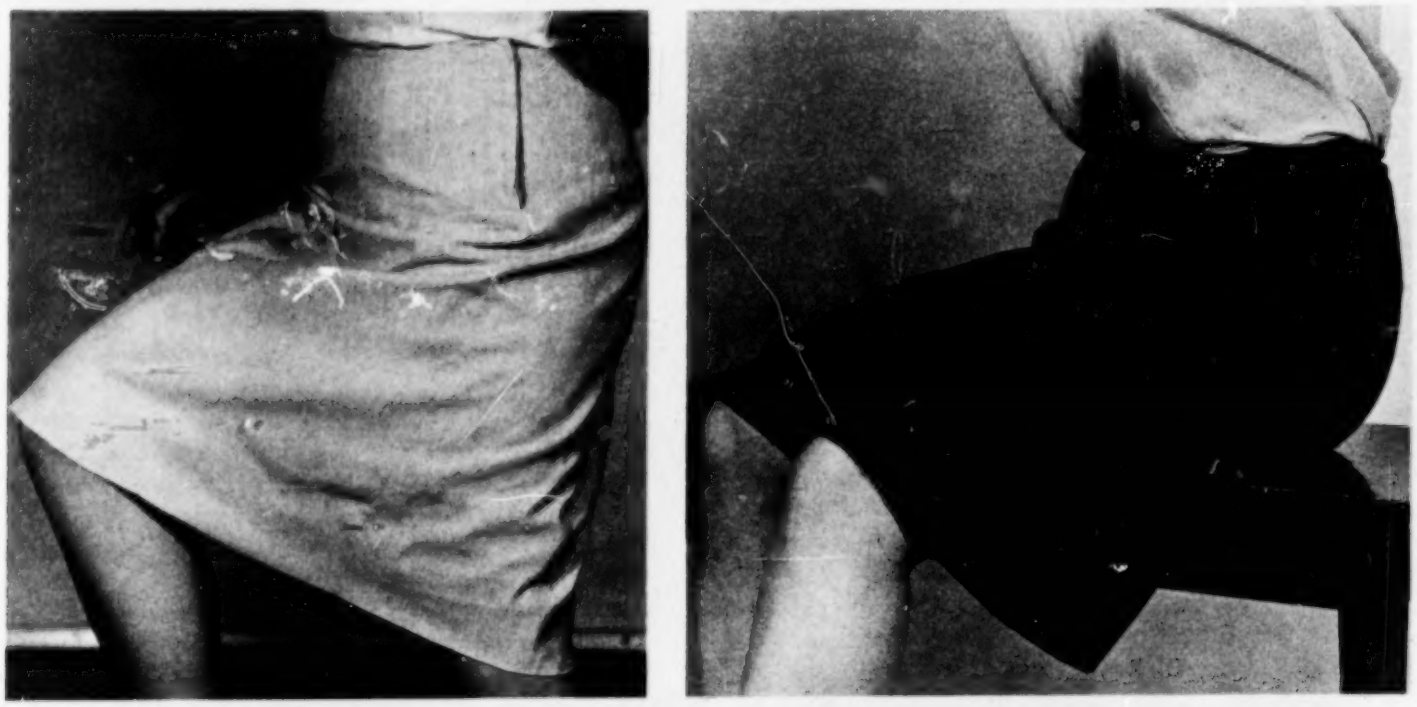

Figure 12-29

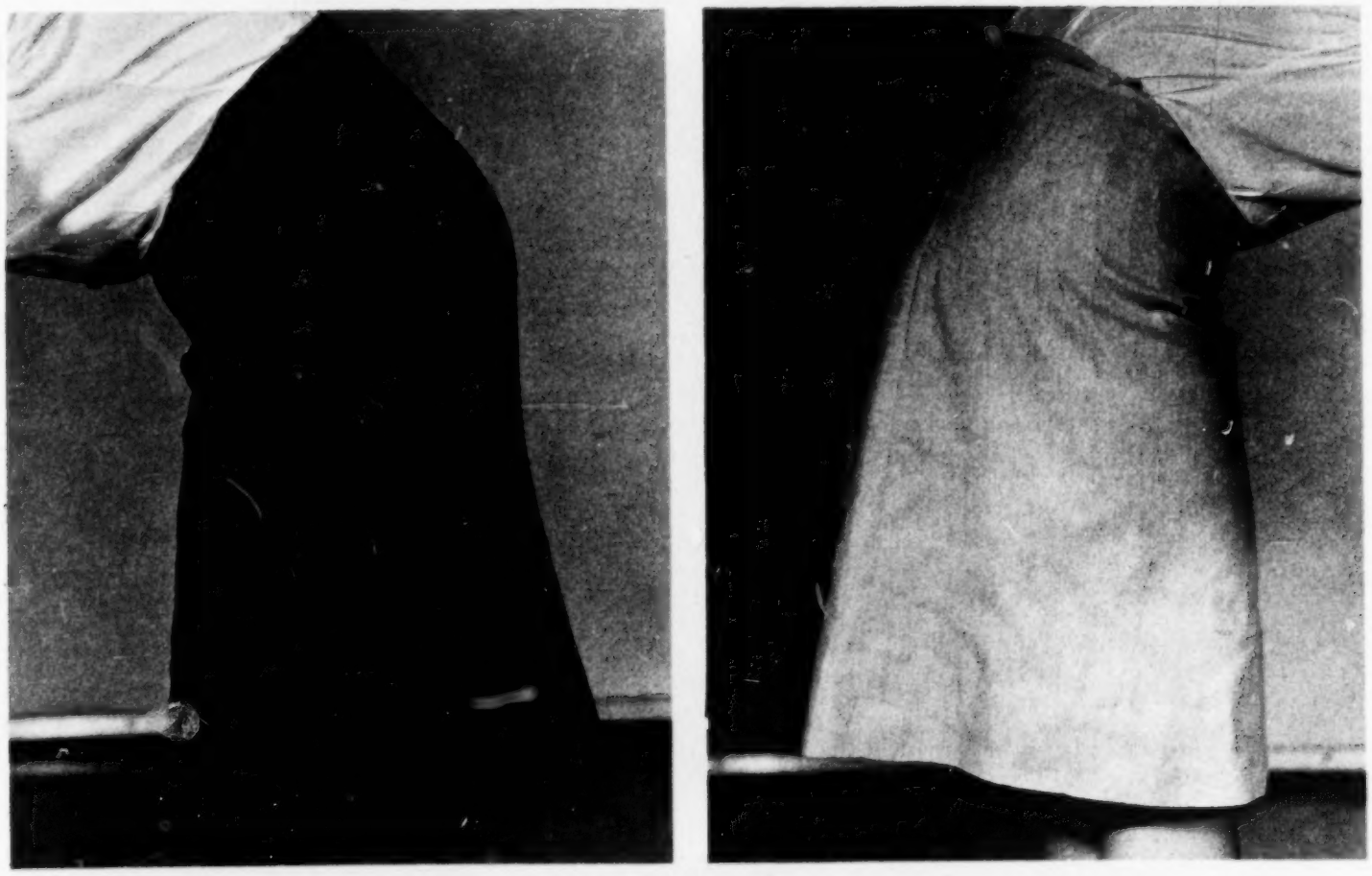

Figure 12-30.

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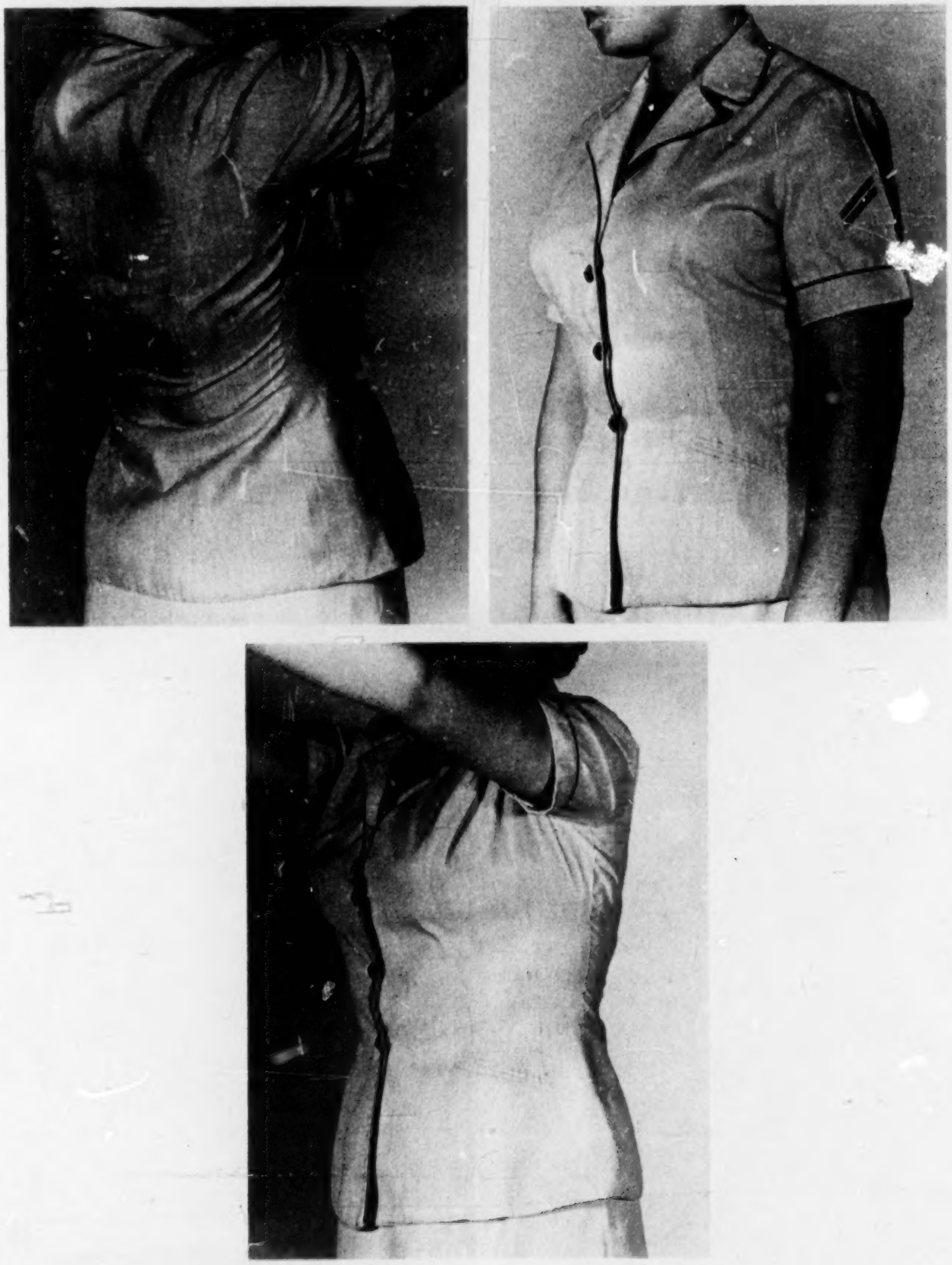

Figure 12-31.

Chapter 13

COMPOSITION AND DESIGN

The composition of a piece of art refers to the way in which its various elements are selected, combined, and arranged within the picture space to express the illustrator's ideas clearly and effectively to the viewer.

In a sense, composition means combining forms and space to produce a harmonious whole. When composing a picture the primary interests are; (1) where to place the objects in the picture space, (2) how important in size and value the objects are to be made, and (3) the relationship of the objects to each other.

Objects in a drawing can be made large or small, depending on the importance you want them to have. Important objects should be made larger or clearer than less important objects which are made smaller and less distinct.

Since in any two layouts the components are never the same, you cannot use a set of ready-made formulas to compose a layout. You must depend on what looks best to you, designing each job individually according to what is to be communicated.

First, analyze the components that are to go into the layout. Then determine which component is the most important so that it may be given the greatest emphasis. Try to picture in your mind the components as they will appear when the layout is completed. This takes practice, but you should learn to think in terms of the finished product from the first.

BASIC THINKING AND ARRANGING

You may find it difficult at first to visualize the complete layout. One helpful method to overcome this difficulty is to visualize each component separately. Draw each object to size and shade it to approximately the tones desired. Now you can cut out each of the separate objects and, on another sheet of paper upon which you have penciled the borders of your layout, place the separate objects in the position that you feel is best. When you view these objects in place, some may appear too large or too small or not in harmony with the other components. Redraw the inharmonious objects and move the objects about until you find an arrangement that appears right to you; one that you feel will make a good layout. This procedure is shown in figure 13-1.

Another method of composition selection used by illustrators is drawing thumbnail sketches, as shown in figure 13-2 and selecting the best one to work into a finished layout. The small size of the thumbnail sketches makes it easier to see the pattern as a whole. However, you may find that a thumbnail sketch that looks good when it is small will lose its harmony when you enlarge it.

EIGHT MAIN ELEMENTS IN PICTURE COMPOSITION

There are eight main elements in composition; (1) the picture area, (2) the picture depth, (3) the line movement, (4) the value, (5) the proportion, (6) the balance, (7) the unity, and (8) the clarity. The last four elements pertain more to poster design than to situation type illustrations.

PICTURE AREA

The picture area is the area within the borders, as seen in figure 13-3. The size of the objects drawn should be influenced by the overall size and shape of the picture area. To use the picture area most effectively, you should study the objects and their size before locating them in the picture area.

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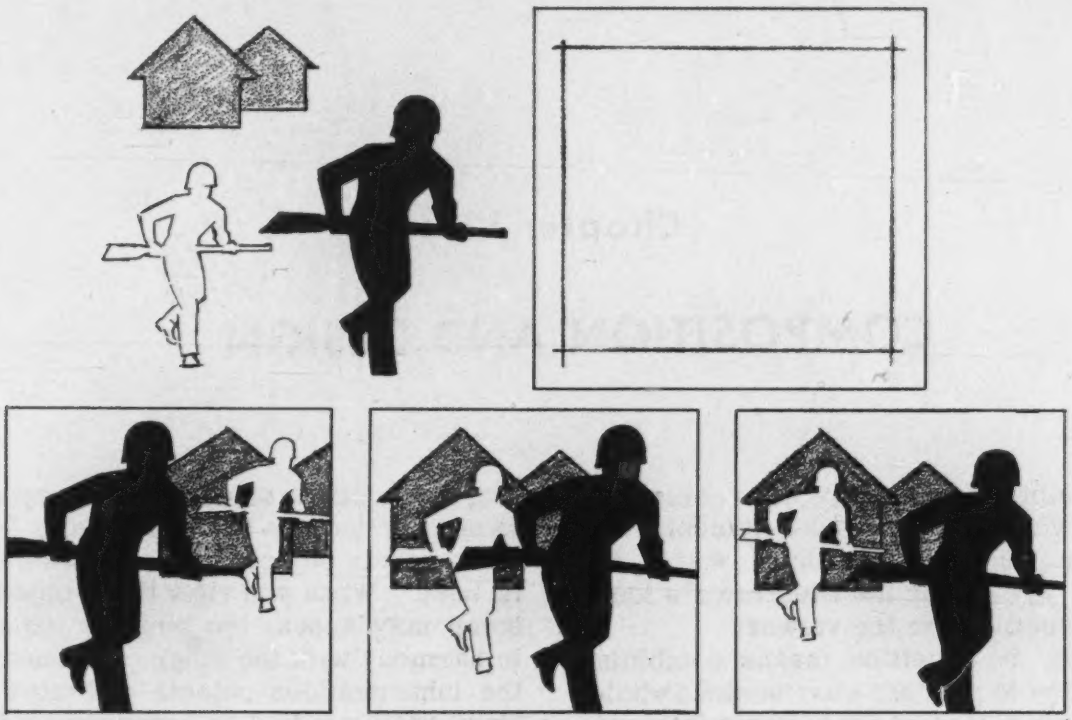

Figure 13-1.—Moveable object.

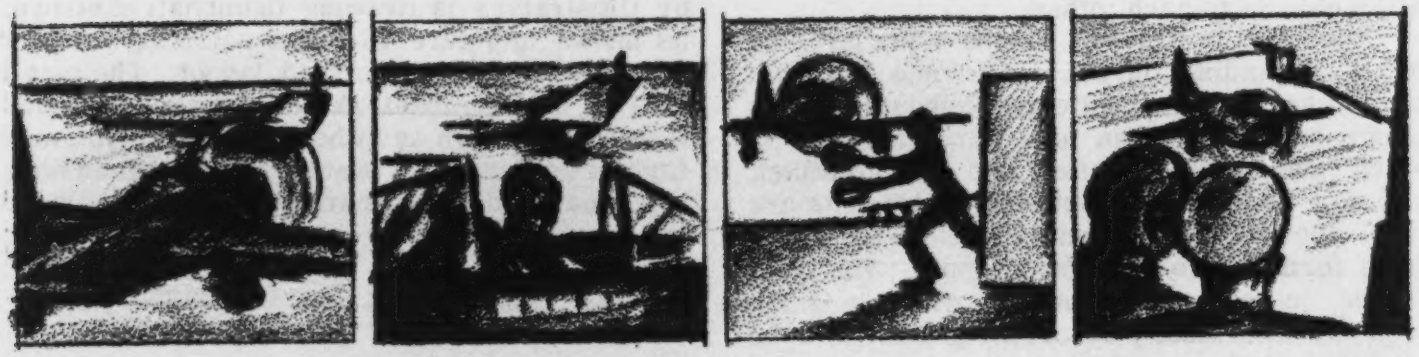

Figure 13-2.—Thumbnail sketch.

Variation of Subject Size

One of the most effective ways of judging the importance of an object in your picture is by noting the relative size of the object. You may give any object importance by drawing the object in the foreground and making the other objects in the picture smaller. This is shown in figure 13-4. The size of the objects and their location determines their relative importance in a picture. You should never choose an object's size without first considering its effect on the layout.

Overlapping Objects

Most pictures you draw will probably have more than one object in them and each of these objects will probably differ in size and shape from the other objects. You may obtain better organization of varied objects and a more interesting and unified arrangement by overlapping. Look around, almost everything you see is partly hidden (overlapped) by other objects. Overlapping may also be used to help emphasize the main object (s) by partially obscuring secondary objects. (See fig. 13-5.)

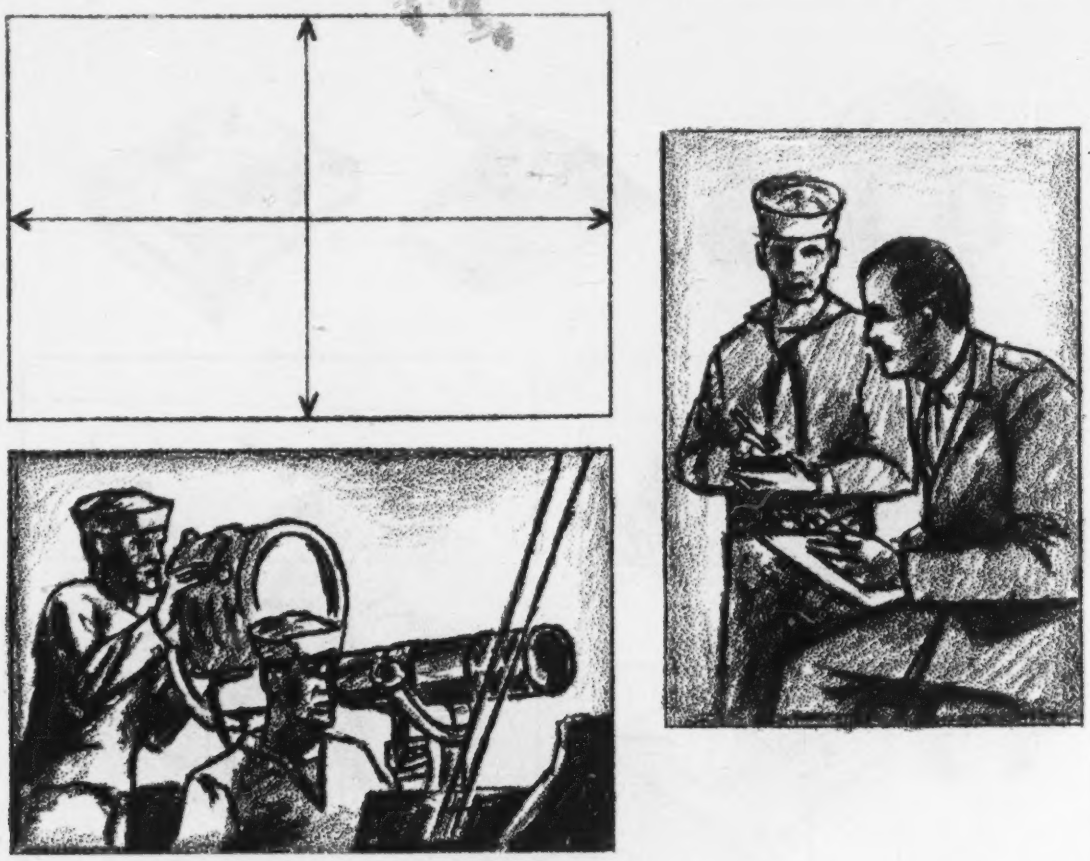

Figure 13-3.—Picture area.

A. FIGURE IN FOREGROUND COMPLETELY OVERWHELMS DISTANT FIGURE.

B. THOUGH NOT SO GREAT A DISTANCE BETWEEN FIGURES, FIGURE IN FOREGROUND STILL DOMINATES PICTURE AREA.

C. HERE NEITHER FIGURE IS DOMINANT BECAUSE OF DISTANCE, BUT FIGURES THE SAME SIZE SHOULD BE USED ONLY IF SITUATION PERMITS, OTHERWISE, THIS ARRANGEMENT COULD BECOME MONOTONOUS.

Figure 13-4.—Variations of subject size.

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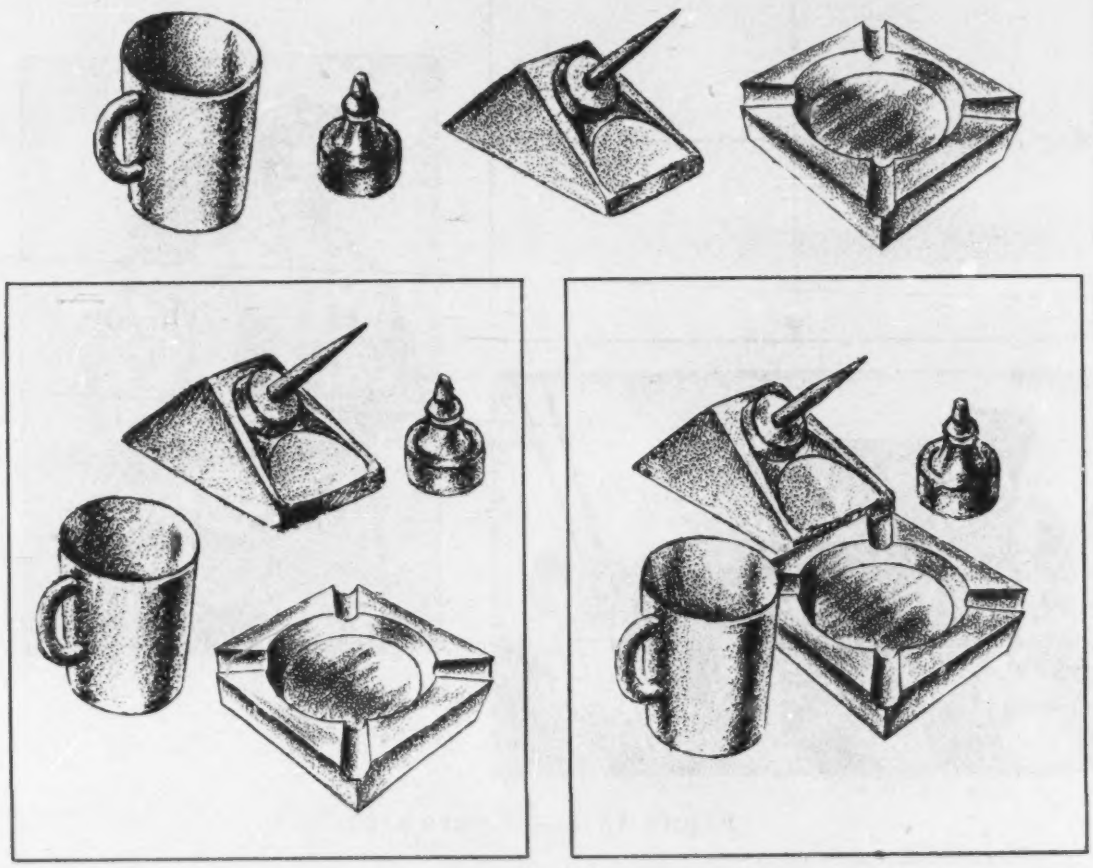

Figure 13-5.—Overlapping objects.

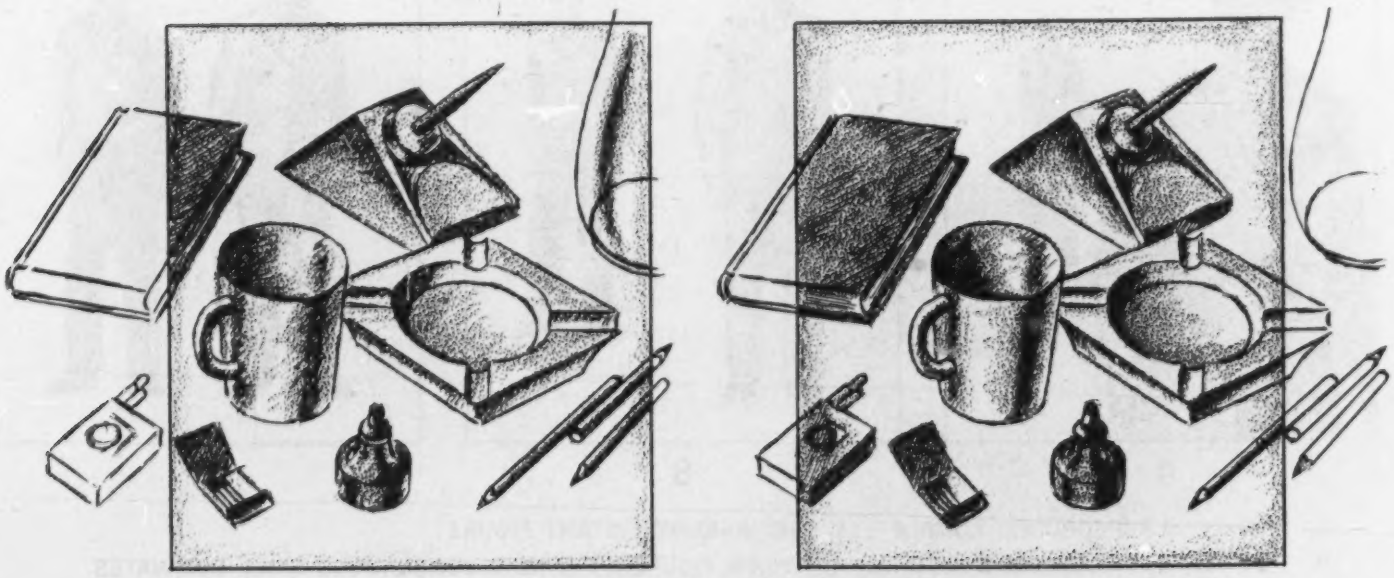

Figure 13-6.—Cropping.

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Cropping

You may also use the border of the picture area to overlap objects; cropping (using only a portion of an object). (See fig. 13-6.) However, the visible portion of the object must be typical enough to identify the object.

PICTURE DEPTH

Depth in a drawing is created by giving the viewer the impression of distance or three-dimensions. The suggestion of depth in a picture makes the scene appear more realistic. Overlapping aids in creating the illusion of depth. Another way to create the impression of depth is to draw some objects smaller than others to suggest that they are further away from the viewer. Purpose and effect should be the main guiding factors when you are creating the illusion of depth in a picture.

Always examine your depth effects carefully to decide whether you have placed the objects at the best depth to achieve the desired effect. If not, make any changes or adjustments which you feel will help to achieve the desired effect.

Creating Interest by Use of Depth

Using overlapping, cropping, and different sized objects to create a sense of depth is not enough to create a good composition. All of these methods should complement each other to form an interesting composition. Unless there is some special reason for doing so, never place objects in a line or row, crowd them into half or a quarter of the picture area, or regularly arrange different illustrations in the same design. To create interesting and appealing compositions, you should place the objects in varied and interesting patterns.

Interest is often increased by selecting a view other than the one you originally started with. Don't be satisfied with ordinary composition. Guard against the tendency to repeat the same basic arrangements in all of your pictures; try to create something original with each assignment. Think and experiment; move the objects around until you arrive at new, different, and interesting effects.

Creating Depth by Use of Props

Props, objects of known shape, can aid in creating a sense of depth in your pictures if you arrange them to lead the viewer's eye back into the center of interest. (See fig. 13-7.)

LINE MOVEMENT

The term line is used here to mean the direction in which the viewer's eye moves as he looks at a picture. This directional line is created by arranging the objects so that the shapes of the main lines will lead the viewer's eye to the center of interest. Your pictures should be designed to lead the viewer to the center of interest. Directional lines may move

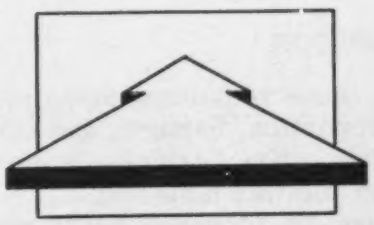

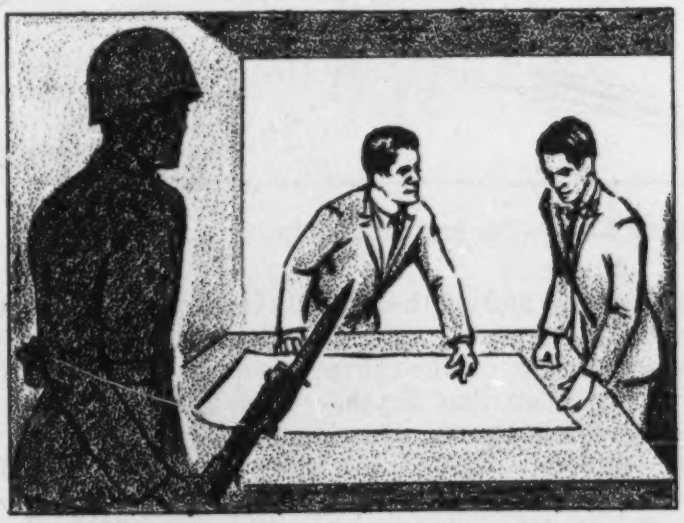

CREATING DEPTH BY USING THE RECEDING TABLE AND OVERHEAD LINE. THE LINE OF THE RIFLE AND BAYONET LEAD TO CENTER FIGURE.

Figure 13-7.—Picture depth, depth by use of props.

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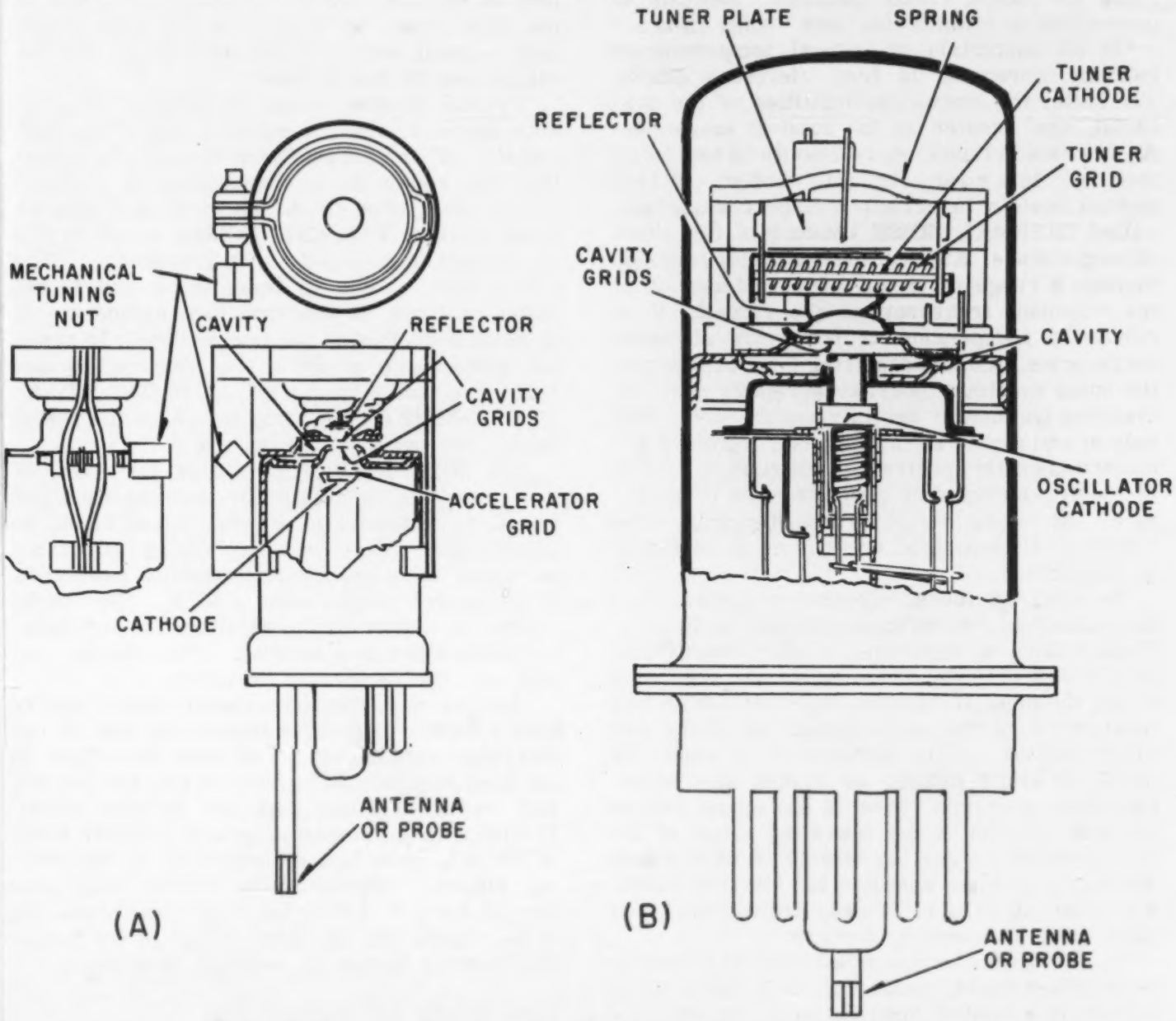

Figure 12-31.—Construction of typical reflex klystrons. (A) Mechanical tuning; (B) thermal tuning.

consideration. An understanding of the characteristics, limitations, advantages, and disadvantages of the various types of input circuits is quite helpful for proper analysis and maintenance of the circuit and the set.

The input circuit determines receiver sensitivity. If gain were the only consideration, the receiver could be made to respond to even the smallest signal by merely adding stages of amplification. However, every amplifier (in fact, every electronic circuit) introduces noise into the overall signal. Since the input signal to the receiver is usually the smallest signal to be found anywhere in the receiver, the noise characteristics of the input circuit are of the utmost importance.

NOISE IN RECEIVERS

There are many types of noise generated outside the receiver. These types enter the receiver along with the desired signal, and may possibly be eliminated by means of the selectivity of the set. In this section, only those noises created within the receiver will be discussed. Included in the discussion will be the

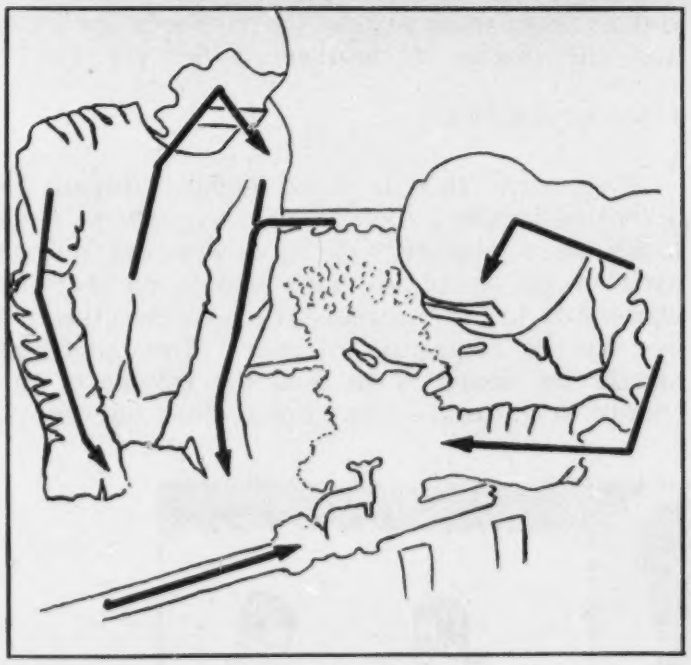

Figure 13-8.—Directional lines.

along quite smoothly and rhythmetically from one object to another, grouping and relating objects which belong together, or the movement may be abrupt, creating lines that clash. This latter method is appropriate when drawing a scene of violence or conflict. Directional lines may be strong or subtle, but they should always lead the viewer so that he will see the things you want him to see. Figure 13-8 illustrates the use of directional lines. When you are planning a picture, make it a point to study the line directions in your rough sketch. Decide whether or not your main lines lead the viewer to the proper portion of the picture area. Ask yourself "Do the background lines interfere with the directional lines leading to the center of interest?" and "Are the lines crowded together or, equally undesirable, spaced at monotonous equal intervals?" Questions like these will help you to get the most out of the lines in your pictures.

VALUE

Value, the lightness or darkness (see ch. 16), should be consistent within a picture. The viewer will be attracted to the area where there is the greatest contrast of values. This phenomenon occurs because objects become more conspicuous when placed next to a value which contrasts with its own value. If on the other hand, an object is surrounded by values which are nearly the same as its own value, the object is not as likely to attract much attention.

Before you start a drawing, you should decide on a basic value pattern. The basic value patterns of most pictures can be reduced to one of the following four patterns: (1) light against dark, (2) dark against light, (3) dark and halftone (in-between tone) against light, and (4) light and dark against halftone.

Small value sketches, similar to thumbnail sketches, are excellent aids to use when deciding on a value pattern. These sketches enable you to quickly see a number of different value patterns. You can place them close together to see which one offers the best possibilities for a good value composition. Examples of the four basic value patterns are shown in figure 13-9.

PROPORTION

The three remaining principles of composition, proportion, balance, and clarity, are used most often when designing posters, pamphlets, or other similar material.

Figure 13-10 shows how a rectangular area can be divided into different proportions to lend more interest to the illustration. Notice that the rectangle divided into a number of equal squares is less interesting than those adjacent to it. Its proportions are less interesting because it is relatively monotonous.

In figure 13-11, rectangles with interesting proportions are shown in different tones. A black, a white, and a medium gray are used.

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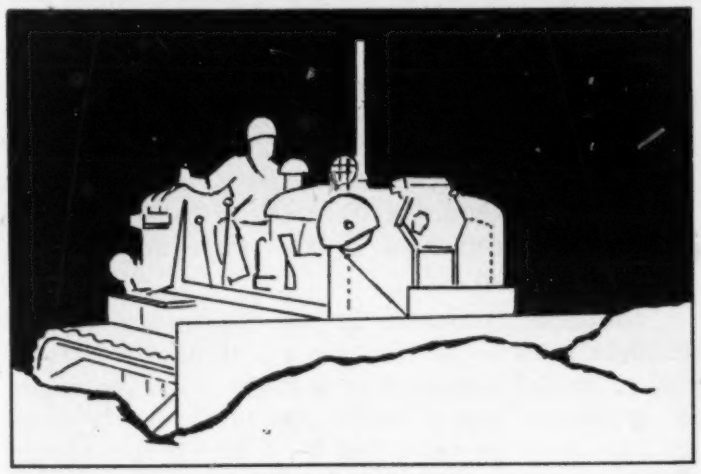

LIGHT AGAINST DARK

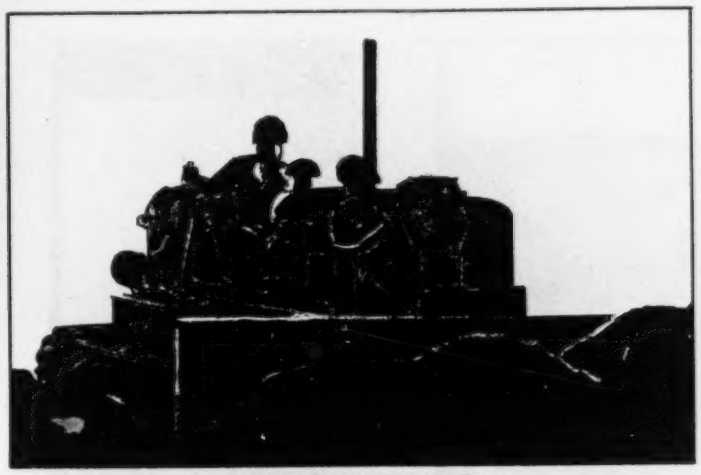

DARK AGAINST LIGHT

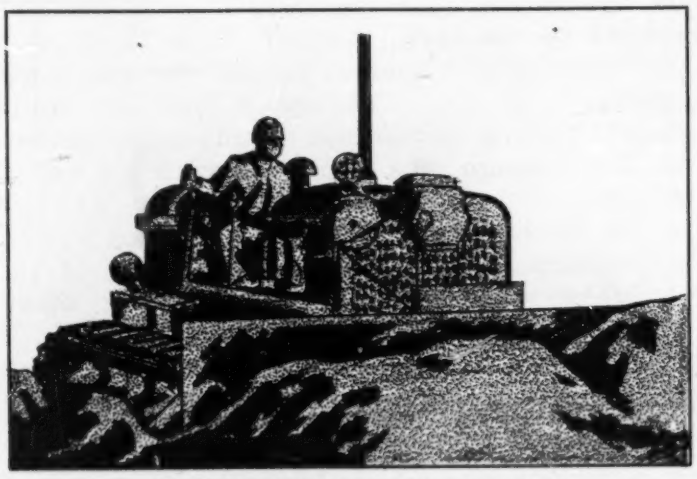

HALFTONE AND DARK AGAINST LIGHT

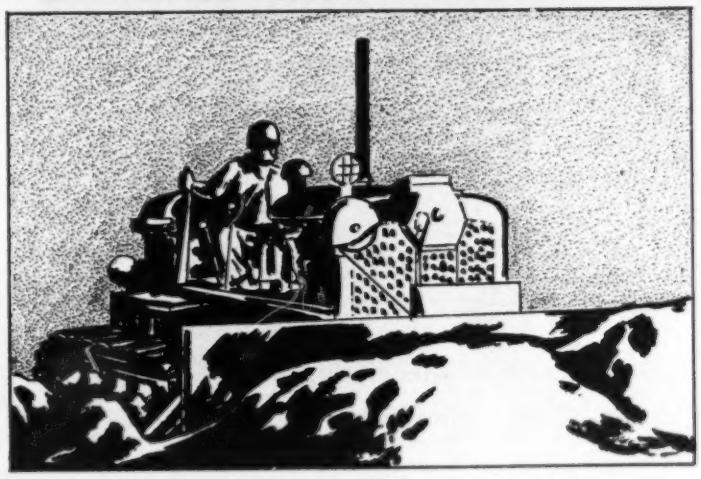

LIGHT AND DARK AGAINST HALFTONE

Figure 13-9.—Value patterns.

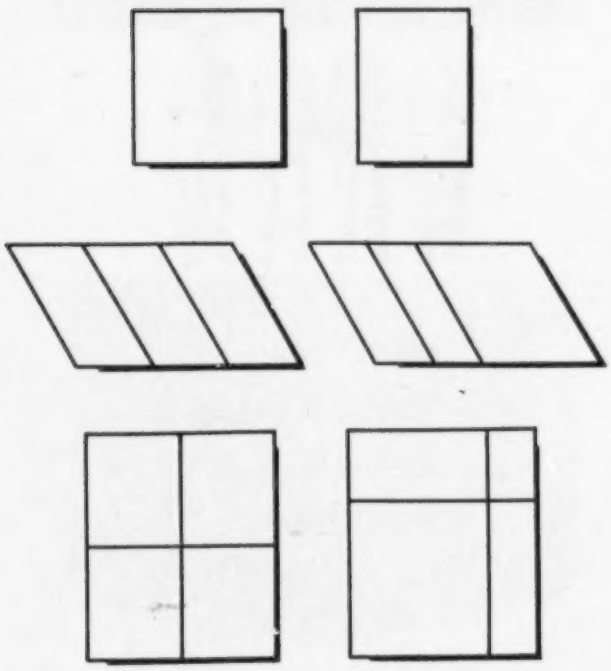

Figure 13-10.—Proportion.

This type of treatment works well on a layout for a pamphlet cover. Whenever several tones are used, the layout will be more interesting if one of the tones clearly dominates the others in size or intensity.

BALANCE

A very important composition factor is balance; the placement of the various objects in the picture area so that the composition will appear to be fairly symmetrical. There are two general classifications for balance; symmetric and asymmetric balance, commonly referred to as formal and informal balance.

Formal Balance

Formal balance is obtained by placing each element squarely on an imaginary central vertical line, or by duplicating on one side each mass, shape, or line that appears on the other

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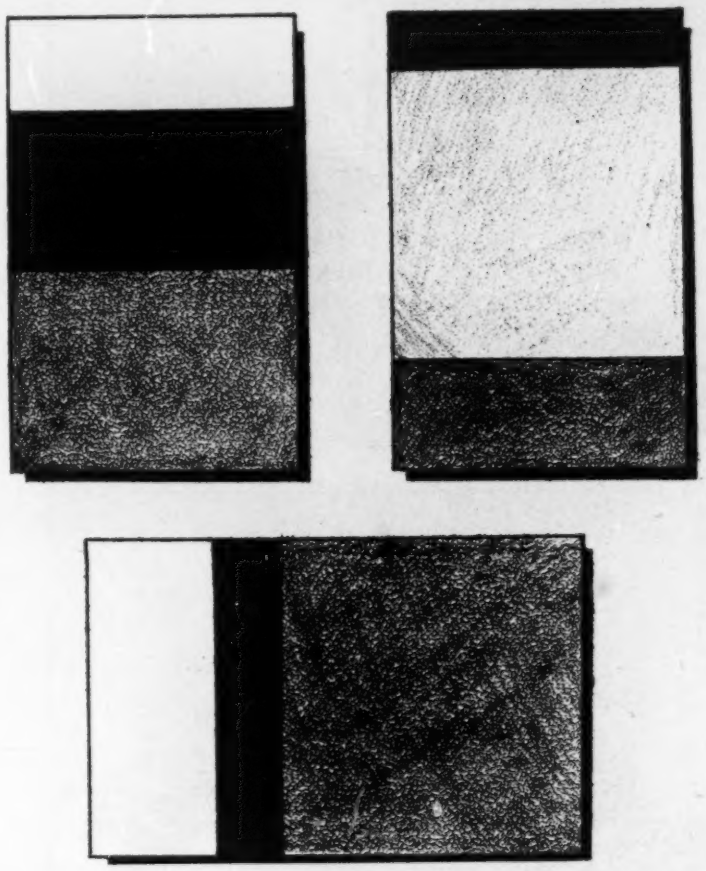

Figure 13-11.—Rectangle divided by tones.

side of the vertical, and at a corresponding position. The result is considered perfect symmetry. An example of formal balance is shown in figure 13-12.

Formal balance is commonly used today in layouts, illustrations, and advertisements in which the subject matter calls for reserve and dignity. For example, the use of formal composition and balance in the advertisement shown in figure 13-12, is fully justified by the subject matter.

Another example of formal composition and balance is found in the religious paintings from the period of the Italian Renaissance. A great many of these are composed by having a pyramid effect in the center of the picture area. The basic pyramid composition lends dignity to such paintings as da Vinci's "Holy Family."

One disadvantage of formal composition and balance is that when it is handled without taste, it may be merely ordinary. Each element should be studied in relation to the others and carefully placed. A pleasing balance should also be maintained between the top and bottom of the picture area. The picture should appear to be balanced when viewed from any direction.

Informal Balance

The use of informal balance permits greater variety and design; however, the problem of balance becomes more complex. The left side of the page should still balance the right side and the bottom half of the page should still balance the top half.

Informal balance is the balancing of the elements over an imaginary central vertical, but in an unsymmetrical manner. For example, a large or heavy mass placed on one side of center may be balanced by a small one placed further away from center on the other side. Do you recall when you were a youngster and played on the teeter-totter? It is likely that you teetered with another person who was much heavier than you. You did it, but how was it done? The heavier person simply moved closer to the fulcrum (the point on which the board rested). The same principle applies in the case of the heavier mass on one side and the lighter or smaller mass on the other. See figure 13-13.

When using informal balance, you must depend to a great extent on your sense of balance; no mathematical rules apply. The more elements to be arranged in an informal layout,

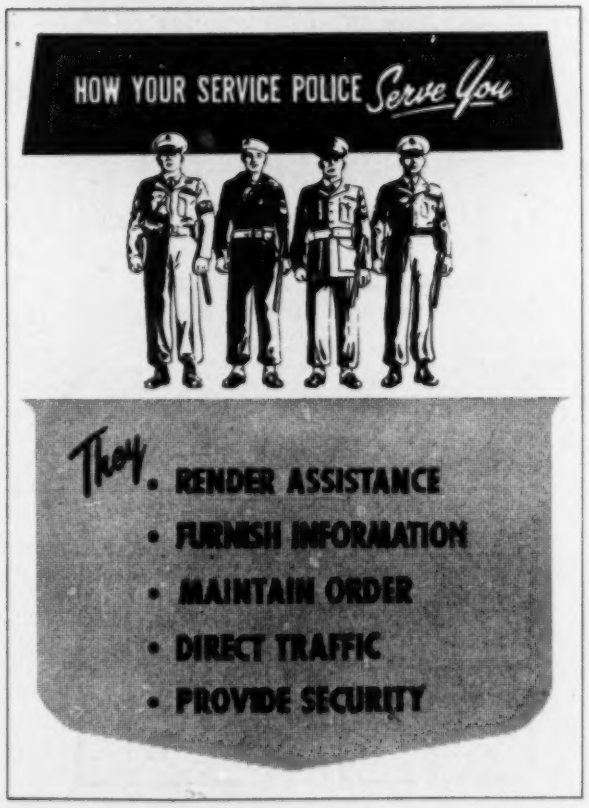

Figure 13-12.—Formal balance.

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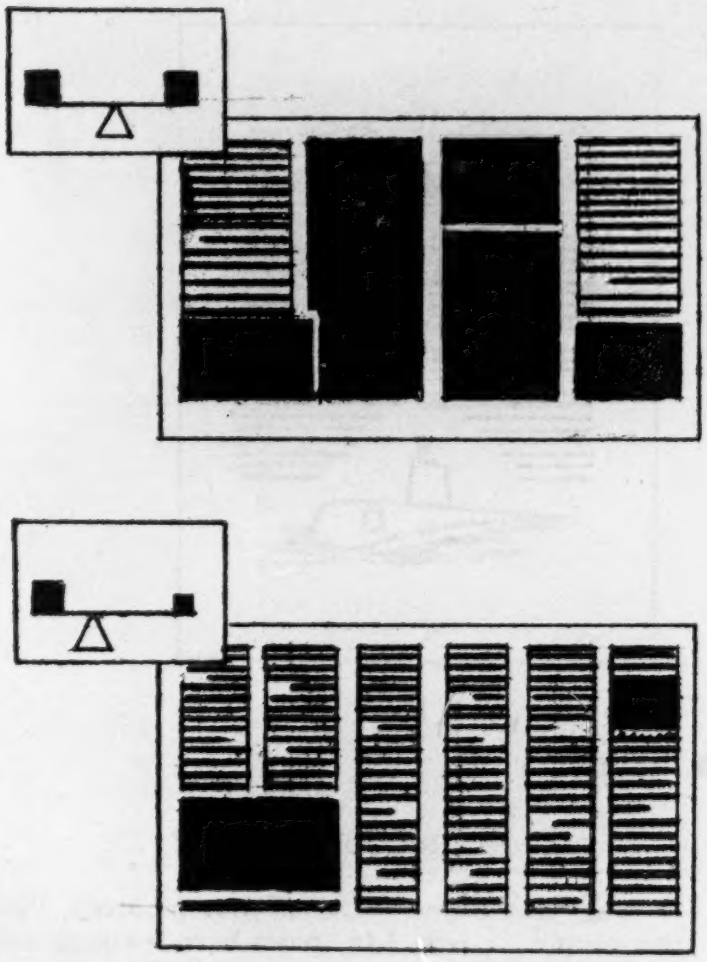

Figure 13-13.—Informal balance.

the more involved balance becomes. The layout must be balanced for shapes, masses, and color. Unless quite large in area, color should not appear in one part of the layout without being reflected elsewhere. For instance, if all blacks were placed in the upper half of the composition and all light elements below, the layout would seem to be separated into two unrelated parts.

In informal balance, a small dark element can be used to balance a large light element. Examples of this kind of balance are shown in figure 13-14. The optical center of an informal layout is also slightly above the actual center. When an element is placed at the exact center as it is in figure 13-14b, it does not appear to be as well balanced as an element placed slightly above the center as shown in figure 13-14c.

UNITY

Unity in a layout is the combining of the elements into an organized pattern which tends to weld the elements into a unified whole. In designing layouts, it should always be remembered that "the whole is more important than any of its parts." A composition without unity appears to be falling apart and produces a disturbing effect. However, it is possible to group the elements in an irregular manner to provide interest and variety. This is accomplished by allowing more white space around the outside edges of an arranged group of

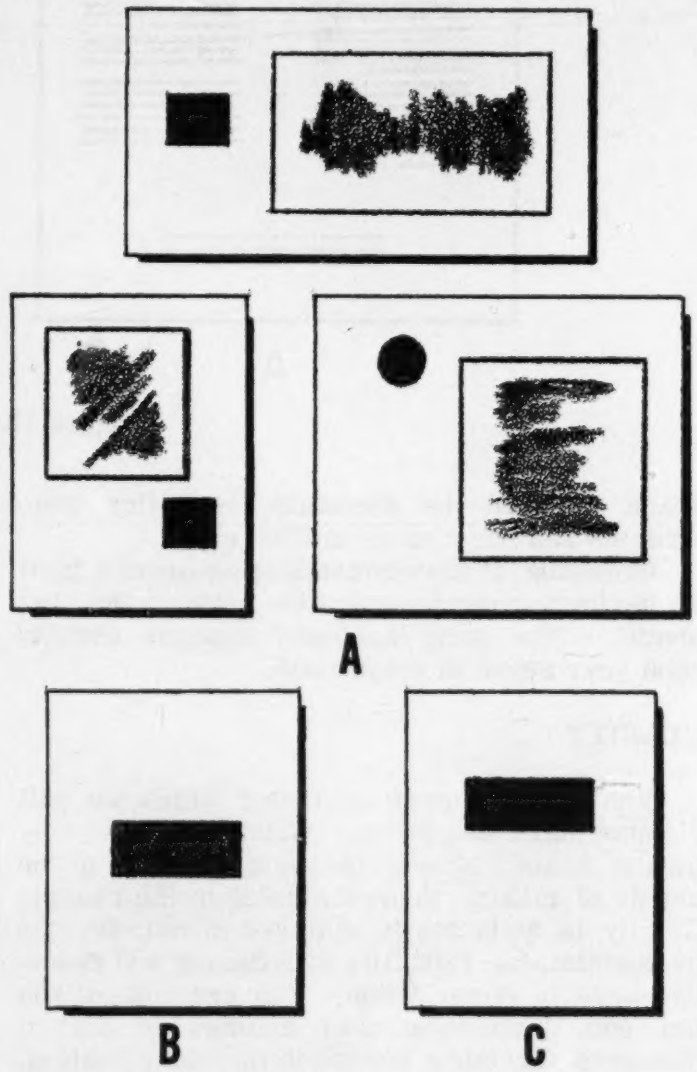

Figure 13-14.—Small dark against large light element.

elements rather than between each individual element. This white border will bring the various elements together; it has the same effect as a frame.

The layout in figure 13-15a is disorganized and seems to be falling apart due to the great amount of white space between the elements. The layout in figure 13-15b, with less white

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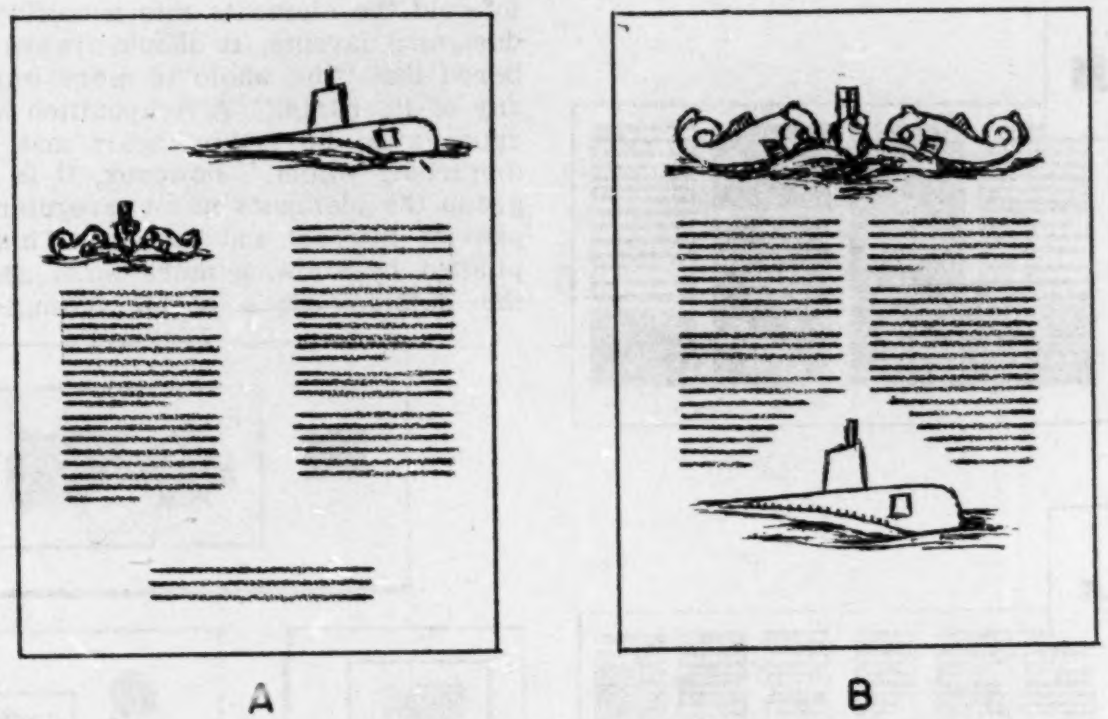

Figure 13-15.—Unity.

space between the elements, is better constructed and has a more unified effect.

Crowding of the elements is as great a fault as having too much separation between the elements. The unity achieved depends greatly upon your sense of proportion.

CLARITY

The last composition factor which we will discuss here is clarity. Clarity defines elements; guards against blending elements to the extent of making them confusing to the reader. Clarity is quite easily achieved in your layouts by maintaining legibility in lettering and definitiveness in composition. For example, if you lap one illustration over another so that it obscures the other too much for identification, or place a heading over a confusing background, you are not achieving clarity. If you choose to letter a message directly on an illustration, the lettering and the illustration should be in contrasting tones. If the tones of the elements are too close in value, such as brown and black, they will blend together and become illegible and confusing. When this happens, a point of confusion has been created which distracts the viewer from the rest of the layout. Examine every layout for clarity as well as for the other factors necessary for good composition.

FIGURE COMPOSITION

The people you show in your pictures, like the people in real life, must have feelings and emotions to appear realistic. In life, people express their emotions and express their actions with words. However, in your pictures, the people you draw can communicate only by expression and gesture. The appearance and action which you give your figures must enable your figures to tell everything.

The figures you place in your picture setting should be complemented by the setting. One of the most important points to remember when placing figures in a setting is to choose a setting which will help to explain and strengthen

Figure 13-16.—Comparison between inanimate object and the human form.

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the figures actions. When you wish to see something more clearly or follow an action better in nature, you can move your eyes or head. However, for a picture, only a set view is possible for the viewer. Therefore, this set view should be presented so that it best clarifies the action.

There may be few or many figures in a picture; arranging each group size into a good composition has its own special problems as well as possibilities. You must work, in effect, as a stage director; selecting appropriate characters, costumes, props, lighting, and, most important of all, a view that is clear and effective. You must become aware that good figure composition is far more than drawing a few figures in some relation to each other or placing them within the four borders of the drawing. You should learn to create a sharp and meaningful statement about a situation, and convey the various feelings of the people shown to be involved in the situation.

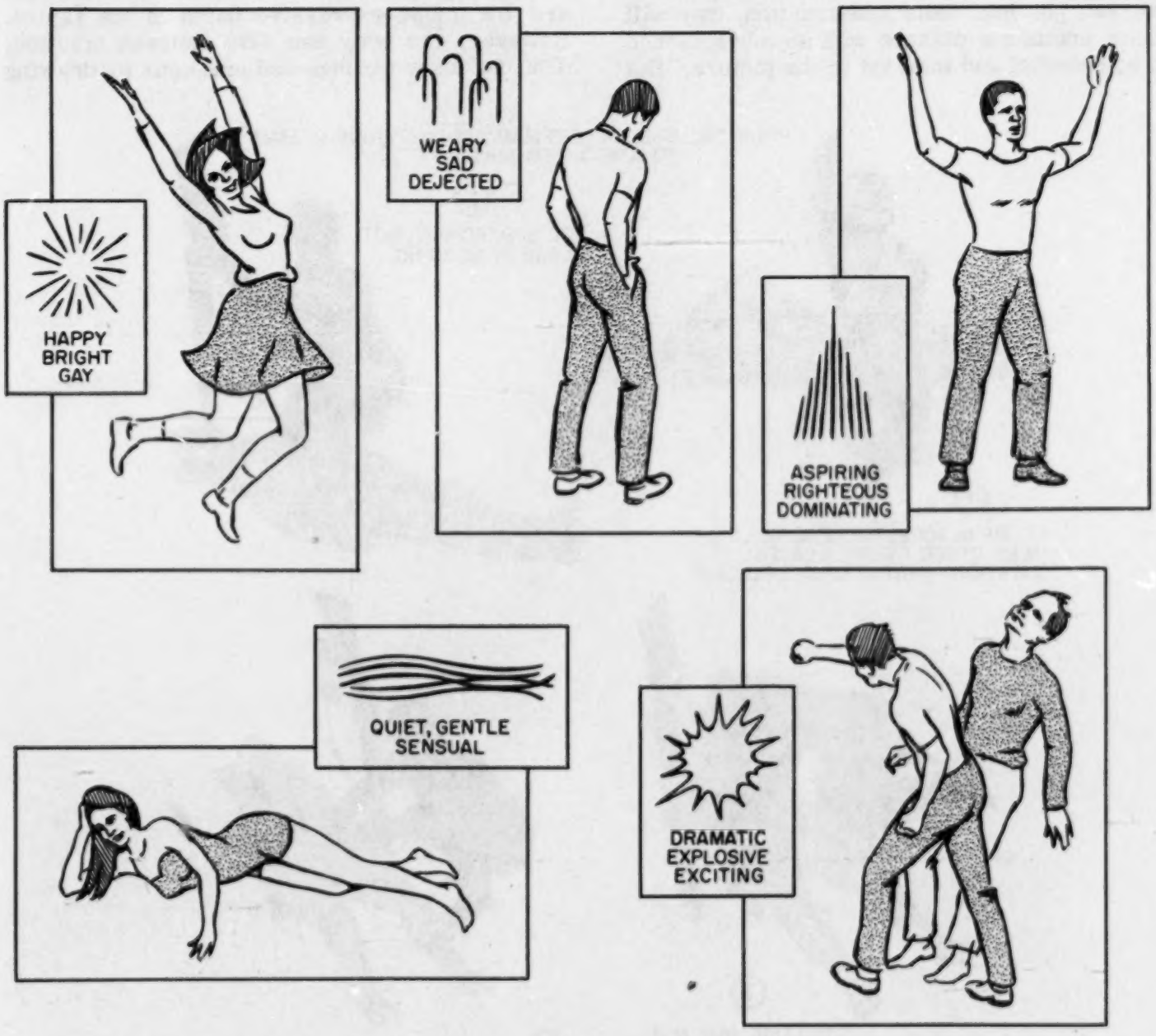

Figure 13-17.—Five mood symbols.

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THE LIVING, CHANGING SHAPE OF THE FIGURE

The drawing in figure 13-16 shows the striking difference between the human figure and the fixed forms of inanimated objects. The human figure is a living, mobile form which constantly changes shape. It can stretch, curl, lean, bend; the figure can assume countless different variations in form as it changes position.

It is this dynamism which provides a great deal of the interest to a picture containing human figures. Whenever you put two inanimated objects in a picture, no matter how much work you put into their construction, they will remain inanimate objects with no movement to add excitement and interest to the picture. But when you place two figures together, they will immediately appear to be related and to be responding to each other. They may also appear to be talking if placed face to face, or may appear to be looking at the same scene or object if both are shown facing in the same direction. The meaning of the picture will change as the attitudes or gestures which you give the figures change. The figure can be made to express any one of the human emotions or actions.

Mood Reflected by the Figure's Action

Earlier we noted that the head and the hands are the most expressive parts of the figure. However, the body can also express emotion. You can show feelings and emotions by drawing

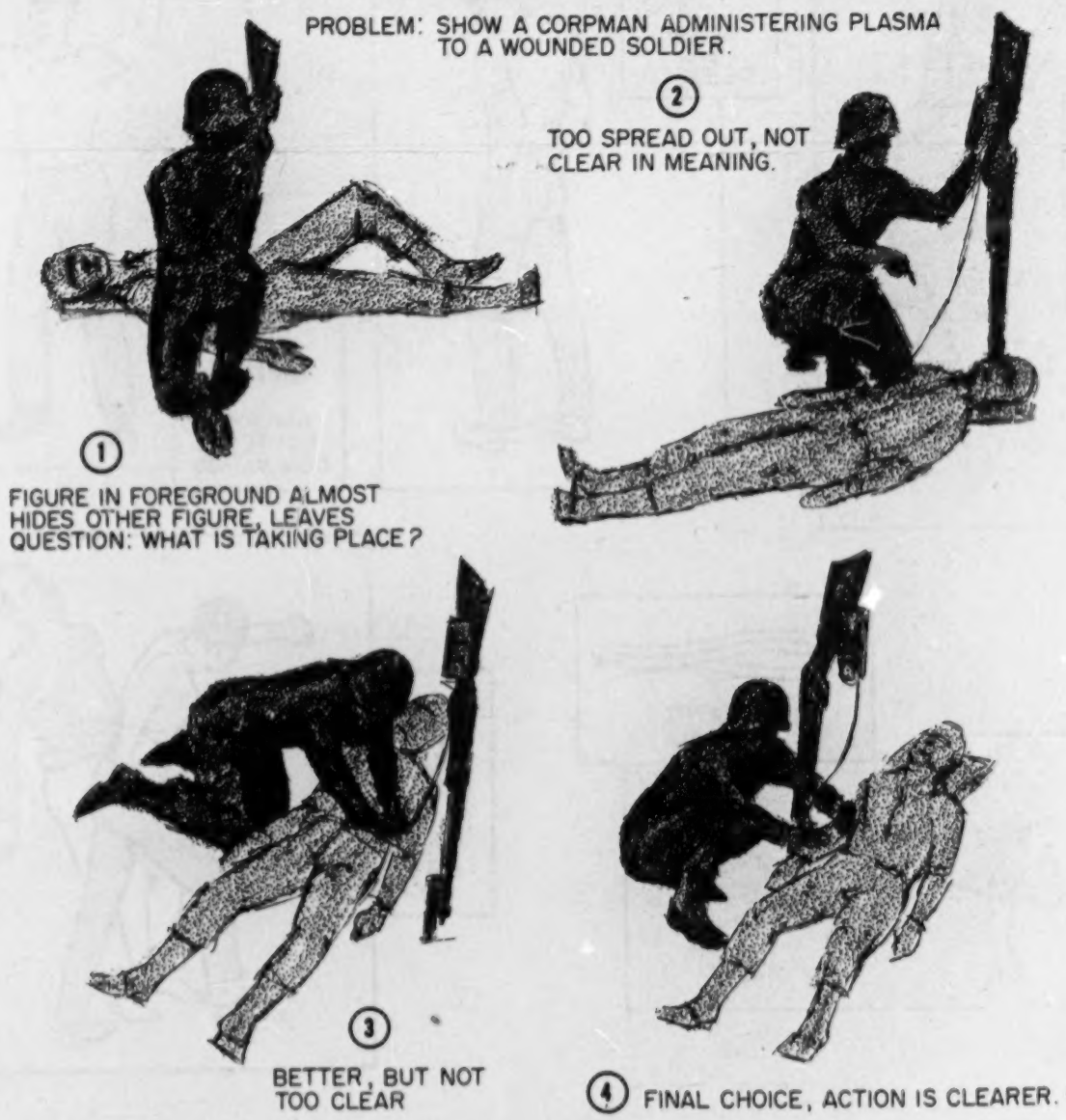

Figure 13-18.—Experiments to find best descriptive layout.

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periment with the placement of the figures in different positions so that you can better determine the most clear and expressive way in which you can arrange them.

The Simple Setting

Most compositions include a place as well as people. It may be anywhere, the corner of a room or a vast forest. You may show a small portion of the setting or a great portion, and permit it to dominate the picture.

The role of the setting varies greatly. Often it simply serves as a background which orients us to the figure's location. However, in many pictures the setting has greater importance; it serves to emphasize the figure's mood and action. Figure 13-19 illustrates the effect of simple settings used to advantage. Whether the background plays a large or a small role, you should use it to strengthen and explain the action of your figures.

Adding Another Figure

When you add another figure to a setting which contains one figure you create a human relationship. Your task is to make the relationship between the figures clear to the viewer. As before, the setting should help explain the story, it should not interfere with the relationship of the figures.

Adding a second figure to a picture area often means that you must vary the size and depth factors. See figure 13-20.

THE APPROPRIATE SETTING

Whenever you start a picture which contains figures, you should have in mind a background which will contribute to the mood and action of

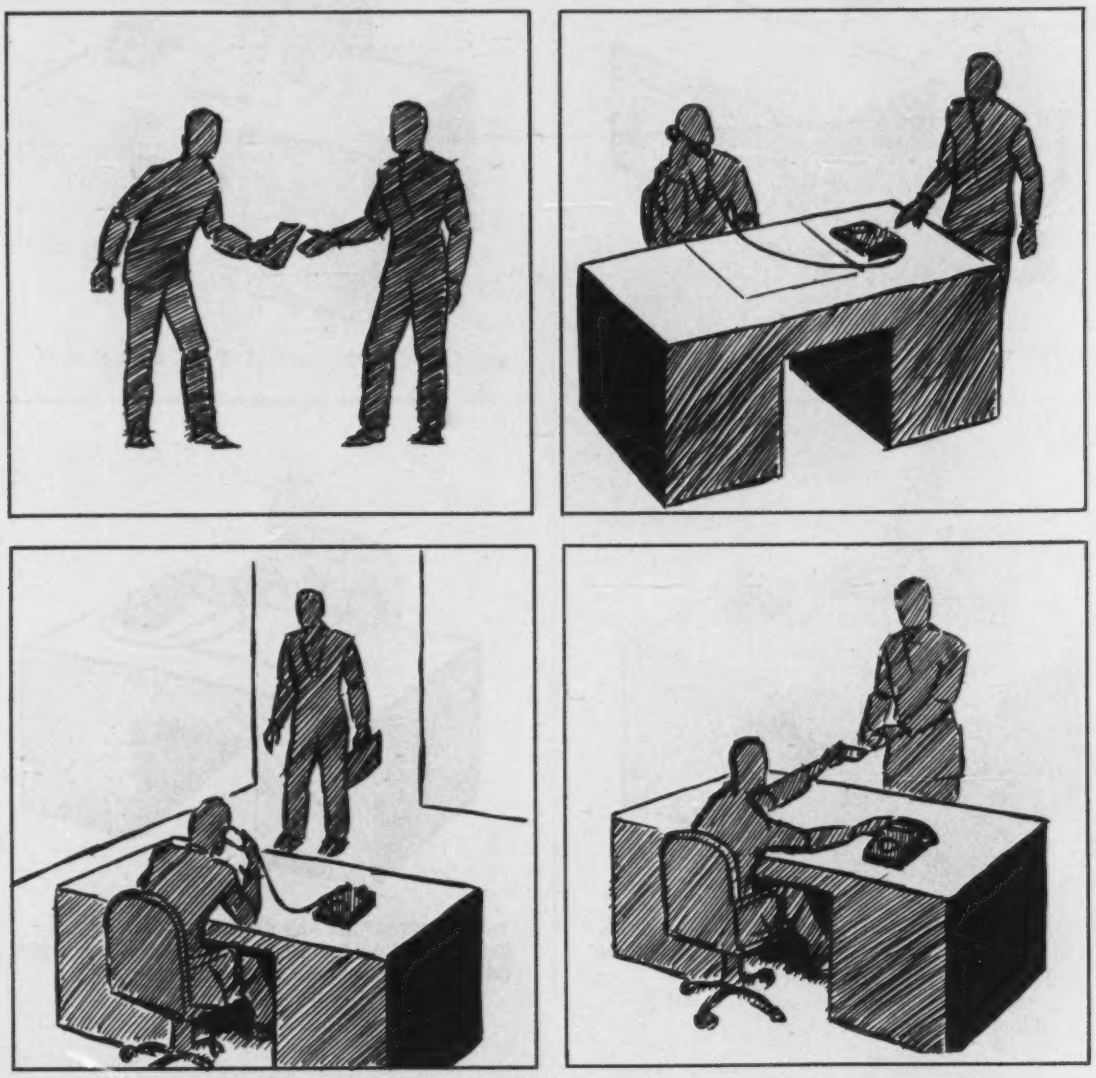

Figure 13-20.—Adding second figure to the simple setting.

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the picture. The scene should also be viewed from the view which best reinforces the impression you are creating.

For example, a light love scene could be more convincing by using a light, pleasant background. The same scene could be misleading or confusing if set against a dark dramatic background because the background would not support the intended mood of the scene.

Of course, events do occur in surroundings which are not generally thought to be appropriate to the event. However, from the picture compositors viewpoit, these are unusual events which would not be readily recognizable in a picture. Your task, as an illustrator, is to make the picture consistent throughout; both the background and the figure should support each other.

MAKING THE FIGURE STANDOUT IN SCENES

Often, the purpose of a picture is the setting. In such cases, you must give the setting the prominence it deserves, but also prevent it from overwhelming the figure. Size, position, value, and contrast are the most effective means to keep the scene from overwhelming the figures involved.

THE BORDERS

You should remember that there is a larger world outside the picture frame. Your placement of figures and objects should convince the viewer that the picture is part of the real world. Also, you should not forget that the borders are a part of the picture and often the link to the real world. The borders can have a particularly strong effect when you are using figures in your composition.

The effect of the borders may be to define or confuse, depending on where you place the figure relative to the borders. If, for example, you place a figure too close to a border, the figure may be obscured by the border; the composition is attracting the viewer's attention to the border rather than the figure's action. Even when the figure does not touch the border, the figure's gestures may direct the viewer's attention to the border. If a figure is placed nearer one border than the others, it tends to attract attention to

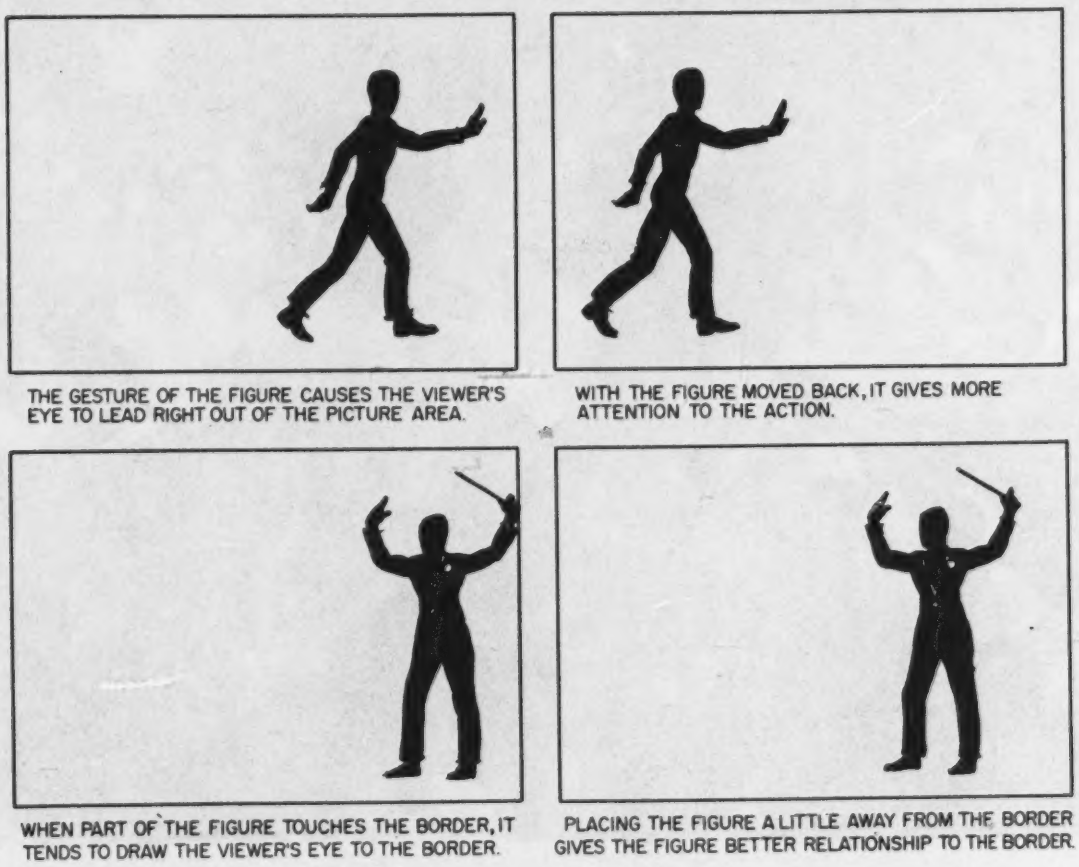

Figure 13-21.—Effect of border on actions of the figure.

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types of noises, their sources, methods of prevention or elimination, and "noise figure."

In all materials at normal temperatures, random movement of free electrons exists. The better the conductive qualities of the material, the greater is the random movement. An increase in temperature results in increased motion. In a conductor, this random electron motion results in erratic voltage fluctuations, called THERMAL NOISE because of the effect of temperature. Although thermal noise operates through a range of frequencies centered about the resonant frequency of the circuit, it is relatively independent of frequency at radar frequencies. Within normal temperature ranges, the noise spectrum decreases rapidly with increasing frequency; but this occurs noticeably only at and above the far infrared region of the electromagnetic spectrum. All random motion of electrons ceases at absolute zero temperature. At other temperatures thermal noise exists in all materials, but it is most important in conductors.

In electron tubes, electron emission from the cathode is not uniform in density or in time. Transit time of electrons is also nonuniform. As a result of these nonuniformities, electrons strike the plate at random intervals which are independent of the input signals or of the desired outputs. This phenomenon is known as SHOT EFFECT NOISE, or simply shot noise. Operating electron tubes in the space charge limiting portion of the operating range of the tube tends to reduce the effects of shot noise. The same problem exists in all electron tubes, and also in crystal diodes, transistors, and other current carrying devices.

In multigrid electron tubes (such as tetrodes, beam power tubes, pentodes, etc.), shot noise results in a random distribution of current between plate and screen. The additional noise which results is called PARTITION NOISE, and explains why pentodes are generally noisier than triodes.

Electrons in transit from the cathode to the plate in an electron tube induce currents into the grid circuit. If the electron flow were uniform, the electrons approaching the grid and those leaving the vicinity of the grid would have opposite effects, and would cancel each other. However, due to the random characteristics of the electron flow, the induced current is also random. The resulting noise is called INDUCED GRID NOISE. By the introduction of a proper mismatch, a reduction in the noise may be realized due to cancellation of part of the shot noise by a part of the grid noise. Only a small portion of the total noise may be eliminated in this manner.

Crystal diodes, when unexcited, will produce thermal noise the same as any other material. When current flows through the crystal, the result is a combination of thermal noise, shot noise in the barrier, and another noise (called FLICKER NOISE) which varies in magnitude inversely with frequency. This effect also occurs in transistors and in the oxide coatings of electron tube cathodes. It is most important at low frequencies. In crystal diodes, the effect of the combined noises is referred to as the CRYSTAL NOISE. TRANSISTOR NOISE is effectively the same as crystal noise, but occurs in transistors.

The NOISE FIGURE (or NOISE FACTOR) of a receiver is calculated by dividing its input signal to noise ratio by its output signal to noise ratio. Since the noise varies with temperature, the noise figure is usually expressed at a standard temperature of 63°F. The noise figure is expressed sometimes in decibels, and sometimes as a number. The smaller the number, the better the receiver.

Amplifiers connected in cascade will normally have a higher total noise figure than any of the individual amplifiers. The noise generated in the first stage will be introduced into the second, and amplified along with the desired signal. In addition, the second stage will generate noise of its own, to be further amplified by succeeding stages. Therefore the second stage also should have a low noise figure, although the noise figure of the first stage is the prime determining factor in receiver sensitivity.

LOW NOISE RF AMPLIFIERS

Conventional design of superheterodyne receivers calls for an RF amplifier as the input stage preceding the mixer stage. Due to the noise considerations just discussed, however, the use of the preamplifier at the microwave frequencies has been found impractical. It has been common practice to use the mixer as the input stage, with no RF amplifier preceding it. Recent developments in low noise devices, however, permit use of amplifiers based on these devices as input stages for microwave receivers. The devices discussed in this section are the triode RF amplifier, the traveling wave tube, the backward wave amplifier, the klystron, the

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the nearer border. This effect is shown in figure 13-21. To avoid this problem, you should learn to leave more space between the figures and the border. Proper placement of a figure greatly aids in creating the illusion of action and movement.

COMPOSING A PICTURE OF A GROUP OF PEOPLE

The principle which we have used for composing one, two, and several figures in a picture are the same principles we will use to arrange a whole crowd of people in a picture. This is because, in general, a crowd is little more than one or two expressive figures shown many times in various attitudes. If you can compose a few figures together in a picture, you can compose any number of figures in a crowd scene.

A crowd, like an individual, may express any emotion; gaiety, sorrow, anger, or tension. Its mood can be a more subtle one, too, it may be indifferent, mildly curious, or merely waiting for something to happen. A large group of people must always express some mood or feeling; a crowd is never expressionless.

Although every figure in a large group usually reveals the same basic emotion, they may do so in various ways. Study a real crowd or a photograph of one, note their different gestures and expressions. Unless you are aware of these individual variations and show them in your pictures, crowd scenes will tend to become monotonous repetition of forms and faces; a caricature rather than a convincing representation. Figure 13-22 illustrates the use of variation in a crowd scene; the individuals showing different forms of the same basic emotion.

SHARPENING THE EFFECT OF THE PICTURE

A composition may be well balanced, pleasant, and interesting, but the picture may still fall short of being effective. Usually this is a

Figure 13-22.—A picture composition of a crowd.

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sign that the illustrator has not given enough thought to sharpening up the picture idea, thought as to how he can get his idea across faster, more clearly, and with the greatest impact.

After you have composed a picture, sit back and ask yourself the questions, "Does this arrangement really do what I want it to do?" "What would happen if I made one figure smaller and the other larger?", "Would the whole idea be clearer if I moved these figures closer together?", and "Do I need to show this much background?"

The time you spend in thought, asking and answering questions like these, is important. This type of directed thought often can mean the difference between a picture which is merely pleasantly composed and one which effectively expresses it's meaning.

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CHAPTER 14

PERSPECTIVE FOR THE ILLUSTRATOR

In chapter 11 you were introduced to perspective and to its importance in the realistic illustration of basic forms. Perspective is the art of drawing an object so that it will appear to recede in distance and create a realistic illusion of depth. Perspective is a natural phenomenon which is easily recognized with regular man-made forms such as railroad tracks, signs, fences and houses. Perspective gives the true length and direction of a receding edge or a receding side of an object. The principles of perspective apply to all forms. Perspective control of all free forms such as trees, clouds, mountains and people is equally important to the visual correctness of a drawing if the drawing is to look normal to the viewer.

Chapter 11 introduced the meaning and use of the horizon line and the vanishing points. The third element in perspective is the station point, the point from which the object is observed. These elements are shown in figure 14-1.

In learning perspective, the cube is the most important single object to study at the outset. When you thoroughly understand the principles of drawing the cube in good perspective, you can easily apply this to all other types of forms in perspective, for you will find as you progress into more complicated structural developments

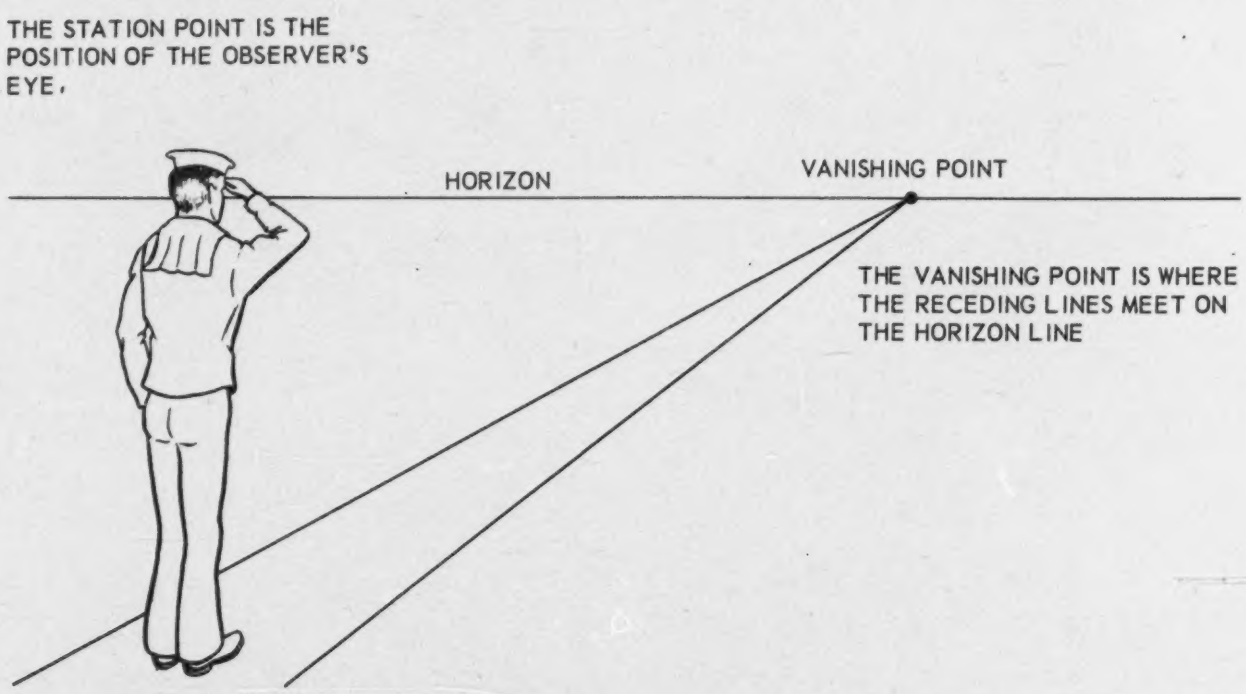

Figure 14-1.—Third element in perspective.

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that relating them to the basic geometric form is the fastest, most accurate method of perspective drawing. Figure 14-2 contains some cube construction exercises that you should study carefully.

Although perspective is a useful tool, it should not be a substitute for careful observation. You may find it necessary to distort the perspective in order to create a more dramatic or realistic drawing. In all final analysis, observation and experience will tell you if a drawing is correct or not, but a thorough understanding of perspective will equip you with a more acute sense of observation and feeling for form and will help you in making your drawings more convincing and realistic.

THE PICTURE PLANE

A simplified definition of the picture plane is that it is an imaginary vertical plane placed

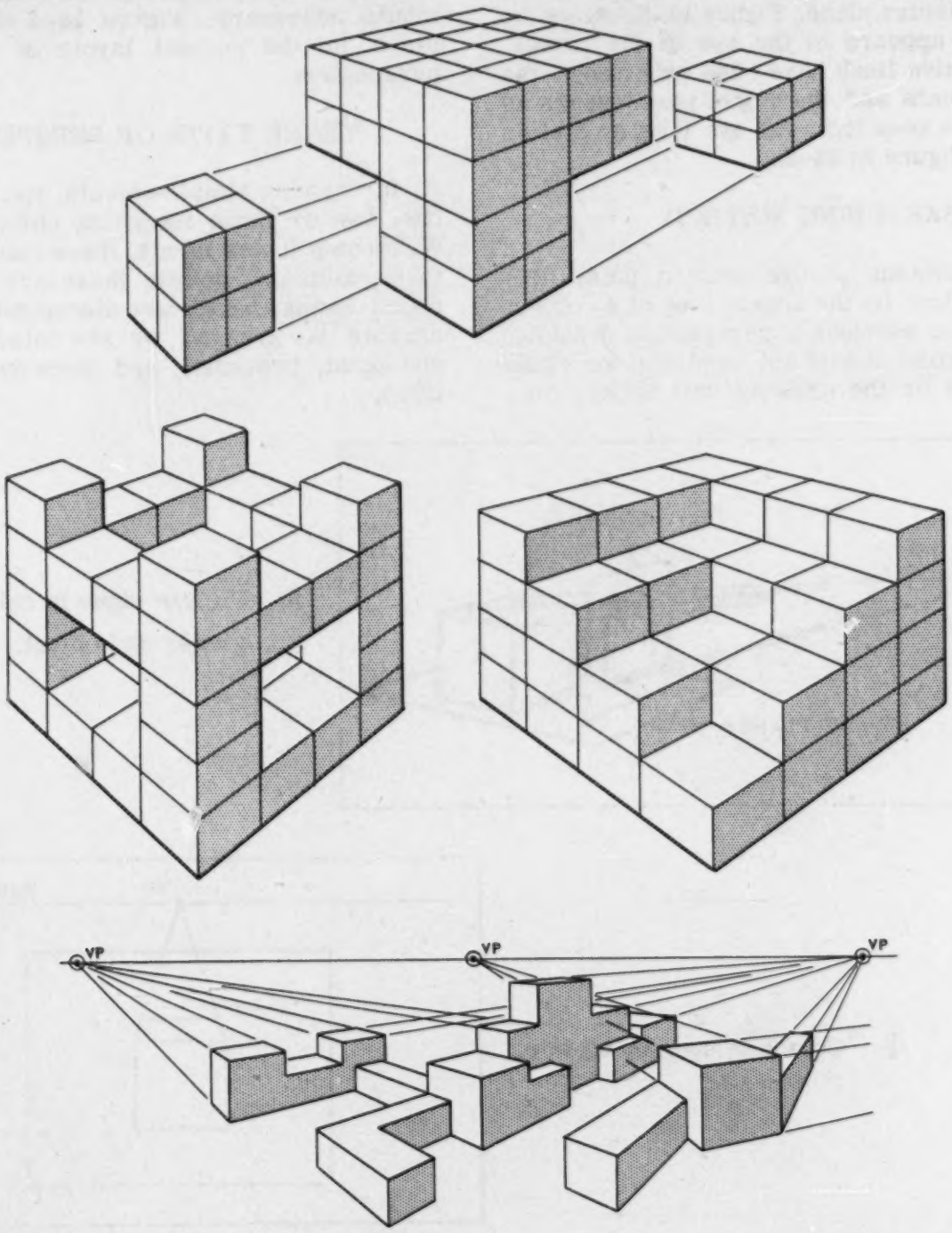

Figure 14-2.—Cube construction.

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between the eye and the object to be drawn. This is seen in figure 14-3. The object being viewed will appear on this imaginary plane just as it will appear on the finished drawing. The location of the picture plane between the viewer and the object will influence the relative size of the object on the finished drawing. The closer the picture plane to the object, the larger the image appears. Figure 14-3a shows a picture plane. You can see the eye level and the object being viewed. Between the eye and the object is the imaginary picture plane. Figure 14-3b shows the object as it appears to the eye of the viewer. The perspective lines have been extended to the vanishing points and the object now appears as it would when seen from the eye level or station point of the figure in 14-3a.

SKETCHING METHOD

The placement of the station point (SP) has more effect on the appearance of an object than any other element of perspective drawing. The station point should not be placed too close to the object or the drawing will appear distorted. Distortion should always be avoided. Whenever the station point is changed, regardless of how slightly, all perspective lines on the drawing change.

When you start a drawing, make several rough sketches to establish the best view for your needs, thereby establishing the best station point.

If a drawing requires accurate perspective, sketch freehand the desired view. Establish eye level and vanishing points and make any adjustments necessary. Figure 14-4 shows various steps in the normal layout of an object in perspective.

THREE TYPES OF PERSPECTIVE

In drawing simple objects, you will find that one, two or three vanishing points may occur. With complicated forms, there can be more than three vanishing points; these are called compound forms, which are discussed later in this chapter. At present, we are interested only in one-point, two-point, and three-point perspectives.

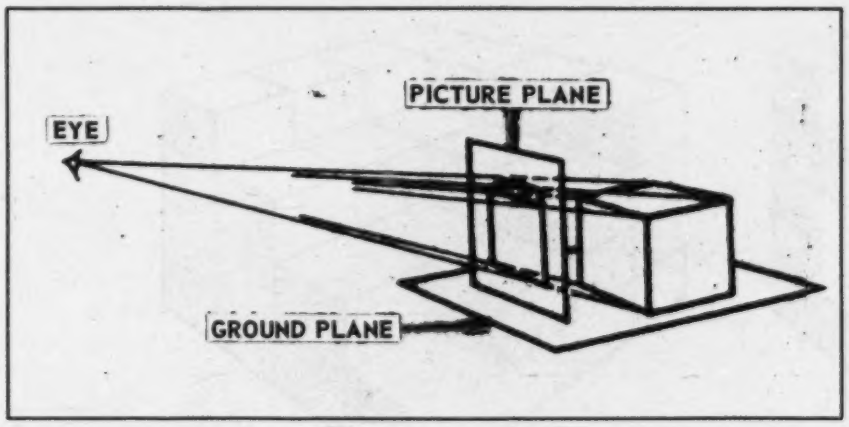

A Picture plane in relation to viewer and object.

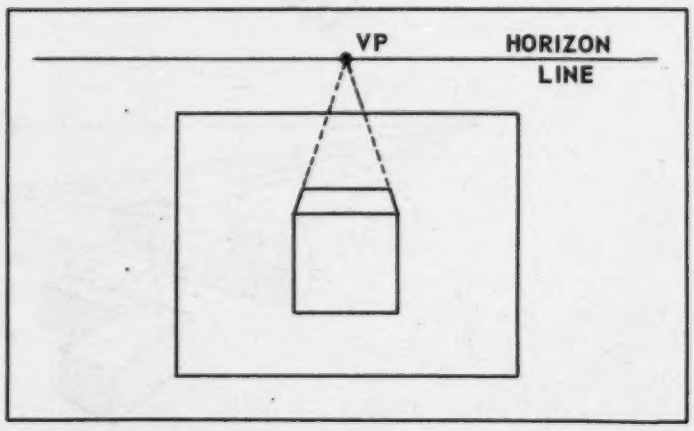

B Object as seen by viewer.

Figure 14-3.—Picture plane.

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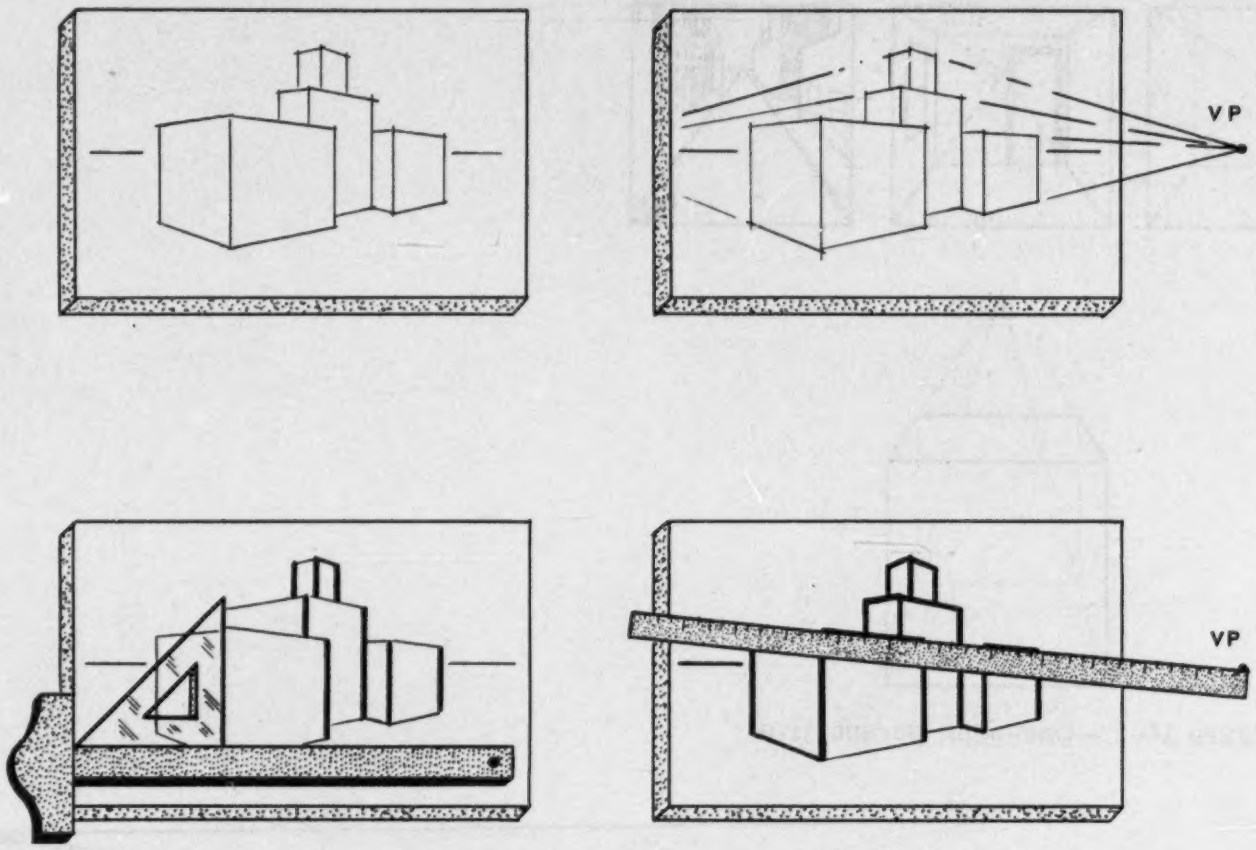

Figure 14-4.—Layout in perspective.

ONE-POINT PERSPECTIVE

One-point perspective exists when two dimensions of an object (height and width) are parallel to the picture plane. This occurs when the object being observed is straight in front of the observer, not at an angle. In such a view there is only one dimension, depth, that is left to be accounted for. This dimension must have a a vanishing point. The two dimensions parallel to the picture plane have no vanishing points. Figure 14-5 shows how one-point perspective can occur in several ways. If you look at a cube straight on, the vanishing point is out of sight behind it. If you were standing inside the cube, as in a room, you would have the same situation that you have when you are looking down the middle of a street. The right and left walls of the enclosure correspond to the flat fronts of the buildings on the side of the street. In such a view all parallel lines appear to run to one vanishing point, except of course, the lines parallel to the picture plane.

TWO-POINT PERSPECTIVE

In two-point perspective, height is the only dimension parallel to the picture plane. This leaves two dimensions, depth and width, which must have vanishing points; thus two vanishing points must be established on the horizon line as shown in figure 14-6. In figure 14-6, the closer together the two vanishing points are, the less you see of the sides of the object being drawn.

When laying out a perspective drawing, follow the steps given in the SKETCHING METHOD. This will help you in deciding how much of the surfaces you wish to show in your drawing before you establish the two vanishing points. This procedure will automatically fix the station point and the view you wish to have. The vanishing points may be as close or as far apart as you wish, but remember that the closer together they are, the greater the chance of distortion. In figure 14-6 you can see that the horizontal edges of the cube become diagonals when drawn

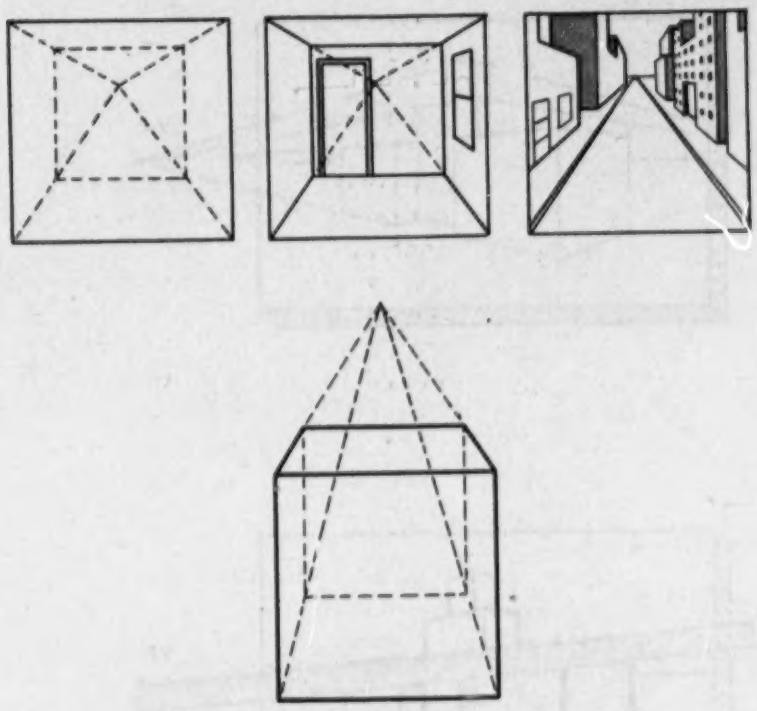

Figure 14-5.—One-point perspective.

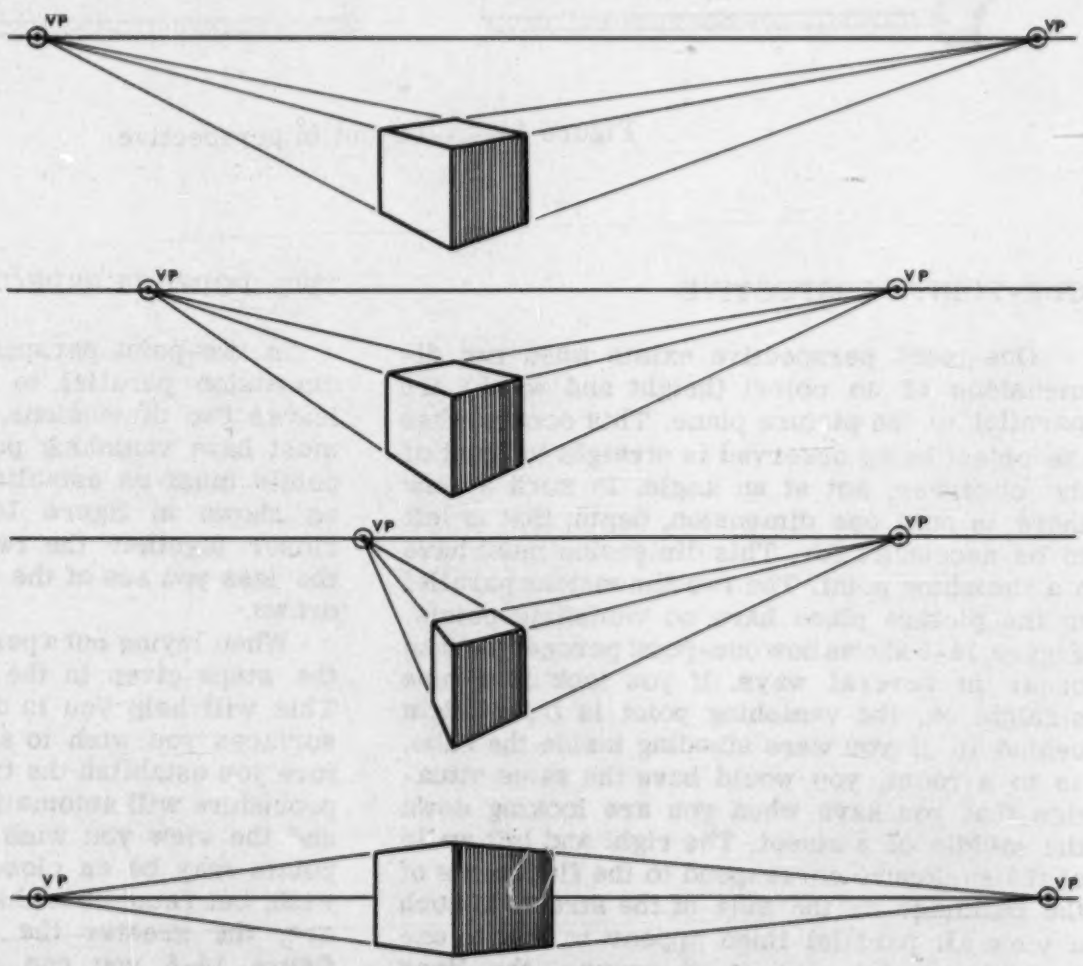

Figure 14-6.—Two-point perspective.

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in perspective. The angle of these diagonals is determined by the closeness of the eye to the object. The closer the eye to the object, the more acute the angle becomes.

THREE-POINT PERSPECTIVE

Three-point perspective occurs when none of the object's surfaces (height, width and depth) is parallel to the picture plane (see fig. 14-7). Three-point is usually needed when the station point is close to the object, such as when you are looking up at a large nearby ship or tall building. The horizon in this case is usually very low, or entirely below the object. If you were looking down from above, the horizon may not appear in the view at all.

A good general rule to follow when doing this type of perspective is that small objects will usually look better if the three vanishing points are well separated. The perspective should not be acute. To emphasize the bigness of an object, sharp diagonal lines are important. Here the closeness of the vanishing points strengthens the bigness effect.

The horizontal diagnonal lines must end at the eye level line. One line cannot be higher or lower than the other. Regardless of their distance apart, they must be established on the same eye level.

HOW TO DRAW A CUBE IN PERSPECTIVE FROM A PLAN VIEW

In order to place a cube in accurate perspective in relation to a definite station point and eye level, a plan view is used as shown in figure 14-8. Application of this method enables you to draw an object as it may appear at any distance and viewpoint you desire. The sources of information necessary for this type of drawing are a scaled drawing of the top and a side view of the object. In regard to drawing a cube, all sides are of equal length and a side view is not necessary. If a box of unequal sides were used, you would need an elevation view of the box in order to find its height. This is covered later in this chapter.

In figure 14-8 two-point perspective is used since only one dimension-height is parallel to the picture plane. Figure 14-8 has you looking directly down on top of a cube. Since the top of the cube is a square, draw a square on paper and establish the station point at a distance (A) no less than three times the length of one side of the cube away from the cube (fig. 14-8). The station point is the spot from which you will view the cube to make the drawing. Now place a horizontal line (B) (picture plane) between the station point and the square so that the line touches the nearest corner of the cube. It is not

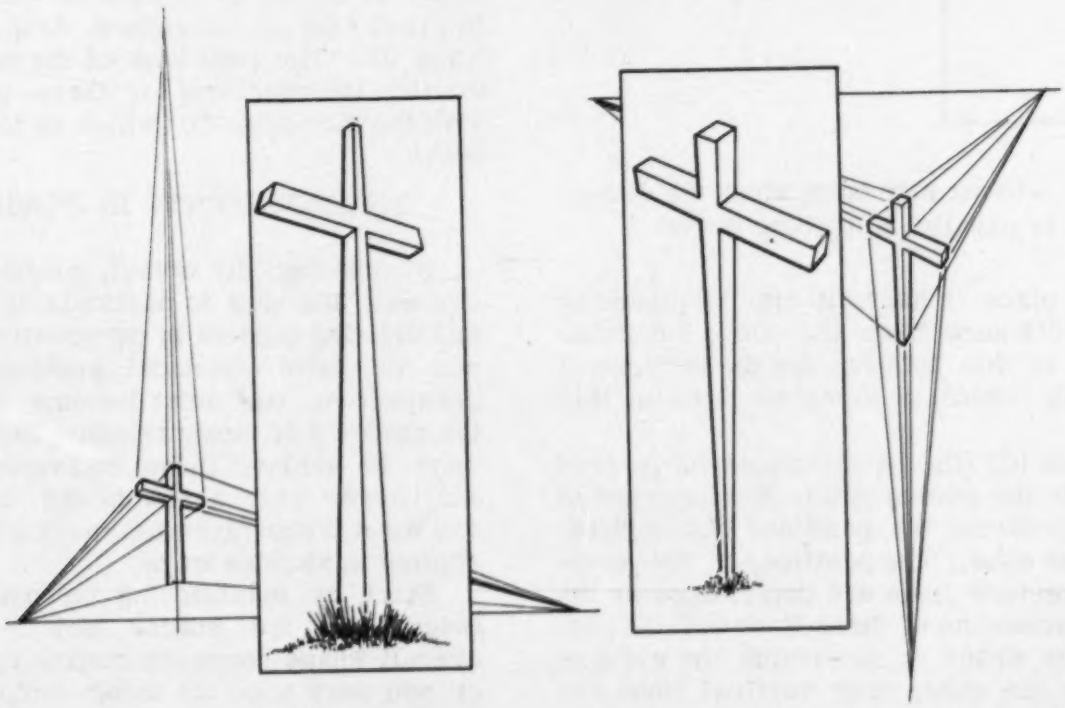

Figure 14-7.—Three-point perspective.

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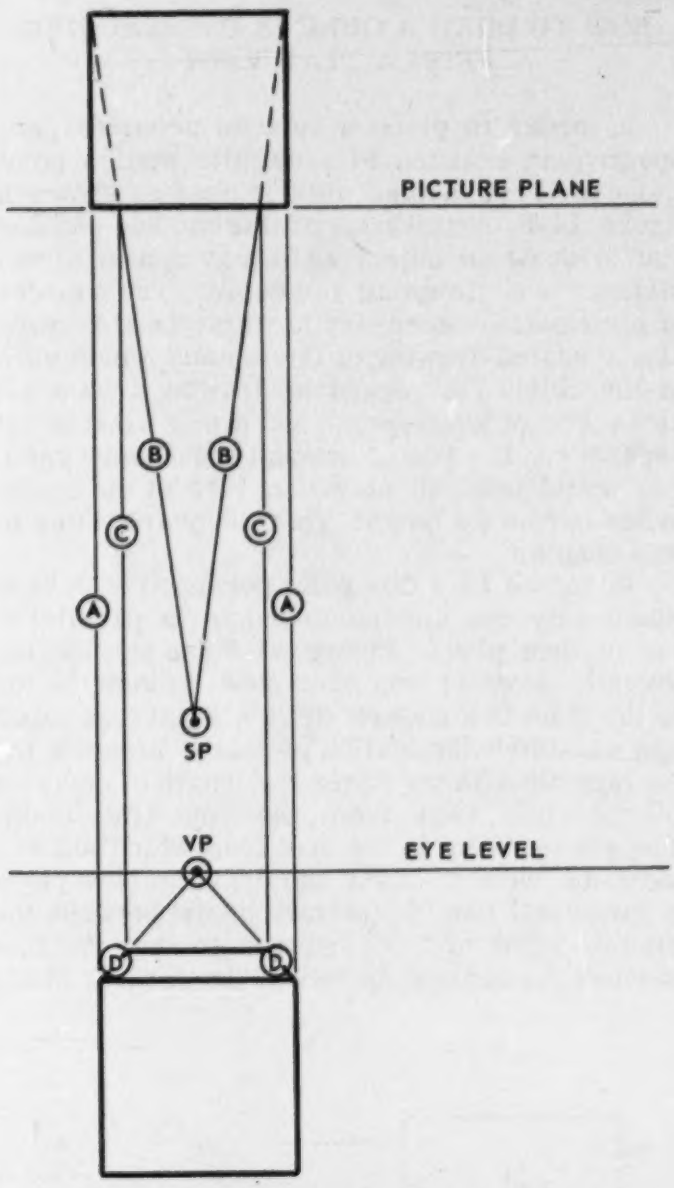

Figure 14-8.—Using plan view when one dimension is parallel to picture plane.

essential to place it here; it may be placed at some other distance from the cube, but it has been placed in this position for the purpose of measurement, which is dicussed later in this chapter.

Draw lines (C) (fig. 14-8) from each corner of the square to the station point. (Each corner of the cube represents the positions of a vertical corner of the cube.) The positions of the verticals on the picture plane are determined by the points of intersection of these lines with the picture plane. In order to determine the width of each side of the cube, drop vertical lines (D) from the points where the lines (C) intersect the picture plane. Make a heavy line (1) the same length as lines (a) or (b). Line (1) represents the corner of the cube closest to you. Because the corner of the cube touches the picture plane, line (1) representing the corner of the perspective drawing, will be the same length as it is in the plan view.

Now draw the eye level or horizon line (E) so that line (1) overlaps it. (If you want to look down on the cube, place the eye level above line (1); and below line (1) if you want to look up at the cube.)

Now draw lines (a') and (b') parallel to lines (a) and (b), extending them upward from the station point until they touch the picture plane. From these two points on the picture plane drop verticals (F) and (G) to the eye level line to establish the left and right vanishing points. To finish the drawing, draw lines from the top and bottom of line (1) to each vanishing point and then heavy-up the portions of lines (D) which represent the right and left edges of the cube.

Figure 14-9 shows how the same cube in figure 14-8 is drawn in perspective when two dimensions are parallel to the picture plane. Again you are looking directly down on the top of the cube in the plan view. The nearest side of the cube touches the picture plane. To establish the near corners in the perspective drawing, drop perpendiculars (A) from the corners in the plan view. To establish the far corners, draw two lines (B) from the station point to the far corners. From the points at which these lines intersect the picture plane, drop perpendicular lines (C). The positions of the far corners are at the intersections of these perpendiculars with the side lines (D) which go to the vanishing point.

MEASUREMENTS IN PERSPECTIVE

In drawing any object, proportions must be correct; and this is particularly true when you are drawing objects in perspective. In order for you to solve practical problems in artistic perspective, you must become acquainted with the methods of measurement. There are several ways to achieve these measurements, but we will cover only a few of the more important and most frequently used methods which may be applied in various ways.

Start by establishing the needed vanishing points and the station point. Establish the overall shape correctly before you continue on, or you may wind up doing endless correcting.

To divide a square, draw diagonal lines from corner to corner as shown in figure 14-10;

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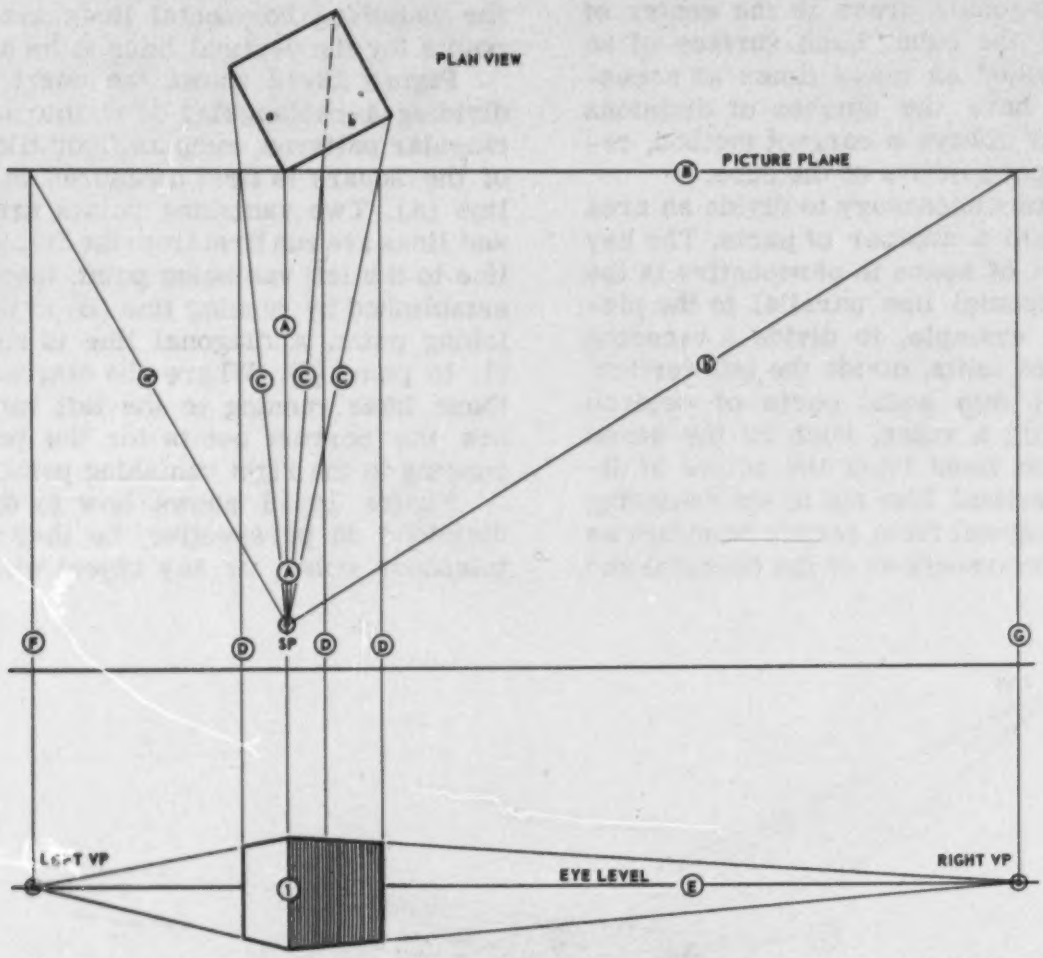

Figure 14-9.—Using plan view when two dimensions are parallel to picture plane.

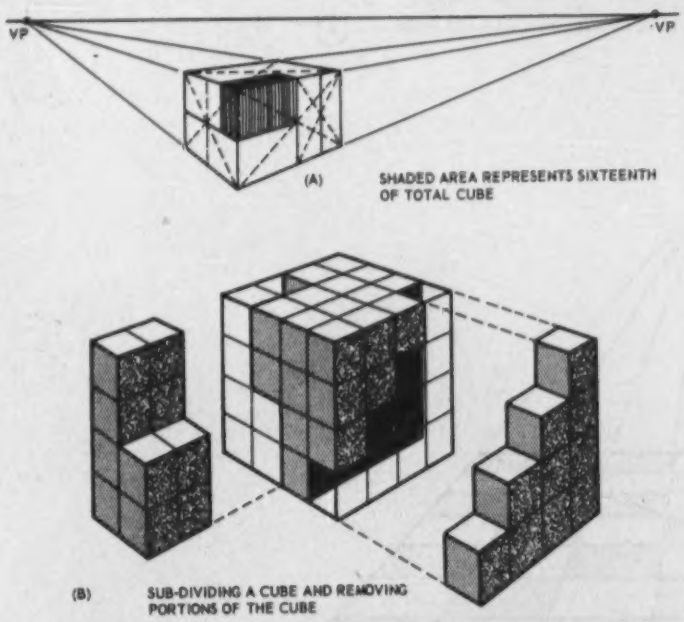

Figure 14-10.—Subdividing a cube. (a) Shaded area represents one-sixteenth of a total cube. (b) Subdividing a cube and removing portions of the cube.

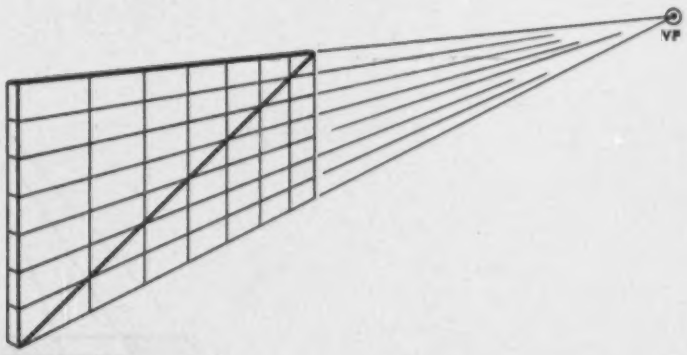

Figure 14-11.—Dividing diagonal areas.

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reactance (parametric) amplifier, the maser, and the tunnel diode.

In addition to the low noise figure already discussed, the input amplifier must have certain other characteristics in order to be wholly effective. The circuit gain must be adequate to overcome the noise which is introduced by the succeeding stages of the receiver. It must be able to withstand the transmitter power leaking through the TR circuit; it should be conveniently small and rugged, and not excessively complex; and it should be as reliable and troublefree as possible.

The Triode RF Amplifier

In the UHF range, it is usually advantageous to precede the vacuum tube mixer by one or more stages of radiofrequency amplification at the carrier frequency. Vacuum tubes are able to withstand relatively large amounts of transmitter power, so the TR circuit is not quite so critical as with the crystal mixer type input circuit to be discussed later in this chapter.

The input circuits of UHF receivers usually employ disk seal triodes and are frequently connected to form a grid return type of circuit. An RF amplifier employing a disk seal tube in a grid return circuit is very stable and has very little tendency to oscillate, the only feedback path being through the extremely low plate to cathode capacitance of the tube. Pentodes are available for operation in the UHF range, but they generally have a higher noise figure than triodes and are therefore less suitable in applications where a high degree of sensitivity is required.

In VHF receivers that operate at 200 megacycles or below, the tuned circuits of the input stages are composed of lumped inductances and capacitances. Often physical capacitors are unnecessary, the inductors being made to resonate with the tube and wiring capacitances. In the region of 1,000 megacycles the lumped-parameter resonant elements are replaced by cavity resonators.

An example of an input circuit of a receiver that operates in the vicinity of 1,000 megacycles is given in figure 12-32. The circuit consists of a single stage of radiofrequency amplification, a local oscillator, and a mixer. Lighthouse tubes and coaxial line resonators are employed in each unit, and connections between units are made by means of short sections of coaxial cable. The lighthouse tubes are shown mounted in their respective tuners in (A) of the figure.

The RF amplifier is similar in construction to the lighthouse tube oscillator shown in figure 12-10 and the local oscillator in figure 12-32 (A). The only major difference between the RF amplifier and the local oscillator shown in figure 12-32 is that in the amplifier the middle cylinder of the tuner is not cut away at the grid terminal of the tube. As shown in the local oscillator section of (A), the cutaway section of the grid line provides the extra coupling needed in the oscillator between plate and cathode lines. Since there is no cutaway section in the RF amplifier's grid line, the plate and cathode circuits are isolated except for the small interelectrode capacitance between the plate and cathode of the tube.

The plate supply voltage is conducted to the plate terminal of the amplifier tube V1 by means of an insulated wire which passes through the innermost coaxial cylinder. This cylinder, which serves as one conductor of the plate line, is coupled to the plate terminal through capacitor C1 in order that the tuner may be operated at ground potential. Inductor L1 serves as a choke to prevent RF signals from entering the power supply. The middle cylinder of the tuner connects directly to the grid terminal, and the outer cylinder fits over the shell of the tube, which is grounded. All cylinders are connected together by the shorting plungers in the plate and cathode lines. A bypass capacitor within the tube provides an RF connection between shell and cathode, and cathode bias voltage is developed across C_{k1} and R_{k1} in parallel between the cathode pin and ground. Input signals are coupled into the cathode to grid line by means of a probe, and a coupling loop is used to take the amplified RF signals from the plate to grid line.

An RF equivalent circuit of the amplifier, in which the plate and cathode lines are replaced by parallel LC circuits, is shown in the upper left portion of (B). Observe that the equivalent circuit is drawn so as to emphasize the grid return aspect of the amplifier. The plate line, represented by L_{p1} and C_{p1} in the figure, is adjusted to resonate with the plate to grid capacitance C_{gp} of the tube at the frequency of the incoming signal, and the cathode line in parallel with C_{gk} is adjusted very nearly to the frequency of the incoming signals.

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where these diagonals cross is the center of that surface of the cube. Each surface of an area can be divided as many times as necessary until you have the number of divisions desired. This is always a correct method, regardless of the perspective of the cube.

It is sometimes necessary to divide an area or a diagonal into a number of parts. The key to most division of space in perspective is the vertical or horizontal line parallel to the picture plane. For example, to divide a receding plane into square units, divide the left vertical in figure 14-11 into equal parts of desired measurement with a ruler, such as the seven parts shown. Run lines from the points of division on the vertical line out to the vanishing point. Draw a diagonal from corner to corner as shown, and the intersections of the diagonal and the vanishing horizontal lines are the correct points for the vertical lines to be added.

Figure 14-12 shows the correct method of dividing a rectangular area into uniform rectangular patterns, such as floor tiles. The width of the square is first measured on a horizontal line (A). Two vanishing points are established and lines are run first from the divided horizontal line to the left vanishing point, then the depth is established by running line (B) to the right vanishing point. A diagonal line is run from point (1) to point (2). Where the diagonal intersects those lines running to the left vanishing point are the correct points for the receding lines running to the right vanishing point.

Figure 14-13 shows how to draw vertical divisions in perspective, be they fence posts, telephone poles, or any object with even space

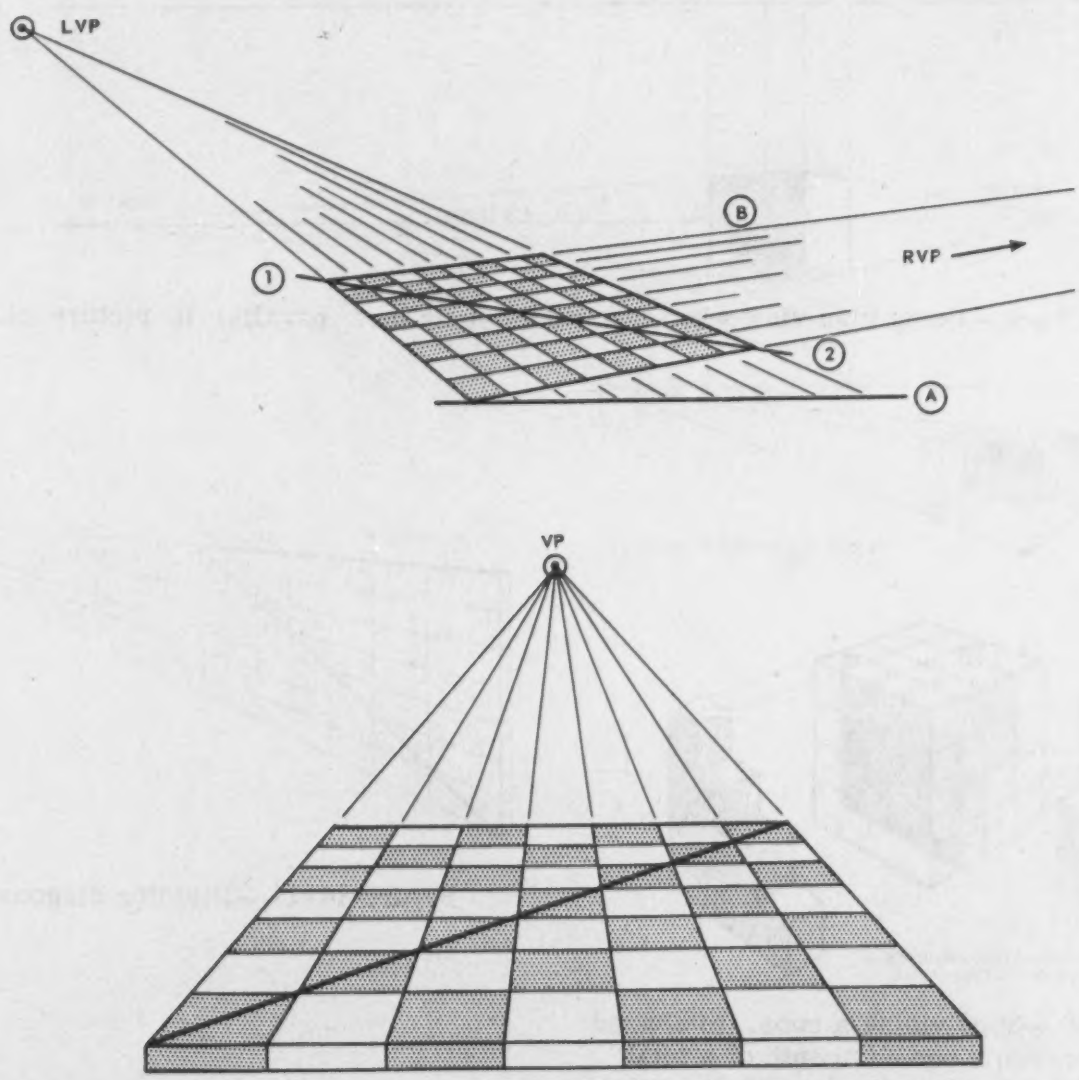

Figure 14-12.—Dividing rectangular area.

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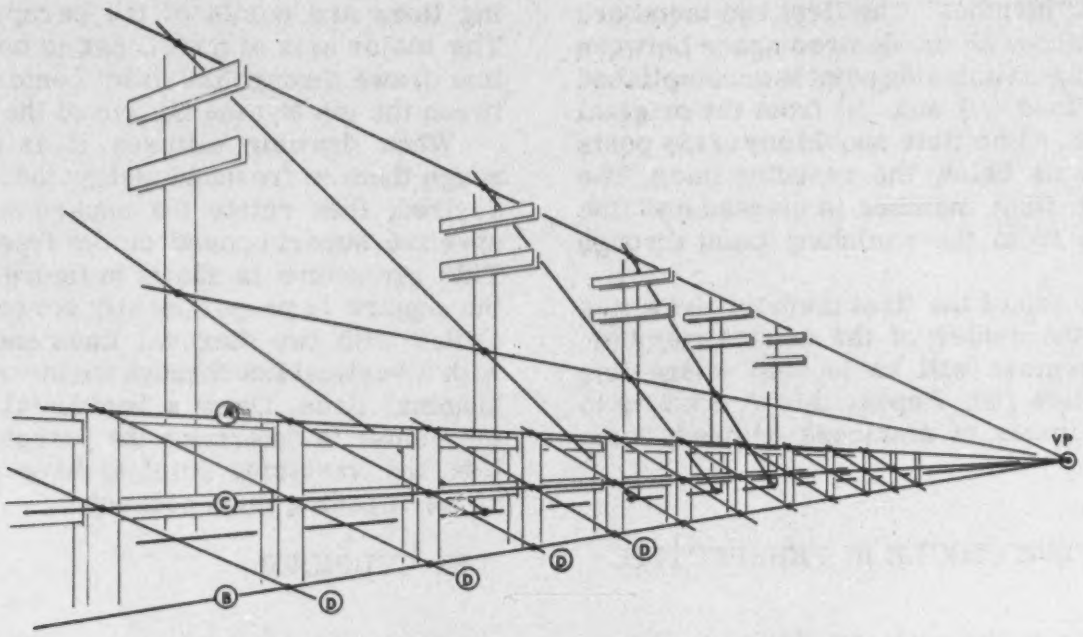

Figure 14-13.—Drawing vertical divisions in perspective.

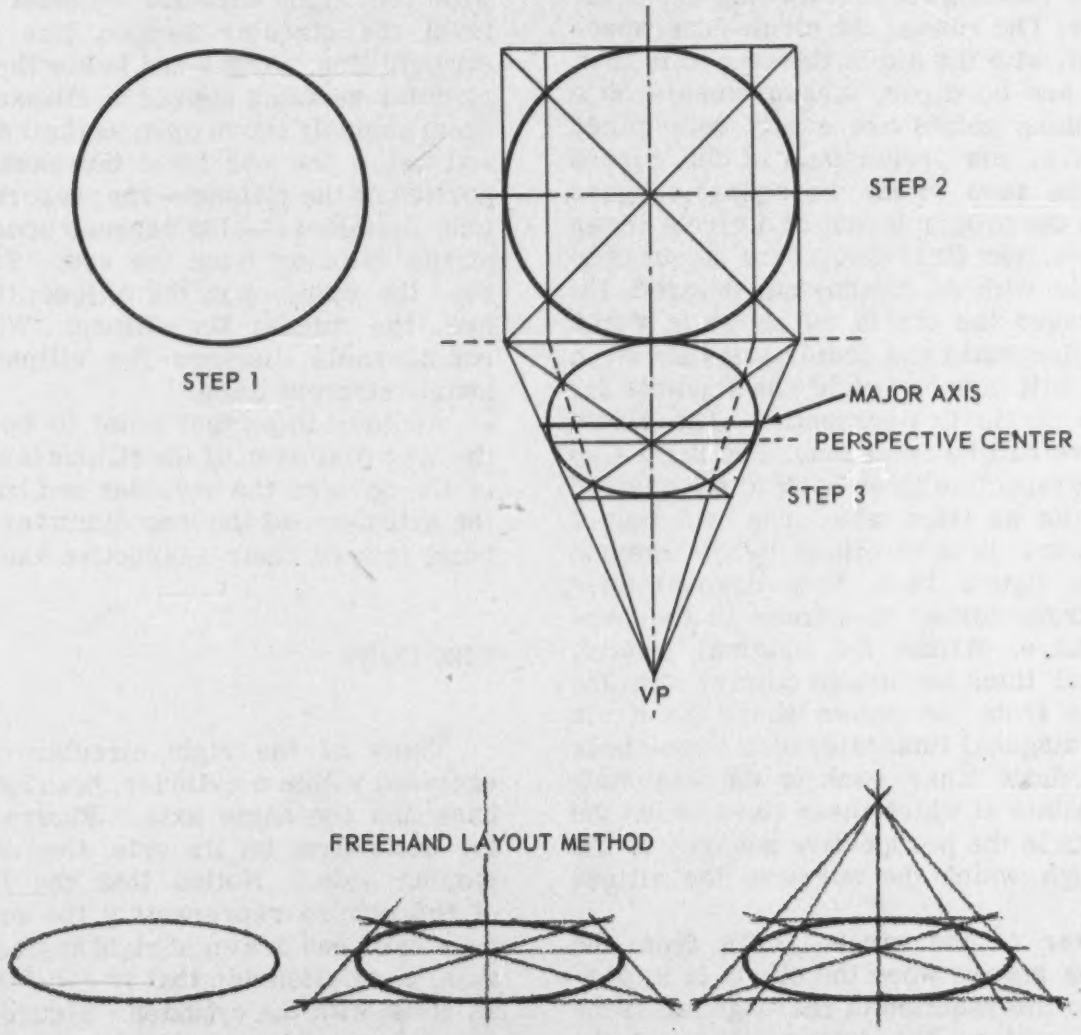

Figure 14-14.—Drawing the circle in perspective.

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between each member. The first two members are constructed with the desired space between them. Locating a vanishing point is accomplished by drawing lines (A) and (B) from the original two members. At no time should any of the posts extend above or below the receding lines. The center of the first member is marked and line (C) is drawn from the vanishing point through the mark.

From the top of the first member draw line (D) through the center of the second member. The third member will be located where line (D) touches line (B). Repeat this procedure to locate any number of members desired, doing one at a time.

DRAWING THE CIRCLE IN PERSPECTIVE

The circle is the guide for drawing all two-dimensional curves, ellipses and ovals in perspective. The base figure for drawing the circle is the square. The reason the circle in perspective is drawn with the aid of the square is that, while there are no direct measurements on a curve, vanishing points are easily determined for the square, and proportions of the curves can easily be seen within the square. Figure 14-14 shows the proper layout of a circle drawn in perspective. The first step in the layout is to draw a circle with the dimensions desired. Fit a square around the circle as shown in step 2 and add the diagonals and center lines shown in step 2. This will give you eight check points for drawing the circle in perspective. The circle in perspective will be an ellipse. The third step is to draw perspective lines back to the desired vanishing point as illustrated. The back line of the new square is determined by the method presented in figure 14-9. Now diagonal lines are drawn from corner to corner in the perspective square. Within the original square, short vertical lines are drawn downward to the picture plane from the points where the circle line and the diagonal lines intersect. From these two points, draw lines back to the vanishing point. The points at which these lines cross the diagonal lines in the perspective square are the points through which the curve of the ellipse is drawn.

The center of the circle shifts from the center of the square when the circle is in perspective. The intersection of the diagonals is the perspective center; the intersections of the horizontal center line with the outermost vanishing lines are points of the perspective circle. The major axis of the ellipse is on a horizontal line drawn through the exact center halfway between the top and the bottom of the ellipse.

When drawing ellipses it is often best to rough them in freehand and get the general shape desired, then relate the square in proper perspective superimposed on the freehand ellipse. This procedure is shown in figure 14-14. When the square is proportionally correct, cross the center with two diagonal lines and cross these with a vertical line through the intersection of the diagonal lines. Draw a horizontal line through the center to determine the perspective center. Use the vanishing point to have the direction of the receding lines correct.

THE CYLINDER

Figure 14-15 shows some of the applications of the circle in perspective when it is associated with the right circular cylinder. At the eye level the circular section line appears as a straight line. Above and below the eye level the circular sections appear as ellipses that become progressively more open as their distance above and below the eye level increases. The proportion of the ellipses—the proportion of short to long diameters—also depends upon the distance of the cylinder from the eye. The nearer the eye, the more open the ellipse; the farther the eye, the thinner the ellipse. When seen at a considerable distance the ellipses appear as nearly straight lines.

Another important point to be noted is that the long diameter of the ellipse is at right angles to the axis of the cylinder and both the axis of the cylinder and the long diameter of the ellipse point toward their respective vanishing points.

THE CONE

Think of the right circular cone as being enclosed within a cylinder, both having the same base and the same axis. Figure 14-16 shows the cone first on its side, then resting on its sloping side. Notice that the long diameter of the ellipse representing the cone's circular base has been drawn at right angles to the cone's axis, a relationship that is constant in the cone as it is with the cylinder. Figure 14-16 shows several examples of circular construction based on the shape of the cone.

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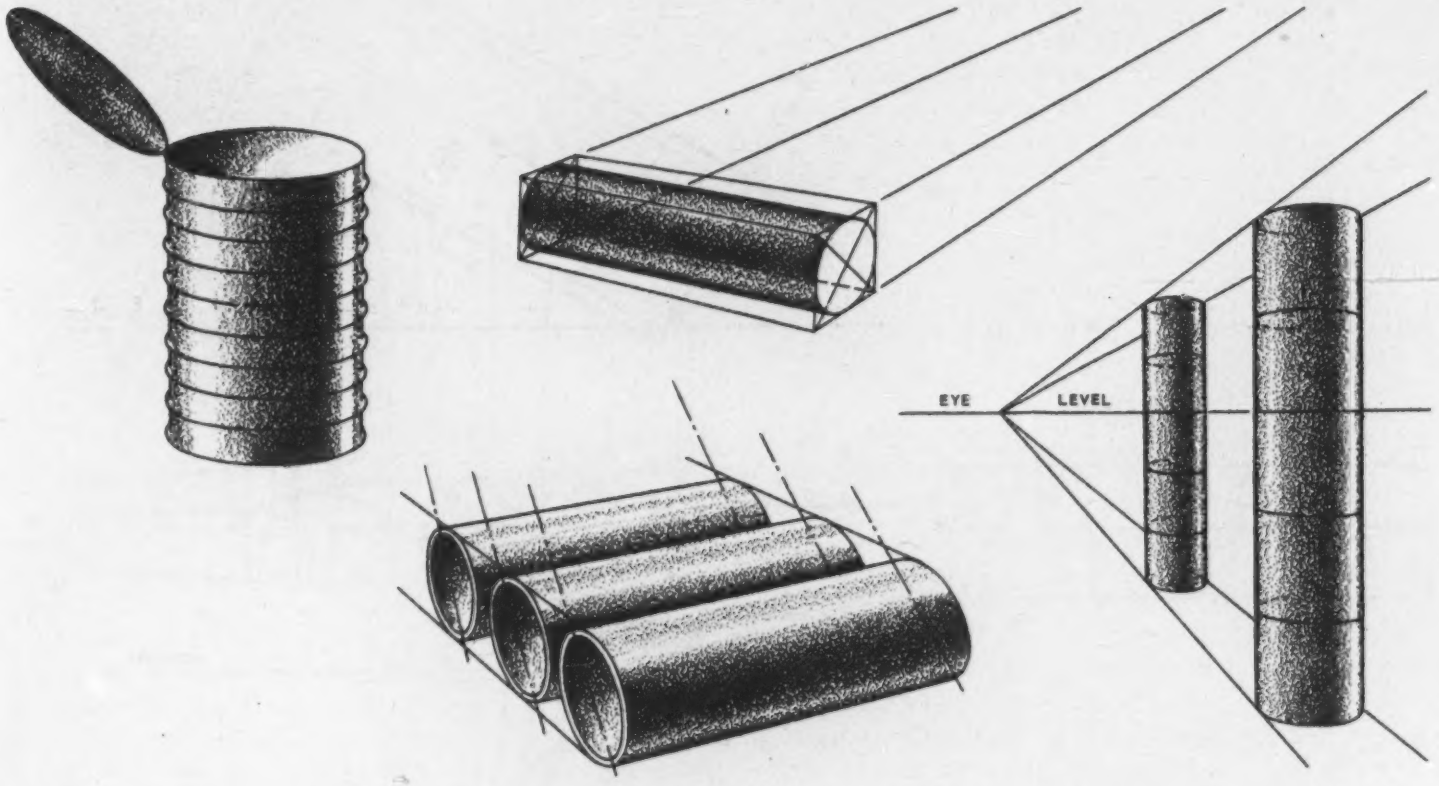

Figure 14-15.—Perspective circles when in relation to cylinders.

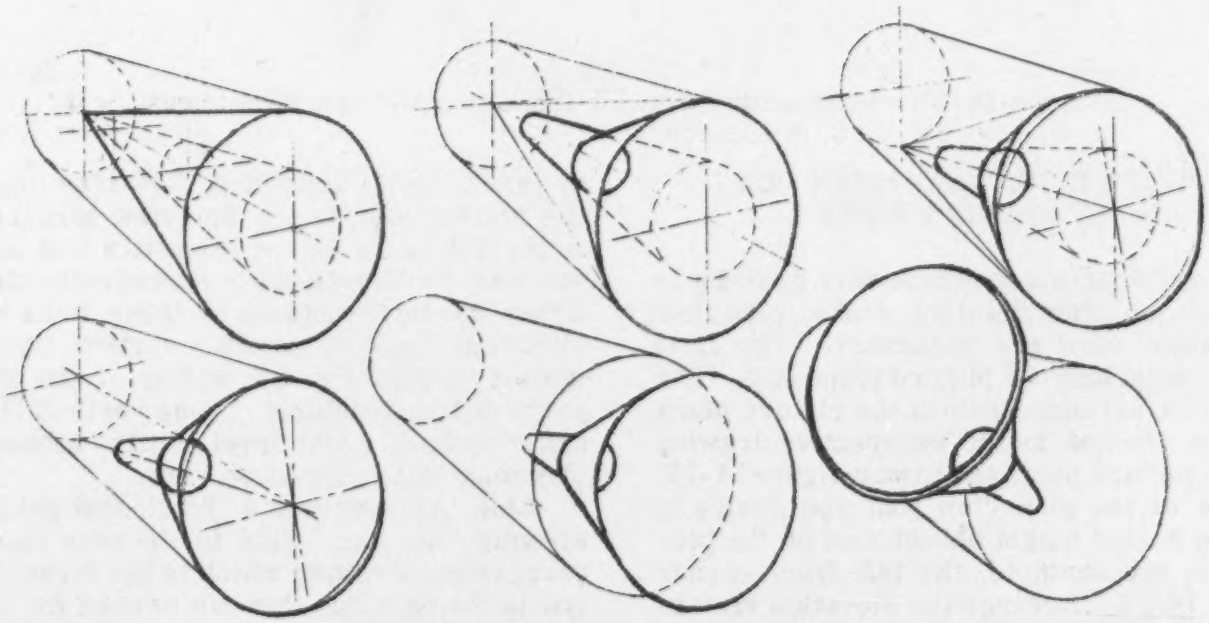

Figure 14-16.—The cone in perspective.

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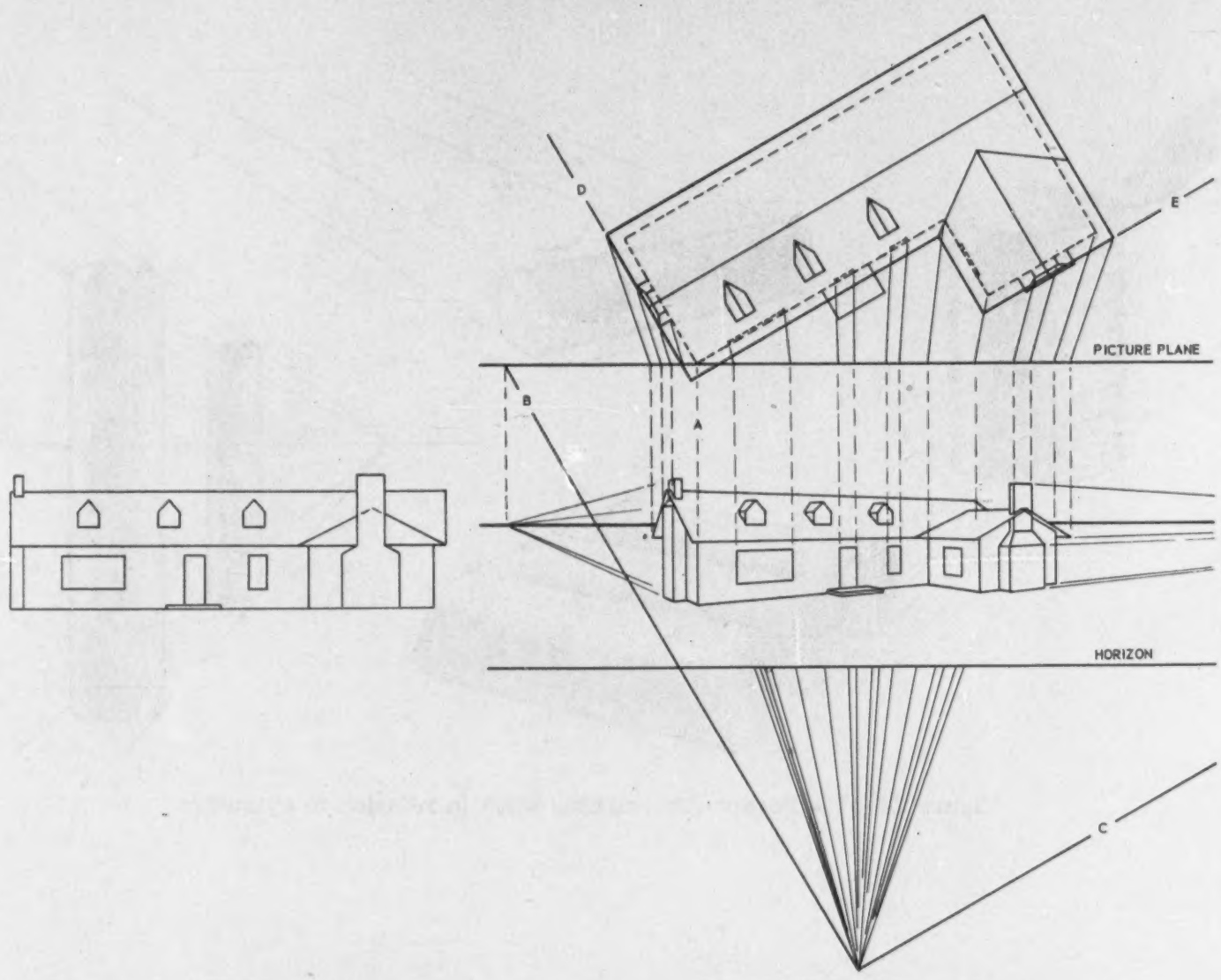

Figure 14-17.—Perspective drawing from plan and elevation views.

PERSPECTIVE DRAWING FROM PLAN AND ELEVATION VIEWS

When constructing a perspective drawing in exact detail, an exact detailed, scaled, plan view and elevation view are necessary. The first step is to establish the picture plane line. The plan view is arranged behind the picture plane with areas desired in the perspective drawing facing the picture plane as shown in figure 14-17. The lines of the plan view that you desire to be of true scaled height should rest on the picture plane; for example, the left front corner in figure 14-17. Arrange the elevation view to the left and below the picture plane at the level you desire for the perspective drawing to be. Select a station below the approximate center of the plan view. Keep the overall angle at 30° or less to avoid distortion. Now draw lines from the station point to the plan view corners of the important parts of the structure and any part you want to include in your perspective drawing. From the intersections of these lines with the picture plane, drop parallel vertical lines to establish accurately the widths of the different parts of the structure. These vertical lines are drawn down to a line level with the bottom of the structure in the elevation view.

Line (A) represents the closest point of the structure to you. This is the only line in the perspective drawing which is not foreshortened and is the only line that can be used for vertical measurements. You must now decide on the location for the eye level or horizon line. After you have located the horizon line, draw lines (B) and (C) parallel to lines (D) and (E)

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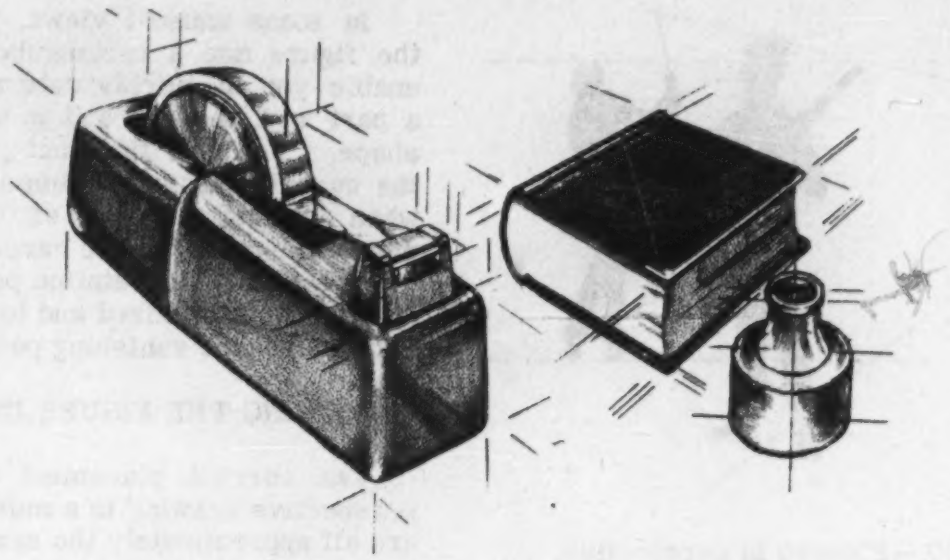

Figure 14-18.—Compound forms in perspective.

in the plan view. From the points at which lines (B) and (C) intersect the picture plane, drop vertical lines to the horizon line and thus establish the right and left vanishing points.

The next step is to carry across vertical measurements from the elevation view to line (A) and draw construction lines from the points on line (A) to the vanishing points using the same procedure already discussed. The vertical lines dropped from the picture plane will automatically establish the width of windows, doors, walls, etc. in the perspective drawing. Remember, you can make direct vertical measurements only on line (A) in the perspective drawing because it is the only line of true length.

COMPOUND FORMS

Most objects consist of compound forms: the combination of different sized cubes, rectangles and ellipses. Using the methods of construction already covered, you need only reduce the compound forms down to their basic simple forms and construct the drawing one step at a time. Figure 14-18 shows how complex designs of compound forms are reduced and, using what has been presented, are laid out in a drawing.

FORESHORTENING

When an irregular object, such as the human arm, recedes toward or away from the viewer it

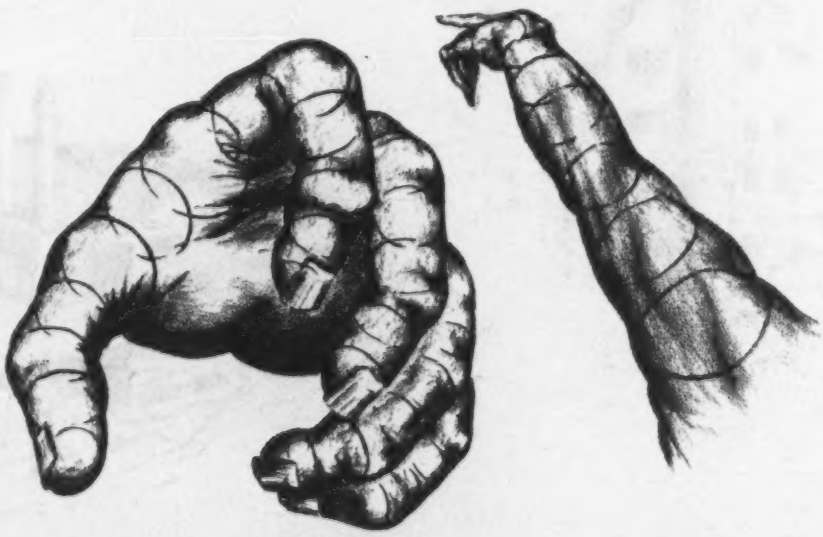

Figure 14-19.—Foreshortening the figure.

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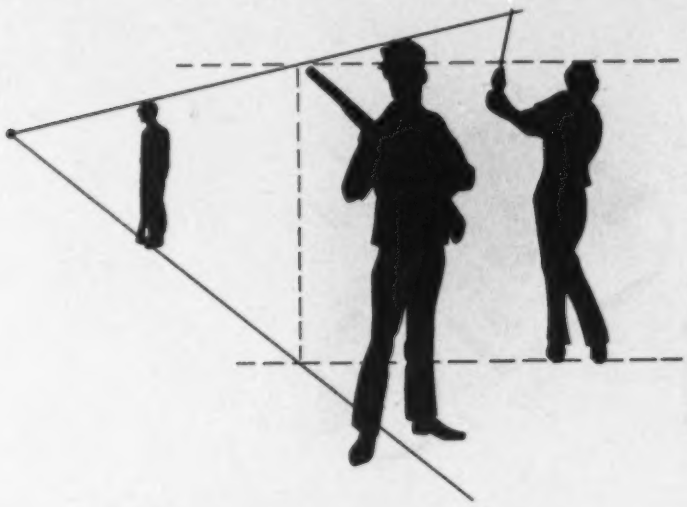

Figure 14-20.—Figures in perspective.

is foreshortened. It is then in perspective. Within the irregular or "free forms" there may be many curves—this makes good foreshortening difficult. The only cure is knowledge and practice, and a great deal of practice in drawing the figure in various positions as mentioned in chapter 12. The principles of measurement that are applied to geometric forms can be used to advantage in foreshortening the figure. In figure 14-19 these principles have been applied in determining how much or how little is seen of the head of the figure lying on the floor with the feet diagonally toward the viewer.

In some unusual views, it is helpful to fit the figure into a rectangular form which will enable you to quickly determine if and where a part will be seen and in approximately what shape. You will find that perspective can be the cure for many problems you may run into when drawing all types of objects. Again, you must remember to give careful consideration to the location of the station point so that distortion will be minimized and to the distance apart that you set the vanishing points.

DRAWING THE FIGURE IN PERSPECTIVE

The correct placement of the figure in a perspective drawing is a must. Because people are all approximately the same size, the viewer of any picture will automatically relate the proportions, scale and sizes of all forms in the picture to the figure.

Proper use of the vanishing point is the main consideration in placing figures correctly in perspective. The vertical distance between the receding guidelines to the vanishing point is used to establish the height of any figure anywhere in the picture. To place the figures to the right or left of these guidelines, horizontal lines from the head and feet are drawn off the guidelines as shown in figure 14-20. Once you have determined the height of one figure, the correct height of all other figures is automatically taken from the intersection of the two

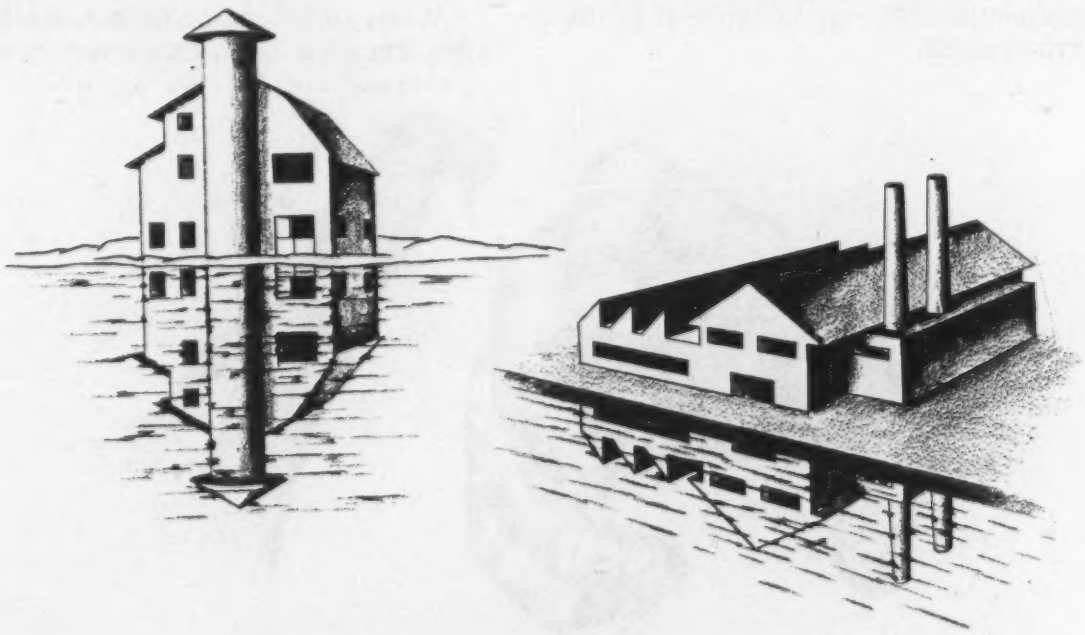

Figure 14-21.—Reflections in perspective.

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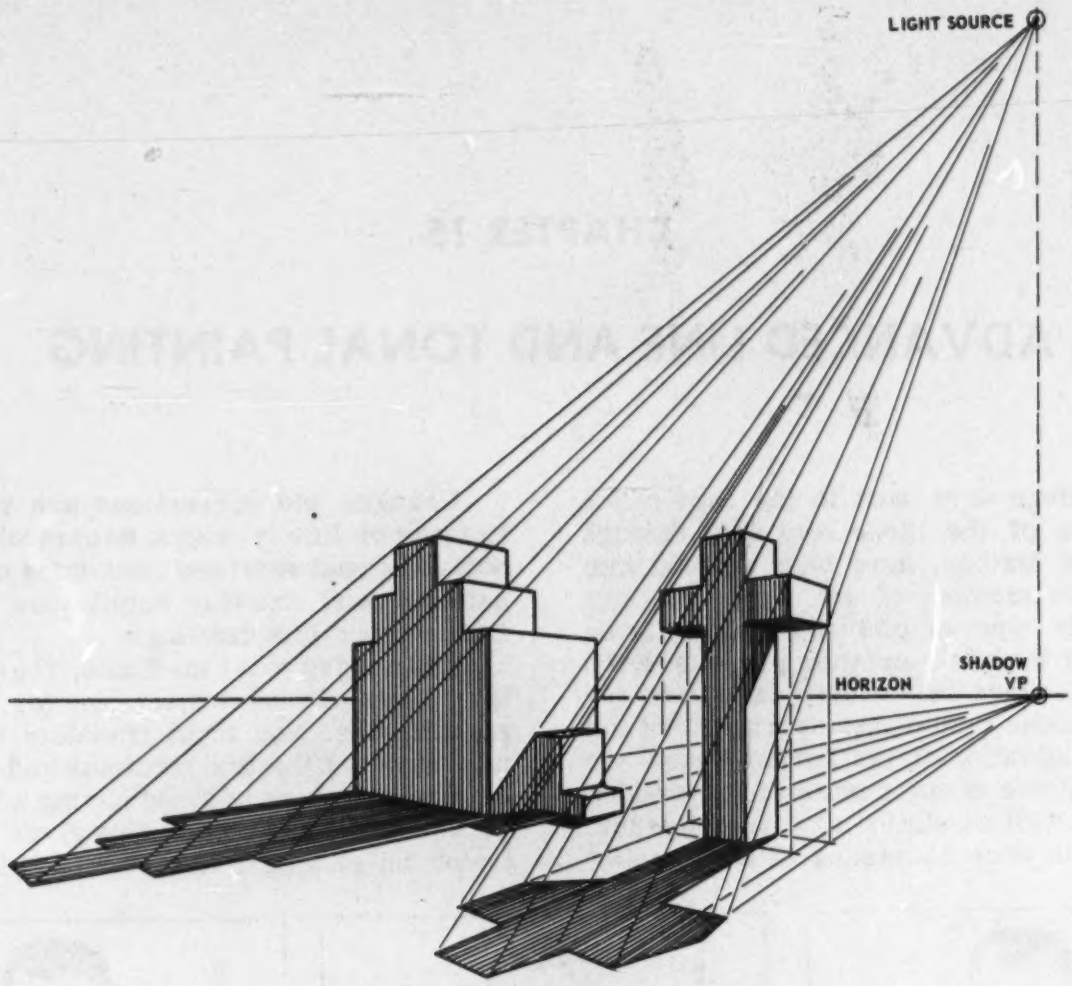

Figure 14-22.—Shadows in perspective.

horizontal lines and the receding lines going to the vanishing point.

REFLECTIONS AND SHADOWS IN PERSPECTIVE

REFLECTIONS

An object reflects as far below a reflecting surface line as it projects above the reflecting surface. Reflection is not a reverse of the scene being reflected. Although the eye level remains constant, the view is a reflected one. When the eye level is above an object, you are looking down at the object and, since the object is reversed in a reflection, the proportions remain the same—but you are now looking up at the object. Refer to figure 14-21. When the object being reflected is close to the eye level, the reflection is nearly a duplicate in reverse, but not so when the object is well below the eye level.

SHADOWS

Light travels only in straight lines. From an established light source, lines are drawn to touch the corners of a form and are continued until these lines touch the surface of the plane on which the object is resting.

All shadows recede to the same vanishing point when there is a single light source. The shadow's vanishing point will fall on the horizon line directly below the source of light. Shadows follow the contour of the plane on which they fall as shown in figure 14-22.

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CHAPTER 15

ADVANCED LINE AND TONAL PAINTING

Line drawings date back to the time of the cave dwellers of the Stone Age and, through the course of history, have been refined into a very precise medium of art. Line drawings were the only type of pictures that could be reproduced by the early printing presses. Even today, line drawings are widely used in newspapers, magazines, and other advertisement and visual communication fields because they are the least expensive of any medium to reproduce and will print well on almost any type of paper. The printing is done by means of a line plate.

Changes and corrections are very difficult to make on line drawings, so careful planning and compositional sketches containing overall value patterns and drawing details are essential in making good line drawings.

When using tonal mediums, you can duplicate the values of your subject tone for tone, but not so with line. You must translate these values into terms of the line mediums and simplify the number of values to avoid having a line drawing of an overall gray tone. This gives to the illustrator an excellent opportunity to interpret the

Figure 15-1.—Five basic line techniques.
(a) Ross Board technique. (b) Dry-brush technique.
(c) Stipple technique. (d) Scratchboard technique.
(e) Crosshatch technique.

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Figure 15-2a.

subject in a highly expressive and personal manner.

Line drawings have been considered by some to be the most sophisticated of all mediums of art because there are no real lines around the forms in nature; just tones or values, colors and edges; but no outlines. But in line drawing, line is used to establish a form; the line is an arbitrary symbol which has long ago been developed for the purpose of artistic expression. Because the outline is an artificial convention, you must learn to handle it with skill if you expect to use it effectively.

You may use a line for three different purposes. First, you may use it to contain the subject, establising the contours within which the subject is understood to exist. Second, you may use the line to create the illusion of three-dimensional form and to suggest texture. Third, you may use the line with other lines to create a compositional pattern and to contribute life and movement to that pattern. Of all the rules and uses of any medium in art, remember, you must always retain the impression that you are depicting form. You must be careful not to lose the sense of solid form in your drawings or you will have nothing but meaningless lines on paper. No matter how cleverly you apply the lines, you will find that technique will not replace the necessity of retaining the form of the subject.

SAME SUBJECT-SAME TONAL EFFECT-DIFFERENT TECHNIQUES

A good knowledge of line techniques is basic to your illustrative career. With imagination, you can create the most intriguing effects with the simplest of tools. With practice and experience you can use one tool with such versatility that you can duplicate the effects in a drawing that was done with several pens or combinations of pens and brushes. In figure 15-1 you can see how the same subject was rendered in five different techniques.

Figure 15-1a illustrates the ROSS BOARD technique. ROSS BOARD is a special drawing paper having a fine pebble grain. When a black crayon is dragged across the top of the grain, the raised area becomes black, while the recessed space between the grain remains white. When the crayon is pressed hard against the board, the white spaces fill up and a solid black results. With this technique, a sable brush and ink is often used to do large, smooth, solid lines.

Figure 15-1b shows the dry brush technique. This technique is usually best accomplished if used on a course-grained paper. Solid areas are painted with a fairly wet brush pressed firmly against the paper. For shaded areas, the brush is used somewhat drier, and the brush is always tested on another piece of the same type paper.

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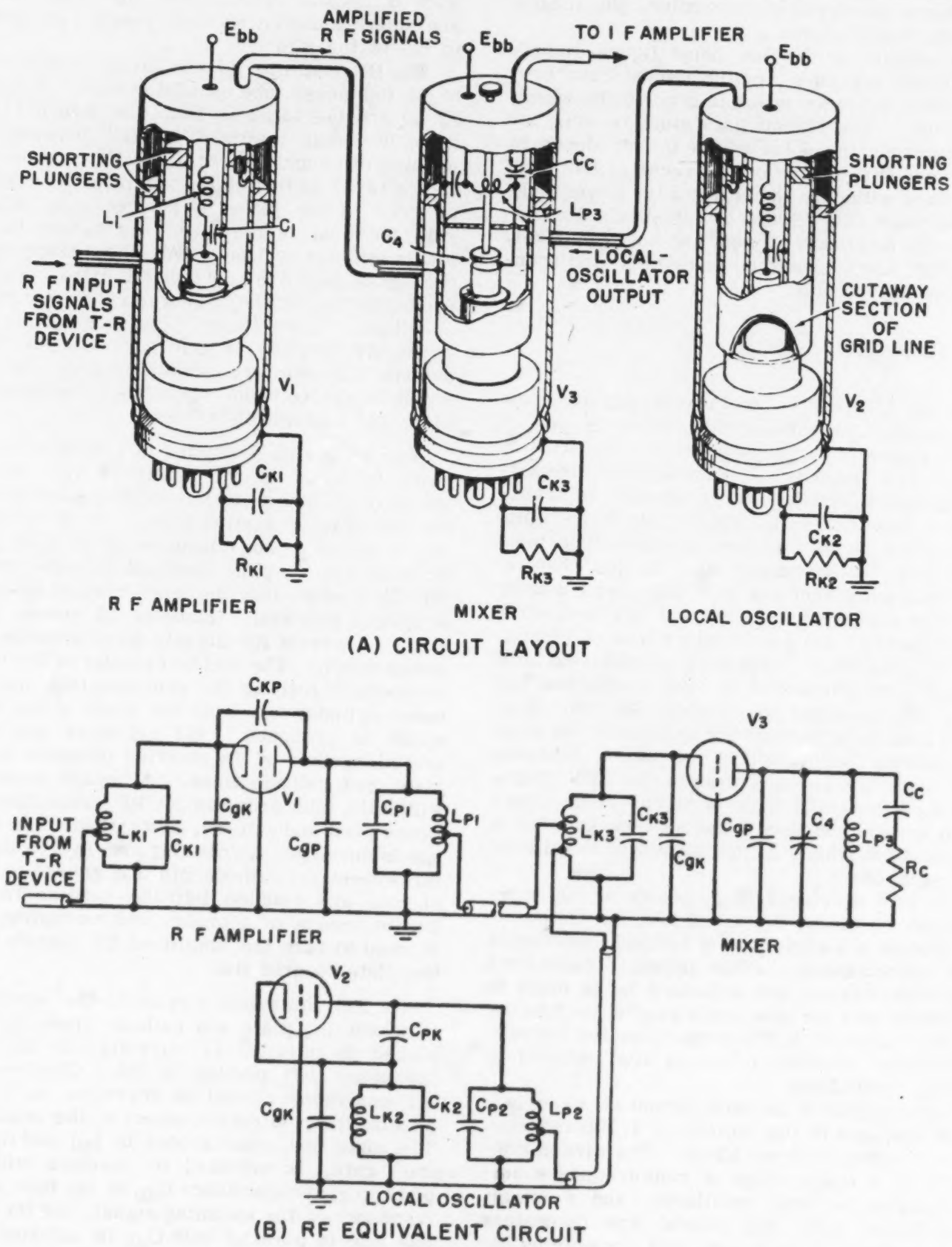

Figure 12-32.—Triode input circuitry.

Rossboard

Dry Brush

Stipple

Scratchboard

Crosshatch

Figure 15-2b.

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For the light tone areas, a comparatively dry brush is dragged across the drawing very lightly so that only the raised tooth of the paper catches the black ink.

Figure 15-1c shows a stipple drawing done with a rigid pen nib. The point is pressed lightly across the paper for the smaller dots and pressed heavier for the larger dot and the lines. This is another technique where a sable brush is used for heavier lines and solid black areas.

Figure 15-1d shows the scratchboard technique (which is described in greater detail later in this chapter). A special scratchboard paper is used as the basis for this technique. A solid ink background is brushed over the whole area with a chisel-edged brush. White chalk is rubbed over the back of a preliminary pencil sketch and the drawing is traced down on the scratchboard with a hard pencil. A needlepointed tool is used to scratch out the fine lines and a square-pointed tool to scratch out the heavier lines. With this technique, a limited number of corrections can be made if mistakes occur.

Figure 15-1e shows the crosshatch technique, the oldest and most effective technique for creating tone. The secret of effective crosshatching lies in the careful control and knowledge of the exact number and character of lines needed to create tone of a given value. A flexible fine nib pen is most commonly used for this technique. When a wider line is needed, the nib is spread apart by pressing it harder against the paper.

The same principles which applied to the construction of the head in figure 15-1 also apply to the drawing of a figure or a group of figures. The figures in figure 15-2a are rendered in a variety of different values, techniques and textures, but in each case the basic form is the same. The same approach to form and value exists when individual forms are combined to form a composition as in figure 15-2b.

SELECTING THE TOOL

After deciding precisely what effect you want to create in a line drawing, you should select the drawing tool that will give you the desired result, if not precisely, then as nearly as possible. It is important for you to become acquainted with some of the most useful tools and the effects possible by using them. In this way, when you know that a certain tool will make a particular design, you can often plan your composition with that tool in mind.

With experimentation you will find many worthwhile effects beyond what is shown in this book. A good illustrator constantly experiments to find new and interesting effects with all of the tools and instruments available to him.

Figure 15-3 contains several examples of one subject rendered with several different tools and combinations of tools.

SCRATCHBOARD TECHNIQUES

A relatively new technique in the medium of line is the scratchboard. This technique of line drawing reproduces very well, even when greatly reduced, and requires the simplest of drawing tools for its construction.

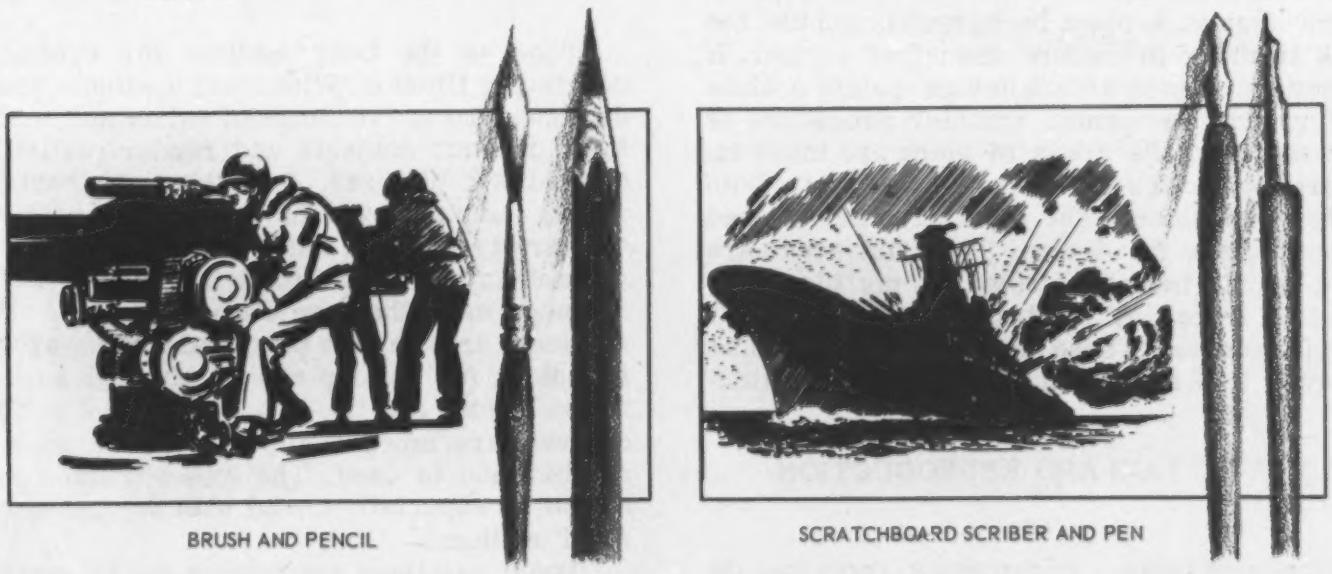

Figure 15-3.—Different tools and combination of tools.

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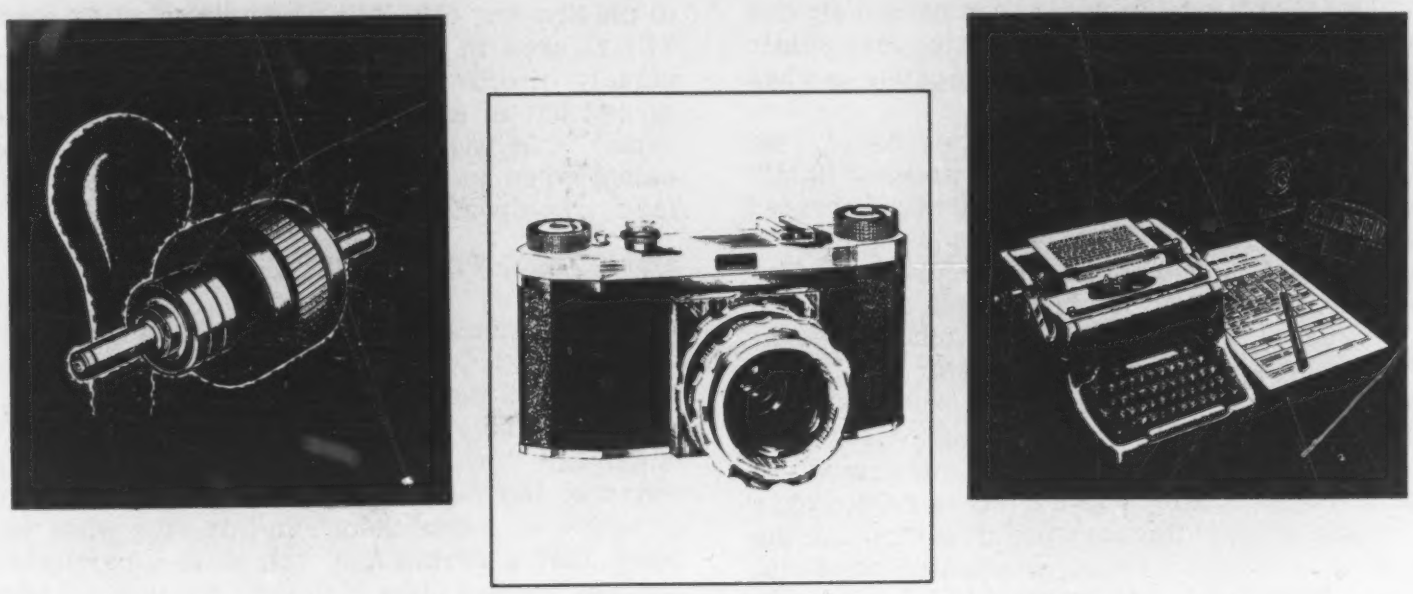

Figure 15-4.—Scratchboard drawing.

The excellent quality of line produced with the scratchboard makes this technique ideal for pictures requiring accurate and precise details.

Scratchboard drawings are easy to create once you understand them. The drawing is made on the special paper (called scratchboard) which is coated with a fine white clay.

A good, detailed preliminary drawing containing value patterns and exact details is essential with this technique.

To transfer the drawing to the scratchboard surface, the back of the preliminary drawing is coated with either white chalk or pencil, depending on the type of drawing being done. If the typical scratchboard method is used, white design against a black background, you use the chalk transfer procedure described earlier. If the pattern is to be a black design against a white background, the pencil transfer procedure is used and then the areas of black are inked in. A third method of scratchboard is to combine both methods mentioned. The pencil transfer is used to trace down the design. The black areas are inked in and then the design on the blackened areas is traced on the back by using the chalk transfer method. These three methods are shown in figure 15-4 along with the three basic scratchboard tools.

KEEP REDUCTION AND REPRODUCTION IN MIND

When you make your drawings larger than the final printed size will be, as is usually the case, you must consider what will happen when the picture is reduced for reproduction. A drawing reduced to one-half of its original size will be reduced proportionately; both the lines and the spaces between the lines are reduced in size.

Figure 15-5a shows a drawing made with reduction in mind. Figure 15-5b was made without allowing for reduction. In drawing A all of the fine lines hold up. In drawing B many of the finer lines are "dropped out" and some sections have "filled up", leaving solid black areas where crosshatching is desired. This is the result of having the lines too close.

ADVANCED TONE PAINTING

Tone is the best medium for creating a convincing illusion. With tonal mediums you can duplicate the entire range of values and textures found in your subjects and render realistic or naturalistic pictures. Any value can easily be mixed, and thus you have complete control of the variety of edges which delineate shapes; you are not limited to just implying the existence of the edge as is the case when using lines. Tonal mediums are the only practical mediums for use in making full color pictures, although a combination of tone and line can be used if the effects desired are more easily recognized when the combination is used. The tone and line combination is especially useful with the transparent tonal mediums.

Tonal paintings are reproduced by means of halftone engravings or are printed by offset

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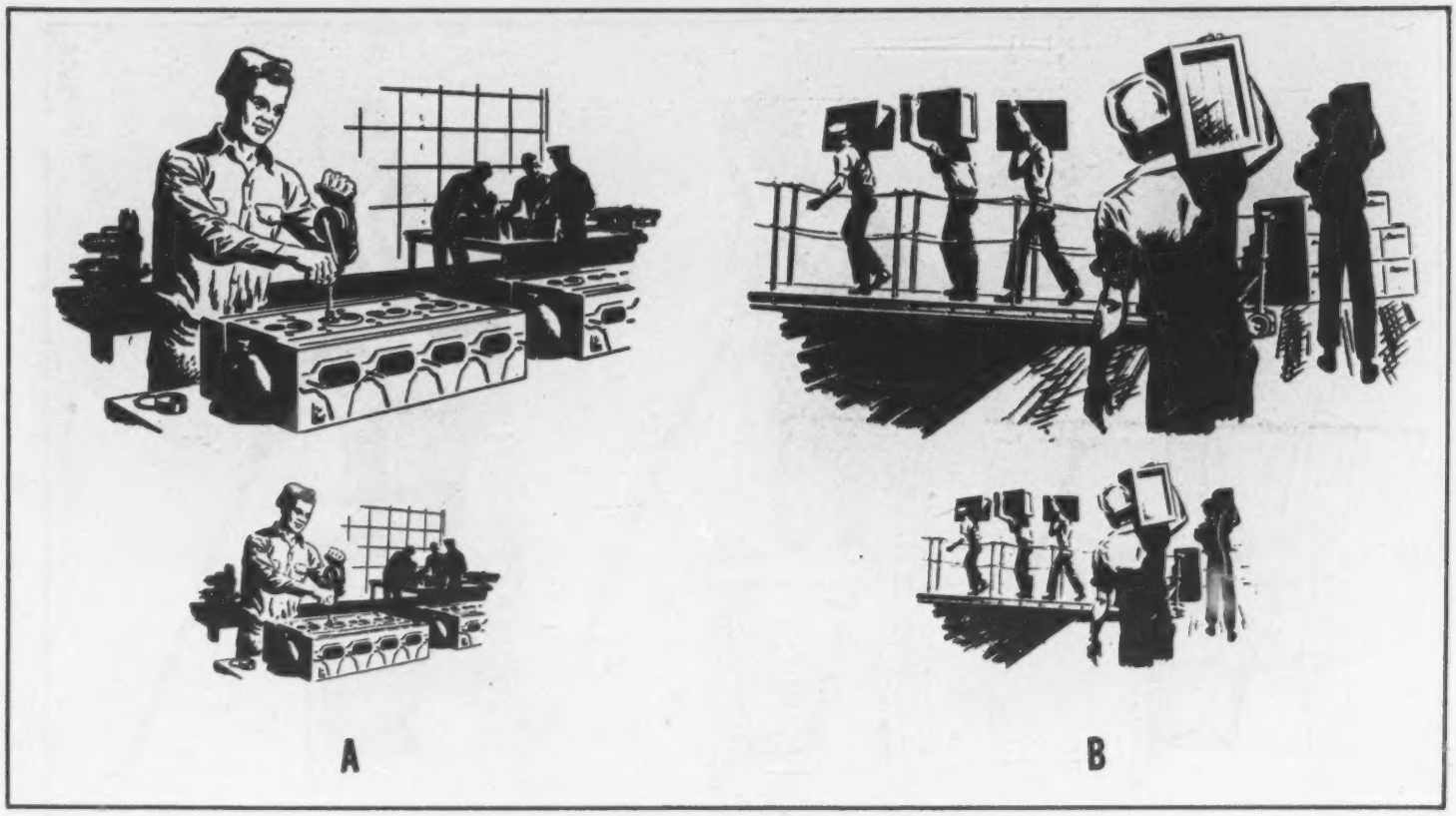

Figure 15-5.—Keeping reduction in mind.

lithography. This latter is a fairly new development in the printing field, but it has been refined in the last few years to such a high degree that almost any tonal medium or combination of tonal mediums can be reproduced with complete accuracy by offset printing methods.

When working with tonal mediums, as with any medium, the first and foremost basic principle you must consider is to have a plan or method of procedure. Any drawing having many shapes and tones can easily get out of hand if a well-organized method of procedure is not followed.

It is best to build up a picture from start to finish in a logical, orderly manner. Most illustrators get the large, simple masses under control before working on any details in the picture. Establishing the pattern of masses and values at the beginning will help to express the mood or feeling of the picture at the start. Another basic principle is to keep all parts of the drawing developing at the same time. This helps in the overall control of the values and forms.

In tonal compositions the edges play a large part in your drawing,. and, next to shapes and values, edges are the most important thing to consider. You will find that hard, sharp edges tend to come forward and attract attention whereas the soft diffused edges tend to stay back and remain subordinate.

Since the goal of all illustrating is to create pictures which tell a story with interesting effects, there are no rules as to which mediums may be used together to achieve the effect desired; so constant experiment with the mediums and combinations of mediums is the only way to broaden your ability to use any and all mediums effectively. Constant experimentation is an absolute necessity in becoming a good illustrator.

Before you begin painting a subject in tone, you must study and analyze the value pattern of the subject thoroughly. This is easily done once you understand that there are three areas to look for: the subject's natural value, the light plane, and the shadow plane. The first to consider is the natural lightness or darkness of the subject (figure 15-6a). This tone remains about the same even with changes of light being cast on the subject. Of course, the values will lighten with a strong light or become darker with the absence of light, but the values will always change proportionately. You should always keep the basic value relationship consistent in your drawing.

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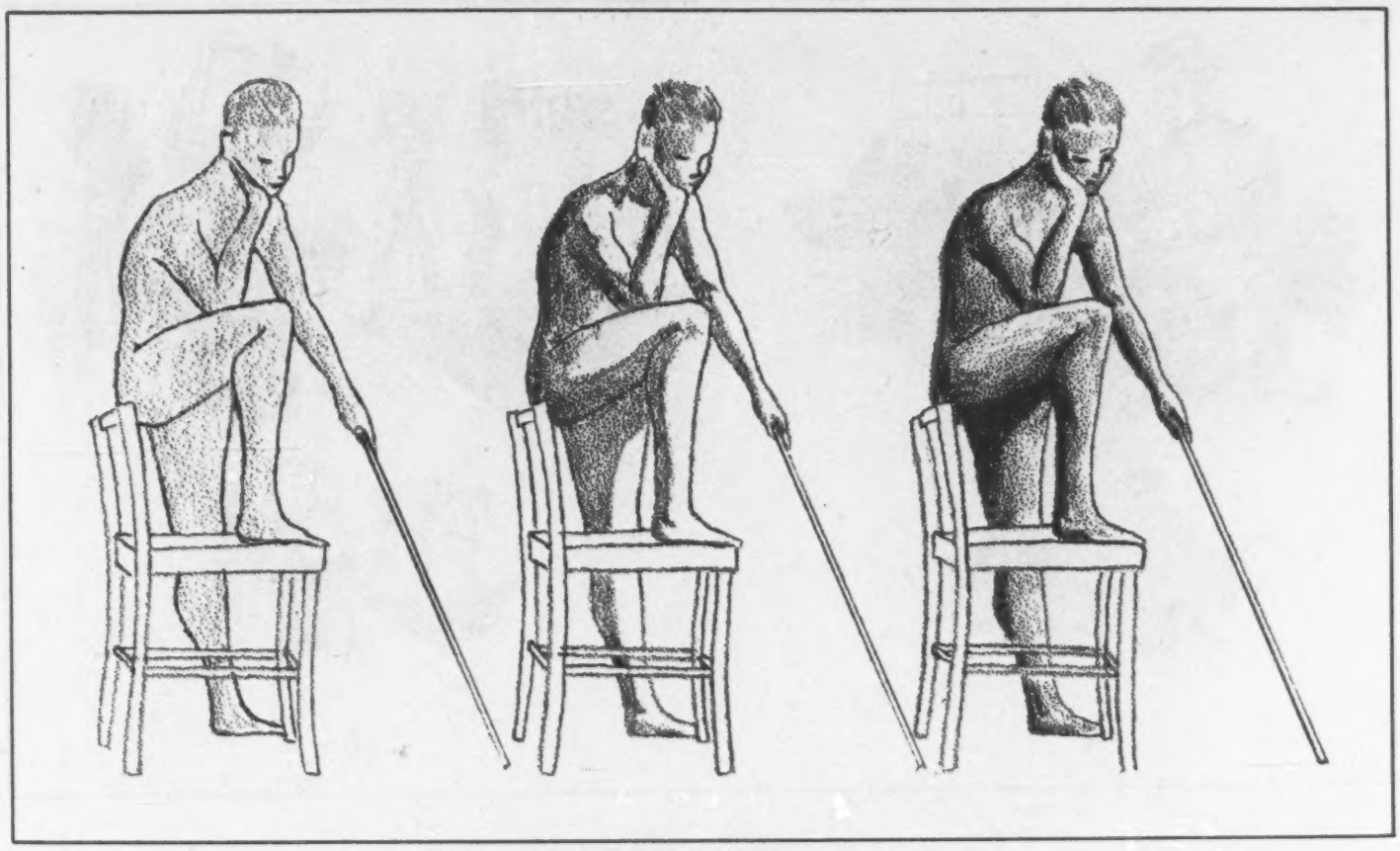

Figure 15-6.—Interpreting tones.

The next thing to analyze is the pattern of light and shadow that falls over the form. Establish or find the source of light and determine what part of the subject will be in shadow. The light should generally come from one direction only; but, in reality, there is usually a secondary light, which must be kept very weak compared to the primary light source. The secondary light is quite helpful for modeling the form in shadows, but it must never compete with the primary light or reality will be lost.

The planes facing the light source from the overall light pattern and the planes facing away from the light form the overall shadow pattern. These are easily seen when the subject is lighted from one direction with a strong, dominant light. The light and shadow pattern can be seen in figure 15-6b. When working with variations of tone within a shadow or light area, do not overmodel them or they will break up the pattern. Forms which are in the middle value range show the separation of light and shadow best. Figure 15-6c shows the tone, shadow and light patterns combined into a final rendering.

CONTROL OF EDGES

In tonal painting the edges can be hard or soft or of any degree between the two. When there is a hard edge, it means there is a sharp dividing edge between two tones of very strong contrast. A hard edge catches the eye and should be used to bring out important parts of the picture upon which you want to focus the attention and interest of the viewer. There can be a hard edge between two tones of close value, but this will not appear nearly as hard as when sharply contrasting tones are used.

A mistake frequently made by illustrators is that they tend to compose their pictures as though every form, figure, or shape were an entity in itself, entirely unrelated to any other shape in the picture. This causes an unconvincing pastedown look. Every object does have a definite tonal relationship to every other object; and this fact is best illustrated by correct handling of the edges. It is a mistake to bring out everything in your pictures. Do not be afraid to lose edges; a soft or a lost edge can be as powerfull as an edge sharply defined. Always keep your edges soft in

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the early stages of a drawing because it is easier to sharpen an edge than to soften one. However, you will find that a hard edge tends to appear soft when reproduced, and a soft edge may be lost altogether. Keep this in mind when your work is to be reproduced.

CASEIN PAINTING

Casein, a very old medium of painting, is one of the most versatile and interesting of the tonal mediums. When varnished, it is almost impossible to tell from a picture done in oils. Without varnishing, it retains a matte or dull surface similar to opaque water color.

Casein paints dry rapidly and can be used on almost any surface-paper, canvas, gesso panel, illustration board, or on Masonite. Thinner materials, especially light weight paper, tend to buckle and the thick casein may crack and chip off. The surface should be rigid enough for the thickness of the paint. Casein is very rough on brushes. Make sure the bristles are clean before you put the brush down.

The size and type of brushes used with casein is purely a matter of personal choice. You may find that, for large areas, a large brush is best; and, for finishing and detailed work, small sables are best. Bristle oil brushes can be used to create rough texture effects. Razor blades are useful to scrape out mistakes or smooth down areas where paint has piled up. A razor blade is also useful for creating interesting effects such as old brick walls or rough earth.

When it is desirable to keep some areas of a picture flexible and wet while other areas dry immediately, drying can be retarded by adding a few drops of SHIVA media varnish to the paint. Similar results can be achieved by mixing one-third oil paint to two-thirds casein. Water can still be used as a mixing agent.

Casein should not be squeezed out in a glob, but made in the shape of a "V" with a drop of water placed on the inside wedge, so that the pigment will not dry out too fast. At the end of the work day, or at anytime you have to leave your work for any length of time, place a damp cloth over the paint to keep it moist and ready for later use.

SURFACE PREPARATION

When working on a pure white surface it is usually difficult to gage the value of your tones. You may find it helful to apply a thin wash-like tone over the surface. The color used for this thin coat should be the color that is predominate in the painting. For example, if orange is the color most predominate, the wash coat should be a grayish orange. Care must also be exercised to avoid keying your pictures too low in value as well as too high. Figure 15-7 shows a drawing in casein.

Figure 15-7.

COLORED INK PAINTING

Painting with colored inks can give very satisfying results because they are easy to handle, with experience, and they are the most foolproof medium for color work to be reproduced.

Many different effects are available with other color mediums, but colored ink also has

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its own advantages which make it unique; (1) it is highly transparent, (2) while water soluble, it is waterproof when dry, and (3) many coats can be applied one over the other without any pickup of the previous coat, creating a rich luminous effect. This latter technique is called glazing, and the coats are called glazes.

The usual procedure of painting with colored inks is to lay a series of transparent color glazes over an underpainting. The underpainting is done with diluted black waterproof ink washes. The undercoating usually is done to a state resembling a finished black and white painting. The main differences between a black and white underpainting and a finished black and white picture is that all of the high-key areas that contain pure color receive no tone and are left for the pure color.

The colored ink is glazed over the underpainting layer upon layer, until the desired depth and richness of color are reached. With each layer, the color becomes richer and stronger; but, since the ink is water soluble, it can be diluted with water to any degree of desired intensity.

With time, colored ink paintings will fade; to protect against this, a coat of clear varnish can be applied over a finished picture. Besides its protective qualities, the varnish will add a surprising depth and richness to the painting.

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CHAPTER 16

COLOR

As an Illustrator Draftsman, you will be called upon to use color in a large portion of your drawings. Before you can use color effectively, you will need to have a clear understanding of what color is, how color is organized, and how color can be employed to best advantage.

What is color? Where does color come from? We find that color is the sensation experienced through the eyes when the eyes are struck by light waves of varying lengths. There must be a light source before colors can be seen. When there is no light, there is no color. The sun gives off rays of light called "white light." This white light from the sun *contains all of the colors* that can be seen by the human eye. This is readily demonstrated when there is a rainbow, or when the rays of white light shine through a piece of glass called a prism. In 1667, Sir Isaac Newton, with the use of a prism, discovered that pure white light could be divided into different color wave groups.

In 1866, a scientist named Helmholz discovered that every color has three different qualities or dimensions; hue (name of a color), value (lightness or darkness of a color), and intensity (purity of a color). Because Helmholz did not work out any practical system for applying his theory, it was not until the turn of the century that an art instructor named Albert H. Munsell took Helmholz's theory and developed the complete system for analysis and organization of color that we have today.

When an object has color, it contains pigment, that quality which gives the object the ability to absorb certain rays of light while reflecting other rays. Light falling on surfaces differing in texture and consistency is reflected and absorbed in different ways. Since the absorption of light rays is never complete, the color of the object is never flat. Also, some of the white light is usually reflected as a highlight on the object. As a consequence, in nature a color is made up of a great number of hues, so that if an artist paints a red table with red pigments only, the painting will be dead in color compared with the real table. On the real table, many variations of light produce many subtle variations of hues, and the artist must paint the table with similar variations of hues, as well as values, if he is to represent the real table adequately.

Those materials which are especially rich in pigment are carefully selected and purified into the paints we use. When you work with these pigments, you are working with pure colors which have the special property of reflecting the particular color waves you want.

As an Illustrator Draftsman you will be most concerned with learning how to recognize, judge, and control the differences in these three dimensions of every color: hue, value and intensity.

COLOR ORGANIZATION

HUE

The word hue is the term used to name a color. Red, yellow, blue, violet, red orange, etc., are different hues. Each hue has its own place on the color wheel as shown in figure 16-1. The hues which are closer together on the color wheel are more related and are harmonious because they contain some part of the colors lying next to them. The more separated they become, the more distantly related they are until a color is situated directly opposite another; then it is referred to as a complementary color. Complementary colors have nothing in common, but are used to form sharp contrasts; or they can be mixed to create neutral grays.

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Warm and Cool Colors

The terms warm colors and cool colors refer to the qualities of the hues. In figure 16-1, you will see that the color wheel shows the primary colors: red, yellow and blue; the secondary colors: orange, green and purple; and the tertiary colors: yellow orange, yellow green, blue green, blue violet, red violet and red orange. These are in a ring labeled pure colors. You will note that the color wheel has been divided into two parts. Those colors on the left, centered around the hue orange are considered to be warm colors, while those colors on the right half of the wheel, centered around the hue blue are considered to be cool colors.

From the pure color ring toward the center, we see that colors are changed in value by adding black, thus shading the color. From the pure color ring outward, we see the primary colors tinted by the addition of white to the color, and thus lightening their value. We can see that though the values of a pure color may change, the hue remains the same.

You will also find that when a color, say a green, is seen fairly close to a yellow, it will tend to be warm, whereas a green further around the wheel toward blue will give the effect of being

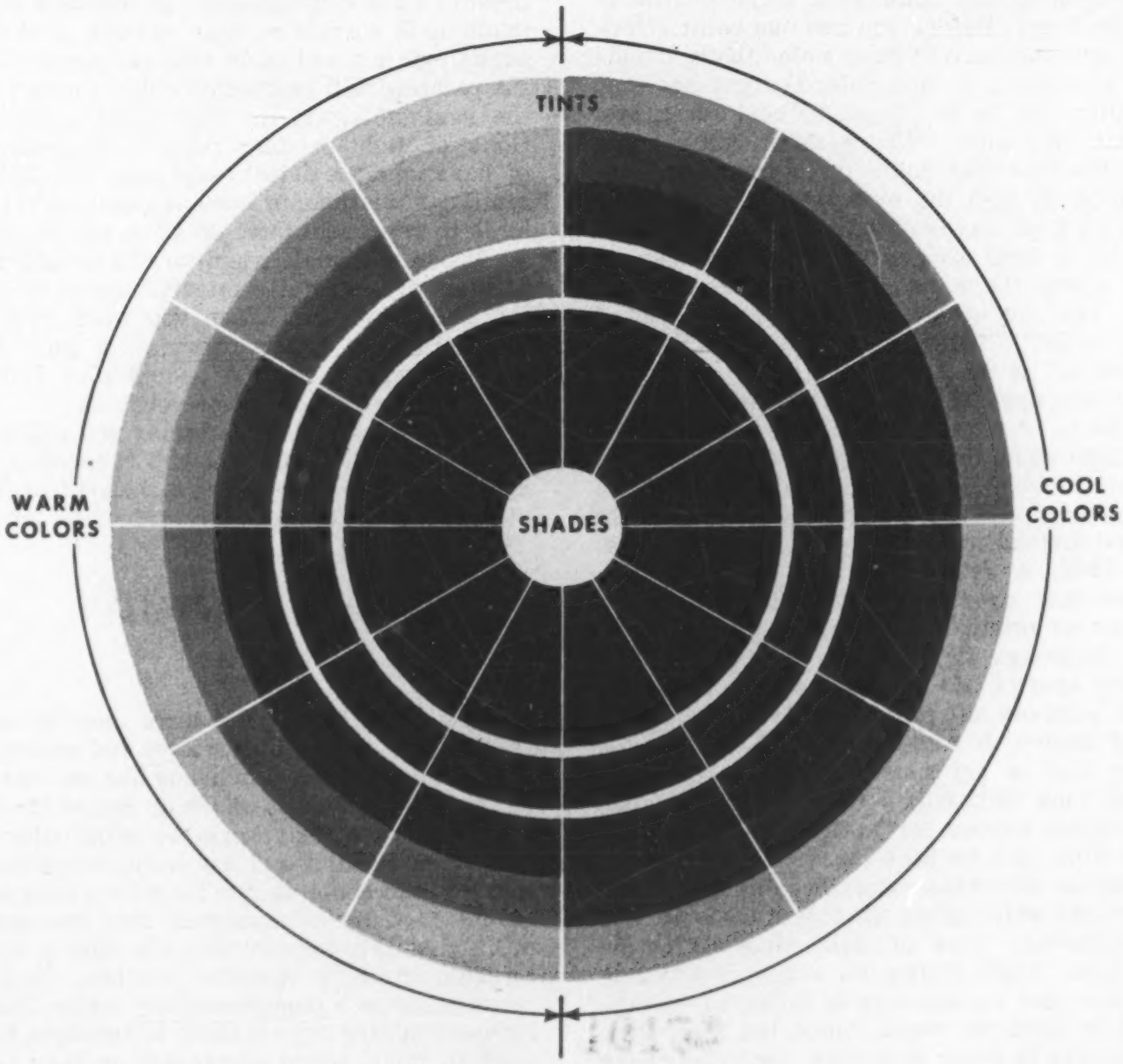

Figure 16-1.—Color wheel.

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cool. When a hue leans one way or the other, it is referred to as a warm hue or a cool hue. This is true of all hues on the color wheel. All hues can be warmed by the addition of yellow, and cooled by the addition of blue.

Achromatic Colors

The neutral (white, gray and black) are achromatic colors and are considered to be colors in only a broad sense because they lack two essential color dimensions: hue and intensity. Black is far from being negative, because it affects the appearance of such hues as orange and yellow, turning them to brown and olive. The neutral colors are also useful in modifying the values and intensities of all other hues. The warmest black is ivory black and the warmest white is flake white; these are manufactured colors not producible by the illustrator from other usual pigments and materials.

VALUE

The second dimension of color is value, and is considered to be the most important dimension of color. Mistakes made in the choice of value are much worse than mistakes made in the choice of hue or intensity.

The word value refers only to the lightness or darkness of a color. The words tint and shade refer to the value of a color. To create a tint, you add white to a hue, to create a shade, you add black to a hue. In neither case has the hue changed, only the value has changed.

In order for you to handle color effectively you must be able not only to see and recognize the differences of value in your subject, but also to interpret those differences on your palette. Because the range of values in nature are far greater than your range of hues, you will not be able to merely match nature's colors with those on your palette. You can readily see that your purest white is many times darker than sunlight reflected from a shiny surface.

As an illustrator, you must be able to decide which area is the lightest and which area is the darkest, and then decide how light it is to be, or how dark it is to be. You must relate all of the other values around this decision. You must also decide if the area is to include the whole range of values from white to black. The choice should depend largely on the effect you desire to create. When a value range has been decided upon which appears to be appropriate, you should attempt to keep it consistent throughout the whole picture.

INTENSITY

The third dimension of color, intensity or chroma, refers to the strength, saturation or purity of a hue. A pure green, for example, will give the sensation of being greener than a diluted green because there is more pigment in the undiluted green, and it will have a greater ability to reflect the green rays of light.

Most colored pigments straight from the tube are of maximum intensity. You will seldom, if ever, use the colors in this pure state. The intensity of any color may be reduced by mixing it with black, white, gray or its complementary.

Colors become weaker in intensity as they change in value. As shown in figure 16-2, starting with purity at the center, the intensity of the three primary colors has been reduced by adding greater quantities of gray to the colors until we have reached an almost pure gray. The value of each color has remained the same, only the intensity has been changed.

We can easily observe this change in intensity in familiar objects around us. The color of a pair of dungarees is most intense when it is new, but the color becomes dull and faded and less intense after repeated washing of the dungarees.

Landscape colors lose their intensity when covered with fog, mist or smoke, but regain their intensity in brilliant sunlight. When colors are seen in the distance, they will have reduced intensity as compared to the same colors seen close up.

ADVANCING AND RECEDING COLOR

In creating the impression of depth in your pictures, you will find that warm colors will tend to appear to be nearer the viewer than will cool colors. As colors become less intense and lighter and grayer, they appear to fall off into the distance giving the feeling of atmosphere being between the viewer's eye and the object being viewed.

In figure 16-3 we see that the colors lose their intensity as they recede to the background. Although the soil is pretty much the same throughout the area in the picture, realism was added by reducing the intensity of the colors as they fall off toward the horizon.

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Actually, the cathode line is made slightly inductive in order that any feedback voltage supplied through the small plate to cathode capacitance C_{kp} (approximately 0.05 $\mu\mu f$) will have a phase opposite to that required to start oscillations. Thus the cathode line length is somewhat less than a quarter wave at the signal frequency.

Because the output coupling loop of the amplifier is located near the shorting plunger in the plate line, the output coaxial cable is shown as a tapped connection to L_{p1} in (B). The plate line thus acts as a resonant transformer to change the low input resistance of the cable (approximately 50 ohms, since the cable is usually matched at the far end) to a higher resistance across the entire resonant circuit. The value of load resistance across the resonant circuit is governed primarily by the bandwidth required for the amplifier. Since no provision is made for tuning the amplifier during its normal operation, the bandwidth must be wide enough to pass received signals despite slight changes in the transmitted frequency.

The tuned cathode circuit is loaded by the input resistance of the amplifier in parallel with a resistance representing grid loading effects and tuned circuit losses. The net resistance is matched approximately to the characteristic resistance of the input line by tapping the input cable to a point near the shorted end of the cathode line. The tap location is chosen for optimum signal to noise ratio and results in a resistance termination for the input line which is slightly more than its characteristic resistance.

Traveling Wave Tubes, Backward Wave Amplifiers, and Klystrons Used as Low Noise Input Amplifiers

Basic operation of traveling wave tubes, backward wave amplifiers, and klystrons has been covered earlier in this chapter. The low noise properties of these devices are obtained by the use of a specially designed electron gun. When the TWT is used as an input amplifier, a filter is normally employed to reject the image frequency. Without the filter, if the image frequency is allowed to pass, the noise power is doubled; but with the filter, the usable output power is slightly reduced as a result of filter losses. Generally no filter is required for narrowband amplifiers such as the backward wave amplifier or the klystron, because the bandwidth is less than the IF frequency and the image is adequately rejected.

Masers

The maser represents the ultimate in low noise characteristics, but requires complicated external circuitry, an external field, and operation at extremely low temperature (the temperature of liquid helium). (The term MASER is taken from the first letters of Microwave Amplification by Stimulated Emission of Radiation.) The operation of this device is based on the principles of quantum mechanics. "Bound" or planetary electrons within the atoms of any material possess a certain amount of energy, and the level of energy possessed by each electron is not constant. The energy level of an electron may be raised by causing the electron to absorb energy; it may be lowered by causing the electron to give up energy. Under normal conditions, with no external forces applied, the energy levels of the electrons within the material are distributed at random but with the higher-level electrons being more scarce than the lower-level ones.

Additional information concerning masers may be found in the February 1963 issue of the Digest of U.S. Naval Aviation Electronics, NavWeps 08-1-503.

Tunnel Diodes

Tunnel diodes may be used as input amplifiers where the noise can be tolerated in favor of simplicity. Although the noise factor is not so good as the maser of the parametric amplifier, it is lower than that of the triodes. The operating principles of tunnel diodes are discussed in Aviation Electronics Technician 3 & 2, NavPers 10317-C.

MIXERS

The purpose of the mixer in a superheterodyne receiver is to combine the frequency of the incoming signal with the frequency of the local oscillator, and to produce from these two a third frequency (the difference between them, usually) known as the INTERMEDIATE FREQUENCY (IF). The IF is normally much lower than either of the other two frequencies. The IF is amplified and used to carry the impressed intelligence of the incoming signal through the remainder of the RF circuits. If

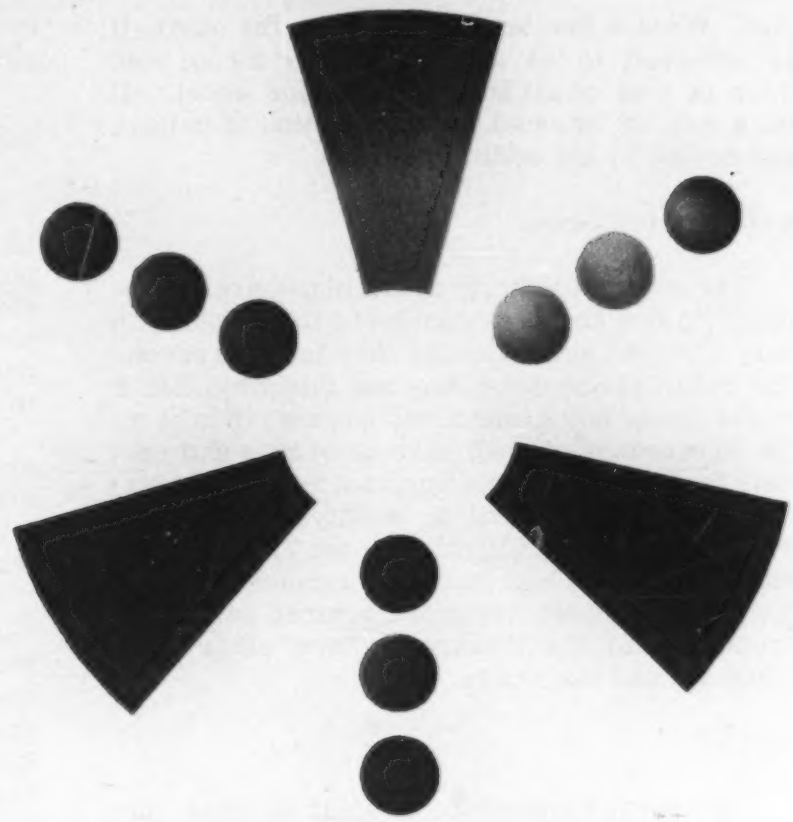

Figure 16-2.—Intensity.

Figure 16-3.—Receding color.

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When cool colors are used to add distance and depth to a picture, it is known as aerial perspective.

VARYING ALL DIMENSIONS OF A COLOR

The three dimensions of color have been discussed separately in order to make them more easily understood. It remains a fact however, that when you mix colors, you will rarely change just one of the dimensions; you will usually alter the hue, value, and intensity simultaneously.

EFFECTS OF ONE COLOR ON ANOTHER

When you use colors in a painting, the hue and the intensity of each color are affected by the colors around it. When you first draw in a shadow tone on a piece of white paper, it often appears too dark because of the large expanse of white surrounding it, but, as you add more tones and build up the rest of the picture, the shadow area begins to look right. The same holds true of using colors. You must keep in mind the color of the object itself, the color of the light shining upon the object, and the color of any surface around the object which may reflect light back upon the object.

In figure 16-4, each of the letters in the top row were painted in true colors: red, yellow, blue and green, and were set under a white light. You will notice that each plane of the letters differs slightly from the others. The true colors of each letter can be seen best in the left vertical plane, where they are least affected by light or shadow.

In the second row, we have the same row of letters but under a warm yellow light. This has changed the colors in the top and left vertical planes. You can see that in the second row, the colors under the influence of yellow tend to appear warmer.

Figure 16-4.—Effect of one color on another.

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The bottom row of letters were all painted red, then each was placed on a different colored surface with a white light shining on it. On the right vertical plane, the shadow area is altered by the reflection from the colored surfaces. The red reflecting surface intensifies the red color in the shadow plane. The blue has created a violet tone in the shadow plane. The yellow has created an orange tone in the shadow plane. The shadow plane from the gray surface is neutral, and the light has not changed the hue of the shadow plane.

With each letter, the reflecting light has not affected either the top plane or the left vertical plane, they have remained the same throughout.

COLOR MIXING

As stated before, you will seldom use a color straight from the tube for a painting. Because of this, it will be of great importance to you that you acquire good color mixing habits from the beginning. Three important points to remember are: (1) always clean your brush before you pick up a color with it, (2) keep your mixtures simple, and (3) mix dark hues into lighter hues—for economy; it takes a small amount of blue into yellow to get the desired green hues. Large amounts of yellow are required when mixed with blue to obtain the desired green hue. With only two or three colors at a time, plus white and black, you can create almost any color you will ever need. If you mix more than two or three together, you will usually wind up with nothing but a muddy or dirty gray.

Some important facts to help you in your color mixing are:

(1) A series of intense orange hues may be formed by mixing vermilion red (intense red orange) with a warm yellow orange.

(2) A series of vivid yellow greens and greens may be formed by mixing turquoise blue (intense blue green) and a cool yellow.

(3) Rich violets may be formed by mixing a purplish red and an ultramarine blue (intense blue violet). The hues magenta (intense red), vermilion red, yellow, turquoise blue, ultramarine blue and purple are pure hues which are manufactured as such and are next to impossible to form through intermixing. Hues such as orange, green and violet (secondary hues), and yellow orange, yellow green and blue green (tertiary hues) are formed by mixing hues which lie adjacent to one another on the color wheel.

When a softness of hue rather than a sharp high intensity hue is desired, combining secondary hues accomplishes this best. For example, a mixture of orange and violet will result in a red of low value.

In the tertiary hue group, satisfactory results may be obtained by mixing green and violet to obtain a soft blue and by mixing orange and green to a dull yellow (olive or tannish cast).

SET PALETTE

When working in color, a prime problem for most beginners is the desire to put every pigment available on their palettes into the picture rather than taking advantage of the infinite number of color differences created by the variations of value and intensity.

Bright advancing colors normally serve their purpose best in small areas attracting attention or as accents. Several intense colors used in the same size areas compete with each other, and their effectiveness is canceled out.

A good way to overcome this problem and achieve color harmony and unity in your pictures is to use a set palette. A set palette is obtained by adding a small amount of any one color or a gray tone to all of the colors on your palette. You will find that the added color will have a greater effect on its complementary color than on the colors adjacent to it on the color wheel. Adding one color to all light areas and another color to all shadow areas is another way of obtaining variation. The added color may be warm or cool, depending upon the effect you are trying to achieve. When you want to emphasize one color in a picture, you should add a color to every other color on your palette except the color you want to emphasize.

Figure 16-5 shows how an illustrator with an arranged palette of colors will follow the same pattern throughout.

COLOR PSYCHOLOGY

It is known that color has a strong emotional effect on the viewer. By using selected colors carefully the illustrator can make the viewer feel cheerful or make him feel depressed. The viewer can be excited with one color or be soothed with another. You can fill the viewer with longing or make him feel at peace, just by the careful selection of colors. Because of this effect, you must learn to take advantage of these

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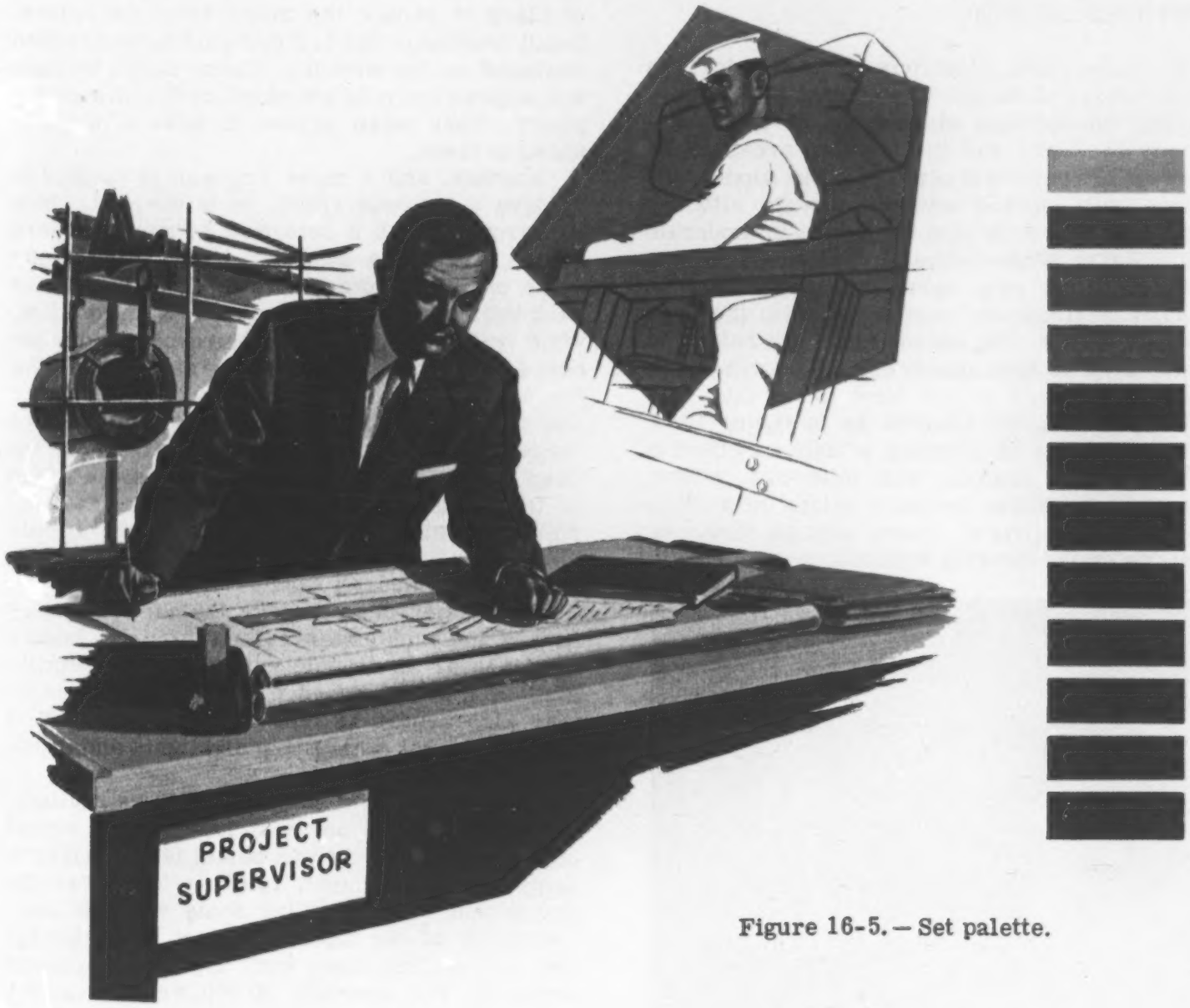

Figure 16-5.—Set palette.

effects in doing your work. The following suggested color interpretations are listed for your use:

Red . . . . . heat, anger, war, danger, excitement.

Yellow . . . . . sun, generates warmth without heat.

Blue . . . . . coolness, pleasure, space, hope, piety.

Green . . . . . springtime, summer foliage, safety, coolness, pleasant and restful.

Orange . . . . . warmth, autumn.

Purple . . . . . mystery, death, suspense, power, regalness. Should be rather restricted in use.

Cool colors . . . winter, early spring; dignified, formal.

Warm colors . . summer, fall, informal; friendly in nature.

You will find it necessary to apply your knowledge of color and how people are going to react to it in order to achieve the effect you are striving for.

CREATING EFFECTS THROUGH COLOR

Thus far in our study of color, we have discussed briefly the history of color, color organization, how a color effects other colors under different conditions, fundamental color mixing and the effect of colors on our emotions.

We will now discuss some of the techniques that, when understood, will greatly increase your ability to create interesting and dramatic works in color.

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LUSTROUS EFFECT

To accomplish a lustrous effect in color, the larger areas of the drawing must be composed of slightly shaded hues which are suppressed uniformly in value, and the smaller areas of the drawing are painted in pure hues. The suppressed colors will appear natural enough, although slightly on the dark side, as if seen in moderate illumination. When touches of pure intense colors are added, the pure colors will appear exceptionally brilliant in comparison with the suppressed colors. The added colors are said to be lustrous since they appear brighter than normal. The added paints do not have to be shiny; the effect is a visual illusion as in figure 16-6.

One method of creating a lustrous effect is to prepare a drawing with pure red, yellow, green or turquoise tempera paints on a white or gray background. Then, with an airbrush, coat the entire drawing with a uniform thin layer of black to reduce the intensity of the colors. Small touches of the original pure hues are then replaced on the drawing. These added touches will appear lustrous and shine forth with striking purity. They often appear to have a metallic sheen to them.

Figure 16-6.—Lustrous effect.

Another, and a more impressive method to achieve a lustrous effect, is to work in a dark background. With a selection of pure tempera colors, prepare a shade scale of three or four steps of value from purity to almost black for each basic hue. Vermilion red, oranges, yellow, vivid yellowish green and turquoise blue are best (avoid deep reds, blues and violet). Working the scale from the darker tones to the brighter and purer tones, paint a simple picture. The largest areas of the drawing should be in the deep tones. When the light pure tones are added to the foreground after the background is completely covered, the pure tones should appear extremely lustrous and far more brilliant than they actually are, as seen in figure 16-6.

The luster perceived by the viewer varies in type and each luster is visually unique. Luster may appear as translucent as a fine metallic cloth or the feathery edge of a silk scarf. Luster may also appear as bold and sharp as a solid polished metal with sharp highlights and shadows.

You do not paint lustrous surfaces realistically and you do not copy nature. The actual color value of a lustrous object is too bright to capture with a pigment. You have to contrast the purest hue of your value scale with the surroundings of the lustrous object by darkening the surrounding area until the effect appears realistic. For example, if you were to paint a red vase, you would not use a soft pink for a highlight since this would not achieve the lustrous effect, but would ruin it. The proper method would be to suppress the red or maroon color of the object and paint the highlight with a pure vermilion to achieve the greatest contrast. The highlight would then appear to shine brightly.

IRIDESCENT EFFECT

Iridescence is defined as a rainbow-like play of colors, such as is found in a soap bubble, in an opal, or in mother-of-pearl. To simulate the phenomenon of iridescence, our uniform suppression is in terms of a gray field in contrast to the blackish field we used in creating the lustrous effect.

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In nature, iridescence is an elusive quality. Iridescent colors in nature owe their existence to diffraction (bending of lightrays) rather than to the pigments inherent in the object. The surface of an iridescent object splits a ray of light into its components, and the viewer sees the various spectral hues separated from one another. The color of an iridescent object tends to change in value and hue when seen from different angles. This is a dynamic quality which seems to defy duplication in a static design such as a painting.

The effect of iridescence in a design is more subtle and softer than the effect of luster. Iridescence features the beauty of delicate tints and pastels against gray. The viewer will be given an illusion of mistiness as he views an iridescent effect. Incidental touches of pure hues or clean tints to this mistiness will take on a fascinating glint as it appears to shine as though endowed with an inherent luminosity; a quality which will seem quite separate from any characteristic of the paint itself.

Using tempera colors, prepare a series of medium valued tints (about halfway between purity and white) such as pink, peach, soft yellow, pale green, pale blue and lavender. Keep the tints as clear as possible, avoiding grayness or darkness. Paint a simple design confining the original tints to relatively small areas and imparting a gray cast to the larger areas. You may achieve the gray cast by adding neutral gray of lower value to the original colors, or by combining opposites. Adding neutral gray is the simplest method.

After completing the painting and the paper's surface is completely covered, (no white paper exposed) use an airbrush to apply a delicate coat of opaque pale gray over the entire surface until the painting appears misty. The final step is to replace touches of the original clean tints.

An alternate method for achieving an iridescent effect is to mix a series of clean tints. To these original clean tints, add equal amounts of a medium gray. Each of the original tints should have about three or four steps of graying from a clean tint to a neutral gray. Scale the color on the drawing gradually from the grayed tints into the clean tints, which should be placed as small touches, highlights or details. A general overall gray cast will establish and fix the illumination quality. This will, by comparison, lend unusual glory and iridescence to the minor areas occupied by the clean tints.

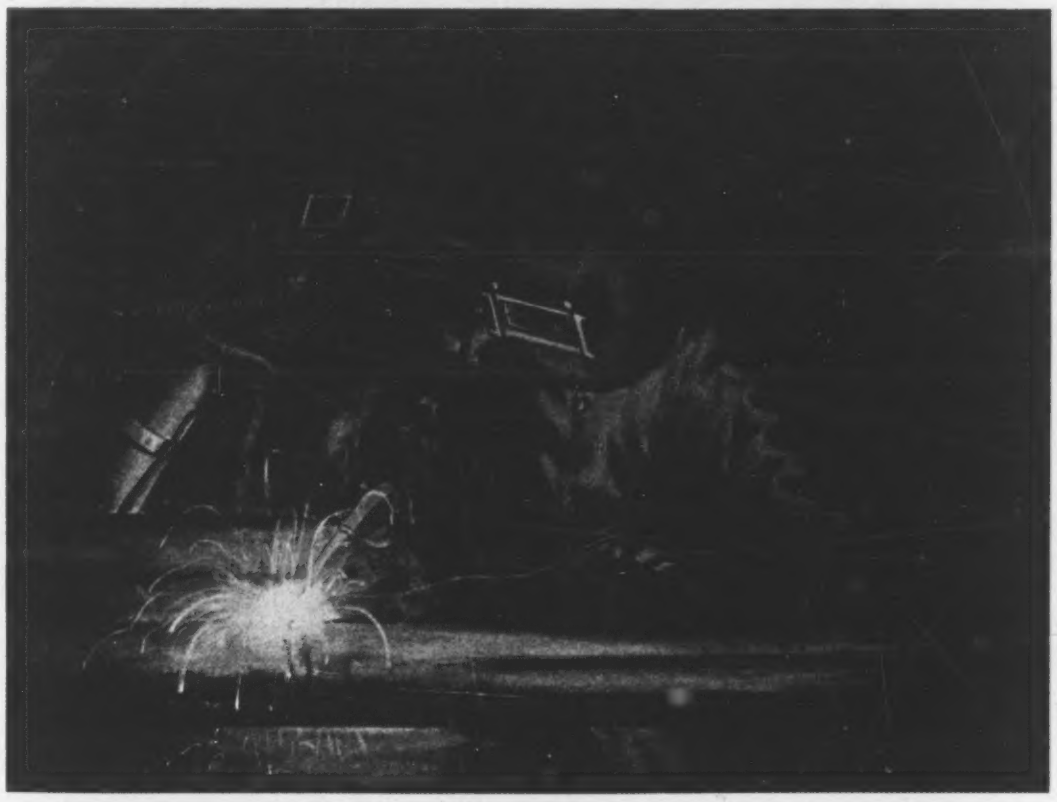

Figure 16-7.—Luminous effect.

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LUMINOUS EFFECT

A luminous object is an object which emits light or appears to have an inner glow (shining). The moon is said to be luminous although it is actually reflecting the sun's light. The effect of luminosity in a painting may be easily and effectively achieved through a carefully established arrangement of color tones and values. The viewer may be convincingly led to believe that light is being emitted from a painting's surface if the proper color tones and values are used throughout the painting, as shown in figure 16-7.

There are several methods for accenting the luminous quality of a hue. The simplest and the traditional methods are to surround the rich pure hue with dark values or with its opposite color on the color wheel. The result may prove disappointing if the color which is to appear luminous is lacking in purity.

There are several conditions which must be met before a color in a painting will provide the viewer with an illusion of the color's luminosity. They are:

1. The luminous area must be relatively small.
2. The color which is to appear luminous must be purer in chroma than its surroundings.
3. The color which is to appear luminous must be of a higher value than its surroundings.
4. The luminous hue must seem to prevail all of the other colors in the painting.
5. The other objects in the painting should appear soft and hazy as though the viewer's vision has been blurred by the relative brightness of the luminous object.

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CHAPTER 17

SHOP PROCEDURES AND PRODUCTION

SHOP PROCEDURES

In all graphic art departments, a large amount of time is spent on projects other than actual illustrating. They are essential projects and include the steps necessary for completing the job order. Such nonillustrative work ranges from simple picture mounting and mat cutting to the more complicated airbrush rendering, photo retouching, and the use of mechanical aids.

RUBBER CEMENT

A useful product which you will find yourself using more than any other is rubber cement. Of all the adhesives available, it is the most versatile, the easiest to handle, and the easiest to remove from almost any surface without leaving any mark.

Pieces that have been mounted with rubber cement can be adjusted or removed by applying rubber cement thinner along the edges of the piece. The thinner seeps beneath the edges and loosens the cement. Rubber cement and the cement thinner are highly flammable. Never use either near an open flame; don't use the thinner near a lighted cigarette. Rubber cement should be of the consistency of honey. The proper proportions, using a rubber cement dispenser jar, are two-thirds cement to one-third thinner. This proportions may vary with the user's preference.

A rubber cement pickup (a small triangular-shaped tool) is very useful in removing excess cement. It is rubbed gently over the dried cement and easily picks up the cement in hard to get at areas.

There are two methods of using rubber cement in mounting: the wet mount method and the dry mount method.

PHOTO AND ILLUSTRATION MOUNTING

Wet Mounting

When you use the wet mount method, the rubber cement is applied to only the underside of the piece being mounted. The first step is to cut the piece to the desired size with the desired margin. A sharp razor blade or x-acto knife is handy for this. On the mounting board, mark the exact position for the piece. Cover the reverse side of the piece being mounted evenly with cement and place it directly on the mounting board while wet. This enables the piece to be moved freely for proper alignment. When the piece is properly located, place a sheet of tissue paper over the piece and press the piece flat with a triangle. This squeezes out the excess cement which can then be removed.

Dry Mounting

The dry mount method is more often used when mounting photographs, type proofs, and artwork. Though not completely permanent, dry mounts hold extremely well. Both surfaces are covered evenly with cement and allowed to thoroughly dry. When dry, the two surfaces stick instantly upon contact. The first step in dry mounting is to secure the mounting board to your drawing board. Line up the piece being mounted with the desired margins marked, as in the wet process. Then apply cement to both surfaces and allow it to dry. When the cement is dry, place a sheet of tracing paper over the cemented mounting board leaving about one-quarter of an inch exposed at the top. This sheet prevents the sticking of the two cemented pieces. Position the piece being mounted and press it firmly against

the exposed area on the mounting board. Slowly withdraw the tracing paper as you gently smooth the piece against the mounting, working from the center outward. Repeat the process slowly until the piece is completely "stuck" down. Place a sheet of tissue over the work and draw the edge of a triangle over the work. Then remove the excess cement with a cement pickup.

Double Slip-Sheet Mounting

For mounting large pieces of art or drawings made on flimsy paper, the two slip-sheet method divides the work area and makes handling easier. Secure the mounting board to the drawing board and mark the corners as before to show margin. Coat both the mounting board and the underside of the art with cement and allow it to dry. When both pieces are completely dry, place two sheets of tracing paper over the mounting board, with the slip sheets overlapping slightly in the center. Place the art exactly within the corner marginal marks. Hold one half the art firmly with one hand as you gently withdraw the opposite slip sheet about half an inch. Smooth this strip down and continue the process with this slip-sheet until one-half the art is entirely cemented down. Then repeat the process with the remaining side. Smooth the art down and pick up the excess cement.

Dry Mounting Press

The dry mounting press offers clean fast mounting. A thin sheet of translucent material which dissolves under heat and adheres to and binds both surfaces is used for the adhesive. It is sometimes necessary that several sheets of adhesive be used for one job. The only restriction is that the sheets cannot overlap beneath the art; this will cause a seam to be visible. It is permissible to leave space between the sheets beneath the art. The dry mounting press is frequently used in graphic and photographic departments on photographs, photostats, or any paper lightweight enough for the heat to penetrate.

An electric "tacking iron" is used to fasten the work temporarily in place. The adhesive sheets are trimmed evenly with the photo. No adhesive should extend beyond the edge of the photo or it will stick to the press. A sheet of paper should be used to protect the photo when using the tacking iron. The photo is placed face up in the press with a protective tissue over it and heat and pressure are applied for 15 to 30 seconds. The tacking iron can be used to press down any bubbles.

CUTTING A MAT

It takes experience to cut a professional looking mat. The usual size mat is 3 x 4, meaning there are three unit margins at the top and sides and a four unit margin at the bottom. Quite often the work requires that a mat be cut for a picture that is only slightly too small for an existing frame. This necessitates that the above rule be set aside. Special matting board is available; and the tools needed for the job are a good

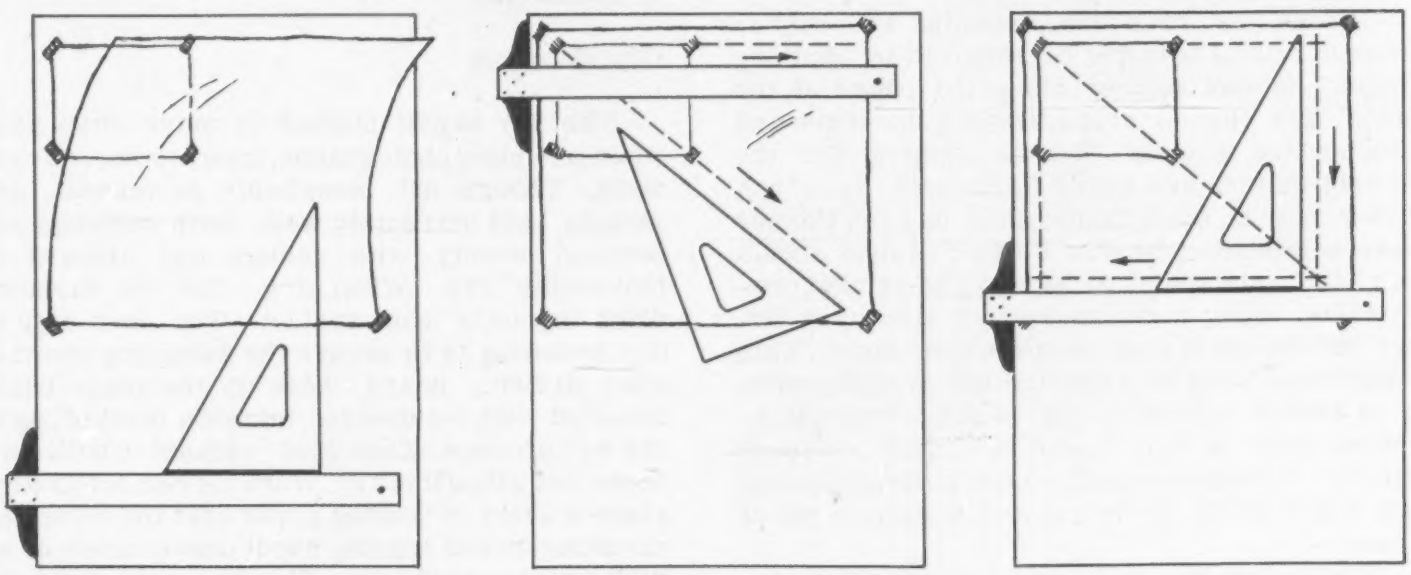

Figure 17-1.

straightedge, a ruler, a mat knife, and tape.

All measurements are made on the front side of the mat and tick marks are located at the corner points of the area to be cut. Before cutting, check the measurements against the desired area on the picture being matted so that any adjustments can be made before cutting.

Start the cut at any corner beginning at a tick mark. This is required to make clean, sharp corners. The knife can be held at an angle to make a beveled cut, or can be held at a right angle to the mat to make a square cut. Whichever you start, use the same cut all the way around, and do not extend the cut beyond the tick marks. An extra piece of mat board or cardboard beneath the mat makes cutting easier.

To attach the picture to the mat, attach a strip of tape to the back of the picture, allowing one-half of the tape to extend beyond the edge of the picture. Place the mat over the picture and, when it is lined up properly, press it against the protruding tape. This will hold the picture and the mat together while you turn them over and tape the remaining sides.

RESCALING

When you want to change the scale or size of a piece of artwork or layout without using any mechanical aids, you can do the job accurately and neatly with your T-square and triangle. Figure 17-1 illustrates how to scale up to a larger proportion. If you need to scale down, reverse the procedure shown in figure 17-1. The first step is to secure the art to the drawing board. Tape a large sheet of tracing paper over the art with the art in the upper left corner. Draw a diagonal line from the upper left corner to the lower right corner and extend the line beyond the corner as shown in figure 17-1. A horizontal and vertical line meeting anywhere on the diagonal will be correctly proportional. Figure 17-1 shows the art being doubled in size. The width of the art is doubled on the top horizontal line, then a vertical line is dropped to where it intersects with the diagonal. The bottom horizontal is drawn at this intersection.

If you want to relocate enlarged art on an enlarged rectangle, follow the procedure shown in figure 17-2. Extend the vertical and horizontal lines on the original until they meet the edge of the original rectangle. From the lower left corner, draw diagonal lines through the points as shown in figure 17-2 until they reach the edge of the larger rectangle. From the four new location points, draw vertical and horizontal lines; their intersection will locate the new area for the photo.

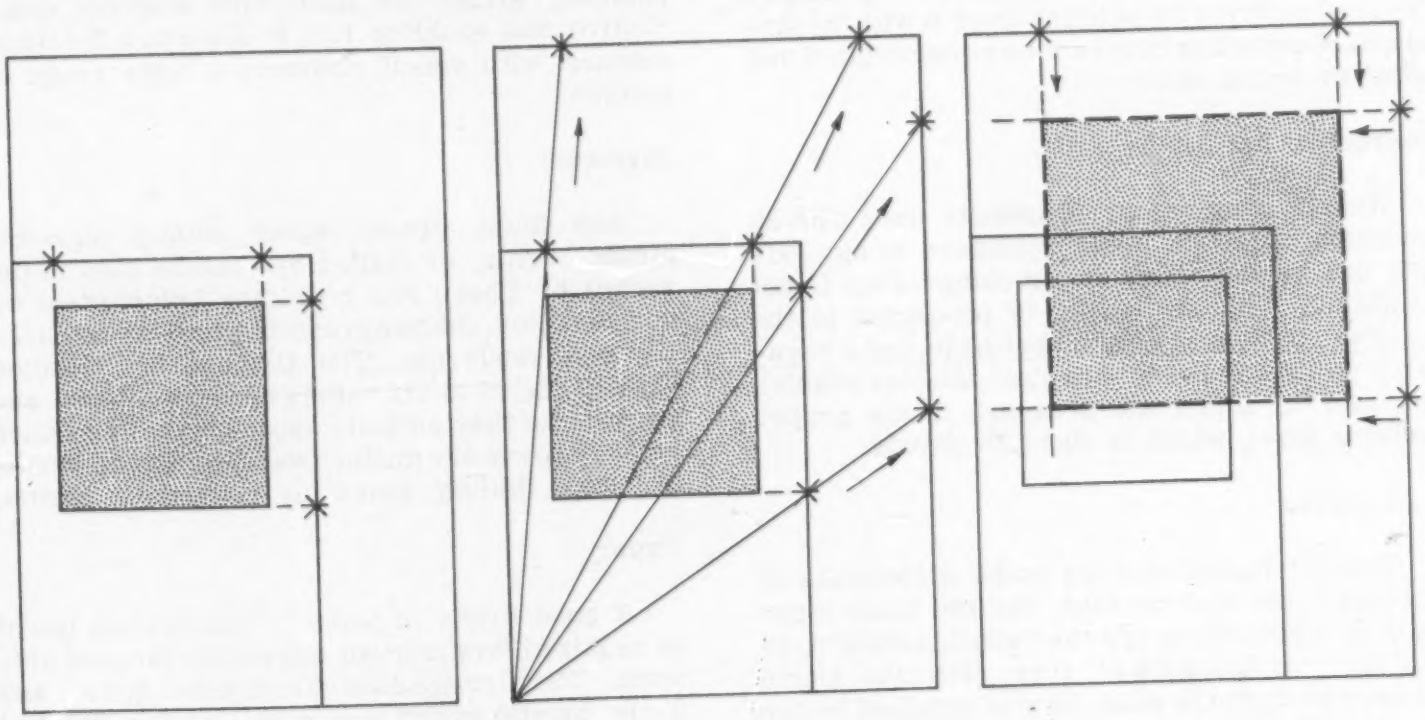

Figure 17-2.

you have not recently reviewed the basic principles of superheterodyne receivers in Basic Electronics, NavPers 10087-B, you should do so before continuing with this chapter.

The remaining pages of this chapter are devoted to some of the important considerations involved in the understanding of the operation of mixers. The first portion is a brief coverage of the local oscillator, followed by the triode mixer, the single-ended crystal mixer, and the balanced mixer. In some microwave equipments the mixer is used as the input circuit, while in others, the mixer is preceded by one or more stages of RF amplification at the frequency of the incoming signal.

INPUT SIGNALS

For operation of the mixer, it is necessary to provide two signals at slightly different frequencies. The first of these frequencies is the incoming signal, with its intelligence impressed upon it. This signal is picked up from the air in the form of electromagnetic waves, and is converted in the antenna circuits into electrical currents and voltages. From the antenna, this signal is carried to the mixer through some form of transmission line (usually coaxial cable or waveguide), possibly (but not necessarily) through an amplifier.

The second required frequency is produced by the local oscillator. The local oscillator may be a klystron, magnetron, backward wave oscillator, or any other type oscillator capable of producing a small amount of energy at the desired frequency. One type triode oscillator used at UHF frequencies is shown in figure 12-32.

The local oscillator, shown at the right in figure 12-32 (A), is similar in construction to the RF amplifier except that the grid cylinder is partly cut away near the local oscillator tube. Thus C_{pk} in the oscillator equivalent circuit (B) includes both the plate to cathode capacitance of the tube and the external coupling capacitance resulting from the opening in the grid line. All cylinders of the oscillator, tuner, like those of the RF amplifier, operate at ground voltage, and the cathode is maintained at a positive potential with respect to ground because of the bias voltage developed across C_{k2} in parallel with R_{k2}.

The local oscillator is tuned in accordance with the principles discussed for the lighthouse tube oscillator in an early part of this chapter. The plate line length is the primary control for frequency and, in fact, constitutes the main tuning control for the receiver. Tuning is accomplished by means of a knob or dial connected to the plate line shorting plunger through a mechanism not shown in the figure. The cathode line length governs the magnitude and phase of the voltage fed back to the cathode circuit from the plate circuit and must be adjusted so that a capacitive reactance appears between grid and cathode at the oscillation frequency. At frequencies in the neighborhood of 1,000 megacycles per second, it is mechanically feasible to choose line lengths so that each line employs its lowest mode of resonance. Thus the cathode line is approximately one-quarter wave at the oscillator frequency, and the plate line is less than a quarter wave.

TRIODE MIXERS

Power coupled from the plate line of the local oscillator is applied, together with input signals from the RF amplifier, to the cathode line of the mixer tube V3. A component of current at a frequency equal to the difference between the local oscillator and signal frequencies is produced in the plate circuit of the mixer, and the plate circuit is tuned to this difference frequency.

The mixer tuner differs from the local oscillator and RF amplifier tuners in that it employs a coaxial line cavity only between cathode and grid, lumped parameters being used in the plate circuit. The tuned plate circuit consists of inductor L_{p3} in parallel with interelectrode capacitance C_{gp}, the series combination of C_c and the input resistance R_c of the output line, and the variable capacitance C4 formed by a movable metallic disk near the plate terminal of the tube. The capacitance of C4 is varied by changing the disk position by means of a rod which passes through the end of the tuner.

The various components comprising the tuned plate load of the mixer are illustrated in figure 12-32 (B). Because input signals are applied between grid and cathode of the mixer and the intermediate frequency signals appear between grid and plate, the equivalent circuit is represented as a grid return circuit. From the equivalent circuit it may be seen that the variable capacitor C4 serves to tune the remaining plate circuit elements to resonance at the intermediate frequency. Placing capacitor C_c in

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THE PANTOGRAPH

The pantograph is a mechanical instrument used to enlarge or reduce or copy a drawing or photograph. It consists of four arms, of either wood or metal, joined at four points. Secure point A (fig. 17-3) to the drawing board. Set trace point C over the object to be copied. Point F, a pencil point, repeats the motions of point C and copies the object on the drawing paper. To adjust the degree of enlargement or reduction, move the connecting points B and E along a scale marked on the arms. Watch point C, following the lines of the original, as you guide the pencil at point F with your hand.

THE AIRBRUSH

In illustrative artwork, airbrush art can be broken down into various specific applications. Airbrush rendering and airbrush photo retouching may be considered the two major categories. An airbrush painting is done on drawing paper or illustration board. It may be pictorial, abstract, or mechanical insofar as subject matter is concerned. It may be partially or completely done with the airbrush, using water color paints or dyes. Photo retouching involves the application of water colors — generally opaque grays — to photographs. Minor adjustments may be made on the photograph or the photographic image may be covered entirely by painting over it with the airbrush. Retouching may be done either in black and white or in full color.

Sources of Air Supply

An air compressor is usually used with an airbrush, although metal cylinders of any safe gas can be used when an air compressor is not available. The air supply is connected to the airbrush by means of a rubber hose, and a regulator on the compressor or gas container enables the user to adjust the pressure to the proper working level, which is about 25 pounds.

Airbrushes

Several manufacturers make airbrushes of various types and models. The two basic types used by illustrators are the "single action" type and the "double action" type. With the single action airbrush the paint flow is obtained by one action: pressing down on the finger lever. This design is the simplest with the least number of parts. A color adjuster can be regulated for fine or coarse effect, but the spray pattern cannot be varied during a stroke, except by varying the distance from the paper. While good for background work and simple airbrush art, this model does not permit the precise control attainable with the double action brush.

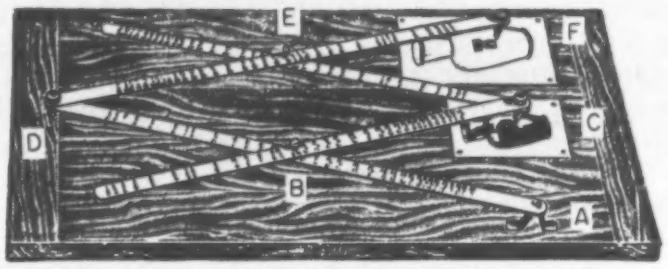

Figure 17-3.

The spray pattern from the double action airbrush is controlled by two actions: pressing down on the finger lever and pulling back on the finger lever — the further back, the larger the pattern. This allows for easier control and variation of the pattern. There are three major all-around studio brushes of the double action type, and a more specialized airbrush for the very finest detail work in photo retouching and air painting, giving the illustrator absolute color control and enabling him to draw in a freehand manner with pencil accuracy a wide range of patterns.

Pigments

Any finely ground water soluble pigment, alcohol color, or aniline dye can be used in the airbrush. These can be either transparent or opaque color. Opaque grays are used for retouching and rendering. The Grumbacher Gamma grays, scaled in six values of neutral gray, reproduce as they actually appear to the eye. Other retouch grays are made in warm (brownish) tones and cool (bluish) tones for retouching photos.

Paper

A good grade of paper or illustration board is required for airbrush, especially finished artwork. The Grumbacher illustration board, and 3-ply bristol board are excellent for finished work. For practice, the 1-ply kid-finish or heavy drawing paper is satisfactory.

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Other Materials

Areas not to be sprayed are covered with masks made of drawing paper, stencil paper or acetate. Intricate areas are managed by attaching frisket paper to the drawing with rubber cement, and cutting out the areas to be airbrushed. A frisket knife is used for the cutting. A rubber cement dispenser, palette, red sable brushes and the usual drawing instruments complete the list of supplies.

Maintenance

For proper care and maintenance, and operating principles of a particular type airbrush, reference should be made to the manufacturer's instruction book. The manufacturer's instruction book will also enable you to properly clean your airbrush, determine causes of breakdown, and make minor replacements and adjustments.

Figure 17-4.

OPERATING THE AIRBRUSH

Start by diluting the pigment to approximately the consistency used to secure a medium value wash, remove it from the palette with a bristle brush or eye dropper and fill the color-cup with it. See figure 17-4. Do not use a brush that will shed hairs, as they will get into the airbrush and clog it. To hold the brush, wrap the hose around your right wrist. When you hold the brush this way, the hose will be restrained by your wrist and will not flop over the paper.

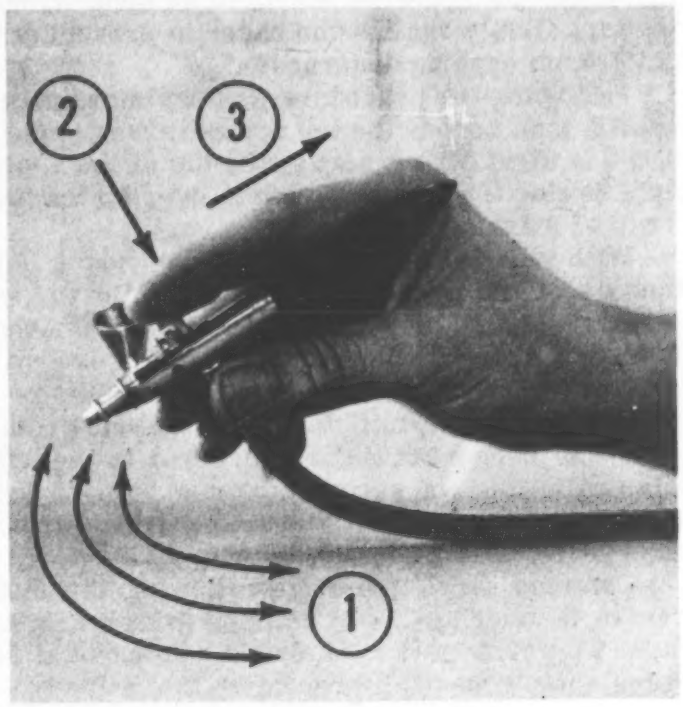

Figure 17-5.

Position yourself so that you are sitting upright, but comfortably relaxed, with enough room between your arm and the drawing so that your arm can move freely. Hold the brush about 8 inches above and at a right angle to the paper through the entire operation. To airpaint properly, three distinct motions must be controlled and coordinated. First, set the hand in motion; second, press the finger lever down, releasing air but not paint; third, release the paint by gently pulling back the finger lever. See figure 17-5. During these three operations, keep your hand in motion to the end of the stroke. At the end of the stroke, allow the finger lever to move forward, stopping the paint, then up, stopping the air flow.

It is very important that the three actions be separate, but follow each other closely. Running the first and second actions together will result in a sudden burst of paint at the beginning of the next stroke. The entire movement should be slow and steady. The whole arm moves across the paper from the shoulder; do not dip the hand or turn the wrist, or change the angle of the brush.

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Flat Wash

Prepare a simple paper mask as shown in figure 17-6. Tape the mask to the drawing paper with masking tape, allowing the tape to overlap the paper by about an eighth of an inch. Press the tape firmly against the paper to prevent any paint from seeping underneath.

Following the procedure just explained, airpaint a tone across the top of the drawing paper. Avoid a light streak across the top of the sheet by allowing the spray pattern to overlap the top strip of masking tape.

With your hand in motion, start at the top left outside of the mask and pull back on the finger lever while still over the mask. This allows the full strength of the pattern to fall on the exposed portion of the paper. The finger lever must remain pulled back until the opposite side of the page has been reached. Now return to the left edge, allowing the second stroke to overlap the first, being careful that no streak will show from the overlap. See figure 17-7.

Continue down the page, allowing the last stroke to overlap the bottom strip of masking tape. This first coverage should be kept light in value, and darkened by repeating the entire process as many times as necessary to create the value desired.

Be certain that the drawing paper and the masking tape are dry before removing the mask. To avoid any damage to the surface of the drawing paper, remove the tape slowly and carefully.

Satisfactory results may not appear right away, for control of the airbrush is a matter of practice.

Graded Wash

Prepare a sheet of drawing paper with a mask as before. Start the spray pattern at the bottom of the page, since this will be the darkest area. Proceed as you did with the first strokes of the flat wash, except that as you progress from the bottom you allow the paint to fade off completely before you reach the top of the exposed area of the drawing paper. See figure 17-8.

Next, start again at the bottom. Proceed upward as before, except that instead of following the pattern up as far as the first passage, stop just short of it, allowing the tone to fade out. It will be necessary to repeat this procedure several times, stopping short of each of the previous passages each time. It may be necessary to add a little more pigment to the solution for the last few passages at the bottom since the paint is very diluted for the gray tone. In figure 17-9 you can see that the top of the drawing is white, the bottom is black, and there is a smooth, graded transition between.

Spotlight Effect

To create a spotlight effect, cut a paper mask with a square opening. Tape the mask over a sheet of clean drawing paper so that it will not shift.

Turn one corner toward you and airpaint horizontally across the corner two or three times, aiming the pattern so that most of the paint spray falls on the mask at this corner. See figure 17-10.

Without moving your aim, bend your wrist upward so the spray pattern is raised slightly.

Return to the original position and apply about two more strokes in the corner again. Now rotate the paper, taking each corner in turn, and repeat the above procedure in the same manner.

With the four corners sprayed in, airpaint about a half-inch of each corner in solid black, fading gradually into the light area. Until the black is added, keep all of the corners light. After all corners have been painted, join them with a light tone along the edge of the mask. Remove the mask as before.

There should be a smooth transition with the spotlight fairly white and about one half-inch of solid black at each corner as shown in figure 17-11.

MAKING A FRISKET

Areas which are not to be sprayed when airbrushing are protected by means of a mask or frisket. A frisket is a sheet of frisket paper coated with rubber cement. It is placed over the drawing or photo and cut out to expose the areas to be painted.

First coat either side of the frisket paper with a thin even coat of thinned rubber cement. Allow it to dry, then give it a second coat. Care must be taken not to lift off the dried first coating.

When the second coat is dry, lift the frisket and turn it over so that the coated surface is face down and place it slowly over the drawing, allowing the middle of the paper to contact the drawing paper first.

Carefully flatten the frisket working from the center outward with the hand or a flat edge.

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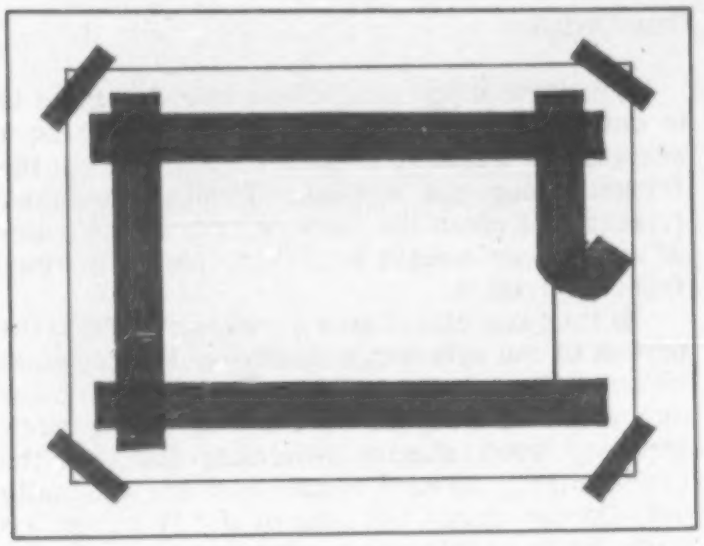

Figure 17-6.

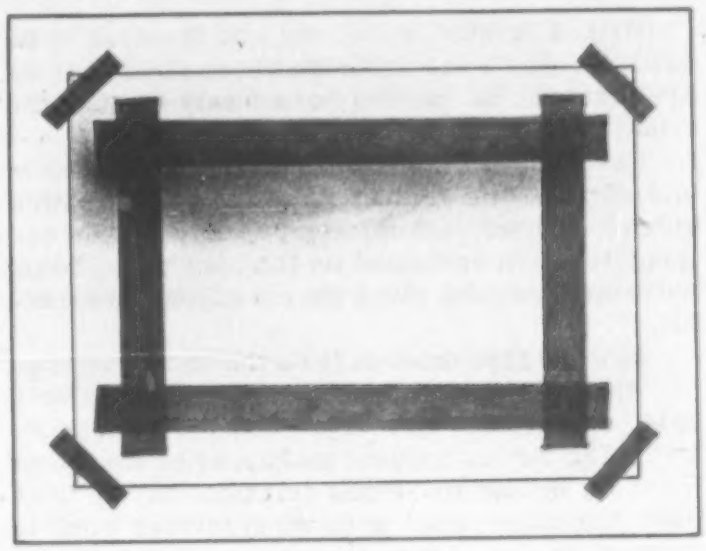

Figure 17-7.

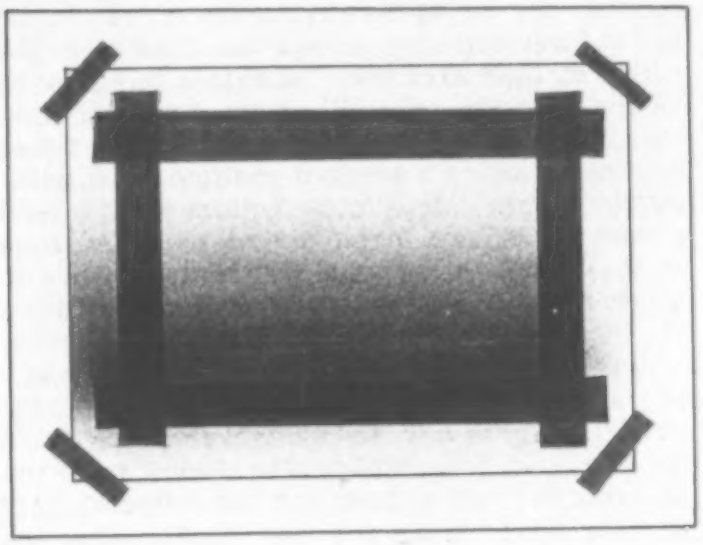

Figure 17-8.

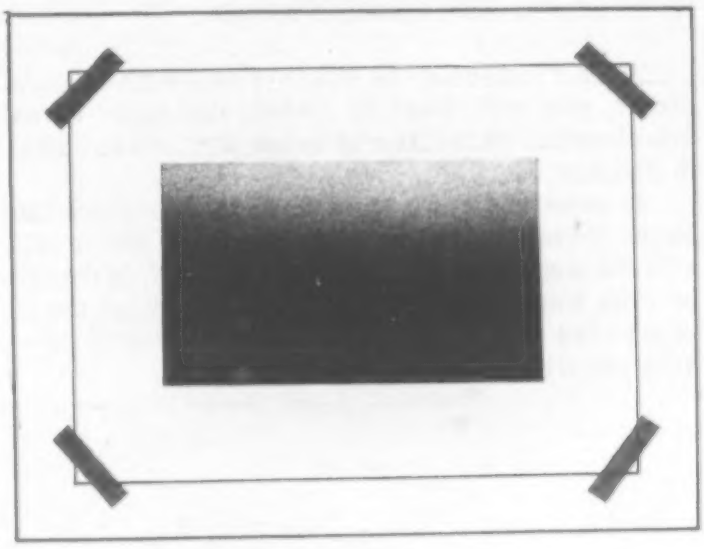

Figure 17-9.

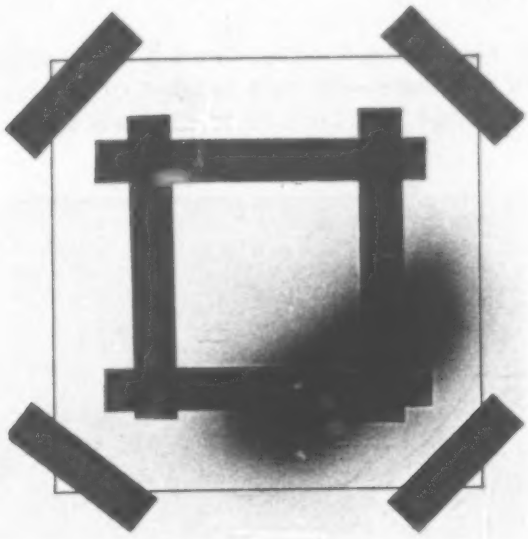

Figure 17-10.

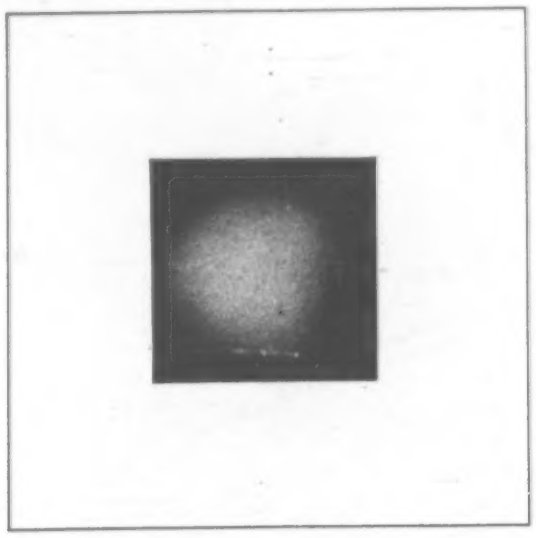

Figure 17-11.

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With a frisket knife, cut out the area to be exposed. Use a straightedge where straight lines are wanted. Be careful to cut only through the frisket paper and not into the drawing.

Carefully lift one corner of the frisket paper and remove the frisket from the paper. With a rubber cement pickup, remove any rubber cement that has remained on the open area, being extremely careful along the cut edges of the frisket.

Now the exposed area is ready for airpainting.

When the area has been airpainted, and both paint and frisket are dry, remove the frisket. Using the rubber cement pickup, remove any cement on the paper. Other friskets may be used over the airbrushed area when further work is necessary.

RENDERING THE BASIC FORMS

When rendering the basic forms with the airbrush, you will want to obtain the same three dimensional character of these forms as you did in chapter 11.

In creating your light source to shadow the basic forms, a single light from the upper left at a 45-degree angle may be assumed, although in real practice, a light source from an angle other than this may be needed to correctly present the illustration.

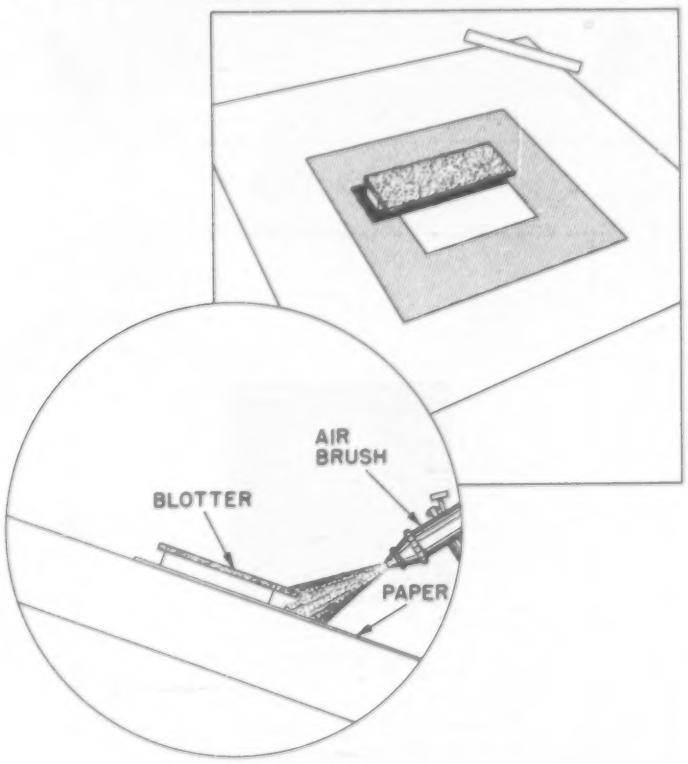

Figure 17-12.

The Cylinder

The first step in making a cylinder form is to outline a cylinder as it will look; that is, a rectangle. Place a frisket over it and cut the frisket along the outline. Remove the inner frisket and clean the working area of the paper of any rubber cement which may have remained from the frisket.

In this exercise, leave a reflected light at the bottom of the cylinder, and have the shading start with a soft edge. To do this, use a raised blotter as a mask. See figure 17-12. For the first few strokes, work almost vertically and turn the brush slightly upward to fade the tone gradually out. Do not spray too long or get this area too dark, but have this area unfinished.

Now, turning the drawing paper upside down, start at the top of the shadow and do as you did in the previous step, except this time make the reflected light narrower. To do this, do not cover as much of the cylinder as you did in the previous step. Do most of this shadow with the brush held close and in a vertical position. Now, without the blotter, airpaint the bottom shadow until a very black area forms across the lower edge of the bottom shadow. It will be necessary to work close so that you do not soften the bottom of the shadow too much. See figire 17-13.

In figure 17-13, the really black area is only at the bottom of the bottom shadow and it fades out gradually to a white highlight about one-third the way down from the top. The shadow at the top is narrower and lighter and the reflected light at the top is narrower and lighter than the reflected light at the bottom.

The Cube

In rendering a cube, draw a dark sharp outline of the cube. Place a frisket over the paper, leaving wide borders of frisket all around. For

Figure 17-13.

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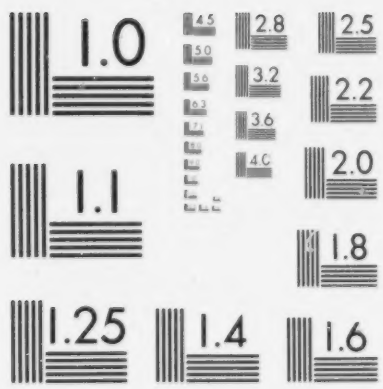

MICROCOPY RESOLUTION TEST CHART

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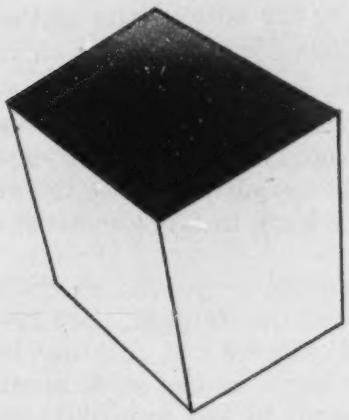

Figure 17-14.

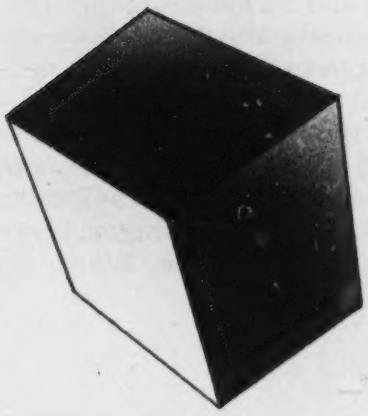

Figure 17-15.

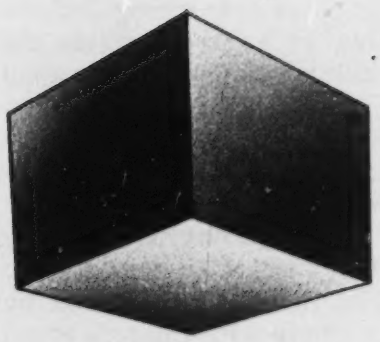

Figure 17-16.

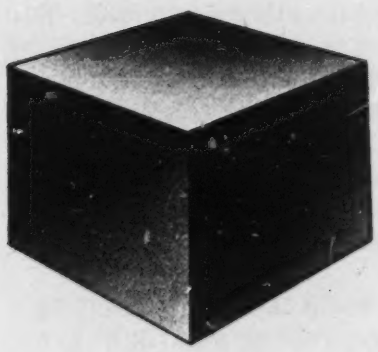

Figure 17-17.

this exercise, start with the darkest plane so it will serve as a value guide for the other planes and will save masking off certain areas when progressing from dark to light planes.

Turn the drawing so that the corner to eventually become the darkest is nearest to you and remove the frisket from this plane. Apply pigment to this corner, fading it out to the corner which is diagonally opposite it. See figure 17-14. Start each passage in the darkest corner, so that it receives most of the pigment. The darkest tone should not be reached until the end of this exercise.

Now remove the frisket from the middle plane. Airpaint on the diagnonal as before, keeping as close as possible to corner No. 1 because it is desirable to have as much contrast as possible between the intersection point of the three planes. Corner No. 2 should not be quite as dark as the black in the first plane. It is not necessary that the first plane be covered with frisket paper. See figure 17-15.

Remove the frisket from the last plane. Airpaint a graded wash that is still lighter than that used on the second plane. No pigment is applied to the far corner, so that it will remain white as shown in figure 17-16. The frisket is now removed from the area surrounding the drawing, and any rubber cement left on the paper removed with a rubber cement pickup. Note that with the frisket removed all of the planes are smoothly graded in value. The only black is in the top left corner of the darkest plane, and the only white is next to it, with the third corner of a value halfway between the two. The completed cube is shown right side up in figure 17-17. In figures 17-14, 15, and 16, the cube was shown at the angle from which you would view it while doing the work.

The Sphere

To render a sphere draw a circle and prepare the drawing paper as before by removing the frisket from the working area and cleaning the working area of any rubber cement which may have stuck to it.

Airpaint a very light tone around the edge of the sphere, allowing the spray to fall on the frisket. Do this with short strokes in both directions since long strokes here are difficult to control. Keep the tone as even as possible, fading it out gradually on the inside edge.

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Figure 17-18.

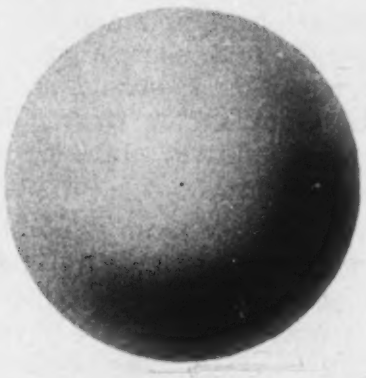

Figure 17-19.

Figure 17-20.

Carry this coverage up farther from the bottom, leaving the highlight—a small circular area at the upper left of the spere. The highlight should be left as white as possible. See figure 17-18.

In the lower right area, airpaint a shadow along the right side a short distance from the frisket, then paint across the bottom and up the left side as shown in figure 17-19.

Now begin your heavy shading, leaving a reflected light. The shading (as in the previous exercise) should be of short strokes in all directions except when fading out either at the upper right or upper left; work here in only one direction.

At the top of the sphere, airpaint a slightly dark tone off the edge of the frisket, then return to the lower right shadow and continue to darken this area. Now work on the solid black tone, which is airpainted in the approximate shape of a crescent. Full black is limited to this area. See figure 17-20.

Remove the frisket and the sphere is finished. The reflected light extends about two-thirds of the way around the sphere. The highlight is in the upper left area and the darkest area is diagonally opposite it in the lower right area. The only solid black should be the crescent shape in this area; the tone fades gradually and smoothly to the highlight. Always pull the finger lever back only slightly and build the tones up gradually.

PHOTOGRAPHS

Photographs are rarely used as illustrations without some work being done on them. This work can range from simple silhouetting or cropping to the more precise retouching. Photographs must be handled with care because the surface is extremely delicate. Most photographs are retouched to either bring out important features or suppress undesirable features. It may be necessary sometimes to eliminate unnecessary features completely.

The surface of a glossy photograph usually has a light film of oil on it which is resistant to water color. This film is easily removed by carefully rubbing the surface with fuller's earth (a fine white powder).

Photographs are not alike in tonal values. Some may be warm while others are cool. For cool tonal values, a cool gray can be made by mixing lampblack and opaque white. To make a warm gray, a touch of yellow ochre is added to the lampblack and opaque white mixture.

When retouching is apparent in the reproduction, it will lose its natural believability and look fixed-up. Care must be exercised never to over-retouch.

Whenever opaque white is used it must be a pure white or it will reproduce as a light gray.

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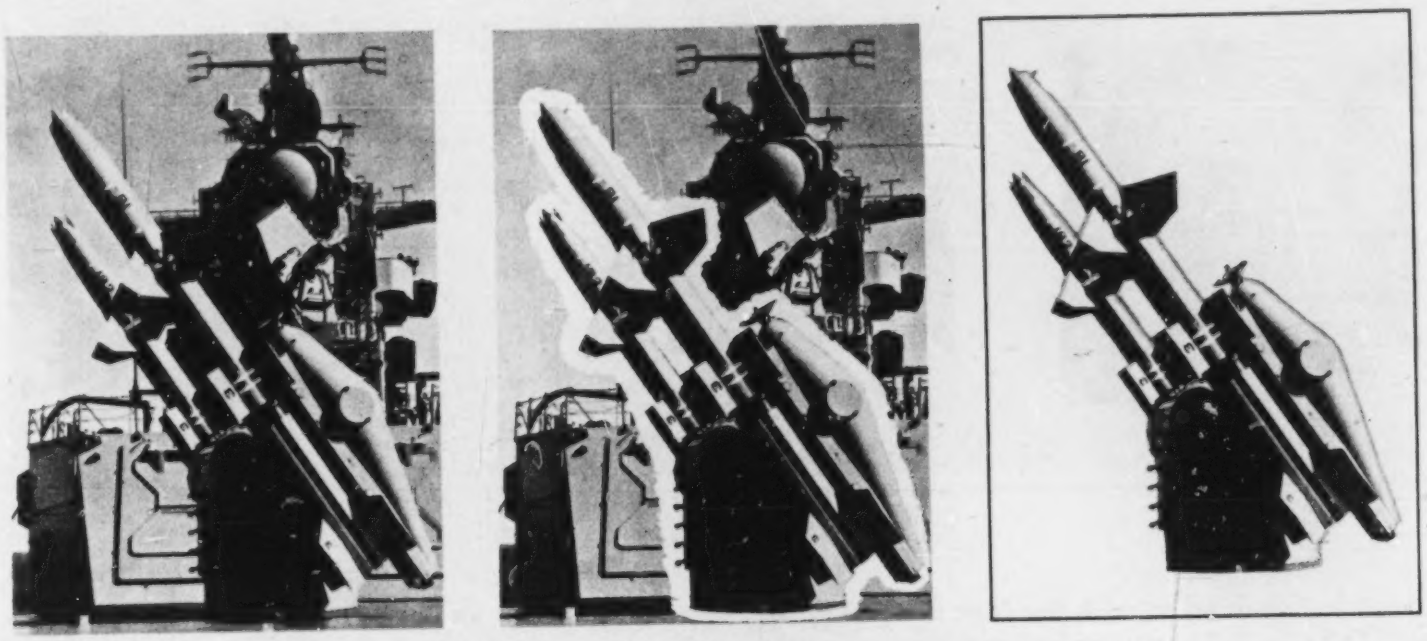

Figure 17-21.

Silhouetting

When a portion of a photograph is to be reproduced without the background, the desired object is outlined with white opaque. The first steps are to mount the photo, rub the surface with fuller's earth, and blow away the residue. The opaque white should very slightly overlap the object being silhouetted. It is not necessary to white out the entire background. A line about 1/4 to 3/8 inches wide around the object is sufficient. When printed, it will be reproduced with the complete elimination of the original background. Figure 17-21 shows silhouetting.

Cropping

Crop marks are directions to the platemakers indicating how much of the photo is to be used. Cropping is done to eliminate meaningless details and to focus interest on the important features of the picture. Since the corners of photographs are rarely square, it is a good habit to establish a squared-up figure inside the original edges. Cut two right angles from heavy white bond. Place these over the photograph and move them about freely until good composition and proportion are obtained. Mark the corners with grease pencil (which is easily removed later with a soft tissue). Remove the two paper right angles and mark the mounting board, not the photograph, where the photo is to be cropped. Figure 17-22 shows this procedure.

Removing Spots from Photographs

Sometimes a photograph will contain spots or scratches which must be corrected before they can be reproduced. This is done with a watercolor sable brush, opaque white and lampblack. A series of grays is mixed so that the tone value of the photograph is matched exactly by the paint in order that the retouching will not show. The photograph is first wiped with the fuller's earth. The tones for the light areas are mixed first and the flaws on the photo are painted over. The darker tones are mixed and the flaws in the dark areas are corrected. Avoid making fingerpints around the areas to be painted. The skin will leave an oily film which prevents the paint from adhering to the photo's surface. Small spots can be eliminated by using a Stabels or similar pencil which is made especially for photo retouching. A slow fine circular motion is used to match the gray tones. Care must be exercised to avoid digging into the pictures surface.

Removing an Object from the Photograph

It is sometimes necessary to completely remove an object from a photograph before it is suitable for reproduction. If the background is a simple flat tone, the airbrush can be used, but if the background contains details and textures, the brush and opaque paints are necessary. The same procedure is used when removing spots. The light tones are painted first, then the middle tones are

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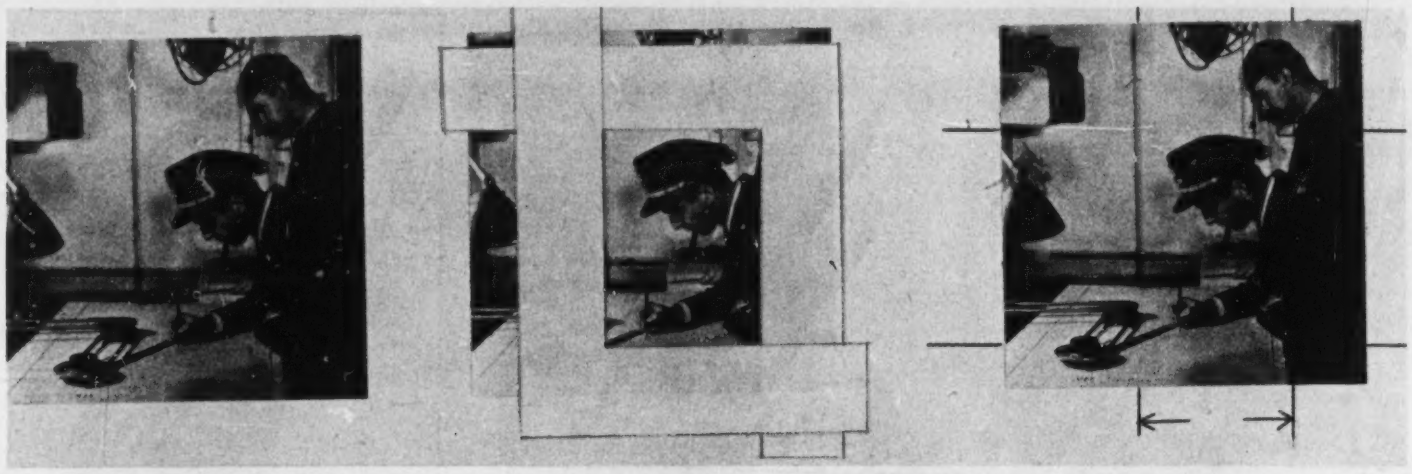

Figure 17-22.

mixed and painted in with the dark tones held for last. Details and textures are matched using the different techniques necessary to match the textures in the photograph as shown in figure 17-23.

Removing or Softening the Background

It is sometimes necessary to remove or soften distracting backgrounds. Sometimes only a particular object will need to be removed and the rest of the background toned down. It may be more appropriate to replace the entire background with a gray tone. To do this; the subject is silhouetted as described before, and the platemaker is instructed to fill in a gray tone over the background. Another method is to apply a frisket to the area to be retained and using the airbrush apply an even coat of gray, either light or dark, whichever is needed, over the undesired area. After removing the frisket, any excess paint which may have seeped underneath may be wiped off the subject with small wads of moist cotton that have been twisted onto the end of a brush handle (fig. 17-24). The edges of the subject may need to be retouched to avoid the subject's edges from being too sharp and unnatural.

Figure 17-23.—Removal of objects by retouching.

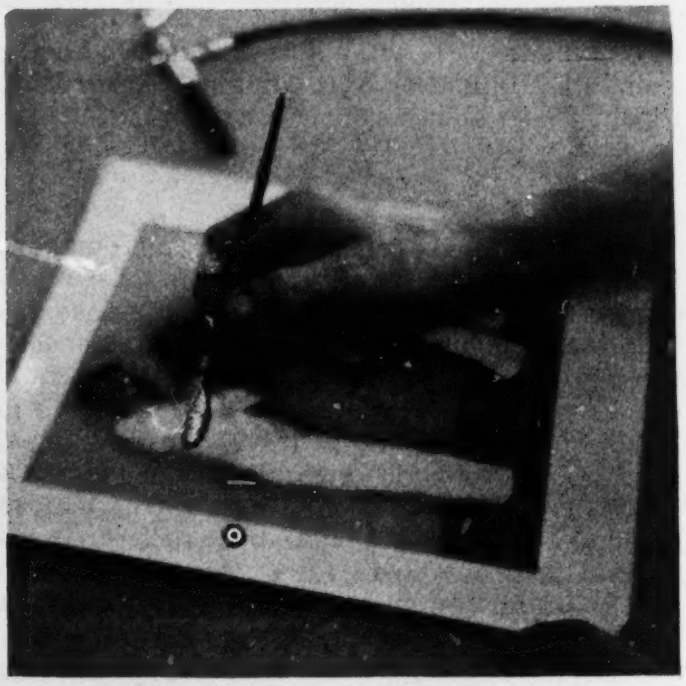

Figure 17-24.

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series with the output cable isolates the cable from the power supply voltage and causes the low input impedance R_c of the cable to appear as a higher resistance across the entire circuit.

The receiver input circuit of figure 12-32 (A) requires that the interconnecting cable between RF amplifier and mixer be short. Otherwise appreciable attenuation of received signals will occur in the cable and cause noise generated in the mixer to become important. If cable loss is excessive, it may become necessary to employ a second stage of RF amplification in order to maintain the signal level well above the noise level of the mixer.

SINGLE-ENDED CRYSTAL MIXERS

Because crystals are delicate, they must be protected extremely well by the TR device in order to avoid burnout during transmission. Vacuum tubes, on the other hand, are able to withstand relatively large amounts of transmitter power. Mixer circuits employing triodes have a somewhat higher conversion gain than crystal mixers, although they generate more noise. The effect of the increased noise may be offset at ultrahigh frequencies by preceding the triode mixer by one or more stages of radiofrequency amplification—the noise figure of a triode is appreciably less when used as an amplifier than when used as a mixer.

Unfortunately, most tubes that are available for operation in the microwave region generate an excessive amount of noise and are therefore not suitable for the input circuits of microwave receivers. Consequently, use of vacuum tube input circuits is usually restricted to receivers that operate in and below the UHF range.

Echo signals of a microwave radar system, after passing through the TR device, are applied to the crystal mixer. A voltage from a local oscillator is applied to the mixer simultaneously with the echo signals, and signals at the intermediate frequency are derived at the mixer output terminals.

The important features of a 10-cm mixer employing coaxial line sections are given in figure 12-33 (A).

Echo signals are coupled into the transmission line section between TR cavity and crystal by means of a coupling loop which penetrates a short distance into the cavity. The crystal fits snugly into the inner conductor of the line and is held concentric with the outer conductor by means of a dielectric bead. The local oscillator signal is introduced into the mixer assembly by means of a coupling probe located approximately a quarter wave (at the local oscillator frequency) from the coupling loop in the TR cavity. A high impedance in the direction of the cavity is thus presented to the local oscillator signal at the probe. The strength of the local oscillator signal at the crystal may be changed by varying the distance the probe extends into the main line. Power from the local oscillator is conducted to the probe via a section of transmission line.

Connection between the crystal and inner conductor of the line section carrying IF signals is provided by a spring contact (fig. 12-33 (A)). The half-wave RF choke appearing on the IF side of the crystal provides an electrical short circuit for radio frequency signals at point B. The d-c return path required for crystal current is provided at the RF end of the mixer assembly by the TR coupling loop and at the IF end by the shunt inductance element located in the grid circuit of the input IF amplifier stage.

A two-wire equivalent circuit of the mixer is given in figure 12-33 (B). If small losses in the RF line and TR cavity are ignored, the portion of the RF transmission system between antenna and output terminals of the TR cavity may be represented by a signal current source I_s in shunt with the characteristic resistance R_c of the transmission line. Because the local oscillator is loosely coupled to the main line, negligible admittance appears in shunt with the lines A and B in figure 12-33 (B). Elements L1 and C1 represent the RF choke at the IF end of the crystal and are series resonant at the echo signal frequency. Hence line B is terminated by the crystal at the echo signal frequency. For maximum receiver sensitivity it is important that essentially all the echo power available at the TR device be transferred to the crystal. The crystal should therefore present a matched load termination to the main line section. Fortunately 10-cm crystal units, when operated with 5/16-inch 50-ohm coaxial lines, provide essentially a matched RF load for the line. An impedance changing device between crystal and TR cavity is therefore unnecessary.

Because the local oscillator is loosely coupled to the main line containing the crystal, an appreciable mismatch of impedance exists on the local oscillator line at the coupling probe. A large impedance mismatch is in general undesirable because of the wide variations in local

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COMPOSITE PHOTOS

A composite photo is a picture that is composed of parts of two or more photographs. All of the photos used must be of the same scale so that the inserted objects will fit proportionally in the larger photo as shown in figure 17-25.

First the objects to be inserted are undercut at about a 45 degree angle. The back of the cutouts must be carefully sanded with very fine sandpaper until the thickness of the paper is gone. Rubber cement is applied to the background photo and the insert is glued down and the excess cement removed.

The composite is retouched with necessary shadows added and any spots removed. Making a composite is the only answer when you need the subject with a particular background and it isn't possible to have the subject photographed with the background.

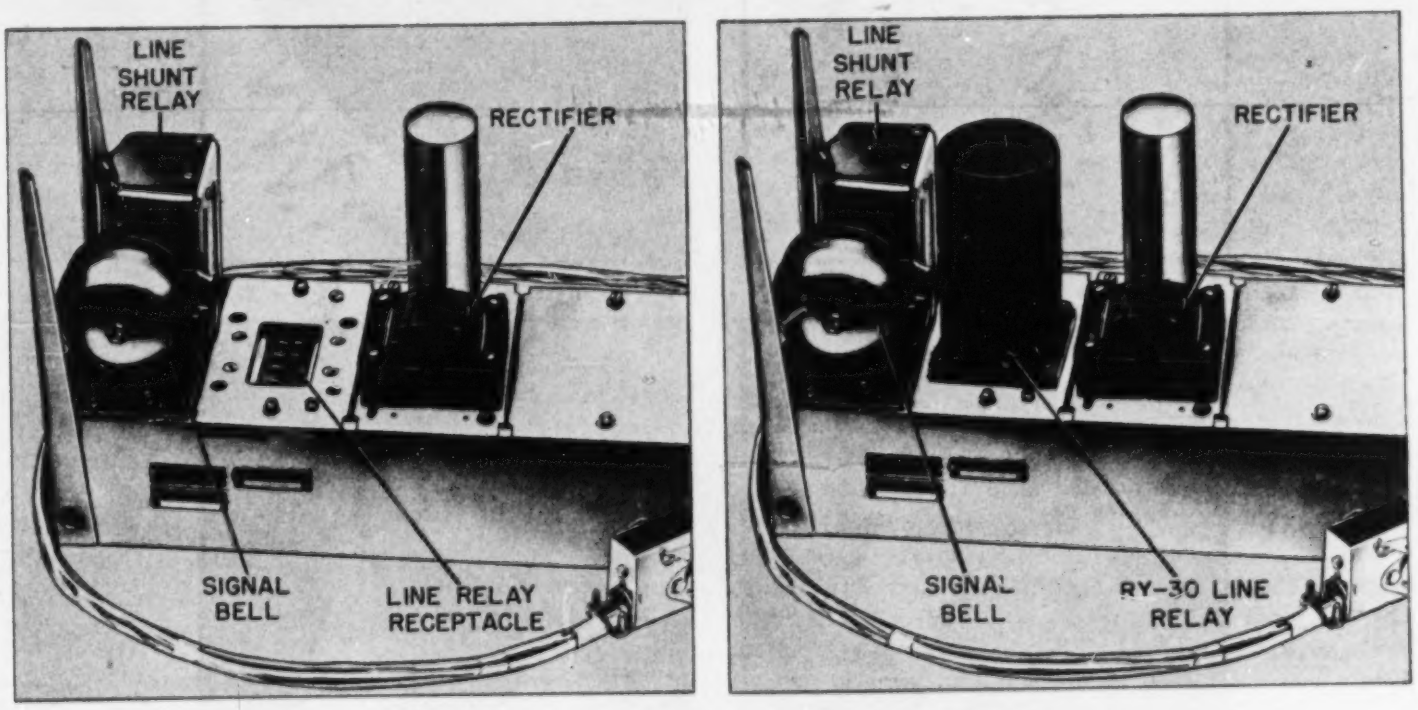

Figure 17-25.

MECHANICAL AIDS IN ILLUSTRATING

There are several mechanical aids available which help to cut down plate cost and allow accurate, foolproof reproduction of black and white drawings.

CRAFTINT

Craftint is a convenient product with which you add tones to a line drawing and still having the drawing reproduced as a line plate. Craftint papers come in single or double tone in a variety of screen patterns. The pencil drawing is done on the craftint paper, then the black areas are put in with pen or brush and waterproof India ink. Fingerprints repel the developing solution so a slip sheet must be kept beneath the hand. The dark tone developer is applied to the areas where a dark tone is desired. Enough developer is applied to bring up sharp, even tones, but all excess developer must be blotted up right away.

After all of the dark areas desired are developed the light tone developer is applied where light grays are desired. After the surface is dry, pencil lines are erased and any black and white accents desired may be added.

ZIP-A-TONE

The Zip-A-Tone sheet is a transparent sheet covered with minute dots or lines. It is applied over a drawing, the areas where the tonal effect is not desired are cut away. There are many patterns and screens available. The pattern to be used depends on the effect you want and the amount of reduction that may take place in the reproduction stages. First, a drawing is made

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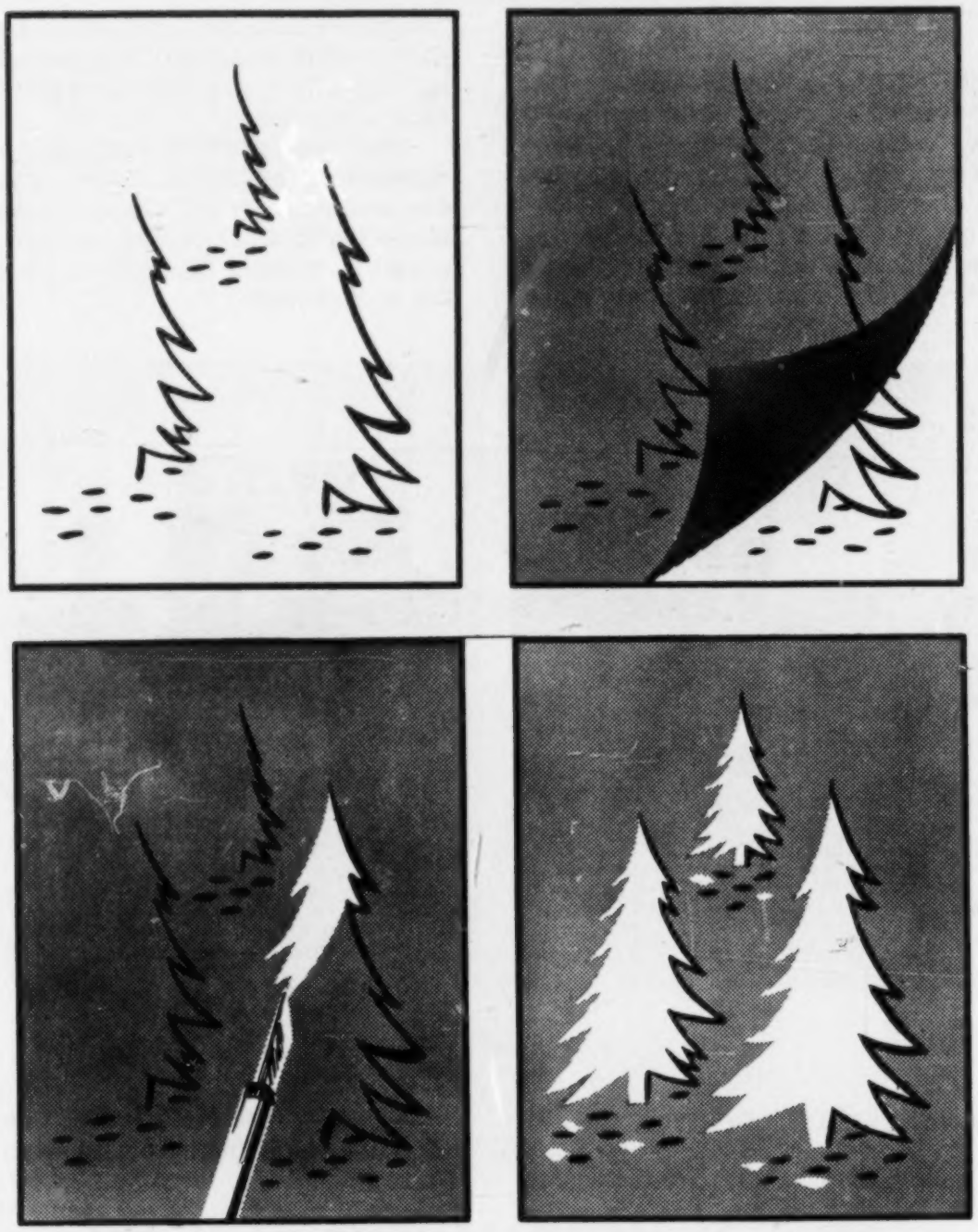

Figure 17-26.

with a brush or pen. All pencil lines must be removed and all corrections made before the Zip-A-Tone sheet is applied. The Zip-A-Tone is burnished to the drawing and then a razor blade or frisket knife is used to remove the Zip-A-Tone from the areas where the screen is not wanted. See figure 17-26.

SHOP PRODUCTION

The preparation of printing plates varies according to the method of reproduction to be used; but in both letterpress and offset printing the general procedure can be simplified something like this: (1) Camera stage; All artwork, line and tonal, is photographed onto negatives to the exact size it is to be printed. (2) Stripping; All negatives prepared in step 1 are stripped together according to the layout provided to the stripper. (3) Opaqueing; With brush and opaque paint, the platemaker "opaques" areas on the negatives that should not appear on the finished plate. In offset lithography, a blueprint or brown print called a vandyke is made for checking by a

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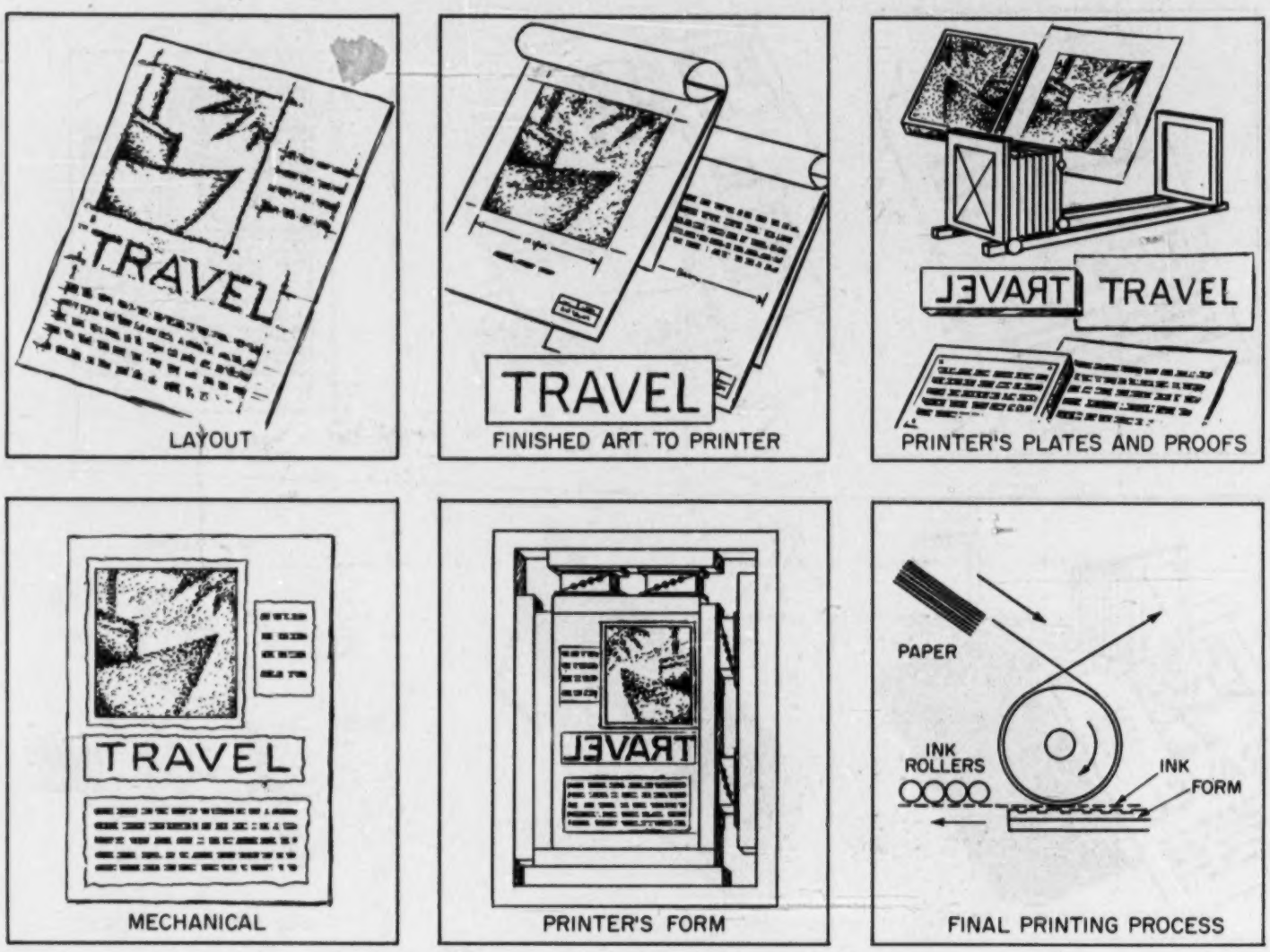

Figure 17-27.

production man. (4) Plate making; The negative is placed on a sensitized metal plate and exposed to light. The plate is then developed. (5) Proving; A proof is pulled when the letterpress is used. The offset uses the blueprint or vandyke as explained.

LETTERPRESS

With the letterpress process, the line and tonal art are usually plated separately. The plates are etched deeply so that the surface that will print is raised. Type is often combined with these plates and both are "locked up" together into one "form" for printing. Printing ink is transferred from the raised surface of this form directly to the paper. A screen must be specified when ordering a halftone plate. Fine screen halftones must be printed on glossy paper for best results. The plate is mounted on a wooden block. Figure 17-27 shows the simplified steps necessary for letterpress reproduction.

OFFSET

The camera stage of the offset process is almost identical to the camera stage of the letterpress process. The work is photographed and everything, tonal, line elements, and type, are transferred to a thin metal plate. With offset, the inked impression is transferred or offset from the plate to a rubber blanket and then to the paper. The word offset derives from this process of offsetting the image from the plate to the rubber blanket before it contacts the paper. Halftones in offset print are very good on almost

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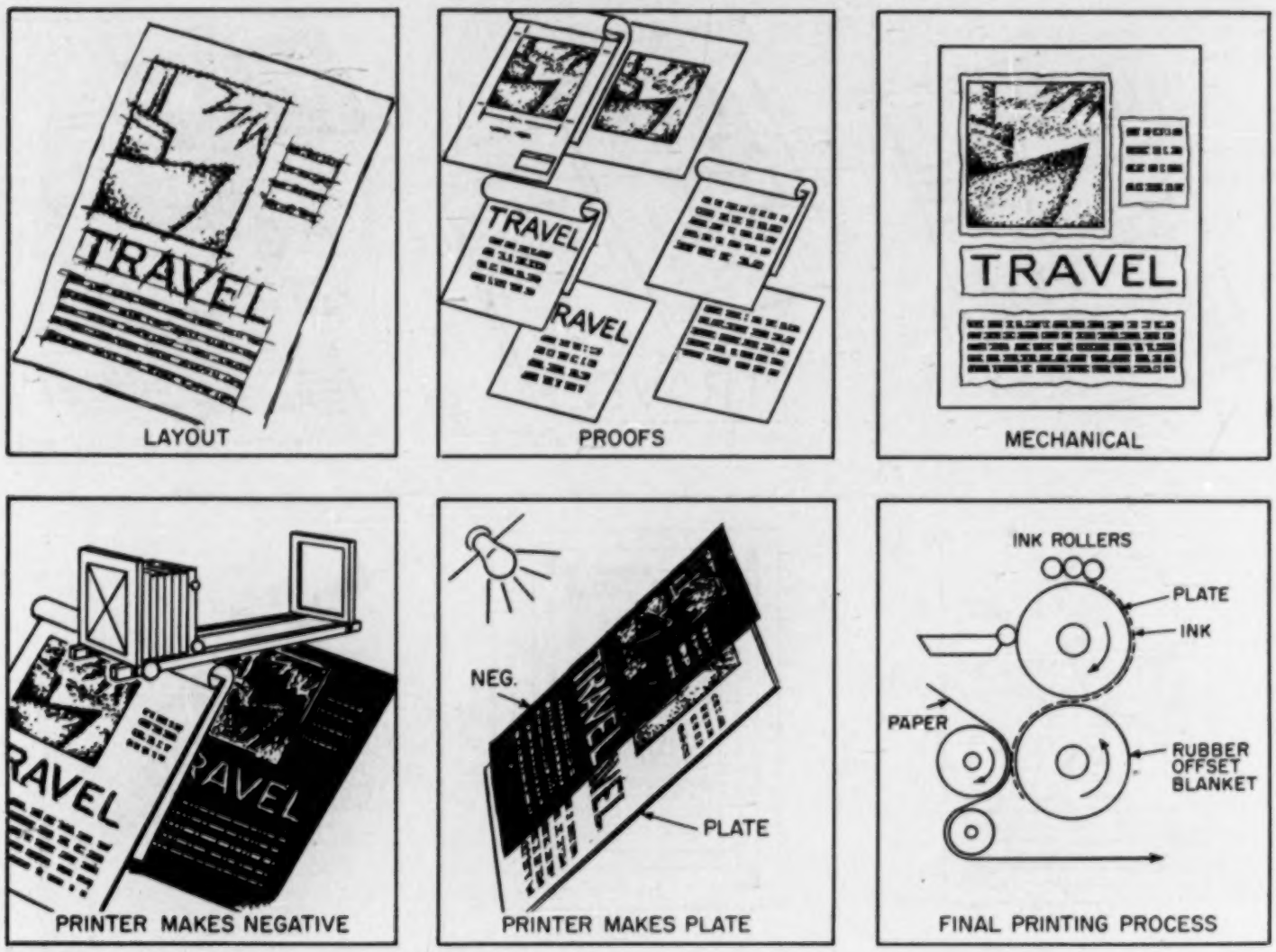

Figure 17-28.

any paper—even very rough textured stock. Figure 17-28 shows the simplified steps necessary for offset reproduction.

LINE REPRODUCTION

A photo-engraver is the one who makes the plates for letterpress printing and the plates are called photo-engravings or engravings. The simplest engraving is a line plate or line cut. Line plates are usually made of zinc and are blocked; that is, attached to a hardwood base exactly type high (0.918 inch). Line cuts are printed on almost any type of paper; they are especially adaptable to coarse newsprint paper. A line plate is made from art work containing only lines and areas of solid color (usually black) and white. Line art is usually done in pen or brush and ink. Line work to be reproduced in line must not contain any gray or tonal areas, simply black and white. A negative of the work is made and the images are then reversed. When the plate is made, the clear portions of the negative, which are the actual printing areas on the plate, allow the light to pass through and hit the sensitized metal. When the plate is passed through the acid baths of the developing process, the acid will etch or eat away those areas that were not exposed to the light. The areas etched away will be the white, clear areas on the print.

HALFTONE REPRODUCTION

All that the engraver cannot shoot as line must be shot as halftone. A haltone engraving is usually made of copper. Almost any tonal subject can be reproduced with the process.

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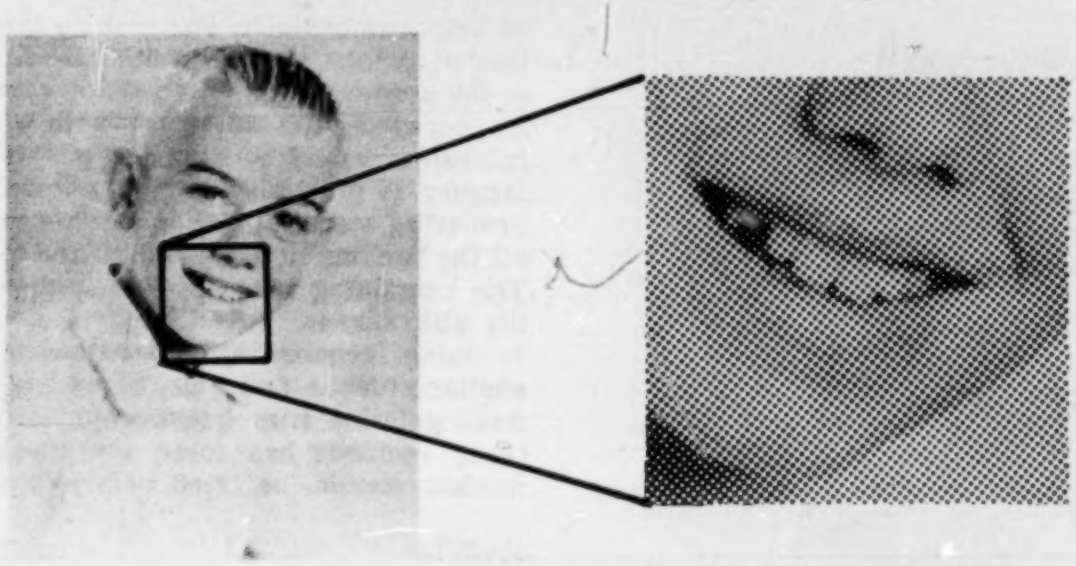

Figure 17-29.

The halftone process is accomplished by photographing the material through a halftone screen. The halftone or engravers screen consists of two glass plates that are covered with very fine parallel lines. The two plates are cemented together so that the lines of one plate cross the lines of the second plate at right angles. The screen is placed in the camera directly in front of the film. Light strikes the screen when the exposure is made and the screen breaks the tonal image into thousands of very small dots on the negative film. Except for the screen, the same process is used in making a halftone plate as in making a line plate. The very small black dots on a finished halftone engraving are in effect a miniature line cut. Where the drawing was light, black dots on the corresponding section of the plate are small. Where the art is dark, the dots are large. The eye, at the proper distance from the reproduction blends these dots into tones which range from white through gray to black.

Figure 17-29 shows a halftone reproduction and an enlargement of a section of the reproduction. You will notice that the halftone is a refined line cut.

SILK SCREEN PRINTING

Printing by means of cutout paper or metal stencils has long been a fast, easy means of lettering signs and applying decorations. The letters and designs made with a stencil show undesirable unpainted areas caused by bridges or ties which hold islands of the stencil in place. Silk screen printing is a method devised to eliminate these undesirable bridges or ties. It has developed in the past 50 years from a crude, seldom used method to an accepted method.

Silk screen printing can be used for producing posters, display cards, and various other items often required at a Navy activity. It is versatile in its effects, which range from the transparent appearance of water colors to the heavy impasto of oil paints.

Basic equipment includes a sheet of silk, a frame, a squeegee, paint, and material for making a stencil.

PRINTING FRAME

Commercially manufactured frames are available, or a frame similar to the one shown in figure 17-30 can be made locally. The size of the frame will limit the size of the prints which can be made. The inside of the screen frame should be long enough to provide reservoir space at both ends for the paint. The frame should be made to accommodate standard sizes of paper. It may be as small as a postcard or as large as 4 feet by 5 feet.

SCREEN

The most satisfactory screen material is pure silk. Number 8xx (86 meshes to the inch) or number 10xx (110 meshes to the inch) silk is satisfactory for all paper and film stenciling.

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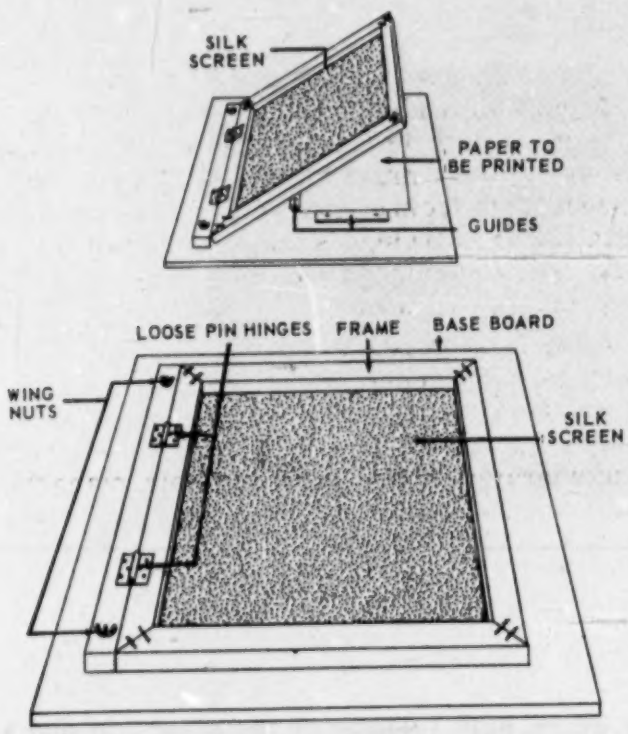

Figure 17-30.

The silk is stretched on the frame by fastening it in the middle at both sides and ends, and gradually working toward the corners. The threads in the silk should be placed parallel to the sides and ends of the frame. Organdy may be used in place of silk because it is less expensive; but it will stretch and sag under use, so that accurate register of colors is difficult to obtain.

STENCIL

With the screen stretched on the frame, you could pour paint into the frame and draw the squeegee across the screen to paint a solid color on a white card. A simple way to make a stencil is to place a sheet of stencil paper on the baseboard and cut out the desired design. Leave all pieces of the stencil in place on the baseboard, lower the frame, and spread the paint across the screen. The paint will stick the entire stencil to the screen when the frame is raised. The pieces of the stencil covering the areas to be painted must be peeled off the screen with tweezers and the stencil is complete. When the frame is lowered again and the squeegee is drawn across the screen, the paper prevents the passage of paint so that a white design is left unpainted.

The stencil paper method of preparing a stencil is one of several ways to make a stencil and should be used only when a limited number of prints is desired. For making larger quantities of prints, the paper stencil can be adhered to the screen with shellac and a warm flat iron. A prepared film material with a translucent (glassine paper) backing and a thin coating of lacquer is probably the most popular method of preparing stencils. The lacquer is cut and peeled off the backing in areas which are to be printed. The remaining lacquer film is then adhered to the silk screen. Stencils may also be prepared by using lacquer (with or without sizing), glue, shellac, tusche and glue, or with a light sensitized gelatine film (photographically). Each of these methods has some advantages and each method should be tried before it is rejected.

PAINTS

The process paints available for silk screen printing may be either oil paints or water colors. The oil paints are made from finely ground pigments mixed in an oil-base vehicle. Water colors have the pigments mixed in glycerine in a gum-base. Silk screen process paints are prepared by the manufacturer in the proper working consistency and packaged in various sized containers. A large selection of colors are available, and additional shades or tones can be produced by mixing.

THE SQUEEGEE

The paint is spread and forced through the screen with a squeegee. The squeegee as shown in figure 17-31 is similar to the windshield wiper blade of a car, but much larger. The

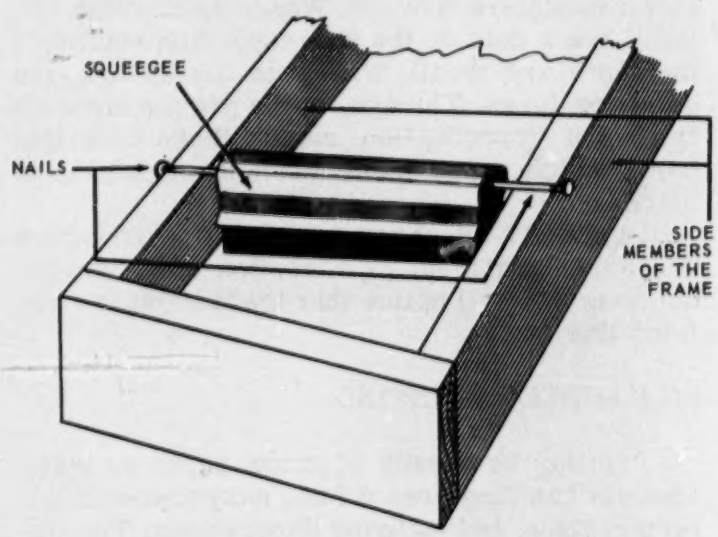

Figure 17-31.

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wooden holder has a groove for holding the blade. The blade may be either rubber or neoprene (synthetic rubber). Neoprene will last longer than rubber because the oils in the paint tend to soften rubber.

The squeegee should be short enough to fit between the side members of the frame and long enough to cover the widest part of the stencil. A nail driven in each of the wooden holder as shown in figure 17-31 will help to keep the holder clean by preventing it from falling into the paint.

The blade should be square on the botton. For best results, the blade should be held at about a 60-degree angle when pushing the paint from one end of the frame to the other. Practice will help you determine the angle to use to obtain the best impression.

PRINTING

A print is made each time the paint is moved from one end of the frame to the other. As prints are made, they must be stored in some way to prevent them from sticking together or smearing while they are drying. Specially designed storage racks will accommodate several prints in a comparatively small space.

After the desired number of prints have been made, all paint must be cleaned from the screen, the frame, and the squeegee. Always be sure to destroy all oily or paint-soaked cleaning rags in an incinerator. If this is not possible, place them in an approved metal container to prevent spontaneous combustion.

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CHAPTER 18

CARTOONING

What is a cartoon ?

Webster defines a cartoon as (1) "An artist's full-size design or study, to be transferred or copied, as in making fresco paintings, stained-glass windows, etc., (2) A large pictorial sketch; esp., a pictorial caricature." Another definition is the one stated by Lawrence Larian in his book Cartooning for Everybody: "A cartoon is a funny picture, any picture that's drawn to make people laugh." Funny or humorous drawings are considered by many illustrators to be the most effective form of illustrative communication because of the way they attract a person's attention. Attention-getting is a prime factor in drawing cartoons.

What makes a humorous cartoon readily acceptable is that most people are able to laugh at their own awkwardness and shortcomings. Also, man has the ability to identify himself with other creatures and still remain a man. An example of the latter is to create the likeness of a bird to represent a pilot since both are fliers. Even with man's gift of humor, it is easy to offend or create undersirable ractions. Because of this, you must remember that the object of your cartoon is to create interest and appreciation by all, especially by those whom the cartoon may characterize. There are exceptions to this rule (for example, political cartoons), but as a military illustrator you will be doing this type of cartooning. Your job is to follow the rules of good taste in cartooning as you have done in your illustrations.

What are you as a cartoonist? You are a story teller with a sense of humor, telling a story in pictures. The stories are short and should be told easily and suddenly. The cartoon should give the impression of being natural and spontaneous.

Cartoons are usually drawn in a simple, unsophisticated style, lacking in detail, but emphasizing the actions and attitudes of the characters.

Figure 18-1.

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Each cartoonist creates his own style, his own character and his own interpretation of the situation. Newspaper comic strips and some of the popular magazines show the great variety of styles employed by different cartoonists. Some cartoons are drawn with more realism than others, but this typifies the individual style of the cartoonist.

EXPRESSIONS

The one set of rules generally accepted by all cartoonists pertains to the facial expression. The facial expressions are produced by the movements of the movable parts of the face, the mouth and muscles around it, the eyelids, eyebrows, even the wrinkling of the nose or forehead. Figure 18-1 shows a number of emotions expressed simply by changing the shape or position of the mouth, eyes, and eyebrows. When the face assumes a happy expression, the parts of the face are lifted. The corners of the mouth are pulled up and out. The cheek muscles are bunched by this action so that the lower lid of the eye is pushed up and the eye is almost closed. The eyebrows are raised.

Figure 18-2.

To make the face unhappy, the corners of the mouth are dropped. Notice that the lines of the eyebrows are lowered but are a little higher toward the bridge of the nose, giving a pathetic cast to the face, whereas in the next figure, determination is expressed in part by the brows that lower toward the nose, as well as by the out-thrust chin and lower lip.

In anger, the brows are pulled still further down, and a frown wrinkle forms between them. Surprise is expressed by raised brows, a dropped chin, and widened eyes. Horror is an exaggeration of surprise. The brows are arched, as well as raised. The mouth is pulled open causing tense lines to form from the nostrils downward. The eyes are widened still further, until they look as if they might drop out. The hair looks as if it were standing on end.

Smugness is expressed by a slight smile, raised brows, almost closed eyes, and the head tilted backward. Scorn is shown by lowered brows and lowered corners of the mouth which form harsh lines downward from the nostrils. Pathos is expressed by raised eyebrows which are higher toward the center of the forehead, closed eyes, and slightly parted lips with the corners pulled slightly downward. The head, relaxed and tilted to one side, and the rumpled hair add to the pathetic appearance.

Along with the facial expressions, the body's movement and character should fit the emotional appearance of the face.

There are occasions where these rules of expression are not used. Although it has been stated that the rules of expression are generally accepted, let it be reemphasized that as a cartoonist, you are bound to no rule except that of good taste.

POSTER WORK

Posters are used for a wide variety of purposes in which a message is to be communicated in the fastest possible way. Cartoons are widely used in poster work because of their great attention getting qualities. There are numerous types of posters, with safety and announcement posters composing the greatest portion. In safety posters, the use of a cartoon character confronted with the various safety hazards is

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more desirable than the use of a photograph of a human being in the same situation. Photographs showing an unfortunate person twisted or mangled in pain or death are quite repulsive to the majority of people and are readily shunned. If the audience will not look upon the poster, no message is communicated and the purpose of the poster is defeated. By using a cartoon character, say in a safety poster about electricity, you can show the character being shocked or worse; this is impossible with photographs.

When a large series of safety posters is to be created, it is often advisable to use just one or two cartoon characters in the series. This allows the audience to quickly associate the character with all of the obvious hazards around them and they will usually be more responsive to the poster series.

CAPTIONS

Ordinarily, there are two types of cartoons. Those that are a sort of pantomime—all action and story telling in the picture, and the caption or punch-line type cartoon. In many instances, it is the caption, or gag or joke that inspires the cartoonist in his drawing. Captions are kept as short as possible. The drawing should be of such nature as to need only a slight emphasis from the caption to achieve its objective.

In as much as it is next to impossible to instruct a person in the art of writing captions, since it would be like trying to teach a person how to tell jokes, we will cover only basic cartoon drawing.

Figure 18-3.

Figure 18-4.

CHARACTER CREATION

The range or limit of different characters a cartoonist can draw is limited only by his own imagination. The most important part of a cartoon character is the face, which controls the mood and emotional expression. The head is usually drawn in the shape of an oval, and a few lines are placed to indicate the eyes, nose, mouth and ears. The head does not have to be in the shape of an oval, though; it can be any shape you want. You can use any basic shape, and by changing the shape of just two or three of the facial features, entirely different characters can be created as shown in figure 18-2. It is also possible to use the same character for two different types of people by simply adding a beard or a shave and the type of clothes the character is wearing. This is shown in figure 18-3. The two characters have identical lines with the exception of the beard, uncut hair and shaggy clothing. The business man was drawn by tracing the main lines from the drawing of the bum. This procedure can be repeated to create an almost unlimited number of different characters. Figure 18-4 shows just a few of the many possibilities.

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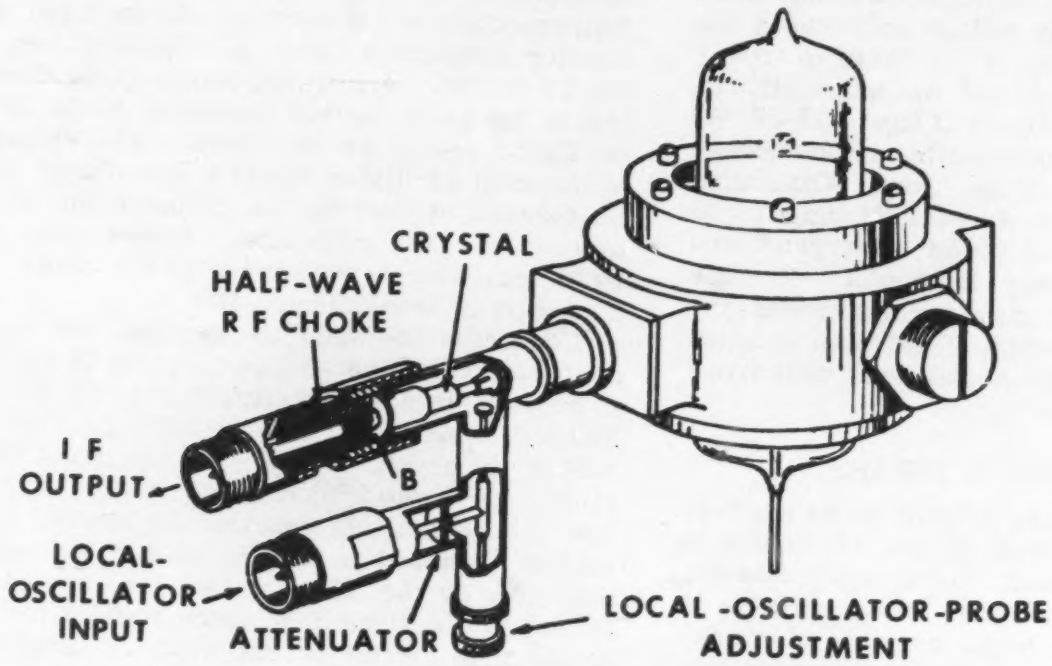

(A) PICTORIAL REPRESENTATION

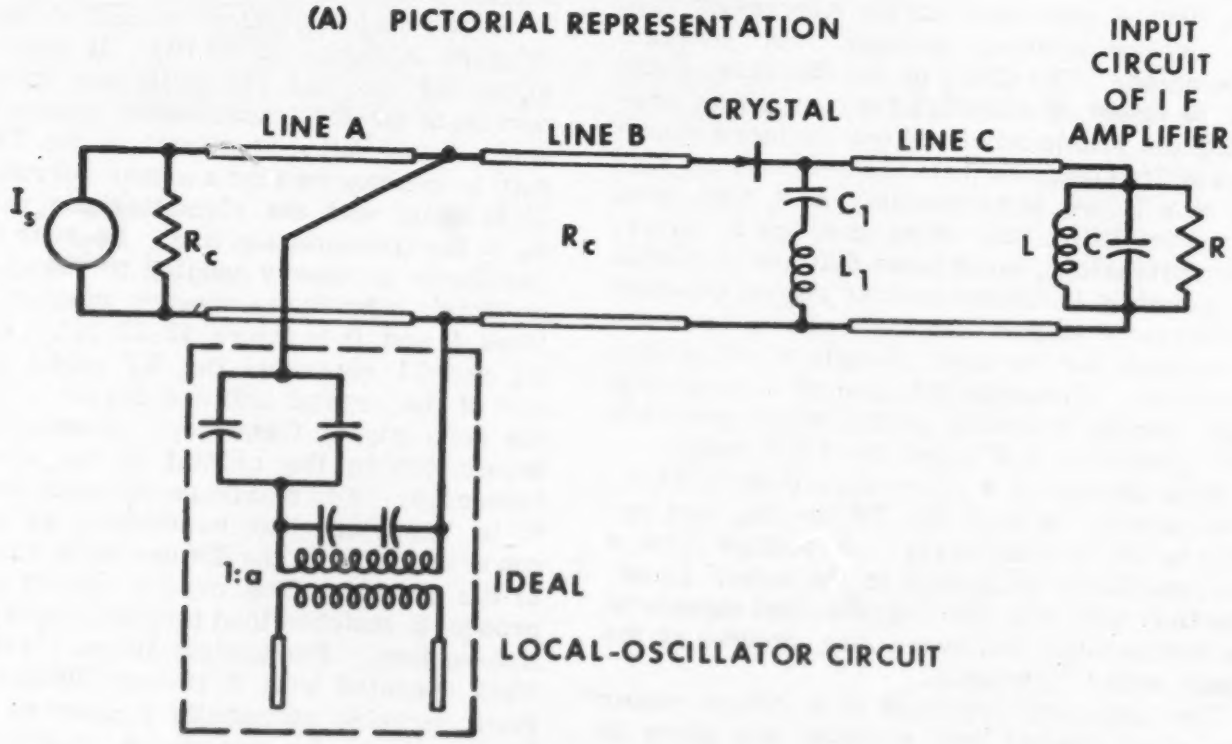

(B) AN EQUIVALENT CIRCUIT

Figure 12-33.—A 10-cm mixer.

oscillator load impedance (and hence power output) that result when the oscillator frequency is varied. A good impedance match is particularly important if the line between local oscillator and probe is long. To insure a relatively constant load impedance for the oscillator, a resistance disk type of attenuator is often inserted in the local oscillator line, as shown in (A), in order to terminate the line section between oscillator and disk in its characteristic

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Figure 18-5.

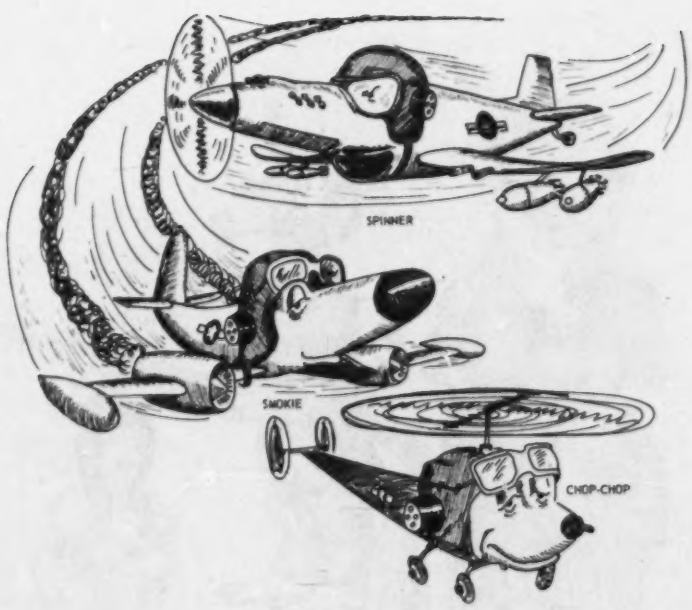

Figure 18-6.

When you are required to create a cartoon character, one of the most important factors to consider is the end use of the cartoon. If the job order, for example, calls for a series of cartoons to be presented before a large civic audience, you should consider the interests and background of the group. Perhaps a comic element may be found in the incongruity of historical situations as compared with a comparable modern situation. Perhaps some factor of local history or local current popular interest can be worked into the presentation.

The use of cartoons in group presentations is highly effective because it both gains the attention of the audience and fosters relaxation. This also helps to build up an eagerness in the audience for the remainder of the presentation.

CHARACTER AND SUBJECT ASSOCIATION

When cartooning, you do not always have to create a character with only human characteristics. The job may call for animation of a piece of machinery, a ship, an airplane, or any number of objects. This animation of objects is usually enthusiastically received when the audience is familiar with the depicted objects. Figure 18-5 shows an animated submarine and dolphin which could be very successful for any work pertaining to the submarine force. This design would not necessarily be as successful, though, if used at a Naval Air Station. In the case of a Naval Air Station, characters similar to those in figure 18-6 would be much more appropriate. Figure 18-7 introduces LT ALBRATROS, USNR, and his crew man, airdale 3rd class WALLY DUMBPELL. These types of characters are highly acceptable and have a wide range of uses.

Figure 18-7.

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of people and with people from certain areas. These symbolic features have been associated with certain types of people for so long that the public will instinctively relate a certain appearance to a particular type of person. For example: the hillbilly right out of the hills. His symbolic attire is a torn checkered flannel shirt, bib type overall with patches, a rumpled wide brim hat; he is also usually in need of a haircut and a shave. He is often shoeless and carries a long barreled squirrel gun.

Although this may not be factual in relation to backwoods people, he is usually pictured as rather ugly and has a warm relationship with his jug of corn whiskey.

The female from this area is usually illustrated in two styles. One, the beautiful, well proportioned lass, and the other one, whose appearance more closely parallels the man's appearance. These three characters are shown in figure 18-11. As you can see, one look at the characters will place them in your mind as hillbillies, and you will have no trouble getting them mixed up with the characters from a more affluent society in figure 18-12.

You should, when possible, use the established public impression that is readily accepted for a particular type of person. There is a symbolic type for nearly every type and for every geographical area in existence, including foreign nations. The list is unending; and the following illustrations show but a few of the long, long list of possibilities.

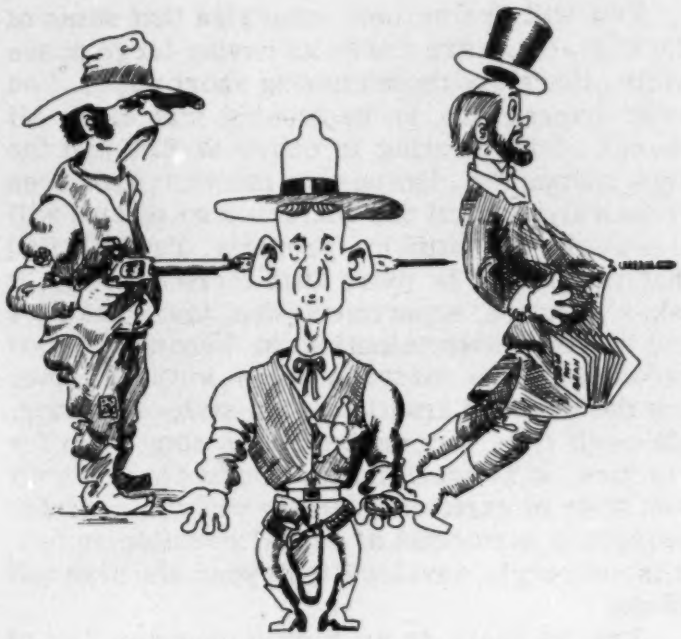

Figure 18-13.

Figure 18-14.

Figure 18-12.

Figure 18-15.

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You will see in these examples that some of the characters are drawn as having large noses while others are drawn having short noses. You must experiment in cartooning just as in all phases of illustrating in order to find just the right design, the right nose or mouth, type of eyes or hairstyle, to fit the character so that he will blend into the situation properly. You will find that cartooning is more than mere doodling; it takes practice, experimentation, more practice and a firm determination to become a good cartoonist. The cartoons shown in this chapter are the writer's creations—his style of drawing. Although it is proper for you to copy them for practice, it is essential for you to develop your own style of cartooning before you can consider yourself a cartoonist of any caliber. Remember, it is your style; develop it to fit your abilities and needs.

Just as there is an almost unending list of different types of people, many of these can be seen as two distinct characters, the good guy and the bad guy. For example, there are both good cowboys and bad cowboys (fig. 18-13). In cartooning, it is not necessary for the good guy to always win. It often adds to the humor of the situation when the bad guy wins.

In the world of music there are many different types of personalities. There is the classical musician and the modern day, no talent, hip swinging howling type of performer (fig. 18-14). Of the latter, some have almost lost their identities as humans (fig. 18-15).

Figure 18-16.

Figure 18-17.

Some of the people of foreign countries offer themselves as excellent specimens for cartooning. The people of Germany (fig. 18-16) have always been well known for their aristocratic, military leaders and the Bavarian-type costumes and beer steins. Typical Russian cartoon characters are shown in figure 18-17.

Remember, it has already been said that not everybody will like your cartoons. What will fracture one group's funny bone may bring screams of protest from another. Solution: always know your audience.

The different people of the world have many different characteristics and costumes and it is most interesting to work up several different interpretations of each of them. So far, you have been shown a few examples.

When you are drawing a cartoon depicting a certain nationality, or race or period of history, it is extremely important to use the correct costume on the character. This aids in his identification and correctness, and when done well, adds to the humor of the character. You may be able to see this in the drawing of the Roman toll collector (fig. 18-18), and the drawing of the Viking and Italian explorers. (fig. 18-19). In any cartoon, not only must the costume be correct for the character, but any supporting characters, the stage or background if there is one, all must be in place with the main theme. The pattern must be consistent, with all particulars related. In cartoons, the background is usually greatly simplified and reduced to just those elements essential to clarify the picture. In some cartoons there is no background at all;

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Figure 18-18.

Figure 18-19.

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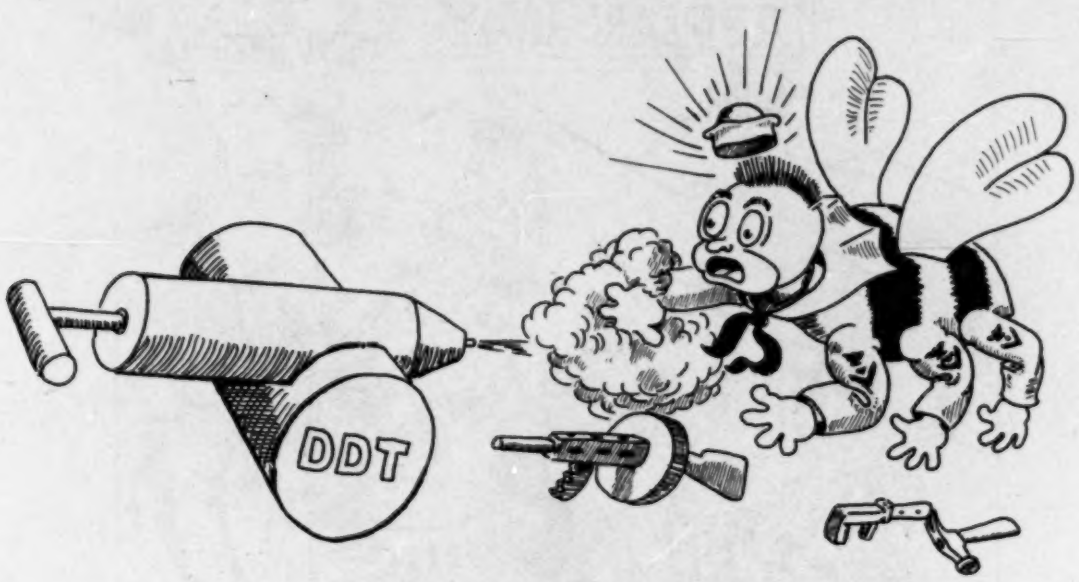

Figure 18-20.

other times, the background may be highly detailed. This again is usually a choice of the cartoonist. The use of background is usually determined by the style of the cartoonist. Most frequently, a cartoonist will use no more background than is needed to identify his character to a specific area or location.

You can also use cartoons effectively to make good-natured fun of someone or some group. This points out again that taking any situation, person, or group, you can create an effective cartoon out of it. For example, figure 18-20 is a cartoon prepared by a DM who is not an ex-Seabee for the benefit of the many DMs who are ex-Seabees.

CARICATURES

Drawing caricatures is very much like having the subject stand in front of the bent mirror found in carnivals and penny arcades. The mirror distorts and exaggerates the features, but does not add or subtract anything not already existing about the subject. The cartoonist does the same thing. The predominant features are exaggerated or distorted; but you must be careful not to get away from the character.

Don't offend; exaggerate but be reasonable. When possible, incorporate a hobby or anything identified with the subject. "Local color" always helps for a truer characteristic.

Capture at least one outstanding feature—a typical expression or mannerism. Put that down (slightly distorted) and draw around it. Once the head is drawn, the body can be drawn in. A good proportion for caricature is 2/3 head, 1/3 body. The only possible way to learn to do caricatures is to practice. Strive for a likeness, then add small distortions to add humor.

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CHAPTER 19

VISUAL PRESENTATIONS

Early man communicated visually by scratching on the walls of his cave and, incidentally, transmitted to us, many years later, ideas and thoughts of his life and culture. From this beginning, man developed tools to help him in the job of communications: the stylus and clay, papyrus, chalk and slate, various drawing tools, and, eventually, the printing press, the camera and the projector.

NEED FOR VISUAL AIDS

CLASSROOM INSTRUCTION

Nowhere in the organization of today's Navy will you find a greater use of visual aids than in our Navy schools and training courses both ashore and afloat. Regardless of the field of study, every passing day finds more students and more subject matter crowded into the classrooms. Instructors today use many audio-visual aids, from diagrams of electronic circuits to charts of human anatomy.

MILITARY BRIEFINGS

Considering the Navy's complexity and size, how can our military commanders keep up to date on statistical information? Every day large amounts of statistical data and operational information are gathered to guide these men who must make the decisions. But this data must be presented clearly and rapidly to those who need to know and act. With the use of audio-visual aids, information can be prepared and projected for viewing within minutes after receipt. These aids may be easily changed and updated at a very low cost. The use of audio-visual aids has made it possible for quicker action to be taken and for vital information to be covered more fully than ever before.

The visual aid equipment used in most military briefings includes the various kinds of projectors described in chapter 8. It is part of your job as an illustrator to make the transparencies to be used in these projectors.

On a more permanent nature, each Naval District has training aids facilities which provide Transparency Catalogs, NavPers 301551-1, Film Catalogs, NavPers 10000, Three Dimensional Visual Aid Catalogs, NavExos P-530-2, and Graphic Visual Aid Catalogs. Quite often the visual aid you need has already been constructed and is cataloged.

Whenever possible, check with these catalogs and secure from proper source the training aid you desire.

HANDMADE TRANSPARENCIES

The simplest of all transparencies for overhead projectors is made by drawing on a clear sheet of plastic with a black grease pencil. The drawing can be easily erased with a dry cloth and the plastic may then be reused.

Grease pencils make lines and letters which are thick and bold. For finely detailed drawing or writing on plastic, a specially designed pencil is available commercially which has an easily sharpened lead which holds a point well. This pencil will write well on any surface, including glass.

The use of ink on acetate plastic sheets offers some problem because the surface of the plastic is nonabsorbent. With some care, however, it is possible to draw with several kinds of special black and colored inks which will adhere to clear plastic. To obtain colored

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lines on plastic, you can draw with felt-tipped marking pens which produce transparent colors on the plastic.

DRAFTON, LUMOCHROM

Drafton plastic has a finely etched and highly transparent surface which accepts pencil lead. Lumochrom pencils for plastic transparencies have special leads which pass light and permit brightly colored images to be projected on a screen.

Because Lumochrom pencils are sharpened like ordinary colored-lead pencils, you can easily do fine detailed work and produce multicolored transparencies with a minimum of effort. The colored pencil marks can easily be removed with an ordinary eraser and the plastic sheets can be used again. The color image can be made permanent by coating the etched surface with a plastic spray or by spreading on a coating solution with a Polaroid Print-Coater.

OPAQUE-COATED ACETATE/PLASTICS

Another type of handmade transparency can be produced by using acetate plastic sheets having a coating which blocks the projection light. These are available commercially or can be made by painting a transparent acetate sheet with black paint. Using a stylus or pencil, the image to be projected is cut away through the coating. When projected, the cutaway areas appear in luminous white on the screen, while the rest of the screen remains dark. This type of projection makes for easier viewing, especially when there are a number of transparencies to be projected.

COMMERCIAL AIDS FOR EFFECT

ADHESIVE LETTERS AND SYMBOLS

There are several brands of plastic letters and symbols which can be used in making transparencies. By using these stick-on letters and symbols, you can easily do fast lettering of a professional quality. Most of these stick-on letters work well on masters for diazo reproduction.

ADHESIVE SHEETS

Large adhesive color sheets are available for covering large areas of a transparency. Unwanted portions are simply trimmed away. Among the trade names for adhesive color sheets are ARTYPE, BOURGES, CRAFTYPE, ZIP-A-TONE and BLUZIP.

PATTERNS AND SYMBOLS

Any gum-backed material may be used for making patterns, symbols, and silhouettes for transparencies. Letters photographically reproduced on film can also be taped in place on clear plastic sheets to produce sharp, clear images. Several machines which produce such lettering are available under the trade names of HEADLINER, PRO-TYPE, and FILM-O-TYPE. With many of these materials, the addition of color to the transparency helps form an attractive and effective image on the screen.

MECHANICALLY PRODUCED TRANSPARENCIES

LIFT METHODS

A unique method of making transparencies is to "lift" a picture from a magazine. Some magazines are printed on paper that has a clay coating. Ink can be lifted from this surface and transferred to a sheet of plastic for projection in black and white or full color.

To find out if the picture you want is printed on clay-coated paper, moisten a finger and rub it on the corner of the paper. If a white deposit rubs off, the sheet is clay-coated and you can lift a transparency from that page. Only one transparency can be lifted from any one picture because the process destroys the picture. Transparencies may be lifted by either the dry mount method or the rubber cement method.

Dry Mount Method

In the dry mount method of lifting pictures, a sheet of specially coated plastic, such as Seal-Transpara film, is placed face to face with the printed picture; then the plastic sheet and paper picture are placed between polished metal plates in a dry-mounting press. These sheets are then heated under pressure for 5 to 10 minutes. When the sheets are removed, the plastic and the picture are laminated. The laminated sheet is soaked in warm water until the paper loosens and comes off. The paper

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may be loosened by rubbing the plastic surface with the hand. The clay-coating residue is sponged off and the plastic sheet, which then contains the picture, is allowed to dry. The image is then coated with a plastic spray to make the sheet more transparent for projection.

Rubber Cement Method

A plastic sheet is also used in the rubber cement method of lifting pictures. An even coat of thinned rubber cement is brushed on both the picture and the clear plastic. When the cement is dry, the two coated surfaces are carefully pressed together, and the air bubbles are smoothed out with a roller. The combined sheets are then soaked in warm water to loosen the paper backing. While the picture is in the water, the remaining clay-coating and paper fibers are gently sponged off. When dry, the plastic should be protected and transparentized by a coating of a plastic spray.

Lift transparencies project well and make excellent masters for diazo transparencies and paper copies.

THE DIAZO PROCESS

The foregoing section has described how to make transparencies for overhead projectors by hand and by using mechanical processes. Now we will look at a method which offers even greater opportunity for you to make top quality visual aid materials. This is the DIAZO process.

THE CHEMISTRY OF DIAZO

Let's examine the chemistry of diazo in its simplest sense.

Diazo is directly associated with the chemistry of azo dyes. These are the dyes frequently used to color the clothing we wear and other fabrics. With diazo reproduction materials, the dye-forming potential is present in the form of molecules of "diazo salts" and a "coupler." In "dry-developing" diazo materials, these elements are suspended in a "stabilizing" solution and coated on the surface of acetate, paper, cloth, glass, and a myriad of other bases. These materials are termed "dry-developing" because they don't require contact with, or immersion in, any liquid solution to create their dye image. The hard, sensitized emulsion on dry-developing foils will react to form a dye image of brilliant azo color when exposed to ammonia vapor.

Why ammonia vapor? The stabilizer in the emulsion of diazo materials is acid by nature. The molecules of diazo salt and coupler are separated by this acid stabilizer. They are prevented from combining to form colored dye until you are ready for them to do so. When you are ready, you expose them to ammonia vapor. Chemically alkaline, this vapor neutralizes the acid stabilizer. With the acid neutralized, the diazo molecules and other coupler molecules are free to unite and form the azo dye. This then is how to "develop" diazo images. You do not need hard-to-use liquids; all you need is ammonia vapor—vapor which does not wet the foil, but develops full, rich color in a matter of seconds and leaves the foil dry, fog-free, permanent, and ready to use.

EXPOSURE AND DEVELOPMENT OF DIAZO FOILS

Before development, the diazo emulsion is sensitive to light just as a roll of photographic film is sensitive to light. But there is a big difference. Whereas photographic film is very sensitive to almost any kind of light, the emulsion on a diazo foil is moderately sensitive to only one kind of light: ultraviolet. Although not greatly affected by indoor lighting, the diazo emulsion is highly sensitive to all ammonia vapor. Because of this, special care must be taken to store all diazo emulsion products away from ammonia or ammonia vapors. A well-ventilated room with controlled temperature is the best storage space for diazo materials.

ULTRAVIOLET USED TO PRODUCE A VISUAL IMAGE

To produce a meaningful diazo transparency, the diazo foil must react in a way similar to photographic film. It must "take a picture" and reproduce an image that contains the information you wish to show. Since diazo foil is appreciably sensitive only to ultraviolet light, this is the kind of light used for our "picture-taking" exposure.

When the foil is exposed to a source of ultraviolet light and certain areas are protected with some sort of light-blocking material, the unprotected emulsion on the foil will have its undeveloped color destroyed or faded, while the

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protected emulsion on the foil will remain intact. Then, when this light-exposed foil is exposed to ammonia vapor, those areas that have been protected will appear as full-color dye images and the rest of the foil will remain clear.

To produce a transparency with a diazo foil, you place a transparent or translucent sheet containing an opaque image over the foil when you expose it. The opaque image will appear on the foil when it is developed by the ammonia vapor. The translucent or transparent sheet which contains the opaque image is called a diazo "master."

PREPARATION OF DIAZO MASTERS

An almost unlimited range of basic materials can be used in the preparation of diazo masters because there is only one principle that must be observed: the passage and blocking of ultraviolet light. In other words, a diazo master must be so constructed that certain parts of it will block ultraviolet light and the other parts will pass the light. The basic material normally used for the diazo master is translucent paper. Tracing paper is translucent; it will permit passage of light. Further, it is a simple matter to affix to its surface other materials such as inks, tapes, and pencil marks which are opaque and block light. A tracing paper which will pass maximum light as well as provide a desirable working surface for affixing opaques is best. There are several tracing papers which are expecially useful as master material for the preparation of overhead projection transparencies by the diazo process. Some of these are Ozalid, Visi-tran, Tecnifax Tecnivellum, and K & E Albenene.

Tracing Paper Masters

After the tracing paper has been selected, the next step is to create a visual image with materials that will block the passage of light. Such materials are lead pencil, grease pencil, opaque ink, photographic film, paste-up letters, shading sheets, graphic illustration materials, and tape. These used together or singly will reproduce well.

Preparation of a master is limited only by your imagination, ingenuity and the instructions of the originator. You can trace an illustration from a book such as this, for instance, with a good black-lead pencil. From this tracing you can easily produce a brilliantly colored or black and white foil for immediate projection.

In designing your transparency master, keep in mind that the image area must block ultraviolet light. Make strong, dense lines and affix materials that have good light-blocking properties. There are a tremendous number of production materials available; experiment with as many as you can to find which ones suit your needs best.

Plastic-Sheet Masters

If tracing paper makes a good diazo master because it is translucent, then obviously a base material that is transparent will also make a good master. The main reasons for using tracing paper as the base material are that it costs less than plastic and it offers a textured surface that is far better to write and draw on than plastic film.

However, any clear film will serve very well as a base on which to create an image for diazo reproduction. This means that the section in this chapter on handmade transparencies can serve a double purpose, since almost any transparency produced by the methods discussed will serve as an excellent master for diazo printing.

Plastic Tape For Paste-Up Work

Attaching materials to masters would be a problem if we had to use glues and pastes. This isn't the case in diazo printing, because with diazo you can use translucent and transparent plastic tape in almost all of your paste-up jobs. The tape will pass light during exposure; so, even though it may be visible on the master, it won't reproduce on the printed and developed Projecto Foil.

In selecting plastic tape for this purpose, you'll get best results from one having a thin base and high translucency. Scotch No. 810 Magic Mending Tape is highly recommended for this purpose.

Use of Orange Carbon Paper

Since diazo materials print their most dense images from masters that have lines which block light effectively, orange carbon paper is an excellent help when preparing drawn or typewritten masters.

A sheet of orange carbon is placed underneath the tracing paper with the carbon side up. When you write or draw on the master, the orange carbon will transfer to the back of the master

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resistance. An alternative to the resistance disk is a piece of lossy cable which may be inserted between local oscillator and mixer assembly. (NOTE: Lossy cable uses resistance wire for the center conductor. An example of lossy cable is RG-21/U.)

Oftentimes mixer assemblies include, in addition to the circuit that supplies IF echo signals, a separate mixer for generating IF signals for the automatic frequency control circuit. An example of a 3-cm mixer assembly of this type is shown in figure 12-34 (A).

Local oscillator power and RF echo signals from the TR cavity are coupled into waveguide 1, which serves as the echo signal channel. A crystal extends between top and bottom walls of the guide, the lower end of the crystal being isolated from the guide by means of a dielectric washer, Echo signal voltages in the intermediate frequency band appear between the lower end of the crystal and the waveguide and are conducted to the input circuit of the IF amplifier, usually over a coaxial cable.

Waveguide 3 is similar in construction to waveguide 1 and serves as the AFC channel. Power from the local oscillator and a small amount of the transmitter power are applied to the AFC crystal, and IF signals for the AFC circuit are derived at the lower end of the crystal mount, as before. Attenuation between the main guide and guide 3 is provided by means of a circular waveguide section operating below cutoff. Sometimes a disk type attenuator is included in the circular section to reduce further the amount of transmitter power reaching the mixer assembly.

The local oscillator tube is mounted above waveguide 2 in a manner that permits the local oscillator output probe to extend a short distance into guide 2. The coupling probe may be displaced slightly from the center of the transverse axis of the guide in order to obtain a load impedance for the oscillator which yields a reasonably uniform power output over the tuning range.

Local oscillator power is coupled from guide 2 into guides 1 and 3 through coupling apertures located in the side walls of the guides. A matching post and tuning screw extending from top and bottom walls of the guides at the aperture locations serve to regulate the amount of local oscillator power coupled to the mixer circuits.

For optimum performance of the radar system, the echo signal channel of the mixer should provide a matched load impedance to the waveguide transmission system. The elements that determine the mixer input impedance are shown in the equivalent circuit (B). The equivalent circuit is derived by dividing waveguide 1 into three sections of lengths βd_1, βd_2, and βd_3 and representing the sections by equivalent lengths of transmission lines (lines A, B, and C in fig. 12-34 (B)). The signal current generator I_s in shunt with R_c in the equivalent circuit accounts for the portion of the RF system between antenna and mixer. The coupling aperature between local oscillator and mixer guides (guides 1 and 2) is represented by a variable inductance L, and in shunt with L is an impedance Z which accounts for the impedance seen in the direction of the local oscillator guide. The parallel combination of L and Z terminates a quarter-wave section of line which is in shunt with lines A and B. At the echo signal frequency, the impedance L and Z in parallel is maintained small enough in comparison with the characteristic resistance of the quarter-wave line to make the imput impedance of the quarter-wave section extremely high and hence the amount of echo signal power entering the local oscillator guide is extremely small.

The crystal is located at the junction of lines B and C, as shown in figure 12-34 (B), and across the crystal output terminals is a series RLC circuit. The counterpart of the RLC combination is an RF choke in the IF output lead of the mixer. The choke prevents RF signals from entering the input circuit of the IF amplifier.

The length of shorted-end line C must be such that the input admittance of line C, in shunt with the RF admittance of the crystal, provides essentially a matched load for line B. Varying the length of line C changes the susceptance component of the total admittance at the crystal location. A length of approximately $\lambda/4$ is usually preferable in order to minimize changes in admittance with frequency.

BALANCED MIXERS

The noise introduced into the input circuit of a microwave receiver by the local oscillator may be reduced appreciably through use of a balanced mixer. An input circuit of this type employs two crystal mixers connected so that the local oscillator voltages applied to each crystal are in phase and the echo signal voltages at each crystal are 180° apart in phase.

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sheet and, in effect, give you double-weight image—your drawing on the front and the carbon on the back. This added opacity assures maximum print density.

When typing a master, put the carbon in the typewriter in back of the master with the carbon side facing you. This will also create a double-weight image: the typewriter-ribbon ink on the front and the orange carbon on the back.

You may wonder why the carbon paper is colored orange. The reason is that orange blocks ultraviolet light better than most other colors. Whenever you need a master of maximum opacity, use orange, yellow, sepia, or brown.

INTERMEDIATES

In the tremendous line of diazo printing materials are products which have special uses as "intermediates." These materials, when made from "original" masters, can be used as permanent "duplicate" masters for repeated or quantity reproduction. Intermediates also offer you opportunities in the production of many-celled overlay-transparencies because they may be corrected and amended and then used as excellent masters for colored-cell reproductions. Since orange, sepia, yellow, and brown are good light-blocking colors, intermediates usually have sepia or brown images on translucent paper or foil.

Reversal Foil

It is sometimes desirable to project clear lines on a colored or black background. You can produce such negative images from positive masters by using Ozalid Reversal Foil.

Expose Reversal Foil from your master as usual and develop it. The negative image which forms is a yellow-orange color, with light areas where the master had dark areas and vice versa.

After the foil is fully developed, rinse it in water to remove unused light-sensitive chemicals, thus "fixing" the image. This rinsing is simple; just dip the foil for 10 seconds in hot water, or rinse for a minute in warm water. To speed drying, blot the foil between paper towels; DO NOT RUB. When dry, the Reversal Foil is ready for use.

Reversal Foil does not project well itself because of its low visual color density. But this image, being orange, blocks ultraviolet light; so it is a good "intermediate" master from which you can produce a sharp, clear image on a foil in the color of your choice.

Photographic Negatives

For photo negatives which are not visually understandable in the negative, you do not have to go through the time-consuming and expensive photographic process to convert these negatives into usable positive transparencies. You can use Reversal Foil and Ozalid Continuous Tone Projecto Foil. Reproduce your film negative on Reversal Foil to produce a positive intermediate, and then use that positive to make foil transparencies. Continuous Tone Projecto Foil gives faithful reproduction of the photographic tones in black, and the other foils make striking, colorful, positive transparencies. Reversal Foil eliminates the need for wet photographic processing in converting photo transparencies. Brown or sepia foils, for example, make excellent intermediates. To make an intermediate from your master, expose and develop a sheet of intermediate foil or paper just as you would a foil transparency. Be sure that it is completely developed so that the image is as dense as possible.

An intermediate paper print can be used as an inexpensive transparency master for distribution or exchange.

Transparentizing Solution

Printed pages of photographs which are blank on one side but not transparent enough for good diazo printing can be made more transparent with a transparentizing solution. The solution is applied liberally to the back of the sheet, and then the excess if wiped off with a soft cloth or cotton. Frequently, transparentizing will make the copy transparent enough to be duplicated directly on a foil.

PREPARING MASTERS BY PROJECTION

You can make a master by drawing from a projected image. Attach a sheet of suitable tracing paper to a drawing surface, and, using either the standard 35 mm slide projector or the opaque projector, enlarge the image by projecting it on the paper. You can adjust the projector distance and the focus so that the appropriate margins are maintained. When the image is sharp, trace the image with a pen or a soft pencil.

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MASKING TECHNIQUES

There are times when large areas of an intricate design must be reproduced in a solid color. The fastest and easiest way to block out a large intricate area is by "masking" it with an opaque material. Here are four methods of masking.

Masking tape. Using a light-table, overlay a sheet of suitable tracing paper on your master. Ink a clean, opaque band about a quarter-inch thick around the inside edge of the area to be masked. Let the ink dry; then cover the area inside the inked band with masking tape. When printed, the masked area will produce a solid color on a foil transparency.

Opaque paper. Place a sheet of tracing paper over your master. With a sharp pencil or fine pen, trace the outline of the area to be masked. After tracing, expose this master to a card-weight diazo paper. Use a knife or scissors to cut out the image area; then mount it with Scotch No. 810 tape in position on your master. The masked area will produce a solid, even color on Projecto Foil.

Intermediates. Fully develop an unexposed sheet of brown foil. Place this over the master. You can see the lines on your master through the foil. Use a stylus or other sharp instrument to scratch away the color on the foil in a line around the outside of the image area. When the outline is complete, remove the rest of the unwanted color by cutting around the outside with scissors or an Xacto knife. Tape the brown foil image onto a sheet of tracing paper in the proper position. When the foil is printed, the brown image will reproduce as a solid color on a foil transparency.

Reversal Foil. When the area to be masked is larger than the unmasked area, Ozalid's Reversal Foil can be a great time saver. First, overlay a sheet of tracing paper; then use one of the previously mentioned methods to mask out everything except the image area. Expose this to a sheet of Reversal Foil and develop the foil. The resulting reverse print will reproduce the unmasked area in a yellow-orange color. This reversed foil will reproduce as a solid color on a foil transparency.

OVERLAY MASTERS

The overhead projector does not require that projection materials be mounted in tight, unmovable packets as is required with other types of slides. This means that "overlay" transparencies can be used with all their outstanding communication effectiveness and visual impact.

Overlay transparencies are made up of a base transparency or "cell" with several additional transparencies or cells mounted on top. These additional cells are positioned so that they may be removed or added to the total visual picture as desired by the user.

With overlays, a series of ideas or instructional points can be projected in any desired order with one multiple-celled transparency. In this way, you can visually develop an idea or system. Also, you can visually separate an idea or system into its components.

Tracing Method of Preparation

The first step in making overlay masters by the tracing method is to prepare a master drawing, in actual size and in complete detail, on a sheet of tracing paper. Having completed your master drawing, add registration marks in the top and bottom margins.

Tape the master drawing on a light-table to make it easier to register subsequent drawings. Take another sheet of tracing paper and place it exactly over the master drawing. Secure the top corners with tape. Leave the bottom of the second sheet free so you can recheck areas on the master if necessary. Place registration marks on the second sheet corresponding with those on the master drawing.

Ink in or opaque the area of the master drawing to be represented by the first overlay. Remember—only the areas that you want for this overlay are filled in on this sheet. For each additional overlay, place a sheet of tracing paper in register over the others and repeat the process. With this technique you can quickly produce separate masters for multicell overlay transparencies.

Nonreproducible Blue Method of Preparation

One intermediate diazo material which is excellent for the production of multicelled transparencies is the nonreproducible blue-line intermediate paper. This translucent paper is coated with a thin diazo blue emulsion which, when developed, is visible to the eye but will not reproduce when reprinted on another diazo material. It does not block ultraviolet light.

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This intermediate is used to produce multi-colored transparencies as follows.

Make a nonreproducible blue-line intermediate of your original master for each color you wish to produce in the finished transparency. Use a different blue-line print for each color. Follow the blue-line image and ink in or mask the areas you want to appear in color. Then print each masked paper intermediate onto the appropriate colored foil. Only those areas you have inked in or masked will be reproduced. Mount these "color-separated" foils in register and you have a multi-colored transparency for projection.

It is easy to correct an overlay master drawing if a mistake is made. If you should accidentally fill in all or part of an area on an overlay, simply use a knife or other sharp instrument to cut away the unwanted image. When reproduced on a foil transparency, the cutout area will be invisible. Or, if a correction is necessary, cut out the area to be corrected and replace it with a clean piece of tracing paper held in place by Scotch No. 810 tape. Then make your correction on the tracing paper patch.

TRANSPARENCY MOUNTING TECHNIQUES

Almost any opaque material may be used to mount your transparencies for overhead projection. Cardboard, heavyweight paper, and even file folders will do the job. Just cut out a section in the middle to serve as the aperture and fasten your transparency in place. The size of the aperture cutout will depend on the size of the projector used. For a 10 x 10 inch aperture, the recommended dimensions for the mount opening are 7 1/2 x 9 1/2 inches. This gives you ample border around an 8 1/2 x 11 inch transparency to permit easy fastening to the mount.

There are a number of mounts available commercially for use with the 10 x 10 inch overhead projector and designed to accept either vertical or horizontal transparencies. Some of these are the Ozalid Projecto Mount, the Tecnifax Fileable Transparency Mount, and the K & E Gemini Transparency Mount, all with a 7 1/2 x 9 1/2 inch aperture.

Mounting a Single Image

Regardless of the type of mount used, the simplest way to attach your transparency is with pressure-sensitive tape such as plastic or masking tape. Simply tape all four edges of the transparency to the underside of the mount. Using the bottom surface makes a more attractive mounting, assures a flat projection area, and leaves the top of the mount free for notations and cues. Even when mounting more than one sheet, it is better to tape them all to the underside of the mount.

Overlays

Overlays are usually hinged at the side of the mount's opening so that they can be swung into position on the projector. However, there are several other ways of mounting overlays. If you want a flexible sequence with the overlays, hinge them on all four sides of the opening. Trim or stagger each overlay so it will fall into place easily. If the overlays are to be added in a given sequence, hinge all of them on the side of the mount opening so that they will always fall in proper order. You can make combinations of these mountings so that some elements are added in sequence while others are inserted as desired.

Roll Mounting

In some instances, you may want to have your transparencies in a fixed sequence and in a roll for easy carrying. Just tape them together, edge to edge, and roll them on a core the size of the roll-holder on the projector. (Don't roll handmade transparencies which have adhesive letters or patterns; they may stick together. Make foil transparency copies, and you can tape and roll the copies.) When projecting a roll of prepared transparencies, place a transparency mount on the projector to mask the aperture to the size of the transparency image area.

Progressive Development

Using overlays, you can "build the unknown on the known," and add elements to your visual aid as you speak. This basic instruction technique is shown in figure 19-1.

Progressive Disclosures

An effective way to present a visual picture during projection is through "progressive disclosure." This effect is achieved by using overlays and removing segments of the total

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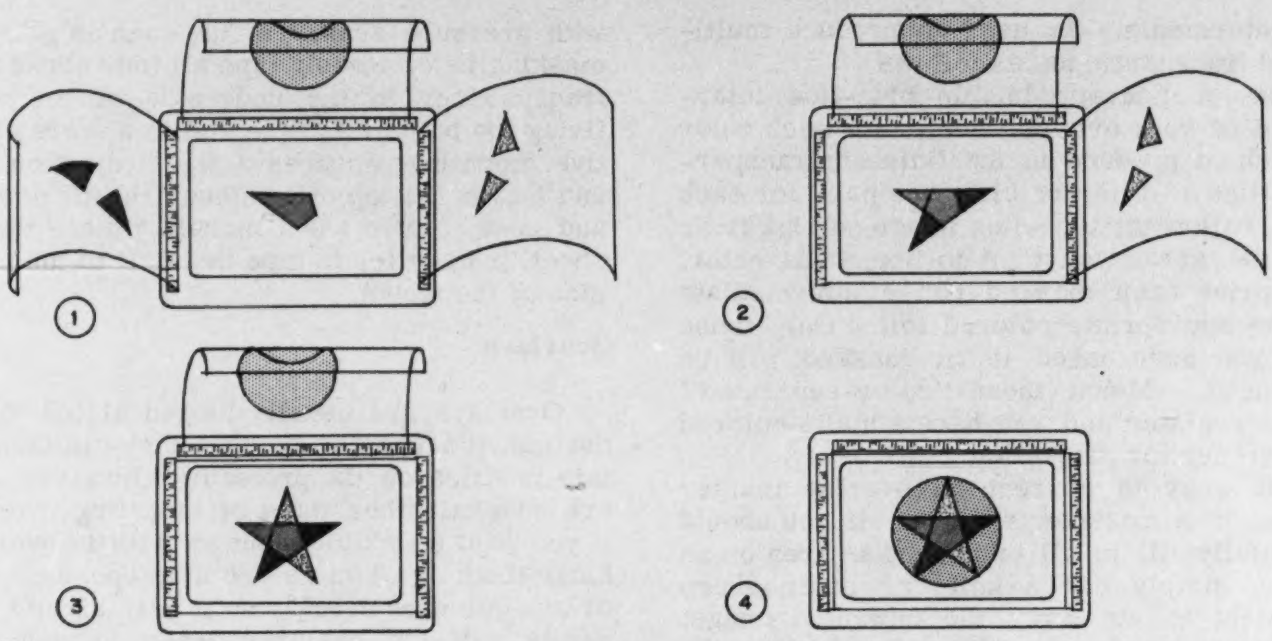

Figure 19-1.

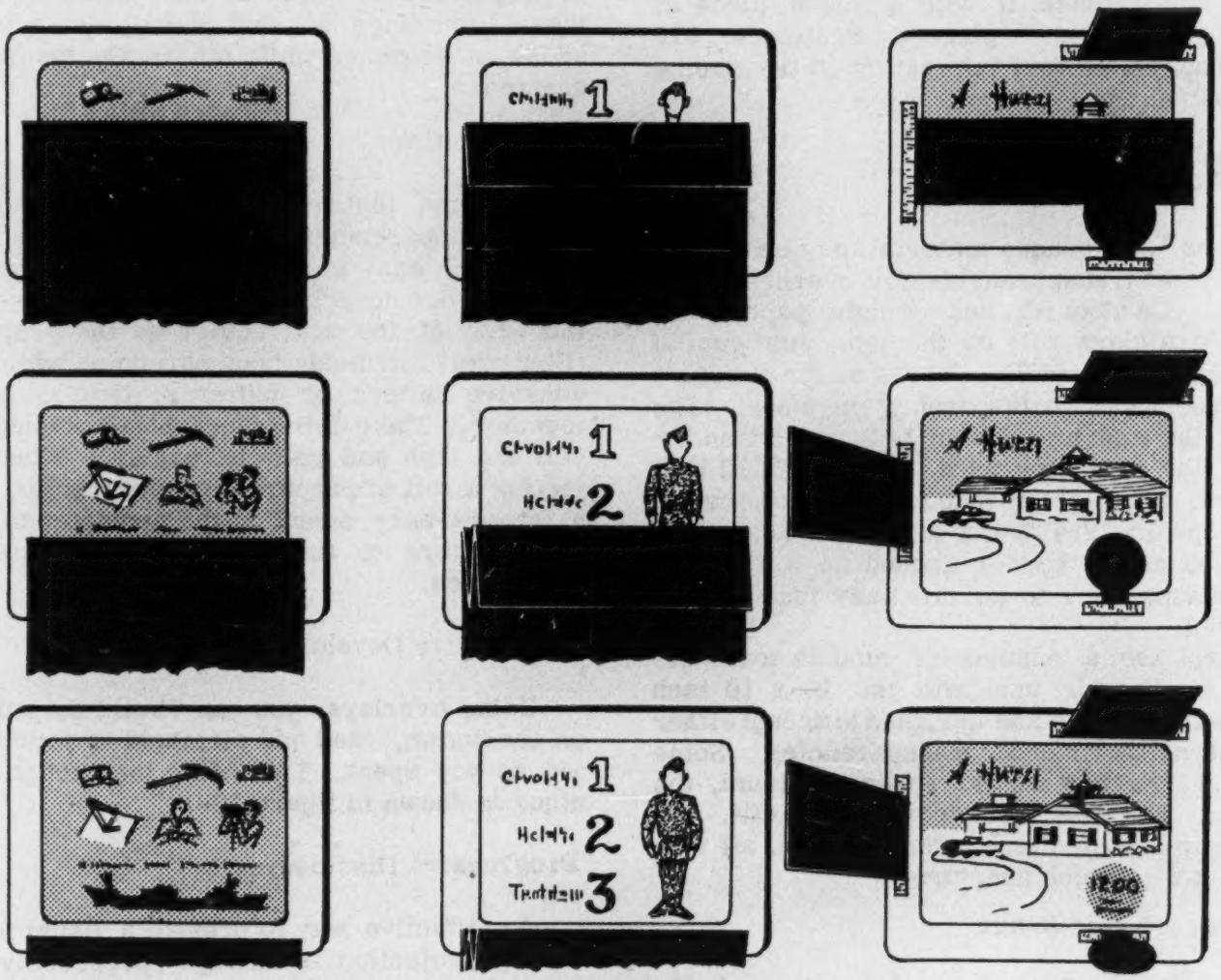

Figure 19-2.

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image to disclose secondary elements. A progressive disclosure effect can also be achieved by covering all of a portion of the transparency with an opaque sheet, such as cardboard, and sliding it off the image a little at a time during projection. Another progressive disclosure effect is possible when an opaque covering is cut into sections so that parts can be lifted off as you disclose different areas on the transparency. This method permits a flexible sequence. These techniques are illustrated in figure 19-2.

TRANSPARENCY DESIGN

The essence of effective visual communication is the transmission of ideas as directly as possible. To be effective, a transparency for overhead projection must tell its story through visualized concepts and ideas rather than through the use of verbal symbols. Projection of words on a screen cannot ordinarily be considered "visual" communication, for if only words are projected, the viewer must mentally convert these words into his own visuals. You should do the visualizing for the viewer. To do this, you need to plan the design of your transparencies to assure that the intended visual message will come through strong and clear. Such planning is not hard to do. The basic rules are simple and the results will always be worth the effort.

ESTABLISH THE IDEA

Consider carefully the exact message you want your transparency to tell. Condense this message in your own thinking to one basic idea that is as clearcut and independent as possible. Select a primary visual symbol of this idea. This symbol will carry the story; consider it your "star performer." It will carry your message to your audience. No star, of course, works alone. A visualization which is not related to things within the framework of an idea can't communicate for us.

SET THE STAGE

Since the star performer alone can't tell the visual message, you must set a stage for it. Determine the secondary elements in your idea that support and identify the primary symbol. These elements will establish the environment in which the idea will be established. Consider all of the secondary elements that might possibly enhance and assist the star to communicate.

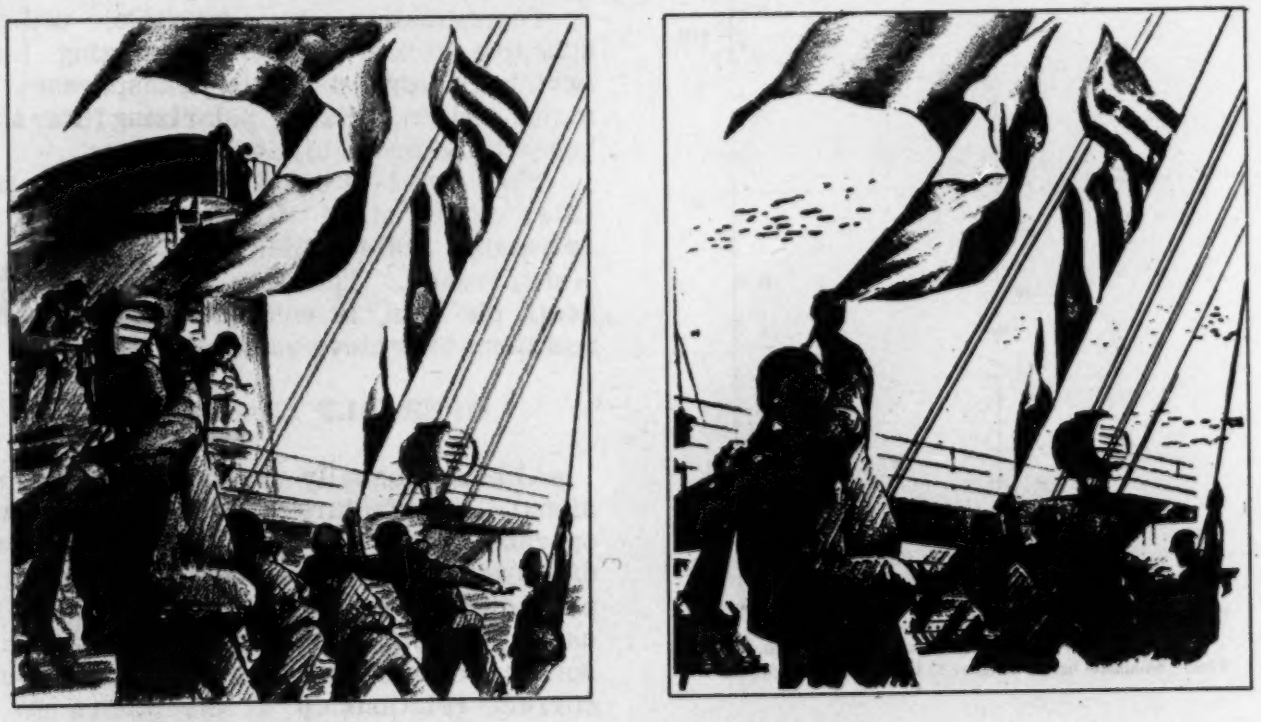

Figure 19-3.

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KEEP IT SIMPLE

Just because you can think of many secondary elements, don't try to use them all! Be particular and select only those that are absolutely needed to tell the story. Reduce the elements to an absolute minimum. You will notice that these rules are very similar to those in pictoral composition in chapter 13. Figure 19-3 shows the relationship between a single, but effective layout, and a layout which is cluttered and confusing.

LETTER SIZE

Since most transparencies for overhead projection incorporate some verbal symbols to support the visualization, lettering and letter size are important considerations when producing a transparency. Figure 19-4 shows a guide for good lettering on transparencies.

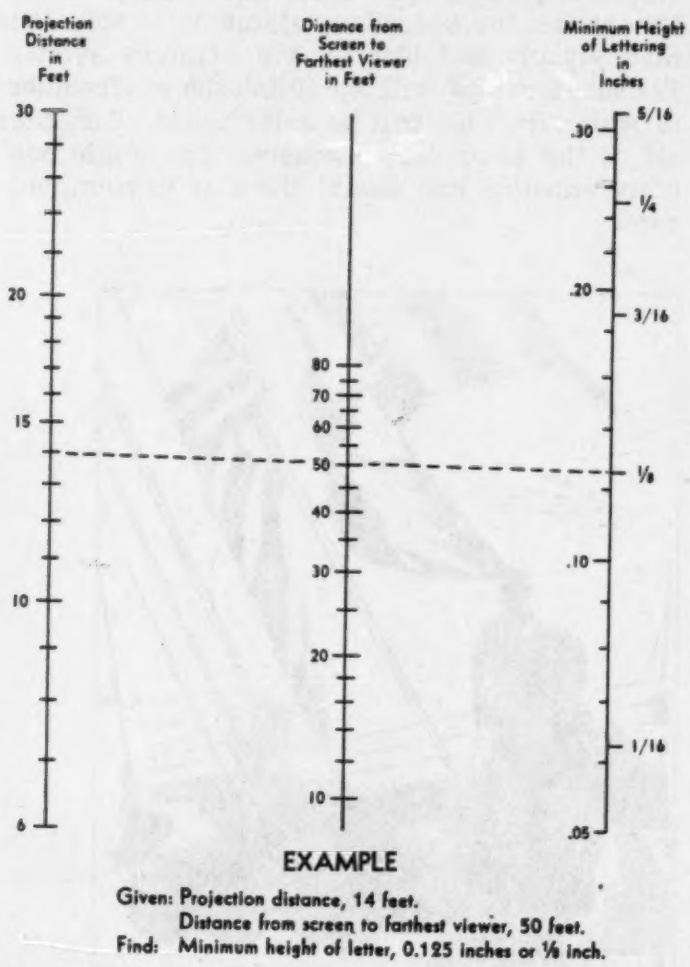

Figure 19-4.

POLARIZED LIGHT

Polarized light can be used in several ways with the overhead projector. You can demonstrate the effect of light-polarizing filters, for example, by placing one filter on the stage of the projector and holding the other between the stage and the lens.

As you turn the upper filter, the light image on the screen will change, showing the light-blocking characteristics of the filters. You can show another application of polarized light by placing a small plastic horseshoe on top of the bottom filter and exerting pressure on it with your fingers. With the top filter in the correct position you will see, in light patterns on the screen, the effect of stressing the plastic. The Polaroid Corporation has published several instruction handbooks which describe experiments with polarized light.

The principles of light-polarization can be applied to the overhead projector to produce effects of motion and spotlighting on the screen. Several systems of application are now commercially available.

Technamation, for example, utilizes an adhesive-backed special polarizing material (which is applied to the transparency) and a motor-driven, rotating polarizing filter attached beneath the projector lens.

The Visa-Matic Systems uses a polarizing filter on the stage of the projector and light-refracting foils which are cemented to the transparency. The Visa-Matic filter, just beneath the lens, is rotated by hand to different positions to achieve various effects.

OPERABLE TRANSPARENCIES

Although usually produced only by professional manufacturers, the two-dimensional operable transparency is an outstanding example of a dynamic projection device. Operable transparencies are constructed of plastic components, usually to duplicate the working elements of some mechanical system. Each component is in correct relationship to the others so that a chain-reaction of movement can be created during projection. Internal parts and mechanical systems of machines can be projected and observed for study and identification of components.

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TECHNICAL ILLUSTRATION

The purpose of this section is to assist you in visualizing appropriate illustrative approaches in developing training aids. Figures 19-5 through 19-8 show some of the types of views that can be used to meet various requirements for technical illustrations.

Figure 19-5 shows four highly effective types of views. The OVERALL VIEW (fig. 19-5a) is good for visual familiarization, parts identification, construction details and maintenance check charts. The CUTAWAY VIEW (fig. 19-5b) illustrates internal details as in the phantom view and in addition shows the relationship of interior parts to the overall subject. The CROSS-SECTION VIEW (fig. 19-5c) shows functional relationships of parts within a system, especially for identification of intricate inner parts that cannot be properly shown in a cutaway or phantom view. This includes such items as indicating the motion of coil springs or the action taking place in an internal combustion chamber. The PHANTOM VIEW (fig. 19-5d) illustrates internal details as seen thru the external shape or form. These views are used to show the relationship of parts or interior construction in relationship to the unit as a whole. It is also used as a basic view to show relationship of alternate positions such as levers and dials.

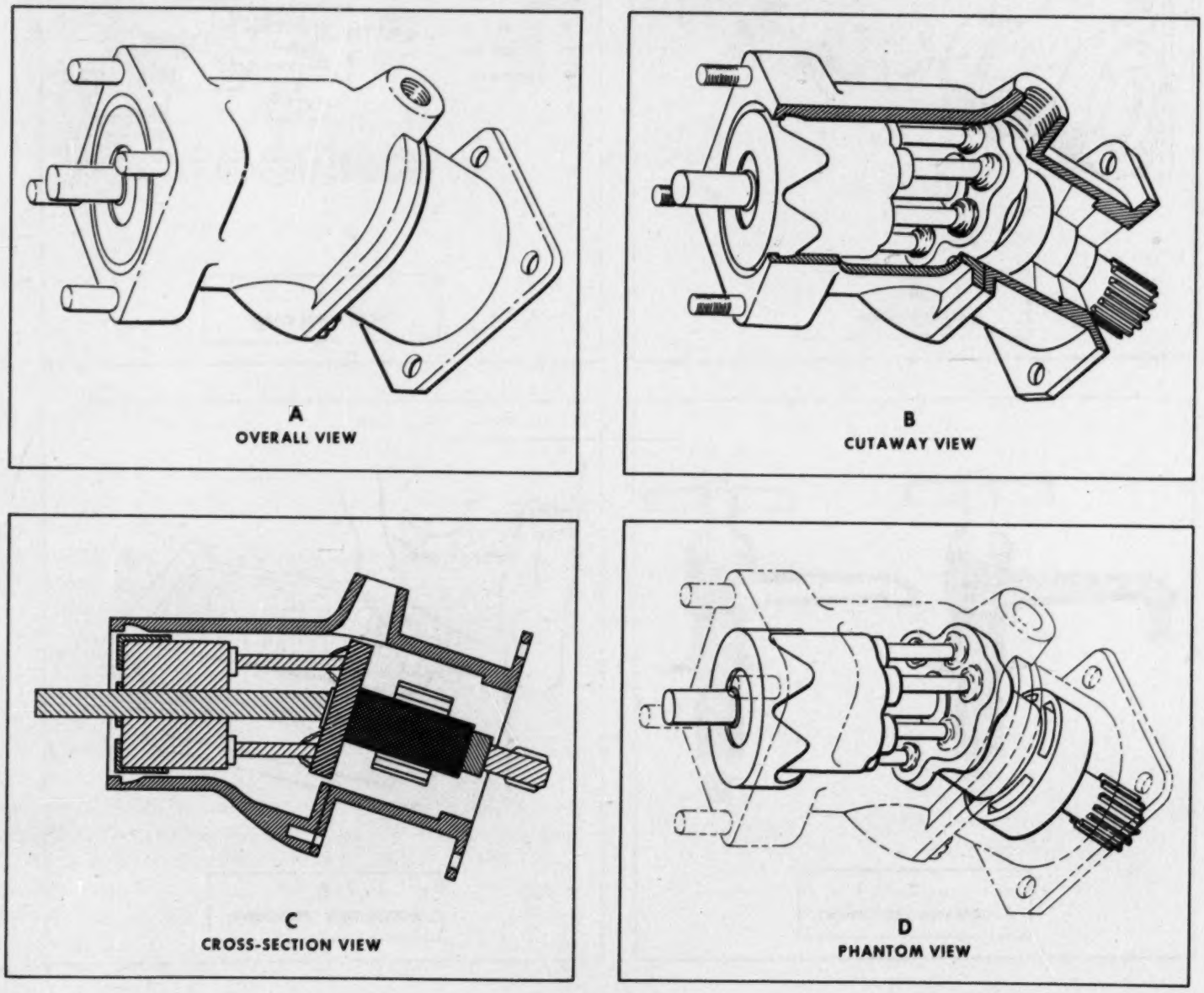

Figure 19-5.

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Figure 19-6 shows four more types of views which are regularly used and are highly effective. The EXPLODED VIEW (fig. 19-6a) is exceptionally effective for showing parts identification and for assembly and disassembly procedures. It shows a piece of equipment entirely broken down into its separate component parts. The CHECK POINT CHART (fig. 19-6b) shows location of fittings and components requiring lubrication, adjustment or calibration. The ACTION VIEW OF EQUIPMENT (fig. 19-6c) illustrates function or action of equipment. The ACTION VIEW OF PERSONNEL (fig. 19-6d) shows the actual performance procedure for operation or maintenance of a piece of equipment.

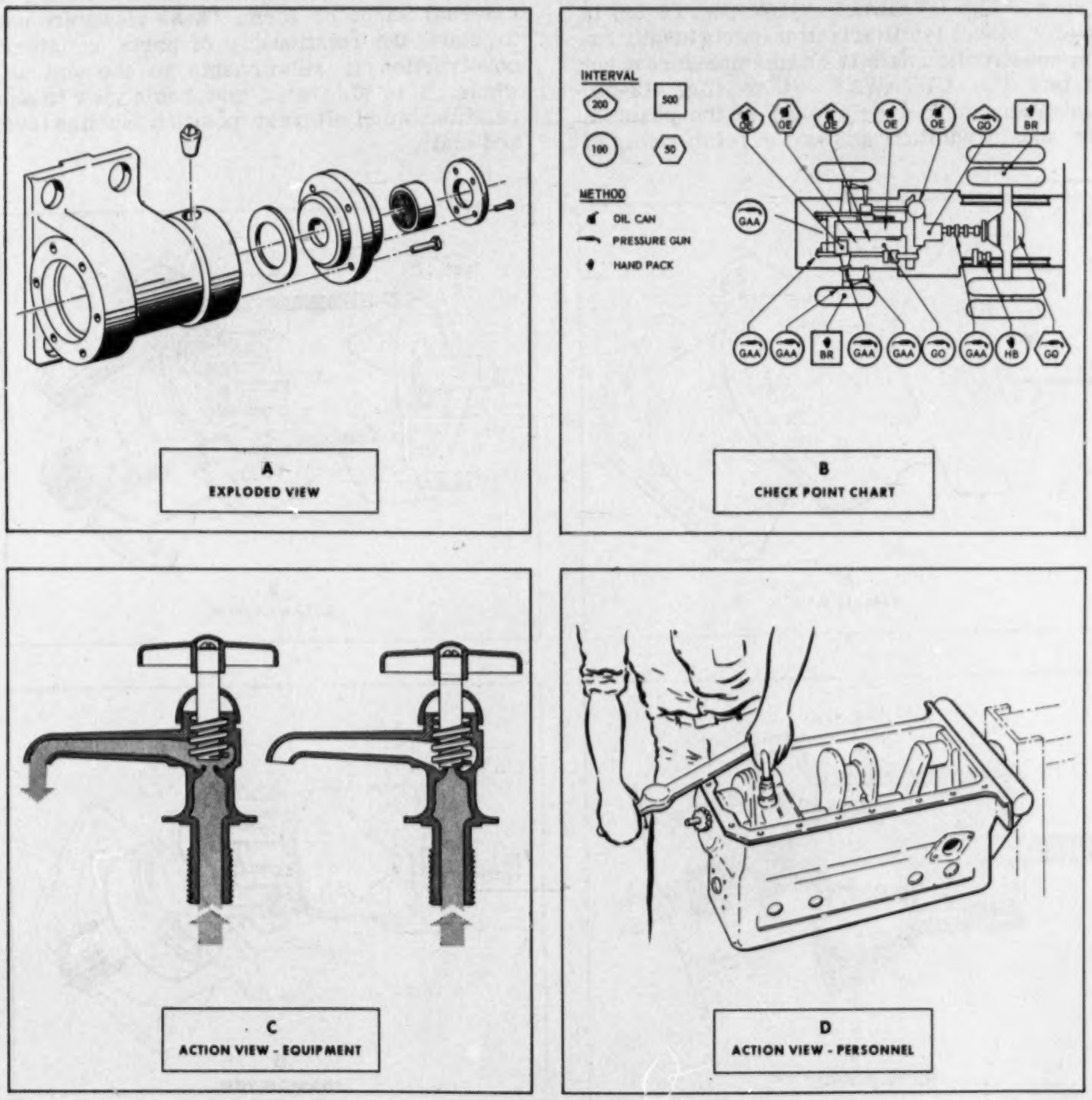

Figure 19-6.

The BLOCK DIAGRAM (fig. 19-7a) shows relationship between functions or components. The WIRING DIAGRAM (fig. 19-7b) presents physical representations of components for reference in diagnosis, repair or installation. The FUNCTIONAL SCHEMATIC-PICTURIZATION (fig. 19-7c) presents overall system concept, individual component functions and sequence of operations. The FUNCTIONAL SCHEMATIC-SYMBOLIC view (fig. 19-7d) shows detailed functions of electrical and electronic circuitry and is used for trouble shooting.

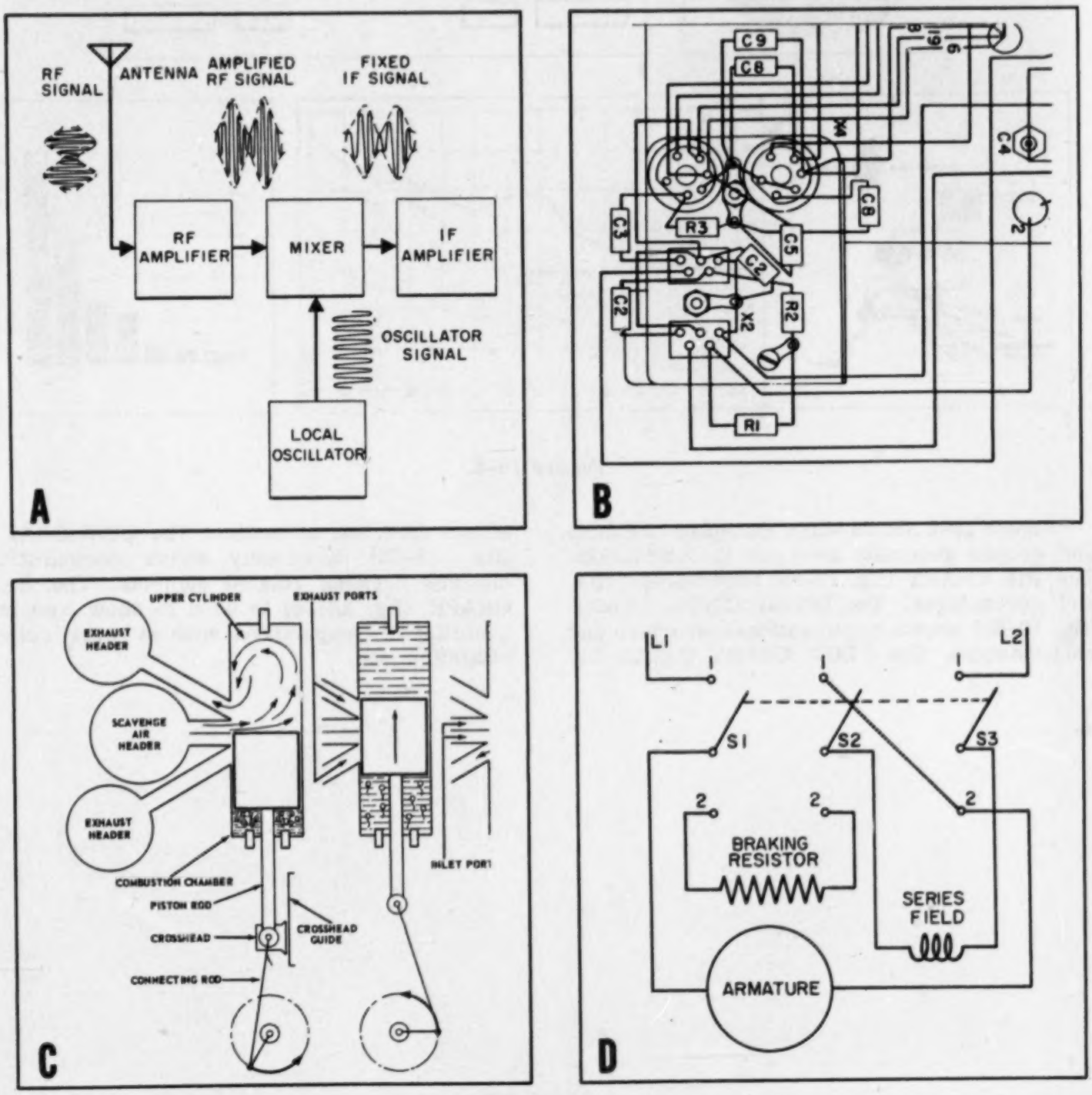

Figure 19-7.

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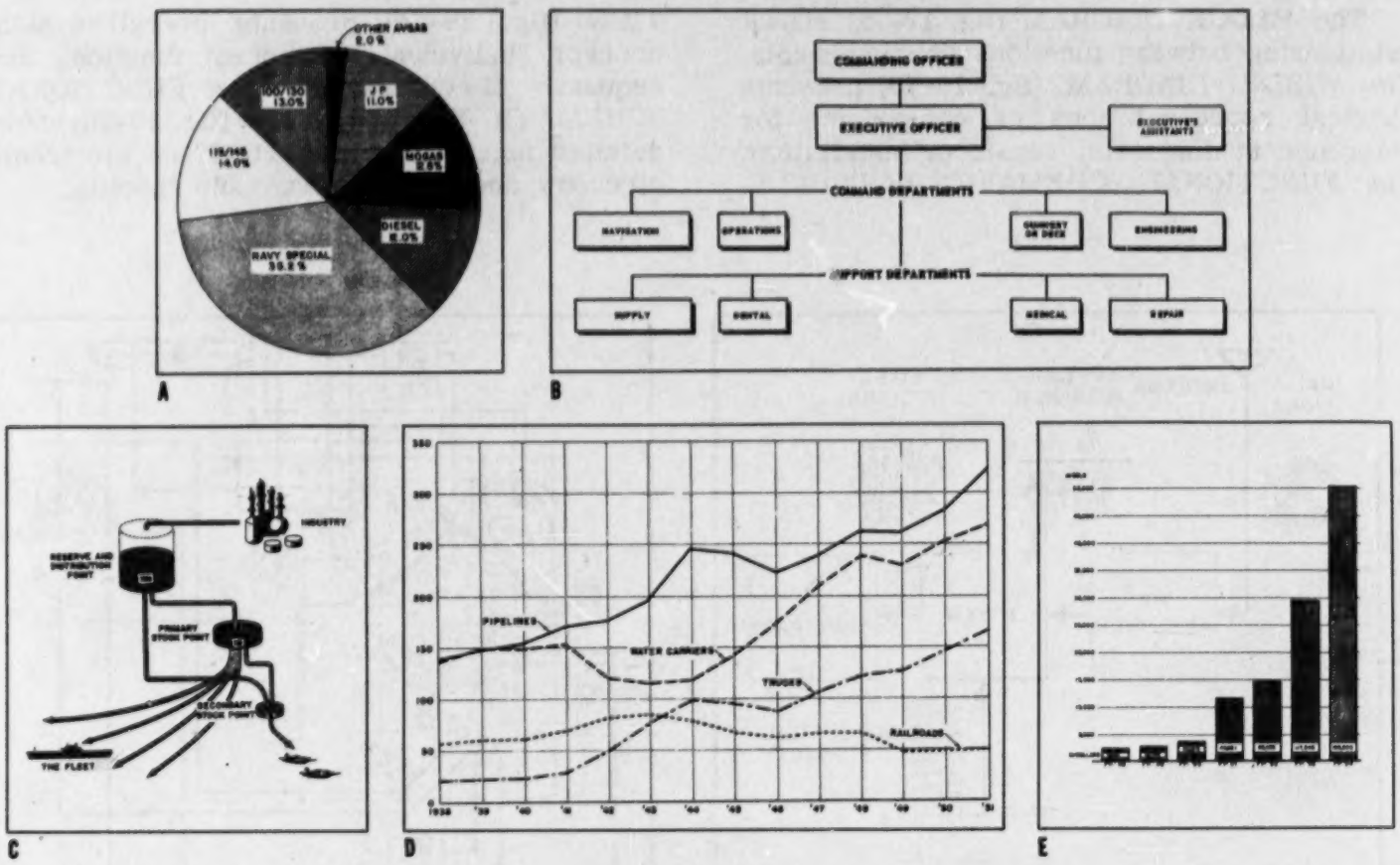

Figure 19-8.

Figure 19-8 shows some examples of charts and graphs generally used for indoctrination. The PIE CHART (fig. 19-8a) shows proportion and percentages. The INTERACTION CHART (fig. 19-8b) shows organizational structure and relationships. The FLOW CHART (fig. 19-8c) shows direction of motion. The LINE GRAPH (fig. 19-8d) accurately shows comparative changes between related subjects. The BAR GRAPH (fig. 19-8e) is used to show complex quantitative comparisons such as yearly output statistics, etc.

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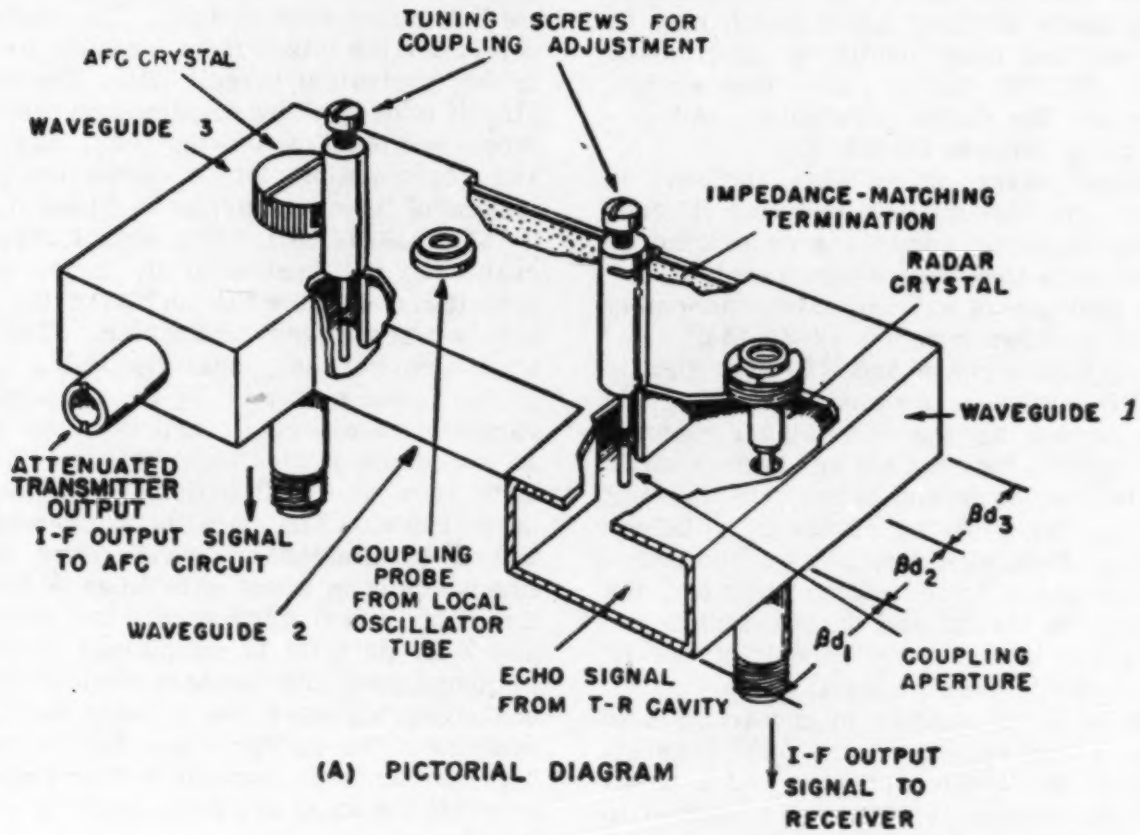

(A) PICTORIAL DIAGRAM

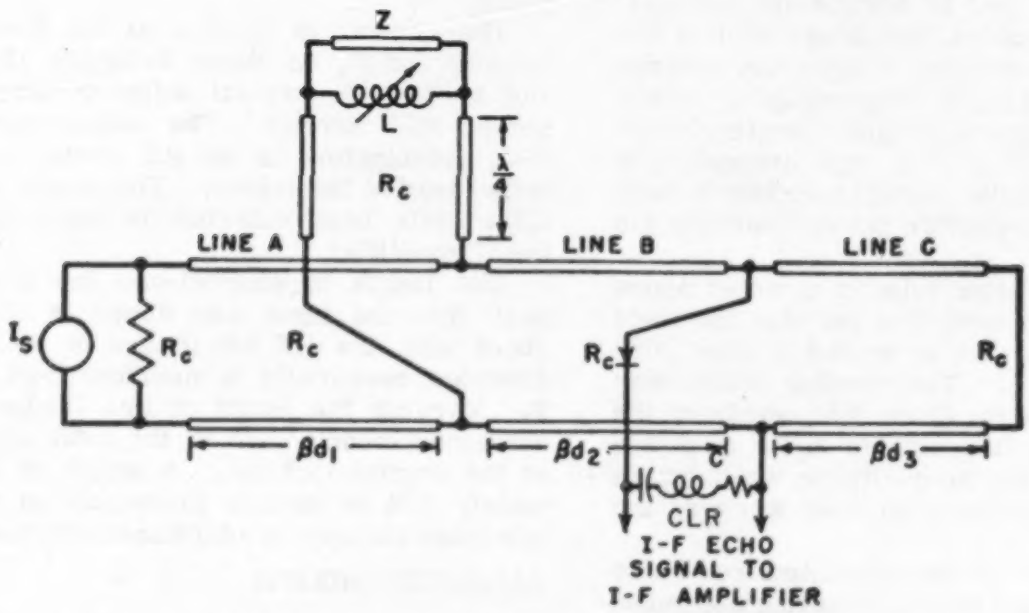

(B) AN R-F EQUIVALENT CIRCUIT OF ECHO-SIGNAL CHANNEL

Figure 12-34.—A 3-cm mixer.

As explained below, this method of circuit connection causes the IF components of local oscillator noise to cancel in the IF amplifier input circuit and the IF components of the signal to add. Because of their ability to suppress local oscillator noise and because of certain additional advantages to be discussed later, balanced mixers are often preferable to single-ended mixers. They are presently finding wide use in microwave radar systems.

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ABSTRACT - Developed for the Bureau of Naval Personnel, this training manual is to be used by Naval and Naval Reserve Personnel preparing for advancement in the rate of Hospitalman. Part I discusses elementary anatomy and physiology, while Part II outlines elementary first aid and bandaging procedures, and Part III is an introduction to the principles and practices of nursing. Illustrations, photographs, and charts augment the text. A subject index is included. (Author/SB)

VT 012 765

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HOSPITALMAN

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BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10664-B

PREFACE

This training course is the first in a series of courses written especially for Hospital Corpsmen. It furnishes study material for U. S. Navy and Naval Reserve personnel preparing for advancement in rating. This material contains extractions from the Handbook of the Hospital Corps to provide an overall coverage of the subject to be studied for advancement. Additionally, this course provides source material for personnel responsible for preparing examination questions for advancement in rate to Hospitalman (HN).

The contents are assembled in three parts including an index and a table of contents for ready reference:

Part I discusses elementary anatomy and physiology. Part II outlines elementary first aid and bandaging procedures. Part III is an introduction to the principles and practices of nursing.

The contents conform to the requirements for advancement to Hospitalman as set forth in the Manual of Qualifications for Advancement in Rating, NavPers 18068-B.

Completion of this course is a prerequisite to advancement to hospitalman except as otherwise provided by current BuPers instructions. A Hospital Apprentice is not eligible to take the examination for advancement until an entry is made in his service record that this training course, or its equivalent, has been completed.

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The basic principles of a balanced mixer may be explained from the diagram of figure 12-35, which shows two crystals mounted a half wavelength apart (at the signal frequency) between conductors of a coaxial line section. Each crystal is located a quarter wave from the nearer end of the line, and the local oscillator signal is probe coupled to the line at a point midway between the crystals. The output terminals of the crystals are connected to an IF transformer, the primary winding of which is balanced to ground. The signal current generator I_s in shunt with resistance R_c accounts for signals entering the mixer from the TR device.

The local oscillator coupling probe gives rise to two waves traveling in opposite directions in the coaxial line. Assume that at the local oscillator frequency the TR device presents a short circuit to the local oscillator wave traveling to the left in figure 12-35, and that the crystals have identical RF impedances equal to twice the characteristic resistance of the line. Then equal-amplitude, in-phase, local oscillator voltages appear at the crystals. Because of the half-wave spacing between crystals, the RF echo signal voltages at the crystals are also of equal amplitude but are 180° apart in phase. An in-phase relation between local oscillator and echo signal voltages produces an IF signal voltage of one phase, and a 180° phase relation between local oscillator and echo signal produces an IF signal voltage of opposite phase. Thus the two IF echo signal voltages add in the balanced input circuit of the IF amplifier. Because the noise that accompanies the local oscillator signal produces voltage components that bear the same phase relation to the local oscillator voltage at each crystal, the corresponding IF components of noise at the output of each crystal are in phase and hence produce no resultant noise voltage across the IF transformer.

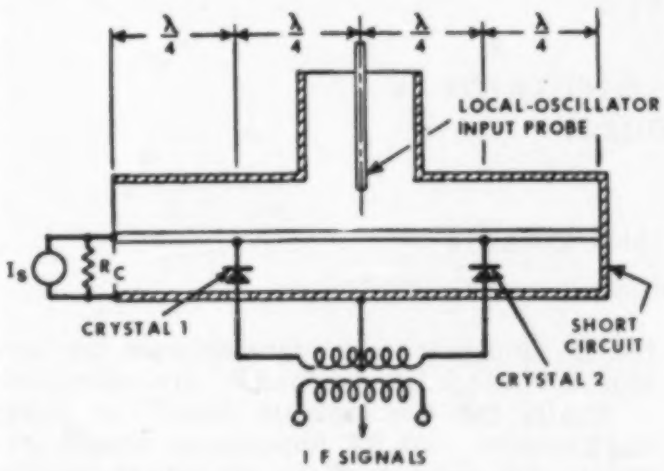

Figure 12-35.—Coaxial line balanced mixer circuit.

In order to realize full benefit from use of a balanced mixer circuit, the crystals should have similar RF impedances as assumed above, and in addition they should have similar conversion gains. Under these conditions of operation, only one-half the available RF power is applied to each crystal, but since the IF signal powers from the crystals add together, the total IF power is the same as that obtained from a single-ended mixer. Since IF components of local oscillator noise are completely eliminated, maximum reduction in overall noise figure is obtained.

An imbalance in conversion gain yields an imbalance in the IF signal voltages obtained from each crystal and also an imbalance in the IF components of local oscillator noise voltages at the crystal output terminals. However, since the IF signal voltages are additive in the crystal output circuit and the local oscillator noise components are subtractive, small imbalances in conversion gains do not seriously affect the overall receiver noise figure.

More important are the effects of a difference in the RF admittances of the crystals. An imbalance of this type causes both the echo signal power and the local oscillator power to divide unequally between the two crystals. As a result, the IF signal power obtained from the mixer is appreciably reduced, and in addition the IF components of local oscillator noise are prevented from canceling completely in the IF input circuit. Crystals intended for use in a mixer constructed as shown in figure 12-35 must be carefully selected on the basis of equal RF admittances in order to insure most satisfactory operation.

A balanced mixer that is superior in several respects to the coaxial line mixer just described is shown in figure 12-36 (A). This mixer employs a waveguide hybrid junction.

Crystals are located in one pair of entries (arms 3 and 4). Usually in a mixer of this type the input circuit of the IF amplifier is also arranged in the form of a hybrid junction.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

NAVY PUBLICATIONS

Standard First Aid Training Course, NavPers 10081 (Current Edition)

Handbook of the Hospital Corps, 1959 (NavMed P5004)

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INTRODUCTION

THE HOSPITALMAN

This training course is the beginning of your career as a member of the Hospital Corps. Created by Act of Congress on 17 June 1898, the Hospital Corps is unique in that it is the only enlisted Corps in the Navy. The heritage of the Hospital Corps is a proud one and you as a Hospitalman must do your part to preserve it.

The duties of the Hospitalman evolve around human lives, their well-being and their health. Prevention of disease as well as treating it, ministering to the wounded and injured, is an occupation as old as humanity itself and one for which we reap the highest rewards.

This book is the bottom rung of your ladder to success in your career as a hospital corpsman. It forms the basis for the skills and knowledge required of you, those vital for better performance of your duties and for future advancement.

Everything you do as a hospital corpsman will have a specific relation to some part or function of the human body and its environment. This training course is the first phase in understanding these relationships.

While each chapter deals with specific parts or functions of the human body, all of them are closely related and in order to effectively do your job as a hospitalman you must have a thorough knowledge of these facts and their relationships.

Part I of this training course covers elementary anatomy and physiology, the study of which is the basis of all medical knowledge. Part II, First Aid, includes elementary first aid and bandaging procedures and Part III, Nursing, embodies the elements of patient care, administration of medicines, and hygiene. A thorough knowledge of the contents of this book will enable you to satisfactorily demonstrate the required knowledge for advancement to Hospitalman (HN).

MISSION OF THE NAVY

The primary mission of our Navy is to maintain control of the seas for ourselves and our allies, and to deny the use of the sea areas to our enemies. Why is this assignment so important? The reason is that some 78 percent of the raw materials that this country needs to survive are transported to this country by sea. If we lose control of the sea and our imports are cut off, we cannot survive.

In days past, the armed sailing ship—the dreadnought—and a strong maritime fleet were the means of achieving this control, which has come to be known universally as sea power.

Today, the elements that make up sea power are diverse and numerous. These elements are the combatant ships and naval air arm, together with the various auxiliary craft, the Marine Corps, and the merchant marine. Thus, it can be seen that the need for and objectives of sea power remain unchanged, but the particular elements composing it have changed.

Our Navy of tomorrow may not be a navy of guided missile cruisers, nuclear-powered submarines, and supercarriers launching supersonic fighters and bombers. Yet, it will certainly be a navy in the best sense—a mobile organization using ocean highways, carrying its own defense against any weapon directed against it by an enemy, and launching from its mobile platform whatever the naval engineers of today and tomorrow may adapt or devise (rockets, guided missiles, nuclear bombs, and so forth).

This certainly, however, should be borne in mind: Although fleets change, the need for sea power always remains. And the Navy of today and tomorrow can be depended on at all times to fulfill this need.

RATING STRUCTURE

The training mission of the peacetime Navy is to produce broadly qualified, versatile personnel who, particularly in time of emergency, can be advanced to positions of greater responsibility and authority. If this mission is to be accomplished, several jobs have to be performed. These jobs have been classified in accordance with the rating structure.

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In order to understand the rating structure, which provides for the Navy's needs under both peacetime and wartime conditions, you must understand the difference between a rating and a rate.

An occupational group of jobs requiring similar interests, training, experience, knowledge, and skills is known as a rating.

Within every rating are steps for advancement, and with each step there is an increase in pay. These steps, or pay grades, are the rates within the rating. The rating in this illustrative case is Hospital Corpsman, abbreviated HM. The rates are Hospital Corpsman Third, Hospital Corpsman Second, Hospital Corpsman First, Chief Hospital Corpsman, Senior Chief Hospital Corpsman, and Master Chief Hospital Corpsman, abbreviated HM3, HM2, HM1, HMC, HMCS, and HMCM. In the same manner, Hospitalman, Hospital Apprentice, and Hospital Recruit are rates, because they also denote levels within occupational areas.

QUALS MANUAL

One of the most important publications relating to any enlisted man's career is the Manual of Qualifications for Advancement in Rating, NavPers 18068B, known throughout the Navy as the Quals Manual. Military and professional requirements for advancing to Hospitalman (and all other rates and ratings) are contained in the Quals Manual. The qualifications for Hospitalman form the basis for this course, and they were current at the date of this printing. But the qualifications change occasionally, and the questions in the advancement examinations for all pay grades are based on the latest revision. Consequently, well before taking an examination for advancement to Hospitalman, you should check for revisions and assure yourself that your knowledge covers all the latest qualifications.

ADVANCEMENT

Before you can advance in rate, you must fulfill certain military and professional requirements.

MILITARY REQUIREMENTS

Military requirements for advancement are those general qualifications applicable to all enlisted personnel, such as watch standing, first aid, and military conduct. These requirements are published in the Quals Manual, near the front, preceding the professional qualifications. Before you can advance, you must show that you are proficient in each of the military qualifications specified for the next higher pay grade. You also may be required to demonstrate your proficiency in the military quals for all the lower pay grades. These are covered in Basic Military Requirements, NavPers 10054-B.

PROFESSIONAL REQUIREMENTS

Professional qualifications are the ones a Navy enlisted man must have to qualify for a rate (apprenticeship, third, second, first, or chief) within a particular rating (Hospital Corpsman, Quartermaster, etc.). The higher the rate, the more the man is required to know.

The qualifications are further divided into practical factors and knowledge factors. Practical factors are qualifications that can be demonstrated best by performance.

A special checkoff sheet, titled Record of Practical Factors, NavPers 760, lists all the practical factors shown in the Quals Manual for the rate to which you are advancing. It is kept by your supervisor or division officer; you are given a duplicate copy. As you qualify in a practical factor, your supervisor or division officer enters the date and initials the entry. When you are transferred, the checkoff sheet accompanies your record to the next duty station.

Before you can take the servicewide examination, there must be an entry in your service record to prove that you are qualified in the practical factors. The servicewide examination is based on (1) a thorough knowledge of the manner in which the practical factors are performed, and (2) the qualifications listed under the knowledge factors. An example of a knowledge factor is the "qual" that requires you to know the meaning and significance of certain Rules of the Road.

HOW TO ADVANCE

The Navy has established certain requirements that must be met before you are eligible to take the servicewide competitive examination for advancement in rate or rating. You must—

First: Meet basic requirements, such as length of service in pay grade, total service, and sea duty time.

Second: Have a statement in your service record that you satisfactorily performed the practical factors for the next higher rate.

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Third: Have a statement in your service record that you successfully completed the training course for the next higher rate.

Fourth: Be recommended by your commanding officer.

When you satisfy all of these requirements, you are eligible to participate in the examination. If you pass the examination with a high enough score, your commanding officer has the authority to advance you in rating.

REWARDS OF ADVANCEMENT

Each time you advance in your rating, you receive many rewards. These rewards include higher pay and allowances, together with additional pension benefits when you retire. But the really important gains are opportunities for more interesting and challenging assignments, increased respect from your superiors as well as from the men you supervise or help, and the chance for greater fulfillment of your abilities. Above all, you are afforded the opportunity to serve your command, your Navy, and your country at a higher level of responsibility in a more important job.

As a member of the greatest Navy in the world, you have the satisfaction of knowing that, as you advance in a rating, you are serving your country in a most important way. Do your job well at all times, and take pride in what you do and how you do it. Service to your country is a special privilege. You must make every endeavor to serve with honor.

Tradition, valor, and victory are the Navy's heritage. The long history of outstanding achievements and noble service of the Navy provides an inspiration and a challenge to you and your shipmates. It is up to you to help maintain and enlarge the prestige and the traditions of the naval service.

NAVPERS 10052

The Navy has set definite limits on the material for which you are accountable on servicewide examinations. The sources from which examination items are taken are listed in the effective edition of a pamphlet called Training Publication for Advancement in Rating, NavPers 10052. This pamphlet is available on your ship or station. It is revised annually, so be sure to consult the current edition. This pamphlet provides the titles of publications and sections of publications that you should study when preparing for the examination. The publications listed contain material covering all the qualifications as shown in the Quals Manual.

Get to know NavPers 10052. After you read the instructions, only two sections are of further interest to you. One section contains the sources you should study to meet the military requirements for advancement. The other lists sources for study to qualify in a specified rating. An asterisk (*) marks the Navy Training Courses you must complete before you can be eligible for servicewide examination for advancement.

LEADERSHIP

As a Hospitalman, the occasions on which you will be able to display your leadership qualities may be very limited. You will be expected to show a continued willingness to undertake any task assigned by your immediate supervisors and to perform it cheerfully and efficiently.

This period of being a follower rather than a leader should be one of valuable training for your future responsibility of leadership. Because they will be advantageous when you are placed in a responsible position over other men, you should develop these leadership factors now: (1) know your job; (2) know the men you work with; and (3) always set a good example.

A man who aspires to be a good leader must know his job. Lack of such knowledge can result only in poor leadership. You should try constantly to improve your knowledge of your specialty and the organization of the Navy.

Knowing the men you work with is also a must. Get to know the capabilities and limitations of the men you work with. This knowledge of men will help you when the time comes to organize them successfully into an efficient working unit.

Finally, set an example that will measure up to the expected Navy standards. There are many ways in which a good example may be set. Some of these are obvious—smart military appearance, exemplary conduct, obedience to rules and regulations, even temperament, loyalty to superiors and subordinates, clean speech and a willingness to share danger and hardship. Other good points, such as moral courage and self-confidence, should be present in every action you perform. All these influences are important, but the degree to which you measure up to them will determine the type of example you set for the men around you.

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PROFESSIONAL ETHICS

Professional ethics refers to the adherence to moral principles by members of a profession in the practice of that profession. As a hospital corpsman, you must learn and ahere to a code of behavior which is based on sound moral beliefs and which is so ingrained as to become a way of life. Your responsibility as a hospital corpsman to exhibit ethical behavior is in three major areas:

YOUR FIRST RESPONSIBILITY IS TO YOUR PATIENT

You must always recognize your obligation to give the best care that you are capable of giving to every patient committed to your charge. This care must reflect a belief in the worth and dignity of every patient as a human being. Courteous, efficient, and conscientious service is the mark of an outstanding corpsman. Respect for the patient's right to privacy must be honored and particularly when he discloses privileged information to you. This should never be repeated to any unauthorized person. Your patient's welfare is paramount.

YOUR SECOND RESPONSIBILITY IS TO THE TEAM

Doctors, nurses, and hospital corpsmen comprise the team dedicated to healing the patient. Mutual respect and understanding of the role and the person of each member is of vital importance to the success of the team. Cooperation of all the members is essential. The doctor, as team leader, carries the overall responsibility for the welfare of the patient. He prescribes the medical treatment and oversees the total care of all patients. The nurse is responsible for meeting the nursing needs of the patient and insuring that all of the doctor's orders and nursing measures are carried out accurately. Both the doctor and nurse are responsible for instructing the hospital corpsman in the performance of his duties.

The hospital corpsman is responsible for carrying out the doctor's and nurse's orders and giving nursing care to patients.

YOUR THIRD RESPONSIBILITY IS TO THE HOSPITAL CORPS

The heritage of the Hospital Corps places a special burden on every new member. He is responsible for upholding its proud tradition. The tradition of "service with distinction" has been established by your predecessors in every corner of the world and under every kind of adversity.

Your patient, the members of the team you serve, and your shipmates deserve your respect and cooperation. They merit your confidence. Respect and confidence coupled with your skill will allow you to carry on in the proud tradition of the Hospital Corps.

Professional ethics is the key to service with distinction.

TRAINING AIDS

There are many good films, both movie and strip, available to assist in the group-training of Hospital Corpsmen. The best source of information for such films and their method of procurement for an organization such as a Naval Reserve Unit where group study of this text is used, is the current edition of "Film Reference Guide for Medicine and Allied Sciences", NavMed P5052.

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CHAPTER 1

INTRODUCTION TO HUMAN ANATOMY

STUDY OF THE HUMAN BODY

The human body is a combination of organ systems with a supporting framework of muscles, bones, and an external covering of skin. The smallest unit of life, the cell, is the building block of which all these organs and systems are made. The study of the body is divided into divisions which may be defined as follows:

1. HUMAN ANATOMY.—The study of body structure and the relation of one part to another. Specifically it is further subdivided into:

a. Descriptive anatomy, the word picture of the character, form, and size of the various parts of the body.

b. Surgical anatomy dealing with special features of those portions of the body that are important in the diagnosis and treatment of surgical diseases.

c. Topographic anatomy, the study of the relationship of the parts of the body to surrounding parts.

d. Surface anatomy concerning the form and markings on the surface of the body. It helps in locating, on a patient, such parts as nerves or bones which are hidden by the skin.

2. HUMAN PHYSIOLOGY.—The study of the body's functions and activities. How the body works—showing what the individual parts do in relation to one another and as a unit (how the heart acts by itself and as a part of the body).

3. EMBRYOLOGY.—The study of the development of the body from a fertilized egg or ovum.

CLASSIFICATION OF LIVING MATTER

Everything in nature is either animal, vegetable, or mineral. Minerals are void of life and are known as inorganic matter. Animals and vegetables possess life and are known as organic matter. This means that they have been made up by matter that has been organized by life processes.

Any living thing, plant or animal, is an organism. The difference between them is that animals have sensation and the power of voluntary movement, and require oxygen and organic food. Plants require only carbon dioxide and inorganic matter for food, and have neither voluntary movement nor special sensory organs.

Plants and animals are symbiotic. Living side by side they sustain each other by their life cycle. Animals need oxygen which the plants give off, and they require plants for food in order to obtain protein, carbohydrates, and fats for building body cells. They exhale carbon dioxide and give off wastes which are in turn used by the plants.

The manner in which plants manufacture proteins, carbohydrates, and fats is interesting. These organic compounds are formed by the action of the sun's rays upon the leaf's green chlorophyll. This action unites the air's carbon dioxide with the mineral salt solution from the soil freeing oxygen to the air in the form of water vapor. This process is called photosynthesis.

Animals eat food containing organic matter and after digesting and absorbing it, either convert it into body cells or burn it with the aid of oxygen inhaled into the lungs to produce energy. As the waste products are formed, some are excreted by the bowels and kidneys while others, mainly carbon dioxide, are exhaled from the lungs.

Animals are classified into many divisions. Those with a backbone, including fishes, reptiles, birds, and mammalia, are called vertebrates. Those without backbone are called invertebrates. Man belongs to the class or division called mammalia (those that suckle their young).

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He is unique in having the power of articulate speech and the ability to reason abstractly.

CHARACTERISTICS OF LIVING MATTER

All animal and plant life have certain chemical processes by which life is sustained and cells regenerated. These processes, from the time the food enters the body until it is made into tissues to repair the body, or is burned to provide energy, are metabolic. Metabolism involves the absorption, storage and use of food for growth and body repair. It also involves the combination of food with oxygen to make energy, and the final elimination of waste materials. It is the burning of foods that supplies the energy for carrying on all body processes. This food burning also maintains body temperature in warm blooded animals.

Another characteristic of living matter is its irritability or excitability. It responds to stimulation. Even a one-celled animal will move away when stuck with a pin, and you are all familiar with how you respond when this happens to you. The action which takes place is similar to that of a telephone call. You dial a number and an impulse is sent through the line to a central control where it is relayed to the proper party. When you receive a pin-prick the skin relays by way of the central nervous system to the brain that something is wrong. The system in turn activates another nerve or set of nerves causing contraction or withdrawal of the part. This is an example of irritability.

THE CELL

All living cells are composed of a viscid, jelly-like substance called protoplasm. Upon it depend all the vital functions of nutrition, secretion, growth, circulation, reproduction, excitability, and movement. The secret of life itself is actually contained in protoplasm.

As the atom is the basic unit of any element, the cell is the basic unit of any living organism. It is the building block of the body. Cells vary in size from the rickettsia (about 0.5 millimicron) to the ostrich egg (about 3 inches or about 15 million times the size of the rickettsia).

A typical cell is made up of a cell wall, cytoplasm, nucleus, and a nucleolus.

The simplest living organism consists of a single cell (yeast and bacteria are one-celled plants; the ameba is a one-celled animal). The single cell of such a one-celled organism must be able to carry on all processes necessary for life. That is they must be able to be stimulated, have movement, eat, grow, and reproduce. This type of cell is called a simple or undifferentiated cell.

In the multicellular organisms, cells vary in size, shape and number of nuclei. When stained, the various types of structures can be more readily recognized under a microscope. Other differences such as the number and type of cells can be seen with the aid of a microscope. Many cells are highly specialized. Specialized cells are those that perform a special function such as muscle which contracts or epithelial cells of the skin which protect.

An important structural feature of body cells is the permeable cell wall through which fluids may pass. This is of importance because all body cells are bathed in tissue fluid from which nourishment, essential to life and growth, is received. From the tissue fluids, they absorb oxygen, proteins, carbohydrates, mineral salts and water. This absorption is accomplished by diffusing these substances from the blood stream to the body cells through the permeable membranes of the body tissues and capillaries.

Cells may be excited to activity by mechanical, chemical or nervous stimulation. This produces muscular movement, or secretions such as the digestive juices of the stomach and the increase of hormones such as adrenalin secreted in anger or fear. The stimuli are carried to the cells by nerves or are caused by chemical substances that reach the cell through blood and tissue fluid.

TISSUES

Tissues are groups of specialized cells similar in structure and function. They are classified in five main groups:

1. EPITHELIAL.—The lining tissue of the body. It forms the outer covering of the body known as the free surface of the skin. It also forms the lining of the digestive, respiratory, and urinary tracts, the blood and lymph vessels, serous cavities, and tubules of such secretory glands as the liver and kidneys. This tissue may be further subdivided into three types:

a. Columnar.—The chief function of this tissue is the secretion of digestive fluids and the absorption of digested foods and fluids. It consists of long narrow cells set close together resembling a palisade type fence. (See fig. 1-1.) In certain areas such as nose, bronchial tubes, and trachea, this tissue has a crown of microscopic hair-like processes known as cilia. These

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cilia provide motion to move secretions and other matter along the surfaces from which they extend. They also act as a barrier—preventing foreign matter from entering into these cavities.

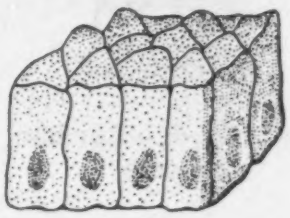

Figure 1-1.—Columnar epithelial tissue.

b. Squamous.—This is the main protective tissue of the body. It is composed of thin plate or scale-like cells forming a mosaic pattern. This tissue is found in the tympanic membrane of the ear (ear drum) as a single layer of cells or in the free skin surface in multiple layers. (See fig. 1-2.)

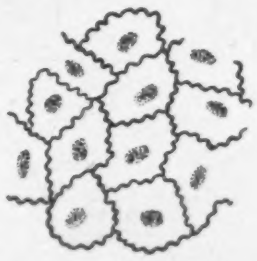

Figure 1-2.—Squamous epithelial tissue.

c. Cuboidal.—This tissue is both a secretory and protective tissue whose shape is similar to a cube. It is found in the more highly specialized organs of the body such as the ovary and kidney. (See fig. 1-3.)

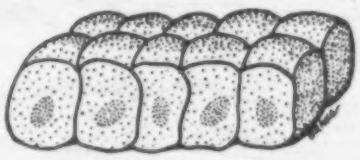

Figure 1-3.—Cuboidal epithelial tissue.

2. CONNECTIVE.—The supporting tissue of the body. This tissue with its many variations, is the most widespread tissue of the body and is highly vascular. It surrounds cells, encases internal organs, sheathes muscles, wraps bones, encloses joints, composes blood and provides the supporting framework of the body structure. Structures of connective tissue differ widely. They range from delicate tissue-paper membranes, strong tough cords, and rigid bones to liquid blood and are all made of connective tissue.

Connective tissue is composed of few cells and large amounts of intracellular material; the reverse is true of epithelial tissue.

Some of the more predominant types of connective tissues are:

a. Areolar.—This serves to connect the various tissues of the organs. It is continuous through the body. Nerves, blood and lymph vessels are found in this tissue. (See fig. 1-4.)

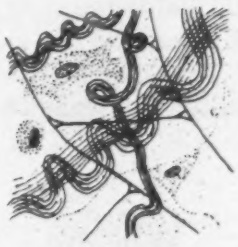

Figure 1-4.—Areolar connective tissue.

b. Adipose.—This is generally called "fatty tissue". It acts as a reservoir for energy producing foods, helps to reduce body heat loss (because of its poor heat conductivity) and serves as support for various organs and fragile structures such as the kidneys, blood vessels, and nerves.

c. Osseous.—Cartilage and fibrous tissue are the least vascular of the connective tissues. They form the supporting framework of the body. (See fig. 1-5.)

Figure 1-5.—Osseous (bone) tissue.

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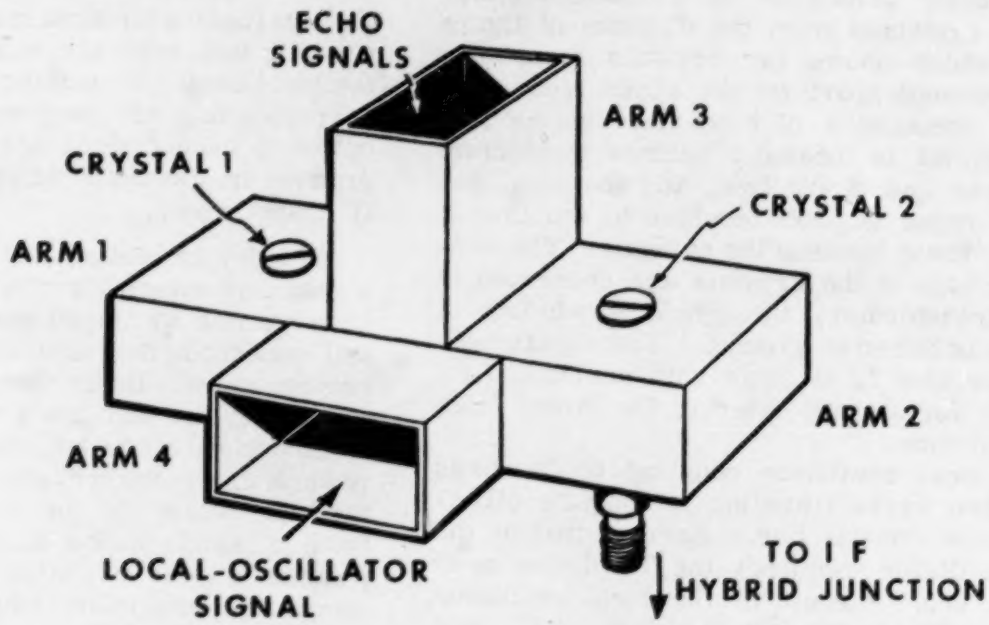

(A) PICTORIAL DIAGRAM

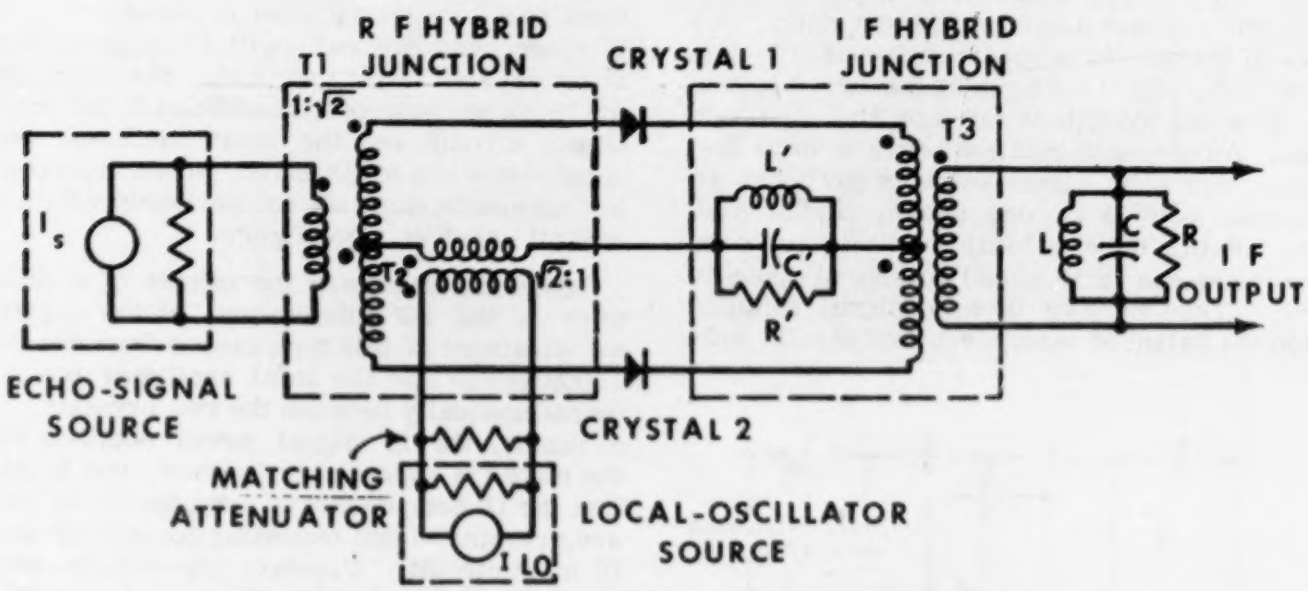

(B) EQUIVALENT CIRCUIT

Figure 12-36.—Balanced mixer employing hybrid junctions.

Details of connections of the IF amplifier input circuit, together with the ideal transformer equivalent circuit of the waveguide junction are given in the right-hand block of (B). The parallel circuit comprising L, C, and R is tuned to the intermediate frequency and the impedance of the parallel combination of L′, C′, and R′ is made equal to the conjugate of the IF impedance appearing between the terminals to which L′, C′, and R′ are connected.

Ideally the two crystals should be alike. Furthermore, all RF impedances should terminate the entries of the RF hybrid junction in matched loads, and all IF impedances should similarly terminate the entries of the IF hybrid junction. Then, because of the properties of

3. MUSCULAR.—The tissue which provides all body movement. It is classified into two types:

a. Voluntary muscle fibers are striated or striped. This type is subject to the control of the individual's will or thought. (See fig. 1-6.)

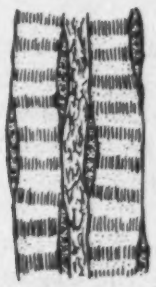

Figure 1-6.—Striated muscle.

b. Involuntary muscle fibers are smooth or non-striated. This type operates involuntarily or automatically and is not subject to the individual's will. The beating of the heart is an example of involuntary muscle action. (See fig. 1-7.)

Figure 1-7.—Non-striated muscle.

Structurally speaking the skeletal muscles are voluntary and the visceral muscles are involuntary. The exception to this classification is the heart. It is an involuntary, faintly striated muscle and is called the CARDIAC MUSCLE. (See fig. 1-8.)

4. LIQUID TISSUES.—These tissues act as a medium for supplying the body with nutrients and as a vehicle for elimination of waste materials. They form the blood, lymph, and tissue fluids.

5. NERVOUS TISSUE.—This tissue is the most complex tissue of the body. It is the

Figure 1-8.—Cardiac muscle.

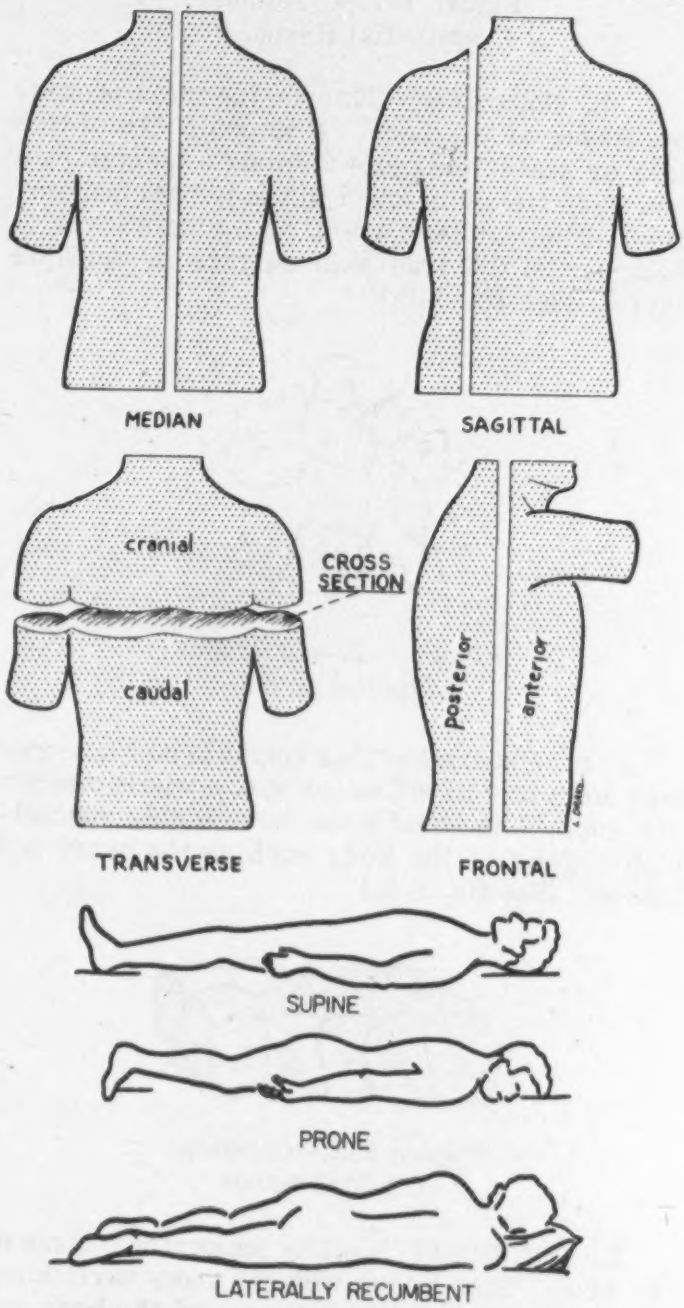

Figure 1-9.—Anatomical planes and postures.

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substance of the brain, spinal cord, and nerves. Nervous tissue requires oxygen and nutrition to a higher degree than any other body tissue.

In the body, cells are the smallest building blocks. Groups of cells form tissues, and similar tissues form organs such as the heart, liver, and kidneys. These organs are grouped together to form systems such as the urinary system, which is composed of the kidneys, ureters, bladder, and urethra.

ANATOMICAL TERMS

To assist in describing the body, certain anatomical terms are used. For determining position and direction you should be familiar with the anatomical position of the body.

THE ANATOMICAL POSITION.—The arms hang to the sides, palms of the hands facing forward or to the front, and the body in an upright or erect standing position.

The terms of reference which indicate direction and position are:

1. Anterior—toward the front or ventral (pertaining to the belly; abdomen) side of the body.
2. Posterior—toward the back or dorsal side of the body.
3. Medial—near or toward the midline of the body.
4. Lateral—farther from the midline of the body.
5. Internal—inside.
6. External—outside.
7. Proximal—nearer the point of origin or closer to the body.
8. Distal—away from the point of origin or away from the body.
9. Superior—higher than or above.
10. Cranial—toward the head.
11. Caudal—toward the lower end of the body.
12. Inferior—lower than or below.
13. Erect—normal standing position of the body, palms of hands to the front.
14. Supine—lying position of the body, face up.
15. Prone—lying position of the body, face down.
16. Lateral recumbent—lying position of the body, on either right or left side.
17. Periphery—the outside or surface of a body organ.

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CHAPTER 2

OSTEOLOGY

SKELETON

The skeleton is the bony framework of the body. (See fig. 2-2.) This framework supports and gives shape to the body, protects vital organs, and affords attachments for tendons, muscles and ligaments. The skeletal bones are joined members by which muscle movement is made possible.

BONES

OSTEOLOGY is the study of the structure of bone. Bone is made up of calcium, phosphorus, and other mineral salts, and an organic substance called ossein. When human bone is soaked in dilute acid until all inorganic mineral salts are washed out, all that remains is a flexible piece of tissue which can be bent and twisted easily. Bone, therefore, depends upon inorganic mineral salts such as calcium and phosphorus for its strength and hardness. From this, we can see that bone is both hard and elastic. Two-thirds of the bone is mineral matter (lime salts) which gives it hardness; the remaining one-third is organic matter containing protein which gives it elasticity. The degree of elasticity decreases with age. Children's bones which are greatly elastic, do not break as easily as an adult's because they do not have the mineral content that increases with age.

Bone structure consists of a hard outer shell, called the compact tissue, and an inner spongy, porous center called the cancellous tissue. (See fig. 2-1.) The center of the bone is called the Medullary canal and contains marrow. There are two types of marrow, red and yellow. Yellow marrow is ordinary bone marrow in which fat cells predominate. It is found in the medullary canals and cancellous tissue of long bones. Red marrow is one of the manufacturing centers of red blood cells and is found in the articular ends of the long bones, and in cancellous tissue. At the ends of the long bones there is a smooth, glossy tissue which forms the joint surfaces. This tissue is called articular cartilage because these surfaces articulate (join) with, fit into, or move in contact with, similar surfaces of other bones. The thin outer membrane which surrounds the bone is called the PERIOSTEUM. An important function of the periosteum is to supply nourishment to the bone. Capillaries and blood vessels run through (course) the periosteum and dip into the bone surface supplying it with blood and nourishment. The periosteum is the pain center of the bone. When there is a fracture, the pain you feel comes from the periosteum, not the bone proper. Periosteum also forms new bone.

CLASSIFICATION.—Bones are classified according to shape, as:

1. Long—the femur and humerus.
2. Short—the wrist and ankle bones.
3. Flat—the skull, sternum and scapula.
4. Irregular—the vertebrae, mandible, hyoid and pelvic bones.

NUMBER OF BONES.—There are 206 named bones in the adult skeleton.

Cranium	8
Face	14
Ear	6
Hyoid	1
Spine Vertebral Column) (True Vertebrae	24
Sacrum and Coccyx	2
Ribs and Sternum	25
Upper Extremities	64
Lower Extremities	62

THE SKULL

Encasing the brain is a bony framework called the skull. It is divided into two parts, the cranium

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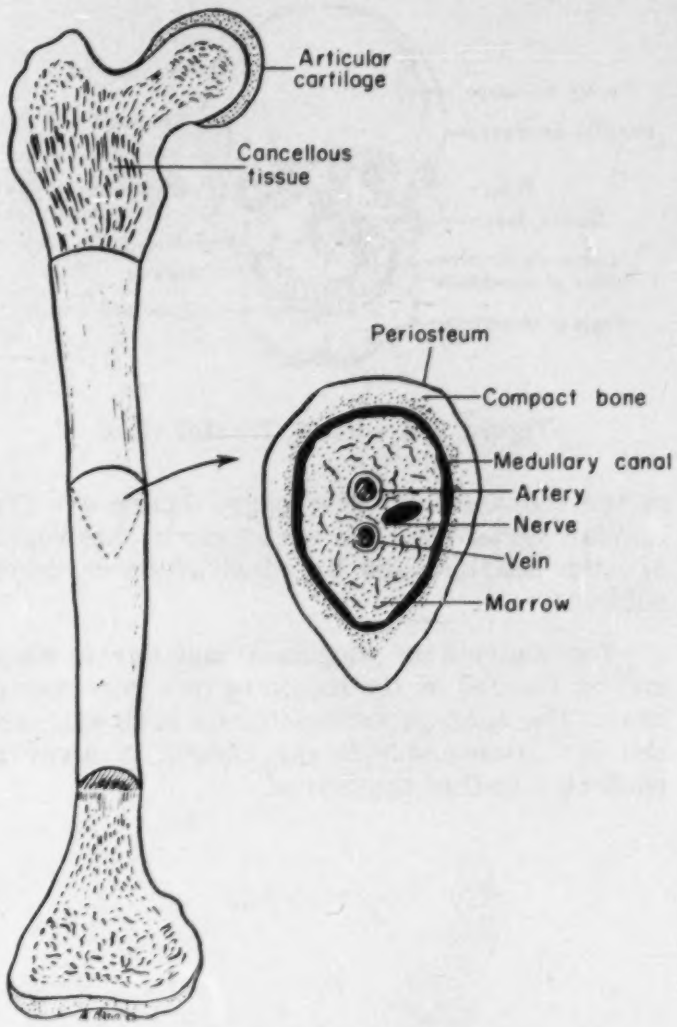

Figure 2-1—Structure of a typical long bone.

and the face. It is made up of 22 bones, 8 of which form the cranium and 14 the face.

CRANIAL BONES.—(See figs. 2-3 and 2-4.) These bones are firmly united and fit snugly together. The lines formed by the interlocking of adjacent bones are called sutures. The most important of these are the sagittal, coronal, and lamboidal sutures. The skull is formed by 8 cranial bones; 6 are essential to know. The frontal bone which forms the forehead, contains the frontal sinuses and helps to form the eye-socket and nasal cavity. The two parietal bones form the roof of the skull. The two temporal bones which help form the sides and base of the skull, also house the auditory or hearing organs. The occipital bone forms the base or back of the skull and has a large hole in it called foramen magnum. This opening permits passage of the spinal cord from the cranium into the spinal column.

FACIAL BONES.—(See fig. 2-4.) The two maxillary bones form the upper jaw, nasal walls, and part of the eyesocket. These bones contain large cavities called maxillary sinuses. Frequently these sinuses become infected causing the individual much discomfort. The lower jaw is called the mandible, and its main function is mastication. It is the only moveable bone in the skull. Other bones of the face are the lacrimal and nasal bones.

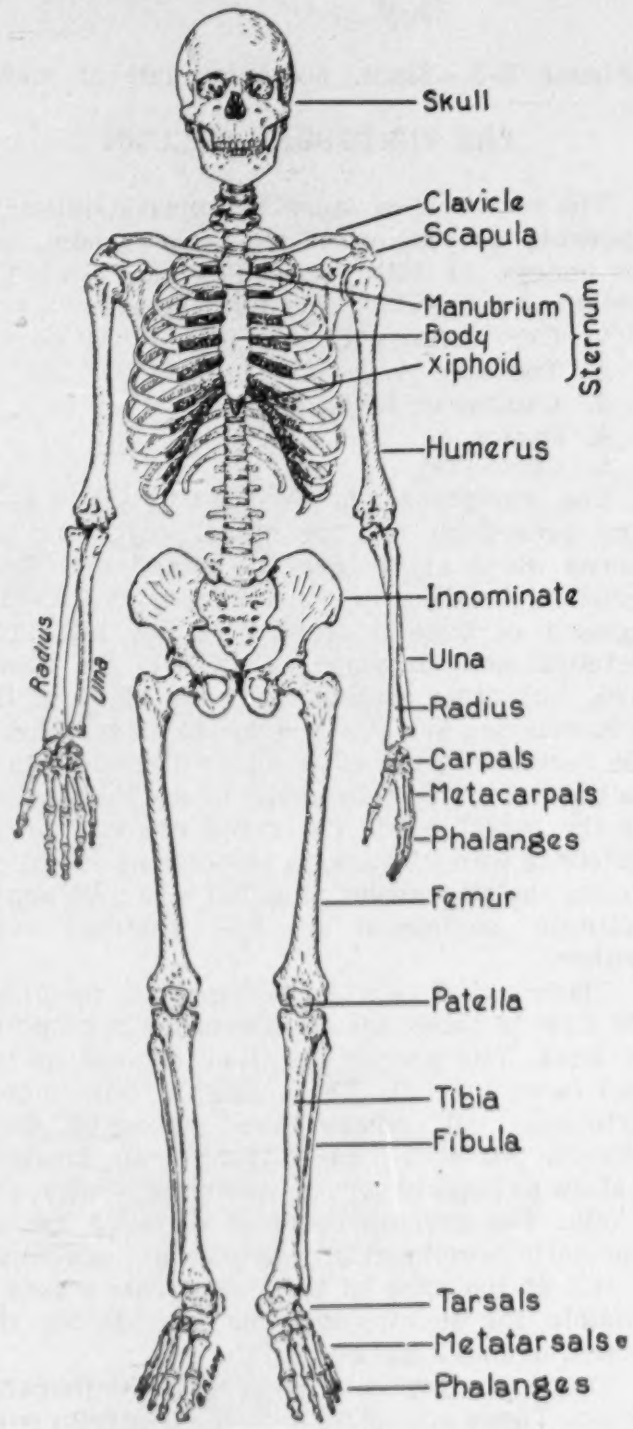

Figure 2-2.—The human skeleton.

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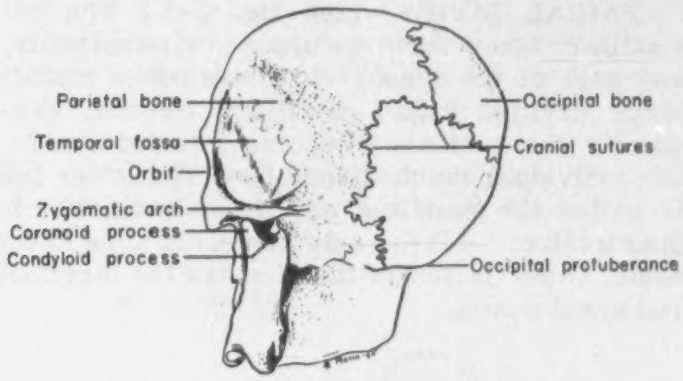

Figure 2-3.—Skull, posterior lateral view.

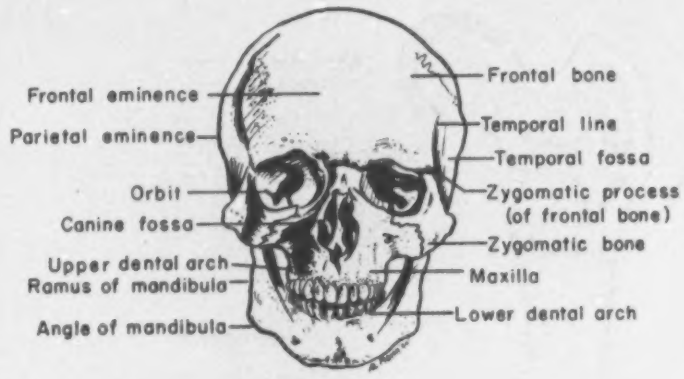

Figure 2-4.—Skull, frontal view.

THE VERTEBRAL COLUMN

The vertebral or spinal column consists of 24 moveable or true vertebrae, the sacrum, and the coccyx or tail bone. (See fig. 2-5.) The vertebrae are divided into five regions:

1. Cervical or neck.
2. Thoracic or chest.
3. Lumbar or lower back.
4. Sacral.
5. Coccygeal.

The vertebrae are designed to serve as a bony protection for the spinal cord, and the nerves which arise from the spinal cord. Each vertebra, bat-like in construction, has a solid segment of bone in front. (See fig. 2-6.) The vertebral column supports not only the spinal cord, but other organs as well. Many of the main muscles are also attached to the vertebrae. The vertebral foramen is a hole directly behind the body of the vertebrae and forms the passage for the spinal cord. The projecting side of the vertebrae with its various projections and facets are for the attachment of spinal muscles, and to facilitate movement of one vertebra over another.

There are 7 cervical vertebrae in the neck. The first is called the atlas because it supports the head. The second is called the axis, as the head turns upon it. These are the only named vertebrae, all others are numbered. Each cervical vertebra has a transverse foramen to allow passage of nerves, vertebral artery, and a vein. The seventh cervical vertebra has an especially prominent projection which can easily be felt at the nape of the neck. This makes it possible for doctors to count and identify the vertebrae above and below it.

There are twelve vertebrae in the thoracic region. These articulate with the posterior portion of the twelve ribs to form the posterior wall of the thoracic or chest cage. There are five lumbar vertebrae. The vertebrae in this region are the heaviest and broadest of the vertebral column.

The sacrum is roughly triangular in shape and is formed by the fusion of five false vertebrae. The sacrum articulates on each side with the hip bone and with the coccyx to form the posterior wall of the pelvis.

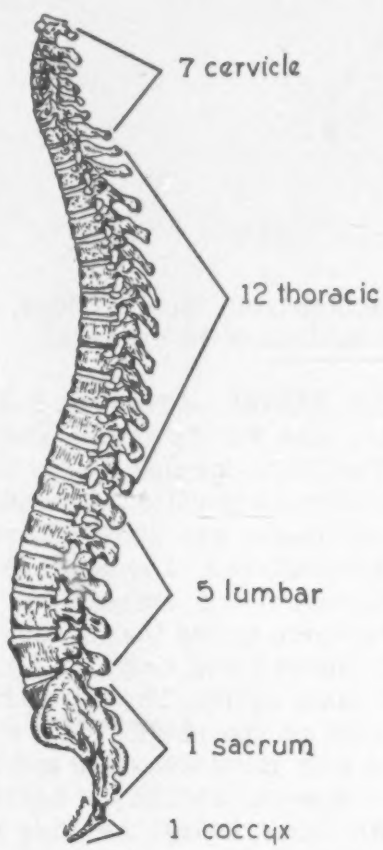

Figure 2-5.—The vertebral column.

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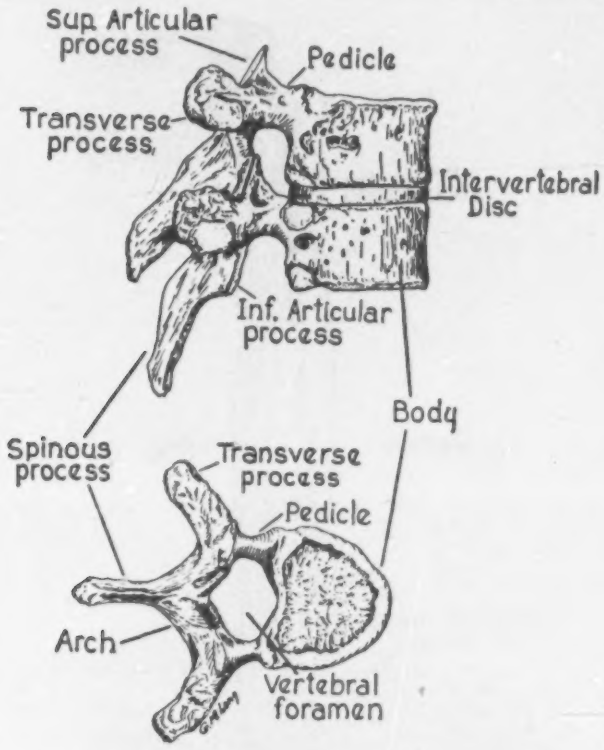

Figure 2-6.—Typical vertebra.

THE THORAX

The thorax is a cone-shaped bony cage, about as wide as it is deep. (See fig. 2-7.) It is formed by 12 ribs on each side which articulate posteriorly with the thoracic vertebrae; 10 of them articulate anteriorly with articulating cartilage and the sternum. It houses the heart and lungs, the vital organs of respiration and circulation.

The sternum occupies the middle of the upper half of the chest wall in front. It is attached to the clavicles and the cartilages of the first seven ribs.

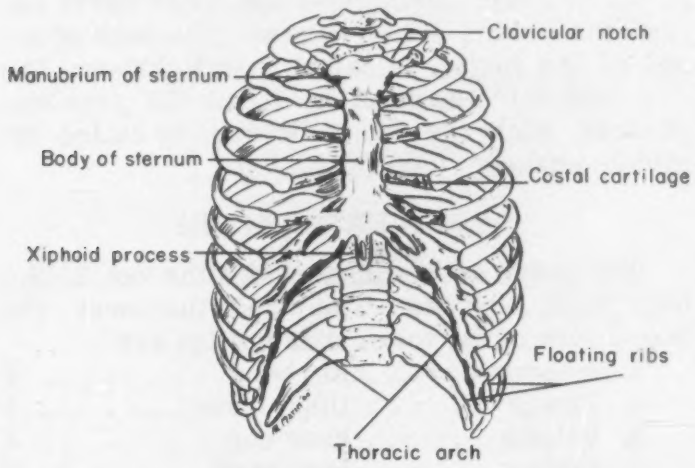

Figure 2-7.—Thorax, anterior view.

There are twelve pairs of ribs which form a series of curved bones to support the chest wall. The first seven ribs attached to the sternum are called true ribs. The eighth, ninth and tenth ribs are united by their cartilages to the cartilage of the seventh rib and are called false ribs. The last two ribs are free or unattached in front and are called floating ribs.

UPPER EXTREMITIES

The upper extremity consists of the shoulder, the arm, the forearm, the wrist and the hand. The bones that form the framework for the upper extremity are:

1. Clavicle	collar bone	2
2. Scapula	shoulder blade	2
3. Humerus	arm bone	2
4. Radius and ulna	forearm bones	4
5. Carpus	wrist bones	16
6. Metacarpus	bones of the palm	10
7. Phalanges	finger bones	28

CLAVICLE.—The clavicle forms the front part of the shoulder girdle. (See fig. 2-8.) It lies in a horizontal position just above the first

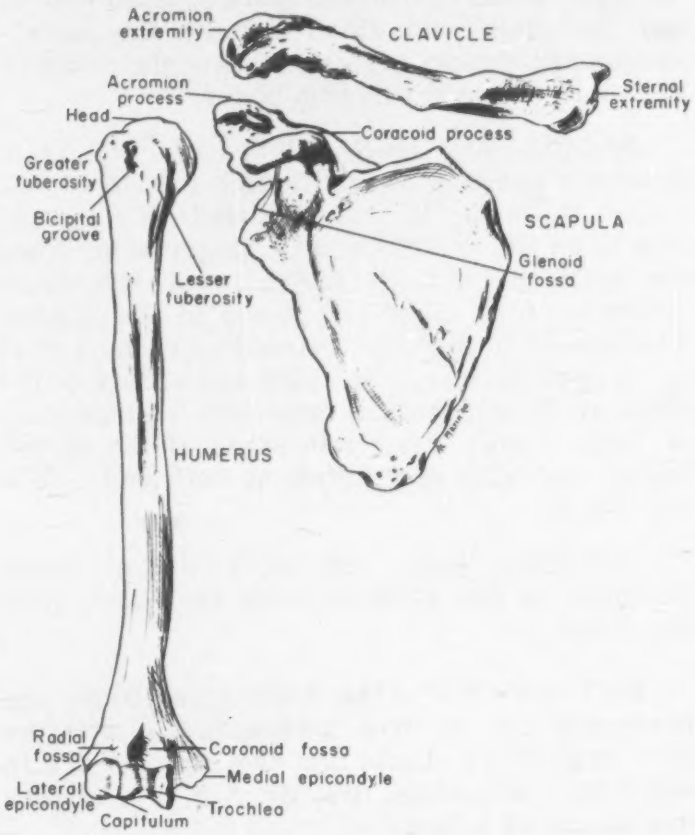

Figure 2-8.—The shoulder girdle—exploded view.

rib and is shaped like a flat letter "S". Because of its poor protection and location, the clavicle is often fractured as a result of falls. Its inner end is round and is attached to the sternum. Its outer end is flattened and is fixed to the scapula.

SCAPULA.—The scapula is a triangular shaped bone which lies in the upper part of the back on both sides between the second and seventh ribs, and forms the posterior portion of the shoulder girdle. Its lateral corner forms part of the shoulder joint, articulating with the humerus (See fig. 2-8.)

HUMERUS.—The humerus is the longest bone of the upper extremity and is often called the arm bone. (See fig. 2-8.) It articulates with the shoulder girdle to form the shoulder joint, and the bones of the forearm to form the elbow. The anatomic portions include the head, a rounded portion which fits into a recess of the scapula called the glenoid fossa (or cavity); the greater and lesser tuberosities which are enlargements of the proximal end; a surgical neck which is a slight narrowing below the tuberosities and a frequent site of fractures; the shaft which is the main part of the humerus; and the distal end which includes the prominences called espcondyles and the surfaces which articulate with the forearm bones.

RADIUS AND ULNA.—When the arm is in anatomic position, the palm facing forward, the radius is on the lateral or thumb side and the ulna in on the medial or little finger side. When the hand is pronated (palm down), the bones rotate on each other and cross in the middle. This makes it possible to turn the wrist and hand as in opening doors. The ulna and radius articulate at their proximal ends with the humerus, at their distal ends with some of the carpal bones, and with each other at both ends. (See fig. 2-9.)

CARPUS.—There are eight carpal bones arranged in two rows forming the wrist. (See fig. 2-9.)

METACARPUS.—The metacarpal bones are numbered one to five corresponding with the five fingers or digits and the phalanges with which they articulate. (See fig. 2-9.) The fingers are named as follows:

1st—thumb; 2nd—index; 3rd—middle; 4th—ring; and 5th—little.

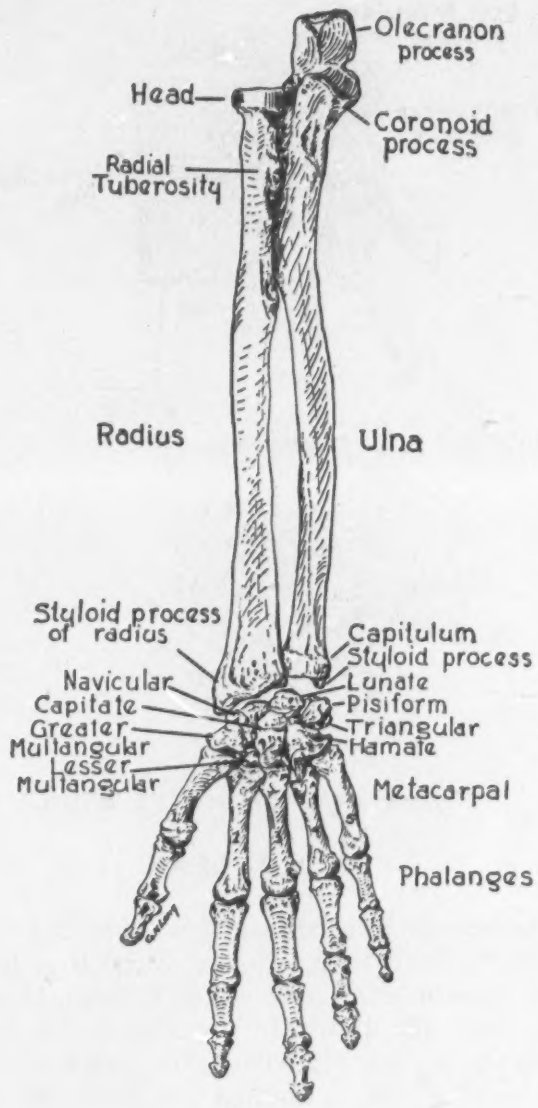

Figure 2-9.—The forearm and hand.

PHALANGES.—These are the small bones of the fingers. Each finger has three bones except the thumb, which has two. The bone at the end of the finger is called distal phalanx. The one closest to the hand is called the proximal phalanx, while the one in between is called the middle phalanx. (See fig. 2-9.)

LOWER EXTREMITIES

The lower extremity includes the foot, ankle, leg, thigh, and hip. The bones that form the framework of the lower extremities are:

1. Innominate . . . . hip bone 2
2. Femur. . . . . thigh bone 2
3. Patella . . . . . knee cap 2
4. Tibia. . . . . leg bones 2
5. Fibula . . . . . leg bones 2

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6. Tarsus . . . . . ankle bones 14
7. Metatarsus . . . foot bones 10
8. Phalanges . . . . toe bones 28

INNOMINATE.—The hip or innominate bone is a large irregularly shaped bone composed of three parts, the ilium, ischium and pubis. (See fig. 2-10.) In children, these three parts are separate bones which become firmly united into one bone to form a cup-like structure called the acetabulum, into which the head of the femur fits. The ilium forms the outer prominence of the hip bone (crest of the ilium), the ischium forms the hard lower part and the pubis forms the front part of the pelvis. (See fig. 2-11.)

The area where the two pubis bones meet is called the symphysis pubis and is often used in anatomical measurements. The largest foramen is located in the hip bone between the ischium and pubis and is called the obturator foramen. The crest of the ilium is used in making anatomical and surgical measurements (i.e., location of the appendix which lies approximately midway between the crest of the ilium and the umbilicus).

FEMUR.—The femur or thigh bone is the longest bone in the body. The proximal end is rounded and has a head supported by a constricted neck which fits into the acetabulum. There are two processes at the proximal end for the attachment of muscles called the greater and lesser trochanters. The neck of the femur located between the head and trochanters is the site most frequently fractured. At the distal

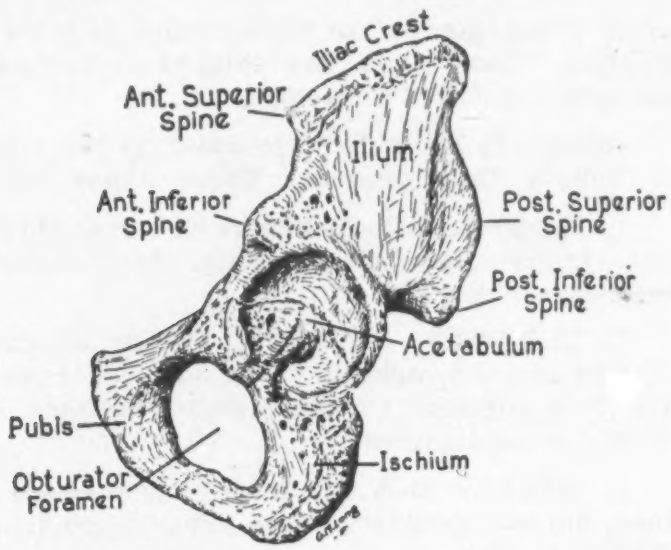

Figure 2-10.—The innominate bone—lateral view.

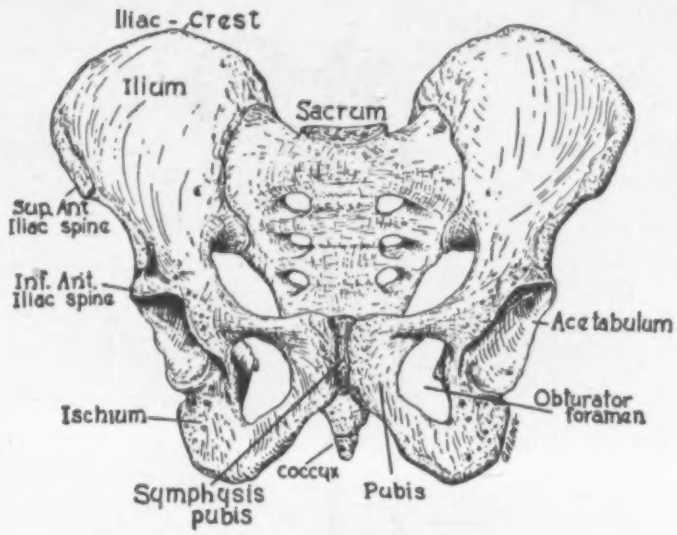

Figure 2-11.—The pelvic girdle.

end are two bony prominences called the lateral and medial condyles. These articulate with the tibia and patella. (See fig. 2-12.)

PATELLA.—This is a small flat, triangular sesamoid bone overlying the knee joint. It is enclosed within the tendon of the quadriceps muscle of the thigh (sesamoid—a small flat bone which develops within a tendon).

TIBIA.—The tibia or shinbone is the larger of the two leg bones and lies at the front and medial side. The proximal end articulates with the femur and fibula. Its distal end articulates with the talus (one of the foot bones) and the fibula. A prominence easily felt on the inner aspect of the ankle is called the medial malleolus. (See fig. 2-12.)

FIBULA.—The fibula, the smaller of the two leg bones, is located on the lateral side of the leg parallel to the tibia. The prominence at the distal end forms the outer ankle known as the lateral malleolus. (See fig. 2-12.)

TARSUS.—The ankle is formed by seven tarsal bones. The strongest of these is the calcaneus or heel bone. The heel bone transmits the body's weight to the grand and acts as a lever for the muscles of the calf. (See fig. 2-12.)

METATARSUS.—The sole and instep of the foot is made up of five metatarsals. They are similar in arrangement to the metacarpals of the hand.

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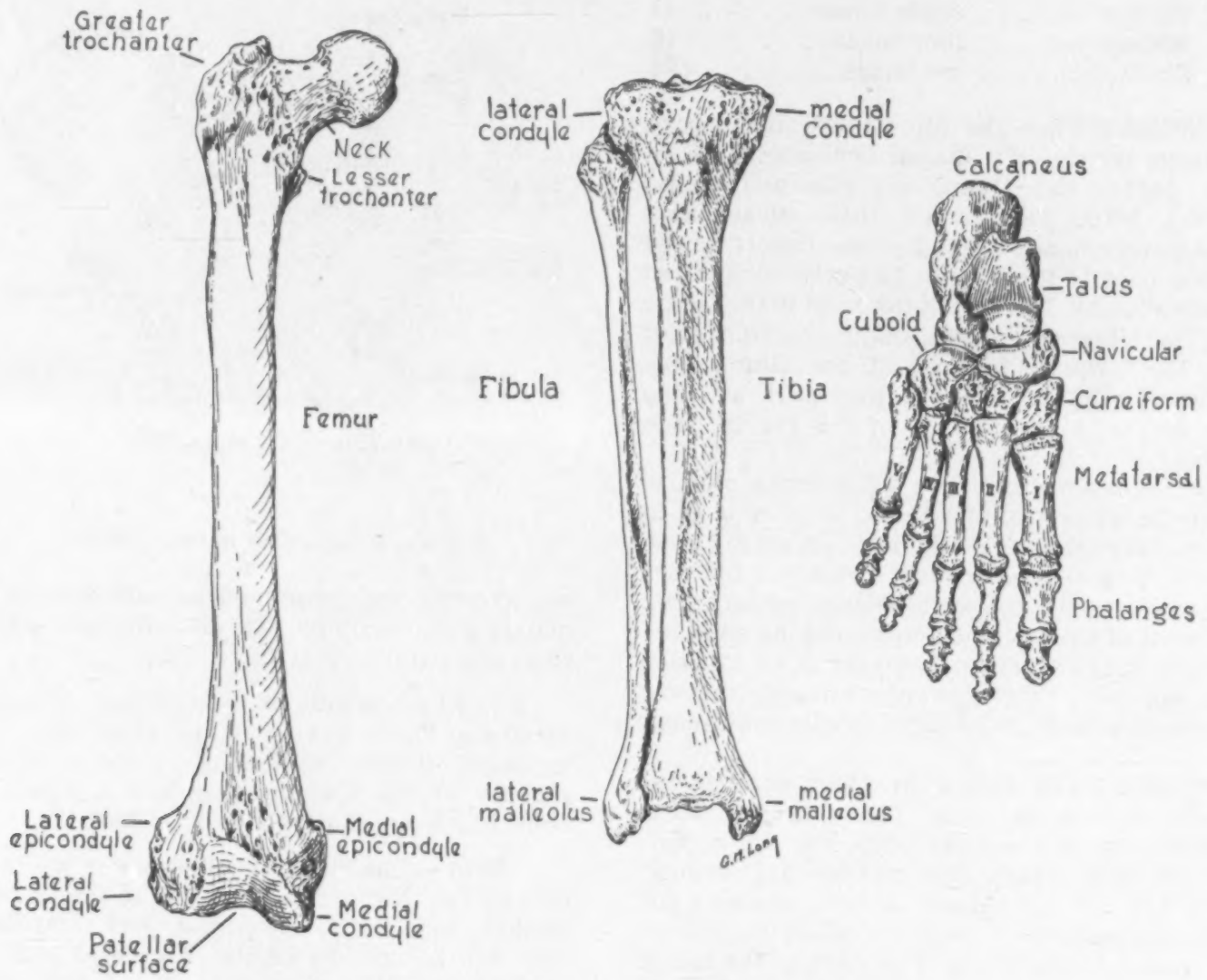

Figure 2-12.—The bones of the lower extremity.

PHALANGES.—These are the bones of the toes and are similiar in number, structure, and arrangement to those in the fingers.

JOINTS

GENERAL.—Arthrology is the study of joints or articulations. Wherever two bones are attached to each other, a joint is formed. In a freely movable joint such as the knee or elbow joint, the ends of the bones are covered with a smooth layer of cartilage. The whole joint is enclosed in a watertight sac or membrane, containing a small amount of lubricating fluid. This enables the joint to work with little friction. The function of the ligaments which reach across the joints from one bone to another keeps them from getting out of place. When ligaments are accidentally torn, we call the injury a sprain; when bones get out of place, there is a dislocation. When bones are chipped or broken, the injury is called a fracture.

Joints are classified according to the type of motion they produce. These types are:

1. IMMOVABLE.—Bones of the skull which are rigidly interlocked along lines called sutures.

2. SLIGHTLY MOVABLE.—Bones of the vertebrae and symphysis pubis, where the bones are held together by broad flattened discs of cartilage and ligaments.

3. FREELY MOVABLE.—Such joints as the knee, hip and shoulder. These joints are further subdivided into:

a. hinge joints . . . . . elbow and knee
b. ball and socket. . . shoulder and hip

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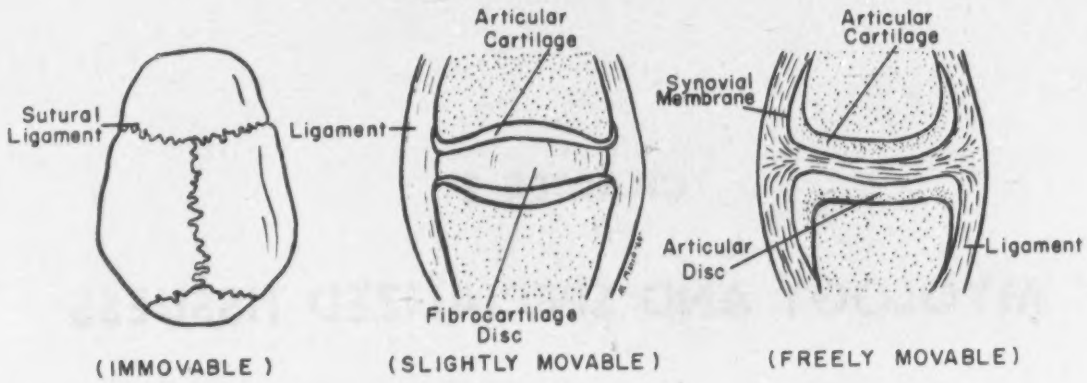

Figure 2-13.—Typical joints.

c. gliding . . . . . wrist and ankle
d. pivot or rotary. . axis rotation about the atlas

JOINT MOVEMENTS.—These movements may be divided into four types:

1. GLIDING is the simplest type of motion. It is one surface moving over another without any rotary or angular motion. This motion exists between any two contiguous or adjacent surfaces.

2. ANGULAR motion decreases or increases the angle between two adjoining bones. The more common types of angular motion are:

a. Flexion.—Bending of the arm or the leg.
b. Extension.—Straightening or unbending, as in straightening the forearm, leg or fingers.
c. Abduction.—Moving an extremity away from the body, as in abducting the arm.
d. Adduction.—Bringing an extremity towards the body, as in adducting the arm.

3. ROTATION is a movement where the bone moves around a central point without being displaced.

4. CIRCUMDUCTION is the movement of hips and shoulders.

Other types of movement include the following, which are generally used to indicate specific anatomical positions.

1. Supination—Turning upward as in placing the hand palm up.

2. Pronation—Turning downward as in placing the hand palm down.

3. Eversion—Turning outward, as in turning the sole of the foot to the outside.

4. Inversion—Turning inward, as in turning the sole of the foot inward.

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a matched hybrid junction, local oscillator signals at the crystals are equal in amplitude and in phase, and echo signals at the crystals are equal amplitude and 180° apart in phase.

The IF components of signals from the crystals are applied in push-pull to ideal transformer T3 and appear across L, C, and R but not across L′, C′, and R′. The IF components of noise, on the other hand, are in effect applied between end terminals of T3 in parallel and appear across L′, C′, and R′, but not across the IF output terminals. Local oscillator noise is thus suppressed completely. Because the RF hybrid junction is matched, the total available power from the echo signal and local oscillator arms divides equally between the two crystals. As in the coaxial line line mixer of figure 12-35, the IF power from each crystal is one-half the available echo signal power times the conversion gain G of the crystal. Since IF power from each crystal is delivered at the IF output terminal, the total IF output is the product of the echo signal power and G, as before.

Ordinarily, in single-ended mixers and in the coaxial line balanced mixer (fig. 12-35), the local oscillator must be loosely coupled to the mixer in order to prevent an appreciable amount of echo signal power from entering the local oscillator circuit. As a result, the local oscillator must generate much more power than is actually needed for mixer operation, the excess power being dissipated in an impedance changing device located in the local oscillator circuit. Because in a hybrid junction mixer the echo signal and local oscillator arms are decoupled, there is no tendency for echo signals to enter the local oscillator circuit, and hence there is no need for loose coupling between local oscillator and mixer. A local oscillator with relatively low power output can therefore be used, the only power necessary being that which is needed to drive the crystals. Actually most local oscillators are capable of generating more than the minimum power required, so that a dissipative attenuator can be inserted in the local oscillator in order to insure a matched termination for the arm. Such an attenuator is desirable, as will be seen later.

Decoupling between echo signal and local oscillator arms also means that there is no tendency for local oscillator power to enter the echo signal arm. Rejection of local oscillator signal by the echo signal arm is particularly advantageous in systems employing a broadband TR device which would allow local oscillator power to pass through and be radiated by the antenna.

Another advantage of the hybrid junction mixer is that its operation is less sensitive to differences in the RF impedance of the crystals than is the balanced coaxial line mixer. Because the two crystal arms are decoupled, any RF power reflected from one crystal cannot reach the other crystal. All the reflected power is directed into the echo signal and local oscillator arms and absorbed by the matched terminations. Thus the amount of RF power delivered to one crystal is independent of the RF impedance of the other.

If a mismatch should exist in either the echo signal or local oscillator arm, a reflection of an RF signal arriving at the mismatched termination will occur, and the signal reflected from the termination will enter the two crystal arms. Under these circumstances, the two crystal arms are not completely decoupled. At the echo signal frequency a mismatch in the echo signal and local oscillator arms is unlikely because in general the TR device provides a matched load for the echo signal arm and, as indicated above, a matching attenuator can normally be inserted in the local oscillator arm.

In general, if the crystals provide an impedance match at the echo signal frequency, they do not yield a perfect match at the local oscillator frequency. This mismatch is unimportant, since the reflected power will be absorbed in the echo signal and local oscillator arms. The attenuator in the latter arm serves to prevent the returned signal from reacting on the oscillator. Should the echo signal arm not provide a matched termination for the returned local oscillator signal, further reflection of the signal will occur and the balance of local oscillator power at the crystals will be further upset. The effect of such an imbalance is to change the conversion gains of the crystals slightly, but usually the change is negligible even with moderate amounts of mismatch at the local oscillator frequency.

Use of the hybrid junction type of IF input circuit shown in figure 12-36 (B) insures suppression of local oscillator noise despite imbalance in the IF impedances of the crystals. When all entries of the IF hybrid junction are terminated in a load that is the conjugate of

CHAPTER 3

MYOLOGY AND SPECIALIZED TISSUESS

MUSCLES

The study of muscles is important because it involves all body movement. Whatever man does in the way of walking, talking, breathing, eating, and even in the circulation of blood is the result of some muscle action.

If you were to remove the skin from the body, you would not see bone. You would see muscles covering the bone. In addition to providing the means of movement, these muscles along with the skeletal bones, provide support and shape.

Muscle comprises from 40% to 50% of total body weight. There are approximately 500 muscles large enough to be seen with the naked eye. There are, however, many thousands of a microscope. The diameter of a single muscle fiber is approximately one-tenth of a micron, much smaller than a strand of hair.

This chapter will discuss the structure, action and location of the more prominent muscles of the body.

Terminology

1. MUSCLE—Tissue or organs which by contraction produce motion.
2. TENDON—A thin strong white cord-like substance connecting muscle to bones.
3. LIGAMENT—A strong non-fibrous band of tissue which holds bone together or organs in place.
4. FASCIA—Fibrous tissue surrounding muscle fibers, keeping them in place during movement.
5. ORIGIN—The more fixed attachment of a muscle: The Fulcrum.
6. INSERTION—The more moveable attachment of a MUSCLE.
7. IRRITABILITY (Excitability)—The property of receiving and responding to stimuli.
8. CONTRACTIBILITY—Property which enables a muscle to become shorter or thicker.
9. ELASTICITY—Property by which muscle returns to its original shape. Ability to stretch.
10. MUSCULAR TONE (Tonicity)—Property which gives muscle a certain firmness and maintains a steady pull upon their attachments.
11. MOTOR NERVE—A nerve which stimulates muscle to contract.
12. RIGOR MORTIS—The stiffening of muscles after death.

Classification

Muscles are classified according to structure. Those of the skeleton are striated (striped), and are called voluntary. These muscles are concerned with voluntary action or thought (arms, legs, face, etc.) The muscles of the viscera are called involuntary, non-striated or smooth. These are the automatic muscles which act without conscious thought. The exception to the rule is the heart muscle—it is a faintly striated, involuntary muscle.

Structure

All muscles are made up of long slender tissue cells called fibers. These muscle fibers are bound together to form the muscle. At one end of some muscles are long white tendons, something like guy wires, which extend to the fingers and feet. This not only makes for graceful movements of the fingers but also reduces the amount of bulk that would be necessary if muscles had extended around the fingers.

Muscles seldom act alone, but usually in muscle groups, and these muscle groups are held together by white fibrous tissue called fascia.

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Action

Muscular action has two distinct mechanisms. One is mechanical, the other chemical. The mechanical action of the muscle is innervated by a motor nerve and consists of a shortening or thickening of the muscle fibers. Muscular action seldom occurs singly. In general, there is action by two muscles, one opposing the other.

The chemical action that takes place is still not clearly understood. In general, this action can be divided into two stages, contraction and recovery. In the contraction stage, two protein substances react to create energy. In the recovery stage, oxygen and glycogen are used to provide energy and react with lactic acid releasing carbon dioxide and water.

When a muscle contracts, it produces chemical waste products (carbon dioxide, lactic acid, and acid phosphate), which make the muscle more irritable. If contraction is continued, the muscle will finally cramp up and refuse to move. This condition is known as fatigue. If it is carried too far, the muscle cells will not recover and permanent damage will result. Muscles, therefore, need rest to allow the blood to carry away the waste materials and bring in fresh glucose, oxygen and protein to restore the muscle protoplasm and the energy that was used.

The importance of exercise for normal muscle activity is clear, but excessive muscle strain is damaging. For example, if a gasoline motor stands idle, it eventually becomes rusty and useless. Similarly, a muscle cell that does not work becomes weak and flabby. On the other hand, a motor that is never allowed to stop and is forced to run too fast or do too much heavy work soon wears out so that it cannot be repaired. In the same way, a muscle cell that is forced to work too hard without proper rest will be damaged beyond repair. Violent exercise is never good. Exercise should be adapted to the individual and should never be carried to the point of extreme fatigue.

During exercise, massage, or performance of ordinary activities, the blood supply of muscles is increased. This brings in fresh food materials, carries away waste products more quickly, and enables the muscles to build up and restore their efficiency and tone.

When a muscle dies, it becomes solid and rigid and no longer reacts. This stiffening which occurs from ten minutes to seven hours after death is called rigor mortis.

Muscular Function

Muscles do three things for us:

1. Provide movement, as in peristalsis in the intestines.
2. Maintain our posture through muscle tone, as in the muscles of the head, neck and shoulders, which keep the head erect.
3. Produce heat. Chemical changes that take place during muscle activity, such as mild exercise on cold days, keep us warm.

Important Functional Muscles

MASSETER.—This muscle raises the mandible or lower jaw to close the mouth. It is the chewing muscle in the mastication of food. It originates in the zygomatic process and adjacent parts of the maxilla, and is inserted in the mandible.

TEMPORAL.—This muscle assists the masseter and draws the mandible backward. It has its origin in the temporal fossa and is inserted in the cornoid process of the mandible.

STERNOCLEIDOMASTOID.—This muscle is located on both sides of the neck, acting as a lever. It acts by pulling the head left or right on the shoulder. Bilaterally, it acts by flexing the head towards the chest or shoulders. It originates in the sternum and clavicle with its insertion in the mastoid process of the temporal bone.

TRAPEZIUS.—A broad diamond shaped pair of muscles on the upper back which raise or lower the shoulders. They cover approximately a third of the back. They originate in a large area, the 12 thoracic vertebrae, 7th cervical and the occipital bone, and have their insertion in the clavicle and scapula.

DELTOID.—Abducts the arm and has its origin in the clavicle and spine of the scapula. Its insertion is on the lateral side of the humerus. It fits as a cap over the shoulder, and is frequent site of intra-muscular injections (1cc or less).

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PECTORALIS MAJOR.—Rotates the arm inwards; abducts and draws the arm across the chest. It originates in the clavicle, sternum and cartilages of the true ribs and the external oblique muscle. Its insertion is found in the greater tubercle of the humerus. It is the prominent chest muscle.

LATISSMUS DORSI.—A broad flat muscle which rotates the arm inward. It covers approximately a third of the back on each side. It arises from the upper thoracic vertebrae to the sacrum and the posterior portion of the crest of the ilium. These fibers converge to form a flat tendon which has its insertion in the humerus.

BICEPS BRACHII.—It flexes the elbow and supinates the hand. In the anatomical position, it is located on the anterior surface of the upper arm. It has its origin in the outer edge of the glenoid cavity and its insertion in the tuberosity of the radius. The brachialis and the triceps are opposing muscles. The triceps is the great extensor of the forearm, while the brachialis is the flexor of the forearm.

DIAPHRAGM.—This muscle, besides being the primary muscle of respiration, forms the floor of the thoracic cavity and the ceiling of the abdominal cavity. It modifies the size of the thorax (chest) and abdomen vertically. It has two large openings—the esophageal and the vena caval. A third opening lies behind the diaphragm, the aortic opening. These openings allow for the passage of nerve and blood vessels.

GLUTEUS MAXIMUS.—It is the large muscle of the buttock. This muscle extends the femur and rotates it outward. It has its origin in several areas; the crest of the ilium, posterior surface of the lower sacrum, and the side of the coccyx. The gluteus maximus is the site of choice for massive intra-muscular injections.

SARTORIUS.—It is the longest muscle of the body, extending obliquely across the thigh anteriorly. It flexes the thigh on the hip and the leg upon the thigh. It also rotates the thigh outward. It is often known as the "tailors muscle."

GRACILIS.—A long slender muscle located on the inner aspect of the thigh. It assists in adducting the thigh and flexing the leg. It originates in the symphysis pubis and has its insertion in the medial surface of the tibia, below the condyle.

BICEPS FEMORIS.—It acts to flex the leg on the thigh and to extend the thigh. It originates from the tuberosity of the ischium and short head of the femur. It has its insertion in the lateral side of the head of the fibula and lateral condyle of the femur. The biceps femoris is often called a hamstring muscle. (The semitendinosus and semimembranosus are also called hamstring muscles. They lie beneath and laterally to the biceps femoris.)

CALF MUSCLES.—The main muscles of the calf are the gastrocnemius and the soleus. The gastrocnemius originates in the heads of the femur and the soleus from the head of the fibula and medial border of the tibia. Both are inserted in a common tendon called the calcaneus or achilles tendon. This tendon has its insertion in the heel or calcaneus bone. These muscles extend the foot at the ankle.

SPECIAL TISSUE

BURSAE

A bursa is a small sac of specialized tissue containing viscid fluid. Bursae are located at various places in the body where friction would ordinarily occur as between skin and bone, tendon or ligament and bone, or between muscles. Bursae may become inflamed (bursitis), and movement then elicits pain. Principal bursae are:

SUBDELTOID BURSA in the shoulder, located between the deltoid muscle and the head of the humerus.

PREPATELLAR BURSA anterior to the kneecap. Inflamation here with formation of fluid, is known as "housemaid's knee" because it occurs frequently in individuals who kneel while scrubbing floors or performing other housekeeping chores.

OLECRANON BURSA between the olecranon process and the skin over the elbow. When inflammed this is known as "tennis elbow", or "student's elbow", the latter because students frequently lean on their elbows for long periods and irritate the fluidfilled sac.

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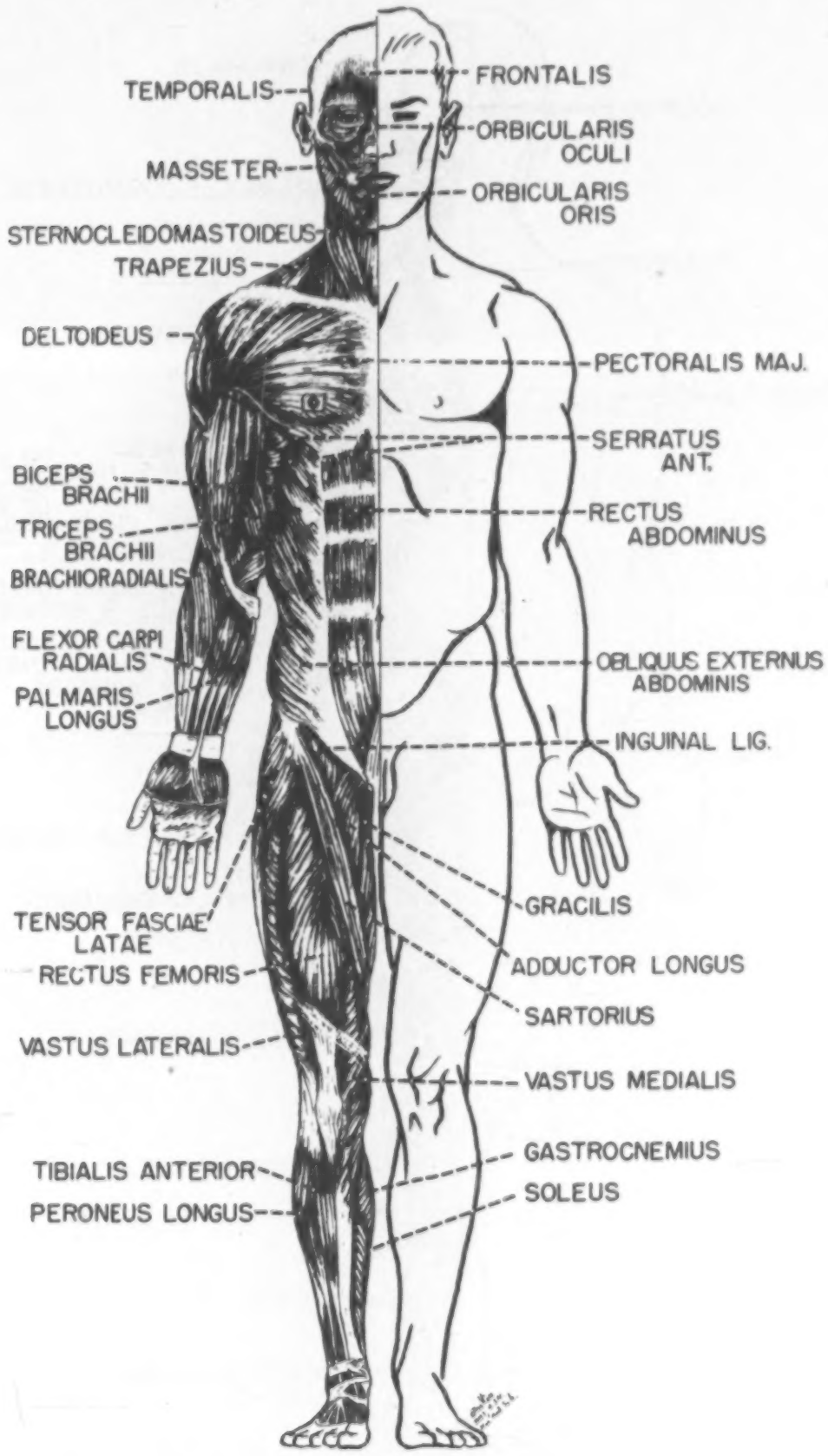

Figure 3-1.—Important superficial muscles, Anterior view.

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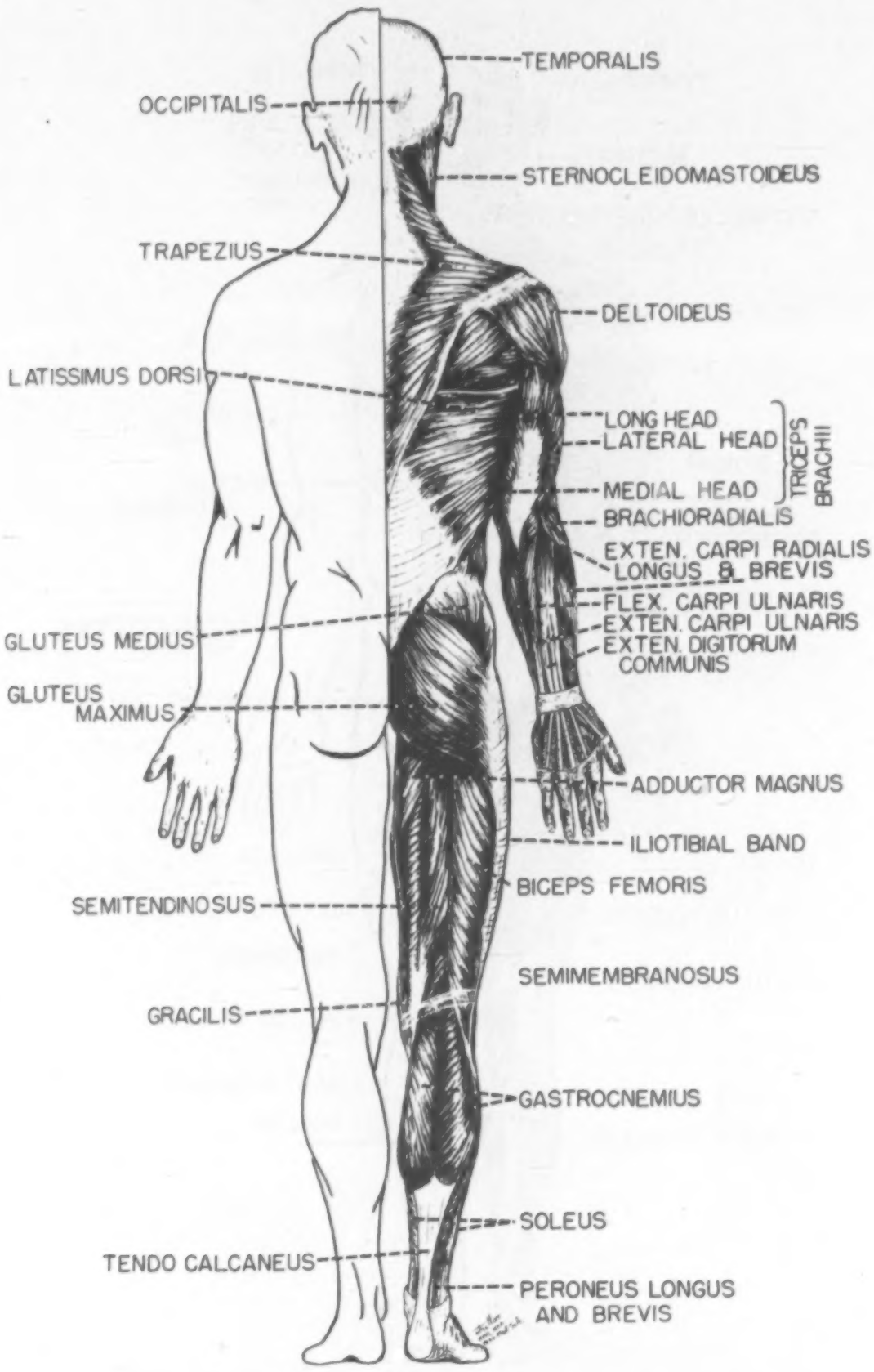

Figure 3-2.—Important superficial muscles, Posterior view.

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SPECIAL MEMBRANES

Lining tissues of the body are termed membranes and are serous, synovial, mucous, or cutaneous.

SEROUS MEMBRANES are so named because they are moistened by a fluid resembling the serum of blood. Serous membranes proper are found in the form of moistened covering of lungs, heart, brain, spinal cord, and organs contained in the abdominal cavity.

SYNOVIAL MEMBRANES are those lining joints; the bursae have a similar lining. These membranes secrete a very small amount of fluid.

MUCOUS MEMBRANES are those lining the canals and cavities of the body which communicate with the air such as the alimentary canal and its branches, the respiratory tract and its connections, and the genitourinary tract.

CUTANEOUS MEMBRANE is the outer covering of the body, the skin. This is the largest organ of the body and important for its protective functions such as sensation and temperature control.

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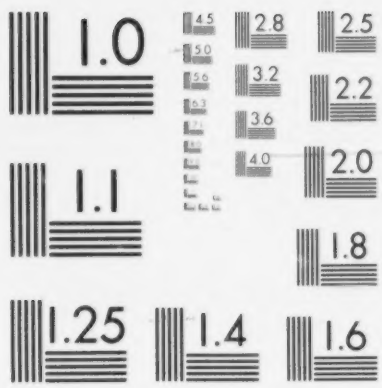

MICROCOPY RESOLUTION TEST CHART

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CHAPTER 4

INTRODUCTION TO THE CIRCULATORY SYSTEM

The blood vascular system is the primary fuel supplier of the body. It is composed of a pump, the heart; feed lines, the arteries; usage points, the capillaries; and waste lines, the veins. The transportation media is the blood. This system in our body is a closed circuit. At no place does it have access to the other tissues of the body except at the capillaries. (See fig. 4-5.)

OSMOSIS, (a transfer of fluids through the cell walls,) is the method of feeding body tissues and eliminating waste materials. This occurs in the smallest of the blood vessels called capillaries.

BLOOD

Blood is very complex liquid. It is a combination of separate particles suspended in a liquid. It is about five times as viscous as water and comprises 1/12 of the body weight. In the average adult, there are approximately 6 quarts of blood. Its color ranges from a bright to dull red, depending on the oxygen content.

The blood functions as the transportation media of the body. It serves many purposes, the most important of which are:

1. Oxygenation
2. Maintains body temperature
3. Aids as a defense against invasion of harmful bacteria
4. Provides transport of nutritive and waste products
5. Maintains normal acid base balance of tissues
6. Provides a defense against bleeding called clotting
7. Acts as a small trucking concern to transport products made in one tissue to another (Hormones and other internal secretions.)

Blood is composed of plasma, red cells, white cells, and platelets.

PLASMA is the fluid portion of the blood in which is suspended discrete particles, the cells and platelets. It is a clear, slightly alkaline, straw colored liquid. It is the total liquid of the blood including Fibrinogen, that portion which contributes to coagulation. Plasma consists of water with proteins, carbohydrates, fats, vitamins, chemicals, hormones, antibodies, and enzymes in solution.

BLOOD SERUM is a clear, pale yellow liquid. It is the liquid portion of the blood remaining after coagulation.

RED BLOOD CELLS, or erythrocytes are circular red saucer like discs with pale center. They contain no nuclei and are formed primarily in the red bone marrow. Blood of the average man contains approximately 30 trillion ($3x10^{12}$) red blood cells or about 5 million per cubic millimeter. Women have slightly less, about 4.5 million per cubic millimeter. Under emotional stress, strenuous exercise, maintained high altitudes, and certain disease conditions, the quantity of red cells is variably increased.

During the development of the red blood cells, a substance called hemoglobin is combined with it. This substance is a combination of heme (an iron containing pigment) and globin (a protein). HEMOGLOBIN is the key of the red cells ability to carry oxygen and carbon dioxide. The red cells deliver oxygen to the body tissues and usually only a fifth to a fourth of the oxygen is released. This is due to the tissues' inability to absorb more. The remainder of the oxygen is held in reserve by the red cells for an emergency. Carbon dioxide is picked up by the same cells and discharged via the lungs.

The color of the red blood cell is determined by the hemoglobin content. Bright red or arterial blood is due to the combination of oxygen and hemoglobin. Dark red or venous blood is the result of hemoglobin combining with carbon dioxide.

The life span of a red blood cell is about 100 to 120 days. The spleen is the "graveyard" where old, worn out cells are removed from the blood stream.

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The red blood cell is dependent upon a normal concentration of salts in the blood. Any variation from this normal will cause the cell to become more fragile.

The amount of various salts and substances dissolved in the blood plasma is about nine-tenths of 1 percent (0.9 percent). A solution of this strength is called ISOTONIC or PHYSIOLOGIC. It has the same osmotic pressure (a pressure which brings about equalization of solutions of different concentrations) as blood plasma and tissue fluid.

Solutions of a lower concentration of blood plasma (hypotonic) when rapidly introduced into the blood stream cause the red blood cells to absorb the water from the plasma (hydrolyzed). This causes them to swell and eventually burst, liberating the hemoglobin. The introduction of a higher concentration (hypertonic) will cause them to shrink and become notched (crenated).

Glucose solutions are frequently given in higher concentrations, 5 and 10 percent or more. But because they are given at a slow rate, the blood plasma does not undergo rapid change and can compensate rapidly. This is accomplished by the transfer of water from the tissues into the blood stream and the red cells suffer no change.

WHITE CELLS vary in size and are called leukocytes. There is about 1 white cell to every 600 red cells. The normal adult has a white count from 6 to 8 thousand per cubic millimeter. This will often rise to 10,000 with exercise, strenuous activity, cold baths, and even digestion. (This is thought to be caused by the increased circulation of the body).

White cells can be divided into three distinct types; granulocytes, lymphocytes, and monocytes. The lymphocytes are manufactured in the lymph tissue, while the granulocytes are thought to be manufactured in the red bone marrow. The monocytes are found in the reticular tissue of the liver, spleen and lungs.

White cells have a movement that is called AMEBOID which permits them to leave the blood stream through the capillary wall and attack pathogenic bacteria. They can travel anywhere in the body and are often named "the wandering cells".

White cells function as regulators. They protect the body from disease-bearing bacteria. They accomplish this by engulfing the foreign body, a condition called phagocytosis. When they are undermanned, more are produced causing an increase in the number of white cells, and a condition known as leukocytosis exists. Another way they protect the body from disease is by the production of bacteriolysins which dissolve the foreign bacteria. The second most important function is that of aiding in blood clotting.

BLOOD COAGULATION.—To protect the body from excessive blood loss, blood has its own power to coagulate or clot. Under conditions wherein blood constituents and linings of vessels are normal, circulating blood will not clot. Once it escapes from its vessel, however, a chemical reaction begins which causes it to solidify. The clot formed is at first fluid but soon becomes thick and then "sets" into a soft jelly (much the same way jello sets), which soon becomes firm enough to act as a plug. This plug is the result of a swift, sure reaction which changes one of the soluble proteins, (Fibrinogen), into a insoluble protein, (fibrin), whenever injury occurs.

In addition to Fibrinogen, other necessary elements for clotting are calcium salts, a substance called prothrombin, blood platelets, and various factors which are necessary for the completion of the successive steps in the coagulation process. Once the fibrin plug is formed, it quickly enmeshes the red and white cells and draws them tightly together. As the mass shrinks and the clot forms, a yellowish clear liquid called blood serum is squeezed out. This clot also serves as the network for the growth of new tissues in the process of healing.

Normal clotting time is 3-5 minutes. If any of the necessary clotting substances are missing, severe bleeding will ensure.

Hemophilia is an inherited disease characterized by delayed clotting of the blood and consequent difficulty in controlling hemorrage. It occurs mainly in the male species.

CIRCULATORY SYSTEM

The circulatory system is comprised of the heart and blood vessels. The heart, a muscular pump, propels the blood through the blood vessel system of closed tubes, composed of arteries, capillaries, and veins.

Heart

The heart is a hollow organ somewhat larger than the closed fist, located anteriorly in the chest to the left of center, and is the major

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structure of the mediastinum. Somewhat cone-shaped, the apex of the heart is directed downward and to the left. Lying obliquely in the chest, much of the base of the heart is immediately posterior to the sternum.

The heart is enclosed in a membranous sac, the pericardium. The smooth surface of the heart and pericardium are lubricated by a serous secretion, pericardial fluid. The inner surface of the heart is lined with a delicate serous membrane, ENDOCARDIUM, similar to and continuous with that of the inner lining of blood vessels.

The interior of the heart is divided into two parts by a septum. In each half there is an upper chamber, the atrium, which receives blood from the veins; and a lower chamber, the ventricle, which receives blood from the atrium and pumps it out into the arteries. The opening between the chambers on each side are supplied with one-way or check valves which prevent the backward flow of the blood stream. The right valve is called the tricuspid and the left valve is the mitral. The outlets of the ventricles are supplied with similar valves. On the right, the pulmonary valve is at the origin of the pulmonary artery and on the left, the aortic valve at the origin of the aorta. (See fig. 4-1.)

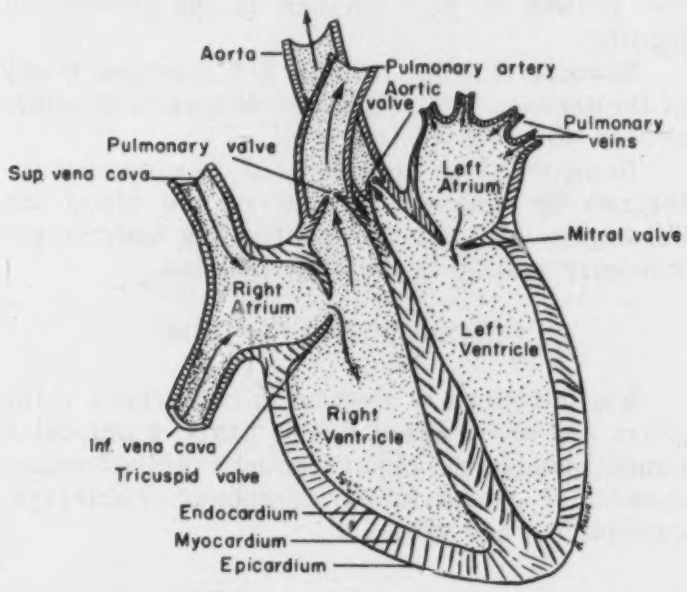

Figure 4-1.—Diagram of the heart.

Physiologically, the heart acts as two separate pumps. The right side receives the deoxygenated blood in the right atrium from the various regions of the body. It passes through the tricuspid valve into the right ventricle where it is pumped through the pulmonary artery via the pulmonary valve to the lungs. There it receives a fresh supply of oxygen and releases carbon dioxide. As it passes into the left atrium from the pulmonary veins, the pulmonary circulation is completed. The left side receives oxygenated blood from the lungs into the left atrium via the pulmonary veins and passes via the mitral valve into the left ventricle, which pumps it into all the body areas through the arteries. This is called systemic circulation.

The heart acts by contraction and relaxation. When the heart contracts it is with a wringing motion forcing the blood into the arteries. Each contraction of the heart is followed by limited relaxation or dilation. Cardiac muscle never completely relaxes but always maintains a degree of tone. Contraction of the heart is systole and is the period of work. Relaxation of the heart with limited dilation is diastole, and is the period of rest. A complete cardiac cycle is the time from the onset of one contraction or heart beat to the onset of the next.

During the cycle, the blood coursing through the valves and chambers of the heart produce sounds, conveyed to the ears of the physician by means of a stethoscope. Variations in the rhythm, intensity, or character of these sounds furnish valuable clues for the determination of heart disease.

The heart has its own blood vessel system. The right and left coronary arteries which arise from the aorta immediately as it leaves the heart; and the coronary sinus, which collects the venous blood from the heart and empties it directly into the right atrium.

The normal heart rate is about 72 beats per minute. This varies with age, weight, sex, amount of exercise and body temperature. It beats about 100,800 times a day. Blood Pressure is the force exerted by the blood within the closed hydraulic system of arteries. It is the result of five factors:

1. The pumping of the heart.
2. The peripheral resistance to the circulating blood.
3. The quantity of blood in the system.
4. The viscosity of the blood.
5. The elasticity of the arterial walls.

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the impedance faced by the load, the two crystals (constituting one pair of entries) are decoupled and the two resonant circuits (constituing the other pair) are also decoupled. If the resonant load entries remain matched, the amount of IF signal power coupled from one crystal to the output terminals is independent even if the IF impedance of the other crystal does not match the arms. Furthermore, the IF components of noise cancel in the output circuit independently of the IF crystal impedance as long as the crystals develop equal IF noise voltage. The IF components of noise appear only across the L′, C′, and R′ arm. If crystals are tested for equal conversion gains while loaded by the conjugate of the IF impedance of a typical crystal, equal IF noise voltages can be expected when the crystals are employed in the circuit.

Terminating the IF output entry in a matched load does not in general insure minimum noise figure. Mismatching the output entry in order to minimize the noise figure alters the load the push-pull IF echo signals and thus reduces the echo signal power delivered to the load but does not alter the load for the IF components of noise which are applied to T3 in parallel. The local oscillator noise suppression property of the mixer is therefore retained.

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The highest pressure is called systolic blood pressure because it is caused when the heart is in systole, or contraction. A certain amount of blood pressure is maintained in the arteries even when the heart is relaxed. This is the diastolic blood pressure, because it is present during diastole, or relaxation of the heart. The difference between systolic and diastolic pressure is known as pulse pressure.

Normal blood pressure for young adults; systolic 120-150 mm of mercury; diastolic 70 to 90 mm of mercury. This varies according to weight, age, and general condition of the individual. Females have a lower blood pressure than males.

Blood Vessels

Blood vessels of the body fall into three distinct classifications.

1. Distributors—Arteries and arterioles
2. Exchangers—Capillaries
3. Collectors—veins and venules

ARTERIAL CIRCULATION (BODY'S BLOOD SUPPLY.—The system of arteries and arterioles is similar to that of a tree, with the aorta as the trunk, the arteries as large branches and the arterioles as small twigs.

ARTERIES are elastic tubes, constructed to withstand high pressures. The smallest branches of the arteries are called arterioles.

The aorta is the largest tube-like structure which arises from the left ventricle of the heart and arches upward over the left lung and then down along the spinal column through the diaphragm. Along the way, arteries branch off to the head, neck, arms, chest and abdomen before finally dividing to send arteries down both legs. (See fig. 4-2.)

The only branches of the ascending aorta are the coronary arteries which supply the heart with blood.

There are certain branches of the aorta with which you should be familiar, since these often must be compressed to control hemorrhage. In the first chapter on first aid you will learn the pressure points which must be compressed if severe arterial hemorrhage is to be controlled.

Three large arteries arise from the aorta as it arches over the left lung. First, the innominate artery which divides into the right subclavian artery, to supply the right arm and the right common carotid to supply the right side of the head. The second branch is the left common carotid which supplies the left side of the head. The third branch from the arch of the aorta is the left subclavian, which supplies the left arm.

The carotids divide into internal and external branches, the external supplying the muscle and skin of the face; the internal supplying the brains and the eyes.

The subclavian arteries are so named because they run underneath the clavicle. They supply the upper extremity branching off to the back, chest, neck, and brain via the spinal column. (See fig. 4-2.)

The large artery going to the arm is called the axillary. This divides into the ulnar and radial arteries. The radial artery is the one at the wrist which you feel to take the pulse of your patient. It is located on the thumb side. (See fig. 4-3.)

The abdominal aorta gives off branches to the abdominal viscera, including the stomach, liver, spleen, kidneys and intestines. It finally divides into the left and right common iliacs which send large arteries to the lower extremities. On entering the thigh, the artery is called the femoral artery, and here again, on the inner aspect of the thigh, is a pressure point (the groin) that you should learn. This artery is frequently injured in fracture accidents and must be compressed to control hemorrhage. (See fig. 4-4.)

At the knee, the femoral becomes the popliteal. It is located posteriorly and can be compressed against the tibia or lower end of the femur.

CAPILLARIES.—At the end of the arterioles is a system of minute vessels which vary in structure, but which are spoken of collectively as capillaries. It is from these capillaries that the tissues of the body are fed. (There are approximately 60,000 miles of capillaries in the body). As the blood passes through the capillaries it releases oxygen and nutritive substances to the tissues and takes up various waste products to be carried away by the veins.

VEINS comprise a system of vessels which collect blood from the capillaries and carry it back to the heart. Veins begin as tiny venules which are formed from the capillaries. Joining together as tiny rivulets, they connect and form a small stream. The force of muscles contracting adjacent to veins aids in the forward propulsion of blood on its return to the heart. Valves, spaced frequently along the larger veins, prevent the backflow of blood.

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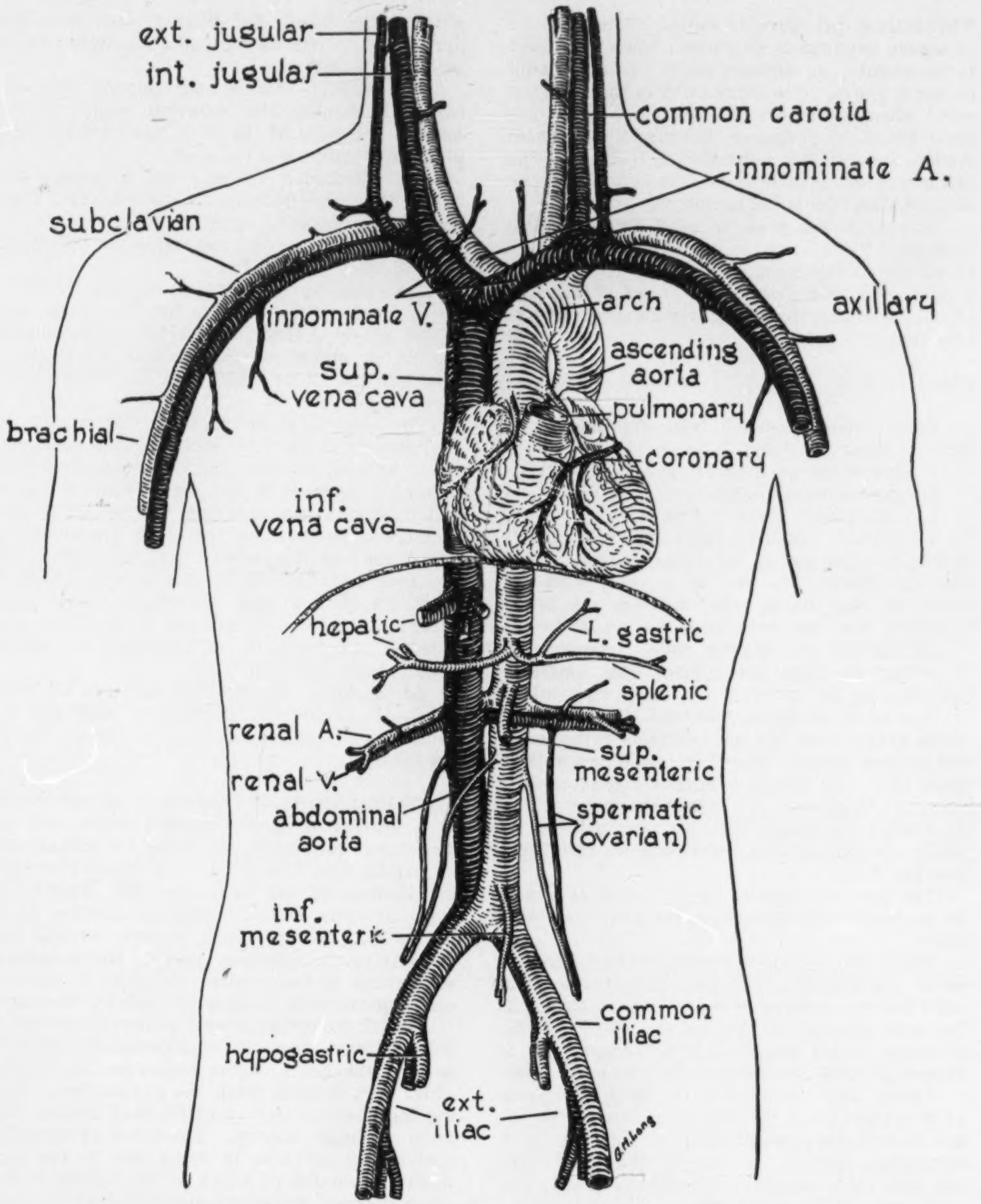

Figure 4-2.—Arteries and veins of torso.

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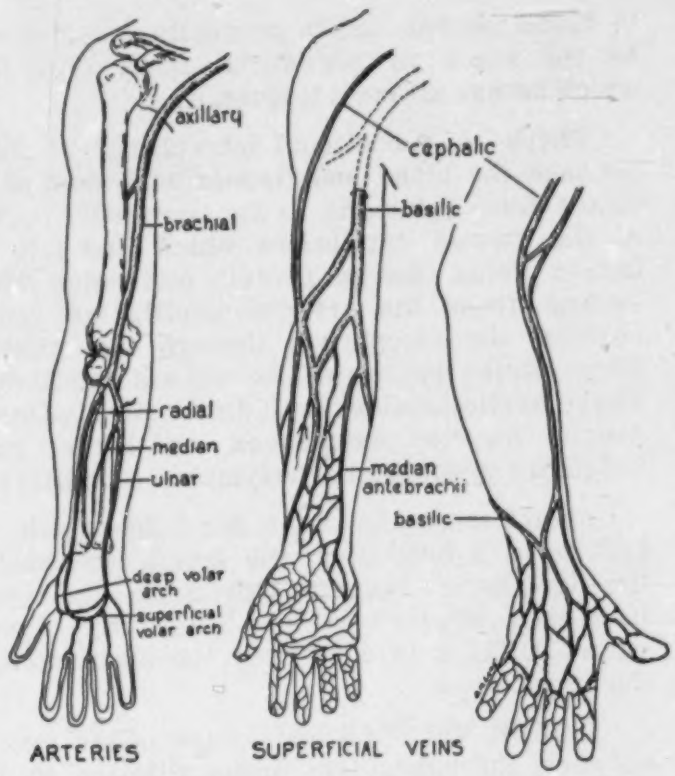

Figure 4-3.—Arteries and veins of the upper extremity.

BLOOD COLLECTION SYSTEMS (Venous circulation).—Since arterial blood arises at the heart, we trace arteries from the heart. To return blood to the heart, we trace veins from their smaller extremities called venules back through larger veins. There are three principal venous systems in the body:

1. Pulmonary . . those from the lungs
2. Portal . . returns blood from the intestines, spleen and liver
3. Systemic . . those from the rest of the body.

The PULMONARY SYSTEM is comprised of four vessels, two from each lung, which empty into the left atrium. These are the only veins in the body that carry freshly oxygenated blood.

The PORTAL SYSTEM is comprised of those veins which drain venous blood from the abdominal part of the digestive tract (except the lower rectum), spleen, pancreas, and gallbladder, and deliver it to the liver. There it is distributed within the liver by a set of venous capillaries. The blood in the portal system conveys absorbed substances from the intestinal tract to the liver for storage, alteration, or detoxification. From the liver the blood flows through the hepatic vein to the inferior vena cava.

The SYSTEMIC SYSTEM is divided into deep and superficial groups. The superficial veins lie immediately under the skin and drain the skin and superficial structures. The deep veins, usually located in the muscle or deeper layers, drain the large muscle masses and various other organs. They usually lie in close relation to the large arteries which supply the various organs of the body, (see fig. 4-2) and usually have the same name as the artery they accompany.

The superficial veins of the head unite to form the external juglar veins. They drain blood from the scalp, face, and neck, and finally empty into the subclavian veins.

The veins which drain the brain and internal facial structures are the internal jugular veins. These combine with the subclavian veins to form the innominate veins which empty into the superior vena cava. (Fig. 4-2.)

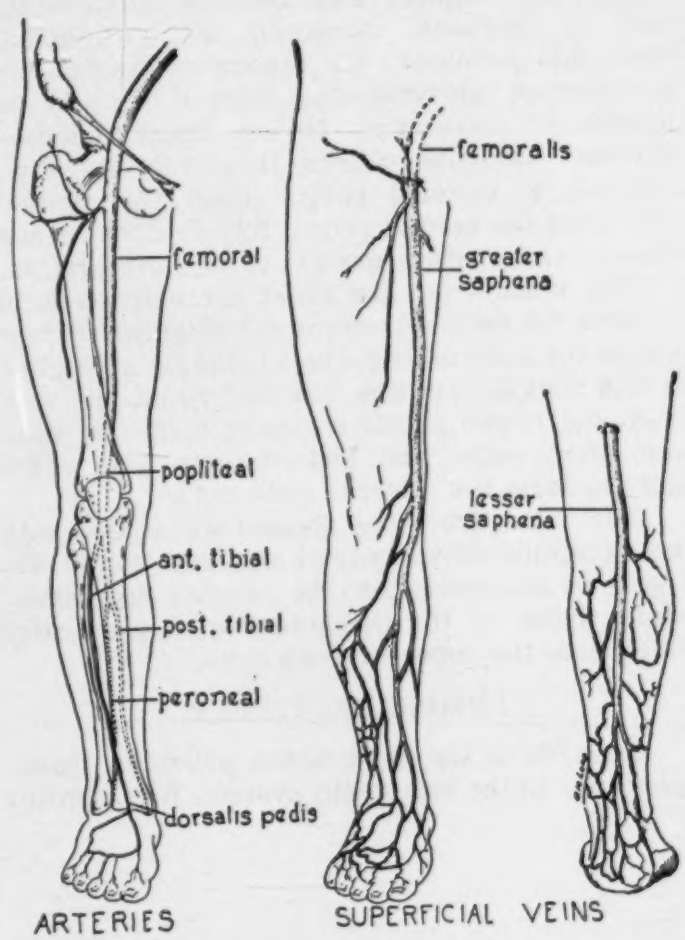

Figure 4-4.— Arteries and veins of the lower extremity.

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The veins of the upper extremity begin at the hand and extend upward. There is one vein, extremely valuable, the median cubital, which crosses the anterior surface of the elbow. It is the vein most commonly used for intravenous injections and infusions.

The deep veins of the upper arm unite to form the axillary vein in the upper arm, which unites with the superficial veins to form the subclavian vein. This later unites with other veins to form the innominate and eventually, after union with still more veins, forms the superior vena cava.

In the lower extremity (fig. 4-4), a similar system drains the superficial areas. One in particular, the great saphenous vein, originates on the inner aspect of the foot and extends up the inside of the leg and thigh to join the femoral vein in the upper thigh. This vein is sometimes used for intravenous injections at the ankle. The superficial venous system of the leg often becomes varicose or excessively dilated, particularly in those persons whose occupations require long periods of standing, such as barbers, surgeons, and policemen. When this develops, the venous valves become incompetent, allowing stagnation of blood in the dependent extremity. Under these circumstances, varicose ulcers frequently develop. Ligation at several points along the system will force the venous return into the deep venous system and restore normal venous circulation.

The veins from the lower extremities unite to form the femoral vein in the thigh which becomes the external iliac vein in the groin. Higher in this region, it unites with the hypogastric vein from the lower pelvic region to form the common iliac vein. The two common iliac veins unite to form the inferior vena cava.

The veins from the abdominal organs, with the exception of the portal system, empty directly or indirectly into the inferior vena cava, while those of the thoracic region eventually empty into the superior vena cava.

LYMPHATIC SYSTEM

LYMPH is the fluid which provides transportation in the lymphatic system. It is similar to blood plasma and is generally considered to be the same as interstitial fluid. (The fluid which bathes all body tissues.)

There is a continual interchange of fluids between the blood and tissues with most of the tissue fluid returning to the circulation by way of the venous capillaries which feed into the larger veins. Large protein molecules which escape from the arterial capillaries cannot reenter the circulation through the smaller intracellular spaces of the venous capillaries. These particles along with dead cells, bacterial debris, injected substances, and larger particles are absorbed by the lymphatic capillaries.

Lymph is usually clear, but following the ingestion of a fatty meal the lymph contained in the lymphatic vessels that drain the small intestines appears milky. This milky lymph called CHYLE is caused by the absorption of the fat globules.

LYMPH VESSELS and lymph nodes form a network throughout the body. Similar to the venous system, lymphatic capillaries collect lymph from the tissue spaces and, by means of a system in which small vessels unite to form larger ones, carry the lymph toward the heart. Along the paths of the larger lymphatic vessels are valves which prevent the backflow of fluid.

Lymphatic channels from the upper half of the right side of the body converge to form the right lymphatic duct which empties into the right subclavian vein. Drainage from the rest of the body is by way of the thoracic duct, the largest lymphatic vessel, which empties into the left subclavian vein.

LYMPH NODES are small bean-shaped bodies of lymphatic tissue found in groups of 2 to 15 along the course of the lymph vessels. Just beneath the skin, they usually occur singly. Nodes vary in size and act as filters to remove bacteria and particles from the lymph stream. Lymph nodes also participate in the manufacture of white blood cells called lymphocytes, and thereby participate in the immunity functions of the body.

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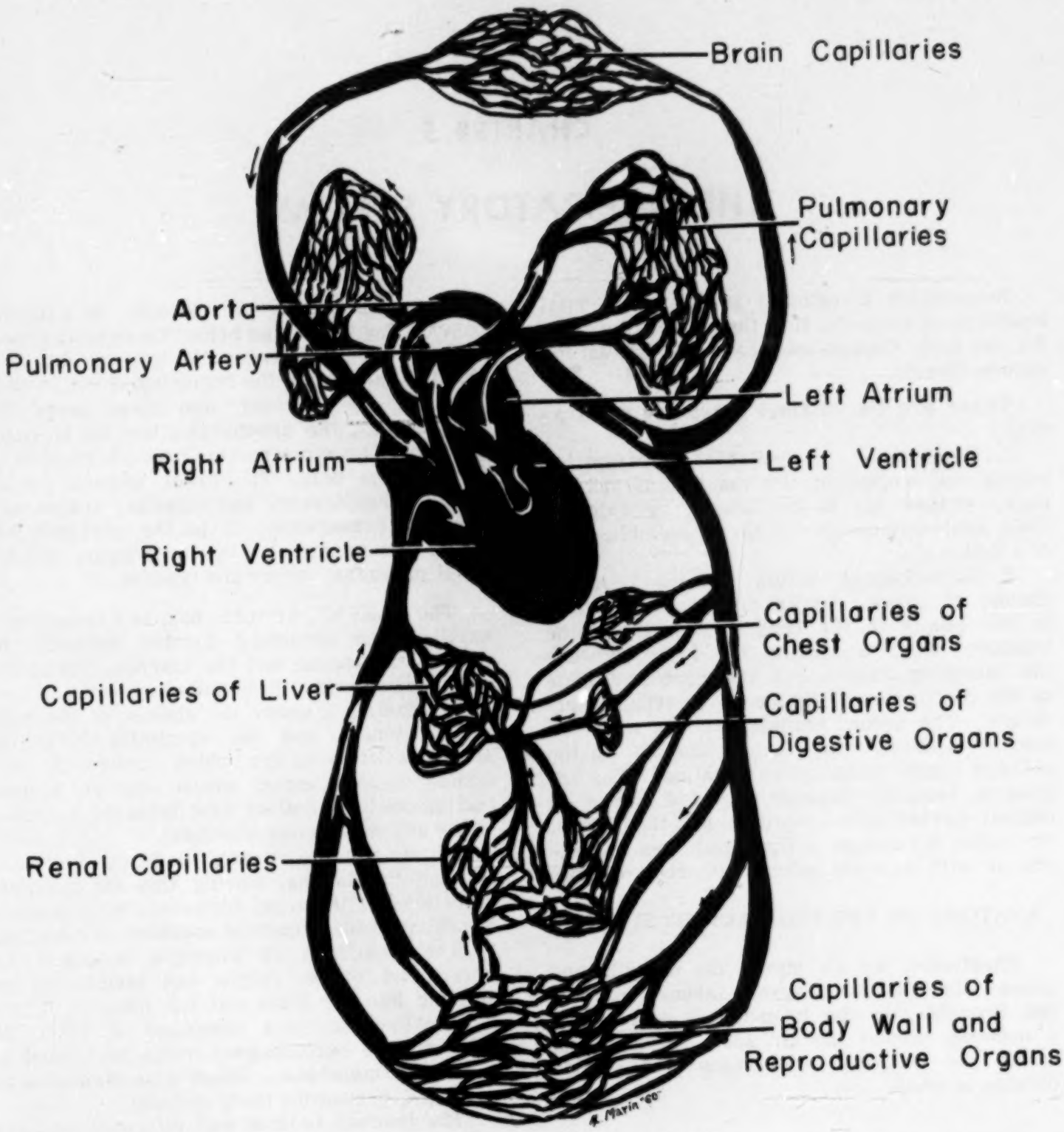

Figure 4-5.—Schema of circulation.

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CHAPTER 5

THE RESPIRATORY SYSTEM

Respiration (breathing) is one of the vital functions of the body. It is the source of oxygen for the body tissues and the main exhaust for carbon dioxide.

There are two distinct phases of respiration;

1. Physical or mechanical respiration involves the motion of the diaphragm and rib cage, causes air to be inhaled or exhaled. This skeleto-muscular action resembles that of a bellows.

2. Physiological action involves an exchange of gases, oxygen and carbon dioxide, at two points in the body. The first is the transfer which occurs in the lungs between the incoming oxygen and the carbon dioxide in the capillaries of the lungs (external respiration). The second transfer occurs when the oxygen replaces the carbon dioxide in the cellular tissue (internal respiration). The degree of transfer depends upon the amount of oxygen carried by the capillaries to the tissues. Normally, the oxygen in the capillaries will exchange with an equal volume of carbon dioxide.

ANATOMY OF THE RESPIRATORY SYSTEM

Physically, the air enters the nostrils and passes through the pharynx, larynx, trachea, and bronchi into the bronchioles which form a network around the air sacs called alveoli where the exchange of oxygen and carbon dioxide is made.

NASAL CAVITY.—The air enters the nasal cavity thru the nostrils or nares. Lining the nasal passages are hairs (cilia), which together with the mucous membrane entrap and filter out dust and other minute particles. In the chambers of the nasal cavity, the air is warmed and moistened.

The PHARYNX, or throat, is a tubular passageway which lies behind the nasal passages and the mouth, between the base of the skull and the larynx and the beginning of the esophagus. It is divided into three parts: the nasopharynx, the oropharynx, and the laryngopharynx. The upper portion (nasopharynx) is an air passage only. The lower portion serves both the respiratory and digestive tracts as a common passageway; it is the corridor between the mouth and the esophagus, and the nasal passages, larynx and trachea.

The LARYNX, or voice box, is a triangular, cartilaginous structure located between the root of the tongue and the trachea. During the act of swallowing, it is pulled upward and forward placing it under the shelter of the base of the tongue and the epiglottis (a lidlike structure of cartilage which covers the entrance to the larynx) which acts as a protecting shelf to deflect food from the entrance of the air passageway (trachea).

All air going to or from the lungs must pass through the larynx. During this air passage, vibrations of the vocal cords may be produced, resulting in the sounds of speaking and singing.

The TRACHEA, or windpipe, begins at the lower end of the larynx and terminates by dividing into the right and left bronchi. It is a long cylindrical tube composed of 16 to 20 "C" shaped cartilinagous rings embedded in a fibrous membrane. These give firmness to the walls, preventing their collapse.

The trachea is lined with microscopic waving hairs (cilia) and mucous glands. The cilia entraps dust and foreign material and also propels secretions and exudates from the lungs to the mouth where they can be expectorated.

The BRONCHI are the terminal branches of the trachea which carry the air through their bronchioles to the alveoli. (See fig. 5-2.)

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chest to return to normal and original size thus expelling the air from the lungs.

The lungs, when filled to their full capacity, hold about 4,500 cc. of air but only 500 cc. of air is breathed out at a normal quiet expiration. This air that is changed with each respiration is called tidal air. The amount of air that is breathed out or in may be increased by forceful expiration and inspiration. The amount of air left in the lungs after forceful expiration is about 1,000 cc., and is known as residual air. Under normal conditions the reserve supply of air left in the lungs is about 2,600 cc.

Certain sounds are produced by passage of air into and out of the lungs. These sounds vary in diseases of the lungs. Doctors depend upon these sounds of the lungs during respiration to diagnose pneumonia, bronchiectasis, and other diseases of the lungs.

ABNORMALITIES OF BREATHING

The following terms are used to describe breathing and *significant variations in exchanges* of respiratory gases:

Eupnea — Ordinary quiet respiration.

Brandypnea — Abnormal slowness of breathing.

Tachypnea — Excessive rapidity of respiration.

Hypopnea — Abnormal shallowness and rapidity of respiratory movements.

Dyspnea — Labored or difficult breathing.

Hyperpnea — Applies to the initial state of dyspnea when the rate and depth of respiration is simply being increased.

Apnea — A condition in which there is a temporary cessation of breathing.

Cheyne-Stokes — The respirations increase with force and frequency up to a certain point, and then decrease until they cease altogether. There is a short period of apnea; then the respirations begin again, and the cycle is repeated.

Stertorous — Breathing with abnormal snoring sounds.

Rales — Abnormal respiratory sounds, either moist or dry depending upon the fluid in the air passages, which are classified according to their location as bronchial rales, laryngeal rales.

Rhonchus — A rattling sound in the throat due to partial obstructions; also a dry course rale in the bronchial tubes.

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CHAPTER 6

ELEMENTARY FUNCTION AND DESCRIPTION OF THE DIGESTIVE SYSTEM

The digestive system consists of the alimentary tract — mouth, esophagus, stomach and intestines - plus the accessory organs of digestion. As food passes along the alimentary tract digestion and absorption occur and eventually waste material is eliminated. Secretions of the accessory organs assist in preparing food for absorption and use by the tissues of the body.

Digestion is both mechanical and chemical. Mechanical digestion occurs when food is mechanically chewed, swallowed and churned by peristalsis. Waste is evacuated when the bowels move. Chemical digestion consists of changing the various foods, with the aid of enzymes, into solutions and simple compounds. Carbohydrates (starches and sugars) change into simple sugars (glucose); fats change into fatty acids; and proteins change into amino acids.

The ALIMENTARY CANAL is about 30 feet long and is divided into eight parts or sections:

- Mouth cavity
  - Teeth
  - Tongue
- Pharynx
- Esophagus
- Stomach
- Small intestines
  - Duodenum
  - Jejunum
  - Ileum
- Large intestines
  - Cecum
  - Ascending Colon
  - Transverse Colon
  - Descending Colon
  - Sigmoid Colon
- Rectum
- Anus

ACCESSORY ORGANS that aid the digestive process are:

- Salivary glands
- Pancreas
- Liver
- Gall bladder
- Intestinal glands

Mouth Cavity

The TEETH break up the food into small particles before it is swallowed. Here the salivary glands secrete saliva to aid in the digestion of the sugar and starches. Approximately 1500 milliliters or 1 1/2 quarts are secreted daily. This secretion moistens the food, makes it easier to chew, and lubricates the food mass to aid in swallowing. Saliva contains one principle enzyme, ptyalin which begins the digestion of starches by changing them into a complex sugar, maltose.

The TONGUE is a muscular organ attached to the lower jaw at the back of the mouth and is the chief organ of taste. It assists in mastication, swallowing, and speech.

The Pharynx

The pharynx is the passageway between the mouth and the esophagus and is shared with the respiratory system.

The Esophagus

The Esophagus is a muscular tube about 25 centimeters (10 inches) long. It is the passageway between the pharynx and the stomach. By means of waves of muscular contractions (peristalsis), food is pushed along this tube to the stomach. When peristalsis is reversed vomiting occurs. Vomiting occurs with overeating, intestinal disease and certain toxic drug reactions.

The stomach and intestines are enclosed in the space between the diaphragm and the pelvis, called the abdominal cavity. This cavity is lined with serous membrane, the peritoneum. The peritoneum covers the intestines and the organs, and by secreting a serous fluid prevents friction between the adjacent organs. Layers of peritoneum that extend from the body wall to an organ and suspend it are called mesentery. The mesentery carries blood vessels to the organs.

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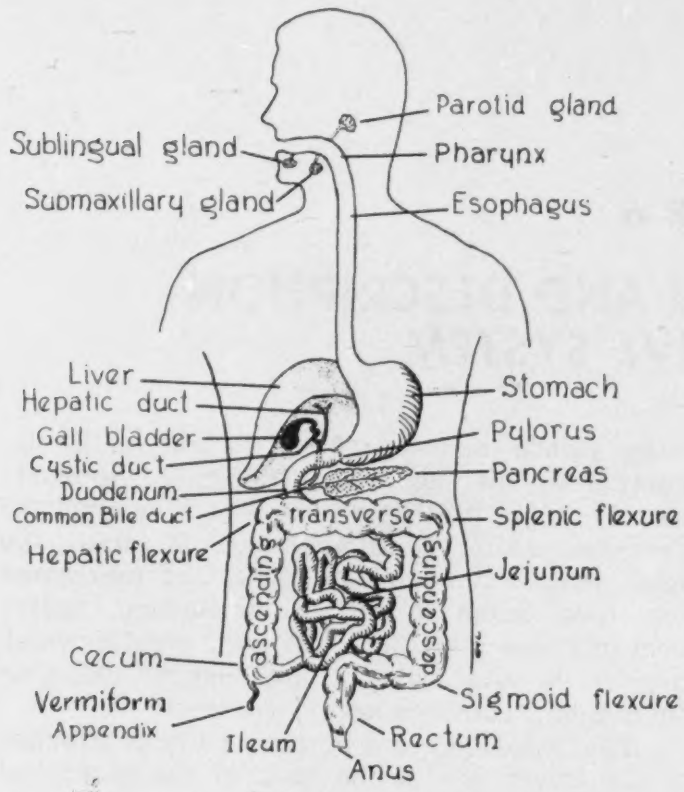

Figure 6-1.—The digestive system.

The Stomach

The stomach is an enlargement of the gastro-intestinal tract and is somewhat bean-shaped. It is connected to the esophagues via the cardiac sphincter and to the small intestine via the pyloric sphincter. These sphincters are muscular rings or valves to prevent the escape of food during the stomach's stage of digestion.

The stomach is the warehouse for swallowed materials. It assists in the chemical change of food materials. Small glands in the walls of the stomach secrete gastric juices. Pepsin and hydrochloric acid are the principal components of the gastric juice. Hydrochloric acid inhibits the action of ptyalin, tends to kill bacteria as it enters the stomach and releases pepsin from pepsinogen. It also helps to regulate the action of the pyloric sphincter. Pepsin acts solely on proteins changing them into simpler substances. As the food is refined in the stomach it becomes semi-liquid (chyme). Normally after the first hour the stomach is half empty, and after the sixth hour the entire meal has emptied through the pyloric sphincter into the small intestine.

Small Intestines

The small intestine is a muscular convoluted tube about twenty three feet long, attached to the posterior abdominal wall by its mesentery. The mesentery is gathered together like a fan to allow the intestines to coil in a small space. The small intestines receives digestive juices from three accessory organs: pancreas, liver and gall bladder. It is divided into three continuous parts: duodenum, jejunum, and ileum.

The DUODENUM is a tube about ten inches long which forms a C-shaped curve around the head of the pancreas, posterior to the liver. It is lined with mucous membrane which contains small glands. These glands secrete intestinal juices containing the enzymes: carbohydrases, peptidases and lipase.

The JEJUNUM is the middle part of the small intestines, about seven and one-half feet long, and its enzymes continue the digestive process.

The ILEUM is the last and longest part of the small intestines. Most of the absorption of food occurs in the ileum where fingerlike projections (villi) provide a large absorption surface. After injestion it takes twenty minutes to two hours for the first portion of the food to pass through the small intestines to the beginning of the large intestines.

Large Intestines

The unabsorbed food or waste material passes through the cecum into the large intestines. Twelve hours after the meal, most of the waste material will be in the colon. The waste material passes through the colon where the water content is absorbed by the body. Twenty four hours after the meal the waste material reaches the rectum.

The Rectum

When waste material reaches this point the body has a desire to defecate. If this desire is ignored constipation may result because of additional water absorption. The rectum is a tube about five inches long that follows the contour of the sacrum and coccyx until it curves back into the short anal canal.

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CHAPTER 13

UHF COMMUNICATIONS

Some of the advantages and general characteristics of UHF and microwave equipment and techniques have been discussed in the preceding chapter. In that discussion, the advantages of high frequency (short wavelength) for radar use were pointed out. In addition, mention was made of the factors of size and weight.

An overall statement as to an advantage of high-frequencies is that the trend toward miniaturization becomes a reality. This is highly desirable for aviation equipment. Circuit components generally become smaller as the frequency increases. Furthermore, it is possible to construct directive antennas of smaller size than when lower frequencies are used. Small directive antennas and compact circuit components are important considerations in airborne equipment where space and weight are major problems.

From the standpoint of communications specifically, another advantage of UHF should be mentioned, aside from the fact that circuit components meet the space and weight requirements of aircraft use. This additional superiority is the wide range of frequency selection available, accompanied by good spacing between active frequencies.

This chapter presents information relating to a representative communications equipment that will be operational during the time this training course is current. The primary objective is to introduce the equipment not as a revolutionary item but as an advancement in communications.

Inasmuch as a Service Instruction Manual exists for the equipment, no attempt at complete coverage is made. Some circuits that employ new or unusual concepts are treated in detail; however, these explanations do not replace the Service Instruction Manual approach, but only serve as supplementary material in presenting theory of operation.

UHF TRANSCEIVER AN/ARC-52

The transceiver described in this section is a representative example of military UHF communication equipment which meets the need in space-premium aircraft for increased effectiveness in smaller packages. It delivers substantially more power output than its predecessor, the AN/ARC-27. Also, it occupies only half as much space as the AN/ARC-27; has improved reliability, and is easier to maintain.

The ARC-52 is basically an AM radiotelephone system capable of operating on any one of 1,750 frequencies with 18 preset channels. Frequency selection is by automatic control. The channels are selected by a single control located remotely from the main unit.

The purpose of the equipment in an aircraft is to provide communication to ground stations, ships, or other aircraft. It operates in the range of 225 to 399.9 mc with a rated power output of 20 watts. The receiver is a double-conversion superheterodyne; two sources are employed for producing injection frequencies. A total of 36 crystals is required for full utilization of the 1,750 available frequencies, with common use of the crystals and many of the circuits for both transmission and reception.

In addition to regular two-way voice communication, the transceiver has the following facilities:

1. A fixed-tune guard receiver in the 238- to 248-mc range.

2. Tone-modulated signals between 920 and 1,120 cps for use as emergency or direction finding signals.

3. An output for operation in conjunction with UHF direction finder group.

MAJOR COMPONENTS

The physical appearance of the equipment is shown in figure 13-1, which illustrates the three basic components. The construction of the principal unit (the receiver-transmitter) and the control box is such that considerable

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The Anus

The anus is the external opening at the lower end of the digestive system. Except during defecation, it is kept closed by a strong muscular ring called the anal sphincter.

Accessory Organs of Digestion

The PANCREAS is a large, elongated gland lying posteriorly to the stomach. Its digestive juices, amylase, proteinase, and lipase are secreted through the pancreatic duct into the duodenum and act on all types of food. The pancreas contains a special group of cells called the Islands of Langerhans which secrete the hormone insulin, which is needed for the utilization of sugar by the body.

The LIVER is the largest gland in the body. It is located in the upper abdomen on the right side, just under the diaphragm and superior to the duodenum and pylorus.

Of its many functions the following are important to remember:

1. Metabolic. Metabolism of carbohydrates, fats, and proteins preparatory to their use or excretion.
2. Excretion. Formation and excretion of bile salts and pigment from bilirubin, a waste product of red blood cell destruction.
3. Storage of blood and water; and the products of carbohydrate, protein, and fat metabolism.
4. Detoxification of end products of protein digestion, and drugs; excess accumulation of certain hormones.
5. Protection. Production of antibodies and essential elements of the blood clotting mechanism.
6. Produces heat and forms vitamin A from carotin.

The GALLBLADDER is a sac usually stained dark green by the bile it contains, located in a hollow on the under side of the liver. Its duct, the cystic duct, joins the hepatic duct from the liver to form the common bile duct which enters the duodenum. The main function of the gallbladder is the storage and concentration of bile when not needed for digestion. In the absence of the gallbladder the common bile duct performs the same function.

Table 6-1.—Principal Digestive Juices, Source and Action.

Source	Digestive juice	Substance acted upon	Product
Salivary glands	Ptyalin	Starch	Complex sugar (Maltose)
Gastric glands	Hydrochloric acid (HCL) Pepsin	Pepsinogen Proteins	Pepsin Split proteins (proteoses, peptones)
Liver	Bile	Fats	Emulsified facts
Pancreas	Amylase	Starch	Complex sugar (maltose)
	Proteinases (trypsin, chymotrypsin)	Proteins, split proteins	Peptids, Polypeptids
	Lipase	Fats	Fatty acids, glycerol
Intestinal glands	Carbohydrases (maltase, sucrase, lactase)	Complex sugars (maltose, sucrose, lactose)	Simple sugars (glucose, fructose, galactose)
	Peptidases	Peptids, polypeptids	Amino acids
	Lipase	Fats	Fatty acids, glycerol

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CHAPTER 7

UROGENITAL SYSTEM

This chapter will discuss the urinary and genital systems. The urinary system is the primary filtering system of the body. It consists of the two glands, the kidneys, which produce urine; two tubes, the ureters, which drain the urine from the kidneys; a large reservoir, the bladder where urine is temporarily stored before it is excreted from the body; and a tube, the urethra, which carries the urine from the bladder to the outside of the body. All these parts, except length of urethra, are the same in both sexes.

KIDNEYS

The importance of the kidney can only be realized when its structure and function is understood. It is the only part of the urinary system in which any changes occur. The bladder, ureters, and urethra only store and pass the products of the kidneys.

The kidneys are two large, bean shaped organs designed to filter waste materials from the blood. They are located in the upper posterior part of the abdominal cavity, outside the peritoneal sac, one on each side of the spinal column. The upper end of each kidney reaches above the level of the 12th rib. The suprarenal gland (adrenal gland) sits like a cap on top of each kidney. Each kidney weighs about 4 to 6 ounces, measures about 4 1/2 x 2 x 1 1/2 inches, and is protected by a considerable amount of fat. Connective tissue and the peritoneum support the kidneys. Attached to the hollow side of each kidney is the dilated upper end of the ureter forming the kidney pelvis (fig. 7-1).

Structure

The kidney is comprised of two types of substances. The outside substance or cortex and the inner substance or medulla. Anatomically the cortex and medulla differ. The cortex or cortical substance is soft and granular in structure and reddish brown in color. The urine is formed in the cortex. The medulla or medullary substance is a pyramid shaped mass of tubes or tubules which drain the urine to the pelvis of the kidney.

Blood enters the kidney via the renal artery and is distributed to the glomerulus (fig. 7-2).

The glomerulus, lying in the cortex, consists of a tuft of capillaries. This tuft is surrounded by the glomerular capsule which is a cup-like dilation of the end of the renal tubule. This combination is called a Malpighian body.

The renal tubule begins with the malpighian body, takes multiple turns called the proximal convoluted tubule, extends toward the hilum in the medullary portion to form the descending loop of Henle, doubles back on itself as the ascending loop of Henle, and goes through several more turns as the distal convoluted tubule. The complete essential unit is called a nephron of which there are about one million in each kidney. For this reason a large portion of the kidney may be destroyed without serious body damage. Several of the nephrons terminate in one collection tubule.

Several collecting tubules unite to form a renal pyramid which drains the urine into a calyx of the kidney pelvis.

Function

The kidneys are effective blood purifiers, and fluid balance regulators. Along with maintaining a normal pH of the blood (acid-base balance), they keep the blood slightly alkaline by removing excess substances from the blood. For example: if the blood becomes too acid they will remove acid in the form of salts; if, on the other hand, the blood is too alkaline, they will remove alkaline salts.

The main function of the kidneys is to remove the nitrogenous waste products that result when

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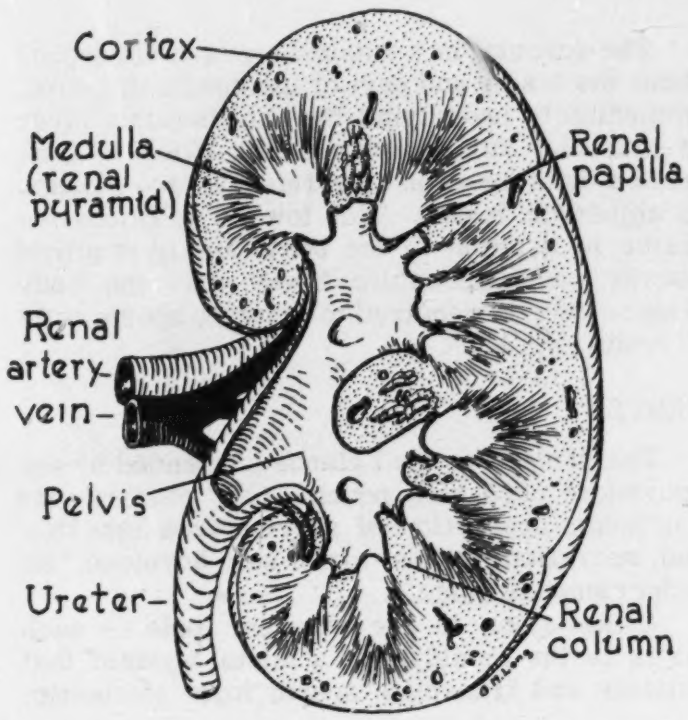

Figure 7-1.—Cross section of the kidney.

products of protein are broken up. They also remove excess sugar.

Besides filtration, the second important function is reabsorption of water, salts, sugar, and protein elements of the blood. This selective reabsorption keeps the blood at an acid-base balance and also at a constant concentration of water, salts, and proteins. This delicate balance if necessary for normal life processes. Controlled reabsorption accounts for the amount of urine which is finally passed from the kidneys. The glomerulus filters gallons of blood each day. It is estimated that 10,000 quarts of blood pass through the kidneys in 24 hours and about 80 gallons of glomerular filtrate is formed. But all the water from this filtrate is reabsorbed in the renal tubules except that containing the concentrated waste products. The amount of urine excreted (micturition) by a normal person varies from 1000 to 1500 ml. per day. A person can get by if he only excretes 500 ml. per day.

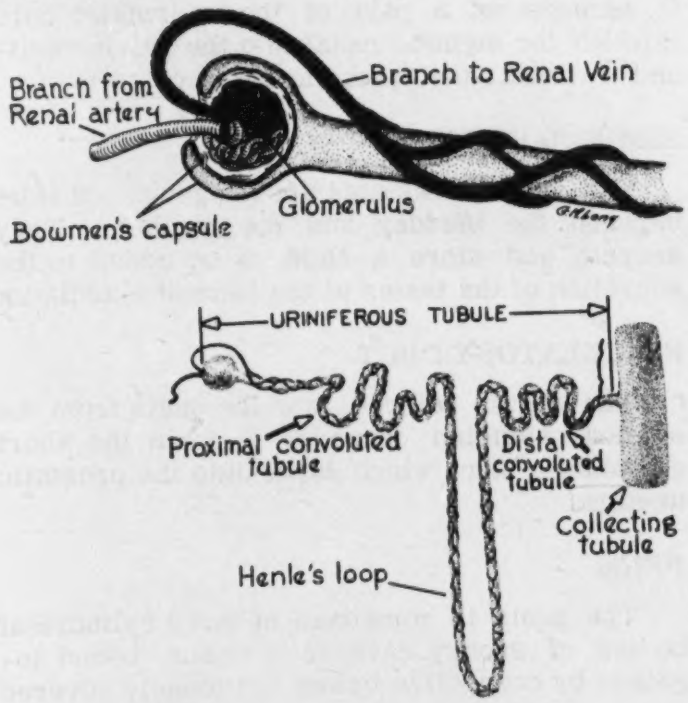

Figure 7-2.—Functional unit of the kidney.

The amount of urine excreted varies greatly with temperature, water intake, and state of health. No matter how much water you drink the blood will always remain at a constant concentration, and the excess water will be excreted by the kidneys. A large water intake does not put a strain on the kidneys as one might think, instead it eases the load of concentration placed on the kidneys.

In blood plasma there is normally 0.03 percent of urea, while in the urine there is normally 67 times as much, or about 2 percent. This great increase is caused by the concentration of urea contained in a large kidney area in a relatively small quantity of urine.

Besides removing waste products normally found in the body, the kidneys also remove toxic substances such as certain barbituric acid derivatives, mercury, alcohol, and other drugs.

One of the familiar diseases associated with the kidneys is glomerulonephritis which is caused by protein loss from the body due to damaged glomeruli. Another disease, though not as prevalent, is uremia. This is caused when the kidneys fail to remove the waste products from the blood and they accumulate in high concentrations. This condition is serious and sometimes fatal.

URETERS

The ureters are two membranous tubes about the diameter of a goose quill (1/8 inch) and 15 to 18 inches long. Their only function is to carry urine from each kidney, down behind the peritoneal sac to the urinary bladder.

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BLADDER

The urinary bladder is a musculomembranous sac located in the pelvic girdle. It functions as reservoir for urine until it empties through the urethra.

URETHRA

The urethra is a membranous tube from the bladder to the exterior, ending in a meatus or opening. It conveys the urine and in the male, the secretions of the genital system to the outside. In the male it is about eight inches long and is divided into three parts, the prostatic, the membranous, and the penile portions. The prostatic urethra, about an inch in length, is surrounded by the prostate gland. It contains the orifices of the prostatic and ejaculatory ducts. In this section the urethra is the largest. The membranous urethra is about 1/2 inch long. The penile urethra is the longest and lies along the base of the penis, extending to its external opening the urinary meatus.

MALE REPRODUCTIVE SYSTEM

The male organs of reproduction are the penis and testes (testicles) with associated ducts and glands (fig. 7-3).

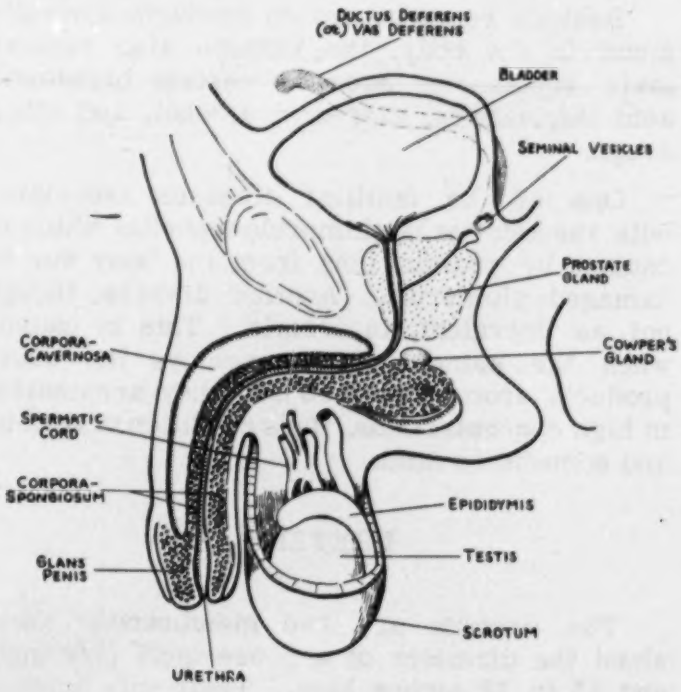

Figure 7-3.—The male reproductive system.

SCROTUM

The scrotum is a cutaneous pouch which contains the testes and part of the spermatic cord. Immediately underlying the skin is a thin layer of muscular fibers (cremaster) which is controlled by temperature, and contracts or relaxes to adjust the testes. This lowers or raises the testes in relation to the body, and is required because a temperature lower than the body temperature is required to bring the sperm cells to maturity.

TESTES

The testes are oval glands suspended by the spermatic cord in a pouch. They perform two functions: production of spermatozoa (sperm), and secretion of the male sex hormone, an endocrine substance.

Lying close to the superior pole of each testis is the epididymis, a ductal system that collects and transmits sperm form the testis.

SPERMATIC CORDS

The two spermatic cords, each of which suspends and supplies a testis, are formed by the ductus deferens, arteries, veins, lymphatics, and nerves, bound together by connective tissue.

DUCTUS DEFERENS (VAS DEFERENS)

The ductus deferens is a small tube which connects the epididymis and ejaculatory duct. It ascends as a part of the spermatic cord through the inguinal canal into the pelvic cavity and transmits the sperm to the ejaculatory duct.

SEMINAL VESICLES

The seminal vesicles are two pouches that lie between the bladder and the rectum. They secrete and store a fluid to be added to the secretion of the testes at the time of ejaculation.

EJACULATORY DUCT

The ductus deferens and the ducts from the seminal vesicles converge to form the short ejaculatory duct which leads into the prostatic urethra.

PENIS

The penis is composed of three cylindrical bodies of spongy cavernous tissue, bound together by connective tissue and loosely covered

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by a layer of skin. Two of the bodies, corpora cavernosa, lie superiorly side by side; the third body, corpora spongiosum, is median, lying in the groove between the other two. The dilated distal end of the corpora spongiosum is known as the glans penis. The cavernous tissue becomes greatly distended with blood during sexual excitement causing erection of the penis. The loose skin of the penis folds back on itself at the distal end forming the prepuce, or foreskin and covers the glans. Frequently the prepuce is surgically removed (circumcision) to prevent irritation and facilitate cleanliness.

PROSTATE GLAND

This gland is made of smooth muscle and glandular tissue that surrounds the first part of the urethra. It resembles a chestnut in shape and size. It secretes an alkaline fluid to keep the sperm mobile and protect them from the acid secretion of the female vagina. This substance is discharged into the urethra as a part of the ejaculate or semen, during the sexual act.

BULBOURETHRAL GLANDS (COWPER'S GLANDS)

Cowper's glands are two pea-sized bodies, one on either side of the membranous urethra, the excretory ducts of which open into the urethra. They secrete a mucous-like alkaline fluid during the sexual act to provide lubrication.

SEMEN

The semen is made of sperm and secretions from the seminal vesicles, prostate, and cowper's glands. It is discharged as the ejaculate during sexual intercourse. There are millions of sperm cells in the semen of each ejaculation, but only one is needed to fertilize the ovum. It is generally considered that fertilization of the ovum occurs while it is still in the uterine tube. Therefore, it is apparent that sperm cells can move actively in the seminal fluid deposited in the vagina, and through the layers of the secretions lining the uterus and uterine tubes.

Although the prostate, seminal vesicles, and bulbourethral glands secrete most actively during sexual intercourse, a certain amount is being formed continously. During periods of prolonged sexual abstinence, discharge of this accumulation may occur spontaneously during sleep as a nocturnal emission or "wet dream". This is an entirely normal condition and does not represent a harmful or disease state; on the other hand, retention of these secretions in no way impairs health or the mental state.

At times, what appears to be semen may drip from the penis on straining to move the bowels. This is the secretion of the prostate and seminal vesicles being forced out by the increased pressure within the abdominal cavity and forceful passage of feces through the rectum which lies close to these structures. This occurrence does not indicate disease or infection, when urethral discharge is present only during such acts of straining. Any continuing discharge should be examined for evidence of infection.

FEMALE REPRODUCTIVE SYSTEM

The female reproductive system includes the ovaries, the uterine (fallopian) tubes, the uterus, the vagina, the external genitalia, and the mammary glands (fig. 7-4).

The essential female organs for reproduction are the ovaries and the uterus. The ovaries produce the ova, one of which normally matures each 28 days. The maturing of female sex cells, or ova, goes on for about 30 years of a woman's life, beginning between the ages of 10 and 15 and stopping between the ages of 40 and 50. The uterus provides a place where a fertilized ovum can be protected and nourished while it is developing into a fetus (unborn child). In making ready to receive and nourish an ovum, the lining of the uterus becomes swollen and soft and has much more blood in it than usual. If the ovum is not fertilized and the blood is not needed for its nourishment, then the excess blood and part of the swollen membrane sloughs off and is discharged from the uterus through the vagina in the form of a bloody discharge. This discharge ordinarily occurs every 28 days and is called menstruation.

OVARIES

The ovaries are two almond-shaped glands suspended by ligaments in the upper pelvic cavity, one on either side of the uterus. Their prime function is to produce the ova and the female hormones estrogen and progesterone. While those hormones are manufactured by the ovaries, their production is controlled by the anterior pituitary gland. These hormones play essential roles in development of secondary sex characteristics, the reproductive cycle, and gestation and lactation.

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Each ovary normally releases an ovum each 56 days, the right and left ovary alternately discharging an ovum every 28 days. Menstruation in most women is therefore a 28-day cycle.

UTERINE TUBES (FALLOPIAN TUBES)

The uterine tubes convey the ova from the ovaries to the cavity in the uterus. These tubes are in contact with the ovaries but are not continuous with them. Their funnel-shaped openings, called free openings, are fringed with finger-like processes. The tubes terminate in the uterus. The precise mechanism by which the ovum is transported from the ovary to the uterine tube is unknown. Contraction of the muscle tissue and the finger-like processes surrounding the funnel-shaped end of the tube, probably effect the transfer. The fertilization of the ovum is believed to take place in the tube and the fertilized ovum is then normally passed on into the uterus.

UTERUS

The uterus is a hollow, pear-shaped organ with thick muscular walls. It is lined with a specialized epithelium called endometrium. It is the endometrium which undergoes partial destruction every 28 days in the nonpregnant woman.

Normally the uterus is about 7 centimeters long by 5 centimeters wide at its upper widest portion. It has three openings: the openings of the uterine tubes laterally, and the opening into the vagina. The parts of the uterus are the body, which is the large upper portion, and the cervix, which is the smaller portion that projects in the upper part of the vagina. The cervical opening into the vagina is called the external orifice.

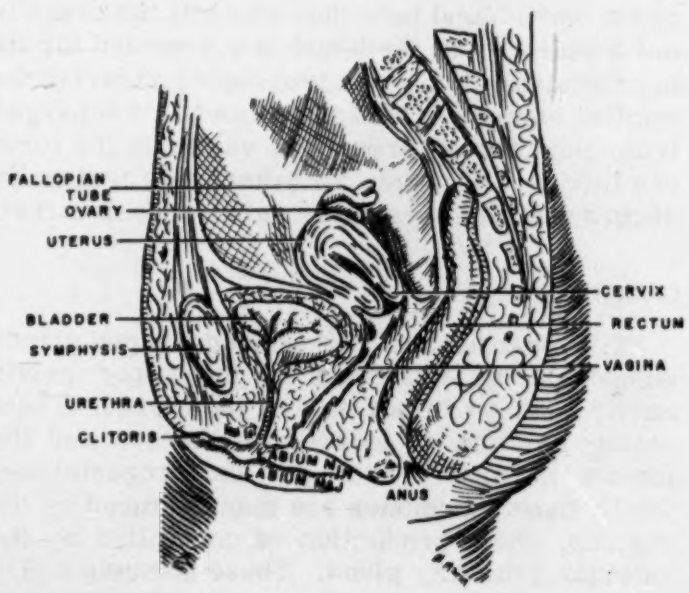

Figure 7-4.—The female reproductive system.

VAGINA

The vagina is a muscular canal lined with mucus membrane which extends from the cervix to the vulva. The canal is about 7.5 centimeters long and its lining membrane, which is greatly folded, is continuous with the lining of the uterus. The vagina is the organ which receives the male sperm during intercourse. It also forms an important part of the birth canal, stretching widely during delivery.

VESTIBULAR GLANDS

The greater vestibular glands (Bartholin's glands) are the female counterpart of the male bulbourethral glands. They consist of two small, roundish bodies on either side of the vagina. Each gland opens by means of a long simple duct and secretes a fluid, cheifly mucus, between the hymen and labia minora.

EXTERNAL GENITALIA

The external genital organs, referred to collectively as the vulva, include the mons pubis, labia majora, labia minora, clitoris, vestibule, the lesser vestibular glands, and hymen. The mons pubis is the fat pad located anterior to the symphysis pubis. It is composed of a collection of fatty tissue beneath the skin and is covered with hair in the adult. The labia majora are two folds of skin extending from the mons pubis anteriorly to the anus posteriorly. Within these two folds of skin are two smaller folds called the labia minora or minor lips. The clitoris is a small body composed of erectile tissue located at the point where the two labia minors meet; the vestibule is the area between the labia minora into which the urethral and vaginal orifices open. The lesser vestibular glands are small mucous glands with ducts opening between the urethral and vaginal orifices. The hymen is a fold of mucous membrane which extends across the lower part of the vagina.

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MAMMARY GLANDS

The mammary glands or breasts are accessory organs of the female reproductive system. They secrete milk for the nourishment of the newborn infant, a process called lactation. The glands resemble sweat glands in structure. At the center on the ventral surface is a nipple with a rounded tip containing 15 or 20 depressions into which ducts from the lobes of the glands empty. During pregnancy, hormones secreted by the ovaries cause the glandular tissue to grow in preparation for lactation. At birth, hormones secreted by the anterior lobe of the pituitary gland stimulate production of milk in the glands which have been prepared by the ovarian hormones. Under average conditions, milk production continues for 6 to 9 months following delivery.

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CHAPTER 8

ELEMENTARY RULES FOR FIRST AID TO THE INJURED

FIRST AID is the emergency treatment of the sick or injured before regular medical or surgical attention can be obtained. It should neither supersede nor take the place of proper medical or surgical attention, and should consist of furnishing temporary assistance to a sufferer, pending the arrival of competent medical aid.

The purposes of first aid are:

1. To save life
2. To prevent further injury
3. To preserve resistance and vitality.

A real knowledge of first aid and its purposes, when properly applied, may mean the difference between life and death, between rapid recovery and long hospitalization, between temporary disability and permanent injury.

Knowing when to, what to, and how to apply first aid measures for the many and various conditions that confront the hospital corpsman in emergency requires a great deal of knowledge, and a continual, studious effort on his part to keep abreast of the changes in and of the newer concepts of first aid treatment.

MINOR SURGERY is that part of surgery that includes procedures not endangering life. It includes the application of bandages, splints, dressings, and sutures, counterirritation, cauterization, and similar simple surgical measures.

GENERAL PROCEDURES IN CASE OF INJURY

Observe the following rules:

1. DO NOT get excited. Take charge of the situation, act quickly but efficiently. Decide as soon as possible what has to be done and which one of the patient's injuries needs attention first.
2. DO NOT MOVE a patient until all possible first aid has been rendered.
3. DO NOT TOUCH open wounds or burns with your fingers or other objects. This may cause serious infections and may cost the patient his life.
4. DO NOT give an unconscious patient liquids.
5. KEEP the patient lying down on a flat surface until his injuries have been determined.
6. EXAMINE THE PATIENT for cessation of respiration, hemorrhage, traumatic injuries and evidence of poisoning. These conditions take precedence over everything else and demand immediate treatment.
7. REMOVE only enough clothing to get a clear idea of the extent of the injury. Preferably, rip the clothing along the seams, but cut if necessary. Removing clothing in the usual way may do great harm, especially in fractures. Do not remove unnecessary clothing; exposure to cold may precipitate the condition of shock.
8. KEEP the patient comfortable. This can be done while the patient's injuries are being cared for. A blanket over the patient may do him as much good as the dressing one applies to his wounds.
9. AVOID allowing the patient to see his injury. Assure him that his injuries are understood and that he will get good care.

ARTIFICIAL RESPIRATION

GENERAL

Breathing is an essential function of the human body. It must be maintained to prevent serious damage or death. When breathing stops, the rescuer must begin artificial respiration within a very few minutes and continue until:

1. Patient resumes regular breathing.
2. Patient is declared dead by competent authority.
3. There is no hope of recovery. (Estimated four hours or longer).

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Before any method of artificial respiration can be effective, the following procedures must be completed:

1. Clear the mouth and throat of all obstructions. (mucous, froth, foreign bodies).

2. Place the patient in proper position for the method to be used.

3. When patient begins breathing, synchronize your efforts with his.

This text will discuss three of the many methods of artificial respiration.

MOUTH-TO-MOUTH

This method is the most practical for emergency treatment of an apneic individual of any age. It gives a far greater exchange of air and is easier to do. The proper technique is as follows:

1. Clear mouth and throat of patient. Wipe out obstructions with fingers or cloth.

2. Place patient in supine (face-up) position.

3. Kneel at patient's side facing the head.

4. Place fingers under angle of patient's chin, thumb in corner of his mouth. Lift the jaw upward.

5. Tilt head back and hyperextend the neck. This will open and align the air passage.

6. Pinch nostrils closed (except infant).

7. Place mouth over patient's mouth (for infant, place mouth over nose and mouth) and form tight seal with lips. Mouth must be wide open to completely seal the open mouth of the patient.

8. Blow (puff for infant), exhale firmly into patient's mouth until chest rises. If the chest does not rise, reposition the head and improve support of the lower jaw.

9. Remove mouth and inhale. During this period, rescuer should hear and feel the escape of air from the patient's lungs.

10. Repeat steps 8 and 9 (15-20) times per minute—20 times for children).

11. Remove air in patient's stomach. Periodically, between breaths, place hand over the pit of the stomach and press air out of the stomach.

12. To prevent dizziness, the rescuer should pause momentarily after each minute (15-20 breaths) and exhale normally. If dizziness persists, the rescuer is working too fast.

BACK-PRESSURE ARM-LIFT (HOLGER NEILSEN)

The back-pressure arm-lift technique is as follows:

1. Clear mouth and throat of patient. Wipe out obstructions with fingers or cloth.

2. Place patient in prone (face down) position.

3. Kneel on one knee or both knees at the patient's head, facing him.

4. Bend patient's elbow and place his hands one upon the other. Turn his face to one side, lift his jaw upward and toward you, and "hook" his jutting jaw over his hands (hyperextension of neck).

5. Place palms of your hands on patient's back, heels of hands lie just below a line running between the armpits, fingers pointing downward and outward.

6. Rock forward until arms are vertical, allowing the weight of the upper part of the body to exert slow, steady pressure downward on the hands. Keep the elbows straight.

7. Release the pressure, avoid a final thrust, and rock slowly backward, grasping the patient's arms just above the elbows and draw his arms toward you just enough to feel resistance in the patient's shoulders. Keep your elbows straight.

Figure 8-1.—Mouth-to-mouth artificial respiration.

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8. Rock forward, dropping patient's arms gently to the ground and repeat steps 6 and 7 (about 20 times a minute).

BACK-PRESSURE HIP-ROLL

The back-pressure hip-roll technique (useful when injuries prevent use of other methods) is as follows:

1. Prepare patient in same manner as for back-pressure arm-lift method.

2. Kneel on one knee astride the patient's thighs, facing toward the head, place the palms of your hands on the lower part of the rib cage, the little finger touching the lowest rib and the ends of the fingers just out of sight.

3. Rock slowly forward, keeping the arms straight, allowing the weight of the upper body to force expiration. At the end of the rock, the rescuer's shoulders should be directly over the heels of the hands.

4. Then quickly bring the hands back along the sides of the patient to the hips, grasping the hips and pulling upward in a single motion. At the end of the upward motion the hips are released and the operator goes back to his original position. This procedure is completed about 20 times a minute.

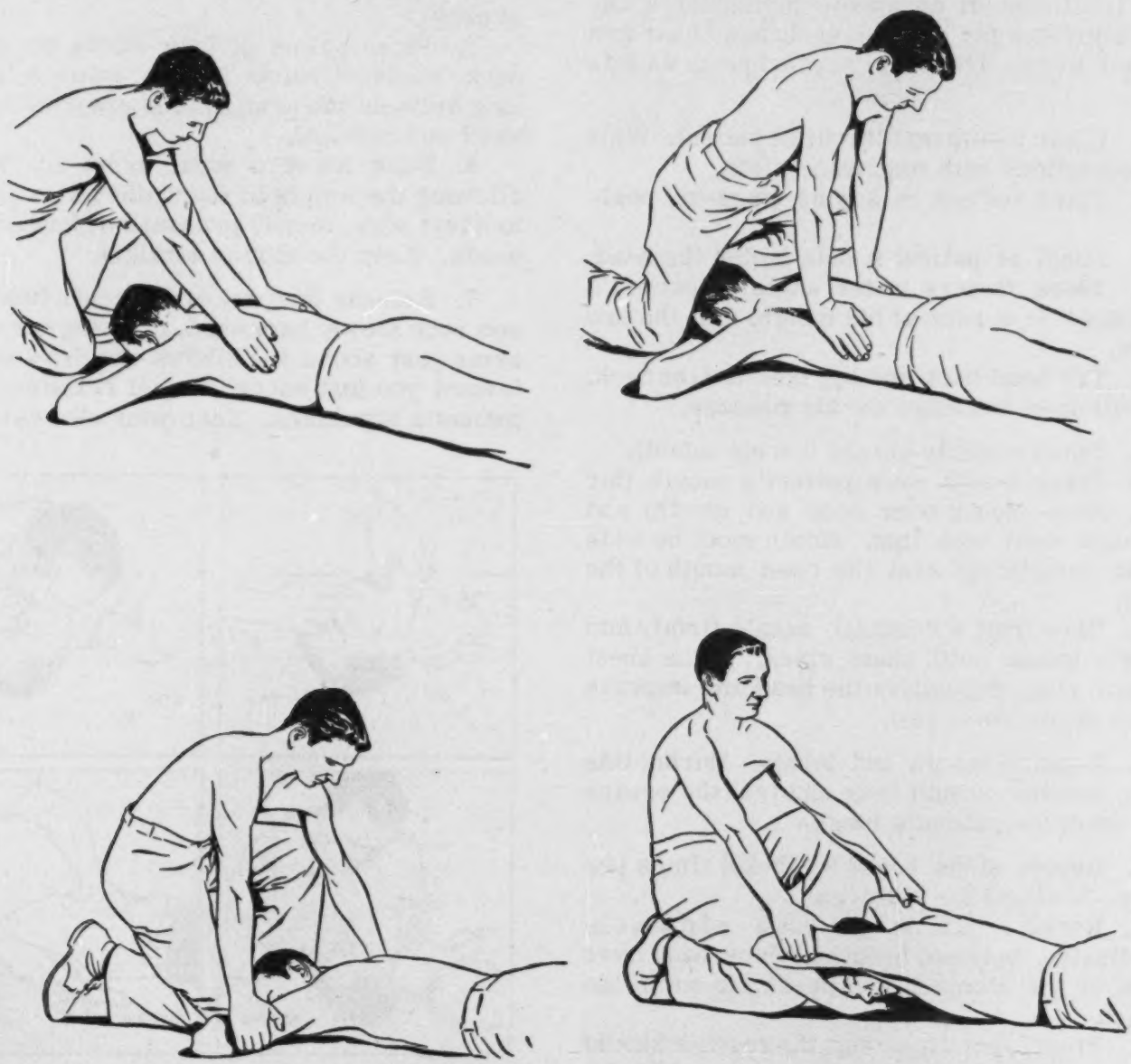

Figure 8-2.—Back pressure-arm lift artificial respiration.

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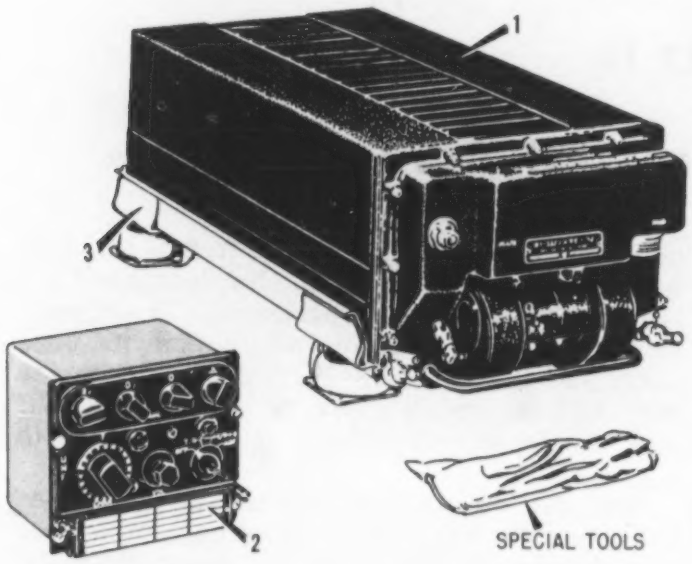

1. Receiver-transmitter.
2. Radio Set Control C-1607.
3. Mounting MT-1477.

Figure 13-1.—Major components of AN/ARC-52.

reduction in weight and size has been made compared with comparable equipments. Weighing 52.5 pounds, including mount and controls the transceiver occupies only 1.08 cubic feet. Thus, it is smaller and lighter than many multichannel UHF sets now in use; many of which have no provisions for pressurization. The latter feature, together with cooling equipment, permits operation at altitudes up to 70,000 feet.

MODULAR UNITS

The ARC-52 is designed from a modular building block approach. As indicated in figure 13-2, the set is made up of 13 subassemblies or modules; these plug into the main chassis. The modules conform in size to a standard of 4 1/2 by 4 1/2 by 1 1/2 inches or some multiple thereof. Besides facilitating maintenance and enabling certain economies in engineering, production, and stocking, modular design provides great flexibility in packaging to adapt the equipment shape to specific aircraft. This feature makes the set especially applicable to communication-navigation-identification (CNI) systems, such as the AN/ASQ-19, AN/ASQ-56, AN/ASQ-57, and AN/ASQ-58.

The modules are shown separately in figure 13-2 with the completed assembly appearing in the center. Reading from left to right in the front row, the units are as follows: guard receiver, audio amplifier, spectrum generator, receiver RF amplifier and transmitter preamplifier, power amplifier, and a-c power supply. Those in the back row are the fixed IF subassembly (1.85 mc), variable IF subassembly (20-30 mc), oscillator, mechanical tuner, modulator, relay, and rectifier.

A major advantage of the type of construction employed is the ease with which the equipment may be modified. Versions of the set have been designed to function with various types of a-c/d-c primary power supply combinations. Modification of other circuitry in the equipment can be accomplished similarly, with module replacement simplifying the logistics problem when the equipments are dispersed over widely separated areas.

The problem of mechanical coupling between modules for tuning functions is solved by connecting the mechanical drive assembly with the appropriate modules by means of a gear-plate assembly mounted underneath the chassis. Any change in the modules involved or their arrangement can be easily accomplished by simple configuration changes in the gear plate. The modules have quick disconnect mechanical couplers. Captive central elements in the couplers make removal and replacement of the module relatively simple with no synchronization problems.

In maintenance, the modular concept permits rapid replacement of defective subassemblies, which increases equipment availability. Troubleshooting is comparatively easy because of the modular breakdown and the provision of readily accessible test points.

Ease of maintenance has been one of the principal considerations in the development of UHF transceiver equipment. The objective is to permit thorough servicing with a minimum of test equipment. After removal from the transceiver, most of the modules can be operated by the use of extension cords and maintenance fixtures which enable operation and servicing of those subassemblies that require mechanical interconnection.

OPERATIONAL PROCEDURES

The operator has fingertip selection of any of the 1,750 available frequencies. Any of 18

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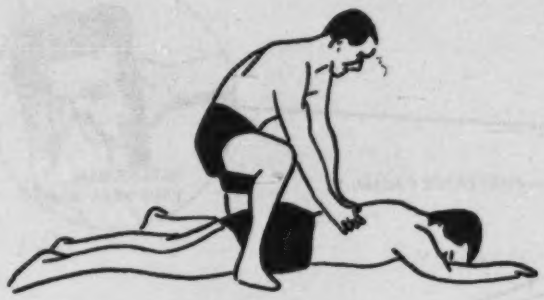

Place hands for back-pressure.

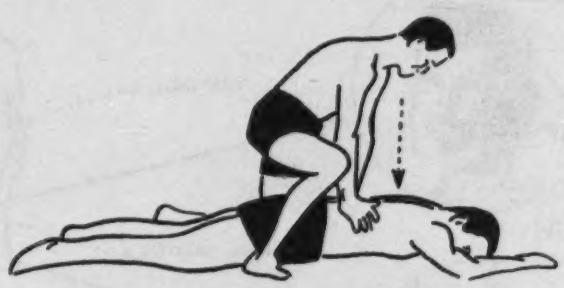

Rock forward and press back.

Roll subject onto operator's thigh or knee. (front view and side view)

Figure 8-3.—Back pressure-hip roll artificial respiration.

CONTROL OF HEMORRHAGE

GENERAL

In the care of the wounded, control of active bleeding must be considered most urgent. Hemorrhage, or bleeding, is the escape of blood from arteries, veins, and capillaries through a break in their walls.

The average adult body contains about six quarts of blood. One pint can usually be lost with no harmful effects. The rapid loss of one quart of blood may produce symptoms:

1. Pale skin or pale mucous membrane. Skin moist and clammy or waxy.
2. Temperature subnormal.
3. Pulse rate increased. Pulse feeble and easily compressible or lost.
4. Blood pressure lowered.
5. Pupils of eyes dilated and slow in reacting to light or in accommodation.
6. Tinnitus (ringing in ears).
7. Faintness or actual fainting (syncope) may be the first symptom of internal hemorrhage.
8. Dehydration, frequent complaints of thirst.
9. Air hunger, often with yawning.
10. Impaired vision, especially in the erect or sitting position.

The greater the loss of blood the more profound the symptoms. The loss of 25 percent of blood volume is dangerous; the loss of one-half the blood volume is usually fatal. The symptoms are indicative of both external and internal bleeding and are easily confused with the symptoms of shock.

TREATMENT OF EXTERNAL BLEEDING

ARTERIAL BLEEDING.—Blood is bright red, gushes forth in spurts which are synchronized with the pulse. This will drain the patient's blood in a very short time. To control the bleeding, apply:

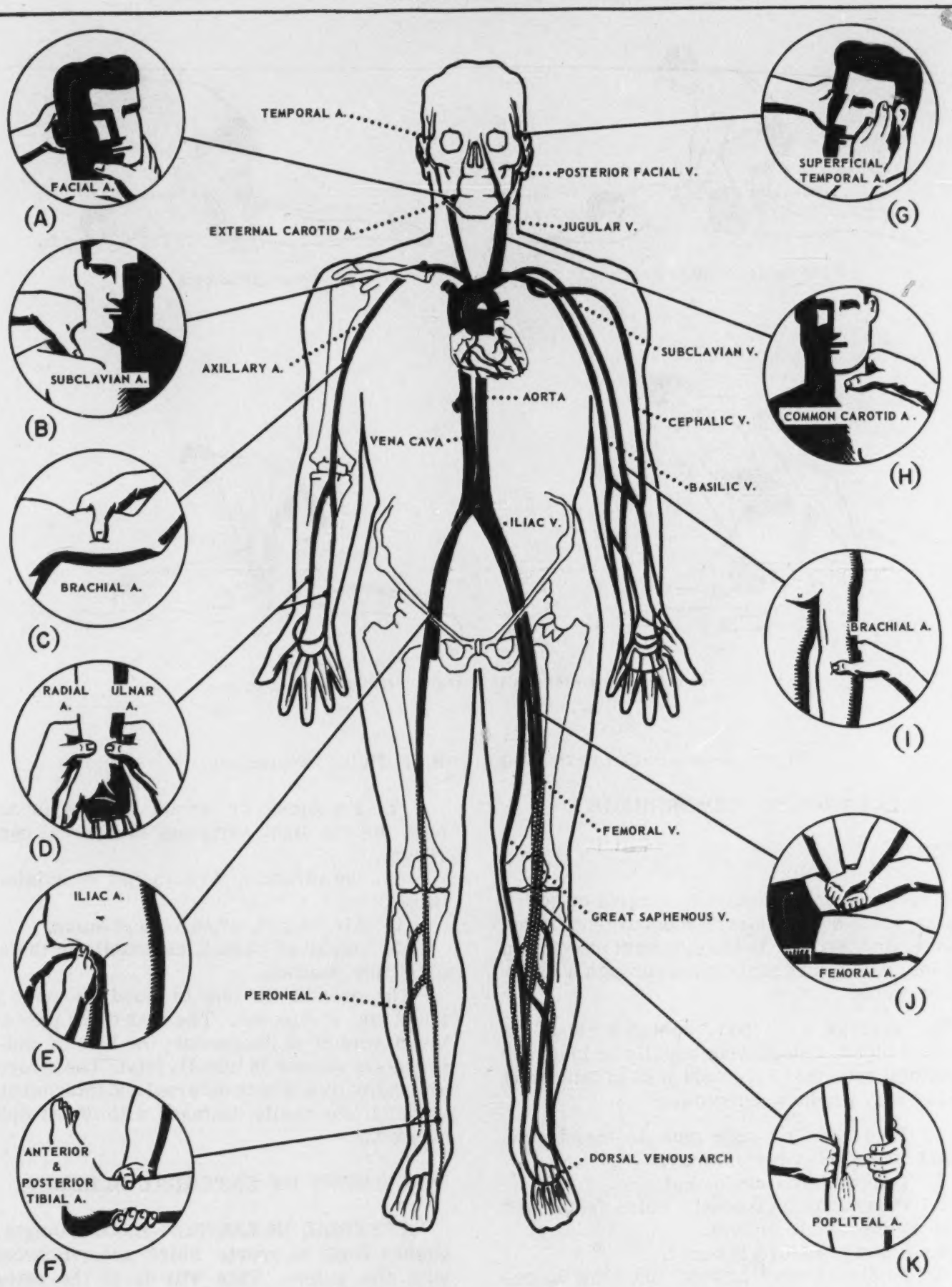

Figure 8-4.—Pressure points.

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1. DIGITAL PRESSURE as illustrated in figure 8-4 followed by elevation of the part and:

2. Application of a firm pressure dressing may impede other circulation if too tight. Remember, control of bleeding by pressure takes a little time. Do not become alarmed; a little persistance with pressure will accomplish the purpose. The pressure should be maintained while someone else brings sufficient sterile gauze or compresses to pack firmly and directly into the wound. A compress should then be applied over the wound and direct, steady, and sustained hand pressure applied while it is snugly bandaged in place. Snug as opposed to tight bandaging cannot be stressed too much. In most instances of serious bleeding this procedure is the best of all methods and will almost always eliminate the need for a tourniquet. Get the patient under professional medical care as soon as possible.

VENOUS BLEEDING.—Blood is dark red and escapes in a steady flow. This is not as apparent as arterial bleeding, but it is more dangerous for that reason.

Venous bleeding is almost always controlled by pressure. In most cases application of a dressing and a snug bandage over the dressing will suffice. In more profuse bleeding, the extremity may be snugly bandaged from the toes or fingers up to the bleeding point after elevation of the part.

CAPILLARY BLEEDING.—Blood is intermediate in color and oozes from the wound. It can be controlled with a sterile compress and a bandage.

TREATMENT OF INTERNAL BLEEDING

Internal hemorrhage can be controlled only by surgery. Until the patient reaches a hospital he must be kept alive by transfusions of whole blood or by blood volume expanders. Keep the patient quiet and reassured.

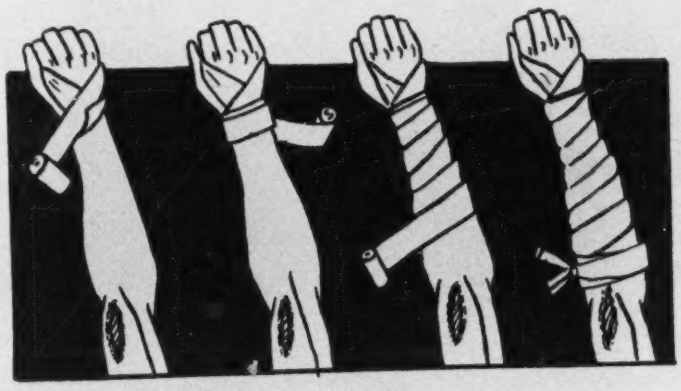

Figure 8-5.—Spiral bandage for control of bleeding.

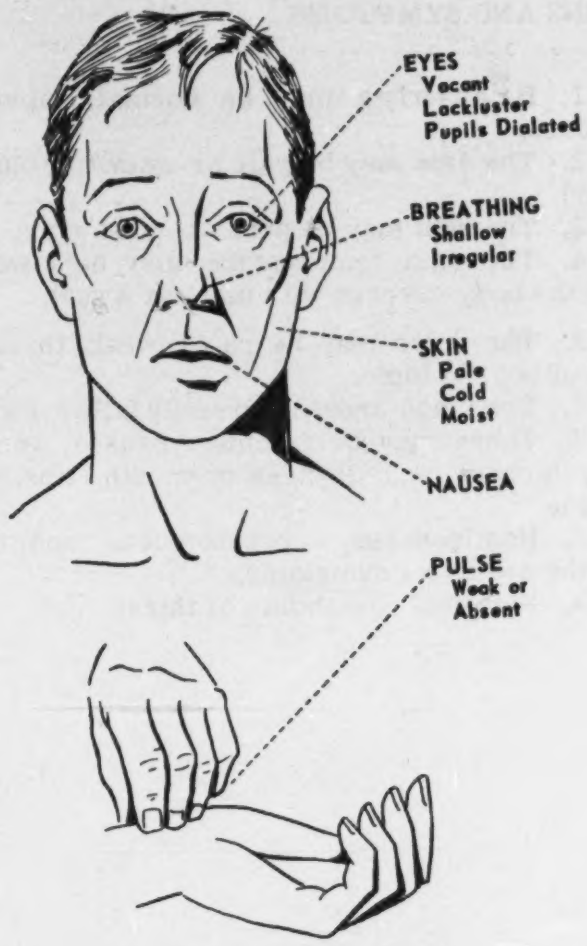

Figure 8-6.—Look for symptoms in shock.

Hemorrhage may be started spontaneously (by straining, coughing and hypertension) or result from trauma (by cutting, crushing, or tearing of body tissue.

SHOCK

Shock is a poorly understood physiological depression of the body's vital processes and is present to a greater or lesser degree in all injuries. It is chiefly nervous in origin and effects a failure in blood circulation with resultant impairment of all vital organs. By and large, the more extensive the injury, the more profound the shock picture will be.

All injured persons are subject to shock in varying degrees. It may be present at the time of injury or develop hours later. Therefore, all injury cases must be observed and treated for shock, should it occur.

SIGNS AND SYMPTOMS

1. Breathing may be normal, rapid or labored.
2. The lips may be pale or cyanotic (bluish gray).
3. The skin may be pale or ashen gray.
4. The skin temperature may be lowered and the body covered with clammy sweat.
5. The pulse may be rapid, weak, thready, and of poor volume.
6. The blood pressure usually falls in shock.
7. There may be retching, nausea, vomiting, hiccups and dryness of mouth, lips, and tongue.
8. Restlessness, apprehension, and then apathy are usual symptoms.
9. Frequent complaints of thirst.

TREATMENT

The first aid treatment of shock is primarily prevention. The patient should be placed in a supine position, with head lowered and feet elevated to encourage return of blood to the heart and a generous supply to the brain. Chest or head injuries should be positioned with the head slightly elevated. If face, jaw, mouth, or throat injuries produce bleeding into the pharynx, it is imperative that the patient be placed in a prone position with the head turned to one side and lowered 1/2 to 1 foot. Keep the patient warm with blankets. Treat the cause of the shock. If bleeding is present it must be stopped. If pain is present, its alleviation is an important part of the treatment. When symptoms of shock persist despite these measures, more expert medical assistance must be obtained.

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CHAPTER 9

BANDAGES, SPLINTS AND FIRST AID MATERIALS

SPLINTS

SPLINTS are used to immobilize a fractured part. There are two general classifications: traction splints and coaptation splints (fig. 9-1).

TRACTION SPLINTS of which the Thomas splint is a well known example, serve to immobilize the limb, resting it in a trough. Most importantly, however, they have a feature that provides for a pulling action (traction) preventing overriding of bone fragments. A Spanish windlass permits application of traction at the narrow end of the splint, while the ring at the wider end provides counter-traction. Many adaptations of the Thomas splint have been made which use the general principle of traction and counter-traction, for example, the Murray-Jones humerus splint. Traction splints are indicated in fractures where there is much muscle pull, tending to displace the fragments.

Now available is an adjustable canvas splint called a "universal" splint. It has parts to make it adaptable for leg, arm, back, and neck. The package contains a leg splint, an outrigger which is adjustable for length, plus two padded wire mesh splints.

COAPTATION SPLINTS are those which are used solely to immobilize the fracture. The most common type used are basswood splints and are conveniently packaged in varying sizes; they are held about the limb by means of roller bandages, cravat bandages, or any material available as handkerchiefs, rope, clothing, adhesive tape. When basswood splints are not available, canes, rifles, sticks, stiff wire or folded blankets may be used to support the broken bones.

Generally, coaptation splints should be long enough to reach the joints above and below the fracture; they should be wide enough to prevent pinching; and they should be padded except perhaps, when applied over thick clothing. Padding may be cotton, clean rags, grass, moss, or pieces of blankets or clothing. An assistant should be sought to support the limb during application to prevent excessive motion at the fracture site.

While splints should be applied snugly, care should be taken not to apply them too tightly for fear of cutting off blood circulation; leave tips of the fingers and toes exposed. Plaster of paris can be used for splinting purposes, but it is best to leave its application to the Medical Officer.

BANDAGES AND BANDAGING

Bandages are used to hold dressings applied to the surface of the body, to secure splints used in treatment of fractures and dislocations, to create pressure, and to immobilize joints. Various materials are employed such as gauze, flannel, muslin, linen, and elastic webbing. Gauze is used frequently because it is light, soft, thin, porous, readily adjusted and easily applied. Muslin is also used frequently since it is inexpensive and universally available.

A hospital corpsman should be familiar with the general rules of bandaging and proficient in the application of various types of bandages. The comfort of the patient, the security of the dressing, and the professional reputation of the corpsman depends upon the proper application of a bandage, since an untidy, uncomfortable, insecure bandage can only result in adverse criticism.

TRIANGULAR BANDAGES

TRIANGULAR BANDAGES are usually made of muslin. They are made by cutting a 36" to 40" square on a piece of cloth, and then cutting the square diagonally, thus making two triangular bandages (in sterile packs on Navy's medical stock list). A smaller bandage of this kind may

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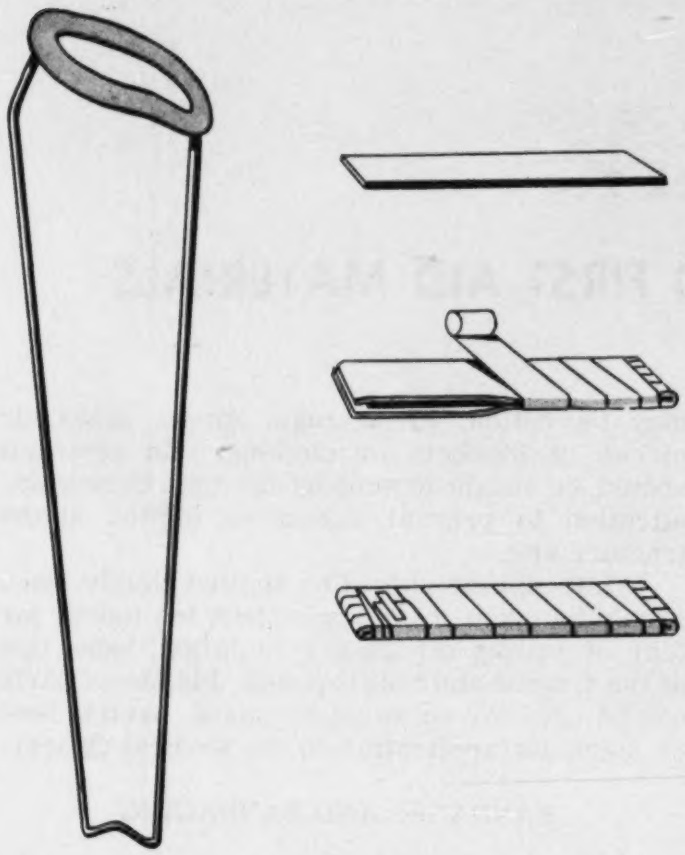

Figure 9-1.—Thomas splint for traction; type of coaptation splint.

be made by folding a large handkerchief diagonally. The longest side of the triangular bandage is called the base; the corner directly opposite the middle of the base is called the point; and the other two corners are called ends (fig. 9-2).

The triangular bandage is useful because it can be folded in a variety of ways to fit almost any part of the body. Padding may be added to areas that may become uncomfortable.

TRIANGULAR BANDAGE OF THE HEAD

This bandage is used to retain dressings on the forehead or scalp. Fold back the base about two inches, thus making a hem. Place the middle of the base on the forehead, just above the eyebrows, with hem on the outside. Let the point fall over the head and down over the occiput (back of the head). Bring the ends of the triangle around the back of the head above the ears, cross them over the point, carry them around to the forehead and tie in a SQUARE KNOT. Hold the dressing firm with one hand and, with the other, gently pull down the point until the dressing is snug; then bring the point

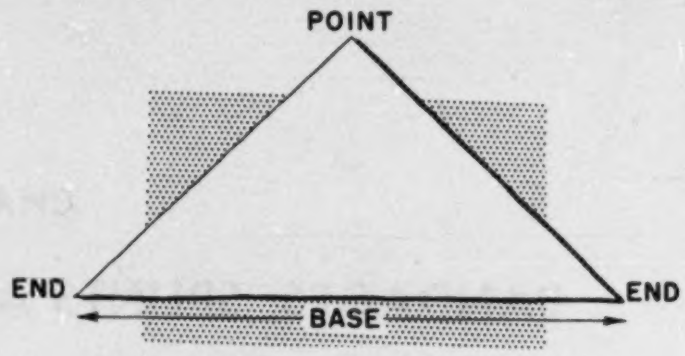

Figure 9-2.—Triangular bandage.

up and tuck it over and in the bandage where it crosses the occiput (fig. 9-3).

TRIANGULAR BANDAGE FOR SHOULDER

Cut or tear the point, perpendicular to the base, about ten inches. Tie the two points loosely around the patient's neck, allowing the base to drape down over the dressing on the injured side. Fold the base to the desired width, grasp the ends, and fold or roll the sides toward the shoulder to store the excess bandage. Wrap the ends snugly around the upper arm, and tie on the outside surface of the arm (fig. 9-4).

TRIANGULAR BANDAGE FOR CHEST

Cut or tear the point, perpendicular to the base, about ten inches. Tie the two points loosely around the patient's neck, allowing the

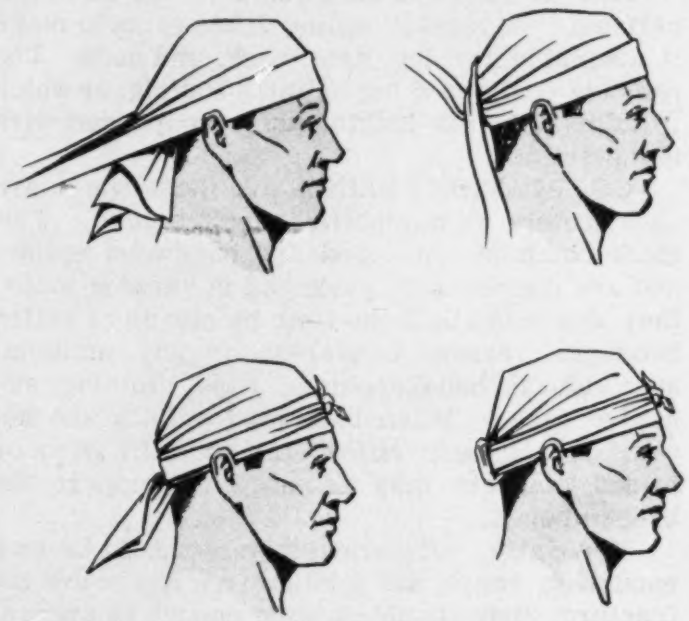

Figure 9-3.—Triangular bandage for head.

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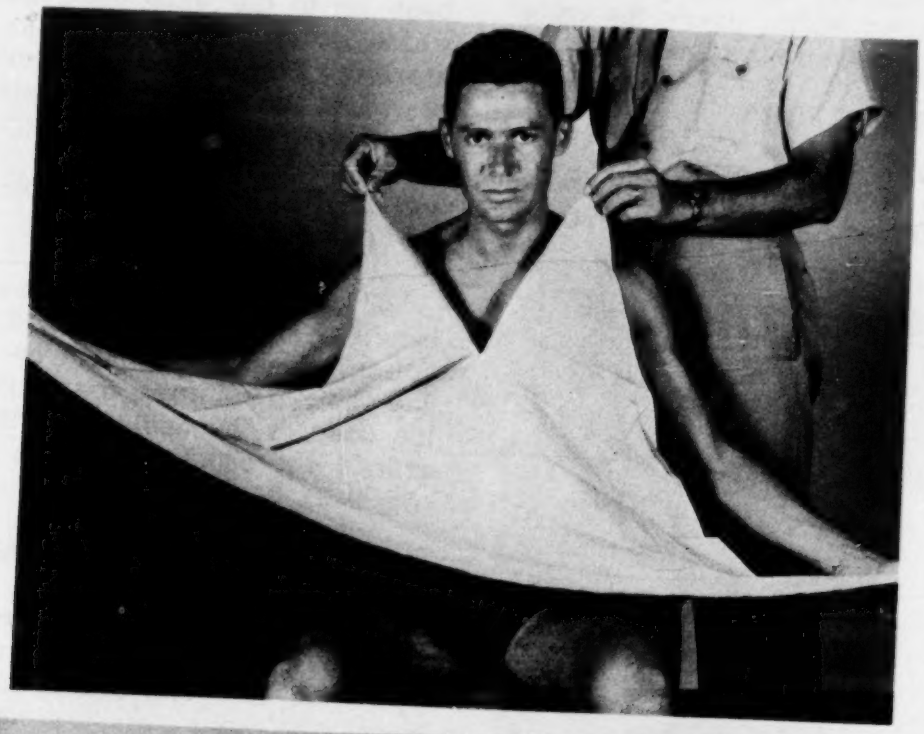

Figure 9-4.—Triangular bandage for shoulder.

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bandage to drape down over the chest. Fold the bandage to the desired width, carry the ends around to the back, and secure by tying (fig. 9-5).

TRIANGULAR BANDAGE FOR HIP OR BUTTOCK

Cut or tear the point, perpendicular to the base, about ten inches. Tie the two points around the thigh on the injured side. Lift the base up to the waist line, fold to the desired width, grasp the ends, fold or roll the sides to store the excess bandage, carry the ends around the waist and tie on the opposite side of the body (fig. 9-6).

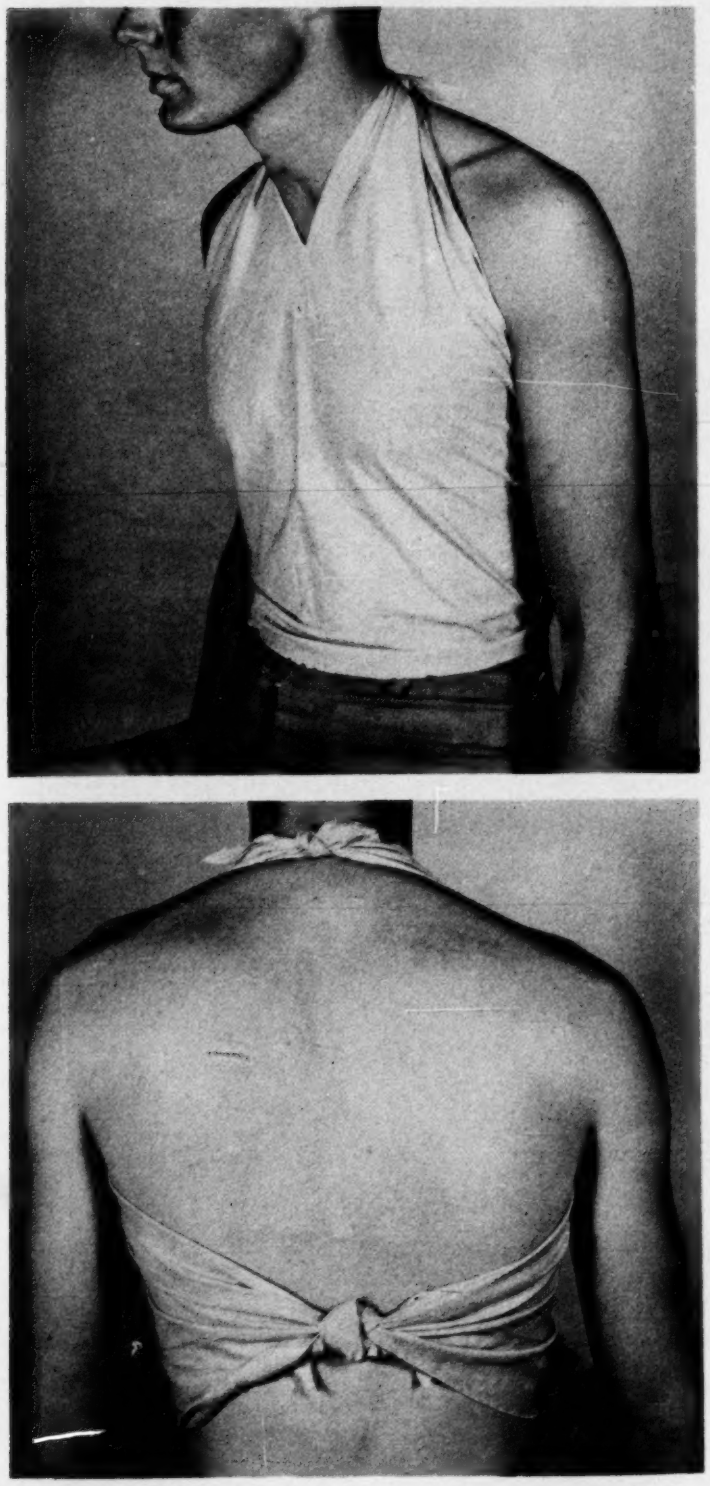

Figure 9-5.—Triangular bandage for chest.

TRIANGULAR BANDAGE FOR SIDE OF CHEST

Cut or tear the point, perpendicular to the base, about ten inches. Place the bandage, points up, under the arm on the injured side. Tie the two points on top of the shoulder. Fold the base to the desired width, carry the ends around the chest and tie on the opposite side (fig. 9-7).

TRIANGULAR BANDAGE FOR FOOT

This bandage is used to retain large dressings on the foot. After the dressings are applied, place foot in center of a triangular bandage and carry the point over the ends of the toes and over the upper side of the foot to the ankle. Fold in excess bandage at the side of the foot, cross the ends, and tie in a square knot in front (fig. 9-8).

TRIANGULAR BANDAGE FOR HAND

This is used to retain large dressings on the hand. After the dressings are applied, place the base of the triangle well up on the palmar surface of the wrist. Carry the point over the ends of the fingers and back of the hand well up on the wrist. Fold the excess bandage at the sides of the hand, cross the ends around the wrist, and tie in a square knot in front (fig. 9-8).

CRAVAT BANDAGE

To make a cravat bandage, bring the point of the triangular bandage to the middle of the base and continue to fold until the desired width is obtained (fig. 9-9).

CRAVAT BANDAGE FOR HEAD

This bandage is very useful to control bleeding from wounds of the scalp or forehead. After placing the dressing over the wound, place the center of the cravat over the dressing and carry the ends around to the opposite side; cross them

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Figure 9-6.—Triangular bandage for hip or buttock.

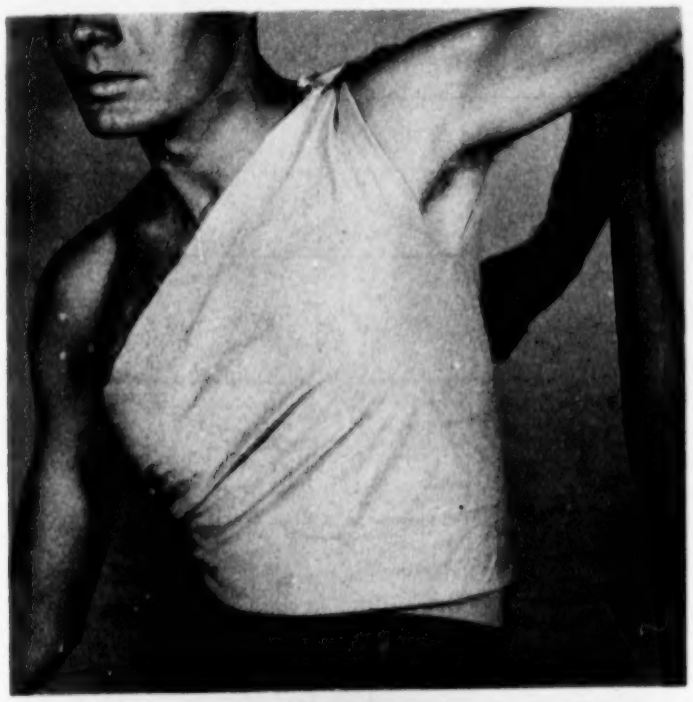

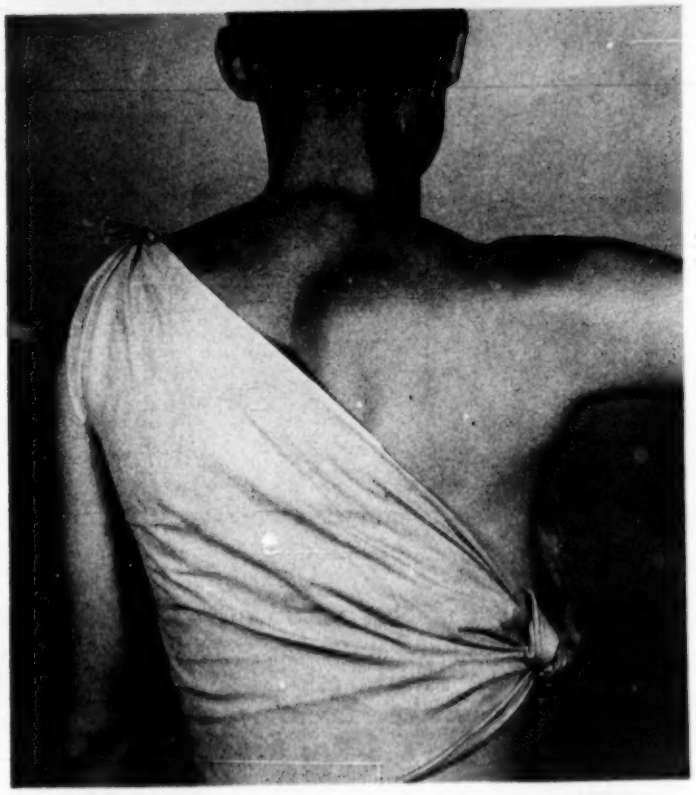

Figure 9-7.—Triangular bandage for side of chest.

and continue to carry them around to the starting point and tie in a square knot.

CRAVAT BANDAGE FOR EYE

After applying a dressing to the affected eye, place the center of the cravat over the dressing

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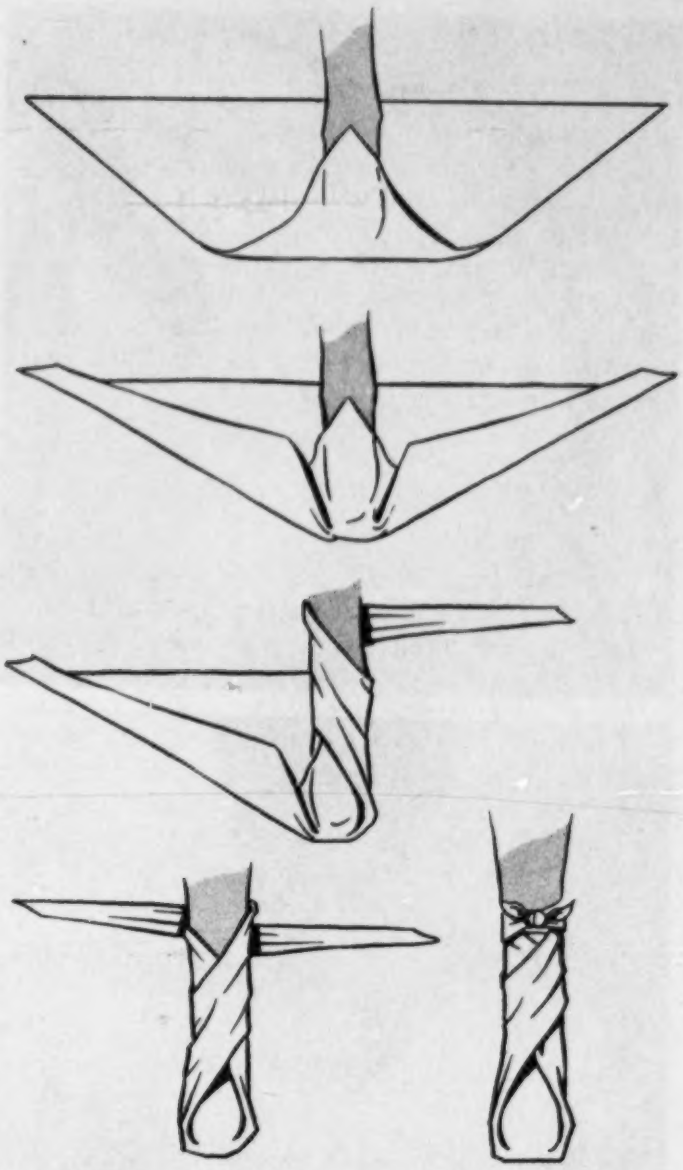

Figure 9-8.—Triangular bandage for foot or hand.

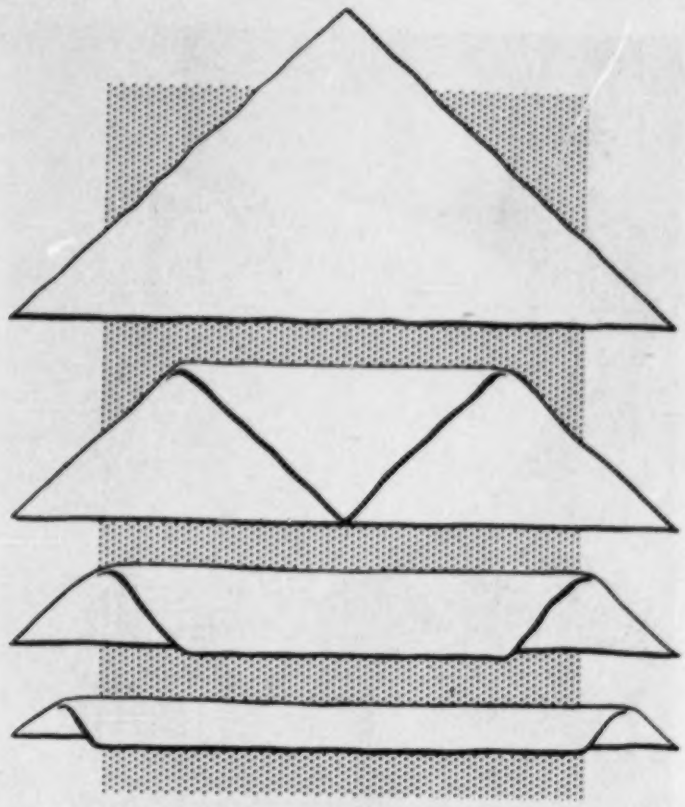

Figure 9-9.—Cravat bandage.

Figure 9-10.—Cravat bandage for the eye.

and on a slant so that the lower end is inclined downward. Bring the lower end around under the ear of the injured side and the other end over the ear on the opposite side. Cross the ends in back of the head; bring them forward and tie them over the dressing (fig. 9-10).

CRAVAT BANDAGE FOR TEMPLE CHEEK OR EAR

After the dressing is applied to the wound, place the center of the cravat over it and hold one end over the top of the head, carry the other under the jaw and up the opposite side, over the top of the head, and cross them at right angles over the temple on the injured side. Continue one end around over the forehead and the other around the back of the head to meet over the temple on the injured side. Tie ends in square knot (fig. 9-11).

CRAVAT BANDAGE FOR ELBOW OR KNEE

After applying the dressing, and, if the injury or pain is not too severe, bend elbow or knee to

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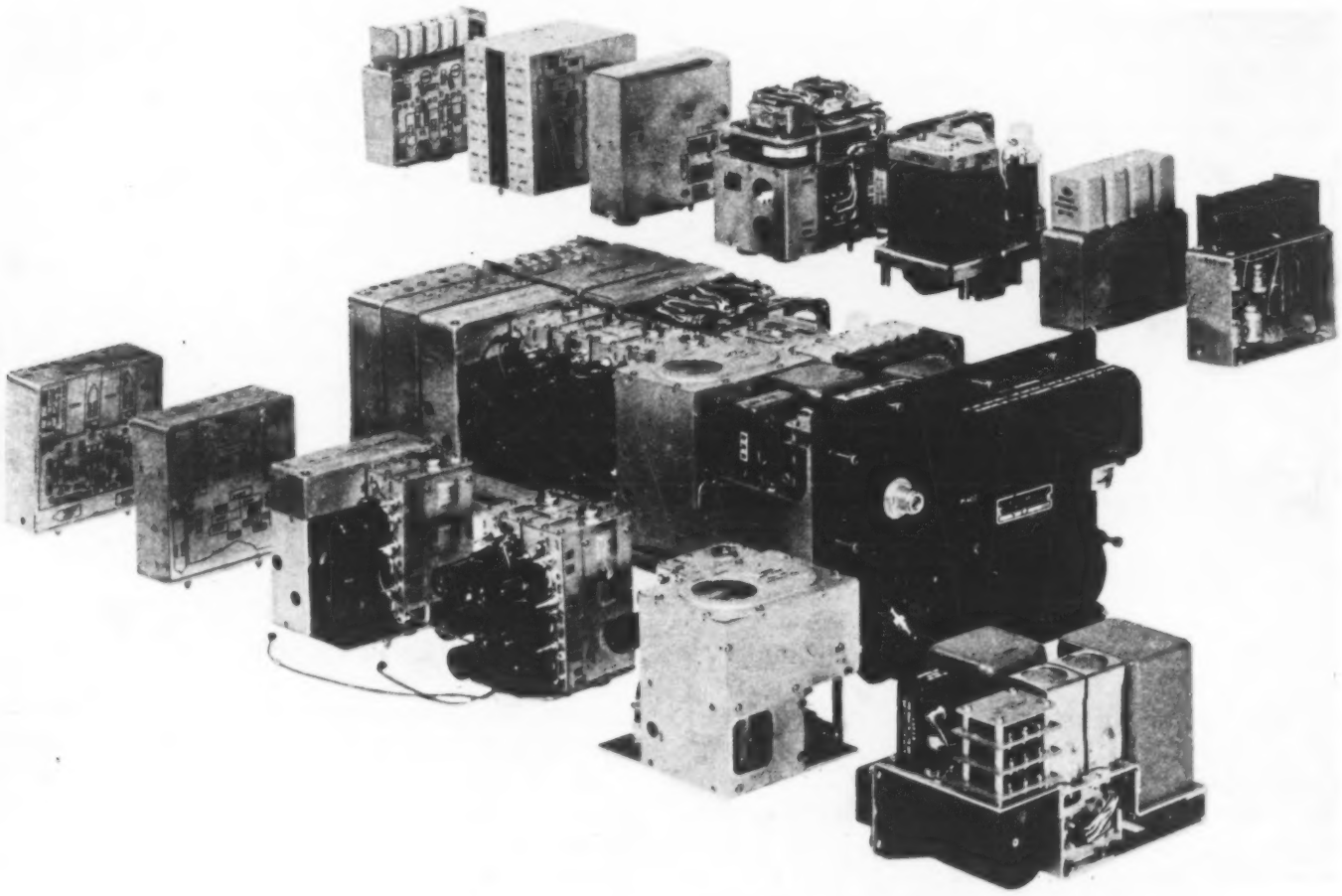

Figure 13-2. —AN/ARC-52 modules arrayed about complete radio set.

preset channels or the guard channel may be selected by rotating a single channel selector control on Radio Set Control C-1607/ARC-52, shown in figure 13-1. Other frequencies may be chosen by rotation of four manual frequency controls until the desired frequency appears on the indicator dials.

The operator also has a volume control, and a function switch which enables him to turn the equipment on and select the following functions: transceiver only, transceiver plus guard receiver, and automatic direction finder.

Another feature which simplifies the operation of the equipment is a signal-to-noise squelch system. It also has carrier-squelch provisions. The squelch circuits are disabled on the basis of the signal-to-noise ratio (understandability) instead of solely on the level of the incoming carrier wave. This eliminates the need for the operator to adjust the RF gain squelch control.

TUNING SYSTEM

Tuning is accomplished automatically by means of autopositioners and associated electrical and mechanical components. The autopositioners are motor-driven units which adjust the tuning circuits and switches of the subassemblies in the receiver-transmitter. Autopositioner tuning action is controlled by the open-circuit seeking system, the basic principle of which is shown by the diagram in figure 13-3.

When the selector switch on the left and the seeking switch are set symmetrically, or with corresponding contacts occupying similar positions, there is no current path from the relay coil to ground. In this condition, the relay remains deenergized and the motor does not run.

When the selector switch is set to a position different from that of the corresponding seeking switch, the motor relay is energized

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Figure 9-11.—Cravat bandage for the temple, cheek, or ear.

a right angle position before applying the bandage. Place the middle of a rather wide cravat over the point of the elbow or knee, and carry the upper end around the upper part of the elbow or knee, bringing it back to the hollow, and the lower end entirely around the lower part, bringing it back to the hollow. See that the bandage is smooth and fits snug, then tie in a square knot outside of the hollow (fig. 9-12).

CRAVAT BANDAGE FOR ARM OR LEG

The width of the cravat to use will depend upon the extent and area of the injury. For a small area, place the dressing over the wound and center the cravat bandage over the dressing. Bring the ends around in back, cross them and tie over the dressing. For a small extremity it may be necessary to make several turns around in order to use all the bandage for tying. If the wound covers a larger area, hold one end of the bandage above the dressing and wind the other end spirally downward across the dressing, until it is secure, then upward and around again and tie a knot where both ends meet (fig. 9-13).

CRAVAT BANDAGE FOR AXILLA (ARMPIT)

This cravat is to hold dressings in the axilla. It is similar to the bandage used to control bleeding from the axilla. Place the center of the bandage in the axilla over the dressing, and carry the ends up over the top of the shoulder and cross them. Continue across the back and the chest, to the opposite axilla and tie them. Do not tie too tight or the axillary artery will be compressed, adversely affecting the circulation in the arm (fig. 9-14).

CRAVAT BANDAGE FOR SPRAINED ANKLE

Do not remove the shoe when applying this bandage. Leaving it on will afford partial support. If the top of the shoe is above the ankle, loosen the laces to allow for swelling. Use a narrow cravat, and begin by placing the middle of the bandage under the instep. Carry the ends back and upward, crossing above and behind the heel and around forward crossing over the instep. Continue downward and backward this time close to the angle and under the first turn. Make a hitch and bring the ends forward, then around the ankle once more and tie over the instep (fig. 9-15).

ROLLER BANDAGE

In applying a roller bandage, the roll should be held in the right hand, so that the loose end is on the bottom; the outside surface of the loose or initial end is next applied to and held on the part by the left hand. The roll is then passed around the part by the right hand, which controls the tension and application of the bandage. Two or three of the initial turns of a roller bandage should overlie each other in order to secure the bandage and keep it in place. (See fig. 9-16.)

In applying the turns of the bandage, it is often necessary to transfer the roll from one hand to the other. Bandages should be applied evenly, firmly, and not too tightly. Excessive pressure may cause interference with the circulation and may lead to disastrous consequences. In bandaging an extremity, it is, therefore, advisable to leave the fingers or toes exposed in order that the circulation of these parts may be readily observed. It is likewise

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Figure 9-12.—Cravat bandage for the elbow.

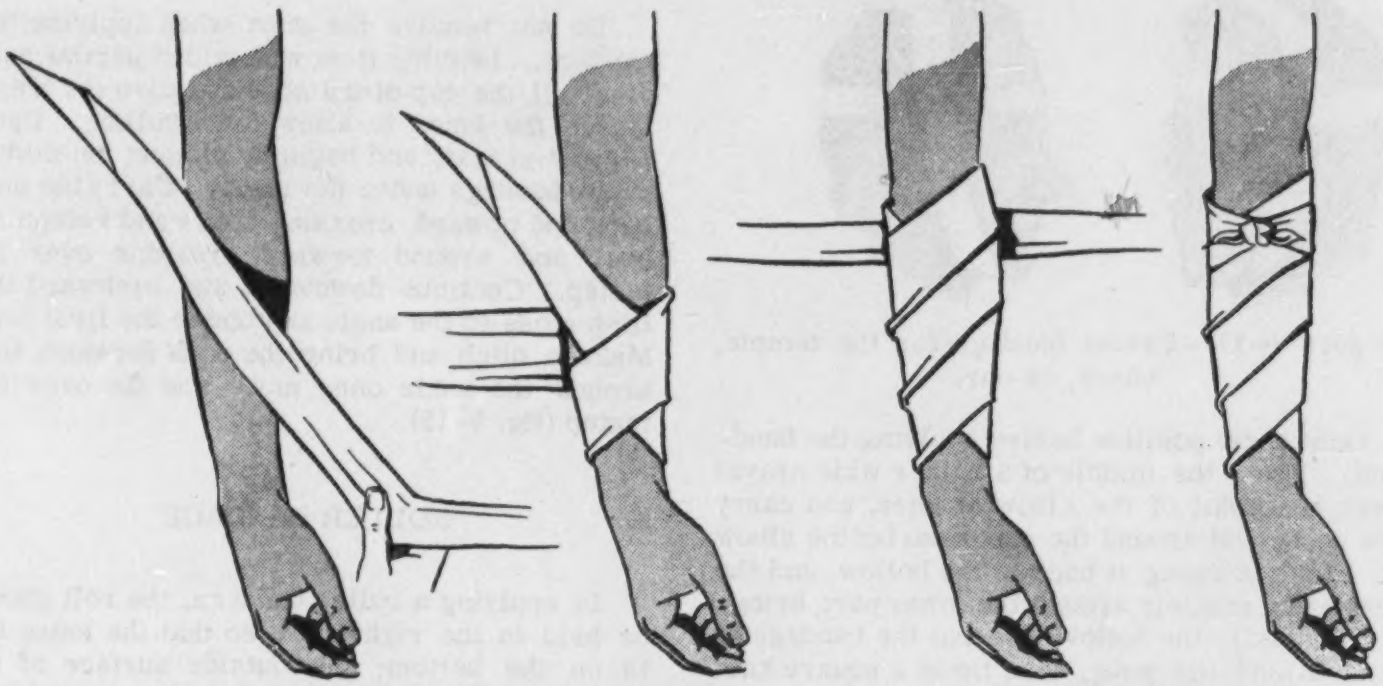

Figure 9-13.—Cravat bandage for the arm, forearm, leg, or thigh.

safer to apply a large number of turns of a bandage, rather than to depend upon a few too firmly applied turns to secure a splint or dressing.

In applying a wet dressing, or one that may become wet, it is necessary to allow for shrinkage. The turns of a bandage should completely cover the skin, as any uncovered areas of skin may become pinched between the turns, with resulting discomfort.

In bandaging an extremity, it is advisable to include the whole member (arm or leg, excepting the fingers or toes) in order that uniform pressure may be maintained throughout. It is also desirable in bandaging a limb, that the part be placed in a position it will occupy when the dressing is finally completed, as variations in flexion and extension of the part will cause changes in the pressure of certain parts of the bandage.

The initial turns of a bandage of an extremity (including spica bandages of the hip and shoulder) should be applied securely, and when possible, around the part of the limb that has the smallest circumference. Thus, in bandaging the arm or hand, the initial turns usually are applied around the wrist, and in bandaging the leg or foot, the

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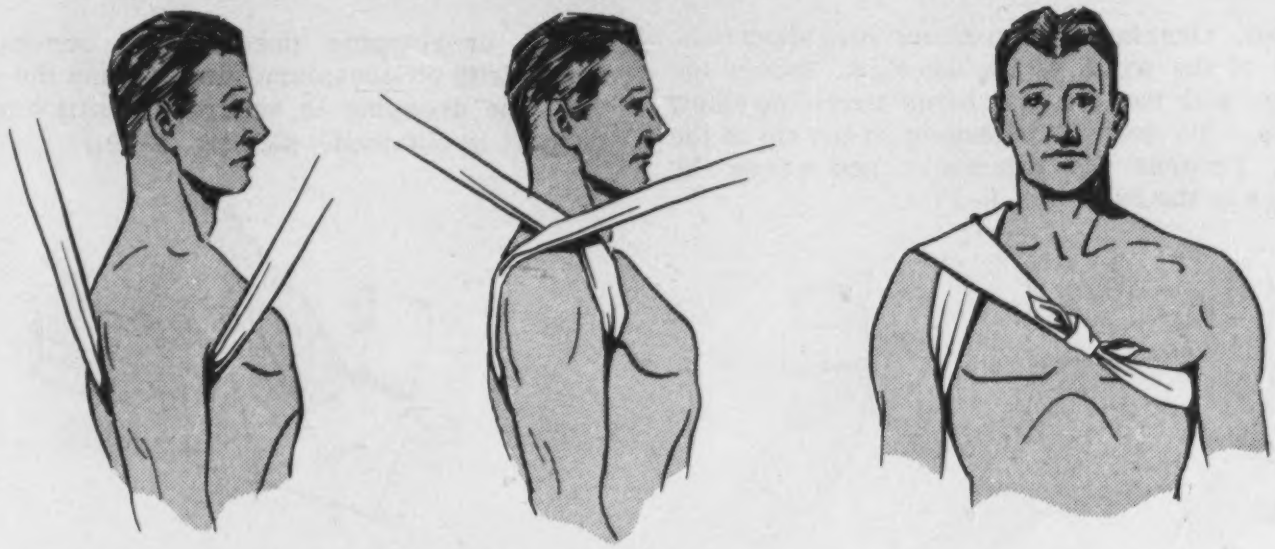

Figure 9-14.—Cravat bandage for the axilla.

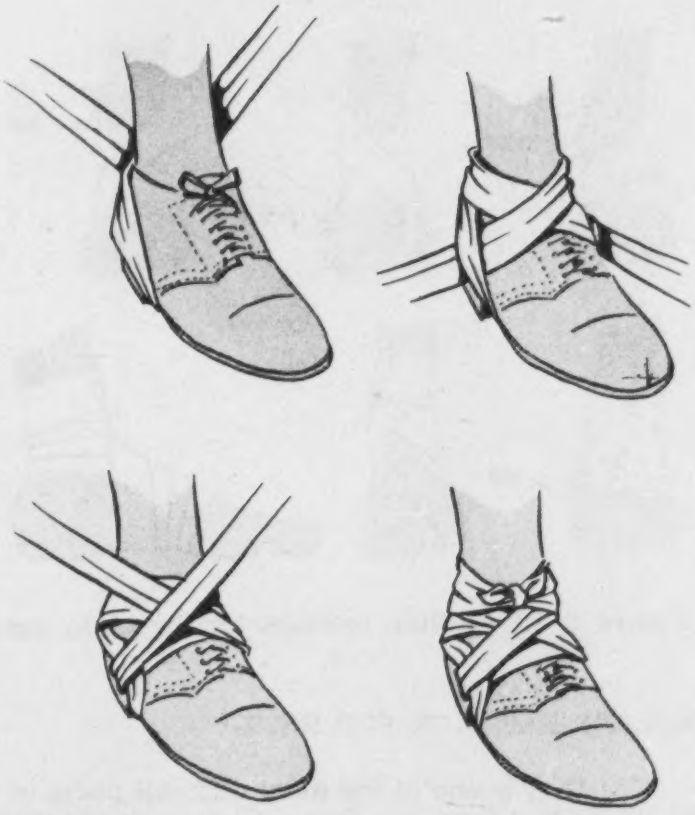

Figure 9-15.—Cravat bandage for a sprained ankle.

the wrist, and in bandaging the leg or foot, the initial turns are applied immediately above the ankle.

The final turns of a completed bandage usually are secured in the same manner as are the initial turns, by the employment of two or more overlying circular turns. As both edges

Figure 9-16.—Anchoring a bandage about the wrist.

of the final circular turns are necessarily exposed, they should be folded under to present a neat, cuff-like appearance. The terminal end of the completed bandage is turned under and secured to the final turns by either a safety pin or adhesive tape. When these are not available, the end of the bandage may be split lengthwise for several inches, and the two resulting tails secured around the part by tying.

ROLLER BANDAGE FOR ELBOW

A spica or figure-of-eight type of bandage is used around the elbow joint to retain dressing in the region of the elbow and to allow a certain amount of movement. Flex the elbow slightly, if you can do so without causing further pain or injury, and anchor a 2 or 3 inch bandage above the elbow with two circular turns. Carry it diagonally downward across the hollow of the elbow, and encircle the forearm below the elbow with a circular turn. Continue the bandage upward across the hollow of the elbow to where you started. Make another circular turn around the upper arm, carry it downward, repeating the figure-of-eight procedure, and gradually ascend

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the arm. Overlap each previous turn about two-thirds of the width of the bandage. Secure the bandage with two circular turns above the elbow and tie. To secure dressings on the tip of the elbow, reverse the procedure and cross the bandage in the back (fig. 9-17).

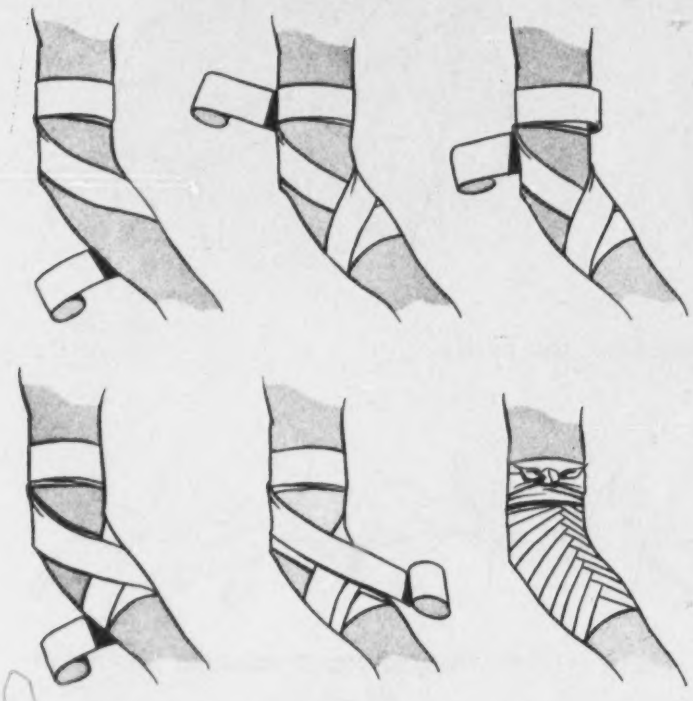

Figure 9-17.—Roller bandage for the elbow.

ROLLER BANDAGE FOR HAND AND WRIST

For the hand and wrist a figure-of-eight bandage is ideal. Anchor the dressing, whether it be on the hand or wrist, with several turns of a 2 or 3 inch bandage. If on the hand, anchor the dressing with several turns and continue the bandage diagonally upward and around the wrist and back over the palm. Make as many turns as necessary to secure the dressing properly (fig. 9-18).

ROLLER BANDAGE FOR ANKLE AND FOOT

The figure-of-eight bandage is also used for dressings of the ankle, as well as for supporting a sprain. While keeping the foot at a right angle, start a 3 inch bandage around the instep for several turns to anchor it. Carry the bandage upward over the instep and around behind the ankle, forward and again across the instep and down under the arch, thus completing one figure-of-eight. Continue the figure-of-eight turns, overlapping one-third to one-half its width, with an occasional turn around the ankle, until the dressing is secure or until adequate support is obtained. (See fig. 9-19.)

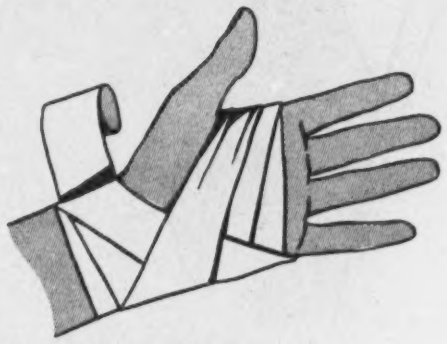

Figure 9-18.—Roller bandage for the hand and wrist.

Figure 9-19.—Roller bandage for the ankle and foot.

ROLLER BANDAGE FOR HEEL

The heel is one of the most difficult parts of the body to bandage. Place the free end of the bandage on the outer part of the ankle and bring the bandage under the foot and up. Then carry the bandage over the instep, around the heel and back over the instep to the starting point. Overlap the lower border of the first loop around the heel and then repeat the turn, overlapping the upper border of the loop around the heel. Continue this procedure until the desired number of turns is obtained and secure with several turns around the lower leg (fig. 9-20).

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Figure 9-20.—Roller bandage for the heel.

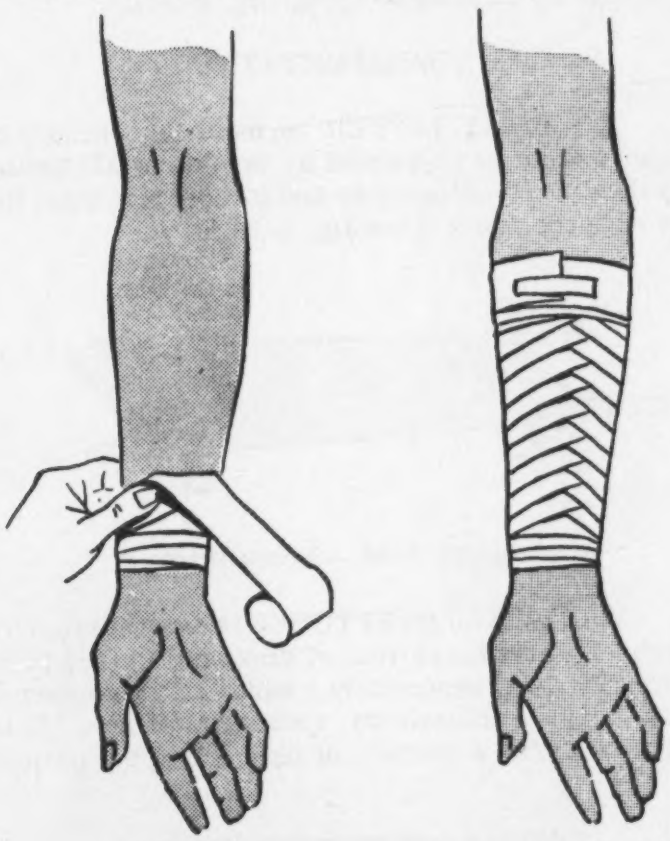

Figure 9-21.—Spiral reverse bandage for the forearm.

ROLLER BANDAGE FOR ARM AND LEG

The spiral reverse bandage must be used to cover wounds of the arms and legs; only such bandages can keep the dressing flat and even. Make two or three circular turns around the lower and smaller part of the limb to anchor the bandage and start upward, going around and around, overlapping about one-third to one-half the width of the previous turn. Continue as long as each turn lies flat. When the edge of a turn is loose, it is necessary to use the reverse lap. Continue the spiral, making the reverse laps when necessary, and secure the end when completed. Note that it is not necessary to reverse each turn as described in most text books. (See fig. 9-21.)

BARTON BANDAGE

With the initial end of the bandage applied to the head, just behind the right mastoid process, the bandage is carried under the bony prominence at the back of the head, upward and forward back of the left ear, obliquely across the top of the head, downward in front of the right ear, under the chin, upward in front of the left ear, obliquely across the top of the head, crossing the first turn in the midline of the head, thence backward and downward to the point of origin behind the right mastoid. Then it is carried around the back of the head under the left ear, around the front of the chin, and under the right ear to the point of origin. This procedure is repeated several times, each turn exactly overlying the preceding turn. The bandage is secured with a pin or strip of adhesive tape at the crossing on top of the head.

USES.—Fracture of the lower jaw and retention of dressings of the chin (fig. 9-22).

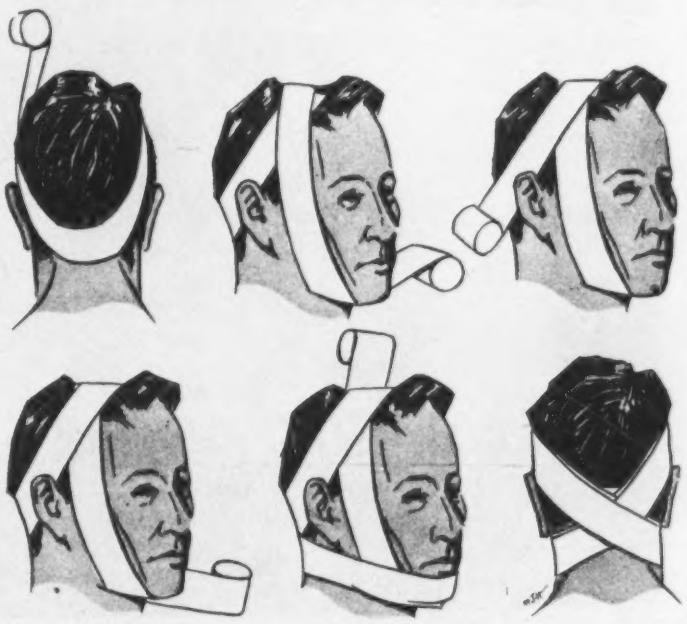

Figure 9-22.—The Barton Bandage.

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Figure 9-23.—Battle dressing.

BATTLE DRESSINGS

A BATTLE DRESSING is a combination of a dressing and bandage in one unit. It is made of many layers of gauze sewed to a muslin strip or strips. Each unit is stored in a sterile package, and is ready for instant use.

The uses of this item are limited only by the imagination of the user: in the field it ranges from minor wounds to splinting material for fractures.

CARE must be exercised in using this item:

1. Select the correct size for the job (small, medium and large).
2. Remove the outer package.
3. Tear off the sealed wrapper. Unfold and hold the dressing without touching the surface that will touch the wound.
4. Apply the sterile surface to the wound; wrap the bandage tails around the part, and secure by pinning or tying (fig. 9-23).

TRANSPORTATION

The ARMY LITTER is made essentially of canvas and is supported by wooden or aluminum poles. It is collapsible and is most practical for use in the field. (See fig. 9-24.)

Figure 9-24.—Army litter.

The STOKES STRETCHER is most commonly used for transportation of sick and injured personnel. It is essentially a wire basket supported by iron or aluminum rods (fig. 9-25). It is adaptable to a variety of uses since the patient

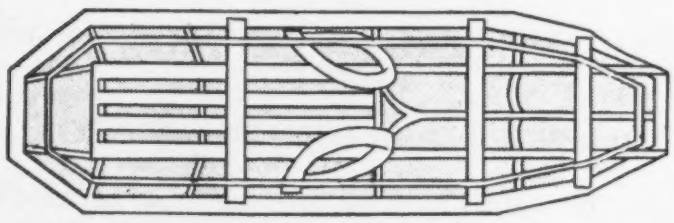

Figure 9-25.—Stokes stretcher.

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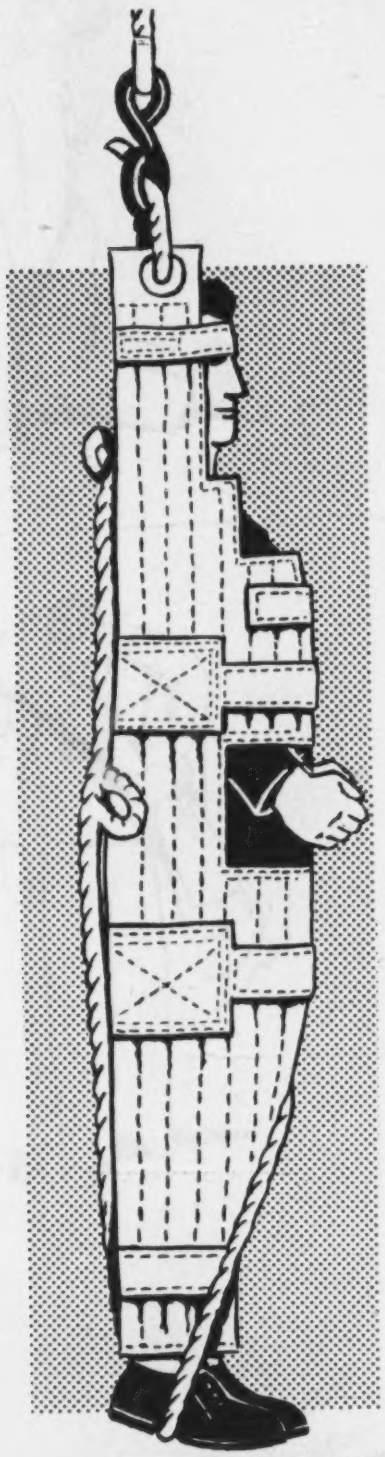

Figure 9-26.—Neil Robertson stretcher.

can be held securely in place even if the stretcher must be tipped or turned. It is frequently used aboard ship, and is particularly valuable for transferring injured persons to and from boats. It can be used to rescue injured survivors from the water. It is also used for direct ship-to-ship transfer of injured persons. The Stokes stretcher should be padded with three blankets; two of them should be placed lengthwise, so that one will be under each of the patient's legs, and the third should be folded in half and placed in the upper part of the stretcher to protect the patient's head and shoulders. The patient should be lowered gently into the stretcher, and made as comfortable as possible. His feet must be fastened to the end of the stretcher so that he will not slide up or down. Another blanket (or more) should be used to cover him. The patient must be fastened by means of the straps which go over his chest, hips, and knees. Note that the straps go OVER the blanket or other covering, and thus hold it in place.

The NEIL ROBERTSON STRETCHER is specially designed for the purpose of removing casualties from engineroom spaces, holds, and other compartments where access hatches are too small to permit the use of regular stretchers. It is made of semi-rigid canvas; when firmly wrapped around the patient, mummy-fashion, it gives sufficient support so that the patient may be lifted vertically (fig. 9-26). Stretchers of this type can be made up on board ship or ordered from the Navy medical stock list and kept in appropriate places, ready for use. If no such stretcher is available when needed, a piece of heavy canvas wrapped firmly around the patient will serve somewhat the same purpose as the Neil Robertson stretcher.

OTHER METHODS OF TRANSPORTATION

When a patient must be moved and the stretchers are not available, it becomes necessary to improvise. Inherent in this problem of moving the injured is the strength required for one man to carry or drag another. Under favorable circumstances, the maximum distance one man can be expected to move a helpless individual is about 150 feet; and when the injured is larger than the rescuer, moving him any distance at all is a feat of strength. The illustrations in figure 9-27 will help in deciding the proper method of transportation for the patient.

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Figure 9-27A.—Improvised transportation—Fireman's carry.

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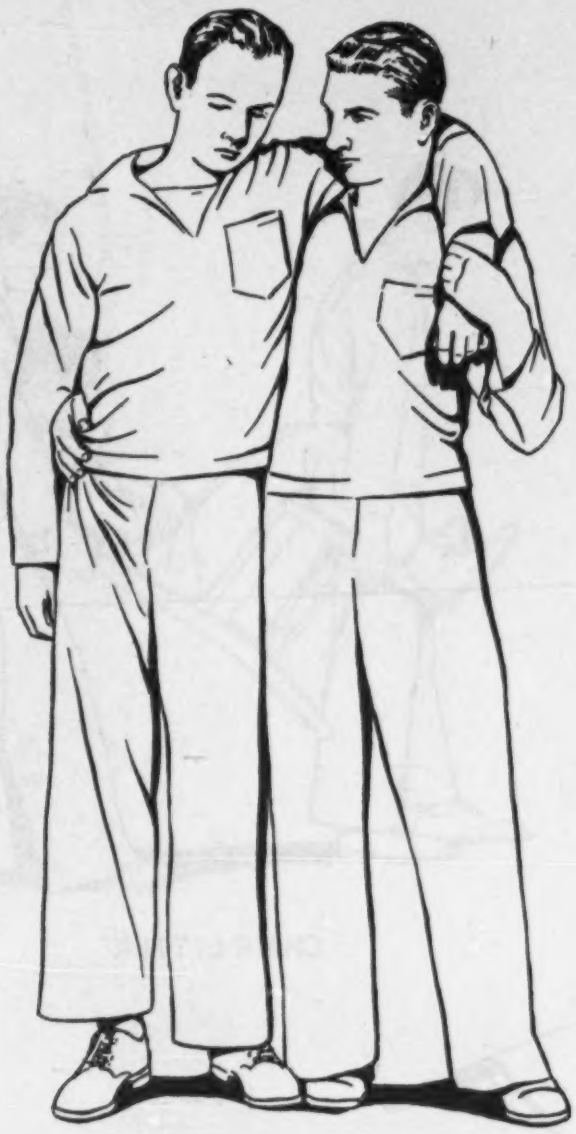

ONE MAN SUPPORT CARRY

ARM CARRY

DRAG CARRY

PACK STRAP CARRY

Figure 9-27B.—Improvised transportation.

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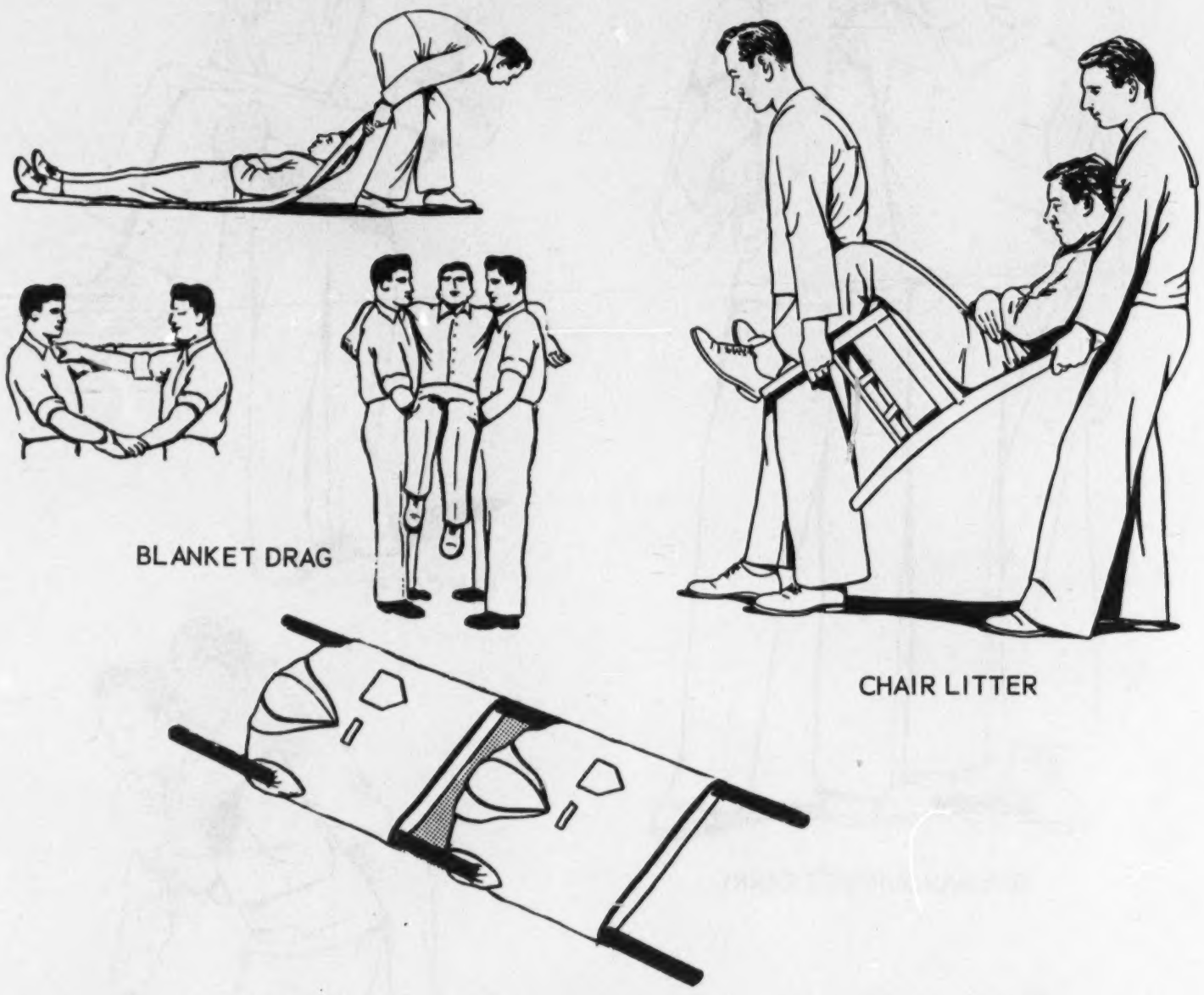

Figure 9-27B.—Improvised transportation—Continued.

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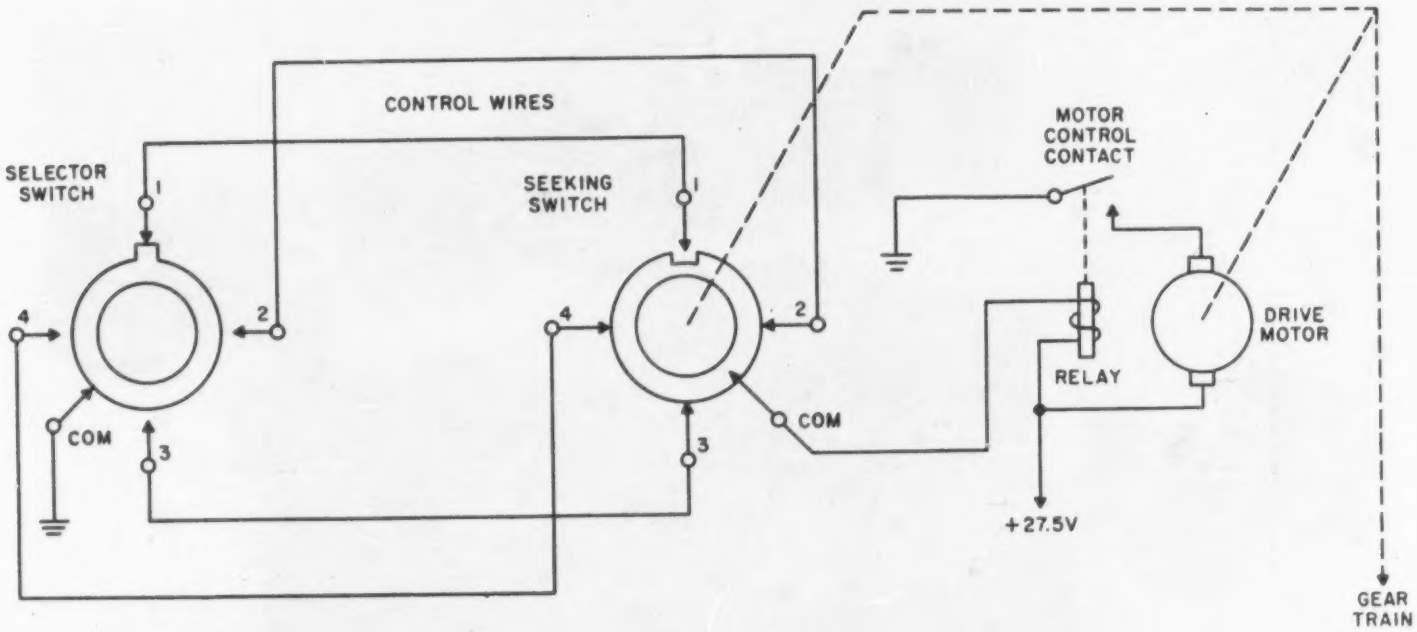

Figure 13-3. —Basic simplified automatic positioning system.

and the motor is started. The motor continues to run until the seeking switch, which is repositioned by the motor, reaches a setting corresponding to that of the selector switch. This arrangement stops the motor by opening the relay circuit.

A simplified functional diagram of an autopositioner unit is shown in figure 13-4 which indicates the elements controlled by the open-circuit seeking system. The principal involved are a motor with a gear reduction train, a slip clutch, a rotary shaft to which is fastened a notched stop wheel, a pawl which engages the notches of the stop wheel, a relay for operating the pawl and controlling the motor, and a set of electrical contacts comprising the control system.

The autopositioner (fig. 13-4) performs the following sequence during the cycle of operation:

1. The system is at rest when the selector and seeking switches are in corresponding positions. The operator begins the cycle of frequency selection by adjusting the setting of the frequency selector knob.

2. The relay is energized, lifting the pawl out of the stop wheel and closing the motor contacts, thereby starting the motor.

3. The motor drives the autopositioner shaft and the rotor of the seeking switch until a position corresponding to the new position of the selector switch is reached. Rotation of the motor shaft sets various switches and tuning elements in the receiver-transmitter.

4. When the setting corresponding to the selector knob position is reached, the open-circuit seeking switch corresponds to the selector switch. The relay circuit is then opened, the pawl engages the stop wheel and the control shaft is brought to a quick stop. The motor coasts to a stop, dissipating the kinetic energy in the slipping clutch.

A diagram of the mechanical linkage in the tuning system of the receiver-transmitter is shown in figure 13-5. The drawing reveals the various tuners and switches which rotate during the operation of frequency selection. The average time required for the equipment to set up to frequency is between three and four seconds.

POWER REQUIREMENT

The physical construction of the ARC-52 is of interest since it illustrates general design features which are effective in attaining improved reliability, a quality of prime importance in airborne equipment. The subassembly method of packaging and the use of miniaturized parts not only permit small size and weight but also facilitates maintenance on a subassembly substitution basis. The power requirements of the equipment are relatively low; when transmitting, it draws 375 volt-amperes, a reduction of about 20 percent of

CHAPTER 10

PRINCIPLES OF NURSING

ORIENTATION TO NURSING PROCEDURES

Nursing in its broadest sense may be defined as an art and a science which involves the body, mind, and spirit of the patient. It promotes the patient's spiritual, mental, and physical health by teaching and by example. In its highest form, nursing calls for the outstanding qualities that are found in most persons who work successfully in other professional fields; sensitiveness to people and their moods, insight into human nature, an ability to distinguish what is true from what is false, the capacity for sustained effort, and the mastery of the techniques involved.

The scope of the material presented in this nursing chapter is limited to those activities which the corpsman will most likely encounter in a sick bay or hospital ward. It is further limited to the "how" and "what" to do and the reader is referred to other sections of the book for the "whys." In this manner it is hoped that the corpsman will more readily see the relationship of sections to one another and thus obtain the maximum benefit and use from this book.

This chapter was compiled with these objectives in mind:

1. To provide the corpsman with a guide for use in the care of his patient.
2. To provide a basis for the standardization of routine nursing procedures in Naval hospitals.

In attempting to attain these objetives, the text is presented in the form of procedures wherever possible.

The elements of care required for all patients are included in detail, while the care of patients with specific conditions is omitted or very limited. The ward management procedures included may be generally applied to all wards.

Nursing, as defined in this book, is the care given to sick and injured people. Nursing procedures are methods used in giving nursing care to these patients.

Purposes

The purposes of nursing and nursing procedures are as follows:

1. To maintain, promote, and restore the patient's health.
2. To prevent the patient from contracting a secondary infection or a complication.
3. To assist in the treatment of a patient with disease or abnormal condition.

To achieve these purposes, it is necessary that the corpsman:

1. Attend to the comfort of the patient.
2. Prevent the spread of infection.
3. Assist with or perform diagnotic and therapeutic procedures as ordered by the doctor.
4. Plan and adapt the nursing care to meet the needs of his patient.

The Comfort of the Patient

Providing for the comfort of a patient requires attention to both the physical and mental state of the patient. By attention is meant the accurate observation of the patient's needs and then doing something about them.

"Make the patient comfortable" is NOT ordered by the doctor; it is up to the corpsman. Making the patient physically comfortable includes providing facilities for a clean patient in clean surroudings; frequent change of position, employing comfort devices when needed; relieving the patient of pain in so far as possible and attention to the patient's diet and elimination.

The bed, when neatly and correctly made, is a most important factor in the comfort of a patient. In promoting the physical comfort of a patient, it should be remembered that his mental attitude has a marked influence on his

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physical condition. Making the patient mentally comfortable includes keeping the ward quiet and cheerful; providing for the patient's rest and relaxation; treating the patient as a person; promoting his confidence in ward personnel; and keeping him contented. Physical and mental comfort depend on each other; both must be considered and remembered when planning a patient's care.

Prevent the Spread of Infection

The patient comes to the hospital or sick bay expecting to be relieved of his complaints. Everything done for the patient must be directed toward relieving his complaints without exposing him to a new infection or causing a new abnormality or disease.

All people are possible carriers and all people are possible victims of disease caused by living organisms. Remember! You are people! That is the reason why you are urged to get enough sleep and rest, why you are told to keep your body and clothes clean, and why washing your hands will be stressed throughout this section.

The comfort of the patient and the prevention of the spread of infection are measures required by and for all patients and therefore, are considered as basic nursing care.

CORPSMAN-NURSE-DOCTOR RELATIONSHIP

This is a team. The primary function of the team is the care of the patient within the limit set by higher authority.

The doctor is the coach of the team. He gives the orders and expects them to be carried out. He is responsible to the chief of his service for the care and treatment of his patients, the efficient operation of the ward, and the coordination of ward activities with other departments of the hospital.

The nurse is the quarterback of the team. She determines how the doctor's orders are to be executed. She is responsible to the doctor and senior nurse for the nursing care of her patients, the management of the ward, and the supervision and instruction of the corpsmen.

The corpsman is the half-back of the team. He carries out the orders of the doctor in the manner designated by the nurse. He is responsible to the doctor and the nurse for the efficient care of his patients and for carrying out his assigned duties.

As on any team, there must be mutual respect, cooperation, coordination, and loyalty among its members. Each must appreciate and understand the other's role. When each member knows where he fits, what he is to do, to whom he is responsible, and how he is to do his part, all members take personal responsibility for the team's product which is providing for the best possible care to, and for, the patient.

CORPSMAN-PATIENT RELATIONSHIP

The corpsman is in close contact with the patient throughout his stay in the hospital or sick bay. The patient frequently first makes known his wants, worries, fears, and pains to the corpsman. The tact, kindness, consideration, and understanding the corpsman shows toward the patient and his problems will help build the patient's confidence in the ability of all sick bay and hospital personnel to return him to health and duty in the shortest possible time.

The attitude of the corpsman toward his patients should be: friendly, sympathetic, kind, considerate, courteous, assuring, fair and honest to all; always interested, calm, dignified, soft-spoken and self-controlled.

The following are suggested as items the corpsman should think about, know and practice in relation to the patient or patients each day.

1. Be an example of good health. Be clean, look clean, feel clean. Use good posture and body mechanics in performing activities for your patient, for you may teach your patient good health habits while he is ill, which, if practiced, will help him keep well after he leaves your care.

2. Get to know your patient: How does he feel about his illness? His treatment? Other patients? Ward personnel? Try to find out and understand what makes him behave the way he does.

3. Be alert and observant. Learn to recognize signs and symptoms; be alert to changes in the mental and physical condition of your patient. Use your eyes, ears, nose, and hands. Read and understand the doctor's orders; if in doubt, consult the doctor or nurse.

4. Be adaptable. Learn to adjust nursing care to fit the individual needs of the patient.

5. Be skillful. Learn the routines of procedures so that they may be done with the least discomfort to your patient.

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6. Have regular study habits; prepare yourself to better understand the reasons for doing the job.

7. Have a plan. Use your head to save your feet. Think out what you want to do, how much time you have to do it, and the method or sequence of doing it. Examine your plan. Is it the best way to save time, materials, and produce the desired results? Will your plan make it possible for you to do the job you are capable of doing?

8. Explain your plans to your patient. Tell him what you are going to do for him and how he may help to get the best results from the procedures.

9. Protect your patient and yourself by preventing the spread of infection.

10. Teach your patient the importance of:
    a. Personal cleanliness, particularly washing his hands.
    b. Covering his mouth and nose when he coughs or sneezes.
    c. Using only his own toilet articles.
    d. Getting the proper rest.
    e. Eating the proper diet.

11. Grow in your job. Analyze your work each day — strive to do a better job the next day.

BASIC NURSING CARE

Basic nursing care, as considered in this book, consists of those environmental, hygienic, and supportive measures required by the patient for the restoration and promotion of his health and his protection against contacting any additional infection, disease, or abnormal condition.

The amount of care needed by the patient will vary with each individual. Some patients will need complete care by the nursing personnel, some will need assistance with their own care, while others will require only supervision and direction by the nursing personnel.

Patients in our hospitals are usually segregated according to clinical services. This segregation serves to protect the patient from exposure to new diseases, to provide a more specialized program of therapy for the patient, and to facilitate nursing care.

Environmental Measures

The following practices, common in the care of all patients, serve to protect the patient and prevent the spread of infection:

1. Beds are spaced at 8-foot center intervals.

2. All furniture is damp-dusted; floors are damp-swabbed.

3. Each patient is provided with a complete bedside unit:
    a. bed
    b. bedside locker
    c. chair

His necessary belongings are kept within this unit.

4. Each bed patient is provided with individual equipment such as:
    a. wash basin
    b. curved basin
    c. bedpan
    d. urinal

5. Only clean articles and utensils are brought to the patient and are disinfected or sterilized after he uses them.

6. All dishes are sterilized or sanitized after each meal.

7. All body discharges and excreta are considered as disease carriers and are treated as such.

8. Sterile supplies and equipment are used for treatments such as irrigations, instillations, surgical dressing and injections.

9. Emphasis is placed on washing hands after the care of each patient and after each task, using plenty of soap (to emulsify the dirt), friction (to loosen the dirt), and running water (to get rid on the dirt).

These practices form the basis for medical and surgical aseptic techniques which are additional measures used in caring for a patient with a communicable disease or a patient with a wound.

MEDICAL ASEPTIC TECHNIQUE is used to confine the communicable disease organisms to the patient and to protect the worker and other patients from the infection. The technique consists of isolating the patient in a separate ward, room or unit; concurrently disinfecting of materials and utensils coming from the patient; and sometimes the using of protective clothing by the worker while caring for the patient. This technique is often termed isolation or precaution technique.

SURGICAL ASEPTIC TECHNIQUE is used to protect the patient's wound from infection that may be carried in the air, by the worker, by worker's equipment, or by other patients. This technique consists of segregating the patient in a separate room or unit; sterilizing

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all articles that come in contact with the patient's wound or lesion and sometimes the wearing of sterilized clothing by the worker (as in the operating room).

Surgical aseptic technique includes the preparation, sterilization and handling of sterile supplies and equipment. When used in this sense, it is often termed sterile technique.

Appearance of the Ward

The ward is a unit of a hospital composed of a number of beds and other equipment necessary to provide service to and for the patients assigned to it. The ward may accommodate from 6 to 60 patients at one time and should provide a pleasant cheerful environment for patients and staff. The ward should be orderly—a place for everything and everything in its place.

The patient's unit should be a clean, comfortable place for the patient to live. While he is under your care, he will spend the greater part of his time in his unit. He will need a comfortable bed, a bedside locker for his personal gear, and a chair for himself or his visitors.

Beds should be in a straight line, away from walls with casters turned in, made up as for standard beds (see Bed Making) and spaced at 8-foot center intervals.

Bedside lockers should be on the right side of beds even with head of beds and clear of all unnecessary articles.

Bedside chairs should be in a straight line near foot of beds on the same side as lockers.

Overbed tables, when used, should be at the foot of the bed.

Window shades should be at uniform height and sills cleared of all articles.

Decks should be clear; shoes and slippers should be inside bedside lockers.

Waste baskets should be kept empty; other furniture arranged in orderly fashion.

Hygiene of the Ward

Ventilation: Provide for free circulation of air; protect patients from drafts by use of ventilators or screens.

Temperature: Maintain constant and proper temperatures during day, 68° (72° -75° during bath time), 65° at night.

Lighting: Avoid glaring lights in patient's eyes; promptly replace burned-out bulbs.

Odors: Eliminate disagreeable odors by prompt disposal of excreta, dressings, trash. Use deodorants, if necessary.

Noise: Avoid dropping and banging equipment and loud talking and laughing; wear rubber heels on shoes.

CLEANING A PATIENT'S BEDSIDE UNIT

Purpose

To insure a clean, sanitary bed and furnishings for the patient. It should be done weekly and when patient is discharged. Whenever presence of vermin is suspected, the entire unit should be cleaned.

Equipment

Basin of warm soapy water
Soap or detergent
Cleaning cloths
Hamper for soiled linen

Stripping the Bed

1. Bring linen hamper to unit.
2. Push bedside locker to back of bed; place chair at foot of bed.
3. Remove pillows, strip, and place on chair; place linen in hamper.
4. Lift mattress with one hand; pull out linen with other hand. Loosen bedding all around bed.
5. Remove spread, sheets, mattress cover separately, and place in hamper.*
6. Remove blanket and rubber sheet and place over back of chair**.
7. Take linen hamper out of unit.
8. Remove all articles from the bedside locker. Articles to be sterilized may be boiled or sent to CSR while the unit is being cleaned.

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*Plastic mattress covers: Do not remove from mattress for routine cleaning or upon discharge of patient. Do inspect for holes and tears. Wash in same manner as rubber sheet.

**Cotton blankets: Send to laundry with other linen. Woolen blankets: If soiled, send to laundry. Requires special laundering and should be so marked. Check station instructions for specific procedures in the care of woolen blankets.

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Cleaning Unit

1. Place cleaning equipment on top of locker.
2. Swing mattress clockwise to assure complete turning of the mattress.
3. Damp dust top and nearest side of mattress. Pay particular attention to tufts and crevices.
4. Raise the headrest of the Gatch bed. With damp cloth, wash springs, coils, bed frame; follow with dry cloth.
5. Lower headrest. Turn mattress clean side down onto the upper half of the bed. Damp dust mattress.
6. Place rubber sheet on springs, wash with damp cloth and dry. Turn onto mattress clean side down and wash other side.
7. Place pillows on springs, dust with damp cloth and turn onto mattress clean side down; do other side. Place blanket over head of bed.
8. Wash lower springs, coils, bed frame as before. With a damp cloth, wash chair; dry well.
9. Wash locker inside and outside; dry well.
10. Use detergent, if necessary, for enamel surfaces.
11. Take equipment to utility room. Scour cleaning basin, place in sterlizer, boil 20 minutes; wash out cleaning cloths, and hang up to dry.
12. Swab deck.
13. Remake bed; straighten unit.
14. Whenever possible, allow unit to air 6 to 24 hours before remaking bed.

BED AND BUNK MAKING

The hospital bed is higher than the bed in the barracks. The purpose is to bring it up to a better working level and thus reduce fatigue and avoid backstrain for the personnel caring for the patient.

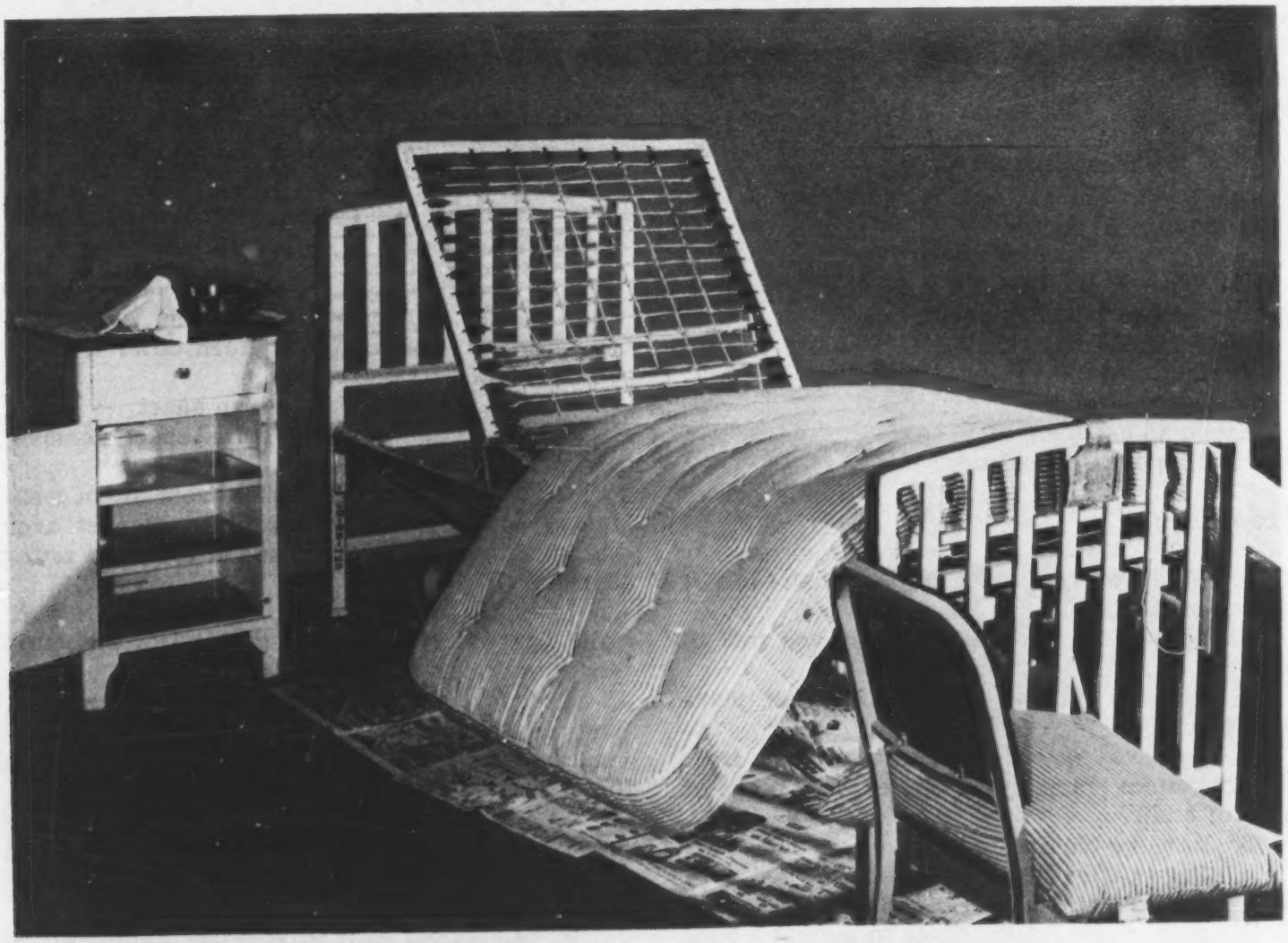

Figure 10-1.—Cleaning a bedside unit.

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The bed with a Gatch frame is the fundamental device for making the patient comfortable. The crank-operated Gatch frame permits raising and lowering of the head and foot; the newer frames may be adjusted to many different positions and have attachments to support fluid containers, orthopedic apparatus, and sidebars. The legs of the bed have rubber tired wheels to make them movable and are equipped with brakes to make them stationary. The mattress in most naval hospitals is of the inner spring type and should be firm, even, and clean. The bedding under the patient should be smooth and tight. The upper bedding should be loose, of light weight, draped evenly and of sufficient warmth and length to keep the patient comfortably warm.

A HI-LO bed has the Gatch frame plus a lever for raising or lowering the height of the bed. These are usually used for elderly patients.

The bunk aboard ship is narrower than the hospital bed and may not have a Gatch frame. The head or foot of the bunk may be raised by inserting a board under the mattress. (See fig. 10-2A.)

OCCUPIED BED

Purpose:

To change bottom sheet and draw sheet, with least exertion to patient.

Equipment:

Linen as needed.
Hamper for soiled linen.

Procedure:

1. Place chair at foot of bed; push bedside locker back of bed.
2. Loosen all bedding at sides and foot of bed.
3. Remove pillow, strip case, and place on chair.
4. Remove spread in quarters, fold from top to bottom, pick up in center, and place on back of chair.
5. Remove blanket in same manner.
6. Turn patient to one side of bed.

To change bottom sheet, draw sheet:

1. Roll draw sheet close to patient's back (Fig. 10-4).
2. Fold rubber sheet up over patient.
3. Roll bottom sheet close to patient's back.
4. Place clean sheet on bed, center fold in center of bed, narrow hem even with foot of mattress.
5. Tuck in excess at head of bed, miter corner, and tuck in at side.
6. Bring down rubber sheet; straighten.
7. Fold large sheet in half, hem to hem, smooth side out.
8. Place on bed, fold toward head of bed, over-lapping rubber sheet.
9. Tuck in rubber and draw sheets together.
10. Roll patient over to completed side of bed toward you.
11. Remove wrinkles from under patient.
12. Go to other side, fold in soiled sheets, remove, and place in linen hamper.
13. Turn back draw sheet and rubber sheets over patient.
14. Pull bottom sheet tight and smooth; proceed as for first side.
15. Pull rubber and draw sheets tight; tuck under mattress. Do center portion first, then upper and lower ends.
16. Bring patient to center of bed.

Top bedding:

1. Place top sheet over patient, wide hem even with top of mattress; turn down to make 10 inch cuff.
2. Ask patient to hold clean sheet.
3. Reach under, grasp soiled sheet, remove, and place in linen hamper.
4. Place blanket 6 inches from top of mattress. Make pleat in sheet and blanket over patient's toes, tuck in excess at foot, and miter corner. (Fig. 10-5).
5. Place spread even with head of bed; fold spread over blanket at head of bed; fold sheet over spread.
6. Tuck in excess at foot, miter corner, and allow triangle to hang loosely. Top sheet and spread may be mitered together when blanket is not needed.
7. Fit pillow into corners of case; place under patient's head, seam toward back, closed end toward entrance to ward.
8. Adjust Gatch bed as ordered.
9. Straighten unit; leave bedside stand within reach of patient.

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BED MAKING

(A) Mattress cover

Fold cover back on itself. Place top corner of mattress into cover, far corner first, flap of cover on top of mattress.

Pull cover down on mattress - working each side alternately.

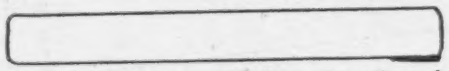

Fold under excess at foot. Smooth out cover, tighten at sides.

(B) Bottom sheet

Place center fold of sheet in center of bed, narrow hem even with foot. Fold excess sheet under mattress at head of bed.

(C) Mitered corner— Pick up hanging sheet 12 inches from head of bed.

(1)

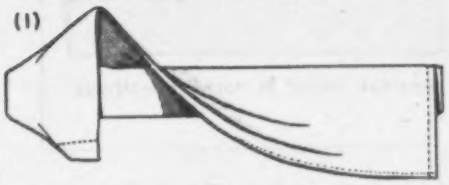

(2) Tuck lower corner under mattress.

(3) Hold fold with left hand. Bring triangle down over side of bed.

(4) Tuck sheet under mattress.

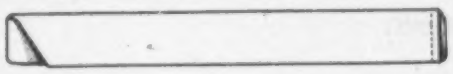

(D) Top sheet

Center fold in center of bed, wide hem even with top of mattress at head of bed, Tuck excess under mattress at foot.

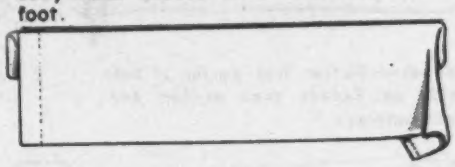

(E) Blanket— Center, in center of bed 6 inches from top of mattress. Fold excess under mattress at foot of bed.

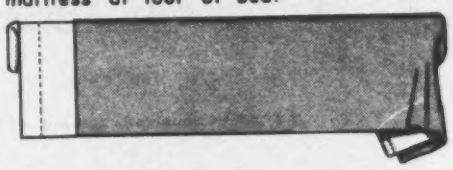

Make mitered corner at foot of bed. Tuck in triangle - do not tuck in sides

(F) Spread— Center fold in center of bed even with top of mattress. Tuck excess under mattress at foot. Miter corner, allow triangle to hang. Fold cuff of top sheet over spread at head of bed.

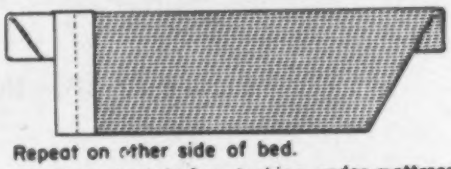

Repeat on other side of bed.
Pull sheet taut before tucking under mattress.

PILLOWS

Open pillow cover and fold it back on itself. Gather pillow lengthwise, fit corners of pillow into corners of pillow cover. Grasp pillow through pillow cover, pull cover down over remainder of pillow. Repeat for pillow case.

Figure 10-2A.—Bed making.

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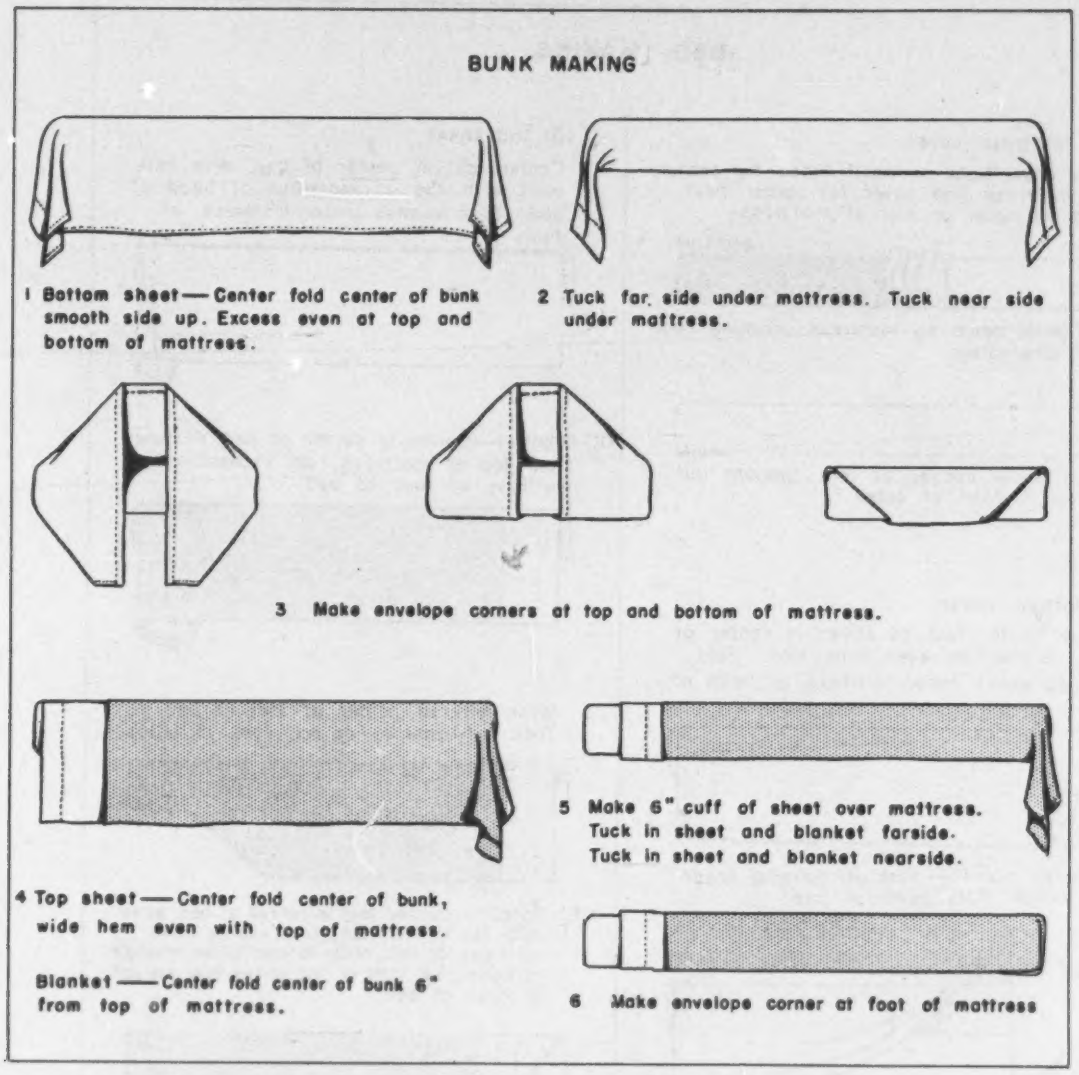

Figure 10-2B.—Bunk making.

Modifications

1. Patient's top sheet may be used as draw sheet; change top sheet first; then fold for draw sheet. Proceed as above.

2. Spread may be too short. Make foot of bed; then fold excess, if any, over blanket.

3. For patients with long-term illnesses, remove, wash and replace rubber sheet weekly or more often as necessary.

THE BUNK ABOARD SHIP is made in the same manner as the bed, with the following exceptions:

1. The patient is turned toward the corpsman.

2. The side of bunk nearest the bulkhead is completed first, the patient is then turned toward the bulkhead and the other side of the bunk is completed.

3. The top bedding is made with envelope corners at the foot of the bunk (Fig. 10-2B).

UNOCCUPIED BED

Purposes:

To provide a clean, warm, sanitary bed or bunk to receive a patient, and to protect the mattress.

To provide a neat, uniform appearance to a ward or sick bay.

Equipment:

1 mattress cover
2 sheets
1 blanket
1 spread
1 pillow with cover and case

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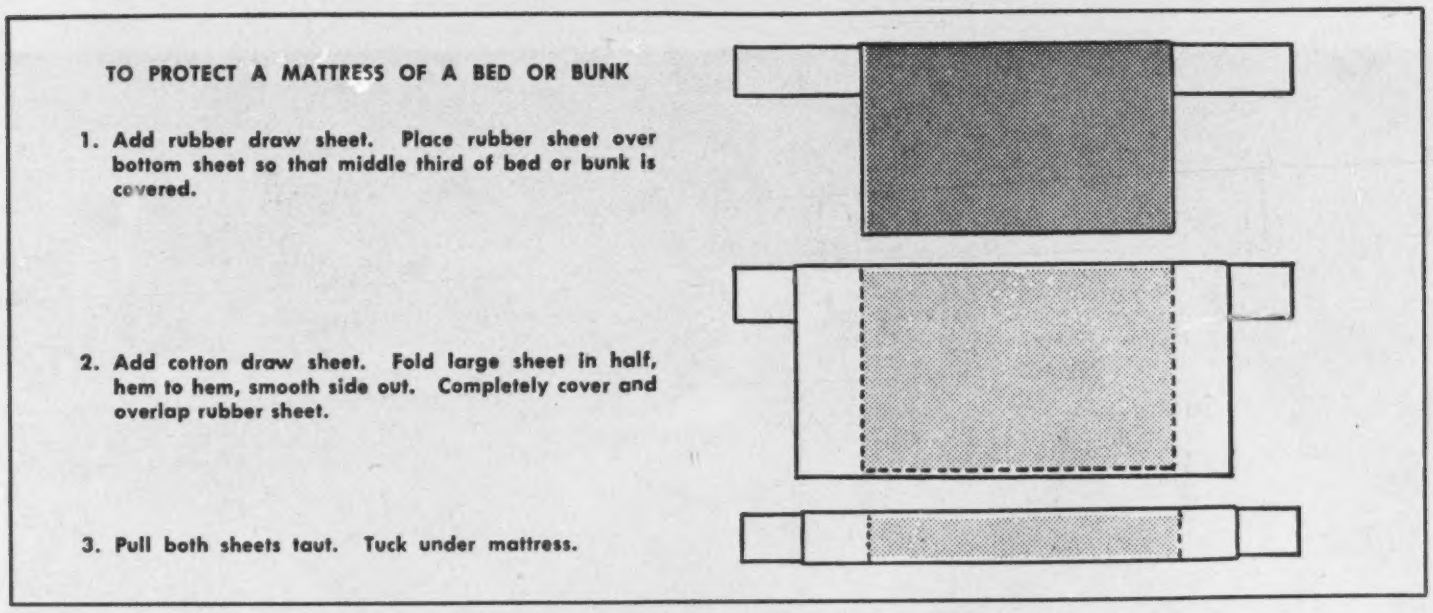

Figure 10-3.—To protect mattress of a bed or bunk.

When additional protection of the mattress is desired, add

1 rubber draw sheet
1 cotton draw sheet

Procedure:

Follow steps in figures 10-2A and 10-3. When a blanket is not needed, the top sheet and bedspread may be mitered together at the foot of the bed.

STORAGE OF PERSONAL EFFECTS

Purpose

To safeguard patient's gear; to safeguard personnel handling patient's gear; to simplify procedure for care of patient's clothes.

Procedure During Hospital Stay

In Ward

1. Check hospital instructions on care of patient's gear on the ward.
2. Toilet articles or kit may be kept in bedside locker.
3. Uniform may be placed in the ward clothes locker, which must be kept locked except when one of the ward personnel is present. All items in this locker must be properly tagged. A schedule of hours when locker is open for deposit and withdrawal by patients should be posted on ward bulletin board.

HOSPITAL BAG ROOM—for storage of all personal effects not needed on ward.

1. Hours for deposit and withdrawal are scheduled by the bag room.
2. Check local instructions before sending patient to this room.
3. Ambulatory patient will break seal and deposit or withdraw the desired items in the presence of the bag room attendant.
4. The bag room attendant will make a note of the deposit or withdrawal on the Baggage Record Card.
5. The patient will sign note.
6. The bag room attendant will draw a line through the broken seal numbers on the record card, top and stub of Patient's Effects Tag; attach new seals to the gear, and enter new seal numbers on the record card and Patient's Effects Tag; give the patient a copy of the new seal number(s).
7. Bed patient will list items he wishes withdrawn or deposited in the bag room.
8. The ward medical or nurse officer will sign a memorandum designating a corpsman to handle the transaction.
9. The bag room attendant will follow the procedure as set out under Ambulatory Patient in resealing the gear.
10. The memorandum will be attached to the Baggage Record Card.

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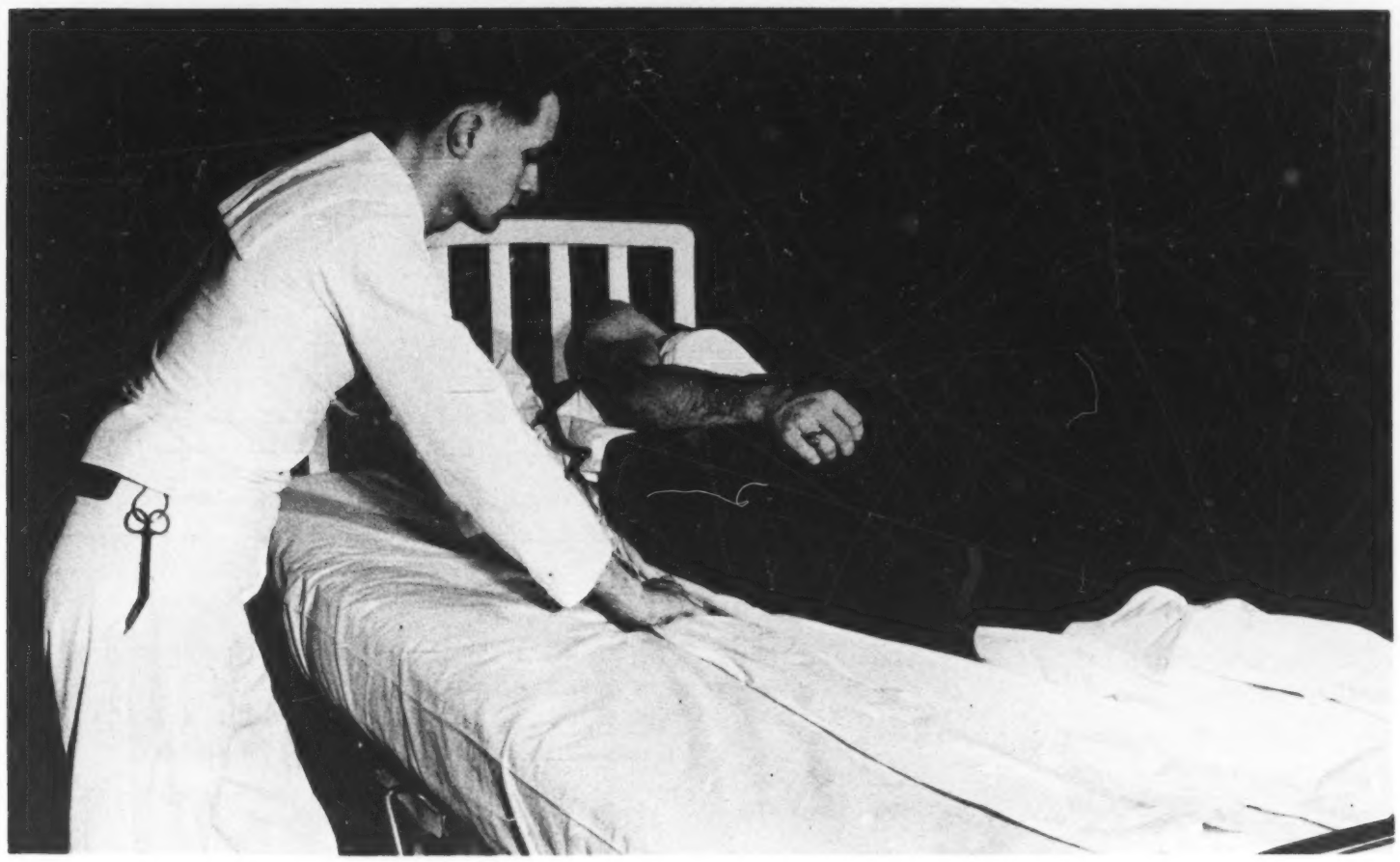

Figure 10-4.—Changing the bottom sheet.

On Discharge from Hospital

1. Patient will report to bag room on day of discharge with check-out slip.
2. Bag room attendant will sign check-out slip and will staple Patient's Effects Tag to Baggage Record Card.
3. Bag room attendant will forward cards to record office for inclusion in patient's chart.

CARE OF VALUABLES

Purpose

All property is valuable to its owner and precautions must be taken to safeguard the belongings of a patient.

Procedure

1. All patients must be informed of the wisdom of depositing their valuables with the disbursing officer for safekeeping.

2. Patient must be made to understand that no responsibility is assumed by the hospital if he retains his valuables at his bedside. A signed statement by the patient should be included in his chart if he insists.

3. Temporary storage of valuables in the narcotic locker or the ward medicine locker is prohibited.

4. Valuables are deposited for safekeeping with the disbursing officer during the day and with the officer of the day after regular working hours.

5. Ambulatory patient will be sent to the disbursing officer or officer of the day. Patient and officer will inventory valuables. The officer will give the patient a signed receipt.

6. Bed patient will inventory his valuables with the ward medical or nurse officer. The

10293

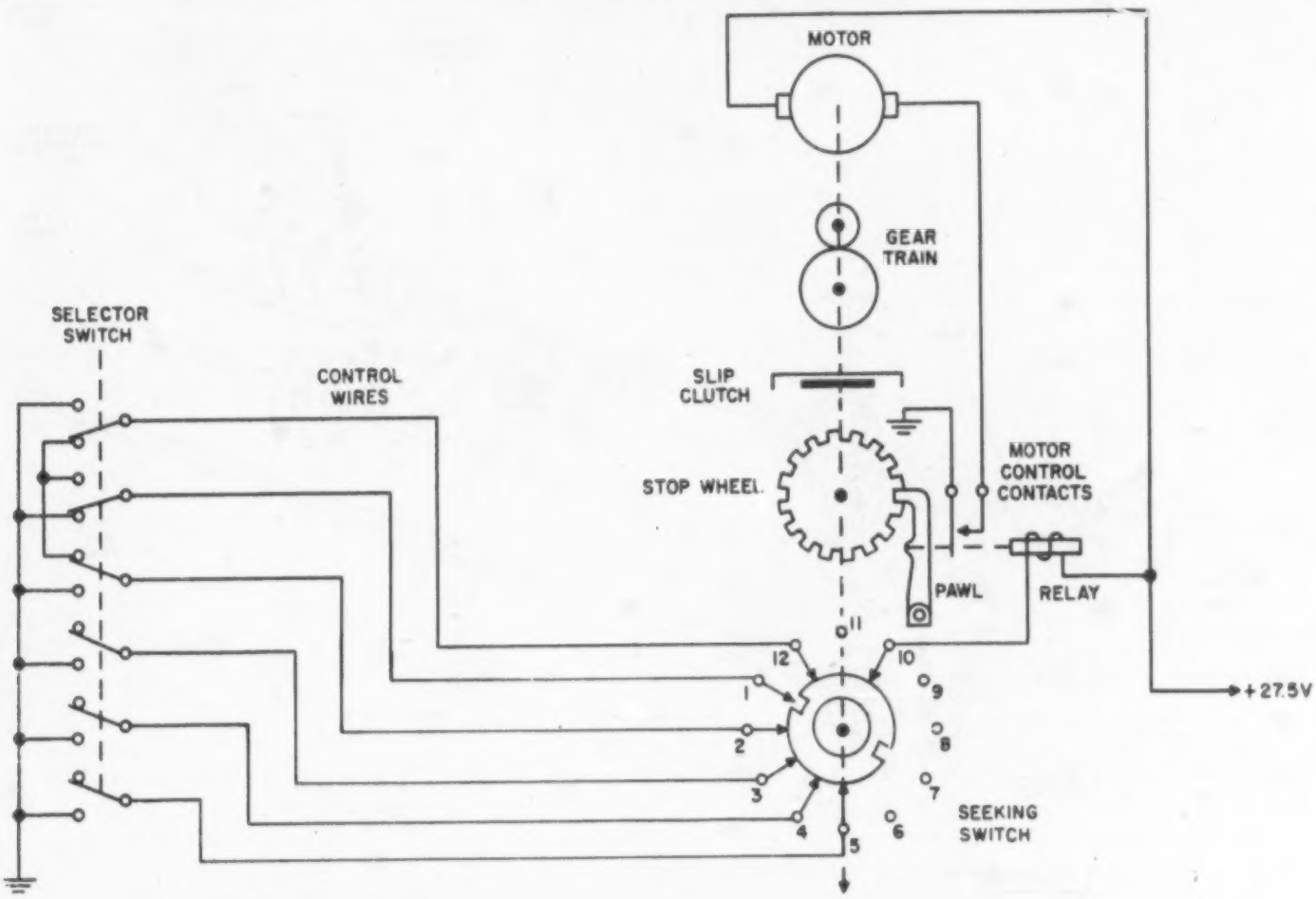

Figure 13-4.—Single automatic positioning system schematic diagram.

the input drawn by the ARC-27. When receiving, the supply power is 225 volt-amperes, a reduction of 40 percent.

The basic set is a-c supplied and hence does not employ a dynamotor. An alternate a-c/d-c version contains a dynamotor which operates only during the transmit mode, thereby minimizing brush wear and other sources of malfunctions common to rotating power equipment.

PRESSURIZATION

The pressurized case of the receiver-transmitter (fig. 13-1) serves as a rugged protective cover, an effective radiation shield, and an efficient heat exchanger. The case, which slides over the main chassis to make airtight contact with the front casting, is double walled and is constructed of corrugated aluminum. A rubber ring mounted between the case and the front casing insures the airtight seal.

Purpose and Method

The need for pressurizing the ARC-52 is to insure a constant dielectric strength of air within the equipment at all altitudes. This tends to reduce equipment failures at higher altitudes; these failures are normally caused by arcing in the less dense atmosphere. A more detailed discussion on pressurization (as it relates to the atmospheric environment) is found in chapter 6. Pressurizing is normally accomplished by the use of the MK-20A/UP dehydrator hand pump to pressurize the unit with 3 to 5 psi (gage) of dehumidified air.

COOLING

Cooling air is forced into what is called the plenum chamber between the walls by an external blower on the transceiver's front panel. After absorbing heat from the inner wall of the case, the air is exhausted through vents in the

1027 1028

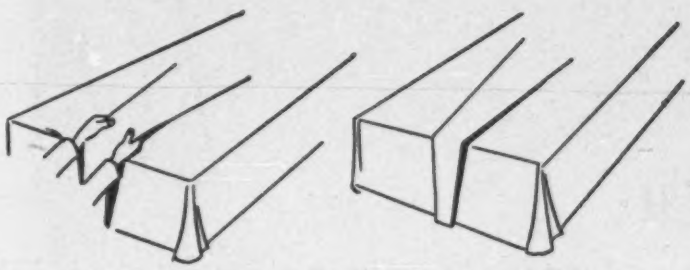

Figure 10-5.—Toe pleat.

officer will give the patient a temporary receipt and take the valuables to the disbursing officer. The patient will be given the disbursing officer's receipt and the temporary one will be destroyed.

7. Incompetent patient is unable to participate in the inventory of valuables. The ward medical and nurse officer will inventory and deposit his valuables with the disbursing officer. The receipt will be placed in the patient's case jacket in the record office.

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CHAPTER 11

CLINICAL RECORDING AND COLLECTION OF SPECIMENS

THE PATIENT'S CHART

PURPOSE

To provide a clear and concise record of the patient's condition and progress throughout each 24-hour period; to record effects and results of treatment the patient is receiving; to aid the doctor in making a diagnosis and in prescribing treatment; to help the corpsman adjust his nursing care to fit the needs of the patient; and to provide records for study, research, and statistics. Such written records are termed clinical records. They are maintained for all patients.

Arrangement of Patient's Chart

The patient's chart is composed of a series of standard clinical record forms. Each form is assigned a number in the series ranging from Standard Form 501 to Standard Form 539 and has been designed for a specific purpose. All forms will not be required for all patients; but each patient should have the following basic clinical chart arranged in NUMERICAL and CHRONOLOGICAL order:

SF 501 – Diagnostic Summary
SF 502 – Narrative Summary
SF 504 – History, Part I
SF 505 – History, Part II and III
SF 506 – Physical Examination
SF 508 – Doctor's Orders
SF 509 – Doctor's Progress Notes
SF 510 – Nursing Notes
SF 511 – Temperature - Pulse - Respiration
SF 514 – Laboratory Report (Reports 514A through Q are stapled to this sheet)
SF 519 – Radiographic Report (Reports 519A are stapled to this sheet)

When other forms in this series are used, they should be inserted into the chart in numerical order. All clinical records pertaining to each patient should be kept together in one chart holder.

The corpsman is responsible for maintaining the temperature, pulse, and respiration sheets, nursing notes, intake and output records and for plotting charts when used. He is also responsible for stapling or inserting other forms or reports in the chart.

Each sheet of the patient's chart should be neat and pleasing to the eye. When writing an entry, try to use lettering that is uniform in height and spacing. Leave a one letter space between words.

Each sheet of the chart should have complete identifying data at the foot of the page. These data should be legible, correct and complete: Patient's last name, first and middle name, service number, case number, date of admission, rank or rate, branch of service, ward, hospital or medical facility. These data may be typed, lettered or mechanically imprinted.

The MECHANICAL IMPRINTER is used for patient's identifying data on the clinical records. When used properly and maintained in good working order, the imprinter will save time and assure legible data (fig. 11-1).

An IMPRINTER PLATE for each patient is made by the admission unit and sent to ward with the patient.

The Mechanical Imprinter

1. Insert patient's plate, face up under the clips, into the bed of the machine.
2. Position the patient's record face down over the plate.

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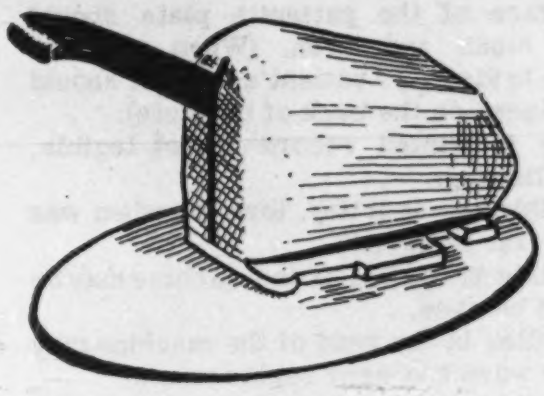

HAND IMPRINTER

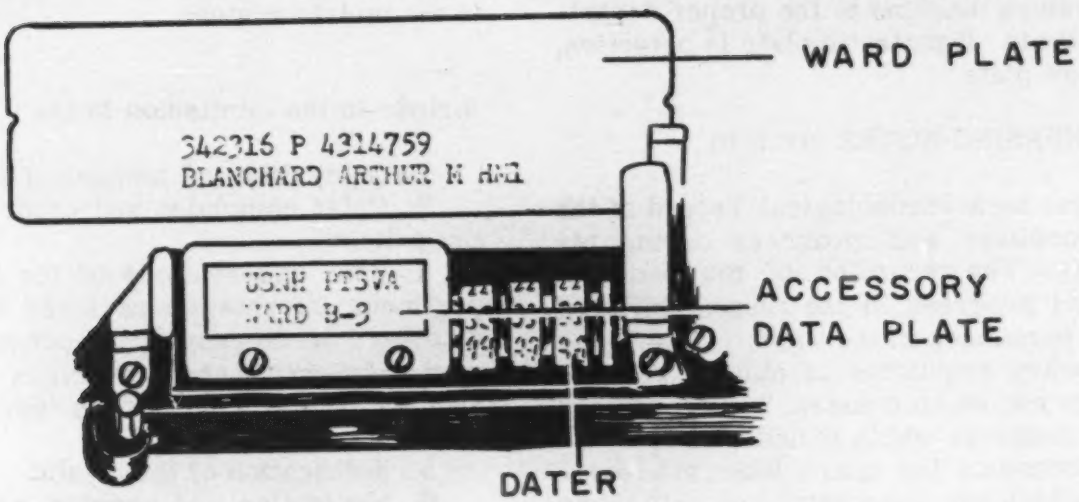

Ward Plate Inserted
in Hand Imprinter

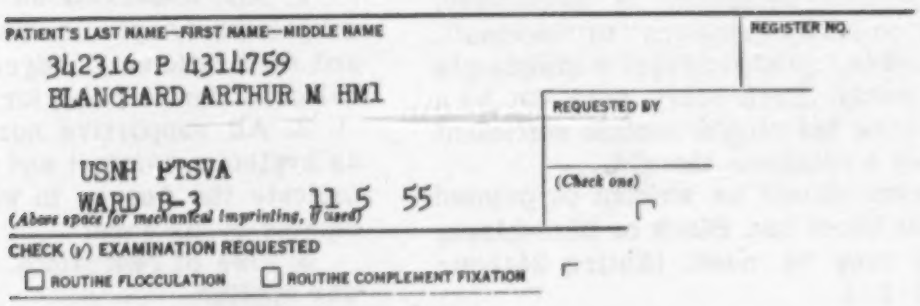

Sample Impression

Figure 11-1.—Mechanical imprinter and sample impression.

3. With the left hand holding the record, lower the head of the machine with the right hand and push the lever downward to the limit of its stroke.

4. Raise the head of the machine and remove the imprinted record. Check the record for complete and legible imprinting.

5. Remove the patient's plate and place it in the appropriate place in the ward file.

Care of the Imprinter

1. If a dater is included in the ward imprinter, it must be set daily, using a wooden stylus, never a metal object.

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2. The face of the patient's plate should always be clean and even. (When adhesive tape is used to identify a patient's plate, it should always be placed on the back of the plate).

3. If the imprinted record is not legible, check the following:

a. Ribbon — Is it dry, torn, or when was it last replaced?

b. Plate in the bed of the machine may be off balance.

c. Roller in the head of the machine may be worn and need replacement.

d. Patient's plate may have been cut unevenly.

4. If the ribbon, machine, plate, or roller is defective, return machine to the proper department for repair. If patient's plate is defective, request a new plate.

NURSING NOTES (SF 510)

This form is a chronological record of the patient's condition and progress during his hospital stay. The recording of the patient's condition and progress is the responsibility of the nursing personnel on the ward.

The primary requisites of clinical records are accuracy and completeness. The recordings must be in language which is understood by all who have access to the chart. When abbreviations or symbols are necessary, use only those listed at the end of this chapter.

The entries must be factual and truthful without interpretation. If interpretation of a patient's subjective symptom is necessary, qualify the statement by "appears" or "seems". Wherever possible, record patient's complaints in his exact words. Each entry need not be a complete sentence but should contain sufficient words to convey a complete thought.

1. All entries should be written or printed in black or blue black ink. Black or blue-black, ballpoint pens may be used. (Entire 24-hour period) (fig. 11-2A).

2. Navy date and time shall be used. (1 Nov 1965, 0220);

a. Date, shall appear at midnight, at the beginning of each new page, on admission and discharge.

b. Hour shall accompany each new entry.

3. Entries shall be signed with the full signature of the person making them. The signature may be placed at the end of the day's entries if the same person has made all of them. EXCEPTION: Narcotics, prn. stat and one time medications and treatments must be charted as soon as given or completed and the signature of the person carrying out the order must follow each entry.

4. When an error is made, draw a straight line through the error. Write "Error" above the line. If for any reason, a page must be copied, it must be marked "Copy" and the original is marked "Copied" and retained in the back of the chart (fig. 11-2B). In either case, the signature of the person making the corrections is required.

5. Include complete patient identification data in the spaces provided.

6. Entries for liquid measures are recorded in the metric system.

Include in the Admission Notes

1. Date, time and manner of admission.

2. Chief complaint and other complaints of the patient.

3. Your observations of the patient and any pertinent information received from relatives or others accompanying the patient.

4. Abnormal characteristics of the pulse and respiration must be fully described. (Record TPR only on SF 511).

5. Notification of the doctor.

6. Medication and nursing measures given.

Nursing Notes During Hospital Stay

1. All observations made. Objective and subjective symptoms. The effects of treatments and medications. Changes in the patient's physical condition or behavior.

2. All supportive nursing care given, such as hygienic, comfort and diversional measures. Indicate the degree to which the patient participates in his care.

3. Use of restraints, siderails, and reasons why applied.

4. Notification of doctor.

5. Doctor's visit other than routine sick call.

6. Treatments and consultations received in other departments, clinics.

7. Working order of apparatus in use, such as tidal drainage.

8. Specimens sent to laboratory.

9. Any accident or unusual happening. Record time and how the event occurred, the effect on the patient, whether the doctor was notified and the time he examined the patient, and the

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Standard Form 510
Rev. Feb. 1966
Bureau of the Budget
Circular A—32

CLINICAL RECORD			NURSING NOTES (Sign all notes)
DATE 1959	HOUR A.M.	HOUR P.M.	OBSERVATIONS Include medication and treatment when indicated
3 Mar		2300	Adm. via wheel chair. To bed stat. Placed in Fowler's position for comfort. States: "I can't breathe when flat in bed." Complains of severe pain in right anterior chest on inspiration. Appears worried about condition. Anxious to see doctor. Ankles and feet edematous, cyanosis about lips and fingernails. Large bruise approx. 6 in. long by 3 in. wide on outer aspect of left thigh. Has hard, dry hacking cough when he attempts to talk or move about in bed. P. 92-Fair volume, regularly irregular rhythm, easily compressed at wrist. R. 26-dyspneic, shallow, grunting in character. Appears acutely ill. Wife states: "He fell against the piano about a week ago. He has been taking Digitalis ~~gr 135~~ daily for past 2 yrs. but has not stayed on his low Sodium diet for past 2 months. He insisted on shoveling snow yesterday although he knows he shouldn't." Ned Watch HN
		2315	Examined by Dr. Alert
		2345	Morphine Sulfate gr 1/6 (N) for pain
4 Mar		2400	Penicillin 600 000 U (I.M.). NO KNOWN ALLERGY to Drug.
	0015		Digalen 2cc (I.M.). P. 92.
	0050		Placed on S.L. by Dr. Alert. Wife at bedside. S.L. slip to O.O.D.
	0045		Last rites administered by Chaplain Good.
	0100		Visited by Dr. Alert. Ned Watch HN

PATIENT'S IDENTIFICATION (For typed or written entries give: Name—last, first, middle; grade; date; hospital or medical facility)

4 15 93 C Wd 2
J654321 2300 3-3-59
VAB
VETERAN IRA BEN
USNH BCWMAN

REGISTER NO. | WARD NO.

NURSING NOTES
Standard Form 510
510-108

Figure 11-2A.—Sample nursing notes (SF 510).

10298

Standard Form 510
Rev. Feb. 1956
Bureau of the Budget
Circular A—32

CLINICAL RECORD			NURSING NOTES (Sign all notes)
DATE 1959	HOUR A.M.	HOUR P.M.	OBSERVATIONS Include medication and treatment when indicated
3 Mar	~~0850~~		ERROR ~~Penicillin 600 000 U (1.2m.)~~ John Jones HN
			Regular diet 7 30 (JB) 11 30 (JB) 4 30 (JS)
			Phenobarbital gr 1/4 8 (JS) — 12 (JS) — (4) (BF) — DC (BF)
	JS 0930		Physiotherapy
	0830		Self care supervised. Able to raise right arm to comb hair.
	1000		Complains of severe aching pain in right shoulder.
			States: "They added another 10 lbs. in P.T. today."
	JS 1015		APC tab ii for pain.
			Hot water bottle to shoulder. Arm elevated on pillows.
	1115		More comfortable but appears discouraged. Discussed his progress with him; showed his improvement over past 2 months; urged him to help other patients with similar cond. who need encouragement.
	1400		Appears more cheerful, states: "You know, that fellow really needs help." Joseph Sympatico HN
	BF 1600		Refused phenobarbital, states: "I don't need that pill anymore."
	1700		Fell while tying shoelace, striking right shoulder against bedside table. Complains of severe sharp pain in right shoulder. Doctor notified. Put to bed, backrest elevated.
	1710		Examined by Dr. Kildare. Accident report completed.
	BF 1715		Morphine Sulfate gr 1/6 (N) for pain.
	1745		Velpeau bandage applied by Dr. Kildare.
			Brian Flanagan HN

Continue on reverse side

PATIENT'S IDENTIFICATION (For typed or written entries give: Name—last, first, middle; grade; date; hospital or medical facility)

8 21 39 P Wd 6
J123456 0730 12 28 58
200 000 01 PFC USMCR
WATELIFTER HUGH (N)
USNH UTOPIA

REGISTER NO. | WARD NO.

NURSING NOTES
Standard Form 510
510-106

Figure 11-2B.—Sample nursing notes (SF 510).

10299

completion and submission of a special report if one is required at your station.

10. Serious or critical lists. Record the time the patient is placed on the S. L. or C. L., whether next of kin are present at the bedside, and the completion and forwarding of the S.L. or C. L. to the proper departments as required by your station. Follow the same procedure when the patient is removed from the S. L. or C. L.

11. Administration of religious rites. Record the time and by whom the rites were administered.

12. Diets. Record the type of diet. Record patient's likes and dislikes of foods and the amount of food he eats if such is significant in his care.

13. Nourishment. Record the type of nourishment when significant in the care of the patient.

14. Single order for medication or treatment:

a. Medication. Record time in hour column, record name of drug, dosage and manner of administration if other than by mouth, after it has been given, followed by signature, in "observations" column.

b. Treatment. Record time in hour column, record name of treatment, amount of solution if used, and duration of treatment if for prescribed time, after it has been given, in "observations" column.

15. Repeated or running orders for diets, medications or treatments are charted in the "observations" column followed by the hours to be repeated. When given make a diagonal line through the hour and place initials above. When a diet, medication or treatment is not given for any reason, record the hour, circle and initial it, and record the reason for the omission in the body of the Nursing Notes at the appropriate hour. When a diet, medication or treatment is discontinued, enter DC and initial above the entry.

TEMPERATURE-PULSE-RESPIRATION, FAHRENHEIT (SF 511)

1. Form SF 511 is usable for one week. The graph is divided into seven major columns—one for each day. Each daily column is subdivided into two parts — a.m. and p.m. Each subdivision is further divided by two vertical dotted lines. Note that the dots in the lines divide the vertical spaces into five even divisions, (for each two-tenths degree of temperature or two pulse beats).

2. Use black or blue-black ink for all entries. Fill in heading at top of page. The day of admission is the first hospital day. The day of operation or delivery is lettered "Operation" or "Delivery"; the following day is the first postoperative or postdelivery day. Record the hours TPR's are taken.

3. After patient's name at the bottom of page print his serial number, rank or rate, branch of service, or civilian status, or use the mechanical imprinter if available.

4. For every four hour and twice-a-day temperature and pulse readings, place the recording within the dotted lines (fig 11-3).

5. For four-times-a-day readings, place the recordings on the dotted lines.

6. Use the same symbol, a dot the size of pinhead, for temperature and pulse. Record by date corresponding vertically to hour, horizontally to scale. Connect the dot with previous recording by a solid line.

7. Record number of respirations in space corresponding vertically to hour.

8. When blood pressure is ordered more than two times a day and pulse and respiration more than six times a day, they may be recorded on the Plotting Graph, (SF-512).

9. Record height and weight on admission. Record subsequent weight in correct date columns.

10. The blank space below the graph may be used as desired; for example: intake and output 24 hour totals, blood transfusions, totals of specific drugs.

PLOTTING CHART (SF-512)

This form may be used for additional graphic representation of data as required.

USE:

Blood pressure recording
Weight chart
Drainage chart
Pulse, respiration, and blood pressure

General Rules for Constructing Graphs

1. Purpose of graph must be known; print purpose of graph on upper left-hand space provided (fig. 11-4).

2. A graph should always read from left to right.

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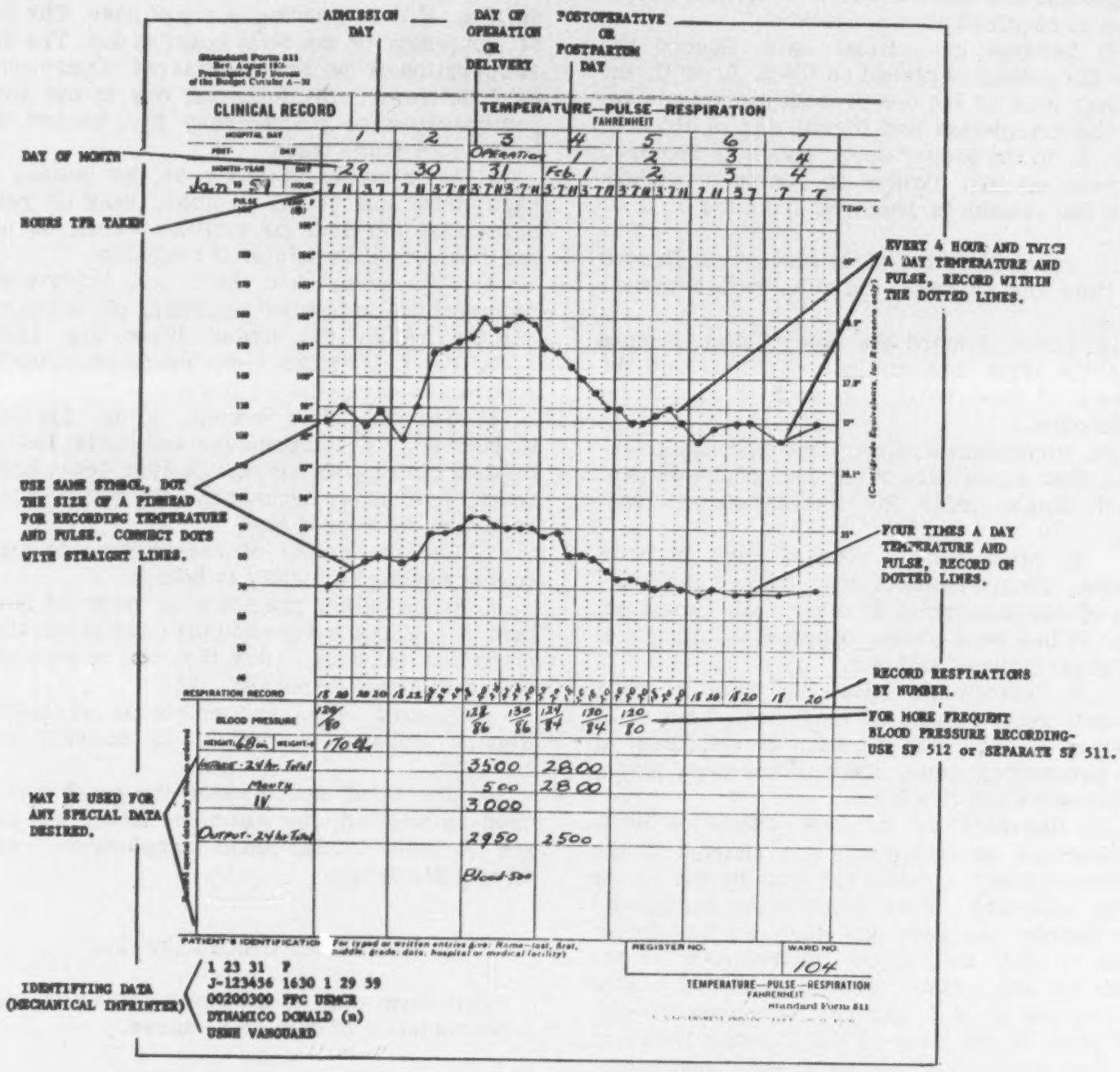

Figure 11-3.—Sample temperature-pulse-respiration (SF 511).

3. Measurement should be calibrated along vertical portion of graph.
   a. Scale should be at a definite and uniform rate of progression. EXAMPLE: 0—10—20—30.
   b. Scale should be labeled at top to show units of measure. EXAMPLE: cc—lbs—mm—gm.

4. Passage of time should be noted along horizontal portion of graph. EXAMPLE: Dates and hours measurements are made.

5. Meaning of symbols used in graphs should be shown in a key to the side of the graph.

6. When lines are used in graphing, they should be labeled to the left of their starting points.

INTAKE AND OUTPUT WORKSHEET (DD 792)

Whenever a record of intake and output of fluids by the patient is required, the Nursing service — Twenty-four Hour Patient Intake and

10300
10301

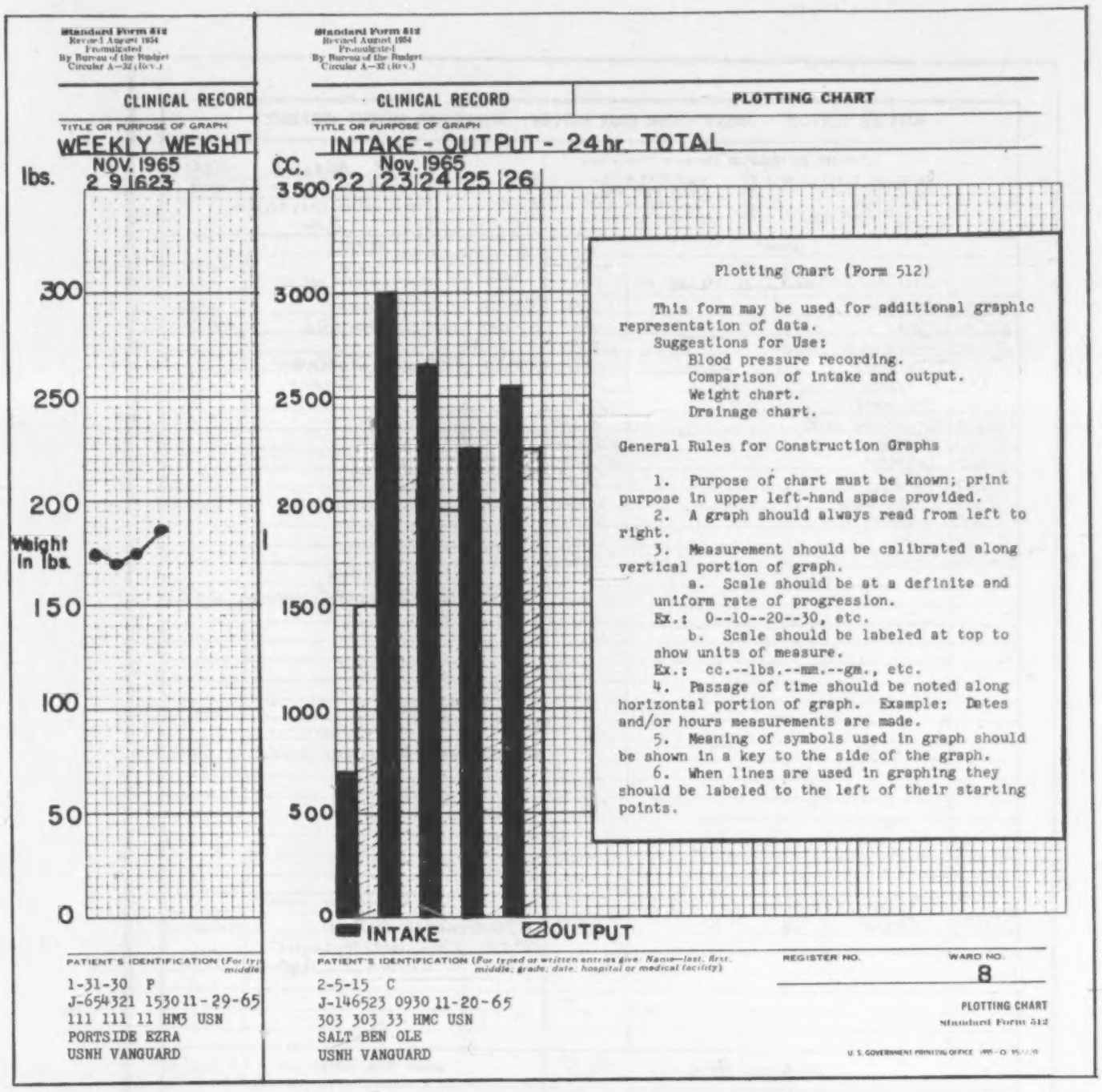

Figure 11-4.—Sample plotting chart (SF512).

Output Worksheet (DD 792) should be used. The worksheet is self-explanatory (fig. 11-5).

At 2400 hours daily, the intake and output totals should be recorded in the Nursing Notes (SF 510) or TPR Sheet (SF 511) of the patient's chart.

When DD 792 is not available:

1. Rule a sheet of paper into columns for time, intake, and output.

2. Each time a patient drinks, is fed through a gastric tube, or receives fluids by intravenous or hypodermoclysis, record time and the amount of intake, using the metric system. The following equivalents may be used:

Medicine glass	30 cc
Small fruit cup	120 cc
Coffee cup	120 cc
Large coffee mug	180 cc
Half pint milk	240 cc
Large soup bowl	240 cc
Large water glass	240 cc
China pitcher	480 cc

60601 10302

NURSING SERVICE - TWENTY-FOUR HOUR PATIENT INTAKE AND OUTPUT WORKSHEET

*INTAKE EQUIVALENTS (Serving levels cc)

MEDICINE GLASS (1 oz.)	30	HALF PINT MILK	240
SMALL FRUIT CUP	120	LARGE SOUP BOWL	240
COFFEE CUP	120	LARGE WATER GLASS	240
LARGE COFFEE MUG	180	CHINA PITCHER	480

DATE: 12 March 1959
FROM 2400 HOURS TO 2400 HOURS
TOTAL NUMBER HOURS COVERED: 24

INTAKE*			OUTPUT		
HOUR	BY MOUTH State type of fluid & if by tube add (T)	AMOUNT (cc)	HOUR	URINE If by catheter add (C)	AMOUNT (cc)
0130	Water	60	0400	1K Amber	90
0630	Tea	60	1100	2K Amber (C)	120
0715	Pineapple Juice	120			
	Coffee	90	2400	Retention catheter	
0930	WATER	60		2K amber	300
1100	Broth	120			
1200	Ginger Ale	60			
1330	Tea	120			
1500	Water	sips			
1600	Tea	60			
1800	Bouillon	120			
1930	Water	60			
2100	Tea	120			
2230	H_2O	90			
				DRAINAGE	
			2400	Gastric-yel. green	250
				EMESIS	
			0630	Vomiting, yel. green	180
	INTRAVENOUS, SUBCUTANEOUS, CLYSIS (Specify)			STOOLS (Character, color)	
0930	D/W 5%	1000	0700	Soft brown	Large
			1200	Thin, watery, light brown Approx	400
	GRAND TOTAL INTAKE (cc)	2140		GRAND TOTAL OUTPUT (cc)	1340

10-2 -13 P Wd 4
J 111111 1030 2-3-59
DEP/W CAPT USN
RANK HEDDA
USNH VANGUARD

INSTRUCTIONS

Space to left is for mechanical imprinting, if used. If typed or handwritten, enter the following:

PATIENT'S LAST NAME, FIRST NAME, MIDDLE NAME;
REGISTER NUMBER; WARD NUMBER;
NAME OF HOSPITAL OR OTHER MEDICAL FACILITY.

DD FORM 1 SEP 54 792

U. S. GOVERNMENT PRINTING OFFICE: 1955 O— 329456

Figure 11-5.—Sample Intake and Output Worksheet (DD 792).

Each time a patient voids, or loses fluids by vomiting, gastric or urinary drainage or diarrhea, record time and the amount of output.

4. Total intake and output columns at 2400 and record in the Nursing Notes (SF 510) or TPR Sheet (SF 511) of the patient's chart. Start a new sheet at 0001.

S0C0110303

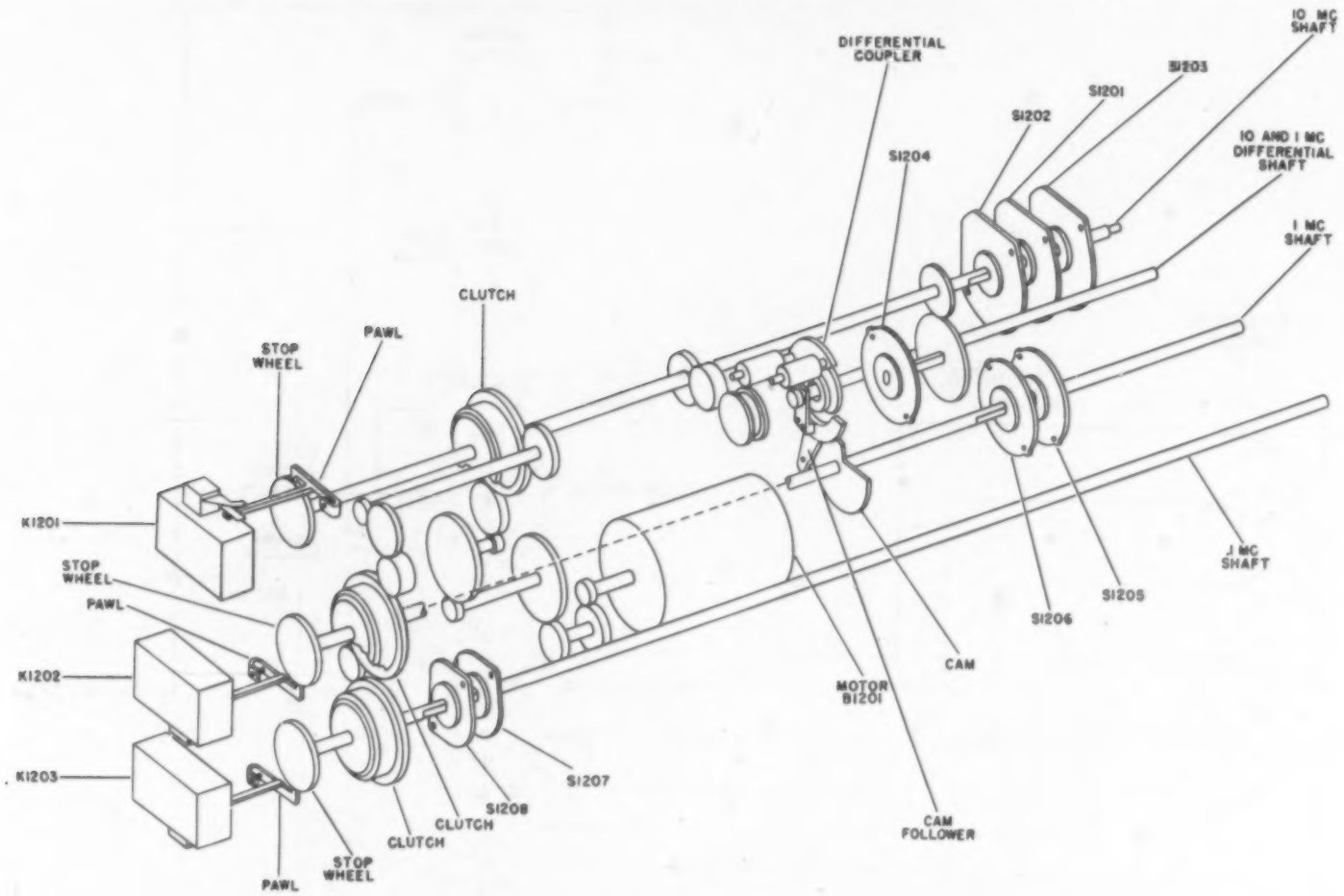

Figure 13-5. —Mechanical drive subassembly of tuning system.

top of the cover. Inside the air-sealed container an axial-flow blower circulates the air to improve the heat transfer.

All blowers are a-c operated so that brush wear and commutator faults are eliminated.

The case is designed structurally to withstand atmospheric internal pressure with complete absence of external pressure. Extra ruggedness in the shock mounts helps to overcome the effects of the high stresses occurring in catapult takeoffs and arrested landings on aircraft carriers.

THEORY OF OPERATION

The ARC-52 system is shown in block diagram form in figure 13-6. A relay switches the signal and it goes through the amplifier in the same direction both in transmit and receive.

The system employs double-conversion superheterodyne operation to provide maximum selectivity and sensitivity. In reception, the incoming signals are heterodyned successively in two mixer stages with injection frequencies from two separate sources to produce the desired intermediate frequencies. Conversely, during transmission a basic frequency is mixed with the two injection frequencies to provide a carrier in the required frequency range.

Injection signals in the 200- to 370-mc range are derived from the spectrum generator (fig. 13-6) in which the fundamental signals are produced by a crystal oscillator, then fed through a frequency multiplication system, and amplified.

Injection frequencies in the 21.85- to 31.75-mc range are produced by heterodyning the output of a crystal oscillator having a 24.9- to 33.9-mc range with the output of a crystal oscillator with a 3.05- to 2.15-mc range.

In reception, the incoming signal is fed through an RF amplifier to the first mixer, where it is heterodyned with the 200- to 370-mc output of the spectrum generator and amplifier. The result is a 20.0- to 29.9-mc first IF signal, which is amplified and fed to

DIAGNOSTIC TESTS AND EXAMINATIONS

The collection of specimens from patients for examination is a very important detail. The doctor must sign the request for the test or examination. Collecting is usually done by the hospital corpsman and the performance depends upon his conscientiousness, sense of responsibility, and understanding of what is required.

The object of collecting specimens is to provide an accurate sample of body fluid or tissues for examination. The examination results provide the physician with information to assist him in diagnosis, to help determine the progress of the patient's disease, and to furnish information regarding results of the treatment employed. Specimens are examined by general appearance, and by chemical and microscopic methods.

Diagnostic and therapeutic procedures have so greatly increased in number, scope, and complexity that the corpsman may find himself spending the greater portion of his time on duty assisting with or performing these procedures.

In order to intelligently assist with or perform these procedures the corpsman should know:

1. How and why the procedure is done.
2. What care the patient should have before, during and after the procedure.
3. What role he takes in the procedure; what part the doctor or technician assumes.
4. What equipment is necessary for the procedure; whether the equipment should be clean or sterile.
5. The time of the day the procedure may be performed to obtain the best results.
6. What symptoms and reactions are expected as a result of the procedure. What symptoms or signs of untoward reactions may occur.

When assisting with or performing these procedures, always strive to keep in mind that each one has been ordered by the doctor for the patient. The benefit the patient will derive from the procedure will depend to a considerable degree upon your ability to explain the procedure sufficiently to him so that he understands what is to be done, why the procedure has been ordered, and how he may help to assure the success of the procedure.

Preparation of the Patient

Explain the test or examination to the patient.

Show the patient how to cooperate to make a successful test or examination.

Provide transportation (wheel chair, stretcher) when test or examination is performed in another ward or department.

Care of the Patient after Test

Relieve pain if present.

Heat and serve food if meal has been withheld.

Give bath or a.m. care if either have been omitted.

Charting — Nursing Notes

1. Specimens:
   Time of collection
   Type of specimen
   Name of test ordered
   Amount of specimen in ml. if measurable.
   Any other item affecting the result of the test.
   EXAMPLE: 1000: Bromsulphalein 25 mg. I.V. given by Dr. Jones.
   1030 Blood specimen collected.

2. Special tests or examinations:
   Time of the test.
   Name of the test.
   Department performing the test.
   Name of the doctor doing the test if done on the ward.
   Amount and description of fluid obtained if applicable.
   Special preparation of the patient for the test.
   Reaction of the patient to the test.
   EXAMPLE: 1000: Lumbar puncture by Dr. Jones. 5cc. clear, colorless spinal fluid obtained. Manometer pressure 150mm. Patient placed in prone position. Patient cautioned to remain flat in bed.
   1030: Patient complains of headache.

10304

COLLECTION OF SPECIMENS

Observe the nine "rights" for collecting specimens

Be sure that –

1. The right specimen, from
2. The right patient, collected in
3. The right manner, at
4. The right time, into
5. The right container, in
6. The right amount, and with
7. The right label, is taken to
8. The right place in the laboratory, and handed to
9. The right person.

Caution

When collecting specimens:

1. Wash your hands before and after touching specimens and containers.
2. Never use a cracked receptacle.
3. Allow no opportunity for the patient to deceive, as one wishing to seem more or less ill than he really is might get another patient to void, expectorate, or produce some other specimen for use.
4. Never leave specimens in the ward, nor uncovered in the head or lavatory; but when necessary, while further collection is being made, keep properly covered in an isolated place in the heads or lavatory.
5. Keep the outside of the container clean to protect other personnel handling the specimen.
6. Attach request for examination to the specimen container with a rubber band, string or clip. Exception: Keep request separate when specimen is from a patient with a communicable disease. Place specimen container inside a clean paper bag and clip request to clean side or bag.
7. Do not send specimens to the laboratory that have been spoiled by cigarette butts, matches, tissues or other debris.

URINALYSIS – ROUTINE AND MICROSCOPIC

Clean Specimen

Equipment

Urinal or bedpan
Specimen bottle with cap
Rubber band
Standard Form 514A

Procedure

1. Patient voids into clean urinal or bedpan. The first morning specimen is preferred.
2. 120 to 150 cc is poured into specimen bottle.
3. SF 514 A is wrapped around bottle and held in place by a rubber band.

Duty of Ward Corpsman

1. Make out request.
2. Collect specimen, and send to laboratory.
3. When report is received, staple the SF 514A to the SF514 in patient chart (fig. 11-6).

Sterile Specimen

Equipment

Catheterization tray
Sterile specimen bottle
Sterile 4 x 4 (2)
Rubber bands (2)
Standard Form 514A

Procedure

1. Patient must be catheterized; however if physician so orders, the specimen may be collected in the following manner:
   a. Meatus throughly cleansed with soap and sterile water using cotton balls.
   b. Patient voids directly into a sterile specimen bottle after voiding and discarding the first ounce of urine.
   c. Specimen is covered with sterile 4x4s.

Duty of Ward Corpsman:

Same as for clean specimen.

24 Hour Specimen (Quantitative)

Equipment

Urinal or bedpan
Gallon bottle (from laboratory)
Shipping Tag
Standard Form 514A

10305
10304

Preparation of SF 514 A-M.
Complete identifying data.

Complete additional information required by test or examination.

Insertion in Clinical Chart.
Call attention of medical officer to report.

Staple report (left side only) to SF 514.

Indicate test or examination performed across foot of report.

Staple each subsequent report on top and above the previous report so that date and action performed are visible. Indicate date of report when it is not visible in lower section of the form.

Standard Form 514
Rev. August 1954
Promulgated by Bureau of the Budget Circular A-32 (Rev.)

CLINICAL RECORD | **LABORATORY REPORTS**

PATIENT'S LAST NAME—FIRST NAME—MIDDLE NAME: 1-23-30 P
J- 203948 0315 2 10 59
675 483 23 PPC USMCR
STARBOARD JOHN (N)
USNH VANGUARD

REGISTER NO.

WARD NO. 9

REQUESTED BY: H. Kiedan

DATE OF REQUEST: 17 Feb 1959

(Check one) ☒ BED PATIENT ☐ AMBULATORY

(Leave space for machine or typewriting, if used)

INDICATE EXAM. REQUESTED BY (✓) ☒ PSP ☐ CONCENTRATION ☐ DILUTION ☐ QUANTITATIVE SUGAR

SOURCE OF SPECIMENS ☐ BLADDER ☒ VOIDED ☐ CATHETERIZED ☐ RIGHT KIDNEY ☐ LEFT KIDNEY

SPECIMEN NO.	TIME COLLECTED	VOLUME	% OF DYE	% OF SUGAR	SP. GR.
#1	0915	320cc	48		
2	0930	90cc	22		
		TOTAL			

REMARKS:

DATE OF REPORT: 17 Feb 1959 | SIGNATURE (Specify Lab. if not part of requesting fac.): B Conley | NAME OF HOSPITAL OR OTHER MEDICAL FACILITY

Standard Form 514 (L)—Rev. August 1954. Promulgated by Bureau of the Budget—Circular A-32 GPO 10—36068-4

RENAL FUNCTION
PSP

DATE OF REPORT: 16 Feb 1959 | SIGNATURE (Specify Lab. if not part of requesting fac.): [illegible] | NAME OF HOSPITAL OR OTHER MEDICAL FACILITY

SPUTUM AND BACTERIA CONTENTS
AFB

DATE OF REPORT: 15 Feb 1959 | SIGNATURE (Specify Lab. if not part of requesting facility): J Sher | NAME OF HOSPITAL OR OTHER MEDICAL FACILITY

Standard Form 514E (Rev. Aug. 1954) Promulgated by Bureau of the Budget Circular A-32

BACTERIOLOGY
Rectal Swab

DATE OF REPORT: 13 Feb 1959 | SIGNATURE (Specify Lab. if not part of requesting fac.): [illegible] | NAME OF HOSPITAL OR OTHER MEDICAL FACILITY

Standard Form 514b—Revised January 1957. Promulgated by Bureau of the Budget—Circular A-32. GPO 10—68370-4

BLOOD CHEMISTRY
BUN

DATE OF REPORT: 13 Feb 1959 | SIGNATURE (Specify Lab. if not part of requesting fac.): [illegible] | NAME OF HOSPITAL OR OTHER MEDICAL FACILITY

Standard Form 514d—Rev. August 1954. Promulgated By Bureau of the Budget—Circular A-32. GPO 10—68367-6

SEROLOGY
KAHN

DATE OF REPORT: 17 Feb 1959 | SIGNATURE (Specify Lab. if not part of requesting fac.): [illegible] | NAME OF HOSPITAL OR OTHER MEDICAL FACILITY

Standard Form 514e—Rev. August 1954. Promulgated by Bureau of the Budget—Circular A-32

HEMATOLOGY
WBC + DIFF

Standard Form 514h—Rev. August 1954. Promulgated By Bureau of the Budget—Circular A-32 GPO: 1958-456228

URINALYSIS
R+M
11 Feb 1959

STANDARD FORMS 514a THROUGH 514m WILL BE ATTACHED TO THIS SHEET

PATIENT'S IDENTIFICATION (For typed or written entries give: Name—last, first, middle; grade; date; hospital or medical facility)

1-23-30 P
J-203948 0315 2 10-59
675 483 23 PPC USMCR
STARBOARD JOHN (N)
USNH VANGUARD

REGISTER NO.

WARD NO. 9

LABORATORY REPORTS
Standard Form 514

U. S. GOVERNMENT PRINTING OFFICE 10—50800-6

Figure 11-6.—Sample laboratory reports (SF 514).

Procedure

1. Shipping tag is made out with patient's name, rate, date, and type of specimen; tied to gallon bottle.
2. All urine voided is placed in gallon bottle.

Duty of Ward Corpsman

1. Instruct the patient in regard to the required procedure.
2. Collect specimen for 24 hours (0700 to 0700), discarding the first morning specimen.
3. Continue as for clean specimen.

Clinitest. Reagent Test for Sugar

Equipment

Clinitest reagent tablets No. 2102.
Bedpan or urinal
Medicine dropper
Clinitest color chart

Procedure

1. Collect as for single specimen 20-30 minutes before meals or as ordered by doctor.

19300L

2. Place 5 drops of urine in test tube. Rinse dropper then add water to test tube. Drop 1 clinitest tablet into tube, watch solution boil. Wait 15 seconds after boiling stops, then shake tube gently.
3. Hold tube next to color chart and compare.
4. All shades of blue negative.
5. More than 2 percent causes rapid change to green, olive tan, orange, brown: Positive.

Duty of ward corpsman

1. Collect urine specimen and conduct test.
2. Record results on patient's chart; report positive results to ward nurse or medical officer.

FECES

Ova and Parasites (O & P)

Equipment

Clean bedpan
Screw-cap bottle
two tongue blades
Standard Form 514G

Procedure

1. Collect specimen in clean bedpan.
2. Take bedpan to utility room
3. With tongue blades, remove feces (at least the size of a walnut) from pan and place in the bottle.
4. Screw cap on tightly.

Duty of Ward Corpsman

1. Collect specimen
2. Send specimen to laboratory immediately.
3. When report is received, staple the SF 514G to the SF 514 in patient chart.

Occult Blood

Equipment

Same as O & P.

Procedure

1. Same as O & P except add that the patient is placed on a meat-free diet at least 2 days before specimen is collected.

Duty of Ward Corpsman

1. Instruct patient regarding the need for a meat-free diet for 2 days before specimen is collected.

Amoeba

Equipment

Same as for O & P plus "basin of warm water."

Procedure

Collect specimen in the same manner as for O & P.
Place bottle containing specimen in basin of warm water and take to laboratory.

Duty of Ward Corpsman

Same as O & P except add "send immediately to laboratory in warm water bath, so that movements of amoeba may be seen."

SPUTUM

Single Specimen

Equipment

Wide mouth screw-cap bottle or jar (60 cc)
Standard Form 514K

Procedure

1. Before breakfast patient rinses mouth, coughs deeply, and expectorates directly into sputum bottle or jar.
2. Specimen must be sputum, not saliva.

Duty of Ward Corpsman

1. Instruct the patient.
2. Collect and send specimen to laboratory.
3. When report is received, staple the SF 514K to the SF 514 in patient chart.

GASTRIC CONTENTS

Gastric Wash (Examined for tuberculosis organisms

10867

Equipment

Levin tube in basin of cracked ice or cold water
Lubricant, water soluble
Rubber sheet and cover
Curved basin
Sterile: syringe 20 cc, specimen tube, normal saline solution
Standard Form 514K

Procedure

1. Specimens are collected before breakfast.
2. Levin tube is passed into stomach through the nose.
3. Test to ascertain that tube is in stomach and not in respiratory tract;
   a. Insert end of tube in water; if bubbles appear withdraw the tube.
   b. Listen to end of tube for breath sounds; if audible withdraw the tube.
4. Observe patient's breathing and voice, to tell whether tube is passing correctly or not.
5. Syringe is attached to the Levin tube.
6. Specimen is withdrawn and placed in specimen tube.
7. If fluid cannot be aspirated: 15 cc of saline solution is injected through tube, specimen withdrawn and placed in specimen tube.

Duty of Ward Corpsman

1. Explain procedure to the patient.
2. Place patient in sitting position.
3. Place covered rubber sheet over chest.
4. The introduction of tubes through the nose or mouth into the stomach is usually the responsibility of the doctor. However, there are times when a corpsman may be called upon to insert a tube or teach his patient how to do so.
5. Send specimen with request to laboratory immediately.
6. When report is received, staple the SF-514K to the SF-514 in patient's chart.

Gastric Analysis (Examined for Hydrochloric acid)

Equipment

Levin tube in basin of cracked ice or cold water (curved basin)
Lubricant (may be water, saline, mineral oil, or lubricating jelly)
Clean test tube
Rubber sheet and cover
Standard Form 514 F

Procedure

Same as for gastric wash except for omitting introducing of saline.

Duty of Ward Corpsman

Same as for gastric wash.

BLOOD

1. Blood examinations are requested on Standard Forms 514B, C, D, K and N. These specimens are collected by the laboratory technicians.
2. Blood is examined for cell counts, coagulation and bleeding times, hematocrit reading, sedimentation rate, serological tests, various chemistries, and other examinations.
3. Specimen for blood chemistry must be collected when the patient is fasting; that is, before breakfast.

BODY FLUIDS

Fluids from body cavities are withdrawn by means of aspiration performed by a doctor. This is strictly an aseptic or sterile procedure. The duty of the ward corpsman is to:

1. Order the equipment from Central Dressing or Central Supply Room.
2. Prepare the patient.
3. Assist the doctor.

Some examples of such withdrawals are:
   a. Lumbar puncture. for spinal fluid.
   b. Paracentesis . . . for abdominal fluid.
   c. Thoracentesis. . . for pleural fluid.
   d. Aspiration of fluid from a joint such as the knee.

ABREVIATIONS AND SYMBOLS

Abbreviations	Meaning
Relating to Personnel	
CO	. . . . . commanding officer
OOD	. . . . . officer of the day
WMO	. . . . . ward medical officer
Sp W	. . . . . special watch

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Relating to Wards and Services

CD	communicable disease
CDR or CSR	central dressing or supply room
EENT	eye, ear, nose and throat
GU	genitourinary
Lab	laboratory
Mechano	mechanotherapy
Med	medical
NP	neuropsychiatric
OB	obstetrical or maternity
OR	operating room
OT	occupational therapy
Ped	pediatric or children
Pharm	pharmacy
PT	physical therapy
SOQ	sick officers quaters
Surg	surgical
TB	tuberculosis
Wd	ward

Relating to Census

CLR	census last report
A	admitted to hospital
AOW	admitted from other ward
TOW	transferred to other ward
DD	discharged by death
D	discharged from hospital
Occ	occupied beds
Vac	vacant beds
Cap	bed capacity
Dep	dependent
VAB	Veterans Administration beneficiary
L	leave or liberty
AWOL	absent without leave
PAL	prisoner at large
CL	critical list
SL	serious list

Relating to Physical Examination

BP	blood pressure
L.L.L.	left lower lobe
L.L.Q.	left lower quadrant
L.U.L.	left upper lobe
L.U.Q.	left upper quadrant
os	mouth
O.S.	left eye
O.D.	right eye
P.E.	physical examination
R.L.L.	right lower lobe
R.L.Q.	right lower quadrant
R.M.L.	right middle lobe
R.U.L.	right upper lobe
R.U.Q.	right upper quadrant
T.P.R.	temperature, pulse, respiration

Relating to Tests and Examinations

BMR	basal metabolism rate
BSP	bromsulphalein test
BUN	blood urea nitrogen
CBC	complete blood count
EECG	electroencephalogram
ESR or Sed rate	erythrocyte sedimentation rate
GB Series	gallbladder series of X-rays
GI Series	gastrointestinal series of X-rays
Hgb	hemoglobin
IVP	intravenous pyelogram
LP	lumbar puncture
NPN	nonprotein nitrogen
PSP	phenolsulphonphthalein test
Rbc	red blood cell
sp.gr.	specific gravity
S. & A.	sugar and acetone
VPC	volume packed cells
wbc & diff	white blood cell and differential count

Relating to Medicines

Amp	ampoule or ampule
h or sc	hypodermic or subcutaneous
I.M.	intramuscular
I.V.	intravenous
p.o.	by mouth
p.r.	by rectum
I.D.	intradermal

Relating to Weights and Measures

aa.	of each
ad.lib	as much as desired
cc.	cubic centimeter
ʒ	dram
Gm	gram
gr.	grain
gtt.	drop (drops)
Kg.	kilogram or 1,000 grams
L	liter
lb.	pound

60809

m. or min ..... minim
mg ..... milligram, 1/1000th of a gram
mil. or ml ..... milliliter, 1/1000th of a liter
℥, oz ..... ounce
pt ..... pint
q.s. ..... sufficient quantity to make
qt ..... quart
SS ..... one-half
t. or tsp ..... teaspoon
T. or tbsp ..... tablespoon

Relating to Time

a.c. ..... before meals
b.i.d. ..... twice a day
h.s. ..... hours of sleep or at bedtime
q.d. ..... every day
q.m. ..... every morning
q.n. ..... every night
p.c. ..... after meals
p.r.n. ..... when necessary
q1 (2,3,4)h ..... every 1 (2,3,4,) hours
q.i.d. or 4 i.d. ..... four times a day
S.O.S. ..... once if necessary
stat ..... at once
t.i.d. ..... three times a day

Relating to Solutions

B.A. ..... boric acid solution
N.S.S. or N.S. ..... normal saline solution
S.S.E. ..... soap suds enema

Relating to Surgical Supplies

Abd ..... abdominal pad
D.S.D. ..... dry sterile dressing
F. sheet ..... Field sheet used to establish sterile field
4 x 4 ..... gauze dressing folded to 4 x 4 inches
2 x 2 ..... gauze dressing folded to 2 x 2 inches

Relating to Surgical Operation

O.P. ..... day of operation
D.O.S. ..... day of surgery
P.O.D. ..... post operative day
Pre-Op ..... before operation
Post-Op ..... after operation

Miscellaneous

c ..... with
C ..... centigrade
DU ..... diagnosis undetermined
et ..... and
etc ..... and so forth
F ..... Fahrenheit
Fr ..... French, denotes size of catheter or tube
s ..... without

MEDICAL TERMINOLOGY

Purpose

To help the corpsman gain understanding of what he reads in his patients' records and in medical literature.

Suggested Method of Study

1. Select a new word each day.
2. Look at it; break it down into its parts.
3. Write down what you think it means.
4. Check your answer with the definition in a medical dictionary.

EXAMPLE

Myocarditis
myo card itis
myo – muscle
card – heart
itis – inflammation of

Myocarditis: Inflammation of the muscles of the heart.

PREFIXES

Pertaining to the Body

brach- ..... arm
capit- ..... head
cardi- ..... heart
cholecyst- ..... gallbladder
cyst- ..... bladder
derma- ..... skin
entero- ..... intestines
glosso- ..... tongue
gastro- ..... stomach
hemo- ..... blood
hepat- ..... liver
laparo- ..... abdomen

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056 238

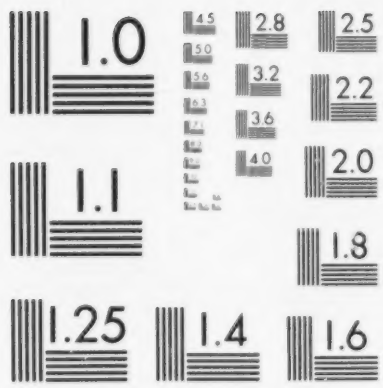

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

myo- . . . . . muscle
nephro- . . . . . kidney
neuro . . . . . nerve
ophthalmo. . . . . eye
oto- . . . . . ear
osteo- . . . . . bone
oral- . . . . . mouth
pharyn- . . . . . throat
phleb- . . . . . vein
pneumo- . . . . . lung
procto- . . . . . rectum
rhino- . . . . . nose
thoracic- . . . . . chest

Pertaining to Conditions

a or an- . . . . . lacking, absence of
auto- . . . . . self
ante- . . . . . before
anti- . . . . . against
contra- . . . . . against, opposed to
dys- . . . . . difficult, painful
endo- . . . . . within
hemi- . . . . . half
hydro- . . . . . water
hyper- . . . . . above, increase, in excess
hypo- . . . . . below, under
mal- . . . . . faulty, poor
neo- . . . . . new
oligi- . . . . . scanty, few
ortho- . . . . . straight
peri- . . . . . around
poly- . . . . . many, much
pyo- . . . . . pus
pyro- . . . . . heat, temperature

SUFFIXES

Pertaining to Conditions of the Body

-algia . . . . . pain
-cele . . . . . tumor, hernia
-clysis . . . . . a slow injection of a large amount of fluid
-emia . . . . . blood
-esthesia . . . . . sensation
-itis . . . . . inflammation
-lith . . . . . stone, calculus
-mania . . . . . insanity
-oma . . . . . morbid condition, tumor
-opia . . . . . vision
-pathy . . . . . disease
-phobia . . . . . fear, or dread
-plegia . . . . . paralysis
-pnea . . . . . breathing
-ptosis . . . . . falling
-rrhea . . . . . flow, discharge
-scopy . . . . . visual examination, looking into
-therapy. . . . . treatment
-thermy . . . . . heat
-throphic, trophy.. growth, nutrition
-uric, uria . . . . . urine

Pertaining to Surgical Operations

-ectomy . . . . . removal of
-plasty . . . . . to form, or build up
-pexy . . . . . to fasten
-(o) stomy . . . . . creation of an opening
-(o) tomy . . . . . cutting into
-(o) rrhaphy . . . . repair of
-manometer . . . . used to measure pressure
-meter . . . . . used to measure
-scope . . . . . used to examine by looking into or by hearing

EXAMPLES FOR PRACTICE

1. Anemia
2. Anesthesia
3. Appendectomy
4. Atrophy
5. Blepharitis
6. Cholelithiasis
7. Claustrophobia
8. Colostomy
9. Cystotomy
10. Dyspnea
11. Endoscope
12. Enteroptosis
13. Glossitis
14. Gonorrhea
15. Herniorrhaphy
16. Hydrotherapy
17. Hypertrophy
18. Hypodermoclysis
19. Myoma
20. Nephropexy
21. Neuralgia
22. Polyuria
23. Psychopathic
24. Pyromania
25. Rectocele
26. Sphygmomanometer
27. Stethoscope
28. Thermometer
29. Thoracoplasty
30. Venoclysis

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Some Symptoms to be Observed and Terms to Use in Recording Them

Concerning	Observation	Term to Use
Abdomen	1. Hard, boardlike	1. Hard, rigid
	2. Soft, flabby	2. Relaxes, flaccid, soft
	3. Hurts when touched	3. Sensitive to touch
	4. Appears swollen, rounded	4. Protuberant
	5. Filled with gas	5. Distended, tympanites
Areas		1. Epigastric
		2. Right lumbar
		3. Umbilical
		4. Left lumbar
		5. Right iliac
		6. Hypogastric
		7. Left iliac
Amounts	1. Large amount:	
	of drainage	Profuse, copious, free
	of urine	Polyuria, measured in cc
	of defecation	Copious
	of emesis	Measured amount in cc
	2. Medium amount:	
	of drainage	moderate, usual
	of urine	measured amount in cc
	of defecation	moderate
	of emesis	measured amount in cc
	3. Small amount:	
	of drainage	Small, amount, scanty, slight very little
	of urine	Scanty, measured in cc
	of defecation	Small amount
	of emesis	Measured amount in cc
Appetite	1. Very fussy about food, refuses to eat many foods	1. Has definite likes and dislikes about food
	2. Eats all foods served	2. Appetite good
	3. Eats very little	3. Appetite poor
	4. Loss of appetite	4. Anorexia
	5. Craving for certain foods	5. List foods
	6. Refuses to eat	6. Refuses food (state reason)
Arm	1. Shoulder to elbow	1. Upper arm (right or left)
	2. Elbow to wrist	2. Lower arm (right or left)
Back (areas)	1. Upper back	1. Interscapular shoulder region
	2. Small of back	2. Lumbar region
	3. End of spine	3. Sacral region
	4. Gluteal region	4. Buttocks
Baths	1. Give when patient is admitted	1. Admission bath

21001031?

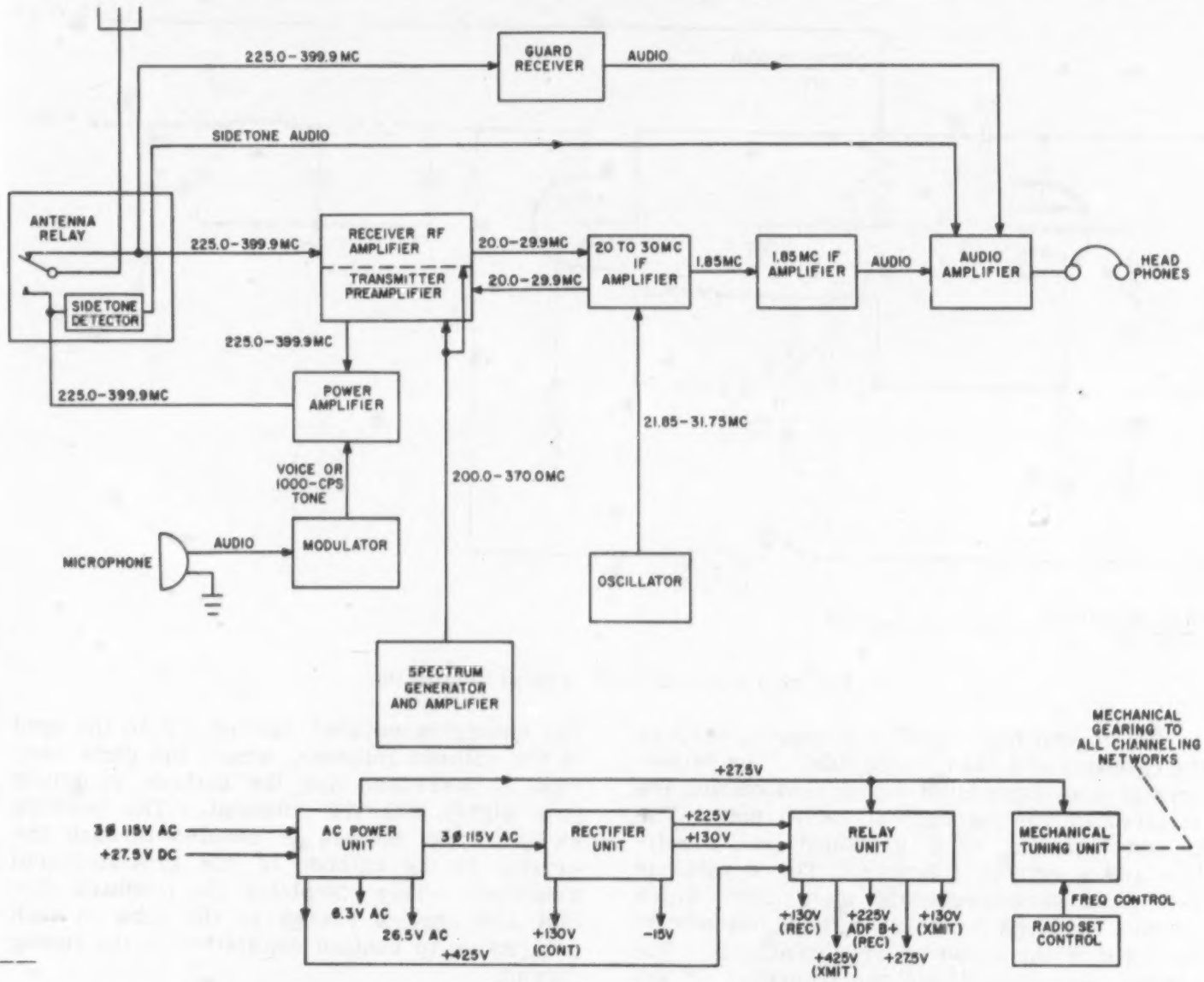

Figure 13-6.—Block diagram of the AN/ARC-52 receiver-transmitter.

the second mixer for heterodyning with the 21.85- to 31.75-mc injection frequency. The resulting final intermediate frequency of 1.85 mc feeds through a filter and four stages of amplification into a silicon diode detector, where it is demodulated and fed to the audio amplifier and into the headset.

The same oscillators and amplifiers (fig. 13-6) are used in transmitting except that a 1.85-mc oscillator replaces the IF stage of the same frequency and a separate preamplifier is used to drive the power amplifier. The initial 1.85-mc excitation is mixed in the first transmitter mixer stage with the 21.85- to 31.75-mc injection frequency. The 20.0- to 29.9-mc output is amplified and then mixed with the 200- to 370-mc injection frequency, producing the carrier frequency in the 225.0- to 399.9-mc range. This is fed through the preamplifier into the power amplifier where it is modulated and fed to the antenna.

Injection Oscillator

One of the representative circuits of interest is the A-bank crystal oscillator employed in conjunction with the injection amplifier. This oscillator, shown schematically in figure 13-7, generates a basic frequency of 24.9 to 33.9 mc in ten steps of 1.0 mc each. Tube VI is connected in a crystal-controlled, cathode-coupled circuit called a Butler oscillator. Oscillators of this type are characterized by good stability at relatively high frequencies and are capable of generating many different frequencies without the use of multiplying stages. The circuit permits operation of the crystal at an overtone frequency, which is an odd multiple of the fundamental crystal frequency.

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	4. Special attention or treatment	4. Special care to back, mouth, etc.
Chill	1. Blanket applied to help warm the patient	1. External heat applied (Method)
	2. Type as to severity	2. Severe, moderate, slight
	3. Duration	3. List number of minutes
Coma.....	1. Partly in coma	1. Partially comatose
	2. Deep in coma	2. Profound coma
Convulsion.....	1. Continuous shaking	1. Duration and description
	2. Shaking with intervals of rest	2. Duration and description
	3. Begin without warning	3. Sudden onset
Cough.....	1. Coughs at all times	1. Continuous cough
	2. Coughing over a long period of time	2. Persistent cough
	3. Coughs up material	3. Productive cough, describe material
	4. Short, hard cough	4. Hacking cough
Defecation.....	1. Bowel movement material	1. Feces, stool
	2. Bowel movement (act of)	2. Defecation
	3. Excessive defecation	3. Diarrhea, describe
	4. Gray colored liquid stool	4. Clay colored liquid stool
	5. Dark brown liquid stool	5. Highly colored liquid stool
	6. Formed, yet soft stool	6. Soft formed stool
	7. Formed with hardened stool	7. Hard formed stool
	8. Infrequent bowel movement	8. Constipation
	9. Black stool	9. Black, tarry stool
Dizziness.....	Dizziness	Vertigo
Drainage.....	1. Watery, from nose	1. Coryza
	2. Containing pus	2. Purulent
	3. Bloody	3. Sanguinous
	4. Consists of feces	4. Fecal
	5. Of serous fluid	5. Serous
	6. Containing mucus and pus	6. Mucopurulent
	7. Tough, sticky	7. Tenacious
	8. From vagina (after delivery)	8. Lochia
Dressings.....	1. A second dressing added to the first	1. Dressing reinforced
	2. Dressing removed, another applied	2. Redressed
	3. Drain tubes cut off	3. Drain tubes shortened (number of inches)
	4. Drain taken out	4. Drain removed
Drop.....	A drop or drops	Gtt/s

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Emesis.....	1. Produced by effort of patient	1. Induced
	2. Ejected to a few feet distant	2. Projectile
	3. If blood is only noticeable	3. Blood tinged
	4. Material vomited	4. Vomitus, emesis
	5. Contents	5. (Describe color, odor, appearance, consistency)
Eyes.....	1. Sharpness of vision	1. Visual acuity
	2. Yellow in color	2. Jaundiced
	3. Puffy	3. Edematous
	4. Motionless	4. Staring
	5. Sensitive to light	5. Photophobia
	6. Double vision	6. Diplopia
	7. Squinting	7. Strabismus
	8. Abnormal protrusion of eyeball	8. Exophthalmos
	9. Inflammation of conjunctiva	9. Conjunctivitis
Faint.....	Fainting	Syncope
Fever.....	1. Without fever	1. Afebrile
	2. Temperature above normal	2. Pyrexia
	3. Temperature greatly above normal	3. Hyperpyrexia
	4. Temperature suddenly returns to normal	4. Crisis
	5. Temperature gradually returns to normal	5. Lysis
Gas.....	1. Gas in the digestive tract	1. Flatus
	2. Having gas in the digestive tract	2. Flatulence
	3. Swelling of abdomen	3. Distention
Gums.....	Inflammation of the gums	Gingivitis
Hallucination.....	1. Of hearing	1. Auditory hallucination
	2. Of sight	2. Visual hallucination
	3. Of smell	3. Olfactory hallucination
	4. Of taste	4. Gustatory hallucination
Hands.....	1. Dirty, rough, nails broken	1. Shows lack of care
	2. Abnormally large	2. Massive
Head.....	1. Forehead	1. Frontal region
	2. Region over temple	2. Temporal region
	3. Back of head	3. Occipital region
	4. Base of skull	4. Basilar region
Hives.....	1. Hives	1. Urticaria
	2. Itching	2. Pruritus
Joints.....	1. Bending	1. Flexion

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Joints — Continued	2. To straighten	2. Extension
	3. Turn inward	3. Inversion
	4. Turn outward	4. Eversion
	5. Revolve around	5. Rotation
	6. Move away from median line	6. Abduction
	7. Move toward median line	7. Adduction
Legs.....	1. Thigh to knee	1. Upper leg (right or left)
	2. Knee to ankle	2. Lower leg (right or left)
Lice.....	1. Head, body, pubic	1. Pediculi
	2. Condition of lousiness	2. Pediculosis
Mental attitude.....	All statements on charts concerning attitudes must have "appears", "seems", or "apparently" before them. These are the observer's interpretations of what he thinks he sees. Only the patient knows for sure what his attitude is.	
	1. Hard to please	1. Irritable, fault-finding
	2. Distrustful	2. Distrustful, suspicious
	3. Happy	3. Optimistic, cheerful
	4. Sad	4. Depressed, moody
	5. Afraid	5. Apprehensive, anxious
	6. Over religious	6. Deeply religious
	7. Lacks emotional control	7. Hysterical
	8. Loss of memory	8. Amnesia
Nourishment.....	1. Very small amount of water	1. Sips water
	2. Small pieces of ice	2. Chopped ice
	3. Drink of water	3. Water (number of cc)
	4. Given through tube into stomach	4. Gavage
	5. Given by enema	5. Nutritive enema, (fluid and amount
Odor.....	1. Not unpleasant	1. Agreeable
	2. Spicy	2. Aromatic
	3. Like fruit	3. Fruity
	4. Very unpleasant	4. Offensive
	5. Belonging to particular drug, etc.	5. Characteristic
	6. Like feces	6. Fecal
Pain.....	1. Great pain	1. Severe
	2. Little	2. Slight
	3. Period of great pain followed by period of little or no pain	3. Paroxysmal
	4. Spreads to distant areas	4. Radiating
	5. Started all at once	5. Sudden onset
	6. Hurts worse when moving	6. Increased by movement
Paralysis.....	1. Of the muscles of the face	1. Facial
	2. Of the legs	2. Paraplegia

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Paralysis — Continued	3. Of one side of body	3. Hemiplegia
	4. Of a single limb	4. Monoplegia
	5. Both arms and legs	5. Quadriplegia
Patient (admission of).....	1. Walking	1. Ambulatory
	2. Carried (infant)	2. In arms
	3. By wheelchair	3. Per wheelchair
	4. By stretcher	4. Per stretcher
	5. Had a bedsore when admitted	5. Decubitus ulcer present on admission; (describe size and appearance)
Perspiration.....	1. Large amount	1. Profuse diaphoresis
	2. Small amount	2. Scanty
Pulse.....	1. Number of beats per minute	1. Rate
	2. Rhythm	2. Regular or irregular
	3. Beats missed at intervals	3. Intermittent
	4. Over 100 beats per minute	4. Rapid
	5. Very rapid, beats indistinct	5. Running
	6. Slow in rate	6. Slow
	7. One scarcely perceptible	7. Thready
	8. Small, rapid and tense	8. Wiry
Reproductive organs.....	External reproductive organs	Genitalia (external)
Respiration.....	See breathing	
Restraint.....	1. Boards put on bed	1. Sideboard applied
	2. Tied down with sheet	2. Sheet restraint applied
	3. Fastened to bed with ankle strap (right)	3. Right ankle strap applied
Rings.....	1. Rubber ring to relieve pressure	1. Placed on rubber ring
	2. Cotton rings applied under heels, elbows, etc.	2. Cotton ring applied to each heel, elbow, etc.
Skin.....	1. Normal	1. Healthy
	2. Pink, hot	2. Flushed
	3. Blue in color	3. Cyanotic
	4. Very white	4. Extreme pallor
	5. Shines	5. Glossy
	6. Raw surface	6. Excoriation
	7. Yellow in color	7. Jaundiced
	8. Torn	8. Lacerated
	9. Containing colored areas	9. Pigmented
	10. Wet	10. Moist
	11. Scraped	11. Abraded
	12. Black and blue mark	12. Ecchymosis
	13. Cold, clammy	13. Cold, clammy
Sleep.....	1. Slept very little	1. Slept very little or slept at short intervals

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Sleep — Continued	2. Tired when wakens 3. Moans while sleeping 4. Inability to sleep	2. Awakens fatigued 3. Sleeps disturbed—moaning 4. Insomnia
Smoke.....	Smokes too much	Smokes excessively
Unconsciousness.....	1. Complete unconsciousness 2. Partial unconsciousness 3. Pretended unconsciousness	1. In comatose condition 2. In stuporous condition 3. Feigns unconsciousness
Urination.....	1. To urinate 2. No control over urination 3. Burning when voiding 4. Large amount of urine voided 5. Total suppression of urine 6. Frequent voiding at night 7. Painful urination 8. Pus in urine 9. Blood in urine 10. Hemoglobin in urine 11. Glucose in urine 12. Albumin in urine 13. Acetone in urine 14. Bile in urine 15. Scantiness of urine 16. Sugar in urine	1. Void, urinate 2. Involuntary, incontinent 3. Burning sensation on urination 4. Polyuria 5. Anuria 6. Nocturia 7. Dysuria 8. Pyuria 9. Hematuria 10. Hemoglobinuria 11. Glucosuria 12. Albuminuria 13. Acetonuria 14. Choluria 15. Oliguria 16. Glycosuria
Vomit.....	Desire to do so (for various types, see Emesis)	
Weight.....	1. Overweight 2. Thin, underweight	1. Obese 2. Emaciated
Wounds.....	1. Deep 2. Slight, surface only 3. Not infected 4. Discharging pus 5. Infected 6. Torn	1. Deep 2. Superficial 3. Clean 4. Suppurating 5. Infected 6. Lacerated

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CHAPTER 12

GENERAL WARD NURSING METHODS AND CARE OF PATIENTS

OBSERVATION OF THE PATIENT

Of all the patient's medical attendants the hospital corpsman is with him most constantly. For this reason the quality of his observation and reports, written and oral, are of utmost importance.

The doctor depends upon the corpsman for accurate recognition, recording, and reporting of the patient's mental and physical condition during the day and night. It is important to be able to recognize even the slightest change in the patient because while the change is slight in itself, when combined with other changes it may show a definite disease process indicating need for further treatment.

The recording of observations should be done as soon as possible after they have been made. Do not wait until the end of the day because by that time you may forget a detail which is important in the treatment of your patient. Use medical terminology in your recording, but if you are in doubt as to the correct term, use plain English.

Purposes

Observation is essential at all times, from the patient's admission until his discharge, and particularly during bath and meal times, while asleep and during treatments and visiting hours.

1. To aid the doctor in making a diagnosis and prescribing treatment for the patient.

2. To determine the effects of a prescribed course of treatment.

3. To modify the nursing care to fit the needs of the patient.

Signs and Symptoms

Indications of the mental and physical condition of the patient may be classified as OBJECTIVE AND SUBJECTIVE symptoms.

OBJECTIVE SYMPTOMS are those which the observer can see, such as rashes, swelling, and inflammation; can feel, such as skin eruptions, masses, and changes in pulse; can hear, such as speech and snorting respiration; can smell, such as odors.

SUBJECTIVE SYMPTOMS are those which only the patient can feel or describe, such as pain, tenderness, ache, and nausea.

ADDITIONAL SIGNS indicating the condition of the patient may be determined by the use of instruments, examinations, and tests, such as thermometers, manometers, X-rays, and specimens.

Learning to recognize signs and symptoms of the patient (those he tells you, those you see, feel, hear and smell, and those you may infer by his actions and attitudes) takes time and experience. Learn to observe your patient using these questions:

1. What am I seeing, feeling, hearing, smelling?
2. How is it affecting my patient?
3. Who should receive the report of these observations?
4. When should I report?
5. Where should I record?
6. What can I do about it?

ASSISTING WITH A PHYSICAL EXAMINATION

Purpose

1. To aid the doctor in making a diagnosis and planning therapy.

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2. To aid the corpsman in planning the necessary nursing care.

Equipment

Tray with—

1. Diagnostic set (ophthalmoscope, otoscope)
2. Tongue depressors
3. Flashlight
4. Stethoscope
5. Sphygmomanometer
6. Tape measure
7. Rubber gloves or finger cots
8. Skin pencil
9. Percussion hammer
10. Paper bag for used depressors
11. Curved basin for specula
12. Safety pins
13. Paper towels

Procedure

1. Place patient in a warm, well-lighted room or screened area.
2. Tell the patient what is to be done and how he may help. (If a female patient is being examined another female must be present.)
3. Undress and cover the patient with a sheet.
4. Take and record height and weight. (Place paper towel on scale.)
5. Place patient in horizontal position.
6. Have all equipment at hand.
7. Assist the doctor as necessary, placing patient in proper position for the examination desired (fig. 12-1). Doctor will usually examine patient's head first then proceed to chest, abdomen, extremities and genitalia. Expose each part of the body as the examination progresses.

After Examination

1. Make patient comfortable in bed.
2. Strip, clean and reset tray.

CHECK-LIST FOR OBSERVATIONS

OBSERVING THE PATIENT

General Appearance

Is he short? Stout? Thin? Average build? Does he appear in pain? Ill? Well? Does he Walk normally? With a limp?

Behavior

Does he appear happy? Worried? Excited? Depressed? Restless? Unconscious?

Does he refuse to talk or eat? Does he shout or sing?

When he talks, do his thoughts appear connected or does he ramble? Does he lisp, stutter, stammer?

Does he appear gloomy? Aggressive? Friendly? Cooperative? Bored? Homesick?

Does he sleep well? Poorly? Is he restless in his sleep? Does he moan, groan, or cry out in his sleep?

How does he act toward the other patients? Ward personnel? His visitors?

Does he join in ward activities?

Position

Does he stay in one position in the bed? On his side or his back? Does he draw his legs up on his abdomen?

Does he have difficulty breathing when he lies down?

Is his neck stiff? Arched backward?

Is he able to move about in bed?

Is he comfortable?

Have you changed his position in the past 2 hours?

Skin

Is it clean? Hot? Cold? Dry? Moist?

Is the skin flushed? Pale? Cyanotic?

Are there any scars? Wounds? Rashes? Scratches? Bruises? Lumps?

Are there any signs of pressure? Redness? Breakdown? Spots of various colors?

Does the skin appear shiny? Stretched? Is there edema present?

Is a pit made when the fingers are pressed into the skin?

Are there lice? Nits?

Does he perspire profusely?

When is the last time you gave him special skin care?

Eyes

Are the eyelids swollen, bruised or discolored?

Are the whites of the eyes clear? Dull? Yellow? Bloodshot?

Are the pupils contracted? Dilated? Equal in size?

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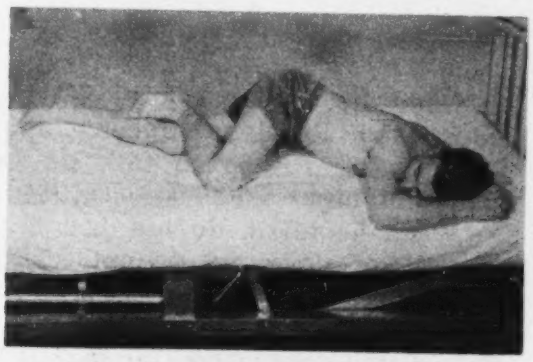

SIMS—Used for rectal, vaginal and perineal examinations and treatments

DORSAL RECUMBENT—Used for examination of external genitalia; urethral, vaginal and rectal treatments

DORSAL LITHOTOMY—Used for examination of external genitalia; urethral, vaginal and rectal treatments

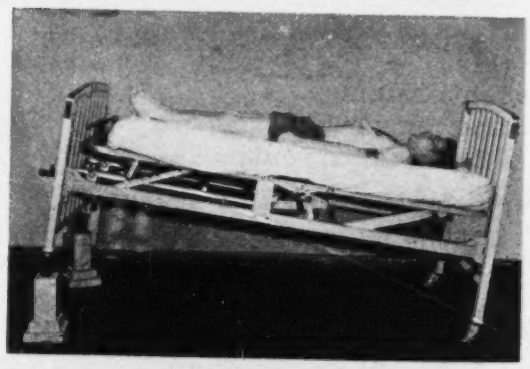

SHOCK or TRENDELENBERG—Used in treatment of shock; pelvic and abdominal surgery. Blocks also used for orthopedic patients in traction

LUMBAR PUNCTURE—Used for lumbar puncture. Important—Hips and shoulders must be in the same vertical plane

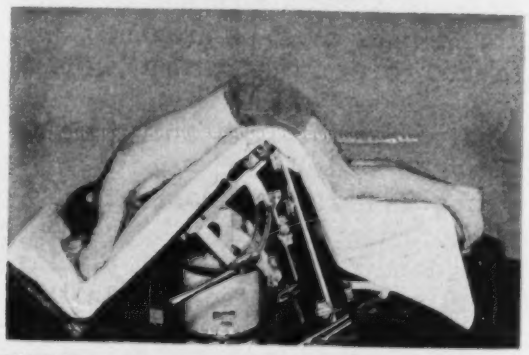

MODIFIED JACK KNIFE—Used for rectal examination and treatment. Legs may hang down straight

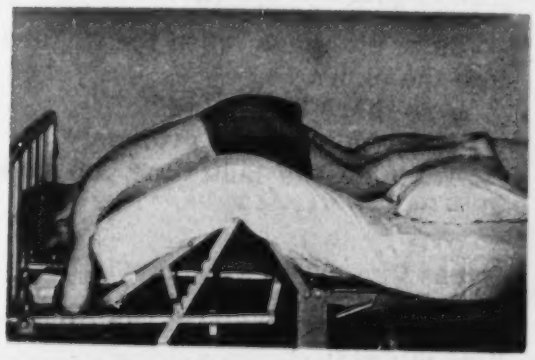

POSTURAL DRAINAGE - GATCH BED—Used to promote drainage from respiratory tract. Patient is placed over knee break of bed

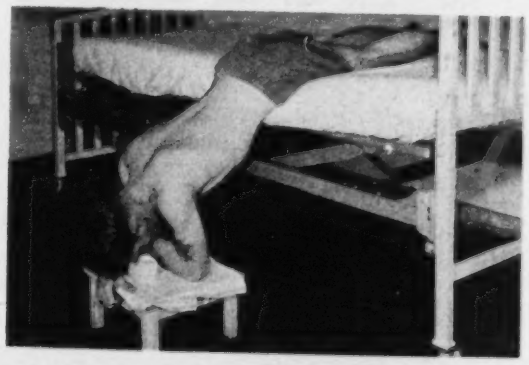

POSTURAL DRAINAGE - STOOL METHOD—Used to promote drainage from respiratory tract

Figure 12-1.—Positions for examinations and treatments.

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Does he complain of pain? Burning? Too much light?

Is there a discharge from his eyes? Tears?

Ears

Do the ears appear normal?

Does he seem to hear well?

Does he complain of buzzing or ringing in his ears?

Does he have any discharge from his ears? What kind it is?

Does it have an odor?

Mouth

Does his tongue appear dry? Moist? Clean? Coated? Cracked? Red? Spotted?

Does he complain of an unpleasant taste? Is there an odor to his breath?

What kind of an odor?

Are his teeth in good repair? Clean? Does he have removable bridges? Dentures?

Does he have any sores in his mouth? What do they look like?

Does he complain of any soreness?

When was the last time you gave him special mouth care?

Nose

Does his nose appear straight?

Does he appear to have difficulty breathing through his nose?

Is there any nasal discharge present?

Chest

Are there rattling, snorting, or wheezing sounds when he breathes?

Does he have pain or difficulty breathing?

Is he coughing? Is the cough productive? Dry? Hacking? Persistent?

Is sputum expectorated? Is it white? Yellow or rusty? Thick or thin? Large or small amount? Does it have an odor? What kind of odor?

Abdomen, Bowels, and Bladder

Is the abdomen distended? Is the distention above or below the umbilicus or over the entire abdomen?

Does he belch?

Is he nauseated?

Is he vomiting? Is pain or nausea associated with it? How often does he vomit?

What does the vomitus look like? Color? Odor? Amount? Contents?

Has he had a bowel movement? When? Is he constipated? Does he have diarrhea? Is he incontinent? What is the color, consistency, amount and odor of the feces? Is there blood, pus or worms in the feces?

Does he void sufficiently? Does he void frequently in small amounts? What is the color, odor and amount of the urine? Is there blood or sediment in the urine?

Does he have difficulty or discomfort passing urine? Burning in urination?

Does he void involuntarily?

Intake

Is he thirsty? Is he drinking enough water? Fruit juices?

Is his drinking water fresh? Can he reach it? Does he have a drinking tube?

Is he on forced or restricted fluids? Is there an Intake and Output sheet with a pencil at his bedside? Have you instructed him on how to keep his record?

Is he receiving an intravenous infusion? Have you checked recently?

Is he eating all his food? Is the tray attractive? Are the dishes and silverware clean?

Is he in the best position to eat? Does he need help? Can he reach his food?

Is he on nothing by mouth? Is a sign posted on his bed to that effect?

Pain

Does he have pain/ache? Where is it?

How long has he had it? How severe is it? Is it sharp, dull, aching, cramping, knife-like?

Is the pain constant? Intermittent?

Is he nauseated with the pain?

Does he assume a special position to relieve the pain?

Does he have a medication ordered to relieve the pain? When was the last time he had the medication? Did the medication relieve him?

Has the pain and its description been reported and recorded?

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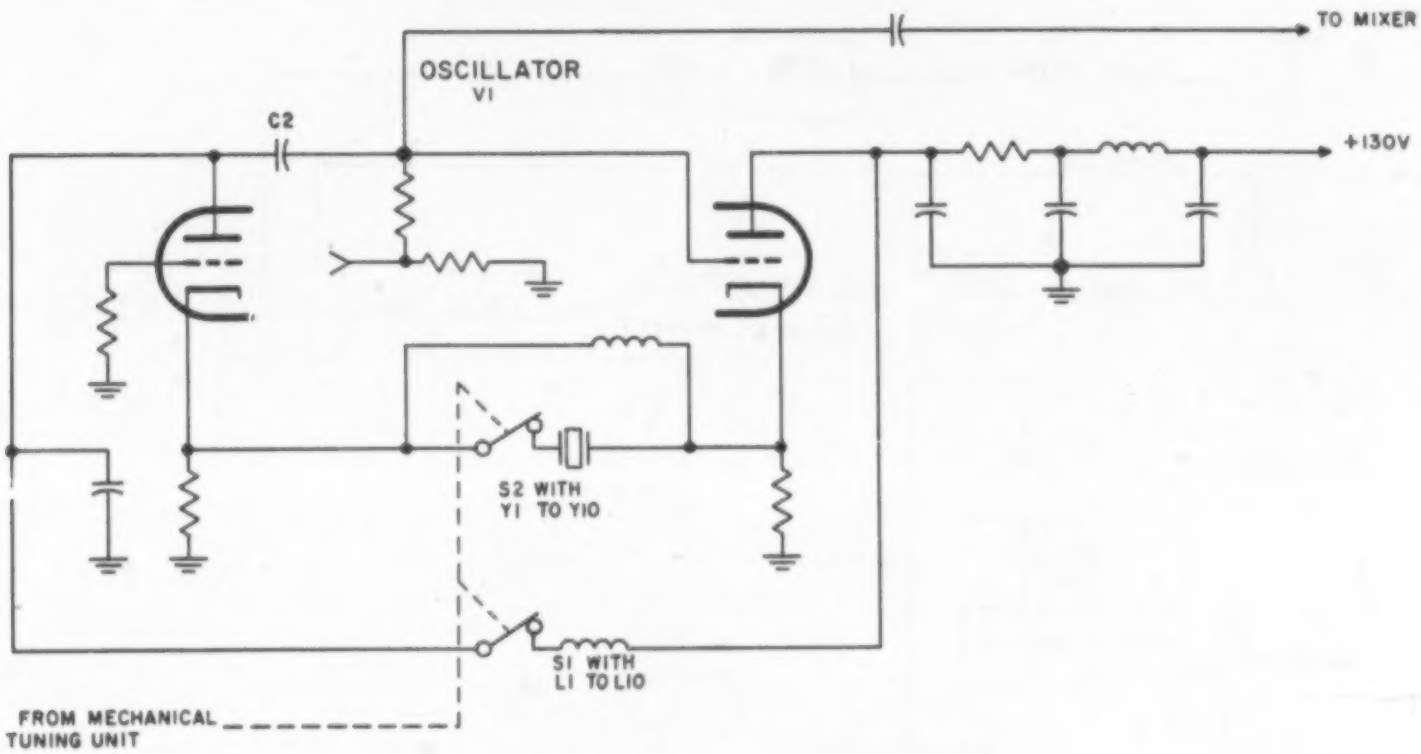

Figure 13-7.—A-bank crystal oscillator.

The crystal (fig. 13-7) is connected between the cathodes of a twin-triode tube. The proper crystal and associated tuning inductance are selected by the mechanical tuning unit. The circuit consists of a grounded-grid amplifier and a cathode follower. The crystal is used as a series-resonant wave filter which couples feedback from the cathode follower to the input of the grounded-grid amplifier. The crystal also determines the frequency of the feedback signals.

The grounded-grid amplifier supplies the energy necessary for sustained oscillation in the resonant circuit composed of L1 and associated capacitance. The action of the feedback circuit is such that if the cathode of the grounded-grid amplifier swings positive, a positive pulse is returned to it. When the cathode swings negative, a negative pulse is returned, thereby meeting the necessary conditions of feedback for sustained oscillation.

The action of the feedback loop in the Butler oscillator (fig. 13-7) takes place in the following sequence. Assume that the grounded-grid amplifier is conducting and that the cathode is swinging more positive. This decreases tube conduction and causes the plate voltage to swing in the positive direction. This voltage change is coupled through C2 to the grid of the cathode follower, where the plate current is increased and the cathode is driven to a higher positive potential. The positive swing at the cathode is coupled through the crystal to the cathode of the grounded-grid amplifier. This completes the feedback circuit and applies energy to the tube in such polarity as to sustain oscillation in the tuning circuit.

The output of the A-bank oscillator is coupled to a mixer stage where it is heterodyned with a signal from the B-bank oscillator (2.15 to 3.05 mc) to produce an injection signal of 21.85 to 31.75 mc.

Audio Input

Referring to the block diagram (fig. 13-6), note the blocks associated with the transmitter power amplifier. These circuits are the microphone input stage, the modulator, and the sidetone audio stage, all of which are included in the transmitter audio system.

Figure 13-8 is a simplified schematic showing the microphone input stage, using a dynamic microphone input.

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Wounds

What is the condition of the wound? Is it clean? Reddened? Swollen? Painful?

Is a discharge present? What is its color? Odor? Consistency? Is it bloody?

Does he have a dressing? Does it need changing?

Patient's Bedding

Does he have enough covers? Too many?

Is his bed linen clean? Wrinkled? Wet? Soiled?

Is the bottom sheet tight and smooth?

Are the top covers light and loose?

Appliances and Apparatus

Does the patient require an air ring, sandbags, bed cradle, extra pillows for support or comfort? Does he have them? Are they positioned correctly?

Does the patient have a cast? Is there pressure anywhere? Are there rough edges on the cast?

Is the cast dry? Are there cracks in the cast?

Is the patient in traction? Are the weights hanging free?

Is the patient up in bed?

Is the rope in the pulley groove? Is the traction pulling in the desired way?

Is the frame causing pressure? Is the frame well padded?

Is his foot or hand supported?

The preceding questions have all been in relation to the patient himself, now consider his environment.

OBSERVING THE WARD

General Appearance

Does the ward look clean? Orderly? Pleasant?

Noise

Is the ward noisy? Is there loud talking, laughing?

Ventilation

Is the air fresh? Stale? Are there odors?

Temperature

Is it hot and stuffy?

What does the wall thermometer read?

Is the ward warm enough for the patient's bath?

Is the ward cool enough for comfortable sleeping?

Is the patient in a draft?

Lights

Are they glaring? Bright enough? Shaded?

Are they shining in the patient's eyes?

Patient's Unit

Is the unit clean, orderly? Complete?

Is his bedside stand within his reach?

Is his signal cord within his reach?

CARDINAL SYMPTOMS OR VITAL SIGNS

Temperature (T), pulse (P), respiration (R), and blood pressure (BP) are called the cardinal symptoms or vital signs because they give important and vital indications of the condition of the patient. Changes in cardinal symptoms, typical of certain diseases and certain stages of diseases, are so important that a special sheet is maintained to record them. The measurement of these symptoms aids the doctor in making a diagnosis and prescribing treatment, and the corpsman in determining the kind and amount of nursing care necessary.

TEMPERATURE

Temperature is the degree of heat in the body. It is the balance between heat produced and heat lost by the body. When the balance is disturbed, deviations of body temperature result. Deviations above the normal range are called elevations or fever; those below normal range are subnormal.

Normal Temperature

(The normal range is 97 to 99 degrees F. (mouth); 98 to 100 degrees F. (rectum); 96 to 98 degrees F. (axilla). The normal temperature is usually at its lowest point in the early morning and at its highest in the late afternoon.

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Fever

Fever may begin suddenly or gradually and its course may be constant, remittent or intermittent (fig. 12-2).

A CONSTANT FEVER is one in which the temperature remains elevated at about the same level during a period of 24 hours or longer.

A REMITTENT FEVER is one in which the temperature rises and falls in a moderate range but does not approach normal.

An INTERMITTENT FEVER is one in which the temperature rises and falls in a great range, approaching normal or below in a 24 hour period.

Subnormal

Due to shivering mechanism of the body, this type of temperature is not often encountered except in certain periods of extreme illness when the subnormal temperature would indicate body resistance is being overwhelmed. It is also found in many chronically ill, starving, cachectic or emaciated patients.

BODY TEMPERATURE is measured by the clinical thermometer. The thermometer is scaled in the Fahrenheit system and calibrated in 2/10 degrees (fig. 12-3).

ROUTES OF MEASUREMENT

1. By MOUTH which is the easiest and most often used route. The thermometer is left in place 3 minutes.
2. By RECTUM which is the most accurate, and is used for children, delirious or unconscious patients, and patients who are mouth breathers, who cough frequently, or those who have had mouth surgery. The thermometer is held in place 5 minutes.
3. By AXILLA which is least accurate and used only when mouth and rectal routes cannot be used. The thermometer is held in place 10 minutes.

Shaking Down the Thermometer

1. Stand in clear space away from bedside table.
2. Hold thermometer firmly at top between thumb and first two fingers (fig. 12-4).
3. Shake with loose wrist movement as though shaking water off the hand.
4. Shake thermometer down to 95 degrees F. or below.

Reading the Thermometer

1. Stand in a good light.
2. Hold thermometer at the stem end, ridge side toward you (fig. 12-5).
3. Read the scale to the nearest 2/10 of a degree, i.e., 98.6.

PROCEDURE FOR TAKING TEMPERATURE, PULSE, AND RESPIRATION

Purpose

To determine the degree of temperature, the rate and characteristic of the pulse and respiration of the patient or group of patients.

Equipment

Tray with:

2 covered containers of isopropyl alcohol 70 percent, or isopropyl alcohol 70 percent with 0.5 percent iodine

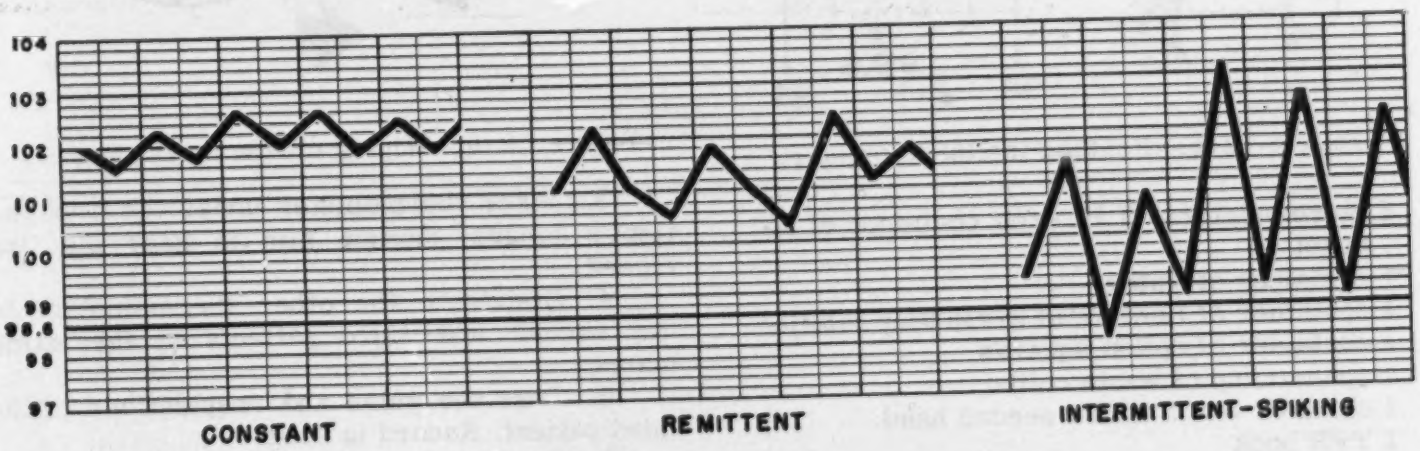

Figure 12-2.—Types of fever.

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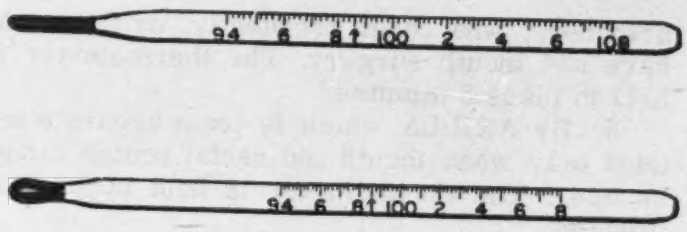

Figure 12-3.—Types of thermometers; (1) oral; (2) rectal.

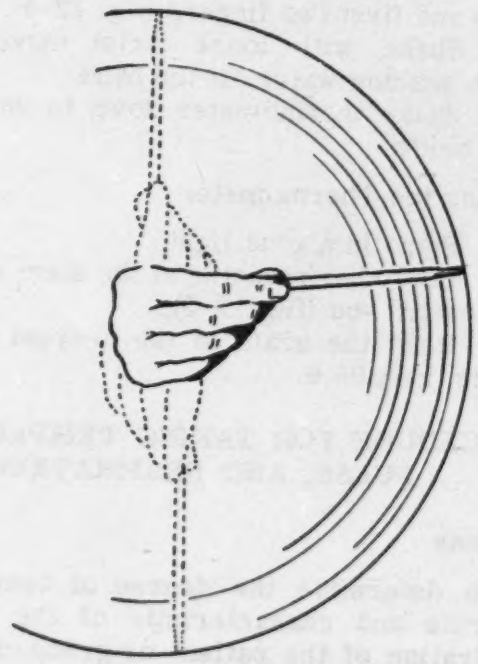

Figure 12-4.—Shaking down the thermometer.

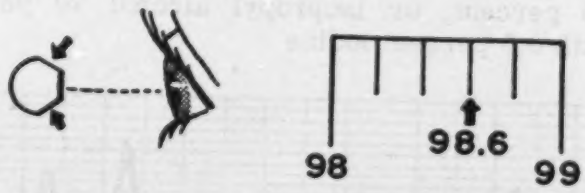

Figure 12-5.—Reading the thermometer.

6 thermometers—3 in each container of alcohol
1 container of water
1 container of tincture of green soap solution
1 container of cotton squares
1 sputum cup of waste cotton
1 clock or watch with a second hand
1 TPR book
1 pen or pencil

NOTE: Benzalkonium chloride or liquid iodine-type disinfectant may be the solution of choice for thermometers at your station. If used, omit soap solution.

NOTE: At some stations individual thermometers are provided for each patient.

Precautions

1. Have the patients lying quietly in beds or sitting down in chairs.

Wait for 30 minutes before taking the temperature of a patient who has had a hot or cold drink or has been smoking.

3. Be sure the thermometer is down to 95° F. before placing it in the patient's mouth.

4. Be sure the thermometer is under the patient's tongue.

5. Wipe thermometer with moistened cotton before and after use. The important step in cleaning a thermometer is the mechanical action of rotary motion when wiping.

Procedure

1. Remove a thermometer from the first container of alcohol.

2. With a cotton square and in a rotary motion, wipe the thermometer from stem to bulb. (Fig. 12-6). Shake down thermometer to 95°F.

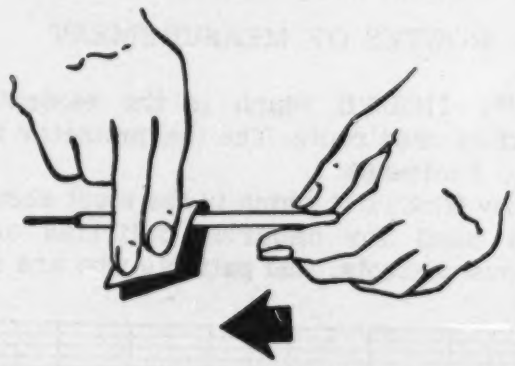

Figure 12-6.—Wiping off the thermometer.

3. Place thermometer under the first patient's tongue; caution him to keep his lips closed.

4. Distribute the other thermometers to the second and third patients in the same manner.

5. Take the pulse and respirations of the third patient. Record in book.

6. Repeat step 5 for the second and first patient.

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7. Remove the thermometer from the first patient's mouth.

8. Moisten cotton square with soap solution; wipe the thermometer from stem to buld in a rotary motion.

9. Moisten a cotton square with water; wipe the thermometer from stem to bulb in a rotary motion.

10. Read the thermometer and record reading in the book.

11. Place the thermometer in the original alcohol container.

12. Repeat steps 8 through 11 for the second and third patients.

13. Remove the thermometers from the second alcohol container.

14. Repeat steps 2 through 12 for the next three patients.

15. Continue alternate use of the thermometer containers until all patients' temperatures have been taken.

16. Record temperature, pulse, and respiration on SF 511 of each patient's chart. Describe abnormal characteristics of pulse and respiration in Nursing Notes.

Care of Equipment

After each use—

1. Remove waste.
2. Reset tray.
3. Stow in proper place.

Daily—

1. Wash all containers and tray in hot soapy water, rinse, and dry.
2. Wash each thermometer in cool soapy water; rinse under running water; dry.
3. Refill and reset tray.

TAKING RECTAL TEMPERATURES

Equipment

Tray with—

Rectal thermometer in container of isopropyl alcohol, 70%
Container soap solution
Container cool water
Container cotton squares
Sputum cup for waste
Water soluble lubricant on tissue

Precautions

1. Wait for 30 minutes after the patient has had an enema.
2. Use only a stub bulb thermometer expressly made for rectal use.
3. Be sure to lubricate the thermometer.
4. Hold the thermometer in place.

Procedure

1. With cotton square wipe down thermometer.
2. Shake down and lubricate thermometer.
3. Turn patient on his side.
4. Insert thermometer about 1-1/2 inches into rectum in an upward and forward direction.
5. Hold thermometer in place 5 minutes.
6. Remove thermometer.
7. Moisten cotton with soap solution, wipe down thermometer; repeat, using water.
8. Read thermometer; record temperature in book. Then place thermometer in container of alcohol.
9. Take pulse and respiration.
10. Record "R" (for rectal) above temperature in book and on patient's chart. WASH YOUR HANDS.

TAKING AXILLARY TEMPERATURES

Equipment

Same as for an oral temperature plus hand towel.

Precautions

1. Be sure the axilla is dry.
2. Be sure the arm is pressed closely to the body (fig. 12-7).

Procedure

1. Wipe axilla dry.
2. Place the thermometer in axilla. Have patient grasp his opposite shoulder and press his arm against his body.
3. Leave in place 10 minutes.
4. Proceed as in Oral Temperature instructions.
5. Record "A" (for axillary) above temperature in book and on patient's chart.

PULSE

Pulse is the alternate contraction and dilation of the arteries due to the pumping of the

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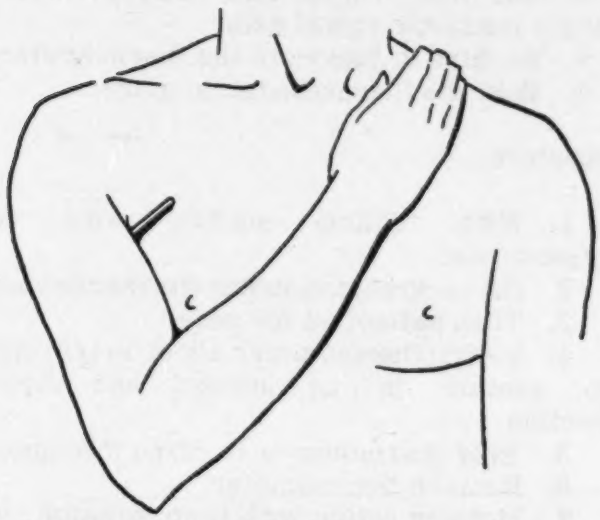

Figure 12-7.—Taking an axillary temperature.

blood by the heart. Changes in the character of the pulse may be due to any factor which interferes with the function of the heart, the volume of the blood, and the elasticity of the blood vessels. Therefore, the measurement of the pulse is a valuable means of learning the condition of the heart, blood vessels, and general condition of the patient.

Normal Pulse

The pulse rate even in good health varies with the individual. The rate is faster in infants and young children, slower in aged persons, faster in women than in men, and is affected by exercise, fatigue, and emotions. The normal range for adult women is 72 to 80; for adult men 62 to 72 pulsations per minute. The pulse rate usually increases 10 beats for each degree rise in temperature. The normal pulse should feel firm, smooth, straight, and elastic under the fingertips and should be regular in rate and rhythm.

The pulse may be taken wherever an artery lies near the surface of the body or over a bone. The most frequently used site is the radial artery on the thumb side of the wrist. Other arteries which may be used:

1. Temporal—side of the head in front of the ear.
2. Carotid—front side of neck, may often be seen beating.
3. Dorsalis pedis—the top of the foot.

Measurement of Pulse

1. The pulse rate—number of beats per minute.
2. The force—strength or weakness of beat.
3. The rhythm—regular or irregular space between beats.
4. The volume—full or soft.

The pulse is usually taken at the same time the temperature is taken and whenever the patient shows a change in condition, postoperatively while recovering from anesthesia, when getting out of bed for the first time, and when receiving medication affecting the pulse.

Variations of Pulse

1. Normal—regular rate, rhythm, force, and volume.
2. Missed beat—regular omissions in rhythm and rate; may be irregular in force and volume.
3. Intermittent—irregular rhythm and rate; may be irregular in force and volume.
4. Thready—rapid, running, difficult to count or to determine quality (fig. 12-8).

RESPIRATION

Respiration is the act of breathing in (inhaling) and breathing out (exhaling) air by the lungs. Oxygen is needed by the body; the act of respiration supplies this need.

Normal Respiration

The normal respiration is regular in rate, rhythm, and depth and is performed without pain, strain, or difficulty. The normal rate is rapid in young children, slow in aged persons; ranges from 16-24 per minute in healthy adults and is affected by age, sex, exercise, sleep, and emotional disturbances. The respiration

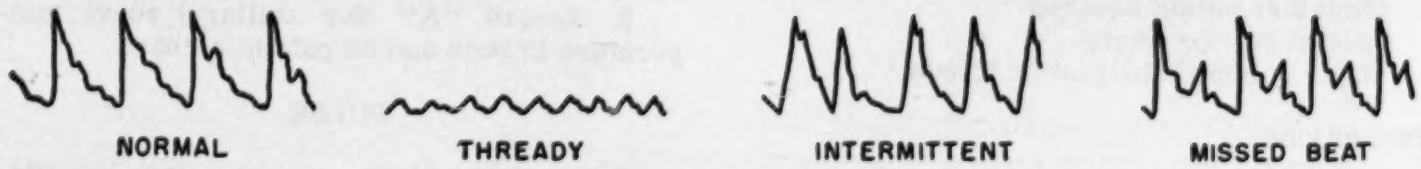

Figure 12-8.—Variations of pulse.

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usually increases 1 to 2 in rate with every 10 beats rise in pulse and each degree rise in temperature. The respiratory movements are more or less under the patient's control and therefore should be counted without his knowledge. To do this keep the fingers upon the pulse as though still counting it, at the same time watching the rise and fall of the patient's chest, thus counting the respiration for a full minute.

Variations of Respirations

DYSPNEA—painful, difficult breathing, usually accompanied by sounds.

AIR-HUNGER—short, gasping breaths followed by a few normal breaths; cycle is repeated.

STERTOROUS—loud, snorting breathing.

EDEMATOUS—moist sounds as if air is passing through water.

CHEYNE-STOKES—gradual increase in depth of respirations until dyspnea is reached; followed by decrease until breathing ceases for few moments; then the cycle is repeated.

APNEA—a condition in which there is a temporary cessation of breathing.

ORTHOPNEA—inability to breath lying down.

Taking Pulse and Respiration

1. Have patient lie or sit down. Place his arm and hand in a relaxed position, thumb up, supported on a chair arm, table, bed or place across his chest.
2. Locate pulse by placing 3 fingers (not your thumb) on the thumb side of patient's wrist.
3. Count pulse rate for 30 seconds, multiply by 2, and record as number of beats per minute. Check again, noting the quality (force, rhythm, volume). If any deviation is noted, take pulse for full minute.
4. With fingers still on wrist, count respirations for 30 seconds; multiply by 2 and record as number of respirations per minute. If any deviations are noted, count respirations for full minute.

BLOOD PRESSURE

Blood pressure is the force that the blood exerts against the walls of the vessels through which it flows. The blood pressure is commonly meant to be the pressure in the arteries. The pressure in the arteries varies with the contraction (work period) and the relaxation (rest period) of the heart. SYSTOLIC PRESSURE—when the heart contracts, the blood in the arteries is at its greatest pressure. DIASTOLIC PRESSURE—when the heart relaxes, the blood in the arteries is at its lowest pressure. PULSE PRESSURE is the difference between systolic and diastolic pressures.

Normal blood pressure.—A systolic pressure of 110 to 136 millimeters of mercury and a diastolic pressure of 60 to 90 mm may be considered as being within the normal range. The pulse pressure is usually about one half the diastolic pressure.

PROCEDURE FOR TAKING A BLOOD PRESSURE READING

Purpose

To determine the systolic and diastolic blood pressure in the brachial artery. To determine the pulse pressure.

Equipment

Stethoscope
Sphygmomanometer
Alcohol sponges.

Precautions

1. Explain procedure to the patient to lessen his fears or apprehension.

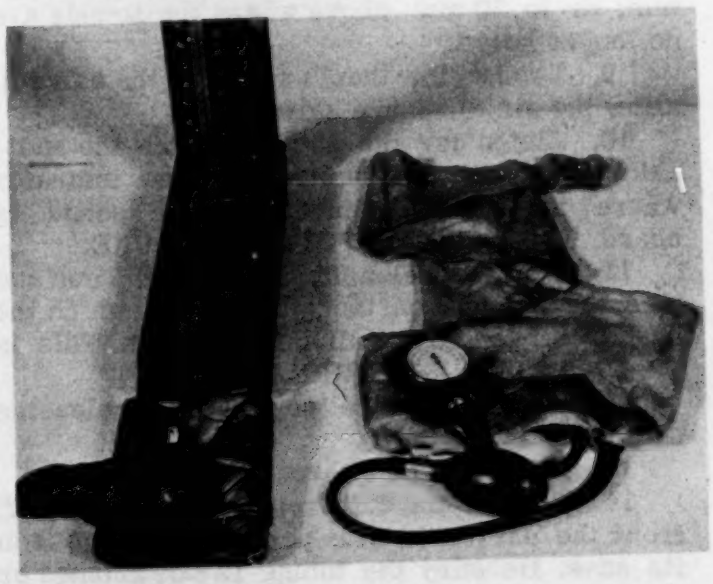

Figure 12-9.—Blood-pressure apparatus (Sphygmomanometer, Aneroid and Mercury type).

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2. Patient must be at rest, lying down in bed or sitting quietly in a chair with the arm to be used well supported.

3. Be sure the cuff of the apparatus is completely deflated and the indicator registers zero before starting the procedure.

4. Wipe the bell and earpieces of the stethoscope with an alcohol sponge before starting the procedure.

5. When repeated readings are ordered, the same arm should be used and the same person should carry out the procedure.

Procedure

1. Push patient's sleeve well above his elbow; if sleeve is tight, remove it.

2. Starting with the wide portion of the cuff, wrap it snugly and smoothly around the arm above the elbow. Tuck narrow end under the previous turn.

3. Clip indicator on the cuff (aneroid type), or place apparatus on a level surface (mercury type).

4. With the fingers, locate the brachial pulse at the bend of the elbow.

5. Place the stethoscope in the ears, earpieces facing forward.

6. Place the bell of the stethoscope over the spot where the brachial pulse was felt.

7. Tighten thumb screw of the valve.

8. Holding the stethoscope in place, inflate cuff with the bulb until the indicator reads 200 mm. or to 20 mm. above where the sounds are no longer heard.

9. Loosen the thumb screw of the valve to allow the air to escape slowly.

10. Listen for the sounds, watch the indicator and note the number on the indicator where the first distinct rhythmic sound is heard. This is the SYSTOLIC PRESSURE.

11. Continue releasing air from the cuff and note the number on the indicator at which the sound changes to a dull muffled beat. This is the DIASTOLIC PRESSURE (fig. 12-10).

12. Open the valve completely, releasing all the air in the cuff.

13. Repeat steps 3 through 12 to recheck.

14. Remove the cuff from the arm; roll cuff from the narrow to wide portion and place it in its case. Be sure the tubing is not pinched or kinked.

15. Wipe earpieces and bell of stethoscope with an alcohol sponge.

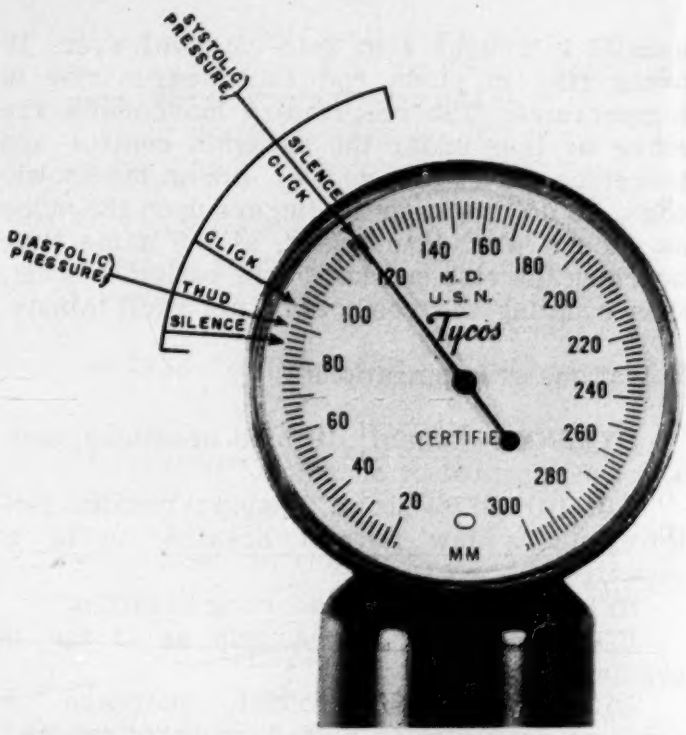

Figure 12-10.—Dial of spring manometer.

16. Record the systolic pressure over the diastolic pressure on the TPR sheet (SF 511) or graph on the Plotting Chart as directed.

PROVIDING FOR THE PATIENT'S COMFORT

In promoting the physical comfort of a patient it should be remembered that his mental attitude has a marked influence on his physical condition. Consequently, it must never be forgotten that a sick person reacts differently than a well one and is affected by things that ordinarily would not be noticed. Therefore, comfort is the enjoyment of physical and mental well-being. This applies to the corpsmen as well as to the patient.

One of the essentials of physical comfort is good posture. Good posture is the position of the body in correct alignment when standing, sitting, lying down, or in any phase of activity. The coordinated use of the body parts to produce motion and maintain equilibrium is termed body mechanics. The use of good posture and proper body mechanics by the corpsman when taking care of his patient will serve to:

1. Conserve the energy of the corpsman.

2. Promote the efficient use of muscles by the corpsman.

3. Avoid backstrain and fatigue of the corpsman.

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4. Teach his patient, by example, the importance of good posture.

The maintenance of good body alignment of the patient while in bed will serve to:

1. Promote the proper functioning of the body systems.
2. Promote a feeling of well-being.
3. Avoid fatigue and prevent deformities.

Providing for the mental comfort of the patient includes:

1. Adequate explanation of what is to be done.
2. Anticipating his wants.
3. Listening to his problems and referring him to the proper person or department when necessary.

These are but a few of the ways of providing for the mental comfort of the patient. The corpsman, by experience, will learn to recognize the general reactions of individuals, what causes people to behave the way they do, and to use these experiences in providing more complete care for his subsequent patients.

Principles of Moving and Lifting

The following principles may be applied to any moving or lifting activity as well as to moving and lifting the patient.

1. Place your body in correct alignment before starting the activity.
2. Place your feet far enough apart to provide an adequate base of support and to maintain balance.
3. Hold the object to be carried as close to the body as possible so that the centers of gravity of both will be close together.
4. Use the large muscle groups to lessen strain and fatigue.
5. Stoop to working level, keeping the back straight.
6. Slide, rather than lift a patient or object whenever possible.
7. Give adequate support to the object or body to be moved. Obtain help when moving a heavy object or unmanageable patient.
8. Work in unison, give signal before starting activity.

Methods of Moving and Lifting

1. Tell the patient exactly what is to be done and how he may help.
2. Bring all needed equipment to the unit.
3. Lock the wheels of the bed.
4. Fold all bedding and clothing so that the patient will not be hampered by them and yet will not be exposed.

Assume the Correct Position

1. Stand, facing in the direction of the move to be made, with the feet apart, one foot well in front of the other.
2. Stoop to working level by flexing knees, keeping back straight. (fig. 12-11).

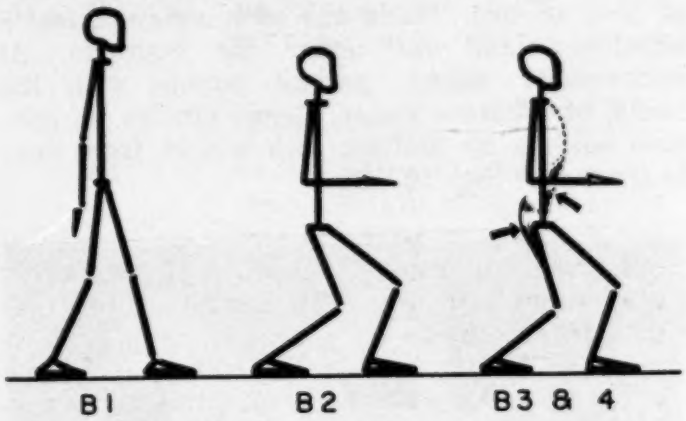

Figure 12-11.—Body in correct position for moving or lifting.

3. Place arms under patient, keeping your elbows close to the body.
4. Set pelvis by tensing the abdominal and gluteal muscles simultaneously.

Move on Lift Patient by Shifting Own Weight From One Foot to the Other (Fig. 12-12).

1. To move patient toward you, let arms holding the patient slide on the bed; shift your weight from front to rear foot.

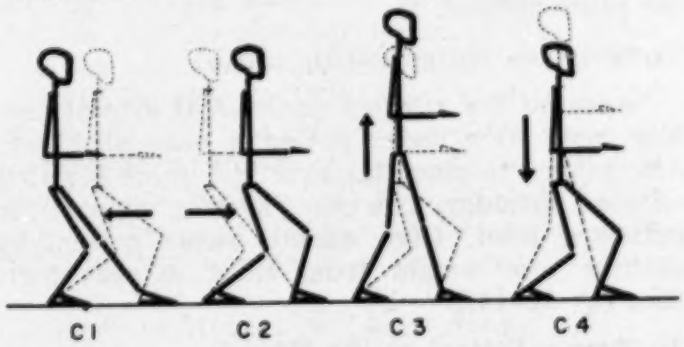

Figure 12-12.—Body in motion when moving or lifting.

2. To move the patient away from you, let arms holding the patient slide on the bed; shift your weight from the rear to the front foot.

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3. To lift the patient, keep elbows close to your body, straighten knees, equal weight on both feet.

4. To lower patient, keep elbows close to your body, flex knees to working level, equal weight on both feet.

To Move a Patient Up in Bed When He Is Able to Assist

Assume the correct position at side of bed. Ask patient to flex his knees and to grasp rungs at head of bed. Place one arm under patient's shoulders and one under the buttocks. At corpsman's signal, patient pushes with his heels, straightens knees, flexes elbows. Corpsman assists by shifting own weight from rear to front foot (fig. 12-13).

Figure 12-13.—To move a patient up in bed when he is able to assist.

To pull up a mattress, grasp underside of mattress, flex knees to working level and use the same method.

To Help The Patient Sit Up in Bed

Assume the correct position at side of bed. Slip near arm under patient's near shoulder. Ask patient to place his arm into same position on your shoulder. Use other arm as support for patient's head. Give signal, raise patient by shifting own weight from front to rear foot. (See fig. 12-14.)

To Turn a Patient on His Side

Assume the correct position at side of bed toward which patient is to be turned. Flex patient's knees. Place your hands on patient's far shoulder and hip. Slowly and gently turn patient toward you by shifting own weight from the front to the rear foot. Check patient's shoulder alignment.

Figure 12-14.—To help the patient sit up in bed.

To Move a Helpless Patient Up in Bed (Two Corpsmen)

A corpsman assumes the correct position on each side of bed. Flex patient's knees, ask him to make himself rigid. Both corpsmen slide arms under patient's head and shoulders and under patient's buttocks—lock wrists. At one corpsman's signal both move patient by shifting their weight from rear to front feet.

To Help the Patient Sit Up on Side of Bed

Dress patient in pajamas. Fanfold covers to foot of bed. Flex patient's knees; turn him on his side. Assume the correct position. Place one arm under patient's shoulder, the other behind the knees with hand under his lower thigh. Ask patient to place his hands around your neck or on your shoulders. Give signal; slowly

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bring patient to sitting position by straightening your knees as you shift weight from front to the rear foot. Support patient's feet on stool or chair.

To Help The Patient Out of Bed Into Chair

Place chair parallel to bed. Bring patient to a sitting position on side of bed. Dress him in bathrobe and slippers. Allow patient to sit on side of bed until he is accustomed to this position. Assume the correct position in front of patient. Ask patient to place his hands on your shoulders. Place a hand on each side of the patient, midway between his axilla and hip. Supporting patient, allow him to slide off bed and stand on floor. Pivot with patient, lower him into chair by flexing your knees, shifting weight from rear to front foot, keeping your back straight.

To Help the Patient into Wheel Chair

Place chair against bedside table or have another corpsman hold it. Fold back foot rests. Follow instruction under To Help the Patient Out of Bed to a Chair. Assume the correct position of deep knee and hip flexion to adjust foot rests. For wheel chairs with adjustable knee rests, fold back knee rests until patient is seated, then adjust them.

To Move Patient From Bed to Stretcher

Place stretcher at right angles to the bed. Three corpsmen assume the correct position at the same side of bed. First corpsman places one arm under patient's shoulders, supporting the head on the crook of his arm, the other arm under patient's back. Second corpsman places his arms under patient's back and thighs. Third corpsman places his arms under patient's thighs and calves. At first corpsman's signal, all slide patient to edge of bed. All corpsmen again assume the correct position and at first corpsman's signal, all lift by straightening knees; then turn and place patient on stretcher.

To move the patient from stretcher to bed—use same method (fig. 12-15).

To Move an Injured Arm or Leg

Place pillows in readiness to support extremity. Place both hands beneath the injured limb, at joints above and below the site of injury. Raise limb slowly and gently. Place extremity on pillow, being sure the entire limb is supported. The toes or hands should be slightly higher than the rest of the extremity (fig. 12-16).

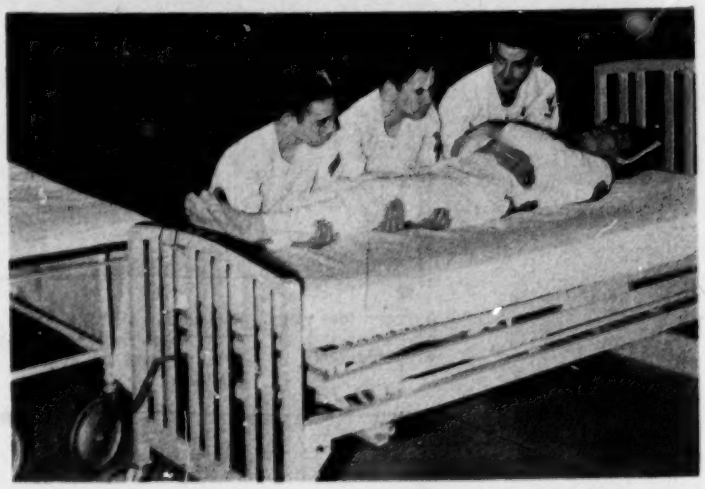

Figure 12-15.—To move the patient from bed to stretcher.

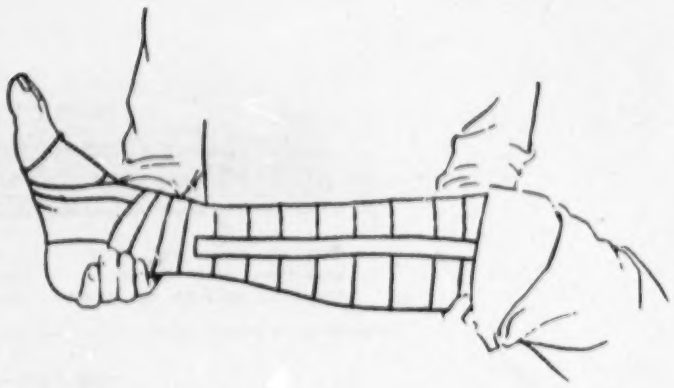

Figure 12-16.—To move an injured arm or leg.

DEVICES FOR THE COMFORT OF THE PATIENT

All devices used for the patient's comfort should:

1. Be large enough to support a part along its entire length.
2. Be firm enough to support, yet not cause pressure.
3. Promote correct anatomical alignment (fig. 12-17).
4. Conform to part of body being supported.

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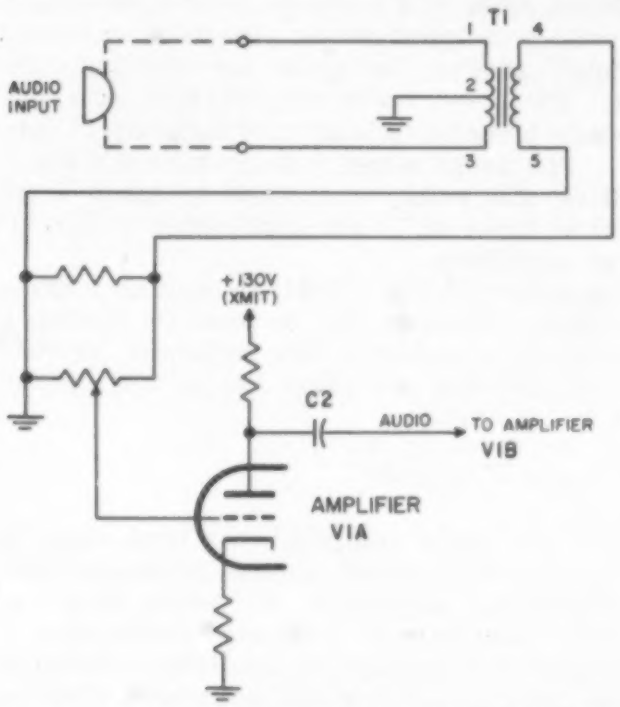

Figure 13-8. —Dynamic microphone input.

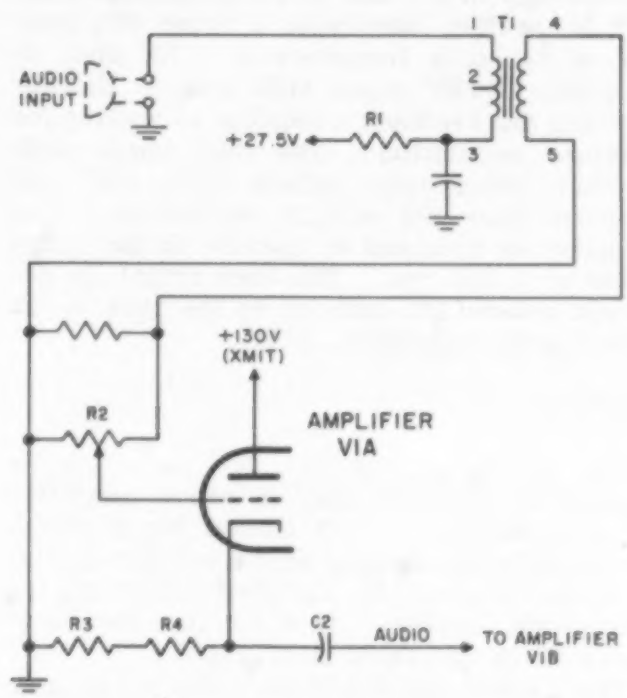

Figure 13-9. —Carbon microphone input

The microphone input amplifier V1A in figure 13-8 may be connected for use with either a dynamic microphone or a carbon microphone. Connections are normally made at the time of manufacture, but may be changed as a part of a special installation.

When using a dynamic microphone, the amplifier operates as a conventional Class A circuit, and has sufficient gain to increase the level of the microphone, which has relatively small audio output. A balanced input to ground is provided by the primary of transformer T1. The secondary winding of the transformer is connected in parallel with a variable resistor which controls the input signal level at the grid. The output is coupled through C2 to the grid of a second audio amplifier stage, V1B.

When employing a carbon microphone, the circuit arrangement shown in figure 13-9 is used. Tube V1A is then connected as a cathode follower to avoid excessive amplification of the higher level audio provided by the carbon microphone. Since this type of microphone requires a constant current flow, it is connected in series with the 27.5-volt line through current limiting resistor R1, the transformer primary, and ground. The audio signal is developed across variable resistor R2. The output of the stage appears across resistors R3 and R4 and is coupled through C2 to the grid of the following audio amplifier.

An alternate audio input signal employed in the transmitter is supplied by the tone oscillator circuit shown in figure 13-10. The tone generator, V5, supplies a 1,000-cps homing signal when the external tone switch is closed. The action of the switch energizes a tone relay which applies plate voltage to the oscillator and also energizes the transmit-receive relay to place the radio set in the transmit condition.

The tone oscillator is of the phase-shift type with feedback applied to the grid from the

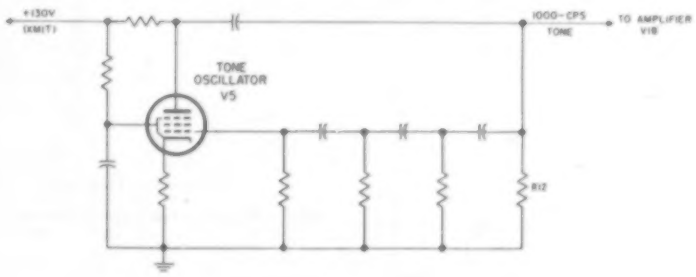

Figure 13-10. —Tone oscillator circuit, ARC-52 transmitter-receiver.

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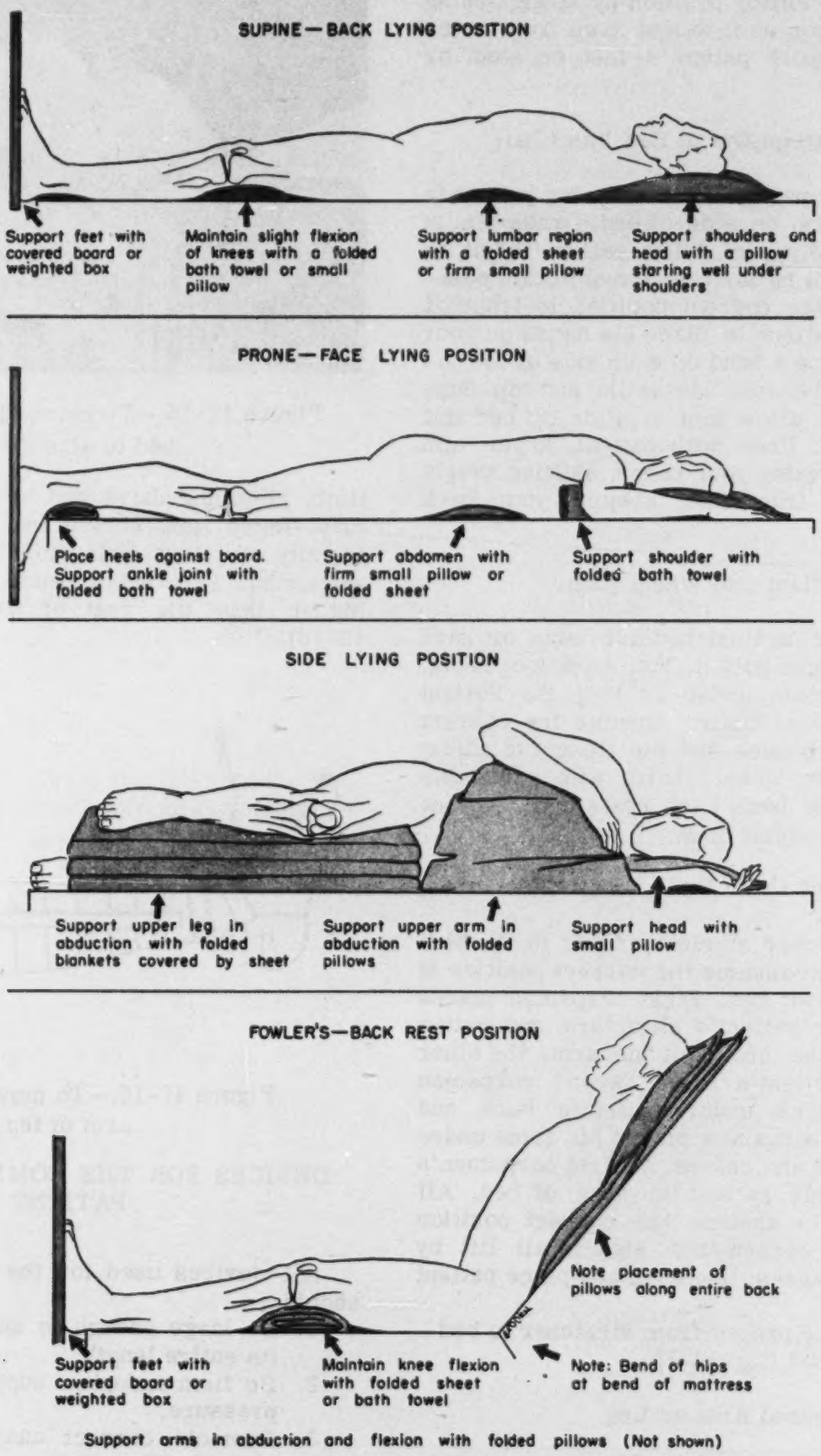

Figure 12-17.—Position for patient's comfort.

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The GATCH BED allows the patient's position to be changed with the least exertion to him. Patients are all different sizes and heights. The breaks in the bed frames for the back and knee rests are in the same place on all beds. Therefore, in most instances, the knee rest will not be usable when the back rest is elevated and vice versa. The knees may be flexed by use of a pillow, rolled sheet, towel, or blanket. The feet should be supported so that they are at right angles to the bed (as in standing position) (fig. 12-18).

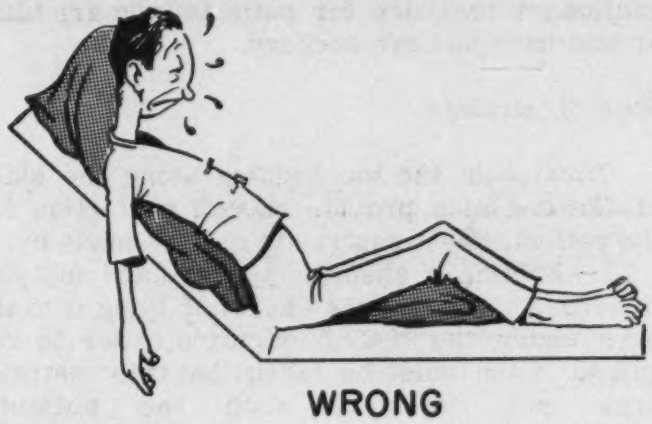

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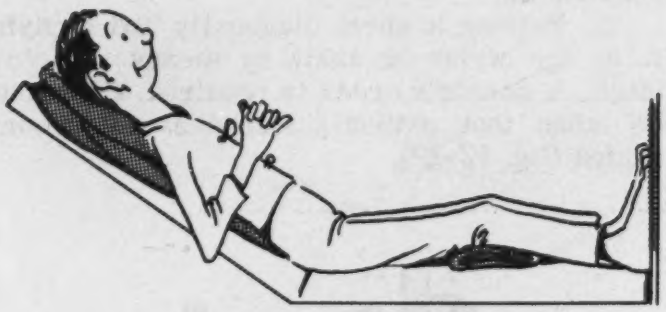

RIGHT

Figure 12-18.—Proper use of the Gatch bed.

FRACTURE BOARD.—A board the width and length of the mattress used to prevent sagging of the mattress. Used particularly in the care of patients with back injuries or fractures.

BALKAN FRAME.—An overhead apparatus attached to the bed providing a trapeze and attachments for traction. Used for patients who are in casts, in traction, or who are paraplegics.

PILLOWS.—Various sizes may be used, depending upon the purpose. Place pillows in rubber cases when there is a possibility of soiling them. Follow the rules for Devices for Comfort.

FOOTBOARD.—A board the width of the bed and at least 3 inches higher than the patient's toes used to support the feet. The board will help the patient stay in the correct position by preventing his slipping down in bed and will prevent the bedding from pressing on his toes. (fig. 12-19).

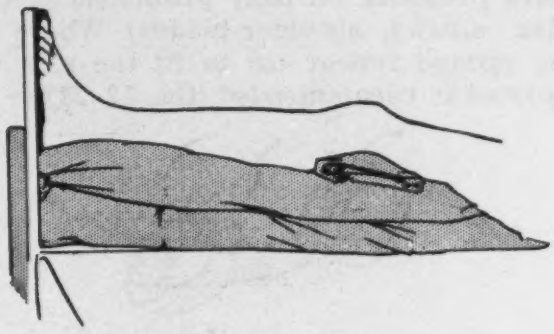

Figure 12-19.—Footboard.

AIR RING.—An air ring used to relieve pressure on the coccyx, hips, or on any part of the body. The ring should be inflated just enough to raise the part off the bed. To inflate: Place a paper straw into valve of ring (or cover valve with gauze). Blow up until one-third full of air; close valve (fig. 12-20).

Figure 12-20.—Inflating air ring.

Place ring inside a cotton pillow cover. Place ring under patient so that the part to be protected is directly over the hole of the ring.

Precautions

1. Be sure valve of ring is away from patient's body. For example, between legs when used to relieve pressure on coccyx.

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2. If ring is too hard after it is under the patient, open valve and release some air so that the ring fits the patient. A hard ring will cause more pressure than no ring at all. A soft ring does not relieve pressure.

3. Rings should be removed every two hours for short periods of time.

Doughnuts (Cotton rings).—Sponge rubber or cotton rings, called doughnuts, may be used to relieve pressure on bony prominences (heels, ankles, elbows, shoulder blades). Where available, sponge rubber cut to fit the part of the supported is recommended (fig. 12-21).

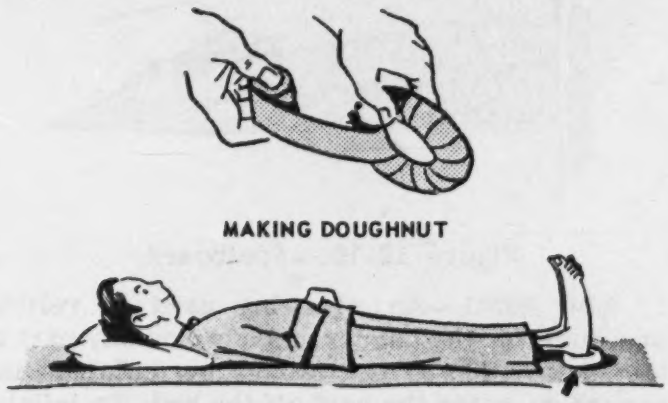

Figure 12-21.—Placement of doughnut.

To make cotton rings: Take cotton wadding of sufficient size to support area. Form into a circle; wind 2 or 3 inch bandage around cotton to make an even, fairly firm ring. Finish bandage with a small piece of adhesive tape.

Cradles.—These are frames of various sizes used to keep weight of bedclothes off patient's leg, toes, or entire body. Anchor cradle to bed by tying to spring or rungs of bed with bandage or string.

Sandbags.—These may be used for support in maintaining certain positions or for immobilization. They are placed also around a part of the body to relieve pain caused by muscle twitching. Cover bag with a pillow case. (Special covers for sandbags may be requested to be made by the linen room.)

Precaution

When using to support an extremity, be sure sandbag is long enough to support entire limb.

DEVICES FOR THE SAFETY OF THE PATIENT

The patient must be protected from injuring himself or, others. The basic safety measure to protect all patients is to have all equipment in good working order. Some patients require additional protection such as side bars, sheet or leather restraints.

SIDE BARS are metal bars, the length of the bed, that serve to keep the patient in bed. Some beds are equipped with bars that slide down when not in use, much like a child's crib. There are detachable bars available for other beds. Side bars are used for patients who are confused, delirious, under sedation, or unconscious. They may also be used as a precautionary measure for patients who are blind or who have had eye surgery.

Sheet Restraints

Tucking in the top bedding along the sides of the bed may provide enough protection for the patient. Sheet restraints may be made by:

1. Folding a sheet in quarters and applying it across the patient's chest and tying it to the bars under the bed. A doctor's order is required. Care must be taken that this restraint does not interfere with the patient's respiration.

2. Folding a sheet diagonally and applying it to the wrist or ankle by means of a clove hitch. A doctor's order is required. Care must be taken that patient's skin does not become chafed (fig. 12-22).

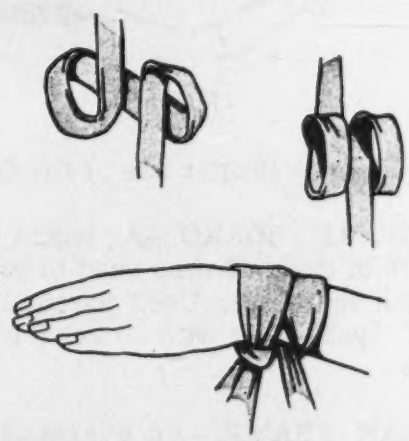

Figure 12-22.—Clove hitch sheet restraint.

Leather Ankle and Wrist Restraints

These restraints MUST have a doctor's order; must be padded; must be loose enough to permit circulation of the parts of the body

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restrained; must be placed on opposite sides of the body (right wrist, left ankle); must be slack enough to allow some body movement.

Applying Restraints

1. Pad the wrist or ankle with towel or cotton wadding.
2. Place cuff over pad.
3. Pass strap through loop of cuff and under bar of bed.
4. Allow enough slack in the strap to permit movement.
5. Lock strap.
6. Watch patient for signs of chafing, burning, or pressure sores.

PERSONAL CLEANLINESS OF THE PATIENT

The need for personal cleanliness of a sick person is as great or greater than that for a well person. The care of the skin, mouth and hair follows the same general outline as in your daily life. Good grooming contributes to a sense of well-being, and the absence of it, in most cultures, suggests a low morale. The amount of assistance the patient will need from you in attending to his personal cleanliness will depend upon the amount of activity permitted him by the doctor, and his general and local condition. Most patients prefer to do as much for themselves as possible; others will need to be encouraged to assume their own care.

ORAL HYGIENE

Purpose

To keep mouth clean; refresh patient; to prevent sores and mouth odors; to stimulate appetite. It should be completed:

1. Morning and evening for all patients.
2. Every 1 or 2 hours for patients who have mouth injuries or surgery, have sore inflamed mouths, or are on NOTHING BY MOUTH.
3. Every 2 to 4 hours for patients who have fever, are unconscious, seriously ill, or dying.

Equipment

Glass of water
Curved basin
Toothbrush, dentifrice
Hand towel

Procedure

When Patient is Able to Help Himself

1. Place patient in comfortable position on backrest or on his side.
2. Arrange equipment within his reach on beside or overbed table.
3. Remove equipment promptly when he is finished.

When Patient Needs Some Assistance

1. Turn patient on side.
2. Place towel under his chin and over bedding.
3. Pour water over brush; place dentifrice on brush.
4. Give patient his brush; hold curved basin under his mouth while he brushes teeth.
5. Give water to rinse mouth; take toothbrush.
6. Remove basin; wipe lips and chin with towel.
7. Make patient comfortable.
8. Remove equipment from unit.

When Patient is Unable to Help Himself

1. Add drinking tube to equipment.
2. Proceed as above, doing all steps for patient. Brushing teeth:

Start at front teeth, brush from one side of mouth to the other.

Brush outer surfaces of the upper and lower teeth toward the biting edge.

Do inner surfaces of teeth in same manner.

Use drinking tube to rinse patient's mouth.

SPECIAL MOUTH CARE

Patient requiring special mouth care are the unconscious, dying patient, or one who has had surgery, injuries, or sores of the mouth.

Do not use force to clean wounds, to clean around wires, or to remove crusts.

Equipment

Seven cotton applicators
Mouth wash (1:3 solution)
Glass of water

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Tube
Hand towel
Curved basin
Tongue depressor wrapped with gauze bandage
Paper wipes
Bag for waste
Mineral oil
One ounce bulb syringe if patient is unable to use tube.

Procedure

1. Follow instructions as above. Moisten applicators in mouth wash. Use in the same manner as toothbrush.
2. Use new applicator for each section of mouth; discard into bag.
3. Use wrapped tongue depressor for cleansing tongue and holding mouth open.
4. Use drinking tube to rinse mouth. If patient is unable to use tube and is conscious, turn his head to one side and gently irrigate mouth. Direct stream of solution to side of mouth. If patient is unconscious, use moistened applicators.
5. Apply mineral oil to lips and gums.
6. Make patient comfortable, remove equipment.

Care of Equipment

1. Rinse toothbrush under cold running water; replace in patient's bedside table.
2. Discard waste into burnable trash can.
3. Wash metalware with soap and water and replace in patient's bedside locker.
4. Wash glassware with soap and water; boil 10 minutes, dry and stow in proper place; return bulb syringe to CSR for sterilizing.

Charting—Nursing Notes

Time, treatment, any unusual condition noted.

CARE OF DENTURES (FALSE TEETH)

Plates and bridges should be cared for as often and in the same manner as natural teeth.

Equipment

Denture cup for teeth
Toothbrush and dentifrice

Procedure

1. Ask patient to place teeth in denture cup.
2. Take to utility room.
3. Place basin under tap sink and place folded towel or wash cloth in basin as a precautionary measure against breakage.
4. Wash dentures under warm running water over basin.
5. Use patient's brush and dentifrice, rinse dentures well.
6. Put teeth in denture cup; return them to patient.
7. Do not wrap dentures in tissue or towel.

Care of Equipment

Same as for Oral Hygiene

EARLY A. M. CARE

Purpose

The average person in health begins the day refreshed by a night's rest; a sick man, although usually relieved to see the dawn, may be anything but refreshed. Therefore, the purpose of A.M. CARE is to refresh and prepare the patient for breakfast. It should be completed for all bed patients, 1 hour before breakfast, or upon awakening.

Equipment

Face basin, one-half full of hot water.
Glass of water; curved basin
Patient's toothbrush and dentifrice
Hand towel; washcloth
Soap in soap dish
Comb

Procedure

1. Offer bedpan or urinal. Complete this item before continuing.
2. Do oral hygiene
3. Wash face and hands
4. Comb hair
5. Prepare patient for breakfast
   a. In correct position (Fowler's or on side).
   b. Clear top of bedside locker or overbed table for food tray.

For Group of Patients.—Use wheeled cart. Load with equipment as above. Add large

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pitcher of hot water, small pitcher of cold water. Distribute equipment to patients who are able to help themselves, then to patients who require help.

EVENING CARE (P.M. CARE)

Purpose

To prepare and relax the patient after the discomforts of the day and to remove or minimize causes of restlessness and sleeplessness during the night. It should be completed for all bed and newly convalescent patients.

Equipment

Same as for A.M. CARE, plus:
1. Rubbing alcohol
2. Powder or skin lotion

Procedure

1. Follow instructions as for A.M. CARE.
2. Add back rub.
3. Straighten and tighten foundation bed, brush out crumbs, and freshen pillows.
4. Bring bedside locker within patient's reach.
5. Give fresh drinking water.
6. Place extra blanket at foot of bed if night is cool.

CLEANSING BATH

The first and perhaps the most important factor for the patient's comfort is the cleanliness of the patient. Cleanliness is essential to the health of anyone, but it is especially so to one who is sick or injured.

Bathing a patient is most important in maintaining his cleanliness, and baths given for that purpose are usually spoken of as cleansing baths. The cleansing bath may be a tub, shower, or bed bath.

Purpose

A cleansing bath is given for the purpose of cleansing the patient in order to observe him; to aid in elimination by keeping the pores of the skin open; to prevent bed sores by stimulating the circulation, and to relax and refresh the patient.

BED BATH

A bed bath is indicated for new patients on admission and daily for all bed patients, preferably in the morning but may be given at any time which best meets the need of the patient.

Equipment

Bath basin or foot tub one-half full of hot water. (110° F.)
Soap in soap dish
Rubbing alcohol, 50 percent, or skin lotion
Nail stick
Nailbrush, if needed
Oral hygiene equipment
Linen as needed: pajamas, bath and hand towels, washcloth

Points to Remember

1. Squeeze washcloth sufficiently to avoid dripping water over bedding.
2. Wrap washcloth around hand and secure ends with thumb or use mitten washcloth, whichever method permits you to squeeze and secure the ends of the cloth and takes the least time (fig. 12-23).

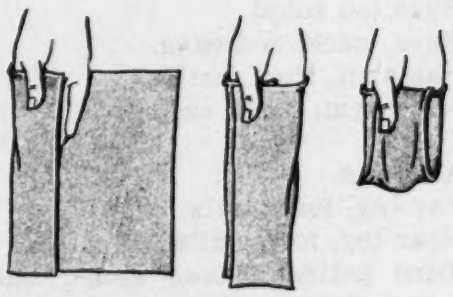

Figure 12-23.—Mitten wash cloth.

3. Expose only that part being bathed.
4. Use long, firm, smooth strokes in bathing.
5. Wash all parts of the body; soak hands and feet.
6. Protect bedding with towel as each part is bathed.
7. Change water after bathing feet and when it becomes dirty, soapy, or cool.
8. Observe patient. Watch for signs of rash, scratching, pressure areas, vermin. Talk to patient during bath; find out how he feels. Any new pains? Aches? Worries?

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9. Keep linen off floor. Place soiled linen in hamper.

Procedure

Preparation of patient and his unit is as follows:

1. Screen patient, close windows, and check temperature of ward (7° to 75°F.).
2. Tell patient what you are going to do.
3. Offer bedpan or urinal. Remove before continuing.
4. Gather equipment needed except basin; bring to bedside.
5. Do oral hygiene.
6. Remove oral hygiene equipment; bring in basin of water.
7. Lower backrest; loosen top bedding at foot and sides of bed.
8. Remove pillow; strip and place on chair.
9. Fold spread from top to bottom; pick up in center and place on back of chair.
10. If ward is warm, blanket may be removed in same way.
11. Remove jewelry; place in drawer of bedside stand.

Order of Bath

1. Eyes (no soap)
2. Face, neck, and ears.
3. Far arm, hand, nails.
4. Near arm, hand, nails.
5. Chest
6. Abdomen
7. Far leg, foot, nails.
8. Near leg, foot, nails.
9. Turn patient. Wash sides, back, buttocks; rinse and dry well.
   a. Pour alcohol into hands; then apply evenly to patient's back. Rub until back is dry.
   b. Sprinkle powder or skin lotion into hands; then apply to patient's back. Rub for 5 minutes. Use long, smooth, firm strokes; even pressure; establish definite rhythm; keep hands on back for duration of back rub.
10. Genitals—patient usually prefers to wash himself; corpsman will do so if patient is too ill.

After Bath

1. Put on pajamas.
2. Comb hair.
3. Make up bed. (See occupied bed.)
4. Remove all equipment; leave unit clean and in order.
5. Leave patient comfortable:
   a. In correct position
   b. Call bell, fresh water and bedside table within reach.
6. Clean equipment.

Male patient.—Patient may shave himself either with his a.m. care or before his bath. When corpsman must shave patient, do so before bath or after lunch, before visiting hours.

Female Patient.—Give patient all her makeup equipment after the bed is finished. She will apply makeup while unit is being straightened.

BEDPAN AND URINAL SERVICE

Some patients can be allowed toilet privileges but those who are not must be assisted by the corpsman; the use of the bedpan or urinal is required for many such cases. The bedpan and urinal are utensils into which a patient defecates or voids when he is unable to get out of bed and go to the head. They are devised to protect the patient from unnecessary exertion, exposure, and embarrassment; to prevent soiling of the bed linen; to avoid chilling of the patient, and to assure cleanliness of the patient's body.

Bedpan Service

Purpose

To maintain proper elimination with least exertion to patient.

Equipment

Bedpan
Bedpan cover
Toilet paper

Procedure

1. Screen unit. Take covered bedpan and toilet paper to bedside. (Bedpan may be warmed by running hot water over it and then drying it.)
2. Remove bedpan cover and tuck under mattress on side of the bed.
3. Lift bed covers; remove any air cushions and pillows.

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4. Pull pajama coat above waist and pajama pants down to knees.

5. Flex patient's knees; slip one hand under the patient's back, raise his hips, and with the other hand, slip pan into place. Or: Roll patient to side of bed, place the pan against his buttocks, and then roll him back to the center of the bed on the pan.

6. Place toilet paper and bell cord within reach.

7. Leave patient alone unless he is too ill.

8. Answer light immediately when patient calls and remove pan quickly.

9. For patient unable to cleanse himself: Ask patient to turn on his side off the pan; take toilet paper and clean patient.

10. Cover pan and place it on chair.

11. Fix bedding; leave patient in comfortable position.

12. Take pan to utility room; look at contents. Note amount, consistency, color, odor, and unusual appearance (mucus, worms):

a. Normal stool—brown, formed, soft.
b. Blood in stool—black, tarry.
c. Absence of bile in stool—clay-colored gray.

13. Provide patient with basin of water, soap and towel to wash his hands.

14. Care of bedpan:

a Automatic Washer—Place pan in sterilizer, close door, and push flusher valve. Push and hold steam valve for 1 minute. Remove pan and stow in rack or return to patient's unit.

b. Manual Washing—Add cold water to bedpan and empty contents into hopper; clean bedpan with brush and hot soapy water. Boil pan in utensil sterilizer for 20 minutes.

15. Wash your hands.

Urinal Service

Equipment

Urinal and cover.

Procedure

1. Bring covered urinal to patient.

2. Remove urinal promptly after patient has voided.

3. Take urinal to utility room; note color, and appearance. Measure amount and record on DD 792 if required.

4. Clean urinal in same manner as bedpan.

5. Wash your hands.

CARE OF INCONTINENT PATIENT

Purpose

To keep the patient as clean and dry as possible; to prevent decubitus ulcers.

Incontinence may be due to:

1. Loss of muscle tone or paralysis of the anal or urethral sphincter.
2. Urinary retention with overflow.
3. Bedpan or urinal not given when needed.

Procedure

1. Answer patient's calls promptly.

2. Change bedding at once when wet or soiled.

3. Wash patient with soap and water each time he is wet or soiled.

4. Watch for signs of burning, redness, or breaks in the skin.

5. Give frequent back rubs alternating oil and alcohol.

6. Place patient on a bedpan at frequent intervals.

7. Place a urinal for a male patient. Be sure it is level and will not tip over. Empty, clean and replace frequently.

8. Use a large disposable pad or covered rubber sheet under the patient's buttocks.

9. Doctor may order an indwelling catheter to keep the patient dry. See Indwelling Catheter and Simple Drainage.

CARE OF BEDSORES (DECUBITUS ULCER, PRESSURE SORE)

A bedsore is an ulcerated area due to poor circulation to a part of the body as the result of pressure. The presence of bedsores almost invariably denotes lack of care and watchfulness on the part of those responsible for the patient's care. The areas most likely to develop bedsores are the elbows, heels, hips, buttocks, ankles, toes, ears, back of the head, and areas over the end of the spine and shoulder blades (fig. 12-24). All patients confined to bed are susceptible to bedsores. The patients most likely to develop bedsores are incontinent patients, those with lowered vitality

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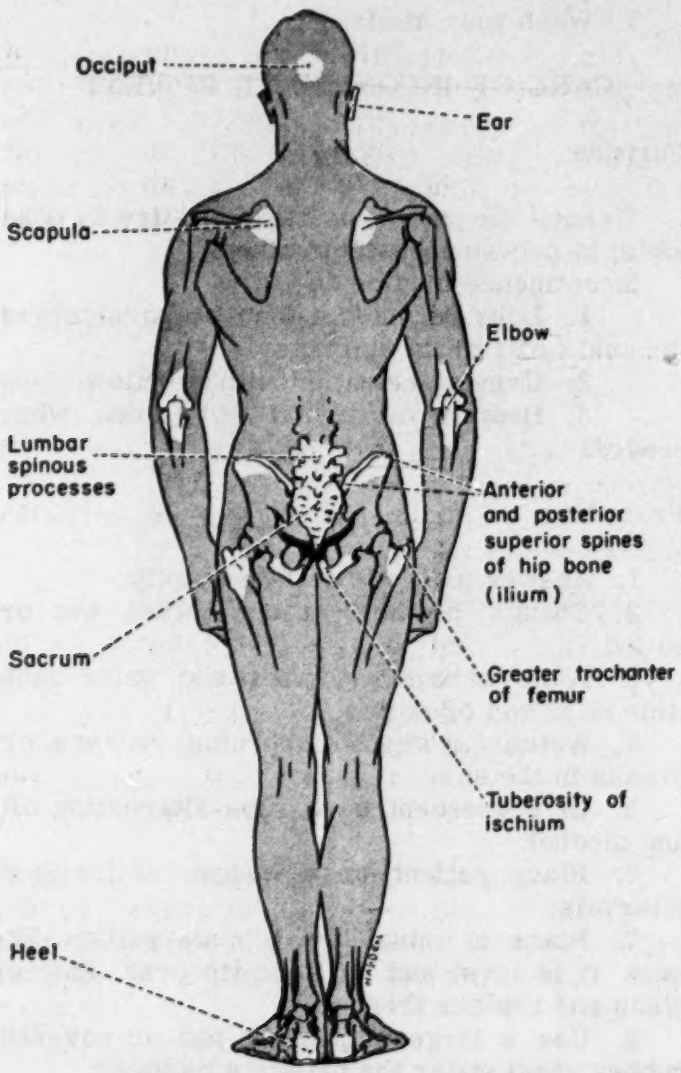

Figure 12-24.—Areas susceptible to bedsores.

due to prolonged illness; the emaciated patients; obese patient; paralyzed patient; unconscious patient, the edematous patient; diabetic, cardiac, or nephritic patients; those with casts, splints, bandages, or in traction.

Causes

1. Constant pressure on an area due to lying in one position too long.
2. Splints, cast, bandages, or traction improperly applied.
3. Moisture due to sweat, urine, feces, water, pus, or other discharges.
4. Friction due to too tight or wrinkled bedding.
5. Pimples or breaks in the skin.
6. Faulty use of the bedpan.

Symptoms

1. Blanching of the skin which quickly turns red when the cause of the pressure is removed.
2. Patient complains of numbness, tingling, or tenderness.
3. Bluish or mottled discoloration of the skin.
4. Breakdown of the skin.
5. Ulceration.

Prevention

1. The most important prevention is the relief of pressure on bony prominences.
2. Inspect the skin of all bed patients every day during the bath and morning and evening care.
3. Change the patient's position every 2 hours.
4. Keep patient and his bed clean and dry.
5. Rub suspected areas frequently, alternate oil and alcohol rubs.
6. Wash, dry and powder patient's skin with talcum or cornstarch each time he is incontinent.
7. Inspect all appliances frequently.

Treatment

1. The best treatment for bedsores is to prevent them.
2. Report any suspicious areas immediately.
3. If skin is broken:
   a. Wash with soap and water; dry well.
   b. Rub the surrounding area with alcohol.
   c. Follow doctor's order for other treatment or medication.

DIETS AND SERVING PROCEDURES

Among the various measures tending to physically support a patient, none perhaps, is of more importance than the food and drink he receives. Illness tends to make a patient very hard to please and notional in regard to food. He may like some things today and tomorrow dislike them, or vice versa. The feeding of a patient must not be taken lightly because food is an important item in his treatment and return to health.

Foods which the patient dislikes, but which have been ordered for him and are essential

for nourishment, may be disguised to alter either taste or appearance. For instance, an egg well beaten may be served in orange juice thoroughly iced, instead of in milk; milk in a cocoa or chocolate shake when the patient does not care for the milk alone; cream in ginger ale rather than as plain cream.

Delay in serving, with food in sight, irritates the patient, sometimes to the point of refusing to eat, and also results in cold food.

The patient's appetite is stimulated by the time of day, by the sight, smell, and taste of food and by the manner and condition in which it is served to him. The ward should be quiet, orderless, and in readiness for meals. No treatment should be done, sick calls made, or visitors permitted during meal hours.

Standard Diets

1. Liquid;
   a. Clear—tea, coffee, broth, gelatines.
   b. Full—add strained soups, juices, ice cream.
2. Soft;
   a. Add chicken, beef; bland vegetables, puddings.
3. Light;
   a. Add light salads, vegetables, lamb, veal, dessert, plain cake.
4. Regular;
   a. Full house diet.
5. Special diets;
   a. For specific conditions, certain foods are increased or decreased according to needs of the patient.

Preparation of Bed Patient

1. Clear bedside stand or overbed table.
2. Bring stand or table within patient's reach.
3. Place patient in sitting position or on his side.
4. Tuck a hand towel under his chin and across his chest.

Preparation of Up Patient

1. Remind patient to be at his bedside when meals are served.
2. Where possible, serve up patients at a table.

Food Trays

At most stations the trays are prepared in the galley or diet kitchen and sent to the wards completely assembled. In these cases the corpsman must ascertain that the patient receives the right tray, the one with his name on it. At stations where food carts are used proceed in the following manner:

1. Wash your hands.
2. Inspect dishes, silverware, and trays for cleanliness.
3. Use clean serving utensils for serving food.
4. Follow Diet List posted in ward diet kitchen.
5. Do not smoke while preparing, setting-up, or serving trays.

Setting-Up Food Trays

1. Sugar, salt, pepper, and water go on most trays, but follow diet lists:
   a. Diabetic diets—omit sugar
   b. Low salt—omit salt
   c. Ulcer diets—omit salt, and pepper
   d. Restricted fluid—omit salt, pepper, water.
   e. Low fat—omit butter.
2. Place cold foods on tray—bread, butter, salad, dessert, milk. Wheel trays and food cart with serving utensils to center of the ward.

Serving Trays

Be sure you have the RIGHT DIET on the RIGHT TRAY for the RIGHT PERSON:

1. Serve small portions; patient may ask for seconds.
2. Place foods in center of dishes; avoid spilling over sides.
3. Fill glasses, cup, and bowls to one-half inch from the top.
4. Place hot foods on each tray as it is served.
5. Cut food into bite size and butter the bread for those patients unable to use knives.
6. Place tray in front of patient so that the knife is on right side of the tray and all dishes are within his reach.

Order of Serving Trays

1. Serve bed patients who are able to feed themselves.

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plate through three phase-shifting, RC networks. Each RC section introduces a phase displacement of 60° at a frequency of 1,000 cps, so that a total of 180° phase shift occurs, thereby providing the feedback condition necessary for sustained oscillation. The total phase shift at other frequencies differs from 180° and therefore does not sustain oscillation. The oscillator is designed to operate in the range of 920 to 1,120 cps. The tone output is developed across R12 and fed to the grid of the second audio amplifier, V1B.

Modulator

The modulator supplies the audio energy required to modulate the RF power amplifier of the transmitter. The modulating power is developed by the circuits shown in figure 13-11, the input to which is provided either by the microphone amplifier or by the tone oscillator described in preceding paragraphs.

The signals applied to the audio power amplifiers (fig. 13-11) are referenced to a negative 15-volt bias which is connected to the center tap of the coupling transformer, T3. A Zener diode (CR1) serves to keep the biasing voltage constant during periods of increased modulation when the grids are drawing current. The power tubes are operated push-pull to obtain higher efficiency and linearity of output. The audio output voltage varies about a positive 425 volts, d.c., and is taken from terminal three of T2 for application to the RF power amplifier.

Capacitor C6 (fig. 13-11) is used as a biasing filter. Resistor R11 is used to develop a voltage for monitoring the modulator cathode current and does not affect the normal operation of the circuit.

RF Power Amplifier

The RF power amplifier, the final stage of the transmitter section, applies modulated UHF signals to the antenna at the power level required. Conventional high-level modulation is employed in this stage. A simplified schematic of the power amplifier and associated circuits is shown in figure 13-12.

The input RF to the final stage is applied from the transmitter preamplifier through two

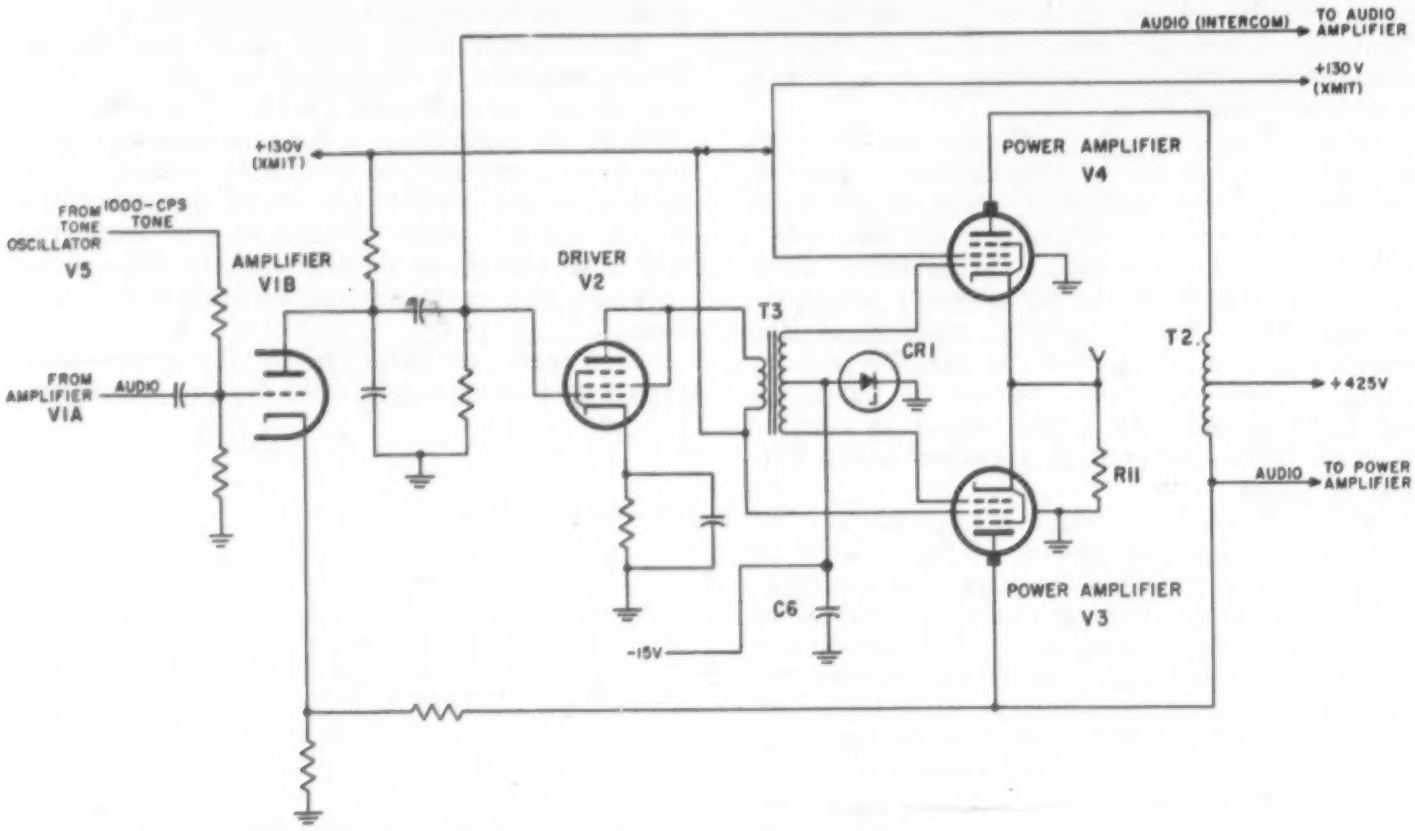

Figure 13-11. —Modulator circuits.

2. Serve up patients.
3. Serve and feed helpless patients.

Feeding the Helpless Patient

1. Place the patient in a sitting position unless otherwise ordered by the doctor.
2. Place a hand towel across the patient's chest; tuck a napkin under his chin.
3. Place tray on overbed table or on bedside stand.
4. Give the patient a piece of buttered bread if he is able to hold it.
5. Feed the patient in the order in which he likes to be fed.
6. Offer fluid during the meal. Use a drinking tube.
7. Do not rush your patient—give a small amount of food at one time; allow patient to chew and swallow food before offering the next spoonful.
8. If patient is inclined to talk, talk with him. It is an excellent time to observe your patient. Find out his likes and dislikes in food, particularly if his appetite is poor or if he is on a special diet.
9. When he is finished, lower backrest; fix his bed so that he may rest.
10. Take tray to diet kitchen; scrape and stack tray.
11. Note amount of food he has eaten; record amount of fluid if on measured intake and output.

Feeding the Blind Patient

1. Follow steps 1, 2, and 3 under Feeding a Helpless Patient.
2. Tell patient what food is on the tray.
3. As you feed him;
   a. Tell him what you are offering him
   b. Whether hot or cold
   c. Whether it is in a spoon, cup, or drinking tube.
   d. Allow him to hold a piece of buttered bread if he wishes.
4. If doctor permits, start patient toward helping himself.
5. Always;
   a. Set tray in the same place in front of him.
   b. Place the dishes in the same order on the tray.
   c. Place the same type of food in the same clockwise position on the dinner plate.
   d. Fill cups and glasses only half full to avoid his spilling fluids.
   e. Go slowly—help him by degrees; a little progress each day will help build his confidence. Stand by until he has confidence in himself.

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CHAPTER 13

ADMINISTRATION OF MEDICINES AND THERAPEUTIC TREATMENTS

The administration of medicines is one of the most serious and responsible duties of the corpsman. The corpsman on the ward who is assigned to the task must be thoroughly aware of that responsibility and be absolutely honest and trustworthy. In the administration of medicines the corpsman is expected to:

1. Carry out the doctor's order accurately. Any doubts should be checked with the doctor before giving the medicine, giving the RIGHT DOSE of the RIGHT MEDICINE to the RIGHT PATIENT at the RIGHT TIME and in the RIGHT WAY.

2. To observe, record, and report the effects of the medicine on the patient.

Patients ask corpsmen many questions about drugs prescribed for them. The corpsman should have a clear understanding of what the physician wants the patient to know about the medication used in his treatment. Increasingly, doctors like their patients to be partners in the theraupeutic plan and usually they are frank about the nature and purpose of the drugs they prescribe. The Corpsman should listen with interest to anything the patient may ask or tell him about medication—his mental attitude toward the treatment, the experiences he has had with drugs and particularly any idiosyncrasies to drugs. The latter should be reported at once, but at all times the corpsman should take every opportunity to learn from the patient and he should report what he leans promptly and accurately. On the basis of the corpsman's observations drugs are often discontinued (DC'd) or dosage changed.

Medicines are usually ordered by the doctor for one or all of the following reasons:

1. To promote the patient's health (EXAMPLE: vitamins).

2. To cure the patient's disease (EXAMPLE: antibiotics).

3. To relieve the patient's pain or discomfort (EXAMPLE: narcotics).

SUGGESTED ROUTINE FOR ADMINISTRATION OF MEDICATIONS AND TREATMENTS

Purpose

To provide an orderly, safe and economical method of administering medications and treatments.

RULES FOR ADMINISTRATION OF MEDICATION

Do:

1. Do have an order for medicine signed by the doctor.
2. Do check the patient and his chart before giving each dose of p.r.n. medicine.
3. Do know how to give the drug in the manner prescribed by the doctor.
4. Do wash your hands before preparing the medicine.
5. Do measure all dosages at eye level, whether in a glass or syringe.
6. Do prepare the medicine you give and give the medicine you prepare.
7. Do have a good light when preparing medicine.
8. Do concentrate.
9. Do know how drugs act; whether a local or systemic effect is desired and what possible bad effects might occur.
10. Do know the minimal, average, and maximal dosage of the drugs you give.
11. Do read the label at least three times when preparing a medicine—
    a. When removing from shelf or drawer.

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b. Before pouring or preparing it.

c. When returning it to the shelf or drawer.

12. Do give minims when minims are ordered, drops when drops are ordered.

13. Do use surgical aseptic technique in preparing injections and when indicated for instillations and irrigations.

14. Do chart medications after you have given them. Include name, amount, time, and mode of administration, if other than by mouth.

Do Not:

1. Do not give a medicine without an order.
2. Do not allow interruptions while preparing medications.
3. Do not give when doubt exists concerning the patient, the drug or the dose. Consult your doctor or nurse in charge of the ward.
4. Do not use a medicine from an unmarked or poorly labeled bottle or container.
5. Do not return excess medicine to the stock bottle or box; discard into sink.

Equipment

Medication and treatment board. (See fig. 13-1.)

Medication and treatment cards. (See NavMed 6550/4 and NavMed 6550/5.)

The board provides a visible file for all medications and treatments to be given over a 24 hour period. This board should be placed as near to the medicine locker as possible. All boards should provide:

1. Space for 25 hooks. One for each hour and p.r.n.
2. Space between hooks sufficient to allow use of 1 3/4 by 3 inch cards.
3. Instructions on the use of boards and cards.

Medication and Treatment Cards

1. Use NavMed 6550/4 for regularly recurring orders.
2. Use NavMed 6550/5 for p.r.n. orders. Specify frequency at which dose or treatment may be safely repeated.
3. Use NAVMED 1374 for preoperative medications and treatments.

Cards should include all necessary information—patient's name, bed number, medication or treatment, date and hours to be given, discontinuation (DC) date if one is specified, and mode of administration, if other than by mouth.

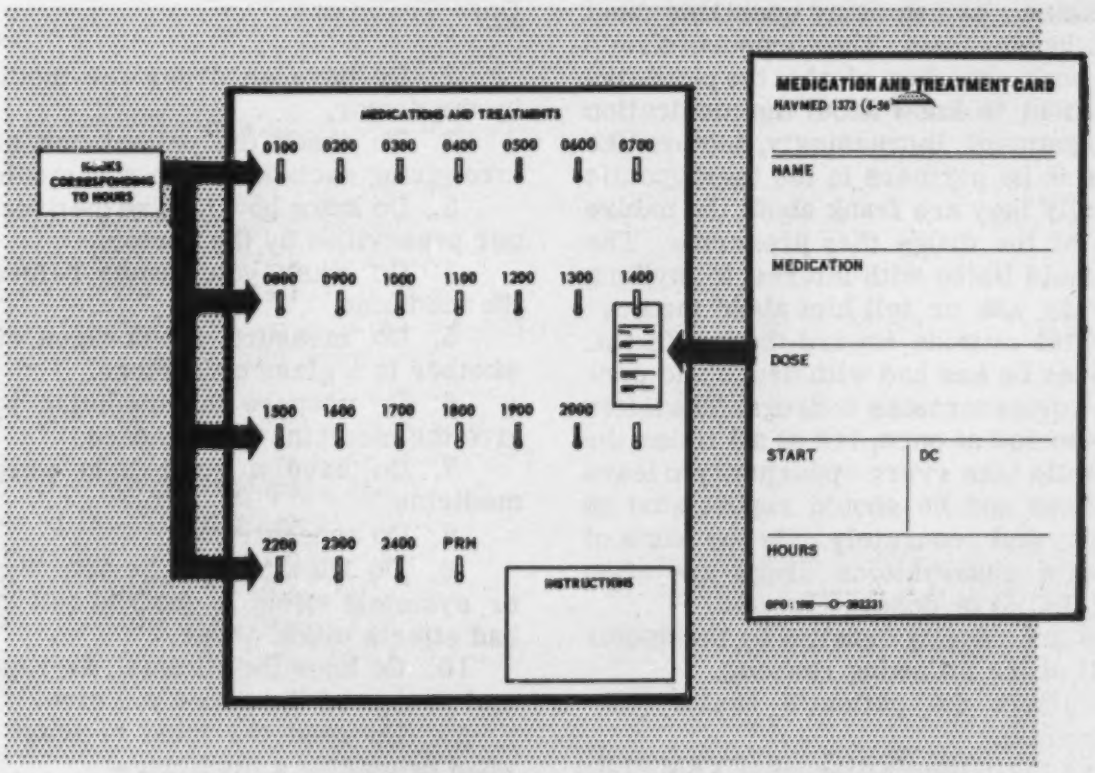

Figure 13-1.—Medication/Treatment board and card.

Cards must be checked with Doctor's Order Sheets (SF 508) and Nursing Care Plans (Nav-Med 6550/1) at least twice daily—new cards made out for new orders, cards destroyed for discontinued orders. (New order for narcotics should be obtained from the doctor after 48 hours.)

Use of Board and Cards

1. Card is placed on the hook corresponding to the hour the medication or treatment is due.
2. When due, the card is removed, medication or treatment is given, and the card placed on the hook for the hour when it is next due.
3. The medication or treatment is noted in the Nursing notes of the patient's chart.
4. Card of p.r.n. order is placed on hook corresponding to the hour at which it may be safely repeated. Before repeating order, patient and his chart are checked. If order is not needed, the card is moved to the p.r.n. hook.
5. Card of a once daily order is placed face down on the same hook after it has been given.
6. Preoperative medication and treatment cards are not placed on the Medication and Treatment Board. They are attached to the outside front cover of the patient's chart with cellulose tape. At the appropriate time the cards are removed, the medication or treatment is given or completed, charted, and the cards are then destroyed.

MEDICATION BY MOUTH

The corpsman preparing an oral medication should consider how to make the dose acceptable to the patient and precautions to take if the drug has an injurious action on the mouth or teeth.

Drugs are given by mouth in the following forms:

1. Liquids
2. Solids

Administration

1. Shake liquids well before pouring.
2. Dilute liquids with 1/2 ounce of water unless contraindicated.
3. Acids, iron, arsenic, salicylates, iodides, bromides, digitalis, and mercury are given well diluted, through a drinking tube, and usually given after meals so that they may be mixed with the stomach contents which reduces the effect on the stomach walls.
4. For young children or helpless patients, crush pill or tablet and dissolve in small amount of water; use teaspoon instead of medicine glass.
5. Cough medicines are given last, undiluted; instruct patient not to drink any fluids for at least 15 minutes afterwards.
6. Give saline medications for edema in small amounts of water; saline cathartics in large amounts of water.
7. Make disagreeable medicines as palatable as possible.
   a. Castor oil mixed with orange juice and 15 grains sodium bicarbonate.
   b. Add small amount of lemon juice to saline cathartics.
   c. Chill mineral oil; follow with slice of orange.

Equipment

Metal tray with—

1. Medicine cards
2. Medicine dropper
3. Medicine glasses for liquids (disposable if available)
4. Paper cups for pills or tablets
5. Paper straws for drinking tubes
6. Paper wipes
7. Pitcher of water
8. Stirring rod
9. Teaspoons

Procedure

Preparation of Medicines:

1. Wash your hands.
2. Remove cards from board.
3. Arrange cards in sequence similar to placement of patients on ward. Stack cards so that the top card is the only one visible.
4. Take first card; locate and remove medicine from shelf.
5. Read label; compare label with card; place card on tray.
6. Obtain medicine glass; read label; place medicine in glass; place glass on card in tray.
7. Read Label; check medicine card with label on bottle; replace bottle on shelf.
8. Repeat necessary steps 4 through 7 for each remaining card.

Pill, Tablet, Capsule

If in bottle, pour required number into cap or bottle (fig. 13-2).

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If in box, remove required number with spoon.

Powder

In paper—empty into medicine glass, add water, stir with stirring rod.

Measured with a spoon—empty into medicine glass, add water, stir with stirring rod.

Liquid

Shake bottle.

Remove cap. Place cap inside up, on shelf.

Hold medicine glass in one hand so that mark of prescribed amount is at eye level. Place thumbnail at mark (fig. 13-3).

Hold bottle in other hand with label next to palm; pour designated amount.

Wipe rim of bottle with paper wipe; replace cap.

Dilute medicine with 1/2 ounce of water unless contraindicated.

Drops

Use medicine dropper.

Draw up approximate amount of drug from bottle.

Holding dropper at 45 degree angle, count prescribed number of drops into medicine glass (fig. 13-4).

Minims

Use a syringe or a glass graduated in minims.

Follow same procedure as given under liquid.

Administration of Medicines

1. Carry tray to ward.
2. Remove medicine glass and card from tray at same time.

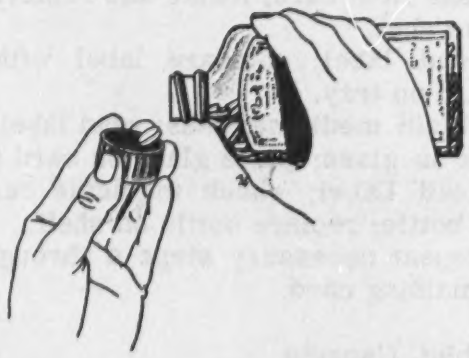

Figure 13-2.—Removing tablets from bottle.

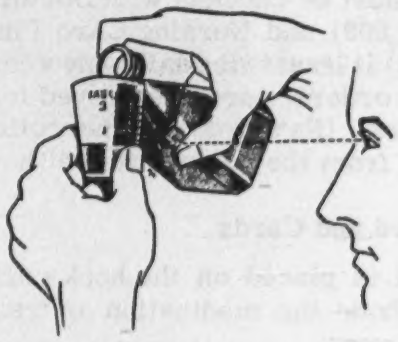

Figure 13-3.—Pouring liquid medication.

3. Identify patient.
   a. Read bed tag.
   b. Check tag with medicine card.
   c. Ask patient his name, compare with card.
   d. Check IDENTO BAND if patient is wearing one and is unable to tell you his name (unconsciousness etc.)
4. Give medicine in glass to patient.
5. Give water with medicine unless contraindicated.
6. Stay with patient until medication has been taken; do not leave medication at bedside.
7. Place medicine glass to one side of tray; turn medicine card face down on tray.
8. Repeat steps 2 through 6 for each remaining medication.

After Medications Have Been Given

1. Chart medications. Return cards to board in correct order (for hour next due).
2. Wash all glasses with hot soapy water; rinse. Boil glasses for 10 minutes.

Figure 13-4.—Correct angle of medicine dropper.

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3. Discard disposable medicine glasses, paper cups etc.
4. Wash spoons, droppers, pitchers and tray.
5. Reset tray.

A wheeled cart may be used for or with a tray; the set up and manner of administration remain the same.

MEDICATION BY SUBLINGUAL ROUTE (UNDER THE TONGUE)

Medicine is in quickly dissolving pill form. The pill is placed under the patient's tongue and allowed to dissolve. NO WATER is given.

MEDICATION BY INHALATION

Medication may be in the form of gases or volatile drugs and given for their local or systemic effect. The inhalation of fumes from volatile drugs is DRY INHALATION. The inhalation of plain steam or steam impregnated with a drug is MOIST INHALATION.

Moist or Steam Inhalations are Used:

1. To relieve inflammation of the mucous membrane in acute colds and sinusitis.
2. To relieve inflammation of the larynx.
3. To soften thick, tenacious mucus and relieve coughing from many causes.
4. To warm and moisten the air following operations such as tracheotomy.

Equipment for Method No. 1

Vaporizer
Medication, if ordered
Water
Bath towel

Precautions

1. Prevent burning the patient. Keep vaporizer 12 to 18 inches away from the patient.
2. Do not wash varporizer under running water; the electrical element must be kept dry.

Procedure

In Utility Room:

1. Fill vaporizer to water level mark.
2. Place medication as directed in instruction for vaporizer.
3. Plug in vaporizer; allow water to boil. Remove plug. Take to bedside.

At Bedside:

1. Bring patient to side of bed.
2. Place bath towel around patient's head.
3. Plug in vaporizer; turn spout so that steam is directed toward the patient.
4. Ask the patient to open his mouth and take deep breaths.
5. Treatments should last 20 minutes.

After Treatment:

1. Dry patient's face.
2. Prevent patient's being chilled. Caution him to stay inside ward for at least 1/2 hour after treatment.

Equipment for Method No. 2

Wash basin
Pitcher
Paper bag
Bath towel
Face towel
Medication
Boiling water

Precautions

Patient must not touch pitcher; ask him to keep his hands at his side.

Procedure

1. Place pitcher in basin.
2. Cut hole in bottom of paper bag to fit over the mouth and nose of the patient.
3. Pour boiling water into pitcher. Place open end of bag over the pitcher.
4. Take to bedside.
5. Have patient place his mouth and nose over hole in the paper bag.
6. Drape bath towel over patient's head and over the pitcher.
7. Ask patient to open his mouth and take deep breaths—about 20 minutes or until water cools.
8. Record date, time, medication, method used, and effect of treatment in Nursing Notes.

MEDICATION BY NEBULIZATION

Purpose

To produce local or systemic effect by application of medication to the respiratory tract.

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By forcing a stream of air over a non-volatile drug in the nebulizer a fine mist or spray is created which contains minute particles of the drug. Such drugs may be administered by using oxygen or hand nebulizer.

Method I

Using oxygen. To be used only when aqueous solutions of medication are to be administered.

Equipment

Oxygen cylinder
Flow regulator
Rubber tubing, 3 feet
Nebulizer
Aqueous solution of medication ordered

Procedure

1. Assemble oxygen cylinder, tubing and regulator as for oxygen therapy. Set flow at 4 to 6 liters.
2. Place drug in nebulizer and connect nebulizer to tubing.
3. Instruct patient to place mouthpiece of nebulizer in mouth and to keep lips closed during the treatment.
4. Treatment lasts approximately 1/2 hour or until all medication is used.

Method II

Using hand nebulizer. To be used when oily solutions of medications are to be administered.

Equipment

Hand nebulizer
Solution ordered

Procedure

1. Place drug in nebulizer.
2. Instruct patient to:
   Place mouthpiece in mouth.
   Inhale with lips closed around mouthpiece.
   Squeeze bulk of nebulizer as he inhales.
   Remove mouthpiece and exhale.
   Repeat procedure until all medication has been used.
   Alternate normal respirations with medicated ones if patient desires.

Methods I and II

Record date, time, medication, method used, and effect of treatment in Nursing Notes.

Wash nebulizer in warm soapy water, rinse and dry after each treatment.

If possible, allow nebulizer to remain in patient's unit until doctor discontinues the order. When order has been discontinued, or nebulizer must be used for other patients, follow the washing by soaking the nebulizer in benzalkonium chloride 1:1000 solution or similar disinfectant.

MEDICATION BY RECTUM

When administration of medicine by mouth is impossible, and when a drug is unpalatable, medication by rectum may be indicated. Ordinarily medication by rectum is for a local effect, but sometimes systemic medication may be given by this route.

Medications may be administered by means of retention enemas or suppositories.

RETENTION ENEMA.—Total quantity of fluid should not exceed 120 cc. (NOTE: Equipment and procedures listed under "enema.")

SUPPOSITORY.—Rectal suppositories are prepared in the shape of a cone. They retain this shape at ordinary room temperatures, but when introduced into the rectum are dissolved by body heat. Drugs contained in them are then released.

Equipment

Prescribed suppository
Finger cot or rubber glove
Lubricant
Toilet tissue

Procedure

1. Explain procedure to the patient.
2. Take equipment to bedside in basin.
3. Screen patient; ask or assist him to turn on his side.
4. Put on glove or finger cot (index finger).
5. Expose rectum.
6. Lubricate glove or cot.
7. Introduce suppository gently into rectum and advance it as far as possible. If patient has difficulty retaining suppository, apply pressure over anus until the desire to defecate has passed.
8. Remove glove; place in basin.
9. A patient should not insert a suppository because it is too difficult for him to do so properly.
10. Record date, time, medication, and effect of treatment in nursing notes.

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In Utility Room:

1. Wash and disinfect basin and glove.
2. Discard finger cot.

LOCAL APPLICATIONS OF MEDICATIONS (INUNCTION)

Medication may be applied locally in the form of lotion, ointment or paste. Inunction means to "rub-in" a medication.

APPLICATION OF LOTION

Equipment

Lotion prescribed
Shallow dish
Cotton pledgets

Procedure

1. Pour lotion into shallow dish.
2. Apply lotion to area, using cotton.

APPLICATION OF OINTMENT OR PASTE

Equipment

Ointment or paste prescribed
Tongue blade or spatula
Gauze or soft muslin
Bandage or binder

Procedure

1. With tongue blade, remove ointment from container or squeeze from tube.
2. Spread a thin layer of ointment on gauze.
3. Apply coated gauze to area.
4. Secure with bandage or binder.

NOTE: When applied to wound, sterile articles must be used and aseptic technique maintained.

MEDICATION BY INJECTION

Purpose

To produce rapid systemic effect; to produce local reaction; to administer drugs which are destroyed by gastric juices or those that cannot be taken by mouth.

METHODS OF INJECTION

The method of injection is listed below in order from the least rapid to the most rapid rate of absorption (fig. 13-5).

INTRADERMAL—between the superficial layers of the skin. Used to test for specific allergic reactions.

SUBCUTANEOUS—under the skin into the subcutaneous tissue. Used primarily to administer narcotics and sedatives.

INTRAMUSCULAR—into the muscle. Used when drugs are not suitable for intravenous injection, when a more rapid effect is desired than could be obtained by subcutaneous method, when drug is not readily absorbed, or when it is irritating to subcutaneous tissue.

INTRASPINOUS—into spinal canal. Used primarily for administering anesthetic.

INTRAVENOUS—into the vein. Used when very rapid effects are desired.

The use of individually wrapped autoclaved syringes and needles is required for intravenous and intraspinous injections and is strongly recommended for all injections.

Equipment, Precautions, and Procedures

The following list of equipment, precautions, and procedures apply to all methods of injections (figs. 13-6, 13-7, and 13-8).

General Equipment

Metal tray with—
Individually wrapped autoclaved syringes or autoclaved multiple syringes and needle container.
Sterile covered container of alcohol sponges.
Sterile covered container of 2 X 2's.
Sputum cup without cover for waste.
Thumb forceps in disinfectant solution such as:
Isopropyl alcohol 70 percent, or Benzalkonium chloride 1:1000 aqueous solution, or liquid iodine-type disinfectant, 200ppm available iodine (12cc to 1000 cc water) (anti-rust agent, sodium nitrate, 0.5 percent should be added to these solutions.)

General Precautions

1. Use sterile technique in the preparation and administration of injections.
2. Numbers on the syringe barrel and plunger must be the same.

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PREPARATION OF MEDICINES FOR NEEDLE (PARENTERAL) INJECTIONS

MEDICINE FROM STOPPERED VIAL

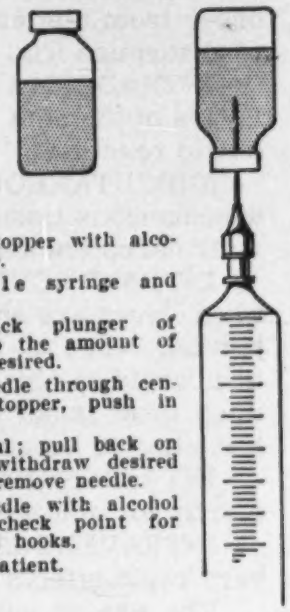

1. Cleanse stopper with alcohol sponge.
2. Assemble syringe and needle.
3. Draw back plunger of syringe to the amount of solution desired.
4. Insert needle through center of stopper, push in plunger.
5. Invert vial; pull back on plunger, withdraw desired amount; remove needle.
6. Cover needle with alcohol sponge; check point for burrs and hooks.
7. Take to patient.

MEDICINE FROM AMPOUL

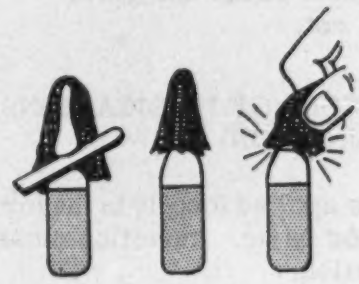

1. Wipe file and neck of ampoul with alcohol sponge.
2. File neck of ampoul.
3. Cover ampoul with alcohol sponge.
4. Break off neck of ampoul at file marks.

1. Assemble syringe and needle.
2. Tip ampoul to 45° angle.
3. Insert needle into ampoul, withdraw desired amount of solution.
4. Cover needle with alcohol sponge; check point for burrs and hooks.
5. Take to patient.

ADMINISTRATION OF PARENTERAL MEDICINES

INTRADERMAL

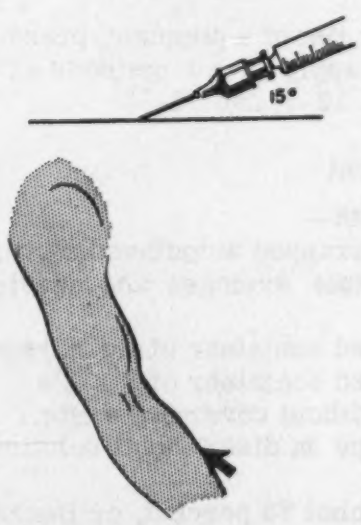

1. Explain to patient.
2. Swab site of injection with an alcohol sponge.
3. Hold syringe upright, expel air bubbles.
4. Insert needle at a 15° angle, just under the skin, so that a raised area is seen.
5. Inject prescribed amount of solution.
6. Cover needle with alcohol sponge, withdraw needle.

SUBCUTANEOUS

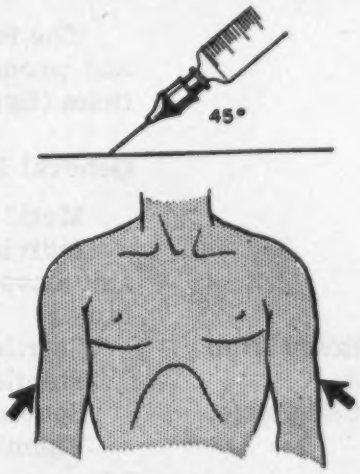

1. Explain to patient.
2. Swab site of injection with an alcohol sponge.
3. Hold syringe upright; expel air bubbles.
4. Make a firm cushion of flesh at injection site.
5. Insert needle quickly at a 45° angle.
6. Draw back on plunger; if resistance is felt and no blood seen, slowly inject solution.
7. Place alcohol sponge over needle; quickly remove needle.
8. Gently massage site of injection with alcohol sponge for one minute.

INTRAMUSCULAR

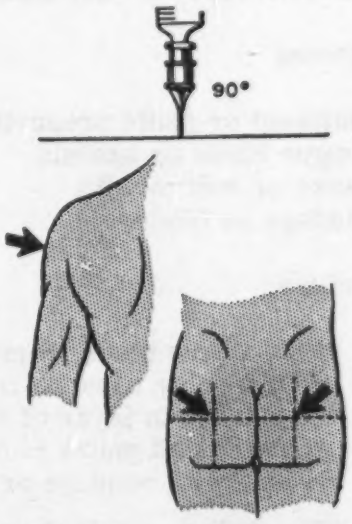

1. Explain to patient.
2. Swab site of injection with an alcohol sponge.
3. Hold syringe upright; expel air bubbles.
4. Make a firm cushion of flesh at injection site.
5. Insert needle quickly at a 90° angle.
6. Draw back on plunger; if resistance is felt and no blood seen, slowly inject solution.
7. Place alcohol sponge over needle; quickly remove needle.
8. Gently massage site of injection with alcohol sponge for one minute.

Figure 13-5.—Preparation and administration of medicine for parenteral injection.

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Figure 13-6.—Hypodermic tray.

3. Test needle for hooks and burrs before preparing medication (use sterile 2 x 2).
4. Use separation syringe and needle for each injection.

General Procedures

Preparation or Syringe and Needle:

Using individually wrapped autoclaved syringe and needle (recommended method):

1. Open syringe package touching only the outside of the package.
2. Remove plunger and insert into barrel of syringe, touching only the outside of the barrel and the back of the plunger.
3. Pick up needle with tip of assembled syringe.
4. With forceps, gently tighten the needle on the syringe.

Using autoclaved multiple syringe and needle container:

1. Using forceps, remove assembled syringe.
2. Using forceps, remove needle and place on tip of syringe.
3. With forceps, gently tighten needle-on syringe.

Preparation of Solution:

1. Refer to figure 13-5 for preparation of medicine for stoppered vial, ampule, and for tablets readily dissolved (EXAMPLE: codeine).

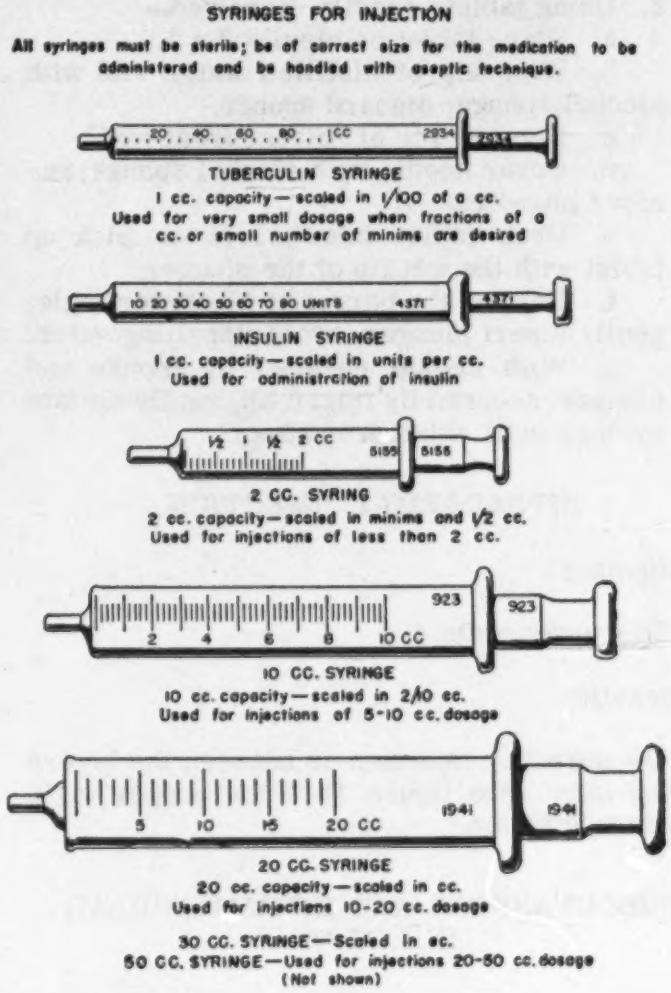

Figure 13-7.—Syringes for injection.

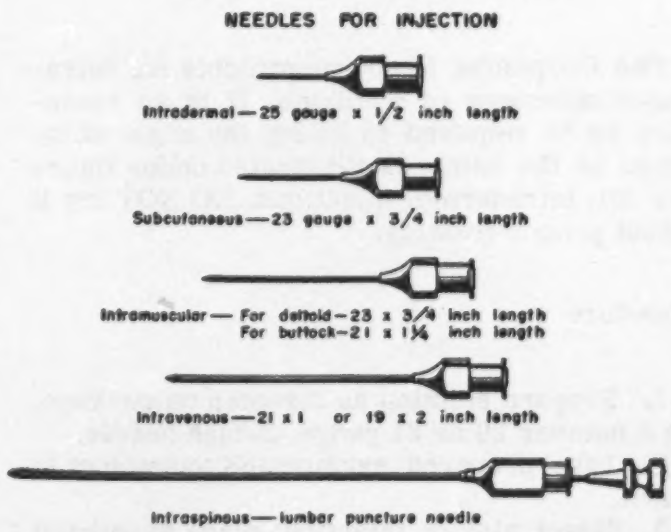

Figure 13-8.—Needles for injection.

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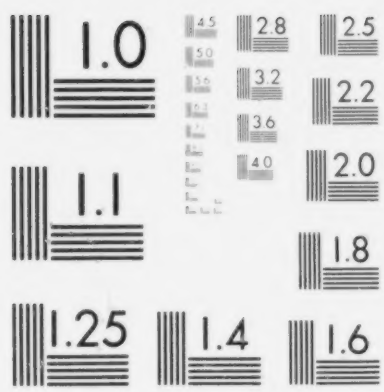

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

2. Using tablets readily dissolved—
   a. Place tablet on sterile 2 x 2.
   b. Wipe top of distilled water vial with alcohol sponge; discard sponge.
   c. Remove 1cc of solvent from vial.
   d. Cover needle with alcohol sponge; remove plunger.
   e. Drop tablet into barrel or pick up tablet with the wet tip of the plunger.
   f. Holding the barrel at 45 degree angle, gently insert plunger, avoid dispelling water.
   g. With needle covered by sponge and plunger secured by finger tip, gently agitate syringe until solution is clear.

INTRADERMAL INJECTION

Equipment

26 gauge needle.

Precaution

Be sure the injection is between the layers of the skin. (See figure 13-5 for proper angle of administration.)

SUBCUTANEOUS AND INTRAMUSCULAR INJECTION

Same equipment, precautions, and procedure as under injections. See figure 13-5 for proper administration of parenteral medicines.

INTRAVENOUS INJECTION

The Corpsman is not responsible for intravenous injections of medicine. If in an emergency he is required to do so, the angle of injection is the same as illustrated under figure 13-5 for intradermal injections. DO NOT try it without proper training.

Procedure

1. Prepare solution as directed on package. Use a number 20 or 21 gauge, 2-inch needle.
2. Take prepared syringe and tourniquet to patient.
3. Select site of injection; place tourniquet under arm above elbow; swab site with alcohol sponge.
4. Tighten tourniquet; doctor will insert needle.
5. When blood appears in the syringe, loosen tourniquet.
6. Doctor will inject solution.
7. Place alcohol sponge over needle; doctor removes needle.
8. Apply gentle pressure with alcohol sponge over injection site for a minute.

Care of Equipment

After Each Use:

1. Rinse syringe and needle first with cool water, then detergent, and a final rinse with water.
2. If autoclaved equipment was used, return to Central Supply Room (CSR).
3. Strip entire tray.
4. Return sponge containers to CSR for autoclaving.
5. Send multiple syringe container to CSR for autoclaving.

FRACTIONAL DOSAGE

1. Work out the problem on paper using the formula:

$$\frac{\text{Dose desired}}{\text{Dose on hand}} \times \left(\begin{array}{l}\text{(Quantity of water)}\\ \text{(in minims in)}\\ \text{(which tablet(s))}\\ \text{(are to be dis-)}\\ \text{(solved.)}\end{array}\right) = \begin{array}{l}\text{dose to be}\\ \text{given in}\\ \text{minims.}\end{array}$$

EXAMPLE

If the dose on hand is larger than the dose desired:

Dose desired: Morphine sulfate 1/6 grain.
Dose on hand: Morphine sulfate 1/4 grain.

$$\frac{1/6}{1/4} \times \text{quantity} = \text{amount to be given}$$

1/6 X 4/1 X 24 minims = 16 minims

ANSWER:

Dissolve one (1/4 grain) tablet of morphine sulfate in 24 minims of water. Discard 8 minims—give 16 minims to patient.

EXAMPLE:

If the dose on hand is less than the dose desired it will be necessary to use two or more tablets.

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Dose desired: Morphine Sulfate 1/6 grain.
Dose on Hand: Morphine Sulfate 1/8 grain.
Therefore it will be necessary to use 2 tablets.

$$\frac{1/6}{2/8} \text{ X quantity - amount to be given}$$

1/6 X 8/2 X 24 minims = 16 minims

ANSWER:

Dissolve two (1/8 grain) tablets of morphine sulfate in 24 minims of water; discard 8 minims, give 16 minims to the patient.

SPECIAL MEDICINES FOR INJECTION

INSULIN

Types of Insulin

There are three types of insulin now available in the supply catalog:

1. REGULAR or standard insulin in 10 cc vials of three strengths:
   40 units in each cc.; 80 units in each cc. or 100 units in each cc.
2. ISOPHANE insulin (NPH) is available in 10 cc. vials of two strengths:
   40 units in each cc.; 80 units in each cc.
3. PROTAMINE ZINC insulin is available in 10 cc. vials of 40 units in each cc.

Doses of all insulin preparations are measured in UNITS. The strength is indicated by the number of units in each cc of the preparation.

Precaution

All insulins should be stored in the refrigerator (not frozen).

Preparation of Insulin

1. Use a dry, sterile insulin syringe.
2. Use the measure on the syringe corresponding to the strength of the insulin.

EXAMPLE:

Regular insulin U35 has been ordered.

ANSWER:

Locate the U40 scale on the syringe; obtain U40 per cc. strength insulin; withdraw insulin from the vial down to the U35 mark on the U40 scale.

3. Regular insulin should be clear and colorless.
4. Isophane insulin is in suspension and the vials must be gently rotated before use. DO NOT SHAKE VIAL.

PRECAUTIONS

If precipitate has become clumped or has formed a deposit of solid particles on the wall of the vial, return to pharmacy and obtain a new supply.

Administration

1. Check date on vial. DO NOT use beyond expiration date.
2. Give the insulin subcutaneously, at the correct angle of injection. Avoid too deep or too shallow injections.
3. Change the site of injection each time a dose is given. Use both upper arms and anterior thighs in rotation.
4. Time of administration:
   a. Regular insulin—usually 20 minutes before meals.
   b. Isophane—once daily, usually before breakfast.
   c. Protamine zinc—once daily, usually before breakfast.
5. Two types of insulin may be ordered for the patient; ask the doctor if he wishes them to be administered in the same injection. If so, the following method is suggested:

Mixing two types of insulin:

1. Wipe tops of both vials with alcohol sponge.
2. Insert sterile 23 gauge needle into each vial.
3. Without air in the sterile syringe, attach syringe to needle in regular insulin vial.
4. Withdraw prescribed amount of insulin; remove needle and syringe.
5. Remove needle from syringe.
6. Attach syringe to the needle that is inserted into the second vial.
7. Withdraw prescribed amount of insulin; remove syringe and needle from second vial.
8. Gently shake syringe to obtain an even distribution of solution.

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PRECAUTION

If either vial of insulin is accidentally mixed with the other type insulin, discard the vial that was accidentally mixed.

MEDICINES IN OILS

1. Warm solution in water bath.
2. Use a large bore needle (20 gauge) to remove solution from the ampule or vial.
3. Most medicine in oil has to be given intramuscularly, using a 20 gauge needle.

ANTIBIOTICS

1. Use autoclaved syringes and needles whenever possible.
2. If syringe has been in alcohol, rinse thoroughly with sterile distilled water before taking up an antibiotic. Alcohol destroys the effectiveness of the antibiotic.

THE ADMINISTRATION OF PARENTERAL FLUIDS

The daily average intake of fluids by a normal adult of average size is about 3,000 cc. This intake consists of the fluid taken as liquids, fluids in solid food, and the water given up as a result of oxidation. The average output of fluid is about the same. This output is that excreted by the kidneys in the form of urine, that lost by the skin through evaporation of air, and fluid lost by the digestive tract in the form of feces. During illness fluids may also be lost through vomitus and hemorrhage.

When a large amount of fluid is lost by the body, it must be replaced. Ordinarily, adequate fluid intake may be maintained by fluids taken by mouth. When a patient is unable to take sufficient fluids by mouth or when his fluid loss has been so great that his intake must be supplemented, fluids are administered by other methods. The doctor may decide to supply fluid by gastric gavage, retention enema, hypodermoclysis, intravenous infusion, or transfusion (fig. 13-9). See procedures relating to Gastrointestinal tract for gavage and retention enema procedures.

The administration of fluids by hypodermoclysis or intravenous methods is the responsibility of the doctor or of the nurse trained by him. The corpsman's role is one of assisting

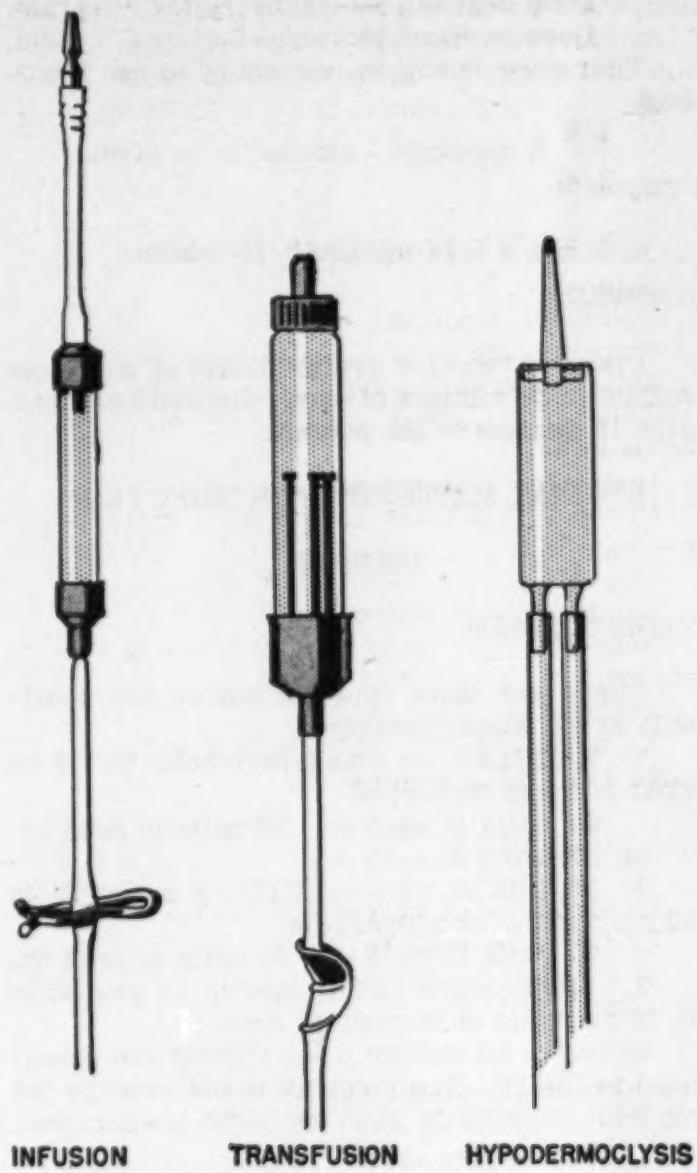

Figure 13-9.—Types of drip regulators.

with these procedures. In order to do so intelligently he should know:

1. How to prepare his patient and his unit.
2. What and how to prepare necessary equipment.
3. How to assist the doctor.
4. What symptoms or reactions are expected and what danger signs may occur as a result of the treatment.

INTRAVENOUS THERAPY

Intravenous infusion is the term used to designate the giving of fairly large amounts of fluids into the veins. Intravenous injection is the term more often used if the quantity is small and if it is a drug. If blood (and sometimes its

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component parts) is given, the injection is called a transfusion. They are given to supply medication and fluids to the body; to increase blood volume; to supply nourishment to the body.

Equipment

Standard (irrigating stand)
Solution ordered
Container of alcohol sponges
Curved basin
Small covered rubber sheet
Technique forceps in container of disinfectant solution
Disposable intravenous set
Correct apparatus for fluid being administered
Arm board
Bandage and scissors
Adhesive tape, 1/2-inch wide cut in 6-inch lengths.
Tourniquet
An airway needle and #18, #19, #20 and #21 gauge 1-1/2 inch needles.

Sites of Injections

1. Median cubital, cephalic or basilic veins
2. Dorsalis pedis vein

Procedure

Preparation of Patient and His Unit:

1. Explain procedure to patient; tell him how he can help.
2. Do any nursing measures required before setting up for intravenous infusion.
3. Offer bedpan or urinal; remove sleeve of gown from arm to be used.
4. Place tourniquet above site of injection. Place arm board under arm, secure with bandage above tourniquet and at wrist.
5. Clear bedside stand of everything except equipment needed.
6. Place standard at foot of bed or fit pole attachment on bed.

NOTE: The use of a board to immobilize the arm during an intravenous infusion is often limited to those patients who are unable to remain quiet during the procedure. The arm of a patient who is to receive an infusion over an extended period of time may be immobilized more comfortably by using a pillow.

Preparation of Solution:

1. Solution should be at room temperature.
2. Hold solution bottle up to the light. Solution should be clear without sediment or shred of mold.
3. Remove cap (see fig. 13-10).
4. Insert 18 G needle into airway vent of bottle. When airway needle is inserted, a rush of air into the bottle should be heard. If this sound is absent, the solution should not be used.
5. Open intravenous administration set and place clamp on tubing. Remove protective rubber cap from tip of drip regulator; insert tip into large depression of rubber stopper of solution bottle. Invert solution bottle; hang on standard.
6. Holding tubing higher than bottle, remove rubber cap from needle adapter—do not touch adapter. Open clamp; slowly lower tubing; allow solution to run through tubing into curved basin until entire tubing is filled with solution

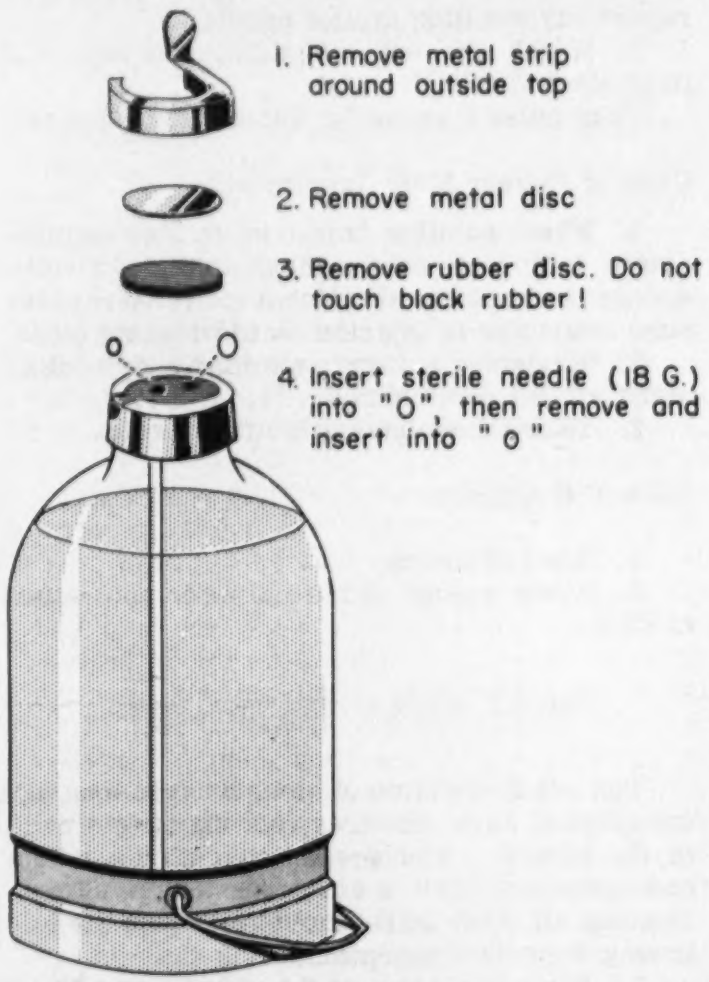

Figure 13-10.—Removing cap of solution bottle.

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and all air bubbles are expelled. Attach needle; clamp tubing.

Injection of Fluids

1. Cleanse site of injection with alcohol sponge.
2. Apply tourniquet.
3. Needle is inserted into the vein. When blood appears in tubing, release tourniquet and open clamp on tubing.
4. Regulate flow 40 to 60 drops a minute or at rate ordered by the doctor.
5. Secure needle in place with adhesive. A gauze sponge may be necessary to hold needle at correct angle of injection.
6. Watch for signs of reaction, infiltration.

Care of Patient During Treatment

1. Watch for signs of reaction such as chills or increased pulse rate. Clamp tubing immediately. Notify ward doctor or nurse at once.
2. Keep patient quiet, especially that part of body where needle is inserted. Watch for and report any swelling around needle.
3. Watch the drip regulator and report if fluid stops flowing.

Take pulse frequently; watch color of patient.

Care of Patient After Treatment

1. When solution bottle is almost empty—clamp tubing, remove adhesive, place alcohol sponge over needle, withdraw needle; exert pressure over site of injection until bleeding stops.
2. Straighten patient's clothing and bedding; make patient comfortable.
3. Take all equipment to utility room.

Care of Equipment

1. Discard tubing.
2. Rinse needle with cold water and return to CSR.

WHOLE BLOOD TRANSFUSIONS

The administration of blood must be done with exceptional care since errors may prove fatal to the patient. The preparation of the patient and equipment used is similar to that for administering all other intravenous fluid with the following important exceptions:

1. The plastic set used to administer blood must be a "transfusion set" and contain a filter.
2. An 18 gauge or larger needle should be used to prevent blood from clotting in the needle and obstructing the flow.
3. The patient must have his blood typed and crossmatched with the blood he is to receive. When this is done, the identifying number is placed on the blood transfusion form. It is also placed on the patient's chart. This number must correspond to the number on the bottle of blood to be administered. These identifying numbers must be checked when preparing the patient for the transfusion. They are also checked by the medical officer administering the transfusion as a further precaution against the patient's receiving the wrong blood.
4. Whole blood transfusions are started by the medical officer.

BLOOD TRANSFUSION USING PLASTIC UNIT

The administration of blood and the care of patient follow the same procedures as for "Whole Blood Tranfusions". The preparation of the plastic unit is slightly different; no airway vent is required and a special recipient set is used.

BLOOD TRANSFUSIONS

Observation of the patient during the administration of intravenous fluids and blood.

1. A patient receiving intravenous fluids or blood must be watched very closely during the entire procedure, but particularly during the first 30 minutes that the fluids are running, for any signs of reaction to the fluids. The corpsman should be on the alert for the following:

a. Infiltration of fluid into tissues around the site of injection.

1. This occurs when the needle is dislodged from the vein and the fluids continue to flow into the soft tissue about the vein.
2. Symtoms: Swelling, coldness and blanching of the tissue about the needle injection site, and later cessation of flow of fluids.
3. Action indicated: Clamp off the tubing to stop the flow of fluids; notify the nurse or doctor. If this is detected early, frequently a minor adjustment of the needle into the vein is all that is needed; frequently the needle must be reinserted into another vein.
4. Treatment: If a large amount of fluid has infiltrated into the tissues, the doctor will order compresses and treatments to aid in absorption of this fluid. If the fluid is irritating to the soft tissues sluffing may occur, thus every effort must be made to prevent this.

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b. Reaction to the fluids being administered.

1. This occurs when the patient is sensitive to the fluids or blood being administered and is more commonly seen when blood is administered; however, when drugs are added to intravenous fluids the patient may react to these.

2. Symptoms: Restlessness, chills, increased pulse and respiratory rate, spiking temperature, vertigo, cold clammy skin, hives, dyspnea, nausea and vomiting, lumbar pain and cyanosis.

3. Action indicated: Clamp off flow of fluids through tubing immediately, apply external heat in form of extra blankets for chills, notify the doctor immediately, who will administer treatment. Have adrenalin on hand when blood transfusions are being given.

c. Infection

1. This occurs from the administration of contaminated fluids or use of contaminated equipment when giving fluids by vein.

2. Symptoms: Usually delayed but can occur while fluids are being administered if the infecting organism is very virulent. Symptoms are those of septicemia with marked elevation of temperature and pulse rate and prostration of the patient.

3. Action indicated: Prevention is most essential. Inspect fluid for any gross contamination or turbidity; use only sterile equipment and discard needles or tubing if they are contaminated or if contamination is questionable. If symptoms occur while fluids are being administered clamp off the tubing immediately and call the doctor. Send tubing and bottle of fluid to the laboratory for bacteriological studies.

d. Embolism

1. This may occur when air from the tubing is passed into the circulation or when a clot within the circulatory system is carried to a small blood vessel and obstructs it.

2. Symptoms: vary depending on the location of the embolism, usually severe pain in chest, respiratory difficulty and prostration if pulmonary vessels are involved; unconsciousness if cerebral vessel are involved.

3. Action indicated: clamp off tubing and notify doctor immediately; administer oxygen for respiratory difficulty.

Charting—Nursing Notes for Intravenous Infusion or Blood Transfusion

1. Time of start and completion of intravenous infusion or transfusion.
2. Amount, solution and by whom started.
3. Any reaction noted.
4. Signature.

HYPODERMOCLYSIS

Definition

Slow introduction of a large amount of fluid into the subcutaneous tissue.

Purpose

To supply body with fluids; to restore fluid balance; to supply fluids to the body when intravenous infusion is contraindicated or inaccessible.

Equipment

1. Sheet
2. Standard or pole attachment on bed
3. Container of alcohol sponges
4. Technique forceps in container of disinfectant solution
5. Disposable hypodermocylsis set
6. Solution
7. Package of sterile towels
8. One-half inch adhesive tape cut in 6 inch lengths
9. Airway needle; each #19, #20, #21, #22 gauge 1-1/2 or 3 inch needles

Site of Injection

1. Anterior aspect of the thighs (fig. 13-11)
2. Subcutaneous tissue under breasts

Procedure

Preparation of Patient and His Unit:

1. Explain procedure to the patient; tell him how he may help.
2. Do any nursing measures required before setting up hypodermoclysis equipment.
3. Clear top of bedside locker of everything except the equipment needed.
4. Place standard at foot of the bed or fix pole attachment on the bed.

Preparation of Solution:

1. Same as for intravenous infusion.
2. Apply screw clamp to each tube.

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3. Attach 21 gauge needle to each tube (keep needles sterile).

Injection of Fluid

1. Fold back bedclothes to below site of injection.
2. Place sheet over patient's body, exposing only area to be used.
3. Cleanse site of injection with alcohol sponges.
4. Fold sterile towel over bedclothes.
5. Needles are inserted into subcutaneous tissues.
6. Open clamps; regulate flow to 40 drops per minute or rate ordered by doctor.
7. Place sterile 4 x 4's under needle hubs; hold in place with adhesive tape.
8. Place sterile towel over field.

Care of Patient During Treatment

1. Watch the site of injection. If area becomes hard, blanched or painful, stop flow until the fluid is absorbed and then restart.

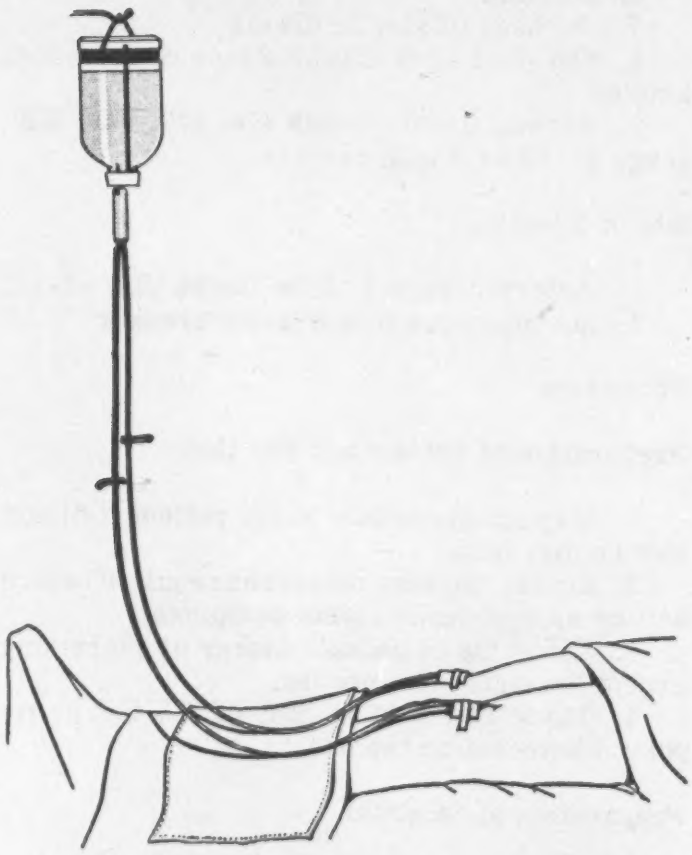

Figure 13-11.—Hypodermoclysis.

2. When solution has been given, clamp tubing; remove needles and cover site of injection with dry sterile dressings.

Care of Patient After Treatment

1. Place patient in a comfortable position, preferably other than the one he has maintained during the treatment.
2. Take all equipment to utility room.

Care of Equipment

1. Discard tubing.
2. Rinse needles with cold water and return to CSR.

Charting—Nursing Notes

1. Time of the start and completion of the hypodermoclysis.
2. Amount, solution, and by whom started.
3. Condition of site of injection on completion of treatment.
4. Any other reactions noted.
5. Signature.

ADMINISTRATION OF OXYGEN

Purpose

To provide an extra supply of oxygen to the patient.

Indicated:

In conditions of anoxia (lack of oxygen) and anoxemia (lack of oxygen in blood). Some symptoms of anoxia are cyanosis and dyspnea, rapid thready pulse and restlessness. Oxygen is used as a supportive measure for patients with cardiac failure, pneumonia, asthma, decompensation, thrombosis, and shock; and is sometimes used for postoperative patients.

SAFETY RULES IN USE OF OXYGEN

In Storerooms

Oxygen cylinders:

1. Keep cylinders secured (strap, chain) in upright position in separate place away from oil, grease, gasoline, matches, alcohol, ether; and from heating equipment such as boilers,

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furnaces, radiators, steam pipes, sterilizers or autoclaves.

2. Have storage space well posted with "oxygen—No Smoking" signs.

3. Keep caps on all cylinders.

4. Have separate and clearly marked place for storing full and empty cylinders.

5. Attach DD Form 1191—Warning Tag for Medical Oxygen Equipment—to each cylinder.

6. When removing cylinder from storeroom, remove cap and open and close valve quickly. This is called "cracking the valve" and is done to blow out dirt and debris in the valve. Listen for a hissing sound. Replace cap (fig. 13-12).

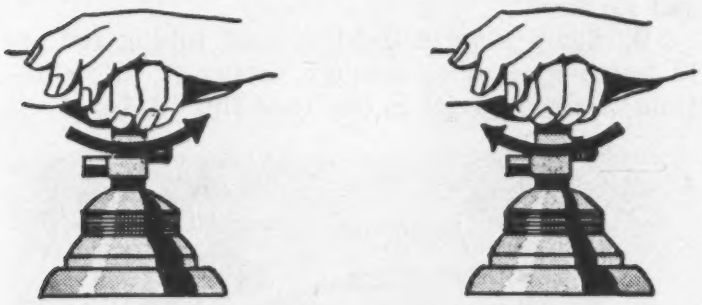

Figure 13-12.—Cracking the valve.

Regulators:

1. Store in closed cabinets.

2. Label all regulators with tags "DO NOT OIL OR GREASE."

3. Test regulators frequently for leaks and liter flow accuracy.

4. DO NOT attempt to repair regulators; return regulators to issue room.

Oxygen Tent Machines:

1. Store in cool, clean, dry rooms.

2. Use muslin dust covers to keep apparatus clean.

3. All electrically operated oxygen machines should be grounded. Check with the electrician at your station.

4. Set up and test motor operation at regular intervals every 2 to 3 weeks.

On Ward

1. Post "OXYGEN—NO SMOKING" signs at the entrance to the ward, room or unit.

2. Strap oxygen cylinder to bedpost or to carrier to keep it in an upright position. Cylinder should be placed away from radiators.

3. Instruct all patients and visitors not to smoke within the area.

4. Always have an extra cylinder of oxygen on hand to assure patient a continuous supply. Watch usage rate of oxygen.

EXAMPLES: Full cylinder, at 2,200 pounds pressure, flowing at rate of 6 liters should last approximately 19 hours. A cylinder with 1,000 pounds pressure flowing at a rate of 8 liters per minute should last 6 hours.

5. When an oxygen tent is in operation:

a. Be sure the electrically operating oxygen machine is grounded. Check with the electrician at your station.

b. Do not use electrical devices (call bells, heating pads, vaporizers) inside tent.

c. Do not use alcohol or ether inside tent.

d. Keep patient clothed in cotton material; wool and nylon are dangerous because of their static electrical properties.

6. To attach regulator to cylinder:

a. Remove cylinder valve cap. Insert regulator inlet into cylinder valve outlet and tighten inlet nut with wrench. Before opening cylinder valve, always loosen regulator flow adjusting knob.

b. Open cylinder valve slowly until needle of cylinder gauge stops moving.

c. Turn flow adjusting knob until desired rate of flow shows on flow indicator gauge.

7. To disconnect regulator and cylinder:

a. Close valve tightly.

b. Wait until both cylinder and flow gauges have registered zero.

c. Loosen flow adjusting knob. Unscrew inlet nut. Remove regulator. Recap cylinder.

8. Mark cylinders with the amount of oxygen remaining before returning them to the storeroom.

When Empty:

1. Remove regulator.

2. Close valve; replace cap.

3. Label cylinder "EMPTY." Use shipping tag or piece of adhesive.

Methods of Administration

The method of administering oxygen is selected by the doctor. He may order oxygen to be given through a nasal catheter, by face mask, or by the tent method.

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Mental Preparation of Patient for All Methods

Many individuals associate oxygen therapy with a critically ill patient who is on his death bed. The patient is able to obtain maximum benefit from oxygen only when any fear, anxiety or suspicion is relieved. Present day uses of oxygen therapy onclude supportive and comfort measures as well as therapeutic. Therefore, explain, reassure, and demonstrate what is to be done, how it will relieve him, and what he must do to get the best results.

Nasal Catheter Method

Oxygen by nasal catheter is one of the simplest and most convenient methods of administration. The chief disadvantage is that it may be irritating to the mucous membrane.

Equipment

1. Oxygen cylinder, flow gauge (regulator), humidifier
2. Lubricant (water soluble) and tissue
3. Four feet of rubber tubing
4. Catheter (No. 8 to 14 French) with extra holes along the side and near the tip.
5. Connector (from tubing to catheter)
6. Rubber band and safety pin
7. Wrench (Non-ferrous)
8. Glass of water
9. Adhesive—1 small piece of mark catheter. Two 6-inch strips of 1/2-inch width split half way down.

Procedure

Preparation of Equipment in Utility Room:

1. Open and close valve of oxygen cylinder.
2. Fill humidifier with water to level mark. Attach tubing.
3. Using wrench, attach regulator and humidifier to cylinder.
4. Select largest sized catheter that can be inserted comfortably in patient's nose.
5. Attach catheter to tubing with connector.

Preparation of Patient:

1. Tell patient how and what you are going to do.
2. With the catheter, measure the distance from the tip of the patient's nose to the lobe of his ear; mark this point on the catheter with a small piece of tape. Instruct the patient that he must not breath through his mouth.
3. Turn valve on oxygen cylinder and adjust flow on regulator to 5-6 liters per minutes.
4. Place small amount of lubricant on tissue; pass catheter lightly through the tissue.
5. Hold tip of catheter in glass of water to be sure holes are not plugged.
6. Holding catheter at the taped mark and with the oxygen flowing, insert the catheter into patient's nose slowly up to the taped mark (see fig. 13-13).
7. Ask the patient to open his mouth; the tip of the catheter will be seen opposite the uvula.
8. Tape catheter firmly at tip or side of nose and forehead.
9. Loop elastic band around tubing and pin to bedding, leaving enough tubing to allow patient to move about in bed (see fig. 13-14).

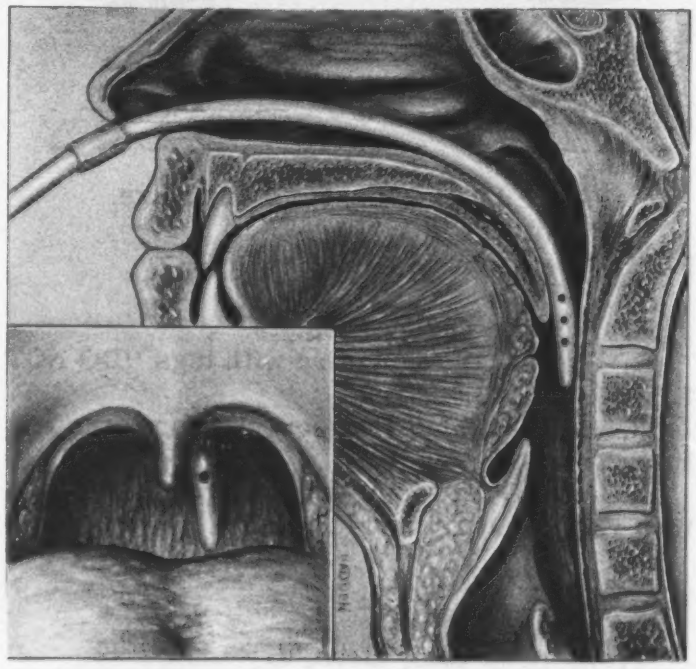

Figure 13-13.—Position of catheter.

Care of Patient with Nasal Catheter:

1. Apply water soluble lubricant about nostril every 4 hours and p.r.n.
2. Give mouth care every 4 hours.
3. Give fluids frequently if permitted.
4. Watch patient; if he shows signs of restlessness, dyspnea, cyanosis, check supply and flow of oxygen and the water level in humidifier. Check opening of catheter.

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Figure 13-14.—Taping catheter in place.

5. Always have a clean catheter ready at bedside.

6. Catheter should be changed every 12 hours and more frequently if nasal secretions make it advisable. Use alternate nostrils each change.

Care of Catheters After Use

1. Wash catheters and return to CSR for sterilizing.

Face Mask Method

Equipment

1. Mask
2. Oxygen cylinder and regulator
3. Wrench (non-ferrous)
4. Four feet of rubber tubing and connecting tip
5. Rubber band, safety pin

Procedure

In Utility Room:

1. Open and close valve of oxygen cylinder.
2. Connect regulator, tubing and mask.

At Bedside:

1. Explain what you are going to do to the patient before bringing any equipment to the bedside.
2. Strap cylinder to bed post.
3. Turn on oxygen 6-10 liters per minute.
4. Tell patient what you are going to do.
5. Apply mask to patient's face. Ask him to exhale as it is applied.
6. Adjust the head band so that the mask fits snugly but not too tightly.
7. Reduce liter flow to 6-8 per minute (or rate ordered by doctor) after patient is accustomed to the mask.
8. Loop elastic band around tubing and pin to bed. Be sure tubing is long enough to allow patient to move about in bed.

Care of Patient and Mask:

1. Every 1-1/2 to 2 hours:
   a. Remove mask to sponge and dry patient's face and inside of mask.
   b. Give fluids to drink if permitted.
   c. Reapply mask.
2. Watch rebreathing bag; it should expand when patient exhales and deflate when patient inhales.
3. Oxygen concentration is controlled by liter flow.
   a. For almost 100 percent oxygen concentration adjust liter flow to 6-8 per minute so that bag never fully collapses during inspiration.
   b. For 50-80 percent oxygen concentration, adjust flow to 5-6 liters per minute so that bag collapses during inspiration.
   c. For 40-50 percent oxygen concentration, adjust flow of 4-5 liters per minute so that bag collapses during inspiration.
4. Patient should be comfortable with no dyspnea, cyanosis; pulse should be slower and of better quality.

If he isn't comfortable, check oxygen supply, and check the mask for leakage about nose and mouth. Small piece of gauze or cotton over bridge of nose or on chin may be necessary to prevent leakage.

Care of Mask After Use:

1. Take mask apart.
2. Wash all parts of mask thoroughly with soap and warm water; rinse. Soak in disinfectant 30 minutes. Remove from solution, wash with warm water, rinse.
3. Dry and reassembly mask; return to proper department.

Tent Method

Equipment

1. Tent canopy
2. Oxygen machine

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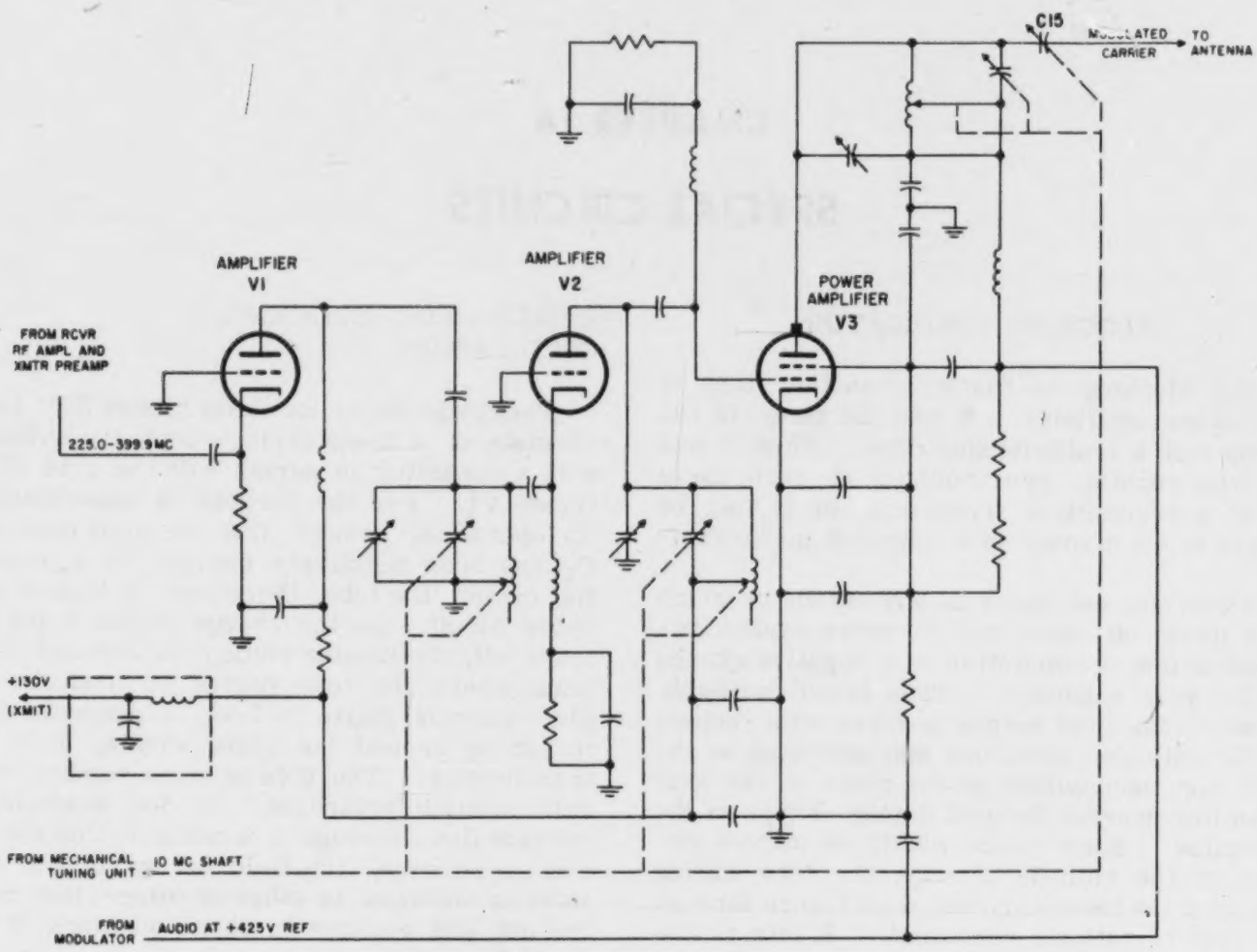

Figure 13-12.—Final amplifier.

amplifiers, V1 and V2. These are grounded-grid circuits and are operated class C. The audio modulating voltage is applied to the plate and screen grid of the final tube. Modulation is accomplished by superimposing the audio voltage upon the RF output of the stage. The resulting modulated RF energy is coupled through capacitor C15 to the antenna relay subassembly. The coupling capacitor is tuned by the mechanical frequency-selection system so that it presents a constant 50-ohm reactance over the entire frequency range of the equipment.

A portion of the modulated output is detected in a sidetone detector circuit, a part of the antenna relay subassembly. The detector circuit contains a crystal diode rectifier, which produces an audible signal to enable the operator to monitor the transmitted signals.

TEST EQUIPMENT

The test equipment used in the maintenance of the ARC-52 is the same as that used with the ARC-27. This is general-purpose type equipment with which you should already be familiar, since it has been in use for a number of years. No special test equipment is needed with ARC-52.

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3. Iceless type—does not require ice and has own electrical air conditioning device.
4. Ice type—requires ice (size of a grapefruit) in cooling chamber, pail to catch water from melting ice
5. Oxygen cylinder, regulator
6. Wall thermometer to hang inside tent (for ice type)
7. Hand bell for patient
8. Wrench (non-ferrous)
9. Oxygen analyzer

Procedure

In Utility Room:

1. Check canopy for leaks. Mend with cellutape.
2. Attach canopy to oxygen chamber. Close sleeves of canopy with clips or clothes pins. Close all zippered openings.
3. Fill ice chamber. Iceless type has own temperature control. Empty small drainage drawer on side of cabinet every 24 hours. Check and report any unusual sound in motor.
4. Attach regulator to cylinder (if regulator is part of cabinet, attach to cylinder in patient's room).

At Bedside:

1. Explain what you are going to do to patient before bringing in any equipment.
2. Place rubber sheet between bottom sheet and mattress.
3. Place patient in a comfortable position (Fowler's position preferred).
4. Bring tent and cylinder to the head of the bed. Leave cylinder on carrier or strap cylinder to bedpost away from radiator.
5. Place bath towel around patient's shoulders.
6. Make and check all connections; turn on oxygen to 15 liters a minute. Open shutters in cooling chamber; place pail under drain.
7. Place canopy over upper part of bed, tucking it well under mattress at sides and back. Bring front of canopy down toward foot of bed. Fold cotton sheet in fourths; place front of canopy within folds of sheets and tuck under mattress on both sides.
8. After 20 minutes, or when oxygen analyzer shows correct concentration, reduce oxygen flow to 8 to 10 liters per minute.

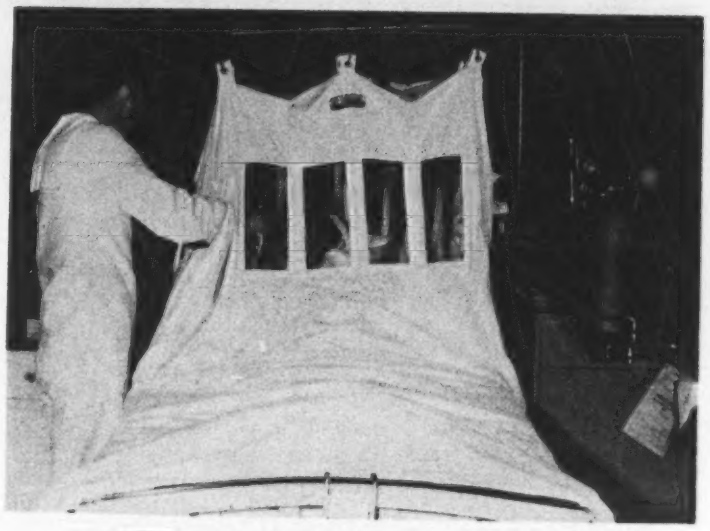

Figure 13-15.—Administration of liquids to patients in oxygen tents.

Care of Patient in Tent:

1. Every time tent is opened, oxygen is lost.
2. When giving a bath or changing the bed—draw canopy up to patient's chin; tuck sides under pillows; increase liter flow to 12 to 15 per minute. Use skin lotion for back rubs. Always wash hands before readjusting liter flow after giving a back rub.
3. When giving fluids use tent sleeves rather than opening entire canopy (fig. 13-15).
4. Watch temperature inside tent—maintain at 68 degrees F. Protect patient's head with towel or cap if he complains of cold.
5. Use oxygen analyzer every 4 hours to determine concentration. Follow directions on analyzer.
6. Watch patient carefully; he should be much more comfortable inside tent. If he is not, check:
   a. Oxygen supply, temperature.
   b. Tent for leaks.
   c. Inflow tube or shutter to see that it is not covered by mattress or bedding.
7. The tent is not soundproof; do not discuss patient's condition within his hearing.
8. Be sure he has a hand bell and paper wipes within his reach.

Care of Tent After Use:

1. If disposable type—discard.
2. Other types:
   a. Wash with warm water and soap; rinse with cool water; dry.

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b. Allow to air for 24 hours.
c. Return to proper department.

APPLICATIONS OF HEAT AND COLD

Very frequently applications of heat and cold are a valuable aid in the treatment of patients. Heat causes a local hyperemia (increase blood supply), a function that may be used to advantage in the treatment of inflammation. Also, heat often relaxes the spasm of involuntary muscles, thereby relieving pain. Heat may be applied in the dry or the moist form. Cold is used in the treatment of recent inflammations, because cold contracts the superficial blood vessels, thereby reducing the circulating fluids, and is used for relief of pain caused by pressure. It is also used to control hemorrhage (fig. 13-16).

The applications of heat and cold as described in this section will be limited to those procedures you will be likely to use on the ward or in sick bay. There are many other methods (lamps, diathermy) of applying heat and cold that are administered by the Physical Medicine Department.

The form of application, the temperature at which it is to be applied, and the duration of the application will be prescribed by the doctor.

General Instructions

1. Always have a doctor's order for all applications of heat and cold.
2. Always explain the procedure to the patient.
3. Always screen the patient when applying moist heat or cold.
4. Always wash your hands before starting procedures.
5. Always have a layer of cotton, flannel, or woolen cloth between the patient and any rubber or plastic materials.

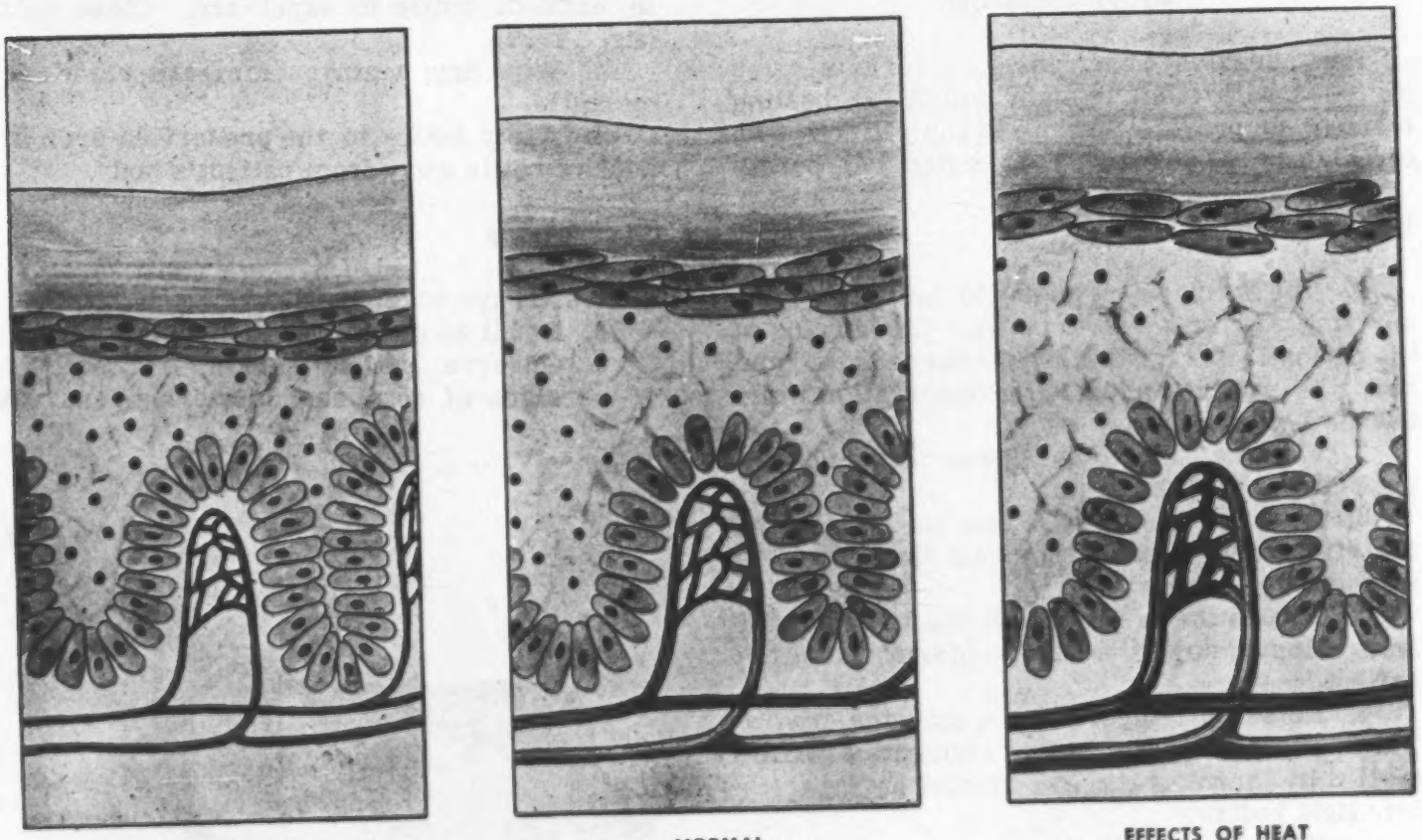

EFFECTS OF COLD
Capillaries constrict. Less blood flows to the part. Circulation is lessened. Pain is relieved (anesthetic effect).

NORMAL

EFFECTS OF HEAT
Capillaries dilate. More blood flows to the part. Circulation improves. Pain is relieved. Draining is promoted.

Figure 13-16.—Effects of heat and cold.

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6. Always watch the patient's skin closely for signs of redness, mottling, edema, or maceration (softening by soaking).

7. Always chart procedure, noting and recording—

Time of application
Form of application
The area to which it was applied.
The duration of the application.
The name, strength, and temperature of solution (moist applications).
The local or the systemic effects.
Your signature.

APPLICATIONS OF DRY HEAT

Dry heat may be applied to the body by means of a heat cradle, an electric pad, or a hot water bottle. It is used to provide warmth and comfort; to relieve pain; to soothe and relax superficial tissue.

HEAT CRADLE

Heat cradles are frames of various sizes equipped with electric light bulb(s) or heating element to provide warmth to the patients with circulatory disturbances or extensive burns.

Precautions

1. The main precautions to be taken when applying dry heat are to prevent the burning of the patient. For this reason the corpsman should keep the patient under close observation while heat is being applied.
2. Check all electrical connections and wiring before using the cradle.
3. Be sure the cradle is large enough to cover the affected area and to permit the patient to without being burned.
4. Secure the cradle to the bed to prevent it from slipping down over the side and burning the patient.
5. Note the temperature inside the cradle. Those cradles having heating elements are controlled by thermostats. For cradles having electric light bulb(s):

Suspend a wall thermometer inside the cradle.

Control temperature by turning bulb(s) on and off (the usual desired temperature inside the cradle is 90° to 95° degrees F.)

6. Electric light bulb(s) should be 25 watt or less and covered by shields.

ELECTRIC PAD

Precautions

1. Check connections and wiring before using.
2. Keep temperature control on LOW.
3. Do not use with wet applications.

HOT WATER BOTTLE

Equipment

Hot water bottle and cover
Pitcher of water 120° degrees F.

Procedure

1. Test bottle for leaks.
2. Fill bottle one-half full.
3. Place bottle on flat surface, neck up; press from bottom of bottle until water appears in neck of bottle to expel air. Close tightly (fig. 13-17).
4. Wipe dry; again test for leaks; place cover on bottle.
5. Apply bottle to the prescribed area with neck of bottle away from patient's body.

Precautions

1. Always cover bottle.
2. Refill as necessary to keep hot.
3. Observe patient's skin frequently for signs of readness, blistering, and pain.

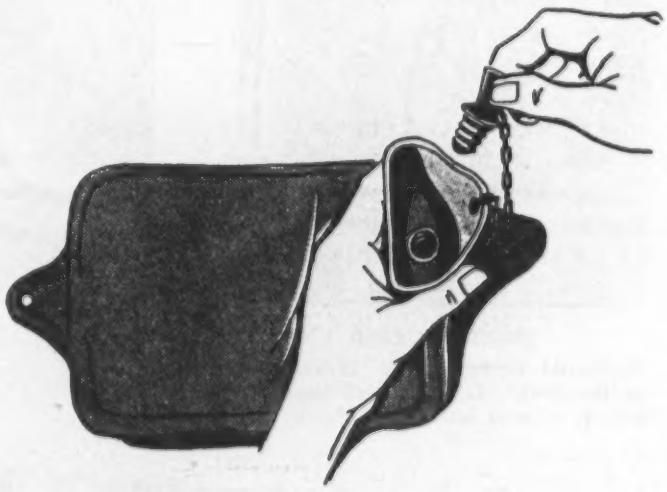

Figure 13-17.—Filling hot water bottle.

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APPLICATIONS OF MOIST HEAT

Moist heat may be applied to the body by means of wet compresses, packs or baths. Irrigations and inhalations are also methods of applying moist heat and are discussed in detail elsewhere in the text. The purposes of applying moist heat are:

1. To relieve inflammation.
2. To provide comfort.
3. To relieve pain.
4. To hasten the localization of infection.

MOIST HOT COMPRESSES (CLEAN)

Purpose

When moist heat is desired for a small area.

Equipment

Tray
Hot plate
Basin of water or solution (105° F.)
Compress of sufficient size to cover area-may be gauze, flannel, or wash cloth
Curved basin
Rubber sheet and cover

Procedure

1. Place compresses in basin of solution on hot plate. Turn on hot plate.
2. Place covered rubber sheet under part to be treated.
3. Wring out excess solution; place compress on part.
4. Repeat step 3 every 1 to 2 minutes for 20 minutes or for prescribed length of time.

Precautions

1. Wring compresses as dry as possible before placing on patient.
2. Observe skin carefully for redness, pain, and blistering.
3. Keep hot plate on LOW after once heated.

STERILE HOT WET COMPRESSES

Used when open lesion or wound is present.

Equipment

Tray
Hot plate
Sterile basin and solution (105° F.)
Sterile compresses
Two sterile forceps
Curved basin
Rubber sheet and cover

Procedure

1. Wash your hands.
2. Place covered rubber sheet under part to be treated.
3. With forceps, place sterile compresses in basin of solution on hot plate.
4. With sterile forceps, wring out excess solution; apply slowly to part.
5. Repeat step 4 every 1 to 2 minutes for 20 minutes.

Precautions

1. Start compresses at low temperature (105° F.) to allow patient to become accustomed to them.
2. Maintain aseptic technique.
3. Watch closely for signs of burning (redness, blisters, pain).
4. Wring out compresses as dry as possible.
5. Keep hot plate on LOW.
6. Use each compress once only.
7. If for both eyes, use separate set-ups for each eye.
8. Wash hands before and after each treatment.

AQUAMATIC K PADS

Equipment

Aquamatic K Pads are electrical units which circulate distilled water at a controlled temperature through a rubber pad. They may be used in application of heat or cold.

Procedure

1. Fill unit with distilled water.
2. Set temperature control.
3. Connect flow tubes from pad to unit.
4. Cover pad and place over part to be treated.

Precautions

1. Tie in place—never use pins.
2. Observe skin frequently for danger signs.

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LOCAL PACKS

Local packs are used to provide moist heat to a large area. This is a clean procedure.

Equipment

Cotton flannel or pieces of old, clean blanketing
Rubber or plastic sheeting
Sheet or bath towel for binder
Vaseline or oil for skin
Safety pins or bandage to hold binder in place
Basin of water 110° to 115° F.

Procedure

1. Place flannel or blanketing in basin of water.
2. Place rubber sheet and binder under the part to be treated.
3. Lubricate the skin.
4. Wring out the flannel as dry as possible; apply around part to be treated.
5. Wrap rubber sheet around flannel.
6. Wrap binder around rubber sheet; pin or tie in place.
7. Change wet flannels every half-hour; note the condition of the skin; report signs of puffiness, blisters, wrinkling, paleness of the skin.

Precautions

1. Be sure flannel or blanketing is large enough to cover the area.
2. Be sure flannels are wrung out as dry as possible to avoid burning patients by steam.
3. When applying wet flannel place it gently on the part and momentarily lift the corner to allow the escape of steam.
4. When packs are ordered continuously, expose the area to the air for one-half to one hour daily to help prevent maceration of the skin.
5. Hot water bottles are occasionally used to maintain a constant heat. Place them inside the binder next to the rubber sheet. Be sure they are no hotter than 120° F.
6. When a broken skin area or a wound is present, use sterile water, sterile abdominal pads for dressings; use sterile technique.

HOT WET SOAKS OF ARM OR FOOT

Equipment

Foot-tub one-fourth full of warm water (105° F.)
Pitcher hot water (115° F.)
Rubber sheet and cover
Bath towel

Procedure

1. Place covered rubber sheet under part to be treated
2. Place foot tub on rubber sheet
3. Place part to be treated in tub
4. Pour hot water into tub slowly, away from patient's extremity; stir water as you pour
5. Repeat step 4 as necessary to keep water hot
6. Continue for 20 minutes.

Precautions

1. Pour hot water away from extremity to avoid burning the patient.
2. Have tub on level surface to avoid spilling water.
3. Cover top of tub to hold in heat.
4. Watch skin carefully for signs of burning.

SITZ BATH

Use in treatment of rectal, perineal, or pelvic conditions.

Equipment

Same as for tub bath.

Procedure

Same as for tub bath except—
1. Amount of water should be sufficient to cover patient's hips.
2. Temperature of water should be 110° F.
3. Duration of treatment—20 minutes unless time is specified by doctor.

Caution

If patient shows signs of dizziness, fainting, or exhaustion, stop treatment, drain water from tub, cover patient with blanket. Report to doctor.

APPLICATIONS OF DRY COLD

Dry cold is usually applied to the body by means of an ice bag or ice collar.

Purpose

To check inflammation; to relieve pain; to check bleeding.

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ICE BAG

Equipment

Ice bag and cover
Cracked ice (size of walnut)

Procedure

1. Test bag for leaks.
2. Fill bag one-fourth full of ice.
3. Place on flat surface; press from bottom of bag until ice appears in neck of bag, to expel air. Close tightly.
4. Wipe dry; test for leaks; place inside cover.
5. Apply bag to prescribed area with neck of bag away from patient's body.

Precautions

1. Always cover bag.
2. Change cover when it becomes moist.
3. Refill as necessary to keep cold.
4. Observe patient's skin frequently for signs of mottling or pallor, complaint of burning sensation.
5. If patient complains of burning sensation, remove ice bag.

APPLICATION OF MOIST COLD

Moist cold may be applied to the body by means of compresses and baths.

Purpose

To prevent or reduce swelling; to relieve pain; to reduce temperature.

COLD MOIST COMPRESSES (CLEAN)

Equipment

Tray
Basin of ice water (with ice)
Compresses of sufficient size to cover area—may be gauze, flannel or a wash cloth
Curved basin
Rubber sheet and cover

Procedure

1. Place covered rubber sheet under part to be treated.
2. Place compresses in ice water.
3. Wring out excess solution; place compresses on part.
4. Repeat step 3 every 1 or 2 minutes for 20 minutes or for prescribed period of time.

Precautions

1. Watch skin carefully for signs of blanching, mottling.
2. Wring compresses as dry as possible before placing on patient.

COLD MOIST COMPRESSES (STERILE)

Equipment

Tray
Face basin with cracked ice
Sterile solution basin, solution
Two sterile forceps
Sterile compresses (gauze)
Curved basin
Rubber sheet and cover

Procedure

1. Place rubber sheet under part to be treated.
2. With sterile forceps, place sterile compresses in solution basin; then place basin in cracked ice.
3. With sterile forceps, pick up compress; wring out excess solution; apply to part.
4. Repeat step 3 every 1 to 2 minutes for 20 minutes.

BATH—TEPID OR ALCOHOL SPONGE

Purpose

To reduce fever when ordered by the doctor or for patients with fever of 103° F. and above.

Equipment

Bath basin
Seven washcloths or pieces of gauze
Bath and hand towels
Rubber and cotton draw sheets
Hot water bottle and cover
Ice cap and cover
Solution:
Water at 95° to 100° F.
Equal parts water and alcohol at 95° to 100° F.

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Procedure

1. Preparation of patient and his unit is the same as for a cleansing bed bath. In addition, place the rubber and cotton draw sheets under him, the ice cap to his head and the hot water bottle to his feet.

2. Order of sponging patient:

Wring out washclothes in solution; place one in each axilla, groin, and under each knee. Replace washcloths frequently.

Follow same order in sponging patient as for Cleansing Bed Bath. Omit genitalia and soaking feet. Pat body dry; avoid vigorous rubbing. Apply alcohol to arms and back.

3. Watch patient for signs of chilliness, cyanosis; increased pulse rate.

Continue treatment for 20 minutes—unless patient shows reaction. In case of reaction, stop sponging; apply blankets and report reaction to ward nurse or doctor.

4. Remake bed; leave patient comfortable. Remove, clean, and store equipment.

5. Take TPR one-half hour after treatment is completed. NOTE: When rapid reduction of very high temperature is desired, bath towels may be substituted for washcloths, thus covering a greater body area with each application. This method must be ordered by the doctor.

PROCEDURES RELATING TO THE GASTROINTESTINAL TRACT

The treatments relating to the gastrointestinal tract are prescribed either to cleanse, to apply heat, to administer or remove fluids, or to administer medication. Most of these treatments require clean equipment and solutions except in the presence of gastric surgery when sterile equipment is needed. All equipment used is these treatments must be sterilized after each use and the returns from these treatments should be discarded down the hopper or bedpan flusher.

INTUBATION

The introduction of tubes through the nose or mouth into the stomach is usually the responsibility of the doctor. However, there are times when a corpsman may be called upon to insert a tube or to teach his patient how to do so.

Purposes:

To obtain a specimen of gastric contents for laboratory examination; to prepare the patient for a gastric lavage, gavage, or siphonage.

Types of Gastric and Intestinal Tubes

LEVIN TUBE (fig. 13-18).—This is a flexible, soft-walled, No. 16 French, 4-foot tube. It has multiple holes near the rounded tip. Markings on the tube indicate distances of 50, 60, 70, 80 centimeters. The Levin tube is used for gastric and intestinal drainage, gastric lavage and gavage. It may be inserted either nasally or orally. It is flexible enough so that there is little danger of producing injury. The chief danger is that the tube may readily enter the trachea.

STOMACH TUBE (Fig. 13-19).—This is a stiff, heavy-walled, No. 28 French, 5-foot tube with a round tip and a funnel at the other end. The stomach tube is used for gastric lavage. It is stiff enough to be easily passed into the stomach of an unconscious or uncooperative patient. The chief danger is that the tube, due to its stiffness, may damage the larynx or

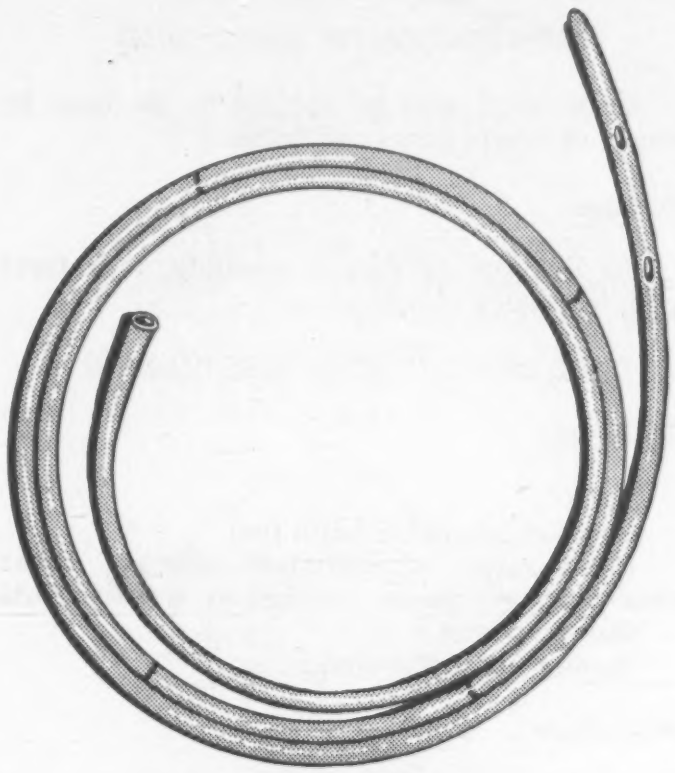

Figure 13-18.—Levin tube.

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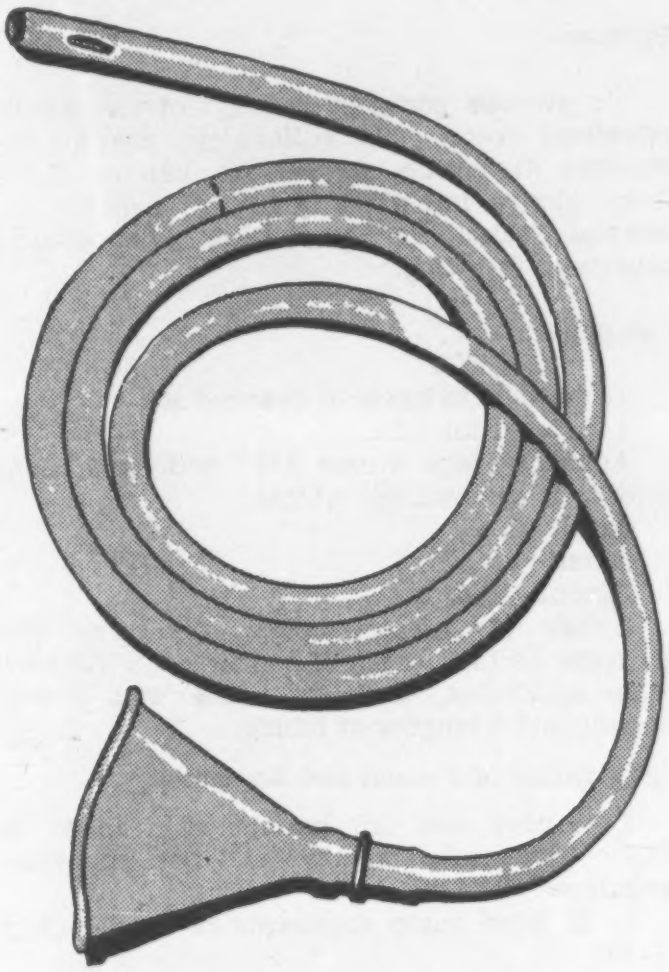

Figure 13-19.—Stomach tube.

perforate the stomach or esophagus if not carefully used.

CANTOR TUBE (Fig. 13-20).—This is a single lumen, No. 18 French, 10-foot intestinal tube with a small mercury-filled bag at its tip. It is used for intestinal drainage. The tube is inserted nasally, suction is started when the letter "S" on the tube is at the patient's nose.

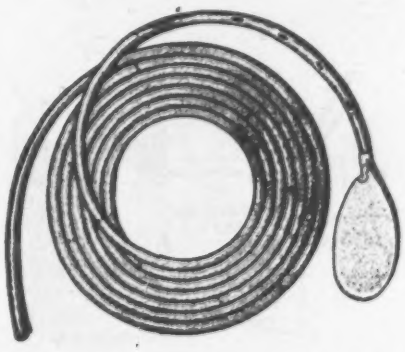

Figure 13-20.—Cantor tube.

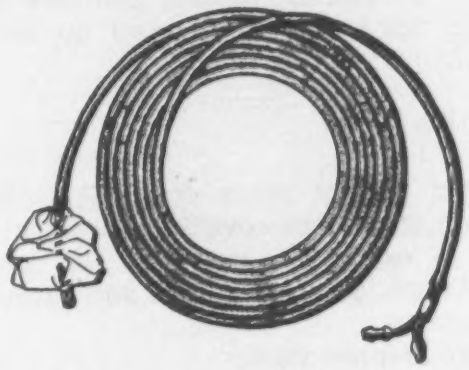

Figure 13-21.—Miller Abbott tube.

MILLER-ABBOTT TUBE (Fig. 13-21).—This is a metal tipped double lumen, No. 16 French, 10-foot intestinal tube with a small balloon near its tip. One lumen of the tube is used to inflate the balloon; the other, entirely independent, for aspiration. Markings on the tube indicate the distance it has been passed. The tube is inserted nasally and suction is started when the first mark is at the patient's nose. Peristaltic action carries the balloon and tube along the intestine.

INTUBATION TECHNIQUE

Equipment

Levin tube in basin of ice water
Water soluble lubricant
20 to 30 cc. syringe
Bath towel
Rubber Sheet
Paper mouth wipes
Curved basin

Procedure

1. Place patient in Fowler's or sitting position. Explain procedure to him.
2. Secure bath towel around his neck. Place rubber sheet over bedding.
3. Remove tube from ice water. Lubricate tip very lightly.
4. Ask patient to tilt head slightly backward.
5. Hold tube about 6 inches from its tip. Rotate it until position of greatest "droop" is found.
6. Holding tube in this position, pass it through the nostril into the pharynx. Ask the patient to tip his head forward and to swallow. Each time he swallows insert the tube a few

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inches. Do not use force. Continue inserting the tube until second marker on the tube is reached.

Precaution

Should patient start coughing, choking or become cyanotic, remove the tube quickly. Allow patient to rest a few minutes. Re-insert tube.

7. Attach syringe to tube and aspirate gastric contents.

8. To remove tube:
   Place towel close to patient's chin.
   Pinch the tube at patient's lips.
   Gently but quickly remove tube and place it directly into towel.

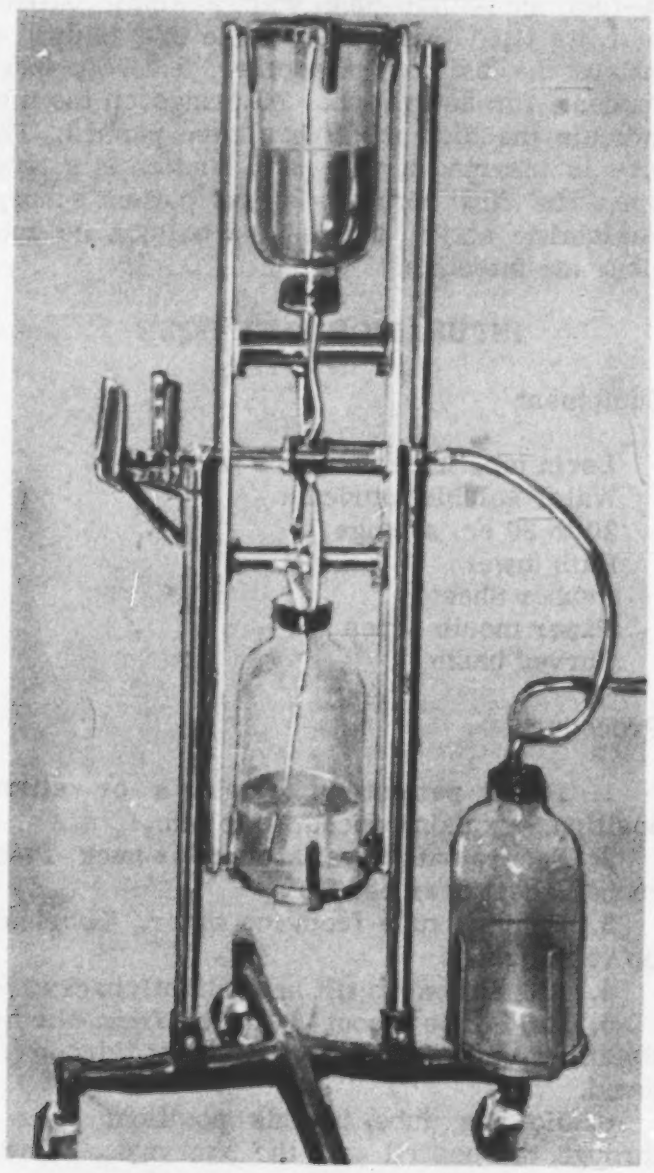

Figure 13-22.—Wangensteen apparatus.

GASTRO-INTESTINAL SUCTIONING

Purpose

To provide constant drainage of the gastro-intestinal tract. To relieve or prevent abdominal distention; to remove gas or fluids from gastro-intestinal tract; to relieve intestinal obstruction; to relieve postoperative nausea or vomiting.

Equipment

Levin tube in basin of cracked ice
Lubricant for tube
Adhesive tape strips 1/2" wide x 6" long split halfway down the middle.
Safety pins
Elastic pins
Elastic band
Either (1) electric pump apparatus with drainage bottle, tubing Y connector or (2) hand pump apparatus, drainage bottle with 2 hole stopper and 2 lengths of tubing.

Preparation of Patient and Equipment

1. Screen and tell patient what is to be done. Levin tube is inserted. See intubation technique.

2. If hand pump apparatus is used: (Fig. 13-23)

   a. Connect the two lengths of tubing to the rubber stopper outlets.

   b. Insert rubber stopper into gallon bottle.

   c. Connect the free end of one piece of tubing to the gauge on the tank.

   d. Connect the other piece of tubing to the patient's tube.

   e. To start drainage, open needle valve on tank by turning knurled knob in a counter-clockwise direction.

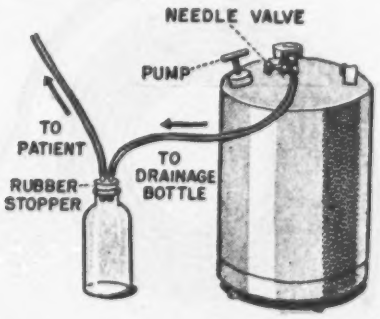

Figure 13-23.--Hand pump suction apparatus.

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f. Create suction to tank by pumping approximately 40 to 50 strokes until the gauge registers 5.

3. If electric (GONCO) pump is used:

a. Connect tube from patient to metal connector located on suction bottle stopper.

b. Turn on water switch to "low".

4. Tape Levin tube to patient's forehead or cheek.

5. Loop elastic band about tubing near connecting tip and pin to bedding.

Care of Patient and Equipment During Treatment

1. Empty and measure contents of the drainage bottle when it becomes two-thirds full or at least every 24 hours.

2. Maintain an accurate intake and output record.

3. Observe working order of the suction apparatus being used and report any interruption in its functioning.

4. Give patient mouth care every 4 hours.

5. Apply ointment or lubricating lotion to each nostril every 4 hours.

6. Do not clamp tubing or stop suction unless ordered by the doctor.

7. Irrigate tube as ordered.

8. Observe patient. Report any complaints of nose or throat irritation; report any sign of blood in drainage.

9. If clear liquids are ordered for the patient by the doctor do not give milk. Do not give solid food.

Care of equipment

1. Wash suction machine.

2. Wash tubing, drainage bottle and cap and return to CSR for sterilization.

3. Return all equipment to proper places.

IMPROVISED (WANGENSTEEN) THREE-BOTTLE METHOD

Equipment

Three gallon bottles

Three lengths rubber tubing—one (6 feet); one (4 feet); one (3 feet) (Fig. 13-24)

Two 2-hole rubber stoppers to fit bottles

Two clamps for tubing

Four lengths glass tubing—one (12 inches); one (6 inches); two (3 inches)

Bandage or tape for hanging bottle

One Levin tube

One connecting tip

One standard or other apparatus for hanging bottle

Procedure

Preparation of Equipment

In Utility Room

Bottles are set up to resemble commercially prepared Wangensteen apparatus (see fig. 13-22).

1. Mark bottles for measuring fluids (see simple drainage).

2. Insert 1 long and 1 short glass tube in each rubber stopper.

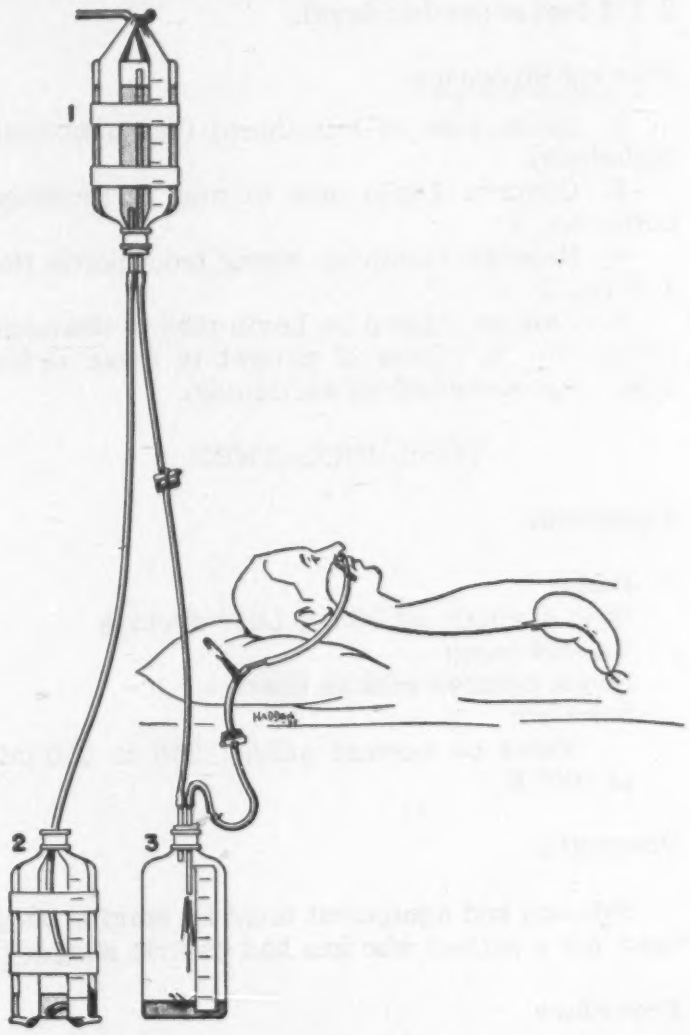

Figure 13-24.—Improvised suction apparatus.

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CHAPTER 14

SPECIAL CIRCUITS

BLOCKING OSCILLATOR

The blocking oscillator is another type of relaxation oscillator. It can do many of the things that a multivibrator does. Thus it can be free running, synchronized at each cycle or at a submultiple frequency, or it can be driven in the manner of a one-shot multivibrator.

A blocking oscillator is any oscillator which cuts itself off after one or more cycles because of the accumulation of a negative charge on the grid capacitor. Thus in an oscillator in which the grid swings positive with respect to the cathode, electrons are attracted to the grid and accumulate on the plate of the grid capacitor nearest the grid during charge of the capacitor. Since these electrons cannot return to the cathode through the tube during charge of the capacitor, they must return through the grid-to-cathode resistance. If this resistance is sufficiently large, electrons may accumulate on the capacitor faster than the resistor permits them to return to the cathode. In this case a negative charge is built up at the grid which may bias the tube beyond cutoff. After the tube is cut off, it provides no additional electrons to the grid capacitor. However, the capacitor continues to discharge through the resistor, and a point is reached eventually where the tube again conducts. Thus the process is repeated and the tube becomes an intermittent oscillator. The rate of the recurrence of operating conditions is determined by the RC time constant of the grid circuit.

There are two general types of blocking oscillators—the single-swing type in which the tube is cut off at the completion of one cycle, and the self-pulsing type, in which each cycle of oscillation causes the grid to become progressively more negative until the tube is biased out of operation. In radar the single-swing type oscillator usually operates within the audiofrequency range.

SINGLE-SWING BLOCKING OSCILLATOR

The single-swing oscillator circuit (fig. 14-1) consists of a transformer-coupled oscillator, with a capacitor in series with the grid of the triode V1. For the purpose of understanding its operation, assume that the grid capacitor C_g has been negatively charged by a preceding cycle. The tube, therefore, is biased well below cutoff. As the charge on the capacitor leaks off, the biasing voltage is reduced to the point where the tube begins to conduct. As plate current starts to flow, a magnetic field is set up around the plate winding P of the transformer. The dots at each winding indicate similar polarities. If, for example, a current flows through a winding so that the dot end is positive, the field set up in the core induces voltages in other windings that make the dot end positive in these windings at the same time.

The field builds from zero to a maximum in direct proportion to the plate current, and therefore induces a voltage across the grid winding. This voltage is of such polarity that the grid end goes positive. This action is impressed upon the grid of the tube through the grid capacitor C_g with a polarity that drives the grid more and more positive as the field in the plate winding is building up. When the grid is driven positive with respect to its cathode, it draws current, and electrons accumulate on the plate of the grid capacitor nearest the grid. At the same time, current is flowing through R_g making the grid positive. As the grid becomes more positive, it eventually takes enough electrons from the plate current to lower the rate of the plate current increase. This reduces the induced voltage from plate to grid windings, the grid stops swinging positive, and the plate current increase is slowed. This action is cumulative and ends with the plate current being settled at a constant value,

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3. Insert stoppers into 2 bottles.
4. Set up suction apparatus.

Bottle No. 1. Fix bandage, or tape, to hang on hook. Fill to 4,000 cc. with water. Insert stopper with 12 inch glass tubing into bottle. Attach 6-foot length rubber tubing to short glass tube.

Bottle No. 2. Fill with water to 300 cc. Place rubber tubing from bottle No. 1 so that end is under water.

Bottle No. 3. Insert rubber stopper. Attach 4-foot tubing to long tube of bottle No. 1, attach 3-foot tubing to other glass tube.

Apply clamps. One to tubing from bottle No. 1 to No. 3, one to tubing from bottle No. 3 to Levin tube.

At Bedside:

1. Place bottles No. 2 and No. 3 on floor.
2. Be sure all clamps are closed.
3. Invert and hang bottle No. 1 on standard 2 1/2 feet above bed level.

Starting Siphonage:

1. Levin tube is introduced (see intubation technique).
2. Connect Levin tube to tube of drainage bottle No. 3.
3. Release clamp on tubing from bottle No. 1 to No. 3.
4. Release clamp on Levin tube to drainage bottle No. 3. Care of patient is same as for other gastro-intestinal suctioning.

TUBE IRRIGATIONS

Equipment

Basin
Bulb syringle or 30 cc. Luer syringe
Curved basin
Small covered rubber sheet
Solution:
Water or normal saline, 250 to 500 cc. at 100° F.

Precaution

Solution and equipment must be sterile when used for a patient who has had gastric surgery.

Procedure

1. Clamp tubing to drainage bottle.
2. Place covered rubber sheet on bed under connector of Levin tube and drainage tube.
3. Place curved basin under connector.
4. Disconnect tubing.
5. Fill syringe; insert tip into Levin tube; gently inject solution.
6. Allow solution to drain out of tube into curved basin.
7. Repeat steps 5 to 6 until all solution is used.
8. Connect Levin tube to drainage tube; unclamp tube.
9. Remove equipment, measure returned fluid.

Charting—Nursing Notes

Record amount and type of solution used; amount and description of returns.

GASTRIC LAVAGE

Purpose

To empty stomach as a preoperative preparation for gastric surgery; to remove poisons. (requires doctor's order)

Equipment

Tray containing—
Stomach tube in basin of ice water
Two gallon pitchers or warm water (105° F.) or solution ordered by doctor
Large pail for returns
Rubber Sheet and cover
Curved basin; paper wipes

Procedure

Preparation of Patient and His Unit

1. Screen and tell patient what you are going to do.
2. Place patient in Fowler's position.
3. Place covered rubber sheet over bedding and under patient's chin.
4. Give patient curved basin and paper wipes to hold.
5. Place pail on floor or bench at bedside.
6. Locate white marker on stomach tube.

Conducting Lavage

1. Stomach tube is usually inserted by the doctor. The tube is placed far back in the

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mouth and as the patient swallows the tube is advanced a few inches each time until the marker is reached.

2. Invert funnel and hold below the level of the patient's stomach; allow drainage into pail.

3. Hold funnel upright, pour solution into funnel and keep full until approximately 500 cc. has been given.

4. Invert funnel while there is still some solution in it; allow to drain.

5. Repeat steps 3 and 4 until returns are clean or until amount ordered has been used. If patient becomes exhausted, stop lavage; report to doctor.

6. Pinch tube at patient's lips; withdraw quickly into curved basin.

7. Make patient comfortable; remove equipment; leave unit in order.

Care of Equipment

1. Measure returns.
2. Place linen in hamper.
3. Wash tubing, pitcher and basin and return with tray to CSR.
4. Wash pail with soap and water, rubbing vigorously for 2 minutes.

Charting—Nursing Notes

Time of gastric lavage, amount of solution used; amount, appearance and odor of returns. Signature.

NOTE: If Levin tube is used: Tube may be inserted through nose. Add 50 cc syringe to equipment. Plunger of syringe may be used to start or reestablish drainage.

GASTRIC GAVAGE

Purpose

To introduce liquid food or medication into the stomach by means of a tube. When ordered by the doctor for patients who are unable to swallow; who are unconscious; who refuse to eat; who have spasm or stricture of the esophagus.

Equipment

To equipment for intubation technique add:
Fluid to be fed

Procedure

1. Warm liquid food to body temperature.
2. Follow procedure for Intubation Technique, steps 1 through 6.
3. Attach barrel of syringe to tube.
4. Slowly pour fluid down side of syringe. Keep syringe full of fluid until all has been given.
5. Pour 60 cc. of water into tube after fluid to clear tube.
6. To remove tube. Follow step 8 of intubation technique procedure.

Charting—Nursing Notes

Record: Time; amount and name of fluid; state whether tube was introduced orally or nasally. Signature.

ENEMAS

Purpose

To remove feces from lower intestinal tract; to relieve flatulence and abdominal distention; to produce local or systemic effects.

CLEANSING ENEMA

Purpose

To remove feces.

Solution

1. Soap suds solution (S.S.E.) (white soap) 500 to 1,000 cc. Never use philsohex or any detergent.
2. Normal saline solution (N.S.) (1 teaspoon salt to 1 pint of water) 500 to 1,000 cc.
3. Temperature of solution: 105° to 110° F.

Equipment

Tray containing
- Irrigation can
- Rubber tubing
- Clamp
- Glass connecting tip
- Rectal tube No. 24 French
- Lubricant (water soluble)
- Toilet tissue
- Paper towel
- Rubber sheet with cover
- Covered bed pan and urinal

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Procedure

Preparation of Patient and Unit

1. Screen patient, explain procedure to him.
2. Clear the top of bedside locker.
3. Lower backrest and turn patient on left side or side most comfortable for him (Sims position). For patients who are paralyzed or unable to retain any fluids, place the patient on a bedpan before injecting fluid.

Preparation of Equipment

1. Attach rectal tube to glass connecting tip; clamp tubing.
2. Fill pitcher with solution—110° F.
3. Pour solution into irrigating can; allow solution to run through tubing; clamp.
4. Remove small amount of lubricant from tube and place on piece of toilet tissue.
5. Lubricate rectal tube; leave tissue around tube.
6. Cover bedpan, place tray on top of pan and carry to bedside. Carry urinal by handle.

Administering Fluid

1. Place bedpan and urinal on chair, tray on bedside table.
2. Fold back upper bedding in triangle to expose anus.
3. Place covered rubber sheet under patient's buttocks.
4. Place curved basin next to anus.
5. Open clamp on tubing, allow small amount of solution to run through tube into curved bedpan.
6. Raise upper buttock, locate anus, insert rectal tube 3 to 4 inches, hold in place with left hand.
7. Open clamp with right hand; hold irrigating can approximately 18 inches above anus (fig. 13-25).
8. Allow solution to flow slowly.
9. If patient complains of discomfort or cramps, pinch tubing for a few moments.
10. Continue flow until patient has taken all solution or as much as he is able.
11. Clamp tubing, pinch and withdraw rectal tube and place in can or tray with rectal tube resting on paper towel.
12. Place patient on bedpan; elevate backrest.
13. Place toilet tissue and call bell within his reach.

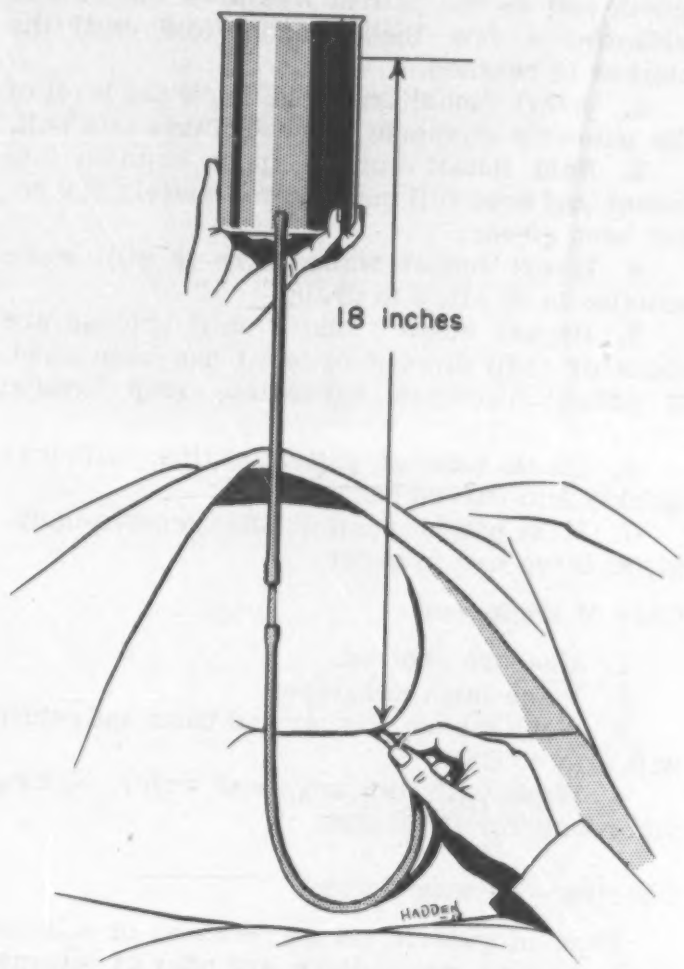

Figure 13-25.—Administration of cleansing enema.

14. Carry tray to utility room. Wash your hands.
15. Leave patient alone until he calls, but look in on him frequently.
16. When patient is finished, remove and cover bedpan; assist patient with cleansing if necessary. If patient is unable to expel enema, insert rectal tube and siphon fluid into bedpan.
17. Take bedpan to utility room, inspect contents; note amount, odor, color and consistency, unusual appearance.
18. Take basin of water to patient to wash his hands.

Care of Equipment

1. Rinse irrigating can and tubing with warm water.
2. Run cold water through rectal tube; wash with soap and water; rinse. (Use applicators if necessary to clean "eye" of tube.)

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3. Return tray to CSR for sterilizing.
4. If no CSR facilities are available then,
   a. Boil irrigating can.
   b. Boil rubber tubing.
   c. After boiling, immerse rubber goods in cold water and dry.
   d. Scour metalware.
   e. Reset tray.
5. Wash rubber sheet with soap and water and dry.

Charting—Nursing Notes

Time
Type of enema given
Results
Reaction of patient
Signature

RETENTION ENEMA

Purpose

To produce a general systemic effect, such as a sedative; to give local remedial effect; to soften feces; to relieve irritation; to relieve flatulence in abnormal distention.

Types

1. Oil enema—4-8 ounces of warm oil (mineral, olive, cottonseed.)

Sedative—drug mixed with 2 to 3 ounces of water, oil, or cornstarch solution. EXAMPLE: chloral hydrate, paraldehyde, sodium bromide, in dosage as ordered by the doctor.

3. Cornstarch—4 to 6 ounces water; dissolve enough starch to make smooth, white fluid. Temperature of solution 100° F.

4. Carminative—1-2-3 enema (one ounces magnesium sulfate, 2 ounces glycerin, 3 ounces water); milk and molasses (6-8 ounces of each) or sodium bicarbonate (8 grams or 2 teaspoonfuls) to 500cc water 105° F.

Equipment

Tray
Pitcher
Funnel
Rectal tube No. 20 French, or catheter
Lubricant
Tongue blade
Toilet tissue
Covered rubber sheet

Procedure

Preparation of Patient and Unit

1. Screen patient; tell him what you are going to do. (A cleansing enema may be ordered 1/2 hour preceding a retention enema to facilitate retention).
2. Clear top of bedside locker.
3. Turn patient on either side (most comfortable position for him).
4. Place covered rubber sheet under patient's buttock.

Preparation of Equipment

1. Prepare solution ordered at correct temperature.
2. Put lubricant on toilet tissue and lubricate rectal tube.
3. Attach rectal tube to funnel. Place in curved basin.
4. Take tray to bedside.

Administration of Fluid

1. Expose anal area by forming triangle of upper bedding. Place curved basin next to anus (fig. 13-26).
2. Fill funnel with solution; allow solution to flow through filling tubing; pinch tubing before funnel is empty.
3. Holding funnel in one hand, raise upper buttock and insert rectal tube about 4 inches.
4. Raise funnel even with top of buttock. Allow solution to flow slowly to avoid stimulating bowel movement. If patient has difficulty retaining solution, apply gentle pressure with toilet tissue to rectum until desire to defecate

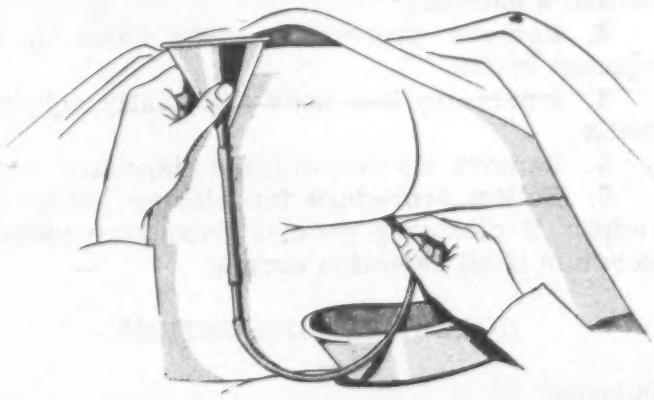

Figure 13-26.—Administration of retention enema

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has passed. Keep funnel full until all solution has been given.

5. Pinch tube—remove and place in curved basin—disconnect funnel and tube. Place basin on tray.

6. Leave patient on his side; do not disturb him. When giving carminative enema urge patient to retain solution for at least 20 minutes if possible.

7. Take equipment to utility room.

Care of Equipment

Same as cleansing enema.

Charting—Nursing Notes

Record time, type and amount of solution
Whether or not solution was retained
Signature

Disposable Enema Units

Types

1. Cleansing—usually contains hypertonic salt solution which acts by withdrawing fluid from the body by osmosis.

2. Retention (oil)—softens faces and eases passage without straining.

Equipment

1. Squeeze bottle of solution with prelubricated rectal tube.
2. Rubber sheet with cover.
3. Covered bedpan and toilet tissue

Procedure

1. Place patient in left Sim's position.
2. Place covered rubber sheet under patient's buttocks.
3. Remove protective cover from tip of squeeze bottle.
4. Insert tip into anus and gently squeeze bottle.
5. Remove tip and discard disposable unit.
6. Follow procedure for placing patient on bedpan if cleansing enema. Encourage patient to retain if oil retention enema.

COLOSTOMY IRRIGATION

Purpose

To remove faces from the large intenstine.

Equipment

Same as for cleansing enema except—
1. Use smaller tube, Nos. 18 to 22 French Catheter or rectal tube.
2. Normal saline or water, 500 to 750 cc. at 100° F.
3. Add dressing tray and curved basin.
4. Paper bag.

Preparation and Care of Equipment

Same as for a cleansing enema.

Procedure

1. Screen patient; tell him what you are going to do.

2. Turn the patient on the side of his colostomy.

3. Place a covered rubber sheet on the bed under the colostomy.

4. Remove the dressing; place it in the paper bag.

5. Place the second curved basin under the colostomy opening.

6. Introduce lubricated catheter about 4 inches into the colostomy opening, hold the tube in place with the left hand.

7. Raise irrigating can 10 inches above the colostomy.

8. Allow solution to flow slowly until all has been given, then pinch and remove the tube.

9. Leave curved basin in place until return flow stops.

10. Open dressing tray, clean wound with soap solution, apply dressing.

NOTE: Be gentle and tactful with this patient, particularly if the colostomy is a recent one. He has to become accustomed to this new situation in which he has no control of his bowel movements and he has fears of possibly offending and embarrassing himself and others. Reassure and encourage him. The colostomy can be regulated in almost the same way as the rectum but it takes time, patience, attention to diet, and the complete cooperation of the patient and all personnel.

PROCEDURES RELATING TO THE UROGENTIAL TRACT

The treatments relating to the urogenital tract are prescribed in order to cleanse the

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Female Patient

Purpose, equipment, and preparation of equipment, same as for male patient. To equipment, add 1 sheet and drop light.

At Bedside

1. Screen patient; tell her what you are going to do.
2. Drape sheet diagonally over patient. Fan-fold bedding to foot of bed.
3. Draping: Fold back corner (2) to groin. Wrap corners (3) and (4) around patient's right and left feet, leaving the genital area exposed (fig. 13-28).
4. Place a covered rubber sheet under patient's buttocks.
5. Place tray on bed between patient's legs, unsterile basin to one side of tray; place drop light to give best light.
6. Open tray, fold back tray cover to patient's buttocks.
7. Put on sterile gloves.
8. Separate labia with left hand.
9. Cleanse labia, urinary meatus, perineum with cotton balls of soap solution. Follow with sterile water. Use each cotton ball once, always wiping from labia to perineum and off. Discard cotton into unsterile basin.
10. Place sterile basin close to buttocks.
11. Pick up catheter, lubricate tip, hold other end of catheter between third and fourth fingers.
12. With other hand separate labia, locate meatus.

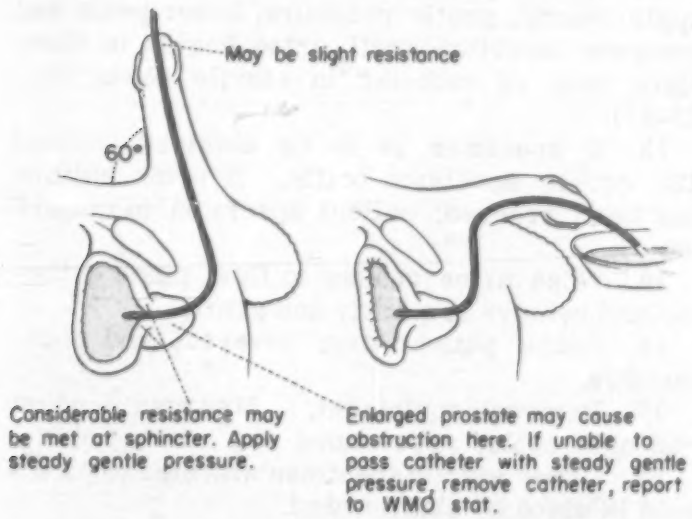

Figure 13-27.—Insertion of catheter.

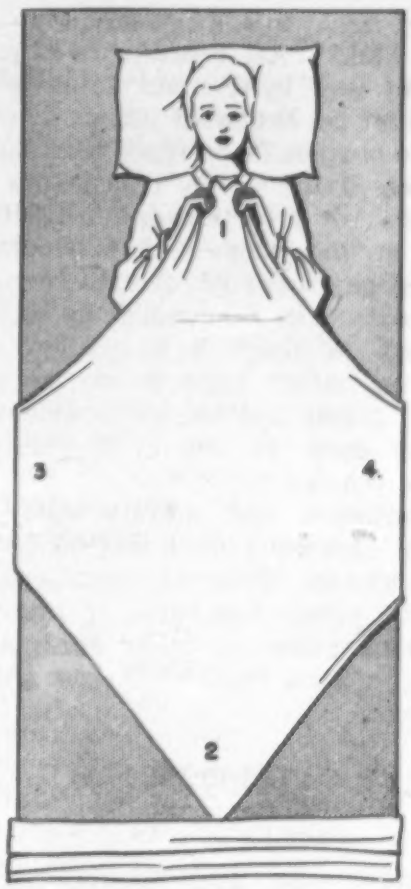

Figure 13-28.—Draping the patient.

13. Insert catheter gently (1 1/2 to 2 inches) until urine begins to flow. Place end of catheter in basin.
14. If specimen is to be obtained, collect about 120 cc. directly into specimen bottle. If urine culture has been ordered, collect specimen in culture tube.
15. Pinch and remove catheter when urine flow stops.
16. Leave patient dry, covered, and comfortable.
17. Clean equipment and return to CSR for sterilization.

BLADDER INSTILLATION

Purpose

To treat the bladder with an antispetic solution.

Equipment

Catheterization tray, plus:
- Medication in sterile container
- Sterile syringe barrel

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Procedure

1. Follow procedure for catheterization through removal of urine.
2. Attach syringe to catheter.
3. Pour medication into syringe.
4. When all medication has passed through catheter, pinch and remove catheter.
5. Proceed as in catheterization.

Charting—Nursing Notes

Record: Time; treatment; amount, color, appearance, and odor or urine obtained; complaints of patient—if specimen was obtained. If bladder instillation was performed—state name, strength and amount of solution instilled. Signature.

INDWELLING OR RETENTION CATHETER

The doctor inserts a retention catheter. The corpsman is responsible for the preparation of the patient and equipment and for keeping a record of intake and output.

Purpose

To provide constant drainage of urinary bladder, following surgery when patient is incontinent of urine, or is having difficulty in voiding.

Types of Catheters Used (Fig. 13-29).

MUSHROOM.—The mushroom catheter has a small bulb near the tip. The catheter is stretched over a metal director and inserted. When director is removed, small bulb reforms in bladder, holding catheter in place. This catheter is inserted by the doctor usually in the treatment room or operating room.

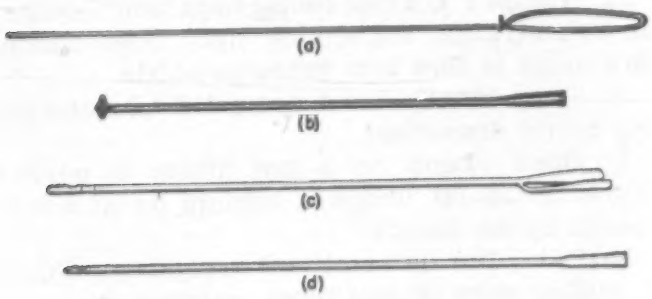

Figure 13-29.—(a) Catheter director; (b) Mushroom catheter; (c) Foley catheter; (d) French catheter.

FOLEY.—The Foley catheter is a double lumen catheter; one opening is for drainage, other opening is to small balloon at tip of catheter which is inflated with 4 cc. sterile water after it is inserted into bladder. Screw clamp is then applied to this opening and is not released until catheter is to be removed.

FRENCH.—A French catheter is a straight catheter. It is fastened by placing adhesive tape along one side of the shaft of the penis, wrapped about the catheter, and fastened on the other side of the penis. Two strips of adhesive are then placed around the shaft of the penis in the manner illustrated (fig. 13-30).

Equipment

All equipment for catheterization, plus—

For Foley catheter:
- Sterile catheter
- Sterile solution basin
- Sterile water
- Sterile 10 cc. syringe
- Screw clamp

For Mushroom catheter:
- Sterile catheter
- Sterile metal director
- Sterile drainage tubing and connecting tip
- Gallon drainage bottle
- Rubber band and safety pin
- Adhesive tape
- Bandage

Procedure

1. Follow procedure for Catheterization.
2. Connect catheter to drainage tube (see simple drainage).

BLADDER IRRIGATION

Purpose

To wash out the urinary bladder, to cleanse the area of sediment, bacteria and their products, pus and excess mucus; to relieve inflammation; to control bleeding.

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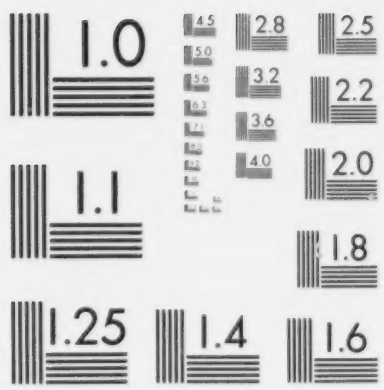

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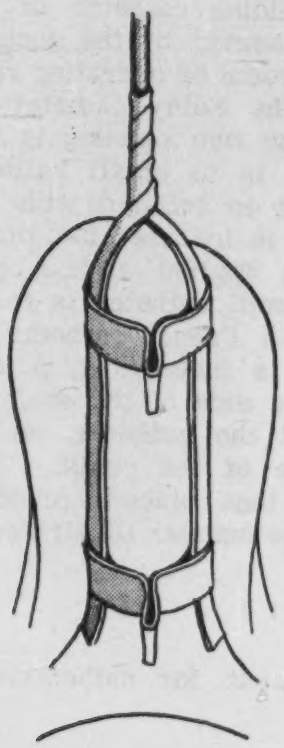

Figure 13-30.—Retention catheter in place.

METHOD I—INTERMITTENT IRRIGATION

Equipment

Catheterization tray
Sterile pitcher
Sterile glass funnel or syringe barrel
250 to 400 cc. sterile solution at 100° F.
Curved basin

Procedure

1. Follow procedure for catheterization through removal of urine.
2. Attach funnel to catheter.
3. Place curved basin under funnel connection.
4. Pour solution slowly along the side of the funnel until 75 to 100 cc. have been given.
5. Invert funnel and allow solution to drain into curved basin.
6. Repeat steps 3 and 4 until all solution has been used.
7. If catheter is to be removed, follow catheterization procedure; if retention catheter is in place, reconnect with drainage tubing.
8. Measure and chart returns of irrigation. Color? Muscus? Pus? Bloody? Cloudy? What was the effect on the patient?

METHOD II—CONTINUOUS IRRIGATION

Equipment

Sterile:
1,000 cc. solution in sterile bottle
Rubber tubing; one 4-foot length, one 2-foot length, and one 1 1/2-foot length.
Connecting tips; one Y tube, one straight tube
Gallon bottle
Two-hole rubber stopper with 2 short pieces of glass tubing
Drip regulator
Airway needle

Unsterile:
Standard
Elastic band, safety pin, and 2 clamps.

Procedure:

Preparation of Equipment

1. Insert two-hole stopper into gallon bottle.
2. Place one clamp on 1 1/2-foot tubing. Close clamp.
3. Insert drip regulator into solution bottle. Attach 4-foot tubing to regulator and to one prong of Y tube (fig. 13-31).
4. Connect 2-foot rubber tubing to drainage bottle and other prong of Y tube.
5. Connect 1 1/2-foot tubing to straight of Y tube.
6. Hang bottle on standard. Release clamp on 4-foot tube. Allow solution to run through tubing until all air is removed. Close clamp.

Irrigating Procedure

1. Explain procedure to the patient.
2. Attach 1 1/2 foot tubing to patient's catheter with straight connecting tip. Open clamp, allow urine to flow into drainage bottle.
3. Loop elastic band around Y tube and pin to patient's drawsheet.
4. Open clamp on 4-foot tubing to permit a flow of 40-60 drops a minute or at a rate ordered by the doctor.

NOTE: For intermittent irrigation—Pinch off outflow tube (2-foot tube), release clamp on inflow tube (4-foot tube), allow 50-100 cc. (doctor's order) to flow into bladder. Close clamp. Release outflow tube. This step is repeated as ordered by the doctor. With the doctor's

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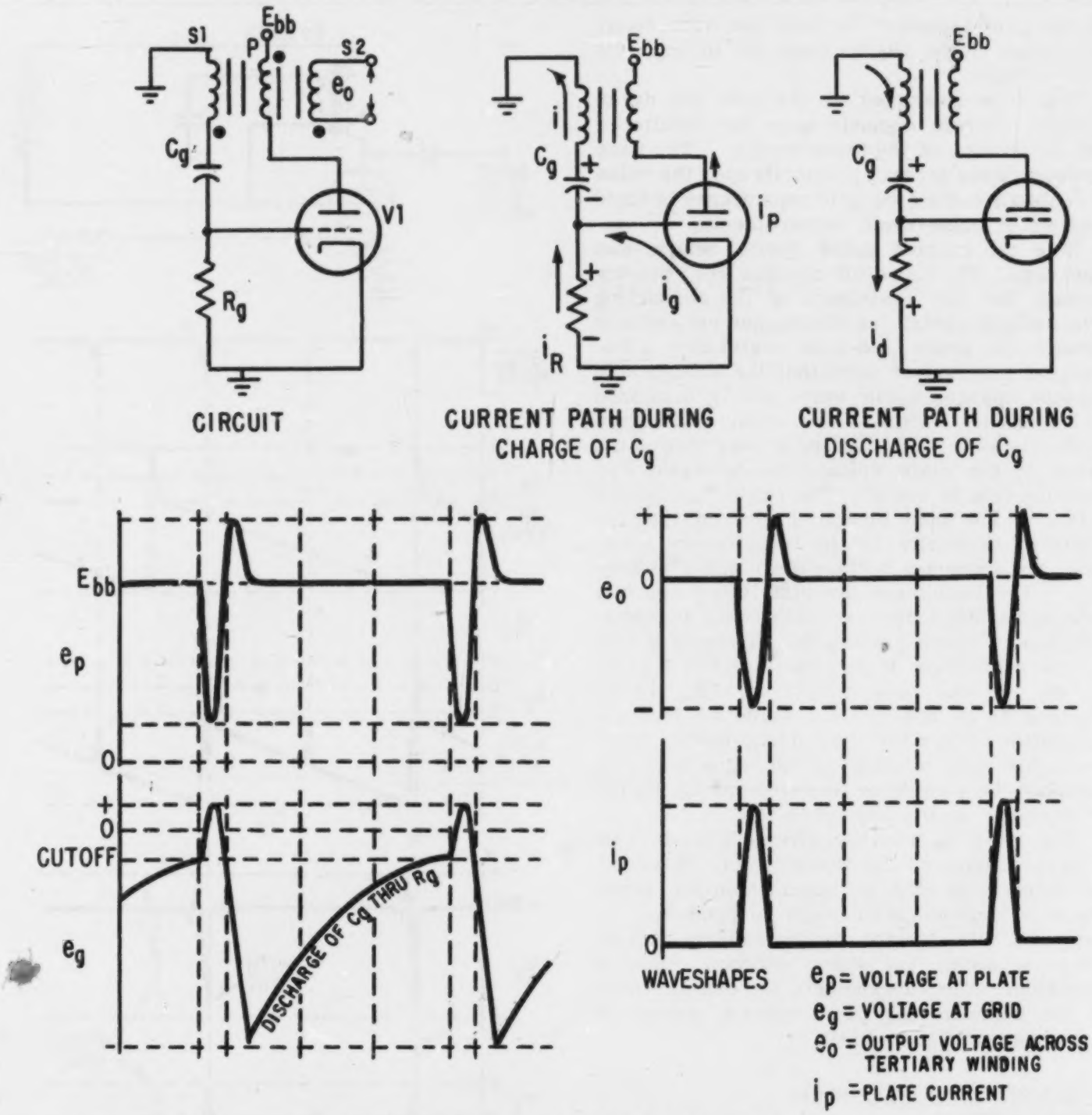

Figure 14-1. —Single-swing blocking oscillator.

and the magnetic field of plate winding P becoming stationary with respect to the secondary.

At this time there is no induced voltage in the grid winding and, because there is no charging potential applied, the capacitor begins to discharge. This discharge causes the potential on the grid to become less positive, thereby causing less plate current to flow in the plate winding. The field around the plate coil starts to collapse. This collapsing field, in turn, induces a voltage in the grid winding in the reverse direction, causing the grid to become more and more negative. This process continues until the grid is driven beyond cutoff, thus completing a cycle of operation. Oscillation does not start again immediately, however, because the flow of grid current when the grid was positive has built up enough charge

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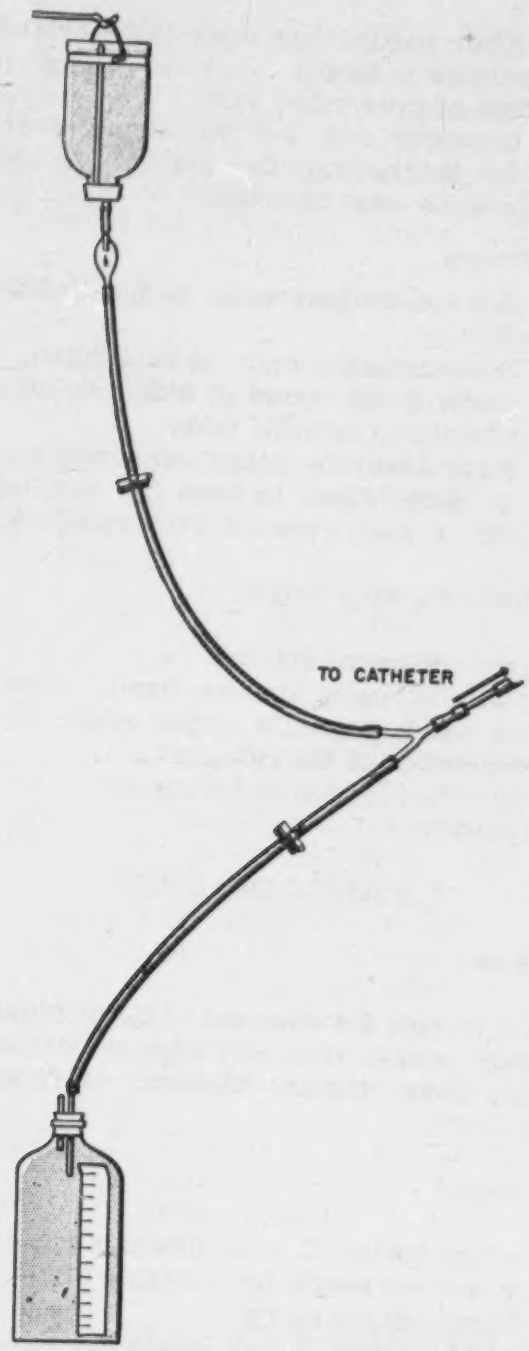

Figure 13-31.—Bladder irrigation.

permission, the patient may be taught to do it himself.

TIDAL DRAINAGE (MODIFIED LINDSEY)

Purpose

To promote muscle tone in the urinary bladder through the alternate filling and emptying of the bladder.

To remove irritating products of inflammation and urine decomposition by continuous or frequent irrigation.

General Information

The height of the tube assembly as measured above the symphysis pubis of the patient determines the amount of pressure that will be attained within the patient's bladder. If the patient becomes distended or complains of pain before drainage starts, the assembly is too high; if the bladder is being emptied too frequently, the assembly is too low on the standard. When the pressure within the patient's bladder and within the test tube assembly are equal, the small tube will float, causing the syphon to start and the bladder to drain. When the bladder is drained the small test tube comes to rest and the cycle is repeated.

Equipment

All equipment listed for method II of bladder irrigation, plus the following which may be assembled and autoclaved by CSR (fig. 13-32):

- Test tube 13 x 120 mm.
- Test tube 25 x 150 mm.
- L-shaped glass tubing 6-mm. bore
- Straight glass tubing 6-mm. bore
- Two-holed rubber stopper No. 5
- Rubber tubing, 2-foot
- Adhesive

Preparation of Equipment in CSR

1. Cut a groove—1/8 inch wide by 1/8 inch deep—connecting the two holes in the underside of the rubber stopper. (See fig. 13-32).
2. Insert straight glass tubing through stopper for 2 1/2 inches. Insert L glass tubing through stopper so that it is flush with the surface of the stopper.
3. Place small test tube over straight glass tubing.
4. Make a small hole near the base of the large test tube.
5. Insert the stopper assembly into the large test tube. Autoclave.

Preparation of Equipment on Ward

Equipment is assembled the same as for Method II except:

1. Drainage bottle is connected to the straight glass tubing of the Lindsey set.

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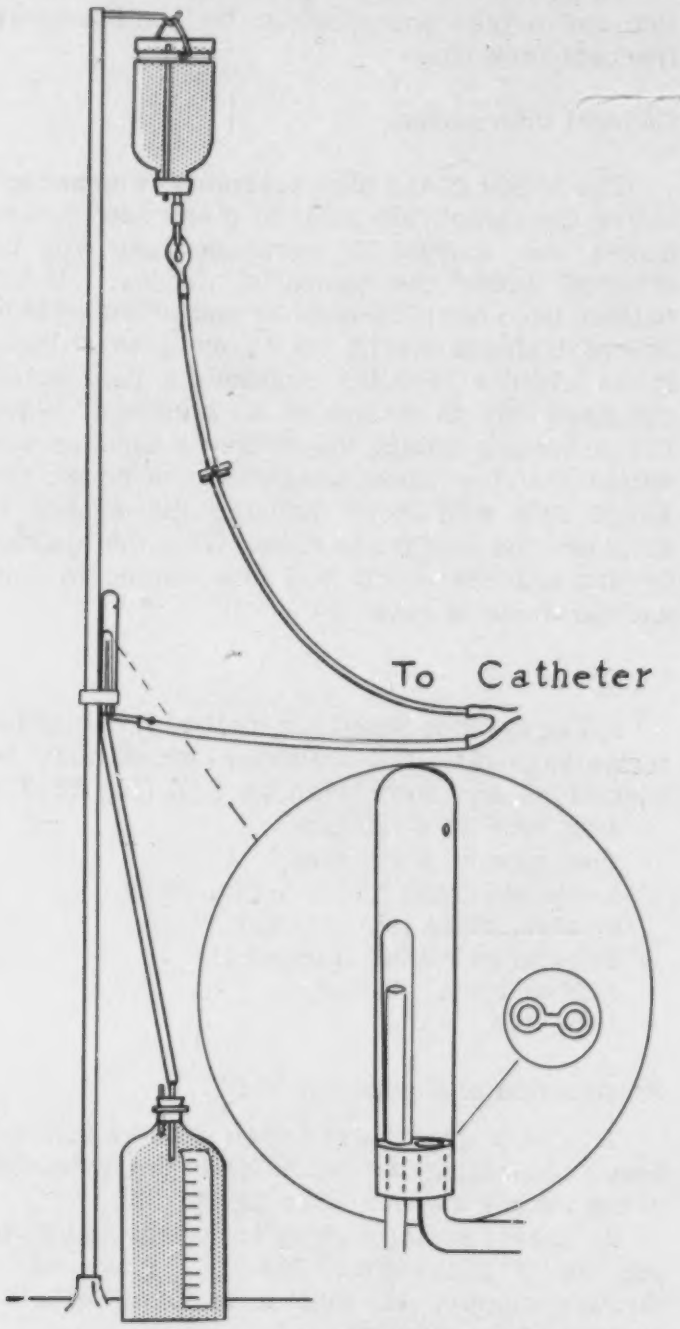

Figure 13-32.—Tidal drainage (modified lindsey)

Procedure

1. Tape Lindsey set to standard at such a height that the top of the small test tube is about 2 inches above the symphysis pubis of the patient. Clamp tube leading to catheter.

2. Allow solution to flow through tubing until all air is removed. Clamp tube from solution bottle.

3. After patient has been catheterized, attach catheter to tubing. Release clamps; regulate drops at prescribed rate.

4. Compute and record output every 12 hours by subtracting the amount of solution used from the total drainage.

Precautions

1. All connections must be handled without contamination.
2. Solution bottle must be kept filled.
3. Control the speed of inflow by adjusting the screw clamp solution tube.
4. Keep accurate intake and output records.
5. If Kelly flask is used for solution, the top must be kept covered with sterile 4 x 4's.

Charting—Nursing Notes

Time treatment started
Total drainage; amount, name, strength of solution used; patient's output every 12 hours
Description of the returns
Patient's reaction to treatment
Signature

SIMPLE DRAINAGE

Purpose

To provide for removal of fluids from wound or body cavity, when drainage is desired from wound, from urinary bladder, or from other body cavity.

Equipment

Gallon bottle, 2-inch adhesive tape, and ink or colored pencil for marking bottle
Glass connecting tip
Rubber tubing, 3-foot length
Safety pin
Elastic band
Two-inch bandage
Graduate

Procedure

Preparation of equipment

1. Provide for measuring fluid—
Place adhesive tape on side of bottle. Pour 500 cc. water into bottle. Mark water level with ink or colored pencil (fig. 13-33).

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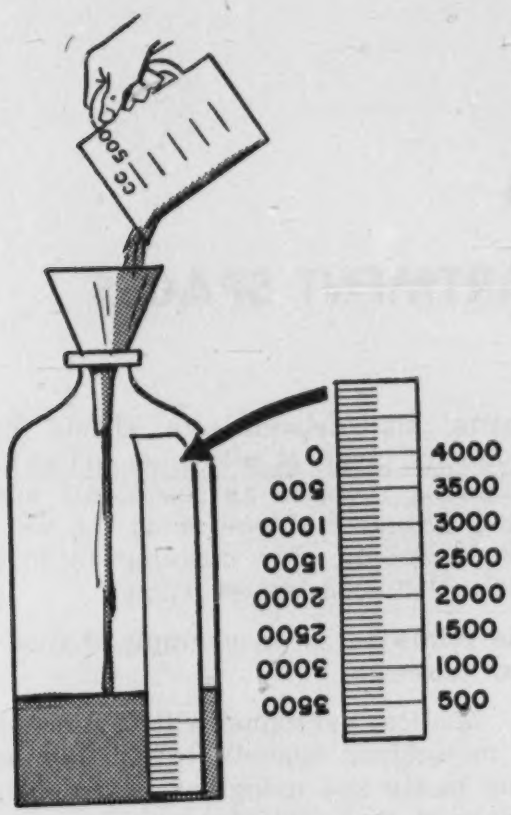

Figure 13-33.—Marking the measurement of a bottle.

Continue until 4,000 cc. is reached and marked.

Divide each space between marks evenly with four short lines. Bottle is now graded at 100 cc. levels. Empty bottle.

2. Attach connecting tip to tubing; place other end of tubing in bottle.

Preparation of Patient

1. Attach connecting tip to catheter from wound or bladder.

2. Tie drainage bottle to lower bar of bed at side.

3. Loop rubber band around rubber tubing, pin to bedding. Rubber tubing should be long enough to allow patient to move freely in bed.

During Treatment

1. Watch drainage; check amount, color, appearance, and odor.

2. Empty drainage bottle every 24 hours. Measure and record amount.

Wash bottle with cold water, warm soapy water, rinse and dry.

Care of Equipment

1. Wash and boil equipment.

2. Return equipment to proper place.

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CHAPTER 14

CLEANING MEDICAL DEPARTMENT SPACES

Every phase of patient care is important and must be understood by the corpsman. When a patient enters the hospital, he expects treatment for his ailments, and a fast return to normal health. There is nothing more discouraging to the patient or more damaging to the hospital's reputation than to have the patient contract new disease through carelessness or poor sanitary conditions. To avoid spreading disease, the hospital must be kept exceptionally clean. In addition, special cleaning procedures are required for personnel and equipment.

A hospital may be sparkling clean and still spread infections among its patients. Therefore, it is mandatory that the corpsman keep himself and his equipment as aspectic as possible. Remember, hospital facilities are never too clean.

The control of staphylococcal infections is an example of the difficult task confronting the corpsman. Some of these infections do not respond to treatment by the "wonder drugs" and are called ANTIBIOTIC-RESISTANT. This means they are very difficult, and sometimes, impossible to cure. The organisms causing these infections are found everywhere. They survive and multiply in the air, on the body, on equipment, and for that reason extinction is impossible. Control of these infections can be attained through prevention and should be the aim of every person charged with the care of patients. The corpsman can do his part to prevent bacterial growth by careful attention to a scheduled cleaning program.

The cleaning procedures should not disturb the patients more than necessary and should not interfere with their care and treatment, if avoidable. The work required should be assigned on an equal basis. The senior corpsman should remain relatively free of cleaning duties as he must supervise the cleaning and the continuing patient care.

Wards and departments should be kept scrupulously clean at all times and should follow cleaning routines as posted for each. All cleaning should be done using the wet disinfectant technique; dry cleaning is forbidden. This is called good housekeeping.

The following is an example of good cleaning procedures:

1. Medical personnel will continuously observe meticulous aspectic techniques including washing hands and using hexachlorophene soap after care of each patient.

2. Staff personnel will not change from civilian to duty uniforms in patient areas.

3. Particular emphasis on clean clothes, hands, nails, and skin.

4. Staff personnel who acquire a skin or respiratory infection will be relieved of patient care duty until the infection clears.

5. Patients who have skin infections will not be permitted to take tub baths. Showers, using hexachlorophene type soap and water, are considered more effective.

6. When removing dirty linen, handle it gently. Do not inventory soiled linen on ward.

7. Plastic or rubber mattress and pillow covers should be disinfected after each patient use. Blankets should be sent to the laundry after each patient use.

8. Waxed paper bags should be pinned to the patient's bed for disposal of tissues.

9. Bath basins, bed pans and similar equipment should be cleaned with disinfectant and sterilized after use.

10. Treatment carts are not used on wards.

11. Trash and garbage cans are kept covered. They are collected, cleaned, steamed, and returned on a regular schedule.

12. Ward and adjacent spaces and equipment are cleaned on a routine schedule using

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a cleaning solution composed of concentrated cleaner diluted with water. To mix the solution, follow instructions on the concentrate container. Using the proper strength of solution, follow the cleaning schedule for the ward. NEVER USE A DRY CLOTH OR SWAB.

a. Decks, lockers, cabinets, counters, shelves, refrigerators, fixtures, air filters, and bedside equipment should be cleaned daily, or more often if necessary.

b. Walls, ceilings, passageways, etc., should be cleaned at least weekly.

c. Treatment and food service items, instruments and utensils, are cleaned and sterilized after each patient use.

d. If a scouring powder must be used, be sure the surface is rinsed clean before allowing to dry.

e. Remember, any procedure that creates or distributes dust will not be used.

f. Areas housing patients with communicable diseases require special precautions for personal and area cleanliness. These precautions should be in addition to the routine procedures, and should be strictly adhered to.

g. Field day is designated to put the extra sparkle to the spaces and should not replace any part of the routine cleaning procedures.

h. Cleaning gear should be properly stowed when not actually in use.

i. The hospital maintenance force will supply clean swabs, cloths, etc., on a daily exchange basis.

SAMPLE CLEANING SCHEDULES

Daily Cleaning

Floors:

1. Sweep down after meals, using sweeping compound. Wet-mop stone, unpolished wooden and linoleum floors.
2. Buff floors each morning.
3. Scrub shower and head floors each a.m. and p.m.
4. Scrub galley floor each a. m. and p. m.

Bedside Units:

1. Damp-dust lockers, beds, chairs, lamps, window sills each a.m.
2. Line up beds, chairs, lockers each a.m., p.m., p.r.n.

Service Rooms:

1. Clean sinks, hoppers, working surfaces each a.m. and p.m.
2. Mop floors each a.m. and p.m.

Weekly Cleaning

Monday:

1. Routine daily cleaning.
2. Damp-dust vents, signal buzzers. Dust electrical fixtures.
3. Clean radiators, electric fans.
4. Clean wheel chairs and special equipment.

Tuesday:

1. Routine daily cleaning.
2. Wash beds, springs, and matresses, chairs, inside and outside of lockers.
3. Polish bright work.

Wednesday:

1. Routine daily cleaning.
2. Dust screens with a brush.
3. Wash windows and venetian blinds.
4. Dust walls with cleaning cloth attached to a long-handled broom.

Thursday:

Field day—any day before inspection.

1. Routine daily cleaning—wax floors. (Exception: orthopedic wards.)
2. Clean medicine lockers, cabinets, desks, cupboards.
3. Wash stretchers, wheel chairs, irrigating stands, screens, overbed tables.
4. Clean gear lockers, racks. Mops should be "twirled and spread out" to dry (in sun if possible). Clean brooms and dust pans.
5. Check all cleaning details.

Friday:

1. Routine daily cleaning.
2. For captain's inspection, open lockers, cabinets, desk drawers. Align beds, chairs, lockers. Open windows evenly; line up venetian blinds or shades.

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Saturday and Sunday:

1. Routine daily cleaning.
2. Ward routine and cleaning schedules may be modified in different stations due to local conditions.

SAMPLE ROUTINE FOR INSPECTION

Ward is in order and all patients are present unless excused by ward medical officer.

Ward medical and nurse officers and senior corpsmen stand at entrance to the ward. Other personnel continue with assignments.

Duties of Senior Corpsman:

1. Stand at entrance to ward equipped with a flashlight, ward keys, and hand towel dampened with water at one end.

2. On arrival of the inspection party, call the ward to attention.

3. Precede the inspection party; turn on lights, open doors as the party progresses through the ward.

a. Adjust the pace of the inspection to the desires of the inspecting officer.

b. Offer the dampened towel for the inspecting officer's hands when needed.

c. Be prepared to answer questions concerning the patients and the ward.

d. Be attentive to all suggestions made by the inspecting officer.

e. Escort the inspection party to the exit of the ward.

4. When the inspecting party has left the ward, announce "carry on". Continue with ward routine.

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on the grid capacitor to hold the tube cutoff until some of the charge leaks off through the grid resistor.

The time consumed by the rise and decay of plate current depends upon the inductance and resistance of the transformer. The time between pulses depends primarily upon the value of resistance since the grid capacitance is fixed because of pulse-width requirements.

Note the current paths during charge and discharge. The capacitor charges very quickly through the low resistance of the conducting grid-cathode circuit but discharges very slowly through the large grid-leak resistance. The rounded waveshapes show that the voltage and current changes occur more slowly than in a multivibrator. This is due to the inductance in the transformer. The inductance also is the cause of the plate voltage rising above E_{bb} when the tube is cut off. The current continues to flow in the same direction as it charges the distributed capacity in the transformer windings, and causes a voltage drop which adds to E_{bb}. The inductance and distributed capacity form a resonant circuit which tends to oscillate due to shock excitation. If the Q of this LC circuit is high, it may oscillate for several cycles. In the case illustrated (fig. 14-1), damping is at the critical value so that the oscillation occurs for about a half-cycle. Sometimes the plate winding of the transformer is swamped by a resistor to lower the Q, thereby damping oscillations very fast.

The output e_o from this circuit is taken from a third winding on the transformer. However, the output can also be taken from the plate, where a large negative pulse is produced, or from a small resistor in the cathode circuit, where a small but sharp positive pulse is available. The waveshape of the cathode pulse is the same as the plate current waveshape (i_p) shown in figure 14-1.

SYNCHRONIZED BLOCKING OSCILLATOR

The synchronized blocking oscillator shown in figure 14-2 is used as the timing oscillator in a small piece of auxiliary equipment. Normally, the set produces its own PRF independently when the oscillator is free running, as you can see in the waveshapes labeled "eg, no sync." The natural frequency for its operation is about 300 cps. However, synchronizing pulses

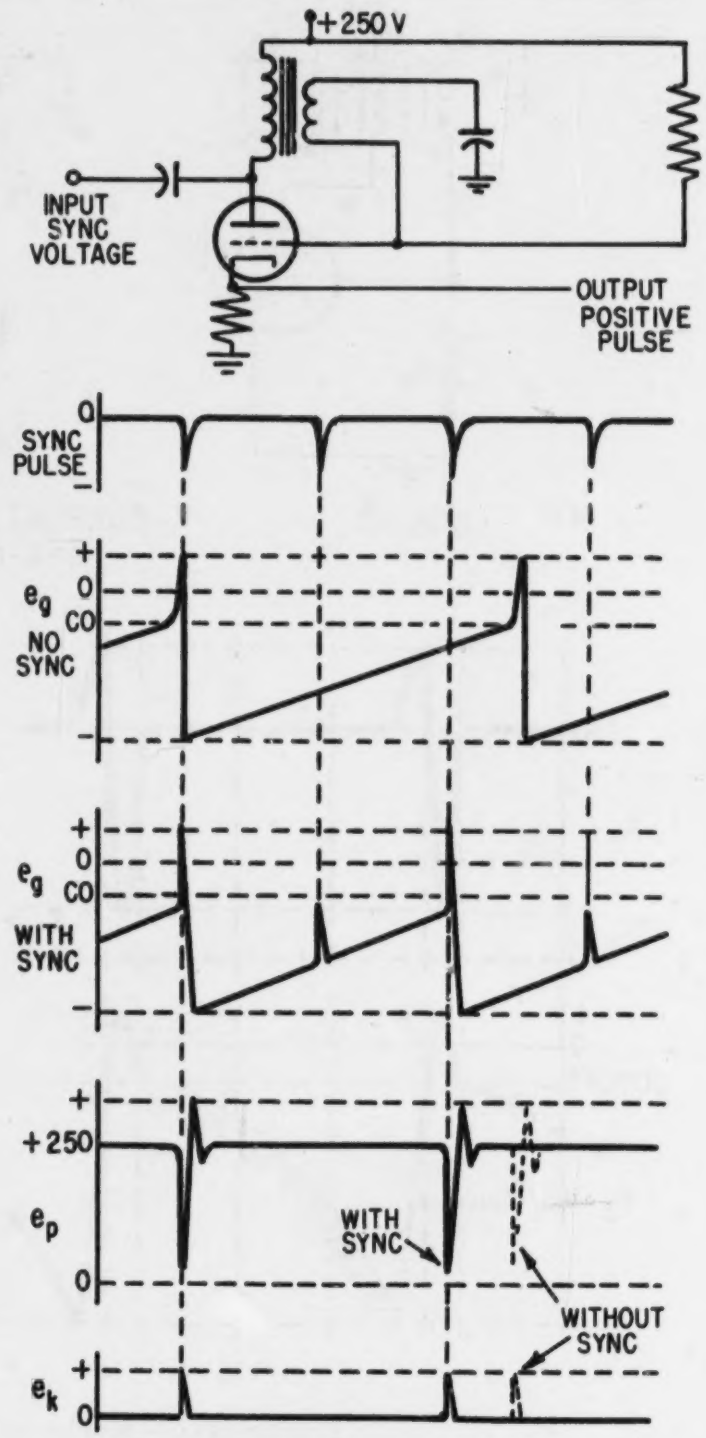

Figure 14-2.—Synchronized blocking oscillator.

can be introduced at the plate without making changes in its circuit that may vary the PRF. The synchronization pulses shown occur at 700 cps. Their amplitude is such that one pulse makes the circuit operate, the next pulse does not bring the grid above cutoff, but the

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ABSTRACT - Prepared by the Navy Training Publications Center, this manual is one of a series of training manuals to be used by enlisted personnel studying for advancement in the Air Controlman rating. Information is arranged in 14 chapters which include: (1) Air Controlman Rating, (2) Control Tower Equipment, (3) Aviation Weather Reports and Advisories, (4) Federal Air Regulations, (5) Airport Traffic Control, and (6) Radar and Allied Equipment and Procedures. Also included are definitions and abbreviations, a joint electronics type designation system, an index and a reading list. A related document is available as VT 012 769, also in this issue. (JS)

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AIR CONTROLMAN 3 & 2

BUREAU OF NAVAL PERSONNEL

RATE TRAINING MANUAL

NAVPERS 10367-D

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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PREFACE

This Rate Training Manual is one of a series of training manuals prepared especially for enlisted personnel of the Navy and Naval Reserve who are studying for advancement in the Air Controlman rating. It may also be used to improve any Air Controlman's daily working proficiency. This manual is based on the professional qualifications for the rates of AC3 and AC2 as set forth in the Manual of Qualifications for Advancement, NavPers 18068 (Series).

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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third pulse does make the tube conduct. Since the oscillator is synchronized on alternate pulses, its PRF becomes 700/2, or 350 cps. If the main radar set has a PRF of 1,000 cps and the amplitude of the sync pulses is slightly less than that shown, the blocking oscillator can be synchronized on every third cycle, and it will operate at 333 1/3 cps. By synchronizing this auxiliary set with the big set, indications received by the small set can be displayed on the main indicator, relieving the operator of observing two radar indicators at the same time.

The amplitude of the synchronizing pulse has a great effect on the frequency of this circuit. If the amplitude of the synchronization pulse shown is increased 50 percent, the first pulse that occurs after the circuit begins operation brings the grid above cutoff and the circuit is synchronized on every pulse. As stated before, a low amplitude could cause triggering on every third pulse since the first two will not have sufficient amplitude to make the tube conduct.

In each case, it is assumed that the natural period of the circuit is longer than the time between the pulses which cause the circuit to operate. If the period of the blocking oscillator is shorter, it produces long and short cycles, because the circuit is triggered on some pulses but conducts on its own accord at times.

Maximum frequency stability is achieved in this circuit by connecting the gridload resistor to the plate-voltage supply. This has the same effect as returning the grids to B plus in multivibrators. The useful output from this circuit is taken from a small resistor in the cathode circuit. This resistor has a negligible effect on the operation of the circuit but develops a voltage pulse due to the plate current flowing through it.

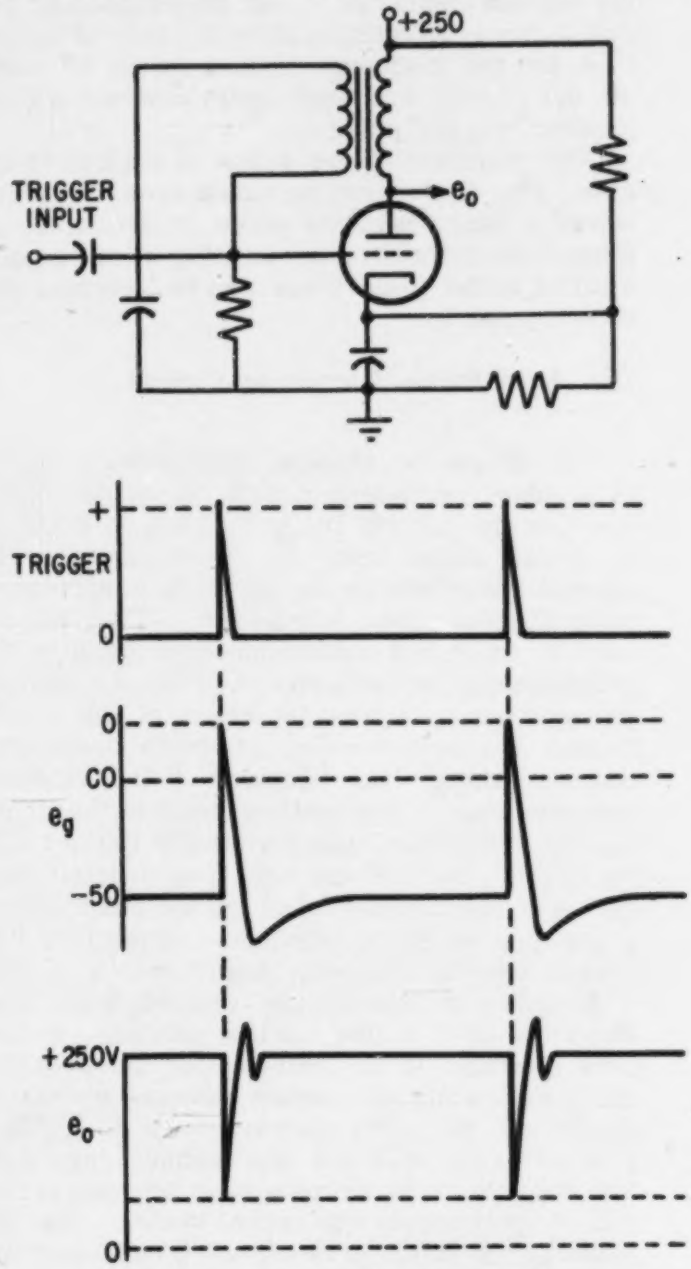

Figure 14-3.—Blocked oscillator.

DRIVEN BLOCKING OSCILLATOR

Some electronic circuits require a blocking oscillator which operates only when triggered. Such a circuit might be called a BLOCKED OSCILLATOR since a permanent d-c voltage prevents the circuit from oscillating of its own accord. In the circuit (fig. 14-3), only a positive voltage on the grid or a negative voltage on the cathode can cause the tube to conduct. If the voltage is a pulse, the circuit goes through a cycle of operation, cuts itself off, and the d-c voltage maintains it below cutoff. Cutoff is maintained by a voltage divider from the plate-supply voltage. With the values shown, the cathode voltage is plus 50 volts with respect to ground. The grid is grounded, and is therefore 50 volts negative with respect to the cathode. The grid waveshape shows voltages with respect to the cathode since these are the important voltages in understanding the circuit operation. Cutoff for most tubes used in this type circuit occurs at about minus 18 volts, so the trigger pulse must be more than 50 minus 18, or 32 volts in amplitude to start a cycle of operation. In the grid waveshape

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READING LIST

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Educational Services Officer.* The following courses are recommended:

C 151 General Mathematics I

E 275 General Science I

*"Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified on the active duty orders."

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CHAPTER 1

AIR CONTROLMAN RATING

This training manual is designed to help you meet the professional qualifications for advancement to Air Controlman Third Class and Air Controlman Second Class. The Air Controlman (AC) qualifications which are used as a guide in the preparation of this manual are current through change 3 to the current revision of the Manual of Qualifications for Advancement, NavPers 18068-B. Therefore, subsequent changes in the qualifications may not be reflected in the information given here.

Chapter 1 gives information on the enlisted rating structure, the Air Controlman rating, requirements, and procedures for advancement, and references that will help you in working for advancement and in performing your duties as an Air Controlman.

Chapter 2 presents the military aircraft designation system and general category characteristics to aid the controller in recognizing the variety in aircraft performance with which he must contend when actually controlling air traffic. Chapter 3 points out the importance of flight planning and describes handling procedures for flight plans and related aircraft movement messages. It also includes procedures affecting overdue or missing aircraft, interphone procedure, recording information on flight progress strips, and a brief discussion of NOTAMs, both civil and military. Chapter 4 contains a brief explanation of the Joint Electronics Type Designation System and types of electronic equipment used in most Navy control towers. Chapter 5 discusses basic meteorological elements that affect aviation and chapter 6 shows procedure for encoding and decoding some of the aviation weather reports used by AC's and phraseology for voice transmission of the elements. Chapter 7 deals with basic air navigation including plotting positions, effects of wind, aeronautical chart construction and use, and a use of the E-10 computer. Chapter 8 discusses air navigation aids common to most naval ATC (Air Traffic Control) facilities. Chapter 9 presents the applicable Federal Air Regulations (FAR). Chapter 10 discusses ATC communications including proper format and phraseology, and visual signals. Chapter 11 deals with airport traffic control from basic layout of the airport, through airport markings and lighting, separation of VFR (Visual Flight Rules) air traffic, and emergency recovery equipment ashore. Chapter 12 discusses procedures for controlling IFR (Instrument Flight Rules) air traffic including radar and nonradar separation minimums. Chapter 13 presents radar fundamentals, types of radar equipment used by AC's, and performance characteristics; a basic functional discussion of a RATCC (Radar Air Traffic Control Center) and a CATCC (Carrier Air Traffic Control Center), basic controller procedure and safety precautions concerning electronic equipment. Chapter 14 concerns publications, logs, and records that AC's use and maintain daily to accomplish the facility mission and that regulate the ATC function.

ENLISTED RATING STRUCTURE

The present enlisted rating structure consists of general ratings and service ratings.

General ratings identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Service ratings identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

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AC RATING

The AC rating is a general rating and is included in Navy Occupational Group IX (Aviation). There are no AC service ratings.

Figure 1-1 illustrates the path of advancement from Recruit to Master Chief Air Controlman, Warrant Officer, or Limited Duty Officer. Shaded areas in figure 1-1 indicate career stages from which qualified enlisted men may advance to Warrant Officer (W-1), and selected Commissioned Warrant Officers (W-2 and W-3) may advance to Limited Duty Officer.

The Third and Second Class Air Controlmen perform air traffic control duties in airport control towers, radar air traffic control centers (RATCC's), ground control approach (GCA) units, carrier air traffic control centers (CATCC's), and air operations offices ashore and afloat. They direct aircraft under varying weather conditions by the use of radiotelephone.

To aid in this direction, they employ such devices as radar and direction finding and identification equipment. The Air Controlman assists pilots in the preparation and processing of flight plans and clearances. Maintining current flight planning information is also a responsibility of the Air Controlman.

The Air Controlman must be conscientious and highly motivated in order to effectively perform the duties of his rating. The importance of the Air Controlman rating in the overall mission of the Navy cannot be overemphasized.

As you advance to Air Controlman Third and Second Class, more and more or your worth to the Navy is judged on the basis of the amount of effecient work you are able to obtain from the men under your supervision. The Secretary of the Navy has outlined some of the most important aspects of naval leadership in General Order Number 21.

Naval leadership is the art of accomplishing the Navy's mission through people. It is the sum of those qualities of intellect, of human understanding, and or moral character that enables a man to inspire and to manage a group of people successfully. Effective leadership, therefore, is based on personal example, good management practices, and moral responsibility.

The naval leadership program is a continuing program to develop those qualities of leadership, to the greatest extent possible, in all people within the Naval Establishment.

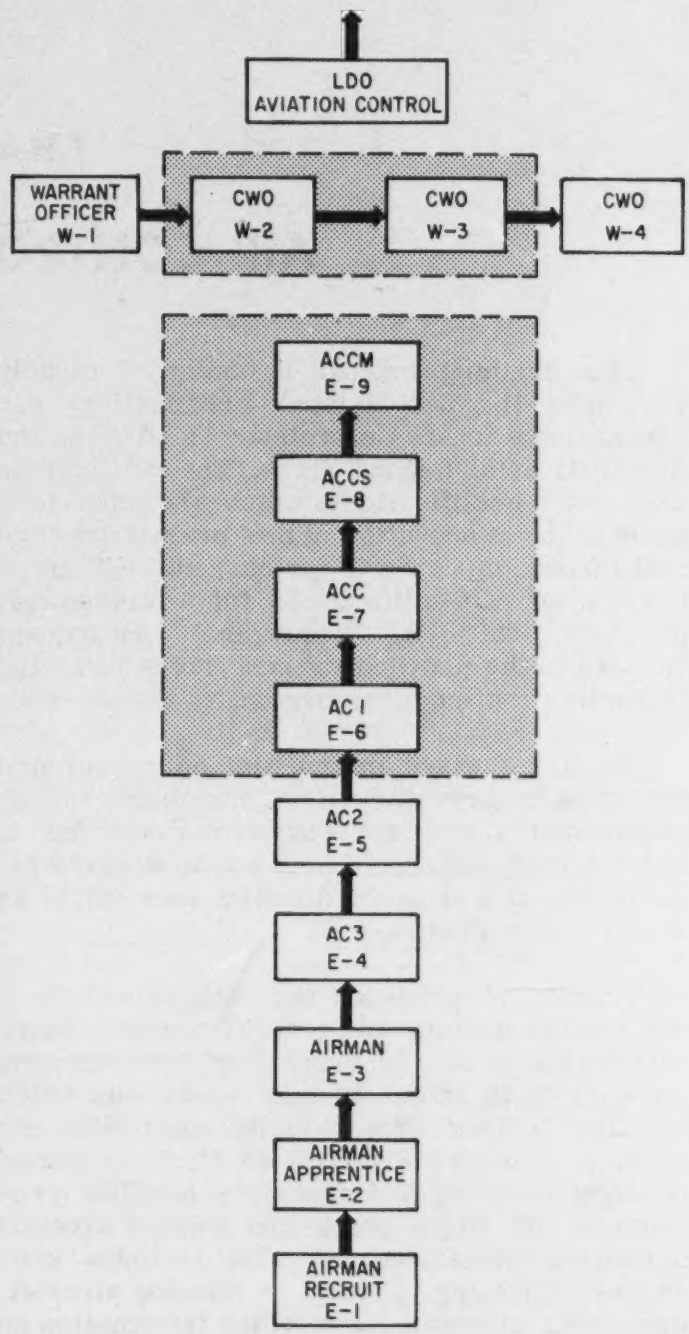

AC.1

Figure 1-1.—Path of advancement.

ADVANCEMENT

Some of the rewards of advancement are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

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The advantages of advancement are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy; and second, you become more valuable as a technical specialist in your own rating.

HOW TO QUALIFY FOR ADVANCEMENT

What you must do to qualify for advancement? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required Rate Training Manuals by either demonstrating a knowledge of the material in the manual by passing a locally prepared and administered test, or by passing the Enlisted Correspondence Course based on the Rate Training Manual.
3. Demonstrate your ability to perform all the practical requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Successfully complete the applicable military/leadership examination which is required prior to participating in the advancement (professional) examination.

Some of these general requirements may be modified in certain ways. Figure 1-2 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-3 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

Advancement is not automatic. After you have met all the requirements, you are eligible for advancement. You will actually be advanced only if you meet all the requirements (including making a high enough score on the written examination) and if quotas permit.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement? Advancement is not an overnight affair. One does not take the advancement examination and wake up in the morning in the next pay grade. There is a path or sequence of events which one must pursue. Certain things must be done or accomplished before one is admitted to the advancement in rate examination. To prepare for advancement, you will need to be familiar with the "Quals" Manual, the Record of Practical Factors, NavPers 1414/1, Training Publications for Advancement, NavPers 10052 (Series), and applicable Rate Training Manuals. The following sections describe them and give you some practical suggestions on how to use them in studying and preparing for the advancement in rate examination.

"Quals" Manual

The Manual of Qualifications for Advancement, NavPers 18068 (Series), gives the minimum requirements for advancement. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: military requirements, and professional (or technical) qualifications.

Military requirements apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all other ratings.

Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into practical factors and knowledge factors. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rate.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. Study these qualifications and the military requirements carefully. The written examination for

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	# E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3. AME 3, HM 3			Class B for AGC MUC, MNC.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
\# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

Figure 1-2.—Active duty advancement requirements.

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INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam	Standard Exam or Rating Training.	Standard Exam required for all PO Advancements.			Standard Exam, Selection Board. Also pass Mil. Leadership Exam for E-4 and E-5.		
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-3.—Inactive duty advancement requirements.

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advancement will contain questions relating to the knowledge factors and the knowledge aspects of the practical factors of both the military requirements and the professional qualifications. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

The "Quals" Manual is kept current by means of changes which occur from time to time. Never trust any set of "quals" until you have checked the change number against an up-to-date copy of the "Quals" Manual. Be sure you have the latest revision.

Record of Practical Factors

Before you can take the Navy-wide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional qualifications. A special form known as the Record of Practical Factors, NavPers 1414/1, is used to keep a record of your practical factor qualifications. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement and revised forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rate but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, NavPers 1414/1 should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-2 through E-8 for his personal record and guidance.

NavPers 10052

Training Publications for Advancement, NavPers 10052 (Series), is a very important publication for anyone preparing for advancement. This bibliography lists required and recommended Rate Training Manuals and other reference material to be used by personnel working for advancement. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be sure that you have the most recent edition.

If extensive changes in qualifications occur between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class. Remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Rate Training Manuals are marked with an asterisk (*). Any manual marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you are eligible to take the Navy-wide examination for advancement. Each mandatory manual may be completed by passing the appropriate enlisted correspondence course that is based on the mandatory training manual; passing locally prepared tests based on the information given in the training manual, or in some cases, successfully completing an appropriate Class A school.

Do not overlook the section of Navpers 10052 which lists the required and recommended references relating to the military requirements for advancement. All personnel must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance.

The references in NavPers 10052 which are recommended, but not mandatory, should also be

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studied carefully. All references listed in NavPers 10052 may be used as source material for the written examinations at the appropriate rate levels.

Rate Training Manuals

There are two general types of Rate Training Manuals. Rating manuals (such as this one) are prepared for most enlisted rates, giving information that is directly related to the professional qualifications. Basic manuals give information that applies to more than one rate and rating.

Rate Training Manuals are revised from time to time to keep them up to date technically. The revision of a Rate Training Manual is identified by a letter following the NavPers number. You can tell whether any particular copy of a Rate Training Manual is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists current training manuals and correspondence courses; you will find this catalog useful in planning your study program.)

Rate Training Manuals are designed to help you prepare for advancement. The following suggestions may help you to make the best use of this manual and other Navy training publications when you are preparing for advancement.

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the "quals" frequently as you study. Remember, you are studying the training manual in order to meet these "quals."

2. Set up a regular study plan. If possible, schedule your study for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training manual intensively, become familiar with the entire manual. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a clear picture of the scope and content of the manual. As you look through the manual in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the qualifications for advancement?

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without referring to the training manual, write down the main ideas that you have learned from studying this unit. Do not quote the manual. If you cannot give these ideas in in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Rate Training Manuals or on other appropriate texts. As mentioned before, completion of a mandatory Rate Training Manual can be accomplished by passing an Enlisted Correspondence Course based on the Rate Training Manual. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training manuals. Taking a correspondence course helps you to master the information given in the training manual, and also helps you see how much you have learned.

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10. Think of your future as you study Rate Training Manuals. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCE OF INFORMATION

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional qualifications of your rating.

Some of the publications described in this manual are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you perform efficiently or to advance; it is likely to be a waste of time, and may even be seriously misleading.

Training films available to naval personnel are a valuable source of information on many technical subjects. Films that may be of interest are listed in the United States Navy Film Catalog, NavAir 10-1-777.

In addition to the sources of information previously listed and the Reading List, there are many helpful publications issued by various departments of the Navy, Air Force and Army, and the Federal Aviation Administration. Various lists of publications, divided by general subject matter, are available through the Government Printing Office. Listings of publications issued by the Naval Air Systems Command are found in NavAir 00-500 (Series) and NavSup 2002 (Series) lists. Federal Aviation Administration publications are available through the Naval Oceanographic Office and may be requisitioned in accordance with OCEANAV Instruction 5604.1. Chapter 14 of this manual, which includes a discussion of various publications applicable to the AC rating is a good source of reference material. Additionally, publications appropriate to specific subject material are referenced throughout this training manual.

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the normal discharge of the grid capacitor reduces the grid voltage after a cycle of operation, but the discharge is to a minus 50 volts, so the circuit does not again conduct without another trigger pulse.

The positive trigger pulse is applied to the grid. The output may be taken from the plate, where a large negative pulse is available, or from a third transformer winding where a pulse similar to the plate pulse can be obtained with either polarity.

Use As a Pulse Sharpening Circuit

The driven or blocked oscillator is useful as a pulse sharpening circuit. A typical radar may use the circuit in figure 14-4 to improve the pulse shape from the phantastron. The phantastron produces the negative square wave pulse labeled input waveshape. This square wave is amplified and becomes the input to the differentiating transformer shown in the circuit. The waveshape at the secondary of the transformer is a peaked wave, as shown in the second waveshape, but because of the inherent imperfections in the trailing edge of the phantastron pulse, the peaked wave due to the trailing edge is not a sharp one. For precise triggering of the circuits following the phantastron, a sharper pulse is required. Therefore the peaked wave is applied to the blocked oscillator.

In place of the voltage divider from plus 250 volts used in the earlier circuits, a long time constant in the cathode circuit provides the cutoff voltage. After several cycles of operation, the grid current, due to positive grid voltages, charges the cathode capacitor. The capacitor discharges slowly between cycles and is recharged with each cycle. The RC combination in the grid circuit (resistance and distributed capacity) is rather short and cannot hold the grid below cutoff for the several hundred microseconds required between pulses.

The negative pulse at the leading edge of the square pulse does not affect the already cutoff tube. The positive pulse at the trailing edge causes the left tube to conduct. The current through the transformer and associated magnetic field induces a positive voltage at the grid of tube V2. This starts a regenerative action in the blocking oscillator associated with tube V2 and it goes through a normal cycle of operation. Meanwhile the pulse ends at the grid of tube V1, and with no other voltage on the grid, the tube is cut off again.

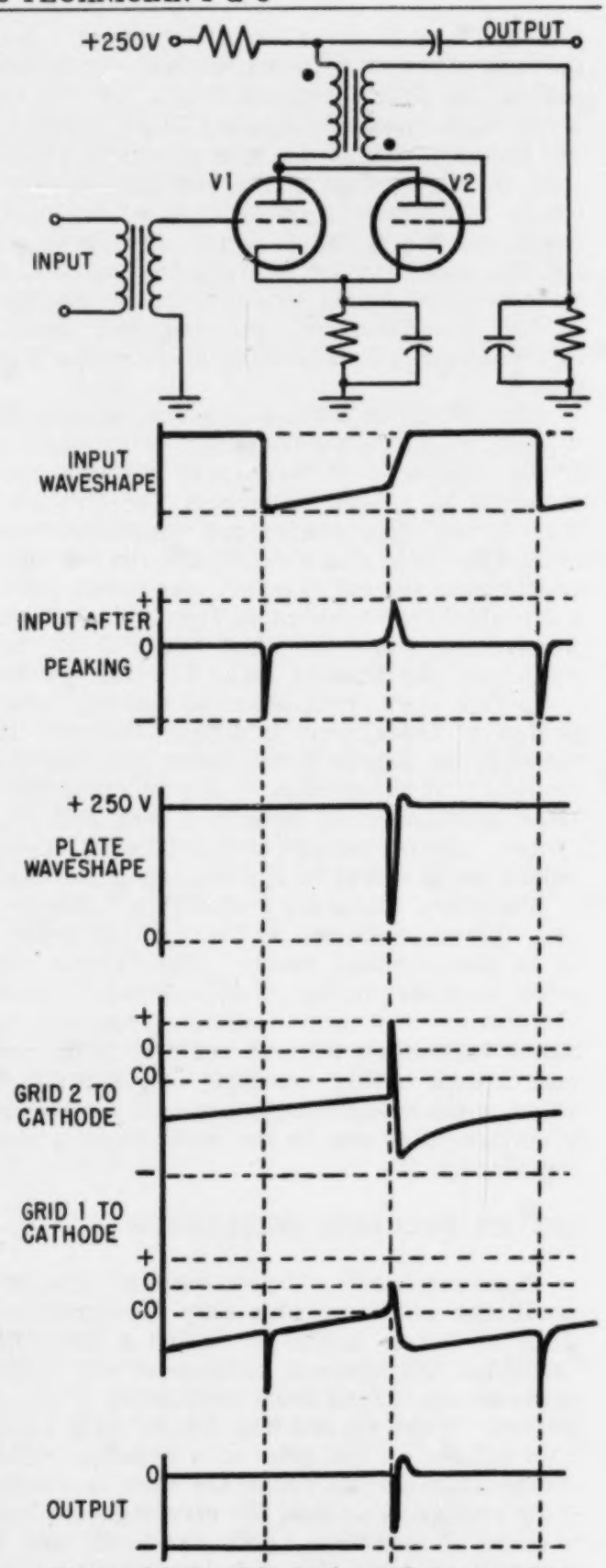

Figure 14-4.—Blocked oscillator used as a pulse sharpening circuit.

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CHAPTER 2

MILITARY AIRCRAFT DESIGNATION AND CHARACTERISTICS

Aircraft performance differences have a direct effect on the airspace needed to perform certain maneuvers such as the overhead break, turn to base leg, airspeed on final approach to land, etc.

Good landings are spawned in the approach to the runway; and although pilot technique is the major factor, correct instructions and information issued by controllers will significantly assist pilots to obtain the desired results. When landings and takeoffs are smooth or normal, orderly movements of air traffic at the airport are enhanced.

Information concerning types of aircraft is received from various sources providing flight data on expected and actual aircraft movements. The AC must be able to mentally translate this information into a workable estimate of performance characteristics upon which air traffic control instructions and information are issued. This mental process must necessarily begin with familiarity with the DOD controlled aircraft designation system, and should mature with experience and association with the various aircraft the DOD operates.

MILITARY AIRCRAFT DESIGNATION

All aircraft used by DOD agencies have been assigned designations to conform to joint regulations. The system covers all current and newly designed military aircraft, rockets, and guided missiles, and applies to all elements of the military departments.

All military aircraft are assigned designations consisting of a combination of significant letters and numbers as described in the following paragraphs and tables.

STATUS PREFIX SYMBOLS

The status prefix symbol (letter), if applicable, indicates an aircraft being used for experimentation and special or permanent test. The status letter is placed at the immediate left of the modified mission symbol or the mission or type symbol if no modified mission symbol is applicable. Examples of the use of a status prefix symbol include the X-15, which is an experimental rocket powered aircraft; the X-22A, which is an experimental vertical/short takeoff or land (V/STOL) aircraft; and the YAT-37D, which is an Air Force T-37 reworked and modified for evaluation as an attack aircraft. Status prefix symbols authorized for use are listed in table 2-1.

MODIFIED MISSION SYMBOLS

The modified mission symbol consists of a prefix letter placed at the immediate left of the basic mission or type symbol. Each military department determines the need for the assignment of such symbols. Only one modified mission symbol is used in any one designation. Some examples of the use of the modified mission symbols are as follows: QF-9G, which is an F-9 aircraft equipped as a drone, as indicated by the Q; RA-5C, which is the A-5 aircraft, (fig. 2-1) modified as a reconnaissance aircraft, as indicated by the R. Modified mission symbols authorized for use are listed in table 2-2.

BASIC MISSION SYMBOLS

A basic mission symbol (letter) is used to denote the primary function or capability of an aircraft. Mission symbols denote the mission of the aircraft. Examples of the use of basic symbols for aircraft illustrated in figure 2-1 are a P-3's mission is patrol; a T-2's mission is trainer, etc. The basic mission symbols authorized for use are listed in table 2-3.

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Table 2-1.—Status prefix symbols.

Letter	Title	Description
G	Permanently grounded.	An aircraft permanently grounded, utilized for ground instruction and training.
J	Special test, temporary.	Aircraft on special test programs by authorized organizations on bailment contract having a special test configuration or whose installed property has been temporarily removed to accommodate the test. At completion of the test, the vehicle will be returned either to its original configuration or to standard operational configuration.
N	Special test, permanent.	Aircraft on special test programs by authorized organizations on bailment contract, whose configuration is so drastically changed that return of aircraft to its original configuration or conversion to standard operational configuration is beyond practicable or economical limits.
X	Experimental.	Aircraft in a developmental, experimental stage where basic mission and design number have been designated but not established as a standard vehicle for service use.
Y	Prototype.	Aircraft procured in limited quantities to develop the potentialities of the design.
Z	Planning.	Designations used for identification purpose during the planning or predevelopment stage.

TYPE SYMBOLS

Type symbols (letters) are used to denote the type of aircraft if other than fixed wing. Where applicable, type symbols are placed immediately to the right of the basic mission symbol. An example of the use of a type symbol among the aircraft depicted in figure 2-1 is the SH-3 the H meaning helicopter, while the basic mission symbol S denotes antisubmarine. Type symbols authorized for use are listed in table 2-4.

DESIGN NUMBERS

Numbers are assigned consecutively for each basic mission or type. New design numbers are assigned when an existing aircraft is redesigned to an extent that it no longer reflects the original configuration or capability; for example, F-4, F-5, F-8, F-9, A-3, A-4, A-5, A-6, and A-7, with the numbers being the design numbers. The design number is that number assigned to a particular design; and since this joint DOD system is relatively new, it does not necessarily date aircraft presently in use. For instance, the F-9 has been in use much longer than the F-4.

SERIES SYMBOL

A letter is assigned to each series change of a specific basic design. In designating new aircraft, the series symbol is in consecutive order, starting with the letter A. The series symbol is placed immediately to the right of the design number in the aircraft designation. To avoid confusion, the letters I and O are not used as series symbols.

DESIGNATION

All aircraft designations consist of the following: Basic mission symbols and type symbols, if applicable, which denote the primary function or capability of the aircraft; a design number assigned in sequence to each aircraft intended to fulfill the mission; and a series symbol which identifies each change of a specific basic design. A hyphen (-) is always inserted between the basic mission symbol and the design number.

10 [redacted]

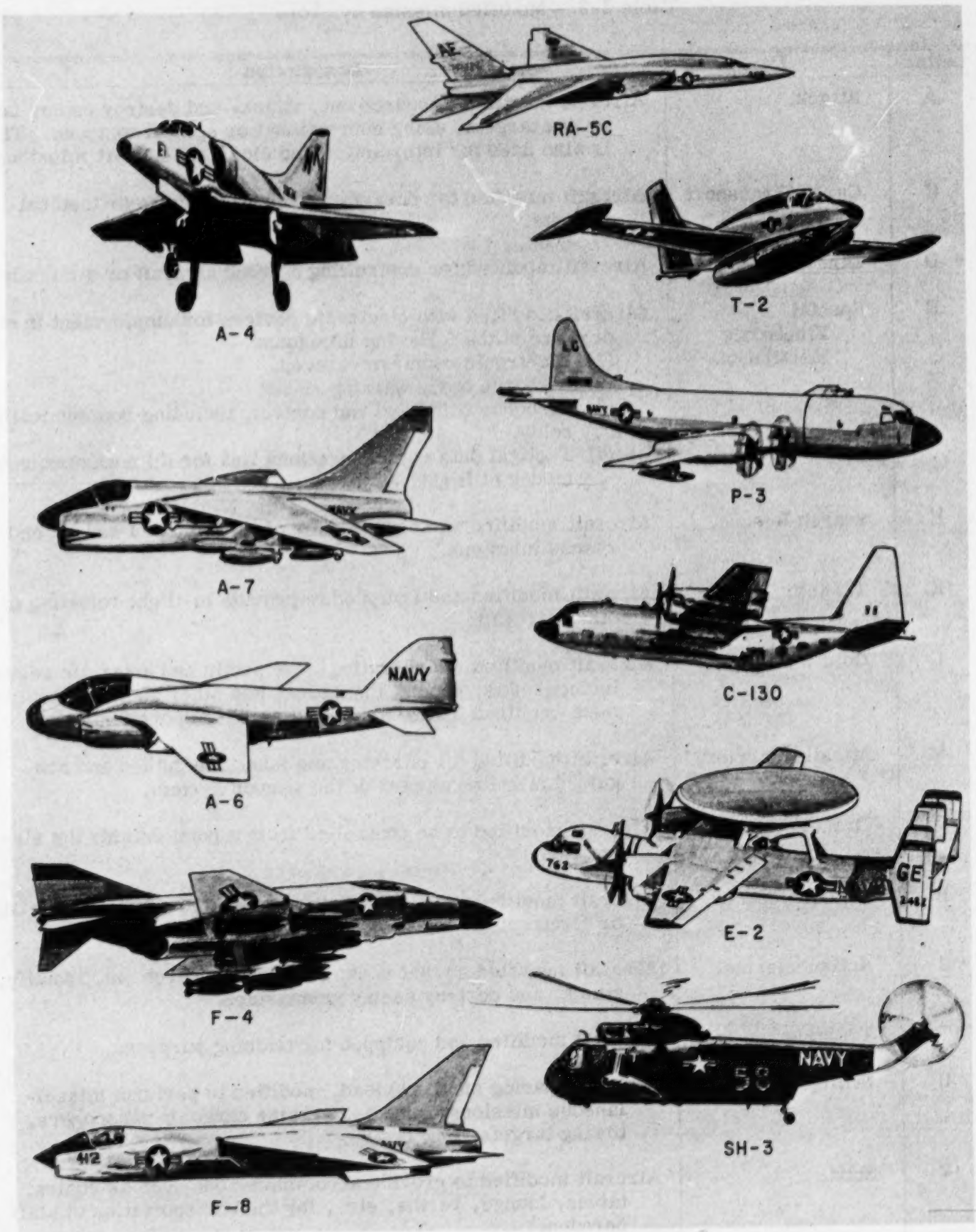

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Figure 2-1.—Military aircraft.

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Table 2-2.—Modified mission symbols.

Letter	Title	Description
A	Attack.	Aircraft modified to search out, attack, and destroy enemy land or sea targets, using conventional or special weapons. This is also used for interdiction and close air support missions.
C	Cargo/Transport.	Aircraft modified for carrying cargo/passengers or medical patients.
D	Director.	Aircraft modified for controlling a drone aircraft or a missile.
E	Special Electronic Installation.	Aircraft modified with electronic devices for employment in one or more of the following missions: (1) Electronic countermeasures. (2) Airborne early warning radar. (3) Airborne command and control, including communications relay. (4) Tactical data communications link for all nonautonomous modes of flight.
H	Search Rescue.	Aircraft modified and equipped for performance of search and rescue missions.
K	Tanker.	Aircraft modified and equipped to provide in-flight refueling of other aircraft.
L	Cold Weather.	Aircraft modified for operation in the arctic and antarctic regions; includes skis, special insulation, and other ancillary equipment required for extreme cold weather operations.
M	Missile Carrier.	Aircraft modified for carrying and launching guided and nonguided missiles as part of the weapon system.
Q	Drone.	Aircraft modified to be controlled from a point outside the aircraft.
R	Reconnaissance.	Aircraft modified and permanently equipped for photographic and/or electronic reconnaissance missions.
S	Antisubmarine.	Aircraft modified so that it can function to search out, identify, attack, and destroy enemy submarines.
T	Trainer.	Aircraft modified and equipped for training purposes.
U	Utility.	Aircraft, having small payload, modified to perform miscellaneous missions, such as carrying cargo or passengers, towing targets, etc.
V	Staff.	Aircraft modified to provide accommodations such as chairs, tables, lounge, berths, etc., for the transportation of staff personnel.
W	Weather.	Aircraft modified and equipped for meteorological missions.

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Table 2-3.—Basic mission symbols.

Letter	Title	Description
A	Attack.	Aircraft designed to search out, attack, and destroy enemy land or sea targets, using conventional or special weapons. This is also used for interdiction and close air support missions.
B	Bomber.	Aircraft designed for bombing enemy targets.
C	Cargo/Transport.	Aircraft designed for carrying cargo/passengers or medical patients.
E	Special Electronic Installation.	Aircraft equipped with electronic devices for employment in one or more of the following missions: (1) Electronic countermeasures. (2) Airborne early warning radar. (3) Airborne command and control including communications relay. (4) Tactical data communications link for all nonautonomous modes of flight.
F	Fighter.	Aircraft designed to intercept and destroy other aircraft and/or missiles (includes multipurpose aircraft also designed for ground support missions). For example, interdiction and close air support.
K	Tanker.	Aircraft designed for in-flight refueling of other aircraft.
O	Observation.	Aircraft designed to observe (through visual or other means) and report tactical information concerning composition and disposition of enemy forces, troops, and supplies in an active combat area.
P	Patrol.	Long-range, all-weather, multiengine aircraft operating from land and/or water bases designed for independent accomplishment of the following functions: antisubmarine warfare; maritime reconnaissance; and mining.
R	Reconnaissance.	Aircraft designed to perform reconnaissance missions.
S	Antisubmarine.	Aircraft designed to search out, detect, identify, attack, and destroy enemy submarines.
T	Trainer.	Aircraft designed for training personnel in the operation of aircraft and/or related equipment, and having provisions for instructor personnel.
U	Utility.	Aircraft used for miscellaneous missions, such as carrying cargo and/or passengers, towing targets, etc. These aircraft will include those having a small payload.
X	Research.	Aircraft designed for testing configurations of a radical nature. These aircraft are not normally intended for use as tactical aircraft.

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Table 2-4. —Type symbols.

Letter	Title	Description
H	Helicopter.	A rotary-wing aircraft designed with the capability of flight in any plane. For example, horizontal, vertical, or diagonal.
V	VTOL and STOL.	Aircraft designed for vertical takeoff or landing with no takeoff or landing roll, or aircraft capable of takeoff and landing in a minimum prescribed distance.

In the aircraft designation A-6A, for example, the A followed by a hyphen (-) indicates that the aircraft is designed for an attack mission, as shown in table 2-3. The number 6 has been assigned to this particular design for an attack mission. The letter A following the number 6 indicates that this is the first series of this design. The designation A-6B would identify the first series change of the basic design.

Aircraft designators may be expanded to indicate an added or restricted capability by the use of one of the modified mission symbols (table 2-2) preceding the basic mission symbol. In the designation A-6B, for example, the prefix letter K placed to the immediate left of the basic mission symbol would identify the KA-6B as an A-6B which has been modified to provide in-flight refueling. When modified mission symbol E is added to A-6B, the resulting term EA-6B can be identified as an A-6B which has been modified with a special electronic installation.

A status prefix symbol may be added to the designation to indicate aircraft being used for experimentation and for special or service testing. (See table 2-1.) The status letter, if used, is placed at the immediate left of the basic mission symbol or the modified mission symbol. The designation JEA-6B would be identified as an aircraft with the same capabilities as the EA-6B but temporarily configured for a special test program; at the completion of the test, the vehicle will be returned to the original configuration.

PERFORMANCE AND MANEUVERABILITY

In addition to being able to visually identify various types of aircraft, AC's must familiarize themselves with aircraft operating characteristics. New aircraft with increased speed and performance capabilities must operate within the same airspace as older, slower aircraft. This presents a problem in all aspects of air traffic control, not only from the standpoint of faster aircraft overtaking slower aircraft but also in regard to the maneuvering area, stalling speed, rate of climb, and other factors which should govern the AC's judgment under various conditions. Since the AC often gives instructions based on visual observations of air traffic in a particular area, it is evident that mistaken calculation of aircraft performance and maneuverability characteristics could lead to confusion for both pilots and controllers.

The control tower operator issues clearances that in his opinion can be safely followed without collision hazard if reasonable caution is exercised by the pilot. The clearance issued is permissive in nature and does not relieve the pilot of the responsibility for cautious handling of his aircraft. The information and clearances issued are intended to aid pilots to the fullest extent in avoiding collisions; this goal requires correct and concise instructions based on sound judgment for an effective flow of air traffic.

Normally, single-engine aircraft (as a class) are comparatively small and require less operating space around the airport than the large multiengine aircraft. However, some of the single-engine jet aircraft do require a rather wide approach due to their high landing speeds.

Multiengine aircraft (as a class) are normally larger than the single-engine types. They require approaches that are much wider and a final approach which is much longer. Each is a separate landing or takeoff problem as they rarely perform these functions in formation; whereas, in the case of the single-engine aircraft, many landings and takeoffs are completed in formation.

It is difficult to make generalizations concerning the performance and maneuverability of various aircraft, as each type has its own set of characteristics governing its performance both in the air and on the ground. Jet aircraft as a

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type require less warmup time than reciprocating engine types. The jets are extremely uneconomical to operate on the ground and at altitudes under those for which they were designed to operate. Their landing and takeoff speeds are universally higher, many requiring the use of drogue chutes for landing and afterburners for takeoff on most present-day airfields. Field elevations and runway temperatures are vital elements in control of jet aircraft and, to a somewhat lesser degree, in the control of reciprocating engine aircraft. As an example of what effect altitude has on even a light aircraft, it may be startling to learn that an aircraft of this type which has a rate of climb of 420 feet per minute at sea level has its rate of climb reduced to 225 feet per minute at 5,000 feet. Also, the distance needed for takeoff is doubled between these two altitudes. (See fig. 2-2.) Higher temperatures and higher humidity have similar effects on aircraft performance. A high-performance jet fighter quite possibly may not operate from an airfield with short runways on a day on which high runway temperatures prevail, even though the field elevation is only moderately high. Later in the afternoon, or at night, the same fighter may be able to effect a takeoff from the same field, because the atmosphere becomes more dense during night hours as a general rule. More lift is afforded the aircraft in dense air, be it a light aircraft or a high-performance jet.

An understanding of the large quantities of fuel consumed by our present-day jet type aircraft is of great importance to the Air Controlman. Whether it be with respect to taxiing for departure, landing, or local flying, a working knowledge of the characteristics of the jet and its fuel problem will put the jet into the traffic

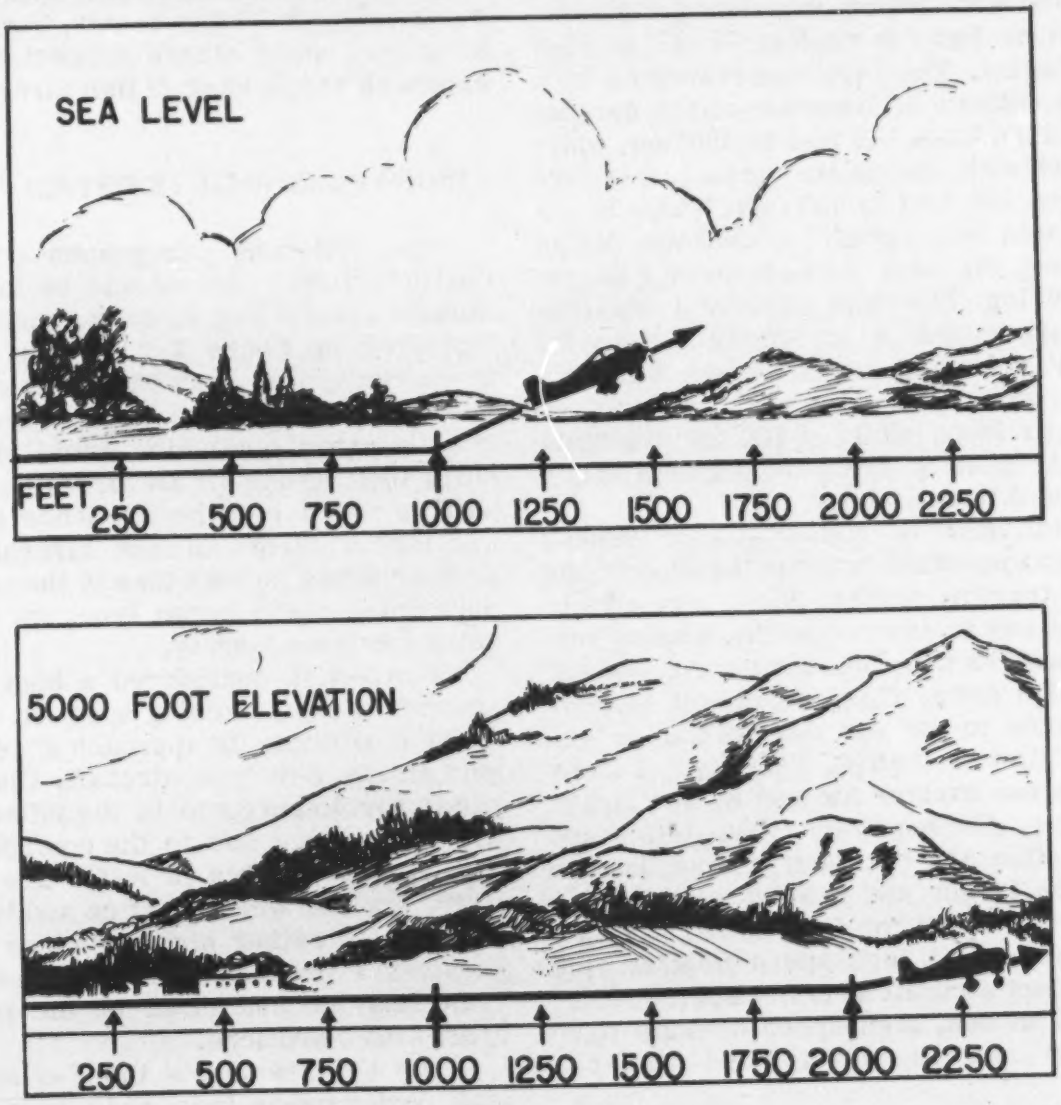

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Figure 2-2.—Comparison of takeoff distances with increased altitude.

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picture without any special priority. A jet engine consumes 10 to 20 times as much fuel as the average reciprocating engine while operating on the ground. For example, a T-33 will consume 4 gallons of fuel per minute at idling speed while on the ground. At 40,000 feet, and using 100 percent power, it consumes 4 gallons per minute and travels 6 to 7 miles.

Cognizance of the hazards to aircraft on the ground and in the air, which are caused by wake turbulence from heavy aircraft, is of the utmost importance to the Air Controlman. Large aircraft can create wake turbulence severe enough to endanger light aircraft, particularly in light wind conditions, as this turbulence may remain in the approach and landing area for several minutes. Turbulence may be encountered by lightweight and mediumweight aircraft when landing or crossing the wake of large aircraft. More detailed information concerning wake turbulence can be found in chapter 11 of this Rate Training Manual. The turbulence created by a jet aircraft without afterburner at 100 percent rpm may extend from 150 feet to 200 feet, while the same jet with afterburner may create turbulence from 300 feet to 400 feet. These areas may vary with atmospheric conditions. If the jet is moving, the area extends farther than if the jet is holding. The blast effect of a present-day large jet engine is extremely dangerous. For example, at a distance of 25 feet temperatures may reach 350 degrees with a velocity of 475 miles per hour, while at 100 feet the temperature may still be about 100 degrees with a velocity of 50 miles per hour.

The installation of high-speed or banked turnoffs is an important factor in the expeditious handling of arriving traffic. Pilots are able to clear the runway in use in a much shorter time than was possible with the earlier runway and taxiway configuration. This in turn is of tremendous assistance to the Air Controlman in expediting the flow of traffic. Taxiways at many airports are too narrow for use by our larger aircraft today. Consequently, remodeling and new construction are constantly being done to cope with the larger and heavier aircraft, as well as those planned for the future. The new taxiways have banked, high-speed turnoffs wide enough to accept aircraft at faster speeds. When installed and in use, high-speed turnoffs have been reported used at speeds up to 63 miles per hour.

The Air Controlman must remain alert to remember all of the performance and maneuverability characteristics needed to handle successfully all types of aircraft which may come under his control. As new types of aircraft are placed in service, he should immediately learn as much about them as possible.

When the pilot of a high-performance aircraft calls in for landing instructions, the Air Controlman must give the pilot a precise and correct set of instructions. These instructions should contain and be based on a great number of determinations made quickly by the Air Controlman. First of all, he has to recognize the aircraft and mentally review the performance characteristics associated with this aircraft. When the proper mental associations have been made, he is ready to give the pilot the necessary correct instructions. His mental review should be concerned with such characteristics as the aircraft's landing speed, approach patterns, runway length requirements, barometric pressure, and many others connected with the safe approach and landing of this aircraft.

AIRCRAFT CHARACTERISTICS

The following paragraphs contain certain characteristics that should be known by individuals controlling aircraft, such as those illustrated in figure 2-1. Keep in mind that memorizing the exact figures is not important, but they are used in this text to show the type of comparison a controller would make when issuing instructions. If all aircraft in your landing pattern were high performance aircraft, then spacing problems of one aircraft relative to another would be less than is the case when high performance and cargo type, for instance, are using the same runway.

The A-4 is considered a high performance aircraft with a cruising speed in excess of 500 knots at altitude. Its approach speed is comparable to the A-6 type aircraft. One problem of particular importance is the effect of a crosswind on landing due to the configuration of the landing gear. Pilots of A-4's are listening intently for the wind direction and velocity since the gear is rather high and close together and presents a problem of stability after the aircraft has touched down on the runway under crosswind conditions.

The A-7 resembles the F-8 aircraft, is a high performance type, and also cruises in excess of 500 knots at altitude. The A-7 lands rather fast with a final approach speed of

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approximately 120 knots which is comparable to the F-8 also.

The F-8 is really a high performance aircraft with the F-8D and E series capable of nearly Mach 2 (Mach 1 = speed of sound at sea level). Its adjustable wing allows it to slow down for the low and slow landing operation.

The A-6 has a cruising speed of about 420 knots but is an extremely stable aircraft at landing speed with a stall speed of about 70 knots, which is comparable to the E-2. This would allow the A-6 to mix with the slower types of aircraft without too much concern about overtaking other traffic.

The F-4 is a high performance aircraft with a maximum speed of over Mach 2. Its approach speed is about 120 knots, which is comparable to most jet fighter type aircraft. Two engines with afterburners enable it to take off in about 5,000 feet, while it has good slow down capability when back on the runway by being able to land in about 3,000 feet.

The P-3 has four turboprop engines and can take off in about 3,700 feet and climb at a rate of 1,500 feet per minute. It cruises at approximately 350 knots at altitude and has good endurance capability, being able to operate for 17 hours on two engines. It also has reversible pitch propellers which enable it to stop in a short distance after landing, for a quick turn off the duty runway.

The RA-5C is another high performance aircraft with a maximum speed of over Mach 2. Its approach speed, takeoff, and landing characteristics are comparable to the F-4.

The T-2 is a jet trainer aircraft and is fairly fast with a cruising speed of over 450 knots but with the straight wing design for more stable training operations and slower landing speeds.

The E-2 is a turboprop aircraft with a cruising speed of approximately 280 knots. It can slow down very effectively for the landing approach with a stall speed of approximately 70 knots.

The C-130 also has four turboprop engines and is a cargo type aircraft with a cruising speed of approximately 350 knots. It lands a little faster than the E-2 with a stall speed of approximately 100 knots. It can take off in about 3,500 feet and with the reversible pitch propellers can land and stop in about 2,200 feet. This enables it to clear the runway unusually fast for a large aircraft.

CHAPTER 3

FLIGHT PLANNING AND FLIGHT ASSISTANCE SERVICE

FLIGHT PLANNING

Planning is important in anything that we do. Where flying is concerned, inadequate or incorrect planning can seriously jeopardize the safety of the flight to the point of causing destruction to property, serious injury, or even disaster. As an Air Controlman, you are directly concerned in assisting pilots in the planning and proper clearance of their flights.

PREFLIGHT ACTION BY PILOTS

Federal Aviation Regulations Part 91.5 states that:

"Each pilot in command shall, before beginning a flight, familiarize himself with all available information concerning that flight. This information must include, for a flight under IFR or a flight not in the vicinity of an airport, available weather reports and forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which he has been advised by ATC."

OpNav Instruction 3710.7 (Series) also states that:

"Except in emergencies and flights of combat necessity wherein conditions do not permit, pilots shall insure that all preflight planning needed for the prosecution of a safe and properly conducted flight has been accomplished prior to carrying out any type of flight in a naval aircraft."

Although the primary responsibility for planning the safe conduct of a flight rests with the pilot in command, you as an Air Controlman, share the overall responsibility. This is accomplished by providing the most efficient service possible. Charts and publications must be available and up to date. Materials and necessary forms must be adequate and easily accessible. You must keep yourself informed about recent changes, additions, or deletions of any material or service affecting air traffic control and be ready to supply the information needed.

FLIGHT CLEARANCE AUTHORITIES

The authority and responsibility for clearance of aircraft flight at naval air stations are vested in the commanding officer. Commanding officers may delegate authority to commissioned officers, warrant officers, and aviation pilots under their command whom they consider qualified to exercise such authority. Detailed responsibilities and procedures are found in OpNav Instruction P3710.7 (Series).

Pilots having a special instrument rating are authorized to approve a flight clearance for any flight of a naval aircraft in which they fly as pilot in command or as flight leader of a formation flight.

FLIGHT CLEARANCE FORMS

The pilot in command of a naval aircraft or group of aircraft proceeding as a unit must prepare and submit a flight clearance form prior to every flight except for the following cases:

1. Flights of combat necessity.
2. Student training flights under the jurisdiction of Naval Air Training Command for which adequate flight guard is provided.
3. SAR flights when there would be undue delay in the accomplishment of the mission.

DD Form 175

A DD-175 is a military flight plan and must be used for all point-to-point and round-robin (departure and destination are the same) flights from U.S. military airfields and civil airfields at which a military operations department is located. (See fig. 3-1.)

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Tube V1 is an amplifier and isolation circuit which causes the blocking oscillator to start very soon after the trigger pulse arrives, then disconnects the triggering circuit from the blocking oscillator so it can go through its normal cycle unaffected by the triggering circuit.

The output is taken from a small resistor above the transformer in the plate lead. A sharp negative pulse of low amplitude is produced across the resistor.

COUNTING CIRCUITS

A counting circuit is one which receives uniform pulses, representing units to be counted, and produces a voltage proportional to their frequency. By slight modifications the counting circuit is used in conjunction with a blocking oscillator to produce a trigger pulse which is a submultiple of the frequency of the pulses applied.

The pulses applied to the counting circuit must have the same amplitude and time duration if accurate frequency division is to be made. Counting circuits, therefore, are ordinarily preceded by shaping and limiting circuits to insure this uniformity of amplitude and width. Under these circumstances the pulse-repetition frequency constitutes the only variable and frequency variations may be measured.

POSITIVE COUNTER

Positive pulses, which may vary only in their recurrence frequency, are applied to the input of the positive counter as shown in figure 14-5.

The charge on the coupling capacitor C1 cannot change instantaneously as the positive leading edge is applied, so the plate of V2 becomes positive and the diode conducts. A charging current flows through R1 during the pulse time and a small charge is developed on C1. At the end of the pulse the change in voltage places the diode side of the capacitor at a negative potential equal to the charge accumulated on C1.

Tube V2 cannot conduct, as its plate is negative with respect to its cathode. However, V1 conducts, discharging the small charge from the capacitor, which would otherwise build up during each succeeding positive pulse, eventually rendering the circuit insensitive to the applied pulses.

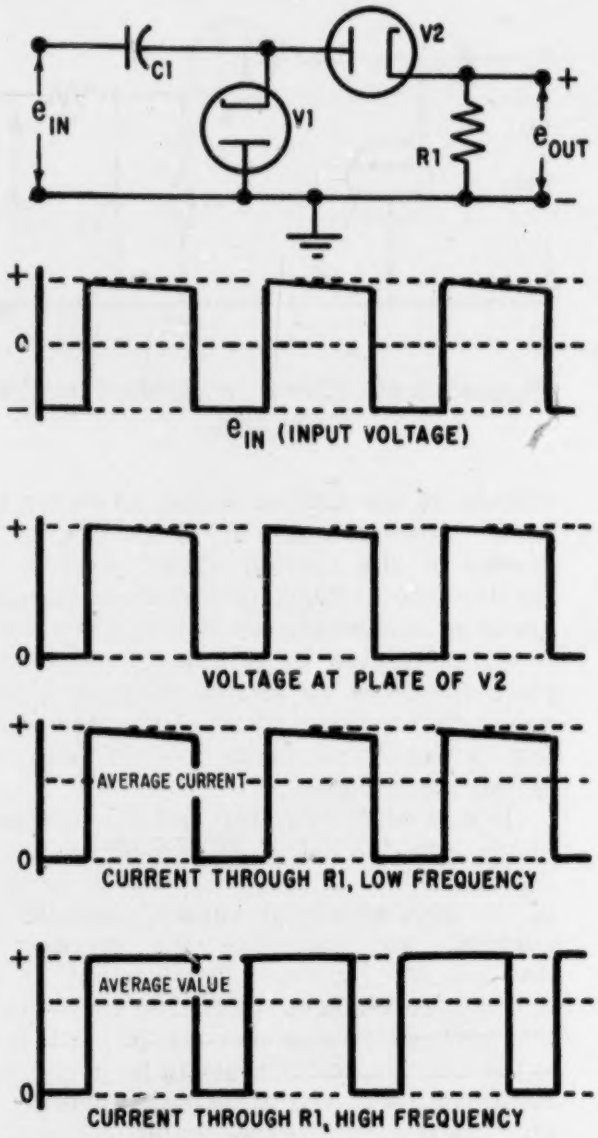

Figure 14-5.—The positive counter.

Circuit Controlled by Positive Counter

Since a certain amount of current flows through R1 each time a pulse is applied, an average current flows which increases as the pulse recurrence frequency increases and decreases as this frequency decreases. The IR drop developed across R1 can be used to control a succeeding stage as is illustrated in the circuit controlled by a positive counter (fig. 14-6).

The filter in the grid circuit of V3 aids in obtaining smooth operation by removing too rapid changes in voltage developed across R1. The voltage developed across R1 is the average

1039 1040

MILITARY FLIGHT PLAN

AIRCRAFT UNIT OF ASSIGNMENT/HOME STATION: NARTU/NAS

AIRCRAFT SERIAL NO.: 71534

TYPE OF FLIGHT PLAN: [x] IFR [ ] DVFR [ ] VFR

RADIO CALL: VV 71534

AIRCRAFT DESIGNATION/TD CODE: C118/B

ESTIMATED TRUE AIRSPEED: 180

DEPARTURE TIME (Z): PROPOSED 1405 ACTUAL

INITIAL CRUISING ALTITUDE: 6,000

POINT OF DEPARTURE: NQA

STANDARD INSTRUMENT DEPARTURE: NAME AND NUMBER / TO

IFR	VFR	ROUTE OF FLIGHT	TO	ETE
✓		MEM V16 DAL V16 S NBE	NBE	2+51

REMARKS: REQ RADEP

RANK/HONOR CODE: 5

PSGR/CARGO CODE: VIP 5N T3 Q3M AP5 NAS

HOURS FUEL ON BOARD	DIST TO DESTN	ALTERNATE AIR FIELD	ETE TO ALTN	NOTAMS	DD FORM 365F (Wt. and Bal.)	WEATHER	REQUEST CLEARANCE AFTER
8+00	540	DAL	0+15	✓	ATTACHED	✓	1330

INST RATING	SIGNATURE OF PILOT IN COMMAND	SIGNATURE OF APPROVING AUTHORITY	DATE
SPECIAL	J P Jones	U. W. Smith	8 MAY 69

CREW/PASSENGER LIST — [ ] Attached [x] See Passenger Manifest

DUTY	NAME AND INITIALS	GRADE	SERVICE NO.	ORGANIZATION AND LOCATION
PILOT IN COMMAND	JONES, J. P.	CDR	135272	NARTU, NAS ALAMEDA
CP	SLATER, M. O.	LCDR	301341	NARTU, NAS ALAMEDA

DD FORM 1 JUL 68 175 PREVIOUS EDITION OF THIS FORM WILL BE USED UNTIL STOCK IS EXHAUSTED. A-8346

Figure 3-1.—DD Form 175.

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DD Form 175-1

A DD Form 175-1 (fig. 3-2) is a flight weather briefing form completed by weather service personnel for a pilot. It is used for all point-to-point and round-robin flights. The DD-175-1 is used in conjunction with a specific DD-175 for which it is completed. The DD-175-1 need not be used on VFR flights provided that the following certification is made on or attached to the DD-175.

BRIEFING VOID (time) Z. FLIGHT AS PLANNED IS CERTIFIED VFR WITH NO DANGEROUS WEATHER EN ROUTE. VERBAL BRIEFING GIVEN.

_____
(Signature of forecaster.)

AC's should assist pilots in insuring that the weather briefing is still valid at takeoff. The weather briefing void time is normally one-half hour after estimated time of departure (ETD). Except under unusual circumstances, this should not exceed 2 hours from the actual time of weather entries on the DD-175-1. Methods of checking weather briefing void times vary between facilities, but most require that the void time be included on the flight progress strips (discussed later in this chapter) used to maintain a file of current air operations.

Local Flight Clearance

Clearance authorities may authorize the use of the daily flight schedule or an abbreviated DD-175 signed by the pilot in command, with the word LOCAL contained in the route of flight block, for clearing aircraft for flight within the established local flying area and adjacent offshore training areas provided that the following conditions apply:

1. Sufficient information is included to satisfy the needs of the local clearance authority which guards the flight.
2. Base operations maintains cognizance of each flight and is responsible for initiating any overdue action or inflight advisory service necessary.
3. Completed flight schedules are retained in base operations files for 90 days.
4. Flights are not conducted IFR within controlled airspace except as jointly agreed upon in writing between the local command and the air traffic control agency concerned.

Foreign Clearance Forms

Flights proceeding from or occurring outside the U.S. at other than U.S. military air facilities must use the flight clearance form required by foreign authorities.

GENERAL FLIGHT CLEARANCE PROCEDURES

Proper identification verifying their status must be shown by all passengers prior to being furnished air transportation. Except for ranking civilian officials, civilian passengers must present a copy of the orders authorizing travel in military aircraft and may be required to complete a Release from Claim for Injury or Death form.

Modification of a flight clearance form may be accomplished only with concurrence of the pilot in command.

Point-to-point flights may be changed to local flights by filing a local flight plan in the air after arrival over destination.

Estimated Time En Route

For the purposes of flight clearance, estimated time en route is defined in the following paragraphs.

VFR FLIGHT.—The time from takeoff to a position over the destination airfield, including known or preplanned en route delays.

IFR FLIGHT.—Total planned time from takeoff to time over the initial approach fix to be used at the destination airport, which is listed as the last fix en route on the flight plan exclusive of the time anticipated for en route delays, such as practice approaches, landings, etc. En route delays are listed in the remarks section.

STOPOVER FLIGHT.—For stopover flights, the ETE is calculated in the same manner as for VFR or IFR flights except that each stopover point may be considered a destination for the purposes of the ETE calculation. The ETE for each leg of such flights is listed on the flight plan opposite the route of flight. The following conditions apply:

1. For IFR stopover flights, each leg is listed on a separate line on the proposed flight plan along with altitude/FL, etc., necessary for obtaining an IFR clearance on subsequent legs.

FLIGHT WEATHER BRIEFING

AIRCRAFT NO.	BRIEFING NO.	DATE
71534	14	8 MAY 1969

I. TAKEOFF DATA

RUNWAY TEMP.	PRESSURE ALT.	TEMP. DEVIATION	VAPOR PRESSURE	SPECIFIC HUMIDITY	DENSITY ALTITUDE
56°F	− 130	−7°F	0.4	0.009	− 300

CLIMB WINDS: 31/15

REMARKS:

II. ENROUTE DATA

FLIGHT LEVEL	TEMPERATURE	WINDS
60	+ 2°C	30/15

CLOUDS AT FLIGHT LEVEL _____ ☐ YES ☑ NO ☐ IN AND OUT

VISIBILITY AT FLIGHT LEVEL 10 ☐ HAZE ☐ DUST ☐ SMOKE ☐ PRECIPITATION

MINIMUM CEILING ENROUTE	MAXIMUM CLOUD TOPS	MINIMUM FREEZING LEVEL
20	45	65

THUNDERSTORMS		TURBULENCE			PRECIPITATION			ICING		
✓	NONE	✓	NONE		✓	NONE		✓	NONE	
	FEW		CAT	LGT		RAIN	DRZL		CLEAR	LGT
	SCATTERED		TSTM	MOD		SHOWERS	SNOW		RIME	MOD
	NUMEROUS			SVR		FREEZING			MIXED	SVR
	HAIL								IN CLOUDS	

III. TERMINAL DATA

DESTINATION (Existing): NBE 30 ⓘ 12 3110

FORECAST: NBE E25 ⓘ 12 3215 (1700 Z TO 1900 Z)

ALTERNATE (Existing): DAL E 35 ⓘ 10 3212

FORECAST: DAL E30 ⓘ 10 3215 (1715 Z TO 1915 Z)

IV. COMMENTS/REMARKS

VOID TIME	EXTENDED TO	FORECASTER
1435		H.J. MATHEWS AGCS

V. TELEVISION/TELEPHONE BRIEFING RECORD

WEATHER FACILITY

TAPE NO.	START	STOP	PHONE CHARGE

DD FORM 1 NOV 64 175-1 D-30537

AC.5

Figure 3-2.—DD Form 175-1.

2. If an ATC clearance is required for a second or subsequent leg of a stopover flight, the pilot just advise the tie-in FSS serving the next stopover point of his estimated time of departure (ETD) from that airport to initiate a request for an IFR ATC clearance for the second or subsequent legs.

3. For all stopover flights, a VOID time is entered in remarks. Such VOID times are computed by adding the ETE for each leg of the flight and the total estimated ground time for all stopovers to the ETD as entered on the flight plan.

4. A NOTAM and weather briefing must be completed at the original departure point for the entire flight. At each intermediate stop the pilot must recheck the weather to insure that the next point of intended landing is at or above landing minimums.

5. En route stops are not authorized on a DVFR type flight in the continental U.S. They may be authorized in overseas areas depending upon agreement between naval commands, air traffic control authority, and the cognizant air defense command.

Estimated Time of Arrival (ETA)

Determining an ETA of an aircraft is simply done by adding the estimated time en route (ETE) to the actual departure time. Normally, the ETA will apply to the final destination; however, on stopover flight plans, the ETA is determined for the first intermediate stopover destination by departure station. Then the intermediate stations become departure stations upon receipt of a departure time and will determine an ETA for transmission to the next stopover or final destination as appropriate.

Mandatory Information to
Flight Service Agencies

The pilot in command of a flight is responsible for assuring that the appropriate flight service agency will be furnished with the essential elements of the flight plan as initially approved and a takeoff report. Delivery of a properly prepared flight clearance form to duty personnel at an established base operations office at the point of departure relieves the pilot of such responsibility. The local clearance authority must then insure that the appropriate flight service agency is furnished the flight plan and takeoff report by duty personnel upon acceptance of the flight clearance form.

The pilot in command is also responsible for assuring that the appropriate flight service agency will be furnished a landing report (close-out) upon arrival at destination. Delivery of a copy of an executed flight clearance form to destination base operations duty personnel satisfies this responsibility. The local flight clearance authority must then insure that duty personnel furnish the appropriate flight service agency with the landing report upon acceptance of the flight clearance form.

Handling of Flight Clearance
Forms by Naval Facilities

Original clearance and weather forms filed at departure station flight clearance offices and duplicate copies of clearance and weather forms turned in to destination station flight clearance offices must be retained for a period of 3 months, after which they may be destroyed.

Shore/Ship Operations

Prior to flight from a shore activity to a ship operating in an offshore area when a landing aboard the ship is intended, the pilot in command must file a flight plan. A DD-175 is required for IFR flight. A daily flight schedule may be used for VFR flight.

Prior to flight from a ship operating in an offshore area to a shore activity where a landing is intended, the pilot in command must file a flight plan with the ship. The ship will relay the flight plan to the shore activity. If no communications link is available, the pilot should file his flight plan with the nearest shore activity by radio as soon as possible after takeoff.

Clearing authorities, and subsequently duty personnel at base operations, are responsible for insuring timely handling of flight movement information for each ship/shore operation.

Flight suspense for search and rescue purposes becomes the responsibility of the destination activity after acknowledging receipt of a flight plan.

When such flights will penetrate or operate within an ADIZ or DEWIZ (discussed in chapter 9) the appropriate air defense command must also be informed of the operation.

FLIGHT PLAN CODES

Various codes are established concerning highest rank aboard, VIP honors requested, and

cargo/passenger control information for the purpose of brevity when processing information contained in the remarks section of a DD-175. (See fig. 3-1.) AC's are responsible for insuring that timely action is effected and appropriate personnel are made aware of such information.

Since these codes are quite lengthy and subject to relatively frequent changes, they are not listed in this training manual. The AC should refer to a current edition of Flight Information Publication, Planning, Section II, for accurate and complete information contained in flight plan codes. OpNavInst. 3722.8 (Series) is also a good reference for flight plan codes.

FLIGHT PACKETS

A thorough knowledge of the contents, maintenance, and assembling of flight packets is another important duty performed by Air Controlmen. These flight packets (or nav kits, as they are more commonly called) are vitally important to each pilot as he prepares to depart on most types of flights. However, the mission of the flight, type of aircraft utilized, and the geographical location of the station cause the contents of the flight packet to vary.

Flight packets are maintained in Flight Clearance for station aircraft only; that is, aircraft for which the station commanding officer is reporting custodian or for which he has responsibility. This usually limits the number of flight packets to 5 or less. Squadrons, units, etc., based at the facility maintain their own flight packets for their use.

Normally, the pilot or a representative of his crew stops at the flight planning room to obtain a flight packet prior to preparing his flight plan. Figure 3-3 is a sample flight packet checklist. This form can be expanded or shortened to meet the needs of the station. The pilot or his representative when presented one of these forms fills out the top portion. Then the Air Controlman can quickly assemble those items that the pilot or his representative has indicated as being required for the particular flight. Normally, the items necessary to complete a flight packet are carried in a brown leather briefcase or other suitable container. A checklist such as shown in figure 3-3 not only allows the pilot or his representative to select the items deemed necessary for the flight but also greatly reduces the chance of an item being left out. In addition, the form serves as a temporary custody receipt. This is very important, as the value of the items that might be included in a flight packet may vary from a few cents to several hundred dollars.

FLIGHT ASSISTANCE SERVICE

An agreement between the FAA and Department of Defense (DOD) provides that the FAA assume certain communications functions dealing with military flight plans and related messages. Designated FSS's, called tie-in stations, are connected to adjacent military bases by local interphone for handling traffic. This does not include flights to or from carriers, which are handled via Navy communications.

COMMUNICATIONS SYSTEMS

The FAA uses a teletype system called Service B to handle communications requirements of aircraft movement and control messages. The system consists of two separate teletype networks, Area B and Center B. Area B circuits are generally arranged to serve ARTCC areas in the conterminous U.S. All FSS's are on an Area B circuit and those FSS's designated as tie-in stations actually enter military messages on the FAA teletype circuit for adjacent military bases. ARTCC's use Center B to handle emergency and IFR movement and control messages addressed to other centers.

A related circuit, called Military B, connects most base operations with ARTCC's for transmitting proposed IFR flight plans.

The FAA uses two interphone systems for the purpose of rapid voice communications. Service F is an interphone system which connects ARTCC's and associated terminal facilities for handling IFR movement and control messages which are time critical. Flight Service Interphone is the landline connection between tie-in stations and adjacent military bases to handle messages between such stations for entry into the Area B teletype circuit.

Interphone Operating Procedure

The equipment used with interphone systems varies according to local requirements; i.e., loudspeaker, handset, headset, manual signaling by use of pushbutton, key or dial, etc. Generally, naval facilities have a loudspeaker at the necessary control positions which must be monitored continuously since they will be called by voice. To call the center or flight service (tie-in

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NAVKIT/FLIGHT PACKET RECEIPT
CNATRA-GEN 3710/3 (Rev. 12-63)

ISSUED BY	FLT. PACKET NO.
HALLER, B.D.	7

PILOT'S NAME	RANK	UNIT ATTACHED	DATE
BRADY, J.H.	LT	VA-176	10-1-69

NAVIGATION KIT			MISCELLANEOUS EQUIPMENT		
ITEM	OUT	IN	ITEM	OUT	IN
ENROUTE SUPPLEMENT U.S.	✓		WEIGHT AND BALANCE BOOK		
ENROUTE HI/LO ALTITUDE CHARTS			LOAD ADJUSTER		
AREA ARRIVAL CHARTS			COMPUTER	✓	
ARRIVAL/DEPARTURE CHARTS			FLASHLIGHT	✓	
APPROACH PROCEDURES NEUS			IFR HOOD		
APPROACH PROCEDURES SEUS	✓		PENCILS	✓	
APPROACH PROCEDURES NWUS					
APPROACH PROCEDURES SWUS					
APPROACH PROCEDURES HI ALT					

PROCUREMENT DOCUMENTS

DD FORM 1348				STANDARD FORM 44	
NUMBER	USED	NUMBER	USED	NUMBER	USED
704821				1265031	
704822				1265032	
704823					

TO BE COMPLETED BY PILOT *(If any of above listed documents used)*

The procurement documents checked above were used and copies are attached. Unless indicated below no other obligations were incurred by me during the period from _____ to _____.

PILOT'S SIGNATURE	DATE

AC.6

Figure 3-3—Flight packet checklist.

FSS), there is usually a pushbutton or dial to engage which activates a buzzer or light at the facility called. There may be several stations on one circuit, all of which may be called by voice except the center or flight service. Each termination on the line has a transmit and receive capability. Voice recorders may be installed to monitor and record the systems.

Standard phraseology must be used on the interphone systems. Messages are terminated with operating initials (locally assigned all AC's). The following are examples of interphone operation:

1. Tower . . . .(Signals the center manually).
   Center . . . .OAKLAND CENTER.
   Tower . . . .ALAMEDA TOWER,

10477101

REQUEST CLEARANCE NAVY SIX ONE EIGHT THREE FOUR.

Center . . . .ATC CLEARS NAVY SIX etc. . . .MB (operating initials).

Tower . . . .BR.

2. Center . . . .BRUNSWICK APPROACH CONTROL, BOSTON CENTER, ESTIMATE.

Approach Control . . . .BRUNSWICK APPROACH CONTROL, GO AHEAD.

Center. . . .NAVY ONE TWO ONE SIX ONE, ESTIMATING etc. . . .RW

Approach Control. . . .ST.

3. FSS. . . .WHITING OPERATIONS, FLIGHT SERVICE, FLIGHT PLAN.

Operations. . . .WHITING OPERATIONS, GO AHEAD.

FSS. . . .NAVY SIX ONE TWO ONE TWO, FLIGHT OF THREE etc. . . .WW.

Operations. . . .AZ.

4. Operations. . . .(Signals flight service manually)

FSS. . . .FLIGHT SERVICE.

Operations. . . .NORFOLK OPERATIONS, ARRIVAL.

FSS. . . .GO AHEAD.

Operations. . . .(arrival message) CB.

FSS. . . .BC.

Clear enuciation is necessary at all times. Words should be spoken directly into the interphone instrument in a moderate tone of voice. The transmitting operator should not speak faster than the receiving operator can accurately copy. Spelling is not necessary unless a word is peculiar or seldom used. When spelling is necessary, use the phonetic alphabet discussed in chapter 10 of this Rate Training Manual.

PRIORITY OF INTERPHONE COMMUNICATION.—Only those messages necessary for air traffic control, contributing to air safety, or directly related to aircraft movements, are authorized on the interphone systems. Priority of such messages is established as follows:

1. First priority—Emergency messages including essential information on aircraft accidents or suspected accidents. After an actual emergency has passed, a lower priority should be given messages relating to an accident.

2. Second priority—Clearances and control instructions.

3. Third priority—Movement and control messages using the following order of preference when possible:

a. Progress reports.

b. Departure or arrival reports.

c. Flight plans.

4. Fourth priority—Movement messages on VFR aircraft.

NOTE: The words EMERGENCY or CONTROL are used for interrupting lower priority messages when necessary.

AC's should refer to OpNav Instruction 3722.8 (Series), and FAA Flight Services Handbook 7110.10 (Series) and TATC Handbook 7110.8 (Series), for possible changes or more detailed information on interphone procedures.

VFR FLIGHT PLAN HANDLING

When a pilot delivers a DD-175 to base operations and subsequently departs, the AC on duty must transmit the necessary information to flight service to be entered on the Area B teletype circuit for transmission to destination. All flights are held in suspense, or kept track of (until the aircraft lands), for the purpose of search and rescue service. The following is a brief discussion of what transpires from departure to arrival to give the AC an idea of the entire operation.

All messages concerning flight movements must be transmitted to flight service within 5 minutes after the required information is received.

Flight Notification Message

After an aircraft has departed or before actual departure for flights of short duration with mutual agreement, the following information from the flight plan must be transmitted to flight service:

1. Type of flight.
2. Aircraft identification.
3. Type of aircraft/special equipment suffix. (Include number and type if a formation flight.)
4. Point of departure.
5. Point of destination.
6. Estimated time of arrival (ETA) at destination.
7. Remarks (VIP and passenger/cargo information).

The FSS will then relay a flight notification message to the tie-in FSS serving the destination airport and will hold the flight in suspense until the destination FSS acknowledges the message. If an acknowledgement for a flight notification message is not received from the destination FSS within the following time limits, FSS personnel may use regular telephone to assure delivery:

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1. Before ETA, if estimated time en route (ETE) is 30 minutes or less.

2. 30 minutes after departure if the ETE is between 30 minutes and 2 hours.

3. 1 hour before ETA, if the ETE is 2 hours or more.

4. 30 minutes after departure if the message contains VIP/RON (remain overnight) information.

When destination tie-in FSS acknowledges the flight notification message, the departure FSS then files it in a completed file. The destination FSS relays the message to destination airport and holds the flight in suspense until an arrival report is received from destination airport.

Arrival Reports

Arrival reports are not transmitted to the departure FSS unless an aircraft arrives for which a flight notification message was not received. In such cases, AC's at the destination airport must provide the tie-in FSS with the aircraft identification, point of departure, and time of arrival to be relayed to the departure tie-in FSS and finally to the departure airport. Arrival reports are also required for overseas flights and special military flights of Presidential or Vice Presidential aircraft. An exception is that in Alaska an arrival report is required on a military aircraft when departure is from a military base.

Stopover Flights

Flights which include stopovers en route to final destination are handled basically the same as VFR flights with the following exceptions:

1. The point of the first stopover and an ETA (in lieu of ETA at destination) at that point, followed by each stopover point and ETE in order of stops and destination is included in the original flight notification message.

2. Each intermediate tie-in FSS will:

a. Acknowledge receipt of departure message.

b. Notify Base Ops of the inbound.

c. Suspense the message until an arrival or close out is received or take the necessary action if overdue.

d. When received, forward a departure time to the tie-in FSS for the next stopover point and obtain an acknowledgment.

Destination tie-in FSS will take the same action as the intermediate FSS's except that the flight plan is closed out when an arrival report is received from destination Base Ops, or if no further information, such as departure time, is received from the preceding stopover point by the message VOID time.

SEARCH AND RESCUE (SAR)
PROCEDURES FOR VFR AIRCRAFT

The following is a list of terms or definitions that the AC must be familiar with to better understand SAR procedure.

1. Inland SAR Region . . . The area in which the USAF exercises the SAR coordinating function. It includes all of the inland area within the conterminous U. S. except the waters under jurisdiction of the U. S. Coast Guard for SAR purposes.

2. Air Rescue Center (ARC). . . . The inland SAR region is further divided into three regions; i.e., eastern, western, and central region, each with an established ARC for the purpose of providing command, technical, and administrative assistance to local rescue detachments within its area of responsibility.

3. Maritime Region. . . . The area in which the U. S. Coast Guard exercises the SAR coordinating function, including the territories and possessions of the U. S. and the high seas.

4. Rescue Coordination Center (RCC). . . . A center which coordinates and controls SAR operations as an integral part of each ARC.

5. Alert Notice (ALNOT). . . . Notice given to appropriate facilities and agencies that an aircraft is overdue.

6. Information Request (INREQ). . . . A request for information concerning an overdue VFR aircraft.

Responsibility

The departure station (tie-in station) is responsible for initiating SAR action on flights for which flight plans have been entered into the FAA communications system until receipt of the destination station's acknowledgment of the flight notification message. Then the responsibility is transferred to the destination (tie-in) station. Military operations offices are responsible for initiating action on all other flights.

A VFR or DVFR flight is considered overdue when communication cannot be established with

it and it fails to arrive 30 minutes (15 minutes for jets) after its ETA.

A flight not on a flight plan is considered overdue if a reliable source reports it one hour overdue at destination.

Overdue Aircraft Action

As soon as a VFR aircraft becomes overdue, the destination tie-in station (including intermediate destination tie-in stations for stopover flights) must attempt to locate the aircraft by checking all adjacent airports that can be reached by government circuits or local telephone. If necessary, a long distance telephone call may be made to the destination airport.

If this communications search (FAA's responsibility for SAR is limited to communications and alert) does not locate the aircraft, the signal QALQ is transmitted to the departure tie-in station.

NOTE: Q signals are listed in FAA Flight Service Handbook 7110.10 (Series). The Q signal above is a code for asking if the aircraft in question has landed at the station queried.

Upon receipt of such an inquiry, the departure tie-in station must check locally for any information about the aircraft. The results of the check must then be transmitted back to the destination station.

Information Request (INREQ)

If the aircraft is not located by the inquiry to departure station, the destination station must transmit a numbered INREQ message to stations along the route, to departure station, and to the destination RCC tie-in station (an FSS with interphone to the appropriate RCC) as follows:

1. For aircraft on a flight plan—1 hour after ETA (30 minutes for jets).
2. For aircraft not on a flight plan—1 1/2 hours after ETA.

NOTE: For special procedures peculiar to Alaska and Hawaii, refer to FAA Flight Services Handbook 7710.10 (Series).

En route stations receiving an INREQ must seek information about the aircraft by checking station records and inquiring at all local airports which can be contacted by interphone or telephone. A reply to the INREQ must be sent to the originating station within 30 minutes after receipt even if the report is negative. If a search cannot be completed within 30 minutes, a status report is sent to the originating station followed by a completion report when available.

The departure station has already conducted a local communications check and holds the INREQ message in suspense.

If the aircraft is located by the INREQ, the originator must transmit a numbered message to all original INREQ addressees informing them of the fact.

Alert Notice (ALNOT)

If replies to the INREQ have been negative, or the aircraft has not been located within 1 1/2 hours (2 hours for no-flight-plan aircraft) after ETA, whichever occurs first, the destination station must transmit an ALNOT to the RCC tie-in station and all Area B circuits serving the ALNOT search area.

The ALNOT search area is normally that area extended 50 miles on either side of the proposed route of flight from the last reported position to the destination station. However, if requested by the RCC, or the discretion of the destination station, the ALNOT search area may be expanded to the maximum range of the aircraft.

Upon receipt of an ALNOT, each station whose area of responsibility extends into the ALNOT search area must condcut a communications search of those airports which could accommodate the aircraft and which were not checked during the INREQ search.

Receiving stations must notify the originator within 1 hour after receipt of the results or the status of the search.

If the ALNOT search fails to locate the aircraft or 1 hour has elapsed since transmission, whichever occurs first, the destination station must notify the RCC by message via the RCC tie-in FSS.

The ALNOT remains current until the aircraft is located or the search is suspended by the RCC. The ALNOT originator must then cancel the ALNOT by message on all circuits over which it was originally transmitted. All agencies which have been alerted must be informed.

Information Furnished ARC

All available information about an overdue aircraft must be given the RCC, including:

1. Agency and the person calling.

2. Details of the flight plan, or if the aircraft was not on a flight plan, all the facts about the source of the report.

3. Time of last radio contact, with whom the contact was made, and the frequency used.

4. Last position report.

5. Action taken and proposed action by the reporting station.

6. Positions of other aircraft known to be along or near the route of flight of the missing aircraft upon request.

HAZARDOUS AREAS

When regularly traveled VFR routes cross large bodies of water, swamps, mountains, or other hazardous areas where survival depends upon rapid rescue, a plan may be established by local authorities for special rescue procedures.

Because of the variety of possible situations a standard procedure is not prescribed. Generally these plans depend on a contact every 10 minutes with aircraft crossing these areas. If contact is lost with the aircraft for more than 15 minutes, SAR is alerted.

IFR FLIGHT PLAN HANDLING

Federal Air Regulations require, in part, that a flight plan be filed and an ATC clearance obtained prior to operation within controlled airspace in accordance with instrument flight rules.

When a pilot files an IFR flight plan with base operations, the AC's on duty must transmit the proposed IFR flight plan message to the ARTCC in whose area the IFR flight originates.

The message may be sent to the ARTCC via Military B teletype (Area B may be used through flight service in some cases) if the aircraft's proposed departure time is 30 minutes or more from transmittal time. If time is critical, the message is transmitted via interphone (Service F). Any subsequent change or cancellation to the proposed flight plan message must be called to the ARTCC via interphone.

IFR Flight Plan Message

The IFR flight plan message consists of the following items, all of which are from the filed DD-175 with the exception of items 1 through 4:

1. The 3-letter identifier of the ARTCC.

2. The 3-letter identifier of the originating station and four figures to indicate the time the flight plan was received by the station.

3. Three figures to indicate the number of the message. This number sequence begins with 100 each day at the time specified by the ARTCC.

4. The alphabetical character N. (All proposed IFR flight plan messages must contain this character.)

NOTE: Items 1 through 4 are required on teletype only.

5. Aircraft identification.

6. Type aircraft/special equipment suffix.

7. True airspeed.

8. Departure point.

9. Proposed departure time.

10. Altitude.

11. Departure point and route of flight. The route of flight must include the departure point, since it may be different from the station transmitting the message; the route of flight to the next fix; the identifier of that fix and route of flight to the next fix; and so on until destination which is the last part of this item. (See example.)

12. Remarks.

ARTCC's will acknowledge all movement messages on Military B and Area B circuits except domestic proposed IFR flight plan messages.

Examples of proposed IFR flight plan messages:

1. Teletype. . . .ZEM NQA 1315103NVV 71534C118/B 0180 NQA P1405 60 NQA MEM V16 DAL V16S NBE REQ RADEP.

2. Interphone (same flight plan as 1.)....IFR FLIGHT PLAN' NAVY SEVEN ONE FIVE THREE FOUR' C ONE EIGHTEEN SLANT BRAVO' ONE EIGHT ZERO, PROPOSED ONE FOUR ZERO FIVE, SIX THOUSAND, NAVY MEMPHIS DIRECT MEMPHIS VICTOR SIXTEEN DALLAS VICTOR SIXTEEN SOUTH NAVY DALLAS' REQUEST RADAR DEPARTURE, BR (operating initials).

3. Teletype. . . .ZEM NQA 1300104 NVV 315273/F4B/P 0410 NQA P1405 350 NQA J66 DAL NBE REQ SID MARION 1 LIT TNSN.

4. Interphone (same flight plan as 3.)....IFR FLIGHT PLAN, NAVY THREE ONE FIVE TWO SEVEN, FLIGHT OF THREE F FOUR B SLANT PAPA, FOUR ONE ZERO, PROPOSED ONE FOUR ZERO FIVE, FLIGHT LEVEL THREE FIVE ZERO, NAVY MEMPHIS, J SIXTY SIX DALLAS DIRECT NAVY DALLAS, REQUEST MARION ONE DEPARTURE LITTLE ROCK TRANSITION, BR.

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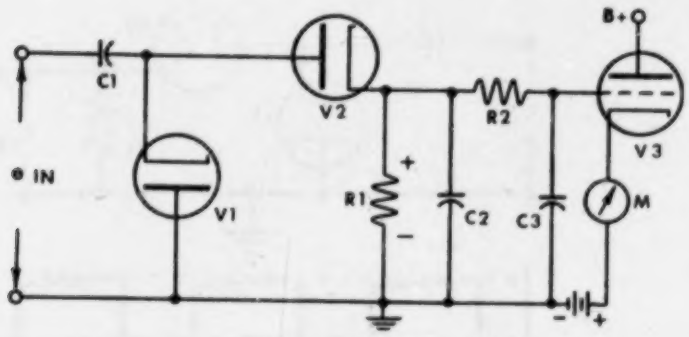

Figure 14-6.—Circuit controlled by positive counter.

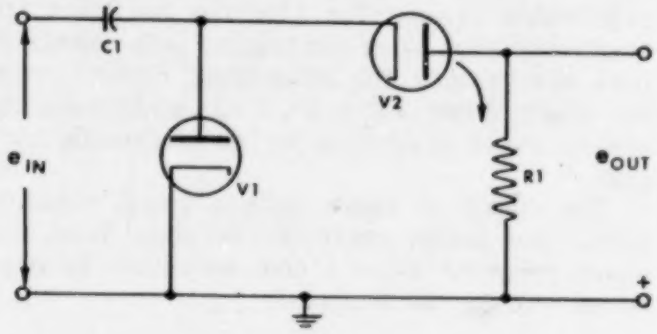

Figure 14-7.—Negative counting circuit.

voltage of the applied signal as shown in figure 14-5. This voltage varies directly as the frequency of the applied signal varies; that is, the average voltage increases as frequency increases, and decreases as frequency decreases. A milliammeter is placed in series with the plate circuit of V3 so that changes in the average plate current of V3 are indicated as a measure of variations in the recurrence frequency of the input pulses.

It was stated earlier that the applied waveshape may vary only in frequency. Glance at figure 14-5. If the pulse width or amplitude of the applied signal varies, then the average current, and therefore the average voltage, through R1 varies. This circuit is intended to indicate changes in frequency by measuring the average voltage across R1, so frequency is the only variation that can be permitted. The applied pulses are first sent through limiting circuits to insure exact amplitude, and shaping circuits to insure exact pulse width.

This counting circuit is frequently found in radio altimeters.

NEGATIVE COUNTER

By reversing the connections to the diodes V1 and V2 in the positive counting circuit the device can be made to respond to negative pulses, and thus it becomes a negative counter circuit. This circuit is shown in figure 14-7. Diode V2 conducts during the time the negative pulse is applied and a current flows through R1 as indicated by the arrow. At the end of the negative pulse V1 conducts sufficiently to remove the small charge which developed on C1 during the pulse time. The current through R1 increases with an increase in the pulse frequency as before. However, if the voltage developed across R1 is applied to the same control tube shown previously, the increase in current causes the grid of V3 to become more negative. This decreases the plate current through V3 and the meter. Thus an increase in the frequency of the negative pulse causes a drop in the average plate current measured by the meter. This effect is the opposite to that in the positive counter.

STEP-BY-STEP COUNTER

The step-by-step counting circuit is similar to those already discussed except that a capacitor which is large compared to C1 replaces the resistor R1 used in the positive counting circuit. The charge on this capacitor, C2 (fig. 14-8) increases slightly during the time of each positive pulse and produces a step voltage across the output. These steps decrease in size exponentially as the voltage across C2 approaches the final value, the rate being dependent upon the output impedance of the driving circuit. As long as there is no path through which C2 can discharge, the voltage across it continues to increase with each successive pulse until it is approximately equal to the amplitude of the applied signals. At this point the cathode of V2 is held at a positive voltage equal to that on the plate during the pulse time and the tube fails to conduct. Note that the charge on C2 eventually approaches 100 volts, the peak-to-peak value of the applied signal. This is caused by the charge on C1 being in series aiding with the input voltage during the negative half cycle of input.

Circuit Action and Waveshape Analysis

Use is made of the step charging circuit to trigger a blocked oscillator after a certain number of steps. A simple circuit of this type

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Flight Progress Strips

Flight progress strips are used to post current data on air traffic and clearances required for air traffic control and air traffic services. Terminal facilities providing approach control service must use the flight progress strips as listed in FAA manual AT P 7230.1 (Series), section 500. At some locations these strips are also used in the tower and flight clearance offices for recording data in a manner prescribed locally.

Figure 3-4 shows a departure and arrival flight progress strip with each box numbered for the purpose of explaining each part.

The following numbered items are appropriate entries in the correspondingly numbered boxes on the departure strip in figure 3-4.

1. Aircraft identification.
2. Type aircraft/special equipment suffix.
3. Computer identification number, if required.
4. Proposed altitude.
5. Proposed departure time.
6. Radar beacon (SIF) code assigned.
7. Departure point, route, destination, remarks, and/or clearance information.
8. Actual departure time.
9. Runway used for takeoff and departure point, if required.
10. (√) After clearance has been issued to the pilot.
11. (√) After clearance has been issued to terminal radar control (TRACON) for relay to the pilot.
12. (√) After actual departure time has been forwarded to the ARTCC.
13. Assumed departure time.

The following numbered items are appropriate entries in the correspondingly numbered boxes on the arrival strip in figure 3-4:

1. Aircraft identification.
2. Type aircraft/special equipment suffix.
3. Computer identification number, if required.
4. Radar beacon (SIF) code assignment.
5. Handoff or transfer of control point.
6. Clearance limit.
7. Destination airport.
8. ETA at clearance limit. The four digits of the hours and minutes should be used for the first entry. Subsequent entries may be only the two digits of the minutes, if desired.
9. Actual time of arrival (ATA) at clearance limit, if required.
10. Altitude in hundreds of feet.

11 through 20 are not standardized and may be used as determined by local authority.

Recording Flight Data

Only authorized control information symbols, abbreviations, and phrase contractions should be used for recording position reports, air traffic clearances, and instructions on flight progress

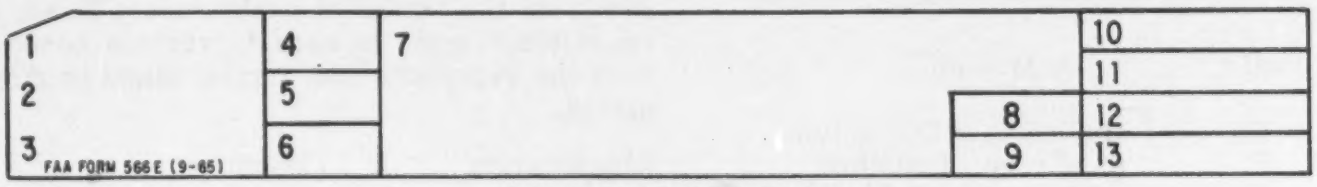

DEPARTURE STRIP

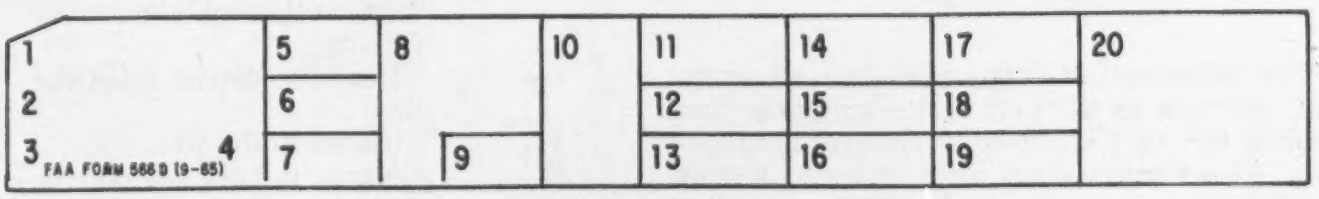

ARRIVAL STRIP

AC.7

Figure 3-4.—Flight progress strips.

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strips. Plain language, abbreviations or contractions contained in FAA Contractions Handbook 7340.1 (Series), and control information symbols contained in FAA Handbook 7110.8 (Series) must be used as necessary so that any written message may be read and understood.

The following list includes approved prefixes used in conjunction with the serial number to identify the branch of military service to which the aircraft is attached. These prefixes are appropriate for use in box number 1 on both the departure and arrival flight progress strips.

Prefix	Branch
A	U.S. Air Force
C	U.S. Coast Guard
G	Army or Air National Guard
VM	U.S. Marine Corps
R	U.S. Army
VV	U.S. Navy
CAF	Canadian Force
CAM	Canadian Armed Force Transport Command

The following list includes approved military mission prefixes which may be used with or in place of the prefix indicating branch of service that may be used in conjunction with the aircraft serial number. These prefixes are appropriate for use in box number 1 on both the arrival and departure flight progress strips.

Prefix	Mission
E	Medical Air Evacuation
H	Hurricane Evacuation
L	LOGAIR (USAF Contract)
S	Special Air Mission
T	MAC (Military Airlift Command)
F	Ferry Flight

The following list is approved aircraft equipment suffixes to indicate that an aircraft has transponder or TACAN-only navigational capability. These suffixes are used following a slant mark (/) after the aircraft type. They are appropriate for use in box number 2 on both the departure and arrival flight progress strips.

Suffix	Meaning
/X	Transponder with no-code capability.
/T	Transponder with 64-code capability.
/U	Transponder with 4096-code capability.
/D	DME
/L	DME, and transponder with no-code capability.
/B	DME, and transponder with 64-code capability.
/A	DME, and transponder with 4096-code capability.
/M	TACAN-only, and transponder with no-code capability.
/N	TACAN-only, and transponder with 64-code capability.
/P	TACAN-only, and transponder with 4096-code capability.

Figure 3-5 shows control information symbols used for recording clearances, instructions, and information on flight progress strips. Some of the symbols can be used in various boxes on both the departure and arrival flight progress strip; however, the most consistent use of these symbols may be in box number 7 on the departure strip where the ATC clearance to be issued to the aircraft is recorded.

The following list includes approved clearance abbreviations used to record a particular clearance issued or to be relayed to an aircraft, or the status of a clearance. These abbreviations may be used in various boxes on both the departure and arrival flight progress strips.

Abbreviation	Meaning
A	Cleared to airport (point of intended landing).
B	Center clearance delivered.
C	ATC clears (when clearance relayed through a non-ATC facility).
D	Cleared to depart from the fix.
F	Cleared to the fix.
H	Cleared to hold and instructions issued.
L	Cleared to land.
N	Clearance not delivered

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Symbol	Meaning
↑ (Altitude)	CLIMB AND MAINTAIN (Altitude).
↓ (Altitude) (Time) (Fix)	CLIMB AND MAINTAIN (Altitude) AT (Time); or; AFTER PASSING (Fix).
→	CRUISE.
@	AT.
X	CROSS.
⊸	MAINTAIN.
≠	CROSS AIRWAYS.
⇒	JOIN OR INTERCEPT AIRWAYS, TRACK OR COURSE.
═	WHILE ON AIRWAYS.
△	WHILE IN CONTROL AREA.
↘△	ENTER CONTROL AREA.
△↗	OUT OF CONTROL AREA.
↘⊙	ENTER CONTROL ZONE.
⊙↗	OUT OF CONTROL ZONE.
⊖→	THROUGH CONTROL ZONE.
Ⓦ	WHILE IN CONTROL ZONE.
>	BEFORE.
<	AFTER.
T→	TAKEOFF (Direction, if specified).
( ) / Restriction	ALTERNATE INSTRUCTIONS. RESTRICTION.
↓	BELOW.
↑	ABOVE.
— (dash)	INDICATES FROM--TO: ROUTE OR ALTITUDE.
V<	CLEARANCE VOID AFTER (Time).

AC.8

Figure 3-5.—Control information symbols.

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Symbol	Meaning
(V)	SPECIAL VFR CONDITIONS.
₵	PILOT CANCELLED FLIGHT PLAN.
✓	INFORMATION FORWARDED.
(NM) (DRCTN)	VIA (number of miles) MILE ARC (direction) OF (name of DME aid).
LAX 120.3	CONTACT (facility name) ON (Frequency).
/	UNTIL.
(50)	OTHER THAN ASSIGNED ALTITUDE REPORTED (circle reported altitude).
[10/6]	DME HOLDING (use with milages). (Upper figure indicates distance from station to DME fix, lower figure indicates length of holding pattern. In this example, the DME fix is 10 miles out with a 6 mile pattern indicated.)
R	RADAR CONTACT.
~~R~~	RADAR SERVICE TERMINATED.
~~X~~	RADAR CONTACT LOST.
(R)	RADAR HANDOFF (circle symbol when handoff completed).
RV	RADAR VECTOR.
~~RV~~	PILOT RESUMED OWN NAVIGATION.
W (red)	WARNING

NOTE: The absence of an airway or route number between two fixes in the route of flight indicates "direct"; no symbol or abbreviation is required.

Figure 3-5.—Control information symbols—Continued.

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Abbreviation	Meaning
O	Cleared to the outer marker.
Q	Cleared to fly (courses, quadrants, radials) within _____ miles from (location).
T	Cleared through (for landing and takeoff through intermediate point).
V	Cleared over the fix.
X	Cleared to cross (airway, route, radial) at (point).
Z	Cleared to tower jurisdiction.

The following listed miscellaneous abbreviations are used mostly by approach control; however, there are occasions when control tower operators make use of them.

Abbreviation	Meaning
C	Change to center frequency.
CT . . .	Contact approach.
I	Initial approach.
F	Final approach.
JP . . .	Jet penetration.
MA . . .	Missed approach.
SR . . .	Standard range approach.
SI	Straight-in approach.
TA . . .	TACAN approach.
LT . . .	Left turn.
RT . . .	Right turn.
VA . . .	Visual approach.
VR . . .	VOR approach.
FM . . .	Fan marker approach.
ILS. . . .	ILS approach.
LP	Left traffic pattern.
OTP . . .	VFR conditions on top.
PT	Procedure turn.
RX	Report crossing.
RP	Right traffic pattern.
SA	Surveillance approach.
PA	Precision approach.

Figure 3-6 shows the standard recording procedure for hand printed characters on flight progress strips.

ATC Clearances

With a proposed IFR flight plan on file, the AC on duty at the ground control position in the control tower, clearance delivery, or departure control position, as appropriate, will request an ATC clearance from the ARTCC when the pilot calls the tower for taxi instructions or requests his clearance. ATC clearances, advisories, or requests must be relayed verbatim.

The following is an example of an ATC clearance received via Service F from the ARTCC of the proposed IFR flight plan shown in figure 3-1.

ATC CLEARS NAVY SEVEN ONE FIVE THREE FOUR TO THE NAVY DALLAS AIRPORT VIA VICTOR SIXTEEN DALLAS VICTOR SIXTEEN SOUTH NAVY DALLAS, MAINTAIN SIX THOUSAND, EXPECT VECTOR TO INTERCEPT VICTOR SIXTEEN, SQUAWK ONE ZERO ZERO ZERO ON DEPARTURE, MB.

Typed	Hand Printed	Typed	Hand Printed	Typed	Hand Printed	Typed	Hand Printed
A	A	J	J	S	S	1	1
B	B	K	K	T	T	2	2
C	C	L	L	U	U	3	3
D	D	M	M	V	V	4	4
E	E	N	N	W	W	5	5
F	F	O	O	X	X	6	6
G	G	P	P	Y	Y	7	7
H	H	Q	Q	Z	Z	8	8
I	I	R	R	Ø	*Ø	9	9

*Placing a slash through the number zero is not required in the hand printing of altitude or time entries on all flight progress strips.

AC.10

Figure 3-6.—Recording of hand printed characters.

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Figure 3-7 is a completed flight progress departure strip on which the clearance is recorded using appropriate symbols and contractions.

IFR Departure Reports

Immediately after an IFR flight is airborne, a departure report must be sent via interphone (Service F) to the control facility with which the flight plan was filed. The departure report must contain the aircraft identification and the actual time of departure.

IFR Flight Progress Reports

IFR flight progress reports consisting of the aircraft identification, position, time, altitude or flight level, estimate of the next reporting point, name of the subsequent reporting point, and any remarks or requests as received from a pilot must be relayed to the appropriate ATC facility via interphone (Service F).

IFR Arrival Reports

The actual time that an IFR flight lands or cancels the IFR flight plan must be relayed to the appropriate ATC facility via interphone (Service F).

Flight Service for IFR Flights

All procedures and reports as discussed earlier in this chapter for handling VFR flights apply to IFR flights as well. The exchange of information between base operations and the ARTCC is additional flight plan handling procedure required for the purpose of providing separation between aircraft operating IFR. In many instances certain reports must be sent to both Flight Service and the ARTCC.

COMBINATION IFR/VFR FLIGHTS

Pilots may file flight plans containing both VFR and IFR operations. Such flight plans are handled in the same manner as regular VFR or IFR flight plans except that the proposed IFR flight plan message is sent to the ARTCC in whose area of responsibility the aircraft changes from VFR to IFR.

If the first portions of such flights are IFR, or the change from VFR to IFR occurs at a position within the ARTCC's area within which the departure airport is located, the proposed flight plan message may be sent via Military B teletype or Service F by base operations at the departure airport. If the first portion is VFR and subsequent portions are IFR in a different ARTCC's area, the proposed flight plan message would probably be sent via interphone to Flight Service for transmission on Area B teletype to the ARTCC in whose area the change from VFR to IFR occurs.

SAR PROCEDURE FOR IFR AIRCRAFT

ARTCC's are responsible for assuring that SAR procedures are initiated for overdue IFR aircraft. ARTCC's serve as the central point for collecting information, coordinating with ARC, and conducting a communications search for overdue or missing IFR flights.

For SAR purposes, ARTCC's consider combination VFR/IFR flights and air filed IFR flights the same as IFR aircraft when 30 minutes have elapsed since the pilot requested clearance and radio communication or radar contact cannot be established.

An IFR aircraft is considered overdue when neither radio communication nor radar contact can be established with it and 30 minutes have elapsed since an ETA over a specified or compulsory reporting point or clearance limit.

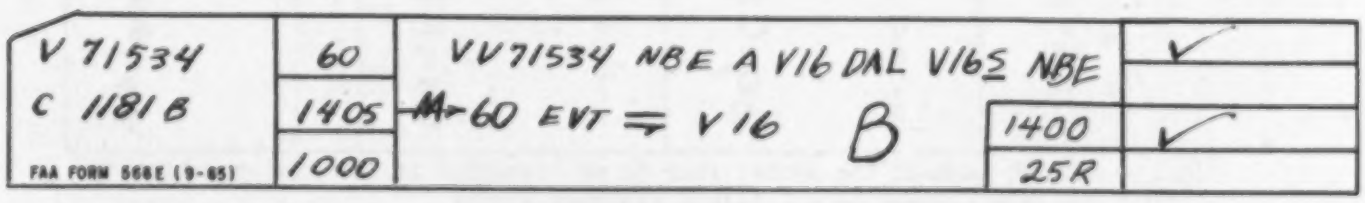

AC.11

Figure 3-7.—Completed flight progress departure strip.

Overdue Action

The ARTCC in whose area of responsibility an IFR aircraft is first unreported or overdue is responsible for making this determination and initiating the necessary action. When an IFR aircraft is determined overdue, the appropriate ARTCC must alert the associated RCC and transmit an ALNOT.

The ALNOT is sent to all ARTCC's and Area B circuits 50 miles on both sides of the route of flight from the last reported position to destination. Included in the ALNOT is the original or amended flight plan, as appropriate, and the last known position. At the recommendation of the RCC or at the discretion of issuing ARTCC, the ALNOT search area may be expanded to cover the maximum range of the aircraft.

The responsibility for further search is transferred to the RCC under any of the following conditions:

1. When 30 minutes have elapsed after the estimated fuel exhaustion time.
2. When the aircraft has not been found within 1 hour after issuing the ALNOT.
3. When the ALNOT search has been completed with negative results.

The ALNOT remains in effect until the aircraft is found or the search is abandoned by the RCC, at which time it must be cancelled by the originating ARTCC.

Handling procedure for stations receiving the ALNOT, including broadcasting the ALNOT, are the same as those listed under SAR procedure for VFR aircraft.

Restriction to Other IFR Traffic

Unless radar separation is applied, when an IFR aircraft is unreported, the facility responsible must restrict or suspend other IFR traffic for 30 minutes after whichever of the following is applicable:

1. The time at which approach clearance was delivered to the pilot.
2. The expected approach clearance time delivered to the pilot.
3. The arrival time over the navaid serving the destination airport.
4. The current estimate, either the control facility's or the pilot's (whichever is later), at the navaid serving the destination airport.

After the 30-minute traffic suspension period has expired, normal air traffic control may be resumed if the operators or pilots of other aircraft concur.

RADIO COMMUNICATIONS FAILURE

When an IFR aircraft experiences two-way radio communications failure, air traffic control is based on anticipated pilot action. Pilot procedures are set forth in FAR 91.127 listed in chapter 9 of this Rate Training Manual. ATC facilities should take the following action, as appropriate, when two-way radio communications are lost with an IFR aircraft:

1. Broadcast clearances through any available means of communication, including the voice feature of navaids.
2. Attempt to reestablish communications by having the aircraft use its transponder (SIF) or make turns, both of which might be considered an acknowledgment when observed on radar.
3. Broadcast a clearance for the aircraft to proceed to its filed alternate airport at the minimum en route altitude if the aircraft operator concurs.

FLIGHT ADVISORY MESSAGES

If hazardous conditions arise which might affect an aircraft already in flight, it may be necessary to issue a flight advisory message to make sure the pilot is aware of the situation.

If a military aircraft's destination is a civil airport, the destination FSS is responsible for screening weather, airport, and navaid conditions, and issuing the necessary advisory to inbound aircraft. If the destination is a military base, the responsibility rests with base operations.

The tie-in station originating the advisory or receiving it from the originating base operations will determine the FSS nearest the aircraft's position for VFR flights or the appropriate ARTCC for IFR flight, and transmit the message to that location.

If the receiving FSS or ARTCC is unable to deliver the flight advisory to the aircraft within 15 minutes after the requested delivery time, the originator must be informed and then the message is filed.

MILITARY OVERSEAS FLIGHT SAFETY MESSAGES

Overseas flights are required to file through specific military based with clearing authority for such flights. Base operations at such locations forward an IFR flight notification message to the appropriate ARTCC. When an aircraft

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departs, base operations must also forward an ICAO DEP PLN (International Civil Aviation Organization flight plan including the actual time of departure) via the tie-in FSS to the appropriate International Flight Service Station (IFSS) for relay to the overseas addressees. FAA IFSS's are located at New York, Miami, and San Francisco to handle international communications in their respective areas.

For outbound flights the departure tie-in FSS holds the DEP PLN in suspense until an arrival or acknowledgment message is received from the destination base.

For inbound flights the relaying IFSS holds the DEP PLN in suspense until an arrival or acknowledgment message from the destination tie-in FSS has been forwarded to the departure base.

CIVIL NOTICE TO AIRMEN

A Notice to Airmen is a notice identified either as a NOTAM or Airmen Advisory containing information concerning the establishment, condition, or change to any component of, or hazard in, the National Airspace System, the timely knowledge of which is essential to personnel concerned with flight operations.

A NOTAM is a Notice to Airmen in message form requiring expeditious and wide dessemination by telecommunications means.

An Airmen Advisory (AIRAD) is a Notice to Airmen normally only given local dissemination, during preflight or in-flight briefing, or otherwise during contact with pilots.

Civil NOTAM's are transmitted by teletype when the basic flight publications do not contain current information concerning the following:

1. A landing area condition which precludes safe operation of aircraft.
2. An unscheduled change in, or irregular operation of, any component of the national airspace system which precludes the use of a facility for normal aircraft operations.
3. Any scheduled and published change to components of the national airspace system that is rescheduled or modified.
4. New or modified instrument procedures or changes in operating minimums.

NOTAM CODE

The NOTAM code provides for coding NOTAM information to reduce telecommunications transmission time and reduce translation difficulties in the International Service.

A NOTAM code group contains 5 letters. The first letter is always the letter Q to indicate a code abbreviation for use in the composition of NOTAM's. The letter Q has been chosen to avoid conflict with any assigned radio call sign.

Five-letter NOTAM code groups are formed in the following manner:

1. First Letter. The letter Q.
2. Second and Third Letters. The appropriate combination of two letters, selected from the "2nd and 3rd letters" section of the code, identifies the facility, service, or danger to aircraft in flight being reported upon. The second letter has been restricted to A, E, I, O, or U. These letters also serve to classify the aid, facility, or service described; i.e., the letters A and E signify radio aids. The letter I signifies lighting facilities. The letters O and U signify airports, search and rescue, and dangers to aircraft in flight.
3. Fourth and Fifth Letters. The appropriate combination of two letters, selected from the "4th and 5th letters" section, denote the operating status of the facility, service, or danger to aircraft being reported upon. The fourth letter has been restricted to A, E, I, O, or U.

Figure 3-8 shows some examples of how the NOTAM code group is assembled along with the meaning of each.

The example below shows a NOTAM transmitted by NAAS Fallon:

→ NFL 4/2 QANOG

Decoded, the NOTAM has the following meaning: The west arrow is an automatic data processing code for Service A, the transmitting station (NFL) is NAAS Fallon, the NOTAM is the second issue since the beginning of the fourth month, and the Fallon TACAN is operative but ground checked only, awaiting flight check.

The complete NOTAM code is found in several publications including the Airman's Information Manual, FLIP Planning, and Flight Service Handbook 7110.10 (Series).

Navy NOTAM's are handled mainly on the USAF Comet teletype system; however, by prior local arrangement, a military facility having a send-receive capability on Service A is authorized to transmit NOTAM's in accordance with

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2nd & 3rd letters	Meaning	2nd & 3rd letters	Meaning
AN	TACAN.	IH	Taxiway lights.
EE	Ground Controlled Approach System (GCA).	OA	Land aerodrome.
EK	Precision Approach Radar (PAR).	UT	Grass landing area.

4th & 5th letters	Meaning	4th & 5th letters	Meaning
AE	Totally free of snow and ice.	OK	Resumed normal operation.
EM	Military operations only.	OG	Operative but ground checked only, awaiting flight check.
IF	Flight checked and found reliable.	UF	Closed for an unknown duration due to flood.

AC.12

Figure 3-8.—NOTAM code example.

FAA procedure (Flight Service Handbook 7110.10 (Series)). NOTAM coverage on Service A includes a daily summary of NOTAM's transmitted at approximately 0800Z.

USAF/USN NOTAM SYSTEM

The USAF/USN NOTAM system was established to provide for rapid dissemination of Navy, Air Force, and selected civil NOTAM's in plain language to USAF and USN air activities, and provide for frequent, periodic summaries of current NOTAM's.

This system is centrally coordinated and operated by the USAF Central NOTAM Facility (CNF). The USAF CONUS Meteorological Teletype System (COMET) is used for the transmission of these NOTAM's. Navy and Marine Corps air facilities in the counterminous U.S. have transmit and/or receive capabilities on the COMET system.

Central NOTAM facilities are also established at certain overseas locations for the purpose of exchange of Navy and Air Force NOTAM's within each area, and between each area and the U.S. NOTAM's in these systems are transmitted over existing administrative and operational circuits.

NOTAM RESPONSIBILITY

The responsibility for originating a NOTAM rests with the commanding officer having jurisdiction over a facility where a hazardous condition exists or is contemplated. This responsibility includes insuring that NOTAM dissemination

is adequate and timely, and that NOTAM's are promptly canceled.

Additionally, the commanding officer (clearing authority) is responsible for the promulgation of all NOTAM's received. This responsibility includes, but is not limited to, conspicuous posting within flight planning areas, and dissemination to local units within their area of jurisdiction.

The Naval Oceanographic Office (NAVOCEANO) monitors Navy NOTAM's to insure compliance with the appropriate instructions governing NOTAM procedure.

Each activity concerned with the issuance of NOTAM's must implement standard procedures to assist appropriate duty personnel in the correct preparation, transmission, and display of NOTAM's.

Originators of NOTAM's must insure the following:

1. Adequate on-station procedures to provide rapid reporting of navaid malfunctions that affect the operation of the station, regardless of the operating agency of the facility concerned.
2. Standardized station procedures for the preparation of each NOTAM in accordance with the requirements for the particular circuit on which it is to be transmitted. The NOTAM is normally prepared by ATC personnel.
3. Each item is carefully phrased and identified as a separate NOTAM, and the same accountability identifier is used in any revisions to or cancellation of the NOTAM.
4. Dissemination on appropriate circuits to civil and military activities concerned.
5. Followup of station orginated NOTAM's to provide for prompt and accurate publication, revision, and cancellation as soon as the condition is rectified or published in FLIP's.
6. Forwarding to the NAVOCEANO any amplifying data necessary for permanent or semipermanent changes to the appropriate FLIP's.

HOW TO PREPARE A USAF/USN NOTAM

NOTAM Format

Each NOTAM is identified by its date and accountability number; for example, 020311397, which is broken down as shown in figure 3-9.

Once this number is assigned, it must be used to refer to the NOTAM for all purposes, including revision, extension, and cancellation. The accountability number is always composed of five digits. The first two digits are assigned consecutively by the initiating base and begin with "01" each month, as computed from Greenwich Time. The CNF uses this portion of the number to verify that it has received all NOTAM's from the respective bases. The last three digits are assigned consecutively by CNF, and run from "001" to "999." This portion of the number provides a means for each receiving point to insure that it has received all NOTAM's retransmitted by the CNF.

Use of Clear Text, Code, or FLIP Abbreviations

If the NOTAM is being transmitted within CONUS or within the USAF Communications System, it is sent in clear text. If the NOTAM is being transmitted via a designated ICAO communications circuit, it is sent in the appropriate five element "Q" code as described earlier in this chapter.

Self-Canceling NOTAM

This is prepared in the same format as a new NOTAM, except that it shows when the NOTAM becomes effective and when it expires. (See date-time groups in fig. 3-10.) Such a NOTAM does not require canceling, because it has a date and time indicating when it expires.

Cancellation NOTAM

Each NOTAM that cancels a current NOTAM must use the letter "C" instead of the letter "N," and must repeat the same accountability number that was assigned to the NOTAM it cancels. The cancellation NOTAM must tell the present condition of the facility. (See example in fig. 3-11.) When a NOTAM has caused information to be added to or removed from FLIP, a cancellation NOTAM is sent, if appropriate, after the removal/addition is made. (The appropriate FLIP is consulted to determine whether the information has already been corrected.)

Revised NOTAM

This NOTAM is sent to revise or correct a current NOTAM. The letter "R" is used preceding the accountability number, and the same accountability number as the NOTAM being

01 10441

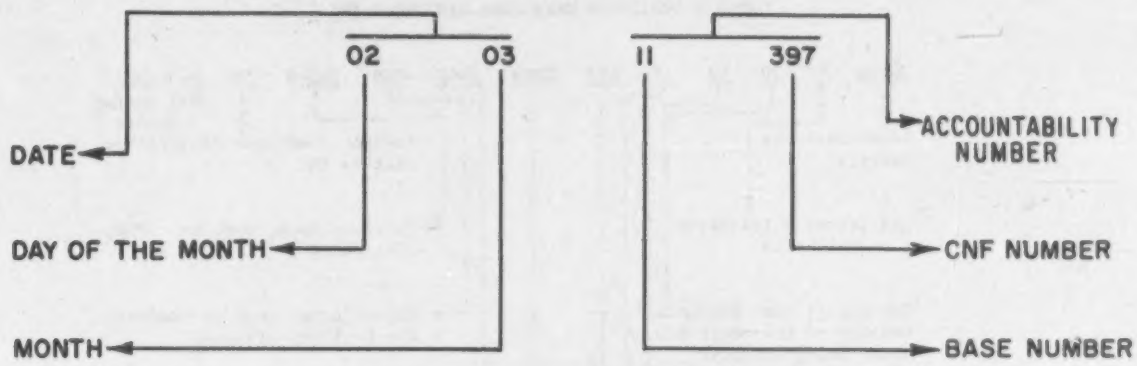

SAMPLE: 2 MARCH 11TH. NOTAM FROM BASE 397TH. FROM CNF

AC.13

Figure 3-9.—Numbering system for USAF/USN NOTAM.

NOTAM N 290114437 KRAN 2468 RAN TACAN OUT (REMARKS)
121200Z-132000Z

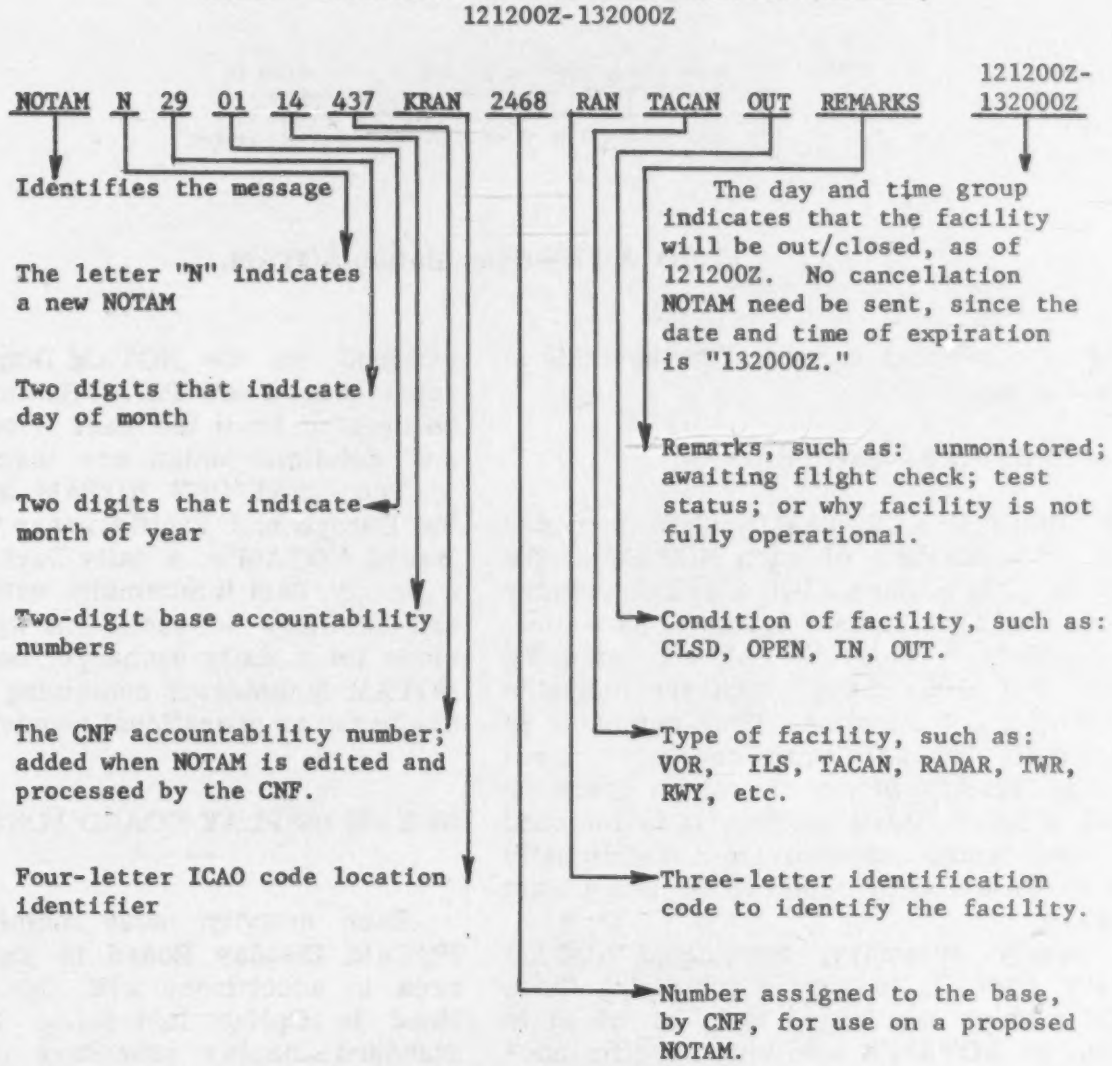

AC.14

Figure 3-10.—Self-canceling NOTAM.

NOTAM C 290114437 KRAN 2468 RAN TACAN IN

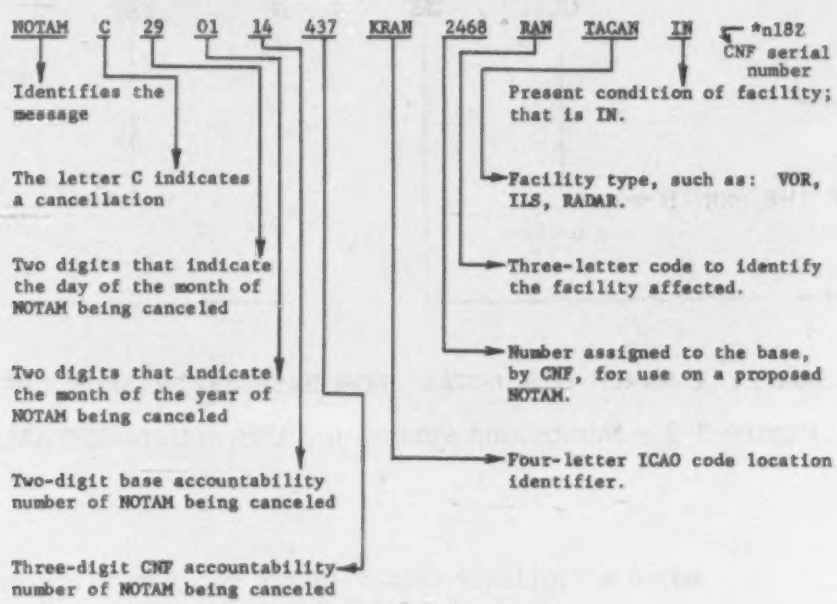

*NOTE: The serial number added on the end of a "C" NOTAM is added by CNF for the purpose of numerical sequence since the original accountability number is used on this type NOTAM and is of no significance to the sender or user.

AC.15

Figure 3-11.—Cancellation NOTAM.

revised or corrected is used. (See how this is indicated in fig. 3-12.)

NOTAM SERVICES FURNISHED

The USAF/USN NOTAM system provides CONUS dissemination of each NOTAM at the time it is initiated, and a twice-daily summary designated NOTAM Summary Part I. This summary consists of those NOTAM's outstanding at 0900Z and 2100Z daily which are judged to be of temporary duration. This summary is alphabetically arranged, and can be removed from the teletypewriter in sheet form for NOTAM Display Board posting. It is intended to be continuously updated from individually issued NOTAM's until replaced by a new Part I Summary.

A weekly summary, designated NOTAM Summary Part II, is issued containing those NOTAM's which are judged to be of indefinite duration, or NOTAM's involving specific corrections to the FLIP's. The CONUS Part II NOTAM Summary is normally compiled as of 0900Z each Saturday, and is intended to be retained on the NOTAM Display Board until replaced by a new Part II Summary. This should be updated from the Part II NOTAM additions and deletions which are issued twice daily.

The USAF/USN NOTAM system provides the Europe and Pacific areas with individually issued NOTAM's, a daily Part I Summary, and a weekly Part II Summary, with daily additions and deletions to each. The system also provides for a daily exchange, between areas, of NOTAM Summaries containing selected coverage based on operational requirements.

NOTAM DISPLAY BOARD POSTING

Each activity must maintain a standard NOTAM Display Board in the flight planning area in accordance with the procedure outlined in OpNav Instruction 3710.7 (Series). Standard display procedure must be implemented at each activity to assist AC's on duty in maintaining the NOTAM display including the following:

NOTAM R 290114437 KRAN 2468 RAN TACAN OUT (REMARKS)

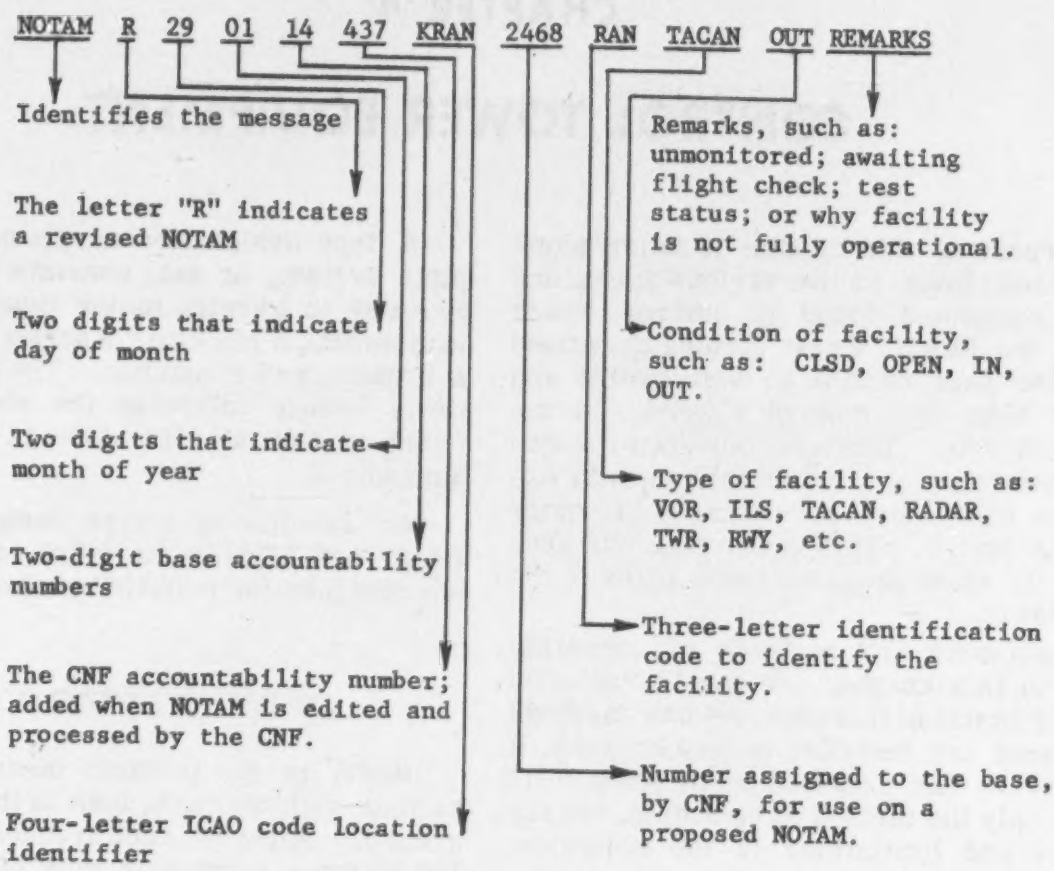

AC.16

Figure 3-12.—Revised NOTAM.

1. Adequate procedures for the receipt, on-station dissemination, and posting of incoming terminal, en route, and special NOTAM's from appropriate circuits.

2. Constantly updating the display and removing obsolete information at least once each hour, or more often.

3. Checking new Summaries for completeness before destroying old Summaries.

4. Monitoring NOTAM's and NOTAM Summaries, and new editions of FLIP's, to insure that they reflect current conditions for their station, and initiate corrective NOTAM's on any deficiencies.

5. Decoding ICAO coded NOTAM's and identifiers to plain language before posting.

6. Availability of sufficiently knowledgeable personnel to assist the pilot in checking NOTAM information.

For more detailed study and information concerning NOTAM's, the AC should refer to OpNav Instruction 2112.2 (Series), Air Force Manual 55-13, and OpNav Instruction 3710.7 (Series).

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CHAPTER 4

CONTROL TOWER EQUIPMENT

The purpose of this chapter is to introduce the Air Controlman to the various types and pieces of equipment found in control towers throughout the Navy. Great strides have been taken in the past decade to standardize and modernize both the control towers and the equipment therein. Through constant research and development, the Air Controlman, may expect to see even more development in equipment in the future. This is necessary to keep pace with the rapid progress being made in the field of aviation.

The equipment and methods of operation discussed in this chapter are considered to be most widely in use at this time. As new methods and equipment are installed at duty stations, it behooves every Air Controlman to study diligently, not only the method of operation, but the capabilities and limitations of the equipment and the techniques utilized.

JOINT ELECTRONICS TYPE DESIGNATION SYSTEM

The Joint Electronics Type Designation System (JETDS), formerly known as the AN nomenclature system, was developed to standardize, within the DOD, identification of electronic material and associated equipment.

This system of type designations applies to developmental, preproduction, and production models of systems, groups, components, and subassemblies of electronic equipment for military use. Once assigned, a type designation will never be duplicated. In the JETDS, nomenclature consists of a name followed by a type designation, which is composed of indicator letters and an assigned number. The type designation will always apply to one specific article or any subsequent improvements that may be made on that article.

A type designation assignment for a complete system, or set, consists of an AN (which is used to identify major items of electronic equipment), a slant bar, a series of three letters, a hyphen, and a number. The meanings of the three letters following the slant bar may be found in the table included in this manual as appendix II.

An example of a type designator would be Radar Set AN/SPS-10, which is a search radar set designed for installation aboard ship.

COMMUNICATIONS CONSOLES

Radio is the primary means of communications with aircraft, both in the air and on the ground. Different radiofrequencies are established for a particular type of operation. For example, most Navy towers have 340.2, 360.2, 142.74, and 126.2 assigned specifically for airport traffic control purposes. Additional frequencies may be established by appropriate authority at some facilities depending upon operational requirements. Different operating positions within the same facility may have to share the same frequency for a single aircraft operation. For example, single piloted IFR aircraft should be provided a single frequency approach to the maximum extent that communications and traffic conditions permit. Therefore, approach control, radar facility, and the control tower may find it necessary to use the same frequency sometime during such an operation. Additionally, interfacility communications may be necessary for coordination between the different operating positions where physical contact between controllers is not possible. To provide controllers with this capability, communications consoles are provided which allow selection of various frequencies and intercommunications between operating positions.

10445 42

AN/FRA-11 COMMUNICATIONS CONSOLE

The AN/FRA-11 is a communications control system designed to provide unified air-to-ground voice communications. Facilities incorporated in the equipment provide flexible control of sixteen transmit/receive communications channels. The transmitters and receivers may be either locally or remotely located. The system is comprised of three operating positions designated as control indicators A, B, and C, and four equipment racks containing the associated control equipment. The three control indicators are installed in the control tower and are normally separated while the equipment racks are installed in the equipment room below the tower.

The control monitor indicators are identical except that indicator A has a control common to all three indicators for controlling the intensity of the indicating lamps.

Radiotelephone messages from aircraft received by any one of the sixteen radio receivers can be heard by operating personnel through the overhead speakers, pulldown speakers, or headsets. Each radio receiving channel has an identification lamp which is automatically illuminated when the channel is in use. Sixteen lever type switches provide the operator with a means of setting the overhead speaker output level for any channel to HI-LO-OFF. A second row of lever type switches permits the operator to select any radio signal and feed it to the pulldown speaker. (See fig. 4-1.) Regardless of the position of the receiver selector switches, the receiver indicator lamps will light when the signals are received.

The sixteen transmitters may be operated from any one of the three control indicators by the level type switches located on the transmitter control panel of the control indicators. When an operator desires to transmit, the lever type switch is operated to the ON position. This causes the green STANDBY lamp to light, then the push-to-talk button on the microphone is depressed, the red BUSY lamp will light and the transmission is made. When the press-to-talk button of the microphone is released, the red BUSY lamp is extinguished. When the channel selector switch is returned to the OFF position, the green STANDBY light is also extinguished. If the operator at any position is using any particular channel, he is protected against having either of the other two operators interrupt his transmission through a system of interlocking relays. The other two operators have visual indication that the channel is in use since their respective BUSY lamps are lighted. However, if either of the operators should try to use the channel, a buzzer gives an audible indication that the channel is in use. Should an operator ignore the light and buzzer the interlocking relays prevent any interruption.

Although the AN/FRA-11 is still in use at many Navy facilities it is being replaced by newer equipment with additional features to satisfy the expanding needs of air traffic control communications.

AN/FSA-17 COMMUNICATIONS CONSOLE

The AN/FSA-17 communications console (fig. 4-2) is a communications control system for air traffic control centers at naval air stations and other facilities where several operators must exercise control over multichannel radio communications while at the same time maintaining interphone communications with each other.

The system provides control of as many as 20 transmitters with a lockout feature that denies the use of a transmitter to any other operator once selected. It also monitors as many as 20 radio receivers at any one time. An operator can talk to one or more other operators on the interphone feature. The interphone feature allows private line or party line intercommunication.

The operation of the console is simple, once the confusion of the multiplicity of controls is overcome. (See fig. 4-2.) Located on the right side of the console is a microphone level indicating meter, level controls for the microphone and headphone, and a dimmer control for illuminations, as well as lights and switches. The 3-position radiophone switches (fig. 4-2) control the receivers and transmitters. These switches are off in the down position. To monitor a frequency the switch is moved to the middle position. To select a transmitter, while monitoring the frequency, the switch is moved to the top position. The radiophone frequency chart (fig. 4-2) is a removable strip of translucent plastic placed below the radiophone switches. The frequency controlled by each switch may be written on this chart for ready reference. Above each switch is an amber light which glows when a

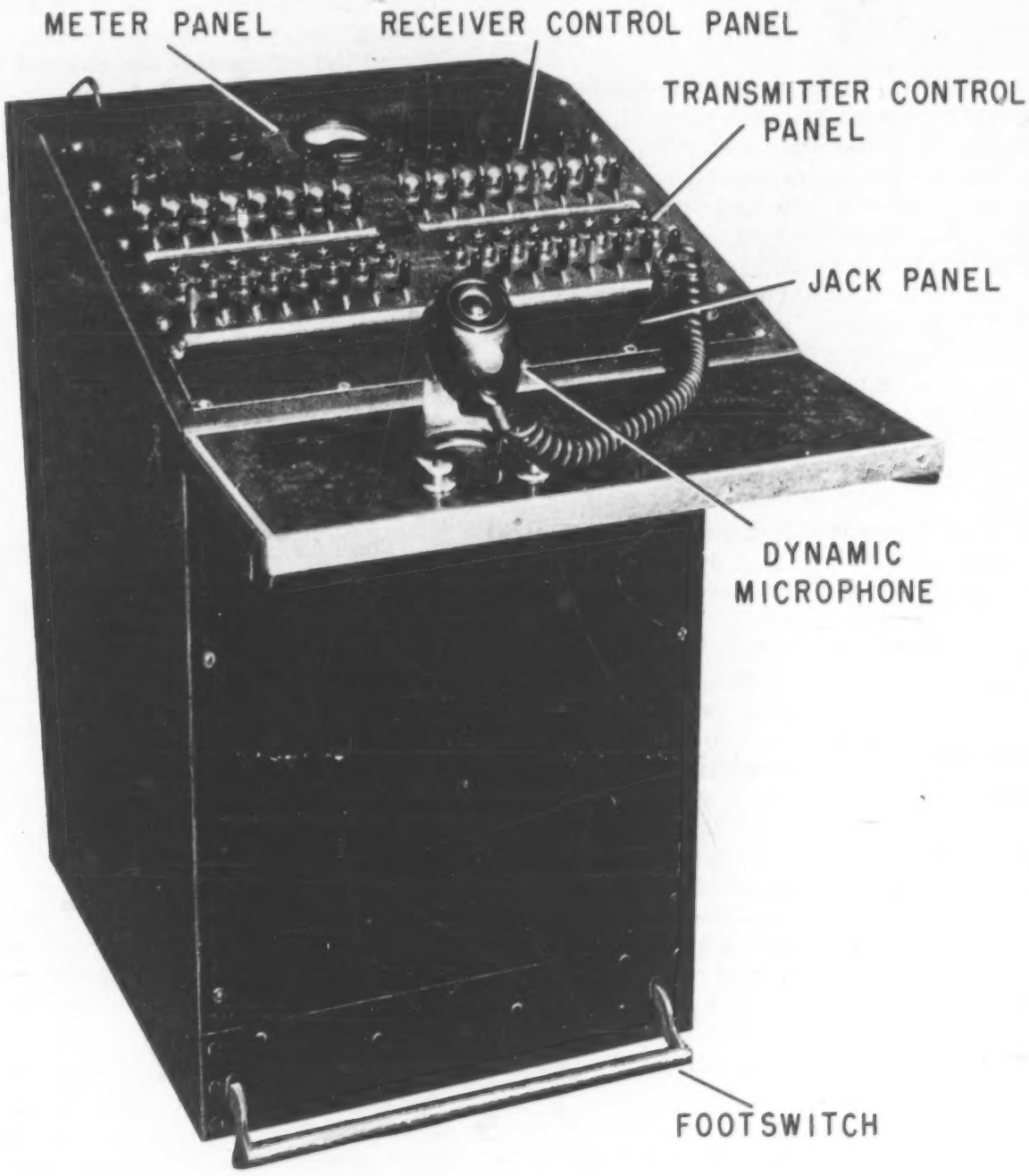

AC. 214

Figure 4-1. —AN/FRA-11 communications console.

radio call is received, regardless of the position of the switch. A green light immediately above each amber light will glow when a transmitter is selected by a corresponding switch.

The 20 interphone switches on the bottom of the console control the 20 private line interphone circuits. The switches are off in the down (middle) position. To call and talk to another operator, the switch corresponding to the desired operator is moved to the upper position. Above each interphone switch is a red light which will glow when the position is called by another operator (the one corresponding to the number under the light). The supervisor interphone switch provides a private line interphone circuit to the supervisor's console in the same manner as the other interphone switches.

The party line cutout enables a controller to disconnect from a party line (programmed into the system) by moving the switch up.

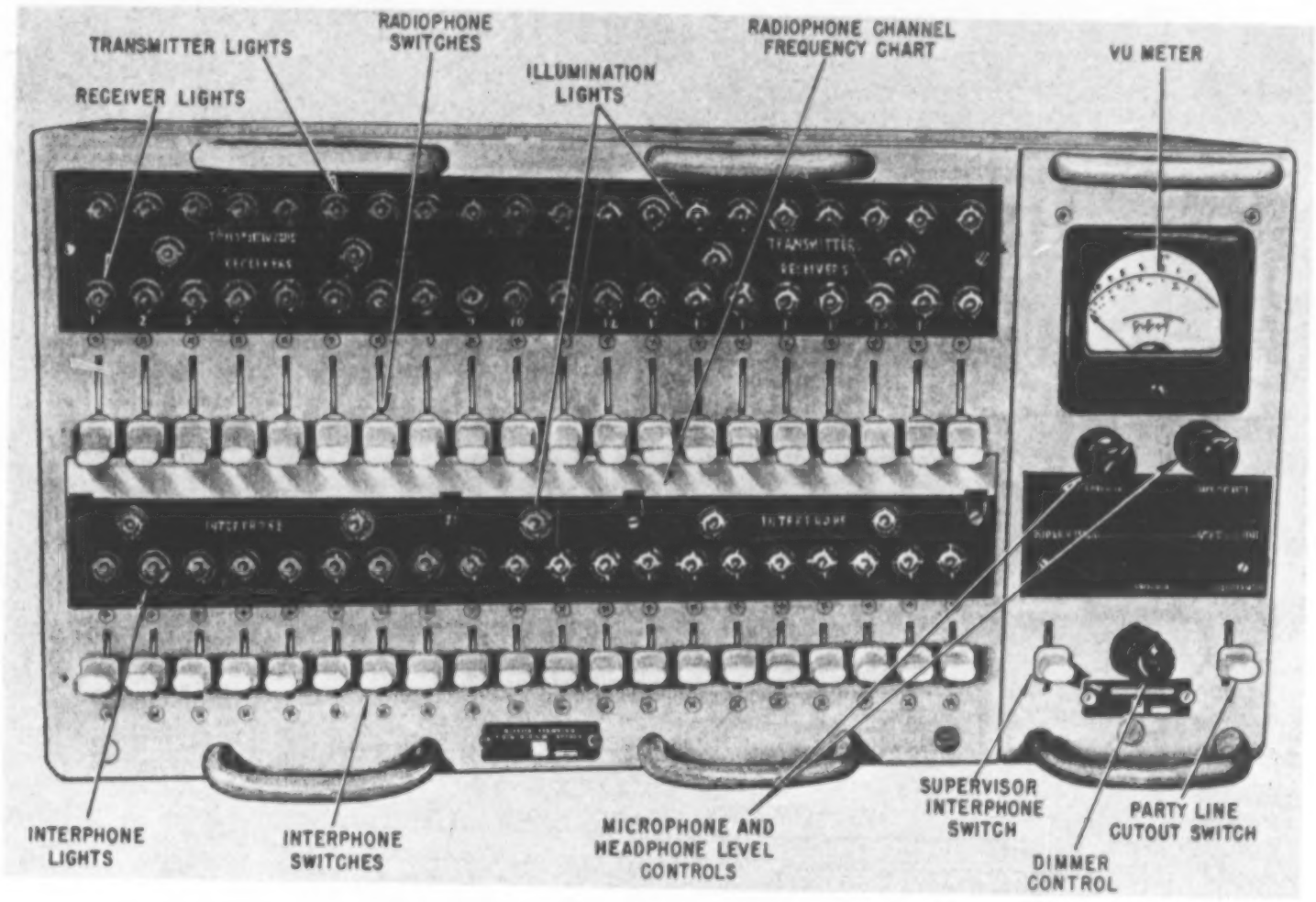

AC. 17

Figure 4-2. —AN/FSA-17 communications console.

A speaker amplifier control is supplementary equipment added to the control tower operator's console. (See fig. 4-3.) This unit is usually installed directly above the basic FSA-17 with corresponding frequencies. Placing any one of the 20 receiver switches on the speaker amplifier control removes that particular receiver from the operator's headphone circuit and feeds it to an associated speaker. The speaker level control provides for control of speaker volume. The dimmer control is used to adjust panel illumination intensity. The speaker muting system prevents acoustical feedback through a microphone. To achieve headphone operation on all frequencies, the operator needs merely to raise the muting switch.

Other auxiliary equipment necessary for controller operation such as headphone, etc., is the same as that shown in figure 4-4.

AN/FSA-52 COMMUNICATIONS CONSOLE

The AN/FSA-52 communications console is similar in design and basically the same in operation as the AN/FSA-17. It is newer equipment and allows for additional frequencies, intercommunication, and possible operating positions. It also may be programmed for the use of several direct telephone lines through the console. (See fig. 4-4.) A speaker amplifier control unit as shown in figure 3-3 is also used with the control tower AN/FSA-52 console. Other auxiliary equipment necessary for controller operation is shown in figure 4-4.

The AN/FSA-17 or AN/FSA-52 is the communications console used in Radar Air Traffic Control Centers (RATCC's). An illustration of the position of the consoles associated with a

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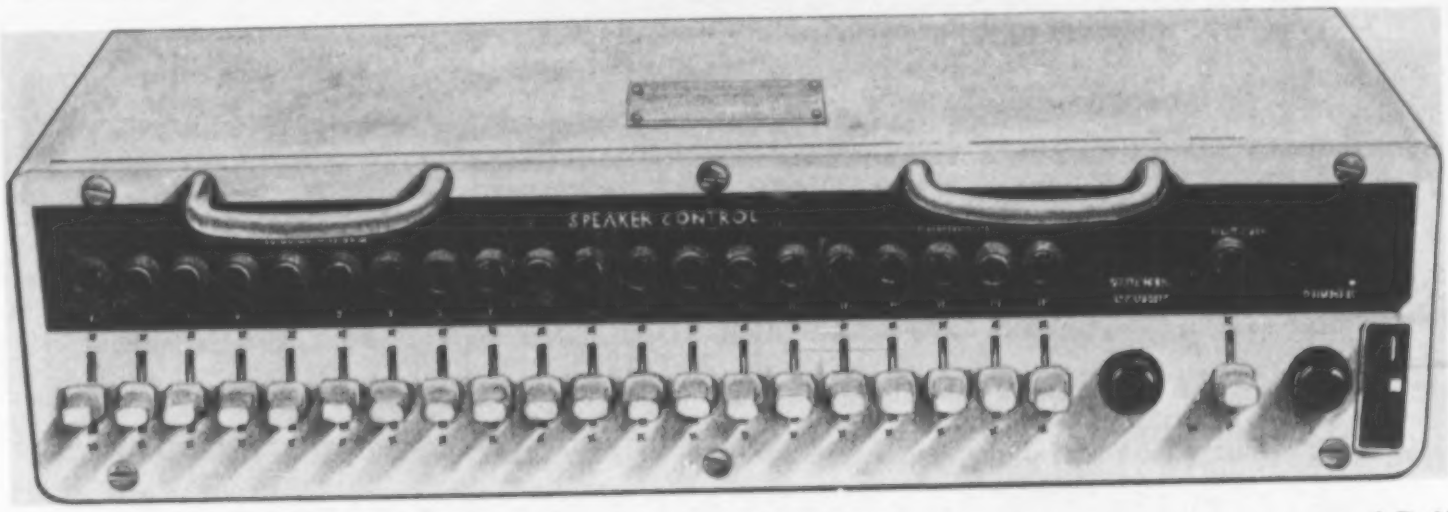

AC. 18

Figure 4-3.—Speaker amplifier control.

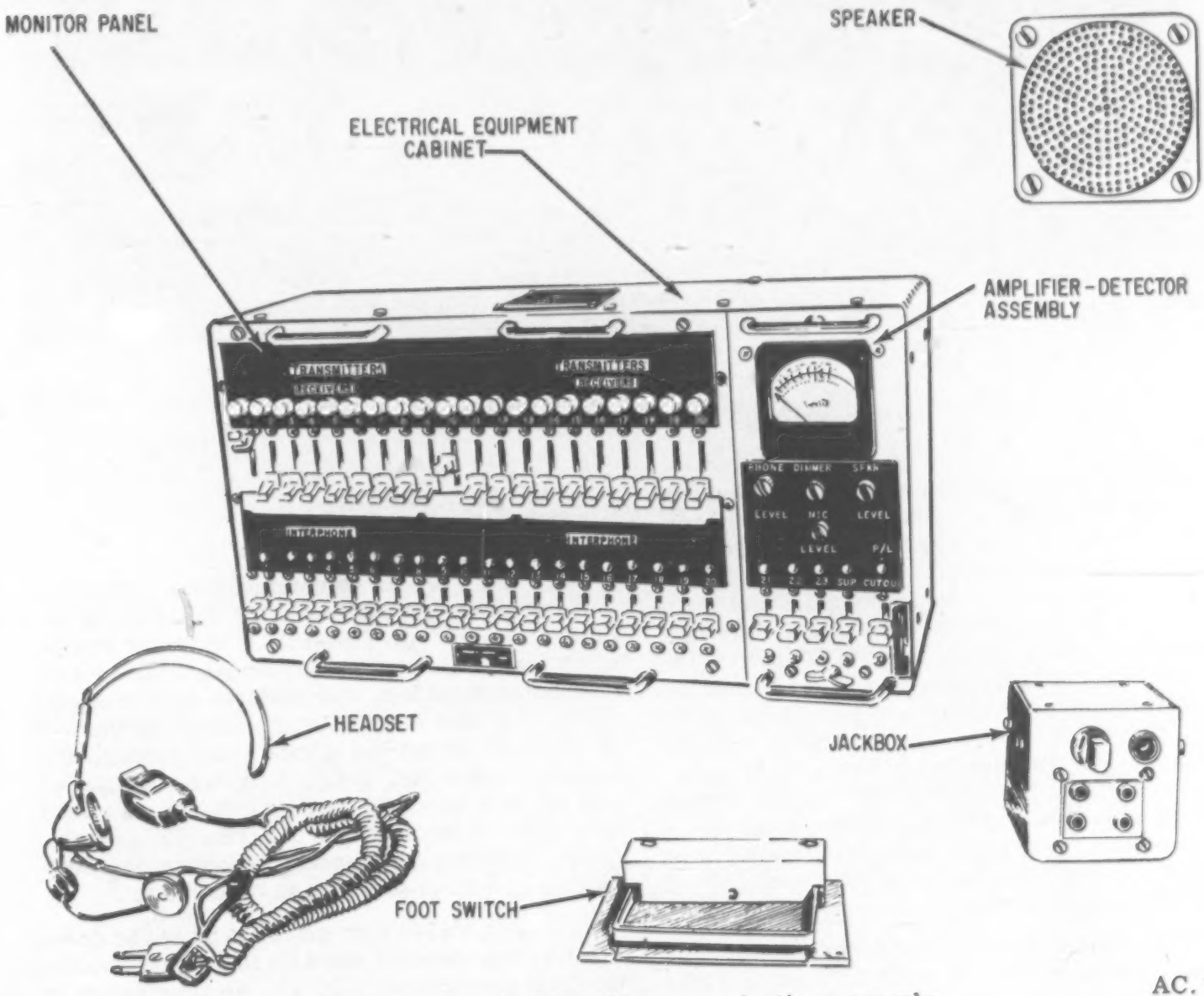

AC. 19

Figure 4-4.—AN/FSA-52 communications console.

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particular radar operating position is included in chapter 13 of this training manual.

Figure 4-5 shows a closeup of an actual installation of an AN/FSA-52 with the speaker amplifier control directly above it. Figure 4-6 shows the installation of the same communications equipment at three operating positions in a control tower. Additionally, some items of equipment discussed later in this chapter are shown in figure 4-6.

MICROPHONES

A microphone is essentially an energy converter that changes sound energy into corresponding electrical energy. When one speaks into a microphone, the audio pressure waves strike the diaphragm of the microphone and cause it to move in and out in accordance with the instantaneous pressure delivered to it. The diaphragm is attached to a device that causes current to flow in proportion to the instantaneous pressure applied to the diaphragm.

TECHNIQUES

Proper microphone technique is a necessity for all Air Controlmen in radiotelephone communications.

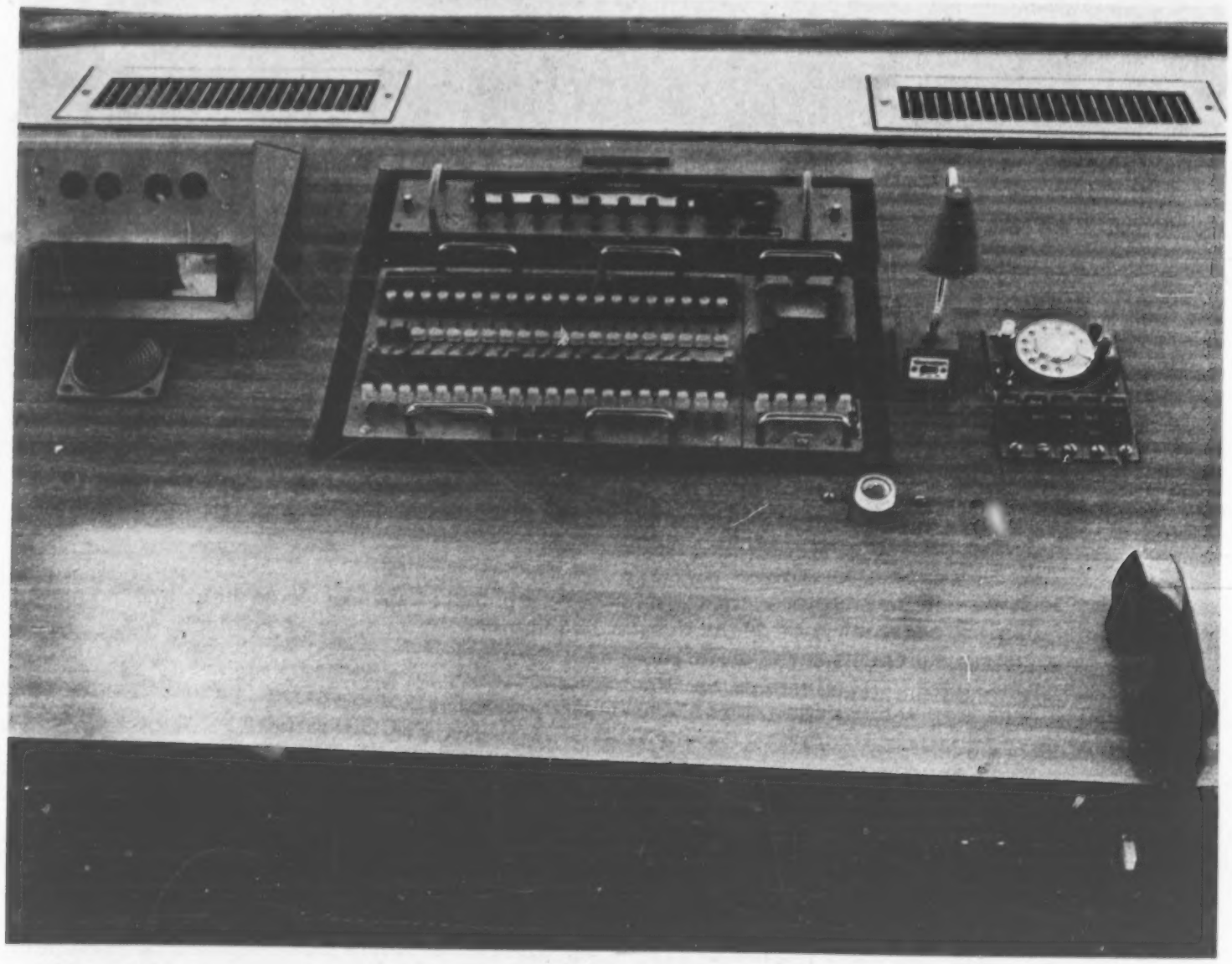

Figure 4-5. —AN/FSA-52 installation. AC. 20

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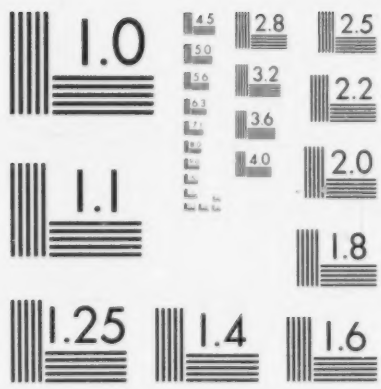

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

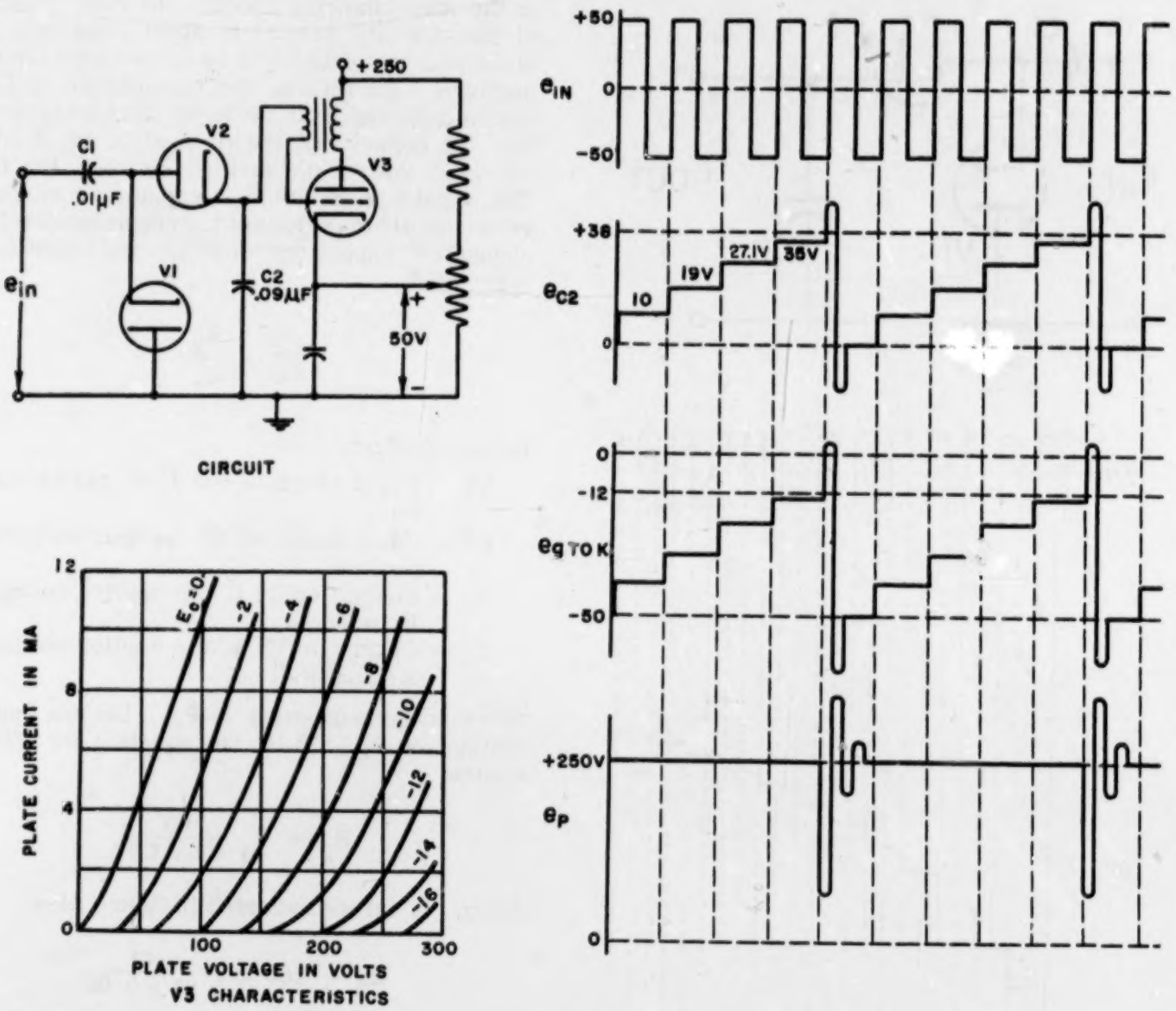

Figure 14-9.—Triggering blocked oscillator with step-charging circuit.

The first input pulse ends, C1 is discharged, but C2 holds its 10-volt charge. The second pulse occurs. The 10-volt charge on C2 opposes the 100 volts of the second pulse, and the total applied voltages to which the capacitors can charge is then 90 volts. E_a is 90 volts, and from the previous equation, C2 is again charged by 10 percent or 9 volts. This is in addition to the initial 10 volts, so at the end of the second pulse, the C2 voltage is 10 plus 9 or 19 volts. The third pulse is 100 volts again, but 19 volts oppose it. Therefore, Ea is 100 minus 19 or 81-volts and C2 charges and additional 8.1 volts. The new E_2 becomes 19 plus 8.1 or 27.1 volts. Successive input pulses raise C2 by 10 percent of the remaining voltage toward plus 100 until the blocked oscillator is actuated.

In the oscillator, the cathode voltage is set at plus 50 volts. The plate supply voltage is 250 volts, so the plate-to-cathode voltage is 200 volts. Using the plate-to-cathode voltage, you can determine the grid voltage for cutoff. From the curves in figure 14-9, this value is near minus 12 volts, as indicated on the characteristic curves. With the cathode at plus

1042

1401

AC. 21

Figure 4-6. —Control tower equipment.

In radiotelephone communications, the operator of the equipment becomes part of the system. The manner in which the message is delivered determines the effectiveness of the transmitted signal as well as the power and efficiency of the equipment.

The two general types of microphones used by AC's are the hand held type and the boom or headset type. Both types should be placed directly in front of the mouth, within one-half inch or almost touching the lips. Most microphones are relatively inefficient and the slightest variation of microphone position can drastically reduce the intelligibility of the message being transmitted. Figures 4-7 and 4-8 illustrate correct technique for hand held and boom or headset type microphones respectively.

VOICE RECORDER-REPRODUCER RD-217/UNH

The purpose of the RD-217/UNH (Sound-Scriber Model S-124) Single Channel Recorder/Reproducer is to record conversation between air traffic control facilities and aircraft. Recordings made of these conversations are used for aircraft accident analysis; circuit discipline; adequacy and accuracy of air traffic control facility instructions; immediate playback for as-

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AC. 22
Figure 4-7.—Hand microphone technique.

sistance in search and rescue; and for voice training of air traffic control personnel.

OPERATION AND CONTROL

The description given here on the Recorder-Reproducer RD-217/UNH is brief. Supplement this description by studying the Sound-Scriber Service Manual sent with the recorder in order to familiarize yourself with the capabilities and limitations of the recorder.

The RD-217/UNH Single Channel Magnetic Tape Recorder-Reproducer has been engineered and designed to perform the specific task of continuously recording any desired communication signal over any period of time up to 24 hours without tape change. In addition, the time in minutes from 0000 to 1455 (24 hours, plus a 15-minute overtime allowance) has been precision printed on the visible side of the tape as it moves past the recording head.

All the controls of the magnetic tape recorder (except the automatic volume control switch) are conveniently located on the front panel. (See fig. 4-9.) Study the service manual for complete procedures as to the proper methods to follow when tapes are to be changed or when playback is desired.

The recording medium is a brown magnetic tape wound on a 3 3/4-inch diameter plastic reel with the coated side wound toward the inside. Each tape is 2 inches wide and approximately 312 feet long.

There are two time scales on each reel of tape. To permit easy location of recorded material, the uncoated side is stamped in minutes to provide a time scale. This scale starts at 0000 minutes at one end of the tape and is stamped along its length a total of 1,455 minutes. (See fig. 4-10.) The time scale that is right side up as the operator faces the recorder is the one being used. In order to locate a specific portion of the recording, it is necessary to convert the number to time. If the number is 0200, it indicates that 200 minutes have elapsed since the tape was actuated. The conversion formulas are: If you have the number, divide by 60; if you have the time in hours, multiply by 60 and add the minutes.

Recorded material can be stored under normal conditions for an indefinite period of time without magnetic deterioration. The ideal site for both the recorder and the spare tapes is a room where dust and dirt are at a minimum, the temperature ranges between 60° to 75° F, and the relative humidity is 60 percent or less. The tapes can be used over and over for recording by erasing the recorded material. To erase the recorded material, a demagnetizer is used.

AC. 23
Figure 4-8.—Boom or headset microphone technique.

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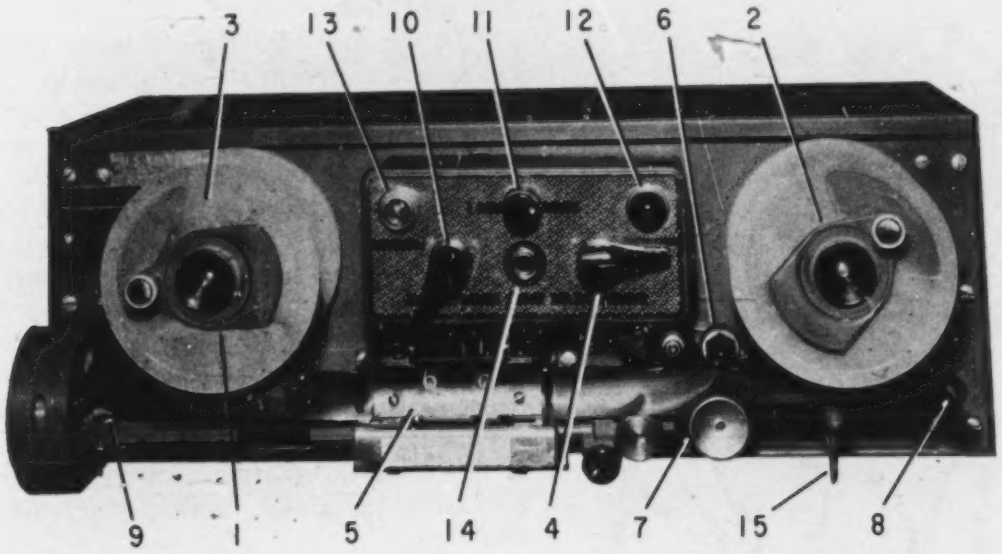

1. Handle crank.
2. Empty reel.
3. Full reel.
4. Load lever.
5. Gate and magnetic heads.
6. Rubber pressure roller.
7. Tape feed roller.
8. Tape guide.
9. Tape guide.
10. Record-stop-play selector switch.
11. Volume control.
12. Power indicator lamp.
13. Visual volume indicator.
14. Monitor jack.
15. Tuning lever.

AC. 24

Figure 4-9.—RD-217/UNH front panel controls.

The Chief of Naval Operations requires all air traffic control facilities to keep their recorded reels on file for a period of 10 days before erasing. However, in some instances a length of recorded material needs to be kept longer than the required time. In this case, the desired portion of the tape can be removed and another piece of tape the same length spliced in its place.

Each air traffic control facility has a maintenance kit supplied with each recorder. Within this kit are two reels of splicing tape. To splice the tape, place the ends of the tape that are to be spliced together, cut the tape at a 60-degree angle using a straightedge and razor blade or similar device and make sure that the cutting device is not magnetized. (See fig. 4-11.) Aline both ends of the tape with the uncoated side of the tape up and cover the alined ends of the tape with the splicing tape. The splicing tape should be allowed to protrude over the edges of the tape and should not be stretched, as stretching will cause it to curl. Apply pressure to the splicing tape with the thumbnail or a smooth object, then remove the excess tape with nonmagnetic scissors.

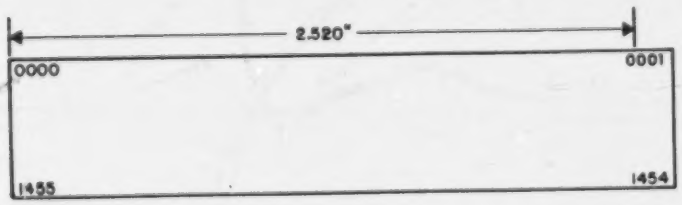

AC. 25

Figure 4-10.—Portion of magnetic tape.

DEMAGNETIZER

The demagnetizer is a portable unit contained in an aluminum cabinet. The demagnetizer is designed to erase the recorded material from a complete reel of tape. (See fig. 4-12 for an illustration and controls of the demagnetizer.)

To demagnetize a reel of tape, hold the power switch of the demagnetizer in the ON position until the neon light becomes bright, then place the reel of tape on the rollers. After the reel is placed on the rollers, rotate the reel three complete turns. After the turns are complete,

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AC. 26

Figure 4-11.—Cutting magnetic tape.

slowly remove the reel from the demagnetizer and release the power switch. Be sure that the power switch is NOT released before removing the reel. If this is not done properly a loud swishing background noise will be heard when this reel is played back after is has been used for recording again. To complete this procedure of erasing, the tape should remain in the demagnetizer approximately 10 seconds, but in no case should it be left in the demagnetizer in excess of 15 seconds.

SAFETY PRECAUTIONS

Both the recorder and the demagnetizer employ voltages which are extremely dangerous if contacted by operating personnel. Operating personnel must at all times observe applicable safety regulations when using or working with this equipment. If the magnetic tape recorder is to be permanently located in one spot, ground chassis of machine to a good earth connection. Because of high voltage generated by the demagnetizer, it must be grounded. NEVER operate the demagnetizer without a proper ground. A very strong magnetic field is created by the two poles of the demagnetizer. Be careful not to place any delicate instrument close to this field.

WIND INDICATOR

Wind direction and wind velocity indicators are mounted in the control tower to provide controllers with first-hand wind information in order to select the proper runway to use during specified wind condition. They provide a method for prompt issuance of wind directions and velocities to pilots by controllers. Also, the controller may note a marked increase in velocity, gustiness, or a wind shift that if relayed immediately to the weather service personnel may be significant of impending or approaching weather changes. These instruments are of several sizes and mounted in various ways in the tower.

Normally the meteorological instruments located in the tower are "slaves" to the equipment in the meteorological office. The wind direction received in the weather office on the "master set" is "true" direction. On the other hand, the directional instruments in the tower must be compensated for magnetic variation so that the controller reads "magnetic wind," which is what he relays to the pilot.

Figure 4-13 illustrates the ID-586/UMQ-5 wind direction and speed indicator which is installed in many Navy control towers.

The wind indicator readings in the control tower must be compared with weather service readings at the beginning of each working day, keeping in mind that weather service direction is true and variation must be applied to obtain

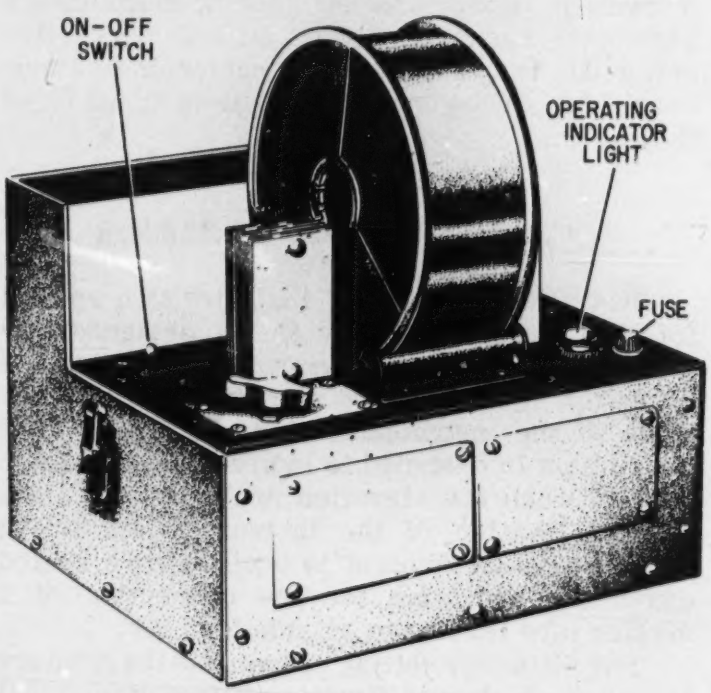

AC. 27

Figure 4-12.—Demagnetizer.

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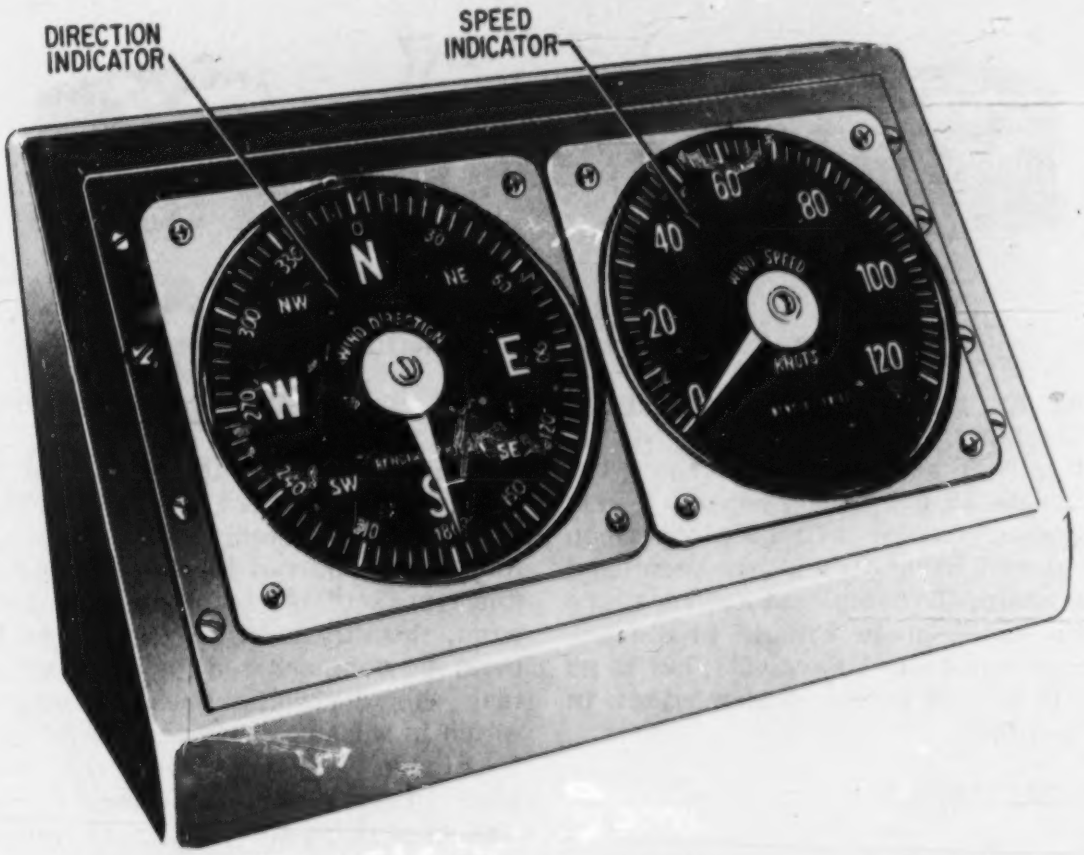

AC. 28

Figure 4-13. —ID/586/UMQ-5 wind direction and speed indicator.

a correct reading. If the wind indicator is in error plus or minus 5 degrees in direction or 5 knots in speed, weather service maintenance personnel must be notified so that corrective action can be taken. If the instrument is in error over 10 degrees or 10 knots it is considered inoperative.

ALTIMETER SETTING INDICATOR

The altimeter setting indicator is a special form of aneroid barometer so designed that after installation and proper adjustment, the altimeter setting may be read directly from the scale of the instrument. (See fig. 4-14.) The instrument is designed to indicate the altimeter setting when the elevation scale is set to the actual elevation of the instrument above sea level. The mechanism is enclosed in a sealed case with provision for the connection of a venting tube leading to outside free air.

The altimeter setting indicator is the primary means of obtaining altimeter settings at terminal facilities. The altimeter setting indicator reading must be compared with the official altimeter setting of the weather service between 0800 and 0900 (local time) each day. If there is an error in the instrument of .02 but less than .04 inch, the correction factor is written on the face of the instrument for application to readings issued until weather service maintenance personnel can

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Figure 4-14. —Altimeter setting indicator.

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check the instrument. If the error exceeds .04 inch, the instrument is considered inoperative. In both cases, maintenance personnel must be advised immediately. If the average windspeed is in excess of 40 knots at the time a correction factor is determined, the previously determined correction factor must be used until the average windspeed is less than 40 knots.

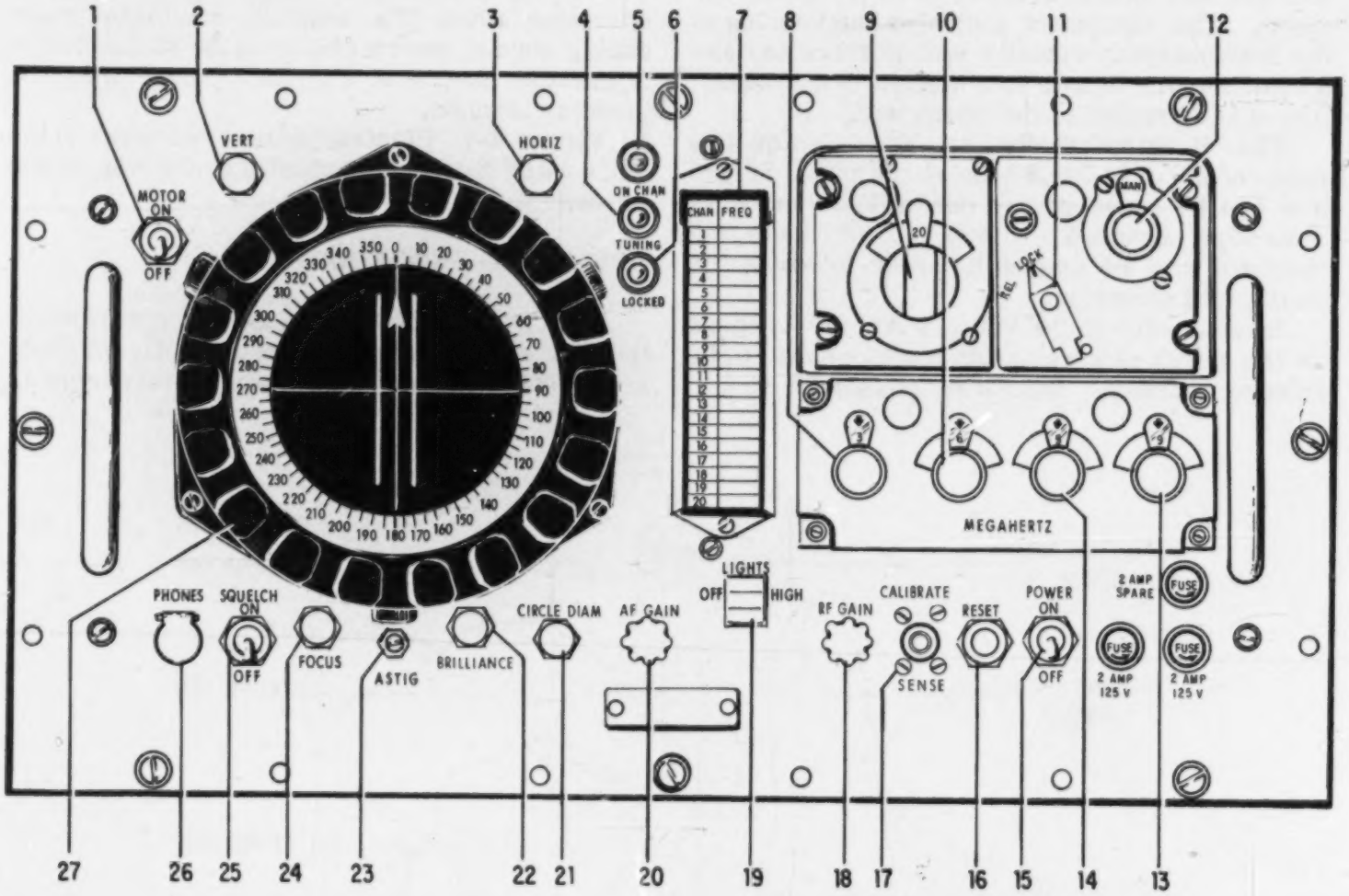

1. MOTOR switch.
2. VERTical control.
3. HORIZontal control.
4. Amber lamp, TUNING.
5. Green lamp, ON CHANnel
6. Red lamp, LOCKED.
7. Frequency log chart.
8. First digit selector switch.
9. Channel selector switch.
10. Second digit selector switch.
11. RELease LOCK switch.
12. MANual PRESET switch.
13. Fourth digit selector switch.
14. Third digit selector switch.
15. POWER switch.
16. RESET switch.
17. CALIBRATE-SENSE switch.
18. RF GAIN control.
19. LIGHTS switch.
20. AF GAIN control.
21. CIRCLE DIAMeter control.
22. BRILLIANCE control.
23. ASTIGmatism control.
24. FOCUS control.
25. SQUELCH switch.
26. PHONES jack.
27. Alidade operating ring.

AC. 30

Figure 4-15.—Direction Finder Set AN/URD-4.

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DIRECTION FINDER EQUIPMENT

Direction Finder Set AN/URD-4 functions as a means of determining rapidly the direction of fixed and mobile sources of radio transmissions. The equipment indicates the bearing of the transmission visually and delivers any associated audio signals to a headset upon connection of the headset to the equipment.

The direction finder set has a frequency range of 225.0 to 399.9 MHz in one band. Selection can be made of any one of 1,750 crystal-controlled channels. Any 20 of the 1,750 channels can be preset in order to allow for their rapid selection.

Inaccuracies in the visual bearing may occur as the result of reradiation from objects in the antenna vicinity. Operating personnel should acquaint themselves with distortions of the propeller-shaped pattern resulting from such reradiation. Preknowledge of such distortions will prevent misinterpretations of the visual pattern.

The equipment is immediately available for operation when IFR weather conditions exist during normal working hours of the station and on 5 minutes notice at all other times when the tower is manned.

Figure 4-15 illustrates the front panel of the URD-4 and lists the function of each control knob or switch.

OPERATING PROCEDURES

The AN/URD-4 found in naval control towers today is a valuable instrument to the Air Controlman. This direction finding equipment serves as

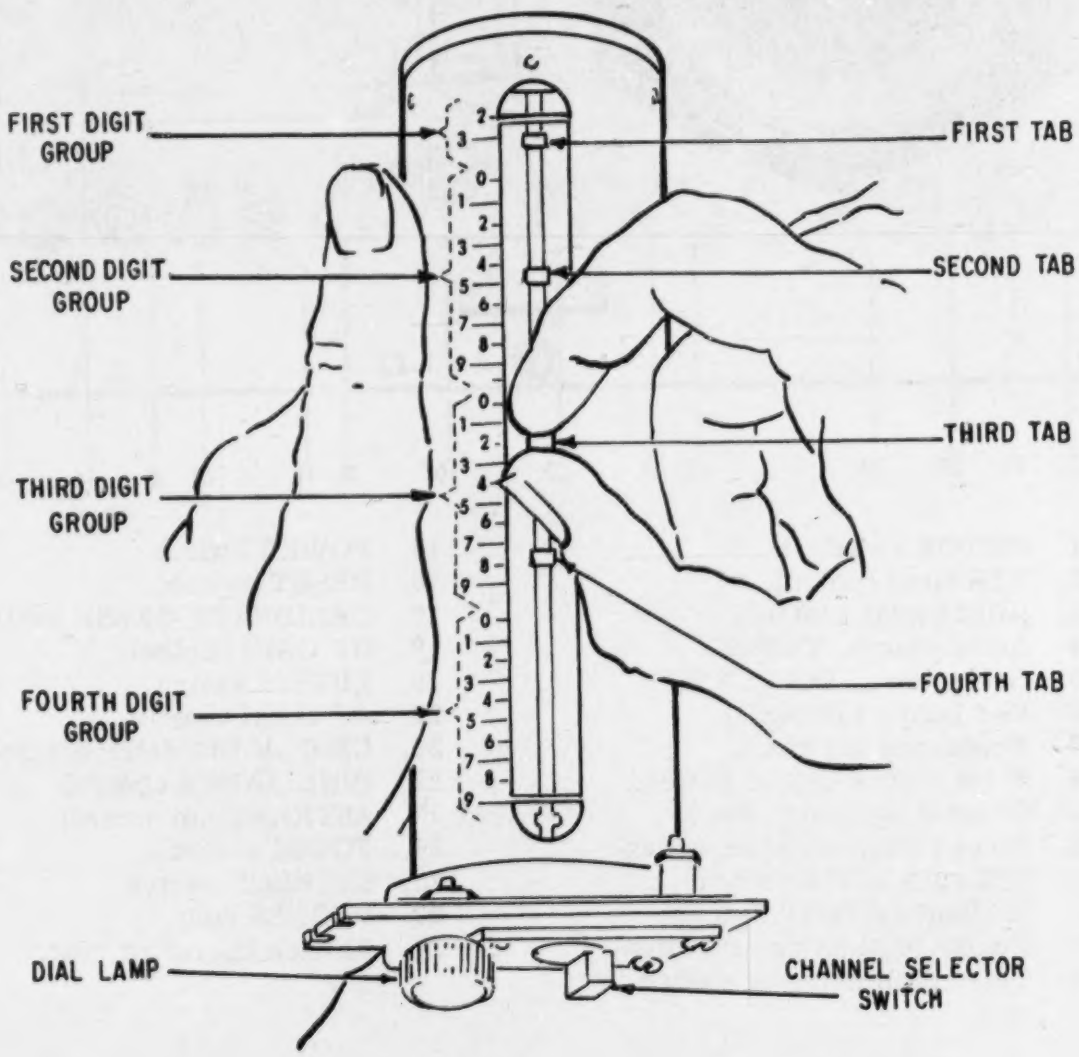

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Figure 4-16.—Memory cylinder adjustment.

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an aid to aerial navigation; and when necessary, may be used as a standby receiver. The principal uses for navigational purposes are as follows: plotting the position of lost aircraft from the station, giving bearings to the aircraft from the station, and giving courses to the aircraft.

The basic operating procedures for the URD-4 are listed in the following paragraphs. Those numbers appearing in parentheses are referenced to the appropriate control knob or switch as illustrated in figure 4-15.

Channel Preselection

Twenty channels of the 1,750 channels available can be preset for rapid selection. Set up these 20 channels as follows:

1. Log the frequencies of the 20 desired channels on the frequency log chart (7) held in place on the indicator panel.
2. Push in the release pushbutton beside the switch and turn the RELease-LOCK switch (11) to RELease.
3. Grasp the channel selector switch (9) and pull the memory cylinder (fig. 4-16) straight out until it is free from the indicator control panel.
4. Hold the memory cylinder firmly with one hand, with the longitudinal slot up and the cylinder in a horizontal position, the panel facing the holder. Figure 4-16 illustrates the method of holding and setting the memory cylinder.
5. Rotate the channel selector switch to the desired channel position as indicated by the numbered dial on the front panel of the memory cylinder.
6. Place the first tab from the rear of the cylinder opposite the index digit marked on the cylinder case which corresponds to the first digit of the four-digit channel frequency being set up on the first preset channel.
7. Place the second tab from the rear of the cylinder opposite the index digit marked on the cylinder case which corresponds to the second digit of the four-digit channel frequency.
8. Place the third tab from the rear of the cylinder opposite the index digit marked of on the cylinder case which corresponds to the third digit of the four-digit channel frequency.
9. Place the fourth tab from the rear of the cylinder opposite the index marked on the cylinder case which corresponds to the fourth or decimal digit of the four-digit channel.
10. Set up the remaining channels as described in steps 5 to 9 inclusive.
11. Slide the memory cylinder back into place in the indicator. Turn RELease-LOCK switch to LOCK.

Energizing the Direction Finder Set

Energize the direction finder set as follows:

1. Throw POWER switch (15) to ON (fig. 4-15).
2. Throw MOTOR switch (1) to ON to start antenna rotation.
3. Turn LIGHTS switch (19) to give desired level of intensity for lamps on indicator panel.

Channel Selection

With the 20 channels preset, a choice can be made as to the mode of channel frequency selection—preset or manual. Procedures for the two modes are as follows:

1. Preset operation is as follows:
   a. Set MANual PRESET switch (12) to PRESET.
   b. Turn channel selector switch (9) to desired channel number. As the switch is turned, the desired channel number will appear under the arrow in the selector dial window, and the tuning mechanism will be activated.
   c. The amber lamp, TUNING (4), glows as the tuning mechanism seeks the channel. When the tuning mechanism comes to rest after finding the channel, the green lamp, ON CHANnel (5), glows.
   d. If the tuning mechanism cannot find the selected channel, due to malfunctioning of the mechanism or because the channel is out of the frequency range of the equipment, the red lamp, LOCKED (6), will glow, indicating that the tuning mechanism is locked. Depress RESET switch (16) momentarily to cause the tuning mechanism to unlock and recycle.
2. Manual operation is as follows:
   a. Set MANual PRESET switch (12) to MANual.
   b. Set digit selector switches (8, 10. 13, and 14) to the desired frequency.
   c. The amber lamp, TUNING (4), glows as the tuning mechanism seeks the channel. When the tuning mechanism comes to rest after finding the channel, the green lamp, ON CHANnel (5), glows.
   d. If the tuning mechanism cannot find the selected channel, due to malfunctioning of

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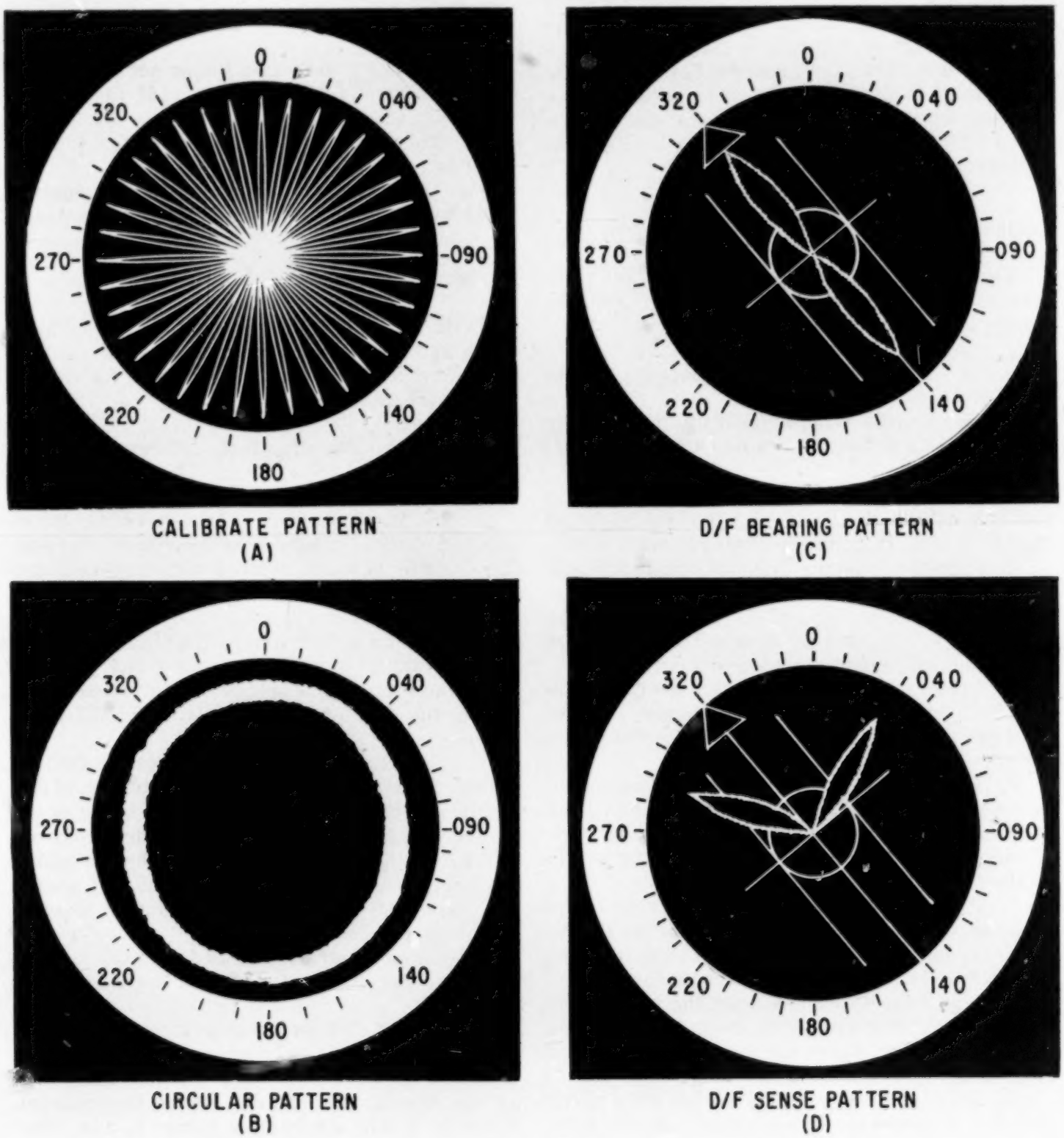

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Figure 4-17.—DF pattern interpretation. (A) Calibrate pattern; (B) circular pattern; (C) DF bearing pattern; (D) DF sense pattern.

the mechanism or because the channel is out of the frequency range of the equipment, the red lamp, LOCKED (6), will glow, indicating that the tuning mechanism is locked. Depress RESET switch (16) momentarily to cause the tuning mechanism to unlock and recycle.

Calibration Pattern Check

Prior to use of the equipment for direction finding, check the calibration pattern as follows:

1. Throw CALIBRATE-SENSE switch (17) to CALIBRATE.
2. The tips of the 36 lobes of the calibration pattern should just touch the inside edge of the azimuth scale. (See fig. 4-17 (A).)
3. Lobes should be precisely at 360 degrees, 90 degrees, 180 degrees, and 270 degrees.
4. The converging point of the lobes should be at the intersection of the crossed lines of the cursor screen.
5. If the calibration pattern does not conform to requirements listed in steps 2 to 4 inclusive, have the equipment recalibrated by the electronic techniques.
6. Adjust the intensity of the calibration pattern with the aid of BRILLIANCE control (22, fig. 4-15). Adjust focus with FOCUS control (24).

Direction Finding Procedure

The direction finding procedure is as follows:

1. Throw CALIBRATE-SENSE switch (17) to center position; set RF GAIN control (18) near maximum.
2. Select the desired channel.
3. When no signal is being received, the cathode-ray tube displays a circular pattern. Random noise will distort the circular pattern if RF GAIN control is at or near maximum. (See fig. 4-17 (B).)
4. When a signal is received, the circular pattern is resolved into a propeller-shaped pattern, the tips of the propeller pointing along the bearing of the signal. (See fig. 4-17 (C).)
5. Rotate the cursor screen by means of the alidade operating ring (27) to line up the arrow etched in the screen along the axis of the bearing signal. The two lines parallel to the arrow facilitate alinement.
6. Throw CALIBRATE-SENSE switch (17) to SENSE. The propeller-shaped pattern will be transformed, the two lobes of the pattern bending back away from the direction of the signal origin. (See fig. 4-17 (D).)
7. The bearing of the signal can be read on the azimuth scale. Should the "sense" pattern indicate that the signal origin direction is opposite from the azimuth reading given by the cursor screen arrow, read the azimuth bearing at the tail end of the arrow.
8. Insert a headset into PHONES jack (26) if monitoring of the signal modulation is desired. Turn AF GAIN control (20) to the desired volume of audio signal level.

The operational procedures described here are only basic and should not be construed as being complete. Additional instruction and practice are necessary to fully understand the operational procedures used to obtain accurate, complete, and concise DF assistance.

When providing DF service to an aircraft in an emergency status, a controller should determine if the aircraft is in VFR or IFR weather conditions and the fuel remaining. If the aircraft is not on an IFR flight plan and is in VFR weather conditions, the pilot should be advised to remain VFR. If the aircraft is in IFR weather conditions, the pilot should be advised of the minimum safe DF altitude and coordination with the appropriate control facility must be effected. The appropriate DF net control should also be alerted.

NOTE: All stations are in a DF net which is an area determined geographically for the purpose of obtaining cross bearings from different stations to provide a fix.

The aircraft's approximate position may be determined in terms of distance or flying time from the DF station. In both cases the following steps are required:

1. Establish the aircraft on a heading inbound to the DF station.
2. Turn the aircraft left or right 90 degrees from the inbound heading.
3. Take new bearings each 20 seconds until a 10- or 20-degree bearing change occurs.

To compute the estimated distance, obtain the true airspeed from the pilot and use the following formula, in which Time is the number of minutes for the bearing change:

$$\text{Distance} = \frac{\text{TAS X Time (minutes)}}{\text{Degrees of change}}$$

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50 volts, the grid must be within less than 12 volts of this value, that is, above 50 minus 12, or 38 volts to allow conduction. The steps continue until the grid voltage exceeds 38 volts. Since the fourth step is approximately 35 volts and the fifth step is approximately 41 volts, the 38-volt level is crossed between the fourth and fifth steps.

The blocked oscillator goes through one cycle of operation at the end of which C2 is discharged. Since every fifth input pulse results in an output pulse, this circuit is a 5-to-1 frequency divider.

To cause the circuit to divide by three, four, or some other value, the bias is established at some new value. For example, a bias of 36 volts would cause the crossover with cutoff voltage to occur at the end of the third pulse, making the circuit a 3-to-1 count divider. The sizes of the steps can be varied by changing the ratio of the two capacitors. For example, if C2 is changed to 0.04 μf, it will take 20 percent of the charge, and the 38-volt level is crossed at the end of the third pulse, causing division at a 3-to-1 ratio.

In practice, frequency division can be carried to the extent that with six successive frequency dividers, a 100,000 cps sine wave can be reduced to 50 cps. The final circuit is triggered on each two-thousandth cycle of the original voltage.

AUTOMATIC FREQUENCY CONTROL (AFC)

The term AFC refers to an automatic system incorporated in a radio or radar receiver circuit for the purpose of maintaining the correct local-oscillator frequency. Almost all Navy radar equipment utilizes an AFC system.

Transmitters that produce frequencies in the UHF and microwave ranges have poor frequency stability. This is caused by factors which have negligible effect at lower frequencies. A partial listing of the cause of frequency instability at UHF and microwave ranges in transmitter oscillators and local oscillators is as follows:

1. Small physical size. Since the frequency determining components are small in physical size any condition that changes their shape or size causes a shift in frequency. Factors that cause these components to change their characteristics are vibrations, variations in temperature, and variations in atmospheric pressure.

2. Frequency pulling. This is the result of load variations which are caused by variations in the length of transmission lines, or reflections from nearby objects such as sea return, aircraft surfaces, or the radome. (This was mentioned previously in chapter 12 of this course.)

3. Frequency pushing. This is caused either by variations in the source of power or by poor regulation in the equipment's power supply.

Because of the previously presented inherent conditions it is important that the tuning of a microwave receiver to the proper frequency be automatic.

Some of the properties of microwave oscillators which may be used for frequency control are as follows:

1. Those of a magnetron-mechanical, thermal, and varying flux field density.

2. Those of a klystron-mechanical, thermal, and electrical.

The system most often used and the one described for the purpose of enabling you to gain a fuller understanding of AFC is the system which controls the repeller voltage of the local oscillator. This is the more practical method because a change in frequency is nearly linear with a change in voltage; also, changes up to 60 megacycles are practical. The operation of this type of oscillator, known as the klystron, is explained in detail in chapter 12.

CLASSIFICATION OF AFC SYSTEMS

AFC systems are classified in accordance with their method of operation. The method of operation may be divided into two major classifications, the absolute and the difference frequency systems.

In the absolute frequency system the frequency of oscillation is determined by a precision frequency standard such as a high-Q cavity. This system is generally used to keep the receiver tuned to the beacon frequency. In the difference frequency system the local oscillator is maintained on a frequency which is greater or less than the magnetron frequency by an amount equal to the intermediate frequency. This keeps the receiver tuned to the magnetron during search operation.

Either of these systems may be a nonhunting or hunting type construction. The hunting system is constructed to cause the oscillator to sweep a wide frequency range. This enables the oscillator to find the correct operating

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To compute the estimated flying time from the DF station use the following formula:

$$\text{Time} = \frac{60 \text{ X Time (minutes)}}{\text{Degrees of change}}$$

EXAMPLE: TAS = 180; time of bearing change = 10 minutes; degrees of bearing change = 20 degrees:

SOLUTION FOR DISTANCE:

$$\text{Distance} = \frac{180 \times 10}{20}$$

Distance = 90 miles; or

SOLUTION FOR TIME:

$$\text{Time} = \frac{60 \times 10}{20}$$

Time = 30 minutes

PORTABLE TRAFFIC CONTROL LIGHT

The portable traffic light is used to control the movement of personnel and vehicles on the landing area and the landings and takeoffs of aircraft not equipped with radio. It is a directive light which emits an intense, narrow beam. Signals from the light are readily discernible to the pilot of any aircraft visible to the tower operator.

The portable traffic light (fig. 4-18) consists of a mica composition case, a reflector mounted inside at the back, a mechanism for controlling a choice of three different colored lights, and a socket for a light bulb. The light selector mechanism consists of two filters, one red and one green, mounted vertically on two arms that extend into a horizontal position from the front to the back. These arms are connected to the light selector handle underneath the case, thus enabling the operator to select the appropriate color. In addition, the selector handle aids in aiming the light. By turning this handle fully clockwise, the red filter is in place, giving a red light; fully counterclockwise puts the green filter in place.

The intermediate position, in which neither filter is in place (both at the side of the case),

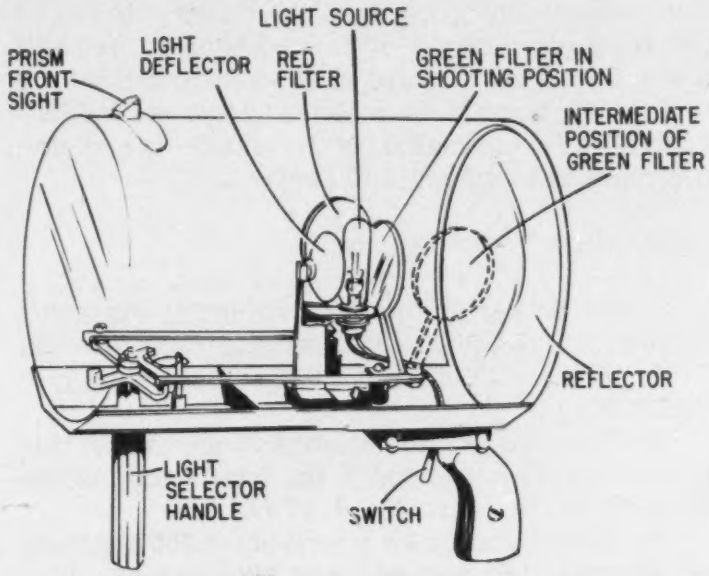

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Figure 4-18.—Portable traffic control light.

produces the clear or white light. The switch that controls the light is in a pistol type grip located toward the rear of the light underneath the case. The switch is a spring-loaded toggle switch that automatically opens the circuit when released. This feature enables the operator to flash the selected color or to hold the toggle switch down when a steady color is desired. The portable traffic light is normally installed in control towers from overhead by means of a cable on pulleys and counterbalanced by weights. This keeps the light within reach for the controller's instant use and in an out-of-the-way position when not in use.

The Air Controlman should be thoroughly familiar with the limitations of the traffic control light, and evaluate its capabilities in connection with its use. The traffic control light has a range of 15 miles at night and 10 miles during daylight hours. It has the following advantages:

1. Requires no radio equipment in the aircraft; therefore, all aircraft can be controlled whether or not they possess radio.

2. Provides an emergency method of control in event of radio failure—either in the tower or the aircraft.

3. In event of power failure in the tower, the light kit includes a battery cable and connections for use with emergency battery power. It has the following disadvantages:

a. The pilot may not be looking at the control tower at the time a signal is directed toward him.

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b. The information transmitted by a light signal is limited. One may transmit only an approval or disapproval of the pilot's anticipated actions to him since no explanatory or supplementary information can be transmitted.

CLOCKS

Two basic types of clocks may be found in the control tower: the large 12-hour wall clock, or the small direct-reading counter type clock in both the 12-hour and 24-hour version, which also has a second drum. (See fig. 4-19.) Some stations have a date-time stamp clock which is most useful for maintaining exact records of the time occurrence of events. Regardless of what type of timing device is utilized, it must be kept accurate at all times.

NAVAID MONITOR

At some shore air activities the navaid monitors are located within the control tower. In such cases the control tower facility is responsible for monitoring navigation aids. Figure 4-20 is an example of an air traffic control console for monitoring navaids. Basically the AN/GSA-35 in figure 4-20 provides facilities to perform the following functions:

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Figure 4-19.—Direct-reading clock.

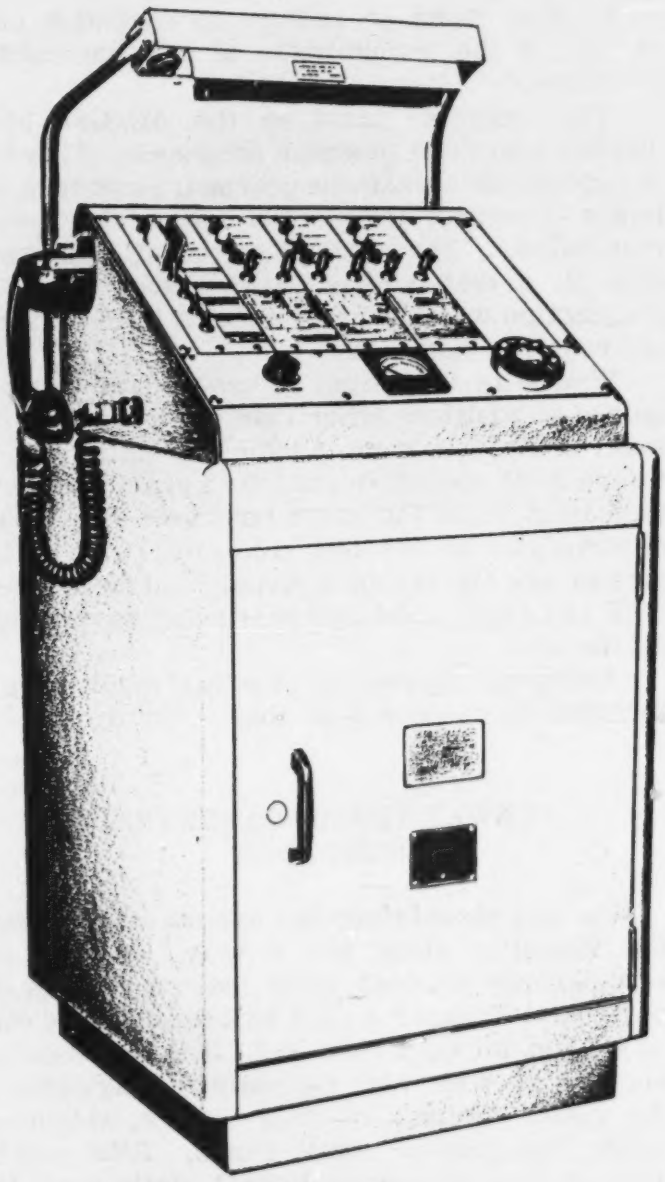

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Figure 4-20.—AN/GSA-35 air traffic control console.

1. Monitor and display the status of TACAN, VOR, and UHF HOMER transmitters at remote locations.
2. Establish voice communications between the console and the remote locations.
3. Provide manual control of TACAN, VOR, and UHF HOMER transmitters, using the telephone dial.
4. Provide a visual and aural alarm should failure occur at the transmitter location.

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5. Voice modulate the VOR and UHF HOMER transmitters.

6. Shut down or restore to operation any, or all, of the transmitters at the transmitter locations.

The control panel on the AN/GSA-35 is divided into four modular subpanels. Three of the subpanels contain the necessary switches and lamps to control and monitor a particular navaid transmitter. The subpanel on the left of the console is a dial control panel which is used in conjunction with the other subpanels to perform the required functions.

Where an indication of navaid status is required at positions other than the location of the main console, a remote indicator illustrated in figure 4-21 may be installed to provide a slave indication from the main console. The navaid descriptions on the left side of the remote indicator are lighted continuously and the adjacent OFF is lighted when that particular navaid goes off the air.

Additional discussion of navaid monitoring is included in chapter 8 of this training manual.

RUNWAY VISUAL RANGE (RVR) INDICATOR

Runway visual range is a system of measuring the visibility along the runway. It is an instrumentally derived value that represents the horizontal distance a pilot will see down the runway from the approach end. It is based on the sighting of either high intensity runway lights or the visual contrast of other targets, whichever yields the greater visual range. RVR may be used in lieu of meteorological visibility in the approval of straight-in instrument approach procedures and takeoff minimums.

AC. 36

Figure 4-21.—Remote navaid status indicator.

Figure 4-22 is an example of an RVR instrument presently in operation in Navy control towers. As the figure illustrates, RVR is measured in hundreds of feet, which requires multiplying the value shown in the window by 100 to have an actual value for application to an instrument procedure or for relay to another position within the facility.

The equipment shown in figure 4-22, located below the RVR display panel, is remote control switching equipment for the purposes indicated on the dialing code card shown.

OPERATING MAINTENANCE

The air traffic control tower is a primary link in the air control system. Peak efficiency can only be maintained by insuring that all electric and electronic equipment is functioning at all times. Outages of power and malfunction of equipment will happen from time to time. Equipment performance checks and constant visual inspections of the tower equipments are necessary.

A good practice to follow is for each section, as it relieves the watch, to utilize some form of checkoff list. These checkoff lists should be completed as soon as possible (traffic conditions permitting) after going on watch. The list can be expanded or shortened as conditions warrant at any locality. Any malfunctions should be immediately brought to the attention of the electronics technicians normally assigned to the tower. Under no circumstances should a tower operator tamper with the adjustments, repair, or maintenance of the control tower equipment.

Another good practice to follow is to make periodic visual inspections of all the tower equipment. This can be accomplished during periods when traffic is light, and can be done in a matter of minutes. Any control tower equipment out of adjustment or otherwise inoperative creates hardships for yourself and your shipmates.

The maintenance, general appearance, and condition of the tower and equipment, including furniture and cleanliness of spaces, reflect directly upon the attitude and spirit of the personnel assigned. Generally, everyone has an area of responsibility under the watch supervisor or section leader. As with any task you are assigned, your actions and attitude toward

menial tasks are making impressions on your senior petty officers, and willingness to cooperate and do a good job will not go unnoticed. Most towers require that certain cleaning functions be completed prior to the change of watches; while details such as window washing are performed less frequently. Remember that towers are filled with valuable electrical and electronic equipment that must be kept clean and free of dust to perform at peak efficiency.

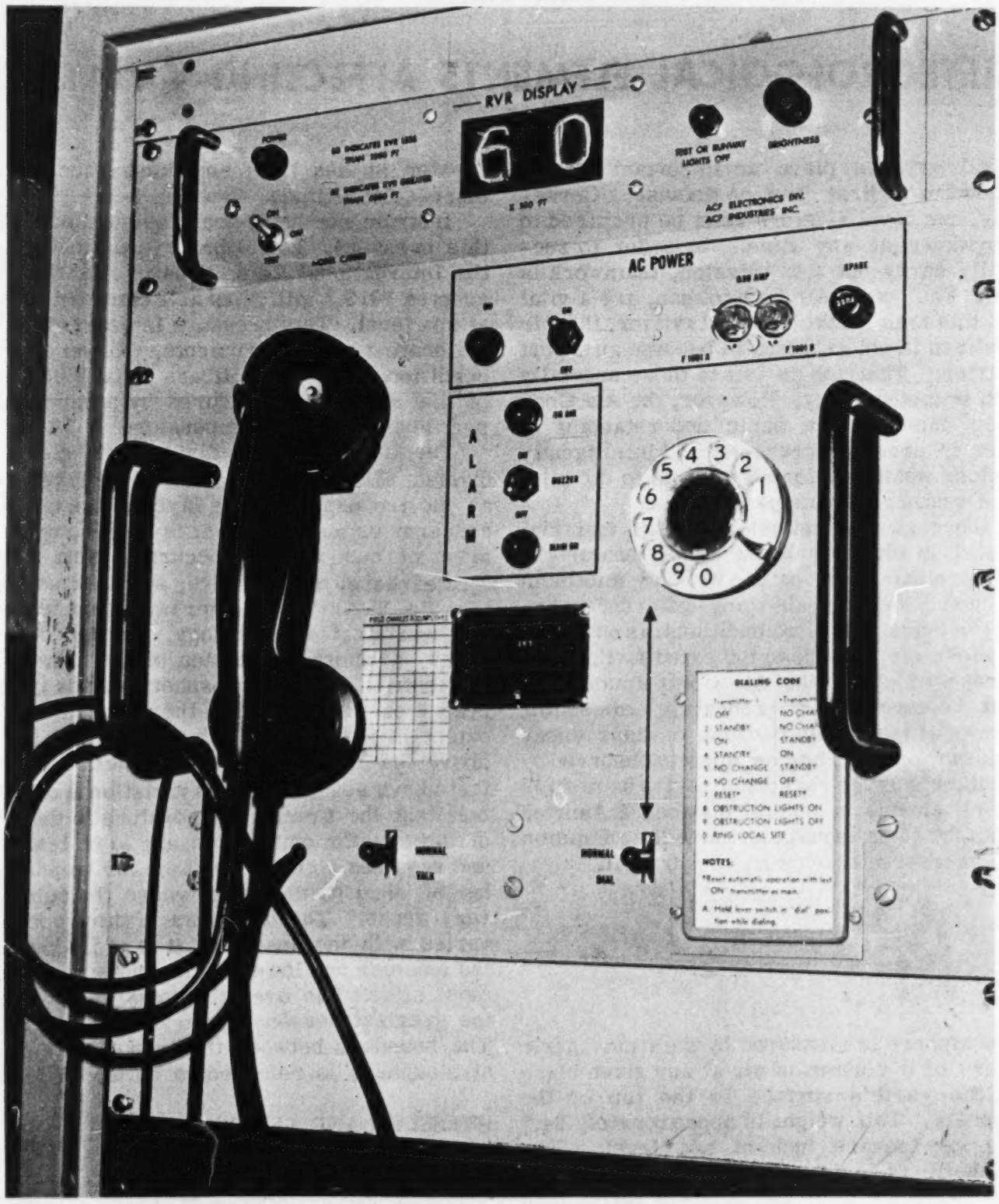

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Figure 4-22.—Runway visual range indicator.

CHAPTER 5

METEOROLOGICAL ELEMENTS AFFECTING AVIATION

Naval aviation plays an important role in this country's first line of defense. Consequently, our naval aviators must be prepared to fly anywhere at any time. In order to successfully carry out this mission, teamwork is a must. You, as an Air Controlman, are a vital link in this team. Like the naval aviator, the Air Controlman is not expected to become an expert forecaster. That job is left to those specially trained in meteorology. However, the Air Controlman must have a basic understanding of weather in order to correctly and intelligently pass along weather information both to the pilot and the weather service personnel.

A thorough understanding of the material contained in chapters 5 and 6 will enable the Air Controlman to recognize not only minimum flying conditions but also any differences between the actual weather conditions, as observed from the tower, and those indicated by the current report. Also, the Air Controlman must become competent in reporting impending weather changes that, because of their unexpectedness, may not be immediately observed by the weather service personnel. At the same time weather elements in general may be transmitted to pilots for them to make an immediate decision in the interest of safety and/or survival.

PRESSURE

ATMOSPHERE

Atmosphere is measured by the atmospheric pressure of a column of air at any given place from the earth's surface to the top of the atmosphere. This weight is approximately 14.7 pounds per square inch at sea level. The atmosphere is acted upon by the forces of gravity; thus air is denser at lower levels than at higher levels due to the greater mass pushing down on it. Consequently, pressure is greater at sea level and diminishes with any increase of altitude. (See fig. 5-1.)

Instruments have been designed to measure this pressure. To calibrate these instruments, the International Committee of Air Navigation adopted 1013.2 millibars as a standard pressure at sea level. This pressure is considered when calibrating the instruments. Under standard conditions, 1013.2 millibars equal 29.92 inches of mercury when measured by a barometer at sea level with the temperature at 15°C(59°F).

The atmosphere is divided into concentric layers. Closest to the earth is the layer known as the troposphere; this layer is the one which concerns us most, since it is in this region that most of our weather occurs. Next are the stratosphere, mesosphere, and thermosphere. (See fig. 5-2.) These outer layers are important in theoretical meteorology, but for our purposes, a short discussion of the troposphere will suffice. The troposphere varies in thickness from the equator to the poles; its vertical extent is greatest over the equator (60,000 feet above sea level) and least over the poles (30,000 feet above sea level). This variation is due to the fact that the greater temperature in the region of the equator causes the air to be less dense and requires a greater volume, or tropospheric height, than at the poles where the cold air is very dense. The thickness of the troposphere varies with the seasons. It is at its highest in the summer and lowest in the winter. The area most affected is over the poles where there is the greatest seasonal contrast of temperature. The boundary between the troposphere and the stratosphere is referred to as the tropopause.

PRESSURE AND TEMPERATURE CHANGES

Atmospheric pressure varies from the standard atmosphere over all areas of the earth's surface. Areas in which pressure is

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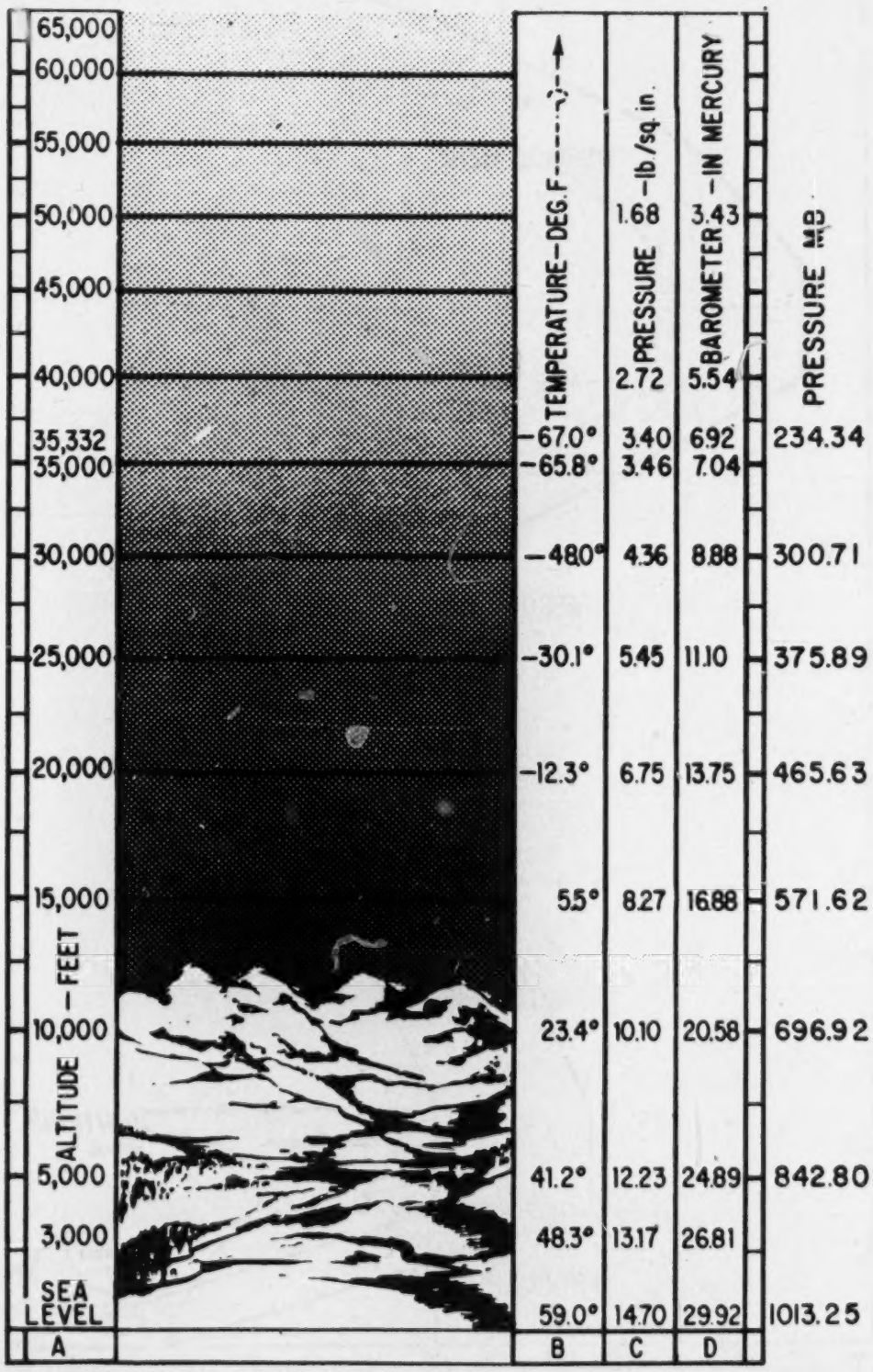

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Figure 5-1.—The standard atmosphere.

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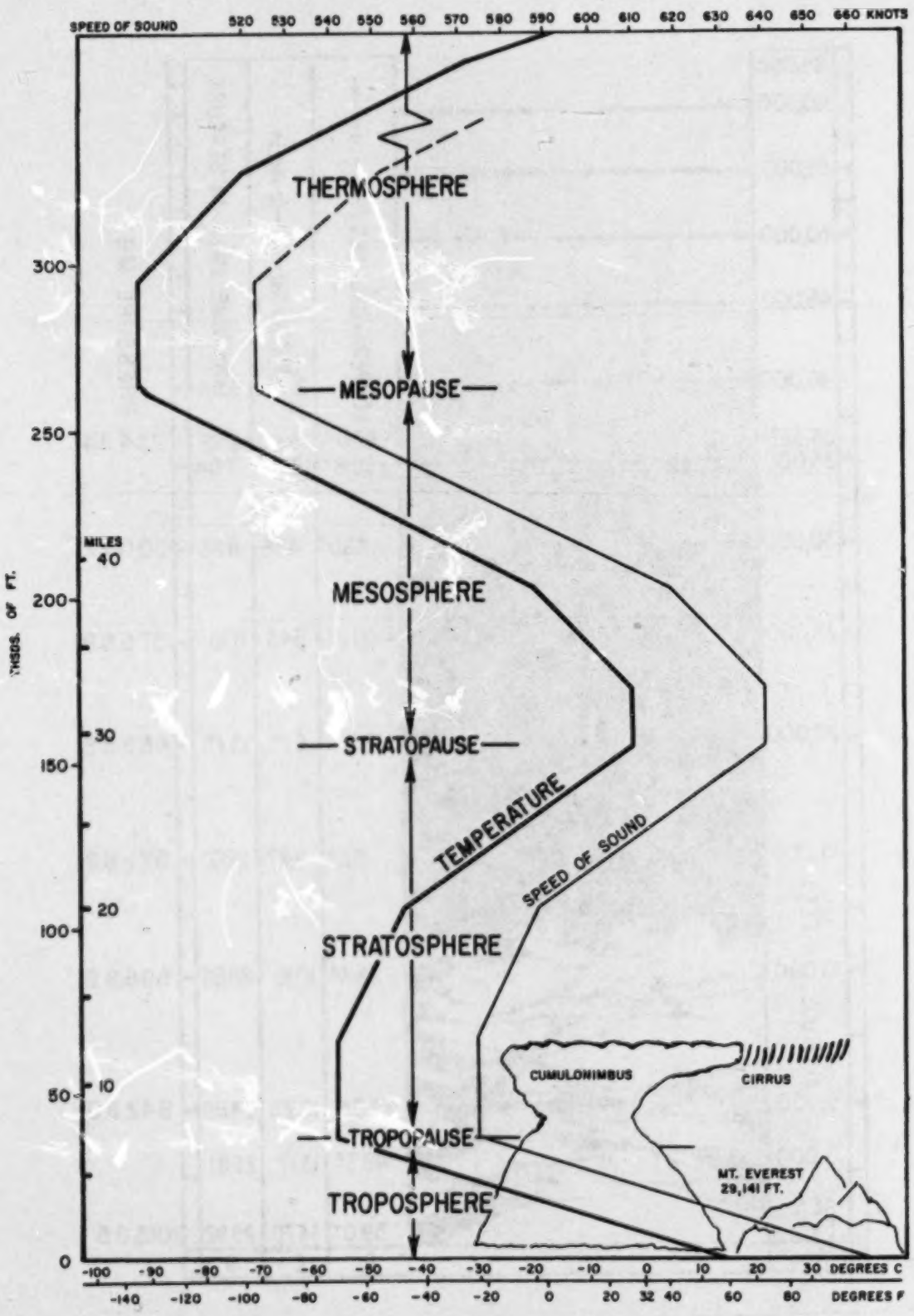

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Figure 5-2.—Vertical structure of the atmosphere.

greater than surrounding areas are called high-pressure areas, and those having less pressure than surrounding areas are called low-pressure areas. The atmospheric pressure at any given point on the earth's surface is constantly changing because of the movements of these high- and low-pressure areas.

In order for the sensitive altimeter and the altimeter setting indicator (discussed in chapter 4) to be read uniformly they are calibrated in accordance with the standard atmosphere as shown in figure 5-1. Also in this figure, note that the atmospheric pressure decreases at the rate of about 1 inch of mercury per thousand feet of altitude up to 10,000 feet and that in the standard atmosphere any given altitude corresponds to a specific atmospheric pressure. The reason for the existence of the standard atmosphere is for it to serve as a base for calibrating pressure-activated instruments. This standard atmosphere assumes certain values of temperature and pressure for various altitudes. The scale of the altimeter is calibrated to these assumed values. The indications read from the altimeter are those that would be correct if the temperature and pressure were standard for that particular altitude.

Atmospheric pressure and temperatures change almost constantly throughout the length of a flight; thus, the altimeter must be reset periodically. If this is not done, incorrect readings are given by the instrument. For example, if an aircraft flies from a high-pressure area into a low-pressure area, the altimeter reads too high. Going from a low to a high-pressure area, the altimeter reads too low. (See fig. 5-3.) Simple rules to remember—HIGH TO LOW READS TOO HIGH AND LOW TO HIGH READS TOO LOW. The same rules apply to the temperature changes. Flying from a low temperature area into a high temperature area, the altimeter reads too low, and from a higher temperature area to a lower temperature area, the altimeter reads too high. The amount of approximate error in the altimeter readings, due to a noncurrent setting, can be determined for the lower levels of the atmosphere by applying the following corrections:

PRESSURE CHANGE	ALTIMETER ERROR
1 inch of mercury	1,000 feet
1/10 inch of mercury	100 feet
1/100 inch of mercury	10 feet

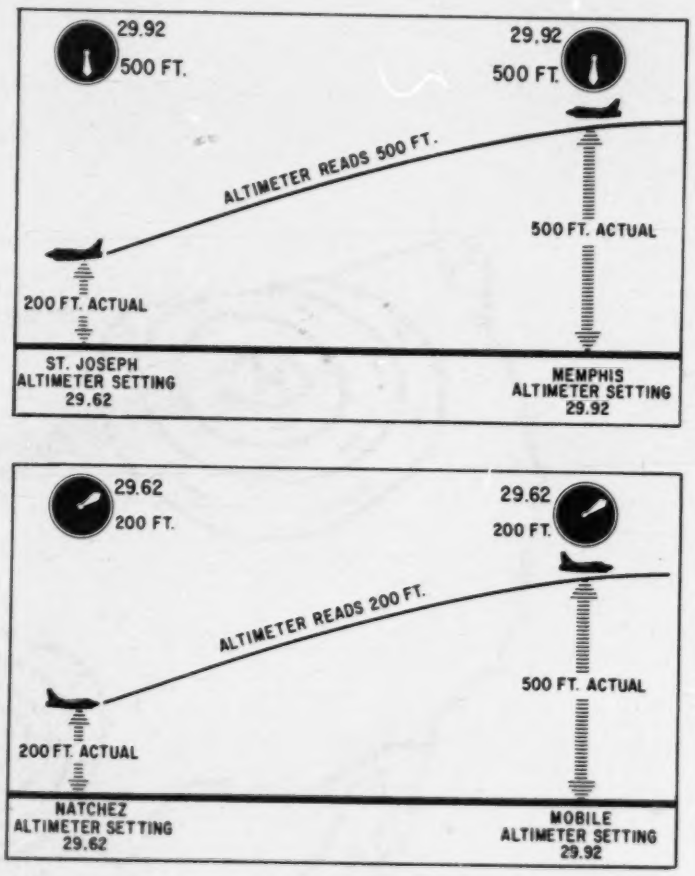

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Figure 5-3.—Effect of pressure changes.

PRESSURE SYSTEMS

Pressure systems are either cyclones (low-pressure areas) or anti-cyclones (high-pressure areas). In the Northern Hemisphere, a general cycle of highs and lows moves through the Temperate Zones from west to east. (See fig. 5-4.)

Cyclones

A cyclone is a low-pressure system in which the barometric pressure decreases toward the center, and the windflow around the system is counterclockwise in the Northern Hemisphere. The terms low and cyclone are interchangeable. Any pressure system in the Northern Hemisphere with a counterclockwise (cyclonic) windflow is a cyclone.

Low-pressure systems with severe storm characteristics are called hurricanes, typhoons, tropical storms, tornadoes, or waterspouts to identify the exact nature of the storm.

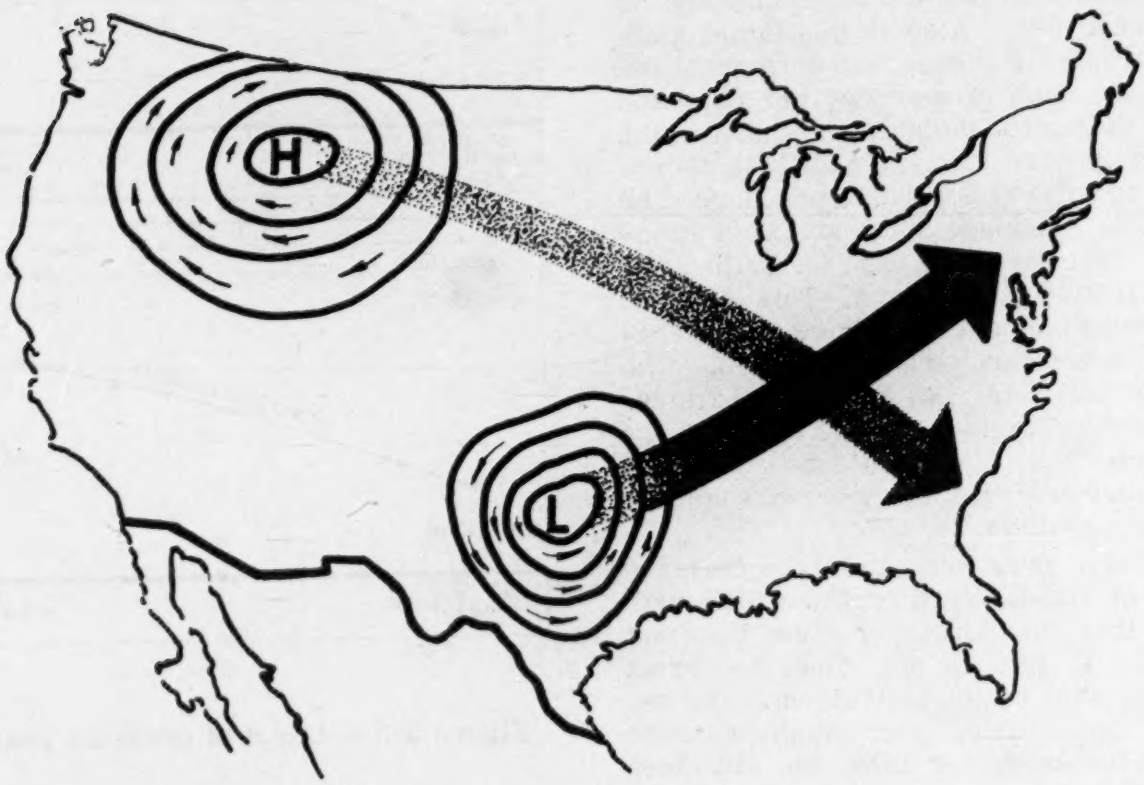

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Figure 5-4.—Directional movement of the pressure systems.

Unfavorable flying conditions in the form of low clouds, restricted visibility by precipitation and fog, strong and gusty winds, and turbulence are common in low-pressure systems.

Anticyclones

An anticyclone is a high-pressure system in which the barometric pressure increases toward the center, and the windflow around the system is clockwise in the Northern Hemisphere. Any pressure system in the Northern Hemisphere with a clockwise (anticyclonic) windflow is an anticyclone.

Flying conditions are generally more favorable in high-pressure systems than in low-pressure systems because of less clouds, better daytime visibility, light or calm winds, and less concentrated turbulent areas.

Hurricanes and Tornadoes

The two most violent atmospheric disturbances found in the United States are the tornado and hurricane. Geography plays a large part in the names given to the hurricane. In the Atlantic it is called a hurricane, and in the Pacific a typhoon.

A hurricane is a low-pressure area with a whirling eddy of air having a diameter of 60 to 1,000 miles. It is accompanied by winds of speeds as high as 175 knots. Along with the

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winds there is an abundance of precipitation and thunderstorm activity.

A peculiarity of the hurricane is the calm center of the storm called the eye. When the eye of the storm passes over a given locality, the wind, which has been extremely violent, suddenly decreases to a much lower intensity and at times becomes a calm and precipitation stops. After the eye passes, the violent winds, precipitation, and thunderstorm activity begin anew. The winds are blowing from the opposite direction after the passage of the eye.

A tornado consists of a funnel cloud with a violently whirling center. It is usually a quarter of a mile or less in diameter. The length of a tornado's track on the ground may be from a few hundred feet to 300 miles, the average being around 25 miles. Winds in the vortex of a tornado may exceed 500 knots. The speed of the tornado over the earth's surface is comparatively slow, usually 25 to 50 knots.

Because of a tornado's highly localized nature and its erratic tendencies, it is impossible for the meteorologists to forecast the exact location at which one will strike. However, forecasting centers do broadcast notices when conditions are favorable for tornado formation in specified areas.

AIR MASSES

An air mass is defined as any huge body of air whose physical properties (temperature and humidity) are horizontally uniform. An understanding of the characteristics of an air mass is essential to any study of weather phenomena in the temperate regions. The weather in these regions is a direct result of the continuous alternation of the influences of warm and cold air masses. Warm air masses predominate in the summer and cold air masses predominate in the winter. However, both cold and warm air, alternately, may prevail almost anywhere in the temperate zone at any season. The basic characteristics of any air mass are temperature and humidity. These properties are relatively uniform throughout the extent of the air masses, and it is by measurement of these properties that the various types of air masses are determined.

The properties of an air mass depend directly upon the type of surface over which the air is lying. Thus, a knowledge of the type of surfaces over which the main bodies of air stagnate in the world circulation system is the basis of an understanding of air mass characteristics. These surfaces of origin are called source regions. They have a primary influence upon the characteristics of air masses. The path over which an air mass travels after expanding and leaving the source region and the length of time the air mass has been away from the source region (its age) also determines the characteristics of an air mass.

As an air mass expands and slowly moves out of its source region to influence other regions, it travels along a certain path. The surface over which this path takes the air after leaving the source modifies the air mass. For example, a warm, moist body of air moves out over cold, dry land and its characteristics are modified; therefore, moisture is lost and temperature is lowered.

Another factor which must not be overlooked in determining how an air mass is being changed or modified is the "age" of that body of air after leaving the source. For example, an air mass which has recently moved from the source region will not have had time to become modified significantly. However, an air body which has moved to a new region and stagnated for some time and is now old will have lost many of its original characteristics. It will have acquired many of the characteristics of the surface over which it now lies.

SOURCE REGION

The surface or region over which an air mass originates is called the source region. It is in this region that the basic characteristics of the air mass are acquired. In order to fulfill the requirements for a good source region, an area must be of uniform surface (either all land or all water), uniform temperature, and preferably, an area of high pressure where air has a tendency to stagnate.

AIR MASS CLASSES

Air masses are classified according to their source regions, as follows:

SYMBOL	SOURCE REGION	TEMPERATURE IN SOURCE REGION
A	Arctic	Coldest
P	Polar	Cold
T	Tropical	Warm
E	Equatorial	Warmest

frequency and automatically remain on this frequency. This system has the advantage that in the event of a sudden shift in magnetron or local-oscillator frequency the correct operating frequency is found automatically. In the non-hunting system the oscillator is manually tuned to the correct frequency and maintained electronically to this frequency.

Block Diagram of AFC System

In the single-mixer system (fig. 14-10), a portion of the transmitter pulse leaks through the TR box and beats with the local-oscillator signal in the mixer. The difference frequency, or the IF signal, appears at the output of the mixer. This IF signal is then amplified by one or two stages of IF amplification. At this point the signal follows two paths—it is further amplified and fed into the detector, and it is also fed into the AFC discriminator. The output of the discriminator is fed to either a d-c amplifier or some special control circuits which regulate the klystron reflector voltage. The regulation of this voltage changes the frequency of the klystron and enables it to oscillate at the correct frequency.

Most modern radar systems use a double-mixer AFC system, as shown in figure 14-11. The separate signal mixer and the AFC mixer are both connected to the same local oscillator. The AFC mixer is coupled to the transmission line through an attenuator which reduces the transmitted pulse and received signals by the same ratio. With this arrangement, strong signals from nearby radar, jammers, or sea return cannot affect the operation of the AFC loop. The double-mixer system is similar to the single-mixer system with the exception that it contains an AFC attenuator and separate IF stages.

DISCRIMINATOR CIRCUIT

The amplified output of the AFC mixer (fig. 14-10, is fed to the AFC discriminator. The output voltage of a frequency discriminator varies in amplitude and polarity with changes in the applied frequency. If the applied frequency is at the resonant or center frequency of the discriminator the output is zero. If the applied frequency is above or below the correct value, the output of the discriminator is either positive or negative, depending upon the direction of deviation. The operation of this type of discriminator is explained in detail in Basic Electronics, NavPers 10087-B.

PHANTASTRON AFC CIRCUIT

The AFC circuit (fig. 14-12 (A)) consists of the following:

1. IF amplifier which increase the amplitude of the IF signal.
2. Discriminator tube V4 which develops the pulse output signal proportional to the deviation of the IF signal from the IF center frequency.

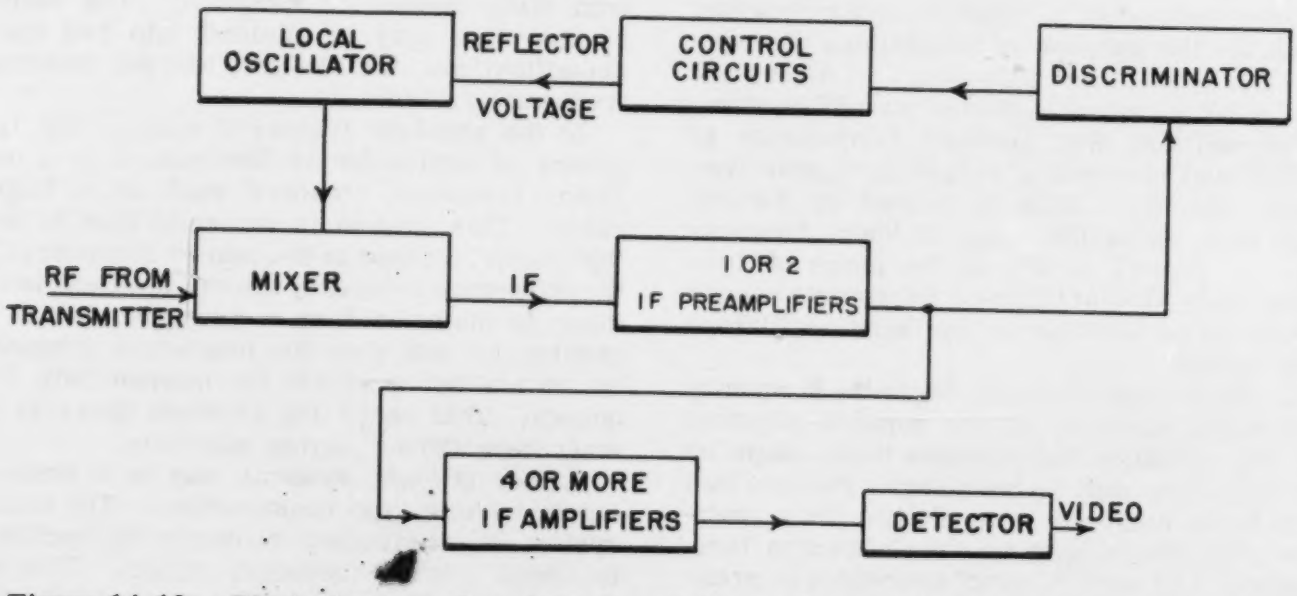

Figure 14-10.—Block diagram of an AFC circuit in a radar receiver, single-mixer system.

Air masses are also classified according to the surface (water or land) over which they lie as follows:

SYMBOL	SURFACE	MOISTURE CONTENT
m	Maritime	High
c	Continental	Low

These symbols are combined to describe air masses as follows:

SYMBOL	SOURCE AND SURFACE	TEMPERATURE AND MOISTURE
cA	Continental arctic	Coldest, dry
cP	Continental polar	Cold, dry
mP	Maritime polar	Cold, moist
mT	Maritime tropical	Warm moist
cT	Continental tropical	Warm, dry
E	Equatorial	Warmest, moist

Air masses are further classified according to their thermodynamic characteristics; that is, according to whether it is cold or warm in comparison to the surface over which it is passing as follows:

k	Cold	Colder than the surface
w	Warm	Warmer than the surface

EXAMPLE: mPw maritime polar air warmer than the surface it is passing over.

It should be noticed that, due to the predominance of land masses or ice fields in the Arctic, mA (maritime arctic) would be a rare type. In like manner, E (equatorial air) is found exclusively over the ocean surface in the vicinity of the Equator and is designated neither c nor m but simply E.

CLOUDS

Varying weather conditions are intimately associated with different types of clouds and cloud formations. For this reason, it is highly important for the Air Controlman to be familiar with and thoroughly understand the different cloud classifications.

The international classification of clouds was established to provide a common nomenclature throughout the world for specific cummuliform and stratiform clouds. The names adopted are based upon the appearance of the clouds.

Observations have shown that clouds are generally encountered over a range of altitude varying from sea level to 25,000 feet in the polar regions, 45,000 feet in the middle latitudes, and 60,000 feet in the tropics. By convention, the part of the atmosphere in which clouds are usually present has been vertically divided into three levels—high, middle, and low. Each level is defined by a range of levels at which clouds of certain genera (classification) occur most frequently as follows:

High Clouds

1. Cirrus (Ci)
2. Cirrocumulus (Cc)
3. Cirrostratus (Cs)

The lower level of high clouds is 20,000 feet above the ground.

Middle Clouds

1. Altocumulus (Ac)
2. Altrostratus (As)
3. Nimbostratus (Ns)

The base of middle clouds may range from 6,500 feet to 20,000 feet above the ground.

Low Clouds

1. Stratocumulus (Sc)

2. Stratus (St)

The bases of the low clouds may range from near the surface to 6,500 feet above the ground.

In addition to the preceding classifications, cumulus and cumulonimbus clouds usually have bases in the lower level, but their tops often reach into the middle and high levels.

Figure 5-5 is a view of the cloud classifications being shown at their average heights.

CLOUD GENERA

Although clouds are continuously in the process of development and dissipation, they nevertheless have many distinctive features. Having

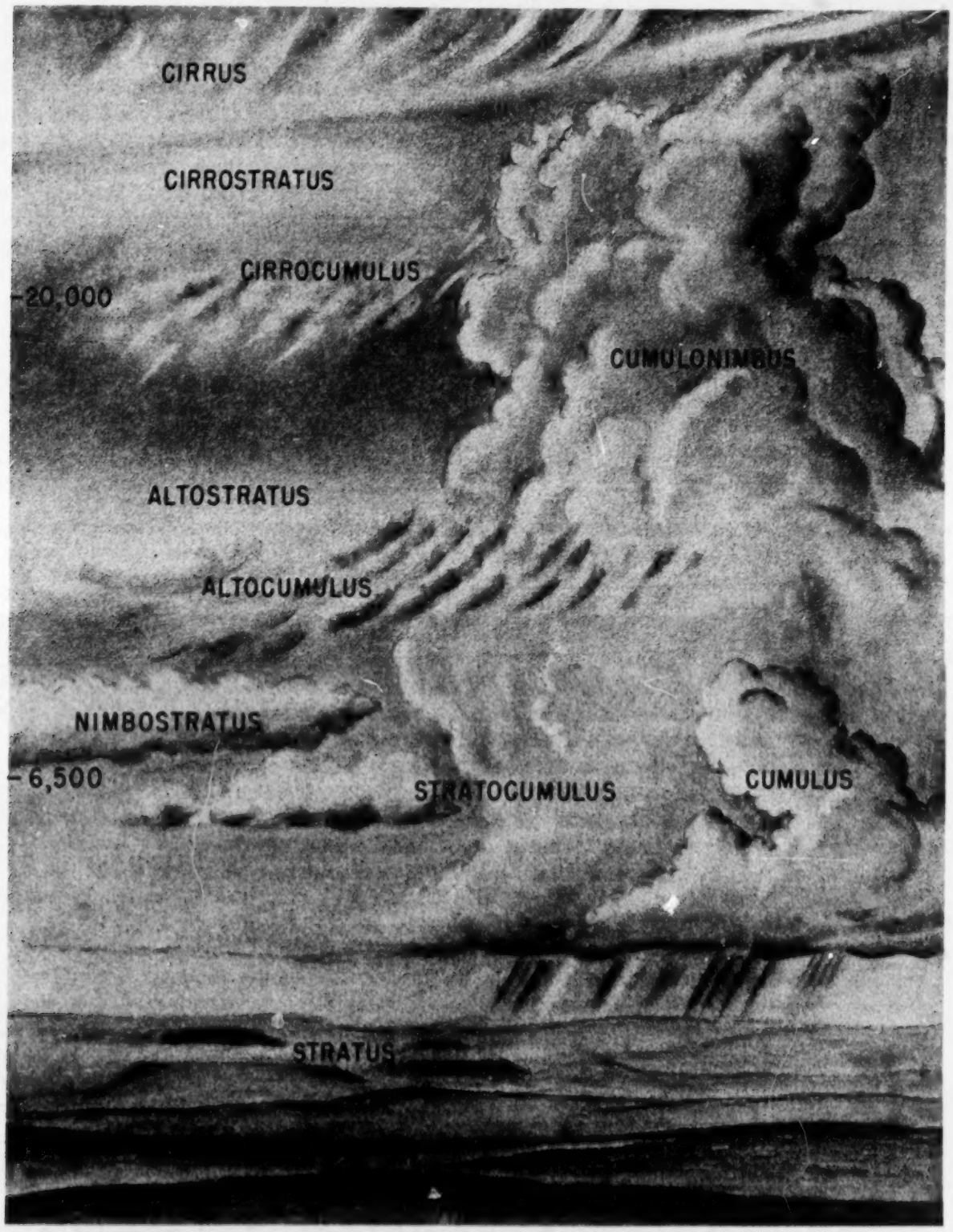

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Figure 5-5.—International classification of clouds.

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outlined the classifications and average level of occurrence, it is now necessary to study cloud recognition features and the weather associated with each, as well as their appearance and how they affect aviation.

Cirrus Clouds

These clouds are fibrous and delicate in appearance, looking like white wisps against the blue of the sky. They appear in a number of forms; occasionally as curls or feathery plumes. (See fig. 5-6.)

Flying conditions within cirrus clouds are good. Turbulence is negligible and the pure ice crystal composition of the cirrus clouds precludes surface icing. Cirrus clouds may indicate the first signs of approaching bad weather. Cirrus wisps, which become more and more compact and then merge into cirrostratus, may indicate an approaching warm front (fronts are discussed later in this chapter).

Cirrocumulus

These clouds appear like fleecy flakes or very small white cotton balls. The term "mackerel sky" is given to this family because the cloud pattern often appears much the same as the scales on a fish. (See fig. 5-7.) Cirrocumulus clouds are relatively rare and appear only in the presence of cirrus or cirrostratus clouds.

Cirrocumulus is a cumuliform cloud but offers only light turbulence. Due to its ice crystal composition no icing occurs on aircraft surfaces. Vapor trails can be noticed within these clouds due to the high moisture content.

Cirrostratus

Cirrostratus appears as a white veil covering all or most of the sky. It is a smooth, thin layer cloud and gives the sky a very milky appearance. It is easily recognized by the halo it produces around the sun or moon. (See fig. 5-8.)

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Figure 5-6.--Cirrus clouds.

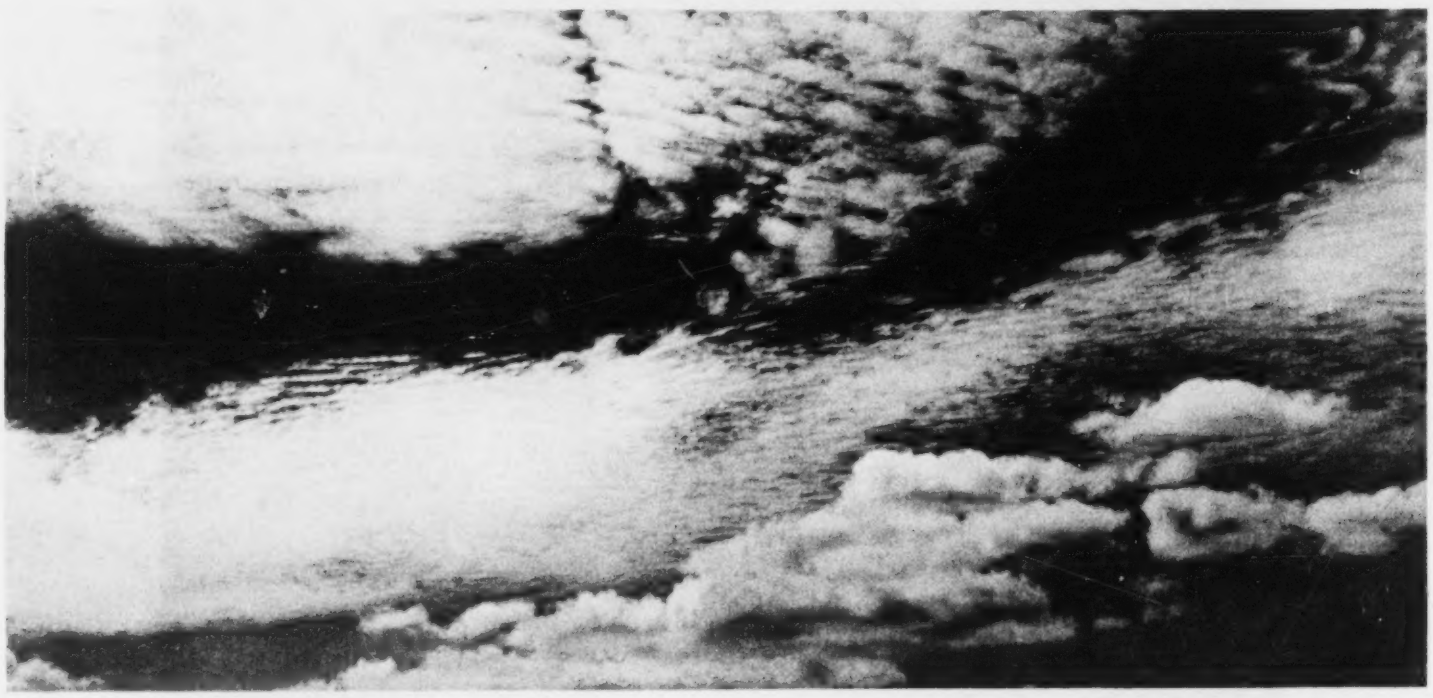

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Figure 5-7.—Cirrocumulus clouds.

If cirrus clouds precede the cirrostratus and the cirrostratus lowers, thickens, and merges into altostratus, the approach of a warm front and bad weather is imminent.

Icing conditions and turbulence in cirrostratus clouds usually offer no hazard to flying in this cloud.

Altocumulus

Altocumulus sometimes looks like cirrocumulus, but the individual cloud balls or flakes are always larger, thicker, and grayer. The center of the underside of each cloud is dark due to the cloud's thickness. These ball-like masses often appear similar to a herd of sheep in the sky. Sometimes altocumulus is arranged in parallel bands stretching across the sky. (See fig. 5-9.)

The visibility within this cloud is poor, and the cloud usually lacks continuity. Turbulence and icing are light to moderate. The icing, if present, is usually the clear type (types of airfoil icing are discussed later in this chapter).

Altostratus

Altostratus appears as a thick gray or blue-gray smooth overcast. It is thicker and less transparent than cirrostratus, which often lowers and gradually merges with altostratus of the approaching warm front. The sun or moon shines through altostratus weakly as through ground glass. (See fig. 5-10.)

This cloud is composed of waterdrops, but ice crystals may also be present in upper levels. The icing conditions are light to moderate and predominantly form rime ice. Turbulence is light. The thickness is usually between 1,000 to 5,000 feet, but in some cases may be somewhat thicker. Visibility within the cloud averages between 50 to 200 yards. Precipitation falls from altostratus in the form of light rain or snow.

Nimbostratus

Nimbostratus is a thick, dark, gray cloud. (See fig. 5-11.) It is ominous and formless in appearance. Rain, snow, or other precipitation is actually falling from this cloud, whether it reaches the surface or not. The sun or moon

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Figure 5-8.—Cirrostratus clouds.

disk is not visible through nimbostratus. There are also ragged scud clouds below the base of the nimbostratus. Turbulence and icing may be moderate to heavy with very poor visibility within and below nimbostratus.

Nimbostratus clouds are almost always in the middle cloud genera, but usually extend into the lower cloud genera. Low ragged clouds frequently occur below the nimbostratus layer, with which they may or may not merge.

Stratocumulus

Stratocumulus usually occurs as an extensive and fairly level layer marked by thick rolls and dark rounded masses of cloud. Its cloud masses are larger, thicker, and darker than those of altocumulus. They may have either small or large breaks between the rolls, however, they may form a continuous layer without any breaks. (See fig. 5-12.)

The visibility within this type cloud is poor. Turbulence in stratocumulus clouds is light to moderate, and the icing conditions are moderate and may form clear ice. The precipitation from stratocumulus clouds is generally showers of rain or snow.

Stratus

Stratus is a flat, shapeless, rather uniform layer of clouds which appear dull gray. (See fig. 5-13.)

Stratus yields precipitation in the form of drizzle only. Visibility within stratus is very poor. Only light turbulence and light to moderate icing may be present. Visibility below the base of stratus is very poor if drizzle is occurring.

Cumulus

Cumulus clouds are dense clouds with vertical development. Their upper surfaces are dome shaped and exhibit rounded protuberances, while their bases are nearly horizontal. Strong updrafts exist under and within all cumulus formations. In fact, cumulus clouds are caused

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Figure 5-9.—Altocumulus clouds.

by updrafts. Turbulence and icing conditions of varying intensities are common within cumulus clouds, depending upon the extent of vertical development.

Cumulonimbus

Cumulonimbus are cumulus clouds with great vertical development. Tops may extend higher than 60,000 feet. The top is composed of ice crystals and often resembles an anvil. (See fig. 5-14.) For more information on cumulonimbus, refer to the section titled Thunderstorms at the end of this chapter.

FRONTS AND ASSOCIATED WEATHER

A front is defined as a boundary, or line of discontinuity, separating two different air masses. From the definition, you can see the close relationship that exists between air masses and fronts. In fact, without the air masses there would be no fronts. A front is a surface, like a thin elastic sheet, separating two air masses.

In our discussion of air masses, we learned that when air stagnates over certain regions it acquires properties from the underlying surface and forms an air mass. In time, these air masses move out of their source region. Due to the general circulation of the atmosphere, terrain, and other factors, the cold air from polar regions tends to move southward while the warm air from tropical regions tends to move northward in the Northern Hemisphere. Therefore, it is inevitable that somewhere in the middle latitudes, these air masses meet. Upon meeting they do not mix readily; each air mass

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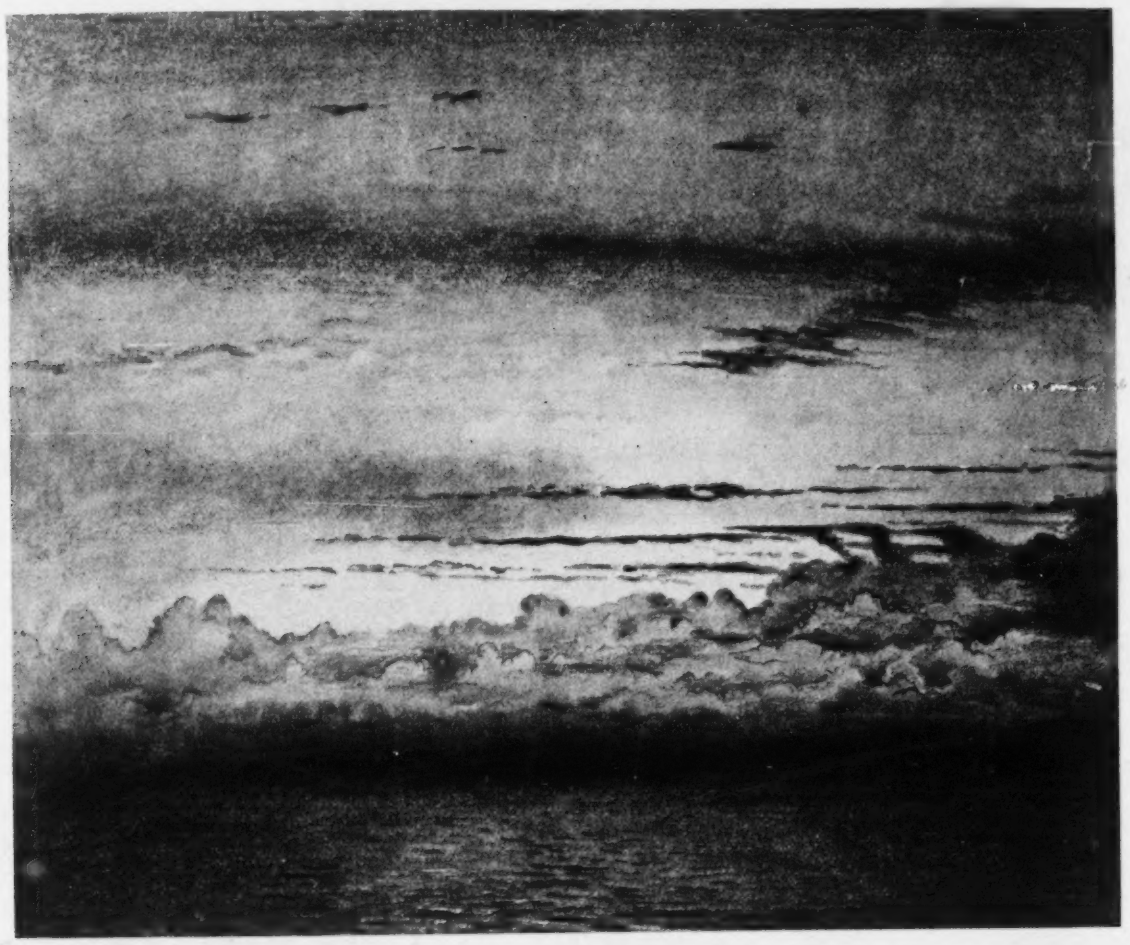

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Figure 5-10.—Altostratus clouds.

tending to remain intact. The surface which separates the air masses is called a frontal surface. This frontal surface, or line, is drawn on the surface weather maps, and its boundary is called a front. (See fig. 5-15.)

As previously stated, a front is indicated on a surface map by a line separating two air masses. However, this is a picture only of the surface conditions. These air masses also have vertical extent. (See fig. 5-16.) A cold air mass, being heavier, tends to underrun a warm air mass. Thus, the cold air is below and the warm air is above the surface of discontinuity. The slope of a frontal surface is usually between 1 to 50 (1 mile vertical for 50 miles horizontal) and 1 to 300 (1 mile vertical for 300 miles horizontal). For example, 100 miles from the place where the frontal surface meets the ground, the frontal surface might be somewhere between 2,000 feet and 2 miles above the earth's surface, depending on the slope. The slope of a front is of considerable importance in understanding the weather along the front.

COLD FRONTS

When cold air invades a region occupied by warm air, it wedges under the warm air pushing it upward. The frontal surface in this case is called a cold frontal surface and its intersection with the earth's surface is called a cold front. (See fig. 5-17.)

There are certain weather characteristics and conditions that are associated with the passage of cold fronts. In general, the temperature and humidity decrease, the pressure rises, and in the Northern Hemisphere the wind shifts clockwise (usually from southwest to northwest) with the passage of a cold front. The distribution and type of cloudiness and the intensity and distribution of precipitation depend primarily on the vertical velocities, stability and moisture

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Figure 5-11.—Nimbostratus clouds.

in the warm air mass. On the basis of these factors, cold fronts are classified as slow- and fast-moving cold fronts.

With the slow-moving cold front there is a general upglide of warm air along the entire frontal surface except for pronounced lifting along the lower portion of the front. The average slope of the front is approximately 1:100 (1 mile vertical to 100 miles horizontal). The cloud and precipitation area is extensive and is characterized by cumulonimbus and nimbostratus clouds, showers, and thunderstorms at, and immediately to the rear of, the surface front. This area is followed by a region of rain and nimbostratus clouds merging into a region of altostratus clouds and then cirrostratus clouds, which may extend several hundred miles behind the front. The development of cumulonimbus clouds, showers, and thunderstorms is largely dependent on the original instability characteristics of the warm air mass. Within the cold air mass there may be some stratified clouds in the rain area, but there are no clouds beyond this area unless the cold air mass is unstable. In the latter case, some cumulus clouds may develop. This type of front is usually slow moving; 15 knots may be considered average. (See fig. 5-18(A).)

With the fast-moving cold front, there is descending motion of the warm air along the frontal surface at high levels and the warm air near the surface is pushed vigorously upward. This type of front has a slope of 1:40 to 1:80 and usually moves rapidly; 25 to 30 knots may be considered as an average speed of movement. As a result of these factors, there is a relatively narrow but often violent band of weather. If the warm air mass is conditionally unstable and moist, cumulonimbus clouds, showers, and thunderstorms occur just ahead of and at the surface front, and rapid clearing occurs behind the front. Frequently altostratus and altocumulus cloud layers form and drift ahead of the main cloud bank. The more unstable the warm air mass, the more violent the weather. If the warm air is relatively dry, this type of front may not produce precipitation or clouds. It is with the fast-moving cold front that squall lines are associated. (See fig. 5-18(B).)

The Air Controlman should note that cold fronts are indicated in blue penciled lines on a colored weather map. When color cannot be used, triangles are spaced along the line of the

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Figure 5-12.—Stratocumulus clouds.

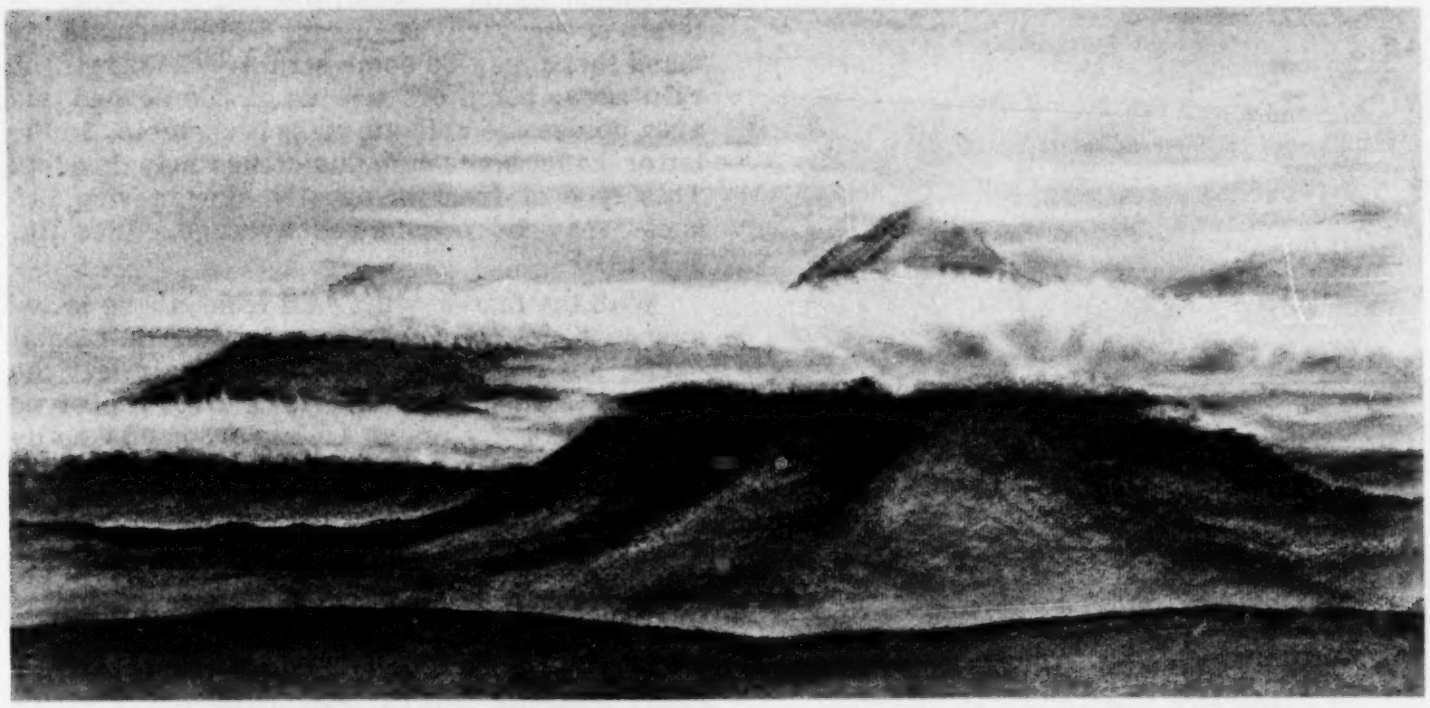

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Figure 5-13.—Stratus clouds.

front with their points indicating the approximate direction in which the cold front moves across the earth's surface.

WARM FRONTS

If cold air is retreating before an advancing mass of warm air, the warm air slides over the cold air. The frontal surface in this case is called warm frontal surface and its intersection with the earth's surface is called a warm front. (See fig. 5-19.)

The weather associated with a warm front varies as it does with a cold front, depending on the degree of stability and moisture of the warm air mass. (See fig. 5-20.)

Certain characteristics and weather conditions are associated with the passage of warm fronts. In the Northern Hemisphere the winds veer from southeast to southwest or west, but the shift is not as pronounced as with the cold front. Temperatures are colder ahead of the front and are warmer after passage of the front. Not being greatly affected by daily heating and cooling of the earth's surface, the dewpoint is normally more constant than is the temperature through the day except with the passage of a front. Therefore, the dewpoint is a good index of frontal passage. The average slope of a warm front is 1:150 (1 mile vertical to 150 miles horizontal).

A characteristic phenomenon of a typical warm front is the sequence of cloud formations. These formations are noticeable in the following order: cirrus, cirrostratus, altostratus, nimbostratus, and stratus. The cirrus clouds may appear 700 to 1,000 miles ahead of the surface front followed by cirrostratus about 600 miles and altostratus about 500 miles ahead of the surface front. Precipitation in the form of continuous or intermittent rain, snow, or drizzle is frequent as much as 300 miles in advance of the surface front. The precipitation is associated with nimbostratus above the frontal surface and stratus within the cold air. However, when the warm air is convectively unstable, showers and thunderstorms may occur in addition to the steady precipitation.

Clearing usually occurs after the passage of a warm front, but under some conditions drizzle and fog may occur within the warm sector. Normally, the speed of a warm front is less than that of cold fronts; an average may be considered to be about 10 knots.

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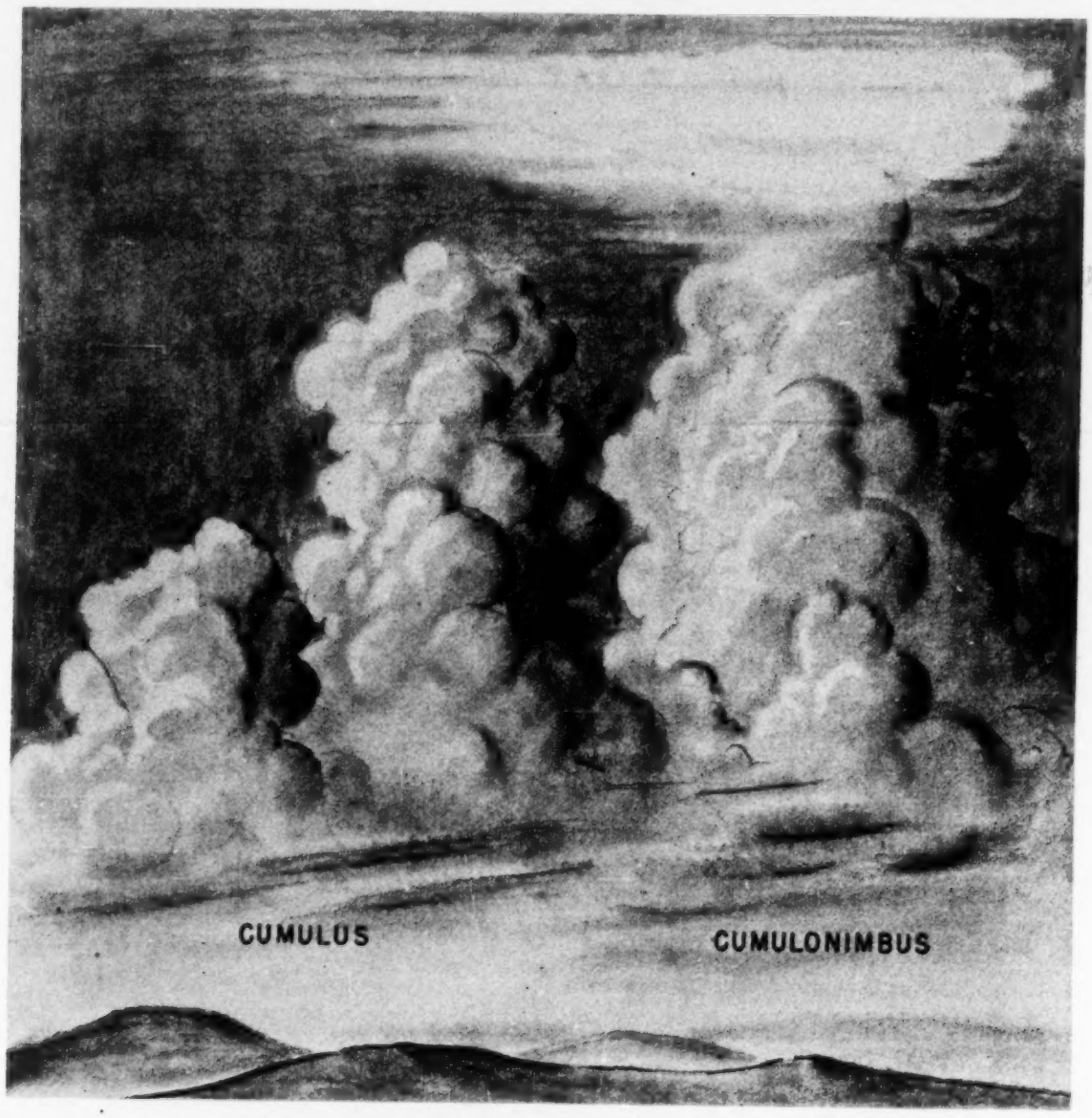

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Figure 5-14.—Cumulus and cumulonimbus clouds.

Warm fronts are indicated by red penciled lines on a colored weather map. When color cannot be used, half circles are spaced along the line of the front on the map on the proper side to indicate the approximate direction of the frontal movement across the surface.

OCCLUDED FRONTS

An occluded front occurs when a cold front overtakes a warm front. One of the two fronts is lifted aloft, and the warm air between the fronts is shut off from the earth's surface. An occluded front is often referred to as an occlusion. The type of occlusion is determined by the temperature difference between the cold air in advance of the warm front and the cold air behind the cold front.

If the air in advance of the warm front is colder than the air behind the cold front, the cold front rides along the warm frontal surface and the occluded front is referred to as a warm type occlusion. If the cold air ahead of the warm front is warmer than the cold air behind the cold front the cold frontal surface underruns the warm front and the occluded front is called a cold type occlusion. (See fig. 5-21.)

The primary difference between a warm type and cold type occlusion is the location of the associated upper front in relation to the surface

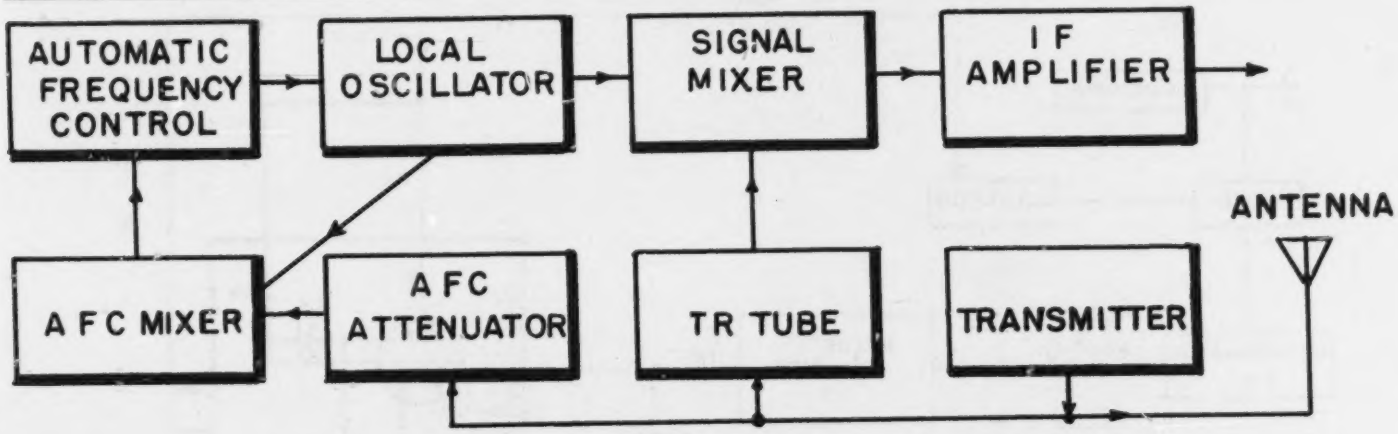

Figure 14-11. —Block diagram of a double-mixer AFC system.

3. Pulse amplifier V3.
4. AFC sweep generator V2 with its diode control tube V1.

Discriminator

The discriminator consists of a twin-diode rectifier, which determines the intermediate frequency that will be maintained by the AFC system. If an intermediate frequency is applied to the AFC search input and it is increased in frequency from approximately 25 to 35 mc, the rectified discriminator output will vary correspondingly from a positive d-c voltage to zero at 30 mc to a negative d-c voltage after the crossover is passed. (See fig. 14-12 (B).)

This variation in intermediate frequency is caused by changing the frequency of the klystron from low to high by varying its repeller voltage. The AFC circuit does this automatically when not locked in. Thus, the discriminator output falls from a positive value on the low side of the center frequency to zero at 30 mc. This output variation does not influence the AFC sweep generator. On the high side the discriminator output is negative, the proper polarity for controlling the sweep.

The discriminator circuit is similar to that of a conventional discriminator; however, instead of using mutual coupling, output from the last AFC IF amplifier is capacitively coupled to the discriminator input circuit.

Pulse Amplifier

Output pulses from the discriminator diode circuit are coupled to the pulse amplifier, V3 which amplifies and inverts the pulses that enable the sweep control tube to lock in the AFC sweep.

AFC Sweep Generator

The AFC sweep circuit consists of sweep generator V2 which, when free-running, generates a slow sweep to vary the klystron frequency over a wide range, and control tube V1, that locks the sweep on positive pulses. When the klystron frequency being swept reaches a point where it beats with the RF pulses from the magnetron and causes the intermediate frequency to increase past the 30 mc center frequency, positive output pulses from the discriminator amplifier lock in the AFC sweep generator at the pulse repetition frequency, and limit the klystron frequency sweep to a low amplitude, producing only a small variation about the correct intermediate frequency. Negative pulses from the pulse amplifier tube do not affect the free-running sweep. Actual locking-in of the sweep generator is performed by a diode control tube, V1.

Free-Running Sweep

To understand the operation of the AFC sweep tube when free-running, assume that the cycle is where the plate voltage begins to fall. (See fig. 14-12 (C).) When this occurs, the suppressor has a high positive potential because of the coupling, through C3, of a positive voltage developed by the previous sharp rise in screen voltage. This positive suppressor potential initiates the plate-current increase that produces the decline in plate voltage. The decline of plate voltage is modified as the negative charge at the plate is applied through capacitor C3.

During this decline, the applied control grid voltage gradually becomes less negative. As

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Figure 5-15.—The meeting of two different air masses.

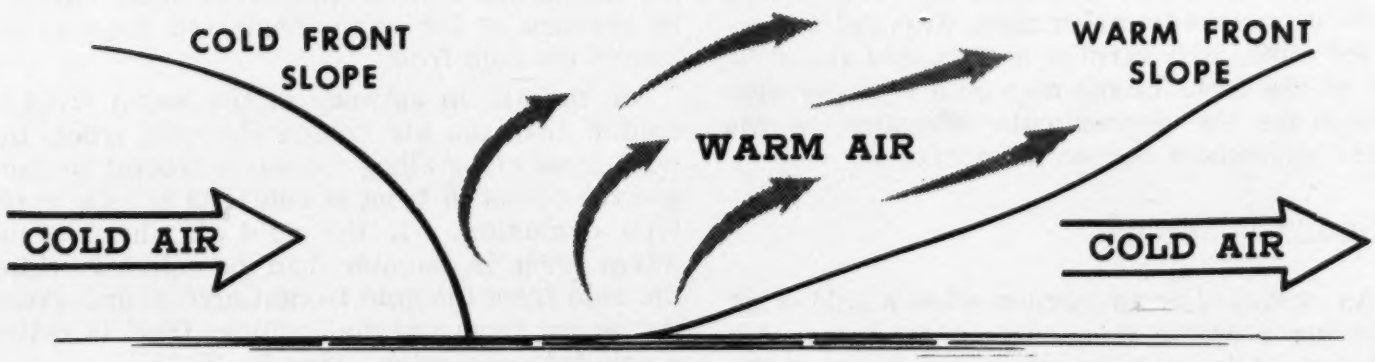

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Figure 5-16.—Vertical cross section of frontal systems (without clouds shown).

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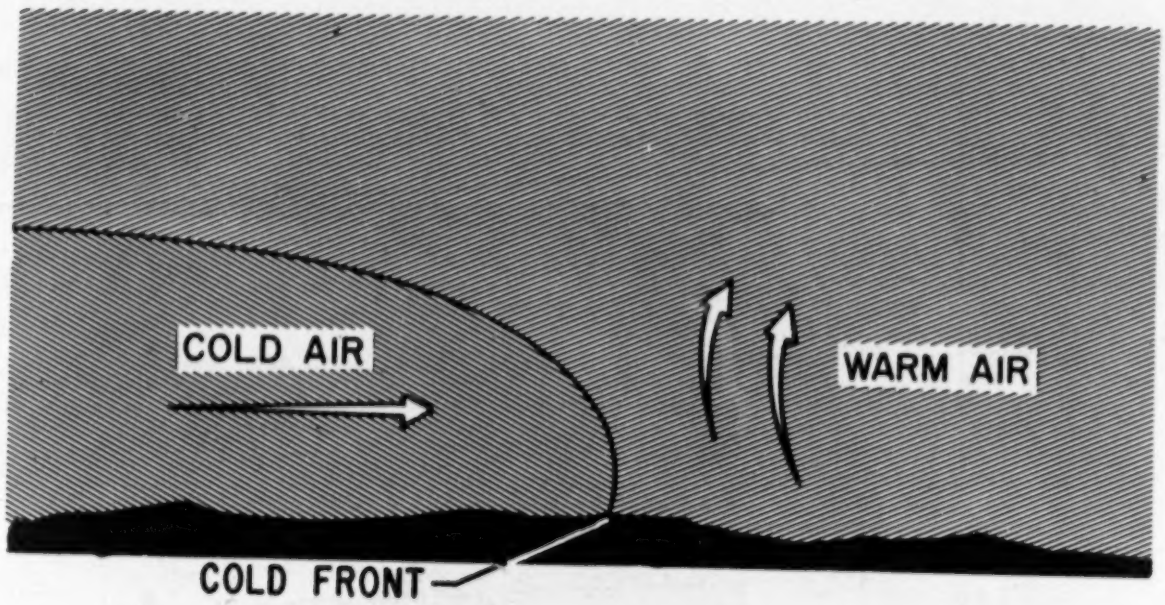

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Figure 5-17.—A cold front.

front. In a warm type occlusion the upper cold front precedes the surface occluded front by as much as 200 miles. In the cold type occlusion the upper warm front follows the surface occluded front by 20 to 50 miles.

Since the occluded front is a combination of fronts, the resulting weather is that of the cold front's narrow band of violent weather and the warm front's widespread area of cloudiness and precipitation occurring in combination along the occluded front. The most violent weather occurs at the tip of occlusion. (The tip is the point at which the cold front is overtaking the warm front.)

Occluded fronts are indicated by a purple penciled line on the colored weather map. When color cannot be used, alternating half circles and triangles are spaced along the line of the front on the map and on the proper side to indicate the approximate direction of frontal movement across the surface.

STATIONARY FRONTS

One of the most annoying characteristics of a stationary front (a front that shows little or no apparent movement) is that it may greatly hamper and delay air operations by persisting in an area for several days.

The weather associated with a stationary front varies with the stability of the warm air or the moisture content of the cold air. (See fig. 5-22.)

If the warm air is unstable, rainfall from thunderstorms normally exists. If the warm air is stable, there generally is drizzle, and beyond the freezing level there are icing conditions, light snow, or light rain. At very high levels there are also some ice type clouds present.

In the cold air there are generally lowered ceilings and extensive fog. Icing conditions, if present, are light.

The width of the weather band with its precipitation and low ceilings varies from 50 to 200 miles, depending upon the temperature of the air mass.

Stationary fronts are indicated by an alternating red and blue penciled line on the colored weather map. When color cannot be used, alternating half circles and triangles are spaced along the line of the front on opposite sides of the frontal line to indicate very little movement across the surface.

HUMIDITY

Weather conditions depend greatly upon the amount of water in the air. The water may be

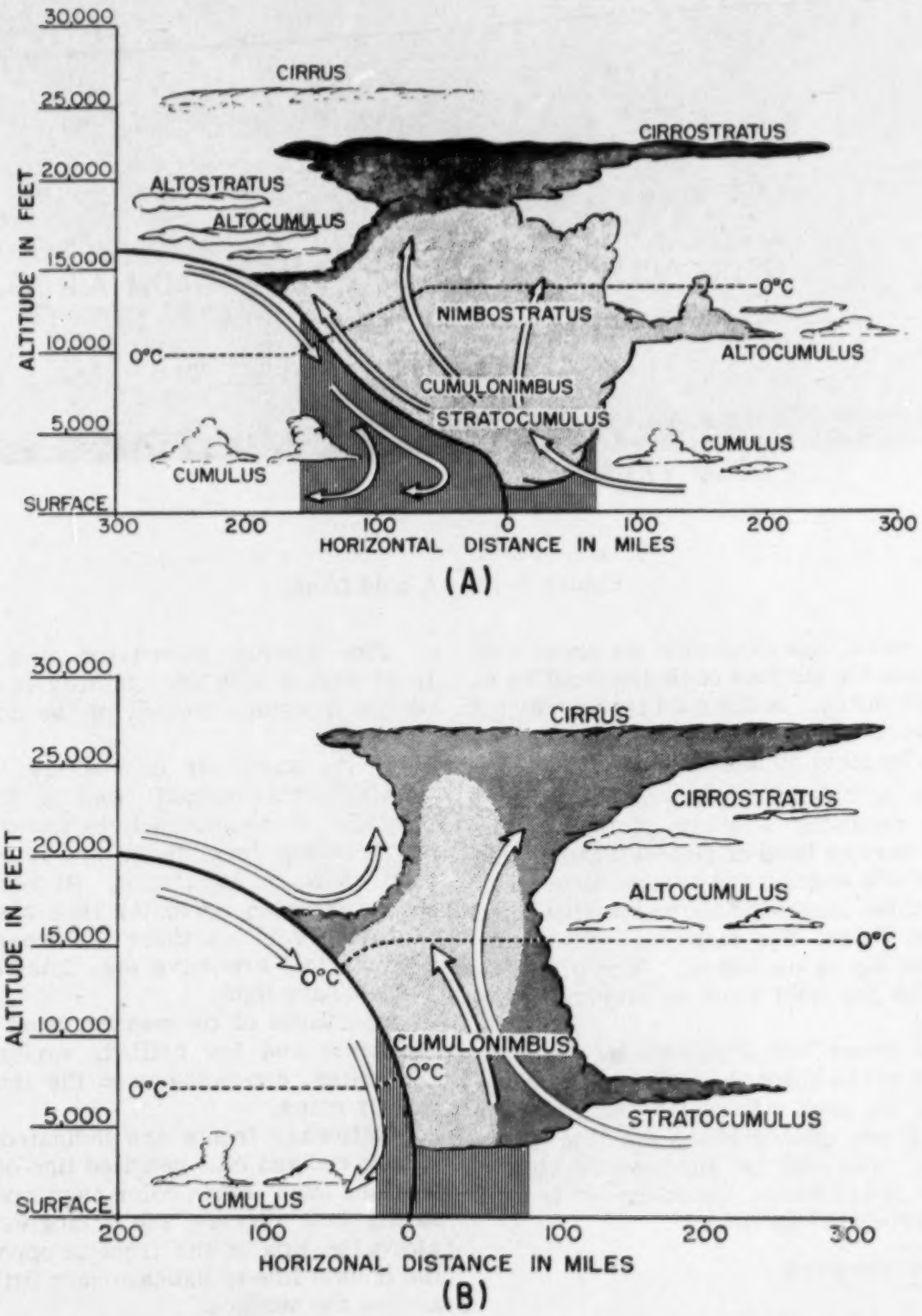

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Figure 5-18.—Vertical cross section of a cold front. (A) Slow-moving cold front; (B) fast-moving cold front.

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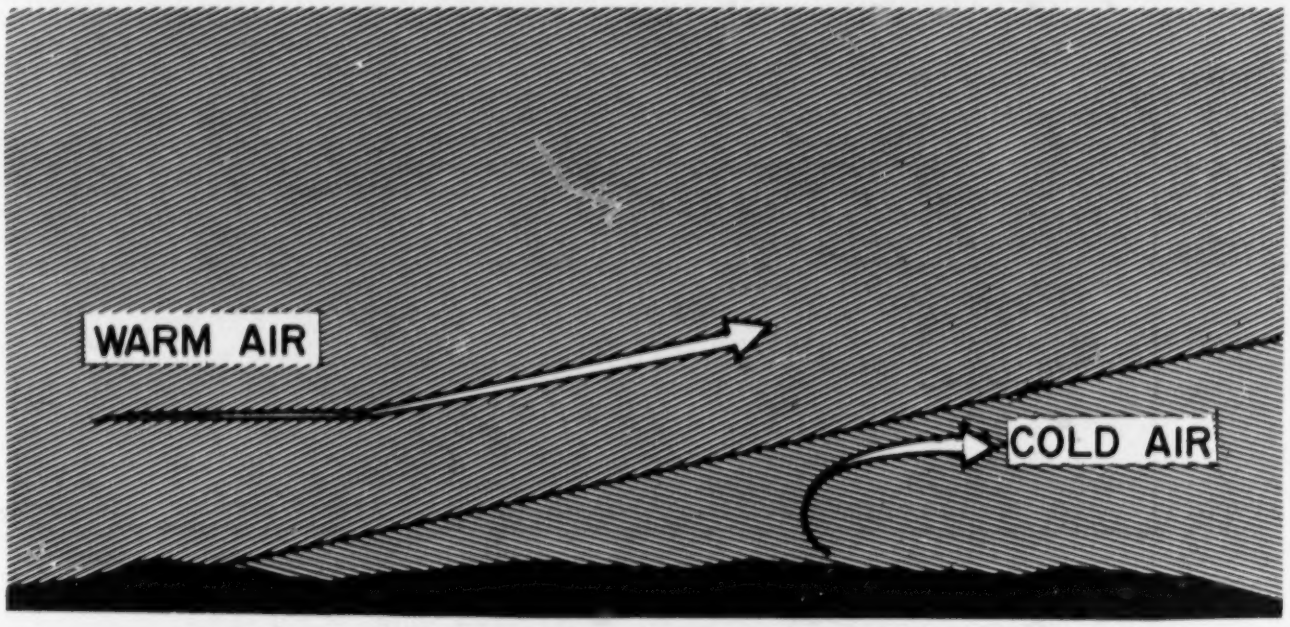

Figure 5-19.—A warm front.

in any of three forms—gas, liquid, or solid. As a gas, it is called water vapor, which is invisible. Solid or liquid water is visible as precipitation or as clouds.

Humidity is a comprehensive concept; therefore, there are available many different definitions and many different manners of expressing humidity.

Most of the weather that interferes with the operation of aircraft is directly associated with water in some form. In this section, the characteristics of water vapor and two manners in which humidity is expressed are discussed.

WATER VAPOR CHARACTERISTICS

Water vapor is a universal constituent of the atmosphere. Any given volume of atmosphere at a given temperature can contain only a certain maximum quantity of water vapor. The maximum amount (by volume) of water vapor that the air can hold is about 4 percent. If more and more water vapor is injected into a given container of dry air kept at a constant temperature, a point is reached when the water vapor condenses, or becomes liquid, as fog within the container or as dew on its walls. As more and more water vapor is added, more of it condenses; but the total amount of vapor in the container remains unchanged, although the amount of liquid water in the form of fog or dew increases. The volume of air in the container is then said to be saturated with water vapor.

Although the quantity of water vapor in a saturated volume of atmosphere is independent of the amount of air present, IT DOES DEPEND ON THE TEMPERATURE. The higher the temperature, the greater the tendency for liquid water to turn into vapor. At a higher temperature, therefore, more vapor must be injected into a given volume before the saturated state is reached and dew or fog forms. On the other hand, cooling a saturated volume of air forces some of the vapor to condense and the quantity of vapor in the volume to diminish.

DEFINITIONS OF HUMIDITY

The actual amount of water vapor contained in the air is usually less than the saturation amount. The amount of water vapor in the air is expressed in several different manners. Two methods are described in the following portion of this section.

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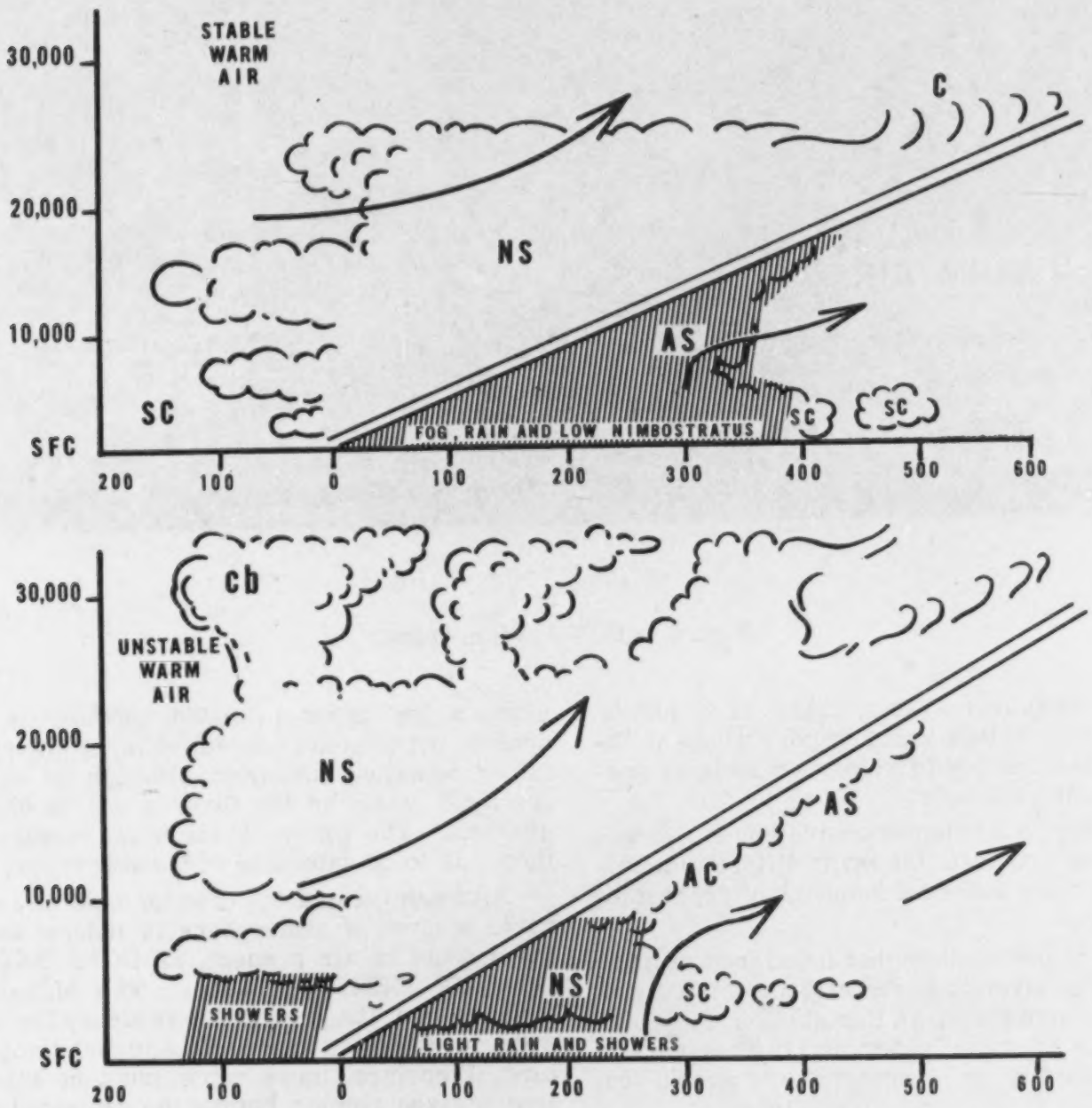

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Figure 5-20.—Vertical cross section of a warm front.

Relative Humidity

Although the major portion of the atmosphere is not saturated, it is desirable to be able to say how near it is to being saturated. This relationship is expressed as relative humidity. The relative humidity of a volume of air is the ratio (in percent) between the water vapor actually present and the water vapor necessary for saturation at a given temperature.

Assume, for instance, that the temperature is 25° C. The amount of water vapor needed to saturate a cubic meter of air at this temperature is 23.05 grams. If observation indicates only 11.525 grams of vapor in a cubic meter,

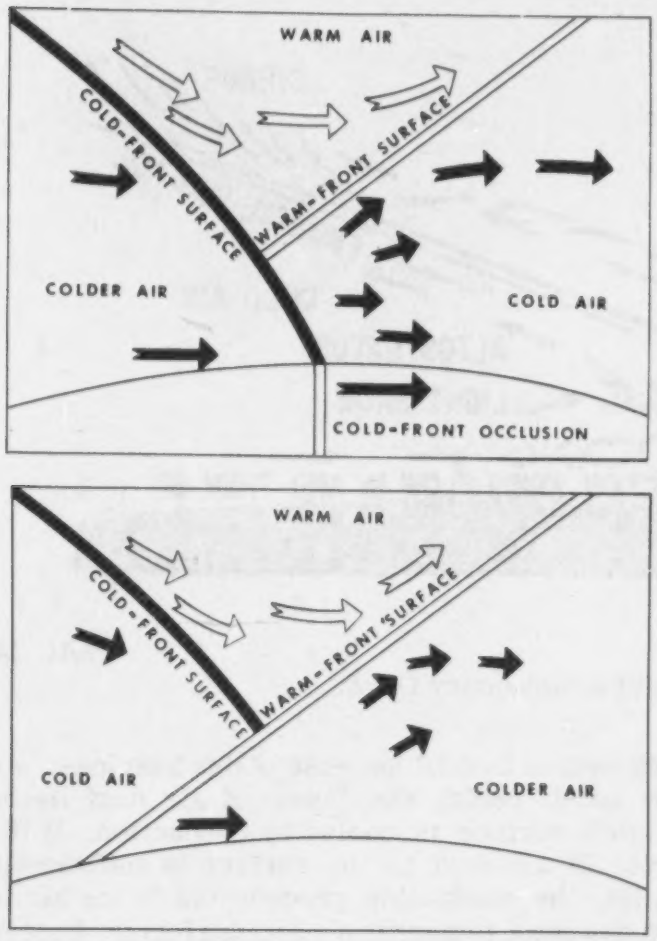

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Figure 5-21.—Vertical cross section of cold and warm type occlusions.

the sample volume is half saturated, or its relative humidity is 50 percent.

Relative humidity shows the degree of saturation, but it gives no clue as to the actual amount of water vapor in the air. Thus, other expressions of humidity are useful.

Dewpoint

The dewpoint is the temperature to which air must be cooled, at constant pressure and constant water vapor content, in order for saturation to occur. The dewpoint is a conservative and very useful element. When atmospheric pressure stays constant, the dewpoint reflects increases and decreases in moisture in the air, and also shows at a glance, under the same conditions, how much cooling of the air might result in condensed moisture.

FOG

Since the Air Controlman's job is primarily one of helping pilots by relaying known and anticipated information to them, it is essential that he have a fundamental knowledge of the classes and causes of fog.

Fog may be defined as a cloud on the earth's surface. It is a visible condensation in the atmosphere of sufficient density to interfere with visibility.

Fog consists of visible water droplets or ice particles suspended in the atmosphere. It differs from other clouds in that it exists on the ground or over the surfaces of bodies of water. It differs from rain or mist in that its water or ice particles are more minute, are suspended, and do not fall earthward.

FORMATION OF FOG

The differential between the dewpoint and the temperature is used in the prediction of fog formation. The smaller the difference between the temperature and dewpoint, the greater the possibilities of fog formation. Spread is the term used to define the difference in degrees between the two. All Air Controlmen should be alert to the possibility of fog formation whenever the spread decreases to 4 degrees or less.

There are two ways in which the temperature and dewpoint may become coincident:

1. The dewpoint rises until it equals the temperature. This results from the addition of water vapor to the air by evaporation from water surfaces, wet ground, or precipitation falling through the air.

2. The temperature lowers to the dewpoint as a result of cooling of the air by contact with a cold surface underneath.

Naturally, other factors influence the formation of fog. Wind is one. In a calm condition, fog will form and is generally very shallow. However, a light wind condition is ideal for fog formation, as it produces deep layers of fog. A moderately strong wind tends to keep fog from forming as it circulates the air too rapidly for fog producing conditions to exist. Strong wind will often dissipate fogs already formed.

Air polluted with dust and smoke particles provides a great quantity of condensation nuclei.

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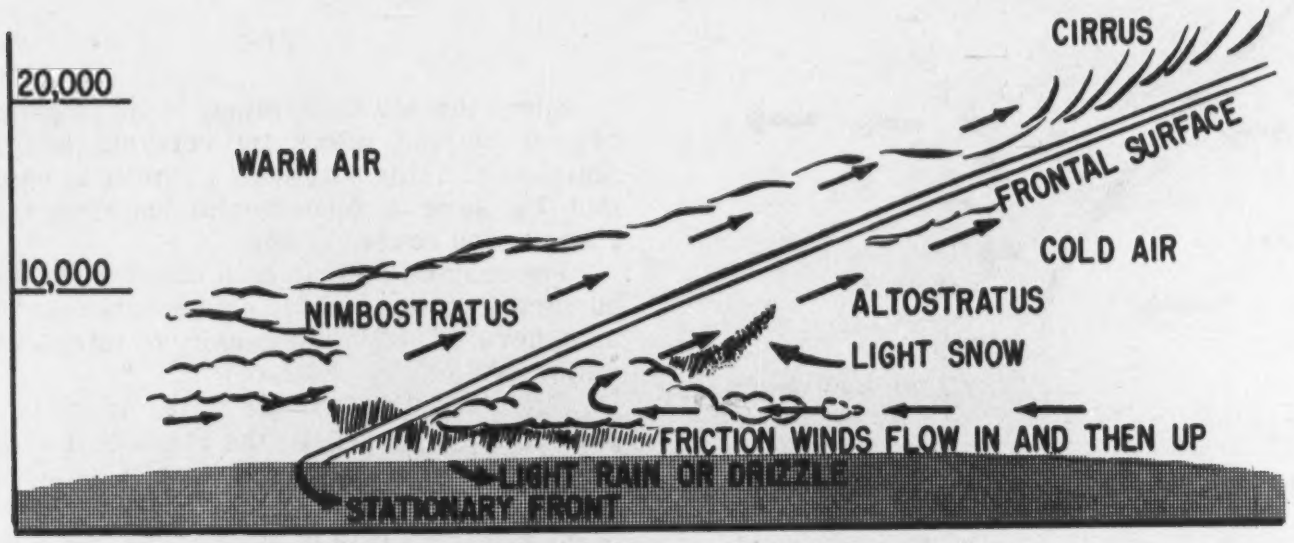

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Figure 5-22.—Cross section of a stationary front.

These nuclei, offering particles of matter upon which moisture may condense, make fog formation much easier and the fog more dense. Although all fog can reduce the ceiling and visibility to near zero, the most dangerous type of fog is one that covers large areas.

CLASSES

Fog is divided into two classes: air mass fog and frontal fog. Each class is discussed as there are different requirements which govern the formation of each class.

Air mass fog occurs within a given air mass and is formed when the layer of air close to the earth's surface is cooled by contact with a colder surface below.

There are four types of air mass fog. Each type gets its name from the particular manner in which air is cooled to the dewpoint or saturated to condensation. The four types are radiation fog, advection fog, upslope fog, and steam fog.

Radiation fog, which generally occurs as ground fog, is formed by the cooling of a land surface on clear nights by radiation of heat to the sky. (See fig. 5-23.) Radiation fog never forms over water.

After sunset, the earth receives no heat from the sun, but continues to radiate heat. The surface begins to cool because of this heat loss. As the earth cools, the layer of air next to the earth's surface is cooled by conduction. If the layer of air next to the surface is sufficiently moist, the conduction process chills the air to the dewpoint temperature and fog forms. In case of a calm wind, this cooling by conduction affects only a very shallow layer of air. In this case, the fog tends to be very thin. Wind from three to five knots provides enough mixing so that the fog will be fairly deep. If the wind is too strong, it causes so much mixing that fog does not form. Radiation fog usually forms at night and generally dissipates before midmorning. The best condition for radiation fog is a clear cool night, light wind, and high humidity.

Advection fog is the name given to fog produced by air in motion or fog formed in one place and transported to another. This type of fog is formed when air is transported over a land or water surface colder than the air mass passing over it. (See fig. 5-24.) Cooling from below takes place and gradually builds up a layer of fog.

Advection fog forms in regions where marked temperature contrasts exist within a short distance of each other, and only when the wind blows toward the cold region. Areas of marked temperature contrast are usually found along

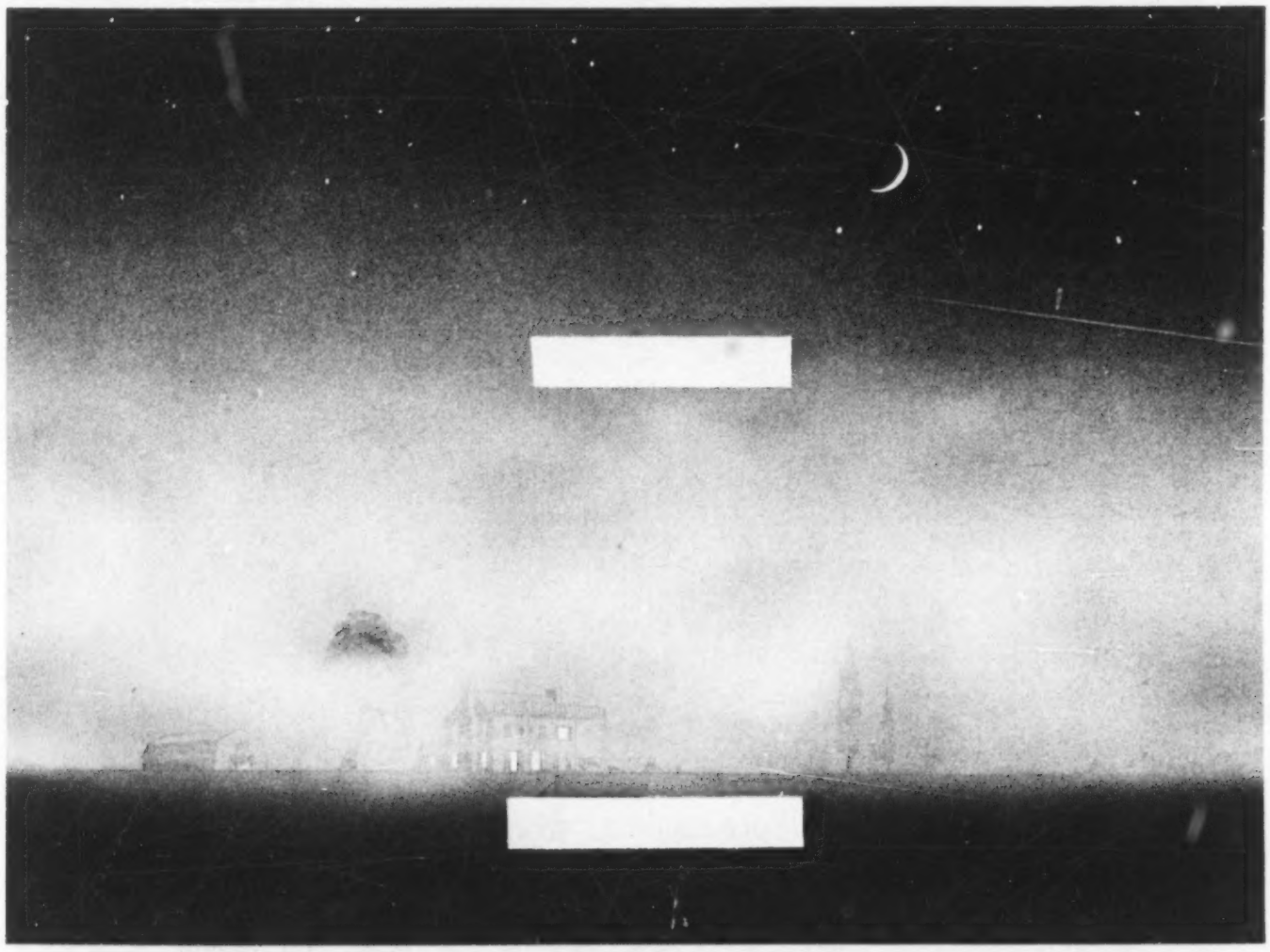

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Figure 5-23.—Radiation fog.

the coastlines, places where snow covered ground is adjacent to bare ground, and at sea where cold and warm water currents are adjacent.

Due to the fact that advection fog covers larger areas than the other types, it is generally considered the most dangerous type.

Upslope fog forms when air is forced to ascend a gradual slope. As the air rises up the slope, the atmospheric pressure decreases causing the air to expand and cool. If the air cools to a temperature equal to the dewpoint temperature, fog will form. Upslope fog forms in very deep layers and requires considerable time to dissipate. The most common fog of this type is called Cheyenne fog and is caused by the westward flow of air from the Missouri valley, which produces fog on the eastern slope of the Rocky Mountains. (See fig. 5-25.)

Steam fog, sometimes referred to as sea smoke, occurs within air masses. However, unlike other air mass fogs which are formed by cooling of the air temperature to the dewpoint temperature, this type is caused by saturation of the air through evaporation of water. It occurs when cold air moves over warm water. Evaporation from the surface of the warm water easily saturates the cold air, causing the fog to form. This type of fog is most common in the northern latitudes. Marsh or swamp mist is a familiar example of steam fog. This type of fog generally forms in the fall of the year only. (See fig. 5-26.)

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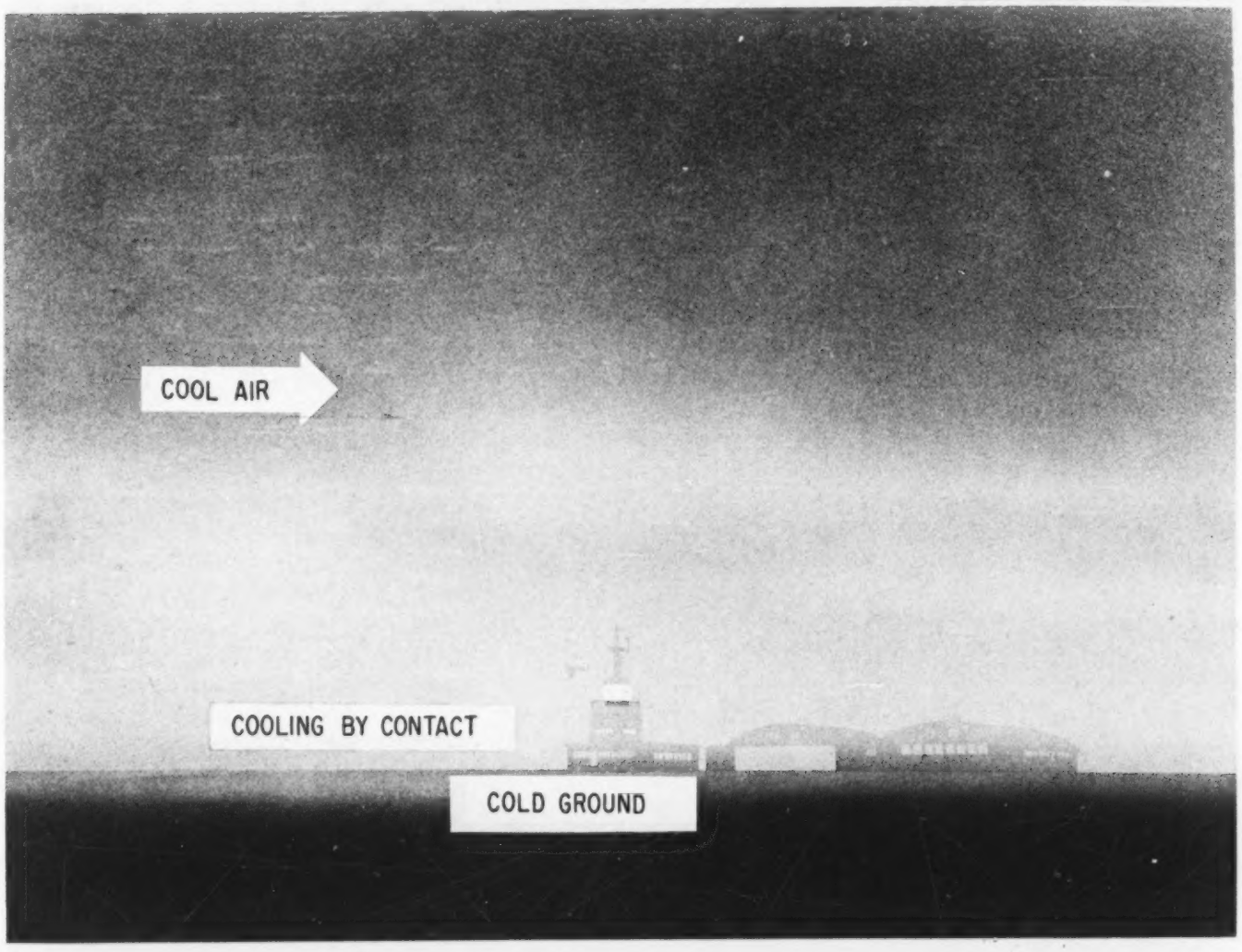

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Figure 5-24.—Advection fog.

Frontal fog is another hazard which must be added to the list of weather troubles associated with fronts. Frontal fog forms under the frontal surface in the cold air mass. Frontal fog is divided into two classes: warm front fog and cold front fog.

The warm front fog is much more extensive than the cold front type and is a definite hazard to flight operations. It is caused by rain falling from warm air into the cold air beneath the front, and is anticipated by a rise in the dewpoint to or very near to the free air temperature. (See fig. 5-27.)

Since the precipitation band accompanying a warm front is quite wide and the movement of the front is slow, this warm front fog may cover an extensive area for considerable time. After the passage of a warm front, an advection type fog frequently occurs in the warm air if the surface is much colder than the air that is moving in. Strictly speaking, this is not a frontal type fog, but is formed within the air mass itself by advection cooling.

Warm front fog is particularly prevalent along the eastern seaboard of the United States, where the cold waters offshore and the general unslope of the terrain are contributing factors toward this fog formation.

Cold front fog is comparatively rare because cold fronts move so rapidly and have associated with them such narrow bands of precipitation

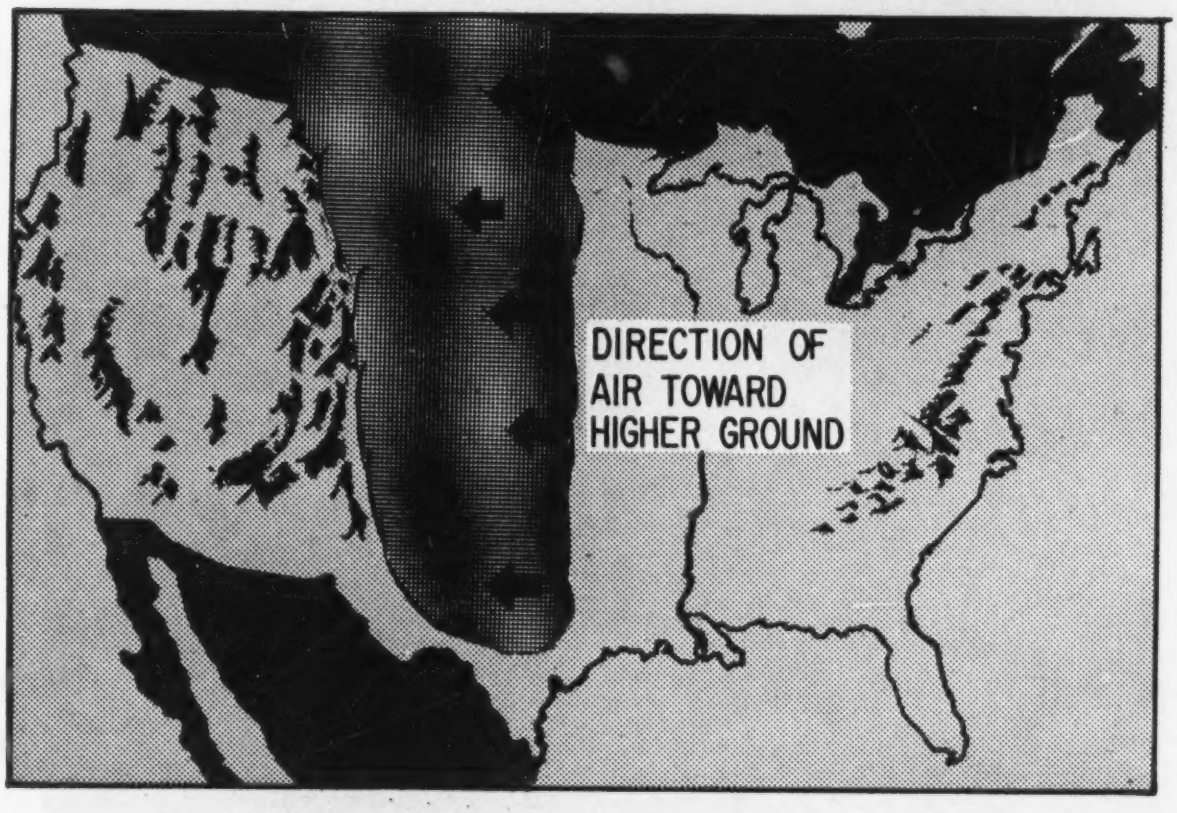

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Figure 5-25.—Upslope fog.

and high wind speeds that fog conditions dissipate or do not develop. On some infrequent occasions, fog does form in the cold air mass just behind the cold front (See fig. 5-27.) When this happens, the fog dissipates rapidly due to the fast movement of the front over the surface of the earth.

AIRFOIL ICING

Another weather hazard to flying is airfoil icing. The Air Controlman who has exact knowledge of when and how ice forms on aircraft is able to lend invaluable assistance to pilots at one time or another.

Formation of ice on an aircraft reduces lift and thrust by adding weight to the structure and changing the airfoil shape of wings, tail, and propeller(s). There are three types of airfoil ice: rime, clear (glaze), and frost. Icing conditions encountered in flight will be a combination of rime and clear ice types with the characteristics of one or the other being dominant. Frost forms on aircraft while on the ground. An everyday comparison between rime ice and clear ice may be found in a home refrigerator. The ice that forms in the ice tray is an example of clear ice. It is very hard and glassy, and can be broken loose only with difficulty. Rime ice is the ice that forms on the refrigerator's coils. It is white and granular, and can be easily broken off. There are only two fundamental conditions necessary for the formation of ice on aircraft in flight. The aircraft must be flying through visible water in the form of rain, drizzle, or cloud droplets; and at the time the water droplets strike the aircraft, their temperature, or the temperature of the surface of the aircraft, must be 32°F or colder. The heaviest airfoil icing will generally occur within the temperature range of 0° C to -10°C (32° F to 15° F) provided moisture is available.

CLEAR ICE

Clear ice, sometimes referred to as glaze ice, is considered to be the most serious of the

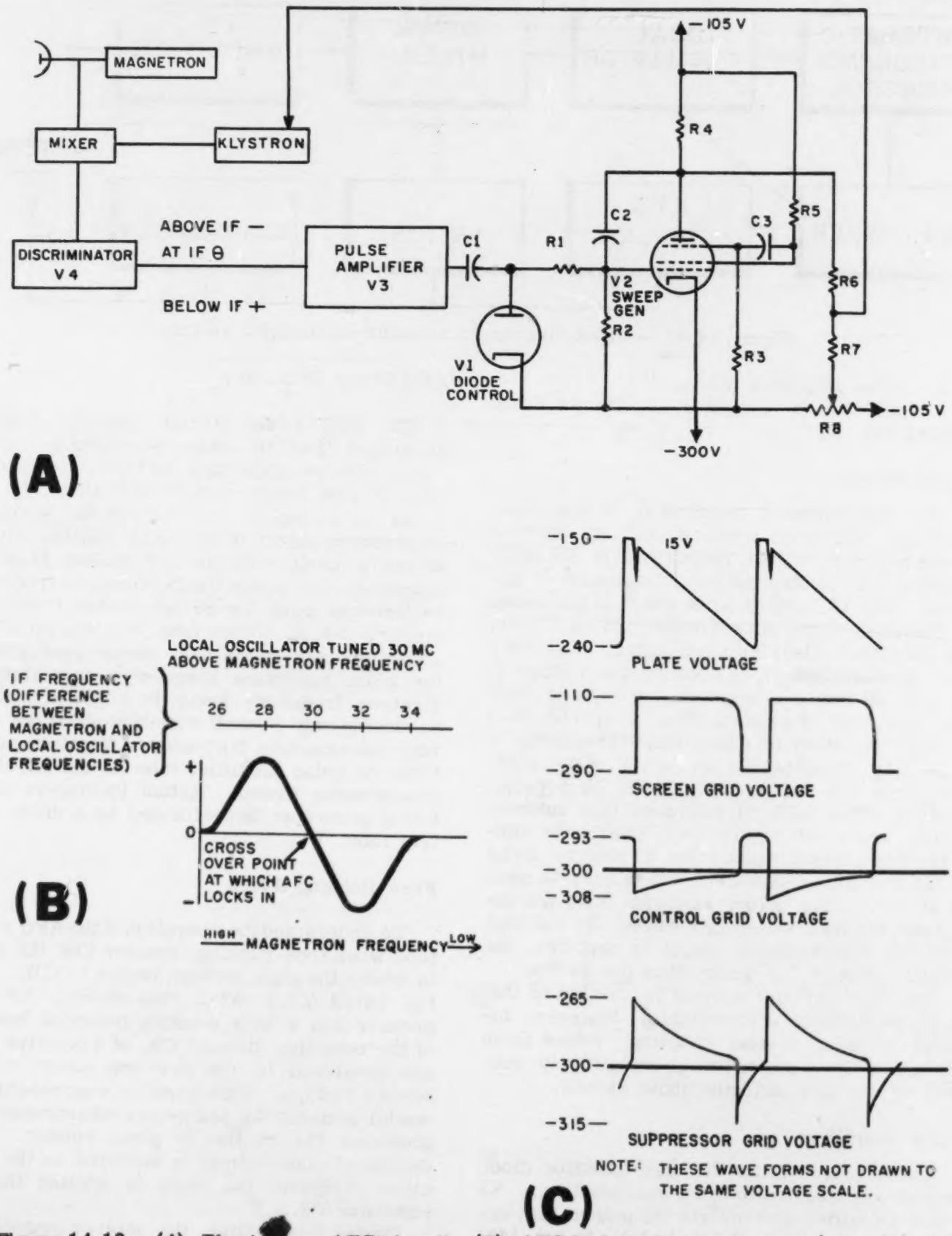

Figure 14-12.—(A) Phantastron AFC circuit; (B) AFC lock-in frequency waveform; (C) AFC sweep generator waveforms.

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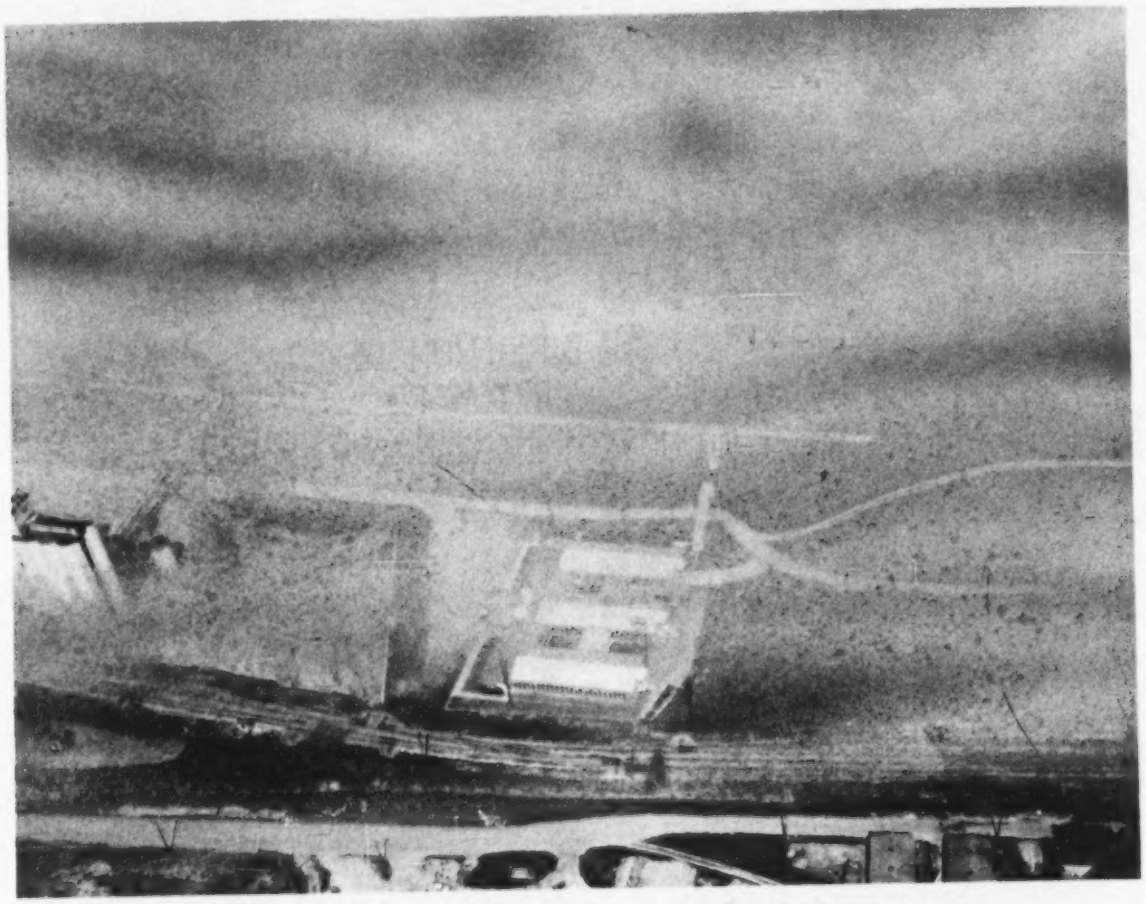

Figure 5-26.—Steam fog.

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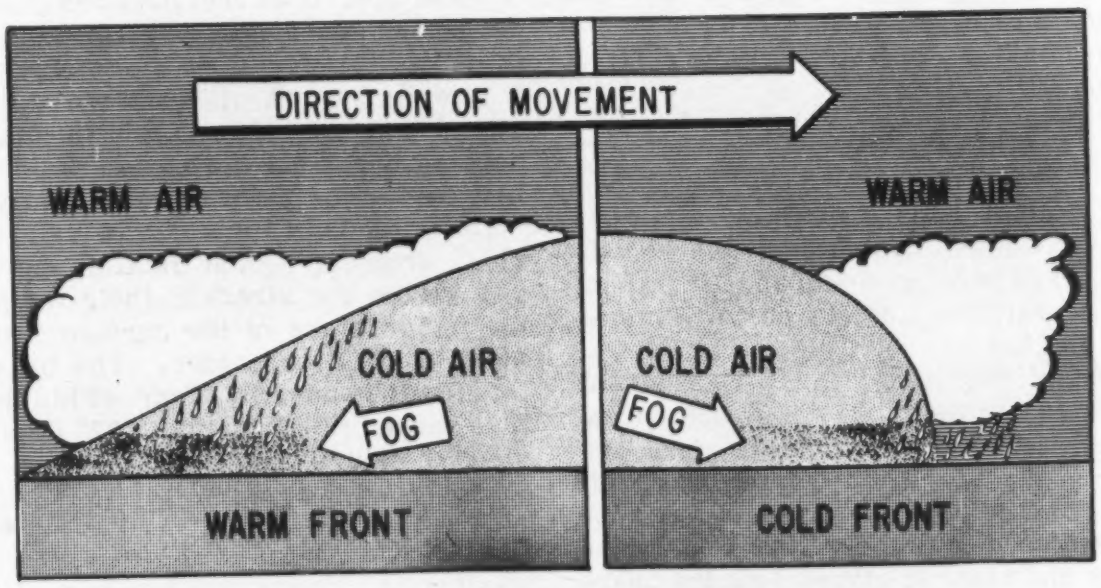

Figure 5-27.—Warm and cold front fog.

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three types. It is clear, dense, and solid, adhering firmly to structures upon which it forms. (See fig. 5-28.) If the water droplets strike an aircraft in such rapid succession that none has a chance to freeze before the next strikes in the same place, the leading edges of the aircraft structures are kept covered by a film of liquid water. This film of water, cooled by contact with the colder air and by partial evaporation, freezes from the inside out forming a clear, dense, strong layer of ice attached to the wing or other surfaces upon which it is freezing.

Some of the conditions which produce a liquid film of water on aircraft favorable to the formation of clear ice are as follows:

1. Large water droplets such as found in cumuliform clouds.
2. Large number of cloud droplets (dense clouds).

These first two conditions are most commonly found in unstable air.

3. Temperature just slightly below freezing.
4. An unstable or conditionally unstable air mass.
5. Rain or freezing rain.

RIME ICE

Rime ice is a granular, whitish, opaque, rough deposit of ice formed from tiny supercooled water drops found in stratiform clouds of stable air. (See fig. 5-29.) Rime ice usually occurs at a lower temperature than does clear ice.

Unlike clear ice, rime is formed as each supercooled water droplet that strikes the airfoil freezes completely before another strikes in the same place. The resulting ice deposit is in the form of tiny pellets frozen together in a spongy mass.

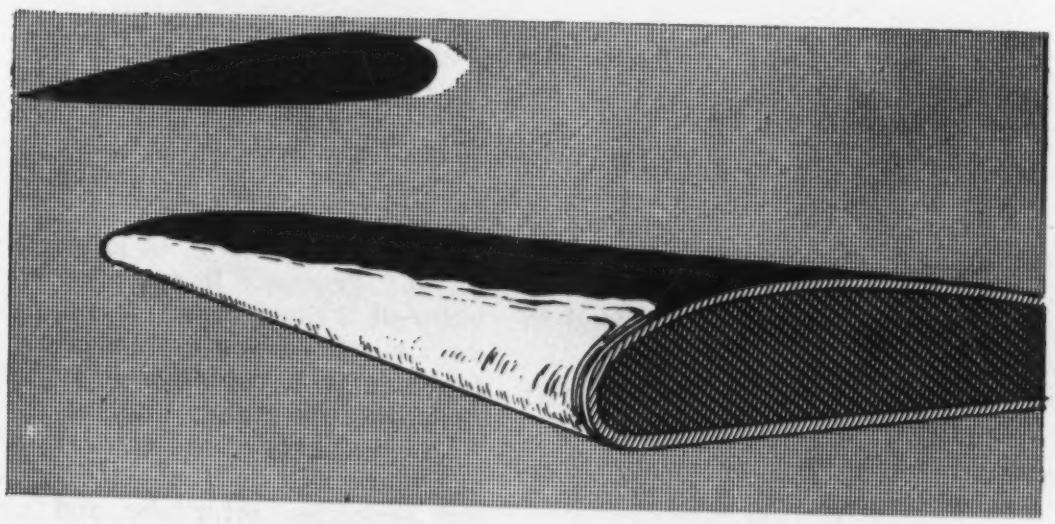

Figure 5-28.—Clear ice on an airfoil.

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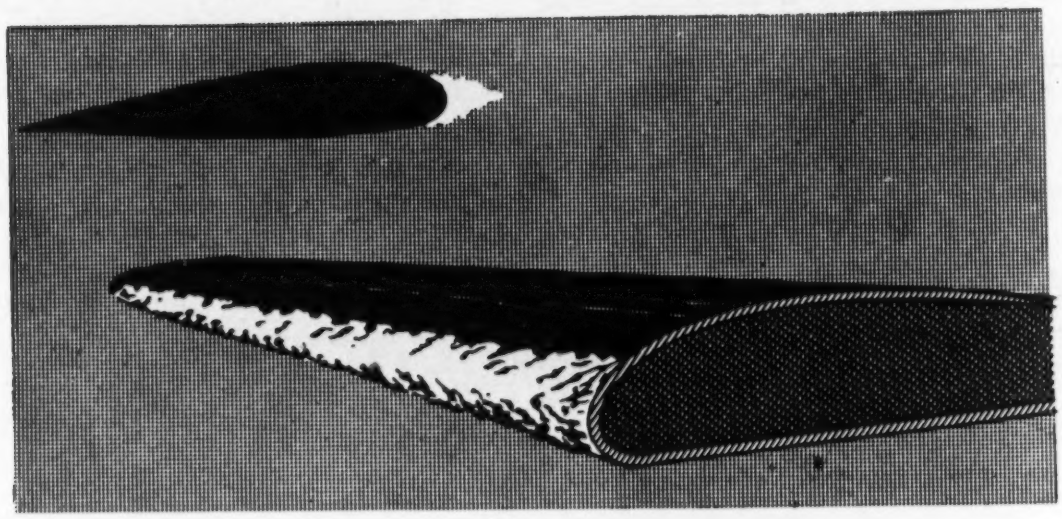

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Figure 5-29.—Rime ice on an airfoil.

The conditions which favor formation of rime ice are as follows:

1. Very small droplets such as found in stratiform clouds.
2. A relatively small number of water droplets found in clouds that are not dense.
3. Temperatures far below freezing.
4. An air mass that is stable or conditionally stable.
5. Drizzle.

FROST

Frost is a light, whitish, feathery crystalline structure, snowlike in character. It forms a dangerous coating on an aircraft surface which adds drag and alters the aerodynamic characteristics of an aircraft. Frost occurs when the temperatures of the surfaces of the aircraft are below freezing at the time condensation takes place. This icing condition usually forms on aircraft on the ground. It can also form on airborne aircraft if the aircraft very quickly flies from a region where the temperature is well below freezing to a region where the temperature is considerably higher and the air is very moist.

Other parts of the aircraft susceptible to icing which will decrease its flight capabilities are the propeller, pitot tube, and carburetor. Propeller ice reduces the power of the aircraft; pitot tube ice causes malfunction of the air speed indicator; and carburetor ice gives the effect of slowly closing the throttle. It occurs under a wide range of temperatures and can result in complete engine failure. Carburetor ice forms during vaporization of fuel combined with the expansion of air as it passes through the carburetor. Temperature drop in the carburetor can be as much as 40° C, but is usually 20° C or less. The temperature at which carburetor

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icing will form depends upon many factors such as relative humidity, type of gas and its ingredients, and the type of carburetors.

WINDS

In general, a reference to wind means air in natural horizontal motion relative to the surface of the earth. Actually, wind has many components of direction. It may be directed vertically upward or downward, or horizontally. The vertical components are difficult to measure. Thus we deal only with the horizontal components—the horizontal direction and speed. In meteorology, reference is generally made to the vertical component of the wind as turbulence, updrafts, or downdrafts.

The cause of windflow is the variation in pressure, which in turn results from a variation in temperature caused by the global circulation of air which maintains a balance of heat on the earth. Since the earth heats unequally, the heat is carried away from a hotter area to a cooler one as a result of the operation of physical laws.

At times confusion arises from the meaning of wind direction. Wind direction is always the direction FROM which the wind is blowing. Windspeed is usually measured and expressed in knots.

PHOTOMETEORS

Photometeors are luminous phenomenon produced by the reflection, refraction, diffraction or interference of light from the sun or moon. They constitute such phenomena as solar and lunar halos, solar and lunar coronas, rainbows, fogbows. Photometeors are not active elements; that is, they generally do not cause adverse weather. However, they are related to clouds which are indicative of what weather to expect.

HALOS

A halo is a luminous ring around the sun or moon. When it appears around the sun, it is a solar halo; when it forms around the moon, it is a lunar halo. It usually appears whitish, but it may show the spectral colors. Halos are formed by REFRACTION of light as it passes through ice crystals. This means that halos are almost exclusively associated with cirriform clouds. Refraction of light means that the light passes through prisms; that is, ice crystals which act as prisms.

CORONAS

A corona is a luminous ring surrounding the sun (solar) or moon (lunar) and is formed by DIFFRACTION of light by water froplets. It may vary greatly in size, but is usually smaller than a halo. All the spectral colors may be visible. Sometimes the spectral colors or portions of them are repeated several times and are somewhat irregularly distributed. It is difficult to distinguish between coronas and halos. The main feature may be size, as previously mentioned, and the colors appear brighter, which is a result of light diffraction by water droplets. This would be associated with cumulus clouds or middle clouds.

RAINBOWS

The rainbow is a circular arc seen opposite the sun, usually exhibiting all the primary colors, with red on the outside. It is caused by diffraction, refraction, and reflection of light within raindrops.

FOGBOWS

A fogbow is a whitish semicircular arc seen opposite the sun in fog. Its outer margin has a reddish tinge; its inner margin has a bluish tinge. The middle of the band is white. An additional bow, with the colors reversed, sometimes appears inside the first.

ELECTROMETEORS

Electrometeors are visable or audible manifestation of the atmospheric electricity. The more important electrometeors include thunderstorms (because of its affect on aviation is discussed as a separate entity later in this chapter), lightning and aurora.

LIGHTNING

Lightning is a flash of light from a sudden electrical discharge which takes place from or inside a cloud or from high structures on the ground or from mountains. Four main types of lightning can be distinguished as follows:

1. Cloud to ground lightning (CG). Lightning occurring between cloud and the ground.

2. Cloud discharge (IC). Lightning which takes place within the thunder cloud.

3. Cloud to cloud discharge (CC). Streaks of lightning reaching from one cloud to another.

4. Air discharge (CA). Streaks of lightning which pass from a cloud to the air but do not strike the ground.

AURORA

Aurora is a luminous phenomena which appears in the high atmosphere, in the form of arcs, bands, draperies, or curtains. This phenomena is usually white but may have colors. The lower edges of the arcs or curtains are usually well defined while the upper edges are not. Polar aurorae are due to electrically changed particles, ejected from the sun, acting on the rarified gases of the higher atmosphere. The particles are channeled by the earth's magnetic field, so that aurorae are mainly observed near the magnetic poles.

LITHOMETEORS

Lithometeors comprise a class of atmospheric phenomena, among which dry haze and smoke are the most common examples. In contrast to a hydrometeor, which consists largely of water, a lithometeor is composed of solid dust or sand particles, or the ashy products of combusion.

HAZE

Haze is suspended dust or salt particles so small that they cannot be individually felt or seen by the unaided eye. They reduce visibility and lend a characteristic opalescent appearance to the air. Haze resembles a uniform veil over the landscape that subdues its colors. This veil has a bluish tinge when viewed against a dark background and a dirty yellow or orange tinge when viewed against a bright background.

SMOKE

Smoke is fine ash particles suspended in the atmosphere. When smoke is present, the disk of the sun at sunrise and sunset appears very red and during the daytime has a reddish tinge. Smoke at a distance, such as from forest fires, usually has a light grayish or bluish color and is evenly distributed in the upper air.

DUST

Dust is finely divided solid matter, uniformly distributed in the air. It imparts a tannish or grayish hue to distant objects. The sun's disk is pale and colorless or has a yellow tinge at all periods of the day.

SAND

Fine particles of sand picked up from the surface by the wind and blown about in clouds or sheets constitute a troublesome lithometeor in some regions.

HYDROMETEORS

Hydrometeors are composed primarily of water in either liquid or solid state. Hydrometeors comprise all forms of precipitation, such as rain, drizzle, snow, and hail, and such elements as clouds and fogs.

PRECIPITATION

Precipitation includes all forms of moisture that fall to the earth's surface, such as rain, snow, hail, drizzle, etc. Dew and frost are not forms of precipitation, although they are hydrometeors. Precipitation is classified according to both its form (liquid, freezing, and solid), size, and rate of fall.

Rain

Precipitation which reaches the earth's surface as large water droplets is classified as rain. If the droplets freeze on contact with the ground or other objects, the precipitation is classified as freezing rain.

Drizzle

Drizzle consists of very small and uniformly dispersed droplets that may appear to float while following air currents. Sometimes drizzle is referred to as mist. Unlike fog droplets, drizzle falls to the ground. However, the rate of fall is very slow. The slow rate of fall and the small size of the droplets distinguish drizzle from rain. When the droplets freeze on contact with the ground or other objects, they are called freezing drizzle. Drizzle always restricts visibility.

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Snow

Snow consists of white or translucent ice crystals. In their pure form the ice crystals are highly complex, hexagonally branched forms. However, most snow falls as parts of ice crystals, as individual crystals, or more commonly as clusters and combinations of these. Snow occurs in meteorological conditions similar to those in which rain occurs, except that with snow the initial temperatures must be at or below freezing.

Snow Pellets (Soft Hail)

Sometimes called soft hail, snow pellets are white, opaque, round (or occasionally conical) kernels of snowlike consistency, 1/16 to 1/4 inch in diameter. They are crisp and easily compressible. They may rebound or burst when striking hard surfaces. They occur almost exclusively in showers.

Snow Grains

Sometimes called granular snow, snow grains take the form of minute, branched, starlike snowflakes, or of very fine simple crystals. They are the solid equivalent of drizzle with diameters generally less than 0.04 inch (1 mm).

Ice Pellets

Ice pellets are composed of frozen raindrops or drizzle or largely melted and refrozen snowflakes that rebound when striking hard surfaces. Their fall may be continuous, intermittent, or showery.

Hail

Ice balls or stones, ranging in diameter from that of a medium-size raindrop to an inch or more, are referred to as hail. They may fall detached or frozen together into irregular, lumpy masses. They are composed either of clear ice or of alternating clear and opaque snowflake layers. Hail forms in cumulonimbus clouds and is associated with thundershower activity. Surface temperatures are usually above freezing when hail occurs. Determination of size is based on the diameter, in inches, of normally shaped hailstones.

THUNDERSTORMS

Intensive research is underway by various government agencies for the purpose of providing the air traffic control system with the capability to locate, identify, and measure the intensity of turbulence associated with severe weather which accompanies thunderstorms. Radar is a valuable tool in this research and much has been discovered. Although this capability does not yet completely exist, controllers must still advise pilots of known weather conditions that should be avoided.

No firm rules can be given such as to avoid thunderstorm cells by a certain number of miles. Controllers must exercise good judgment based on knowledge of thunderstorm characteristics to adequately advise and assist pilots in the accomplishment of safe flight.

FORMATION

The thunderstorm represents a violent and spectacular atmospheric phenomenon. The thunderstorm is usually accompanied by lightning, thunder, heavy rain, gusty surface wind, and frequently by hail. A certain combination of atmospheric conditions is necessary for the formation of a thunderstorm. These factors are conditionally unstable air of relatively high humidity and some type of lifting action. Before the air actually becomes unstable, it must be lifted to a point where it is warmer than the surrounding air. When this condition is brought about, the relatively warmer air continues to rise freely until, at some point aloft, its temperature has cooled to the temperature of the surrounding air. In order to bring the warm surface air to a point where it will continue to rise freely, some type of external lifting action must be introduced. Many conditions satisfy this requirement. For example, an air mass may be lifted by heating, terrain, and fronts or convergence.

STRUCTURE

The fundamental structural element of the thunderstorm is the unit of convective circulation known as a convective cell. A mature thunderstorm contains several of these cells, which vary in diameter from 1 to 6 miles. By radar analysis and measurement of drafts, it has been determined that, generally, each cell is independent of surrounding cells of the same

storm. Each cell progresses through a cycle which lasts from 1 to 3 hours. In the initial stage (cumulus development), the cloud consists of a single cell; but as the development progresses, new cells form and older cells dissipate.

The life cycle of the thunderstorm cell consists of three distinct stages; they are the cumulus stage, the mature stage, and the dissipating or anvil stage. (See fig. 5-30.)

Cumulus Stage

Although most cumulus clouds do not become thunderstorms, the initial stage of a thunderstorm is always a cumulus cloud. The chief distinguishing feature of this cumulus or building stage is an updraft, which prevails throughout the entire cell. Such updrafts vary from a few feet per second to as much as 100 feet per second in mature cells.

Mature Stage

The beginning of surface rain, with adjacent updrafts and downdrafts, initiates the mature stage. By this time the apex of the average cell has attained a height of 25,000 feet or more. As the raindrops begin to fall, the frictional drag between the raindrops and the surrounding

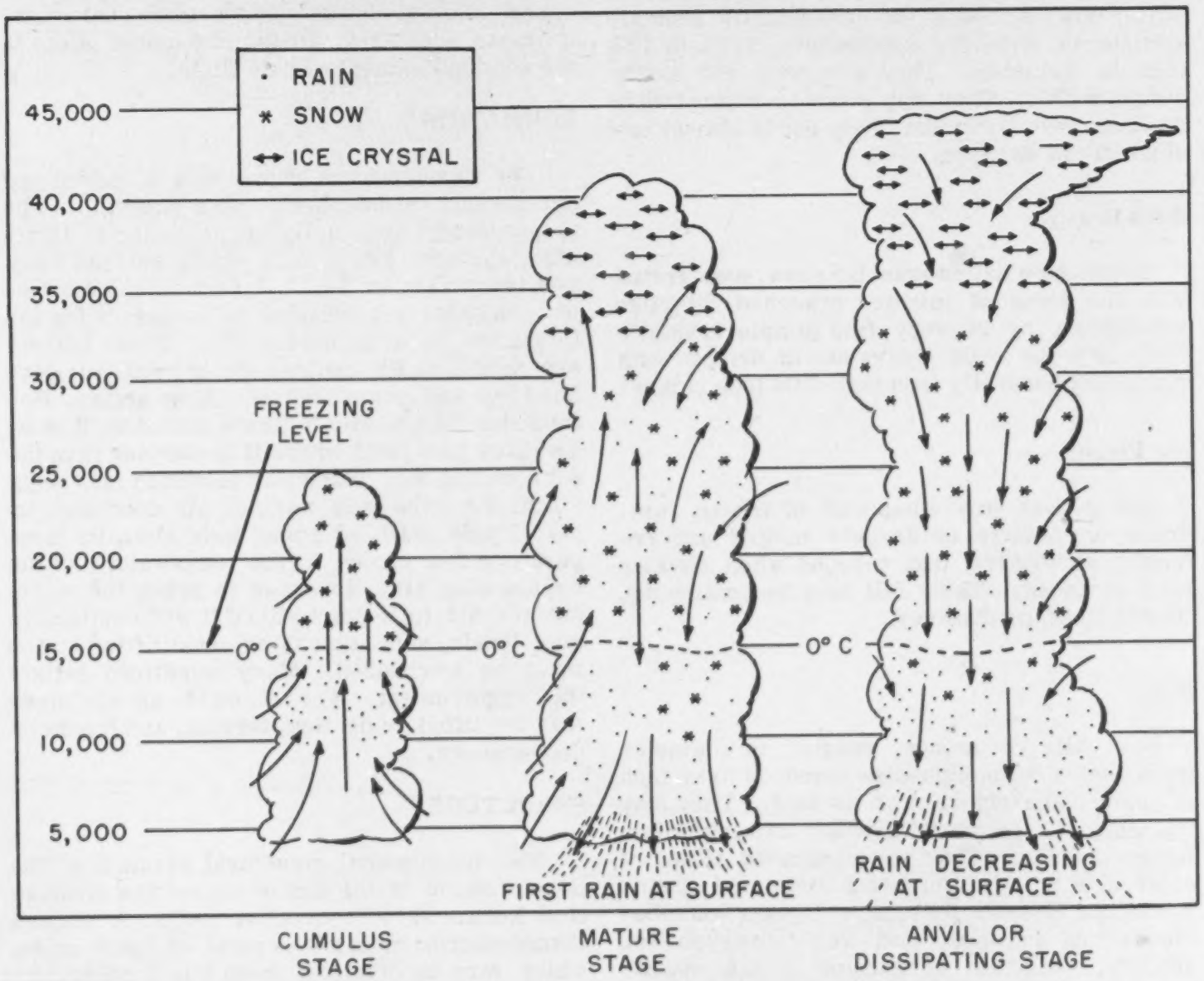

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Figure 5-30.—Life cycle of a thunderstorm cell.

air causes the air to begin a downward motion. The descending saturated air soon reaches a level where it is colder than its environment; consequently, its rate of downward motion is accelerated. This is a downdraft.

Dissipating (Anvil) Stage

Throughout the life span of the mature cell, more and more air aloft is being dragged down by the falling raindrops. Consequently, the downdraft spreads out to take the place of the dissipating updraft. As this process progresses, the entire lower portion of the cell becomes an area of downdraft. Since this is an unbalanced situation, and since the descending motion in the downdraft effects a drying process, the entire structure begins to dissipate. The high winds aloft have now carried the upper section of the cloud into the anvil form, indicating that gradual dissipation is overtaking the storm cell.

THUNDERSTORM WEATHER

Rain

Liquid water in a storm may be ascending if encountered in a strong updraft; it may be suspended, seemingly without motion, yet in extremely heavy concentration; or it may be falling to the ground. Rain, as normally measured by surface instruments, is associated with the downdraft. This does not preclude the possibility of a pilot entering a cloud and being swamped, so to speak, even though rain has not been observed from surface positions. Rain is found in almost every case of penetration below the freezing level. In instances in which no rain is encountered, the storm probably has not developed into the mature stage.

Hail

Hail is a possibility in any thunderstorm, and the presence of damaging hail should always be considered with moderate or severe storms.

Turbulence

Data obtained by research indicates that the frequency and severity of turbulence encounters decrease slowly with distance from the storm cores. Moderate to severe turbulence may be encountered up to 20 miles from the center of severe storms at any altitude and up to 10 miles from the centers of less severe storms. Severe turbulence is often found in the anvil cloud 15 to 20 miles downwind from the severe storm cores. The storm cloud is only the visible portion of a turbulent system whose updrafts and downdrafts often extend outside of the storm proper. Very little evidence exists that maximum turbulence occurs at the middle heights of a storm. The same turbulence considerations which apply to flight at high altitudes near storms apply to low altitudes as well. No useful correlation exists between the external visual appearance of thunderstorms and the turbulence and hail within them.

Surface Wind

A significant hazard associated with thunderstorm activity is the rapid change in surface wind direction and speed immediately prior to storm passage. The strong winds at the surface accompanying thunderstorm passage are the result of the horizontal spreading out of downdraft currents from within the storm as they approach the surface of the earth.

CHAPTER 6

AVIATION WEATHER REPORTS AND ADVISORIES

AVIATION WEATHER SERVICE

The U. S. Weather Bureau is the agency responsible for the nation's aviation weather service. It is the primary organization for providing weather service to pilots. To prepare, collect, and transmit the thousands of observations and forecasts now available to pilots would require an organization many times the size of the Weather Bureau. Therefore, the Weather Bureau obtains the cooperation of other government agencies, and private individuals and organizations to satisfy the overwhelming aviation weather service requirements.

The FAA is considered the principal distribution agency for weather information to aviation interests through its vast communications systems and pilot weather briefing service.

The military weather service cooperate extensively with the Weather Bureau at all levels by exchange of weather information. However, the military weather services concentrate their efforts toward satisfying military requirements and directly serve military interests.

TYPES OF WEATHER OBSERVATIONS

The term "observation" is used to cover both measured and estimated existing values of weather elements. Observations are made at the ground (surface), from the ground, and aloft.

Surface Observations

Surface observations are the most readily obtained. They are made by Weather Bureau personnel, military weather services personnel, and FAA Flight Service Specialists. Surface observations from Navy and commercial ships at sea further add to the weather picture. Automatic observing stations (AMOS), which automatically record wind, ceiling and precipitation information, etc., are being added to the network of surface observation sites.

Radar Observations

Radar observations afford a continuous presentation of significant cloud and precipitation patterns. These are made by Weather Bureau and military personnel at many locations.

Rawinsonde Observations

These observations are obtained by sending a balloon aloft with miniature weather observing equipment and radio gear. They furnish information on temperature, humidity, pressure and wind often to heights above 100,000 feet.

Pilot Balloon Observations (PIBALS)

PIBALS supplement the rawinsonde observations. It is a balloon sent aloft and tracked visually to determine wind information.

Pilot Reports (PIREP's)

These observations come directly from the pilot and are often relayed through the Air Controlman to the weather service personnel. Much of the time, PIREP's are the only sources of information relating to conditions such as turbulence, icing, and cloud tops.

Aerial Weather Reconnaissance Flights

The Air Force and Navy make scheduled flights along fixed routes over relatively inaccessible land and water areas with trained weather personnel aboard to make weather observations.

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Satellite Observations

Satellites orbiting the earth at altitudes above 400 miles furnish photographs of cloud patterns over a large area.

ANALYSES AND FORECASTING CENTERS

Some of the analyses and forecast centers of the Weather Bureau directly support aviation, while others provide general or special services. The following centers are those which directly support the aviation weather service.

National Meteorological Center (NMC)

This center is the hub of the nation's weather information processing function. It receives weather information from all over the Northern Hemisphere and provides analyses and forecasts to other weather facilities for periods of up to 30 days in the future. Other facilities may interpret NMC products without having to perform identical tasks in preparing detailed forecasts for their areas.

Flight Advisory Weather Service (FAWS) Center

FAWS centers have areas of forecast responsibility which roughly correspond with areas of responsibility of the FAA Air Route Traffic Control Centers (ARTCC's). These centers prepare and distribute aviation terminal and area forecast with the assistance of guidance material from the National Meteorological Center.

Weather Bureau Airport Stations (WBAS)

The WBAS is the Weather Bureau's main link between the aviation interest and the processing centers such as NMC and FAWS. The weatherman in a WBAS is an observer-briefer. He depends mostly on material received from the larger centers, but must do some analyses and forecasting also. The WBAS is responsible for the information given to pilots and other aviation interests.

Special Processing Centers

NATIONAL SEVERE STORM FORECAST CENTER (NSSFC).—This facility, located in Kansas City, Mo., issues warnings of severe thunderstorms and their accompanying hazards including tornadoes, funnel clouds aloft, hail at the surface, areas of extreme turbulence, and surface wind gusts of more than 50 knots.

THE NATIONAL HURRICANE CENTER.—This facility is located in Miami, Fla. All efforts concerning tropical storms or hurricanes which may affect the southern and eastern United States (U. S.) are supervised and coordinated at this center. The Weather Bureau office in San Francisco serves as the hurricane center for tropical storms of all intensities in the Pacific Ocean along the west coast of the U.S. A corresponding service for tropical storms and typhoons in the central and western Pacific is provided through joint efforts of the Weather Bureau and military weather services.

HIGH ALTITUDE FORECAST CENTERS.—These centers provide forecast of temperature, wind, and significant en route weather for high altitude operations.

THE NATIONAL WEATHER SATELLITE CENTER (NWSC).—NWSC prepares cloud analyses for distribution. The analyses are based on pictures of cloud coverage of large areas taken by the cameras of the weather satellites orbiting the earth.

WEATHER COMMUNICATIONS SYSTEMS

Weather information is extremely perishable because of its changeable nature. The distributing function is a very large one, including the collection and dissemination of observed data and the delivery of products of the analyses and forecasting centers. Existing methods for collection and distribution of weather information over long distances are teletype circuits and facsimile networks. Weather information may be transmitted by landline, which is a fixed wire circuit from station to station or from a control station to a group of stations, or by radio, which is used to transmit and receive information where the use of landline is impracticable or impossible. Radio is the means by which weather information is transmitted to ships and overseas land stations.

Teletype Circuits

The teletype circuits used for distribution of aviation weather information are service A, C, and O, operated by the FAA, and military teletype networks.

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the plate voltage reaches minimum, the negative voltage applied to C2 ceases, and the control grid potential rises positively. Because of the low potential of both the suppressor and plate at this time, the grid-voltage change causes a rapid increase in screen current; the resulting negative voltage, coupled from the screen through capacitor C3 to the suppressor, drives this element sharply negative, cutting off the plate current.

The plate voltage rises sharply to maximum, and this positive-voltage rise at the plate, applied through capacitor C2 to the control grid, drives the grid positive to the point of screen-current saturation. The screen current and the plate voltage remain at maximum while the negative charge on C3, at the suppressor, is leaking off through resistor R3 and the repeller resistor network. As the suppressor potential rises positively past a certain critical value, a pulse of plate current occurs, and the resulting spike of plate voltage drives the control grid negative, causing the cutoff of screen current and returning the screen potential to the maximum positive value. This negative spike of plate voltage occurs as the circuit "flops", transferring the control action of the control grid from the screen back to the plate. Following this charge, the plate voltage starts to decline linearly, and the entire cycle is repeated.

Locked-In Sweep

When the free-running AFC sweep voltage starts to swing more negative, the frequency of the klystron increases. As the beat frequency comes within range of the pass band, positive pulses are developed by V4, and by inversion they appear at the plate of the pulse amplifier, V3, as negative pulses. These pulses are applied to the grid circuit of V2, the AFC sweep generator. Because the low-amplitude negative pulses do not affect the AFC sweep, the repeller voltage continues to decline. When the beat frequency goes past the 30-mc point, the discriminator pulse-output polarity is reversed and the positive pulses are produced at the output of V3. As each positive pulse is applied to capacitor C1, charging current flows rapidly through the electron path provided by the sweep-control tube, V1. As the peak of the pulse passes, the conductivity of V1 is reduced to zero, and C1, discharges slowly through R2. This decline of negative voltage is so slow that as each succeeding pulse occurs, it is integrated with the preceding pulse.

Since the discriminator response changes sharply from the 30-mc crossover point, the corresponding positive pulses from V3 appear in increased amplitude. After several pulses, the bias becomes negative enough to cut off the sweep, which then reverses direction and attempts to rise quickly to a peak value. However, this means that the intermediate frequency begins to decrease, and the positive voltage output of the pulse amplifier begins to lose amplitude, falling to zero at the crossover. The resulting loss of negative bias voltage on the sweep-generator tube again changes the sweep direction, causing it to resume its original slow decline, and the positive pulses from the pulse amplifier again cut off the sweep. When locked in by this sequence of functions, the frequency of the klystron is varied in correct relationship with that of the magnetron, so that the IF beat frequency varies about the crossover point of the discriminator.

The frequency sweep of the klystron with the AFC locked in is restricted by limiting the amplitude of the voltage applied to the klystron, so as to produce only a small frequency deviation. The amplitude is controlled by the rate of slop of the sweep and by the pulse repetition frequency. Reduction in sweep rate (steepness of sweep waveform) represents a smaller change in voltage in a given time.

DELAY SYSTEMS

The term delay systems refers to special control circuits that are used in many electronic systems, particularly in radar sets. These circuits are used for the purpose of delaying a waveform, which, in turn, produces a delayed action. A knowledge of several of the basic circuits will prove helpful in gaining an understanding of the application and operation of delay systems.

Some of the more common types of electronic delay systems are the RC, the phantastron, and the delay line (artificial lines).

PURPOSE AND APPLICATION

The PPI radarscope is a unit that makes use of various applications of different delay systems. Some of these are:

1. CLOSED CENTER OPERATION. In this operation the PPI sweep is started after the magnetron is fired. (See fig. 14-13.) As compared to normal operation, the targets appear

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SERVICE A.—The primary purpose of this system is collecting and disseminating aviation weather reports and NOTAM's.

SERVICE C.—The primary purpose of this network is collecting and disseminating domestic synoptic weather information.

SERVICE O.—The Service O system is used primarily for collecting and disseminating international weather information.

MILITARY NETWORKS.—CONUS Meteorological Teletype System (COMET) is an air Force network used to collect military aviation weather observations and pilot reports in the contiguous U.S. and to provide rapid distribution of this information to military users.

The Navy has established six Fleet Weather Centrals which collect weather observations from ships at sea and other Navy weather facilities through the worldwide U. S. Naval Communications System. Navy-originated weather reports may be entered on the FAA weather circuits, COMET, or transmitted via naval communications depending upon their origin, content, and purpose.

Facsimile Networks

Facsimile networks are used to distribute analyses and forecasts in graphic form. Special depictions of other types, such as photographs, also can be made through this distribution method. There are four such networks presently, two operated by the Weather Bureau and one each by the Navy and Air Force. This method may be considered preferable to the teletype; however, present facsimile networks are incapable of handling the volume of aviation weather required.

Local Distribution

Air Controlmen are concerned mostly with weather conditions in the immediate vicinity, and within 50 miles, of the airport. Weather forecasts are used regularly for planning purposes, such as selection of runway, etc. However, air traffic controllers are more concerned with conditions at the present and within the next hour.

Obviously, the amount of weather reports and forecasts discussed to this point, (although necessary for complete weather service) is much more than is actually utilized by the Air Controlman in the performance of routine tasks. Therefore, weather service personnel digest all the weather information and supply the Air Controlman with the needed meteorological information.

This weather information is distributed locally by various methods including TelAutograph (a remote mechanical writing device), interphone, and closed circuit television.

HOURLY AVIATION WEATHER REPORTS

Weather information received from weather service personnel will consist of numerals, symbols, and contractions as used on Teletypewriter networks to describe a large amount of weather information in a small space. The Air Controlman must be able to decode this information for transmission to pilots via radio telephone.

The following section discusses the hourly aviation weather report and gives an explanation of encoding and decoding the symbols used. This explanation is limited to a brief coverage intended to provide the Air Controlman with a working knowledge of aviation weather reports.

CONTENT AND FORMAT OF THE HOURLY AVIATION WEATHER REPORT

Figure 6-1 is an example of an hourly aviation weather report as it would be received on Service A or the Air Force COMET network with minor variations.

LOCATION IDENTIFIERS	"SPECIAL" REPORT	SKY AND CEILING	VISIBILITY WEATHER AND OBSTRUCTION TO VISION	SEA LEVEL PRESSURE	TEMPERATURE AND DEW POINT	WIND	ALTIMETER SETTING	RUNWAY VISUAL RANGE	CODED PIREPS	REMARKS
MKC	S	15⊕M25⊕	4R-K	132	/58/56	/18Ø7	/993/	R16VR13	/⊕55	RBØ5-⊕V⊕

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Figure 6-1.—Hourly Aviation Weather Report.

Location Identifiers

Three-letter location identifiers identify the station sending the report. All location identifiers are contained in the FAA publication Location Identifiers 7350.1 Series.

Special Report

The letter "S" is used on FAA's Service A to indicate a special report when some significant change in existing weather has occurred and requires immediate dissemination. On the Air Force COMET network, this type of report is identified by the contraction SPUS for Special United States. On all other reports this space is omitted since most other reports fall in the category of hourly weather reports.

Sky and Ceiling

Figures preceding the symbols are heights of clouds in hundreds of feet above the surface rounded off to the nearest reportable value as in table 6-1.

The letter "V" following the cloud height indicates the height is variable. This is a condition in which the value rapidly increases and decreases by one or more reportable values during the period of observation. It is reported only for ceilings less than 3,000 feet. The average of all values secured is used as the cloud height.

Sky cover symbols indicate the amount of sky cover. These symbols are listed on the report in ascending order if more than one layer of clouds or obscuration exists. Table 6-2 lists the sky cover symbols, their meaning, contraction, and explanation.

Table 6-1.—Sky cover height values

Feet	Reportable values (coded in hundreds of feet)	Encoded
5,000 or less	To nearest 100 ft	1,10,50, etc.
5,001 to 10,000	To nearest 500 ft	55,75,100 etc.
Above 10,000	To nearest 1,000 ft	140,180, 200, etc.

A ceiling is either:

1. The height ascribed to the lowest reported opaque broken or overcast layer of clouds or obscuring phenomena aloft, or;
2. The vertical visibility in a surface based pheomena associated with an obscured sky.
3. "Unlimited" when neither of the preceding conditions in 1 or 2 are present.

The letter preceding the height of a ceiling layer of sky cover indicates how the ceiling height was obtained. Specific symbols are employed to denote ceilings obtained by various methods. (See table 6-3.)

Visibility

Visibility is reported in statute miles and fractions thereof to 3 miles, the nearest whole mile to 15 miles, and the nearest 5 miles beyond 15 miles. When the prevailing visibility is judged to exceed 15 miles and the most distant marker is 15 miles or less, but more than 7 miles from the point of observation, the visibility is coded as 15+.

If visibilities of less than 3 miles rapidly increase or decrease by one or more reportable values, the vibibility is followed by the letter "V" for variable.

PREVAILING VISIBILITY.—Prevailing visibility is the greatest visibility which is attained or surpassed throughout at least half of the horizon circle not necessarily continuous. In uniform weather conditions, determination of visibility is relatively simple since it is the same in all directions. In non-uniform weather conditions one aid in determining prevailing visibility is to divide the horizon circle into several sectors, each of which has substantially uniform visibility. (See fig. 6-2.) The prevailing visibility is the visibility entered on the hourly aviation weather report under such conditions.

SECTOR VISIBILITY.—Sector visibility is the visibility within a specified sector of the horizon circle having essentially uniform visibility. Sector visibility is encoded in the remarks section of the hourly aviation weather report when it is different from the prevailing visibility and is less than 3 miles, or when it is considered operationally significant if 3 miles or more. Such remarks include the direction from the station of the sector in which the visibility is different.

CONTROL TOWER OBSERVATIONS AND ACTIONS.—Unless otherwise exempted, certified, qualified Navy Air Controlmen, or otherwise

Table 6-2.—Sky cover symbols.

Symbol	Meaning and contraction	Explanation
○	Clear CLR	0.0 total sky cover. (This symbol is used alone—not in combination with others.)
◐	Scattered layer aloft SCTD	0.1 to 0.5 sky cover at and below level of layer aloft and not classified as "thin."
◑	Broken layer aloft BRKN	0.6 to 0.9 sky cover at and below level of layer aloft and not classified as "thin."
⊕	Overcast layer aloft OVC	1.0 (ten-tenths) sky cover at and below level of layer aloft and not classified as "thin."
X	Obscuration (surface layer)	All of sky is hidden by a surface-based layer; i.e., vertical visibility is restricted by the layer.
-X	Partial obscuration (surface layer)	0.1 or more, but not all of sky is hidden by surface-based layer; i.e., vertical visibility through the layer is not completely restricted.
-◐	THIN SCTD	Sky or higher clouds are visible through the sky cover.
-◑	THIN BRKN	
-⊕	THIN OVC	

Table 6-3.—Ceiling Symbols.

Symbol	Meaning
A	Aircraft.
B	Balloon.
E	Estimated height of noncirriform clouds.
M	Measured.
R	Rawinsonde Balloon or Radar.
W	Indefinite. (Vertical visibility is restricted by surface based obscuration which prevents a determination of the cloud heights.)

authorized tower personnel must report prevailing visibility when the prevailing visibility at the usual point of observation or at the tower level is less than 4 miles. The control tower visibility observations may be used immediately for aircraft operations but must be recorded and forwarded to weather service personnel as soon as practicable. During this condition, control tower personnel must notify weather service as soon as possible when they observe the prevailing visibility at the tower level to decrease to less than 4 miles and change by one or more reportable values.

When the visibility at the usual point of observation is less than 4 miles and the control tower visibility is different but does not qualify as the prevailing visibility, the control tower visibility is encoded in the remarks section of the hourly aviation weather report.

Control tower visibility may be encoded in the remarks section when different from prevailing

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visibilities of 4 miles or more when considered operationally significant.

Weather Element Symbols

The following symbols are used to indicate weather elements:

T+ . . . . . Severe thunderstorm
T . . . . . Thunderstorm
R . . . . . Rain
RW . . . . . Rain showers
L . . . . . Drizzle
ZR . . . . . Freezing rain
ZL . . . . . Freezing drizzle
IP . . . . . Ice pellets
IPW . . . . . Ice pellet showers
S . . . . . Snow
SW . . . . . Snow showers
SP . . . . . Snow pellets
SG . . . . . Snow grains
IC . . . . . Ice crystals
A . . . . . Hail

Suffix + to precipitation symbols to indicate heavy intensity,—For light intensity, and -- for "very light." The absence of an intensity symbol indicates "moderate." No intensity is assigned to tornadoes, waterspouts, funnel clouds, hail, or ice crystals, and only moderate or severe is reported for thunderstorms.

Tornadoes, waterspouts, and funnel clouds are always spelled out in full and are followed by letters showing the direction they are bearing from the station and direction toward which it is moving. AN EXAMPLE WOULD BE: TORNADO NW MOVG E.

Precipitation is divided into three classes: liquid, freezing, and frozen. If two different classes of precipitation are present, they are encoded in the above order. If more than one type of precipitation of the same class are present (heavy snow, ice pellets), the one with the greatest intensity is encoded first (S+IP).

Obstructions to Vision Symbols

Hydrometeors (other than precipitation) and lithometeors are called obstructions to vision and are encoded by means of letter symbols if conditions reduce the prevailing visibility to less than 7 miles and the obstruction to vision is occurring at the station. If the visibility is reduced to less than 7 miles by an obstruction at a distance from the station, the phenomena is described in remarks.

The order of encoding, if more than one obstruction is present at the time of the observation, is in order of decreasing predominance. The various symbols follow:

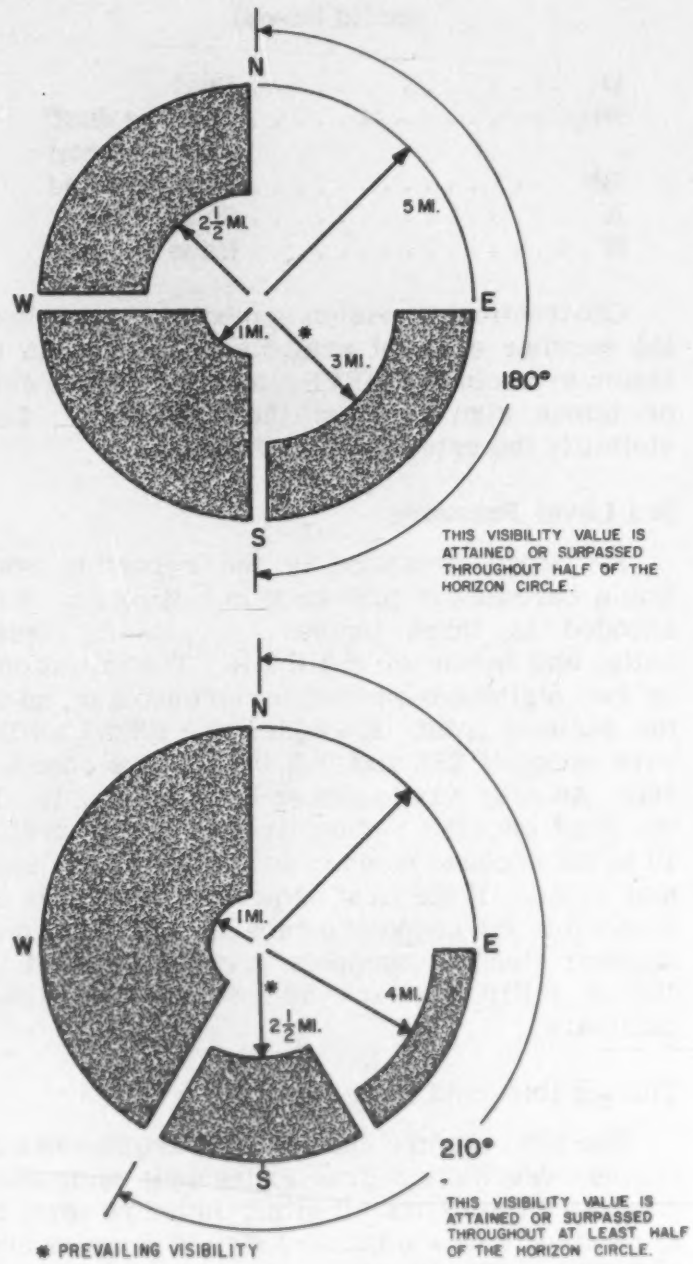

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Figure 6-2.—Prevailing visibility.

HYDROMETEORS
(water based)

F . . . . . Fog
GF . . . . . Ground fog
IF . . . . . Ice fog
BS . . . . . Blowing snow
BY . . . . . Blowing spray

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or RVRNO would appear in place of the normal reading in the hourly aviation weather report.

Coded PIREP's

Pilot reports of heights of bases or tops of sky cover within 20 miles (50 miles for cirriform layers) of the reporting station which are not visible from the station are included in the hourly weather report. These heights are above mean sea level (MSL) as read from the aircraft's altimeter. Figures indicating height preceding the sky cover symbol are the bases of the higher layer not visible from the station. Figures indicating height following the sky cover symbol are the tops of the layer.

EXAMPLE: ⊕ 55/75- ⊕ 1ØØ would mear the top of the reported overcast layer is 5,500 MSL, the base of a higher thin overcast layer is 7,500 MSL, and the top of that layer is 10,000 MSL.

Remarks

Remarks may be work contractions, symbols, and/or plain language where authorized symbols or contractions do not apply. They are used to amplify or explain elements of the report.

Some examples of symbols used in the remarks sections are as follows:

REMARKS	EXPLANATION
K1Ø ⦶	Scattered smoke layer aloft, base 1,000 feet.
BINOVC	Breaks in overcast.
HIR CLDS VSB	Higher clouds visible.
TWRG CU SW	Towering cumulus to the southwest.
CB ALL QUADS	Cumulonimbus all quadrants.
TWR VSBY1 GFDEP 7Ø	Tower visibility 1 mile, ground fog depth 70 feet.
OCNL LTGCC	Occasional lightning cloud to cloud.
HLSTO 1 1/4	Hailstone one and one-quarter inches in diameter.
RWB45	Rain showers began at 45 minutes past the hour.
AE16	Hail ended 16 minutes past the hour.
LTGCG	Lightning, cloud to ground.
LTGIC	Lighting, in clouds.
ICGIC	Icing in clouds.
PRESFR	Pressure falling rapidly.
KDSIPTG	Smoke dissipating.
ALSTG	Altimeter setting.
VSBY N1S4	Visibility north 1 mile, south 4 miles.
T OVHD MOVG SE	Thunderstorm overhead moving southeast.
PRESRR	Pressure rising rapidly.
F INCRG	Fog increasing.
ICGIP	Icing in precipitation.
⦶V⦶	Broken layer in the report is occasionally scattered.
CIG 15V2Ø	Ceiling is varying between 1,500 and 2,000 feet.
VSBY 1V2	Visibility is varying between 1 and 2 miles.
SFC VSBY 1	Surface visibility is 1 mile.
WSHFT ØØØ3	Wind direction shifted at 0003 (GMT).
WSHFT ØØØ3 FROPA	Wind direction shifted at 0003 associated with a frontal passage.

In the remarks section, items extracted from Notice to Airmen (NOTAM's, chapter 3) may be included on FAA Service A hourly aviation weather reports.

All possible contraction for remarks cannot be listed here. For possible changes and additional information, refer to FAA Contractions Handbook 7340.1 Series.

In certain hourly aviation weather reports, additive data is included in remarks such as pressure tendencies, maximum and minimum temperature, cloud groups, etc., intended primarily for use of weather service personnel in preparation of forecast maps.

EXAMPLES OF DECODING HOURLY AVIATION WEATHER REPORTS

1. NCQ -XM3⦶5⊕1 1/2F 1Ø3/63/61/ØØØØ/985/F1. NAS Atlanta, sky partially obscured,

measured ceiling 300 broken, 500 overcast, visibility one and one-half fog, barometric pressure 1010.3 millibars, temperature 63 degrees, dewpoint 61 degrees, wind calm, altimeter 29.85, fog one-tenth.

2. NHZ E46⊕4GFH 1Ø6/55/5Ø/362Ø/983. NAS Burnswick, Maine, estimated ceiling 4600 overcast, visibility 4 ground fog and haze, barometric pressure 1010.6 millibars, temperature 55 degrees, dewpoint 50 degrees, wind 360 degrees at 20 knots, altimeter 29.83.

3. NMM-X/5-⦶3/16GF 623/39/39/Ø1Ø4/ØØ1/ R02VV 1/4/F3. NAS Meridian, sky partially obscured, five hundred thin broken, visibility three-sixteenths ground fog, barometric pressure 962.3 millibars, temperature 39 degrees, dewpoint 39 degrees, wind 010 degrees at 4 knots, altimeter 30.01, runway 2 visibility 1/4 mile, ground fog three tenths.

4. NHK M5⦶2R—F 796/62/59/Ø9Ø3/Ø13/ F4CIG⦶V⦶. NAS Patuxent, measured ceiling 500 broken, visibility 2 very light rain, fog, barometric pressure 979.6 millibars, temperature 62 degrees, dewpoint 59 degrees, wind 090 degrees at 3 knots, altimeter 30.13, fog four tenths, ceiling broken variable scattered.

AVIATION OBSERVATIONS ASSOCIATED WITH THE HOURLY AVIATION WEATHER REPORTS

Aviation weather observations are classified as record (R), special (S), record special (RS), or local (L).

Record Observation (R)

Record observations are normally taken at hourly intervals having a standard time of H + 00 (on the hour). They are the basic observations which supply the weather information for the hourly aviation weather report.

Special Observation (S)

Special weather observations are supplementary to the hourly record observation. They are taken and transmitted as soon as possible after certain significant weather changes have occurred.

Comparing the special to a record observation, the letter S and time of filing is an addition. The sea level pressure, temperature, and dewpoint are omitted.

CRITERIA FOR TAKING SPECIAL OBSERVATIONS.—A special observation is made whenever one or more of the elements listed below have changed in the amounts specified. The amount of change is derived from the last record or special observation.

In any instance when ceiling forms below, decreases to less than, or if below, increases to equal or exceed:

1. 3,000 feet.
2. 1,000 feet.
3. 500 feet.
4. All nationally published minima applicable to the airport.
5. Values established locally because of their significance to aircraft operations.

At all stations, a special observation is made when the sky condition shows clouds below 1,000 feet, and when no clouds were previously reported below this level.

In any instance when prevailing visibility decreases to less than, or if below, increases to equal or exceed:

1. 3 miles.
2. 2 miles.
3. 1 1/2 miles.
4. 1 mile.
5. All nationally published minima applicable to the airport.
6. Values established locally because of their significance to aircraft operations.

A special observation is to be made when a tornado is first observed, disappears from sight, or is reported by the public to have occurred within the last 6 hours.

A special observation is to be made when a thunderstorm begins (thunder is first heard), increases in intensity, or ends (15 minutes after thunder is last heard).

Precipitation causes a special observation to be made when hail begins or ends; freezing precipitation, other than very light, begins, changes intensity, or ends; and ice pellets, other than very light, begins, changes intensity or ends.

Wind and wind shifts are causes for making special observations when the wind suddenly doubles its average speed to more than 26 knots, or when a wind shift occurs.

Tornado or wind special observations may be transmitted as single element specials on the teletype; i.e., the only information transmitted is that which actually requires the special.

These criteria are regarded as minimum requirements for the making of special observations. In addition, any weather situation

that the observe feels is important to safety and efficiency of aircraft operation is reported in a special observation.

Record Special Observation (RS)

If the time of the significant weather changes which constitute a special coincides with the time of the record observation, the two reports are combined; hence the name record special. If this happens, the letter S remains in the report to attract attention to the fact that something special has happened since the last record observation was sent. The date-time group is omitted. The sea-level pressure, temperature, and dewpoint is encoded.

Local Observations (L)

Local observations may be taken at any weather observing station. The elements normally included in a local are ceiling and sky condition, prevailing visibility, weather and obstructions to vision, and remarks (as appropriate).

Local observations are taken when changes in ceiling, visibility, weather, or other elements are significant for local aircraft operations. Definitions or standards of significance are developed locally.

Local observations are taken immediately following an aircraft mishap at or near the station except when notification is delayed or there has been a intervening record observation. Such observations consist of all the elements normally included in a record observation except sea-level pressure. Local arrangements are made to insure that weather service personnel are notified as soon as possible of all aircraft mishaps.

Local observations may also be requested by appropriate personnel when required for purposes other than those listed in the preceding paragraphs.

PILOT'S REPORTS (PIREP'S)

Pilot's reports of meteorological phenomena encountered in flight are called PIREP's. These reports are an extremely valuable source of weather information often not available otherwise. PIREP's are reports of the weather along the actual routes the pilots are flying. Reports concerning such things as cloud tops, icing levels, etc., are extremely valuable in planning and executing flights. All Air Controlmen are expected to cooperate to the fullest extent possible in securing and disseminating PIREP's. In order to do this, it is necessary to learn what information is included in the PIREP's and learn their encoding and decoding.

PIREP's are encoded and disseminated locally and on weather communications networks. These PIREP's are in addition to the Pilot Reports of bases and tops of clouds included in the remarks section of the hourly aviation weather report.

PIREP FORMAT

Arrangement of the elements of a PIREP is as follows:

1. Station identification.
2. The term PIREP
3. Location or extent of phenomena relative to an observing station or other nationally known point.
4. Time (GMT) of pilot's observation, if known.
5. Phenomena reported.
6. Altitude of phenomena in hundreds of feet above mean sea level (MSL).
7. Type of aircraft in reports of turbulence, condensation trails, electrical discharge, and icing only; if unknown, the contraction ACFT UNKN would be inserted.

EXAMPLES OF PIREP'S

The pilot of a P2 between Richmond, Va., and Washington, D.C., reports to Washington that at 1620 EST his aircraft experienced an electrical discharge 20 miles south of Washington at an altitude of 5,000 MSL. This would be encoded as follows:

DCA PIREP 20 S

DCA 212Ø DISCHARGE 5Ø P2

The contraction TURBC preceded by an indication of the intensity is used to encode turbulence as follows:

LGT TURBC . . . . Light turbulence
MDT TURBC . . . . Moderate turbulence
SVR TURBC . . . . Severe turbulence
EXTRM TURBC . . Extreme turbulence

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When clear air turbulence is reported, the contraction CAT is used in place of TURBC.

A pilot reports to Atlanta, Ga., that his C-54 encountered extreme turbulence at 2330 CST, 10 miles northeast of Knoxville, Tenn., at 6,000 MSL. This would be encoded as follows:

ATL PIREP 10 NE TYS

053Ø EXTRM TURBC 6Ø C54

At 1215 CST, the pilot of a P3 reports to Madison, Wis., a 72-knot wind from 240 degrees, 20 miles southeast of the station, at 8,500 MSL. This would be encoded as follows:

MSN PIREP 2Ø SE MSN

1815 WND 24Ø 72 KT 85

The contraction ICG preceded by an indication of its intensity and type, (if known), is used to encode icing conditions as follows:

TRACE ICG . . . . Slow rate of accumulation not hazardous unless encountered for extended periods.

LGT RIME ICG . . . . Rate of accumulation may become a problem with prolonged encounter. Usually not a problem if deicing equipment used.

MDT ICG . . . . Rate of accumulation is such that brief encounters may become hazardous and use of deicing equipment or diversion necessary.

SVR ICG . . . . Rate of accumulation is such that deicing equipment fails to control the hazard and immediate diversion is necessary.

AT 0925Z the pilot of an F-4 reports to Burbank radio an encounter of severe clear icing between 10,000 and 11,500 feet over mountains north of Burbank. This would be encoded as follows:

BUR PIREP MTNS N BUR

Ø925 SVR CLR ICG 1ØØ-115 F4

Pilots reports of tornadoes, funnel clouds or waterspouts, severe or extreme turbulence, hail, and severe icing must be given immediate local desimination.

WEATHER ADVISORIES

FLIGHT ADVISORIES

Flight Advisories are prepared by the Weather Bureau FAWS Centers and contain information of weather developments in their areas of responsibility that are considered to be potentially hazardous to aircraft in flight. The advisories are issued in two categories, SIGMET's (Significant Meteorological Information), and AIRMET's (Airman's Meteorological Information).

Significant Meteorological Information

A SIGMET advisory will be issued concerning weather of such severity as to be potentially hazardous to transport category and other aircraft for the following weather developments:

1. Tornadoes.
2. Lines of thunderstorms (squall lines).
3. Hail, 3/4 inch or more in diameter.
4. Servere and extreme turbulence.
5. Severe icing.
6. Widespread dust storms/sand storms lowering visibility to less than 2 miles.

Airmen's Meteorological Information

AIRMET advisories will be issued concerning weather of such a degree as to be potentially hazardous to light aircraft, but not necessarily to transport category aircraft for the following weather developments.

1. Moderate icing.
2. Moderate turbulence.
3. The initial onset of phenomena producing areas of visibility less than 2 miles with ceilings less than 1,000 feet, including mountain ridges and passes.
4. Winds of 40 knots or more within 2,000 feet of the surface.

Flight advisories are transmitted on Service A.

HURRICANE ADVISORIES (WH)

Huricane advisories are written in plain language and are usually transmitted four times daily when a hurricane is threatening an area. The complete and detailed message is filed on Service C to describe the location, extent, intensity, and movement of the storm, as well as to forecast these general features of the storm.

COLLECTIVE OUTLOOKS (AC)

The AC is a daily outlook for thunderstorm activity in the U.S. and is transmitted on Service

A. These advisories are transmitted only during the appropriate season by the National Severe Storm Forecast Center (NSSFC) at Kansas City. This plain language outlook describes the prospects of severe weather for the next 24 hours in general terms.

SEVERE WEATHER FORECASTS (WW)

WW's are severe weather forecasts issued on Service A by the (NSSFC) center at Kansas City as required by severe weather conditions. Their chief use is in preflight briefing, but tower and ARTCC personnel also use them when their area of concern is affected.

RADAR WEATHER REPORTS (SD) AND RADAR WEATHER REPORT SUMMARIES (SD-1)

Radar Weather Reports (SD) (S for storm, D for detection) initiate mainly from Weather Bureau stations, but are supplemented by reports from military radar stations. SD's contain information on intensity and tendencies, etc., of storms. They are transmitted on Service A at irregular intervals.

Radar Weather Report Summaries (SD-1) are prepared by the Weather Bureau Radar Unit at Kansas City at hourly intervals for transmission on Service A. The summary is divided into broad geographical areas of the U.S. depending upon the degree of storm activity at the time the SD-1 is prepared.

PHRASEOLOGY FOR WEATHER REPORT ITEMS

AC's are continuously required to transmit weather information to pilots via radio; for example, to departing or arriving aircraft or in response to special pilot requests. The following list includes examples of phraseology which coincide with FAA voice procedure for broadcasting aviation weather reports to which pilots listen frequently. Its purpose is to enhance standardization of transmitting weather information.

1. State the height and character of sky coverage data as follows:

a. In the same order of ascending height in which they appear in the weather report.

b. Do not say the word "clouds."

c. Announce ceiling height designators as follows:

CODED	SPOKEN
A	PILOT REPORTS CEILING
E	ESTIMATED CEILING
B	BALLOON CEILING
M or R	MEASURED CEILING
W	INDEFININTE CEILING

d. State heights in hundreds and/or thousands of feet.

CODED	SPOKEN
3	THREE HUNDRED
18	ONE THOUSAND EIGHT HUNDRED
2ØØ	TWO ZERO THOUSAND

e. Announce cloud symbols as follows:

CODED	SPOKEN
○	CLEAR
⦶	SCATTERED
⦷	BROKEN
⊕	OVERCAST

f. When a dash precedes a cloud symbol, say the word THIN.

CODED	SPOKEN
7 -⦷	SEVEN HUNDRED THIN BROKEN

g. Announce a ceiling height indicated by the figure "0" as ZERO.

h. Announce a condition indicated by "X" or "-X" as:

CODED	SPOKEN
X	SKY OBSCURED
-X	SKY PARTIALLY OBSCURED

i. Announce sky and ceiling conditions (not all possible combinations of phenomena

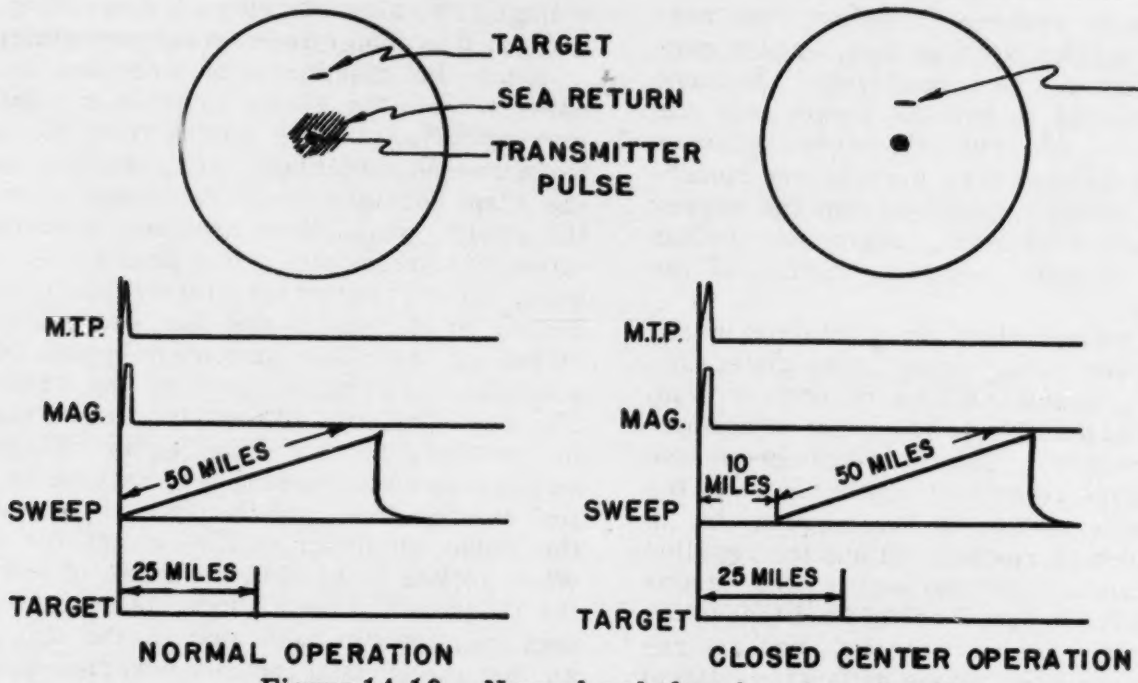

Figure 14-13. —Normal and closed center operation.

to be moving in toward the center of the scope, hence the name closed center. This is used to eliminate the ground or sea return in the center of the scope. Also, it extends the range of the radar by the amount of delay that is used.

2. OPEN CENTER OPERATION. The magnetron fires after the sweep has started. (See fig. 14-14.) As compared to normal operation, the targets appear to be moving toward the outer edge of the scope. This action moves close-in targets toward the outer edge of the scope where they occupy more space on the scope face. This spreads the target over more area and improves target resolution. The effective range on this sweep is reduced by the amount of delay used.

3. EXPANDED DELAY SWEEP. The start of the sweep is delayed for a number of miles. (See fig. 14-14.) A much faster sweep speed

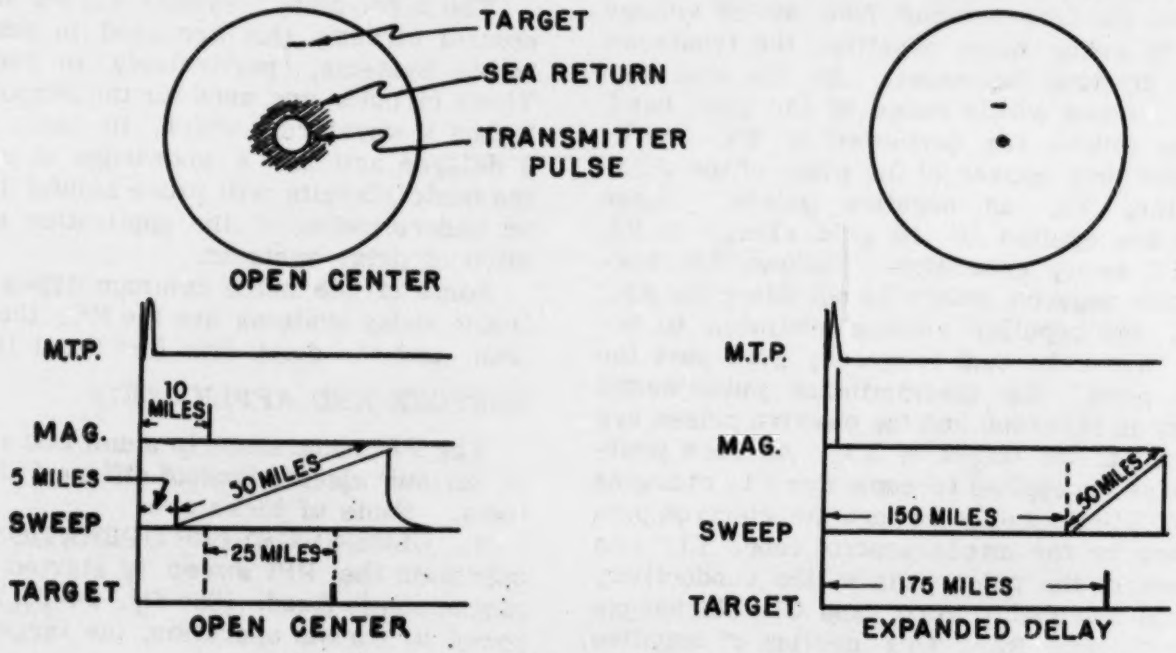

Figure 14-14. —Open center and expanded delay operation.

are included) in accordance with the following:

CODED	SPOKEN
-XM1ØⒹ5ØⒹ	SKY PARTIALLY OBSCURED, MEASURED CEILING ONE THOUSAND BROKEN, FIVE THOUSAND BROKEN.
20ⒹE30Ⓓ 250Ⓓ	TWO THOUSAND SCATTERED, ESTIMATED CEILING THREE THOUSAND BROKEN, TWO FIVE THOUSAND BROKEN.
M1ØⒹ5ØⒹ 3ØØ⊕	MEASURED CEILING ONE THOUSAND BROKEN, FIVE THOUSAND BROKEN, THREE ZERO THOUSAND OVERCAST.
1ØⒹ5ØⒹ	ONE THOUSAND SCATTERED, FIVE THOUSAND SCATTERED.
5ⒹW15X	FIVE HUNDRED SCATTERED, INDEFINITE CEILING ONE THOUSAND FIVE HUNDRED, SKY OBSCURED.
-XM5⊕	SKY PARTIALLY OBSCURED, MEASURED CEILING FIVE HUNDRED OVERCAST.
-X5-Ⓓ1Ø-Ⓓ 5Ø-⊕	SKY PARTIALLY OBSCURED, FIVE HUNDRED THIN BROKEN, ONE THOUSAND THIN BROKEN, FIVE THOUSAND THIN OVERCAST.
1Ø-ⒹE2ØⒹ 45Ø⊕	ONE THOUSAND THIN SCATTERED, ESTIMATED CEILING TWO THOUSAND BROKEN, FOUR FIVE THOUSAND OVERCAST.
2ØⒹA25Ø⊕	TWO THOUSAND SCATTERED, PILOT REPORTS CEILING TWO FIVE THOUSAND OVERCAST.

2. Announce prevailing visibility immediately following sky conditions. This element is reported in statute miles at land stations and in nautical miles on ships and ocean station vessels (OSV).

NOTE: When visibility is less than 3 miles and variable, this information is reported in remarks.

Announce prevailing visibility in accordance with the following examples:

CODED	SPOKEN
1/16	VISIBILITY ONE-SIXTEENTH
1/8	VISIBILITY ONE-EIGHTH
3/4	VISIBILITY THREE-QUARTERS
1 1/2V	VISIBILITY ONE AND ONE-HALF VARIABLE
6	VISIBILITY SIX
15+	VISIBILITY MORE THAN ONE FIVE

3. If atmosphere phenomena and obstructions to vision appear in a weather report, announce these conditions following the prevailing visibility, as follows:

a. Atmospheric phenomena:

CODED	SPOKEN
T	THUNDERSTORM
R	RAIN
RW	RAIN SHOWERS
ZR	FREEZING RAIN
L	DRIZZLE
ZL	FREEZING DRIZZLE
IP	ICE PELLETS
IPW	ICE PELLET SHOWERS
S	SNOW
SW	SNOW SHOWERS
SP	SNOW PELLETS
SG	SNOW GRAINS
IC	ICE CRYSTALS
A	HAIL

b. Announce HEAVY, MODERATE, LIGHT or VERY LIGHT when a plus sign (+), no sign, one dash (-), or two dashes (--) respectively are suffixed to the precipitation symbol, except announce "T" as THUNDERSTORM and "T+" as SEVERE THUNDERSTORM. No suffix is attached to hail or ice crystals regardless of the intensity.

c. Obstructions to vision:

CODED	SPOKEN
F	FOG
GF	GROUND FOG

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CODED	SPOKEN
IF	ICE FOG
BD	BLOWING DUST
BN	BLOWING SAND
BS	BLOWING SNOW
BY	BLOWING SPRAY
H	HAZE
K	SMOKE
D	DUST

4. Omit sea-level pressure from the broadcast. Give sea-level pressure in millibars only in response to a specific request from a pilot.

5. Announce temperature and dewpoint in accordance with the following:

a. In two or three figures in degrees Fahrenheit.

b. Below zero Fahrenheit values by prefixing the temperature with the word MINUS.

CODED	SPOKEN
37/36	TEMPERATURE THREE SEVEN, DEWPOINT THREE SIX
1Ø4/99	TEMPERATURE ONE ZERO FOUR, DEWPOINT NINER NINER
-2/-3	TEMPERATURE MINUS TWO, DEWPOINT MINUS THREE

6. Announce current local wind direction and speed as determined from the instruments in the console as follows:

a. State wind direction in tens of degrees (in terms of the magnetic compass), using three digits.

b. Omit the words MAGNETIC, TRUE, or KNOTS.

c. Announce a north wind as THREE SIX ZERO.

d. Read other than local wind direction as it appears in the report; i.e., TRUE rather than MAGNETIC.

CODED	SPOKEN
3514	WIND THREE FIVE ZERO DEGREES AT ONE FOUR

e. Announce wind speed in knots. If it is estimated, state: WIND (direction), ESTIMATED (speed).

7. Announce each of the four digits of the altimeter setting by adding as the first digit the figure "2" or "3," as appropriate, and using values obtained from altimeter setting indicator instruments, where available.

CODED	SPOKEN
996	ALTIMETER TWO NINER NINER SIX
Ø1Ø	ALTIMETER THREE ZERO ONE ZERO

8. Announce RVV and RVR as follows:

a. State runway visibility (RVV) in the same manner as prevailing visibility.

CODED	SPOKEN
R4VV1/4V1	RUNWAY FOUR VISIBILITY ONE QUARTER VARIABLE TO ONE
R36VV1 1/2+	RUNWAY THREE SIX VISIBILITY MORE THAN ONE AND ONE HALF
RVVNO	RUNWAY VISIBILITY NOT AVAILABLE

b. Announce runway visual range (RVR) at the location of origin only, in hundreds or thousands of feet. When the readout reports 1,000 --, announce LESS THAN ONE THOUSAND FEET.

CODED	SPOKEN
R18VR4Ø	RUNWAY ONE EIGHT VISUAL RANGE FOUR THOUSAND FEET
R16VR1Ø	RUNWAY ONE SIX VISUAL RANGE LESS THAN ONE THOUSAND FEET
RVRNO	RUNWAY VISUAL RANGE NOT AVAILABLE

9. Announce remarks and NOTAM's included in weather reports when of interest to pilots. Do not include additive data intended primarily for the preparation of forecast maps. Announce as follows:

a. State the variable prevailing visibility in accordance with the following:

CODED	SPOKEN
VSBY 1V2	VISIBILITY VARIABLE BETWEEN ONE AND TWO

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b. State sector visibility in the same manner as prevailing visibility.

CODED	SPOKEN
VSBY NE3 SE2 1/2 SW2	VISIBILITY NORTHEAST THREE, SOUTHEAST TWO AND ONE-HALF, SOUTHWEST TWO

10. Announce remarks in accordance with the following:

CODED	SPOKEN
PTCHS GF W N E	PATCHES OF GROUND FOG WEST, NORTH, AND EAST
TWR VSBY5 GF DEP 3Ø	TOWER VISIBILITY FIVE, GROUND FOG THREE ZERO FEET DEEP
22Ø⊙28Ø FEW AC OVR RDG SW	BROKEN CLOUDS REPORTED AT TWO TWO THOUSAND, TOPS AT TWO EIGHT THOUSAND, FEW ALTOCUMULUS OVER RIDGE SOUTHWEST
TOVHD MOVG E B28FQT LTGCG	THUNDERSTORM OVERHEAD MOVING EAST. (TIME BEGUN—H + 28—NOT SPOKEN). FREQUENT LIGHTNING CLOUD TO GROUND
⦶V⦶	SCATTERED LAYER VARIABLE BROKEN
TCU NW	TOWERING CUMULUS NORTHWEST
K1Ø⦶	SMOKE LAYER ONE THOUSAND
RWU E	RAIN SHOWERS OF UNKNOWN INTENSITY EAST
SN0INCR5	SNOW INCREASED DURING PAST HOUR FIVE INCHES
S-OCNLY S+	LIGHT SNOW, OCCASIONALLY HEAVY SNOW

CHAPTER 7

BASIC AIR NAVIGATION

Air navigation has borrowed and adapted many of the instruments, practices, and procedures of marine navigation; thus, fundamental knowledge and skills are the same for marine and air navigation. It will be necessary for the Air Controlman to understand some of the problems encountered by pilots in planning and completing a successful flight. Also, a sound understanding of the basic theories of navigation is of importance to the Air Controlman to give him the required know-how in the daily application of his duties.

This chapter is intended to familiarize the AC with the fundamentals of air navigation and should give him the confidence necessary when called on to render assistance to pilots.

BASIC CONCEPTS OF AIR NAVIGATION

Any purposeful movement in the universe ultimately involves an intention to proceed to a definite point, and navigation is the business of proceeding in such a manner as to arrive at that point. Air navigation is defined, formally, as the process of directing the movement of an aircraft from one point to another. The function of air navigation is primarily to determine the direction necessary to accomplish the intended flight, locate positions, and measure distance and time as means to that end.

Position is a point defined by stated or implied coordinates. This term is frequently qualified by such adjectives as estimated, dead reckoning, no wind, etc., whose meanings will be explained later in this chapter. But however qualified, the word position always refers to some place that can be identified. One of the basic problems of the navigator is that of fixing his position; unless he knows where he is, he frequently cannot know how to direct the movement of the aircraft to its intended destination.

Direction is the position of one point in space relative to another without reference to the distance between them. Direction may be either 3-dimensional or 2-dimensional, the horizontal being the usual plane of 2-dimensional direction. For example, the direction of San Francisco from New York is approximately west (2-dimensional); while the direction of an aircraft from an observer on the ground may be west and 20 degrees above the horizontal (3-dimensional). Direction is not itself an angle (that is, the direction east) but it is often measured in terms of its angular distance from a reference direction.

Distance is the spatial separation between two points and is measured by the length of a line joining them. This seems understandable enough. Suppose, however, that the two points are on opposite sides of a baseball. How is the line to be drawn? Does it run through the center of the ball, or around the surface? If around the ball, what path does it follow? The term distance as used in navigation must be qualified to indicate how the distance is to be measured. The shortest distance on the earth's surface from San Diego to Sydney, Australia, is 6,530 miles, but via Honolulu and Guam, a frequently used route, it is 8,602 miles. And, furthermore, the length of the chosen line could be expressed in various units, as miles, kilometers, or yards.

Time has many definitions, but those used in navigation consist mainly of two: the hour of the day, and an elapsed interval. The first is used to designate a definite instant, as takeoff time is 0215. The second definition is used to indicate an interval, as time of flight, 2 hours 15 minutes.

A map or a chart of the earth's surface is the primary instrument used in air navigation. Without a chart it would be impossible to navigate. Therefore, it is important to understand certain known facts indicated on these charts

about the earth's surface. Some of these will be familiar, others may not. To insure that all are known, let us start from the very beginning and review the pertinent facts.

The earth resembles a spinning ball. The imaginary line about which the earth rotates is called the axis of the earth. The ends of the axis are called the North Geographic Pole and the South Geographic Pole.

Although most people think of it as such, the earth is not a true sphere. A sphere is a body whose surface is equidistant from a point within, known as the center. Any line which passes from one side of a sphere through the center to the other side is a diameter of the sphere. Obviously, one diameter is equal to every other diameter.

The earth is slightly flattened at the poles. This causes its axis to be about 26 miles shorter than its greatest diameter. This difference, however, is only about 0.3 percent of the diameter. Therefore, for the purposes of navigation, the earth may be considered a true sphere.

POSITION

It is necessary to have a system for designating any position on the surface of the earth. Sometimes we may simply say that the aircraft is 10 miles south of San Diego or that its destination is the municipal airport. Such designations may be clear and simple enough, but they would be useless in designating the aircraft's position while crossing the Atlantic Ocean. It would not be sufficient to say that the aircraft was in the middle of the Atlantic or 3 miles south of an iceberg. What is needed is a universal method of expressing position without regard to nearby geographic features.

To tell a stranger the location of a restaurant in Chicago, one might say that it is at the corner of 2nd Street and 3rd Avenue. This definitely tells him the location, as there is only one place in all the city at which 2nd Street and 3rd Avenue cross. You might also tell him that the restaurant is 2 blocks north of Main Street and 3 blocks east of Broadway. This is just as definite. Quantities which give position with respect to two reference lines are called coordinates. Thus, "2 blocks north" and "3 blocks east" are the coordinates of the restaurant relative to Main Street and Broadway.

Positions on the earth may be given by a similar system of coordinates. However, since there are no natural lines on the earth to serve as reference lines, it is necessary to use imaginary lines.

Straight lines are usually the most convenient with which to work. However, straight lines cannot be drawn on a curved surface. On a sphere, the most convenient reference line is a circle.

Circles on a Sphere

If a sphere is cut straight through the center, the resulting cut edges are circles. Thus, the intersection of a plane with a sphere forms a circle. If the plane passes through the center of the sphere, dividing it in half, the circle formed is a great circle. (See fig. 7-1.) A great circle is the largest circle which can be drawn on a given sphere. Any circle, other

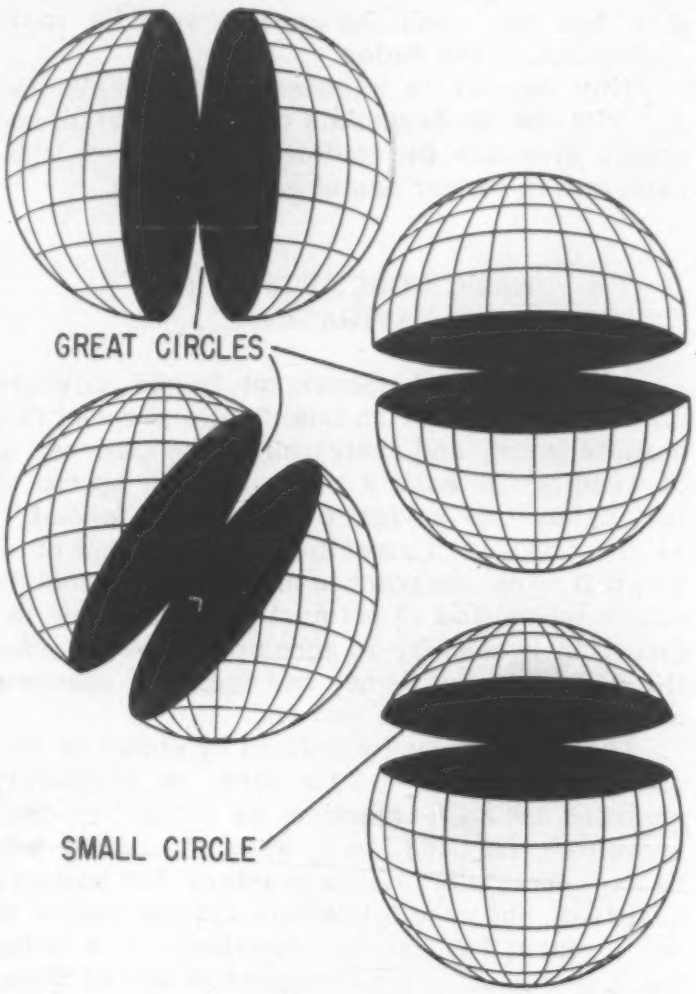

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Figure 7-1.—Circles on a sphere.

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than a great circle, no matter how large, is called a small circle. (See fig. 7-1.) The plane of a small circle, of course, does not pass through the center of the sphere, and hence does not divide it into equal halves.

Segments of circles or arcs are measured in degrees, minutes, and seconds. A circle contains 360° of arc. Each degree (°) is 1/360 of the circumference of a circle. Thus, if any circle is divided into 360 equal arcs, each arc is 1° in length, regardless of the size of the circle. A minute (') is 1/60 of 1°—a second ('') is 1/60 of 1'.

Notice in figure 7-2 that if a straight line is drawn from each end of an arc to the center of the circle, the two lines meet to form an angle at the center. This angle is subtended by the arc. Angles, like arcs, are measured in degrees, minutes, and seconds. The angle at the center of a circle (fig. 7-2) always contains the same number of degrees, minutes, and seconds as the arc which subtends it.

Reference Lines on the Earth

As stated earlier in this chapter, circles make the best reference lines for designating position on a sphere. The question is where to draw the circles. A sphere is a continuous surface without beginning or end, and on the earth the only distinctive natural geometric line is its axis, which is different from every other diameter, by about 26 miles, as previously stated. Thus, the geographic poles are distinctive points on the earth. The geographic poles are used as the central points for one set of reference circles. The most important circle of this set is the Equator.

The Equator is the great circle halfway between the poles. Since the poles are 180°, or half a circle apart, every point on the Equator is 90° from each pole. The plane of the Equator is perpendicular to the earth's axis. The Equator divides the earth into a northern and southern hemisphere, and it is important to remember that the Equator serves as a reference line for denoting north and south latitude.

Any small circle on the earth whose plane is parallel with the plane of the Equator is called a parallel of latitude, or simply a parallel. Each parallel is everywhere equidistant from the poles, from the Equator, and from every other parallel. Thus, the parallels and the Equator are concentric about the polar axis. (See fig. 7-3.)

Every point on the earth has a parallel passing through it. However, only a few of these parallels are shown on the globe; the globe would be solid black if they were all shown. Each parallel is designated by its angular distance north or south of the Equator; that is, toward the North or South Pole, as the case might be.

Points east or west on the earth are located by reference to a meridian of longitude, or simply a meridian. (See fig. 7-4.) Instead of

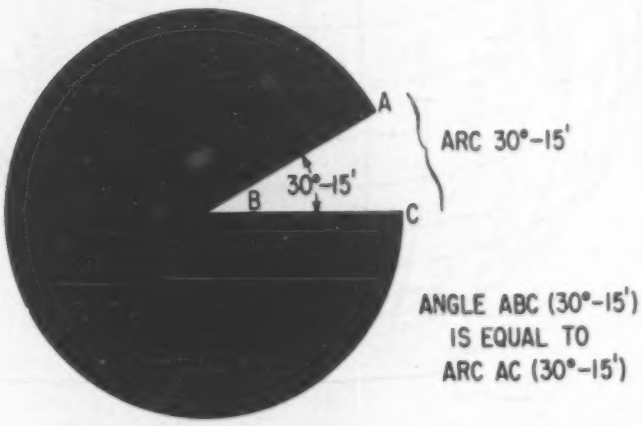

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Figure 7-2.—The angle at the center is equal to the arc.

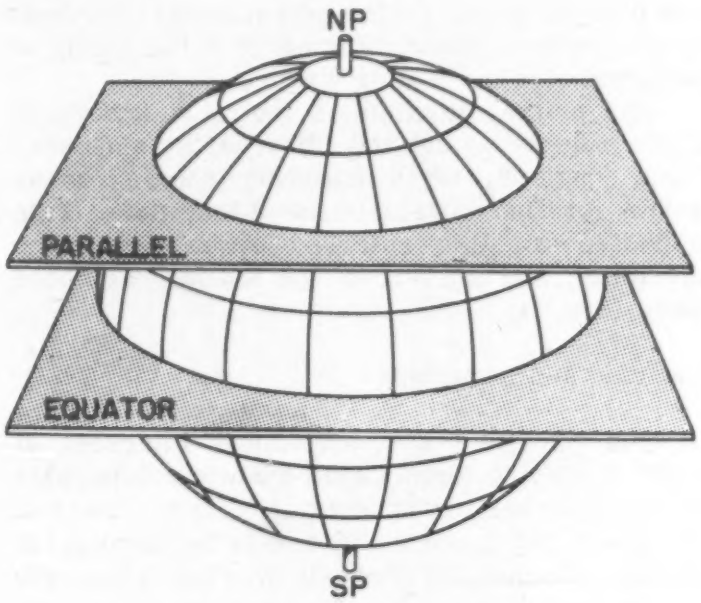

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Figure 7-3.—Parallels of latitude.

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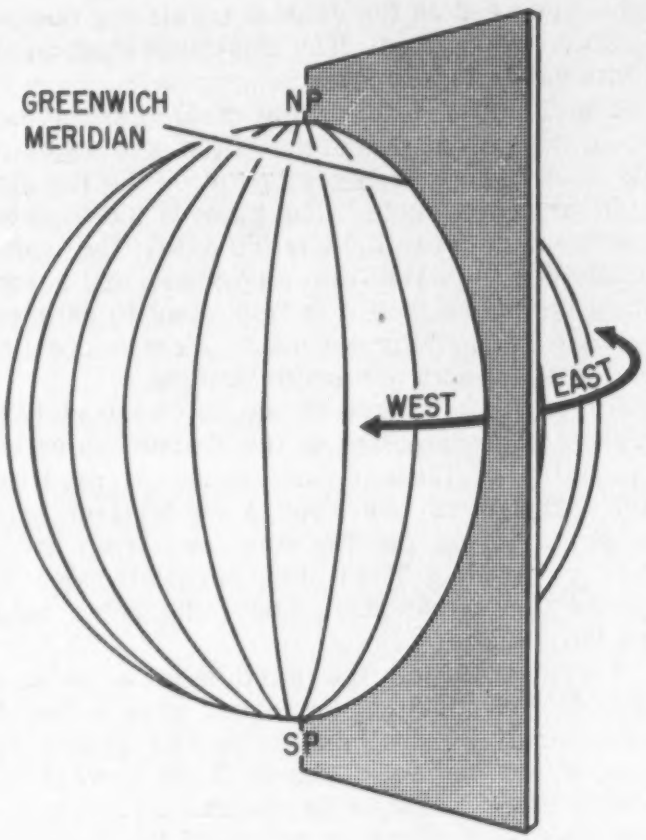

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Figure 7-4.—Meridians of longitude.

using small circles as in the case with latitude, the longitude system is based on great circles passing through the poles. These great circles are divided in half by the poles, and are farthest apart at the Equator. Each half of the circle is assigned a value east or west.

The prime meridian is the meridian whose plane passes through the Observatory at Greenwich, England, which has been adopted as an origin for the measurement of longitude. This meridian is also referred to as Greenwich meridian, and serves as our second reference line. (See fig. 7-4.)

Latitude and Longitude

The parallels and meridians intersect at right angles to form a grid system comparable to the intersecting streets of a city. You can designate any position in a city by naming the streets which pass through it. Likewise, you can designate any point on the earth by naming the parallel and meridian which pass through it. Thus, the 29°45'N parallel and the 95°22'W meridian together designate Houston, Texas. (See fig. 7-5.) Any point on the earth can be designated by giving its coordinates relative to the Equator and Greenwich meridian. These coordinates are called latitude and longitude.

The latitude of a point is its angular distance north or south of the Equator, measured in the plane of the meridian. It is measured from 0° at the Equator, north to 90° at the North Pole, and south to 90° at the South Pole.

The longitude of a point is its angular distance east or west of the prime meridian, measured in the plane of the Equator or of a parallel. Longitude is measured from 0° to 180° east and from 0° to 180° west from the prime meridian. In giving the coordinates of a place, give latitude first, then longitude; i.e., 29°45'N, 95°22'W. Note again in figure 7-5 how this was illustrated.

Each parallel and meridian is named according to its angular distance from the Equator or the prime meridian. Keep in mind, however, that a meridian of longitude is a line; whereas longitude is an angle. Likewise, a

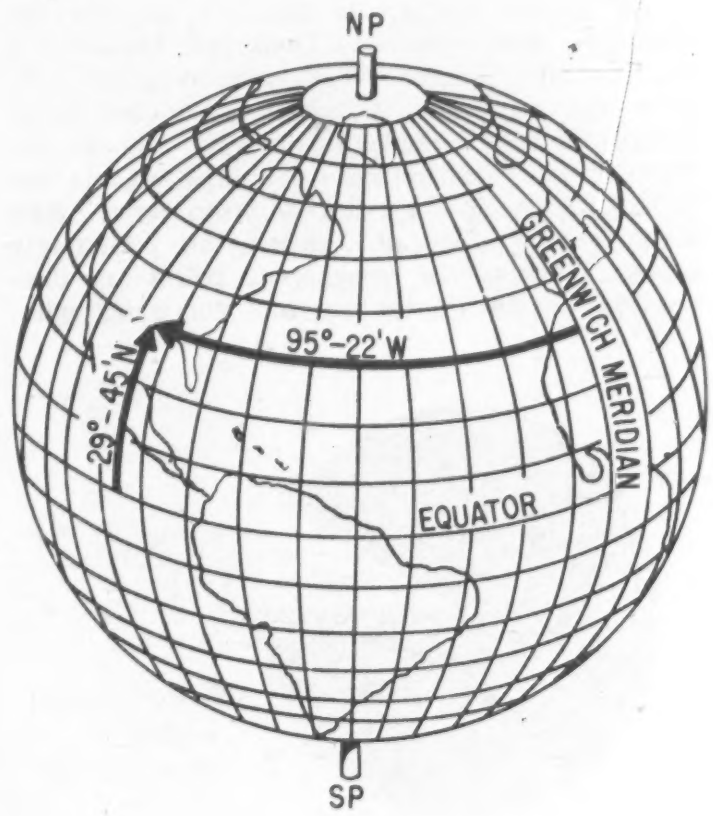

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Figure 7-5.—Position designated by coordinates.

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parallel of latitude is a line; whereas latitude is an angle.

DL and DLo

The difference of latitude (DL) between two points is the angular distance between the parallels which pass through these points. Thus, it is the arc of any meridian between these parallels. If both points are on the same side of the Equator, the smaller latitude is subtracted from the larger. Therefore, the DL between 20° N at point A and 40° N at point B is 20°. (See fig. 7-6.) If the two points are on opposite sides of the Equator, the two latitudes are added. In figure 7-6, the latitude at A is 20° N. If the latitude at C is 15°S, the difference of latitude between A and C is 35°.

Similarly, the difference of longitude (DLo) between any two points is the angular distance between their meridians. If both points are in east longitude or if both are in west longitude, the smaller longitude is subtracted from the larger. Therefore the DLo between 85° E at point A and 125° E at point B is 40°. (See fig. 7-7.) If one point is in east longitude and the other west longitude, the two longitudes are added. If their sum is greater than 180°, this figure is subtracted from 360°. Thus, the DLo

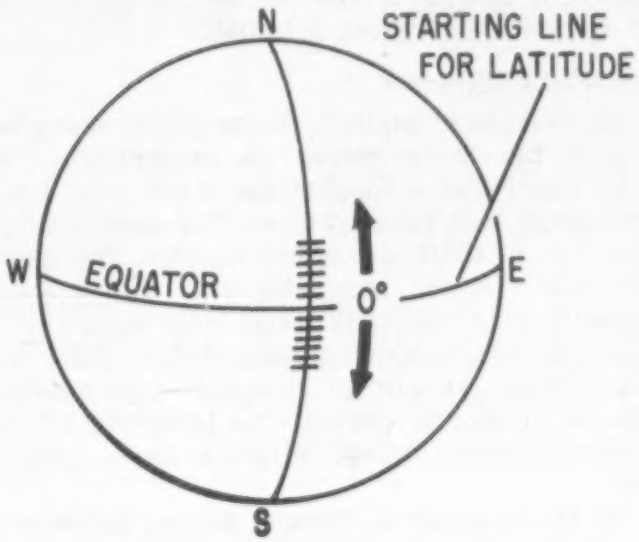

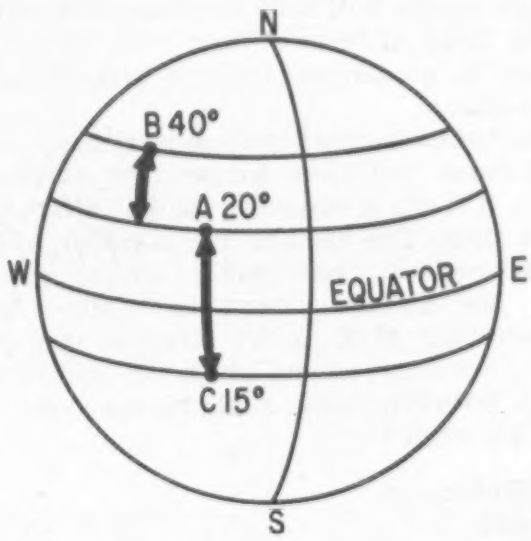

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Figure 7-6.—Difference of latitude.

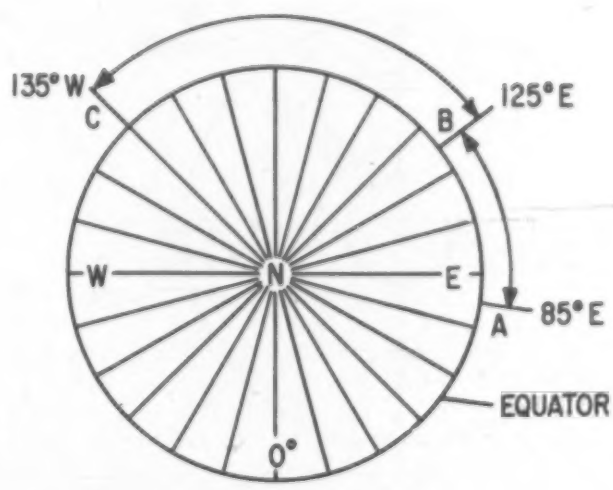

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Figure 7-7.—Difference of longitude.

of 125°E at point B and 135°W at point C is 100°.

DIRECTION

To walk across the street to a friend's house, one merely glances at the house and starts walking in that direction. But to fly from Norfolk to Jacksonville, this simple method cannot be used. The direction must be obtained in some other manner, usually from a chart. The pilot keeps the aircraft headed in the right direction in order to reach Jacksonville. From this example, it can easily be seen that direction is important in navigation, and that some system must be used for expressing the direction from any point to any other point.

North is the direction of the North Pole from any point on the earth, south is the direction of the South Pole; and as one faces north, east is to the right and west is to the left. These are only four of an infinite number of possible directions. In navigation, the system of designating direction permits more exact locating of positions.

Direction is expressed as an angle measured clockwise from north. At any position, imagine a circle whose circumference is divided into 360 equal units. If the divisions are numbered clockwise from north, they indicate true directions from the central point. Such a circle is called a compass rose. The direction of north is 000° or 360°, east is 090°, south is 180°, and west is 270°. In figure 7-8, the direction of B from A is the angle measured clockwise from north to the line AB. (Direction is navigationally defined as a point on the horizon toward which a craft is moving, and it is essentially a line.) Line AB is the angle between the meridian and AB and the direction of B is 045°. Likewise, the direction of C from A is 100° and the direction of D from A is 260°. (See fig. 7-8.)

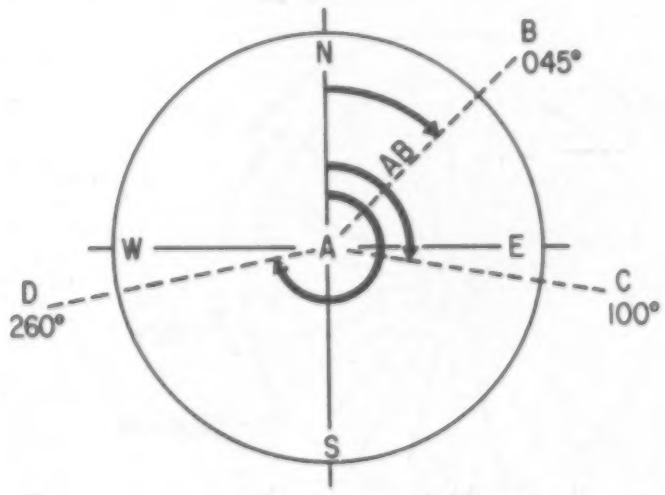

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Figure 7-8.—Direction.

It will be helpful to think of directions as angles. Practice estimating the directions of lines by dividing a compass rose into quarters or quadrants, and note which directions fall into each quadrant. Unless there is an arrow, or some device, to show which way a line points, the line has two directions differing by 180°. Later in this chapter, it will be seen why it is important to learn to estimate direction now and avoid making a 180° error. In figure 7-8, the direction of B from A is 045°.

Magnetic Compass

As its name implies, the magnetic compass utilizes the force known as magnetism. The earth itself has a magnetized core, two magnetic poles, and lines of force that form a magnetic field. Like any other magnet, the earth also has a north magnetic pole and a south magnetic pole. Each is about 1,400 miles away from its corresponding geographic pole. Although they are placed at specific geographic sites on magnetic charts, the locations of the magnetic poles change slightly from time to time.

As in any magnet, lines of force run between the north and south magnetic poles of the earth. Its magnetic field affects any magnetic substance; and as a result, a freely suspended magnetic bar or needle will tend to aline itself with the earth's lines of force. These lines of force are similar to meridians and are called magnetic meridians.

The magnetic compass is simple in construction. It contains two steel magnetized needles mounted on a float. A compass card is attached around the float. The needles are parallel, with their north-seeking ends pointed in the same direction. The compass card has letters for cardinal headings (N, E, S, W). Each 30° is represented by a number, from which the last zero is omitted. Between these numbers, the card is graduated for each 5°.

Heading Determined by a Compass

Compasses are used for determining heading, which is the angle measured clockwise

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from a reference point to the longitudinal axis of the aircraft.

Notice in figure 7-9 that no specific reference point is mentioned. The reference point could be one of several. If the angle is expressed with relation to true north, it is known as TRUE HEADING (TH). If it is measured from magnetic north, it is called MAGNETIC HEADING (MH). Theoretically, it might be measured from compass north, and the term used would be COMPASS HEADING (CH). In each case, the angle is measured in a clockwise direction from the north reference to the longitudinal axis of the aircraft. It is important to designate which reference was used since all of them do not have the same value as shown in figure 7-9. This is accomplished by designating the reference by one of the terms true, magnetic, or compass.

Variation

It has already been stated that when a magnetized needle is influenced by the earth's magnetic field, the direction it points is magnetic north (MN), and the direction of the north geographic pole is called true north (TN). The angle between magnetic north and true north is termed the variation. Variation differs at different points on the earth. If the needle points to true north, then magnetic north and true north coincide and the variation is zero. When the needle points east of true north, the variation is said to be east; if the needle points west of true north, the variation is called west. (See fig. 7-10.)

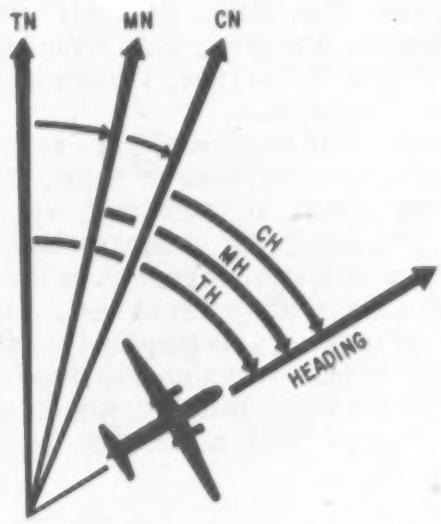

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Figure 7-9.—Reference points in determining headings.

Note that most charts have information concerning lines of variation. The lines that connect points of equal variation are called isogonic lines. A line which connects points of zero variation is known as an agonic line. Usually, aircraft courses are plotted from a true north reference rather than a magnetic north reference simply because the grid on conventional charts is designed using true north as a reference. As the compass needle is deflected east or west of true north by an angular amount known as variation, a correction must be applied to the true heading in order to obtain magnetic headings. This amount of correction is found on the chart by noting the position of the aircraft in relation to the nearest isogonic line.

Deviation

It has been brought out that variation is caused by magnetic forces outside the aircraft. However, a compass is affected by ALL magnetic fields. A piece of iron close to a compass needle tends to deflect it from magnetic north. Whenever an electric current passes through a wire, a magnetic field is set up around the wire. The combined effect of all the magnetic fields within the aircraft (due to its metal structure (metal containing iron), and operation of electrical and electronic equipment) causes an error in the compass known as deviation.

To understand deviation better, assume that the compass needle always points directly to a nonexistent compass north pole. The direction in which the compass needle points is known as compass north. Compass directions may be expressed relative to compass north just as true directions are expressed relative to true north and magnetic directions are expressed in relation to magnetic north.

Although the compass needle primarily seeks alinement with the earth's magnetic field, deviation will vary as the aircraft changes heading. The metal structure and electrical devices naturally turn with the aircraft, creating a different alinement relationship. As this relationship to the compass needle changes, deviation also changes.

Since deviation may vary with each heading, deviation must be determined for each heading that differs by approximately 15° from the

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is used but sweep amplitude remains the same. This causes the distant returns to be spread so they can be distinguished from each other. The disadvantage is that nothing can be seen on the scope prior to the time the sweep is started. (All close-in targets are obscured).

RC DELAY SYSTEM

This system may be used for open or closed center operation. It is used in some radar systems to permit the sweep to become linear before the transmitter is fired. The PPI sweep starts at time zero; the RC delay causes the transmitter to be fired later, at a fixed time, after the sweep has become linear. (Refer to fig. 14-15.)

Since the grid is connected to a positive voltage, V1 normally conducts heavily. Thus, plate voltage is low and C2 is charged to this low voltage. The input to V1 is derived from the multivibrator timer and is a negative square wave. The leading edge of this square wave is time zero, and it is at this time that the sweep generator is triggered. The leading edge of this square wave cuts off V1 which was normally conducting. Plate voltage of V1 cannot rise instantly because of the time required to charge C2. Although C2 charges at an RC rate, during the first 10 percent of time the change in voltage is linear. V2 is normally cut off by a voltage divider network in the grid circuit which places a minus 19.5 volts on the grid. The linear change in voltage at the plate of V1 is coupled to the grid of V2 causing it to go positive and to overcome its bias. The delay is a function of the bias applied to the grid of V2 and the rate of charge of C2. When the bias is overcome, V2 conducts and the blocking oscillator action produces a pulse output. A positive pulse output may be taken from the cathode and a negative pulse from across the plate load resistor. The blocking oscillator action in the grid circuit charges both C2 and C3 in a negative direction. This causes the plate voltage of V1 to decrease and keeps V1 from again triggering V2 immediately. Before C2 can again become positively charged to the point that it can trigger V2, the short RC in the grid of V1 has allowed V1 to conduct. Therefore, the circuit has returned to the static condition of V1 conducting heavily and V2 cutoff.

The output of V2 can be used to start the sweep and other timing circuits such as range mark generators.

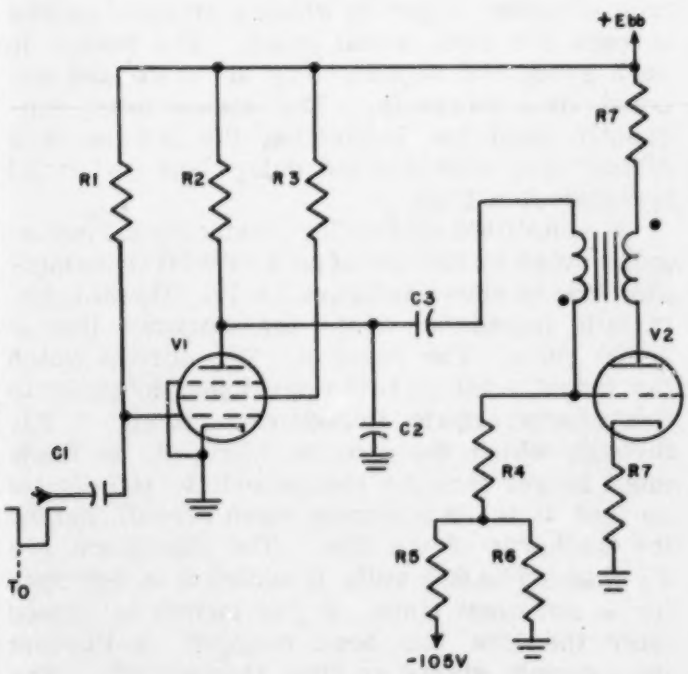

Figure 14-15.—RC delay circuit

PHANTASTRON DELAY SYSTEM

A phantastron delay system may be used to produce a variable delay over the PPI range. In order to provide a delay over most of the full range of the PPI, it is necessary to use a cathode follower with the phantastron. (See fig. 14-16.)

The phantastron is triggered simultaneously with the firing of the transmitter. The trigger input is applied to the cathode of V1 and the output of the phantastron is taken from the screen of V2. This output is a square wave that goes positive at the start of the delay and negative at the end. The output of the phantastron is applied to the trigger amplifier V4A. The end of the delay appears as a positive pulse at the plate of the amplifier. This pulse is coupled to the grid of the blocking oscillator V4B. This oscillator is biased negatively by the voltage divider network R3, R4, and a negative 105 volts; thus, it is normally cut off. Blocking oscillator action is initiated by the positive pulse from the trigger amplifier. The delayed sweep trigger is taken from the plate of the blocking oscillator V4B. A delay marker is taken from the cathode of the same tube. This marker appears as a movable range marker or ring on

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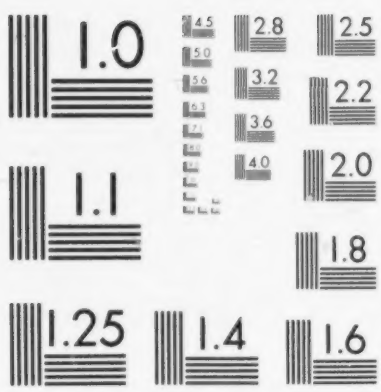

MICROCOPY RESCLUTION TEST CHART

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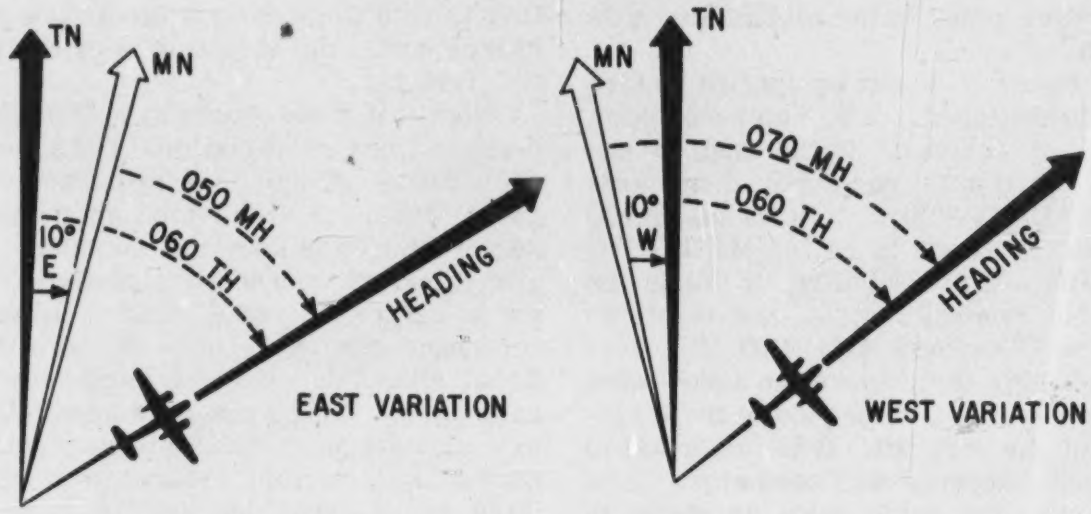

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Figure 7-10.—Angles of variation.

previous heading. This is accomplished by a process called swinging the compass. This may be done either in the air or on the ground. The most common method on the ground makes use of a large compass rose, on a concrete area, with magnetic headings inscribed at 15° intervals. Swinging the compass essentially consists of obtaining a compass reading from a known magnetic heading. If the compass reading is greater than the magnetic heading, that is, if the compass reads too high, the deviation is east, and if the compass reads lower than the magnetic heading, the deviation is west. The values of deviation are then recorded on a suitable deviation card and placed in the cockpit of the aircraft.

Applying Variation and Deviation

In navigation it is necessary to be able to change a compass heading to a corresponding true heading, or to start with a true heading and determine the equivalent compass heading. For example, we may start with a compass heading. By applying deviation to this compass heading we obtain the magnetic heading. Variation applied to this magnetic heading gives us the true heading. To help solve a problem of this nature, the following formula is used:

COMPASS ± DEVIATION = MAGNETIC
MAGNETIC ± VARIATION = TRUE HEADING

In going the other way, the same procedure is followed. If we know the true heading that is to be flown, it is necessary to find the compass heading to steer in order to maintain this true heading. In this case it is customary to proceed as follows:

TRUE ± VARIATION = MAGNETIC
MAGNETIC ± DEVIATION = COMPASS HEADING

Sometimes this information is summarized in the form of a memory aid by making use of the following statement:

Can Dead Men Vote Twice

Reading from left to right we have C D M V T—Compass, Deviation, Magnetic, Variation, True. Reading the other way, from right to left, we have T V M D C—True, Variation, Magnetic, Deviation, Compass.

However, it is impossible to add or subtract a quantity known as east or west. Therefore, it must be given an algebraic sign (plus or minus). To solve for compass heading when true heading is known, a good rule to remember is: East is least, and west is best. This means easterly errors are subtracted and westerly errors are added. When proceeding from compass heading to true heading, the signs are reversed. Figure 7-11 offers this easy method of application.

DISTANCE

Distance, as previously defined, is measured by the length of a line joining two points. In

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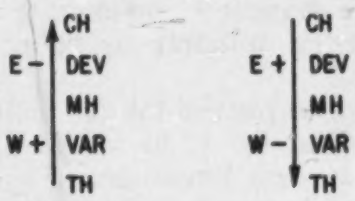

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Figure 7-11.—Aplication of compass errors.

navigation the most common unit used for measuring distance is the nautical mile. Since miles have various lengths, one should be careful to specify which mile is meant.

In the U.S. one mile has been defined by statute to be 1,760 yards or 5,280 feet. This is called a statute mile. Navigators use the nautical mile as a distance unit. The DOD has adopted the International nautical mile which equals 6,076.10 feet.

For most practical navigation purposes, all of the following units are used interchangeably as the equivalent of one nautical mile:

1. 1,852 meters (6,076 feet approximately).
2. One minute of arc on the earth's Equator (geographical mile).
3. One minute of arc on a meridian (one minute of latitude).
4. 2,000 yards (for short distances).

Closely related to the concept of distance is speed, which determines the rate of change of position. Speed in air navigation is expressed in nautical miles per hour. When the measure of distance is nautical miles, it is customary to speak of speed in terms of knots. Thus, a speed of 200 knots and a speed of 200 nautical miles per hour are the same thing; however, it is incorrect to say "200 knots per hour" unless referring to acceleration.

TIME

One of your earliest experiences in the Navy was that of learning nautical time. This time is expressed in accordance with the approved naval practice; using the 24-hour day with the hours and minutes expressed in a 4-figure group. In working daily as an Air Controlman, a thorough knowledge of time is necessary, particularly in handling communications, processing flight plans, and checking on overdue aircraft.

As seen from the earth, the sun appears to travel across or orbit the earth. The fact that the sun rises in the east and sets in the west seems to substantiate this. However, the opposite is actually true. The earth orbits the sun and the earth's rotation on its axis creates the illusion that the sun goes around the earth. This is called the "apparent motion of the sun." Since the sun, for all practical purposes, appears to move from east to west, it is a good idea to remember that TIME IS ALWAYS LATER TO THE EAST. (See fig. 7-12.)

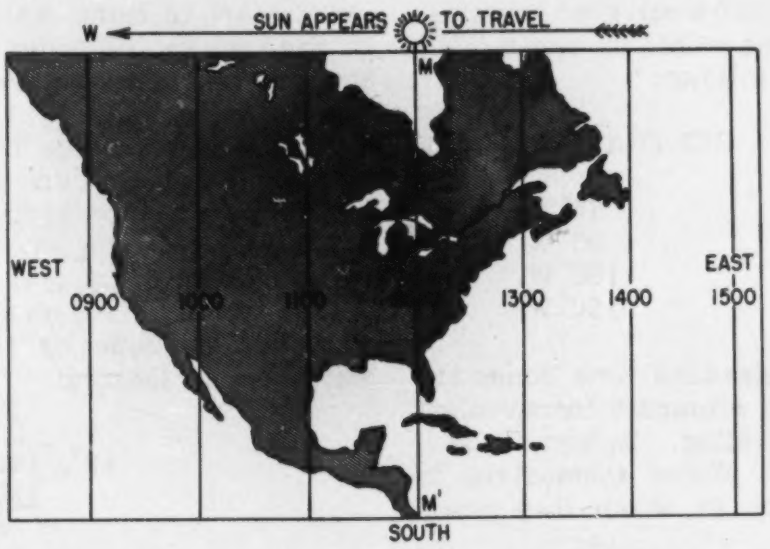

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Figure 7-12.—Noon over a meridian MM'.

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Greenwich Mean Time

For uniformity, the meridian of Greenwich, England, has been selected as the prime meridian from which time is measured. You may recall the prime meridian is also the basis for measuring longitude. The moment the sun crosses the meridian, it is noon of that date. Therefore, it can be noon at only one meridian at the same moment. This gives us a common time known as Greenwich Mean Time (GMT) or Greenwich Civil Time (GCT). GMT gives us a reference time to locate time at other points on the earth.

Zone Times and Description

The world is divided into 24 time zones whose central meridians are 0°, 15°, 30°, 45°, etc. All places in any time zone keep the same mean time of the central meridian. Hence, the time can differ only by an integral number of hours from the time at Greenwich.

The local mean time at any one place differs from the mean time at Greenwich by the difference in longitude, 1 hour for each 15°. If local mean time was in common use, there would be a great diversity in the times used at various places. For example, an aircraft flying in an easterly or westerly direction would find that changes in longitude would result in comparable changes in local time.

Late in the 19th century, Congress adopted a uniform system applicable to the continental United States, establishing four time zones. Each central meridian was designated the standard meridian and its local mean time was designated as standard time within its zones. The U.S. time zones are as follows:

ZONE	CENTRAL MERIDIAN
Eastern standard	75° W
Central standard	90° W
Mountain standard	105° W
Pacific standard	120° W

Boundaries of the standard time zones are somewhat irregular, to eliminate inconvenient time changes when traveling. In some cases, cities and states have placed themselves in zones east of the ones in which they would naturally fall.

Generally, in navigation, the standard time zones extend from pole to pole and are exactly 15° wide in longitude. In this system of zone time (ZT) the standard meridian is always the nearest meridian divisible by 15° of longitude. (See fig. 7-13.)

The zone is numbered for the multiple of 15° and labeled plus (+) if in west longitude and minus (-) if in east longitude. Thus, zone +1 extends from pole to pole 7 1/2° on each side of the standard meridian at 15° W, and zone -5 centered on 75° E, extends from 67 1/2° E to 82 1/2° E. The zero zone centered on Greenwich extends from 7 1/2° E to 7 1/2° W, and the twelfth zone centered on the 180th meridian, from 172 1/2° W, to 172 1/2° E; that half in west longitude being designated +12 and the half in east longitude -12. (See fig. 7-13.)

In the zone time system an instant of time is uniquely described by the time and the zone description (ZD) or letter suffix; for example, 1745 zone +5 or 1745 R. The limits, description, and letter suffix of each zone are shown in figure 7-13.

For brevity of communication, the zones are sometimes designated by a letter suffix (mentioned in the preceding paragraph) instead of a zone description. Thus, zones in east longitude are lettered A through M (omitting J), and zones in west longitude are lettered N through Y. The letter Z is reserved for the zero zone, denoting Greenwich time, commonly referred to as ZULU time.

Zone Identification

One of the principal advantages of the zone time system in navigation is the ease with which any instant of time can be converted to GMT, or vice versa. In order to find the number for the ZD, you already know that you will divide any given longitude by 15°. If, when dividing, the remainder exceeds 7°30', add one unit to the answer that you received. For example, let us say that we desire to find the ZD for longitude 142°45'W. Immediately upon observing that it is a westerly longitude, we find the first component of our ZD to be a plus (+). Then we divide the longitude by 15° to find the zone in which we are located:

```
        9
15°/143°45'
    135
     8°45'
```

Since the remainder exceeds 7°30', add one full unit to the quotient (9), resulting in a ZD of +10

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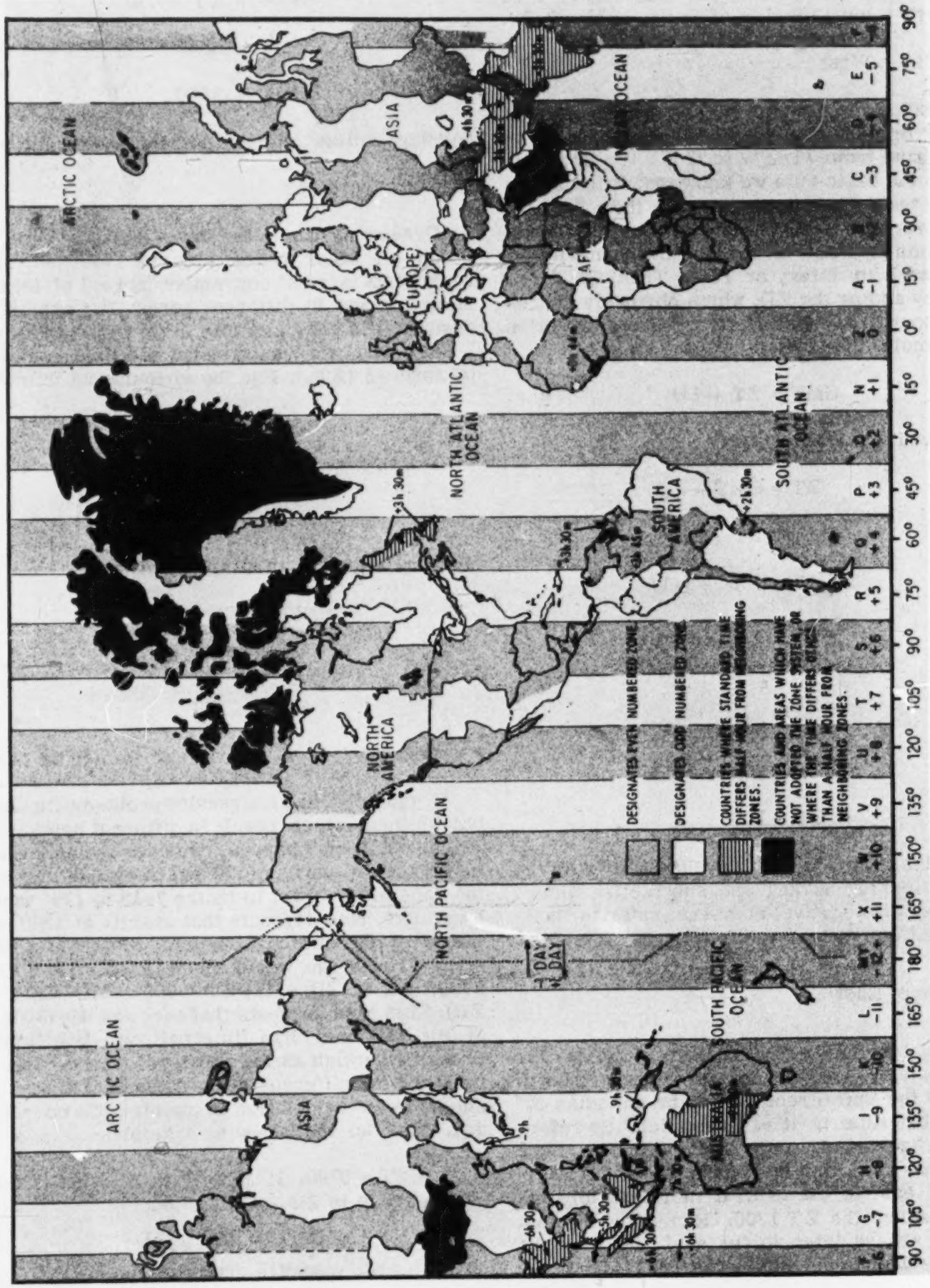

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Figure 7-13.—Standard time zones.

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removed in time from Greenwich. Figure 7-13 shows that longitude 143°45'W has a ZD of +10.

Zone Time, West

In examining figure 7-13, imagine the sun to be over the meridian 15°W. What time is it in the entire band from 7 1/2°W to 22 1/2°W? By referring to the basic rule we know that it is exactly 1200 in the entire time zone when the sun is exactly over the central meridian for that zone. What time is it now on the Greenwich meridian? It is one hour later, or 1300. Thus, GMT was found by adding the ZD, which obviously represents hours, to the ZT. From this calculation the formula

$$GMT = ZT + ZD$$

is derived, and consequently

$$ZT = GMT - ZD.$$

$$GMT = ZT + ZD$$

$$GMT = 1200 + (+1)$$

$$GMT = 1300$$

and

$$ZT = GMT - ZD$$

$$ZT = 1300 - (+1)$$

$$ZT = 1200$$

At this point, if you are unfamiliar with the laws governing adding and subtracting signed (positive and negative) numbers, refer to Basic Mathematics, Volume I, NavPers 10069 (Series).

Zone Time, East

To determine times in east longitude, the same basic procedure and formulas are used. Imagine the sun directly over the meridian 30° east. What time is it at Greenwich? By referring to figure 7-13 or by dividing the longitude by 15, we know that the time zone or ZD is -2, and 30° east is the central meridian for this zone making the ZT 1200. Remembering that time is always later to the east and using the formulas we can determine the GMT.

$$GMT = ZT + ZD$$

$$GMT = 1200 + (-2)$$

$$GMT = 1000$$

(Adding unlike signs indicates subtraction.)

Time Conversions

Greenwich time provides a standard time to which all other times may be referred, and represents a most convenient method of determining times in different zones. For example, assume it is 1500 in a city in zone + 5 (ZT_1), on 1 May, and you want to know the time in a city in zone -3 (ZT_2). Use the formulas as follows:

$$GMT = ZT_1 + ZD_1$$

$$GMT = 1500 + (5)$$

$$GMT = 2000$$

(Adding like signs is simply addition.)

$$ZT_2 = GMT - ZD_2$$

$$ZT_2 = 2000 - (-3)$$

$$ZT_2 = 2300$$

(Subtracting -3 is equivalent to adding +3.)

Frequently time conversion problems involve calculations which result in different dates. To see how this may happen, consider the apparent motion of the sun from 179° east longitude across the face of the chart in figure 7-13 to 179° west longitude. This suggests that exactly at 1200 on the 0° or Greenwich meridian, the date is the same around the world since in ZD - 12, ZT = 2400, and in ZD + 12, ZT = 0000 (ZT = GMT - ZD). This also suggests that each new day begins at the 180° meridian (international date line). Using Greenwich as the reference time to determine ZT in different ZD's, dates should be included in the calculation to maintain the correct day. Consider the following examples:

1. ZT = 0700, 15 June; ZD -5. What is the correct time in ZD + 4? Solution:

$$GMT = ZT + ZD$$

$$GMT = 0700, 15\ June + (-5)$$

GMT = 0200, 15 June

ZT = GMT - ZD

ZT = 0200, 15 June - (+4)

(At this point we cannot subtract 4 hours from 0200, so we must add 24 hours (1 day) to the ZT to permit the mechanical operation of the problem. Since it is always later to the east, the 24 hours we are adding has already elapsed so we must subtract 1 day from the date.)

ZT = 2600, 14 June - (+4)

or

ZT = 2200, 14 June.

2. ZT = 2100, 31 Aug, ZD + 7. What is the correct time in ZD - 5? Solution:

GMT = ZT + ZD

GMT = 2100, 31 Aug + (+7)

GMT = 2800, 31 Aug.

(Considering again that time is later to the east and the answer exceeds 24 hours, this would indicate that GMT = 0400, 1 Sept. However, it is usually more convenient to wait until the problem is complete to subtract the 24 hours.)

ZT = 2800, 31 Aug. - (-5)

ZT = 3300, 31 Aug.

or,

ZT = 0900, 1 Sept.

Chronometers and Time Signals

Time is determined in the various countries of the world by national observatories such as the U.S. Naval Observatory at Washington and the Royal Observatory at Greenwich. A bureau, coordinated by an international agency, sets up uniform computing procedures, compares time signals, etc.

Accurate time is essential in navigation and air traffic control. Chief among the navigational timepieces is the chronometer. It is a clock of unusually fine construction, designed for extreme accuracy and dependability, and built to withstand shock, vibration, and variations of temperature. Even a chronometer cannot keep exact time indefinitely. The chronometer is checked with a radio time signal to determine its accuracy.

On account of their simplicity and accuracy, time signals are transmitted mainly be radio. Naval Observatory time is broadcast in this country by the naval radio station NSS at Annapolis, Md., NPG at Mare Island, Calif., and others. These broadcasts are sent on a continuous wave (CW) so that they can be heard only be receivers suited to code reception. Signals are transmitted during the last 5 minutes of the hour.

Station WWV at Washington, D.C. continuously broadcasts signals based on Naval Observatory time. These broadcasts may be heard with any ordinary radio receiver. Complete schedules and information on Navy time signals can be found in FLIP, Planning, Section III.

ELEMENTARY PLOTTING

From the time an aircraft departs one station until the time it arrives at destination, the pilot or navigator is very busy. In order to get an aircraft to a given destination and back again, the navigator must keep an accurate account of the aircraft's progress on the chart, plus a complete record or log.

Plotting and measuring are the basic operations of navigation. Plotting is the establishment of points or lines on a chart with reference to the meridians and parallels. Measuring means the measurement of direction and distance on a chart. If one is to understand the fundamentals of plotting, he must be familiar with some of the plotting terms, standard symbols and labels, and the use of plotting and measuring tools.

PLOTTING TERMS AND SYMBOLS

Directions and Lines

True course (TC) is the intended direction or path of travel over the surface of the earth expressed as an angular distance from true north. The course line on a chart represents the intended path or direction of travel. A course line is comprised of the course and the element of distance. Track (TR) is the actual path followed by the aircraft over the ground.

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Speeds

Groundspeed (GS) is the speed of the aircraft over the ground, most commonly expressed in knots. True airspeed (TAS) is the rate of motion of the aircraft relative to the surrounding air.

Position

Dead reckoning position (DR) is determined by advancing a known position on a specified course for a specified distance. It is established by keeping accurate account of time, speed, and direction traveled since the last known position. A fix is an accurate position determined without reference to any former position. A way point is a reference point between the point of departure and destination.

Time

Time of departure (TD) is the time at which the aircraft leaves the point of departure. Minutes or minutes on leg (min) is the interval of time, estimated or actual, required for the aircraft to fly a given distance at a given groundspeed. Estimated time of arrival (ETA) is the predicted time of reaching a destination or way point. It is determined by estimating the length of time required for the flight from the point of departure to the destination or way point and adding this to the time of departure. Since the groundspeed is constantly affected by various factors in flight, the ETA is revised at frequent intervals if needed during the flight. Actual time of arrival (ATA) is the time at which the aircraft actually arrives at its destination or way point.

Distance

Miles on course (MC) is the distance, predicted or actual, which the aircraft travels on any given course. It may be one leg of a search pattern, or it may be the entire distance from the point of departure to the destination.

Application of Plotting Symbols

True course (TC) is indicated by a solid line with a single arrowhead showing direction. (See fig. 7-14.) Track (TR) is indicated by a solid line with double arrowheads showing direction. It is sometimes shown darker than a course line to increase the contrast between the two. A fix is

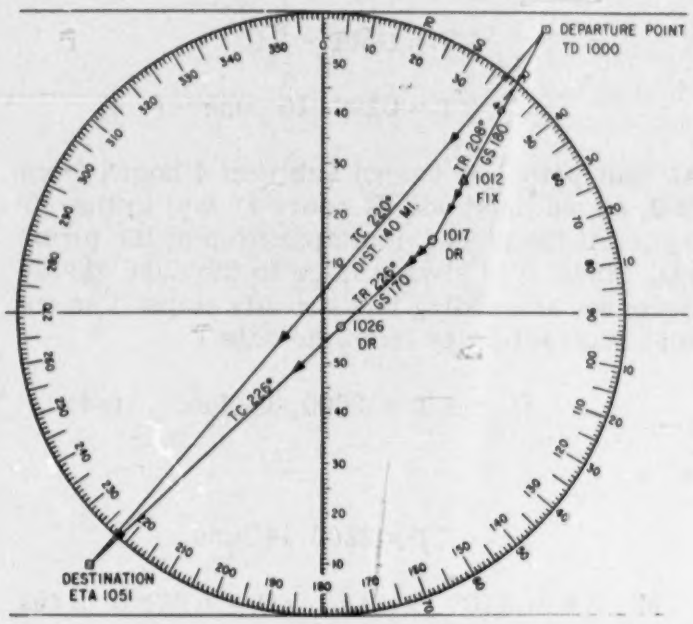

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Figure 7-14.—Typical chart work illustrating correct symbols and labels.

indicated by a triangle, labeled with the time and title, FIX. A dead reckoning position is indicated by a circle, labeled with the time and title, DR. The point of departure and destination are graphically illustrated as squares. They may be considered fixes; but in order to distinguish them from the fixes obtained while in flight, the triangle is not used.

PLOTTING EQUIPMENT

The pencil and eraser are the most elementary and indispensable articles of plotting equipment. The pencil should be of soft lead and well sharpened. A hard lead pencil is undesirable, not only because it makes the lines which are light and difficult to see, but also because it makes lines which are difficult to erase. A soft eraser, which will not smudge or damage the chart is used.

A pair of dividers is an instrument used for measuring distance on a chart in the following manner. Separate the points of the dividers to the desired distance on the proper scale (usually the latitude scale), and transfer this distance to the working area of the chart. In this way, lines of desired length can be marked off.

While measurement is being made, the chart should be flat and smooth between the points of

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dividers, because a wrinkle may cause an error of several miles. Points on a chart may be marked by applying slight pressure on the dividers so that they prick the chart. Too much pressure results in large holes in the chart and tends to spread the points of the dividers farther apart, reducing measurement accuracy.

A plotter is an instrument designed primarily to aid in drawing and measuring lines in desired directions. Plotters vary from complicated drafting sets to a simple plotter combining a type of protractor and straightedge. Figure 7-15 (A) and (B) shows two widely used aircraft navigational plotters.

The rectangular model plotter, type B-2(A), is standard equipment, and is replacing the older AN model (B), which is still in use. The B-2 is made of very heavy plastic to resist breakage when cold, and has the advantage that two or more plotters can be joined to facilitate

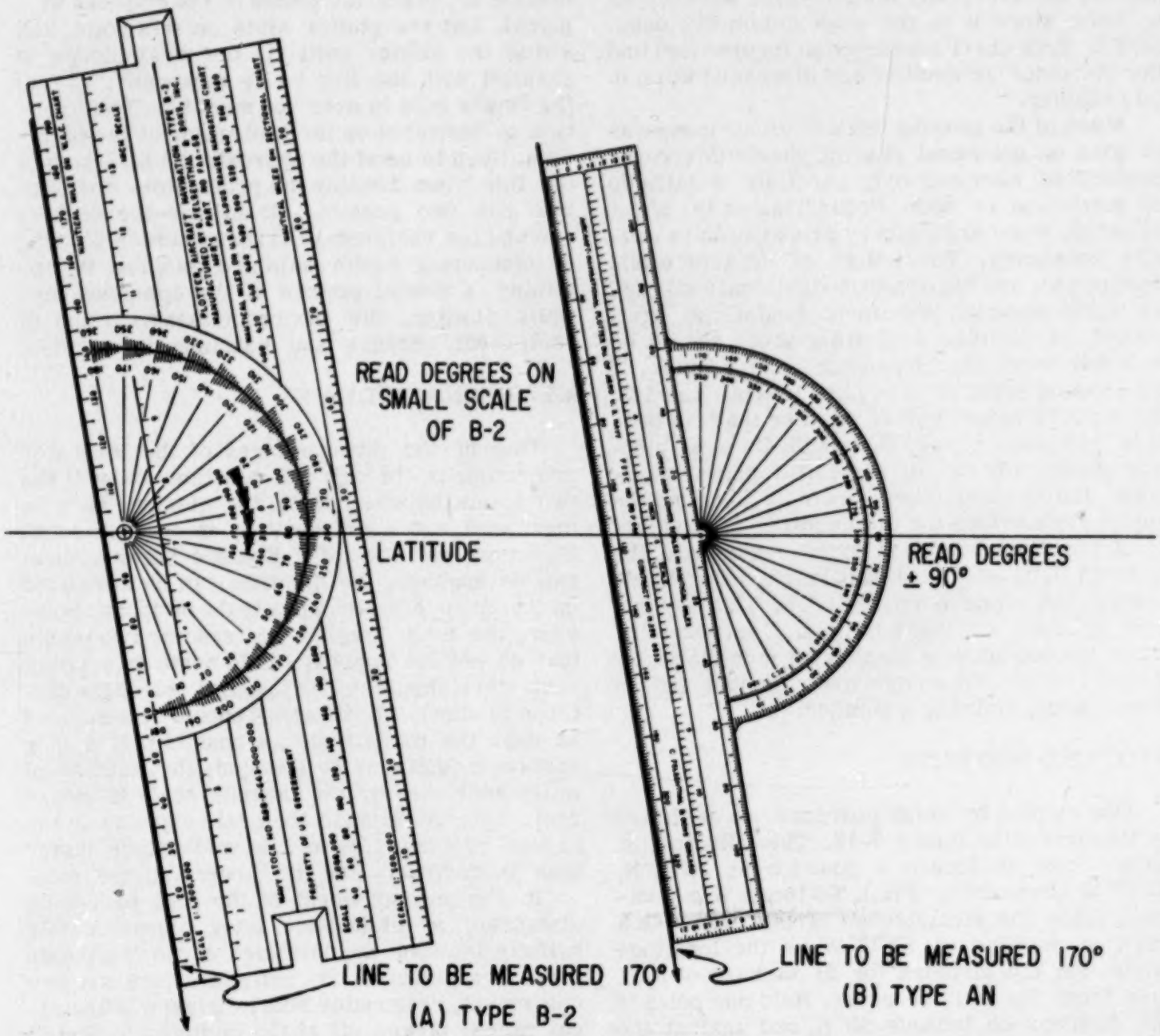

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Figure 7-15.—Navigational plotters. (A) Type B-2; (B) type AN.

plotting long lines. Both plotters carry convenient scales for measuring distance in nautical miles on a chart.

Plotting Sheets

A plotting sheet is a blank or incomplete chart. It has latitude and longitude lines, and it may have a compass rose for measuring direction, but little or no additional information. The meridians are usually unlabeled so the plotting sheet can be used for any longitude. Any projection may be used for constructing plotting sheets; however, only the Mercator is referred to here since it is the most commonly used. NOTE: Both chart construction (projection) and the Mercator projection are discussed later in this chapter.

Much of the plotting work of an air navigator is done on universal plotting sheets (Mercator projection) carrying only parallels of latitude or meridians or both. Regardless of the sheet selected, some preliminary preparation is usually necessary. The points of departure and destination, and important navigational aids such as radio stations, prominent landmarks, etc., should be plotted. A plotting sheet should be oriented correctly, depending upon latitude. If the plotting sheet is to be used in south latitude, the sheet is turned upside down so that the latitude increases toward the south. On most plotting sheets only the parallels bear printed numbers, and the meridians should be assigned the appropriate values for the longitude of the flight involved. West longitude increases toward the western (left) edge, and east longitude increases toward the eastern (right) edge. This is true both in north and south latitude. Common mistakes encountered in numbering meridians are giving two meridians the same number and, in some cases, omitting a number.

PLOTTING POSITIONS

One method by which positions can be plotted is illustrated in figure 7-16. This illustration shows how to locate a position at 30°21'N, 87°17'W (Pensacola, Fla.). To locate this position, place the straightedge of the plotter in a vertical position at 87°17' W on the longitude scale. Set the dividers for 21 minutes of latitude from the latitude scale. Hold one point of the dividers on latitude 30° N, and against the straightedge. Let the other point also rest against the streightedge upward, and with a little pressure lightly prick the chart. This marks the desired position.

PLOTTING AND MEASURING COURSES

After the departure point and destination have been plotted on the chart, the next step is to plot the course line between these two points with a plotter or several plotters connected. After the course line has been plotted and labeled as was shown in figure 7-14, measure its direction. Anywhere along the line to be measured, place the points of the dividers or a pencil. Let the plotter slide on this point, and swing the plotter until (1) the straightedge is parallel with the line to be measured, and (2) the center hole is over any meridian. The direction is indicated on the protractor at the meridian. Keep in mind the approximate direction of the line when reading the protractor. A course line has two possible directions—the correct one and the reciprocal. Errors made by plotting or measuring reciprocals are common. By retaining a mental picture of the compass rose while plotting, the incorrect measurement of reciprocal courses and bearings is avoided.

MEASURING DISTANCE

One of the disadvantages of the Mercator projection is its lack of a constant scale. If the two points between which the distance is to be measured are approximately in a north-south direction, and the total distance between them can be spanned, the distance can be measured on the latitude scale opposite the midpoint. However, the total distance between any two points that do not lie approximately north or south of each other should not be spanned unless the distance is short. All distances should be measured as near the midlatitude as possible. If a long east-west distance is spanned, the number of miles indicated by the latitude scale is incorrect. This is because the scale expands on the higher latitude side of the midlatitude faster than it contracts on the lower latitude side.

In the measurement of the long east-west distances, a midlatitude lying approximately halfway between the latitudes of the two points should be selected. By using dividers set to a convenient, reasonably short distance (60 nautical miles, picked off at the midlatitude scale), one may determine an approximate distance by walking off units along the line to be measured

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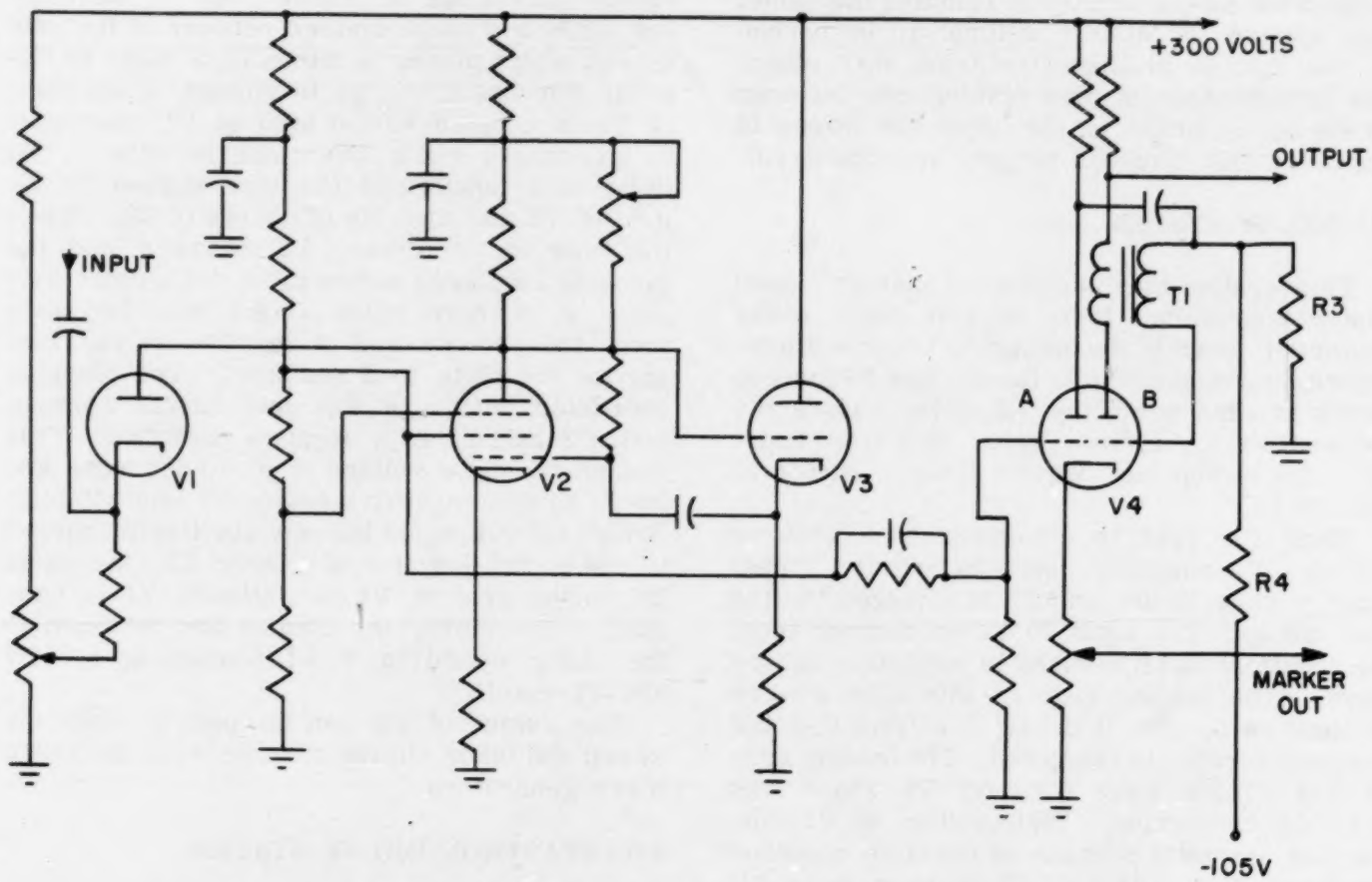

Figure 14-16. —Phantastron delay system.

the PPI when the scope is in a nondelayed condition. This delay marker indicates the point at which the delayed or expanded sweep will start. (EXAMPLE: When 60 miles of sweep delay is desired, the delay marker is adjusted to aline with the 60-mile range marker. When the delay is switched-in, the sweep starts at the center of the scope after 60 miles of delay. Thus if a 30-mile sweep is used, the scope will cover 60 to 90 miles.)

DELAY LINE SYSTEM

Delay lines may be used for accurate short periods of delay such as delaying the start of a PPI sweep. This enables the sweep and transmitter to be triggered at the same time. They are also used to generate coded pulses. Special types of pulse equipment, in which pulses are transmitted at one location and received at another, frequently use coded pulses. These pulses are used for the purpose of preventing signals of the same carrier frequency, that contain similar pulses, from interfering with the desired signal pulses. A common type of coding is that in which a group of pulses is used for each actual pulse. The pulses in each group are separated by accurate and unequal time intervals. The means most frequently used for generating the pulses is a circuit that contains the delay line (artificial transmission line).

A simplified circuit for producing a rectangular pulse by the use of an artificial transmission line is shown in figure 14-17. The characteristic impedance of the transmission line is 2,500 ohms. The resistor, R2, across which the output pulse is to be developed is equal to this characteristic impedance. Resistor R1, through which the line is charged, is made much larger than the characteristic impedance so that it is an apparent open circuit during the discharge of the line. The capacitors are all charged to 600 volts if switch S is left open for a sufficient time. If the switch is closed after the line has been charged, a current immediately starts to flow through R2. The line may be considered as a battery with an

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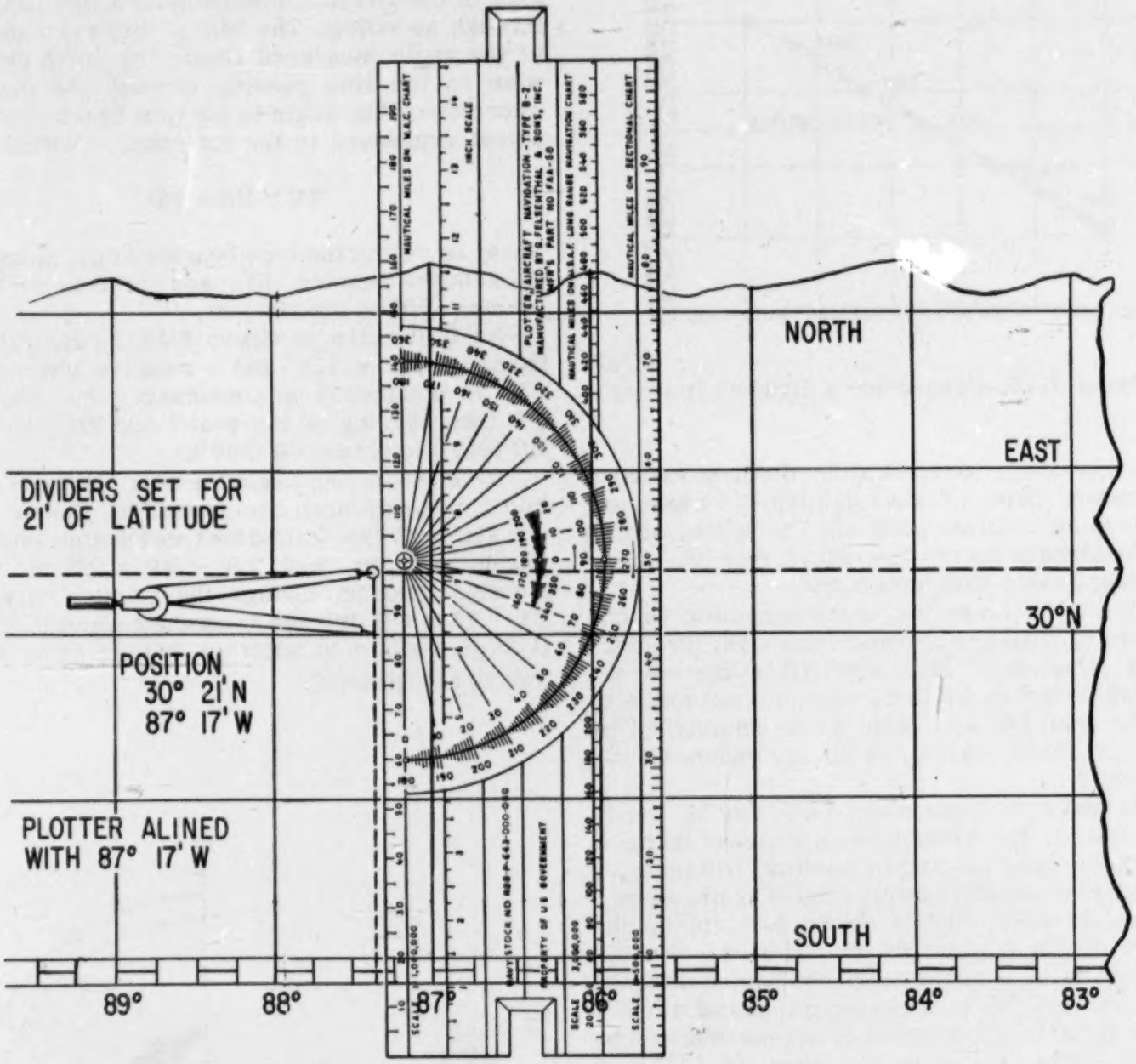

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Figure 7-16.—Plotting a position.

as shown in figure 7-17. The number of steps walked off should be multiplied by the length of each step, and the length of any last step added.

The scale at the midlatitude is accurate enough if the course line does not cover more than about 5° of latitude. If the course line does exceed this amount, or if it crosses the Equator, it should be divided into two or more legs and the length of each leg measured with the scale of its own midlatitude.

PLOTTING LINES OF POSITION (LOP'S)

Suppose, for example, the aircraft is flying over a railroad, but its location along the length of the railroad is not known. If the railroad can be located on the chart, a line of position is established, but not a fix. Then, another railroad that crosses the first is seen. When the second railroad is located on the chart, the exact

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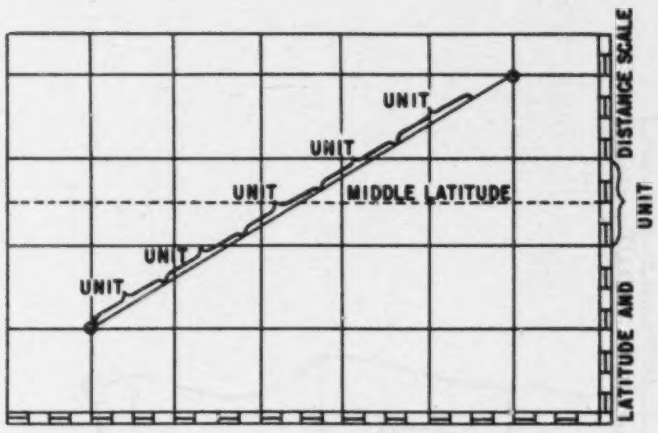

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Figure 7-17.—Measuring a distance in steps.

location of the aircraft along the first railroad is known. Thus, a fix is established. Remember, a fix is an accurate position. Therefore, a fix is determined when the aircraft is over two intersecting LOP's simultaneously.

With chart reading, a fix can often be obtained by finding a specific landmark. However, with other navigation aids, fixes are not obtained directly. Rather, with the exception of radar and TACAN, each fix is established by two or more LOP's which are independently obtained.

It has been seen that a LOP may be a visible line on the ground like a railroad track or another object of known position. However, a LOP is not usually visible until it is drawn on a chart. A radio LOP is obtained by finding the direction of a radio station from the aircraft by means of a radio compass. Having obtained this radio LOP, it is plotted on the chart. Once plotted, it is no different from one obtained by visual reference or by any other aid. LOP's of different types and origins may be crossed to obtain a fix.

LOP's Established by Bearings

A bearing may be measured with reference to true north or with reference to the longitudinal axis of the aircraft; in either case, it is an angle between 0° and 360°.

There is a simple relationship between true heading (TH) of the aircraft, true bearings (TB) of an object, and relative bearing (RB) of an object. True heading is the angle measured from true north clockwise to the longitudinal (fore and aft) axis of the aircraft. Relative bearing is the angle measured from the longitudinal axis of the aircraft, clockwise to a line passing through an object. The sum of these two angles is the angle measured from true north clockwise to the line passing through the object. Therefore, this angle is the true bearing of the object expressed in the following equation:

$$TH + RB = TB$$

Thus, to obtain the true bearing (TB), measure its relative bearing (RB) and add it to the true heading (TH) of the aircraft.

As illustrated in figure 7-18, an aircraft is flying a TH of 210° and a relative bearing of 070° is obtained from a mountain peak. What is the true bearing of the peak? Add TH (210°) to RB (070°) to obtain TH (280°).

By changing the basic formula, you may obtain any one of three components if the other two are known. Thus, to find the true heading, change the formula to read TB - RB = TH. To find relative bearing, change the formula to read TB - TH = RB. Whenever an angle exceeds 360°, it is necessary to subtract 360° to determine the correct bearing.

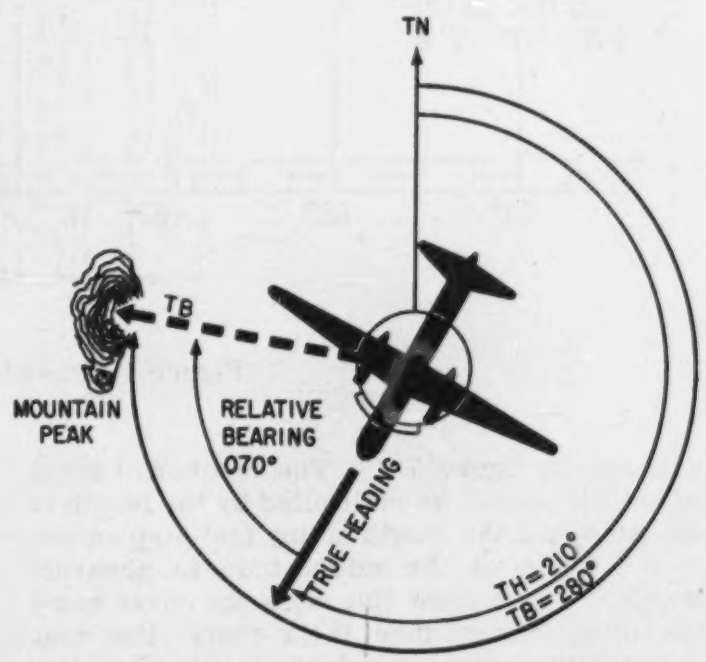

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Figure 7-18.—TH + RB = TB.

Plotting from Known Positions

In plotting LOP's, it is obvious that a plot cannot be made from the aircraft's position as it is unknown. Plot the LOP from the origin, which is a known position. To plot the LOP, use the reciprocal of the true bearing of the object from the aircraft.

When using the plotter to draw a LOP, you need not compute the reciprocal mathematically. Simply aline the plotter so that the point of origin lies on the straightedge and the center hole and true bearing (as read on the scale) are over the same meridian. Then draw the LOP toward your position.

Although two intersecting LOP's determine a fix, three intersecting LOP's give a more accurate fix. It is possible to combine a radio LOP with a radar LOP, or a loran LOP with a visual LOP, etc. If three LOP's intersect at one point, use that point for the fix. Usually, however, the errors in obtaining the LOP's and in plotting them will cause the LOP's to form a small triangle for the fix. When this happens, use the center of the triangle.

Positioning by RADAR and TACAN

Airborne radar is oriented so that 360° is represented by the nose of the aircraft. By use of a radar scope in the aircraft, the relative bearing, and also the distance the aircraft is from known landmarks can be determined, providing a fix. (See fig. 7-19.)

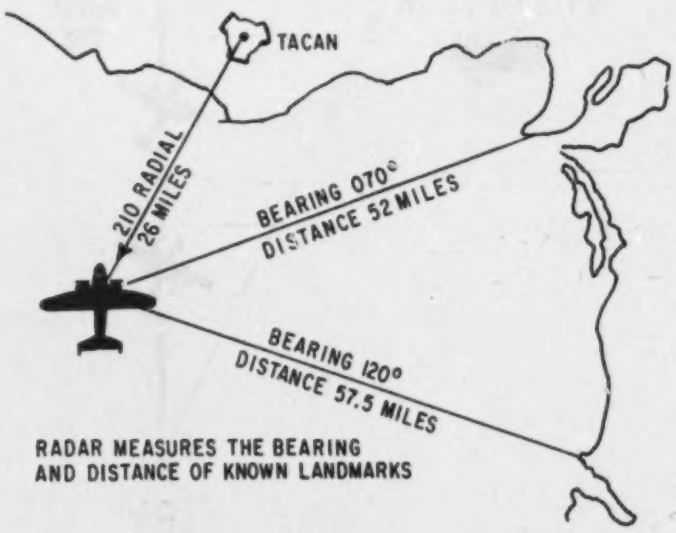

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Figure 7-19.—Positioning by RADAR and TACAN.

TACAN provides bearing and distance information. By use of aircraft instruments, the pilot can determine what TACAN radial his aircraft is on and its distance from the TACAN station. Since the position of the TACAN station is known, a fix, or the aircraft's position, can be determined relative to the TACAN station. (See fig. 7-19.)

WIND AND ITS EFFECTS ON NAVIGATION

If air masses were absolutely still, relative to the ground, navigation of aircraft would be very simple. A pilot could easily fly any desired course by merely correcting for variation and deviation. He could calculate ETA's and determine positions en route by using true airspeed.

Unfortunately, however, this situation never exists. The air masses are always moving. This produces the phenomenon called wind. Wind is air in approximate horizontal motion and has both direction and speed.

Wind direction is expressed in the direction FROM which the wind is blowing. Keep in mind that wind direction differs from other directions used in navigation in that it is the direction from which, rather that the direction toward which, motion occurs. True heading, for example, is the direction toward which an aircraft is headed.

Windspeed is the rate of movement or speed of the air over the earth's surface. To maintain conformity, both Aerographer's Mates and Air Controlmen express windspeed in knots. The term wind velocity (WV) includes both wind direction and speed. In diagrams involving wind, which will be discussed in detail in this section, the wind vector is labeled, for example, WV 180°/25K, and is indicated by a solid line with three arrowheads.

DRIFT AND DRIFT CORRECTIONS

Any vehicle traveling on the ground, such as an automobile, moves in the direction in which it is steered and is affected very little by the wind. An aircraft, however, seldom travels in exactly the direction in which it is headed. This is understood when the effect of wind on the flightpath is considered.

Consider first the effect of wind on a balloon which has no motion of its own. A balloonist never feels any wind because he is

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suspended in the body of air and moves with it. Consequently, no air moves past him. A balloon in the air is just like an empty bottle floating down a river; the bottle travels with the current.

Any free object in the air moves downwind with the speed of the wind. This is just as true of an aircraft as it is of a balloon. If an aircraft is flying down wind in a 20K wind, the body of air in which it is flying moves 20 nautical miles in one hour. Therefore, the aircraft also moves 20 nautical miles downwind in 1 hour. This movement is in addition to the forward movement of the aircraft through the body of air.

The path of an aircraft over the earth is determined by two unrelated factors: (1) the motion of the aircraft through the air mass, and (2) the motion of the air mass across the earth's surface. An aircraft's movement over the ground is comparable to a boat crossing a river. If there is no current in the river, a boat starting at one shore of the river and rowed perpendicular to the river's edge would end at a point on the opposite shore directly across from its starting point. However, if there is a current, the boat will be carried downstream. Until the boat eventually reaches the opposite shore, the displacement downstream is dependent upon the velocity of the river current and the speed of the boat.

The aircraft shown in figure 7-20 (A) departs from point X on a heading of 360° and flies for 1 hour in a wind of 270°/20K. The aircraft is headed toward point M, directly North of X, so its true heading (TH) is represented by the line XM. If there is no wind, the aircraft would be at point M at the end of the hour. However, there is a wind. The body of air in which the aircraft is flying moves 20 nautical miles toward the East during the hour, and the aircraft moves with it. Consequently, at the end of the hour the aircraft is at point N, 20 nautical miles downwind from point M. Thus, line XM is the intended path of the aircraft, line XN is the actual path of the aircraft over the earth.

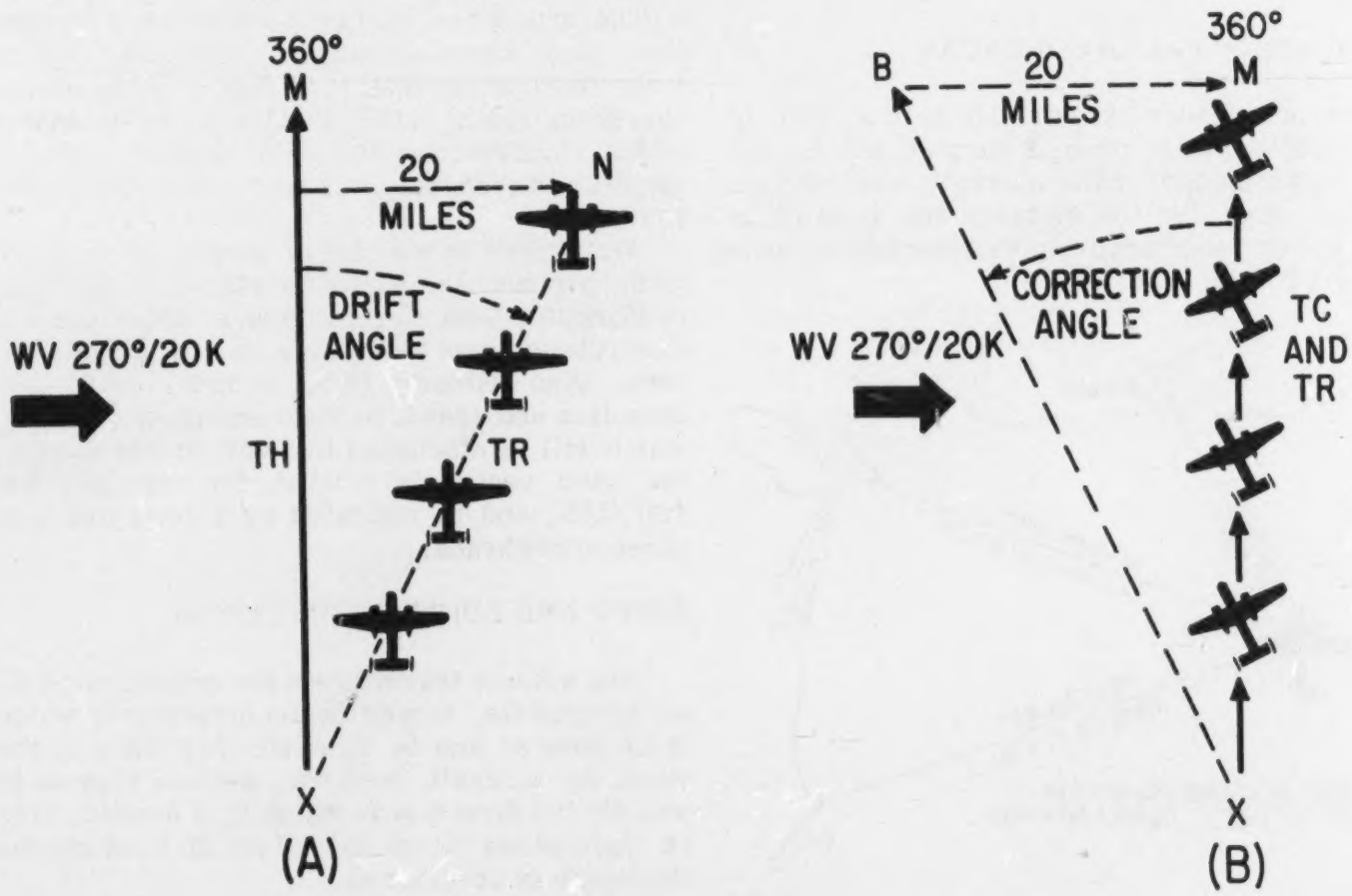

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Figure 7-20.—(A) Drift angle; (B) drift correction angle.

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The effect, then, of this wind on the aircraft causes it to follow a different path over the ground than was originally intended.

The angular difference between TH and TR (TRACK) is the drift angle, commonly called drift. As shown in figure 7-20(A), the aircraft has drifted to the right. This is known as right drift. Drift is always labeled right or left.

Thus far it has been learned that wind causes drift and affects the track of an aircraft. But we have not determined how to adjust the true heading to allow for drift, and thus maintain a desired true course and track. The true course (TC) and track (TR) must always coincide to arrive at a given point by the most direct route.

Figure 7-20 (B) shows the drift correction angle needed to proceed from point X to M, a true course of 360°, wind 270°/20K. As described above, if the pilot flies a true heading of 360° he will not arrive at point M but at some point downwind from point M as shown in figure 7-20 (A). Therefore, he must head for some point upwind from M and let the wind (right drift) bring him to point M. If the aircraft flies for 1 hour it will drift 20 nautical miles downwind, therefore, the pilot must head for a point 20 nautical miles upwind from point M. Flying the heading XB, he arrives at point M. The track of the aircraft is XM.

Heading an aircraft upwind in order to maintain the true course and intended track is called correcting for drift. The angle MXB is the drift correction angle, or simply drift correction. Drift correction is the correction which must be applied to a true course to find the true heading needed to make good that true course. The angle MXB is the correction to the left which must be made for a right drift condition in order to make TR and TC coincide.

A change of heading will also affect the distance traveled over the ground in a given time. This rate of travel, relative to the earth's surface, is known as groundspeed (GS). Therefore, with a given wind, the GS varies on different headings.

THE WIND TRIANGLE

In aerial navigation there are many problems to solve involving speeds and directions. Primary concern is with track, groundspeed, true heading, true airspeed, wind direction, and windspeed. Often, four of these quantities will be known and it will be necessary to determine the other two. For example, the true heading, true airspeed, wind direction, and windspeed will be known; track and groundspeed unknown. In order to solve such problems, it is necessary to understand the relationships of the six quantities.

These quantities are represented by vectors. Any quantity having both direction and any other magnitude such as speed or distance is called a vector quantity, and can be represented by a line called a vector.

Two or more vectors can be added together simply by placing the tail of each succeeding vector at the head of the previous vector. These vectors when added together are known as component vectors. The sum of these component vectors can be determined by connecting, with a straight line, the tail of one vector to the head of the other. This sum is known as the resultant vector. By its construction, the resultant vector forms a closed figure or triangle.

The solution of a problem involving velocities and drift is usually done by means of a vector diagram called a wind triangle. Naval aviators use a standardized system of symbols. The wind vector is represented by a line EW as shown in figure 7-21. Note that EW is drawn to show in the direction FROM which the wind is blowing. The true heading-true airspeed vector is the line WP. The track-groundspeed vector is the line EP. These symbols are always used to represent the same quantities.

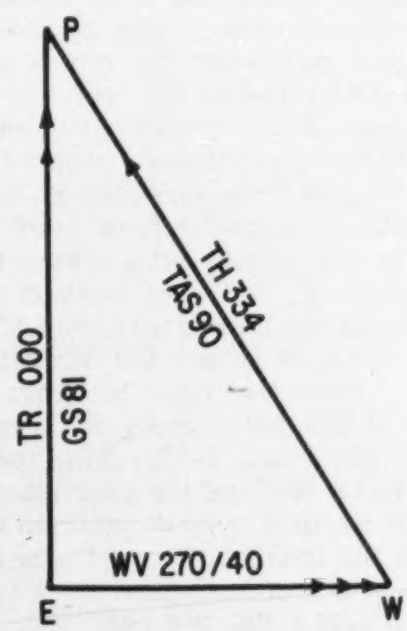

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Figure 7-21.—Determining TR and GS.

We will first work a wind triangle that gives us the track and groundspeed. Given are TH 334°, TAS 90K, WV 270°/40K. Inasmuch as wind exists on every flight, we will draw the wind vector first. This is done by placing the plotter along any meridian and alining the straightedge of the plotter to indicate 270°. Use the scale on the straightedge of the plotter to determine the length of the vector (40 units). Label this vector EW. We are now ready to draw the true heading-true airspeed vector which is WP. Aline the plotter, from W, along the true heading, which is 334°, and measure the length of the vector to 90 knots. This, too, is measured on the straightedge of the plotter scale. At the end of the vector, label point P. To find the track and groundspeed, aline the plotter along the vector EP. Draw a line to join E and P. Line EP is the track (000°), and its length (81 units) is the groundspeed. (See figure 7-21.)

Another, and the most common type of vector problem used, is the one in which a pilot measures the direction of the true course from a chart, and gets a forecast of wind from weather service. Also, he knows the true airspeed at which he will fly his aircraft.

To find the true heading and groundspeed, the following procedure is used. First, plot the wind. Aline the plotter so the straightedge is parallel to the direction of the wind. Again measure the wind velocity on the scale (WV 215/15) at the bottom of the plotter. Now, aline the plotter along the true course (295°), and from point E draw a line of indefinite length. This line will show the true course or track necessary to travel. But, since it was measured from point E, the length of the vector, which is actually the groundspeed, cannot be determined. However, the true airspeed given is 125 knots. Next, aline the plotter from point W, so that the scale of the plotter falls across the line drawn from point E, and the length of the WP vector represents the true airspeed of 125 units on the scale. Now, measure the direction of the WP vector, read the true heading, measure the length of the EP vector, and read the groundspeed. (See fig. 7-22.) The true heading is found to be 289° and the groundspeed 122 knots.

Still another type of problem used is that of finding the true heading and true airspeed when the track and groundspeed are known. Given are TR 315°, GS 110K, WV 045°/30K. Again, on this type of vector, plot the wind first. The wind is drawn in the same manner as before. (See fig. 7-23.) Now aline the plotter along the track, and from point E measure the length of the vector EP to 110 knots. This is the groundspeed. At this point label point P. Aline the plotter along the WP vector and read the direction or the true heading, and measure the length of the WP vector to find the true airspeed. By careful plotting, we find the heading to be 331° and the required airspeed to be 114 knots.

It has been shown that if any four of the six basic elements are known, the remaining ones can be found by drawing a wind triangle and measuring these parts. Care should be used to place the arrowheads on the lines of the triangle, otherwise the reciprocal direction may be used by mistake. The directions of the elements of the wind triangle are always E to W, W to P, and E to P, as shown in the three preceding illustrations.

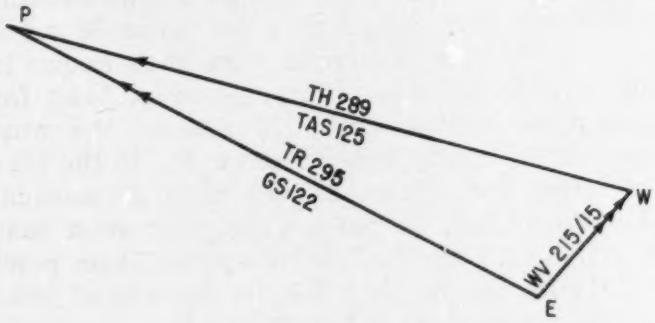

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Figure 7-22.—Determining TH and GS.

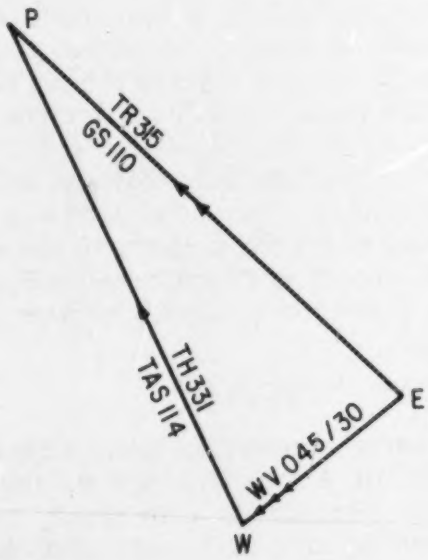

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Figure 7-23.—Determining TH and TAS.

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AERONAUTICAL CHARTS

From ancient times, man has attempted to reproduce accurately the surface of a sphere on a plane surface. The procedure is similar to that of taking a hollow rubber ball and flattening it; the ball will stretch and split before it will flatten. This is exactly the problem which is encountered in chart construction. As in the case of the rubber ball, when the earth is displayed on a plane surface, some features are distorted and others are lost altogether. Much of the distortion is minimized with the introduction of various mathematical modifications of the geometric map, and the most desirable navigational properties can either be accurately or very nearly accurately portrayed.

FACTORS IN CHART CONSTRUCTION

The surface of a sphere or spheroid is said to be undevelopable because no part of it may be spread out flat without distortion. A plane, cylinder, or cone, which can be easily flattened, is called a developable surface. The method of representing all or part of the surface of a sphere or spheroid on a plane surface is called a chart projection.

Geometric projections are actual projections of graticule (lines of latitude and longitude) of the reduced earth onto a developable surface. In theory, a chart could be constructed by placing a light source in a hollow plastic model of the earth with the parallels and meridians inscribed on it, and projecting this graticule on some developable surface. This surface, if it is not a plane, is unrolled to form a flat surface. Any chart that can be constructed in this manner is called a geometric or graphic projection. The appearance and properties of the resultant chart will depend upon two factors: The type of developable surface and the position of the light source within the plastic model of the earth. In actual practice, the projection is constructed mathematically.

Mathematical projections are constructed to provide certain properties which cannot, in theory, be constructed geometrically.

There are many projection methods available for use in chart construction. Each projection has distinctive features which make it preferable for certain uses. No one projection is best for all conditions. Some of the desirable features are:

1. Conformality. Conformality provides that the angle between intersecting curves on the earth will be preserved on the chart. For a chart to be conformal, parallels and meridians must intersect at right angles. In addition, scale or scale expansion must be the same along the meridian as it is along the parallel. Scale on a conformal chart will vary from point to point, but provided that the variation is the same in all directions, the requirement is met.

2. Constant and correct scale. An ideal model of the earth would have constant and correct scale; i.e., the distance of every place from every other place would bear a constant ratio to the true distance on the earth. Unfortunately, the earth's surface cannot be developed into a plane without stretching or shrinking, which prevents correct and constant scale representation over the entire projection.

3. Correct shape representation. To possess the property of correct shape, a chart must be conformal and the scale must be constant and correct in all directions. As pointed out previously, this latter prerequisite is not possible to obtain over the entire projection.

4. Straight line. The nature of a straight line on a chart is equally as important as conformality. The rhumb line (a line between any two points which crosses all meridians of the earth at the same oblique angle) and the great circle (defined previously in this chapter) are the two curves that a navigator might wish to have represented on a chart as a straight line. The rhumb line is desirable because it is convenient to fly, and the great circle is flown because it provides the shortest path between any two points.

5. Coordinates easy to locate. The geographic latitudes and longitudes of places should be easily found from their positions on the chart; and conversely, positions should be easily plotted on the chart when the latitudes and longitudes are known.

Figure 7-24 shows types of projections and basic characteristics of the projections from which the majority of aeronautical charts used by AC's are constructed.

INFORMATION SHOWN ON AERONAUTICAL CHARTS

An aeronautical chart is a pictorial representation of the earth and its culture. It can provide a picture of any region of the earth.

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CHARACTERISTICS	LAMBERT CONFORMAL	MERCATOR	TRANSVERSE MERCATOR	POLAR STEREOGRAPHIC
PARALLELS	ARCS OF CONCENTRIC CIRCLES NEARLY EQUALLY SPACED	PARALLEL STRAIGHT LINES UNEQUALLY SPACED	CURVES CONCAVE TOWARD NEAREST POLE	CONCENTRIC CIRCLES UNEQUALLY SPACED
MERIDIANS	STRAIGHT LINES CONVERGING AT THE POLE	PARALLEL STRAIGHT LINES EQUALLY SPACED	COMPLEX CURVES CONCAVE TOWARD CENTRAL MERIDIAN	STRAIGHT LINES RADIATING FROM THE POLE
APPEARANCE OF GRID	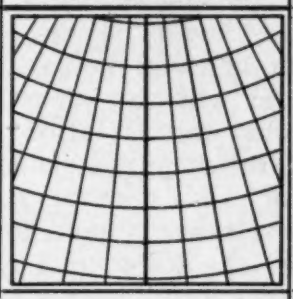	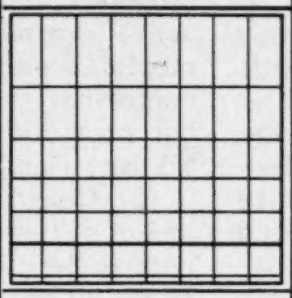	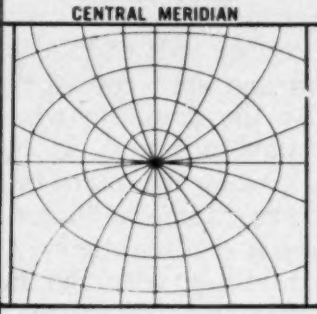	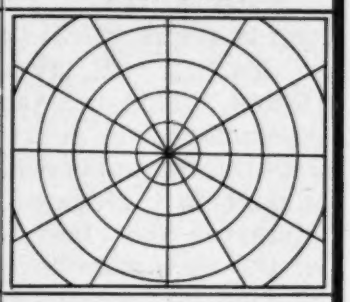
ANGLE BETWEEN PARALLELS & MERIDIANS	90°	90°	90°	90°
STRAIGHT LINE CROSSES MERIDIANS	VARIABLE ANGLE (APPROXIMATES GREAT CIRCLE)	CONSTANT ANGLE (RHUMB LINE)	VARIABLE ANGLE	VARIABLE ANGLE (APPROXIMATES GREAT CIRCLE)
GREAT CIRCLE	APPROXIMATED BY STRAIGHT LINE	CURVED LINE (EXCEPT EQUATOR AND MERIDIANS)	CURVED LINE	APPROXIMATED BY STRAIGHT LINE
RHUMB LINE	CURVED LINE	STRAIGHT LINE	CURVED LINE	CURVED LINE
DISTANCE SCALE	NEARLY CONSTANT	MID-LATITUDE		NEARLY CONSTANT EXCEPT ON SMALL SCALE CHARTS
GRAPHIC ILLUSTRATION	SECANT CONE	CYLINDER TANGENT AT EQUATOR 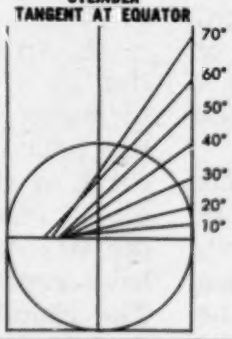		PLANE TANGENT AT POLE 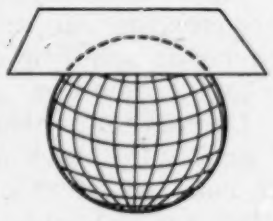
ORIGIN OF PROJECTORS	CENTER OF SPHERE (FOR ILLUSTRATION ONLY)	CENTER OF SPHERE (FOR ILLUSTRATION ONLY)	CENTER OF SPHERE (FOR ILLUSTRATION ONLY)	OPPOSITE POLE
DISTORTION OF SHAPES & AREAS	VERY LITTLE	INCREASES AWAY FROM EQUATOR	INCREASES AWAY FROM MERIDIAN OF TRUE SCALE	INCREASES AWAY FROM POLE
METHOD OF PRODUCTION	MATHEMATICAL	MATHEMATICAL	MATHEMATICAL	GRAPHIC OR MATHEMATICAL
NAVIGATIONAL USES	PILOTAGE AND RADIO (SUITABLE FOR ALL TYPES)	DEAD RECKONING AND CELESTIAL (SUITABLE FOR ALL TYPES)	GRID NAVIGATION IN POLAR AREAS	POLAR NAVIGATION, ALL TYPES
CONFORMALITY	CONFORMAL	CONFORMAL	CONFORMAL	CONFORMAL

Figure 7-24.—Chart projections. AC.94

Several miscellaneous terms frequently utilized in reference to aeronautical charts are defined as follows:

1. Small scale chart. A chart portraying large areas, as the world, a hemisphere, continent, or a country. Usually this is referenced to scales of 1:2,000,000, 1:5,000,000, etc.

2. Large scale chart. A chart portraying small areas with a relatively large amount of detail, as an area of less than state or county size. Usually this refers to scales of larger than 1:1,000,000, such as 1:500,000; 1:200,000; or 1:100,000.

3. Graticule. This is the portrayal of meridians of longitude and parallels of latitudes.

4. Base detail. This includes all features portrayed on a chart other than those on the aeronautical or grid overprint. It includes relief, culture, hydrography and vegetation.

5. Contours. A contour is represented by a line on a chart connecting all points of a given elevation above sea level. The shoreline of an ocean may be considered as the mean 0-foot contour. On a steep slope contours are close together; on a gentle slope they are farther apart.

6. Gradient tints. This means different colors used to depict intervals between certain contour lines.

7. Spot elevations. A dot with an elevation value depicts an accurately measured elevation above sea level at a specific location. On some charts a small "x" is used to indicate an approximate elevation at a specific location. If the exact location of an elevation is unknown, only the figures are shown.

8. Water tint. This depicts open water areas such as oceans and lakes by a solid tint, usually a light blue.

9. Water vignette. This is an alternate treatment of open water wherein the water is depicted with a deep or dark tone along the shoreline, and rapidly but evenly lightened in tone with progression outward from the shore to a blank or white portrayal. This technique makes a chart with large white open water areas easier to plot on, and accentuates small bodies of water and small islands.

10. Land tint. Land tint is a solid tint over all land area with no gradient tints and often no contours.

11. Relief. This refers to physical features related to the relative differences in elevation of the land surface. It includes features such as mountains, hills, plateaus, plains, depressions, etc. Complexity of relief features is dependent upon scale and/or contour interval used. Generally large scale charts show many relief features, whereas very small scale charts can only show major mountain masses.

12. Culture. Culture includes populated places, roads, railroads, installations, miscellaneous construction, such as dams, bridges, and mines. Standard symbology is used. Density of portrayal is related to chart scale, chart use, and the geographic area covered.

13. Hydrography. Hydrography includes coast lines, oceans, lakes, rivers and streams, canals, swamps, reefs, etc. Density is indicated by reference to principal or detailed drainage. Open water may be portrayed by water tint or vignette, or may be left blank.

14. Vegetation. This is not shown on most small scale charts. Forests and wooded areas in certain parts of the world are shown on some medium scale charts. Some large scale charts have park areas, orchards, hedgerows, and vineyards.

15. Aeronautical information includes airfields; electronic communications and navigational facilities such as radio beacons, VOR's, D. F. stations, and broadcast stations; ADIZ's, compulsory corridors, restricted airspace, and warning notes; lines of magnetic variation; and navigation grids.

The amount of detail, extent of features portrayed, and the density of information shown on a chart are governed by the designed purpose of the chart, and the altitude, range, and aircraft performance category for which the chart was designed. In other words, an attempt has been made to portray only that information which will be appropriate to and significant for the altitudes and speed ranges utilized in accomplishing the types of missions for which the chart was designed.

CHART SOURCE, CORRECTIONS, AND PROCUREMENT

The DOD Catalog of Aeronautical Charts and Flight Information Publications lists the current edition of charts which are issued by the Oceanographic Office regardless of source. Included are charts published by the U.S. Naval Oceanographic Office, USAF Aeronautical Chart and Information Center, and the U. S. Coast and Geodetic Survey. Whenever new or revised charts are needed by members of the naval service, all requests should be submitted on Form DD 1149 to the nearest Air Navigation Office or the supporting Oceanographic Distribution Office via the commanding officer.

Charts available at Flight Clearance are kept current by the following publications:

1. DOD Aeronautical Chart Updating Manual (CHUM), which contains:

a. A cumulative listing of significant additions or corrections to be considered when using current editions of USAF/USN published aeronautical charts.

b. Notices of special interest to aeronautical chart users.

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NOTE: The CHUM should be made available to flight crews for use during preflight planning.

2. DOD Aeronautical Chart Bulletin, published monthly, which contains availability of new charts and publications; new editions of previously published charts; discontinued charts; and notices of special use to requisitioners.

Place this bulletin in the front of the DOD Catalog.

3. DOD Aeronautical Chart Bulletin Digest published semiannually which contains listings of current editions of charts on issue.

Naval activities are also provided with Memorandum to Aviators and NOTAM's which may include corrections to charts.

NAVIGATION COMPUTERS

The Air Controlman should have a working knowledge of navigation computers as a quick and accurate method of solving simple navigation problems. This knowledge may be used in preflight planning or in-flight assistance to pilots. For example, the pilot of an aircraft observed on radar desires a groundspeed check. Two factors of the problem can be determined immediately from the radar. This information is then applied to a navigation computer, after which an accurate groundspeed is relayed to the pilot.

Various computers have been devised but only the E6D (AN-5834-1B, also called the E-10) is discussed in this training manual.

The E6D computer is really a combination of two devices. One side is a specially designed scale for the solution of wind problems. This side is known as the wind face which is not discussed here, in that its use is for solving problems not normally encountered by the Air Controlman. The other side, known as the slide rule face, is a circular slide rule for the solution of mathematical problems.

The slide rule consists of two circular scales—one a stationary scale, called the MILES SCALE; the other a rotating scale, called the MINUTES SCALE. Each scale has a reference mark, the 10, called the INDEX. The rotation scale also has a black arrowhead at the 60-minute or 1-hour point. This is known as the SPEED INDEX. (See fig. 7-25.)

Graduation of both scales are identical. The graduations are numbered 10 to 100; the unit intervals decrease in size as the numbers increase in size. The first element of skill in using the computer is a knowledge of how to read the scales. For example, there are no numbers between 25 and 30; but it is obvious the larger intermediate divisions are 26, 27, 28, and 29. Between 25 and (unnumbered) 26 there are five smaller divisions; therefore, each of these is 0.2 (1/5 x 1.0 = 0.2) of the larger unit. For a number such as 258, first find 25 (for the 250). Then, since the divisions

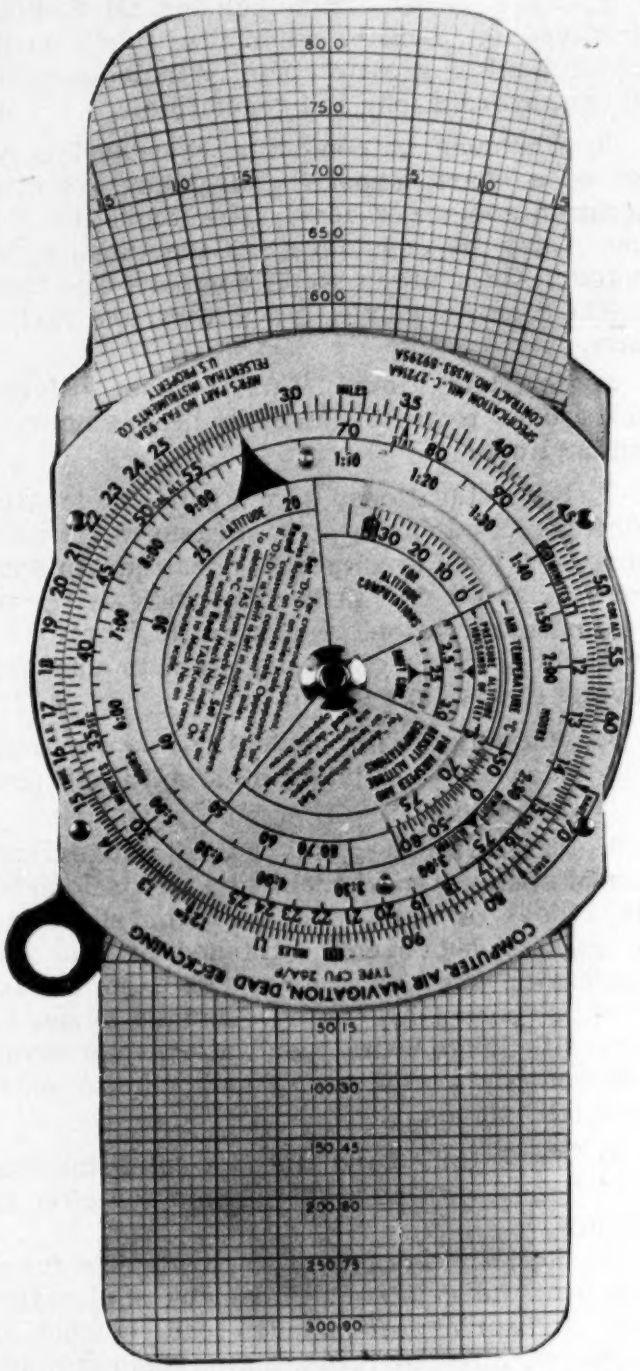

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Figure 7-25.—E6D computer.

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internal impedance of 2,500 ohms during the discharge time (fig. 14-17 (B)). The voltage across R2 is one-half the voltage to which the line was charged, or 300 volts, since one-half the available voltage is lost across the 2,500-ohm internal impedance, Z_0. If the network consisted only of capacitors, the discharge would follow an exponential curve, and the voltage across R2 would not be constant. However, the inductance and capacitance of the line are so designated that the discharge rate is practically constant.

The discharge of the artificial line can be explained best as follows: At the instant that the switch (fig. 14-17 (A)) is closed, the voltage at point A falls to 300 volts. This can be looked upon as a traveling wave of -300 volts applied at point A to reduce the voltage there immediately from 600 to 300 volts. As the wave moves from A to B the voltage across the line is reduced from 600 to 300 volts. On reaching point B, the wave sees an open circuit, since resistor R1 is very large. The wave is reflected without change in sign, and immediately reduces the voltage at point B from 300 volts to zero as the wave travels back to point A; and the remaining 300 volts across the line is canceled out. On reaching point A, the wave has reduced the voltage across all sections to zero, the wave itself disappearing because it is absorbed by a load which matches the characteristic impedance of the line. The pulse formed across R2 by the line discharge lasts for the time required for the traveling wave to move from the switch end of the line to the open end and back.

A typical line may be constructed by winding may turns of copper wire on a flexible tube of insulating material. This coil is first covered with a thin layer of insulation, and then a braided shield and another layer of insulation. The capacitance between the coil and the shield simulates the distributed capacitance of the actual transmission line and the inductance of the coil simulates the distributed inductance.

MARKER SYSTEMS

Marker systems are used to enable the radar operator to determine the location of targets with great accuracy. This may be accomplished by causing visual guides to appear on the face

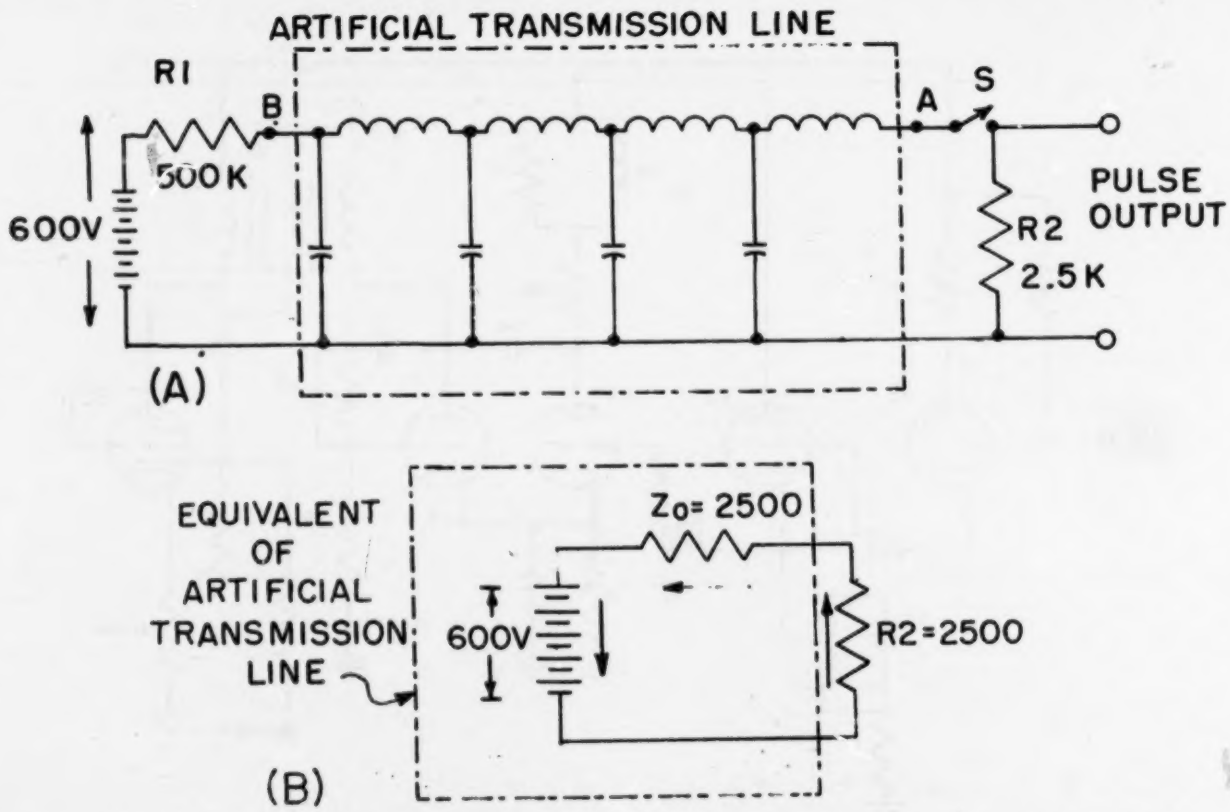

Figure 14-17. —Artificial transmission line. (A) Simple circuit for producing a pulse: (B) equivalent circuit during discharge.

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here are 2 units each, find the fourth intermediate division (4 x 0.2 = .8) for 258. The slide rule does not indicate where to place the decimal point. You must place it according to commonsense. The 25 on the scale may stand for .25, 2.5, 25, 250, and so on, depending on the figures with which you have to work. The position of the decimal point will not matter in picking the point on the scale which represents the number.

PROBLEMS ON THE SLIDE RULE FACE

The slide rule face of the computer is so constructed that any relationship between two numbers, one on the stationary scale and one on the movable scale, will hold true for all other numbers on the two scales. A slide rule is a mechanical device which solves proportions. A proportion is a statement that two fractions or ratios are equal. Thus, 1/2 = 3/6 is a simple proportion. If you know three of the four numbers or terms of a proportion, you can solve for the fourth. Thus if 2/3 = X/9, it is obvious that X = 6. If you consider the figures on the outer (miles) scale and inner (minutes) scale as the upper and lower parts of a simple proportion, you can set the known values on the computer, and the unknown values will automatically be given by the computer scale. Consider the following examples:

(1) To find distance:

Given—Groundspeed, 204 knots.

Problem—Find the distance traveled in 75 minutes.

Solution (fig. 7-26)—Set the speed index on the minutes scale opposite 204 on the miles scale. Opposite 75 on the minutes scale, read 255 nautical miles on the miles scale.

NOTE: Notice the speed index is part of the proportion when a constant rate per hour is involved such as nautical miles per hour (knots).

(2) To find groundspeed:

Given—Distance traveled, 140 nautical miles; elapsed time, 40 minutes.

Problem—Find groupspeed.

Solution (fig. 7-27)—Set 40 on the minutes scale opposite 140 on the miles scale. Opposite the speed index, read the groundspeed 210 knots.

(3) To find time:

Given—Groundspeed, 160 knots. Destination is 200 nautical miles.

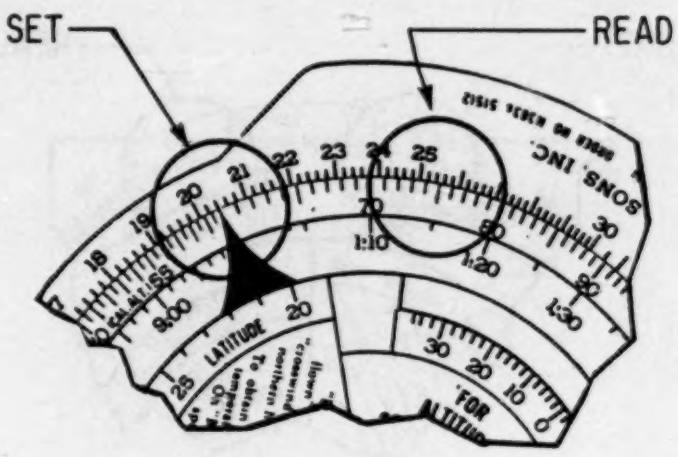

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Figure 7-26.—Given speed and time to find distance.

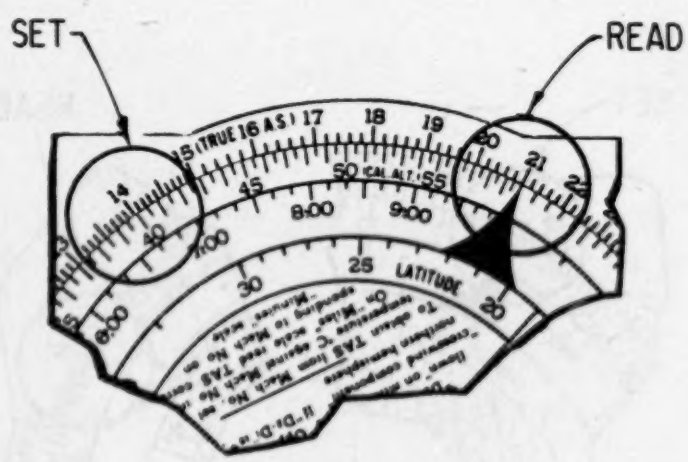

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Figure 7-27.—Given distance and time to find speed.

Problem—Find the time for the aircraft to reach destination.

Solution (fig. 7-28)—Set speed index opposite 160 on the miles scale. Opposite 200 on the miles scale, read 75 on the minutes scale.

(4) To find fuel consumption:

Given—At cruising speed the fuel consumption is 460 pounds per hour. The aircraft has been at cruising speed for 3 hours (180 minutes).

Problem—Find the amount of fuel consumed.

Solution (fig. 7-29)—Set the speed index on the minutes scale to 46 on the miles scale. Opposite 180 (3 hours) on the minutes scale read, 1,380 pounds on the miles scale.

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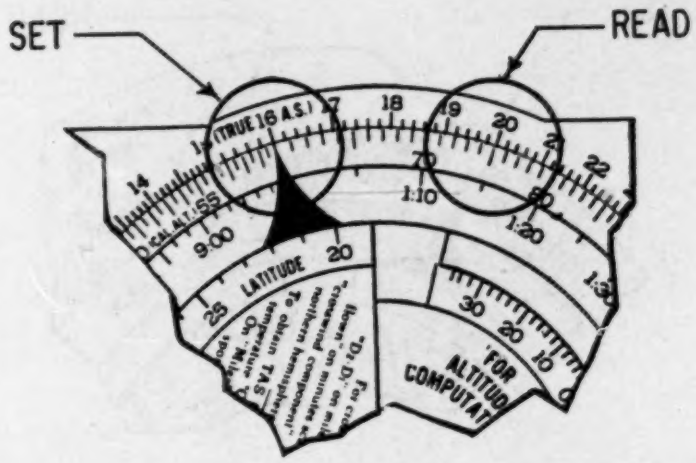

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Figure 7-28.—Given speed and distance to find time.

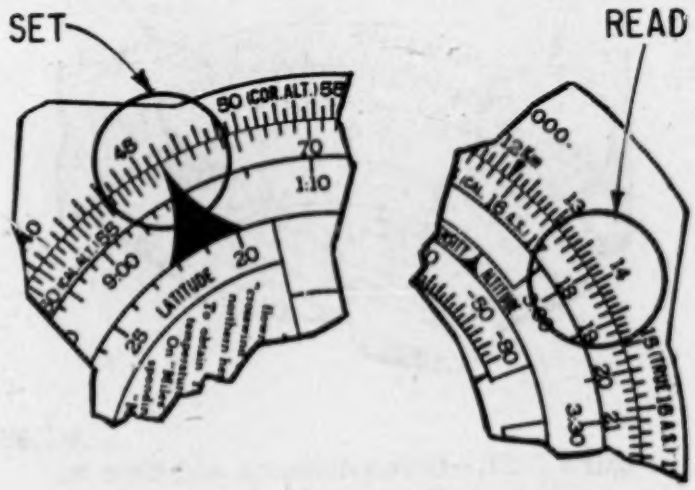

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Figure 7-29.—Given fuel consumption rate and time to find fuel consumption.

(5) To find possible cruising time:

Given—An aircraft uses 35.5 gallons of fuel per hour. The tank holds 100 gallons.

Problem—Find the possible cruising time.

Solution (fig. 7-30)—Set the speed index opposite 35.5 on the miles scale. Opposite 100 on the miles scale, read 169 minutes (2 hours 49 minutes) on the minutes scale.

All mileage and speed in aviation are nautical. Should you be faced with a problem involving statute miles or miles per hour, there is a conversion marker for each of these units on the miles scale. To convert from one unit to another, place the known unit on the minutes scale under the respective unit arrow on the miles scale. Read the equivalent distance or speed under the desired unit arrow. For example, change 120 statute miles to nautical miles. (See fig. 7-31.) Set 120 on the minutes scale opposite the STAT arrow on the miles scale. Read 104 on the minutes scale opposite the NAUT arrow on the miles scale.

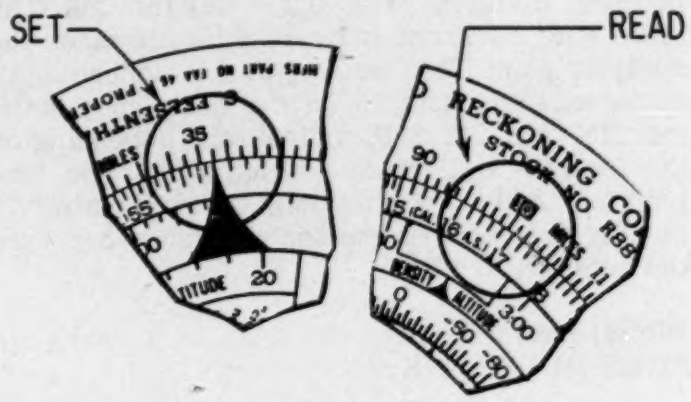

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Figure 7-30.—Given fuel consumption and tank capacity to find cruising time.

Simple multiplication or division can also be done with the E6D. In doing this, use the "10" index instead of the speed index for part of the proportion.

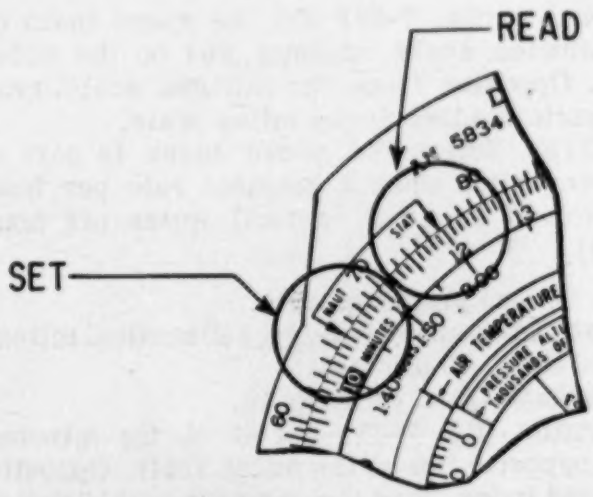

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Figure 7-31.—Converting statute miles to nautical miles.

In multiplying, set the "10" index on the minutes scale opposite either of the numbers to be multiplied on the miles scale. Then read the answer on the miles scale opposite the other number to be multiplied on the minutes scale. For example, multiply 2 times 12 on the E6D. (See fig. 7-32.) Set the "10" index on the minutes scale opposite 12 on the miles scale. Read the answer (24) on the miles scale opposite the other number to be multiplied (2) on the minutes scale.

When dividing on the E6D, it appears exactly the same as it does when given a fraction. Place the dividend on the miles scale opposite the divisor on the minutes scale. Read the quotient or answer on the miles scale opposite the "10" index on the minutes scale. For example, divide 24 by 8 on the E6D. (See fig. 7-33.) Set 24 (divident) on the miles scale opposite 8 (divisor) on the minutes scale. Read the answer (3) on the miles scale opposite the "10" index on the minutes scale.

In addition to the miles and minutes scales, the slide rule face of the E6D has several other scales. One is marked "For Air Speed Computations" and is used for applying air temperature and pressure altitude to correct the airspeed indicator reading. Another is marked "For Altitude Computations" and is used for applying air temperature and pressure altitude to correct the altimeter reading. Additionally, there are scales to compute for density altitude, to determine true airspeed from Mach number, and to solve for wind correction factors in constant heading flight technique.

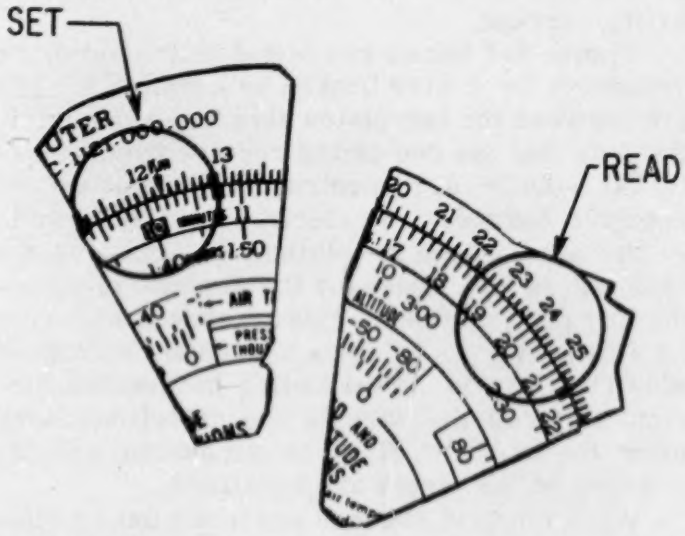

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Figure 7-32.—Multiplication.

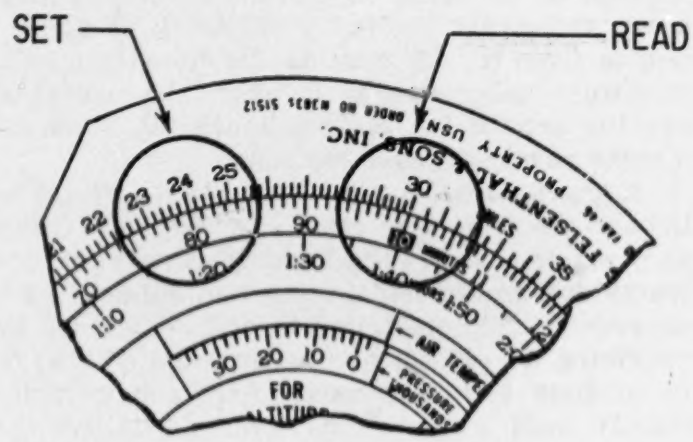

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Figure 7-33.—Division.

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CHAPTER 8

AIDS TO AIR NAVIGATION

To understand how communication by radio propagation is possible, a brief consideration of the electrical nature of all matter is helpful.

All matter consists of a great number of tiny units called molecules. Each molecule consists of one or more atoms. An atom is composed principally of subatomic particles called electrons, protons, and neutrons. Protons and neutrons are a closely packed group called the nucleus of the atom. Electrons revolve at high speed around the nucleus at relatively great distances from it. An atom can be visualized as a miniature solar system in which the electrons revolve around the nucleus much the same as planets revolve around the sun.

A gravitational force exists between the proton and electron of an atom. An electrical force also exists. A gravitational force always attracts, but an electrical force can either attract or repel. This electrical force is explained by ascribing an electrical property called charge to protons and electrons. A proton is arbitrarily said to have one unit of positive (+) charge, and an electron one unit of equal but opposite negative (-) charge. During a state of rest, protons repel other protons, electrons repel other electrons, but a proton attracts and is attracted by an electron. Hence, the rule that like charges repel, and unlike charges attract each other. Neutrons, as the name implies, are electrically neutral, having no charge, and are neither attracted nor repelled by a proton or electron.

In addition to the electrical forces between charged particles at rest, other forces exist which depend upon the relative motion of the particles. These are called magnetic forces, and always accompany moving electrical charges. Thus, electricity and magnetism are not separate phenomena; both aris from the properties of electrical charges.

A conductor is material containing charges which are free to move under the influence of an electric field. If the electric field is maintained within the conducting circuit, the motion of the free charges is continuous. This motion is called current. If the field is always in the same direction, the resulting current is called direct current. If the field periodically reverses direction, the current also reverses and is called an alternating current.

Figure 8-1 shows two metal plates which are connected by a wire broken by a switch S. The air between the two plates acts as an insulator. Suppose that the two plates receive from an external source a concentration of positive and negative charges. An electric field then exists in the air between the plates. The charges are isolated on the plates by the absence of a conducting path, and hence this arrangement, known as a capacitor, provides a convenient storage of electric charges. If the switch is closed, a current flows in the wire in the direction shown until the electric field is exhausted and the charges on the plates are equalized.

When electric charges are in motion, as when a current is flowing in a conductor, a magnetic field forms around the conductor. Once formed, the magnetic field surrounding all portions of the conductor is constant in direction and intensity if the generating current is also constant. If the current carrying wire is wound into a coil, called an inductor (fig. 8-2), the resulting magnetic field is intensified in proportion to the number of turns. The greater the inductance, the stronger the magnetic field for a given current.

Suppose that a circuit contains both capacitance and inductance, or a combination of circuits as in figure 8-1 and 8-2. When the switches are closed, the energy in the electrical field at the capacitor causes a current to flow in the inductor, thereby creating a magnetic field. This continues until the capacitor is completely discharged. All the energy now resides in the

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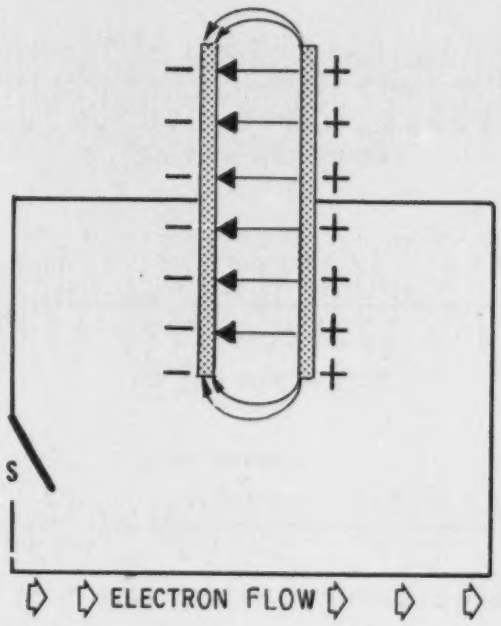

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Figure 8-1.—Capacitance.

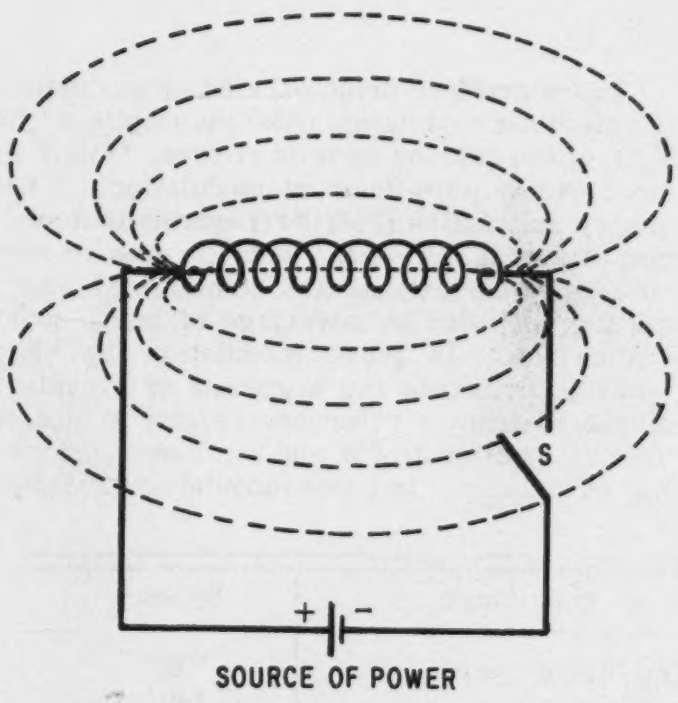

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Figure 8-2.—Inductance

magnetic field. When the current ceases, there is nothing to sustain the magnetic field, which promptly collapses, returning the energy to the circuit. This recharges the capacitor and the energy of the circuit has now been transferred from the magnetic field back to the electric field. This type of circuit is known as an oscillating circuit and the sequence repeats itself indefinitely. The oscillating circuit lies at the heart of radio, because it provides a source of alternating electric and magnetic fields and a means of controlling the frequency of oscillations known as tuning.

Most of the energy stored in the electric field of a capacitor or the magnetic field of an inductor is restored to the circuit when the capacitor has become discharged or when current ceases to flow in the inductor. These fields expand and contract at nearly the speed of light, which is approximately 186,000 miles per second. At very low frequencies there is ample time for the restoration of energy to take place. However, as frequency increases, the recurring cycles become faster. When the time needed for the field to expand and collapse is more than about one-half cycle, some of the energy becomes detached and continues to radiate into space at approximately the speed of light. Such radiating energy, called electromagnetic radiation, is the link between a radio transmitter and receiver.

BASIC RADIO PRINCIPLES

Radiated electromagnetic energy suitable for radio communication is called a hertzian wave. The wave is named for an early German physicist and mathemetician named Hertz, who introduced the theory of the kinetic energy of an electrical current. Hertz's discoveries, along with many other discoveries, laid the basis for the development of radio telegraphv.

The hertzian wave can be represented by a sine curve as shown in figure 8-3. The top of the wave represents the maximum positive value, and the bottom represents the maximum negative value. Either maximum may be called a peak. Wave length is the distance between corresponding points on consecutive waves as shown in figure 8-3. It is the distance a wave travels during one cycle. Frequency is the number of cycles that occur per second, stated in terms of hertz, abbreviated Hz; thousands of cycles per second stated in terms of kilohertz, abbreviated kHz; or millions of cycles per second stated in terms of megahertz, abbreviated MHz. The range of frequencies involved, called the radio spectrum, extends from approximately 10kHz to 300,000 MHz as shown in table 8-1.

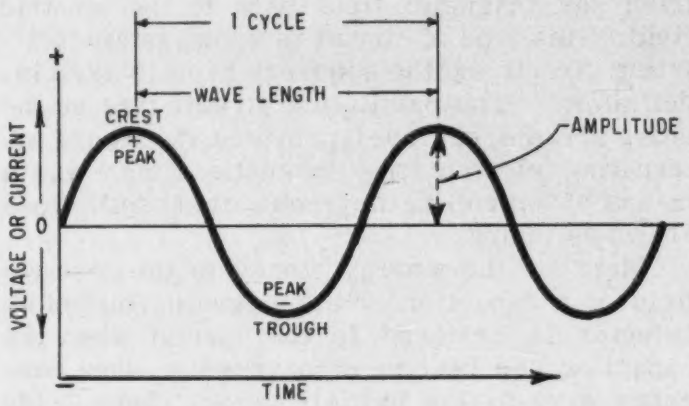

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Figure 8-3.—Hertzian wave nomenclature

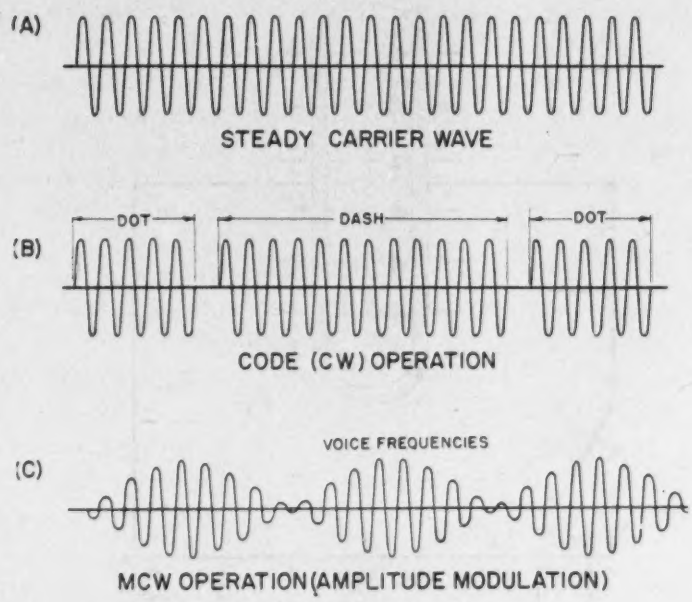

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Figure 8-4.—Types of radio waves.

A hertzian wave, as previously indicated, is an oscillating electromagnetic field. A continuous series of such waves of like characteristics is called a continuous wave (CW). (See fig. 8-4 (A).) Such a wave can be used in Morse code transmissions, being keyed so that the signal is interrupted when desired. (See fig. 8-4 (B).) A continuous wave may be modified in accordance with some characteristics of an audio frequency signal, such as that produced by the human voice. When thus used, it is called a carrier wave. The process of modifying the carrier wave in this manner is called modulation. After this has taken place, the carrier wave may be called a modulated carrier wave. (See fig. 8-4 (C).) When this form of radio transmission is used, the transmitting station generates the carrier wave and modulates it by the message to be conveyed. The receiver demodulates the incoming signal by removing the modulating signal and converting it to its original form.

There are four principal kinds of modulation. In amplitude modulation (AM) the amplitude (fig. 8-3), of the carrier wave is altered. This is the most widely used form of modulation. In frequency modulation (FM) the frequency of the carrier wave is altered. This is used in some voice communications and commercial broadcasting and has an advantage of being nearly static free. In phase modulation the phase (amount by which the beginning of a cycle is displaced from a reference origin) is altered. This is similar to FM and has some engineering advantages. In pulse modulation (PM) very

Frequency range	Name of the range	Symbol
Below 30 kHz	Very low frequency	VLF
30-300 kHz	Low frequency	LF
300-3,000 kHz	Medium frequency	MF
3-30 MHz	High frequency	HF
30-300 MHz	Very high frequency	VHF
300-3,000 MHz	Ultrahigh frequency	UHF
3,000-30,000 MHz	Superhigh frequency	SHF
30,000-300,000 MHz	Extremely high frequency	EHF

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short bursts of carrier wave signals are transmitted, followed by relatively long periods during which no signal is transmitted. PM is used in RADAR, DME, and radio teletype.

With amplitude modulation, two sidebands are radiated, the frequencies of which are the sum and difference, respectively, of the carrier and modulating frequencies. The intelligence is carried only on the sidebands. In single sideband (SSB) transmission the carrier and one of the sidebands are suppressed, producing narrow bandwidth transmission. Bandwidth is the amount of radio spectrum required for transmission, including the carrier wave and both sidebands when present. SSB transmission is desirable in that it effects economy in the use of limited frequency bands and in power.

RADIO TRANSMITTER

A radio transmitter consists essentially of a power supply to furnish direct current; an oscillator to convert direct current into radio frequency oscillations (the carrier wave); an amplifier to increase the output of the oscillator; a device for controlling the frequency of the generated signal; and, for most transmitters, a modulator to produce modulation of the carrier wave. (See fig. 8-5.) In addition, an antenna is needed to project the electromagnetic radiation into space. An antenna may be nondirectional or directional depending upon the design or arrangement of antennas, called an array. Reflectors are also used to reflect some of the radiated energy in a desired direction.

RADIO RECEIVER

When an electromagnetic field passes a conductor such as an antenna, a current is induced in the conductor, which thereby becomes a generator of radio frequency power. A radio receiver is a device which accepts the power thus generated by an antenna, and transformed it into usable form. The output of receivers most used by AC's is presented aurally via earphones or a loud speaker, or visually on a cathode ray tube as in RADAR or DF.

A radio receiver consists essentially of electrical components capable of doing four things as follows:

1. Selecting a signal of a single frequency from among the thousands existing together in the receiving antenna.
2. Amplifying the selected signal without distortion until it is sufficiently powerful to actuate succeeding devices within the receiver.
3. Demodulating any modulated signal so as to produce a new signal of audible or other usable frequency.
4. Amplifying that signal still further until, at the output of the receiver, it can operate the devices which present the signal in usable form. (See fig. 8-6.)

VHF/UHF OMNIDIRECTIONAL RANGES

The omnidirectional facility derives its name from the Latin word omnis, meaning all. Hence

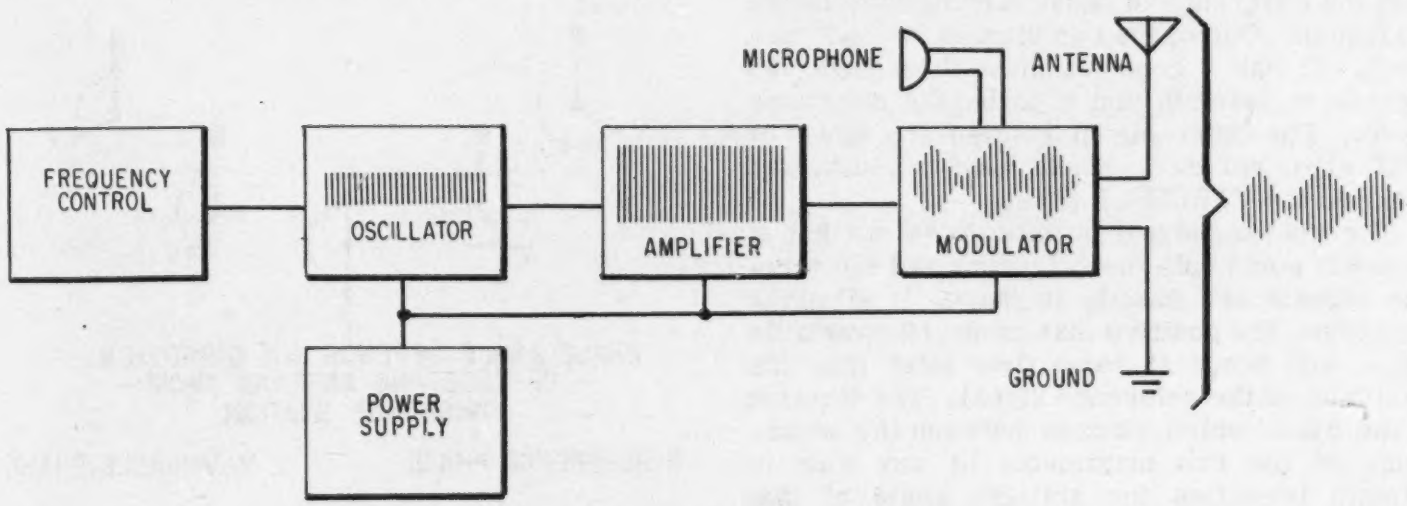

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Figure 8-5.—Radio Transmitter.

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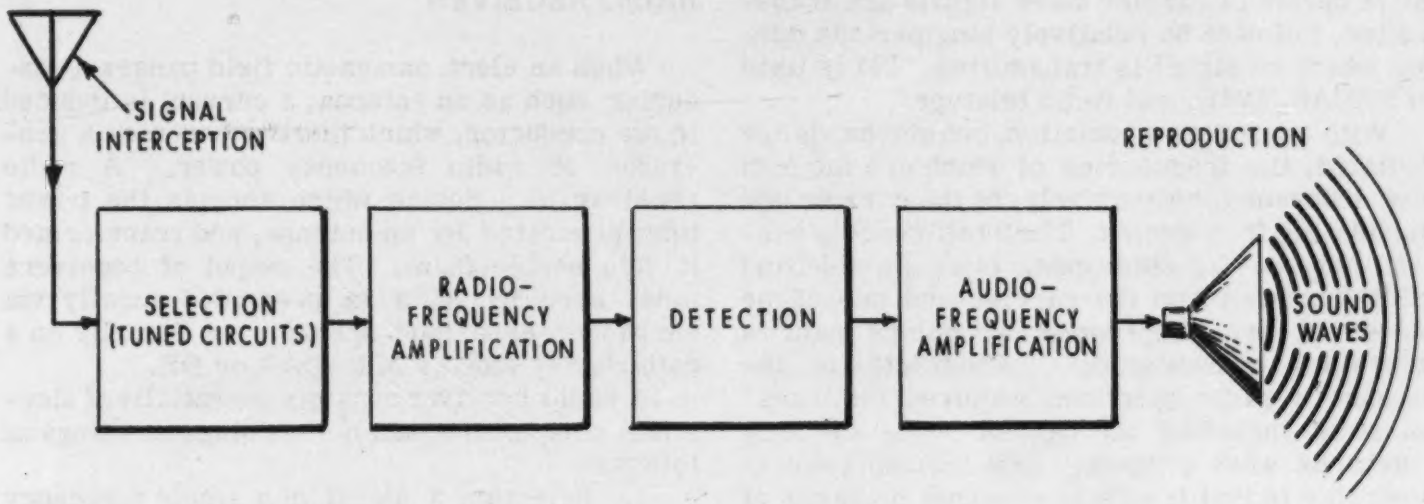

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Figure 8-6.—Radio receiver.

the omni facilities produce directional guidance in all directions. Theoretically speaking, an infinite number of courses are produced by these facilities, but in actual practice only 360 are usable under optimum conditions. Courses produced by omni facilities radiate from the station like spokes from the hub of a wheel and are called RADIALS. It is important to remember that the radials are always FROM the station.

PRINCIPLE OF OPERATION

The principle of the omnidirectional facility is based on the comparison of the phase difference between two radiated audio frequency signals, the difference in phase varying with change in azimuth. One of the two signals is nondirectional. It has a constant phase throughout 360 degrees of azimuth and is called the reference phase. The other signal rotates at a speed of 1,800 rpm, varies in phase with azimuth, and is called the VARIABLE phase.

The rotating signal is initially set so that at magnetic north both the reference and the variable signals are exactly in phase. In all other directions, the positive maximum of the variable signal will occur at some time later than the maximum of the reference signal. The fraction of the cycle which elapses between the occurrence of the two maximums at any point in azimuth identifies the azimuth angle of that point. (See fig. 8-7.)

For an analogy to help visualize the method of determining bearing from the transmitter let

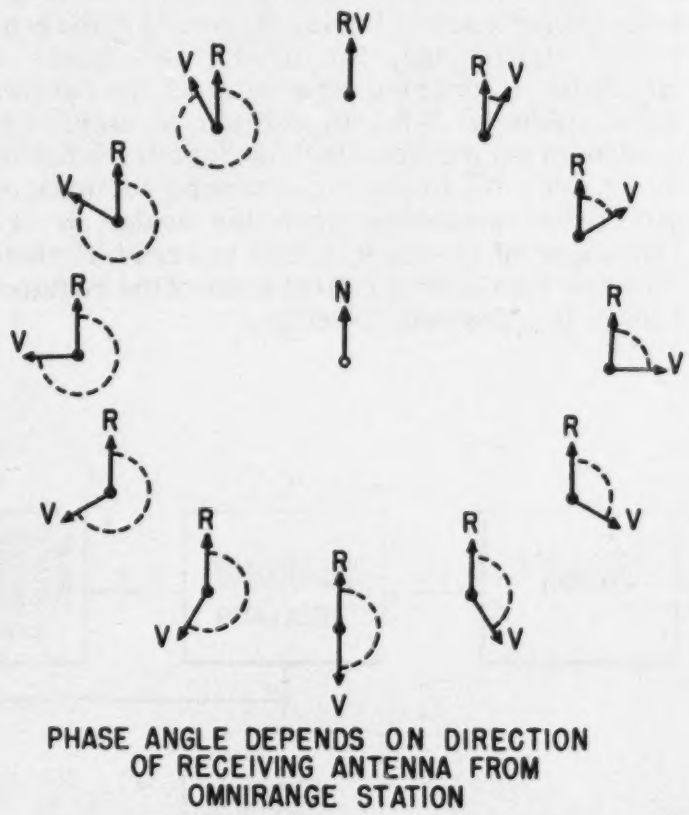

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Figure 8-7.—Comparison of reference and variable phase.

us use as an example, a rotating light beacon. Suppose that an additional light flashes each time the light beam sweeps past magnetic north and the beacon rotates clockwise at 6 rpm (one revolution each 10 seconds or 36 degrees per second).

To determine our direction from the beacon, we could use a stopwatch, starting the watch at the instant we see the start of the flash and stopping it when the rotating beam sweeps past our position. Then, by multiplying the number of seconds shown on the stopwatch by 36, we can obtain our magnetic bearing from the beacon. Suppose that exactly 5 seconds elapse from the start of the flash until the rotating beam flashes past us: 5 x 36 = 180. From this we determine that our bearing from the beacon is 180 degrees.

If we move our position to the right (counterclockwise), the elapsed time interval would be shorter; hence, our bearing would be something less than 180 degrees. The reverse would be true if we moved our position to the left (clockwise). In effect, the reference and variable voltages of the omni facility provide the same information electronically that the flasher and the beacon supply visually in this example.

RECEIVING EQUIPMENT

The basic function of the airborne receiving equipment is to measure the phase angle between the reference voltage and the variable voltage. As described previously, each point or degree of azimuth radially from the ground transmitter has a definite, fixed phase difference between the reference and the variable signals. Therefore, it our receiving equipment can translate and provide in readily usable readings on the instrument panel the phase difference existing at the receiving position, a bearing from the transmitter is obtained. Likewise, if out equipment can be adjusted to any desired bearing (or phase difference), and indicate when the aircraft has reached that bearing, we may preset courses, then fly to and continue along them. That is exactly what the receiving system is designed to do, and a great deal of information is available to the pilot taking advantage of all its possibilities.

DISTANCE MEASURING EQUIPMENT (DME)

Distance and direction from a known ground point are two items of information necessary to establish position in air navigation and assist the air traffic controller to effectively maintain separation. Until the advent of equipment for measuring distance, a pilot could find his bearing toward a selected navaid; but in order to determine his actual position (bearing and distance), it was necessary to tune to another facility and determine his position by cross-reference methods. This was time consuming. By use of the present-day distance measuring equipment the pilot has both the bearing and distance from the station displayed on the indicators.

Principles of Operation

Distance measuring capability requires special equipment in the aircraft and on the ground. The airborne equipment is known as the INTERROGATOR and the ground equipment is called the TRANSPONDER. In the operation of distance measuring equipment, paired pulses at a specific spacing are sent out from the aircraft (this is interrogation) and are received at the ground station. The ground station (transponder) then transmits paired pulses back to the aircraft at a different pulse spacing and on a different frequency. The time required for the round trip of this signal exchange is measured in the airborne unit and is translated into distance (nautical miles) from the aircraft to the ground station.

Operating in the UHF band on the line-of-sight principle, distance measuring equipment furnishes distance information with a very high degree of accuracy. DME measures slant distance rather then horizontal distance over the ground. Except in the immediate vicinity of the transponder and at a relatively high altitude, the navigation error introduced by the slant measurement is minor and usually may be ignored.

TYPES OF OMNIRANGES

Several types or combinations of VHF/UHF omni facilities are in operation today; therefore, careful use of terminology referring to these facilities is necessary. The omni facilities and their operating frequencies are as follows:

1. VOR. VHF omnidirectional radio range which provides bearing (direction) information. VOR facilities operate on frequencies between 108.0 MHz and 118.0 MHz.

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2. VOR/DME. VHF azimuth information and UHF distance information furnished from collocated components. Frequency pairing allows the use of a single receiver tuning selector capable of simultaneously selecting a paired VOR and DME receiver frequency.

3. TACAN. UHF omnidirectional radio range which provides direction and distance information. TACAN facilities operate on frequencies between 960 mc and 1,215 mc. VOR receivers are unable to receive navigational signals from TACAN facilities.

4. VORTAC. A combination of VOR and TACAN. This facility provides azimuth navigational information on VHF (108-118 mc) and azimuth and distance navigational information on UHF (960-1,215 mc). Aircraft having complete TACAN airborne equipment can receive both distance and azimuth information from the TACAN portion. Aircraft equipped with VOR receivers use the azimuth information from the VOR and must obtain distance information from the TACAN portion. This is accomplished through single receiver tuning selection of paired frequencies as with VOR/DME.

RECEPTION DISTANCE

Like all VHF/UHF transmissions, omni facility signals follow an approximate line-of-sight course. (See fig. 8-8.) Therefore, reception distance increases with an increase in the altitude of an aircraft. Since the reliable operating range is about 40 miles at minimum en route altitude (1,000 ft above terrain), omni facilities are spaced approximately 90 miles apart to assure navigation coverage over an airway. Due to the operational band of the omni facilities, they are relatively free of atmospheric and precipitation static.

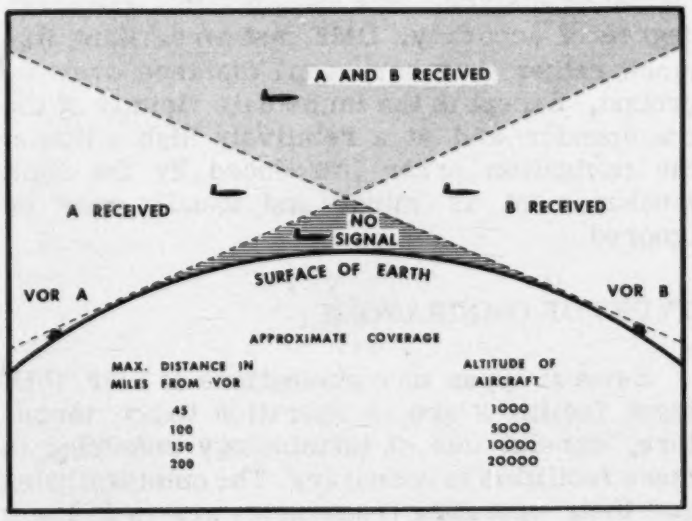

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Figure 8-8.—Line-of-sight transmission characteristics.

CLASSIFICATION

VOR, VORTAC, and TACAN navaids are classed according to their operational use. There are three classes as follows:

T . . . . . Terminal
L . . . . . Low altitude
H . . . . . High altitude

Table 8-2 shows the normally anticipated altitude and interference-free distance service. It is apparent from the table that this is not maximum range of the facility. Use of these facilities beyond the prescribed limitations is not intended, and may therefore result in undependable or inadequate indications in the aircraft.

Class	Altitudes	Distance (miles)
T	12,000' and below	25
L	Below 18,000'	40
H	Below 18,000'	40
H	14,500' -- 17,999'	100*
H	18,000' -- FL 450	130
H	Above FL 450	100

*Applicable only within the contiguous 48 states.

IDENTIFICATION

VOR's are identified by two methods consisting of the ground facility transmitting one of the following:

1. A 3-letter identifier in Morse code.
2. A recorded automatic voice identification announcing the name of the facility followed by the statement V-O-R.

Identification of VOR facilities is transmitted continuously except when interrupted by an actual

of the scope. These guides or markers provide range and azimuth (bearing) of a target. Some systems present additional information that gives the operator the relative height of the target.

Markers are also used on equipment other than radar, for example—electronic countermeasures, loran, oscilloscopes, and many others. In these equipments, markers are used to determine pulse width, pulse spacing, pulse amplitude, and various other functions.

Early radars depended on the linearity of the scope sweep for accuracy in range. A rough range scale was etched on a transparent plastic plate and this was placed on the face of the scope. Present-day radars obtain range markers from a range marker circuit. This circuit consists of a stable oscillator that generates accurately spaced range markers which are used to modulate the electron beam in a PPI type scope. This type presentation causes intensity type markers to appear.

An A-scope may also utilize intensity type markers or the markers may be applied to the deflection circuits. The application of the marker to the deflection circuits causes pulse type markers to appear on the scope.

FIXED RANGE MARKER

This circuit uses a gated type ringing oscillator which produces range marks that are synchronized with the sweep. A circuit that illustrates this system is shown in figure 14-18.

The gating tube V1, because of positive bias, is normally conducting and producing a steady flow of current through L1. The flow of current through L1 maintains a magnetic field around the coil; thus, the tank circuit composed of L1 and C2 cannot oscillate. Simultaneously with the starting of the scope sweep a negative square wave is applied to the grid of V1, cutting the tube off and causing the magnetic field around L1 to collapse. The collapsing of this field shock-excites the oscillator. The circuit continues to oscillate throughout the duration of the negative square wave. The values of L and C, in the series-fed Hartley oscillator, are so chosen that the duration of each cycle of oscillation is equal to the time between the desired range marker spaces. The leading edge of each negative oscillation produces a range marker in the output of the circuit. V2 replenishes the losses of the tank circuit, thereby maintaining the amplitude of oscillation.

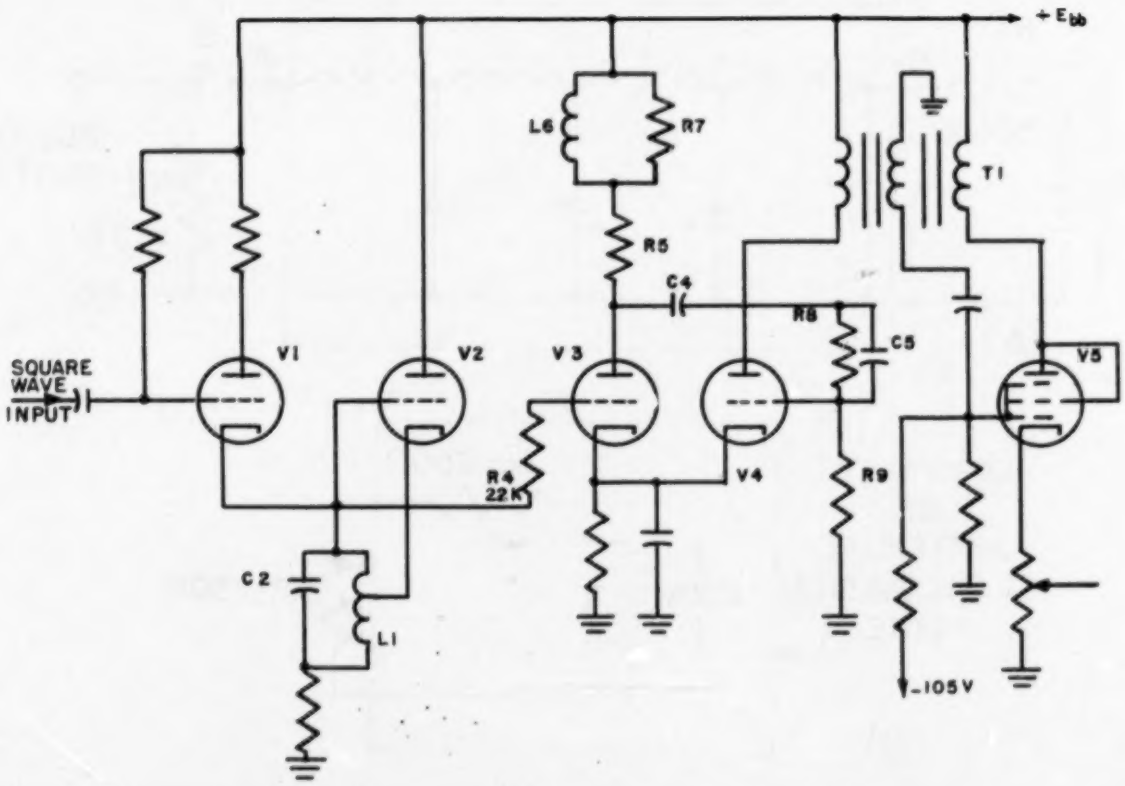

Figure 14-18.—Ringing oscillator range marker.

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voice transmission on the voice feature of the navaid, or during periods of maintenance, in which case the identification of the facility is removed.

TACAN's are identified by ground facility transmission of a 3-letter identifier in Morse code at regular intervals of 37.5 seconds.

VORTAC identification requires identification of both the VOR and TACAN portions of the facility. The procedure is basically the same as for individual facilities except they are interlocked; i.e., the VOR identification is continuous except at regular intervals of every 37.5 seconds when the TACAN is identified. Where the recorded automatic voice identification is used for the VOR portion, it consists of the name of the facility followed by the word VORTAC.

VOR RECEIVER CHECKS

Federal Air Regulations Part 91 (covered in chapter 9 of this training manual), provides for certain VOR equipment accuracy checks prior to flight under instrument flight rules (IFR). The FAA has provided the following means of checking VOR receiver accuracy:

1. VOR test facility (VOT).
2. Certified airborne checkpoints.
3. Certified checkpoints on the airport surface.

The VOR test facility (VOT) transmits a test signal for VOR receivers which provides a convenient and accurate means to determine the operational status of their receivers.

Airborne and ground checks consist of certified radials that should be received at specific points on the airport surface, or over specific landmarks while airborne in the immediate vicinity of the airport.

Should an error in excess of plus or minus 4 degrees be indicated through the use of the ground check, or plus or minus 6 degrees using the airborne check, IFR could not be attempted without first correcting the error.

In addition to the above procedure, the Navy has established checkpoints on taxiways, usually in close proximity to the warmup area, or those used just prior to taxiing on the runway in use. These checkpoints consist of a position on the taxiway, marked by a yellow triangle painted on the surface, and a painted sign adjacent to the taxiway that indicates the distance and bearing to the TACAN/VOR from a position directly over the triangle. (See chapter 11.)

CAPABILITIES AND LIMITATIONS

The VOR and TACAN characteristics are similar with the exception of VOR providing bearing information only and operating in the VHF frequency band. Since TACAN is widely used throughout the Navy as a primary navaid, no reference is made to VOR in this section.

The TACAN system employs 126 two-way operating channels of 1 megacycle spacing within the frequency range of 960 to 1215 megacycles. Bearing information is available to an unlimited number of aircraft within range (line or sight) of the facility. Distance information is also limited to line of sight and normally extends from 0 to 195 miles. Newer equipment may provide distance information to 300 miles. A ground facility will reply to as many as 120 interrogations for distance information simultaneously. Thus it can be said that each of the 126 TACAN channels available will provide full service (bearing and distance) to as many as 120 aircraft simultaneously.

TACAN bearing accuracy is plus or minus 3/4 of 1 degree. The distance accuracy is about plus or minus 600 feet plus 2 percent of the distance measured.

Atmospheric conditions above 50,000 feet are such that the high voltages within the equipment are sufficient to cause arcing. Therefore, TACAN operation is limited to altitudes up to 50,000 feet.

On later models of airborne TACAN equipment, air-to-air ranging has been added which provides distance information between airborne TACAN radio sets. To accomplish this function, pilots of the aircraft concerned must agree upon selection of two different TACAN channels which are separated by exactly 63 megacycles. Channels 15 and 78, for instance, constitute one channel pair which is necessary for the system to work. If such a capability exists, an airborne TACAN radio set can transmit distance reply signals to interrogations from as many as five other sets simultaneously. At the same time, the set will receive replies to its own interrogations from all five other sets. However, only the distance to one other set can be displayed on the aircraft's distance indicator. No bearing information is available between aircraft when the air-to-air ranging feature of the equipment is selected. Also, ground-to-air information is not available when the air-to-air feature is selected.

Figure 8-9, is an example of the visual display provided the pilot of an aircraft receiving full service from a TACAN facility. Figure 8-10 is an example of the visual display provided the pilot when the air-to-air feature is selected.

AIRCRAFT INSTRUMENTATION

The purpose of this section is to provide the Air Controlman with an idea of the practical use of TACAN and the basic aircraft instruments involved. There are several types of instruments, or modifications thereof, available, and new ones are being produced continuously to provide Navy pilots with the best possible navigation assistance. The instruments depicted here are not to be considered as standard in Navy aircraft. VOR is not referred to due to similarity of operation with the exception that VOR provides bearing information only and operates within the VHF frequency band instead of the UHF band as does TACAN.

Figure 8-11 shows a TACAN control box and the various switches. The control system labeled CHAN allows a pilot to select one of the 126 operating TACAN channels available. The switch at the upper right hand side of the control box allows a pilot to turn the TACAN set off, receive only (REC) which provides bearing information only, transmit/receive (T/R) which provides both bearing and distance information, or air-to-air ranging (A/A) which provides distance information between airborne TACAN radio sets. Th volume control selects the desired volume level of the identification of the TACAN channel selected. This identification is the 3-letter Morse code identification of the TACAN and is heard in the pilot's radio headset.

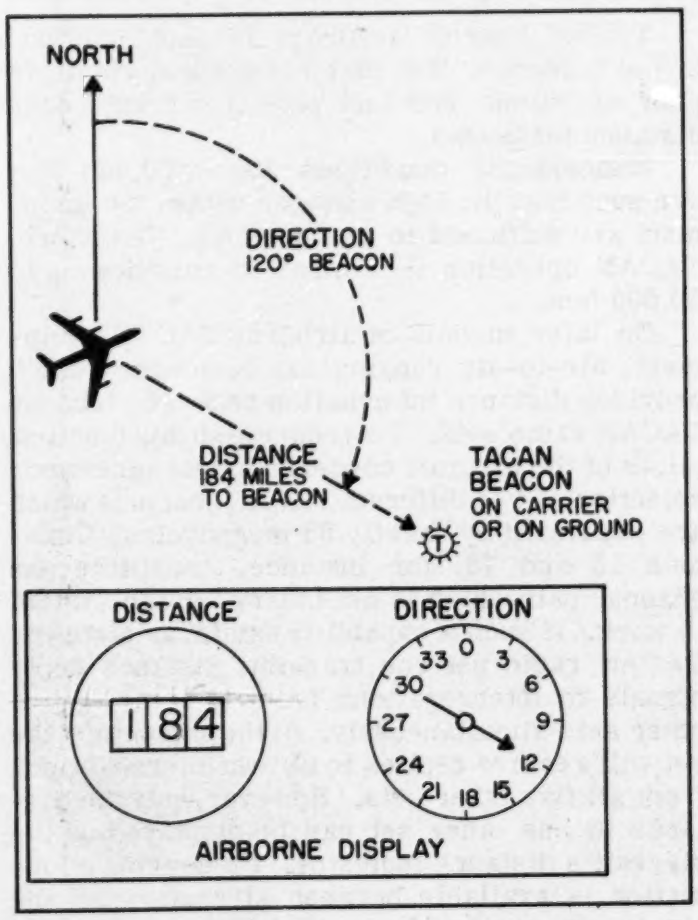

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Figure 8-9.—TACAN system.

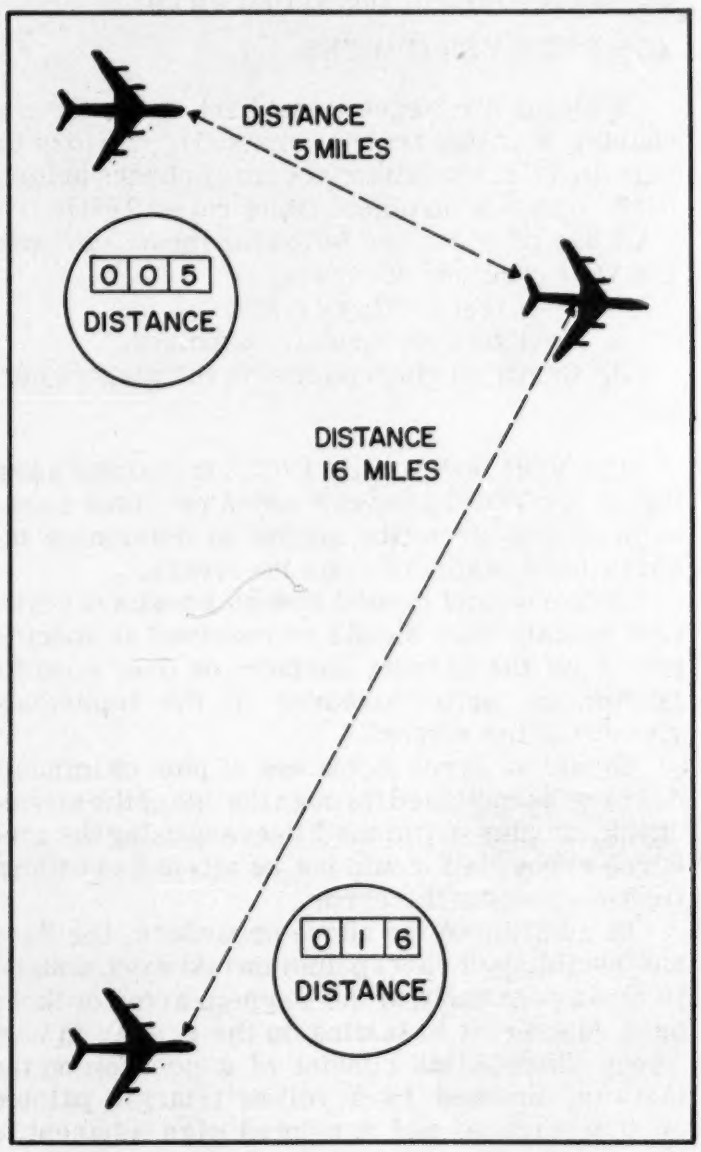

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Figure 8-10.—Air-to-air ranging.

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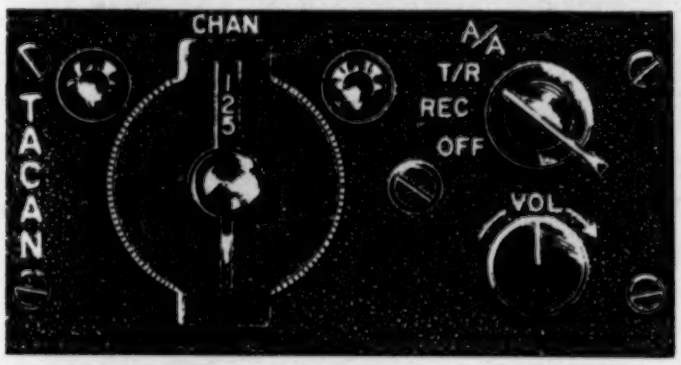

AC.114

Figure 8-11.—TACAN control box.

Figure 8-12, shows three basic instruments used for TACAN air navigation. They are as follows:

1. The range indicator, which displays distance in nautical miles to the TACAN station selected by the channel selector.

2. The course indicator, which displays the following:

a. The relative position of the course selected (the window labeled course) to the aircraft (vertical bar).

b. Whether the selected course will take the aircraft TO or FROM (TO-FROM indicator on the left side of the instrument) the station.

c. The relationship of the aircraft's heading (vertical needle) to the course selected.

3. The radio magnetic indicator (RMI), which displays the following:

a. The magnetic heading of the aircraft (rotating compass card).

b. The relative bearing of the TACAN station from the aircraft (large needle with the number 2 on it).

NOTE: There is another small needle used on the RMI for Automatic Direction Finding (ADF), which is discussed later in this chapter, but is not shown in figure 8-12.

Figure 8-13 is an example of maintaining flight along a specified TACAN radial by correcting for wind drift.

Figure 8-12 is the actual instrument display of the aircraft's position No. 1 in figure 8-13 as follows:

1. The range indicator shows that the aircraft is 60 miles from the TACAN station.

2. The course indicator shows that the aircraft is on the selected course (060) which will take it TO the station.

3. The radio magnetic indicator (RMI) shows that the aircraft's magnetic heading is 060 and the TACAN is directly ahead of the aircraft.

At position No. 2 of figure 8-13, wind has blown the aircraft off the radial. The instruments indicate this as follows:

1. The range indicator shows that the aircraft is now 50 miles from the TACAN station.

2. The course indicator shows:

a. The selected course (060) which will take the aircraft TO the station is left of the aircraft's position (vertical bar).

b. The aircraft's heading is parallel to the selected course (vertical needle).

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Figure 8-12.—Range indicator, course indicator, and radio magnetic indicator.

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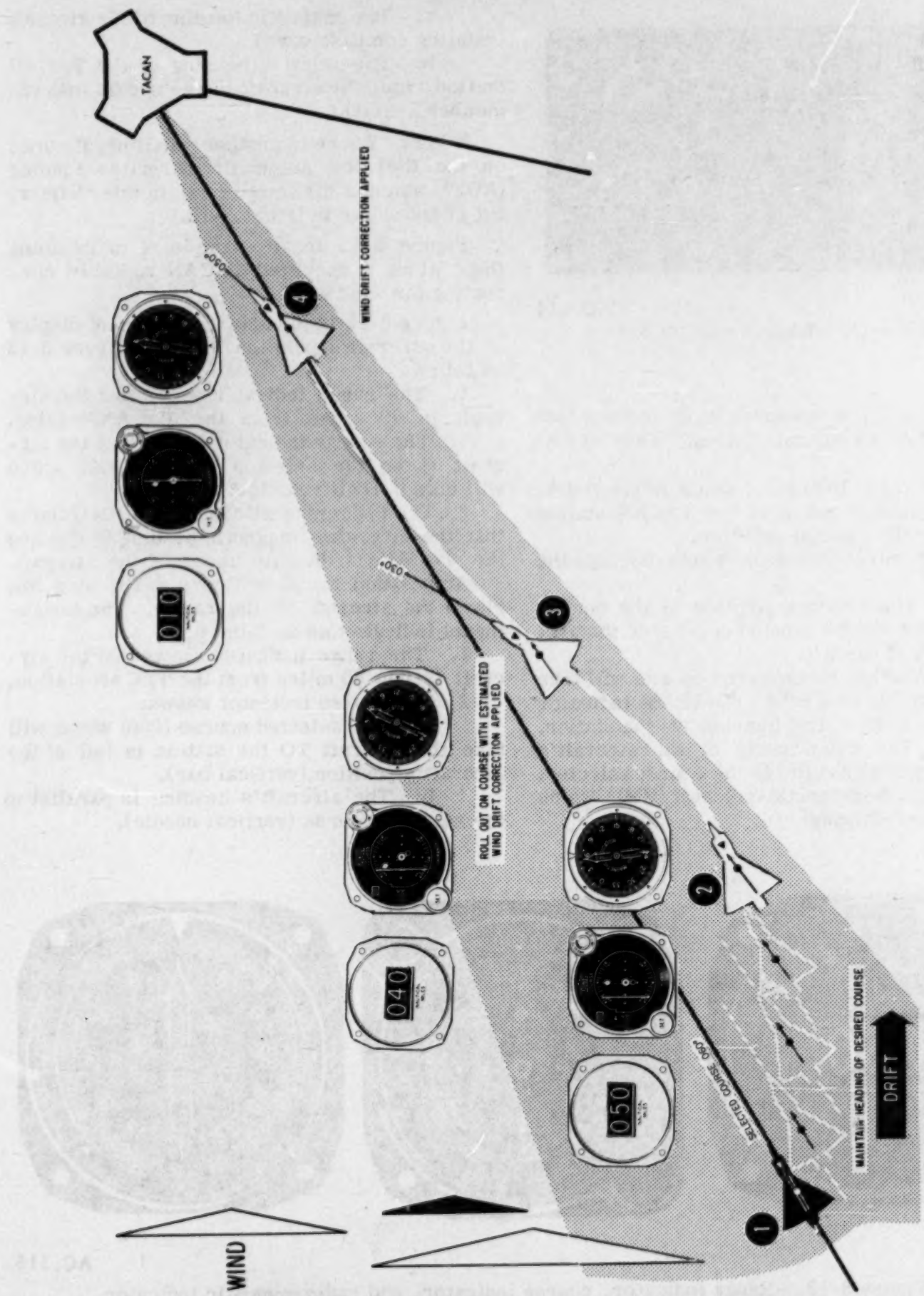

AC. 116

Figure 8-13.—Flying a TACAN radial.

3. The RMI shows that the aircraft's heading is still 060 magnetic, but the TACAN station now bears left of the aircraft's nose.

The pilot must apply corrections to return the aircraft to the desired radial. Position No. 3 shows the instrument display after the corrections have been made as follows:

1. The range indicator shows the aircraft is now 40 miles from the TACAN station.

2. The course indicator shows that the selected radial (060) is stall left of the aircraft's position (vertical bar), and the heading of the aircraft will intercept or is toward the selected course (vertical needle).

3. The RMI shows that the pilot has changed the magnetic heading to 030 and the TACAN station now bears to the right of the aircraft's nose.

Position No. 4 shows the aircraft back on course with a corrected heading to maintain such course as follows:

1. The range indicator shows the aircraft is now 10 miles from the TACAN station.

2. The course indicator shows the following:

a. The aircraft is back on the selected radial (vertical bar) which will take it TO the station.

b. The aircraft's heading is left of the course selected to compensate for the wind (vertical needle).

3. The RMI shows the aircraft's magnetic heading is 050 and the TACAN station bears right of the aircraft's nose.

When the aircraft passes over the station, distance on the range indicator will commence to increase, the vertical bar on the course indicator will fluctuate from side to side momentarily, the TO-FROM indication on the course indicator will change to FROM, and the needle on the RMI will rotate aimlessly, then stabilize 180 degrees from the bearing approaching the station, or point aft of the aircraft to the TACAN station. The reason for the course indicator and RMI TACAN needle fluctuation is a large cone of ambiguity directly over all TACAN stations in which no bearing information is received. Therefore, the instruments which use bearing information will not settle down until an aircraft has passed through the cone. However, distance information is constant; and since it is slant range, there will be a reading of distance directly over the TACAN station which indicates the vertical distance or altitude of the aircraft. (See fig. 8-14.)

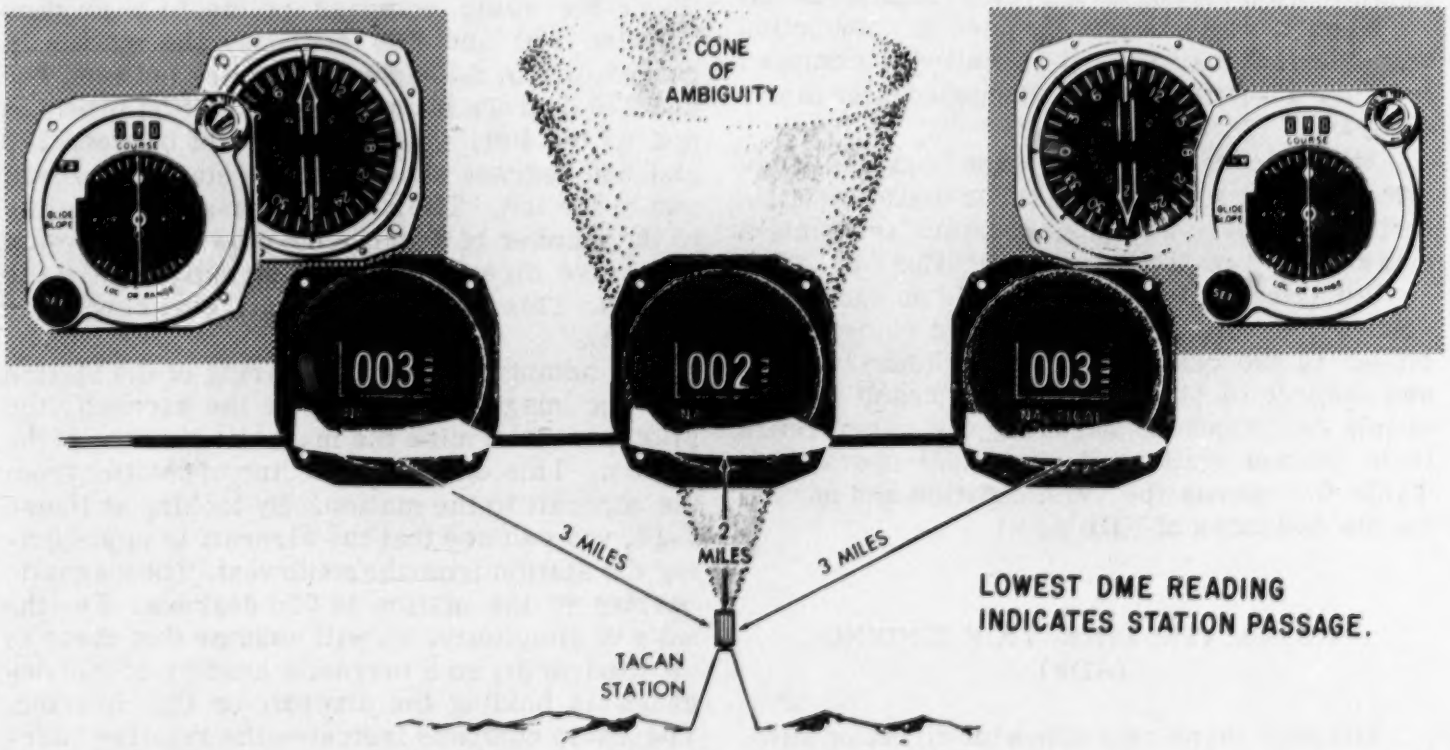

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Figure 8-14.—TACAN station passage.

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TACAN may also be used to maintain a constant distance, called ARC, from a TACAN station. To accomplish this a pilot would, after arriving at the desired distance (ARC), select a magnetic heading on the RMI to cause the RMI TACAN needle to point off the aircraft's wing or 90 degrees relative to the TACAN station. Then the magnetic heading would be altered slightly to maintain a constant distance or fly the ARC, and constant relative bearing to the TACAN station.

RADIO BEACONS

Several types of radio beacons are used as aids to aircraft navigation. The discussion in this chapter includes nondirectional beacons, ADF procedures, and marker beacons.

NONDIRECTIONAL RADIO BEACONS (NDB)

A low or medium-frequency radio beacon transmits nondirectional signals whereby the pilot of an aircraft equipped with a loop antenna can determine his bearing and "home" on the station. These navaids normally operate in the frequency range of 200 to 415 kHz and transmit a continuous carrier with a continuous keyed identification except during voice transmissions.

When a radio beacon is used in conjunction with the ILS markers, it is called a compass locator. ILS systems are discussed later in this chapter.

All radio beacons except the compass locators transmit a continuous three-letter identification in code. Compass locators transmit a continuous two-letter identification in code.

Voice transmissions are made on radio beacons unless the letter W (without voice) is included in the class designator. Radio beacons are subject to disturbances that result in ADF needle deviations, signal fades, and interference from distant stations during night operations. Table 8-3 shows the classification and normal usable distances of NDB's.

Class	Power (watts)	Distance (miles)
Compass Locator	Under 25	15
MH	Under 50	25
H	50 -- 1999	50
HH	2000 or more	75

AUTOMATIC DIRECTION FINDING (ADF)

Although many new types of direction finding and homing equipment are coming into widespread use, the radio compass still remains a basic and important piece of equipment for homing, tracking, course interception, time/distance checks, and similar purposes. Therefore, a brief description of the basic method utilized in an ADF orientation is included so that the Air Controlman may visualize the "pilot's position" during an ADF orientation.

When the pilot is flying ADF, the problem of orientation is solved automatically. The 0-180 degree axis of the radio compass indicator is alined with the longitudinal axis of the aircraft. Thus you can think of 0 degrees on the radio compass dial as representing the nose of the aircraft, while 180 degrees on the radio compass dial represents the tail of the aircraft. The radio compass needle always points toward the station. This means that when the radio compass indication is between 0 and 090 degrees, the station is ahead and to the right of the aircraft. When the radio compass points to a reading between 180 and 190 degrees, the station is behind and to the right. A reading between 180 and 270 degrees shows that the station is behind and to the left, while a reading of between 270 and 360 degrees shows that the station is ahead and to the left. The radio compass needle points to the number of degrees the pilot must turn in a clockwise direction to head directly toward the station. This is called the relative bearing of the station.

By adding the relative bearing of the station and the magnetic heading of the aircraft, the pilot can determine the magnetic bearing of the station. This establishes a line of position from the aircraft to the station. By looking at figure 8-15, you can see that the aircraft is approaching the station from the southwest. The magnetic bearing of the station is 060 degrees. For the sake of simplicity, we will assume that there is no wind drift, so a magnetic heading of 060 degrees is holding the aircraft on this bearing. The radio compass indicates the relative bearing of the station—the angle measured clockwise from the nose of the aircraft to the station. In this case, the relative bearing is 0 degrees.

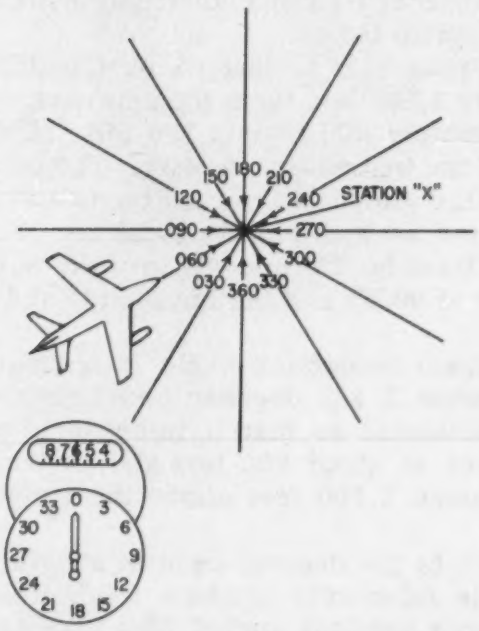

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Figure 8-15.—Inbound bearings to station X.

MARKER BEACONS

Marker beacons serve to identify a particular location in space along an airway or on the approach to an instrument runway. This is done by means of a 75-MHz transmitter which transmits a directional signal to be received by aircraft flying overhead. Three classes of markers are now in general use—FM, LFM, and the Instrument Landing System (ILS) marker beacons.

The class FM fanmarkers are used to provide a positive identification of positions at definite points along the airways. The transmitters have a power output of approximately 100 watts. Two types of antenna array are used with class FM fanmarkers. The first type used, and generally referred to as the standard type, produces an elliptical-shaped pattern, which at an elevation of 1,000 feet above the station is about 4 miles wide and 12 miles long. At 10,000 feet the pattern widens to about 12 miles wide and 35 miles long. (The long axis lies across the airway.)

The second array produces a dumbell or bone-shaped pattern, which, at the "handle" is about 3 miles wide at 1,000 feet. The bone-shaped marker is preferred at approach control locations because the narrow pattern provides a more accurate position.

The class LFM or low-powered fanmarkers have a rated power outupt of 5 watts and are usually located within 5 miles of the station with which they are associated. The antenna array produces a circular pattern which appears elongated at right angles to the airway due to the directional characteristics of the aircraft receiving antenna.

ILS marker beacon information is included under the heading "Instrument Landing System" in this chapter.

At certain installations where the fanmarker is located off the airways and the radio beacon is installed at the fanmarker site, is the FMHW. The FMHW is a combination of two facilities, for the specific purpose of allowing aircraft to proceed directly to the marker by means of the radio compass. The FMHW consists of the following:

1. FM—A fanmarker, bone or elliptical, 100 watts.
2. MH—A low-powered radio beacon, less than 50 watts.
3. W—Designates without a voice facility.

INSTRUMENT LANDING SYSTEM

One of the most important problems in the achievement of all-weather flight reliability has been the development of a system for landing aircraft by instruments. This development has gradually evolved into the present Instrument Landing System, commonly known as ILS.

ILS was originally known as the 3-element system and has three main components:

1. A localizer radio beam to furnish directional guidance to the airport runway.
2. A glidepath radio beam to furnish vertical guidance down the correct descent angle to the runway.
3. Fanmarkers to provide accurate radio fixes along the approach course.

While these three elements are being improved, there are several supplementary elements being incorporated to further increase the utility and safety of the system. Compass locator stations have been added to assist in holding procedures and in tracking the localizer course. High-intensity approach lights have been installed to furnish visual guidance to the runway under extremely low visibility conditions. PAR is another added feature with which to monitor the actual flightpath of aircraft using ILS.

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To utilize the localizer associated with ILS, an aircraft must be equipped with VHF receiver capable of receiving frequencies in the 108- to 112-MHz band. The aircraft must also be equipped with a course indicator to display the information received.

The structure housing the localizer unit of the ILS is located on the extended centerline of the instrument runway of an airport. It is located far enough from the end of the runway to prevent it from being classed as a hazard.

This unit radiates a field pattern directly down the centerline of the runway toward the fanmarkers. It also directs another field pattern in the opposite direction. These patterns are called the front and back courses, respectively. (See fig. 8-16.)

Utilizing the front course for an ILS approach is desirable since glidepath information is displayed only on this course. The back course may also be used, but since no glidepath information is available, the approach minimums will be considerably higher.

The localizer transmitter is designed to provide an oncourse signal at a minimum distance of approximately 25 miles from the runway at a minimum altitude of 2,000 feet. The power of this transmitter is approximately 100 watts. To produce the oncourse signal, the radiated field pattern is modulated at two different frequencies. The right side, looking from the outer marker toward the transmitter, is modulated at 150 Hz. This is identified as the blue sector on maps or charts. The left side is modulated at 90 Hz and is identified as the yellow sector. The oncourse is the point of equisignal strength between the radiated pattern.

Each localizer is identified by a 3-letter code group preceded by an "I" designator; for instance, I-MIA or I-DAL. Most ILS installations include a voice facility on the localizer frequency. This voice faclity is used for the transmission of approach control instructions from the airport control tower.

The glidepath unit is housed in a building approximately 1,000 feet from the approach end and approximately 400 feet to the side of the centerline of the instrument runway. The beam projected by the glidepath transmitter is essentially the same as would be the localizer beam operating on its side. The upper side of the beam is modulated at 90 Hz and the lower side at 150 Hz.

The glidepath projection angle is normally adjusted between 2 1/2 degrees and 3 degrees above the horizontal so that it interesects the middle marker at about 200 feet and the outer marker at about 1,100 feet above the runway elevation.

In addition to the desired course, all glidepath facilities inherently produce 5 additional courses at high vertical angles (the lowest of these courses at approximately 16 degrees above the horizontal). However, provided pilots are properly indoctrinated in glidepath instrumentation and follow procedures correctly, these high angles will not be encountered and will cause no difficulty in glidepath navigation. (See fig. 8-17.)

The glidepath transmitter operates in a frequency band of 328.6 to 335.4 MHz, with a reception range of approximately 25 miles and a power output of 100 watts.

Every localizer frequency has a corresponding glidepath frequency. The frequency selector control is designed to switch the glidepath receiver to the corresponding frequency automatically when the pilot selects the proper localizer frequency, provided the aircraft is

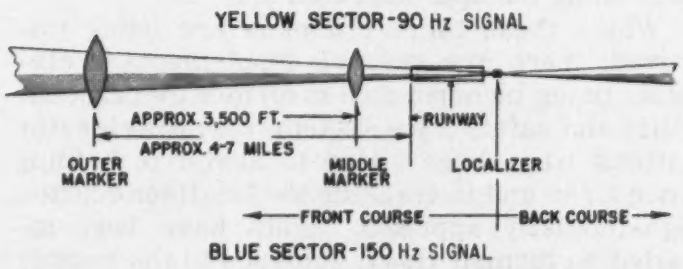

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Figure 8-16.—ILS localizer installation.

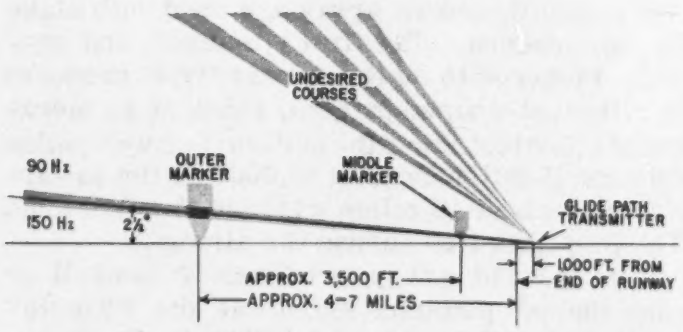

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Figure 8-17.—ILS glidepath and marker installation.

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equipped with a glidepath receiver. This process is known as PAIRED FREQUENCIES.

The markers used with the ILS are low-powered fanmarkers of approximately 2 watts output, operating on the fanmarker frequency of 75 mc and radiating the same vertical elliptical-shaped pattern.

The outer marker is located approximately 4 to 7 miles from the instrument runway and is alined on the front course of the ILS.

The middle marker is located approximately 3,500 feet from the approach end of the runway, between the runway and the outer marker.

Certain civil and military aircraft are equipped with ILS marker receivers which are used in connection with ILS facilities. They are usually equipped with purple and amber lights mounted on the instrument panel of the aircraft. Although all ILS markers are on the same frequency, the different lights are designed to operate independently, depending on the modulation frequency (tone) of the signal being received. A 400 hertz band-pass filter is included in the purple light hookup and a 1,300-hertz filter, for the amber light. These filters are intended to pass only the particular modulation frequency for which they are designed. Thus, when the aircraft is over an outer marker (400-hertz tone), the purple light will flash two dashes per second. When the aircraft is over a middle marker (1,300-hertz tone), the amber light will flash alternate dots and dashes.

The modulated tone signal is heard in the headset, and at the same time the visual signal is displayed by the marker beacon light.

The compass locator is a low-powered (25-watt) nondirectional radio beacon, operating in the 200- to 415-kHz frequency band. It is employed as an aid in the following:

1. Transition from en route to ILS, flying a homing path direct to the outer marker from the designated radio fix or facility.
2. Flying a holding pattern by keeping the pilot advised at all times of his position relative to the outer marker.
3. "Tying down" and tracking the localizer course.
4. Determining when the markers are passed. This is particularly useful in case of failure of the fanmarker equipment.

A 2-letter identifier is used for the identification of the compass locator (LOM and LMM). The two letters are derived from the 3-letter location identifier.

The first and second letters of the 3-letter location identifier are assigned to the front course outer marker compass locator (LOM), and the second and third letters are assigned to the front course middle marker compass locator (LMM).

Example: Oklahoma City, Okla.-OKC LOM-OK LMM-KC.

When used in conjunction with ILS, compass locators are installed at the outer and/or middle marker location. They are designed for use with automatic direction finding (ADF) equipment in the aircraft.

NAVAID MONITORS

A malfunction of navaid equipment could place a pilot in a critical position; therefore, it is necessary that some automatic means be provided for continuously checking a navaid system.

Normally, the control tower is responsible for monitoring navaids at an air station. This is accomplished by electronic navaid monitoring devices located in the tower. Most monitor equipment is similar, in that it provides both a light and an aural alarm to indicate that a particular navaid is malfunctioning. Some monitor equipment provides for an automatic changeover to standby navaid equipment when the main system has failed. Other equipment requires that the standby equipment be "dialed" on, which is a method similar to dialing a telephone with certain codes being dialed for certain functions.

When an alarm system of a navaid monitoring device goes off, the Air Controlman on duty in the tower should attempt to get the standby equipment in operation, if not automatic. Then he should notify the technician responsible for maintenance of the navaid equipment to provide for rapid repairs.

If the navaid has to be shut down or is unreliable, control tower personnel should immediately notify the appropriate persons or facilities, which is determined locally. These generally include the duty section leader, the appropriate duty officer, the technician who will repair the equipment, the associated approach control if not located in the tower, and the ARTCC in whose area of responsibility the station is located.

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AERONAUTICAL LIGHT BEACONS

The aeronautical beacon is a visual navaid displaying flashes of white and/or colored light, which is used to indicate the location of airports, landmarks, and hazards to air navigation. The principal light used is a rotating beacon of relatively high intensity.

The color or color combination displayed by a particular beacon tells whether the beacon is indicating a landing place, landmark, or hazard.

COLOR AND MEANING OF LIGHT BEACONS

The colors and color combinations of aeronautical light beacons and their meaning are as follows:

1. A rotating beacon displaying alternating white and green flashes indicates that the beacon is at or within 2 miles of a lighted airport or landing field.

2. Military lighted airport rotating beacons display alternating white and green flashes, but the white flash has dual peaked (two quick) flashes to differentiate from civil beacons.

3. Green flashes alone, usually coded, from a code beacon (not a rotating beacon) used by itself, means that the code beacon is located at or beside a lighted airport. When a rotating white and green beacon is located more than 5,000 feet from an airport or landing field, the green-flashing code beacon is used to show more exactly the location of the landing area.

4. A rotating beacon displaying alternating white and yellow flashes indicates the presence of a lighted water airport (sea drome) at or within 2 miles of the beacon site.

5. Yellow flashes alone, usually coded, from a code beacon (not a rotating beacon) used by itself means that the code beacon is located at or beside a lighted water airport. When a rotating beacon showing alternate white and yellow flashes is located more than 5,000 feet from a water airport, the yellow flashing code beacon is used to show more exactly the location of the landing area.

6. A rotating beacon displaying alternating white and red flashes indicates the location of a natural or manmade landmark.

7. A rotating beacon displaying red flashes alone indicates the presence of an obstruction or obstructions to air navigation, or an area on the ground used for purposes hazardous to air navigation.

8. Steady burning red lights are used near airports to mark obstructions, and are also used to supplement flashing lights in marking enroute obstructions.

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The peaking amplifier V3, that is normally conducting, is cut off by the oscillator's negative output. A high positive voltage at the plate of V3 is produced by the collapsing magnetic field around L6. Oscillations across L6 are prevented by damping resistor R7, thereby preventing possible double range markers on the scope. Positive oscillation of the grid signal causes limiting to occur in the grid of V3 due to R4 in the grid circuit. Therefore, the negative-going portion is the only part of the input wave that has an appreciable effect on the plate current of V3. The positive pulse output is coupled to the grid of V4 through C4 and C5. C4 functions as an ordinary coupling capacitor; C5 in conjunction with R8 acts as a fast coupling network. The leading edge of the output pulse from V3 contains high frequency components. These are coupled through C5 which bypasses R8; therefore, the complete leading edge of the output of V3 is developed across R9. This sharp rise in voltage on the grid of V4 causes it to draw current charging the lower plate of C5 negatively, since C5 and R8 have RC time of approximately 1 second. The charge due to grid current rapidly discharges through R8 and returns the coupling circuit to a static condition.

If only C4 were used to couple the sharp rise to the grid of V4 when the grid drew current, the grid side of C4 would go negative. Since the discharge path for C4 is long, it would soon assume an average charge and the coupled signal would be reduced to minimum. The blocking oscillator V5 is normally cut off by a fixed negative voltage on the grid. This circuit is triggered by the output of V4 which is coupled to the grid. Positive range marks are taken from the cathode of V5.

MOVABLE RANGE MARKER

Many present day radarscopes utilize the movable marker or range strobe. This system provides a continuously variable marker that may be used to aid the operator in quickly determining the accurate range of a target. Movable marker action may be incorporated in a radar system by using multivibrators or the phantastron time delay circuits previously discussed in this chapter. Another system whereby such marker action amy be obtained is a timing circuit using a linear sawtooth and diode pickoff tube (fig. 14-19). This system is explained in detail in the following paragraphs.

The sweep generator tube V1, which is normally conducting, is cut off by the negative input square wave. When cut off, its plate voltage rises at a rate determined by the sweep capacitor C1. In order to obtain a linear sawtooth output it is necessary to use either the first ten percent of the charge or to add a bootstrap circuit to the sawtooth generator. This sawtooth waveform is applied to the plate of V2. V2 is normally cut off by the positive voltage on its cathode. The sawtooth rise applied to the plate of V2 eventually overcomes the cathode voltage and causes the diode to conduct. When this occurs the cathode voltage rises at the same rate as the plate voltage and is applied to the grid of V3. Tube V3, because of the transformer T1 in its plate circuit, then functions as a peaker amplifier. The output of V3 is applied to the grid of V4 and causes it to conduct momentarily. The current through the plate winding of T2, due to the conduction of V4, causes the single-swing blocking oscillator to cycle and produce the delayed pulse output.

The duration of the delay depends upon the voltage applied to the cathode of V2; this voltage is determined by the position of the potentiometer arm of R7. As the arm of the potentiometer is moved toward the more positive end, a higher voltage is then applied to the cathode of V2 and more time is required for V2 to start conducting, thus giving more delay before the pulse is produced. This delayed pulse is the movable marker that appears on the scope. Range is read from a mechanical counter or other indicating device which is mechanically coupled to the arm of the delay potentiometer R7. This counter is calibrated by adjusting the zero adjustment R10 and the slope adjustment R9. These potentiometers are positioned to provide the correct voltage across R7 so that the delay that is provided, dependent upon the location of its arm, is correctly indicated by the counter.

MOVABLE HEIGHT MARKER

The linear sawtooth delay circuit (fig. 14-19) may be used as the timing system for measuring target height with radar equipment. In order for it to apply to movable height markers, certain modifications must be made. The angle of elevation of the height finder antenna is referred to as ϕ. In the movable range

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CHAPTER 9

FEDERAL AIR REGULATIONS

Pilots of naval aircraft must comply with Federal Air Regulations. Although the AC is not directly concerned with the physical operation of an aircraft, he must, nonetheless, have a knowledge of the regulations which govern such operations. Based on this knowledge, the AC is able to issue instructions and information which allow pilots to operate aircraft in conformance with both the ATC instructions and the FAR's. Additionally, FAR's contain the general operating rules for holders of control tower operator certificates and ratings.

The study of this chapter is intended to provide the Air Controlman with a knowledge of air traffic rules and regulations. Only those parts, subparts, or certain paragraphs of FAR which the Air Controlman needs to know in his work are reprinted in this chapter. Additions, deletions, and explanations to FAR within the text have been made for clarification only.

This chapter is NOT intended to replace, substitute for, or supersede official regulations or directives which should be consulted for latest changes and final authority.

FAR, PART 1—DEFINITIONS AND ABBREVIATIONS

1.1 General definitions.

As used in this chapter—

"Administrator" means the Administrator of the Federal Aviation Administration or any person to whom he has delegated his authority in the matter concerned.

"Air Carrier" means a person who undertakes directly by lease, or other arrangement, to engage in air transportation.

"Air commerce" means interstate, overseas, or foreign air commerce or the transportation of mail by aircraft or any operation or navigation of aircraft within the limits of any Federal airway or any operation or navigation or aircraft which directly affects, or which may endanger safety in, interstate, overseas, or foreign air commerce.

"Aircraft" means a device that is used or intended to be used for flight in the air.

"Airplane" means an engine-driven fixed-wing aircraft heavier than air, that is supported in flight by the dynamic reaction of the air against its wings.

"Airport" means an area of land or water that is used or intended to be used for the landing and takeoff of aircraft, and includes its buildings and facilities, if any.

"Airport traffic area" means, unless otherwise specifically designated in Part 93 that airspace within a horizontal radius of 5 statute miles from the geographical center of any airport at which a control tower is operating, extending from the surface up to, but not including 2,000 feet above the surface.

"Airship" means an engine-driven lighter-than-air aircraft that can be steered.

"Air traffic" means aircraft operating in the air or on an airport surface, exclusive of loading ramps and parking areas.

"Air traffic clearance" means an authorization by air traffic control, for the purpose of preventing collision between known aircraft, for an aircraft to proceed under specified traffic conditions within controlled airspace.

"Air traffic control" means a service operated by appropriate authority to promote the safe, orderly, and expeditious flow of air traffic.

"Alternate airport" means an airport at which an aircraft may land if a landing at the intended airport becomes inadvisable.

"Approved," unless used with reference to another person, means approved by the Administrator.

"Armed Forces" means the Army, Navy, Air Force, Marine Corps, and Coast Guard, including their regular and reserve components

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and members serving without component status.

"Autorotation" means a rotorcraft flight condition in which the lifting rotor is driven entirely by action of the air when the rotorcraft is in motion.

"Balloon" means a ligher-than-air aircraft that is not engine driven.

"Calibrated airspeed" means indicated airspeed of an aircraft, corrected for position and instrument error. Calibrated airspeed is equal to true air speed in standard atmosphere at sea level.

"Ceiling" means the height above the earth's surface of the lowest layer of clouds or obscuring phenomena that is reported as "broken", "overcast," or "obscuration," and not classified as "thin" or "partial."

"Civil aircraft" means aircraft other than public aircraft.

"Controlled airspace" means airspace, designated as continental control area, control area, control zone, or transition area, within which some or all aircraft may be subject to air traffic control.

"Decision height" with respect to the operation of aircraft, means the height at which a decision must be made, during an ILS or PAR instrument approach, to either continue the approach or to execute a missed approach.

"Flight level" means a level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Each is stated in three digits that represent hundreds of feet. For example, flight level 250 represents a barometric altimeter indication of 25,000 feet; flight level 255, an indication of 25,500 feet.

"Flight plan" means specified information relating to the intended flight of an aircraft, that is filed orally or in writing with air traffic control.

"Flight visibility" means the average forward horizontal distance, from the cockpit of an aircraft in flight, at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.

"Foreign air carrier" means any person other than a citizen of the United States, who undertakes directly, by lease or other arrangement, to engage in air transportation.

"Glider" means a heavier-than-air aircraft, that is supported in flight by the dynamic reaction of the air against its lifting surfaces and whose free flight does not depend principally on an engine.

"Ground visibility" means prevailing horizontal visibility near the earth's surface as reported by the United States Weather Bureau or an accredited observer.

"Helicopter" means a rotorcraft that, for its horizontal motion, depends principally on its engine-driven rotors.

"Heliport" means an area of land, water, or structure used or intended to be used for the landing or takeoff of helicopters.

"IFR conditions" means weather conditions below the minimum for flight under visual flight rules.

"IFR over-the-top," with respect to the operation of aircraft, means the operation of an aircraft over-the-top on an IFR flight plan when cleared by air traffic control to maintain "VFR conditions" or "VFR conditions on top."

"Indicated airspeed" means the speed of an aircraft as shown on its pitot static airspeed indicator calibrated to reflect standard atmosphere adiabatic compressible flow at sea level uncorrected for airspeed system errors.

"Kite" means a framework, covered with paper, cloth, metal, or other material, intended to be flown at the end of a rope or cable, and having as its only support the force of the wind moving past its surfaces.

"Large aircraft" means aircraft of more than 12,500 pounds, maximum certificated takeoff weight.

"Lighter-than-air aircraft" means aircraft that can rise and remain suspended by using contained gas weighing less than the air that is displaced by the gas.

"Mach number" means the ratio of true airspeed to the speed of sound.

"Medical certificate" means acceptable evidence of physical fitness on a form prescribed by the Administrator.

"Minimum descent altitude" means the lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circle-to-land maneuvering in execution of a standard instrument approach procedure, where no electronic glide slope is provided.

"Navigable airspace" means airspace at and above the minimum flight altitudes prescribed by or under this chapter, including airspace needed for safe takeoff and landing.

"Night" means the time between the end of evening civil twilight and the beginning of

morning civil twilight, as published in the American Air Almanac, converted to local time.

"Non-precision approach procedure" means a standard instrument approach procedure in which no electronic glide slope provided.

"Operate," with respect to aircraft, means use, cause to use, or authorize to use aircraft for the purpose of air navigation, including the piloting of aircraft, with or without the right of legal control (as owner, lessee, etc.).

"Operational control," with respect to a flight, means the exercise of authority over initiating, conducting, or terminating a flight.

"Over-the-top" means above the layer of clouds or other obscuring phenomena forming the ceiling.

"Parachute" means a device used or intended to be used to retard the fall of a body or object through the air.

"Pilot in command" means the pilot responsible for the operation and safety of an aircraft during flight time.

"Positive control" means control of all air traffic, within designated airspace, by air traffic control.

"Precision approach procedure" means a standard instrument approach procedure in which an electronic glide slope is provided, as in ILS and PAR.

"Rating" means a statement that, as part of a certificate, sets forth special conditions, privileges, or limitations.

NOTE: Applies to FAA certificates only. Not to be confused with Navy enlisted rating.

"Prohibited area" means designated airspace within which the flight of aircraft is prohibited.

"Reporting point" means a geographical location in relation to which the position of an aircraft is reported.

"Restricted area" means airspace designated under Part 73 of this chapter within which the flight of aircraft, while not wholly prohibited, is subject to restriction.

"Rocket" means an aircraft propelled by ejected expanding gases generated in the engine from self-contained propellants and not dependent on the intake of outside substances. It includes any part which becomes separated during the operations.

"Rotorcraft" means a heavier-than-air aircraft that depends principally for its support in flight on the lift generated by one or more rotors.

"Route segment" means a part of a route. Each end of that part is identified by—

(1) a continental or insular geographical location; or

(2) a point at which a definite radio fix can be established.

"Small aircraft" means aircraft of 12,500 pounds or less, maximum certificated takeoff weight.

"True airspeed" means the airspeed of an aircraft relative to undisturbed air.

"Traffic pattern" means the traffic flow that is prescribed for aircraft landing at, taxiing on, or taking off from, an airport.

"United States," in a geographical sense, means (1) the States, the District of Columbia, Puerto Rico, and the possessions, including the territorial waters, and (2) the airspace of those areas.

"VFR over-the-top," with respect to the operation of aircraft, means the operation of an aircraft over-the-top under VFR when it is not being operated on an IFR flight plan.

1.2 Abbreviations and symbols.

In this chapter—

"ALS" means approach light system.

"ASR" means airport surveillance radar.

"ATC" means air traffic control.

"CAS" means calibrated airspeed.

"DH" means decision height.

"DME" means distance measuring equipment compatible with TACAN.

"FAA" means Federal Aviation Administration.

"FM" means fan marker.

"HIRL" means high-intensity runway lighting system.

"IAS" means indicated airspeed.

"ICAO" means International Civil Aviation Organization.

"IFR" means instrument flight rules.

"ILS" means instrument landing system.

"INT" means intersection.

"LMM" means compass locator at middle marker.

"LOM" means compass locator at outer marker.

"M" means Mach number.

"MAA" means maximum authorized IFR altitude.

"MALS" means medium intensity approach light system.

"MCA" means minimum crossing altitude.

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"MDA" means minimum descent altitude.

"MEA" means minimum en route IFR altitude.

"MM" means ILS middle marker.

"MOCA" means minimum obstruction clearance altitude.

"MRA" means minimum reception altitude.

"MSL" means mean sea level.

"NDB(ADF)" means nondirectional beacon (automatic direction finding).

"NOPT" means no procedure turn required.

"PAR" means precision approach radar.

"RBN" means radio beacon.

"RCLM" means runway centerline marking.

"RCLS" means runway center line light system.

"REIL" means runway end identification lights.

"RVR" means runway visual range as measured in the touchdown area.

"SALS" means short approach light system.

"TACAN" means ultra-high frequency tactical air navigational aid.

"TAS" means true airspeed.

"TDZL" means touchdown zone lights.

"VFR" means visual flight rules.

"VHF" means very high frequency.

"VOR" means very high frequency omnirange station.

"VORTAC" means collocated VOR and TACAN.

1.3 Rules of construction.

(a) In this chapter, unless the context requires otherwise—

(1) Words importing the singular include the plural;

(2) Words importing the plural include the singular; and

(3) Words importing the masculine gender include the feminine:

(b) In this chapter the word—

(1) "Shall" is used in an imperative sense;

(2) "May" is used in a permissive sense to state authority or permission to do the act prescribed, and the words "no person may. . ." or "a person may not . . ." mean that no person is required, authorized, or permitted to do the act prescribed; and

(3) "Includes" means "includes but is not limited to."

FAR, PART 65—CERTIFICATION: AIRMEN OTHER THAN FLIGHT CREWMEMBERS

65.1 Applicability.

This part prescribes the requirements for issuing air traffic control tower operators certificates and associated ratings and the general operating rules for the holders of such certificates and ratings.

65.11 Application and issue.

(a) An application for a certificate and rating, or for an additional rating, under this Part is made on a form and in a manner prescribed by the Administrator.

(b) An applicant who meets the requirements of this Part is entitled to an appropriate certificate and rating.

(c) Unless authorized by the Administrator a person whose air traffic control tower operator certificate is suspeded may not apply for any rating to be added to that certificate during the period of suspension.

(d) Unless the order of revocation provides otherwise, a person whose air traffic control tower operator certificate is revoked may not apply for the same kind of certificate for one year after the date of revocation.

65.13 Temporary certificate.

A certificate and rating effective for a period of not more than 90 days may be issued to a qualified applicant, pending review of his application and supplementary documents and the issue of the certificate and ratings for which he applied.

65.15 Duration of certificates.

(a) An air traffic control tower operator certificate or rating issued under this Part is effective until it is surrendered, suspended, or revoked.

(b) The holder of any certificate issued under this Part that is suspended or revoked shall, upon the Administrator's request, return it to the Administrator.

65.16 Change of name; replacement of lost or destroyed certificate.

(a) An application for a change of name on a certificate issued under this Part must be

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accompanied by the applicant's current certificate and the marriage license, court order, or other document verifying the change. The documents are returned to the applicant after inspection.

(b) An application for a replacement of a lost or destroyed certifice is made by letter to the FAA Airman Certification Branch, Federal Aviation Administration, Oklahoma City, Oklahoma. The letter must:

(1) Contain any available information regarding the grade, number and date of issue of the certificate, the name in which it was issued, and the ratings on it; and

(2) Be accompanied by a check or money order for $2.00, payable to the FAA.

(c) An application for replacement of a lost or destroyed medical certifice is made by letter to the Aeromedical Certification Branch, Civil Aeromedical Institute, FAA, P.O. Box 1082, Oklahoma City, Oklahoma 73101, accompanied by a check or money order for $2.00.

(d) A person whose certificate issued under this Part or medical certificate, or both, has been lost may obtain a telegram from the FAA confirming that it was issued. The telegram may be carried as a certificate pending his receiving a duplicate certificate under paragraph (b) or (c) of this section, unless he has been notified that the certificate has been suspended or revoked. The request for such a telegram may be made by prepaid telegram, stating the date upon which a duplicate certificate was requested, or including the request for a duplicate and a money order for the necessary amount. The request for a telegraphic certificate should be sent to the office prescribed in paragraph (b) or (c) of this section, as appropriate. However, a request for both at the same time should be sent to the office prescribed in paragraph (b) of this section.

65.17 Tests: general procedure.

(a) Tests prescribed by or under this Part are given at times and places, and by persons, designated by the Administrator.

(b) The minimum passing grade for each test is 70 percent.

65.18 Written tests: cheating or other unauthorized conduct.

(a) Except as authorized by the Administrator, no person may:

(1) Copy, or intentionally remove, a written test under this Part;

(2) Give to another, or receive from another, any part or copy of that test;

(3) Give help on that test to, or receive help on that test from, any person during the period that test is being given;

(4) Take any part of that test in behalf of another person;

(5) Use any material or aid during the period that tests are being given, or;

(6) Intentionally cause, assist, or participate in any act prohibited by this paragraph.

(b) No person who commits an act prohibited by paragraph (a) of this section is eligible for any certificate or rating under this chapter for a period of one year after the date of that act. In addition, the commission of that act is a basis for suspending or revoking any certificate or rating held by that person.

65.19 Retesting after failure.

An applicant who fails a written, oral, or practical test for a certificate and rating, or for an additional rating, under this Part may apply for retesting—

(a) After 30 days after the date he failed the test; or

(b) Upon presenting a statement from a certificated and appropriately rated ground instructor or air traffic control tower operator, certifying that he has given the applicant at least 5 hours of additional instruction in each of the subjects failed and now consideres that the applicant is ready for retesting for the air traffic control tower operator certificate.

65.20 Fraudulent or false statements or records.

(a) No person may make or cause to be made:

(1) Any fraudulent or intentionally false statement on any application for a certificate or rating under this Part;

(2) Any reproduction, for fraudulent purpose, of any certificate or rating under this Part; or

(3) Any alteration of any certificate or rating under this Part.

(b) The commission by any person of an act prohibited under paragraph (a) of this section is a basis for suspending or revoking any certificate or rating held by that person.

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65.21 Change of address.

Within 30 days after any change in his permanent mailing address, the holder of a certificate issued under this Part shall notify the FAA Airman Certification Branch, Oklahoma City, Oklahoma, in writing, of his new address.

65.30 Certificate and rating required.

No person may act as an air traffic control tower operator in connection with any civil aircraft in air commerce unless he holds an air traffic control tower operator certificate and an appropriate rating issued to him under this part. NOTE: OpNav Instruction 3722.6 (Series) promulgates the applicability of these regulations to Navy AC's.

65.31 Eligibility requirements: general.

To be eligible for an air traffic control tower operator certificate, a person must—

(a) Be at least 21 years of age;

(b) Be of good moral character;

(c) Be able to read, write, and understand the English language and speak it without accent or impediment of speech that would interfere with two-way radio conversations;

(d) Hold at least a second-class medical certificate issued under FAR, Part 67 within the 12 months before the date he applies; and

(e) Comply with 65.33.

A certificate that is held by a member of an Armed Force who is less than 21 years of age is valid only while he is serving as a member in a control tower operated by an Armed Force.

65.33 Knowledge requirements.

Each applicant for a certificate must pass a written test on the following:

(a) The flight rules in Part 91 of this chapter.

(b) Airport traffic control procedures, and this subpart.

(c) En route traffic control procedures.

(d) Communications operating procedures.

(e) Flight assistance service.

(f) Air navigation and aids to air navigation.

(g) Aviation weather.

65.35 Ratings.

The holder of an air traffic control tower operator certificate is entitled to a junior or senior rating, based on his qualifications to perform the duties of an operator at a particular airport.

65.37 Skill requirements: junior rating.

For a junior rating, an air traffic control tower operator must pass a practical test on—

(a) The control tower, including equipment, its use, and hazards to operations;

(b) The airport, including rules, facilities and their use, and hazards to operations;

(c) The control zone, including prominent objects, reporting points, traffic patterns, and hazards to operations;

(d) Notices to Airmen;

(e) Weather facilities and procedures, including weather stations, sequence reports, forecasts, and visibility check points; and

(f) Controlling air traffic under VFR conditions.

65.39 Skill requirements: senior rating.

(a) For a senior rating, an air traffic control tower operator must pass the test for a junior rating, meet the requirements of paragraphs (b) and (c) of this section, and pass a practical test on—

(1) The tower, the center, and the airways serving the airport;

(2) Air navigation facilities, including beacons, ranges, fan markers, compass locators, and instrument landing systems and ground controlled approach if these procedures or facilities have been established;

(3) Using the Airman's Information Manual;

(4) (Number reserved for future use);

(5) Holding procedures;

(6) The standard instrument approach procedures and tower approach control procedures, if approach control has been established;

(7) Missed approaches;

(8) Alternate airports;

(9) Search and rescue procedures; and

(10) Controlling air traffic under IFR conditions.

(b) An applicant for a senior rating must have satisfactorily served—

(1) As an operator with a senior rating for at least 6 months;

(2) As an operator with a junior rating, for at least the 6 months before the date he applies for rating, at the airport for which he seeks a rating;

(3) As an air traffic control trainee for at least 6 months in the service of the United States, or

(4) As an operator with a junior rating, at an airport other than the one for which he seeks a rating or as an operator at a landing area under the jurisdication of an Armed Force of the United States, for at least 1 of the 2 years before the date he applies for the rating.

(c) An applicant for a senior rating must show that he can satisfactorily supervise and manage all activities of the airport control tower, including preparing such reports as may be required by the airport manager or the Administrator.

65.41 Performance of duties.

(a) An air traffic control tower operator shall perform his duties in accordance with the limitations on his certificate and rating and the procedure and practices prescribed in air traffic control manuals of the FAA, to provide for the safe, orderly, and expeditious flow of air traffic.

(b) Whenever weather conditions are at least as good as the basic minimums prescribed for VFR flight by Part 91 of this chapter, an operator with either a senior or junior rating may control air traffic at the airport concerned. However, if the character or volume of the air traffic, the type and equipment of aircraft using the airport, or the airport facilities, require that an operator with a junior rating be supervised, an operator with a senior rating shall supervise the controlling of all air traffic at the airport.

(c) Whenever weather conditions are below the basic minimums prescribed for VFR flight by Part 91 of this chapter an operator with a senior rating shall supervise the controlling of all air traffic at the airport concerned. However, he may not issue an air traffic clearance for flight without advance authority from the appropriate air route traffice control center.

(d) In an emergency, an operator with a senior rating may delegate his authority to an operator with a junior rating.

65.43 Maximum hours.

Except in an emergency, a certificated air traffic control tower operator must be relieved of all duties for at least 24 consecutive hours at least once during each 7 consecutive days. Such an operator may not serve or be required to serve—

(a) For more than 10 consecutive hours; or

(b) For more than 10 hours during a period of 24 consecutive hours, unless he has a rest period of at least 8 hours at or before the end of the 10 hours of duty.

65.45 General operating rules.

(a) Each person who holds an air traffic control tower operator certificate shall keep it readily available when performing duties under it, and shall present that certificate or a medical certificate held by him, or both, for inspection upon request of the Administrator or an authorized representative of the National Transportation Safety Board, or of any Federal, State, or local law enforcement office.

(b) No person may act as an air traffic control tower operator under a certificate issued to him under this Part unless he has in his personal possession an appropriate current medical certificate issued under FAR, Part 67.

(c) An air traffic control tower operator may not perform duties under his certificate during any period of known physical deficiency that would make him unable to meet the physical requirements for his current medical certificate. However, if the deficiency is temporary, he may perform duties that are affected by it when ever another certificated and qualified operator is present and on duty.

(d) A certificated air traffic control tower operator may not control air traffic with facilities that the Administrator has found to be inadequate.

(e) The holder of an air traffic control tower operator certificate or an applicant for one, shall, upon the reasonable request of the Administrator, cooperate fully in any test that is made of him.

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65.47 Recent experience.

The holder of an air traffic control tower operator certificate may not perform any duties under that certificate unless—

(a) In the case of a junior operator, he has served for at least 3 of the preceding 12 months as an operator at the airport to which his rating applies;

(b) In the case of a senior operator, he has served for at least 3 of the preceding 6 months as an operator at the airport to which his rating applies; or

(c) He has shown to the satisfaction of the Administrator that he meets the standards for his certificate and rating.

FAR, PART 67—MEDICAL STANDARDS AND CERTIFICATION

67.1 Applicability.

This Part prescribes the medical standards for issuing medical certification for airmen.

67.11 Issue.

An applicant who meets the medical standards of this Part, based on medical examination and evaluation of his history and condition, is entitled to an appropriate medical certificate.

Medical certificates are designated as First, Second, and Third Class, with established medical standards for each class.

Air Controlmen are required to possess a Second Class medical certificate.

Medical examinations are given by an examiner designated by the FAA. The FAA has designated flight surgeons of the Armed Forces on specified military posts, stations, and facilities to give physical examinations to applicants for FAA medical certificates who are on active duty, or who are, under Department of Defense medical programs, eligible for FAA medical certification as civil airmen. In addition, such examiners may issue or deny, as appropriate, FAA medical certificates in accordance with the regulations of Part 67 and policies of the FAA

FAR, PART 71—DESIGNATION OF FEDERAL AIRWAYS, CONTROLLED AIRSPACE, AND REPORTING POINTS

71.3 Classification of Federal airways.

Federal airways are classified as follows:
(a) Colored Federal airways -

(1) Green Federal airways.
(2) Amber Federal Airways.
(3) Red Federal airways.
(4) Blue Federal airways.

(b) VOR Federal airways.

71.5 Extent of Federal airways.

(a) Each Federal airway is based on a centerline that extends from one navigation aid or intersection to another navigation aid (or through several navigation aids or intersections) specified for that airway.

(b) Unless otherwise specified—(1) Each Federal airway includes the airspace within parallel boundary lines 4 nautical miles each side of the center line. Where an airway changes direction, it includes the airspace that is enclosed by extending the boundary lines of the airway segments until they meet.

(c) Unless otherwise specified—

(1) Each Federal airway includes the airspace that extends upward from 1,200 feet above the surface of the earth to, but not including, 18,000 feet MSL, except that Federal airways for Hawaii have no upper limits. Variations of the lower limits of an airway are expressed in hundreds of feet above the surface (AGL) or mean sea level (MSL) and, unless otherwise specified, apply to the segment of an airway between adjoining navigational aids or intersections.

(2) The airspace of a Federal airway within the lateral limits of a transition area has a floor coincident with that of the transition area.

(d) One or more alternate airways may be designated between specified navigational aids or intersections along each VOR Federal airway. Unless otherwise specified, the centerline of an alternate VOR Federal airway and the centerline of the main VOR Federal airway are separated by 15°.

(e) A Federal airway does not include the airspace of a prohibited area.

71.7 Control areas.

Control areas consist of Federal airways, additional control areas, and control area extensions, but do not include the continental control area. Unless otherwise designated, control areas include the airspace between a segment of a main VOR Federal airway and its associated alternate segments with the vertical extent of the area corresponding to the vertical extent of the related segment of the airway.

71.9 Continental control area.

The continental control area consists of the airspace of the 48 contiguous states, the District of Columbia, and Alaska south of latitude 68 degrees north, excluding the Alaska peninsula west of longitude 160 degrees west, at and above 14,500 feet, but does not include—

(a) The airspace less than 1,500 feet above the surface of the earth; or

(b) Prohibited and restricted areas, other than restricted area military climb corridors and the restricted areas listed in 71.151. Part 71.151 is not printed in this training manual.

71.11 Control zones.

Control zones consist of controlled airspace which extends upwards from the surface of the earth and terminates at the base of the continental control area. Control zones that do not underlie the continental control area have no upper limit. A control zone is normally a circular area with a radius of 5 miles and any extensions necessary to include instrument approach and departure paths.

71.13 Transition areas.

Transition areas consist of controlled airspace extending upward from 700 feet or more above the surface of the earth when designated in conjunction with an airport for which an approved instrument approach procedure has been prescribed; or from 1,200 feet or more above the surface of the earth when designated in conjunction with airway route structures or segments. Unless otherwise spedified, transition areas terminate at the base of the overlying controlled airspace.

71.15 Positive control areas.

Positive control areas consist of controlled airspace within which there is positive control or aircraft.

71.17 Reporting points.

(a) Reporting points consists of geographic locations, in relation to which the position of an aircraft must be reported in accordance with 91.125.

(b) Unless otherwise designated, each reporting point applies to all directions of flight. In any case where a geographic location is designated as a reporting point for one or more airways, or for a particular direction of flight along an airway only, it is so indicated by including the airways or direction of flight in the designation of geographical location.

(c) Unless otherwise specified, place names appearing in the reporting point descriptions indicate VOR or VORTAC facilities identified by those names.

71.163 Designation of additional control areas.

Unless otherwise specified, each additional control area designated as other than previously described has a lateral extent identical to that of a Federal airway and extends upward from 700 feet (until designated from 1,200 feet or more) above the surface of the earth. An exception is that the airspace of a control area within the lateral limits of a transition area has a floor coincident with the floor of the transition area.

71.165 Designation of control area extensions.

Unless otherwise specified, each designated control area extension extends upward from 700 feet above the surface of the earth, except that the airspace of a control area extension within the lateral limits of a transition area has a floor coincident with that of the transition area.

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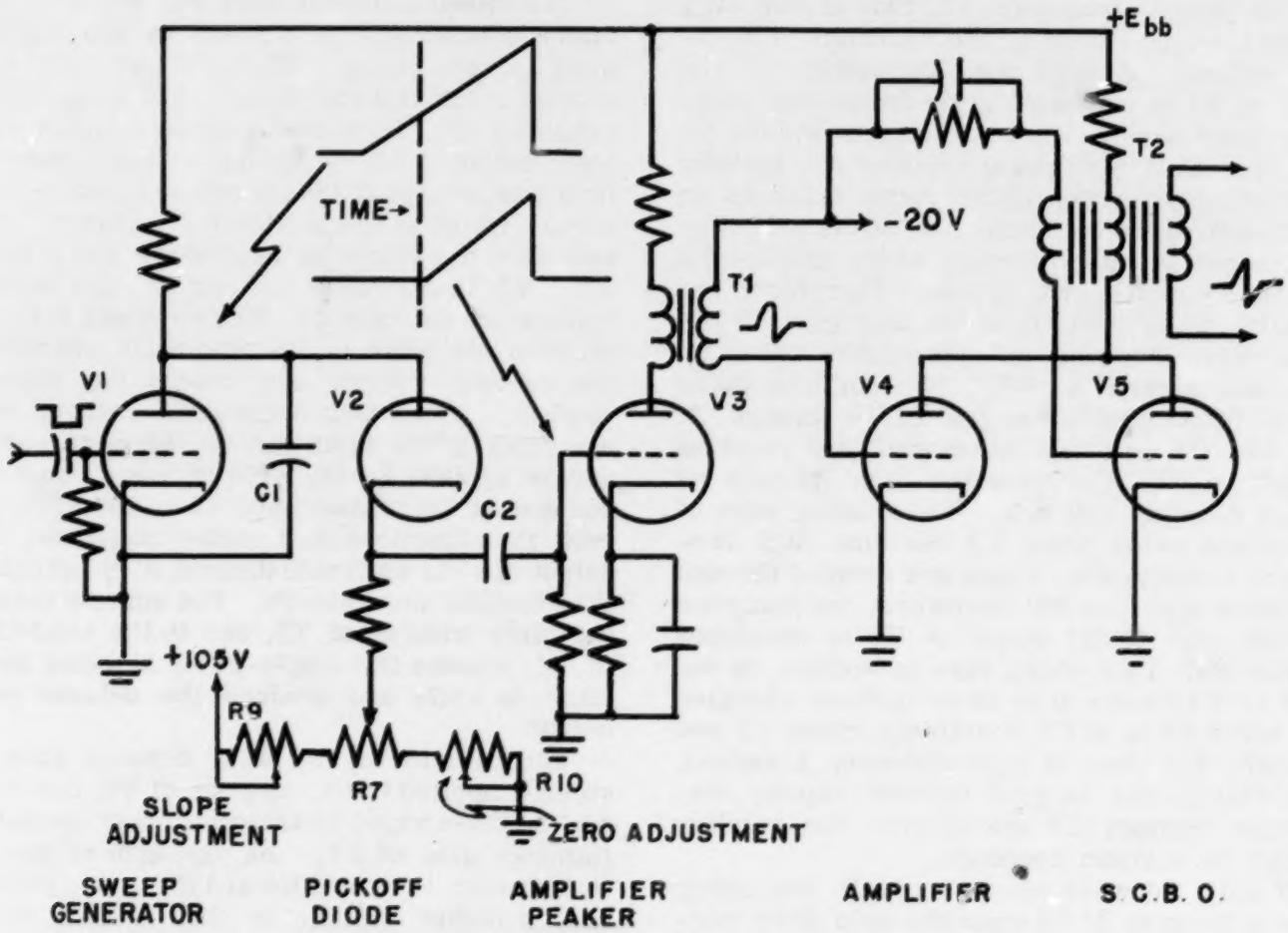

Figure 14-19. —Sawtooth type movable marker.

marker (fig. 14-19), a fixed supply potential was used for the sawtooth generator, but when this circuit is used for height finding the supply voltage varies with the angle of elevation of the antenna. Thus, the slope of the sawtooth is proportional to sin ϕ. In this application the counter or other indicator that is connected to the delay potentiometer indicates the target's height.

The curvature of the earth may be neglected when determining height at short or medium ranges. The relationship between delay time and target height, or the time when the height marker appears on the sweep, may be expressed as follows:

$$T = \frac{2H}{C \sin \phi}$$

T equals time
H equals height
C equals speed of radio waves
ϕ equals angle of elevation

Since the slope of the sawtooth has been made proportional to sin ϕ, the time delay is inversely proportional to sin ϕ or, in other words, directly proportional to

$$\frac{1}{\sin \phi}$$

for a given diode bias.

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75.11 Jet routes.

Each jet route consists of a direct course for navigating aircraft between 18,000 feet MSL and flight level 450, inclusive, between the navigational aids and intersections specified for that route.

75.15 Jet advisory areas.

(a) Jet advisory areas consist of airspace as designated, within the continental control area.

(b) En route radar jet advisory areas consist of areas within which jet advisory service is provided by using radar. Unless otherwise designated, each of them includes the area within 14 miles on each side of the jet route segment from flight level 240 through flight level 410, inclusive.

(c) Terminal radar jet advisory areas consist of areas in which jet advisory service is provided by using radar. Unless otherwise designated, each of them includes the area within 14 miles on each side of the VOR/VORTAC radials, bearings from L/MF navigational facilities, direct courses between navigational facilities, or centerlines of control areas from flight level 240 through flight level 410, inclusive.

(d) Nonradar jet advisory areas consist of areas within which jet advisory service is provided on a procedural basis without the use of radar. Unless otherwise designated, each of them includes the area within 14 miles on each side of the jet route segment from flight level 270 through flight level 310, inclusive, and from flight level 370 through flight level 410, inclusive.

(e) Jet advisory areas do not include the airspace within positive control areas, prohibited areas, or restricted areas except restricted area military climb corridors and other restricted areas so specified.

(f) Jet advisory areas that are based on jet routes are identified by the associated jet route number. Those based on VOR/VORTAC radials, bearings from L/MF navigational facilities, direct courses between navigational facilities, or centerlines of control areas and those in the vicinity of geographical locations, are identified by geographical names.

FAR, PART 91—GENERAL OPERATING AND FLIGHT RULES

Subpart A—General

91.1 Applicability.

(a) Except as provided in paragraph (b) of this section, this Part prescribes rules governing the operation of aircraft (other than moored balloons, kites, unmanned rockets, and unmanned free balloons) within the United States.

(b) Each person operating an aircraft of U.S. registry in air commerce over the high seas shall comply with Annex 2 (Rules of the Air) to the convention on International Civil Aviation.

91.3 Responsibility and authority of the pilot in command.

(a) The pilot in command of an aircraft is directly responsible for, and is the final authority as to, the operation of that aircraft.

(b) In an emergency requiring immediate action, the pilot in command may deviate from any rule of this subpart or of Subpart B to the extent required to meet that emergency.

(c) Each pilot in command who deviates from a rule under paragraph (b) of this section shall, upon the request of the Administrator, send a written report of that deviation to the Administrator.

91.5 Preflight action.

Each pilot in command shall, before beginning a flight, familiarize himself with all available information concerning that flight. This information must include, for a flight under IFR or a flight not in the vicinity of an airport, available weather reports and forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which he has been advised by ATC.

91.7 Flight crewmembers at stations.

During takeoff and landing, and while en route, each required flight crewmember shall—

(a) Be at his station unless his absence is necessary in the performance of his duties in connection with the operation of the aircraft

or in connection with his physiological needs; and

(b) Keep his seat belt fastened while at his station.

91.8 Prohibition against interference with crewmembers.

(a) No person may assault, threaten, intimidate, or interfere with a crewmember in the performance of his duties aboard an aircraft being operated in air commerce.

(b) No person may attempt to cause or cause the flight crew of an aircraft being operated in air commerce to divert its flight from its intended course or destination.

91.9 Careless or reckless operation.

No person may operate an aircraft in a careless or reckless manner so as to endanger the life or property of another.

91.10 Careless or reckless operation other than for the purpose of air navigation

No person may operate an aircraft, other than for the purpose of air navigation, on any part of the surface of an airport used by aircraft for air commerce (including areas used by those aircraft for receiving or discharging persons or cargo), in a careless or reckless manner so as to endanger the life or property of another.

91.11 Liquor and drugs.

(a) No person may act as a crewmember of a civil aircraft while—

(1) Under the influence of intoxicating liquor; or

(2) Using any drug that affects his faculties in any way contrary to safety.

(b) Except in an emergency, no pilot of a civil aircraft may allow a person who is obviously under the influence of intoxicating liquors or drugs (except a medical patient under proper care) to be carried in that aircraft.

91.13 Dropping objects.

No pilot in command of a civil aircraft may allow any object to be dropped from that aircraft in flight that creates a hazard to persons or property. However, this section does not prohibit the dropping of any object if reasonable precautions are taken to avoid injury or damage to persons or property.

91.15 Parachutes and parachuting.

(a) No pilot of a civil aircraft may allow a parachute that is available for emergency use to be carried in the aircraft unless it is an approved type and—

(1) If a chair type (canopy in back), it has been packed by an appropriately rated parachute rigger within the preceding 120 days; or

(2) If any other type, it has been packed by an appropriately rated parachute rigger within the preceding 60 days.

(b) Except in an emergency, no pilot in command may allow, and no person may make, a parachute jump from an aircraft, within the U.S., except in accordance with Part 105.

91.18 Towing.

(a) No pilot of a civil aircraft may tow anything with that aircraft (other than gliders) except in accordance with the terms of a certificate of waiver issued by the Administrator. Rules and regulations for glider towing operations, without the necessity of obtaining a waiver, are covered in FAR 91.17 but are not included in this training manual. For glider towing operations other than those authorized under 91.17, a certificate of waiver is not issued to tow a glider unless the pilot is qualified under FAR Part 61.

(b) An application for a certificate of waiver under this section is made on a form and in a manner prescribed by the Administrator and must be submitted to the nearest Flight Standards District Office.

91.19 Portable electronic devices.

Except as provided in the following paragraphs of this section, no person may operate, nor may any operator or pilot in command of an aircraft allow the operation of any portable electronic device on any of the following U.S. registered civil aircraft:

1. Aircraft operated by an air carrier or commercial operator; or

2. Any other aircraft while it is operating under IFR.

The preceding paragraph does not apply to:

a. Portable voice recorders.

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b. Hearing aids.
c. Heart pacemakers.
d. Electric shavers.
e. Any other portable electronic device that an aircarrier, commercial operator, pilot in command, or other operator of aircraft has determined will not cause interference with the navigation or communication system of the aircraft on which it is to be used.

91.21 Flight instruction and simulated instrument flight.

(a) No person may operate a civil aircraft that is being used for flight instruction unless that aircraft has fully functioning dual controls.

(b) No person may operate a civil aircraft in simultated instrument flight unless—

(1) An appropriately rated pilot occupies the other control set as a safety pilot;

(2) The safety pilot has adequate vision forward and to each side of the aircraft, or a competent observer adequately supplements the vision of the safety pilot; and

(3) Except in the case of a lighter-than-air aircraft, that aircraft is equipped with functioning dual controls.

91.23 Fuel requirements for flight in IFR conditions.

No person may operate a civil aircraft in IFR conditions unless it carrier enough fuel (considering weather reports and forecasts, and weather conditions) to—

(a) Complete the flight to the first airport of intended landing;

(b) Fly from the airport to the alternate airport; and

(c) Fly thereafter for 45 minutes at normal cruising speeds.

However, the requirements for fuel to fly from the first airport of intended landing to the alternate airport does not apply if an approved instrument approach procedure has been established for the first airport of intended landing and the weather conditions at that airport are forecast to be, from 2 hours before to 2 hours after the estimated time of arrival, a ceiling of at least 1,000 feet above the lowest MEA, MOCA, or altitude prescribed for the initial approach segment of the instrument approach procedure for the airport and visibility at least 3 miles, or 2 miles more than the lowest authorized landing minimum visibility, whichever is greater.

Subpart B—Flight Rules.

91.61 Applicability.

This subpart prescribes flight rules governing the operation of aircraft within the United States.

91.63 Waivers.

(a) The Administrator may issue a certificate of waiver authorizing the operation of aircraft in deviation of any rule of this subpart if he finds that the purposed operation can be safely conducted under the terms of that certificate of waiver.

(b) An application for a certificate of waiver under this section is made on a form and in a manner prescribed by the Administrator and may be submitted to any FAA office.

(c) A certificate of waiver is effective as specified in that certificate.

91.65 Operating near other aircraft.

(a) No person may operate an aircraft so close to another aircraft as to create a collision hazard.

(b) No person may operate an aircraft in formation flight except by arrangement with the pilot in command of each aircraft in the formation.

(c) No person may operate an aircraft, carrying passengers for hire, in formation flight.

(d) Unless otherwise authorized by ATC, no person operating an aircraft may operate his aircraft in accordance with any clearance or instruction that has been issued to the pilot of another aircraft for radar air traffic control purposes.

91.67 Right-of-way rules; except water operations.

(a) General. When weather conditions permit, regardless of whether an operation is conducted under IFR or VFR, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft in compliance with this section. When a rule of this section gives another aircraft the right of way, he shall give way to that aircraft and may not pass over, under, or ahead of it, unless well clear.

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(b) In distress. An aircraft in distress has the right of way over all other air traffic.

(c) Converging. When aircraft of the same category are converging at approximately the same altitude (except head-on, or nearly so) the aircraft to the other's right has the right of way. (See fig. 9-1.) If the aircraft are of different categories—

(1) A balloon has the right of way over any other category of aircraft;

(2) A glider has the right of way over an airship, airplane or rotorcraft; and

(3) An airship has the right of way over an airplane or rotorcraft.

However, an aircraft towing or refueling other aircraft has the right of way over all other engine-driven aircraft.

(d) Approaching head-on. When aircraft are approaching each other head-on, or nearly so, each pilot of each aircraft shall alter course to the right. (See fig. 9-2.)

(e) Overtaking. Each aircraft that is being overtaken has the right of way and each pilot of an overtaking aircraft shall alter course to the right to pass well clear. (See fig. 9-3.)

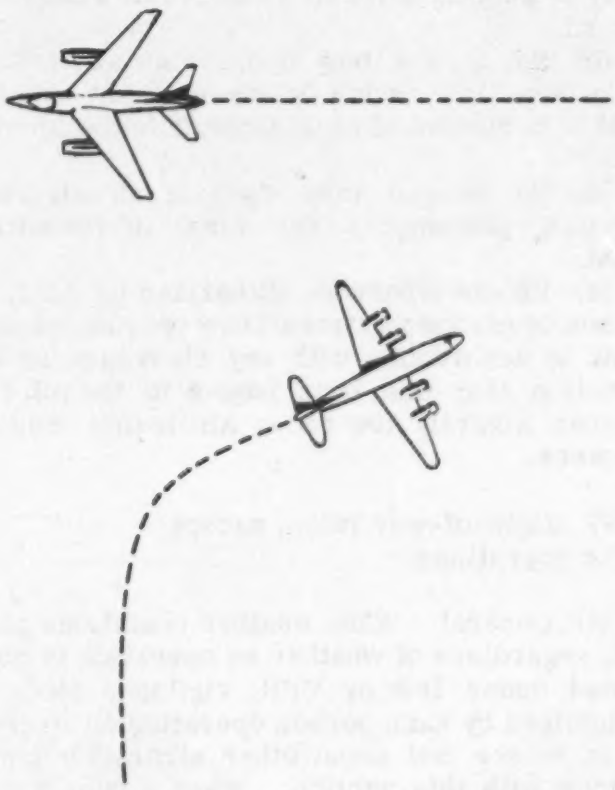

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Figure 9-1.—Converging aircraft.

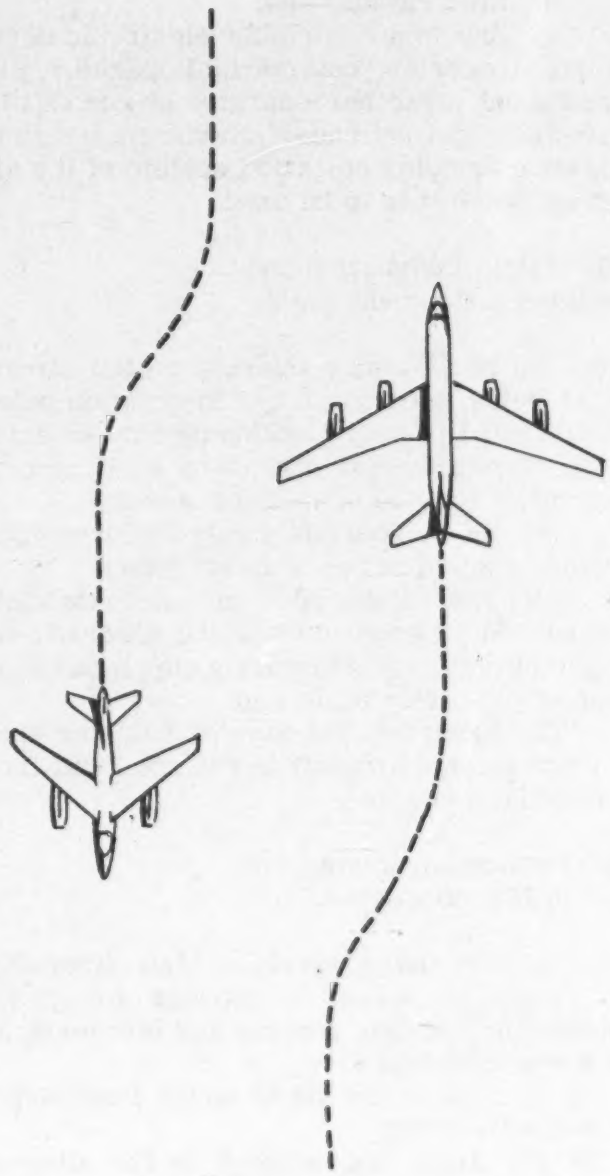

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Figure 9-2.—Aircraft approaching head-on.

NOTE: Passing an overtaken aircraft on the right is required because the pilot in side-by-side, dual-control aircraft is seated on the left and has a better view on that side. Further, in narrow traffic lanes, passing on the left of an overtaken aircraft would place the overtaking aircraft in the path of oncoming traffic.

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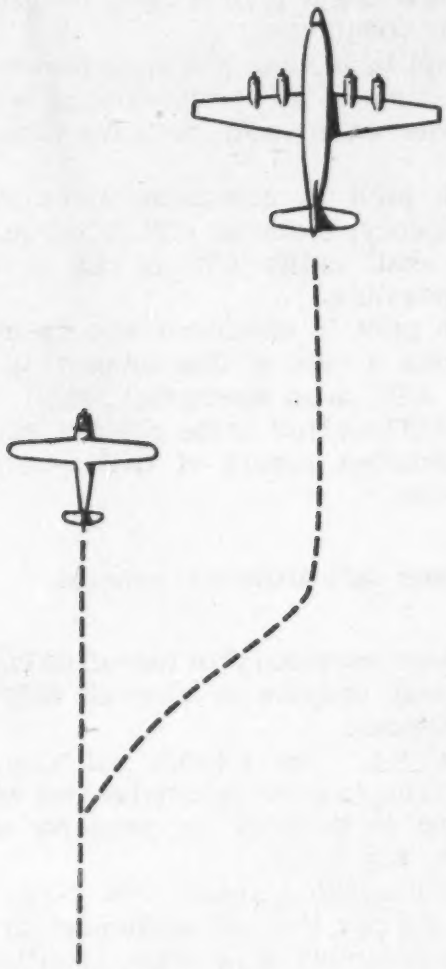

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Figure 9-3.—Aircraft overtaking another.

(f) Landing. Aircraft, while on final approach to land, or while landing, have the right of way over other aircraft in flight or operating on the surface. When two or more aircraft are approaching an airport for the purpose of landing, the aircraft at the lower altitude has the right of way, but it shall not take advantage of this rule to cut in front of another which is on final approach to land, or to overtake that aircraft.

(g) Inapplicability. This section does not apply to the operation of an aircraft on water.

91.69 Right-of-way rules; water operations.

(a) General. Each person operating an air craft on the water shall, insofar as possible, keep clear of all vessels and avoid impeding their navigation, and shall give way to any vessel or other aircraft that is given the right of way by any rule of this section.

(b) Crossing. When aircraft, or an aircraft and a vessel are on crossing courses, the aircraft or vessel to the other's right has the right of way.

(c) Approaching head-on. When aircraft, or an aircraft and a vessel, are approaching head-on or nearly so, each shall alter its course to the right to keep well clear.

(d) Overtaking. Each aircraft or vessel that is being overtaken has the right of way, and the one overtaking shall alter course to keep well clear.

(e) Special circumstances. When aircraft, or an aircraft and a vessel, approach so as to involve risk of collision, each aircraft or vessel shall proceed with careful regard to existing circumstances, including the limitations of the respective craft.

91.70 Aircraft speed.

(a) Unless otherwise authorized by the Administrator, no person may operate an aircraft below 10,000 feet MSL at an indicated airspeed of more than 250 knots.

(b) Unless otherwise authorized or required by ATC, no person may operate an aircraft within an airport traffic area at an indicated airspeed of more than—

(1) In the case of reciprocating engine aircraft, 156 knots; or

(2) In the case of turbine-powered aircraft, 200 knots.

However, if the minimum safe airspeed for any particular operation is greater than the maximum speed prescribed in this section, the aircraft may be operated at that minimum speed.

91.71 Acrobatic flight.

(a) No person may operate an aircraft in acrobatic flight—

(1) Over any congested area of a city, town, or settlement;

(2) Over an open air assembly of persons;

(3) Within a control zone or Federal airway;

(4) Below an altitude of 1,500 feet above the surface; or

(5) When flight visibility is less than three miles.

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For the purpose of this paragraph, acrobatic flight means an intentional maneuver involving an abrupt change in an aircraft's attitude, an abnormal attitude, or abnormal acceleration, not necessary for normal flight.

(b) Unless each occupant of the aircraft is wearing an approved parachute, no pilot of a civil aircraft, carrying any person (other than a crewmember) may execute any intentional maneuver that exceeds—

(1) A bank of 60 degrees relative to the horizon; or

(2) A nose up or nose down attitude of 30 degrees relative to the horizon.

(c) Paragraph (b) of this section does not apply to—

(1) Flight tests for pilot certification or rating; or

(2) Spins and other flight maneuvers required by the regulations for any certificate or rating when given by a certified flight instructor, or an airline transport pilot instructing in accordance with FAR 61.

91.73 Aircraft lights.

No person may, during the period from sunset to sunrise (or, in Alaska, during the period a prominent unlighted object cannot be seen from a distance of three statute miles or the sun is more than six degrees below the horizon)—

(a) Operate an aircraft unless it has lighted position lights;

(b) Park or move an aircraft in, or in dangerous proximity to, a night flight operations area of an airport unless the aircraft—

(1) Is clearly illuminated;

(2) Has lighted position lights; or

(3) Is in an area which is marked by obstruction lights; or

(c) Anchor an aircraft unless the aircraft—

(1) Has lighted anchor lights; or

(2) Is in an area where anchor lights are not required on vessels.

91.75 Compliance with ATC clearances and instructions.

(a) When an ATC clearance has been obtained, no pilot in command may deviate from that clearance, except in an emergency, unless he obtains an amended clearance. However, except in positive controlled airspace, this paragraph does not prohibit him from cancelling an IFR flight plan if he is operating in VFR weather conditions.

(b) Except in an emergency, no person may, in an area in which air traffic control is exercised, operate an aircraft contrary to an ATC instruction.

(c) Each pilot in command who deviates, in an emergency, from an ATC clearance or instruction shall notify ATC of that deviation as soon as possible.

(d) Each pilot in command who (though not deviating from a rule of this subpart) is given priority by ATC in an emergency, shall, if requested by ATC, submit to the chief of that ATC facility a detailed report of that emergency within 48 hours.

91.79 Minimum safe altitudes; general.

Except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(a) Anywhere. An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface. (See fig. 9-4.)

(b) Over congested areas. Over any congested area of a city, town, or settlement, or over any open air assembly of persons, an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft. (See fig. 9-5.)

(c) Over other than congested areas. An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In that case the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure. (See fig. 9-6.)

(d) Helicopters. Helicopters may be operated at less than the minimums prescribed in paragraphs (b) or (c) of this section if the operation is conducted without hazard to persons or property on the surface. In addition, each person operating a helicopter shall comply with routes or altitudes specifically prescribed for helicopters by the Administrator.

91.81 Altimeter settings.

(a) Each person operating an aircraft shall maintain that aircraft's cruising altitude or

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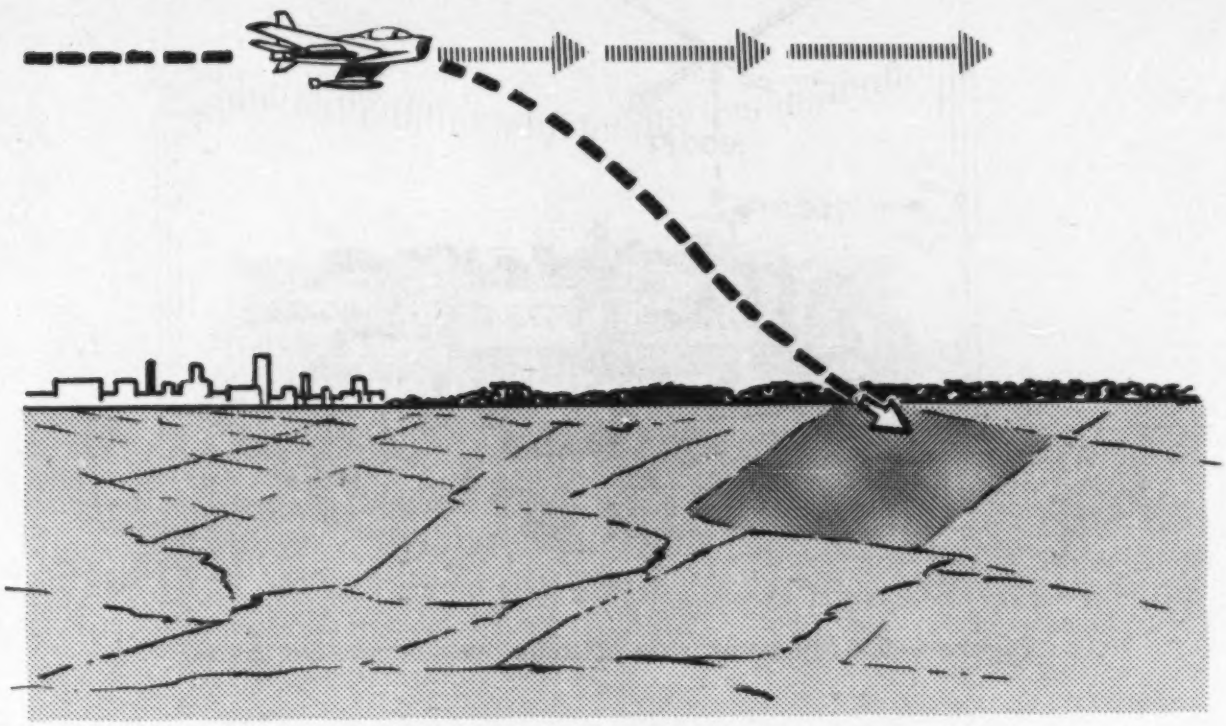

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Figure 9-4.—Minimum safe altitudes—anywhere.

flight level, as the case may be, by reference to an altimeter that is set, when operating—

(1) Below 18,000 feet MSL, to—

(i) The current reported altimeter setting of a station along the route and within 100 nautical miles of the aircraft;

(ii) If there is no station within the area prescribed in subdivision (i) of this subparagraph, the current reported altimeter setting of an appropriate available station; or

(iii) In the case of an aircraft not equipped with a radio, the elevation of the departure airport or an appropriate altimeter setting available before departure; or

(2) At or above 18,000 feet MSL, to 29.92" Hg.

(b) The lowest usable flight level is determined by the atmospheric pressure in the area of operation, as shown in the following listing:

Altimeter setting (Current reported)	Lowest usable flight level
29.92 or higher	180
29.91 to 29.42	185
29.41 to 28.92	190
28.91 to 28.42	195
28.41 to 27.92	200
27.91 to 27.42	205
27.41 to 26.92	210

(c) To convert minimum safe altitude to minimum flight level, the pilot should add the appropriate number of feet specified below, according to the current altimeter setting, to the flight level equivalent of the minimum safe altitude.

29.92 (or higher)	None
29.91 to 29.42	500 feet
29.41 to 28.92	1,000 feet
28.91 to 28.42	1,500 feet
28.41 to 27.92	2,000 feet
27.91 to 27.42	2,500 feet
27.41 to 26.92	3,000 feet

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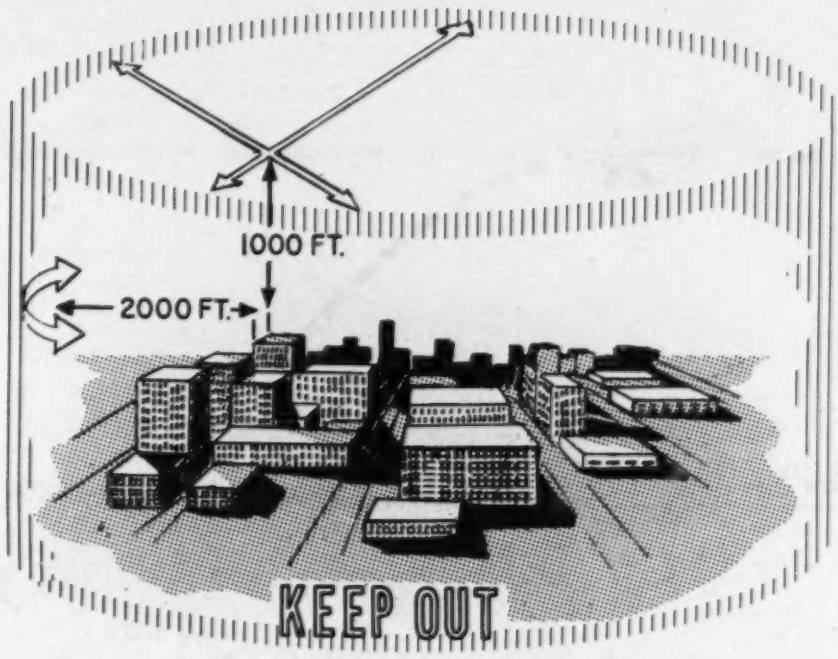

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Figure 9-5.—Minimum safe altitude over congested areas.

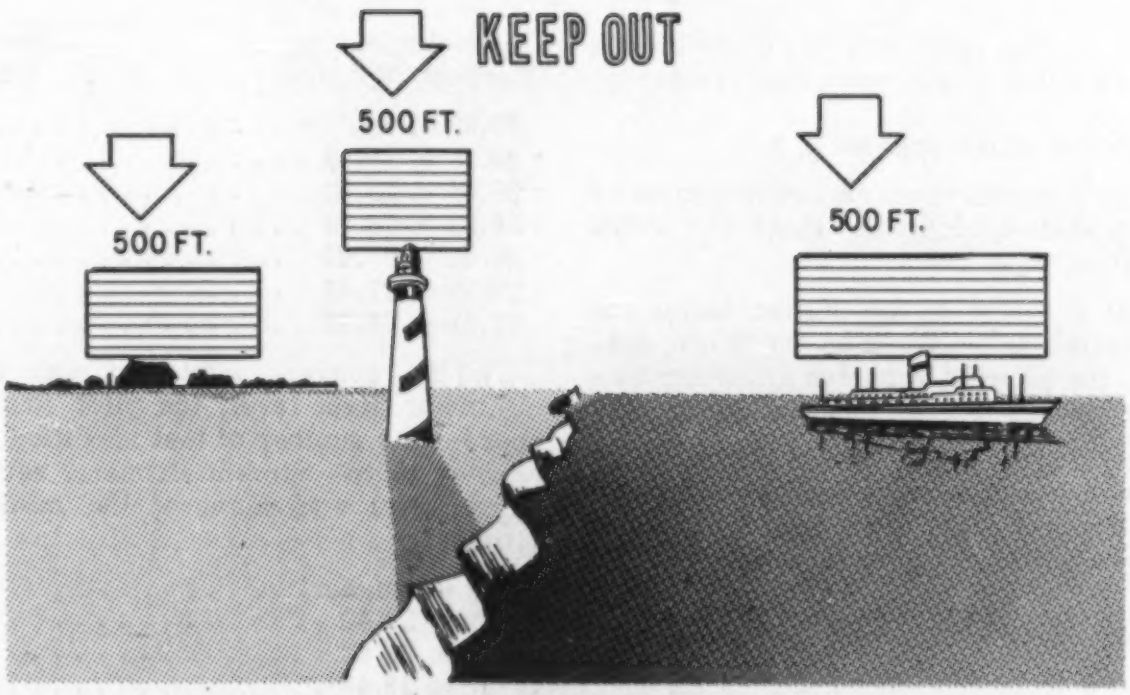

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Figure 9-6.—Minimum safe altitude over other than congested areas.

91.83 Flight plan; information required.

(a) Unless otherwise authorized by ATC, each person filing an IFR or VFR flight plan shall include in it the following information:

(1) The aircraft identification number and, if necessary, its radio call sign.

(2) The type of the aircraft or, in the case of a formation flight, the type of each aircraft and the number of aircraft, in the formation.

(3) The full name and address of the pilot in command or, in the case of a formation flight, the formation commander.

(4) The point and proposed time of departure.

(5) The proposed route, cruising altitude (or flight level), and true airspeed at that altitude.

(6) The point of first intended landing and the estimated elapsed time until over that point.

(7) The radio frequencies to be used.

(8) The amount of fuel on board (in hours).

(9) In the case of an IFR flight plan, an alternate airport, except as provided in paragraph (b) of this section.

(10) In the case of an international flight, the number of persons in the aircraft.

(11) Any other information the pilot in command or ATC believes necessary for ATC purposes.

When a flight plan has been filed, the pilot in command, upon canceling or completing the flight under the flight plan, shall notify the nearest FAA Flight Service Station or ATC facility.

(b) Paragraph (a) (9) of this section does not apply if FAR Part 97 prescribes a standard instrument approach procedure for the first airport of intended landing and the weather conditions at that airport are forecast to be, from two hours before to two hours after the ETA, as follows:

(1) A ceiling of at least 1,000 feet above the lowest MEA, MOCA, or altitude prescribed for the initial approach segment of the instrument approach procedure for the airport.

(2) Visibility at least 3 miles, or 2 miles more than the lowest authorized landing minimum visibility, whichever is greater.

(c) IFR alternate airport weather minimums. Unless otherwise authorized by the Administrator, no person may include an alternate airport in an IFR flight plan unless current weather forecasts indicate that, at the ETA at the alternate airport, the ceiling and visibility at that airport will be at or above the following alternate airport weather minimums:

(1) If an instrument approach procedure has been published in FAR Part 97 for that airport, the alternate airport minimums specified in that procedure or, if none are so specified, the following minimums:

(i) Precision approach procedure: ceiling 600 feet and visibility 2 statute miles.

(ii) Non-precision approach procedure: ceiling 800 feet and visibility 2 statute miles.

(iii) If no instrument approach procedure has been published in FAR Part 97 for that airport, the ceiling and visibility minimums are those allowing descent from the MEA, approach, and landing, under basic VFR.

91.85 Operating on or in the vicinity of an airport; general rules.

(a) Unless otherwise required by Part 93 (Special air traffic rules and airport traffic patterns) each person operating an aircraft on or in the vicinity of an airport shall comply with the requirements of this section and of 91.87 and 91.89.

(b) Unless otherwise authorized or required by ATC, no person may operate an aircraft within an airport traffic area except for the purpose of landing at, or taking off from, an airport within that area. ATC authorizations may be given as individual approval of specific operations or may be contained in written agreements between airport users and the tower concerned.

91.87 Operation at airports with operating control towers.

(a) General. Unless otherwise authorized or required by ATC, each person operating an aircraft to, from, or on an airport with an operating control tower shall comply with the applicable provisions of this section.

(b) Communications with control towers operated by the United States. No person may, within an airport traffic area, operate an aircraft to, from, or on an airport having a control tower operated by the United States unless two-way radio communications are maintained between that aircraft and the control tower. However, if the aircraft radio fails in flight, he may operate that aircraft and land if weather conditions are at or above basic VFR weather

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minimums, he maintains visual contact with the tower, and he receives a clearance to land. If the aircraft radio fails while in flight under IFR, he must comply with 91.127.

(c) Communications with other control towers. No person may, within an airport traffic area operate an aircraft to, from, or on an airport having a control tower that is operated by any person other than the United States unless—

(1) If that aircraft's radio equipment so allows, two-way radio communications are maintained between the aircraft and the tower; or

(2) If that aircraft's radio equipment allows only reception from the tower, the pilot has the tower's frequency monitored.

(d) Minimum altitudes. When operating to an airport with an operating control tower, each pilot of—

(1) A turbine-powered airplane or a large airplane shall, unless otherwise required by the applicable distance from cloud criteria, enter the airport traffic area at an altitude of at least 1,500 feet above the surface of the airport and maintain at least 1,500 feet within the airport traffic area, including the traffic pattern, until further descent is required for a safe landing:

(2) A turbine-powered airplane or a large airplane approaching to land on a runway being served by an ILS, shall, if the airplane is ILS equipped, fly that airplane at an altitude at or above the glide slope between the outer marker (or the point of interception with the glide slope, if compliance with applicable distance from clouds criteria requires interception closer in) and the middle marker; and

(3) An airplane approaching to land on a runway served by a visual approach slope indicator, shall maintain an altitude at or above the glide slope until a lower altitude is necessary for a safe landing.

However, subparagraphs (2) and (3) of this paragraph do not prohibit normal bracketing maneuvers above or below the glide slope that are conducted for the purpose of remaining on the glide slope.

(e) Approaches. When approaching to land at an airport with an operating control tower, each pilot of—

(1) An airplane, shall circle the airport to the left; and

(2) A helicopter, shall avoid the flow of fixed-wing aircraft.

(f) Departures. No person may operate an aircraft taking off from an airport with an operating control tower except in compliance with the following:

(1) Each pilot shall comply with any departure procedures established for that airport by the FAA.

(2) Unless otherwise required by the departure procedures or applicable distance from clouds criteria, each pilot of a large or turbine-powered airplane shall climb to an altitude of 1,500 feet above the surface as rapidly as practicable.

(g) Noise abatement runway system. When landing or taking off from an airport with an operating control tower, and for which a formal runway use program has been established by the FAA, each pilot of a turbine-powered airplane and each pilot of a large airplane, assigned a noise abatement runway by ATC, shall use that runway. However, each pilot has final authority and responsibility for the safe operation of his airplane and if he determines in the interest of safety that another runway should be used, ATC will assign that runway (air traffic and other conditions permitting).

(h) Clearances required. No pilot may, at an airport with an operating control tower, taxi an aircraft on a runway, or take off or land an aircraft, unless he has received an appropriate clearance from ATC. A clearance to "taxi to" the runway is a clearance to cross all intersecting runways but is not a clearance to "taxi on" the assigned runway.

91.89 Operation at airports without control towers.

Each person operating an aircraft to or from an airport without an operating control tower shall—

(a) In the case of an airplane approaching to land, make all turns of that airplane to the left unless the airport displays approved light signals or visual markings indicating that turns should be made to the right, in which case the pilot shall make all turns to the right;

(b) In the case of a helicopter approaching to land, avoid the flow of fixed-wing aircraft; and

(c) In the case of an aircraft departing the airport, comply with any FAA traffic pattern for that airport.

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CHAPTER 15

PRINCIPLES OF RADAR

The purpose of this chapter is to review the principles which determine the characteristics of radar circuits and to follow this review with a discussion of how these circuits are applied in a typical multipurpose pulse modulated radar set.

RADAR PERFORMANCE FACTORS

Among the principles which should be reviewed before continuing with the present discussion are certain factors which affect radar performance. Such factors are carrier frequency, pulse width and pulse repetition frequency, the power relation (relation between peak and average power), beam width, and scan rate. The choices of these arbitrary constants for a particular system are determined by its tactical use, the accuracy required, the range to be covered, the practical physical size, and the problem of generating and receiving the signal. Basic information concerning these factors may be found in chapter 15 of Basic Electronics, NavPers 10087-B.

PULSE SHAPE

The shape of the pulse determines range accuracy, minimum and maximum range, and resolution or definition of target. The pulse shape is of little importance in the detection of a target as long as it has sufficient power to cause a detectable echo at the receiver. However, the shape of the pulse is very important for range and Doppler velocity measurements. Pulsed Doppler radar depends on the duration of the waveform (pulse width) where it is used in moving target indicators (MTI).

For good range resolution (that is, the ability to separate two targets at nearly the same range), a narrow pulse width is required. If a pulse width of 6 microseconds is used, targets one-half mile apart may be resolved. Remember that 6.18 microseconds equals one-half radar mile.) When the two targets are separated by less than one-half mile, the leading edge of the pulse will be striking the farthest target while the trailing edge of the pulse is arriving at the closest target. This will cause both targets to appear as one on the scope. Thus the narrower the pulse, the better is the range resolution.

From the foregoing it would seem that an extremely narrow pulse would be desirable. This is not always the case. In order to be detected, a target must return an echo that is strong enough to cause an indication on the scope. The energy in the returned echo may be increased by increasing the peak transmitted power or by illuminating the target for a longer period of time. Longer target illumination may be achieved by increasing the pulse width. The peak power that a radar transmitter may produce is limited by the size and quality of its power supply, magnetron, waveguides, and other components. Therefore, it is usually more practical to design a radar with a lower peak power, increasing the pulse width to maintain a sufficient total energy level.

There are also other practical limitations to the minimum pulse width that can be used. Narrow pulses require a receiver with a greater bandwidth. (This is due to the harmonic content of a narrow pulse.) This reduces the gain of the receiver and increases noise.

The ideal pulse with perfectly vertical leading and trailing edges is not attainable. To have perfectly vertical sides (zero rise and fall times) would require an infinite bandwidth. In actual practice, rise and fall times of 0.001 microsecond (10 manoseconds) are commonplace. The steepness of the leading edge is a predominant factor in the accuracy of range

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91.91 Avoidance of disaster areas.

(a) Designated disaster areas consist of that airspace below 2,000 feet above the surface within five statute miles of an aircraft or train accident, forest fire, earthquake, flood, or other disaster of substantial magnitude. (See fig. 9-7.) The designation of a disaster area is made in a Notice to Airmen.

(b) No person may operate an aircraft within a designated disaster area unless—

(1) That aircraft is participating in airborne relief activities under the direction of the Agency responsible for relief activities;

(2) That aircraft is being operated to or from an airport within the area, if that operation does not hamper or endanger relief activities;

(3) Flight around or above the area is impractical due to weather, terrain, or other considerations, if that en route operation through the area does not hamper or endanger relief activities and prior notice is given to the Air Traffic Service facility specified in the Notice to Airmen;

(4) It is specifically authorized under an IFR ATC clearance; or

(5) That aircraft is carrying properly accredited news representatives or persons on official business concerning the disaster, is operated in accordance with 91.79 and, unless otherwise authorized by the Agency responsible for relief activities, it is operated above altitudes used by relief aircraft and the operator has filed with the Air Traffic Service facility specified in the Notice to Airmen a flight plan that includes the following information:

(i) Aircraft identification, type, and color.

(ii) Radio communications frequencies to be used.

(iii) Proposed times of entry and exit of the disaster area.

(iv) Name of news media or purpose of flight.

(v) Any other information deemed necessary by ATC.

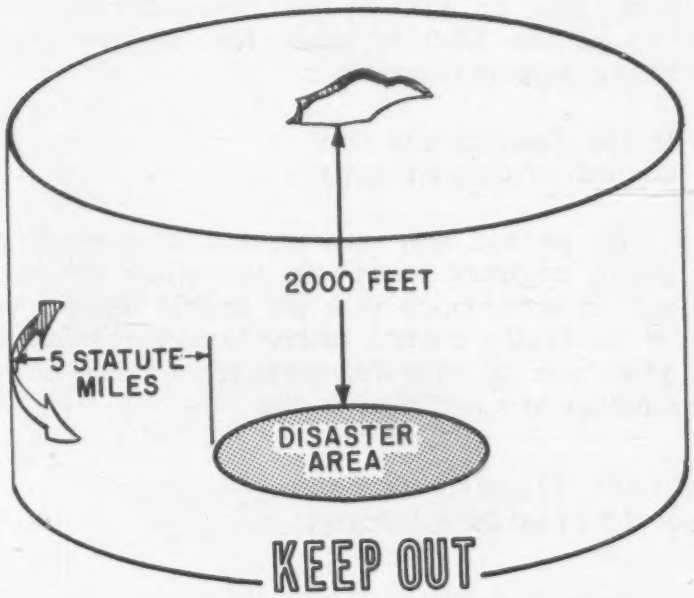

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Figure 9-7.—Avoidance of disaster area.

91.93 Flight test areas.

(a) No person may flight test an aircraft except over open water or sparsely populated areas having light air traffic.

91.95 Restricted and prohibited areas.

(a) No person may operate an aircraft within a restricted area (designated in Part 73) contrary to the restrictions imposed, or within a prohibited area, unless he has the permission of the using or controlling agency, as appropriate.

(b) Each person conducting, within a restricted area, an aircraft operation (approved by the using agency) that creates the same hazards as the operations for which the restricted area was designated, may deviate from the rules of this subpart that are not compatible with his operation of the aircraft.

91.97 Positive control areas.

(a) Except as provided in paragraph (b) of this section, no person may operate an aircraft within a positive control area designated in Part 71 unless that aircraft is—

(1) Operated under IFR at a specific altitude assigned by ATC;

(2) Equipped with instruments and equipment required for IFR operations and is flown by a pilot rated for instrument flight; and

(3) Equipped with—

(i) A coded radar beacon transponder, having a Mode A (military Mode 3) 64 code capability, replying to Mode 3/A interrogation with the code specified by ATC; and

(ii) A radio providing direct pilot/controller communication on the frequency specified by ATC for the area concerned.

(b) ATC may authorize deviations from the requirements of paragraph (a) of this section for operation in a positive control area. In the case of an inoperative transponder, ATC may immediately approve an operation allowing flight to continue to the ultimate destination, including any intermediate stops, or to proceed to a place where suitable repairs can be made, or both. A request for authorization to deviate from a requirement of this section must be submitted at least four days before the proposed operation, in writing, to the ATC center having jurisdiction over the positive control area concerned. ATC may authorize deviations on a continuing basis or for an individual flight, as appropriate.

91.99 Jet advisory areas.

(a) No person may operate an aircraft within a radar jet advisory area designated in Part 75 unless—

(1) That aircraft is operated under IFR at a specific altitude assigned by ATC; or

(2) If the aircraft is not so operated and—

(i) That aircraft is equipped with a functioning coded radar beacon transponder having a Mode A (military Mode 3) 64 code capability, that transponder is operated to reply to Mode 3/A interrogation with the code specified by ATC;

(ii) If that aircraft is not so equipped, it is operated under specific authorization from ATC; or

(iii) If radio failure prevents the receiving of that authorization, he maintains an appropriate VFR cruising flight level.

(b) No person may pilot an aircraft within a nonradar jet advisory area designated in Part 75 unless that aircraft is operated under—

(1) IFR at a specific altitude assigned by ATC; or

(2) Specific authorization from ATC.

91.101 Operations to, or over, Cuba.

No person may operate a civil aircraft from the United States to, or over, Cuba unless—

(a) Departure is from an international airport of entry designated in 6.13 of the Air Commerce Regulations of the Bureau of Customs (19 CFR 6.13); and

(b) In the case of departure from any of the 48 contiguous States or the District of Columbia, the pilot in command of the aircraft has filed—

(1) A DVFR or IFR flight plan as prescribed in 99.11 or 99.13 and

(2) A written statement, within one hour before departure, with the office of Immigration and Naturalization Service at the airport of departure, containing—

(i) All information in the flight plan;

(ii) The name of each occupant of the aircraft;

(iii) The number of occupants of the aircraft; and

(iv) A description of the cargo, if any.

This section does not apply to the operation of aircraft by a scheduled air carrier over routes authorized in operations specifications issued by the Administrator.

91.102 Flight limitation in the proximity of space flight recovery operations.

No person may operate any aircraft of United States registry, or pilot any aircraft under the authority of an airman certificate issued by the FAA within areas designated in a NOTAM for space flight recovery operations except when authorized by ATC, or operated under the control of the DOD Manager for Manned Space Flight Support Operations.

91.103 Operation of civil aircraft of Cuban registry.

No person may operate a civil aircraft of Cuban registry except in controlled airspace and in accordance with air traffic clearances or air traffic control instructions that may require use of specific airways or routes and landings at specific airports.

91.104 Flight limitations in proximity of the Presidential Party.

No person may operate an aircraft, over or in the vicinity of areas to be visited or traveled by the President, the Vice President, or other

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public figures, contrary to the limitations specified in a Notice to Airmen (NOTAM).

Visual Flight Rules

91.105 Basic VFR weather minimums. (See fig. 9-8 and table 9-1.)

(a) Except as provided in 91.107, no person may operate an aircraft under VFR when the flight visibility is less, or at a distance from clouds that is less, than that prescribed for the corresponding altitude in table 9-1.

(b) When the visibility is less than 1 mile, a helicopter may be operated outside controlled airspace at 1,200 feet or less above the surface if operated at a speed that allows the pilot adequate opportunity to see any air traffic or other obstruction in time to avoid a collision.

(c) Except as provided in 91.107, no person may operate an aircraft, under VFR, within a control zone beneath the ceiling when the ceiling is less than 1,000 feet.

(d) Except as provided in 91.107, no person may takeoff or land an aircraft, or enter the traffic pattern of an airport under VFR within a control zone—

(1) Unless ground visibility at that airport is at least 3 statute miles; or

(2) If ground visibility is not reported at that airport, unless flight visibility during landing or takeoff, or while operating in the traffic pattern, is at least 3 statute miles.

(e) For the purpose of this section, an aircraft operating at the base altitude of a transition area or control area is considered to be within the airspace directly below that area.

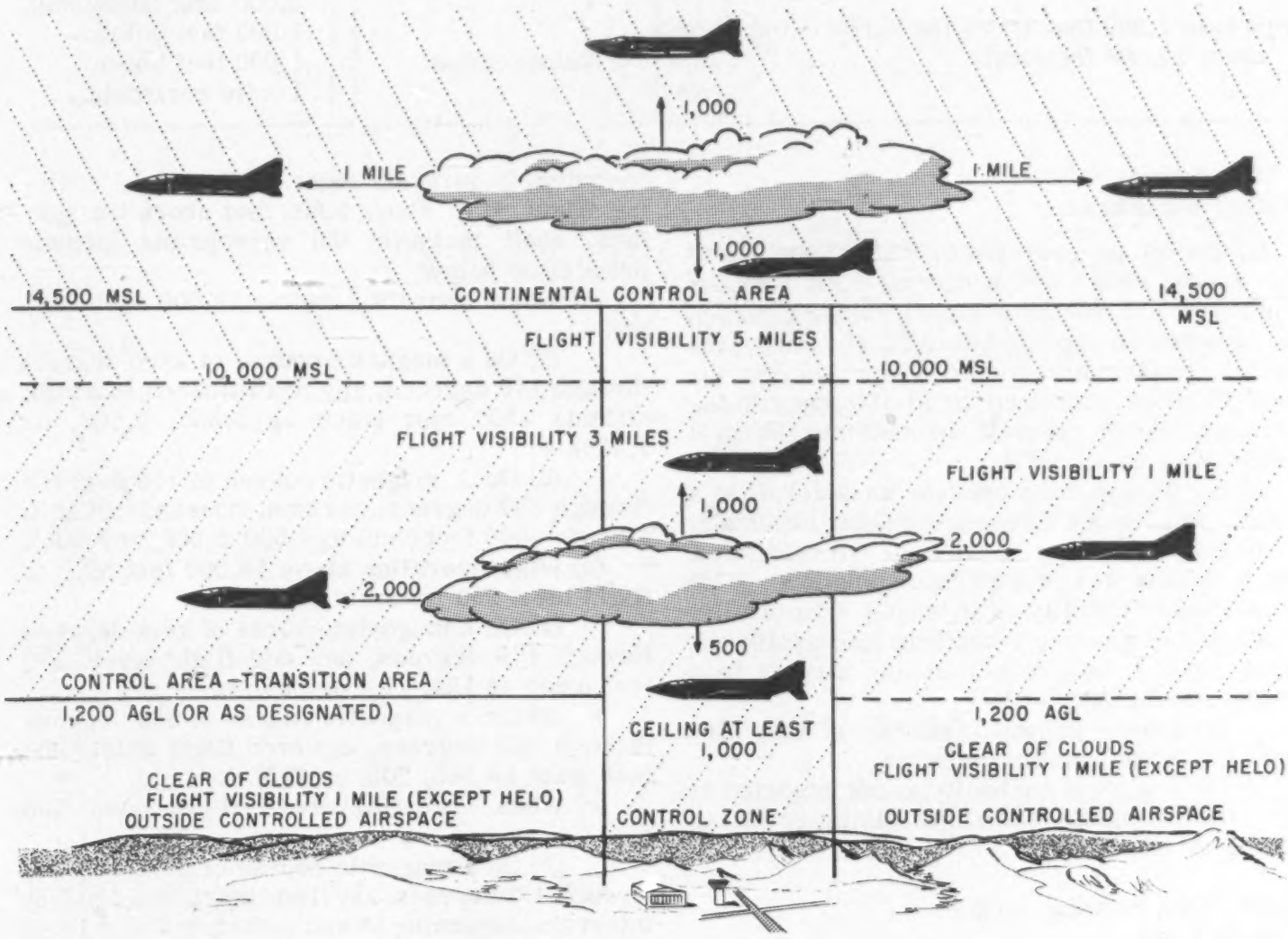

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Figure 9-8.—Basic VFR weather minimums.

Table 9-1.—Basic VFR weather minimums.

Altitude	Flight visibility	Distance from clouds
1,200 feet or less above the surface (regardless of MSL altitude)—		
Within controlled airspace.	3 statute miles. . .	500 feet below. 1,000 feet above. 2,000 feet horizontal.
Outside controlled airspace.	1 statute mile (except as in 91.105(B)). . . .	Clear of clouds.
More than 1,200 feet above the surface but less than 10,000 feet MSL—		
Within controlled airspace.	3 statute miles. . .	500 feet below. 1,000 feet above. 2,000 feet horizontal.
Outside controlled airspace.	1 statute mile . . .	500 feet below. 1,000 feet above. 2,000 feet horizontal.
More than 1,200 feet above the surface and at or above 10,000 feet MSL.	5 statute miles. . .	1,000 feet below. 1,000 feet above. 1 mile horizontal.

91.107 Special VFR weather minimums.

(a) Except as provided in FAR 93.113 (Control zones within which special VFR weather minimums are not authorized), when a person has received an appropriate ATC clearance, the special weather minimums of this section instead of those contained in 91.105 apply to the operation of an aircraft by that person in a control zone under VFR.

(b) No person may operate an aircraft in a control zone under VFR except clear of clouds.

(c) No person may operate an aircraft (other than a helicopter) in a control zone under VFR unless flight visibility is at least 1 statute mile.

(d) No person may takeoff or land an aircraft (other than a helicopter) at any airport in a control zone under VFR—

(1) Unless ground visibility at that airport is at least 1 statute mile; or

(2) If ground visibility is not reported at that airport, unless the flight visibility during landing or takeoff is at least 1 statute mile.

91.109 VFR cruising altitude or flight level.

Except while holding in a holding pattern of 2 minutes or less, or while turning, each person operating an aircraft under VFR in level cruising flight, at or above 3,000 feet above the surface, shall maintain the appropriate altitude prescribed below:

(a) When operating below 18,000 feet MSL and—

(1) On a magnetic course of zero degrees through 179 degrees, any odd thousand foot MSL altitude +500 feet (such as 3,500, 5,500, or 7,500); or

(2) On a magnetic course of 180 degrees through 359 degrees, any even thousand foot MSL altitude +500 feet (such as 4,500, 6,500, or 8,500).

(b) When operating above 18,000 feet MSL to flight level 290 (inclusive), and—

(1) On a magnetic course of zero degrees through 179 degrees, any odd flight level +500 feet (such as 195, 215, or 235); or

(2) On a magnetic course of 180 degrees through 359 degrees, any even flight level +500 feet (such as 185, 205, or 225).

(c) When operating above flight level 290 and—

(1) On a magnetic course of zero degrees through 179 degrees, any flight level, at 4,000 foot intervals, beginning at and including flight level 300 (such as flight level 300, 340, or 380); or

(2) On a magnetic course of 180 degrees through 359 degrees, any flight level at 4,000-

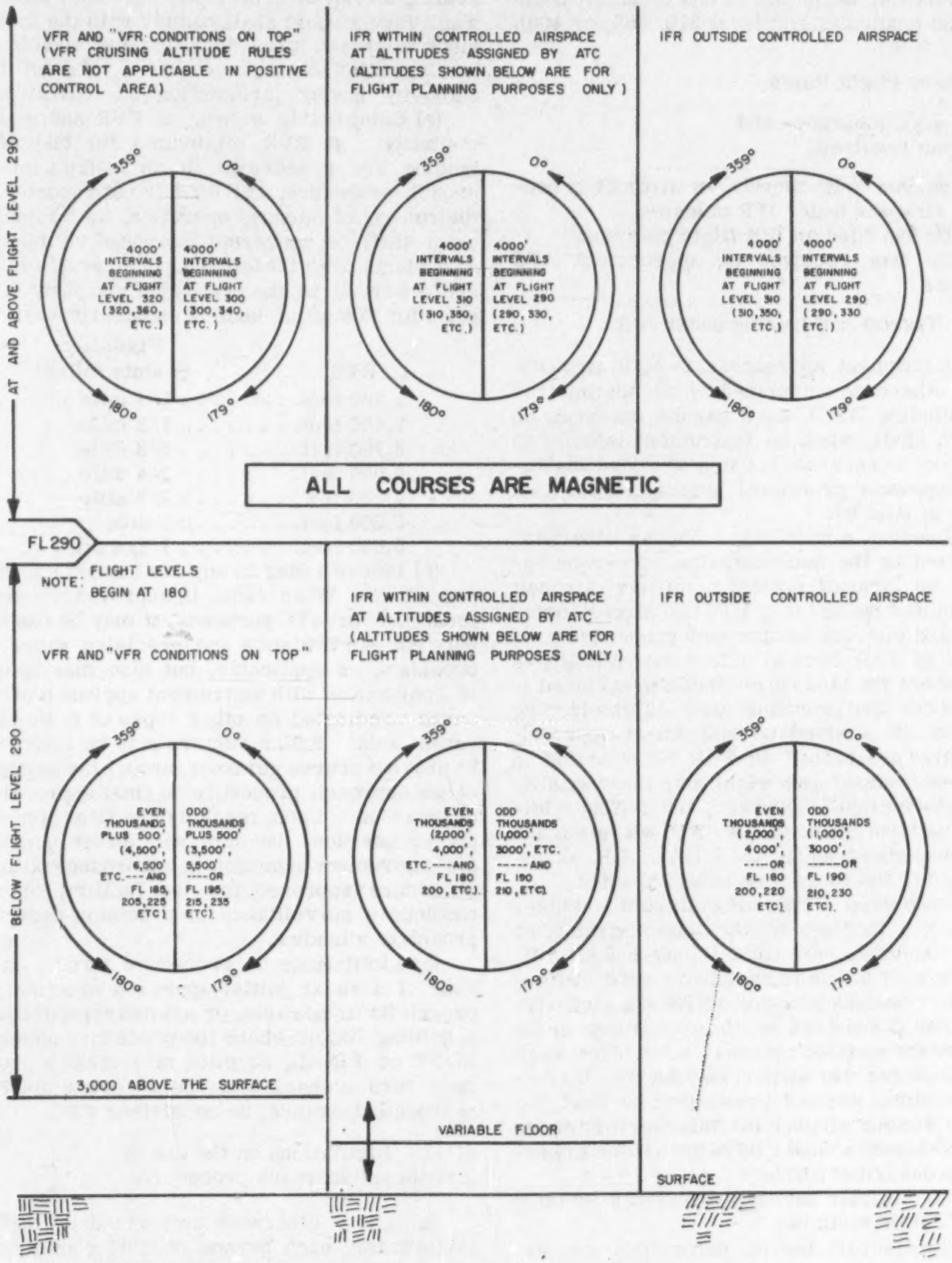

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Figure 9-9.—Cruising altitudes.

foot intervals, beginning at and including flight level 320 (such as flight level 320, 360, or 400). (See fig. 9-9.)

Instrument Flight Rules

91.115 ATC clearance and flight plan required.

No person may operate an aircraft in controlled airspace under IFR unless—

(a) He has filed an IFR flight plan; and

(b) He has received an appropriate ATC clearance

91.116 Takeoff and landing under IFR.

(a) Instrument approaches to civil airports. Unless otherwise authorized by the Administrator (including ATC), each person operating an aircraft shall, when an instrument letdown to an airport is necessary, use a standard instrument approach procedure prescribed for that airport in Part 97.

(b) Landing minimums. Unless otherwise authorized by the Administrator, no person operating an aircraft (except a military aircraft of the United States) may land that aircraft using a standard instrument approach procedure prescribed in FAR Part 97 unless the visibility is at or above the landing minimum prescribed in FAR 97 for the procedure used. If the landing minimum in a standard instrument approach procedure prescribed in FAR 97 is stated in terms of ceiling and visibility, the visibility minimum applies. However, the ceiling minimum shall be added to the field elevation and that value observed as the MDA or DH, as appropriate to the procedure being executed.

(c) Civil airport takeoff minimums. Unless otherwise authorized by the Administrator, no person operating an aircraft under FAR 121, 123, 129, or 135 (commercial aircraft operators including foreign) may takeoff from a civil airport under IFR unless weather conditions are at or above the weather minimums for IFR takeoff prescribed for that airport in FAR 97. If takeoff minimums are not prescribed in FAR 97, for a particular airport, the following minimums apply to takeoffs under IFR for aircraft operating as described above:

(1) Aircraft having two engines or less: 1 statute mile visibility.

(2) Aircraft having more than two engines: 1/2 statute mile visibility.

(d) Military airports. Unless otherwise prescribed by the Administrator, each person operating a civil aircraft under IFR into, or out of a military airport shall comply with the instrument approach procedure and the takeoff and landing minimums prescribed by the military authority having jurisdiction on that airport.

(e) Comparable values of VFR and ground visibility. If RVR minimums for takeoff or landing are prescribed in an instrument approach procedure, but RVR is not reported for the runway of intended operation, the RVR minimum shall be converted to ground visibility in accordance with the following comparable values and observed as the applicable visibility minimum for takeoff or landing on that runway:

RVR	Visibility (statute miles)
1,600 feet	1/4 mile
2,400 feet	1/2 mile
3,200 feet	5/8 mile
4,000 feet	3/4 mile
4,500 feet	7/8 mile
5,000 feet	1 mile
6,000 feet	1 1/4 mile

(f) Use of radar in any instrument approach procedure. When radar is approved at certain locations for ATC purposes, it may be used not only for surveillance and precision radar approaches, as applicable, but also may be used in conjunction with instrument approach procedures predicated on other types of radio navigation aids. Radar vectors may be authorized to provide course guidance through the segments of an approach procedure to final approach fix or position. Upon reaching the final approach fix or position, the pilot will either complete his instrument approach in accordance with the procedure approved for the facility, or will continue a surveillance or precision radar approach to a landing.

(g) Limitations on procedure turns. In the case of a radar initial approach to a final approach fix or position, or a timed approach from a holding fix, or where the procedure specifies NOPT or FINAL, no pilot may make a procedure turn unless, when he receives his final approach clearance, he so advises ATC.

91.117 Limitations on the use of instrument approach procedures.

(a) Unless otherwise authorized by the Administrator, each person operating an aircraft using an instrument approach procedure prescribed in FAR 97 shall comply with the requirements of this section.

(b) Descent below MDA or DH. No person may operate an aircraft below the prescribed minimum descent altitude or continue an approach below the decision height unless—

(1) The aircraft is in a position from which a normal approach to the runway of intended landing can be made; and

(2) The approach threshold of that runway, or approach lights or other markings identifiable with the approach end of that runway, are clearly visible to the pilot. If, upon arrival at the missed approach point or decision height, or at any time thereafter, any of the above requirements are not met, the pilot shall immediately execute the appropriate missed approach procedure.

91.119 Minimum altitudes for IFR operations.

(a) Except when necessary for takeoff or landing, or unless otherwise authorized by the Administrator, no person may operate an aircraft under IFR below—

(1) The applicable minimum altitudes prescribed in Parts 95 and 97; or

(2) If no applicable minimum altitude is prescribed in those Parts—

(i) In the case of operations over an area designated as a mountainous area in Part 95, an altitude of 2,000 feet above the highest obstacle within a horizontal distance of 5 statute miles from the course to be flown; or

(ii) In any other case, an altitude of 1,000 feet above the highest obstacle within a horizontal distance of 5 statute miles from the course to be flown. However, if both a MEA and a MOCA are prescribed for a particular route or route segment, a person may operate an aircraft below the MEA down to, but not below, the MOCA, when within 25 statute miles of the VOR concerned (based on the pilot's reasonable estimate of that distance).

(b) Climb. Climb to a higher minimum IFR altitude shall begin immediately after passing the point beyond which that minimum altitude applies, except that, when ground obstructions intervene the point beyond which the higher minimum altitude applies shall be crossed at or above the applicable MCA.

91.121 IFR cruising altitude or flight level.

(a) In controlled airspace. Each person operating an aircraft under IFR in level cruising flight in controlled airspace shall maintain the altitude or flight level assigned that aircraft by ATC. However, if the ATC clearance assigns "VFR conditions-on-top," he shall maintain an altitude or flight level as prescribed by 91.109.

(b) In uncontrolled airspace. Except while holding in a holding pattern of 2 minutes or less, or while turning, each person operating an aircraft under IFR in level cruising flight, in uncontrolled airspace, shall maintain an appropriate altitude as follows:

(1) When operating below 18,000 feet MSL and—

(i) On a magnetic course of zero degrees through 179 degrees, any odd thousand foot MSL altitude (such as 3,000, 5,000, or 7,000); or

(ii) On a magnetic course of 180 degrees through 359 degrees, any even thousand foot MSL altitude (such as 2,000, 4,000, or 6,000).

(2) When operating at or above 18,000 feet MSL but below flight level 290, and—

(i) On a magnetic course of zero degrees through 179 degrees, any odd flight level (such as 190, 210 or 230); or

(ii) On a magnetic course of 180 degrees through 359 degrees, any even flight level (such as 180, 200, or 220).

(3) When operating at flight level 290 and above, and—

(i) On a magnetic course of zero degrees through 179 degrees, any flight level, at 4,000-foot intervals, beginning at and including flight level 290 (such as flight level 290, 330, or 370); or

(ii) On a magnetic course of 180 degrees through 359 degrees, any flight level, at 4,000-foot intervals, beginning at and including flight level 310 (such as flight level 310, 350, or 390). (See fig. 9-9.)

91.123 Course to be flown.

Unless otherwise authorized by ATC, no person may operate an aircraft within controlled airspace, under IFR, except as follows:

(a) On a Federal airway, along the centerline of that airway.

(b) On any other route, along the direct course between the navigational aids or fixes defining that route.

However, this section does not prohibit maneuvering the aircraft to pass well clear of other air traffic or the maneuvering of the aircraft,

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in VFR conditions, to clear the intended flight path both before and during climb or descent.

91.125 IFR, radio communications.

The pilot in command of each aircraft operated under IFR in controlled airspace shall have a continuous watch maintained on the appropriate frequency and shall report by radio as soon as possible—

(a) The time and altitude of passing each designated reporting point, or the reporting points specified by ATC, except that while the aircraft is under radar control, only the passing of those reporting points specifically requested by ATC need be reported;

(b) Any unforecast weather conditions encountered; and

(c) Any other information relating to the safety of flight.

91.127 IFR operations; two-way radio communications failure.

(a) General. Unless otherwise authorized by ATC, each pilot who has two-way radio communications failure when operating under IFR shall comply with the rules of this section.

(b) VFR Conditions. If the failure occurs in VFR conditions, or if VFR conditions are encountered after the failure, each pilot shall continue the flight under VFR and land as soon as practicable.

(c) IFR Conditions. If the failure occurs in IFR conditions, or if paragraph (b) of this section cannot be complied with, each pilot shall continue the flight according to the following:

(1) Route.

(i) By the route assigned in the last ATC clearance received;

(ii) If being radar vectored by the direct route from the point of radio failure to the fix, route, or airway specified in the vector clearance;

(iii) In the absence of an assigned route, by the route that ATC has advised may be expected in a further clearance; or

(iv) In the absence of an assigned route or a route that ATC has advised may be expected in a further clearance, by the route filed in the flight plan.

(2) Altitude. At the highest of the following altitudes or flight levels:

(i) The altitude or flight level assigned in the last ATC clearance received;

(ii) The minimum altitude (converted, if appropriate, to minimum flight level as prescribed in 91.81 (c)) for IFR operations; or

(iii) The altitude or flight level ATC has advised may be expected in a further clearance.

(3) Climb. When it is necessary to climb in order to comply with subparagraph (2) of this paragraph, the following applies;

(i) Climb to the assigned altitude or flight level in accordance with the last ATC clearance received;

(ii) Climb to the minimum altitude for IFR operation at the time or place necessary to comply with that minimum; or

(iii) Climb to the altitude or flight level ATC has advised may be expected in a further clearance at the time or place included in the expect-further-clearance.

(4) Leave holding fix. If holding instructions have been received, leave the holding fix at the expect-further-clearance time received, or, if an expected approach clearance time has been received, leave the holding fix in order to arrive over the fix from which the approach begins as close as possible to the expected approach clearance time.

(5) Descent. Begin descent from the en route altitude or flight level upon reaching the fix from which the approach begins, but not before—

(i) The expect-approach-clearance time (if received); or

(ii) If no expect-approach-clearance time has been received, at the estimated time of arrival, shown on the flight plan, as amended with ATC.

91.129 Operation under IFR in controlled airspace; malfunction reports.

(a) The pilot in command of each aircraft operated in controlled airspace under IFR, shall report immediately to ATC any of the following malfunctions of equipment occurring in flight:

(1) Loss of VOR, TACAN, ADF, or low frequency navigation receiver capability.

(2) Complete or partial loss of ILS receiver capability.

(3) Impairment of air/ground communications capability.

(b) In each report required by paragraph (a) of this section, the pilot in command shall include the—

(1) Aircraft identification;

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(2) Equipment affected;

(3) Degree to which the capability of the pilot to operate under IFR in the ATC system is impaired; and

(4) Nature and extent of assistance he desires from ATC.

FAR PART 95—IFR ALTITUDES

95.1 Applicability.

(a) This part prescribes altitudes governing the operation of aircraft under IFR on Federal airways, jet routes, or other direct routes for which an MEA is designated in this part. In addition, it designates mountainous areas and changeover points (not included in this training manual).

(b) The MAA is the highest altitude on a Federal airway, jet route, or other direct route for which an MEA is designated in this part at which adequate reception of navigation aid signals is assured.

(c) The MCA applies to the operation of an aircraft proceeding to a higher minimum en route altitude when crossing specified radio fixes.

(d) The MEA prescribed for a Federal airway or segment thereof, applies to the entire width of that airway or segment between the radio fixes defining that airway or segment. An MEA prescribed for an off-airway route or route segment applies to the airspace 5 statute miles on each side of a direct course between radio fixes defining that route or route segment. The MEA in effect between fixes assures navigation signal reception and obstruction clearance between those fixes.

(e) The MOCA applies to the operation of an aircraft within 25 statute miles of the VOR station concerned. The MOCA assures obstruction clearance between the fixes specified but adequate reception of navigational signals is assured only within 25 miles of the VOR station concerned.

(f) The MRA applies to the operation of an aircraft over an intersection used in the navigation of that aircraft. The MRA is the lowest altitude at which the intersection can be determined.

(g) The COP (changeover point) applies to operation of an aircraft along a Federal airway, jet route, or other direct route for which an MEA is designated in this part. It is the most appropriate point for transfer of the airborne navigation reference between the facility abaft the aircraft and the next appropriate facility along the Federal airway, jet route, or other direct route that provides:

(1) Continuous reception between facilities; and

(2) A common source of azimuth guidance for all aircraft operating along the same segment of the Federal airway, jet route, or direct route.

FAR, PART 99—SECURITY CONTROL OF AIR TRAFFIC

99.1 Applicability.

(a) This subpart prescribes rules for operating civil aircraft in a defense area, or into, within, or out of the United States through an Air Defense Identification Zone (ADIZ).

(b) Except for 99.7, this subpart does not apply to the operation of an aircraft—

(1) In a Coastal or Domestic ADIZ north of 28 degrees north latitude or west of 85 degrees west longitude at a true airspeed of less than 180 knots;

(2) In the Alaskan DEWIZ at a true airspeed of less than 180 knots while the pilot maintains a continuous listening watch on the appropriate frequency;

(3) From any point in the 48 contiguous States on an outbound track through the Southern Border ADIZ that does not penetrate a Coastal ADIZ;

(4) Within the 48 contiguous States and the District of Columbia, or within the State of Alaska, which remains within 10 nautical miles of the point of departure; or

(5) Over any island, or within three nautical miles of the coastline of any island, in the Hawaiian ADIZ.

(c) Except as provided in 99.7, the radio and position reporting requirements of this subpart do not apply to the operation of an aircraft within the 48 contiguous States and the District of Columbia, or within the State of Alaska, if that aircraft does not have two-way radio and is operated in accordance with a filed DVFR flight plan containing the time and point of Domestic or Coastal ADIZ penetration and that aircraft departs within five minutes of the estimated departure time contained in the flight plan.

(d) An FAA ATC center may exempt the following operations from this subpart (except

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99.7), on a local basis only, with the concurrence of the military commanders concerned:

(1) Aircraft operations that are conducted wholly within the boundaries of an ADIZ and are not currently significant to the air defense system.

(2) Aircraft operations conducted in accordance with special procedures prescribed by the military authorities concerned.

99.3 General.

(a) Air defense identification zones (ADIZ's) are areas of airspace over land or water in which the ready identification, location, and control of civil aircraft is required in the interest of national security. (See fig. 9-10.) They are classified as—

(1) Coastal air defense identification zones (Coastal ADIZ's);

(2) Domestic air defense identification zones (Domestic ADIZ's); and

(3) Distant early warning identification zones (DEWIZ's).

(b) Unless designated as an ADIZ, a Defense Area is any airspace of the United States in which the control of aircraft is required for national security.

(c) For the purposes of this Part, a Defense Visual Flight Rules (DVFR) flight is a flight within an ADIZ conducted under the visual flight rules in Part 91.

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Figure 9-10.—ADIZ's and defense area.

determination. Slope of the trailing edge causes the receiver to remain blanked longer than necessary, reducing minimum range performance and target resolution.

Noise may also affect the shape of the pulse, thereby affecting the accuracy of range measurements. Figure 15-1 illustrates a typical pulse shape with a pulse corrupted by noise superimposed (shown by the dotted line). The time delay from transmitted pulse to received echo will be shortened by the amount Δt.

Notice that if the rise and fall times were zero, noise would affect only the amplitude of the pulse and would not affect range accuracy. For large signal to noise ratios, the slope of the pulse plus noise is the same as the slope of the uncorrupted pulse.

PULSE REPETITION FREQUENCY

The pulse repetition frequency (PRF) largely determines the maximum range and, to some degree, the accuracy of a radar set. The actual time elapsing between the beginning of one pulse and the beginning of the next, called the pulse repetition period, is the reciprocal of the PRF. Thus, for example, if the PRF is 400 cycles per second, the pulse repetition period is 1/400 seconds, or 2,500 microseconds. When the PRF is too high—that is, when the period between pulses is too short—the echo from the farthest target may return to the receiver after the transmitter has emitted another pulse, making it impossible to tell whether the observed pulse is the echo of the pulse just transmitted or the echo of the preceding pulse. Such a condition is referred to as range ambiguity.

Although the pulse repetition rate must be kept low enough to attain the required maximum range, it must also be kept high enough to avoid some of the pitfalls a single pulse might encounter. If a single pulse were sent out by a transmitter, atmospheric conditions might attenuate it, the target might not reflect it properly, or moving parts—such as a propeller—might throw it out of phase or change its shape. Thus, information derived from a single pulse would be highly unreliable; but by sending many pulses, one after another, many good ones will return. The equipment will integrate or sum up the good points of all the pulses and present you with a clear, reliable picture. Equipment is therefore designed in such a way that many pulses (10 or more) are received from a single object. In this way, effects of fading are somewhat reduced. At short ranges the repetition frequency is increased in order to insure accurate measurements. Many echoes are received from one target, and the integrating effect is increased.

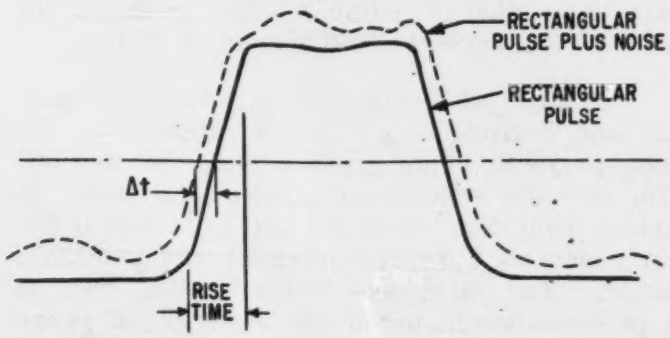

Figure 15-1. —Noise distorted radar pulse.

Tactical employment of a radar set determines, to a large degree, the PRF to be used. Long range search sets require a pulse rate slow enough to allow echoes from targets at the maximum range to return to the receiver before the transmitter is again pulsed. Higher pulse rates are used in aircraft interception sets where the maximum range is less.

The following equation will readily determine either the PRF or the range if one of them is known:

$$\text{PRF} = \frac{\text{Speed of Light}}{2 \times \text{Range}}$$

(Multiplying range by 2 converts range to radar range.) Thus a radar with a PRF of 800 cycles per second could operate to a maximum range of about 100 miles without range ambiguity. Most radar equipments use 2,000 yards as the standard radar mile; the difference between it and the nautical mile (6,076 feet) is approximately 1 percent.

In theory it is desirable to strike a target with as many pulses of energy as possible during a given scan. Thus, the higher the PRF the better. A high PRF combined with a narrow pulse improves angular resolution and range rate accuracy by sampling the position of the target more often. However, we have shown that maximum range limits the PRF.

99.5 Emergency situations.

In an emergency that requires immediate decision and action for the safety of the flight, the pilot in command of an aircraft may deviate from the rules in this Part to the extent required by that emergency. He shall report the reasons for the deviation to the communications facility where flight plans or position reports are normally filed (referred to in this Part as "an appropriate aeronautical facility") as soon as possible.

99.7 Special security instructions.

Each person operating an aircraft in an ADIZ or Defense Area shall, in addition to the applicable operating rules of this Part, comply with special security instructions issued by the Administrator or in the interest of national security and consistent with appropriate agreements between the FAA and Department of Defense.

The special security instructions referred to in the above paragraph is the plan for the Security Control of Air Traffic and Air Navigation Aids (short title: SCATANA). This plan is distributed in the Navy as OpNav Instruction 3722.30. This plan defines the responsibilities of the Administrator, and the appropriate military authorities for the security control of civil and military air traffic and Federal air navigation aids. It defines the responsibility of the Federal Communications Commission (FCC) for the security control of non-Federal civil air navigation aids. It describes the situations which concern national security, and the necessary action to be taken. It also provides for testing the plan at least once every 60 days. Air Controlmen should study OpNav Instruction 3722.30 as all control tower personnel will become involved in an actual implementation of the plan or the frequent test procedures.

99.9 Radio requirements.

No person may operate an aircraft in an ADIZ unless the aircraft has a functioning two-way radio.

99.11 Flight plan requirements; Coastal or Domestic ADIZ.

(a) No person may operate an aircraft in or penetrating a Coastal or Domestic ADIZ unless he has filed a flight plan with an appropriate aeronautical facility.

(b) Unless ATC authorizes an abbreviated flight plan—

(1) A flight plan for IFR flight must contain the information specified in 91.83; and

(2) A flight plan for VFR flight must contain the information specified in 91.83 (a) (1) through (7).

(c) The pilot shall designate a flight plan for VFR flight as a DVFR flight plan.

99.13 Flight plan requirements; DEWIZ.

(a) No person may operate an aircraft in or penetrating a DEWIZ unless he has filed a flight plan before takeoff with an appropriate aeronautical facility. If there is no facility for filing a DVFR flight plan, the pilot must comply with 99.25 (a) (2) and proceed according to the instructions issued by the appropriate aeronautical facility. These instructions normally require the flight to proceed to a specific area for visual identification or to land at a stated location.

(b) Unless ATC authorizes an abbreviated flight plan—

(1) A flight plan for IFR flight must contain the information specified in 91.83 and the estimated time and point of DEWIZ penetration (ETDP); and

(2) A flight plan for VFR flight must contain the information in 91.83 (a) (1) through (7) and the estimated time and point of DEWIZ penetration (ETDP).

(c) The pilot shall designate a flight plan for VFR flight as a DVFR flight plan.

99.15 Arrival or completion notice.

The pilot in command of an aircraft for which a flight plan has been filed shall file an arrival or completion notice with an appropriate aeronautical facility, unless the flight plan states that no notice will be filed.

99.17 Position reports; aircraft operating in or penetrating a Domestic ADIZ; IFR.

The pilot of an aircraft operating in or penetrating a Domestic ADIZ under IFR—

(a) In controlled airspace, shall make the position reports required in 91.125; and

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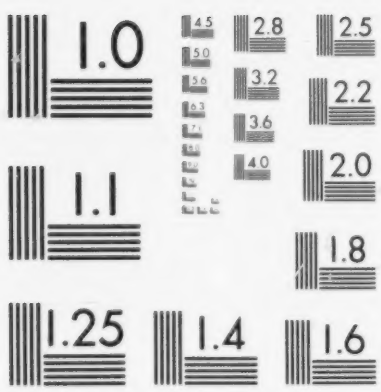

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(b) In uncontrolled airspace, shall make the position reports required in 99.19.

99.19 Position reports; aircraft operating in or penetrating a Domestic ADIZ; DVFR.

No pilot may penetrate a Domestic ADIZ under DVFR unless—

(a) He reports to an appropriate aeronautical facility before penetration: The time, position, and altitude at which the aircraft passed the last reporting point before penetration and the estimated time of arrival over the next appropriate reporting point along the flight route;

(b) If there is no appropriate reporting point along the flight route, he reports at least 15 minutes before penetration: The estimated time, position, and altitude at which he will penetrate; or

(c) If the airport of departure is so close to the Domestic ADIZ boundary that it prevents his complying with paragraphs (a) or (b) of this section, he has reported immediately after taking off: The time of departure, altitude, and estimated time of arrival over the first reporting point along the flight route.

99.21 Position reports; aircraft entering the United States through a Coastal ADIZ; United States aircraft.

The pilot of an aircraft entering the United States through a Coastal ADIZ shall make the reports required in 99.17 or 99.19 to an appropriate aeronautical facility.

99.23 Position reports; aircraft entering the United States through a Coastal ADIZ; foreign aircraft.

In addition to such other reports as ATC may require, no pilot in command of a foreign civil aircraft may enter the United States through a Coastal ADIZ unless he makes the reports required in 99.17 or 99.19 or reports the position of the aircraft when it is not less than one hour and not more than two hours average direct cruising distance from the United States.

99.25 Position reports; aircraft entering the United States through a DEWIZ.

(a) The pilot of an aircraft entering the United States through a DEWIZ—

(1) If under IFR, shall report his position as required by 91.125; or

(2) If under DVFR, shall report when within radio range of an appropriate aeronautical facility but before penetration: The time, altitude, and position at which he passed the last reporting point and the estimated time, altitude and point of penetration.

(b) If requested, the pilot of an aircraft entering the United States through a DEWIZ shall advise an appropriate aeronautical facility of the difference between the actual time and point of penetration and the same data recorded in the original ground filed flight plan.

99.27 Deviation from flight plans and ATC clearance and instructions.

(a) No pilot may deviate from the provisions of an ATC clearance or ATC instruction except in accordance with 91.75 of this chapter.

(b) No pilot may deviate from his filed IFR flight plan when operating an aircraft in uncontrolled airspace unless he notifies an appropriate aeronautical facility before deviating.

(c) No pilot may deviate from his filed DVFR flight plan unless he notifies an appropriate aeronautical facility before deviating.

99.29 Radio failure; DVFR.

If the pilot operating an aircraft under DVFR in an ADIZ cannot maintain two-way radio communications, he may proceed in accordance with his original DVFR flight plan or land as soon as practicable. The pilot shall report the radio failure to an appropriate aeronautical facility as soon as possible.

99.31 Radio failure; IFR.

If a pilot operating an aircraft under IFR in an ADIZ cannot maintain two-way radio communications, he shall proceed in accordance with 91.127 of this chapter.

99.33 Flight plans: Panama Canal Zone Domestic ADIZ.

Civil aircraft may operate within the Panama Canal Zone Domestic ADIZ only under a flight plan that has been proved by appropriate military authority acting through an FAA air traffic control facility.

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CHAPTER 10

AIR TRAFFIC CONTROL COMMUNICATIONS

Consider the vital link supplied by communications between controllers and air traffic. Without such communications, the controller is severely limited to approval or disapproval of anticipated air traffic movements and then only when visual contact exists, such as with the traffic control light as illustrated in chapter 4 of this training manual. It stands to reason that such an important tool deserves considerable attention from the controller. Existing communications equipment at naval control facilities is relatively simple to operate; however, correct application of the simple or basic procedures is a prerequisite to reliable communications when engaged in air traffic control. This chapter is intended to provide the AC with the fundamental knowledge necessary for the correct use of communications and equipment.

RADIO PROCEDURE

RECEIVER CHECK

It is a generally accepted practice to check all receivers at least once during each watch to be sure that they are operating. Logically the oncoming watch will do this upon relieving the offgoing watch to determine the usability of the equipment. This may be accomplished by making short transmissions on each assigned frequency at one operating position with all receivers OFF at that position but ON at another position to monitor the check transmission. In actuality, both the transmitters and receivers are being checked by this method since no reception of the check transmission on a particular frequency could indicate a malfunction of either the transmitter or receiver. In the event a malfunction is indicated, controllers should notify the technicians who make further checks and repairs where necessary.

VOLUME ADJUSTMENT

NOTE: The Phone Level, Speaker Level, Mic Level controls, and VU meter referred to in this section are illustrated in chapter 4 of this training manual on the FSA-17 and FSA-52 communications equipment.

Volume adjustment is an individual operation in that each controller has his own desired level of volume. The basic requirement to consider, however, is that volume is not reduced to the extent that transmissions from aircraft within your area of responsibility might not be heard. Conditions affecting volume adjustment vary also. If a controller is monitoring only one frequency and is using a headset, then volume adjustment consists only of adjustment of the Phone Level control for a comfortable listening level in the headphone. If a speaker is used, then the Speaker Level control is adjusted for a reasonable listening level but not louder than absolutely necessary, so as not to disturb other controllers at different operating positions. In the case of overhead speakers in the tower, the Speaker Level control is usually physically located in the equipment room and once the levels are set at a comfortable level they are left in that position. However, there will be times when a controller will want more volume, in which case someone has to go to the equipment room and make the adjustment.

Along with volume control, the Mic Level control should be set for proper modulation of the transmitters. To accomplish this, set all radiophone switches in the OFF position, depress the Mic switch, and speak into the microphone in a normal conversational manner. Vary the Mic Level control until the majority of the peak swings on the VU meter needle pass just above the zero level on the meter. This will properly modulate the transmitters and set the level for the interphone circuits.

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FREQUENCY MONITORING

Radiofrequencies are assigned to naval facilities by appropriate military authority, each for a particular function. Monitoring procedure differs between facilities; however, the normal procedure at most continuously manned facilities is to monitor all tower and approach control frequencies on a continuous basis. At certain operating positions, such as approach control where the operator normally uses a headset, the receivers may be switched to a speaker and the volume increased during periods of light or no traffic.

RADIO DISCIPLINE AND SECURITY

Radio discipline is defined as including the maintenance and proper use of radio equipment, the adherence to prescribed procedure when operating, and employment of remedial action when and where necessary.

Air Controlmen are particularly concerned with the portions of radio discipline having to do with the proper use of equipment and adherence to prescribed procedures. Radio discipline is not only an essential factor in communication security, but an essential for efficient and reliable communications. Standard radio procedures contribute to rapid and accurate communications and relieve the various channels of unnecessary congestion. Message phraseology must be as brief as possible consistent with intelligibility and understandability. Messages should, however, be adequately worded so that they are understood the first time they are transmitted. For this reason certain words are sometimes included in standard messages which may appear unnecessary. They contribute sufficiently to intelligibility and understandability to make their use desirable. In wording radio-telephone messages, the best rules are: First, be sure it will be understood on the first transmission; and second, be brief.

Judgment must be used in the employment of the phonetic alphabet, even though it is an excellent aid when properly used. There is no advantage in using it for transmission of abbreviations when words for which the abbreviations stand can be transmitted as easily and as intelligibly. For example, controllers and pilots are sometimes heard transmitting, "India Foxtrot Romeo Flight Plan," when instrument flight or IFR flight plan would actually be more quickly understood.

Security may not always seem to be such an important factor in peacetime. Radio security, however, cannot be routinely disregarded and then be resumed overnight with the beginning of hostilities. It must be practiced at all times so that it causes no distraction at a time when immediate attention is required by many other things.

A radio transmission, like the spoken word, once uttered can never be recalled. It must be assumed that the enemy intercepts every transmission made. Therefore, give as little information as possible. Transmission security is that part of communication security which is the controller's responsibility.

Just as there is an antidote for every poison, for every tool of warfare an effective countermeasure is usually developed. To prevent the enemy from learning the truth through his observation of our radio activity, the principles of transmission security have been developed. These principles are grouped into four categories—deception, interference, silence, and discipline. Discipline has just been discussed.

Deception is the means by which the enemy is misinformed to drive him into a trap; he is encouraged to draw the wrong conclusions, and he is generally thrown off balance. The enemy analyzes our traffic; and by studying the volume of traffic and the direction of flow, he attempts to predict what move we are planning.

Radio silence is one of the most effective ways of keeping information from the enemy, and it must be observed carefully. During radio silence it is imperative that no radio transmission be made.

Interference properly executed can prevent the enemy from communicating efficiently and possibly cause such confusion and disorganization of his activities that it might affect the tide of battle. One must be alert to change frequencies quickly, if the enemy is attempting to interfere with the transmission, and deliver the message before the enemy has time to discover the new frequency.

As a guide, there are general regulations and additional local regulations governing things one can or cannot do on the air. One of the important rules which must be followed everywhere is that no transmission is made which has not been authorized by proper authority. Other practices which are specifically forbidden are:

1. Violation of radio silence.

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2. Unofficial conversation between operators.

3. Transmitting in a direct net without permission.

4. Excessive tuning and testing.

5. Transmission of an operator's name or personal sign by other than the operator concerned.

6. Unauthorized use of plain language.

7. Use of unauthorized prowords.

8. Linkage or compromise of classified call signs and address groups by plain language disclosures or associated with unclassified call signs.

Other than the forbidden transmission, there are some things that should be avoided as much as possible. They are as follows:

1. Use of excessive power.

2. Needless loss of time in tuning, changing frequency, or adjusting equipment.

3. Transmission beyond the capabilities of receiving operators.

Authentication

Authentication is a security measure used to protect naval communication from fraudulent transmission. The best defense against imitative deception by the enemy is proper authentication. An authenticator is a letter, numeral, or groups of letters or numerals inserted in a message to prove its authentication. By correct use the operator can distinguish between genuine and fraudulent stations or transmissions.

Authentication is used, especially during wartime, when transmitting or receiving operating instructions may affect the military situation; examples include closing down a station, shifting frequency, or directing establishment of a special guard. Always authenticate when establishing radio contact with a station in an area where unfriendly forces are known to have communications interception capability. In this case, authenticators should be exchanged to prevent an enemy station from issuing false instructions to an unsuspecting station which would possibly produce a military situation favorable to the enemy.

Whenever an authentication system is promulgated, there will be accompanying instructions specifying how and when it is to be used; this is classified information.

EMERGENCY COMMUNICATIONS

Because of the infinite variety of possible situations, specific procedures cannot always be prescribed for every situation which might be considered an emergency. As a rule of thumb, an emergency includes any situation which places an aircraft in danger; i.e., uncertainty, alert, being lost, or in distress. Emergency communications would be any communications associated with these situations as described.

All military towers and most civil towers guard the emergency frequencies 121.5 MHz and 243.0 MHz. The prowords established for use to indicate the severity of an emergency situation in voice communication are MAYDAY, to indicate that the aircraft is threatened by serious and imminent danger and immediate assistance is required; and PAN, to indicate that the aircraft is in a situation which requires urgent action but is not in actual distress.

Controllers may expect to receive the following information from pilots of aircraft in an emergency condition:

1. PAN or MAYDAY 3 times and aircraft call sign 3 times.
2. Type of aircraft.
3. Actual or estimated position.
4. Heading.
5. Indicated airspeed.
6. Altitude/FL.
7. Fuel remaining.
8. Nature of emergency.
9. Pilot's intentions.
10. Assistance desired.
11. Two 10-second dashes with the mike button for DF purposes.

The pilot will accept "communications control" of one particular ground station, and all other stations must remain silent so as not to interfere.

CIRVIS Messages

The contraction CIRVIS is derived from the title of a document published by the Joint Chiefs of Staff, Joint Communication Electronics Board. It is entitled "Communications Instructions for Reporting Vital Intelligence Sightings from Airborne and Waterborne Sources." FAA facilities become involved with CIRVIS messages since they contact aircraft, both civil and military by radio.

The procedures used by aircraft to call ground stations and report CIRVIS information should be similar to those used when sending position reports, except that the call should be preceded by the word CIRVIS (pronounced SUR

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VEES) spoken three times to clear the frequencies of all other communications except DISTRESS or URGENCY. Should this procedure fail to clear the frequencies, the International Urgency Signal XXX transmitted three times on telegraph transmissions or the word PAN spoken three times may be employed as an alternate signal. CIRVIS reports are transmitted in plain language and as soon as possible (FLASH precedence is authorized) to any U.S. or Canadian military or civil air-ground communications facility.

There are three types of CIRVIS messages which controllers may be called upon to handle, as follows:

1. CIRVIS Report. Initial sighting report.

2. Additional CIRVIS reports. Additional reports should be made if more information becomes available concerning a previously sighted object. These reports should contain a reference to the original report to identify them with it.

3. Cancellation report. Cancellation reports should be made in the event that a previously reported sighting is positively identified as friendly or that it has been erroneously reported.

EXAMPLE OF INITIAL CIRVIS REPORT:

Aircraft—CIRVIS CIRVIS CIRVIS, KINDLEY THIS IS NAVY TWO FIVE NINER THREE SIX, CIRVIS REPORT, OVER.

Communications facility—NAVY TWO FIVE NINER THREE SIX, THIS IS KINDLEY, GO AHEAD.

Aircraft—NAVY TWO FIVE NINER THREE SIX SIGHTED FORMATION OF SIX JET BOMBERS, CONFIGURATION IS SWEPT WING WITH EIGHT JET ENGINES, TWO HUNDRED MILES EAST OF BERMUDA OR THIRTEEN MAY AT ONE THREE FIVE ZERO ZULU, ALTITUDE THREE FIVE THOUSAND, HEADING TWO SEVEN ZERO DEGREES, NO MARKINGS OBSERVED, OVER.

Communications station—KINDLEY, ROGER OUT.

FAA stations and Navy towers must immediately pass the CIRVIS message to the appropriate ARTCC. FAA ARTCC's in the conterminous United States forwards the CIRVIS message immediately by direct interphone to the appropriate Air Division Control center. If no direct interphone is available, the report should be relayed to the ARTC center nearest to and having direct interphone connection with the Air Division Control center. The Air Division is responsible for forwarding to other military services, or higher headquarters, as required.

TECHNIQUES

Proper microphone technique is important in radiotelephone communications. Transmissions should be concise and in a normal conversational tone. Consider the following suggestions for proper technique: Speak clearly and distinctly; avoid extremes of voice pitch; be natural; use standard phraseologies to the maximum extent practicable, but do not be afraid to use plain language where no precedence has been set; shield your mike from outside noises; keep your mike a sufficient distance from an associated speaker to avoid acoustical feedback; give an accurate response to a request for a radio check (a transmission with a high level of background noise is not LOUD AND CLEAR); do not depress the mike button until absolutely ready to talk; and do not tie up a frequency with excessive test signals and radio checks.

PHRASEOLOGY

The use of standard phraseology is necessary for efficient utilization of communications frequencies. Controllers through acquired experience in using standard phraseology are able to make transmissions as brief as possible yet completely understandable. Proficiency may be developed to the extent that in the exchange of communications between controller and pilot the intent of the message is comprehensible even before the verbal transmission is complete. In other words, proper phraseology is second nature to a proficient controller.

Identification of Ground Facilities

The Air Controlman must know how ground facilities such as towers, centers, approach control, and communications stations, are identified during radiotelephone communications. Then, he must know how to identify all types of aircraft, even those of foreign registry. He cannot communicate with these aircraft properly if he is not completely familiar with how to make radio contacts through use of standard phraseologies.

Airport traffic control towers are identified during radiotelephone communications as follows:

State the name of the facility, followed by the word "tower." Where military and civil airports are located in the same general area and have similar names, state the name of the military service, followed by the name of the military facility and the word "tower."

EXAMPLES: MEMPHIS TOWER; NAVY MEMPHIS TOWER.

Air Route Traffic Control Centers (ARTCC's) are identified by the location name followed by the word "center."

EXAMPLE: KANSAS CITY CENTER.

Approach control facilities, including Army radar approach control facilities (ARAC's), radar approach control facilities associated with the USAF (RAPCON's), and radar air traffic control centers associated with the USN (RATCC's), are identified by the name of the facility, followed by the words "approach control." Where military and civil facilities are located in the same general area and have similar names, state the name of the military service, followed by the name of the military facility, and the words "approach control."

EXAMPLES: DENVER APPROACH CONTROL; NAVY JACKSONVILLE APPROACH CONTROL.

Functions within a terminal facility are identified by the name of the facility, followed by the name of the function.

EXAMPLES: OCEANA DEPARTURE CONTROL; MERIDIAN GROUND CONTROL.

Radar facilities having air surveillance radar (ASR) and/or precision approach radar (PAR) but not providing approach control service are identified by the name of the facility followed by the letters "G-C-A."

EXAMPLE: OLATHE G-C-A.

Air traffic communications stations are identified during radiotelephone communications in the following manner:

Navy communications stations; by the word "Navy," followed by the name of the station and the word "radio."

EXAMPLE: NAVY NORFOLK RADIO.

Air Force communications stations; by the name of the station followed by the word "airways."

EXAMPLE: BROOKLEY AIRWAYS.

FAA flight service stations (FSS) by the name of the station followed by the word "radio."

EXAMPLE: LEXINGTON RADIO.

Aircraft Identification

Military aircraft are identified by one of the following:

1. The service name followed by the last five digits of the serial number.

EXAMPLE: NAVY FIVE SIX ONE TWO THREE.

2. Air evacuation flights, rescue flights, or helicopters, by the abbreviation AIR EVAC, RESCUE, or (service name) COPTER, as appropriate, followed by the last five digits of the serial number. The word COPTER may be omitted in transmissions subsequent to initial contact.

EXAMPLES: AIR EVAC ONE SEVEN THREE TWO ONE; RESCUE FIVE ONE SIX EIGHT FOUR; or, NAVY COPTER THREE TWO ONE ONE FIVE.

3. The abbreviations for special military operations followed by the last five digits of the serial number.

EXAMPLES: MAC SEVEN EIGHT FIVE SIX TWO (Military Airlift Command); SAM NINER ONE FIVE SIX TWO (Special Air Mission); LOGAIR SEVEN FIVE EIGHT SIX ONE (USAF Contract Aircraft).

4. Pronounceable words 3, 4, 5, and 6 letters followed by a 4-, 3-, 2-, or 1-digit number.

EXAMPLE: PAUL TWO ZERO.

5. An assigned double letter 2-digit flight number.

EXAMPLE: ALFA KILO ONE FIVE.

6. Navy and Marine fleet and training command aircraft, one of the following:

a. The service name and two letters (use phonetic alphabet equivalents), followed by two or three digits.

EXAMPLE: NAVY GOLF ALPHA TWO ONE.

b. The service name and a digit and a letter (use phonetic alphabet equivalents), followed by two or three digits.

EXAMPLE: MARINE FOUR CHARLIE TWO THREE SIX.

Civil aircraft are identified by the aircraft type, model name, or manufacturer's name (if none of these are known, use the word November or the letter N followed by the digits and letters of the registration number.

EXAMPLE: APACHE ONE FOUR TWO PAPA; DOUGLAS THREE ZERO ONE ROMEO; NOVEMBER THREE SEVEN ONE FIVE.

Air carrier and other civil aircraft having FAA authorized call signs are identified by the

call sign followed by the flight number in group form.

EXAMPLE: AMERICAN FIVE TWENTY ONE; COMMUTER SIX ELEVEN; GENERAL MOTORS THIRTY SEVEN.

Aircraft of foreign registry are identified by one of the following:

1. Civil—the letters or digits of the aircraft registration or call sign.
EXAMPLE: C-F-R-L-G.
2. Air carrier—the abbreviated name of the operating company followed by the letters or numbers of the registration or call sign or the flight number in group form.
EXAMPLES: AIR FRANCE F-L-R-L-G; SCANDINAVIAN SIXTY ONE.
3. Military—the name of the country and the military service followed by the separate digits or letters of the registration or call sign. An exception to this is Canadian military aircraft which are identified by the word CANFORCE, followed by the separate digits of the serial number.

EXAMPLES: BRAZILIAN AIR FORCE FIVE ONE SIX ONE TWO; or, CANFORCE FIVE SIX TWO SEVEN ONE.

Presidential or Vice Presidential aircraft are identified as follows:

1. When the President or the Vice President is aboard a military aircraft, state the name of the military service followed by the word ONE for the President or the word TWO for the Vice President.
2. When the President or the Vice President is aboard a civil aircraft, state the words EXECUTIVE ONE for the President or EXECUTIVE TWO for the Vice President.
3. When a member of the President's or Vice President's family is aboard any aircraft, if the U.S. Secret Service or the White House Staff determines it is necessary, state the words EXECUTIVE ONE FOXTROT for the President's family or EXECUTIVE TWO FOXTROT for the Vice President's family.

Presidential or Vice Presidential escort aircraft are identified by the word QUAIL followed by not more than two digits.

If a controller should encounter an unfamiliar call sign, the same identification as the pilot used in the initial callup should be used in the reply even though it may be different than those listed in the appropriate publications.

Procedure Words and Phrases

There are certain procedure words and phrases that have special meanings. These must be mastered by all Air Controlmen, as they are used repeatedly. The following are some of these procedure words and phrases and their meanings:

WORDS AND PHRASES	MEANING
Acknowledge	Let me know that you have received and understand this message.
Affirmative	Yes.
Correction	An error has been made in this transmission (or message indicated). The correct version is . . . .
Go ahead	Proceed with your message.
How do you head me	Self-explanatory.
I say again	Self-explanatory.
Negative	That is not correct.
Out	This conversation is ended and no reply is expected.
Over	My transmission is ended and I expect a reply from you.
Read back	Repeat all of this message back to me.
Roger	I have received all of your last transmission. (To acknowledge receipt; shall not be used for any other purpose.)
Say again	Self-explanatory.
Speak slower	Self-explanatory.
Standby	If used by itself means, I must pause for a few seconds. If the pause is longer than a few seconds, or if the word Standby is used to prevent another station from transmitting, it must be followed by the ending, OUT.
That is correct	Self-explanatory.
Verify	Check with originator.

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WORDS AND PHRASES	MEANING
Wilco	I have received your message, understand it and will comply (for use by USN only).
Words twice	Communication is difficult. Please say every phrase twice. (As a request.) Since communication is difficult, every phrase in this transmission will be spoken twice. (As information.)

Statement of Numbers

Statement of numbers is always of extreme importance in radiotelephone messages. The following pronunciation of the numerals has been found to be the best and most intelligible.

NUMERALS	PRONUNCIATION
1	WUN
2	TOO
3	TREE
4	FOW-ER
5	FIFE
6	SIX
7	SEV-EN
8	AIT
9	NIN-ER
0	ZERO

ALTITUDES.—State the separate digits of the thousands plus the hundreds.

EXAMPLES:

ALTITUDE	STATEMENT
500	FIVE HUNDRED
4,500	FOUR THOUSAND FIVE HUNDRED
9,000	NINER THOUSAND
10,000	ONE ZERO THOUSAND
13,000	ONE THREE THOUSAND

FLIGHT LEVELS.—State the words FLIGHT LEVEL, followed by the separate digits of the flight level.

EXAMPLES:

FLIGHT LEVELS	STATEMENT
180	Flight level one eight zero.
275	Flight level two seven five.

SERIAL NUMBERS.—State the separate digits.

EXAMPLES:

NUMBER	STATEMENT
18143	ONE EIGHT ONE FOUR THREE
26075	TWO SIX ZERO SEVEN FIVE

TIME.—State the separate digits of the hour and minutes in terms of Greenwich Mean Time (GMT) based on the 24-hour clock.

EXAMPLES:

TIME	STATEMENT
0615 GMT	ZERO SIX ONE FIVE
2230 GMT	TWO TWO THREE ZERO

NOTE: GMT is often referred to as ZULU time which is the phonetic equivalent of the designated letter suffix (Z) of the zero time zone.

Upon request, state the digits of the hours and minutes in terms of GMT, followed by local standard time based on the 24-hour clock.

EXAMPLE:

TIME	STATEMENT
1430 PST (2230 GMT)	TWO TWO THREE ZERO GREENWICH, ONE FOUR THREE ZERO PACIFIC.

TIME CHECKS.—State the word TIME followed by the separate digits of the hour, minutes, and nearest quarter minute.

EXAMPLE: TIME, ONE FOUR ONE FIVE AND THREE QUARTERS.

ABBREVIATED TIME.—State the separate digits of the minutes only.

EXAMPLE:

TIME	STATEMENT
1415	ONE FIVE

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POWER OUTPUT

The ability of the transmitter to provide sufficient power is also a limiting factor. Increasing the PRF increases the average power a proportional amount as shown by the equation

Average Power = Peak Power x Pulse Width x PRF

The useful power of the transmitter is that contained in the pulses and is termed the peak power of the system. Power is normally measured as an average value over a relatively long period of time. Since the radar transmitter is resting for a time which is long with respect to its operating time, the average power delivered during one cycle of operation is extremely low compared to the peak power available during the pulse time. High peak power is desirable to produce a strong echo at the maximum range of the equipment. Low average power enables the transmitter tubes and circuit components to remain cooler while operating and thus can be made smaller and more compact.

SCAN RATE AND BEAM WIDTH

Another factor affecting the PRF is the rate of angular motion of the antenna in searching extensive regions. If the antenna is moved through too large an angle between pulses, not only will the number of pulses per target be too low, but there may even be areas in which targets may exist without their being detected. In this connection, still another factor to consider is the sharpness of the antenna beam. A sharp beam must be pulsed more often than a wide beam to avoid skipping over targets.

The following equation shows the relationship of the antenna beam width, PRF, and antenna scan rate:

$$N_B = \frac{\theta_B f_r}{\dot{\theta}_s}$$

where

θ_B = antenna beam width in degrees

f_r = PRF in pps

$\dot{\theta}_s$ = antenna scanning rate in deg/sec

N_B = the number of pulses returned from a point target as the antenna scans through its beam width. (Generally, at least 10 pulses must be returned from a point target for reliable detection probability.)

RECEIVER SENSITIVITY

The sensitivity of radar is determined by several factors. Among these are transmitter output, transmitter frequency spectrum, pulse width, losses in the RF line, signal losses in the TR and ATR boxes, and receiver design and operation.

The sensitivity of a radar receiver is its ability to respond to weak echoes; the more sensitive the receiver, the greater the detection range of the radar.

The sensitivity of a radar receiver does not depend on the maximum amount of gain obtainable but on the noise level of the receiver. In other words, the gain could be increased many times above a given figure, but receiver noise would be amplified so greatly that a weak signal could not be seen among the "grass" and "clutter" produced on the indicator scope by the noise. Thus, the noise level of a receiver places a limit on the sensitivity of the receiver. The noise level depends on several factors. The signal-to-noise ratio in the first receiver stage is most important. Increasing the gain increases the noise level as well as the signal level. Receiver gain, therefore, is the result of a compromise between signal amplification and noise amplification.

Though noise voltages are highly undesirable in radar receivers, they cannot be completely avoided due to circuit elements. Although receivers have been built having greater input sensitivity, their operating limit is determined by the noise level within the receiver. When the signal voltage level falls below the noise voltage level, the returning signals are obscured by noise on the indicator. A further increase in amplification is useless because the noise and signal voltages are both amplified equally. Therefore, the highest obtainable signal-to-noise ratio is desired in the input stage of a radar receiver in order that the signal at the indicator is discernible from the noise. The loss of small power in the echo

FIELD ELEVATION.—State the words FIELD ELEVATION followed by the separate digits of the elevation.

EXAMPLES:

ELEVATION	STATEMENT
17 feet	FIELD ELEVATION ONE SEVEN
150 feet	FIELD ELEVATION ONE FIVE ZERO

ALTIMETER SETTING.—State the word ALTIMETER, followed by the separate digits of the altimeter setting.

EXAMPLE:

SETTING	STATEMENT
30.01	ALTIMETER, THREE ZERO ZERO ONE

SURFACE WIND.—State the word WIND, followed by the indicated wind direction to the nearest 10-degree heading, the words DEGREES AT, and the indicated velocity in knots.

EXAMPLE:

WIND, TWO SIX ZERO DEGREES AT ONE FIVE.

HEADINGS.—State the word HEADING, followed by the three digits of the number of degrees and omit the word DEGREES. Use heading 360 to indicate a north heading.

EXAMPLES:

HEADING	STATEMENT
005 degrees	HEADING ZERO ZERO FIVE
095 degrees	HEADING ZERO NINER FIVE

RADAR BEACON CODES.—State each digit of the four-digit code.

EXAMPLES:

CODE	STATEMENT
1000	ONE ZERO ZERO ZERO
2100	TWO ONE ZERO ZERO

RUNWAYS.—State the word RUNWAY, followed by the separate digits of the runway designation. For a parallel runway, state the word LEFT, CENTER, or RIGHT if the letter L, C, or R is included in the designation.

EXAMPLES:

DESIGNATION	STATEMENT
3	RUNWAY THREE
24L	RUNWAY TWO FOUR LEFT
7R	RUNWAY SEVEN RIGHT

FREQUENCIES.—State all the digits of the frequency, inserting the word POINT where the decimal point occurs. When the frequency is in the LF/MF band, include the word KILOHERTZ.

EXAMPLES:

FREQUENCY	STATEMENT
142.74 MHz	ONE FOUR TWO POINT SEVEN FOUR
360.2 MHz	THREE SIX ZERO POINT TWO
302 kHz	THREE ZERO TWO KILOHERTZ

SPEEDS.—State the separate digits of the speed followed by the word KNOTS.

EXAMPLES:

SPEED	STATEMENT
250	TWO FIVE ZERO KNOTS.
180	ONE EIGHT ZERO KNOTS.
90	NINER ZERO KNOTS.

International Phonetic Alphabet

It is quite often necessary to identify particular letters and groups of letters and/or spell out difficult words since certain sounds have low intelligibility when heard in noise. The standard phonetic alphabet identifies each letter of the alphabet with more readily recognized words. This is done to make the message clear when individual letters of the alphabet are transmitted, and to spell out words that are hard to understand on the air. The phonetic alphabet is as follows:

LETTER	RECOGNIZED WORD	PRONUNCIATION
A	ALFA	AL-FAH
B	BRAVO	BRAH-VOH
C	CHARLIE	CHAR-LEE or SHAR-LEE
D	DELTA	DELL-TAH
E	ECHO	ECK-OH
F	FOXTROT	FOKS-TROT

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LETTER	RECOGNIZED WORD	PRONUNCIATION
G	GOLF	GOLF
H	HOTEL	HOH-TELL
I	INDIA	IN-DEE-AH
J	JULIETT	JEW-LEE-ETT
K	KILO	KEY-LOH
L	LIMA	LEE-MAH
M	MIKE	MIKE
N	NOVEMBER	NO-VEM-BER
O	OSCAR	OSS-CAH
P	PAPA	PAH-PAH
Q	QUEBEC	KEH-BECK
R	ROMEO	ROW-ME-OH
S	SIERRA	SEE-AIR-RAH
T	TANGO	TANG-GO
U	UNIFORM	YOU-NEE-FORM or OO-NEE-FORM
V	VICTOR	VIK-TAH
W	WHISKEY	WISS-KEY
X	XRAY	ECKS-RAY
Y	YANKEE	YANG-KEY
Z	ZULU	ZOO-LOO

Routes and Navaids

Air controlmen operating at the Ground Control position in the control tower will be required to relay IFR clearances to IFR flights. A careful study of the following procedures and examples will enable him to properly describe routes and navaids, using proper phraseology.

VOR/VORTAC/TACAN AIRWAYS.—State the word VICTOR followed by the number of the airway in group form.

EXAMPLE: VICTOR THREE NINETEEN.

VOR/VORTAC/TACAN JET ROUTES.—State the letter J followed by the route number in group form.

EXAMPLE: J SIXTY NINER.

L/MF AIRWAYS.—State the color of the airway followed by the number in group form.

EXAMPLE: BLUE EIGHTY ONE.

VOR/VORTAC/TACAN RADIAL.—State the name of the navaid, followed by the magnetic bearing of the radial, omitting the word DEGREE.

EXAMPLE: MEMPHIS TWO FIVE ZERO RADIAL.

ARCS ABOUT VOR-DME/VORTAC/TACAN NAVAIDS.—State the distance in miles from the navaid, followed by the words MILE ARC, the direction from the navaid in terms of the eight principal points of the compass, the word OF, and the name of the navaid.

EXAMPLE: TWO ZERO MILE ARC NORTHWEST OF EL CENTRO TACAN.

L/MF RANGE COURSES.—State the name of the station, followed by the bearing of the course from the station in terms of the eight principal points of the compass, and the word COURSE.

EXAMPLE: ROSWELL NORTHEAST COURSE.

NONDIRECTIONAL BEACON COURSES AND BEARINGS.—State the course to, or the bearing from the radio beacon, omitting the word DEGREE, followed by the words MAGNETIC COURSE TO, or MAGNETIC BEARING FROM, the name of the radio beacon and the words RADIO BEACON.

EXAMPLES: ZERO FOUR FIVE MAGNETIC BEARING FROM MEMPHIS RADIO BEACON; TWO TWO FIVE MAGNETIC COURSE TO MEMPHIS RADIO BEACON.

VOR-DME/VORTAC/TACAN FIXES.—When the fix is not named, state distance in miles, followed by the phrase MILE D-M-E FIX, and the specified radial.

EXAMPLE: ONE TWO MILE D-M-E FIX, ARGENTIA TWO FOUR ZERO RADIAL.

When the fix is named, state the name of the fix followed by the phrase D-M-E FIX.

EXAMPLE: EAST GATE D-M-E FIX

Radio Contact Procedure

Radio communications may be initiated with an aircraft by using the following format:

1. Initial callup:
   a. Identification of the aircraft being called.
   b. The words THIS IS.
   c. Identification of the calling unit.
   d. The type of message to follow, when this will assist the pilot.
   e. The word OVER.
2. Replying to callup from an aircraft:
   a. Identification of the aircraft initiating the callup.
   b. The words THIS IS.
   c. Identification of the replying unit.
   d. The word OVER.

EXAMPLES: MARINE THREE ONE FIVE SIX EIGHT, THIS IS LEMOORE TOWER, ATC CLEARANCE, OVER; NAVY GOLF ALFA TWO ONE, THIS IS LEMOORE TOWER, OVER.

This same format is used after communication has been established except that after

stating the identification of the calling or replying unit, the message to be sent is stated or the message received is acknowledged.

A clearance or instructions intended for a specific aircraft must be prefaced with the identification of that aircraft, except that aircraft identification may be omitted after initial callup when conducting the final descent portion of a radar approach.

Where no confusion is likely, transmissions may be shortened as follows:

1. After communications have been established, the aircraft identification (with the exception of an air carrier or other civil aircraft having an FAA authorized call sign) may be shortened to the appropriate prefix and the last 3 digits or letters of the identification number, and the facility identification may be omitted.

2. The words THIS IS may be omitted and the word OVER may be omitted when the message obviously requires a reply.

3. A message may be transmitted immediately after callup (without waiting for aircraft reply) when it is short and receipt is generally assured.

In the following example, the words which may be omitted are enclosed within parentheses:

Aircraft - MIRAMAR TOWER (THIS IS) NAVY SEVEN FIVE ONE THREE ONE, OVER.

Tower - NAVY SEVEN FIVE ONE THREE ONE, (THIS IS) MIRAMAR TOWER, (OVER).

Aircraft - (MIRAMAR TOWER) (THIS IS) NAVY (SEVEN FIVE) ONE THREE ONE, FOUR MILES SOUTH (AT) TWO THOUSAND, LANDING MIRAMAR, (OVER).

Tower - NAVY (SEVEN FIVE) ONE THREE ONE ROGER, RUNWAY TWO FOUR, WIND TWO SIX ZERO DEGREES AT ONE FIVE, (OVER).

Aircraft - NAVY (SEVEN FIVE) ONE THREE ONE, (ROGER) (OUT).

Traffic Clearances And Instructions

An airport traffic controller should issue such traffic clearances and instructions as are, in his judgment, necessary for the purpose of controlling and protecting air traffic. He accomplishes this by aiding pilots in the prevention of collisions between aircraft under his jurisdiction.

A clearance issued by an airport traffic control tower is authority for a pilot to proceed only insofar as known air traffic and field conditions are concerned; it does not constitute authority for him to violate any provisions of military or federal air regulations.

Clearances issued by airport traffic controllers are predicated upon known or observed traffic and field conditions which, in the judgment of the controller, affect safety in aircraft operations. Such known traffic conditions include not only aircraft observed in the air within the control zone and on the movement area over which control is being exercised, but also any known or observed vehicular traffic or other obstructions not permanently installed on the movement area in use.

If a clearance issued by the airport traffic controller is not acceptable to the pilot, he may request and, if practicable, receive an alternate clearance.

Departure Information

The following information, as appropriate, is issued to departing aircraft:

1. Runway in use.

EXAMPLE: TAXI TO RUNWAY TWO FOUR LEFT; or, RUNWAY TWO FOUR LEFT.

2. Surface wind.

3. Altimeter setting. Unless specifically requested by the pilot, this need not be issued to local aircraft operators who have requested this omission in writing or to scheduled air carriers.

4. Time check to all USN/USAF IFR traffic and when requested by VFR traffic.

5. Issue the official ceiling and visibility to a departing aircraft before takeoff as follows:

a. To a VFR aircraft—when weather is below VFR minima.

b. To an IFR aircraft—when weather is below that published as the highest takeoff minimums for the airport, or if none are published, when weather is below VFR minimums.

6. Taxi information as necessary. Taxi route information need not be issued unless specifically requested by the pilot.

7. Inform departing IFR aircraft of the appropriate departure control frequency. This may be issued on the clearance delivery frequency or ground control frequency as applicable.

The following is an example of departure information issued in response to a request for such from the pilot of a departing IFR aircraft:

NAVY ONE THREE SEVEN, MAYPORT GROUND CONTROL, RUNWAY TWO FOUR LEFT, WIND TWO ONE ZERO DEGREES AT

ONE FIVE, ALTIMETER THREE ZERO ZERO ONE, TIME ONE FOUR ONE FIVE AND ONE QUARTER, TAXI EAST ON THE PARALLEL TAXIWAY, DEPARTURE CONTROL FREQUENCY WILL BE THREE TWO FIVE POINT TWO.

Normally, the taxi instructions issued permit an aircraft to proceed to a specified point without delay or confliction to other traffic under tower jurisdiction. If in the judgment of the controller, a potential conflict exists, taxiing aircraft must be held short of the area in which the conflict may exist to await further instructions. Issue concise and easily understood taxi information.

An EXAMPLE of taxi instructions from one point to another on the movement area would be as follows:

NAVY TWO ONE SEVEN TURN RIGHT AT THE FIRST INTERSECTION, TAXI ON THE PARALLEL TAXIWAY, HOLD SHORT OF RUNWAY TWO FOUR.

Subsequent taxi instructions to the above would be as follows:

NAVY TWO ONE SEVEN CLEARED TO CROSS RUNWAY TWO FOUR, CONTINUE TAXIING STRAIGHT AHEAD. TURN LEFT AT THE NEXT INTERSECTION TO OPERATIONS.

The absence of holding instructions authorizes the aircraft to cross all runways which the taxi route intersects except the runway to which it has been instructed to proceed.

TAKEOFF CLEARANCE

The takeoff clearance, as the name implies, is issued after the aircraft has taxied to the warmup area at the end of the runway. The pilot has previously received information on the runway in use, wind direction and velocity, the altimeter setting, and time check. By his statement to the tower, READY FOR TAKEOFF, the pilot indicates he is interested in obtaining authorization to commence his takeoff, and he needs information on such local traffic that may affect his flight while in the control zone.

Takeoff clearance should be issued in the following form:

1. (Identification).
2. (Any pertinent information).
3. CLEARED FOR TAKEOFF.

EXAMPLE: NAVY THREE TWO ONE, CLEARED FOR TAKEOFF.

Immediately after takeoff, many pilots want their time off the ground. An EXAMPLE of a response to such a request would be as follows:

NAVY ONE TWO THREE, OFF AT ONE SIX.

Aircraft may be authorized to taxi into takeoff position and hold when takeoff clearance cannot be issued because of traffic. Traffic information should be issued such aircraft unless the traffic is another aircraft which has landed or is taking off on the same runway.

EXAMPLE: TAXI INTO POSITION AND HOLD (traffic information, if required).

Aircraft CANNOT be authorized to taxi into position to hold for an unreasonable length of time before takeoff clearance can be issued or to hold simultaneously on intersecting runways.

When issuing additional instructions or information to an aircraft holding in takeoff position, include instructions to continue holding or taxi off the runway, unless it can be cleared for takeoff.

EXAMPLE: CONTINUE HOLDING; or, TAXI OFF THE RUNWAY.

Clearance for a requested right/left turn after takeoff is given at the discretion of the controller based on the existing traffic situation, and is usually included with the takeoff clearance. This would be stated as:

RIGHT/LEFT TURN APPROVED, CLEARED FOR TAKEOFF.

In the event an aircraft is on final approach and there is still sufficient time to clear a departing aircraft for takeoff, the following phraseology should be used:

CLEARED FOR IMMEDIATE TAKEOFF.

In the event an aircraft is on final approach and there is still sufficient time to clear a departing traffic aircraft which is in takeoff position, but some doubt exists as to whether or not the departing aircraft will take off immediately, the following phraseology should be used:

TAKE OFF IMMEDIATELY OR TAXI OFF THE RUNWAY.

Intersection takeoffs may be authorized to expedite the movement of traffic. Such procedure may be initiated by a controller or in response to a pilot's request. If a pilot requests the distance from the intersection to the end of the runway, the measured distance from an appropriate chart constructed for this purpose is issued.

Landing Information and Instructions

Instructions to enter the traffic pattern to approach the airport and land must include the following:

1. Specific traffic pattern information. (May be omitted if the aircraft is to circle the airport to the left.)

EXAMPLES:

ENTER LEFT/RIGHT BASE.
STRAIGHT-IN.
MAKE STRAIGHT-IN.
STRAIGHT-IN APPROVED.
RIGHT TRAFFIC.
MAKE RIGHT TRAFFIC.
RIGHT TRAFFIC APPROVED.
CONTINUE.

2. Runway in use.
3. Surface wind direction and velocity. (When the aircraft is being controlled by a radar facility not having wind measurement equipment, relay this information to the radar controller at the time approach, landing, or touch-and-go clearance is issued.)
4. Any supplementary information.
5. Clearance to land (when appropriate).
6. Requests for additional position reports when required.

Using the above form, instructions governing a flight from a visual reporting point, holding point or fix, or other outlying point to the traffic pattern would be stated as follows:

NAVY THREE TWO NINER, THIS IS NAVY MEMPHIS TOWER, ROSEMARK AT TWO THOUSAND, ENTER DOWNWIND, RUNWAY THREE SIX, WIND ZERO ONE ZERO DEGREES AT ONE FIVE, REPORT ENTERING DOWNWIND.

Instructions to a jet aircraft that will use the overhead type of approach would be as follows:

NAVY FOUR ONE FIVE, THIS IS OCEANA TOWER, FIVE MILES SOUTH AT TWO THOUSAND, RUNWAY THREE TWO LEFT, WIND THREE ONE ZERO DEGREES AT ONE FIVE, REPORT INITIAL.

The instructions to enter a traffic pattern should not be confused with the clearance to land since the former is issued when the aircraft is some distance from the field and traffic conditions usually do not permit the issuance of a landing clearance at that point.

Clearance to land should be given as follows:

NAVY THREE TWO NINER, CLEARED TO LAND.

In the event aircraft are landing and taking off at an airport without coming to a stop during their landing roll, such operations are described as touch-and-go landings. Pilots are required to request approval of same at least by the time they are turning on their final approach leg. Approval for such operation should be issued by use of the following phraseology:

CLEARED FOR TOUCH-AND-GO.

In the event it is not possible to approve a requested touch-and-go operation, but a full stop landing can be approved, the following phraseology is used:

UNABLE TOUCH-AND-GO, MAKE FULL STOP LANDING OR GO AROUND (CIRCLE THE FIELD).

If an aircraft cannot be cleared to land and it is desired that it continue to circle the airport, the following phraseology should be used:

CIRCLE THE AIRPORT.

When it is desired to delay an aircraft in effecting separation, and a normal circle of the field would take more than the required time, the following phraseology should be used if circumstances permit:

MAKE LEFT/RIGHT THREE SIXTY/TWO SEVENTY.

When an aircraft is on final approach and it becomes necessary to cancel the landing clearance, the following phraseology should be used:

GO AROUND.

Whenever it is desired that pilot shorten his approach path, the following phraseology should be used:

MAKE SHORT APPROACH.

When it is desired that the pilot lengthen the downwind leg, the following phraseology should be used:

EXTEND DOWNWIND.

To inform pilots of arriving aircraft of their respective positions in the traffic pattern landing sequence, the following phraseology may be used:

NUMBER (landing sequence number).

If it is desirable or necessary to be specific and indicate that an arrival follow a particular aircraft in the traffic pattern, the following phraseology may be used:

FOLLOW (description and location of traffic).

If other landing traffic is utilizing a runway different from that which an arriving aircraft will use, traffic information should be issued to the arrival as follows:

TRAFFIC IS (description and location of traffic)

LANDING RUNWAY (number).

When describing location, descriptions such as TO YOUR RIGHT, ABOVE YOU, ONE MILE AHEAD OF YOU, etc., are much more satisfactory than NORTH OF YOU, ONE MILE EAST OF YOU, etc.

Request aircraft to report wheels down when it reaches an appropriate position in the traffic pattern, unless the pilot has previously reported wheels down, as follows:

REPORT WHEELS DOWN.

Landing clearance should not be issued to an arriving aircraft until a WHEELS DOWN report is received.

In the event an aircraft has encountered landing gear difficulty and has to proceed within close proximity of the control tower for personnel to observe the landing gear, the following phraseology should be used:

1. If the landing gear appears to be in a normal position the control tower personnel should transmit:

LANDING GEAR APPEARS DOWN AND IN PLACE.

2. If the landing gear does not appear normal, a description of the appearance should be given, as for example:

RIGHT WHEEL APPEARS RETRACTED, or LEFT WHEEL DOES NOT APPEAR IN PLACE.

Additional Phraseology

Controllers approve or disapprove pilots' requests as circumstances and traffic conditions permit. In cases where specific phraseology is not set forth for the applicable procedure, use of the words APPROVED, or UNABLE (include reason and/or additional instruction when necessary), as appropriate.

EXAMPLES: FREQUENCY CHANGE APPROVED; UNABLE HIGH SPEED LOW APPROACH, SLOWER TRAFFIC IN THE PATTERN.

The word IMMEDIATELY is used in phraseology only when expeditious compliance is required to avoid an imminent situation. If time permits, the reasons for this action should be included.

AC's should refer to the appropriate sections of TATC Handbook 7110.8 (Series) for additional phraseology not included here or for possible changes thereto.

FIGHTER DIRECTOR VOCABULARY

Air Controlmen should be well versed in the brevity codes which are used for aircraft control, search and rescue, carrier deck conditions, and flight operations. These brevity codes are provided in the current Allied Communications Publication (ACP) 165 and are required knowledge factors for all Air Controlmen.

DIRECTION FINDER COMMUNICATIONS PROCEDURES

Direction finder communication procedures may not always be identical, as situations may arise which necessitate modifications. Listed below is a typical D/F voice procedure:

1. Pilot calls D/F station:
NAVY MEMPHIS TOWER, THIS IS NAVY 34568, REQUEST STEER, OVER.
2. D/F station acknowledge callup:
NAVY 34568, THIS IS NAVY MEMPHIS TOWER. TRANSMIT FOR STEER, OVER.
3. Pilot replies:
NAVY MEMPHIS TOWER THIS IS NAVY 568 TRANSMITTING FOR STEER (pilot then depresses microphone button for a period of approximately 15 seconds).
4. D/F station replies:
NAVY 568, THIS IS NAVY MEMPHIS TOWER. STEER WITH ZERO WIND IS 180, OVER.
5. Pilot replies:
NAVY MEMPHIS TOWER, THIS IS NAVY 568, MY STEER IS 180, OUT.

Frequent followup checks are made, as outlined above (about every 30 seconds to 1 minute) to compensate for wind drift, compass error, etc., and to insure that the aircraft does not overfly the station. When the pilot states he no longer requires or desires this service, the D/F steer is then discontinued.

VISUAL COMMUNICATIONS

PORTABLE TRAFFIC CONTROL SIGNALS AND MEANING

The nomenclature and operation of the portable traffic control light were previously discussed in chapter 4. However, since the portable traffic control light is used to control the movement of personnel and vehicles on the landing area, as well as aircraft without radio, the control signals and their meaning are discussed at this time.

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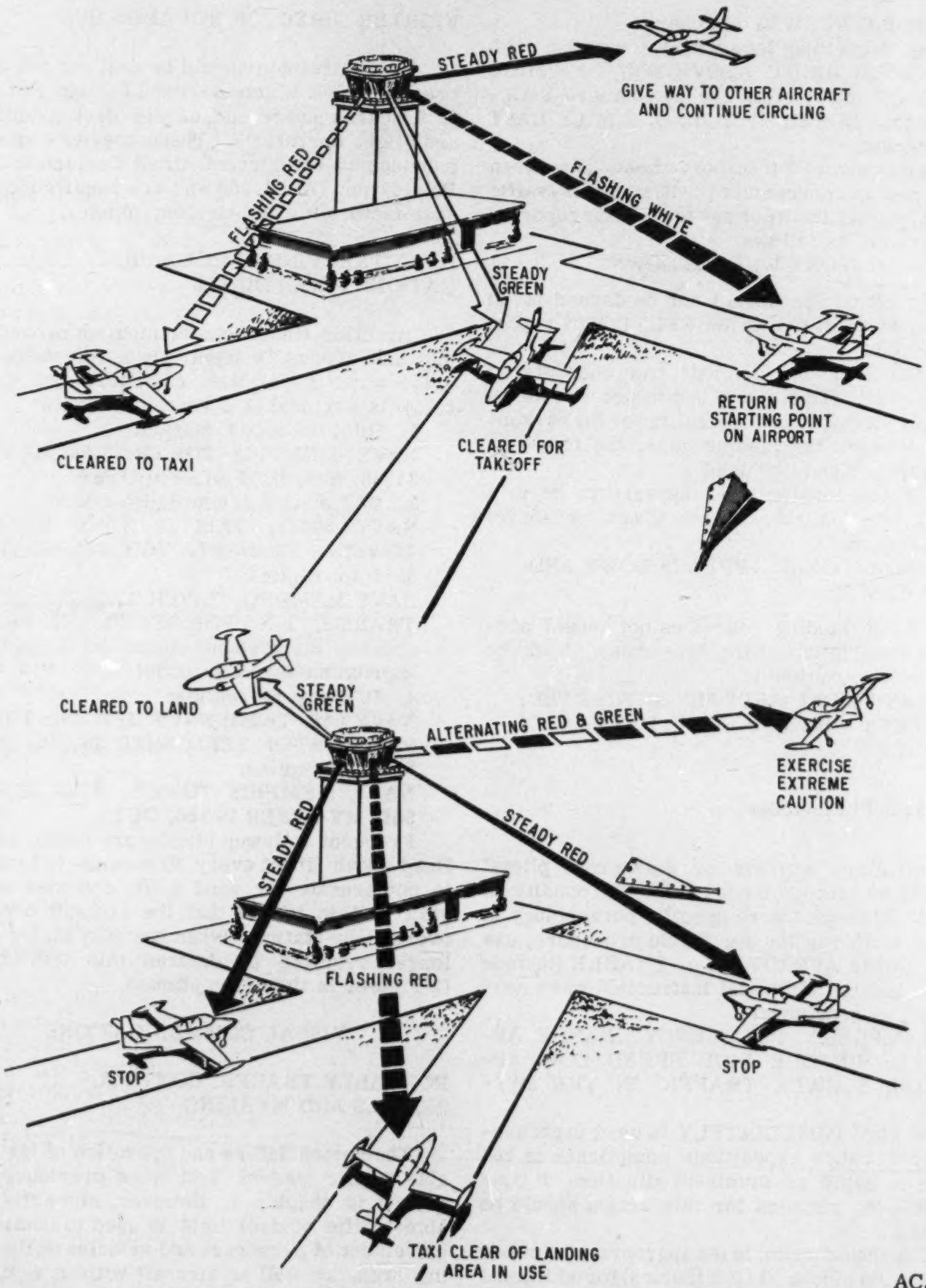

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Figure 10-1.—Portable traffic control light signals.

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Table 10-1.--Meaning of traffic control light signals.

Color and type of signal	On the ground	In flight
STEADY GREEN	Cleared for takeoff	Cleared to land
FLASHING GREEN	Cleared to taxi	Return for landing (to be followed by steady green at proper time).
STEADY RED	Stop	Give way to other aircraft and continue circling.
FLASHING RED	Taxi clear of landing area (runway) in use.	Airport unsafe—do not land.
FLASHING WHITE	Return to starting point on airport.	Not applicable.
ALTERNATING RED AND GREEN	General warning signal—exercise extreme caution.	

In addition to the operation and limitations of the portable traffic light, the Air Controlman must know the meaning of the traffic control light signals used. Figure 10-1 shows the meaning of the signals to be used for aircraft, vehicles, and personnel on the ground and for aircraft in the air. This is shown in tabular form in table 10-1.

A series of alternating red and green flashes from a directed traffic control light are used as general warning signals to advise a pilot or driver of a vehicle on the landing area to be on the alert for hazardous or unusual conditions. As an example, the warning signal may be directed to a pilot to indicate a change of runway, since this can prove hazardous if the pilot attempts to land crosswind.

In controlling traffic by means of visual signals it should be remembered that the warning signal is not a prohibitive signal. This means that it may be followed by either a red or a green light as circumstances warrant. The general warning signal is directed to pilots of the aircraft concerned as follows:

1. When aircraft are converging and there is a possibility of collision.

2. When hazardous conditions are present and the pilot must be unusually alert in order to complete the operation safely. (Such conditions include obstructions, soft field, ice on runway, and many others.)

3. When mechanical trouble is apparent to the controller and he has reason to believe that the pilot may not be aware of it.

4. At any other time when believed necessary in the opinion of the controller.

SPECIAL LIGHT SIGNALS

Aircraft Inbound Without Radio

Between sunset and sunrise, a pilot wishing to land should turn on a landing light as he approaches the airport unless he has already been given a green light.

A series of flashes of a landing light by a pilot intending to land mean: If the floodlight is on, the pilot wants it turned off; and if the floodlight is off, the pilot wants it turned on.

Pilots should acknowledge portable traffic control light signals by rocking the aircraft's wings during hours of daylight and by blinking their landing or navigation lights during the hours of darkness.

Aircraft on the Airport Without Radio

During the hours of darkness, a pilot wishing to attract the attention of the control tower

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operator should turn on a landing light and taxi the aircraft in a position so that the light is visible to the tower controller. The landing light should remain on until appropriate signals are received from the tower.

Pilots should acknowledge light signals by moving the ailerons or rudder during the hours of daylight or by blinking the landing or navigation lights during the hours of darkness.

Low Ceiling and Visibility Signals

During the hours of daylight, the lighting of the airport rotating beacon (fig. 10-2) means that the ground visibility in the control zone is less than 3 miles and/or the ceiling is less than 1,000 feet. Flashing light outlining the traffic direction indicator at night (fig. 10-2) indicate that the ground visibility in the control zone is less than 3 miles and/or that the ceiling is less than 1,000 feet.

Airport Course Lights

Some military airports have special light signals, such as course lights, which indicate landing direction, runway in use, traffic pattern in use, and other similar information for local activities. These lights are to be used as directed by the commanding officer. The principal advantage in using the course lights is that it gives pilots pertinent and specific visual information; therefore, radio contact with the control tower is unnecessary. However, the meaning and arrangement of these lights have no standardization and are used only for pilots known to be familiar with the meaning of the special light signals.

VISUAL EMERGENCY SIGNALS

Visual emergency signals are the means by which downed airmen communicate with rescue aircraft. Airmen in distress should use every effort to attract attention either by means of radio or visual emergency signals. Visual emergency signals consist of various positions of the body and its extremities, the display panels, and parts of the aircraft itself which may be used if not destroyed. These parts consist of engine cowling, doors, flooring, ailerons, strips of fabric, etc., and, in addition, pyrotechnic light and smoke signals.

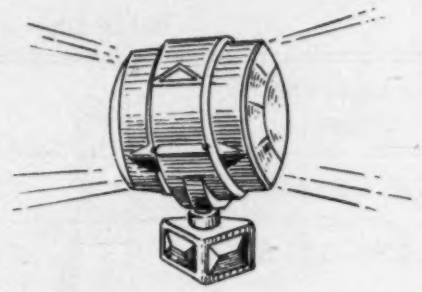

ROTATING BEACON (day only)

Ground visibility in control zone less than 3 miles and/or ceiling less than 1,000 feet. Traffic clearance required for landings, takeoffs, or flight in the traffic pattern in a control zone.

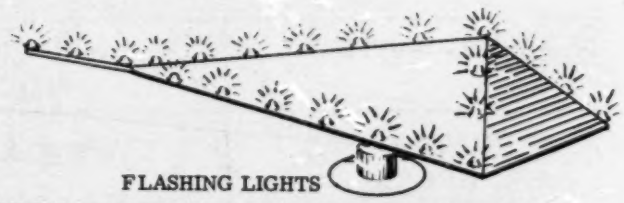

FLASHING LIGHTS
OUTLINING TRAFFIC DIRECTION INDICATOR (night only)

Ground visibility in control zone less than 3 miles and/or ceiling less than 1,000 feet. Traffic clearance required for landings, takeoffs, or flight in the traffic pattern in a control zone.

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Figure 10-2.—Light signals used in air traffic control.

Body Signals

The body signals as illustrated in figure 10-3 are used by airmen who have made forced landings to attract the attention of a rescue aircraft. Messages are transmitted to the pilot by using these body signals as the aircraft circles over the location of the downed airmen. The person using the body signals should stand in the open making certain the background, as seen from the air, is not confusing. Each motion must be accomplished slowly, and each signal repeated until the person being rescued is positive that the pilot understands the message.

Visual Panel Signals

The international ground-to-air emergency code for use in distress signals when using display panels is shown in figure 10-4. These signals are for international use by personnel who crash in aircraft or descend by parachute in remote areas and who are in need of medical assistance, food, or information as to what

AC.133

Figure 10-3.—Body signals.

route should be followed in order to effect rescue.

The symbols may be made by laying out strips of fabric or parachutes, pieces of wood, peeled logs, stones, or any available material. As much color contrast as possible should be provided between material being used for the symbols and the background against which the symbols are exposed. Ground contrast can be often increased by using fluorescein dye sea-marker to dye uncolored parachutes, snow, or light sand. The symbols should be at least 8 to 10 feet high. Care should be taken to lay out the symbols exactly as shown in figure 10-4 to avoid confusion with other panel display communication symbols. When the ground is covered with snow, signals can be made by dragging, shoveling, or tramping the snow, as the depressed areas forming the symbols should appear to be black from the air. In addition to

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signal or the addition of an equally small noise power in the input stage may reduce the maximum range of the radar set as much as the loss of large amounts of power from the transmitter. Thus, the sensitivity of a radar receiver is measured by the smallest input signal that can produce an output signal discernible against the noise background on the indicator.

In order to obtain as high a signal-to-noise ratio as possible a compromise must be made. If the band-pass of the IF amplifiers is increased, the pulse shape will be maintained as desired but the noise, which is random frequencies, will also be amplified.

If the band-pass of the IF amplifier is decreased, the random frequency noise will be decreased but the pulse shape will be distorted. (This distortion is due to the composition of the square pulse desired which contains many harmonics.)

RF amplifiers are normally not used due to their high noise level when operating in the microwave region. This noise level is due to thermal agitation, shot noise, and induced grid noise. A remedy for noise created in microwave amplifiers is the traveling wave tube, discussed in chapter 9 of Basic Electronics. This tube is fleet use.

The compromise, therefore, is the allowable distortion of the echo pulse versus the acceptable noise level.

BASIC RADAR SYSTEM

Radar sets currently used in aviation vary greatly in detail and in the function they are designed to accomplish. They may be very simple or, if more accurate data is required, they may be highly refined. However, the principles of operation are essentially the same for all sets. Thus, a single basic radar set can be visualized in which the functional requirements hold equally well for all specific sets. The varying details are due to a choice of specific circuits to fulfill these general functional requirements. In general the degree of refinement of radar circuits increases as the operating frequency of the radar increases. (Microwave frequencies lend themselves to a higher degree of precision in determining angular measurement.)

A typical pulse radar set consists essentially of six basic components—synchronizer (timer), transmitter, antenna system, receiver, indicator, and power supply. The relationship of each component is illustrated by block diagram in figure 15-2 (A).

SYNCHRONIZER

The circuits in an airborne radar system that control or synchronize the operation of the various componenets of the system are known as timing circuits.

The functions which the timing circuits must perform depend to a large extent upon the purpose of the set, the type of modulator used, and the method of data presentation employed. Thus, the functional block diagram shown in figure 15-2 (A) does not apply to any particular set but shows a method of control (timing) which is used in airborne radar sets.

Figure 15-2 (B) shows the control pulses furnished by the timer and their proper time relationships to the transmitted pulse.

The first pulse (waveform (1), fig. 15-2(B)) is the transmitter trigger. It causes a pulse of RF energy to be transmitted as shown in waveform (2). The transmitter trigger also acts as a reference point from which the other operations are timed.

The timer also supplies a trigger pulse to start the range sweep as shown in waveform (3). However, in some radar sets both the transmitter trigger and the range sweep trigger are delayed. The transmitter trigger delay is a fixed amount, and the range sweep delay may be varied to allow the start of the range sweep as desired. This enables the range sweep trigger to start the sweep at exactly the same time as the transmitter fires, regardless of any inherent delay in the sweep circuit. This time is usually referred to as time zero (t_0), shown as the dotted line in figure 15-2 (B).

Another voltage which the timer may supply in an intensifier pulse, waveform (4), usually referred to as an intensity gate. The intensity gate functions to blank the indicator except during the time of the desired range sweep. Thus, signals arriving outside the time interval corresponding to the desired range are eliminated. The intensity gate shown in waveform (4) is applied to the grid of the CRT. This gate cancels the CRT's disabling voltage, thus allowing the video signal to intensity-modulate the electron stream. An alternate method is to make the CRT normally operative and to apply a negative gate, or blanking pulse, to

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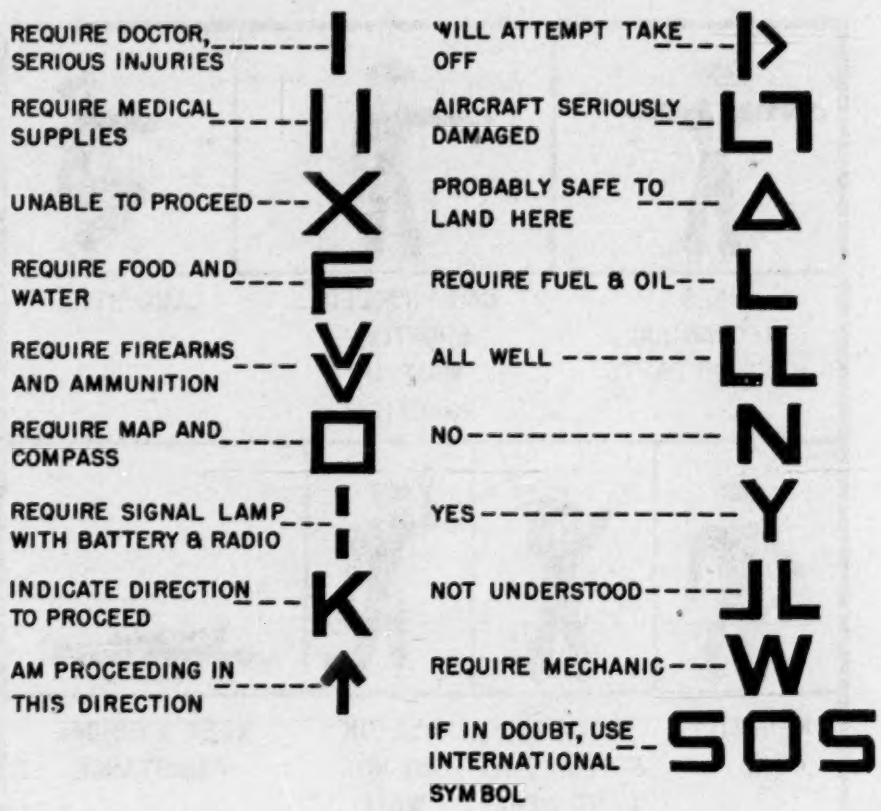

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Figure 10-4.—Ground-to-air emergency code.

ground (or surface vessel), or from ground (or surface vessel) to aircraft. The signals are used for either day or night identification and communication. The pyrotechnic pistol and signals are not described because the Air Controlman likely will have little contact with them. Instead, he will need to know the use made of using symbols, every effort is to be made to attract attention by means of radio, flares, smoke, or other available means.

Pyrotechnic Light and Smoke Signals

Aircraft signals are intended to be fired from aircraft to aircraft, from aircraft to signals locally and be able to recognize the signals when fired.

Use of aircraft signals are many and varied. Various color combinations are carried and used. They may be used by pilots when forced down or during emergencies. The Air Controlman often sees them used at air stations, particularly during night-flying operations. It is common practice for a runway watch to be stationed near the end of the duty runway. Whenever a landing aircraft appears to have failed to lower its landing gear, the runway watch fires a red pyrotechnic light signal, which indicates to the pilot he must not land.

An international signal, meaning aircraft in distress, is a single red pyrotechnic light displayed singly or in succession.

One green pyrotechnic light from the ground at an airfield grants the aircraft permission to land. This same signal FROM the aircraft at night means that the pilot is requesting permission to land, whereas by day, the pilot is requesting permission to land in any direction other than that authorized.

A white pyrotechnic light at night from a shore station means that the distress signal or plight has been observed and assistance has been summoned. In the daytime, an international white smoke signal means the trouble has been noted and assistance will be given as soon as possible.

An orange or white pyrotechnic light from an airfield means local recall. This signal may also be used in fog or mist or for any other reason to indicate the position of an airfield.

CHAPTER 11

AIRPORT TRAFFIC CONTROL

AIRPORT LAYOUT

The Air Controlman must have a thorough knowledge of the airport layout, airfield markings, and airfield lighting equipment to effectively control traffic on and in the vicinity of the airport.

SELECTION OF SITE

Why did the Wright brothers journey from Ohio to Kitty Hawk, North Carolina, to conduct their early tests? They were selecting a site, and for a very good reason. Their primary concern of the selection of a site was the prevailing wind conditions. They knew from earlier experiments, that their fragile and somewhat low powered craft needed the advantage of a steady wind to become airborne. The site at Kitty Hawk offered such an advantage.

In the early days of aviation a smooth field at the edge of town served quite adequately as an airport. Then, as aircraft became heavier and faster, and with the advent of instrument flying, bigger and more elaborate facilities had to be constructed. The airport of today is much more complex than in the past and many factors must be considered in selecting a site. Some of the major factors are adequate area, accessibility, weather conditions, and terrain.

Adequate Area

The site selected must afford a sufficient and suitable area for the required airport facilities. In the past years of aviation it was extremely difficult to accurately predict the rapid growth of aviation. Higher performance aircraft and the great volume of air traffic that grew so fast caused some airport areas to become inadequate very quickly. To add to the problem, cities and towns grew outward to meet the airport area. In planning the modern airport, careful consideration should be given to possible expansion in the future.

Accessibility

Another aim of site selection is to insure that adequate supply routes are available either by land, water, or by air. Railroads and surrounding highways naturally simplify the supply problem. When an airport is planned to serve a metropolitan area, it is necessary to locate the airport where it is easily accessible to the city and still does not create a hazard in the congested areas.

Many Navy airports exist for the primary purpose of supporting the fleet. In order to best serve this need they must be easily accessible. Their easy accessibility contributes not only economically, but to the combat readiness of fleet units.

Weather Conditions

Prevailing weather conditions should also be considered. By checking past weather bureau records of the area, future weather conditions can be predicted rather accurately. From an operational standpoint some things to consider are the frequency, severity, and persistence of wind, fog, snow, and rainfall. Additional items to be considered are the need for snow removal equipment, number and type of instrument landing aids, and elaborate drainage construction in areas of heavy rainfall. These factors figure greatly in the cost of construction and maintenance of any airport.

Terrain

A site with favorable topography is one located on high ground with sufficient slope for natural drainage and a reasonably level surface.

Rough or hilly terrain can easily become hazardous to low flying aircraft operating from an airport. In addition, rugged terrain can increase considerably the cost of construction.

The proposed area should be flight-tested for planning approaches to future runways. Special attention should be given to the possibility of shifting wind, downdrafts, and the presence of air eddies that may affect these approaches. From these tests it may even be determined that the proposed site is not a suitable one.

FACILITIES

Throughout the development and construction of airports, facilities have become more standard in the Navy. In keeping with this standardization, further studies of considerable scope and magnitude are presently underway due to progress in the development of aircraft and related installations. The facilities aboard any military airport are many and varied. The Air-Controlman must keep abreast of airport advances and the facilities that are available in order that he may properly handle and expedite air traffic.

Runways

A runway is that portion of the landing area, usually paved, upon which aircraft actually land and takeoff. Runway pavement is designed to meet rigid specifications under certain conditions and to resist jet blasts and fuel spillage. The number and orientation of runways are determined from an analysis of wind and other pertinent data. When more than one runway is considered for an airport, the primary runway is determined by the direction of maximum wind coverage (prevailing wind) to facilitate landings and takeoffs into the wind. The secondary and subsequent runways are oriented to provide the greatest overall wind coverage. This plan is generally the most widely followed. However, adjustments may be required for surrounding developments, local terrain features, excessive construction problems, or alinement of an instrument runway to suit all weather conditions. At airports where the volume of traffic would be restricted by the availability of only one runway, parallel runways may be incorporated either in the original design or added later as necessary.

Runway Overrun Areas

These areas are usually nonpaved, relatively smooth areas which extend beyond the ends of runways. A portion of this area is constructed of selected materials, compacted and stabilized. This stabilized area is essentially an extension of the runway. The primary purpose of this strip is to provide a reasonably effective deceleration area for aborting or overshooting aircraft. This area may also serve as an emergency all-weather access for firefighting, crash, and rescue equipment. Provisions are made at the upwind end of takeoff runways for a crash strip which is an extension beyond the overrun area. Takeoff runways are those runways whose takeoff usage exceeds 40 percent of total takeoffs. All obstructions are removed; and ditches, gullies, and embankments are leveled off into the general profile of the extended centerline of the runway to minimize damage to aircraft.

Some runways have paved overruns and the area is marked with yellow chevrons across the area. With this type marking, it becomes a nontouchdown area. At some stations these areas are called blast pavements; used primarily to prevent erosion of runway ends from propeller and jet blast. They are usually made of highway paving material and do not have runway-bearing strength.

Taxiways

A taxiway is a specially prepared area, or lane, over which aircraft usually operate under their own power to and from the landing and parking areas. Taxiways are normally constructed to the same specifications as the runways except for dimensions. A warmup area, usually an expanded portion of the taxiway adjacent to the end of the runway, is used for aircraft holding, engine warmups, and checking aircraft instruments and radio equipment. In any event, the warmup area must be of sufficient dimensions to permit aircraft to hold at least 100 feet clear of the runway in use.

Parking Areas

This is a hard-surfaced area located in the vicinity of hangars for the purpose of parking, servicing, and loading aircraft. They are connected to the runways by taxiways, and normally padeyes are sunk into the surface for tying down aircraft during storm conditions.

Mat Facilities

The mat is a large, hard-surfaced area usually located near the center of the field or at a common intersection of runways. It is often used for the operation of small aircraft and facilitates the taking off and landing of several aircraft at the same time. The mat is especially useful where pilot training is being conducted. The load limits of mat areas are often less than the regular runways; therefore, Air Controlmen assigned to fields which have these facilities should be aware of their load limitations.

Compass Calibration Pad

The compass calibration pad or compass rose is a special paved installation, ordinarily circular in design, used for calibrating the magnetic compass(es) in the aircraft and situated well clear of approach and departure paths of aircraft landing or taking off. The surface is marked every 15 degrees to indicate magnetic bearings beginning with magnetic north. The taxiway to the compass rose is generally placed perpendicular to the taxiway with the least traffic, and the compass rose location must be free from local magnetic influences. All metal used in the construction is either brass or bronze, because it will not affect magnetic instruments. Other metal objects should be kept clear of the area when the compass rose is in use. In calibrating an aircraft compass, all electrical equipment is turned on and the engines kept running to simulate actual flight conditions.

Wind Direction Indicators

The three principal types of wind indicators are the wind tee, the windsock, and the tetrahedron. (See fig. 11-1.)

The wind tee is similar in outline to a small aircraft. It is mounted on a pedestal and will weathercock into the wind, thereby indicating the wind direction. This free swinging characteristic affords the pilot a visual presentation of the exact direction from which the wind is blowing. If the tee is not alined perfectly with the runway being used, the pilot knows that he has to compensate his landing for a crosswind—the amount of compensation being roughly judged from the angle the tee is deviating from the centerline of the landing runway. Also, while taking off it is expedient for the pilot to have this same information. The wind tee may be lighted by one or more lights for nighttime use with green lights on the fore and aft bar and red lights on the crossbar.

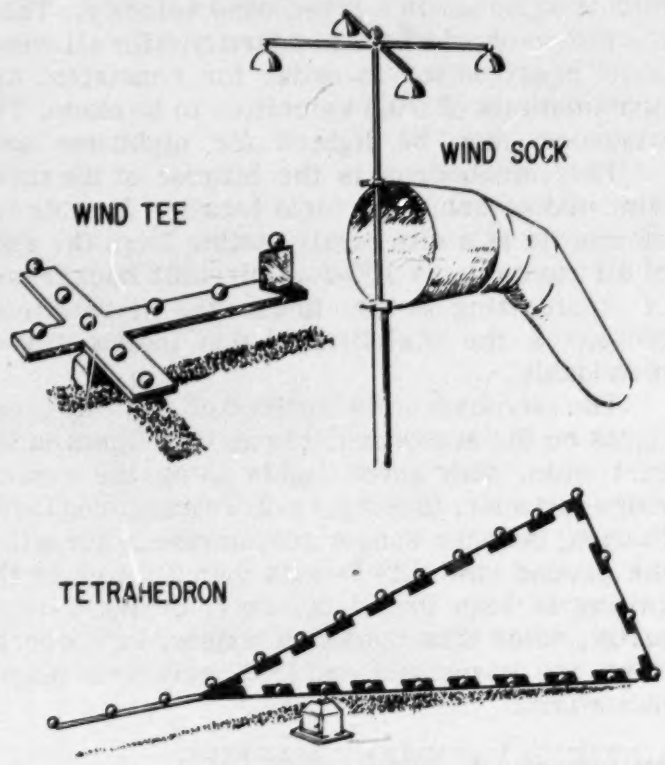

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Figure 11-1.—Wind direction indicators.

The windsock has the appearance of a large stocking minus the foot. It is made of light, durable fabric and is secured to a mast by means of a swivel on the hoop at the large end. Air in motion passing through the windsock alines the windsock with the wind to indicate the direction from which the wind is blowing. The windsock has an advantage over the wind tee in that besides indicating the direction, it also gives an approximation of wind velocity.

The velocity of the surface wind can be approximated by comparing the angle of the windsock in its relation to the ground. The windsock will stand out parallel with the ground when the wind is 15 to 20 knots. (A steady wind greater than 20 knots will give the same indication; hence caution must be exercised if the windsock is the only available reference.) A gusty wind is indicated when the windsock alternately rises and falls rapidly. A calm wind is indicated when the windsock hangs limply at the mast. Gusty, shifting wind is denoted by the windsock swinging from side to side and rising and falling.

The type of fabric from which the windsock is constructed determines to a great extent how high it will rise in a given wind velocity. Thus, the fabric should be a standard type for all windsock construction in order for consistent approximations of wind velocities to be made. The windsock may be lighted for nighttime use.

The tetrahedron is the largest of the three wind indicators. The ideal location for this indicator is at a site easily visible from the ends of all runways. A 100-foot circular background of contrasting color, under the tetrahedron, increases the visibility of this indicator tremendously.

The tetrahedron is outlined at night by green lights on the starboard side and red lights on the port side, with green lights along the central ridge and spar. (See fig. 11-2) Tetrahedron lights flashing between sunset and sunrise indicate that the ground visibility is less than 3 miles or the ceiling is less than 1,000 feet, or both. Normally, when this condition exists, VFR operations are suspended and IFR operations placed into effect.

AIRFIELD PAVEMENT MARKING

Runway Markings

Runway numbers which appear near the approach end of all runways indicate the magnetic heading of the runway. The number assigned to a runway is one-tenth of the magnetic compass reading to the nearest whole number. This means that when a pilot lands toward the South with a compass reading of 168 degrees, he will be landing on runway 17. (If the last figure is 5 or more, select the next higher 10-degree increment.) In this example the nearest whole number is 170 degrees; so, by dropping the zero from 170 degrees or 1/10 x 170, the figure 17 is produced. This number will appear on the approach end of the runway.

If the inbound magnetic heading of a runway is less than 100 degrees, such as 070, 080, 090, etc., the first zero and the last zero are dropped, resulting in runways numbered 7, 8, and 9. (See fig. 11-3.)

At airports using multiple parallel runways L indicates left, R indicates right, and C indicates center. All numbers and letters are painted with reflective white paint and the paint may be applied solid or composed of 6-inch strips spaced 6 inches apart.

The runway centerline stripe is 3 feet wide on a primary runway and 2 feet wide on all other runways. They are painted white (reflective) and when placed on concrete pavement the stripe is edged with a 1-foot band of black paint. The runway centerline marking is formed by a broken line. At intersections of two or more runways, the centerlines are continued through the intersection.

To aid further in takeoff and landing guidance, there are runway side stripes in addition to the runway centerline stripe. The painting specifications are the same, except that the side stripes are solid instead of broken lines. (See fig. 11-3.) At intersections of two or more runways, the side stripes are continued on one runway only. Preference for the continuous runway stripe is given to the primary runway.

Navy markings also include runway distance markers which afford pilots information as to length of runways during landings and takeoffs. These markers are 4-foot square vertical signs painted international orange with white numerals and each has a hooded floodlight for night viewing. The numerals express, in decreasing order, the distance in thousands of feet of actual runway remaining. Only the first number appears on the sign; for example, 4 indicates 4,000 feet of runway remaining. The markers are mounted directly opposite each other on each side of the runway at 1,000-foot intervals

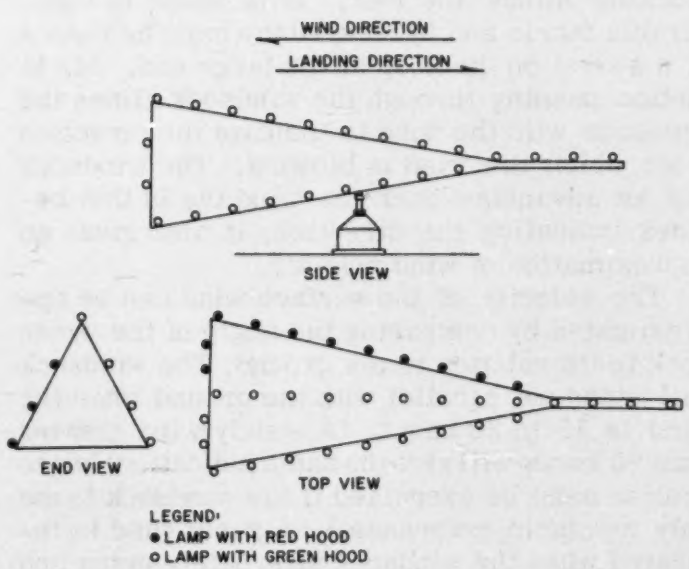

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Figure 11-2.—Tetrahedron lighting arrangements.

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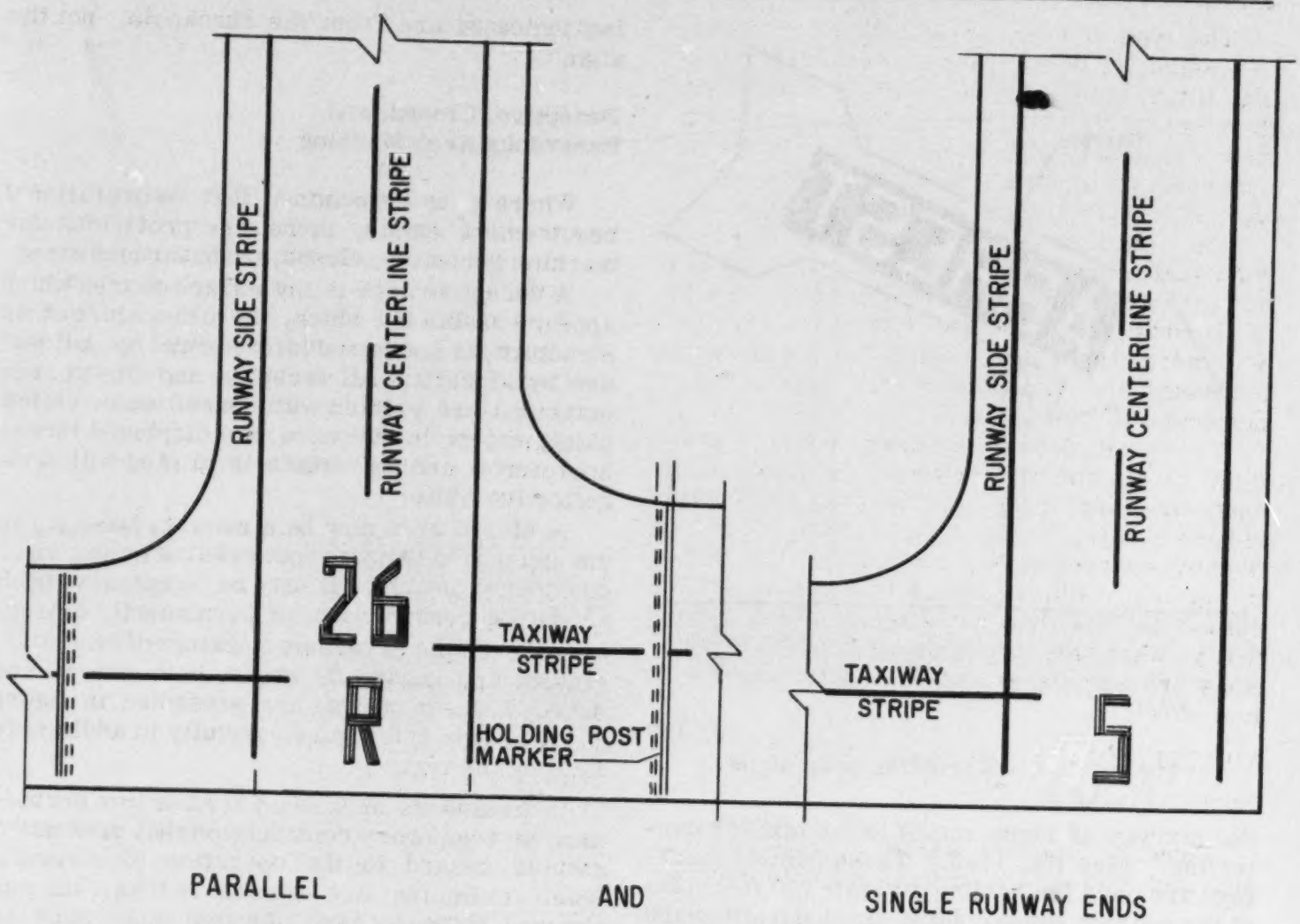

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Figure 11-3.—Runway markings.

25 feet outboard of the runway edge and perpendicular to the runway centerline. Where runway intersections or taxiway entrances interfere, the longitudinal spacing may be varied, but in no case will markers along the last 3,000 feet indicate appreciably more runway than actually exists.

At some locations there are markings that are used for a specific purpose. One most common is an area used for field carrier landing practice (FCLP). In this instance an area is painted to simulate an aircraft carrier deck. Stations involved in testing new or modified aircraft sometimes require special markings in the course of conducting various tests. Fields that are used primarily for pilot training may have certain markings arranged so as to better accomplish this task.

Large signs are installed on both sides of the runway to mark the location of arresting gear (discussed later in this chapter). The signs are large (7 feet long) yellow plexiglass arrows with white letters on a black background. The signs are lighted. (See fig. 11-4.)

Taxiway Markings

Taxiway centerline stripes, like runway markings, give visual aid to pilots. A noticeable difference between runway and taxiway markings is that white markings are used on runways, whereas taxiway stripes are indicated with reflective yellow paint. Each taxiway is marked by a single centerline stripe 6 inches wide and continues onto the runway to the runway centerline (fig. 11-5) except at runway ends as in figure 11-3.

Holding post markers are also painted reflective yellow and consist of two solid lines and two broken lines. They are placed across

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AC.138
Figure 11-4.—Arresting gear signs.

the taxiway at right angles to the taxiway centerline. (See fig. 11-5.) These painted markings are used for holding aircraft 100 feet clear of the nearest runway edge. Ground traffic must not proceed beyond the holding post marker without a control tower clearance.

Another taxiway marking is the VOR/TACAN checkpoint triangle pavement marker. It is an equilateral triangle (a triangle with all sides equal), painted with an 8-inch stripe in yellow, with sides 5 feet long. From this checkpoint an aircraft is able to ground check his VOR/TACAN equipment prior to flight. There are usually several on an airport to facilitate ground checks regardless of the taxiway in use. (See fig. 11-6.)

The checkpoint is used in conjunction with a VOR/TACAN check sign. The sign is constructed of lightweight material, utilizing frangible supports, and placed 25 feet from the edge of the taxiway. It is painted with black lettering and has a hooded floodlight for night viewing. (See fig. 11-6.) The hood is provided so that the vision of pilots will not be impared during night operations. The information included on the sign is station identification, channel number or frequency, and magnetic bearing and distance to the VOR or TACAN station. The distance and bearing indicated are from the checkpoint, not the sign.

Deceptive, Closed, and Hazardous Area Marking

Where it is determined that an operational requirement exists, there are provisions for marking deceptive, closed, and hazardous areas.

A deceptive area is any surface or area which appears usable but which, due to the nature of its structure, is not intended for normal operational use by aircraft. All deceptive and closed area markings are painted with nonreflective yellow paint, except in the case of a displaced threshold arrow and bar which is painted with nonreflective white.

A closed area may be a runway, taxiway, or any other area that was once used but is no longer considered usable. It may be temporary, such as during construction, or permanently closed.

An example of various markings of deceptive, closed, and hazardous areas, both overall and detailed descriptions, are presented in figure 11-7. Study this figure carefully in addition to reading the text.

A hazardous area is an area or any permanent or temporary construction that presents a definite hazard to the operation of aircraft. Some examples are smoke stacks, antenna towers, buildings, and elevated tanks such as water supply tanks. When considered a hazard to flight, they are painted with aviation surface orange and white paint, normally in a checkerboard pattern. Where the predominating background does not afford a satisfactory contrast

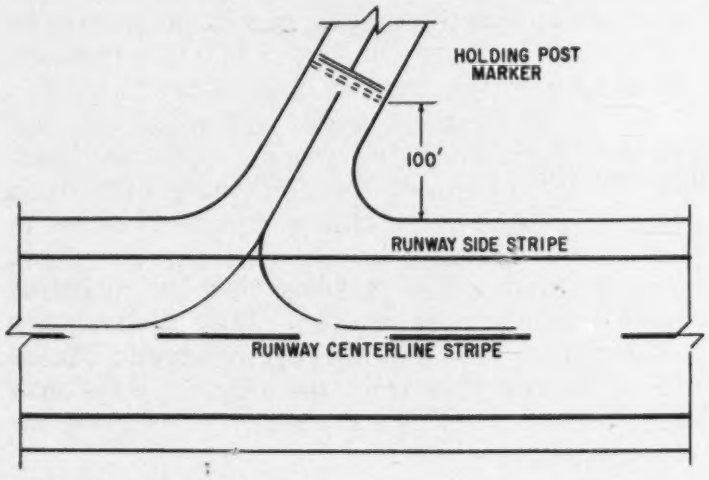

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Figure 11-5.—Taxiway/runway intersection.

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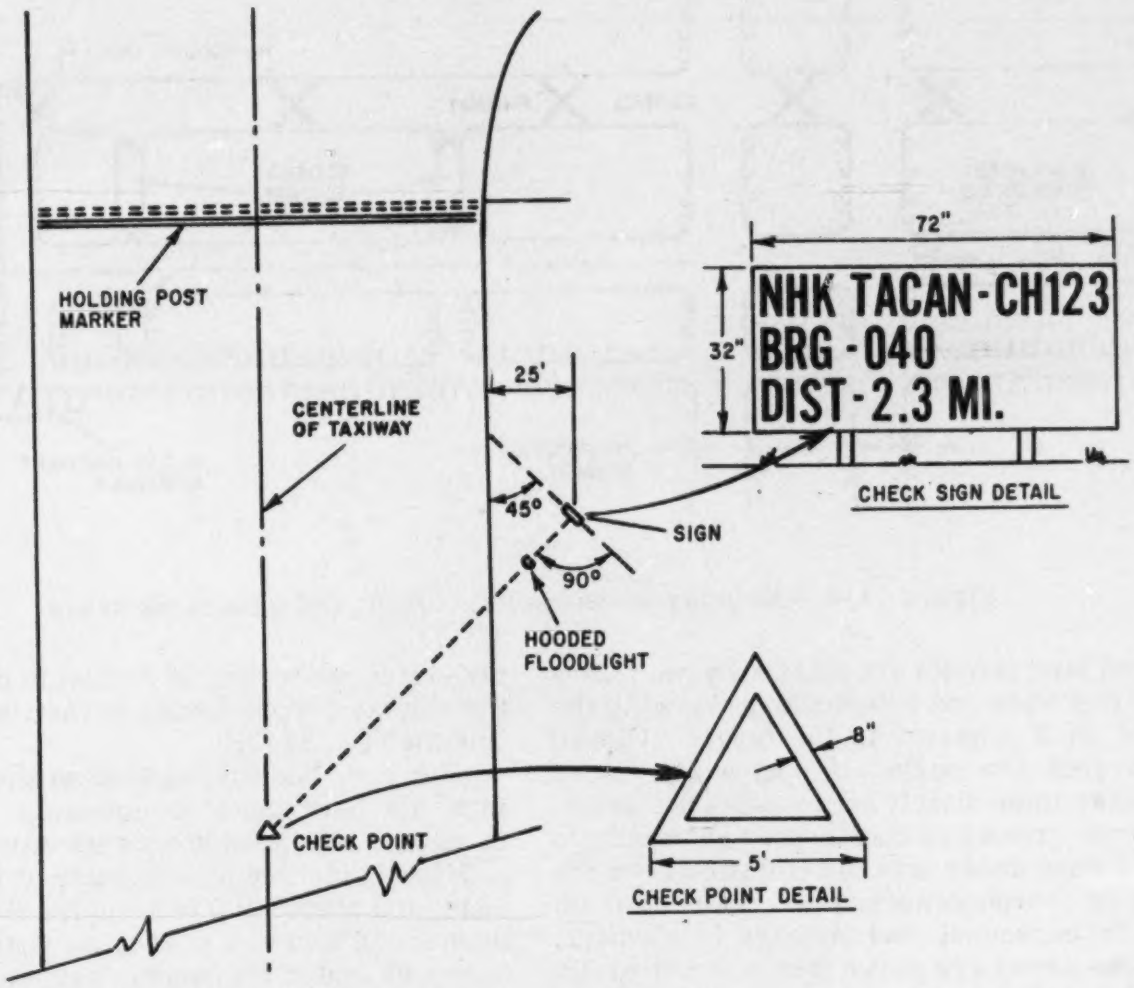

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Figure 11-6.—VOR/TACAN checkpoint and check sign.

with aviation surface orange, the use of chrome yellow paint is permitted.

A closed runway is marked with a cross composed of two yellow bands 10 feet wide and 60 feet long. They are placed in the center of the closed runway, with no specified minimum distance between crosses but they cannot be placed more than 1,000 feet apart. One cross is always placed near both ends of the closed runway and adjacent to other runways and taxiways. At night, red lights in the form of a cross are placed at the ends of the runway in sufficient numbers to make certain that the cruciform arrangement is clearly distinguishable.

A closed taxiway marking is quite similar to a closed runway marking; however, the cross formed by the yellow bands, or red lights at night measure just half the size of the runway marking. They are always placed at or near the entrance of the closed taxiway. There is no set minimum or maximum distance between the crosses since each one in effect denies the use of the affected area. (See fig. 11-7.)

Small holes, soft spots, etc., on the usable portion of landing fields, are marked by day with yellow flags or yellow pyramids and by night with red lights, to warn incoming pilots that the particular spots so marked are unsafe for landing.

When relatively large areas are unsafe for landing they are outlined by day with yellow flags and by night with red lights.

An entire area outlined as unusable is indicated by placing in its approximate center, a relatively large cross made up of yellow flags or strips of yellow fabric by day, or made up of red lights at night.

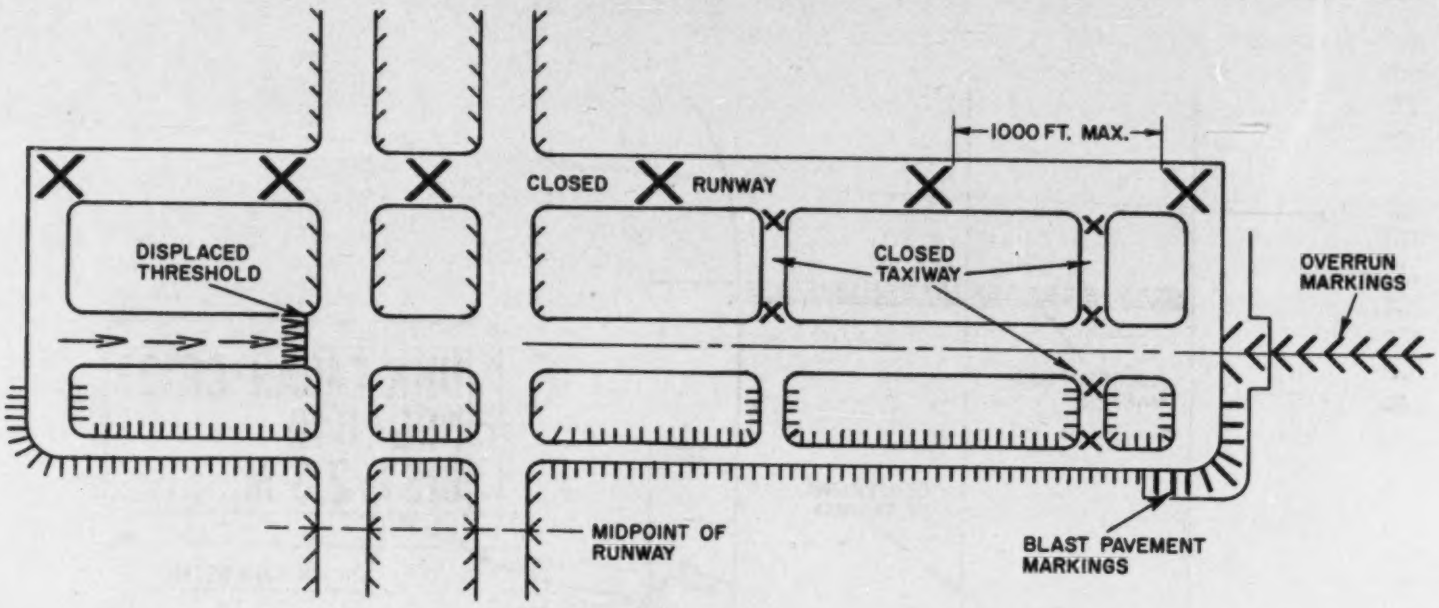

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Figure 11-7.—Marking at deceptive, closed, and hazardous areas.

Closed land targets are marked by two yellow strips 3 feet wide and 200 feet long placed in the shape of an X adjacent to the target. Closed water targets are marked by yellow dye placed in the water immediately surrounding the target.

Overrun areas are constructed primarily to provide a reasonably safe deceleration area for aborting or overshooting aircraft, with minimum danger to personnel and damage to aircraft. When these areas are paved they could be easily mistaken for a landing area. When this possibility exists, runway overrun markings are used. These are in the form of chevrons painted nonreflective yellow, and the apex of the chevron points toward the runway. The stripes forming the chevron form a 45-degree angle away from the runway centerline extended and are 3 feet in width. There is no specified minimum size of the chevron, but the overall dimensions cannot exceed 100 feet. They are placed on the paved over-run, along the runway centerline extended, 100 feet apart. (See fig. 11-7.)

When the threshold is moved forward on a runway, the area leading to the new location must be adequately marked to prevent aircraft from landing short of the newly established landing area. This marking is composed of a series of arrows painted nonreflective white, with an overall length of 120 feet and with 80-foot spaces between them. They are placed along the runway centerline and point toward the new threshold with the last arrow point placed 5 feet from the threshold bar. The threshold bar itself is a nonreflective white bar 10 feet wide placed across the runway perpendicular to the runway centerline (See fig. 11-7.)

Runway, taxiway, and apron shoulder markings all have much in common. All of these markings are painted nonreflective yellow with a 3-foot wide stripe beginning at the pavement edge, and placed 100 feet apart. Runway markings are placed at a 45-degree angle toward the approach end of the runway beginning at the runway midpoint. Taxiway and apron shoulder markings are perpendicular to the edge of the area. (See fig. 11-7.)

Blast pavement markers are nonreflective yellow stripes 3 feet wide and 50 feet long. They are placed in areas where jet and propeller blast should be directed when making engine runups at high power settings. Usually these markings are placed near the ends of runways. However, some areas may be established at other points on the airport specifically for maintenance checks. (See fig. 11-7.)

Remember that deceptive, closed, and hazardous area markings are only used when and where they are needed. A particular airport may have all, some, or none of these markings.

FIELD LIGHTING SYSTEMS AND OPERATION

Airport field lighting systems have been standardized by the Air Force, Navy, and the FAA in order to present a uniform and unmistakable appearance so that flight personnel who

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are familiar with the adopted standards may readily interpret the lighting aids at any airfield. These standards specify the location, spacing, and color of lighting components in use.

A field lighting system is composed of runway lighting and other lighting aids with necessary controls and power supply. All the lighting aids are considered in this section even though their installation is determined by the mission of the airport. It is necessary that the Air Controlman have a thorough knowledge of these lighting standards as well as the essential function and operating rules of the separate components.

Airport Beacons

A rotating beacon is located on the highest elevation available and must be at least 20 feet above the control tower floor.

The rotating airport beacon has a vertical light distribution such as to make it most effective at angles of one to three degrees above the horizontal from its site; however, it can be seen well above and below this peak spread. Rotation is in clockwise direction when viewed from above. It is always rotated at a constant speed which produces the visual effect of flashes at regular intervals. Those flashes may be of one color or may be of two colors alternately. (See chapter 8.) This beacon rotates at the rate of 12 to 15 revolutions per minute.

Where white and green or white and yellow color combinations are installed, the lights of different color are separated by 180 degrees. Rotating beacons are placed so that they are not closer than 750 feet to the centerline or extended centerline of the nearest runway.

Operation of an airport rotating beacon during the hours of daylight, means that the ground visibility in the control zone is less than 3 miles and/or the ceiling is less than 1,000 feet and that a traffic clearance is required for landing, takeoff, and flight in the traffic pattern.

Runway Lighting

Runway lights and threshold lights form the outline of the runway for night operations. The runway lights are located along both sides of the runway, extending the entire length. The spacing of these lights approaches but does not exceed 200 feet and can be installed as close as 70 feet to reduce a large gap in the lighting pattern of an intersection. Runway lights are white in color.

Threshold lights are green in color and are placed on each side of the runway ends. They form, in effect, green bars of light. The number of lights used in this corner group system will vary due to various widths of runways. Regardless of the number of lights installed, they will give the pilot the exact indication of where the landing area begins.

Both runway and threshold lights operate on the same control for a given runway. These controls are on a master control panel in the control tower. Runway lights are turned on for inbound aircraft as soon as the pilot reports in the control zone and are turned off when no longer needed. For outbound aircraft the runway lights are lighted as the aircraft approaches the takeoff position and turned off when no longer needed.

All-weather air stations have high intensity runway lights installed. The intensity or brightness of the runway lights can be varied by a selection switch on the lighting control panel in the control tower. There are five settings which may be selected with number 1 being the lowest and number 5 the highest. High intensity runway lights intensity settings may be operated as prescribed by local procedures or as requested by a pilot for his operation. Table 11-1 is a guide for determining the appropriate intensity setting.

Runway End Identifier Lights

Some facilities have runway end identifier lights installed. These are bluish white lights of the condenser discharge type (flashing) which identify the runway threshold. One such light, where installed, is located on each side of the runway end. These lights are normally connected

Table 11-1.—High intensity runway lights settings.

Step	Day visibility	Night visibility
5	Less than 1 mile	When requested
4	1 to 2 miles	Less than 1 mile
3	When requested	1 to 3 miles
2	When requested	3 to 5 miles
1	When requested	More than 5 miles

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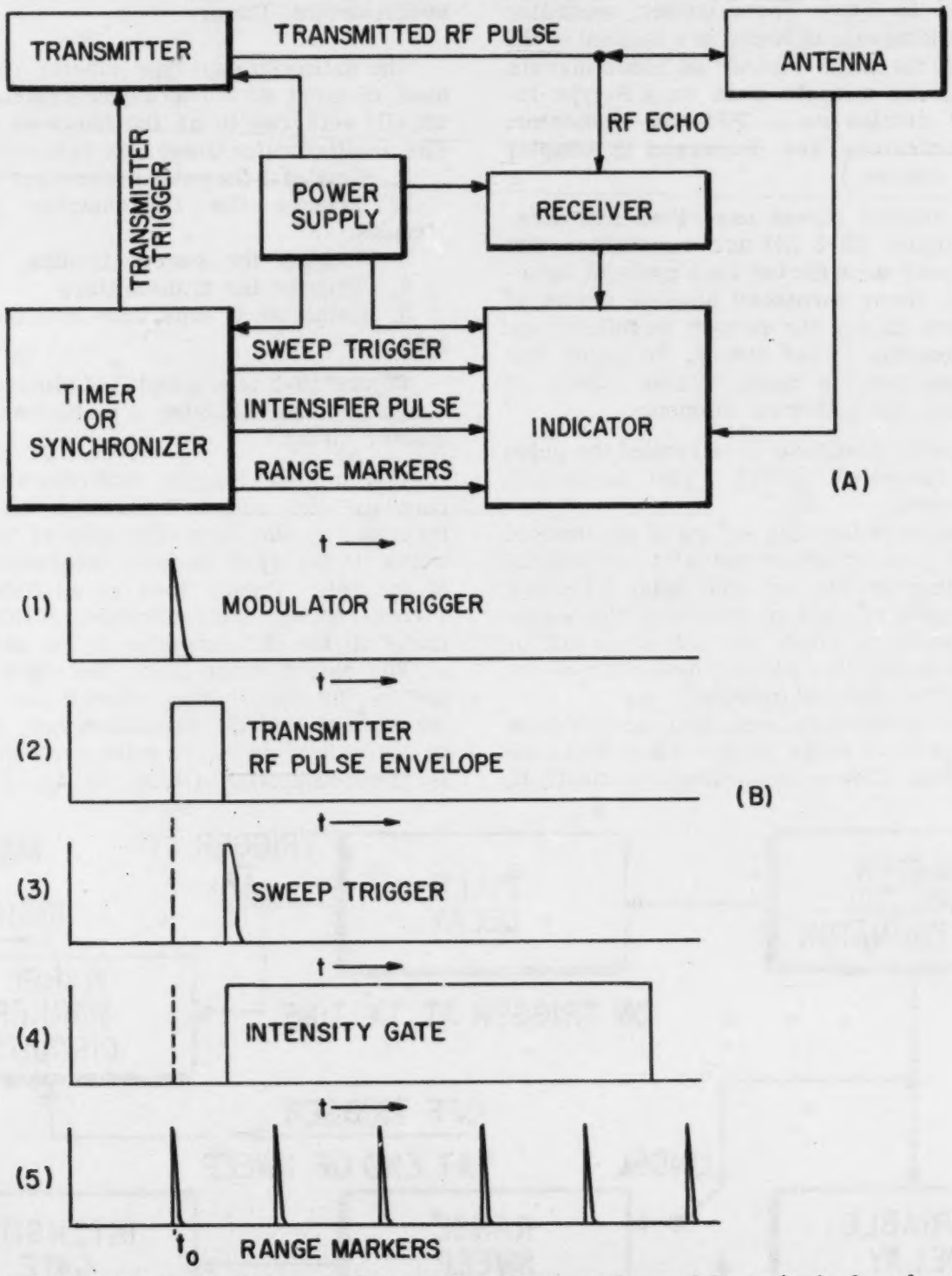

Figure 15-2. —(A) Block diagram showing functions performed by a typical radar timer; (B) synchrogram of control pulses furnished by the timer shown in figure 15-2 (A).

blank the screen when signals are not to be received.

An important function of any radar set is the determination of range of the targets observed. The methods of range determination vary. Some use a simple transparent overlay (upon which ranges are marked) for the indicator screen. Others have complex circuits used for very accurate range measurements.

One method is the use of rangemarkers generated in the timer. The markers are pulses of very short duration, as shown in waveform

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to the runway light switch in the control tower and operate for the runway selected on that switch. An additional switch is provided to allow runway light operation with the runway end identifier lights off.

Runway Centerline Lighting System

Runway centerline lights, where installed, consist of a single row of lights at uniform intervals along the centerline of the runway to provide a continuous lighting reference from threshold to threshold. The lights may be installed on a primary and secondary runway. On/off and brightness controls for individual runway centerline lights are provided in the control tower. Runway centerline lights are white lights. The intensity selected should be the same as that selected for the high intensity runway lights.

Approach Lights

Approach lights of varying tvpes, colors, and construction have been specifically developed to meet civil and military requirements. These lights are installed in an area extending outward from the threshold of the instrument runway, and are usually the pilot's first visual contact with the ground under extremely low visibility conditions. Electronic landing aids, such as GCA and ILS, are used to bring the pilot down to the approach minimums. Approach lights are required for final alinement with the runway, and runway lights are required to complete the landing.

High-intensity incandescent lights penetrate somewhat farther through fog, smoke, or rain than neon lights. Several types of high-intensity approach lights have been installed in the United States, taking the place of the neon system.

The current system being installed at Navy facilities is called Centerline Approach Lighting System (U.S. Standard (A)). It consists of a series of crossbars of lights (normally 3,000 feet) with condenser discharge (sequence flashing) centerline lighting that coincides with the runway centerline lighting, that indicates the approach to, and threshold, of the runway. The intensity of the approach lights can be varied from the control tower. To be most useful, the lights must be bright enough to penetrate the overcast effectively without blinding the pilot or producing halo effects. Different intensity settings are needed for day and night use. The operation and intensity setting selected may be determined by local procedure and instructions. Table 11-2 is a guide for determining the appropriate approach lights intensity settings.

Visual Approach Slope Indicator (VASI)

VASI is designed to provide by visual reference the same information that a glide slope of an ILS provides electronically. It provides a 2 1/2- to 3-degree visual glide slope within the approach zone which a pilot can see and use for descent guidance during an approach to a landing.

The standard installation consists of 12 light source units arranged in light bars of 3 units placed on each side of the runway opposite the 600-foot mark, and three units on each side of the runway opposite the 1,300-foot mark. (See fig. 11-8.) Each light unit projects a beam of light having a white color in the upper part and a red color in the lower part. The light units are so arranged that the pilot, during an approach, would see one of the combinations shown in table 11-3.

The VASI can normally be seen at a distance of 4 to 5 miles, and at greater distances at night. The intensity of the VASI system is controllable at some installations while at others the intensity is controlled by an electronic device. Where controllable, the controls are located in the tower as is the on/off switch. Normally the VASI system is left on at all times; however, local procedure and instructions may require otherwise.

Table 11-2.—High intensity approach lights settings.

Step	Day visibility	Night visibility
5	Less than 1 mile	When requested
4	1 to 3 miles	When requested
3	3 to 5 miles	Less than 1 mile
2	When requested	1 to 3 miles
1	Greater than 5 miles	Greater than 3 miles

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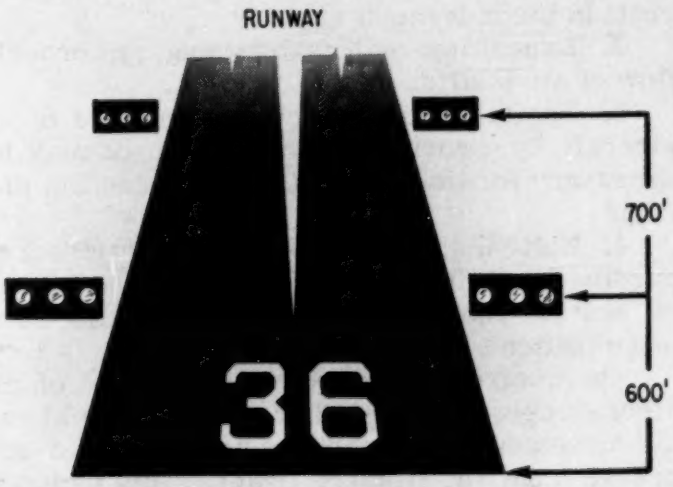

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Figure 11-8.—Visual approach slope indicator.

Taxiway Lighting

Taxiway lights, which are blue in color, have a variable spacing distance, depending upon the length of a straight taxiway segment or radius of curve of a taxiway turn. On a straight segment over 200 feet in length, the space between lights may approach but not exceed 200 feet. On a straight segment of 200 feet or less, the distance between lights may approach but not exceed 50 feet. Taxiway lights marking a curved edge of a taxiway follow the rule that the sharper the radius of curvature, the closer the lights are placed. In no case will there be less than three taxiway lights on any one taxiway.

Two blue lights spaced 5 feet apart and placed on each side of a taxiway entrance into (or exit from) a runway or parking area are called entrance-exit lights. These lights are not installed at intersections of taxiways or at locations that are normally runway entrances or exits.

Table 11-3.—VASI glide slope presentation.

Aircraft position	Presentation	
Above the glide slope	white	white
	white	white
On the glide slope	red	red
	white	white
Below the glide slope	red	red
	red	red

The control system for taxiway lights is designed to permit the lighting of combinations of individual taxiways necessary to provide any required lighted taxiing path. The taxiway lights are turned on as soon as the pilot of an aircraft is cleared to taxi out and turned off when the aircraft is on the runway or another taxiway. For inbound aircraft, they are turned on as the aircraft approaches the taxiway to be used and turned off when the aircraft is parked.

Floodlights

Mobile and portable floodlights have superseded the older type of permanently mounted runway floodlights. The field lighting truck is a mobile unit to provide emergency lighting. The portable floodlight is for emergency use, principally at outlying fields where floodlighting may be required for the landing area.

Floodlights are turned on for outbound aircraft when the pilot has taxied onto the runway and is facing the direction for takeoff. They are turned off when the aircraft has cleared the edge of the field, or when requested by the pilot. For inbound aircraft, the floodlights are turned on when the aircraft is identified near the field unless the pilot requests they be left off. In the latter event they are lighted briefly, before the aircraft enters the landing glide, to ascertain that the runway to be used is clear of obstacles. If the floodlights are used for landing, they are turned off when the aircraft has cleared the runway.

Obstruction Lights

Obstruction lights are located on all elevated obstructions on the airport and on all other obstructions within a given glide angle of an airport. They are red in color and are lighted from sunset to sunrise and during daytime when flight visibility is restricted.

Boundary Lights

Airport boundary lighting is no longer in general use; however, some older fields are still equipped with these aids. When used, the boundary lights are spaced around the perimeter of the landing area and are orange in color. These lights are in operation from sunset to sunrise.

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At airports where no boundary lights are installed (or when boundary lights are inoperative), runway lights on the runway most nearly alined into the wind, or the "calm wind" runway when appropriate, must be lighted between sunset and sunrise.

With the exception of the rotating beacon, the commanding officer or airport manager may establish hours of operation of the field lighting system NOT in accordance with the hours of operation heretofore discussed. In such cases, however, the commanding officer or airport manager must assume responsibility when field lighting is available on a request basis.

Wheels-Up/Runway Waveoff Lights

Wheels-up/runway waveoff lights consist of six clusters of three red lights located on each side of the runway starting approximately 800 feet from the runway threshold and spaced approximately 800 feet apart. Additionally, a wheels-up light bar is located approximately 1,000 feet outboard of the runway threshold on the same side of an imaginary extension of the runway as the control tower. (See fig. 11-9.) The lights face landing aircraft and are turned in toward the runway centerline. The lights can be controlled from the wheels watch position and the Landing Signal Officer (LSO) platform. When activated, a flashing device causes the lights to flash 90 times per minute with equal on and off time. The flare gun warning system previously used is being replaced by this system.

Fresnel Lens Landing System

Many facilities have a Fresnel Lens optical landing system installed along the side of a heavily used runway for use in field carrier landing practice and for pilots to keep proficient using this type of landing approach. The unit is the same as that installed on aircraft carriers. An example of such an installation is shown in figure 11-9.

CONTROL TOWER

The key facility of the airport operational system is the control tower. It is elevated to a suitable height to afford the maximum visibility of the airport and the immediate area. The primary objective of the control tower is to promote the safe, orderly, and expeditious movement of air traffic. This includes the following:

1. Aiding pilots in preventing collisions between aircraft and between obstructions and aircraft in the movement area.
2. Expediting and maintaining an orderly flow of air traffic.
3. Assisting the person in command of an aircraft by providing such advice as may be necessary for the safe and efficient conduct of a flight.
4. Notifying appropriate organizations regarding aircraft known or believed to be in need of search and rescue aid, and assisting such organizations as required.

The control tower exercises control of all aircraft operating on and around an airfield and all movements of aircraft must have prior approval from the Control Tower. This includes instructions and permission to tow, taxi, takeoff, land, and related aircraft operations (except where preventive control has been authorized.)

NOTE: Preventive control differs from other airport traffic control in that repetitious, routine approval of pilot action is eliminated. Controllers intervene only when they observe a traffic conflict developing.

COMBINED RESPONSIBILITIES

Both controllers and pilots are responsible to each other for good communications, coordination, and cooperation. These three factors are not separate entities but must be considered as different parts of responsibility which are shared by pilots and air traffic control personnel. Some of these responsibilities are set forth in publications, while others are not delineated as a regulation or a rule but are recognizable as definite responsibilities of a controller since his profession is one of service-that of aiding the pilot to accomplish a safe flight.

AUTHORIZED CONTROLLERS

Only those naval personnel properly qualified in accordance with the current OpNav instruction 3722.6 can exercise the control of air traffic. Additionally, this instruction requires that personnel exercising tower air traffic control possess an FAA Control Tower Operator Certificate (CTO).

TOWER OPERATING POSITIONS AND RESPONSIBILITIES

Establishment of controller positions varies according to local requirements and type of

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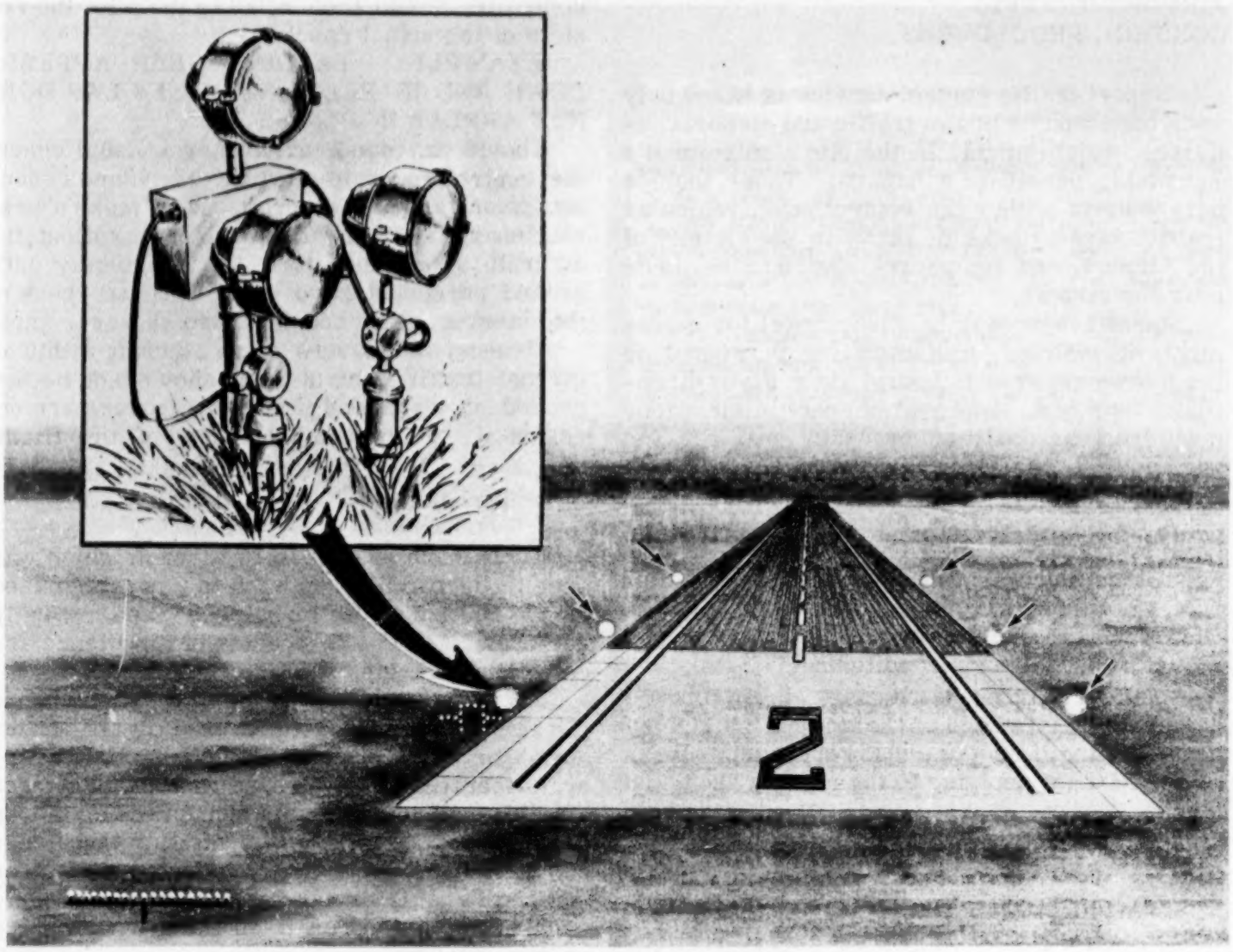

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Figure 11-9.—Wheels-up/runway waveoff lights.

facility, but those included in most control towers are Local Control position, Ground Control position, and Approach Control position.

The primary duties of the tower supervisor are to direct activities of a tower under the general supervision of the leading chief and/or watch officer. He supervises all positions of operation and directs the training of new personnel.

The following types of messages are ordinarily transmitted by the position indicated in the following paragraphs.

1. Local controller—issues information and clearances to air and vehicular traffic operating on the landing area, to VFR traffic operating in the control zone, and to IFR traffic released to local control position.

2. Ground control—assists other operating positions by handling taxiing aircraft and vehicular traffic on the landing area.

3. Approach control—provides separation between all aircraft operating IFR within the designated area of jurisdiction through application of separation standards.

At a Radar Air Traffic Control Facility, approach control would be located in the RATCC itself instead of the tower.

Some facilities use a flight data position, the duties of which consist of receipt, posting, and relaying flight data for the other positions and assisting in the operation of the tower as directed.

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AIRPORT TRAFFIC CONTROL PROCEDURES

Airport traffic control service is based only upon observed or known traffic and airport conditions which might, in the Air Controlman's judgment, constitite a hazard. These include parachutists within the control zone, vehicular traffic, large flocks of birds in the vicinity of the airport, and temporary obstructions on or near the airport.

Specific approval or disapproval for movement of vehicles, equipment, or personnel on the movement area is issued via radio or directional light gun. Approval of specific situations should not be qualified by conditional phrases such as BEHIND LANDING TRAFFIC, or AFTER THE DEPARTING AIRCRAFT.

A clearance to take off, land, or touch-and-go can only be denied on the basis of traffic conditions, except in the case of a closed runway or below minimum visibility conditions. Clearance for a low approach can only be denied on the basis of traffic conditions.

Should a pilot request to use a closed runway, he should be informed of the fact that the runway is closed and if necessary, the appropriate parts of the NOTAM applying to the runway should be quoted.

Any message related to an aircraft by the tower should include the source of the message.

EXAMPLE: OPERATIONS OFFICER ADVISES, or SQUADRON DUTY OFFICER REQUESTS (message).

A pilot's request to cross an airport traffic area at speeds in excess of the speed limit for an airport traffic area (200 knots for turbine powered aircraft and 156 knots for reciprocating engine powered aircraft) may be approved if traffic conditions permit. However, speeds in excess of 250 knots should not be approved unless the pilot advises that a higher minimum speed is required, or normal military operating procedures require such speeds.

If a controller should observe an abnormal condition of an aircraft, the pilot of such aircraft should be informed.

EXAMPLE: REAR BAGGAGE DOOR APPEARS OPEN.

When a pilot has any doubt that his landing gear is down and locked, he will notify the control tower. The controller would then instruct the pilot to perform a low pass in front of the tower for the purpose of a visual check. The controller would then relay to the pilot the results of the visual check.

EXAMPLE: LANDING GEAR APPEARS DOWN AND IN PLACE; or, NOSE GEAR DOES NOT APPEAR IN PLACE.

Should any doubt exist after a visual check, the controller would alert the crash and rescue equipment and the aircraft would make a precautionary landing. After the landing rollout, the aircraft should not turn off the runway until ground personnel have made a visual check of the landing gear and installed the gear pins.

Unusual maneuvers of an aircraft within an airport traffic control area should not be approved or requested if such maneuvers are not essential to the performance of the flight.

Wake Turbulence

Turbulence generated by aircraft which was once thought to be prop wash is now categorized as "thrust stream turbulence" and "wingtip vortexes." These categories of turbulence are collectively termed WAKE TURBULENCE.

Thrust stream turbulence is the disturbance of air behind aircraft caused by propeller action or jet blast. It could be a hazard to aircraft operating on the ground close behind larger aircraft making an engine runup. At distances of 400 to 500 feet, thrust stream turbulence should not constitute a serious hazard except for aircraft landing or taking off in the immediate area of another aircraft on the ground making an engine runup.

Wingtip vortexes are trailing masses of disturbed air created by the wing of an aircraft as it produces lift. An aircraft creates two such vortexes with rotational air movement, one trailing each wingtip. The rollup process is normally complete about 200 to 400 feet behind the aircraft. Once formed, the vortexes extend and may be hazardous for an undetermined distance behind the generating aircraft and may last from 3 to 5 minutes. The turbulence is directly related to the weight, wingspan, and speed of the aircraft. Its intensity is directly proportional to the weight, and inversely proportional to the wingspan and speed of the aircraft. The heavier and slower the aircraft, the greater will be the intensity of the turbulence. Thus, modern large transport aircraft will create maximum turbulence during takeoff and landing at or near maximum gross weights.

Another factor to consider is the vertical and lateral movement of the vortexes. Vortexes

generated more than 100 feet above the surface will drop vertically in a no-wind condition a distance equal to approximately one-half the wingspan of the generating aircraft. At that point they start to curve outward and spread laterally away from the aircraft track. Additionally, both the vertical and lateral movement will be affected by and move with the encompassing airmass.

If a tower controller should foresee the possibility of wake turbulence, cautionary information should be issued to the pilot of the aircraft concerned.

EXAMPLE: CAUTION WAKE TURBULENCE, C ONE FORTY ONE JUST DEPARTED.

Since the existence and effect of wake turbulence are unpredictable, a controller is not responsible for anticipating the need for such information in all cases. However, controllers must be especially alert for a situation wherein the possibility of aircraft under their jurisdiction encountering wake turbulence exists and insure that the affected pilots are advised. This will enable the pilot to avoid the suspected hazardous area and enhance the safety of flight.

Traffic Information

Local traffic information is issued when in the judgment of the controller such information is necessary in the interests of safety or when requested by a pilot.

Vehicles, equipment, or personnel on the movement area are described in a manner which will assist pilots in recognizing them.

Military air traffic is described as follows:

1. Military designator, with numbers spoken in group form.
2. Service and type with the following exception.
3. Type only, if no confusion or misidentification is likely.

EXAMPLES: F-FOUR; NAVY FIGHTER; or, FIGHTER.

Air carrier traffic is described as follows:

1. Manufacturer's name or model.
2. Add company name or other identifying features if confusion or misidentification is likely.

EXAMPLES: VISCOUNT; AMERICAN DC-NINER; or, UNITED VISCOUNT.

General aviation air traffic is described as follows:

1. Manufacturer's model, name or designator.
2. Add color when considered advantageous.

EXAMPLES: TRI-PACER; CESSNA THREE TEN; or, GREEN APACHE.

When it is necessary to make a hurried, brief transmission of traffic information, the aircraft type may be omitted.

The relative position of traffic must be issued to pilots in an easily understood manner, such as TO YOUR RIGHT, or AHEAD OF YOU, instead of local terminology or compass directions.

EXAMPLES: TRAFFIC U ELEVEN ON DOWNWIND LEG TO YOUR RIGHT; or, F FOUR BE INBOUND FROM INITIAL, RUNWAY SIX.

Field Condition Information

Pertinent field condition information necessary for an aircraft's safe operation is issued in time for it to be useful to the pilot. The following information concerning field conditions must be issued to pilots concerned:

1. Construction work on or immediately adjacent to the movement area.
2. Rough portions of the movement area.
3. Braking conditions caused by ice, snow, slush, or water.
4. Snowdrifts or piles of snow on or along the edges of the area and the extent of any plowed area.
5. Parked aircraft on the movement area.
6. Irregular operation of part or all of the field lighting system.
7. Any other field conditions considered pertinent by the controller.

Description of field conditions issued should be stated clearly and concisely.

EXAMPLES: MOWER TO THE LEFT OF RUNWAY; or, MEN AND EQUIPMENT NEAR THE APPROACH END OF THE RUNWAY.

Weather Information

The tower may transmit to pilots or other ATC facilities, without consulting weather service personnel, any elements of weather information derived directly from instruments, from radar, or received as a pilot report. Observed weather conditions such as LARGE BREAKS IN THE OVERCAST, VISIBILITY LOWERING TO THE SOUTH, or similar statements which do not include specific values may be transmitted. Terminal radar control facilities should inform towers for which they provide approach control service about storm areas observed on radar.

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Elements of weather information which include specific values (such as ceilings and visibility) may not be transmitted unless the observing controller is properly certificated and acting as a weather observer, or the weather observation was made or verified by weather service personnel.

Controllers should inform local weather service personnel of any differences between weather conditions observed from the tower and those reported by weather service.

Visibility observations may be taken from the control tower during periods when the visibility at the usual point of observation is less than 4 miles. Control tower personnel who make official visibility observations must be properly certificated. Weather service personnel should be advised whenever the visibility is apparently reduced to less than, or has risen to equal or exceed, 4 miles.

Current weather changes should be forwarded to the appropriate control facility as follows:

1. When the official weather decreases to less than or increases to exceed:

a. 1,000 foot ceiling or the highest circling minimum, whichever is greater.

b. 3 miles visibility.

2. Changes which are classified as special weather observations during the time the ceiling is below 1,000 feet or the highest circling minimum, whichever is greater; or 3 miles visibility.

Towers at airports where military turbojet enroute descents are routinely conducted should also report these changes to the appropriate ARTCC even if it is not the controlling facility.

Bird Activity Information

Bird activity information including position, size and species (if known), and their course of flight should be issued to pilots of aircraft concerned for at least 15 minutes after receipt of the information from pilots or adjacent facilities. This time may be reduced when either visual observations or subsequent reports reveal that the activity is no longer a factor.

Visual Signals

Air traffic control light signals are used to control aircraft and movement of vehicles, equipment, or personnel on the movement area when radio communications cannot be employed. These signals are in accordance with figure 10-1 in chapter 10 of this training manual.

To obtain an acknowledgment from aircraft equipped with a receiver only, a controller should request the pilot of the aircraft to move the aileron or rudders on the ground, or rock the wings when airborne, during daylight hours; or, blink the navigation or landing lights at night.

Runway Use

Except where a "runway use" program is in effect, the selection of the runway to use, or the duty runway, is as follows:

1. The runway most nearly alined with the wind, when the wind velocity is 5 knots or more.

2. The calm wind runway, when the wind velocity is less than 5 knots.

Use of a runway other than those mentioned above is permissible if it will be operationally advantageous or if it is requested by a pilot. If a pilot prefers to use a runway different than that specified by a controller, he is expected to advise the controller accordingly.

Runway use programs for large aircraft and turbojet aircraft may be established at some airports. Where such programs are established, runway assignment is affected by consideration of noise sensitive areas and noise abatement benefits. Acceptance or refusal of such assignments is still the pilot's prerogative.

Both wind direction and velocity must be issued when authorizing the use of runways, even though the wind velocity is less than 5 knots and the calm wind runway is to be used. This information is necessary since some aircraft are adversely affected by a tailwind or crosswind component, and pilots must be aware of the exact wind condition to make the decisions necessary for a safe flight. Therefore, the wind condition is described as "calm" only when the velocity is actually zero.

Runway Conditions

At those facilities affected by winter weather conditions, runway condition and braking action is important information which must be relayed to pilots when adverse conditions exist on the landing area. The following contractions have

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been established to indicate the runway surface condition:

1. WR . . . . . Wet runway.
2. SLR. . . . . Slush on runway.
3. LSR. . . . . Loose snow on runway.
4. PSR . . . . . Packed snow on runway.
5. IR. . . . . Ice on runway.
6. P. . . . . Patchy (used as a suffix to the condition reading. See example.)

Procedures have been established for determining decelerometer readings to indicate the effect of the runway condition on braking action. This is called runway condition reading (RCR). A decelerometer is an instrument used in a moving vehicle which indicates the amount of deceleration when the brakes are applied. Average readings are taken and expressed in two digit numbers from 00 to 25, giving an indication of braking action as follows:

1. 00 to 05 . . . . . Braking nil.
2. 06 to 12 . . . . . Braking poor.
3. 13 to 18 . . . . . Braking fair.
4. 19 to 25 . . . . . Braking good.

When relaying runway conditions to aircraft, Navy controllers should state the runway surface condition and the RCR reading, and give a description of the braking action.

EXAMPLE: CODED—IR RCR07 P. SPOKEN—ICE ON RUNWAY, RCR ZERO SEVEN, BRAKING POOR, PATCHY.

Separation

Air traffic should be controlled in accordance with established traffic and taxi patterns. The controller must establish a sequence of arriving and departing aircraft by issuance of instructions and information that require pilots of aircraft to adjust flight or ground operation as necessary to achieve proper spacing or separation.

To assist the controller in determining the minimum interval between various operations, the following categories of aircraft have been established.

1. Category 1. —Lightweight, single-engine, personal type, propeller driven aircraft. (Does not include high performance aircraft such as the T-28.)

2. Category 2. —Lightweight, twin-engine, propeller driven aircraft weighing less than 12,500 pounds, such as the U-11 and C-45.

3. Category 3. —All other aircraft such as the high performance single engine, heavy twin-engine, four engine, and turbo jet aircraft.

The application of procedures and minimums, local deviations or application of reduced separation, and conditions allowing such operations are the same as those listed under IFR CONTROL PROCEDURE later in this chapter.

SIMULTANEOUS OPERATIONS ON PARALLEL RUNWAY.—Simultaneous, same direction operations may be authorized on parallel runways, or landing strips, under the following conditions:

1. Operation must be conducted in VFR conditions unless visual separation is applied between aircraft concerned by the tower controller or pilots of the aircraft conducting the operation.

2. Two-way radio communications must be maintained with the aircraft involved and pertinent traffic information must be issued.

3. The distance between the runways, or landing strips, must be in accordance with table 11-4.

NOTE: If two categories of aircraft are involved, the greater distance must be applied.

Simultaneous, opposite direction operations on parallel runways or landing strips, or on a runway and a parallel landing strip, may be authorized under the following conditions:

1. Operations must be conducted in VFR conditions.

2. Two-way radio communications are maintained with the aircraft involved and pertinent traffic information is issued.

Table 11-4.—Criteria for simultaneous, same direction operations on parallel runways.

Aircraft type	Minimum distance in feet between.	
	Runway center-lines	Adjacent edges of runway or landing strips
Light-weight, single-engine, propeller-driven	300	200
Twin-engine, propeller-driven	500	400
All others	700	600

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Table 11-5.—Criteria for simultaneous, opposite direction operations on parallel runways.

Time of operation	Minimum distance in feet between.	
	Runway center-lines	Adjacent edges of runways or landing strips
Between sunrise and sunset	1400	1400
Between sunset and sunrise	2800	Not authorized

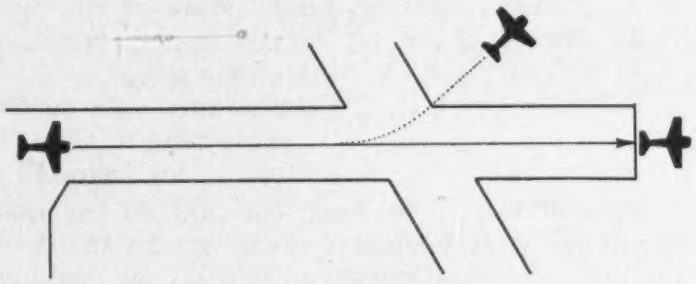

AC.144

Figure 11-10.—Separation of departing aircraft.

3. The distance between the runways or landing strips must be in accordance with table 11-5.

SEPARATION OF DEPARTING AIRCRAFT.—Departing aircraft are separated from other aircraft using the same runway by insuring that they do not begin takeoff roll until one of the following conditions exist:

1. The other departing aircraft has crossed the runway end, or is airborne and turning to avert any conflict. (See fig. 11-10.)

2. Provided that distances by reference to suitable landmarks can be determined, the other departing aircraft need only be airborne if the following minimum distances exist between aircraft (fig. 11-11):

a. If only category 1 aircraft are involved - 3,000 ft.

b. If either aircraft is a category 2 aircraft - 4,500 ft.

c. If either aircraft is a category 3 aircraft - 6,000 ft.

3. A preceding arriving aircraft has taxied off the runway. (See figure 11-12.)

Departing aircraft are separated from another aircraft using an intersecting runway by insuring that it does not begin takeoff roll until one of the following conditions exists:

1. The preceding departing aircraft has passed the intersection or is airborne and is turning to avert any conflict. (See fig. 11-13.)

2. The preceding arriving aircraft has taxied off the landing runway, or completed the landing roll and will hold short of the intersection, or has passed the intersection. (See fig. 11-14.)

SEPARATION OF ARRIVING AIRCRAFT.—Arriving aircraft are separated from other aircraft using the same runway by insuring that the arriving aircraft does not cross the landing

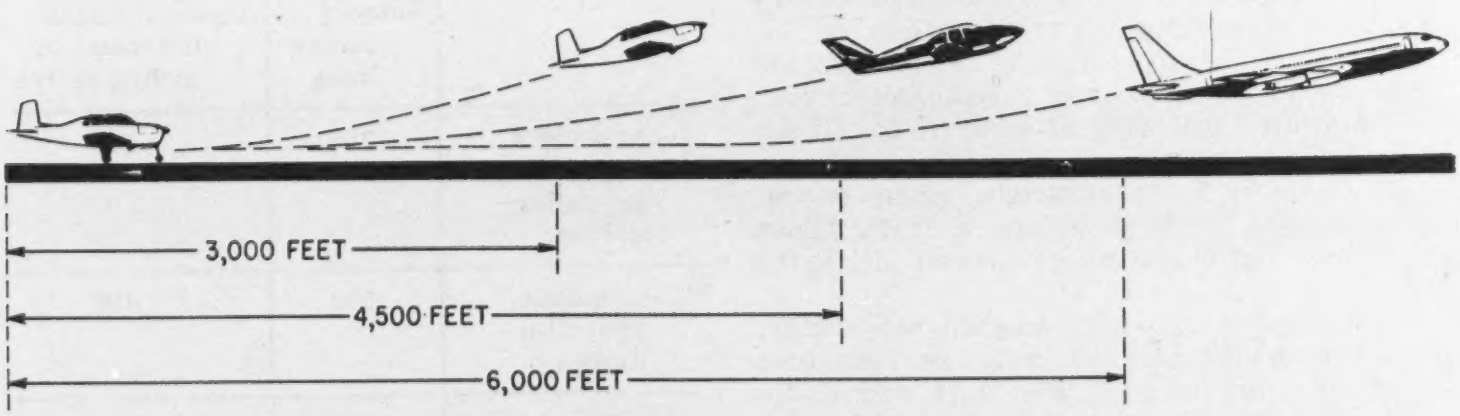

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Figure 11-11.—Separation of different category departing aircraft.

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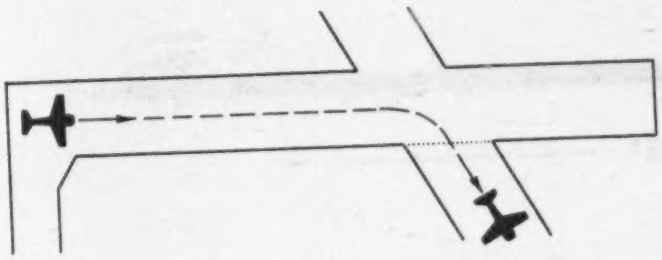

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Figure 11-12.—Separation between departing and a preceding arriving aircraft.

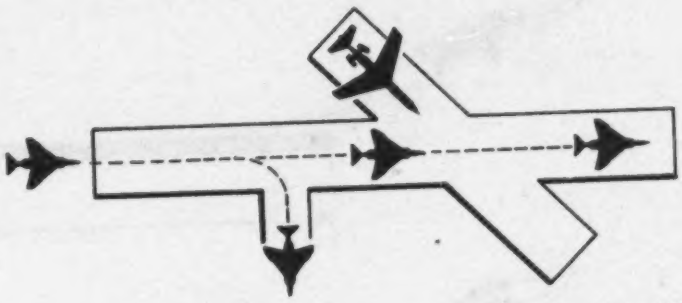

AC.148

Figure 11-14.—Separation between departing and arriving aircraft using intersecting runways.

threshold until one of the following conditions exists:

1. The other arriving aircraft has taxied off the runway. (See fig. 11-15.)

2. Between sunset and sunrise, if distances by reference to suitable landmarks can be determined and the other aircraft has landed, the preceding arrival need not clear the runway if the following minimum distances from the landing threshold exist (fig. 11-16):

a. When a category 2 aircraft is landing behind a category 1 or 2 aircraft —4,500 feet.

b. When a category 1 aircraft is landing behind a category 1 or 2 aircraft—3,000 feet.

3. The other departing aircraft has crossed the end of the runway. (See fig. 11-17.)

4. If distances by reference to suitable landmarks can be determined and the preceding departure is airborne, it need not have crossed the runway end if the following minimum distances from the landing threshold exist (fig. 11-18):

a. When only category 1 aircraft are involved—3,000 feet.

b. When either aircraft is a category 2 aircraft—4,500 feet.

c. When either aircraft is a category 3 aircraft—6,000 feet.

An arriving aircraft is separated from another aircraft using an intersecting runway by insuring that the arriving aircraft does not cross the landing threshold until one of the following conditions exists:

1. The preceding departing aircraft has passed the intersection or is airborne and turning to avert any conflict. (See fig. 11-19.)

2. A preceding arriving aircraft has taxied off the landing runway, completed landing roll and will hold short of the intersection, or has passed the intersection. (See fig. 11-20.)

NOTE: Touch-and-go, or low approach operations are two separate operations; i.e., the aircraft is considered as arriving aircraft until

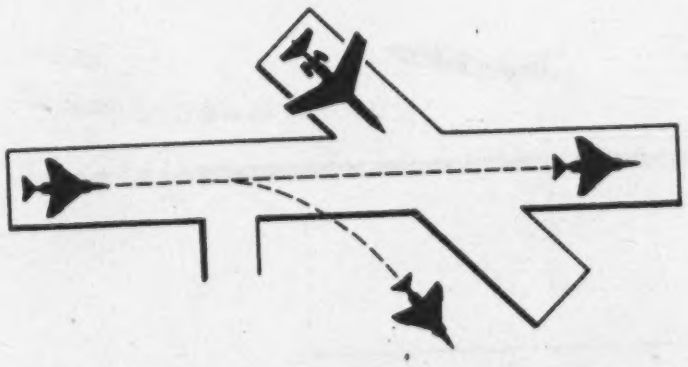

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Figure 11-13.—Separation between departing aircraft using intersecting runways.

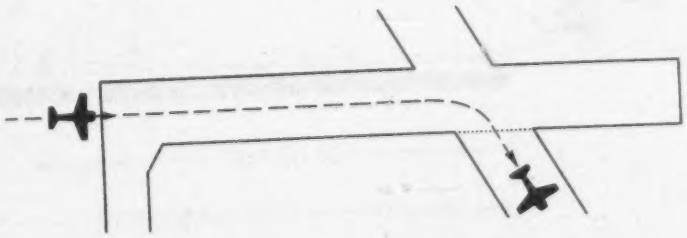

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Figure 11-15.—Separation between arriving aircraft.

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(5) of figure 15-2 (B). These pulses, separated by specific intervals of time, are applied to the indicator in the same manner as video signals. They appear as straight lines on a B-type indicator or circles on a PPI-type indicator. (NOTE: Indicators are discussed in chapter 17 of this course.)

All the control pulses described and illustrated in figure 15-2 (B) are repetitive; that is, they appear once during each cycle of operation. The timer furnished several series of pulses, each having the proper waveform and time relationship to the others. In order that a timer may provide these control pulses, it must contain the following elements:

1. A master oscillator to determine the pulse repetition frequency (PRF). This is usually a multivibrator.
2. A means of forming pulses of the desired shapes and time relations (usually miltivibrators, blocking oscillators, and delay circuits).
3. Circuits capable of matching the waveform generator to either its output circuit or to a transmission line without distortion of the waveform (the cathode follower).

All of the previously mentioned circuits have been discussed in detail in the Navy Training Course, Basic Electronics, NavPers 10087-B.

Multivibrator Timer

The multivibrator type master oscillator is used in most airborne radar systems, and is usually referred to as the heart of the radar. The multivibrator timer may do the following:

1. Establish the pulse recurrence frequency.
2. Trigger the rangemarker generating circuits.
3. Trigger the sweep circuits.
4. Trigger the transmitter.
5. Establish a time base for the intensity gate.

Figure 15-3 is a simplified block diagram of a synchronizer utilizing a multivibrator as the master timer.

The master trigger multivibrator is free running. Its output frequency, which is determined by the time constants of the RC networks in the grid circuits determines the PRF of the set. Figure 15-4 is an illustration of a free-running multivibrator. C1R3 and C2R4 make up the RC networks in the grid circuits.

The output taken from the plate circuit is fed to the fixed delay circuit for firing the transmitter and the variable delay, or directly to the range sweep circuits if no sweep delay is to be employed. (Refer to fig. 15-3.) The

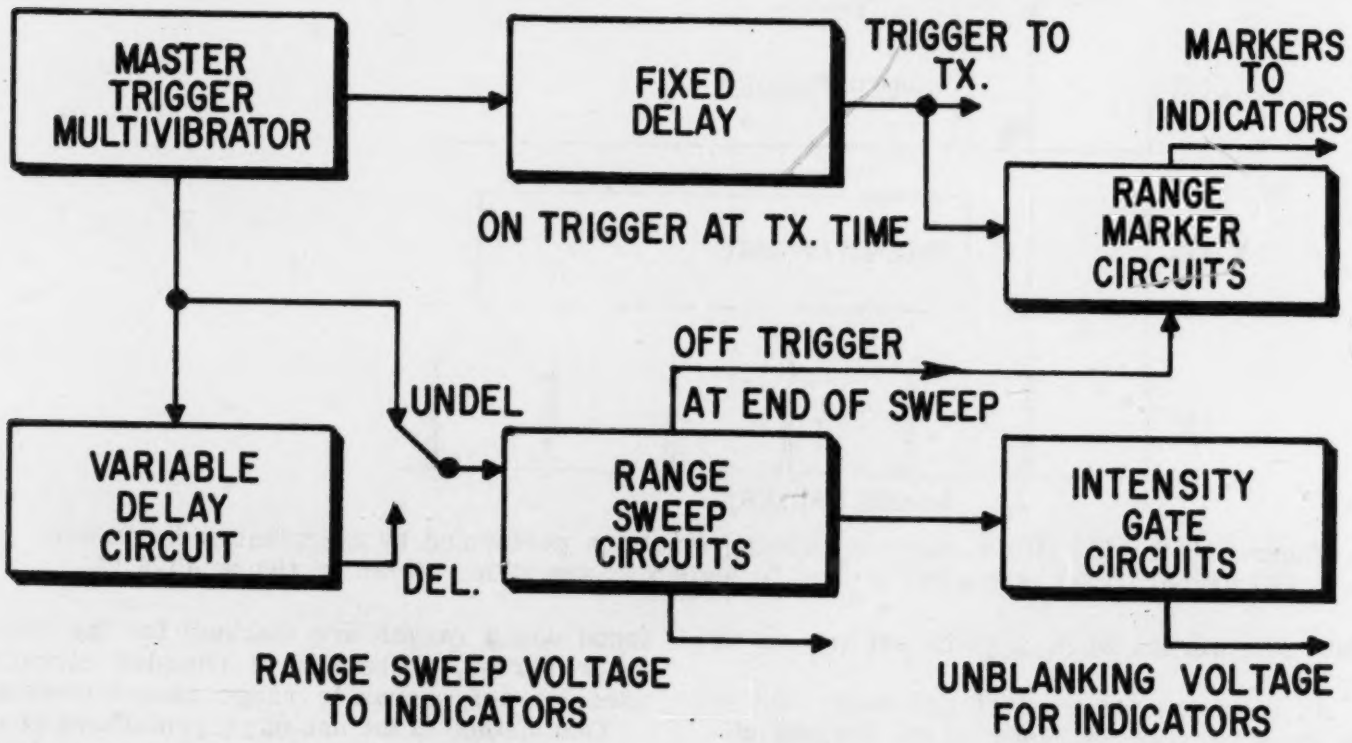

Figure 15-3. —Simplified block diagram of a synchronizer using a multivibrator master timer.

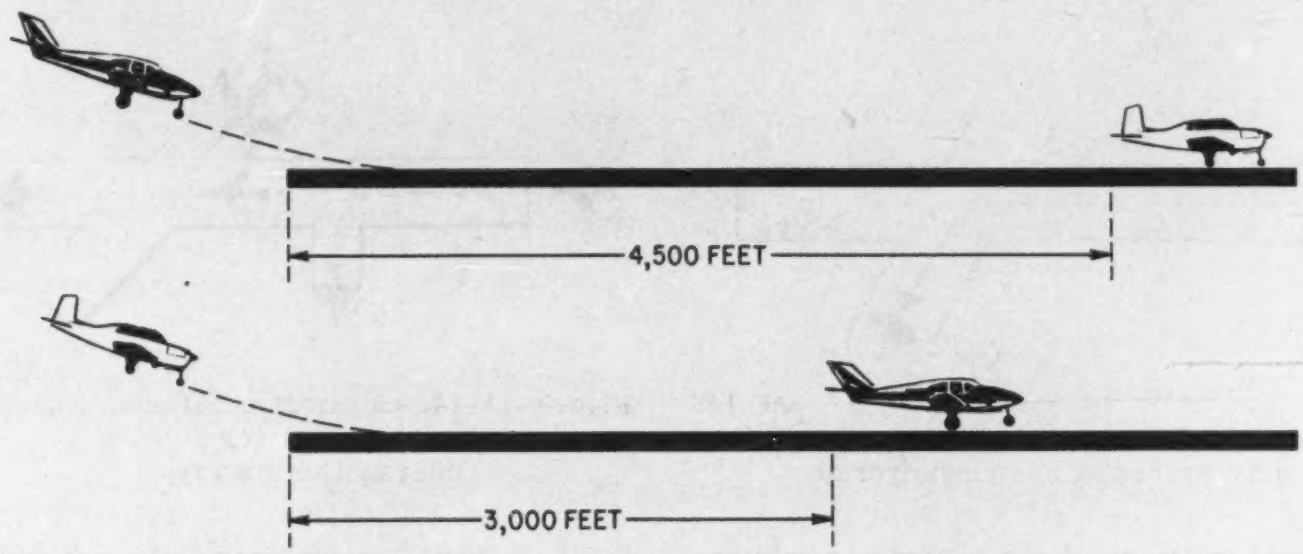

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Figure 11-16.—Separation of different category arriving aircraft.

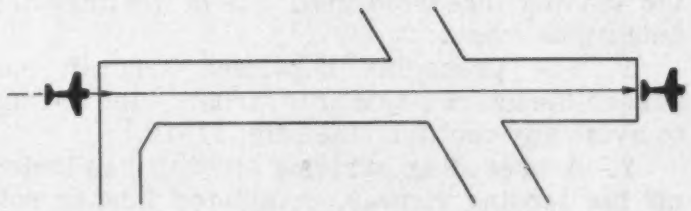

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Figure 11-17.—Separation of arriving and preceding departing aircraft.

it touches down (for touch-and-go) or crosses the landing threshold (for low approach) and thereafter becomes a departing aircraft.

SEPARATION OF HELICOPTERS.—Departing helicopters are separated from other helicopters by insuring that they do not takeoff until one of the following conditions exist:

1. A preceding, departing helicopter has proceeded away from the takeoff area. (See fig. 11-21 (A).)

2. A preceding, arriving helicopter has taxied off of the landing area. (See fig. 11-21 (B).)

An arriving helicopter is separated from other helicopters by insuring that it does not land until one of the following conditions exists:

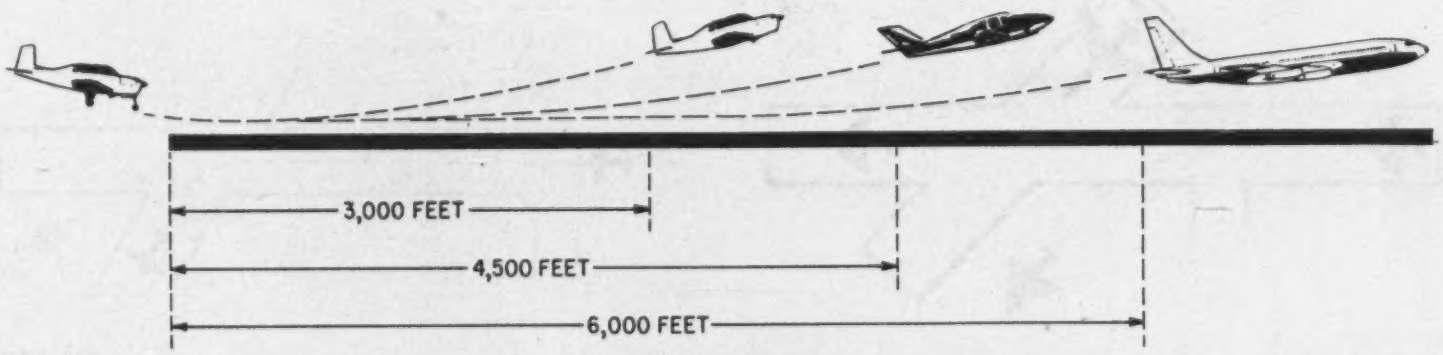

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Figure 11-18.— Separation of arriving and preceding departing aircraft of different category.

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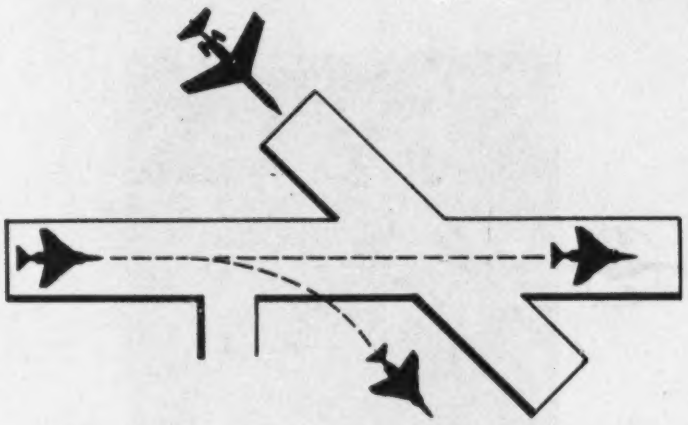

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Figure 11-19.—Separation of arriving and other departing aircraft using intersecting runways.

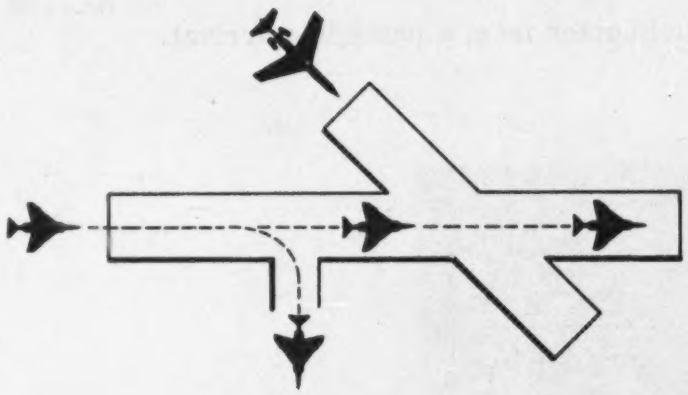

AC.154

Figure 11-20.—Separation of arriving and other arriving aircraft using intersecting runways.

1. A preceding arriving helicopter has come to a stop or taxied off the landing area. (See fig. 11-22.)

2. A preceding, departing helicopter has proceeded away from the landing area. (See fig. 11-23.)

Helicopters may be authorized to conduct simultaneous landings or takeoffs if the distance between the landing and takeoff points is at least 200 feet and the courses to be flown do not conflict. (See fig. 11-24.)

NOTE: Surface markings would have to be referred to, in order to determine the minimum distance between helicopters, or the pilots of the helicopters may be instructed to remain at least 200 feet from other helicopters.

Helicopters performing air taxiing operations (normally not above 10 feet) on the movement area are considered to be taxiing aircraft.

Departing Aircraft

Taxi information issued to departing aircraft is listed in chapter 10 of this training manual.

Pilots of departing aircraft will contact ground control prior to taxi for taxi information. Formation leaders may request and receive taxi information for their entire flight.

Ground control issues the necessary instructions, and clears an aircraft from the parking area to the warmup area. Pilots of taxiing aircraft should remain on ground control frequency while in the warmup area until instructed to

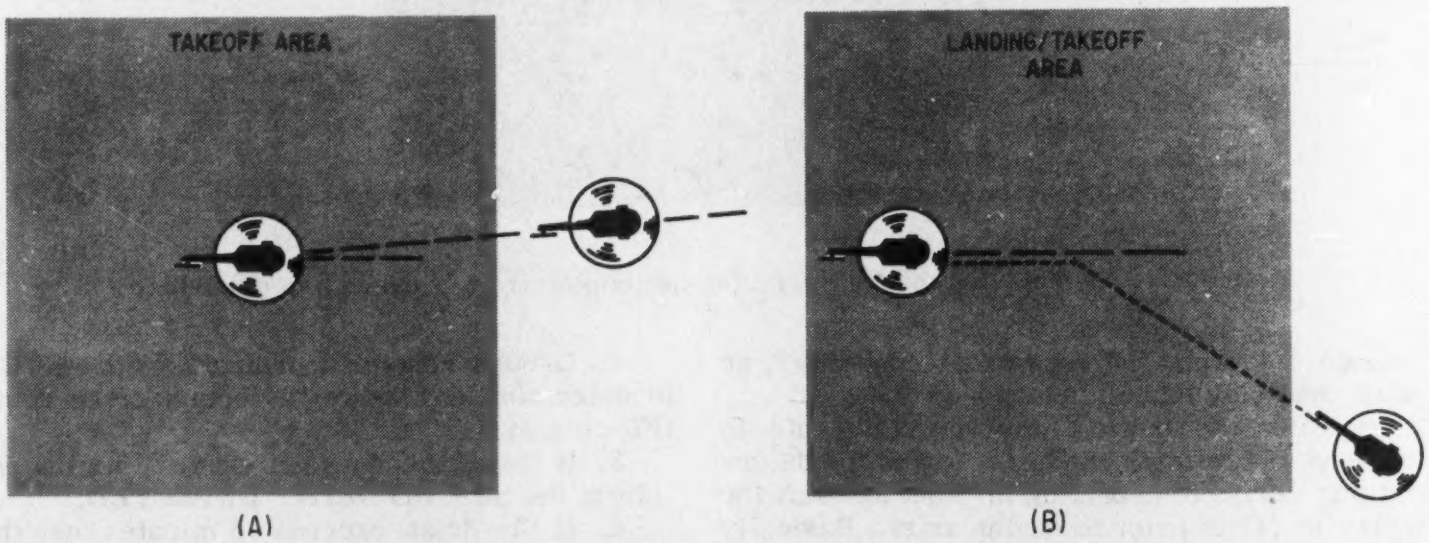

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Figure 11-21.—Separation of a departing helicopter. (A) From a preceding departure; (B) from a preceding arrival.

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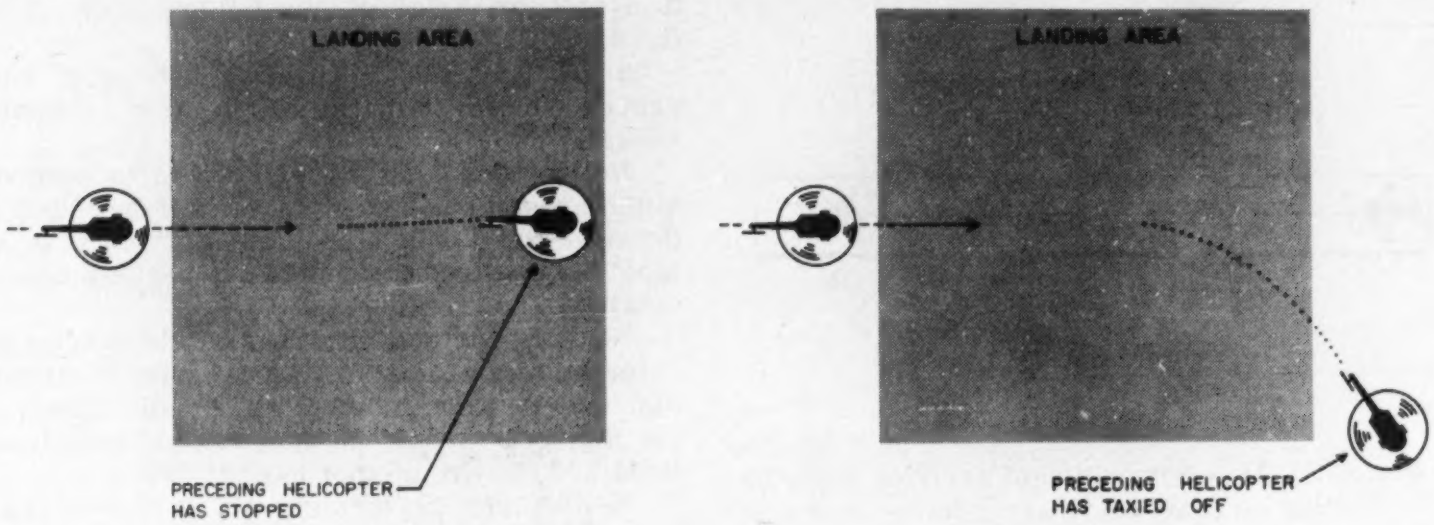

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Figure 11-22.—Separation of an arriving helicopter from a preceding arrival.

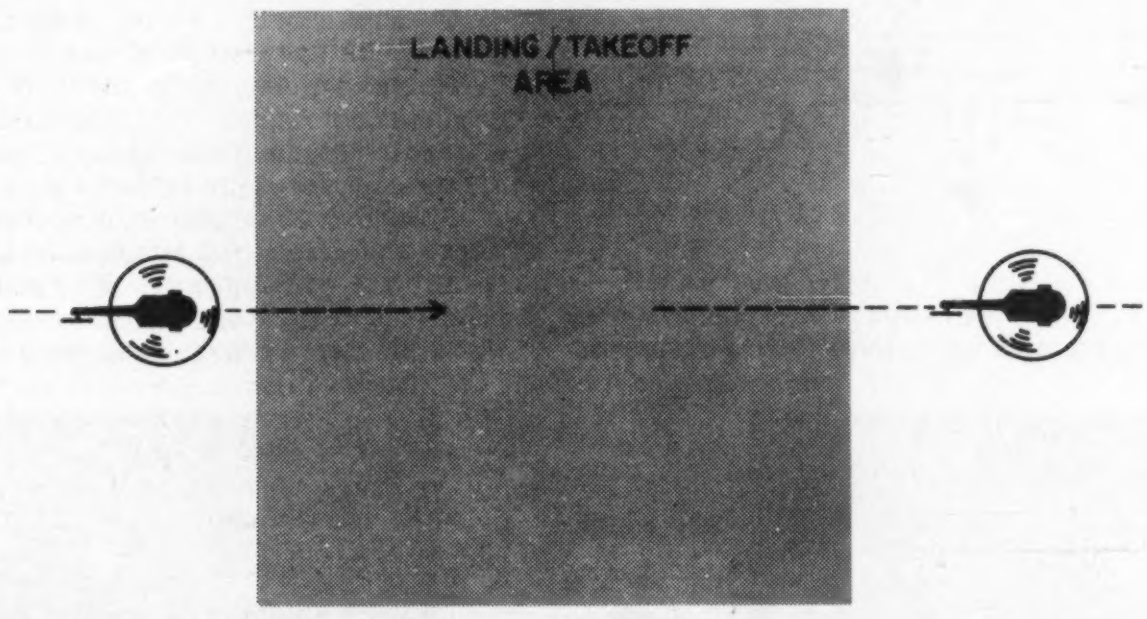

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Figure 11-23.—Separation of an arriving helicopter from a preceding departure.

change frequency by the ground controller, or until ready for takeoff clearance.

Because of critical fuel requirements in turbojet operations, there is a need for determining delays to departing turbojet aircraft for relay to pilots prior to engine start. Basically the procedure consists of the following:

1. The pilot contacts ground control before starting engines.

2. Ground control coordinates with ARTCC to determine any delay in receipt of en route IFR clearance.

3. If the delay does not exceed 15 minutes, inform the pilot NO DELAY EXPECTED.

4. If the delay exceeds 15 minutes, use the following procedure:

a. Inform the pilot of the proposed departure time.

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as local traffic conditions permit. The facility must be informed of the VFR departure time.

Official ceiling and visibility are issued to departing VFR flights prior to takeoff when the weather is below VFR minimums; and to departing IFR flights when the weather is below takeoff minimums, or if none are established, when the weather is below VFR minimums.

The Navy has established takeoff minimums for IFR flights based on the pilot's instrument rating. These ratings are entitled Special or Standard and are issued to individual pilots after successful completion of a flight check and written exam administered by an Instrument Flight Board which is established by the Commanding Officer of a facility. There are no takeoff minimums established for pilots with a Special instrument rating and takeoff will depend on the judgment of the pilot and urgency of the flight. Takeoff may be authorized for pilots with a Standard instrument rating under the following conditions:

1. Where GCA is available, if the weather is at least ceiling 200 feet and visibility 1/2 mile, but in no case when the weather is below GCA minimums.

2. Where GCA is not available, if the weather is ceiling 300 feet and visibility 1 mile.

At certain air stations where commercial or air carrier aircraft are authorized to operate carrying passengers or cargo for hire or compensation, there is a minimum visibility below which takeoff clearance to such aircraft must be denied. The specific minimum visibility is variable, depending upon the type of visibility reporting procedure and equipment available at the particular station. Should your station be so affected, refer to the appropriate section of TATC Handbook 7110.8 (Series) for the applicable minimum visibility.

A departing IFR flight should be instructed to contact departure control when appropriate. For aircraft that can change radio frequencies after takeoff, the instructions are normally issued when the aircraft is one-half mile beyond the end of the runway provided that no further communications with the tower are required. For others, the instructions may be issued prior to, or in conjunction with, the takeoff clearance.

Takeoff clearance need not be withheld until prescribed separation exists if there is reasonable assurance that it will exist when the aircraft starts its takeoff roll.

Arriving Aircraft

Landing information, as appropriate, to be issued to arriving aircraft is listed in chapter 10 of this training manual.

A continuous broadcast of recorded non-control landing information is being used at certain high activity terminal areas. This service is called Automatic Terminal Information Service (ATIS). Its purpose is to relieve frequency congestion and improve controller effectiveness by eliminating the necessity of issuing routine essential information to each arrival. Pilots tune to the published frequency for the information. When they call the tower for landing instructions they indicate by some suitable phrase that they have the information and the controller only has to issue the necessary additional instructions.

At certain facilities, procedures may be established for arriving VFR traffic to contact approach control for landing and traffic information. In such cases approach control assists the local controller with the communications workload and traffic spacing in addition to enhancement of safety by making traffic information available for a greater distance from the airport. Local instruction will be promulgated which govern such operations.

Arriving aircraft normally call the tower for landing instructions prior to entering the airport traffic area. Aircraft carrying very important persons (VIP), or cargo requiring assistance, should contact the tower as soon as possible and again when entering the airport traffic area.

Spacing of arriving aircraft must begin prior to their reaching that portion of the traffic pattern where a landing clearance must be given. VFR traffic tends to arrive at irregular intervals or in large numbers requiring a controller to issue the necessary instructions and information to establish an evenly timed flow of traffic.

Traffic patterns are established at airports to specify the desired flow of air traffic in the vicinity of the airport. Standard patterns are left-hand patterns as depicted in figure 11-25. A conventional pattern, used mostly by reciprocating engine powered aircraft, consists of the following:

1. Upwind leg. A flight course parallel to the landing runway in the direction of landing.

2. Crosswind leg. A flight course at right angles to the landing runway off its upwind leg.

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3. Downwind leg. A flight course parallel to the landing runway in the direction opposite to landing.

4. Base leg. A flight course at right angles to the landing runway off its approach end and extending from the downwind leg to the intersection of the runway centerline extended.

5. Final approach. A flight course in the direction of landing along the runway centerline extended from the base leg down to the runway. (See fig. 11-25.)

A standard overhead approach pattern for use by military high performance aircraft consists of the following:

1. An initial approach 3 to 5 miles in length.
2. A breakpoint at which the first 180 degree turn is started. (Normally over the numbers on the runway of intended landing.)
3. Direction of turns is normally left.
4. Pattern altitudes at least 500 feet above the conventional pattern until the second 180 degree turn is started.
5. A rollout on final approach not less than one-fourth mile from the runway threshold and not less than 300 feet above the ground. (See fig. 11-25.)

Entry of the overhead approach pattern is normally from the initial point. Entry of the conventional pattern is normally an interception of the downwind leg at an angle of 45 degrees. (See fig. 11-25.)

Specified procedures and control techniques vary from one facility to another, as well as from one controller to another. However, certain basic rules apply regardless of the techniques that are used; for example:

1. The controller is responsible for issuing instructions and information relative to all known traffic conditions.
2. All turns by the pilot around the airport will be left-hand, unless otherwise specified by the controller.
3. At least one component of a traffic pattern (final approach) will be used by the pilot, consistent with instructions issued by the controller.
4. Pilots are responsible for conformance with the applicable pattern requirements established by antinoise programs, etc.
5. Pilots have the final authority for the acceptance of clearances issued from the tower.

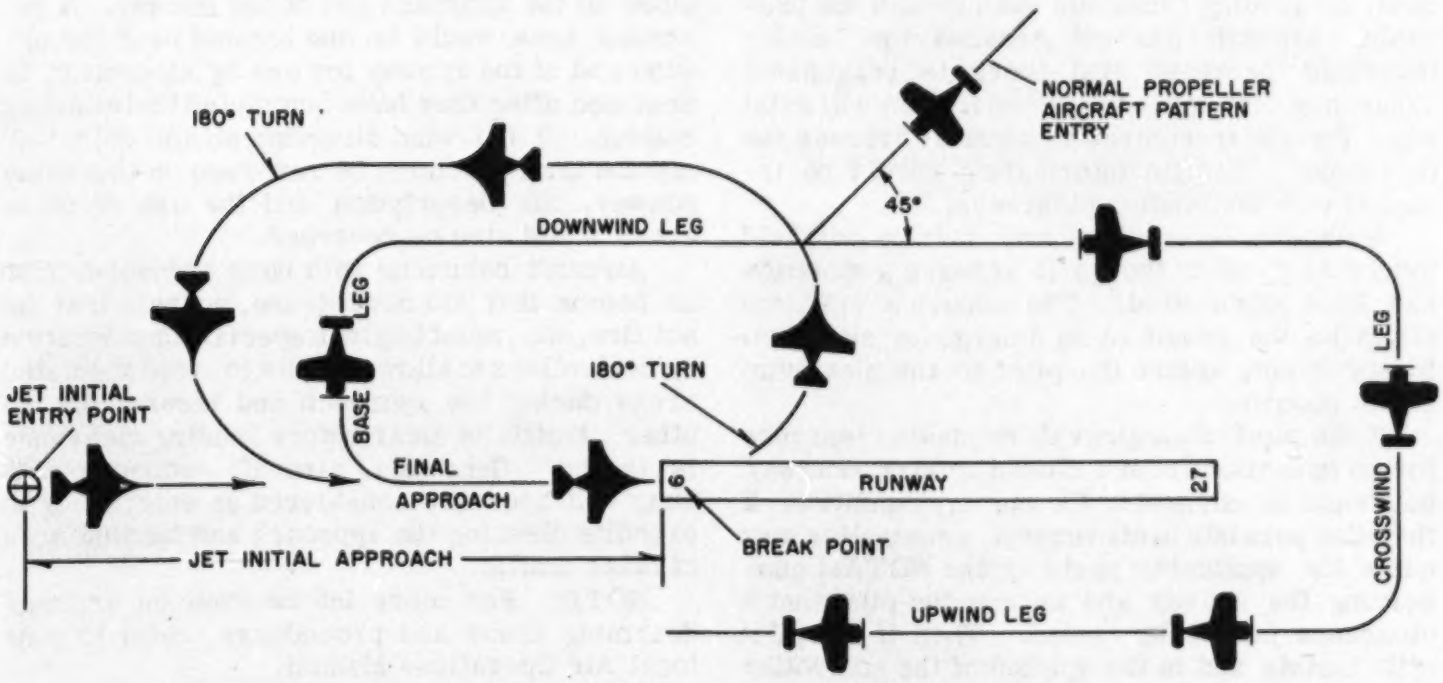

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Figure 11-25.—Conventional and overhead approach traffic patterns.

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6. All instructions issued by the controller, and accepted by the pilot, must be adhered to by the pilot concerned.

7. Pilots landing or taking off are entitled to all usable and available portions of the runway.

If it is necessary to hold arriving VFR aircraft at visual holding points because of traffic congestion, such aircraft would be cleared to a selected, prominent geographical fix easily recognized from the air and preferably one depicted on aeronautical charts. Instructions should be issued regarding the direction of holding and turns. Traffic information is issued to aircraft cleared to hold at the same fix.

Landing clearance is normally issued when arriving aircraft turn to base leg or begin the second 180 degree turn for the overhead approach. Such clearance is normally issued after prescribed separation between aircraft concerned exists and the pilot reports "wheels down."

Landing clearance need not be withheld until prescribed separation exists if there is reasonable assurance that it will exist when the aircraft crosses the landing threshold. However, a succeeding aircraft should not be cleared to land before a preceding arriving aircraft crosses the landing threshold.

Landing clearance may be issued to a radar-controlled aircraft when it is 3 miles from touchdown or landing threshold even though the preceding aircraft has not crossed the landing threshold provided that there is reasonable assurance that appropriate separation will exist when the radar-controlled aircraft crosses the threshold. Traffic information should be included with the landing clearance.

A landing clearance may not be withheld indefinitely, even though it appears a violation has been committed. The apparent violation might be the result of an emergency situation. In any event, assist the pilot to the maximum extent possible.

If the pilot of an aircraft requests clearance for an operation from a closed or unsafe runway, he should be advised of the runway condition. If the pilot persists in his request, a controller may quote the applicable parts of the NOTAM concerning the runway and inform the pilot that a clearance cannot be issued. Then if the pilot still insists and in the opinion of the controller the operation would not adversely affect other traffic, he should be informed that the operation will be at his own risk.

Ordnance, Parking, and Refueling Operations

When appropriate, the local controller may instruct the pilot where to turn off the runway after landing. This may be necessary for pilots who are unfamiliar with the field in order to expedite traffic; or special circumstances may require additional instructions to be issued such as to direct an aircraft to a dearming area.

At certain stations where flights require the use of ordnance, it may be necessary to direct aircraft to a particular arming/dearming area where ground crews can place the ordnance in a ready condition or render it harmless, as applicable. Where such operations are required, local authority establishes arming/dearming areas for each available runway. These areas vary at each station, but generally will be located in close proximity to the end of a usable runway and a specific heading will be determined upon which subject aircraft must be established before ordnance can be armed or dearmed. The required heading will be one that points the aircraft in a direction which is unpopulated or a clear area for safety purposes. These areas are interchangeably described as arming or dearming areas.

An arming area would be for use by aircraft just prior to takeoff and would be relatively close to the approach end of the runway. A dearming area would be one located near the upwind end of the runway for use by aircraft to be dearmed after they have completed their landing rollout. If the wind direction should shift 180° and the traffic pattern be reversed on this same runway, the description and the use of these areas would also be reversed.

Aircraft returning with hung ordnance, such as bombs that did not release, rockets that did not fire, etc., must be given special consideration by controllers to allow the pilot to avoid populated areas during his approach and insure that all other traffic is clear before landing clearance is issued. Generally, aircraft returning with hung ordnance are considered an emergency to expedite clearing the approach and landing area of other traffic.

NOTE: For more information on arming/dearming areas and procedures, refer to your local Air Operations Manual.

Pilots of arriving aircraft will normally shift to ground control frequency upon clearing the duty runway. At this time the ground

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controller will issue any additional instructions necessary for the aircraft to proceed to the appropriate destination on the field. Pilots of aircraft based aboard a particular station or those who are known to be familiar with the field may only need an acknowledgment from ground control that they are on ground control frequency and a brief instruction to complete the operation.

EXAMPLE: TAXI TO YOUR LINE.

Pilots who are unfamiliar with the field may need precise step-by-step instruction to get the aircraft to the proper place. Actual parking of the aircraft is accomplished by a line crew; however, the ground controller should provide the line crew with advance notification of the aircraft arrival so that the transition from instructions issued by the tower to visual signals provided by the lineman is a smooth and continuous operation. Use of FOLLOW ME vehicles is common at many fields to simplify the procedure of getting an unfamiliar pilot to his destination on the field as expeditiously as possible. The ground controller will have communications with both the FOLLOW ME vehicle and the aircraft, but communications do not normally exist between the vehicle and the aircraft. This requires liaison and coordination to get the vehicle in the proper pickup position and insure that the pilot establishes visual contact with the vehicle. These vehicles are usually lighted for night use.

Refueling operations are outside the authority or responsibility of tower controllers; however, they may be called upon to relay advance information to the appropriate personnel about the type or grade of fuel required by a transient aircraft. This allows the refueling truck to be called out and meet such aircraft when they are parked, thereby expediting refueling and reducing ground time.

Priority

Air traffic control service is provided on a first come, first serve basis as circumstances permit, with the following exceptions:

1. Maximum possible priority should be provided military air evacuation flights when requested by a particular pilot. Particular consideration to priority should be given in terminal areas and to avoid turbulent conditions.
2. Maximum assistance should be provided SAR aircraft while performing a SAR mission.
3. Special handling may be required to expedite a Semiautomatic Flight Inspection Aircraft (SAFI), which is a specially equipped aircraft with a preplanned system of checking certain navigation aids.
4. Special consideration must be given to expedite the movement of the Presidential or the Vice Presidential aircraft and any escort aircraft as well as related control messages when traffic conditions and communications facilities permit.
5. Expeditious handling is required for any aircraft using the code name FLYNET. This code name indicates that the aircraft is transporting a nuclear emergency team to the location of a nuclear incident.
6. Expeditious handling must be provided to aircraft using the code name GARDEN PLOT when Central Altitude Reservation Facility (CARF) indicates that such priority is authorized. This code name is assigned to aircraft engaged in transporting troops to areas of civil unrest.

All naval air activities may assign priorities to VFR traffic. Priority is not normally given to VIP's; however, all Navy air traffic control facilities may give consideration to VIP's as long as safety is not affected.

The operation of jet-propelled aircraft necessitates expeditious handling to avoid excessive fuel consumption during taxiing, takeoff, and landing operations. Therefore, the following instructions must be followed by naval control tower operators:

1. Jet aircraft must NOT be granted priority for taxiing, takeoffs or landings unless the pilot so requests.
2. In granting priority: (1) Jet aircraft may be cleared first when propeller-driven aircraft will delay taxiing and takeoff; (2) if jet aircraft are ready for takeoff and propeller-driven aircraft are approaching for landing, jet aircraft may be cleared for takeoff and all other aircraft; except jet, hospital evacuation, and aircraft in emergency may be instructed to circle the field, (3) jet aircraft approaching for landing may be cleared ahead of all other aircraft (both jet and conventional) taking off and ahead of all other aircraft landing except those in emergency and hospital evacuation aircraft.

Pilots of jet aircraft should not request priority except when considered necessary. Ordinarily, the necessity should not exist for flights in local flying areas.

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VFR Helicopter Operations

Where helicopter and fixed wing aircraft use the same facility, a controller must consider the maneuverability and operational characteristics of helicopters when issuing instructions and information to establish a smooth flow of traffic. Helicopters do not necessarily conform to a standard traffic pattern as do fixed wing aircraft. Local procedures may be established to insure uniformity of helicopter operations. Local pilots would probably be familiar with such local procedures, but transient pilots would depend upon the controller to issue appropriate instructions. Conflicting flight paths and movements between helicopters and fixed wing aircraft must be prevented.

Pilots of helicopters should request permission from the control tower to cross a duty runway, or runway in use. The controller should then issue appropriate instructions based upon an assessment of the current traffic situation.

Navy helicopter flights within a control zone should not exceed an altitude of 500 feet unless authorized to do so by the control tower or other appropriate agency.

Helicopter training flights should stay well clear of other traffic. When they are within the boundaries of the airfield, the pilot should guard the tower frequency so a controller can keep the pilot informed of current traffic information.

Practice autorotations (defined in chapter 9) may be conducted within the limits of the field boundaries, over a surface where a full autorotation might be safely completed, and which is readily accessible to crash and firefighting equipment.

Special VFR Operations

Special VFR weather minimums are listed under FAR 91.107 in chapter 9 of this training manual.

Special VFR operations may be authorized only within control zones by the ATC facility providing IFR service to such control zones. This authorization is based on weather conditions officially reported at the airport of intended operations. If weather conditions are not reported at that airport, special VFR may be authorized whenever the pilot advises he is unable to maintain VFR and requests special VFR. (An example of such an airport would be a small outlying field that has no weather service available at the field.)

EXAMPLE: CLEARED OUT OF CONTROL ZONE NORTH OF PODUNK AIRPORT ON A HEADING OF THREE SIX ZERO, MAINTAIN SPECIAL VFR CONDITIONS WHILE IN CONTROL ZONE.

Local special VFR operations may be authorized for a specified period (such as a series of landings or takeoffs) upon request, if the aircraft can be recalled when traffic or weather conditions require. Where traffic density or complexity of operations warrant, Letters of Agreement may be consummated with the local authority.

Aircraft may be authorized to climb to VFR upon request if the only weather limitation is restricted visibility.

EXAMPLE: CLIMB TO VFR WITHIN THE THE CONTROL ZONE, MAINTAIN SPECIAL VFR CONDITIONS UNTIL REACHING VFR.

Approved separation must be provided between special VFR flights and between special VFR and IFR flights. One type of approved separation that is easily adaptable to special VFR operations is visual separation. (See chapter 12 of this training manual.) When applying vertical separation, a fixed altitude should not be assigned to a special VFR operation, but the special VFR aircraft may be cleared at or below an altitude which is at least 500 feet below any conflicting IFR traffic. Minimum safe altitudes must also be considered when applying this procedure.

CONTROL PROCEDURE. —For the purpose of the following discussion, these terms have the meanings indicated:

1. Ingress flight — An arriving aircraft which enters the control zone and lands at an airport within the zone.

2. Egress flight — A departing aircraft which takes off from an airport within the control zone and leaves the zone.

3. Local flight—An aircraft which operates within the traffic pattern of an airport within the control zone, usually for series of takeoffs and landings.

4. FW/SVFR—Fixed wing special VFR flights.

In control zones where FW/SVFR operations are permitted, priority may be given to arriving and departing IFR aircraft in accordance with the following:

1. Ingress or egress FW/SVFR flights are handled as follows:

a. Where radar service is provided by a terminal facility, ingress or egress FW/SVFR

flights may be authorized when arriving or departing IFR aircraft are within the control zone, provided:

(1) Arriving or departing IFR aircraft are not delayed.

(2) Radar surveillance of the FW/SVFR aircraft and the pertinent arriving or departing IFR aircraft is maintained until the FW/SVFR aircraft landing is assured or it has left the control zone.

b. When authorization cannot be granted for a FW/SVFR flight, the aircraft should be informed of the anticipated delay. If the aircraft is arriving, it should be instructed to remain outside the control zone. EAC's or EFC's are not issued to special VFR flights.

2. Local FW/SVFR flights should be handled as follows:

a. Where radar service is provided by a terminal facility, local FW/SVFR flights may be authorized when arriving or departing IFR aircraft are within the control zone, provided:

(1) Arriving or departing IFR aircraft are not delayed.

(2) Local FW/SVFR flights can be conducted independently and without conflict with arriving or departing IFR aircraft.

(3) Radar surveillance of arriving or departing IFR aircraft is maintained to insure that the flight paths of these aircraft do not encroach upon the area in which the local FW/SVFR flights are being conducted.

The priority afforded IFR aircraft over FW/SVFR aircraft is not intended to be so rigidly applied that it causes grossly inefficient use of airspace. If better overall efficiency will be gained thereby, the controller has the prerogative of allowing completion of a FW/SVFR operation already in progress when an IFR aircraft becomes a factor. Examples follow:

1. A FW/SVFR aircraft has been cleared to enter the control zone and subsequently an IFR aircraft is ready to depart or is in position to begin an approach. Less overall delay might accrue to the IFR aircraft if the FW/SVFR aircraft is allowed to proceed to the airport and land, rather than leave the control zone or be repositioned to provide IFR priority.

2. A FW/SVFR aircraft is number one for takeoff and located in such a position that the number two aircraft, an IFR flight, cannot taxi past to gain access to the runway. Less overall delay might accrue to the IFR aircraft by releasing the FW/SVFR departure rather than by having the aircraft taxi down the runway to a turnoff point so that the IFR aircraft could be released first.

At locations where radar service is provided by a center, or where radar service ordinarily provided by a terminal facility is out of commission or considered unsatisfactory radar coverage, FW/SVFR operations are authorized only when there are no IFR aircraft operating with the control zone.

Requests for authorization of special VFR operation within control zones, by other than helicopters, when the flight and/or ground visibility, as appropriate, is less than 1 mile must be treated as follows:

1. Pilots of departing aircraft who request such authorization must be advised of the weather conditions and that, as a result, such a clearance cannot be issued.

2. Pilots of aircraft who request clearance to enter a control zone and land must be advised of the weather conditions and that, as a result, unless an emergency situation exists, such a clearance cannot be issued.

3. Pilots of arriving aircraft operating within the control zone who request landing clearance must be advised that the ground visibility is less than 1 mile, and must be asked if the aircraft can depart the control zone with a flight visibility of at least 1 mile. If the aircraft cannot depart the control zone accordingly, or an emergency exists, issue a clearance as soon as traffic conditions permit.

When weather conditions are not officially reported at an airport and the pilot advises the flight visibility is less than 1 statute mile, treat requests for special VFR operations the same as outlined above except no mention need be made of the visibility since the pilot determines the extent of visibility in such cases.

Scheduled air carrier aircraft in the U. S. may be authorized takeoff or landing where a local surface restriction to visibility is not less than one-half mile, provided that all turns after takeoff or before landing and all flight beyond 1 mile from the airport boundary can be accomplished above or outside the area of visibility

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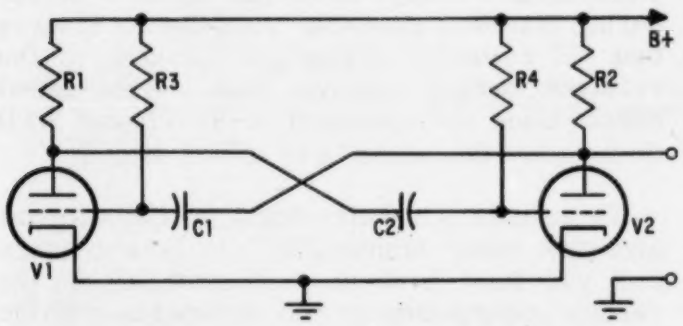

Figure 15-4. —Free-running multivibrator.

fixed delay circuit delays the firing of the transmitter until the nonlinear portion of the range sweep is past. The output of the fixed delay is then fed to the modulator and range marker circuits simultaneously. Thus, the range-marker circuits are turned on at the time the transmitter fires, and turned off at the end of the range sweep time by a pulse from the range sweep circuits. The output of the range marker circuits is fed to the indicator in the form of evenly spaced pulses and appear as intensified range lines on the scope.

The trigger to the range sweep circuits may be either delayed or direct. If direct, the range sweep will start immediately; if delayed, the range sweep will start sometime after the transmitter is fired, delay time being equal to the output of the variable delay circuit.

The range sweep circuits provide the indicator with sweeps of various time duration (ranges). They also furnish trigger pulses to start and stop operation of the intensity gate circuit (for unblanking the indicator during sweep time only), and an output to the rangemarker circuits to turn the marker circuits off at the end of sweep time.

TRANSMITTER

The transmitter is a high powered, high frequency microwave oscillator. It is designed to operate around a predetermined frequency and to be fairly stable at this frequency. It operates during the pulse period and is then shut off for a comparatively long rest period. Its power, in the form of high frequency microwave oscillations, is delivered during the pulse time to the waveguide transmission system for delivery to the antenna, where it is then propagated into space.

The block diagram (fig. 15-5) is a simplified drawing and does not refer to any particular type of transmitter; however, it contains the elements found in a majority of airborne radar systems.

The technician should bear in mind that the various components discussed may be physically located in one unit or in several different units, depending on the type of installation.

Functional Operation

Referring to figure 15-5, the trigger shaper receives an input trigger from the system's synchronizer. As the name implies, the trigger is amplified and shaped into a sharp trigger pulse and fed to the next stage, a cathode follower. The cathode follower is used to match the high output impedance of the trigger shaper to the low input impedance of the pulse switch stage. The output from the cathode follower is applied to the control grid of the pulse switch. Before discussing the triggering action, the function of the power supply, charging diode, and pulse forming network are discussed.

The power supply furnishes the high voltage and supplies the energy which the pulse forming network (PFN) stores for release to the transmitter. The PFN, an open end artificial transmission line, stores this energy, and determines the width and shape of the pulse to the transmitter. The charging diode controls

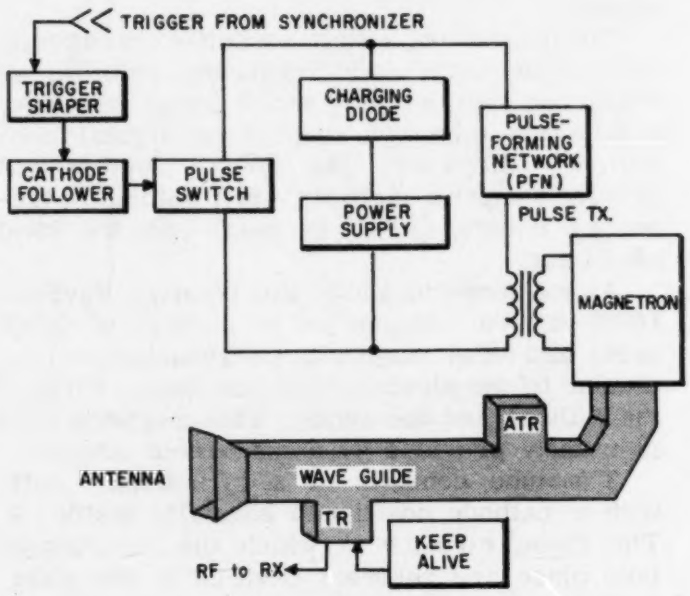

Figure 15-5. —Radar transmitter (block diagram).

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restriction. The pilot is solely responsible for determining if the nature of the visibility restriction will permit such operation.

Special VFR Helicopter Operations

Due to their special flight characteristics, helicopters are an exception to the minimum of 1 mile visibility for special VFR operations within a control zone. However, the Navy has established additional minimums for Special VFR Navy helicopter operations of one mile forward flight visibility and ceiling 500 feet.

Special VFR helicopter operations are controlled by the same procedures prescribed for special VFR aircraft unless other procedures are contained in a Letter of Agreement.

At locations where the volume or complexity of helicopter operations warrant, a Letter of Agreement will specify the fact that special VFR helicopter flights are required to maintain visual reference to the surface and traffic patterns, routes, and reporting or holding fixes necessary to achieve appropriate separation. These minimums are listed in TATC Handbook 7110.8 (Series) which should be referred to by AC's at air stations where the above situation exists.

Simulated Flameout
(SFO) Procedures

Military turbojet aircraft may be authorized to make SFO maneuvers. Practice SFO approaches are authorized only for specific Navy aircraft. However, precautionary SFO approaches might be made by any aircraft when engine failure is considered possible.

A simulated flameout pattern consist of the following:

1. High Key, which is a position over the airport where the pilot begins to maneuver the aircraft to enter a high downwind leg. (Recommended altitude 5,500 to 15,000 MSL.)
2. Low Key, which is a position on high downwind leg just before turning on base leg. (Recommended altitude 3,500 to 10,000 MSL.)
3. Flameout Maneuvering Area, which is that airspace to be occupied by an aircraft conducing a SFO approach, which begins at high key, includes the low key, and ends at the end of the runway. (See fig. 11-26.)

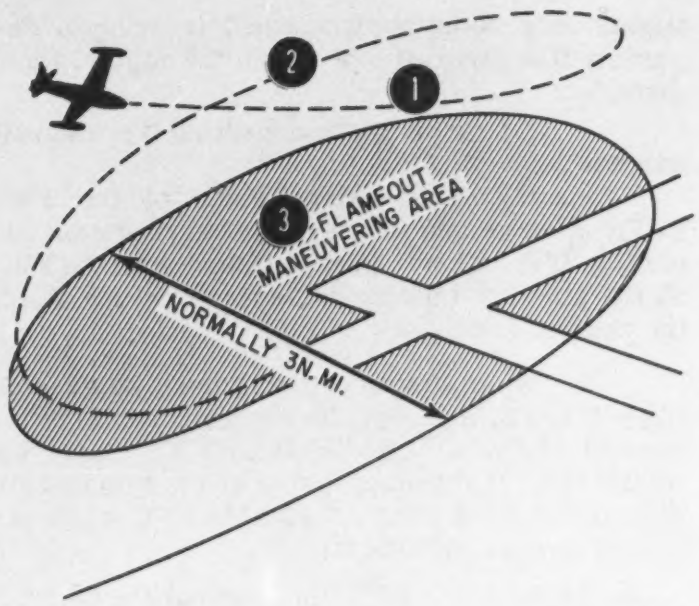

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Figure 11-26.—Simulated flameout pattern.

Aerial Tow Target Operations

Aerial tow targets and related equipment are used in gunnery practice by ships and shore installations and in air-to-air firing exercises. Towing operations enable gunners to fire at targets that simulate moving aircraft in speed, shape, and maneuvers.

Most aerial tow targets presently employed are of the type that can be released, or trailed, behind the aircraft in flight and retracted when the mission is completed. These targets do not normally require any special consideration concerning airport traffic control. However, the possibility of a mechanical malfunction exists and a pilot may not be able to retract the target. In such cases the pilot may desire to make a low approach over the airport and drop the target in an area from which it could be retrieved. The local Air Operations Manual designates specific procedures and areas for dropping towed targets.

It should be kept in mind that an aircraft with a tow in the traffic pattern is a definite hazard and the Air Controlman has the responsibility of controlling traffic accordingly. This may require additional spacing of traffic or having other traffic vacate the traffic pattern until the tow drop is complete.

Field Carrier Landing Practice

Involvement of the Air Controlman in the procedures of field carrier landing practice (FCLP) stems from his position of control of aircraft at and around the airport. The extent to which he is called upon to exercise control and handle other aspects connected with FCLP is discussed in the following sections.

The landing safety officer (LSO) is an experienced carrier pilot, designated and trained by the Navy to assist and instruct pilots in carrier and field carrier landing techniques. The LSO has direct responsibility for the aircraft in the FCLP pattern. The tower retains overall control of the traffic, which means the control tower will issue instructions whenever there is danger present to the aircraft in the pattern. To effectively accomplish this, there must be close coordination between the tower and the LSO regarding any emergency action that may be necessary. In addition, tower operators can relay any information to the LSO pertaining to the aircraft in the pattern if it will result in safer operations. The only instructions other than those issued by the control tower during FCLP when a hazardous condition exists, are initial takeoff clearance and taxi instructions. All other instructions given to the pilots of aircraft conducting FCLP are given by the LSO.

Practicing of FCLP is the most hazardous routine operation conducted on the field. The tower operator must be constantly alert for any emergency while these operations are in progress. These emergencies may result from spins, stalls, and ground loops, due to the slow speed and low altitude of the aircraft in the pattern. While conducting FCLP, more than the normal amount of crash requipment is required to be available on the field because of the greater hazards involved. Station instructions designate the positioning of this equipment and the amount required.

Pilots receive an extensive training program at shore installations, preparing them for actual carrier landings prior to going aboard an aircraft carrier. Therefore, to approximate shipboard landing conditions, a runway is marked off in size and shape similar to the flight deck of an aircraft carrier. Landing area markings, discussed earlier in this chapter, sometimes serve as a simulated flight deck for FCLP. However, when it is impractical to conduct FCLP operations on the landing area marking, additional simulated flight deck markings are painted at appropriate locations on the runway. Lights are used to outline the runway for nighttime use. These may be either portable lights or smudge pots.

FCLP PATTERN.—The FCLP pattern is usually a touch-and-go pattern. This means that the aircraft is able to stay in the pattern and complete more approaches. When the aircraft takes off, the pilot will usually turn slightly to the right so as to leave the runway clear of turbulence. An aircraft entering turbulence from an aircraft ahead may have trouble recovering because of the low altitude, and a crash may result. The airspeeds used vary with the type of aircraft; however, it is normally not much above stalling speed. In their final approach, aircraft are controlled by the LSO. The LSO may, at his discretion, wave off an aircraft at any point in the landing approach. The pilot will land after completion of the required number of approaches, or when low on fuel. The control tower will then issue instructions to the pilot for taxiing back to the parking area.

An aircraft receiving a waveoff will remain in the pattern and will make its next approach in its regular sequence, with other aircraft still in the pattern.

Most facilities have a portable or permanently installed Fresnel lens for use with FCLP. This visual landing aid is the same as that used aboard ship and is illustrated in chapter 13 of this Rate Training Manual.

EMERGENCY AND CRASH PROCEDURES

The facilities for fighting fires and aiding personnel involved in crashes are a vital part of the airport equipment.

While flight operations are being conducted, commanding officers must insure that adequate firefighting, crash, rescue, and ambulence equipment is on hand. They must also see that the equipment is favorably located, adequately manned, and in efficient operating condition and that the crew is alerted. Only a minimum of equipment is required on the field during normal operations, but other crash and rescue equipments are held in readiness at all times.

All air stations maintain a current crash bill detailing the duties of those assigned the handling of such emergencies including control tower operators. Additionally, procedures are established for handling emergencies or accidents when the aircraft involved is carrying

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hazardous cargo. These instructions are normally separate from the crash bill because of their classified nature.

It is the primary responsibility of the control tower operator to observe closely all activities on the airfield and within the visible traffic pattern, and maintain radio communications with aircraft concerned. Normally the control tower operator will obtain initial information on an impending emergency or accident. Control tower personnel must speedily convey exact information to crash, firefighting, and rescue units so that prompt action by those units can be taken.

Primary Crash Alarm Intercommunications System

This system is a direct wired intercommunications system normally installed between the control tower, flight clearance dispatcher, crash shack, and ambulance fixed stations. Its purpose is to provide an immediate means of communication to primary emergency activities so they may notify all essential supporting activities.

Secondary Crash Alarm Intercommunication System

This system may operate through the regular telephone switchboard and may be activated from the control tower and the flight clearance desk. This system is referred to as the "crash phone." Telephone receivers on this system are installed as required at each facility. The following stations are suggested:

1. Crash stations.
2. Fire stations.
3. Hospital or Dispensary.
4. Fire chief.
5. Security office.
6. Aircraft maintenance.
7. Boathouse (if near water).
8. Commanding Officer.
9. Officer of the Day.

This system allows notification of all essential personnel and activities simultaneously by the flight clearance dispatcher without further interference with control tower duties.

Emergency Radio Communications Systems

Two radio networks are provided for the purpose of coordinating crash and firefighting activities. The primary network is referred to as the "crash network" which provides communications between the control tower and the necessary mobile units such as crash trucks and ambulances. The other network is a standby or spare in case of outage of the primary equipment. The secondary network is referred to as the "internal security network."

Responsibility

In the event of a crash or impending emergency, control tower personnel must convey exact information to the necessary units concerned and keep them advised of the status and pertinent details. They must notify all traffic on the field and in the air of the crash or emergency, and, at the direction of the operations officer or his authorized representative, close the field to traffic until free for normal operations.

When activating the crash phone system, give the following information:

1. Crash or emergency.
2. Location of crash (using the crash grid map).
3. Brief description, including type of aircraft.
4. Number of persons aboard.
5. Ordnance load, if known.

Aircraft crashes are usually described as to location by using a grid map system especially constructed for this purpose. (See fig. 11-27.) Sometimes it is desirable to construct two grid maps. One map is used for crashes on or near the airport and one is expanded to cover more area for off station crashes. In either case all crash vehicles, crashboats, and rescue aircraft must be supplied with copies of these maps to be able to interpret tower directions. Two examples in using this map are: Area THREE FOXTROT would include the approach end of runway 18 and SIX BRAVO would include the approach end of runway three.

There is a certain amount of excitement generated with the occurrence of an emergency or crash. However, since you are transmitting very vital information it is extremely important

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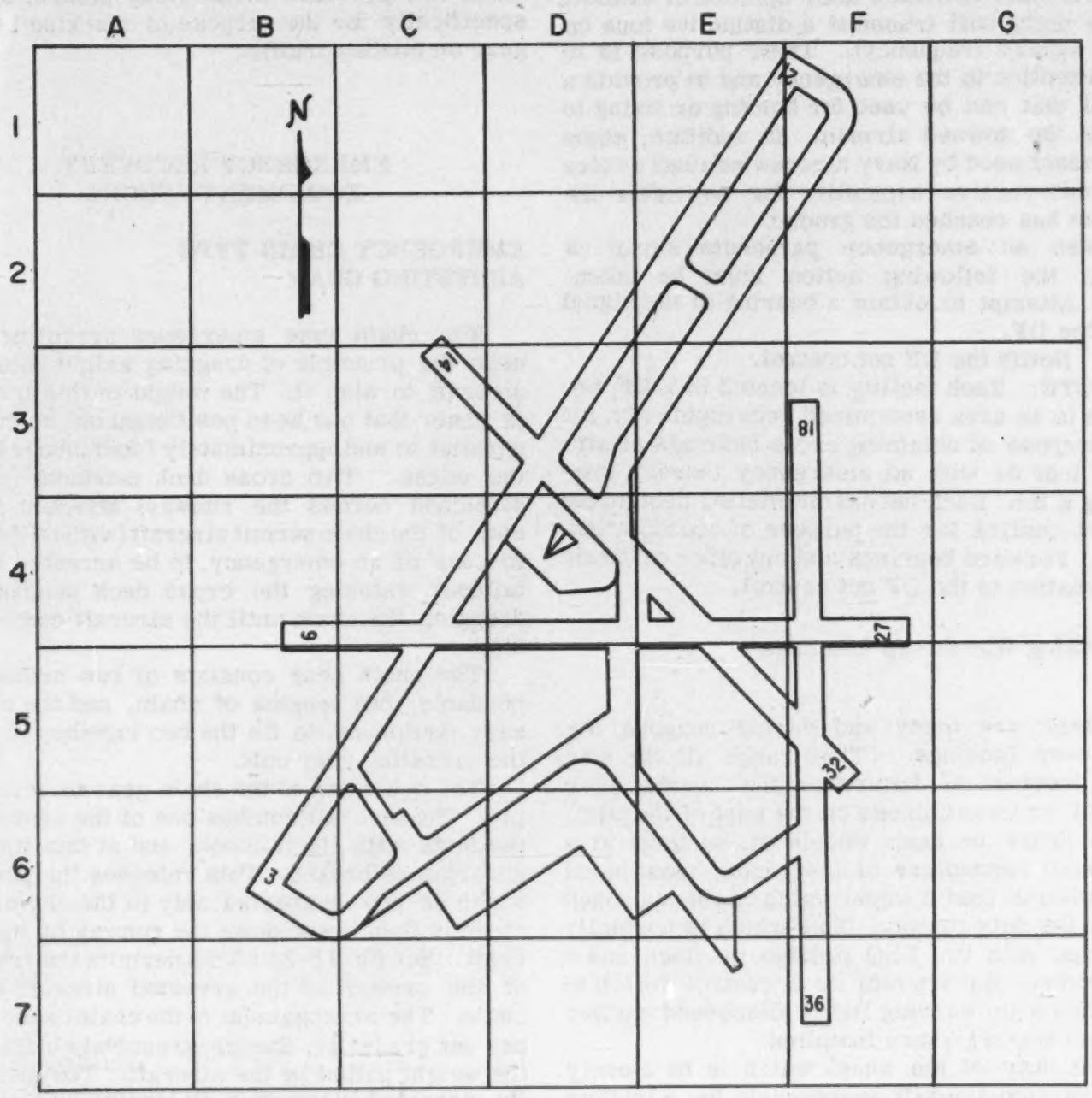

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Figure 11-27.—Crash grid map.

that you be CORRECT, CONCISE, and CALM. Remember that you are talking to several people at one time and they must absorb the information that you are giving in order to take proper action.

Emergencies and crashes more distant from the field are usually handled by search and rescue facilities. The procedures for alerting search and rescue facilities are covered in chapter 3 of this rate training manual.

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Parachute Distress Signals

Parachutes worn by some aircrewmen are equipped with a small radio transmitter which automatically activates after ejection or bailout. These units will transmit a distinctive tone on 243.0 (guard frequency). Their purpose is to call attention to the emergency and to provide a signal that can be used for homing or fixing to locate the downed airman. In addition, some equipment used by Navy aircrewmen has a voice transmit-receive capability for use after the airman has reached the ground.

When an emergency parachute signal is heard, the following action must be taken:

1. Attempt to obtain a bearing of the signal with the DF.
2. Notify the DF net control.

NOTE: Each facility is located in a DF net, which is an area determined geographically, for the purpose of obtaining cross bearings of aircraft lost or with an emergency thereby providing a fix. Each net has one station designated as net control for the purpose of coordination.

3. Forward bearings and any other pertinent information to the DF net control.

Preventing Wheels-Up Landings

There are many and varied reasons for wheels-up landings. They range all the way from mechanical failure of the landing gear system, to forgetfulness on the part of the pilot.

In order to keep wheels-up landings at a minimum regardless of the cause, most naval air stations post a wheel watch at the approach end of the duty runway. This watch is normally provided with two LSO paddles or flags and a pyrotechnic flare pistol or a control switch to the wheels-up warning lights (discussed earlier in this chapter) where installed.

The duty of the wheel watch is to closely observe each aircraft approaching for a landing and if the landing wheels appear to be down and in place he signals a ROGER (arms extended parallel to the ground). A waveoff (signal not to land) is given to all aircraft not having landing gear extended (wave arms overhead to side).

At any time there is any doubt, the wheel watch gives a waveoff. If the aircraft continues, and it becomes apparent that the waveoff signal has not been observed pyrotechnic flares are fired or the wheels up warning lights are activated, if applicable.

Alert controllers can prevent many wheels-up landings by closely observing each aircraft in the final stages of the landing approach and giving timely warnings when appropriate. Binoculars are provided in all Navy control towers specifically for the purpose of checking landing gear on landing traffic.

EMERGENCY RECOVERY EQUIPMENT ASHORE

EMERGENCY CHAIN TYPE ARRESTING GEAR

The chain type emergency arresting gear uses the principle of dragging weight behind an aircraft to stop it. The weight in this instance is chain that has been positioned on the runway parallel to and approximately 1 foot inboard from the edges. Two cross deck pendants (cables stretched across the runway) attached to the ends of the chain permit aircraft (with tailhooks), in case of an emergency, to be arrested by the tailhook catching the cross deck pendant and dragging the chain until the aircraft comes to a stop.

The chain gear consists of two cross deck pendants, two lengths of chain, and the necessary equipment to tie the two together to make the arresting gear unit.

The operation of the chain gear is very simple. The aircraft catches one of the cross deck pendants with its tailhook, and at this time the shearpin is broken. This releases the pendant, which is now connected only to the chain. The chain is then towed down the runway by the aircraft. (See fig. 11-28.) This permits the transfer of the energy of the arrested aircraft to the chain. The arrangement of the chain causes it to pay out gradually, thus progressively increasing the weight pulled by the aircraft. The energy of the arrested aircraft is dissipated by the chain until the arrestment is completed. Then the aircraft is disengaged from the gear and the gear is restored for future use.

AIRCRAFT EMERGENCY ARRESTING GEAR (WATER SQUEEZER)

The aircraft emergency (water squeezer) arresting gear is designed as an emergency standby gear for arresting hook-equipped aircraft. Located on the runway, it is ready to save

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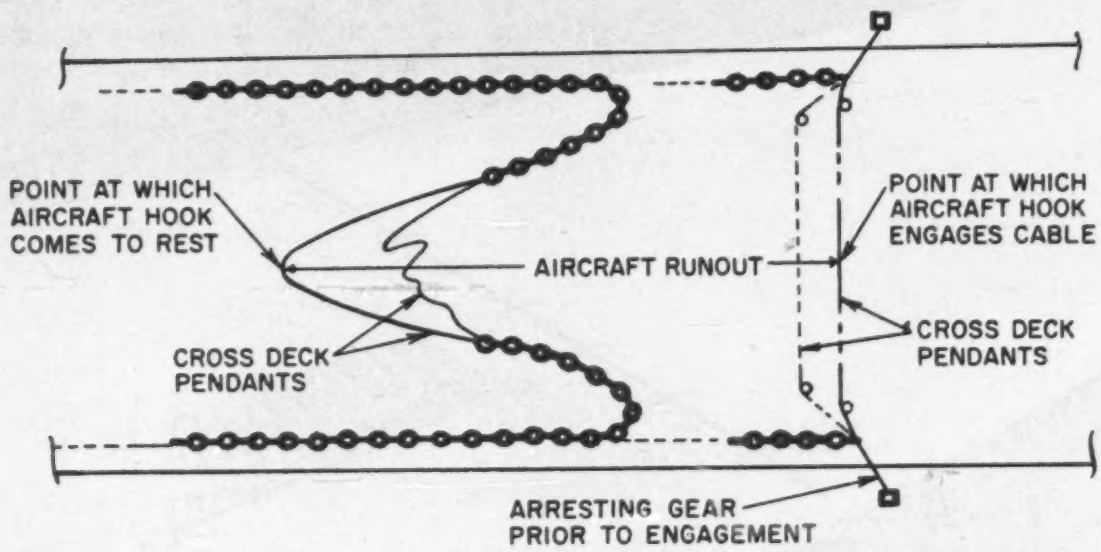

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Figure 11-28.—Operation of chain arresting gear.

the pilot and the aircraft in case of an aborted takeoff or an emergency overrun landing. (See fig. 11-29.)

The arresting gear is designed so that it can be installed quickly and easily with little obstruction to the runway. The general arrangement of the arresting gear is shown in figure 11-29. The manner in which each arresting gear is installed depends upon the local conditions and requirements.

It is designed to arrest hook-equipped aircraft up to 50,000 pounds in weight and at engaging speeds up to 160 knots. Within these limits the aircraft will be halted within a 1,000-foot runout. Engagements may safely be made at up to 50 feet to either side of the runway centerline. There is only one cross deck pendant, which spans the runway, and may be engaged by an aircraft landing in either direction. (See fig. 11-29.) The time required to rerig will depend entirely upon weather conditions and the number and experience of personnel assigned to the task. It should be possible, however, to complete the rerigging operation within 15 to 20 minutes, provided that no repairs are necessary. The time it takes to get this sytem ready for another engagement is much less than the time required for the chain type gear. This is a definite advantage.

ROTARY FRICTION ENGINE EMERGENCY ARRESTING GEAR

The purpose of the rotary friction engine arresting gear is the same as chain or water squeezer type, but is a later design to handle heavier and faster aircraft. Additionally it has a rerigging time of approximately 5 minutes.

The arresting engine consists of a nylon tape or tapes wound around a drum. The aircraft is stopped by unwinding the tape while a braking action is applied to the drum. There are various designations for the equipment to signify a difference in either the quantity of engines used, the installation configurations, or both. In other words, some installations have the engines installed in pits on each side of the runway, some have just one engine on one side of the runway with the tape passed under the runway to the other side of the deck. Other installations have the units installed above deck.

Aircraft arrestment with this type of gear is accomplished by the engagement of the aircraft arresting hook with a single cross deck pendant which spans the runway and can be engaged from either direction. During runout, the energy of the arrested aircraft is absorbed in the rotary friction arresting engine.

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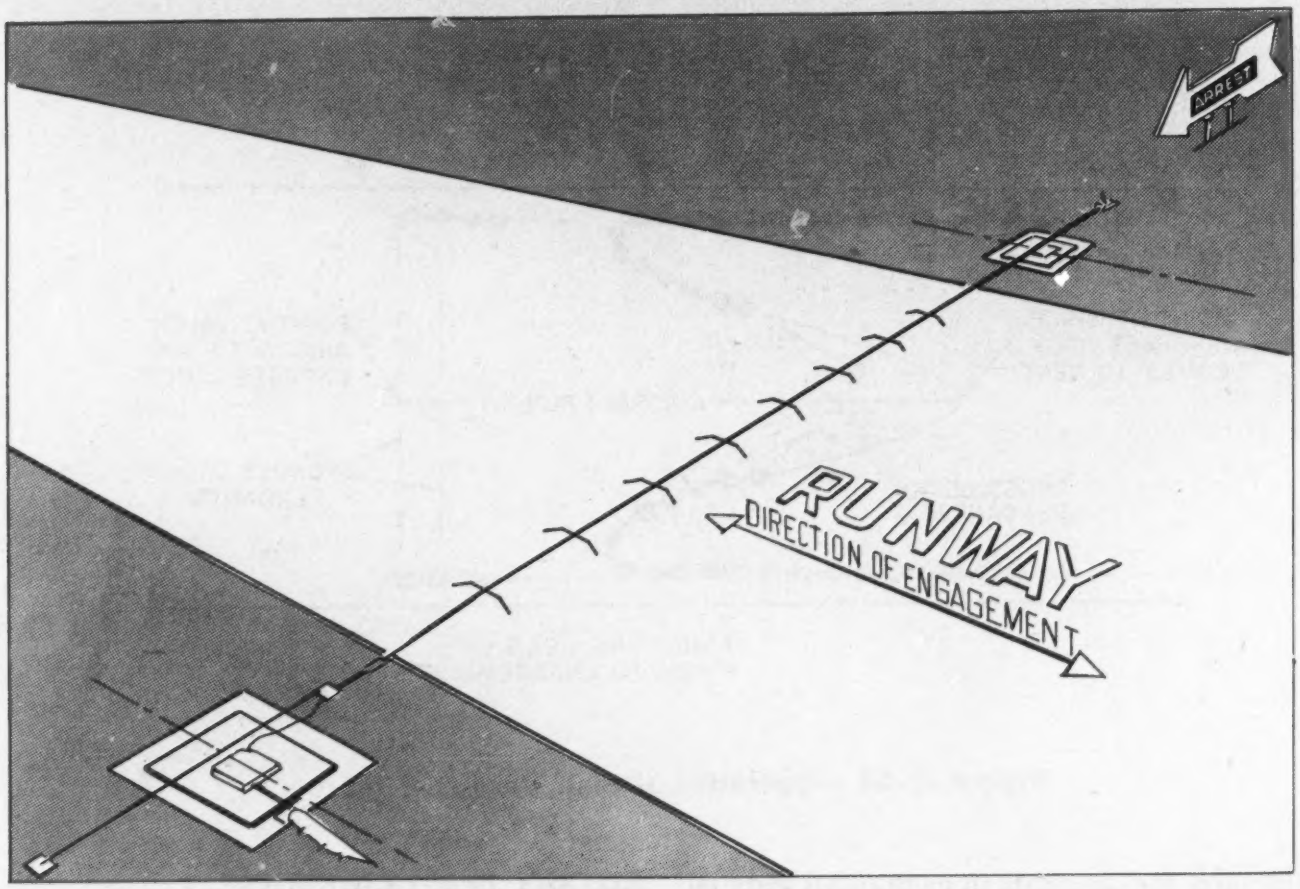

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Figure 11-29.—Emergency arresting gear (water squeezer).

As the aircraft arresting hook engages the cross deck pendant, the tape storage reels turn and the tape pays out. This action causes the energy of the aircraft to be absorbed by the braking action of the arresting gear engine or engines.

The installation in figure 11-30 is an above deck installation and includes two arresting engines, one on each side of the runway. The engines are attached in parallel to one cross deck pendant. This configuration uses two nylon tapes on each engine attached to a single cross deck pendant. However, some above deck installations have only one tape per engine. The cross deck pendant is a cable 1 1/4 inches in diameter and the nylon tape has an ultimate strength of 65,000 pounds.

MOREST EMERGENCY ARRESTING GEAR

Morest arresting gear is a self-sustaining, mobile, portable unit that is capable of being installed on small landing fields. (See fig. 11-31.)

The arresting engines are mounted on a semi-trailer for mobility. In figure 11-31 the wheels have been removed from the trailer so the engines can be stabilized.

E-28 EMERGENCY RUNWAY ARRESTING GEAR

The E-28 arresting gear is a rotary hydraulic system. It is fast and efficient, and needs little maintenance. It can arrest hook equipped aircraft in all types of landings. The simplicity of the gear's structure, and its high caliber reliability, make it exceptional. The cycle time for reuse is approximately 80 seconds. No initial preparation or adjustments are necessary for arresting any type of naval aircraft. A man can usually qualify to operate the E-28 within a day or so. Figure 11-32 is an example of the E-28 installation. It is anticipated that the E-28 will replace all other types of arresting gear ashore eventually.

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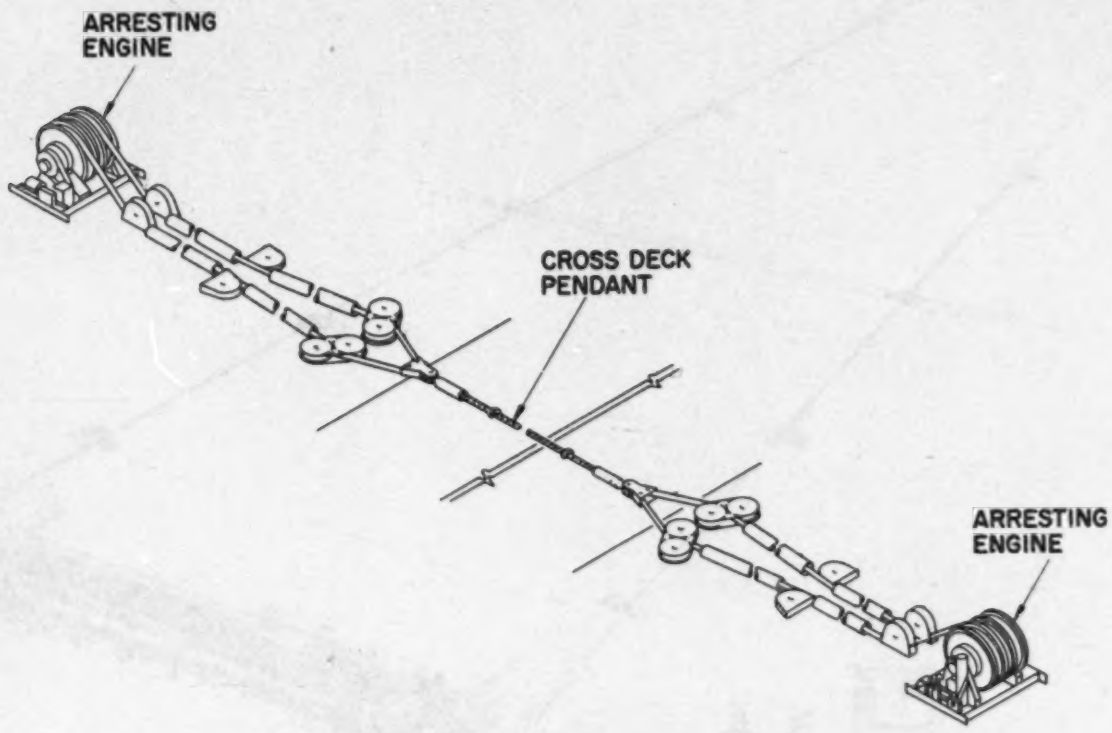

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Figure 11-30.—Rotary friction engine emergency arresting gear.

Basically, the E-28 includes a rotary hydraulic system with two identical arresting engines that control the payout of a cross-deck pendant held by the nylon tapes that feed into a winding drum mechanism attached to each energy absorber unit. Each system also contains a cooling system and a retrieve system. Once the hook engages the pendant, the forward motion of the aircraft pulls out the nylon purchase tape and activates the energy absorber units. Each such unit has a rotor and an arrangement of stationary vanes in a container of hydraulic fluid. As the tape unwinds, the rotating wheel turns the rotor, thus creating turbulence in the fluid. This turbulent fluid offers such resistance against the rotor that the speed of the unwinding wheel reel diminishes to the point where the payout of tape is stopped. The heat generated by resistance of the turbulence is drawn off by the pumping of the hydraulic fluid through a cooling tank in which the large exposed surface serves as a heat exchanger, dissipating excess heat to the outside air. The retrieve assembly is a gasoline engine driven assembly with an electrical starting system and is operated from a control panel on the assembly base. The retrieve assembly rewinds the tape and pre-tensions the pendant after each arrest.

RUNWAY OVERRUN BARRIER

Barriers are that part of the shore based recovery equipment used for the emergency arrestment of aircraft which, because of tailhook or other mechanical failure, cannot make a normal arrested landing during an emergency situation. The makeup of the barrier includes the following basic items or parts: nylon webbing, port and starboard stanchions, and cross deck pendants that are attached to the arresting gear as previously described.

The barrier webbing assembly is a group of all nylon webbing, straps combined as a unit, through which the kinetic energy of an aircraft is absorbed, to produce arrestment within a short runout distance. (See fig. 11-33.)

When the aircraft engages the barrier, the nose penetrates the webbing and the vertical straps engage the leading edges of the wings and wrap about the aircraft. The barricade then

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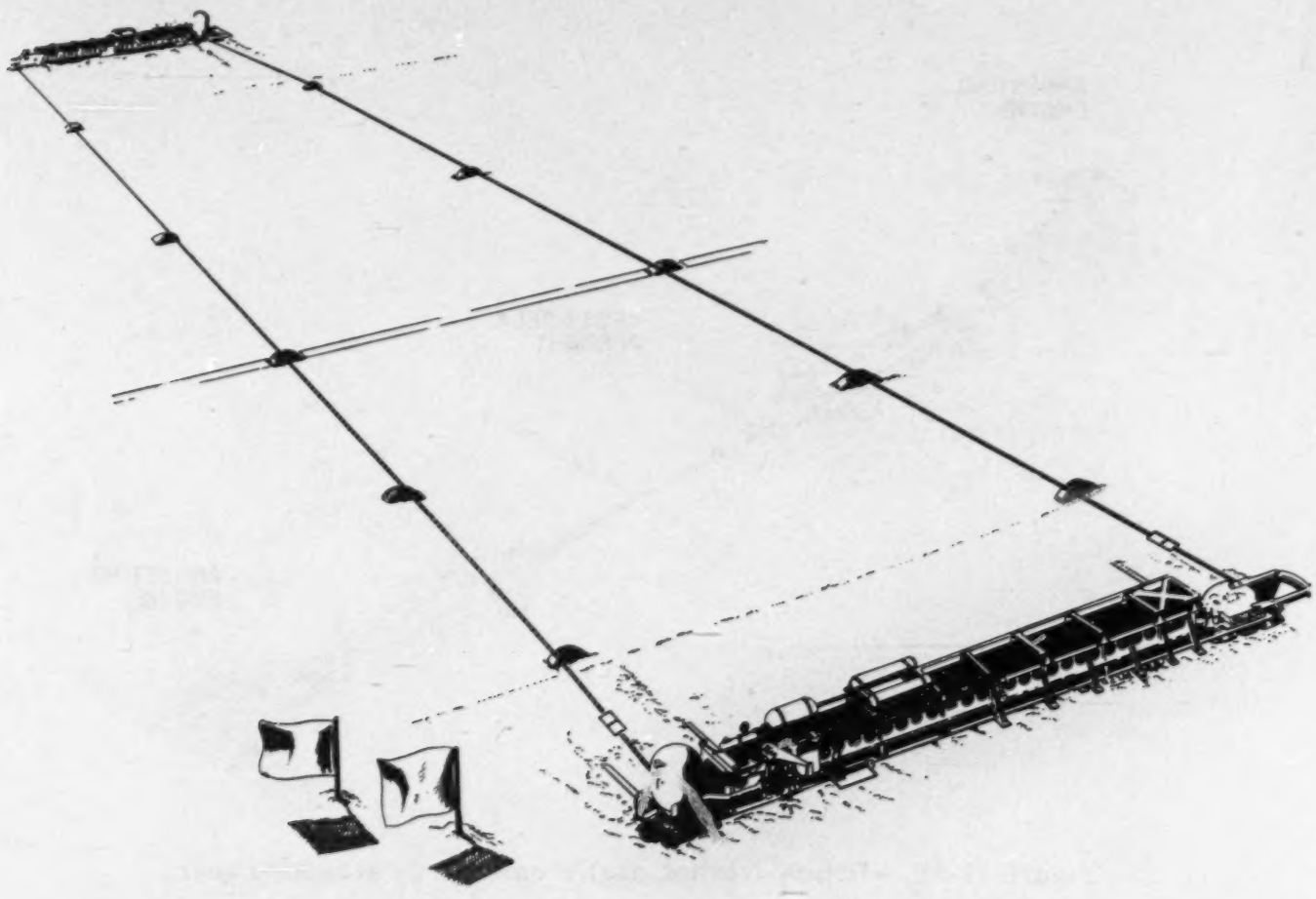

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Figure 11-31.—Morest emergency arresting gear.

passes the forces of arrestment to the chain, water squeezer, or nylon tape, at which point the arresting procedure follows in the same manner as the three previously described emergency arresting techniques.

Whenever possible, the barrier is located in the runway overrun area at a sufficient distance from the end of the runway to permit it to remain in a ready position while conducting normal aircraft operations. If sufficient overrun area is not available for such installation, the barrier is located as close to the end of the runway as possible. However, locating the barrier so near the runway makes the barrier an obstruction hazard when making approaches over it. For this reason it is required that it be possible to raise and lower the barrier. At most installations, it can be controlled remotely from the tower.

Emergency recovery of an aircraft by the barrier is the least desirable system described in this chapter, since some damage to the aircraft is likely to result. However, damage is usually minor compared to what could result during an aborted takeoff or during a landing when the aircraft would roll past the runway or overrun area into rough surface where considerable damage and/or injury to occupants could occur.

LOCATION OF ARRESTING GEAR

Figure 11-34 shows possible locations of emergency arresting gear. Location A represents a runway overrun barrier for aborted takeoffs and landing overruns. Location B represents an installation where only one gear is available and affords landing protection in both directions, but does not provide for an aborted arrestment. Location C represents an installation that provides landing overrun and aborted takeoff protection for both ends of a runway where overrun areas are inadequate.

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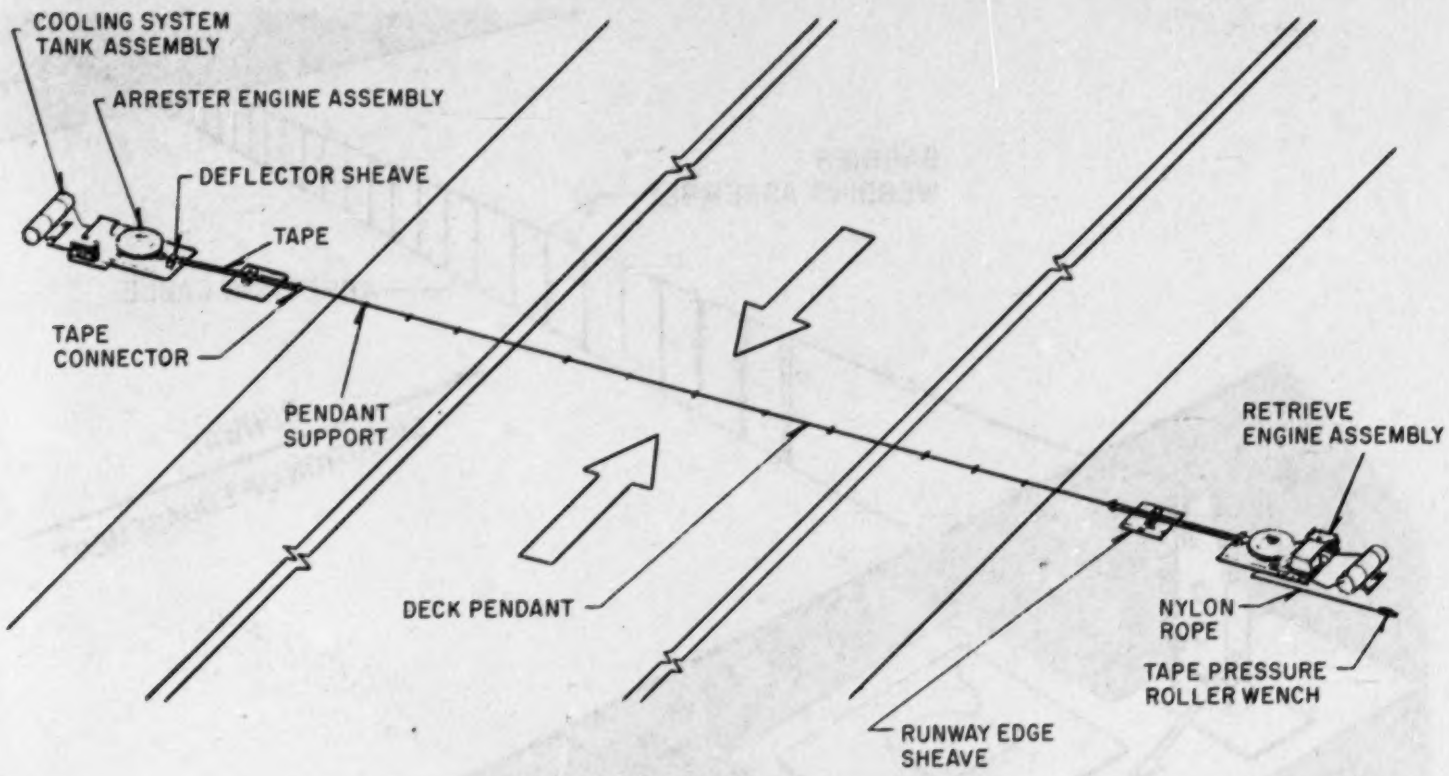

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Figure 11-32.—E-28 emergency arresting gear.

RUNWAY FOAMING

Due to the numerous variables present in any emergency landing there is little chance of positively and accurately predicting the usefulness of foam in any given emergency. However, where there is likelihood of fuel spillage that may ignite from friction produced sparks, the use of foam on the runway will decrease the possibility of a fire from this source by a significant factor. Time is of the essence. First consideration is an estimate of how long the aircraft concerned can remain airborne. The crash trucks require a minimum of 10 to 20 minutes to apply a foam blanket, recharge, and return to the standby position.

The operations officer (operations duty officer) is responsible for the decision to foam the runway with or without pilot request if considered desirable, and conversely, to deny the procedure if necessary.

Foam Patterns

Presently there are two basic foam patterns used. They are as follows:

1. Foam is laid from the 2,000 foot to the 5,000 foot position in the center of the runway approximately 40 feet wide. This pattern is usually associated with the landing gear retracted or "belly landing."

2. Foam is laid immediately upwind of the arresting gear that is to be used. It extends for 1,500 feet and fans out toward the side in which the aircraft is anticipated to swerve.

Foam may be removed from the runway in one or two ways. During hours of sunshine, water will settle out of foam and evaporate readily in 2 or 3 hours, or small areas may be washed away with high pressure hose.

In any event, the runway may have reduced braking action until the foam is dry or is removed.

the transfer of energy from the power supply to the PFN. The use of an inductive charging impedance causes the PFN to charge to approximately twice the power supply voltage. It also prevents the power supply output from being shorted during the pulse time when the switch tube conducts.

The pulse switch, when triggered, acts like a closed switch which completes the circuit for discharge of the PFN very rapidly through the primary of the pulse transformer. The pulse transformer matches the impedance of the transmitter to the characteristic impedance of the PFN, and thus results in maximum power transfer. Also by using a step-up transformer (from the PFN to the transmitter), a lower voltage may be used on the PFN for a given pulse voltage to the transmitter.

A magnetron is used as the transmitting tube in most pulsed transmitters operation at frequencies above 1000 mc. The fact that the magnetron has the capability of high power outputs and is not subject to the change in input impedance at high frequencies encountered in conventional tubes, makes it well suited for use at these high frequencies. Several types of oscillators have been developed which compete with magnetrons as radar high-powered oscillators, such as the velocity modulated types, the back-wave oscillator, and the klystron, which operate in the radar range and are capable of greater power output than the triodes. These are discussed in chapter 12 of this course.

The magnetron, which is a self-excited oscillator, possesses fair frequency stability as compared with the more stable lower frequency oscillators (electron coupled or crystal controlled). However, the overall system will provide adequate stability when automatic frequency control (AFC) is used with the local oscillator.

As explained in Basic Electronics, NavPers 10087-B, the magnetron is a type of diode using and axiel magnetic field which is perpendicular to the electric field that exists between the cathode and the anode. This magnetic field is usually provided by a permanent magnet.

The tube consists of a cylindrical plate, with a cathode positioned coaxially inside it. The tuned circuits in which the oscillations take place are resonant cavities in the plate.

The duplexer, which consists of an ATR and a TR, is used to enable the use of one antenna for both the transmit and receive cycle of the system. The TR device effectively blocks the transmitter's energy from entering the receiver during transmit time—the ATR device insures that all reflected energy is directed to the receiver during receive time. The actual construction and operation of the TR and ATR devices are discussed later in this chapter.

Prior to the actual circuit analysis of a typical airborne radar transmitter, it is necessary that you first have an understanding of the various components used in conjunction with the transmitter, their uses, construction, and theory of operation.

ANTENNA SYSTEM

The antenna system has two general purposes. It radiates pulses of microwave energy developed by the magnetron, confining the waves into a narrow beam. In addition it receives the echo signals from targets which are applied to the receiver. The antenna system consists of waveguides, switching tubes, a reflector for beaming the radiated energy and concentrating the received energy, a mechanism for rotating the reflector during operation, and servo units which coordinate the position of the indicator sweep with the position of the antenna reflector.

Duplexers

In present day aviation radar, it is desirable to use a single antenna for both transmitting and receiving. A fast acting electronic switching device is required to disconnect the receiver from the transmission line during periods of transmission and to disconnect the magnetron during periods of reception. The receiver must be disconnected in order to protect the receiver input section and crystal since the magnetron output may be several megawatts. The magnetron must be disconnected during periods of reception in order to allow all available reflected energy from the target to pass to the receiver.

The duplexer is the device which performs this dual function of switching the antenna for transmitting and receiving, and protecting the

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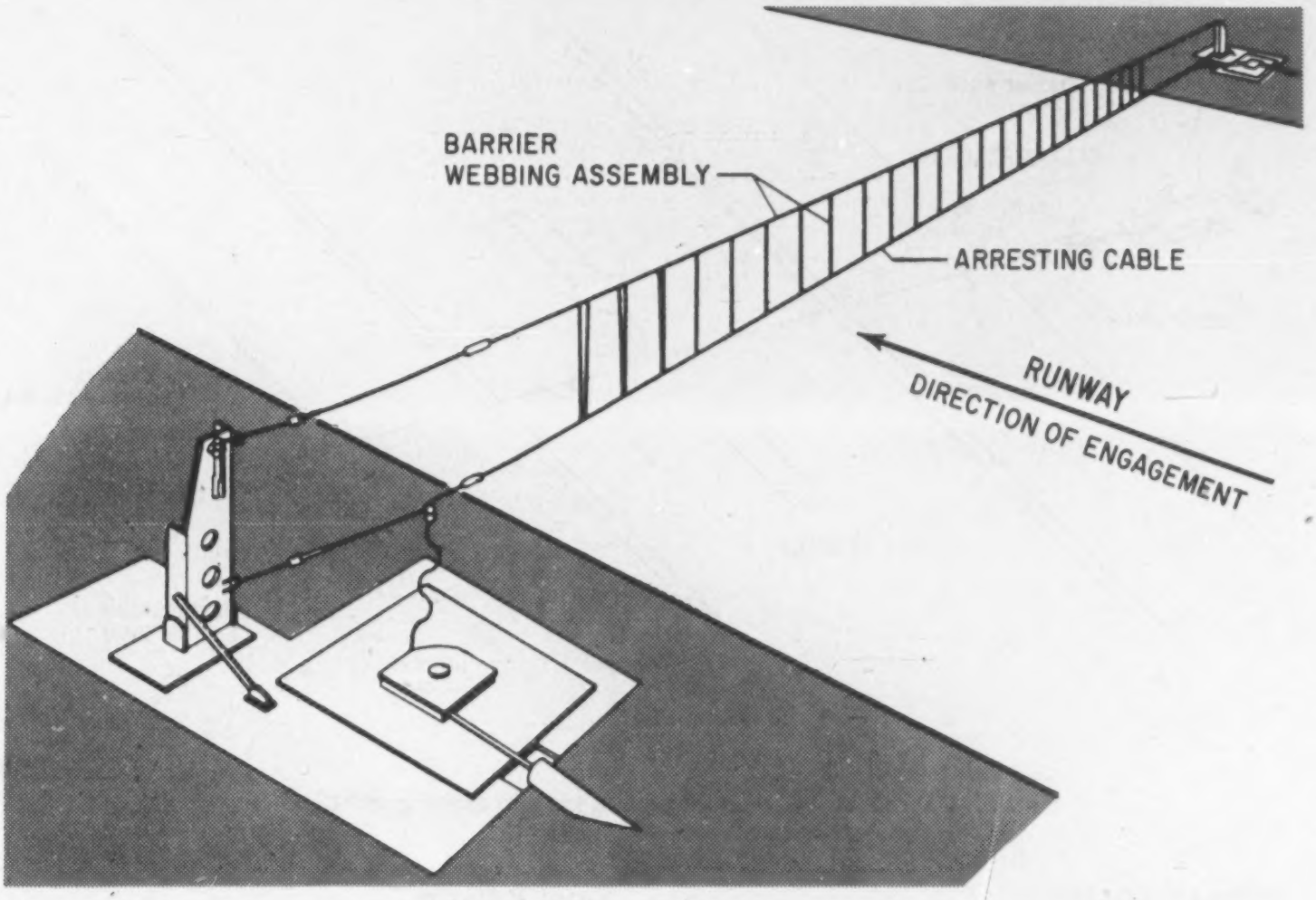

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Figure 11-33.—Runway overrun barrier.

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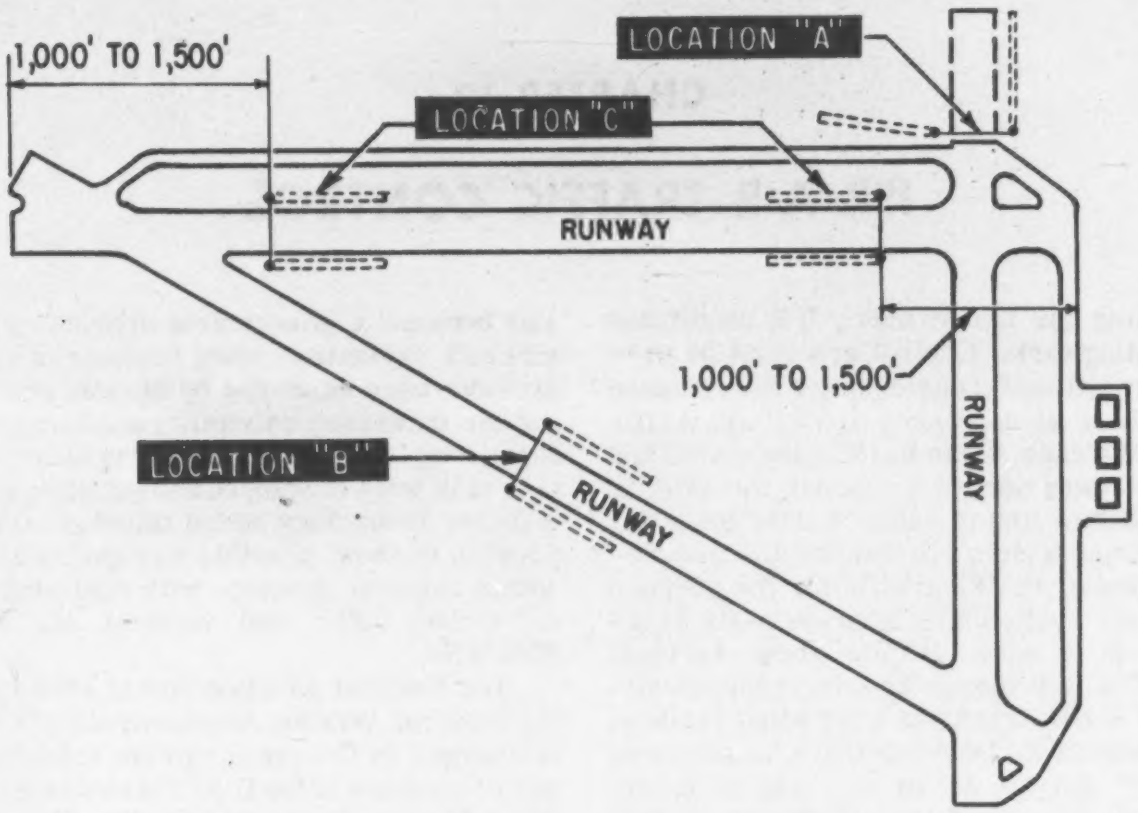

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Figure 11-34.—Arresting gear location.

CHAPTER 12

IFR AIR TRAFFIC CONTROL

Controlling air traffic under IFR conditions is a demanding task. Controllers must be precise in their actions, considering the increased responsibilities as compared to VFR air traffic control. In the case of the latter, clearances and instructions were issued to assist the pilot in avoiding collision and to enhance the flow of air traffic. In comparison, clearances and instructions are issued to IFR traffic for the purpose of keeping all such traffic appropriately separated and at a safe altitude above terrain.

Navy AC's will most likely be involved with the control of IFR traffic at a terminal facility. However, there is a possibility that your terminal facility may operate in an en route capacity. Since you will be controlling IFR flights into and out of a terminal area, a basic knowledge of the entire airspace system is necessary.

As with any difficult procedure, the logical start is with basic details. The intent herein is to discuss IFR air traffic control procedure and minima so the AC3 or AC2 can describe them, and with the necessary supervised experience, apply them to the actual control of IFR air traffic.

NATIONAL AIRSPACE SYSTEM

The national airspace system as it exists today began to develop in 1918 with the U.S. Post Office airmail service. Radio equipment was installed near telephones, providing a link of air and ground communications for keeping track of air traffic.

Lighted airways were set up using rotating light beacons spaced at specific intervals by which pilots could navigate. Coded lights were later added to the rotating beacons so that pilots could determine their distance from a certain reference point with knowledge of the code. Low frequency radio range stations were established and became a government operated system for aircraft navigation when landmarks and lighted airways were obscured by clouds, etc. In striving for increased reliability and to meet increasing air traffic needs, several types of air navigation aids were developed and put into general use. Military technology added impetus to the drive to provide the best possible navigation aids for use within national airspace with contributions such as radar, IFF, and tactical air navigation (TACAN).

The Federal Aviation Act of 1958 established the Federal Aviation Administration (FAA) which is charged by Congress with the safe and efficient use of airspace of the U.S. This includes military aircraft operations within the U.S. airspace, hence the required compliance of Navy AC's with air traffic rules and regulations of the FAA.

Two route systems have been established for air navigational purposes within the contiguous U.S.—the airway system and the jet route system. The airway system consists of airways designated from not less than 700 feet above the surface, up to but not including 18,000 feet MSL, and is designed to serve aircraft which operate at these altitudes. They are predicated solely on VOR/VORTAC navaids. They are designated on aeronautical charts by a V and referred to orally as Victor airways. The jet route system consists of jet routes established from 18,000 feet MSL to FL 450 inclusive, and are designed to serve aircraft which operate at these altitudes. They are identified by a J on aeronautical charts and referred to orally by statement of the same letter.

The airspace structure above FL 450 is designed to permit free selection of routes. Navigation is conducted by navaids serving the jet route system provided the aids are not more than 200 miles apart. Flight above FL 600 must contain at least one fix within each ARTCC's area through which flight is planned without regard to distance between fixes.

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IFR air traffic control service is provided within controlled airspace. This controlled airspace includes airways, jet routes, control areas, transition areas, control zones, and the continental control area. These areas are described in chapter 9 of this training manual.

Airspace of the contiguous U.S. from FL 240 to FL 600 inclusive, except an area roughly described as the northeast 1/4th of the U.S. within which the effective limits are from 18,000 feet MSL to FL 600 inclusive, is designated as positive controlled airspace. Positive control of all air traffic within this area is exercised and additional requirements for flight apply as follows:

1. Complete IFR flight procedure is required and prior ATC approval mandatory.

2. All aircraft must be equipped with a coded radar beacon transponder (discussed in chapter 13), having a Mode 3, 64-Code capability which must be operated to reply to Mode 3 interrogation with the code specified by ATC, provided that in the event a radar beacon transponder failure is experienced in flight, ATC may approve operation within positive control area.

3. All aircraft must be equipped with radio equipment capable of providing direct pilot-controller communications on the frequencies specified by ATC for the sector in which flight is conducted. Pilots will monitor assigned ATC frequency and request ATC permission prior to any change. This includes aircraft in formation and those operating in altitude reservations.

4. Local flying areas are established within the positive control area to permit activities which are not readily adaptable to air traffic control. This includes activities in which aircraft do not maintain constant heading and/or altitude; that is, local areas are not restricted areas but are open to any user, traffic permitting. ATC clearance is required and aircraft are assigned to a flight level or group of levels by ATC, depending on the activity. Using military activities may schedule aircraft to operate in local flying areas in excess of the quantities that can be accepted by ATC, subject to Military Assumption of Responsibility for Separation of Aircraft. In this event, participating aircraft must remain in VFR conditions to preclude collision with other aircraft in the local areas.

5. Radius of action flight plans may be approved consistent with traffic conditions. However, pilots should be prepared to convert to point-to-point routing should radius clearance be refused.

6. Altitude reservations continue to apply within the positive control areas.

Procedures for entering and departing positive control areas are as follows:

1. Pilots operating on IFR flight at an assigned flight level require no additional clearance.

2. Pilots operating VFR and VFR on top (on IFR flight plan) must obtain an ATC clearance with an assigned flight level prior to entering positive control areas. An abbreviated flight plan containing the following information must be provided ATC at least 30 minutes prior to estimated penetration:

a. Identification
b. True airspeed (TAS)
c. VFR position and altitude/flight level
d. Estimated time and point of penetration
e. Requested route and flight level

3. When flight inbound to destination is VFR on top above the positive control area or departure from the area is to be IFR/VFR on top, only the discrete frequency of the sector of arrival or departure need be preset.

4. Upon departing the area, IFF/SIF is reset to the proper Mode 3 Code as assigned by ATC.

IFR CONTROL PROCEDURE

The procedure and minima which apply when providing IFR air traffic control service are those contained in Terminal Air Traffic Control Handbook 7110.8 (Series). When other procedures are contained in a Letter of Agreement, or other appropriate FAA or military document, they may only supplement the TATC Handbook 7110.8. Any minima they specify cannot be less than those in TATC Handbook 7110.8 unless appropriate military authority has authorized application of reduced separation between military aircraft in special procedures. The ultimate authority for naval ATC procedures is CNO. Deviation is also permitted when necessary to conform with pertinent ICAO Documents, National Rules of the Air, or special agreements in airspace outside the U.S. and its possessions where the U.S. provides air traffic control service.

Military procedures in the form of additions, modifications, and exceptions to the basic FAA procedure are provided in TATC Handbook 7110.8 when a common procedure has not been attained or to fulfill a specific requirement. These military procedures are applied by ATC facilities operated by the designated military service, by ATC facilities supporting a designated military service exclusively, or by other ATC facilities when specified in a Letter of Agreement.

IFR CONTROL RESPONSIBILITY

Air Route Traffic Control Centers (ARTCC's) provide air traffic control service to IFR and special VFR aircraft operating within controlled airspace except where this responsibility has been delegated to another facility.

Other facilities, such as approach control or a RATCC, provide air traffic control service to IFR and special VFR aircraft for which control responsibility has been received.

PRIORITY OF SERVICE

First priority is given to the separation of aircraft to comply with the procedure and minima prescribed for the control of IFR traffic. Any other service or information is provided to the extent possible.

Radar procedures should be used in preference to nonradar procedures to the extent practicable, consistent with workload, communications, and equipment capabilities.

Air traffic control service is provided on a "first come, first serve" basis as circumstances allow. For example, it is solely the pilot's prerogative to cancel his IFR flight plan, but a retention of an IFR flight plan does not afford priority over VFR aircraft, and he may be required to adjust his flightpath to enter a traffic pattern in sequence with arriving VFR aircraft. Exceptions to the first come, first serve rule do exist for certain types of aircraft operations such as AIREVAC, SAFI, Presidential and Vice Presidential, FLYNET, and GARDEN PLOT aircraft. For more information on this subject, see Priority in chapter 11 of this training manual and the appropriate section of TATC Handbook 7110.8.

TRANSFER OF IFR CONTROL RESPONSIBILITY

Control responsibility must be transferred between facilities, or between controllers within a facility, at a specified time, fix, or altitude. Additionally, any potential conflict with other aircraft under the jurisdiction of the transferring facility or controller must be eliminated prior to the transfer of control responsibility.

TRANSFER OF RADIO COMMUNICATIONS

Radio communications are transferred by specifying to the aircraft the following:

1. Location name of the facility or the terminal control function to be contacted. (The location name may be omitted when transferring communications within the same terminal area facility.)
2. Frequency to use. (When departure control frequency has been previously issued, omit the frequency.)
3. The time, fix, altitude, or specified conditions to contact the receiving facility. (This may also be omitted when transferring communications within the same terminal area facility.)

EXAMPLE: CONTACT KEYWEST APPROACH CONTROL TWO SIX THREE POINT SIX LEAVING FLIGHT LEVEL TWO ZERO ZERO; or, CONTACT DEPARTURE CONTROL WHEN AIRBORNE.

FORMATION FLIGHTS

Formation flights are treated as single aircraft unless the formation leader requests that ATC separate individual aircraft.

IFR CLEARANCE DELIVERY AND RELAY

IFR clearances issued by a facility other than the originating facility must be relayed verbatim. A non-ATC facility would prefix the clearance with the prefatory phrase "ATC clears." Such facilities would handle a relay of advice or a request for information in the same manner; i.e., "ATC advises," or "ATC requests." When a clearance, information, or a request for information is issued to an ATC facility or to an aircraft by direct ATC communications, the "ATC" portion of the prefatory phrase is omitted.

To correctly apply this procedure, refer to the definition of an ATC facility and ATC service. These definitions are included in appendix I of this training manual.

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When appropriate, specific delivery instructions may be issued with a clearance for relay, such as an "attempt delivery" time or a "cancellation" time which must be adhered to by the relaying facility. The ATC facility originating the clearance should be advised if the requirements of specific delivery instructions are not met.

SIGNIFICANT WEATHER

Every assistance should be afforded pilots to enable them to avoid areas of significant weather. When a requested deviation to avoid such areas cannot be approved due to traffic conditions, the altitude or route of the conflicting traffic may be changed to permit approval if there is reasonable assurance that the action will not place the conflicting aircraft in hazardous weather conditions.

Pilot reported information about significant weather conditions should be relayed to other aircraft concerned and the appropriate weather service.

ALTIMETER SETTING INFORMATION

Altimeter settings issued to IFR flights must be current settings obtained from direct-reading instruments or received directly from weather reporting stations.

When issuing an altimeter setting to an aircraft, a terminal facility must identify the source of the setting for a location other than at the facility. The time of the report must also be included if it is more than 1 hour old.

Aircraft operating below flight level 180 must be issued the associated altimeter setting of compulsory reporting points when reporting over such points. If in "radar contact", the controller issues the altimeter setting when the aircraft is observed passing or adjacent to compulsory reporting points. (Pilots discontinue making position reports when informed of "radar contact.")

When aircraft have been cleared to descend from a flight level to an altitude below the lowest usable flight level, the altimeter setting for the weather reporting station nearest the aircraft's position must be issued to the pilot.

The destination altimeter setting should be issued to pilot's of arriving aircraft when they are approximately 50 miles from destination unless approach control service will be provided; or it may be issued even though approach control service will be provided. (Approach control issues the altimeter setting on initial contact.) It is not necessary to issue additional altimeter settings when such aircraft report over subsequent compulsory reporting points since the destination altimeter setting is the one upon which the approach is predicated.

ALTITUDE VERIFICATION

If the pilot of an IFR aircraft does not provide altitude information on initial contact and with each position report, he should be requested to verify altitude information.

EXAMPLE: VERIFY AT FIVE THOUSAND.

Terminal area facilities should apply this procedure on initial contact after receiving control jurisdiction from another facility or when communications are established with an aircraft departing from another airport under their control jurisdiction. However, it is not necessary to verify altitude when, on initial contact, a new altitude is assigned an aircraft that is climbing or descending.

NONRECEIPT OF POSITION REPORTS

When a position report affecting separation is not received, action should be taken to obtain the report not later than 5 minutes after the aircraft was estimated over the fix.

NONRADAR IFR SEPARATION MINIMUMS AND METHODS

Pilots are required to file IFR flight plans and obtain an ATC clearance prior to conducting flight under instrument flight rules of FAR 91 within controlled airspace. Special VFR flights must obtain an ATC clearance prior to operations within control zones. By this procedure, ATC facilities know of all IFR and special VFR traffic operating within controlled airspace for which they are responsible. Thus they are able to regulate traffic by issuance of clearances and instructions for the purpose of keeping such traffic separated.

There are three types of nonradar separation: vertical, longitudinal, and lateral. One of these must be in effect whenever separation is required. Exceptions to the above statement are instances when controllers or pilots are authorized to maintain visual separation between

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aircraft, or when pilots are authorized upon request to operate IFR in accordance with a VFR restriction (discussed later in this chapter).

Each type of nonradar separation has established minimums to which controllers must adhere for safe operation. These minimums and methods of establishing and maintaining them are discussed separately in this chapter.

Vertical Separation

IFR aircraft may be separated vertically by assigning different altitudes or flight levels (FL), using the following minimums:

1. Up to and including FL 290-1,000 feet.
2. Above FL 290-2,000 feet.

A previously occupied altitude/FL may be reassigned to another aircraft when the pilot of the aircraft that previously occupied the altitude reports leaving it. However, when severe turbulence is reported, such altitudes may not be reassigned until the pilot of the aircraft that previously occupied the altitude reports at or passing another altitude separated from the first by appropriate minimum vertical separation.

EXAMPLE OF PHRASEOLOGY: REPORT LEAVING/REACHING FIVE THOUSAND; or, REPORT LEAVING ODD ALTITUDES; or SAY YOUR ALTITUDE.

When pilots of aircraft in direct radio communication with each other during climb and descent concur, the lower aircraft, if climbing, or upper aircraft, if descending, may be authorized to maintain their own vertical separation.

Longitudinal Separation

Longitudinal separation is spacing of aircraft so that after one aircraft passes over a specific position, a succeeding aircraft occupying the same altitude will not arrive over that position with less than the minimum longitudinal separation prescribed for the particular situation.

Longitudinal separation may be established by requiring aircraft to do one of the following:

1. Depart at a specified time.
2. Arrive at a fix at a specified time.
3. Hold at a fix until a specified time.
4. Change altitude at a specified time or fix.

DME procedures and minimums may only be used when direct pilot-controller communications are maintained.

Aircraft on the same, converging, or crossing courses at the same altitude are separated by an interval expressed in minutes of flying time or a specified distance in accordance with the following minimums:

1. When a leading aircraft maintains a speed at least 44 knots faster than a following aircraft, and (a) a departing aircraft follows a preceding aircraft which has taken off from the same or adjacent airport, or (b) a departing aircraft follows a preceding en route aircraft which has reported over a fix serving the departure airport, the minimum is 5 miles between aircraft using DME or 3 minutes between other aircraft. (See fig. 12-1.)

2. When a leading aircraft maintains a speed of at least 22 knots faster than a following aircraft, and (a) a departing aircraft follows a preceding aircraft which has taken off from the same or an adjacent airport, or (b) a departing aircraft follows a preceding en route aircraft which has reported over a fix serving the departure airport, or (c) an en route aircraft follows a preceding en route aircraft which has reported over the same fix, the minimum is 10 miles between aircraft using DME or 5 minutes between other aircraft. (See fig. 12-2.)

3. Minimum separation between aircraft climbing or descending through the altitude of another aircraft is as follows:

a. 10 miles between aircraft using DME, provided that the descending aircraft is leading or the climbing aircraft is following. (See fig. 12-3.)

b. 5 minutes between other aircraft if all of the following conditions are met:

(1) The descending aircraft is leading or the climbing aircraft is following. (Up behind/down in front.)

(2) The aircraft were separated by not more than 4,000 feet when the altitude change started.

(3) The change is started within 10 minutes after a following aircraft reports over a fix reported over by the leading aircraft or has acknowledged a clearance specifying the time to cross the same fix. (See fig. 12-4.)

4. If the required conditions which allow 3-minute/5-mile or 5-minute/10-mile separation for aircraft assigned the same altitude or 5-minute/10-mile separation for same direction aircraft climbing or descending do not exist, then the minimum longitudinal separation is 20 miles between aircraft using DME or 10 minutes between other aircraft.

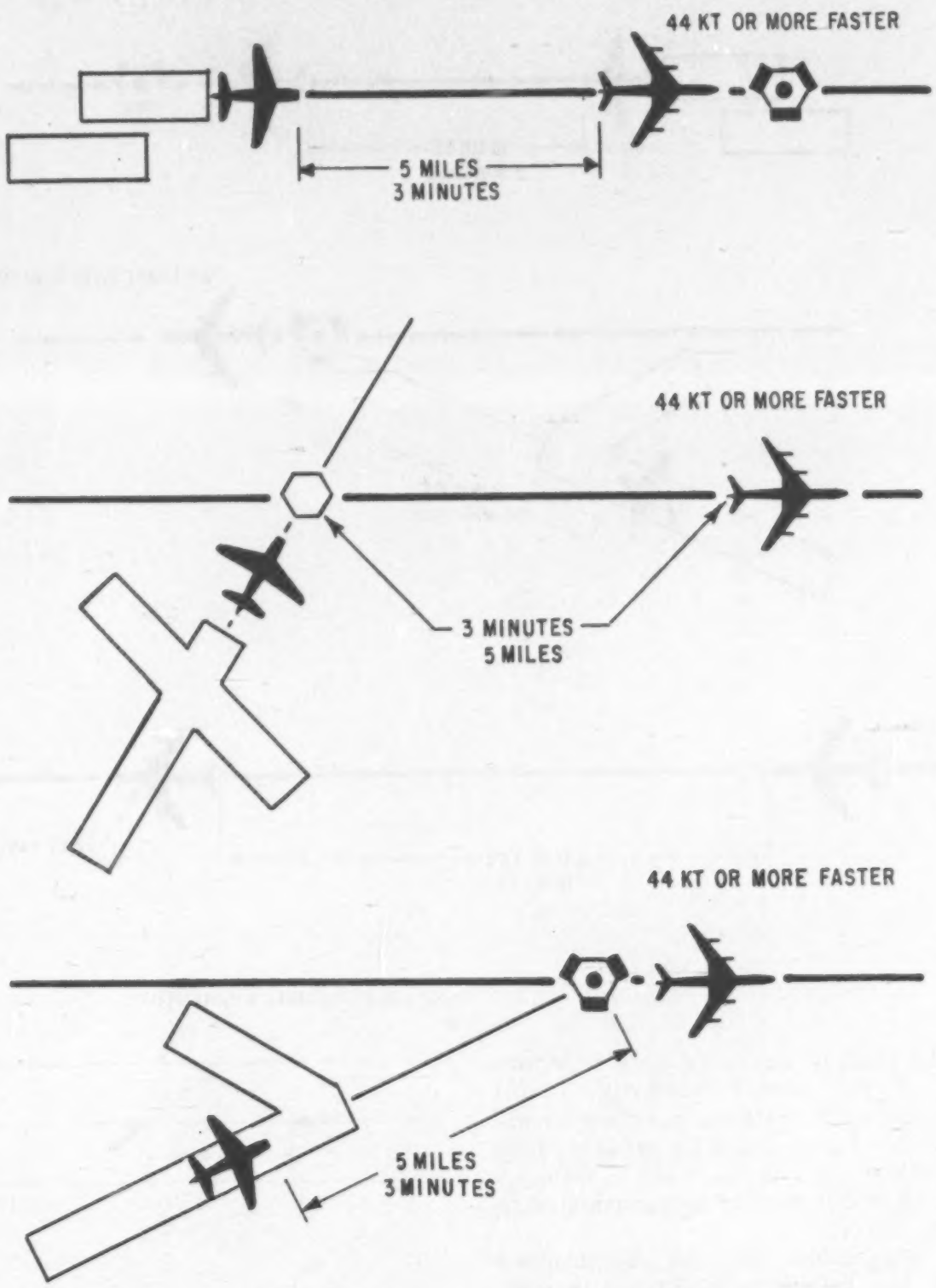

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Figure 12-1.—5-mile or 3-minute longitudinal separation.

5. The minimum between an aircraft using DME and an aircraft not using DME is 30 miles if both of the following conditions are met:

a. The aircraft using DME derives distance information by reference to the same navaid over which the aircraft not using DME has reported.

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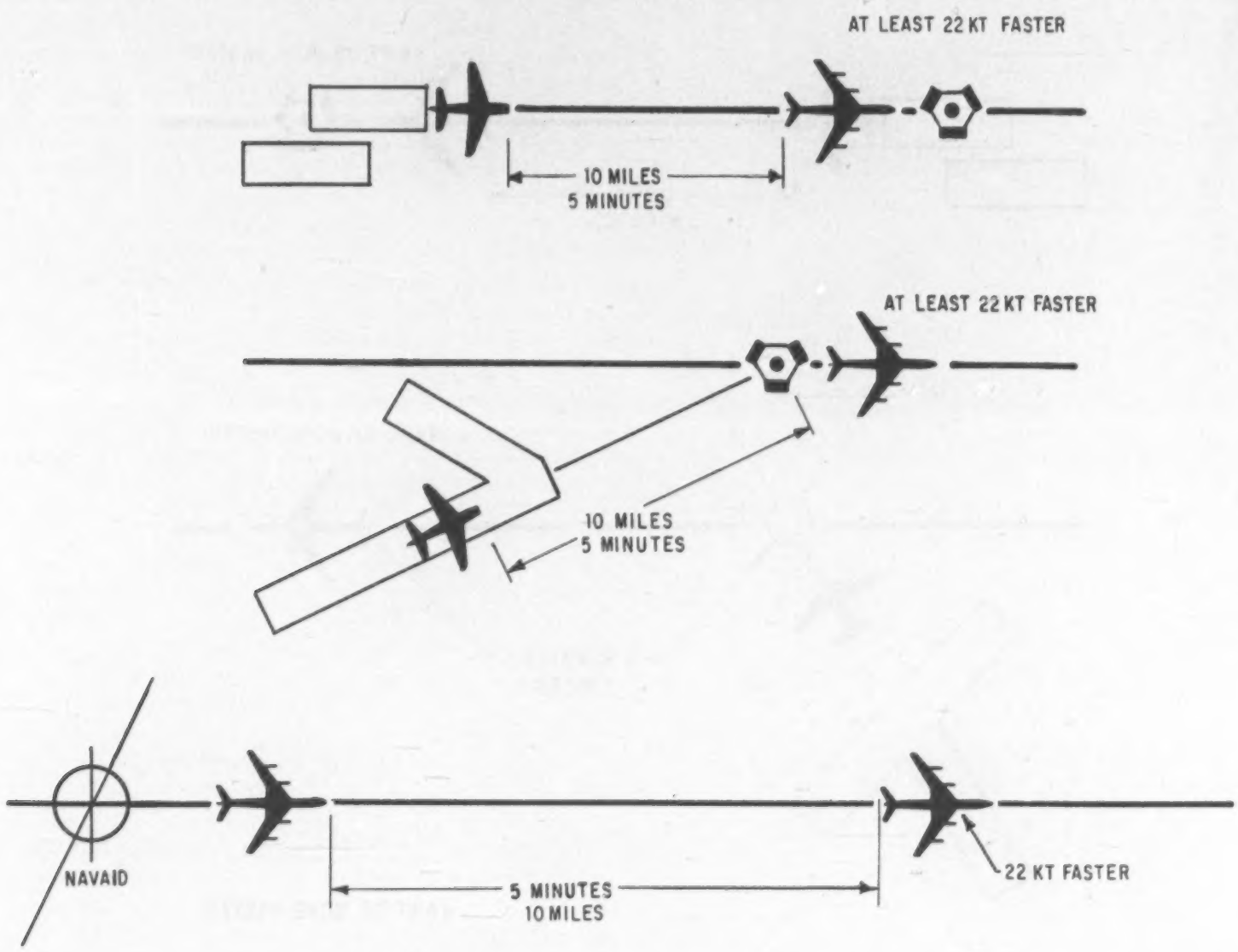

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Figure 12-2.—10-mile or 5-minute longitudinal separation

b. The aircraft not using DME is within 15 minutes of the navaid. (See fig. 12-5.)

Opposite direction traffic requesting a conflicting altitude change must be separated by minimum vertical separation from 10 minutes before until 10 minutes after they estimated to pass. (See fig. 12-6.)

Vertical separation may be discontinued after one of the following conditions is met:

1. Both aircraft have reported passing navaids or DME fixes indicating they have passed each other.

2. Both aircraft have reported passing the same intersection and they are at least 3 minutes apart.

When pilots of aircraft on the same course and in direct communication with each other

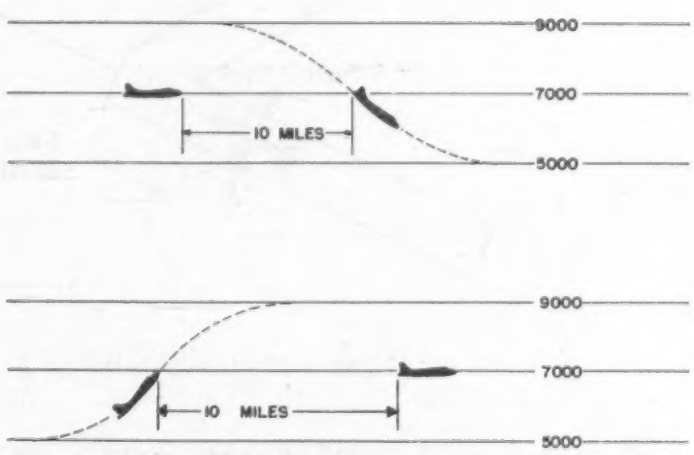

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Figure 12-3.—Same direction altitude change using DME.

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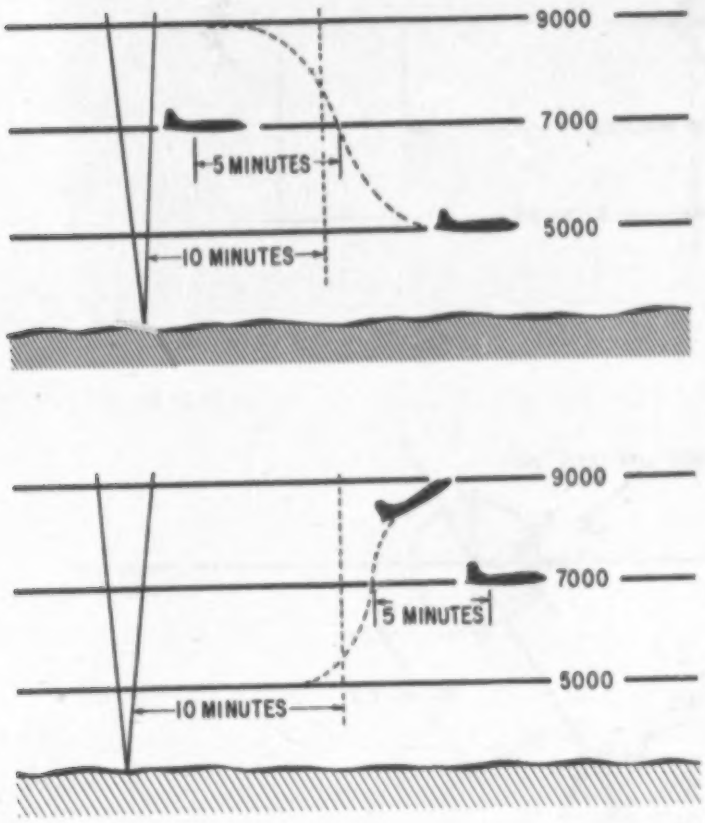

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Figure 12-4.—Same direction altitude change.

concur, the pilot of the following aircraft may be authorized to maintain longitudinal separation of 10 minutes, or 20 miles if they are using DME, from the leading aircraft.

Lateral Separation

Lateral separation is the lateral spacing of aircraft at the same altitude. Aircraft may be laterally separated by one of the following methods:

1. Clear aircraft on different airways or routes whose airspace to be protected for one flight does not overlap airspace to be protected for the other. NOTE: Airspace protected for airways and routes is based on the width described in FAR 71.5 which is normally 4 miles either side of centerline.

2. Clear aircraft below 18,000 to proceed to and report over or hold at different geographical locations determined visually or by reference to navaids. (See fig. 12-7.)

3. Clear aircraft to hold over different fixes whose holding pattern airspace areas do not overlap each other or other airspace to be protected.

4. Clear departing aircraft to fly specified headings which diverge by at least 45 degrees. (See fig. 12-7.)

Lateral separation is considered to exist between aircraft established on radials of the same navaid that diverge by at least 15 degrees when either aircraft is beyond the airspace to be protected for the other aircraft. (See fig. 12-8.)

There is a table in TATC Handbook 7110.8 under the lateral separation section that shows appropriate distances necessary to clear the airspace to be protected for divergence angles from 15 to 90 degrees. Since this type computation is one which should be predetermined and shown on charts located at or near operating positions rather than an on the spot type separation, the table is not included herein.

Lateral DME separation is applied by requiring aircraft using DME to fly an arc or arcs of a navigational aid.

The minimum is 10 miles between arcs of a navigational aid when aircraft are maintaining different specified arcs of the aid.

Between an arc of a navigational aid and the boundary of the holding pattern airspace to be protected for an aircraft holding the minimum is 5 miles. (See fig. 12-9.)

Airspace to be protected along other than established airways or routes is as follows:

1. For direct courses and course changes of 15 degrees or less at FL 600 and below, and any course change below FL 180, the width of the protected airspace is 4 miles on each side of the route to a point 51 miles from a navaid. Beyond the 51-mile point, the airspace increases in width, based on a 4.5-degree angle from the aid, to a width of 10 miles on each side of the route at a distance of 130 miles. (See fig. 12-10.)

2. For course changes of more than 15 degrees through 90 degrees, the airspace to be protected on the overflown side, beginning at a point where the course change begins, is as follows:

a. FL 180 to FL 230 inclusive—14 miles.

b. Above FL 230 to FL 600 inclusive—17 miles.

3. For course changes of more than 90 degrees through 180 degrees, the airspace to

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receiver against the high power pulse from the transmitter. In addition, there is one device which is sometimes used in conjunction with the duplexer which should be mentioned at this time, although it is not a true duplexer.

A CRYSTAL SHUTTER is frequently used as a protective device for the receiver crystal while the radar is turned off, due to the possibility that energy radiated from nearby radars may damage the crystal. A typical shutter assembly may consist of a waveguide gate and a solenoid that controls the position of the gate. When the radar system is not in operation the solenoid is not energized and the position of the gate is such that it causes a virtual short circuit across the waveguide path to the receiver input. When the radar system is in operation, the solenoid is energized and causes the gate to move from the waveguide to a position where it will offer no interference to signals traveling to the receiver.

TR AND ATR TUBES.—A simplified cross section view of a waveguide system duplexer is shown in figure 15-6. These tubes are a spark gap enclosed in a gas filled envelope. They are practical for this function because of the tremendous power difference between the transmitted and received signal. Ionization occurs during the transmitter pulse period and causes the tube to function as a short circuit or closed switch. During the reception period these tubes remain de-ionized because the received signals are low power; thus they appear as an open circuit.

The TR tube is used to protect the crystal mixer and the receiver circuits during transmission. When the magnetron fires, sufficient voltage is impressed on the TR tube to ionize it completely and break down the gap, producing an effective short circuit. Since the TR tube is placed an even number of quarter wavelengths from the waveguide a short circuit existing within the tube reflects an effective short circuit at the entrance of the receiver T-junction. This prevents the RF pulse from reaching the crystal and the receiver, but permits it to flow freely to the antenna.

The operation of the duplexer during transmission is shown in (A). After the pulse has passed, the tube de-ionizes and again presents a high impedance at the entrance of the receiver T-junction. This allows any reflected signals to reach the crystal mixer. Duplexer action during signal reception is shown in (B).

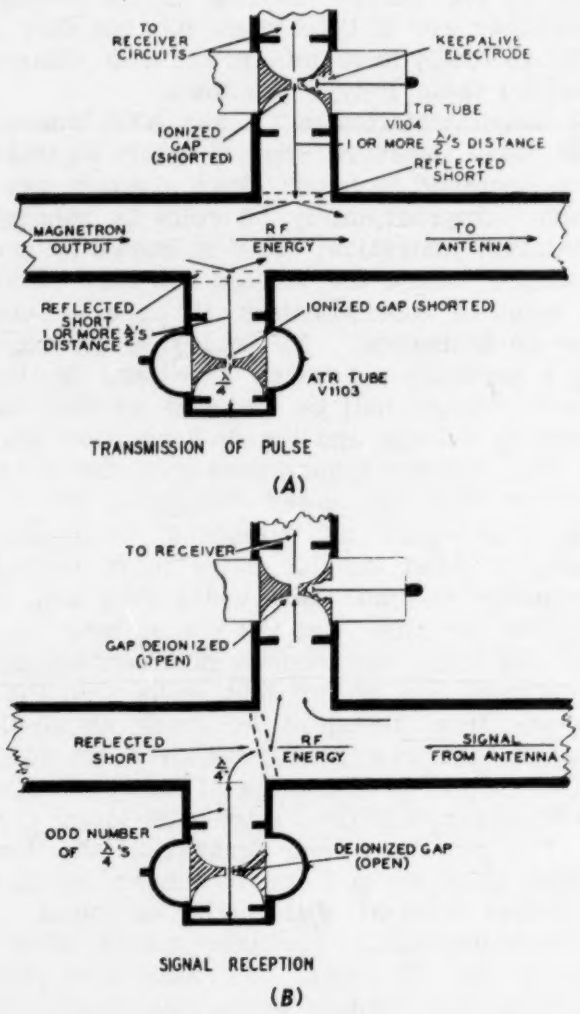

Figure 15-6.—TR/ATR action in a waveguide.

The ATR tube is located an even number of quarter wavelengths from the waveguide; thus when the transmitter fires, which breaks down the gap of the ATR tube, an effective short circuit is reflected across the opening at this T-junction. This causes the wall to appear continuous to the transmitter energy; thus the energy passes unimpeded.

The ATR waveguide section is so constructed than an even number of quarter wavelengths exists between its gap and the opening to the waveguide. During signal reception, the ATR tube is de-ionized and causes an affective open circuit to appear at the opening of the ATR junction. This causes a reflected short across the waveguide adjacent to the TR opening, as illustrated in (B). The received signal is guided into the TR cavity instead of continuing to the magnetron.

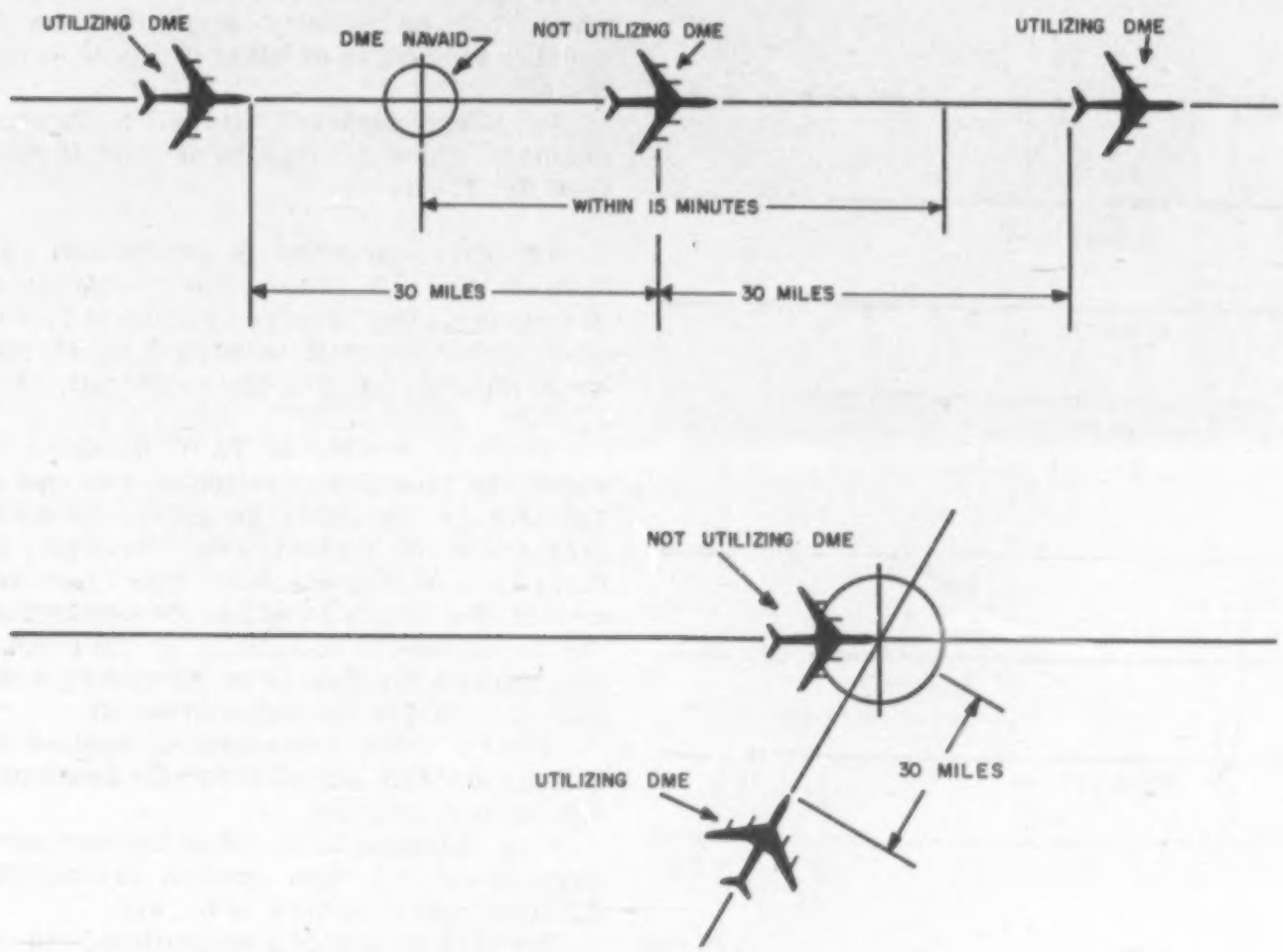

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Figure 12-5.—Separation of DME and non-DME equipped aircraft.

be protected on the overflown side, beginning at a point where the course change begins, is as follows:

a. FL 180 to FL 230 inclusive—28 miles.

b. Above 230 to FL 600 inclusive—34 miles.

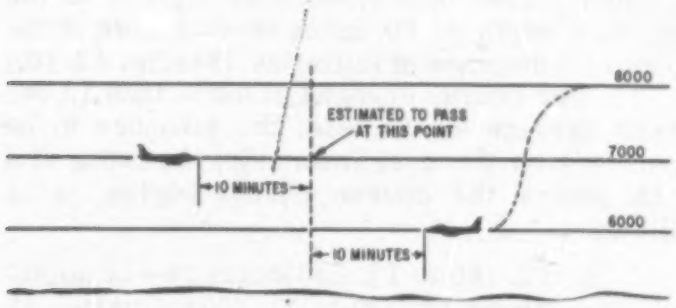

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Figure 12-6.—Opposite direction altitude change.

4. After the course changes have been completed and the aircraft is back on course, the appropriate minima as specified in paragraph 1 applies.

5. For direct courses defined by degree/distance fixes (DME fixes of TACAN navaids which define a flightpath by a line connecting the fixes, not necessarily along a particular radial), the width of the protected airspace is 4 miles on each side of the route for flight below FL 180 and 10 miles each side of the route from FL 180 through FL 600.

INITIAL SEPARATION OF SUCCESSIVE DEPARTING AIRCRAFT

Initial separation between successive departing aircraft may be considered an interim measure to expedite departures. The controller must

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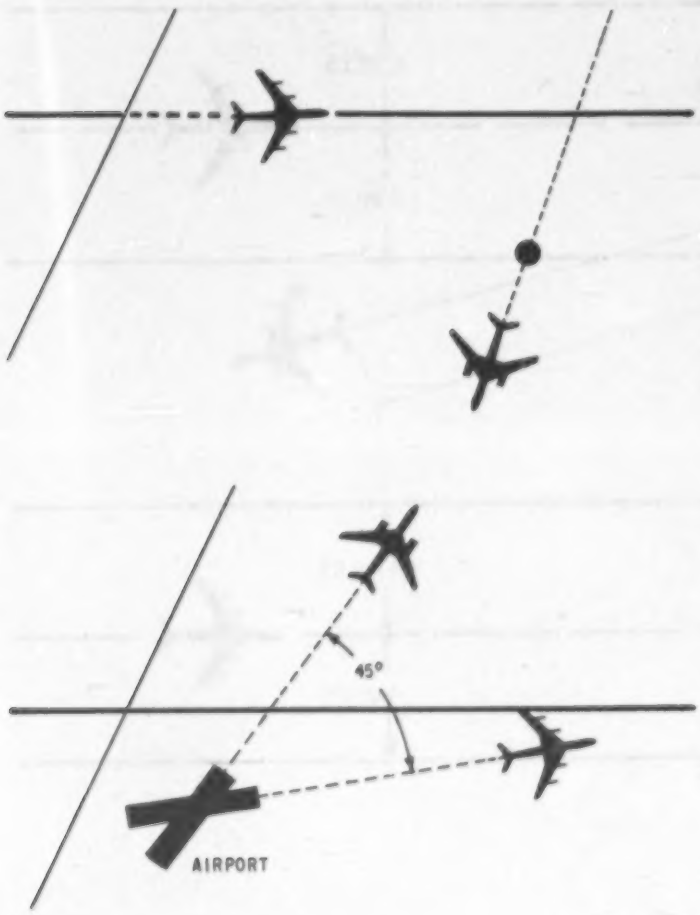

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Figure 12-7.—Two illustrations of lateral separation.

plan ahead to insure that the initial separation applied will allow a smooth transition to at least minimum vertical, longitudinal, or lateral separation when the initial departure phase of the flight is complete.

Aircraft that will fly courses which diverge by 45 degrees or more after departing the same or adjacent airports may be separated by use of one of the following minimums:

1. Between aircraft departing from the same runway (fig. 12-11):

a. One minute until courses diverge when the aircraft will fly diverging courses immediately after takeoff.

b. Two minutes until courses diverge when the aircraft will fly the same course initially but will fly diverging courses within 5 minutes after takeoff.

c. Three miles until courses diverge when aircraft using DME will fly the same course initially but will fly diverging courses within 13 miles after takeoff.

2. Simultaneous takeoffs may be authorized when aircraft will fly diverging courses immediately after takeoff in the same direction from different runways whose centerlines are parallel and separated by at least 3,500 feet. (See fig. 12-12.)

3. Simultaneous takeoffs may be authorized from diverging, nonintersecting runways when aircraft will fly diverging courses immediately after takeoff and either of the following conditions exist:

a. The runways diverge by 30 degrees or more.

b. The distance between runway centerlines at and beyond the points where takeoffs begin is at least:

(1) 2,000 feet and the runways diverge by 15 fo 29 degrees inclusive.

(2) 3,500 feet and the runways diverge by less than 15 degrees. (See fig. 12-13.)

4. On intersecting runways, a succeeding aircraft may be authorized to take off when the preceding aircraft has passed the point of runway intersection and the following conditions are met:

a. The runways diverge by 30 degrees or more.

b. The runways diverge by 15 to 29 degrees inclusive and the preceding aircraft has commenced a turn. (See fig. 12-14.)

Aircraft that will fly the same course, when the following aircraft will climb through the altitude assigned to the leading aircraft, maybe separated by a minimum of 3 minutes until the following aircraft passes through the altitude of the leading aircraft. The minimum separation is 5 miles if both aircraft are using DME. (See fig. 12-15.)

Initial Separation of Departing and Arriving Aircraft

At airports where approach control service is provided, a departing aircraft may be separated from an arriving aircraft making an instrument approach to the same airport by using one of the following minima until vertical or lateral separation is achieved:

1. When takeoff direction differs by at least 45 degrees from the reciprocal of the final approach course, the departing aircraft must take off before the arriving aircraft leaves a fix inbound not less than 4 miles from the airport.

2. When the takeoff direction is not different by 45 degrees from the reciprocal of the final

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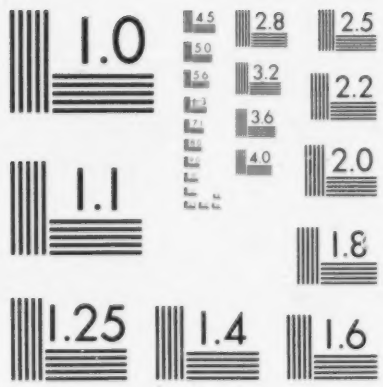

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

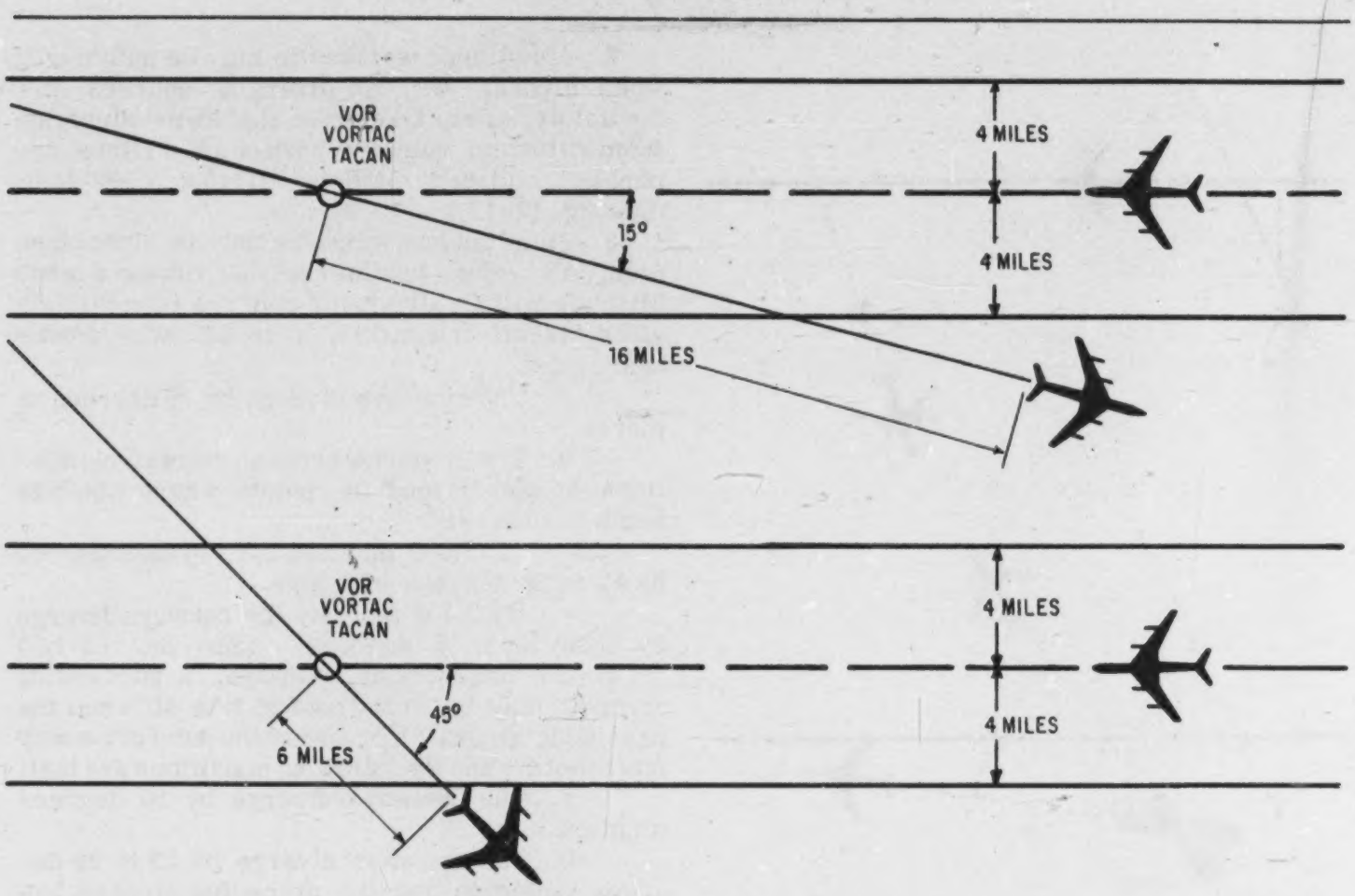

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Figure 12-8.—Lateral separation using radials of the same navaid.

approach course, the departing aircraft must take off so that it is established on a course diverging by at least 45 degrees from the reciprocal of the final approach course before the arriving aircraft leaves a fix inbound not less than 4 miles from the airport.

When the absence of an appropriate fix precludes the use of initial separation described in the preceding paragraph, and at airports where approach control service is not provided, a departing aircraft may be separated from an arriving aircraft making an instrument approach to the same airport by using one of the following minima until vertical or lateral separation is achieved:

1. When takeoff direction differs by at least 45 degrees from the reciprocal of the final approach course, the departing aircraft must take off 3 minutes before the arriving aircraft is estimated at the airport. (See fig. 12-16.)

2. When the takeoff direction does not differ by 45 degrees from the reciprocal of the final

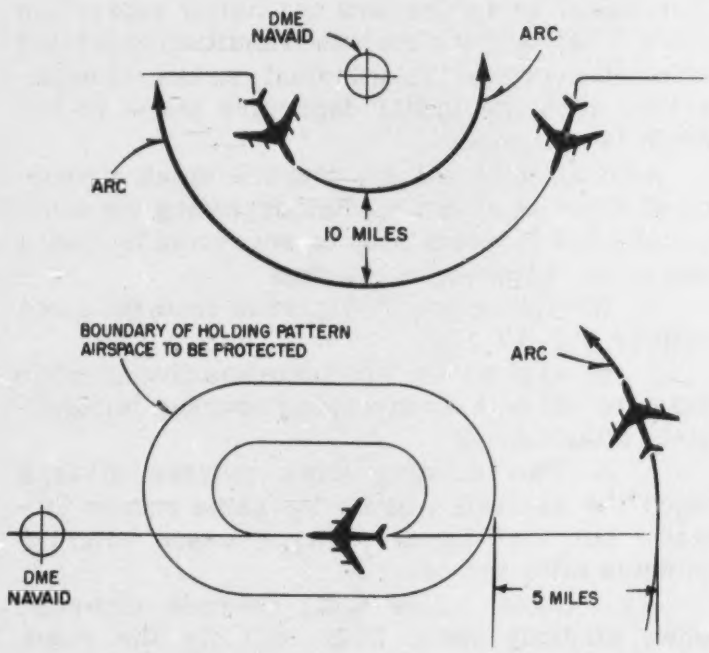

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Figure 12-9.—Lateral DME separation.

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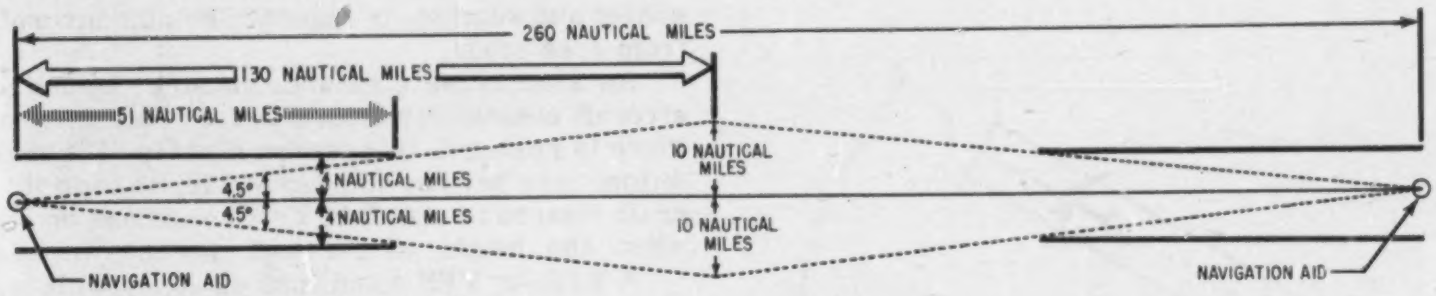

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Figure 12-10.—Airspace protected for other than established routes or airways.

approach course, the departing aircraft must take off so that is is established on a course diverging by at least 45 degrees from the reciprocal of the final approach course 5 minutes before the arriving aircraft is estimated at the airport or before the arriving aircraft starts its procedure turn. (See fig. 12-16.)

Visual Separation

Aircraft within control zones may be separated by one of the following methods:

1. The controller sees them and can provide visual separation.

2. The pilot sees the other aircraft and says he will maintain visual separation from it.

A nonapproach control tower may be authorized to provide visual separation between:

1. An arriving and a departing IFR aircraft.

EXAMPLE PHRASEOLOGY: RELEASE SUBJECT YOUR DISCRETION WHEN (Aircraft identification) IN SIGHT.

2. Arriving IFR aircraft within control zones when the weather is at or above basic VFR minima and the tower has reported that it has them in sight and visual separation can be applied.

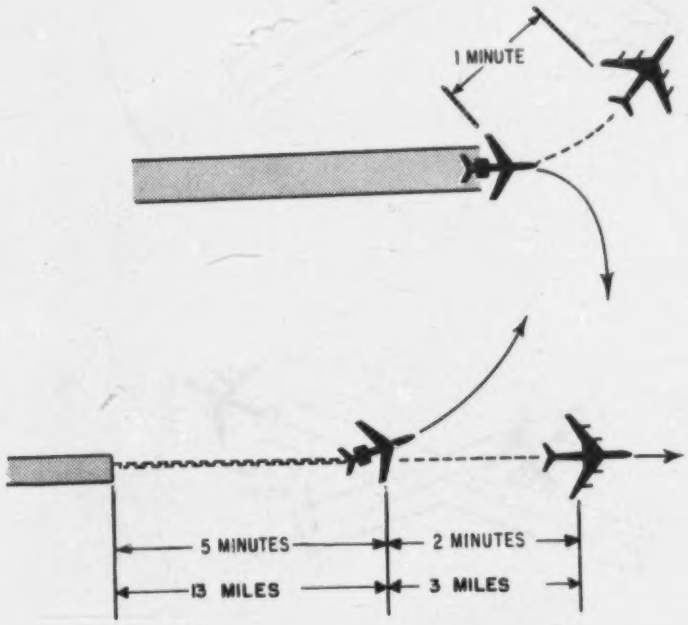

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Figure 12-11.—Separation of departing aircraft using the same runway.

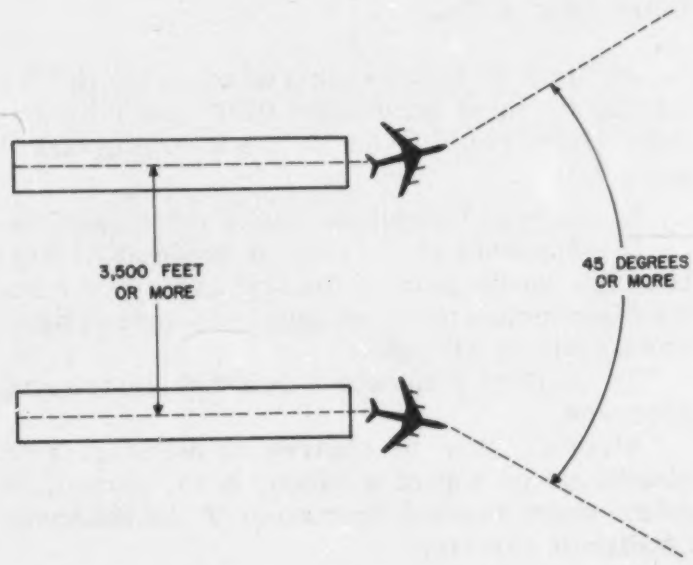

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Figure 12-12.—Simultaneous takeoffs from parallel runways.

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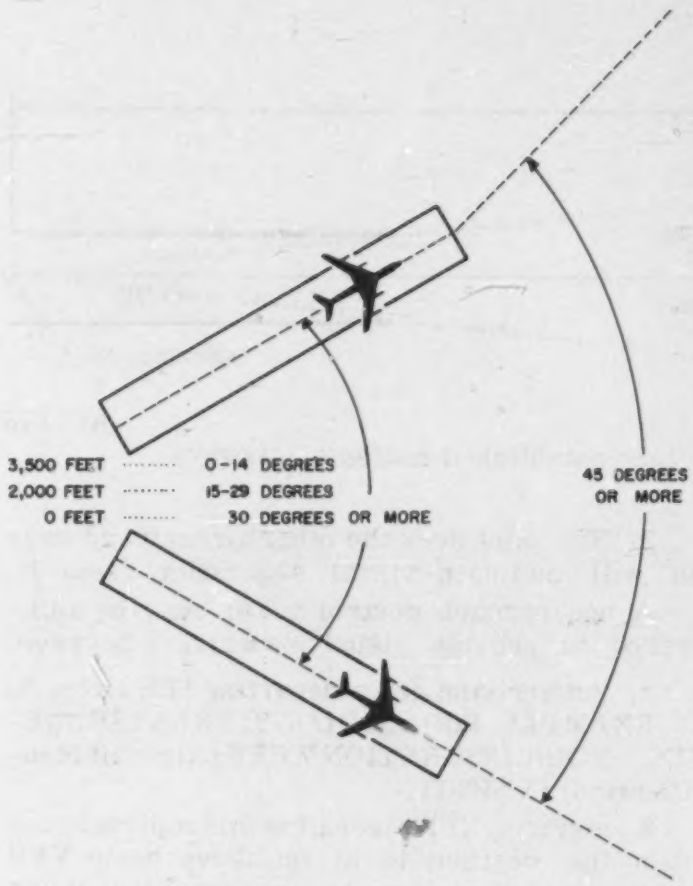

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Figure 12-13.—Simultaneous takeoffs from diverging runways.

Use of VFR and VFR Conditions on Top

An aircraft may be cleared to maintain VFR conditions when conducting flight under instrument flight rules if one of the following conditions exists:

1. A pilot requests such a clearance.
2. A clearance results in noise abatement benefits where part of the IFR departure route does not conform to an approved noise abatement route or altitude.
3. A pilot requests a practice instrument approach.

Aircraft may be cleared to maintain VFR conditions on top of a cloud, haze, smoke, or other meterological formation if the following conditions are met:

1. A pilot requests such a clearance.
2. The pilot is informed of the reported height of the top of the meteorological formation or that no report is available.

A VFR conditions-on-top type clearance may not be issued when pilot reports indicate weather conditions which are not suitable, or between sunset and sunrise, to separate holding aircraft from each other.

An alternative clearance must be issued to aircraft cleared to maintain VFR conditions when there is reason to believe that flight in VFR conditions may become impracticable, or to an aircraft cleared to maintain VFR conditions on top when the height of the tops is unreported.

A VFR-or VFR conditions on-top type clearance may not be issued to aircraft operating in positive controlled airspace.

Aircraft that operate VFR conditions on top must maintain a VFR cruising altitude/flight level. If a controller becomes aware that an aircraft on such a clearance is not an appropriate altitude for the direction of flight, the

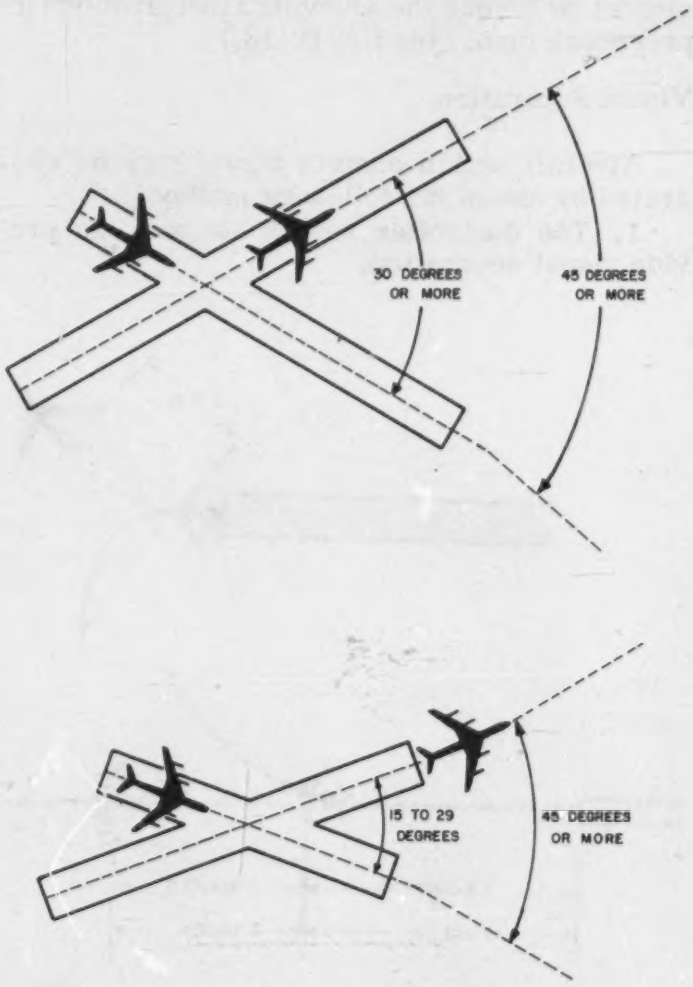

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Figure 12-14.—Takeoffs from intersecting runways.

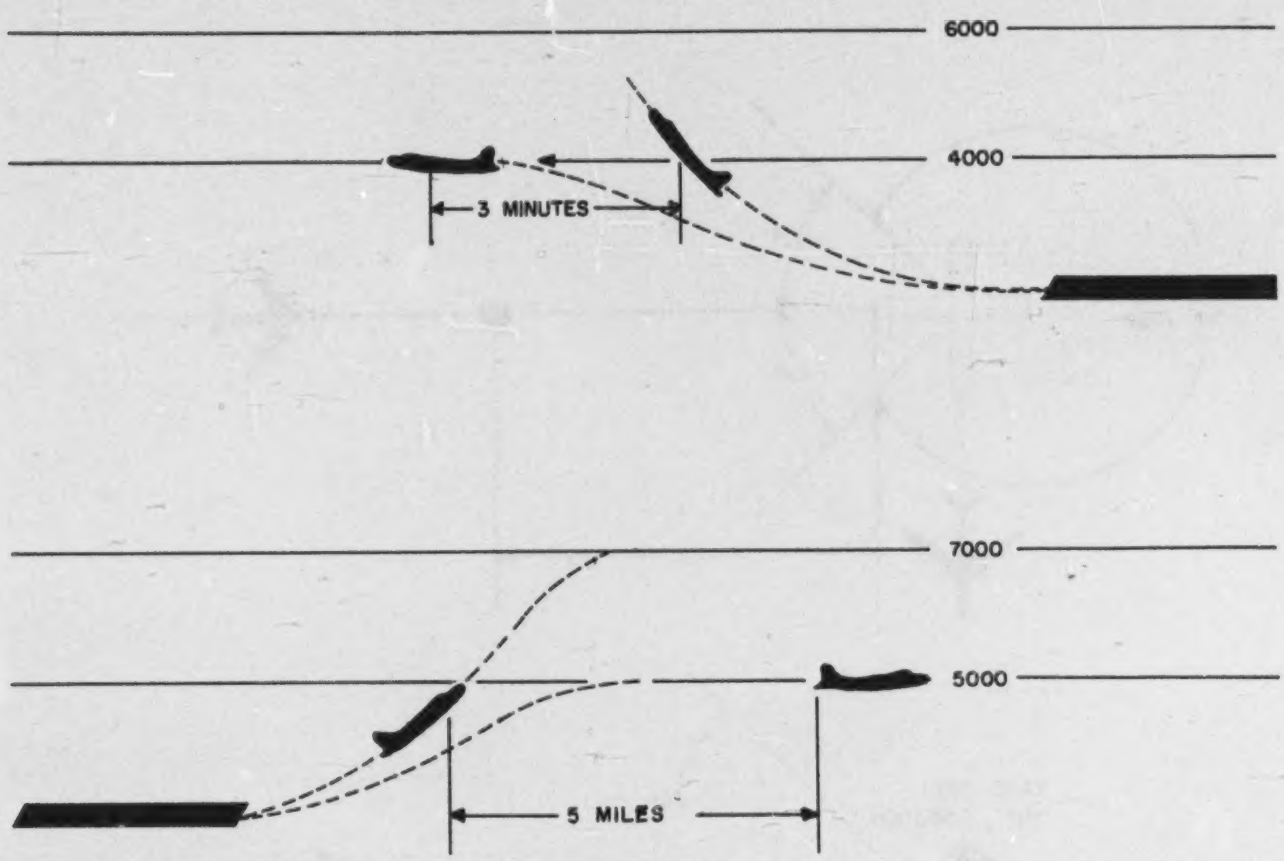

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Figure 12-15.—Takeoffs from the same runway when the succeeding aircraft climbs to the higher altitude.

pilot of the aircraft should be informed of the discrepancy.

No separation is provided for IFR flights operating in accordance with a VFR condition restriction.

Special VFR Operations

Only approved separation may be applied between special VFR aircraft and between such aircraft and IFR aircraft.

When vertical separation is applied to such operations, a fixed altitude is not assigned the special VFR traffic because of the clearance-from-clouds requirement. Special VFR aircraft would be cleared at or below an altitude which is at least 500 feet below any conflicting IFR traffic but not below the minimum safe altitude.

Helicopter Operations

The control of IFR helicopters is governed by the same rules and procedures as any IFR flight.

The control of special VFR helicopters is governed by the same special VFR procedures as any special VFR flight unless other procedures are covered in a Letter of Agreement.

At locations where the volume or complexity of helicopter operations warrants, a Letter of Agreement must specify the fact that special VFR helicopters are required to maintain visual reference to the surface and the traffic patterns, routes, and reporting or holding fixes necessary to achieve appropriate separation. This separation is based on specific criteria and is contained in chapter 4, section 9 of the TATC Handbook 7110.8 (Series).

RADAR IFR SEPARATION MINIMUMS AND PROCEDURES

This section contains primarily radar separation minimums. For a more detailed discussion of radar procedures, refer to chapter 13 of this training manual.

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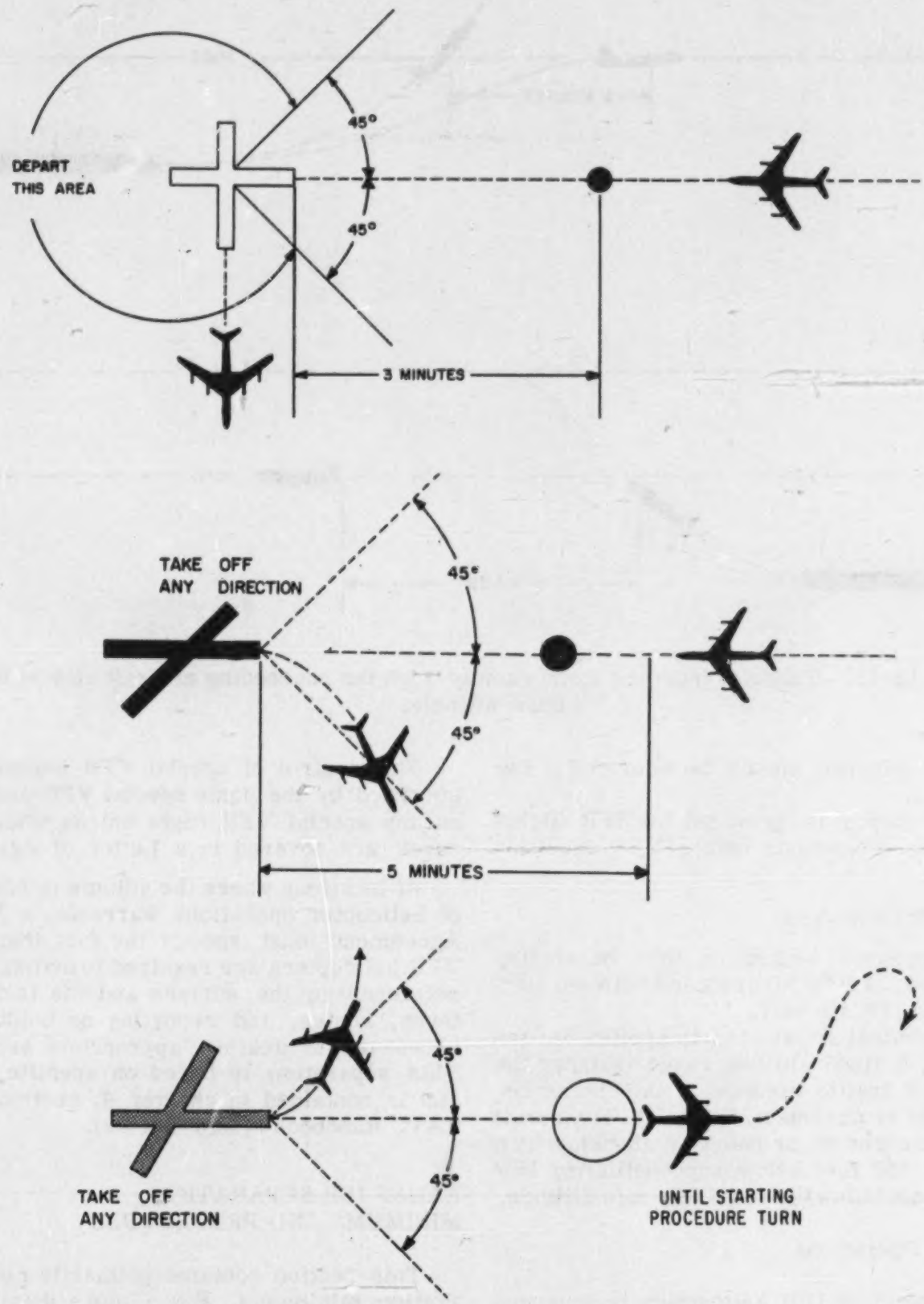

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Figure 12-16.—Separating departures from arrivals.

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Radar separation may be applied between the the following:

1. Radar identified aircraft.

2. An aircraft taking off and another identified IFR aircraft when the aircraft taking off will be identified within 1 mile of the end of the runway.

3. A radar identified aircraft and an IFR aircraft not radar identified when the indentified aircraft is climbing or descending through the altitude of the nonidentified aircraft and the following conditions exist:

a. The performance of the primary radar system is adequate.

b. The airspace in which separation is applied is not less than 6 miles from the edge of the radarscope (10 miles if 40 miles or more from the antenna site).

c. Flight data on the unidentified IFR aircraft indicates it is a type which can be expected to give an adequate primary return in the area where separation is applied.

d. The identified aircraft is vectored on a flightpath different from the route of the unidentified IFR aircraft before descent or climb.

e. Radar separation in maintained from all observed primary and radar beacon targets until nonradar separation is established from the unidentified aircraft.

Application of Radar Separation

Minimum radar separation is applied as follows:

1. Between the centers of primary radar targets. The primary target must not be allowed to touch another primary target or a beacon control slash (radar beacon or SIF target).

2. Between the ends of beacon control slashes.

3. Between the end of a beacon control slash and the center of a primary target.

Radar beacon targets may be used for separation purposes only if beacon range accuracy is verified by one of the following methods:

1. Correlation of beacon and primary targets of the same aircraft to assure that they coincide.

2. When beacon and primary targets of the same aircraft do not coincide, correlate to assure that any beacon displacement agrees with the specified distance and direction for that particular radar system.

If the beacon range accuracy cannot be verified, beacon targets may be used for traffic information only.

Separation Minimums

Minimum radar separation between airborne aircraft radar targets is 3 miles if less than 40 miles from the antenna site, and 5 miles if 40 miles or more from the antenna site.

Vertical separation applied between aircraft may be discontinued when the targets are observed to pass each other and no longer touch each other and their courses diverge by at least 15 degrees.

For single runway operations, a departing aircraft is spearated from an arriving aircraft on final approach by a minimum of 2 miles if separation will increase to a minimum of 3 miles (5 miles if 40 miles or more from the antenna site) within 1 minute after takeoff.

Simultaneous operations may be authorized on parallel runways, provided that the following conditions exist:

1. If the landing thresholds are even, the runway centerlines are separated by at least 3,500 feet. (See fig. 12-17.)

2. If the landing thresholds are staggered and one of the following conditions is met:

a. The approach is made to the runway nearest the arriving aircraft, the runway centerlines are laterally separated by at least 1,000 feet, and the thresholds are horizontally staggered at least 500 feet for each 100 feet of centerline separation below 3,500 feet. (See fig. 12-18.)

b. If the approach is made to the runway farthest from the arriving aircraft, the runway centerline separation exceeds 3,500 feet by at least 100 feet for each 500 feet of threshold stagger distance. (See fig. 12-18.)

3. The departure course will diverge immediately after takeoff from the missed approach course by at least 45 degrees until minimum radar separation is achieved and can be maintained.

4. Departing aircraft that have not commenced takeoff are held, or appropriate clearances issued to those committed to take off, when an arriving aircraft is observed to deviate from the approach/missed apporach course sufficiently to cause a potential conflict.

Simultaneous operations may be authorized on nonintersecting, diverging runways (fig. 12-19) provided that the following conditions exist:

1. The departure course upon or immediately after takeoff diverges from the missed approach course by at least 45 degrees until

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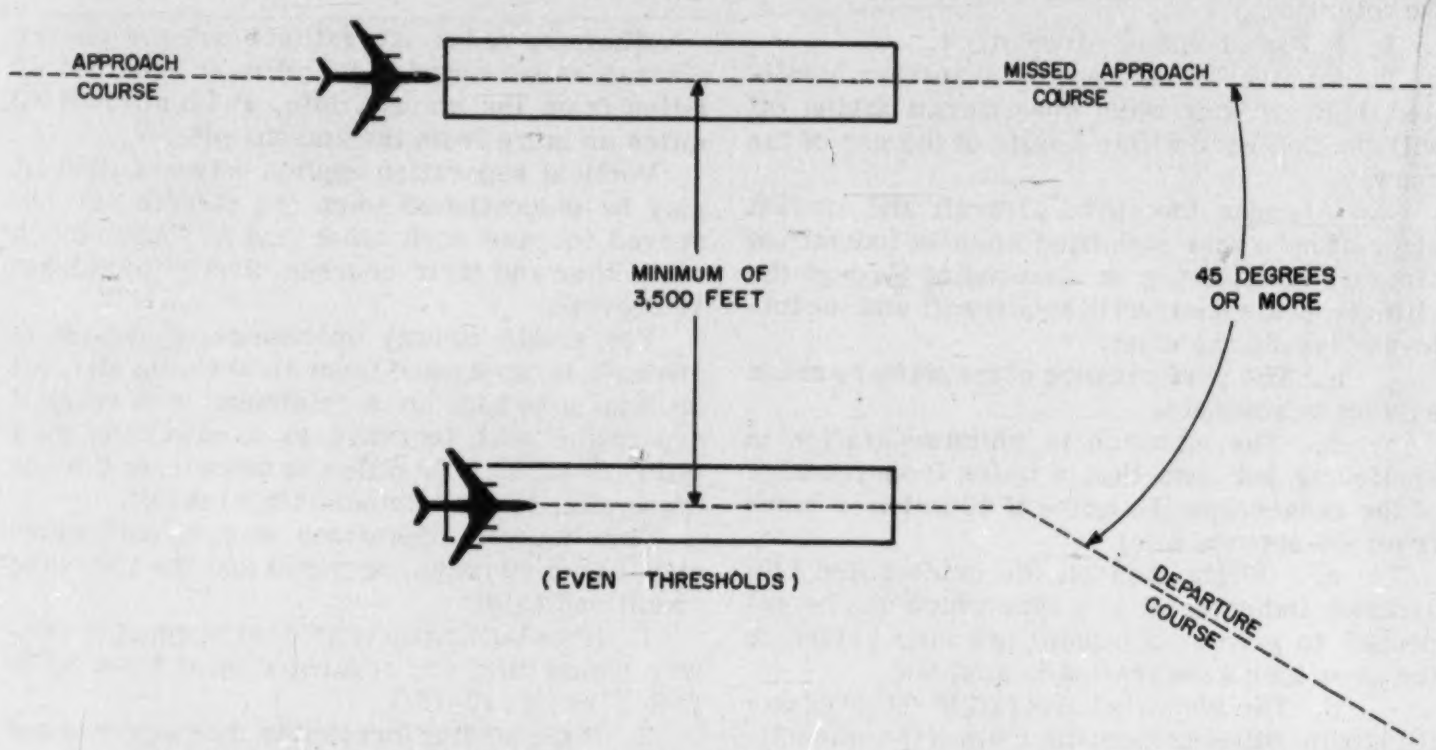

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Figure 12-17.—Simultaneous operations from parallel, even threshold runways.

minimum radar separation is achieved and can be maintained.

2. The distance between the centerline or extended centerline of the landing runway and the centerline of the takeoff runway (measured from the point where the takeoff is commenced) is as follows:

a. 1,000 feet if the runways diverge by at least 30 degrees.

b. 2,000 feet if the runways diverge by 15 to 29 degrees inclusive.

c. 3,500 feet if the runways diverge by 14 degrees or less.

3. Departing aircraft that have not commenced takeoff are held, or appropriate clearances issued to those committed to takeoff, when an arriving aircraft is observed to deviate from the approach/missed approach course sufficiently to cause a potential conflict.

Radar controlled aircraft are separated from the boundary of adjacent airspace, in which radar separation is also being used, by 1.5 miles when less than 40 miles from the antenna site, and 2.5 miles when 40 or more miles from the antenna site.

Radar controlled aircraft are separated from the boundary of airspace in which nonradar separation is being used by a minimum of 3 miles (5 miles when 40 or more miles from the antenna site). However, this separation is not required if the radar controlled aircraft are either climbing or descending and they are definitely outside of the airspace in which nonradar separation is being used.

A radar controlled aircraft that is climbing or descending through the altitude of an aircraft that has been tracked to the edge of the scope is separated by a minimum of 3 miles (5 miles when 40 or more miles from the antenna site) from the edge of the scope until nonradar separation has been established.

Radar controlled aircraft may be separated from prominent obstructions shown on the radarscope (displayed on the video map, scribed on the map overlay, or displayed as a permanent echo) by a minimum of 3 miles within 40 miles of the antenna site.

Vertical separation of aircraft above a prominent obstruction, which is displayed as a permanent echo, may be discontinued after the controller observes that the aircraft target has passed the obstruction.

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Notice that both tubes in this illustration are in the narrow section of the waveguide; thus they are E-type junctions, but they could just as easily have been in the wide dimension, making them H-type junctions.

Characteristics of TR and ATR Tubes. —At sea level pressure approximately 30,000 volts are required to break down a spark gap of 1 inch. Approximately 50 volts is required to maintain ionization; this is known as running voltage. Once the voltage has been removed, a lapse of approximately 10 μsec is required for de-ionization. By enclosing the spark gap in a partially evacuated envelope, the breakdown voltage will be reduced as well as the running voltage and the de-ionization time.

For efficient transmitter operation it is important that the power dissipated by the TR tubes is small as compared to transmitter power. Also the TR tubes must maintain a properly matched line while they are fired. During the time that the transmitter is fired the TR tubes must afford sufficient attenuation to prevent the power that leaks into the receiver from being of so great an amplitude that it may damage the receiver crystal. To allow scope presentation of nearby targets it is necessary that the TR tubes de-ionize rapidly.

The amplitude and duration of the ignition spike must be reduced to the extent that the receiver crystal will not be damaged. This is accomplished by providing a keep-alive voltage to the TR tubes. TR tubes that perform this function contain three electrodes, two of which provide the main gap which does the switching; the third is called the keep alive electrode. This keep-alive electrode is mounted close to one of the other electrodes. It is connected to a relatively high direct negative potential which causes steady partial ionization of the gas between it and the main electrode. This insures almost instantaneous firing of the TR tube for each pulse of the magnetron.

Recovery time may be described as the time required for a TR tube to de-ionize effectively. The length of the recovery time period is determined by the length of time required for the free electrons and ions, that remain in the gas after the transmitter pulse has been removed, to recombine. A short recovery time means that target echoes can be received sooner after the transmitter pulse ends.

The life of a TR tube is relatively short as compared with most other tubes. A major factor that shortens the life of these tubes is the gradual loss of gas pressure. This is the result of chemical combination of the gas and the tube electrodes; also molecules of gas become embedded in the electrodes as a result of glow and keep-alive discharge.

One means of lengthening the life of these tubes is to maintain the keep-alive current within design limits. Some equipments provide test points for making current checks. A reading lower than the normal minimum current will most likely be an indication that the TR tube is not operating at proper efficiency.

The most general indications of defective TR tubes are as follows:

1. Receiver recovery time will increase.
2. Receiver sensitivity will decrease.
3. Receiver crystals will become defective. (This will be indicated by an increase in crystal back current.)

Some radars use the same type tube for TR and ATR operation. In some cases a tube that will not operate as a TR may be used satisfactorily as an ATR; thus for emergency operation the tubes may be interchanged.

HYBRID DUPLEXER. —A type of duplexer somewhat different from those already discussed is the HYBRID RING. This duplexer is capable of performing the duties of the conventional ones already discussed, and in addition it has a low standing wave ratio and the ability to transfer high power.

The hybrid ring is a form of hybrid junction, which is a device that transmits power to two lines from each of two independent inputs that are not coupled together. This type of junction is frequently referred to as a "magic-T."

NOTE: This statement holds true for the hybrid ring duplexer only during reception; thus the magnetron is not coupled to the antenna and there is no dissipation of received power by the magnetron. The magic-T is discussed in greater detail later in this chapter and in chapter 12 of Basic Electronics.

During the transmitter pulse the duplexer does not function as a true hybrid ring because the ionization of the TR tubes by the high power transmitter pulse serves to couple the magnetron to the antenna. The TR tubes also perform their normal protective action for the receiver crystal.

RADAR RECEIVERS

Earlier in this chapter the importance of developing an extremely high powered pulse

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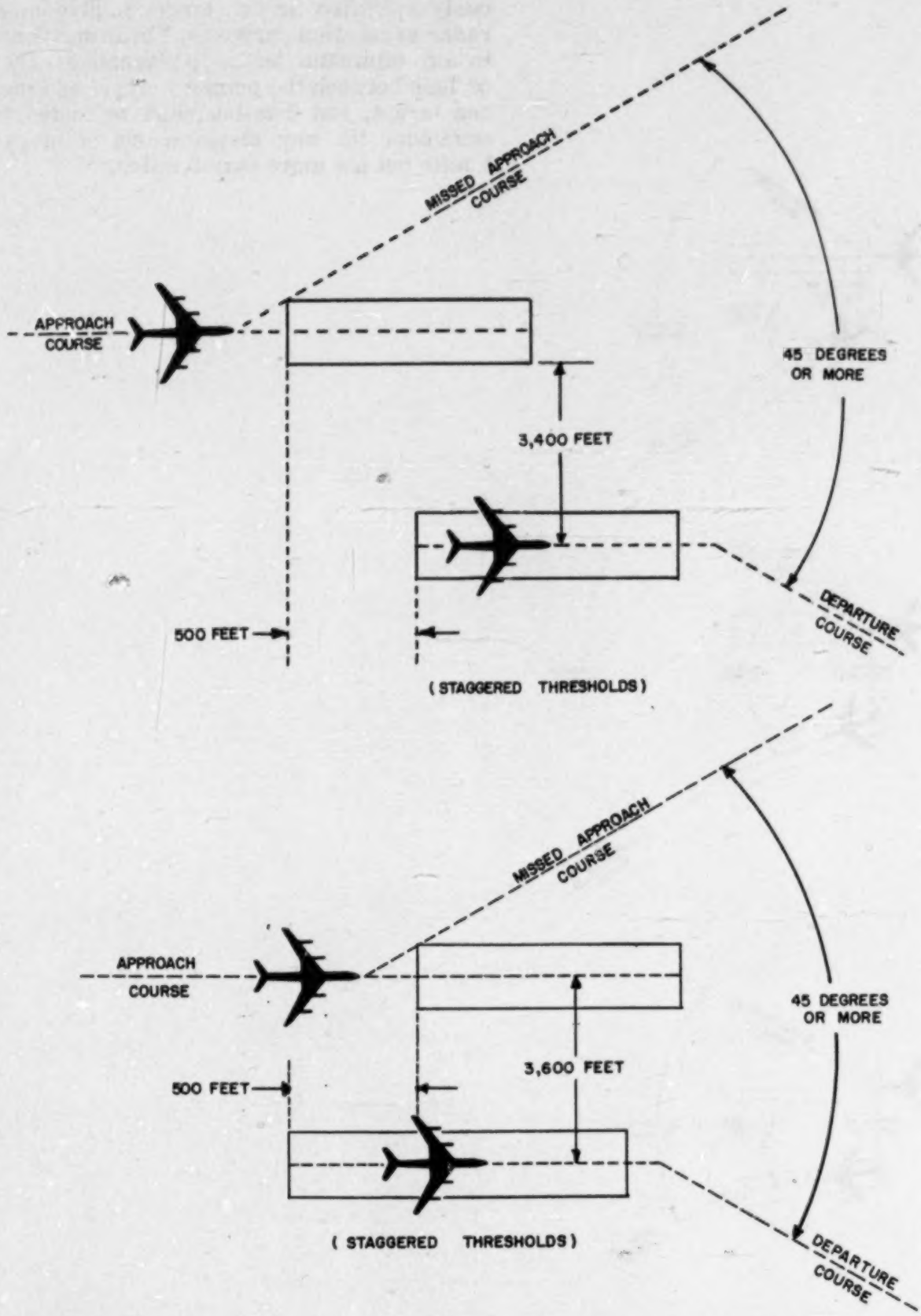

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Figure 12-18.—Simultaneous operations from parallel, staggered threshold runways.

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When using a radar display with a previously specified beacon target displacement for radar separation purposes, 1 mile must be added to any minimum for a displacement of 1 mile or less between the primary target and the beacon target, and 2 miles must be added to any minimum for any displacement of more than 1 mile but not more than 2 miles.

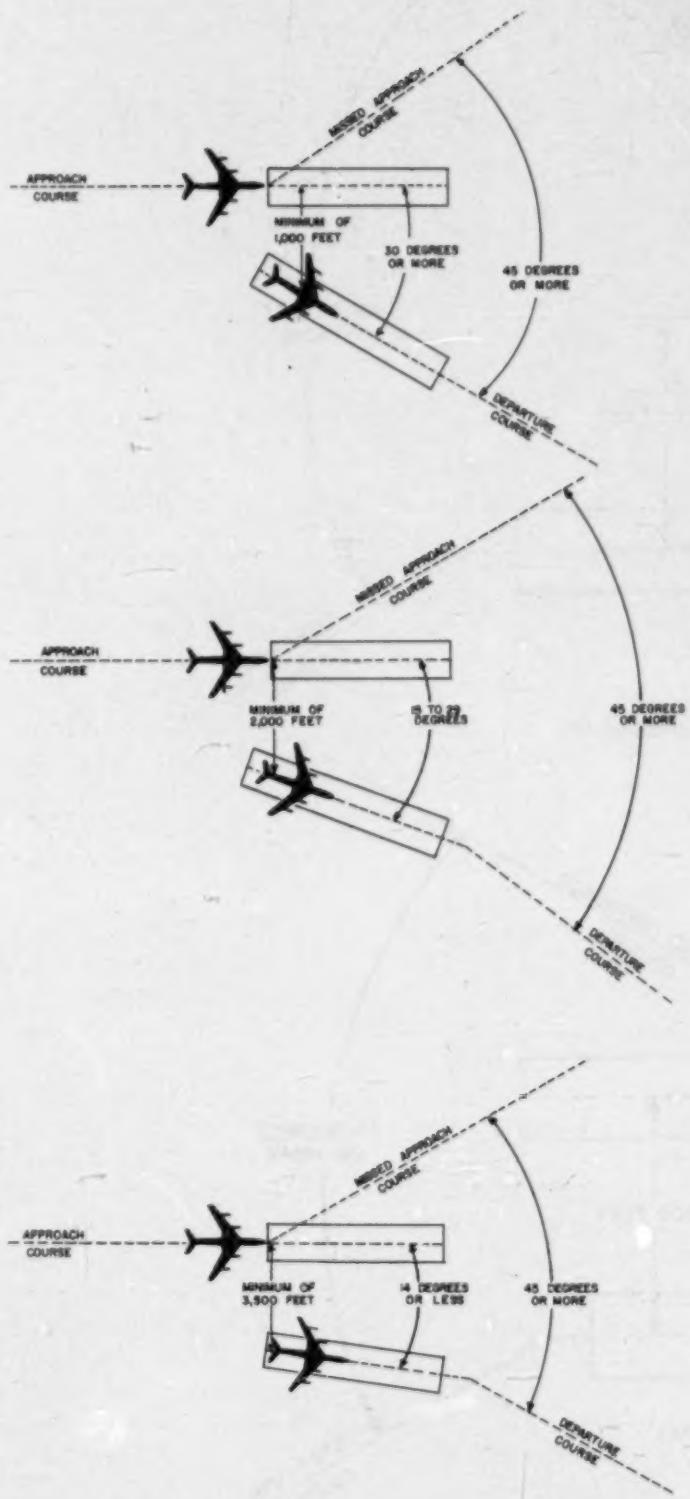

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Figure 12-19.—Simultaneous operations from diverging, nonintersecting runways.

CHAPTER 13

RADAR AND ALLIED EQUIPMENT AND PROCEDURES

The name RADAR is formed from the initial letters of the words RAdio Detection And Ranging. Radar was developed principally for the purpose of detecting and ranging targets in wartime. This, of course, is still the primary purpose of military radar; however, the ability of radar to spot unseen objects has proven to be of great assistance in the problem of air traffic control. Civil and military aviation have grown to be a veritable giant compared to the days prior to World War II. The many departures and arrivals at major air terminals could not be effectively and safely controlled without the assistance of radar. Previous separation standards can be reduced, and this contributes to the expeditious and orderly flow of air traffic without any compromise of safety. In fact, safety is increased in many situations. Radar is used in many ways but, in this chapter, our main concern will be radar as applied in air traffic control.

HOW RADAR WORKS

ECHO PRINCIPLE

Radar depends on a principle that energy emitted from one point and traveling at a uniform rate will be reflected by obstructing surfaces in its path, in which case a small portion of the original energy returns, at the same rate of speed, to the point of origin.

This is the old principle of the echo, which we have all had demonstrated to us by sound waves. For example, the man who shouts at the side of a cliff to hear his echo is, in effect, illustrating the basic principles of radar, using sound waves instead of radio waves. (See fig. 13-1.) Radio waves that travel at the speed of light (162,000 nautical miles per second) also have echoes.

The nautical mile is used in this chapter because it is standard for navigation purposes, radar work, and when calibrating facilities.

FUNDAMENTALS OF RADAR OPERATION

In radar, the shout of our sound analogy is a short pulse from an ultrahigh frequency transmitter which generates electromagnetic waves that travel in very straight lines. (See fig. 13-1.) Upon striking an object, these waves are reflected and some of the energy returns to the transmitter sight where they are amplified by a receiver, and the elapsed time is measured very accurately. The Greek word "micro" means one-millionth of a unit; thus, one-millionth-second time unit is known as a microsecond. Despite the fact that radio pulses travel incredibly fast, electronic devices can accurately time these echoes.

Again, consider the man who shouts at the cliff. If he had cupped his hands around his mouth when shouting and around his ears when listening, he would have noted two improvements: First, the effective range of the echo would have been increased since the radiated sound waves were concentrated into a narrow beam and returning echoes were funneled into the ear; and second, he would have been able to more readily distinguish between two reflecting surfaces that were separated in azimuth from his position. This is of particular importance in radar if a high degree of accuracy of angular position is desired. The radar beam may be only one-half degree wide. Such a narrow beam can distinguish between two objects at the same range, differing by as little as 1 degree in angular position.

The radar antenna has two important tasks. It is not only required to radiate the radar pulse, but also has to catch the returning echo. The antenna array, or its size and shape, will vary

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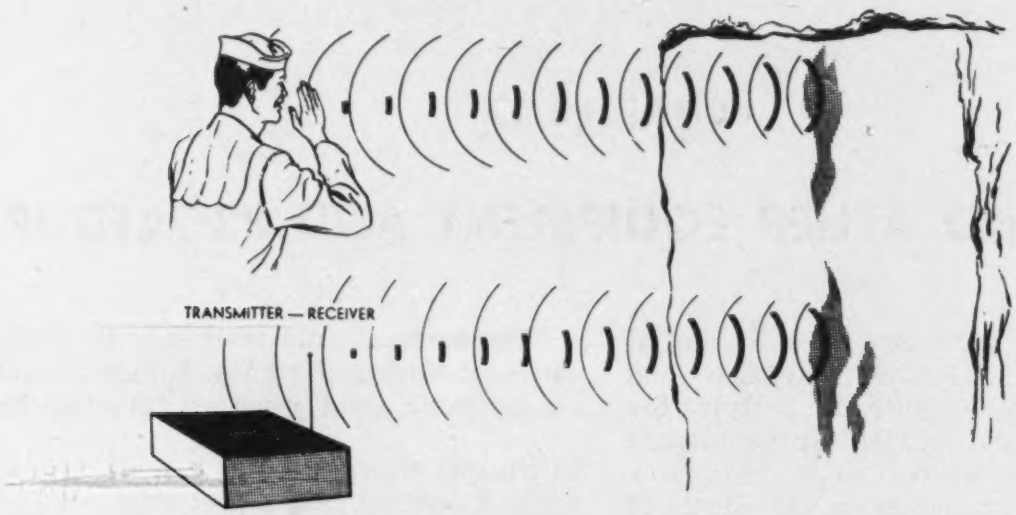

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Figure 13-1.—Reflection of sound and radio waves.

with the performance requirements of the unit. Frequently some type of special directivity in the vertical or horizontal plane is required. In *the airport surveillance system, for example,* an ideal coverage would be from the ground to an elevation of 10,000 feet and ranges from 30 to 60 miles. Special antenna arrays have been designed to provide this coverage. The surveillance system of a ground controlled approach (GCA) unit is a prime example.

BASIC RADAR COMPONENTS

The basic components of a radar system are shown in figure 13-2. The function of each component is explained in the following paragraphs by tracing the sequence of events that go into the manufacture of a single blip on the indicator. (Part numbers used in this section refer to the number designation used in figure 13-2.)

Transmitting System

The transmitter power supply (1, fig. 13-2) provides a steady, high d-c voltage to the modulator.

The synchronizer (2) furnishes a sharp, low power pulse to trigger the modulator and the sweep generator simultaneously. These pulses are repeated between 60 and 4,000 times per second, depending on the design of the set.

The modulator (3) acts as an electronic switch or valve to furnish high voltage d.c. to the transmitter in brief pulses. These pulses *are extremely short (duration less than 1 micro-*second) in some equipment. After each pulse the transmitter is off the air while the system waits for echoes from that pulse to be received.

The maximum rapidity with which this cycle can be repeated has a direct bearing on the minimum distance over which targets may be detected. To illustrate, let us suppose you are bouncing a rubber ball against a wall. You are throwing the ball (transmitting the energy) with your right hand and catching the ball (receiving the reflected energy) with your left hand. As you get closer to the wall, you reach a point where you are physically unable to catch the ball and throw it again immediately. Something very similar happens in the radar set when the receiver, which has been disabled during pulse transmission, has not had sufficient time to return to operation when the return signal from a close-in target is received.

The transmitter (4) converts the d-c pulses received from the modulator into extremely high frequency radio energy. Frequencies used in aviation radar are:

BAND	FREQUENCY	USE
S	1,550 - 5,200 MHz	Airport Surveillance.
X	5,200 - 10,900 MHz	GCA Precision.
L	390 - 1,550 MHz	Long Range Surveillance.

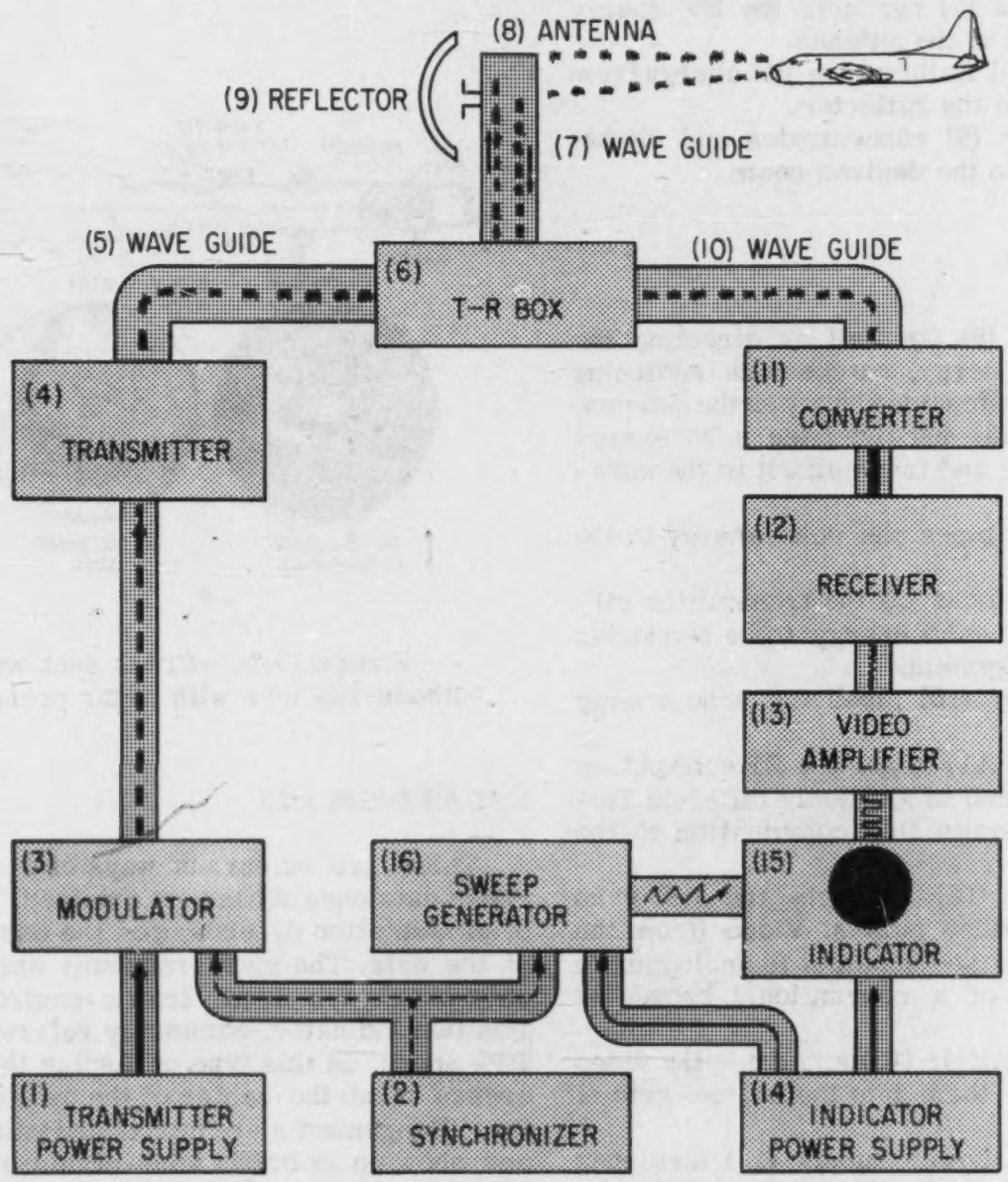

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Figure 13-2.—Basic components of radar system.

Transmitter peak power of over 1,000,000 watts (1 megawatt) is possible with present long range radar. An appreciation of the large amount of power required for radar is evident if we compare this transmitter with commercial broadcast transmitters where 50 kilowatts is considered high power.

One factor which helps to make possible such high transmitter power in radar is that the transmitted signal is a surge of energy which lasts only for the very short interval that the pulse is being sent out. The high power components then have a period of rest during the time the receiver is in operation.

The waveguide (5) pipes the radiofrequency (RF) energy from the transmitter to the transmit-receive (T-R) box. "Pipes" is a descriptive term, inasmuch as waveguides are simply metal plumbing of rectangular cross section.

The T-R box (6) blocks the high power pulse of the transmitter from the receiver circuits. This is necessary to prevent the receiver system

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from being burned out by the extremely high-powered energy.

The waveguide (7) conducts the RF energy from the T-R box to the antenna.

The antenna (8) radiates the RF energy from the waveguide into the reflector.

The reflector (9) concentrates and shapes the RF energy into the desired beam.

Receiving System

The reflector (9), as well as directing the transmitted RF energy, catches the returning echo and concentrates this energy on the antenna.

The antenna (8) receives the echo energy from the reflector and transmits it to the waveguide (7).

Waveguide (7) pipes the echo energy to the T-R box.

T-R box (6) blocks off the transmitter circuits to allow all echo energy to be conducted into the receiver system.

The waveguide (10) pipes the echo energy into the converter.

The converter (11) mixes the RF echo pulses with a steady signal of a slightly different frequency, and transmits this combination to the receiver.

The receiver (12) converts the RF echo pulses to sharp video pulses. Video (from the Latin meaning "to see") output is analogous to the audio output of a conventional broadcast receiver.

The video amplifier (13) amplifies the video signals and feeds them into the control grid of the indicator.

The indicator power supply (14) furnishes relatively low voltages to the heaters, cathodes, and anodes of the sweep generator and the indicator.

The indicator (15) converts the video pulses received from the video into light indications and presents this information in the desired form. Practically all indicators are based on the use of a cathode-ray tube (CRT). The CRT, or "scope," is a conical glass bulb with an electron gun at the small end and a flattened glass disk at the other end. Their basic construction is somewhat similar to a television picture tube. (See fig. 13-3.)

The sweep generator (16, fig. 13-2) generates the variable current, which is applied to the deflecting coils, to sweep the electron beam back and forth inside the scope.

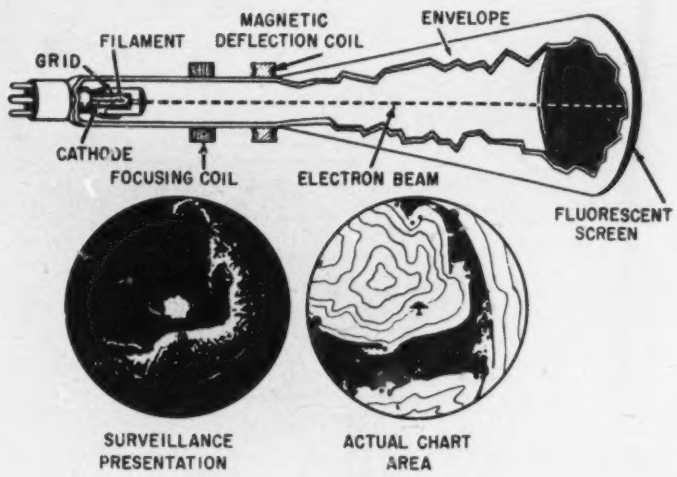

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Figure 13-3.—Cross section of cathode-ray tube with radar presentation.

RADAR DISPLAYS

There are numerous ways of displaying the radar data once it has been obtained. The manner of presentation depends upon the use to be made of the data. The most frequently employed type of presentation in air traffic control is a Plan Position Indicator, commonly referred to as the PPI-scope. In this type of display the time reference is at the center of the cathode ray tube face. Rangemarks are introduced into the system and show up as bright concentric circles on the display. Their spacing in terms of miles may be various values (1, 5, etc.), although at any one time the spacing will be uniform throughout the display.

The PPI-scope may be expanded for short ranges; for example, a 5-mile range may actually cover the same area on the face of the tube as a 30-mile range. The rangemark spacing interval may be manually changed or the indicator equipment may be of the type that produces a certain rangemark spacing interval for a specific range selected.

The offcenter PPI display is one in which the start of the sweep is moved away from the center of the tube face. One advantage of this type display is the increase in maximum range presented on the tube in a selected azimuth sector.

If 30 miles were the greatest range on a range selector switch, it would be possible to extend the sweep out to 60 miles in any desired sector by offcentering to the edge of the tube face. Whether targets could be seen out to 60 miles depends on the radar system itself and the type of target. Figure 13-4 shows two PPI-scopes with the same range selected but with one off-centered to increase range.

Targets show up on the PPI-scope as bright spots at their respective range and bearing from the antenna site. An example of a PPI-scope presentation is shown in figure 13-5.

This type display is commonly used for airport surveillance equipment which in conjunction with an aircraft's altimeter gives positive control of aircraft within the coverage of the radar equipment.

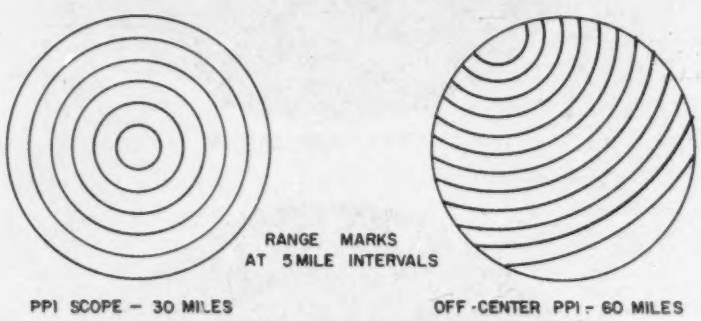

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Figure 13-4.—Advantage of offcenter PPI-scope.

AUXILIARY RADAR EQUIPMENT

A basic PPI display shows all types of radar echoes, both fixed and moving targets. Ground targets are usually displayed as strong echoes, and they will mask echoes from aircraft flying over these areas. Any echo that is undesirable, or that prevents the controller from observing aircraft, is called clutter. The moving target indicator eliminates clutter resulting from fixed targets.

Moving Target Indicator

The principle of the moving target indicator (MTI) is that the phase of the echoes from one transmitted pulse is compared with the phase of the echoes from the next successive transmitted pulse. If the phases of the two returns from the same target are the same, the returns cancel each other. If there is a phase difference, resulting from the target moving, the returns do not cancel, and there is an indication on the scope of moving targets only. The ability of MTI to display any specific aircraft target depends on the radial velocity of the aircraft. Radial

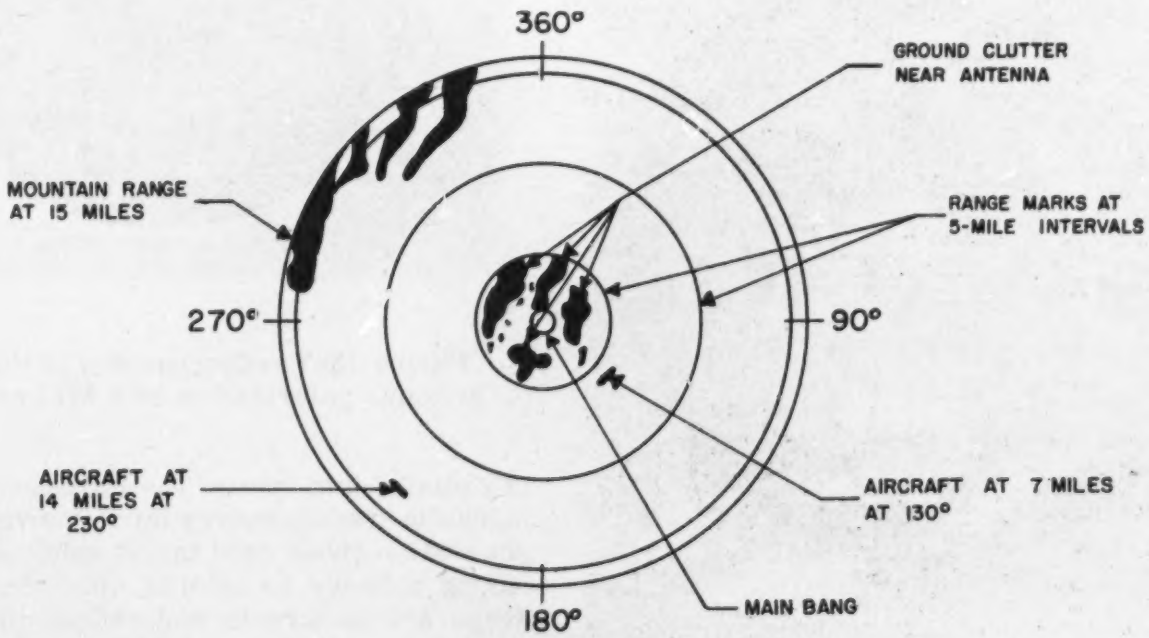

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Figure 13-5.—PPI-scope display.

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velocity is the speed an aircraft is making toward or away from the radar antenna, regardless of the heading or groundspeed. An aircraft target would not be displayed if it were flying a perfect circle around the antenna at a constant range; i.e., it would have no radial velocity.

The radar operator can control the video output from both normal radar and MTI. Normally, any of the following PPI displays can be selected by the operator (in some cases, the MTI range gate, or range of the MTI, is adjusted by a technician):

1. A completely normal radar display; signals from stationary and moving targets.
2. MTI display; uncanceled signals from moving targets only.
3. A display in which MTI signals are range gated at any desired range with normal signals appearing beyond the MTI presentation.

Figure 13-6 is an example of a 20-mile PPI display with the MTI range adjusted to 10 miles and normal radar appearing beyond that. The lines on the scope in figure 13-6 comprise a mapping system discussed later in this chapter.

Circular Polarization

A factor that determines the effective range of radar is the manner in which the radar energy is radiated into space. The radiation of electromagnetic (radar) energy during normal weather conditions gives good target returns. However, during a heavy rainstorm, the individual raindrops act as targets and reflect the polarized electromagnetic energy which may completely illuminate or clutter the scope and obscure any target that may be in the area. This condition is

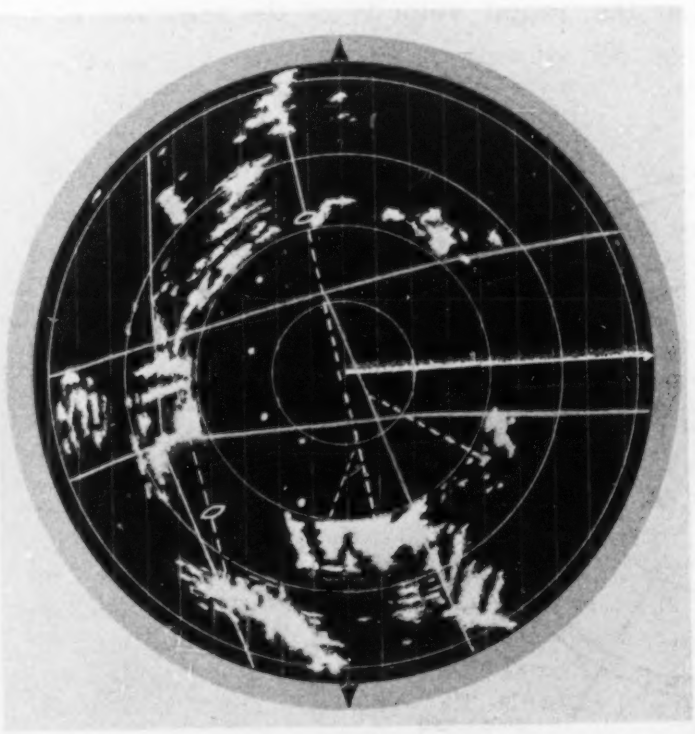

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Figure 13-6.—A 20-mile PPI display with MTI adjusted to 10 miles.

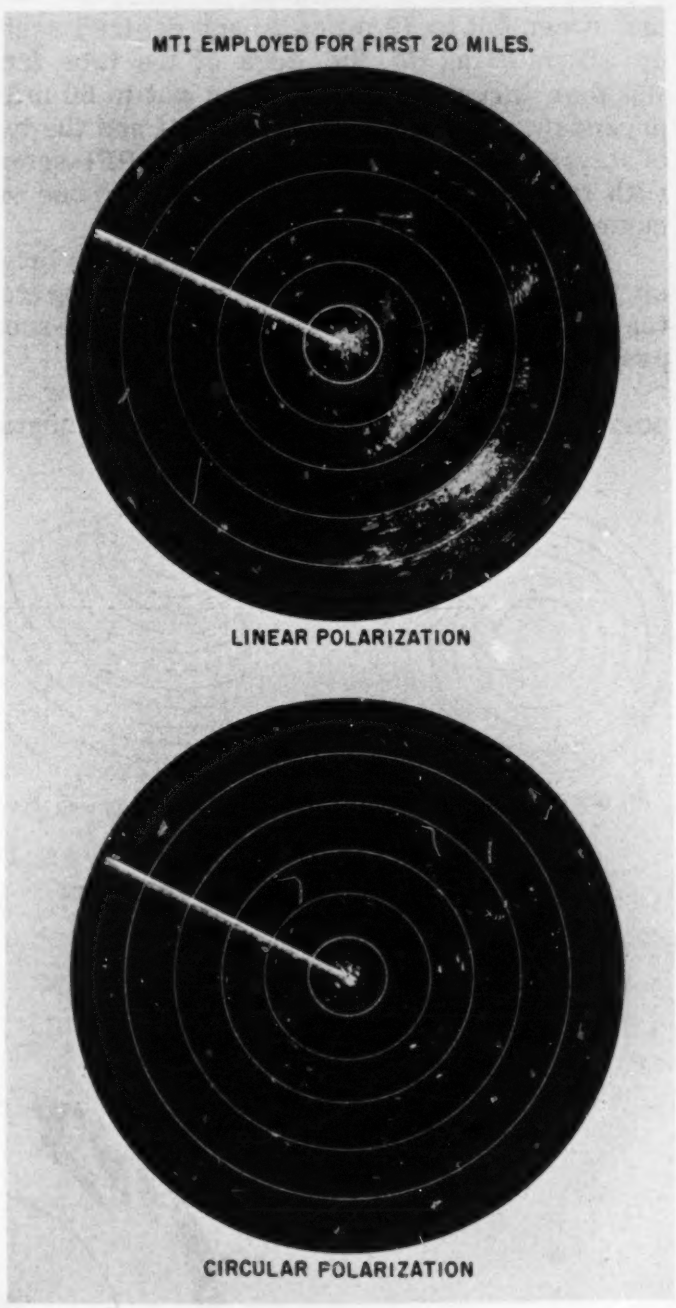

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Figure 13-7.—Comparison of linear and circular polarization with MTI employed.

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undesirable and is overcome by radiating energy in a type of polarization that is designed to cancel returns from symmetrical targets, such as raindrops, while accepting returns from asymmetrical targets such as aircraft. This type of polarization is known as circular polarization.

Operator control of polarization is normally a two-position toggle switch labeled LP-CP (linear-circular polarization). LP is selected for normal operation and CP is selected when necessary to reduce clutter from precipitation. Figure 13-7 shows a comparison of linear and circular polarization used in conjunction with MTI. MTI will eliminate some precipitation clutter but normally precipitation is moving fast enough to be displayed as a moving target.

Caution should be exercised when using circular polarization in the control of certain types of aircraft such as the T-33 which normally displays only a very weak return. The CP will also reduce the target strength of aircraft targets and in some cases may eliminate it altogether.

Mapping Systems

A radar controller uses the rangemarks on the PPI and the compass rose around the edge of the scope to obtain the position of an aircraft target. Information from these two sources only gives range and azimuth from the radar antenna, and does not depict the geographical location of the aircraft; therefore some type of map display would be advantageous. Two types of mapping are available as integral parts of a PPI: a map overlay and video mapping.

The simplest solution is the map overlay. As the name implies, it is installed so that it covers the face of the cathode ray tube. The overlay is made of transparent plastic, and necessary reference marks, location of navaids, runways, and obstructions are etched into the surface. The overlay is edge-lighted, and the controller can control the brilliance. The shape of the overlay conforms to the surface of the CRT, but does not touch it.

There are two inherent disadvantages to the map overlay. Since the map is installed a short distance away from the tube, the targets do not appear in proper relation to the map unless the controller looks at the target from a point directly above the target. This is called parallax. Targets will apparently drift away from one of the etched courses, when the controller's viewing position changes. The controller must be extremely careful of his posture, so that he will observe the target correctly, and prevent parallax. The other disadvantage is that the map is only good for one range setting of the radarscope, since it does not expand with the display on the tube.

The video map is a great improvement over the map overlay. It is produced by a separate mapping unit rather than being installed on the radar console. A scale map of the desired features is drawn and then reproduced as a round photographic negative. This information is fed to the video amplifier ahead of the indicator tube and mixed with radar information from the receiver so that the resulting signals to the PPI will contain a combination of radar and map data. The antenna scan and the map scan are synchronized so the map is developed directly on the PPI as the sweep progresses. The result, and biggest advantage of the video map, is that the map expands or contracts as the range of the indicator is changed. The map coverage is in direct proportion to the area covered, and is accurate when the scope is offcentered.

Since the map is produced on the face of the tube along with the radar information, there is no parallax error. Thus, with a single map and mapping unit, a number of ranges with corresponding plotting information are available for display on several indicators operating independently of each other. Figure 13-8 is an example of a video map.

The video map is subject to some drift, but slight errors resulting from drift can usually be corrected by a radar technician. Another disadvantage of the video map is the possibility of failure of the mapping unit which would result in no map on the PPI.

SURVEILLANCE APPLICATION

Surveillance radar is a potent tool for all air traffic control use. It releases the controller from the restriction imposed by the uncertainty which formerly existed as to the actual position of the aircraft. Accuracies of the radar indications are superior to human vision, and a clear plan position of all aircraft and their approximate headings within the range of the radar is indicated. The many advantages of such a display are obvious.

It is evident that if a controller can continually see the position of an aircraft whose pilot is

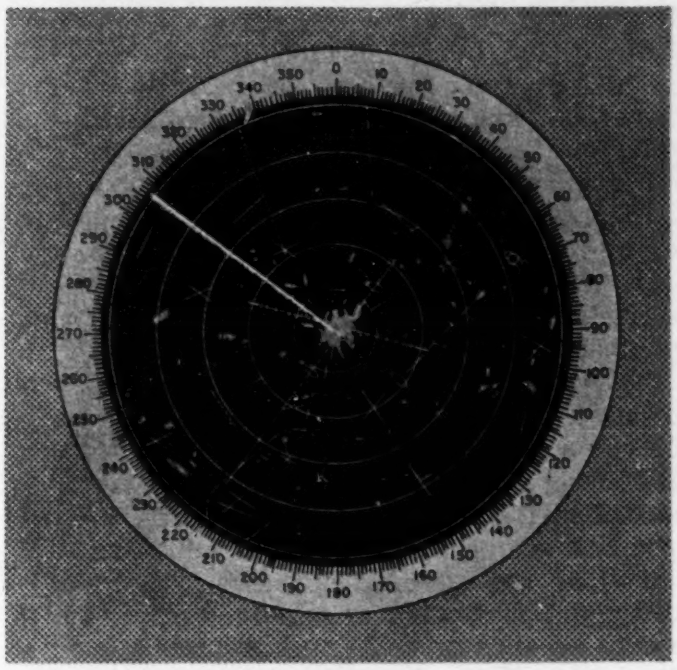

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Figure 13-8.—Video map.

unable to see his position, he can relay information which will enable the pilot to make the necessary corrections in heading to bring him to his destination.

In the case of terminal radar operations, lines are drawn to show runway extensions, and usually are marked to indicate distances from the runway. Using any suitable radiotelephone, a controller can then give the pilot heading instructions which will keep his radar target accurately on the approach lines, and inform the pilot of the exact distance from the runway at any time. Knowing the sea level altitude of the airport, and the fact that a normal rate of descent for the desired glide angle is 300 feet per mile, a controller can advise a pilot what his altitude should be each mile. Such an approach is perfectly practicable under ceiling conditions of 300 feet or higher.

RADAR PERFORMANCE CHARACTERISTICS

MTI Blind Speed

When a radar system is developed that will detect only flying aircraft, and nothing else, the radar controller will have a nearly perfect system for controlling traffic. Such a system has not been developed yet but with the MTI system he has the next best thing. Nevertheless, radar systems do have limitations, and some of these are discussed in the following paragraphs.

If we review the principle of the MTI system, we find that the basic function of the MTI is to compare the phase of each signal received with that of the last signal return. The phase of each reply from a stationary target will be the same and the system will cause the returned signal to be canceled. If, however, the target is moving with a radial component of velocity with respect to the antenna, the reflected wave will have a different time phase from pulse to pulse and will be indicated on the radarscope.

Should an aircraft be moving at a speed such that the distance covered between pulses is equal to half the wavelength, or multiple thereof, of the transmitting frequency, the phase relationship is unchanged. As a result, the signal will be canceled in the same manner as the fixed target signal. Such a condition is known as MTI blind speed.

Blind speeds differ with each type and model of radar according to the wavelength of the transmitted signal. Complete loss of targets is seldom experienced with conventional aircraft since the propeller rotation will rarely be synchronized with the radial velocity of the radar and a partial return will be received. Seldom will an aircraft be able to maintain a course which affects MTI blind speed for more than a few seconds due to wind or variations in altitude.

Target Fades

An inherent feature of all radar systems with which the controller should become thoroughly familiar is target fading. Target fades will vary with the type of equipment, antenna height, tilt angle of the antenna, atmospheric conditions, and the surrounding terrain. Target fades will be apparent when an aircraft is over the antenna site. The degree and length of such a fade will be determined by the amount of antenna tilt. It should be noted that the lower the tilt angle of the antenna, the better will be the low angle coverage. On the other hand, the higher the tilt angle of the antenna, the better will be the high angle coverage. Most antennas are set to give maximum coverage for the particular type of control being employed.

The coverage in range, altitude, and azimuth for a particular site is determined by means of

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by the transmitter was discussed. Although the high power pulses are radiated in a narrow beam, only a small part of the radiated energy actually strikes a distant target. Since the energy striking the target is reflected or radiated over a wide angle, only a very small part of the transmitted energy is returned to the radar's antenna. Thus, the function of the radar receiver is to receive the weak target echoes from the antenna and amplify them sufficiently to provide the indicator with the desired target information. Consequently, the weaker the signal which the receiver can use, the greater the effective range of the radar set.

Before considering the detailed operation of the radar receiver, some of the requirements it must fulfill will be discussed. However, the discussion will be limited to those requirements that are within the scope of this course.

With the exception of some superregenerative IFF receivers, all modern radar receivers are of the superheterodyne type. The compnents of a typical receiver are a mixer, local oscillator, IF amplifiers, video detector, video amplifiers, and output provisions for built-in or remote indicators. The use of conventional RF amplifiers becomes progressively less practical from the lower radar frequencies to the higher and therefore are not used extensively in the microwave region. In cases where RF amplification can be used, the RF amplifier is placed ahead of the mixer. (Such application utilize traveling wave tubes.)

Improved receiver design has probably done more to improve the usefulness of radar than any other one thing. Radar receivers are quite sensitive, having been perfected to the point where they will accept signals in the order of a pico watt and will amplify and display them in many useful ways. The weaker the signal which a receiver can accept and efficiently display, the greater is the effective range of the set.

Signal-To-Noise Ratio

The name commonly given to small random fluctuating voltages present in the input stages of radar receivers is noise. In a radar set the noise voltages cause unwanted deflections of the electron beam in electrostatic deflection systems, and erratic fluctuations in intensity of the beam in intensity modulated systems.

Signal-to-noise ratio as well as proper bandwidth are important properties which are designed and built into receivers.

The noise level, at microwave frequencies, is practically all within the receiver. Most of the noise is generated in the amplifier stage and includes thermal agitation, shot effect, and induced voltages. Good design reduces these unwanted noises to a minimum but a strict maintenance schedule is necessary to maintain peak performance.

Bandpass

The input to the receiver amplifiers consists of minutes rectangular pulses of RF energy. In addition to being able to pass the carrier (intermediate frequency), the amplifying stages must be capable of amplify the modulation frequency. It should be recalled from Basic Electronics that a perfectly square wave consists of a fundamental frequency sine wave plus an infinite number of odd harmonics. Thus, to pass signals of this broad frequency range, radar receivers use amplifiers that have a relatively wide bandpass characteristic. Improper alinement of the receiver's amplifiers may cause distortion and loss of gain, resulting in poor target definition, reduction of range, and reduced accuracy of range measurements.

Radar receiver bandwidths may vary from 1 to 10 megacycles. The noises contained within the receiver include frequency components throughout the entire frequency spectrum and are, therefore, affected by the bandwidth of the receiver. Generally, a reduction in bandwidth reduces the noise voltage but does so at the expense of pulse shape. The amount of permissible distortion of the pulse shape thus limits the reduction in noise which may be accomplished by reducing the receiver bandwidth.

Tuning

Radar transmitters (magnetrons) used in aviation equipment have relatively poor frequency stability. As the radar antenna rotates, the antenna impedance may change. Thus, the load presented to the transmitter changes, and the output frequency of the magnetron changes. Other inherent factors cause considerable magnetron frequency shift over longer times. When the output frequency of the magnetron changes, the receiver must be retuned automatically if

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a flight check evaluation, which is conducted by the FAA flight check team before the facility is commissioned. In the event that a previously unknown fade area is suspected, another flight check should be requested in order to verify or confirm its existence. The data obtained from the flight check gives the controller an indication of coverage and target fades inherent in the type of equipment being used. In order to understand the capabilities and limitations of the system, a controller should become thoroughly familiar with the coverage pattern and fade areas which were determined by the flight check.

Anomalous Propagation

The atmosphere surrounding the earth is not uniform in density or moisture content; therefore, it is possible for local conditions to exist in which radar beams are bent upon passage through the atmosphere. Conditions under which the radar beam does not travel a straight line are called conditions of anomalous propagation. This condition is most apt to occur on days when there is little wind, and when air temperature is different from the ground temperature.

Anomalous propagation is most prevalent over water where water evaporation causes a temperature and moisture gradient to exist. The refraction of dry or dense air is greater than that of moist or less dense air; therefore radar beams will be bent in the direction of the dry or dense layers. Figure 13-9 depicts two conditions of anomalous propagation with the atmosphere causing a downward and upward bending of radar beams.

Under conditions depicted in figure 13-9, targets hundreds of miles away may be detected even though they are far below the horizon. On the other hand, relatively close targets may not be detected.

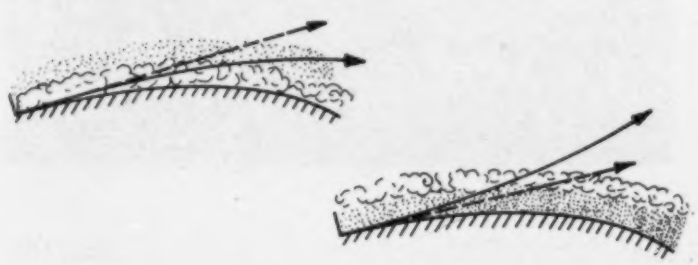

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Figure 13-9.—Anomalous propagation effect.

False Targets

The proficient radar controller must be quick to recognize temperature inversion as a false target. Such indications are often secondary reflections of radar energy from isolated refracting areas in a temperature inversion level. Correlation of radar reports with the Weather Bureau records indicates that a temperature inversion is usually present when unidentified flying objects appear on the scope. These inversions often travel across the radar at tremendous speeds and in changing directions. Apparently this phenomenon is produced by isolated refracting areas traveling with the wind at or near temperature inversion levels. Although the exact size, shape, and composition of these isolated areas are not known, it is believed that they may be atmospheric eddies produced by a shearing action of dissimilar air strata. It appears that such eddies may reflect and focus the radar energy with a lens effect to produce a small concentration of ground return with sufficient strength to show up on the radar display.

Radar Jamming

Jamming, as used in conjunction with radar, is defined as an introduction of false radiation into radar and radar devices. False targets produced by jamming may appear on the scope at varying ranges and bearings or in some cases may clutter large portions of the scope.

Jamming may be classified into two main categories, active and passive. Active jammers are those which generate radar energy producing interference. Passive jammers are those which act as parasitic radiators such as chaff. Chaff is thin strips of aluminum or other metal cut in a particular length. When released from aircraft at high altitudes, the strips float down to the ground slowly and the resultant echoes cause large areas of clutter.

The Air Force has equipped the ejection seats of some of their training aircraft with chaff dispensing bags. In the event of crew ejection, chaff will disperse over a wide area and will remain visible in the form of clutter on radarscopes for a period of 30 minutes or so depending on the altitude of ejection.

Controlled jamming is conducted by the military and regulated by the FAA to preclude interference with air traffic control radar. Controllers observing jamming operations, when no

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prior notification has been received, should notify appropriate authority. Figure 13-10 is an example of chaff interference.

Electronic Radar Interference

Interference from other radar installations operating on a similar frequency may be encountered when two or more radar installations are in close proximity. Such interference will appear as shown in figure 13-11. When this interference is encountered, nearby radar installations should be advised to check the frequency calibration of their equipment.

Also, most radar installations have dual channels so that a standby channel is always available. At times, the standby channel will transmit a signal that produces interference as shown in figure 13-12. In most cases, retuning by the technician will decrease the amount of interference.

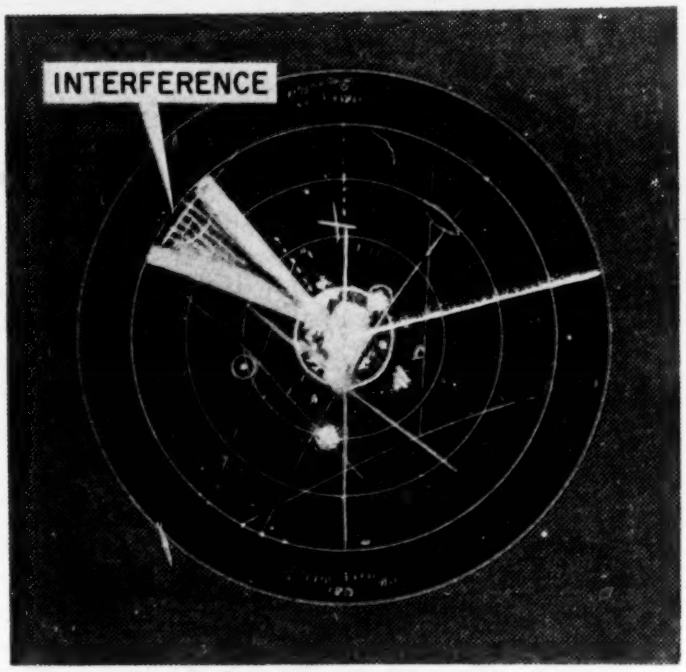

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Figure 13-11.—Interference from another radar set.

SECONDARY SURVEILLANCE RADAR

Secondary surveillance radar is the international term for the air traffic control radar beacon system. This term refers to the form of secondary radar used only in air traffic control, and is not applicable to any other type of secondary radar. Secondary surveillance radar is a

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Figure 13-10.—Chaff interference.

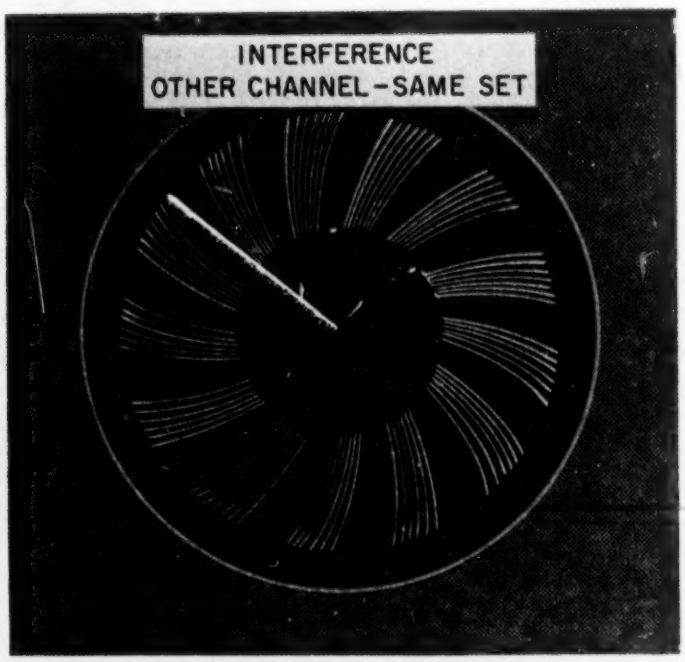

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Figure 13-12.—Interference from the standby channel.

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separate system, and is capable of independent operation; however, in normal air traffic control use it is slaved with surveillance radar. A display of both the primary and secondary radar targets is presented on the associated plan position indicator. The term radar beacon is commonly used in reference to secondary surveillance radar. This term should not be confused with the term RACON which is a contraction for radar responder beacon. The RACON is a ground based navigational aid that emits a signal when activated by appropriate transmissions from an airborne unit. The operation of secondary surveillance radar is the reverse of a RACON.

The term radar beacon as used in this training manual will refer to a secondary surveillance radar system having as component parts a functioning interrogator on the ground, a functioning transponder in an aircraft, and a display on an air traffic control radarscope. When the word radar is used it will refer to a primary radar system. Primary radar differs from secondary surveillance radar in that it displays reflected signals rather than signals which have been transmitted by an airborne transponder.

Secondary surveillance radar effectively counteracts the following shortcomings of primary radar:

1. Aircraft reflection areas vary with size and configuration, thus limiting radar effectiveness.
2. The radar display may be degraded by weather conditions, especially precipitation.
3. Ground clutter frequently impairs the radar display, even though the radar is equipped with MTI.
4. Radar is more vulnerable to blind spots in the antenna coverage pattern.

Aircraft targets, unaided by airborne transponders, are not filtered but are displayed to controllers for all aircraft within the radarscope coverage. This includes those that are above, below, or beyond a particular area of control jurisdiction. Such targets clutter air traffic control displays and make the job of identifying one aircraft from another more difficult. Thus, the performance of essential air traffic control functions may be more complex and time consuming.

Development of Radar Beacons

A beacon system which was the prototype of those in use today was developed early in World War II, due to a need for some method of identifying an aircraft echo as friend or foe. This system used equipment on the ground to transmit an interrogation signal to the aircraft and a receiver/transmitter in the aircraft to transmit a response back to the ground station. The challenge, or interrogation, signal was received by the aircraft receiver and decoded. If the receiver/transmitter in the aircraft was set to respond to the challenge, the transmitter portion of the equipment sent a signal to the ground station. This signal was processed by the ground equipment and presented on a radar indicator. If the response was satisfactory, the aircraft was assumed to be friendly. As an IFF (identification friend or foe) system, the basic Mark X performed satisfactorily in its wartime role and made a valuable contribution to the progressive development of a secondary surveillance radar system.

Some basic Mark X transponders are still in use. However, they are programed to be discontinued, because without a coding capability, they are not compatible with the air traffic control environment. In this environment, radar beacon is used to identify and to provide radar services to individual aircraft rather than for identification of friend or foe.

The basic concepts of the modern radar beacon are essentially the same as those of the wartime IFF system. However, the capabilities of both ground and airborne equipment have been greatly increased. The result is an extremely versatile system which enables the radar controller to make rapid and positive identification of aircraft in nearly all conditions. In addition, it enables him to more effectively manage the display of data on his radarscope. This display management is accomplished through the use of the codes on mode 3/A which permit radar beacon targets to be systematically filtered. Through the use of target filtering, only those targets within a specific area and altitude (or altitudes) will be displayed to the controller concerned.

BASIC RADAR BEACON SYSTEM

The ground equipment of the system is made up of three major components—the I/R unit, the antenna, and the decoder. Included in the I/R unit are the interrogator (transmitter), the receiver, and the pulse pair generator. The major function of the interrogator is to generate distinctive radiofrequency transmissions in accordance

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with the mode in use. The action of the interrogator is similar to that of a primary radar transmitter as both transmit extremely short, powerful bursts, or pulses, of radio energy. In both systems the interval between transmissions is dependent upon the associated pulse repetition frequency (PRF); however, there is an essential difference in the transmission characteristics of the two systems. Radar transmits individual pulses while radar beacon interrogations consist of pulse pairs which are spaced in accordance with the interrogation mode. When a beacon system is used in conjunction with a primary radar, the interval between pulse pairs is related to the pulse repetition frequency of the primary radar equipment.

Simultaneous presentation of beacon and radar information requires that both system displays be correlated in range and azimuth. Range correlation is achieved by transmitting the beacon pulse pair a preset time before the radar pulse, in order to allow for the processing time in the transponder and in the decoder. A corresponding beacon pulse pair is not necessarily transmitted for every radar pulse. Azimuth correlation is accomplished by mounting both the beacon antenna and the primary radar antenna on a common pedestal. Consequently both antennas scan the same area simultaneously.

The receiver section of the I/R unit receives the replies from the transponder and passes them on to the decoder.

The decoder accepts beacon video and beacon trigger signals from the I/R unit. The beacon video signals are processed in the decoder, and then passed to the radar PPI. Beacon video may go either to the radar video mixer or directly to the console, depending upon the primary radar equipment being used. In either case the beacon targets are displayed on the PPI with the primary radar targets. The decoder performs several functions depending on the control setting.

The transponder is the airborne unit of the system. The basic parts of a transponder are a receiver, a signal processing unit, and a transmitter. A transponder is an active device; however, it may be partially quiescent. Before the transmitter portion will reply to an interrogation, specially keyed pulses must have been received and processed. When actuated, or triggered, the transmitter will emit a series of specific reply pulses which are independent of and stronger than echoed radar signals. (See fig. 13-13.)

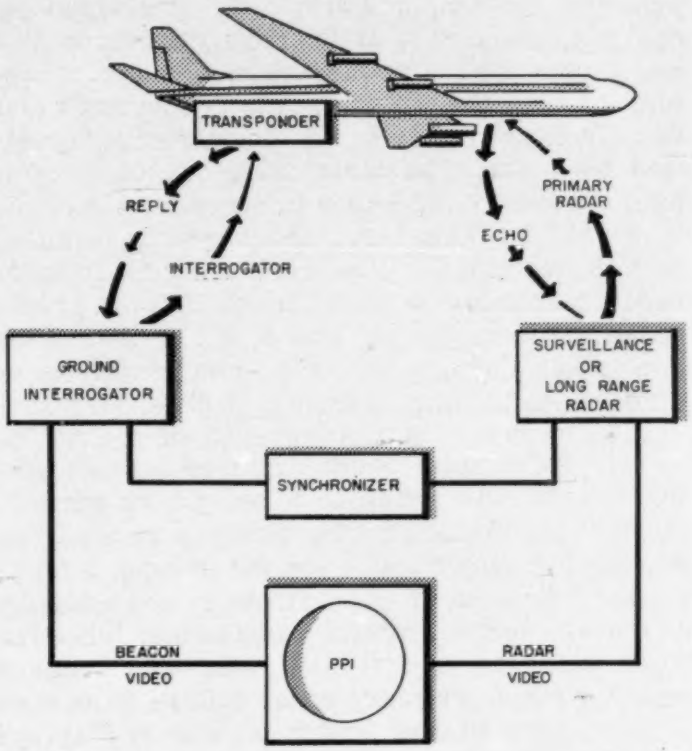

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Figure 13-13.—Primary and secondary surveillance radar systems.

The response differs from an echo in several other respects:

1. The strength of the response is independent of the intensity of the interrogating signal received.
2. Interrogation and reply frequencies are not the same.
3. The response signal is different from the interrogation signal. (May be a coded or uncoded reply. This will be discussed later.)
4. A small delay is inherent between the receipt of an interrogation and the transmission of a reply. For standardization, this delay is adjusted to be 3 microseconds in duration.

FACTORS AFFECTING OPERATION

Both primary and secondary radars are subject to variances, both internal and external, that may adversely affect the operational efficiency of the equipment. A radar controller must know when to expect such things as fades, false targets, and interference. He must be able to cope with these situations when they occur on either the radar or the radar beacon equipment.

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Secondary surveillance radar and primary radar both operate with signals received within the line of sight. A target must be within the line of sight. A target must be within the radiated antenna pattern and be within scope range in order to be displayed on a PPI.

Aircraft attitude will affect the quality of the display, since the transponder antenna is normally located on the underside of the aircraft. If the aircraft is in a turn, the wings or fuselage may block the pulse pairs transmitted by the interrogator, and the transponder may not be activated.

Buildings or other obstructing surfaces, usually within 2 miles of the beacon antenna site, will sometimes reflect either the interrogation or the reply. Reflections will cause a false target to be displayed at a different azimuth from that of the true target. These reflected targets are sometimes different in appearance from true targets and may be pivoted from the normal display position.

When two or more displayed aircraft with operating transponders are within 3.3 nautical miles of each other on the same general radial from the I/R, the reply signals may garble and the decoder equipment can cause the generation of false targets between the aircraft. Also, it may cause cancellation of parts, or all, of either or both actual returns. False targets or cancellations may occur even though altitude separation exists. Targets that are more than 3.3 miles apart will not be subject to decoder garble. Killer circuits in the decoder equipment will cancel garbled transponder replies.

A beacon target close to the antenna will sometimes be displayed as a concentric circle around the main bang rather than a distinct target on a definite azimuth. This display, called ring-around, is caused by maladjustment of the interrogator sensitivity. This maladjustment will permit the display of transponder replies received from interrogation by the side lobes or reflections of the antenna pattern.

Benefit may be obtained through use of the transponder low-sensitivity feature. With this, operation of a switch on the transponder control panel will reduce the sensitivity level of the receiver unit. Thus only the strongest interrogation signals will be accepted; generally the main lobes from I/R sites within 20 miles of the aircraft. Although most side lobes will be rejected, this feature should be used with discretion due to the greatly reduced effective range of the transponder.

Both primary and secondary radars display slant range. Slant range is the most direct line between the ground antenna and the aircraft. Thus the position of the aircraft, as displayed on a PPI, is only an approximate geographical position.

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM

The standard secondary surveillance radar designed for use by FAA air traffic control facilities is the Air Traffic Control Radar Beacon System (ATCRBS) with 10 channel decoders. This equipment is not a modification or adaptation of existing or surplus systems. It has been designed specifically for use in air traffic control and is versatile enough to handle present needs of both the domestic and international beacon program, as well as anticipated future expansion.

Functions of the air traffic control radar beacon are:

1. Reinforcement of radar target.
2. Rapid target identification.
3. Extension of radar coverage area.
4. Transmission of altitude and other data.

If optimum performance is to be obtained, the requirements of U.S. National Standard for Common System Component Characteristics for the IFF Mark X (SIF)/Air Traffic Control Radar Beacon (Secondary Surveillance Radar) Systems, SIF/ATCRBS (SSR), must be met by all civil and military users of air traffic control radar systems under all expected operating conditions. The ATCRBS is in use at FAA facilities and the Mark X (SIF) is in use at military facilities as well as RAPCON's and RATCC's that are jointly operated by the military and the FAA.

The ATCRBS is capable of making interrogations in any four of the six different modes shown in figure 13-14. Mode A has been designated as the civil/military air traffic control mode. Since civil mode A is the same as mode 3 in military equipment, this common air traffic control mode is called mode 3/A. Modes 1 and 2 are military tactical modes; mode B has been designated a civil air traffic control mode but will not be used in the United States; mode C is to be used for automatic altitude transmissions. Mode D has been established but its use has not been specified.

A displayed transponder reply will appear as an arc of one or more concentric circles centered at the I/R site. The RAW VIDEO display appears as separate slashes (arc segments) for each of the framing pulses and information pulses. (See

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MODE	APPLICATION
1	MILITARY (IFF)
2	MILITARY (IFF)
3/A	COMMON (ATC)
B	CIVIL (ATC)
C	CIVIL (ALTITUDE)
D	CIVIL (UNASSIGNED)

AC.201

Figure 13-14.—Interrogation modes.

fig. 13-15.) The series of pulses is called either a code train or pulse train. Identification pulses may be presented, and will be different depending on the transponder type. Complete code trains are displayed only if the decoder switch is set to

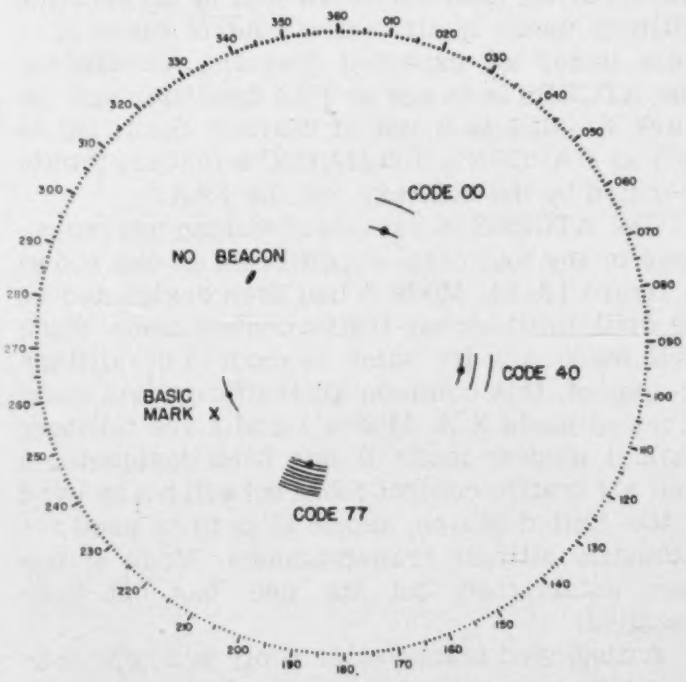

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Figure 13-15.—Examples of raw video displays, mode 3/A.

RAW VIDEO (CODE on UPA-24). This allows the reply signals to proceed directly from the I/R to the scope without decoding action.

In order to eliminate the clutter of numerous code trains, the radar controller can select discrete displays which are abbreviated and different from a raw video display. With the decoder set to display selected common system replies, the controller observes beacon targets as a maximum of two slashes. As a result it is easier to monitor beacon targets under conditions of heavy beacon traffic. Normally the slash of the beacon target display that is closest to the I/R site (main bang) is centered on the primary radar target.

MILITARY SECONDARY SURVEILLANCE RADAR

Standard Air Force secondary surveillance radar equipment is the Mark X selective identification feature (SIF). SIF equipment was designed for use by USAF facilities, but it is also used in RAPCON's which are jointly operated by the FAA and the Air Force. Secondary surveillance radar equipment used by the Navy is similar but different in capability as well as operation. The UPA-24 is the standard decoder at Navy facilities and jointly staffed RATCC's.

The abbreviation SIF is commonly used in referring to both the decoder and the transponder. SIF equipment is the basic Mark X IFF beacon that has been modified to make the transponder capable of transmitting coded replies, and the decoder capable of presenting displays of the decoded replies on a PPI. These decoders are capable of single channel selection only.

UPA-24 Decoder

Radar controllers at RATCC's are presently using radar beacon equipment with the decoder group UPA-24. This equipment, when interconnected with primary radar, provides interpretation of coded IFF signals. The UPA-24 accomplishes this by selecting a coded video pulse train in one of three modes. The coded pulse train is presented to the decoder circuitry and, if correctly coded, an indication in the form of a single decoded pulse is available for presentation on a radarscope. If the pulse train is not correctly coded, a decode pulse is not available for presentation.

The UPA-24 permits the presentation of the coded raw or decoded identification signal alone,

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the radar signal alone, or the radar signal mixed with either the coded raw or decoded identification signals. When used in conjunction with primary radar, the equipment provides decoding of IFF coded pulse trains in modes 1, 2, and 3. Thirty-two coded trains are available in mode 1; sixty-four coded trains are available in each of modes 2 and 3.

Most U.S. Navy radar beacon equipment, in its present form, is not compatible with the FAA ATCRBS in that it is not capable of providing all of the necessary features for the ATC common system. The equipment can only display one discrete code at a time—all other codes are not displayed. To display returns of all aircraft, it is necessary to utilize raw beacon video which clutters the radarscope and negates discrete decoding.

Figure 13-16 is a diagram of the Radar Set Control (Decoder) C-1008/UPA-24 operational controls and functions. Refer to figure 13-16 for a description of the operational controls and functions of the UPA-24 decoder in the following correspondingly numbered paragraphs.

1. Left-Hand Mode 1 Code-Selector Switch. This is a rotary switch having eight positions and is used to determine the desired first digit of a code pulse train for use in decoding mode 1 responses.

2. Right-Hand Mode 1 Code-Selector Switch. This is a rotary switch having four positions and is used in conjunction with the left-hand mode 1 code-selector switch, to determine the desired second digit of a pulse code for decoding mode 1 responses.

3. Left-Hand Mode 2 Code-Selector Switch. This is a rotary switch having eight positions and is used to determine the first digit of the desired codes for decoding mode 2 responses.

4. Right-Hand Mode 2 Code-Selector Switch. This is an eight-position rotary switch and is used in conjunction with left-hand mode 2 code selector switch, to determine the desired second digit of the codes for decoding mode 2 responses.

5. Left-Hand Mode 3 Code-Selector Switch. This is an eight-position rotary switch and is used to determine the desired first digit of the codes for decoding mode 3 responses.

6. Right-Hand Mode 3 Code-Selector Switch. This is an eight-position rotary switch and is used in conjunction with the left-hand mode 3 code-selector switch to determine the desired second digit of the codes for decoding mode 3 responses.

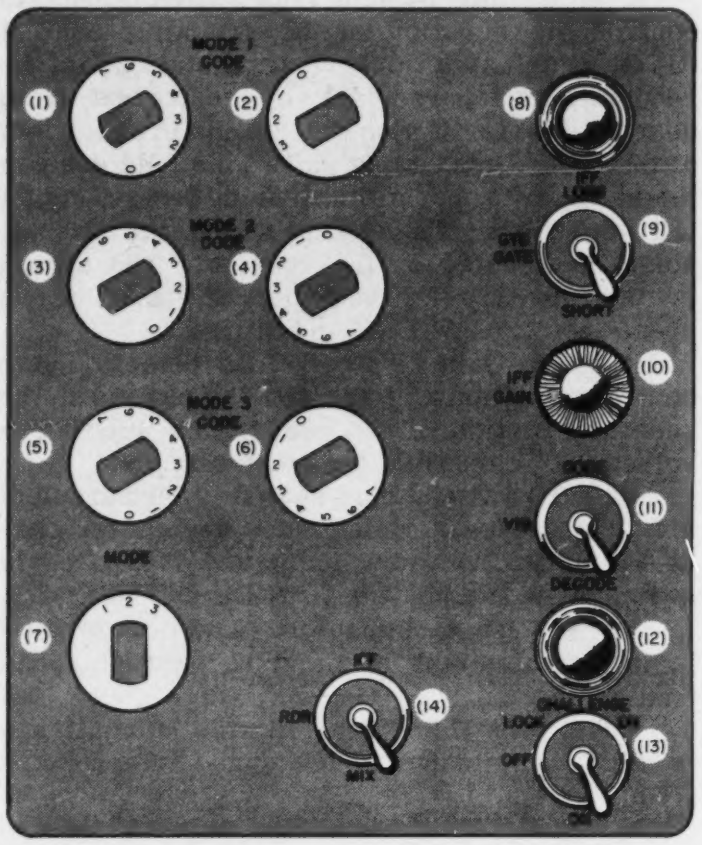

1. Left-hand mode 1 code-selector switch.
2. Right-hand mode 1 code-selector switch.
3. Left-hand mode 2 code-selector switch.
4. Right-hand mode 2 code-selector switch.
5. Left-hand mode 3 code-selector switch.
6. Right-hand mode 3 code-selector switch.
7. Mode selector switch.
8. IFF indicator.
9. GTC gate switch.
10. IFF gain control.
11. VID switch.
12. Challenge indicator.
13. Challenge switch.
14. IFF-RDR-MIX switch.

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Figure 13-16.—UPA-24 decoder.

7. Mode Selector Switch. This switch is used to select one of three modes of coded pulse trains (modes 1, 2, and 3). It should be noted that this equipment is not designed for mode interlace.

8. IFF Indicator. Lighting of this lamp indicates that the radar recognition set is energized and power is on.

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9. GTC Gate Switch. This switch is used to control the duration of the gain time control (GTC), which aids in preventing saturation of the recognition set receiver by responses from nearby targets. It also selects the preset width of the receiver enabling gate. This gate enables the receiver to operate only during desired actual IFF operation, thereby reducing the overall noise contributed by the receiver. The switch is a toggle type for selection of either of two preset positions, LONG and SHORT.

10. IFF Gain Control. This potentiometer controls the gain of the IFF amplifier of the receiver portion of the recognition set. It revolves 270° clockwise for maximum gain.

11. VID Switch. This switch is used to select either coded or decoded video signals for presentation on the radar indicator. It is a toggle switch with two positions, CODE and DECODE.

12. Challenge Indicator. Lighting of this lamp indicates that the radar recognition set is challenging.

NOTE: The U.S. Navy definition of challenge is the transmission of the coded interrogator (IFF) signals.

13. Challenge Switch. This switch is used to select momentary or continuous interrogation of the recognition set. It is a three-position toggle switch with a momentary ON position; the other positions are LOCK-ON and OFF.

14. IFF-RDR-MIX Switch. This switch is used to select the IFF signals alone, radar signals alone or mixed radar and IFF signals. It is a toggle switch with three positions, IFF, RDR, and MIX.

Table 13-1 shows the various possible combinations of switch selection and the resulting display on a radarscope.

FUTURE USE OF ATCRBS

The general concept for the use of both identification and altitude codes is to provide the controller with a means of selectively limiting aircraft position, identify and altitude data displayed on his scope to that which pertains to aircraft under his control. It also provides an automatic display of the position and altitude of aircraft operating within a controller's airspace area of interest which are not operating on approved flight plans. Provisions will be made for the selective display of such data continuously, or at long or short intervals.

The DOD presently has a program of vast scope, designed to improve military IFF equipments. This program involves participation in the FAA plans for improving the ATC system during peacetime use of the national airspace. Identified by the acronym AIMS, derived from the title ATCRBS IFF Mark XII Identification Systems, the program calls for coordinated management by the Navy, Air Force, and Army.

Basically, the program will provide the following specific capabilities:

1. An increase to 4,096 from 64 codes on Mode 3/A.

2. Implementation of Mode C which will provide automatic altitude reporting in 500- or 100-foot increments.

3. An improved military IFF system.

Besides implementing the specific capabilities, the AIMS program has a significant objective of standardization so that overall operational requirements of FAA's national standards are met.

The equipment designed for the ground environment is the Direct Altitude and Identity Readout (DAIR) system. The basic function of the equipment is to provide digitally derived synthetic display markers for the readout of beacon-furnished target information.

The synthetic target markers will be of several types, depending upon the nature of the reply codes and selections made at the display control boxes. Numerical readout of identity reply codes and/or pressure-corrected altitude information will be presented in close-association with the target markers. Special markers and alarms for emergency and communication failure replies will be presented, and discrete markers will be generated for code-selected targets and for aircraft flying within a selected altitude zone.

In the generation and presentation of synthetic markers and numerical tags for beacon information, the system capability for display of primary radar information will be preserved. A backup presentation will also be provided wherein beacon decode signals are displayed, as is presently done with secondary surveillance radar.

Figure 13-17 is an example of the various displays that may be available with the DAIR equipment.

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Table 13-1.—Mark X (SIF) Transponder—UPA-24 decoder displays.

Code VID Decoder	IFF RDR-MIX-	Mode	Display
Code	IFF	3	One slash for each pulse in the code trains; two successive code trains for I/P (IDENT); four successive code trains for EMERGENCY. Only beacon targets will be displayed.
Code	RDR	3	Only primary radar targets will be dsiplayed.
Code	MIX	3	One slash for each pulse in the code train; two successive code trains for I/P; four successive code trains for EMERGENCY. Both beacon targets and primary radar targets will be dsiplayed.
Decode	IFF	3	One slash if transponder code has been selected on decoder. Only beacon targets will be displayed.
Decode	RDR	3	Only primary radar targets will be displayed.
Decode	MIX	3	One slash if transponder code has been selected on decoder. Both beacon targets and primary radar targets will be displayed.
ANY POSITION	ANY POSITION	2 or 1	Display will be same as for mode 3.

NOTE: Code 7700, I/P, and EMERGENCY will be characteristic display only when CODE-DECODE switch is in CODE (same as RAW VIDEO) position.

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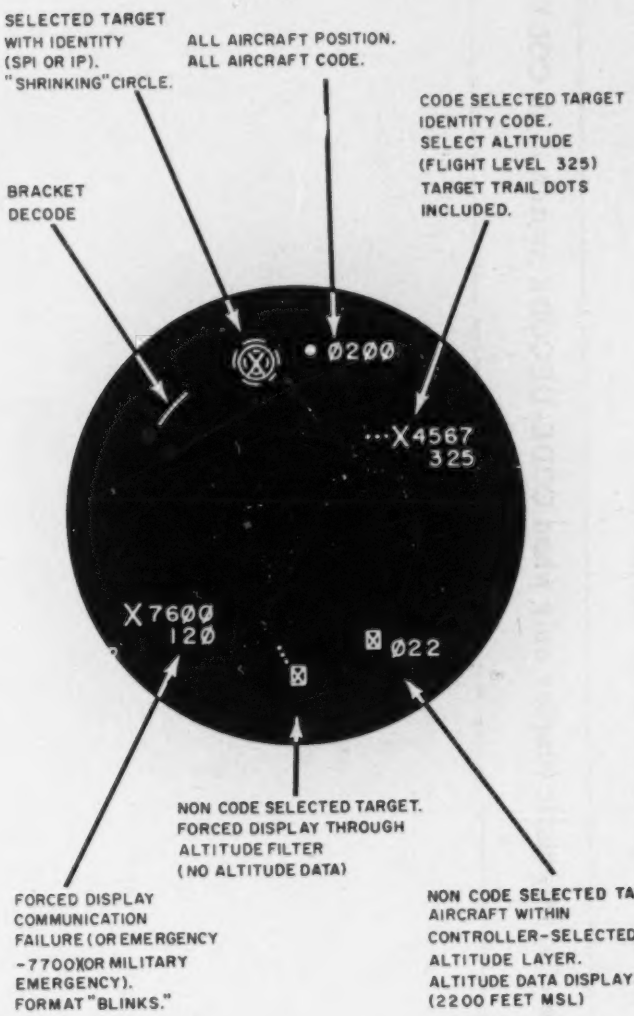

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Figure 13-17.—DAIR display legend.

TYPES OF ATC RADAR EQUIPMENT

Ever since naval aircraft operations began, the Navy has actively sought to develop reliability in all-weather landing systems both ashore and afloat. Research and development of such systems is a continuous process taking advantage of new equipment and ideas as they are introduced. Now, because of precision radar, high speed data processing, and microcircuit electronics, new equipment is being introduced at a fairly fast pace.

In this section, an attempt is made to briefly describe radar equipment in general use, leaning toward newer equipment. It is not intended to be all-inclusive or a substitute for familiarity with the equipment in use at your facility; neither is it a substitute for study of the operator's section of the applicable technical manual.

GROUND CONTROLLED APPROACH EQUIPMENT

Ground controlled approach (GCA) is a radar system providing air navigation to an aircraft. Through the use of air surveillance radar, precision approach radar, and radio communications, a ground operator assists a pilot in his approach during weather conditions of low visibility and ceilings. No special airborne electronic components are required. Thus, a two-way functioning radio is all that is necessary in the aircraft.

The GCA unit consists of a surveillance radar system and a precision approach radar system (PAR) for controlling the initial and final approach portion of an approach. The surveillance radar is displayed on a PPI scope. The PAR is displayed on an AZ-EL scope providing the controller with a precision radar picture of azimuth and elevation coverage in the final approach area. (See fig. 13-18.)

Figure 13-19 shows the AN/CPN-4 GCA unit. This unit is a self-contained, mobile radar unit designed for controlling and landing of aircraft during periods of reduced ceiling and visibility.

GCA QUADRADAR AN/FPN-36

The FPN-36 is actually four radar sets in one. The operator sits before the single 12-inch scope and with a selector switch, displays the desired radar function—surveillance, precision, height finding, or airport taxi control.

Some of the advantages of this equipment are:

1. Small, light, and easily transportable.
2. Only one operator required.
3. Minimum cost.
4. All four systems on one scope.
5. Multiple runway coverage from one location.
6. Circular polarization.

The two main disadvantages of this equipment are: Only one aircraft can be worked at a time; and without two units, the search and precision system cannot be monitored simultaneously. No IFF/SIF capability is available.

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it is to receive the reflected echoes. Therefore, radar receivers must have the necessary circuitry to provide for automatic tuning—commonly called automatic frequency control (AFC).

Functional Operation

Radar receivers found in aviation equipment use syperheterodyne circuits of the single-conversion type (single-intermediate frequency). Superheterodyne receivers are discussed in detail in chapter 14 of Basic Electronics, and should be studied prior to continuing in this chapter. Although the receiver circuits discussed are primarily broadcast and communication receivers, their basic principles of operation are applicable to radar receivers.

Radar receivers differ from communication receivers in the following respects: (1) most radar receivers must detect received signals of approximately the same amplitude as the random noise generated by resistors, vacuum tubes, and other electronic components in its input stage; (2) radar receivers must be much more sensitive than communication receivers, in which static limits the smallest signal that can be heard; and (3) radar receivers must receive very short pulses of RF power reflected from distant targets. The pulses returned to a radar receiver have widely varying amplitudes and distorted waveshapes. To determine target range accurately, pulse wave fronts must rise very rapidly. To reproduce these rapidly changing signals, the radar receiver band-pass must be very wide.

The block diagram illustrated in figure 15-7 is representative of a typical superheterodyne type radar receiver which is found in most airborne radar sets.

Referring to the block diagram, it should be noted that RF energy from the antenna is fed to the mixer. Crystal mixers are used as the first stage in radar receivers because of their high signal-to-noise ratio. The actual construction and operation of crystal mixers was discussed in chapter 12 of this course.

The local oscillator, a special type high-frequency oscillator called a klystron, couples its output through the waveguide to the mixer. The theory of operation, its adjustments, and tuning procedure will also be discussed later in this chapter. The local-oscillator frequency beats with the transmitter frequency (heterodyne action) and produces the IF (intermediate frequency), which is the frequency resulting as the difference between the local-oscillator and the transmitter frequencies. This difference frequency may range from 30 to 100 mc, but in most receivers the IF is either 30 or 60 mc.

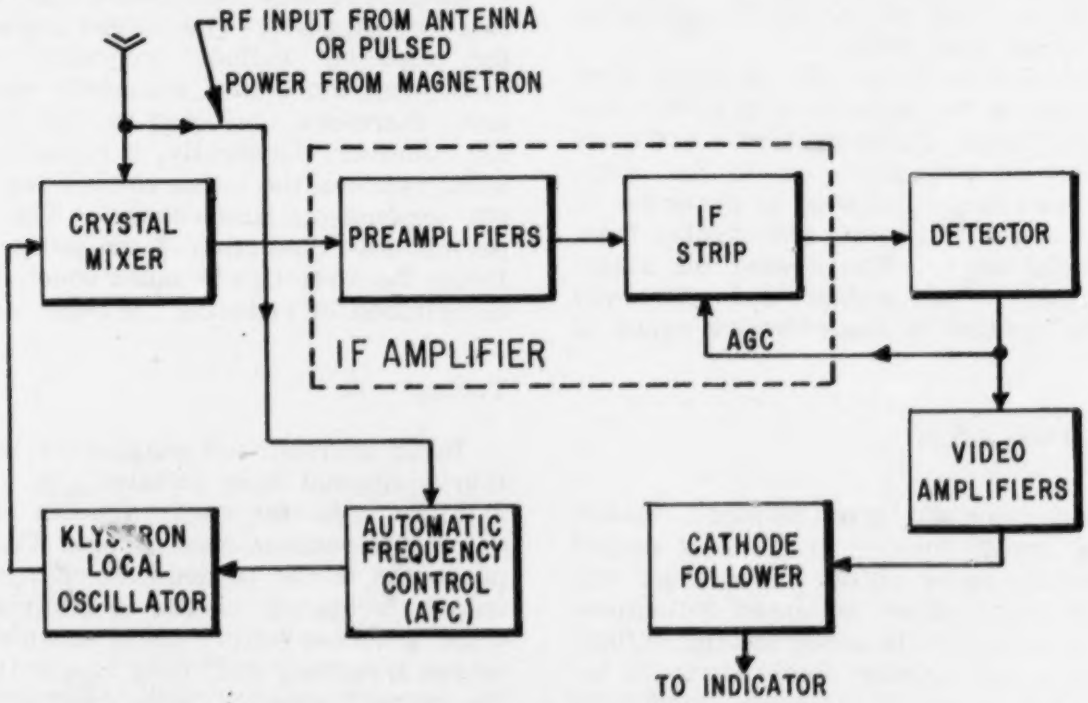

Figure 15-7. —Block diagram of a radar receiver.

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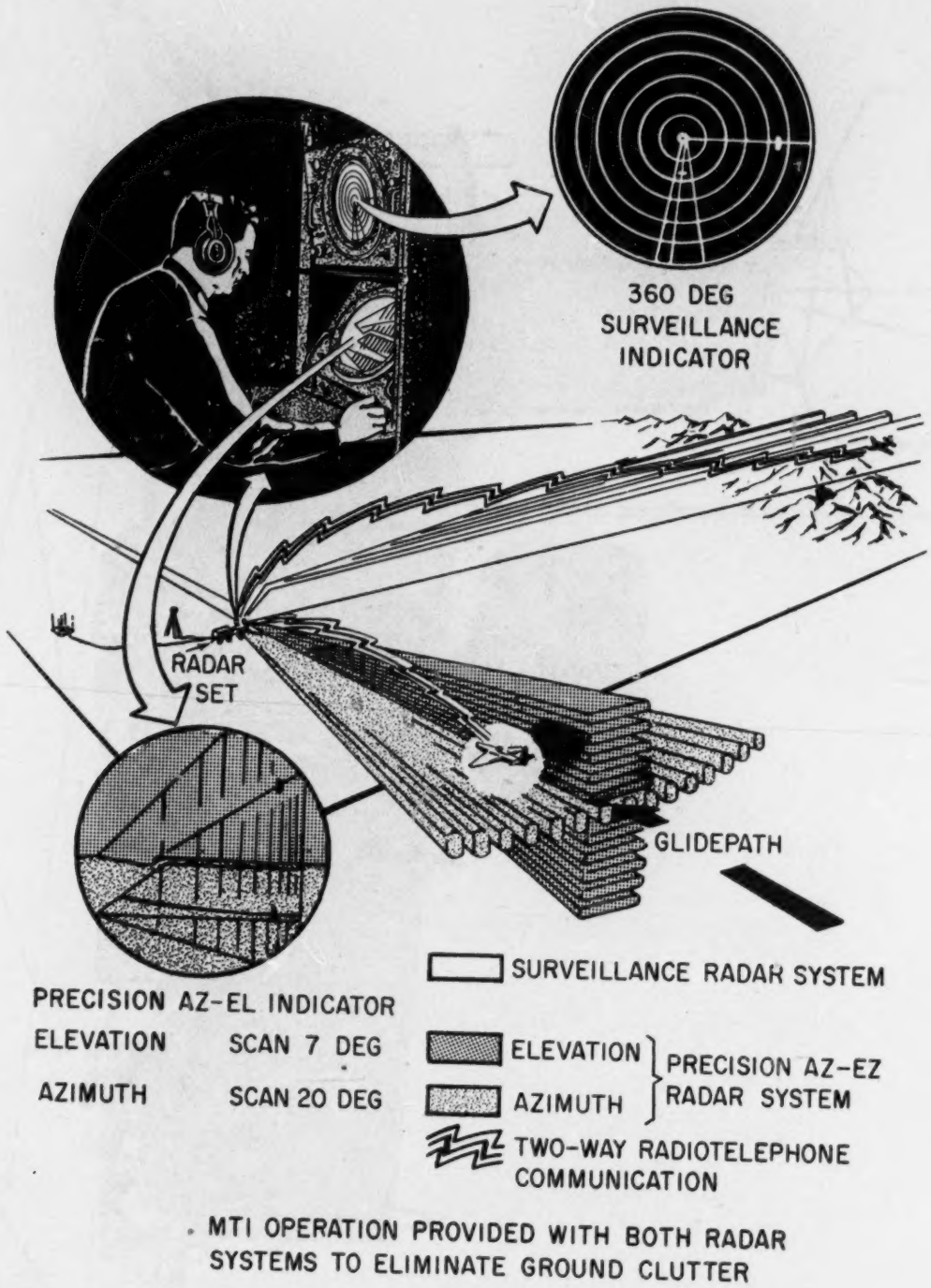

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Figure 13-18.—Functions of a GCA unit.

AN/FPS-8 RADAR

The AN/FPS-8 radar is a medium range surveillance radar used in most RATCC's. It has a range of approximately 200 miles for both primary and secondary (SIF) radars, and an altitude range of 40,000 to 50,000 feet.

AN/FPN-28 RADAR

This radar system is the short range search and precision approach radar remotely operated from the RATCC building. The search has a range of 30 to 50 miles and an SIF range of 200 miles where SIF equipment is installed. The

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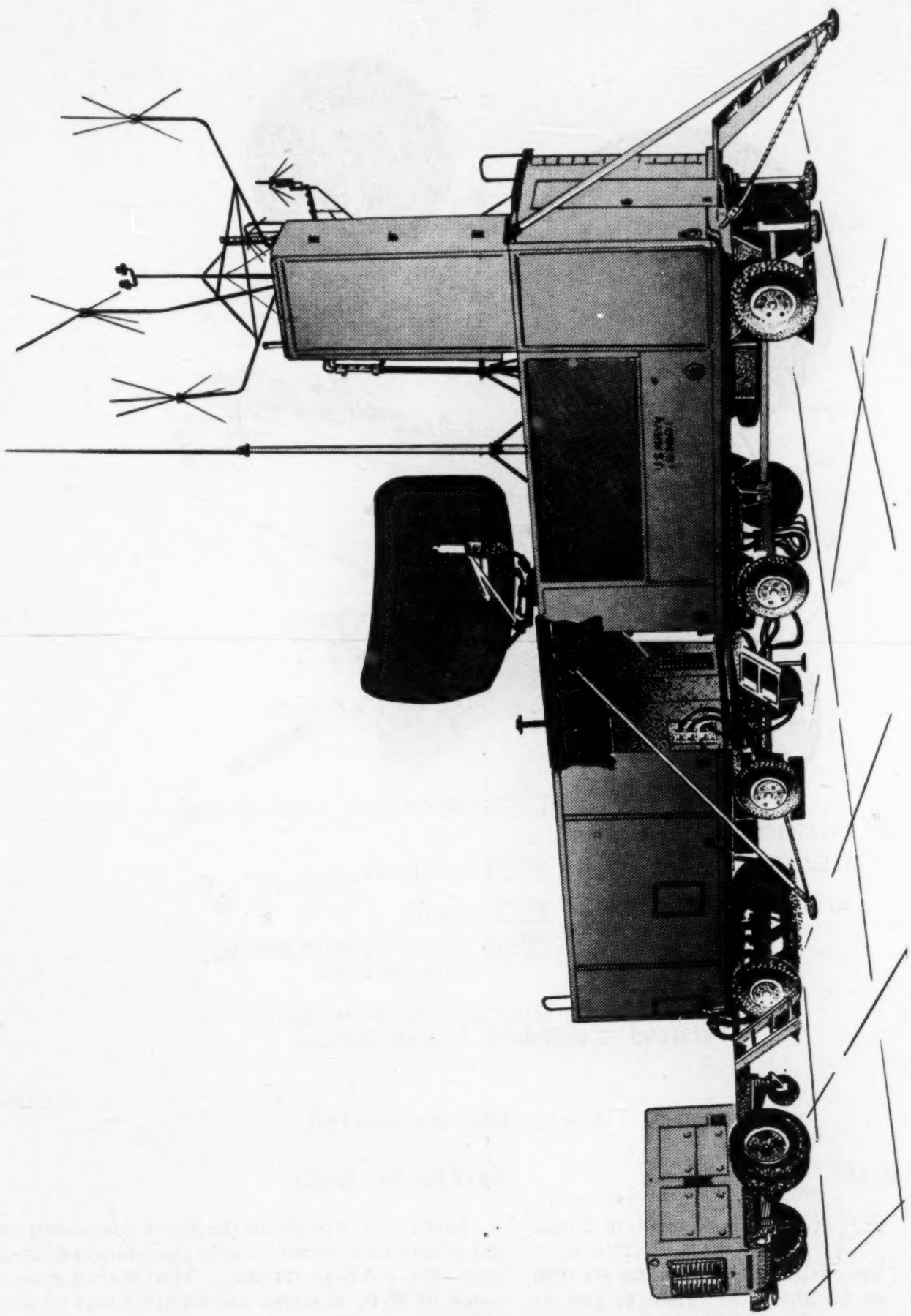

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Figure 13-19.—AN/CPN-4 GCA unit.

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precision radar has a range of approximately 10 miles in the final approach area.

AN/FPN-47 RADAR

The AN/FPN-47 is the standard surveillance radar system in general use by the FAA, Air Force, and Navy in airport surveillance as part of the air traffic control system. This system is replacing or has replaced the FPS-8 radar and the search portion of the FPN-28 radar at Navy ATC facilities.

This system has a maximum radar video range of 60 miles and a maximum SIF/beacon range of 200 miles. The SIF/beacon video can be displayed in conjunction with the normal and MTI video on all sweep ranges except the 200-mile range. With the 200-mile range selected, radar and SIF/beacon video are displayed simultaneously for the first 60 miles of the sweep, and SIF/beacon video only is displayed from 60 to 200 miles. Six fixed ranges of 6, 10, 20, 40, 60, or 200 miles may be selected by the operator, and two variable sweep ranges are available for selection from 6 to 60 miles. The 6- and 10-mile ranges provide range marks at 2-mile intervals; the 20-, 40-mile, and first variable range at 5-mile intervals; the 60-mile and second variable range at 10-mile intervals; and the 200-mile range at 25-mile intervals. The altitude range of the FPN-47 is from 0 to 10,000 feet MSL.

An electronic cursor and range strobe is also provided with this equipment. The cursor origin may be selected as centered with the radar sweep or offcentered and manually positioned on any desired target and cursor azimuth alined and range strobe positioned on any other target. Then the target range and bearing can be read from indicators on the front panel of the PPI console. This provides accurate range and bearing of targets from the antenna site (centered) or relative range and bearing between two targets (off-centered).

The surveillance position illustrated later in this chapter, under the heading Radar Air Traffic Control Centers, shows the PPI console used in the FPN-47 radar system. For detailed information on the capabilities and operating controls used by operators, refer to the appropriate technical manual for this equipment.

AN/FPN-52 RADAR

The AN/FPN-52 is the standard precision radar system in general use by the FAA, Air Force, and Navy. This precision radar system is replacing or has replaced the precision portion of the FPN-28 radar at Navy ATC facilities.

The function of the FPN-52 is the same as that shown in figure 13-18 for the precision portion of a GCA unit. In order to track both the course and the glidepath of aircraft on approach, the antenna system of this radar scans or "looks" in both the vertical and horizontal planes. The two scans (elevation and azimuth) are shown on the map face of an AZ-EL scope as shown in figure 13-18.

The coverage of the FPN-52 is 7 degrees in elevation and 20 degrees in azimuth in the final approach area with a range of at least 8 miles. Normal and MTI video, range marks at 1-mile intervals, cursors (centerline and glidepath), and servo data information are displayed on the AZ-EL scope. A logarithmic time base sweep is used on the AZ-EL indicator to give greater emphasis to more critical, close-in targets. Thus the glidepath cursor appears slightly curved on the scope although it represents a straight line in space. The first few range marks are comparatively far apart and the more distant ones are comparatively close to each other. An aircraft will appear to pick up speed on its approach as its range decreases. An approaching aircraft may be tracked by means of the antenna servo. Antenna servocontrol is used to move the azimuth antenna up or down and/or the elevation antenna right or left. This allows the controller to center the radar beam on the aircraft even though it may be considerably off the desired course or glidepath.

The precision position illustrated later in this chapter shows the AZ-EL scope used with the FPN-52 radar system. For more details on the capabilities and operating controls used by operators, refer to the appropriate technical manual for this equipment.

ALL-WEATHER CARRIER LANDING SYSTEM (AWCLS)

The AWCLS is a combination of several systems developed independently, each of which performs a significant function in the complexity of automatic landings. The AWCLS consists of precision tracking radar coupled to a computer data link to provide continuous information to the aircraft, and independent beam scanning transmitters which provide the pilot with a monitoring capability and a backup approach system.

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AN/SPN-10 RADAR

The AN/SPN-10 was the first radar system developed to provide the carrier landing capability described in the preceding paragraph. Since its development, system reliability has continuously improved through testing and newly acquired technology. The latest improvement concerns the conversion of the AN/SPN-10 to a digital system using solid state radar. This converted system has been designated the AN/SPN-42.

AN/SPN-42 RADAR

In addition to precision tracking radar, the AN/SPN-42 consists of the necessary electronic equipment to provide a completely automatic landing capability. When an aircraft is approaching a carrier, the precision tracking radar monitors the aircraft's progress and feeds position information to a computer. There the aircraft's position is measured in relation to a preselected approach path. The computer determines what corrections are necessary to maneuver the aircraft to the desired path and transmits this information to the aircraft by radio. Equipment in the aircraft feeds the commands through an autopilot to the aircraft's control surfaces and throttle and the aircraft reacts accordingly. (See fig. 13-20.) This same information, in addition to intelligence concerning the distance from the ship to the aircraft, is also fed to the CCA operator's console. An example of the operator's console is shown in figure 13-21. The information may also be presented on an ILS type instrument display for the pilot as a visual presentation of error information and corrections to be made. Thus, three modes of operation are available for landing approaches—(1) fully automatic, (2) manual approach similar to a conventional ILS type approach, and (3) conventional CCA approach in which the aircraft is talked down by the controller.

AN/SPN-41 SYSTEM

The need for the pilot to monitor his progress during a fully automatic approach was recognized early in the development of AWCLS. To provide the pilot with this capability, the AN/SPN-41 was developed. This is a completely independent guidance system which, in addition to providing a means for monitoring, affords the pilot another method of making an instrument approach to the ship. In this system, shipboard transmitters scan coded microwave signals alined on the desired approach path. On the aircraft's instrument panel, the information from this system is displayed on an ILS type instrument. This is illustrated in figure 13-22. The AN/SPN-41 provides guidance information in excess of 20 miles. This type approach requires the pilot to transfer to a visual landing aid, such as the Fresnel lens system, prior to touchdown as would mode two or three approaches using the AN/SPN-42.

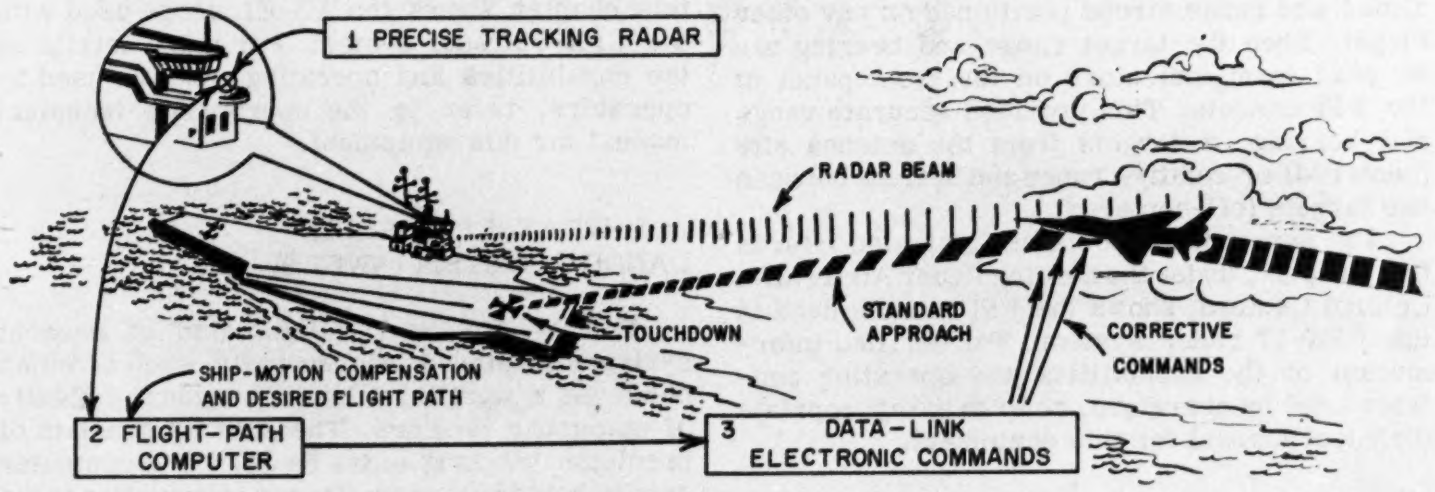

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Figure 13-20.—AWCLS method of operation.

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When both the AN/SPN-41 and AN/SPN-42 are installed in aircraft and ships, the SPN-41 will serve as a feeder and monitor system for the AWCLS. The SPN-41 furnishes the pilot with information on the same ILS type instrument as does the SPN-42 for a mode 2 operation. Since modes 1 and 2 may be lost or the data link system could possibly fail in the SPN-42 system, the SPN-41 provides backup for continuation of a mode 2 type approach should an equipment failure occur while an aircraft is on an approach.

Of course, the ever-present CCA controller monitors the entire system on the operator's console and is always there to transition to a mode 3 or conventional talkdown approach when necessary or desired.

RADAR AIR TRAFFIC CONTROL CENTERS (RATCC)

Established by the Navy at many major Fleet Support air stations and All-Weather air stations to meet the trend of increased aircraft performance and increased air traffic under all types of weather conditions is the Radar Air Traffic Control Center. A RATCC is designed to provide radar service at ranges beyond those of ordinary GCA equipment. With modern, permanently installed radar equipment, these facilities have an increased capacity for handling IFR traffic. As an Air Controlman, you may be ordered to duty at one of these centers, or to a station that coordinates with one.

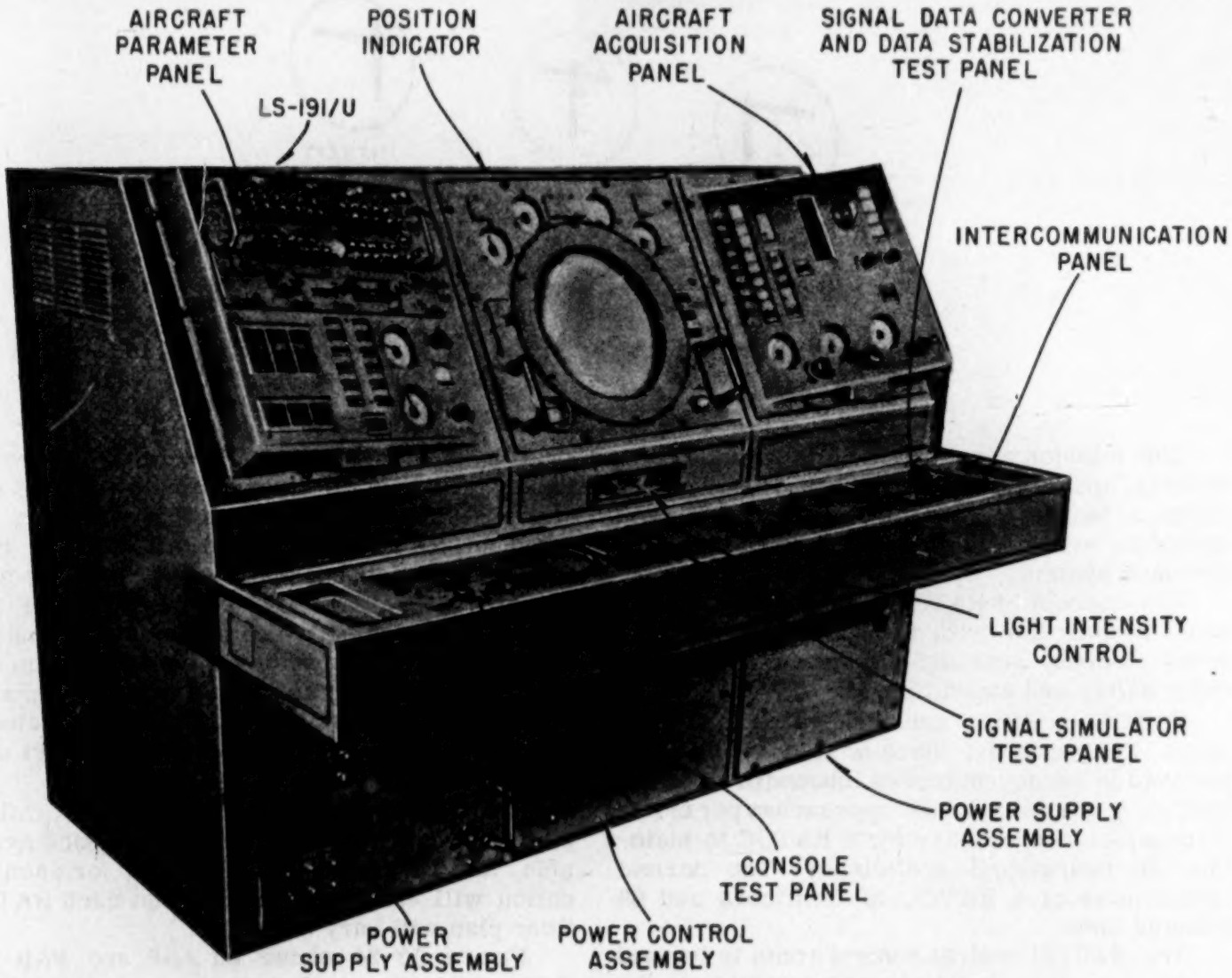

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Figure 13-21.—AWCLS operators console.

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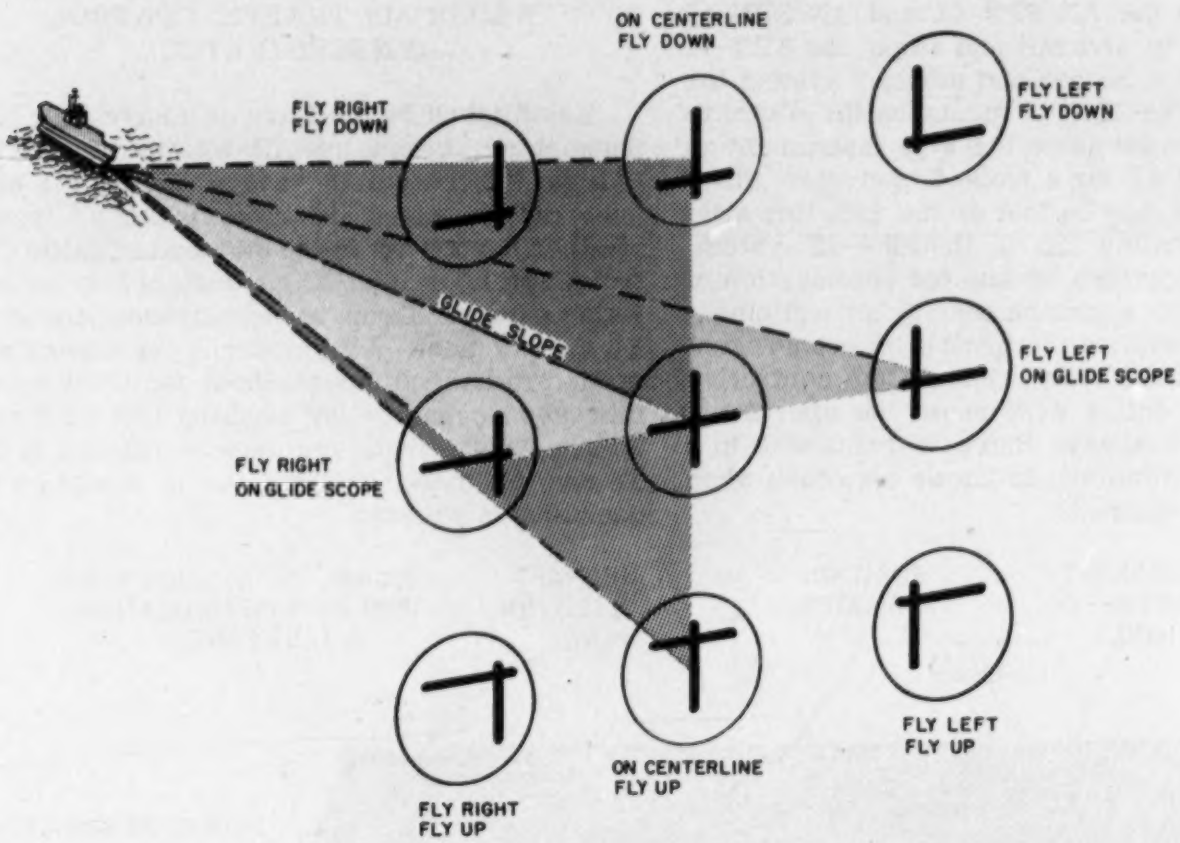

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Figure 13-22.—AN/SPN-41 approach system.

The mission of a RATCC is to provide safe, orderly, and expeditious movement of air traffic within a facility's area of control, to and from operating areas, and into and from the national airspace system.

The concept of RATCC is to provide the approach controller with the added capability of radar, thereby enabling him to control traffic more safely and expeditiously.

RATCC facilities are manned on a 24-hour basis. Consequently, there is seldom any delay involved in taking control of inbound or outbound traffic. A minimum of 800 approaches per month is considered necessary for a RATCC to maintain its operational proficiency. The normal complement of a RATCC is 7 officers and 69 enlisted men.

The RATCC central control room is located in the operations building and accessible to the visual control tower. This room contains remote indicating scopes and control consoles for each of the following radar equipments: Medium Range Air Traffic Control Radar; Short Range Air Traffic Control Radar; Precision Approach Radar; and certain other maintenance and operational controls. Additional equipments located in RATCC are large direct-view type situation display boards for the traffic control radars; VHF/UHF DF equipment; IFF/SIF equipment; a selective communications and intercommunications system; wind direction and velocity indicators; as well as an altimeter setting indicator. At stations that utilize the closed TV circuit for weather briefings, a TV set may also be installed.

Figure 13-23 is a diagram of a RATCC floor plan. Since the control problems, space available, and the equipment allocated for each location will vary, it is natural that each RATCC floor plan will vary as well.

Figure 13-24 shows an ASR and PAR operating position including the communications equipment. The communications equipment may be the AN/FSA-17 or AN/FSA-52 communications console which is discussed in chapter 4 of this rate training manual.

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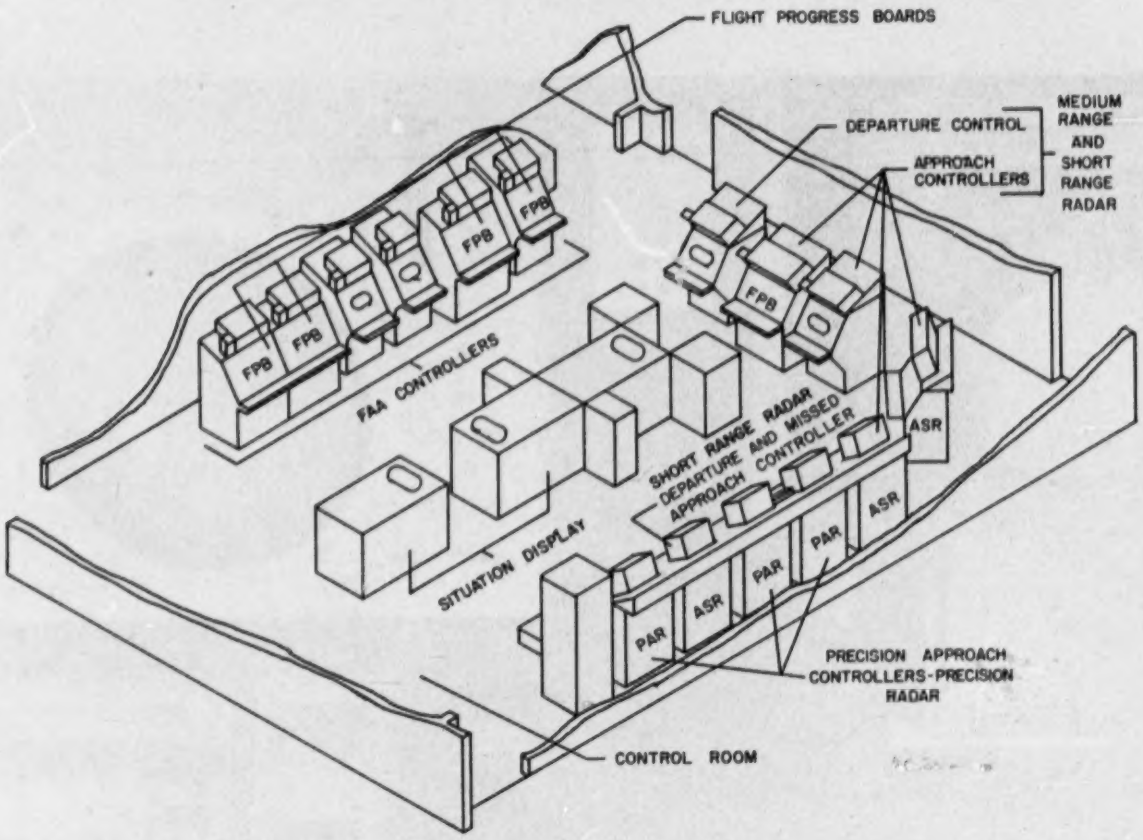

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Figure 13-23.—RATCC floor plan.

INTERRELATIONSHIP OF OPERATING POSITIONS

In order that all phases of the air traffic control function at a RATCC facility be adequately manned by competent controllers at all times, general knowledge of the duties of all operating positions is a must. This policy is strongly recommended in current OpNav Instruction 3721.1 (Series). This cross training of personnel at a RATCC facility creates an extremely flexible air traffic control division. Also, when a controller transfers, he has undoubtedly gained valuable experience that should benefit not only himself but his next duty station as well. The instruction previously mentioned directs commanding officers to make suitable entries in the service record of a man considered properly qualified to control instrument traffic.

Certification and Qualification

Due to the nature of their importance to the Air Controlman, the qualifications and certificates necessary for the enlisted positions at a RATCC are printed verbatim from OpNav Instruction 3721.1 (Series) (enclosure (2)).

APPROACH CONTROLLER.—The Approach Controller will possess a Control Tower Operator's certificate with a senior rating for the appropriate area or an Air Traffic Control Specialist (ATCS) certificate with an area rating. His general duties, in addition to such supplementary duties as may be assigned by the RATCC watch officer, are as follows:

1. Control and coordinate the movement of all instrument traffic in accordance with existing regulations and directives.
2. Issue air traffic clearances and information to all aircraft which are operating under the jurisdiction of the RATCC.
3. Maintain radar surveillance of air traffic, monitor approaches, vector inbound and departing aircraft, and provide radar assistance to aircraft as required.
4. Determine the interval to be used between successive approaches, taking into

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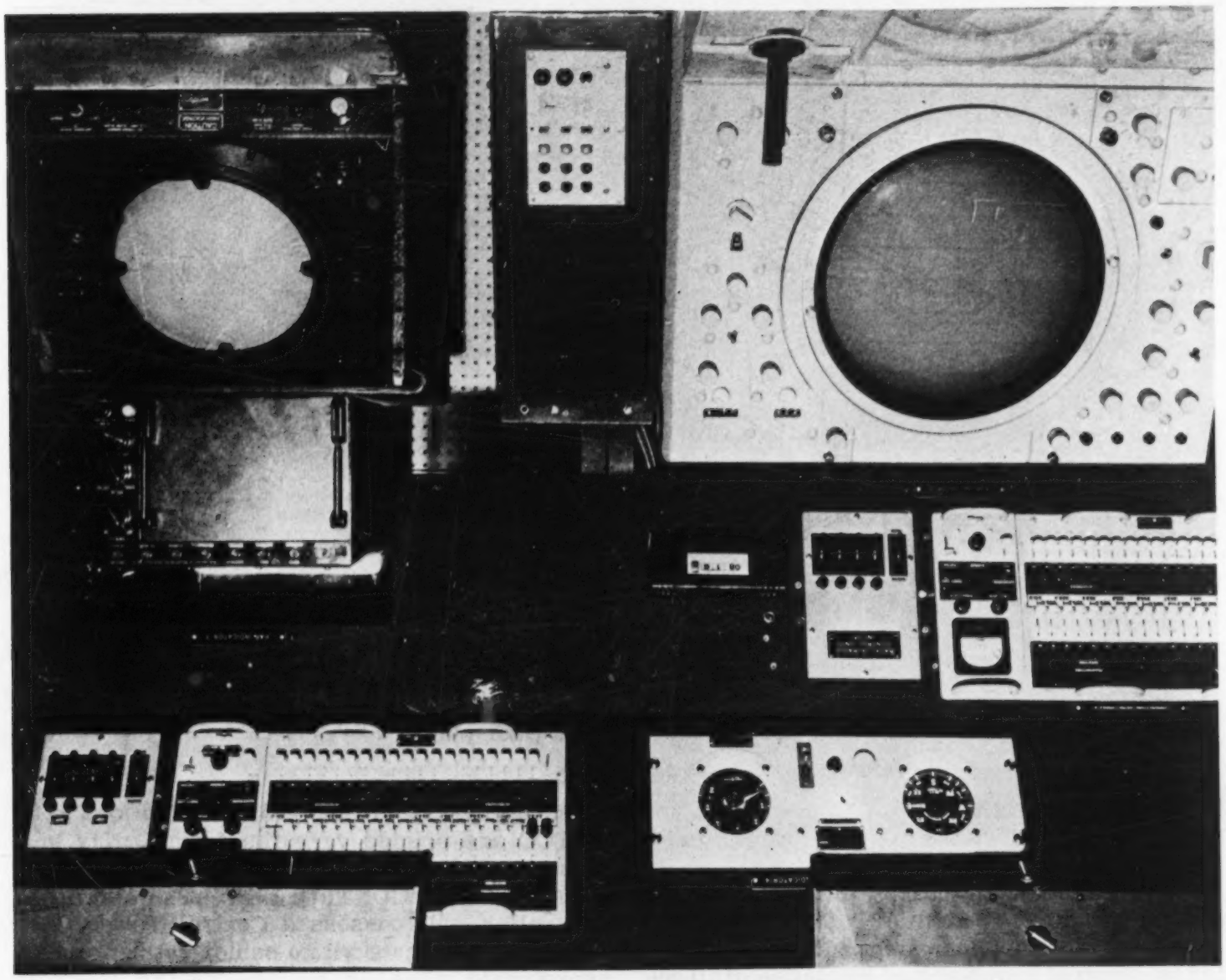

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Figure 13-24.—ASR and PAR operating positions.

consideration all aspects of the air traffic control sideration all aspects of the air traffic control situation at the time, including the following: weather, runway in use, reliability of radar equipment, reliability and sufficiency of communications, types of aircraft under control, runway acceptance rate, and other factors which may affect operations.

5. Provide assistance and priority of services to aircraft in emergency situations.

6. Utilize any or all other operating positions as necessary to assist in the control of air traffic.

ASSISTANT APPROACH CONTROLLERS.—The Assistant Approach Controller will possess a Control Tower Operator's certificate with a senior rating for the appropriate area or an ATCS certificate with an area rating. In order to provide the maximum flexibility of operations, the RATCC officer is authorized to modify the duties of this position as the local situation dictates. His general duties may include the following:

1. Assist the Approach Controller in the control and coordination of the movement of all IFR traffic as directed.

3. Air Operations Supervisor.
4. Section Leader.
5. Radio Operator-Ship/Shore Communications.
6. Land/Launch Recordkeeper.
7. Status Board Keeper.
8. Teletype Operator.
9. Dead Reckoning Tracer (DRT) Operator.
10. Sound-Powered Telephone Talker.

The duties and responsibilities of Air Operations' personnel assigned the operating positions below the section leader level are discussed here.

Radio Operator

The radio operator establishes and maintains radio communications with shore activities on Raspberry, Air Defense Liaison, and intratype frequencies as applicable. He insures that the AIR OPS officer sees all messages received. He also is responsible for the following:

1. Maintains a routine message log and the message boards for the CATCC.
2. Makes sure that all messages are initialed and filed.

Land/Launch Recordkeeper

The person in this position mans the 2JG sound powered aircraft information circuit and uses it to relay information to pilots' readyrooms as a followup to the interior teletype. He also:

1. Maintains the ship's aircraft launch and landing log.
2. Insures the accuracy of aircraft calls, side numbers, and pilot's names on the status boards.

Status Board Keeper

The status board keeper uses a split headset to man both the 2JG circuit and the land/launch frequencies. He also records pertinent information relayed to him on the status board including the fuel state of each aircraft.

Teletype Operator

This operator is in charge of the teletype transmitter for the CATCC. Receiver repeaters are located in pilots' readyrooms to promulgate information to pilots, such as changes in flight schedule, weather, ship's intended movement, etc.

DRT Operator

The operator of the Dead Reckoning Tracer:

1. Knows the location of maps, charts, and publications used in CATCC.
2. Provides bearing and distances of nearest land and airfields to CCA, CIC, Pri-Fly, and status board keeper every half hour, and at other intervals as specified by the Air Operations Officer.
3. Properly operates the DRT and periodically checks the ship's indicated position with the ship's navigator.
4. Makes sure the navigation information on the status board is accurate.
5. Keeps up-to-date information on danger areas, operating areas, firing areas, etc., on the chart in use.
6. Obtains path of intended movement (PIM) information from navigation personnel and check its relation to flight advisory areas and other control areas.

CCA

The contraction CCA as used in this instance is expanded to include all those operating positions involved in the actual radar control of airborne aircraft under the Operations Officer's cognizance except those being controlled by the Combat Information Center (CIC).

In many instances some of these positions may be combined due to personnel shortages. However, an ideal arrangement is as follows:

1. One CCA Officer.
2. One Assistant CCA Officer.
3. One CCA Supervisor (normally a CPO).
4. One Departure Controller.
5. One Departure Status Board Keeper.
6. One Marshal Controller.
7. One Marshal Status Board Keeper.
8. Two Approach Controllers.
9. Two Final Controllers.
10. One CCA Approach Status Board Keeper.
11. Two Sound-Powered Telephone Talkers.

The duties and responsibilities of some personnel below the supervisor level assigned to CCA are discussed in the following paragraphs.

NOTE: For explanation of unfamiliar terms, refer to the list of definitions following this section.

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The IF amplifier consists of a preamplifier and an IF strip. The preamplifier is physically located near the crystal detector to prevent loss or attenuation of the signal before it can be amplified. The input circuit of the first preamplifier stage is tuned to the intermediate frequency, which is the difference between the transmitter and local oscillator frequencies, and bypasses all other unwanted frequencies to ground. (NOTE: It is in this section of the receiver where noise generation must be rigidly controlled.) The preamplifier normally consists of at least two stages of amplification, the first of which may be a cascade type. Its output is fed to the main amplifier which is normally referred to as the IF strip.

The IF strip consists of several stages of double-tuned IF amplifiers. They are double tuned to broaden the band pass of the receiver for better fidelity. The gain of the IF amplifier is normally between 10^6 and 10^{12}, and can be varied by altering either the control grid bias or the screen voltage of one or more stages.

The greatly amplified signal is then fed to the detector, usually a conventional diode detector, where the video signal is removed from the IF carrier. The detector filters used in most airborne radar receivers must be a long RC filter to the IF frequency and a short RC to the video envelope. Thus, the intermediate frequency is shorted to ground and the detected video pulses are passed to the next stage.

The video amplifier receives the detected pulses and amplifies them to the magnitude required to operate the indicator. The input to the video amplifier is in the form of rectangular pulses which are made up of infinite number of odd harmonics. Therefore, the video amplifiers must be designed for a wide band-pass in order to amplify the principal harmonics and preserve the shape of the input waveform.

The output from the video amplifier is fed to the video output cathode follower. The cathode follower is used as an impedance matching device between the video amplifiers and the indicator. It also serves as a power amplifier to drive the indicator. In the case of remotely located indicators, it is also used to match the impedance between the video amplifiers and the interconnecting coaxial cable.

The last block to be discussed in figure 15-7 is the AFC circuit. The AFC circuit is used to automatically adjust the local-oscillator frequency so that the radar receiver is always tuned to the radar transmitter frequency. Remember, the loading of a radar transmitter often changes as the transmitting antenna rotates (scans). The frequency of a microwave oscillator is very sensitive to changes in load impedance. Thus, as the transmitting antenna of a microwave radar is rotated, the transmitter frequency changes. If the local oscillator frequency does not also shift, these frequency changes may be so great that the received signal is outside of the receiver band-pass. In these cases AFC is used to automatically track the radar receiver tuning with the transmitter frequency.

Although many different types of automatic frequency control circuits are used in microwave radars, all AFC systems are basically similar in operation. Practically every AFC system has circuits that produce an output voltage proportional to the change in transmitter frequency. This output voltage changes the local-oscillator output frequency in such a way that the radar receiver remains tuned to the transmitter frequency.

INDICATORS

The purpose of the indicator and its associated components is to display target information supplied by the receiver and antenna system. The indicator may be a relatively simple device such as an indicating light that goes ON and OFF when specific conditions exist, a small meter, or an elaborate assembly containing a cathode-ray tube (CRT). However, in any case the complexity of the indicating system will vary with the amount of information to be displayed to the operator.

In most cases the technician will be working with the CRT type of indicator. This type indicator is the only one discussed in this chapter. CRT indicators may also vary in degree of complexity and may be used to display numerous data simultaneously to the operator. Some of the data presented to the operator are as follows:

1. Target range.
2. Range rate.
3. Target position.
4. Artificial horizon.
5. Steering references.
6. Altitude.

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Departure Controller

Primary responsibility for adherence to the assigned departure rests with the pilot; however, advisory control is normally exercised, with a shift to close control as required by weather conditions, upon request, or when the assigned departure is not being adhered to. In addition, the departure controller is responsible for the following:

1. Insure that communications and positive track are established with all aircraft to the extent possible under existing electronic emission control (EMCON) conditions.
2. Request navaid checks as necessary.
3. Maintain advisory control of departing point-to-point flights until pilots shift to en route frequencies, and of other aircraft until control is accepted by CIC or another controlling agency.
4. Before releasing aircraft to another controlling agency, give each pilot (flight leader) any pertinent information such as changes in composition of flight, changes in PIM, or in mission.
5. When transferring control to CIC, give CIC the range and bearing of the aircraft being transferred, and insure that CIC acknowledges assumption of control.

Departure Status Board Keeper

The Departure Status Board Keeper maintains the appropriate status board for the Departure Controller.

Marshal Controller

Upon entering the carrier control area, inbound flights are normally turned over to the marshal controller for further clearance to the marshal pattern. The marshal controller must provide the inbound flight with the following:

1. Marshal instructions.
2. Steer to marshal (if required).
3. Type of recovery.
4. Ramp time
5. Altimeter setting and weather.
6. Expected final bearing.

The marshal controller must also insure that the following information has been provided each aircraft prior to commencing approach:

1. Expected approach time.
2. Final control frequency.
3. Type of approach.
4. Final bearing.
5. Time check.
6. Other pertinent data such as changes in weather conditions, altimeter setting, etc.

To reduce frequency congestion, items of general interest may be transmitted to blocks of aircraft rather than make repetitious broadcasts to individual aircraft.

Approach Controller

The Approach Controller assumes control of the inbound aircraft from the Marshal Controller. Circuit discipline is essential because two controllers and several aircraft are on each frequency. Two Approach Controllers are normally used, each with a separate frequency and with a final controller being on the same frequency. Each controller controls a block of four aircraft and passes control of each aircraft to the final controller when the aircraft reaches approximately 6 miles inbound (4 miles when using SPN-42). This procedure will vary when the radar equipment used provides a complete PAR approach, i.e., glidepath as well as azimuth, such as the SPN-42. In such cases the approach controllers (and final controllers) accept control of individual aircraft alternately.

In addition, the Approach Controller is responsible for the following:

1. Monitoring the aircrafts letdown and providing assistance as necessary on TACAN approaches.
2. Providing positive radar control during periods of TACAN failure.
3. Maintaining the proper interval between aircraft on all approaches.
4. Controlling the fouled deck holding pattern as necessary to maintain proper separation.
5. Insuring that approach control information on the approach status board is current and correct.

Final Controller

The Final Controller assumes positive control as soon as radar contact is established, normally at 6 miles from the ramp (4 miles on SPN-42). There are normally two Final Controllers, each of whom will be on a frequency with an Approach Controller. Since it is possible that a controller may have as many as four aircraft on final at one time, it is absolutely necessary that transmissions be kept to a minimum.

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Bolter/Waveoff Controller

The type of final approach radar installed will determine control responsibility for the bolter/waveoff pattern (e.g., those aircraft whose previous approaches did not result in an arrested landing).

This operator directs aircraft around the bolter/waveoff pattern to a point astern of the ship, from which another landing attempt can be made.

Close coordination is required with the approach controller to insure that aircraft approaching from the bolter/waveoff pattern are positioned properly with respect to other arriving aircraft.

Approach Status Board Keeper

The Approach Status Baord Keeper monitors the approach and final frequencies utilizing a split headset and insures that the latest information is displayed on the approach status board.

It is mandatory that personnel assigned duty as a status board keeper remember that the CCA officer and supervisor rely on the information displayed on the status boards to maintain the delicate teamwork balance required to make successful efficient approaches. Each operator also relies on the status board for pertinent information required for his respective position. Current and correct status boards provide CCA supervisors with a comprehensive display of the entire recovery, thereby eliminating interruption of operator personnel for progress reports.

Sound-Powered Telephone Talkers

The X1JG Sound-Powered Telephone Talker is assigned to provide for direct communications to Pri-Fly and LSO. The 2JG Sound-Powered Telephone Talker is assigned to receive and transmit general aircraft information to and from other offices concerned, such as CIC.

DEFINITIONS OF CATCC TERMS

Adivsory control. A form of Air Control in which the controlling agency monitors radar and radio contact with aircraft under its control and provides traffic advisories. Traffic separation is the responsibility of the individual pilot, with the assistance provided by the control agency.

Air operations. That section of the Operations Department responsible for coordinating all matters pertaining to air operations including the proper functioning of the CATCC.

Approach control. A control station in CATCC responsible for controlling air traffic from marshal until handoff to Primary Fly or the final controller.

Base recovery course (BRC). The ship's magnetic heading for the recovery of aircraft.

Bingo. An order to an aircraft to proceed immediately to a divert field. Bearing, distance and destination will be provided.

Bolter/waveoff control. A control station in CATCC responsible for all CCA bolter/waveoff traffic. The bolter/waveoff controller will vector assigned traffic under close control until responsibility is assumed by another control station.

Carrier air traffic control center (CATCC). The centralized agency responsible for the status keeping of all carrier air operations, and control of all airborne aircraft under the Operations Officer's cognizance except those being controlled by CIC.

Carrier control area. A circular airspace with a radius (50 miles for CVA's and 25 miles for CVS's) around the ship which extends upward from the surface to unlimited altitude and is under the cognizance of CATCC.

Carrier control zone. The airspace within a circular limit defined by 5 miles horizontal radius from the carrier, extending upward from the surface to and including 2,500 feet unless otherwise designated for special operations. The Air Officer exercises control over aircraft arriving and departing under visual flight rules and has clearance authority over all aircraft entering the zone.

CCA. Carrier controlled approach.

Center. A collective radio call prefixed by a ship's code name which is used in the same manner as the shore based counterpart.

Charlie. Signal for aircraft to land aboard the ship. A number suffix indicates time delay before landing.

Clara. A pilot transmission meaning he does not have the meatball in sight.

Close control. A form of air traffic control in which the controlling agency has radar and radio contact with the aircraft being controlled, and where specific assignments regarding heading and altitude are issued by the controller. While altitude separation is provided by pilots maintaining assigned altitude, lateral and time

separation is the responsibility of the Air Controller. Speed changes may be directed by the Air Controller.

Departure control. A control station in CATCC responsible for the orderly flow of assigned departure traffic.

Expected approach time (EAT). The future time at which an aircraft is cleared to depart inbound or penetrate from a preassigned fix. Aircraft depart and commence approach at assigned time if no further instructions are received.

Final bearing. The magnetic bearing assigned by CATCC for final approach. It is an extension of the landing area centerline.

Final control. A control station in CATCC responsible for controlling traffic in instrument conditions from acquisition until pilot reports "Meatball" or reaches approach minimums.

Inbound bearing. The magnetic heading assigned by CATCC to pilots descending directly to the carrier. It may be, but is not necessarily, the final bearing.

Inbound heading. The magnetic heading assigned by CATCC that will insure interception of the final bearing at a specific distance from the carrier.

Kilo. A pilot report indicating that the flight is ready to proceed on assigned mission.

Marshal. A bearing, distance, and altitude fix designated by CATCC from which pilots will orient holding and from which initial approach will commence.

Marshal control. A control station in CATCC responsible for the orderly flow of inbound traffic.

NOTE: For a detailed study of CATCC procedure, AC's should refer to the latest edition of the CVA/CVS NATOPS MANUAL.

FRESNEL LENS OPTICAL LANDING SYSTEM

The purpose of the lens system is to provide the pilot with a visual indication of his relative position with respect to a prescribed glide slope. This glide slope, as determined by the lens settings, is designed to bring the aircraft down to the deck, within the cross-deck pendant pattern, with a safe arresting hook clearance above the stern ramp of the carrier. Figure 13-25 illustrates the Fresnel lens unit.

A yellow bar of light is displayed over the full width of the lens box. The lens box may be considered a window through which the pilot views the bar of light. The bar of light appears as though it were located approximately 150 feet beyond the window. When viewed from anywhere on the prescribed glide slope, this bar of light (meatball) will appear in line with the green datum lights. The meatball will rise above the datum lights as the pilot rises above the glide slope, eventually sliding off the top of the lens box when the pilot is more than three-fourths of a degree above the glide slope. The same holds true as the pilot drops below the glide slope. The meatball will drop below the datum lights and finally slide off the bottom of the lens box. To sum up; when the meatball is high, (above the datum lights), the pilot is above the glide slope. When it is low the pilot is below the glide slope. In either case, the object is to lineup the meatball with the datum lights.

At great distances from the lens unit, it is difficult to distinguish the relative position of the meatball with respect to the datum lights, because the meatball can be distinguished before the green datum lights become visible. Pilots are therefore provided with a warning of low meatball by installing a RED lens in the bottom cell of the lens box. Thus, regardless of distance, when the meatball is RED instead of YELLOW, a pilot will know he is too low.

While controlling a CCA approach, it is the responsibility of the CCA final controller to position each aircraft on final as near to the centerline of the carrier angle deck as possible by giving right or left corrections. The final controller should have the aircraft on the courseline and holding a good heading prior to reaching a point 1 1/2 miles from the carrier.

Large azimuth corrections, to get back to the oncourse, should be avoided in the final stages of the approach. Carrier approaches are a critical phase of aircraft operation and erratic maneuvers at slow speeds usually prove ineffectual, if not disastrous.

The secret of a smoothly controlled approach is to assign large heading changes, as required, while the aircraft is at least 3 miles or more

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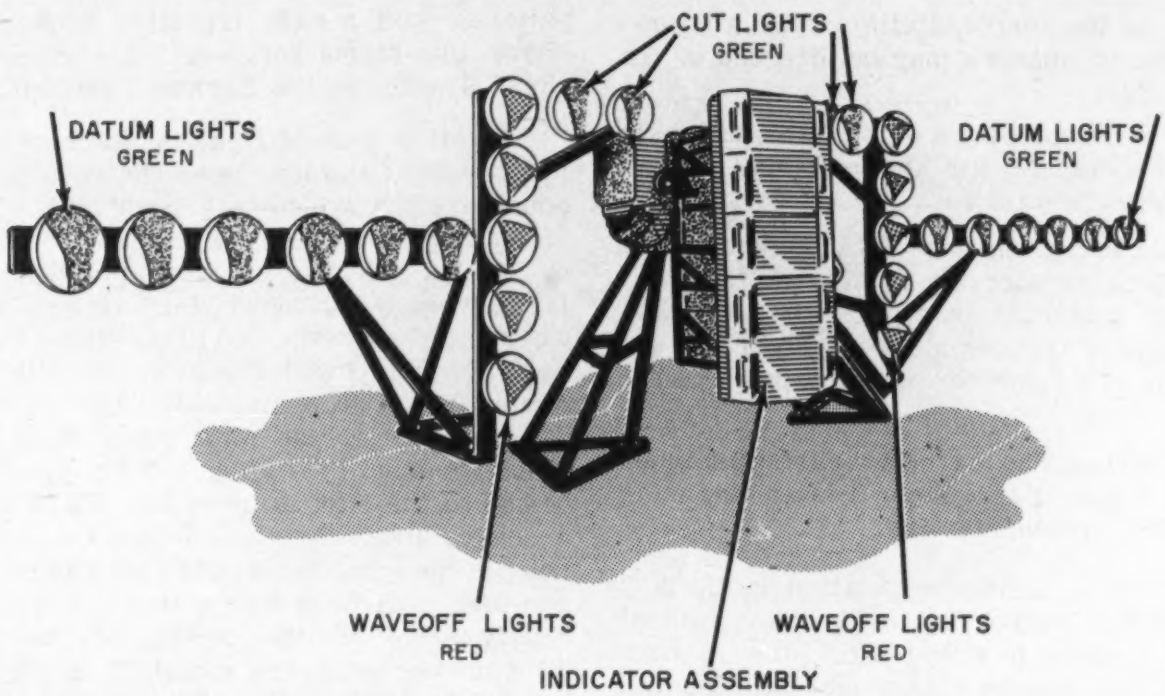

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Figure 13-25.—Fresnel lens unit.

from the ship. If this technique is used, only small corrections should be needed when the aircraft gets closer.

When the pilot has the meatball in sight and is prepared to complete the approach visually, he will transmit, MEATBALL. The controller ceases transmission and the pilot then adjusts his descent to put the meatball in line with the datum lights and makes any necessary azimuth corrections. The pilot continues to visually fly the meatball to an arrested landing.

PILOT LANDING AID TELEVISION (PLAT) SYSTEM

PLAT is a completely integrated system of electronic picture and sound recording designed to monitor and simultaneously record aircraft landing operations from approach through final touchdown, under both day and night conditions, and to immediately play back the recording for postflight analysis and evaluation.

The PLAT system consists of four television cameras. Two unmanned centerline cameras (one regular, one emergency), stabilized to the ship's optical landing system, pick up and follow aircraft through final approach and landing. Aircraft attitude and glide slope are displayed on picture monitors in combination with the output of a special effects camera focused on a data board carrying time, date, wind velocity, and aircraft landing speed. During the launch and the recovery, and after touchdown, the aircraft can be monitored by a fourth (manned) camera on the ship's island structure as it passes over the centerline cameras and the information is again displayed with the output of the data board camera. The entire operation is recorded on video tape at the same time it is monitored by the television cameras.

Television receivers are located at various places throughout the ship. There is a receiver in each pilot's readyroom, in air operations, in the CCA control room, and on the bridge.

In addition to the benefits afforded in the later study of a pilot's landing technique, PLAT is also helpful as a viewing aid for personnel (air operations and CCA) that previously were unable to view the flight deck activity. It reduces somewhat the sound-powered phone conversation. In the past, certain information had to be collected over the phone circuits that can now be seen on the television receiver.

RADAR PROCEDURE

Radar procedure contained herein pertains in most part to the ATC program ashore. Basic control procedure applies to all areas of radar air traffic control; however, detailed procedures for shipboard operations are contained in the CVA/CVS NATOPS MANUAL.

AC's assigned duty in a CCA or GCA crew receive specialized training at a Class C school

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and upon completion and qualification are assigned a Naval Enlisted Classification Code indicating their specialty within the Air Controlman general rating.

A radar controller must be personally satisfied that the radar presentation and the equipment performance are adequate for the service to be provided before attempting to provide such service.

Upon assuming responsibility for a control position, a controller should check radar alinement. This may be accomplished by assuring that the video map or map overlay in use is properly alined relative to the true geographic position, or by correlating a permanent target of known range and azimuth with the radar display. A target in each quadrant should be checked where possible. A brief check should again be made at various times throughout the watch to insure accuracy of the radar.

When radar mapping is not available, radar service is limited to separating identified aircraft targets, vectoring aircraft to intercept a PAR final approach course, and providing service in areas that insure no confliction with traffic on airways or other ATC areas of jurisdiction.

RADAR IDENTIFICATION

Positive radar identification must be established before radar service is provided. There are instances where radar separation may be applied between two aircraft when only one aircraft is radar identified. For example, this occurs when a radar identified aircraft is separated from an aircraft taking off that will be identified within 1 mile of the end of the takeoff runway. It also occurs when a radar identified aircraft is separated from an IFR aircraft not radar identified by maintaining radar separation from all primary and secondary radar targets.

Primary and secondary radar identification may be established by one of the following methods:

1. Observing a departing aircraft target within 1 mile of the end of the takeoff runway.

2. Observing a target whose position with respect to a fix displayed on a video map, map overlay, as a permanent echo, or an accurately determined visual reporting point, corresponds with a direct position report received from the aircraft, and the observed track is consistent with the reported heading or route of flight. If a TACAN/VORTAC is located within 6,000 feet of the radar antenna, it may be used as a reference fix for radar identification without being displayed on the video map or map overlay. When such situations exist, a pilot reported radial/distance may be correlated with the main bang for establishing radar contact.

3. Observing a target, make an identifying turn or turns of 30 degrees or more, provided that, except in the case of lost aircraft, it is determined that the aircraft is within radar coverage, and only one aircraft is observed making the turns.

When using secondary radar (SIF) to identify a target, one of the following methods may be used:

1. Request the pilot to activate the IDENT feature of the transponder and observe the identification display.

EXAMPLE: IDENT; or, SQUAWK ONE TWO ZERO ZERO AND IDENT.

2. Request the pilot to change to a specific code and then observe the target display change.

3. Request the pilot to change the transponder to STANDBY. After observing the target disappear for a sufficient number of scans to assure that loss of target resulted from placing the transponder in STANDBY, request the pilot to return the transponder to normal operation and observe the reappearance of the target.

EXAMPLE: SQUAWK STANDBY, then, SQUAWK ONE TWO ZERO ZERO.

Where circumstances are present to cause doubt as to target identification, more than one method of identification should be used.

If identification of a radar target becomes questionable due to ring-around, scope clutter, etc., immediate action should be taken to maintain identity, re-identify the aircraft, or terminate the radar service.

The pilot must be informed whenever radar identification with his aircraft is initially established or re-established after radar contact being lost or radar service being previously terminated. He must also be informed when radar contact is lost.

Whenever radar identification is established by means of identifying turns or radar beacon (SIF) procedure, the pilot should be advised of the aircraft's position. Position information need not be given when radar identification is established by position correlation or when a departing aircraft is observed within 1 mile of the end of the takeoff runway.

The pilot of an aircraft being provided radar service must be informed when the service is terminated except when any of the following conditions exist:

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a. The aircraft conducts a visual approach.

b. Stage I, II, or III procedures (discussed later in this chapter) are employed.

c. The aircraft is vectored to the final approach course.

d. The aircraft conducts a radar approach.

NOTE: These exceptions allow reduction of transmission by eliminating the need to state the obvious to a pilot; for example, completion of a radar approach.

LOST COMMUNICATIONS

As soon as practicable after establishing identification, inform the pilot of the aircraft being vectored of the procedure to follow (proceed visually, execute a specified nonradar approach, or follow the missed approach procedure) if radio communications are lost for a specified time interval. This interval cannot be more than 1 minute during vectors to final approach.

RADAR VECTORS

A radar vector is a heading issued to an aircraft to provide navigational guidance by radar. IFR and VFR aircraft may be vectored within controlled airspace and special VFR aircraft may be vectored within control zones. An aircraft may be vectored outside controlled airspace only on request of a pilot. Radar advisories may be offered to the pilot of an aircraft operating within or outside of controlled airspace since an advisory is intended to assist pilots by offering advice or information and is not a clearance or instruction.

IFR and special VFR aircraft may be vectored when it is necessary for separation purposes, when required for noise abatement considerations, when an operational advantage to the pilot or controller exists, or when requested by a pilot. When separation from other aircraft is based on vectoring special VFR aircraft, a controller must consider the pilot's requirement to conduct flight clear of clouds with at least 1 mile flight visibility.

VFR aircraft, other than special VFR aircraft, may be vectored only when one of the following conditions exists:

1. The pilot requests a vector.

2. A controller suggests the vector and the pilot concurs.

3. A special program is established and vectoring service is advertised.

4. In the controller's judgment, a vector is necessary for safety.

Vectoring aircraft for the purpose of separation can only be done if the aircraft to be vectored is within the airspace for which the radar controller has control jurisdiction.

A controller must insure that an aircraft can be returned to its original route within radar coverage before providing radar vectors and should use one of the following vectoring methods:

1. Specify direction of turn and magnetic heading to be flown after completion of the turn.

EXAMPLE: TURN LEFT/RIGHT HEADING THREE FIVE ZERO.

2. Provide no-gyro vectors as follows:

a. Inform the pilot of the aircraft of the type of vector and the manner in which turns are to be made.

EXAMPLE: THIS WILL BE A NO-GYRO VECTOR; EXECUTE TURN INSTRUCTIONS ON RECEIPT.

b. Specify the direction of turn and when to stop the turn when issuing each turn instruction.

EXAMPLE: TURN RIGHT/LEFT. STOP TURN.

3. When the heading of the aircraft is not known and time does not permit obtaining it, specify, in group form, the number of degrees to turn and the direction of turn.

EXAMPLE: TURN THIRTY DEGREES LEFT/RIGHT.

4. Specify the magnetic heading to be flown.

EXAMPLE: FLY HEADING TWO SEVEN ZERO.

5. Specify that the present heading be maintained.

EXAMPLE: MAINTAIN PRESENT HEADING.

When an aircraft is vectored off a previously assigned nonradar route, the pilot should be informed of the purpose of the vector, including the airway, route, or point to which the aircraft is being vectored.

EXAMPLE: TURN RIGHT HEADING ZERO FIVE ZERO FOR VECTOR TO VICTOR THREE TWELVE, or FOR VECTOR TO RUNWAY THREE FIVE TRAFFIC PATTERN, etc.

An altitude to be maintained and all altitude restrictions should be issued to the pilot of such aircraft unless the aircraft is operating at an assigned en route altitude, or the aircraft is or

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will be climbing or descending unrestricted to the assigned en route altitude.

Radar navigational guidance must not be terminated until the aircraft being vectored is reestablished within the airspace to be protected for the airway or route being flown, on an assigned heading which will intercept the desired route within a reasonable distance, and the pilot of the aircraft is informed of his position.

EXAMPLE: OVER GEEDUNK TACAN, RESUME NORMAL NAVIGATION.

When an aircraft will be vectored through a previously assigned nonradar route, the pilot should be so informed and given the purpose of the vector.

Whenever an aircraft is observed in a position and on a track which will obviously cause it to deviate from its protected airspace, the pilot should be informed and if necessary the controller should assist the pilot to return the aircraft to the assigned protected airspace.

Whenever radar identification is established or lost, or radar service is terminated, the pilot of the aircraft must be informed.

After the pilot receives the statement that his aircraft is in RADAR CONTACT, he discontinues reporting over compulsory reporting points. The pilot will resume normal position reporting when a controller informs him RADAR CONTACT LOST, or RADAR SERVICE TERMINATED. If necessary, a controller may request a pilot to provide an estimate or report over a specific fix even though RADAR CONTACT has been established. Additionally, the controller may inform the pilot of such aircraft of his position with respect to a fix or route when required.

RADAR HANDOFF

Radar handoffs should be made along regularly used routes to the maximum extent practicable. A controller effects a handoff by physically pointing out the target to the receiving controller, or informing the receiving controller of the distance and bearing of the target from a fix or transfer point shown on both displays, and if appropriate, the radar beacon code assigned. The receiving controller may consider that the target being transferred is identified on his display when the transferring controller has pointed out the target physically, or the target is the only one observed which corresponds with the information furnished.

Communications should be transferred to the receiving controller before the aircraft being handed off enters his area unless previously coordinated otherwise. To the extent possible, the communications transfer should be initiated at the time of handoff.

A receiving controller may assume control of an aircraft being handed off only after it enters his area of responsibility unless specifically coordinated otherwise at the time of handoff. When a transferring controller transfers control of an aircraft by handoff before it leaves his area of responsibility, he must issue to, and coordinate with, the receiving controller any restrictions which may be necessary to separate the aircraft being handed off from other traffic in the transferring controller's area.

After a receiving controller accepts a handoff from another facility, he should confirm the identity of a nonbeacon target by advising the pilot of the aircraft's position. Alternatively, he may confirm the identity of a beacon target by observance of an IDENT, a code change, or a standby squawk, as appropriate. It is not necessary to require additional confirming transponder replies if one of these methods was used to remove doubt during the handoff. In either situation, the receiving controller should advise the pilot of RADAR CONTACT when appropriate after the handoff.

RADAR BEACON CODE ASSIGNMENT

Controllers with equipment capability must monitor the beacon codes assigned for use by aircraft operating within their areas of responsibility. Specific codes are assigned to indicate a particular type of aircraft operation. Some of the frequently used codes are listed as follows:

1. 1000—To aircraft which will climb to operate below FL 240, including VFR OTP.
2. 2000—To aircraft which will climb to operate at FL 240 or above, including VFR OTP.
3. 0100—To aircraft which will operate under tower en route control; may be assigned to aircraft receiving terminal VFR radar advisory service.
4. 1100—To IFR en route aircraft below FL 240.
5. 2100—To IFR en route aircraft at or above FL 240.

NOTE: 1100 or 2100, as appropriate, may be assigned at takeoff with prior coordination

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with the facility concerned to eliminate the necessity of changing codes.

6. 0600—To aircraft below FL 240 operating VFR on top on an IFR clearance or which cancels IFR.

7. 0700—To aircraft at FL 240 or above, operating VFR on top on an IFR clearance or which cancels IFR.

8. 0400—To aircraft transferred to the destination approach controller.

9. 1400—To aircraft when issued descent clearance unless otherwise agreed upon between center and terminal controllers.

These codes may be considered as a basis from which the discrete coding procedure begins. Facilities or positions within a facility may be assigned a code not included herein by appropriate authority. With coordination between controllers concerned, various modifications of the basic procedure may be used when circumstances require. For more information, the AC should refer to the appropriate section of the TATC Handbook 7110.8 (Series).

Pilots of aircraft operating a transponder should be instructed to SQUAWK STANDBY when approximately 15 miles from destination if the transponder is no longer desired by the terminal controller. They may also be instructed to SQUAWK LOW when necessary to reduce clutter or ring-around, provided that the pilot is instructed to SQUAWK NORMAL as soon as possible after the problem is eliminated.

DEPARTING AIRCRAFT

Standard departure routes and channelized altitudes should be used for radar departures whenever practicable to reduce coordination. However, such procedure should not be used solely to provide for possible radar or communications failure.

When an aircraft is to be vectored immediately after takeoff, the initial heading to be flown should be assigned before takeoff.

If a radar beacon reply is required immediately after takeoff, the appropriate mode/code, and if necessary a low sensitivity setting, should be assigned before takeoff.

An IFR departure, or a missed approach aircraft, within 40 miles of the antenna site, may be vectored before it reaches the minimum altitude for IFR operations provided that one of the following conditions is met:

1. The aircraft is vectored to maintain at least 3 miles separation from prominent obstructions shown on the radarscope when the takeoff path is 3 miles or more from the obstruction.

2. The aircraft is vectored to increase lateral separation from such obstructions until the 3-mile minimum is achieved when the takeoff path is less than 3 miles from the obstruction.

ARRIVING AIRCRAFT

Successive arriving aircraft may be handed off with only radar separation if previously agreed to between facilities concerned and the following conditions are met:

1. The receiving controller establishes communication with the first aircraft before the pilot of a second aircraft, cleared to or over the same fix, is instructed to change to the receiving controllers frequency (unless an airport clearance limit is used).

2. The pilot of the first aircraft establishes communication with the receiving controller before it reaches the clearance limit fix.

3. The receiving controller does not delay the first aircraft at a fix to or over which a second aircraft is cleared.

Arriving aircraft may be vectored to intercept the final approach course of a precision approach. In such cases, the vectoring technique must allow for interception of the final approach course prior to reaching the point where interception of the glide slope is normally made.

If it becomes necessary to vector an aircraft through the final approach course of the approach the aircraft is executing, the pilot should be so informed. This will clarify your actions with the pilot and avoid confusion since the pilot is anticipating a turn inbound on final approach course and is naturally concerned when such instructions are not received as anticipated.

An arriving aircraft may be descended to minimum vectoring altitude, vectored to the VFR traffic pattern, instead of the final approach course, and cleared for a visual approach if the following conditions are met:

1. The reported ceiling is at least 500 feet above the minimum vectoring altitude and the visibility is at least 3 miles.

2. Radar separation must be provided from any preceding IFR aircraft until visual separation can be provided. (Visual separation may be applied even though the aircraft is outside the control zone when this procedure is used.)

3. The clearance for the visual approach is issued after the pilot reports sighting the air-

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port and the tower controller is advised of the aircraft's position where there is no preceding aircraft; or, when following a preceding aircraft, the clearance is issued after the pilot reports sighting the preceding aircraft, is instructed to follow it, and the tower controller is advised of the aircraft's position in the landing sequence.

Aircraft may be vectored simultaneously to the traffic pattern for more than one runway provided the following conditions are met:

1. Radar separation is maintained until the aircraft involved are cleared for a visual approach.
2. Traffic information is exchanged between all aircraft involved, irrespective of the runway being used.

Speed Adjustment

To avoid excessive vectoring and provide for orderly radar handoffs, a radar controller may request arriving aircraft to adjust speed. This procedure should not be applied as a substitute for good vectoring technique. Speed changes should not be requested of aircraft in the following situations:

1. Conducting a published penetration.
2. After an aircraft has been cleared for approach. However, when subsequent circumstances require additional spacing, a request for a speed adjustment would be preferable to S-turns or a discontinuance of approach.
3. After an aircraft has passed the approach gate on final (see appendix I for approach gate).

All speed adjustment requests should be expressed in terms of knots, based on indicated airspeed, using 10-knot increments or multiples thereof.

Consideration must be given to maximum speeds authorized by FAR 91 in particular airspace to insure that speed adjustment requests are within those limits. Requests requiring alternate decreases and increases should be avoided.

For more information on speed adjustment minima and limitations, refer to the appropriate section of TATC Handbook 7110.8 (Series).

ADDITIONAL RADAR SERVICES

Several types of service available through the use of radar may be provided pilots, such as observed traffic information. These services should be provided to the extent possible. Many factors, such as controller workload, limitations of the radar, communications congestion, etc., may preclude providing these services. The controller himself must determine if he is able to provide them.

Traffic Information

Traffic information should be issued to all IFR flights (unless omission is requested by the pilot or the aircraft is operating in positive controlled airspace), and to other than IFR flights when requested by the pilot.

Traffic information issued to radar identified aircraft must include the following items:

1. Azimuth from the aircraft in terms of the 12-hour clock.
2. Distance from the aircraft in miles.
3. Direction in which the traffic is proceeding.
4. Type of aircraft and altitude if known, or the relative speed of the traffic; i.e., slow or fast moving.

EXAMPLE: TRAFFIC, THREE O'CLOCK, WESTBOUND, SLOW MOVING.

Traffic information issued to aircraft that are not radar identified must include the following items:

1. Distance and direction with respect to a fix.
2. Direction in which the traffic is moving.
3. Type of aircraft and altitude if known, or the relative speed of the traffic.

EXAMPLE: TRAFFIC, SIX MILES SOUTH OF SNARE VOR, NORTH BOUND, C ONE FORTY ONE, FLIGHT LEVEL TWO ONE ZERO.

Radar separation is provided between the aircraft receiving traffic information and the observed traffic only if the pilot requests it, and the aircraft to be vectored is within airspace for which the controller has jurisdiction.

The pilot of a radar identified aircraft that reports he does not see the traffic as reported should be advised when the observed traffic is no longer a factor unless his aircraft is being vectored to provide separation from the traffic.

Whenever a controller observes a situation which, in his opinion, is likely to affect the safety of a radar identified aircraft, an advisory should be issued to the pilot.

When it becomes known that an aircraft not under radar control is at the same altitude and in the same general area as a radar controlled aircraft, the controller must take whatever ac-

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tion considered necessary to separate the aircraft concerned.

Weather and Chaff Information

Weather and chaff information, when applicable, should be issued by stating its position with respect to the aircraft or a fix, as is traffic information. A vector or alternate route to avoid such areas may be suggested as appropriate.

Bird Activity Information

Advisory information on pilot reported or radar observed and pilot verified bird activity should be issued. The position, and, if known, the size or species of the birds and their course of flight and altitude must be included in the advisory.

Surveillance of Outer Fix Holding

Radar surveillance of outer fix holding pattern airspace areas shown on the radarscope should be provided when aircraft are being held there. If a controller should detect an aircraft straying outside the area, he should assist the pilot to return it to the assigned airspace.

Pilot Requested
Navigational Guidance

Navigational guidance requested by pilots should be limited to vectors within a controller's particular area of responsibility unless such action can be coordinated with a subsequent receiving controller or facility.

Navigational guidance may be provided as a radar advisory to aircraft outside of controlled airspace when requested by the pilot.

TERMINAL RADAR SERVICE

The FAA has established a national program for terminal radar facilities. The extent and complexity of the service provided is varied depending on the facility and whether or not a formal, approved program has been established for that facility. The variance is described in STAGES, i.e., STAGE I, II, or III. This service is in addition to the "Additional Radar Services" previously described.

Stage I service procedure is applicable to all approach control facilities utilizing radar and includes the following radar controller actions when arriving VFR aircraft are handled by approach control:

1. Wind and runway information is issued unless pilots indicate they already have this information.
2. Traffic information is issued on a workload permitting basis.
3. The time or place at which the pilot is to contact the tower for further landing information is specified.
4. Vectoring service is provided if the pilot requests, if the controller suggests it and the pilot concurs, or if controller judgment deems it necessary for safety.
5. When initial contact is made with the tower, it may be suggested that the aircraft contact approach control for landing and traffic information.

Stage II service is only applicable at facilities where a formal, approved program has been established for this purpose. It is in addition to Stage I service and generally includes identification, holding, sequencing aircraft in the landing pattern including IFR traffic, vectors to landing patterns for more than one runway, transfer of control procedure between the local controller and approach controller, missed approach aircraft resequencing, and departure information for VFR aircraft.

Stage III service is only applicable within a designated Terminal Radar Service Area (TRSA) where a program has been established for this purpose. It is in addition to Stage II service and in essence is positive control of aircraft that operate within the TRSA.

For detailed procedure concerning Stage II and III service refer to the applicable section of TATC Handbook 7110.8 (Series).

EMERGENCY RADAR
FLIGHT PATTERNS

Radar controllers must be on the alert for emergency radar flight patterns executed by pilots who experience two-way communications failure and must render assistance to the extent possible to any aircraft determined by this method to be experiencing an emergency. If an emergency radar flight pattern is observed by a controller in a facility other than a center, the appropriate center must then be notified immediately. The center is then responsible for coordinating action pertinent to the emergency.

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This list, however, should not be construed as being all inclusive.

The indicator or presentation system accepts the radar data such as video pulses, range-marker voltages, sawtooth timing waves, and presents them in a visual display on the cathode-ray tubes. An indicator assembly contains the cathode-ray tube and various electronic circuits necessary for presenting the desired information on the CRT. These circuits include video amplifiers, clampers, and the controls for adjusting the brilliance and focus of the visual pattern.

Two general types of presentation are used in radar indicators—deflection-modulated and intensity-modulated displays. In the deflection method, the video pulse causes a momentary deflection of the cathode-ray electron beam and produces a pip in the trace to indicate a target echo. In the intensity method, the video signal is applied to the element of the CRT which controls the intensity of the electron beam, and the resulting target image is a bright spot of light. Three types of intensity presentations are shown in figure 15-8. A detailed discussion of indicators is made in chapter 17 of this training course.

MONOPULSE

Monopulse is a simultaneous scanning system capable of obtaining the range, bearing, and elevation of a target from a single pulse. Hence, the name mono (one) pulse. In the monopulse system, the radar radiates into space a single beam whose axis coincide with the antenna axis. Normally, with a single beam fixed with respect to the antenna, a target could move a substantial distance from the antenna's axis before the radar's tracking system would detect a displacement and react.

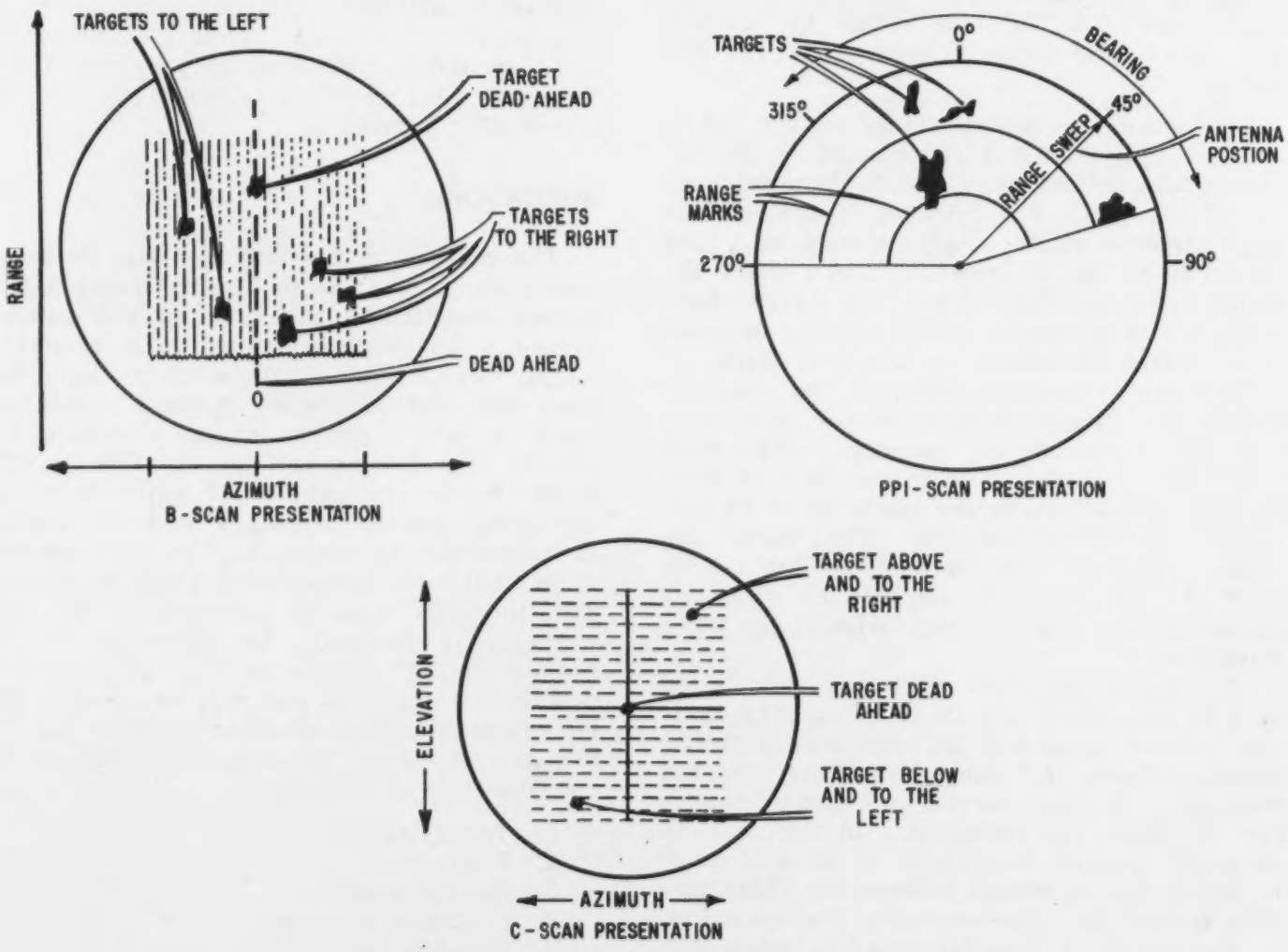

Figure 15-8.—Scan presentation.

The emergency radar flight patterns designed to alert radar systems are as follows:

1. If the aircraft radio transmitter is inoperative but the receiver is operative, the aircraft is flown in a triangular pattern to the RIGHT. The heading for each side of this pattern is followed for 2 minutes (1 minute for turbojet aircraft). After completion of at least two such patterns, the aircraft is returned to its original course. The pattern is then repeated at 20-minute intervals. In these circumstances, pilots ordinarily guard emergency radiofrequencies (121.5 or 243.0 MHz).

2. If the aircraft transmitter and receiver are both inoperative, the aircraft is flown in a triangular pattern to the LEFT in the same manner as above. (See fig. 13-26.)

3. If the pilot of a distressed aircraft is unable to communicate by radio or radar beacon and is in urgent need of assistance, he may make a series of four chaff drops followed by a series of 360-degree turns. (See fig. 13-26.) The pilot will attempt to dispense four chaff bundles with a 2-mile interval between each drop and will then fly approximately 2 miles, make a 360-degree turn to the left and repeat the 2-mile legs and 360-degree turns until a series of 4 turns have been completed.

NOTE: Any unscheduled chaff observed on radar should be suspected as a possible emergency since radar limitations may preclude detection of the entire emergency pattern.

SAFETY PRECAUTIONS

AC's in the performance of the majority of the duties of their rating, are operating electric or electronic equipment. They may also be called upon to assist maintenance personnel with that portion of preventive maintenance which requires the equipment to be kept free of potential problem-causing dust and dirt. There are many dangers to personnel who operate and maintain electronic equipment. Among the possible dangers in the Air Controlman's work are high voltages, breakage of cathode-ray tubes, volatile liquids, electrical fires, and noxious gases. Because of these dangers the Air Controlman should regard the formation of safe and intelligent work habits as being equally as important as development of the technical knowledges and skills of the Air Controlman rating.

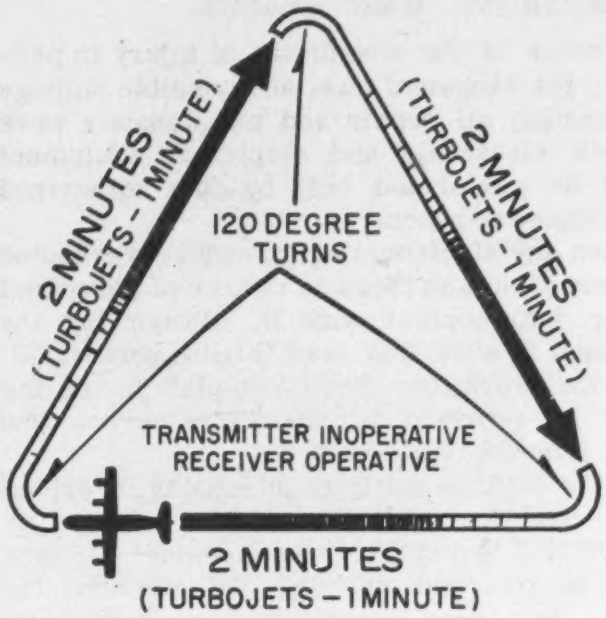

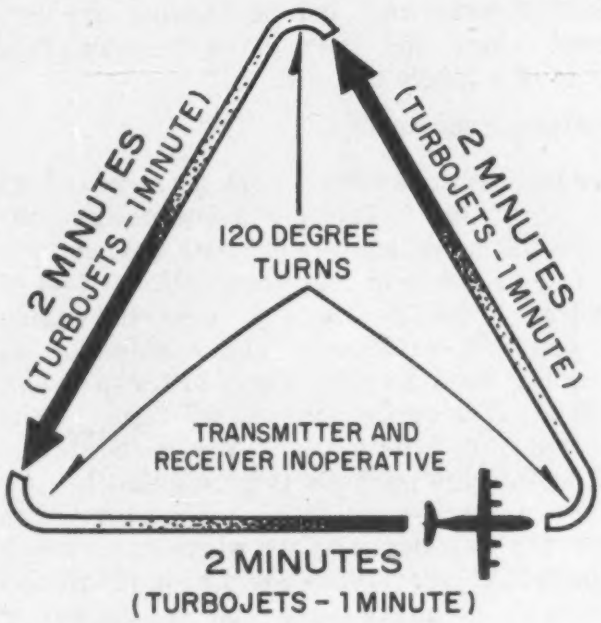

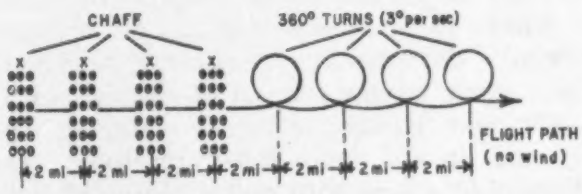

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Figure 13-26.—Emergency radar flight patterns.

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GENERAL SAFETY PRECAUTIONS IN ELECTRONIC MAINTENANCE

Because of the possibility of injury to personnel, the danger of fire, and possible damage to material, all repair and maintenance work on both electronic and electrical equipment should be performed only by duly authorized and assigned persons.

When any electronic equipment is overhauled or worked on, and there is danger of personnel coming into contact with it, always tag the equipment to show that work is being performed. After the work has been completed, the tag should be removed by the same person who placed it on the equipment.

Safety devices such as interlocks, overload relays, and fuses should never be altered or disconnected except for replacement. Fuses should be removed and replaced only after the circuit has been completely de-energized. When a fuse blows, it should be replaced with a fuse of the same current rating. When possible, the circuit should be carefully checked by maintenance personnel before making any replacement since the burned-out fuse is often the result of a faulty circuit.

High Voltage Precautions

Personnel should never work alone near high voltage equipment. Tools and equipment containing metal parts, such as brushes and brooms, should not be used in any area within 4 feet of high voltage circuits or any electric wiring having exposed surfaces. The handles of all metal tools, such as pliers and cutters, should be covered with rubber insulating tape. (The use of plastic or cambric sleeving or of friction tape alone for this purpose is prohibited.)

Before a worker touches a capacitor which is connected to a deenergized circuit, or which is disconnected entirely, he should short-circuit the terminals to make sure that the capacitor is completely discharged. Grounded shorting prods should be permanently attached to workbenches where radar equipment and other types of electronic devices are regularly serviced.

Do not work on any type of electrical apparatus with wet hands or while wearing wet clothing, and do not wear loose clothing. The use of thinsoled shoes with metal plates or hobnails is prohibited. Safety shoes with nonconducting soles should be worn if available. Flammable articles, such as celluloid cap visors, should not be worn.

When working on electronic or electrical equipment, personnel should first remove all rings, wristwatches, bracelets, and similar metal items. Care should be taken that the clothing does not contain exposed zippers, metal buttons, or any type of metal fastener.

Warning signs and suitable guards should be provided to prevent personnel from coming into accidental contact with high voltages.

Transmitter adjustments should not be made while the equipment is energized unless the adjustments can be accomplished from the front control panel. Similar precautions should be taken with oscilloscope circuits, which employ voltages corresponding to those used in transmitting equipment.

Energized Circuits

Insofar as is practicable, repair work on energized circuits should not be undertaken. When repairs on energized operating equipment must be made because of emergency conditions, or when such repairs are considered to be essential, the work should be done only by experienced personnel. Every known safety precaution should be carefully observed. Ample light for good illumination should be provided; and the worker should be insulated from the ground with some suitable nonconducting material such as several layers of dry canvas, dry wood, or a rubber mat of approved construction. The worker should, if possible, use only one hand in accomplishing the necessary repairs. Helpers should be stationed near the main power source or circuit breaker so that the equipment can be deenergized immediately in case of emergency. A man qualified in first aid for electrical shocks should stand by during the entire period of the repair.

Volatile Liquids

Volatile liquids such as insulating varnish, lacquer, turpentine, and kerosene are dangerous when used near electronic equipment which is operating because of igniting the fumes by sparks. When these liquids are used in compartments containing nonoperating equipment, be sure that there is sufficient ventilation to avoid an accumulation of fumes and that all fumes are cleared before the equipment is energized.

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Alcohol should never be used for cleaning in locations where a spark is possible. Neither should carbon tetrachloride be employed as a cleaning agent. Unlike alcohol, the use of carbon tetrachloride does not create a fire hazard; however, it is dangerous because of the injurious effects of breathing its vapor. The careless use of carbon tetrachloride may result in headache, dizziness, and nausea. If a sufficient amount of these fumes are breathed (as might happen in poorly ventilated compartments), the effect will be loss of consciousness or even death. For these reasons, the use of carbon tetrachloride as a solvent or cleaner has been specifically prohibited in Navy maintenance operations. When cleaning electrical or electronic equipments or parts, always use the new approved cleaning agent trichlorethylene.

Electrical Fires

In case of electrical fire, the following steps should be taken:

1. Deenergize the circuit.
2. Call the Fire Department.
3. Control or extinguish the fire, using the correct type of fire extinguisher, if at all possible.
4. Report the fire to the appropriate authority.

For combating electrical fires, use a CO_2 (carbon dioxide) fire extinguisher and direct it toward the base of the flame. Carbon tetrachloride should never be used for fighting fires since it changes to phosgene (a deadly gas) upon contact with hot metal. Even in open air this gas creates a hazardous condition. The application of water to electrical fires is also dangerous; and foam type fire extinguishers should not be used since the foam is electrically conductive. In case of cable fires in which the inner layers of insulations, or insulation covered by armor, are burning, the only positive method of preventing the fire from running the length of the cable is to cut the cable and separate the two ends.

Precautions in Handling Cathode-Ray Tubes

The trend toward the use of large cathode-ray tubes has increased the dangers of implosions, or collapse of the glass tube, as a result of atmospheric pressure. The tubes are not dangerous if properly handled; but if they are struck, dropped, or handled carelessly in any way, they can very well become an instrument of severe injury or death.

The following precautions should be taken for the protection of personnel:

1. Wear goggles to protect the eyes from flying glass particles which result from implosion due to fracture of the envelope. The goggles should be of the type which provide side and front protection and which have clear lenses that can stand a rigid impact test.
2. Wear suitable gloves to protect the hands.
3. Be sure that no part of the body is directly exposed to possible glass splinters caused by implosion. Also remember that the coating on some tubes is poisonous if absorbed into the bloodstream.
4. Take care of the tube by not exposing it to possible damage. When a new tube is needed, remove it from the packing box with caution, taking care not to strike or scratch the envelope. Insert the tube into the equipment socket cautiously, using only moderate pressure. Do not jiggle the tube. Use these same precautions when removing the tube from the equipment.

When the tube must be set down, it is important that the face be placed on a clean, soft padding. Do not stand directly in front of the face, because accidental implosion may cause it to be propelled directly forward with a velocity sufficient to cause severe injury.

TREATMENT FOR ELECTRICAL SHOCK

The greatest hazard around electrical and electronic equipment is the danger of electrical shock. Some very important things to remember when treating a victim for electrical shock are as follows:

1. Deenergize the circuit or release the victim from contact. Use caution, or you too may become a victim.
2. Begin artificial respiration IMMEDIATELY but only if the victim is not breathing. (Use the mouth-to-mouth method if at all possible.)
3. Keep the victim quiet after normal breathing is resumed.
4. Keep the victim lying down, head slightly lower than the feet. Keep him warm, but do not overheat him.

For a more detailed coverage of first aid methods, study Standard First Aid Training Course, NavPers 10081 (Series).

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CHAPTER 14

PUBLICATIONS, LOGS, AND RECORDS

Regardless of the segment of the air traffic control that you, as an Air Controlman, may be assigned, a knowledge and effective use of the various publications and catalogs associated with the field of air traffic control are extremely important. In addition, the Air Controlman must have a working knowledge of the maintenance of logs, records, reports, and forms used in this field.

It would be impractical to list and discuss all the publications, records, reports, logs, and forms that have a direct bearing on the Air Controlman in the course of this chapter. Therefore, only those most frequently used in the daily routine are discussed.

FAA PUBLICATIONS

AIRMAN'S INFORMATION MANUAL

The Airman's Information Manual has been designed as a pilot's operational manual for use primarily within the conterminous United States. All AC's should be familiar with this manual for ready reference when assisting pilots. Use of the Airman's Information Manual is part of the practical test for a Senior Rating in accordance with FAR Part 65. The manual is divided into three parts, each of which is described in the following paragraphs.

Part 1, Basic Flight Manual and ATC Procedures

This part is issued quarterly and contains basic fundamentals required to fly in the national airspace system; adverse factors affecting safety of flight; health and medical facts of interest to pilots; ATC information affecting rules, regulations, and procedures; a glossary of aeronautical terms; U.S. entry and departure procedures, including airports of entry and landing rights airports; Air Defense Identification Zones (ADIZ's); designated mountainous areas; SCATANA, and emergency procedures.

Part 2, Airport Directory

This part is issued semiannually and contains a directory of airports, seaplane bases, and heliports in the conterminous U.S., Puerto Rico, and the Virgin Islands which are available for transient civil use. It includes all of their facilities and services, except communications, in codified form. Those airports with communications are also listed in Part 3, which reflects their radio facilities. A list of new and permanently closed airports which updates this part is contained in Part 3.

Included, also, is a list of selected commercial braodcast stations of 100 watts or more of power.

Parts 3 and 3A, Operational Data and NOTAM's

Part 3 is issued every 28 days and contains a master index covering all parts of the Airman's Information Manual; an airport/facility directory containing a list of all major airports with communications; a tabulation of air navaids and their assigned frequencies; parachute jump areas; preferred routes; standard instrument departures (SID's); substitute route structures; a sectional chart bulletin, which updates sectional charts cumulatively; restrictions to enroute navaids; VOR receiver checkpoints; special, general, and area notices; a tabulation of new and permanently closed airports, which updates Part 2; and Oil Burner Routes.

Part 3A is issued every 14 days and contains NOTAM's considered essential to the safety of flight as well as supplemental data to Part 3.

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LOCATION IDENTIFIERS HANDBOOK 7350.1 (SERIES)

A location identifier is a three-letter or other code suggesting, whenever practicable, the location name of the place it represents. Usually the first letter of the code is the initial letter of the location name. A code with the initial letter of the location name is not always assignable because of the large number of assigned codes. All three-letter identifiers assigned to Navy and Marine Corps air stations begin with the letter N.

This handbook incorporates all authorized three-letter location identifier assignments worldwide, the Canadian Government location identifier assignments, and special use assignments within the United States and areas under its jurisdiction.

CONTRACTIONS HANDBOOK 7340.1 (SERIES)

This handbook contains the approved word and phrase contractions used by personnel of FAA and other agencies that provide air traffic control, communications, weather, charting and associated services.

A contraction is a word or phrase represented in shortened form for the purpose of brevity. Contractions are developed by omitting letters, sounds, or syllables from words or phrases. They save space on telegraphic circuits, charts, reports, etc. Three-letter contractions that might conflict with location identifiers are always avoided.

The more common contractions used in telegraphic communications can be easily and quickly memorized. However, the entire list of contractions is so long that the manual must be referred to quite frequently.

TERMINAL AIR TRAFFIC CONTROL HANDBOOK 7110.8 (SERIES)

This handbook prescribes air traffic control procedures and phraseology for use by personnel providing terminal air traffic control services. It is one of the air traffic control manuals referred to in FAR Part 65. Controllers are required to be familiar with the provisions of this handbook which pertain to their operational responsibility and to exercise their best judgment if they encounter situations not covered by it.

OpNav Instruction 3710.7 (Series) directs that the procedures contained in this handbook be used by U.S. Navy shore activities when performing air traffic control functions.

EN ROUTE AIR TRAFFIC CONTROL HANDBOOK 7110.9 (SERIES)

This handbook prescribes air traffic control procedures and phraseology for use by personnel providing en route air traffic control services.

Should your facility operate in an en route capacity, this manual should be referred to for procedures.

FLIGHT SERVICES HANDBOOK 7110.10 (SERIES)

This handbook consists of two parts. Part I, the basic part, prescribes procedures and phraseology for use by personnel providing flight assistance and communications services. Part II, the teletypewriter portion, includes services A and B teleypewriter operating procedures, pertinent International Teletypewriter Procedures, and the conterminous U.S. Service A Weather Schedules.

This handbook is primarily for Flight Service Specialists at FAA FSS's. However, certain portions contain information of use to the Navy AC that is not found in the Terminal Air Traffic Control Handbook. Of particular interest is Chapter 8, Flight Handling. This chapter describes the flight plan handling of military flight plans via FAA communications systems, and what action is taken when a flight is overdue or missing.

CERTIFICATION AND RATING HANDBOOK 7220.6 (SERIES)

This handbook governs the certification and rating of FAA Air Traffic Service Specialists and civil personnel engaged in air traffic control. It also governs those military and foreign national personnel who participate in the Air Traffic Service certification and rating program.

ADVISORY CIRCULAR

FAA issues advisory circulars to inform the aviation public in a systematic way of nonregulartory material previously issued in a wide variety of manuals, circular letters, aviation

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safety releases, etc. Advisory circulars are issued in a numbered-subject system, corresponding to the subject areas in the Federal Aviation Regulations. Persons who want to be placed on the mailing list for circulars should write to: Federal Aviation Administration, Distribution Section, HQ-438, Washington, D.C. 20553 and specify the subject matter desired.

FEDERAL METEOROLOGICAL HANDBOOK #1 SURFACE OBSERVATIONS

This handbook is promulgated within the Navy as NavAir 50-1D-1. It has been approved by appropriate personnel of the Departments of Commerce, Defense, and Transportation.

The handbook describes weather elements and how they are observed. The latter part of the handbook is devoted to types of observations, pilot's reports, and the determination, coding requirements, and dissemination of weather reports.

FLIGHT INFORMATION PUBLICATIONS

Flight information publications (FLIP) consist of that textual or graphic information required to plan and conduct a flight and accomplish a landing under varying weather conditions. Emphasis is on information required for navigation under IFR conditions although not confined to that alone. Generally, the publications are divided into the categories of use; i.e., the planning, en route, and terminal phases of flight; and the publications are tailored to these uses. A further breakdown, high and low altitude, results from differences in operational capabilities of jet versus conventional aircraft.

FLIP, PLANNING

The FLIP, Planning, was designed primarily for desk use and not for carrying in the aircraft. A complete FLIP, Planning, for the entire area of coverage will be composed of sections I through IV, as described in the following paragraphs of this section. A publications cycle (listed in Section I) is established to keep all information current. All sections may be revised between publication dates established by issuing replacement pages or a Planning Change Notice (PCN) on an "as required" basis. PCN's should be filed in front of the appropriate section.

A quarterly check list which spans the entire FLIP, Planning, is issued to holders of the publication as an additional means to determine that information is current.

The FLIP, Planning, does not contain all the information published elsewhere which may be needed in planning a flight. Planning charts, en route charts and supplements, and instrument letdown procedures must be consulted, as well as NOTAM files. In planning for international flights, reference must also be made to the Foreign Clearance Guide.

Section I, General Information

This section contains general information on all FLIP's, a list of FLIP and NOTAM abbreviations, the ICAO NOTAM code, conversion tables, sunrise and sunset tables, and an area of coverage chart.

Section II, Planning Data and Procedures

This section contains planning and procedure information for a specific geographic area including an index for aeronautical information, flight plans, clearances, etc.

Only the appropriate section II is included in an individual FLIP, Planning, as determined by the geographical area of coverage chart on the back cover of section I. For example, a station in the U.S. would have section II, Continental U.S. and Alaska; a station in the Pacific would have section II, Pacific, Australasia, and Antarctica.

Section IIA, Military Training Routes United States

This section is published primarily for flight planning and contains detailed data covering VFR and IFR/VFR Oil Burner Routes, VFR low altitude high speed training routes, Heavy Wagon low level routes and low and high altitude refueling tracks.

Accompanying charts (6 charts on 3 sheets) contain graphic descriptions of low altitude high speed training routes.

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Section IIB, Special Use Airspace

This section includes a tabulation of all Prohibited, Restricted, Danger, Warning, and Alert Areas, Intensive Student Jet Training Areas, Military Training Areas, and known Parachute Jumping Areas.

Section III, International Rules and Procedures

This section is provided for use in all areas of the world, and will be the same in each FLIP, Planning. It contains such detail as the following: Procedures covering international flights; international procedure charts showing ICAO (International Civil Aviation Organization) FIR (Flight Information Region) boundaries; Area Control Centers (ACC's); world wide altimeter setting procedures; regional VOLMET (ICAO abbreviation for meteorological information for aircraft in flight) plans; communications procedures; and emergency signals.

Section IV, Regulations

This section contains a list of regulations recommended to be inserted by the operations officer for reference by aircrew personnel. One list is issued for use in each FLIP, Planning, worldwide; this also lists, however, the regulations which are pertinent to any specific area.

IFR WALL PLANNING CHART—LOW ALTITUDE—U.S.

The IFR Wall Planning Chart consists of two sheets. It covers East and West U.S. and contains required information for preliminary flight planning. Its publication cycle is concurrent with the FLIP en route low altitude charts for the U.S.

There are also FLIP Planning Charts for both low and high altitude available for Europe and North Africa.

EN ROUTE AND TERMINAL PUBLICATIONS

FLIP en route and terminal publications are designed to provide airway structure, radio navigation, letdown, approach, and landing information for use during the in-flight phase of IFR operations. The FLIP En Route Supplement supports these publications with supplemental aerodrome, facility, communication, and procedural information. En route and terminal publications are available for all areas of the world, but only those applicable to the U.S. are discussed herein. AC's should refer to FLIP Planning Section I, or the publications themselves, for more detailed information.

Standard Instrument Departures (SID)

SID charts are published either as individual charts or as a bound booklet containing departure air traffic control instructions in a pictorial form, for departure from an individual aerodrome. Revisions are issued as required.

FLIP En Route Low Altitude—U.S.

These charts portray the airway system and related data required for IFR operation at altitudes below 18,000 MSL. Twenty-six variable scale charts are printed on 13 sheets, L-1 through L-26, covering the entire U.S. An additional sheet, containing charts L-27 and L-28, which duplicate data shown on L-20, L-22, L-24, and L-25, is available for those who frequently plan flights north and south along the east coast within the area of coverage.

The effective date and the expiration date are shown on the cover of each item. Major changes to the airway structure and procedures are scheduled by the FAA to become effective on a specific date, once every 4 weeks. Charts are revised accordingly and show the date this information is effective. Charts, therefore, should not be used prior to the effective date. Other information, such as frequencies, hours of operation, etc., is not scheduled and changes occur daily. Action is taken to update this data during the revision cycle, but it has to be terminated 15 days before the projected effective date of the issue under revision to permit printing and timely distribution to users. NOTAM's must be consulted for latest information on data changing after the cutoff date and during the life of the current charts. These charts are published every 4 weeks.

FLIP Area Charts—U.S.

These charts portray the airway system and related data required for IFR operations in selected terminal areas at altitudes below 18,000

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MSL. Ten variable scale charts are printed on six sheets and are published every 4 weeks.

FLIP En Route High Altitude—U.S.

These charts portray the jet route system and related data required for IFR operations at and above flight level 180. Four constant scale charts are printed on two sheets. These charts may be assembled to form a wall planning chart for high altitude. They are published every 4 weeks.

FLIP En Route IFR Supplement—U.S.

This supplement is a bound booklet containing an alphabetical listing of all IFR aerodromes, integrated with an alphabetical listing of all navaids and ARTCC facilities. Also published are brief presentations of such items as ADIZ, direction finding, IFR emregency procedure, position reporting, two-way radio failure, and other information. It is published every 4 weeks.

FLIP En Route VFR Supplement—U.S.

This supplement is a bound booklet containing an alphabetical listing of selected VFR aerodromes and cross-references to IFR aerodromes as published in the IFR supplement. Also included are city/aerodrome cross-referency listings, VFR special notices, and visual air/ground emergency procedures. It is published every 12 weeks.

Military Aviation Notices (MAN's) are issued as required for the purpose of updating and correcting this supplement. All MAN's are numbered consecutively beginning each calendar year, and those published during the effective time of the VFR supplement should be attached to the inside front cover so that all significant changes are readily available.

FLIP Terminal High Altitude—U.S.

These publications consist of four bound booklets, each covering a certain geographic area of the U.S. They contain instrument approach procedures for high performance aircraft. Transitional information from the jet route structure to the terminal facility has been added to charts covering the U.S. They are published every 4 weeks.

FLIP Terminal Low Altitude—U.S.

These publications consist of nine bound booklets, each covering a certain geographic area of the U.S. They contain low altitude instrument approach procedures. They are published every 4 weeks.

FLIP Terminal Aerodrome Sketches—U.S.

This publication is a bound booklet containing IFR and VFR aerodrome sketches arranged in alphabetical order by aerodrome name. Sketches are designed as an aid to visual identification of aerodromes. They are published every 16 weeks.

FOREIGN CLEARANCE GUIDE

The Foreign Clearance Guide is a group of bound booklets, including a general information section. The Foreign Clearance Guide is the official publication for disseminating USAF worldwide foreign clearance requirements and information on personnel travel; aircraft movement to, from, and between foreign areas; and transport of material aboard aircraft. It is also used by the Navy and Army. Revised area booklets and general information sections are issued on a semiannual and quarterly basis. The Foreign Clearance Guide Change Notices (FCCN) are issued monthly. These notices contain a cumulative listing of all permanent and temporary changes not yet incorporated in the booklets. A classified supplement is issued quarterly. Teletype Interim Changes Notices (ICN) are dispatched as required to selected addressees who require immediate notification of changes to the Guide.

DOD CATALOG OF AERONAUTICAL CHARTS AND FLIGHT INFORMATUON PUBLICATIONS

This catalog is a looseleaf publication, which provides a complete listing of DOD/USN/USAF aeronautical charts, flight information publications, and miscellaneous items available to DOD users. It includes indexes of available items, together with descriptive information for each item and requisitioning procedures. In this publication will be found added detail regarding publications produced by other agencies, and

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available for DOD usage (such as ICAO documents). A classified supplement is also available.

DOD AERONAUTICAL CHART UPDATING MANUAL (CHUM)

This manual is published monthly to provide a cumulative listing of significant additions or corrections to be considered when using current editions of USAF/USN published aeronautical charts. It is used to up date charts other than those contained in the FLIP series and contains notices of special interest to aeronautical chart users. It should be made available to flight crews during preflight planning.

DOD AERONAUTICAL CHART BULLETIN

This is also a monthly publication to inform activities of the availability of new aeronautical charts and publications, new additions of previously published charts, discontinued charts, and notices of special interest to requisitioners of aeronautical charts. The chart bulletin may be placed in the front of the DOD Catalog of Aeronautical Charts and Flight Information Publications for ready reference during preflight planning.

New issues of the Bulletin do not make prior issues obsolete. The most recent six issues of the Bulletin become obsolete by each subsequent publication of the DOD Aeronautical Chart Bulletin Digest.

DOD AERONAUTICAL CHART BULLETIN DIGEST

This bulletin is published semiannually to provide activities with a listing of current editions of charts on issue. This information is provided so a check can be made of charts on hand to assure that editions carried are up to date.

NAVY PUBLICATIONS

MEMORANDUM FOR AVIATORS

This publication is published when necessary to disseminate urgent information or information of a temporary nature concerning dangers and aids to navigation.

DIRECTIVES

Directives pertinent to policies, operating procedure, etc., are set forth in the form of instructions and notices by authorities in the chain of command. Each activity maintains a current file of those instructions and notices directly related to air traffic control. AC's should familiarize themselves with all such directives which in any way pertain to their rating.

GENERAL FLIGHT AND OPERATING INSTRUCTIONS, OPNAV 3710.7 (SERIES)

This manual prescribes general flight and operating instructions and procedures applicable to the operation of naval aircraft and related activities. Chapters 5 and 6 are of direct interest to the AC 3 & 2 and chapter 11 to a lesser extent. AC's should familiarize themselves with the appropriate parts of this manual since it is applicable to the naval establishment and compliance with the procedures is mandatory.

CVA/CVS NAVAL AIR TRAINING AND OPERATING PROCEDURES STANDARDIZATION (NATOPS) MANUAL

This manual is published under the authority of the Chief of Naval Operations as part of the NATOPS program. Extensive coverage of CCA operating procedures and responsibilities is included.

AIR OPERATIONS MANUAL

OpNav Instruction 3710.7 (Series) sets forth a basic outline for preparing standard Air Operations Manuals. These manuals are prepared locally under the supervision of the commanding officers of the air stations and they must be signed by the commanding officers.

These manuals contain specific information and instructions for the control of aircraft and aircraft-handling equipment in use at the field, instructions relating to transient aircraft and personnel, and procedures for crash and rescue. The Operations Manual should be read and understood by all Air Controlmen soon after reporting to a new duty station so as to become familiar with types of local operations and facilities.

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TECHNICAL MANUALS

In all phases of work, the Air Controlman operates different types of electronic equipment designed for use in air traffic control. To efficiently and effectively use these different types of equipment, the Air Controlman must know where to find information describing proper equipment operating procedures. With such technical assistance and instructions from experienced personnel, the time required to become familiar with a particular piece of equipment may be shortened. Equipment familiarity is necessary to be a good controller since one must have confidence in his ability to operate and in the performance of the equipment.

There is a technical manual published for each electronic equipment system. This manual should be available in the local ground electronics shop. One chapter in each manual is devoted to operation. Such chapters contain information necessary for operating personnel to start, operate, and stop the equipment.

RECORDS AND REPORTS

While performing duties in the different fields of the rating, certain records, reports, operating logs, and equipment logs are maintained by the Air Controlman. With the exception of a few, there is no standard authorized format to be employed in the maintenance of these records. However, the general contents of many are the same. The reports, records, and logs discussed in this chapter are the ones that are maintained by control towers, operations offices, and radar facilities.

CONTROL TOWER WATCH STANDER'S LOG

This record or log is kept from watch to watch in all Navy control towers. It contains all of the pertinent data accumulated during each watch performed in the control tower. A partial listing of the data that is entered indicates status of equipment, check of communications, status of airport lighting facilities, runway or runways in use, and any other information deemed necessary by the control tower officer, chief, or section leader of the tower concerned. The items listed above are not standard throughout the Navy, but they serve to indicate certain items which should be contained in the control tower log.

At many facilities it is an accepted practice to make an entry in the tower log of the weather when the watch is changed and at anytime the field goes from VFR to IFR weather conditions or vice versa.

Additionally, many facilities log entries of emergencies and crashes in the tower log in red ink. All details of such incidents with the associated time of occurrence are included for later reference.

DAILY AND MONTHLY TRAFFIC COUNTS

To facilitate completion of certain reports required of the ATC Division, a daily and monthly tabulation of aircraft operations is necessary. One system commonly used is posting flight progress strips (described in chapter 3) on each operation. At midnight a traffic count is made from the strips and subsequently a monthly count is made. These strips are kept for 3 months before they are destroyed. If any strip contains information on an aircraft involved in an accident or emergency, it is kept for a longer period of time.

This same basic procedure may also be used in flight clearance and at the approach control position in a RATCC; however, different data is required at these positions.

FLIGHT CLEARANCE OFFICE LOGS AND RECORDS

The flight clearance office is the central point for processing aircraft movement and related messages. This office must maintain various records, logs, and files connected with air operations. Examples of information on file include SCATANA action forms, Facility License for civilian concerns, VIP notification procedure, telephone numbers of other departments that furnish services required by transient aircrews, FLIP's, and FAA publications required in daily functions. Examples of records kept are flight plans (DD 175's) filed with flight clearance, flight progress strips, and teletype messages.

Duty Dispatcher's Log

The duty dispatcher's log is maintained at the clearance desk from watch to watch. Personnel assuming the watch enter in the log

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To track a moving target, an error signal is necessary. Error signals are obtained by comparison. In sequential scanning the error signal is obtained by comparing the strength of echo returns from successive pulses. In monopulse systems the pulse is divided into four separate parts in the waveguide system. The four parts are radiated by separate feed horns, and are combined by the antenna into a single beam. Return echoes are divided back into four parts. The relative strength of the parts are compared to obtain target position with respect to the antenna axis (fig. 15-9).

The heart of this monopulse system is called the microwave comparator. It consists of four feed horns, four hybrid rings, and connecting waveguide sections.

NOTE: Prior to the discussion of monopulse comparator operation, a review of the basic operation of a hybrid ring is considered necessary. This discussion follows.

HYBRID RING REVIEW

The hybrid ring is used principally as a duplexer in a high power radar system. However, a combination of three hybrid rings may be used as a balance mixer. This type of mixer is very effective in isolating the receiver from the transmitter during the time the transmitter is firing.

A simplified version of the hybrid ring used as a duplexer is illustrated in figure 15-10 (A) and (B). The operation during transmission and reception is illustrated in parts (C) and (D), respectively.

During TRANSMISSION (fig. 15-10 (C)), the operation of the hybrid ring may be explained as follows:

1. The field from the transmitter enters arm 3. At the junction with the ring, the field divides into two out-of-phase fields, one moving clockwise around the ring and the other, counterclockwise. (See fig. 15-11 (B) (1)). In order that energy may be coupled to the antenna via arm 1, the E fields arriving at the arm 1 junction must be 180° out of phase (fig. 15-11 (B) (3)).

2. The field moving clockwise around the ring from arm 3 fires the TR tube in arm 4, and the energy is blocked from the receiver or load. A high impedance (equivalent to an open circuit) appears at the junction of arm 4 and the ring. There is a phase reversal at this junction (fig. 15-11 (B) (4)).

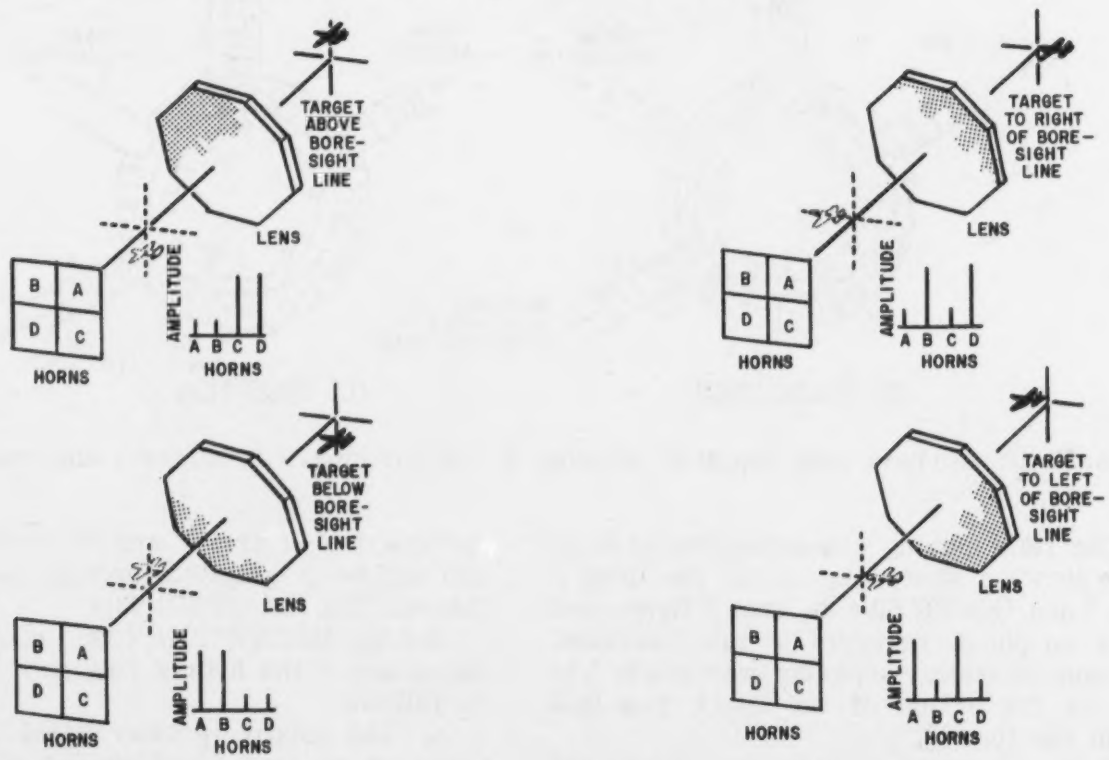

Figure 15-9.—Amplitude changes of received energy with target position.

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their name and the date and time the watch is being performed. Examples of entries made in such a log are crash phone check, time checks, intercommunications checks, and any other data pertinent to operations that transpires during the watch.

PASS DOWN THE LINE (PDL) LOG

This type of log may be maintained for the purpose of passing instructions from crew to crew and to insure that night crews have access to information etc. put out by supervisors who work straight days. Also it may be used to relay local verbal standing or temporary orders issued by the division or operations officer. It is generally an informal type log strictly for the purpose of getting the word to everyone.

RADAR FACILITIES RECORDS

Radar facilities must keep an accurate record of all radar approaches and services provided. The most common method, in addition to approach control flight progress strips where applicable, is a daily run sheet. Various formats are used; however, the information recorded includes the aircraft involved, frequency used, weather, type of approach or service provided, and the controller. All this information, along with information from other positions, is the basis for the monthly and quarterly reports required of such facilities. Care must be taken to insure that complete information is recorded to provide for accurate reports.

FLIGHT DATA AND STATUS BOARDS

To reduce the constant answering in the air operations office of questions from the general public, flight data and status boards are useful tools to the Air Controlman. The actual size, shape, and construction, as well as the manner in which the information is portrayed, undoubtedly may vary from station to station. However, the information normally displayed on the flight data board for inbound flights is as follows:

1. Bureau number.
2. Type aircraft
3. Point of departure.
4. ETA.
5. Pertinent remarks.

Status boards are usually of the type to show the present status of the various navigational aids at the particular station. It is also possible that an additional status board may be maintained by the Air Controlman at stations assigned aircraft for search and rescue purposes. This type status board normally contains information as to the flight status of the aircraft assigned and pertinent information concerning the crew.

Status boards may be maintained in a RATCC showing the area of responsibility and adjoining airspace, airways and jet routes, SID's, fixes, handoff points, holding points and holding pattern airspace areas, and the published approaches available for reference at operating positions.

When assigned the duty of maintaining any status board, remember that the information is important and should be kept neat, accurate, and current at all times.

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APPENDIX 1

DEFINITIONS AND ABBREVIATIONS

ACIC.—Aeronautical Charting and Information Center.

ADVISORY SERVICE.—Advice and information provided by a facility to assist pilots in the safe conduct of flight and aircraft movement.

AIM.—Airman's Information Manual.

AIR COORDINATING COMMITTEE (ACC).—A committee organized to investigate aviation problems and developments affecting more than one government agency.

AIRCRAFT MOVEMENT INFORMATION SECTION (AMIS).—A service to provide aircraft identification for security purposes.

AIRCRAFT OPERATIONS.—Arrivals or departures of aircraft at airports.

AIR DEFENSE COMMAND (ADC).—A service providing for national defense.

AIR DEFENSE IDENTIFICATION ZONE (ADIZ). —Area within which the security control of air traffic is exercised.

AIR-GROUND COMMUNICATIONS.—Air-to-ground and ground-to-air communication; used in traffic control, search and rescue, inflight advisory service, emergency recall, security identification, and air safety advice.

AIRMET.—Airmen's Meteorological Information.

AIRPORT.—An area of land or water that is used or intended to be used for the landing and takeoff of aircraft, and includes its buildings and facilities, if any.

AIRPORT SURFACE DETECTION EQUIPMENT (ASDE).—A short distance radar used for the control of aircraft and surface vehicles on an airport.

AIRPORT SURVEILLANCE RADAR (ASR).—A relatively short range radar used by control tower personnel for arrival and departure control within a 30-mile area.

AIRPORT TRAFFIC AREA.—Unless otherwise specifically designated, that airspace within a horizontal radius of 5 statute miles from the geographical center of any airport at which a control tower is operating, extending from the surface up to, but not including, 2,000 feet above the surface.

AIRPORT TRAFFIC CONTROL SERVICE.—Air traffic control service provided by an airport traffic control tower for aircraft operating on the movement area and in the vicinity of an airport.

AIRPORT TRAFFIC CONTROL TOWER (TOWER).—A facility providing airport traffic control service.

AIR ROUTE TRAFFIC CONTROL CENTER (CENTER).—A facility established to provide traffic control service to instrument flight rules (IFR) flights operating within controlled airspace and principally during the en route phase of flights.

AIR TRAFFIC.—Aircraft in operation anywhere in the airspace and on that area of an airport normally used for the movement of aircraft.

AIR TRAFFIC CLEARANCE.—Authorization by air traffic control facilities, for the purpose of preventing collision between known aircraft, for an aircraft to proceed under specified traffic conditions within controlled airspace.

AIR TRAFFIC CONTROL FACILITY (FACILITY).—A facility providing air traffic control service.

AIR TRAFFIC CONTROL SERVICE (CONTROL). —A service provided for the purpose of promoting the safe, orderly, and expeditious flow of air traffic including airport, approach, and en route air traffic control services.

AIR TRAFFIC CONTROL SPECIALIST (CONTROLLER).—A duly authorized person providing air traffic control service.

ALERT AREA.—Airspace within which flights are not restricted but pilots should be aware that a high volume of unusual aerial activity exists.

ALNOT.—Alert notice.

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ALTERNATE AIRPORT.—An airport, specified in the flight plan, to which a flight may proceed when a landing at the point of first intended landing becomes inadvisable.

ALTIMETER.—An aneroid barometer graduated to show height instead of pressure.

ALTIMETER SETTING.—A barometric pressure in inches for setting a pressure scale type altimeter.

ALTIMETER SETTING INDICATOR.—A direct reading aneroid barometer graduated to show station pressure corrected to sea level.

ALTRV.—Altitude reservation.

AMOS.—Automatic Meteorological Observing System.

ANEROID BAROMETER.—An instrument for measuring atmospheric pressure.

APPROACH CONTROL FACILITY.—A facility providing approach control service.

APPROACH CONTROL SERVICE.—Air traffic control service, provided by a terminal area traffic control facility, for arriving and departing IFR aircraft and, on occasion, VFR aircraft.

APPROACH FIX.—The fix from or over which final approach (IFR) to an airport is executed.

APPROACH GATE.—That point on the final approach course which is 1 mile from the approach fix on the side away from the airport or 5 miles from the landing threshold, whichever is farther from the landing threshold.

APPROACH LIGHTING.—A configuration of ground lights placed in the approach area to a runway, to assist the pilot in making an approach to that runway.

APPROACH SEQUENCE.—The order in which aircraft are positioned while awaiting approach clearance or while on approach.

ARAC.—Army radar approach control facility.

ARC.—The track over the ground of an aircraft flying at a constant distance from a navaid by reference to distance measuring equipment (DME).

ARCP.—Air refueling control point.

ARIP.—Air refueling initial point.

ARRIVAL.—An aircraft arriving at an airport.

ATC.—Air Traffic Control.

ATCRBS.—Air traffic control radar beacon system.

ATIS.—Automatic Terminal Information Service.

AUTOMATIC DIRECTION FINDER (ADF).—An L/MF device, giving relative bearings on the L/MF navaids. The ADF is normally used for homing purposes but can be used in conjunction with the magnetic compass to provide line-of-position information.

AVIATION WEATHER OBSERVATION.—An evaluation made from the surface, according to set procedures, of those weather elements which are most important for aircraft operations.

AZ-EL.—A type of radarscope that provides azimuth, range and elevation data. This unit of radar is used by precision radar units.

AZIMUTH.—Angular position or bearing in a horizontal plane.

BASE LINE.—The line formed by the sweep on a cathode-ray tube. Commonly referred to as time base.

BASIC VFR.—Ceiling of 1,000 feet and visibility of 3 miles.

BEARING.—The direction of the line of sight, from the radar antenna to the target, measured in degrees.

BEARING CURSOR.—A mechanical bearing line for reading target and/or course. Also commonly known as navigation head.

BLIND ZONE.—The area within the coverage of the radar reception pattern where radar echoes cannot be received.

CALIBRATION MARKERS.—Indications on the screen of a radar indicator which divide the range scale into known intervals for range determination, or for checking against mechanical indicating dials, scales, or counters.

CANADIAN AIR DEFENSE IDENTIFICATION ZONE (CADIZ).—An ADIZ located in Canada.

CARDINAL ALTITUDES OR FLIGHT LEVELS.—Odd or even 1,000-foot altitudes or flight levels. Examples: 5,000, 6,000, 7,000, FL 250, FL 260, FL 270.

CEILING.—The height above the ground or water of the lowest layer of clouds or obscuration phenomena that is reported as "broken," "overcast," or "obscuration," and not classified as "thin," or "partial."

CENTER's AREA.—The specified airspace within which an air route traffic control center provides air traffic control and advisory service.

CENTRAL ALTITUDE RESERVATION FACILITY (CARF).—A facility established to act as a clearing house for mission type flights.

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CLEARANCE.—An air traffic control clearance.

CLEARANCE LIMIT.—The fix to which an aircraft is issued an air traffic clearance.

CHECK OBSERVATION.—An abbreviated surface aviation weather observation taken to determine if certain elements have changed by some specific value since the preceding aviation observation.

CODES.—The numbers assigned to the multiple pulse reply signals transmitted by ATCRBS and SIF transponders.

COMBINED STATION/TOWER (CS/T).—A facility resulting from the combining of a Flight Service Station and an Airport Traffic Control Tower, as is done for economy at relatively low activity airports.

COMMON SYSTEM.—Common civil/military system of air traffic control and navigation.

COMPASS LOCATOR.—An L/MF nondirectional radio beacon installed in the approach area, at or near the ILS outer marker and/or middle marker, to be used with an airborne direction finder in making an approach to landing.

CONAC.—Continental Air Command.

CONTACT APPROACH.—An approach wherein an aircraft on an IFR flight plan, operating clear of clouds with at least 1 mile flight visibility and having received an air traffic control authorization, may deviate from the prescribed instrument approach procedure and proceed to the airport of destination by visual reference to the surface.

CONTROLLED AIRSPACE.—Airspace designated as continental control area, control area, control zone, or transition area, within which some or all traffic may be subject to air traffic control.

(1.) CONTINENTAL CONTROL AREA.—airspace within the continental United States at and above 14,500 feet MSL, excluding the State of Alaska, airspace less than 1,500 feet above terrain, and prohibited and restricted areas (except certain specified restricted areas).

(2.) CONTROL AREA.—Unless otherwise provided, airspace extending upward from 700 feet above the surface (until designated from 1,200 feet above the surface or from at least 300 feet below the MEA, whichever is higher) to the base of the continental control area.

(3.) CONTROL ZONE.—Airspace extending upward from the surface of the earth which may include one or more airports and is normally a circular area of 5 statute miles in radius with extensions where necessary to include instrument approach and departure paths.

(4.) TRANSITION AREA.—Airspace extending upward from 700 feet or more above the surface of the earth when designated in conjunction with an airport for which an approved instrument approach procedure has been prescribed, or from 1,200 feet or more above the surface of the earth when designated in conjunction with airway route structures or segments. Unless otherwise limited, transition areas terminate at the base of the overlying controlled airspace.

CONTROL SLASH.—That slash, of a beacon target consisting of more than one slash, which represents the actual position of the associated aircraft. The control slash is always the one closest to the interrogating radar beacon site.

CORNER REFLECTOR.—A metal device of triangular shape, used for the purpose of providing a strong radar echo from a known position on the ground.

CPN.—"C" for air transportable, "P" for pulse radar, "N" for navigation aid. This is a self-contained truck-trailer unit with both surveillance and precision equipment (military).

CPS.—Air transportable/pulse radar/"S" for search radar. Equipment used for long range early warning purposes (military).

CRUISE.—A word used instead of the word "maintain" in an ATC clearance to indicate to a pilot that climb to and descent from the assigned altitude may be made at his discretion.

CRUISING ALTITUDE.—A level determined by vertical measurement from mean sea level.

DECODER.—The device used to deciper signals received from ATCRBS and SIF transponders to effect their display as select codes.

DIRECTION FINDER (DF).—VHF/UHF navigation aid operated by personnel on the ground to furnish azimuth information to aircraft.

DISTANCE MEASURING EQUIPMENT (DME).—Equipment (airborne and ground) used to measure, in nautical miles, the distance of an aircraft from a navigational aid.

DME FIX.—A geographical position determined by reference to a navigational aid which provides distance and azimuth information and defined by a specified distance in nautical miles and a radial in degrees magnetic from the aid.

DME SEPARATION.—Spacing of aircraft in terms of distances determined by reference to distance measuring equipment (DME).

ECHO.—The signal reflected by a target (fixed or moving) to a radar receiver. Also, the deflection or indication, on the screen of a cathode-ray tube, representing a target.

EDDY.—A local irregularity in a wind. All winds near the earth's surface contain eddies, which at any given place produce gusts or lulls. Air containing numerous eddies is said to be turbulent.

EN ROUTE AIR TRAFFIC CONTROL SERVICE.—Air traffic control service provided aircraft on an IFR flight plan, generally by centers, when these aircraft are operating between departure and destination terminal areas.

ESTABLISHED AIRWAYS/ROUTES.—Preplanned and/or published airways or routes not requiring "on-the-spot" computation by the controller to determine airspace to be protected. These include:

(1.) A designated airway, published in the FAR's, plus any locally charted turning-radius airspace.

(2.) A designated route, published in the FAR's and its locally charted, associated, protected airspace, plus any turning-radius airspace.

(3.) A direct route, locally charted by a facility for sector use but not disseminated in the FAR's, and its associated, protected airspace plus any turning-radius airspace.

ESTIMATED TIME OF ARRIVAL (ETA).—Estimated time of arrival over the point of first intended landing.

EXPECTED APPROACH CLEARANCE TIME (EAC).—The time at which it is expected that an arriving aircraft will be cleared to commence approach for a landing.

EXPECTED FURTHER CLEARANCE TIME (EFC).—The time at which it is expected that additional clearance will be issued to a flight.

FACILITY.—See air traffic control facility.

FANMARKER (FM).—A radio navigation aid creating a pattern in the vertical plane, placed perpendicularly across an airway to mark certain points along the airway course.

FAR.—Federal Aviation Regulations.

FAST TIME CONSTANT (FTC).—An anticlutter circuit, effective in breaking up large blocks of signals into small echoes so that aircraft might be tracked more easily.

FAWS.—Flight Advisory Weather Service.

FEDERAL AVIATION ADMINISTRATION (FAA).—The administration of the United States created to provide for the regulation and promotion of civil aviation in such a manner as to best foster its development and safety, and to provide for the safe and efficient use of the airspace by both civil and military aircraft.

FINAL APPROACH-IFR.—The flightpath of an aircraft which is inbound to the airport on an approved final instrument approach course, beginning at the point of interception of that course and extending to the airport or the point where circling for landing or missed approach is executed.

FINAL APPROACH-VFR.—A flightpath of a landing aircraft in the direction of landing along the extended runway centerline from the base leg to the runway.

FINAL CONTROLLER.—That controller providing final approach guidance utilizing precision approach radar equipment.

FIX.—A geographical position determined by visual reference to the surface, by reference to one or more radio navaids, by celestial plotting, or by another navigational device.

FLIGHT LEVEL (FL).—A level of constant atmospheric pressure related to a reference datum of 29.92 inches in mercury. Each is stated in 3 digits that represent hundreds of feet. For example, FL 250 represents a barometric altimeter indication of 25,000 feet. FL 255 indicates 25,500 feet.

FLIGHT PLAN.—Specified information relating to the intended flight of an aircraft that is filed orally or in writing with an air traffic control facility.

FLIGHT SERVICE STATION (FSS)—An FAA Communication Station.

FLIGHT SERVICE SPECIALIST.—Flight Service Station personnel.

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FLIGHT VISIBILITY.—The average forward horizontal distance from the cockpit of an aircraft in flight at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.

FLOW CONTROL.—Limitations applied to the flow of traffic to keep elements of the system, such as airports or airways, from becoming overloaded.

FOG.—A cloud at the earth's surface.

FPN.—Fixed pulse radar navigational aid. Precision equipment or AZ-EL scope.

FPS.—Fixed pulse radar search equipment (military).

GAIN.—Control for increasing or decreasing the amplification of the radar data on the scope.

GENERAL AVIATION.—That segment of aviation operating for private purposes, either for individual pleasure or transportation of business personnel, crop dusting, etc.

GLAZE.—Term applied by the U.S. Weather Bureau to a smooth coating of ice on terestrial objects due to the freezing of rain.

GRASS.—A voltage fluctuation or electronic noise introduced into the receiver in such a manner that it appears on the scope. Sometimes referred to as snow. It gives the scope a speckled appearance so that weak signals might not be observed.

GROUND CLUTTERS.—Radar echoes reflected from ground targets or objects. In poor radar locations, obscurement of relatively large areas of the radar indicator may result.

GROUND CONTROLLED APPROACH (GCA).—The radar system developed to give azimuth, range, and elevation along a fixed approach path.

GROUND CONTROLLED INTERCEPT (GCI).—Long range high altitude equipment used by military AC & W units.

GROUND VISIBILITY.—Prevailing horizontal visibility near the earth's surface as reported by the U.S. Weather Bureau or an accredited observer.

GUST.—A sudden, intermittent increase in windspeed, with at least 9 knots variation between peaks and lulls.

HAIL.—A form of precipitation consisting of balls or irregular lumps of ice, often of considerable size, having a complex structure.

HAZE.—A lack of transparency in the atmosphere caused by the presence of dust or of salt particles left by evaporated ocean spray.

H FACILITY.—An L/MF nondirectional radio beacon primarily intended for use with airborne direction finders to give bearing information to the pilot.

HF COMMUNICATIONS.—Communications using highradio-frequencies (HF).

HH FACILITY.—A high powered H facility, used primarily for transoceanic or other long distance flights.

HIGH PRESSURE SYSTEM.—An area of high barometric pressure; an anticyclone.

HIGH RADIOFREQUENCY (HF).—3,000 to 30,000 kilohertz.

HOLDING.—A predetermined maneuver which keeps an aircraft within a specific airspace while awaiting further clearance.

HOLDING FIX.—A specified fix used as a reference point in establishing and maintaining the position of an aircraft while holding.

ICAO.—International Civil Aviation Organization.

IDENT FEATURE.—The special feature in ATCRBS equipment and the I/P feature in certain SIF equipment used to distinguish one displayed select code from other codes.

IFR AIRCRAFT.—An aircraft conducting flight in accordance with Instrument Flight Rules.

IFR CONDITIONS.—Weather conditions below the minimum for flight under Visual Flight Rules.

INSTRUMENT APPROACHES.—Approaches to airports made by aircraft under instrument flight rules.

INSTRUMENT FLIGHT RULES (IFR).—Rules prescribed by Federal Aviation Regulations governing instrument flight.

INSTRUMENT LANDING SYSTEM (ILS).—Consists of four radio transmitting stations on the ground and in the vicinity of an airport radiating directional signals to approaching aircraft. The received signals operate indicators in the aircraft to alert the pilot of any deviation from the ideal safe approach path to the correct touchdown point on the runway.

INTERFERENCE.—Confusing signals or patterns produced on a radar indicator by another radar on the same frequency, and more rarely, by the effects of nearby electrical apparatus or machinery, or by atmospheric phenomena.

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INTERNATIONAL FLIGHT SERVICE STATION (IFSS).—An FAA Communication Facility which provides services for overseas and international aircraft operations.

INTERPHONE.—See Service F.

INTERROGATOR.—The ground-based surveillance radar beacon transmitter-receiver which scans in synchronism with a primary radar, transmitting discrete radio signals which repetitiously request all transponders, on the mode being used, to reply. The replies received are then mixed with the primary radar video to be displayed on the same plan position indicators.

I/P FEATURE.—See IDENT feature.

ISJTA.—Intensive student jet training area.

ITINERANT TRAFFIC.—Air traffic moving from one locality to another, as opposed to local traffic.

JET ADVISORY SERVICE.—The service provided certain civil aircraft while operating within radar and nonradar jet advisory areas. Within radar jet advisory areas, civil aircraft receiving this service are provided radar flight following, radar traffic information, and vectors around observed traffic. In nonradar jet advisory areas, civil aircraft receiving this service are afforded standard IFR separation from all other aircraft known to ATC to be operating within these areas.

JET ROUTES.—Routes at and above 18,000 feet.

JET STREAM.—A concentrated core of high speed winds embedded in the general flow.

LANDING THRESHOLD.—The beginning of that portion of a runway usable for landing.

LATERAL SEPARATION.—The lateral spacing of aircraft at the same altitude by requiring operation on different routes or in different geographical locations.

LINE OF POSITION.—A navigational term meaning the line of position along the earth's surface defined by some characteristic of a navigational aid or technique.

LOCAL OBSERVATION.—An abbreviated weather observation taken at specified intervals, usually every 15 minutes, when aircraft operations are impending and when weather conditions are below certain operational weather limits; also taken when an aircraft accident is reported in the vicinity.

LOCAL TRAFFIC.—Aircraft operating in the traffic pattern of the landing area concerned.

LONGITUDINAL SEPARATION.—The longitudinal spacing of aircraft at the same altitude by a minimum distance so that after one aircraft passes over a specified position, the next aircraft at the same altitude will not arrive over the same position within less than the standard minimum separation.

MAP OVERLAY.—Plexiglas sheet laid over the face of the scope, etched to display radio facilities and landmarks of the area under radar coverage.

MARKER.—Electronic range or bearing indication on a radar indicator.

MARSA.—Military assumes responsibility for separation of aircraft.

MICROSECOND.—One-millionth of a second. The unit of time commonly used in radar.

MICROWAVE EARLY WARNING (MEW).—This is the long range-high altitude equipment used for coastal monitoring units (military).

MIDDLE MARKER.—Radio beacon emitting a vertical fanshaped pattern, normally placed 3,500 feet out from the approach end of the runway, along the localizer course.

MILLIBAR.—A unit of pressure equal to a force of 1,000 dynes per square centimeter.

MINIMUM CROSSING ALTITUDE (MCA).—The lowest altitude at certain radio fixes at which an aircraft must cross when proceding in the direction of a higher minimum en route IFR altitude.

MINIMUM EN ROUTE IFR ALTIUDE (MEA). —The altitude in effect between radio fixes which assures acceptable navigational signal coverage and meets obstruction clearance requirements between those fixes.

MINIMUM OBSTRUCTION CLEARANCE ALTITUDE (MOCA).—The specified altitude in effect between radio fixes on VOR airways, off-airway routes, or route segments which meets obstruction clearance requirements for the entire route segment and which assures acceptable navigational signal coverage only within 22 miles of a VOR.

MINIMUM RECEPTION ALTITUDE (MRA).—The lowest altitude required to receive adequate signals to determine specific VOR/VORTAC/TACAN fixes.

MODE.—The number or letter referring to the specific pulse spacing of the signals transmitted by an interrogator.

MOVEMENT AREA.—The part of an airport reserved for the taking off, landing, and taxiing of aircraft.

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MOVING TARGET INDICATOR (MTI).—A device which limits the display of radar information primarily to that of moving objects; e.g., aircraft or surface vehicles.

MSL.—Mean sea level.

NATIONAL AIRSPACE SYSTEM.—The common system of air traffic and air traffic control encompassing communication facilities, air navigation facilities, airways, controlled airspace, special use airspace, and flight procedures authorized by Federal Air Regulations for domestic and international aviation.

NAVAID.—Navigational aid.

NOTAM.—A Notice to Airmen in message form requiring expeditious and wide dissemination by telecommunications.

NATIONAL SEARCH AND RESCUE PLAN.—An interagency agreement whose purpose is to provide for the effective utilization of all available facilities in all types of search and rescue missions.

OUTER FIX.—A fix in the destination terminal area, other than the approach fix, to which aircraft are normally cleared by an air route traffic control center or a terminal area traffic control facility, and from which aircraft are cleared to the approach fix or final approach course.

OUTER MARKER.—Radio beacon emitting a vertical fanshaped pattern, normally placed 4 1/2 miles out from the approach end of the runway, along the localizer course.

PARALLAX.—The apparent displacement of a target due to the eye position of the observer. Occurs when a map overlay system is used.

PENETRATION.—That portion of a published high altitude instrument approach procedure which prescribes a descent path from the fix on which the procedure is based to a fix or altitude from which an approach to the airport is made.

POSITIVE CONTROL AREA.—Airspace so designated by FAR 71.193 and depicted on high altitude charts between FL 180 or FL 240 up to and including FL 600.

PRECAUTIONARY APPROACH.—A procedure designed to afford a pilot experiencing flight difficulties a means of landing safely and expeditiously while providing a safe ejection altitude if he elects to discontinue the approach.

PRECIPITATION.—A collective name for deposits of atmospheric moisture in liquid and solid form, including rain, snow, hail, dew, hoar frost, etc.

PRECISION APPROACH.—An instrument approach conducted in accordance with directions issued by a controller referring to the surveillance radar display until the aircraft is turned onto final approach and, thereafter, to a precision approach radar display.

PRECISION APPROACH RADAR (PAR).—Utilizing the AZ-EL scopes, it gives the controller three types of radar data—azimuth, elevation, and range. Used for the final approach portion of the approach.

PRESENTATION.—The form which the radar echo signals are made to take on the cathode-ray tube screen, as determined by the nature of the sweep circuit utilized. Examples: AZ-EL or surveillance presentation.

PREVAILING VISIBILITY.—The greatest horizontal visibility which is equalled or exceeded through half of the horizon circle. It need not be a continuous half. In the case of rapidly varying conditions, it is the average of the prevailing visibility while the observation is being taken.

PRIMARY RADAR.—See radar.

PROHIBITED AREA.—Airspace identified by an area on the surface of the earth within which the flight of aircraft is prohibited. A prohibited area may be established by the President of the United States or any State of the United States.

PULSE.—A momentary, sharp change in a current or voltage, followed almost immediately thereafter by a sharp return to normal.

PULSE LENGTH OR DURATION.—Elapsed time, from start to finish, of a single pulse. Radar uses one antenna for both transmitting and receiving. Transmissions must cease prior to the moment of reception. A system of pulsed energy makes the use of one antenna possible. The length of time the transmitter is ON during one cycle is determined by the pulse length.

PULSE REPETITION FREQUENCY (PRF).—After a pulse is fired, the transmit-receive switch shifts to receive. The transmitter remains off for a period greater than the time required for the pulse to return. This process is repeated continuously at a rate known as the pulse repetition frequency.

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RADAR (RADIO DETECTION AND RANGING).—A device which, by measuring the time interval between transmission and reception of radio pulses and correlating the angular orientation of the radiated antenna beam or beams in azimuth and/or elevation, provides information on range, azimuth, and/or elevation of objects in the path of the transmitted pulses.

(1.) PRIMARY RADAR.—A radar system in which a minute portion of a radio pulse transmitted from a site is reflected off an object and then received back at that site.

(2.) RADAR BEACON (SECONDARY RADAR).—A radar system in which the object to be detected is fitted with cooperative equipment in the form of a radio receiver/transmitter (transponder). Radio pulses transmitted from the searching transmitter/receiver (interrogator) site are received in the cooperative equipment and used to trigger a distinctive transmission from the transponder. This latter transmission, rather than a reflected signal, is then received back of the transmitter/receiver site.

RADAR ADVISORY.—The term used to indicate that the provision of advice and information is based on radar observation. (See advisory service.)

RADAR CONTACT.—The term an air traffic controller uses to inform an aircraft that it is identified on the radar display, that radar service can be provided until radar identification is lost or radar service is terminated, and that when the aircraft is informed of "radar contact" it automatically discontinues reporting over compulsory reporting points.

RADAR FLIGHT FOLLOWING.—The radar tracking of identified aircraft targets and the observation of the progress of these flights sufficiently to retain identity.

RADAR HANDOFF.—That action whereby radar identification of, radio communication with and, unless otherwise specified, control responsibility for an aircraft is transferred from one controller to another without interruption of radar flight following.

RADAR IDENTIFICATION.—The process of ascertaining that a radar target is the radar return from a particular aircraft.

RADAR INDICATOR.—A unit of radar equipment which provides a visual indication of the reflected energy received, using a cathode-ray tube or tubes for such indication. The radar indicator comprises, besides the cathode-ray tube, the sweep and calibration circuit, and associated power supplies.

RADAR RECEIVER.—An instrument which amplifies radio frequency signals, demodulates the RF carrier, further amplifies the desired signal and delivers it to the indicator. It differs from the usual radio receiver in that it is more sensitive, has a better signal to noise ratio, and is designed to pass a pulse type signal.

RADAR SERVICE.—A term which encompasses one or more of the following services based on the use of radar which can be provided by a controller to a radar-identified aircraft. These include:

(1.) Radar separation—radar spacing of aircraft in accordance with established minimums.

(2.) Radar navigational guidance—vectoring aircraft to provide course guidance.

(3.) Radar monitoring—the radar flight-following of an aircraft whose primary navigation is being performed by its pilots to observe and note deviations from its authorized flight path, airway, or route. This includes noting the aircraft's position relative to approach fixes.

RADAR SURVEILLANCE.—The radar observation of a given geographical area for the purpose of performing some radar function.

RADAR TRACKING.—The observation of the movement of specific radar targets.

RADAR TRANSMITTER.—A unit of radar equipment in which the radiofrequency power is generated and pulse modulated. Differs from communications transmitter in frequency and type of modulation used.

RADIAL.—A magnetic bearing extending from a VOR/VORTAC/TACAN.

RANGE MARKS.—Electronic reference lines appearing on the scope to indicate distance from either touchdown or the antenna site.

RANGE SELECTOR.—On surveillance equipment the controller has a choice of ranges to be presented. Usually four or five different setting from 5 miles to over 30 miles.

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RAPCON.—A radar approach control facility established by or in cooperation with the U.S. Air Force primarily to serve air traffic at an Air Force base.

RATCC.—A radar air traffic control center established by or in cooperation with the U.S. Navy primarily to serve air traffic at a naval air station.

RCC.—Search and rescue coordination center.

RCR.—Runway conditions reading.

RECEIVING CONTROLLER/FACILITY.—A controller/facility receiving control of an aircraft from another controller/facility.

RECORD OBSERVATION.—A type of aviation weather observation taken at scheduled intervals unless otherwise specified; the most complete of all such observations.

REPORTING POINT.—A geographical location in relation to which the pilot of an aircraft reports his position to air traffic control.

RESOLUTION:

(1). Range—The mimimum range difference between two separate targets at the same bearing that will allow both to appear as distinct, separate echoes on the indicator.

(2.) Bearing—The minimum angular separation between two targets at the same range that will allow both to appear as distinct, separate echoes on the indicator.

(3.) Elevation—The minimum angular separation in a vertical plane between two targets at the same range and bearing that will allow both to appear as distinct, separate echoes on the indicator.

RESTRICTED AREA.—An area in which there is a hazard, generally invisible, to flight or navigation such as aerial gunnery, guided missile, artillery, or other type firing. Permission must be granted to a flight before it may traverse an area during those periods when it is live, or in use.

RIME.—A rough or feathery coating of ice.

ROUTE.—A defined path, consisting of one or more courses, which an aircraft traverses in a horizontal plane over the surface of the earth.

RUNWAY END.—The end of that portion of a runway useable for landing or takeoff.

RUNWAY VISUAL RANGE (RVR).—The maximum distance in the direction of takeoff or landing at which the runway, or specified lights or markings delineating it, can be seen from a position above a specified point on its centerline, at a height corresponding to the average eye-level of pilots at touchdown.

SAR.—Search and rescue.

SCAN.—That area in space covered by the radar antenna pattern. It may be an area of 360° with varying ranges as on the airport surveillance radar, or a restricted area such as that of the precision radar.

SCOPE.—The face of the cathode-ray tube that is visible to the operator on which appears a display of a given area of coverage. It contains the visual display of the reception of the radar system and video mapping.

SCOPE ALINEMENT.—A means of checking the accuracy of the radar data received and displayed. It also is the means of making minor corrections to the radar display or attain proper and correct positioning of radar data.

SEARCH AND RESCUE FACILITY.—A facility responsible for maintaining and operating a search and rescue service for occupants of missing or downed aircraft.

SECONDARY RADAR.—(See radar.)

SELECT CODE.—That code displayed when the ground interrogator and the airborne transponder are operating on the same mode and code simultaneously.

SELS.—Severe Local Storms.

SENSITIVITY TIME CONTROL (STC).—This is an automatic electronic aid that reduces the gain of targets close in and increases the gain on targets at distance ranges.

SEPARATION.—Spacing of aircraft to achieve their safe and orderly movement in flight and while landing and taking off.

SEPARATION MINIMUMS.—The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of air traffic control procedures.

SERVICE A.—A teletypewriter network used to collect and distribute national service weather reports and NOTAM's.

SERVICE B.—A teletypewriter network used to distribute all messages pertaining to VFR flights and to supplement Service F for certain types of IFR movement and control messages.

SERVICE C.—A teletypewriter network used to collect and disseminate 3- and 6-hourly weather data, including upper air observations and weather map data, terminal and regional forecasts and weather advisories.

SERVICE F.—A system of telephone circuits (interphone) which are exclusive and

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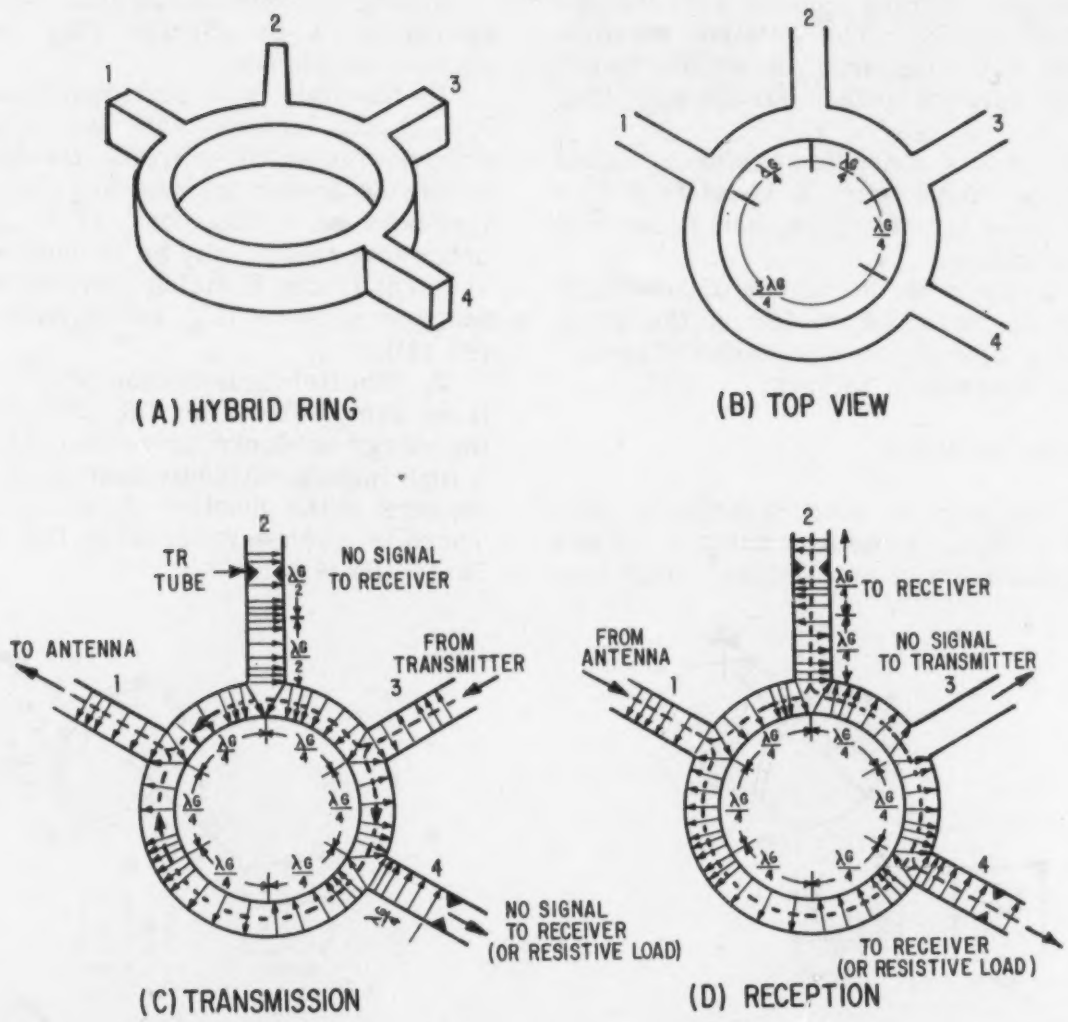

Figure 15-10.—Hybrid ring duplexer showing E lines during transmission and reception.

3. The field moving counterclockwise from arm 3 "sees" a short circuit at the arm 2 junction when the TR tube in arm 2 fires, and there is no phase reversal at this junction. The amount of energy entering waveguide 2 is limited by the action of the spark gap (not shown in the figure).

4. If the complete circuits are traced out (fig. 15-10 (C)), it will be seen that the clockwise and counterclockwise signals arriving at the junction of arm 1 are of opposite polarity and will be propagated through the arm to the antenna (fig. 15-11 (B) (3)).

During RECEPTION (fig. 15-10 (D)), the operation of the hybrid ring may be explained as follows:

1. The relatively weak signal from the antenna enters arm 1 and divides at the junction into two out-of-phase components (fig. 15-11 (B) (1)). To avoid coupling energy into the

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continually available for direct communications between ground stations for air traffic control purposes, to handle messages of aircraft position reports, clearance and requests for clearance for civil aircraft to enter or proceed through controlled airspace in accordance with instrument flight rules.

SERVICE O.—A teletypewriter system used to exchange meteorological data with locations outside the continental United States. Also used to disseminate meteorological information from overseas sources to key terminals and forecast centers within the United States.

SERVO.—An electromechanical system which is used for moving antenna(s) and giving an indication of their position.

SFA.—Single frequency approach.

SID.—Standard instrument departure.

SIF.—Selective identification feature (of the basis Mark X radar beacon system).

SIGMET.—Significant Meteorological Information.

SINGLE-PILOTED AIRCRAFT.—An aircraft possessing one set of flight controls, tandem cockpits, or two sets of flight controls but operated by one pilot.

SLANT RANGE.—The straight line distance to the target. Radar range is determined by slant line range and not the normal geographic ranging.

SLASH.—A radar beacon reply displayed as an elongated target.

SPECIAL OBSERVATION.—A category of aviation weather observation taken to report significant changes in one or more of the observed elements since the last preceeding record, record-special, or special observation.

SPECIAL VFR CONDITIONS (SPECIAL VFR MINIMUM WEATHER CONDITIONS.)—Weather conditions which are less than basic VFR weather conditions and which permit flight under Visual Flight Rules.

SPECIAL VFR OPERATIONS.—Aircraft operating in accordance with clearances within control zones in weather conditions less than the basic VFR weather minimums.

SQUALL.—A wind that increases suddenly in speed, maintains a peak speed of 16 knots or more over a period of 2 or more minutes, and then decreases in speed.

STATIONARY RESERVATIONS.—Altitude reservations which encompass activities in a fixed area. Stationary reservations may include such as special test of weapons systems or equipments, certain U.S. Navy carrier, fleet, and antisubmarine operations, rocket, missile and drone operations, and certain aerial refueling or similar operations.

STRAIGHT-IN APPROACH—IFR.—An instrument approach wherein final approach is begun without first having executed procedure turn.

STRAIGHT-IN APPROACH—VFR.—Entry of the traffic pattern by interception of the extended runway centerline without executing any other portion of the traffic pattern.

SUNSET AND SUNRISE.—The mean solar times of sunset and sunrise as published in the Nautical Almanac, converted to local standard time for the locality concerned. Within Alaska, the end of evening civil twilight and the beginning of morning civil twilight, as defined for each locality.

SURVEILLANCE APPROACH.—An instrument approach conducted in accordance with directions issued by a controller referring to the surveillance radar display.

SWEEP.—A luminescent line formed by a stream of electrons on the face of the radarscope.

TACAN.—UHF navigational aid (omnidirectional course information).

TACAN-ONLY AIRCRAFT.—An aircraft possessing TACAN but no VOR navigational system capability.

TAKEOFF CLEARANCE.—Authorization by an airport traffic control tower for an aircraft to take off.

TAKEOFF THRESHOLD.—The beginning of that portion of a runway usable for takeoff.

TARGET.—The indication shown on a radar display resulting from a primary radar return or a radar beacon reply.

TELETYPEWRITER SYSTEM.—A system of circuits, either landline or radio, whereby messages are transmitted or received in typewritten form.

TERMINAL AREA FACILITY.—A facility (RAPCON, RATCC or tower) providing air traffic control service for arriving and departing IFR aircraft and, on occasion, tower en route control service.

THUNDERSTORM.—A local storm produced by a cumulonimbus cloud, and always accompanied by lightning and thunder. It is usually accompanied by strong gusts of wind, heavy rain, and sometimes hail. It is usually of short duration, seldom over two hours.

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TOWER EN ROUTE CONTROL SERVICE.—Departure, en route and arrival control service provided to IFR aircraft by one or more terminal area facilities.

TRACK.—The flightpath of an aircraft over the surface of the earth.

TRACON.—Terminal Radar Control Facility.

TRAFFIC INFORMATION—RADAR.—Information issued to alert an aircraft to any radar targets observed on the radar display which may be in such proximity to its position or intended route of flight as to warrant its attention.

TRAFFIC PATTERN.—The traffic flow that is prescribed for aircraft landing at, taxiing on, and taking off from an airport. The usual components of a traffic pattern are upwind leg, crosswind leg, downwind leg, base leg, and final approach.

TRANSFERRING CONTROLLER/FACILITY.—A controller/facility transferring control of an aircraft to another controller/facility.

TRANSMISSOMETER.—A direct reading instrument that indicates the visibility in the vicinity of a particular runway, usually the instrument runway.

TRANSPONDER.—An airborne radar beacon receiver-transmitter which automatically receives radio signals from all interrogators on the ground and which selectively replies with a specific reply pulse or pulses group only to those interrogations being received on the mode to which it is set to respond.

TRIGGER.—A sharp voltage pulse usually from 1/2 to 2 microseconds, which is applied to the modulator tubes to fire the transmitter, and simultaneously applied to the sweep generator to start the electron beam moving from the sweep origin to the edge of the scope.

TURBOPROP.—Turbine-engine-driven propeller.

TURBOJET EN ROUTE DESCENT.—A procedure for effecting the descent of military jet aircraft from an en route altitude to the final approach without execution of the maneuvers prescribed in a published high altitude instrument approach procedure. Its purpose is to expedite the movement of air traffic.

TURBULENCE.—Irregular motion of the atmosphere produced when air flows over a comparatively uneven surface, such as the surface of the earth, or when two currents of air flow past or over each other in different direction or at different speeds.

TWEBS.—Transcribed Weather Broadcast Service.

UHF COMMUNICATIONS.—Communications using ultrahigh radiofrequencies.

ULTRAHIGH RADIOFREQUENCY (UHF).—300 to 3,000 megahertz.

USERS.—The various groups of aviation that use the services of the nation's aviation facilities.

VECTOR.—A heading issued to an aircraft to provided navigational guidance by radar.

VFR AIRCRAFT.—An aircraft conducting flight in accordance with Visual Flight Rules.

VFR CONDITIONS.—Basic weather conditions prescribed for flight under Visual Flight Rules.

VFR-ON-TOP.—A type of IFR clearance in which the aircraft may be operated at any altitude at or above the minimum en route altitude (MEA) which is 1,000 feet or more above the cloud layer.

VHF COMMUNICATIONS.—Communications using the very high radiofrequencies.

VIDEO MAPPING.—A method of reproducing a map of the area covered by the radar on the face of the cathode-ray tube or scope. It is electronically fed into the receiving system and displayed on the scope along with any target returns of the radar. The video mapper is synchronized with the antenna rotation so that the video map corresponds to the area covered by the antenna.

VISIBILITY.—The transparency and illumination of the atmosphere as affecting the distance at which objects can be seen.

VISUAL APPROACH.—An approach wherein an aircraft on an IFR flight plan, operating in VFR conditions and having received an air traffic control authorization, may deviate from the prescribed instrument approach procedures and proceed to the airport of destination by visual reference to the surface.

VISUAL FLIGHT RULES (VFR).—Rules prescribed by Federal Aviation Regulations governing visual flight.

VOR.—VHF navigational aid (omnidirectional course information).

VORTAC.—Collocated VOR and TACAN navigational aids (VHF and UHF course and UHF distance information).

WARM AIR MASS.—Broadly speaking, an air mass that is warm relative to neighboring

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air masses. The term implies that the air mass originated in latitudes lower than those in which it now finds itself and that it is, therefore, warmer than the surface over which it is moving.

WARM FRONT.—The discontinuity at the forward edge of an advancing current of relatively warm air which is displacing a retreating colder air mass.

WARNING AREA.—An airspace warning area is the same as a Restricted Area but is located outside the United States or its Territories and possessions.

WEATHER ADVISORY.—In aviation weather forecast practice, an expression of anticipated hazardous weather conditions as they affect the operation of air traffic and as prepared by the Weather Bureau.

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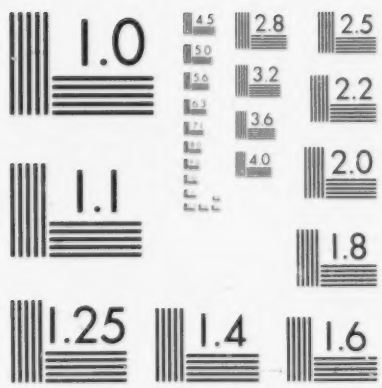

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX II

JOINT ELECTRONICS TYPE DESIGNATION SYSTEM

	Set Indicator Letters				
1st letter (designed installation classes)	2d letter (type of equipment)	3d letter (purpose)	Model No.	Modification letter	Miscellaneous identification
Installation	Type of Equipment	Purpose			
A—Piloted aircraft.	A—Invisible light, heat radiation.	A—Auxiliary assemblies (not complete operating sets used with or part of two or more sets or sets series).	1	A	X—Changes in.
B—Underwater mobile, submarine.	C—Carrier.	B—Bombing	2	B	Y—Voltage.
C—Air transportable (inactivated, do not use).	D—Radiac.	C—Communications (receiving and transmitting).	3	C	Z—Phase or frequency.
D—Pilotless carrier.	E—Nupac.	D—Direction finder, reconnaissance, and/or surveillance.	4, etc.	D, etc.	T—Training.
F—Fixed ground.	F—Photographic.	E—Ejection and/or release.			(V)—Variable grouping.
G—Ground, general ground use.	G—Telegraph or teletype.	G—Fire control or searchlight directing.			
K—Amphibious.	I—Interphone and public address.	H—Recording and/or reproducing (graphic, meteorological and sound).			
M—Ground, mobile.	J—Electromechanical or inertial wire covered.	K—Computing.			
P—Portable.	K—Telemetering.				
S—Water surface.	L—Countermeasures.				
T—Ground, transportable.	M—Meteorological.				
U—General utility.	N—Sound in air.				
V—Ground, vehicular.	P—Radar.				

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APPENDIX II

JOINT ELECTRONICS TYPE DESIGNATION SYSTEM—Continued.

	Set Indicator Letters				
1st letter (designed installation classes)	2d letter (type of equipment)	3d letter (purpose)	Model No.	Modification letter	Miscellaneous identification
Installation	Type of Equipment	Purpose			
W—Water surface and underwater combination.	Q—Sonar and underwater sound. R—Radio. S—Special types, magnetic, etc., or combinations of types. T—Telephone (wire). V—Visual and visible light. W—Armament (peculiar to armament, not otherwise covered). X—Facsimile or television. Y—Data processing.	M—Maintenance and test assemblies (including tools). N—Navigational aids (including altimeters, beacons, compasses, racons, depth sounding, approach, and landing). Q—Special or combination of purposes. R—Receiving, passive detecting. S—Detecting and/or range and bearing, search. T—Transmitting. W—Automatic flight or remote control. X—Identification and recognition.			

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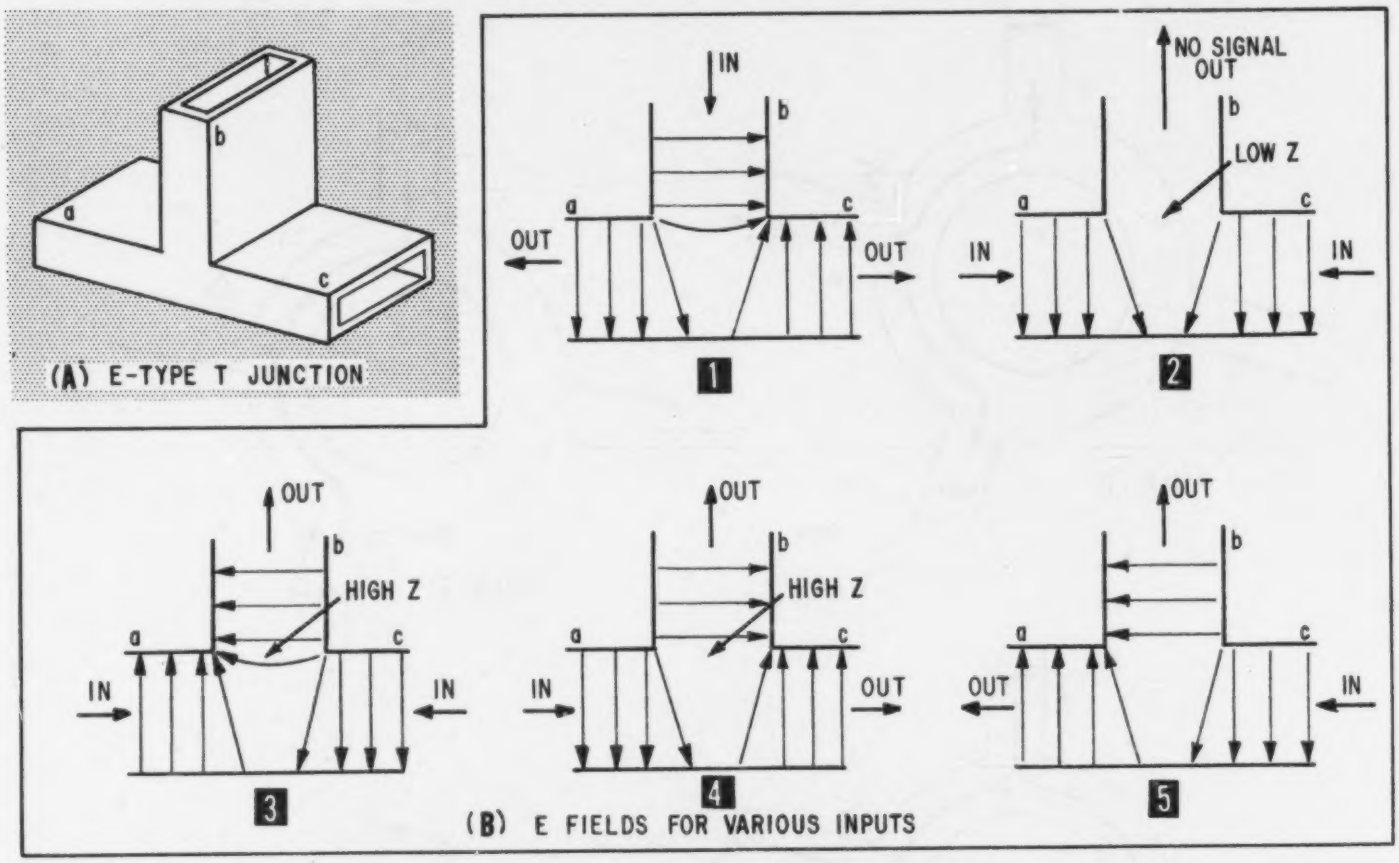

Figure 15-11. —E-type T-junction and E field.

transmitter via arm 3, in phase signals must arrive from both directions at this junction (fig. 15-11 (B) (2)).

2. The energy moving clockwise around ring from arm 1 is not sufficient to fire the TR tube in arm 2, and energy passes to the receiver through arm 2. There is a phase reversal (arm 2 presents high Z at the junction with the ring (fig. 15-11 (B) (4)), and the remainder of the energy moves clockwise around the ring to arm 3.

3. The energy moving counterclockwise around the ring from arm 1 is likewise not sufficient to fire the TR tube in arm 4, and energy passes to the receiver through arm 4. There is a phase reversal (fig. 15-11 (B) (4)), and the remainder of the energy moves counterclockwise around the ring to arm 3.

4. At arm 3 the clockwise and counterclockwise components are in phase, and no energy is coupled to the transmitter through arm 3 (fig. 15-11 (B) (2)).

Rules for Hybrid Ring Junctions

Hybrid ring junctions are often given a more colorful name: ratrace. These rings are used to add, subtract, and split up RF energy. They also provide switching of energy into appropriate channels. The hybrid ring junctions consist of a waveguide ring with four arms projecting from it. Each arm can be connected to a waveguide section. In the figures of hybrid ring junctions, the symbols delta (Δ) and sigma (Σ) placed by an arm stand for the difference and the sum respectively, of signal amplitudes of single input signals.

The principle of operation of a hybrid ring can be summarized very briefly by the following rules, which are illustrated in figure 15-12.

1. A signal applied to a Σ (sum) arm will split and leave the ring at two adjacent arms. The output signals will be equal in amplitude, but 180° out of phase with one another.

2. A signal applied to a Δ (difference) arm will split and leave the ring at two adjacent

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ABSTRACT - Prepared by the Navy Training Publications Center, this manual is to be used by enlisted naval personnel studying for advancement in the Air Controlman rating. Chapters are: (1) Air Controlman Rating, (2) Flight Planning, (3) Facility Operation, (4) Terminal Instrument Procedures, (5) Air Traffic Control, (6) Emergency Procedures, (7) CVA/CVS Procedures, and (8) Administration. Other information found in this manual are definitions, abbreviations, numerous illustrations, and a list of suggested readings. A related document is available as VT 012 768, also in this issue. (JS)

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AIR CONTROLMAN 1 & C

BUREAU OF NAVAL PERSONNEL

RATE TRAINING MANUAL NAVPERS 10368-D

PREFACE

This Rate Training Manual is one of a series of training manuals prepared especially for the enlisted men of the Navy and Naval Reserve who are studying for advancement in the Air Controlman rating. The manual is based on the professional qualifications for the rates of AC1 and ACC, as set forth in the Manual of Qualifications for Advancement, NavPers 18068 (Series).

Combined with the necessary practical experience and a thorough knowledge of the materials contained in Air Controlman 3 & 2, NavPers 10367-D, completion of the correspondence course based on this manual will greatly assist the AC2 and AC1 in preparing for their advancement examinations. This manual should also be valuable as a refresher for the ACC who is studying for advancement to ACCS and the ACCS who is studying for advancement to ACCM.

This training manual was prepared by the Navy Training Publications Center, Millington, Tennessee, for the Bureau of Naval Personnel. Technical reviews were provided by the Naval Air Technical Training Center, Glynco, Georgia, and the Naval Examining Center, Great Lakes, Illinois.

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THE UNITED STATES NAVY

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READING LIST

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Educational Services Officer.* The following courses are recommended:

C 152 General Mathematics II

E 290 Physics I

*"Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified on the active duty orders."

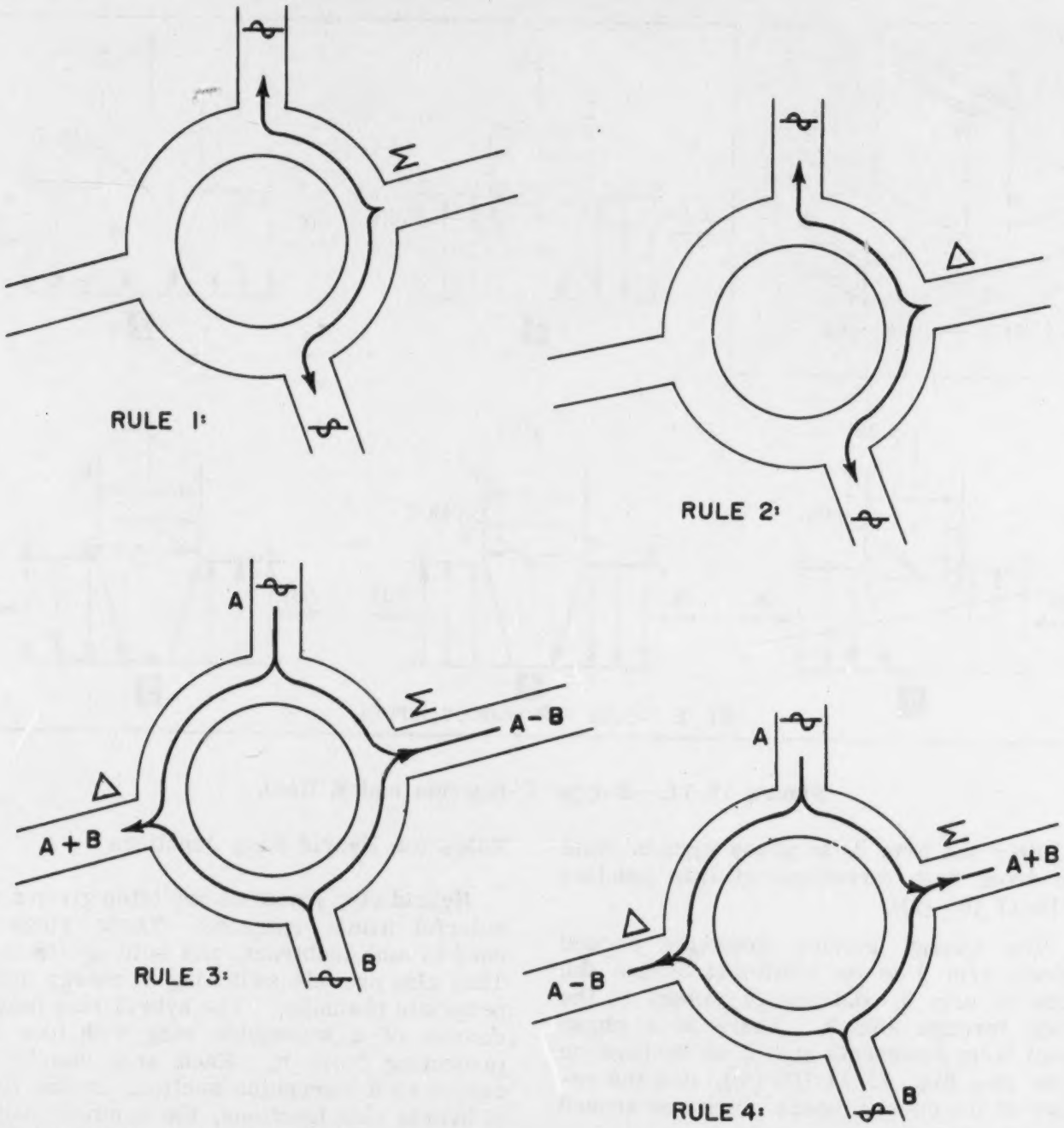

Figure 15-12.—Hybrid ring junctions.

arms. The two output signals from these arms are equal in amplitude and in phase.

3. If in-phase signals are applied to two opposite arms, the output of the adjacent Δ arm will be proportional to the sum of the input signals. The output of the Σ arm will be proportional to the difference of the input signals.

4. If 180° out-of-phase signals are applied to two opposite arms, the output of the adjacent Δ arm will be proportional to the difference of the input signals. The output of the Σ arm will be proportional to the sum of the amplitudes of the input signals.

MONOPULSE COMPARATOR OPERATION

A simplified schematic of the comparator is shown in figure 15-13. To find out how it works, first trace out the energy paths during transmission. Transmitter energy enters the summation arm of HY-1. According to

CHAPTER 1

AIR CONTROLMAN RATING

This training manual is designed to help you to meet the professional qualifications for advancement to First Class and Chief Air Controlman. The Air Controlman qualifications which are used as a guide in the preparation of this manual are current through change 4 of the current revision of the Manual of Qualifications for Advancement, NavPers 18068. Subsequent changes in the qualifications may not be reflected in the information given here.

The remainder of this chapter gives information on the Air Controlman rating, the enlisted rating structure, requirements and procedures for advancement, and references that will help you in preparing for advancement. Information on how to best use Navy Rate Training Manuals is also included. Therefore, it is strongly recommended that you study this chapter carefully before beginning intensive study of the remaining chapters.

ENLISTED RATING STRUCTURE

The present enlisted rating structure includes two types of ratings: general ratings and service ratings.

GENERAL RATINGS are designed to provide paths of advancement and career development. A general rating identifies a broad occupational field of related duties and functions requiring similar aptitudes and qualifications. General ratings provide the primary means used to identify billet requirements and personnel qualifications. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Subdivisions of certain general ratings are identified as SERVICE RATINGS. These service ratings identify areas of specialization within the scope of a general rating. Service ratings are established in those general ratings in which specialization is essential for efficient utilization of personnel. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

AC RATING

The Air Controlman rating is a general rating and is included in Navy Occupational Group IX (Aviation). There are no AC service ratings.

Before an individual can be recommended for any Air Controlman rating, he must possess the following as minimum qualification:

1. A certificate indicating successful completion of the FAA basic airman written examination for air traffic controllers.
2. A Class II FAA medical certificate.

Figure 1-1 illustrates the path of advancement from Recruit to Master Chief Air Controlman, Warrant Officer, and Limited Duty Officer. BuPers Instruction 1120.18 (Series) provides guidance for submission of application for promotion to Warrant Officer and Limited Duty Officer.

Shaded areas in figure 1-1 indicate career stages from which qualified enlisted men may advance to Warrant Officer (W-1), and selected Commissioned Warrant Officers (W-2 and W-3) may advance to Limited Duty Officer.

Unlike the civilian counterpart, the Navy Air Controlman is not a specialized Center Controller, Tower Controller, or a Flight Service Specialist. The Navy AC is required to be

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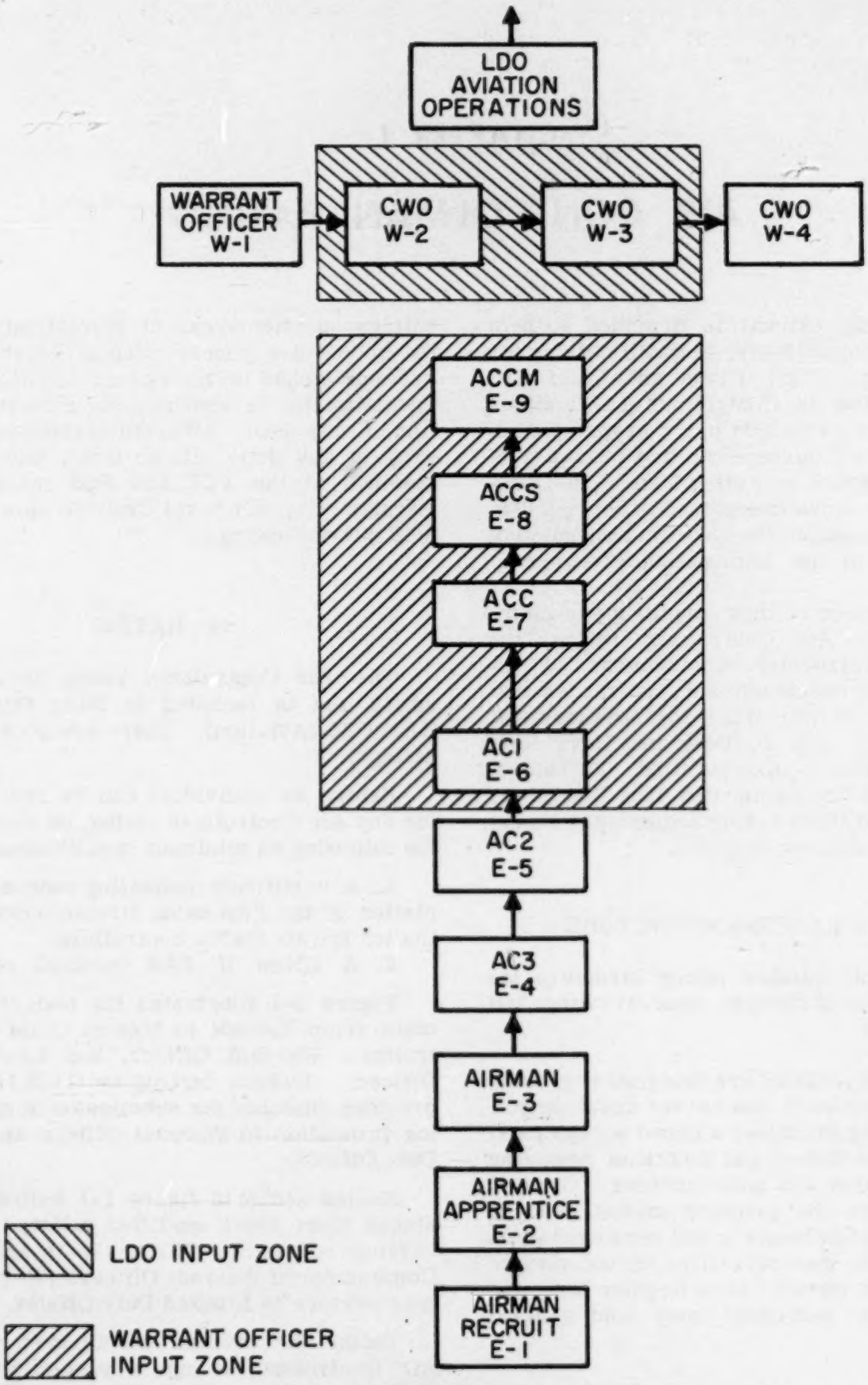

AC.1

Figure 1-1.—Paths of advancement.

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a professional air traffic controller, knowledgeable in all areas of air traffic control and a professional military man who transfers at regular intervals.

This point may be accented by a brief description of the types of duty which an Air Controlman may expect to receive or that he may request as follows:

1. Naval air stations.

a. AC's assigned to air stations are normally attached to the Air Traffic Control division within the operations department. AC1's and ACC's normally serve as watch supervisors or branch supervisors and normally have several personnel under their supervision performing the various air traffic control duties.

b. The AC1 or ACC performs supervisory and ATC functions in control towers, radar air traffic control centers, ground controlled approach units, and flight clearance offices. Tools of the trade include radio, radar, direction finding equipment, teletype, and various forms of direct line telephone equipment.

c. They control air traffic under all types of weather conditions, assist in the administration of the ATC division and ATC function of the naval air station, process flight plans and clearances, keep appropriate records as basis for reports required, and maintain current flight planning and related information.

2. CVA/CVS's

a. Air Controlmen assigned aboard aircraft carriers may be members of the CCA team or the Air Operations crew, both of which make up the CATCC.

b. AC's perform basically the same type duties aboard ship as described for naval air stations, adapted to the mobility aspect of aircraft carriers and the increased tempo and precision required for aircraft operations at sea.

3. LPH's

a. Air Controlmen are assigned aboard each of the LPH's.

b. They perform communications and air traffic control service, including the use of radar.

4. Instructor billets.

a. AC "A" and "B" schools, and CATCC and GCA "C" operator schools, all located at NAS Glynco, Georgia.

b. The technical advisor/writer for the Air Controlman Rate Training Manuals located at the Navy Training Publications Center, Millington, Tenn.

c. The item writer for Air Controlman fleet-wide rating exams, located at the Naval Examining Center, Great Lakes.

d. One billet exists at each of the Navy Regional Airspace Offices (NARASPO) which correspond to the FAA regions dealing with problems concerning the use of airspace for Navy air traffic control.

e. The Fleet Computer Training Center, San Diego.

f. The Office of the CNO (OP-534) having to do with airspace matters in liaison with the regional NARASPO's.

g. Naval Safety Center as a technical expert on air traffic control matters.

h. Fleet Antiaircraft Warfare Training Center in the CCA mockup portion of the training program.

i. COMNAVAIRPAC and COMNAVAIR LANT duty as instructors for the automatic carrier landing system.

5. Miscellaneous Billets.

a. Radar bomb sites or bomb ranges where senior AC's act as range safety officers and others act as spotters, observers, etc.

b. The White House Staff having to do with the movement of helicopters to and from the White House lawn.

c. Recruiting duty for second class AC's and above. The criteria for selection for these billets stress military pride and performance and uniform perfection.

d. Wave Air Controlmen may get duty at the Wave Recruit Training Center.

e. San Nicholas Island in support of the Point Mugu missile range.

f. San Clemente Island in support of the Sea Lab operations.

g. Naval Air Tactical Control Squadrons to perform the various functions relating to control of aircraft in amphibious operations.

You can see by this varied list of duties and duty stations available the variety of positions of responsibility the AC's may occupy.

The technical assistant to the AC rating control officer in the Bureau of Personnel (BuPers 2144) is an ACCM. He can provide more or detailed information on the billets described and can be reached by phone or correspondence.

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The Naval Enlisted Classifications Codes for the AC rating are as follows:

1. AC-6900 is an Entry Series NEC and is assigned to E-2 and E-3 personnel in training as AC's and who are not designated strikers.
2. AC-6922 identifies a GCA Controller and is assigned to a GCA operator school graduate.
3. AC-6912 identifies a CCA Controller. This code may be assigned to a CATCC school graduate upon recommendation of the commanding officer after qualification as a final controller and one other of the following:
   a. Approach Controller.
   b. Marshal Controller.
   c. Wave-Off/Bolter Controller.
   d. Departure Controller.

An AC must be an AC-6922 to be eligible for AC-6912.

4. AC-6911 indentifies a CATCC Supervisor. To be assigned AC-6911, an AC must be qualified in all CATCC operator positions (hence be an AC-6912), be able to supervise and direct the operation of the CATCC, and be recommended by the commanding officer.

Air Controlmen that do not fall within the above classifications may be assigned 0000 or a Special Series NEC such as one which designates instructors.

SUPERVISORY SKILLS

As you advance in rating, more of your work becomes a matter of supervision and training others in the performance of the various functions of the air traffic control facility. Your value to the organization will be measured largely in terms of the quality of work of your subordinates. This does not mean that everything can be delegated to subordinates, as there will continue to be tasks and responsibilities that you must take care of yourself. However, you must not take the attitude that it is easier to do the work than to train and supervise someone else.

Supervision is being responsible for and directing the work of others. In supervising your subordinates, you will need to have certain skills and knowledge. A supervisor is a manager; therefore, he should be well versed in the principles of management. The material presented here is for a twofold purpose: First, to acquaint you with the basic principles so that your first supervisory duties will get off to a good start; and second, to give you a basis from which to build as you progress toward the higher ratings.

The supervisor needs to know and be skilled in the following factors to effectively supervise the men under him:

1. Skill in leading.
2. Skill in organizing.
3. Knowledge of his work.
4. Knowledge of his responsibilities.
5. Skill in communicating ideas.
6. Skill in instructing.
7. Problem solving.

Skill in Leading

Here is where you should excel. Lead the men that you are coaching, do not drive them. Set examples for them to follow. Know them as individuals and handle their problems individually. Reprimand them in private; praise them in public. The men will work for you, and their training will be more easily accomplished and more effective if you can learn to (1) be predictable and consistent in your dealings with them, (2) project to your men the enthusiasm you feel for the work they are doing, and (3) have no fear of your position, your boss, the people you are supervising, and tough jobs, or honest mistakes.

This is not an all-inclusive list of things that will make you a leader of men overnight. These items are sound, basic principles that, when mixed well with common sense, will improve your leadership abilities.

Skill in Organizing

Another skill needed in supervision is skill in organizing. Organization is a form of discipline which, if carefully accomplished, can contribute substantially to successful supervision.

An important element of good organization is the delegation of AUTHORITY and RESPONSIBILITY, which must always go together. It has been said that the ideal of sound organization should be to fix responsibility as low in the organization as competence exists to assume the responsibility. Many individuals are reluctant to delegate authority because they fear the possibility of being embarrassed by the acts of

their subordinates. These fears are generally an indication of a feeling of insecurity on the part of the supervisor. This insecure feeling can best be overcome by training the subordinates to increase their capacity for accepting responsibility and authority.

Not only do supervisors sometimes fail to delegate authority, but they also frequently fail to delegate properly the work that needs to be done. A supervisor can very readily handicap himself by trying to do more than he needs to do. The result is that he becomes an ineffective supervisor and leader.

Knowledge Required

Successful supervision demands a vast amount of knowledge. The wide variety and complexity of jobs require the supervisor to have considerable technical knowledge. It is inevitable, however, that the supervisor will be given some tasks for which his training and experience are inadequate. In these situations the supervisor must be dependent upon the knowledge and abilities of others, and upon his own leadership.

The supervisor must have a knowledge of the overall objectives of the organization of which he is a part. In addition, he needs to have a clear understanding of the specific part his own group must play in attaining the basic goals. His planning, organization, directing, and, in fact, all problem solving should be done with both the general and specific aims of the organization clearly in mind.

Knowledge of Men as Individuals

Of paramount importance to a successful supervisor is a thorough knowledge of the subordinates as individuals. The supervisor needs to be continuously aware of the fact that individual differences do exist and that they cannot be overlooked.

It is particularly dangerous for a supervisor to fall into the habit of stereotyping people.

Skill in the Communication of Ideas

Another skill which is required of a good supervisor is skill in the communication of ideas. This is essential in giving orders, in the dissemination of information, and in training or teaching. In the Navy, the channels for communication and the lines of authority are the same. These channels should not be bypassed. If one's subordinates are expected to function willingly and cooperatively, they should be given all the information they need or can use.

Skills in Instructing

The actual development of a training program is discussed in a later chapter. The apprentice is depending on you to demonstrate and coach him in the correct procedures and methods to be used. You must develop skill in imparting your knowledge to trainees on how the job is to be done. As the trainee progresses from one work experience to another, you will be guiding and coaching him. To assist you in developing skill in instructing, keep the following in mind:

1. Show your new man how to do the job without showing off or showing him up.
2. Have all the answers you can, admit it when you do not, and get him the correct answer as soon as possible.
3. Learn to be sincerely interested in others.
4. Keep your sense of humor.
5. Be patient.
6. Be sure the trainee understands what the job is and how it is to be done.

Problem Solving

The practical exercise of supervision (or leadership) is largely concerned with problem solving. Every day new problems are encountered; there are difficulties different from any you have ever met. If you can look at these difficulties briefly, and then, almost without pause, see and apply a sound solution, you are fortunate. Indeed, you are exceptional; for most of us must cautiously examine difficult problems and weigh the solutions carefully. Even then, we are subject to serious errors if we overlook some of the details which are not too obvious.

If all of us were to go about solving problems in exactly the same manner, we would necessarily have exactly the same thought processes. Although we do not think alike, all those who are capable of finding proper solutions quickly and easily do have something in common. They follow a fairly well established pattern of thought and action.

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Some people practice the pattern instinctively, thereby reaching solid, useful conclusions in what appears to be an amazingly short time. For most of us, this pattern is not one we know instinctively. We learn it only after having paid in concerted effort. We may lean of it in the classroom, on the job, or from books, but it becomes a habit only after the trial and error of repeated application.

TECHNIQUES IN PROBLEM SOLVING.—The problem solving process may be divided into six steps. Individual leaders go through these steps either deliberately or automatically.

Preliminary to solving a problem, you must recognize that there is an actual problem to be solved. Then you proceed as follows:

1. Define the problem.
2. Establish objectives. By this is meant what do you want to accomplish.
3. Get the facts. Assemble all the facts pertinent to the problem. Ascertain what personnel, if any, are involved. Review the record. Find out what rules, regulations, and customs apply. Contact the individual concerned for opinions and feelings, as well as facts. Be sure you have the whole story. Perhaps materials or equipment constitute a part of the problem. Methods or operational schedules may also affect the problem.
4. Weigh and decide. After all the facts have been assembled, analyze the problem in light of the facts. Fit the facts together and consider their bearing on each other. Check regulations, policies, and practices. What possible actions are there? What are the possible results of each action? Choose the best action, but do not make sudden or quick conclusions.
5. Take action. First consider the following questions: Should I handle this problem myself? Do I need any help in handling it? Then consider the proper time and place to take the action that appears most likely to solve the problem. Do not depend on someone else to solve the problem.
6. Evaluate the action. In this step, check the results of your action to see if it solved the problem. Never just assume that the problem was solved, as you may find that the action brought about additional problems instead of solving the initial problem. Watch for changes in output, attitudes, and relationships. If the problem was not solved, you may need to gather more facts and go through the entire problem solving procedure again.

The problem solving technique can be mastered by any individual who is capable of learning. It may seem to take a great deal of time, but eventually it will actually save time. The individual who desires to become a good supervisor should become so skilled in its use that this technique is used automatically when dealing with the problems of supervision.

ADVANCEMENT

By this time, you are probably well aware of the personal advantages of advancement—higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen career. By this time, also, you have probably discovered that one of the most enduring rewards of advancement is the training you acquire in the process of preparing for advancement.

The Navy also profits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a technical specialist, and thus make far-reaching contributions to the entire Navy; and second, you become more valuable as a person who can supervise, lead, and train others.

Since you are studying for advancement to PO1 or CPO, you are probably already familiar with the requirements and procedures for advancement. However, you may find it helpful to read the following sections. The Navy does not stand still. Things change all the time, and it is possible that some of the requirements have changed since the last time you went up for advancement. Futhermore, you will be responsible for training others for advancement; therefore, you will need to know the requirements in some detail.

HOW TO QUALIFY FOR ADVANCEMENT

To qualify for advancement, a person must:

1. Have a certain amount of time in grade.
2. Complete the required Rate Training Manuals either by demonstrating a knowledge of the material in the manual by passing a locally prepared and administered test or by passing the Enlisted Correspondence Course based on the Rate Training Manual.

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3. Demonstrate the ability to perform all the PRACTICAL requirements for advancement by completing applicable portions of the Record of Practical Factors, NavPers 1414/1.

4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.

5. Demonstrate KNOWLEDGE by passing a written examination on (a) military requirements, and (b) professional qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-2 gives an overall view of the requirements for advancement of active duty personnel; figure 1-3 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

When you are training lower rated personnel, it is a good idea to point out that advancement is not automatic. Meeting all the requirements makes a person ELIGIBLE for advancement, but it does not guarantee his advancement. Such factors as the score made on the written examination, length of time in service, performance marks, and quotas for the rating enter into the final determination of who will actually be advanced.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement? You must study the qualifications for advancement, work on the practical factors, study the required Rate Training Manuals, and study other material that is required. You will need to be familiar with the following:

1. Manual of Qualifications for Advancement, NavPers 18068 (Series).
2. Record of Practical Factors, NavPers 1414/1.
3. Training Publications for Advancement, NavPers 10052 (Series).
4. Applicable Rate Training Manuals and their companion Enlisted Correspondence Courses.

Collectively, these documents make up an integrated training package tied together by the qualifications. The following paragraphs describe these materials and give some information on how each one is related to the others.

"Quals" Manual

The Manual of Qualifications for Advancement, NavPers 18068 (series), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications. Military requirements apply to all ratings rather than to any one rating alone. Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups. Then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. The "Quals" Manual is changed more frequently than Rate Training Manuals are revised. By the time you are studying this training manual, the "quals" for your rating may have been changed. Never trust any set of "quals" until you have checked the change number against an UP-TO-DATE copy of the "Quals" Manual.

In training others for advancement, emphasize these three points about the "quals":

1. The "quals" are the MINIMUM requirements for advancement. Personnel who study MORE than the required minimum will have a great advantage when they take the written examinations for advancement.
2. Each "qual" has a designated rate level—chief, first class, second class, or third class. You are responsible for meeting all "quals" specified for the rate level to which you are seeking advancement AND all "quals" specified for lower rate levels.
3. The written examinations for advancement will contain questions relating to the practical factors AND to the knowledge factors of BOTH the military requirements and the professional qualifications.

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REQUIREMENTS*	E1 to E2	E2 to E3	#† E3 to E4	#E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos as E-3	12 mos. as E-4	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3, AME 3, HM 3, PN 3, FTB 3, MT 3,			Class B for AGC MUC, MNC.††		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.
†† Waived for qualified EOD personnel.

Figure 1-2.—Active duty advancement requirements.

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REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	6 mos.	12 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit in accordance with BUPERSINST 5400.42 series.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam		Standard Exam required for all PO Advancements. Also pass Military Leadership Exam for E-4 and E-5.				Standard Exam, Selection Board.	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-3.—Inactive duty advancement requirements.

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Record of Practical Factors

Before you can take the Navy-wide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional qualifications. A special form known as the Record of Practical Factors, NavPers 1414/1 (plus the abbreviation of the appropriate rating), is used to keep a record of your practical factor qualifications. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

As a PO1 or CPO, you will often be required to check the practical factor performance of lower rated personnel and to report the results to your supervising officer.

As changes are made periodically to the "Quals" Manual, new forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the "Quals" Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skill which are within the general scope of the rating but which are not identified as minimum qualifications for advancement. Keep this in mind when you are training and supervising other personnel. If a person demonstrates proficiency in some skill which is not listed in the "quals" but which is within the general scope of the rating, report this fact to the supervising officer so that an appropriate entry can be made in the Record of Practical Factors.

When you are transferred, the Record of Practical Factors should be forwarded with your service record to your next duty station. It is a good idea to check and be sure that this form is actually instered in your service record before you are transferred. If the form is not in your record, you may be required to start all over again and requalify in practical factors that have already been checked off. You should also take some responsibility for helping lower rated personnel keep track of their practical factor records when they are transferred.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-2 through E-8 for his personal record and guidance.

The importance of NavPers 1414/1 cannot be over-emphasized. It serves as a record to indicate to the petty officers and officers supervising your work that you have demonstrated proficiency in the performance of the indicated practical factors and is part of the criteria utilized by your commanding officer when he considers recommending you for advancement. In addition, the proficient demonstration of the applicable practical factors listed on this form can aid you in preparing for the examination for advancement. Remember that the knowledge aspects of the practical factors are covered in the examination for advancement. Certain knowledge is required to demonstrate these practical factors and additional knowledge can be acquired during the demonstration. Knowledge factors pertain to that knowledge which is required to perform a certain job. In other words, the knowledge factors required for a certain rating depend upon the jobs (practical factors) that must be performed by personnel of that rating. Therefore, the knowledge required to proficiently demonstrate these practical factors will definitely aid you in preparing for the examination for advancement.

NavPers 10052

Training Publications for Advancement, NavPers 10052 (Series) is a very important publication for anyone preparing for advancement. This publication/bibliography lists required and recommended Rate Training Manuals and other reference material to be used by personnel working for advancement. NavPers 10052 (Series) is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number; be SURE you have the most recent edtion.

The required and recommended references are listed by rate level in NavPers 10052 (Series). It is important to remember that you are responsible for all references at lower rate levels, as well as those listed for the rate to which you are seeking advancement.

Rate Training Manuals that are marked with an asterisk (*) in NavPers 10052 (Series) are MANDATORY at the indicated rate levels. A mandatory training manual may be completed by (1) passing the appropriate Enlisted Correspondence Course that is based on the mandatory training manual; (2) passing locally

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the rule 1, the signal splits and leaves the ring at the two adjacent arms. These two signals have the same amplitude, but are 180° out of phase. Then the signals are fed to the summation arms of hybrid rings HY-2 and HY-3. The waveguide lengths between HY-1 and HY-2, and HY-1 and HY-3 are equal; hence the signals enter the rings simultaneously. Again keeping in mind rule 1, the signals in HY-2 and HY-3 divide their energy equally and out of phase with each other. The energy, now divided into four separate signals, is sent to the horn cluster. By varying the waveguide sections between the hybrid rings and horns, the separate signals will arrive at each horn in phase with one another. The energy radiated from the horns combines to form a single wave front. The radiated energy is focused into a narrow circular beam by the lens antenna. Energy does not pass through the difference arms of HY-1, HY-2, and HY-3 because the signals are canceled at these junctions by proper waveguide matching. If energy were allowed to pass through these arms, it would burn out the mixer crystals, and possibly the receiver.

Echo returns are focused by the lens into the four horns. The amount of energy entering each horn is determined by the position of the target with respect to the antenna axis. Phase inversion of the energy takes place due to the lens. Returned energy is combined in the four hybrid rings of the comparator. The comparator compares the amplitude of the energy in each horn, and produces a sum signal and two difference signals. The sum signal is used for ranging and also provides a reference for the elevation and traverse tracking channels.

The sum or range signal is composed of signals from all four feed horns added together in phase. Since the radar's range system is only interested in the presence of the target in the beam, and not in the target's relative position within the beams, the sum of all the energy received is used in ranging to insure maximum detection capability. The sum signal

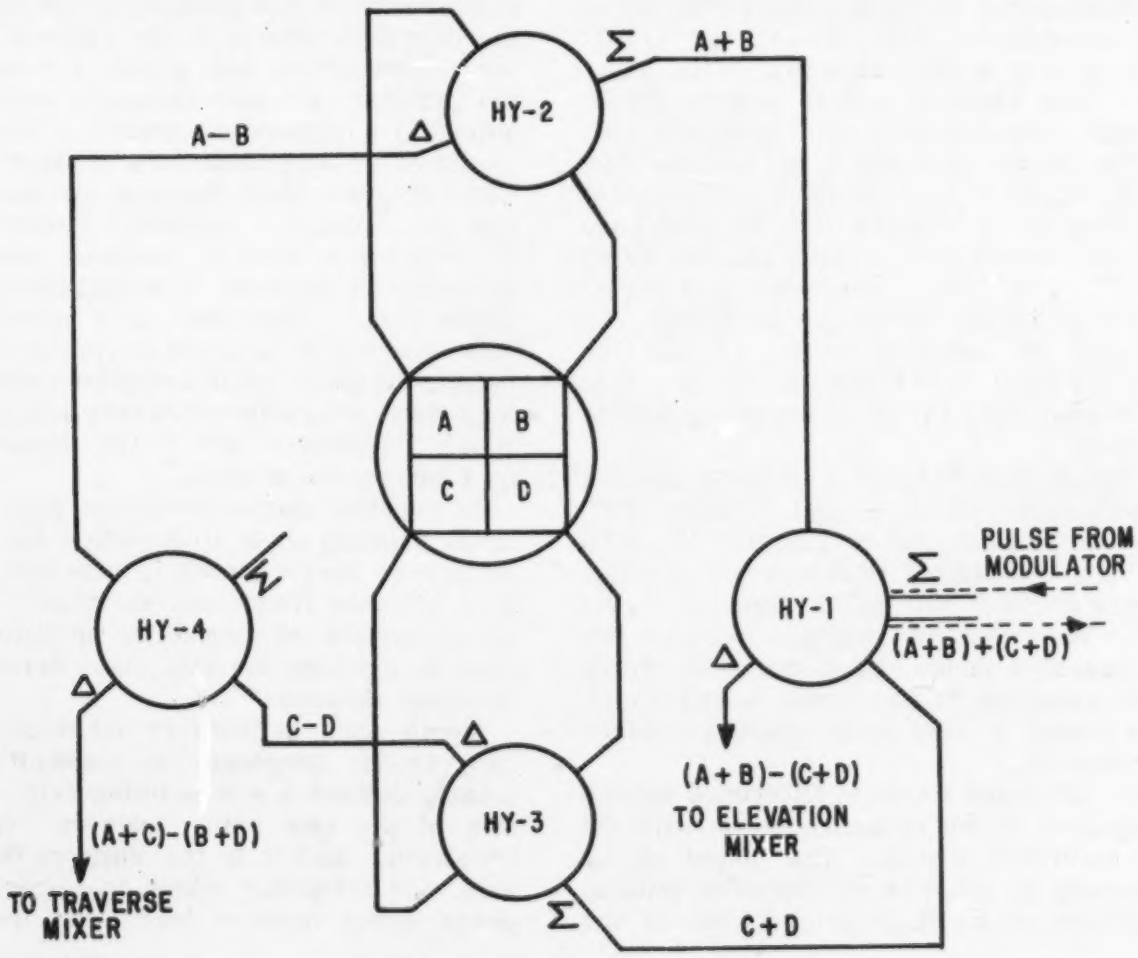

Figure 15-13. —Microwave comparator.

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prepared tests based on the information given in the mandatory training manual; or (3) in some cases, successfully completing an appropriate Navy school.

When training personnel for advancement, do not overlook the section of NavPers 10052 (Series) which lists the required and recommended references relating to the military requirements for advancement. All personnel must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance. Also, make sure that personnel working for advancement study the references listed as recommended but not mandatory in NavPers 10052 (Series). It is important to remember that ALL references listed in NavPers 10052 (Series) may be used as source material for the written examinations, at the appropriate levels.

Rate Training Manuals

There are two general types of Rate Training Manuals. Rate Training Manuals (such as this one) are prepared for most enlisted rates and ratings, giving information that is directly related to the professional qualifications for advancement. Subject matter manuals give information that applies to more than one rating.

Rate Training Manuals are revised from time to time to bring them up to date technically. The revision of a Rate Training Manual is identified by a letter following the NavPers number. You can tell whether a Rate Training Manual is the latest edition by checking the NavPers number (and the letter following the number) in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061 (Series). (NavPers 10061 is actually a catalog that lists current training manuals and correspondence courses; you will find this catalog useful in planning your study program.)

Rate Training Manuals are designed for the special purpose of helping naval personnel prepare for advancement. By this time, you have probably developed your own way of studying these manuals. Some of the personnel you train, however, may need guidance in the use of Rate Training Manuals. Although there is no single "best" way to study a training manual, the following suggestions have proved useful for many people:

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the "quals" frequently as you study. Remember, you are studying the training manual primarily to meet these "quals."

2. Set up a regular study plan. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training manual intensively, get acquainted with the entire manual. Read the preface and the table of contents. Check through the index. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a clear picture of the scope and content of the manual.

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying each unit, write down questions as they occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, ask yourself some questions. Does this information tie in with past experience? Or is this something new and different? How does this information relate to the qualifications for advancement?

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without referring to the training manual, write down the main ideas you have

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learned from studying this unit. Do not just quote the manual. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Rate Training Manuals or other appropriate texts. As mentioned before, completion of a mandatory Rate Training Manual can be accomplished by passing an Enlisted Correspondence Course based on the training manual. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training manuals. Taking a correspondence course helps you to master the information given in the training manual, and also gives you an idea of how much you have learned.

INCREASED RESPONSIBILITIES

When you assumed the duties of a PO3, you began to accept a certain amount of responsibility for the work of others. With each advancement, you accept an increasing responsibility in military matters and in matters relating to the professional work of your rate. When you advance to PO1 or CPO, you will find a noticeable increase in your responsiblities for leadership, supervision, training, working with others, and keeping up with new developments.

As your responsibilities increase, your ability to communicate clearly and effectively must also increase. The simplest and most direct means of communication is a common language. The basic requirement for effective communication is therefore a knowledge of your own language. Use correct language in speaking and in writing. Remember that the basic purpose of all communcation is understanding. To lead, supervise, and train others, you must be able to speak and write in such a way that others can understand exactly what you mean.

Leadership and Supervision

As a PO1 or CPO, you will be regarded as a leader and supervisor. Both officers and enlisted personnel will expect you to translate the general orders given by officers into detailed, practical, on-the-job language that can be understood and followed by relatively inexperienced personnel. In dealing with your juniors, it is up to you to see that they perform their jobs correctly. At the same time, you must be able to explain to officers any important problems or needs of enlisted personnel. In all military and professional matters, your responsibilities will extend both upward and downward.

Along with your increased responsibilities, you will also have increased authority. Officers and petty officers have POSITIONAL authority—that is, their authority over others lies in their positions. If your CO is relieved, for example, he no longer has the degree of authority over you that he had while he was your CO, although he still retains the military authority that all seniors have over subordinates. As a PO1, you will have some degree of positional authority; as a CPO, you will have even more. When exercising your authority, remember that it is positional—it is the rate you have, rather than the person you are, that gives you this authority.

A Petty Officer conscientiously and proudly exercises his authority to carry out the responsibilities he is given. He takes a personal interest in the success of both sides of the chain of command . . . authority and responsibility. For it is true that the Petty Officer who does not seek out and accept responsibility, loses his authority and then the responsibility he thinks he deservies. He must be sure, by his example and by his instruction, the the Petty Officers under him also accept responsibility. In short, he must be the leader his title—Petty Officer—says he is.

Training

As a PO1 or CPO, you will have regular and continuing responsibilities for training others. Even if you are lucky enough to have a group of subordinates who are all highly skilled and well trained, you will find that training is necessary. For example, you will always be responsible for training lower rated personnel for advancement. Also, some of your best workers may be transferred; and inexperienced or poorly trained personnel may be assigned to you. A particular job may call for skills that none of your personnel have. These and similar problems require that you be a training specialist—one who can conduct formal and informal training programs to qualify personnel for advancement,

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need arises. When using any publication that is subject to revision, make sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made.

The reading list at the beginning of this manual consists of USAFI courses that offer additional background material. The educational services officer will always have the most up-to-date information and training manuals applicable to your rating.

In addition to training manuals and publications, training films furnish a valuable source of supplementary information. Films that may be helpful are listed in the U. S. Navy Film Catalog, NavAir 10-1-777.

ADVANCEMENT OPPORTUNITIES FOR PETTY OFFICERS

Making chief is not the end of the line as far as advancement is concerned. Proficiency pay, advancement to Senior (E-8) and Master (E-9) Chief, and advancement to Warrant Officer and Commissioned Officer are among the opportunities that are available to qualified petty officers. These special paths of advancement are open to personnel who have demonstrated outstanding professional ability, the highest order of leadership and military responsibility, and unquestionable moral integrity.

PROFICIENCY PAY

The Career Compensation Act of 1949, as amended, provides for the award of proficiency pay to designated enlisted personnel who possess special proficiency in military skill. Proficiency pay is given in addition to regular pay and allowances and any special or incentive pay to which you are entitled. Certain enlisted personnel in pay grades E-4 through E-9 are eligible for proficiency pay. Proficiency pay is allocated by ratings and NEC's, with most awards being given in the ratings and NEC's which are designated as critical. The eligibility requirements for proficiency pay are subject to change. In general, however, you must be recommended by your commanding officer, have a certain length of time on continous active duty, and be career designated.

ADVANCEMENT TO SENIOR AND MASTER CHIEF

Chief petty officers may qualify for the advanced grades of Senior and Master Chief which are now provided in the enlisted pay structure. These advanced grades provide for substantial increases in pay, together with increased responsibilities and additional prestige. The requirements for advancement to Senior and Master Chief are subject to change but, in general, include a certain length of time in grade, a certain length of time in the naval service, a recommendation by the commanding officer, and a sufficiently high mark on the Navy-wide examination. The final selection for Senior and Master Chief is made by a regularly convened selection board.

Examination Subjects

Qualifications for advancement to Senior Chief Petty Officer and Master Chief Petty Officer have been developed and published in the Manual of Qualifications for Advancement, NavPers 18068 (Series). They officially establish minimum military and professional qualifications for Senior and Master Chief Petty Officers.

Training Publications for Advancement, Nav Pers 10052 (Series) contains a list of study references which may be used to study for both military and professional requirements.

The satisfactory completion of the correspondence course titled Navy Regulations, Nav Pers 10740-A4, is mandatory for advancement to E-8, and the course titled Military Justice in the Navy, NavPers 10993-A, is required of all personnel advancing to E-9.

ADVANCEMENT TO WARRANT AND COMMISSIONED OFFICER

The Warrant Officer program provides opportunity for advancement to warrant rank for E-6 and above enlisted personnel. E-6's, to be eligible, must have passed an E-7 rating exam prior to selection.

The LDO program provides a path of advancement from warrant officer to commissioned officer. LDO's are limited, as are warrants, in their duty, to the broad technical fields associated with their former rating.

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If interested in becoming a warrant or commissioned officer, ask your educational services officer for the latest requirements that apply to your particular case.

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CHAPTER 2

FLIGHT PLANNING

Except in emergencies and flights of combat necessity wherein conditions do not permit, pilots must insure that all preflight planning required for the prosecution of a safe and properly conducted flight has been accomplished prior to carrying out any type of flight in a naval aircraft.

Inadequate preflight planning has been, in some instances, responsible for aircraft accidents. Safety is not an inherent quality in any profession. It is one quality that is achieved by process and is based largely on accumulated knowledge and experience. To a greater extent than is generally realized, unfortunate experiences in the air can be avoided by increasing the overall knowledge and familiarity with each phase of flight planning by Air Controlmen and pilots alike. In short, there is no compromise for good, adequate flight planning.

The thoroughness of flight planning by pilots before takeoff can contribute immeasurably to all-around safety, comfort, and success of any flight, and to the task of preventing accidents. To aid in the safety and efficiency of a flight, pilots must rely to a varying extent upon the assistance provided by the Air Controlmen.

FLIGHT CLEARANCE AUTHORITIES

CLEARANCE AUTHORITY AT NAVAL ACTIVITIES

The authority and responsibility for clearance of aircraft flights at naval activities are vested in the following, who must be guided by existing orders and regulations:

1. Commanding general, commanding officer, or officer in charge of:
   a. Naval air stations.
   b. Marine Corps air stations.
   c. Coast Guard air stations.
   d. Naval auxiliary air stations.
   e. Naval air facilities.
   f. Marine Corps air facilities.
   g. Marine Corps auxiliary air stations.
   h. Auxiliary landing field.
   i. Outlying landing field.

2. The senior naval aviator attached to a naval station having aircraft operating facilities.

3. Fleet Air Detachment Commanders, Marine Aircraft Group Commanders, and the Commanding Officers of NARTU's may clear aircraft under their cognizance based at the naval air activity to which they are assigned. They may delegate authority for clearance of local flights to commanding officers of their units when weather conditions are at or above the IFR minimums specified for IFR clearance of naval aircraft in OpNav 3710.7 (Series) and are forecast to remain at or above these minimums for the duration of the flight. When weather conditions are below such IFR minimums or are forecast to go below those minimums, and operational commitments dictate, clearance of fleet aircraft rests with the cognizant Commander Fleet Air Detachment. Fleet aircraft are subject to local traffic procedures and tower control. Liaison and coordination must be established with the commanding officer of the naval air activity to insure orderly flight clearance procedures.

Pilots holding a valid Special Instrument Rating are authorized to approve flight clearance for any flight of a naval aircraft in which they fly as pilot in command or as flight leader of a formation of aircraft. This may not be construed as authorization to clear members of a flight in weather conditions below the minimums for the type instrument rating held by the individual pilots of the flight.

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CLEARANCE AUTHORITY OF PILOT IN COMMAND

When not at a naval activity, or when locally furnished flight clearance facilities are not available at the place of filing, or when in-flight deviation from the initial flight clearance is required, the pilot in command of a naval aircraft is authorized to approve as clearance authority the flight plan for his proposed flight or modification thereof. Appropriate air traffic control regulations must be observed and facilities of Flight Service Stations should be utilized.

DELEGATION OF AUTHORITY

The clearance authorities previously stated may delegate clearance authority to commissioned officers, warrant officers, and naval aviation pilots under their command whom they consider qualified to exercise such authority

GENERAL RESPONSIBILITIES OF CLEARANCE AUTHORITIES

While the actual responsibility for approving flight plans submitted to flight clearance offices normally applies to the operations duty officer, senior AC's working in these offices are in a position to be of great help to the duty officer by checking flight plans for correctness and completeness and bringing any discrepancies to his attention. Knowing your immediate superior's responsibilities is a principle of good leadership, and by actions based on your knowledge of flight clearance procedures you are setting an example for the men who work with and for you.

Flight Clearance Approval Procedures

The clearance authority must insure that all portions of the flight clearance form are complete and that the aircraft is not cleared on a flight that will violate known instructions. The clearing authority should be particularly alert to the following:

1. Pilot in command has signed.
2. The crew is listed on the DD-175. Passengers may be listed on the DD-175 or on a separate passenger manifest.
3. The route of flight section is listed in the proper code to indicate selected navigation fixes.
4. Fuel reserve is sufficient for the flight. Aircraft must carry sufficient usable fuel, considering meteorological factors and mission requirements, to fly from takeoff to destination, or to the approach fix serving destination and thence to an alternate airfield, if one is required, plus 10 percent of planned fuel requirements. The fuel reserve at destination or alternate, if required, cannot be less than that required for 20 minutes of flight. If in-flight refueling is planned, sufficient usable fuel must be carried to fly from takeoff point to the Air Refueling Control Point(s) (ARCP), and thence to a suitable recovery field in the event of an unsuccessful refueling attempt. The fuel reserve at rendezvous point cannot be less than 10 percent. For multiple in-flight refuelings, the aircraft must have the required reserve at each rendezvous point. After the last in-flight refueling is completed, the fuel reserve required for the remainder of the flight is the normal requirement as previously discussed. Any known or expected traffic delays must be considered when computing fuel reserves.
5. Pilot in command holds a valid instrument card if applicable.
6. Check for improper filing into an ADIZ, warning or restricted area, or positive controlled airspace.
7. Alternate airport, if required. An alternate airport is required except for VFR flights or for IFR flights when the weather at the destination is forecast to be equal to or better than 3,000 feet ceiling and 3 miles visibility during the period 1 hour before until 1 hour after the ETA.
8. Insure that the weather briefing has been conducted and that the flight is not in violation of established weather minimums for the type of flight.
9. Insure that stopover procedure is understood by the pilot in command, if applicable.
10. Check for the proper weight and balance forms, if applicable. Generally speaking and for weight and balance control purposes, Nav-Air Instruction 13060.2 (Series) classifies the majority of attack, fighter, and trainer aircraft as class 1A or 1B. The majority of cargo and patrol aircraft are class 2. With the exception of aircraft to be ferried, the responsibility for insuring safe loading of class 1A and 1B aircraft is assigned to reporting

custodians. The responsibility for safe loading of aircraft to be ferried rests with the activity preparing the aircraft for ferry movement. The pilot in command of a class 2 aircraft certifies by his signature on the DD-175 that the aircraft's weight and center of gravity will be within safe limits at the time of takeoff and remain so for the duration of the flight. Such a pilot will submit a completed weight and balance form (DD-365F) which represents the actual loading of the aircraft with the DD-175 or, by his signature, certify that a completed DD-365F, dated within the previous 3 months and which represents the actual loading of the aircraft, is on file at the aircraft's home base.

Authorized Airfields

Pilots cannot clear for airfields other than those listed in the current DOD FLIP IFR/VFR Supplement unless such flights are necessary for the accomplishment of a mission assigned by higher authority. The pilot is responsible for insuring that facilities, such as type runway, length, and load bearing capacity are adequate for the type aircraft involved.

All jet aircraft operating in the continental U. S. and engaged in training or itinerant flight are prohibited from landing at or taking off from civil airports, except for those aircraft of units occupying facilities at the airport. Civil airports are those listed in the FLIP Supplements under Directory of Aerodrome as P, FAA, and those airports where the military designation is enclosed in parentheses. Exceptions to this restriction are as follows:

1. Civil airfields on which naval air stations or units of another military service which operate jet aircraft are located.
2. Flights requiring an alternate may use civil airports as alternates when military alternates are not available.
3. When necessary to visit for official business in the area. Written orders are not required.
4. Required flights for procurement, acceptance, modification, test, and delivery of aircraft. This includes ferry flights to permit flexibility in accomplishing the mission.
5. Flights necessary for the accomplishment of unit mission where prior coordination has been effected with the airport authorities involved and where the Type Commander has granted waivers to permit use of the airport involved.

NOTE: These restrictions do not preclude the use of civil airports for the accomplishment of essential approach and low approach training which cannot be accomplished at military airfields.

Helicopters are authorized to land at nonairfield locations such as fields, highways, and parks, with the following provisions:

1. A military requirement exists for such landings.
2. Adequate safeguards are taken to permit safe landing and takeoff operations without hazard to people or property.
3. There are no legal objections to landing at such nonairfield sites.

The above restrictions may be waived by commanding officers when helicopters are dispatched or engaged in rescue operations.

Meteorological and
Communication Services

The clearance authority must assure that provisions for satisfactory meteorological services and air/ground and point-to-point communication services are available, to insure safe and positive flight guard, prior to granting clearance. At those activities where weathervision is installed, the provision of satisfactory meteorological service may be accomplished by this means, provided that the following conditions are met:

1. The weathervision briefing is recorded at the transmitting end.
2. The pilot accepts responsibility for completion of the weather form and gives his name and grade to the weather briefing officer providing the briefing.

Flight Jeopardy

The commanding officer of a naval air activity is not authorized to permit naval aircraft departures from the activity under his command when the state of the weather or the condition of the crew or aircraft is such that, in his estimation, it will jeopardize the proposed flight. This restriction does not apply to cases where Commander Fleet Air Detachment, or a pilot holding a valid special

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instrument rating flying as pilot in command, or as flight leader of a formation of aircraft, has authorized flight clearance for a flight.

Non-Naval Aircraft

Aircraft of other military services and Military Airlift Command aircraft are granted clearance in accordance with their respective instructions. Civil aircraft will be cleared in accordance with FAA regulations.

VFR FLIGHT CLEARANCE REQUIREMENTS

CLEARANCE APPROVAL

The clearance authority must ascertain that the VFR clearance requested is in accordance with the VFR requirements of FAR 91, other governing regulations, and OpNav 3710.7 (Series).

WEATHER MINIMUMS

Within airspace where FAR 91 is applicable, the cloud clearance and visibility minimums contained therein (illustrated in NavPers 10367-D, AC 3 & 2, chapter 9) prevail throughout a naval VFR flight. If more stringent minimums have been established for the point of departure or destination, as noted in the aerodrome remarks section of the DOD FLIP (En route) IFR Supplement, then the ceiling and visibility must be at or above these minimums in the applicable control zone.

Existing and forecast weather must be such as to permit VFR operations for the duration of the flight. Destination weather must be at least 1,000 feet ceiling and 3 miles visibility, or such higher minimums as noted in the aerodrome remarks section of the DOD FLIP (En Route) IFR Supplement, and forecast to remain at or above these minimums during the period from 1 hour before until 1 hour after ETA.

Exceptions to the preceding paragraph are as follows:

1. Deviations pursuant to FAR 91.107, Special VFR Weather Minimums, are permitted subject to an ATC clearance.

2. Outside of controlled airspace, helicopters may be operated below 1,200 feet above the surface when the visibility is less than 1 mile, if operated at a speed that allows the pilot adequate opportunity to see and avoid other air traffic and maintain obstacle clearance.

Where FAR 91 is not applicable, FLIP Planning Section III, International Flight Rules and Procedures, outlines the general flight rules for operation of military aircraft in such airspace.

Aircraft must be instrument equipped and pilots must be qualified for instrument flight to fly VFR above a ceiling.

Fixed wing aircraft must maintain at least 500 feet above the terrain or surface of the water except when landing or taking off or when the mission of the flight requires otherwise.

Prior approval must be obtained for a simulated instrument approach from the appropriate approach control facility or from the control tower at locations not served by an approach control facility. At an airport with no tower, the associated FSS, if applicable, must be notified.

IFR FLIGHT CLEARANCE REQUIREMENTS

In order to decrease the probability of midair collisions, all Navy/Marine Corps point-to-point and round-robin flights within the conterminous U.S. should, to the maximum extent practicable, be conducted in accordance with IFR procedure. This procedure is not always practicable and pilots should not be required to adhere to it when one or more of the following conditions exist:

1. When compliance would result in derogation of the mission or task.
2. When necessary to avoid severe weather.
3. When dictated by an in-flight emergency.

Pilots of point-to-point helicopter flights should be encouraged to file IFR where feasible and when the aircraft is suitably equipped.

An IFR or combination VFR/IFR flight plan must be filed for all flights of naval aircraft which may reasonably expect to encounter in-flight IFR weather conditions during any portion of the planned route. The VFR portion of the flight must meet the VFR criteria at

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the time of departure and be forecast to remain so during that period.

CLEARANCE APPROVAL

The clearance authority must ascertain that the clearance requested is in accordance with the IFR requirements of FAR 91, OpNav 3710.7 (Series), and other governing regulations.

WEATHER

IFR clearance is based on the actual weather at the point of departure at the time of clearance and forecast weather en route, at destination, and at destination alternate during the period 1 hour before until 1 hour after ETA. Existing weather may be used as a basis for clearance when no forecast weather is available and the pilot's analysis of available data indicates satisfactory conditions for the planned route. Clearance cannot be authorized for destinations at which the weather is forecast to be below minimums (depicted in table 2-1) upon arrival, except when one of the following conditions exists:

1. The flight clearance is authorized by a Commander Fleet Air Detachment.
2. An alternate airport is available which is forecast to be equal to or better than 3,000 feet ceiling and 3 miles visibility during the period 1 hour before until 1 hour after ETA at the alternate.

Flights should be planned to circumvent areas of forecast atmospheric icing conditions and thunderstorms when practicable.

Severe Weather Forecast (WW)

Clearance authorities or pilots who possess clearance authority should not authorize flights through areas for which an Aviation Severe Weather Forecast (WW) has been issued unless the aircraft performance characteristics permit an en route flight level above existing or developing severe storms, or storm development has not progressed as forecast for the planned route. In the latter case, the following conditions apply:

1. VFR clearance may be authorized if existing and forecast weather for the planned route permits such clearance.
2. IFR clearance may be authorized if the aircraft has radar installed, thus permitting detection and avoidance of isolated thunderstorms.
3. IFR clearance may be authorized in positive control areas if visual meteorological conditions can be maintained thus enabling pilots to detect and avoid isolated thunderstorms.

Exceptions to the above restrictions are flights of operational necessity, emergencies, and flights involving all-weather research projects or weather reconnaissance.

INSTRUMENT FLIGHT RULES

IFR flights of naval aircraft are governed by the rules and procedure in FAR 91. The following conditions are in addition to those established therein.

IFR ALTITUDES

Except when the mission of the flight requires otherwise, naval aircraft operated IFR outside of controlled airspace must maintain at least 1,000 feet above the highest terrain, surface of the water, or obstacle within 25 miles of the intended line of flight. When operated IFR outside of controlled airspace, over designated mountainous terrain as shown in the appropriate DOD FLIP, a naval aircraft must maintain at least 2,000 feet above the highest terrain or obstacle within 25 miles of the intended line of flight.

Naval aircraft operated IFR within controlled airspace cannot be flown at less than the minimum en route altitude or that altitude specified by the agency exercising control over the area concerned.

INSTRUMENT DEPARTURES

If a departure takes place under IFR conditions, takeoff weather minimums must be considered. In addition, an approved standard instrument departure may be applicable.

Takeoff Minimums

No takeoff weather minimums apply to pilots who hold a valid special instrument rating.

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is also used as a phase reference for the amplitude difference signals which are the elevation and traverse error signals. The sum signal is obtained in the following manner. The energy from horns A and B is applied to the ring HY-2. These signals are 180° out of phase with each other. (Remember that the waveguides are different between these two horns and the ring.) Now, according to rule 4: the output of the Σ arm will be proportional to the sum of the amplitudes of the input signals, (A + B). The energy from horns C and D is applied to the ring HY-3. The action here is the same as for ring HY-2. The output of the Σ arm of HY-3 is C + D. The signals A + B and C + D are 180° out of phase with each other and are applied to the ring HY-1. The output of the Σ arm of HY-1 is the sum of both signals or (A + B) + (C + D). This signal is sent to the radar receiver.

The traverse difference signal is made up of signals from horns A and C added in phase, and from horns B and D added in phase, but the latter combination of energy is 180° out of phase with the energy from A and C. The energy from horns A and B enters ring HY-2 and, in accordance with rule 4, the output from the Δ arm is the difference of the input signals. This signal A - B is sent to HY-4. The energy from horns C and D enters ring HY-3. The output from the Δ arm of the ring is C - D, which is sent to HY-4. The output of the difference arm of HY-4 is the difference between the two signals, which can be stated as (A + C) - (B + D). Note that this statement determines the difference in energy received from the left-hand horns, A and C, and from the right-hand horns, B and D. This signal is then sent to the traverse mixer in the receiver.

The elevation difference signal consists of the signals from horns C and D added 180° out of phase with A and B signals: (A + B) - (C + D). This signal is arrived at by using the Σ arm of HY-2 and HY-3, and the Δ arm of HY-1. Note that this signal compares the energy received in the upper horns A and B with that received in the lower horns C and D. The signal is sent to the elevation mixer in the receiver.

The elevation and traverse difference signals are compared in the radar receiver with the sum or reference signal. The output of the receiver may be positive or negative pulses, the amplitude of which is proportional to the displacement of the target from the boresight (beam) axis. The polarity of the output pulses indicates the direction of the displacement. NOTE: The positive or negative output of the receiver is determined by the phase relationship of the ranging signal and the error signal. An example of how this phase difference may be detected can be found by a review of the magic-T coupler in chapter 11 of this course. Of course if there is no angle tracking error, the output is zero.

This monopulse system provides direct amplitude comparison of the RF signals. Hence noise generated by the local oscillator and produced in the IF section of the receiver has less effect on the angle tracking system.

SYSTEM ERRORS

In any of the monopulse antenna systems, pointing errors can arise in two distinct ways. Phase or amplitude discrepancies in the received signals, which result from asymmetries in the feed structure from radome refraction, give rise to pointing errors. A second contribution to the pointing error arises from the combined effects of the radome error and the asymmetries and phase errors between the parallel receiver channels which are required in a monopulse system. Signal errors in phase or amplitude are always present to some degree, since the feed structure and the radome cannot be perfect. Similarly, phase discrepancies between receiver channels will generally be present. For satisfactory system performance, however, it is mandatory that both sources of pointing error be minimized; in fact, the design of IF amplifiers with satisfactory phase characteristics over a large dynamic range constitutes one of the major problems in a monopulse system.

A constant phase distortion causes the antenna pointing angle to deviate a fixed distance as long as the frequency is constant; however, at a constant frequency, variations will occur in the errors introduced by amplitude distortions in combination with phase errors between receiver channels.

Some shift in itself is not detrimental (as long as the frequency is constant), since it merely defines a new pointing axis. The position of the new axis, however, varies with frequency, and it is the shift of the pointing axis with frequency which is important. The phase error between feeds may result from

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Takeoff depends on the judgment of the pilot and urgency of the flight.

For pilots who hold a valid standard instrument rating a takeoff minimum of 300 feet ceiling and 1 mile visibility applies. When a radar approach facility with published minimums less than 300 and 1 is available, takeoff may be authorized, provided the weather is at least equal to the precision approach (PAR) minimums for the runway in use but in no case when the weather is less than 200 feet ceiling and one-half mile visibility.

Two-aircraft formation takeoffs for subsequent flight into IFR weather conditions may be authorized, provided the weather is at or above the published circling minimums for the runway/airport in use. In the event a circling approach is not authorized, VFR weather minimums apply.

If available, runway visibility may be used to determine the visibility appropriate to a particular takeoff minimum.

Standard Instrument Departure (SID)

Where available, the use of approved SID's is encouraged for IFR departures. An appropriate SID procedure should be suggested to pilots during preflight planning in order for them to realize the greatest benefit from standardization of instrument departures.

INSTRUMENT APPROACHES AND LANDING MINIMUMS

Approved instrument approach procedures are published in DOD Flight Information Publications (Terminal) or other similar type publications. Landing minimums for precision and surveillance radar approaches are published in DOD Flight Information Publication (IFR Supplement). If available, runway visibility may be used to determine the visibility minimums except that prevailing visibility is used for circling approaches.

Definitions

For the purpose of instrument approach criteria, the Navy defines multipiloted and single-piloted aircraft as stated in the following paragraphs.

SINGLE-PILOTED AIRCRAFT.—A single-piloted aircraft is any aircraft that has one set of flight controls or any aircraft configured with two sets of flight controls and being operated by only one pilot, except that tandem cockpit aircraft are considered as single-pilot aircraft regardless of the number of pilots embarked.

MULTIPILOTED AIRCRAFT.—A multipiloted aircraft is any aircraft that has two sets of flight controls located side by side in a single cockpit and operated by two pilots. Single-piloted aircraft with side by side seating occupied by the pilot in command and an assisting crewmember, which are configured for and assigned all-weather missions, may operate within the same clearance and approach criteria assigned to multipiloted aircraft provided the assisting crewmember has the equivalent of an instrument rating (in accordance with chapter 10, OpNav 3710.7 (Series)) in type aircraft and can monitor the pilot's flight instruments, monitor and control communications, and assist the pilot in acquiring the runway visually.

Approach Criteria

SINGLE-PILOTED AIRCRAFT.—An instrument approach is not commenced in single-piloted aircraft when the reported weather is below the minimums prescribed in table 2-1 for the type approach being conducted, unless an emergency exists. However, once an approach has been commenced, a pilot may, at his discretion, continue the approach to the approved published landing minimums as shown in the appropriate Flight Information Publication for the type approach being conducted.

The absolute minimums for a single-piloted aircraft on a precision approach are: 200 foot ceiling/height above touchdown (HAT) and visibility one-half mile/2,400 feet RVR or published minimums, whichever is higher.

AIRCRAFT IN FORMATION.—Formation flights of more than two aircraft during descent in instrument weather conditions are prohibited except in an emergency.

Formation flights may not commence an instrument approach when the reported weather

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is less than circling minimums for the runway/airport in use unless an emergency exists.

In the event a circling approach is not authorized, VFR weather minimums apply. Once an approach has been commenced, the leader may, at his discretion, continue the approach in formation to the approved landing minimums as shown in the appropriate FLIP for the type of approach being conducted.

MULTIPILOTED AIRCRAFT, RECIPROCATING AND TURBOPROP.—Except in an emergency, instrument approaches in reciprocating and turboprop multipiloted type aircraft may not be commenced when the reported weather is below approved published landing minimums unless it has been determined that the aircraft has the capability to proceed to an alternate airport in the event a missed approach must be executed.

MULTIPILOTED AIRCRAFT, JET.—Except in an emergency, jet multipiloted aircraft may not commence an approach when the reported weather is below the approved published landing minimums for the type approach being conducted. Once an approach has been commenced, a pilot may, at his discretion, continue the approach to the approved published landing minimums as shown in the appropriate FLIP for the type approach being conducted.

CRITERIA FOR CONTINUING INSTRUMENT APPROACHES TO A LANDING.—The published minimum alitutude, minimum descent altitude, or decision height, as applicable, is the lowest altitude to which any aircraft may descend during an instrument approach, unless the pilot has the runway environment in sight and landing can be executed, either straight-in or from a circling approach, whichever is speicifed in the approach clearance. A missed approach must be immediately executed upon reaching the missed approach point if the runway environment is not in sight or if a safe landing cannot be made. For PAR approaches, the point at which the glide path elevation and minimum altitude or decision height coincide must be used to identify the missed approach point.

FINAL APPROACH ABNORMALITITES DURING RADAR APPROACHES.—The radar controller will issue instructions to execute a missed approach or climb and maintain a specific altitude and fly a specified course, whenever the completion of a safe approach is questionable because one or more of the following conditions exist:

1. Safe limits for the radar approach are exceeded or radical aircraft deviations from the normal approach are observed.
2. Position or identification of the aircraft is in doubt.
3. Radar contact is lost or a malfunctioning radar is suspected.
4. Field conditions, conflicting traffic, or other tower observed unsafe conditions, preclude approach completion.

Execution of the missed approach by the pilot is not always necessary for conditions stated in sentences numbered 1, 2, or 3 in the preceding paragraph if the pilot has the runway or approach/runway lights in sight. In these cases, controller phraseology is: "IF RUNWAY OR APPROACH/RUNWAY LIGHTS NOT IN SIGHT, EXECUTE MISSED APPROACH (reason)." The reason might include loss of radar contact, etc.

Execution of the missed approach is MANDATORY for the condition stated in sentence numbered 4 in a preceding paragraph in this section. Controller phraseology should be "EXECUTE MISSED APPROACH (reason)." The reason might be traffic on the runway, etc. The controller may issue instructions to climb and maintain a specific altitude and fly a specified heading, giving the reason therefore, instead of the applicable missed approach procedure.

Practice Approaches

These criteria are not intended to preclude single aircraft from executing practice approaches (no landing intended) at a facility when operating in conformance with an appropriate clearance and the weather at the intended final distination, and alternate if required, meet the criteria for an instrument clearance.

WEATHER CRITERIA FOR IFR CLEARANCES

Table 2-1 shows the actual or forecast weather, as appropriate, to be used as criteria in the approving of clearances for flights to be conducted under instrument flight rules.

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Table 2-1.—Weather criteria for IFR clearances.

Destination		Alternate	
VOR, TACAN, ADF, ASR, LF RANGE, LOC.	ILS, PAR, ALS	VOR, TACAN, ADF, ASR, LF RANGE, LOC.	ILS, PAR,** ALS
Published landing minimums	Published landing minimums. *	300 feet ceiling and 1-mile visibility both above published landing minimums; e.g., published minimums are 400 and 1, then weather must be at least 700 and 2.	200 feet ceiling and one-half mile visibility both above landing minimums.

* Single-piloted aircraft: Not less than 200 feet ceiling/HAT and one-half mile visibility (2,400 feet RVR).

** Single-piloted aircraft and those multipiloted aircraft equipped with only one operative means of two-way communications: Not less than published ADF, VOR, TACAN, or LF RANGE minimums as applicable to installed equipment/navaids available.

FLIGHT PLANNING SECTION

In flight planning, pilots utilize the facilities and space provided in the flight planning section of air operations. Here pilots assemble the necessary information, which is required for a proposed flight, on the flight plan log and the aircraft clearance form (DD Form 175).

Flight planning facilities of operations buildings vary in size, depending on the mission of the station and the amount of traffic that they support. Examples of two different missions are major training stations and fleet support stations. The intent is to provide space and facilities sufficient to permit a reasonable number of pilots to concentrate on flight planning problems at the same time without crowding or other unnecessary annoyance during this important phase of every flight.

EQUIPMENT AND LOCATION

The purpose of the flight planning section is to provide a centralized collection of aeronautical information necessary for, and required by, aircrews to prepare flight plans.

The flight planning section should be located, organized, and equipped in conformity with the following standards:

1. It should be located in a convenient position adjacent to the weather office and the clearance desk. Its location should be clearly indicated by direction indicators to guide transient aircrews.
2. It should be manned by Air Controlmen trained and qualified to maintain flight information publications and associated wall displays. The personnel assigned to this section should be in sufficient numbers to operate the section throughout the normal working hours of the air establishment.
3. It should include adequate accommodation with suitable furnishings for aircrews to thoroughly prepare their flight plans in reasonable comfort. The furnishings should include wall space for the display of required aeronautical information, plotting tables, adequate lighting arrangements, and storage for charts, publications, and forms required by aircrews.
4. Navigation equipment must include plotting instruments, flight comupters, and a clock indicating Greenwhich Mean Time.
5. Sufficient quantities of flight information publications and related information applicable to the mission of the activity and area of location should be available.

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6. NOTAM's decoded to plain language (if necessary) must be maintained up-to-date for ready reference.

7. The following publications are utilized occasionally for reference purposes and should be available in limited quantities where required:

a. Federal Aviation Regulations, Volume VI.
b. Airman's Information Manual.
c. International NOTAM's (FAA).
d. International Flight Information Manual.
e. Air Almanac.
f. Foreign Clearance Guide.
g. Language Glossaries.

AERONAUTICAL CHARTS AND PUBLICATIONS

One of the flight clearance section supervisor's functions should be to insure that an adequate stock of aeronautical charts and publications is maintained in the flight clearance spaces and that they are kept current and corrected. All the Navy's aeronautical charts and publications are procured and distributed by the Naval Oceanographic Office (NAVOCEANO).

The Oceanographer of the Navy is responsible for production or procurement, inventory management, and distribution of navigational and intelligence material to meet the Navy/Marine Corps operational requirements. He also maintains appropriate liaison with agencies within the Department of Defense, Coast and Geodetic Survey, and other chart producing agencies regarding production procurement, and distribution matters.

The general stocking pattern of the Naval Oceanographic distribution system is as follows:

1. Naval Oceanographic Distribution Offices (NAVOCEANDISTO's), of which there are two: Clearfield, Utah, which supports the Pacific area and the continental U. S. (CONUS) west of the Mississippi river; Philadelphia, Pa., which supports the Atlantic area and CONUS east of the Mississippi River. The NAVOCEANDISTO's serve as primary stock and distribution points.

2. Air Navigation Offices (AIRNAVO's), of which there are three to provide service west of the Mississippi River and four to provide service east of the Mississippi River. Each AIRNAVO has a geographical area of the world for which it is responsible. They stock and issue aeronautical charts and publications, selected periodicals, air intelligence publications, and Army maps. Additionally, selected nautical chart portfolios and related publications are stocked uncorrected for emergency issue.

The requisitioning of aeronautical material from the NAVOCEANO distribution system is accomplished as described in the DOD Catalog of Aeronautical Charts and Publications. The purpose of this catalog is to provide a listing of USN/USAF aeronautical charts and publication, DOD Flight Information Publications (FLIP's), and miscellaneous items available to DOD users. This catalog itself is a looseleaf notebook type publication containing several sections, each of which describes certain procedures or charts and publications available. For example, Section II consists of requisitioning and distribution procedure which must be followed and Section III lists the FLIP's available, etc. The catalog is kept current by semiannual publication of new or replacement pages containing changes or additions. There is also a classified DOD Catalog of Aeronautical Charts and Publications of similar construction for ordering classified charts and publications.

That portion of Section II that applies to Navy/Marine Corps requisitioning procedure should be the subject of the supervisors close attention both in general use and training. This section contains complete information necessary to correctly order needed aeronautical charts and publications, including the source to order from. Figure 2-1 is an example of a completed DD Form 1149, which is the document used for requisitioning charts and publications from the NAVOCEANO distribution system.

In order to expedite the processing of requisitions, items should be double spaced on the DD Form 1149 and separate requisitions should be submitted for each category of material as follows:

1. Charts.
2. Publications.
3. FLIP's.

All requisitions must be signed by the Commanding Officer or his authorized representative.

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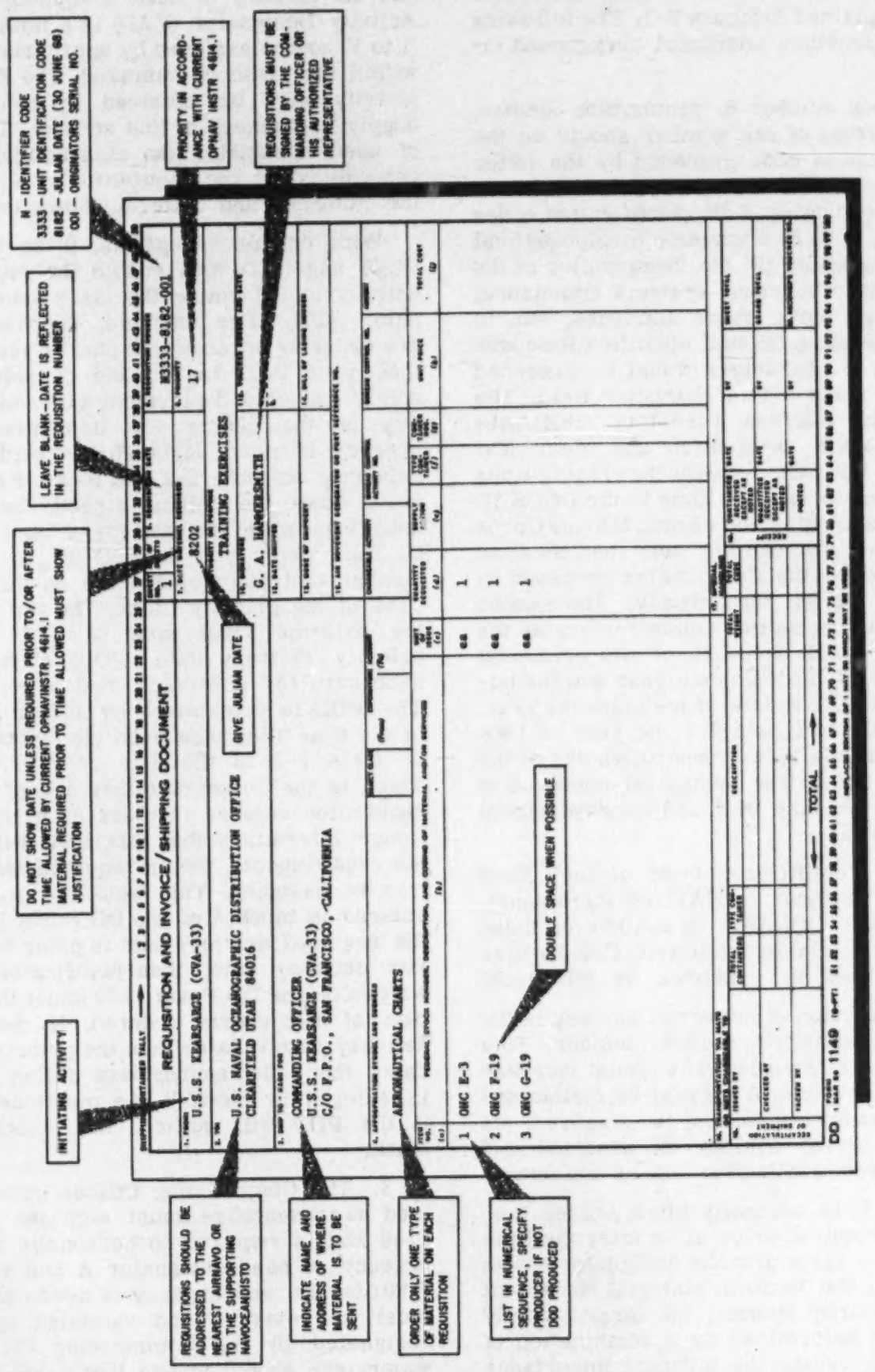

Figure 2-1.—DD Form 1149.

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The spaces to be filled out on the DD Form 1149 are explained in figure 2-1. The following explanation provides additional background information:

1. In block number 6, requisition number, the first portion of the number should be the unit identification code preceded by the letter N. This is referred to as the activity account number in the catalog. Unit identification codes consist of 2, 3, 4, or 5 numeric or alphabetical characters assigned by the Comptroller of the Navy to identify bureaus, systems commands, ships, aircraft units, shore activities, etc. In machine processing the unit identification codes of less than 5 characters would be preceded by zeros to make a five character field. The DOD Activity Address Directory (DODAAD) provides a code designation and clear text address of each DOD activity that requisitions or receives material. The code in the DODAAD for all Navy activities and certain Marine Corps activities consists of the unit identification code assigned by the Comptroller preceded by the letter N or M respectively. The second portion of the requisition number indicates the Julian date, which consists of two elements: the last digit of the calendar year and the numerical consecutive date of the calendar year. In the example in figure 2-1 the year is 1968 and the day is the 182nd consecutive day of the year or 30 June. The numerical consecutive day of the year may be found on government issue calendars.

The unit identification code of each Navy activity can be found in NAVCOMPT Manual, Vol. II, or the DODAAD. If neither of these references is available, the activity Comptroller Department may be contacted by telephone.

The last portion of the serial number is the requisitioning activity's request number. This number on each new requisition must increase by at least one digit. A log may be maintained so that as each requisition is prepared, its originator's serial number is assigned and logged to prevent duplication and/or omissions.

2. Block 7 is normally blank unless the material is required prior to/or after the time allowed by the issue priority designator shown in block 8. In the Uniform Material Movement and Issue Priority System, the issue priority designator is determined by a combination of factors which relate the military importance of the requisitioner (Fleet Activity Designator) and the urgency of need designator. The Fleet Activity Designator (FAD) is a Roman numeral (I to V) and is assigned by appropriate authority within the chain of command. The FAD for any activity may be obtained by contacting the Supply Department of that activity. The urgency of need designator (an alphabetical letter) is determined by the requisitioning activity using the guidance and criteria shown in table 2-2.

With certain exceptions, these two factors (FAD and UND) will enable the requisitioning activity to determine the issue priority designator (IPD). For example, suppose that you are ordering aeronautical charts; you determine that your FAD is IV, and considering your ship's expected deployment date and the necessity of the charts you determine that the urgency of need designator should be C. By referring to table 2-2 you locate FAD IV, then move down the column directly below the IV until adjacent to the urgency of need designator C. This gives you an IPD of 14. This is the number that you would place on the DD Form 1149 in the priority block. The two columns to the extreme right side of table 2-2 titled priority delivery date (PDD) show the time necessary for normal processing and shipping. The PDD is determined by adding the appropriate time allowance from the last two columns in table 2-2 to the date of the requisition, which is the Julian date included as part of the requisition number in block 6. If the requisitioner determines that this PDD will not meet his requirements, then a required delivery date may be assigned. This would be a Julian date entered in block 7 on the DD Form 1149. When the required delivery date is prior to the priority delivery date, then justification must be written on the DD Form 1149 under the description of the charts ordered. If the required delivery date is later than the priority delivery date, then the appropriate Julian date only is entered in block 7. As mentioned earlier, if the PDD will suffice, then block 7 is left blank.

3. The Commanding Officer or his authorized representative must sign the DD Form 1149 and is required to personally review any urgency of need designator A and validate it. Additionally, and urgency of need designator B must be reviewed and validated by persons designated by the Commanding Officer. The supervisor should insure that control of issue priority designator utilization is exercised in

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Table 2-2.—Issue priority designators.

URGENCY OF NEED DESIGNATOR (UND)	FORCE/ACTIVITY DESIGNATOR (FAD)					PRIORITY DELIVERY DATE (PDD)	
	I	II	III	IV	V	CONUS	OVERSEAS
	ISSUE PRIORITY DESIGNATOR (IPD)						
DESIGNATOR A							
Emergency requirements for nonavailable material without which the force/activity concerned is unable to perform assigned missions or tasks.	01	02	03			5 days (120 hr)	7 days (168 hr)
				07	08	8 days	15 days
DESIGNATOR B							
Requirements for nonavailable material which impairs the capability of the force/activity concerned. Missions can be performed, but with decreased operational effectiveness and efficiency.	04	05	06			8 days	15 days
				09	10	20 days	45 days
DESIGNATOR C							
Material requirements needed on a more urgent basis than routine. For example, immediate end use requirements for repair of collateral and administrative support equipment; to meet scheduled deployment; or deficiencies in newly established outfitting or allowance lists.	11	12	13	14	15	20 days	45 days
DESIGNATOR D							
Material requirements for initial outfitting and filling of allowances, scheduled maintenance, routine stock replenishment, repair or maintenance of supply systems stocks.	16	17	18	19	20	30 days	60 days

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the division and kept realistic before submitting the requisition for an approving signature.

4. FLIP's are distributed in predetermined quantities and to a predetermined list of addresses or automatic distribution. The basis of distribution is in accordance with a table included in Section III of the Catalog of Aeronautical Charts and Publications. When requisitioning FLIP's using the DD Form 1149, if automatic distribution of subsequent issues of the material ordered is not required, then a statement that the request is a one-time request must be included on the form. An annual survey is made by NAVOCEANO to establish, confirm, or revise organizational requirements for FLIP's to keep the automatic distribution effective.

Chart Updating Information

Additional updating information on aeronautical charts is provided for DOD users listed in the catalog in two monthly publications. The DOD Aeronautical Chart Updating Manual (CHUM) is published to furnish information on significant chart changes and corrections. Each monthly CHUM supersedes the previous one. The DOD Aeronautical Chart Bulletin is published to inform users of new editions of charts and publications, to furnish information on replacement charts, and to provide notices pertaining to supply. Semiannually a DOD Aeronautical Chart Bulletin Digest is published to list the current edition dates of all charts shown graphically in the catalog. The monthly bulletin is a cumulative system which contains new additions since the last bulletin was published and they should be retained for the six month period preceding publication of the Bulletin Digest. The Bulletin Digest includes the still new or revised information from those previous six bulletins and when the Bulletin Digest is received, the previous six bulletins may be discarded and the process starts again.

To determine if a chart is a current edition, use the following procedure:

1. Check the edition number of the chart against the edition number listed in the latest Bulletin Digest and subsequent monthly bulletins. If the numbers are the same, the chart is current. If the bulletins list a higher edition number, the chart is obsolete and should be replaced.

2. Check the CHUM to see if the chart requires modification. Refer to Section II of the latest CHUM for a listing of charts which require additional or updating information. If the chart is listed, refer to Section III of the CHUM for the correction information and apply the changes to the chart.

3. Check Section IV of the CHUM to see if there are any special notices that contain corrective information for the chart.

4. Check NOTAM files and Memorandum for Aviators files for possible navigation notices which may effect the chart.

There is also a classified DOD CHUM of similar construction for use with classified charts.

WALL DISPLAYS

Certain types of information required to be available in flight clearance can be displayed very effectively as a wall display. The amount, extent, and complexity of such displays are dictated by the mission of the particular activity. However, the following items of information are examples of material which may be made available in flight clearance as wall displays:

1. A general flight planning chart. This chart should be a large one such as the FLIP low altitude planning chart, and have some means of measurement for roughly determining distance of considerable magnitude, for preliminary planning.

2. A local flight planning chart(s) of suitable scale showing VFR ingress and egress corridors.

3. Scaled terrain/obstruction charts which may include overlays depicting current SID courses and their proximity to known hazards.

4. Charts showing details of local special use airspace and training areas, including limits of the local flying area.

5. A wallboard, appropriately marked, upon which to place effective Memoranda for Aviators.

6. NOTAM display. A standardized display board for NOTAM's as prescribed in OpNav 3710.7 (Series) is designed to accommodate the publication procedure of the Navy/Air Force NOTAM system. This particular area of responsibility of the flight clearance supervisor

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should receive considerable attention. He must insure availability of sufficiently knowledgeable personnel to maintain a current NOTAM display and to assist pilots in checking the NOTAM information. The NOTAM board must be constantly updated, at least once each hour, and obsolete material must be promptly removed. When a new NOTAM is received, the Summary should be updated immediately. The accuracy of NOTAM's for your particular activity should be verified at least one hour after receipt of the Summary. Since the sole purpose of the NOTAM system is to assist the pilot in safer flight and the information is only of value after it reaches the pilot who is planning a flight, the effectiveness of the entire NOTAM system depends on how well each individual performs the functions assigned.

7. Lighted or other types of display boards to indicate general flying weather conditions are not mandatory. If used, however, such displays must be standardized to show terminal ceiling and visibility conditions indicated by the following color codes:

a. At or better than ceiling and visibility minimum prescribed for flight under VFR.—GREEN.

b. Below ceiling and visibility prescribed for flight under VFR but at or above the lowest minimum for an approved instrument approach, including PAR.—AMBER.

c. Below the lowest minimum for an approved instrument approach, including PAR.—RED.

USE OF FLIGHT CLEARANCE EQUIPMENT AND SAFETY PRECAUTIONS

Most Flight Clearance officers have some type of landline (direct phoneline) equipment for direct voice communications with ARTCC, FSS, etc. All such phone lines are identified by a particular number. Correct procedure to follow if these lines should fail is developed locally by the supervisor. Supervisors must insure that all personnel in Flight Clearance are familiar with such procedures. It is especially important that they know what to do and who to call on the regular telephone in case of a direct line failure.

Teletype machines in Flight Clearance will probably require more attention from a supervisor than most other equipment since they are relatively difficult to operate correctly. The supervisor must insure that the operators are properly indoctrinated concerning the proper codes prescribed for the particular types of messages that his office sends. This is especially important with automatic systems since improper coding of a heading to a message may cause the message to be rejected by the computer that routes the message to intended receivers. This would require doing the same job again, which introduces a delay in message delivery. Normally there is a time lapse of at least 30 minutes between the time the pilot of a proposed IFR flight submits his proposed flight plan until he calls departure control for his clearance. If too many delays are introduced into the processing and submission of the proposal via teletype, the clearance may not be available when the pilot is ready for it. Considering the expense of the aircraft and pilot sitting there waiting for clearance, when the delay problem is at the Flight Clearance office, the necessity for correct and rapid communications should be apparent.

As in any situation, the senior personnel of Flight Clearance must be continuously safety conscious. They should make periodic inspections of work areas of Flight Clearance for potentially hazardous situations. Around teletype machines, consider the following precautions or actions:

1. The top cover of the machine should never be opened when anyone is working around it with metal objects such as paperclips, thumb tacks, etc., that might fall into the mechanism. Such objects, if allowed to fall into the machine, could severly damage it or possibly short out an electrical component and cause an electrical fire.

2. If an electrical fire should result, unplug the machine or otherwise disconnect the electrical circuit, such as with a master switch. It may be necessary to use a fire extinguisher. Be sure a CO_2 extinguisher is available in the area and that everyone knows the location.

3. Insure that personnel are properly indoctrinated as to the proper procedure for replacing teletype paper and ribbons since improper installations may jam or damage the machine or in any event delay its return to service.

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FLIGHT CLEARANCE SUPERVISOR

The supervisor is the key to the efficient and effective function of any operation. Flight Clearance may be considered one of the most important functions of the ATC division. Although it does not include what may be considered the more exciting functions of actually controlling air traffic, as do the tower or RATCC, it probably presents the greatest challenge to a supervisor. It is at Flight Clearance that physical contact is made between the users of, and the air controlmen who provide, air traffic control services. Logically, the image or personality of the division, department, and station may be the result of the majority of opinions formed concerning the services received, culminated by this contact.

It is a generally accepted practice to assign the young personnel, new to the Navy, to Flight Clearance to begin their development of air traffic control skills. These men have a tendency to try to imitate or take for their own those qualities they admire and respect in those they identify as leaders. If the leaders they respect and admire are skillful, aggressive, and professional air controlmen who create by their interest and action a good attitude toward flight clearance functions, then these new men will develop good attitudes. A supervisor wants his men to be cooperative, to be willing to pitch in when emergencies arise, to have pride in the organization, and to feel they have a stake in it. These cooperative attitudes are a byproduct of a supervisor's dealings with his men.

A supervisor can stimulate interest in flight clearance by helping his men see why their work is needed and how it fits into the whole pattern of air traffic control. He can develop their initiative by encouraging them to join in figuring out ways of making their work easier and better, and by delegating jobs to those who can and should be doing them and occasionally checking and acknowledging the fact that they are done properly. At the same time the supervisor must avoid stifling initiative by oversupervision.

A supervisor will necessarily carry out an orientation program for all new men. But it takes more time and attention to get the younger men off to a good start. This is worth doing because they have many useful years in the Navy ahead of them if they get started right. The new men probably lack confidence and it is up to the supervisor to relieve the tension. Once they have some confidence, are familiar with their surroundings, know their shipmates, and know who is to give them orders, they are able to learn faster. It may be helpful to put them under the wing of a more experienced air controlman to help them adjust and find their way around.

The flight clearance supervisor's professional qualities are already proven by his attained rate and selection to a supervisor position by his seniors. This combined with good training and management practices will insure the efficient and effective operation of the Flight Clearance Branch.

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structural asymmetries in the feed, or it can result from radome effects as well. Since the phase errors caused by the radome vary as the antenna scans, a variable shift in pointing axis then results, even with a fixed frequency. The major source of error for both phase and amplitude comparison monopulse systems are in the feed system as follows:

1. For the phase comparison system the primary errors are phase errors, and secondary errors are amplitude errors (in front of the sum and difference circuits).
2. In the amplitude comparison systems the primary errors are amplitude errors and secondary errors are phase errors.
3. Both systems experience phase errors between receiver channels.

PULSE EXPANSION AND COMPRESSION

Within the past few years, an amazing and powerful radar technique called pulse compression (nicknamed "Chirp Radar") has been incorporated in all types of radars. Pulse compression is possibly the most significant new advance in radar techniques in many years. It can improve a radar's performance by a factor of possibly several hundred. There appears to be no limit in sight to its possibilities. It is finding use in long range search, missile control, fire control, weather observation, aircraft traffic control, and mapping radar, and many more. Frequently, computers are used to display the returned target information using standard target symbols rather than displaying conventional video on a PPI type indicator. These symbols depict target position, size, type aircraft, and movement of the target. Generally, the radar is computer controlled.

ADVANTAGES

Some of the advantages which are discussed in this section are extended range with improved range resolution, height finding capabilities, immunity from ECM jamming, and an increased signal-to-noise ratio.

Extended Ranges

One important factor in any radar's maximum range is the envelope power. Envelope power is found by multiplying the pulse width times the peak power. The AN/APS-20, which is a typical search radar, has a pulse width of 2 μsec and a peak power of 2.5 megawatts. This will produce an envelope power of 5 watts/sec. A typical pulse compression radar will have a pulse width of 10 μsec and peak power of 1 megawatt which will produce an envelope power of 10 watts/sec. Since range is partially determined by the transmitter, this will give us the possibility of an increased range over the conventional pulse radar.

Improved Range Resolution

Range resolution is the minimum distance which two targets must be separated to appear as two separate displays on a scope. This separation is largely determined by the pulse width of the echo being returned to the receiver. In our typical conventional radar with a 2-μsec pulse width, range resolution would be 1,000 feet. In the pulse compression radar, the 10-μsec returned pulse is compressed to 0.1-μsec before being applied to the receiver. Therefore, the range resolution is 0.1 x 500 or 50 feet. This improved range resolution is accomplished without affecting maximum range because the envelope power is not changed.

Height Finding Capabilities

The theory employed by pulse compression to determine height is based on the ability of the radar to receive multiple path returns from a single target. With sufficient power, receiver sensitivity, and range resolution, the system can distinguish between three echo returns. (See fig. 15-14.) By measuring the time difference of the three returns and comparing the altitude of the radar transmitter, the computer can determine the target altitude. Only the pulse compression radar has both the

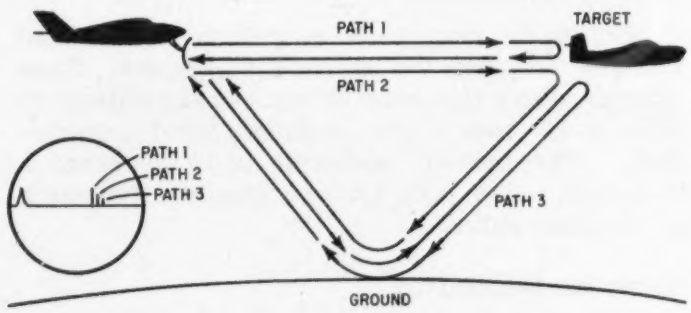

Figure 15-14.—Multiple echo paths.

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CHAPTER 3

FACILITY OPERATION

Because of the many advantages of standardization, the Navy has endeavored to apply this principle to air traffic control to the extent possible. Cooperation with the FAA and other military agencies of the DOD to develop a common civil/military system is one example. The NATOPS program is another. These standards attempt to provide uniform systems of efficient operation and operational guidance for ATC facilities. Differences between agencies and facilities are recognized, however, and appropriate options to provide the required flexibility is retained. It is the intent of this chapter to discuss those procedures applicable to most naval ATC facilities relative to the operation of the facility which are not included or referred to elsewhere in this training course.

AIR OPERATIONS MANUAL

Local flying rules and instructions are found in regulations issued by the various fleets, forces, naval air stations, and other naval activities where aircraft are based or operated. In accordance with OpNav 3710.7 (Series), Navy and Marine Corps facilities develop and publish Air Operations Manuals which should include all those subjects that are considered as local administrative or operational procedure. Since this manual establishes local regulations, it is considered as a continuation or supplement to OpNav 3710.7 (Series) which contains the overall standardized general flight and operating instructions for Navy and Marine Corps facilities.

Senior AC's should become involved with their Air Operations Manual. They should make their ideas for improved or more efficient procedures known to the proper individual in the chain of command. The best possible evaluation of such a publication must come from pilots using and the controllers providing the service regulated by this manual.

The following basic outline for an Air Operations Manual should be adhered to as closely as possible considering local conditions and services offered, which could necessitate some variation.

1. General.
   a. General prudential rules.
   b. Hangar and service facilities (including wheel load capacity of runways and parking aprons).
   c. Night lighting facilities.
   d. Hours of operation.
2. Clearance of aircraft.
   a. Instructions for filing flight plans.
   b. Weather minimums.
3. Course rules.
   a. Taxi instructions.
   b. Takeoff instructions.
   c. Landing instructions
   d. Runway use procedure.
   e. Definition of local flying area.
   f. Acrobatic areas.
   g. Bombing areas.
   h. Local obstructions.
4. Air traffic control.
   a. PAR procedures, if applicable.
   b. Procedures for checking "wheels down and locked."
   c. Emergency procedures.
   d. Procedures for civil operations which infringe upon the control zone and/or airport traffic area, such as crop dusting, sign towing, forest fire fighting, etc.
5. Transient aircraft.
   a. Accomodations available.
   b. Transportation available.
   c. Instrctions for clearance of passengers for flights.
   d. Procedures for handling visiting VIP's.

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e. Procedures for expeditiously handling the orders of personnel authorized per diem.

f. Customs procedures, hours, and requirements (at stations on foreign soil and where applicable in the U.S.).

g. Procedures for obtaining flight rations.

h. Procedures for obtaining special aircraft security.

i. Procedures for obtaining required registered publications necessary for flight.

j. Procedures and facilities for temporary stowage of registered material and weapons.

k. Availability of clothing, shaving articles, etc., for unexpected RON's and Bingo crews.

6. Aircraft crash and rescue.
   a. Crash and rescue bill.
   b. Search and rescue bill.
   c. Salvage bill.
7. Illustrations.
   a. Traffic pattern charts.
   b. Taxi pattern charts.
   c. Prohibited, warning, and alert area charts.
   d. Target dropping and bombing area charts.
   e. Scaled terrain/obstruction chart.

One copy of each new or revised Air Operations Manual is sent to CNO, OCEANO, COMNAVAIRSYSCOM and the appropriate NARASPO. Distribution to other activities that use local facilities is accomplished as needed.

A complete and current Air Operations Manual is a definite asset to an ATC facility. By direction, it enjoys faily wide distribution and is useful to interested persons unfamiliar with the local activity who intend to use the facility and services offered. Also, it is a useful tool for a facility's indoctrination and training program since it is a collective publication of regulations which affect local flying operations and procedures.

Moreover, if the Air Operations Manual is ignored and allowed to become a dust catcher in the files, it can be a meaningless waste. The Navy has taken steps to prevent this by requiring, through regulation, that a periodic review be conducted to insure that the subject matter is up to date. However, like any regulation, the effectiveness at the local level depends upon the initiative and insight of those regulated.

FACILITY LICENSE

SecNav Instruction 3770.1 (Series) establishes responsibility and describes the procedures for use of Navy/Marine Corps aviation facilities by other than military aircraft as authorized by the Federal Aviation Act of 1958.

AUTHORITY

The Federal Aviation Act of 1958 states that air navigation facilities owned and operated by the U.S. may be made available for public use under such conditions and to such extent as the head of the department or other agency having jurisdiction thereof deems advisable and may by regulation prescribe.

Navy and Marine Corps aviation facilities are established to support the operation of Navy and Marine Corps aircraft. Equipment, personnel, and material are maintained only at a level necessitated by these requirements. SecNav has established the policy that, except in the case of a bona fide emergency, Navy and Marine Corps aviation facilities will not be used to support the operation or maintenance of commercial or private aircraft except as follows:

1. Aircraft other than those belonging to the U.S. Government may use Navy and Marine Corps facilities if necessary and if so authorized under the provision of SecNav 3770.1 (Series), provided that:
   a. They do not interfere with military requirements, and the security of the military operations, facilities, or equipment is not compromised.
   b. No adequate civil airport is available. (An exception to this is flights in connection with official government business.)
   c. Pilots comply with regulations promulgated by the cognizant military agency and the commanding officer of the facility.
   d. Civil aircraft users assume the risk in accordance with the provisions of the Aviation Facility License.
2. At joint civil/military facilities, the agreement entered into when establishing the joint use operation may take the place of SecNav 3770.1 (Series) concerning civil use.
3. At facilities in foreign countries, the provisions of status of forces agreements,

treaties of mutual cooperation, or other international agreements must also be considered.

4. Aircraft being produced for a military agency under contract may use Navy facilities for testing and experimental purposes if the contract so provides, or it is determined that it is in the best interest of the government to do so.

5. Department of Defense single manager (MAC) contract and charter aircraft may use Navy or Marine Corps facilities when authorized in accordance with a facility license approved by CNO.

CIVIL USE OF NAVAL FACILITIES

The use of naval facilities by civil aircraft is at the risk of the operator. The Navy assumes no liability or responsibility by reason of the condition of the landing area, taxiways, radio or navairds or other equipment, or for notification of such conditions, or by acts of its agents in connection with the granting of the right to use such facility. Additionally, no responsibility is assumed for the security of or damage to aircraft while on government property.

Operators of civil aircraft using a naval facility are required to comply with the air and ground rules promulgated by the Navy or the commanding officer. Such operators are required to comply with FAA requirements for filing flight plans. When a flight plan is required, it must be filed with the commanding officer or his authorized representative prior to departure. When no flight plan is required, the operator must furnish a list of passenger and crewmembers, the airport of first intended landing, the alternate airport, and the amount of fuel in hours to the flight clearance authority, or the local company official, as appropriate, prior to takeoff.

The applicable weather minimums are those established for a specific airline, if appropriate, or those as published in the Airman's Information Manual, or if none are established, those established by the commanding officer.

The commanding officer may conduct an inspection of the aircraft, its crew and cargo, or passengers as may be required. Compliance with local customs, immigration, agriculture, and public health regulations is the responsibility of the aircraft commander. The commanding officer will inform local officials of the arrival of civil aircraft subject to such regulations and will not authorize takeoff clearance until such regulatios have been met.

If a Navy facility has been approved as an alternate airport, radio clearance must be obtained from such facility as soon as the decision is made to use it.

In the case of an emergency landing, the commanding officer will obtain from the pilot of the aircraft a written report of the conditions pertaining to the emergency.

APPLICATION AND APPROVAL OF FACILITY LICENSE

Nonmilitary aviation interests desiring use of a Navy/Marine Corps facility will be required to execute an application (OpNav Form 3770-1) and an Aviation Facility License (OpNav Form 3770-2), and furnish adequate evidence of insurance coverage before approval for use of the facility can be given. The following list contains exceptions to this condition:

1. Aircraft owned or operated by departments or agencies of the U.S. Government.
2. Aircraft owned or operated for noncommercial purposes by agencies of a foreign government, except in the case where the foreign government charges fees for U.S. Government aircraft.
3. Aircraft owned and operated by states, counties, or municipalities of the U.S.
4. Aircraft operated by Navy/Marine Corps flying clubs or Aero Clubs of other military services which are operated as instrumentalities of the Federal Government.

The commanding officer has authority to approve or disapprove operations of civil aircraft at his facility. There are conditions which require higher authority approval, in which case commanding officers forward the application and license to such higher authority.

HANDLING PROCEDURES AT THE ATC DIVISION LEVEL

Copies of approved Facility Licenses are normally on file in the ATC division office for reference. It is necessary that division personnel are aware of the aircraft operators

authorized to use your facility to avoid unnecessary delays when such operations are impending. The simplest procedure would probably be maintenance of a current list of approved licenses in the tower, RATCC, and flight clearance.

EMERGENCY PLANS AND SERVICES

Commanding officers of air facilities are required to develop and maintain current operational plans and procedures to insure maximum protection of aircraft and safety of personnel during an emergency situation. Senior AC's will be called upon for advice and assistance when these plans are developed or updated to insure that they are effective and workable from the air traffic control aspect.

Additionally, training of new personnel in this particular function is probably the most difficult to perform since actual conditions requiring the use of these procedures occur infrequently. Consequently, supervisors must conduct drills frequently which simulate emergency conditions to develop the skills and reactions required of controller personnel.

CRASH AND RESCUE SERVICES

NavAir Instruction 11320.4 (Series) provides the basic policy and organization for performing the crash and rescue function at Navy and Marine Corps air activities. This instruction is the basic document from which commanding officers promulgate the local crash and rescue bill which should be a part of the facility's Air Operations Manual.

The AC's participation in crash and rescue procedure is mainly one of communication; i.e., notification of impending flight operations to permit positioning of equipment in an alert status and notification of a crash or an impending emergency landing to the appropriate stations on the crash alarm system.

At all times when the runways are in use at a facility, a runway alert will be maintained. The runway alert consists of the appropriate men and equipment strategically located to permit the men to observe the entire runway and respond immediately to an emergency. The purpose of the runway alert is rescue of personnel involved in unannounced emergencies and to observe and report any suspected malfunction of aircraft to the control tower. In the event landings and takeoffs are being conducted simultaneously and both operations cannot be observed from one position, a second runway alert should be provided.

At all times when flight operations are being conducted, a standby alert of the appropriate men and equipment should be maintained in a state of readiness such that they can respond to an emergency from their standby position to the field alert position within 3 minutes. The purpose of the standby alert is to supplement the runway alert and provide additional firefighting capability when necessary.

Additionally, a backup standby alert is maintained when flight operations are being conducted consisting of the appropriate men and equipment from the security forces, ordnance disposal crews, and the station firefighting organization in a state of readiness such that they can respond to an emergency promptly from their normal working spaces. These supporting forces should assume the position of standby alert upon notification of an emergency and await the instructions of the senior firefighter at the scene.

AC's in the tower will usually observe or receive information regarding impending emergencies and will notify the crash and rescue crews and other appropriate personnel on the crash alarm system. If such information is initially received at locations other than the tower, personnel in the tower should be notified immediately to permit timely notification to all concerned. Various systems of notification and communications are required for crash and rescue operations at air facilities; these are discussed in detail in AC 3 & 2, NavPers 10367-D.

Crash Drills

Response time seems to be the most important factor to surface when evaluating a reaction to an aircraft emergency other than actual control procedure employed by the air traffic controller. Data on survivable aircraft accidents and fire tests emphasize the urgency of arriving at the accident scene in the shortest possible time. Test and experience data show that occupant escape time can be extended by prompt fire suppression operations. Many items that affect response time are fixed, such as

number and type of crash equipment necessary per category of aircraft operation and the number of personnel necessary to adequately man such equipment. However, crew reaction time is one item which may be considered variable and is affected by communications procedures and practices for the alert. The AC has a definite degree of control of the alert. To enhance development of a minimum response time, frequent drills should be conducted to allow tower personnel to actually use the procedure for alerting the crash crew. The following items should be stressed in each drill:

1. Use of the grid maps to pinpoint accident scenes both on and off the airport.
2. Prompt transmission of messages pertaining to a crash and other information available to assist in the location of the accident scene.
3. Prepositioning of crash equipment when the situation permits advance notice that an emergency exists but the aircraft concerned is still en route to the air station. Although the physical positioning is the Crash Captain's responsibility, the tower controller must concern himself with which runway the emergency aircraft will use, the control of other traffic at the air station, both ground and air traffic, and insuring that such other traffic does not hinder the movement of emergency vehicles and equipment.
4. Tower crew efficiency in effecting an alert when word is received from another source that an emergency situation exists or a crash has occurred.

HAZARDOUS CARGO

The crash and rescue bill must contain provisions for notification of the necessary personnel concerning the movement of hazardous cargo. The operations duty officer and the tower will be aware of the movement by aircraft by inclusion of such information in the normal exchange of flight plan information. Particular phraseology and d scriptive terms associated with hazardous cargo are contained in Navy SWOP 20-11 entitled Precautionary Measures Involving Aircraft Carrying Hazardous Cargo, and are classified Confidential. Senior AC's must make sure that their men have the necessary security clearance and know and understand these terms.

In the event an aircraft carrying hazardous cargo is involved in an emergency, specific information, in addition to the normal emergency procedure, must be relayed to the crash and rescue crews and explosive ordnance disposal personnel for the protection of all concerned. Specific local directives are established for notification procedure of an accident involving special weapons based on OpNav Instruction 8110.16 (Series) entitled Nuclear Activities and Nuclear Weapons Incidents.

SCATANA

A plan for the Security Control of Air Traffic and Air Navigation Aids (SCATANA) was prepared jointly by the Department of Defense, the Federal Aviation Administration, and the Federal Communications Commission. The purpose is to establish responsibilities and procedures to provide for the security control of civil and military air traffic and certain Federal and non-Federal air navigation aids during a Defense Emergency/Air Defense Emergency. SCATANA is disseminated in the Navy as OpNav Instruction 3722.30 (Series).

The North American Air Defense Command (NORAD), based on the requirements of the existing military situation, directs the extent of security control of air traffic and air navigation aids in the area or areas affected in the interest of national security. Full SCATANA procedures may be implemented or, in limited situations, only the Emergency Security Control of Air Traffic (SCAT) rules may be placed in effect. Emergency SCAT rules are contained in FAR 99 and provide for the ready identification and control of all air traffic in the event of a Defense Emergency.

Upon declaration of an Air Defense Emergency, NORAD region commanders notify FAA ARTC centers within their areas of responsibility of the alert and the extent of implementation of the plan. The ARTC centers, in turn, will disseminate the appropriate portions of the alert to civil and military air traffic control facilities under their jurisdiction.

Each civil and military ATC facility must maintain a current SCATANA action form for that facility and execute the instructions thereon at the direction of the ARTCC.

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Testing Procedures

To insure that SCATANA actions can be taken expeditiously, tests are conducted at frequent intervals. The tests are originated at the NORAD region level. All Federal facilities responsible for SCATANA actions must participate. The participation and reporting are prescribed on the SCATANA actions form for a particular facility. During such tests, all actions are simulated.

Senior AC's must be familiar with SCATANA and the facility's SCATANA action form to provide for expeditious action and handling of an alert or tests. An internal procedure for dissemination of an alert or test is necessary to insure that those concerned or affected at a facility receive notification and accomplish the required action in minimum times.

SAFETY

Safety is definitely one of the most important areas of responsibility with which supervisors must concern themselves. Recognizing the potentially hazardous conditions associated with electrical and electronic equipment, knowing how to prevent such conditions or what to do if confronted with them, and imparting this awareness to personnel for whom responsible, are major responsibilities of all senior AC's.

The safety program may necessarily be a general one; i.e., it must extend to every facet of an operation and apply equally at all levels. Safety is everyone's responsibility. Unsafe conditions must be reported to appropriate authority, other personnel must be warned when endangered, any injury or evidence of impaired health must be reported, and in the event of an emergency or some hazardous condition, reasonable caution must be exercised appropriate to the situation.

One approach to the safety program may be to insure that personnel are aware of the hazards that exist and the precautions that must be taken or observed. For example: indoctrinate them that a 60-hertz alternating current passed through a man's body from hand to hand or from hand to foot, with gradually increasing current, causes a perceptible shock at one milliampere, voluntary control of muscles becomes impossible at 10 milliamperes, and one second or more at 100 milliamperes or over generally proves fatal. The following precautions should be observed:

1. Lock and tag switches open before anyone works on a circuit.
2. Never bridge a fuse.
3. Consider all circuits alive until proven otherwise.
4. When someone is working on high-voltage equipment, make sure that another person is present that is capable of rendering assistance or first aid in an emergency.
5. Do not energeize equipment if there is evidence of water leakage.
6. Make certain that all ground connections to electrical equipment are inspected and cleaned periodically and that they are not painted or greased.
7. If use of CO_2 is necessary to extinguish an electrical fire, consider the danger of suffocation from prolonged exposure in confined spaces.
8. Rope off and place danger signs in hazardous areas.

Indoctrinate personnel that electromagnetic radiation, depending upon the intensity, can produce harmful biological effects in humans, cause spark ignition of volatile combusibles, or actuate electroexplosive devices contained in aircraft ordnance systems. The following precautions should be observed:

1. Minimize the hazard by increasing the distance between the energy source and the item to be protected or by reducing the power output of the radiation at its source.
2. Park aircraft employing high-power radar so that the beam is directed away from working areas, fueling operations, and ordnance loading.
3. Post warning signs at the limits of hazardous areas subject to entry by personnel.

Indoctrinate personnel that all solvents will dissolve the natural skin oils and may cause skin irritation or burns and they are toxic causing an inhalation hazard to exist. The following precautions should be observed:

1. Avoid prolonged or frequently repeated contact with skin.
2. Wear rubber gloves when using solvents.
3. Work in a well-ventilated area or wear a protective mask.

Indoctrinate personnel that carbon monoxide, a normal byproduct of all combustion engines, is a colorless, odorless, and tasteless gas which is extremely hazardous. When inhaled by an individual, it inactivates and absorbs the blood hemoglobin, which in a very short time causes unconsciousness and possibly

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death. Never allow anyone to work on or around a combustion type engine such as power units of emergency generator systems without adequate ventilation.

The safety program may not lend itself to any well-defined system which should be followed and practiced in all situations but it must be brought to everyone's attention frequently as a reminder. Any infraction of accepted safe procedure should be corrected and dealt with accordingly.

LETTERS OF AGREEMENT

Letters of Agreement, after appropriate approval, are official documents describing specific procedures and jurisdiction concerning air traffic mutually agreed upon between ATC facilities. Requirements for issuing Letters of Agreement are varied and in general include the following:

1. Supplement established operational or procedural instructions.
2. Define interfacility coordination requirements concerning control of air traffic.
3. Establish or standardize operating methods.
4. Describe special operating conditions or specific air traffic control procedures.
5. Delegate areas of control jurisdiction and conditions of their use.
6. Describe procedures or minimums that differ from normal standard procedures to satisfy a requirement of a user activity.

DEVELOPMENT

A Letter of Agreement is a jointly executed agreement. However, through coordination of affected facilities, the responsibility for development and processing of such Letters is determined and assigned to a single facility. Letters of Agreement depicting naval operations are normally prepared by the affected naval facility. Although the responsibility is ultimately the commanding officer's, senior AC's are necessarily involved and frequently responsible for development of the original Letter for approval of higher authority.

When developing Letters of Agreement, the following guidelines should be followed:

1. Confine the material in each Letter to a single subject or purpose.
2. Describe the responsibilities and procedures applicable to each facility and organization involved.
3. Attach charts or other visual presentations, when appropriate, to depict the conditions of the agreement.
4. Delegate responsibility for control of IFR traffic by describing the area affected, defining the conditions of use of the area, specifying the details of the control procedures to be used and communications and coordination requirements.
5. Coordinate with other facilities and agencies as appropriate.

APPROVAL

After the necessary coordination with affected facilities and the basic Letter is mutually agreed upon locally, two copies of the proposed Letter are sent to the FAA regional office for review. This may not be required where local FAA officials possess authority to approve such documents. In any case, the local FAA officials will normally handle the proposed Letter as far as FAA review and approval are concerned.

After review and approval of the proposed Letter by the FAA, the responsible facility will prepare the Letter in final form including incorporations of instructions as a result of the FAA review. An effective date should be established allowing sufficient time after distribution for facilities and controllers affected to become familiar with the conditions of the agreement. Additionally, Letters of Agreement between naval facilities and the FAA must be approved by the Chief of Naval Operations before they are official.

CONTROLLER CERTIFICATION, RATING, AND PROFICIENCY

Commanding officers of Navy and Marine Corps shore activities operating ATC facilities must insure that only personnel who are certified in accordance with FAR 65 and qualified in accordance with OpNav 3721.1 (Series) and local facility directives are permitted to control air traffic. Additionally, air traffic controllers under training must be properly supervised by qualified controllers.

FAR 65 established the requirement of possession of basic FAA certification (Airman written examination report). Then, qualification by operating position is accomplished locally;

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and when an applicant has qualified for all operating positions at a particular control tower, he is issued a "facility rating."

Surveillance and precision radar controllers, in addition to the basic FAA certification, must be graduates of the GCA controller school and be qualified in accordance with local directives. Commanding officers must insure that an appropriate entry is made in an individual's service record when considered qualified to control aircraft under instrument conditions using surveillance or precision radar.

A facility's training program must necessarily be a continuous operation for the various levels of certification and ratings required. Keeping the number of qualified controllers at the required level is a never-ending problem considering the Navy's duty assignment rotation system. Senior AC's may be directly responsible for the training program itself, and in every case will have definite responsibilities within the various phases of training.

The officers and enlisted crews of the ATC facilities should train at the activity as a team and as such are considered watch standers.

Training of controllers in positions other than those at which they are qualified should be conducted in VFR conditions. Nonqualified controllers in training must be under the direct supervision of a qualified controller when actually engaged in the control of aircraft.

Cross training in as many operating positions as possible is desirable for ATC personnel to provide the flexibility of rotating controllers throughout the air traffic control division.

Information required to qualify controllers at each operating position must be included in local ATC facility operating instructions, except when such information is readily available in other publications. All information required to train and qualify controllers must be kept current and readily available.

Officer and enlisted radar operators must develop and maintain proficiency by controlling at least 5 approaches per week. Where the amount of air traffic limits proficiency, those controllers qualified to control IFR traffic may concurrently count those trainee controlled approaches they actively monitor.

EXAMINERS

CTO examiners are designated by the FAA in sufficient numbers and locations to meet the certification and rating requirements. All FAA tower chiefs, the FAA chief controllers at jointly operated Navy/FAA facilities, and FAA air traffic representatives at military approach control facilities are designated as examiners. The examiners are authorized to conduct the written and practical examinations prescribed by FAR 65.

Where FAA examiners are not sufficient or available to satisfy the needs of a military facility's certification and rating needs, military examiners may be appointed as required and requested by the military agency. This initial request is made to CNO (OP-534) for validation of the requirements. For other than the initial request, a commanding officer may communicate directly with the FAA Regional Office to obtain a Letter of Designation for an individual which signifies the designation of a military examiner by the FAA. CNO (OP-534) must be informed in the latter case. Personnel recommended as military examiners must meet the eligibility qualifications listed in Handbook 7220.6 (Series) for examiners.

MONITORING CONTROLLER PROCEDURE

The FAA has been authorized and requested to report results of in-flight monitoring of air traffic control procedures employed by Navy/Marine Corps air traffic facility personnel. In reporting the results and making recommendations concerning the procedures checked, the FAA personnel communicate directly with the facility commanding officer or his authorized representative. The report is made by completion of an FAA form entitled ATS Facility Monitor Report. If conditions allow, the FAA personnel may discuss the check informally with the facility personnel.

Senior AC's supervisory positions should insure that the FAA flight monitor personnel and/or the reports are appropriately received and that the recommendations or comments are taken in the constructive manner in which offered. The discrepancies noted should be reviewed and corrected as feasible. A careful analysis of any derogatory comments should be made and consideration given to

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recommendations. The supervisor can make good use of the recorder tape in a review of this type and preferably in company with the controllers affected. The proper attitude toward and the use of these reports will assist supervisors in maintaining a high degree of professionalism among controllers.

FAA AIR TRAFFIC REPRESENTATIVES

At certain locations where approach control authority has been delegated to the military, an FAA representative may be assigned on a resident basis. The Navy considers such liaison representation with the FAA important to maintain an efficient and effective operation of Navy approach control service. The responsibilities and authority of such representatives include the following:

1. Conduct continuous inspections to insure that the equipment performance and assigned personnel meet acceptable standards.
2. Suspend approach control authority in the interest of safety considering sufficient numbers and proper certification of facility personnel and operation in accordance with jointly agreed upon control procedure.
3. Recommend changes to improve the scope of service provided, personnel training and certification, and development and utilization of improved procedures for increased efficiency.

Deficiencies or discrepancies noted by such representatives are normally brought to the attention of the ATC facility officer for correction, except that when the time element involved would jeopardize the safety of flight, on-the-spot action may be taken prior to the normal notification procedure.

NAVY APPROACH CONTROL FACILITIES

The Federal Aviation Administration (FAA) has statutory authority and the responsibility for the provision of air traffic control service to promote the safe, orderly, and expeditious flow of air traffic within designated controlled airspace. Accordingly, the authority for the conduct of approach control service rests with the FAA. However, by mutual agreement between the FAA and the cognizant military service, approach control authority may be delegated to the commanding officer of a military aviation activity. This authority is for the primary purpose of providing approach control service for military installations, but may include civil airports located within the designated controlled airspace. When so delegated, approach control authority may be exercised through a tower, mobile or fixed ASR/PAR facility, Radar Air Traffic Control facility, or a combination thereof, utilizing the standardized procedures prescribed by FAA Terminal Air Traffic Control Handbook 7110.8 (Series). Military air traffic control personnel conducting approach control operations must be qualified and certificated in accordance with the FAA Certification and Rating Handbook 7220.6.

In the interest of economy, the FAA has been invited to utilize naval radar air traffic control facilities to provide approach control service for certain terminal areas encompassing naval aviation shore activities. When the FAA chooses to exercise this option, such facility is designated a joint USN/FAA facility and approach/departure control is conducted therefrom for all airports within the designated controlled airspace. General guidance regarding the administration and operation of joint USN/FAA facilities is contained in applicable provisions of OpNav Inst. 3722.7 (Series).

FACILITIES FLIGHT CHECK

Safety of flight and effective control of aircraft movements necessitate that the components of air navigation systems be accurate, adequate, and reliable, Various types of navaids are in use, each serving a special purpose in the system of air navigation. Experience has shown that electronic navaids do not always provide accurate information even though ground monitoring equipment indicates normal operation. A physical check of navaids must be conducted to determine the degree of accuracy to insure continued reliable operation.

The FAA, having statutory responsibility for the operations and maintenance of the common system of air navigation and traffic control within controlled airspace, conducts the flight checks of navaids based on jointly agreed standard flight inspection procedures. These procedures are contained in the U.S. Standard Flight Inspection Manual.

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AUTHORITY AND RESPONSIBILITY OF FLIGHT INSPECTORS

Standard flight inspection procedures require specially equipped aircraft and specially qualified aircrews. Because of the influence and importance of a flight inspector's position, only the highest caliber personnel are assigned this duty.

The authority and responsibilities of a flight inspector include the following:

1. Schedule and conduct flight inspections of navaids and ground communications equipment in accordance with established procedure.
2. Determine the adequacy of the facility to fulfill its required function.
3. Certify the operational status of facilities based on the results of a flight inspection.
4. Coordinate with maintenance personnel in the correction of malfunctions noted.
5. Report the results of the flight inspection to the appropriate authority.
6. Analyze and evaluate the overall performance of all services provided for use in air navigation by a facility.
7. Determine minimum reception altitudes of navaids and communication equipment.
8. Conduct initial and periodic flight inspection of reporting points.

TYPES AND PRIORITY OF FLIGHT INSPECTIONS

Official flight inspections are of five basic types as follows:

1. Site evaluation. To determine the suitability of a proposed site for a permanent installation.
2. Commissioning. A comprehensive flight inspection to determine that the facility will support its operational requirements.
3. Periodic. A regularly scheduled flight inspection to determine that the facility will still meet the standards for a commissioned facility.
4. Special. A flight inspection required by special circumstances to determine facility performance or characteristics.
5. Surveillance. An unscheduled flight inspection of commissioned aids to determine that performance continues to meet applicable standards.

Priorities of flight inspections are assigned to provide for an order of accomplishment when such inspections are required for more than one purpose at the same time. Generally speaking, all Special flight inspections are first priority; all Site and Commissioning inspections are second priority; and Periodic and those Special inspections for the purpose of adjusting a navaid that is already within acceptable tolerance are third priority.

FREQUENCY OF RECURRING FLIGHT INSPECTIONS

A schedule of periodic flight inspections is contained in the Flight Inspections Manual specifying the minimum number of inspections required annually and the number of days between inspections. This schedule is the minimum requirement. In some cases it may be necessary to conduct inspections more frequently to assure satisfactory performance.

Generally, the requirements for periodic flight inspections of each individual navaid are satisfied by complete inspection of that aid. However, some navaids such as TACAN and DF lend themselves to a partial inspection on a progressive basis. In this manner, requirements for checking all the required items are satisfied within the specified number of days between inspections.

GENERAL FLIGHT INSPECTION PROCEDURE

Except for periodic flight inspections, the usual procedure to initiate a flight inspection is by a request from appropriate authority. A request for a flight inspection should not be initiated unless all ground equipment is in place, properly adjusted and calibrated, and operating normally. Upon receipt of a request for a flight inspection, authority within the flight inspection organization will notify the facility of the ETA of the flight inspection aircraft. No request or advance notice of arrival is required for a periodic or special flight inspection, but it is often desirable to permit ground personnel to schedule their activities to allow participation in the inspection.

power and range resolution necessary for this type of altitude determination.

ECM Deception

The pulse compression radar depends on the phase and frequency characteristic of the transmitted pulse to determine whether or not to accept a returned signal. If the phase and frequency do not match the transmitted pulse, compression will not take place and the signal will not pass through the receiver.

Signal-to-Noise Ratio

Due to the response of the matched filter to the definite phase and frequency characteristic of the transmitted signal, and the attenuation of other signals, the pulse actually applied to the receiver has a signal content much higher than its content of random noise. The signal-to-noise ratio of the system will be improved by a factor equal to the compression ratio over conventional radar.

Target Velocity

Target velocity can be rapidly determined by the use of a computer and sideband inversion. If a signal receives up Doppler, after sideband inversion the shift will appear as down Dopper. By shifting the local oscillator frequency above and below the returned echo on alternate pulses, the Doppler can be changed from up to down alternately with each transmitted pulse. This will produce a shift equal to twice the normal Doppler shift and will make it possible to determine target velocity in a time equal to two PRT. This principle could be easily incorporated. Sideband inversion is explained in detail later in this discussion.

PULSE EXPANSION

The pulse expansion operation will utilize a 0.1-μsec pulse and expand it to 1-μsec. Then stagger delay (frequency) the 1-μsec pulses to form a 10-μsec chain of pulses for transmission. The overall operation is to generate a 0.1-μsec pulse and, after expansion, transmit a 10-μsec pulse.

Spectrum Generation

RF energy is generated by a Coherent Master Oscillator (COMO) which is gated with a square wave of the desired time duration. For discussion purposes we will use a COMO with a center frequency of 100 mc which is gated for 0.1-μsec at a PRF of 300 cps. When this pulse is produced, it contains not only the basic frequency, but also many other frequencies within a spectrum as illustrated in figure 15-15. While the difference between each frequency is determined by the PRF, the pulse width determines the bandwidth and therefore the number of frequencies within the spectrum is controlled by both PRF and pulse width.

In figure 15-15 the frequency which has the largest amplitude is the resonant frequency of the signal source by means of which this spectrum was created. Numerous other frequencies result on either side of f_o. Those above f_o will be f_o plus one PRF, f_o plus 2 PRF's etc. At this rate, numerous different frequencies are present, each 300 cps apart, and each smaller in amplitude as these frequencies approach the upper bandwidth limit.

Those below f_o will be f_o minus one PRF, f_o minus 2 PRF's, etc. At this rate numerous different frequencies would be present, each one lower in frequency by 300 cps, and each one lower in amplitude as the lower bandwidth limit is approached.

Since the COMO is gated for 0.1-μsec of time, the COMO will generate a spectrum with a bandwidth of 20 megacycles. Bandwidth is determined by dividing the pulse width into 2. NOTE: In order to receive and to reproduce satisfactorily rectangular pulses equal in amplitude to the noise voltage, the receiver bandwidth in cycles per second should be approximately 2, divided by the pulse width in seconds. Therefore, a 0.1-μsec pulse width will generate a 20 megacycle spectrum bandwidth. Because each different frequency between the bandwidth is 300 cps apart, over a

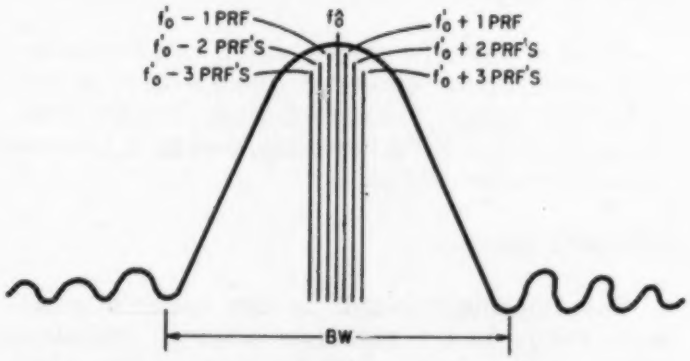

Figure 15-15. —COMO output

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In preparation for the flight inspection, a thorough understanding between ground personnel and the flight inspection team is essential for a successful inspection. In the interest of making an efficient flight inspection, certain preparations are required of ground personnel so as to insure adequate communications, provide for availability of maintenance personnel, insure that controller personnel are briefed on the altitudes and areas to be flown when in congested areas, etc.

Normally, the flight inspection is technically an operation between the inspection team and maintenance personnel concerning the error of the equipment, etc. However, controller personnel are utilized by the inspection team concerning air traffic control during the in-flight inspection; and although the controllers are not evaluted, apparent controller deviations will be noted during inspections of the entire facility.

Where dual equipment is provided, both sets of equipment must meet the same tolerances. On some types of equipment, both sets must be thoroughly checked while for other types a spot check and comparison of operation are sufficient. Details for each type navaid are included in the Flight Inspection Manual section on that particular navaid. Additionally, standby power supplies will be checked on the commissioning inspection only unless there is suspected deterioration while the standby source of power is in use.

Upon completion of the flight inspection, the inspector will discuss the inspection with ground personnel, determine facility status, and prepare the appropriate reports. An informal discussion is usually best to acquaint ground personnel with problems encountered during the flight inspection. This is especially true in the case of DF and radar inspections where the human element is involved. Whenever possible, such discussions should be held directly with the personnel concerned.

The flight inspector will determine the facility status and insure the appropriate ground personnel are advised.

FACILITY STATUS CLASSIFICATION

The facility status classification indicates the general extent of usability as determined from each inspection. The flight inspector will assign one of the classifications as follows:

1. Unrestricted. The facility meets all tolerances and is fully usable within its service volume (specific limits of distances and altitudes).
2. Restricted. The facility meets established tolerances within its service volume except in specific areas which must be clearly defined in the various publications available to users.
3. Unusable. The facility is unsafe, unreliable, and unusable for air navigation.

FLIGHT INSPECTION PROCEDURES FOR CONTROLLERS

No specific tolerances are established for controllers during flight inspections; however, supervisors should insure that experienced controllers are available. Apparent participating controller deviations are normally brought to the supervisor's attention.

For flight inspections of DF aids, controllers must be able to direct the aircraft over the station, report station passage, and provide pertinent information relative to the DF service. The inspector determines whether or not the entire system is safe and reliable. If a DF approach has been established for emergency use, the controller must be able to direct the pilot into a position from which a safe landing can be made.

Controllers that participate in flight inspections of ASR and PAR equipment should be experienced personnel and familiar with the flight inspection objectives. They should participate in the initial meetings prior to the flight inspection where scope operation, target interpretation, and other techniques are mutually agreed upon. To determine the usability of the entire system, an evaluation of the controller performance, in addition to checks of the system accuracy, is necessary. It is difficult to determine the exact degree to which equipment or controllers contribute to overall performance. Any tendency of controllers to give erroneous advisories or instructions, or become confused during a simulated emergency, should be noted regardless of how well the equipment works. While it is not feasible to

evaluate each controller, several approaches should be made to obtain an overall viewpoint. Appropriate remarks regarding controller performance are entered on the flight inspection report.

FAA EQUIPMENT CERTIFICATION

A vast, complex system of air traffic control and navigational aid facilities enables large numbers of aircraft to move efficiently and safely within the National Airspace System. This includes FAA, military, and non-Federal facilities designated for use in the National Airspace System.

In addition to the flight inspection procedure discussed earlier, the FAA has established a ground inspection procedure for air traffic control and navigational aid facilities. The actual inspection is made by technical personnel in accordance with appropriate performance standards and tolerances which will assure continual accuracy and reliability of the system. The publication governing ground inspection is entitled U. S. Interagency Ground Inspection Manual, Air Traffic Control and Navigational Aid Facilities. It is promulgated within the Navy as OpNav Instruction 3721.18. The inspections and technical performance standards prescribed in this manual apply to all military ATC and navaid facilities DESIGNATED for use in the National Airspace System. The required ground inspections are a responsibility of the cognizant maintenance authority for the facility or facilities. Cognizant military authority forwards certification, based upon the maintenance authority's assurance of operation within the prescribed tolerances, to the appropriate FAA operational authority that the facility is functioning properly.

When it has been determined, either by flight check or by ground inspection, that a facility does not meet prescribed technical performance standards or tolerances, the cognizant maintenance technician must notify the air traffic control officer having operational jurisidiction over the facility and provide appropriate technical information on which to base a NOTAM. In addition to military NOTAM action the appropriate FAA authority must be notified and a civil NOTAM will be issued.

Notification of scheduled maintenance shutdowns of military facilities which have been certified for use in the National Airspace System must be submitted to the appropriate ARTCC for concurrence in sufficient time to allow for NOTAM issuance at least 5 hours prior to the shutdown.

AIRFIELD AVAILABILITY

The Navy's policy is that naval airfields must be available for the use of military aircraft to the maximum extent possible, and that the aircraft and crew must be supported to the fullest extent possible within the capabilities of the facility.

Transient military aircraft cannot be prohibited from landing at any naval airfield except when:

1. An emergency situation exists.
2. Construction hazards, etc., render the airfield useless.
3. CNO has authorized prohibition.
4. The airfield is in a caretaker or inactivated status.
5. Due to special operations or activites.

Any restrictions placed upon aircraft operations for safety reasons, such as inspections, public events, etc., must be limited to only that time period during which the hazard actually exists.

Commanding officers of stations located on airfields which are used jointly with civil or other military agencies can only impose restrictions which are applicable to naval facilities under their control.

In local areas containing several naval airfields, the duplication of facilites at each of the airfields to fully accommodate transient aircraft is not required if one of the fields can provide for the needs of transients. However, any restrictions imposed must be approved by CNO.

Commanding officers furnish OCEANO with pertinent information concerning the hazards, hours of operation, field condition, etc., for publication in the appropriate DOD FLIP.

Official business only indicates the field is closed to all transient military aircraft except those on official business at, or near, the airfield. Official business is further defined

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as the necessity for personnel aboard an aircraft to contact personnel, units, or organizations at, or near, the airfield most conveniently located for the service of and in the interest of the Government. This does not provide for use of the airfield by transient military aircraft for the purpose of obtaining clearance, services, or other items attendant to itinerant operations. Official business only restrictions do not apply in case of emergencies or for designation of the airfield as an IFR alternate. Permanent official business only restrictions must be approved by CNO.

Navy commanders cannot permanently restrict any military aircraft from landing at their airfields unless CNO has approved of the restriction. Emergency restrictions of a temporary nature (10 days or less) may be imposed by commanding officers without higher authorization when landing of aircraft at their airfields is considered unsafe.

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CHAPTER 4

TERMINAL INSTRUMENT PROCEDURES

To safely satisfy the instrument approach and departure requirements of the present air traffic volume and the ensuing increases, continuing emphasis is placed on establishment, review, and updating such procedures. The Terminal Instrument Procedures (TERP's) handbook, OpNav 3722.16 (Series), prescribes standardized methods to be used by all personnel charged with the responsibility for the preparation, approval, and promulgation of terminal instrument procedures. This handbook, however, is not a substitute for sound judgment and common sense, and does not relieve personnel so charged from exercising initiative or taking appropriate action in recognizing the capabilities and limitations of navaid equipment and aircraft performance as associated with terminal instrument procedures.

ESTABLISHING APPROACH PROCEDURES

The Navy establishes and approves terminal instrument procedures for airports under its jursidiction. Navy terminal instrument procedures are official procedures. The FAA should be notified when military procedures are canceled.

RESPONSIBILITY AND JURISDICTION

Commanding officers of Navy and Marine Corps shore installations supporting flight operations must establish terminal procedures that provide instrument approach capability for local and transient flight operations. The procedures must conform to the appropriate provisions of OpNav's 3722.16 (Series) and 3770.2 (Series). The Naval Oceanographic Office is designated as the review and approving authority for all Navy/Marine Corps terminal approach procedures. Where waivers are required, they will be referred to CNO by the Oceanographic Office for approval. All minimums established must be the lowest permissible consistent with mission accomplishment and flight safety.

COORDINATION WITH FAA

During the formulation of approach procedures, coordination must be effected with the ATC activities that provide the associated en route and approach control services. ATC concurrence in the optimum approaches available must be sought. In the event that the existing airspace structure in and around the terminal area is not suitable for optimum procedures, the appropriate Navy Regional Airspace Officer (NARASPO) or a Command Airspace Liaison Officer should be consulted for assistance. Planned cancellation of procedures must be coordinated with ATC activities concerned. When practicable, this coordination should be effected well in advance of the planned effective date of cancellation.

NUMBERING APPROACHES

Terminal instrument procedures should be numbered to be meaningful to the pilot, and to permit ready identification in air traffic control phraseology.

When the angle between the final approach course and the runway centerline meets the straight-in landing criteria, the approach should be numbered to identify the type of facility which provides final approach guidance and the runway with which the final approach course is alined. Examples: VOR RWY 15; TACAN RWY 21.

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When military operational requirements necessitate that more than one procedure be published to serve the same runway, using the same navaid, they should be numbered to indicate the difference. Examples: TACAN 1 RWY 18; TACAN 2 RWY 18.

Where the straight-in landing criteria are not met and the procedure is published with circling minimums only, it should be named to identify the type of facility which provides the final approach course guidance. The first procedure formulated for a type of facility should be given the suffix A, even though there may be no intention to formulate additional procedures. If addtional procedures are formulated, they should be lettered in sequence. Examples: VOR-A; VOR-B. A revised procedure should retain the original letter suffix.

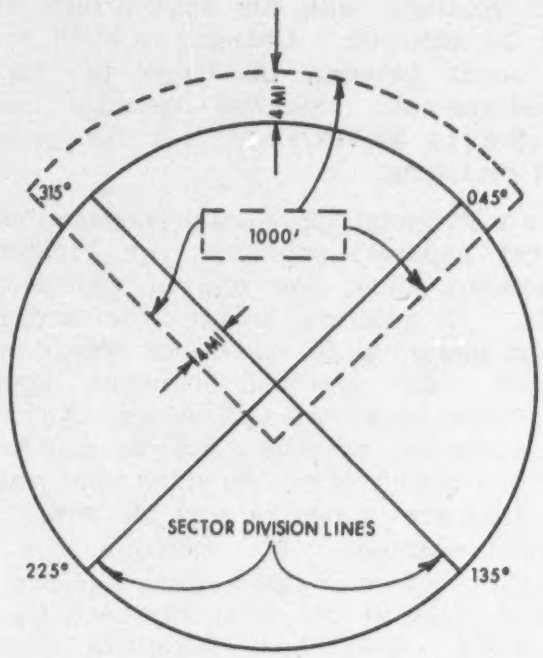

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Figure 4-1.—Minimum safe altitudes.

PROCEDURE DESIGN

The minimum number of approach procedures should be established at a given facility consistent with the mission requirements.

Aircraft performance differences have a direct effect on the airspace and visibility needed to perform certain maneuvers, such as circle to land, turning missed approach, final alinement correction to land, and descent. To compensate for these differences, all aircraft are divided into five categories, designated category A through E, based on landing speed and weight characteristics. The approach category characteristics must be considered when determining turning radii, minimums, and obstruction clearance areas for circling and missed approaches. Military aircraft category data is published in FLIP Planning Section I. Each low altitude procedure should prescribe minimums for category A, B, C, and D aircraft. Each high altitude procedure should prescribe minimums for category C, D, and E aircraft.

A minimum safe altitude should be established for emergency use which provides 1,000 feet obstruction clearance in a sector of a circle with a 25-mile radius from the facility upon which the procedure is predicated. The sectors should not be less than 90 degrees, and the obstruction clearance should also apply to adjacent sectors and the periphery of the sector within 4 miles of the sector division lines. (See fig. 4-1.) Establishment of minimum safe altitudes is not mandatory in high altitude procedures. These criteria do not apply to radar procedures.

Emergency safe altitude is the lowest altitude for emergency use which provides 1,000 feet (2,000 feet over designated mountainous terrain) obstruction clearance within a 100-mile radius of the facility upon which the approach procedure is predicated. Emergency safe altitudes are established at the option of the approving authority and are the responsibility of OCEANO for naval procedures.

Terminal transition routings should begin at a navaid or fix by which the en route structure is defined and terminate at the initial approach fix of an approach procedure. Transition routings may be direct from the en route navaid or fix or via another navaid known as a "feeder" facility. Any navaid or fix, including en route structure facilities, used by ATC authorities in connection with the particular approach may be selected as a "feeder" facility. The navaids selected for transition routings must, whenever practicable, be within the frequency range of the instrument approach facilitiy; i.e., VORTAC

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for TACAN procedures, etc. Coordination of these routings with the appropriate ARTCC must be effected. Changes to such routings that occur between the times the approach procedures are reviewed annually must be reported to NAVOCEANO for the necessary chart revisions.

An instrument approach procedure may have several separate segments; i.e., initial, intermediate, final, and missed approach segments. In addition, an area for circling the airport under visual conditions should be considered. The approach segments begin and end at designated fixes; however, under some circumstances, certain segments may begin at specified points where no fixes are available. The fixes are named to coincide with the associated segment. For example, the intermediate segment begins at the intermediate fix and ends at the final approach fix. (See fig. 4-2.) Only those segments which are required by local conditions need be included in a procedure. In constructing a procedure, the final approach course should be identified first because it is the least flexible and most critical of all the segments. When the final approach has been determined, the other segments should be blended with it to produce an orderly maneuvering pattern which is responsive to the local traffic flow.

Approach and missed approach procedures should be so designed as to avoid the necessity for navaid, SIF code, and frequency changes at altitudes below 2,500 above the ground. Where facilities have the required communications capability, procedures designed primarily for high performance single piloted aircraft, or aircraft without dual radio capability, should be designed to eliminate the need for frequency changes after commencing approach.

Initial Approach Segment

The instrument approach as such commences at the initial approach fix (IAF). In the initial approach the aircraft has departed the en route phase of flight and is maneuvering to enter an intermediate segment. It may not be necessary to designate an initial approach segment, depending upon local conditions, in which case the approach commences at the intermediate fix (IF). An initial approach may be made along an arc, radial, course, heading, radar vector, or a combination thereof. Procedure turns and high altitude teardrop penetrations are initial approach segments. Where holding is required, prior to entering the initial approach segment, the holding fix and the initial approach fix should coincide.

Intermediate Approach Segment

This is the segment which blends the initial approach segment into the final approach segment. It is the segment in which aircraft configuration, speed, and positioning adjustments are made for entry into the final approach segment. The intermediate segment begins at the IF or point, and ends at the final approach fix (FAF). This segment may be based on an arc, course, or radial.

Final Approach Segment

This is the segment in which alinement and descent for landing are accomplished. The final approach segment considered for obstruction clearance begins at the FAF or point and ends at the runway, airport, or missed approach point, whichever is encountered last. Final approach may be made to a runway for a straight-in landing, or to an airport for a circling approach.

NOTE: Refer to the applicable sections of the TERP's handbook for specific obstruction clearance areas, required obstruction clearance, final approach course alinement and other detailed procedure since it is not considered practical to include these items in this training manual.

Minimum Descent Altitude (MDA)

The MDA is the lowest altitude to which descent is authorized in procedures not using an electronic glide slope (nonprecision). Aircraft are not authorized to descend below the MDA until the runway environment is in sight, and the aircraft is in a position to descend for a normal landing. The MDA must be expressed in feet above MSL and is determined by adding the required obstruction clearance to the MSL height of the controlling obstruction in the final approach and circling approach areas.

The MDA for a straight-in landing approach must provide at least minimum obstruction clearance of obstructions in the final approach area and meet the requirements for the missed

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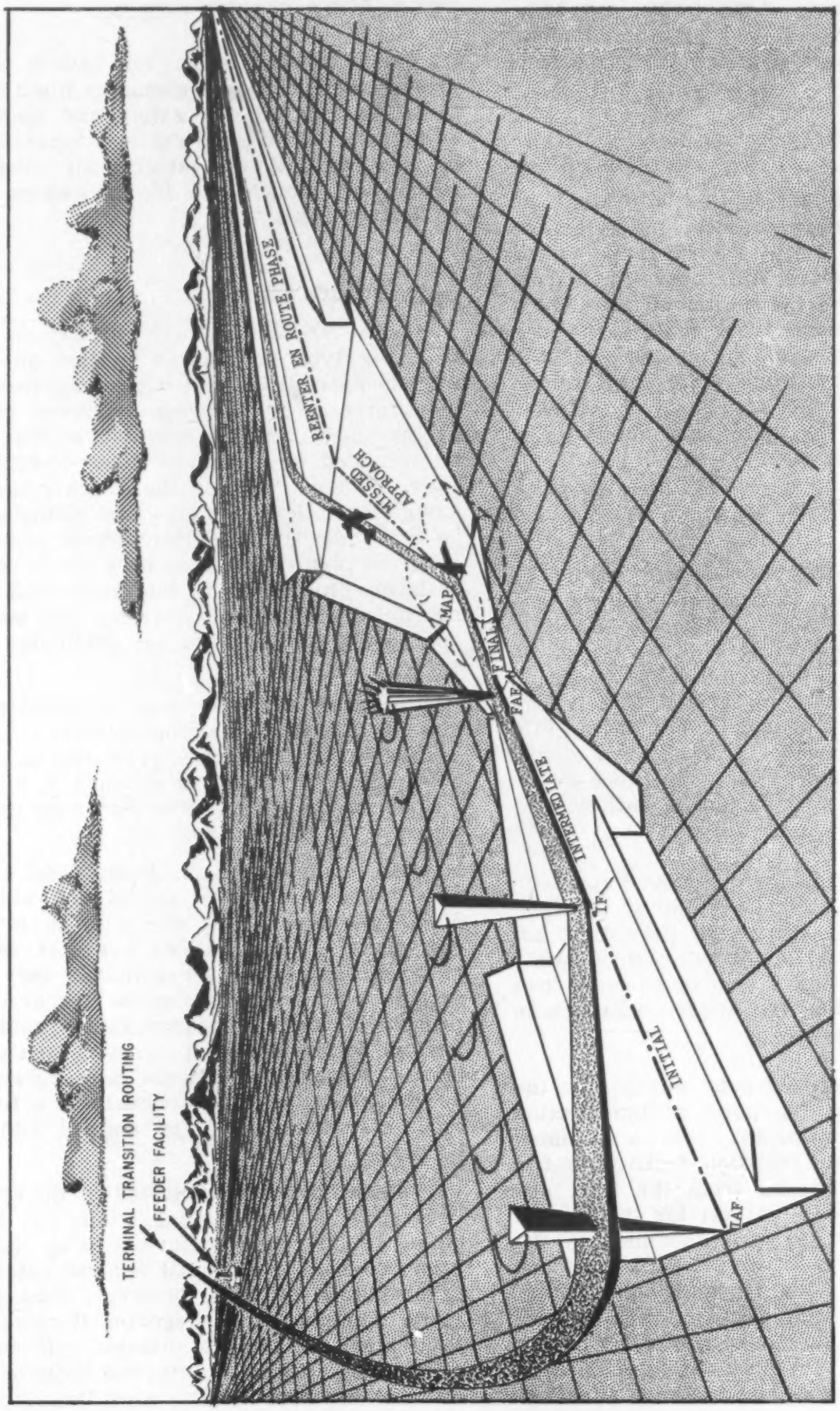

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Figure 4-2. —Approach segments.

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approach transition. Additionally, the MDA for a circling approach must provide minimum obstruction clearance in the circling approach area.

Decision Height (DH)

The decision height applies only where an electronic glide slope provides the reference for descent, as in PAR. The DH is the height, specified in feet above MSL, above the highest runway elevation in the touchdown zone (first 3,000 feet of the runway beginning at the runway threshold) at which a missed approach should be initiated if visual reference has not been established. DH's must be established with respect to the appropriate obstruction clearance requirements.

Missed Approach Segment

A missed approach procedure should be established for each instrument approach procedure. The missed approach should be initiated at the decision height in precision approaches or at a specified missed approach point in nonprecision approaches. The missed approach procedure should be simple, specify an altitude, and whenever practicable, a clearance limit. The missed approach altitude specified in the procedure should be sufficient to permit holding or en route flight.

Whenever practicable, the missed approach course should be a continuation of the final approach course. Turns are permitted, but should be minimized in the interest of safety and simplicity. When a turn of no more than 15 degrees is made, the missed approach is considered straight.

The missed approach point specified in the procedure may be the point of intersection of an electronic glidepath with a decision height or MDA, a navigation facility, a fix, or a specified distance from the final approach fix. Specific criteria for the missed approach point (MAP) are contained in the appropriate sections of the TERP's handbook describing the various types of approaches. The missed approach obstruction clearance area is basically the same for all types of approaches except PAR which has a specific missed approach procedure to fit the situation.

PROCEDURE FLIGHT CHECK

Prior to submission for review and approval, each procedure should be flight checked by local aircraft for safety and operational suitability. When practicable, a separate check by an aircraft of each category for which minimums are included in the procedure should be accomplished.

RADAR PROCEDURE

Radar procedures are similar in design to other type procedures in that an initial, intermediate, final, and missed approach segment may be established. Course guidance in the initial and intermediate segments may be provided by radar or other navaid facilities. Where radar is the primary means of navigation, radar patterns and altitudes must be established, and altitudes must provide the required obstruction clearance for a specified distance either side of the designated pattern course. Where other navaids are used, the appropriate criteria for the particular navaid apply.

Vectoring altitudes may be established by dividing the area within operational radar coverage into sectors based primarily on existing obstructions. This establishes a minimum altitude within a particular sector for use when providing radar vectors.

Lost communications procedures must be established for radar approaches which include procedures for the pilot to follow in the event communications are lost with the radar facility. Where practicable, they should include a provision to execute a nonradar approach. If such a provision is not practicable, certain items essential for safe and orderly traffic management should be included such as the route to fly, clearance to a fix, altitude assignment, and the control facility to contact.

Unless otherwise indicated in the approach procedure, a single ceiling, visibility, and decision height approved for precision radar approaches will apply to all aircraft categories. Commanding officers, however, may specify PAR minimums by categories if required by application of TERP's criteria. In such instances a ceiling, visibility, and decision height for each aircraft category must be established.

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As a matter of policy, PAR minimums of ceiling 100 feet and visibility 1/4 mile may only be established when the runway concerned is configured with high intensity runway lighting and an approach lighting system. Touchdown zone and centerline lighting are desirable, but not mandatory for the 100 and 1/4 minimums.

Circling minimums should be included in ASR procedures in addition to the straight-in landing minimums unless a straight-in landing ASR approach is available for each runway usable for IFR approaches, and provided that definite restrictions do not preclude circling approaches. Examples of such restrictions are limited radar coverage and nonavailability of certain runways during IFR weather conditions. When circling ASR minimums are not to be authorized—the submitted procedure should be so annotated.

APPROACH MINIMUMS

As previously stated, established minimums should be the lowest permissible consistent with mission accomplishment and flight safety, with the determining factors being the required obstruction clearance in the final approach segment and possibly the missed approach segment. In general, the straight-in minimums will seldom vary by aircraft category. The primary differences will occur for circling minimums, because the size of the area to be considered for obstruction clearance varies by aircraft category. This may require consideration of different obstructions for different category aircraft.

Additional restrictions are possible by application of the tables of standard minimums contained in the TERP's handbook. These tables specify the lowest minimums which may be prescribed for each type approach approved. Consideration is given for the various lighting configurations in the standard straight-in minimums table. In addition to the MDA for nonprecision approaches and the DH for precision approaches, a ceiling value must be established for military procedures which, when added to the airport elevation or the touchdown zone elevation, will result in an altitude above MSL that is equal to or greater than the MDA or DH. When determining the ceiling value, consideration must also be given to reportable ceiling values observed by weather service personnel. If a resultant DH is 275 feet above the surface, the ceiling value would necessarily be 300 feet, since ceilings are reported in 100-foot increments through 5,000 feet.

Visibility Minimums

Several factors must necessarily be considered when determining visibility minimums, as follows:

1. The distance necessary for the pilot to see the airport or runway and safely descend from the MDA or DH and accomplish a landing.
2. The distance from the final approach fix to runway threshold.
3. The runway centerline and final approach course alinement, etc.

No single factor can determine the required visibility, and the various factors will vary with the different types of approaches and local conditions. The TERP's handbook contains tables of minimum visibilities which must be applied in addition to consideration of requirements of the individual approaches.

Runway visual range (RVR) minimums may be authorized for other than circling approaches at locations where an approved RVR installation is available.

Approved Lighting Systems

At installations where lighting systems are identifiable with standard lighting systems contained in the TERP's handbook, the visibility reduction afforded by such aids may be applied. For each procedure containing straight-in minimums to a specified runway, an indication should be made as to whether or not credit for lighting has been applied or is desired. Because of the variations in lighting systems installed at naval facilities, the Oceanographic Office, as the reviewing authority in coordination with NavAirSysCom, will ascertain whether or not the lighting installed qualifies for the reduced visibility credit. Application of lighting credit to reduce visibility minimums is not required.

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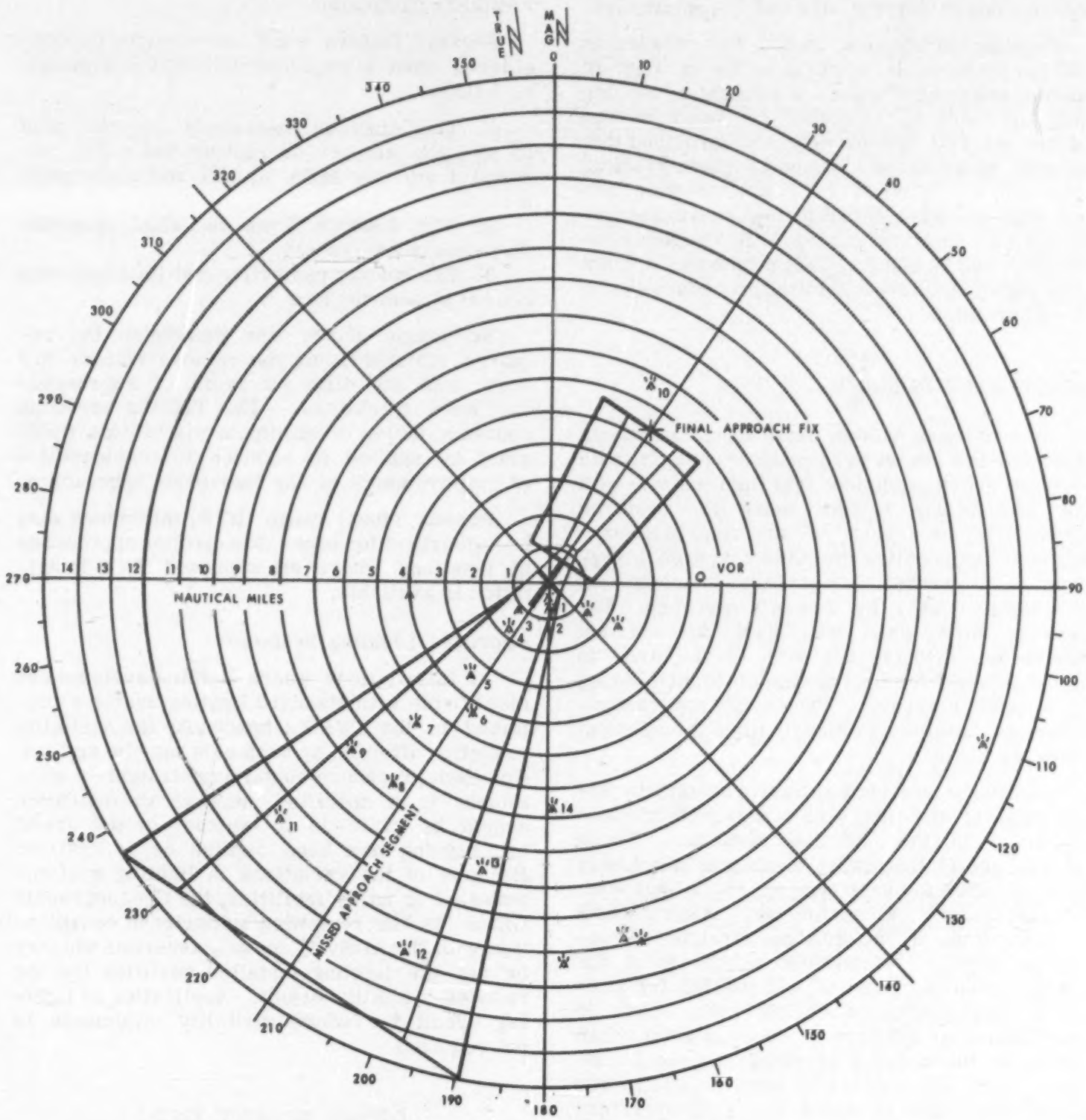

Figure 4-3.—Plan diagram of a PAR approach.

20-megacycle bandwidth, there are 66,666 different frequencies contained in this frequency spectrum.

Matched Filters

For this discussion our matched filter will consist of 10 channels. Each channel will have one or more amplifier (one of which must be tuned) and a delay line as shown in figure 15-16. Each channel has individual gain and frequency controls with a bandwidth of 1 mc. The amplifiers are tuned to successive frequencies 1 mc apart so that their response curves overlap at their half power points as shown in figure 15-17. The entire filter band pass will be 10 mc from the center of the above described spectrum. The filter will now respond to 33,333 different frequencies with each channel responding to 3,333 different frequencies. The 10 sections with their respective delay lines are connected with parallel inputs and all outputs connected to a summing amplifier to produce a single output.

The entire frequency spectrum bandwidth (20 mc) is applied to the input of each of the 10 channels through the delay line (all except channel 1 which has no delay line).

Each of the 10 channels is tuned so as to cover only a small part of the total frequency spectrum. Since there are only 10 channels, each with a bandwidth of 1 megacycle, only one-half of the overall spectrum is covered. Therefore, one-half of the spectrum is not passed through the matched filter because it is not within the half power points of any of the 10 channels.

This is necessary because the amplitude of the different frequencies is too great between the maximum and minimum. If the frequencies outside of the channel spectrum half power points are rejected, the amplitude difference between f_0 and f_1 or f_2 is now only 3 db. This allows the gain of the channel to be within practical limits.

As was previously determined, the numerous different frequencies within the entire spectrum bandwidth were separated from each other by

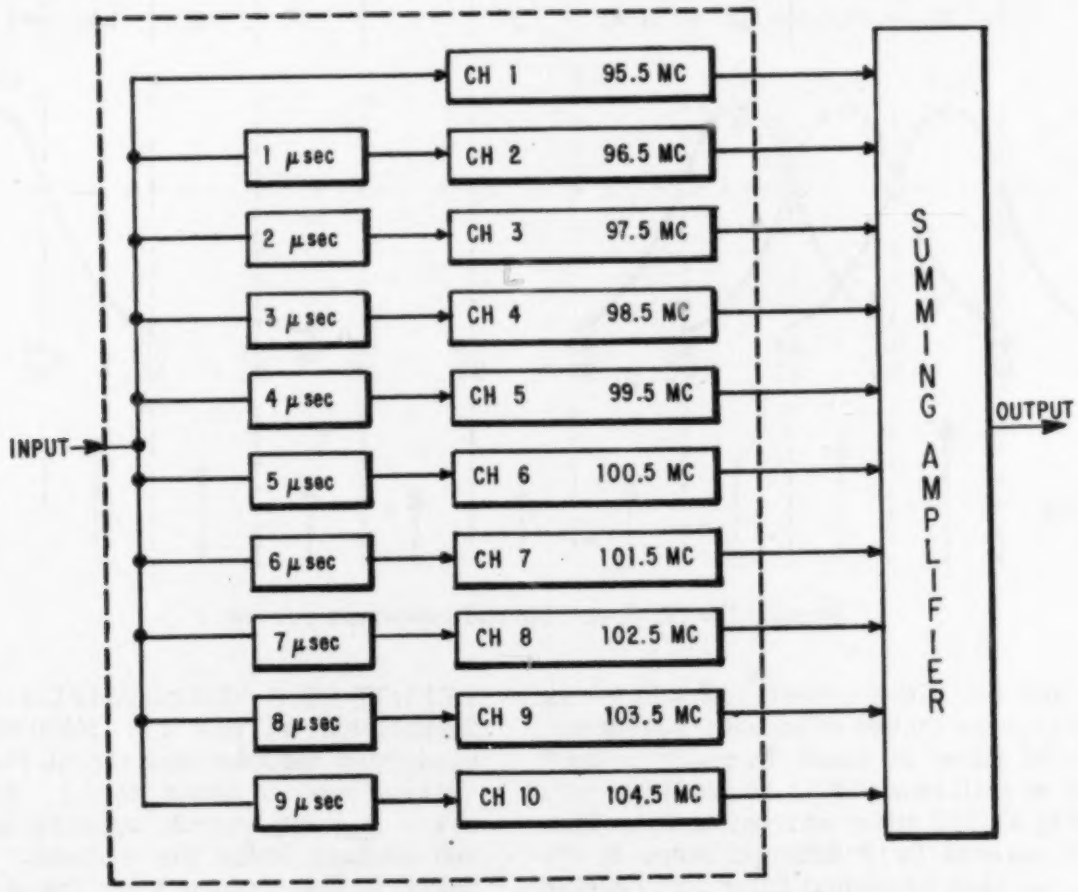

Figure 15-16. —Matched filter assembly block diagram.

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officers must periodically review terminal approach procedures at their facility and submit an annual report designated OpNav Report 3722-1. This report is scheduled in various months, depending on the geographical location of the facility. To determine when the report for your particular facility is required, refer to OpNav 3770.2 (Series). This report is confirmation that currently approved terminal approach procedures are operationally suitable and necessary, and that they conform to the provisions of the TERP's handbook and OpNav 3770.2 (Series). The report is accomplished by completion of an OpNav Form 3722/1 for high and low altitude ADF, VOR, or TACAN approaches and an OpNav Form 3722/2 for PAR and ASR approaches. Requirements for new or revised approach procedures that occur between annual facility reporting dates are handled in this same manner with the exception of the scheduled reporting dates. Senior AC's in the ATC division may be required to initiate this report by physically preparing the appropriate form(s) and insuring compliance with appropriate instructions for the commanding officer's review and approval.

Plan and profile obstruction diagrams of appropriate runway approach areas as depicted in Planning Standards (NavAir 00-100-505) must be forwarded with requests for approval of PAR procedures, unless a current diagram is on file at the Oceanographic Office. In addition, a diagram or chart showing the location and elevation of terrain and manmade obstructions within the prescribed obstruction clearance areas for each nonprecision and ASR approach, specifying the appropriate circling approach areas, must be included.

Figure 4-3 is an example of an enlarged, simplified plan diagram for a PAR approach to a particular facility. Figure 4-4 is a profile diagram of the same approach as shown in figure 4-3. In this particular case, controlling obstructions and other governing factors allow the transition directly from pattern altitude (initial approach) to final approach. Therefore, no intermediate approach is included. The profile shows obstructions and terrain considered and the PAR final approach surface slope ratio which will vary with the glide slope angle. In this case the glide slope angle is 3 degrees which requires a 34:1 ratio for the first 10,000 feet and a 29 1/2:1 ratio for the remaining final approach surface slope. No obstructions may penetrate this final approach surface slope to allow use of

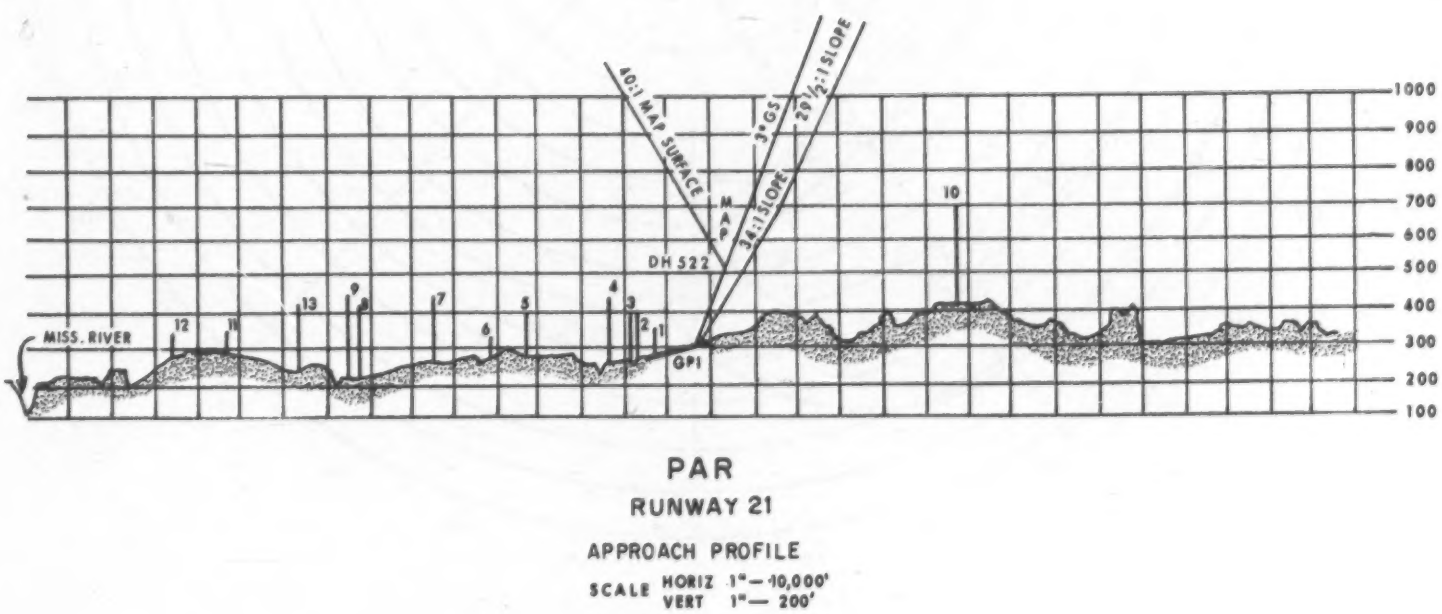

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Figure 4-4.—Profile diagram of a PAR approach.

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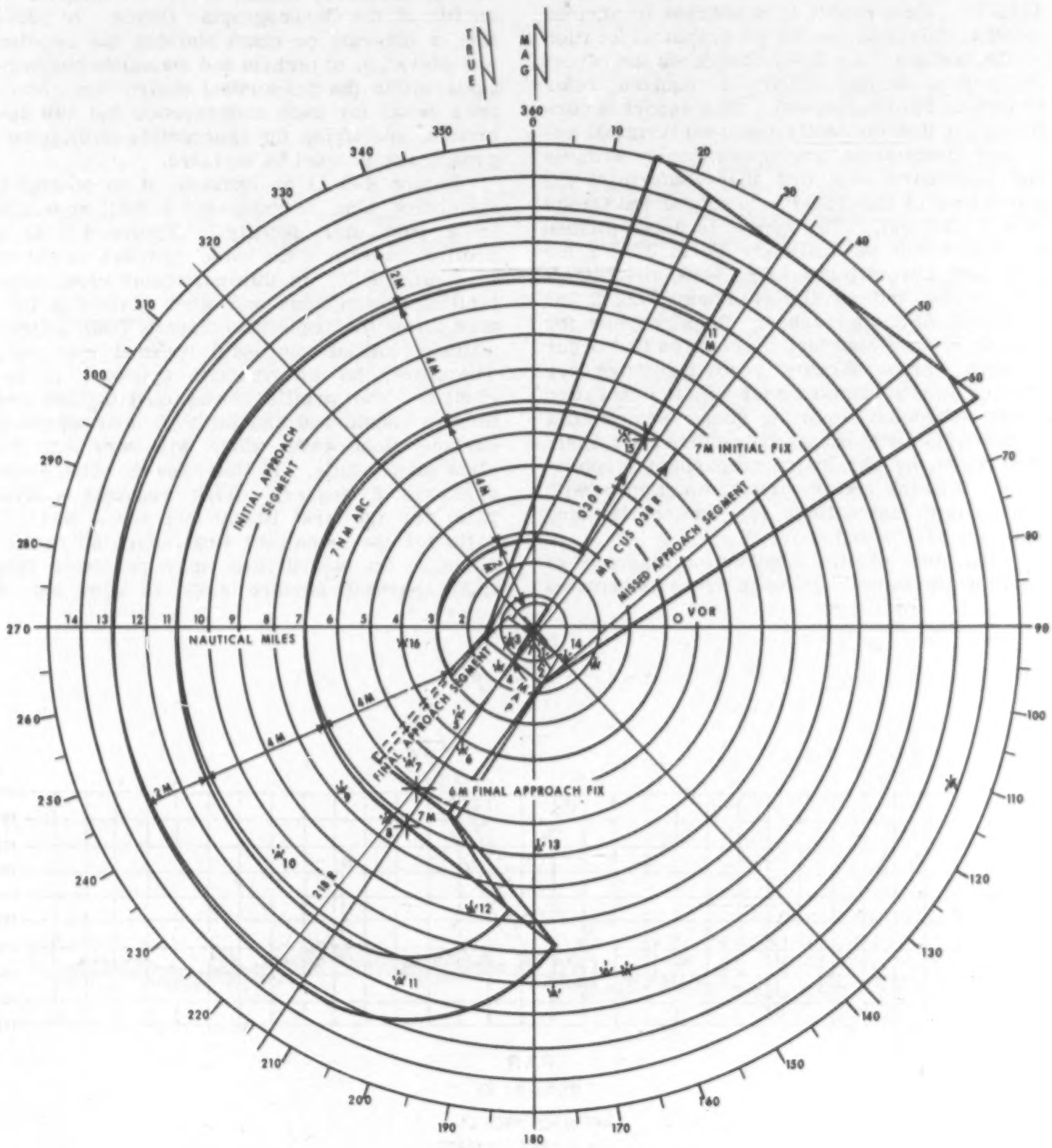

AC.5

Figure 4-5.—Plan diagram of a TACAN approach.

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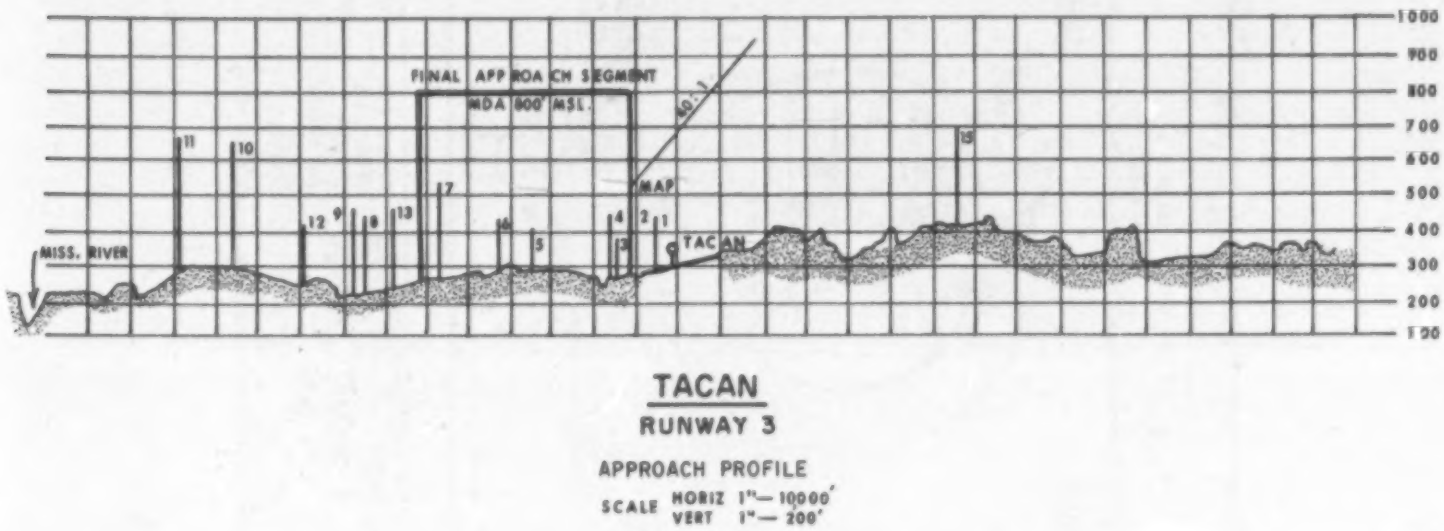

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Figure 4-6.—Profile diagram of a TACAN approach.

this glide slope. Also shown is the missed approach obstruction clearance area and a 40:1 slope ratio of this area on the profile to show that no obstructions penetrate the missed approach surface slope and that the procedure is safe.

All the area sizes, slope ratios, and other technical information necessary to construct this diagram are contained in the TERP's handbook. Much of the information necessary to complete an OpNav Form 3722/2 can be taken from a diagram of this type.

Figure 4-5 is an example of a plan diagram for a low altitude TACAN approach. Although the profile is not required for a nonprecision approach, it may be considered helpful in determining obstruction clearance requirements, MDA's, missed approach points, etc. Figure 4-6 is an example of a profile diagram of the same approach as shown in figure 4-5. Again the specifications for constructing the diagram are contained in the appropriate section of the TERP's handbook.

Figure 4-7 is an example of a completed OpNav Form 3722/1 for the approach diagramed in figures 4-5 and 4-6. Keep in mind that when determining the minimums the appropriate table of standard minimums in the TERP's handbook must be considered in addition to required obstruction clearance.

PUBLICATION OF APPROACH PROCEDURES

To satisfy the primary requirement of having a current procedure in graphic form in the possession of the pilot and controller at the time of implementation, procedures should be submitted as far in advance of the implementation date is possible. They should normally be submitted no less than 60 days prior to the desired effective date to allow sufficient time for review and approval and for chart publication and distribution. The effective date will be assigned by the Oceanographic Office and will be calculated to coincide with the publication date of the charted procedure.

In order to provide sufficient time to effect removal of an approach procedure from the FLIP system, commanding officers should notify the NAVOCEANO approximately 30 days in advance of the effective date of the cancellation. Advance coordination of cancellations should be effected with the appropriate ARTCC authorities. The cancellation should be promulgated by NOTAM procedures when the next scheduled Terminal

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STANDARD INSTRUMENT APPROACH PROCEDURE -HIGH OR LOW ALTITUDE--RNG, ADF, VOR, VORTAC, TACAN, ILS

OPNAV FORM 3722/1 (11-66) S/N-0101-728-3001

NOTE: Bearings, headings, courses, tracks and radials are MAGNETIC. Procedure altitudes are MINIMUM ALTITUDES unless otherwise specified. The minimum altitude for initial approach will be MEA or as indicated below. Distances are in NAUTICAL MILES. Visibility MINIMUMS are in STATUTE MILES. Elevations and altitudes are in FEET MSL.

OPNAV REPORT 3722-1

AIRPORT, CITY, STATE	ELEVATION	FOR ILS PROCEDURE	FREQUENCY	IDENTIFICATION	CLASS	TYPE AND NUMBER	
NAS BEE, TENNESSEE	322	LOCALIZER				EFFECTIVE DATE	AL TACAN 1 RWY 3
FACILITY / FREQ/CHANNEL/TGONY. / CLASS		GLIDE SLOPE					1 February 1971
TACAN / 38 / L		OUTER MARKER				SUPERSEDES	TACAN - 2
		MIDDLE MARKER				DATED	1 April 1967

TERMINAL TRANSITION ROUTING

FROM	TO	MIN. ALT.

INITIAL APPROACH FIX/FACILITY: 7 NM R 030

LIGHTING: HIRL

FACILITY TO AIRPORT OR M.A.P. TO TACAN

BEARING	DISTANCE
038	1.0

REMARKS: Hold NE of the 7NM DME Fix, R 030, 4NM Legs.

DESCRIPTION OF PROCEDURE FROM INITIAL APPROACH FIX THROUGH MISSED APPROACH:

Depart the initial fix to intercept the 7 NM arc North of Bee TACAN, maintain 2000. Intercept R 218 proceed inbound. Commence descent at 6 NM fix, R 218. If visual contact not established 1.0 NM prior to TACAN, climb to 2000 out R 038 within 12 NM, contact Bee Approach Control for further instructions.

DIAGRAM

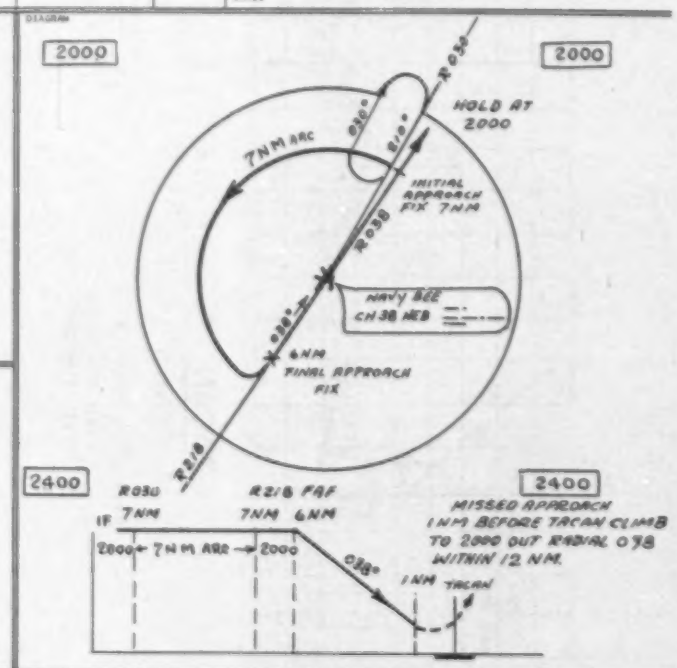

MINIMUMS

CATEGORIES	A		B		C		D		E	
	MDA	CEIL-VIS	MDA	CEIL-VIS	MDA	CEIL-VIS	MDA	CEIL-VIS	MDA	CEIL-VIS
STR. IN	800	500-1	800	500-1	800	500-1	800	500-1		
CIRCLING	800	500-1	800	500-1	800	500-1 1/2	880	600-2		

LOW ALTITUDE - A THROUGH D, HIGH ALTITUDE - C THROUGH E

SIGNATURES	TITLE	DATE
ORIGINATOR (Commanding Officer) Lcdr J. D. Beer USN	CO NAS BEE	2/1/68
LOCAL MILITARY D. E. Gatt LCDR USN	OPERATIONS OFFICER	2/1/68
FAA J. Doe	ASA PODUNK ARTCC	2/10/68
FAA Quentin Smith	FIDO Chief 38th Region	2/20/68

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Figure 4-7.—Completed OpNav Form 3722/1.

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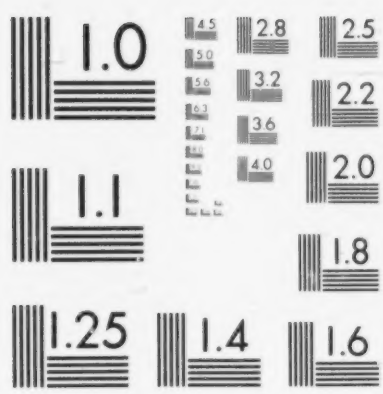

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

FLIP revision date will occur subsequent to the effective date of cancellation.

COMMON CIVIL/MILITARY FORMAT

The TERP's handbook contains the approved criteria for formulating both civil and military instrument procedures requiring a format which includes ample information to satisfy the needs of both agencies.

The standard format normally provides landing minimums for approach categories A through D on low altitude (AL) approach charts, and C through E on high altitude (JAL) approach charts. Any category may be included on either chart when an operational advantage can be achieved. Only those categories of aircraft authorized to use a given procedure will be listed on the approach chart. The term not authorized (NA) is used when a particular category of aircraft is not authorized to use a specific approach. Figure 4-8 is an example of the landing minimum format portion of a low altitude approach chart.

The following is an explanation of terms not considered self-explanatory in figure 4-8:

1. DH (decision height) applies to precision approaches. The DH is the height MSL above the highest runway elevation in the touchdown zone at which a missed approach must be initiated if the required visual reference has not been established.

2. MDA (minimum descent altitude) applies to nonprecision approaches. The MDA is the lowest MSL altitude to which descent is authorized in procedures not using a glide slope until the runway environment is sighted.

3. HAA (height above airport) is for civil use and indicates the height of the MDA above the published airport elevation.

4. HAT (height above touchdown is for civil use and indicates the height of the DH above the highest runway elevation in the touchdown zone.

5. CEILINGS are values shown in parentheses for military use, and represent the lowest ceiling authorized for an approach. A ceiling is expressed in feet above the published airport elevation and is at or above the MDA or DH.

6. VISIBILITY values are expressed as runway visual range (RVR) shown in hundreds of

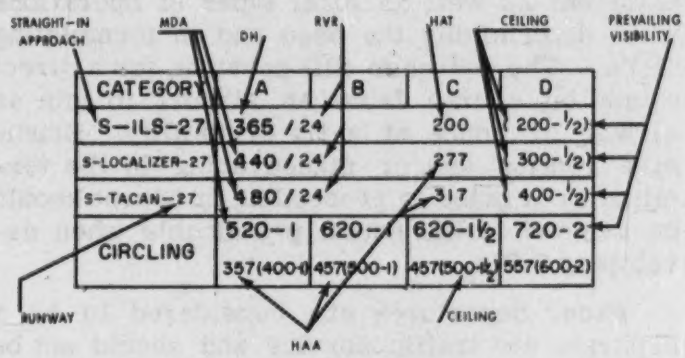

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Figure 4-8.—Low altitude landing minimum format.

feet, (24 equals 2,400 feet) runway visibility (RV), or prevailing visibility (PV), which are both shown in miles and fractions thereof.

Radar Minimums

Radar minimums are presently published in the FLIP IFR supplement in the aerodrome/facility directory section for the airport concerned. The information provided is basically the same as that provided on approach charts.

STANDARD INSTRUMENT DEPARTURES

A Standard Instrument Departure (SID) is an approved procedure that prescribes a route of flight with instructions for safely departing a runway and climbing to the en route structure. SID's are descriptions of air traffic control clearances. Their purpose is to increase the safety and efficiency of terminal flight operations by presenting departure clearances to pilots in graphic and textual form. Their proper use reduces pilot and controller workload and minimizes the probability of misunderstanding clearances. Additionally, the number and length of radio transmissions required for issuance of departure clearances are reduced.

POLICY FOR ESTABLISHMENT

Commanding officers of Navy/Marine Corps facilities are responsible for determining the

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need for SID procedures at their respective activities. Consideration will be given to transient as well as local types of operations when determining the need and in formulating SID's. The optimum SID provides for a direct climb on course from an airport to join an airway or route at a fix or facility. Extensive routing and/or maneuvering in the terminal area prior to proceeding on course should be avoided to the extent practicable when developing SID's.

Radar departures are considered to be a separate air traffic service and should not be included in SID's. However, this is not intended to preclude a route within a SID based on radar vectors in lieu of a route based on a navaid, or radar monitoring of a SID provided that vectoring aircraft off the prescribed SID routing is not undertaken as a monitoring function.

Senior AC's occupying the position in the chain of command which performs the physical function of air traffic control may be in the most ideal position to recognize the need for establishing, revising, or canceling SID procedures at their facility. Where the need is recognized, they should initiate action at the division level by presenting all the applicable facts and figures which would sustain the proposed procedure or action and the advantages possible.

Commanding officers of Navy/Marine Corps aviation shore facilities located within the contiguous U.S., Alaska, and Hawaii should request the appropriate FAA regional Air Traffic Division to assist in the development and/or revision of SID's for their activity. During the development or revision, coordination with local ATC authority and nearby civil or military airports must be effected. In obtaining desired routings, airspace limitations may create local coordination problems. In such instances, the appropriate NARASPO should be contacted for assistance.

At facilities where the FAA does not provide air traffic service, such as overseas, SID's may be established or revised as prescribed for CONUS except that FAA functions are not applicable. Commanding officers are responsible for formulation of SID's in coordination with the local ATC authorities of the host government.

After coordination of new or revised SID's has been completed, they should be forwarded to NAVOCEANO for review in conformance with OpNav 3770.2 (Series), and for approval, publication, and distribution in required quantities. A sketch of the SID should be submitted together with necessary textual information, delineating the appropriate ATC clearance to be charted. The sketch should depict actual flight paths from runway(s) to the start of the en route description to permit climb gradient computation.

Charting is accomplished in accordance with the appropriate SID chart specifications. Chart quantities desired for station usage should be made known to NAVOCEANO. Printing quantity requests should be based on an estimated 6 months' requirement. When existing stocks of SID charts are reduced to a point where reordering is indicated, the request for additional SID charts should be forwarded directly to NAVOCEANO since SID charts are not stocked in the distribution system.

SID's should be designated as either high altitude or low altitude, according to the route structure in which the SID is intended to terminate. If high and low altitude SID's are identical, they may be combined to be designated as high/low altitude SID's. The appropriate designation—high, low, or high/low—should be indicated on each SID pamphlet.

During local coordination, a mutually agreeable effective date for new or revised SID's should be decided upon. This date normally should be a minimum of 45 days after date of submission to NAVOCFANO to allow for review, approval, publication, and distribution.

DEVELOPMENT PROCEDURE

SID's may be implemented at any airport where terrain or other obstructions require specific departure restrictions. In addition, SID's may be established at any airport where they would be advantageous to air traffic control or pilots. The number of SID's implemented at a given facility should be kept to a minimum consistent with operational needs and the departure routes most frequently used.

When developing SID's, the following guidelines should be considered:

1. SID's may commence at the end of a runway, or basic departure routing procedures

for each particular runway may be included as part of a basic SID.

2. Radar vectors may be included in lieu of a route based on a navaid.

3. Routing should be the most direct and simplest possible.

4. The number of navaids used should be the minimum number possible.

5. Crossing altitudes/FL's should be kept to a minimum, based on radials of the same navaid, and may or may not be specified altitudes/FL's. If crossing altitudes/FL's are specified, they should be developed with consideration of the capabilities of the lowest performing type aircraft that would use the SID.

6. Noise abatement requirements should be considered.

7. SID's should terminate at an airway, radial, route, or fix.

8. SID's may have more than one transition from a common point.

9. More than one SID may have the same identical transition.

10. The description of the SID and transition, if appropriate, on the SID chart should be worded so that it can be easily understood.

The obstruction clearance criteria for SID's are contained in TERP's.

Minimum rate of climb information must be provided on published SID's which require a rate of climb greater than 150 feet per mile to obtain the required obstruction clearance. A rate of climb in excess of 300 feet per mile is not authorized.

Hazards, such as towers, buildings, terrain elevation, etc., which create a hazard to safety of flight in the event the departure procedure were not executed precisely, must be shown on the SID chart in their exact location to present a true relationship.

Naming and Numbering SID's

The designated name of a SID should correspond to a geographical location or a navaid along the SID route. The original SID should be assigned a name and the number 1; for example, Dutch 1 Departure. Old numbers should not be reused. The same or a similar name should not be assigned to different SID's within the same geographical location. When revisions or changes are made to the original SID, regardless of the degree of change, the SID should be renumbered.

Revisions or changes refer to items in the ATC clearance such as courses, altitudes, fixes, navaids, etc. Not included would be radiofrequency changes or chart detail other than the ATC clearance, or items involving flight safety such as climb gradients, etc.

If a SID is developed for specific types of aircraft, the adjective phrase to indicate this may be printed on the chart, such as Jet. If the SID is applicable to all types of aircraft, no specific description is necessary. The name of a transition should correspond to a navaid or a geographical location along the route to be flown. Cancellation of a transition route should not require a renumbering of the basic SID.

OPNAV REPORT 3722-2

An annual review of SID's to determine their consistency with operational needs and any revisions, additions, or deletions required must be made by commanding officers of Navy and Marine Corps facilities, and the result of this review is submitted to the Naval Oceanographic Office.

The annual reporting date for individual facilities is determined by the geographical location of the facility. To determine when the report for your facility is required, refer to the schedule contained in OpNav 3770.2 (Series). This report is designated OpNav Report 3722-2.

HOLDING PATTERN CRITERIA

The criteria for holding pattern airspace are contained in FAA Handbook 7130.3 and provide for separation of aircraft. However, when determining minimum holding attitudes based on required obstruction clearance, this same airspace area, with slight modification, is used.

APPLICATION TO THE ATC SYSTEM

Sufficient holding airspace areas should be planned and established to meet IFR traffic

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requirements within a facility's area of jurisdiction. Holding airspace area dimensions were developed to permit the following: Use of all types of en route navaids, reduction of holding airspace when optimum direction of entry is made, compatibility between patterns flown by reference to time and those flown by reference to DME, and selection/application of tailor-made airspace by furnishing several pattern sizes.

Holding pattern airspace areas should be pictorially displayed including captions to explain their use. Displays should be near appropriate controller positions and should be so constructed as to facilitate the maximum possible amount of traffic situations to preclude the requirements for controllers to determine holding airspace on the spot.

Good facility planning minimizes the need for unplanned holding at the control position. Unusual circumstances may require occasional unplanned holding; therefore, each control position should be analyzed according to altitude controlled and holding speeds normally encountered. When an analysis has been made, appropriate template sizes can be selected and captioned.

HOLDING PATTERN COMPONENTS

Efficient and economical use of airspace required standardization of aircraft holding procedures. All the variable factors such as navaid systems error, wind, aircraft speed, etc., which affect aircraft during holding maneuvers, were considered and incorporated into the holding pattern airspace criteria. Procedures were developed to accommodate the performance capabilities of pertinent civil and military aircraft.

The following basic components were developed as standard for the purpose of determining holding pattern airspace:

1. Outbound leg. The length of the outbound leg is based on time or distance. Standard time values are 1 minute for altitudes from minimum holding through 14,000 and 1 1/2 minutes above 14,000. Distance value of an outbound leg is not standard but must be established at a distance appropriate to the holding situation and in conformance with the tables for determining the DME leg lengths of holding patterns in Handbook 7130.3.

2. Maximum holding airspeed. Basic speed groups with compatible holding maneuvers were adopted. Aircraft are provided protected airspace based on the maximum holding airspeed. (See table 4-1.)

3. Angle of bank. Pilot procedure for entry and holding pattern turns is based on the result of pilot actions to establish and maintain a 30-degree angle of bank. To compensate for varying pilot technique, instrument precession, etc., the initial criteria used in determining the holding pattern area was 25 degrees angle of bank.

AIRSPACE DETERMINATION

The actual determination of airspace to be considered has been made relatively easy by establishment of a system of templates which allows selection of an appropriate template based on a aircraft's holding speed and altitude and the holding fix distance from the primary navaids. These templates are numbered 1 through 31, and each one is related to one or more even numbered altitudes/FL's. The templates were developed at a scale of 1: 500,000 which is the same as the Sectional Chart scale for easy application. A partial listing of speed group, fix distance, altitude/FL, and template number relationships is shown in table 4-2. Holding levels through 50,000 are provided at even 2,000-foot intervals. Holding at odd levels above 2,000 is based on the next higher even altitude/FL pattern.

DME APPLICATION

When establishing a DME holding, fix, the difference between fix-to-navaid distance and slant range distance must be considered. Such differences can be significant within 45 miles of the navaid. Figure 4-9 shows a comparison of an 11-mile DME (slant range) fix and the actual fix-to-navaid distance and points out the required comparison when plotting airspace to be protected. For simplification, differences of 1/4 miles below 14,000 and 1/2 mile at and above 14,000 may be disregarded.

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Table 4-1.—Maximum holding airspeeds.

a.	Propeller-driven (including turboprop)		
	(1) MHA through 30,000 feet	175K	IAS
b.	Civil turbojet		
	(1) MHA through 6,000 feet	200K	IAS
	(2) Above 6,000 feet through 14,000 feet	210K	IAS
	(3) Above 14,000 feet	230K	IAS
c.	Military turbojet		
	(1) All - except aircraft listed below in (2), (3), (4), and (5)	230K	IAS
	(2) F-84F, F-100[2], F-102, F-104[2], F-106, T-38, F-4, F-11, A-5	265K	IAS
	(3) F-4[3]	280K	IAS
	(4) F-100[2], F/RF-101, F-104[2], F-105, F-111, F-5, B-58	310K	IAS
	(5) T-37	175K	IAS

[1] Flown by reference to DME.
[2] Holding speed depends upon weight and drag configuration.
[3] Only USAF F-4 aircraft.

Table 4-2.—Pattern selection chart.

175 Knots IAS

0-14.9 n.mi.				15-29.9 n.mi.				30 n.mi. and Over			
Alt.	No.	Alt.	No.	Alt.	No.	Alt.	No.	Alt.	No.	Alt.	No.
2	1	18	8	2	1	18	9	2	2	18	10
4	1	20	8	4	2	20	9	4	3	20	10
6	2	22	9	6	3	22	10	6	4	22	11
8	3	24	10	8	4	24	11	8	5	24	12
10	4	26	11	10	5	26	12	10	6	26	13
12	5	28	12	12	6	28	13	12	7	28	14
14	6	30	13	14	7	30	14	14	8	30	15
16	7			16	8			16	9		

200-230 Knots IAS

2	3	28	18	2	4	28	19	2	5	28	20
4	4	30	19	4	5	30	20	4	6	30	21
6	5	32	20	6	6	32	21	6	7	32	22
8	6	34	21	8	7	34	22	8	8	34	23
10	7	36	22	10	8	36	23	10	9	36	24
12	7	38	23	12	8	38	24	12	9	38	25
14	8	40	24	14	9	40	25	14	10	40	26
16	12	42	25	16	13	42	26	16	14	42	27
18	13	44	26	18	14	44	27	18	15	44	28
20	14	46	27	20	15	46	28	20	16	46	29
22	15	48	28	22	16	48	29	22	17	48	30
24	16	50	28	24	17	50	29	24	18	50	30
26	17			26	18			26	19		

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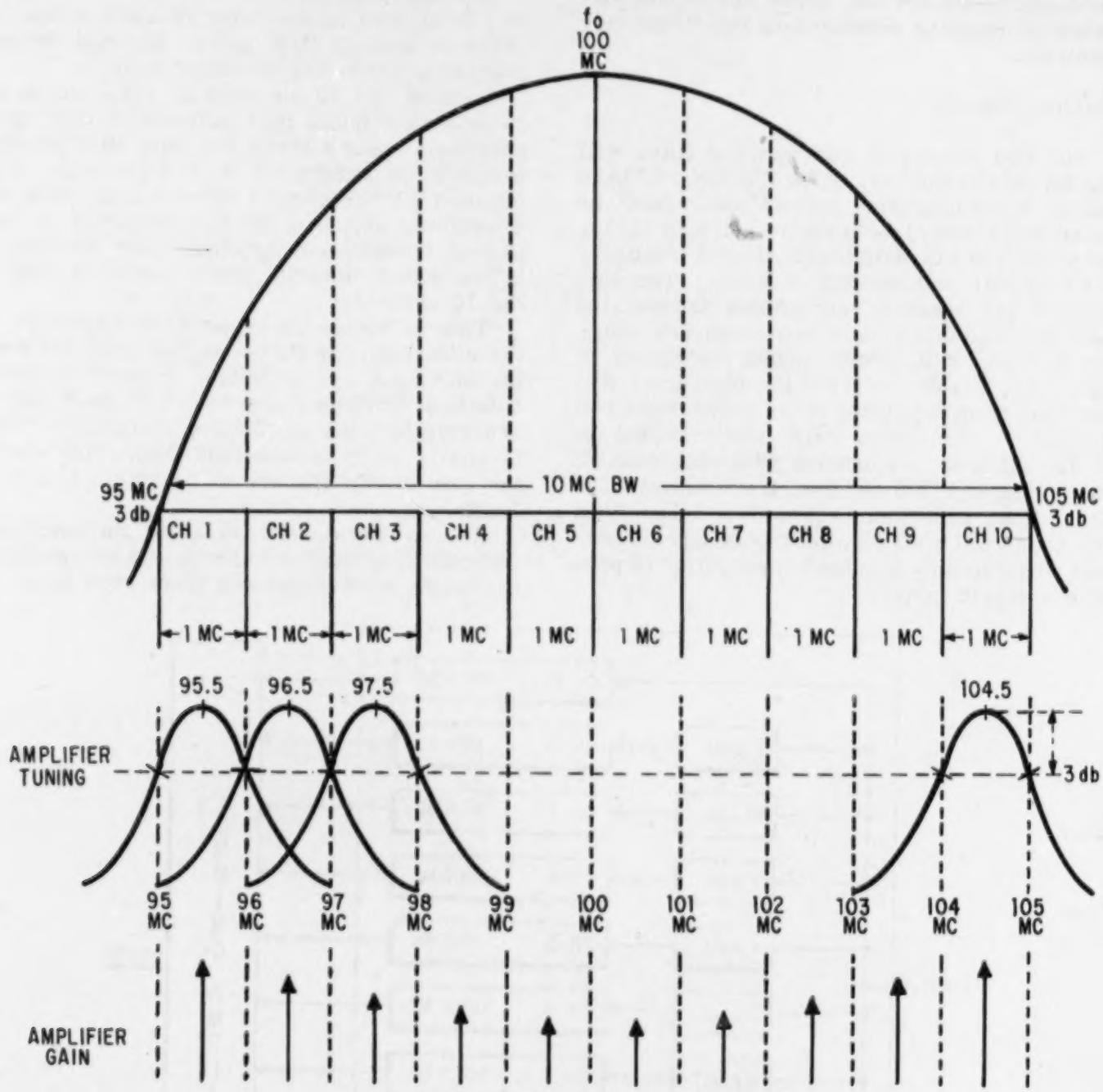

Figure 15-17. —All channel response curves.

300 cps, and since the overall bandwidth was 20 mc, there were 66,666 different frequencies. The matched filter is tuned to react to only half of the overall bandwidth, so the filter will receive only 33,333 different frequencies. This is in turn covered in 10 different steps by the 10 filters, so each individual filter will receive only 3,333 different frequencies. For ease of explanation, only 3,300 frequencies will be used in the remainder of this chapter.

EFFECT OF A TUNED AMPLIFIER ON FREQUENCIES WITHIN ITS BANDWIDTH. —In a paralleled resonant tank circuit the voltage and current are in phase at f_o. At frequencies below f_o, the circuit appears inductive X_L, and voltage leads the current. The farther below f_o the frequency is, the more inductive the tank appears, and the greater lead voltage has over current. At f_1, the voltage leads the current a maximum usable amount.

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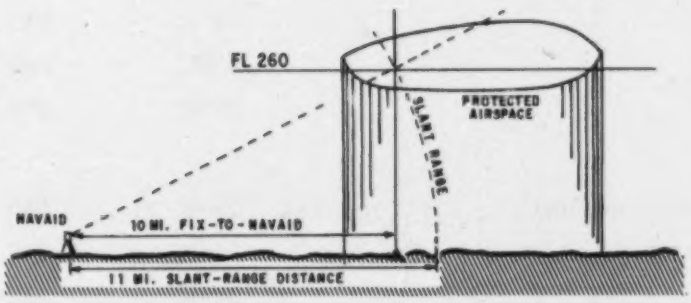

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Figure 4-9.—Fix-to-navaid distance and slant range distance.

Additionally, the no-course signal zone associated with TACAN and VOR navaids must be kept in mind when establishing DME holding fixes.

A graph included as an appendix to Handbook 7130.3 has been established for the purpose of determining both fix-to-navaid and slant range distance and whether a particular fix falls within the no-course-signal zone.

By use of DME as a holding fix, the holding may be accomplished either toward or away from the primary navaid. When holding toward the navaid, the fix end of the holding pattern airspace may lie within the no-course-signal zone, provided that normal pattern entry is from a direction other than through the no-course-signal zone. When holding away from the navaid, no part of the holding pattern airspace may lie within the no-course-signal zone. (See fig. 4-10.)

To substantiate the reasoning of the preceding paragraph, imagine an aircraft holding in each situation pictured in figure 4-10. When holding away from the navaid, at the completion of the outbound leg of the holding pattern, the pilot must turn to proceed inbound to the holding fix on a specified radial. Since no bearing (radial) information is available in the no-course-signal zone, the complete pattern must be one in which bearing information is available. Compare this to holding toward the navaid. When the pilot reaches the holding fix, which must be outside the no-course-signal zone, he will turn to proceed outbound on a heading to parallel the inbound course. Positive course guidance is not necessary for proper execution of this portion of the holding pattern. Therefore, a portion of this type holding pattern airspace area may fall within the no-course-signal zone.

OPTIONAL REDUCTION AREAS

Figure 4-11 is an example of template No. 9. Depicted are the fix end and outbound

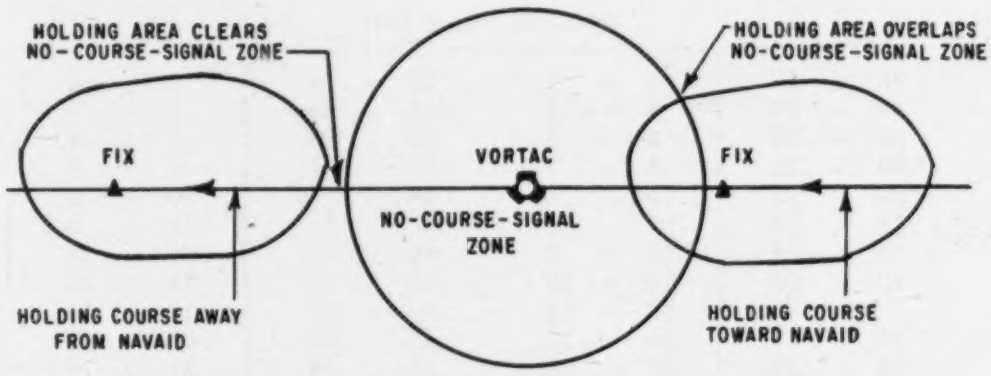

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Figure 4-10.—DME holding.

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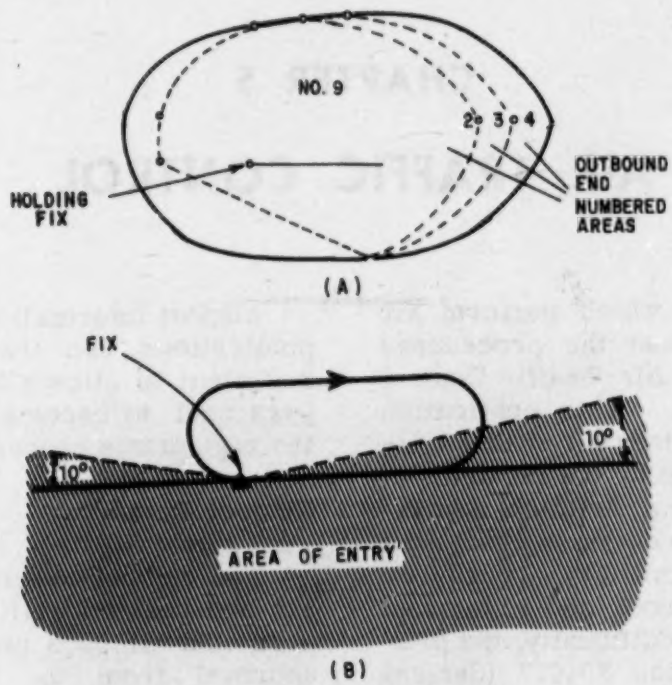

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Figure 4-11.—(A) Holding pattern template; (B) area of entry.

end reduction areas shown by dotted lines. For more efficient use of available airspace, these reduction areas may not have to be considered when providing protected airspace if certain conditions exist.

For example, the fix end reduction area may not have to be included if entry into the holding pattern is made from a direction that lies within the crosshatched area depicted in figure 4-11 (B) as the area of entry. Additionally, a table has been established and is included as an appendix to Handbook 7130.3 which shows the various DME holding pattern leg lengths which may be used and the outbound end reduction areas which must be included for a particular fix-to-navaid versus template number situation. This table must be referred to when establishing a DME holding pattern and the associated protected airspace.

APPLICATION OF HOLDING AIRSPACE FOR OBSTRUCTION CLEARANCE REQUIREMENTS

When determining minimum holding altitudes, the appropriate template selected for use in determining the holding pattern airspace area to be protected is also the primary area to be considered for obstruction clearance. In addition, a secondary area 2 miles wide surrounds the perimeter of the primary area and must be considered. Required obstruction clearance is contained in the TERP's handbook.

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CHAPTER 5

AIR TRAFFIC CONTROL

Naval shore activities which perform air traffic control functions use the procedures published in the Terminal Air Traffic Control Handbook 7110.8 (Series). This publication contains common civil/military air traffic control procedures agreed upon by the Department of Defense and the Federal Aviation Administration. In areas where a common procedure was not feasible, special military procedures were specified in the handbook and so marked to indicate applicability. Additionally, the provisions of OpNav Instruction 3710.7 (Series) apply to naval ATC facilities.

AIRPORT TRAFFIC CONTROL

All aircraft movement on the airport movement area and within the airport traffic area is normally governed by positive control requiring specific clearances from the control tower. Exceptions to this occur where preventive control has been authorized at facilities.

The following paragraphs in this section concern areas of interest normally encountered by senior AC's as supervisors. For more detailed study of basic airport traffic control, refer to the applicable section of the Terminal ATC Handbook 7110.8 (Series) or Air Controlman 3 & 2, NavPers 10367-D.

LOCAL AIR TRAFFIC OPERATIONS

A continuous review of local VFR traffic operations is necessary to insure that traffic patterns and arrival and departure corridors are established to provide maximum avoidance of populated areas and established airways or routes. For a smooth operation, adequate coordination and cooperation must be maintained with adjacent airfields and the appropriate FAA authorities.

Airport information contained in the various publications and training programs must be sufficient to allow pilots and air traffic control personnel to become thoroughly familiar with the regulations concerning the facility.

Control Tower

The control tower exercises control of all air and vehicle traffic on and around the airport, and all such movements must have prior approval from the tower. Senior AC's in supervisory positions must insure that tower personnel are thoroughly indoctrinated concerning their responsibilities and the use of proper techniques, phraseology, and control procedures.

Formation Takeoffs and Landings

A formation is a flight of more than one aircraft operating by prior arrangement as a single aircraft with regard to altitude, navigation and position reporting, and where responsibility for separation between aircraft within the flight rests with the pilots in that flight.

Formation flying is authorized only for those units and types of aircraft for which a valid requirement exists. Appropriate commanders must insure issuance of and adherence to specific instructions and standard operating procedures for all aspects of formation flying since it is contrary to the procedures prescribed in TATC Handbook 7110.8 (Series).

Two-plane section takeoffs for aircraft of similar performance may be authorized for units and types of aircraft whose military missions require such for essential pilot training. Maximum lateral separation should be maintained with the leading aircraft on the downwind side, where applicable, during formation takeoffs.

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When a landing interval will result in two or more aircraft on the runway at the same time, staggered landings on alternate sides of the runway should be made. When crosswind conditions dictate, or when centerline landings are preferred, the landing interval would be the same as that for aircraft operating independently.

Crash and Firefighting Equipment

Firefighting, crash, rescue, and ambulance equipment at air activities must be alerted and in an efficient operating condition while flight operations are in progress. During such operations, appropriate equipment should be stationed at strategic locations on the field. In the event an emergency is anticipated, the various types of equipment should be relocated, depending upon their particular mission, to the best possible position in relation to the anticipated scene of the emergency.

Although ATC personnel are not responsible for the placement of such equipment, collaboration and coordination is necessary with the Crash Captain and his assistants to provide for the best possible response to an emergency on the airport movement area.

More detailed information concerning crash and firefighting equipment and procedures useful to a supervisor may be found in NavPers 10367-D, AC 3 & 2.

Control Tower Nonvisibility Areas

Where portions of the airport surface or traffic pattern are not visible from the tower, supervisory personnel must insure that such information is given appropriate dissemination to those concerned. A description of such areas should be developed, both for printed and oral use, of sufficient detail to insure understanding of the discretionary use of such areas and the reasons therefor.

Intersection Takeoffs

At facilities where intersection takeoffs are authorized, supervisory personnel must insure that appropriate distance information is available to controllers concerning the amount of usable runway available beyond an intersection. An airport diagram showing such information should be constructed and made available to controllers.

CONTROL TOWER VISIBILITY OBSERVATIONS

The following paragraph is adapted from the Federal Meteorological Handbook No. 1, Surface Observations, NavAir 50-1D-1.

Unless otherwise exempted, certificated, qualified Navy Air Controlmen, or otherwise authorized tower personnel, must report prevailing visibility when the prevailing visibility at the usual point of observation or at the tower level is less than 4 miles. These control tower visibility observations may be used immediately for aircraft operations but they must be recorded and forwarded to the weather station as soon as practicable. During this condition, control tower personnel must notify the weather station as soon as possible when they observe the prevailing visibility at the tower level to decrease to less than 4 miles, and change by one or more reportable values. When the tower visibility is reported as variable, subsequent actual observed values within the limits of the reported variability need not be transmitted to the weather station.

NOTE: For a review of prevailing visibility, variable visibility, and reportable values, refer to AC 3 & 2, NavPers 10367-D, chapter 5.

Where control tower visibility observations are required of controllers, visibility charts identifying lights or objects used in determining visibility at the station should be maintained in the tower. Separate charts for day and night use may be maintained; otherwise, one chart with an indication of each marker's day or night use should be prepared. The charts should incorporate features for easy identification of markers and distance determination. Coordination with weather service personnel is necessary to produce an appropriate visibility chart.

Dark or nearly dark objects outlined against the horizon sky are preferred as markers for daytime visibility evaluations. However, the use of less ideal markers is usually necessary in order to obtain a representative value for each sector.

The most suitable objects for determining visibility at night are unfocused lights of

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moderate intensity at known distances. The red or green "course lights" of certain airport beacons; TV and radio tower obstruction lights, etc., may be used as definite nighttime visibility markers. Because of their intensity, focused lights, such as the airport beacon, may not be used as visibility markers. However, the degree of their brilliance may be used as an aid to indicate whether the visibility is greater or less than the distance to the light source. Before taking a visibility observation at night, the observer should spend as much preliminary time in a darkened or dimly lighted area as practicable, to allow for accommodation of his eyes to the darkness.

At stations where the visibility must be determined over short distances (less than 7 miles) and the absence of appropriate visibility markers requires estimates, values greater than the distance for which markers are available will be estimated. Under such conditions, visibility values greater than 7 miles will not be reported.

To estimate the visibility when it is greater than the distance to the farthest marker, the sharpness with which the marker stands out should be noted. Sharp outlines in relief with little or no blurring of color indicate that the visibility is much greater than the distance to the reference object. A blurred or indistinct object indicates the presence of an obstruction to vision that has reduced the visibility to not much more than the distance to the object.

Runway Visibility and Visual Range

Runway visibility value (RVV) is the visibility along a runway in terms of the distance a moderate intensity light source can be seen. Runway visual range (RVR) represents the horizontal distance a pilot will see down a runway from the approach end in terms of the distance high intensity runway lights can be seen. RVR is replacing RVV because it is a more realistic and accurate indication of what the pilot will encounter when on the runway. Its primary advantage is that it takes into account the penetrating capability of the high intensity runway lights (HIRL).

The presentation of RVV or RVR for use by controllers is through a meter display calibrated in fractions of a mile for RVV or a digital display calibrated in feet for RVR. These readout display instruments are normally located in the weather service office, the RATCC, and the control tower.

If available, RVV or RVR may be used concerning the visibility minimum for an IFR departure or or an approach (except circling approaches) in lieu of the prevailing visibility.

IFR PROCEDURE FOR AIR TRAFFIC CONTROL

The purpose of naval air stations is to support aircraft operations. In order to perform this function it is essential that these airfields are equipped with navaids and communications equipment and can provide services necessary to control aircraft operating under IFR conditions.

Naval air stations are categorized based upon equipment and services available from the following list:

1. Crash/rescue equipment.
2. Hard surfaced runway with standard runway markings.
3. Runway lights.
4. Control tower.
5. UHF air-ground communications.
6. Flight planning facilities (including weather briefing and NOTAM services).
7. Published instrument approach procedure (other than radar).
8. Approach control service.
9. Air surveillance radar.
10. Precision approach radar.
11. High intensity runway lights (HIRL).
12. Approach lights, U.S. standard A (or equivalent).
13. Runway centerline lights.
14. Touchdown zone (TDZ) lights.
15. Runway visual range (RVR) capability.
16. Radar equipped terminal area facility.

CNO will categorize air stations initially using the information in the DOD FLIP IFR SUPPLEMENT. The following defines airfield category in terms of IFR capability and the required equipment and service:

CATEGORY A—Precision Approach (PAR, ILS, AWCLS) with minimums less than 100 feet height above terrain (HAT) and 1/4 mile visibility (1,200 feet RVR) and all the equipment and services listed in the previous list.

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CATEGORY B—Precision approach with minimums less than 200 feet HAT and visibility 1/2 mile (2,400 feet) but not less than 100 feet HAT and visibility 1/4 mile (1,200 feet RVR), and the equipment and services numbered 1 through 12 of the previous list.

CATEGORY C—Precision approach with minimums not less than 200 feet HAT and visibility 1/2 mile (2,400 feet RVR), and the equipment and services numbered 1 through 11 of the previous list.

CATEGORY D—Nonprecision approach (TACAN, ADF, VOR) and equipment and services numbered 1 through 8 of the previous list.

Certainly a major part of the overall capability must depend upon the ability of controller personnel to expeditiously apply separation criteria to the control of IFR traffic. The term approach control includes this application and encompasses both arriving and departing aircraft. Local policies, agreements, training programs, and mission requirements definitely have an effect on controller procedure at a particular facility. The procedures listed herein are considered applicable to facilities in general.

IFR CLEARANCE

A clearance is defined as authorization by air traffic control, for the purpose of preventing collision between known aircraft, for an aircraft to proceed under specified traffic conditions within controlled airspace. An IFR clearance, then, is authorization as described above to operate in accordance with the instrument flight rules. An IFR clearance is normally issued by an ARTCC in whose area an IFR flight originates. However, at approach control locations, the initial/final portion of the clearance may be a mutually agreed departure/arrival clearance that meets separation requirements of the ARTCC and the terminal facility. Under certain conditions, such as a proposed flight to be conducted entirely within the terminal facility's area of responsibility, the terminal facility will issue the IFR clearance. Such procedures, as with the procedures for the issuance of short range clearances, are established and published locally in the appropriate format—usually Letters of Agreement.

An IFR clearance can be very simple or quite complicated, depending on traffic conditions and operations authorized by the clearance. Each clearance will contain all or part of the following items, as appropriate, in the order listed:

1. Aircraft identification.
2. Clearance limit or approach clearance.
3. Route of flight.
4. Altitude data in the order flown.
5. Departure procedure or SID.
6. Holding instructions.
7. Any special information.
8. Frequency and beacon code information.

Route or Altitude Amendments

When the route of flight in a previously issued IFR clearance requires amending, one of the following methods must be used:

1. State which portion of the route is being amended and then state the amendment.

EXAMPLE: CHANGE VICTOR TWENTY TWO TO READ VICTOR TWO TWENTY. (Only route in the clearance.)

2. State the amendment to the route and then state that the rest of the route is unchanged.

EXAMPLE: CHANGE J TEN TO READ J TWENTY, REST OF ROUTE UNCHANGED.

3. Reissue the entire route, including the amended portion in the appropriate place.

When a route or altitude in a previously issued clearance is amended, all applicable altitude restrictions must be restated or state that the restrictions are cancelled.

Composite Flight Plan

The clearance limit for an IFR proposal planning IFR operations for the initial part of the flight and VFR operations for the latter part would be the fix at which the IFR portion ends.

A proposal planning VFR for the initial part of the flight and IFR for the latter part of the flight is treated as a VFR departure. IFR clearance would be issued when the pilot requests it, approaching the fix where he proposed to start IFR operations. The remainder of the flight would simply be treated as any other IFR flight.

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COORDINATION BETWEEN FACILITIES

•For efficient operation, constant coordination is necessary between ATC facilities. The content and the scope of information exchanged between facilities differ, depending upon the type of ATC service provided.

IFR flight progress data is forwarded from controller to controller within and between Centers and terminal facilities when operating in an en route capacity, as aircraft progress along a route. Such information must be forwarded at least 15 minutes before the aircraft concerned is estimated to enter a receiving facility's area. In such cases the information forwarded is as follows:

1. Aircraft identification.
2. Type of aircraft and appropriate equipment suffix.
3. Assigned altitude/FL and ETA over the last reporting point/fix in the transferring facility's area or assumed departure time when the departure point is the last point/fix in the transferring facility's area.
4. Altitude/FL at which the aircraft will enter the receiving facility's area if other than the assigned altitude.
5. True airspeed.
6. Point of departure.
7. Route of flight remaining.
8. Destination airport and clearance limit if other than the destination airport.
9. ETA at destination airport if other than military or scheduled air carrier aircraft.
10. FL requested by the pilot of a turbojet aircraft, if assigned FL differs from the requested FL (within a facility only).
11. Longitudinal separation being used between aircraft at the same altitude, if it results in the aircraft having less than 10 minutes separation at the facility's boundaries.

The position report over the last reporting point in the transferring facility's area should be forwarded to the receiving facility if any of the following conditions exists:

1. The time differs by more than 3 minutes from the estimate previously forwarded.
2. It is requested by the receiving facility.
3. It is agreed to, between facilities, as a routine operation.

When necessary to revise information already forwarded, the revised information is forwarded as required except that revision to the ETA over the last fix in the transferring facility's area is required only if it differs by more than 3 minutes from the estimate already given.

Centers forward the following information to approach control facilities before transfer of control jurisdiction. NOTE: Transfer points are usually specified in a Letter of Agreement.

1. Aircraft identification.
2. Type of aircraft and appropriate equipment suffix.
3. ETA or actual time, and proposed or actual altitute of the clearance limit. The ETA need not be given if the arrival information is being forwarded during a radar handoff.
4. EAC issued the aircraft.
5. Time, fix, or altitude when control responsibility is transferred to the approach control facility.

Approach control facilities must keep ARTCC's currently advised of the following information:

1. The particular approach that may be expected, where two or more instrument approach procedures are published or the fact that radar vectors to the traffic pattern will be used.
2. Highest altitude in use by the approach control facility at the holding fix.
3. Average time interval between successive approaches.
4. Arrival time of aircraft over the holding fix or a statement or other indication that acknowledges control responsibility if already received.
5. Revised EAC if different by 10 minutes or more from that issued by the ARTCC. (The ARTCC may issue EAC's to arrivals; however, this operation is usually covered in a Letter of Agreement.)
6. Missed approaches if they affect the ARTCC's area of operation.

The facility providing IFR service to the terminal area must forward the following information to nonapproach control towers soon enough to allow adjustment of the traffic flow, or to FSS's soon enough to allow provision of airport advisory service (the specific time

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requirement is usually covered in a Letter of Agreement):

1. Aircraft identification.
2. Type of aircraft.
3. ETA and proposed altitude over the fix.
4. Type of instrument approach procedure the aircraft will execute.

Nonapproach control towers must forward the following information to the ARTCC or approach control as appropriate:

1. When an arriving aircraft is sighted and, in the tower controller's judgment, a landing can be completed.
2. Actual time of arrival.
3. Pilot report of cancellation of the IFR flight plan.
4. Information related to missed approach aircraft or overdue/unreported aircraft.
5. Runway in use.

DEPARTURE PROCEDURE

Departure control is an approach control function responsible for insuring separation between departures. Departure control may suggest a takeoff direction other than that which may normally have been used so as to expedite the handling of departures. At times it is preferred to offer a pilot a runway that will require the fewest turns after takeoff to place his aircraft on the filed course or selected departure route as quickly as possible. At some locations a runway use program may be in effect which pays particular attention to noise abatement programs and will route departures away from congested areas.

IFR Clearance for Departing Aircraft

The departure clearance is issued before takeoff and should include the following items as applicable:

1. Clearance limit. This should be the destination airport when practicable even though it may be outside of controlled airspace. Where authorized and prescribed, short range clearances may be used which would necessarily specify some fix other than the destination as the clearance limit.

2. Route of flight. When assigning a route of flight, an aircraft should be cleared via esablished airways, route structures, and navaids established for the altitude stratum in which the operation is to be conducted. Routes through uncontrolled airspace should be included only when requested by the pilot.

When any part of an airway or route requested is unusable because of navaid status, aircraft should be cleared via one of the following alternative routes:

a. A route published in the AIM and depicted on U.S. Government charts. The word SUBSTITUTE should be used immediately preceding the alternative route in issuing such a clearance.

b. A route defined by specifying navaid radials or courses.

c. A route defined as direct to or between navaids.

To effect transition within or between route structures, aircraft should be cleared via one or more of the following methods, based on VOR, VORTAC, or TACAN navaids (unless use of other navaids is essential to aircraft operation or ATC efficiency):

a. The aircraft should be vectored to or from the radials or courses of the airway or route assigned.

b. An SID should be assigned.

c. Aircraft may be cleared to climb via radials or courses of the airways or jet route assigned.

d. Aircraft may be cleared via direct to or between the navaids forming the airway or route assigned.

e. Aircraft may be cleared to climb on specified radials or courses of navaids.

If the aircraft will operate in an area adjacent to restricted airspace, the following action is required:

a. For joint-use or military climb corridor restricted airspace, coordinate as necessary with the facility designated as controlling facility or using agency and obtain permission for the aircraft to transit the airspace. If permission is not obtained, clear the aircraft so that it avoids the restricted airspace.

b. For prohibited or nonjoint-use restricted airspace, clear the aircraft so that it avoids the airspace unless the pilot informs you

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that he has obtained permission from the using agency to operate in the airspace or the using agency informs you that they have given the pilot permission to operate in the airspace, or unless the aircraft is on an approved altitude reservation flight plan.

Except when a pilot requests a detailed clearance or when military operations are conducted in an altitude reservation; operations are conducted above FL 600; or operations requiring special handling are conducted; an abbreviated departure clearance may be issued if its use reduces verbiage and the following conditions are met:

a. The route of flight filed with ATC has not been changed by the pilot or operations officer prior to departure.

b. The terminal facility is provided sufficient information about the flight to exercise its control responsibility.

c. Destination airport information is relayed between facilities concerned, prior to departure.

d. The assigned en route altitude is stated in the clearance.

The destination airport is not stated in the abbreviated departure clearance. When a specific SID, including a transition, is filed by the pilot, it is considered as part of the route of flight.

When no changes are required to the filed SID or route the phrase CLEARED AS FILED may be stated. An SID may be assigned by the controller if appropriate and any additional instructions or information necessary may be included along with the en route altitude.

When a filed SID or route will require minor revisions the same procedures applies except that the necessary revisions must be specified. Example: CLEARED AS FILED EXCEPT CHANGE DEPARTURE TO READ DUTCH ONE DEPARTURE, MAINTAIN FLIGHT LEVEL THREE FIVE ZERO.

In a nonradar environment, one, two, or more fixes as necessary to identify the initial route of flight must be specified.

3. Altitude. When assigning altitudes for an en route operation, aircraft should be cleared at altitudes or flight levels appropriate to the direction of flight. These altitudes/FL's are contained in FAR's and in AC 3 & 2, NavPers 10367-D. When traffic, meteorological conditions, or aircraft operational limitations prevent assignment of altitudes/FL's appropriate to the direction of flight, any cardinal altitude or flight level below FL 290, or any odd cardinal FL at or above 290, may be assigned without regard to direction of flight as follows:

a. For traffic conditions, this action may be taken only if one of the following conditions exists:

(1) The aircraft will remain within the facility's area and prior approval is obtained from other affected positions or sectors or the operations have been covered in a Facility Directive.

(2) The aircraft will proceed beyond the facility's area and specific operations and procedures permitting random altitude assignments are covered in a Letter of Agreement between the appropriate facilities.

(3) Military aircraft are operating on random routes and prior approval is obtained from the facility concerned.

b. For meteorological conditions, this action may be taken only if the controller obtains prior approval from other affected positions or sectors within the facility and, if necessary, from the adjacent facility concerned.

c. For aircraft operational limitations, this action may be taken only if the pilot informs the controller that the available appropriate altitude exceeds the operational limitations of his aircraft and only after prior approval is obtained from other affected positions or sectors within the facility and, if necessary, from the adjacent facility.

Consideration must be given to the atmospheric pressure and the lowest usable flight level when assigning FL's.

If practicable, the pilot should be informed when to expect climb or descent clearance or to request altitude change from another facility.

Aircraft must be cleared at an altitude at or above minimum en route altitude (MEA) or minimum crossing altitude (MCA) for any part of an airway or route within the originating facility's area and the first part of the airway or route into an adjacent facility's area except where one of the following applies:

a. An aircraft may be cleared below the MEA but not below the minimum obstruction clearance altitude (MOCA) if the altitude assigned is at least 300 feet above the floor of

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controlled airspace and further provided that the following conditions are met:

(1) Nonradar procedures are used only within 22 miles of a VORTAC, CORTAC, or TACAN.

(2) Radar procedures are used only when definite operational benefits will be realized and the aircraft is vectored, and lost communications procedures are issued.

b. An aircraft may be cleared to operate on jet route below the MEA (but) not below the prescribed minimum safe altitude or above the maximum authorized altitude if, in either case, radar service is provided.

NOTE: Minimum en route and maximum authorized altitudes for certain jet route segments have been established above the floor of the jet route structure due to limitations on navigational signal coverage.

c. Where a higher altitude is required because of an MEA (and no MCA is specified), an aircraft must be cleared to begin climb to the new MEA immediately after passing the fix beyond which the new MEA applies.

d. Where MEA's have not been established, aircraft may be cleared at or above the minimum safe altitude prescribed in FAR.

When issuing an altitude or FL to be maintained en route, one of the following procedures should be used in the order of preference listed:

a. The altitude filed by the pilot should be assigned.

b. An altitude within the highest route stratum filed by the pilot and as near as possible to the altitude filed should be assigned.

c. An altitude as near as possible to the highest route stratum filed by the pilot should be assigned, and the pilot should be informed when or at what point he can expect clearance to an altitude within the stratum he requested. In this case the expected altitude should be as near as possible to that filed by the pilot originally.

4. SID routes. An SID may be assigned to air carrier or military aircraft whenever appropriate and to other aircraft only if the pilot requests it. If it is necessary to assign a crossing altitude which differs from the SID altitude, the changed altitude should be repeated to the pilot for emphasis. Some SID's do not include altitudes in the design, in which case the appropriate altitude to be maintained must be inserted in the proper place in the SID assignment.

5. Nonstandard departure routes. For departures from airports that provide airport traffic control service, the direction of takeoff, the direction of turn after takeoff, or the initial heading to be flown after takeoff may be specified. At airports without airport traffic control service the initial heading to be flown after takeoff may be specified when considered necessary. In such cases, the specification can only be made after the direction of takeoff and/or direction of turn after takeoff has been determined by coordination with the pilot.

6. Departing USAF/USN IFR flights must be instructed to read back the ATC clearance to insure receipt as issued.

7. Frequency and beacon code changes. Departing IFR military turbojet aircraft (except cargo and transport type) should be instructed to change to departure control frequency before takeoff.

If the local control position in the tower has override capability on the departure frequency, instruction to change to departure control frequency is included in the takeoff clearance. This allows the local controller to communicate with the aircraft if necessary on the departure control frequency. If the local controller does not have override capability, the same procedure is used; however, the pilot must be instructed to monitor guard channel to provide for communications with the local controller if necessary.

If the appropriate mode/code and departure control frequency have not been previously assigned, these items are included in the takeoff clearance.

Caution must be exercised so as not to require radiofrequency or beacon changes for turbojet aircraft before the aircraft reaches 2,500 feet above the surface.

Coordination With the Receiving Facility

If the departure point is less than 15 minutes flying time from the transferring facility's boundary, coordination with the receiving facility must be accomplished before takeoff of a departing aircraft. Facilities needing earlier

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To frequencies above f_o, the circuit will appear capacitive by the amount that the frequencies differ from f_o. Above f_o, the current leads the voltage by the amount of X_C to the frequency applied. At f_2, the current leads the voltage by the maximum usable amount. Since each tank circuit in the matched filter has a bandwidth of 1 megacycle, and receives 3,300 different frequencies, approximately 1,650 of them will be above f_o, and 1,650 will be below f_o. To those above, the tank will appear capacitive. To those below, it will appear inductive. To the one frequency at f_o the tank circuit appears purely resistive.

The tuned amplifier is so designed that signal voltages are coupled out rather than signal current. To determine which signal voltages will be developed by the tank, first a reference must be used. This reference is the voltage and current which occur at f_o of the tank, and which are in phase because the tank is resistive.

The 1,650 frequencies, both above and below f_o, are applied to the tank circuit (tuned amplifier) at the same time. The voltage at the frequency f_1 of the tank will be leading the f_o current by the amount of X_L that this frequency sees.

Frequencies in between f_1 and f_o will be leading by a lesser amount because the tank circuit will appear less inductive to these frequencies. These voltages will have been advanced in phase (or time) in respect to the voltage at f_o of the tank.

The voltage of the frequency f_2 will be retarded in phase (or time) because the tank circuit will appear capacitive to that frequency. Before any voltage can be developed, current had to first begin to flow (because current leads voltage across a capacitive circuit). Voltages at frequencies in between f_2 and f_o saw less X_C, therefore, were retarded less.

The output from this tuned amplifier will be a series of signal voltages at 3,300 different frequencies with the lowest frequency (f_1) occurring first because it was advanced the most in time, and the highest frequency (f_2) occurring last because it was retarded the most in time.

The Q of the tank circuit will be selected so as to advance the voltage at f_1 by 0.5-μsec, and to delay or retard the voltage at f_2 by 0.5-μsec. THE TIME DIFFERENCE BETWEEN THE TIME WHEN THE FREQUENCY AT F_1 IS DEVELOPED AND THE TIME WHEN THE FREQUENCY AT F_2 IS DEVELOPED WOULD THEN BE 1-μsec. Since there are 3,300 different frequencies produced and coupled out of the tuned amplifier in a period of 1-μsec, the time delay between each of these different frequencies is 0.00031 μsec. As shown in figure 15-18, the first frequency to leave the tuned amplifier would be the frequency at f_1, and each 0.00031 μsec thereafter another frequency would be developed and coupled out until the frequency of f_2 is developed 1 full μsec later.

Since frequency is the reciprocal of time, it can be seen that the output from each channel (1 μsec in time) will be 1 mc wide in frequency.

What has been done is to take 3,300 different frequencies, each one in phase, and time delay or time advance each one by a different amount. This process has created a waveform which begins to appear as a linearly swept FM wave, and is called time dispersion or phase dispersion.

COMBINED OUTPUT OF THE MATCHED FILTER. —As shown in figure 15-16, the entire frequency spectrum is applied to the input of each of the 10 filter channels simultaneously, but through a delay line for channels 2 through 10. This means that channel 1 will receive its input at the instant the spectrum is applied to the input of the filter; however, channel 2 will not receive its input until later in time due to

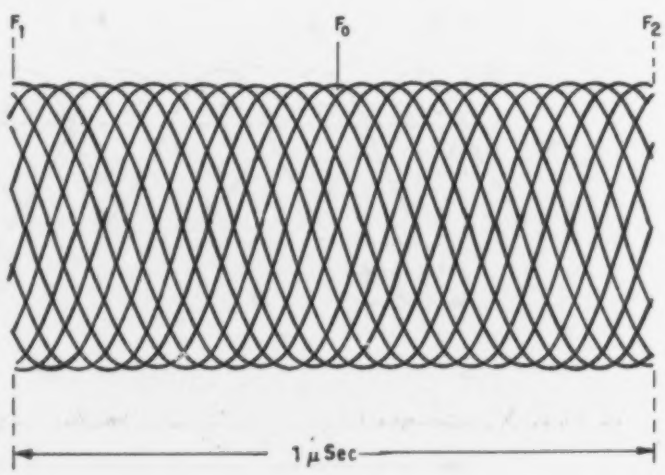

Figure 15-18. —Individual channel frequency output (expansion).

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coordination may enter into agreement to establish this coordination. However, when agreements establish mandatory radar handoff procedures, coordination need only be effected in a timely manner prior to transfer of control.

The actual departure time must be forwarded to the receiving facility for departures that require advance coordination unless an assumed departure time is agreed upon and that time is within 3 minutes of the actual departure time.

Radar Departures

Departure control utilizing radar will clear aircraft out of terminal areas using standard instrument departures via radio navigation aids whenever possible, to reduce the amount of necessary coordination between facilities. Radar departures may be provided to expedite departures and to establish them on course by the most direct route. Radar departures may overlie but should not be restricted to the standard departure routes for radar or lost communications backup.

If a departure is to be vectored immediately after takeoff, the initial heading to be flown must be issued before takeoff. Additionally, it may be necessary to instruct the pilot to squawk low if a beacon reply is required immediately after takeoff.

Departing IFR aircraft may be vectored before reaching minimum vectoring altitude, provided that they are within 40 miles of the antenna site and a minimum of 3 miles separation is maintained from prominent obstructions shown on the radarscope. If the takeoff path is less than 3 miles from such obstructions, the vectors provided must increase the separation to 3 miles.

HOLDING PROCEDURE

Holding is a predetermined maneuver which keeps an aircraft within a specified airspace while awaiting further clearance. A holding fix is used as a reference point in establishing and maintaining the position of the aircraft while holding. Most generally used holding patterns are charted on en route high/low and area aeronautical charts.

Holding Instructions

General holding instructions include the following items:

1. Direction of holding from the fix.
2. Name or description of the holding fix.
3. Radial, course, bearing, airway, or jet route on which the aircraft is to hold.
4. Outbound leg length in miles if DME is to be used.
5. Direction of holding pattern turns, if left turns are to be made. (Right turns are standard.)

Detailed holding instructions consist of the same items as general holding instructions, and in addition the outbound leg length in minutes or miles and the direction of holding pattern turns are always specified.

Delay Anticipated

If a delay is anticipated requiring an aircraft to be held and the holding pattern is not charted, the following items as appropriate must be issued at least 5 minutes before the aircraft is estimated to reach the clearance limit:

1. General holding instructions.
2. Detailed holding instructions if the pilot requests or the controller deems it necessary.
3. The time at which the pilot can expect to receive approach clearance (EAC) or further clearance (EFC).

If a delay is anticipated and the holding pattern is charted, the following items must be issued at least 5 minutes before the aircraft is estimated to reach the clearance limit:

1. Direction the pilot is to hold.
2. EAC or EFC.

NOTE: The direction issued must correspond to that charted unless another holding pattern is required for ATC purposes in which case it would be treated the same as any noncharted holding procedure.

Delay Not Anticipated

If it becomes apparent that an aircraft will not be delayed at a clearance limit and clearance beyond the clearance limit is required, the following action is required:

1. For departing or en route aircraft—clearance beyond the clearance limit must be

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issued at least 5 minutes before the aircraft reaches the clearance limit.

2. For arriving aircraft—clearance beyond the clearance limit must be issued before the aircraft reaches the clearance limit.

Clearance Beyond the Holding Fix

When issuing clearance beyond the holding fix, the following items should be included:

1. A clearance limit or approach clearance.
2. Route of flight. This should include complete details of the route, airway, course, heading, arc, or vector to be used. The phrase VIA LAST ROUTING CLEARED may be used only when the most recently issued routing beyond the holding fix can be reinstated and verbiage will be reduced.

Lengthy Delay

If it is determined that an aircraft intending to land within a facility's area of responsibility would be delayed more than 1 hour, the EAC or EFC should be issued as soon as practicable after such aircraft enter the facility's area and the aircraft operator or military equivalent notified.

Holding Patterns and NavAids

The holding pattern airspace is determined as described in chapter 4 of this manual. By requiring the pilot to keep his aircraft within the specified airspace and other aircraft out of the same airspace, separation is maintained.

Holding points are normally navaids; however, a location that the pilot can determine by visual reference or a visual holding point may be used. In such cases, the controller must determine that the pilot is familiar with the visual holding point.

When holding is accomplished by using unmonitored navaids as the holding fix, separation must be provided for any other aircraft that may occupy the course which the holding aircraft will follow in the event the holding aircraft does not receive signals from the unmonitored navaid.

ARRIVING AIRCRAFT

The initial clearance issued IFR aircraft will include, whenever practicable, the destination airport as the clearance limit. However, an ARTCC may clear an aircraft to a fix short of its destination airport and normally amends an existing destination airport clearance limit to a fix short of destination for the purpose of transfer of control responsibility of an en route aircraft to a terminal facility. In such cases, if no delay is anticipated, clearance beyond such clearance limit must be issued to arriving aircraft before the aircraft reaches the clearance limit. Transfer of radio communications and control responsibility must be accomplished soon enough to allow the receiving facility to issue further clearance before the aircraft reaches the clearance limit. Specific requirements for transfer of control of arriving aircraft are usually stated in a Letter of Agreement.

At nonapproach control locations the ARTCC retains control of arrivals until they have landed, canceled IFR, or until they are no longer a factor in provision of IFR service. At approach control locations the center normally clears all arriving IFR traffic to the appropriate holding point, and in some cases includes holding instructions and the expect-approach-clearance times in such clearance. The number of aircraft to be released to approach control by the center is determined by a joint center/approach control Letter of Agreement.

Advance Approach Information

When an aircraft intends to land at an airport where approach control service is provided and two or more instrument approach procedures are published, the facility controlling the aircraft immediately before entry into the approach control area should inform the pilot of the type of approach to expect or that he will be vectored to the traffic pattern. This information may be omitted if airport terminal information service (ATIS) is provided by the airport or if the visibility is 3 miles or better and the ceiling is at or above the highest initial approach altitude established for any low altitude instrument approach procedures for the airport.

Approach Control

Approach control is responsible for controlling all instrument flight operating within its area of responsibility. Approach control may serve one or more airports, and control is

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exercised primarily by direct pilot/controller communications.

Approach control facilities must provide arriving aircraft with approach information on initial radio contact or as soon as possible thereafter. The approach information consists of the following:

1. Approach clearance or type of approach to be expected if two or more approaches are published and the clearance limit does not indicate which will be used.
2. Runway in use.
3. Surface wind.
4. Ceiling and visibility if the ceiling at the airport of intended landing is reported below 1,000 feet or below the highest circling minimum, whichever is greater, or the visibility is reported less than 3 miles. When such conditions exists, any known changes classified as special weather observations must also be transmitted as soon as the volume of traffic, controller workload, and communications frequency congestion permits.
5. Altimeter setting.

Specific items of approach information do not have to be reissued if the pilot indicates he has already received them via ATIS or the ARTCC.

Approach control service is provided at terminal facilities for the purpose of maintaining an orderly flow of arriving traffic without interruptions of continuity while expediting departures. The order in which arrivals are positioned while awaiting approach clearance or while on approach is termed the approach sequence. Many factors affect an approach sequence. The ARTCC has a considerable effect on the sequence by the altitude/FL assigned to aircraft released to approach control. The most desirable result is to prevent delays to arriving aircraft.

The time lapse between aircraft on approach or between expect-approach-clearance times issued is termed the approach interval. Again many factors affect the interval such as type of aircraft, type of approach, weather conditions, etc. Probably the most influential factor concerning the approach interval is the length of the approach procedure and the separation required between aircraft on approach. If only one aircraft may be on approach at one time, then the interval is the average time it takes to complete the approach. For two different approaches to the same runway, or possibly one approach, it is possible to have more than one aircraft in certain segments of approach at the same time provided appropriate separation is maintained.

Timed approaches appear to allow the shortest time interval under manual or nonradar type approach control procedure. Timed approaches are seldom used by naval facilities due to the wide variety of aircraft operational characteristics involved at such facilities. Timed approaches are most effective when used with aircraft of similar operating characteristics such as speed. If all conditions are perfect, it is possible to have an interval of 2 minutes between aircraft using timed approach procedures.

Each approach control operation maintains its operational identity, in that, it is adapted to a particular local traffic situation. However, it can be said that the desired results of approach control's concern with arriving aircraft are as follows:

1. Maintenance of an approach sequence that avoids gaps and unnecessary delays between approaches.
2. Use of the minimum possible approach interval, consistent with the appropriate separation required.

At nonapproach control locations, a subsequent arriving aircraft can only be cleared for an approach after one of the following conditions exists:

1. The preceding aircraft has landed or canceled IFR.
2. The preceding aircraft is visible to the tower controller at that location and, in his judgment, landing can be completed.

Nonradar Approaches

The order of priority of issuance of appraoch clearance is normally established on the basis that the first aircraft estimated over the fix from which approaches are commenced will be the first to receive an approach clearance, followed by other aircraft in the order of their estimated or actual times of arrival over the fixes. If visual contact with the ground is made before the approach is completed, it is required that the complete approach procedure be

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followed unless ATC has authorized a contact approach or the pilot cancels his IFR flight plan.

To require an aircraft to execute a particular instrument approach procedure, the controller must specify in the approach clearance the name of the approach as published on the approach chart.

If landing will be made on a runway other than that alined with the direction of instrument approach, instructions to circle to the runway in use must be included in the approach clearance.

When adherence to an altitude as published on the approach chart is required for separation from other aircraft, the altitude must be specified in the approach clearance.

If it is determined that a pilot is unfamiliar with an approach procedure, a complete description of the approach must be included in the approach clearance.

Clearance for a high altitude penetration may be issued in conjunction with a clearance for approach, a vector to a final approach course, or to a fix or altitude from which a clearance for an approach can be given when no delay is anticipated.

A military en route descent for trubojet aircraft may be authorized provided that only normal vectoring delays are anticipated. It may be used in a nonradar environment; however, radar capability should exist which will permit the aircraft to be vectored to the final approach course of a published high altitude instrument approach procedure or PAR/ASR approach. The type of final approach to be conducted must be mutually understood by the pilot and controller before the en route descent is begun. Prior to issuance of an en route descent clearance, the current weather conditions at the destination airport must be transmitted when any of the following conditions prevail:

1. The ceiling is below 1,000 feet.
2. The ceiling is below the highest circling minimum.
3. The visibility is below 3 miles.

To avoid requiring an aircraft to fly at low altitude for an excessive distance, descent clearance should be issued at a point determined by adding 10 to the first two digits of the flight level; for example FL 370; 37 plus 10 equals 47 miles.

A turbojet en route descent should not be terminated without the consent of the pilot except as required by a radar failure or an emergency situation. It remains the pilot's prerogative to elect to conduct a published high altitude penetration instead of an en route descent.

Clearance for a contact approach may be issued only if the following conditions are met:

1. The pilot requested it.
2. The reported ground visibility is at least 1 statute mile for all aircraft except civil air carriers which must have 1/2 statute mile. Approved separation must be applied between aircraft authorized to conduct a contact approach and other IFR and special VFR aircraft. When applying vertical separation, a fixed altitude should not be assigned; clear the aircraft at or below an altitude which is at least 1,000 feet below any other IFR traffic but not below the minimum safe altitude. An alternative clearance should be issued when weather conditions are such that a contact approach may be impracticable.

Radar Approach Control

In a radar environment, arriving aircraft may be cleared to an outer fix most appropriate to the route being flown with vertical separation and, if required, given holding instructions. When radar handoffs are effected between the ARTCC and approach control, or between two approach control facilities, aircraft are cleared to the airport or to a fix so located that the handoff will be completed prior to the time the aircraft reaches the fix. When radar handoffs are utilized, successive arriving flights may be handed off to approach control with radar separation in lieu of vertical separation, provided that such procedures are previously agreed upon between the facilities concerned and the following conditions are met:

1. The first aircraft communicates with the receiving facility before a second aircraft, cleared to or over the same fix, is told to communicate with the receiving facility. This need not be applied if the first aircraft is cleared to the airport.

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2. The first aircraft communicates with the receiving facility before it reaches the clearance limit fix.

3. The receiving facility does not delay or hold the first aircraft at the fix to or over which a second aircraft is cleared.

Radar vectors and altitudes/FL's will be assigned as required for spacing and separating aircraft. Aircraft will normally be informed when it is necessary to vector through the final approach course for spacing or other reasons. In the event the controller is unable to so inform the pilot, he is not expected to turn inbound on the final approach course unless approach clearance has been issued (such as for ILS, VOR, TACAN final approach).

Approach clearance will normally be issued with the final vector for interception of the final approach course, and the vector will be such as to enable the pilot to establish his aircraft on the final approach course prior to reaching the approach fix. This approach clearance would not be issued in the case of an ASR or PAR approach.

In addition to the foregoing conditions, if terrain or traffic does not permit unrestricted descent to the lowest published altitude specified in the approach procedure for which cleared, the controller must either defer issuance of approach clearance until there are no restrictions, or issue altitude restrictions with the approach clearance specifying when or at what point unrestricted descent can be made. Except for ASR/PAR, the pilot would have to be instructed to contact the tower or monitor a certain frequency until completion of the approach.

APPROACH SEPARATION RESPONSIBILITY.—When approaches are not monitored by the PAR controller, the radar approach controller must maintain radar separation until visual separation can be provided by the tower controller. The tower controller may provide radar separation within an area designated for his use if this responsibility has been delegated to him in a Letter of Agreement or Facility Directive.

When monitoring instrument approaches, the PAR controller must provide IFR separation between aircraft on approach from the final approach fix to the airport until visual separation is provided by the tower controller.

When timed approaches are being conducted, the radar controller must maintain radar separation until the aircraft is observed to have pased the final approach fix inbound and is within 5 miles of the runway on final approach course or until visual separation can be provided by the tower controller.

VISUAL APPROACH.—In a radar environment, ATC may descend an aircraft operating in accordance with an IFR clearance to the minimum vectoring altitude, vector it to the airport traffic pattern, and issue clearance for a visual approach. This may be done whenever the reported ceiling is at least 500 feet above the minimum vectoring altitude and the visibility is 3 miles or more.

With a visual approach, the pilot may deviate from the prescribed instrument approach procedures and proceed to the airport visually, maintaining VFR conditions at all times. This procedure affords a more expeditious service to arriving aircraft and precludes unnecessary vectoring to the final approach course of a published instrument approach.

Radar separation must be provided from any preceding IFR aircraft until visual separation can be provided. The radar controller must continue flight following and traffic information until the pilot is instruced to contact the tower. The point at which an aircraft cleared for a visual approach is instructed to contact the tower will vary, depending on the runway in use, weather, etc., and it is determined by prior coordination between the tower and approach control. Ordinarily, the changeover occurs at least 5 miles from the runway. Changeover points should be far enough from the airport so that the tower controller can properly establish a landing sequence but not at a distance which may derogate the provision of radar traffic information.

If an arriving aircraft is not following a preceding arriving aircraft sequenced by approach control, it may be cleared for a visual approach when the following conditions exist:

1. The pilot of the aircraft concerned reports sighting the airport.

2. The tower controller is informed of the aircraft's position.

If the aircraft concerned is following a preceding arriving IFR or VFR aircraft sequenced

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by approach control, it may be cleared for a visual approach when the following exist:

1. The pilot of the succeeding aircraft reports sighting the preceding aircraft.
2. The tower controller is informed of the succeeding aircraft's position in the approach sequence.
3. The pilot of the succeeding aircraft is instructed to follow the preceding aircraft.

Aircraft may be vectored simultaneously to the traffic pattern for visual approaches to more than one runway or to the traffic pattern for visual approaches to one runway while aircraft are conducting a different type instrument approach to another runway provided that the applicable preceding conditional provisions for issuance of a visual approach clearance are adhered to and radar separation is maintained between IFR aircraft until at least one of the following conditions is met:

1. If parallel runways separated by less than 3,500 feet are in use, the pilot must have reported sighting the preceding IFR aircraft making an approach to the other runway and all aircraft involved must be informed that other arriving aircraft are using the other runway.
2. If parallel runways separated by 3,500 feet or more, or converging runways are in use, all aircraft involved must be informed that other arriving aircraft are using the other runway.

RADAR APPROACHES.—Prescribed or approved radar instrument approach procedures may be provided to any aircraft upon request and may be offered to aircraft in distress, regardless of weather conditions, or to expedite traffic.

The following information must be issued to aircraft that propose to conduct a radar approach:

1. Altimeter setting.
2. Ceiling and visibility if the ceiling is reported below 1,000 feet or below the highest circling minimum, whichever is greater, or if the visibility is less than 3 miles. When such conditions exist, all known changes which are classified as special weather observations must be transmitted as soon as the volume of traffic, controller workload, and communications frequency congestion permit.
3. Pertinent information on known field conditions if they are considered necessary to the safe operation of the aircraft concerned.
4. Lost communications procedures. When weather reports indicate an aircraft will likely encounter IFR weather conditions during the approach, lost communications instructions are issued as soon as possible after establishing radar identification and radio communications (this may be ommitted after the first approach when successive approaches are made and the instructions remain the same). Advise the pilot that if radio communications are lost for a specified time interval (not more than 1 minute) on vector to final approach, 15 seconds on a surveillance final approach, or 5 seconds on a precision final approach, one of the following actions should be taken:

a. Attempt contact on a secondary or tower frequency.
b. Proceed in accordance with VFR if possible.
c. Proceed with an approved nonradar approach.
d. Execute the specific lost communications procedure for the radar approach being used.

The pilot is responsible for determining the adequacy of lost communications procedures with respect to aircraft performance, equipment capability, or reported weather conditions. If a pilot should state that he cannot accept a lost communications procedure due to weather conditions or other reasons, the controller should request the pilot's intentions and take appropriate action.

If an aircraft on a radar approach proposes to execute a low approach or touch-and-go landing, climbout instructions including a specific heading and altitude must be issued before the aircraft commences final descent. If an aircraft is making a series of approaches, this type of instruction may be omitted after the first approach, provided that no change exists.

The pilot should be advised to perform cockpit check while the aircraft is on the downwind leg and in time to complete it before turning base leg. If an incomplete pattern is used, this instruction, must be issued prior to handoff to the final controller for a precision approach or prior to beginning descent on a surveillance approach.

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The following should be accomplished before the aircraft on a radar approach commences final descent:

1. Inform the pilot of the position of the aircraft at least once.
2. Inform the pilot of the type of approach (ASR or PAR), the runway to which the approach will be made, and, if appropriate, the airport.
3. Request the pilot to report wheels down and locked unless he has previously reported it.
4. Missed approach instructions should be issued according to the specific missed approach procedure approved for the radar approach in use.

A clearance must be obtained from the tower and relayed to the pilot for an aircraft on a radar approach to make a landing, touch-and-go, or low approach. Surface wind must be included with clearances for landing or touch-and-go. If such clearances are not received, the pilot should be informed and then issued instructions for an alternate course of action.

When directed by the control tower, instructions to execute a missed approach must be issued to the pilot of an aircraft on a radar approach. In such cases, or when the pilot initiates a missed approach, the missed approach should be monitored by the radar controller and advisories issued. Instructions that could be interpreted as a continuation of the approach must be avoided.

The pilot of an aircraft conducting a radar approach should be instructed to take over visually, execute the missed approach, or climb and maintain a specified altitude and fly a specified course, whenever the completion of a safe approach is questionable because one or more of the following conditions exists:

1. Safety limits are exceeded or radical target deviations are observed.
2. Position or identification of the aircraft is in doubt.
3. Radar contact is lost or a malfunctioning radar is suspected.
4. Field conditions or traffic preclude approach completion.

If radar contact is lost during an approach and the aircraft has not started on final approach, the aircraft should be cleared to an appropriate navaid for an instrument approach.

On a surveillance approach the controller provides navigational guidance in azimuth only. The pilot is furnished headings to fly to aline his aircraft with the extended centerline of the landing runway. Since the radar information used for a surveillance approach is considerably less precise than that used for a precision approach, the accuracy of the approach will not be as great and higher minimums will apply.

Guidance in elevation is not possible on a surveillance approach, but the pilot is given advance notice of where descent will begin, the straight-in minimum altitude/MDA for the approach, and instructions to begin descent when the aircraft reaches the descent point. Unless a descent restriction exists for the approach, the pilot is instructed to descend to minimum altitude/MDA at that point. If a restriction to the descent does exist, the prescribed restriction must be applied and the pilot is told to maintain a certain altitude until he is observed to have passed the altitude limiting point, after which he is instructed to descend to minimum altitude/MDA.

If recommended altitudes on final approach are requested by the pilot, they should be given down to the last mile which is at or above the published minimum altitude/MDA. The recommended altitudes are determined locally. For example, with a gradient of 300 feet per mile, add this value for each mile to the airport elevation and round it out to the nearest 100 feet.

The minimum altitude/MDA published for the approach procedure is applicable in determining the point at which recommended altitudes will be discontinued. For example, if the published MDA is 1,290 feet at an airport with an elevation of 970 feet MSL, altitude information is not given for the last mile because the recommended altitude of 1,270 feet would be below the MDA of 1,290 feet (300 plus 970 equals 1,270). Course guidance and the distance from the runway or touchdown (if using the azimuth portion of PAR) should be furnished the pilot each mile while the aircraft is on final approach. The pilot should be informed when his aircraft is on course and frequently informed when any deviation from the desired course is observed.

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published for the particular approach being executed or to be executed, a controller should take the following action:

1. Issue the weather report to each arriving IFR aircraft.
2. Request the pilot to state his intentions.
3. Issue approach clearance or other clearances or instructions as appropriate, according to the pilot's intentions and the traffic situation.
4. Qualify each landing clearance issued under these conditions with the phrase IF YOU HAVE LANDING MINIMUMS.

If the pilot of an arriving aircraft reports the weather conditions are below his landing minimums, a controller should take the following action:

1. Issue appropriate instructions to the aircraft to hold or proceed to another airport.
2. Adjust, as necessary, the position in the landing sequence of any other aircraft desiring to make approaches, and issue approach clearances accordingly.

Approach Monitoring

PAR equipment should be used to monitor approaches when the following conditions exists:

1. Whenever the reported weather is below basic VFR minimums.
2. When the navaid final approach course from the final approach fix to the runway coincides with the PAR final approach course.
3. When the final approach fix is within PAR coverage.

When approaches are being monitored, pilots of arriving aircraft should be informed of the frequency on which advisories will be transmitted if it will not be the same as the communications frequency used for the approach. No more than two aircraft or two flights of aircraft should be monitored simultaneously.

When issuing advisories, pilots should be informed when their aircraft are passing final approach fix. At that point the pilot may be instructed to report sighting the approach lights or the runway. The pilot should be advised if his aircraft is well left or right of course; and if conducting an ILS approach, he should be advised when well above or below the glidepath. If repeated advisories are issued and the aircraft is still proceeding outside the prescribed safety limits, the pilot should be advised to proceed visually or, if unable, to climb to a specified altitude and/or turn to a specific heading. Advisories may be terminated and the pilot concerned so informed when the pilot reports sighting the approach lights or the runway, or when the aircraft reaches the ILS middle marker or a point where the glidepath intercepts 200 feet elevation, whichever is nearer the landing threshold.

Practice Instrument Approaches

When requests for practice instrument approaches are received, controllers should take steps to determine the type of approach and how it will terminate, such as a touch-and-go, the missed approach maneuver, or a landing. When approving such requests, controllers should include instructions to conduct the entire approach in VFR conditions unless the aircraft is on an IFR flight plan and requests IFR separation. In addition, instructions are issued to report at a specific position for further clearance or abandon the approach.

Frequency and Beacon
Changes During Approaches

When military turbojet (except cargo and transport type) or A-1 type aircraft will conduct an instrument approach wholly or in part in IFR weather conditions or at night, an approach controller should take the following action:

1. Avoid radiofrequency and radar beacon changes to the maximum extent that communications capabilities and traffic conditions will permit. However, when changes are required, use the following procedures:

a. Instructions should be given early enough to allow the change before the aircraft reaches the approach fix or handoff point.
b. Frequency changes must be kept to a minimum below 2,500 feet above the surface and should be avoided during the time an aircraft is making a turn.

2. When the traffic volume requires, coordinate with the ARTCC and request that a frequency other than the one used by aircraft making approaches be used in transferring control of aircraft to the approach control facility.
3. A frequency common to both the GCA and approach control should be used for an approach, if practicable, to minimize frequency changes.

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4. When GCA is not able to communicate on a common frequency, a change to the GCA frequency may be authorized.

5. When a nonradar approach will be made, the pilot of the aircraft may be instructed to change to the tower frequency in the following instances:

a. The reported ceiling is at or above 1,500 feet and visibility is 5 statute miles or more.

b. The pilot reports that he is able to proceed by visual reference to the surface.

6. Radar beacon changes should be avoided after an aircraft begins a penetration/approach.

7. In the event of a missed approach, a frequency or beacon change should not be required before the aircraft reaches the missed approach altitude, MEA, or the minimum vectoring altitude.

Single Frequency Approaches

Where single frequency approach (SFA) procedures for single piloted turbojet aircraft on an IFR flight plan are contained in a Letter of Agreement, radiofrequency changes may not be required after the aircraft begins the penetration/approach, or after initial contact during an en route descent, until a landing or low approach has been completed, except under the following conditions:

1. During daylight hours while the aircraft is in VFR conditions.
2. On pilot request.
3. When the pilot cancels his IFR flight plan.
4. In an emergency situation.

Minimum Fuel

If a USAF, FAA, or USN jet aircraft declares a state of MINIMUM FUEL, a controller should inform any facility or controller to whom control jurisdiction is or will be passed of the minimum fuel situation. Facilities and/or controllers concerned must be alert for any occurrence which might delay the aircraft en route.

Use of the term MINIMUM FUEL indicates recognition by the pilot that his fuel supply has reached a state such that, upon reaching destination, he cannot accept any undue delay. This is not an emergency situation but merely an advisory that indicates an emergency situation is possible should any undue delay occur. Common sense and good judgment will determine the extent of special handling to be given in such situations.

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the delay line. Channel 3 will receive its input still later in time than channel 2. This process will continue so that channel 10 will receive its input last because the delay line in its input offers the largest amount of delay.

Channel 1, since it received the frequency spectrum first, will produce an output first. Channel 1 is tuned to 95.5 mc, and has a 1 megacycle bandwidth, so it will produce in its output only that part of the spectrum from 95 mc to 96 mc. The frequency to first appear at the output of channel 1 will be the lowest frequency within the bandwidth of the tuned amplifier. This is because the lowest frequency receives the greatest phase or time advance because of X_L of the tank circuit at that frequency. The last frequency to leave channel one will be the highest frequency within its bandwidth. This frequency receives the most time or phase delay because of X_C of the tank circuit to that frequency. Each of the remainder of the 3,300 frequencies will be either advanced or retarded by a lesser amount, so that the time required for channel 1 to reproduce all 3,300 frequencies will be 1 μsec.

As channel 1 is finishing its output waveform, channel 2 is just receiving the spectrum at its input (because the spectrum was delayed 1 μsec by the delay line). Channel 2 is resonant to 96.5 mc, has the same 1-mc bandwidth, and will reproduce that part of the spectrum from 96 mc to 97 mc. The lowest frequency within the bandwidth of channel 2 will be reproduced first because it receives the greatest advance by X_L. The highest frequency will be reproduced last because it is delayed by X_C. Channel 2 will require 1 μsec to produce its full 1-mc output. Two μsec in time have now elapsed.

As channel 2 finished producing its output, channel 3 receives the frequency spectrum at its input through the 2-μsec delay line. Channel 3 picks up in frequency where channel 2 left off and provides another 1-mc part of the output for a period of 1 μsec.

This process continues until channel 10 receives the frequency spectrum at its input after being delayed by the 9-μsec delay line. It then produces the tenth part of the total output waveform which is resonant from 104 mc to 105 mc. It is also 1 μsec wide.

The lowest frequency of channel 1 (95 mc) is produced, and 10 μsec later, the highest frequency of channel 10 (105 mc) is produced. This is shown in figure 15-19.

Each of the 10 channels output waveforms will be combined in the summing amplifier to produce the waveform shown in figure 15-19. This waveform sweeps a 10-mc band of frequencies during a time of 10 μsec with a linear change of 1 mc/1-μsec. This type of waveform is called a linear frequency modulated pulse. The matched filter which produces this type of waveform is called a LIFMOP filter being coined from LInear Frequency MOdulated Pulse. This LIFMOP waveform contains approximatedly 33,000 different frequencies, each one being in a very definite time and phase relationship to the others.

The output from each channel must be equal in amplitude. To insure equal amplitudes from each channel, an oscilloscope is connected to

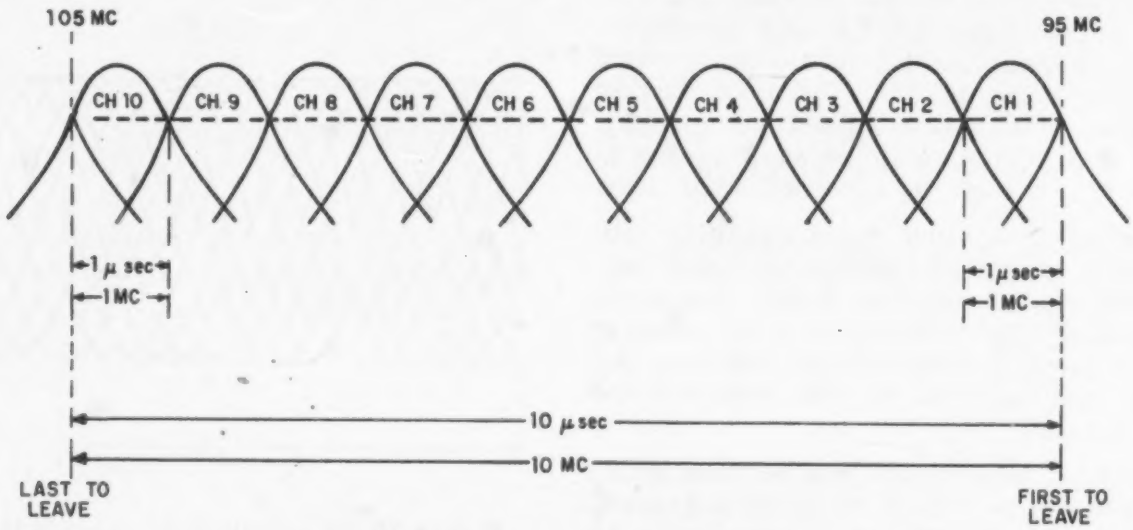

Figure 15-19. —Summing amplifier output.

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CHAPTER 6

EMERGENCY PROCEDURES

Emergency procedures cannot always be prescribed for every situation which might be considered an emergency because of the infinite variety of possible situations. As a rule of thumb, an emergency includes any situation which places an aircraft in danger, uncertainty, alert, lost or distress. When it is believed that an emergency exists or is imminent, an air traffic controller must select and pursue a course of action which appears to be most appropriate under the existing circumstances. The decision as to what type of assistance is needed is based on requests and information received from the pilot, because he is authorized by FAR 91 to determine his course of action.

EMERGENCY ASSISTANCE

Maximum assistance must be provided aircraft in distress. This includes services of available radar facilities, military, FAA, and FCC DF facilities, and emergency services that may be available at or from these facilities.

If a controller is communicating with an aircraft in distress, he is the one who should handle the emergency and coordinate and direct the activities of assisting facilities. This responsibility should be transferred to another controller or facility only when it is determined that better handling of the emergency will result.

Information received about aircraft in distress should be forwarded in detail to the center in whose area the emergency exists, even VFR traffic. Logically this would mean en route traffic, not local traffic around your station. You may have to coordinate the efforts to assist any aircraft believed in distress either between facilities or between the aircraft and a facility.

Should your facility receive a request for information concerning an ALNOT from the tie-in FSS, a thorough search of the records is necessary to determine whether the aircraft has contacted or landed at your facility. No one can say which little piece of information may be the missing link or a key to the location of a downed aircraft.

A course of action determined appropriate for an emergency situation must be implemented as soon as enough information has been obtained to act upon. What is considered a minimum amount of information will naturally vary according to the situation; however, the following may be considered as a minimum for an inflight emergency:

1. Aircraft identification and type.
2. Weather, as reported by the pilot.
3. Nature of emergency.
4. Aircraft altitude/FL.
5. Pilot's desires.
6. Fuel remaining, in terms of time.

After initiating emergency assistance procedure, and if the nature of the situation allows, the following information is desirable and may be obtained from the pilot as necessary and as time permits:

1. Pilot capability for IFR flight.
2. Time and place of last known position.
3. Heading since last known position.
4. Airspeed.
5. Point of departure and destination.
6. Navaid equipment capability.
7. Navaid signals being rceived.
8. Visible landmarks.
9. Aircraft color.
10. Number of people on board.
11. Emergency equipment on board.

When providing emergency assistance, it may be best to keep the aircraft on the initial

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contact frequency. Even though 121.5 and 243.0 MHz are available as emergency frequencies, their use is not mandatory. A frequency change for an aircraft in distress should be made only if there is a valid reason.

Aircraft orientation is of primary importance to the pilot of an aircraft that is lost or uncertain of his position. The initial phase of assistance to pilots in such situations will probably be some method of locating the aircraft such as radar, DF, navaids, landmarks, or sighting by other aircraft.

When considered necessary, and provided that the weather permits, a controller could recommend that the pilot maintain or increase altitude to improve communications, radar, or DF reception.

OVERDUE AIRCRAFT

An IFR aircraft is considered overdue when neither communications nor radar contact can be established with it and 30 minutes have passed after its ETA over a specified reporting point or clearance limit.

An aircraft on a combination VFR/IFR or air filed IFR flight plan is considered overdue when 30 minutes have passed since the pilot requested IFR clearance and neither communications nor radar contact can be established with it.

A VFR aircraft is considered overdue when communications cannot be established and it fails to arrive 30 minutes (15 munutes for jets) after its ETA.

EMERGENCY SITUATIONS

An emergency situation may be considered to exist, and the center should be notified immediately, when any of the following conditions exist:

1. An emergency is declared by either the pilot, facility personnel, or officials responsible for the operation of the aircraft.

2. Reports indicate that an aircraft has made a forced landing, is about to do so, or its operating efficiency is impaired to the extent that a forced landing will be necessary.

3. Reports indicate that the crew has abandoned or ditched the aircraft or is about to do so.

4. An emergency radar beacon (SIF) response is received on radar.

5. Intercept or escort aircraft services are required.

6. The need for ground rescue appears likely.

7. A left or right turn triangular pattern is observed on radar.

8. A series of four chaff drops followed by a series of 360° turns is observed on radar.

INFORMATION FORWARDED TO ARTCC

When an aircraft is considered to be overdue or in an emergency status, ARTCC must be alerted and forwarded the following information, as available:

1. Flight plan including the color of the aircraft if known.

2. Time of last transmission received, by whom, and the frequency used.

3. Last position report and how it was determined.

4. Action taken by the reporting facility and the proposed action.

5. Number of persons on board.

6. Fuel status.

7. Facility working the aircraft and the frequency being used.

8. Last known position, estimated present position, and maximum range of flight of the aircraft based on the remaining fuel on board and the airspeed.

9. Position of other aircraft near the distress aircraft's route of flight when requested.

10. Other information the controller deems pertinent.

Position Plots

The facility working the distress aircraft should plot the flight path of the aircraft on a chart, including position reports, predicted positions, possible range of flight, and any other pertinent information. The assistance of other aircraft known to be operating near the distress aircraft may be solicited. This information should also be forwarded to ARTCC.

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RADIO COMMUNICATIONS FAILURE

Communications failure action should be considered for both an aircraft and a facility. In case of the latter, most Navy facilities have backup or emergency radio equipment plus standby or auxiliary power supplies. This system does not eliminate the possibility of a facility communications failure but reduces it to improbable. However each facility should develop an internal plan to follow in the event part or parts of the backup system do not function as designed. The AC1 or Chief may be involved in the planning or actual construction of a plan of action to reestablish communications with aircraft under control of a facility if such an emergency should arise.

Aircraft communications failures with modern, reliable equipment are uncommon, but since it is a possibility, advanced planning and training is necessary to effectively handle such a situation should it arise. When an aircraft experiences two-way communications failure, air traffic control is based on anticipated pilot actions. Pilot procedures and recommended practices are set forth in FAR's, the Airman's Information Manual, and pertinent military instructions. For information, FAR 91.127, "IFR Operations; Two-way Communications Failure" is quoted as follows:

1. Unless otherwise authorized by ATC, each pilot who has two-way radio communications failure when operating under IFR shall comply with the rules of FAR 91.127.

2. VFR conditions. If the failure occurs in VFR conditions, or if VFR conditions are encountered after the failure, each pilot shall continue the flight under VFR and land as soon as practicable.

3. IFR conditions. If the failure occurs in IFR conditions, or if the provisions of the preceding paragraph cannot be complied with, each pilot shall continue the flight according to the following:

a. Route.

(1) By the route assigned in the last ATC clearance received;

(2) If being radar vectored, by the direct route from the point of radio failure to the fix, route, or airway specified in the vector clearance;

(3) In the absence of an assigned route, by the route that ATC has advised may be expected in a further clearance; or

(4) In the absence of an assigned route or a route that ATC has advised may be expected in a further clearance, by the route filed in the flight plan.

b. Altitude. At the highest of the following altitudes or flight levels:

(1) The altitude or flight level assigned in the last ATC clearance received;

(2) The minimum altitude (converted to minimum flight level if appropriate) for IFR operations; or

(3) The altitude or flight level ATC has advised may be expected in a further clearance.

c. Climb. When it is necessary to climb in order to comply with the preceding paragraph, the following applies:

(1) Climb to the assigned altitude or flight level in accordance with the last ATC clearance received;

(2) Climb to the minimum altitude for IFR operation at the time or place necessary to comply with that minimum; or

(3) Climb to the altitude or flight level ATC has advised may be expected in a further clearance at the time or place included in the expect-further-clearance.

d. Leave holding fix. If holding instructions have been received, leave the holding fix at the expect-further-clearance time received, or, if an expected-approach-clearance time has been received, leave the holding fix in order to arrive over the fix from which the approach begins as close as possible to the expected approach clearance time.

e. Descent. Begin descent from the en route altitude or flight level upon reaching the fix from which the approach begins, but not before—

(1) The expect-approach-clearance time (if received); or

(2) If no expect-approach-clearance time has been received, the estimated time of arrival, shown on the flight plan, as amended with ATC.

CONTROL ACTION

Although SAR is not limited to aircraft incidents the restrictive nature of this training manual limits this discussion to subject matter concerning air traffic control. AC's by virtue

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of their job of keeping track of each aircraft operation may be the first to suspect an emergency situation. In nearly every instance, a timely alert to the appropriate SAR facility or organization is an essential contribution to a successful mission.

Each ship or station has its own crash and rescue bill which the AC1 or Chief may be involved in drafting, updating, or revising. This bill is a collection from various publications of the necessary information and action required locally. This bill is included as part of the local Air Operations Manual and is the guideline to be followed by AC's in the command during an actual incident on or near the station and in training junior or new personnel.

Flight Service Stations serve as the central points for collecting and disseminating information on overdue or missing aircraft which are not on an IFR flight plan.

Centers serve as the central points for collecting information, for coordinating with SAR, and for conducting a communications search by distributing any necessary ALNOT's concerning:

1. Overdue or missing IFR aircraft.
2. IFR aircraft in an emergency situation occurring in their respective areas.
3. Overdue or missing aircraft which have been authorized to operate in accordance with special VFR.

For more information on action taken by the appropriate facility for overdue or missing aircraft, refer to AC 3 & 2, NavPers 10367-D, chapter 3.

Traffic Restrictions

Unless radar separation is used, when an IFR aircraft is unreported, the facility responsible must restrict or suspend other IFR traffic for 30 minutes after whichever of the following times is applicable:

1. The time at which approach clearance was delivered to the pilot.
2. The expected approach clearance time delivered to the pilot.
3. The arrival time over the navaid serving the destination airport.
4. The current estimate—either the control facility's or the pilot's, whichever is later—at the navaid serving the destination airport.

Lighting Requirements

The runway lights, approach lights, and all other required airport lighting systems must be operated for at least 30 minutes before the ETA of the unreported aircraft until the aircraft has been located or until 30 minutes after its fuel supply is estimated to be exhausted.

Traffic Resumption

After the 30 minute traffic suspension period has expired, normal air traffic control may be resumed if the operators or pilots of other aircraft concerned agree.

Communications Failure

The following action, as appropriate, may be taken if two-way radio communications is lost with an aircraft:

1. Broadcast clearances through any available means of communications including the voice feature of navaids.

2. Attempt to reestablish communication by requesting the pilot of the aircraft to use his transponder or make turns to acknowledge clearances and answer questions. Consider the following possibilities using the transponder:
   a. Request the pilot to reply Mode A/3 IDENT.
   b. Request the pilot to reply on an identification code (1200 or 2200).
   c. Request the pilot change to STANDBY for a sufficient length of time for the controller to be sure that the lack of target is the result of the requested action.

3. Broadcast a clearance for the aircraft to proceed to its filed alternate airport at the MEA, if the aircraft operator concurs.

VFR AIRCRAFT IN WEATHER DIFFICULTY

If the pilot of a VFR aircraft should request assistance when he is about to encounter IFR weather conditions, he should be instructed to contact the appropriate facility responsible for the area concerned. If your facility is not the control facility and the pilot advises he is unable to contact the control facility, you may be required to relay information and clearances necessary to assist the VFR aircraft.

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At radar facilities, if VFR traffic requests radar assistance when encountering or about to encounter IFR weather conditions, the controller should first determine if the pilot is capable and qualified for IFR flight. If the pilot is qualified for IFR, he should be requested to file an IFR flight plan after which a clearance may be issued after coordination with the necessary facility. If it is determined that the pilot is not qualified or capable of IFR flight, then the following actions as appropriate should be taken:

1. Inform the pilot of airports where VFR conditions are reported, provide other available pertinent weather information, and determine if the pilot will elect to conduct VFR flight to such an airport.

2. If the pilot does not elect to proceed to an airport as described in the preceding paragraph, radar assistance should be provided if the pilot declares an emergency or if the controller can determine the exact nature of the radar service the pilot desires.

3. If the aircraft has already encountered IFR conditions, the pilot should be informed of the minimum safe altitude. If the aircraft is below the minimum safe altitude and sufficiently accurate position information has been received or radar identification is established, a heading may be furnished on which to climb to reach minimum safe altitude.

Assistance Techniques

When providing radar assistance to a pilot not qualified to operate in IFR conditions, the following techniques should be used to the extent possible:

1. Avoid radio frequency changes except when necessary to provide a clear communications channel.
2. Turns should be made when the aircraft is in VFR conditions so it will be in a position to fly a straight course when in IFR conditions.
3. The pilot should be instructed to lower the landing gear and slow the aircraft to approach speed while in VFR conditions.
4. Requiring a climb or descent while in a turn and in IFR conditions should be avoided.
5. Abrupt maneuvers should be avoided.
6. Vector such aircraft to VFR weather conditions if possible.

LOCATOR BEACON SIGNALS

Some aircraft and/or occupants carry locator beacons of various types which are independently powered devices emitting a distinctive tone for homing purposes on 121.5 and/or 243.0 MHz. Several types of signals are produced by these beacons such as a beep beep, or a warbling or steady tone. The latest Navy equipment provides for two-way radio communication. Since the emergency signal from a locator beacon may only be heard for a short period of time, quick action is essential.

When a locator beacon signal is heard or reported the following steps are recommended:

1. Attempt to obtain a bearing on the signal.

2. Notify the DF net control.

3. Forward bearings and any other pertinent information to the DF net control.

DIRECTION FINDER SERVICE

Providing practice DF steers or approaches to aircraft that are operating normally and in accordance with VFR might be considered a relatively simple matter. The only real action required is to provide the necessary headings for the pilot to comply with to accomplish the desired operation. On the other hand, an emergency situation or IFR operation can complicate the procedure somewhat requiring the controller to provide information to insure proper terrain clearance, proper position relative to controlled airspace, and possibly a complete instrument approach plus coordination with other facilities and separation from other traffic.

To assist controllers, certain guidelines may be established to identify the steps necessary when providing DF service to an aircraft in emergency as follows:

1. It should be determined if the aircraft concerned is on a flight plan, whether it is in VFR or IFR weather conditions, the amount of fuel remaining, its altitude/FL, and heading.

2. If it is determined that the aircraft is not on an IFR flight plan and is in VFR weather conditions, the pilot should be advised to remain in VFR conditions.

3. If it is determined that the aircraft is operating in IFR weather conditions, the pilot should be informed of the minimum safe

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altitude and the controller must coordinate with the appropriate control facility for the purpose of separation from other IFR traffic and flight progress information if the aircraft in distress is operating in accordance with an IFR clearance.

4. The DF net control should be alerted if the pilot declares an emergency or is lost, even though the aircraft may be radar identified (unless the aircraft is sighted visually). This will provide for capability of cross checks and continued assistance under almost any conditions such as radar failure or loss of radar target due to altitude, etc.

Generally speaking, a DF net's area of coverage would be an ARTCC's area of responsibility (flight advisory area) with the ARTCC as net control. However, the ARTCC may designate any DF station as DF net control and if a center's area includes two DF nets, a control station for each would be designated. When alerted by a station of an emergency which may require DF assistance, the center or net control, as appropriate, can further alert those DF stations within the network which may be required to assist. The DF station having primary responsibility for radio communications with the distress aircraft would be considered the primary station and all other DF stations on the net remain silent on the frequency in use. Whenever possible, radar identification of the distressed aircraft should be accomplished. All courses received from the DF stations are plotted on a plotting board to establish a fix. A minimum of two DF courses are required to form or establish a fix. However, one station can determine a no-wind position of the aircraft by the time or distance method of determining position in relation to a DF station expressed in terms of miles or minutes from the station. For more detailed information on operation and procedure for direction finding, refer to NavPers 10367-D, AC 3 & 2, chapter 4.

Under emergency conditions where a standard instrument approach cannot be executed, an instrument approach based on DF guidance may be provided. DF approaches are established at some facilities for this purpose in the same manner as TACAN and radar approaches. These procedures are described in the TERP's handbook. Generally a teardrop type approach is used for low altitude operations and a triangle type approach for high altitude operations. Both types consist of an outbound leg, turn(s), and an inbound leg with an angular difference of 45° from the reciprocal of the outbound course. The triangle type procedure includes a base leg before turn to final. Both lost communications procedure and missed approach procedure instructions must be issued to the pilot of an aircraft being provided a DF approach. Generally, the approach criteria for DF approaches is the same as that for ADF approach procedures. The minimums established must provide obstruction clearance in the final approach area and the circling approach area per category of aircraft. Since DF navigation is based on communications, maximum intervals between contacts for a published DF approach have been specified, as follows: while the aircraft is en route to the station prior to initial approach, 60 seconds; from initial approach fix to within an estimated 30 seconds from final station passage or missed approach point, 15 seconds; when 30 seconds or less from final station passage or missed approach point, 5 seconds.

EMERGENCY AIRPORT RECOMMENDATION

A controller handling an aircraft in distress may decide to recommend an emergency airport to the pilot. Such a decision may be reached after several essential conditions are considered, as follows: remaining fuel in relation to the distance to the recommended airport; the existing weather conditions both en route and at the recommended airport; airport conditions, such as runway length and weight capacity; navaid status; type of aircraft and pilot qualifications versus actual operation necessary to get to and land at the recommended airport; and radar vectoring, DF guidance, or homing capability to the emergency airport recommended.

When such a recommendation is made and accepted by the pilot of the distressed aircraft, every conceivable means of guidance to the emergency airport must be considered and used if necessary, including radar, DF, following another aircraft, pilotage by landmarks, or compass heading.

SEARCH AND RESCUE

Search and Rescue (SAR) is defined as the employment of available personnel and facilities

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in rendering aid to persons and property in distress. The development of the SAR concept as a planned undertaking is of fairly recent origin, although the recognition of the moral obligation to assist persons in distress dates back to ancient times. The rescue of military, personnel is an integral and important part of military operations. The armed forces have traditionally accepted, to the extent practicable a moral or humanitarian obligation to aid non-military persons and property in distress. This has been further implemented by the National SAR Plan.

The National SAR Plan assigns search and rescue responsibility as follows:

1. To the military agencies—Conducting physical search and rescue operations.

2. To the FAA—

a. Providing emergency service to aircraft in distress.

b. Assuring that SAR procedures will be initiated if an aircraft becomes overdue or unreported. This is accomplished through the ATC system for IFR aircraft and the VFR flight plan service provided by Flight Service Stations for VFR aircraft.

c. Attempting to locate overdue or unreported aircraft by INREQ and ALNOT communications search.

d. Cooperating in the physical search by making all possible facilities available for use of the searching agencies.

Under the National Search and Rescue Plan the facilities of all these agencies, as well as those of the Navy, are integrated into a single SAR network to provide maximum efficiency and economy in the prosecution of any SAR mission. The U.S. Coast Guard is responsible for coordination of search and rescue for the Maritime Region, and the U.S. Air Force is responsible for coordination of search and rescue for the Inland Region. In order to carry out this responsibility, the Air Force and Coast Guard have established Rescue Coordination Centers to direct search and rescue activities within their regions. This service is available to all persons and property in distress, both civilian and military. Normally, for aircraft incidents, information will be passed to the Rescue Coordination Centers through the appropriate Air Route Traffic Control Center.

DEVELOPMENT OF SAR

The rescue of personnel in distress has become an integral and important part of naval operations. The primary objective of SAR is to save the lives of personnel in distress. It applies principally, but is not restricted to, the rescue of personnel of the Armed Forces of the United States and its allies. Successful SAR operations not only have a beneficial effect on the morale of fighting forces when a life is saved, but also aid in preserving the strength of the Armed Forces by retrieving its highly trained personnel.

The present-day concept of SAR is an outgrowth of the Air Sea Rescue Plan inaugurated by the U.S. Coast Guard in 1939. The plan became subject to expansion and additional development as a result of the U.S. Navy's role in World War II. The Navy, then engaged in operations extending over vast areas of the earth's water surface, found it necessary to develop standardized procedures for the search and rescue of its own downed air personnel and survivors of ships damaged or sunk by enemy action.

To accomplish the SAR mission, suitable surface ships and aircraft were periodically placed under the tactical command of a rescue task group commander in the area of operations. Submarines were also detailed to these missions as requested by the tactical commander. As the war progressed and the magnitude of naval operations increased, these SAR missions assumed greater importance. It became apparent that the employment of specially trained and equipped units specifically assigned to SAR duties could relieve other units of these operations which interfered with their primary missions. This procedure, when instituted, resulted in greater effectiveness on the part of all units in the performance of their respective duties.

When reports of survivors' experiences were studied, it also became apparent that additional survival equipment was needed, particularly equipment which permitted survivors themselves to assist the searchers. As a result, such items as the self-inflating liferaft, the emergency signal mirror, emergency radio transmitters, and various pyrotechnic distress signals were developed.

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INTERAGENCY COORDINATION

In time of peace, it is incumbent upon the U.S. Navy to take full advantage of the SAR techniques developed and facilities operated by the U.S. Coast Guard. The reason for this is that the U.S. Coast Guard is charged with the development, establishment, maintenance, and operation of aids to maritime navigation and rescue facilities which promote safety on and over the high seas, and waters subject to the jurisdiction of the United States. The Coast Guard, under its responsibilities, may render aid to persons and protect and save property at any time at any place where its facilities and personnel are available.

As a result, operational commands of the U.S. Navy may delegate to the Coast Guard such SAR functions as duties of the SAR Commander and other functions that may be jointly agreed upon by the respective commands. However, before these functions are given to the Coast Guard, full consideration must be given to the adequacy of Coast Guard facilities and other responsibilities imposed upon that service by laws. In addition to using Coast Guard SAR facilities, naval commands cooperate fully, when requested, in assisting the Coast Guard in the execution of its functions. Navy commands also keep Coast Guard commands in the area of their operations informed in detail on their SAR requirements and provide logistic assistance as requested by Coast Guard SAR operations. The extent of this assistance is governed by existing instructions and the availability of facilities and equipment.

In wartime, the Coast Guard operates as a specialized service within the naval establishment, and its responsibilities for SAR are subject to orders of the Secretary of the Navy.

The U.S. Army and the U.S. Air Force maintain SAR facilities for use in support of their own operations. The Federal Aviation Administration (FAA) of the Federal Government has broad statutory responsibility in the field of air safety. In addition, the FAA has air traffic control and communications facilities available for SAR purposes. AC 3 & 2, NavPers 10367-D, chapter 3, outlines facilities and procedures used by FAA in connection with SAR. Other federal agencies, such as the Federal Communications Commission (FCC), cooperate in SAR operations.

COMMAND AND ORGANIZATION

COMMAND PROVIDES THE AUTHORITY for the control of forces and facilities attached to SAR, while ORGANIZATION PROVIDES THE MEANS—the personnel, techniques, and procedures—necessary to carry out the mission. Command authority for a designated area or region is usually vested in one person, the SAR Coordinator. It is his responsibility to provide the organization and insure that it functions efficiently. This is achieved through the formation of the Rescue Coordination Center (RCC) and the training of assigned personnel in all operational aspects of SAR.

Authority and Responsibility of the SAR Coordinator

Responsibility for SAR is divided into several classifications, each containing certain definite assignments for SAR. Thus, commands to whom the primary responsibility has been assigned have greater duties to perform than do commands which have been assigned secondary support or informational responsibility. In spite of the division of SAR responsibility among commands, all hands possess a basic responsibility to take part in SAR operations, at any time, with or without prior direction.

Any commander responsible for SAR may designate a SAR Coordinator for his area of responsibility. In making that designation the command should be guided by the availability of facilities, the nature of SAR operations normal to the area or sphere of action, and any special qualifications of the officers under consideration.

The person directing a specific SAR mission is known as the SAR Mission Coordinator.

In general, the duties of the SAR Coordinator involve establishing operationally efficient RCC's, staffed with competently trained men and actively linked with other centers in neighboring areas or services. He must be prepared to provide all-out assistance in SAR missions, to assume tactical responsibility, to control surface and air unity in any SAR operation under his direction, and to direct or coordinate rescue operations.

The SAR Coordinator has operational control of all primary facilities assigned to him

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for SAR purposes. Submarines, whether primary or secondary SAR facilities, remain under the operational control of submarine force commanders. Commands exercising operational control, or higher authority, may assign secondary facilities to the SAR Coordinator for operational control for a specific incident. He coordinates the activity of all units participating in SAR incidents within the area of his responsibility, effecting coordination of all other units with those under his operational control. Coordination is to be exercised through the normal chain of command. Rescue commanders of forces afloat coordinate SAR activities incidental to the operation of these forces, regardless of the area of operation, unless other plans are mutually agreed upon by the commander of the forces afloat and the command with primary SAR responsibility in the area of operations.

At times it may be necessary for the SAR Mission Coordinator to designate an on-scene commander. An on-scene commander controls SAR operations at the scene of a distress incident when control of the mission cannot be exercised effectively by the SAR Mission Coordinator. This loss of effective control may be due to the distance between the Rescue Coordination Center (RCC) and the scene of the incident, or due to communications difficulties. The commander of the first unit at the scene to be in communication with the craft in distress, with other SAR forces, or with the RCC, assumes on-scene command until an on-scene commander has been designated by the appropriate SAR Mission Coordinator.

To provide continuity of command, any officer who is senior to the on-scene commander and who arrives subsequently is not to take over command of operations unless ordered to do so by the SAR Mission Coordinator, or unless the senior officer present decides that a change of command is essential, and so informs the SAR Mission Coordinator.

If the on-scene commander is airborne, he retains control of the mission until relieved, either by the Mission Coordinator or by mutual agreement with an adequately equipped surface craft. The SAR Mission Coordinator must be informed accordingly.

Formal designation of an on-scene commander or any change in that designation is promulgated by the SAR Mission Coordinator to all concerned.

Rescue Coordination Center (RCC)

The RCC is the heart of SAR operations. It is the place from which SAR operations are controlled and where reports of operations are received and evaluated. The primary aim of all efforts in the RCC is to conclude all rescue missions successfully and promptly. The RCC's are established by the SAR Coordinator.

RCC's may be based ashore or afloat. Where practicable, they should be located in or near an operation or information center. The RCC afloat is normally located in Air Operations. Ashore, it may be located in or adjacent to a command or information post. Wherever it is located, the RCC should have ready access to a control room, surface and air plots, communications facilities, navigational aids, direction-finding facilities, and meteorological services.

It is the responsibility of the RCC to perform the following:

1. Receive and evaluate all reports of distress.
2. Direct or coordinate the search for and rescue of survivors, keeping all interested commands and operating agencies (including the survivor's parent ship or base) fully informed, as appropriate.
3. Plot positions of all distress incidents and the tracks of all assisting aircraft.
4. Keep informed of weather, sea conditions, and other factors affecting rescue.
5. Undertake arrangements necessary for the return of rescued personnel to their ship or base.
6. Maintain a status board showing all primary rescue facilities.
7. Maintain information on secondary facilities available.
8. Guard assigned radio communications circuits.

An RCC is a primary SAR facility suitably staffed by supervisory personnel and equipped for coordinating and controlling SAR operations. RCC's vary with the physical location and the regional level on which they are operated, but all should have the common element of centralized communication and

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coordination. RCC's should be staffed with RCC controllers capable of acting as SAR Mission Coordinators.

SAR facilities available to RCC's are classified as primary and secondary.

PRIMARY facilities may include the following:

1. Specially equipped air and surface craft maintained in constant readiness for full-time SAR duties.
2. Other craft, including submarines, specifically assigned to SAR.
3. Ground units specially equipped and maintained in constant readiness.
4. Meteorological forecasting and advisory services.

SECONDARY facilities may include the following:

1. Local military land-based aircraft and surface craft.
2. Other aircraft suitable for SAR missions.
3. Any military facility.
4. Merchant ships, private vessels, and civilian aircraft.
5. Other means available to local authorities.

Full information concerning any significant change in the status or location of primary facilities established for and used by SAR agencies should be given widest possible dissemination by the SAR Coordinator, the SAR Mission Coordinator, or the agency concerned.

AUTOMATED MERCHANT VESSEL REPORT SYSTEM

The Automated Merchant Vessel Report System (AMVER) is an international maritime mutual assistance program. It provides important aid to the development and coordination of search and rescue efforts in the offshore ocean areas of the world during marine and aviation emergencies. Merchant ships of all nations are encouraged to voluntarily send sailing and position reports during offshore passages to the AMVER Center in New York through cooperating radio stations made available by participating countries. Information from these and meteorological reports is entered into the AMVER electronic computer which generates and maintains dead reckoning positions for the participating ships. Characteristics of ships which are valuable for determining search and rescue capability are also stored in the computer. Information concerning predicted locations and characteristics of ships plotted near the scene of an actual or potential emergency is made available to recognized SAR agencies of any nation or person in actual or potential distress for use during an emergency. Predicted positions and identification of ships are disclosed only for reasons related to maritime safety.

Surface Pictures

The basic service provided for use during emergencies is the Surface Picture (SURPIC). A SURPIC is a list of ships with SAR characteristics predicted by the computer to be within a specified geographical region at a specified time, present or future. SURPIC's are useful to aircraft commanders during an alert or emergency situation by assisting in making contingency plans in case the situation should deteriorate rapidly into a distress and a ditching become imminent.

Network of Precautionary Trackline SURPIC's in the Pacific Region

Because of the special nature of the long overwater flights in the Pacific and Indian Oceans and the associated lack or remoteness of regular SAR facilities, special services have been provided to aviation for many years by several countries. Positions of ships participating in weather reporting schemes were used to predict future locations and this information was provided to flight briefing officers by the cognizant civil aviation authority. In the United States Pacific Maritime region this service was called SAR Plan ALFA. The AMVER system has replaced Plan ALFA and has begun providing additional precautionary trackline SURPIC's to rescue centers and international flight service stations throughout the north and south central Pacific for major international flight routes. Additional routes will be added as the AMVER plot is developed in the more remote areas.

The precautionary trackline SURPIC's are predicted for a future mean time and distributed to briefing points by governmental communications networks. Copies of the SURPIC's

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observe the output of the summing amplifier. The amplitude adjustment (screwdriver adjustment) is set on each channel so that the output from each amplifier is equal in amplitude. With the oscilloscope connected to the same point, the frequency adjustment, (a technician's adjustment) is set so that the output of each amplifier coincides with the output of the amplifiers on either side of it with no interruption of the pulse. When any of the amplifiers are changed, both of these adjustments must be performed.

This LIFMOP waveform may be transmitted at these frequencies, or it may be passed through frequency converters to increase the frequency to whatever is desired to be transmitted. It will normally be amplified by several RF amplifiers prior to being transmitted. These RF amplifiers, of necessity, have a very broad bandwidth and linear frequency response to avoid any type of distortion of the LIFMOP waveform. The waveform shown in figure 15-19 leaves the summing amplifier with some amplitude variations. It is desirable that the transmitted waveform have no variations of amplitude. Normally, the waveform will be passed through a limiter prior to transmit to remove these amplitude variations.

The transmitted pulse will be rectangular, swept in frequency over 10 mc, and 10 μsec in duration. It is composed of the combined outputs of all 10 filters.

PULSE COMPRESSION

This operation is basically the inverse of pulse expansion. That is when a 10-μsec target return is received, it is compressed so that the receiver output is a 0.1-μsec echo.

Echo Return from a Target

For discussion purposes assume that a target is located a distance from the receiving antenna so that a 100-μsec of travel time will be required for the return echo to reach the receiver antenna. The lowest frequency was the first to leave the transmitter, and the first to strike the target; thus, the lowest frequency will be the first to be picked up by the receiving antenna. (It will be returned 100-μsec after it strikes the target.) The highest frequency transmitted did not leave the transmitter until 10 μsec later. It did not strike the target until 10 μsec after the lowest frequency struck the target. Therefore, it was not returned to the receiving antenna until 10 μsec after the lowest frequency was received. Refer to figure 15-20.

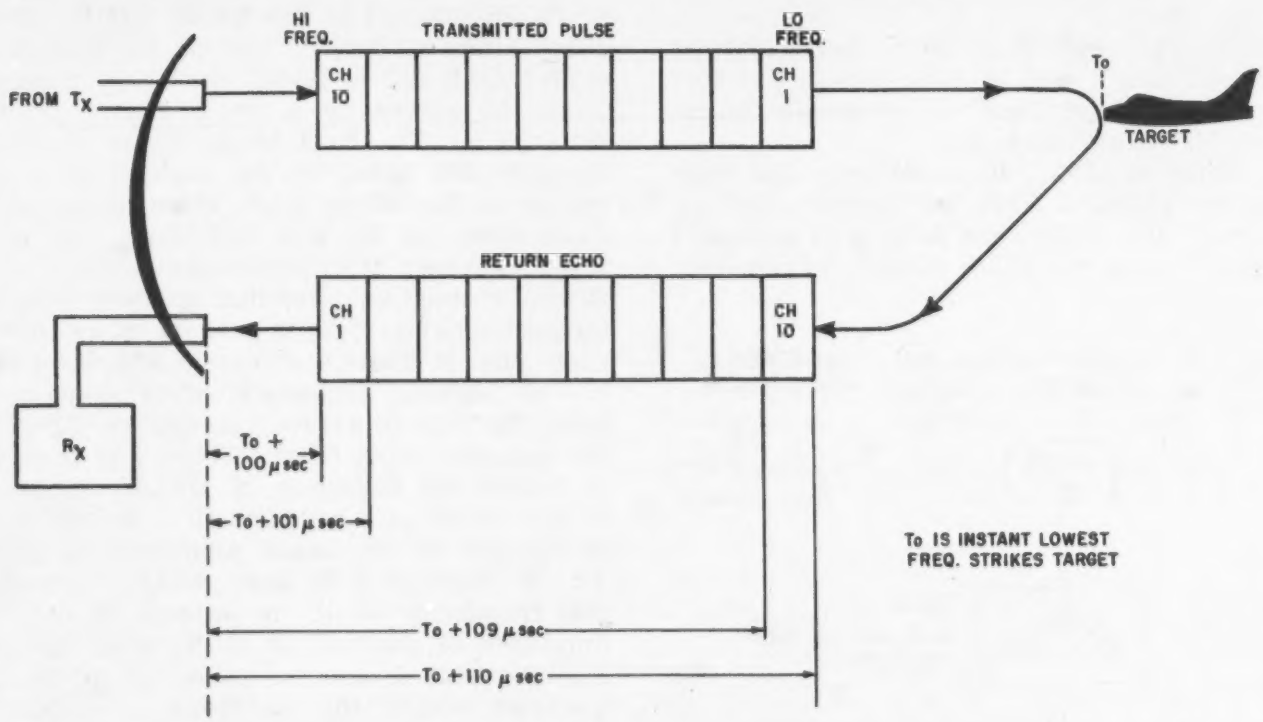

Figure 15-20. —Time function of transmitted pulse.

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are normally made available by the briefing station for inclusion in the preflight briefing kit. The aircraft commander can easily calculate the approximate position of ships of interest for the time estimated abeam and place the information on the navigation chart.

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CHAPTER 7

CVA/CVS PROCEDURES

As defined by naval regulations, the Operations Officer of an aircraft carrier is responsible for the control of airborne aircraft operating from the carrier except those assigned to other authority. The primary facility through which the Operations Officer exercises his authority and responsibility for safe and effecive control of airborne aircraft is the Carrier Air Traffic Control Center (CATCC). The Air Operations Officer is responsible to the Operations Officer for all matters pertaining to flight operations and for the proper functioning of the CATCC. The CATCC is responsible for the status keeping of all carrier air operations and control of all airborne aircraft under the Operations Officer's cognizance except for the following:

1. The Air Officer is responsible for visual control of aircraft operating in the carrier control zone. He is the clearing authority for the carrier control zone.
2. The Landing Signal Officer is responsible for visual control of arriving aircraft immediately prior to landing.
3. The CIC Officer is responsible for mission control of aircraft assigned to him.

CVA/CVS INSTRUMENT PROCEDURES

CVA/CVS instrument procedures are necessarily different from those applicable ashore. The basic necessity for safe and efficient procedures may be even more prevalent aboard carriers. The conditions which affect CVA/CVS instrument procedures are of a different nature since the carrier is a mobile airfield normally operating in areas where obstruction clearance presents little if any problem. This discussion is limited in content concerning the overall picture of CATCC. The CVA/CVS NATOPS Manual should be referred to for a more detailed study of the subject matter.

MARSHAL PROCEDURE

A common question asked by trainees is "Why the word MARSHAL?" This is good question. Apparently reference is being made to one of the many meanings of the word, which is "to arrange objects or people in order." Compared to approach procedure ashore, a marshal fix would be the same as the initial approach fix.

A primary TACAN marshal fix is normally established on a predetermined radial at a distance appropriate for the type aircraft. The radial is established with reference to the base recovery course (BRC). The BRC is the ship's magnetic heading for recovery of aircraft.

For jet aircraft, the primary TACAN marshal fix is normally on the 170 radial, relative to the BRC, at a distance of 15 miles plus 1 mile for each 1,000 feet of altitude.

For propeller aircraft aboard CVA's, the primary TACAN marshal fix is on the 125 radial relative to the BRC at a distance of 7 miles plus 1 mile for every 1,000 feet of altitude as assigned.

Turboprop aircraft aboard CVA's may use either the jet or the prop marshal as required.

Aboard CVS's, the primary TACAN marshal fix is on the 170 radial relative to the BRC at a distance of 10 miles plus 1 mile for every 1,000 feet of altitude as assigned. This marshal could not be used if jet aircraft were being recovered.

The primary TACAN marshal fix for helicopters is on the 090 radial relative to the BRC at a distance of 5 miles, plus 1 mile for every

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500 feet of altitude as assigned, starting at 500 feet.

A secondary TACAN marshal fix for propeller air craft may be designated on CVS's; for example, the 225 radial relative to the BRC at a distance of 7 miles, plus 1 mile for each 1,000 feet of altitude as assigned.

Alternate marshal fixes may be established on radials at 30-degree intervals, clockwise from the primary marshal radial, or CVS's may establish an overhead marshal. In the event of TACAN failure or restricted airspace, CATCC may specify overhead holding in lieu of an alternate marshal.

In the event an aircraft or flight cannot reach the assigned marshal point in time to make an assigned approach time due to mission, fuel state, or ordnance load, an en route radar approach may be used to place the flight in the proper approach sequence. Positive radar control is required for all en route descents.

Marshal Pattern and Altitude

Unless otherwise specified in the operations order or instructions issued by marshal control, the marshal pattern should be a 6-minute racetrack pattern. The inbound leg should pass over the marshal fix. Direction of turn for each pattern is depicted on the respective approach chart.

Every effort should be made to anticipate weather conditions and provide marshaling in visual conditions if practical. Aircraft below an overcast cloud layer should not be required to climb into the overcast to comply with marshal altitude limits if approach control can maintain the interval and sequence from the lower altitude. Aircraft above an overcast cloud layer should be assigned altitudes above the overcast and retained in formation where possible.

Formation flights should be limited to a maximum of four aircraft at any one assigned altitude. Under IFR weather conditions, a section of two aircraft is the maximum number authorized in any one flight and hence at the same marshal altitude.

Fixed-wing aircraft are normally assigned marshal altitudes which provide 1,000 feet vertical separation except where required to provide 2,000 feet above 29,000 feet. A CVS using a secondary marshal fix should assign thousand foot altitudes (1,000, 2,000, etc.) at the primary marshal fix and thousand-plus-500 (1,500, 2,500, etc.) at the secondary marshal fix.

Helicopters are assigned altitudes at marshal which provide 500 feet vertical separation.

APPROACH PROCEDURE

Approach procedures described and depicted herein are primarily for single carrier operations. However, with slight modifications they can be used for multicarrier operations; letdown under reduced navigation and control, using a plane guard destroyer's navaids; and during EMCON conditions.

Figures 7-1 through 7-8 are examples of approaches designed for use on carriers regardless of weather conditions. Each ship should utilize the standard approaches so that pilots who transition to other ships will encounter minimum changes in operating procedures.

Each pilot adjusts his holding pattern to depart the marshal fix at the assigned expected approach time. Early or late departures from the marshal fix must be reported to approach control so that adjustment in the interval can be made for safe separation.

Changes in radio communications frequencies and IFF codes should not be required of the pilot after platform (5,000 feet) except under emergency conditions.

Letdown/Penetration

Jet aircraft descend at 250 knots and 4,000 feet per minute until platform is reached. At platform the descent is shallowed to 2,000 feet per minute. They should arrive at the 10-mile gate at 1,200 feet and 250 knots. The pilot will commence transition of his aircraft to landing configuration at the 10-mile gate unless directed otherwise by CCA.

Turboprop aircraft, when in a jet marshal, will fly the letdown/penetration in the same manner as that prescribed for jet aircraft.

Propeller aircraft descend at 140 knots and 1,000 feet per minute from the marshal fix to arrive at the 6-mile gate at 1,200 feet.

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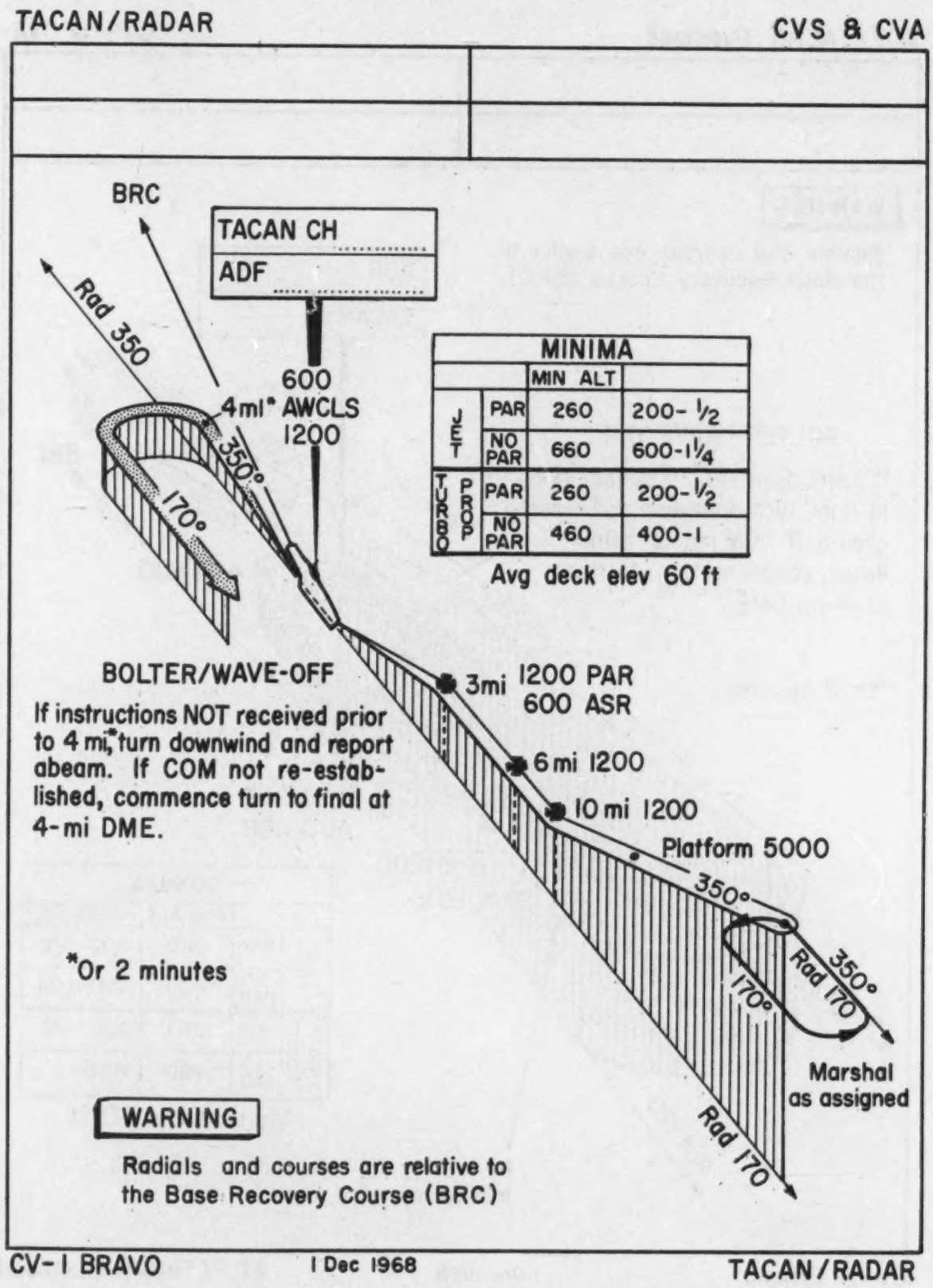

AC.215

Figure 7-1.—CVA/CVS TACAN/radar approach (jet and turboprop).

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ADF/TACAN Overhead — CVS & CVA

WARNING

Radials and courses are relative to the Base Recovery Course (BRC)

BOLTER/WAVE-OFF

If instructions NOT received prior to 4 mi,* turn downwind and report abeam. If COM not re-established, commence turn to final at 4-mi DME.

*Or 2 minutes

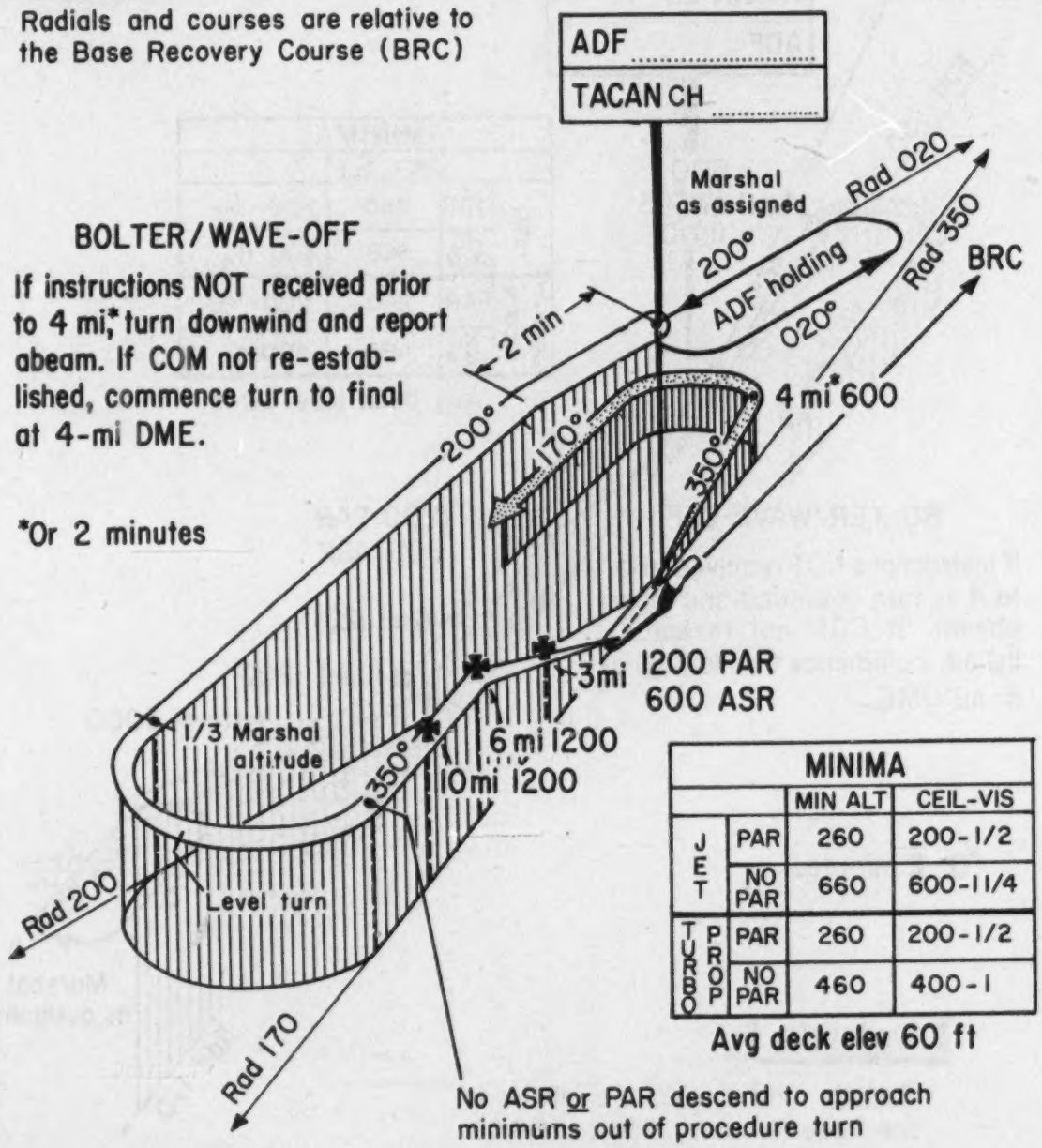

MINIMA		MIN ALT	CEIL-VIS
JET	PAR	260	200-1/2
JET	NO PAR	660	600-1 1/4
TURBOPROP	PAR	260	200-1/2
TURBOPROP	NO PAR	460	400-1

Avg deck elev 60 ft

CV-2 BRAVO — 1 Dec 1968 — ADF/TACAN Overhead

AC.216

Figure 7-2.—CVA/CVS ADF/TACAN approach, overhead marshal (jet and turboprop).

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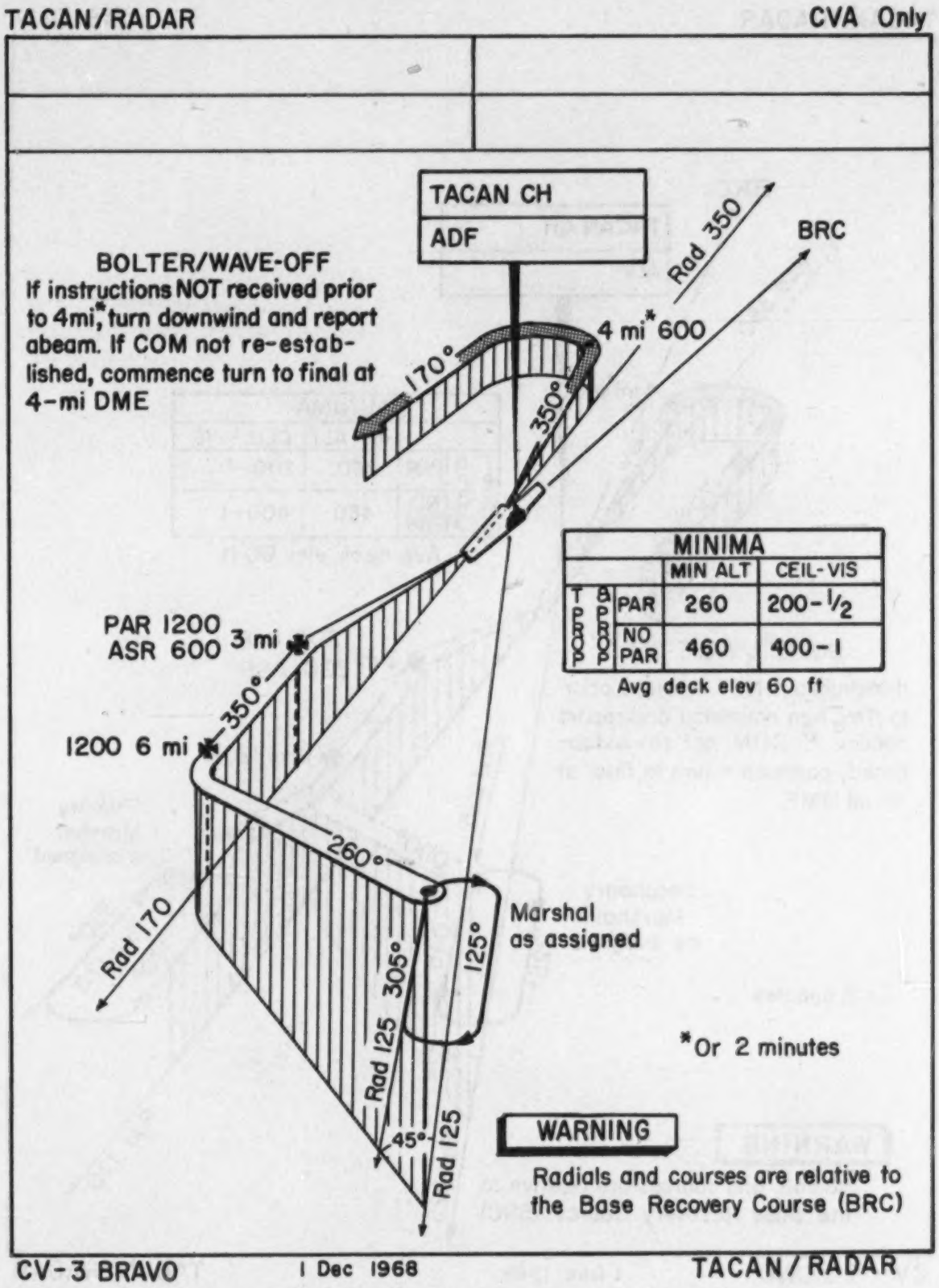

AC.217

Figure 7-3.—CVA only TACAN/radar approach (prop and turboprop).

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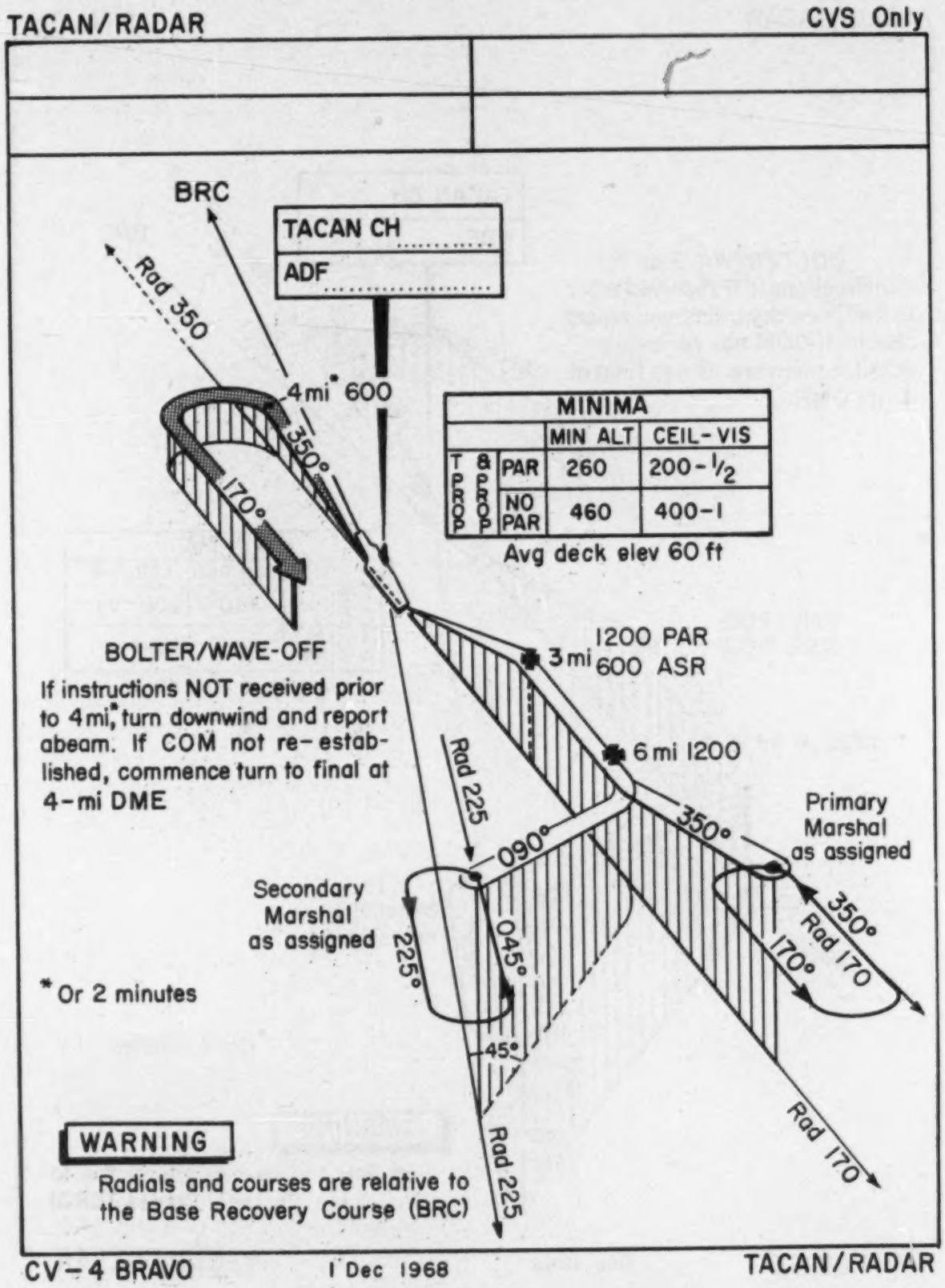

AC.218

Figure 7-4.—CVS only TACAN/radar approach (prop and turboprop).

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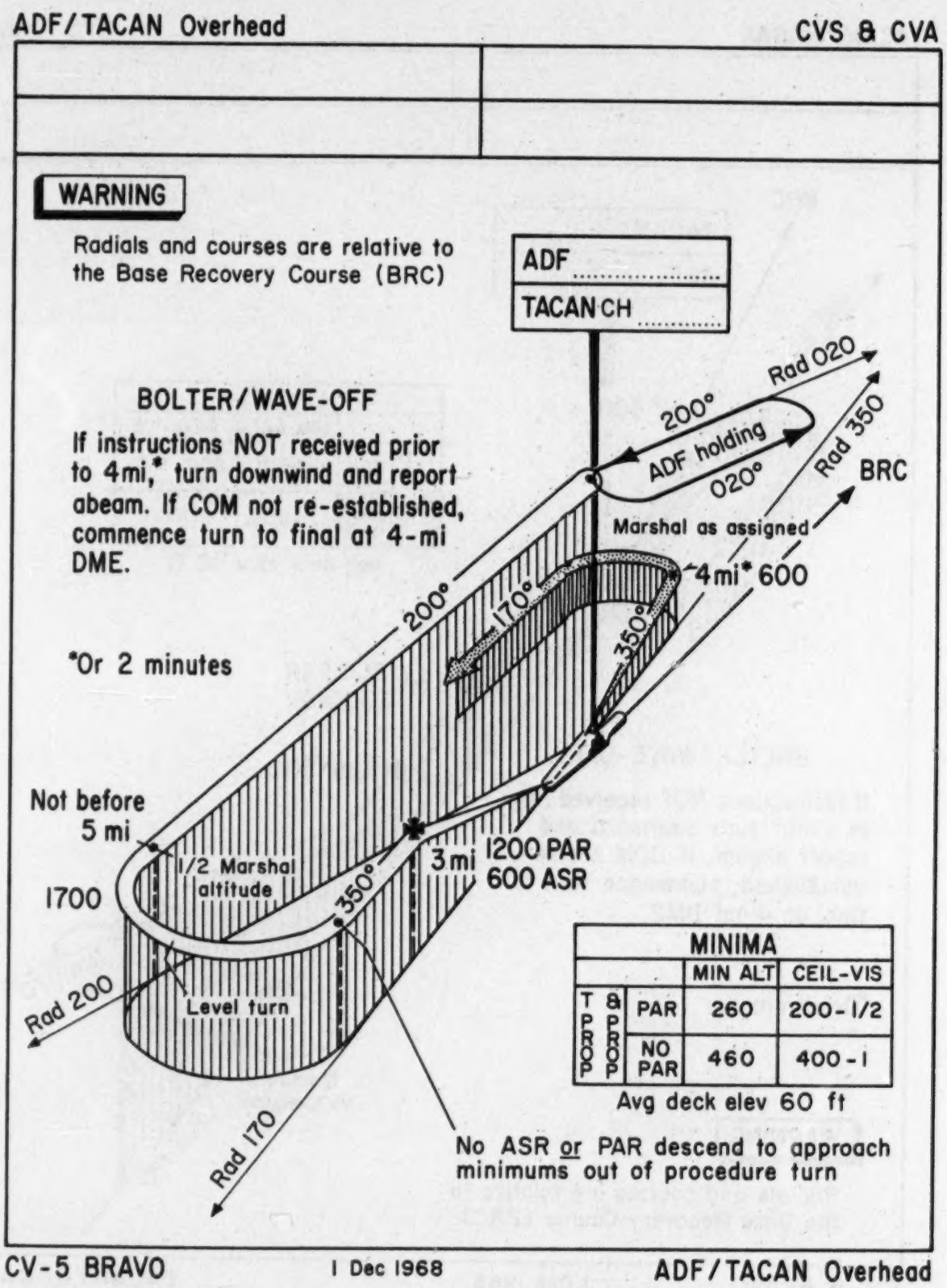

AC.219

Figure 7-5.—CVA/CVS ADF/TACAN approach, overhead marshal (prop and turboprop).

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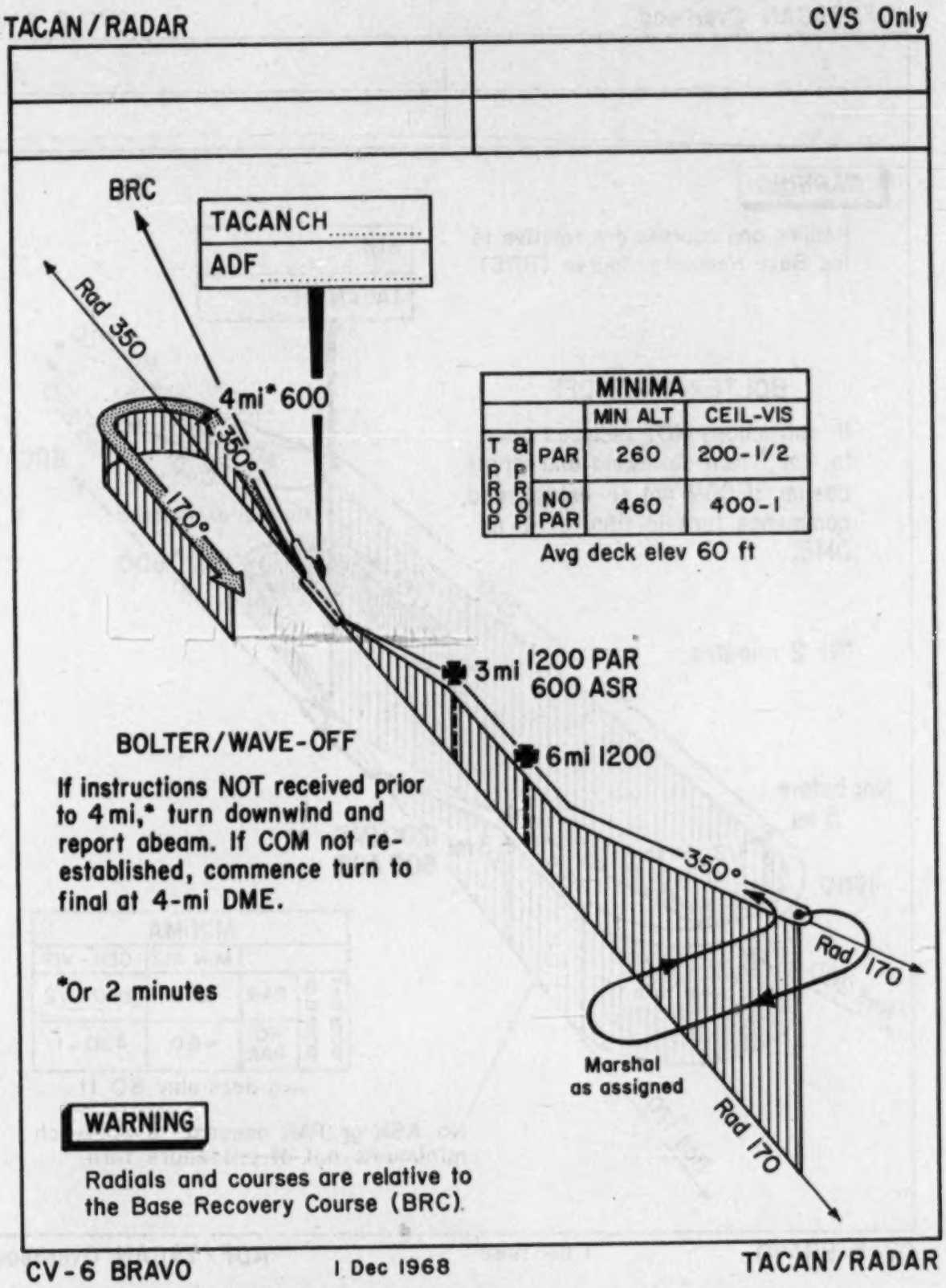

AC.220

Figure 7-6.—CVS only TACAN/radar approach (prop and turboprop).

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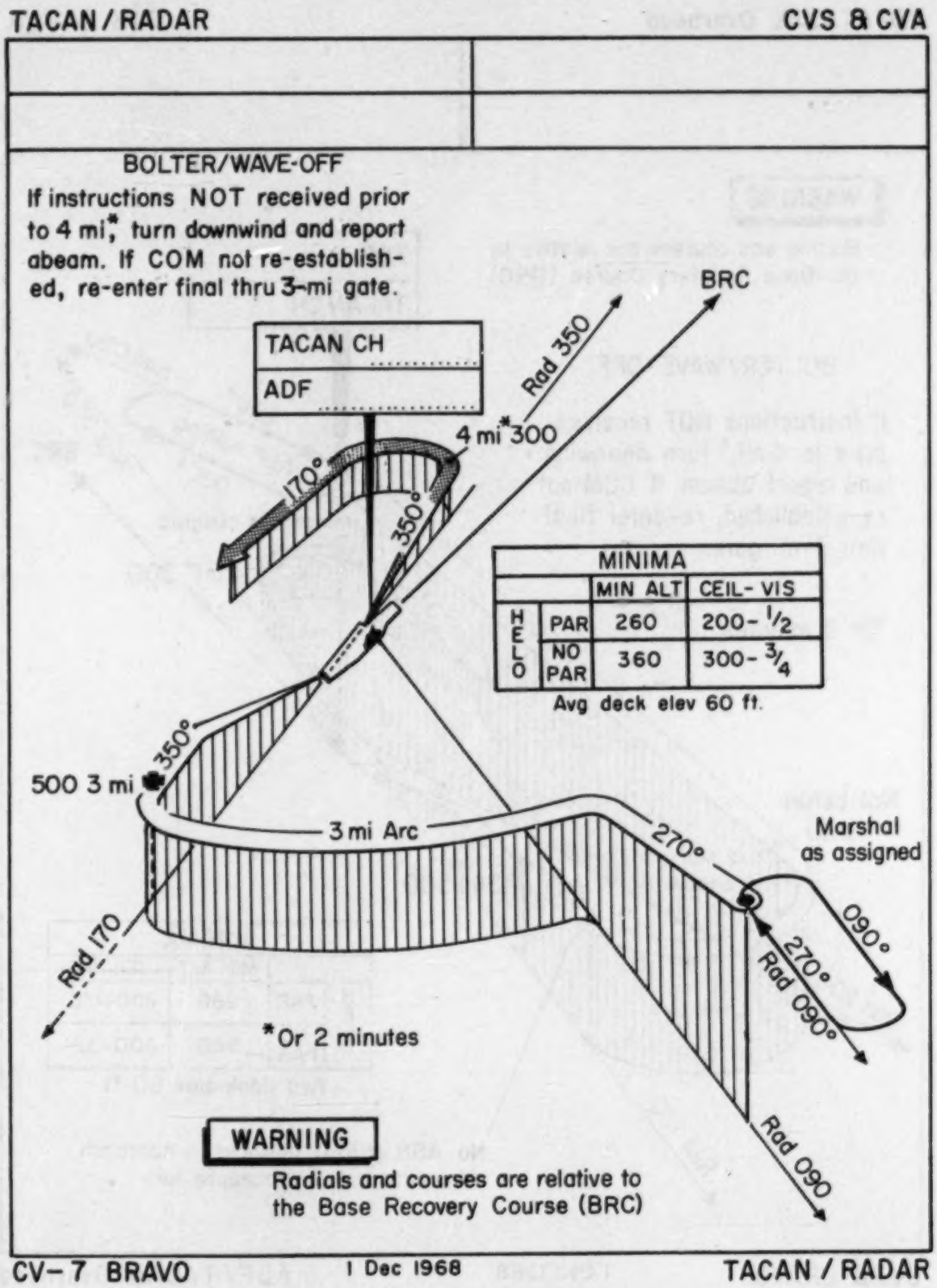

AC.221

Figure 7-7.—CVA/CVS TACAN/radar approach (helo).

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It can be seen that a definite time versus frequency relationship exists during the 10 μsec that the returning echo is felt on the receiver input. At any time, the frequency can be determined and, therefore, which channel is receiving a signal. For instance, at T_0 plus 106 μsec, the frequency which will enter channel No. 6 is just arriving at the receiver antenna. This means that the frequencies affecting channels 1 thru 5 have already arrived, and channels 7 thru 10 are yet to come.

If the returned echo is applied to the matched filter as it is now (lowest frequency first), by action of the L and C of the tanks, the filter would tend to expand the signal again, rather than compress it as is desired. FOR THE PULSES TO BE COMPRESSED, THE FREQUENCY RELATIONSHIPS MUST BE REVERSED. That is, the returned echo must be turned around so that the highest frequency enters the matched filter first, and the lowest frequency enters last, or 10 μsec later. This is easily accomplished by sideband inversion.

SIDEBAND INVERSION. —Sideband inversion is a process of inverting the frequencies contained in the upper and lower sidebands during the process of frequency conversion. This process occurs any time the local oscillator is tuned ABOVE the frequency to be converted, and the DIFFERENCE frequency is selected. (See fig. 15-21.)

NOTE: The reader should be aware that the frequency values used in figure 15-21 are arbitrary values and were selected only to illustrate sideband inversion.

From figure 15-21, it can be seen that when the upper sideband (101 mc) passes through the mixer, the difference frequency produced is 9 mc. When the lower sideband frequency (99 mc) is converted, the difference will be 11 mc. Thus, the highest incoming RF produces the lowest difference frequency, and the lowest RF produced the highest difference frequency. In the case of the pulse compression radar under discussion, the returned echo is passed through a frequency conversion stage for the purpose of sideband inverting the frequencies. The lowest frequency which was first returned will become the highest frequency after sideband inversion (95 mc will emerge as 105 mc). The highest frequency (105 mc), returning last will emerge from the mixer as 95 mc. Because of this process, the entire frequency content of the returning pulse will be reversed. After this inversion, the echo is now ready to be applied to the matched filters for pulse compression.

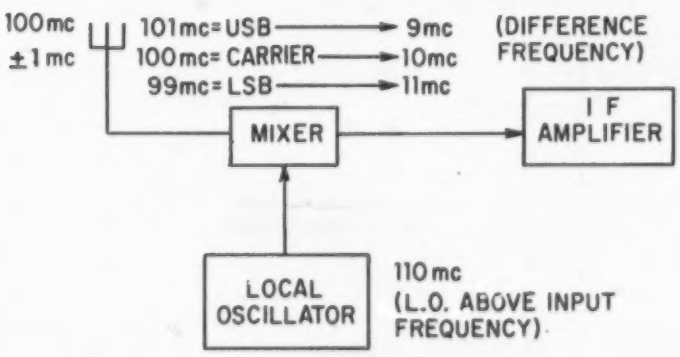

Figure 15-21. —Sideband inversion block diagram

Action of Matched Filter on the Returned Echo

The returning pulse, AFTER SIDEBAND INVERSION, is once again applied to the parallel inputs of all 10 matched filter channels. The difference between the input to the matched filter, now on the pulse compression function, and the input for the pulse expansion function on transmit is that on pulse expansion, ALL frequencies (each one in phase) were present at EACH channel at the SAME TIME. But on pulse compression (or receive), the frequencies arrive ONE AT A TIME, each one separated from the others by a small phase and time difference. The first frequency to arrive, at T_0 plus 100 μsec, is the highest input frequency to the filter after conversion, and 10 μsec later, at T_0 plus 110 μsec, the lowest input frequency after conversion arrives at the filter. It must be noted that as each individual frequency arrives, it is present at the input to each one of the 10 channels simultaneously.

The highest frequency (after conversion), being the first to arrive, is applied directly to the matched input filter. Since this frequency is within the bandpass of ONLY channel 10, it will affect only channel 10. Before it can be applied to the tuned amplifier of channel 10, it receives a 9-μsec delay. Therefore, this frequency finally is present at the tuned amplifier of channel 10 at T_0 plus 109-μsec. For the next 1-μsec of time, all of the frequencies within the bandpass of channel 10 will arrive and be processed. The highest frequency (105 mc) at T_0 plus 109 μsec, is

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ADF/TACAN Overhead — CVS & CVA

WARNING

Radials and courses are relative to the Base Recovery Course (BRC)

BOLTER/WAVE-OFF

If instructions NOT received prior to 4 mi,* turn downwind and report abeam. If COM not re-established, re-enter final thru 3-mi gate.

*Or 2 minutes

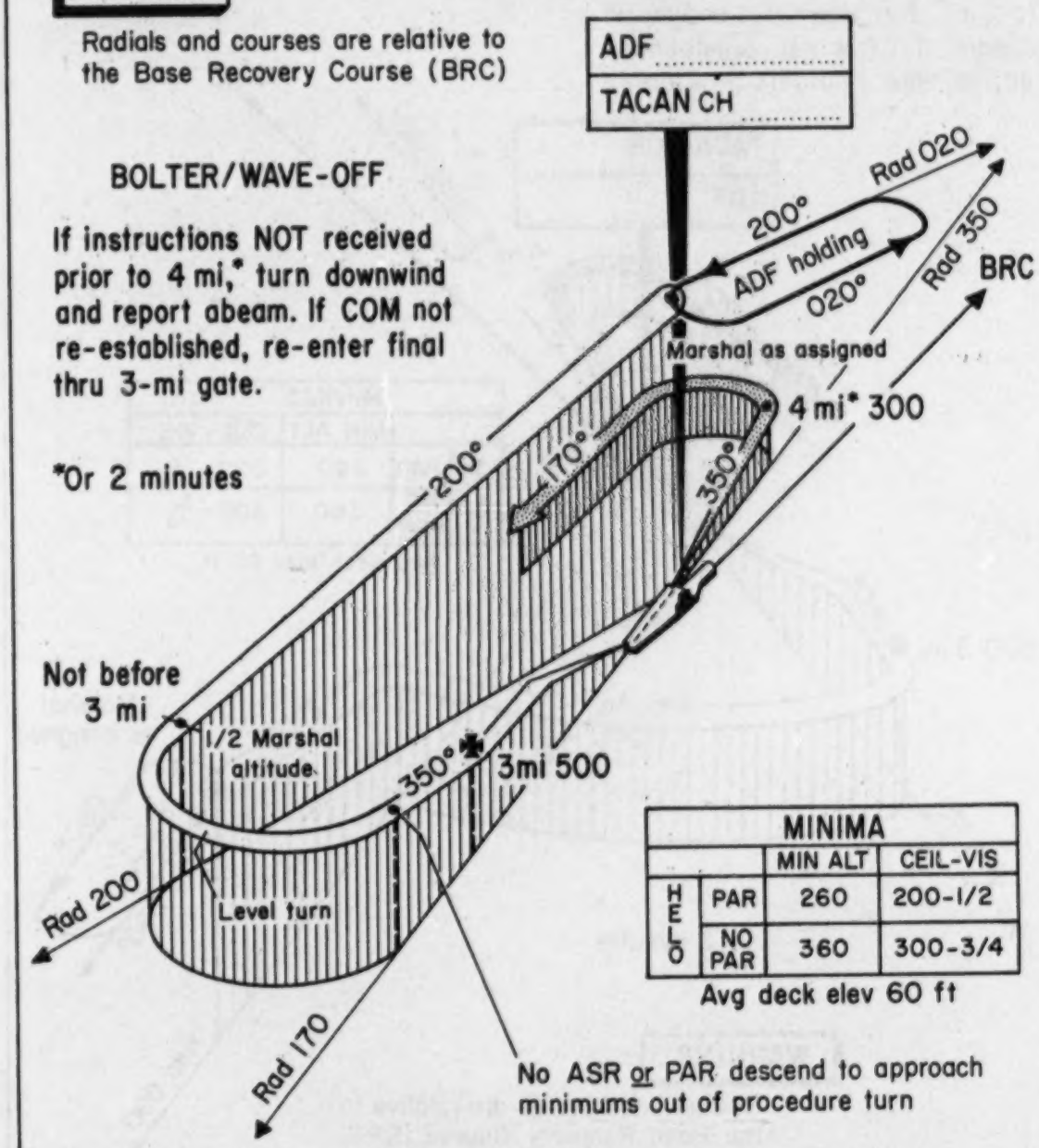

MINIMA		MIN ALT	CEIL-VIS
HELO	PAR	260	200-1/2
	NO PAR	360	300-3/4

Avg deck elev 60 ft

CV-8 BRAVO — 1 Dec 1968 — ADF/TACAN Overhead

AC.222

Figure 7-8.—CVA/CVS ADF/TACAN approach, overhead marshal (helo).

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Helicopters descend at 90 knots and 500 feet per minute from the marshal fix to arrive at the 3-mile gate at 500 feet.

Correction to Final Bearing

If conditions were always stable during carrier operations, then there would be no reason to alter the ship's heading once a base recovery course had been decided upon. In the case of the CVA jet letdown/penetration, the final bearing would be the same as the reciprocal of the marshal radial if no changes occur. But often the variable elements exercise their option to change, such as a wind shift, frontal passage resulting in variable wind, proximity to land masses, etc., which require a change to the BRC upon which CATCC has based the recovery approach procedure. If aircraft are already in the letdown/penetration or are in the holding pattern at marshal fix when the change occurs, then a change to the final bearing is required. When this happens the pilots concerned must be informed of the situation and corrections must be made to intercept the new final bearing.

Jet or turboprop aircraft on TACAN/RADAR approaches initiate correction from the marshal radial to the final bearing at 20 miles. If the final bearing is within 10 degrees of the reciprocal of the marshal radial, a gradual correction is made. If the difference is more than 10 degrees, the pilot will make a 30-degree turn to intercept the final bearing. If the aircraft is not established on the final bearing at 12 miles, then the pilot will fly the 12-mile arc until intercepting the final bearing.

Prop and turboprop aircraft on a TACAN/RADAR approach would correct from the marshal radial to the final bearing with a 45-degree correction turn from the inbound heading in the holding pattern when departing marshal. This heading would be held until the final bearing is reached or, if the 6-mile arc is reached first, then the 6-mile arc would be flown until intercepting the final bearing.

Nonprecision Final Approach

When precision approach radar or suitable visual landing aids are not available, aircraft on final approach will continue descent to 600 feet after passing the 6-mile gate. The final controller will provide sufficient information to the pilot for him to maintain an accurate azimuth and altitude until reaching nonprecision minimums.

Precision Final Approach

Jet and turboprop aircraft pass through the 6-mile gate at 1,200 feet and 150 knots in a landing configuration. The altitude of 1,200 feet is maintained at approach speed until intercepting the glidepath (approximately 3 miles) unless otherwise directed by the final controller.

Propeller aircraft pass through the 3-mile gate at 1,200 feet in a landing configuration and maintain 1,200 feet until intercepting the glidepath or until otherwise directed by the final controller.

Helicopters pass through the 3-mile gate at 500 feet in a landing configuration and maintain 500 feet until interception of the glidepath or until otherwise directed by the final controller.

When precision radar is available, precision final approach procedures should be used for all Case III (IFR letdown and approach) recoveries. CCA will furnish glidepath and azimuth control until the aircraft on approach reaches shipboard PAR minimums or until the LSO takes control.

AWCLS Final Approach

The letdown/penetration portion of an All Weather Carrier Landing System (AWCLS) approach is the same as previously described to a point 4 to 6 miles from the ship on final at an altitude of 1,200 feet.

If a mode IA approach (automatic to minimums and manual takeover to touchdown) is to be conducted, the following will transpire:

1. At 4 to 6 miles on final, the pilot should receive a landing check discrete signal to indicate positive data link communications between the aircraft and the ship.
2. The SPN 10/42 controller should acquire the aircraft between 3.5 and 4 miles and initiate lockon.
3. When the pilot has the aircraft in the proper attitude and engages the autopilot, he will report COUPLED to the controller.

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4. The pilot should report receiving comand control signals via data link by reporting COMMAND CONTROL to the controller.

5. The pilot should be given a voice warning, as the aircraft approaches within 1 mile, that he is approaching minimums.

6. At one-half mile, the pilot will be informed by the controller, ONE-HALF MILE, AT MINIMUMS, UNCOUPLING NOW. The pilot resumes control of the aircraft and continues the approach.

7. If the pilot reports MEATBALL earlier than one-half mile, the controller should downgrade the approach to mode II (manual approach using the ILS type instrument (needles) in the aircraft) and transmit UNCOUPLING NOW.

If a mode II approach is to be conducted, the following should transpire:

1. At 4 to 6 miles on final, the pilot should receive the landing check discrete signal to indicate positive data link communications between the aircraft and the ship.

2. The SPN 10/42 controller should acquire the aircraft between 3.5 and 4 miles and initiate lockon.

3. After lockon, if the instruments in the cockpit are functioning properly, the pilot will report NEEDLES and fly the approach manually by reference to the instruments.

4. The pilot should receive a warning from the controller that his aircraft is at 1 mile and approaching mode II minimums.

5. At one-half mile the pilot should be informed by the controller that his aircraft is at one-half mile and passing through mode II minimums. The pilot should acquire the MEATBALL and complete the approach.

Approach Minimums

The commanding officer establishes approach minimums for his ship which reflect significant changes in operational capabilities, such as may be occasioned by decreased/increased proficieny of the CATCC or embarked air wing/group. However, absolute minimums are established as follows:

1. PAR, Mode IA and II—200 and 1/2.
2. Nonprecision approaches:
   a. Jet—600 and 1 1/4.
   b. Prop/turboprop—400 and 1.
   c. Helo—300 and 3/4.

When a suitable BINGO field is available, aircraft may not commence an approach when the reported weather is below the minimums as previously described unless it has been determined that the aircraft has enough fuel to proceed to the BINGO field in the event of a missed approach.

MISSED APPROACH/WAVEOFF/BOLTER

In the event of a missed approach, waveoff, or bolter, fixed-wing aircraft climb straight ahead on the extended reciprocal of the final bearing to a minimum of 600 feet and wait for instructions from the waveoff/bolter controller. Helicopters climb straight ahead on the extended reciprocal of the final bearing to 300 feet and await instructions.

If instructions are not received prior to reaching 4 miles or 2 minutes ahead of the ship, the pilot will attempt to make contact with the ship, giving indentification and position. If instructions are still not received, the pilot will assume communications failure and execute a turn downwind, reporting DOWNWIND ABEAM. If he still has no radio contact, the pilot will proceed downwind; and if in a fixed-wing aircraft, he will commence a turn to final at 4 miles DME. If in a helicopter, the pilot will reenter through the 3-mile gate.

In the event the deck becomes fouled or an excessive number of aircraft bolter or are waved off, the CCA officer will issue DELTA via the controllers to all aircraft. The following actions should be initiated:

1. Aircraft in holding. They should continue to hold and await assignment of a new expected approach time. Pilots should acknowledge receipt of DELTA. If the pilot of an aircraft experiences radio failure after receiving the DELTA, he should commence approach at 6 minutes after the assigned expected approach time.

2. Aircraft on approach above platform. They should level off at the next lower odd altitude and hold on the inbound bearing at a range in miles equal to 1 mile for each thousand feet of actual altitude plus 15 miles for jets, 7 miles for props, and 5 miles for helocopters. The holding pattern should be the same as the original marshal holding pattern. Pilots should

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acknowledge receipt of DELTA, repeating distance and altitude. Pilots experiencing radio failure after receiving DELTA would depart the holding fix 6 minutes after the time of receipt of DELTA.

3. Aircraft on approach below platform. They should continue a normal approach and await specific instructions prior to dumping fuel.

4. A new expected approach time should be assigned as soon as possible by approach control with a minimum of 6 minutes delay before continuing descent. If a pilot should experience radio failure prior to receiving a new expected approach time, he would depart the holding fix 6 minutes after receiving DELTA and continue penetration to the last known final bearing.

DEPARTURE PROCEDURE

Departure procedures are based upon the assignment of TACAN radials for the purpose of providing lateral separation. The minimum standard separation of departure radials under IFR weather conditions is 20 degrees.

The assignment of departure radials is normally dependent on the following:

1. Mission of the aircraft.
2. Number of carriers in the formation.
3. Topographical features in the area.
4. Those radials reserved for emergencies, letdowns, or propeller aircraft and helicopter holding.

Direct routing should be utilized as much as possible in order to lessen delay time in the execution of departures.

CARRIER AIR TRAFFIC CONTROL

Existing weather in the ship's control area and control zone is the most prominent factor affecting the degree of control necessary. The type of control to be employed during departure and recovery operations is determined by the Air Operations Officer unless specified by higher authority. In periods of reduced ceiling and/or visibility, electronic air traffic control techniques must be utilized to provide separation and maximum safety.

CONTROL CRITERIA

The degree of control exercised by CATCC is described as close control, advisory control, or monitor control.

Close control is defined as a form of air traffic control in which the controlling agency has radar and radio contact with the aircraft being controlled. Published approach or departure procedures are complied with or specific assignments regarding heading and altitude are issued by the controller. Vertical separation is provided by requiring pilots to maintain assigned altitudes or flight levels while lateral or longitudinal separation is provided by the controller. Speed changes may be directed by the controller.

Close control is utilized when the following conditions exist:

1. Ceilings of 1,000 feet or less for fixed-wing operations or 500 feet or less for helicopters.
2. Flight visibility of 3 miles or less for fixed-wing operations or 1 mile or less for helicopters.
3. Whenever flight operations are conducted between one-half hour after sunset and one-half hour before sunrise, except as modified by the Officer in Tactical Command (OTC) or the commanding officer.
4. During mandatory letdown in thunderstorm areas.
5. In any other situation where supervisory personnel can anticipate weather phenomena that might cause difficulty to pilots.

Advisory control is a form of air traffic control in that the controlling agency maintains radio and radar contact with aircraft under its cognizance and provides traffic advisories. Traffic separation is the responsibility of the pilot making use of the assistance provided by the agency. Advisory control must be utilized when the traffic density in an operating area requires a higher degree of control for safety of flight than required under the see-and-be-seen method. Advisory control is normally limited to VFR weather conditions and is recommended for all operations in or adjacent to oceanic control areas or routes.

Monitor control is the monitoring of radar and radio channels for emergency transmissions. Monitor control must be utilized only

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when aircraft are operating in VFR weather conditions outside of controlled airspace and the responsibility for separation from other traffic can be safely assumed by the pilot.

SEPARATION CRITERIA

The following criteria are provided as guidance for Carrier Air Traffic Controllers in the control of aircraft under instrument conditions. Either lateral or vertical separation will be provided. These restrictions do not apply to launch and recovery operations or tactical maneuvers.

1. Lateral separation:

a. Aircraft operating within 50 miles of the monitoring antenna—at least 3 miles.

b. Aircraft operating at more than 50 miles from the monitoring antenna—at least 5 miles.

2. Vertical separation:

a. Aircraft operating at altitudes up to and including 29,000 feet must be separated by 1,000 feet except that 500 feet may be permitted for propeller driven aircraft when required.

b. Aircraft operating at altitudes above 29,000 feet must be separated by 2,000 feet.

c. Helicopters must be separated by 500 feet.

APPROACH CRITERIA

The Air Operations Officer determines the type of approach and the required degree of control considering weather in the approach area as follows:

1. Case I, visual descent/approach. This approach may be utilized when it can be anticipated that flights will not encounter instrument weather conditions at any time during the descent, break, and final approach. A ceiling of 3,000 feet and 5 miles visibility within the carrier control zone is required for CVA's to utilize Case I procedures. The pilot retains full responsibility for proper navigation and separation from other aircraft. The pilot should be advised of the expected Charlie time and changed to tower control after reporting sighting the ship.

2. Case II, controlled descent/visual approach. This procedure should be utilized during daylight hours when weather conditions are such that flights may encounter instrument conditions during the descent, but visual conditions exist at the ship down to the following ceiling and visibility minimums:

a. 1,000 feet and 3 miles.
b. 900 feet and 4 miles.
c. 800 feet and 5 miles.
d. 700 feet and 6 miles.

Close control must be utilized until the pilot reports the ship in sight. The maximum number of jet aircraft in the pattern is limited to 6 when the ceiling and visibility are less than 1,500 feet and 5 miles.

3. Case III, controlled descent/approach. This procedure should be utilized whenever existing weather at the ship is below Case II minimums and during all flight operations between one-half hour after sunset and one-half hour before sunrise, except as modified by the OTC or commanding officer.

ARRIVAL PROCEDURES

On entering the carrier control area, inbound flights will normally be turned over to CATCC for further clearance. The flight leader should provide CATCC with the necessary information such as position, altitude, low fuel state in the flight, number of aircraft, type of AWCLS approach requested, and other pertinent information including navaid status, hung ordnance, weather, etc., which may affect the recovery. CATCC should provide the flight leader with marshal instructions, steer to marshal (if required), type of recovery, approach time or ramp time, altimeter setting and weather, time check, and expected final bearing.

Case I Procedure

Essential information is issued to the flight leader and updated if necessary. When the flight leader reports the ship in sight, the center should switch the flight to tower control.

Case II Procedure

The CATCC will control the descent until VFR weather conditions are reached. Division

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penetrations should not be made through an overcast that is more than 10,000 feet thick with a ceiling of less than 3,000 feet. Flight leaders should squawk normal and follow reporting procedures for Case III until the flight has broken into the clear beneath the clouds and has the ship in sight. The flight leader will then be switched to tower control and proceed as in Case I.

Case III Procedure

CATCC controls the descent and approach. This type of recovery should only be made by single aircraft except in those cases where an aircraft with inoperative radio or nagivational equipment is brought down on the wing of another aircraft. Formation penetrations/approaches by dissimilar aircraft should not be attempted except in extreme circumstances where no safer options are available to effect recovery. Directing a recovery in adverse weather conditions where alternate airports are not available demands the utmost proficiency, mutual confidence, and cooperation between pilot and controller. Marshal controllers must insure that pilots under their control have all the appropriate information necessary for a successful approach prior to commencing approach. This includes the following:

1. Expected approach time.
2. Altimeter setting.
3. Final control frequency.
4. Type of approach.
5. Final bearing.
6. Time check.
7. Ceiling, visibility, and deck conditions.
8. Divert field/data.

The marshal controller will hand off the aircraft to the approach controller as they depart the marshal fix. Unless weather or operating circumstances dictate otherwise, aircraft departing the same marshal fix are normally separated by 1 minute. Expected approach time adjustments may be made for greater separation as necessitated by varying models and numbers of aircraft, type of approach, bolter, and waveoff traffic.

Positive radar identification should be accomplished by the receiving controller prior to transfer of control. Control may be transferred only after the receiving controller has notified the transferring controller that positive radar contact exists. Approach controllers maintain control until handoff to the final controller is accomplished. Changes in radiofrequencies and IFF code must be made no lower than platform altitude except under emergency conditions.

When precision approach radar is available, precision final approach procedures are used by CATCC for Case III arrivals. In such cases, CCA furnishes glideslope and azimuth information and controls the aircraft until it reaches PAR minimums or the LSO takes over. When precision approach radar or suitable visual landing aids are not available, aircraft on final approach will continue descent to 600 feet after passing the 6-mile gate. The final controller will provide sufficient information to the pilot for him to maintain an accurate azimuth and altitude until reaching nonprecision minimums.

DEPARTURE PROCEDURE

Primary responsibility for adherence to the assigned departure rests with the pilot; however, advisory control is normally exercised with a shift to close control if weather conditions require, upon request, or when the assigned departure is not being adhered to. After launch, CATCC takes the following action:

1. Record flight data as required on status boards.
2. Insure that communications and positive track are established to the extent possible under existing EMCON conditions.
3. Request navaid checks as necessary.
4. Maintain advisory control of departing point to point flights until pilots shift to en route frequencies and of other aircraft until control is accepted by CIC or another controlling agency.
5. Before releasing aircraft to another controlling agency, CATCC should give each pilot or flight leader any pertinent information such as changes in PIM or mission.
6. When transferring control to CIC, include the range and bearing of the aircraft being transferred and insure that CIC acknowledges assumption of control.
7. File flight plans as necessary.

Aircraft are normally launched on the departure frequency which is monitored by the

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tower. Condition aircraft (conditions I through IV) represent various states of aircraft readiness concerning repsonse time when ordered to launch. Condition I is the minimum possible and IV is the maximum allowable. They are determined by appropriate authority, depending upon the tactical situation as it exists initially and as it changes. CAP (combat air patrol, the ships defense) aircraft will be launched on a frequency designated by CIC and monitored by the tower.

Single-frequency departures are highly desirable and should be utilized whenever possible. Where single-frequency departures are not possible, single-piloted aircraft should not be required to change radiofrequency or IFF codes after launch until the aircraft are at least 2,500 feet above the surface and in a climbing, wings level attitude. Single-piloted aircraft that are assigned operating altitudes below 2,500 feet should not be required to change frequencies or IFF codes until a level attitude and cruise configuration have been attained.

Position reports that pilots will be required to make to departure control will vary depending upon the weather, state of training, EMCON, and type of operation being conducted. The following reports are considered as minimum during IFR/night operations:

1. Outbound on assigned radial.
2. Popeye (with altitude).
3. On top (with altitude).
4. Kilo.

The degree of control exercised by CATCC concerning departures again depends upon existing weather conditions and is described similarly to arrivals.

1. Case I departure is VFR from takeoff through rendezvous.

a. On CVA's all fixed-wing aircraft proceed directly to a point at least 5 miles from the carrier at an altitude of 300-500 feet, and remain clear of the control zone. Rendezvous will be in accordance with ship/air wing/air group doctrine.

b. On CVS's all fixed-wing aircraft proceed 1 minute on the launch course, then execute a 40-degree right turn, remaining at or below 300 feet until at least 5 miles from the carrier, then proceed to their assigned areas.

2. Case II, VFR departure from the ship with a controlled climbout required.

a. CVA's. All fixed-wing aircraft will proceed straight ahead and maintain an altitude of 300-500 feet until 5 miles from the carrier. Jet aircraft fly a 7-mile arc to intercept their assigned departure radial. Propeller and turboprop aircraft fly a 5-mile arc to intercept their assigned departure radial. Such aircraft must remain VFR until established on the assigned departure radial.

(1) Jet rendezvous will be accomplished between 20 and 50 miles from the carrier. Propeller aircraft rendezvous between 10 and 50 miles. The rendezvous may be accomplished below or above cloud layers, at the flight leader's discretion, but will be on the left side of the assigned departure radial. The air wings/groups will normally prescribe their own VFR rendezvous doctrines.

(2) For jet and turboprop aircraft, the first aircraft of each flight will report to departure control passing 24,000 feet if not ON TOP. Unless operational necessity dictates otherwise, the departure controller will then direct pilots to climb and maintain the following altitudes in each sector or on the departure radial:

(a) First aircraft—29,000 feet.
(b) Second aircraft—27,000 feet.
(c) Third aircraft—25,000 feet.
(d) Fourth aircraft—23,000 feet.

If the aircraft are still "popeye" when the assigned altitude is reached, pilots will establish a nonstandard holding pattern between 40 and 50 miles out on the assigned departure radial and conserve fuel.

(3) For propeller aircraft, the first aircraft of each flight will report to departure control passing 7,000 feet if not ON TOP. Unless operational necessity dictates otherwise, the departure controller will then direct pilots to climb and maintain the following altitudes in each sector or on the departure radial:

(a) First aircraft—10,000 feet.
(b) Second aircraft—9,000 feet.
(c) Third aircraft—8,000 feet.
(d) Fourth aircraft—7,000 feet.

If the aircraft are still "popeye" when the assigned altitude is reached, pilots will establish holding on the outbound radial between 20 and 30 miles and conserve fuel.

(4) After the aircraft previously described in (2) and (3) report that they are

established in holding, departure controllers should issue clearance to proceed on the assigned mission if operationally required, or to continue holding until other returning flights have been recovered. When the returning flights have been recovered, the holding aircraft will be vectored under close control to their prebriefed marshal fix for recovery.

b. CVS's. A minimum departure interval of 30 seconds is utilized between aircraft. After takeoff, propeller aircraft climb straight ahead to an altitude of 300 feet until 5 miles out. Then they climb at 130 knots on the 5-mile arc until intercepting the departure radial and continue climb to assigned altitude. When pilots report KILO, the departure controller should execute a radar handoff to the CIC tactical controller. Mission unable aircraft will enter holding at the prebriefed departure fix and await instructions. Within the control area, aircraft will maintain the assigned departure altitude while outbound to the assigned area. CVS's operating jet and propeller aircraft would follow the same procedure as CVA for Case II departures under these conditions.

3. Case III. IFR at the carrier and a controlled climb required.

a. CVA's. A minimum departure interval of 30 seconds is utilized between elements (section or single aircraft) when instrument conditions exist. Jet aircraft climb straight ahead at 300 knots until 5 miles from the carrier. They then fly the 7-mile arc, climbing to intercept the assigned departure radial. Turboprop aircraft climb straight ahead at 165 knots to intercept the 5-mile arc and maintain an altitude of 1,000 feet until intercepting the assigned departure radial. Propeller aircraft climb straight ahead to 800 feet and fly the 5-mile arc maintaining 800 feet until intercepting the assigned departure radial. Jet rendezvous will be accomplished between 20 and 50 miles. If unable to reach ON TOP, aircraft will proceed as in Case II, unable to reach ON TOP.

b. CVS's. Propeller aircraft departures under Case III are the same as for Case II except that the aircraft will climb straight ahead to 500 feet using a minimum interval of 1 minute at departure. Jet aircraft departures are the same as for CVA Case III.

Helicopter Departures

Case I. Helicopters should clear the control zone as directed by the tower. When departing for operations within the control zone, they should remain under control of the tower or other designated controlling agency until clear of launching and recovering aircraft.

Case II and III. Whenever possible, helicopters should remain beneath the clouds. If unable to do so, they should proceed individually to prebriefed departure fixes. After takeoff, they should climb straight ahead to an altitude of 300 feet at 90 knots to intercept and fly the 3-mile arc to the assigned departure radial. The climb to departure altitude should be commenced upon reaching the departure radial.

Plane guard helicopters fly the 1-mile arc to intercept the plane guard pattern, remaining beneath the clouds. If unable to remain beneath the clouds, the plane guard helicopter should transition from the plane guard pattern to the helo marshal (fig. 7-7) under positive control of CATCC.

Helicopters proceeding to the screen should be switched to the tactical controller upon reporting KILO. If unable to perform the assigned misson, they should hold at the departure fix and await further instructions. When helicopters are assigned a search area toward the stern of the ship, they should be kept under close control by the departure controller until they clear the final approach sector and then be given to CIC via radar handoff. Helicopters should never be vectored across the bow when fixed-wing aircraft are being launched or recovered.

TANKER OPERATIONS

Tanker aircraft are assigned duties in support of the recovery of aircraft. Normally, a tanker that has just been launched will become the duty tanker for the recovery that follows immediately, provided that the tanker's store is operational. Those tankers which are known to have a good store and sufficient fuel to meet receiver requirements display a flashing green light.

A specific existing agency, for example departure control, is designated as tanker control

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and will have the responsibility of monitoring the following:

1. Tanker give-away fuel.
2. Tanker location.
3. Location and fuel requirements of the low state aircraft.
4. Coordination of the tanker and receiver rendezvous.

Duty Tanker Procedures

When VFR weather conditions exist (day and night), the oncoming duty tanker joins the offgoing tanker at 2,000 to 5,000 feet overhead the ship. The oncoming aircraft should have his store checked by, and receive the excess fuel from, the offgoing aircraft (referred to as Happy Hour). All tanker packages should be checked as soon as possible after launch by the offgoing tanker. If there is no offgoing tanker, then another aircraft should be used to check the tanker package.

Tanker control is advised when it has been determined that the new tanker's store is operational. During the time that one tanker is being relieved by another, both tankers should stay within 10 miles of the ship to be available for emergency tanking. When the relief process has been completed, the new duty tanker will advise tanker control of the amount of give-away fuel available. Give-away refers to the amount of fuel transferable based on scheduled recovery time.

The duty tanker orbits overhead the ship (within 5 miles) between 2,000 and 5,000 feet during recovery operations until the last jet aircraft is aboard. When the recovery is complete, the tanker will climb to the prebriefed altitude (usually 20,000 feet) and switch to the assigned frequency for control. Prior to the next launch, the duty tanker will descend to between 2,000 and 5,000 feet and check out the oncoming tanker.

When IFR weather conditions exist (day and night), tanking is accomplished 1,000 feet above the overcast, or between layers in VFR conditions. The tanker pilot should advise tanker control of the best altitude and position to conduct emergency tanking. Close radar control should be provided for tanker overcast penetrations. Tanker control must assist in positioning the tanker near a potential receiver and should keep the tanker informed of the potential receiver's position.

RENDEZVOUS PROCEDURE.—During VFR weather conditions (day and night), the duty tanker will HAWK (closely monitor) a particular aircraft that is a potential receiver. The tanker pilot is advised which aircraft is to be HAWKED, and he should take up a 2 o'clock position relative to the low state aircraft as it bolters or waves off. The low state aircraft is directed to rendezvous with the tanker, and the tanker will be switched to the low state aircraft's frequency at the appropriate time. The tanker pilot will report to tanker control when the receiver is engaged and taking on fuel, when the refueling has been completed, and the amount of fuel transferred.

When IFR weather conditions exist, tanker control will coordinate the tanker and receiver rendezvous.

DUTY TANKER PATTERN.—The tanker pattern is established as a racetrack pattern around the ship in VFR weather conditions. The downwind turn should be initiated as soon as the receiver is taking on fuel. The tanker should remain within 10 miles of the ship unless special circumstances exist. The downwind leg should be 3 to 5 miles abeam and tanking should be completed prior to reaching a point 6 miles astern to allow for pattern entry. If tanking is done above an overcast or between layers, the distance astern is increased to allow for normal descent and CCA pickup.

DIVERSION OF AIRCRAFT

The Air Operations Officer and the Air Officer are normally responsible for making the recommendation to the commanding officer when and which aircraft should and should not be diverted in the interest of safety of flight. The Air Operations Officers determines the condition of the navigation, communications, and lighting facilities of the divert field prior to the first night or IFR recovery.

CATCC and CIC must be alerted when an aircraft is approaching diversion state and they should be prepared to take control of the aircraft as soon as it is given a divert signal. When it is determined to divert an aircraft, the pilot will be given the name of the field, the magnetic heading, and distance to the field. A readback of diverting instructions from the

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pilot or flight leader is mandatory. When appropriate, the pilot of the diverting aircraft is instructed to shift to a particular frequency for positive control while en route to the diversionary field. When positive communications have been established, additional items of information such as latest en route and field weather, altimeter setting, and position from which the diversion is being initiated are provided to the pilot.

If operating outside an ADIZ boundary, the CIC controller will provide the pilot with the necessary ADIZ information. The appropriate GCI site must be advised of the diverted aircraft's departure point, ADIZ penetration point, time of penetration, altitude, ETE, destination, and any additional information that may be pertinent to safety of flight. CIC will maintain a radar plot and radio monitor all diverting aircraft as long as possible and retain responsibility for the aircraft until positive radar handoff to GCI/ARTCC or other appropriate agency is accomplished.

Under IFR weather conditions, the pilot of a diverting aircraft must be instructed to shift to the appropriate FAA or other controlling agency frequency after the additional divert information has been issued. Once communications have been established with this controlling agency, the flight plan particulars should be furnished (by the pilot) including ADIZ penetration information for relay to a GCI site. If communications cannot be established, as is often the case, the pilot should file the flight plan information on the GCI common frequency.

The Air Operations Officer must insure that a divert flight plan is transmitted to the appropriate divert airfield, and similar information to the pertinent air defense system agency should an ADIZ penetration be involved. This is normally done on ship to shore radio circuits from the air operations office. The pilot should insure that an arrival time is filed and sent to the ship immediately upon landing. The Air Operations Officer is responsible for receipt of an arrival report on the diverted aircraft.

Squadron or Unit Commanders and the Air Operations Officer are jointly responsible for insuring that aircraft performance data pertinent to diversion of aircraft is available to and understood by personnel engaged in the control of aircraft.

CARRIER EMERGENCY PROCEDURE

From a control standpoint, carrier aircraft emergencies fall into three broad categories; i.e., communications failures, navaid failures, or other aircraft systems failures. The nature of some emergencies requires priority and/or diversionary measures. The ultimate resolution of these emergencies involves a command decision, based upon the type of emergency and weather conditions in the recovery area. It is imperative that CATCC collect every pertinent detail that might aid in the evaluation of an emergency and keep the command and other interested agencies properly informed.

Initial control responsibility for aircraft emergencies rests with the agency exercising control of the aircraft when the emergency occurs. Aircraft in a state of emergency within visual range of the ship will normally be controlled by the Air Officer. Outside the visual range of the ship, aircraft in an emergency will be controlled by either CIC or CATCC.

COMMUNICATIONS OR NAVAID FAILURE DURING AN APPROACH

Control of air traffic in the vicinity of a carrier, as well as ashore, during an emergency is based on anticipated pilot action. Therefore, the AC aboard ship must be alert for the following procedures a pilot may execute in the event an aircraft on approach experiences navaid or communications failure:

1. Aircraft alone.

a. If navigational equipment is available, lone aircraft will continue approach.

b. If all communications and navigational equipment is lost, the pilot will proceed as follows:

(1) The pilot may elect to continue the approach by dead reckoning. Having made this decision, he will continue DR until 2 minutes past his expected ramp time, and then fly the appropriate triangular pattern for lost communications, squawk emergency, and conserve fuel. If below the overcast, the pilot may elect to fly a search pattern to locate the ship.

(2) If the pilot elects to discontinue the approach, he will climb on final bearing

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above the resonant frequency of channel 10 (104.5 mc), so the tank cirucit appears capacitive to that frequency.

The tank circuit has the same effect on frequencies ABOVE its resonant frequency that it has previously during pulse expansion—that is, it will delay these frequencies by an amount proportional to the amount of capacitive reactance the tank offers to that frequency. The 105-mc signal, being the farthest away from the f_0 of the tank, will be delayed the most (approximately 0.45-μsec).

The next frequency to arrive at the tank is slightly later in time and lower in frequency, and receives slightly less delay than did 105 mc. When 104.5 mc arrives (at T_0 plus 109.5 μsec), the tank simply passes it exactly as it is. The rest of the frequencies within the bandpass of channel 10 are lower than the f_0 and sees an inductive reactance. This advances these lower frequencies by an amount proportional to the X_L of the tank. The 104-mc signal, the lowest frequency within channel 10's bandpass, sees maximum inductance and is advanced approximately 0.45-μsec. The end result is that the bandwidth of frequencies of channel 10 (which was 1 μsec wide) is compressed to 0.1-μsec, and comes out of channel 10 at T_0 plus 109.45-μsec to T_0 plus 109.55-μsec. This is shown in figure 15-22.

The band of frequencies processed and compressed by channel 10 arrived at the receiver antenna from T_0 plus 100-μsec to T_0 plus 101-μsec. From T_0 plus 101 μsec to T_0 plus 102-μsec, the frequencies within the bandwidth

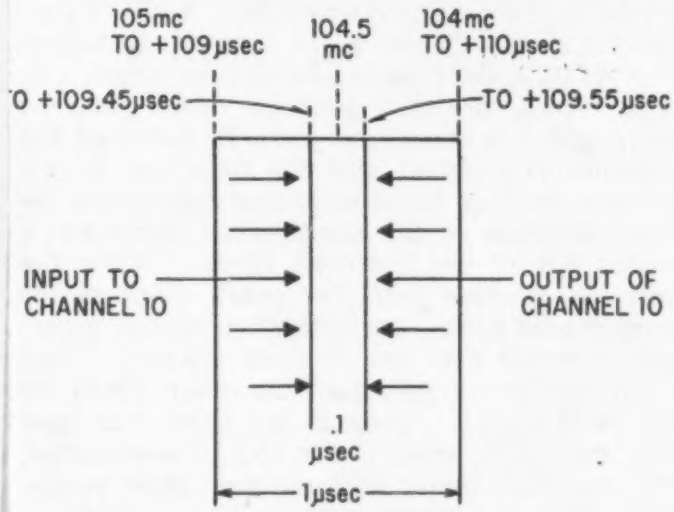

Figure 15-22.—Individual channel compression.

of channel 9 will be arriving at the receiving antenna. To get to the tuned tank of channel 9, they must pass through the 8-μsec delay line. Then, at T_0 plus 109-μsec, the first frequency for channel 9 (104 mc) will arrive. This frequency is higher than the resonant frequency (103.5 mc), so it will be retarded approximately 0.45-μsec, and will be reproduced in the output of channel 9 at T_0 plus 109.45-μsec. The lowest frequency to channel 9 (103 mc) sees maximum inductance and will be advanced approximately 0.45 μsec. Channel 9 will produce its output from T_0 plus 109.45 μsec to T_0 plus 109.55 μsec, or during the same time channel 10 was producing an output.

This process continues as each one of the channels receives its band of frequencies 1 μsec apart in time, but produces its output at the same time as each of the other channels. Finally, at T_0 plus 109-μsec, the first frequency to pass through channel 1 arrives at the receiving antenna, and is felt directly on the tuned tank in channel 1 since channel 1 has no delay line. Channel 1 then produces an output at the exact same time as the previous nine channels.

COMBINED OUTPUT OF THE MATCHED FILTER.—The output circuit of each individual channel is fed into summing amplifiers where all 10 outputs are combined. Because each channel produces an output at exactly the same time, and for exactly the same time duration, all 10 outputs add directly, and appear at the output of the summing amplifiers as one pulse 0.1 μsec in duration. The entire 10-μsec return echo has been compressed to 0.1-μsec, and is now ready to be detected and sent to the indication devices.

The ratio between the pulse width of the transmitted pulse and the returned compressed target echo is expressed as the compression ratio. It is determined as follows:

$$\text{Compression ratio} = \frac{\text{pulse width of expanded pulse}}{\text{pressed width of compulse}}$$

The compression ratio of the radar being discussed is:

$$\text{Compression ratio} = \frac{10\text{-}\mu\text{sec}}{0.1\text{-}\mu\text{sec}} = \frac{100}{1} = 100{:}1$$

This expression is considered a figure of merit for a pulse compression type radar.

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heading to VFR conditions and expeditiously join up on the tanker or other available aircraft. If unable to join on another aircraft the pilot will fly two left-hand triangles, conserving fuel. Depending upon weather at the divert field and fuel state, the pilot may elect to proceed directly to the divert field after having climbed out on the final bearing heading.

(3) Helicopters may continue descent to 300 feet, proceed by DR until 2 minutes past individual expected ramp time, and then fly the appropriate triangular patters for lost communications, squawk emergency, and conserve fuel.

2. Aircraft in company. An aircraft with navigation and/or communications failure in the company of an escort aircraft with navigation and communication equipment in working order will be handled as a single aircraft in the recovery procedure. The escort aircraft as flight leader will visually communicate with the distressed aircraft. When the distressed aircraft can safely continue the approach, he will acknowledge a lead change and continue to a landing. The escort aircraft will then assume the position of a safety wingman, as necessary until the distressed aircraft is recovered, and then continue normal procedures for his own recovery.

LOST COMMUNICATIONS DURING AN INSTRUMENT DEPARTURE

If communications are lost during an instrument departure, the pilot should squawk modes II and III and IDENT once every minute for 5 minutes. Climbout should be continued to the assigned emergency altitude and distance on the assigned departure radial unless a different altitude assignment by air traffic control has been acknowleged. The pilot should hold at this point for 30 minutes and then proceed to emergency marshal and commence approach at the emergency expected approach time. The pilot should proceed to emergency marshal by arcing counterclockwise AROUND the ship, climbing or descending to arrive at emergency marshal at emergency altitude. If under VFR weather conditions when communications are lost; pilot should remain VFR and return to the ship.

EMERGENCY FOLLOWING NIGHT/IFR LAUNCH

Should an aircraft have an emergency following a night/IFR departure and require an immediate landing, the departure controller should provide vectors until the final controller has acquired the aircraft on radar. Every effort should be made to retain the aircraft on the departure frequency until it is safely aboard. Pri-Fly and the LSO must be advised immediately of the emergency and the control frequency.

When feasible, aircraft with emergencies which do not require immediate recovery should continue the departure until cleared into the marshal pattern.

BASIC PROCEDURES

Controllers must be familiar with and alert for conditions and pilot actions which indicate communication or navigation failures. Basic control procedures which may be performed, depending upon the situation, include the following:

1. Attempt to establish communications with and control of the aircraft.
2. Vector the aircraft as appropriate.
3. If unable to communicate with the aircraft in difficulty, attempt the following:

a. Identify it on radar and maintain a track.

b. Vector available aircraft to join up if practicable.

c. Alert the CATCC watch officer and Pri-Fly.

d. Broadcast instructions and essential information in the blind.

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CHAPTER 8

ADMINISTRATION

There are many definitions of administration. Each one is probably perfectly valid and incorporates the concept of getting things done through planning, supervision, direction, and coordination of human activity. Using this concept as a basis, administration may be thought of as a means by which the ATC/OC division accomplishes its mission.

The basic objective of administration is very broad; namely, effective management. Its major operational objectives include the following:

1. To obtain the best qualified people for the work to be done and to insure that the best use is made of their capacities in the organization.
2. To establish policies and working conditions that will develop and maintain the best work interest, satisfaction, and performance.
3. To assure value for value in expenditure of funds and quality of performance commensurate with cost.

It is immediately apparent that administration is not a specialized field, but is a responsibility and function of every supervisor.

When a supervisor is given a task, he first should determine the objectives of the task. He should then organize his personnel and material by assigning and coordinating such specific duties and functions as are necessary to reach the objective. Finally he should administer the organization by providing leadership, direction, coordination, and control to guide the organization toward the accomplishment of the objective. This would indicate, then, that organization is the machinery of administration.

ORGANIZATION

Organization is the means by which management plans, directs, coordinates, and controls operations and activities. It is the division of work into logical groupings of functions and the establishment of channels of authority, communications, and control between the personnel assigned to the various functional groupings.

Our fast moving world with its scientific and technological advances and the role of our nation in international affairs have thrust upon the United States tremendous responsibilities and challenges. The organization of the Department of Defense is the method by which the efforts of military and civilian personnel are systematically coordinated to shoulder the responsibilities and meet these challenges.

Senior AC's deal not only with other divisions and departments within their own activity, but also with various commands and offices of the Department of the Navy.

For a review of the organization of the DOD and Department of the Navy down through the operating forces level, refer to Military Requirements for Petty Officer 1 & C, NavPers 10057-C.

ACTIVITY ORGANIZATION

NavAir Instruction 5450.89 sets forth the standard structure for the internal organization of field activities under NavAirSysCom management control.

The purpose of this guide is to assist each activity in establishing and maintaining its organization so that the assigned mission can be accomplished in the most effective and efficient manner.

The formal organization structure of an activity is determined by the functions to be performed, the personnel available to perform

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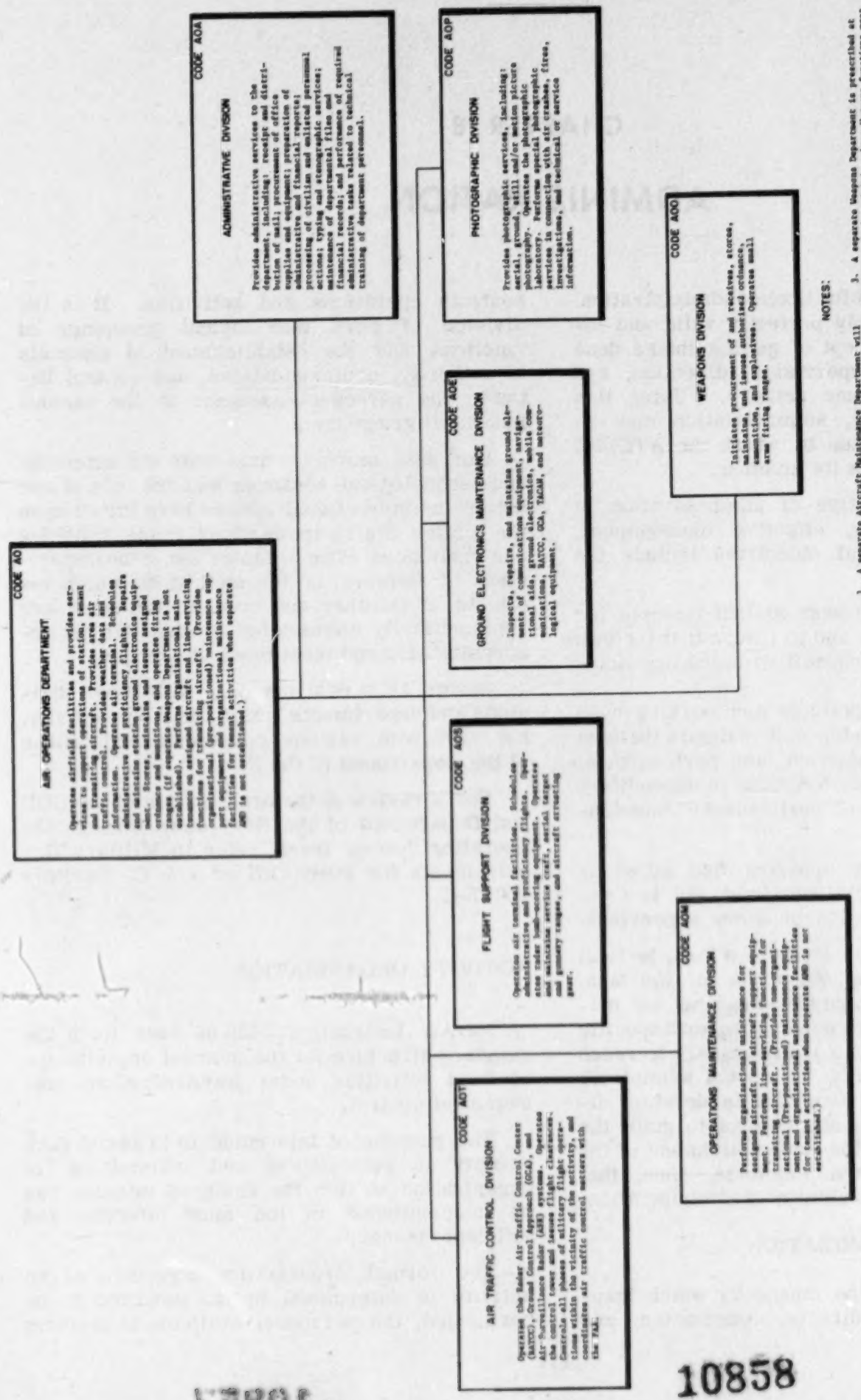

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Figure 8-1.—Structural/functional chart of an Air Operations Department.

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them, available material resources, and the management policies and philosophies of the management command and higher levels of authority.

Each activity will maintain an organization manual, in current status, in accordance with the standard organization guide. This manual can be a valuable tool to senior AC's in determining lines of authority and responsibility, and for assistance in indoctrinating new personnel.

The top level of organization is the activity commanding officer, variously titled Commander, Commanding Officer, Officer in Charge, etc. The following nomenclature in descending order are the components of naval air station organization at the lower levels:

1. Department.
2. Division.
3. Branch.
4. Section.
5. Unit.
6. Subunit.

AC's are normally assigned to the Air Operations Department of a naval air station. Figure 8-1 is a combined structural/functional chart of an Air Operations Department with the various exceptions noted.

Figure 8-2 is an example of an OC division organizational chart aboard ship. Although shipboard organization is not described in the Standard Organization Manual, this chart indicates the chain of command applicable to AC's aboard ship at the division level.

Every individual appointed as head of a component of organization (department, division, branch, section, etc.) is inherently responsible for the effective and efficient performance of that portion of the activity's work assigned to his component. He is also responsible for compliance with applicable directives from higher authority; leadership, training, safety, and supervision of subordinate personnel; and proper use, care, and custody of equipment, facilities, and materials provided.

GENERAL DIVISION ADMINISTRATION

The size, mission, personnel complement, and the service provided by the local ATC/OC division vary widely throughout the Navy. The organization to which the AC1 or ACC is assigned is probably already well established. If not, then the supervisor is faced with a greater challenge. If so, changes are continuously required for improved applications or directed procedural or equipment modifications.

THE NAVY DIRECTIVES SYSTEM

The Navy Directives System, which provides a uniform plan for issuing and maintaining directives, was placed in effect 1 July 1952. The basic system has been retained since that date; however, improved procedures to increase its usefulness have been incorporated.

When directed by the Chief of Naval Operations or the Chief of the cognizant bureau or systems command, commands in the Operating Forces and activities in the Shore Establishment will install the system following the standards set forth in SecNav Instruction 5215.1 (Series), the Navy Directivies System. The most significant benefits derived from this System are as follows:

1. The Navy-wide use enables each activity which receives directives to:

a. Effectively group the directives on any specific subject and relate directives on the same subject with other materials.

b. Have an easy method for filing directives and describing them as references.

c. Differentiate between directives of a continuing nature and those of brief duration.

d. Obtain copies of instructions to replace lost or damaged copies, or obtain complete sets of instructions upon reactivation or commissioning.

e. Determine periodically by use of checklists the current status and the completeness of its set of directives.

f. Determine by the use of subject indexes what directives are in effect on a subject.

2. Each naval activity which issues directives is able to:

a. Reduce the number of directives in effect by systematically consolidating instructions which cover the same subject, by eliminating instructions which duplicate, overlap, or conflict, and by promptly canceling obsolete directives.

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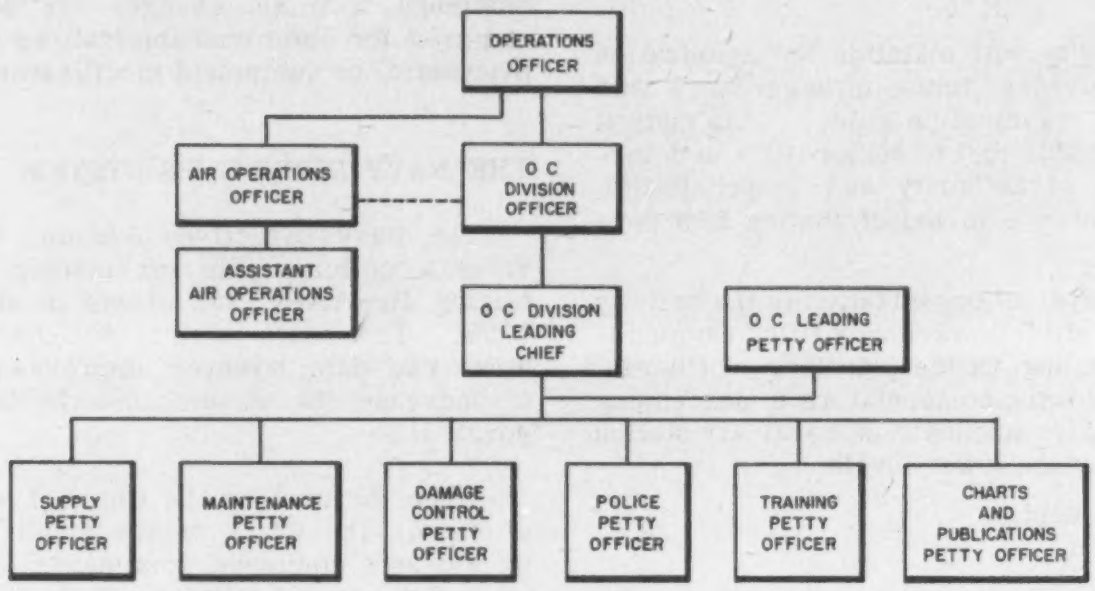

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Figure 8-2.—OC division organization.

b. Improve the adequacy and coverage of instructions and identify gaps in policy and procedures so that directives can be issued to cover necessary subjects.

c. Eliminate duplicate writing, printing, and distributing operations.

d. Insure that recipients are sent only those directives which pertain to their operations.

e. Improve general administration by using a uniform system which includes reference aids for recipients of directives.

Directive

A directive is an Instruction or Notice that prescribes or establishes policy, organization, conduct, methods, or procedures; requires action or sets forth information essential to the effective administration or operation of activities concerned; or contains authority or information that must be promulgated formally.

Instruction

An Instruction is a directive containing authority or information having continuing reference value or requiring continuing action. It remains in effect until superseded or otherwise canceled by the originator or higher authority.

Notice

A Notice is a directive of a one-time or brief nature with self-canceling provision that has the same force and effect as an instruction. Usually it remains in effect for less than 6 months, but is not permitted to remain in effect for longer than 1 year.

Alphabetical Subject Indexes

The Navy Directives System, Consolidated Subject Index, consisting of unclassified instructions originating in various bureaus and offices and promulgated by the Navy Publications and Printing Service, is issued on 30 June. (Quarterly supplements are also issued.) This Index is to assist addressees in identifying departmentally originated instructions on any desired subject. Each current edition provides an alphabetical guide to the subject matter of all unclassified instructions by components of the Navy Department.

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Directives issued by components of the Navy Department are addressed to many different distribution lists. Therefore, no specific activity receives all the instructions included in this Index. However, since originators determine distribution on a need-to-know basis, each activity receives or should receive instructions on subjects with which it is concerned. An activity may determine whether it is an addressee on a particular instruction by referrring to the current Navy Directives System, Consolidated Check List.

Numerical Checklists

The Consolidated Check List is prepared annually on 30 June and should be retained for use in conjunction with subsequent quarterly supplements. These numerical checklists are issued to only those units and facilities listed in Part 1 and Part 2 of the Standard Navy Distribution List (SNDL) in checking their master sets of instructions. Checklists cannot be used by activities not on the SNDL and cannot be used by activities not maintaining the master set of directive binders for the cognizant command.

Standard Navy Distribution List

The Standard Navy Distribution List is published to provide for the proper addressing and distribution of mail to all activities of the Naval Establishment, and to provide a condensed procedure for permitting circular distribution of correspondence.

The Standard Navy Distribution List is published in two parts. Part 1 is a Confidential, nonregistered publication entitled Standard Navy Distribution List (Operating Forces of the Navy and Unified Commands). Part 2 of the SNDL contains the Catalog of Naval Shore Activities. This part (nonregistered and unclassified) contains the official list of shore activities of the Naval Establishment. The term "shore activities of the Naval Establishment" includes activities of the Shore Establishment and shore activities assigned to the Operating Forces.

SECURITY FOR CLASSIFIED INFORMATION

In the daily work routine, Air Controlmen learn information and strategic data of importance to the military and the nation. Some of the information carried in messages handled by Air Controlmen, if available to an enemy, would reveal facts relating to the strength and movements of naval aviation. Furthermore, an Air Controlman uses official documents and publications which relate to such communications matters as procedures, frequencies, call signs, etc. Their contents must also be protected.

The following discussion is generalized and is not intended to serve as a complete reference of security matters for the Air Controlman. If the leading Air Controlman needs further references on security matters, he should refer to chapter 15, U.S. Navy Regulations, 1948, and to OpNav Instruction 5510.1 (Series).

Material considered to be of such importance that its disclosure to unauthorized persons would be detrimental to our defense effort is said to be classified. Classified material is any matter, document, product, or substance on or in which classified information is recorded or embodied. Three general categories of classification are authorized for such material. They are, in descending order of importance, TOP SECRET, SECRET, and CONFIDENTIAL.

Top Secret

Top Secret material or information is that of which the defense aspect is paramount, and the unauthorized disclosure of which would result in exceptionally grave damage to the Nation. Such grave damage might consist of, but is not limited to, either of the following statements:

1. Leading to a definite break in diplomatic relations affecting the defense of the United States, an armed attack against the United States or her allies, or a war.
2. The compromise of military or defense plans, or intelligence operations, or scientific or technological developments vital to the national defense.

Particular attention should be paid to the words "grave," "war," "definite," "attack," and "vital." They are used as words of emphasis. Top Secret material is of tremendous importance to our country.

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Secret

The classification Secret is limited to defense information or material the unauthorized disclosure of which could result in serious damage to the Nation. Its disclosure might jeopardize the international relations of the U.S., endanger the effectiveness of a program or policy of vital importance to national defense, compromise important military or defense plans or technological developments, or reveal important intelligence operations.

Confidential

The Confidential classification is limited to defense information or material, the unauthorized disclosure of which could be prejudicial to the defense interest of the Nation.

The Term Confidential—Modified Handling Authorized may be used to identify certain categories of Confidential information requiring lesser security safegaurds in stowage and transmission.

Types of Security

Provisions for safeguarding classified matter are based on law and executive order. Those of interest to Air Controlmen may be grouped into three categories: COMMUNICATIONS SECURITY, PHYSICAL SECURITY, AND PERSONAL CENSORSHIP.

COMMUNICATIONS SECURITY.—Communications security prevents the enemy from obtaining information from United States or allied communications. Communications security is subdivided into two categories: cryptographic security and transmission security.

Cryptographic security is designed to thwart enemy efforts to obtain intelligence through cryptanalysis and the study of traffic trends. It is the science of cloaking information in codes and ciphers. A code is a system whereby words, phrases, numbers, or syllables are replaced by numbers, letters, or code words. A cipher is a system in which individual letters of a message are replaced, letter for letter, by other letters rather than by complete words, phrases, or numbers.

Transmission security is that component of communications security which results from all measures designed to protect transmissions from interception, traffic analysis, and imitative deception.

Any time a message leaves the originator and is sent on its way to the addressees it is transmitted. It does not matter whether the message goes by courier, radio, wire, mail, or visual means; it must be safeguarded in transit. The means of protection vary, but the purpose, in every case, is two: to keep the information out of the hands of those not authorized to have it, and to prevent our own communications from being turned against us. The means of transmission of messages in order of security are as follows:

1. Messenger authorized to carry classified material.
2. Registered mail.
3. Approved wire circuits.
4. Ordinary mail.
5. Nonapproved wire circuits.
6. Visual means.
7. Sound systems.
8. Radio.

However, all Air Controlmen must consult the Confidential publication ACP 122 for the final authority for transmission security.

PHYSICAL SECURITY.—Measures designed to keep classified information from physically coming into the possession of persons not authorized to have it come under the heading of physical security. Physical security is based on two principles: (1) constant surveillance of classified material when in use, and (2) proper stowage when not in use. The classification of material has a bearing on the number of authorized personnel entitled to have access to the material, and each classification has its own stowage and transmission requirements. Air Controlmen having access to classified matter should keep in mind that physical security precautions must be observed in handling, distributing, accounting for, and storing such material.

PERSONAL CENSORSHIP.—Every individual in the Navy is a censor in that he or she is expected to be discreet in his or her own utterances and writings. The only safe conversational policy to follow when off duty is to say nothing about official matters to anyone. One should plead ignorance of the subject or make it plain they do not wish to talk shop. Personal censorship is most abused through such means as the following:

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1. Loose talk in public places.
2. Personal correspondence.
3. Telephone conversations.
4. Diaries.

These precautions do not guarantee protection nor do they attempt to meet every conceivable situation. However, all Air Controlmen who adopt a commonsense outlook in addition to knowledge of the few basic regulations can solve most of the personal censorship problems involved in security.

Security Clearances

No one may have access to classified matter without proper clearance. If your duties as an Air Controlman require you to use classified publications and documents, the commanding officer is authorized to grant this clearance after ascertaining that you are trustworthy, discreet, and of unquestionable loyalty.

Clearance to handle Confidential information may be based on an unblemished service record and the good opinion of your officers. Clearance to handle Top Secret and Secret material can be granted only after an additional check of BuPers records and an investigation by the Office of Naval Intelligence. A notation of a man's clearance must be made in his service record.

Need-To-Know Concept

The need-to-know concept requires that only those persons whose official military or other governmental duties require it are allowed access to any piece of classified information. The responsibility for determining whether a person's duties require that he possess or have access to classified information and whether he is authorized to receive it rests upon each individual who has possession, knowledge, or command control of the information involved and NOT upon the prospective recipient. This principle applies whether the prospective recipient is an individual, a command, a defense contractor, another Federal agency, or a foreign government.

A need to know is recognized as being established when (1) the disclosure is necessary in the interests of national defense; (2) there must be evidence, from the position, status, duties, and responsibilities of the applicant, that he has a legitimate requirement for access to the classified information in order to carry out his assigned duties and responsibilities; (3) there is no other equal or ready source of the same classified information available to him; and (4) the applicant is or can be appropriately cleared for access to the degree of classified information involved and is capable both physically and mentally of providing the degree of protection which that information requires.

Control of Top Secret Information

All individuals having knowledge of Department of Defense information classified Top Secret must be identifiable at all times. Each organization or office originating or receiving information classified Top Secret must maintain a list of those persons within such organization or office having access to Top Secret information. Access lists of recipients of Top Secret information will not be forwarded to the office originating the information except upon request.

Upon preparation or receipt of Top Secret information, each originator or recipient must keep a record of the names of all persons, including stenographic and clerical personnel, who are afforded access to the Top Secret information originated or received.

Upon origination or receipt of Top Secret material, a disclosure record form must be attached immediately to the material and any individual gaining knowledge of the contents thereof must affix to the form his name, the name of the activity, and the date of access. If an individual's signature is used and is not clearly legible, the name must also be printed.

Disclosure record forms must not be detached from the Top Secret material upon which they are placed unless such material is transmitted to another activity for retention. When such forms are detached, they must be retained locally for a period of at least 1 year, in accordance with SecNav instructions.

Mail rooms, file rooms, communication and message centers, and printing and reproduction activities engaged in processing large volumes of Top Secret material need not require assigned personnel to individually sign the disclosure record form if access to such areas is limited to permanently assigned

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personnel and if such individuals are identifiable by roster as having access on any given date.

Oral discussions within committees or at conferences involving the disclosure of Top Secret information are also subject to accountability requirements. The minutes of the conference or meeting, showing a complete listing of all persons present and giving a summary of the information discussed, are considered to be a sufficient record for purposes of accountability.

Control of Copies and Extracts

Material classified Top Secret and Secret originating outside the Department of Defense must never be reproduced without the consent of the originating agency.

Originators of Top Secret documents must insure, at the time of issuance, that all copies of each document are serially numbered and limited as to reproduction.

Originators of classified material other than Top Secret, including RPS-distributed nonregistered publications, may limit the reproduction or extracting thereof as necessary. In no event, however, may classified material be reproduced or excerpted without the approval of competent authority.

When classified documents are reproduced on office copying equipment, care must be taken to see that the classification marking is clearly legible on each finished copy. Office copying equipment does not always clearly reproduce all colors of ink or marginal images.

Destruction of Classified Documents

Top Secret, Secret, and Confidential material may be destroyed by burning, pulping, pulverizing, or shredding, provided that the destruction of the classified material is complete and that reconstruction is impossible.

Destruction of classified material must be accomplished in the presence of two witnessing officials. A witnessing official must be a commissioned officer, a warrant officer, an enlisted man E-7 or above, or a United States civilian employee GS-7 or above. If none of these categories is available, a mature and reliable enlisted man E-5 or E-6 or a U.S. civilian employee in grade GS-5 or GS-6 may be designated as a witnessing official. All persons witnessing the destruction of classified material must have a security clearance at least as high as the category of material being destroyed, and they must be thoroughly familiar with the regulations and procedures for safeguarding classified information.

When appropriate, Certificates of Destruction must be prepared and signed by the witnessing officials. Witnessing officials must observe the complete destruction of the classified documents. Residue must be checked to determine if destruction is complete and reconstruction is impossible. When classified material is being burned, witnessing officials must take precautions to prevent portions of the classified material from being carried away by the wind or draft. When classified material is being destroyed by other methods, precautions must be taken to see that no scraps of undestroyed material are carried away by the wind.

Destruction of Classified Equipment

When it is necessary to dispose of equipment that must remain classified, destruction must be accomplished by any means that will prevent recognition and reconstruction. Jettisoning of classified equipment in water of sufficient depth to preclude any possibility of recovery may also be employed.

Record of Destruction

An accurate record of destruction of classified material is as important as its destruction. Proper accounting procedures, together with accurate records of destruction, provide official information as to the status of classified material.

A Certificate of Destruction of nonregistered Top Secret and Secret documents must be prepared. The certificates must be retained for a period of 2 years by the command destroying the material. Each certificate must provide complete identification of the material destroyed and the date of destruction, and it must be signed by the officer authorizing the destruction and by the witnessing officials, one of whom may be the official authorizing destruction.

In the case of Secret documents only, use of routing sheets, mail logs, or other similar

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administrative records in lieu of a Certificate of Destruction is authorized, provided that all necessary information (complete identification of the material destroyed, date of destruction, and signatures of the two officials, one of whom is to be the official authorizing destruction) is included. A Certificate of Destruction must be signed by witnessing officials when the material has actually been destroyed or when torn and placed into waste bags for central disposal.

Certificates of Destruction must be prepared for all classified equipment destroyed. The certificate must be retained for a period of 2 years by the command destroying the equipment, and a copy of the certificate must be forwarded to the technical bureau, office, or command responsible for procurement of the equipment.

Emergency Destruction

Commands located outside the fifty United States must include in their destruction plans provisions for an emergency involving the danger of capture of classified material. In an emergency involving the danger of capture of classified material, the importance of beginning its destruction sufficiently early cannot be overemphasized. The consequences of such destruction would be relatively unimportant when measured against the possibility of compromise through capture. Destruction plans of each activity will require of personnel at all levels the highest degree of individual initiative practicable in preparing for and in actually commencing the required destruction. Particular care should be taken to indoctrinate all personnel to insure their understanding that, in such emergencies and when required, they must initiate necessary destruction under the plan without waiting for specific orders. Lists must be prepared which show the locations of classified material, personnel responsible for the destruction, and the recommended place and method of destruction.

Priority for Emergency Destruction

In general, emergency destruction of classified materials should be carried out in the following order:

1. Classified communication material. Insofar as humanly possible, cryptomaterial must not be allowed to fall into enemy hands. Therefore, cryptographic material has the first priority. Noncryptographic communications material has the second priority; destruction should begin with the highest classification and work down to the lower classifications.

2. Other classified material. Emergency destruction of other classified materials must be carried out in order of priority, as follows:

a. Classified material pertaining to current and future plans and operations.

b. Classified material pertaining to standing operating or tactical procedures.

c. Equipment of a classified nature, together with pertinent technical, descriptive, and operating instructions.

d. Remaining classified material, with the order of destruction beginning with the highest classification and working down to the lower classifications.

Accessibility for Emergency Destruction

Classified material must be readily accessible at all times for emergency destruction by assigned personnel. When provisions in shipboard emergency destruction plans include jettisoning publications as a means for emergency destruction, document sinking bags are to be available for this purpose.

Material to be destroyed first must, when practicable, be marked in a distinctive manner and stowed in the most accessible location.

Keys and safe combinations to spaces where classified material is stowed may be kept in designated locations, safeguarded by proper security arrangements.

Local Printing, Duplication, and Reproduction of Classified Material

From a security point of view, the printing, duplicating, or reproduction of classified material poses many problems. It contributes to the increasing volume of classified material; it permits quick and easy production of uncontrolled material containing classified information; the equipment or processes require care for special procedures to prevent or eliminate latent impressions or offset versions of the classified material; and a quantity of excess and waste material is produced which can also contribute to the compromise of the classified information.

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During this process of pulse compression, some apparent amplification occurs across the matched filter. This is because of the energy content and time duration of the returned echo. The 10-μsec pulse arrives with a certain volt/amps energy content, but it is compressed in time down to a pulse of 0.1-μsec. Assuming none of the energy content was lost across the matched filter, the same amount of energy must still be present in the compressed pulse. If the pulse width narrows, the amplitude of the compressed pulse will increase. This increase is the same as the compression ratio. In the radar under discussion the pulse is compressed by a ratio of 100:1, so the amplitude of the compressed pulse is 100 times larger than the amplitude of the received target return, and still contains the same energy content.

It must be noted that in a practical radar using pulse compression, it is very difficult to get the returned energy compressed back to the same pulse width that was used in the pulse expansion sequence. As previously, there are many thousands of frequencies, each different by one PRF, in the transmitted pulse. Each of these frequencies bears a very definite time/phase relationship to each other. To compress the returning echo back to the original pulse width, each one of the frequencies must be present, and must still bear the exact same time/phase relationship that it did upon leaving the transmitting antenna. Due to atmospheric conditions and waveguide vibration, some phase modulation occurs between pulse expansion and pulse compression. Some of the frequencies will be changed, so it will not be easy to reconstruct the original pulse. In the radar under discussion, typically the 10-μsec returned echo is compressed into a 0.2-μsec pulse, for a compression ratio of 50:1. This means that if the entire energy content is maintained across the filter, the amplitude of the compressed target video would be 50 times larger than the amplitude of the returning echo.

SIGNAL-TO-NOISE RATIO

The noise which might exist in the band of frequencies covered by the radar are at random frequencies and bearing random phase relationships to each other, and to the returning target echo. Any of these frequencies which exist within the bandpass of the matched filter passes through the filter, but are not affected by the filter. That is, they are neither expanded nor compressed because of their random relationship, so they emerge at the same amplitude at which they went in while the return echo emerges enlarged in amplitude by the amount of the compression ratio. Radars using pulse compression are generally considered to have an increase in the signal-to-noise ratio across the matched filter approximately equal to the compression ratio. This is in addition to the signal-to-noise ratio increase which might be gained by using suitable receiver input amplifiers.

ECM CONSIDERATIONS

As was previously stated, it is very difficult to jam a pulse compression type radar. This is primarily because of the characteristics of the matched filter. To overcome the target video noise jammers would have to produce enough noise signal so that the noise at the receiver antenna would be greater than the returning target echo by the amount of the compression ratio. This is easily eliminated by insertion of circuits between the antenna and matched filter which automatically reject abnormally large signals. This method is currently in use in certain long range search radars in operation with the fleet. Repeater jammers, to override the actual target return, would have to generate a spectrum containing exactly the same frequencies, each bearing the exact same phase and time relationships as that of the transmitted pulse. Even if this were possible (some types of ECM equipments simply amplify whatever their antennas receive), the ECM signal would be rejected since it would be larger in amplitude than the valid received target return. This repeater jammer could have no more delay between the time it received the transmitter's signal and the time that it retransmitted this same amplified signal than the time duration of the compressed pulse as it comes out of the matched filter. When the delay is greater than the pulse width of the compressed pulse, the indication device (computer) would see two distinct returns. One would be the target, and the other would be the ECM signal. Even if the delay was less than the pulse width of the compressed pulse, the computer would still see the target return first, then a sudden increase in amplitude as the ECM signal came through. The computer would automatically reject ECM return,

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Because of these problems, local commands must require close supervision and careful control of all reproduction facilities under their jurisdiction. Of particular importance is the need for controlling and supervising the use of office copying machines for the printing duplication, or reproduction of classified material and to assure the proper recording and safeguarding of the classified material reproduced by such means. In no event, however, must classified material be reproduced without the approval of competent authority.

When authorized by competent authority, classified material may be produced or reproduced. The number of copies made should never exceed that required to meet a known need.

Classified material produced or reproduced by any means must be recorded in accordance with the requirements of the Security Manual. Samples, waste, or overruns resulting from the reproduction process must be safeguarded in accordance with the classification involved and must be destroyed promptly as classified waste.

When classified material is reproduced, the reproduced material must be marked with the classification and other special markings which appear on the original material from which copies or reproductions are made.

When thermal copy paper is used to reproduce documents upon which classified information has been recorded, only Type I (back coated) thermal copy paper must be used. When slip sheets are placed between the diazo process film sheets in the reproduction process of classified information, the slip sheets must be handled as classified waste.

FILING AND DISPOSITION OF RECORDS

The main objective of any filing system is to insure ready location of any correspondence with a minimum amount of effort and loss of time. As a leading petty officer of an ATC/OC division, the AC1 or Chief may be responsible for establishing and/or maintaining an adequate filing system for the division.

Details of file arrangement within any activity depend upon the mission of the activity and on the volume of official correspondence generated or received. There is no limit to the possible expansion under the Navy subject classification system, yet the system is equally adaptable to the needs of small offices. Files of the components of the Navy Department, for instance, occupy hundreds of cabinets; those of a division office may be kept in one or two cabinets. Yet the same general headings are used for both. The difference lies in the number of subdivisions under each major group.

Navy Filing System

The Navy filing system (used by the entire Navy) is the Standard Subject Classification System for the filing of records, correspondence, and other documents. This system is set forth in SecNav Instruction 5211.3 (Series).

The standard subject classification numbers (outlined in SecNav Instruction 5211.3 (Series)) used in the Navy for filing all correspondence and directives consist of 13 major subject groups. Each of these major subject groups is designated by a 4- or 5-digit numeric code. These major subject groups are as follows:

1000 Series	Military Personnel
2000 Series	Communications
3000 Series	Operations and Readiness
4000 Series	Logistics
5000 Series	General Administration and Management
6000 Series	Medicine and Surgery
7000 Series	Financial Management
8000 Series	Ordnance Material
9000 Series	Ships Design and Ships Material
10000 Series	General Material
11000 Series	Facilities and Activities Ashore
12000 Series	Civilain Personnel
13000 Series	Aeronautical Material

Small activities may adapt this sytem to their needs by preparing file folders for a minimum number of major subjects and arranging material within these folders according to the classification number assigned. Files may be expanded by adding more file folders as required. The file numbers originally assigned to the records remain pertinent and need not be changed. This makes expansion logical and easy. Large activities may adapt this filing

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system to their needs by preparing folders not only for the major subject groups but also for the primary and secondary groups.

The 13 major subject groups are subdivided into primary, secondary, and sometimes tertiary breakdowns. Primary subjects are designated by the last three digits of the major subject group numeric code. For example, the major subject of General Administration and Management, coded 5000, is subdivided into primary groups as follows:

5000 . . . . . General Administration and Management
5200 . . . . . Management Improvement
5300 . . . . . Personnel
5400 . . . . . Organization, Function, Status, etc.

Primary subjects are subdivided into secondary subjects by the last two digits of the numeric code. Tertiary breaks are indicated by the final digit. For example:

5200 Management Improvement
5210 Office Methods and Records Management
5211 Files and Records Systems

Additional information pertaining to classifying and filing correspondence and other documents by subjects may be found in SecNav Instruction 5211.3 (Series).

Establishment and Maintenance of Files

The following are factors contributing to the establishment of an efficient filing system:

1. Organization of a correct system.
2. Setting up correct file subjects in folders.
3. Correct classification of all incoming and outgoing correspondence.
4. Modification of the system as required.
5. Thorough indoctrination of personnel maintaining the file.

With a filing system correctly established, it is possible for anyone with a general knowledge of the Navy filing system to locate a particular piece of correspondence speedily and conveniently.

Filing equipment will vary depending upon needs of the division. Some of the most common are visible files and file drawer cabinets. The visible files are those in which cards, sheets, or strips of paper are arranged so that the margins can all be seen at once. These are frequently used to file AC data cards, for instance. The file drawer cabinet is used extensively for general filing purposes. It uses standard size filing folders with tabs for printing subject classification numbers to provide for visual sighting and easy location. (See fig. 8-3.)

How important are the records of the division's files? Important enough that Congress has passed laws governing their disposition and fixing penalties for their unauthorized destructtion.

Though sometimes monotonous, all tasks connected with files, including their disposition, must be taken seriously. Decisions whether to save or not to save cannot be avoided by simply saving everything. Sooner or later, filing cabinets become overfull and something has to be done. The key to the filing is to be able to tell what should be held in the files and for how long, and what should, or must, be destroyed or transferred for preservation.

Basic Government legislation covering records disposal defines Government records essentially as follows: All documentary material, including books, papers, maps, and photographs, made or received by an agency of the U.S. Government in connection with the transaction of public business and appropriate for preservation.

Navy Regulations defines Navy records as "Copies of all official correspondence sent and the originals of all official correspondence received, and such other correspondence as will or may become the subject of future reference or action." Additionally, official correspondence is defined as "All recorded communications sent or received by a person in the Naval Establishment in the execution of the duties of his office." Nonrecord material, then, may be defined as any material which serves no documentary or record purpose or, in other words, it is material that just is not worth keeping except for a limited time.

It is quite possible that very little of the material in the division office files would be classified as official records. It is not always possible to draw a distinct line between record and nonrecord material and apply a hard and fast rule. The disposition of the majority or records that the ATC/OC division would keep are referenced in official instructions.

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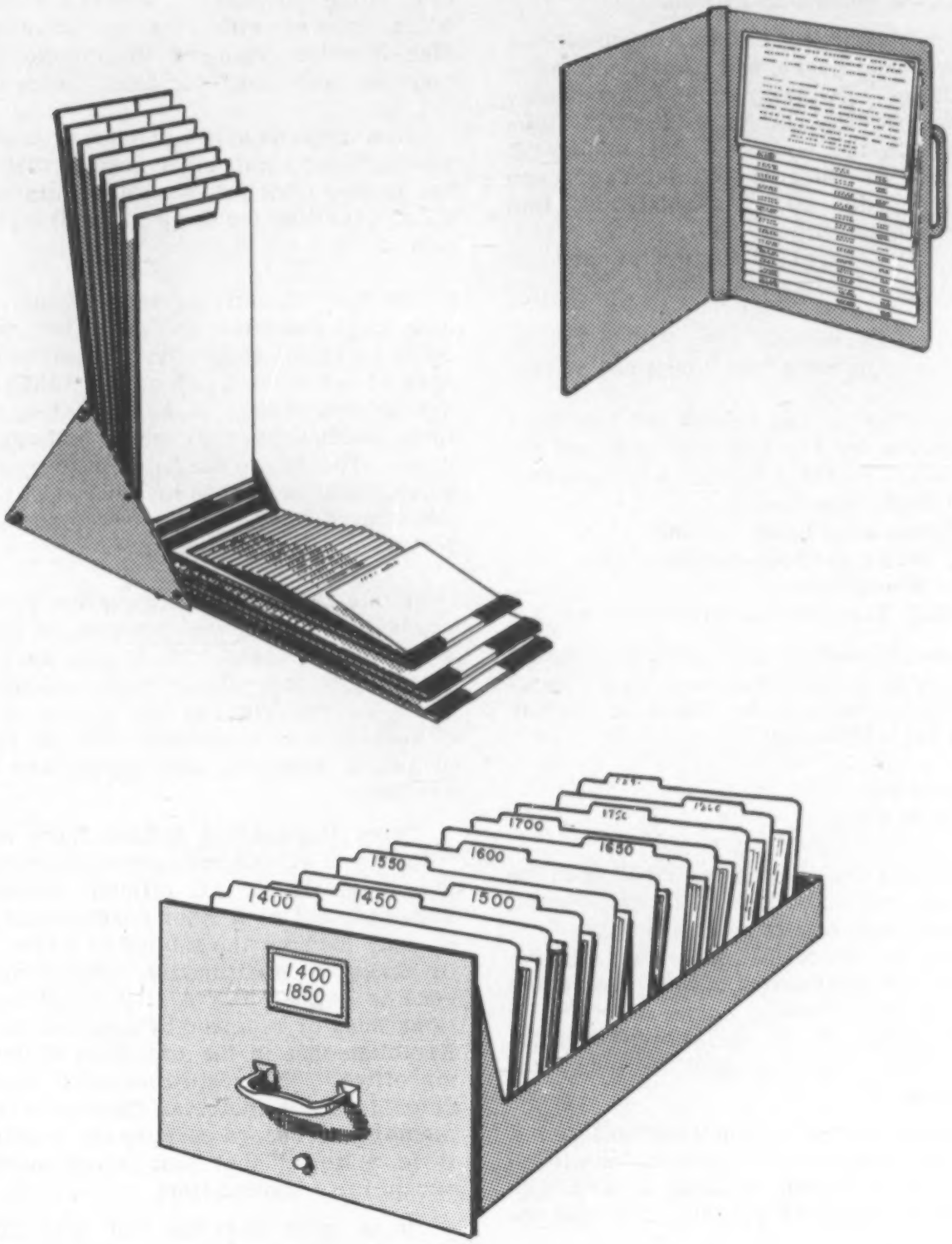

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Figure 8-3.—Visible files and file drawers.

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The following is a partial listing of logs and records common to air traffic control. The complete Navy system of records disposal is found in SecNav Instruction 5212.5 (Series).

1. Traffic control records relating to the internal control of air and space traffic and records relating to the supervision of clearance and other traffic control records—retain for 6 months.

2. Operations logs accumulated by the operations department of flight activites including control tower records—retain for 6 months.

3. Daily flight logs of visiting aircraft—retain for 6 months after date of last entry or after log is filled.

4. Aircraft clearance and arrival reports (progress strips)—retain for 3 months.

5. Clearance and weather forms (DD-175)—retain for 3 months. (OpNav 3710.7 (Series).)

NOTE: By agreement between FAA and DOD, military flight plans filed directly with FAA FSS's will be retained by them for 15 days and then forwarded to the home station indicated on the flight plan. Flight plans forwarded to naval shore installations by FSS's are retained in the operation department files for a period of 3 months after which they may be destroyed.

6. Correspondence, copies of reports, and other records relating to the internal operation and administration of air and space traffic—retain for 2 years.

7. Weight and balance clearance form (DD-365F)—retain originals 3 months.

These records are considered temporary and should be destroyed after the prescribed retention period.

There are two ways that records which have outlived their current value may be disposed of: (1) local destruction, or (2) transfer for later destruction or, if records are permanent, for preservation. To insure that handling of records is consistent and is not left to chance one officer is usually assigned the duty of coordinating all records disposal aboard an activity, either ship or station. This officer would then take charge of the physical dispostion of all official records that have been designated for either transfer or destruction. Most unclassified material in the division files would not require transfer but is of the type that may be destroyed in the office. Classified items must be destroyed by burning in accordance with current security regulations. At sea, unclassified records as well as those classified should be burned.

The General Services Administration is responsible for general procedures, both for disposal of Federal Government records and for reproduction of them. Seventeen Federal Records Centers have been established at locations conveniently accessible to the various districts and ocean areas. The Administration Office, Navy Department, is the Navy's liaison with Federal Records Centers.

PERSONNEL TRAINING

The object of a training program is to increase the usefulness of an individual to the organization and to provide a climate and career incentives that will retain high caliber personnel. The many complex functions of controlling aircraft operations may be successfully accomplished only by integrated action of several individuals working together as a team. With these two facts in mind, it would be safe to say that training programs must provide for both individual and group training.

In this section it is intended to present some of the administrative aspects of the division training program; i.e., scheduling, recording accomplished training, and reporting to higher authority.

First, the ship or station will have a training program in effect as directed by higher authority. It normally consists of nonprofessional subject matter; that is to say, subject matter such as military duties and responsibilities or moral attributes not technically required within the AC rating. The Educaction and Training Officer, through the chain of command, will normally instruct the division training petty officer concerning subject material and required application to division personnel.

The training petty officer will normally establish and maintain the training program from the professional standpoint, for the division. The desired effect is to increase the individual's value to the division and retain high caliber personnel. Therefore, training must be directed toward qualifying air traffic controllers to maintain the desired level of controller personnel and to help individuals qualify and advance as rapidly as time requirements and their willingness and ability to accept more responsibility will allow.

10869

It is obvious that one man working alone cannot set up and execute an entire training program. The training PO, therefore, must select instructors from within the division to assist him. The ideal situation would be to have several qualified instructors in each watch section to maintain the formal instruction situation. However, the ideal never seems to exist. This places another large requirement upon the training PO. He must locate and train, if necessary, qualified instructors. This might be considered the most important link in the chain of events over which the training PO has control. If the instructors are not interested, motiviated, and well trained, chances are that the subject material will not reach the trainee because of one of various possible reasons. Therefore, the time spent in that particular training situation may be wasted, or if there is a complete lack of interest or necessity for the material concerned, the instructor may "gundeck" the local record with a net result of production of useless paperwork. This may not be apparent immediately, but it usually stands out when evaluated in terms of the following questions:

1. How many personnel made rates last time?
2. How smooth is the operation of the local facility when the weather is bad and traffic heavy?
3. What is the general attitude or morale of the division personnel?

Some of the problems the training PO must consider when compiling a training schedule are availability of people, an appropriate place where formal training can be accomplished, and the applicability to the various rates.

The schedule must be flexible since most ATC/OC personnel are watch standers with variable working hours. If at all possible, the training should be conducted during the watch when traffic will permit. There will be times, however, when watch standers will be required to attend training sessions even though they are off duty. The schedule should be simply stated and easy to follow. The general scheduled times for training will depend almost entirely upon the type of watch bill the division is working. The actual time of training is usually left to the discretion of the section leader within a specific time frame to allow optimum management practice.

Most facilities have a ready room available for formal training purpose use. If such a room is not readily available, then the training PO will have to make other arrangements for appropriate space. This may not seem very important; however, it has been proven over and over that the trainee will learn faster and retain more if the physical environment provides reasonable trainee comfort. If it is necessary to schedule and conduct training, then it should be necessary to consider every possible asset to effective presentation of the program.

The basis for applicability of each part of the training program to the various ratings should be the Record of Practical Factors, NavPers 1414/1 (AC). Few people realize the importance of practical factors to the individual. The basic decision factors for what will be taught in the service schools, what will be published in the Rate Training Manuals such as this one, and what will be covered by the fleetwide rating exams are covered in the Record of Practical Factors. If, then, the 1414/1 (AC) is thoroughly reviewed and used as a basis for determining the subjects to be taught in a formal training program, it would be logical that a trainee could receive considerable assistance in advancement and increase his value to the Navy by undergoing such training.

Keeping records of training is necessary as a reference for each individual concerned and for preparing reports of training accomplished. A training report for the division is accomplished in accordance with local directives, so that it blends into a department training report. A department training officer should be available for assistance with this report if needed. Various forms have been devised for recording training within a division; however, some use no form but merely handwritten reports. Figure 8-4 is an example of one facility's form for recording training within the section to submit to the training PO and reference for recording training received on an individual's training record. A record of training for each individual should be kept in the division files. One handy and personal way to accomplish this is to keep a folder for each man for record purposes and personal use. This individual training record should contain a record of practical factors, a record of all formal training received, and other local

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056 238

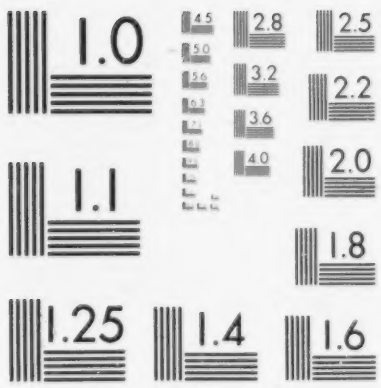

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AIR OPERATIONS TRAINING RECORD

DIVISION ATC

DATE TRAINING HELD 8 MAY 1969 TYPE (circle one) MILITARY PROFESSIONAL

BRANCH TOWER

INSTRUCTOR'S NAME MILLER, D. AC3 DM

LESSON NAME, UNIT, NUMBER DRIFT & DRIFT CORRECTIONS 1AF2

NAME	
1 HARRIS, G.F.	
2 LANG, W.R.	
3 McREYNOLDS, J.W.	
4 HAGGERTY, W.A.	
5 PURDOM, B.A.	
6 CHAPMAN, W.R.	25
7	26
8	27
9	28
10	29
11	30
12	31
13	32
14	33
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16	35
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23	42
24	43

REMARKS

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Figure 8-4.—Section training record.

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qualifications such as designation of PAR IFR controller. Figure 8-5 is an example of an individual training folder and contents. This type recordkeeping allows the training PO to hand over the folder to the individual upon transfer so that he can show it to the new training PO at the next duty station and continue the process indefinitely.

Job Rotation

The practice of rotating men though the various phases of their rating is recognized as beneficial to the men and hence the Navy. A plan of rotation may be worked out covering several months by each section. The rotation schedule should show relief of mess cooks and compartment cleaners where necessary. This advance notice of such assignment and knowledge of what he will do when he returns to the division may help combat the feeling of many young men that they have been abandoned or eliminate the common belief that it is punishment for the individual concerned. By use of a rotation schedule the training PO can help the individual progress in knowledge and application of his acquired knowledge as he advances. Additionally, with periodic rotation, an individual is presented with challenges of new jobs and phases of the rating, and he is less likely to become disinterested and dissatisfied with his job and consequently the Navy.

Testing

The overall effectivness of a training program will be indicated by the proficiency with which trainees perform their various taks, by the demonstation of their understanding of the subject matter, and by the results returned from the rating exams. However, testing should not be overlooked as an important teaching tool and as a short term evaluation of the program progress.

The most difficult thing about testing is the job of compiling a test containing valid and thought-provoking questions. Since this job must be performed by the instructor, it may be one of the reasons that this method of teaching and evaluating is overlooked in many instances. A well-preparted test can generate lively discussion, instill a competitive spirit in the trainees, and provide them with a sense of accomplishment if they do well or an indication of areas where additional study is needed if they do poorly.

RESOURCES MANAGEMENT

Resources management systems are a series of systems designed to promote better management throughout the DOD by providing managers with improved means of obtaining and controlling resources required to accomplish missions.

Within the Department of the Navy, planning and programing are major functions of the Office of CNO and Headquarters, U.S.M.C. It is through the proper execution of these functions that the effort of the entire Navy Department is initially guided and subsequently controlled.

Navy programs are in general developed along a well ordered and clearly defined pattern. Requirements are identified, validated, and planned; plans are translated into programs; and programs are translated into budget requests which, upon approval, provide the dollars to produce the men, equipment, and facilities needed to satisfy requirements.

Budgeting is usually decentralized at large activities; that is, those composed of a number of departments. At such an activity, the commanding officer normally issues a budget call for the various activity components to develop their operating budget estimates and supporting data. In the budget call he communicates policy decisions, assumptions, and instructions based on guidance he has received through command channels, together with his projection of local program and workload objectives.

In preparing his budget, each department head translates the planning information into appropriate budget elements for each division or function under his management. He then assigns a realistic dollar estimate to each with the total representing his department's estimate. Completed departmental estimates are usually forwarded first to the activity comptroller for analysis and review by his staff. The comptroller then presents them to the commanding officer and offers such recommendations as he consid rs necessary. Senior AC's may be called upon to furnish a

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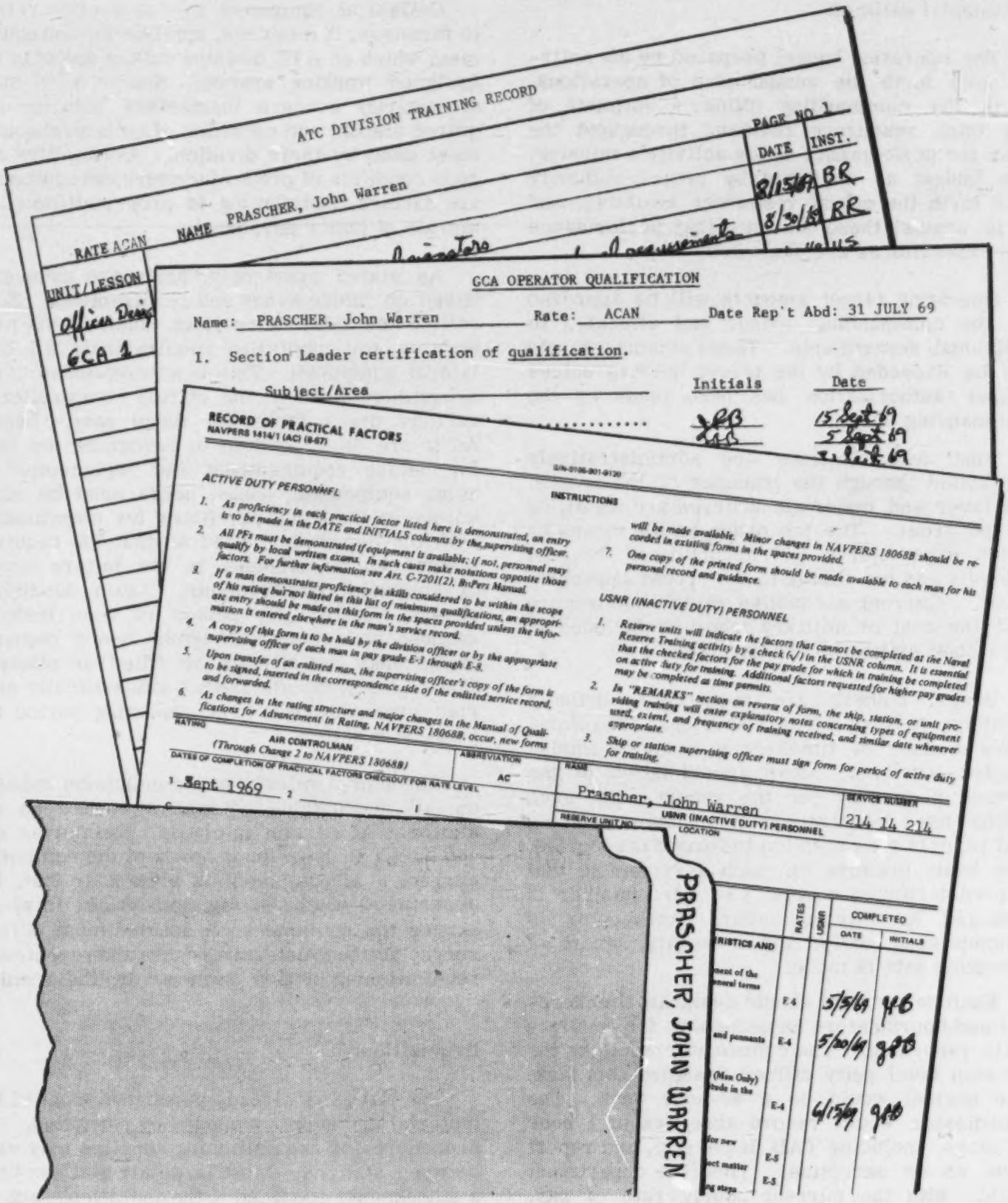

ATC DIVISION TRAINING RECORD

RATE ACAN NAME PRASCHER, John Warren

PAGE NO 1

DATE	INST.
8/15/69	BR
8/30/69	RR

UNIT/LESSON

Officer Desig

GCA 1

GCA OPERATOR QUALIFICATION

Name: PRASCHER, John Warren Rate: ACAN Date Rep't Abd: 31 JULY 69

I. Section Leader certification of qualification.

Subject/Area	Initials	Date
		15 Sept 69
		5 Sept 69
		21 Sept 69

RECORD OF PRACTICAL FACTORS
NAVPERS 1414/1 (AC) (8-67)

S/N-0106-801-9120

ACTIVE DUTY PERSONNEL

INSTRUCTIONS

1. As proficiency in each practical factor listed here is demonstrated, an entry is to be made in the DATE and INITIALS columns by the supervising officer.
2. All PFs must be demonstrated if equipment is available; if not, personnel may qualify by local written exams. In such cases make notations opposite those factors. For further information see Art. C-7201(2), BuPers Manual.
3. If a man demonstrates proficiency in skills considered to be within the scope of his rating but not listed in this list of minimum qualifications, an appropriate entry should be made on this form in the spaces provided unless the information is entered elsewhere in the man's service record.
4. A copy of this form is to be held by the division officer or by the appropriate supervising officer of each man in pay grade E-3 through E-8.
5. Upon transfer of an enlisted man, the supervising officer's copy of the form is to be signed, inserted in the correspondence side of the enlisted service record, and forwarded.
6. As changes in the rating structure and major changes in the Manual of Qualifications for Advancement in Rating, NAVPERS 18068B, occur, new forms will be made available. Minor changes in NAVPERS 18068B should be recorded in existing forms in the spaces provided.
7. One copy of the printed form should be made available to each man for his personal record and guidance.

USNR (INACTIVE DUTY) PERSONNEL

1. Reserve units will indicate the factors that cannot be completed at the Naval Reserve Training activity by a check (✓) in the USNR column. It is essential that the checked factors for the pay grade for which in training be completed on active duty for training. Additional factors requested for higher pay grades may be completed as time permits.
2. In "REMARKS" section on reverse of form, the ship, station, or unit providing training will enter explanatory notes concerning types of equipment used, extent, and frequency of training received, and similar data whenever appropriate.
3. Ship or station supervising officer must sign form for period of active duty for training.

RATING: AIR CONTROLMAN (Through Change 2 to NAVPERS 18068B) | ABBREVIATION: AC | NAME: Prascher, John Warren | SERVICE NUMBER: 214 14 214

DATES OF COMPLETION OF PRACTICAL FACTORS CHECKOUT FOR RATE LEVEL: 1 Sept. 1969 2 3

RESERVE UNIT NO. | LOCATION | USNR (INACTIVE DUTY) PERSONNEL

PRASCHER, JOHN WARREN

RISTICS AND	RATES	USNR	COMPLETED DATE	COMPLETED INITIALS
nent of the neral terms	E-4		5/5/69	JHB
and pennants	E-4		5/20/69	JHB
(Men Only) tude in the	E-4		6/15/69	JHB
for new	E-5			
ect matter	E-5			
g steps				

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Figure 8-5.—Individual training record.

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realistic estimate of division needs which the department will use in formulating the departmental estimate.

The operating budget prepared by the activity sets forth the annual plan of operations. It is the commanding officer's estimate of the total resources required throughout the year for performance of the activity's mission. The budget as approved by proper authority sets forth the actual resources available, and it is against these amounts that performance and expenditures are evaluated.

Operating target amounts will be approved by the commanding officer and allocated to individual departments. These amounts should not be exceeded by the target holders unless proper authorization has been made by the commanding officer.

Fund authorizations are administratively controlled through the issuance of job orders. All labor and materials charges are identified by job order. The job order is the means by which expenditures are accumulated for cost analysis and for charge to the proper appropriation. Current accounting directives require that the cost of military labor be included in the budget estimates and execution.

Budget holders are required to make a monthly report of military services. Therefore, some method of timekeeping must be implemented locally to allow accumulation of the figures necessary for the report. One such method used frequently is the exception method; that is, only the exception to normal is reported. The basic premise for such a system is that a predetermined normal job order number is assinged to military labor, timekeeping is accomplished daily, and a weekly report of exception data is made.

Each department should designate timekeepers and coordinators as necessary for accurate daily recording. The coordinator would be the division level petty officer assigned this task. The normal would be a 40-hour week. The coordinator would record absences of 1 hour or more, including TAD, leave etc., and report them as an exception. Then the department could, with the current hourly rate of pay, compute the cost of military services, compare the actual cost against the approved budget, and use current data for future estimates.

Collateral Equipment Requirements

Collateral equipment in this section refers to furniture, furnishings, appliances, and equipment which an ATC division makes use of in the assigned working spaces. Senior AC's must necessarily concern themselves with the required amount and condition of collateral equipment used by their division. Availability and good condition of proper furniture and equipment are factors contributing to proper attitude and morale of junior personnel.

As stated previously, funds are requested based on future needs and requirements. Each station has local instructions which outline procedures for submitting requirements for collateral equipment. This is accomplished at the department level to the station comptroller at various times during the fiscal year. Senior AC's are in a position to recognize the need for future requirements and replacement of aging equipment. These needs must be made known to the division officer for coordination with the department head so that the requirements can be included in the latters report of equipment requirements. Again, conditions change due to the period of time between request and receipt of funds; hence requirements may not always be filled as planned. These requirements are not automatically carried over into the next reporting period but must be restated.

The comptroller's office maintains records on all accountable equipment aboard an air station. At certain intervals, inventories are conducted to keep the records of the equipment current. If equipment is broken or lost, the department head and division officer in whose spaces the equipment was located must initiate survey action to determine cause and recommend requisitioning action required by the results.

Requisitioning

The Navy has already purchased most of the material and supplies needed by activities. The procedure for requisitioning supplies may vary between stations. Most large air stations have a storekeeper assigned to the operations department or one individual trained by the supply department for the actual completing of the standard requisition, DD form 1348. A relatively

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but would see the target return. Chaff jamming is easily countered by the incorporation of circuits which reject abnormally slow moving targets such as chaff, corner reflectors, balloon borne devices, and etc.

To further increase the difficulty in jamming the pulse compression type of radar, the PRF could be made to vary at random rate. This will cause each and every frequency in the transmitted pulse to change slightly each time the transmitter fires. Unless the returning echo contains exactly the same frequencies that were just transmitted, the matched filter will reject them.

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new concept of providing office and general supplies is the SERVMART system. These SERVMART's resemble a private self-service store. The petty officer responsible for maintaining supplies determines what is needed, obtains the approval from the officer within the department authorized to approve such expenditures by obtaining a signed DD form 1348 for an amount not to exceed the total cost of the supplies needed. The supplies may then be picked up at the SERVMART and the actual amount of purchase recorded on the DD form 1348. The various copies of the form are distributed to the necessary individuals so that the amount of the purhcase can be charged against the funds allocated to the department and the station.

Of course every need cannot be satisified by the SERVMART system. When the requirement exists, a properly completed DD form 1348 must be submitted through the supply department so that they can order what is required. In order to procure exactly what is needed when requisitioning supplies, the correct Federal stock number is required.

Plant Property Accounting

Plant property is all Navy-owned and Navy-controlled real and personal property of a capital nature located in the Naval Shore Establishment.

Plant property is divided into four classes: Class 1 (land); Class 2 (buildings and improvements); Class 3 (equipment, other than industrial plant equipment); and Class 4 (industrial plant equipment). It is around these classes of property that the inventory control system for plant property is built.

The inventory control system for plant property is designed to provide controls essential for compliance with statutory and DOD requirements concerning Government property. It provides for Navy-wide collecting, compling, recording, and reporting of plant property information. The system meets the objective of furnishing factual information on capital equipment to both financial and technical management. By requiring a reconciliation with funds expended for plant property, the system also insures that all such property in the Navy is accounted for.

The fiscal officer at each activity is charged with the establishment and maintenance of plant property account records. He must institute local procedures to insure compliance with directives and instructions issued by higher authority.

Department heads at each activity are responsible for plant property under their custody. In addition they must assist the fiscal officer in obtaining technical descriptions of plant property; affixing identification plates and decals on the property; determining the estimated life of property; reporting acquisitions, dispositions, transfers, and surveys of plant property; and conducting physical inventories.

FORMS, RECORDS, AND REPORTS

The Navy Stock List of Forms and Publications, NavSup 2002, contains a complete numerical listing of all available naval forms and publications distributed by the Navy and stocked for issue.

NOTE: There are a few exceptions to the above statement such as Aeronautical Charts and Publications discussed earlier in this manual.

Section I of the stock list is a general introduction in the use of the publication. Instructions for the breakdown of the columnar headings as they appear in the stock list, requisitioning instructions, etc., which if carefully studied should help determine the correct procedure for ordering the necessary forms and publications required for administrative functions.

The remaining sections of the stock list contain forms and publications which have been categorized on the basis of departmental sponsorship and/or functional usage. For example, section II contains forms used by the Navy. In section II can be found the NavPers Form 1414/1, AC Record of Practical Factors, and OpNav Forms 3722/1 and /2 used when submitting OpNav Report 3722-1. Section III contains BuPers publications. In section III can be found the AC 3 & 2 and 1 & C training manuals. Section VIII, parts C & D, contains aeronautical manual and letter publications such as technical

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OPNAV FORM 1000/2 (REV 1-61)

MANPOWER AUTHORIZATION

FROM: CHIEF OF NAVAL OPERATIONS
TO: DISTRIBUTION LIST

MARP CODE SEQ	LINE	S/L	ACTIVITY CODE	ACTIVITY NAME	S/S	COG	DISTR CODE	WD1 PROJ CODE	MANPOWER SPONSOR
5	01	5	1452-0537-00	NAS BEE	1	061			OP-50

TRANS NUMBER	DATE MO	DA	YR	PAGE NO
12786	08	15	68	18

SPONSOR P	A	M	MOB CODE ALC	LOC	TOTAL COPIES	DESK CODE
50	6	50	3A	06	18	HZ

SEQ CODE	BILLET TITLE	PRI NOBC NEC	SEC NOBC NEC	A F S B A P C T	DESIG RATE	G R A DATE E MO YR	ALLOW	COMPLEMENTS MD1	M+1	M+2	M+3	M+6	M+12	REQUIREMENTS FY 69	FY 70	FY 71	FY 72	FY 73	FY 74	M P S C
42000	OPERATIONS DEPT																			
42050	PER LEADING CHIEF						1	1	1	1	1	1	1	1	1	1	1	1	1	
42200	BARRACKS MAA/OPS BLDG MAA			B	GADCS		2	2	2	2	2	2	2	2	2	2	2	2	2	
42260	DUTY DRIV-MSNGR			G	BT2		1	1	1	1	1	1	1	1	1	1	1	1	1	
42360	COMP CLN				AN		1	1	1	1	1	1	1	1	1	1	1	1	1	
					AA		1	1	1	1	1	1	1	1	1	1	1	1	1	
42390	ATC DIV																			
42400	ATC LEADING CHIEF			B	ZACCM		1	1	1	1	1	1	1	1	1	1	1	1	1	
42450	TOWER CHIEF			B	ZACC		1	1	1	1	1	1	1	1	1	1	1	1	1	
42500	WATCH SUPV			B	ZAC1		4	4	4	4	4	4	4	4	4	4	4	4	4	
44500	APPROACH CONTROLLER	6922		B	ZAC1		1	1	1	1	1	1	1	1	1	1	1	1	1	
44550	APPROACH CONTROLLER	6922		B	ZRD1		3	3	3	3	3	3	3	3	3	3	3	3	3	
44600	TRAFFIC DIR			B	ZAC2		1	1	1	1	1	1	1	1	1	1	1	1	1	
44650	TRAFFIC DIR	6922		B	ZRD2		3	3	3	3	3	3	3	3	3	3	3	3	3	
44700	ELEVATION TRACKER			B	ZAC2		1	1	1	1	1	1	1	1	1	1	1	1	1	
44750	ELEVATION TRACKER			B	ZAC3		3	3	3	3	3	3	3	3	3	3	3	3	3	
44800	CA MAINT	1577		B	ZETC		1	1	1	1	1	1	1	1	1	1	1	1	1	
44850	CA MAINT	1577		B	ZET1		1	1	1	1	1	1	1	1	1	1	1	1	1	
44900	CA MAINT	1577		B	ZETR2		1	1	1	1	1	1	1	1	1	1	1	1	1	
44950	EQUIP MAINT	4353		B	ZEN1		1	1	1	1	1	1	1	1	1	1	1	1	1	
45500	SUPPLY DEPART																			
43550	MIL DIV CHIEF				SKC		1	1	1	1	1	1	1	1	1	1	1	1	1	
45300	TRAINING P O				SK2		1	1	1	1	1	1	1	1	1	1	1	1	1	
45750	ESNGR-EXTERNAL				SN		4	5	5	5	5	5	5	5	5	5	5	5	5	

FOR DETAILED DESCRIPTION OF ENTRIES REFER TO OPNAV INST. 1000.16 (SERIES)

TOTALS

PROG ELEMENT CODE	BUIC
31	45

AC. 226

Figure 8-6.—Manpower Authorization format.

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manuals for specific radar equipment. AC's may be interested in the operator's section of these manuals.

Aviators Flight Logbook

The Aviators Flight Logbook currently in use is OpNav Form 3760-31. This book is bound with a navy blue cover. Each naval aviator, naval aviation pilot, naval student pilot, and naval flight officer possesses a currently maintained aviators Flight Logbook. Possession of such a logbook by other personnel on duty involving flying is neither required nor prohibited. Each duly issued Aviators Flight Logbooks is considered to be the personal property of the individual who is currently, or in the past was, required to possess it.

AC's aboard ship assigned to the Air Operations branch of the OC division may be required to assist the ship's pilots in keeping their logbooks current. Instructions for coding the flight to indicate classification of flights are included in the front part of each logbook. Additional information may be found in the current OpNav Instruction 3710.7.

Manpower Authorizations

Manpower Authorizations reflect two expressions of naval manpower defined as follows:

1. Complement.

a. Fleet Units. The quantitative and qualitative naval personnel needs of an activity to effectively carry out all missions and tasks in wartime. This includes the ability to perform all equipment maintenance and to maintain Readiness Condition III and full power operations for indefinite periods as well as providing 100 percent battle station manning.

b. Shore Activities. The quantitative and qualitative naval personnel needs of an activity to effectively perform all tasks envisioned when moblized.

2. Allowance.

a. Fleet units. The quantitative and qualitative naval personnel needs of an activity to effectively carry out all missions and tasks in peacetime. This includes the ability to perform all equipment maintenance, carry out normal operating and training, and maintain Readiness Condition III and full power operations for limited periods, varying by type from 72 hours to 1 week, after which capacity for sustained effort is progressively reduced.

b. Shore Activities. The quantitative and qualitative naval personnel needs of an activity to effectively perform all peacetime operations.

While the CNO has responsibility for the preparation of Manpower Authorizations, commanding officers can assist in insuring the accuracy of their Manpower Authorizations by reviewing and submitting justified requests for changes. In reviewing Manpower Authorizations, it is of the utmost importance that the need for increases or reductions in both allowances and complements be considered and insure that the skills reflected in the Manpower Authorizations are valid.

Requests for changes to Manpower Authorizations may be submitted under the following circumstances:

1. Quantitive increases in allowances which are required to accommodate valid requirements resulting from changes in missions, tasks, or equipments.
2. Quantitative and/or qualitative reductions in allowances when the needs of an activity can be met with personnel in fewer numbers or lesser grades or rates than those authorized.
3. Qualitative changes in allowances when deemed necessary.
4. Quantitative and/or qualitative changes in complements when deemed necessary.

Manpower Authorization format, OpNav 1000/2, is normally held in the activity Personnel Office. Senior AC's should periodically review that portion applicable to the ATC division for possibly better utilization of manpower and when necessary initiate action for changes to the Manpower Authorizations.

Figure 8-6 is an example of a facility's OpNav Form 1000/2. To be absolutely sure that this is the very latest information, access must be available to all changes approved for the basic document since it was printed or reprinted.

From studying the form in figure 8-6, it can be seen that the operations leading chief billet at this particular activity is an E-8

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ALLOWANCE/COMPLEMENT CHANGE REQUEST
OPNAV FORM 1000/3 (8-65)
0107-700-0900

LEAVE BLANK	MARP CODE			ACTIVITY CODE	ACTIVITY NAME	TRANS NO. (Leave Blank)	DATE		PAGE NO.
	RED	LINE	M/L				MO	DA	YR
	5	01	5	1452-0567-00			5	15	70	1

SEQUENCE CODE	BILLET TITLE	PRI NOBC NEC	SEC NOBC NEC	A B R C	P A C	S E C K T	DESIG RATE	G R A D E	EFF DATE MO	EFF DATE YR	ALLOW MO	COMPLEMENTS MO1	MO2	MO3	MO4	MO5	CUR. RENT FY	REQUIREMENTS (BUREAU USE ONLY – LEAVE BLANK) FY1	FY2	FY3	FY4	FY5	M P S C
42390	ATC DIV																						
42400	ATC LEADING CHIEF				B	Z	ACCS		7	70	1												

billet and that the ATC division leading chief billet is an E-9 billet. This is an apparent discrepancy in that the ATC division is a part of the operations department. This situation could be resolved by changing the operations leading chief billet to an E-9 billet. However, suppose that all concerned decided that the duties performed by the ATC leading chief were such that the billet should properly be an E-8 billet. In such instances a change request on the proper form as shown in figure 8-7 is submitted as an enclosure to a cover letter containing justification for the change.

Change requests for Manpower Authorizations are submitted on OpNav Form 1000/3. (See fig. 8-7.) Complete instructions and information on Manpower Authorizations can be found in OpNav Instruction 1000.16 (Series). A revised Manpower Authorization is not promulgated each time a change is made. Significant changes will usually result in a complete reprinting, while minor changes do not justify the cost of reprinting and distribution.

A later section of this chapter, headed "Navy Correspondence," contains a sample of a letter that would accompany the 1000/3 form shown in figure 8-7.

The current information in the manpower system can be determined by checking the latest BuPers Report 1080-14 for enlisted personnel.

Enlisted Distribution and Verification Report

The Enlisted Distribution and Verification Report, BuPers Report 1080-14, is a report common to the activity and the distributional authority. It is a basic decision document which is used by the distributor to determine the activity's enlisted personnel status and requirements. The report is normally held in the activity personnel office. Senior AC's should review this monthly report periodically to insure that all the information contained in the report is correct. If an error is found, it should be brought to the attention of personnel so that they can initiate change action. The report is a machine printed report that contains a considerable amount of information about individuals in the division. For a breakdown on the code system used in the report, refer to chapter 6 of the Naval Manpower Information System Manual, NavPers 15642.

Figure 8-8 is an example of BuPers Report 1080-14, showing a partial listing of Air Controlmen at an air station.

Air Controlman Data Card

Personnel serving in BuPers-controlled billets in air traffic control facilities and all Air Controlmen must submit an Air Controlman Data Carda (NavPers 1306/6) directly to the Chief of Naval Personnel (Pers B2144). The submission cycle is 6 to 8 months prior to an individual's tour completion date (TDC). Additional cards may be submitted as changes occur.

Data cards are used by the Chief of Naval personnel for the efficient and orderly rotation of Air Controlmen. They are most important to the individual in that they are the ONLY information furnished the Air Controlman detail officer concerning the individual's duty choices and other pertinent assignment data.

Figure 8-9 is an example of AC data card, front and back.

The data card should be filled out by the individual concerned. Senior AC's must assist their men since they may be unfamiliar with the various schools available or may want information about a particular duty station to determine their choices. Also some of the newer individuals may not even be aware of the data card or the system of submission.

On the back of these cards is space for the division officer's evaluation of the individual's qualifications in air traffic control duties performed and space for recommendation of E-6 and above for instructor duty or to a strictly administrative billet filled by an AC. This helps the detail officer select the best qualified men for those important billets.

Air Traffic Activity Report

Commanding officers of shore activities operating ATC facilities are required to submit an Air Traffic Activity Report semiannually as of 30 June and 31 December. This report is assigned the report symbol 3721-13. The report is accomplished by completing OpNav

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ENLISTED DISTRIBUTION AND VERIFICATION REPORT — BUPERS REPORT 1080-14 — PAMI CONUS-LANT-PAC (REV 3-63)

ACTIVITY NAME: NAS BEE — BUPERS TO DISTY CODE: 03 7300 00 — EFFECTIVE DATE OF ALLOWANCE: 12 FE 60 — ALLOWANCE REVISION: 30624 — ACCOUNTING PERIOD ENDING: 28 FE 70 — PRINTED BY PAMI: CONUS — PAGE OUT CODE: 2316 — PAGE NUMBER: 68

ABCD	E NAME	F SERVICE NUMBER	G ACTUAL RATE	H P/R C	I DISTR RATE	J DISTR NEC	K NEC'S PNEC	L NEC'S SNEC	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	BB	CC	DD
	TOTAL BY RATE				ADR2			1	1										3	3						
	TOTAL BY RATING				AD			1	1											3	3					
	EDP/ALLOW TOTAL				ACCS			1	1																	
E2	THOMLEY RALPH M JR	2290720	ACCS	0	ACCS	0000	69110000	0	0	G	50	EE	00	1	03	JE	70	00	00	JE	71				R	
	TOTAL BY RATE				ACCS			1	1					1			1		1		1					
	EDP/ALLOW TOTAL				ACC			1	1																	
	NEC EDP/ALLOW TOTAL				ACC	5922		3	3																	
E26	FILDES BOBBIE GENE	5402489	ACC	0	ACC	5922	69119506	0	0	G	40								1	2	2	AU	72	00	00	
E2	FRENCH RICHARD D	11374100	ACC	0	ACC	0000	69110000	0	0	G	70								1	3	0	DR	70	00	00	
E2	LOWE WILEY G	3046268	ACC	0	ACC	0000	69220000	0	0	G	30								1	2	9	AU	72	00	00	
	TOTAL BY RATE				ACC			4	4					3					3		3					
	EDP/ALLOW TOTAL				AC1			5	5																	
	NEC EDP/ALLOW TOTAL				AC1	5922		1	1																	
E2	CATCHPOLE FREDERI R	5935909	AC1	0	AC1	0000	69220000	0	0	G	20								1	0	4	OC	71	00	00	
E2	FERGUSON WILLIAM AL	4689561	AC1	0	AC1	0000	69220000	0	0		30								1	3	0	OC	72	00	00	
E2	FRANK ELTON L	3497678	AC1	0	AC1	0000	69220000	0	0		30								1	0	7	AP	72	00	00	
E2	HUNT TERRY E	4512416	AC1	0	AC1	0000	69220000	0	0	G	40								1	2	4	NO	70	00	12	
E2	PAYNE HAROLD E	4900252	AC1	0	AC1	0000	69220000	0	0		10								1	1	0	SE	72	00	00	
E2	SCHMALL JAMES P	9734592	AC1	0	AC1	0000	69119588	0	0		60								1	1	3	SE	72	00	00	
E2	SHORT COTTIE W	5263702	AC1	0	AC1	0000	69118277	0	0	G	30								1	1	0	SE	72	00	00	
E2	WARDLAW WILLIAM ROY	5408142	AC1	0	AC1	0000	69120000	0	0	G	40								1	1	0	JE	71	00	00	
E2	WHYTE RICHARD A	2824091	AC1	0	AC1	0000	69220000	0	0	G	30								1	2	7	DE	73	00	00	
	TOTAL BY RATE				AC1			6	7					6					9	9	9					
	EDP/ALLOW TOTAL				AC2			7						9												

EXPLANATION OF TOTAL LINES

EDP	ALLOW	REV ALLOW	DISTY STATUS PUT PL 6 PR	ADBO	POB-1	POB-2	POB-3	POB-4	POB-5	POB-6	POB-7	POB-8	POB-9	POB-12	DISTY STATUS FPA, FPT, STP, TPA, PAT, REP, DIS	TOTAL REQUIRED ON BOARD
					MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	FEB	SEE COL. 2	SEE COL. 2

PROJECTED ON BOARD 3 MONTHS SHOWN

Figure 8-8.—Enlisted Distribution and Verification Report.

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1. NAME (Last, first, middle)	2. SERVICE NO.	3. RATE	4. PNEC	5. SNEC	6. CLASS	7. EAOS
U. R. APEON	B11111	AC1	6912		USN	9/5/72

(Submit in accordance with the Enlisted Transfer Manual, NAVPERS 15909A, Chapter 9.32)

8. REENLISTMENT INTENTIONS YES	NO	UNDECIDED	9. DEPENDENCY STATUS (W1DC, W3DC, etc., see PARI INSTRUCTIONS)	10. DEPENDENTS LOCATION (City & State) - (If overseas, enter date dependents arrived at that location)	DATE
X			W2DC	ANYWHERE, STATE, USA	4/19/70

11. SCHOOLS COMPLETED (Enter month and year school completed in appropriate block; if none completed, leave blank)

AC (Class A)	AC (Class B)	OCA	CCA	VCGE	VCGF	OTHER (Specify)
6/60	8/64	9/64	11/68			

12. PRESENT AND PREVIOUS DUTY ASSIGNMENTS AND QUALIFICATIONS (Enter five most recent duty stations including present station in chronological order. Place "X" in appropriate block for qualifications held and duties performed at each station. Under "OTHER", enter any other qualification such as CTO (Certified Tower Operator), AOS (Airways Operational Specialist), or Examiner.)

FROM (Mo/Yr)	TO (Mo/Yr)	NAME OF ACTIVITY	SR	JR	FLCL	TOW	APC	PAR	ASR	CCA	OTHER
12/69	---	USS CONTINUOUS (CVA-88)								X	NTDS
10/64	10/68	NAS Southwest	X	X	X	X	X	X	X		
7/62	8/64	NAS Overseas		X	X	X			X		
7/60	7/62	NAS STATESIDE		X	X	X					
1/60	7/68	Boot Camp and "A" school									

13. Enter any combination of duty preferences in order desired. For school preference, enter only if willing to obligate for active service required for school.

FIRST	SECOND	THIRD	SCHOOL PREFERENCE
NAS Lemoor	NAS Fallon	INSTRUCTOR DUTY West Coast	INSTRUCTOR TRAINING

AIR CONTROLMAN DATA CARD - NAVPERS 1306/6 (1-67) (Formerly NAVPERS 205) S/N.0105-402-7005

(Leave Blank) See reverse side

(A)

NAVPERS 1306/6 (1-67) (Formerly NAVPERS 205)

14. REMARKS (Enter any pertinent information affecting your availability, or of interest in determining your next duty assignment. May be filled in by you and/or the command)

U. R. Apeon (SIGNATURE OF AC) 4/19/70 (DATE)

15. ATC/CARRIER AIR OPS OFFICER'S EVALUATION (Indicate level of qualification in duty assigned by checking appropriate box)

LEVEL OF QUALIFICATION	DUTY ASSIGNED SR	JR	FLCL	TOW	APC	PAR	ASR	CCA (Indicate NEC)
Fully qualified; serves in a supervisory capacity.								
Fully qualified under all conditions.								
Qualified under normal (non-emergency conditions).								
Under training; acceptable with supervision								
Not qualified.								

16. FUTURE ASSIGNMENT RECOMMENDATIONS (E-6 and above only)

Considering this AC's performance in training other AC's, his leadership, military bearing, and deportment, would you recommend him for instructor duty? [✓] YES [ ] NO

Considering his objective attitude and interest in improving and evaluating ATC, would you recommend him for independent administrative duty? (e.g. NARASPO, Exam. Ctr., Washington Bureau) [✓] YES [ ] NO

COMMENTS (Note any deficiencies)

AC1 Apeon is a very competent and reliable individual. It is my opinion that he would excell as an instructor or in independent duty.

D. M. Pulde LCDR USN
(Signature of ATC/CARRIER AIR OPS OFFICER)

17. (Leave Blank)

(B)

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Figure 8-9—AC data card.

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Form 3721/12 shown in figure 8-10. Air traffic activity at satellite airfields (OLF and ALF) is reported by the parent activity.

Various uses of the information required by this report, such as budgetary, statistical, or trend information, are made by both CNO and FAA. Therefore a copy of the report is sent to FAA. Each facility must keep records of aircraft operations religiously to insure accurate data for the report. The instructions for completing OpNav Form 3721/12 are included on the back of the form. The instructions include the following definitions of terms for the purpose of this report and standardization of recordkeeping:

1. Aircraft Operations. Count aircraft operations as follows:

a. Count an arrival or departure as one operation.

b. Count aircraft touch and go landings as two operations.

c. Count an approach followed by a waveoff as two operations; e.g., field carrier landing practice or practice instrument approaches to minimium descent altitude or decision height.

d. Count each aircraft which transits the control area of jurisdiction and is provided ATC services as one operation.

e. Count aircraft operating in a formation as a single aircraft except when the formation breaks up into smaller formations or single aircraft. When this occurs, count each additional formation or single aircraft as a separate aircraft operation.

2. Instrument flight rules operations. An IFR operation is the handling by an ATC facility of the arrival or departure of an aircraft operating in accordance with instrument flight rules or the provision of IFR separation from other aircraft. Instrument operations must be counted whenever aircraft are provided IFR separation regardless of the existing weather conditions or the type of flight plans.

3. Visual flight rules operations. A VFR operation is an aircraft operation conducted in accordance with visual rules, except when the aircraft is being provided IFR separation from other aircraft.

4. Radar approaches. Any surveillance or precision radar approach to a landing, missed approach, or waveoff. Each approach executed must be counted, regardless of the flight rules under which the aircraft is operating or the existing weather conditions.

5. Automatic carrier landing system approaches. Activities with ACLS capability must report approaches and the mode of approach utilized in the appropriate spaces on the form.

NAALS Program

Naval Air Traffic Control, Air Navigation Aids and Landing Systems (NAALS) program is the subject of OpNav Instruction 3721.5 (Series). The purpose of the instruction, and hence of the program, is to promulgate policy and guidance for planning, programming and implementation of ATC, navaid, and landing system equipment at Navy and Marine Corps aviation activities ashore and afloat.

It is necessary for operating commands to continually review their NAALS operational capability to identify needed improvements. The need for an improved operational capability at an activity may be identified by any command responsible for supporting aircraft operations, by the Chief of Naval Material (CNM), by CNO, or may be imposed by FAA regulations. The need may stem from a technical deficiency in the installed equipment or from an operational deficiency that limits or derogates the operational capability of the ATC facility to support the mission and tasks assigned the aviation activity. The relief of these deficiencies may require additional or substitute equipment or the development of new equipment. Further, a need for an improved capability may arise from prospective rulemaking by the FAA which requires advanced planning at the Navy Department level.

Two formats are established as enclosures to OpNav Instruction 3721.5 (Series), titled NAALS Operational Capability Improvement Request (OCIR) and Master Implementation Plan (MIP). The OCIR, which is a typewritten format, delineates the deficiency, required operational capability, solution, and relative priority, in that order, that is submitted as a request for improved operational capability. The MIP is the responsibility of CNM which shows the operational requirements and programed equipments for the entire Navy and is revised semiannually for use by CNO. OCIR's having sufficient justification and not involving research and development may be reflected as revisions to the MIP, thereby becoming part

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AIR TRAFFIC ACTIVITY REPORT
OPNAV FORM 3721/12 (6-70)

(See Reverse Side For Instructions)

REPORT SYMBOL OPNAV 3721-15

TO: CHIEF OF NAVAL OPERATIONS
NAVY DEPARTMENT
WASHINGTON, D.C. 20350

1. REPORT PERIOD: January-June 1971

2. NAME OF ACTIVITY SUBMITTING REPORT: NAS MIRAMAR

3. LOCATION IDENTIFIER: NKX

4. NAME OF AIRFIELD THIS REPORT: MITSCHER FIELD

5. AIRCRAFT OPERATIONS	MILITARY		CIVIL		TOTAL
	NAVY/ MARINE CORPS	OTHER MILITARY	AIR CARRIER	GENERAL AVIATION	
IFR	12,117	656	35		12,808
VFR	25,613	10,151		23	35,787
TOTAL	37,730	10,807	35	23	48,595
6. RADAR APPROACHES					

7. ACLS APPROACHES	MODE I	MODE IA	MODE II	MODE III	TOTAL
		751	520	130	2201

8. REMARKS

APPROVED BY *(Name, title, and signature)*
B.G. WHEEL, LCDR, USN
BY DIRECTION, ATC FACILITY OFFICER, NAS MIRAMAR *B.G. Wheel*

COPY TO:
FEDERAL AVIATION ADMINISTRATION
INFORMATION AND STATISTICS DIVISION
OFFICE OF MANAGEMENT SYSTEMS
WASHINGTON, D.C. 20590

AC.230

Figure 8-10.—OpNav Form 3721/12.

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OPNAVINST 2400.7C

FREQUENCY USAGE REPORT
OPNAV FORM 2400/4 (1-66) S/N 0107-706-9002
Adhere to Instructions in OPNAVINST 2400.7C: DATA IS MACHINE PROCESSED

CONFIDENTIAL- MODIFIED HANDLING AUTHORIZED *(When filled in)*

OPNAV REPORT 2400-1

1. ACTIVITY CODE OR DESIG.	2. NAV. DIST. OR AREA	3. NAME OF REPORTING ACTIVITY OR SHIP	4. CALL SIGN	5. REPORTING PERIOD
DD XXX	LANT	USS NEVERSAIL C/O FPO, NY	NXYZ	0666

6. FREQUENCY	7. K	7. M	8. DESIGNATOR	9. EMISSION	10. TRANSMIT HRS.	11. GUARD HRS.	12. AUTHORITY
2030	X		A02	0.1A1	10		
2030	X		A02	1.24F1	10		
2030	X		A02	3A7J	10		
2030	X		T01	1.24F1	20		CNO ltr ser 01234 of 1 Jan 66
2030	X		TEMP	3A3J	50		CNO ltr ser 05678 of 15 Jan 66
2030	X		UNK	1.08F1	15		COMDESRON 21 OPORD 501
2030	X		UNK	6A3	12		CNO msg 010101Z Jun 66
2050	X		D26.02	1.24F1	5		
2060	X		A03	3A3J	100		
2500	X		UNK	6A3	10		CINCLANTFLT OPORD 37-65
2700	X		A01.01	0.1A1	30		
29,999.9	X		A03	6A3	50		
30,000	X		E03	1.24F1	25		
30.1		X	E06.01	3A3J	40		
30.1		X	E06.12	3A3J	50		
30.1		X	T14	3A3J	16		CNO ltr ser 5678 of 1 Feb 66
225.0		X	D08	6A3			
225.0		X	D10	6A3			
225.0		X	D26.01	3A3J			
225.0		X	D27.01	1.24F1			
225.0		X	TEMP	6A3			FAPUS 010203Z Jan 66

NOTE: This is a sample page and contains unclassified information.

SAMPLE

CONFIDENTIAL MODIFIED HANDLING AUTHORIZED *(When filled in)*

TITLE, RANK, SIGNATURE
CDR John DOE, USN, Commanding Officer

PAGE 1 OF 1

Enclosure (2)

A-22147

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Figure 8-11.—Frequency Usage Report form.

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CHAPTER 16

RADAR CIRCUITS

The purpose of this chapter is to review the principles which determine the characteristics of radar circuits and to follow this review with a discussion of how these circuits are applied in a typical radar set.

Among the principles which should be reviewed before continuing with the present discussion are certain factors which affect radar performance. Such factors are carrier frequency, pulse width and PRF, power relation (relation between peak and average power), beam width, and scan rate. The choice of these arbitrary constants for a particular system is determined by its tactical use, the accuracy required, the range to be covered, the practical physical size, and the problem of generating and receiving the signal. Basic information concerning these factors may be found in Basic Electronics. Other factors, such as antenna characteristics, wave guide design, and special circuits, have already been discussed in previous chapters of this course.

Three categories of basic circuits are discussed in the following paragraphs. These are timing circuits, sweep circuits, and transmitter circuits.

TIMING CIRCUITS

Timing or control is the function of the majority of the circuits in radar. Circuits in a radar set accomplish this function by producing a variety of voltage waveforms, such as square waves, sawtooth waves, trapezoidal waves, rectangular waves, brief rectangular pulses, and sharp peaks.

In sound and in radio, tubes operate within the limits for which they are designed; but in radar timing circuits, they are often violently overdriven, frequently operating at points which range from well in the grid current region to far beyond cutoff. Although all of these circuits are broadly classified as timing circuits, the specific function of any individual circuit might be timing, waveshaping, or wave generating.

The basic function of the radar timer is to synchronize the sweep voltage or current for the indicator with the transmitter pulse. The specific function is to produce the trigger pulse that starts the transmitter, the sweep circuits, rangemark generators, blanking circuits, and gating circuits. (See figure 16-1.)

BASIC REQUIREMENTS

The basic timing circuit should meet three basic requirements:

1. It must be free running (astable)—since the timer is the heart of the radar, it must establish the zero time reference and the PRF.
2. It must be stable in frequency (PRF)—the PRF, or its reciprocal, the PRT, must not change between pulses for accurate ranging.
3. The frequency must be variable in steps—for the radar to operate on different ranges.

There are three basic circuits that can meet the above mentioned requirements. They are the sine-wave oscillator, single-swing blocking oscillator, and the master trigger multivibrator.

The multivibrator timer is discussed because of its greater usage due to its better frequency stability.

MULTIVIBRATOR TIMER

Some of the information dealing with multivibrators, as presented in this chapter, may seem repetitious of Basic Electronics. Since this chapter is written for Aviation Electronics Technicians First and Chief, the treatment of multivibrators must be more thorough. The preliminary data is given as an aid in introducing more complicated aspects of the subject.

The multivibrator (square wave generator) is a form of relaxation oscillator. There are several different types in use, depending on the function they are required to perform. They are used for time sharing, gating, counting, and timing bases. Some of these circuits produce a

of the implementation cycle. This determination is made by CNO; however, in many instances that office depends upon feeder information from the aviation activities—hence the personnel who man and operate them.

Commanding officers of aviation activities ashore and afloat must review the NAALS operational capability of their respective activities on a continuing basis. Whenever a NAALS deficiency is identified pursuant to this review, a NAALS OCIR is completed and submitted to CNO (OP-53).

Frequency Usage Report

The radiofrequency spectrum has become increasingly congested as a result of the development of electromagnetic equipment and an increasing international requirement for radiofrequencies.

Frequency utilization data is a most valuable evidence to justify retention and to manage existing frequency resources. The Military Communications-Electronics Board, Joint Chiefs of Staff, has directed that frequency usage information be provided by the military services for inclusion in a Joint Radio Frequency Management Program.

U.S. Navy and Marine Corps acitivities and ships utilizing radiofrequencies for communications purposes must prepare a Frequency Usage Report, OpNav Report 2400-1.

The Communications Department normally prepares this report. However, senior AC's are frequently called upon to assist in its preparation by providing an accurate estimate of frequency usage for air traffic control at the facility. Complete information on this report is found in OpNav Instruction 2400.7 (Series) and JANAP 195, plus information on how to get new frequencies or delete old ones when required. This report is classified Confidential.

Figure 8-11 is an example of a Frequency Usage Report.

NAVY CORRESPONDENCE

The Navy Correspondence Manual prescribes policies and outlines procedures for the preparation of correspondence in the Department of the Navy. These policies and procedures are followed unless prescribed otherwise by the Secretary of the Navy or by his authority.

The selection of the proper communication for use in transmitting information is of special importance in Navy operations. Listed below are some of the types of correspondence and their uses:

1. Naval Letter. The naval letter is used by all activities of the Department of the Navy as a formal means of intranaval communication. It may be used also in addressing other agencies, either governmental or nongovernmental, which are familiar with the style. (See fig. 8-12.)

2. Joint Letter. When officials of two or more activities need to issue a letter concerning a particular subject of common interest to the activities, a joint letter is prepared. It may be directed to one addressee, or to two or more addresses identified separately or as a group. (See fig. 8-13).

3. Speedletter. A speedletter is a form of naval correspondence used for urgent communication which does not require electrical transmission. It is not used for directives. The primary purpose of the speedletter is to call attention to the communication, so that it will be handled as promptly as possible by the recipient. (See fig. 8-14.)

4. Memorandum. A memorandum is a form of naval correspondence used for informal communications within and between headquarters components of the Navy Department, between fleet and force commanders and units of command under their justification, and within a field activity. It may be directed to one or more addressees.

The naval letter is perhaps the most formal type of correspondence used by the Navy, but this does not mean that its content cannot be simple. Avoid long sentences and long words where short sentences and short words convey the same meaning. Each paragraph should contain one complete thought expressed in logical sequence. Tables, diagrams, and sketches should be included as enclosures if necessary to add to the clarity of the letter.

Figure 8-15 is an example of a smooth naval letter associated with the change request for a local Manpower Authorization format.

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DEPARTMENT OF THE NAVY
Name of Activity with Primary Interest
Name of First Participating Activity
and
Name of Second Participating Activity
Address

Official short title and code of first cosigner	Official short title and code of second cosigner	Official short title and code of originator Date

From: Title of head of activity with primary interest
Title of head of first participating activity
Title of head of second participating activity
To: Title of head of activity receiving letter, name of activity, location or mailing address if necessary

Subj: Brief topical statement of the subject of the letter

1. Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx. Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxx. Xxxxxxxxxxxxxxxxxxxxxxxx. Xxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx. Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx.

2. Xxxxxxxxxxxxxxxxxxxx

NAVEXOS-4181 11 A 0104 901 8800

USE FOR URGENT LETTERS ONLY

NAVAL SPEEDLETTER

DO NOT CLEAR THROUGH COMMUNICATION OFFICE

(One box must be checked)

☐ REGULAR MAIL ☐ SPECIAL DELIVERY

☐ AIR MAIL ☐ REGISTERED MAIL

CLASSIFICATION
*Appropriate designation
*Downgrading and declassification notation

IN REPLY REFER TO
Originator's code
*File number
*Serial number

DATE

TO: Title of head of activity, name of activity, mailing address of activity

NAVAL SPEEDLETTER—

Permits dispatch or informal language.

May be sent (1) with enclosures, (2) in a window envelope (size 8¾" x 3⅞"), if contents are not classified as confidential or higher, (3) to both naval and nonnaval activities.

Is packaged 500 sheets of white or of one color: yellow, pink, or green.

(Fold)

*Subj: Brief topical statement of the subject of the speedletter *(Classification symbol)

*Ref: (a) Identification of referenced document

*(Classification symbol) Xxxx

Code 01/my
15 May 1970

From: Commanding Officer, Naval Air Station Bee, Anywhere, State 66616
To: Chief of Naval Operations (Op-100)
Via: Chief of Naval Operations (Op-50)

Subj: Change to Manpower Allowance/Complement (OPNAV 1000-2)

Ref: (a) OPNAVINST 1000.16 (Series)
(b) OPNAV 1000/2, Enlisted, Activity Code _____,
Transaction No. _____, dated _____.

Encl: (1) Allowance/Complement Change Request, OPNAV Form 1000/3

1. In accordance with reference (a) it is requested that reference (b) be changed to reflect the change as indicated by enclosure (1).

2. Due to the nature of the required tasks of the ATC Division Leading Chief it is felt that they can be performed very effectively by an individual possessing broad technical or specialty expertise as required of an ACCS.

3. Further, the Operations Department Leading Chief billet is an E-8 billet which is incompatible with the existing allowance of an E-9 for the ATC Division Leading Chief.

4. In view of the foregoing it is requested that an allowance for an ACCS vice ACCM for ATC Division Leading Chief be approved.

I. M. STRONG

AC.234

Figure 8-15.—Smooth naval letter.

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APPENDIX I

DEFINITIONS AND ABBREVIATIONS

AL.—Approach and Landing (Chart).

APPROACH SEQUENCE.—The order in which aircraft are positioned while awaiting approach clearance or while on approach.

CONTROLLING OBSTRUCTION.—The highest obstruction relative to a prescribed geometric plane within a specific area.

DECISION HEIGHT (DH).—The height, specified in MSL, above the highest runway elevation in the touchdown zone at which a missed approach must be initiated if the required visual reference has not been established. This term is used only in procedures where an electronic glide slope provides the reference for descent, as in ILS or PAR.

FAC.—Final approach course.

FAF.—Final approach fix.

FLIGHT INSPECTION.—In-flight investigation and certification of certain operational performance characteristics of electronic and visual navigation facilities by an authorized inspector in conformance with the U.S. Standard Flight Inspection Manual, NavAir 16-1-520.

GPI.—Ground point of intercept. A point on the runway centerline at which it is assumed that a straight line extension of the glide slope intercepts the runway surface.

HAA.—Height above airport. Indicates the height of the MDA above the published airport elevation. This is published in conjunction with circling minimums. (Civilian only.)

HAT.—Height above touchdown. Indicates the height of the DH or MDA above the highest evelation in the touchdown zone. This is published in conjunction with straight-in minimums. (Civilian only.)

IAC.—Initial approach course.

IAF.—Initial approach fix.

IC.—Intermediate course.

IF.—Intermediate fix.

JAL.—High altitude approach and landing(Chart).

MAP.—Missed approach point. A point specified in the approach procedure which may be the point of intersection of an electronic glidepath with a decision height or MDA, a navigation facility, a fix, or a specified distance from the final approach fix, at which a pilot on approach will commence missed approach procedure if visual requirements for a landing do not exist.

MDA.—Minimum descent altitude. The lowest altitude to which descent can be authorized in procedures not using a glide slope. Aircraft are not authorized to descent below the MDA until the runway environment is in sight, and the aircraft is in a position to descend for a normal landing.

MHA.—Minimum holding altitude.

OBSTRUCTION.—An existing object, object of natural growth, or terrain at a fixed geographical location, with reference to which vertical clearance is or must be provided during flight operation.

OBSTRUCTION CLEARANCE.—The vertical distance between the lowest authorized flight altitude and a prescribed plane within a specific area.

PENETRATION.—That portion of a published high altitude instrument approach procedure which prescribes a descent path from the fix on which the procedure is based to a fix or altitude from which an approach to the airport is made.

PLATFORM.—A point 5,000 feet in the approach pattern at which all jet and turboprop aircraft will decrease their rate of descent to not more than 2,000 feet per minute, continuing letdown to the 10-mile gate. (Carriers only.)

PRECIPITOUS TERRAIN.—Terrain characterized by steep or abrupt slopes.

RUNWAY ENVIRONMENT.—The runway threshold or approved lighting aids or other markings identifiable with the runway.

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SEGMENT.—The basic functional division on an instrument approach procedure. The segment is oriented with respect to the course to be flown; i.e., intermediate, initial, or final approach segment.

TRANSITIONAL LEVEL.—The flight level below which heights are expressed in feet MSL and are based on approved station altimeter settings.

TDZ.—Touchdown zone. The first 3,000 feet of runway beginning at the runway threshold.

TDZ ELEVATION.—The highest elevation in the TDZ.

TERMINAL AREA FACILITY.—A facility providing air traffic control service for arriving and departing IFR aircraft and, on occasion, tower en route control service.

TOWER EN ROUTE CONTROL SERVICE.—Departure, en route, and arrival control service provided to IFR aircraft by one or more terminal area facilities.

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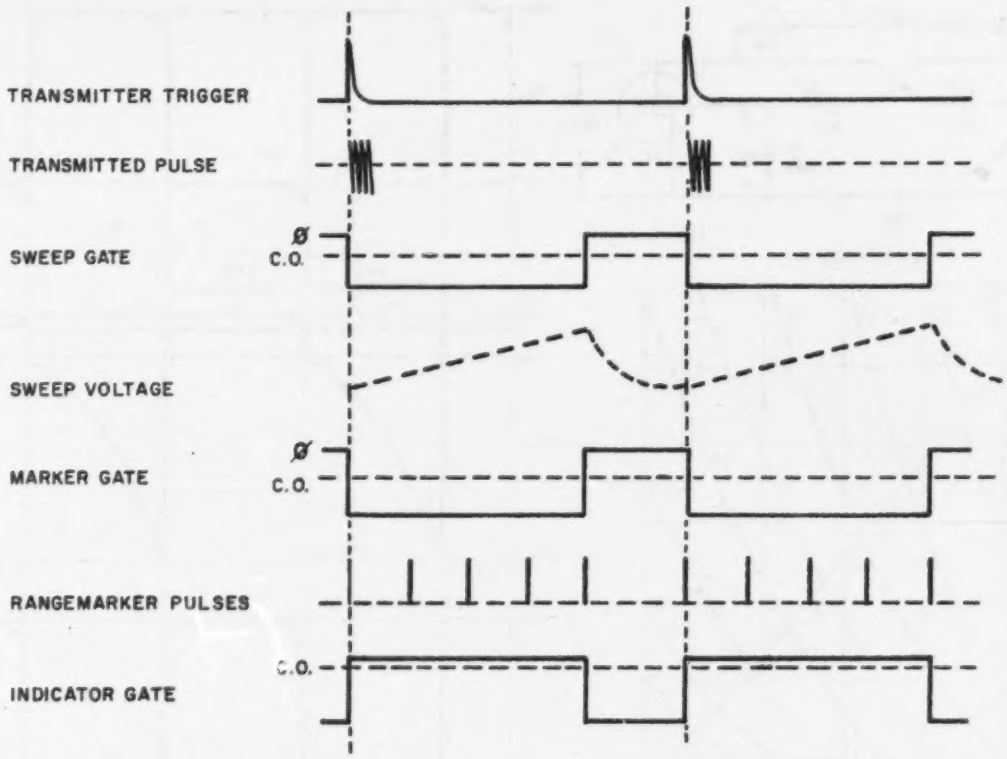

Figure 16-1.—Synchrogram of timer pulses.

specified wave shape repeatedly as long as power is supplied. Others produce one wave when pulsed, and remain inactive until another pulse is applied to the circuit; then they produce another wave. The output wave shape is the same regardless of the waveshape or amplitude of the initiating or TRIGGER pulse. Those which run continuously with only power applied are called free-running multivibrators. Those which produce one complete cycle of operation for each synchronizing pulse are called ONE-SHOT, ONE-CYCLE, or MONOSTABLE. Those which produce only a half cycle of operation for each synchronizing pulse are called BISTABLE, FLIP-FLOP, or SCALE-OF-TWO circuits. The frequency of free-running multivibrators, as with other types of oscillators, is influenced by all voltages and component sizes associated with the circuits. Therefore, although such circuits have only fair frequency stability when free running, adequate stability is readily achieved from a reliable a-c synchronizing voltage.

The square waveshape produced can be differentiated to produce accurately spaced peaked waveshapes. The duration and amplitude of any of the waveshapes are readily varied. Time delayed pulses can be produced by triggering a multivibrator with a peaked wave, letting it go through a cycle, and obtaining a new peaked wave somewhat later from the square wave produced.

Plate Coupled Multivibrator

The plate coupled multivibrator is the simplest of the multivibrators. The basic operating principles of this circuit are discussed in Basic Electronics. The following paragraphs are devoted to a quantitative analysis of the circuit and a discussion of methods for improving circuit action.

QUANTITATIVE ANALYSIS.—It is fairly easy to calculate the frequency and approximate voltage throughout a given circuit of this type. Consider, for example, the circuit shown in figure 16-2 (A). A plate voltage of 300 volts is applied to a 6SN7 dual triode with the circuit components shown. The plate voltage of V1 varies between the value corresponding to zero grid voltage and the value corresponding to zero plate current. You can determine these values from a 20-K loadline on the 6SN7 characteristic curves. The loadline crosses the zero grid voltage line at a plate voltage of 97 volts. At zero plate current, the plate voltage is 300 volts. From this information you can construct the plate voltage waveshape.

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ABSTRACT - Prepared by the Navy Training Publications Center, this manual is to be used by enlisted Naval personnel studying for advancements in the Aircrew Survival Equipmentman (PR) rating. Arranged in 20 chapters, this information includes sections on: (1) Parachute Familiarization, (2) Automatic Parachute Actuators, (3) Fasteners, (4) Standard Liferafts and Equipment, (5) Oxygen, and (6) NES-8A and NES-8B Personnel Parachute Assembly. Numerous illustrations, a reading list, and an index are included. (JS)

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AIRCREW

SURVIVAL EQUIPMENTMAN 3 & 2

BUREAU OF NAVAL PERSONNEL
RATE TRAINING MANUAL NAVPERS 10358-D

PREFACE

This Rate Training Manual was prepared for enlisted personnel of the Regular Navy and the Naval Reserve who are studying for advancement in the Aircrew Survival Equipmentman (PR) rating. It is based on the professional qualifications for advancement to PR3 and PR2, as set forth in the Manual of Qualifications for Advancement, NavPers 18068 (Series).

The manuscript for this training manual was prepared by the Navy Training Publications Center, Millington, Tennessee, for the Bureau of Naval Personnel. Technical reviews were provided by personnel of the Aircrew Survival Equipmentman Schools, Lakehurst, New Jersey; the Naval Examining Center, Great Lakes, Illinois; and the Naval Air Systems Command, Washington, D.C.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Educational Services Officer.* The following courses are recommended:

E 275 General Science I

E 290 Physics I

*"Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified on the active duty orders."

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CHAPTER 1

AIRCREW SURVIVAL EQUIPMENTMAN (PR) RATING

Many men engaged in a great number of specialized fields are needed to maintain the Navy's air arm in a condition of constant military readiness. All of these specialists are mutually dependent, and each contributes his part to the efficient operation of the entire organization. An important member of this team of specialists, which keeps naval aviation the most potent force of its kind in the world, is the PR.

The PR has as his primary mission the business of saving lives, a mission equally important in peace and in war. One generally thinks of the aviator as trusting his life to the aircraft he is flying. However, if for some reason the aircraft becomes disabled, the aviator's probability of survival would be small—except for the equipment that the PR has provided for such an emergency. With this equipment, aviators and their crews are able to abandon their disabled aircraft, parachute to safety, and survive on land, at sea, or even in the arctic wastelands.

This training manual is designed to help you meet the professional qualifications for advancement to Aircrew Survival Equipmentman Third and Second Class. The Aircrew Survival Equipmentman qualifications which are used as a guide in the preparation of this manual are current through the latest revision of the Manual of Qualifications for Advancement, NavPers 18068 (Series).

Chapter 1 gives information on the enlisted rating structure, the PR rating requirements, and procedures for advancement. It also includes references that will help you in working for advancement and in performing your duties.

Chapter 2 covers the Naval Aircraft Maintenance Program and Aircraft Maintenance Forms and Records involved in the implementation and maintenance of this program.

Chapter 3 is titled "Parachute Familiarization" and covers introduction to parachutes, types of parachutes, and components of parachutes.

Chapter 4 is concerned with parachute inspection and the arrangement of a parachute loft and facilities. It covers the purpose of parachute inspection, factors affecting malfunctions, inspection intervals, inspection procedures, and the general floor plan of a typical parachute loft.

Chapter 5 discusses parachute packing and rigging. It covers the rigging tools, packing tools, removing suspension line entanglements, handling packed parachutes, and safety precautions.

Chapters 6 and 7 present information on packing and rigging the NC-3 and NB-11 parachutes with and without the pararaft.

Chapter 8 deals with the Martin-Baker parachutes and the Martin-Baker drogue parachute.

Chapter 9 discusses the Master Specialties 1000 series automatic parachute actuator. It covers information on preparation, maintenance, inspection, and safety precautions.

Chapter 10 deals with parachute maintenance and repairs. It gives information on fabric materials, tapes and webbing, precautions against fabric damage, parachute cleaning, stenciling, and types of stitches and seams.

Chapter 11 is devoted to sewing machine familiarization, cleaning, and lubrication.

Chapter 12 covers the different types of fasteners, such as snap fasteners, grommets, speedy rivets, hook and pile tape, and slide fasteners.

Chapter 13 is titled "Protective Helmets and Oxygen Masks," and covers the various types of helmets and oxygen masks used by the Navy.

Chapter 14 lists some of the different types of flight clothing and protective equipment, such as flight suits, torso harness suit, anti-g suit, antiexposure suits, and flight boots.

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Chapter 15 is titled "Standard Liferafts and Equipment," and covers multiplace liferafts and single place liferafts.

Chapter 16 deals with recharging carbon dioxide cylinders. It covers CO_2 recharge equipment and liferaft inflation requirements.

Chapter 17 discusses safety belts, shoulder harnesses (V and H types), and the testing machine.

Chapter 18 is devoted to oxygen. It deals with test stands, regulators, and controllers.

Chapter 19 introduces the NES-8A personnel parachute assembly. It discusses the operation and packing procedures for this unit.

Chapter 20 presents the NES-8B parachute. It is devoted to the sequence of events of operation and packing procedures.

ENLISTED RATING STRUCTURE

The present enlisted rating structure consists of general ratings and service ratings.

General ratings identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Service ratings identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

PR RATING

The PR rating is a general rating and is included in Navy Occupational Group IX (Aviation). There are no PR service ratings.

Figure 1-1 illustrates the path of advancement from Recruit to Master Chief, Warrant Officer, or Limited Duty Officer. Figure 1-1 indicate career stages from which qualified enlisted men may advance to Warrant Officer (W-1) and selected Commissioned Warrant Officers (W-2 and W-3) may advance to Limited Duty Officer.

The Aircrew Survival Equipmentman (Class A) School, located at Lakehurst, New Jersey, is designed to provide PR strikers with the understanding and knowledge which lead to the fulfillment of the technical requirements for advancement to PR, Third Class. The

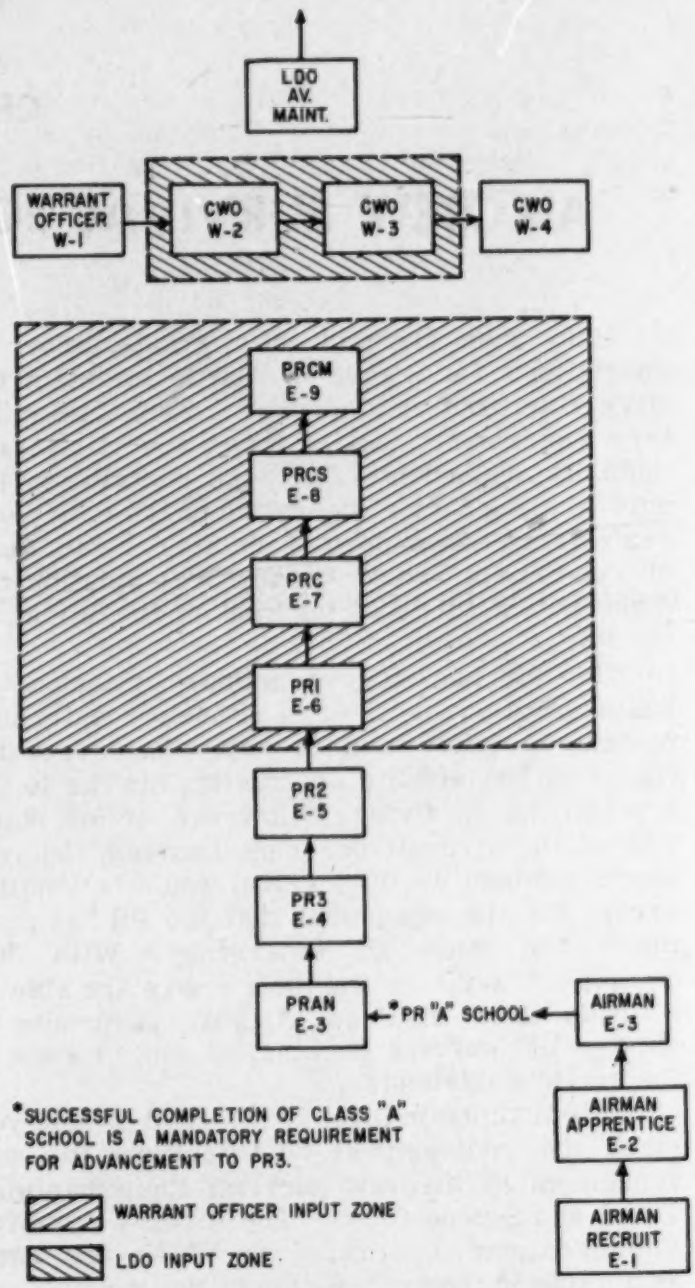

PR.1

Figure 1-1.—Path of advancement.

opportunity is provided to make one premeditated free-fall descent, using a parachute packed by the student, under the supervision of a qualified instructor. This is on a strictly voluntary basis after the man arrives at the school.

Entrance requirements to the school are as follows:

Candidate must have a minimum GCT plus MECH score totaling 105. Twenty-four months

of obligated service from the date of entry is required.

The Third Class and Second Class PR's have the following duties to perform:

Inspect, maintain, and repair parachutes, survival equipment, and flight and protective clothing and equipment. Pack and rig parachutes. Pack and equip rafts. Repair and test oxygen regulators, controllers, oxygen bailout bottles, and liquid oxygen converters removed from aircraft. Fit and maintain oxygen masks, flight clothing, antiexposure suits, and anti-g suits. Operate and maintain carbon dioxide and oxygen shop transfer and recharge equipment. Operate oxygen component test stands. Operate and make minor adjustments on sewing machines. Test safety belts and shoulder harnesses removed from aircraft. Assist in supervising the operation of parachute lofts, oxygen shops, and survival shops, and instruct personnel in the proper techniques of survival.

LEADERSHIP

As you advance to PR3 or PR2, more and more of your worth to the Navy is judged on the basis of the amount of efficient work you are able to obtain from the men under your supervision. The Secretary of the Navy has outlined some of the most important aspects of naval leadership in General Order Number 21.

Naval Leadership is the art of accomplishing the Navy's mission through people. It is the sum of those qualities of intellect, of human understanding, and of moral character that enables a man to inspire and to manage a group of people successfully. Effective leadership, therefore, is based on personal example, good management practices, and moral responsibility.

The Naval Leadership Program is a continuing program to develop those qualities of leadership, to the greatest extent possible, in all people within the Naval Establishment.

ADVANCEMENT

Some of the rewards of advancement are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

The advantages of advancement are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy; and second, you become more valuable as a technical specialist in your own rating.

HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required Rate Training Manuals by either demonstrating a knowledge of the material in the manual by passing a locally prepared and administered test, or by passing the Enlisted Correspondence Course based on the Rate Training Manual.
3. Demonstrate your ability to perform all the practical requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Successfully complete the applicable military leadership examination which is required prior to participating in the advancement (professional) examination.

Some of these general requirements may be modified in certain ways. Figure 1-2 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-3 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

Advancement is not automatic. After you have met all the requirements, you are eligible for advancement. You will actually be advanced only if you meet all the requirements (including making a high enough score on the written examination) and if quotas permit.

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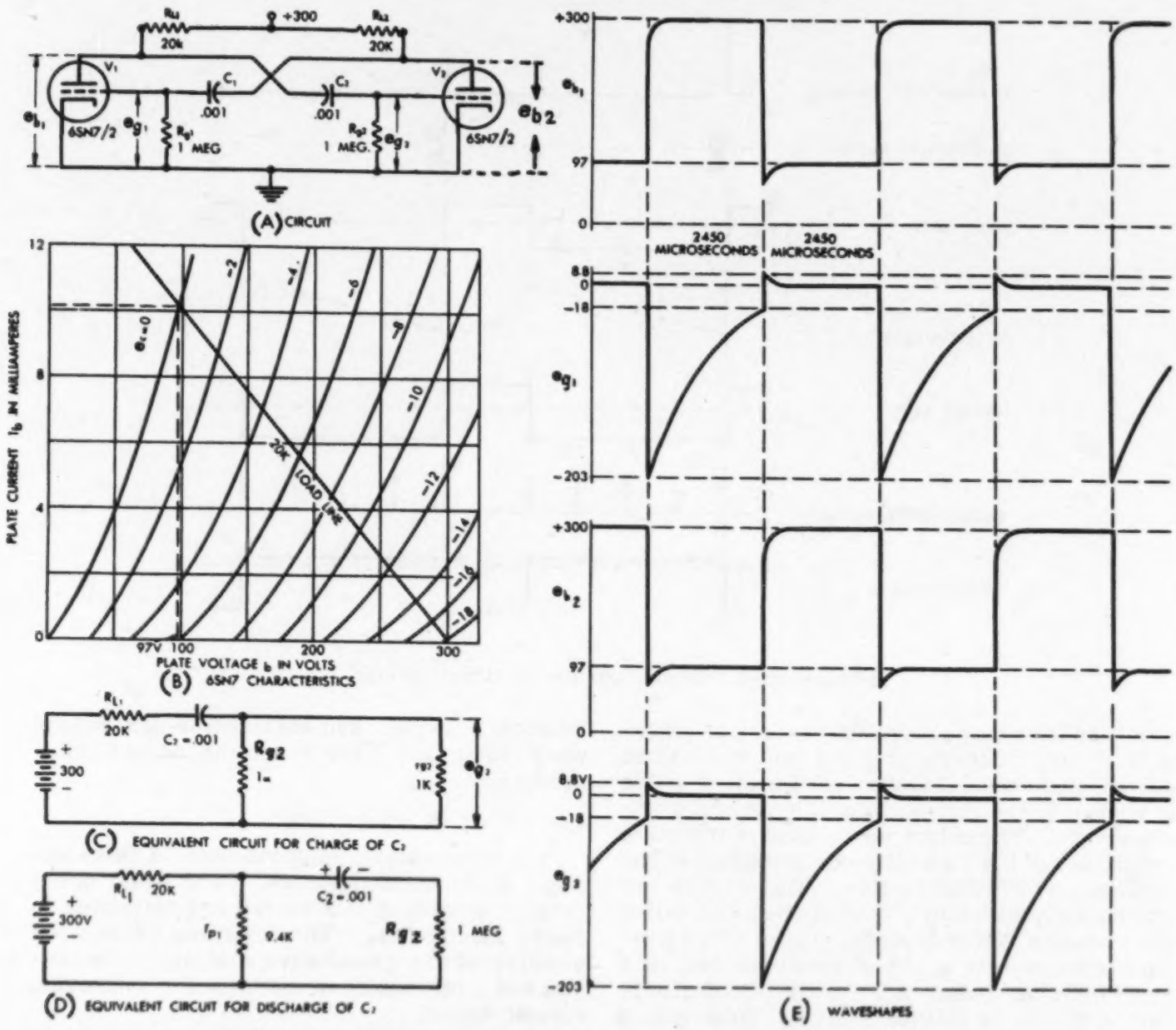

Figure 16-2.—Quantitative analysis of plate coupled multivibrator.

All this plate voltage change occurs across the grid resistor of V2 at the first instant. The resistor voltage is the grid voltage for V2; so the grid will swing negative by the same amount that the plate voltage drops. The plate voltage drops from 300 to 97, or 203 volts. The grid is at zero when the plate voltage drop occurs, so the grid immediately goes 203 volts negative. The equivalent circuit during the discharge is shown in (D) of figure 16-2. The voltage across r_{p1} (the tube's plate resistance) is 97 volts. The plate resistance r_{p1} is found by using the plate current and voltage when the grid voltage of V1 is zero.

$$r_{p1} = e_b/i_b = 97/10.3 \text{ ma} = \text{about } 9.4 \text{ K ohms}$$

In parallel with this (through the battery) is the 20-K plate load resistor. This parallel combination will have a resistance of about 6 K and will be in series with the 1-megohm resistor. For simplicity this 6-K resistance can be disregarded. This will introduce an error of less than one percent. The discharge time constant

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	# E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3. AME 3, HM 3			Class B for AGC MUC, MNC.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
\# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

Figure 1-2.—Active duty advancement requirements.

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INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam	Standard Exam or Rating Training.	Standard Exam required for all PO Advancements.			Standard Exam, Selection Board. Also pass Mil. Leadership Exam for E-4 and E-5.		
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-3.—Inactive duty advancement requirements.

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HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement? Advancement is not an overnight affair. One does not take the advancement examination and wake up in the morning in the next pay grade. There is a path or sequence of events which one must pursue. Certain things must be done or accomplished before one is admitted to the advancement in rate examination. You must study the qualifications for advancement, work on the practical factors, study the required Rate Training Manuals, and study other materials that are required for advancement. To prepare for advancement, you should be familiar with the purpose, use, and interrelationship of the following publications pertaining to the advancement process.

1. Manual of Qualifications for Advancement, NavPers 18068 (Series).
2. Record of Practical Factors, NavPers 1414/1.
3. Training Publications for Advancement, NavPers 10052 (Series).
4. Applicable Rate Training Manuals and their companion Enlisted Correspondence Courses.
5. Examinations for advancement.

Collectively, these documents make up an integrated training package tied together by the qualifications. The following paragraphs describe these materials and give some information on how each one is related to the others.

"Quals" Manual

The Manual of Qualifications for Advancement, NavPers 18068 (Series), gives the minimum requirements for advancement. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: military requirements, and professional (or technical) qualifications.

Military requirements apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all other ratings.

Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into practical factors and knowledge factors. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rate.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. Study these qualifications and the military requirements carefully. The written examination for advancement will contain questions relating to the knowledge factors and the knowledge aspects of the practical factors of both the military requirements and the professional qualifications. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

It is essential that the "quals" reflect current requirements of fleet and shore operations, and that new fleetwide technical, operational, and procedural developments be included. For these reasons, the qualifications are continually under evaluation. Although there is an established schedule for revisions to the "quals" for each rating, urgent changes to the "quals" may be made at any time. These revisions are issued in the form of changes to the "Quals" Manual. Therefore, never trust any set of "quals" until you have checked the change number against an up-to-date copy of the "Quals" Manual. Be sure you have the latest revision.

Record of Practical Factors

Before you can take the Navy-wide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional qualifications. A special form known as the Record of Practical Factors, NavPers 1414/1 (plus the abbreviation of the appropriate rating), is used to keep a record of your practical factor qualifications. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement and revised forms of NavPers 1414/1 are provided when

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necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes. The Record of Practical factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rate but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, NavPers 1414/1 should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-2 through E-8 for his personal record and guidance.

The importance of NavPers 1414/1 cannot be overemphasized. It serves as a record to indicate to the petty officers and officers supervising your work that you have demonstrated proficiency in the performance of the indicated practical factors and is part of the criteria utilized by your commanding officer when he considers recommending you for advancement. In addition, the proficient demonstration of the applicable practical factors listed on this form can aid you in preparing for the examination for advancement. Remember that the knowledge aspects of the practical factors are covered in the examinations for advancement. Certain knowledge is required to demonstrate these practical factors and additional knowledge can be acquired during the demonstration. Knowledge factors pertain to that knowledge which is required to perform a certain job. In other words, the knowledge factors required for a certain rating depend upon the jobs (practical factors) that must be performed by personnel of that rating. Therefore, the knowledge required to proficiently demonstrate these practical factors will definitely aid you in preparing for the examination for advancement.

NavPers 10052

Training Publications for Advancement, NavPers 10052 (Series), is a very important publication for anyone preparing for advancement. This bibliography lists required and recommended Rate Training Manuals and other reference material to be used by personnel working for advancement. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be sure that you have the most recent edition.

If extensive changes in qualifications occur between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class. Remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Rate Training Manuals are marked with an asterisk (*). Any manual marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you are eligible to take the Navy-wide examination for advancement. Each mandatory manual may be completed by passing the appropriate enlisted correspondence course that is based on the mandatory training manual; passing locally prepared tests based on the information given in the training manual, or in some cases, successfully completing an appropriate Class A School.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military standards/requirements for advancement. For example, all personnel must complete the Rate Training Manual, Requirements for Petty Officer 3 & 2, NavPers 10056-B, for the appropriate rate level before they can be eligible to advance.

The references in NavPers 10052 which are recommended, but not mandatory, should also be studied carefully. All references listed in NavPers 10052 may be used as source material for the written examinations at the appropriate rate levels.

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Rate Training Manuals

There are two general types of Rate Training Manuals. Rating manuals (such as this one) are prepared for most enlisted rates, giving information that is directly related to the professional qualifications. Basic manuals give information that applies to more than one rate and rating. Basic Electricity, NavPers 10086-B, is an example of a basic manual, because many ratings use it for reference.

Rate Training Manuals are revised from time to time to keep them up to date technically. The revision of a Rate Training Manual is identified by a letter following the NavPers number. You can tell whether any particular copy of a Rate Training Manual is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists current training manuals and correspondence courses; you will find this catalog useful in planning your study program.)

Rate Training Manuals are designed to help you prepare for advancement. The following suggestions may help you to make the best use of this manual and other Navy training publications when you are preparing for advancement.

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the "quals" frequently as you study. Remember, you are studying the training manual in order to meet these "quals."

2. Set up a regular study plan. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training manual intensively, become familiar with the entire manual. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a clear picture of the scope and content of the manual. As you look through the manual in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the qualifications for advancement?

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without referring to the training manual, write down the main ideas that you have learned from studying this unit. Do not quote the manual. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Rate Training Manuals or on other appropriate texts. As mentioned before, completion of a mandatory Rate Training Manual can be accomplished by passing an Enlisted Correspondence Course based on the Rate Training Manual. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training manuals. Taking a correspondence course helps you to master the information given in the training manual, and also helps you see how much you have learned.

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10. Think of your future as you study Rate Training Manuals. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you.

SOURCE OF INFORMATION

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional qualifications of your rating.

Some of the publications described in this manual are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you perform efficiently or to advance; it is likely to be a waste of time, and may even be seriously misleading.

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CHAPTER 2

NAVAL AIRCRAFT MAINTENANCE PROGRAM

Aircraft maintenance is the responsibility of the Aircraft Maintenance Department or the Operations Maintenance Division. The Aircraft Maintenance Department is, in most operating units (or activities), the largest department, and its primary efforts are expended toward supporting the unit mission. The Operations Department has the responsibility of carrying out the unit mission of flight operations (other than ferry or test flights) by Navy aircraft. In support of the unit mission, the objective of the Aircraft Maintenance Department is to maintain all assigned aircraft in a ready or "UP" status. An aircraft in an UP status is considered to be in a material condition of readiness to safely perform its intended mission and return to its base of operations.

All Aircraft Maintenance Departments are organized along the same general lines; that is, a standard organization is used throughout the Navy. The advantages of having a standard organization are readily apparent when one stops to consider what happens when aviation maintenance personnel are transferred between aircraft maintenance activities. The Aircrew Survival Equipmentman (PR) will find that the work centers have the same numbers and names; the officers will occupy similar billets as in the old outfit, though names and ranks will be different; and he will be performing essentially the same maintenance functions, using the same types of equipment and tools, procedures, and technical directives as before. In short, personnel newly received from another aviation maintenance activity can, in a very short time, be performing in their new unit as effectively as before without a lengthy indoctrination or break-in period.

This standard organization of Aircraft Maintenance Departments did not come about by accident, and it is not limited to the operating activity (squadron) level. Broad avenues of responsibility and certain guidelines are prescribed at the Department of Defense level and are based on years of aircraft maintenance experience by the Navy, Army Air Corps, and the Air Force.

The Naval Aircraft Maintenance Program is a part of the Navy Maintenance and Material Management System and is governed by the Naval Air Systems Command Instruction entitled the Naval Aircraft Maintenance Program (NAMP), NavAir Instruction 4700.2 (Series). All naval aviation activities performing aircraft maintenance and related functions base their policies, plans programs, and procedures on this instruction.

In the very early days of naval aviation, it was standard practice for every operating activity to perform their aircraft maintenance using whatever organization the commanding officer considered most expedient. Naturally, these organizations differed in varying degrees and in different ways. Most of these activities would likely be termed wasteful in the use of manpower, money, and material if their procedures were compared with modern maintenance procedures.

Much manpower was wasted, since technical training of personnel was left up to the squadron and was provided mostly on an on-the-job basis. Although effective maintenance was performed, maintenance techniques used by mechanics often varied with the individual. Of all the ways and means utilized to effect aircraft maintenance, one way would usually be the fastest and most reliable, but no provisions existed in the early days for determining which was the most desirable or for disseminating this information to all activities with a need to know. Centralized training, mandatory standardization of maintenance practices, engineering advances in research and development, and increasing use of machine accounting methods in Maintenance Data Reporting and Analysis have largely eliminated this problem.

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Not too many years ago the operating activities were self supporting; that is, they were provided with all the tools and equipment necessary for effecting all required maintenance short of overhaul. If more than one squadron was assigned to a ship or station, each had their full share of tools and equipment. It is evident that during a large part of the time, much of the equipment was not being used. Attempts at solving this problem led successively to the establishment of Carrier Aircraft Service Units (CASU's), Fleet Aircraft Service Squadrons (FASRon's), and finally the centralized local maintenance organizations of today—the Aircraft Maintenance Departments ashore and Air Wing/Group intermediate maintenance afloat.

The Aircraft Maintenance Departments and intermediate maintenance perform aircraft maintenance functions which are beyond the capability of the operating activities. Capability refers, not to the skill level of assigned personnel, but to the scope of the work assigned by the NAMP to the squadrons. In addition to maintenance work performed, the Aircraft Maintenance Departments provide material, together with the necessary facilities and support equipment, to the operating squadrons and units. This support to the squadrons aboard ship, as well as to the intermediate effort therein, is provided by the ship.

NOTE: It is common practice among maintenance personnel to refer to the station intermediate activity by its initials—AMD. In accordance with this common usage, AMD, as used in this manual, should be interpreted to mean the station Aircraft Maintenance Department.

In a similar manner, AIMD refers to the Aircraft Intermediate Maintenance Department aboard aircraft carriers.

The Naval Aircraft Maintenance Program is designed to provide for the greatest use of men, facilities, and materials. It further establishes a standard set of rules and regulations for the accomplishment of all maintenance on naval aircraft and associated equipment.

Whenever a new aircraft model is accepted for naval service, it is expected that these aircraft will fill a specific need for a given length of time. Enough men, facilities, and material for maintenance support of these aircraft for this length of time, are planned, procured, and assigned in accordance with where, how, and when these aircraft will be used. It is therefore mandatory that all naval aircraft maintenance personnel have a thorough knowledge of and abide by the maintenance program rules and regulations.

MAINTENANCE LEVELS AND RESPONSIBILITIES

The term "aircraft maintenance" has a very general meaning, ranging from a matter of minutes of squadron servicing to a matter of months of overhaul in an industrial type activity. More than the work or words, "maintenance" or "aircraft maintenance," is needed to indicate a specific meaning. The present military concept is to divide all aircraft maintenance functions into three distinct levels. The terms used to describe these levels are "Organizational Maintenance," "Intermediate Maintenance," and "Depot Maintenance."

ORGANIZATIONAL MAINTENANCE

Organizational maintenance is the type of work performed by the operating squadron or unit on a day-to-day basis in support of its own operations. Maintenance performed at this level includes (1) inspection, (2) servicing, (3) handling, (4) "on-aircraft" corrective maintenance including removal and installation of parts and components, (5) complying with technical directives (when prescribed), and (6) the necessary recordkeeping and reports peculiar to organizational maintenance.

Organizational maintenance in an operating activity is performed by permanently assigned personnel who are not responsible for intermediate maintenance. Organizational maintenance at naval air stations (on aircraft assigned to the station) is a function of the Operations Maintenance Division (OMD). The OMD also provides organizational maintenance and such other assistance to transiting aircraft as may be directed by higher authority.

INTERMEDIATE MAINTENANCE

Intermediate maintenance is that type of work performed in centrally located facilities for the support of operating activities within a designated geographical area, at a particular base or station, or aboard aviation ships. This level of maintenance includes shop type repair and test work on aircraft, components, and equipment from the supported units. Technical

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assistance, when required, is furnished by personnel of the Intermediate maintenance facility to the supported operating activities.

Intermediate maintenance activities are manned by a nucleus of permanently assigned personnel and designated Intermediate maintenance personnel temporarily assigned from the on-board tenant squadrons. When these squadrons deploy, their Intermediate maintenance personnel accompany their squadrons, and are then temporarily assigned to the AIMD if afloat or to the AMD at their new station.

NOTE: The Intermediate maintenance activity (AMD or AIMD) is commonly referred to as the supporting activity, and the Organizational activity (squadron) as the supported activity.

DEPOT MAINTENANCE

Depot maintenance is that type of work that must be done in an industrial type facility. Such facility may be either military or civilian. If the work is contracted out to a civilian concern, the type of work is still depot maintenance. This level includes overhaul and major repair or modification of aircraft, components, and equipments. It also includes the manufacture of specified aeronautical parts to be stocked as spares and the manufacture of kits for the accomplishment of aircraft and equipment modification. Installation of these spare-parts kits may be done at this or a specific lower level of maintenance.

Navy depot maintenance activities are manned primarily by civilians and are known as Naval Air Rework Facilities (NARF). However, some military personnel are usually assigned and assist with the intermediate and organizational type work necessarily connected with the depot facility.

It can be seen from the foregoing that the three aircraft maintenance levels or categories provide for an orderly separation of the various maintenance tasks. The bases for the separation are complexity of the task, equipment and space requirements, the skill level of assigned personnel, and the scope of support responsibility.

STANDARD AIRCRAFT MAINTENANCE ORGANIZATIONS

The aircraft maintenance organization supports naval operations by the upkeep of aircraft and associated support equipment to the assigned level of maintenance. This support is accomplished while adhering to the organizational principles and objectives as prescribed in the NAMP Manual, NavAir Instruction 4700.2 (Series).

Since all maintenance activities have similarities in mission, operation, and administration, it is only reasonable that they be standardized in these areas as much as possible. A standard maintenance organization, properly set up and administered, is designed to improve the following:

Performance and training of maintenance personnel.
Availability of aircraft for flight.
Safety.
Use of manpower and materials.
Planning and scheduling of the workload.
Management control of the organization.
Evaluation of work performance.
Combat readiness of the unit.
Continuity when aircraft and/or personnel are transferred between commands.

The foregoing objectives cannot be attained by means of a manual or an organization structure alone. They are attained by the sensible and conscientious efforts of all naval personnel engaged in the maintenance tasks, working harmoniously toward a common goal, under the management control processes used in the organization.

Specific functions of Aircraft Maintenance Departments include:

1. Periodic maintenance and routine inspection and servicing of aircraft, associated support equipment, and aeronautical material and components, including the necessary disassembly, cleaning, examination, repair, modification, test, inspection, assembly, and preservation.
2. Special work (when required) to comply with technical directives or local instructions.
3. Correction of aircraft and equipments discrepancies.
4. Assurance of high quality of all work.
5. Maintenance of required records and technical publications.
6. Maintenance and custody of tools and other equipment provided for use by the activity.
7. Training of assigned personnel. Most ratings, including the PR, will have already been provided with a satisfactory theoretical background for the performance of their assigned tasks. Further training in the practical

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aspects of aircraft maintenance is a continuing requirement.

8. Conducting of maintenance and ground handling safety programs.

9. Submission of reports for statistical, analytical, and historical purposes.

The depth and complexity of the specific functions in connections with the foregoing, vary in number and type of aircraft involved and the assigned maintenance level. Further coverage of aircraft maintenance organizations in this chapter is devoted primarily to the intermediate and organizational levels, as these are the basic levels to which NavAir Instruction 4700.2 (Series) is directed. Activities performing these levels of maintenance are also the ones to which most PR's are normally assigned.

An intermediate level maintenance department organization is illustrated in figure 2-1. An organizational level maintenance department (typical of a squadron or OMD) is illustrated in figure 2-2. The numbers shown in the blocks are work center codes. Work center codes are used in the Maintenance Data Collection System, which is an important part of the Navy Maintenance and Material Management System. Typical work centers are the maintenance office, aviators equipment branch, flight line, electronics branch of the avionics division, etc. Work center codes are necessary for recording and reporting work accomplished, since electric accounting machine methods are used for these purposes.

The organization for aircraft maintenance activities provides firm lines of authority from the Aircraft Maintenance Officer to the personnel accomplishing the work for which the activity is responsible. The term "department" is used in this training manual as a general term which applies equally to all maintenance activities having a department head. All major groups in the department which report directly to the department head are called divisions. Divisions are subdivided into branches. Branches may be broken down into sections and sections into units. (In OMD's, the Aircraft Maintenance Officer is a division officer of the Operations Department, and the divisions listed in figure 2-2 are then branches, etc.) Realinement of responsibilities and functions implied in figures 2-1 and 2-2, from one division to another or physical combination of divisions, is not authorized under current instructions. However, if the maintenance department/division has no responsibility for performing any of the

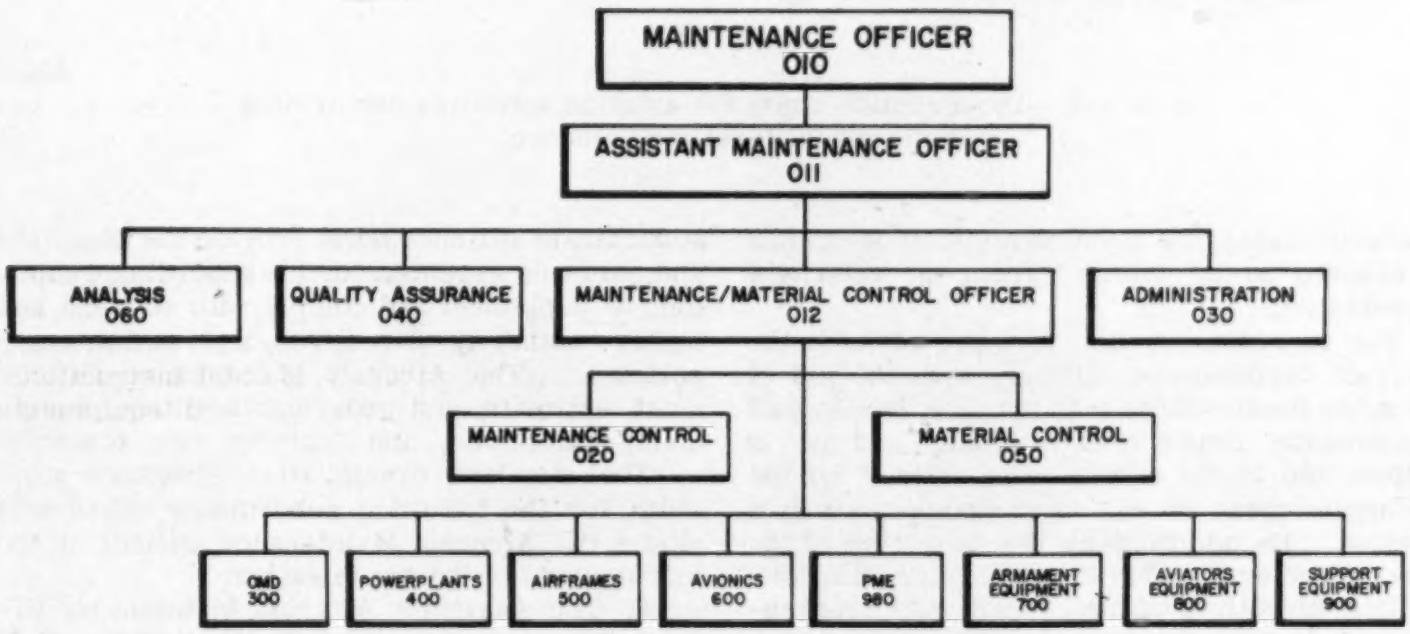

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Figure 2-1. —Organization chart for aviation activities performing intermediate level maintenance (ashore).

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without the 6-K resistance will be 0.001μf x 1 megohm = 1,000 microseconds.

Capacitor C2 discharges exponentially until the grid voltage of V2 is just above cutoff. Cutoff voltage for this tube with 300 volts applied is minus 18 volts as read from the characteristic curves. The cutoff period is terminated when the voltage drops to 18/203 or 0.089 of its initial value. The grid voltage is down to this value in 2.45 time constants, as calculated from the capacitor discharge curve on the universal time constant chart in Basic Electricity. Since the discharge time constant is 1,000 microseconds, the cutoff time equals 2.45 time constants multiplied by 1,000 microseconds or 2,450 microseconds.

The cutoff time for tube V2 will be 2,450 microseconds. Since the resistor and capacitor values are exactly the same, tube V1 will be cut off for 2,450 microseconds during the other half cycle of operation. The grid and plate voltage values and curves will also be identical. If a difference exists in the circuit of each tube, separate calculations must be carried out for each half cycle. In this case, 2,450 + 2,450 = 4,900 microseconds. The frequency at which square waves are produced is the reciprocal of the duration.

$$F = \frac{1}{4,900 \times 10^{-6}} = 204 \text{ cycles per second}$$

The duration and amplitude of the positive peak on the grid waveform can be readily calculated from the equivalent circuit shown in (C) of figure 16-2. The positive peak occurs as the capacitor is charged to a higher plate voltage. The capacitor charges through the resistance that consists of the plate load resistor for V1 and the grid to cathode resistance of V2. This is a total of 21K. The 1-megohm resistor carries only 0.1 percent of the charging current and is therefore safely disregarded. With the 0.001-μf capacitor the time constant is $0.001 \times 10^{-6} \times 2.1 \times 10^{4}$ or 21 microseconds. If the charge requires 5 time constants, the positive peak will disappear after a hundred microseconds.

The amplitude of the peak can be determined by using Ohm's law. The total voltage rise at the plate of V1 is 203 volts. This raises the grid voltage from cutoff (minus 18 volts) to some positive value. Since the first 18 volts of plate voltage rise changes the grid voltage to zero, the remaining rise above zero is 203 - 18, or 185 volts. This causes grid current to flow and the voltage to divide across the series combination of the grid to cathode resistance and the plate load resistance. As the grid to cathode resistance equals 1,000 ohms, and the plate load resistance equals 20,000 ohms, 1/21 of the 185 volts, or 8.8 volts, appears across the grid to cathode resistance. Thus the positive peaks at the grid will be 8.8 volts above zero.

Because the plate voltage cannot rise faster than the capacitor can charge, the plate voltage rise is exponential over a period of 100 microseconds. This rounds off the leading edge of the plate waveshape. The positive grid at the other tube causes a dip in plate voltage at that tube. The output from this circuit is normally taken from either plate although the grid voltage is sometimes useful.

In the chart (fig. 16-3) showing the effects of varying the sizes of the component parts of this circuit, the essential data is given, but the detailed and less important effects are omitted because of a lack of space. The effects of changing R_{L2}, R_{g2}, C2, and V2 are not listed since these effects are similar to those that result from changing R_{L1}, R_{g1}, C1 and V1 respectively—except that each effect occurs with the other half cycle of operation.

Improving Circuit Action

There are a number of slight changes that can be made in the basic plate coupled multivibrator circuit to improve its stability and output waveshape. One is to return the grids to a positive voltage, and another is to use series limiting resistors.

RETURNING THE GRIDS TO A POSITIVE VOLTAGE.—Returning the grids to a positive voltage improves the stability of a plate coupled multivibrator. In this arrangement, the grid-leak resistors are often connected to the source of plate voltage; in other words, the grids are returned to B plus. Under this condition the grid current flow causes the B-plus potential to exist mostly across the resistor while the grid to cathode voltage remains within a fraction of a volt or zero. When the plate voltage of the other tube drops, the capacitor discharges as usual, with a current that is high enough to drive the grid negative by the amount of the plate voltage drop. Due to this condition the exponential discharge of the capacitor appears as though the capacitor were charged to the plate voltage drop plus the plate voltage

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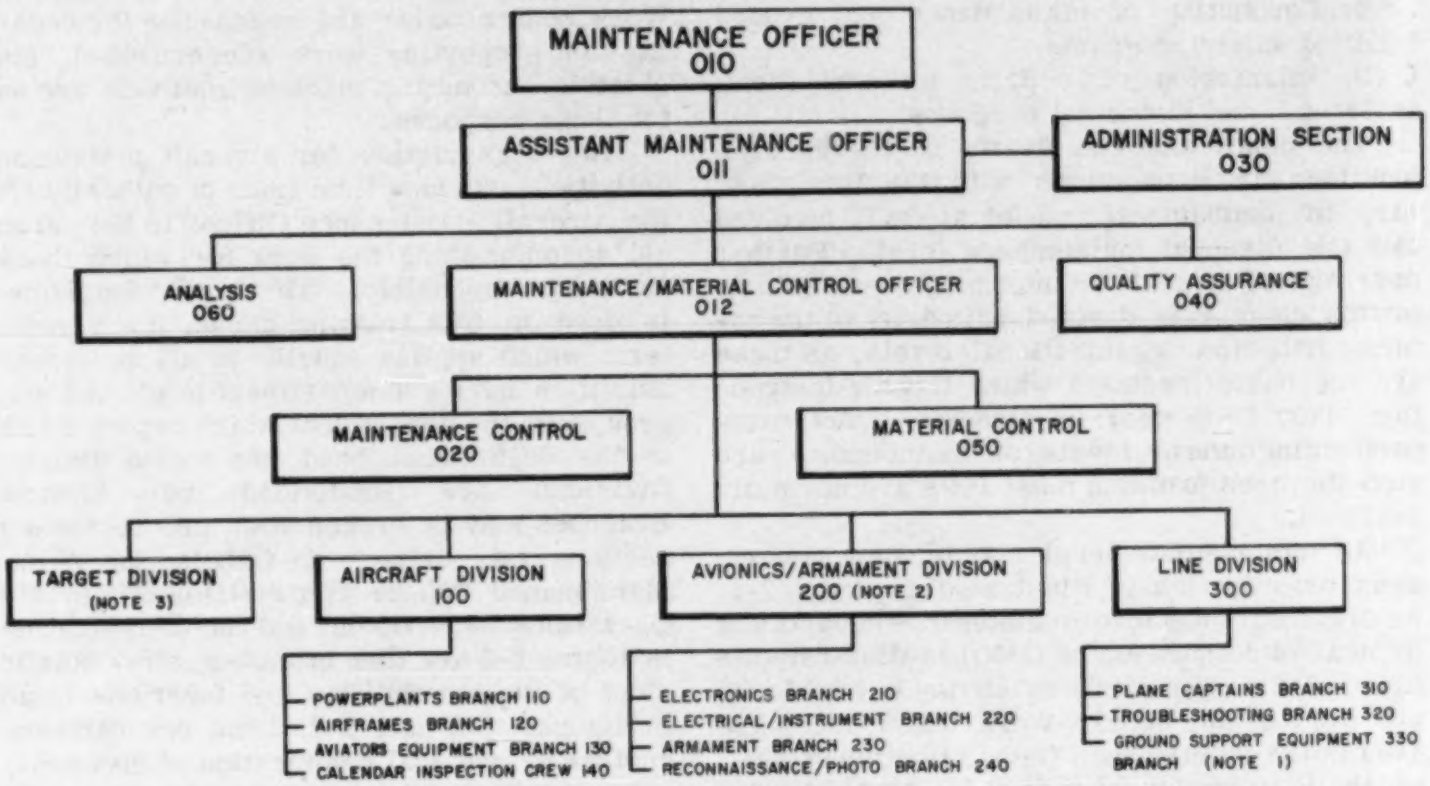

NOTE 1: WHEN RESPONSIBILITIES RELATIVE TO OPERATION AND MAINTENANCE OF GROUND SUPPORT EQUIPMENT ARE EXTENSIVE, THE COMMANDING OFFICER WILL ESTABLISH A GROUND SUPPORT EQUIPMENT BRANCH UNDER THE LINE DIVISION TO COORDINATE AND/OR CARRY OUT ORGANIZATIONAL MAINTENANCE FUNCTIONS ON ASSIGNED SUPPORT EQUIPMENT.

NOTE 2: IN MARINE CORPS ACTIVITIES THE AVIONICS AND ARMAMENT FUNCTIONS ARE SEPARATE DIVISIONS.

NOTE 3: WHEN RESPONSIBILITIES RELATIVE TO THE OPERATION AND MAINTENANCE OF AERIAL OR SURFACE TARGETS ARE EXTENSIVE, THE COMMANDING OFFICER WILL ESTABLISH A TARGET DIVISION.

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Figure 2-2. —Organization chart for aviation activities performing organizational level maintenance.

functions listed, the affected division or branch is allowed to be omitted from the activity's organization.

The organization structure provides for the Aircraft Maintenance Officer, with the aid of his subordinate officers, to manage the Aircraft Maintenance Department/division, and he is responsible to the commanding officer for the accomplishment of the maintenance activity's mission. He administers the operation of the department or division in accordance with controlling directives of higher authority concerning organization, reports, policies, procedures, workloads, and personnel complements.

Planning, control, and production are functional management responsibilities assigned the Aircraft Maintenance Officer. He and his subordinate officers must provide the direction and guidance essential for his subordinate echelons to implement and comply with all local and higher authority directives and maintenance policies. The Aircraft Maintenance Officer must estimate and program facilities, equipment, manpower, and training requirements.

The standard organization structure provides for the following subordinate officers to assist the Aircraft Maintenance Officer in the management of the organization:

1. The Assistant Aircraft Maintenance Officer to supervise the activities of the staff elements.

2. The Maintenance/Material Control Officer to exercise direct supervision over the production elements and material control.

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3. Various aircraft maintenance division/branch officers to organize and manage in their respective functional areas.

ORGANIZATIONAL LEVEL

Organizational level maintenance activities are the prime users and operators of naval aircraft; therefore, most of their maintenance tasks involve day-to-day support for their own operations.

Organizational level activities are composed of maintenance managers who manage the activity; staff divisions which perform support type functions for the production elements; and production divisions which actually perform the various maintenance tasks.

Staff Divisions

Staff divisions are incorporated into the framework of Organizational level maintenance activities for the purpose of providing services and support to the production divisions, and of correlating the accomplishments and progress of the production divisions. Together, they provide the maintenance officer with a consolidated view of the current status of the maintenance picture.

A discussion of some of the more important functions of the staff divisions is contained in the following paragraphs. A more detailed discussion of these divisions and their responsibilities is contained in NavAir Instruction 4700.2 (Series).

The normal staff divisions in Organizational level maintenance activities are the quality assurance and analysis divisions.

QUALITY ASSURANCE DIVISION.—Quality assurance is fundamentally the prevention of the occurrence of defects. This includes all events from the start of the maintenance operation to its completion. Achievement of quality assurance depends on prevention, knowledge, and special skills.

Prevention is based on the concept that it is necessary to preclude maintenance failures. In the true sense, this principle extends to safety of personnel, to maintenance of equipment, and to virtually every aspect of the total maintenance effort. Prevention is concerned with the regulation of events, rather than being regulated by them.

Knowledge is derived from factual information. The NAMP introduces the practices of data collection and data analysis as means of acquiring this knowledge.

Special skills, not normally possessed by production personnel, are required in a staff of personnel trained in the techniques of data analysis and supervision of the quality assurance program.

The quality assurance program provides a systematic and efficient process for gathering and maintaining information on the quality characteristics of products and on the source and nature of defects and their immediate impact on the current operation. It permits decisions to be based on facts rather than on intuition or memory. It further provides comparative data which will be useful long after the details of the current occasion have been forgotten. The proper functioning of quality assurance requires the delegation of authority and the assumption of responsibility for action.

Teamwork must be achieved before benefits can be obtained from a quality assurance program. To be effective, quality assurance functions must blend with the interest of the entire organization. Each individual in the department must be permitted to use an optimum amount of judgment in the course of his daily work, since his judgment plays a vital part in the quality of his work. Quality assurance techniques supply each person, from the worker to the Commanding Officer, with information on actual quality achieved. This information provides a challenge to the individual to improve the quality of his work.

The quality assurance division provides the department head with information regarding the quality of work accomplished, points up areas that need particular attention, and develops more realistic inspection requirements. Among the primary functions performed by the quality assurance division are the following:

1. Establishes qualification requirements for quality assurance inspectors and collateral duty inspectors. (Quality assurance representatives are those personnel permanently assigned to the quality assurance division as inspectors. Collateral duty inspectors are those personnel permanently assigned to a production division who have a secondary or collateral duty assignment to inspect work accomplished within their assigned production division.) Reviews the qualifications of personnel nominated for these positions and endorses nominations to the department head. Maintains a record of all designated inspectors.

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2. Provides for the continuous on-the-job training of all inspectors in the techniques and procedures pertaining to the conduct of inspections.

3. Maintains the technical library for the department. Insures that each work center receives all publications applicable to their work areas, and that these are kept current and complete.

4. Reviews all incoming technical publications and directives affecting the department to determine their application to quality assurance.

5. Reviews publications and directives, such as Changes, Bulletins, Periodic Maintenance Requirements Manuals, etc. Prepares and submits recommendations for revision or change of these documents.

6. Prepares or assists in the preparing of Maintenance Instructions to insure that proper direction and emphasis is given to implementing quality assurance.

7. Reviews inspection records, flight records, and work records, and notes unnecessary or recurring discrepancies requiring special attention.

8. Insures that all work guides, checkoff lists, inspection forms, test flight forms, etc., used to define or control maintenance operations, are complete and current.

9. Insures that the configuration of aircraft, aircraft components, and support equipment are such that all essential modifications have been incorporated.

ANALYSIS DIVISION.—The analysis division provides qualitative and quantitative analysis information to the maintenance officer in order to enable him to continually review the management practices within his organization. Some of the functions performed by this division are related to quality assurance; therefore, the analysis division and quality assurance division usually work in conjunction with each other.

Maintenance data analysis functions are regularly assigned to personnel of the AZ rating. The size of the analysis division varies from one activity to another, dependent upon the size of the maintenance activity, number of aircraft maintained, etc. In activities performing Organizational level maintenance, this division normally consists of not more than three.

The primary responsibility of the analysis division is to monitor and control all procedures connected with the Maintenance Data Collection System (MDCS). It is the hub around which an activity's Maintenance Data Reporting System turns. The analysis division reviews and analyzes reports, produced by the MDCS, for information that is of benefit to the maintenance activity.

The general responsibilities of the analysis division encompass the extraction, examination, and presentation (in chart, tabular, or graphic form) of pertinent data from the MDCS reports. The requirements for these functions may stem from various sources and apply to a wide range of maintenance subjects. In some instances, analysis may be initiated to provide an answer to a specific problem. In other instances, analysis of selected areas of maintenance (for example, personnel utilization or productivity of work centers) may be initiated as a monitoring action.

Certain of the more important specific responsibilities of the analysis division are listed as follows:

1. Sort and arrange all source documents (cards and forms which contain data to be reduced, tabulated, and analyzed) prior to their delivery for key punching.

2. Collect and maintain in various forms all data needed to manage the maintenance effort.

3. Analyze and compare maintenance performance against maintenance plans and workload estimates.

4. Review maintenance data reports for significant variations from normal—isolate and identify the trouble areas revealed by these reports.

5. Assist the Aircraft Maintenance Officer and other supervisory personnel in developing new types of recurring machine-run reports deemed necessary for management of the maintenance effort.

6. Prepare briefs and explanations covering the content of the reports produced by the Maintenance Data Reporting System for presentation as required by the commanding officer, Aircraft Maintenance Officer, etc.

7. Identify and analyze material deficiencies, high manhour consumption areas, and study other pertinent trends.

8. Assist material control in relating the contents of monthly data reports to material consumption and forecasts for material.

9. Train work center personnel in proper methods of filling out documents, and assist supervisory personnel in the correct interpretation of resulting reports.

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10. Coordinate all the activity's data collection matters with the local machine accounting installation (Data Services), including the preparation of additional reports as required.

MAINTENANCE/MATERIAL CONTROL

Although the tasks performed by maintenance/material control may be considered a staff function to the Aircraft Maintenance Officer, the Maintenance/Material Control Officer exercises authority in a line position between the Aircraft Maintenance Officer and the production divisions.

The Maintenance/Material Control Officer is directly responsible to the maintenance officer for the management of the overall productive effort of the department. A recent reorganization of maintenance activities has placed the material control element directly under the Aircraft Maintenance/Material Control Officer. In order to separate the functions performed by maintenance/material control, it is divided into two work centers—one for the maintenance production control functions, and one for the material control functions. These are discussed further in the following paragraphs.

Maintenance Control Work Center

The space in which the personnel of this work center perform their functions is commonly referred to as maintenance production control, production control, maintenance control, or the maintenance control office. All of these terms are used synonymously in this training manual.

The maintenance control office is the nerve center of the entire maintenance department. As head of this office, the Aircraft Maintenance/Material Control Officer directs the production divisions. He is assisted in this task by the Maintenance Control Chief. The Aircraft Maintenance/Material Control Officer establishes and exercises control and coordination of the action of the production divisions to insure prompt movement of aircraft, parts, and materials and to promote harmony and cooperation. He maintains liaison with the supporting activity to insure that the department's productive capacity is kept compatible with workload requirements.

In discharging these responsibilities, the personnel assigned to the maintenance control perform the following functions:

1. Plan and schedule aircraft through all phases of assigned maintenance.
2. Initiate maintenance actions to the work centers for scheduled and unscheduled maintenance as required, assigning priorities and completion times.
3. Perform progress checks on work assigned.
4. Maintain an aircraft status board and keep cognizant divisions and work centers informed of the status of aircraft and related equipment.
5. Prepare necessary aircraft parking plans and movement schedules.
6. Maintain aircraft logs in accordance with current directives.
7. Insure that maintenance instructions are prepared when required, and provide the necessary control to insure compliance by work centers concerned.
8. Assign job control numbers for reported discrepancies.
9. Maintain the Organizational Maintenance Control Register.
10. Receive all completed source documents from the analysis division after processing and file for historical records.
11. Take necessary actions for reporting aircraft accounting data, aircraft engine accounting data, and other required reports.

Material Control Work Center

In order to maintain an effective aircraft maintenance program, a cooperative working relationship must exist between production and supply. Effective maintenance of complex weapons systems cannot be accomplished without an adequate material supply program. A material control work center is provided in the Organizational maintenance department organization to act as liaison between the maintenance department and the local supply activity.

The material control work center insures that proper parts, tools, and equipment are available to the production divisions in the required quantities at the proper time. The work center must compile and analyze maintenance usage data and furnish technical advice and information to the local supply activity on the identity and quantity of supplies, spare parts,

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and materials necessary to accomplish the assigned workload.

The material control work center provides material support to the department by accomplishing the following functions:

1. Passes all requirements for material required for direct support of weapons system maintenance to the Supply Support Center.
2. Maintains a Material Control Register for all material requested in direct support of weapons system maintenance.
3. Maintains liaison with the supporting supply department on maintenance material matters to insure that material needs of the maintenance department are satisfied.
4. Initiates surveys in the event of loss, damage, or destruction of accountable items of material and equipment.
5. Establishes standard operating procedures which insure the inventory of tools and the adequate accountability of material and equipment.
6. Records and reports custody materials.
7. Performs certain cost and allotment record accounting, charting, and budgeting of costs.
8. Monitors the operation of toolrooms.
9. Obtains, controls, and reports authorized allowances of material.

This work center is also responsible for the maintenance of aircraft inventory logs/records for assigned aircraft. This includes the inventory of aircraft prior to transfer, upon receipt, and at other times, as required.

PRODUCTION DIVISIONS

Maintenance of naval aircraft involves the actual performance of maintenance tasks by mechanics and technicians. The production divisions are manned by such personnel. Although on an organization chart the production divisions are shown as the lowest element, this is not in keeping with their importance. If it were not for the production divisions, there would be no reason for the existence of any part of the organization.

The production element of Organizational level maintenance activities consists of three divisions as indicated in figure 2-2. These divisions may be subdivided into branches (as indicated) to more efficiently perform the required maintenance tasks. A discussion of some of the more important functions of the production divisions of an Organizational level maintenance activity is contained in the following paragraphs:

Line Division

The line division administers the Plane Captain Program. In addition, it is responsible for the maintenance which involves the day-to-day tasks and functions associated with actual flight operations, including participation in the FOD program. AMD's do not have a division which corresponds to the line division, since they do not operate aircraft. Preflight, postflight, and daily inspections, between-flight servicing and replenishment, responsibility for organizational level GSE, and the minor adjustment and checkout of installed aircraft equipment are examples of functions performed in this division. The line division coordinates and directs the troubleshooters, who are normally assigned from work centers in the other production divisions to accomplish correction of minor discrepancies.

Aircraft Division

The aircraft division coordinates and completes schedules (inspections) and unscheduled maintenance (major discrepancies which cannot be corrected by troubleshooters) of assigned aircraft. This division performs organizational maintenance tasks in the airframes, powerplants, and aviators equipment areas.

Avionics Armament Division

The Avionics armament division performs organizational maintenance tasks in the avionics and ordnance areas on assigned aircraft. This division provides personnel to the aircraft division as required to accomplish scheduled maintenance (inspections) on aircraft.

INTERMEDIATE LEVEL (ASHORE)

The primary purpose of Intermediate level maintenance is to support and supplement the work of Organizational maintenance activities. These functions are usually performed in centrally located areas for the support of operating aircraft on a shore station, aboard a ship, or within a designated area.

Intermediate level maintenance activities are not assigned aircraft for operational

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purposes; and their efforts are concentrated on the repairing and testing of aircraft components. Naturally, this requires a certain amount of record keeping and reporting.

The organizational structure of activities performing Intermediate level maintenance is, for the most part, closely related to that of an Organizational level maintenance activity. Because of their size and maintenance functions performed, Intermediate level maintenance activities are composed of more divisions than Organizational activities. As in the case of Organizational level activities, Intermediate level maintenance activities are composed of maintenance managers, staff divisions, and production divisions. An Intermediate level maintenance department organization, with assigned work center codes, is illustrated in figure 2-1. A discussion of the various divisions of an Intermediate level maintenance department is contained in the following paragraphs.

STAFF DIVISIONS

Staff divisions are incorporated into the organizational structure of Intermediate level maintenance activities for essentially the same reasons as they are in Organizational level activities—to provide services and support to the production elements. In addition to the two staff divisions previously discussed, Intermediate level maintenance activities have an administration division.

Administration

The administration division functions basically as the coordinator for all records and reports, directives, correspondence, and personnel matters for the department. It provides the department with such administration and clerical services as the reproduction, distribution, and routing of messages, directives, correspondence, and other forms of informational data. It implements directives concerning the distribution, retention, and disposition of records, reports, and logs. It controls the classified matter required by the department, establishes and coordinates the department training requirements, and obtains any school quotas needed to support these requirements. It acts as a liaison between the divisions of the departments, between the maintenance department and other departments of the organization, and between the maintenance department of its parent organization and the maintenance department of other organizations.

NOTE: In activities where the highest level of maintenance performed is Organizational, the standard organization does not provide for an administration division. In these activities, the administration functions are transferred to the assistant aircraft maintenance officer.

Administration division personnel accomplish the following specific functions:

1. Establish and control a central recordkeeping and reporting system for all maintenance reports and correspondence.
2. Implement all directives concerning distribution, retention, and disposition of records, reports, and logs.
3. Provide clerical and administrative services for the department.
4. Receive and control department correspondence.
5. Reproduce as necessary and distribute incoming messages and other data.
6. Maintain all correspondence and report files for the department, except those special reference files maintained by each division or branch.
7. Supervise and coordinate department administrative responsibilities with other departments/divisions as required.
8. Conduct liaison with the squadron or station administration department regarding maintenance department personnel matters.
9. Distribute personal mail to department personnel.
10. Make proper distribution of all nontechnical information and publications.
11. Publish and distribute approved locally issued maintenance directives, procedures, reports, and studies.
12. Control classified material required by the department.
13. Establish and coordinate the department training requirements. Obtain necessary school quotas to support these requirements.
14. Establish proper transportation and communication systems to provide complete support of the workload.
15. Assign spaces to the various divisions and establish the responsibility for security and cleanliness of such spaces.
16. Arrange department participation in joint inspections of facilities assigned to tenant activities especially incident to the departure of a tenant activity.

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Quality Assurance

The quality assurance division of Intermediate level activities has the same prime function as previously discussed—to preclude the occurrence of defects. This is accomplished in two ways: (1) Through statistical analysis to compare the results obtained with those desired, and (2) through intensive research to find methods of improving effectiveness of the overall maintenance effort.

The major concerns of the quality assurance division include the following:

1. Safety (of both personnel and equipment).
2. The need of maintenance personnel for training in the most efficient and effective methods and procedures.
3. The quality of workmanship and of materials used in maintenance.
4. The reliability of each equipment and its component parts, and of the procedures used in maintenance of the equipment.
5. Qualifications of all quality assurance personnel, including the collateral duty inspectors.

Analysis Division

As is the case in Organizational level maintenance activities, the analysis division in Intermediate level activities operates as a staff function to management. The functions performed by the analysis division in both levels of maintenance are practically the same; therefore, they are not discussed further in this section.

MAINTENANCE/MATERIAL CONTROL

Maintenance/material control in an Intermediate level activity is very similar to that previously discussed in an Organizational level activity; that is, it is divided into two work centers.

As the name implies, maintenance production control is the central control point of the entire maintenance effort. This is accomplished primarily by the proper planning, scheduling, and assignment of the various maintenance tasks performed within the maintenance department.

Intermediate level maintenance activities exist primarily for the purpose of supporting operating activities; therefore, the personnel working in the maintenance control work center are concerned with the procedures involved in planning and scheduling the workload which consists of repairing, testing, and processing aircraft parts, components, and related equipment. They perform some of the previously discussed functions; however, those concerning the scheduling of aircraft inspections, aircraft log book maintenance, and aircraft status board maintenance are not required in Intermediate level maintenance control.

Due to the size of Intermediate level activities, the location of the various work centers, and the number of components involved daily, it is not practical to control each component inducted into the activity from a central maintenance control area. Maintenance control delegates some of its functions to certain selected production divisions. Divisions so designated exercise direct control of the production efforts of assigned work centers, are responsible to maintenance control for the production efforts of the assigned work centers, schedule components into work centers, and assign priorities as directed by maintenance production control.

The segment of these selected divisions concerned with production control functions should not be confused with the production control work center depicted in figure 2-1. The production control work center in the figure is the overall coordinator for all division production control segments. The entire responsibility for production of the department is controlled by this work center.

Maintenance control cooperates with the staff members by utilizing their findings and recommendations to improve the overall maintenance effort. Together with the administration division, the analysis division, and the quality assurance division, maintenance/material control provides the Aircraft Maintenance Officer with a complete picture of the maintenance situation as it exists at a given time, and makes recommendations for improvement.

The functions of the material control work center of Intermediate level activities are closely related to those previously discussed under Organizational level. Since Intermediate level activities do not operate aircraft, their material control work center has no responsibility for aircraft inventory and inventory log/record maintenance.

The material control work center coordinates and controls the supply functions of the department. It acts as liaison between the

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department and the local supply activity, and it processes all supply and material transactions for the other divisions of the department. It requisitions material, maintains the Material Control Register, maintains inventories of materials on hand, maintains subcustody records of accountable items held by the department, maintains records of all material transactions, and accounts for the expenditure of funds by the department. It furnishes technical advice and information to the local supply activity concerning material requirements for the assigned workload.

The material control work center of Intermediate level maintenance activities has an aeronautical material screening unit which coordinates the screening of received materials and parts to determine the status and repair responsibility/capability.

PRODUCTION DIVISIONS

The standard organization framework for Intermediate level maintenance activities provides for six production divisions. (See fig. 2-1.) These production divisions are generally manned by personnel of the same rating; whereas, in Organizational level maintenance departments, personnel of more than one rating are grouped into fewer divisions. The type of work usually performed by an individual is the same regardless of the maintenance level at which he is working; that is, AD's work on engines and related equipment, AE's on instruments and electrical equipment, and AT's work on avionics equipment. The difference between work performed in production divisions at various levels lies in the depth of maintenance performed.

The production divisions provide intermediate level maintenance on aircraft components and equipment for the supported activities. Some of the more important responsibilities and functions of these divisions are described in the following paragraphs.

Powerplants Division

The powerplants division is manned by Aviation Machinist's Mates who perform maintenance on powerplants, powerplant components, and associated systems.

Airframes Division

Aviation Structural Mechanics are assigned to work centers in the airframes division. This division is responsible for the specified level of maintenance of the airframe and structural components; movable structures and surfaces including their hydraulic and pneumatic control and actuating systems and mechanism; air-conditioning, pressurization, visual improvement, oxygen, and other utility systems; and seat and canopy ejection systems and components.

Avionics Division

The avionics division is manned with the necessary combination of the following ratings to provide the required level of maintenance of avionics equipment for the supported activities:

Aviation Electrician's Mates maintain aircraft electrical and instrument systems.

Aviation Electronics Technicians maintain and test aviation electronic equipment including detection, reconnaissance, identification, communication, navigation, display, and special purpose equipment.

Aviation Antisubmarine Warfare Technicians maintain and test aircraft antisubmarine warfare (ASW) systems and equipment, including those related to magnetic anomaly detection, long and short range underwater detection, nuclei detection, integrated displays, and associated ASW equipment.

Aviation Fire Control Technicians maintain and test aircraft armament control systems, including fire control, automatic turrent control, and bomb director systems.

Aviators Equipment Division

Aircrew Survival Equipmentmen (PR's) are assigned to the aviators equipment division. This division is responsible for intermediate level maintenance as required in connection with parachutes, liferafts, lifevests, pressure suits, oxygen masks, emergency equipment kits, flight clothing, oxygen regulators, automatic parachute actuators, aviator's protective helmets, etc. AME's may also be assigned to this division for the upkeep and support of the oxygen system, pressurization and air-conditioning systems, and other emergency equipment as assigned within the scope of that rating.

Armament Equipment Division

Aviation Ordnancemen (AO's) are assigned to the armament equipment division and are

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responsible for the maintenance of aircraft armament equipment and aviation ordnance equipment.

Support Equipment Division

The support equipment division is composed of personnel of the Aviation Support Equipment Technician rating who perform necessary maintenance on the support equipment assigned to the maintenance department and supported activities. Support equipment includes, but is not limited to, such items as test stands, workstands, mobile electric powerplants, and pneumatic and hydraulic servicing equipment.

INTERMEDIATE (AFLOAT)

A recent revision in aircraft carrier organization has established the Aircraft Intermediate Maintenance Department (AIMD). This department has the same basic responsibilities afloat as AMD's ashore, the accomplishment of intermediate maintenance in support of embarked aircraft and related equipment. In addition, the AIMD is responsible for Organizational maintenance functions relating to the ship's utility aircraft.

This department is headed by the AIMD Officer and consists of a nucleus of permanently assigned personnel and temporarily assigned maintenance personnel from the embarked squadrons and detachments.

The difference in the organizational structure of Intermediate maintenance ashore and afloat can be seen by referring to figures 2-1 and 2-3.

Some specific responsibilities and functions of the AIMD Officer include the following:

1. Administer the AIMD under the direction of the commanding officer in accordance with existing directives.

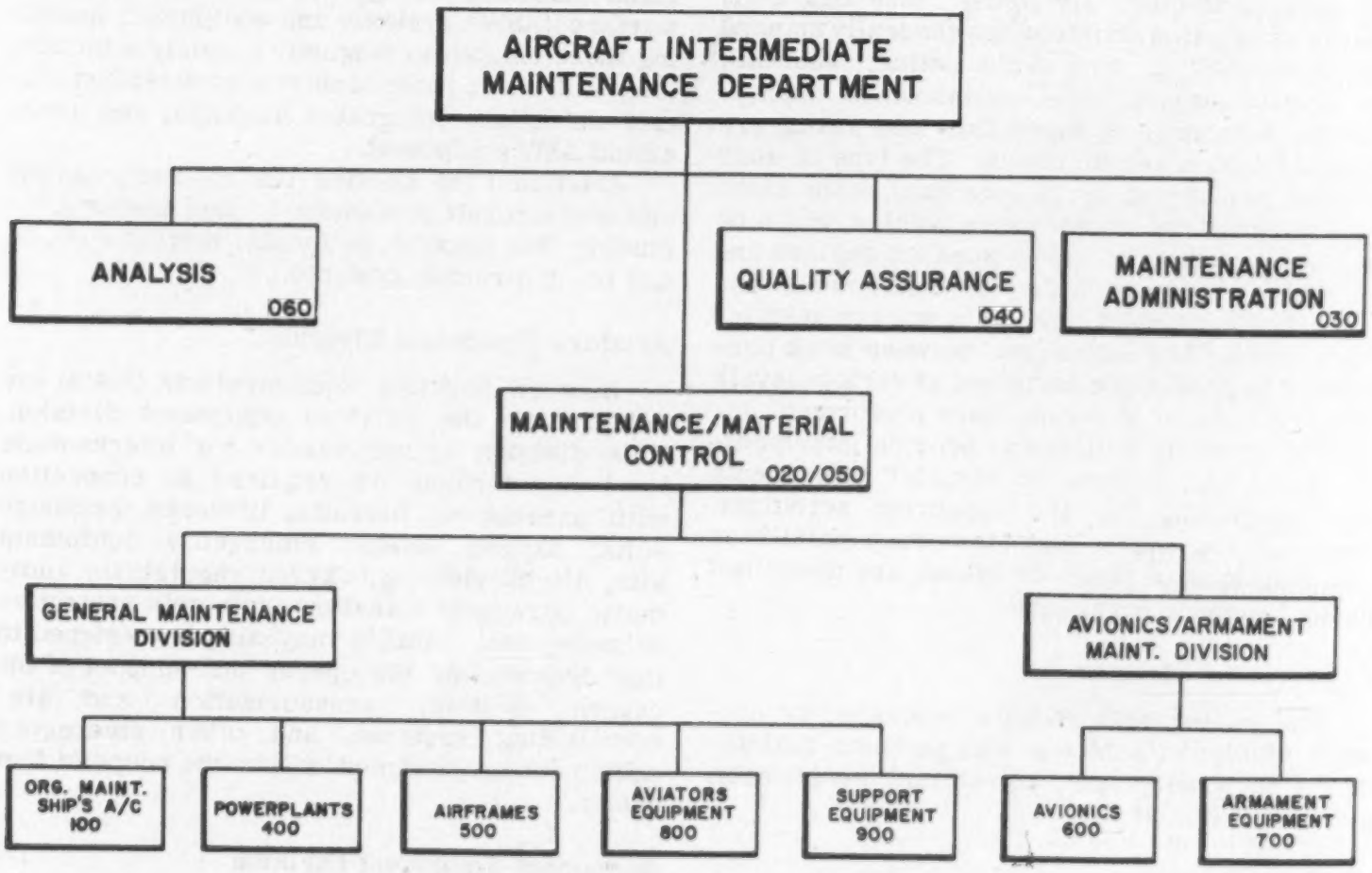

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Figure 2-3.—Intermediate level maintenance department organization (afloat).

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2. Manage the Intermediate maintenance effort performed in support of embarked aircraft including custody and upkeep of associated maintenance facilities and support equipment.

3. Assume Organizational maintenance responsibility for the ship's aircraft.

4. Provide and maintain aircraft maintenance facilities to support the embarked aircraft.

5. Update facility plans to accommodate deck load changes and new weapons systems.

6. Establish and update ship/wing/group personnel requirements in conjunction with the air wing/group maintenance officer to insure adequate manning for support of the Intermediate maintenance effort.

7. Maintain a current inventory of maintenance facilities and equipment and submit recommendations for changes to the Individual Material Readiness List.

8. Establish and maintain an effective training program and provide for training and licensing of personnel to operate support equipment.

9. Maintain and control a central technical library of publications for performance of Intermediate maintenance on embarked aircraft and assigned equipment.

10. Conduct maintenance/material planning conferences prior to and during deployments.

11. Assume responsibility for coordinating maintenance and security of all Intermediate and Organizational maintenance work spaces.

SUPPLIES

Nearly every maintenance task generates a need for supplies of one type or another. These supplies may consist of common everyday items like rags, screws, nuts, bolts, etc., or one of the many hundreds of aircraft or equipment components for which the PR has maintenance responsibility. If the job is to progress smoothly and if the assigned job completion deadlines are to be met, all material needs must be satisfied promptly.

A large number of aircraft and equipment components are reparable. For this reason, replacements for these items are not stocked to the depth that nonreparable items are stocked. In order to keep the supply of reparable items rotating from the shelves to the aircraft (or equipment) to repair and back to the shelves in an efficient and orderly manner, the turn-in of reparable items is stressed to the PR (and all other applicable aviation personnel).

The first part of this section provides a thumbnail sketch of the relationship of the PR and the local supply organization insofar as material procurement is concerned.

The second portion is devoted to handling and turn-in of reparable materials.

PROCUREMENT OF MATERIAL

Rapid communications is an integral part of the Navy Maintenance and Material Management (3-M) System. Every PR should be aware of all the means of rapid communications at his working area (center, station, etc.) and make use of them as necessary in obtaining needed parts or supplies. Such systems as 2-digit telephones, walkie-talkies, and intercoms are typical of the rapid communication systems at various stations. Using such systems greatly reduces the elapsed time between ordering and receiving a part or parts. The PR should use whatever means is available to let his needs be known.

Procedure

When the need for a part becomes evident to a PR who is working at a maintenance task, he immediately notifies his work center supervisor. The work center supervisor in turn notifies the maintenance control chief, requesting a priority. The supervisor then relays the need for the material to material control. Material control, in turn, informs the local supply support center. As knowledge of the need for this part is being pushed along from the worker to the supply activity, each place along the line of communications adds some information. For instance, the worker tells his work center supervisor the name of the part and the quantity needed. The work center supervisor looks up the part number and upon notifying the maintenance control chief tells him that so many of such and such an item is needed for job control number so and so. The maintenance control chief assigns a priority for the material. The work center supervisor then communicates with the material control division and gives them the following information: Name of needed part, part number, job control number, aircraft bureau number/serial number, quantity required, and delivery point. The material control division enters the necessary information

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CHANGE	FREQUENCY	AMPLITUDE OF e_{b1}	DURATION e_{b1} AT E_{bb}	AMPLITUDE e_{b2}	DURATION e_{b2} AT E_b	WAVESHAPE CHANGE ——— BEFORE CHANGE -------- AFTER INCREASE			
						e_{b1}	e_{b2}	e_{g1}	e_{g2}
$R_{l,1}$ INCREASED	DECREASED. V_2 CUTOFF LONGER.	INCREASED. e_{b1} IS LOWER DURING ZERO GRID VOLTAGE TIMES	UNCHANGED	UNCHANGED	LONGER. GRID IS MORE NEGATIVE AT START OF C.O TIME		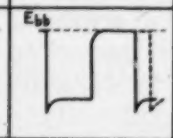	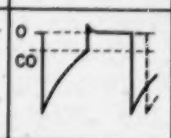	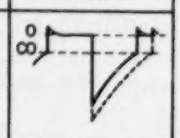
R_{g1} INCREASED	LOWER. V_1 CUTOFF LONGER	UNCHANGED	LONGER. TUBE IS CUT OFF LONGER	UNCHANGED	UNCHANGED	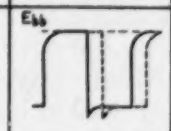	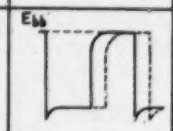	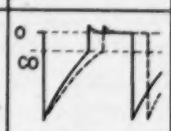	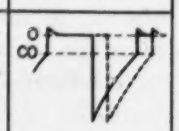
C_l INCREASED	LOWER. V_1 CUTOFF LONGER	UNCHANGED	LONGER	UNCHANGED	UNCHANGED				
E_{bb} INCREASED	LOWER. BOTH GRIDS DRIVEN BELOW CUTOFF. CUT OFF VALUE LOWERS SLIGHTLY.	INCREASED. E_b GOES UP. e_{b1} VALUE FOR ZERO GRID VOLTAGE GOES UP SLIGHTLY.	INCREASED. V_1 IS CUT OFF LONGER.	INCREASED. E_b GOES UP. e_{b2} VALUE FOR ZERO GRID VOLTAGE GOES UP SLIGHTLY.	INCREASED. V_2 CUTOFF LONGER.			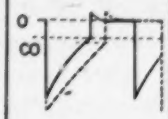	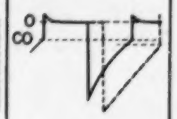
V_1 REPLACED WITH TUBE OF HIGHER Mu.	HIGHER	DECREASED. HIGH r_p OF V_1 CAUSED e_{bb} FOR ZERO GRID VOLTAGE TO BE HIGHER.	SLIGHTLY LONGER. CUTOFF FOR V_1 IS LOWER.	UNCHANGED	DECREASED SINCE GRID OF V_2 IS NOT DRIVEN VERY FAR NEGATIVE.	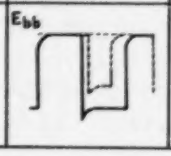	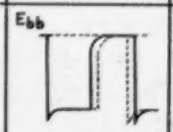	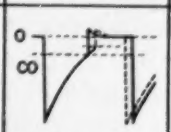	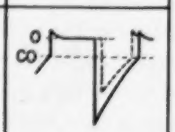

Figure 16-3. —Effects of varying elements in multivibrator.

supply. The net result is that the curve shown in figure 16-4 (A), resulting from the negative peak value to cutoff, is much more linear due to the fact that a smaller percentage of the discharge curve is used.

Returning the grids to a positive voltage produces an advantage in that the discharge curve strikes cutoff at a more nearly vertical angle. This means that if variations of voltage or temperature in the circuit affect the relation of the waveshape to the cutoff value only a small change of time will occur. In contrast, study the grid voltage curve in (B) of figure 16-4 where the grid resistor is grounded. The discharge curve is almost parallel at the cutoff value. In this case a small variation of the cutoff value will cause a large time change. In conclusion, then, returning the grids to B plus decreases the CHANGE in duration of pulses and the free-running frequency for a given change in circuit constants.

You can increase your understanding of the effect of returning the grid to B plus by making quantitative analyses and studying equivalent circuits. In figure 16-5 (C), notice the equivalent charging circuit of C1 during the time that V1 is conducting. In (B), the parts of the circuit involved during the charge of C1 are shown. Since the grid to cathode resistance is very small, compared to the grid-leak resistor, it can be represented as a direct connection, producing the equivalent circuit in (C). Here R2 is relatively small; as a result the capacitor will be fully charged before tube V2 starts to conduct. Thus, while V2 is cut off, capacitor C1 has a charge of 300 volts.

The discharge circuit for C1 is shown in (D). V2 is brought into conduction at this time, causing a 203-volt drop across the load resistor R2. A closed circuit is formed as shown in (E). The voltage across the load resistor may be considered as a source of voltage or battery which is of a polarity to aid the capacitor in causing current flow. The total voltage across the resistor R3 becomes the capacitor charge plus the load resistor voltage (300 + 203 = 503 volts). The grid end of resistor R3 is 503 volts negative with respect to the end connected to 300

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in their register, then informs the local supply support center (SSC) of the number of the part, the priority, and the designated delivery point.

When the material is available locally (on hand in supply), the maximum time allowed for processing and delivery is usually as follows:

Priority	Process/Delivery Time
1-3	1 hour
4-8	2 hours
9-20	24 hours

If needed materials are not available on station, the supply department transmits these needs off station through the proper channels to insure prompt service and follows up on such orders as necessary.

A branch of the local supply support center, the supply response section (SRS), is responsible for delivering the required material to the delivery point designated by the supported organization. In most cases in which no delivery delays are encountered, the needed material is delivered directly to the worker at the job site.

Naturally, there is paperwork involved, but this is taken care of by the supply support center in due time after or while the part is being delivered. The main thing is that the part is not delayed anywhere in the line of communications by paperwork.

The usage of a part or of supplies generally governs how fast it can be placed in the hands of the man on the job. For common items of hardware, rags, etc., the local supply activity maintains stocks in the vicinity where maintenance is being performed. These are known as preexpended stocks; that is, they are written off on their accounts just as if they had been issued, and the mechanics can pick up the desired quantity of these items as soon as they need them. When the stock gets low, the supply activity preexpends another batch and restocks.

For fast moving reparable items of aircraft and equipment parts, an adequate stock is kept more readily available than for slower moving items. In some cases, such items may be positioned in a roving van or pie wagon which maintains constant touch with the supply activity by a 2-way radio. In such cases, delivery of a needed part can be accomplished in a matter of minutes.

Material Turn-In

As mentioned previously, it is often necessary that defective parts be turned in to supply. Such parts are known as accountable items; and whenever one is issued for installation, the removed item must be turned in within 2 days. The PR is not normally responsible for the physical return of the item. Defective accountable items are picked up by a representative of the supply department's supply support center for delivery to the local intermediate maintenance activity.

The defective item, if within the repair capability of the IMA, is repaired and returned to the supply department in an RFI condition. If the defective item cannot be repaired by the IMA, it is forwarded to the supply screening section of the supply support center for transfer to the appropriate depot level of maintenance. The IMA may consider the defective item beyond economical repair and may forward the item to the supply screening section, recommending survey or salvage.

NAVY MAINTENANCE AND MATERIAL MANAGEMENT (3-M) SYSTEM

The 3-M System was established to insure maximum readiness and reliability at the lowest cost in men, money, and material throughout the Navy. It has application to both ships and aircraft.

NOTE: Throughout this training manual when reference is made to the 3-M System, it concerns only the naval aviation portion of the system.

The 3-M System is sponsored and directed by the Chief of Naval Operations (CNO), administered through the operating chain of command, and provided material and technical support by the Naval Material Command. In reality, the 3-M System provides maintenance managers information required for efficient and economical utilization of human and material resources in the performance of aircraft maintenance. This system insures that maintenance personnel, equipment, and facilities are utilized to the fullest extent in actual aircraft and related equipment maintenance performance.

The 3-M System includes two broad areas: (1) A planned maintenance system (PMS), and (2) a Maintenance Data Collection System (MDCS).

Through the use of the PMS it is possible for operating and maintenance activities to achieve and maintain maximum operational

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efficiency of all aircraft and related equipment at all times, reduce down time of equipments to the minimum consistent with good maintenance practices, and reduce the cost of maintenance on both manhours and money.

The PMS systemizes the conduct of the various required aircraft inspections by combining, in convenient sets of Maintenance Requirements Cards (MRC's) for each type aircraft, information required by the workers to accomplish the inspections. These MRC sets are based on information contained in the Periodic Maintenance Requirements Manual (PMRM) for the type of aircraft concerned.

Together, the PMRM and MRC's tell what inspections have to be performed; when and how they should be performed; what skills, tools, and special equipment are required to perform them; what safety precautions should be observed; and in what sequence individual inspection actions should be accomplished.

The Maintenance Data Collection System is the second area covered by the 3-M system. It is actually a maintenance and material management control and information system, which includes maintenance data reporting among other things. It was designed to provide a means of recording maintenance actions in sufficient detail so that a great variety of information may be retrieved concerning maintenance actions and the performance of equipment involved. The system also provides data concerning the initial discovery of malfunctions, how equipment malfunctioned, what equipment was involved, what repair parts and materials were used in the repair process, how assigned manhours were utilized, and aircraft flights and readiness data.

The MDCS includes three major categories of data recorded by maintenance personnel and collected for machine processing. These categories are manhour data, maintenance data, and aircraft statistical data.

NOTE: Manhour accounting and maintenance data collection system forms (source documents) are discussed in detail later in this chapter.

AIRCRAFT MAINTENANCE FORMS AND RECORDS

Forms and records are used for many purposes in naval aviation maintenance. Various kinds of information about each flight are required to be recorded. This type of information is useful for the reduction of operational, maintenance, personnel training, aircraft utilization, and aircraft historical data. Other forms and records are used to specify what maintenance is to be performed on aircraft and who is to perform it; and when the maintenance is completed, form the basis for establishing credit for an outstanding job or fix responsibility for poor work.

This chapter deals with the most common forms and records with which the PR is concerned in his day-to-day duties.

NAVAL AIRCRAFT FLIGHT RECORD

The Naval Aircraft Flight Record is a four-part, four-page record that is completed for every flight of naval aircraft. This form, printed on yellow paper, is familiarly known as the yellow sheet. In fact, the usage of the term has been so widespread and long continued that the words "Yellow Sheet" are printed at the top of the first page of the form to help identify it.

Of the four parts of this record, the PR, when and if he is assigned as plane captain, will be primarily concerned with only Part A—Preflight. After inspecting and servicing his aircraft and before the arrival of the pilot at the aircraft, the plane captain initiates the yellow sheet for the next flight.

In Part A he enters in the appropriate spaces the date, aircraft model, its bureau number (BUNO), and its side number. NOTE: The bureau number is a number assigned to the aircraft by the Naval Air Systems Command upon acceptance of the aircraft. This number remains with that aircraft until it is stricken from the Navy inventory and is not thereafter assigned to another aircraft. The aircraft side number (also termed the squadron number, local number, or modex) is used for local identification, since each squadron in a Group or Wing utilizes a different series of side numbers.

Also included in Part A to be filled in by the plane captain are spaces to identify the aircraft's reporting custodian (the activity to which the aircraft is assigned), the grade and quantity of fuel and oil aboard, the kind and quantity of ordnance and pyrotechnics aboard, and the aircraft's flight limitations. Local instructions always govern the specific content of the aircraft limitations space and this information is always available to the plane captain for copying in this space.

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There is a space on Part A for the plane captain to sign, also furnishing his rate. The plane captain thus certifies that the aircraft has been inspected that day in accordance with approved preflight instructions, is serviced as stated on the form, and is ready for flight. NOTE: Daily and preflight inspections are performed in accordance with the applicable set of Maintenance Requirements Cards (MRC's).

The plane captain also fills in basic information pertaining to date, model, BUNO, side number and reporting custodian wherever it appears in the other parts of the form.

Part A of the yellow sheet is always retained at the place of first takeoff of the flight. The other parts may or may not accompany the aircraft, depending upon where the flight is to terminate and local policy.

At the completion of the flight, the pilot fills in the applicable portions of Part B—Maintenance. The pilot's action may be limited to circling an arrow to indicate that the aircraft is still in an UP (flyable) status with no minor discrepancies and signing it. Or, he may list one or more discrepancies, numbering them in numerical order. If any of the discrepancies DOWN the aircraft, he circles the DOWN (unsafe for further flight, pending corrective action) arrow and indicates each grounding discrepancy by making an X in the column alongside the number of the discrepancy.

Whenever a pilot reports aircraft, system, or equipment discrepancies on Part B of the yellow sheet, they must be corrected. Normally, Maintenance Control issues necessary authority to the appropriate shop(s) for the accomplishment of the necessary work and initiation of the Maintenance Action Form. As each discrepancy is completed, it is entered in the "Corrective Actions Accomplished" section of Part B. Each corrective action entry is numbered to correspond with the discrepancy number. Whenever the maintenance action corrects a grounding discrepancy, the pilot's X, which identifies the discrepancy, is circled. This system provides supervisory personnel with a quick method of determining the number of outstanding grounding discrepancies against an aircraft.

When all grounding discrepancies have been corrected; it may be possible to again place the aircraft in an UP status. Of course, it is possible to have several minor discrepancies against an aircraft, no single one of which justifies downing it, yet when taken collectively, they can amount to a serious liability if the aircraft is flown.

Parts C and D of the Naval Aircraft Flight Records are used to record aircraft, engine, and accessory operating time and operations data, respectively.

MAINTENANCE INSTRUCTIONS

A single type of maintenance instruction form is used to promulgate the three kinds of maintenance instructions required by the Naval Aircraft Maintenance Program. A checkbox area at the top of the page is used to indicate the kinds of maintenance instruction being issued in each case. The three kinds of maintenance instructions are discussed in the following paragraphs.

Single Action Maintenance Instruction

The Single Action Maintenance Instruction (SAMI) is issued when work of a one-time nature is to be performed on aircraft or equipment. The work ordered is of such a nature that it will not thereafter need to be performed again on the same aircraft. An example is an Airframe Change issued for all aircraft of a particular model. The SAMI itself is not authority to proceed with the work. It merely specifies what has to be done and, when applicable, has appended to it all the necessary references, directives, and other information.

Compliance with a SAMI is accomplished by Maintenance Control making an entry in their maintenance control register and then relaying the job control number along with other pertinent facts to the work center supervisor concerned. The work center supervisor makes his entries on the work center's register and assigns men to comply with the SAMI. Verification of completion of the task along with the manhours expended are documented on the Maintenance Action Form (MAF).

In areas where technical directives are to be incorporated, compliance is accomplished by Maintenance Control issuing a Technical Directive Compliance Form (TDC). This form initiates the maintenance action, verifies completion, and accounts for the manhours expended.

Using a SAMI to describe the work and verbally initiating the action on each aircraft simplifies the MAF preparation, standardizes logbook entries, and results in more orderly

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scheduling of the necessary work among all applicable aircraft assigned. Figure 2-4 illustrates the maintenance instruction prepared as a SAMI.

Continuing Action Maintenance Instruction

A Continuing Action Maintenance Instruction (CAMI), as its name implies, is a local directive providing instructions for the performance of work which is or may be of a continuing nature. Like the SAMI, it is not authority needed to proceed with the work. Here too, a Maintenance Action Form reports compliance with the directive. Examples of work properly covered on a CAMI are (1) the accomplishment of minor inspection and cleaning of a component after a given number of flight hours; and (2) a special inspection which must be performed on a conditional basis; i.e., an airframe inspection if and when the aircraft has been subjected to a hard landing.

Technical Information Maintenance Instruction

Technical Information Maintenance Instruction (TIMI's) are issued by local maintenance activities to promulgate technical information within that activity only. Issuance of a TIMI does not involve the accomplishment of work; however, the information contained is sustaining in nature. Typical of instances where TIMI's may be issued are (1) precautions in handling of certain chemicals, (2) changes in specification materials, and (3) changes in service life of explosives or soft goods.

MAINTENANCE ACTION FORM (MAF)

This section outlines the procedures for documenting maintenance actions using a single and multicopy Maintenance Action Form. A maintenance action is any corrective or preventive action taken to maintain or restore equipment or material to a satisfactory operating condition. This action consumes manhours or material, or both.

The Maintenance Action Form is originated in the work center. Whenever the work center supervisor is notified of required work, he enters this information in the work center register and assigns men to the job. Upon completion of the work the worker or crew leader fills out the MAF, using information from the supervisor's work center register and verifies completion of the work, manhours expended, materials used, etc. Whether the worker uses the single copy MAF or the multicopy MAF depends upon whether a reparable item is removed from the aircraft. The single copy MAF (fig. 2-5) format is identical with the multicopy form. The uses of the two MAF's are discussed later in this chapter.

Referring to figure 2-5, completion of the numbered and lettered spaces is discussed in the following paragraphs.

Job Control Number (JCN). The Job Control Number is a 10- or 11-character "number" that serves as a base for maintenance data reporting and maintenance control procedures. The JCN provides separate identification of each maintenance action, when necessary. It also identifies the maintenance actions accomplished by intermediate maintenance activities in support of organizations or an organizational discrepancy. The four parts of the JCN are organization code, date code, sequence number, and suffix and are thus explained.

The organization code is a 3-character code composed of letters and numerals (alphanumeric) which identifies an organization. This part of the JCN is published by higher authority for each individual activity performing or which is responsible for aircraft maintenance and always remains constant within the activity.

The date code identifies the date on which the JCN was initiated or assigned to a job. Therefore, this is not necessarily the date on which the work was actually started. NOTE: The date code, known as the Julian date, identifies the year and the numerical day of the year and consists of four numbers. The first number indicates the last digit of the calendar year, the next three numbers specify the number of days in the calender year which have elapsed since January 1 of that year; for example, the Julian date 5350 identifies the 350th day of 1965 or, in more familiar terms, 16 December 1965; 6006 is the 6th day of 1966. All dates used in the Maintenance Data Reporting Program are reported in Julian dates since any date in any 10-year period can be shown in just four digits. Encoding the date in this manner simplifies recordkeeping and data reduction by machine methods.

The sequence number part of the JCN (identified SER on the form) is either a 3-digit

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MAINTENANCE INSTRUCTION
NAVAIR FORM 4710/7 (7-67)
0102-607-4370

☐ TECHNICAL INFORMATION ☒ SINGLE ACTION ☐ CONTINUING ACTION

ORIGINATING ACTIVITY	DATE	MAINTENANCE INSTRUCTION NO.
NAS Memphis Aircraft Maintenance Dept.	9-8-69	S-11-69

SUBJECT
Full Pressure Suit, Mk-2 Anti-G Coverall; conversion to a Mk2A Anti-G Coverall.

REFERENCE
Air Crew Systems Bulletin No. 77

APPLICATION
Mk2 Anti-G Coverall.

ACTION

1. Incorporate Air Crew Systems Bulletin No. 77.

WHEN TO BE DONE
ASAP

MATERIAL REQUIRED	MATERIAL ORDERED ON REQUISITION NO.
1 MS 17966 Adapter, Anti-G Suit	93230088

WORK RESPONSIBILITY	LOG BOOK ENTRY (ENTRIES) REQUIRED
	☐ YES (State entry required) ☒ NO

SUBMITTED BY (Signature of Division Officer)	APPROVED BY (Signature of Maintenance Officer)
S.R. Hawes S.R. HAWES ENS, USNR	G.L. Takken G.L. TAKKEN, CDR USN

(See instructions on reverse)

Figure 2-4.—Single Action Maintenance Instruction (SAMI).

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MAINTENANCE ACTION

MMMPC TEST FORM #5 (REV. 3-67) S/N-0140-001-0011

1. JOB CONTROL NUMBER (ORG. / DATE / SER / SUF)	2. TYPE EQUIP.	3. BU/SER NO.	4. ACTION ORG.	5. WORK CENTER	6. MAINT LEVEL	7. ACTION DATE
T09 / 9251 / 503 /	AADB	151601	T09	130	☒ 1 ORG ☐ 2 INT ☐ 3 DEP	9251

8. WORK UNIT CODE	9. WHEN DISCD	10. TYPE MAINT	11. ACTION TAKEN	12. MAL	13. ITEMS PROC	14. MAN HRS	15. EMT	16.
91151.00	J	B	Z	135	1	1 0	1 0	

20. REMOVED ITEM — .1 RIC/MFGR | .2 SERIAL NUMBER | .3 PART NUMBER | .4 METER READING

21. INSTALLED ITEM — .1 RIC/MFGR | .2 SERIAL NO. | .3 PART NUMBER | .4

B. DISCREPANCY

Rocket Jet hardware difficult to operate.

C. CORRECTIVE ACTION

Rocket Jet hardware cleaned.

D. ENTRIES REQUIRED — CONFIGURATION ☐ YES ☑ NO; LOG ☐ YES ☑ NO; ACCESS RECORD ☐ YES ☑ NO — SIGNATURE

E. CORRECTED BY: H. L. Hoell — F. INSPECTED BY: F. L. Turner — G. SUPERVISOR: E. L. Collom

30. REPAIR CYCLE DATA

	DATE		DATE
1. REMOVED		5. TO AWP	
2. RECEIVED MAT'L. CONTROL		6. OFF AWP	
3. WORK STARTED		7. TO AWP	
4. COMPLETED		8. OFF AWP	
RFI ☐ B COND ☐ R/S ☐		9.	
		0.	

H. PCN | PRIORITY | DATE DUE — IN | OUT

40. FAILED MATERIAL

.1 ACT TKN	.2 MAL	.3 QTY	.4 MFGR	.5 PART NUMBER

J. ACCUMULATED HOURS

NAME/SHIFT	DATE	MAN HRS.	EMT
TOTAL			

K. REQUIRED MATERIAL

REQ. NO.	MFGR	PART NUMBER	QTY	PRI	DATE/TIME ORD	DATE/TIME REC	AWP

COPY 1

PR.106

Figure 2-5.—Maintenance Action Form.

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number that runs consecutively from 001 to 999 or a 3-character alphanumeric code with an alphabetic first character and two numbers which run from 00 to 99. The sequence number is normally assigned in sequence as new jobs come up. When the number 999 (or alphanumerically, 99) has been assigned, the next number in sequence is again 001. The alphanumerical sequence numbers are used only when documenting calendar inspection maintenance actions.

The JCN suffix is a single alphabetic character which is added to the basic JCN (those parts just discussed) to identify a subcomponent repair job which was done separately from the major repair job. This code applies to intermediate maintenance only. An example of this is when a defective item is replaced with a good one during the course of a major job. The MAF Job Control Number used to process the removed part through repair (intermediate) maintenance would be the same basic code as the major job but the suffix A would be added to identify the subcomponent repair.

Type Equipment. The type equipment code is a 4-character code consisting entirely of letters. The type equipment code on the MAF shown in figure 2-5 is the code for the A-4E aircraft. These codes are listed in official directives and are mandatory for use.

Bu/Ser No. A bureau number or serial number is a number that identifies a specific end item or component, including aircraft and their components. The number is usually assigned by the manufacturer (serial numbers) or the Navy (bureau numbers), and is used to differentiate between a given end item and others of the same type, model, series, design, etc.

Action Org. Entered here is the organization code number of the organization performing the work. In case the same organization that assigned the JCN is performing the work, the code entered is the same as the organization code in the JCN.

Work Center. Entered here is the work center code of the work center accomplishing the maintenance action described on the MAF. This is either (1) the code of the worker's assigned work center, or (2) if temporarily assigned, the code of the work center to which he is temporarily assigned.

Maintenance Level. Entered here is a checkmark in the block which describes the level of maintenance being performed. This information should not be confused with organizational assignment of personnel. For instance, a man assigned to an intermediate maintenance activity may actually work on an aircraft. Such a job would normally be considered as organizational level work. As a general rule, all work performed on aircraft or missiles is considered as organizational level maintenance and work performed off the aircraft or missile as intermediate level maintenance.

Action Date. Entered here is the Julian date on which (1) the action is completed, or (2) the MAF is turned in to account for manhours accumulated against a job, or (3) the job is turned over to another work center, or (4) a job is interrupted due to the fact that supply must go off station for parts, or (5) a reporting period ends.

Work Unit. The work unit code is a 5- or 7-character alphanumeric code which normally identifies the system, subsystem, component and part of the end item being worked on. Work unit codes are published by the NavAirSysCom in Work Unit Code Manuals for end items in two major categories: Type/model/series for aircraft, drones, and missiles; and aircraft maintenance support equipment. Five-character work unit codes from these manuals are used to code all work on an end item and its components. The sixth and seventh characters are used in benchwork (off equipment) to allow identification of reparable subassemblies of major components.

When Discd. When discovered codes are single alphabetic characters which identify when the need for maintenance was discovered. These codes are applicable to the MAF only. There are two sets of when discovered codes, covering the following equipment categories: Aircraft and engines and aircraft maintenance support equipment.

When discovered codes relate primarily to conditions under which the malfunction or discrepancy was discovered rather than to the time in days or hours. For instance, code F (aircraft and engines) identifies a discrepancy or other need for maintenance that was discovered during the pilot's weekly inspection, while code F (aircraft maintenance support equipment) indicates that a need for additional maintenance was discovered during a period of unscheduled maintenance on the support equipment.

Type Maint. The type maintenance code is 1-character alphabetic code used to describe the type of work being accomplished (i.e., scheduled, unscheduled, supply support, etc.).

Definitions and explanations of all these codes are contained in an appendix to the Navy Maintenance and Material Management Program Manual.

Action Taken. The action taken code is a 1-character alphabetic or numeric code which describes the action that has been taken to correct the discrepancy. The action taken code A (discrepancy checked, no repair required) is used only in those cases where an inspection or operational check has been performed and the reported trouble cannot be duplicated or does not exist. In these cases the Malfunction Description Code is 799 (no defect) rather than a code that describes the reported discrepancy.

MAL. (Malfunction Description). The malfunction description code is a 3-character numeric code used to describe the malfunction occurring on or in the item identified by the work unit code on the Maintenance Data Reporting Forms. These codes are listed in alphabetical and numerical sequence in all Work Unit Code Manuals.

Items Proc. (Items Processed). Items processed, for the purpose of Maintenance Data Reporting, is defined as the number of times that an action indicated by an action taken code is applied to the item identified by the work unit code recorded on an MDR form, or the number of times a support action is accomplished. EXAMPLE: Since the fuel nozzle of a jet engine is a coded item, replacement of five fuel nozzles would be documented as five items processed. In contrast to this, replacement of several tubes in an electronic assembly would be documented as one item processed with the work unit code identifying the electronic assembly being repaired, and the action taken code indicating repair.

Manhours. Entries in the manhours block of the MAF forms represent all manhours expended by assigned personnel in completion of the work described on the source document. Hours and/or tenths worked multiplied by the number of men working equals total manhours. Time expended in exceptions of three-tenths of an hour or less is included in the total labor hours for the job. Exceptions which exceed three-tenths of an hour are not accounted for on Maintenance Action Forms. They are charged to the proper labor distribution code in the Manhour Accounting System described later in this chapter. Entries in the manhour block of the Maintenance Data Reporting (MDR) forms do not include labor hours for any work center other than the one submitting the document. For example, if two work centers jointly correct a discrepancy (same JCN) on the same aircraft or equipment, workers from each work center submit a source document with that particular work center's labor hours in the manhour block.

EMT. (Elapsed Maintenance Time). Elapsed maintenance time is defined as the actual clock time, in hours and tenths, that maintenance was being performed on a job. Although the EMT is directly related to job manhours, it is not to be confused with total manhours required to complete a job.

Block 16. Left blank. Use of this block is not currently prescribed.

Removed Item. This block is completed on the 4-part MAF when a reparable item is removed from the aircraft or equipment being worked on. Also entered in this block is the serial number of the removed item and the manufacturer's code, and part number. METER READING in this block refers only to those items which have a meter or clock installed. Entered here is the number of starts, cycles, hours, etc., if applicable. If no meter is installed, no reading entry is required.

Installed Item. The component serial numbers of the installed item is entered here. Also, the manufacturer's code, serial number, and part number are entered.

NOTE: The removed and installed item blocks on the single copy MAF should be completed when recording cannibalization actions or when removing or installing items on the configured item lists. Configured items are selected items which require configuration accounting. Any item which meets one or more of the following criteria may be selected as a configured item.

1. An item which affects mission capability and can be interchanged with a similar item.
2. Management attention items.
3. Items with Accessory Record Cards. (See Aircraft Logbook.)

Discrepancy. A narrative description of the reported discrepancy or work to be performed is entered in this space. The appropriate arrow below the word DISCREPANCY is circled to indicate the flying status of the aircraft.

Corrective Action. A narrative description of the work accomplished in compliance with the discrepancy block is entered here by the person accomplishing the job.

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Entries Required. Applicable checkmarks in the entries required space are made when the action or discrepancy requires logbook or accessory record card entries. Maintenance Control enters a checkmark in the configuration block when configuration of the equipment is affected. The person making the entries signs his name and rate in the adjacent signature block.

Corrected By. The worker or crew leader who accomplishes or supervises the repair signs his name and rate in this block.

Inspected By. The quality assurance or collateral duty inspector who inspects the job for proper standards signs his name and rate in this block.

Supervisor. The work center supervisor or his assistant signs his name and rate in this block to indicate that screening and other appropriate action has been accomplished.

Repair Cycle Data. Enter the Julian dates for 1. Removed; 2. Received Material Control; 3. Work Started; and 4. Completed. Check the appropriate block to indicate if the item is Ready for Issue (RFI), Requires Rework (B COND), or is Recommended for Survey or Salvage (R/S).

During the actual repair, if the job is interrupted for one or more days due to a lack of parts, enter the Julian date that the job goes AWP (awaiting parts) adjacent to block 5 or 7. Enter the Julian date that the parts are received adjacent to block 6 or 8. Blocks 5 and 6 are used the first time the job status is AWP and blocks 7 and 8 are used the second time the status is AWP. If the job status is AWP more than twice, dummy dates within the actual repair time are entered adjacent to blocks 7 and 8 to reflect the actual number of days lost due to the second and subsequent AWP status.

Failed Material. On the single copy MAF, enter the action taken code, malfunction description code, quantity, manufacturer's code, and part number of failed material in this block if the parts replaced during repair are parts, bits, and pieces that have failed in a major component. If the failed item is removed and replaced, enter Action Taken code R (removed and replaced). If the removed item is removed, repaired, and reinstalled, at the organizational level of maintenance, enter action taken code C (repaired). It is intended that this block be utilized to record only primary items that have failed. It is not intended to be used for recording all items replaced (i.e., common hardware, nuts, screws, safety wire, etc.), nor is it to be used to record routine replacement of seals, gaskets, washers, fittings, etc., that are installed during overhaul or repair.

Accumulated Hours. The work centers use this block to record manhours and elapsed maintenance time (EMT) accumulated against a job. Whenever (1) completing a repair action, (2) turning in a supplementing document in support of the job, (3) making a work center change, (4) a reporting period ends, or (5) going AWP, manhours and EMT are totaled in this section and entered in blocks 14 and 15 (near the top of the MAF) of the submitted document, after which the entries in the accumulated hours block are lined through to indicate they have already been documented.

Required Material. Whenever material is required to complete a maintenance action, it is requisitioned and a line for each item ordered is filled in in this section. Entered are the requisition number, manufacturer's code, part number, quantity, priority, date and time the material was ordered, and date and time the material was received.

Single Copy MAF

A single copy MAF is used to document the following actions:

1. Repair work on the equipment which does not involve removal of defective or suspected defective reparable components.
2. That portion of calendar, conditional, periodic, acceptance, and transfer inspections which involves the search for (not repair of) defects, sometimes called the "look phase."
3. Removal of components for check, test, inspect, and service actions.
4. Item removal and replacement for cannibalization.
5. Fix-in-place actions discovered during inspections.
6. Recording manhours accumulated during work stoppage for parts or maintenance.
7. Recording accumulated maintenance manhours at the end of a reporting period for a job not completed.
8. To report assistance from work centers in support of a basic work center.
9. In support of a reparable item processing through an intermediate maintenance activity.

SECRET 10933

Multicopy MAF

This form, provided in four-copy sets, is used when processing a defective or suspected defective reparable component through the intermediate maintenance activity. It is also used to induct a component (including engines) into an intermediate maintenance activity for compliance with technical directives. However, the multicopy MAF is not used for the accomplishment of test, inspect, and service actions. Instead, see 9, under Single Copy MAF.

Each copy of the multicopy MAF is used as follows:

Copy 1—Used for removal/replacement of reparable components from aircraft, engines, or support equipment.

Copy 2—Used to provide status control and suspense information to the Component Control Section of the Supply Support Center for items undergoing processing in the intermediate maintenance activity.

Copy 3—Used to document the action taken by the Intermediate maintenance activity on reparable components. Such actions include a determination that the part was beyond the capability of maintenance (BCM), repaired, checked OK, etc.

Copy 4—Used to provide status control to the Component Control Section of the Supply Support Center and serve as an information copy for all off-station shipment of all material requiring rework.

WORK REQUEST

The NavAir 4710/6 is provided for use as a work request. This request form will be utilized for the following:

1. Requesting check, test, and servicing of items removed from an aircraft or equipment for scheduled maintenance.
2. When requesting work or assistance which is beyond the requesting activity's capability and does not involve repair of aeronautical material (i.e. when the MAF does not apply).
3. To induct components into IMA from Supply for technical directive compliance, updating, and check and test.
4. To induct items into IMA, from an Organizational level maintenance activity, that are not part of an aircraft or support equipment (i.e. pilots personal equipment, oxygen masks, life preservers, etc.) that require check, test, servicing, or minor repair.

The organization requesting check and test will fill out the 4710/6 Work Request in duplicate. In addition to the information required by the 4710/6, the following additional information must be included:

1. Job Control Number or Work Request Number.
2. BUNO/Serial Number of the aircraft/equipment from which the item was removed (if applicable).
3. Type Equipment Code.
4. Nomenclature and Serial Number of items to be checked. Any number of like items may be included on a single 4710/6. The check and test items will be delivered to a production division of the IMA. For further details of the Work Request Form 4710/6 see figure 2-6.

UNSATISFACTORY MATERIAL/
CONDITION REPORT (UR)

The Unsatisfactory Material/Condition Report (UR) is a four-page set, carbon interleafed, snap-out form, and is a supporting document of the Maintenance Data Collection System. The UR is intended to provide a method for the expeditious reporting of special situations and safety conditions. The use of this form provides a direct narrative link between the user and the responsible supporting activity and therefore should be used when prompt corrective action is required and/or amplifying details are necessary beyond those provided by means of routine 3-M documentation.

The purpose of the UR is to provide all activities concerned with aeronautical material with a system for reporting SPECIAL SITUATIONS which require prompt attention and corrective action and insure that the Naval Air Systems Command Headquarters, its field activities, contract administration agencies, supply activities, and industry are promptly appraised of material defects and failures which have a serious impact on operational safety, fleet readiness, and aircraft delivery.

Although the Maintenance Data Collection System provides for reporting of routine defects and failures, the UR provides a system for submittal of specific information concerning failures, material defects, and other critical situations affecting naval aeronautical equipment which require prompt attention and corrective action.

The front page of each UR set contains instructions for the completion of the form. These

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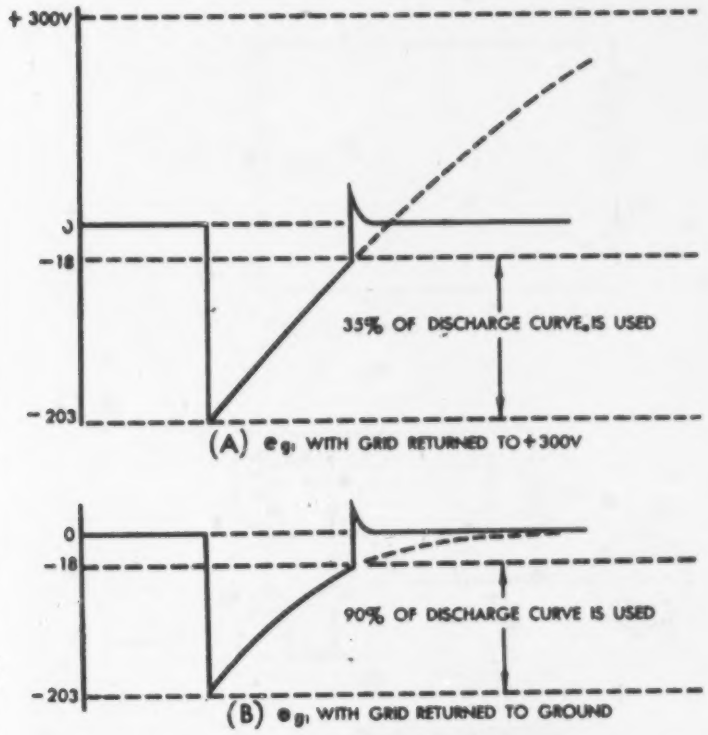

Figure 16-4. —Improving the basic circuit.

volts. As a result, the grid of V1 is 203 volts negative with respect to its cathode.

Since the direction of capacitor current is reversed, the plate voltage source will aid the discharge of the capacitor. When a source is connected to a charged capacitor with a polarity that discharges it, the capacitor will completely discharge and recharge to the new voltage all in one long exponential curve. In this case, the curve will have the same amplitude as it would if charged from zero to 503 volts. The resulting slope is as shown in figure 16-4 (A). Of course, the slope due to the more rapid discharge will go through zero earlier if the same RC is used. Therefore a longer RC must be used when grid resistors are returned to a positive voltage than is used when the resistors are returned to ground, for the same duration of output pulse.

SERIES LIMITING RESISTORS. —The use of series limiting resistors in the grid circuits of this multivibrator increases the squareness of the waveshapes. In the circuit shown in figure 16-6, these resistors are R5 and R6. The first half cycle of the plate and grid waveshapes shown is without the grid limiting resistors in the circuit, and the second half cycle is with R5 and R6 in the circuit. Note that the grid does not go positive when resistors are provided. When the other plate becomes more positive most of the voltage change occurs across the grid limiting resistor while only a small fraction of a volt exists between the grid and cathode, provided that the grid limiting resistor is of the order of 500K or more. The plate that is going positive cannot normally rise in voltage any quicker than the coupling capacitor can charge. Therefore in the normal circuit, the plate waveshape resembles the coupling capacitor charging curve. When grid limiting resistors are inserted, each limiting resistor is in series with the low grid to cathode resistance, and with the grid-leak resistor, forming a high resistance circuit for the capacitor to charge through. The circuit is like the trapezoidal sweep generator in that a "jump" voltage will occur across the limiting and grid-leak resistors. The exponential rise will start from there. In the waveshape of this illustration, the jump is about 90 percent of the total amplitude, with only slight rounding of the leading edge of the pulse.

RADAR SWEEP CIRCUITS

The range sweep in a radar set is of paramount importance for the correct presentation of target information. To accomplish this, a sawtooth voltage or current of proper amplitude and slope must be supplied to the indicator's deflection system. This discussion will include a typical range sweep circuit used for generating a linear sawtooth of the proper amplitude and time duration. The same circuit is used to generate the sweep for more than one range, and yet maintain the same physical sweep length on the scope. Since the basic circuits involved in the sweep generator are discussed in chapter 8 of AT 3 & 2, NavPers 10317-C, only its actual operating condition is explained in detail in this chapter.

SWEEP GATE CIRCUIT

The sweep gate circuit consists of a one-shot multivibrator, V6 and V8 (fig. 16-7), a negative grid clamper V7, and two sweep gate amplifiers V26 and V27. (NOTE: V26 and V27 are discussed later in the chapter.) It should be noted that V8 is cut off in static condition by the voltage divider network in its grid circuit and that V6 is conducting. The circuit is triggered by a negative pulse which is applied to the grid of V6. It should be recalled from the discussion

SECRET 1091

WORK REQUEST
NAVAIR FORM 4710/6 0102-607-4360

TO (Supporting Activity) NAS Memphis Aircraft Maintenance Department	DATE PREPARED 9251
ORIGINATING ACTIVITY (Supported Activity) VS-125	WORK REQUEST NO. 9227
JUSTIFICATION FOR WORK REQUESTED Beyond squadron capabilities.	
LOCATION OF JOB (at originating activity or at supporting activity to which job will be delivered) NAS Memphis Aircrew Survival Equipment Shop	
FOR FURTHER INFORMATION CONTACT (Name and telephone number) E.L. Collom Ext 8751	REQUESTED COMPLETION DATE 9-9-69

WORK REQUEST
(Give complete, accurate and detailed description of desired work. Attach sketch if necessary.)

SUPPORTED ACTIVITY

A. Type equipment, ASAB

B. Work unit code, 91151.00

C. BUNO of Aircraft, 124567

D. Inspect and Repack (one) NB-6 parachute, Serial No. 162956

REQUESTING ACTIVITY WILL FURNISH MATERIAL AS FOLLOWS: (Show stock number and nomenclature)	REQUESTING ACTIVITY WILL FURNISH ASSISTANCE AS FOLLOWS:

SIGNATURE (Maintenance Officer of Supported Activity)
R.T. NELSON, USN

SUPPORTING ACTIVITY

[X] APPROVED
[ ] DISAPPROVED

REASON (If work is disapproved)

SIGNATURE (Maintenance Officer of Supporting Activity)
W.E. POOLE, CDR USN

DATE WORK STARTED	DATE WORK COMPLETED	DATE REQUESTING ACTIVITY NOTIFIED THAT WORK HAS BEEN COMPLETED	WORK ORDER NUMBER ASSIGNED
9252	9252	9252	800-117

Figure 2-6.—Work Request Form 4710/6.

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instructions should be read carefully before the form is completed. The spaces should be completed by use of a typewriter or ballpoint pen. If a ballpoint pen is used, care should be exercised to insure that all copies are legible. The back of the form may be used if additional space is required.

Detailed procedures for the preparation, security classification, and mailing of completed UR's are contained in the current NavAir 4700.2 Instruction.

SUPPORT ACTION FORM (SAF)

The separate reporting of support type data is designed so that time expended in the accomplishment of repetitious type tasks that consume many manhours (but do not involve malfunctions, repairs, or condemnation action) may be easily identified, reported, and monitored. Manhours expended in support duties (such as aircraft refueling, engine or tire buildup, parachute packing, etc.) are documented on the Support Action Form (SAF).

The SAF is a standard electric accounting machine (EAM) card which may be either handscribed or prepunched and preprinted, depending upon the desires and requirements of local maintenance managers. In either case, all support action forms are signed by the work center supervisor to indicate that screening has been accomplished. Figure 2-7 illustrates a handscribed support action form.

In order to identify manhours expended in specific categories of support type work, 3-character codes known as support action codes are used. Nine basic categories of support type work and the related code for each are listed on the back of the SAF form together with type maintenance codes.

Support codes may be further broken down within basic categories if deemed appropriate by local command; i.e., 011, 012, etc. In the event such a breakdown is desired, its use is controlled by the maintenance officer and managed by the analysis section. The areas of support work covered by each basic category are defined in detail in an appendix to the

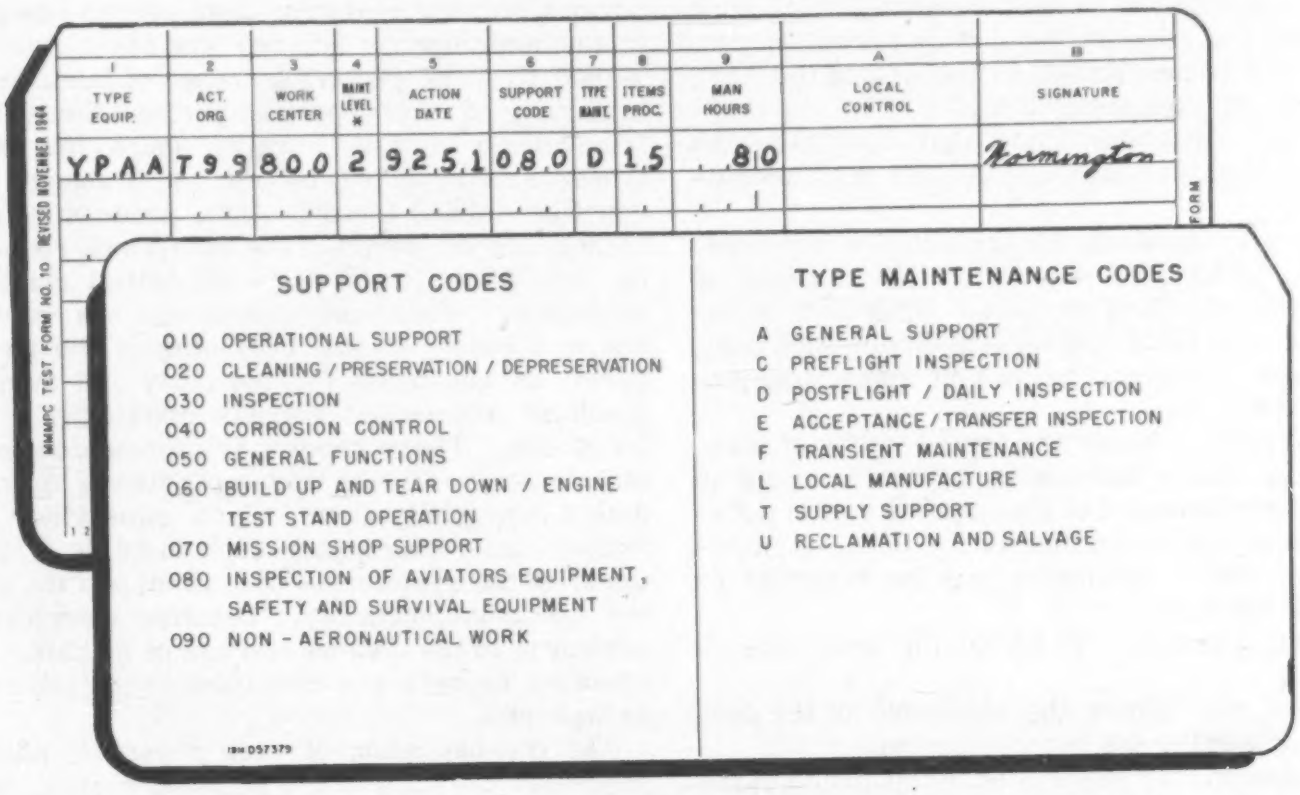

1 TYPE EQUIP.	2 ACT. ORG.	3 WORK CENTER	4 MAINT LEVEL *	5 ACTION DATE	6 SUPPORT CODE	7 TYPE MAINT.	8 ITEMS PROC.	9 MAN HOURS	A LOCAL CONTROL	B SIGNATURE
Y.P.A.A	T.9.9	8.0.0	2	9.2.5.1	0.8.0	D	1.5	.8.0		Normington

MMMPC TEST FORM NO. 10 REVISED NOVEMBER 1964

SUPPORT CODES

010 OPERATIONAL SUPPORT
020 CLEANING / PRESERVATION / DEPRESERVATION
030 INSPECTION
040 CORROSION CONTROL
050 GENERAL FUNCTIONS
060 BUILD UP AND TEAR DOWN / ENGINE TEST STAND OPERATION
070 MISSION SHOP SUPPORT
080 INSPECTION OF AVIATORS EQUIPMENT, SAFETY AND SURVIVAL EQUIPMENT
090 NON - AERONAUTICAL WORK

TYPE MAINTENANCE CODES

A GENERAL SUPPORT
C PREFLIGHT INSPECTION
D POSTFLIGHT / DAILY INSPECTION
E ACCEPTANCE / TRANSFER INSPECTION
F TRANSIENT MAINTENANCE
L LOCAL MANUFACTURE
T SUPPLY SUPPORT
U RECLAMATION AND SALVAGE

IBM 057379

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Figure 2-7.—Handscribed Support Action Form (front and back).

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Maintenance and Material Management Manual (3-M Manual).

Support Action Forms are filled out in the following manner:

Type Equipment Code. Enter a 4-character code that identifies the equipment on which support work is being accomplished; i.e., aircraft, engines, ground support equipment, etc. This code is found in appendix H of the 3-M Manual.

Action Organization. If the SAF is not preprinted and prepunched, enter the 3-character code that identifies the organization accomplishing the support action. This is the same alphanumeric organization code that was explained in connection with the Maintenance Action Form.

Work Center Code. This, too, is the same numeric code series that is used with the MAF.

Maintenance Level. If the card is not prepunched and preprinted, enter the 1-character numeric code that identifies the maintenance level of the support action being performed. These codes are provided on the front of the SAF.

Action Date. The action date is the Julian date of the day the support action was completed.

Support Code. Enter the 3-character numeric code that identifies the category of work in which the support action was accomplished. These codes are listed on the back of the SAF.

Type Maintenance Code. This is a 1-character alphabetic code that identifies the type of support maintenance that was accomplished.

Items Processed. Entered here is the number of items processed, or the number of times that the support action identified in the support code block has been accomplished (i.e., 4-aircraft refueled, 3 preflight inspections accomplished, etc.).

Manhours. Enter the total number of manhours (in hours and tenths of hours) spent in the accomplishment of the support action documented on the same line of the card. A maximum of 999.9 manhours may be reported on one line entry.

Local Control. Provided for local use, if desired.

Signature. Enter the signature of the person documenting the support action.

Replenish. If preprinted, prepunched cards are used, enter a checkmark in the REPL block when more cards are needed. The maintenance officer controls and the analysis section coordinates the production, volume, and distribution of preprinted prepunched cards.

The Support Action Form is designed so that documentation may be completed by either the work center supervisor or the individual worker. Additionally, the card provides a multiple entry feature so that several different entries may be made on the same form.

MANHOUR ACCOUNTING

The effective use of available manpower is an important function of maintenance management. Manhour accounting is an important part of the Maintenance Data Collection System. The purpose of collecting manhour data is to provide management with essential information necessary to more efficiently plan and direct the distribution of assigned personnel.

This system is based upon the "exception" principle; that is, only the deviations or exceptions from normal are reported. Through the use of master rosters, electric accounting machine cards, and machine processed reports, the system provides summaries of the hours expended by maintenance personnel during the normal working day or in an overtime status. Basically, the system is designed so that the normal working hours for each person assigned to the maintenance activity are allotted or assigned to work centers by types of labor at the beginning of each reporting period. Exceptions from these normal working hours, or labor types, are reported by use of Manhour Accounting (MHA) Cards. Data processing machines add or subtract the exceptions reported on the MHA Cards from the initial manhour allotment. These exceptions and the working hours allotted at the beginning of the period serve as the basis for the daily and monthly manhour accounting reports mentioned in the foregoing. These reports are forwarded to the maintenance officers and supervisors for validation and utilization. Each supervisor and worker must thoroughly understand the importance of the system, its operation, and the need for continual accuracy. Detailed instructions pertinent to the content and use of manhour accounting reports are contained in the following paragraphs.

At the beginning of each reporting period, generally the first of the calendar month, manhours are assigned to every work center to which personnel are assigned. These manhours are based on an 8-hour work day 5 days

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per week for every person assigned. Not included in these "Original Assigned Manhours" are any hours for work on Saturdays, Sundays, or holidays during the month. If every person assigned to the work center could be continuously employed throughout the month during all the time available for work, there would be no need for manhour reporting, as the time would be accounted for on the Maintenance Action Form. Since continuous employment is not possible, each worker must report what he did when he was not working during any period in excess of 20 minutes, or approximately three-tenths of an hour.

To simplify reporting of hours spent in a labor category other than that for which assigned, a group of MHA Cards is provided for every worker assigned. A card is initiated each time a person excepts from normal for a period in excess of three-tenths of an hour and is completed at the end of the exception. The most frequent exceptions requiring the submission of MHA Cards are (1) each time a person is assigned to, or transferred from, a work center or organization, (2) each time a person performs work in other than his regularly assigned labor code, (3) each time a person is absent from his work center for nonmaintenance purposes such as watches, leave, sick, special liberty, etc., and (4) each time a person works overtime during a single work day or on his day off (holiday, Sunday, etc.).

MHA Cards are, for the most part, prepunched and preprinted. However, handscribed cards have a place in the system. A prepunched, preprinted card is illustrated in figure 2-8.

Handscribed MHA Cards are normally used to report (1) newly assigned personnel, (2) temporarily assigned personnel, (3) composite manhours involving more than one person, and (4) whenever prepunched, preprinted cards are not available.

The use of the blocks and spaces on the MHA Card is discussed in the following paragraphs.

Block 1—Organization Code. The organization code is the same 3-character alphanumeric code described for use with the Maintenance Action Form. Use of the code simplifies the identification of the unit to which a person or persons is/are attached or temporarily assigned. For example, AY 1 is the code for RVAH-1, and is much easier and faster to write in than the name of the activity.

Block 2—Work Center Code. The work center code identifies the functional area to which a person is assigned or temporarily assigned. A standard system of work center codes is prescribed. Therefore, a PR assigned to the airframes division at the intermediate level of maintenance anywhere in the world would use

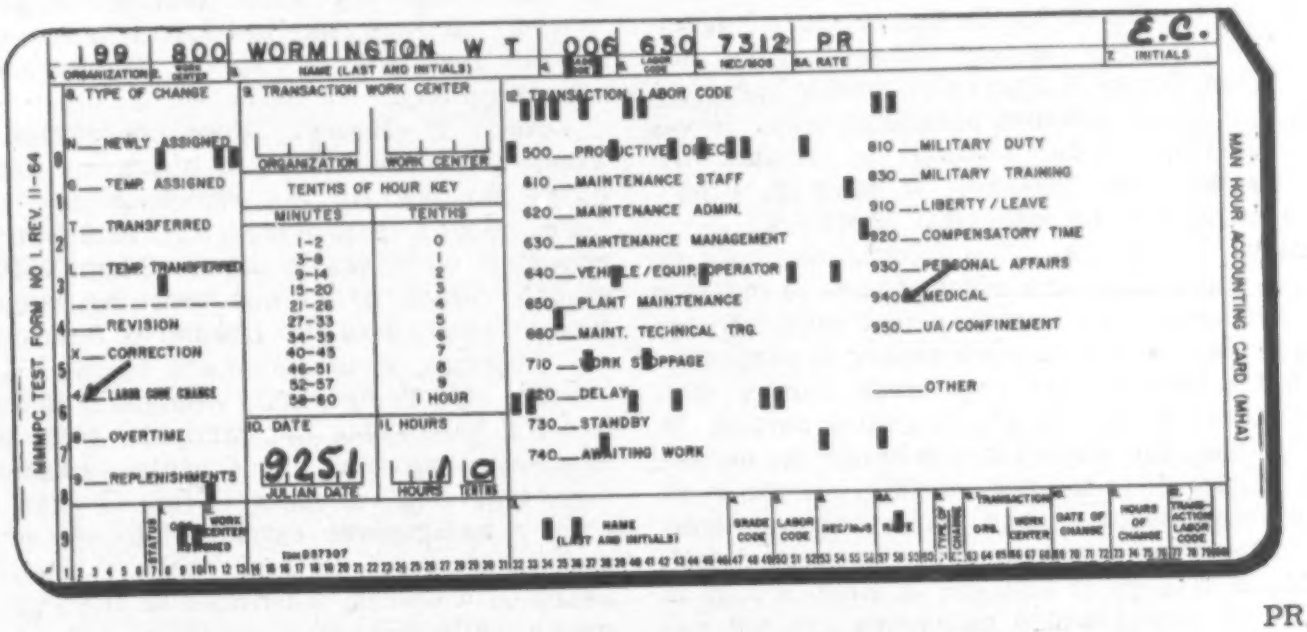

PR.109

Figure 2-8.—Prepunched/preprinted MHA Card.

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500 as his work center code. Those PR's attached to the aviators equipment branch at the organizational level of maintenance all use work center code 130.

Block 3—Name and Initials. This block is self-explanatory, except that in the case of composite cards (used for two or more persons) enter the applicable number of men; i.e., "2 men," "4 men," etc.

Block 4—Grade Code. This code is a 3-character numeric or alphanumeric code used to designate the grade and status of the individual being reported on. All military grade codes start with 0 and range upward from 001 (recruit) to 019 (captain/colonel). All civil service codes start with G and correspond to their pay status. For example, a GS-1 code is G01 and the top is G14 for a GS-14. Grade codes C01 through C04 are special civilian codes and are provided for use where necessary as directed by the major command.

Block 5—Labor Code. Labor codes in five major categories are prescribed for use here. Manhour expenditures are charged to the labor code which best describes the type of labor performed or how a worker's time was spent. The five major categories are as follows: Direct Labor (500), Productive Indirect (600), Nonproductive (700), Duty Absence (800), and Nonduty Absence (900). All of these code groups except Direct Labor employ digits other than 00 to more precisely picture what was done. For example, Duty Absence (800) is further divided into Military Duty (810) and Military Training (830).

Block 6—NEC/MOS. In this block is entered the primary Navy Enlisted Classification Code or Marine Corps Military Occupation Specialty Code for newly assigned personnel only. Naval Officer Billet Codes (NOBC) or designators may be used for officers. If desired, a person's rating may be entered in block 6A.

Block 7—Initials. The initials of the work center supervisor are entered here to indicate that screening has been accomplished. Every worker assigned to a work center is responsible for submitting his own cards, except when he is absent at the end of a reporting period. In such cases, the supervisor submits the necessary cards. It is the responsibility of the work center supervisor to see that every card submitted by everyone is correct in every detail.

Block 8—Type of Change. It must be kept in mind that maintenance manhours are not reported on MHA Cards. Whenever the normal routine (which is set up on the electric accounting machines) varies or changes for any of the reasons listed in block 8, a card must be submitted AFTER the change occurs. For instance, after being temporarily assigned or transferred or immediately after working overtime. A check (✓) in a block 8 space is nearly always accompanied by a check in block 9, 10, 11, and/or 12. An exception to this is "Replenishments." A preprinted, prepunched card, checked in the "Replenishments" space, is submitted by the man concerned when the number of preprinted, prepunched cards remaining in his personal stack is less than 10. The data center will forward him a new supply the next day. The relationship of block 8 spaces to blocks 9, 10, 11, and 12 will be discussed in conjunction with the coverage of the latter group of blocks.

Block 9—Transaction Work Center. Block 9 is used in conjunction with the "Temporarily Assigned" and "Temporarily Transferred" categories in block 8. When a man is temporarily transferred to another work center, the change requires the initiation of two cards, because it involves two work centers. At his permanent work center he initiates a card checked "Temporarily Transferred" in block 8, and his temporary work center code is entered in block 9. When he arrives at his temporary work center, he initiates the second card. On this card, "Temporarily Assigned" is checked in block 8, and the code number for his permanent work center is entered in block 9.

Block 10—Date. Block 10 is not filled in until the temporary work assignment is completed. At that time the Julian date is entered in this block, identifying the day the exception was completed.

Block 11—Hours. Upon completion of the exception, the number of hours and tenths of hours involved in the exception are entered here. Space is provided for 999.9 hours to be reported on a single card. When Newly Assigned (block 8) is checked, the number of hours reported is the number of hours of normal working time remaining in the reporting period. If "Temporarily Assigned" is the reason for submitting the card, the total elapsed number of working hours while so assigned is reported. The exception to this is when a temporary assignment extends into the next reporting period. In such cases a temporarily assigned card is submitted at the end of the month with that month's hours reported and, when the exception ends during the next reporting

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period, another temporarily assigned card is submitted to report only the number of temporarily assigned hours elapsed in that reporting period.

If "Transferred" (block 8) is the reason for submitting an MHA Card, the number of working hours remaining in the reporting period is reported. It will be recalled that the total number of working hours available for a reporting period for a work center is obtained by multiplying the number of men assigned by 5 days per week and 8 hours per day. When a person is transferred during the reporting period, all the working hours that he would have worked had he remained must be subtracted from the work center's total manhours available. The same reasoning holds true for "Temporarily Assigned" where the number of hours in this category is added to the temporary work center's totals and "Temporarily Assigned" where the number of hours in this category is added to the temporary work center's totals and "Temporarily Transferred" where the number of hours away is also deducted from the permanent work center's totals.

Block 12—Transaction Code. An entry in this block is mandatory if "Labor Code Change" or "Overtime" has been checked in block 8. A checkmark is entered to identify the labor code in which manhours were expended. If the "Other" line is checked, the appropriate subcode promulgated by the analysis section is entered in the space provided. The majority of MHA Cards submitted are "Labor Code Changes."

Rectifying Erroneous Data

In the event that erroneous maintenance data enters the system either (1) through faulty documentation or (2) a mistake appears on the daily manhour accounting listing, it is important that the erroneous information be extracted and the correct information substituted therefor. Such errors in blocks 8 through 12 require that two cards be submitted. One is a "Correction" card which is identical to the erroneous card in every respect (even the error is included), except for a checkmark in the "Correction" space in block 8. Through machine manipulation, the two incorrect cards will cancel one another. The second card, containing the correct information, is submitted in order to get the correct information into the system.

Another type of erroneous information that must be changed is when prepunched, preprinted MHA Cards are incorrect due to name changes, promotions, changes to NEC/MOS, or key punch error. When these occur, a "Revision" card is prepared and submitted. This is accomplished by lining out the incorrect information and writing in the correct information just beneath it and checking the "Revision" space in block 8. Revision cards are limited to changing information appearing in blocks 3, 4, 6, and 6A.

Revision of an incorrect organization code (block 1), work center code (block 2), or labor code (block 5) requires the submission of two cards, neither of which is a "Correction" or "Revision" card. In these cases the first card is a "Transferred" card that contains the erroneous entry in block 1, 2, and 5. This removes the previously recorded number of hours from the incorrect account. The second card contains the correct entry in block 1, 2, or 5, as the case may be, and is checkmarked in the "Newly Assigned" space in block 8. This card assigns the hours involved to the correct organization, work center, or proper labor code.

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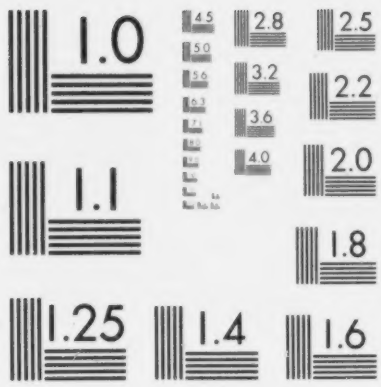

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CHAPTER 3

PARACHUTE FAMILIARIZATION

In 1495, shortly after Columbus discovered America, another great Italian, Leonardo da Vinci, designed the first parachute. This was a huge pyramid of cloth, but a functional parachute was not actually made and used until more than a century later. The word "parachute" is derived from the Italian word "parare," meaning to protect or shield from, and from the French word "chute," meaning a fall or quick descent—literally, "to protect from a fall".

Fouste Veranzio, also an Italian, is given credit for the first parachute jump. He made this jump in 1617 from a tower in Venice, using a parachute made of a square wooden frame, covered with canvas. Since man had no use for a lifesaving device of this nature, parachutes were considered novelties or items of amusement, and interest in them gradually dwindled. It was not until the invention of the first aerial balloon than interest in the parachute was renewed.

In 1783, the Montgolfier brothers invented a balloon which would stay aloft. This balloon was kept in the air by burning bundles of straw beneath the bag to make the necessary supply of hot air. If the fabric should catch fire, the flight was abruptly ended. This meant that men who went up on such flights had to have a means of escape and descent. This necessity for a lifesaving device removed the parachute from the list of novelties.

In 1808, Andre Kuparento, a Polish balloonist, became the first man to leap to safety from a flaming bag of hot air, using a parachute. The need for a foolproof parachute, however, did not become sufficiently acute to stimulate a great deal of inventive effort until nearly 100 years later.

Then, with the coming of the air age in 1903, when the Wright brothers made their spectacular flight at Kitty Hawk, North Carolina, there came also an era of experimentation with parachutes designed especially for the new type of aircraft.

Captain Albert Berry is given credit for being the first American military man to successfully jump from an airplane using a parachute. This jump was made in 1912. His parachute was packed in a coneshaped metal cylinder with a trapeze bar serving as a harness, and the weight of his body pulled the canopy from the container. Many others using makeshift or experimental parachutes made descents before World War I, but parachutes still were not considered as essential equipment for military aviators. The resultant mortality rate among pilots on active duty at the front during the war was very high. This, together with the fact that the lives of 800 balloonist observers and artillery fire directors were saved by parachutes, pointed out a desperate need for a foolproof, lifesaving device. The next logical step then, was to improve parachute reliability and make them mandatory for military aircraft.

With World War II, when the number of naval aircraft was increased tenfold, the parachute became more and more important and its improvement became an important objective of the Navy. Pursuing this objective led to the development of the Naval Aerospace Recovery Facility at El Centro, California.

This facility must test and approve any change to the parachute and/or components, and is responsible for the design and testing of many items now in use.

The Naval Aerospace Recovery Facility, along with the Aerospace Crew Equipment Department at Philadelphia, Pennsylvania, enables personal survival equipment development to keep abreast of the design and development of newer and faster aircraft.

PRINCIPLES OF OPERATION

A parachute is made like a giant umbrella and protects a falling body from severe injury or damage in landing by offering a large air-

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10921

resisting surface. In each successful parachute descent the same action takes place—the ripcord is pulled, the pilot chute emerges from the pack, and pulls the main canopy out. The canopy fills with air and lowers the body slowly to the ground. This series of events is illustrated in figures 3-1 through 3-7.

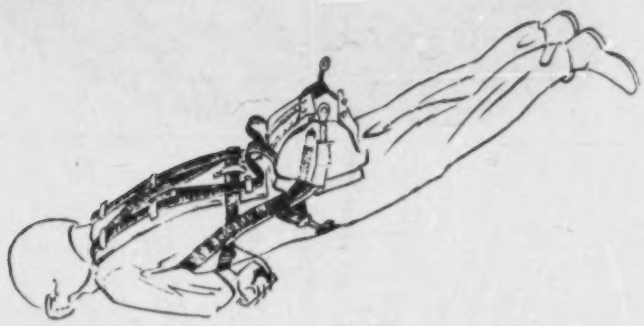

PR.110

Figure 3-1.—Exerting a pull of 27 pounds (maximum) on the ripcord releases the ripcord pins from the locking cones. The flaps of the pack are then drawn back by spring-opening bands.

PR.111

Figure 3-2.—The pilot chute springs beyond the negative pressure area immediately above the falling body. This results in its getting a better "bite" on the surrounding air, thus speeding the opening of the canopy.

PR.112

Figure 3-3.—Canopy completely extended. Suspension lines almost completely out of pack.

DESIGN AND CONSTRUCTION

A parachute consists of five major parts: the pilot chute, the canopy, the suspension lines, the pack, and the harness. The pilot chute is a small parachute attached to the top of the main canopy. Its purpose is to retard the main canopy while the weight of the falling body withdraws the suspension lines and inflates the canopy. The canopy is a large area of cloth which slows the descent of the falling body. The suspension lines are strong lines which join the canopy to the harness. The pack is a nylon assembly which encloses the pilot chute, canopy, and suspension lines. The harness is an arrangement of nylon webbing and metal fittings. It is designed to hold the canopy securely to the jumper and provide a seat or sling during descent.

TYPES OF PARACHUTES

There are several basic types of parachutes now in service use by the Navy. Among these are the Navy chest type (NC), the Navy seat type (NS), and the Navy back type (NB). All Navy parachutes are placed in one or the other of these categories. An oversize harness may be used with the NS type parachute; therefore, the letter "R" indicating regular size harness, or the letter "O" indicating an oversize harness, is also included after the model number as a part of the letter designation; i.e., NS-3R.

NAVY CHEST TYPE PARACHUTE

The Navy chest type is attached to the harness with quick connector hardware and is worn on the chest. (See fig. 3-8.) It was designed for use in aircraft where duties of the pilot and

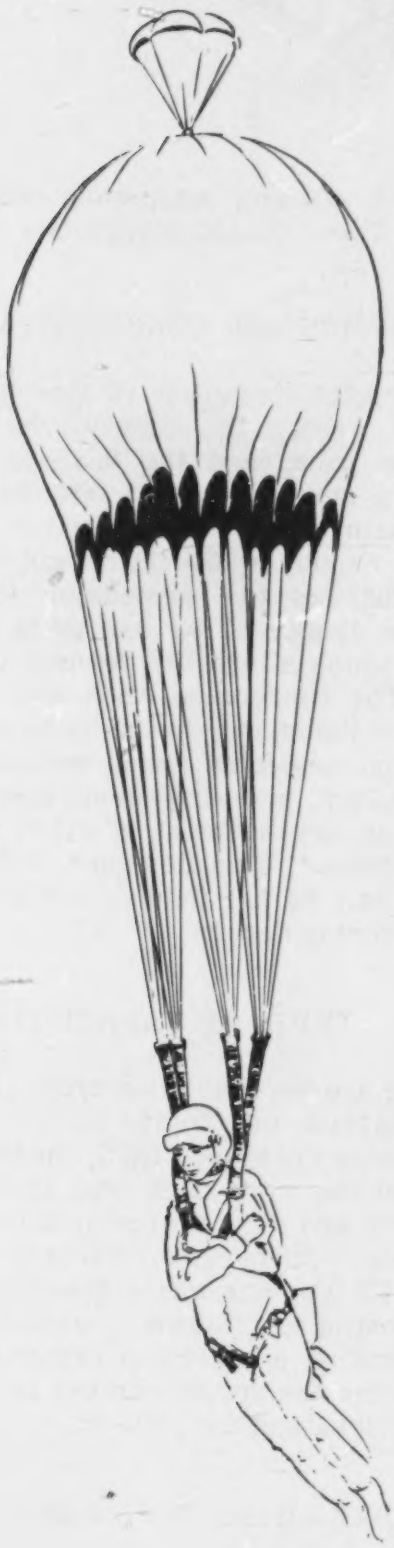

PR.113
Figure 3-4.—Canopy filling with air. Body assuming upright position.

PR.114
Figure 3-5.—Canopy completely open. Opening shock felt.

crewmen require them to have freedom of movement in various sections of the aircraft. When the chest type parachute is used, the harness must be worn at all times during flight.

The pack is usually stored in a spot near the individual's flight station or bailout station, allowing maximum efficiency of the crewman and still providing a high degree of safety. This accessibility of the pack allows quick attachment of the parachute before bailing out.

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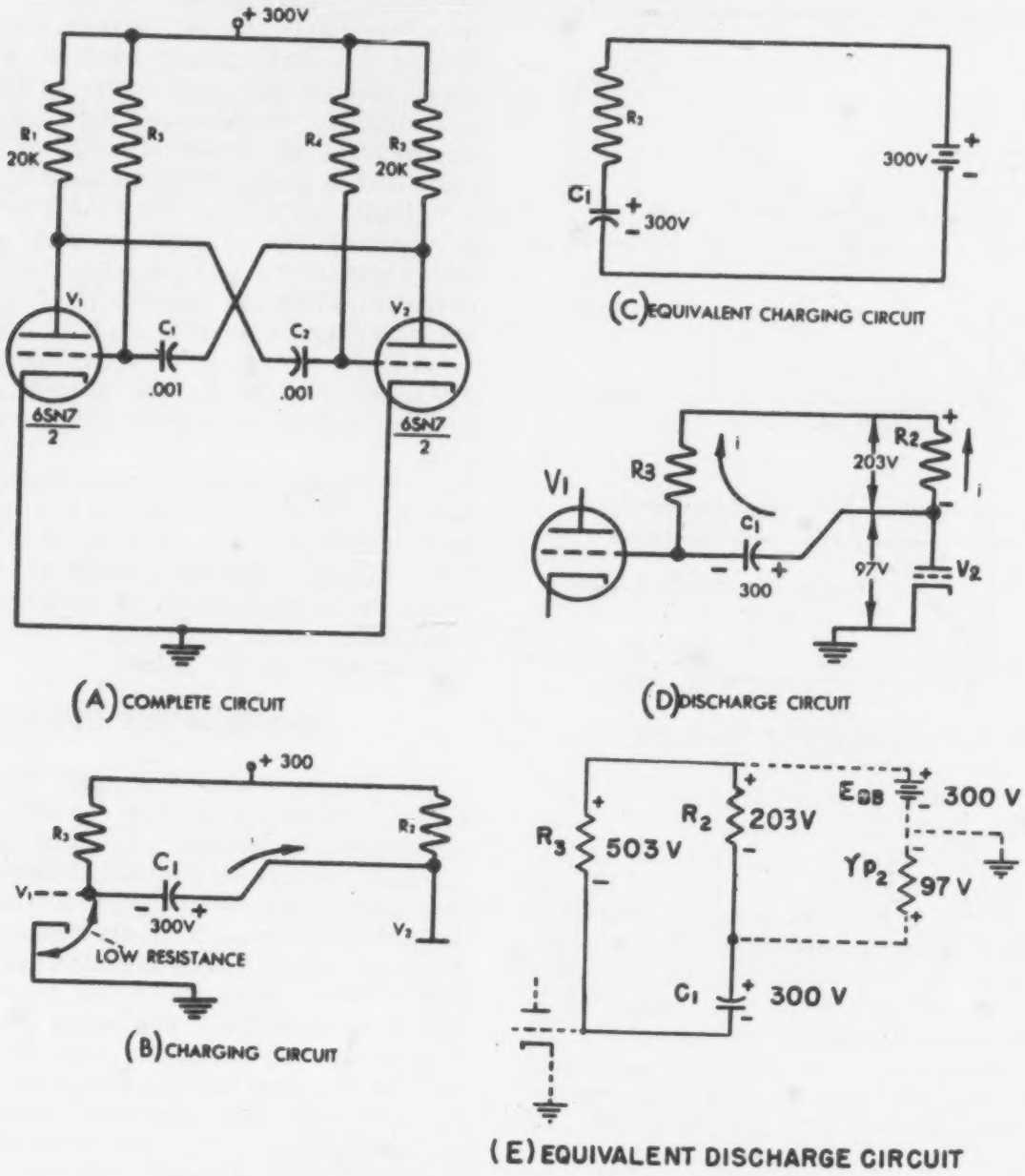

Figure 16-5.—Effect of returning grid to B plus.

on the timer block diagram that the sweep gate circuit is triggered by a negative pulse from either the master trigger output on normal operation, or the variable delay circuit on time delay operation.

The negative input trigger pulse drives V6 toward cutoff, causing a rise in its plate voltage and a drop in its cathode voltage. This plate voltage rise is coupled to the grid of V8, driving V8 into conduction. The resulting drop in plate voltage is coupled back to the grid of V6 as in any one-shot multivibrator. However, the negative grid clamper does not permit the grid of V6 to be driven below an approximate negative 23 volts.

The action of V7 and the sweep shutoff circuit (fig. 16-8) controls the duration of the output pulses from the sweep gate circuit. (NOTE: The output from the sweep gate determines range sweep time which is discussed later in this chapter.)

The outputs of the sweep gate circuit are as follows:

1. A negative square wave (generated by conduction of V8 through R29 and capacitively coupled to the grid of V6) from the grid of V6 which is fed to the grid of sweep gate amplifier V27.

2. A negative square wave from the cathode of V6 which is used to trigger the compensating gate circuit.

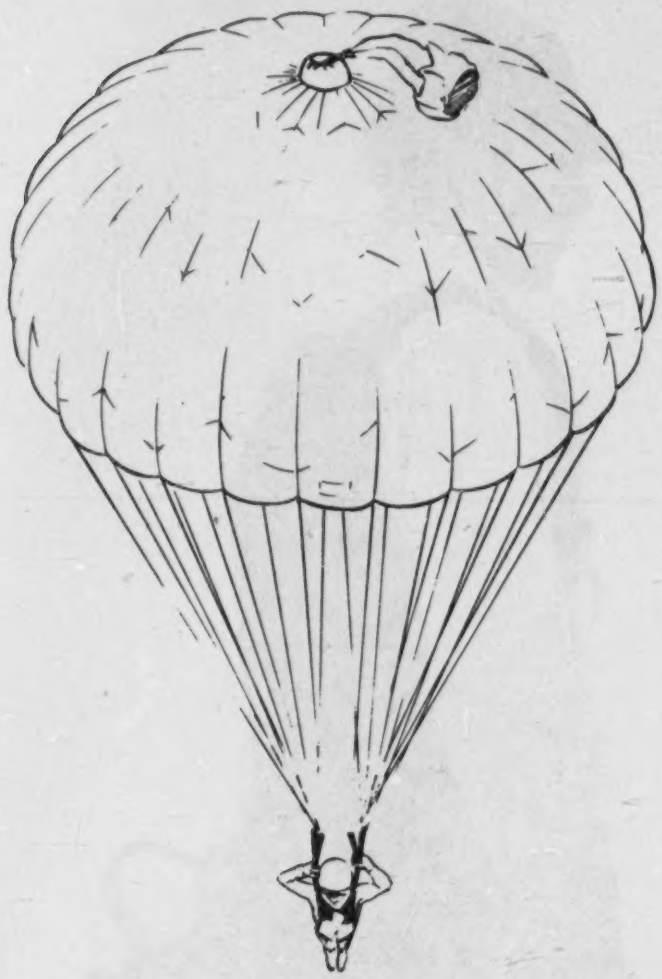

PR.115
Figure 3-6.—Steady rate of descent established. Pilot chute resting on canopy.

PR.116
Figure 3-7.—Parachute deflating as body touches ground.

To be completely effective, it is necessary that every person using a chest type parachute be properly trained in its use. It is obvious that each person aboard an aircraft should be continuously aware of the exact location of his pack at all times.

NAVY SEAT TYPE PARACHUTE

The seat type parachute (fig. 3-9) is the oldest type still in service use. It is designed to be worn as a seat for the wearer, and when in use, fits in the bucket section of the aircraft seat.

It was designated the SS (Standard Seat) when first used in 1924. It continued in use with the same designation and very little change to its design until well into the 1940's.

World War II created a necessity for different designs in parachutes to fit the requirements of newer types of aircraft. This led to the design of the Quick Attachable Seat (QAS) parachute. This parachute was designed to be left in the seat of the aircraft and quickly attached to the pilot's harness. This would help him in getting in and out of the aircraft as well as speed the launching of aircraft.

A later development of this parachute was the Quick-Fit Seat (QFS). This one could also be left in the cockpit of the aircraft, but the harness was permanently attached to the parachute and could be quickly adjusted by the wearer.

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PR.117

Figure 3-8.—Navy chest type parachute.

In 1948 all parachutes were redesignated and given their current designations. It was then that the QFS became the NS.

NAVY BACK TYPE PARACHUTE (NB)

The Navy back type parachute is worn on the back, as shown in figure 3-10. This model is

PR.118

Figure 3-9.—Navy seat type parachute.

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PR.119

Figure 3-10.—Navy back type parachute (NB) with LR-1 liferaft attached.

ideally suited for use with jet-powered aircraft, the ejection seat, and its automatic devices.

Parachutes of this type are the NB-5, NB-7, NB-7E, NB-8, NB-9, NB-10, and NB-11.

The NB-5, NB-7, NB-7E, NB-9, NB-10 and NB-11 are designed to be used with an integrated torso suit harness as part of the ejection seat escape system.

MARTIN-BAKER PARACHUTE (MBEU)

Another type of integrated parachute designed for use with ejection seats is the Martin-Baker. This parachute has a 24-foot diameter canopy and when configured with the Martin-Baker ejection seat they combine to form the Martin-Baker Escape Unit. The MBEU 622PA parachute assembly has the canopy packed in a rigid, wedge type container. The MBEU 4150PA parachute assembly has the canopy packed in a hard-shell, horseshoe type container. Both the MBEU 4002PA and the MBEU 4004PA parachute are packed in a soft, horseshoe type container; all are specially designed to provide the proper ejection posture or attitude by means of the shoulder and takeup mechanism.

TRAINING TYPE PARACHUTE ASSEMBLY

For all practical purposes the training assembly may be considered as a standard back pack parachute with a chest pack attached to the same harness. Naval Air Systems Command regulations, like those of the Federal Aviation Administration require that two packs be worn when making training or demonstration parachute jumps. The training assemblies are designated the NT5-R or NT5-O, depending on whether the flat circular canopy contained in the back pack is a 28-foot (regular) or a 35-foot (oversize) one.

The training assembly is rarely used in the Navy except at the Aircrew Survival Equipmentman School, Lakehurst, New Jersey. In order for naval personnel to make a premeditated parachute jump at other than this activity, it is necessary to pass a rigid physical examination and to have obtained, through the chain of command, the permission of the Chief of Naval Operations.

NES-8 PARACHUTE

The NES-8A and NES-8B parachute assemblies are recent developments, designed for use

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with the Navy Ejection Seat. The NES-8A assembly includes a multicolored, 29.7-foot diameter, ringsail canopy with 24 gores. The NES-8B includes a 28-foot diameter canopy with PDVL. The canopy is packed in a hardshell, horseshoe type container. The assembly is installed in the ejection seat and designed for use with the integrated torso suit harness. The survival kit is also connected to the integrated torso suit by means of quick-release fittings.

LW-3B PARACHUTE

The LW-3B parachute assembly is used with an integrated torso suit harness as part of the ejection seat escape system. The assembly is mounted on the back of the ejection seat on the left side for the LW-3B-1 and on the right side for the LW-3B-2.

The LW-3B assembly includes a 28-foot diameter, flat, nylon canopy with 28 gores. The canopy is packed in a metal-based fabric container.

HIGH ALTITUDE LOW OPENING (HALO) PARACHUTE ASSEMBLY

The high altitude low opening parachute assembly is a back type parachute designed for high altitude free-fall and low opening. The HALO assembly includes a 35-foot diameter, parabolic, nylon canopy with 30 gores. The canopy is packed in a container and secured to the aircrewman's back by means of a harness assembly.

The assembly also includes a parachutist's kit and a chest type reserve parachute.

The HALO parachute assembly is used primarily for premeditated jumps over designated areas where pinpoint landings are necessary. Free-fall parachuting allows greater maneuverability and landing accuracy.

T-10 PARACHUTE ASSEMBLY

The T-10 parachute is a back type parachute designed for static line operation only. The assembly includes a 35-foot diameter, parabolic, nylon canopy with 30 gores. The T-10 parachute assembly is used by paratroopers for premeditated jumps over a designated area.

COMPONENTS OF PARACHUTES

The design and construction of a parachute and its components are based on the old idea that a chain is only as strong as its weakest link. Every link from the jumper to the canopy must carry its share of the maximum load applied during the opening shock.

The five major parts of a standard service parachute, starting at the top and working down, are the pilot chute, main canopy, suspension lines, harness, and pack. Figure 3-11 illustrates these five major parts.

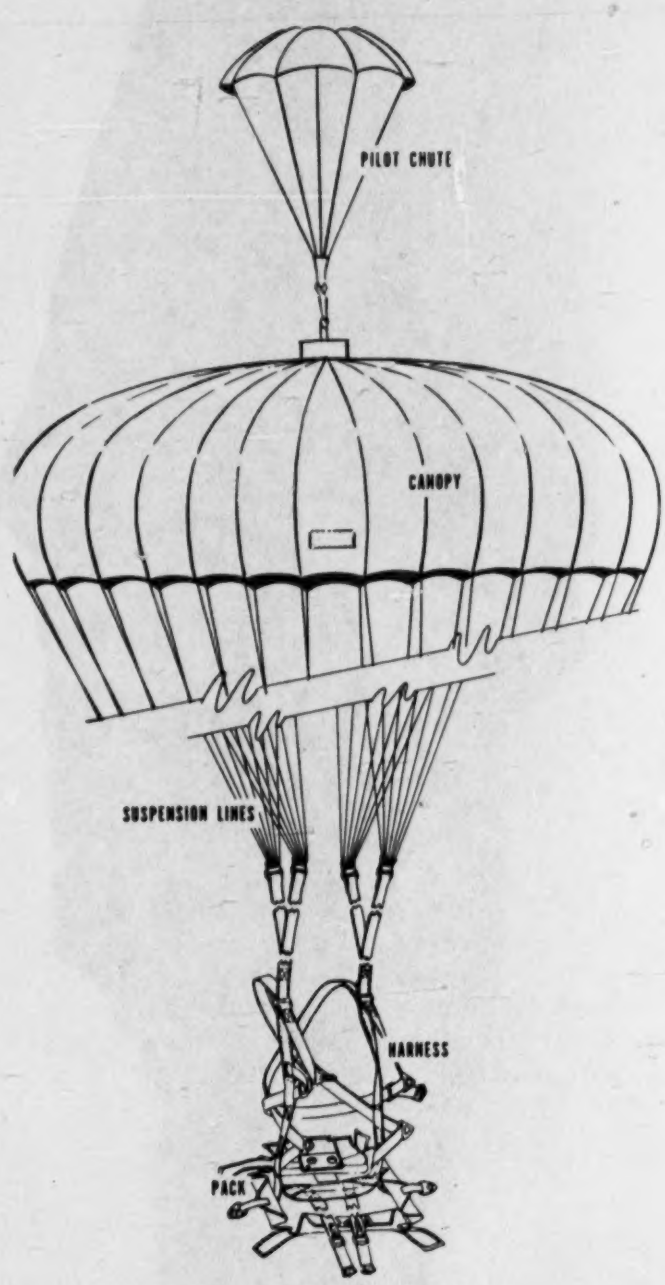

PR.120

Figure 3-11. —The five major parts of a parachute.

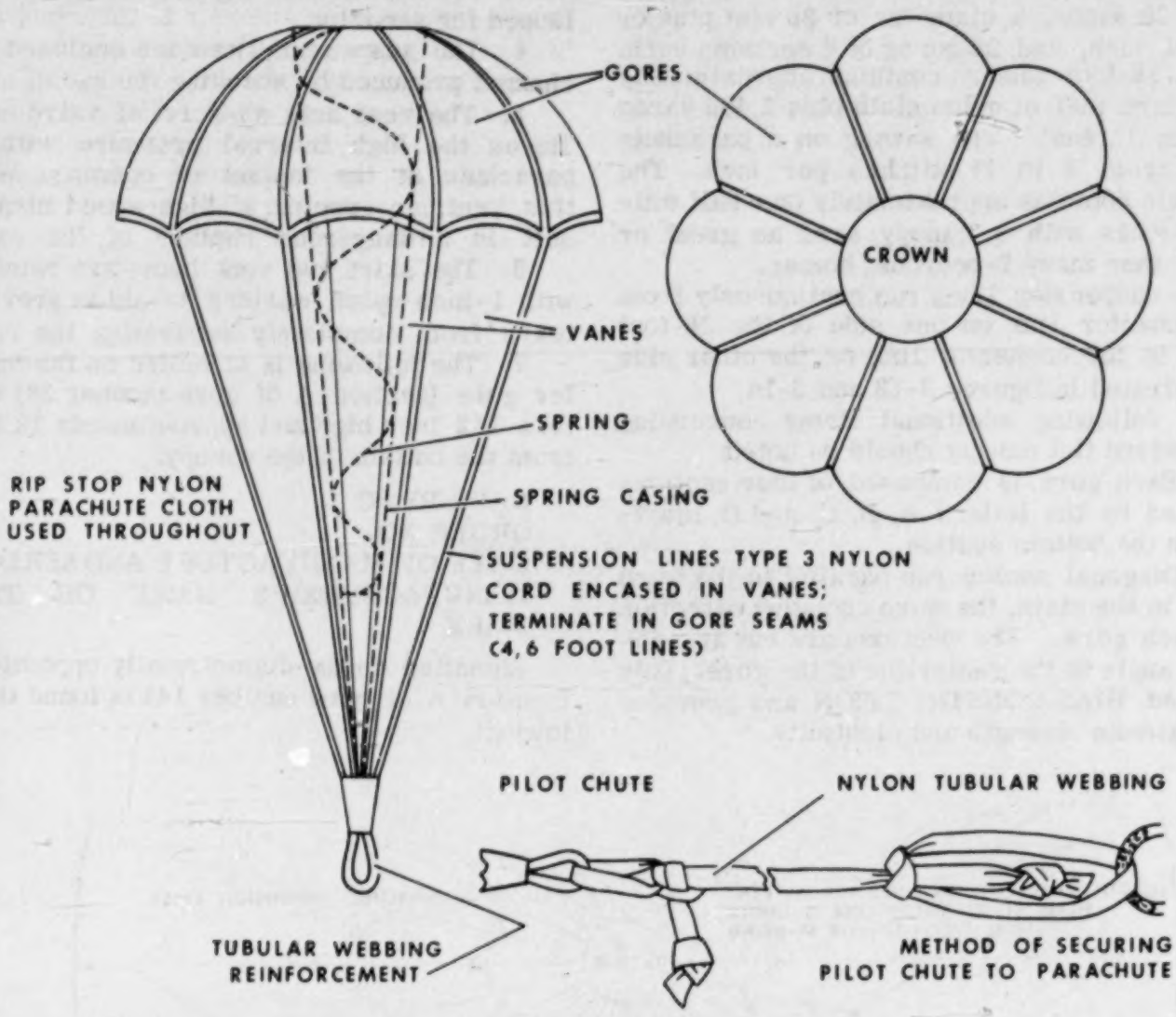

PR.121

Figure 3-12.—The vane type pilot chute.

PILOT CHUTE

The vane type pilot chute is used on all Navy parachutes except the Martin-Baker parachute. Figure 3-12 shows the nomenclature or names of parts and materials that make up a pilot chute. A thorough knowledge of this nomenclature will prove invaluable in your future work with parachutes.

CANOPIES

The size and shape of the parachute canopy have been controversial subjects since da Vinci envisioned a pyramid of cloth as being a safe way of falling through the air. After experimentation with many different canopies over the years, two shapes have emerged as acceptable. One is the standard flat design which has remained virtually unchanged for the past 30 years. The second is a new idea in construction, but still follows the basic shape pattern. This latter canopy type is known as the 26-foot 22-gore conical canopy. This canopy is used with the NB-5 and NB-6 parachute assemblies. The "conical" reference comes from the fact that the peak of the canopy is conical in construction. In descent the canopy presents a slightly raised shape at the apex, but fails to radically change the basic appearance so familiar to the service.

Standard Flat Type

The 28-foot ripstop nylon canopy is the old standard size used on all Navy parachutes. The

10948

parachute canopy is described as a polygon, having 28 sides, a diameter of 28 feet plus or minus 1 inch, and 28 gores of 4 sections each.

The 28-foot canopy contains approximately 796 square feet of nylon cloth plus 2,400 yards of nylon thread. The sewing on a parachute varies from 8 to 11 stitches per inch. The parachute contains approximately one-half million stitches with a canopy area as great or greater than many 2-bedroom homes.

The suspension lines run continuously from the connector link on one side of the 28-foot canopy to the connector link on the other side as illustrated in figures 3-13 and 3-14.

The following additional items concerning the standard flat canopy should be noted:

1. Each gore is composed of four sections identified by the letters A, B, C, and D, starting with the bottom section.

2. Diagonal seams run parallel to the warp thread in the cloth, the warp changing direction with each gore. The sections are cut at a 45-degree angle to the centerline of the gore. This is called BIAS CONSTRUCTION and provides the maximum strength and elasticity.

3. The radial and diagonal seams are double lapped for security.

4. The suspension lines are enclosed in the channel produced by stitching the radial seams.

5. The vent acts as a relief valve and relieves the high internal pressure within the parachute at the instant of opening. Without this vent, an opening at high speed could result in a dangerous rupture of the canopy.

6. The skirt and vent hems are reinforced with 1-inch nylon webbing to aid in preventing tears from completely separating the canopy.

7. The following is stenciled on the top center gore (section A of gore number 28) in letters 1/2 inch high and approximately 12 inches from the bottom of the canopy:

NAVAIRFAC
ORDER NO.
DATE OF MANUFACTURE AND SERIAL NO.
MANUFACTURER'S NAME OR TRADE MARK

Stenciled on the diametrically opposite gore (section A of gore number 14) is found the following:

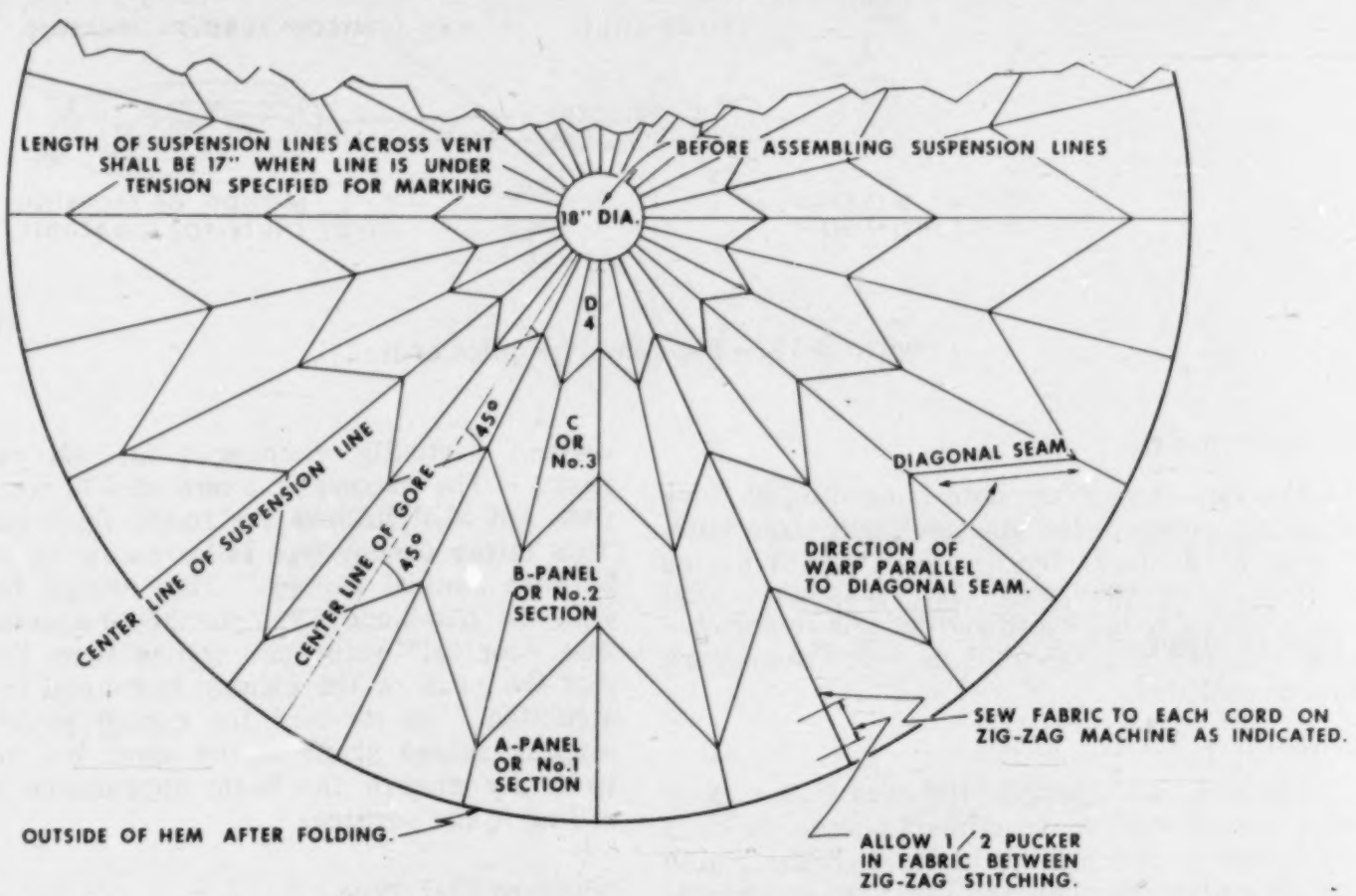

PR.122

Figure 3-13.—The 28-foot ripstop canopy.

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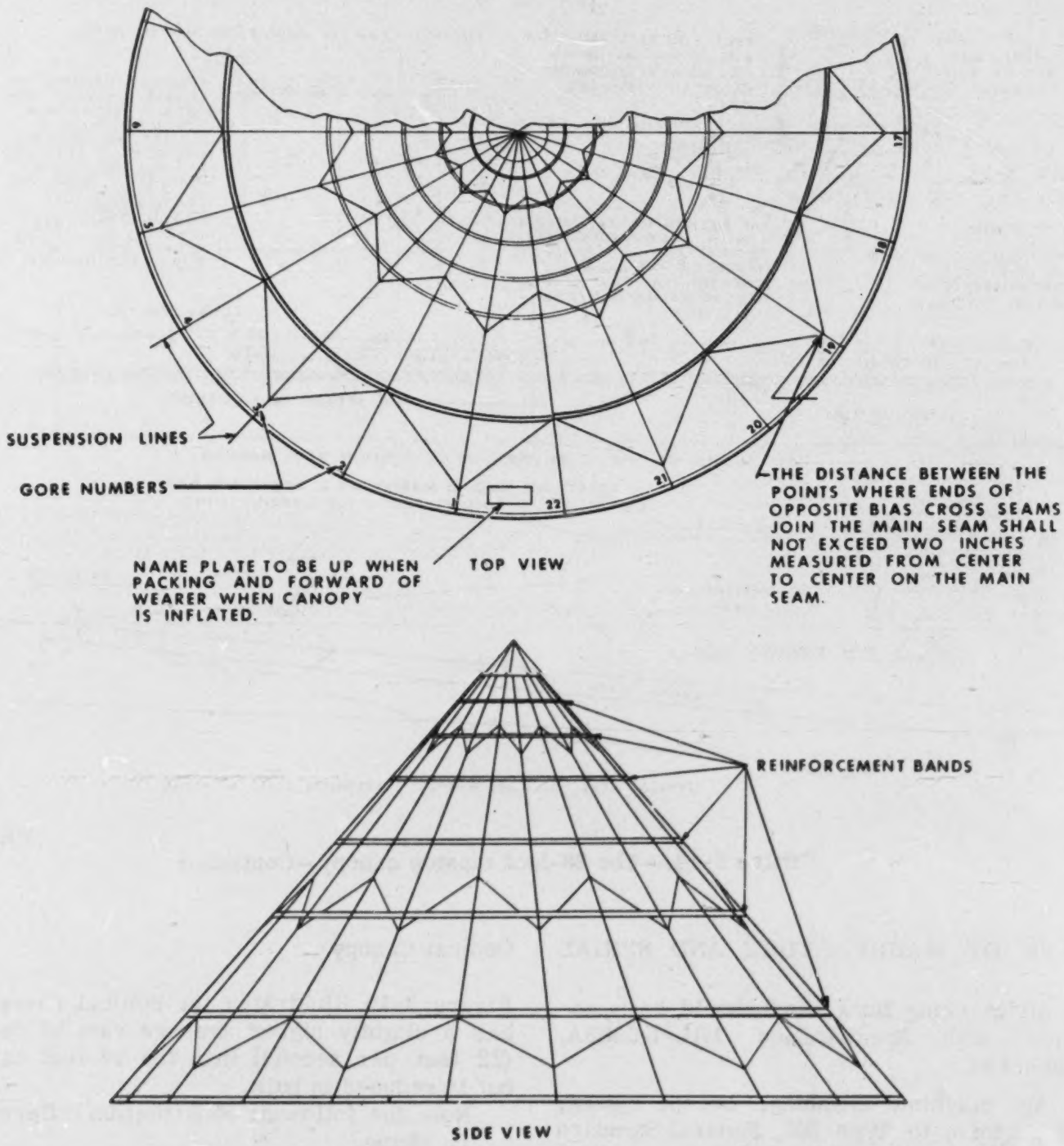

PR.124

Figure 3-15.—Conical canopy, 26-foot, 22-gore.

6. The rate of descent has been sacrificed to a certain degree in order to increase the strength and stability of the parachute.

SUSPENSION LINES

The suspension lines form a net or skeleton for the canopy and absorb much of the shock load. They must therefore be placed under a 20-pound tension, marked, and cut as a group to assure equal distribution of the shock load. The 28 suspension lines counted at the links are actually 14 lines, 75 feet 4 inches in length. These lines run continuously from link to link; that is, each line is secured to a connector link on one side of the canopy, runs up and over the

10951

canopy, and down to a link on the opposite side.

Type III nylon suspension line is used on all main canopies and vane type pilot chutes. This line consists of a loosely woven outer covering called a sleeve, and several strong inner cords called the core. This core provides the greater portion of the strength of the suspension line.

Figure 3-16 illustrates the arrangement of the suspension lines on both the 28-foot and the 26-foot canopies. On the 28-foot canopy the lines are arranged in four groups of 7 lines each, while on the 26-foot canopy they are arranged in two groups of 5 and 2 of 6 lines each.

The suspension lines are attached to the connector links by tying a clove hitch, a half-hitch, and completing the attachment with 2 inches of zigzag stitching. This attachment is shown in figure 3-17.

To prevent the canopy on the 28-foot parachute from slipping along the suspension lines, each line is anchored by zigzag stitching at several points to the radial seams through which it passes. One-half inch of slack is allowed in the vicinity of the skirt between the zigzag sewing points to relieve the strain during opening shock.

PARACHUTE HARNESS

Parachute harnesses are designed to secure the parachute to the wearer and provide support during opening shock and descent. The harnesses currently being used by the Navy are the quick fit (so called because of the ease and speed with which they may be adjusted by the wearer) and the integrated torso harness.

The integrated torso harness combines parachute harness, lap belt, and shoulder harness into one integrated garment which improves comfort, mobility, and retention, and is easier to don and remove. It also reduces the number of exposed straps and overall bulk and weight. This harness is discussed in detail in chapter 15.

The parts of the parachute harness which take the load during a descent are nylon webbing of a

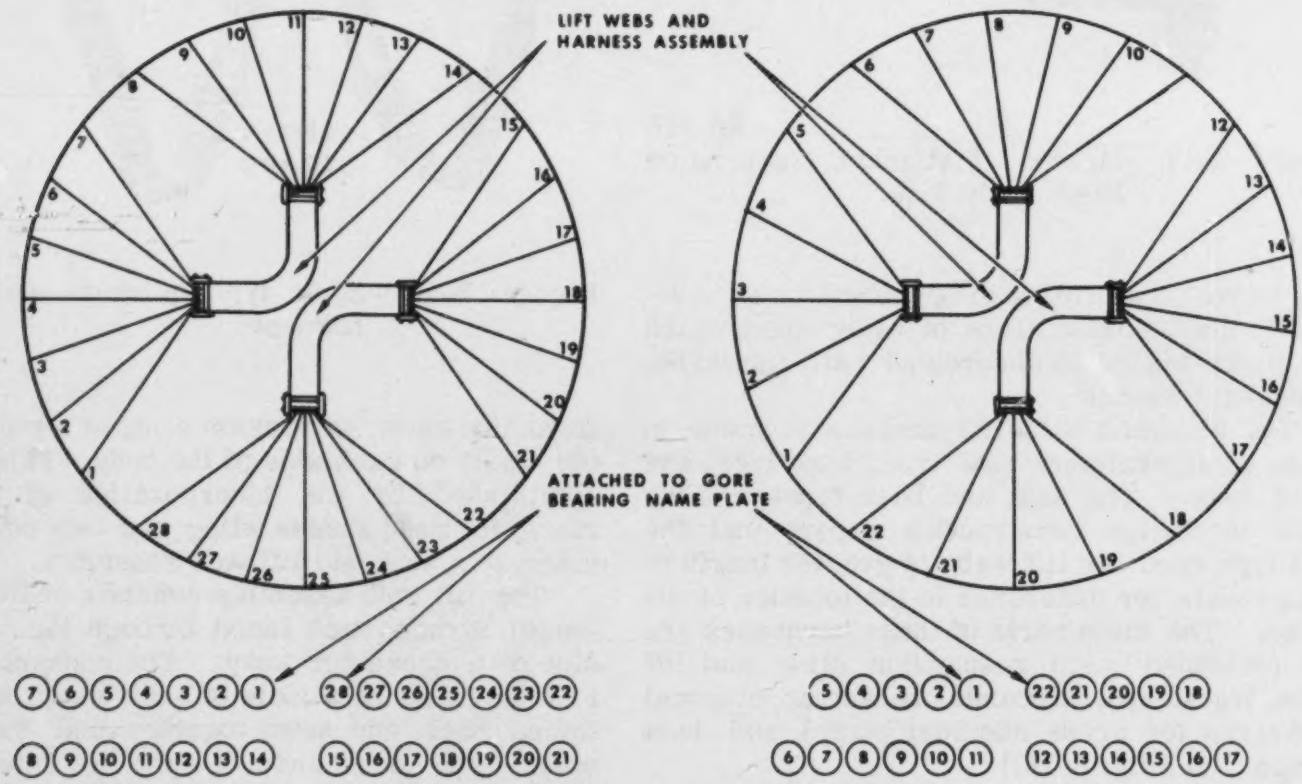

PR.125

Figure 3-16.—Suspension line arrangement.

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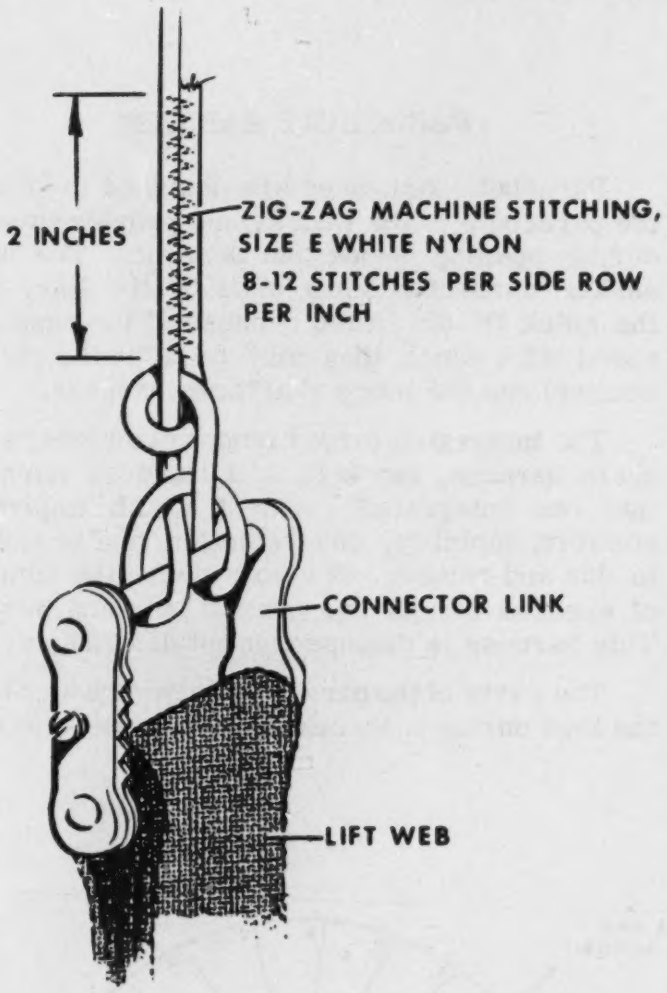

PR.126

Figure 3-17.—Method of attaching suspension lines at the link.

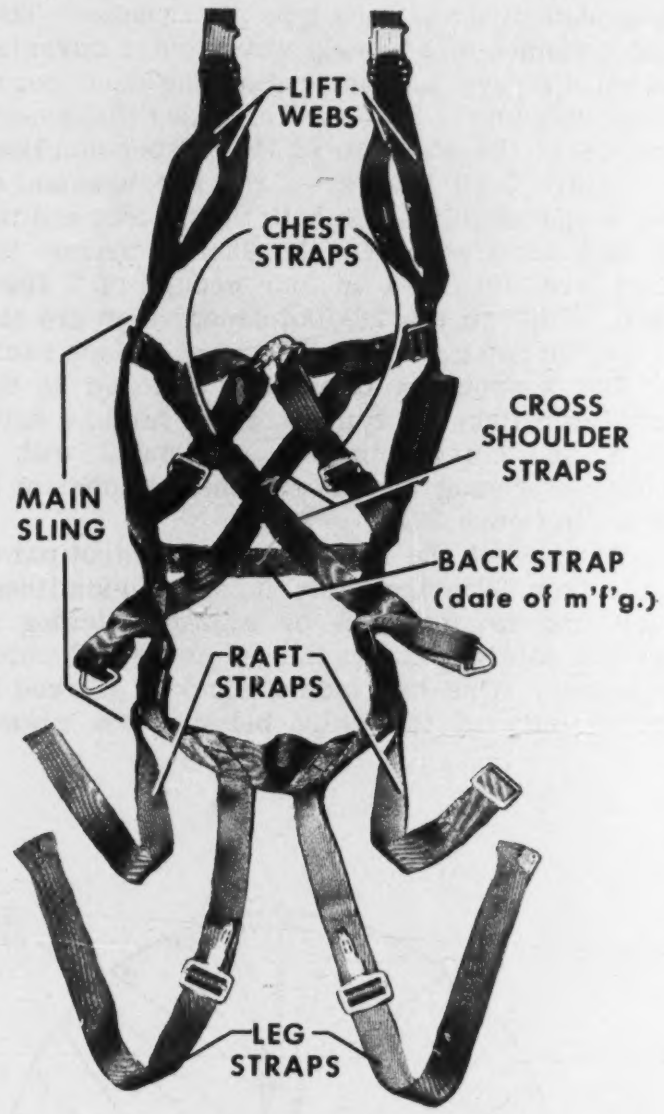

PR.127

Figure 3-18.—Back type quick-fit parachute harness.

soft weave, conforming to Specification MIL-W-4088D, and metal fittings of alloy steel which are proof loaded in accordance with applicable standard drawings.

The standard quick-fit harness is made in three configurations—seat type, back type, and chest type. The seat and back types are the same in design construction except that the seat type requires lift webs of greater length to compensate for difference in the location of the packs. The main parts of these harnesses are the combined main suspension sling and lift webs, leg straps, horizontal backstrap, diagonal backstrap (or cross shoulder strap), and chest straps. (See fig. 3-18.)

The principal difference between the chest type and the seat or back type harness is that on the NC-3 harness the lift webs separate from the main suspension sling at a point near the chest on each side of the body. This is accomplished by the incorporation of two D-rings in the harness sling and two connector snaps in a separate lift web assembly.

The lift web assembly consists of two equal length straps each laced through the webbing slot of a connector snap. The connector snap is located at the middle of each strap, which is folded back and sewn together just above the snap. The loose ends of each are sewn to individual links connecting to the canopy. Two connector snaps are joined by a cross-connector strap which prevents collapse of the

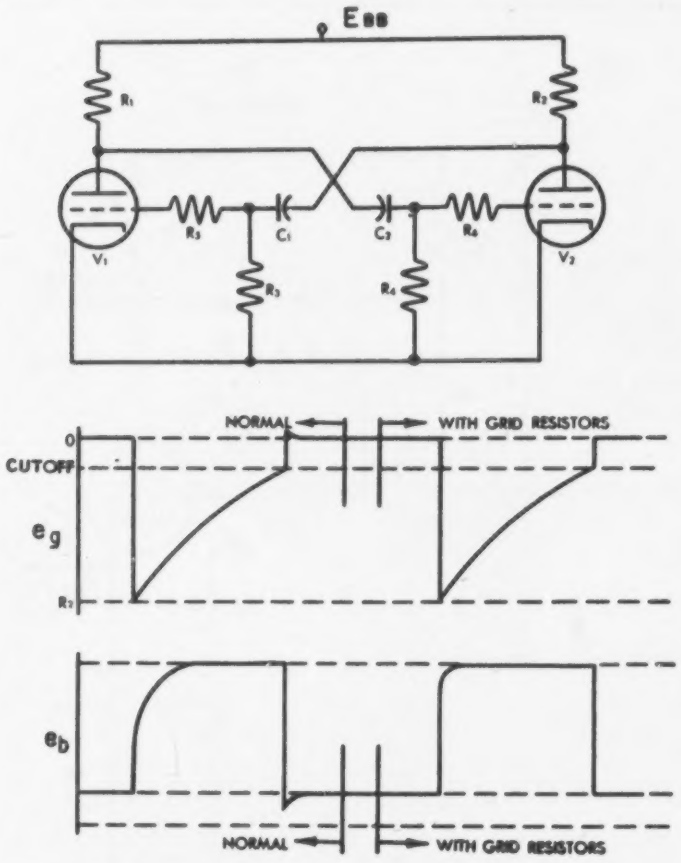

Figure 16-6. —Using series limiting resistors.

3. A positive square wave from the cathode of V8 which is used as a gating voltage. The relationship of the output waveforms to the master timing pulse is shown by waveforms (1), (2), and (3) of the figure 16-9.

The sweep gate amplifier V27 and sweep gate output V26 circuits are discussed later in this chapter with the intensity gate circuit.

SWEEP CLAMP, SHUTOFF, CHARGING CLAMP, AND BOOTSTRAP AMPLIFIER

Before considering the overall operation of the circuit illustrated in figure 16-8, the functions it performs are discussed. The circuit may be divided into three stages with each stage performing a separate function.

The first stage consists of the RC network composed of C18 to C21, R37, R38, R39, and the two diodes V10A and V10B. The RC network is used to generate a sawtooth waveform for use as a range sweep voltage. V10A and V10B function to clamp the upper plates of the sweep capacitors (C18 through C21) at near ground and provide a means of eliminating the clamping action during sweep time.

The stage V9 controls the amplitude of the sawtooth voltage waveform. It also generates a pulse which cuts off the sweep gate output voltage when the sawtooth voltage reaches the desired amplitude.

It should be remembered that at any instant the charge on a capacitor depends on the RC time of the network and the applied voltage. For the fixed ranges (all ranges except 5-60 miles), range is controlled by switching in various size capacitors and the applied voltage is held at a positive 150 volts. In the variable range (5-60) mode of operation, the applied voltage is varied by the variable range control R606.

Referring to figures 16-7 and 16-8 note that without an input signal, current (electron flow) will flow from ground up through R28 to the cathode of V10A, from cathode to plate of V10A, through R37 and R39 to cathode of V10B, from cathode to plate of V10B, and to pin 8 of relay K6. Pin 8 of K6 is connected to a positive 150 volts through pin 7 when the equipment is operating on a fixed range. When operating on a variable range, pin 8 is connected to the variable range control R606 which forms a voltage divider network between ground and a positive 150 volts.

The path from K6 through R34 to the top of R35 has negligible effect because of its high resistance. The static current maintains the plate of V10A at a relatively low potential which also determines the static voltage across capacitors C18 thru C21. (The relative size of R28 to R37 plus R39 clamps the plate of V10A slightly above ground.) The sweep cutoff tube V9 is biased beyond cutoff by a positive potential applied to the voltage divider network in its cathode circuit. The cathode potential of V9 is important since it determines sweep amplitube which indirectly controls sweep time.

Now consider the operation of the circuit when a signal is applied. (For the following discussion refer to waveforms illustrated in figure 16-9.) A positive square wave taken from the cathode of V8 is applied to the cathode of V10A. It should be remembered that this square wave is generated by the sweep gate multivibrator. With the cathode of V10A now more positive than its plate, V10A is effectively removed from the circuit. The sweep charging capacitors (C18 thru C21) may now charge at an RC rate as determined by the RC network being used. As the sweep capacitors charge toward 150 volts (assume fixed range operation), the grid of V9 will also rise

canopy in the event that only one snap is attached to the harness D-ring. The lift web is tacked to the pack with cord which breaks when the canopy inflates and allows the pack to break away. The chest type harness and the lift web assembly are illustrated in figure 3-19.

The date of manufacture (month and year) should be stamped with black washproof ink,

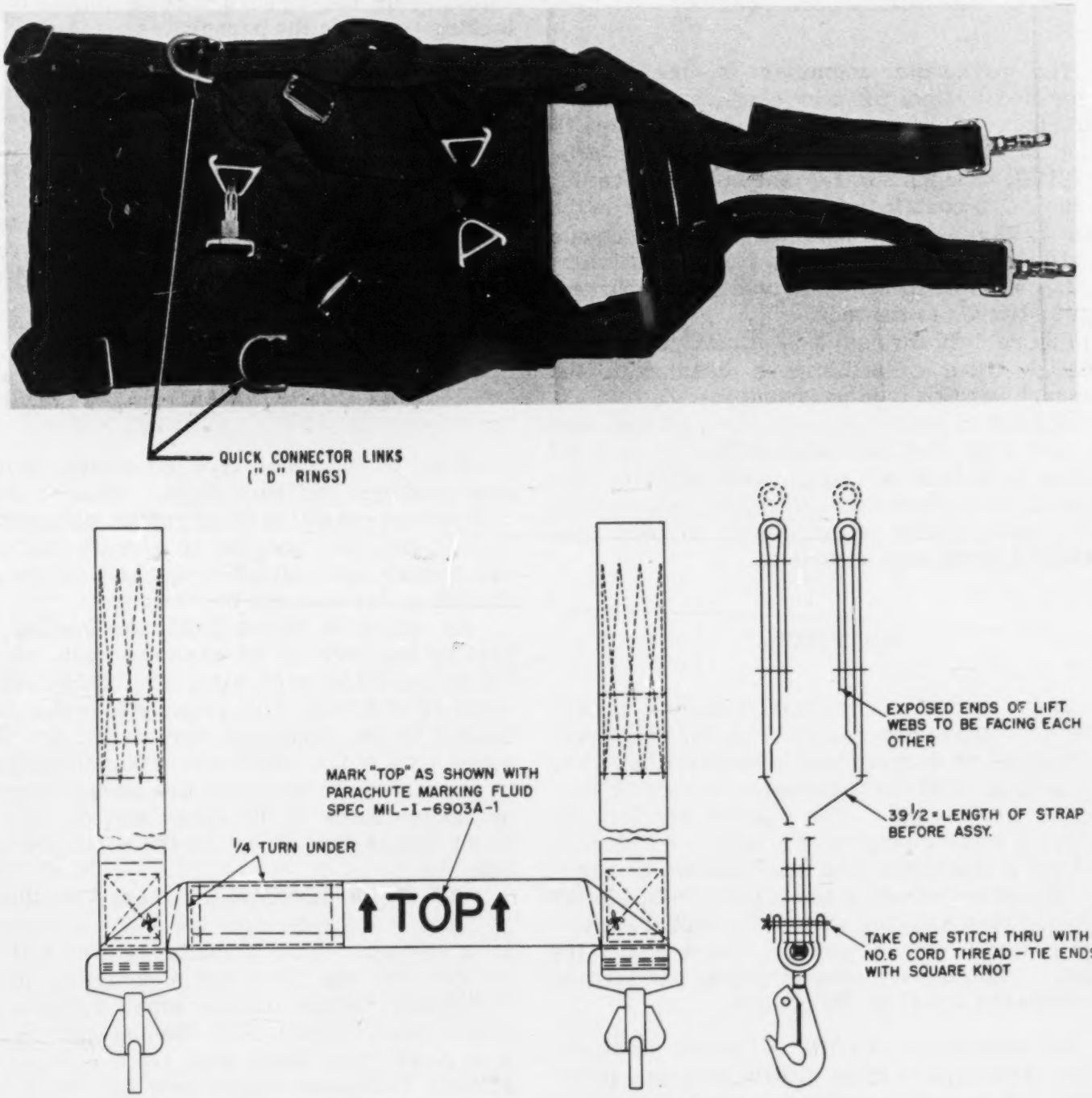

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Figure 3-19.—Chest type harness and lift web assembly.

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TT-I-542, in letters 1/2 inch high on either the inside of the horizontal backstrap or on the inside of the sling. All exposed ends of webbing should be seared to prevent fraying; and unless otherwise specified, all machine stitching is to be 6-cord sage green nylon thread with not less than 4 nor more than 6 stitches per inch. Ends of all stitching should be backstitiched a distance of not less than 1/2 inch.

PARACHUTE CONTAINER

The parachute container is designed to house and protect the pilot chute, main canopy, and suspension lines. It is made of type III nylon fabric, conforming to Specification MIL-C-7219B, amendment 1. The outside covering of the NC-3 container is cut in one piece on the bias. This is necessary to provide adequate elasticity for the pack. The machine stitching on the container is made with type E nylon thread, 6 to 8 stitches to the inch.

Figure 3-20 through 3-22 illustrate the three general types of containers used with the standard service type parachutes.

Additional information on the material used in this work may be found in NavAir and Air Force publications, along with Military and Federal Specifications. Frequent reference to these publications is necessary to keep your technical knowledge up to date.

RIPCORDS

The ripcord is a manual releasing device, used to release the canopy from the container. It consists of locking pins securely attached to a length of 3/32-inch diameter corrosion-resistant steel cable. The ripcord handles are made of steel tubing in the shape of a cloverleaf or a trapezoid, and are attached by passing the cable through a small hole drilled in the grip and then swaging a retaining ball or clamping a small sleeve onto the loose end of the cable. The pins are swaged in place and tested to withstand a pull of 300 pounds.

An extensible ripcord is shown in figure 3-23. This type is used with the seat type parachute and makes changing to or from the pararaft easier by eliminating the need of changing to longer or shorter ripcords.

RIPCORD HOUSING

The ripcord housing consists of a flexible steel tube affixed to the parachute container at one end and to the main sling on the left side of the harness at the other. It is provided to house the ripcord cable and prevent accidental opening of the parachute. The housing is secured to the harness and container in such a manner as to permit the parachute assembly to be improperly lifted by the housing without withdrawing the ripcord locking pins from the locking cones on the parachute container.

RIPCORD GRIP POCKET

The ripcord grip pocket is made of type III nylon fabric conforming to Specification MIL-C-7219B, amendment 1. It is designed to retain the ripcord grip under normal circumstances and still provide ease in removal when the ripcord is properly pulled.

SEAT CUSHIONS AND BACK PADS

Some of the older type parachutes still use seat cushions and back pads. These cushions and pads are made of foam rubber covered with canvas and are designed to provide comfort to the wearer when attached properly between the parachute harness and the wearer.

As shown in figure 3-24, the cushion is a part of the survival kit when used with the NB-7E in the RA5C type aircraft. This cusion is made of a sponge type polyurethane pad and is bonded to the contoured surface on top of the upper half of the container. The parachute and upper half of the container are secured together by zipper flaps at the lower end of the parachute and at the aft end of the container upper half.

The NB-9 parachute, as used in the A-4 (A4D) type aircraft, uses the seat pan assembly as a cushion. This assembly serves both as a cushion for the pilot and a container for the emergency bailout oxygen supply cylinder. As illustrated in figure 3-25, the seat pan consists of a metal pan, shock pad, foam comfort pad, 28-inch U-shaped oxygen cylinder, and a cover which is zippered over the complete assembly. The pararaft kit is attached to the bottom of the seat pan and both are fitted into the seat bucket.

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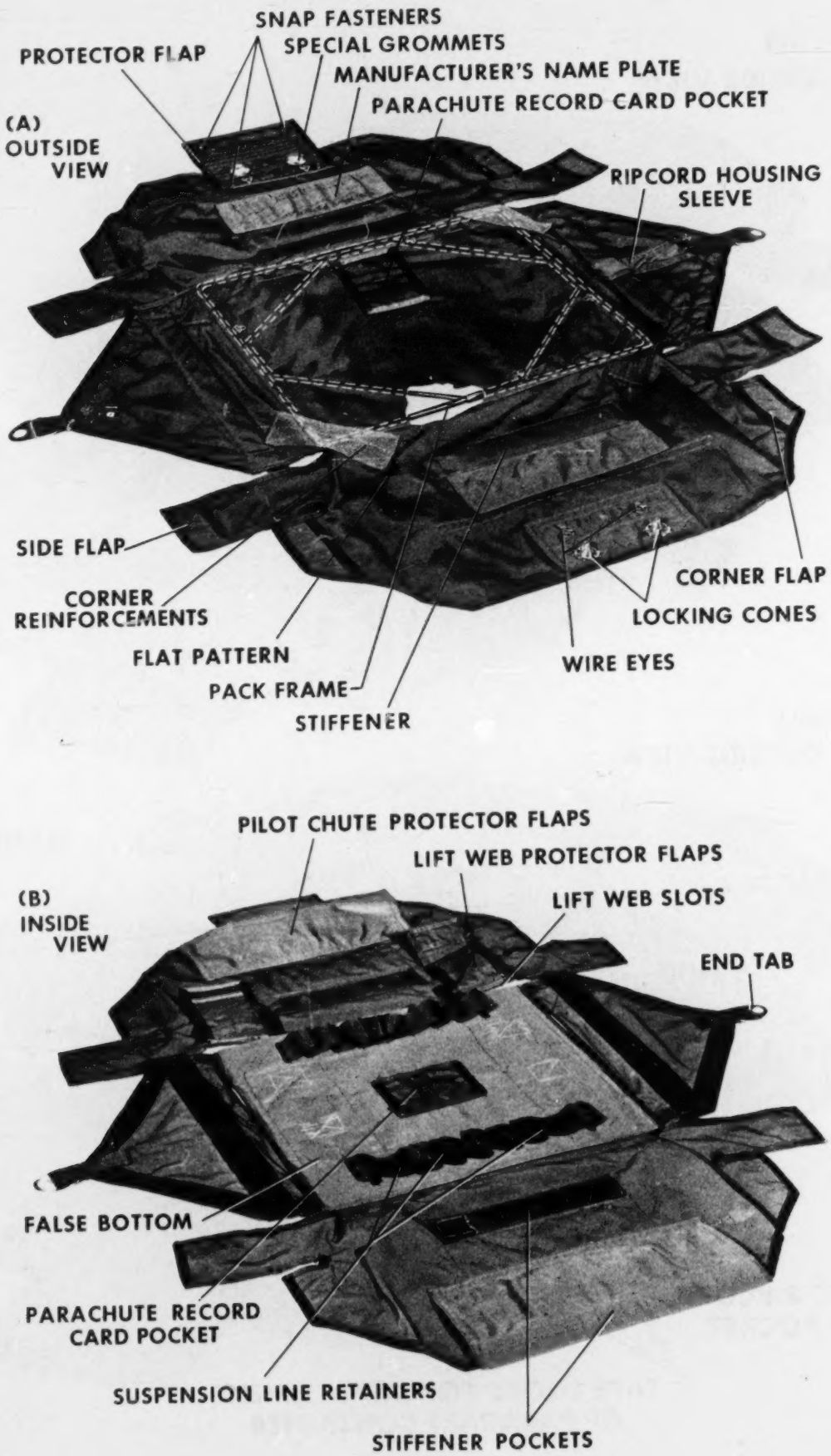

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Figure 3-20. —Seat type container.

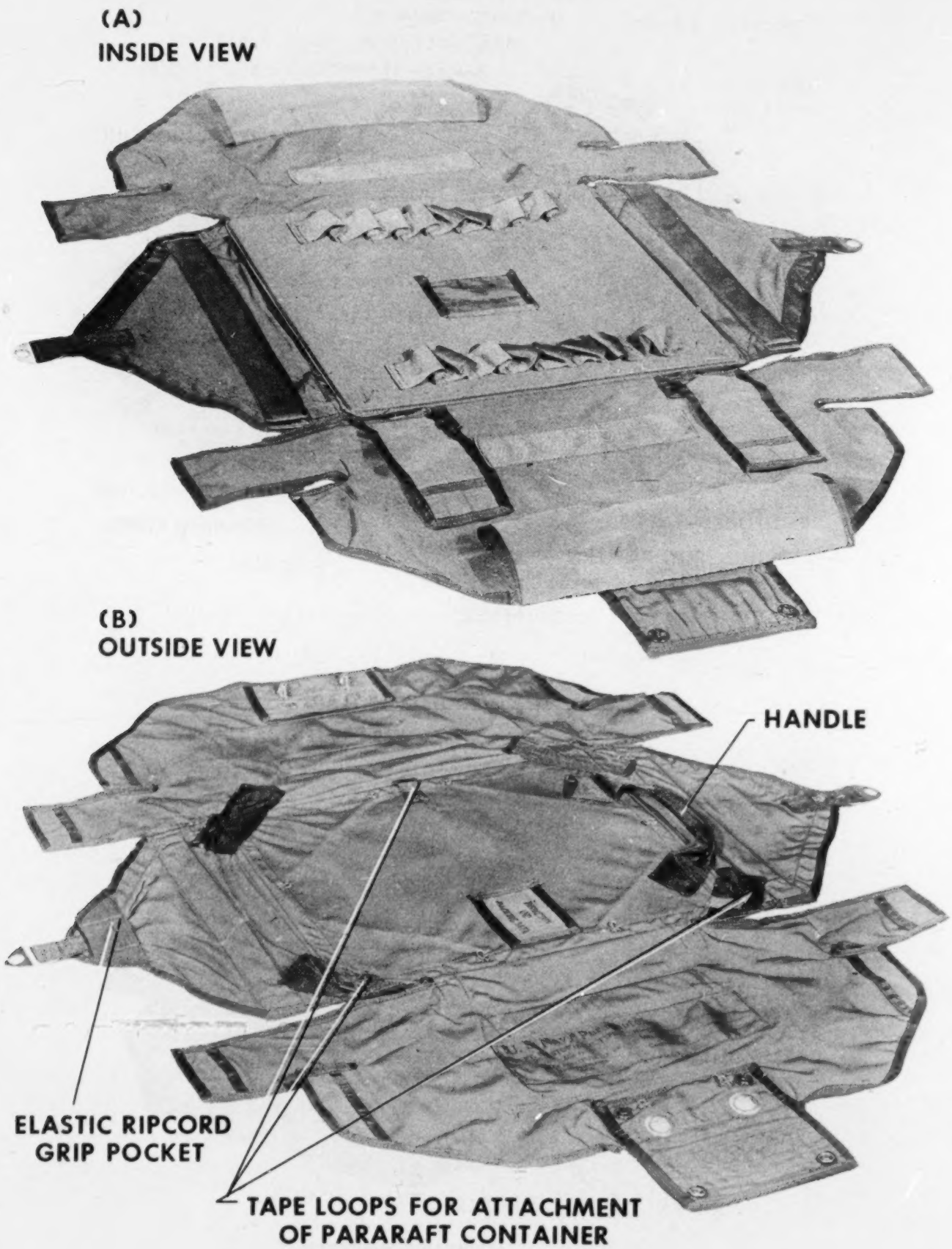

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Figure 3-21. —Chest type container.

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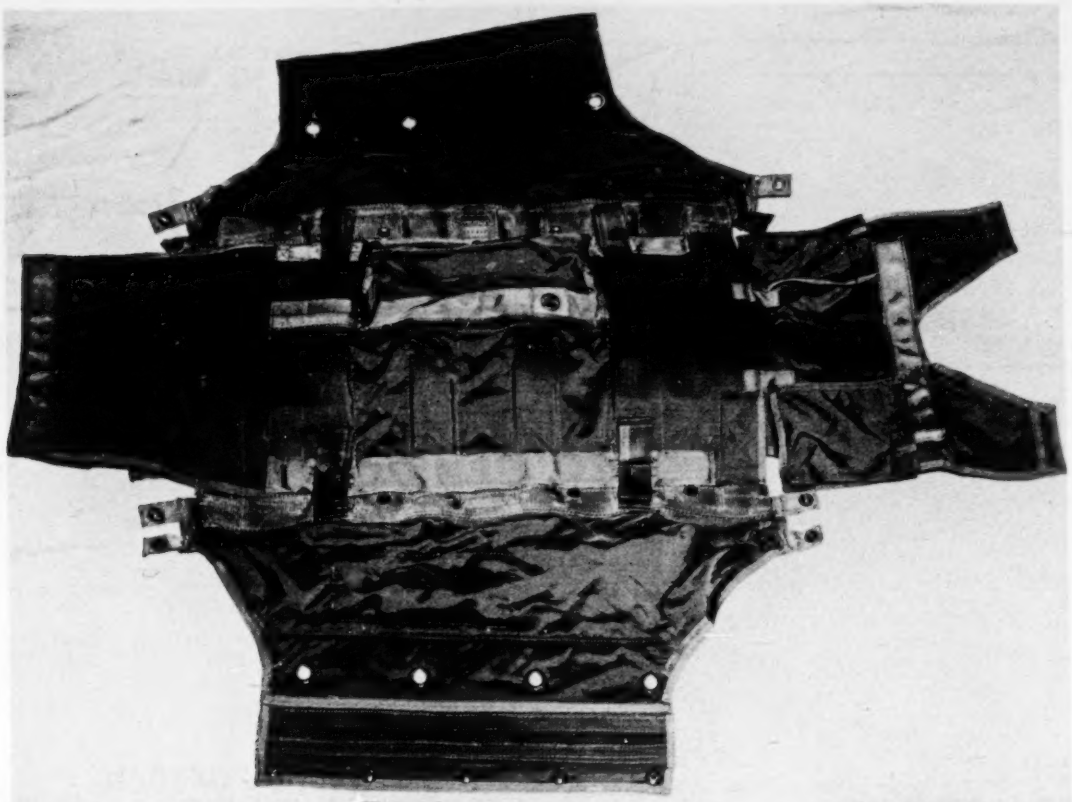

(A) INSIDE VIEW

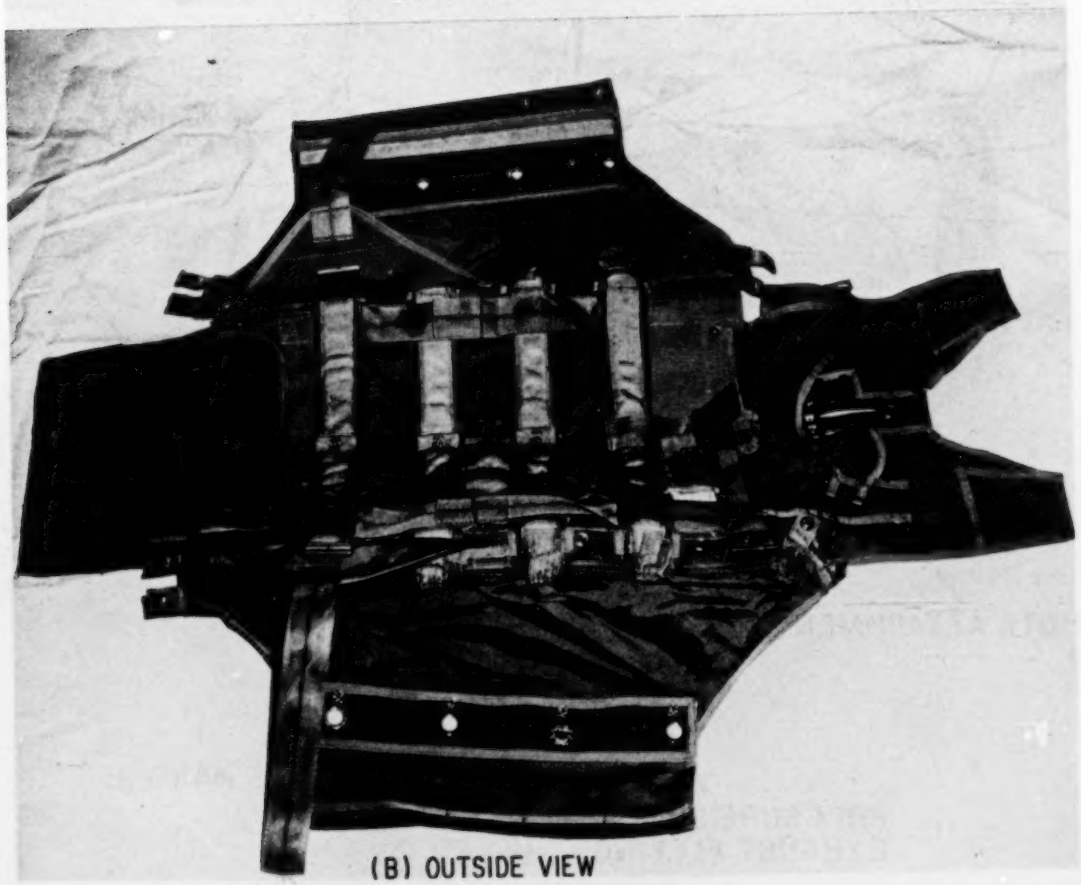

(B) OUTSIDE VIEW

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Figure 3-22. —Back type container.

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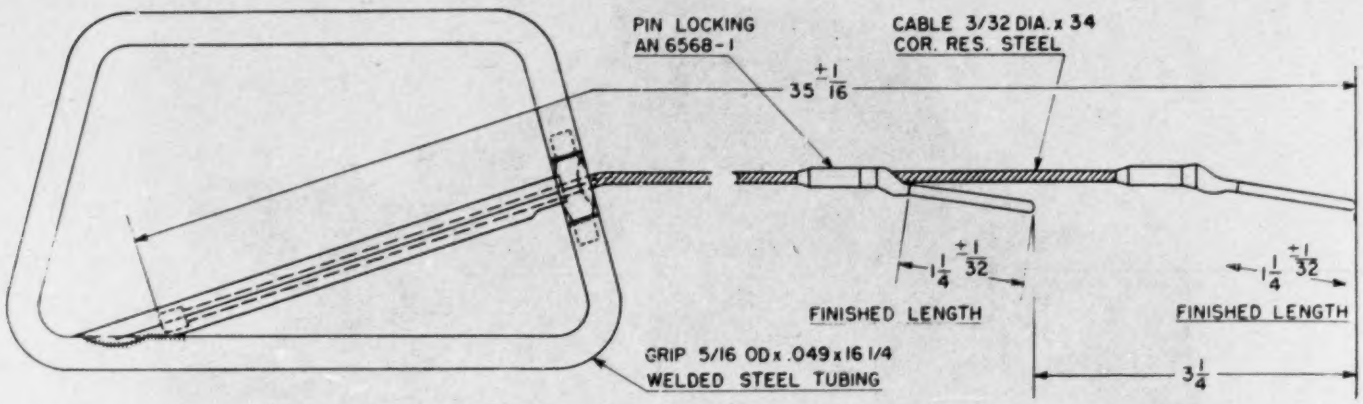

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Figure 3-23. —Extensible ripcord.

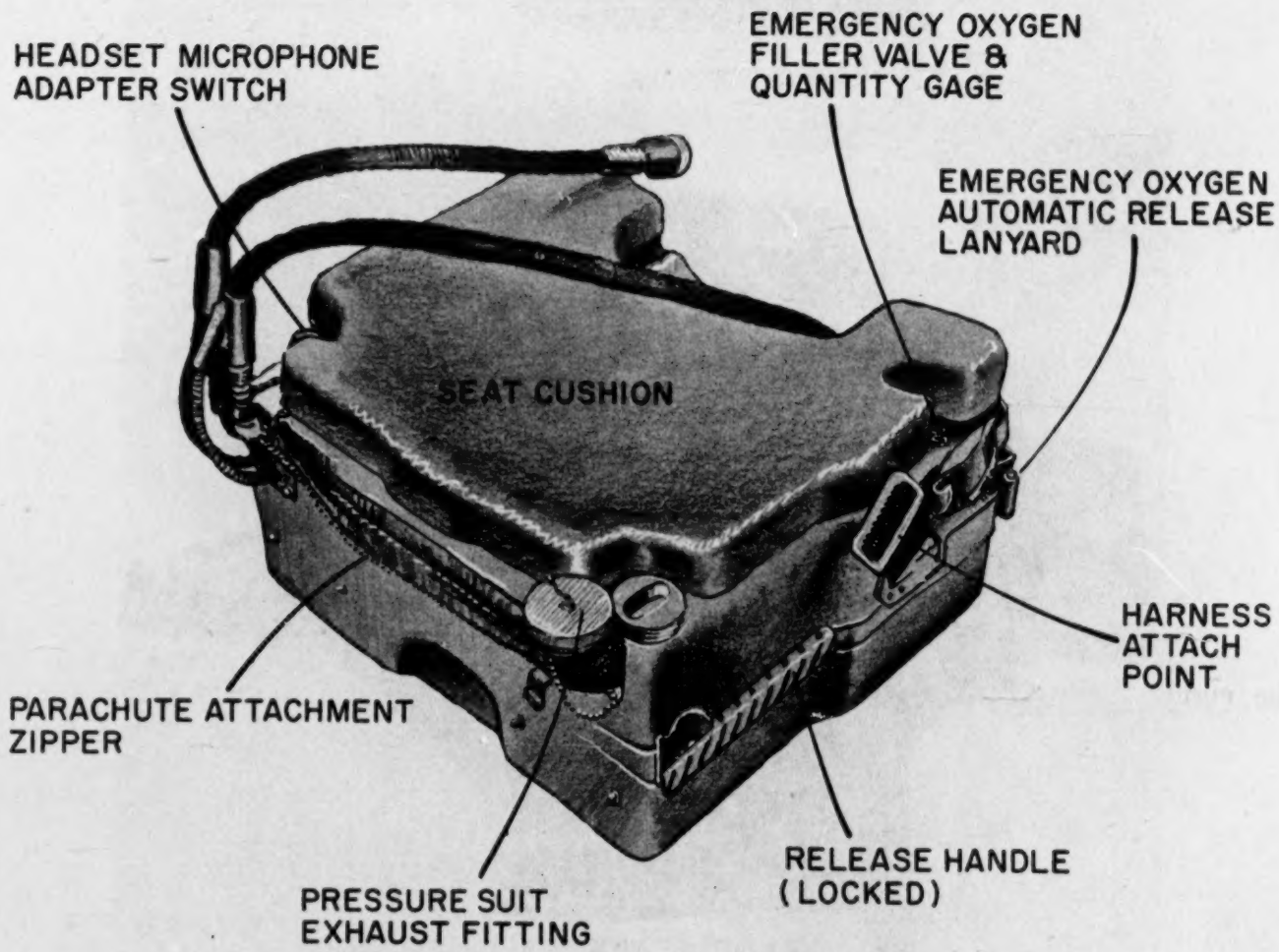

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Figure 3-24. —Survival kit container.

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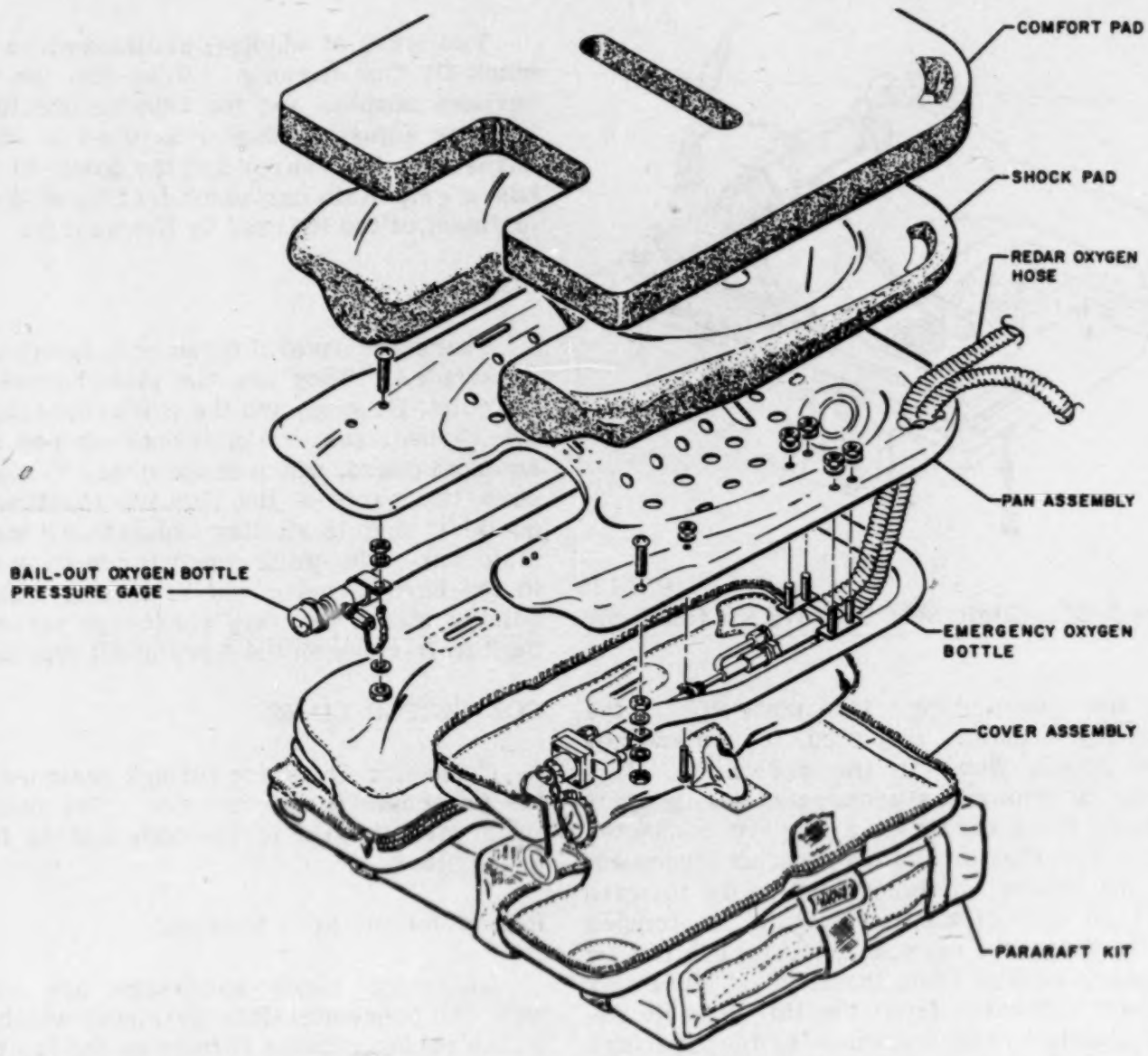

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Figure 3-25. —Seat pan assembly.

RIGID SEAT SURVIVAL KIT (RSSK)

The rigid seat survival kit is designed for use with an ejection seat and functions as a seat cushion for the crew member as well as a container for an emergency oxygen supply, liferaft, and survival equipment. (See fig. 3-26.)

The survival kit consists of an interconnected lid, lower container, and a cushion which forms a seat for the crewman. Mounted inside the lid is an oxygen system for emergency use. An oxygen/communication hose, installed on the aft left hand side of the lid, provides connection between both the emergency and normal aircraft oxygen supplies and the crewman. The longer hose of the oxygen/communication hose connects to the aircraft system and the short hose connects to the crewman's personal leads. Both hoses incorporate quick disconnect features.

The lower container provides space for the LR-1 liferaft and and an equipment bag which contains survival equipment.

Two adjustable straps, permanently installed on the kit lid, provide attachment of the survival kit to the crewman's parachute torso suit harness via two quick disconnect releases. An emergency oxygen actuator is mounted on the front of the lid.

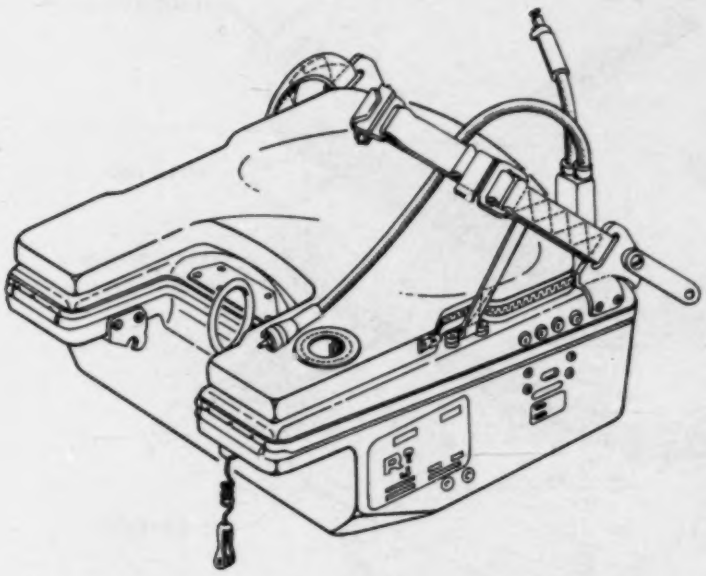

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Figure 3-26. —Rigid Seat Survival Kit RSSK-8A.

When the green ring, incorporated in the emergency actuator, is pulled, the emergency oxygen supply flows to the crewman. This actuator is automatically operated during ejection from the aircraft by a lanyard connected between the actuator and the aircraft structure. When the yellow handle, located on the forward right hand side of the survival kit, is stripped from the kit by the crewman, following airborne emergency egress from the aircraft, the lower container separates from the lid. The lid remains attached to the crewman by the parachute side straps; the container and inflated liferaft are deployed on a dropline connected to the lid.

PARACHUTE HARNESS HARDWARE

Parachute harness fittings (hardware) are small metal devices usually made of cadmium or chrome-plated steel. They are designed to join the parachute pack and harness and to afford easy and rapid adjustment of the harness to the wearer.

The many types of parachute harness fittings include adapters, snaps, D-rings, V-rings, connector links, and rocket jet canopy release fittings. Some of the more common types of these fittings and their tensile strengths are illustrated in figures 3-27 and 3-28.

ADAPTERS

Two types of adapters are used with a regular quick-fit type harness. They are the regular harness adapter and the friction adapter. The harness adjuster adapter is used to adjust the harness to the wearer and the quick-fit adapter has a grip slide bar which facilitates quick adjustment of the harness by the wearer.

SNAPS

There are several types of snaps in use with parachutes. They are the plain harness snap, the quick-fit snap, and the quick connector snap. The harness snap is a plain hook-shaped, spring-actuated guard, which snaps over a V-ring to secure two parts of the harness together. The quick-fit snap is similar except that it has a grip slide bar. The quick connector snap is similar to the harness snap and is used as a means to quickly attach the Navy chest type parachute to the two D-rings on the Navy chest type harness.

CONNECTOR LINKS

Connector links are fittings designed to join the parachute to the harness. The suspension lines are attached to one side and the harness to the other.

Rocket Jet and Koch Release

Integrated torso harnesses are equipped with two connector links (D-rings) which attach to the rocket release fittings on the lap belts of the integrated parachute. In addition, two Koch parachute release fittings are attached to each side of the upper chest of the torso harness and the riser assembly of the integrated parachute. Release fittings are manufactured in two parts—male and female. The male portion is attached to the torso suit, while the female portion is attached to the riser assembly of the parachute. Figure 3-29 shows the Rocket Jet and Koch parachute release, while figure 3-30 shows the attachment of the fittings to the integrated torso harness.

Inspection and Testing Rocket Jet Hardware

Inspection and testing of the release must be performed concurrently with the parachute repack. Visually inspect the release for cracks

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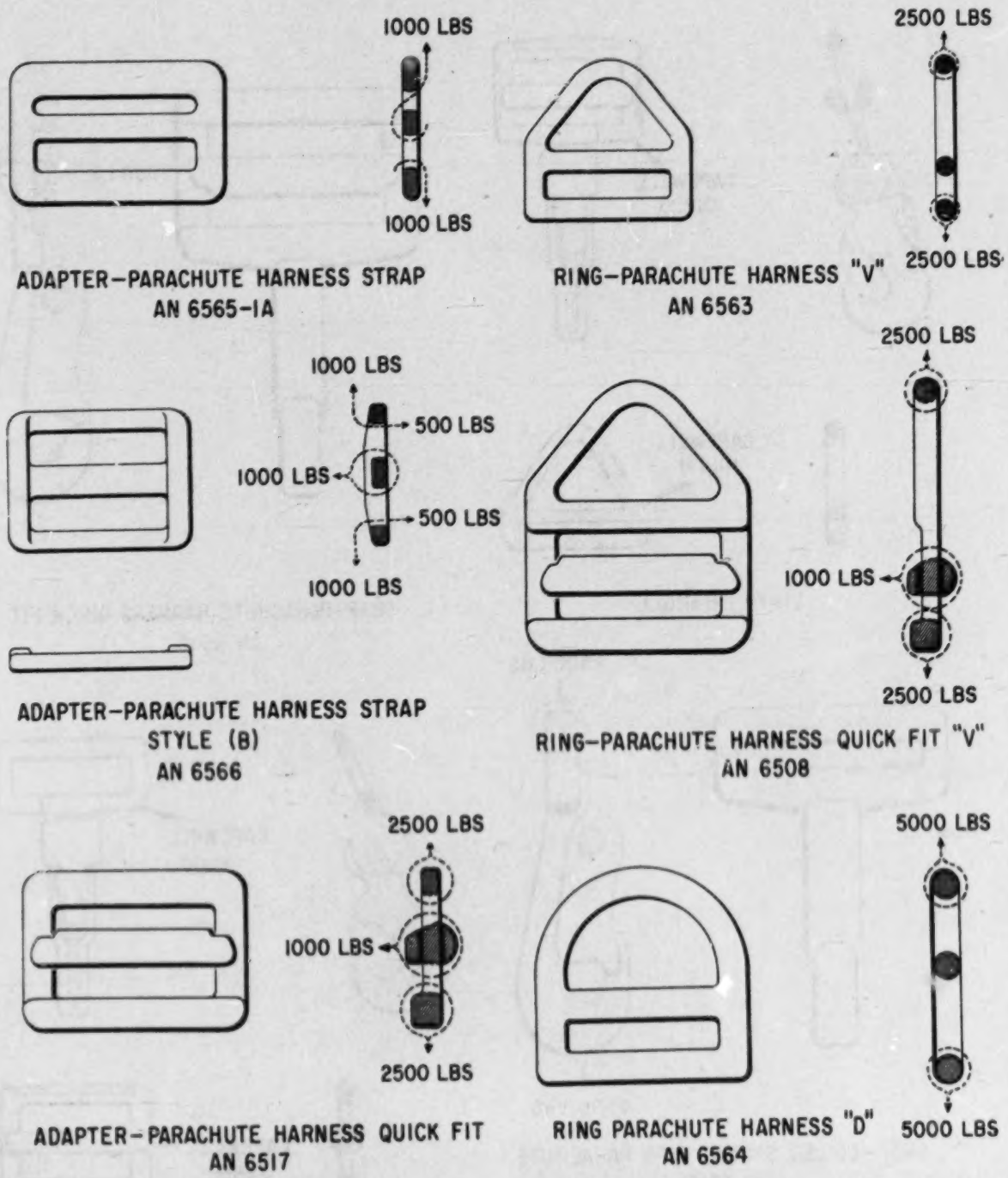

Figure 3-27.—Parachute harness hardware.

and structural damage. Operational testing must be performed by personnel wearing a torso suit harness. With the parachute riser and/or lap belt fittings placed properly over the shoulder and thighs and with the webbing tensioned to approximate operational loading, each fitting must be locked and unlocked 25 times without binding or failure. The release operation must be accomplished by fully depressing both lock buttons and pushing the collar fully against the stop pins. When the buttons are released and the collar pulled downward in the locking operation the collar should close by spring action the last 1/8 inch of travel. During the cycling

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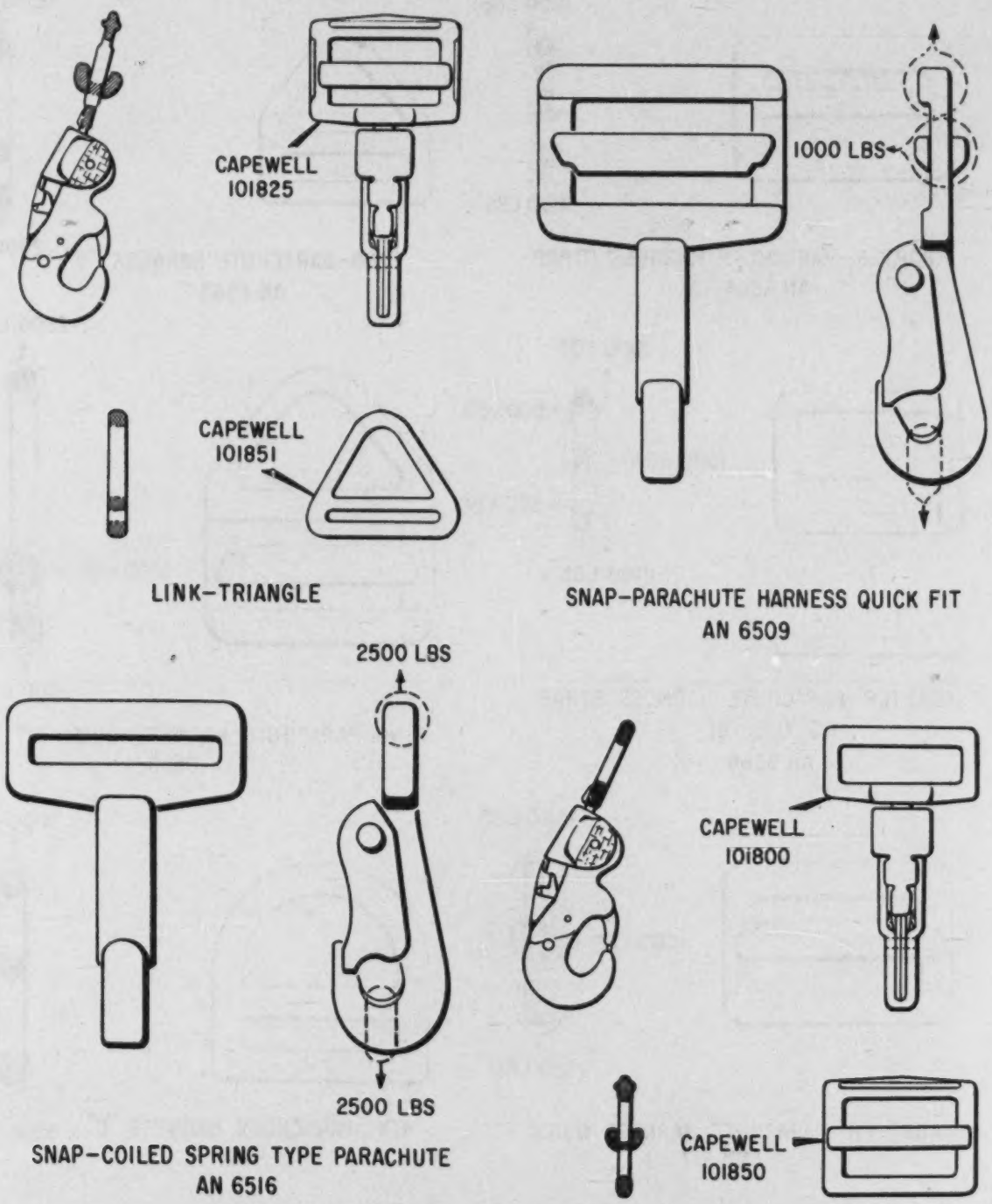

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Figure 3-28.—Parachute harness hardware—Continued.

operation, there should be no binding or hang up. Attempt to operate the collar by depressing one lock button at a time. The collar should stay locked when either lock button is depressed separately. Fittings which fail to meet either of these operations must be removed and replaced.

If it appears that foreign particles inside the release are affecting operation, clean with compressed air with a maximum pressure of

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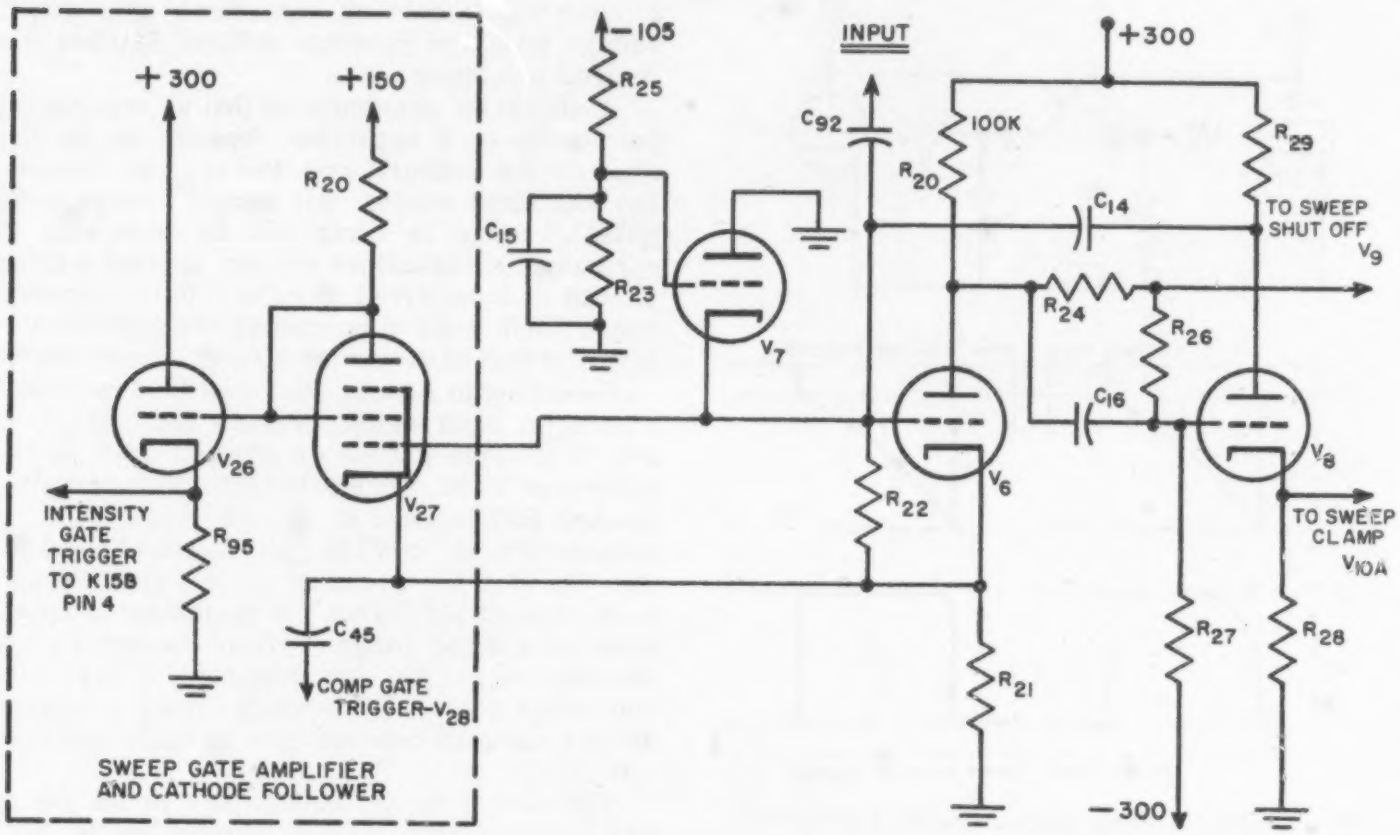

Figure 16-7.—Sweep gate circuit.

at the same rate. When the grid voltage rises sufficiently to overcome its cathode bias, V9 will conduct, producing a negative-going pulse of sufficient amplitude to cut off V8. Since the conduction of V8 provided the voltage source which cut off the clamping circuit (V10A), the circuit will not return to its static condition.

The time required for V9 to conduct was determined by its static cathode potential and the RC network being used to generate the sawtooth voltage waveform (assuming a constant sweep amplitude). Therefore sweep time is controlled by varying the values of resistance and capacitance in the charging circuit on all fixed ranges.

The relationship of the MTP to the waveforms of the range sweep generating circuits is shown in figure 16-9. Waveform (3) is the positive square wave which disables the clamper V10A. It should be noted that waveforms (4) is a sawtooth superimposed on a low amplitude square wave. The square wave portion, called a jump voltage, is developed across R38 when V10A is cut off. Waveform (5) should be studied noting that when the sawtooth voltage reaches cutoff, waveforms (2), (3), and (4) are also terminated.

The output of the sweep charging circuit, a positive sawtooth on a pedestal, taken from the plate of V10A is directly coupled to the grid of the sweep amplifier V12. (NOTE: The operation of V11 has been omitted purposely at this time; however, it is discussed later in this chapter.) This output waveform is shown as waveform (1) of figure 16-10.

Sweep adjustments are provided to allow the technician a means of compensating for any slight variations in circuit parts. R36, located in the cathode V9, is a screwdriver adjustment for setting the sweep amplitude. R39 is a similar adjustment, but it permits a fine adjustment of the sweep slope or sweep time.

SWEEP AMPLIFIER CIRCUITS

You should now be familiar with how the sawtooth sweep is generated and how it is used as

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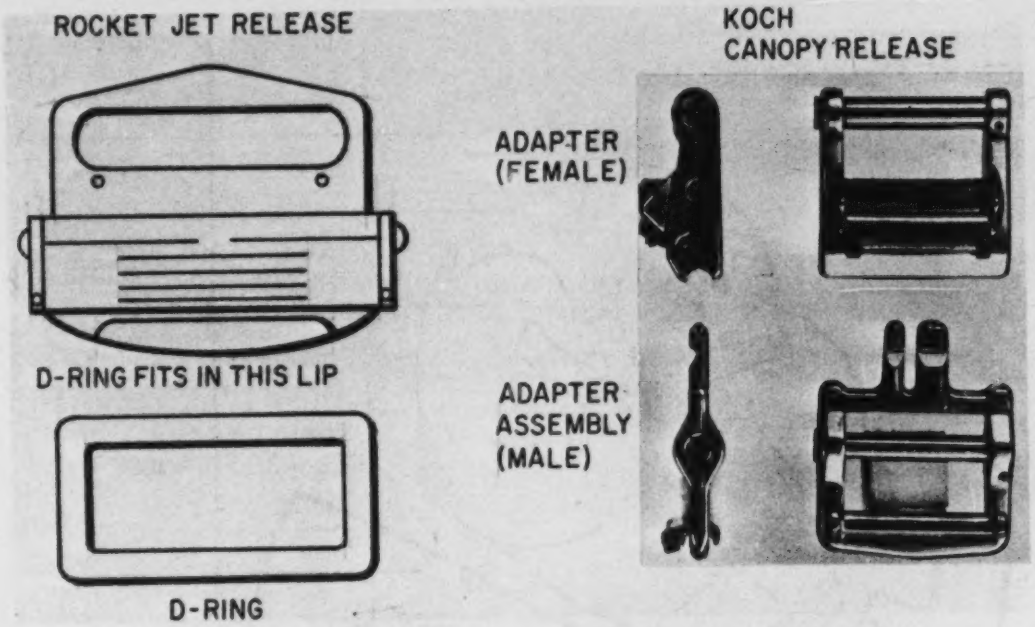

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Figure 3-29.—Rocket Jet and Koch canopy release.

50 psi. Clean the exterior surface of the release using a cloth dampened with an approved cleaning solvent. Prevent the cleaning solvent from contacting interior working parts, such as springs and pins. NOTE: Do not lubricate the release.

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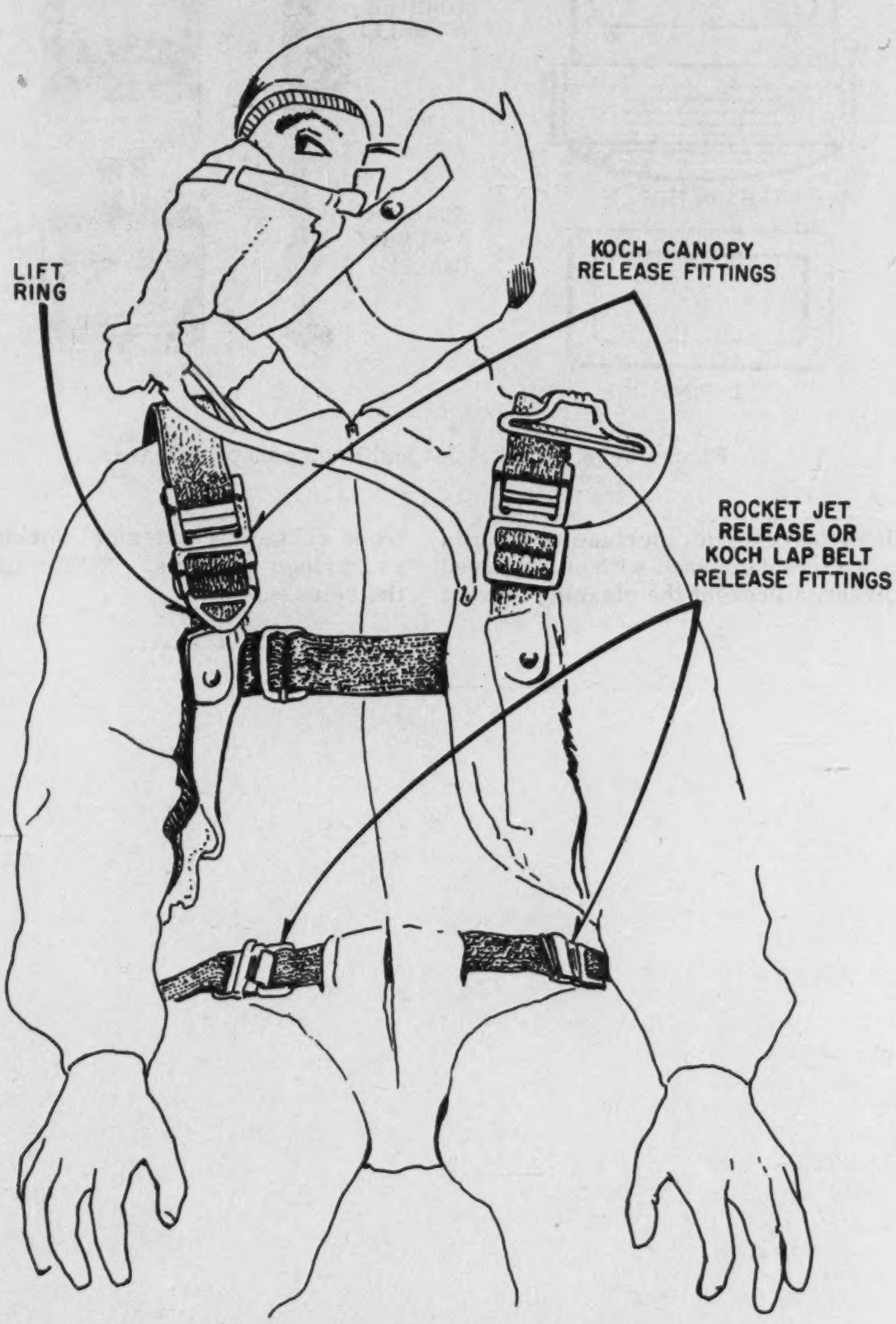

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Figure 3-30.—Rocket Jet and Koch fittings on integrated harness.

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CHAPTER 4

PARACHUTE LOFT ARRANGEMENT AND PARACHUTE INSPECTION

PARACHUTE LOFTS

The parachute loft is the work area designated for the inspection, maintenance, repair and packing of parachute assemblies, systems, and components. The design and style of parachute lofts ashore and afloat will vary in size and maintenance capabilities, depending upon the space available, loft equipment, and the activity's basic mission. The three general types of parachute lofts currently in use are the shore-based parachute loft, the shipboard parachute loft, and the portable advanced-based parachute loft.

The shore-based parachute loft is designed and equipped to perform repairs generally required of the higher levels of maintenance. The shipboard parachute loft is designed and equipped to perform repairs at the lowest maintenance level possible. The portable advanced-base parachute loft should be equipped to perform limited repairs. All parachute lofts must be manned by qualified Aircrew Survival Equipmentmen.

Proper utilization of the limited working space alloted to the parachute loft is a primary concern and responsibility of the branch supervisor. In order to accomplish the vast amount of work that flows through the parachute loft, everyone concerned must cooperate by adhering to a well-planned work schedule.

PARACHUTE PACKING SECTION

The parachute packing section is devoted to packing and inspection of parachutes. Parachute packing tables naturally occupy the greatest area of the loft. Thorough consideration should be given to the number of tables that can be successfully utilized, allowing ample working space around the tables. Packing tables must be of sufficient length to allow laying out the complete parachute assembly for inspection and packing. The recommended dimensions are 45 feet by 36 inches by 36 inches.

A cutaway packing table is the least tiring to use, as the packers do not have to stretch across its full width during the closing and finishing of the packing.

Workload

The number of air groups, the types of parachutes, the number of parachutes assigned each, and the loft equipment will have to be taken into consideration in order to determine the number of tables necessary to adequately carry out the prescribed packing schedule. There are many factors that determine the workload of a parachute loft.

Packing operations should not be interrupted and the area where the tables are located should be kept free of traffic. Spacing the tables at least 3 feet apart and parallel to each other provides the best arrangement.

Lighting the parachute loft is very important. It takes good eyes and good lighting to find stitching irregularities and ruptures in glossy white material. Fluorescent lighting has been found to be best, as it gives a flat light bright enough for inspecting, packing, and sewing machine work. However, parachutes should not be exposed to fluorescent lights closer than 5 feet for long periods of time.

Parachute inspection tables have glass tops and are illuminated by fluorescent lighting from beneath the table top. The inspection table should be long enough to inspect an entire gore at one time, be smooth and free of slivers and burrs, and radiate minimum heat from the lighting source.

Do not leave parachutes on lighted tables longer than required for an inspection. Excessive exposure to artificial lighting is harmful to nylon parachute materials.

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ENVIRONMENTAL REQUIREMENTS

Regulated temperature and humidity conditions must be maintained in the parachute loft wherever possible; advanced-based and temporary facilities are the exceptions. The temperature and humidity in the parachute loft must be maintained within specified limits, ideal conditions in the packing section being a temperature of 75°F and a relative humity of 60 percent. The loft must be kept free of dust and dampness and be well ventilated.

DRY LOCKER

The dry locker, or drying tower as it is sometimes called, is used to condition parachutes which are subjected to excessive moisture. The dry locker must contain controlled environmental conditions. The height of the dry locker should be sufficient to permit the parachute to hang full length without touching the walls, the deck, or other parachutes. To suspend freely, a 28-foot parachute requires a height of approximately 45 feet; and for adequate drying, the hoisting lines should be a minimum of 2 feet apart, and at least 12 inches from the bulkhead.

For adequate lighting, the flush type, low heat, incandescent light fixtures are recommended; the dry locker should be devoid of windows or skylights.

A dry locker is shown in figure 4-1, which illustrates one of the many possible floor plans of a typical parachute loft.

WET LOCKER

The wet locker is used for drying parachutes after washing. It must be a separate compartment from the dry locker, and must be provided with dehumidification and deck water drains. Other construction features of the wet locker are similar to those of the dry locker requirements.

WASHROOM

The washroom is used for washing parachutes. It should contain a large tub or vat of sufficient size to allow complete submersion of the parachute assembly. Hoist lines should be provided over the tub to simplify handling of the parachute.

STORAGE AREA

Bins, shelves, and cupboards must be provided in the parachute loft to accommodate packed or unpacked parachutes and various other components. The shelving should be designed to facilitate storage of parachutes at least 4 inches from the walls and 12 inches from the deck. The storage area must be well ventilated and free of dust and other contaminates.

SEWING SECTION

The sewing section of the parachute loft must be equipped with sewing machines, cutting tables, fabric racks, and a suitable locker facility.

The cutting table should be from 30 to 33 inches high, so that the PR may comfortably perform any cutting operation. The table should be at least 54 inches wide to handle the most frequently used widths of materials. The table length will depend upon the available area and workloads.

The fabric rack should be located adjacent to the cutting table, as it is used for the purpose of stowing fabric materials in the sewing section; A fabric rack should be designed and constructed of considerable strength in order to accommodate large heavy rolls of material. The rack may or may not be portable.

Lockers should be located in the vicinity of the fabric section. Small items, such as measuring instruments and cutting, stapling, and setting tools, should be safely stowed in lockers. Needles and spare sewing machine parts should be stowed in a manner to keep dust from them. The number and location of lockers required to satisfactorily stow all necessary items can be determined by the available space in the parachute loft.

PARACHUTE INSPECTION

Parachutes are designed to provide an avenue of escape for pilots and aircrewmen from disabled aircraft. The nature of this lifesaving item leaves no margin for error in the work of the PR. The parachute must be ready to render prompt, efficient, and reliable service at all times.

Parachute inspections must be carefully conducted, insuring comfort, security, rapid

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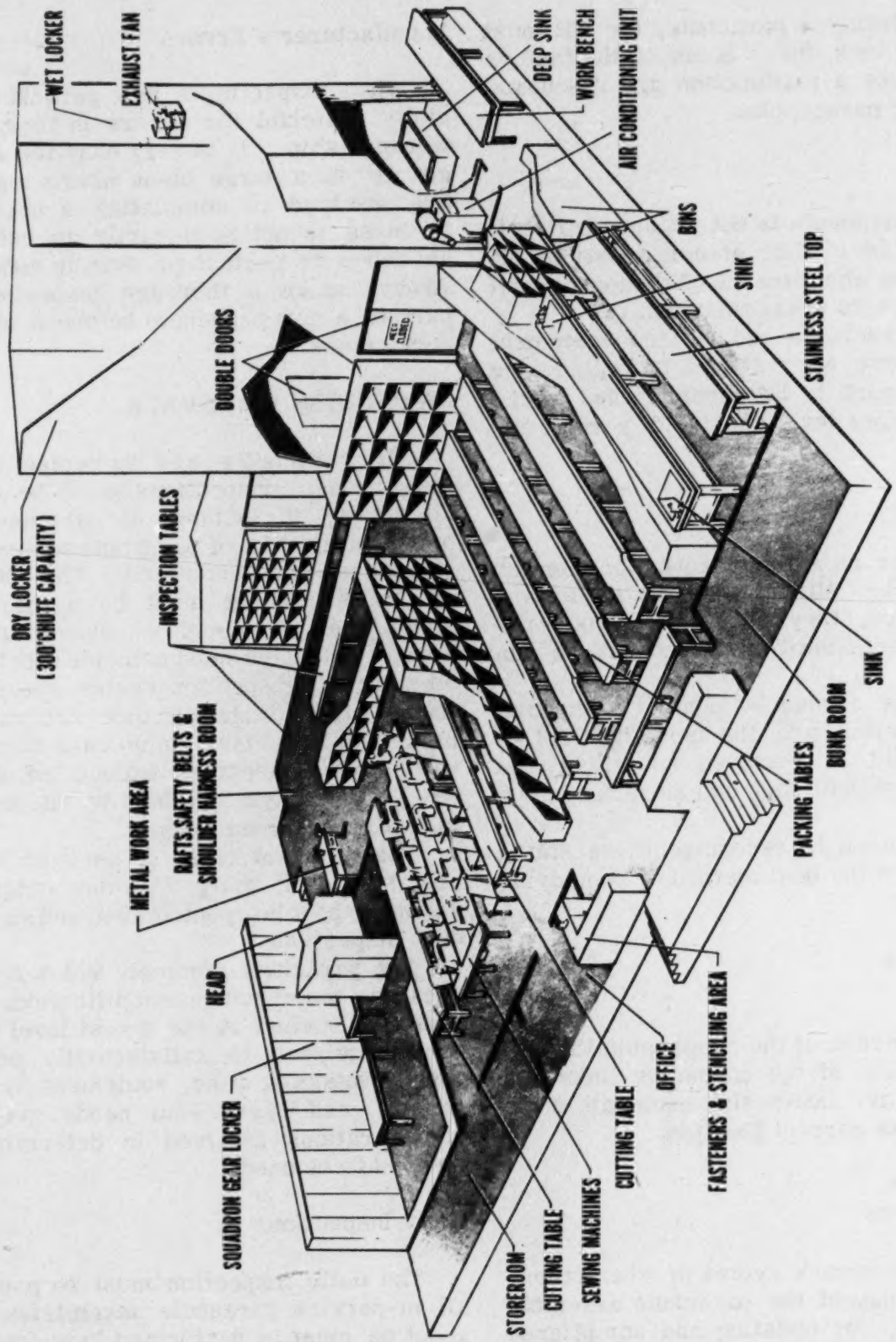

Figure 4-1. —Floor plan for a parachute loft ashore.

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positive functioning, and airworthiness of the entire assembly.

FACTORS AFFECTING MALFUNCTIONS

Before inspecting a parachute, the PR must know what to look for. Some of the factors which may cause a malfunction are discussed in the following paragraphs.

Wear

Wear in a parachute is not difficult to detect. It is indicated by chafing at corners or on the outside surfaces where the most frequent contact with moving objects is encountered.

Parts of parachutes and related equipment showing excessive wear should be replaced or repaired, the work to be accomplished at the lowest maintenance level capable of performing the task.

Stains

Stains appear as a discoloration or blemish in the material. Although not all stains are harmful to nylon, they should be considered as harmful agents until identified and proven harmless.

Those stains caused by contact with acid, oil, and salt water are the most harmful to nylon and should be removed as quickly as possible to prevent further deterioration of the material.

PR's must learn to recognize these stains quickly and know the best method of remedying each.

Suspension Lines Out of Position

Be sure that each of the suspension lines is in proper rotation at the connector links and through the canopy. Insure that each unit of the assembly is in its correct position.

Compliance With Current Directives

On parachute repack cycles or when otherwise directed, inspect the parachute assembly and components, for updating and compliance with the latest modifications. For each type of parachute, refer to the Aviation-Crew Systems Personnel Parachute Manual, NavAir 13-1-6.2, and recent Aircrew System Bulletins and changes for all current parachute configurations. Do not permit any local modifications without prior approval of proper authority.

Manufacturer's Errors

When inspecting a new parachute, be especially watchful for errors in the material and workmanship. It is very easy for a mistake to get by in a large plant where many persons are involved in completing a single product. Newness is not necessarily an indication that an object is perfect or even in good condition. Always make a thorough inspection of every part of a new parachute before it is packed for service use.

INSPECTION INTERVALS

All parachutes are subjected to periodic inspections. Inspections must be thorough at all times; no instance of careless treatment or willful neglect of parachute equipment may be allowed to pass unnoticed. The vital function of this equipment must be uppermost in the minds of all personnel concerned. The periodic inspection cycles must coincide with the applicable aircraft inspection cycles specified in the Naval Aircraft Maintenance Program, NavAir Inst. 4700.2 (Series). In no case may the interval between inspections exceed 182 days for the NB-11, 147 days for the LW-3B, and 126 days for all other assemblies.

The different types of periodic inspections are as follows: daily, 7/14 day, original issue/calendar/special, postcombat, and aircraft accident inspections.

Any parachute assembly which requires repacking, maintenance, modification, or repair must be handled at the lowest level of maintenance equipped to satisfactorily perform the work. Mission, time, equipment, trained personnel, and operational needs are the basic considerations involved in determining which level is to be used.

Daily Inspections

The daily inspection must be performed on all in-service parachute assemblies. This inspection must be performed in accordance with local maintenance requirements cards by a representative of the organizational maintenance

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activity, the plane captain, or a designated aircrewman. It must be performed daily and following ground transportation of an assembly. This inspection is not detailed, involving only in-place checks for external damage and security of tackings or broken strands in tackings.

Seven/Fourteen Day Inspection

The 7/14 day inspection must be performed on all in-service parachute assemblies by organizational level maintenance activities or an authorized aircrewman.

Parachute assemblies assigned to OV, VA, VF, and VT type aircraft must be inspected every 7 days.

Parachute assemblies assigned to VP, VR, VS, VH, and VW type aircraft must be inspected every 14 days. Assemblies used for training, para-rescue, pathfinding, and reconnaissance teams, and those parachute assemblies not assigned to a specific type of aircraft, must be inspected every 14 days. These inspections include, but are not limited to, emergency aircraft escape assemblies and/or systems, as well as assemblies used for premeditated free-fall or static line parachute descents.

The reserve (emergency) parachute which may form a part of a training type, troop type, or a test assembly must also be included in the inspections. If any damage or contamination is found or suspected, notify maintenance control. Record the completion of inspections on the Parachute Record Card.

Do not open the parachute assembly or damage ripcord safety-ties while performing the 7/14 day inspections.

On all parachute assemblies that employ a metal ripcord handle clip, the ease of removal of the ripcord handle from the metal clip must be checked on each 7/14 day inspection. To perform this examination, carefully remove the ripcord handle from the clip. The ripcord handle should be retained by the clip but removed easily when pulled.

ORIGINAL ISSUE INSPECTION

The original issue inspection is performed at the time a parachute is placed into service. When a parachute assembly is an aircraft inventory item, the acceptance inventory inspection and packing may serve as the original issue inspection. In this case, the records concerning the parachute must be examined. If any discrepancy is found, a special inspection, as discussed later in this chapter, must be performed.

Special Inspection

When a parachute assembly must be inspected at a time other than the aircraft calendar interval, a special inspection must be performed.

Postcombat Inspection

Organizational level maintenance must inspect parachute assemblies for external damage or abnormal condition after each combat mission. When an aircraft has been subjected to gunfire, all parachutes must be examined for damage prior to the next flight. If it is found that bullets or fragments have entered the parachute assembly, remove it from service and perform a special inspection.

Aircraft Accident Report Inspection

Parachutes and related equipment which have been recovered following emergency bailout or ejection must be removed from service and turned in to the nearest supply activity on an exchange basis.

The turned-in parachute must be shipped to the Commanding Officer, Naval Aerospace Recovery Facility, El Centro, California 92243, marked "For Naval Aerospace Recovery Facility Evaluation and Testing."

In accordance with NavAir Inst. 13480.1B, and to provide the Naval Aerospace Recovery Facility with sufficient information to properly evaluate and improve these parachutes for service use, a brief summary of the ejection or bailout must be enclosed with each parachute turned in after emergency use. This summary must contain the following information:

1. Name of activity.
2. Date, time, and place of emergency escape.
3. Serial number and date of manufacture of the parachute assembly.
4. Serial number of the automatic actuator.
5. The name, rank, or rate of personnel involved.
6. Type of aircraft, altitude, and airspeed, if known.
7. Was emergency exit successful in all respects. If not, list difficulties encountered.

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8. Did parachute and actuator function properly?

9. Include remarks or additional information.

Calendar Inspection

The calendar inspection of parachute assemblies is scheduled to correspond with the aircraft calendar inspection. On the calendar inspection all personnel parachutes in service use are opened, and each component part given a complete and thorough inspection. The parachute is then hung in a suitable drying locker to air and dry for a period of 24 hours and repacked for service use. This period may be reduced in the interest of operational effectiveness with the approval of the commanding officer.

When performing the calendar inspection, the following procedure should be followed. If doubt exists as to the serviceability of a parachute assembly, it should be forwarded to the next higher level of maintenance.

PREPARATION.—Open the parachute by pulling the ripcord handle with a suitable scale attached. The maximum pull force is 27 pounds (60 pounds for LW-3B). If the maximum pull force is exceeded, the ripcord pins, cones, and grommets must be inspected for bends, dents, and roughness. Insure that the ripcord cable moves freely in its housing. Inspect the housing for sharp bends or dents, and replace damaged parts as necessary. Silicone spray may be sparingly applied to ripcord parts. On all assemblies with metal ripcord handle clip, reinsert the handle into the clip and seat the handle fully. Reset the scale to read 0. Using a straight, steady pull, remove the handle from the clip. The force required to remove the handle from the clip must be 10 to 20 pounds. If not within limits, examine the clip for corrosion, sharp edges, bends, twists, and dents. The clip may be adjusted by using pliers, taking care not to mar the clip. If any maintenance was performed on the clip, repeat the test.

Examine the webbing for contamination, fraying, loose or broken stitches, cuts, and burns. Replace any damaged stitching; if other damage exists, replace webbing and/or clip.

CAUTION: Before performing the ripcord pull test, insure safety pins are installed on parachute assemblies that employ automatic actuators, ballistic spreading guns, and static line cutters.

The parachute is now ready to be laid out full length on the packing table and the connector links fastened to the tensioning hooks. Engage the hook at the opposite end of the table into the loop of the pilot chute connector.

CANOPY.—Starting at the gore with the nameplate, the two suspension lines attached to the gore are taken, one in either hand, and flicked up and down together so as to trap air beneath the gore. This will reveal any holes or tears in the fabric and straighten out any creases. A careful examination of every part of the gore proceeds systematically up the gore from the skirt. As each section seam is reached, it is thoroughly inspected to detect any signs of broken stitches. The attachment of the suspension lines to the skirt hem of each gore must be carefully examined to determine that the zigzag stitching reinforcement is intact and that the hem is undamaged. The canopy must be examined for stains of all sorts that may lead to deterioration of the fabric. Every effort must be made to keep the canopy clean. Continue this method of inspection until each gore has been completely checked for every possible damage which might endanger the life of a prospective user. Check the peak for attachment of the vent collar and test the vent ring for strength and elasticity by stretching it to its fullest extent.

SUSPENSION LINES.—Examine the connector link for cracks, rust, or corrosion. Check the continuity of the suspension lines and attachment at the links. Check zigzag stitching for defects both in the attachment at the links and at the skirt hem. Carefully examine each suspension line for fraying, projecting loops of thread, friction burns, and stains. This examination may be made by grasping one group of lines and placing them side by side in the hand. Slide the hand underneath the group and inspect about 2 feet, then turn the group over and check the reverse side. Continue this method of inspecting 2 feet at a time until the entire length of both groups have been carefully inspected.

If uneven lengths are found during the inspection of the suspension lines, the parachute must be sent to a depot level maintenance station for correction. Never attempt to shorten or lengthen a suspension line.

PARACHUTE CONTAINER.—Inspect the parachute container for rips, tears, stains, and proper attachment of flaps and hesitator loops. Watch for a bent or broken pack frame, and look at the pack stiffeners for evidence of chafing of

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the fabric enclosures and damage to the stiffeners.

Look closely at the attachment of the harness to the container. Be sure that all stitches are intact and made in accordance with latest directives. See that the end tabs are not damaged and are secured properly to the end flaps. The metal end tab must be positioned with the concave side toward the container when in position over the cone. If a cone is rough or badly damaged it must be replaced. Watch for damaged or unserviceable grommets and ripcord protector flap fasteners, and check pack opening bands for security of attachment of the eyes and general condition.

HARNESS.—When checking the harness and flit web assemblies, examine the hardware for corrosion, rust, cracks, breaks, bends, or other damage, and ease of operation. Check the webbing for fraying, wear, abrasion, stains, defective stitching, and twists. Check the harness, insuring that the webbing straps of the assembly follow the proper sequence.

PILOT CHUTE.—Examine the pilot chute for stains, broken or loosened stitching in the seams, and holes or tears in the canopy. Check closely the coiled spring for breaks, bends, and proper spring tension. Check the connector cord for length of cord and loops and for damage and security of the connecting knots.

RIPCORDS AND HOUSINGS.—The ripcord housing should be checked for security of the end ferrules to the coil housing, for breaks, crushing, or other deformation of the housing. Check the proper location and security of attachment.

The ripcord is checked for proper length, bent, broken, or rough locking pins, the swaged joints for attachment, and the cable for frayed strands and rust or corrosion.

SEAT CUSHIONS/PADS.—Look closely at the cushions and back pads for overall condition. See that all keepers are secure and that all snaps are in good working order and fastened properly. A defective or missing snap fastener should be repaired or replaced, and damage to the cover or weakened stitching should be repaired.

CONTAMINATION INSPECTION.—All parachute assemblies must be carefully inspected for evidence of contamination. When a discoloration appears on the parachute container, canopy, or related equipment, the stain should be identified and remedied as soon as possible. The identification of these discolorations or stains may be accomplished by several methods, the best of which is to identify by sight the more common stains as follows:

1. Acid stains appear as a gray putty-colored stain or a powdery ash, depending upon the strength of the acid solution which made the stain.

2. Salt water stains are generally characterized by the appearance of a white crystalline substance on the surface of the material with a slight discoloration in the area.

3. Oil and grease stains have a greenish color and produce an oily or greasy feeling when touched or rubbed between the fingers.

Parachutes and components stained by any of these or other injurious substances must be cleaned as described in chapter 11 of this manual. If the contamination cannot be removed, the parachute assembly must be forwarded to a depot level maintenance for additional cleaning. Attach a report of the nature and location of all stains.

SERVICE LIFE CHECK.—The service life of a parachute assembly or subassembly is 7 years from the date it was placed in service (opening manufacture's package), or 8 1/2 years from the date of manufacture, whichever occurs first. When an assembly or subassembly reaches the service life limit, it must be removed from service and forwarded to supply for disposition.

NOTE: The service life of troop, training, and NB-5 assemblies is 10 years from the date of manufacture.

When a parachute is placed in service from stores, the month/year of opening the manufacturer's individual shipping container must be stenciled on the parachute's nameplate gore. Letters must be 1/2 inch high and made with blue parachute marking fluid (MIL-I-6903). The term "date placed in service" followed by month/year notation must be placed directly below the nameplate.

When an in-service parachute lacks a start of service date, the service life will expire 7 years from the date of manufacture.

NOTE: On MBEU assemblies if determination of age of a canopy is unclear, as reasonable an estimate as possible must be made from information on the Parachute History Card and other available parachute records. All MBEU canopies manufactured after June 1967 have a date of manufacture located on gore number 1 near the skirt hem.

If no date of manufacture is available on a subassembly, the date marked on the parachute canopy will apply to the subassembly.

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PARACHUTE MAINTENANCE RECORDS AND FORMS

The records and forms used by the Aircrew Survival Equipmentman to provide a systematic means of control will be discussed in this section.

Parachute Record Card

The Parachute Record Card, NavAir 13480/1, is used to record the 7/14 day inspection and the normal inspection and repacking data including the automatic actuator cartridge expiration date and load lot number. Since the repack cycle differs for each type of parachute assembly, depending on which type aircraft the assembly is in, this information must be recorded on the upper right-hand corner of the card front. When the Parachute Record Card is completely filled, it must be replaced by a new card. Review the card and compare it to the Parachute History Card to verify that all entries have been recorded. The Parachute Record Card is shown in figure 4-2.

Parachute History Card

The Parachute History card, NavAir 13480/2, contains all information found on the Parachute Record Card, including the repack cycle information in the upper right-hand corner of the card front. The Parachute History Card is shown in figure 4-3.

In cases where the aircraft inspection cycle is changed, a notation must be added to the card referencing the specific entry in the Aircraft Log Book authorizing the change. In addition, all modifications performed on a parachute assembly must be recorded on the Parachute History Card. When the card is completed, it is stapled to the back of the new card. The Parachute History Card is maintained at the organizational level.

Information concerning repacking, modifications, and repairs must be extracted from the Work Request, NavAir 4710/7, after work at a higher level is performed and entered on the card. Whenever a parachute assembly is transferred from one unit to another, an updated parachute History Card must be forwarded to the receiving unit, attached to the parachute assembly. If the parachute is an aircraft inventory item, the Parachute History Card is inserted into the Inventory Log book and forwarded.

Canopy Damage Charts

Whenever a canopy is inspected and found to need repairs, the appropriate Canopy Damage Chart must be filled out. A Canopy Damage Chart for 24- and 28-foot canopies is shown in figure 4-4.

If repairs cannot be accomplished locally, the chart must accompany the canopy to the next higher level of maintenance. This form must not be discarded. Upon completion of the repairs, the Canopy Damage Chart must be affixed to the Parachute History Card.

NOTE: DO NOT MAKE ANY MARKS ON THE CANOPY.

Until Canopy Damage Charts are published as NavAir Forms, the examples contained in the Aviation-Crew Systems Personnel Parachute Manual may be locally reproduced.

Shop Process Cards

Shop Process Cards will be made available in the near future. These cards will contain minimal shop procedures. Clearances, tolerances, diagrams, and equipment required will be included. The Shop Process Cards will be arranged in a logical sequence to aid the Aircrew Survival Equipmentman.

SURVEY

To survey is to examine, inspect, or consider carefully. Therefore, survey boards are composed of an officer (or officers) appointed by the commanding officer to examine, inspect, or consider carefully the facts surrounding an accountable item which, for reasons of loss, damage, deterioration, or normal wear, must be expended from the records.

There are two types of surveys—formal and informal. The choice of survey to be used is designated by the systems command concerned with the item to be surveyed, or by the commanding officer. The formal survey is made by a commissioned officer appointed by the commanding officer, or by a survey board appointed by the commanding officer and consisting of three officers, one of whom must be a commissioned officer.

The custodian of an item to be surveyed prepares a written statement of the circumstances

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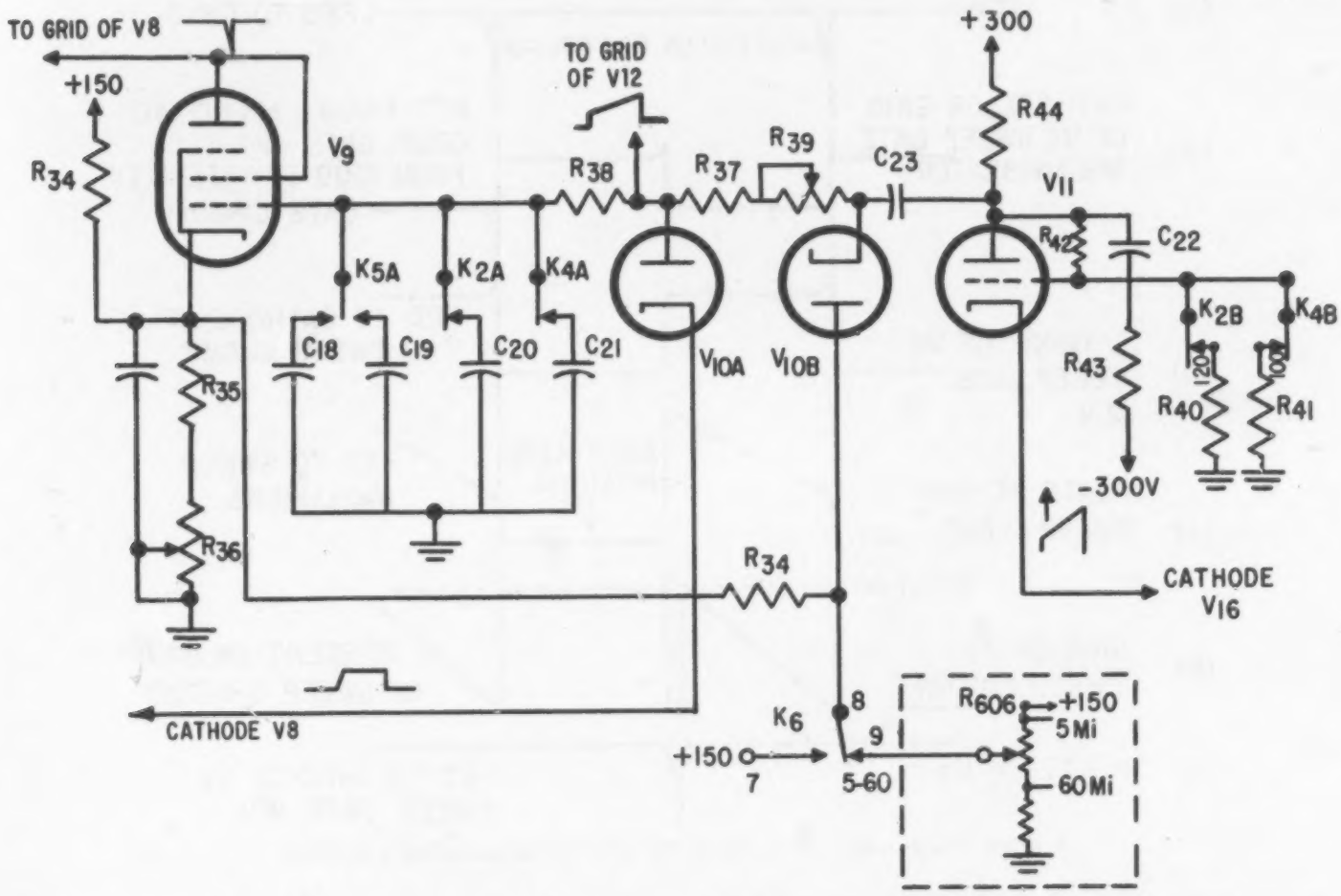

Figure 16-8.—Sweep clamp, shutoff, charging clamp, and bootstrap amplifier.

a time base for the measurement of range. However, this sawtooth must be amplified before it is applied to the deflection system of the indicator. The sweep amplifier circuits also provide a means of feedback to improve the linearity of the sweep voltage. The feedback voltage is taken from the sweep driver stage and fed to the bootstrap amplifier V11.

The basic circuits utilized in the sweep amplifier circuits are discussed in detail in Basic Electronics. Therefore, only the operation of the sweep amplifier and its waveforms are discussed. Figure 16-10 is an illustration of the waveforms throughout the sweep amplifying chain. Reference to waveforms illustrated are by number as shown. Figure 16-11 is the schematic of the sweep amplifying circuits and should be referred to for the following analysis.

As stated previously, the positive sawtooth on a pedestal is coupled directly from the plate of the sweep clamper V10A to the grid of the first sweep amplifier V12 (waveform (1), fig. 16-10). Note that the cathode of V12 is returned to ground through the sweep driver's cathode resistor. This provides degenerative feedback which improves the linearity of the amplifying circuits. This should not be confused with the feedback loop through the bootstrap amplifier to the sweep generator. Feedback within the sweep amplifiers aids in eliminating distortion that may be generated within the sweep amplifier circuits. The feedback voltage is illustrated by waveform (3). The relative amplitudes of the two signals applied to V12 should be noted. Thus, the output of V12, because of the feedback voltage, has been greatly reduced.

A linear negative sawtooth on a pedestal is coupled to the grid of the second sweep amplifier V13. The oscillation suppression circuit, consisting of C25 and R48 in the grid circuit of V13, acts as a low impedance path for high frequency oscillations. (NOTE: A sudden change in input voltage such as the trailing edge

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NAVAIR FORM 13480/1 (9-67)
S/N-0104 620 4810

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND

PARACHUTE RECORD CARD

TYPE NC-3R

SERIAL NO. 168800

DATE OF MANUFACTURE JUNE 1969

DATE ASSEMBLY PLACED IN SERVICE 12 AUG. 1969

FINAL STRIKING DATE FEB. 1978

DATE	PLACE	PACKER	Q.C.	REMARKS
12 Aug. 69	NAS MEMPHIS	N.D. WHITWORTH	R. STUBBS	

WHEN FILLED ATTACH TO PARACHUTE HISTORY CARD

C-5735

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Figure 4-2.—Parachute Record Card, NavAir 13480/1.

as known or suspected; then the division officer originates a rough Survey/Request, Report and Expenditure Form, NavSup 154, through normal channels. This request provides a record showing the cause, conditions, and responsibility for the survey, and recommendations for disposition and authority to expend the item or materials from the records.

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PARACHUTE SERIAL NO.	DATE OF MANUFACTURE	MANUFACTURER	CONTRACT NO.	TYPE
168714	March 68	Stenthal	N38399590-A	NC 3R
PART NUMBERS	CANOPY	HARNESS	PACK	PILOT CHUTE
	60A113650-1	605508-1	602817-1	603535-1

DATE PLACED IN SERVICE	AUTOMATIC ACTUATOR			
	DATE INSTALLED	SERIAL NO.	DATE INSTALLED	SERIAL NO.
2 Mar. 1968 NAS Memphis, Tenn.				

(This card shall accompany the above parachute when transferred for any purpose)

REPAIR/MODIFICATION AND CHANGE RECORD

BACSEB 26-54
CSEC 5 Rev. A

PARACHUTE HISTORY CARD NAVAIR FORM 13480/2 (8-67) 0102-620-4820 (over)

PARACHUTE HISTORY CARD NAVAIR FORM 13480/2 (8-67) (Back)

PARACHUTE PACKING RECORD

NO.	DATE	PLACE	PACKER	NO.	DATE	PLACE	PACKER
1	2/3/68	NAS Mphs.	E.L. Tolson	31			
2	4/7/68	NAS Mphs.	E.L. Turner	32			
3	8/11/68	NAS Mphs.	H. Neell	33			
4				34			
5				35			
6				36			
7				37			
8				38			
9				39			
10				40			
11				41			
12				42			
13				43			
14				44			
15				45			
16				46			
17				47			
18				48			
19				49			
20				50			
21				51			
22				52			
23				53			
24				54			
25				55			
26				56			
27				57			
28				58			
29				59			
30				60			

AUTOMATIC ACTUATOR CARTRIDGE INSTALLED

NO.	DATE	PLACE	PACKER	NO.	DATE	PLACE	PACKER
1				12			
2				13			
3				14			
4				15			
5				16			
6				17			
7				18			
8				19			
9				20			
10				21			
11				22			

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Figure 4-3.—Parachute History Card, NavAir 13480/2.

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CANOPY DAMAGE CHART
—FOR 24—FOOT AND 28-FOOT FLAT CANOPIES—

ACTIVITY NAS MEMPHIS, TENN.			DATE
DATE OF MANUFACTURE MARCH 1969	CONTRACT NO. N383-99590A	SERIAL NO. 168690	INSPECTOR (PRINT) S.R. HOBBS

INSTRUCTIONS

1. USE FOLLOWING SYMBOLS TO INDICATE LOCATION AND TYPE OF DAMAGE ON CANOPY DIAGRAM.

6	TEAR, 6—INCHES LONG
3 4	TEAR, "L" SHAPED WITH 3— AND 4— INCH LEGS
3 4	TEAR, "T" SHAPED WITH 4— INCH BASE AND 3—INCH LEG
8	RUPTURE, 8—INCH DIA AT WIDEST POINT
	BURN MARKS
	STRAINED AREA
	PULLED DRAG SURFACE THREAD

	SINGLE BROKEN DRAG SURFACE THREAD
#	WEAVE SEPARATION
S D	STAINS/DISCOLORATION
3	BROKEN SEAMS STITCHES ALONG 3 INCHES OF SEAM
	PULLED OR LOOPED SEAM THREAD
	OTHER DAMAGE: EXPLAIN

2. MARK DAMAGE USING SYMBOLS TO SHOW AREA AFFECTED.
3. CANOPY DIAGRAM CONTAINS 28 GORES FOR CANOPIES WHICH HAVE 24, DELETE EXTRA GORES IN DIAGRAM BY MARKING THEM "N/A" NOTE THAT 28— AND 24— FOOT DIA FLAT CANOPIES HAVE 28 AND 24 GORES RESPECTIVELY.
4. AS DAMAGE IS REPAIRED ON EACH GORE, PLACE SYMBOL "OK" ADJACENT TO SKIRT AT END OF EACH GORE.
5. 24—FOOT DIA CANOPIES MAY HAVE NAMEPLATE ON GORE 1 OR ON SKIRT HEM AT GORE 1.
6. 28—FOOT DIA CANOPIES HAVE NAMEPLATE ON GORE 28.

REMARKS: _____

THIS IS A PERMANENT RECORD. DO NOT DISCARD.
UPON COMPLETION OF REPAIRS, THIS CHART IS TO BE AFFIXED TO THE PARACHUTE HISTORY CARD. (FRONT)

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Figure 4-4. —Canopy Damage Chart for 24- and 28-foot diameter canopies (front).

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CANOPY DAMAGE CHART (REAR)

CANOPY DIAGRAM (TOP VIEW)

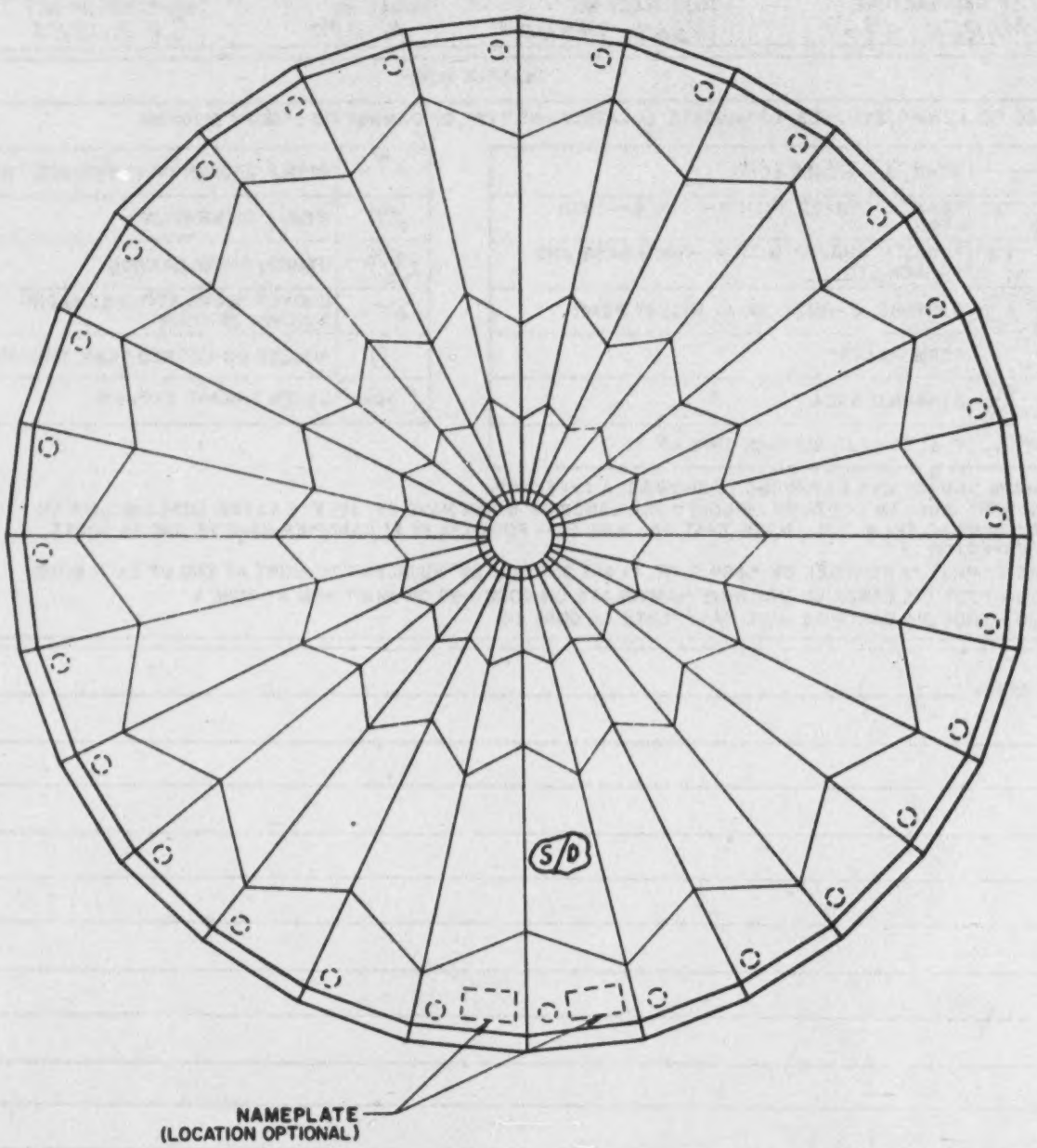

THIS IS A PERMANENT RECORD. DO NOT DISCARD.
UPON COMPLETION OF REPAIRS, THIS CHART IS TO BE AFFIXED TO THE PARACHUTE HISTORY CARD.

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Figure 4-4.—Canopy Damage Chart for 24- and 28-foot diameter canopies (rear)—Continued.

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CHAPTER 5

PARACHUTE PACKING AND RIGGING

Packing is more than a matter of inserting a canopy into its pack. It is a combination of rigging, inspecting, and packing. However, most of the inspection phases of the operation can be carried out independently. Thus, inspection was treated separately in the previous chapter. The perfect working of the parachute depends on the methods used in the rigging and packing processes, proper inspection, and configurations. If a thorough and reliable packing procedure is understood, the PR should be able to apply that knowledge to any type of parachute.

The beginner may take as long as 45 minutes to pack a parachute. A large part of that time will be spent on the stowage of suspension lines. After a few weeks practice, this time will shorten to an average of 20 minutes or less until peak performance is reached. Due to the uniform system taught to the Navy Aircrew Survival Equipmentman, any two men can soon work in harmony and form a good packing team. It should be kept in mind that speed is secondary to accuracy. A good Aircrew Survival Equipmentman will recognize his best packing speed consistent with quality and settle down to a good reliable pace that guarantees perfection. As each phase of the packing and rigging is completed, a collateral duty inspector must examine the finished work and verify correctness of the work.

RIGGING TOOLS

As a general rule, rigging a parachute in preparation for packing involves tacking various appendages and assemblies to the parachute. Making these tackings necessitates the use of several special type handtools common only to hand sewing.

The most useful of these—the sail needle—is used in passing the thread or cord through the materials being tacked. The difficulty encountered in passing the needle through the various weights and thicknesses of webbing, fabric, and/or canvas makes the use of other tools such as the awl, the sewing palm, and smooth-jawed pliers necessary in rigging a parachute for packing.

SAIL NEEDLES

The most distinctive feature of the sail needle is its broad, three-edged shape in relation to its size. Although the shape of the sail needle sometimes prevents its use in hard, closely woven fabrics, it is still the most useful hand sewing needle for parachute maintenance. It is the toughest needle available and will take a lot of rough use without breaking at the eye, as do many of the round needles.

Sail needles are issued in various numbered sizes. The larger the number, the finer the needle. The most popular sizes are the 14 and 16, shown in figure 5-1 along with the No. 10 size.

When selecting a needle for use, remember that the eye is intended to offer just enough resistance to the thread or cord to keep the needle in place and prevent it from sliding out of position. The cord or thread should pass freely through the eye of the needle. Difficulty is encountered in passing a needle through a piece of cloth when the needle is threaded with a cord too heavy for the eye. The choice of size therefore depends on the size of thread or cord to be used in sewing. An improper selection will interfere with speed and efficiency and increase the possibility of damaging the material.

SEWING PALM

The sewing palm is a small metal disk insert, stitched in a leather glove type device. It is designed to be worn in the palm of the hand

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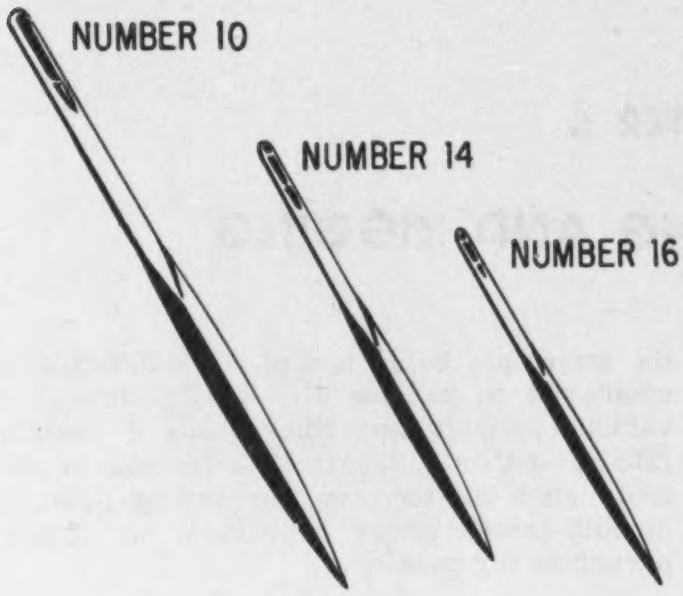

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Figure 5-1.—Sail needles.

and is used to aid in pushing a sail needle through the material being sewn or tacked. (See fig. 5-2 (K).)

AWL

The awl (I) is another instrument used as an aid in sewing heavy material where pushing the sail or hand sewing needle becomes difficult. It is a sharp pointed instrument, with a handle attached, used for punching holes in a fabric or material prior to inserting the needle.

PLIERS

Other tools which aid in hand sewing are pliers (H), either the needle-nosed or the combination slip-joint type. In either case they must by smooth jawed to prevent damage to the needle.

Among miscellaneous rigging tools needed in the parachute loft are a sharpening stone, for keeping needles, awls, and knives in tip-top condition; a knife for miscellaneous cutting jobs; and a soldering iron or other suitable instrument for searing nylon.

SPRING SCALE

The spring scale is an instrument used in the ripcord pull test. It measures and records the amount of force required to remove the ripcord pins from the locking cones. (See fig. 5-2 (N).)

All parachute assemblies are subjected to a ripcord pull test prior to being unpacked for inspection. The maximum pull force allowable is 27 pounds (60 pounds for the LW-3B assembly).

NOTE: Due to the employment of pyrotechnic devices on various assemblies, the following precautions are cited to insure safety of personnel performing inspection and maintenance operations:

1. NB-11 assembly: Carefully raise the folded canopy at the top end of the container, exposing the fail-safe ballistic spreading gun. Open the fasteners on the extractor sleeve and insert the safety pin in the gun.

2. NB-7E and LW-3B assemblies: Carefully remove the tacking from the static line cutter cover and slide back the cover. Insert the safety pin in the static line cutter.

3. NB-5, NB-6, NB-7, NB-7D, NB-7E, NB-8, NB-9, NB-10, NB-11, and NS-3 assemblies: These assemblies may employ cartridge operated actuators. Insure that the automatic actuator arming cable is not pulled while the actuator is armed. To dearm, open the actuator pocket slide fastener and base plate protector flap. Remove the actuator from the pocket. Remove the locking screw and slide the barrel, piston, and the receiver from the cover assembly. Hold the arming pin in position until the barrel and piston have been removed from the receiver. Remove the cartridge from the barrel immediately after the barrel and piston assembly are removed.

PACKING TOOLS

The packing tool kit (fig. 5-2) reveals a simple array of tools. The individual tools, while unimpressive in appearance, are quite specialized in application. These tools cannot be drawn from stock individually, but may be drawn through supply as a kit. Some of these tools may be made locally.

The long bar (A) is a bar of aluminum approximately 1 5/8 inches wide, 18 inches long, and one-fourth inch thick. The edge must be rounded and the entire surface smoothed and polished to prevent damage to the fabric of the canopy. It is used to make the folds in the canopy and to aid in smoothing out the pack.

The fid (B) can be made of aluminum or of wood. It is about 8 inches long and the same

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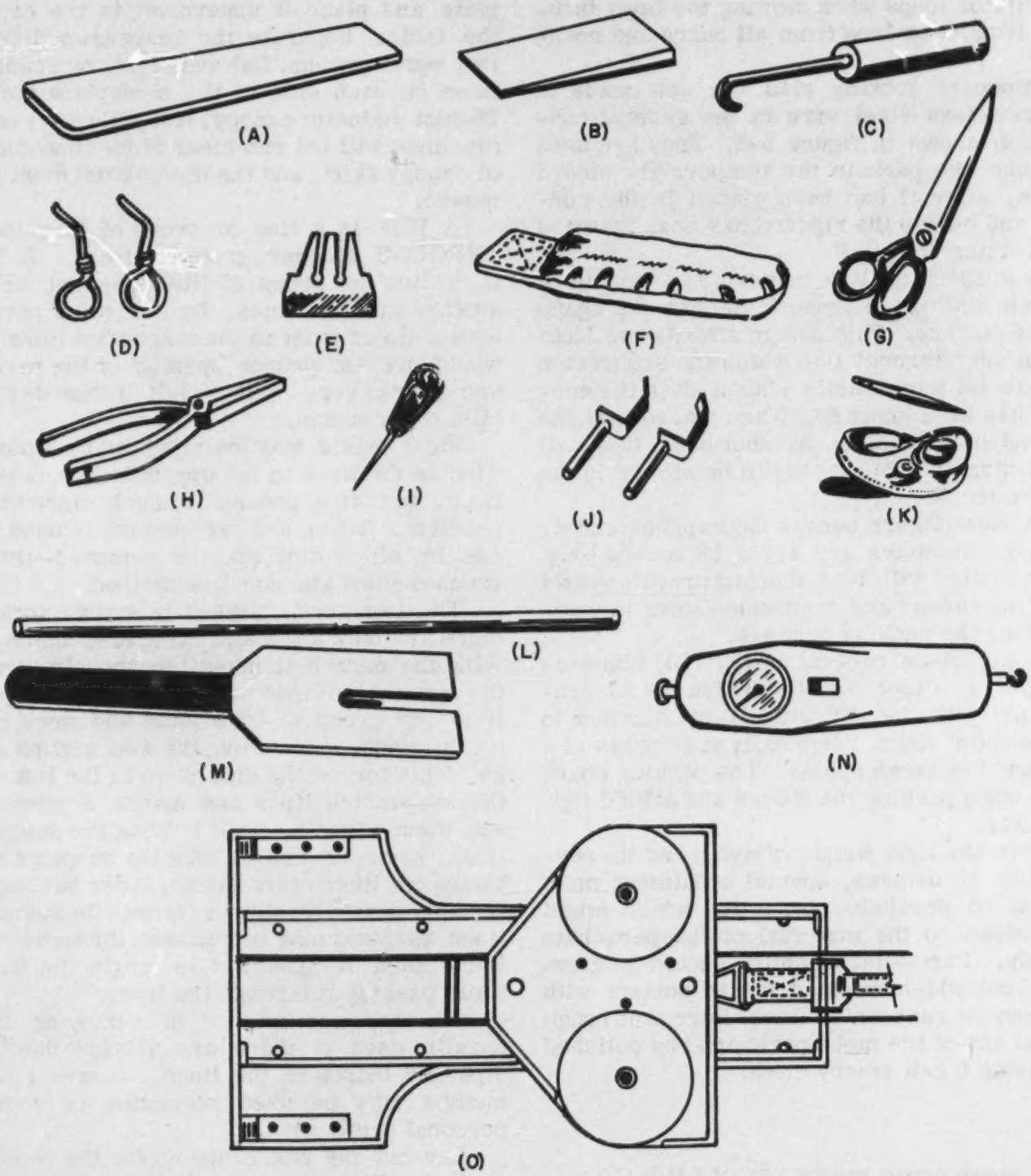

Figure 5-2.—Packing and service tools. (A) Long bar; (B) fid; (C) suspension line hook; (D) temporary locking pins; (E) suspension line holder; (F) shot bag; (G) shears; (H) pliers; (I) awl; (J) tension hooks; (K) sewing palm and needle; (L) pilot chute guide tube; (M) pilot chute locking pin plate; (N) spring scale; (O) parachute packing board.

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approximate width and thickness as the long bar. It is used in smoothing out the pack and tucking in the flaps.

The suspension line hook (C) is made of a suitable metal to give it the strength and durability needed to pull the suspension lines through the hesitator loops when stowing the lines in the pack. It must be free from all burrs and rough edges.

Temporary locking pins (D) are made of 0.080 stainless steel wire in the general configuration shown in figure 5-2. They are used to secure the pack in the temporarily closed position, after it has been placed in the container and before the ripcord has been inserted in the locking cones.

The suspension line holder (E) is made of aluminum and is designed in the general shape of three fingers. This design affords two slots between the "fingers" into which the suspension lines can be temporarily placed after the continuity has been checked. When placed in these slots and held in place by shot bags, they will remain straight until ready to be stowed in the hesitator loops.

Shot bags (F) are canvas bags approximately 1 inch in diameter and 16 to 18 inches long. They are filled with lead shot and provide weight to hold the canopy and suspension lines in position during the packing process.

The parachute packing board (O), shown in figure 5-2, is a tool used to tension the suspension lines with the antisquid lines attached to the connector links. Basically it consists of a board and two large spools. The packing board is used when packing the NES-8 and MBEU type parachutes.

Due to the light weight of nylon and its susceptibility to damage, special treatment must be given to preclude any action which might be injurious to the material of the parachute assembly. Particular attention should be given to any tool which might come in contact with the canopy or suspension lines. Burrs and rough areas on any of the metal parts must be polished down, using 0 grit emery cloth.

REMOVING SUSPENSION LINE ENTANGLEMENTS

Suspension line entanglements (dips and twists) are caused by the canopy or harness passing in between the suspension lines. In chapter 3 we studied the method of attaching the suspension lines to the links and in turn how the links are attached to the lift webs of the harness.

In separating the lines to check for dips and twists, first find the gore bearing the nameplate and place it uppermost in the center of the table. Separate the suspension lines into two equal groups, left and right, by counting 14 lines on each side of the nameplate gore of a 28-foot diameter canopy. If any lines are tangled, the lines will not run clear from connector link to canopy skirt, and the dip or twist must be removed.

A DIP is a line or group of lines passing THROUGH another group of lines. A TWIST is a line or group of lines passing AROUND another group of lines. Do not pack a parachute with a dip or twist in the suspension lines. This would prevent proper opening of the parachute and might very well result in the death of a pilot or crewman.

Most twists may be removed by simply unwinding the lines in the opposite direction of the twist, but dips present a much more difficult problem. There are two commonly used methods by which dips may be removed—the two-group method and one-line method.

The two-group method is satisfactory when there are only a few dips in the suspension lines. With the parachute hooked up loosely, separate the suspension lines at the skirt into two groups. Hold one group in each hand and work toward the harness, separating the two groups as you go. This forces the dips down to the link end of the suspension lines and makes it possible to see them clearly. Still holding the suspension lines, have the helper take the suspension line connector links off of the spreader bar and pass the harness and container through the suspension lines wherever one line passes through the rest. Care must be used not to tangle the harness while passing it through the lines.

The one-line method of removing dips is usually used if there are a large number of dips and twists in the lines. However, either method may be used according to your own personal preference.

Lay out the parachute as for the two-group method. Pick up either line No. 1 or line No. 28 and, while holding it loosely in one hand, walk toward the harness. With the other hand, form a loop of all the lines around the hand. Hold the single line and place all the lines that go over this over the arm and those that pass under the

line, under the arm. Pass the container and harness through the loop thus formed.

The last step in removing dips and twists from the suspension lines by either method is to check the lines for continuity. This is the only positive method of determining if the job has been properly done. To check the lines for continuity have the helper stand at the skirt hem and, starting with suspension line No. 1, lift the lines away from the group one at a time while checking the same line at the connector link to make sure that each line is in sequence.

CHAINING SUSPENSION LINES

Suspension lines are chained by tying a series of hitches to form a chain. Grasp the lines at a point near the skirt hem and make an overhand knot. Reach through the loop of this knot and grasp the lines again and pull them through the loop. This makes the first hitch. Tighten the loop of the first hitch and repeat the process of reaching through the loop of each successive hitch and pulling through another loop until the entire length of the suspension lines is chained. Pull all of the chained lines through the loop of the last hitch to complete the chain (See fig. 5-3.)

PR.147

Figure 5-3.—Steps in chaining suspension lines.

KNOTS USED IN PARACHUTE MAINTENANCE

In addition to the overhand knot used in chaining the suspension lines, PR's should learn to tie the half-hitch (a variation of the overhand knot). The half-hitch is used to make the ripcord safety tie and also used with the clove-hitch in securing the suspension lines to the connector links. Other knots which PR's need to know are the square knot, bowline knot, fisherman's knot, surgeon's knot, and lark's head knot.

The square knot may be used in most cases in which a knot is required and a particular knot is not specified. The bowline knot is used to secure the pilot chute connector cord to the apex of the parachute. The lark's head knot is used to attach the pilot chute connector cords on the MBEU assemblies. The fisherman's knot and the surgeon's knot are used in tying off various tackings on parachute harness and containers where a knot that will not slip is needed. (See fig. 5-4.)

HANDLING PACKED PARACHUTES

The most effective way to explain the subject of handling packed parachutes is to list a series of general rules in the form of DO's and DON'Ts.

1. Do not pick up a parachute by its lift webs or ripcord handgrip. Lift web tackings break relatively easy and when they do, the suspension lines are almost certain to become disarranged. Carrying or attempting to carry a parachute by its ripcord grip will always result in a premature opening.
2. Do not place a parachute near any source of heat. Heat will cause brittleness in nylon fabric.
3. Do not place a parachute in or near any source of dirt, grease, or oil. Stains can be extremely harmful to fabrics when they contain strong acids or alkalies.

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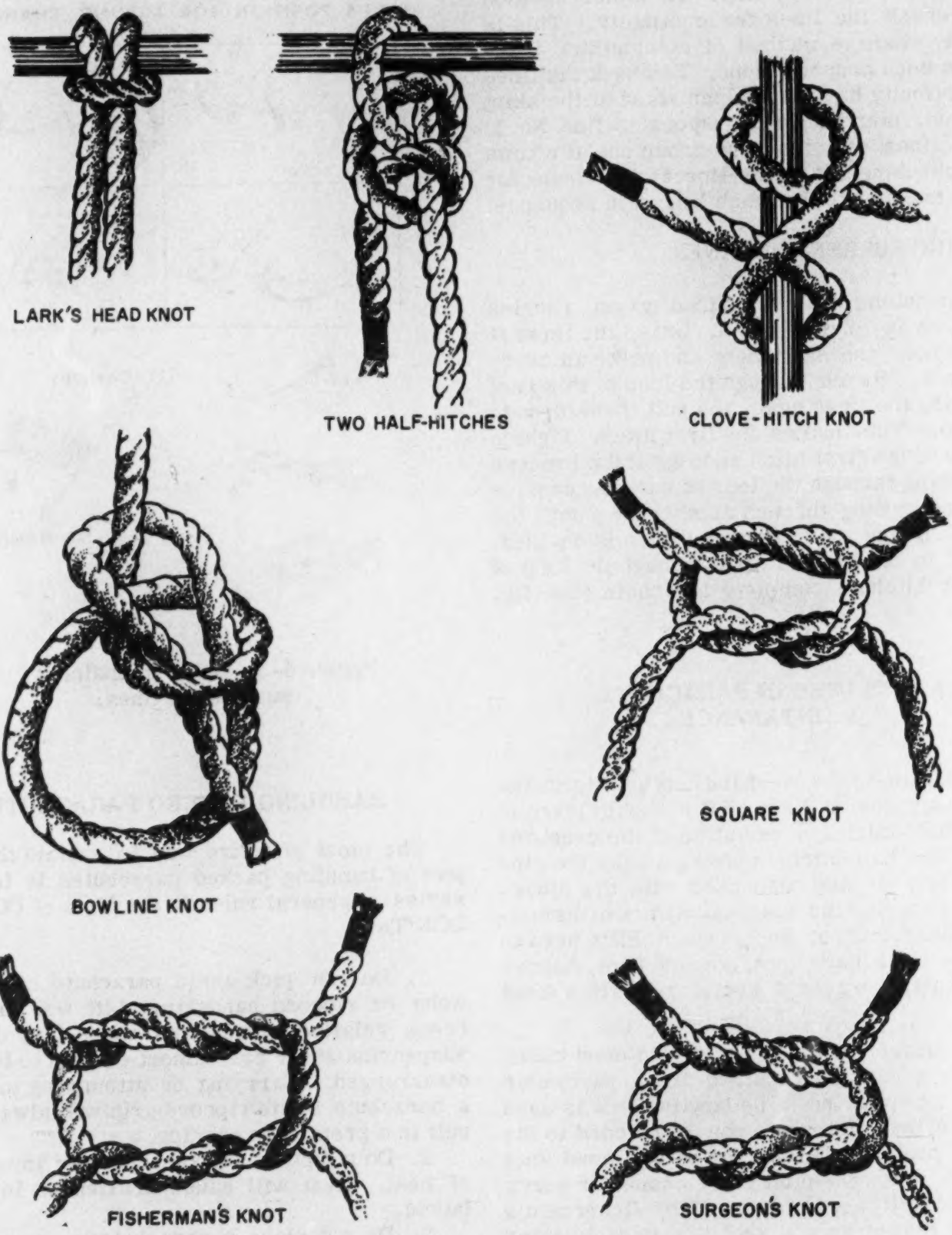

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Figure 5-4.—Knots and hitches used in parachute maintenance.

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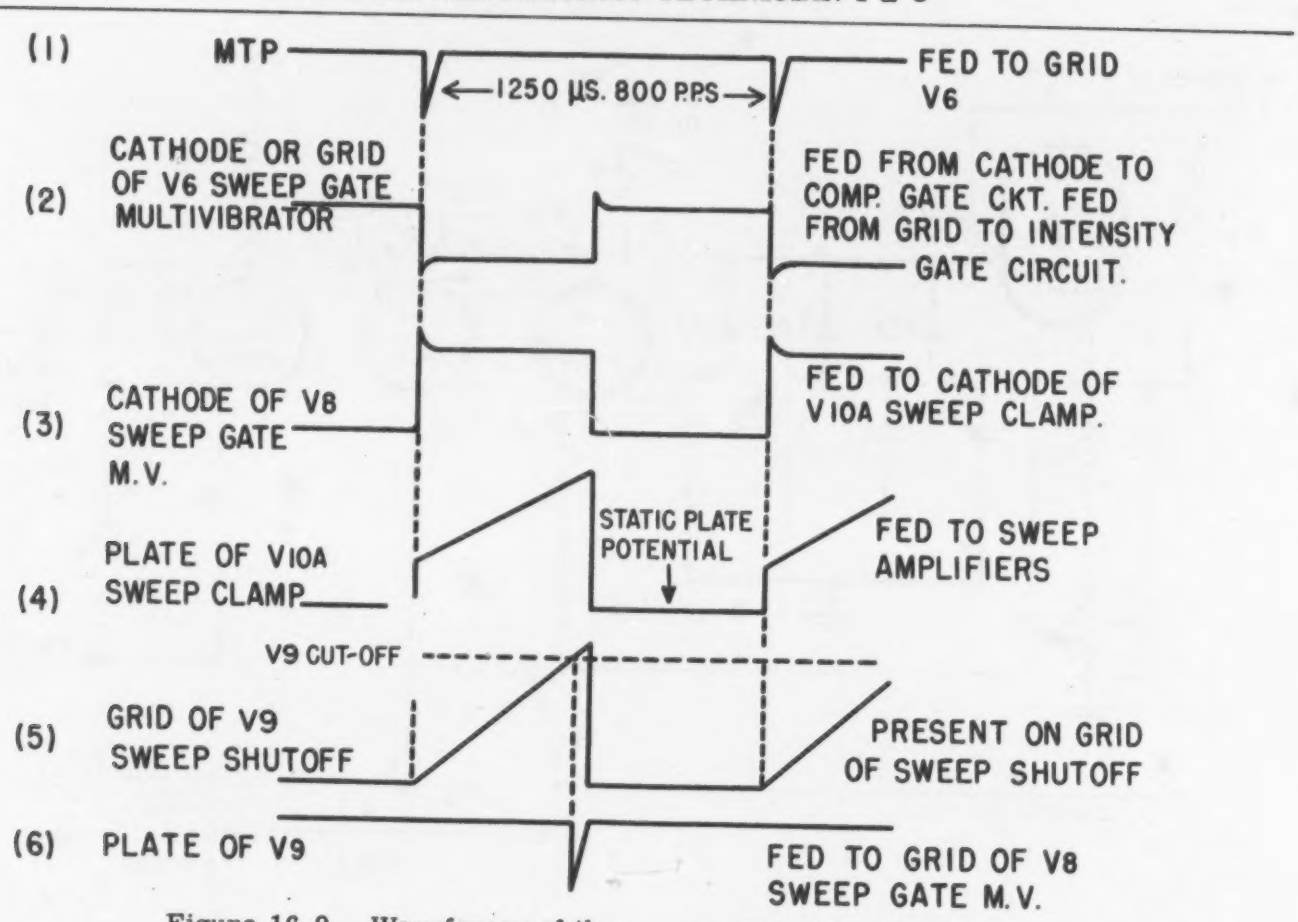

Figure 16-9. —Waveforms of the sweep generating circuits.

of waveform (1) may shock-excite an amplifier into oscillating.) The second sweep amplifier also amplifies and inverts the signal as shown by waveform (4). Its output, a positive sawtooth on a pedestal, is fed to the grid of the cathode follower V15.

The cathode follower is used to match the high impedance output of the second sweep amplifier to the low input impedance of the sweep driver. In static condition, V15 is biased negative by the voltage divider network in its grid circuit. However, with the plate of V15 connected to a positive 150 volts and its cathode connected through R53 to a negative 300 volts, it will conduct and bias V16 at approximately minus 40 volts. The diode V14A is used as a clamper to return the grid to its static potential following each sawtooth input.

The sweep driver receives the positive trapezoidal voltage (sawtooth on a pedestal) from the sweep cathode follower. As the slope of the waveform is reduced (longer ranges), the pedestal amplitude is also reduced.

The output transformer T2 is the plate load for the sweep driver. As shown in waveform (6), a linear positive sawtooth of current appears in its primary with each input. It is combined with a signal from the compensating gate driver which is discussed later in this chapter. Resistors R61 and R62 are in parallel with the primary of T2 and are used to dampen oscillations of the transformer. Degenerative feedback resulting from the unbypassed cathode resistor R56 also aids in reducing oscillations as well as providing a source of signal which is fed back to earlier stages. A sweep reference level signal is also fed from this point to the sweep compensating gate circuit.

Bootstrap Amplifier

Now that the basic operation of the sweep circuits has been discussed, the action of the bootstrap amplifier will be explained. For the following discussion refer to figure 16-8.

The input to the bootstrap amplifier (applied to the cathode) is a linear positive sawtooth voltage from the cathode of the sweep driver. The amplitude of the input signal is proportional to the output current of the sweep driver. The

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4. Do not drop a parachute. Dropping a parachute can bend or break the metal components and perhaps cause failure of the entire assembly.

5. Do not leave a parachute where it is likely to get wet.

6. Do not leave a parachute where heavy objects can be dropped or placed on it. Permitting a parachute to be carried in a cargo net along with squadron cruise boxes or similar gear displays poor handling techniques.

7. Use the chafing bag to cover the parachute when it is expected to be kept out of service for a considerable amount of time.

8 Use utmost caution when handling parachutes with installed cartridge activated devices.

9. Be prepared to give brief lectures instructing personnel on how to handle parachutes.

Figures 5-5 through 5-8 illustrate the best methods of carrying packed parachutes when rigged with and without the pararaft kit.

CHAFING BAGS

The parachute chafing bag, closed with two long slide fasteners, provides ample stowage portection for the parachute in a packed or unpacked condition. The slide fasteners, when opened, offer a large cavity capable of receiving most parachutes. The basic rules for stowing a parachute in the chafing bag are:

1. Chain the suspension lines.
2. Place the harness in the bag first.
3. Let the pack act as the separator between the canopy and hardware.
4. Accordion pleat the canopy into the bag.
5. When appropriate, and for very short periods in transit, compress the pilot chute into the bag, using the side as a backstop for the top of the pilot chute. Otherwise, disengage the pilot chute and stow separately.
6. Be careful when closing the bag and do not catch the canopy fabric in the slide fasteners.
7. Do not stow the bag directly on the floor.
8. Make certain that the bag is properly stenciled or tagged for identification purposes.

SHIPPING CANS

Parachutes are shipped from the manufacturer in sealed cans and may remain in the shipping can as long as they are not bent,

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Figure 5-5.—Method of carrying the chest type parachute with or without the pararaft kit.

PR.150

Figure 5-6.—Method of carrying the seat type parachute when rigged with or without the pararaft kit.

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PR.151

Figure 5-7.—Method of carrying the back type parachute without the pararaft kit.

PR.152

Figure 5-8.—Method of carrying the back type parachute when rigged with the pararaft kit.

crushed, or ruptured. Once the can is opened and the plastic liner is broken, the parachute should be placed in service, or placed in a chafing bag for stowage.

SAFETY PRECAUTIONS

Extra care must be given to the handling of packed parachutes, especially on the flight line. Instruction of squadron personnel in proper handling techniques is the responsibility of the PR.

Extra instruction should be directed to plane captains since they are required to handle parachutes frequently. The following are some of the precautions which should be observed by all personnel handling parachutes:

Parachutes should not be hauled around on dirty bomb trucks, trailers, and the like.

Parachutes should not be placed on the wing or tail surfaces of aircraft. They should be placed immediately in the seat or other storage space in the aircraft. Parachutes must never be placed in a wet seat.

Seat type parachutes should be carried over the shoulder, with the hand through the grip, locking it in its pocket as shown in figure 5-6.

CHAPTER 6

PACKING AND RIGGING THE CHEST TYPE PARACHUTE

The NC-3 personnel parachute assembly is a chest type parachute used primarily in transport and patrol type aircraft. The advantage of the NC-3 in these types of aircraft is mobility, as aircrewmen ordinarily wear only the harness during flight. With the quick-fit harness, aircrewmen can be ready for bailout in a matter of seconds.

The NC-3 parachute assembly includes a 28-foot diameter, flat, circular, nylon canopy with 28 gores. The canopy is packed in a container assembly secured to the aircrewman's chest by means of a harness assembly.

Two different configurations of the NC-3 parachute are in service. These configurations are (1) the basic NC-3 assembly; and (2) the NC-3 assembly with the standard soft pack attached.

The standard soft pack is one of several types of packaged LR-1 life rafts.

RIGGING THE BASIC NC-3 ASSEMBLY

At the time of issue, the NC-3 parachute assembly must be rigged as described in the following paragraphs. Subsequent rigging of the NC-3 assembly must be accomplished in the same sequence, omitting the nonrequired steps. It is not always necessary to break and remake the tackings that go together in the rigging of certain appendages.

INITIAL PREPARATION

Lay out on the packing table all required packing tools, inspect the packing tools for serviceability, and count and record the number of packing tools to be used.

Lay out the parachute canopy full length on a clean packing table. Position the canopy gore containing the nameplate uppermost in the center of the packing table. Separate the suspension lines into two groups, counting 14 lines on each side of the nameplate gore. If necessary, attach the pilot parachute to the canopy peak using 1,000 pound tubular nylon, 1/2 inch width. Measure and cut the pilot parachute connector cord to a starting length of 42 1/2 to 43 1/2 inches; the tied off, finished length must be 21 to 22 inches.

Arrange the two groups of 14 suspension lines on each side of the nameplate gore in accordance with figure 6-1 as viewed from the connector links. The numbers in figure 6-1 illustrate the location and orientation of the suspension lines when attached to the skirt hem and the connector links.

Place the connector link holding suspension lines 1 through 7 on top of the connector link holding the suspension lines 8 through 14. Place the connector link holding the suspension lines 22 through 28 on top of the connector link holding the suspension lines 15 through 21. Connect these two groups of connector links to their respective tension hooks on the packing table.

NOTE: The knurled portions of the connector link yoke and plate assemblies must face up and the screwheads must face outboard.

ATTACHMENT OF BACK CUSHION TO THE HARNESS ASSEMBLY

Lay out the harness assembly on the packing table, oriented in such a way that the wearer would be facing down on the packing table with his head towards the canopy, and position the back cushion underneath with the keepers released. Secure the diagonal backstraps under the upper corner keepers and the horizontal backstrap under the two bottom center keepers.

SUSPENSION LINE CONTINUITY CHECK

Attach a tension strap at the canopy vent lines and tighten. When viewed from the riser

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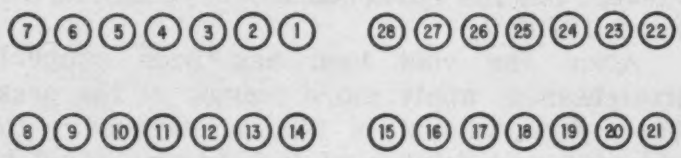

PR.153

Figure 6-1.—Arrangement of the suspension lines on the connector links and the canopy skirt hem.

end of the packing table, the suspension lines must be arranged on the skirt hem and the connector links as shown in figure 6-1. The suspension lines must run free from the skirt hem to the connector links without dips or twists.

The packer must start with suspension line number 1 on the left side of the nameplate gore and work through line 14. The helper must be positioned at the connector links to check continuity of the suspension line selected by the packer. The same procedure is used on the right side of the nameplate gore except that the packer must start with line number 28 and work through line number 15.

ATTACHMENT OF CONNECTOR LINKS TO THE RISER ASSEMBLY

Position the riser assembly at the connector link end of the suspension lines. The spring loaded levers of the quick connector snaps must face up and the corresponding lift webs must be placed on top of each other.

Remove the connector link yoke and plate assemblies. Insert the bottom connector links into the bottom lift web loops and the top connector links into the top lift web loops. Reattach the yoke and plate assemblies and tighten screws to a torque value of 20 to 25 inch pounds.

ATTACHMENT OF THE PARACHUTE CONTAINER TO THE RISER ASSEMBLY

Position the container under the riser assembly, with the inside facing the packing table and the ripcord pin protector flap facing the canopy. The riser assembly cross connector strap must be positioned on top of the container, just inside the container frame, with the spring-loaded levers of the quick-connector snaps turned away from the container.

The NC-3 lift web assembly tacking must be very strongly made to hold the pack securely while the parachute is being worn and at the crucial time of egress from the aircraft. This tacking must be drawn up tightly to prevent slippage during hookup to the harness.

To make the tacking, position the container on the end with the side flap with locking cones on the table and the lift webs inserted through the slots on the upper edge of the container.

With the container and the riser in position, connect the container and riser as shown in figure 6-2.

Tack the quick connector snaps to the container bottom using waxed nylon 6-cord, doubled. Tie a simple overhand knot in the end of the cord to anchor when starting the tracking.

Starting from the inside of the container (1), butterfly tack through the left webs and around the snap slot at one side of the shank (2), around the snap hook (3, 4), through the inside of the container, and around the snap slot at the opposite side of the shank (5, 6). Pull the thread tight and tie off the ends with a surgeon's knot followed by a square knot, ending on the inside of the container.

PACKING THE NC-3

After the parachute has been inspected and all discrepancies corrected as outlined in chapter 4, then aired and dried as described in chapter 5, it is ready to be repacked.

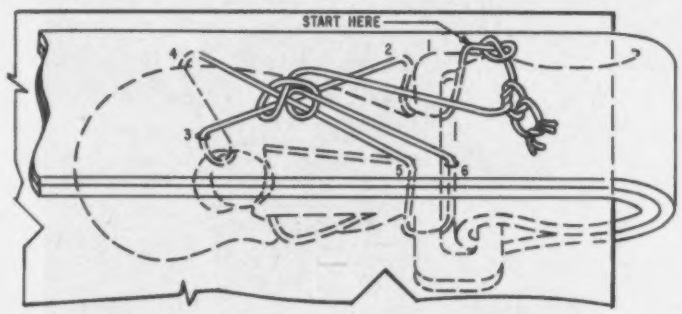

1. Container.
2. Shank.
3 & 4. Snap hooks.
5 & 6. Snap slots.

PR.154

Figure 6-2.—Lift web tacking to the NC-3 parachute container.

The first step is to dust off the packing table. Then, grasp the lift web section and hold it at the packing end of the table while the helper pulls the apex of the canopy toward the opposite end. This will remove the chaining from the suspension lines and stretch the chute to its full extent on the table.

Remove dips and/or twists from suspension lines and lift web assembly. Attach connector links to the tensioning hooks (on the packing end of the table) and engage the hook at the opposite end of the table into the loop of the pilot chute connector cord at the point of encirclement of the suspension lines. (See fig. 6-3.)

Apply only enough tension at the peak to straighten the chute out on the table. The helper should then straighten the vent hem by entwining his fingers through the suspension lines and working them (the lines) back and forth through the loop in the pilot chute connector cord until the vent hem is straight. Manipulating the vent hem in this manner will usually straighten both vent hem and skirt hem.

NOTE: It is very difficult to straighten a vent hem when too much tension has been applied.

Check the information found on the nameplate of the canopy and compare with that found on the Parachute Record Card, NavAir Form 13480/1 and the Parachute History Card, NavAir Form 13480/2.

After the vent hem has been properly straightened, apply more tension at the peak. The exact amount of tension necessary for whipping and folding of the canopy cannot be measured, since the tension varies with the personal wishes of the packer. The chute should be tight enough to draw the suspension lines to the center of the table, but not so tight as to be difficult to hold up to shoulder level while whipping and folding the canopy. (See fig. 6-4.) Both members of the packing team should be able to see the entire gore on the inside when the suspension lines are held at shoulder level. This is an instance in which personal experience is necessary to find the tension which suits you most. Practice packing (especially stowing suspension lines and whipping and folding the canopy) until you develop skill and dexterity of movement.

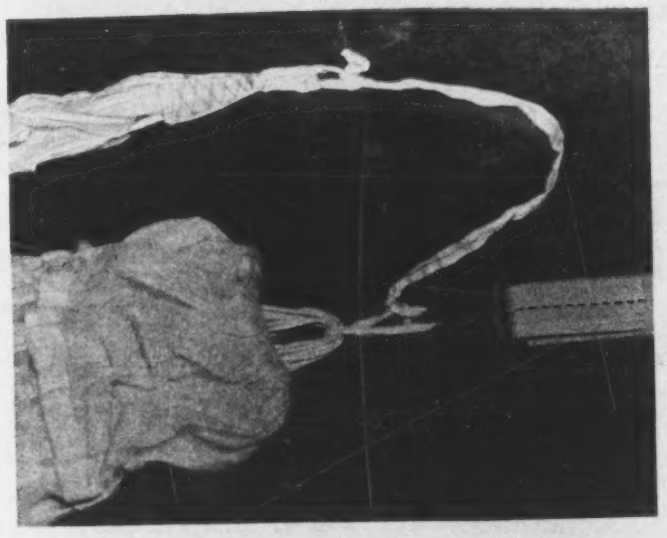

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Figure 6-3.—Attaching peak of canopy to tensioning device. Do not attach tensioning hook to the suspension lines. This could cause damage to the lines.

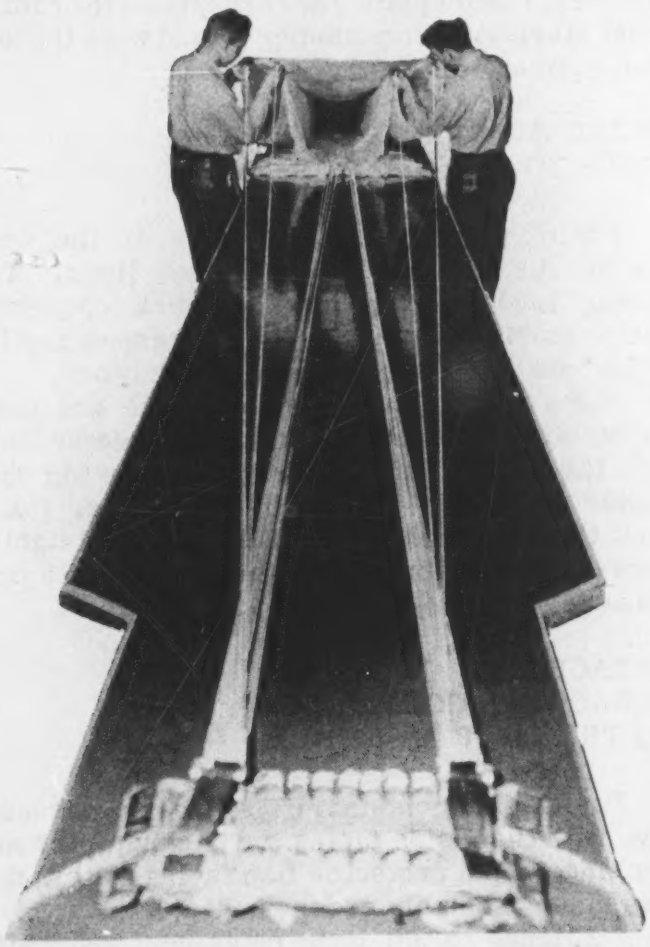

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Figure 6-4.—NC-3 under tension and ready for whipping and folding.

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The next step is to whip and fold the canopy. The packer and helper should work simultaneously from opposite sides of the table at the skirt hem. In beginning the whipping and folding, grasp the two top inboard lines and look back to the links to make sure that the lines are free and clear of entanglements. Raise the lines to a level where the inside of the canopy can be clearly observed to the peak. Visually follow the skirt hem to the next suspension line. Pick up this line and swing it in a wide arc toward the person on the opposite side of the table, bringing it up to shoulder level and holding it in this position. Look down this line on the inside of the canopy to the peak and make sure that no folds from the previous gore have overlapped the suspension line in view. Repeat this process throughout the canopy until each gore is folded in half and each suspension line is held in place in its proper rotation. Fold each gore until all lines have been taken up by the packing team. When these folds have been made, there will be two gores remaining between the two sets of suspension lines which have not been folded. Stretch the two sets of lines to the outermost edges of the packing table, as shown in figure 6-5. Each member of the packing team should grasp all of the folds at their outer edge and grip them firmly. While holding the suspension lines at the edge of the table, move the folds up and down rapidly in a whipping motion. This motion will assure that most of the wrinkles put into the fabric by the folding action are removed.

To make the last two folds, the packer reaches over the suspension lines with his left hand and grasps the center of the top gore, while the helper reaches underneath the lines with his right hand and catches the center of the bottom gore. On a signal, both packer and helper swing their group of suspension lines in an arc toward the center of the table (the packer arcs downward and the helper upward) while at the same time pulling the top and bottom gores to the outer edges of the table. (See fig. 6-6.)

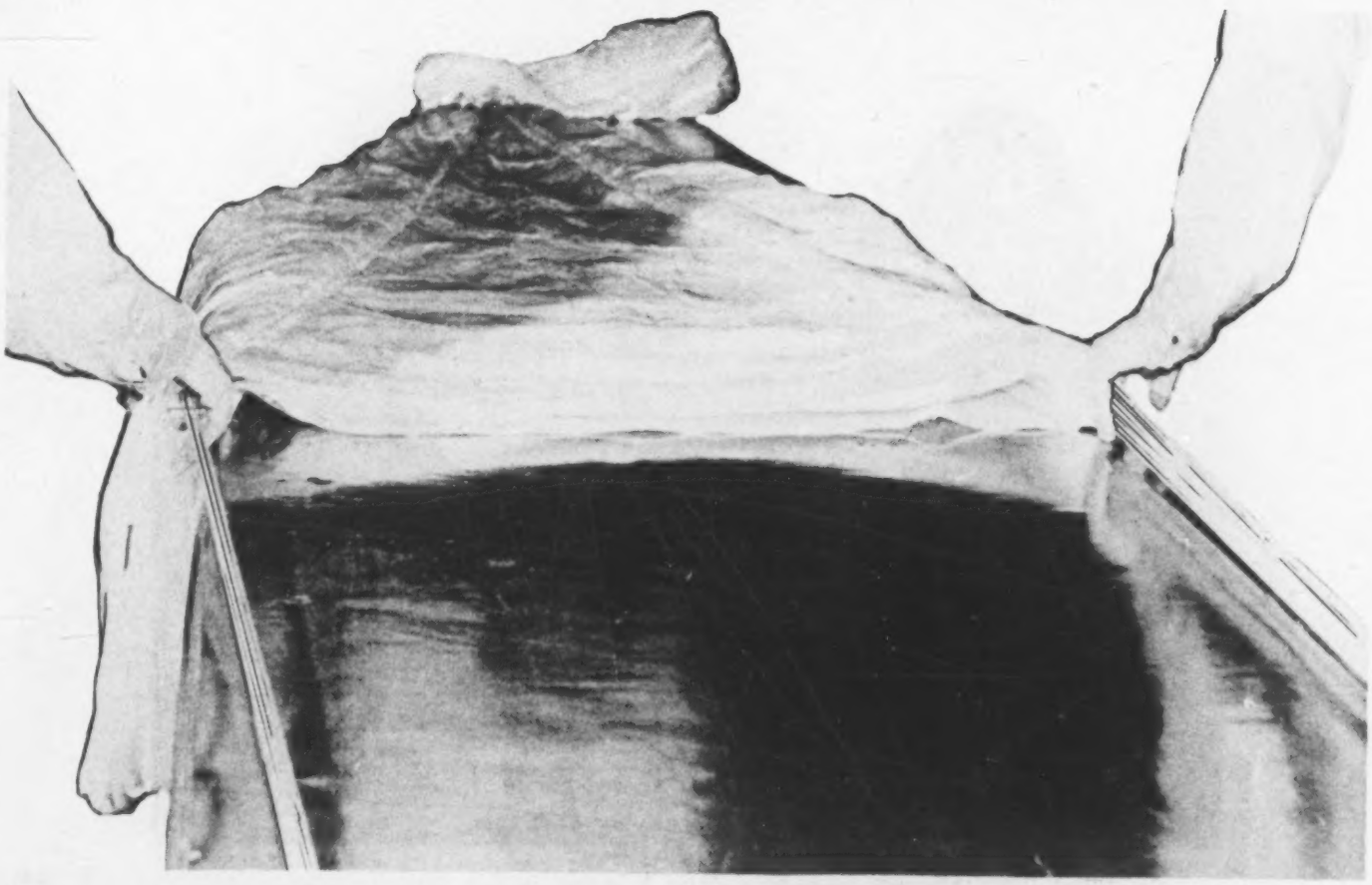

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Figure 6-5.—Suspension lines stretched to outer edge of table in preparation for whipping the folds.

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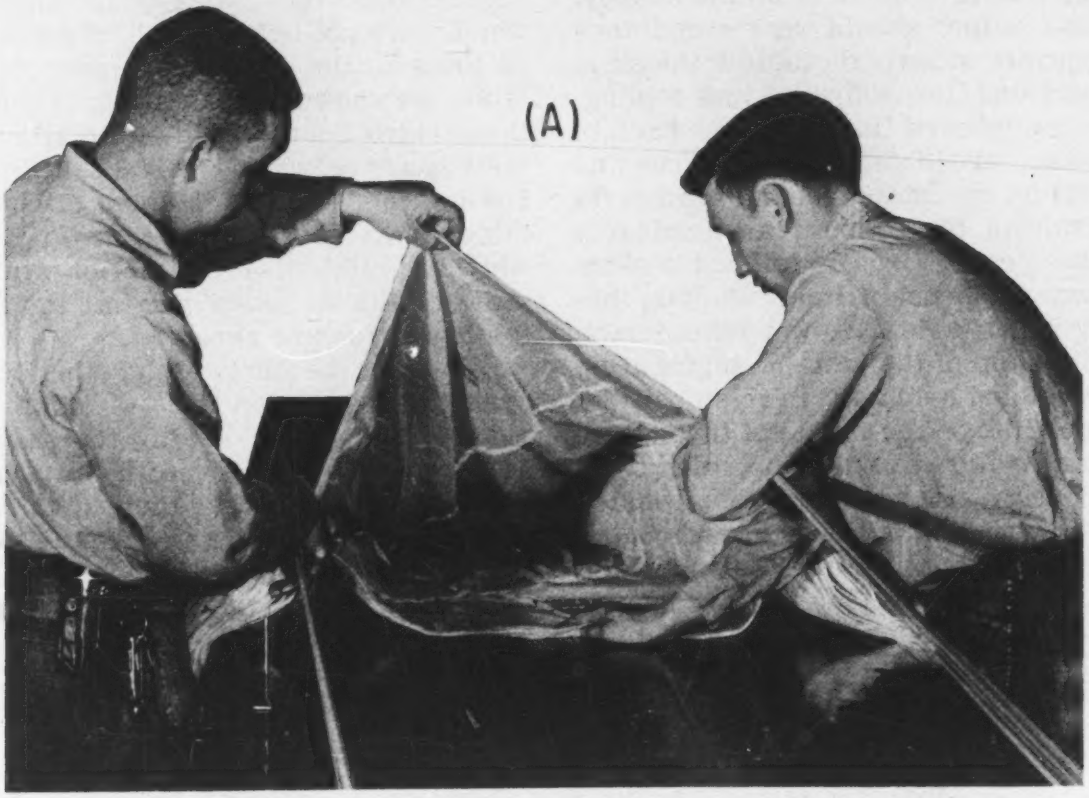

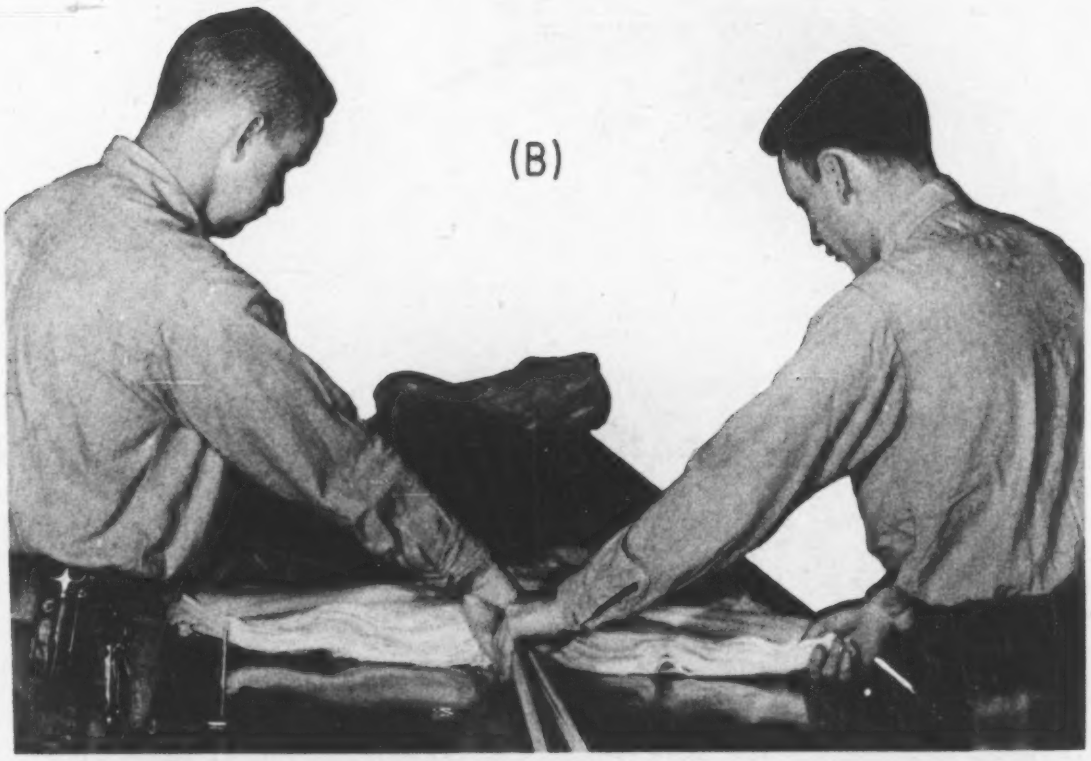

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Figure 6-6.—Completing last two folds of canopy.(A) Gores being grasped in the center prior to moving suspension lines to center of table. (B) Lines brought to the center and skirt hem folds brought out in the opposite direction.

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The last fold on the helper's side is made on the bottom of the other folds. It therefore requires special attention in straightening all wrinkles from skirt to peak.

Insert the suspension lines in the slots of the suspension line holder and place a shot bag across the lines to hold them in place. The lines may now be released by both packer and helper. Place a shot bag on the folds of the canopy on the packer's side. Whip all of the folds on the helper's side to the packer's side, except the bottom one. The packer should remain at the skirt hem to hold the folds and suspension lines in position while the helper (starting at the skirt hem) pulls the bottom fold out to its proper position throughout the length of the canopy. NOTE: Do not pull or brush too hard on this fold, or the opposite fold may be disturbed. When the helper reaches the peak, the packer then flips all of the folds, positioned above the shot bag, back to their original position on top of the bottom fold on the helper's side of the table. The helper then proceeds to brush out any remaining wrinkles in the folded canopy.

Figure 6-7 illustrates the method of folding the skirt hem back in preparation for straightening, and figure 6-8 shows the method of straightening.

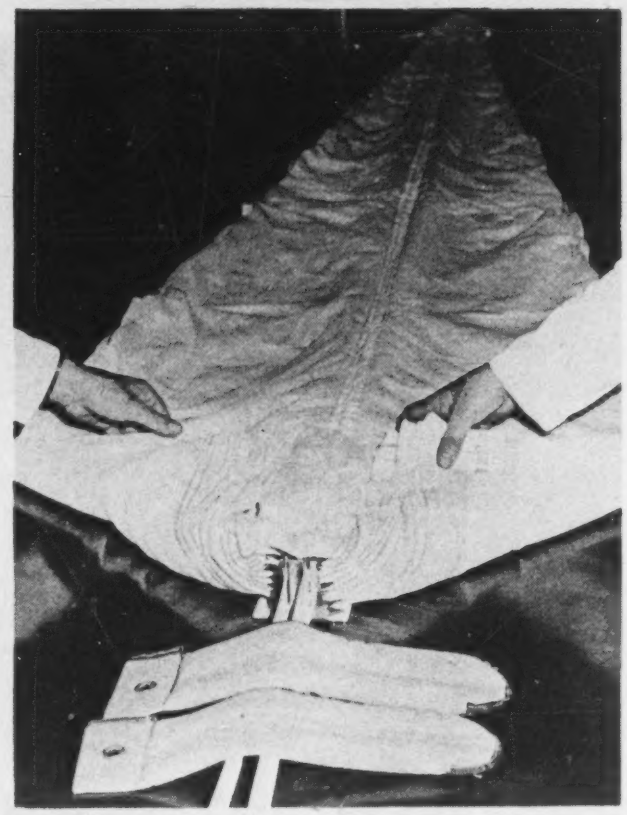

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Figure 6-7.—Folding the skirt hem in preparation for straightening. Before attempting to straighten the skirt hem, grasp the folds of the skirt at the corners and fold them back out of the way.

Before stowing the suspension lines the canopy must be folded as shown in figure 6-9.

The packer should sign inside Parachute Record Card while the helper releases the tension at the peak very slowly and carefully. A sudden release might disturb the canopy folds. Unhook the hooks, or tensioning device, from the connector links and prepare to stow the suspension lines. Place pilot chute on top of canopy. This prevents it from falling off the table while stowing lines.

The pack should be as level as possible on the table to provide an even working area when packing the chute. It can be leveled by inserting a wooden leveling block or an old foam rubber seat cushion under the pack and tucking the flaps in around it to hold it in place. By having this added elevation, the packing hook is easier to manipulate and the lines are easier to stow in the hesitator loops.

Stowing suspension lines consumes more time than any other step in the packing process, because they must be stowed as straight as possible and absolutely free of twists and entanglements. Stowing them properly requires deft, decisive movements and skill, acquired only by diligent practice. Suspension lines become entangled very easily; therefore, extra caution must be used when stowing to keep them running straight and without tangles between the loops. The shot bags are left on the canopy while stowing the lines. This, coupled with drawing only enough line to form the bight being taken, keeps enough tension on the lines to aid in keeping the lines straight.

Once the hook is engaged in drawing a bight of the lines through a hesitator loop, do not permit the tip to lose contact with the bottom of the pack. This action will prevent "dropping" a line, which could cause a "line-over" during a descent.

The packer stows the lines while the helper holds the pack steady in the center of the table and assists with the stowing by holding the bights of the suspension lines in place as they are stowed. The proper method of stowing suspension lines is illustrated in figures 6-10 and 6-11. When making the first bight, bring the

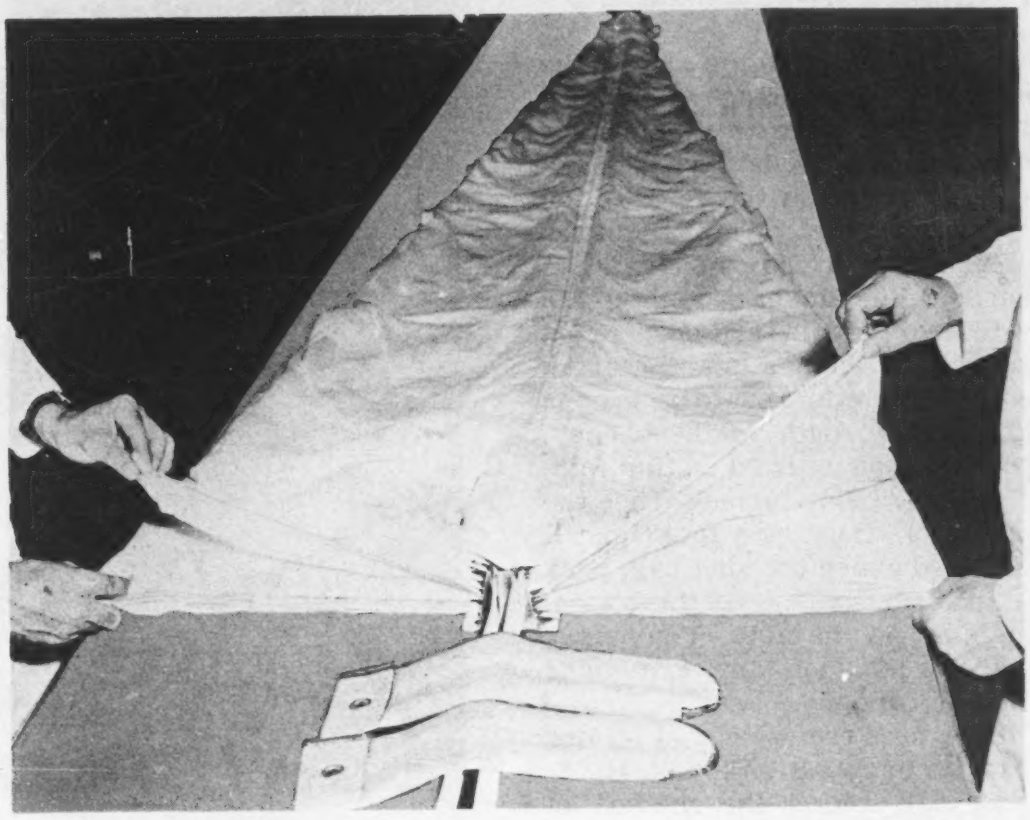

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Figure 6-8.—Straightening skirt hem. Aline each fold one upon the other until all are nearly in place. Count the folds while straightening to be sure that an equal number of folds fall on each side of the suspension lines.

lines up to the first hesitator loop. This is the loop nearest the helper's left hand when he is in position for packing. Insert a packing hook through the loop from the outside edge of the pack. Engage the hook in the lines and draw them through the loop. The completed bight should extend about 1 inch beyond the loop.

The second bight is made by inserting the packing hook in the hesitator loop directly opposite the first, then carefully estimating the amount of suspension lines needed to make the bight and grasping the lines at this point. Without twisting the lines, lay them up on the container and engage the hook at the point decided in your estimate of length. Pull this bight through the loop. Repeat this process of inserting the bights of lines alternately from one side to the other until all 16 hesitator loops are filled.

After the last bight has been placed in the hesitator loops, check for twists and dropped lines. Remove all wrinkles from the hesitator loops, using the temporary locking pins as a straightening tool. There should be 15 (±3) inches of line remaining between the skirt hem and the last bight taken. This line permits bringing the skirt up to the far edge of the pack. (See fig. 6-12.)

Proceed with the packing operation as illustrated in figures 6-13 through 6-26.

Caution the helper not to hold down or draw back on the long bar while bringing the skirt up on the pack, but to follow the motion of the lines. Holding down or drawing back will cause the skirt to tuck under and may pull the last bight of suspension lines out of the hesitator loop.

When the helper is certain that the skirt is in position at the edge of the pack and the suspension lines have not been disturbed, he withdraws the long bar and places it on top of the folded canopy in preparation for the next fold. The packer checks the long bar position for alinement. The bar is held to produce a clean fold over the edge of the frame. If the bar is held out too far from

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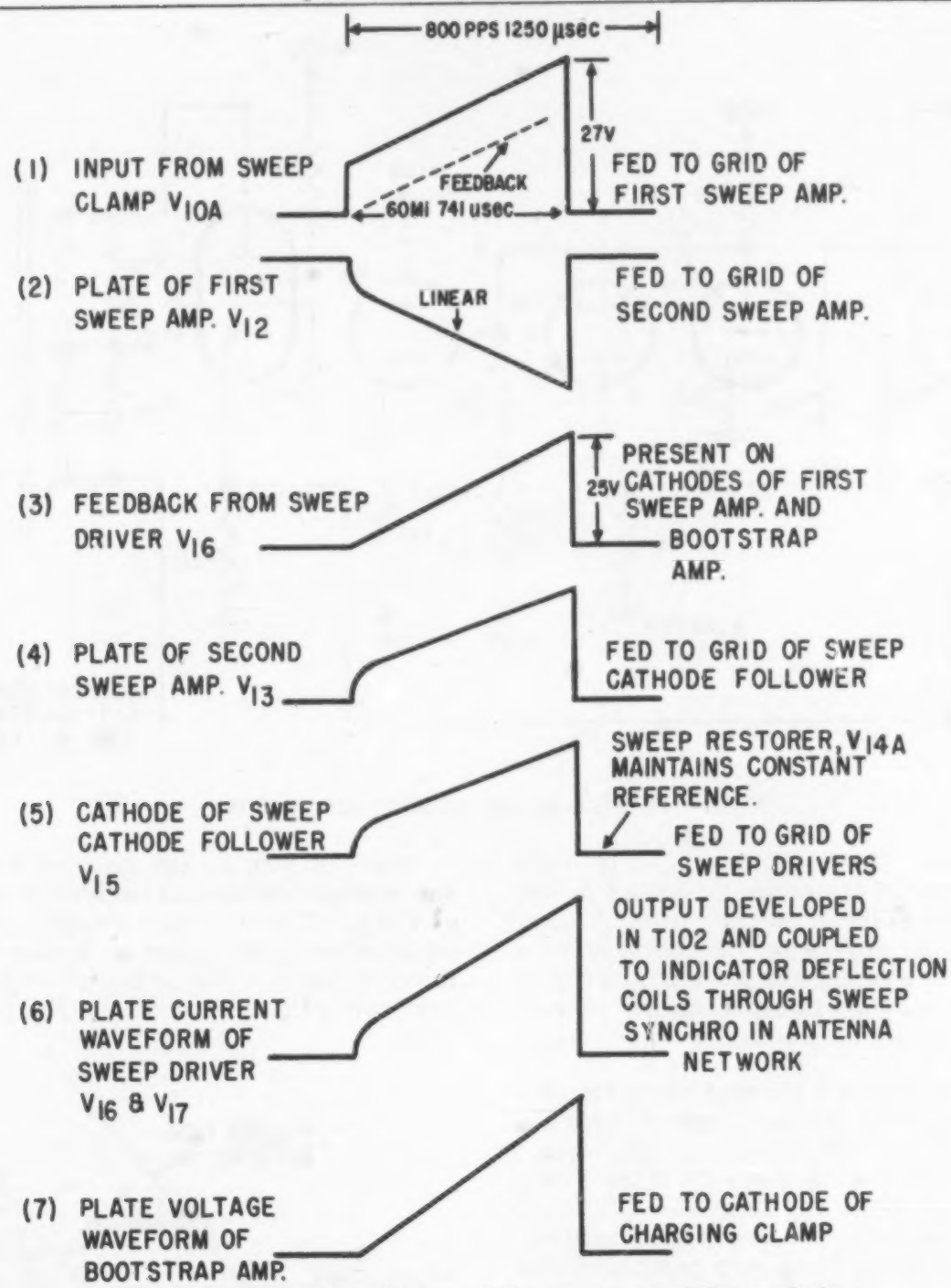

Figure 16-10. —Waveforms of the sweep amplifying chain.

output of the bootstrap amplifier is also a positive sawtooth voltage which is slightly greater in amplitude than its input signal. This output is coupled to the sweep generating circuit through C23.

In explaining the operation of the sweep generating circuit, it was stated that the charge path of the sweep capacitors was through V10B and relay K6 to the voltage source. This statement is not true when considering the operation of the bootstrap amplifier. Since coupling capacitor C23 plays an important part in the operation of the circuit, consider in detail its static condition. The left plate of C23 is connected to the cathode of V10B and will be at plus 150 volts on all but the 5-60 mile range. The right plate is connected to the plate of V11 which is at approximately plus 80 volts during

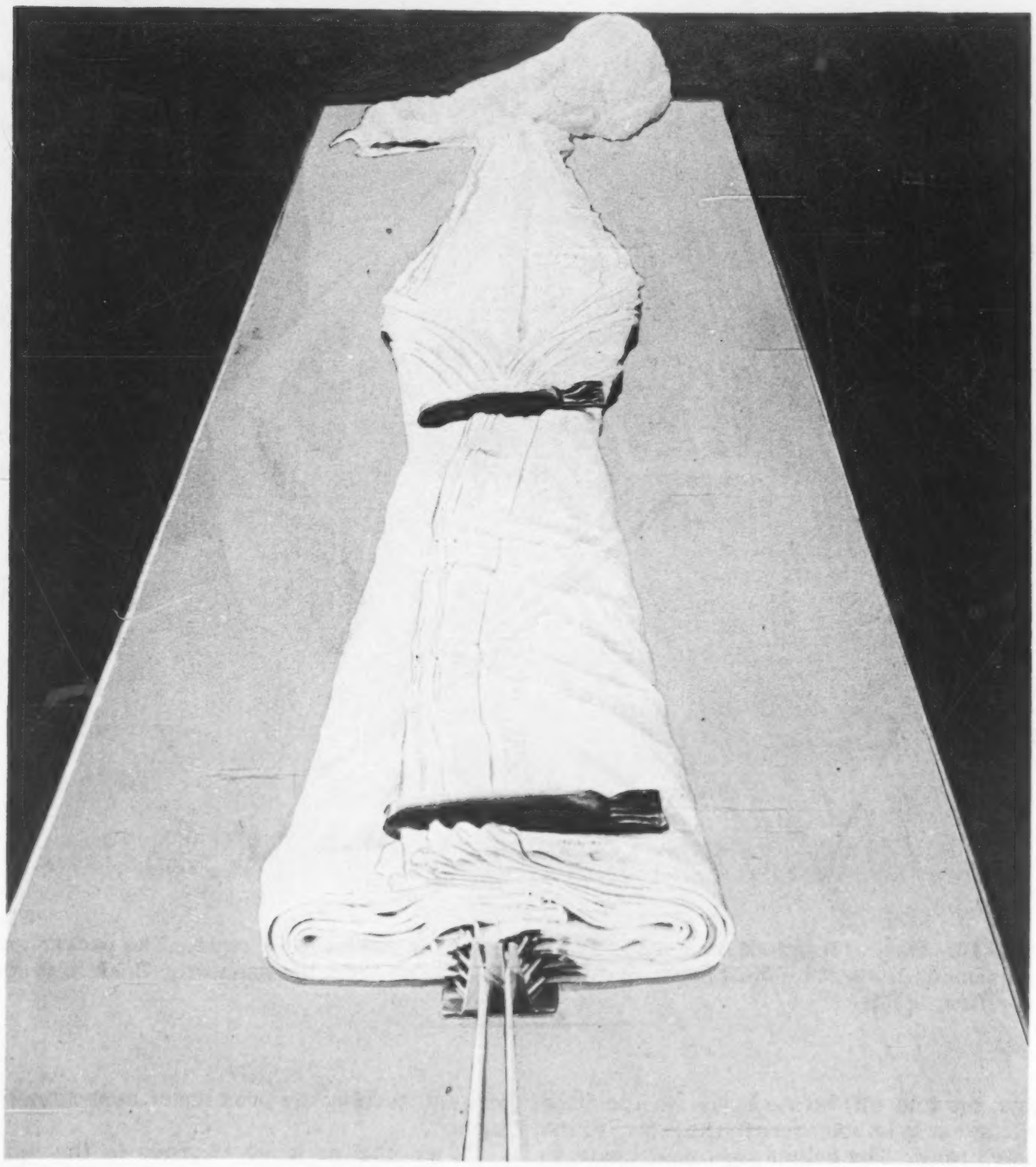

PR.161

Figure 6-9.—Canopy folded to proper width for making accordion folds into parachute pack. Remove the shot bag from suspension lines and fold the outer edges of the folds in the canopy equally in toward the center to an approximate width of 19 to 20 inches. The canopy is folded lengthwise in thirds, to a point approximately two-thirds up the canopy, measuring from the skirt hem. Place the shot bags on the canopy—one near the point where the folds "break," in order to hold the folded canopy in place.

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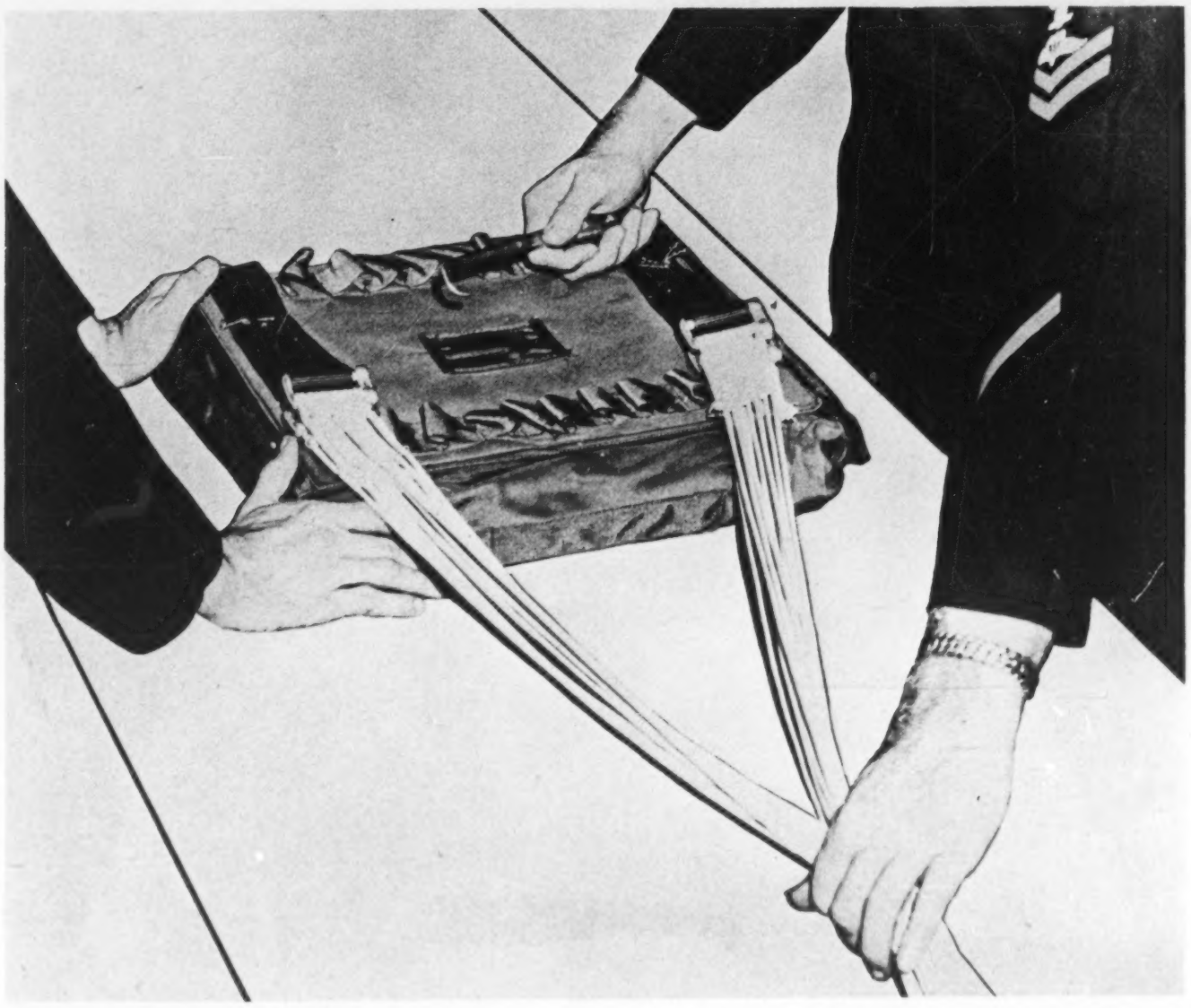

PR.162

Figure 6-10.—Gaging length of suspension lines required for making first bight. The packer grasps the suspension lines at a point approximately 18 to 24 inches from the connector links in preparation for first bight.

the edge, the fold will be too long. The position of the long bar is important to the neatness of the completed pack. The helper uses his left hand to steady the skirt end at the same time that the first fold is made.

As the canopy is folded on the pack, draw the material of the folds about 2 inches beyond the sides of the pack. This will assure a tight pack when the sides and ends are closed.

Another fold is made and then the packer lifts the pilot chute off the peak and the last fold is cast, turning the peak under approximately 9 inches.

Turn the pack 90 degrees to the left and prepare to compress the pilot chute spring and place the pilot chute directly on top of canopy.

Fake or coil the connector webbing on top of the canopy as the helper prevents the canopy from slipping. Position the pilot chute directly in the center of the pack and compress it while guiding the spring in as straight a pattern as possible.

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PR.163

Figure 6-11.—Stowing suspension lines.

Straighten the folds and corners of the canopy. Work the excess fabric back into the center portion of the canopy. Pay particular attention to the corners.

When closing the end flaps, do not pound on the pack or push the canopy out through the end of the container. The end flaps can be worked into position without too much effort by carefully shifting the canopy back and forth.

The opposite end is closed in much the same manner. The helper holds the pack steady while the packer pushes excess canopy fabric back toward the center of the pack and smooths out protruding portions of the canopy folds. The helper then holds the ends of the side flaps down in position while the packer brings up the end flaps.

Hook the pack opening bands and snap the ripcord protector flap in the closed position. Sign the Parachute Record Card and insert it in the outside record card pocket. Insert the emergency signal code in the pocket on the connector strap.

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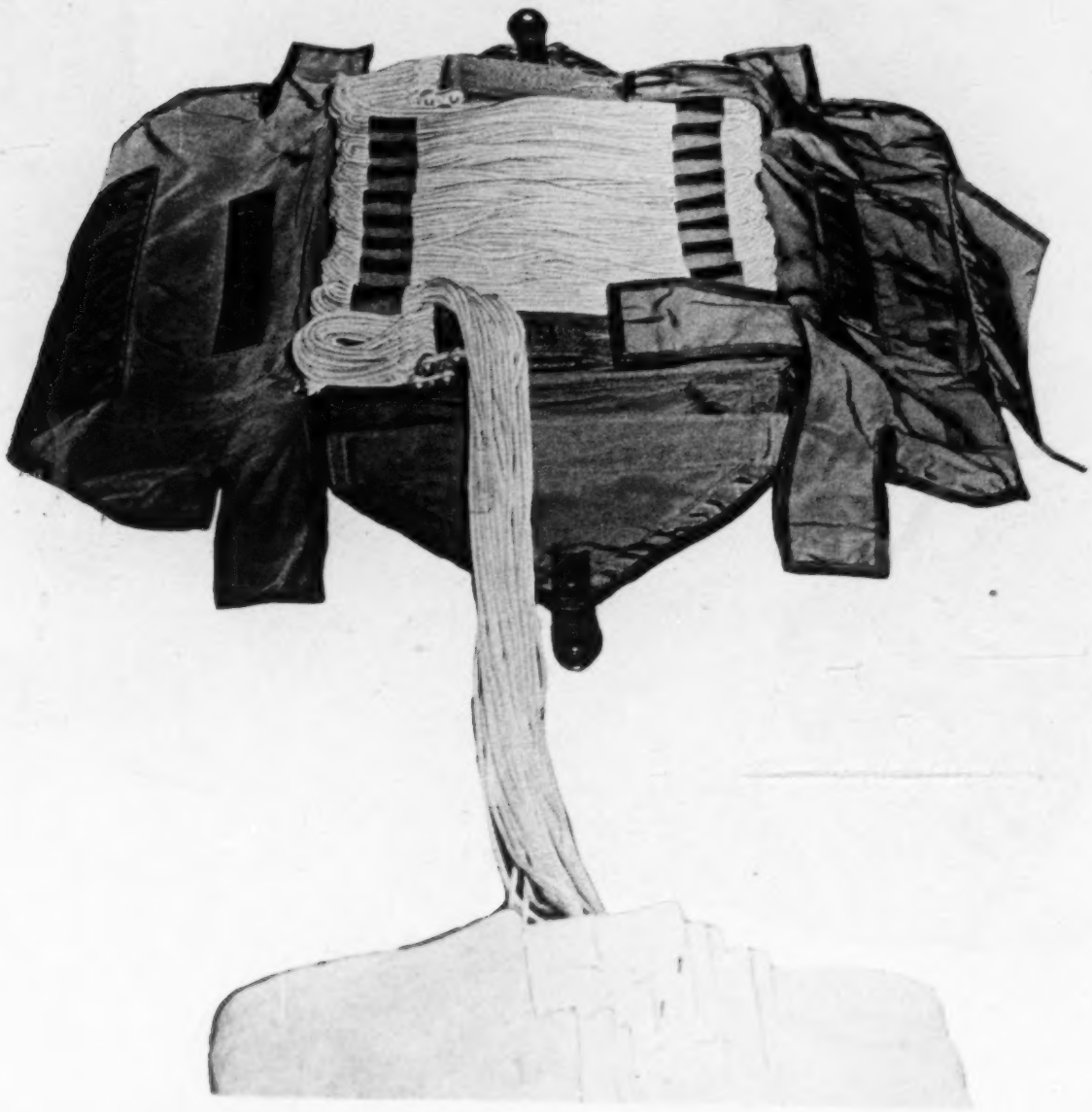

PR.164

Figure 6-12.—Lines stowed, hesitator loops straightened, and pack turned ready to receive canopy.

QUICK-FIT HARNESS ADJUSTMENTS

One of the most important responsibilities of the PR is the training of personnel in the use of parachutes and other survival equipment. All naval aviation personnel should know how to don and adjust the quick-fit parachute harness and how to hook the NC-3 fit parachute to the harness.

The quick-fit harness is designed to be adjusted for body length before the aircraft becomes airborne. The leg straps and chest straps may be adjusted when needed.

Since the harness is designed to serve as a seat or sling to support the wearer during descent, it must be fitted comfortably while the body is in a seated position. Therefore, all quick-fit adjustments are made either in a sitting or simulated sitting position.

To don the harness, slip the arms between the back straps and the chest straps positioned on each side of the harness. Grasp the main sling on both sides and slide it down over the buttocks to form a sling or seat underneath the body. Sit down in a straight chair, or assume a simulated sitting position by bending forward about 45 degrees, bending at the waist and holding the trunk straight. (See fig. 6-27.)

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Figure 6-13.—Skirt of canopy placed on pack. Bring the skirt in a straight line toward the ripcord end of the pack and place the hem directly over the edge, flush with the wire frame of the pack. Do not permit the free length of suspension lines between the skirt and the last hesitator loop to become entangled in the lines already stowed or to project from the edge of the pack.

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PR.166

Figure 6-14.—First fold coming up. The skirt hem is bulky and therefore must be held lightly in place to prevent the disarrangement of the alinement of the skirt hem folds.

The harness should fit the body snugly and comfortably lengthwise when in this position. If it does not, remove the harness and adjust for proper body length. This adjustment is made by moving the shoulder adapters—up to shorten or down to lengthen. After adjustment for length, don harness and reassume the original position for donning. While in this position, adjust the leg and chest straps to a snug comfortable fit.

It will be noted that the properly adjusted harness is extremely uncomfortable when an attempt is made to stand erect. For this reason the harness may be worn loosely for comfort while moving about in the aircraft, and quickly adjusted to the wearer when the need arises. This feature, coupled with the fact that the harness may be worn without the parachute being permanently attached, makes the NC-3 parachute desirable for use in aircraft in which members of the crew are required to move about in the performance of their duties.

It is important to stress that personnel should learn to adjust their harness from the stooped position since rarely will anyone have time to look for a seat in which to adjust his harness when the need arises to use the parachute for an emergency descent. A person should be able to don his harness and chute and prepare to jump from any point in the aircraft.

ATTACHMENT OF THE STANDARD SOFT PACK TO THE NC-3 PARACHUTE CONTAINER

Attachment of the soft pack container to the parachute container must be performed prior to packing the parachute in order to prevent inadvertent stitching of the canopy or suspension lines when making the required hand tackings.

Insure that six 10-inch lengths of type III nylon cord are tied to the standard soft pack outer container as shown in figure 6-28.

Position the standard soft pack outer container on the packing table with the horizontal and vertical strap adapters facing up as shown in figure 6-29.

Insert the combination carrying case and equipment container into the outer container with the shoulder straps facing up and the strap handle positioned at the open end of the outer container. (See fig. 6-30.)

Pull the outer container main panels over the sides of the combination carrying case and equipment container and fasten the vertical strap quick disconnect shackle. Reeve the horizontal and vertical straps snugly together as illustrated in figure 6-31.

Mark the horizontal and vertical straps midway between the adapter and end of the strap as shown in figure 6-32.

Remove the combination carrying case and equipment container from the outer container. Fold the horizontal and vertical straps under at the mark made in the previous paragraph. Tuck the strap ends under the adapters. Tack the folded under strap to the strap located beneath it, passing the cord around the adapter. Use one turn of waxed nylon 6-cord, double. Tie the ends with a surgeon's knot followed by a square knot. (See fig. 6-33.)

Place the standard soft pack outer container on top of the parachute, with the outer container adapters facing the parachute container. Tack the four corners of the standard soft pack outer container to the bottom of the parachute container. Tack the outer container main panel on

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Figure 6-15.—First fold placed immediately behind skirt hem. Bring the first fold up to a position just back of the skirt hem. This compensates for the bulky hem and provides a relatively flat surface on which the other folds can be made.

each side of the vertical strap to the parachute container. Pass all tackings around the parachute container wire frame. Tackings must be made with two turns of waxed nylon 6-cord, double. Tie the ends with a surgeon's knot followed by a square knot as shown in figure 6-34.

Insert the combination carrying case and equipment container into the standard soft pack outer container. Position the parachute container under the riser assembly with the inside facing the packing table and the ripcord pin protector flap facing the canopy as shown in figure 6-35.

Tie the riser assembly quick-connector snaps to the standard soft pack outer container using the six 10-inch lengths of type III nylon cord. Pass the cord through each side of the slot and around the hook on both quick-disconnect snaps. Tie off the ends with a square knot. Tack one turn of waxed nylon 6-cord, single, through each square knot. Tie the ends with a surgeon's knot followed by a square knot. (See fig. 6-36.)

Rotate the parachute container, from the ripcord pin protector flap side over, so that the standard soft pack faces the packing table. The connector links must be positioned on top of the container with the lift webs through the top side flap slots. Tack both sides of the lift webs to the container, passing one turn of waxed size B nylon thread, single, through the webbing and around the container frame. Tie the ends with a surgeon's knot followed by a square knot as shown in figure 6-37.

Remove the combination carrying case and equipment container from the standard soft pack outer container. Pull the parachute container out from under the connector links so that the inside of the parachute container faces the packing table and the ripcord pin protector flap faces the canopy. Fold the side and end flaps under the container and insert the tension hooks into the connector links and the packing table. The assembly is now ready for packing the parachute canopy as illustrated in figure 6-38.

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Figure 6-16.—Fourth fold placed directly over the top of the skirt hem.

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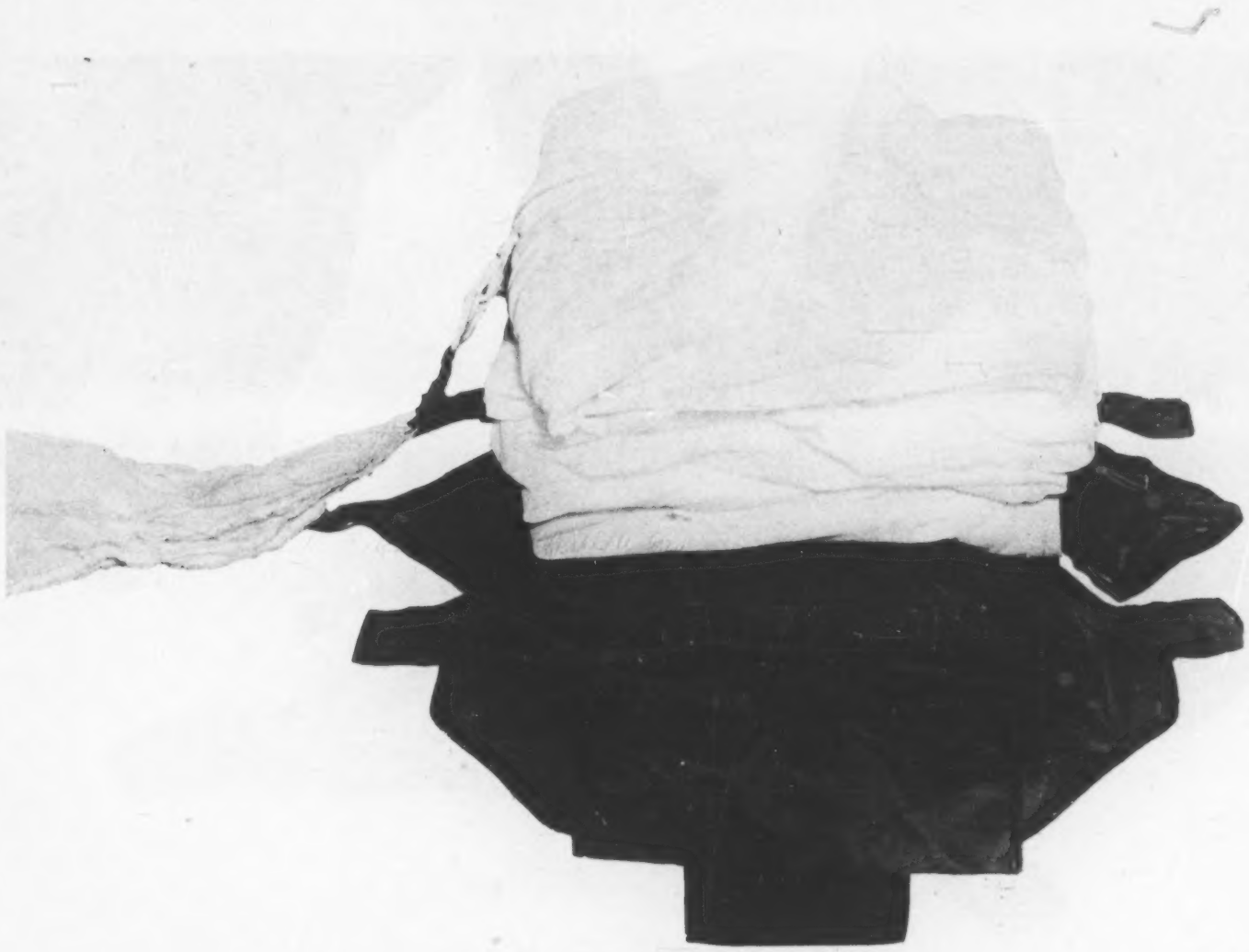

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Figure 6-17.—Last fold made and peak turned under; pilot chute ready to be placed on top of canopy.

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Figure 6-18.—Ready to draw up first side of pack. The packing team holds the pilot chute compressed with their forearms then simultaneously grasps the pilot chute protector flap which is a flap attached to the locking cone side of the pack. As the side is drawn up, keep the fabric from bunching in the center by smoothing down with your free hand between side flap and canopy. Once this side is drawn into position, shift around and pull up the other side while holding the first in place with your arms.

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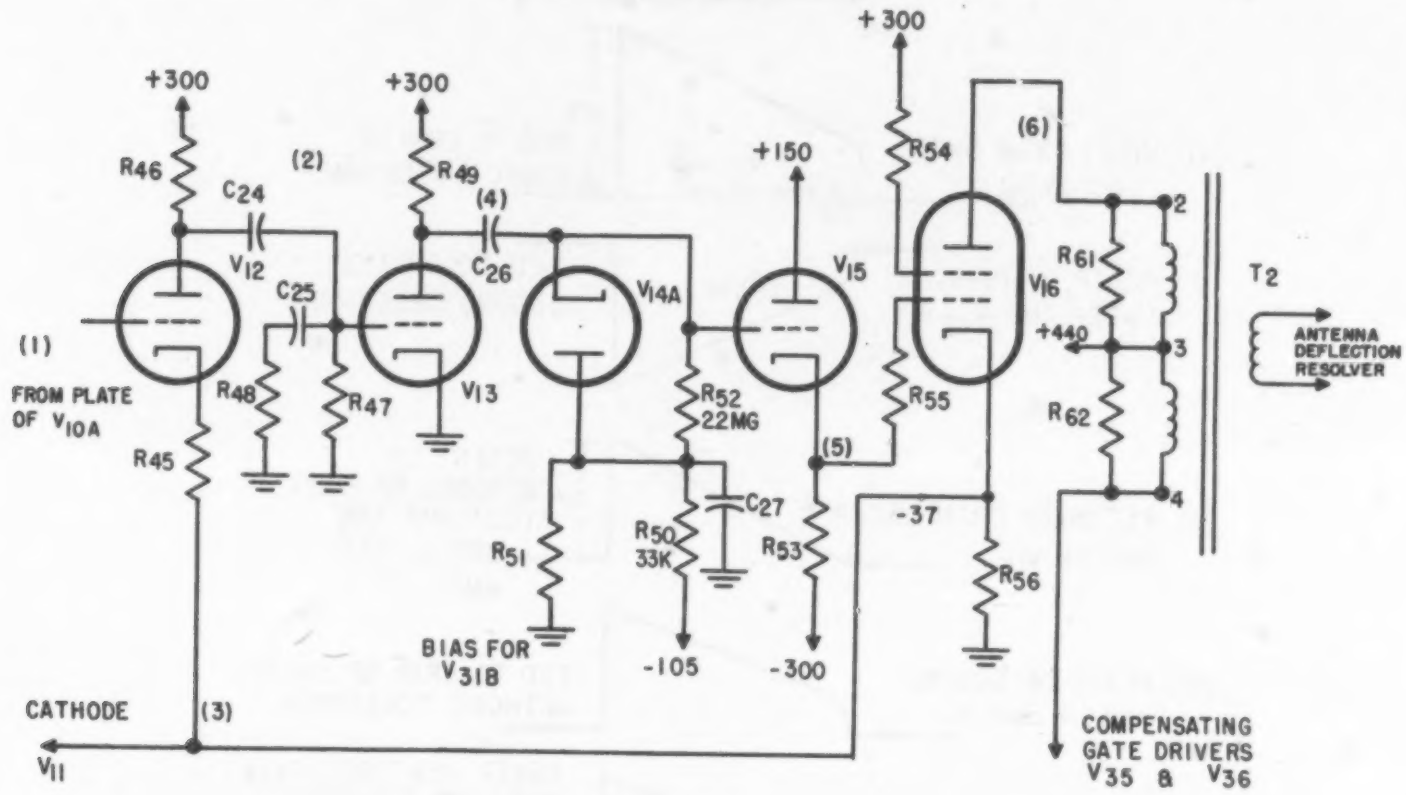

Figure 16-11.—Sweep amplifying circuits.

static condition. The capacity of C23 is much greater than that of the capacitors used by the sweep generating circuit on any range. Therefore, should the charge on C23 be used as a source of voltage during the time the sweep is being generated, the sweep charging current would have negligible effect on the voltage across C23.

(NOTE: The use of a charged capacitor as a source of voltage for short periods of time has been employed in numerous cases in radar equipment.) Now consider the operation of the sweep generating and bootstrap amplifier circuits. When the pulse from the sweep gate multivibrator cuts off V10A, the sweep capacitors will begin to charge as stated in the previous explanation. However, as the sawtooth is being generated, it is also being fed back to the bootstrap amplifier. This causes the voltage of the right side of C23 to rise. This rise in voltage is coupled to the sweep generating circuit by C23 which causes V10B to be cut off. From this point on to the end of sweep time, the charge on C23 and sawtooth on the plate of V11 will be the source of charging potential for the sweep generating circuit.

The sawtooth on the plate of V11 is of the same amplitude as that appearing on the plate of V10A. This increase results in a constant effective charging potential during sweep time for maximum linearity. Figure 16-12 illustrates graphically the voltage relationship during sweep time.

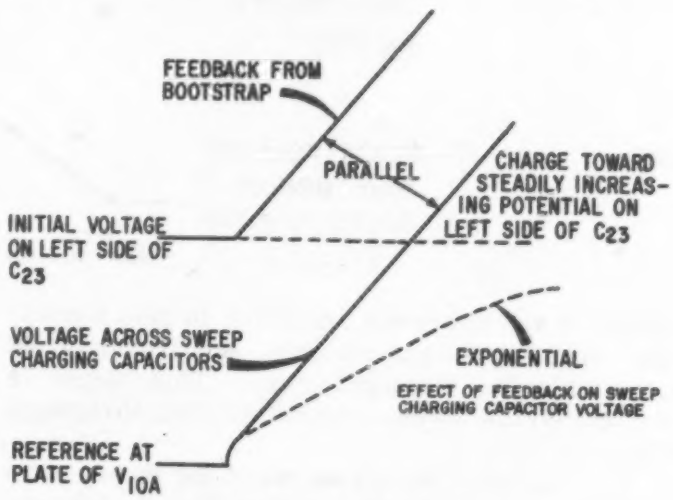

Figure 16-12.—Effect of feedback on sweep charging capacitor voltage.

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Figure 6-19.—Ready to draw up the second side. Still grasping the pilot chute protector flap attached to the grommet side of the pack, draw the side up to position while keeping the canopy smoothed in place.

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Figure 6-20.—Side flaps drawn up and held in position by temporary locking pins. The grip is shifted, pressure is brought to bear on the assembly, the locking cones are brought into position, the grommets are passed over the cones, and the temporary locking pins are inserted in the cones.

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Figure 6-21.—Closing first end flap. Position end flaps (helper pulls up end flap while packer exerts pressure to compress the pack.) Bring end tab into position; remove temporary locking pin and place end tab down over locking cones. Insert locking pin through locking pin hole and over end tab. The temporary locking pin may be removed at this time and replaced with the ripcord. However, it is advisable to use the locking pins until the straightening of the pack has been completed. This will prevent inadvertent opening of the pack while using the bar and fid to smooth out the pack.

11006

A. ARROWS INDICATE ROLLING MOTION
B. ARROWS INDICATE ROCKING MOTION

PR.174

Figure 6-22.—Sides and ends closed and ready for straightening. Insert long bar under end flaps and straighten container by twisting the bar as indicated by arrow (A) and pulling in a downward motion. Then further shape the pack with a rocking motion as shown by arrow (B). This procedure is repeated on both ends of the pack.

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Figure 6-23.—Using the fid. Further straighten the pack and insert the protector flaps with the fid.

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Figure 6-24.—Temporary locking pins removed and ripcord inserted.

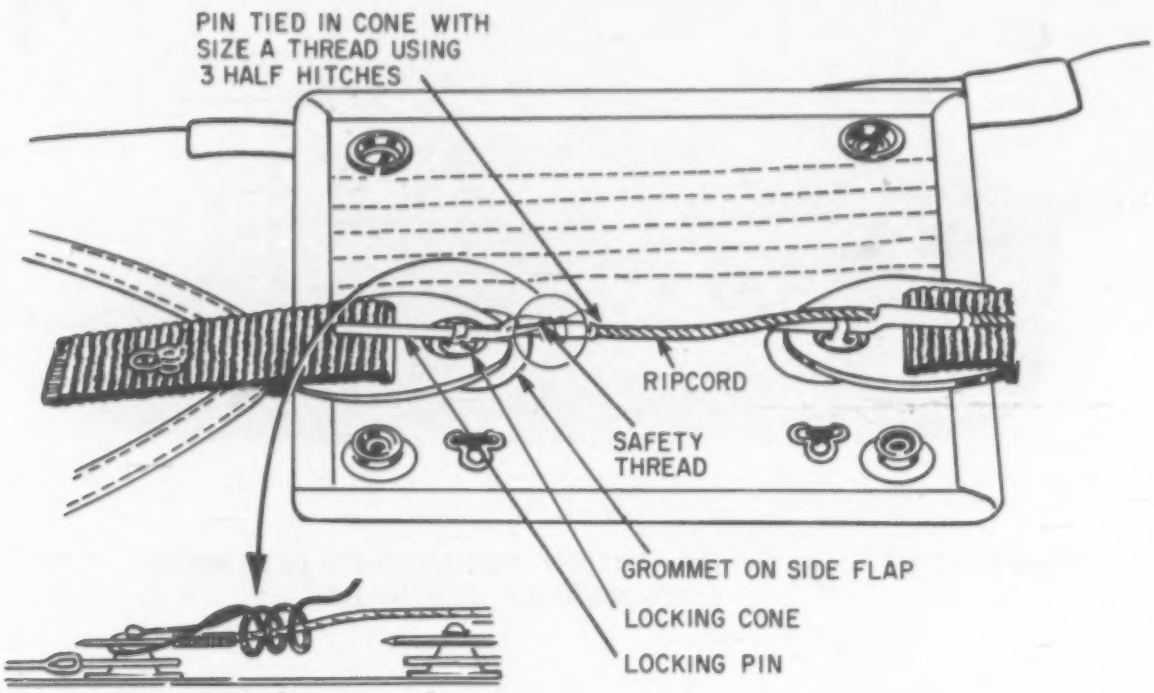

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Figure 6-25.—Method of safety tying the ripcord locking pins.

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Figure 6-26.—Hook up pack opening bands. Note that bands go underneath cross connector strap.

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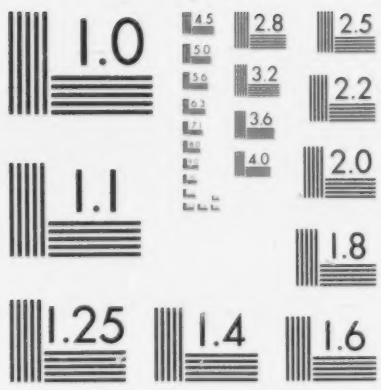

MICROCOPY RESOLUTION TEST CHART

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PR.179
Figure 6-27.—Body in position for donning NC-3 harness.

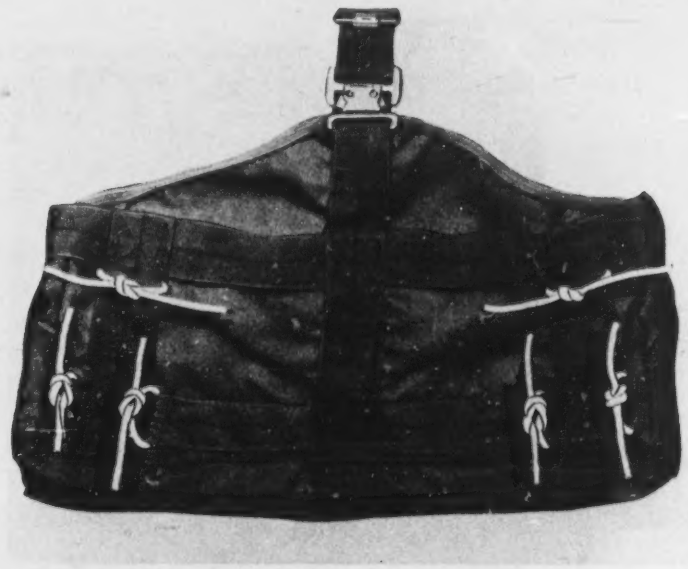

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Figure 6-28.—Attachment of the six 10-inch lengths of nylon cord.

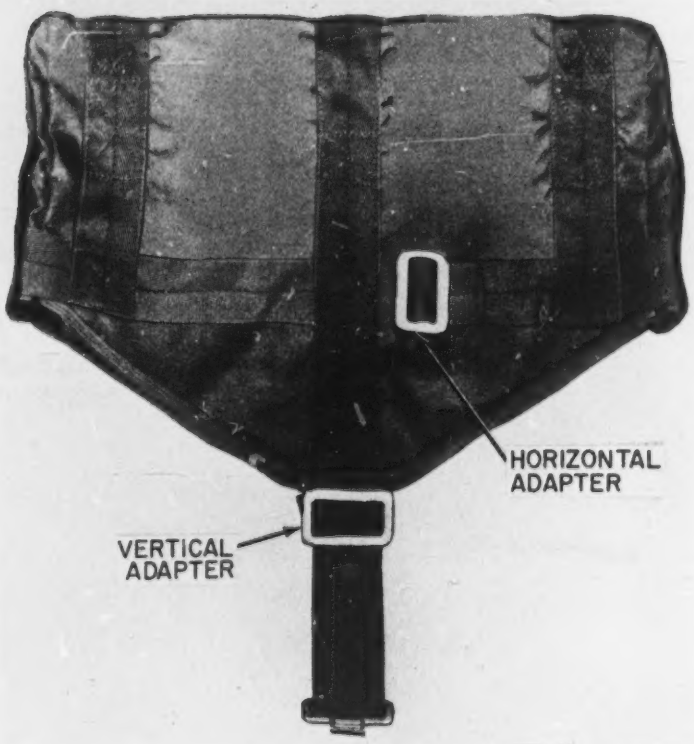

PR.181
Figure 6-29.—Position of the horizontal and vertical strap adapters.

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Figure 6-30.—Position of shoulder strap and strap handle.

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Figure 6-32.—Marking the horizontal and vertical straps.

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Figure 6-31.—Horizontal and vertical straps reeved.

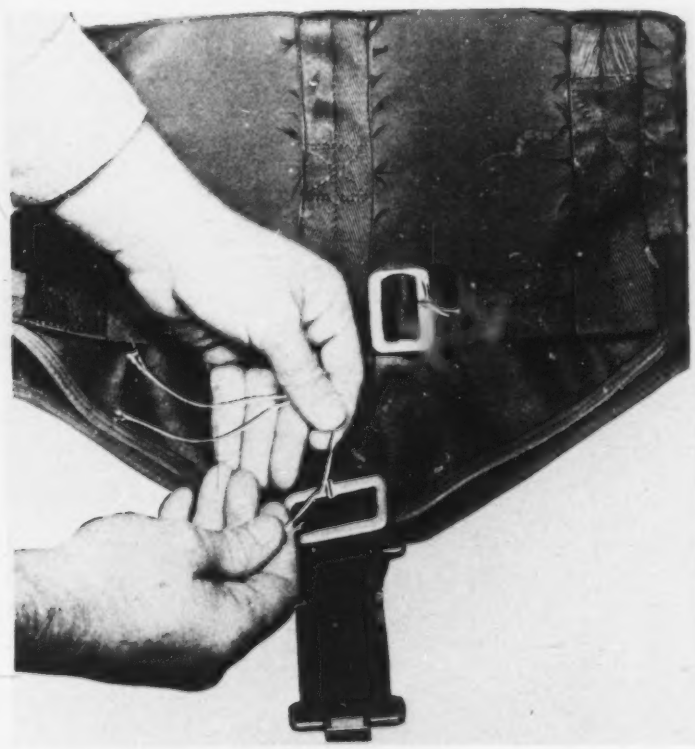

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Figure 6-33.—Tacking the straps to the adapters.

At the termination of sweep time, V10A and V10B conduct, resetting or clamping the potential of the capacitors in the circuit.

COMPENSATING GATE GENERATING CIRCUITS

As stated previously, the purpose of the compensating gate circuit is to generate a gating voltage that will cause the indicator's electron beam to be reset at the end of each range sweep, thus insuring that each trace on the indicator will start at the same point. The compensating gate circuit consists of a trigger generator, a multivibrator, a gate clamp, an amplifier, and a driver. It also utilizes two other diode clamp circuits to aid in maintaining proper reference potentials.

Compensating Gate Trigger

The compensating gate trigger V28 (fig. 16-13) is a single-swing blocking oscillator. It is biased beyond cutoff by the voltage divider network consisting of R97 and R98 in its grid circuit. It receives as its input a square wave from the sweep gate circuit. (NOTE: The relationship of this square wave to sweep time is important and is illustrated by waveforms (1) and (2) of figure 16-14.) However, the square wave is differentiated by C45, R97, and R98. The waveform as it appears at the grid of V28 is shown by waveform (3). The negative spike does not affect the operation of the circuit since the stage is cut off when it arrives. However, the positive spike drives the grid above cutoff which starts the oscillator to operating.

Once the grid is driven above cutoff, the oscillator operates as any single-swing blocking oscillator. The circuit has two outputs—(1) a negative spike taken from the remaining transformer secondary winding which is fed to the range marker circuit, and (2) a negative spike developed by the surge of plate current through the plate load resistor. The latter output is

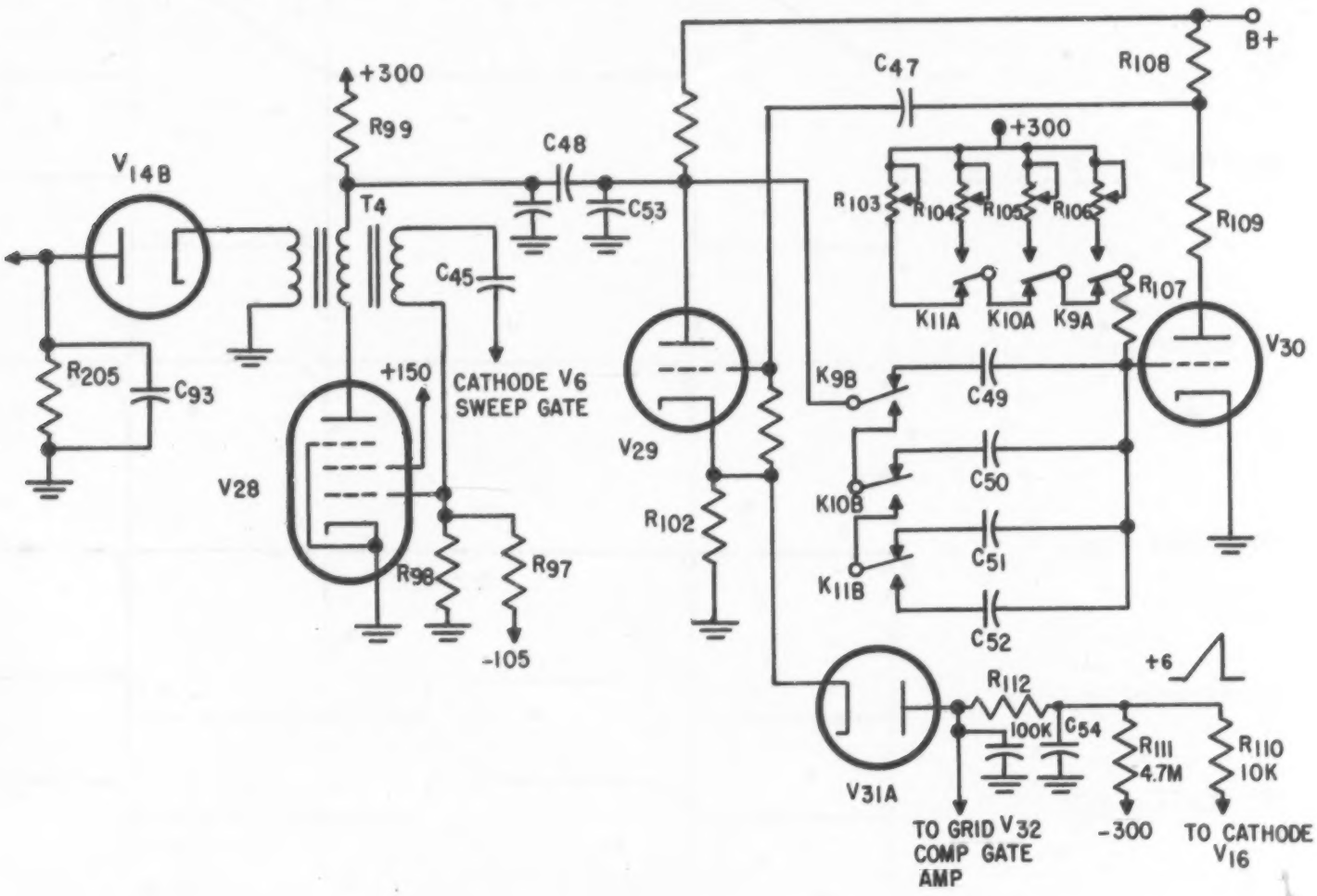

Figure 16-13.—Compensating gate circuit, part 1.

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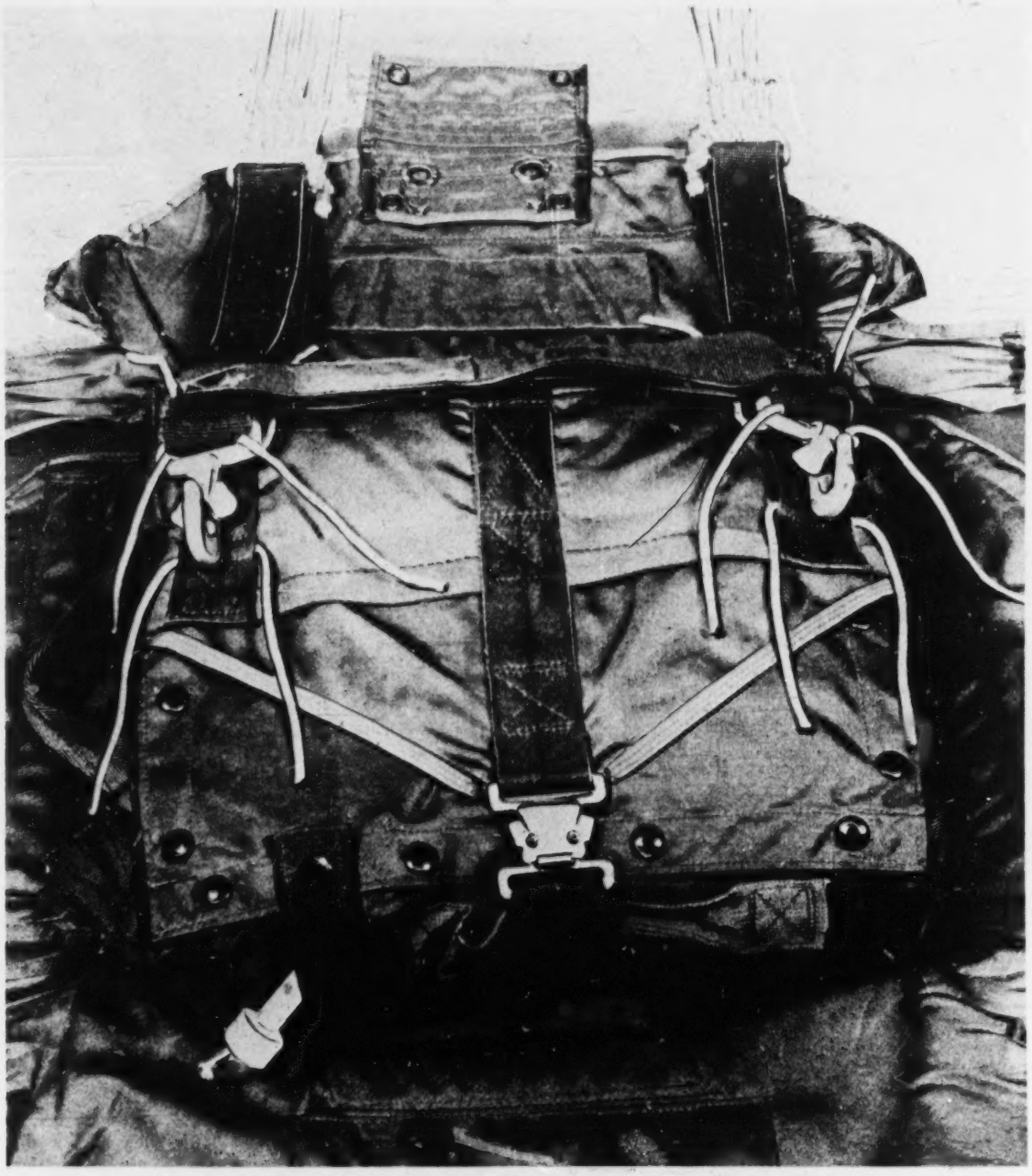

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Figure 6-35.—Positioning the riser assembly and the two containers.

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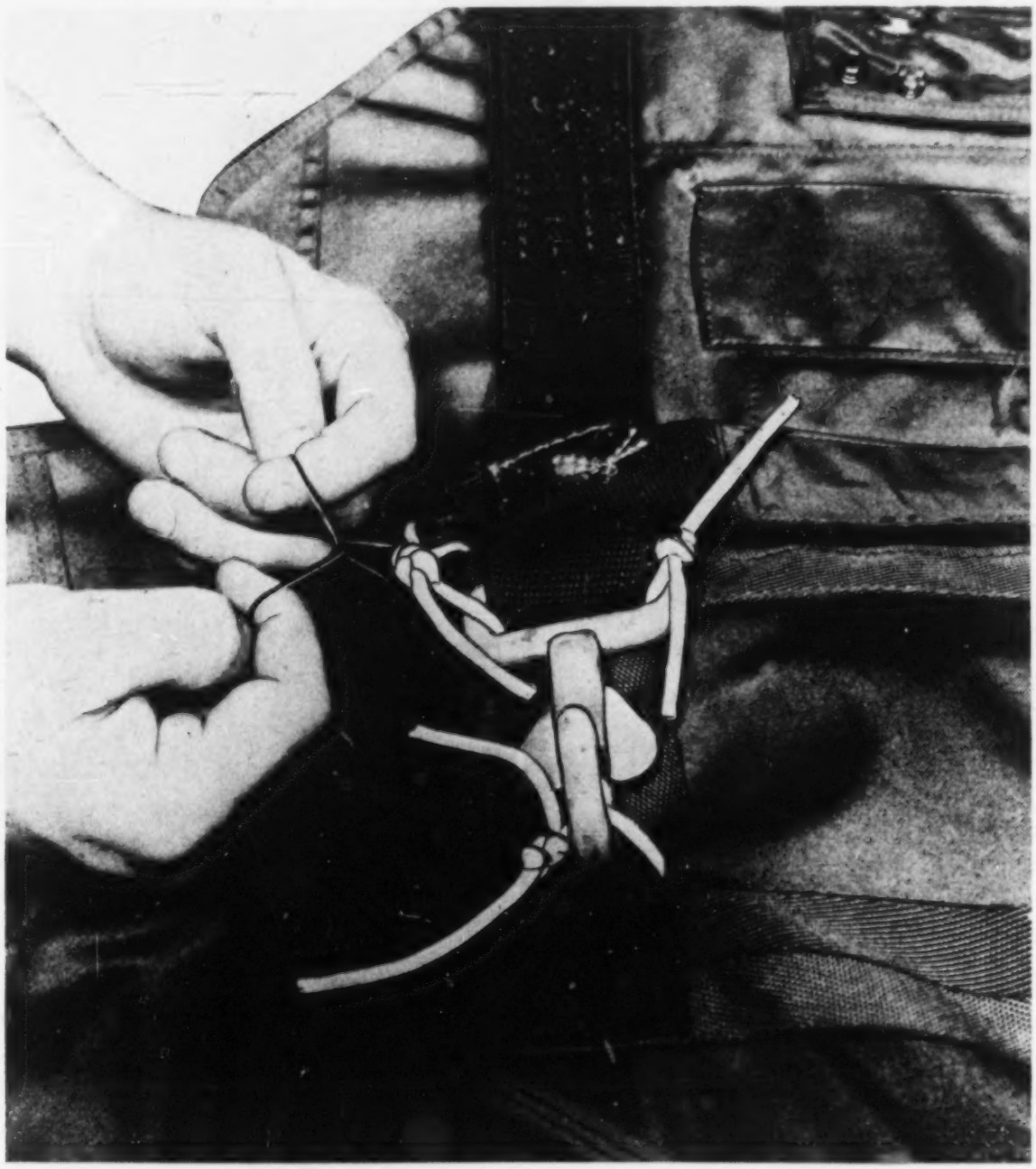

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Figure 6-36.— Tying the riser assembly quick-disconnect snaps to standard soft pack outer container.

PR.189

Figure 6-37.—Lift webs tacked to the parachute container.

PR.190

Figure 6-38.—Standard soft pack container attached to the NC-3 assembly.

CHAPTER 7

PACKING AND RIGGING THE NB-11 PARACHUTE

The NB-11 personnel parachute assembly is a backtype parachute used with an integrated torso suit harness as part of the ejection seat escape system.

The assembly includes a modified 28-foot diameter, flat, nylon canopy with 28 gores. A fail-safe ballistic spreading gun is used to rapidly deploy the canopy. The canopy is packed in a semirigid contoured container. The riser assembly, which is rigged to the container, is connected to the torso suit harness with quick-release fittings. The integrated torso suit harness combines the aircrewman's parachute harness and lap and shoulder restraint straps. The harness is channeled through the torso suit to retain it in position and to facilitate donning. When aboard the aircraft and seated, the aircrewman connects the quick-release fittings on the parachute riser assembly to the quick-release shoulder fittings on the integrated torso suit. The survival kit is also connected to the integrated suit by means of quick-release fittings.

OPERATION

After ejection, the external pilot parachute is pulled from its pocket and opened, at seat separation, by the static line attached to the ejection seat. At speeds in excess of 120 knots, the external pilot parachute will separate from the container by release of a shear link assembly. At speeds below 120 knots, the external pilot parachute will be retained.

At a preset altitude, the automatic parachute actuator fires. The ripcord pins are removed from the locking cones, allowing the spring opening bands to open the container. The pilot parachute springs from the container and fills with air during this operation. The external pilot parachute release assembly releases the shear link cable when the container opens.

The weight of the aircrewman, falling away from the external pilot parachute (if still attached) and the internal pilot parachute, causes the main canopy to be pulled from the container, followed by the suspension lines. The canopy begins to fill with air during this operation. The connector link ties break as load is applied, allowing the risers to be pulled from the container. The external pilot parachute is used to effect more rapid opening of the parachute, especially at low altitudes or ground level ejection.

Just prior to full suspension line stretch, the spreading gun fires and forces the suspension lines outward at the skirt hem. This aids in rapid opening of the canopy by allowing it to fill with air faster.

If the spreading gun fails to fire, the slugs will separate from the gun assembly at full suspension line stretch, allowing the canopy to open fully.

The aircrewman hangs suspended in his harness from the quick-release shoulder fittings during descent. Upon landing, the canopy and suspension lines can be disengaged from the integrated torso suit by using the quick-release shoulder fittings.

If the aircrewman should have to bail out without using the ejection seat, the internal pilot parachute alone will deploy the main canopy and will disconnect from the external pilot parachute bridle by means of the external pilot parachute override disconnect assembly.

PACKING AND RIGGING THE NB-11

Open the parachute assembly, insuring that the external pilot parachute release assembly releases the swaged ball on the external pilot parachute release cable. USE EXTREME CAUTION AS THIS ASSEMBLY INCORPORATES A BALLISTIC SPREADER GUN. The external pilot parachute is shown in figure 7-1. If the

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release assembly fails to release the swaged ball, replace the release assembly.

NOTE: Do not remove the folded canopy or suspension lines from the container.

Carefully raise the folded canopy at the top end of the container, exposing the spreading gun. Open the fasteners on the extractor sleeve and fully insert safety pin into the spreading gun. The safetypin button must be pressed to insert the pin as shown in figure 7-2.

Untie, remove, and retain the 36-inch length of nylon tape securing the canopy peak in position on top of the folded canopy. Remove only the folded canopy from the container. Remove the lower spreading gun firing lanyard from the outboard connector link on the right side of the packing table. Also remove the lower spreading gun firing lanyard from the hesitator loops and retaining bands, and then remove the connector link ties. Remove the external pilot parachute from the elastic stow pocket on the container side flap. Insure that the firing lanyard is not attached to the connector link.

Lay out the canopy and the pilot parachute full length on a packing table as shown in figure 7-3. Rotate the spreading gun so that suspension lines 1 and 28 are facing up and lines 14 and 15 are on the bottom. Separate the folded gores into two groups, counting 14 gores on each side of the spreading gun. Connect the two groups of connector links to their respective tension hooks on the packing table, and complete the parachute assembly inspection in accordance with chapter 4 of this manual.

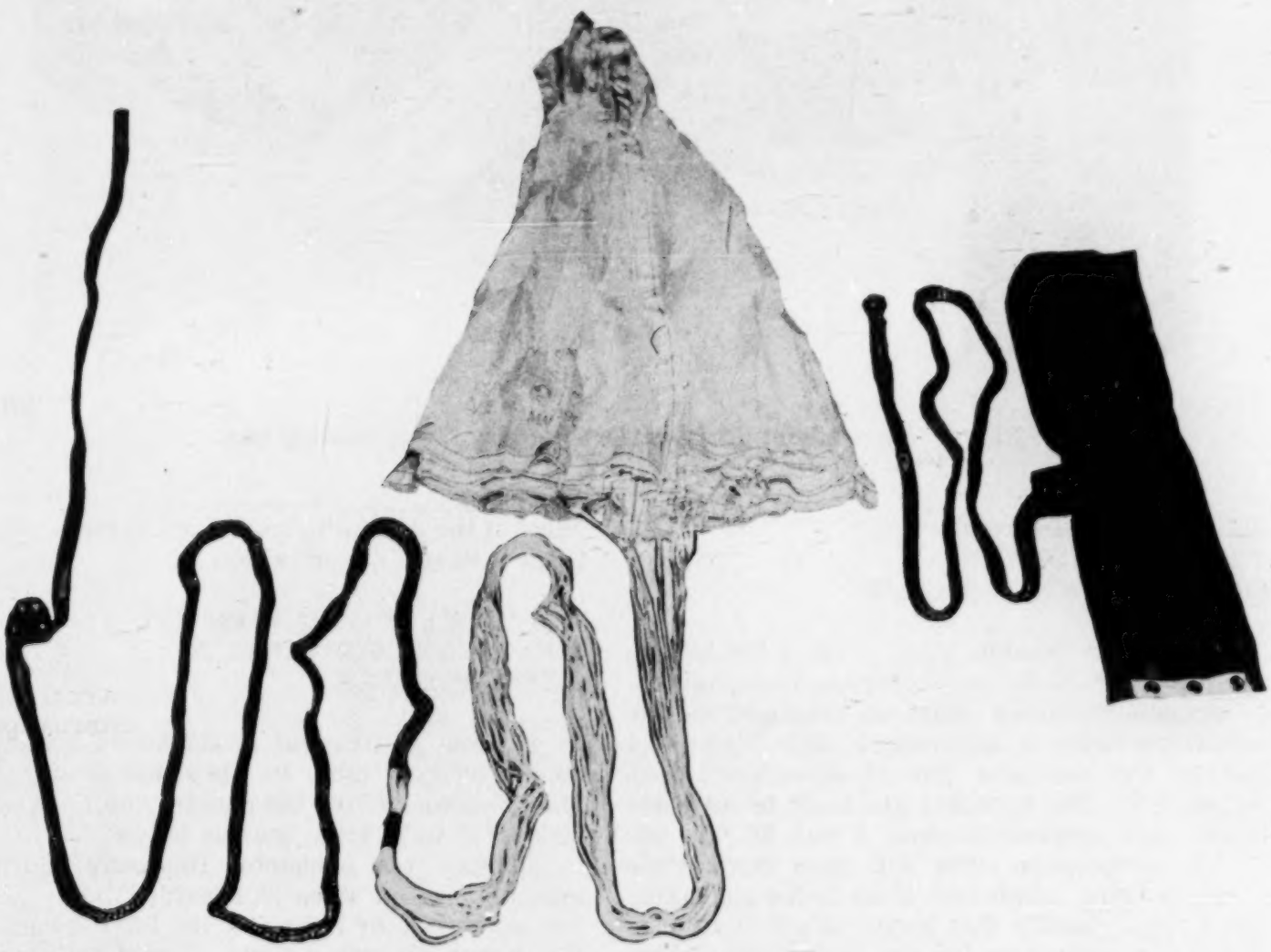

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Figure 7-1.—External pilot parachute and deployment bag.

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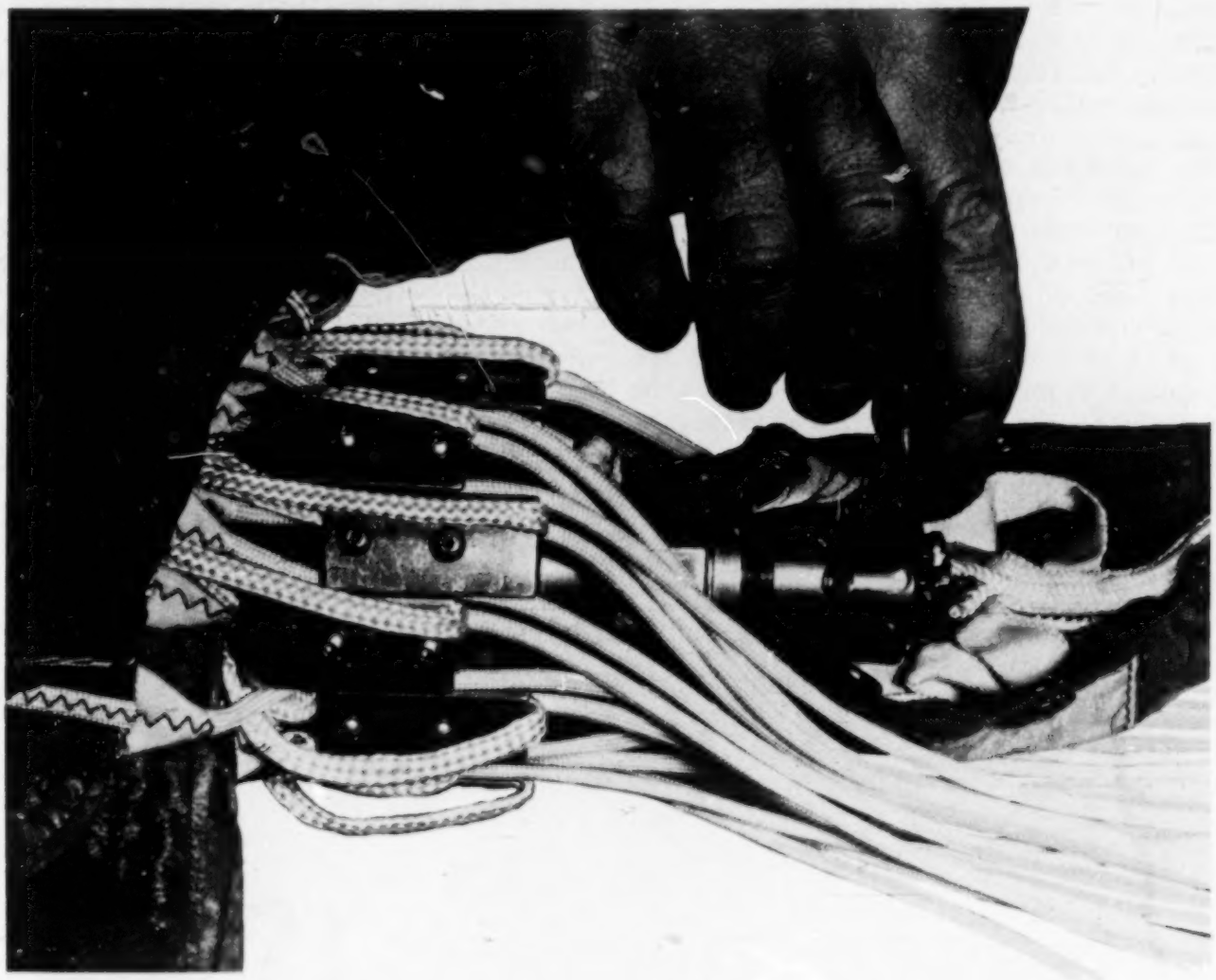

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Figure 7-2.—Inserting the safety pin into the spreading gun.

SUSPENSION LINE CONTINUITY CHECK WITH SPREADING GUN INSTALLED

Attach the tension strap hook to the loop in the pilot parachute connector cord and tighten.

Suspension lines must be arranged on the connector links in accordance with figure 7-4 and on the spreader gun in accordance with figure 7-5. The spreader gun must be so positioned that suspension lines 1 and 28 face up.

The suspension lines will pass through the corresponding numbered slots in the spreading gun slugs. Insure that loops attached to odd-numbered suspension lines pass through slots in odd-numbered slugs.

Suspension lines must run free from the skirt hem through the corresponding numbered slots in the spreading gun slugs to the connector links without dips or twists.

ATTACHMENT OF SUSPENSION LINE CONNECTOR LINKS TO RISER ASSEMBLY

Lay out risers and cross connector straps on the packing table in a position such that the riser fasteners face the packing table. Remove connector links from tension hooks.

Remove the connector link yoke and plate assembly from each connector link. Insert bottom connector links into the loop at each end of a cross connector strap. Insert bottom connector links in bottom lift webs. Reattach yoke and plate assemblies to the bottom connector links and tighten screws to a torque value of

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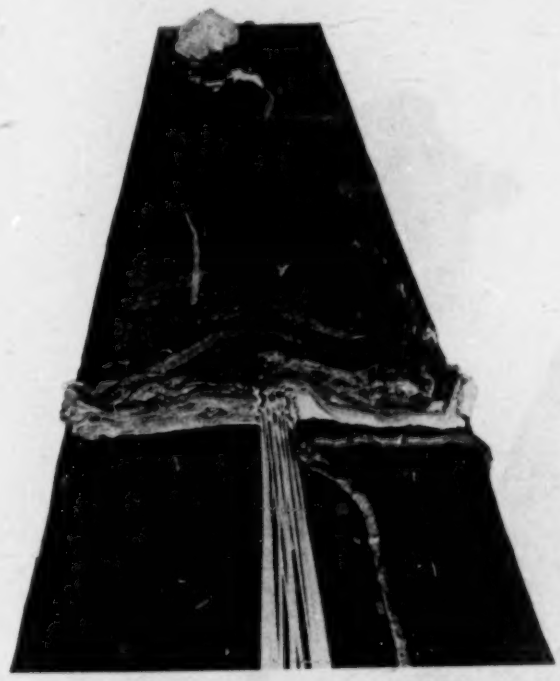

PR.193

Figure 7-3.—Canopy laid out on packing table.

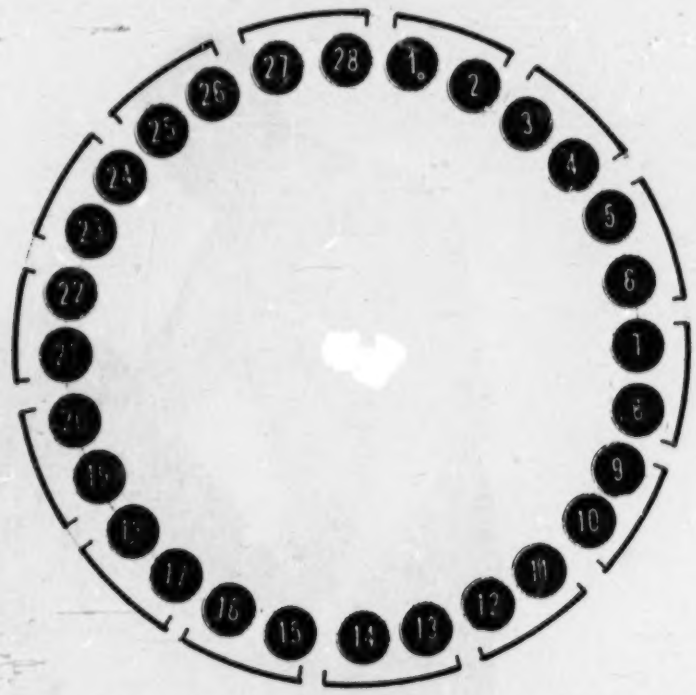

PR.195

Figure 7-5.—Arrangement of suspension lines on spreader gun.

PR.194

Figure 7-4.—Arrangement of suspension lines on connector links and skirt hem.

20 to 25 inch-pounds. Insure that the knurled portions of the connector link yoke and plate assemblies face up and screwheads face outboard.

Attach the top lift webs and cross connector strap to the top connector links in the same manner. After performing the continuity check, whip and fold the canopy.

STRAIGHTENING CANOPY GORES WITH SPREADING GUN INSTALLED

Insure that the safety pin is installed in the spreading gun and that the spreading gun firing lanyard is detached from the connector link.

Place a shot bag on the right side of the skirt hem. The packer must fold all the gores on the left side as a group, except the bottom gore, over the right side of the packing table. The packer then straightens and smooths the bottom gore, on the left side of the table, throughout its length to the peak. The packer returns the gores above the shot bag on the right side of the packing table to the left side one at a time and straightens and smooths each gore. The folded gores on the helper's side of the table must be straightened and smoothed in the same manner. This procedure is shown in figure 7-6.

INSTALLATION OF SPREADING GUN

Insure that the spreading gun has the safety pin installed. Position the spreading gun between suspension line groups 1 through 14 and 15 through 28 on a whipped and folded canopy so that the upper firing lanyard faces the canopy. Remove the tension strap from the canopy peak. With the use of type III nylon line attached to the upper firing lanyard, pull the upper firing lanyard through the canopy and out the peak.

Untie the type III nylon line from the upper firing lanyard. Route the upper firing lanyard

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Figure 7-6.—Straightening the canopy.

over the vent lines, through the loop in the pilot parachute connector cord, and under the vent lines. Center the upper firing lanyard plastic sleeve over the indexing line on the firing lanyard. Aline the indexing line on the firing lanyard above the vent lines, as shown in figure 7-7.

Telescope 2 inches of the firing lanyard into itself, forming a 3 (±1/4) - inch loop around the vent lines and connector cord, using a bodkin

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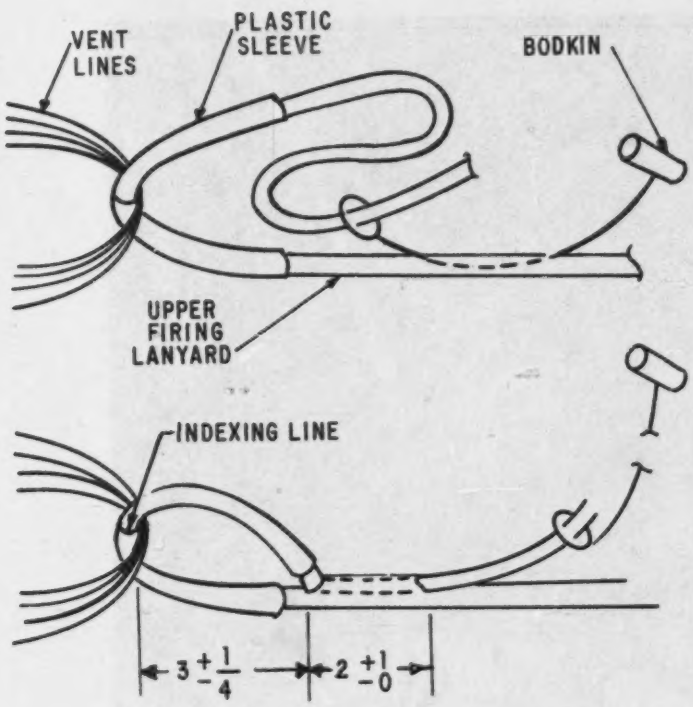

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Figure 7-7.—Routing the upper firing lanyard.

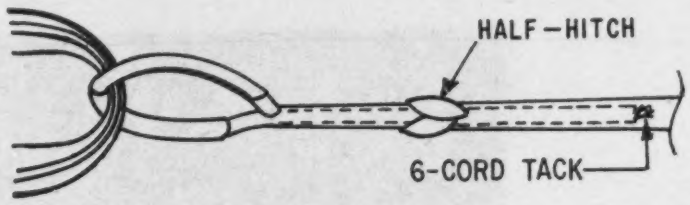

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Figure 7-8.—Firing lanyard half-hitch and 6-cord tacking.

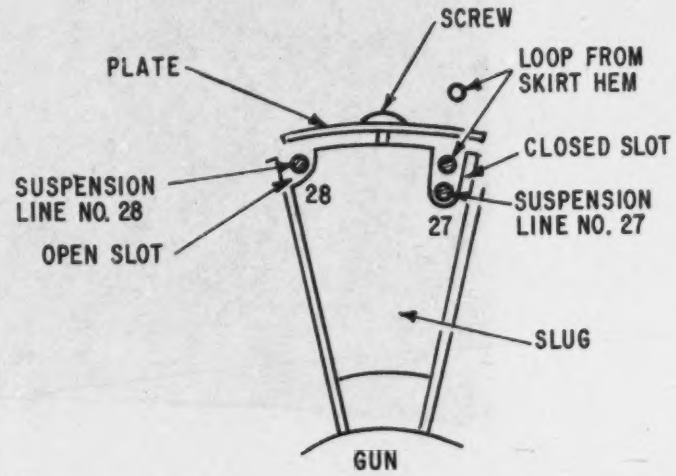

PR.199

Figure 7-9.—Application of suspension line into slug.

tool, as shown in figure 7-7. Tie a half-hitch around the firing lanyard and telescope the remainder of the end into the firing lanyard. Tack the end inside the firing lanyard with two turns of waxed nylon 6-cord, single. Tie ends with a surgeon's knot followed by a square knot, as shown in figure 7-8.

Aline the top of the spreading gun with the skirt hem and rotate the gun so that the slug labeled "28-27" is facing up. Loosen the screws and plate on "28-27" and place suspension line number 27 and a single length of the attached loop in the closed slot of the slug. Place suspension line 28 in the open slot of the same slug. The numbers on the slugs correspond to the suspension line numbers and loops to be secured in the slug, as shown in figure 7-9.

Insert the plate into the loop and over the suspension lines in the slug. Secure the plate to the slug with the screws provided. Insure that the suspension lines move freely in the slots. Secure the remainder of the suspension lines and loops to the corresponding slugs in the same manner as above. Work from suspension line 26 through 15 and from line 1 through 14. After all the suspension lines are secured, straighten the canopy, as shown in figure 7-10.

STOWAGE OF LOWER FIRING LANYARD IN EXTRACTOR SLEEVE

Do not remove the spreader gun safety pin at any time during this procedure.

Release the fastener holding the stowage sleeve to the extractor sleeve and remove the stowage sleeve from the extractor sleeve. Inspect the lower firing lanyard for proper stowage; if found to be improperly stowed, remove the firing lanyard from the stowage sleeve and proceed as in the following paragraphs.

Cut a 30-inch length of type I nylon line. Do not sear the ends of this line as the seared ends may cause snagging of the firing lanyard. Form a bight twice the length of the stowage sleeve in the lower firing lanyard. Route the type I nylon line through the bight of the firing lanyard and draw only the type I line through the stowage sleeve channel, using a telescoping tool. Slowly remove the type I nylon line from

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used to synchronize the compensating gate multivibrator V29 and V30.

Compensating Gate Multivibrator

This multivibrator is used to generate a positive square wave for gating the compensating gate clamp circuit. When the trigger pulse from the trigger generator arrives, V30 is conducting and V29 is cut off. The negative trigger pulse is coupled from the plate of V29 through one of the grid capacitors to the grid of V30. The pulse cuts off V30 and its rise in plate voltage is coupled back to the grid of V29, driving it to saturation. The time V30 remains cut off depends on the values of resistance and capacitance in the grid circuit. Relays K9, K10, and K11 are used to control the RC time in the grid circuit of V30 which, in turn, are controlled by the PRF selection circuit. Thus, the frequency of the multivibrator output is controlled by the sweep gate circuit and the pulse width varies with the PRF of the equipment.

The output of the multivibrator, a positive square wave—the leading edge of which coincides with the end of sweep time—is shown by waveform (5) in figure 16-14. Like the output of the sweep gate multivibrator, this square wave is used as a gating pulse by the compensating gate clamp circuit.

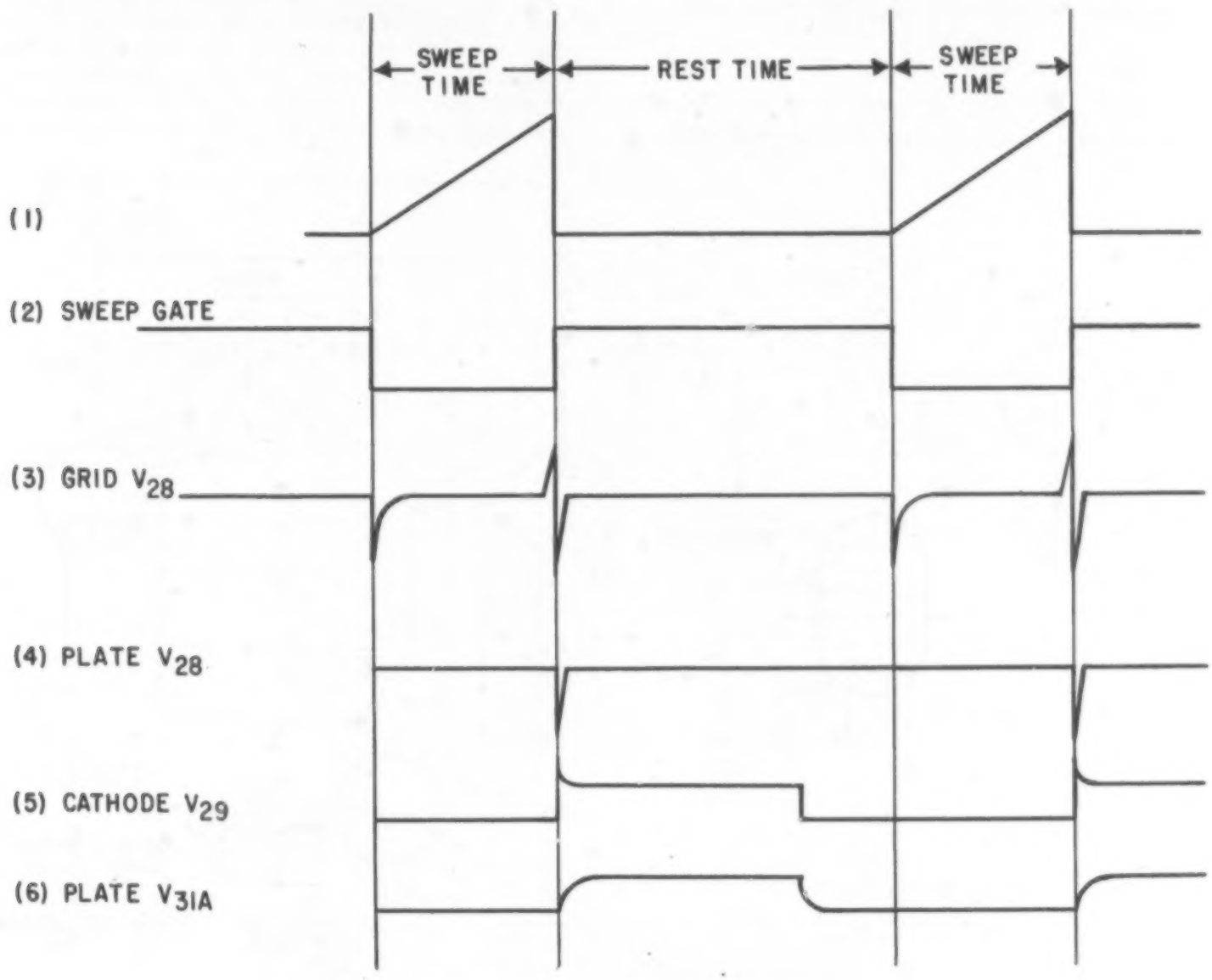

Figure 16-14. —Compensating gate waveforms.

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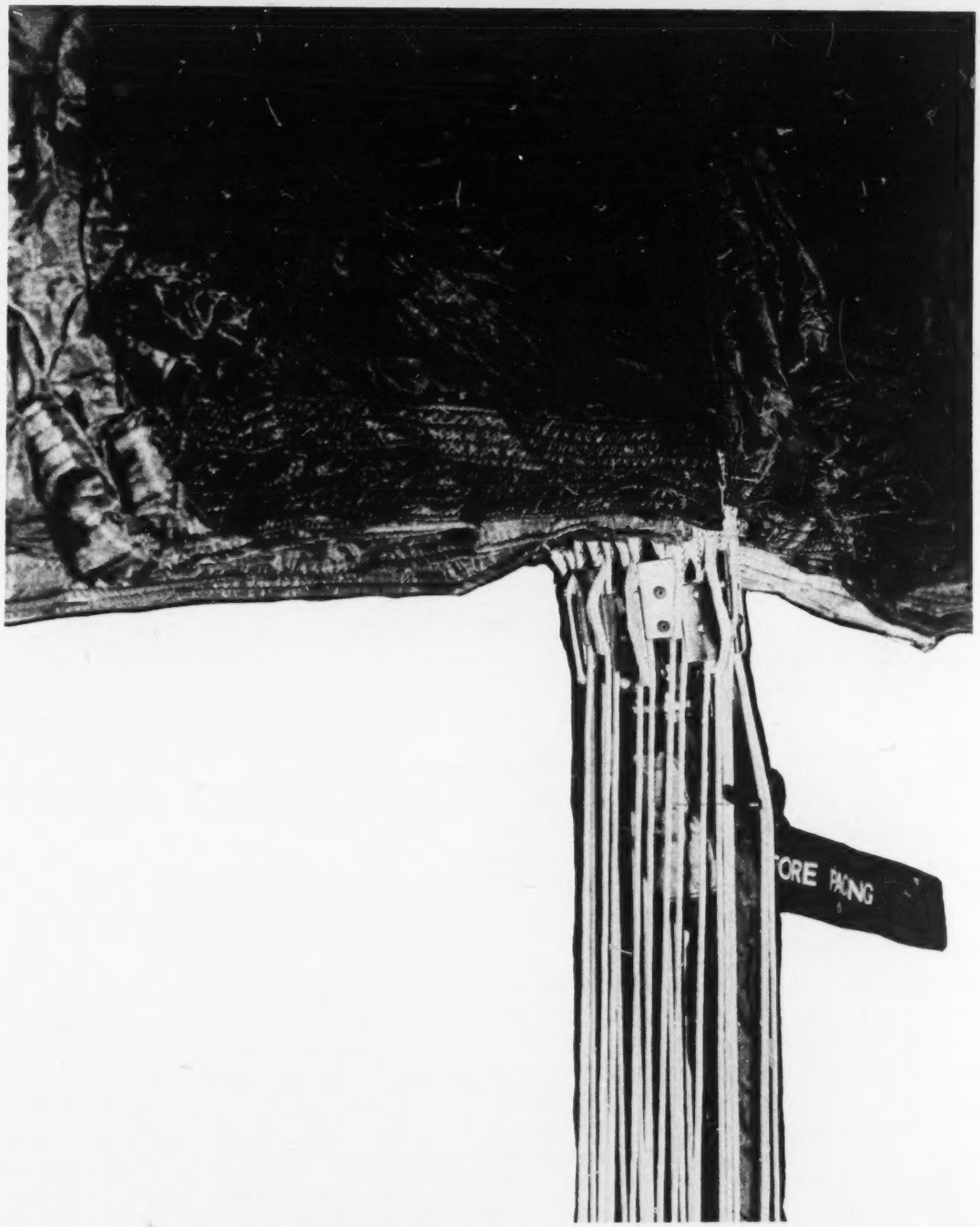

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Figure 7-10.—Spreading gun installed.

the firing lanyard bight. Use extreme caution when removing the type I line as rapid removal will sever the firing lanyard.

Form and stow a 9-inch bight of firing lanyard in the remaining stowage sleeve channel in the same manner.

Tack the second lanyard bight to the stowage sleeve with 1 turn of waxed size A nylon thread, single. Tie the ends with a surgeon's knot followed by a square knot. Insure that the firing lanyard is not twisted around the 1/2-inch tape. Insert the stowage sleeve into the extractor

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sleeve, open end first. Engage the fastener on the stowage sleeve to the fastener on the extractor sleeve. Engage the extractor sleeve fasteners on each side of the safety pin. (See fig. 7-11.)

ATTACHMENT OF THE EXTERNAL PILOT PARACHUTE

Insert the spring and sear attached to the external pilot parachute bridle into the wide end

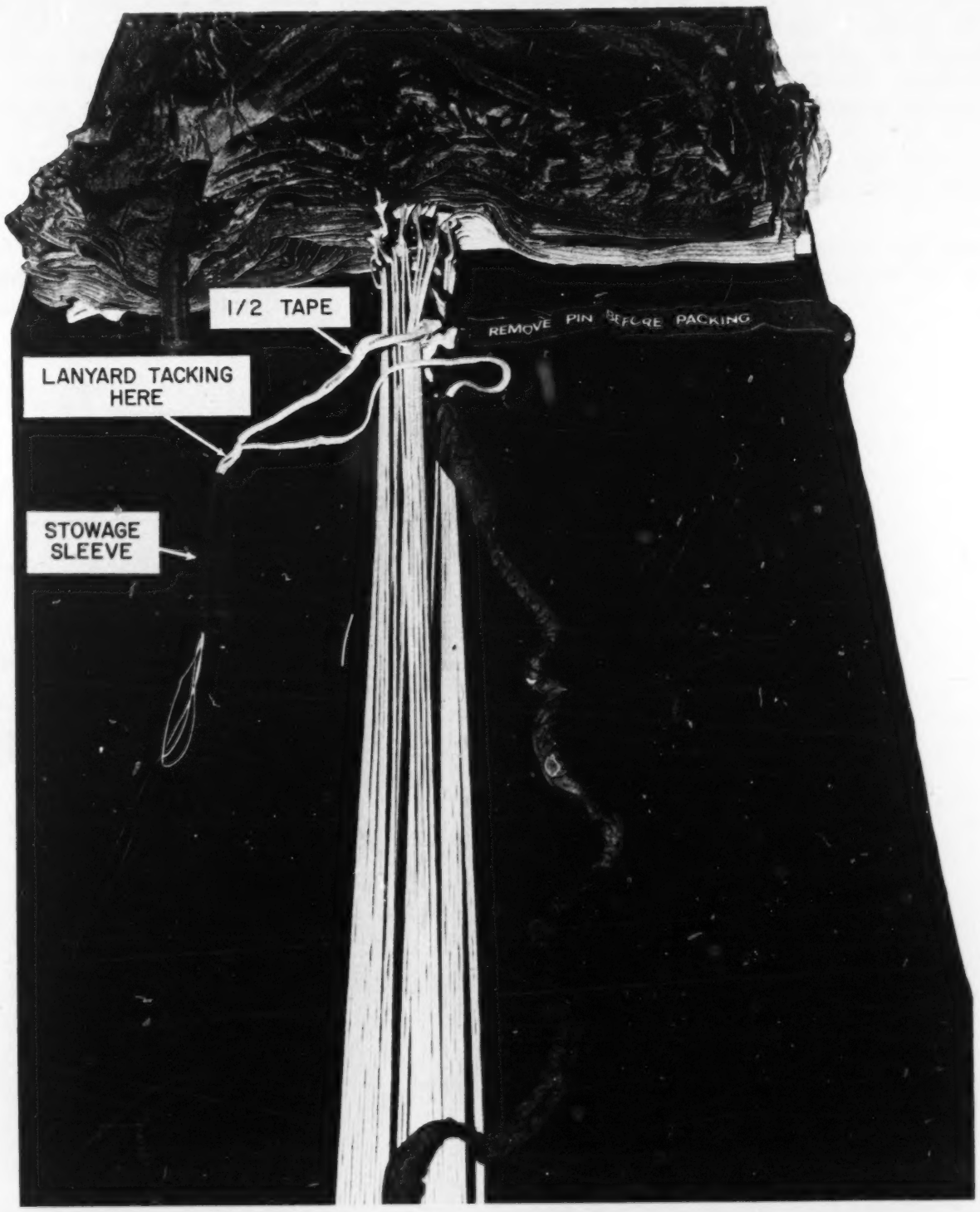

PR.201

Figure 7-11.—Stowing firing lanyard in stowage sleeve.

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of the override disconnect barrel. (See fig. 7-12.)

Push the sear into the barrel, until the sear protrudes from the opposite end. Engage the sear on the internal pilot parachute connector cord with the spring and sear in the barrel and release the tension on the spring and sear. Tack the override disconnect to the external pilot parachute bridle 3 inches above the knot, securing the bridle to the vent line at two places. Use two turns of waxed nylon 6-cord, double, for each tacking. Tie the ends with a surgeon's knot followed by a square knot.

INSTALLATION OF AUTOMATIC ACTUATOR

To install the automatic actuator, rotate the risers over the suspension lines and position the container on the packing table so that the bottom end is toward the canopy and the inside faces up. Insert the power cable through the buttonhole in the top end of the container. Route the end of the arming cable through the housing port located in the right side of the actuator pocket and through the buttonhole located on the right side of the containers, as shown in figure 7-13.

Inspect, arm, and assemble the automatic actuator in accordance with NavAir 13-1-6.2 and chapter 10 of this manual. Record the actuator time delay, installation date, and cartridge expiration date on Parachute Record Card and Parachute History Card.

NOTE: The automatic actuator must be armed with a Mk 4 Mod 0, 0.75-second time delay cartridge or a Mk 4 Mod 1, 0.75-second time delay cartridge.

Install the actuator into the actuator pocket and close the slide fastener. Snap the actuator pocket flap closed.

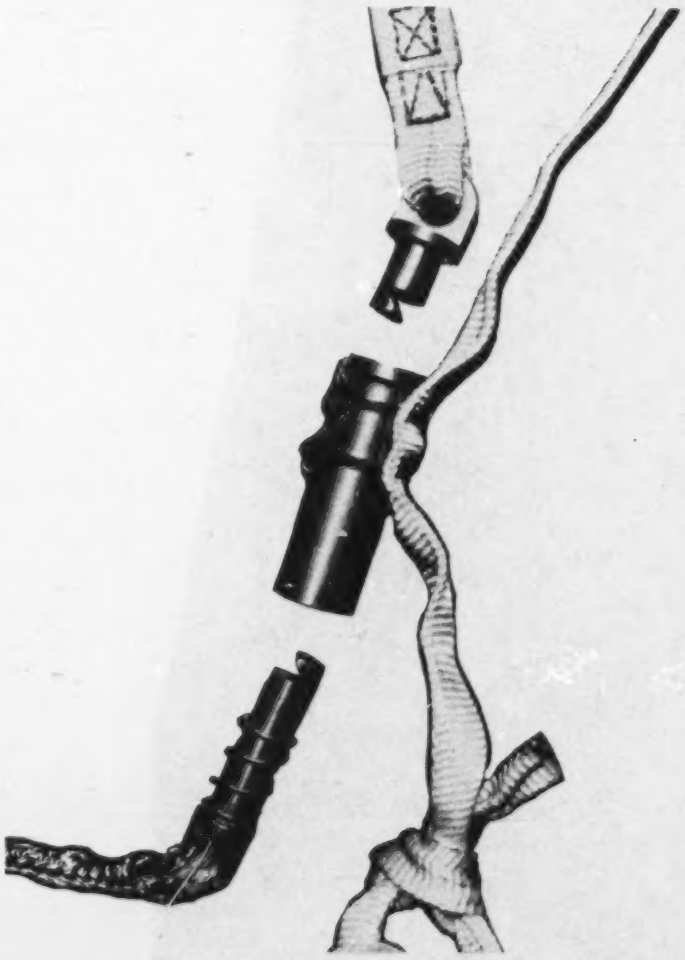

PR.202

Figure 7-12.—Attachment of external pilot parachute.

PR.203

Figure 7-13.—Installation of automatic actuator.

Install new suspension line retaining bands on the eight retaining band loops. New retaining bands must be installed each time the NB-11 is packed.

ATTACHMENT OF CONTAINER ASSEMBLY TO RISER ASSEMBLY

Remove the tension strap from the canopy peak and remove the tension hooks from the links. Rotate the risers onto the container and secure the riser fasteners to the four inboard container fasteners.

To install the connector link ties, cut two 12-inch lengths of 100-pound nylon cord and sear the ends. Form a 1-inch loop in one end of each line and secure with a bowline knot, followed with an overhand backup knot. (See fig. 7-14.)

Position the connector links side by side so that the top lift webs are on the right and bottom connector links are on the left. Form a noose around the connector links as shown in figure

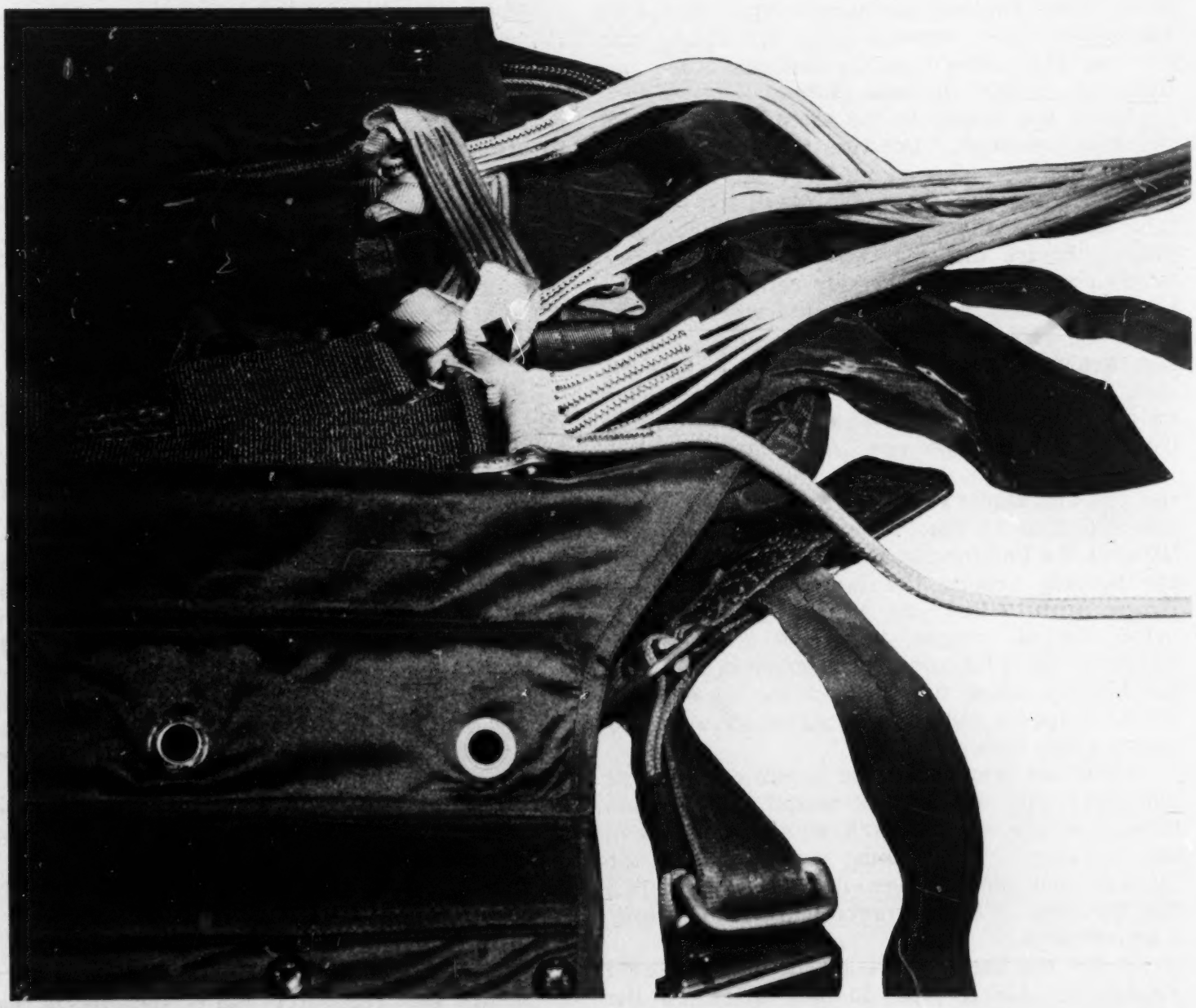

PR.204

Figure 7-14.—Tying the connector link ties.

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7-14. Tighten the noose and tie the free end of the tie cord to the bottom cloth retaining band loop with 3 to 4 half-hitches; trim the excess cord. Secure the connector links on the packer's side and the helper's side in the same manner.

RELEASE ASSEMBLY LANYARD AND RIPCORD ASSEMBLY INSTALLATION

Mark the clamp release lanyard 36 inches from the locking pin end, and fold the top end flap onto the container so that the base plate faces up. Position the large slotted end of the base plate clamp under the screwhead on the base plate. Position the manual ripcord housing and power cable housing under the clamp with the two flat sides together and the other two flat sides against the base plate.

Place the clamp in the clamping groove of the two housings. Position the small slotted end of the base plate clamp over the base plate stud. Insert the release lanyard locking pin into the stud hole, and secure the clamp in place. Insure that the two housings are correctly positioned and securely retained. Safety-tie the locking pin to the stud with one turn of waxed size FF nylon thread, single. Pass the thread through the lanyard knot and tie the ends with a surgeon's knot followed by a square knot. Insert the top ripcord pin through the beveled side of the eye in the power cable.

Route the lanyard over the helper's side of the top end flap "V." Tack the lanyard to the top end flap at the "V" with 1/8-inch slack between the locking pin and the tacking, passing the tacking around the lanyard as shown in figure 7-15. Use one turn of waxed size A nylon thread, single, tying the ends with a surgeon's knot followed by a square knot. Route the lanyard along the inside of the top end flap to the helper's side of the automatic actuator power cable buttonhole.

Tack the lanyard to the upper edge of the container with one turn of waxed size A nylon thread, single, allowing 1/8-inch slack between the tackings. The tacking passes around the lanyard and not through it. (See fig. 7-16.) Tie the ends with a surgeon's knot followed by a square knot.

Reeve the lanyard through the lanyard guide grommet. Locate the 36-inch mark on the lanyard over the bar on the inboard connector link positioned on the helper's side. Secure the lanyard to the connector link bar with a bowline knot. The bowline knot must be positioned as close as possible to the connector link bar. Tie an overhand backup knot in the end of the lanyard cord.

Insert the ripcord housing clip into the riser loop attached to the ripcord handle clip. Using size A nylon thread, single, tack through the loop and hole in the ripcord housing clip. Tie ends with a surgeon's knot followed by a square knot. Insert the ripcord handle in the clip.

ATTACHMENT OF LOWER FIRING LANYARD TO SUSPENSION LINE CONNECTOR LINK

Route the lower firing lanyard at the gun between suspension line 21 and 22. Slide the container towards the canopy and form "S" folds in the suspension lines large enough to allow the loop in the end of the firing lanyard to aline with the connector links. Remove the yoke and plate assembly on the outboard connector link located on the helper's side. Insert the connector link bar through the loop in the lower firing lanyard and reattach the yoke and plate assembly. Tighten the screw to a torque value of 20 to 25 inch-pounds.

STOWAGE OF SUSPENSION LINES

Grasp the suspension lines approximately 16 inches from the connector links and form and stow the first suspension line bight in the hesitator loop farthest from the canopy on the helper's side, as shown in figure 7-17.

The second bight will be stowed in the hesitator loop opposite the first bight on the helper's side. Bights 3 through 8 will be stowed in the same manner as bights 1 and 2. The packer will stow bight 9 in the retaining band next to bight 7. Stow bights 10 through 12 in the same manner as bight 9. There must be 15 (±1/4) inches of line between bights. Packer can stow bight 13 in inboard retaining band across from bight 12. (See fig. 7-18.)

There will be 10 1/2 (± 1 1/2) inches of suspension line between the last stowed bight and the skirt hem.

STOWAGE OF LOWER FIRING LANYARD

Insure that the safety pin is installed in the spreading gun. Form a bight in the lower firing lanyard at the white tape mark on the extractor sleeve. The white tape mark must be

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Figure 7-15.—Lanyard tacked to top end flap.

22 (± 1/2) inches from the spreading gun. Stow the first firing lanyard bight in the center of suspension line bight number 16, as shown in figure 7-19. Continue stowing the firing lanyard in the suspension line bights 15 through 9 in the same manner as shown in figure 7-19.

Using a 3/8-inch wood or steel rod with a smooth rounded end, tuck a 1/2 (±1/8)-inch bight of firing lanyard into the hesitator loop holding bight 8. Position the bight on top of the suspension lines. Stow bights of firing lanyard in suspension line bights 7 through 4 in the same manner as in the previous step. Position the remaining firing lanyard between the suspension lines and outboard connector link on the helper's side of the container.

STOWAGE OF SPREADING GUN AND CANOPY

Insure that the safety pin is installed in the spreading gun. Do not lift the gun by either the firing lanyard or the skirt hem. Grasp the gun above the safety pin only.

Simultaneously the packer must grasp the skirt hem on the left side with the left hand and the spreading gun with the right hand. The helper

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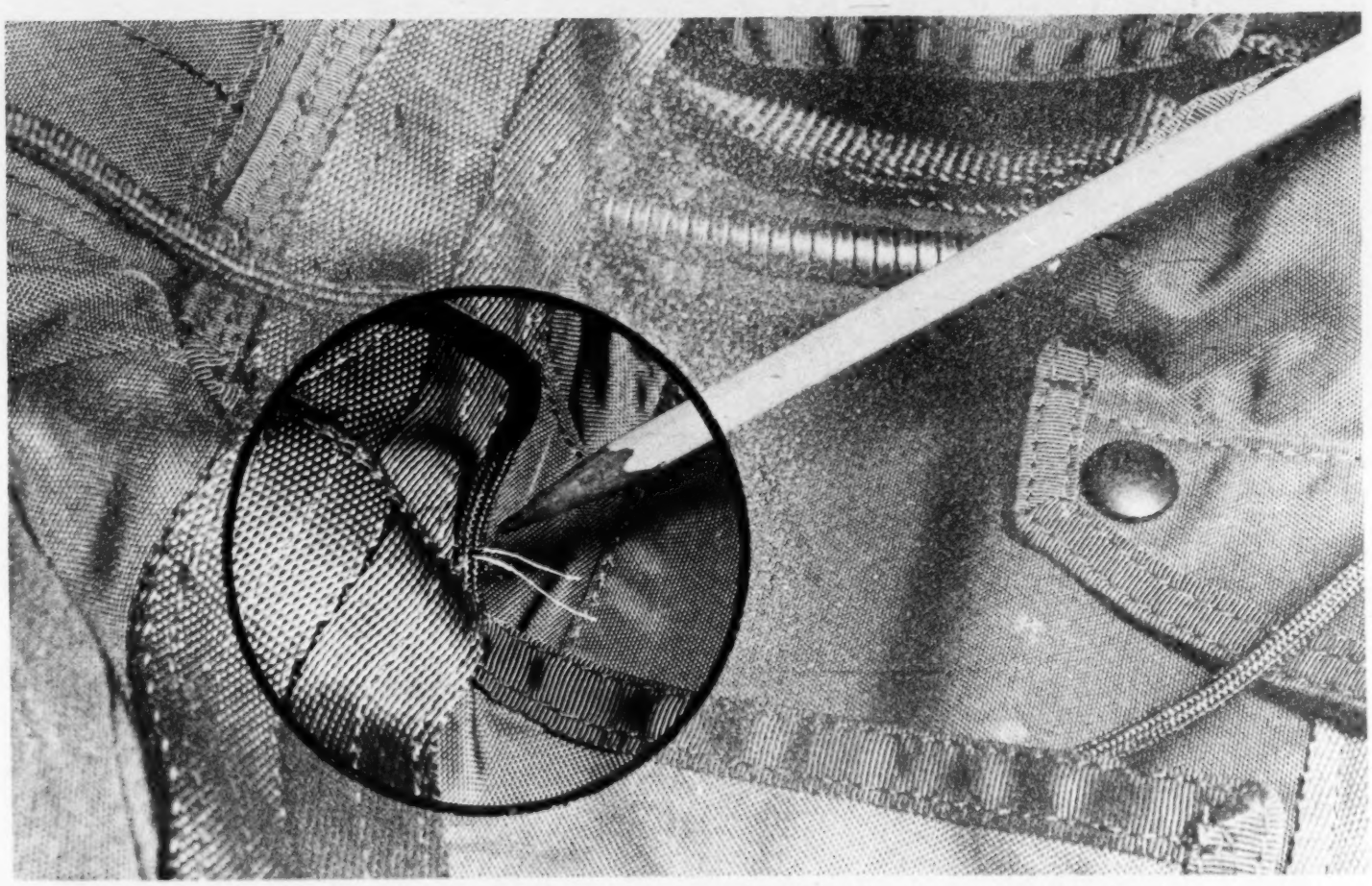

PR.206

Figure 7-16.—Lanyard tacked to upper edge of container.

grasps the skirt hem on the right side. The packer and helper together draw the skirt hem across the container to the top edge and fold it under so the spreading gun is positioned with the firing mechanism facing toward the container bottom. The canopy is lowered into the container with the spreader gun positioned off center to the left, next to the left group of risers, and butted against the top edge of the container. The packer folds the canopy back and removes the spreader gun safety pin. Tuck the canopy into the sides and top corners of the container, and continue folding the canopy, as shown in figure 7-20, up to the third fold.

Cut a 36-inch length of 18-pound nylon tape, MIL-T-5608, and tie an overhand knot in each end of the tape. Insert the tape through the loop on the canopy radial seam, place the tapes across the folded canopy, and continue folding the canopy. Route one end of the 18-pound nylon tape through the vent lines and loop in the upper firing lanyard. Tie the ends of the tape together with a surgeon's knot. (See figure 7-21.)

Check for entanglements in the pilot parachute connector cord. Form a pocket in the top fold of the canopy in line with the second grommet from the top end of the container, and position the pilot parachute override disconnect in the pocket. Position the compressed pilot parachute on top of the override disconnect so that the locking cone is alined with the second grommet from the top end of the container. The pilot parachute temporary locking pin should

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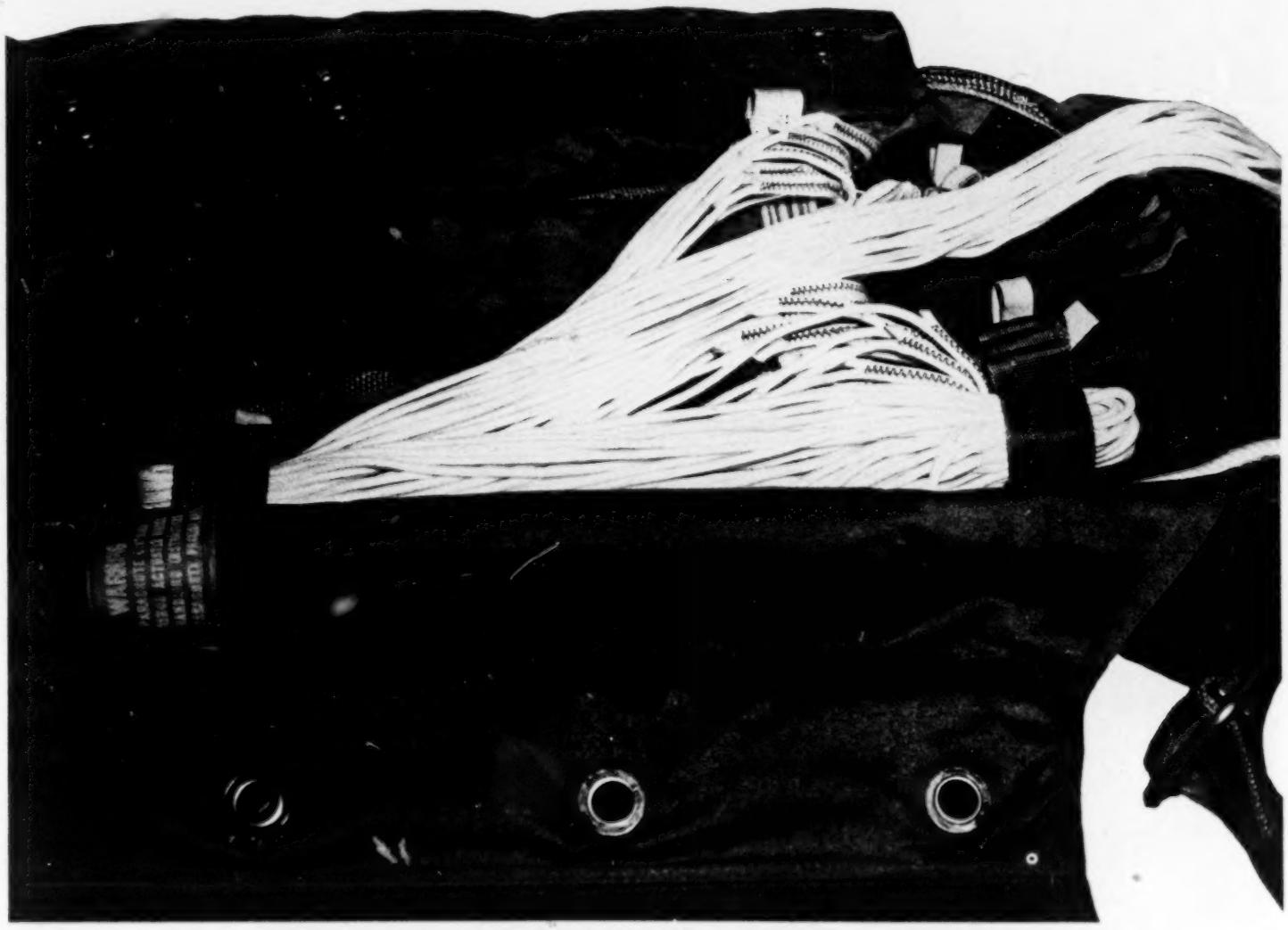

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Figure 7-17.—First and second bight taken in stowing of suspension lines.

extend over the top end flap. Roll the pilot parachute cloth under the outer edge of the crown.

Rotate the container 90° clockwise so the top end of the container is on the packer's side of the packing table. Route the external pilot parachute bridle out the bottom end of the container, to the left of the bottom end flap locking cone. Close the container in the normal manner.

INSERTING THE RIPCORD

The packer will insert the ripcord pin into the beveled side of the power cable eye and into the top end flap locking cone. Replace the temporary locking pins with ripcord pins, working from the packer's side to the helper's side of the container.

Pass the ball end of the shear link through the buttonhole in the bottom end flap of the container, as shown in figure 7-22.

Insert the ball end of the shear link cable firmly into the opening in the external pilot parachute release mechanism. The helper can proceed to tuck the bottom end flap under the side flaps, using long bars inserted into pockets; this will apply tension to the locking lanyard and lock the shear link cable in the release mechanism. The packer and helper must aline the grommets in the side flaps over the locking cone in the bottom end flap. Insert the bottom ripcord into the locking cone and pull on the shear link cable several times to insure that it is properly locked in the release mechanism.

The external pilot parachute bridle must be routed to the left of the bottom end flap locking

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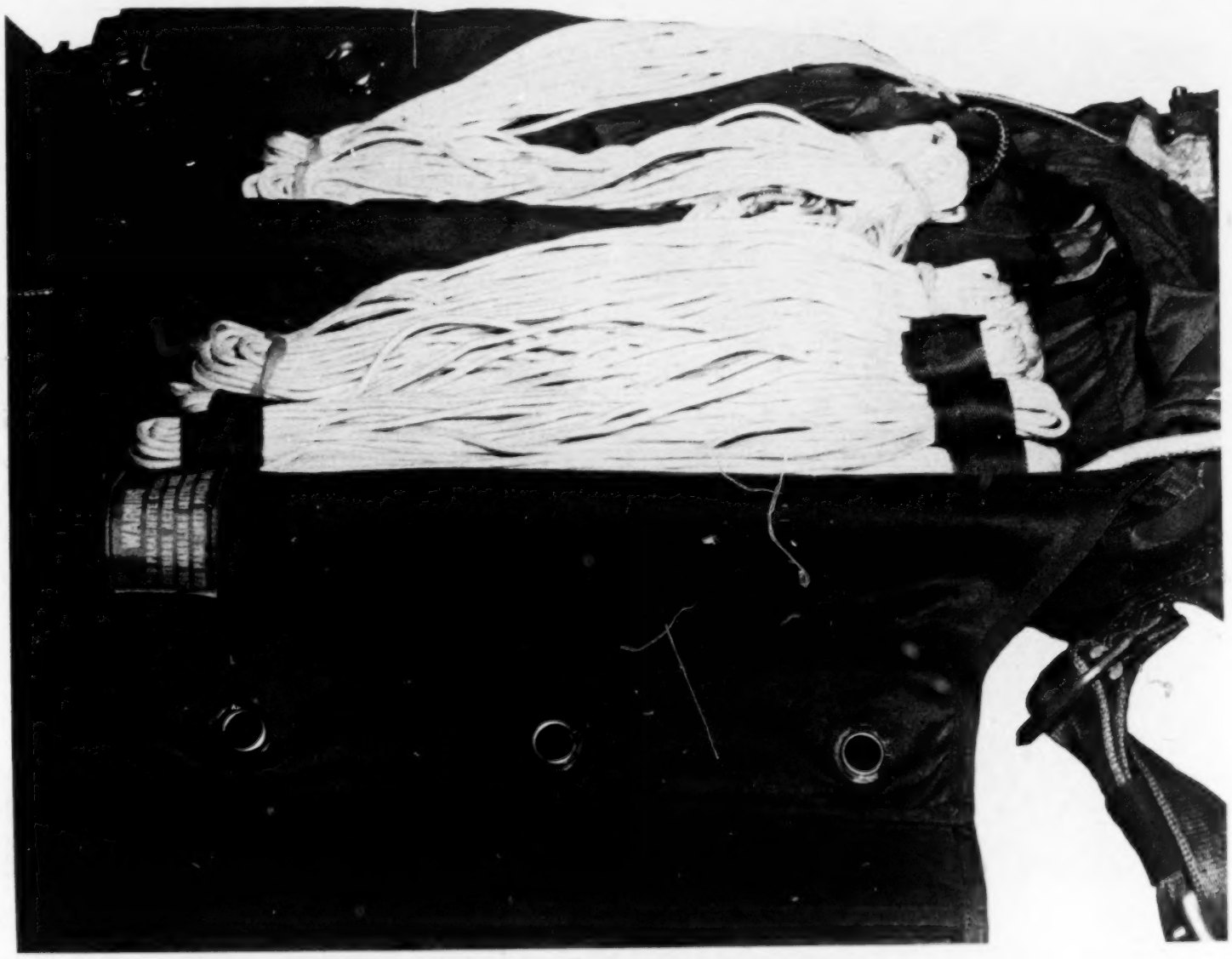

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Figure 7-18.—Suspension lines stowed.

cone. Safety-tie the bottom ripcord pin with one turn of unwaxed size A nylon thread, single. Tie the ends with three to four half-hitches.

NOTE: Do not pass the external pilot parachute bridle under the spring opening bands.

Attach the container spring opening bands to the eyes on the container side flaps and end flaps.

FOLDING AND STOWING THE EXTERNAL PILOT PARACHUTE

Remove dips and twists from the external pilot parachute suspension lines, then whip and fold the pilot parachute canopy in the same manner as the main parachute canopy. (See figure 7-23.)

Fold both sides of the skirt hem together and position above the radial seams. Fold the gores on each side of the radial seams on top of each other above the radial seams. (See fig. 7-24.)

Place a long bar over the folded pilot parachute and fold the peak over the long bar so that the pilot parachute is 1 inch shorter than the deployment bag. (See fig. 7-25.)

Insert the pilot parachute peak into the deployment bag using the long bar, then remove the long bar. Tie each pair of grommets on the deployment bag together with one turn of waxed size A nylon thread, single. Tie the ends with a surgeon's knot followed by a square

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Figure 7-19.—Stowing the first bight of the lower firing lanyard.

knot. Position the deployment bag so that the static line is on the packer's side of the packing table with the hesitator loops facing up. Form a hook bend in the end of the temporary locking pin. The packer stows a bight of the pilot parachute suspension lines in the hesistator loop farthest from the helper and farthest from the grommets, using the modified temporary locking pin. The remaining suspension lines and four bights of pilot parachute bridle will be stowed in the same manner, as shown in figure 7-26.

Position the external pilot parachute shear link in the center of the elastic stow pocket. Insert the deployment bag into the elastic stow pocket with the suspension lines facing down and the static line facing inboard. Position the deployment bag so that the static line is routed out the center of the stow pocket. Tack both elastic stow pocket flaps to the static line and place the ring on the end of the static line over the arming cable. Route a length of waxed, 6-cord, single, through the adjacent slots in the automatic actuator arming cable fitting. Tie the static line to the arming cable fitting with a surgeon's knot followed by two square knots. Close the lanyard release assembly protector flap. (See fig. 7-27.) Check the flatness of the packed container using a go-no-go gage.

Insure that the fail-safe ballistic spreader gun safety pin has been removed, and account for all packing tools.

The packer must sign off the Parachute Record Card and Parachute History Card.

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Compensating Gate Clamp

Before discussing how the compensating gate clamp circuit utilizes the gating pulse, first consider its static state. Referring to figure 16-13, note that R111 and R110 form a voltage divider between minus 300 volts and the cathode of V16 which is approximately positive 6 volts in static condition. The plate of V31A is held slightly positive (approximately 1 volt) with a small current flowing through R102 and V31A.

When the equipment is operating, a sawtooth voltage of approximately 20 volts in amplitude is developed across the sweep driver cathode resistor. This 20-volt increase will increase the charge on C54 and the current through V31A. The voltage to which C54 will charge will be proportional to the amplitude and duration of the sweep sawtooth.

As the sawtooth is terminated, the compensating gate multivibrator produces a positive square wave (discussed previously) which cuts off V31A. This effectively connects the capacitor C54 to the grid of the first compensating gate amplifier. Thus, the voltage across C54 which is proportional to sweep amplitude is used to generate the compensating gate voltage.

A summary of the action of the circuit is as follows:

1. C54 is charged to a voltage that is proportional to the amplitude of the sweep sawtooth.
2. At the end of sweep time the compensating gate circuit is triggered and a square wave gating pulse is generated.
3. This square wave is used to disconnect V31A from the circuit.
4. The voltage across C54 is now applied to the grid of the first amplifier.
5. At the end of the gating pulse, V31A conducts and the circuit is ready for its next sweep.

Study the waveforms in figure 16-14 carefully and insure that the time relationship of each waveform is understood.

Compensating Gate Amplifier

The compensating gate amplifier consists of two voltage amplifiers and a cathode follower. (See fig. 16-15.) Their function is to amplify the compensating gate pulse to the proper level to drive the compensating gate driver. The amplifier is similar to the sweep amplifier discussed in the previous section and therefore is discussed only briefly.

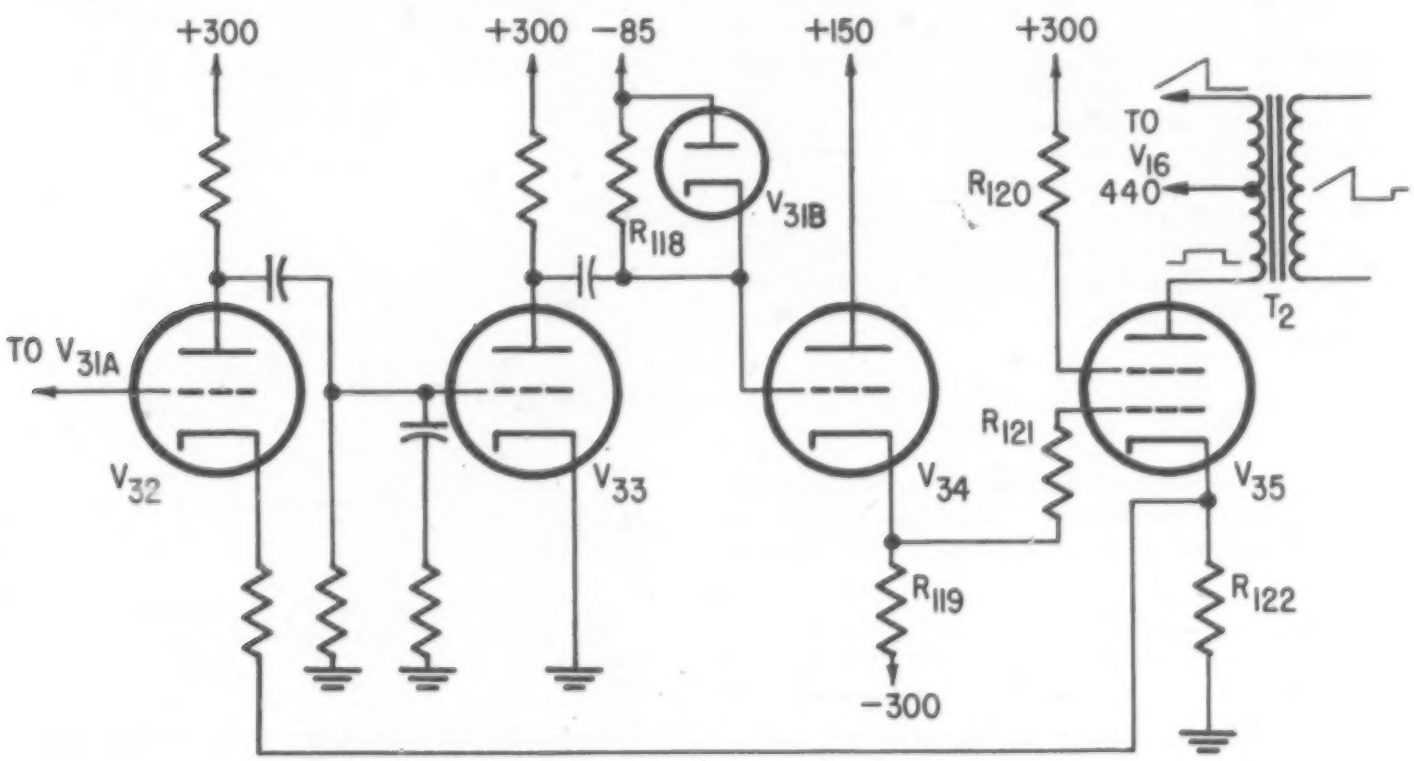

Figure 16-15.—Compensating gate circuit, part 2.

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Figure 7-20.—Stowage of canopy.

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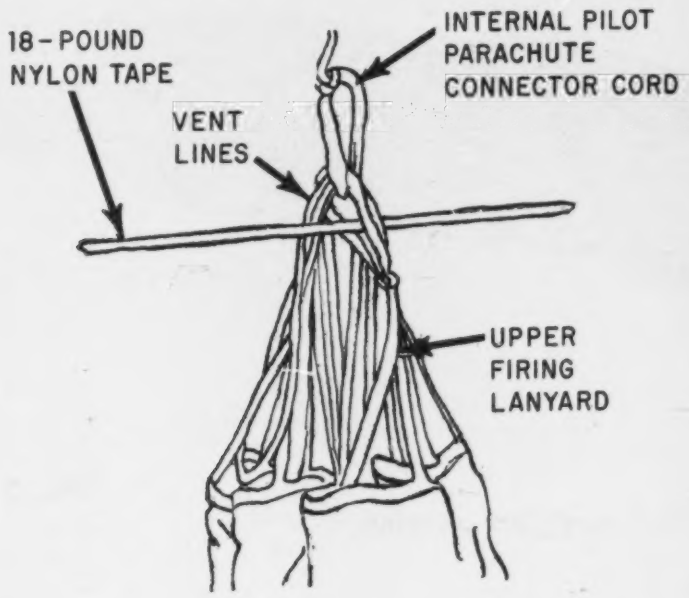

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Figure 7-21.—Routing of 18-pound nylon tape.

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Figure 7-22.—Inserting ball end of shear link cable.

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Figure 7-23.—Whipped and folded pilot parachute canopy.

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Figure 7-24.—Pilot parachute ready for stowing.

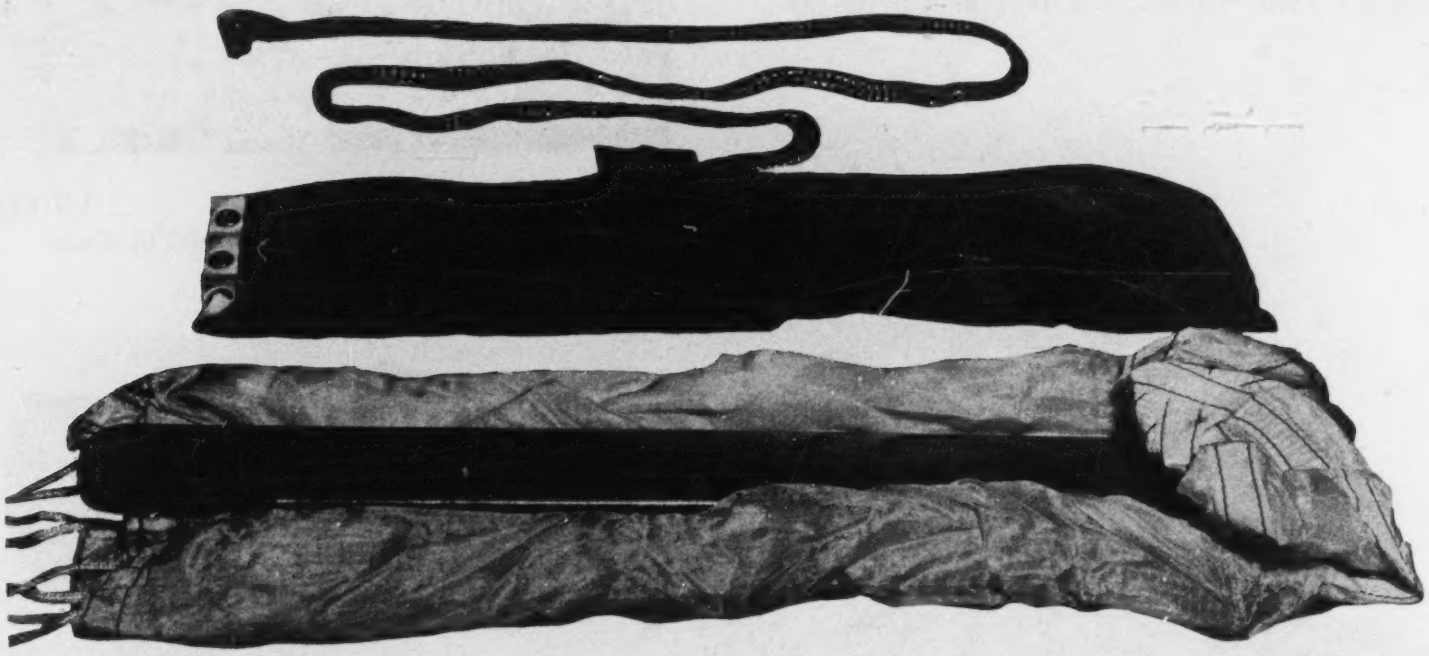

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Figure 7-25.—Pilot parachute peak folded over long bar.

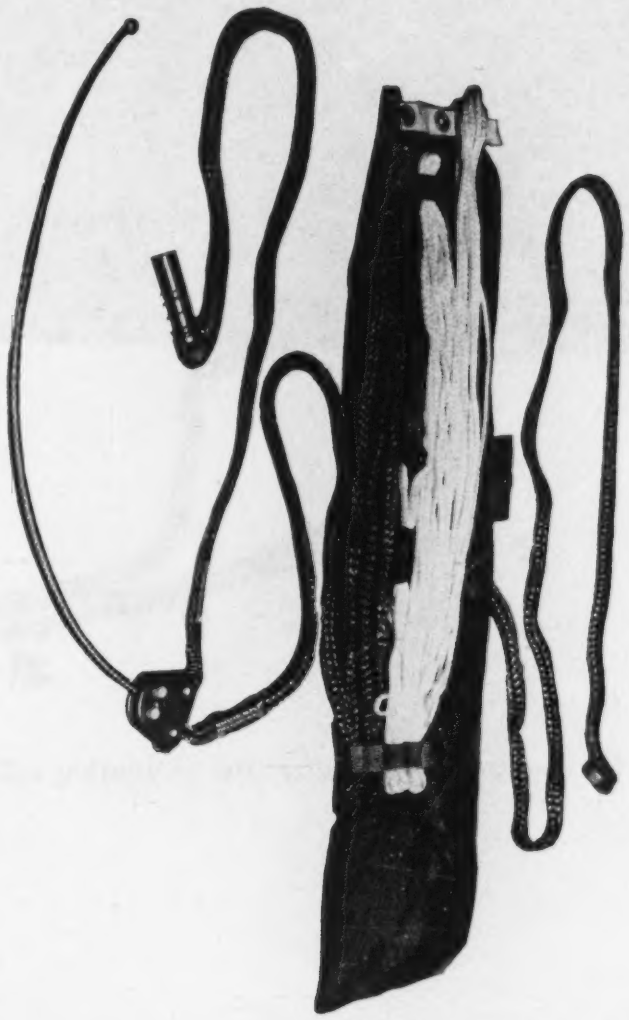

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Figure 7-26.—Suspension lines and pilot parachute stowed.

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Figure 7-27.—Tacking of static line to arming cable.

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CHAPTER 8

PACKING AND RIGGING THE MARTIN-BAKER PARACHUTE

The Martin-Baker parachute is designed to be used with the Martin-Baker ejection system. The complete ejection system consists of an ejection seat, ejection gun, drogue gun, two drogue parachutes, time release mechanism, and personnel parachute and harness assembly.

The system is designed to provide safe escape at all altitudes and speeds, and after ejection, to automatically extract the personnel parachute and lift the occupant from the ejection seat.

Ejection at ground level during takeoff or landing when the airspeed is 100 knots or over is both safe and practicable because of the high ejection velocity of the ejection gun and the rapid extraction of the personnel parachute.

When ejection is made above 10,000 feet, a barostatic control prevents separation of the pilot and seat during the descent to 10,000 feet. The occupant is supplied with oxygen during the descent, and his drop is controlled by the stabilizer drogue.

Normal ejection is accomplished by pulling a face (blind) curtain. A secondary handle is located on the forward part of the seat bucket and is used if normal ejection cannot be effected. Either action causes the seat to be propelled upward by three successively fired cartridges operating in a telescoping ejection gun composed of three cylinders.

After ejection, the following operations take place:

1. The ejection seat drogue gun fires a piston which deploys the controller drogue parachute.
2. The controller drogue parachute, in turn, deploys the stabilizer drogue parachute. The stabilizer drogue parachute remains attached to the seat by a scissor shackle.
3. The scissor shackle is released at a preset altitude and safe "G" level by the operation of the time release mechanism. The aircrewmen separates from the seat during this operation.
4. When the stabilizer drogue parachute releases from the seat, it pulls the withdrawal line assembly from the container assembly. As the withdrawal line reaches full stretch, the ripcord locking pins are removed from the locking cones, permitting the grommets, locking cones, and end tabs to disengage.
5. The container spring opening bands pull the end side flaps apart, allowing the pilot parachute to spring from the container and fill with air.

If the ejection seat time release mechanism fails to operate, the aircrewman can manually disengage himself from the seat by pulling the emergency harness release handle. This procedure is also followed in crash rescue operations. When manual disengagement is necessary, the guillotine assembly will cut the withdrawal line (if the slide disconnect pin is not used), securing the drogue parachute to the pilot parachute. The slide disconnect pin, if used, replaces action of the guillotine assembly. The manual ripcord handle is then pulled, deploying the pilot parachute which deploys the canopy. The canopy fills with air and the aircrewman hangs suspended in his harness.

Although personnel of the AME rating are responsible for the removal and installation of the seat and its components, the PR is responsible for packing and rigging both the drogue chutes and the personnel parachute.

Personnel parachute packs of various shapes are used with Martin-Baker parachute canopies. The type of pack used depends on the design requirements of the seat and aircraft concerned. Two of these containers are the horseshoe and the envelope. The most unusual of these types is the horseshoe. Coverage in this section is limited to the integrated horseshoe type.

The Martin-Baker horseshoe pack is a back type, secured to the seat by two restraining straps. It is shaped like a horseshoe to allow

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the shoulder straps to pass under the arch of the horseshoe into the top lock of the inertia reel while leaving the canopy free for clean extraction through the opening in the top of the pack.

Differences occur in packing of the various types of Martin-Baker parachutes. Therefore, before attempting to pack one of another configuration, be sure to consult NavAir 13-1-6.2, covering the parachute and seat involved.

DUPLEX DROGUE PARACHUTES

The drogue parachute assembly (fig. 8-1) is composed of two parachutes—a 22-inch diameter controller drogue (small controller) and a 5-foot diameter stabilizer drogue (main stabilizer).

This assembly stabilizes and decelerates the seat with a minimum of altitude loss, and positions the seat in a convenient attitude for occupant separation. Upon actuation of the time release mechanism, the main drogue parachute extracts the occupant's personnel parachute from its container, and releases the occupant's face curtain restraints and personnel parachute slide disconnect static cable anchorage, if applicable.

When the drogue gun is fired, the projectile (connected to the controller drogue withdrawal line) first pulls the drogue container spring pin, releasing the four flaps. The pull of the projectile through the withdrawal line pulls the drogue from the top of the container. The pull of the deployed controller drogue extracts the stabilizer drogue from its container by the withdrawal line connected to the apex. After deployment, the stabilizer drogue stabilizes and decelerates the seat and occupant with a minimum of altitude loss and positions the seat into a convenient attitude for occupant separation.

The two drogue parachutes are fabricated of a cotton material and stowed in the headrest structure at the top of the seat. The controller drogue is packed on top of the stabilizer with a protective cloth sleeve between the two. The packed controller is attached to the controller drogue withdrawal line, and covered by four cloth flaps which are secured by a pin.

The face blind is stowed in a separate compartment at the front of the drogue parachutes container. The face blind handle cross tube is retained at each end by a spring-loaded pin which engages in a hole in the side of the container. The face blind straps extend aft through a channel-shaped housing within the container on each side and terminate in lugs which are retained by the link line pins. The face blind firing cable passes aft through the container and emerges between the flaps, together with a secondary firing cable.

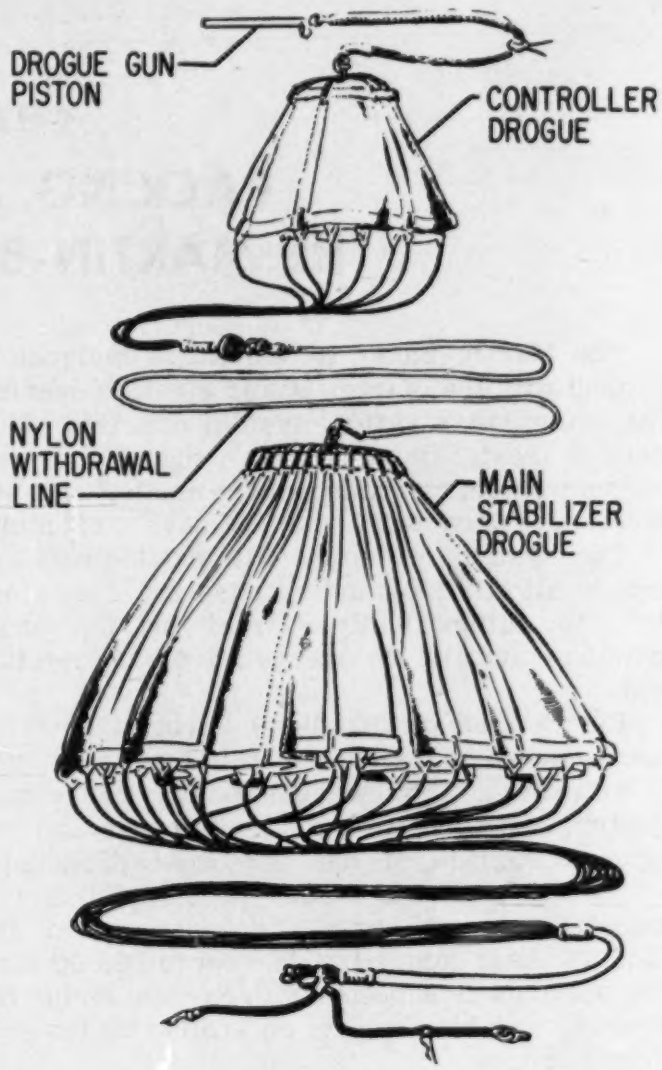

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Figure 8-1.—Martin-Baker drogue parachutes.

REMOVAL AND INSTALLATION

In order to assure safe operation of the seat, it is essential that the drogue parachutes be properly packed, and that the lines are correctly routed.

The drogue parachutes should normally be inspected and repacked at intervals of 182 days

(maximum), unless required more frequently by unusual circumstances. This work should be done only by personnel qualified in parachute handling.

It is not necessary to remove the drogue parachutes to the parachute loft for repacking. It is recommended that this work be done indoors with a clean surface available on which the parts may be laid, but it may be performed on the aircraft if necessary.

The following safety precautions must be observed:

1. If seat is not installed in the aircraft, check that the ejection gun is not with the seat and that the drogue gun is either unloaded (barrel removed) or safetied (safety pin in hole).

2. If the seat is installed in the aircraft, check that the safety pins are installed in the ejection gun sear and in the drogue gun safety pin hole.

The life of the face blind is 36 months after installation in the aircraft. The expiration date is stamped or stenciled on the face blind. The face blind should be replaced with a new one when the life period has expired. Expiration dates and replacements must be recorded in the aircraft logbook.

Removal of Face Curtain (Blind)

Retaining the safety pin in the ejection gun sear, push the sear forward and remove two firing cable eyes from the hook of the sear. This step is not necessary if the seat is not mounted on the ejection gun.

Remove the safety pin from the face curtain and stow in the clip on the seat pan.

Pull on the striped face curtain handle to extend the face curtain, then pull the firing cable forward through the hole in the container.

Pull the link line pins out of the fittings at the sides of the container to free the lugs at the ends of the face curtain restraining straps. The face curtain may now be removed from the seat. This step is necessary only if it is desired to remove the face curtain from the seat.

Removal of Drogue Parachutes

Disconnect controller drogue withdrawal line from the drogue gun piston by removing the nut and bolt. Temporarily replace the bolt and nut in the small shackle.

Break and remove the safe-tie thread on the flap securing pin.

Pull the flap securing pin out of the flap pocket and out of the wire loop on the flap. The pin will also be pulled out of the shackle safe-tie loop. This loop of nylon line may be reinstalled later if not damaged.

Lift up the scissor and shackle to a vertical position.

Placing the secondary firing cable to one side, fold back the four flaps and pull out the controller drogue by means of its withdrawal line.

Pull out the protective sleeve and remove the stabilizer drogue by pulling on the withdrawal line.

Note that the drogue shackle is still held in the scissor and retains the stabilizer drogue suspension lines. It is not necessary to break this connection; but if it is desired to remove the drogue parachutes from the seat, proceed as follows:

1. Unscrew the link line connector, if the personnel parachute is installed.

2. Operate the time release mechanism by pulling the trip rod sear. Keep hands away from descending plungers to avoid injury. After operation, replace the trip rod sear fully home in the time release mechanism.

3. Open the scissor and remove the shackle. The link line will also be removed, as it is attached to the shackle.

Examine the drogue parachutes, suspension lines, withdrawal lines, shackle attachments, etc., for evidences of possible deterioration. Take corrective action if necessary.

Clean the inside of the drogue parachute container.

Packing Stabilizer Drogue Parachute

Open the four flaps. Pull up the protective sleeve and roll it down so that it does not obstruct the packing.

If the drogue shackle has been removed from the scissor, proceed as follows:

1. Place the shackle bolt within the jaws and close the scissor. The link line should be forward and the eye of the stabilizer drogue suspension line should be aft.

2. Cock the time release mechanism. The shackle will then be retained in the scissor.

Holding the stabilizer drogue, extend the suspension lines from the shackle and straighten them out, so that they are not twisted or tangled.

Pair off the 24 suspension lines and fold the skirt into 6 double folds. (See fig. 8-2.)

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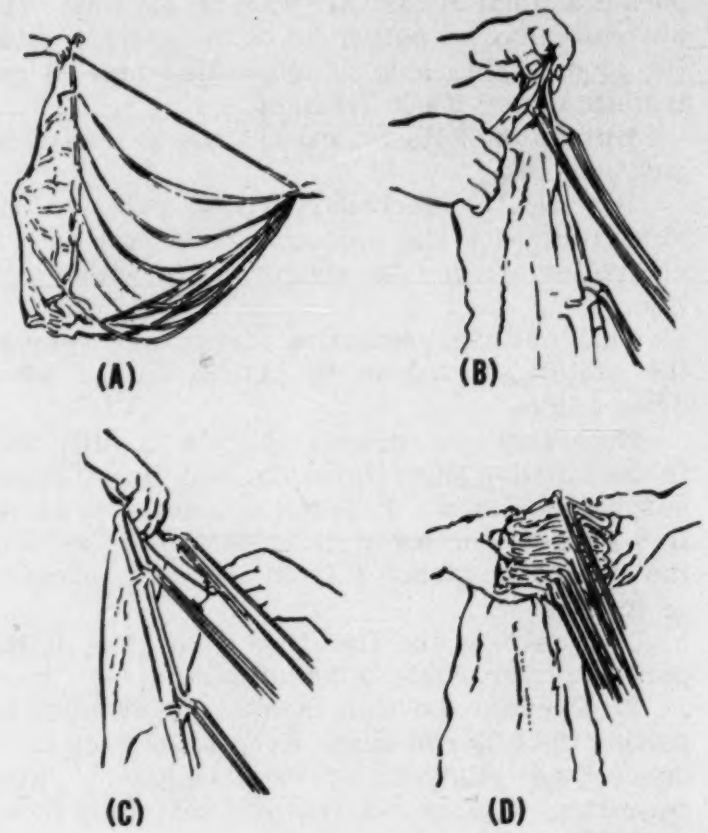

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Figure 8-2.—Pairing suspension lines.

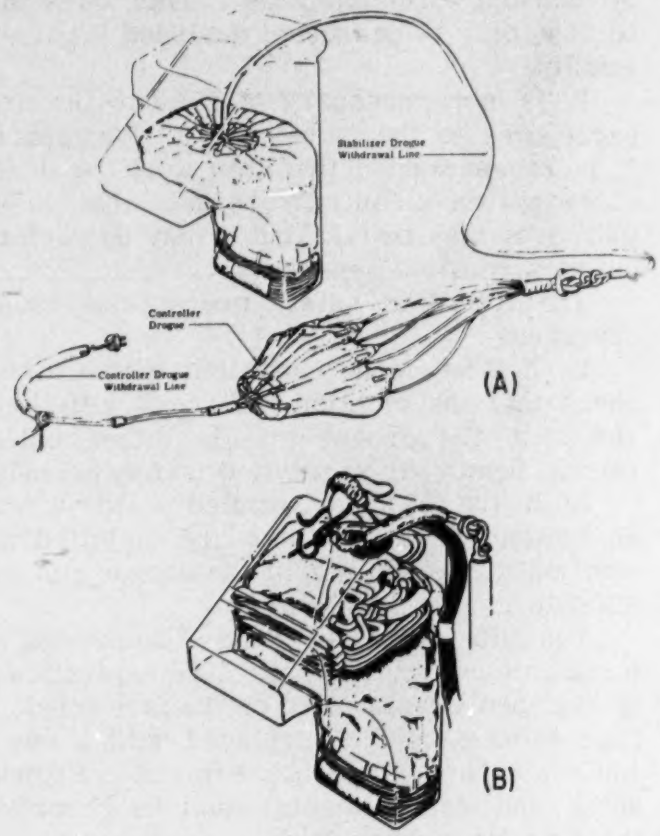

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Figure 8-3.—Martin-Baker drogue chute packing.

Holding the folds as shown in view (D) of figure 8-2, stow the suspension lines as follows:

1. Lead the sleeve protected portion from the shackle down the right aft corner of the container.

2. Stow the remainder of the suspension lines in the bottom of the container by looping them from side to side.

Stow the stabilizer drogue on top of the suspension lines. Insert the skirt first and pack the parachute in accordion fashion well down into the container. The apex remains on top. (See fig. 8-3 (A).)

Unroll the protective sleeve and pack it down into the container to cover the stabilizer drogue. At the same time, bring the withdrawal line out at the right aft corner of the container, together with the suspension (shackle) line.

Packing Controller Drogue Parachute

Holding the controller drogue, extend the suspension lines and the stabilizer drogue withdrawal line and straighten them out, so that they are not twisted or tangled.

Pair off the 10 suspension lines and fold the skirt into 3 single folds.

Holding the folds, stow the lines as follows:

1. Folding the withdrawal line into about 7 folds, place it in the front part of the container.

2. Loop the suspension lines over the remainder of the protective sleeve.

Fold the apex of the controller drogue on top of the skirt and stow in the container with the apex toward the left rear corner of the container toward the drogue gun, then pack it down. (See fig. 8-3 (B).)

The controller drogue withdrawal line must emerge from the left rear corner of the container toward the drogue gun. Loop the line behind the parachute so that 3 inches of line are exposed beyond the flap securing pin.

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Closing Flaps and Stowing Face Blind

If the face blind has been removed from the seat, proceed as follows:

1. Bring the face blind up to the headrest with the firing cable on top. (See fig. 8-4.)

2. Push the strap lugs back through the housings on each side and locate the lugs in the fittings for the link line pins, being sure the straps are not twisted.

3. Insert the link line pins into fittings at sides of the headrest, making sure that they pass through the lugs of the face curtain restraint straps and the lugs of the parachute restraint straps, if installed.

4. Mate or connect the link line connector, if removed, and personnel parachute is installed.

Pass the face curtain firing cable through the hole in the center of the container and lead aft. During this operation, push the packed parachute down with the finger to assure that there is no entanglement.

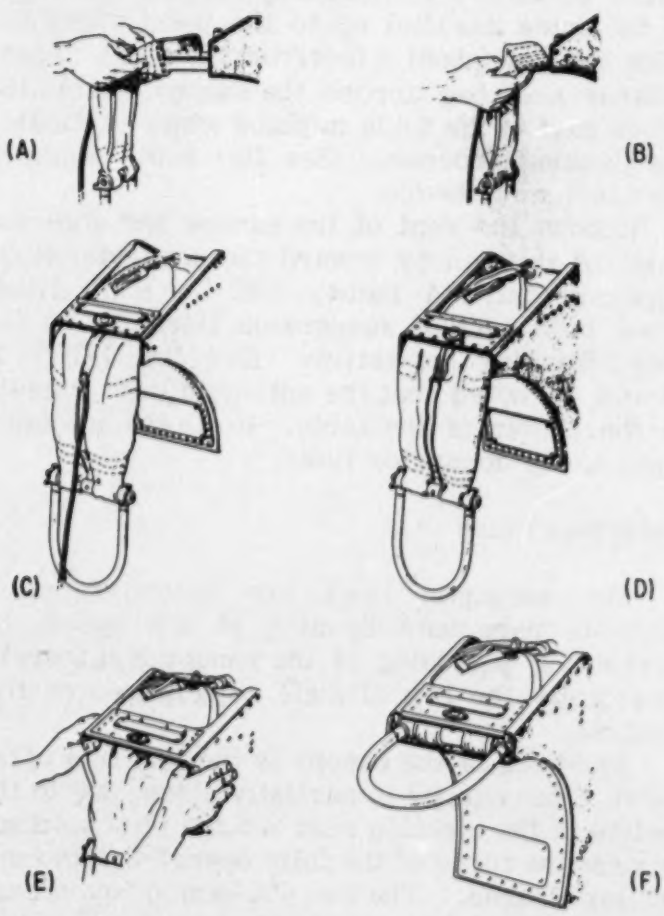

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Figure 8-4.—Stowing face curtain (blind).

Fold the undersides of the face curtain to the width of the container mouth.

Fold under the stitched aft end of the face curtain and insert it into the container.

Close the right, left, rear, and front flaps—in that order. Be sure that the wire loop on the right flap extends up through the grommets on the other three flaps. During this process make certain that the two firing cables pass under the front flap and over the rear flap.

Fold the scissor and shackle forward and down on top of the flaps.

Insert the points of the flap securing pin (on withdrawal line) through the wire loop of the flaps, then through the shackle safe-tie loop, and finally into the pocket on the front flap.

NOTE: If it should be necessary to replace the shackle safe-tie, use single nylon 6-cord Spec. MIL-C-7807 Type I or II, and tie the loop with a square knot. The loop must pass under the flap securing pin (not through it) between the wire loop and the pocket. The scissor and shackle must be free to lift up when the pin is pulled out by the withdrawal line.

Safe-tie the flap securing pin with a single loop of 6-cord nylon, through the eye of the pin and through the loop on the flap pocket; then tie with a double square knot. The two safety ties, which hold the flap securing pin and the drogue shackle in place must be replaced every 91 days. This can be done with the parachute in place.

Stow the remainder of the face curtain into the container and, using the thumbs, pack firmly into the sides.

Push the cross tube of the handle into the container, first one side and then the other, retracting the pins in turn. Make sure that the pins extend into the fittings on each side.

Install the face blind firing handle safety pin.

Connect the controller drogue withdrawal line to the drogue gun piston with the bolt and nut of the small shackle.

WARNING: It is essential for safe operation of the seat that the withdrawal line be routed over the link line and not under it, so that the withdrawal line is free to extract the controller drogue without entanglement.

MAIN PARACHUTE CANOPY

An Irvin 24-foot diameter flat nylon canopy with 24 gores is used with the Martin-Baker ejection seat. As stated earler, the canopy is

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The positive gate on the grid of V32 is amplified and inverted, and fed to the grid of V33. The gate is again amplified and inverted and appears as a positive gate on the grid of the cathode follower V34. The diode V31B is employed as a clamper to insure that each gate starts from the same static potential. The grid of the cathode follower is connected to a negative 85 volts, permitting an input signal of considerable amplitude without distortion. It should be noted that inverse feedback from the cathode of the driver to the cathode of the first amplifier is used to improve the shape of the compensating gate output.

Compensating Gate Driver

The driver V35 is identical to the sweep driver V16. Its output is a square wave of the same area as the sweep waveform. Although the compensating gate is of the same polarity as the sweep voltage, it is inverted since it appears at the opposite end of the primary winding of T2. Thus, the compensating gate is combined with the range sweep sawtooth voltage as shown in figure 16-16.

INTENSITY GATE CIRCUIT

The purpose of the intensity gate circuit is to provide a means of unblanking and blanking the indicator at the proper time. However, before discussing the intensity gate circuits, consider the circuits that provide it with a trigger or gating pulse. When the equipment is using a delay, the intensity gate circuit is triggered by the output of the sweep gate multivibrator. However, this pulse is not usable without prior amplification. This is accomplished by the sweep gate amplifier and the sweep gate cathode follower.

Sweep Gate Amplifier and Cathode Follower

The sweep gate amplifier V27 is conducting during static condition. (See fig. 16-7.) A negative square wave is applied to its control grid during sweep time, cutting it off. This produces a positive-going square wave which is direct-coupled to the grid of the sweep gate cathode follower V26. Its output, taken from the cathode, is fed to pin 4 of relay K15B. Thus, when the equipment is using a delayed operation, the intensity gating circuit is controlled by a positive square wave of the same time relationship as the range sweep sawtooth.

Figure 16-16.—Range sweep sawtooth and compensating gate voltage waveform

Intensity Gate Output

The intensity gate output V25 (fig. 16-17) is a cathode follower whose input comes from either the sweep gate output (just discussed) or the rangemarker gate circuit, depending on the type of operation employed. In either case the operation of the intensity gate stage is identical. Its input is a positive-going square wave, beginning and ending with sweep time, which causes V25 to conduct heavily. The increased current flow develops a positive square wave at the output, which is coupled to the intensity gate clamp circuit.

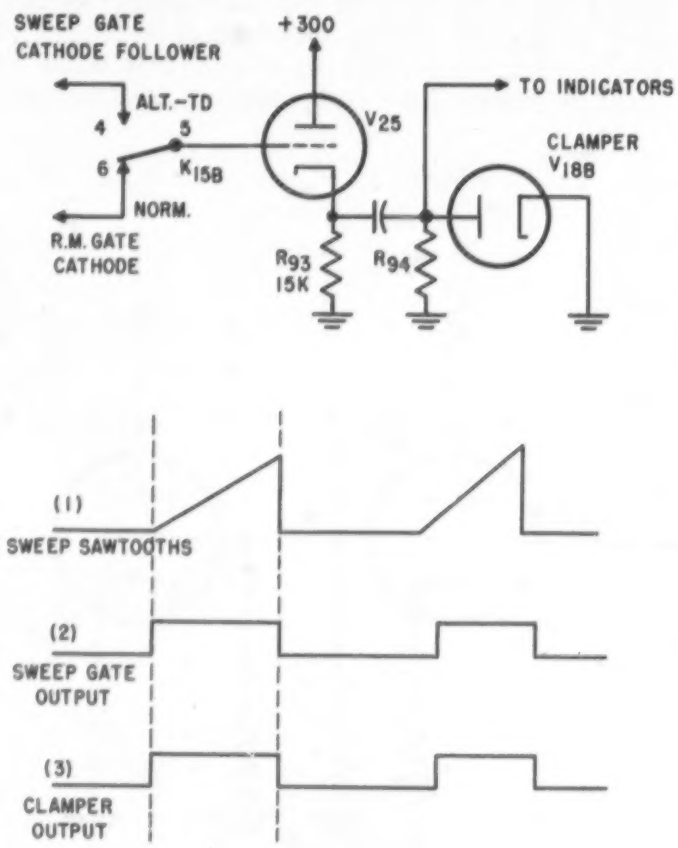

Figure 16-17.—Intensity gate circuit and waveforms.

packed in a soft, horseshoe or envelope type container. The integrated torso harness combines the aircrewman's parachute harness and shoulder restraint straps. The harness is channeled through the torso suit to retain it in position and to facilitate donning.

When aboard the aircraft and seated, the aircrewman connects the quick-release fittings (Koch) on the parachute riser assembly to the quick-release shoulder fittings on the integrated torso suit. The survival kit is also connected to the integrated torso suit by means of quick-release fittings (Rocket Jet).

The parachute and lift web assembly normally remain installed in the aircraft, except when removal for packing of the chute or servicing of the seat is required.

This section describes the procedure for packing the personnel parachute into the horseshoe pack. Before beginning the packing, check that the pack zippers are open, that pack opening bands are released, and that loose threads are removed. Parachutes in service are required to be repacked to coincide with the applicable aircraft inspection cycles specified in NavAir Inst. 4700.2.

Packing and Rigging

Lay the parachute on the table with the canopy assembly laid out its full length. Locate the canopy gore with the nameplate and place it uppermost in the center of the table. Separate the suspension lines into two equal groups, counting 12 lines on each side of the nameplate gore as shown in figure 8-5.

The connector links will have the snap fasteners down and be in position to attach to the tensioning device. (See fig. 8-6.)

Locate suspension lines No. 1 and No. 24. Follow lines down to the connector links (these lines must be on the inside of the upper links). Place the links on the tensioning device.

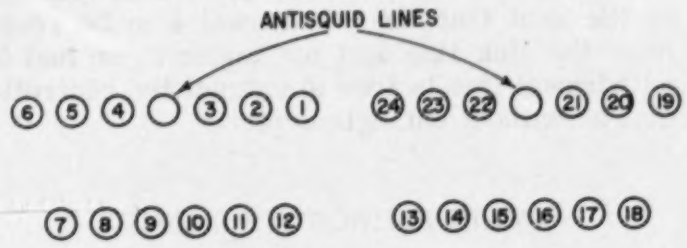

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Figure 8-5.—Arrangement of suspension lines.

Grasp the left and right paired groups of lines and follow them up to the skirt of the parachute to assure that there are no twists. If twists are found, pull the pack and lift web assembly through the lines until straight. (See fig. 8-7.) Pull the tensioning device strap up tight.

Check to insure that the lines at the apex are even and that the vent is straight with approximately the same length of line on each side of the loop in the connector cord.

Folding the Canopy

Untie the antisquid lines at the connector links and whip and fold the canopy in the same manner as described in chapter 6 of this manual for packing the NC-3 parachute. Fold each group of 12 gores in thirds, forming an S fold. (See fig. 8-8.) Place a shot bag on the folds near the skirt.

Extend the S fold on each side, holding the folded width to a minimum by keeping the edges of the folds parallel up to the point where the folds run out (about 4 feet from the apex). Place another shot bag across the canopy to hold the upper part of the folds in place while continuing the packing process. (See fig. 8-9.) Remove the tensioning device.

Unhook the vent of the canopy and slide the skirt of the canopy toward the connector links approximately 14 inches. At the same time, draw both sets of suspension lines out to the side, forming an arrow. (See fig. 8-10.) It should be noted that the antisquid lines remain in the center of the table. Retie the antisquid lines to the connector links.

Antisquid Lines

The antisquid lines are incorporated to promote parachute opening at low speeds by preventing squidding of the canopy and thereby improving the low altitude capabilities of the system.

Squidding of the canopy is the tendency of the skirt of the canopy to partially close, due to the weight of the ejection seat and the pilot working against the force of the fully opened 5-foot controller drogue. The two 400-pound rayon cord lines are braided and coreless and are cut 26 feet in length. Both of these lines should be marked 12 inches from each end. To obtain

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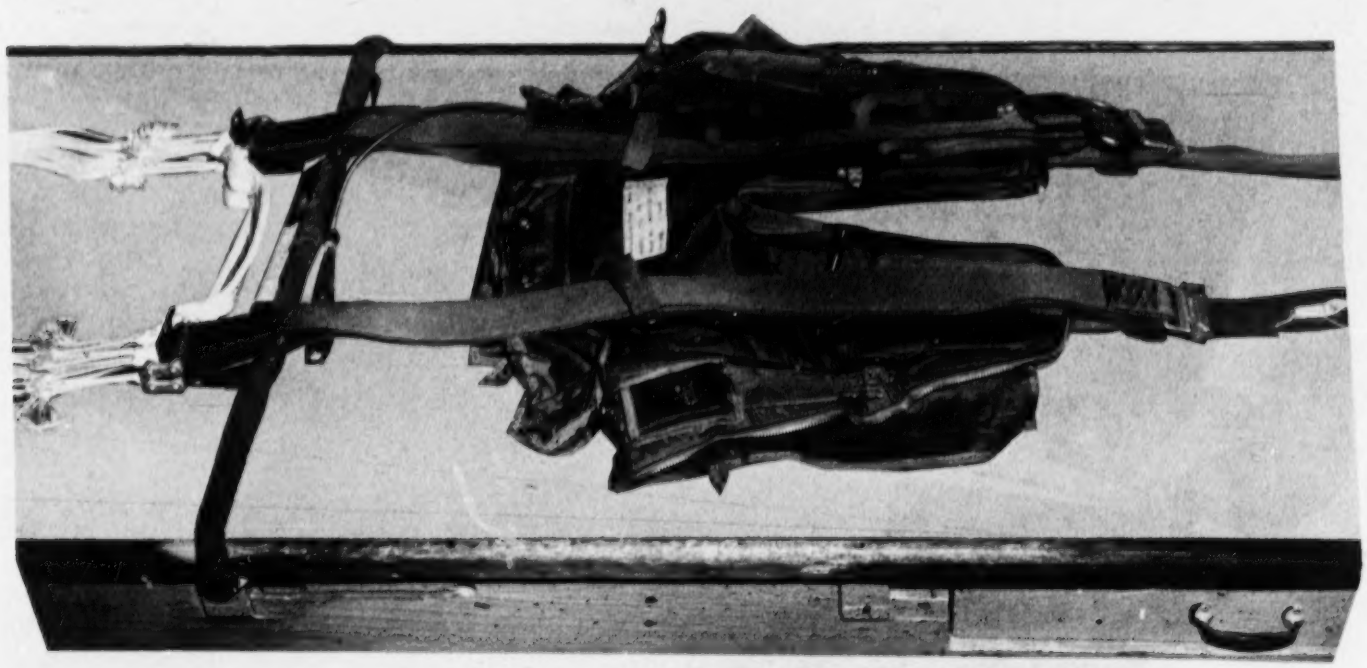

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Figure 8-6.—Layout of webs for packing.

accuracy in measurement, each line should be tensioned to a load of 5 pounds when being cut. Dip the free ends of the lines in a hot melted mixture of 50 percent paraffin and 50 percent beeswax, thereby preventing the ends of the lines from fraying. The antisquid lines are passed up through the center of the canopy. They are secured to the bight of the parachute withdrawal line and the suspension lines at the apex of the parachute with two turns and three half hitches. (See fig. 8-11 (A).) Be sure that the first knot is tied on the 12-inch mark. Whip the free end of the line with 3/4-inch pressure sensitive filament adhesive tape. Secure the other end of the antisquid line to the top connector link, passing the line under the first three suspension lines and parting the suspension lines so that the antisquid lines have three suspension lines on each side. Secure the line with two turns and three half hitches, insuring that the first knot is tied on the 12-inch mark. (See fig. 8-11 (B).) Whip the free ends with pressure sensitive filament adhesive tape.

Stowing the Suspension Lines

Before stowing the suspension lines, completely unzip and open the parachute pack and check that the pack opening bands are released. The antisquid line is not stowed with the suspension lines until the suspension lines are stowed in loop No. 8. Begin stowing the lines in the loop nearest the connector link. Pull the bight through the first two loops so that the loops of the suspension lines will be toward the inside leg of the pack when it is folded back over for closing. Bights will extend a maximum of 1/2-inch beyond hesitator loop. Then route the lines to the bottom center of the leg and take a bight through loop No. 3. Continue stowing the lines by pulling a bight alternately from one side to the other until loop No. 8 is reached. Stow the antisquid line with the suspension lines in loop No. 8. (See fig. 8-12.) Continue stowing the suspension lines through all the loops in the leg. Figure 8-13 illustrates the lines as stowed in one leg of the Martin-Baker pack. The helper will repeat the same process for the suspension lines in opposite leg.

After stowing the lines in both legs, bring the two groups of lines together at the arch of the pack. If the lengths of the two sets of lines are uneven to the skirt, place the junction off-center toward the side which is shorter, and stow the remainder of the suspension lines in the loops which are outside the legs. (See fig. 8-14.)

On one side, close the protective flap over hesitator loops 1 and 2, pass a length of FF nylon thread through each of the loops on the flap

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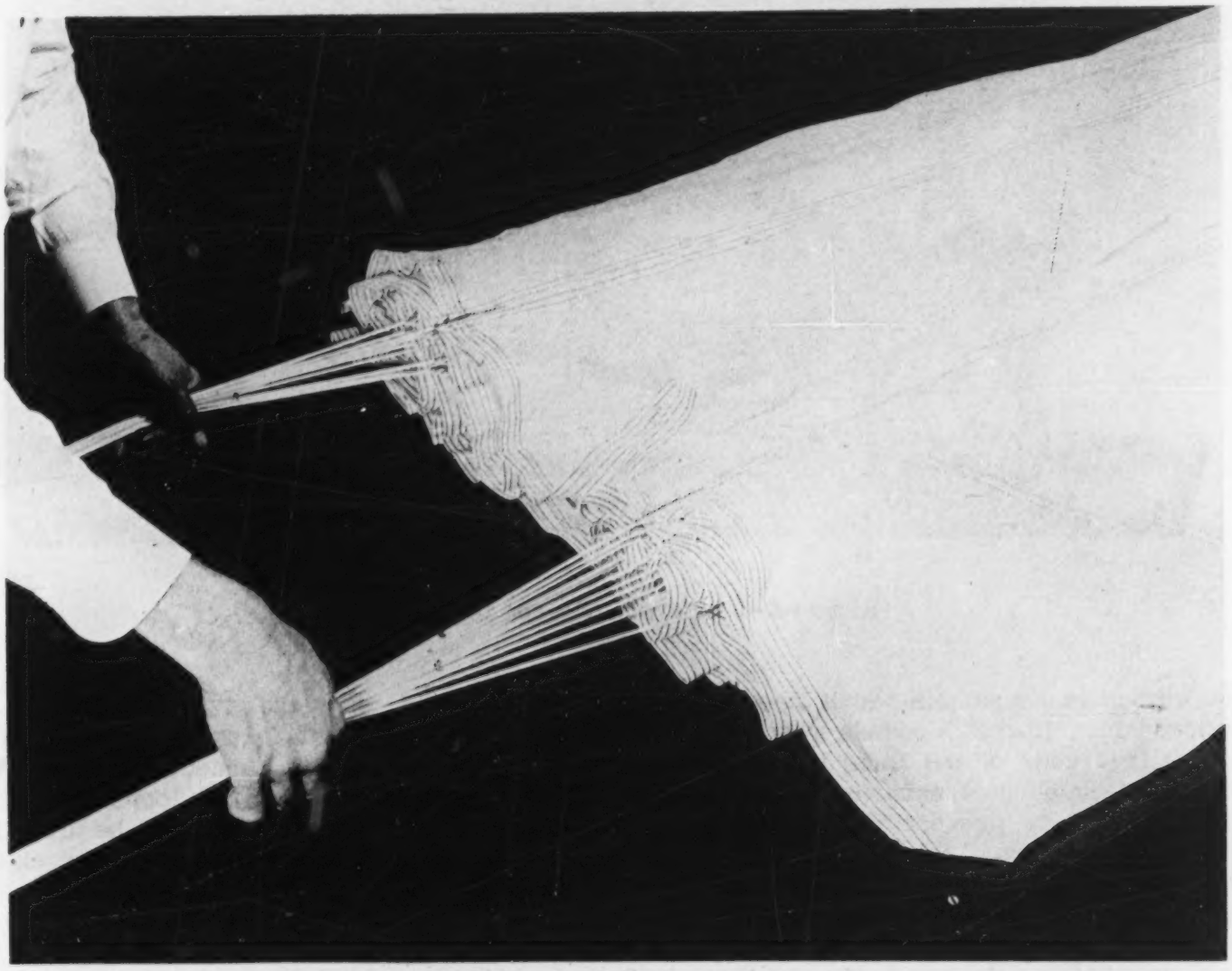

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Figure 8-7.—Separating the two groups of suspension lines.

and through the corresponding loops on the pack, and tie with a surgeon's knot and a square knot. Tie the flap, covering loops 3 through 13 in the same manner, then repeat the entire process for the opposite leg of the pack. (See fig. 8-15.)

Remove the lower shot bag and bring the canopy over the pack with the skirt touching the arch of the horseshoe.

Stowing Lower Canopy

Grasp all gores except Nos. 1 and 13 near center. While retaining the double fold in the other gores, pull this half of the skirt down to a position about 4 inches from the bottom of the pack leg as illustrated in figure 8-16.

Grasp the top part of the double fold at the side and pull the skirt down to the bottom of the pack leg in a telescopic fashion so as to finish in a taper. (See fig. 8-17.)

Close the slide fastener at the bottom, tucking the parachute in carefully to make sure that it is not caught in the teeth of the slide fastener. Pull the protective flap up between the fabric of the canopy and the slide fastener and close about 6 inches of the leg of the pack. Repeat the same procedure for the opposite leg of the pack. (See fig. 8-18.) Make sure that the legs of the pack are filled out firmly.

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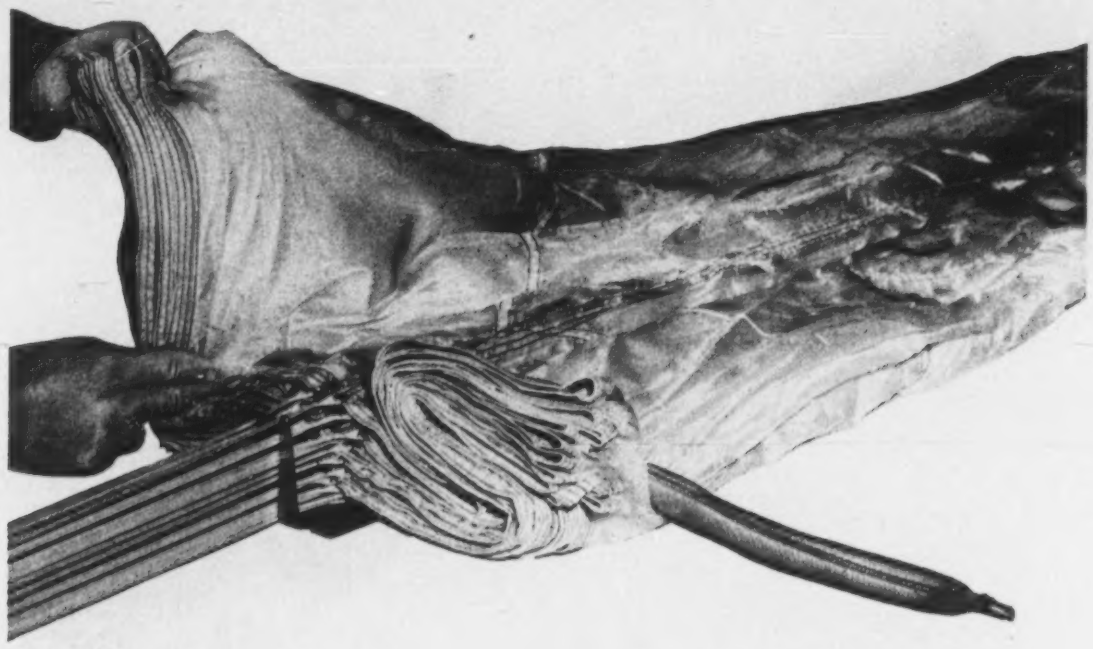

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Figure 8-8.—Folding each group of gores into double folds.

Inserting the Pack Stiffener

Insert the pack stiffener into the pocket provided, and secure into place by tying the nylon laces which are attached to the pack. The excess length of these cords may be tied back out of the way by tying a double bow knot in the ends. (See fig. 8-19.)

Stowing Upper Canopy

While keeping the double folds of the canopy intact, grasp the canopy and begin making accordion folds across the upper section of the pack. Make the folds 3 to 4 inches wider than the pack in the manner shown in figure 8-20. When the entire canopy is folded into the top of the pack, there will be approximately four folds with the apex in the center facing the packer. The suspension lines which emerge from the apex should be folded across the vent and brought back to the helper. Lead the pilot chute connector cord and the withdrawal line to the ripcord side of the parachute. Sign and insert the packing record card in the inside pocket, which is located on the inside front of the pack.

Closing Side and Top Flaps

Tuck the upper part of the canopy into the pack. First, bring the inner back flap over the parachute, next the front, and then the back flap. Then close the slide fasteners on each leg.

NOTE: When closing the zippers, it is important to make sure that the protective webbing is in position on the inside of the fastener so that the canopy does not become enmeshed in the teeth of the zipper.

Place the pack on the packing stand. This will assist in keeping the pack in position while tucking in the flaps and making the final steps to complete the packing operation. (See fig. 8-21.)

Tuck the canopy into the pack, making sure that the withdrawal line emerges from the pack on the ripcord side.

Pull the inner back flap over on top of the folded canopy, and pull the front flap which carries the locking cones over it. Place the ejector board so that it lies on top of both front and back flaps. (See fig. 8-22.)

Pull the main flap forward, fit the grommets over the cones, and insert the temporary locking pins into the cones. Tuck in the left side corner of the front inner flap, lift the withdrawal line, and place the small triangular flap on top of the inner flap. Replace the corner of the main flap on top of the withdrawal line. Bring up the flap opposite the ripcord, remove the temporary locking pin, and place the end tab

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Figure 8-9.—Extending the folds of the canopy.

over the cone. Replace the temporary locking pins.

Place the ripcord pins (attached to the withdrawal line) in position alongside the locking cones. Open the slide fastener on the left side about 5 inches down the side of the pack and insert all excess length of the withdrawal line. Close the slide fastener.

Folding and Inserting Pilot Chute

Check the pilot chute suspension lines for dips and twists, then lay the canopy on the table with the suspension lines up. Let the folds of the canopy fall in over the ribs of the spring, forming a square. Place the connector cord and folded suspension lines diagonally across the canopy of the pilot chute. (See fig. 8-23.)

Grasp the two ribs of the pilot chute lying parallel to the connector cord. Close these ribs in together, then pull up the other two ribs in the same manner. Hold the folded canopy and ribs in one hand, pull the canopy out between the ribs into four triangular folds, and insert into the pack on top of the ejector board. Fold the remainder of the connector cord and tuck in under the ejector board.

Insert the rear ripcord pin through the eye on the end of the ripcord cable. Remove the temporary locking pin from the rear locking cone (the cone nearest the end of the ripcord cable), and place the cable securing plate in position over the locking cone. Insert the rear ripcord pin through the hole in the rear locking cone. (See fig. 8-24.)

Completing the Pack

Safety tie the right-hand locking pin in the same manner as described in chapter 6 for the NC-3, using size A thread. Fold the ripcord pin protector flap back on top of the locking cones, then fold the withdrawal line in a loop on top of the flap. Fold over the top outer flap, and secure the two snap fasteners. Hook the pack opening elastics.

Make sure that ripcord handle is installed correctly in the spring clip with handle facing outboard of the lift web. NOTE: The ripcord for the integrated Martin-Baker parachute differs from ripcords for the conventional Navy parachutes in that an eye is swaged to the end of the cable which would normally have the ripcord pins attached. The cable housing also

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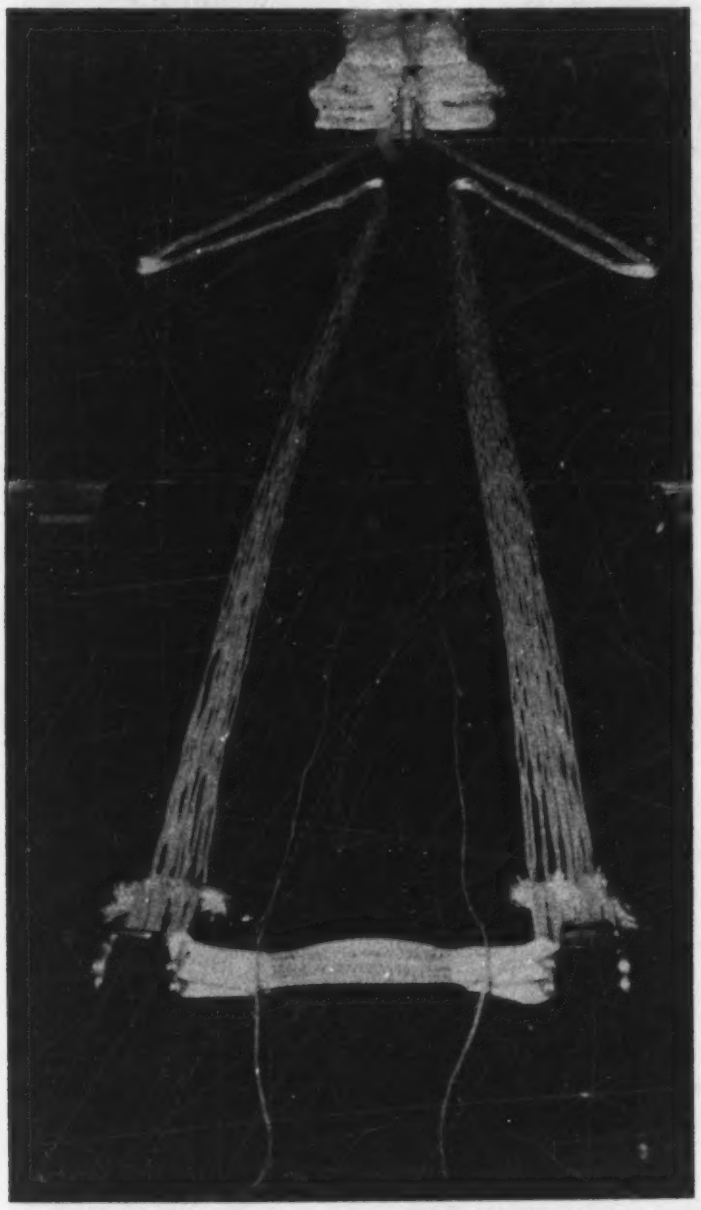

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Figure 8-10.—Suspension lines out to the side, forming an arrow.

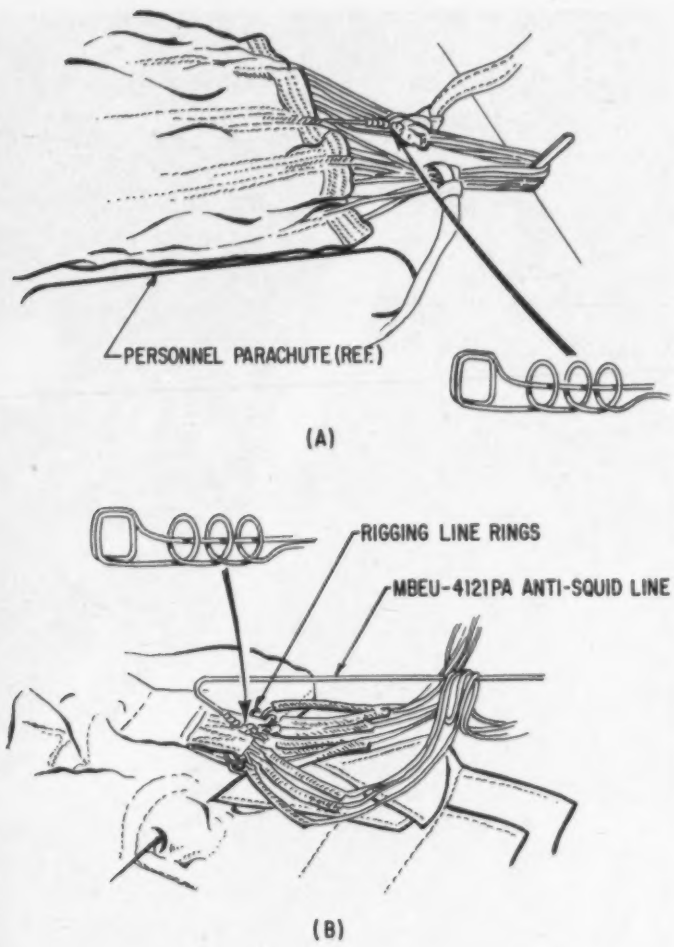

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Figure 8-11.—Installation of personnel parachute antisquid lines.

differs from other housings in that it is smaller in diameter, has a protective covering of a green plastic type substance, and has a cable securing plate attached to the free end.

The ripcord handle end of the cable housing is attached to the left-hand lift web at a point near the rocket jet fitting and then reeved through a nylon canvas channel sewn to the edge of the lift web. As it emerges from the channel, the end of the cable housing is a free end until the cable securing plate is set over the cones and held in place by the locking pins.

Sign the outside packing card, when the pack is complete.

PERSONAL SURVIVAL KIT

Survival equipment kits are now being tested which will tend to standardize survival kits for all types of aircraft. These kits are the rigid seat survival kit (such as the one described in chapter 15 of this training manual for use in aircraft utilizing ejection seats) and the "soft pack" kits for use in nonejection type aircraft. Although in the future no "soft pack" kits are to be used with ejection seats, the one described in this chapter has been used until recently

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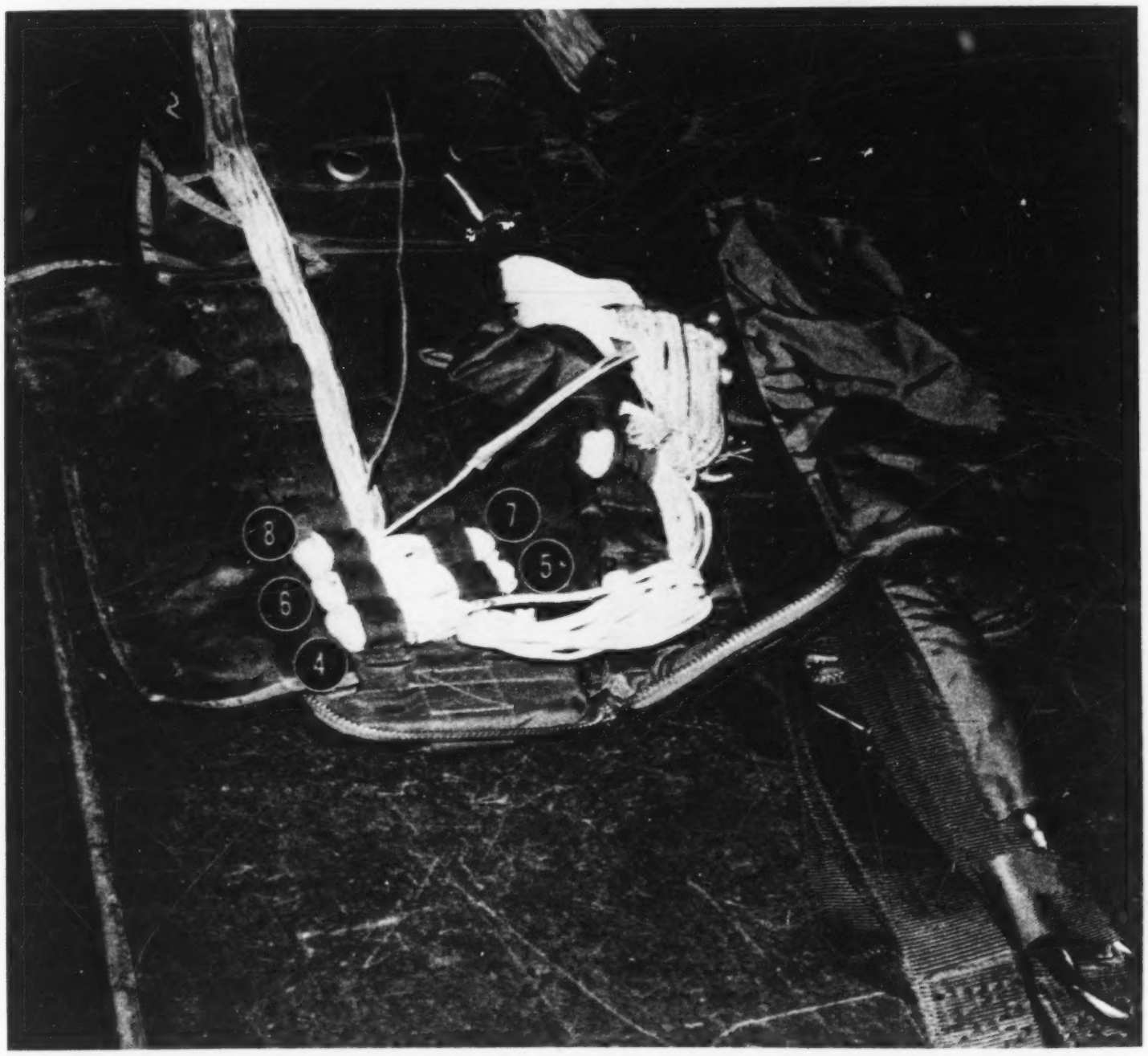

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Figure 8-12.—Antisquid line stowed with suspension lines in loop No. 8.

with certain of the Martin-Baker ejection seats. Before attempting any maintenance work on these survival kits be sure to consult the Maintenance Instructions Manual covering the aircraft and seat concerned.

The "soft kit" consists of two assemblies: the seat pan assembly and the survival kit assembly.

SEAT PAN ASSEMBLY

The seat pan assembly is designed to provide an emergency oxygen breathing supply to the pilot during ejection at high altitudes and, when the pilot is using a full pressure suit, to maintain pressurization corresponding to an altitude of 35,500 feet. The system is automatically actuated upon ejection or may be

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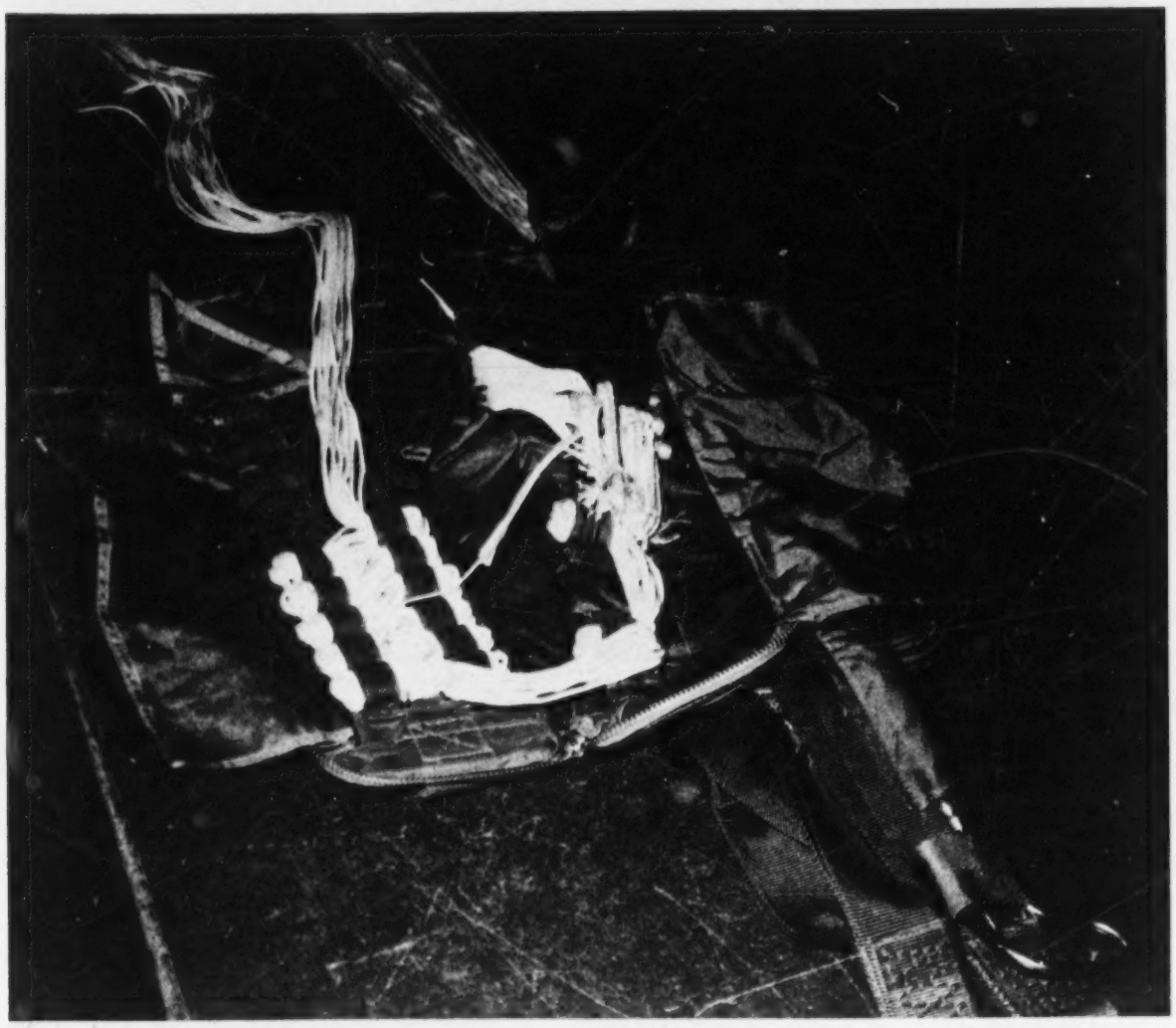

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Figure 8-13.—Suspension lines stowed in one leg.

manually actuated by the pilot. A gage installed at the upper left front of the seat indicates the oxygen supply pressure. This system also furnishes pressurization and oxygen breathing supply in the event of a failure of either system in the aircraft. The seat pan assembly incorporates provisions for the attachment of the survival kit, as well as the shock and comfort pads.

SURVIVAL KIT ASSEMBLY

The survival kit consists of survival equipment in a special container assembly. The equipment kit contains survival gear to sustain the pilot in the case of an emergency. This gear includes the following:

LR-1 pararaft.
Equipment container.
Water storage bag.
Appropriate pilot's emergency beacon.
Nylon cord (50 feet).
Dye marker.
Desalter kit.
Solar still.
Signal mirror.
Bailing sponge.
Poncho.
Rations.
Ointment.
Sea anchor.
Inflation cylinder.
High-speed container.

The LR-1 pararaft and CO_2 bottle fill the aft section of the equipment kit and are connected

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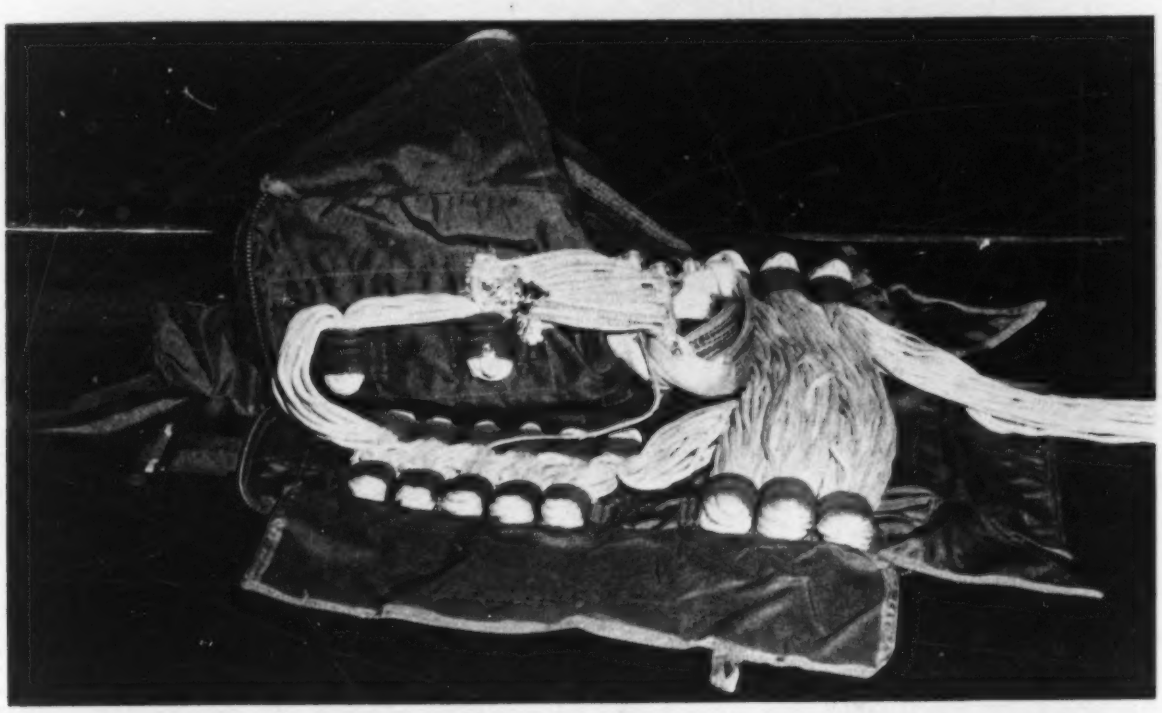

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Figure 8-14.—Suspension lines placed in loops outside the legs.

by a line zipper ring of the survival kit. The container assembly flaps are folded inward to protect the pararaft and CO_2 bottle and are secured by a ripcord assembly. The ripcord assembly pins secure the outer flap of the container on locking cones. A lanyard from the ripcord assembly to the CO_2 bottle manifold pulls the bottle and pararaft from the container when the ripcord is pulled to open the container assembly. A release cord on the CO_2 bottle must be pulled to inflate the raft. The survival kit is strapped to the seat pan and is stowed in the seat bucket beneath the seat pan.

NOTE: The contents of the survival kit as listed above are considered as typical of a survival kit and substitutions may be made as directed by local authority.

A typical personal survival kit is shown in figure 8-25.

MARTIN-BAKER SAFE-TIES

Table 8-1 shows the recommended safe-ties for the Martin-Baker parachute.

Table 8-1.—Recommended safe-ties for Martin-Baker system.

Item	Material	Size	Tensile (lb)
Connector links	Nylon	FF	16
Outer eyelets	Nylon	FF	16
Protective flaps (upper and lower)	Nylon	FF	16
Slide fastener toggles	Nylon	FF	16
Cone locking pin	Nylon	A	2.75
Slide disconnect	Nylon	A	2.75

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Figure 8-15.—Tying protective flaps over suspension lines.

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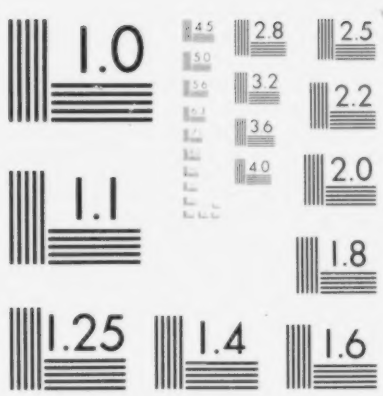

MICROCOPY RESOLUTION TEST CHART
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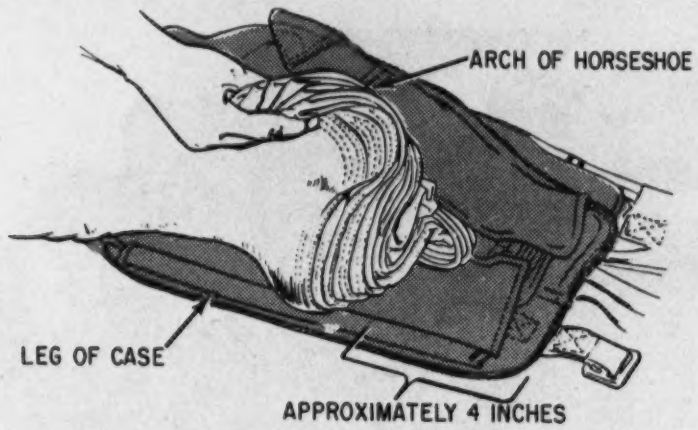

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Figure 8-16.—Skirt placed 4 inches from bottom of leg.

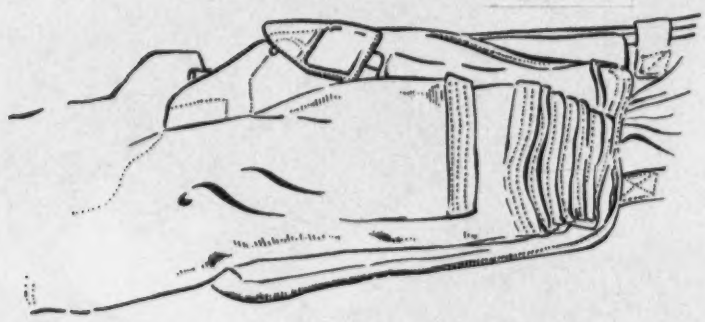

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Figure 8-17. —Half of the skirt pulled to bottom of leg in telescopic fashion to form a tapered finish to the leg.

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Figure 8-18.—Close the slide fastener approximately 6 inches.

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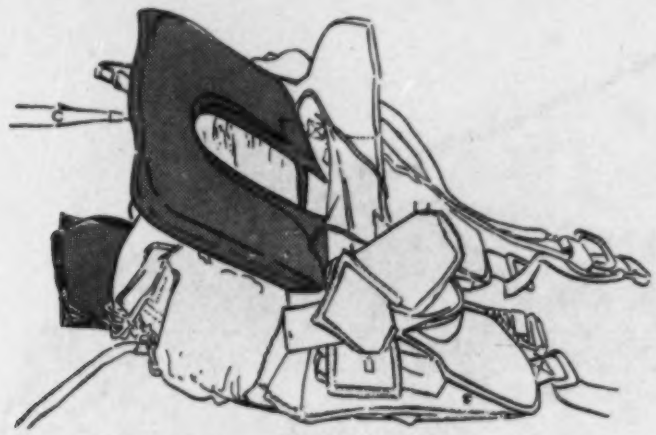

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Figure 8-19.—Inserting pack stiffener.

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Figure 8-20.—Accordion folding canopy into pack.

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Figure 8-21.—Pack placed on stand for final closing.

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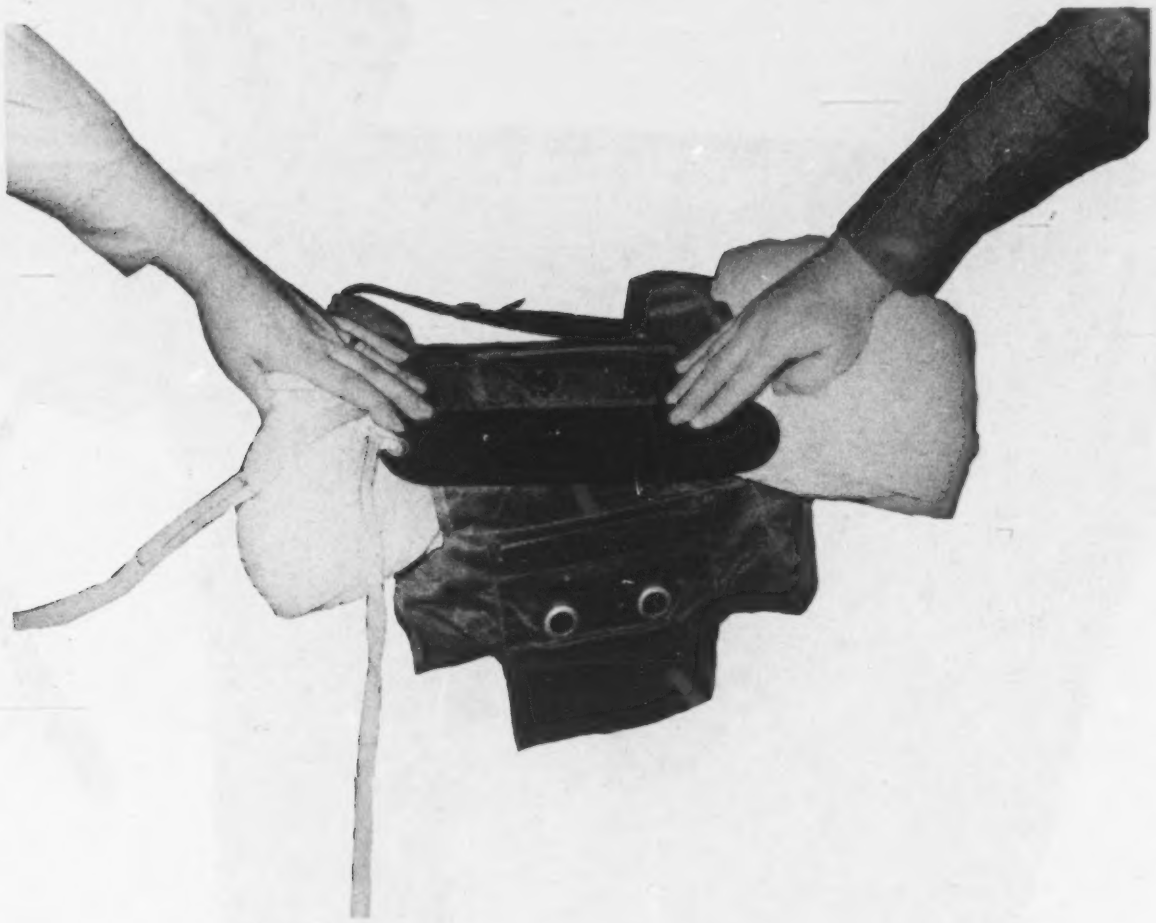

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Figure 8-22.—Ejector board placed on top of flaps.

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Figure 8-23.—Pilot chute ready to be inserted into chute.

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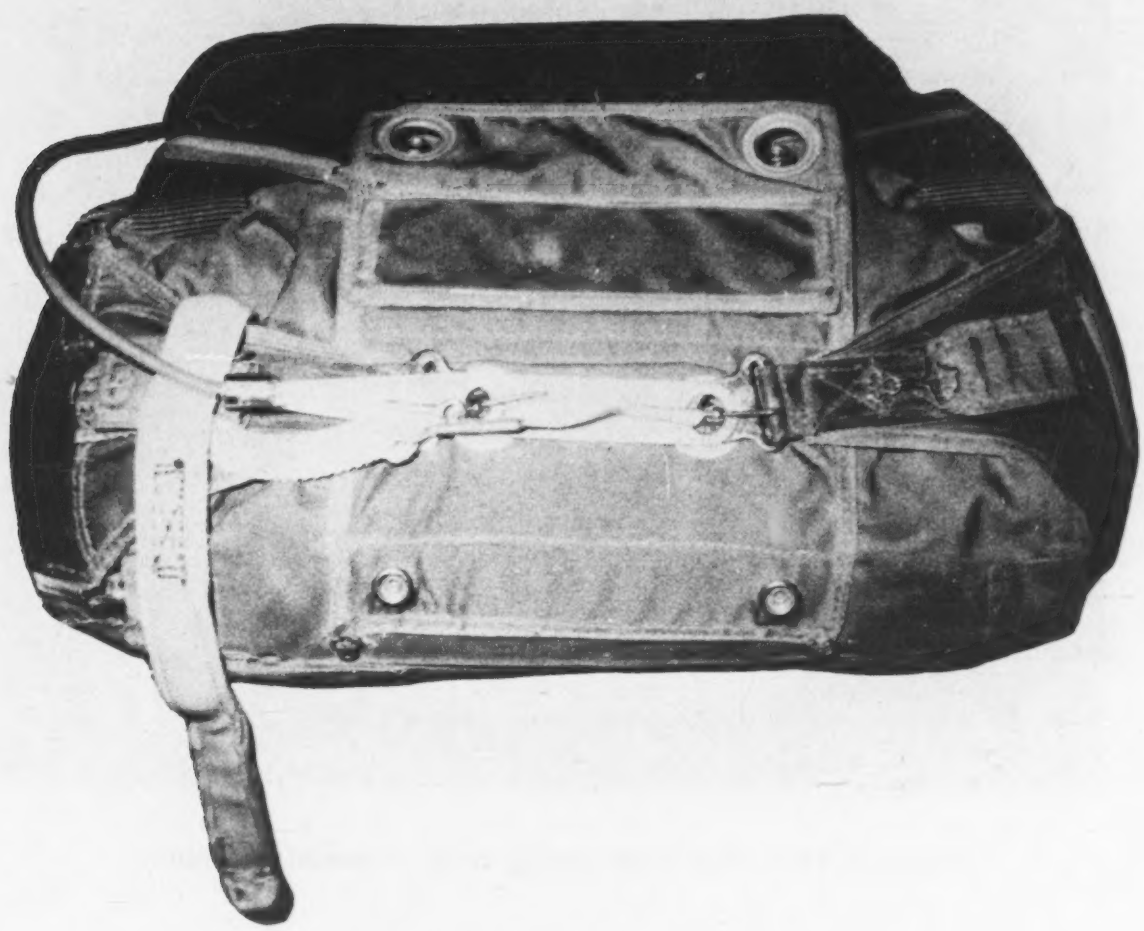

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Figure 8-24.—Pack completed and ready to be safety tied.

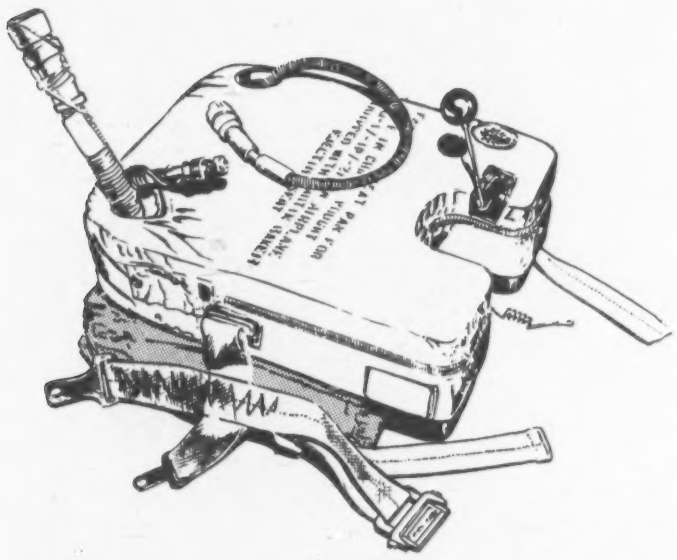

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Figure 8-25.—Personal survival kit used in [illegible] series aircraft.

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CHAPTER 9

AUTOMATIC PARACHUTE ACTUATORS

MASTER SPECIALTIES PARACHUTE ACTUATOR

The automatic actuator currently used by the Navy in personnel parachute assemblies is a barometrically controlled, pyrotechnic device. The actuator is designed to open a parachute at a preset altitude of 14,000 (±500) feet above mean sea level (MSL), for all parachutes except those used in the T2A, T2B, and A5 series aircraft. The T2A, T2B, and A5 will be set at 10,000 (±500) feet above MSL. Figure 9-1 shows a cutaway view of the Master Specialties actuator.

OPERATION

When an aircrewman bails out at an altitude above that for which the actuator is set to open the parachute, the arming pin is pulled. This pin locks the actuator firing mechanism while installed. When the arming pin is withdrawn, the assembly will fire at or below the preset altitude for the actuator. The sear and aneroid mechanism locks the actuator. As the aircrewman free-falls, increasing air pressure causes the aneroid to contract. As the operating altitude is reached, the aneroid contracts enough to remove the sear from the firing hammerlock. The hammer's firing pin strikes the time delay cartridge which fires 3/4, 2, or 3 seconds after the hammer strikes, depending on the type of cartridge used. A piston is forced out of the barrel and pulls the power cable, which is attached to the parachute locking pins. The locking pins are pulled and the standard parachute opening sequence begins.

PREPARATION FOR USE

Upon removal of the actuator from the shipping carton, the exterior parts of the unit should be inspected for damage during shipping and storage. An inspection should be made for corrosion, dirt, dents, and cracks. If any damage or discrepancy is found, a tag must be affixed to the actuator, stating that the actuator is not to be used. Remove this tag only after correction has been made.

Loading

To load the actuator, proceed as follows:

Remove the screw (3) and washer (4) from the cover assembly (fig. 9-2). Slide the receiver assembly from the cover assembly and check the position of the hammer assembly. If the hammer assembly is not in the position shown in figure 9-3 (A), completely separate the barrel assembly from the receiver assembly and allow the hammer assembly and lock to drop into the armed and cocked position.

Insert the pin of the arming knob assembly (24, fig. 9-2) through retainers (34). The pin must pass through the holes in the lock (28).

With the hammer assembly secured in the armed position, reassemble the barrel assembly to the receiver assembly.

WARNING: Engage the forked end of the longest spring of the barrel assembly with the pin on the hammer assembly so that hand pressure is needed to press the barrel into the recess of the receiver assembly. If the spring is inadvertently positioned under the hammer assembly pin, the unit will not operate.

Use only the proper length barrel assembly. Barrels are not interchangeable between models. For example, a 1000C barrel will not properly fit a 1000D receiver.

Insert a cartridge in the barrel (fig. 9-4) and press the barrel into the recess of the receiver assembly. Slide the receiver assembly into the cover assembly, exercising care that the base of the housing assembly is properly alined with the barrel assembly and the cover assembly. NOTE: The cartridge service life is 5 years from the date of manufacture or 18 months after opening of the original package, whichever occurs first.

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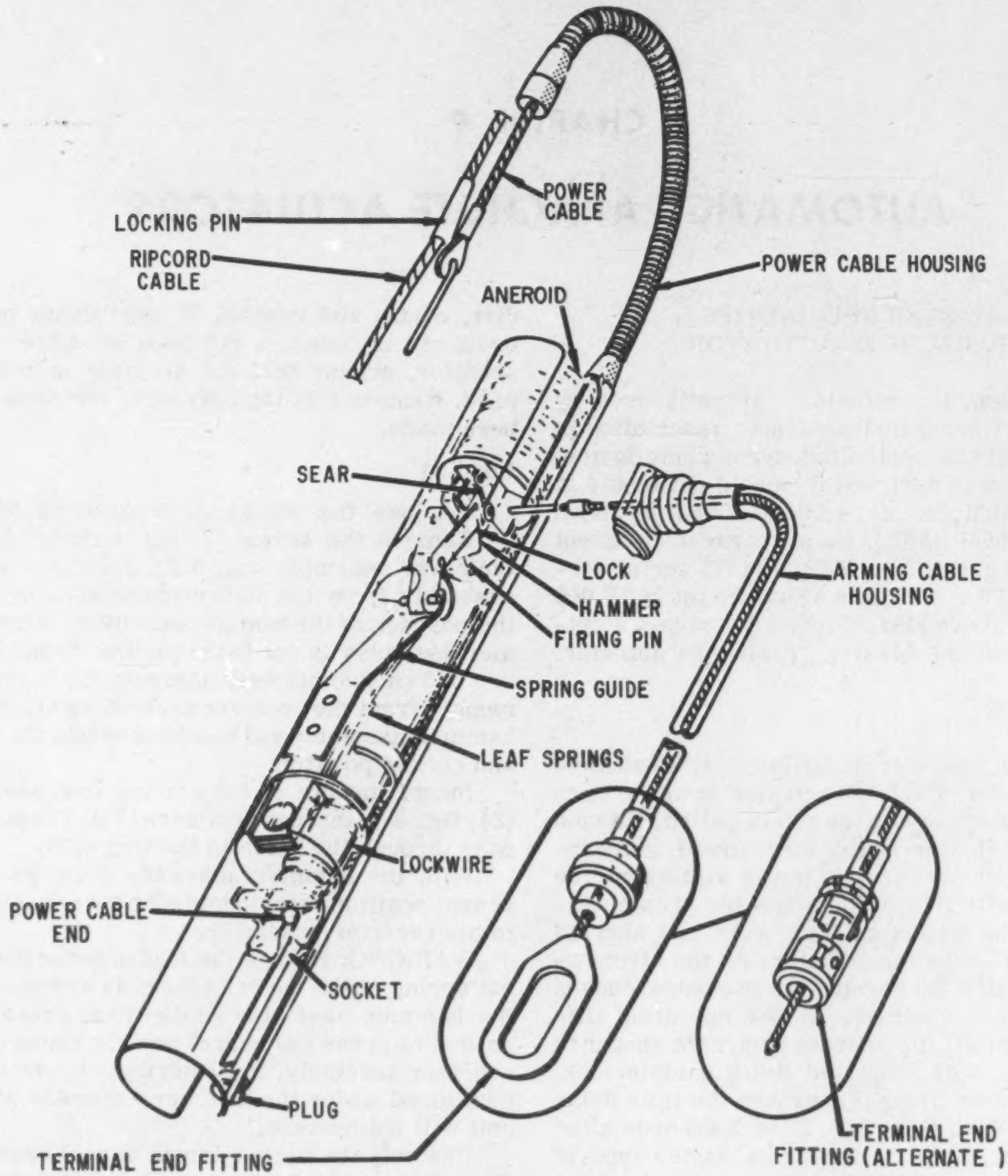

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Figure 9-1.—Master Specialties actuator (cutaway view).

WARNING: Exercise extreme caution after the cartridge has been inserted in the barrel. Do not allow either end of the cover assembly to be pointed toward the face as flame and smoke may result in injury. Another reason for extreme caution is the possibility that the piston of the actuator may become a projectile if the cartridge accidentally fires.

Install the washer and screw in the cover assembly.

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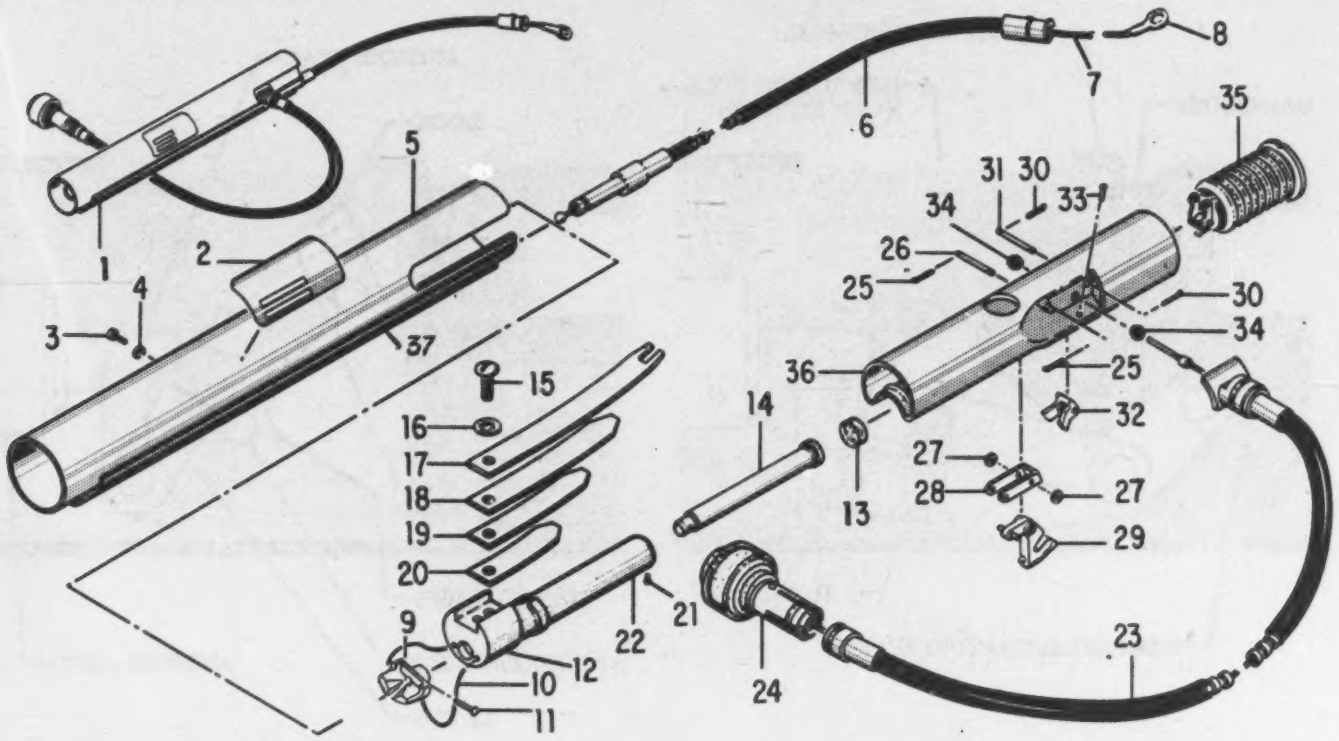

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1. Actuator assembly.
2. Nameplate.
3. Screw.
4. Washer.
5. Cover assembly.
6. Cable housing assembly.
7. Cable assembly.
8. Swaged fitting.
9. Socket.
10. Wire.
11. Rivet.
12. Spring retainer.
13. Teflon seal.
14. Piston.
15. Screw.
16. Washer.
17. Spring.
18. Spring.
19. Spring.
20. Spring.
21. Rivet.
22. Barrel.
23. Housing assembly.
24. Arming knob assembly.
25. Pin.
26. Pin.
27. Spacer.
28. Lock.
29. Hammer assembly.
30. Pin.
31. Pin.
32. Sear.
33. Rivet.
34. Retainer.
35. Aneroid assembly.
36. Receiver.
37. Cover assembly.

Figure 9-2. —Master Specialties parachute actuator.

Installation

Connect the swaged fittings at the end of the power cable assembly to the parachute ripcord.

Attach the parachute actuator to the parachute pack in accordance with the instructions contained in the applicable Aviation Clothing and Survival Equipment Bulletin, or NavAir 13-1-6.2.

ADJUSTING THE ANEROID.—There may be a number of Master Specialties Model 1000C and Model 1000D actuators in service with an altitude setting of 10,000 feet, mean sea level. If a walk-in type chamber is available, the altitude setting of these actuators may be changed to the correct altitude setting of 14,000 feet ±500 feet by the procedures discussed in the following paragraphs. The altitude setting of 14,000 ±500 feet is designed to give flying personnel greater protection while operating over high mountainous terrain.

Remove the receiver assembly from the cover assembly of the actuator. Then remove the barrel and piston assembly from the receiver assembly and remove the explosive cartridge. Do not remove the arming pin. Install a dummy cartridge in the barrel and replace the barrel

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Intensity Gate Clamp

The intensity gate clamp V18B is a negative clamper. It clamps the positive portion of the square wave from V25 at the zero reference voltage. This effectively provides a negative square wave for blanking the indicator's sweep when there is no sweep voltage fed to the indicator (flyback). Waveform (3) illustrates the waveform fed to the indicator.

RADAR TRANSMITTERS

The transmitter functions to provide RF energy, often at extremely high power, for short intervals of time. The science of radar requires that the frequency of this energy be in the microwave region. The high-power oscillator that produces the RF carrier is usually a magnetron.

MODULATING THE MAGNETRON

The modulator for the magnetron serves a double purpose—it determines the waveform of the output pulse, and it stores energy between pulses and releases it through the magnetron during the pulse.

The basic circuit for a magnetron modulator is shown in figure 16-18. In this circuit the storage element is charged through the charging impedance Z_{ch} and the load. It is discharged through the load when the switch is closed. On examining this circuit, you can see that closing the switch also completes a circuit containing the power source and Z_{ch}. This has little consequence, however, since the switch is closed for only a microsecond or so at a time and Z_{ch} is large enough to prevent any damage. It is well to become familiar with the components of some of the modulator circuit elements which are shown as blocks in this circuit. In the modulator, the source from which the storage element is charged may be either a d-c voltage or an a-c voltage. The magnetron requires a voltage of 10 to 15 kilovolts or higher for proper operation. In some types of equipment a transformer is used between the storage element and the magnetron to step up the voltage, while in many others a direct connection is made between the storage element and the magnetron. Actual charging circuits are discussed in a later section dealing with line-pulsing modulators. In these circuits the charging impedance may be a high resistance or a high inductance, or both. Its purpose is to control the charging time for the storage element and to prevent short circuiting of the source during the pulse.

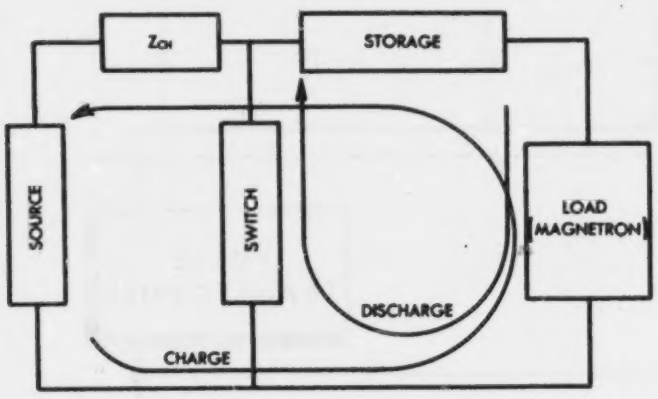

Figure 16-18.—Basic circuit for storage and release of energy in a modulator.

SWITCHING DEVICES

Switches for controlling the discharge time of pulse-forming networks may be of various types. Three types that will be discussed in this chapter are the ROTARY SPARK GAP, GAS DIODE, and THYRATRONS.

Rotary spark gaps are generally not used in aviation equipment because they are instable, must be enclosed in a pressurized chamber, and different repetition rates are difficult to obtain.

Gas diodes are used in some high-powered modulators. Figure 16-19 illustrates a gas diode type switch in which two cold cathode gas diodes are used. Some equipments use more than two of this type diode. These tubes are

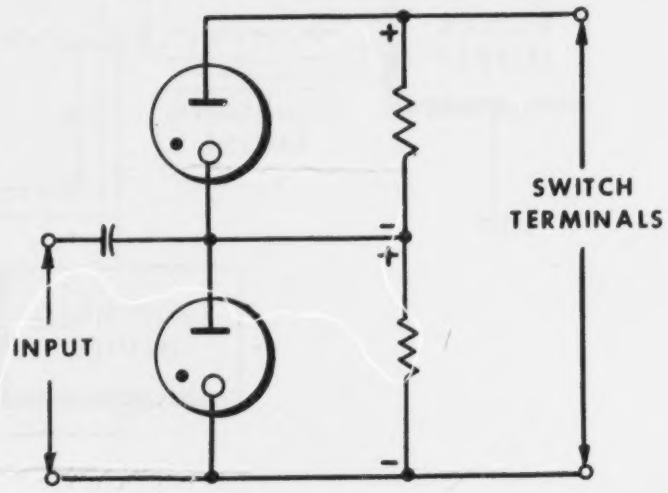

Figure 16-19.—Gas diode switch.

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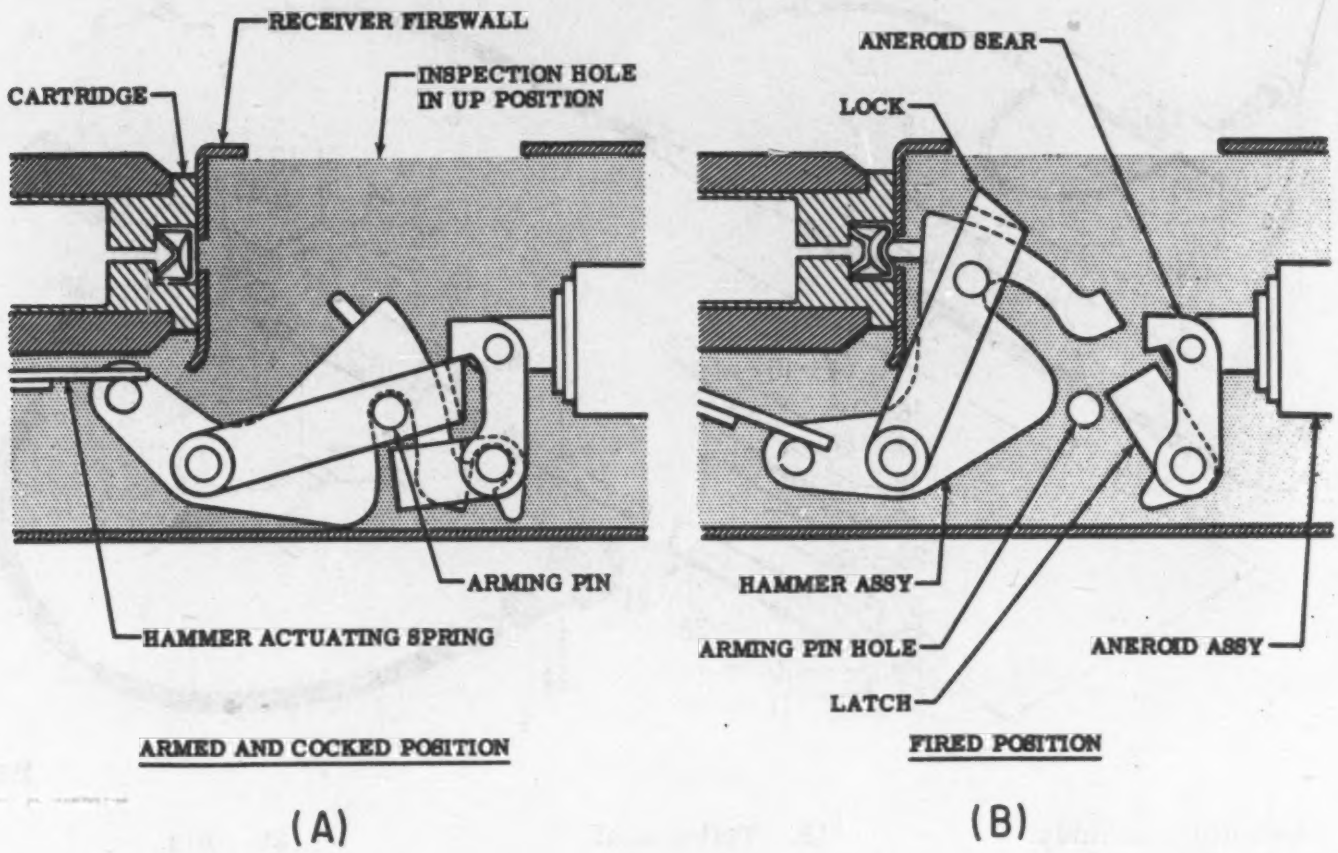

PR. 245

Figure 9-3. —Firing mechanism.

and piston in the receiver assembly. Place a hose clamp around the barrel and tighten it until the barrel lies flush with the receiver, as shown in figure 9-5. Prior to removing the aneroid sealing compound, it is advisable at this point to perform an actuator operating altitude check. It is possible that the actuator was previously adjusted to 14,000 ± 500 feet, but not properly marked. If the actuator operating altitude test confirms a 10,000-foot setting, remove the sealing compound from the end of the aneroid assembly using a pointed instrument; this will expose the aneroid adjusting screw.

Take the receiver assembly into a low pressure chamber, evacuate to 14,000 feet, and level off. Remove the arming pin from the assembly. Loosen the small Bristol locking set-screw on the side of the aneroid adjusting screw (fig. 9-6). slowly turn the aneroid adjusting screw clockwise until the aneroid assembly is retracted far enough to release the lock from the sear and permit the hammer assembly to strike the dummy cartridge. Tighten the locking setscrew at this setting (NOTE: Never allow the unit to fire unless it is loaded with a dummy test cartridge.) Remove the hose clamp and place the hammer assembly in the armed and cocked position and insert the arming pin through the retaining holes in the receiver. Place the hose clamp around the barrel and tighten until the barrel lies flush with the receiver.

Evacuate the chamber to 16,000 feet and remove the pin. Descend in altitude at a rate of approximately 200 feet per second. Record the altitude at which the aneroid releases the lock and permits the hammer to strike the dummy cartridge. Repeat the steps above; both runs must be 14,000 ± 500 feet. Make certain the locking screw as shown in figure 9-6 is set. Fill the aneroid adjusting screw with auto body filler, and paint the aneroid with red lacquer and stencil 14,000 FEET on the end of the aneroid cover on the receiver.

Parachutes having automatic actuators installed with the 14,000-foot setting will have a notation recorded on the Parachute History Card, and the Parachute Record Card.

NOTE: Actuators 1000A and 1000B are not to be reset, but are to be removed from service.

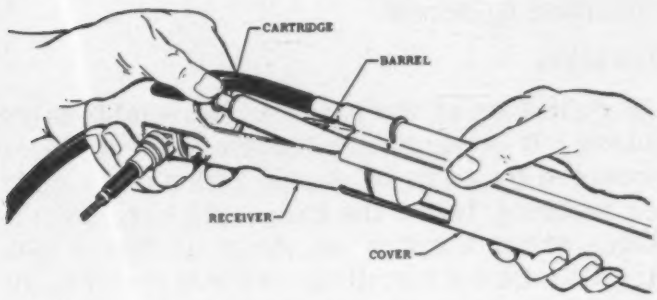

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Figure 9-4. —Installing cartridge in barrel.

INSPECTION.—Any automatic actuator in service must be inspected each time its parachute assembly is repacked. Careful attention and close supervision are required when work is performed on an actuator. Operation of the actuator is a critical function of a parachute assembly and any carelessness or misunderstanding in inspection or assembly can easily result in failure of an assembly. Supervisors must impress upon both riggers and quality assurance inspectors the importance of careful work. After any modification, the actuator must be reinspected.

To inspect the automatic actuator, proceed as follows:

1. Remove the cartridge from the actuator. If the actuator has been fired, it must be scrapped. Check the nameplate on the housing or receiver. The actuator must be a 1000 series Model C (Mod), Model D, Model F, or Model 153-100. Models A and B must be turned in to Supply.

2. Inspect the hammer and lock. If the sear is in the full forward position locking the hammer, the receiver has a defective aneroid.

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Figure 9-6. —Locking setscrew.

3. Check the receiver body of the actuator for dents, corrosion, and distortion. Inspect the interior parts for freedom of movement and corrosion.

4. Inspect the cover assembly as follows:

a. Check the metal housing for bends, dents, sharp edges, and corrosion.

b. Inspect the power cable tube for dents, security of the power cable locking ring, and presence of plug in the end.

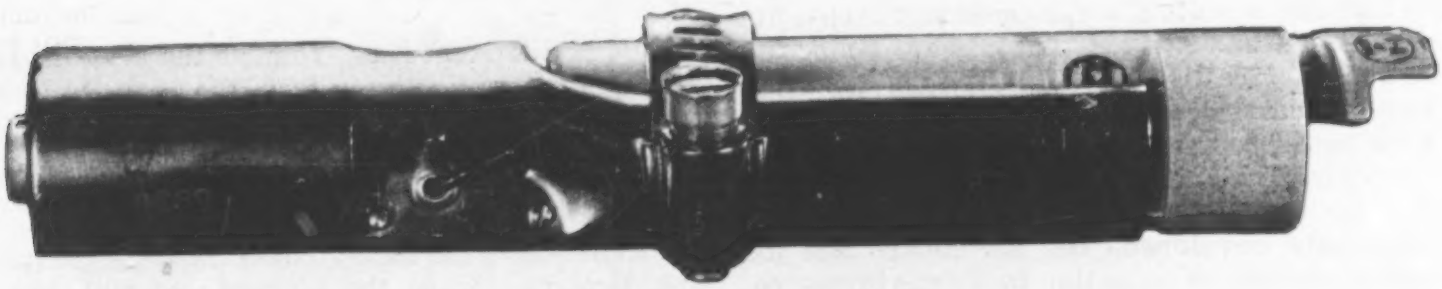

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Figure 9-5. —Master Specialties actuator barrel assembly clamp.

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c. Examine the power cable housing and cable for signs of corrosion, breaks, permanent bends, and security of swaged fittings.

d. Check the swaged ball on the end of the power cable. The ball must be inside the main housing and not in the power cable tube.

5. Inspect the barrel and piston assembly for proper installation. All springs must curve away from the barrel and the smallest spring will be nearest the barrel.

6. Examine the safety wire on the barrel for proper size and type (0.032 inch, soft copper wire), installation, and security.

TROUBLESHOOTING.—Table 9-1 lists the most common troubles, along with the probable causes and remedies.

CARTRIDGE ACTUATED WEBBING CUTTER

The webbing cutter is a factory-loaded expendable unit powered by a small blank cartridge. The unit weighs 16 ounces and is 2 1/2 inches wide, 1 1/4 inches thick, and 1 1/2 inches high.

The purpose of the webbing cutter is to sever the right-hand riser of nonintergrated parachute assemblies after parachute descent and land or water impact. Cutting of the riser results in the collapsing of personal parachute, preventing the the pilot or crew-member from being dragged by an inflated parachute. The device cuts only one riser and does not eliminate the need for immediate parachute removal in order to prevent being pulled under the water by the sinking parachute. The unit is not reusable once it has been fired.

Operation

Removal of the safety cover exposes a T handle lanyard as shown in figure 9-7 (A) and (B). Pulling the lanyard outward, from the assembly, fires the cartridge mechanically. When the lanyard is pulled, a spring-loaded firing pin is released and strikes the primer, firing the cartridge. (See fig. 9-7 (B).) The gas resulting from the cartridge firing passes through a port in the cutter body and contacts the top of the knife assembly. The knife assembly is held in position by a shearpin. When the pressure of the gas is completely developed, the pin shears and the knife assembly is propelled by the gas pressure, cutting the webbing slot and impacting the hardened base plate as shown in figure 9-7 (C). The gases generated by cartridge firing are contained by O-rings, and the knife assembly is a captive mechanism when the base plate is secured by the positioning screw.

Installation

Modification of the parachute assembly is not required. It is mandatory that the webbing cutter be mounted by a single hinging action to the right riser webbing below the parachute harness adjustable strap adapter as shown in figure 9-8. CAUTION: Do not install the webbing cutter to the left riser because the ripcord pocket which is sewn to the left riser would restrict separation after the webbing is severed. The installation of the webbing cutter is to be accomplished without removing the safety cover. Prior to installation, determine the service life of the webbing cutter (5 years from date of manufacture which is stamped on the container, or not more than 1 year after the sealed metal container is opened, whichever occurs first). Stamp the expiration date (that is, the date the cutter is to be removed from service in accordance with the above criteria) on the body of the cutter device between the webbing slot and the safety cover.

Remove the positioning screw shown in figure 9-7 (C). This will allow the base plate to swing open. Insert the right riser assembly into the slot with the webbing cutter base plate next to the wearer's body. The cutter is to be installed so that the safety cover is removed by a motion away from the body. Close the base plate and replace the positioning screw tightly. Loop the tiedown cord through and around the loop in the right riser for the back strap. Tie both ends securely with a square knot. Fastening of the tiedown prevents the cutter from sliding during routine handling and operation and firmly anchors the cutter during parachute deployment. Installation instructions are embossed on the back of the cutter base plate.

Operation Procedures

Using the right hand, remove the slide cover by a pulling motion away from the body. A quick visual inspection can be made by observing the direction of the arrow mounted on the cover. (See fig. 9-7 (B).)

Removal of the safety cover exposes the firing lanyard. Grasp the lanyard and pull away from the body. Pulling directly forward is preferred, although the cutter will actuate when the lanyard is pulled in any direction away from the

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Table 9-1.—Troubleshooting Chart for Master Specialties Actuator.

Trouble	Probable Cause	Remedy
Sear engages lock at altitude less than 14,000 feet.	Aneroid assembly leaks.	Return to Supply.
	Aneroid assembly bent.	Return to Supply.
	Receiver housing bent.	Return to Supply.
Power cable or arming pin cable stuck in housing assembly.	Housing assembly damaged.	Return to Supply.
	Cable assembly defective.	Return to Supply.
Cartridge will not fit in barrel.	Wrong size cartridge.	Use recommended cartridge.
	Obstruction in barrel.	Remove obstruction, clean barrel.
Barrel assembly cannot be seated in receiver assembly.	Hammer assembly has not been pinned in armed position and allows firing pin to restrict seating of parts.	Insert arming pin through lock.
Receiver assembly will not fit in cover assembly.	Cover assembly dented or damaged.	Return unit to Supply.

body. Operation instructions are embossed on the safety cover.

Inspection

1. Insure that the positioning screw is tightly secured and the back plate is engaged.

2. Inspect the tiedown cord for security to the harness.

3. Check the direction for removal of safety cover away from the body. Gently slide the safety cover back a quarter of the way and observe that the lanyard and T handle are in place in accordance with figure 9-7 (A). The lanyard will not be visible if the cutter has been fired because the lanyard and the cover cannot be replaced on a fired unit.

4. Determine the service life of the webbing cutter.

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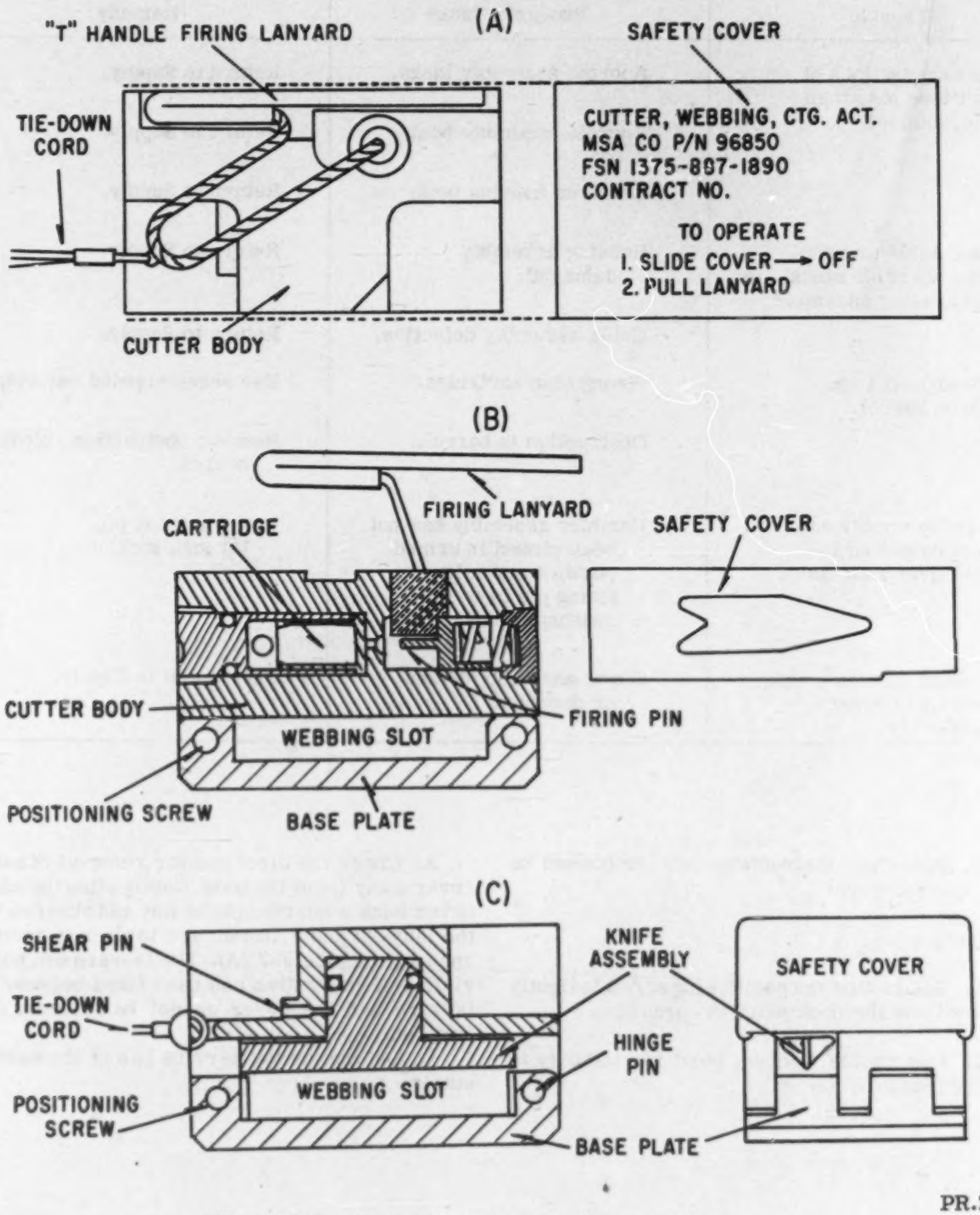

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Figure 9-7.—Cartridge actuated webbing cutter.

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Figure 9-8. —Location of webbing cutter.

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CHAPTER 10

PARACHUTE MAINTENANCE AND REPAIRS

Materials used in parachute construction are of the very best grade obtainable. All of these materials—the fabric, webbings, cords, tapes, hardware, and fasteners—are manufactured in accordance with strict government specifications.

A specification is a document intended primarily for use in procurement, which clearly and accurately describes the essential and technical requirements for items, materials, or services, including the procedures by which it will be determined that the requirements have been met.

In the case of the Armed Forces, specifications are necessary to insure that the item procured meets all the requirements for which the government is paying and that the item will perform all the necessary functions.

As each item is procured under this program, it is assigned a Military (MIL) Specification number. The MIL specification numbers listed in this chapter are now in effect. However, specifications are revised from time to time, and specification numbers are often changed, canceled, or superseded. The Index, List of Military Specifications and Standards, NA 00-25-544, lists all specifications in effect and those recently canceled. This index is reissued periodically under the supervision of the Naval Air Systems Command and is available in your technical library.

As a PR, you must not tolerate the use of substitutes or substandard materials in the fabrication or repair of survival equipment. A knowledge of specifications and tensile strengths will better equip you to design local projects which must meet specified tensil strength requirements.

The prime authority for all parachute construction, component replacement, and perplexing repairs will be the applicable drawing of the parachute concerned. The drawing numbers of parachute assemblies and particular components may be found in the Master Drawing Index.

Activities servicing parachutes should maintain a file of current parachute drawings, and review any extensive rework for compliance with the drawing.

Parachute assemblies requiring maintenance, repair, modifications or repack will be assigned to the lowest maintenance level capable of performing the work, in accordance with NavAir Instruction 4700.2.

TYPES OF FABRIC MATERIALS

NYLON PERSONNEL PARACHUTE CLOTH

Nylon parachute cloth used in the construction of personnel parachutes is made in accordance with Specification MIL-C-7020. This cloth is neutral in color unless otherwise specified, and is used in constructing the gores and panels of the parachute canopy. The specification states that the maximum weight cannot be more than 1.1 ounces per square yard. The breaking strength in minimum pounds per inch of width is 42 pounds. The minimum tear resistance is 5 pounds for both the warp and filler thread. The air permeability in cubic feet per minute per square foot of cloth is 80 to 120.

NYLON CORD

Nylon cord used for suspension lines for pilot chutes and parachutes is made in accordance with Specification MIL-C-5040. Type I cord, 100 pounds breaking strength, is used for the lines of Martin-Baker pilot chutes. Type III, 550 pounds breaking strength, is used for constructing the suspension lines of the canopies of service personnel parachutes.

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NYLON REINFORCING TAPE

Nylon reinforcing tape is made in accordance with Specification MIL-T-5038. Reinforcing tape comes in many widths and styles. Some of the uses for this tape are parachute container reinforcements, edgings, hesitator loops, and general strengthening of stress areas.

Type II tape is three-fourths of an inch wide and has a minimum breaking strength of 400 pounds. Type IV tape comes in both 1-inch and 1 1/2-inch widths. The 1-inch width has a minimum breaking strength of 1,000 pounds, and is used to reinforce end flaps. The breaking strength of 1 1/2-inch tape is 1,500 pounds. This tape is used to construct hesitator loops and to house phenol fiber stiffeners. Type VI tape is three-fourths of an inch wide and has a breaking strength of 425 pounds.

NYLON WEBBING

Nylon webbing is made in accordance with Specification MIL-W-4088. Type VI nylon webbing is used for the construction of harness keepers, carrying handles on the NC-3 parachute, and reinforcement of corners and chaffing webbing. It has a breaking strength of 1,800 pounds.

Another type of webbing is type VIII. This is used to manufacture the cross-connector straps on the NC-3 parachute. It has a tensile strength of 3,600 pounds.

Type XIII soft textile nylon webbing is used for constructing parachute harness. This webbing has a breaking strength of 6,000 pounds and is olive drab in color. The width of this webbing is 1 23/32 ± 1/16 inch.

Type XVII 1-inch nylon webbing is used for the construction of end tabs. Its breaking strength is 2,400 pounds.

TUBULAR NYLON WEBBING

Nylon tubular webbing is made in accordance with Specification MIL-W-5625. Nylon tubular webbing is neutral in color and is used in reinforcement of the parachute canopies. Nylon tubular webbing is also used in making the pilot chute connector cords. The 1/2-inch tubular webbing has a breaking strength of 1,000 pounds and is used for the pilot chute connector cord on the NB-6, NB-7, NB-7E, NB-8, NB-9, NB-10, NB-11, NC-3, NS-3, and LW-3B parachutes. All MBEU parachutes use 1,500 pound tubular nylon webbing, 9/16-inch wide for making their pilot chute connector cords.

The 1-inch nylon tubular webbing has a breaking strength of 3,000 pounds and is used for the vent reinforcement. The nylon warp and cotton filler webbing is also 1-inch wide and has a breaking strength of 525 pounds. It is used to reinforce the skirt hem.

FABRIC CONTAMINATION INSPECTION AND REMOVAL

Parachute assemblies must be carefully inspected for evidence of contamination. The various types of contamination are acid, alkaline, salt water, fresh water, perspiration, mildew and fungus, fire fighting agents, mud, dirt, and petroleum.

ACID AND ALKALINE

Parachute assemblies suspected of acid or alkaline contamination must be tested with pH test paper. A pH reading of 5.0 to 9.0 is in the safe zone. Readings below 5.0 indicate excess acidity, and readings above 9.0 indicate excess alkalinity.

To test for excess acidity or alkalinity dampen the suspected area with distilled water. NOTE: Handle test paper by one end or edges only to prevent obtaining a false reading.

Place a piece of full range test paper (0.0 to 14.0 pH) on dampened area. A color change will indicate the approximate pH and which specific shortrange test paper to use. Place a piece of shortrange test paper indicated in the above test on the dampened area. The color change indicates the pH factor of the affected area. By matching the test strip with the applicable range color chart supplied with the pH indicator kit, acid or alkaline strength can be determined.

If contamination is found, care must be used to prevent contact between the contaminated area and other portions of the assembly, as this could spread the damage.

If acid contamination is found, the affected parachute assembly must be forwarded to supply for screening.

If alkaline contamination is found, rinse with cool, fresh water until a safe pH reading is attained. Carefully inspect for deteriorated portions, repair or replace any affected areas.

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SALT WATER CONTAMINATION

Parachutes that have been contaminated by salt water must be cleaned, inspected, and treated as soon as possible after contamination. Any portion of a parachute assembly which has been immersed in salt water for a period of more than 24 hours must be turned into supply for screening. Any portion of a parachute assembly which has been contaminated by salt water and cannot be cleaned within 36 hours must be turned into supply for screening. Clean any parachute assembly contaminated by salt water as described later in this chapter.

PERSPIRATION CONTAMINATION

Any parachute assembly which is stained with perspiration must be cleaned as described later in this chapter. After cleaning, the fabric affected must be closely inspected to insure that deterioration has not taken place. Scrap or repair any damaged portion of the parachute assembly.

FRESH WATER CONTAMINATION

Any parachute that has been contaminated by fresh water must be dried as soon as possible. The assembly must then be inspected for signs of stains by oil, hydraulic fluid, mud, etc. Such stains must be removed by cleaning as described later in this chapter.

MILDEW AND FUNGUS CONTAMINATION

If mildew or fungus is present on a parachute assembly, wash the affected area with a mild soap and water solution. Rinse the affected area thoroughly with clean, fresh water and hang the assembly by vent lines in a wet locker to dry.

FIREFIGHTING AGENTS CONTAMINATION

If a parachute assembly is contaminated with firefighting agents, forward to supply for screening.

PETROLEUM PRODUCTS CONTAMINATION

Oil, grease, hydraulic fluid, and other petroleum stains must be removed by repeated applications of a mild soap and water solution. Each application must be followed by a rinse in clean, fresh water. Hang the assembly by vent lines in a wet locker to dry.

CLEANING PARACHUTE ASSEMBLIES

Cleaning of parachute assemblies should be held to a minimum and done only when necessary to avoid malfunction or deterioration.

Do not scrub fabric with any cleaning implement or against itself, do not brush fabric. Do not pick at or try to break off dried or caked mud. Wrap all metal fittings in heavy flannel cloth.

Hang the parachute assembly by vent lines and thoroughly shake to remove all sand, dust, and mud. If the assembly is wet, immerse it in clean, fresh water not over 120° F. Gently move the parts by hand until all air pockets are removed. Agitate by hand until water flows through and around the fabric. MACHINE AGITATION MUST NOT BE USED.

After 5 to 10 minutes, lift the assembly from the tub and allow to drain as completely as possible. Drain and rinse the tub and refill with water; repeat the 5 to 10 minute wash twice.

If the parachute has dried before the first rinse is performed, the first rinse must be preceded by a 2- to 3-hour soaking in a tub filled with clean, cool, fresh water. If a large tub is not available, hang the assembly by the canopy vent lines and spray clean using clean, fresh water not over 120° F.

Do not use a forced-heat dryer. Do not wring water from the canopy.

Place the cleaned parachute assembly into a low speed dryer and spin dry. If a low-speed dryer is not available, hang the parachute assembly by vent lines in a wet locker only until dry. When the assembly is completely dry, remove the flannel cloth from the metal fittings.

If the parachute assembly has stains which cannot be removed by the procedure described in the foregoing paragraphs, it must be forwarded to a depot-level maintenance activity for additional cleaning. Attach a report of the nature and location of stains.

STENCILING PARACHUTE ASSEMBLIES

Parachute assemblies are marked by the manufacturer in accordance with the general

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specifications for parachutes. When a parachute is placed in service from stores, the month/year of opening the manufacturer's individual shipping container must be stenciled on the canopy nameplate gore. Letters are 1/2 inch high and made with blue parachute marking fluid (MIL-I-6903). The term "date placed into service" followed by month/year notation must be placed directly below the nameplate.

When a replacement parachute harness is installed, the date, preceded by the letter "R," must be stenciled in the center of the horizontal back strap in letters 1/2 inch high.

Service life of integrated torso suit harness is the same as for parachute assemblies. The start-of-service date must be stenciled in the center of the lap belt strap outer surface. Use black washproof ink (TT-I-542).

Use an appropriate size adjustable metal stencil for all markings on parachute assemblies. Join each letter properly in the grooves provided. When the stencils are joined, aline the letters or figures in order to prevent a wavering line. Use the end plates provided in each kit, which offer the necessary margin to prevent smearing the marking fluid off the ends. Hold each letter down tightly as the fluid is applied with a dampened brush. Do not attempt to stencil with a wet brush as the fluid will run off in all directions. Wipe the back of the stencil clean with a dry cloth between each operation. Before storing, clean the adjustable stencils in a safe cleaning solvent.

STITCHES, SEAMS, AND STITCHINGS

Federal Standard No. 751 is the official standard specification used in the manufacture and repair of parachutes, survival equipment, and other items which require the use of stitches, seams, or stitchings. The following information is taken from this specification.

CLASSIFICATION OF STITCHES, SEAMS, AND STITCHINGS

As a prerequisite to an understanding of stitches, seams, and stitchings, a clear understanding of their classification and the terms employed in their use is essential.

Stitches

A stitch is one unit of conformation of thread resulting from repeatedly passing a strand or strands and/or loops of thread into or through a material at uniformly spaced intervals to form a series of stitches.

Stitches are divided into six classes which are identified by the first digit of three-digit numerals. Each class is divided into several types which are identified by the second and third digit. These classes are as follows:

100—Chain stitch
200—Hand stitch
300—Lock stitch
400—Multithread chain stitch (double locked stitch)
500—Overedge stitch
600—Flat seam stitch

STITCH CLASS 100.—This class of stitch is formed with one or more needle threads and has for its general characteristic interlooping. A loop or loops of thread or threads must be passed through the material and secured by interlooping with succeeding loop or loops to form a stitch, as shown in figure 10-1.

STITCH CLASS 100.—This class of stitch is formed with one or more needle threads and has for its general characteristic interlooping. A loop or loops of thread or threads must be passed through the material and secured by interlooping with succeeding loop or loops to form a stitch, as shown in figure 10-1.

STITCH CLASS 200.—This class of stitch is formed by hand with one or more needle threads. Each thread passes through the material as a single line of thread, and the stitch is secured by the single line of thread passing in and out of the material or interlooping of the threads with themselves. When more than one thread is used, the threads pass through the same

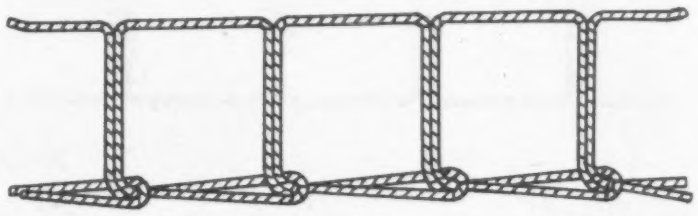

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Figure 10-1.—Stitch type 101. This type of stitch is formed with one needle thread which is passed through the material and interlooped with itself on the undersurface of the material.

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connected in series and an equal resistance is connected in parallel with each so that the high voltage will divide equally across each tube. This division prevents the voltage across either tube from becoming high enough to cause the tube to conduct.

As illustrated figure 16-19, the trigger pulse is applied across one diode and causes it to conduct. This conduction causes the triggered diode to appear as a closed switch which connects the full high voltage across the other diode and causes it to conduct. The conduction of this tube closes the network circuit. This circuit remains closed until the storage network discharges to the point where the diodes de-ionize. At this time the storage network begins to recharge.

The thyratron is the more common switching device utilized in modulators. It is operated at cutoff until a positive trigger pulse is applied to the grid. The tube then conducts until the network circuit becomes discharged to the point that the thyratron de-ionizes and the grid regains control. The most common thyratron of this type is the HYDROGEN THYRATRON. While the gas diodes require an extremely high trigger voltage, the hydrogen thyratron requires a much lower voltage, approximately 30 to 100 volts. The normal life of this type of thyratron is expected to be about 900 hours; tube life is influenced by repetition rate and not pulse widths, providing the widths do not exceed 5 microseconds. The two advantages of the thyratron switching system are the accuracy of the firing time and the fact that the thyratron is not affected by the impedance of the trigger source.

PULSE-FORMING NETWORKS

The pulse-forming network consists of a series of coils and capacitors in an arrangement like that shown in figure 16-20. There are other arrangements for the elements in the PFN, but the arrangement shown is the most common. Most pulse-forming networks have a CHARGING CHOKE in series with the input. The choke is series resonant with the line and isolates the power supply from the switching device during discharge time. The LC constants in the network are carefully selected to provide a pulse of the proper shape and duration. The coils and capacitors must be rated to withstand the high voltages and currents they encounter in building up the high-powered pulse.

The PFN and charging choke are designed so that their combined impedance matches the output load as nearly as possible when the network is switched. The output line therefore appears as an infinitely long transmission line when the switch is closed. This reduces reflections in the charging circuit during the discharge interval. During the charging time, however, when the switch is open, the network is resonant. It can be shown that when a voltage is suddenly applied to an inductance and capacitance in series, the voltage at the resonant frequency of the circuit oscillates in such a manner as to give a sine wave, the amplitude of which is almost twice the applied voltage.

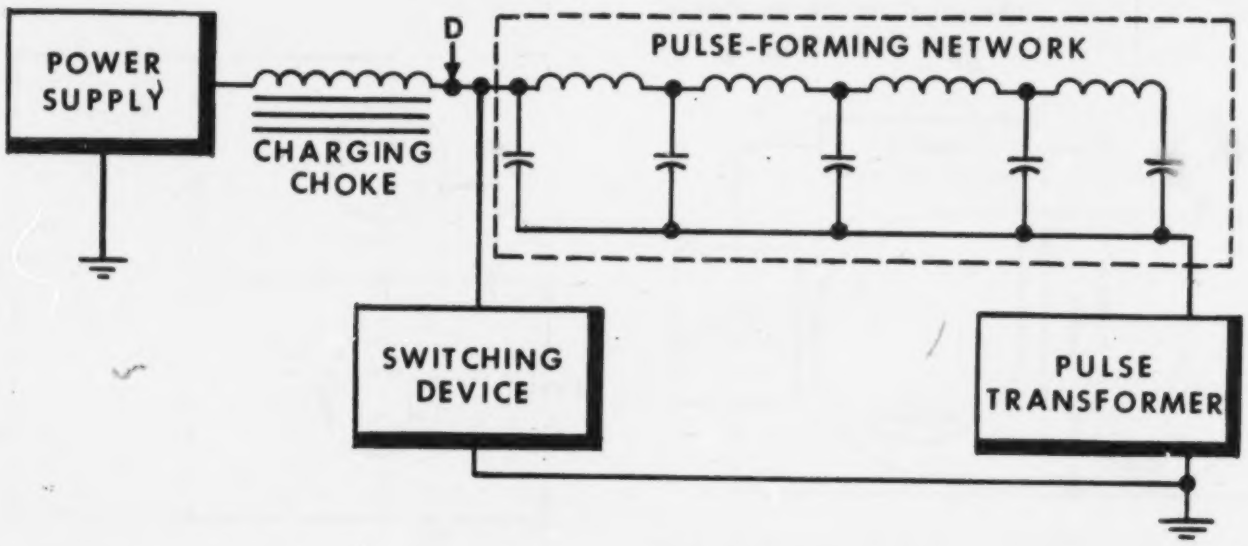

Figure 16-20. —Schematic diagram of a typical pulse-forming network and charging choke.

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perforations in the material, as illustrated in figure 10-2.

STITCH CLASS 300.—This class of stitch is formed with two or more groups of threads and has for a general characteristic the interlacing of the two groups. Loops of the first group of threads are passed through the material where they are secured by the thread or threads of the second group to form a stitch. This is the most common type of stitch in use in repair and maintenance of parachutes and other survival equipment. It is made by machine and is illustrated in figure 10-3.

STITCH CLASS 400.—This class of stitch is formed with two or more groups of threads and has for a general characteristic the interlacing and interlooping of the loops of the two groups. Loops of the first group of threads are passed through the material and are secured by interlacing and interlooping with loops of the second group to form a stitch.

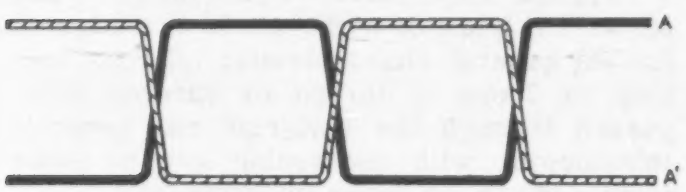

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Figure 10-2.—Stitch type 201. This type of stitch is formed with two needle threads (A) and (A') passed through the material in the same perforations from opposite directions without interlacing or interlooping.

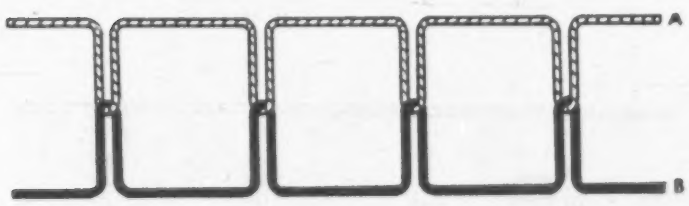

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Figure 10-3.—Stitch type 301. This type of stitch is made with two threads: one needle thread (A) and one bobbin thread (B). One loop of thread A is passed through the material and interlaced with thread B. Thread A is pulled back so that the interlacing is midway between the surfaces of the material being sewn.

STITCH CLASS 500.—This class of stitch is formed with one or more groups of thread, and loops from at least one group of thread are passed around the edge of the material. Loops of one group are passed through the material and are secured by interlooping with themselves before succeeding loops are passed through the material, or secured by interlooping with loops of one or more interlooped groups of threads before succeeding loops of the first group are passed through again.

STITCH CLASS 600.—This class of stitch is formed with two or more groups of threads, and two or more groups cover the raw edges of both surfaces of the material. Loops of the first group of threads are passed through loops of the third group already cast on the surface of the material and then through the material where they are interlooped with loops of the second group on the underside of the material. The one exception to this procedure is stitch type 601. In this type only two groups of thread are used and the function of the third group is performed by the threads of the first group.

Seams

A seam is a joint consisting of a sequence of stitches uniting two or more pieces of material and is used for assembling parts in the production of sewn items. Seams are divided into four classes:

SS—Superposed seam (Superimposed)
LS—Lapped seam
BB—Bound seam (Binding)
FS—Flat seam

Seams are further subdivided into types, designated by a system of lowercase letters which indicate the type of the class. These types run consecutively through the alphabet; however, since there are many variations of seams and only 26 letters in the alphabet, multiple lowercase letters must also be used; for example, a, b, c, aa, ab, etc.

Most seam types can be produced using either one row or multiple rows of stitches. The number of rows of stitches is indicated by an arabic numeral preceded by a dash; thus, the complete symbol for a simple superposed seam formed with standard stitch type 301 and one row of stitches is specified 301-SSa-1.

SEAM CLASS SS.—In this class of seam the plies of material are superposed and sewn with one or more rows of stitches.

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SEAM CLASS BS.—This class of seam is formed by folding a binding strip over the edge of one or more plies of fabric and seaming the strip to the material with one or more rows of stitches.

SEAM CLASS LS.—In this class of seam the plies of material are lapped and seamed with one or more rows of stitches.

SEAM CLASS FS.—This class of seam is formed by seaming the abutted edges of the material together in such a manner that the stitches extend across and cover or tend to cover the edges of the plies joined.

Typical examples of these seams are illustrated in figure 10-4. A careful study of these examples will give the reader an idea of the basic seams and stitchings used in the repair of survival equipment. However, when a specific seam is called for in a drawing or a specification, reference should be made to Federal Standard 751 for the specifications for the seam or stitching to be used.

Stitchings

Stitching consists of a sequence of stitches for finishing an edge or for ornamental purposes (or both) in preparing parts for assembly. Stitchings are divided into two classes as follows:

OS—Ornamental.

EF—Edge finishing.

These stitchings are illustrated in figure 10-5. Note the difference between these stitchings and the previously mentioned seams. These stitchings are used as finishing touches to a product.

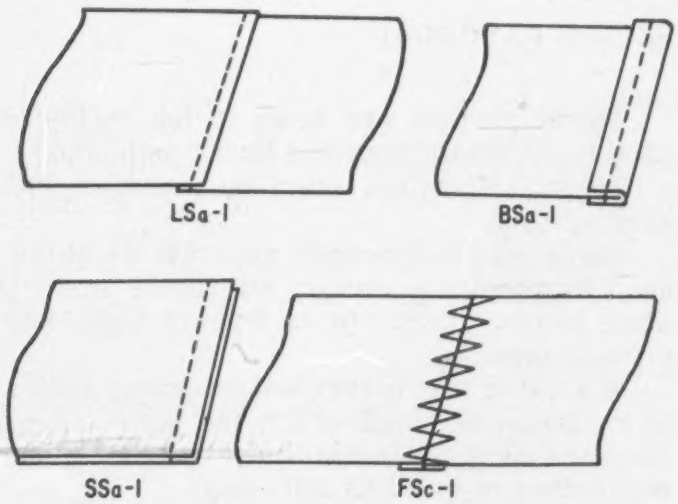

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Figure 10-4.—Classes of seams.

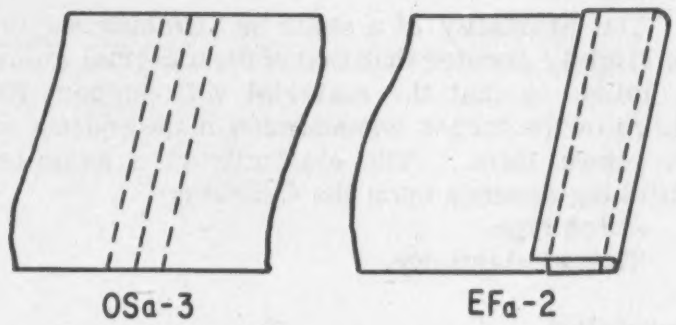

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Figure 10-5.—Stitching class OS and EF.

STITCHING CLASS OS.—In this class of stitching a series of stitches are embodied in a material either in a straight line, a curve, or following a design, for ornamental purposes.

STITCHING CLASS EF.—In this class of stitching edge, finishing is accomplished by either (1) stitching a series of stitches at or over the edge of a material (the edge may or may not be folded as specified), or (2) the edge of the material is folded and stitched to the body of the material with a series of stitches.

CHARACTERISTIC OF SEAMS AND STITCHINGS

A properly constructed seam or stitching must have strength, elasticity, durability, security, and a neat appearance. These characteristics must be balanced with the properties of the material to be joined to form the optimum seam. The end use of the item will govern the relative importance of these characteristics, and the selection of the seam or stitching type should be based upon these considerations.

Strength

The strength of a seam or stitching should equal that of the material it joins in order to have balanced construction that will withstand the forces encountered in the use of the item of which the seam is a part. The elements affecting the strength of a seam or stitching are as follows:

Stitch type.
Thread strength.
Stitches per inch.
Thread tension.
Seam or stitching type.
Seam efficiency of the material.

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Elasticity

The elasticity of a seam or stitching should be slightly greater than that of the material which it joins, so that the material will support its share of the forces encountered in the end use of the sewn item. The elasticity of a seam or stitching depends upon the following:

Stitch type.
Thread elasticity.

Durability

The durability of a seam or stitching depends largely upon its strength and the relation between the elasticity of the seam and the elasticity of the material. However, in the less elastic, tightly woven, dense materials there is a tendency for the plies to "work" or slide on each other. To form a durable seam or stitching in such materials, the thread size must be judiciously chosen and the stitches well set to the material (without undue tension which will unbalance the elasticity and cause puckering) to minimize abrasion and wear by contact with outside agencies.

Security

The security of a seam or stitching depends chiefly upon the stitch type and its susceptibility to become unraveled. The stitch must be well set to the material to prevent snagging which can cause rupture of the thread and unraveling of certain stitch types.

Appearance

The appearance of a seam or stitching generally is governed by the proper relationship between the size and type of thread, the length of stitch or number of stitches per inch, and the texture and weight of the fabric. In addition to this relationship, the technique and skill of the sewing machine operator also governs the appearance of the seams and stitchings.

Some of the factors which adversely affect the appearance of seams and stitchings are listed below.

Defects in stitchings:
- Loose stitches.
- Poorly formed stitches.
- Crowded stitches.
- Tight stitches.
- Crooked stitches.
- Skipped stitches.

Defects in seams and stitching:
- Puckers.
- Twists.
- Pleats.
- Raised seams (run-offs).
- Felled seams (raw edges exposed).

PATCHING THE PARACHUTE CANOPY

A canopy is considered beyond repair if one or both of the following conditions exist: One or more complete gores are torn or there are holes larger than 8-inches long in four or more sections. If damaged beyond repair, the canopy should be forwarded to a supply activity for screening. Any section with holes, tears, or cuts larger than 8 inches must be replaced in accordance with drawings and specifications.

Only two single patches or one double patch may be installed on a single section. If additional patches are required, replace the section. Any hole, cut, or tear 1 inch square or less may be patched with a single patch. A severe separation or a separation with broken threads must be patched using a single reinforcement patch. Holes larger than 1 inch must be repaired using a double patch, one on the inside and one on the outside of the section. The patch on the inside must be applied first.

If a thread separation is not severe and no threads are broken, the thread can be pressed into place using a soft brush or a pencil eraser. Do not brush the damaged area in the wrong direction as this will cause the separation to increase.

SINGLE PATCHING

Single patches are sewn to the inside of a canopy. A hole or tear less than 1 inch square or a thread separation must be repaired with a single patch.

Salvaged or overaged material must not be used to repair a canopy; all repair materials must have a shelf life of 2 years from date of manufacture.

If a cut or tear is even and no canopy material is missing, baseball-stitch the patch or tear. Lock the first and last stitch. Figure 10-6 shows the method of baseball stitching.

If a cut, tear, or hole has canopy material missing, trim the edges and cut a filler patch the same size and shape as the cut, tear, or hole.

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Figure 10-6.—Baseball stitching a tear.

Baseball stitch the filler patch in the hole, locking the first and last stitch. (See fig. 10-7.)

To obtain the measurements of the patching material, outline a damaged area using a soft lead pencil. Outline a minimum margin of one inch around a 1- to 3-inch hole; 1 1/2 inches around a 3- to 6-inch hole; and 2 inches around a 6- to 8-inch hole. If possible, anchor the patch to at least one seam or hem.

Place a piece of new material over the outlined area so that the weave of new material matches the weave of the canopy. Cut the patch 1 inch larger than the outlined area.

Place the damaged area with the inside of the canopy facing up on a padded table. Pin the damaged area flat to eliminate wrinkles and baste the patch to the outlined area. Turn the raw edges of the patch under 1/2 inch. Lock-stitch the patch using two rows of stitching around the edges of the patch with 8 to 10 stitches per inch; stitching around the edges of a patch must be continuous. Upon completion of a row of stitches, backstitch 2 1/2 inches on radial seams or hems and 1 1/4 inches on diagonal seams. If the patch is not anchored on a seam or hem, backstitch 1 1/4 inches. (See fig. 10-8.)

For all sewing of patches and other repair work on personnel parachute canopies, size E nylon thread must be used.

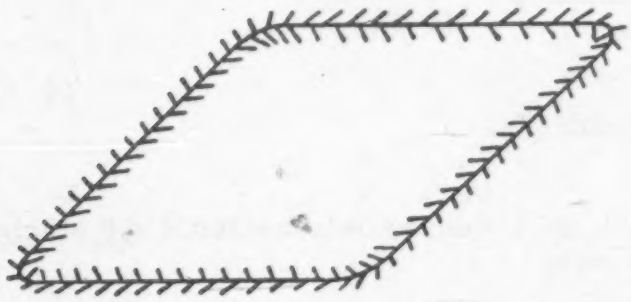

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Figure 10-7.—Filler patch applied with baseball stitch.

DOUBLE PATCHING

A hole, tear, or cut in the canopy greater than one inch square and less than 8 inches square must be patched with a double patch.

Use the same method for baseball stitching and applying filler patches as described for single patching. In order to measure and cut the outside patch, use the inside patch as a gage.

Place the inside patch on a piece of new material and cut the outside patch 1/4 inch larger on all sides except the side or sides that will be anchored to a seam or hem. Sides to be anchored to a seam or hem are cut to the same size as the inside patch.

The inside patch should be the smaller patch and must be applied first, so that its stitching will be covered by the outside patch.

Pin the outside patch to the canopy material, with the outside of the canopy facing up. Sew with size E nylon thread, 8 to 10 stitches per inch, using two rows of stitchings. For additional strength always try to anchor one or more sides of the patch to a seam or hem. NEVER sew through a suspension line. Figure 10-9 shows the method of double patching.

REPLACING PARACHUTE COMPONENTS

VENT RING

Broken or damaged vent rings cannot be repaired and must be replaced.

Open the seam holding the vent ring, remove the damaged vent ring and insert the new ring. Resew the hem using size E nylon thread, 8 to 10 stitches per inch. When the seam is completed backstitch 1 1/4 inch.

HARNESS/RISER ASSEMBLY

Inspect webbing for signs of contamination, cuts, fraying, burns, and loose or broken

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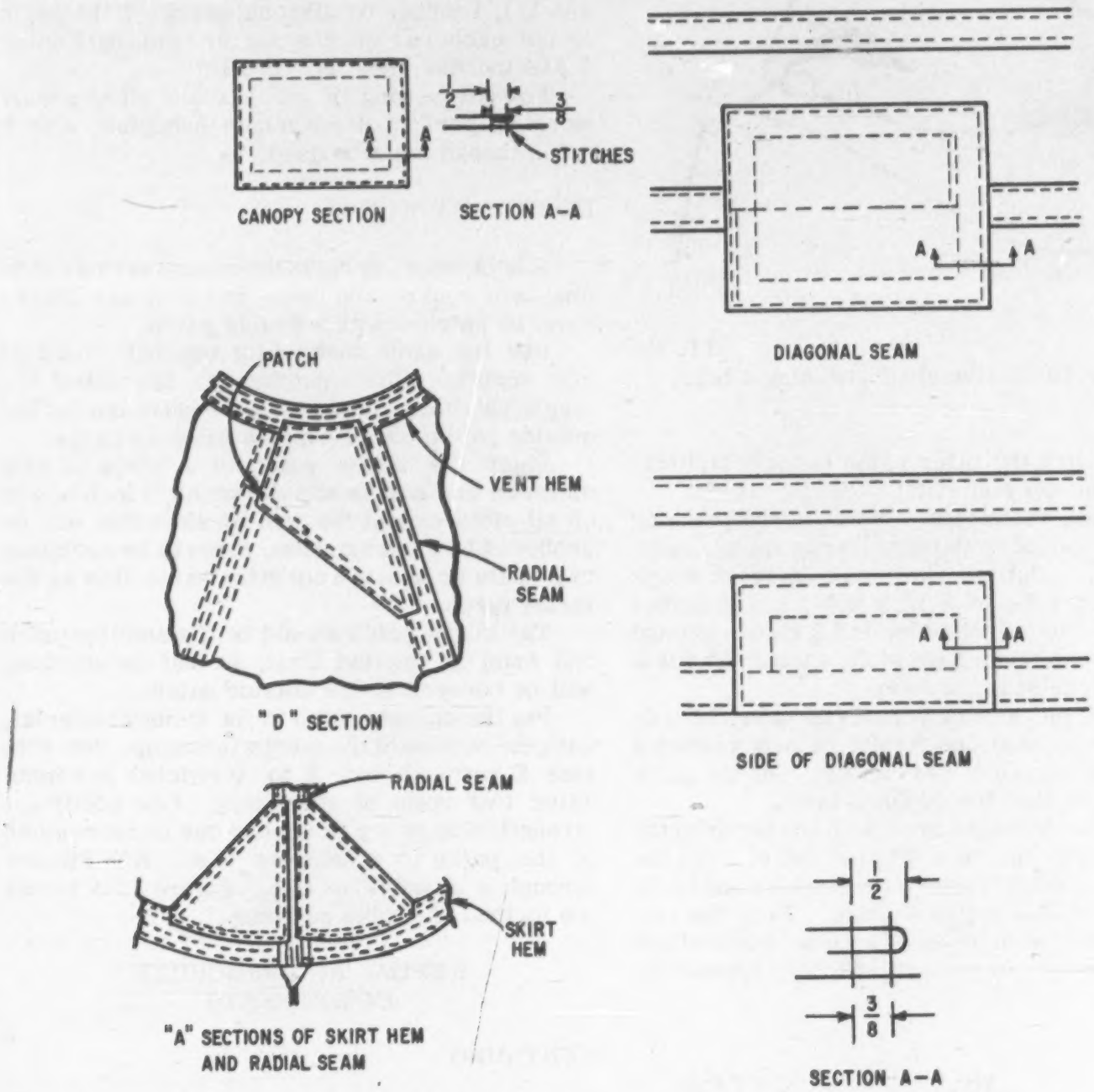

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Figure 10-8.—Single patching.

stitching. If any damage is found in excess of three stitches, strike the assembly from service and replace it in accordance with the applicable rigging and packing procedures.

If less than three stitches are loose or broken, repair the harness or riser assembly using nylon 6 cord. Lock-stitch over the original stitch and 3/4 inches on both sides, 4 to 6 stitches per inch.

HARDWARE

Inspect canopy quick-release fittings for breaks, corrosion, pitting, bends, dents, and

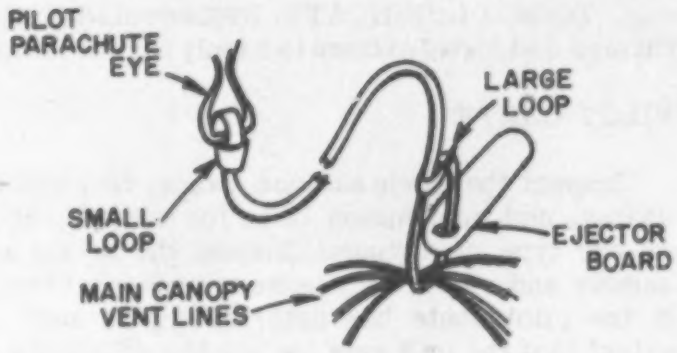

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Figure 10-10.—Attaching MBEU pilot chute connector cord.

CONTAINER REPAIR

Reconditioning of the container can be accomplished with or without a sewing machine. Patches, modifications, additions, attachment of cushions or liferaft cases, or other repairs of any nature may not be made while the parachute is in a packed condition. To do so is to risk the possibility of accidentally securing one of the main parts of the parachutes to the container and slowing or possibly preventing the proper opening of the parachute in an emergency.

To repair small holes, tears, or snags, 1/2 inch square or less, machine darn in the same direction as the weave, using size E nylon thread. To reinforce corners and edges, use flat webbing; do not use tubular webbing or light herringbone tape.

Cut flat webbing to size and sear ends; if necessary, remove container frame. Boxstitch webbing over the damaged area with size FF nylon thread, 8 to 10 stitches per inch.

To patch large holes, tears, or rips, the container repair material used must be the same as the type used to construct the container. Do not use overaged or salvaged material. Cut the patch large enough to fully cover the damaged area, overlap 3/4 to 1 inch and allow for the edges to be turned under 1/2 inch.

Place the patch over the damaged area, folding edges under 1/2 inch, sew two rows of stitches around the edge of the patch, and backstitch at least 3/4 inch.

Original manufacturing details of the container should be noted, and any repairs should reproduce these details as closely as possible.

GROMMET REPAIR

Defective or missing grommets must be replaced, using special dies. The same size grommet and grommet washer used in the manufacture of the container assembly must be used for the replacement.

To repair the damaged area, cover the hole in the container assembly with a square patch that is 3/8 inch larger than the grommet washer. Stitch the patch on all four sides with two rows of stitching. Turn raw edges under 1/4 inch and sew using 8 to 10 stitches per inch. The patching material must be nylon cloth, 7.5-ounce MIL-C-7219.

Care must be taken when applying the reinforcement so that the thickness around the grommet will not be increased to such an extent as to prevent the locking pins from passing through the holes in the cones. Care must be taken that the edges of the grommets are perfectly smooth and rounded so as not to obstruct the operation of the locking pins or retard the action of the grommets in slipping off the cones.

When cones have become corroded, have bent or broken flanges, or are worn where the grommets or end tabs bear, they must be replaced. In replacing cones on the container, sew with double 3-cord nylon thread. (Note the way other cones are sewn and follow the same sewing pattern.) Be sure the ripcord pin holes in the cones are in line with each other and also in line with the direction of ripcord pull.

In replacing loose or lost eyes, sew with double 3-cord nylon thread. (Note the way the other eyes are stitched and follow the same stitching pattern.) It should be noted that at each point of stitching, five turns of the doubled 3-cord is used. It does not matter in which order the stitches are made. Finish the stitching with the thread on the underside of the container material and tie off.

INSPECTION OF COMPLETED WORK

Though many of the more common repairs have been covered in this chapter, this should not be construed to mean that such procedures are the only authorized repairs. Any time a parachute assembly may be reasonably restored to operational condition, repairs may be made.

The primary concern in repairing any assembly is insuring that the basic integrity designed into the assembly is maintained. All

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repair work must be carefully inspected and compared to drawings and specifications at completion of work to insure absolute conformity to drawings.

QUALITY ASSURANCE

Examine the finished work and verify correctness of work. In no case may a man who accomplished the repairs perform his own quality assurance inspection.

SAFETY PROCEDURES

Due to employment of pyrotechnic devices on various parachute assemblies, the following precautions are cited to insure safety of personnel performing maintenance and repair operations.

NB-11 PARACHUTE ASSEMBLY

This assembly employs a fail-safe ballistic spreader gun. Do not remove folded canopy or suspension lines from container before installing spreader gun safety pin.

NB-7E AND LW-3B ASSEMBLIES

These assemblies employ a pyrotechnic static line cutter. Do not open the container by pulling on static line. Do not unpack the parachute before inserting the safety pin in the static line cutter device.

CARTRIDGE ACTUATED ASSEMBLIES

The NB-5, NB-7, NB-7D, NB-7E, NB-9, NB-10, and NB-11 assemblies employ cartridge operated automatic actuators (optional on NB-6, NB-8, and NS-3 parachutes for specific applications). Insure that the automatic actuator arming cable is not pulled accidentally while the automatic actuator is armed.

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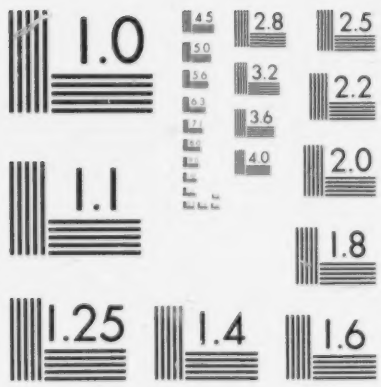

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CHAPTER 11

SEWING MACHINES

The nature of the PR's work in the maintenance and upkeep of aviator's equipment requires that he have a thorough knowledge of the minor adjustments to be made, and the proper lubrication of standard sewing machines. He must also be a skilled operator of these machines in order to keep flight clothing and survival equipment in good repair.

This chapter gives a background for obtaining this knowledge, but the actual skill in operating machines can be acquired only by practice at sewing on scraps of material or on jobs which may not require a lot of skill such as manufacture of pitot covers, small flags or pennants, etc. It behooves the PR striker to use as much of the time spent in the loft as is possible in practice sewing.

SEWING MACHINE FAMILIARIZATION

Sewing machines are divided into two types, OSCILLATING and ROTARY. Both types are operated by electric motors and are fitted with rheostats and special clutch arrangements which enable the operator to control the speed.

Oscillating type sewing machines are named for the action of the sewing hook, which rocks back and forth through half of one revolution to complete one stitch.

Rotary type sewing machines are also named for the action of the sewing hook, which makes two complete revolutions to complete one stitch,

The type of stitch commonly used and made by sewing machines in repair work is the lockstitch. The lockstitch makes use of two separate threads. One comes from the spool down through the eye of the needle, the other from the bobbin. In making the lockstitch, these two threads must become interlocked, as shown in figure 11-1.

The thread passing through the eye of the needle is pushed down through the material being sewn. As the needle travels downward to the material, a thread controller spring pulls on the needle thread to prevent any slack that might tangle the thread around the needle.

After the needle reaches its lowest position and starts its upward movement, a small loop of thread forms alongside the needle beneath the throat plate. The sewing hook catches this loop and carries it around the bobbin, which floats in its track in the bobbin case. By locking the loop of needle thread around the bobbin thread, the sewing hook forms the stitch.

As the needle completes its upward movement, the thread tension disks hold the needle thread firmly, and the thread takeup lever, rising quickly, pulls on the loop that has been formed and thus tightens the stitch. When the thread takeup lever reaches its highest position, the stitch is completed.

The standard sewing machine has four basic parts: bed, uprise, arm, and face. The BED houses the linkage from the safety clutch pulley to the sewing hook assembly; the UPRISE houses the arm shaft connection belt; the BALANCE WHEEL is connected to the arm shaft in the ARM which operates the needle bar mechanism in the FACE of the machine.

The machine is powered by an electric motor, which is connected to the motor driving pulley by a clutch. The motor is connected to the clutch by pressing the forward part of the foot treadle. The aft part of the treadle is the brake which acts upon the clutch.

The material to be sewn is held in position on the feed dog by the presser foot. The pressure of the presser foot upon the material enables the feed dog to push the material forward each time the needle goes up. The pressure of the presser foot on the material is released either by a knee lifter or a hand lifter. The presser foot can be raised by pushing the knee lifter to the right. The hand lifter is located behind the face of the machine. The

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For maximum voltage production the pulse recurrence frequency should be equal to twice the resonant frequency of the charging circuit. To permit operation at more than one repetition rate, a charging diode must be connected in series with the charging choke. This diode would be connected at point D in figure 16-20. Figure 16-23 shows a multi-PRF modulator using a charging diode. The pulse-forming network is thus prevented from discharging after the maximum oscillation is reached. The diode also causes some additional damping in the circuit, so that the maximum value is slightly less than the original maximum value of almost twice the value of the d-c supply.

Because the diode maintains the voltage at practically twice the d-c supply for a considerable time the interval between times of closing the switching device can have any value greater than a half cycle of the charging oscillation.

The output voltage pulse from a d-c resonant charging network is about half the voltage to which the network is charged because the line impedance and load impedance are equal. Since the network is charged to nearly twice the supply voltage and the output pulse voltage is half the network charge, the usable voltage in the output pulse is about 0.9 of the supply voltage.

This type of pulse network is usually sealed in a metal box filled with oil which acts as an insulator. For that reason it is sometimes called a POTTED NETWORK. It is impossible to replace components in the line. Some lines using only a few elements are not potted. These do not generally give as nearly a rectangular output pulse, due to the smaller number of sections.

THE PULSE TRANSFORMER

In the circuits discussed thus far the load can be a magnetron and its associated circuits or the primary of a pulse transformer which has its secondary connected to the magnetron. The use of a high-voltage step-up transformer to furnish voltage for the magnetron makes possible the use of lower voltages in the pulse-forming network and thus simplifies the insulating problem. An advantage in using a transformer with two secondaries (bifilar windings), as shown in figure 16-21, is that it avoids having high voltage in the magnetron filament transformer. The bifilar windings have the same voltage induced into each since they are wound side by side. This winding

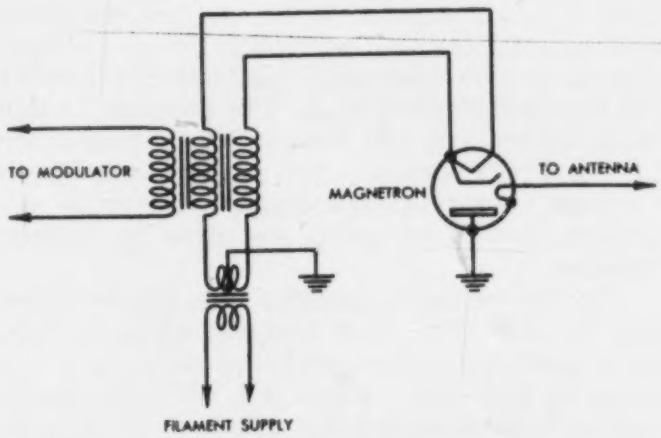

Figure 16-21.—A transformer with two secondaries makes possible the grounding of the filament transformer secondary.

makes it possible to connect a filament transformer, without high-voltage insulation, to the heater of the magnetron and to couple the high-voltage pulse between the cathode and plate.

A third need for the high-voltage pulse transformer is matching impedances, particularly where the radar antenna is remote from the set itself. Since the use of long transmission lines between the magnetron and the antenna makes the magnetron's operation somewhat erratic, it is desirable to have the magnetron near the antenna. This necessitates the use of long lines to carry the modulator pulse to the magnetron. In order to be able to use 50-ohm line for this purpose and still obtain an impedance match with the impedance of the magnetron (approximately 1,000 ohms), it is necessary to use a 4 1/2 to 1 step-up transformer at the magnetron end.

The pulse transformer must be specially designed because there are very high frequency components present in a rectangular pulse of such short duration. The core is usually silicon steel and has laminations in the order of 0.003 inch in thickness. In general a good pulse transformer must have low leakage inductance, low interwinding capacitance, and high primary inductance.

TYPES OF MODULATORS

There are two types of modulators—the line-pulsing modulator and the driver-hard-tube modulator. The line-pulsing modulator stores energy and forms pulses in the same circuit element. This element is usually the pulse

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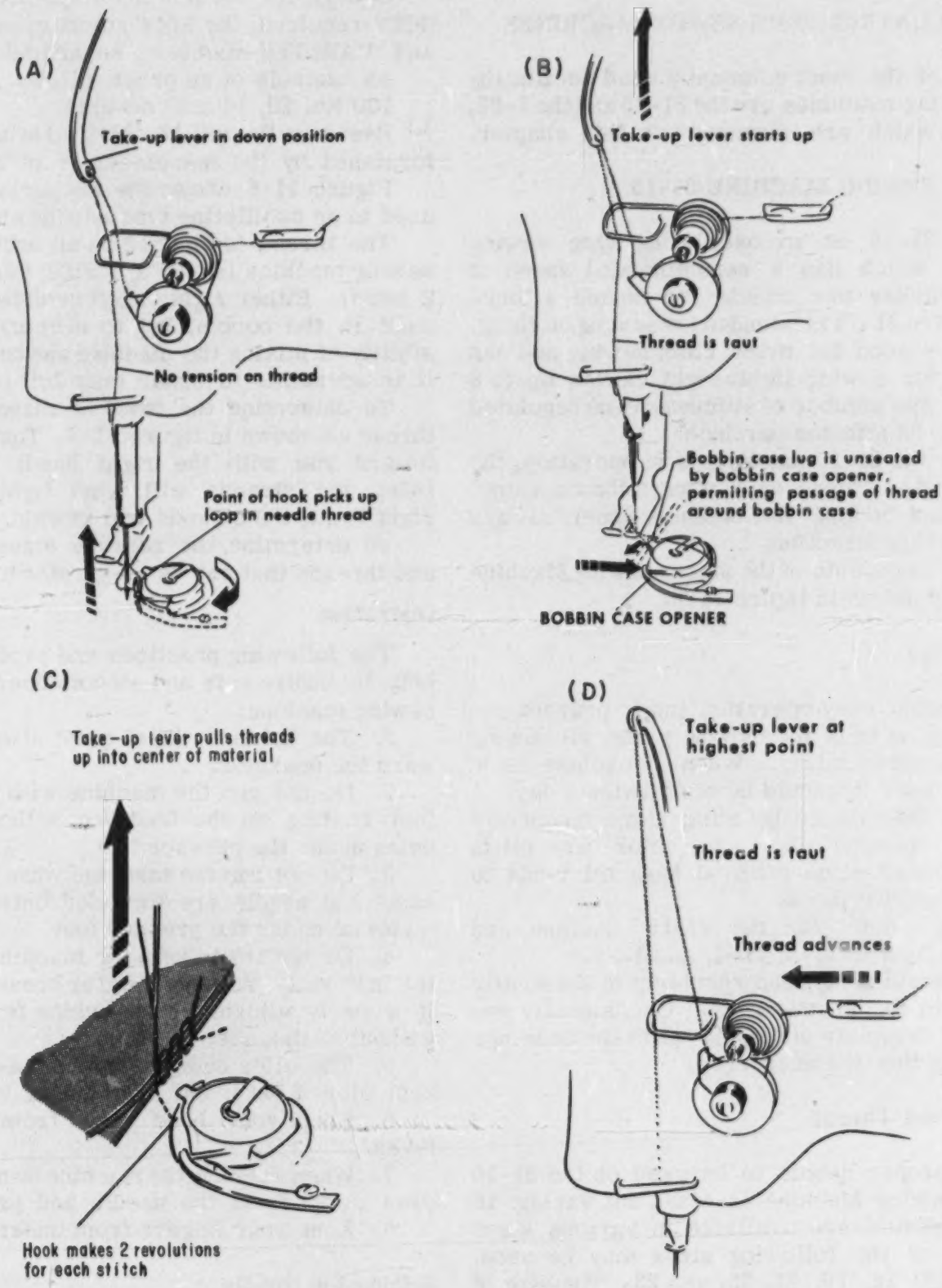

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Figure 11-1.—The lockstitch.

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presser foot may be lifted and locked into position by raising the hand lifter to its highest position.

OSCILLATING TYPE SEWING MACHINES

Two of the most commonly used oscillating type sewing machines are the 31-15 and the 7-33, both of which are discussed in this chapter.

SINGER SEWING MACHINE 31-15

The 31-15 is an oscillating type sewing machine which has a recommended speed of 2,200 stitches per minute and makes a lockstitch. The 31-15 is intended for sewing clothing. It is very good for nylon cloth sewing and can be used for sewing lightweight canvas up to 8 ounces. The number of stitches can be regulated from 7 to 32 stitches per inch.

When the 31-15 machine is in operation, the balance wheel turns over toward the operator. When hand-turning the balance wheel, always rotate in this direction.

The components of the Singer Sewing Machine 31-15 are shown in figure 11-2.

Lubrication

To insure easy operation and to prevent unnecessary wear of the moving parts, all sewing machines need oiling. When a machine is in constant use, it should be oiled twice a day. A new machine should be oiled more frequently when in constant use. A castor base oil is recommended since mineral base oil tends to gum the moving parts.

Oiling points for the 31-15 machine are shown in figures 11-3, 11-4, and 11-5.

Oil should be applied regularly to the shuttle bearing in the shuttle race. Occasionally remove the faceplate and apply oil to the bearings and joints that are uncovered.

Needles and Thread

The proper needle to be used on the 31-15 Singer Sewing Machine is class and variety 16 x87. Needles are available in various sizes and any of the following sizes may be used: 14, 16, 17, 18, 19, 21, 22, and 23. The size of thread and material used determines the size of needle to be used. Needles vary in size according to number: the smaller the number, the smaller the needle eye; the larger the number, the larger the needle eye. Needles do not vary in length within the same class and variety.

Orders for needles must specify the QUANTITY required, the SIZE number, and the CLASS and VARIETY number, separated by an "X."

An example of an order follows:

100 No. 18, 16 x 87 needles.

Best results will be obtained in using needles furnished by the manufacturer of the machine.

Figure 11-6 shows the six parts of a needle used in an oscillating type sewing machine.

The thread to be used on an oscillating type sewing machine is LEFT TWIST (also known as Z twist). Either right or left twist thread can be used in the bobbin, but to eliminate the possibility of mixing the machine and bobbin thread, it is advisable to order only left twist thread.

To determine the twist of thread, hold the thread as shown in figure 11-7. Turn the thread toward you with the right hand; if it is left twist, the strands will wind tighter; if it is right twist, the strands will unwind.

To determine the relative sizes of needles and threads that can be used, refer to table 11-1.

Operation

The following practices and procedures will help to insure safe and smooth operation of the sewing machine:

1. The balance wheel must always turn toward the operator.
2. Do not run the machine with the presser foot resting on the feed dog without material being under the presser foot.
3. Do not run the machine when both bobbin case and needle are threaded unless there is material under the presser foot.
4. Do not try to help the machine by pulling the material. You may bend or break the needle. If properly adjusted, the machine feeds the work without assistance.
5. The slide over the bobbin case should be kept closed when the machine is in operation.
6. Keep your head away from the takeup lever.
7. When running the machine do not take your eyes away from the needle and presser foot.
8. Keep your fingers from under the needle.

Setting the Needle

Turn the balance wheel toward you until the thread takeup lever moves upward to its highest

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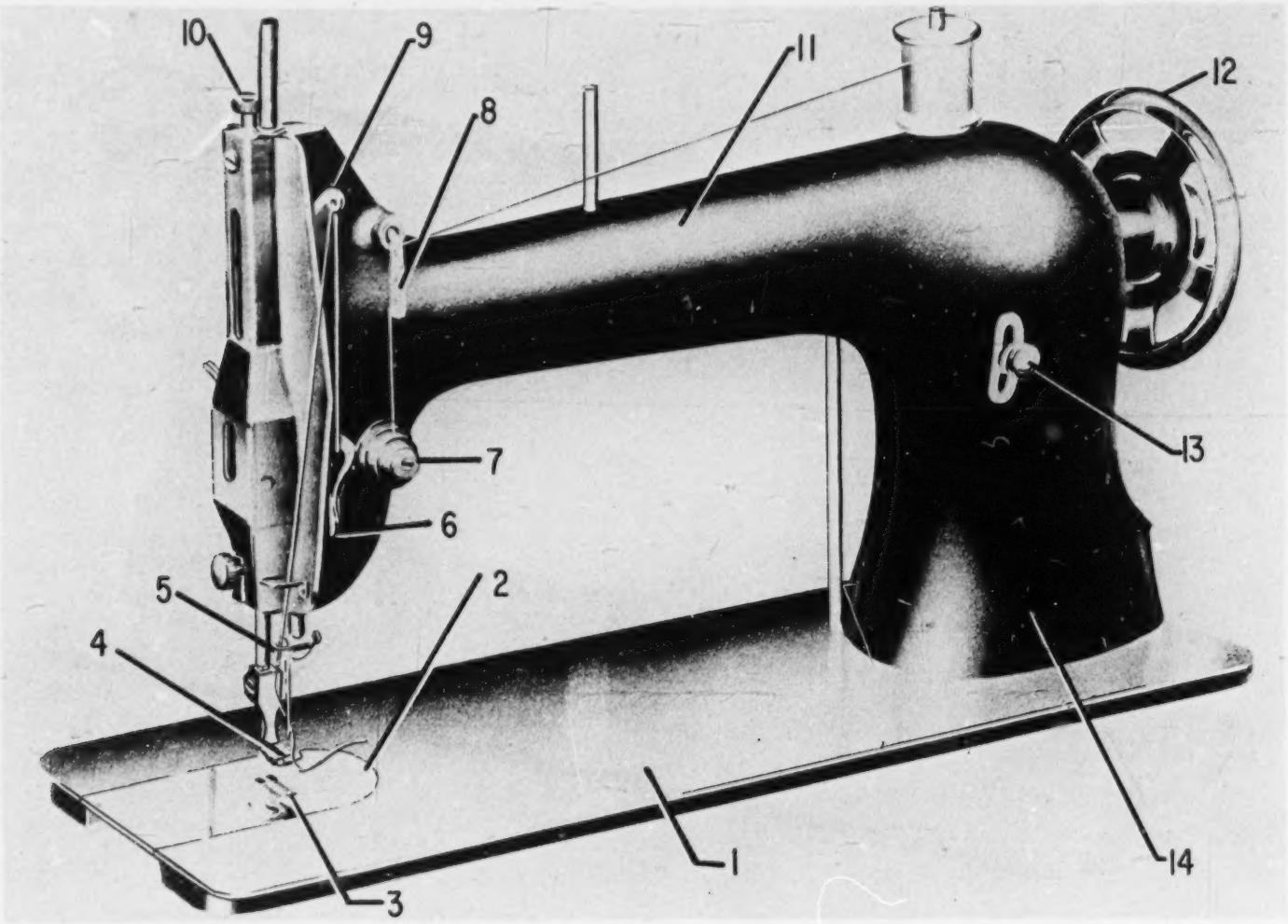

1. Bed.
2. Throat plate.
3. Feed dog.
4. Presser foot.
5. Needle bar.
6. Face.
7. Upper tension regulating thumb nut.
8. Thread retainer.
9. Thread takeup lever.
10. Pressure bar pressure regulating thumbscrew.
11. Arm.
12. Balance wheel.
13. Feed regulator thumbscrew.
14. Uprise.

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Figure 11-2. —Singer Sewing Macgine 31-15.

point; loosen the setscrew in the needle clamp; insert the needle ALL THE WAY into the needle bar so that the long groove of the needle is toward the left, and the eye of the needle is directly in line with the arm of the machine; then retighten the setscrew. NOTE: When setting any needle, always insert it with the long thread groove away from the bobbin.

Threading the Machine

Threading a sewing machine is a very simple job. The procedure may vary slightly with different models; but after working with the various machines in the loft, the task will become automatic.

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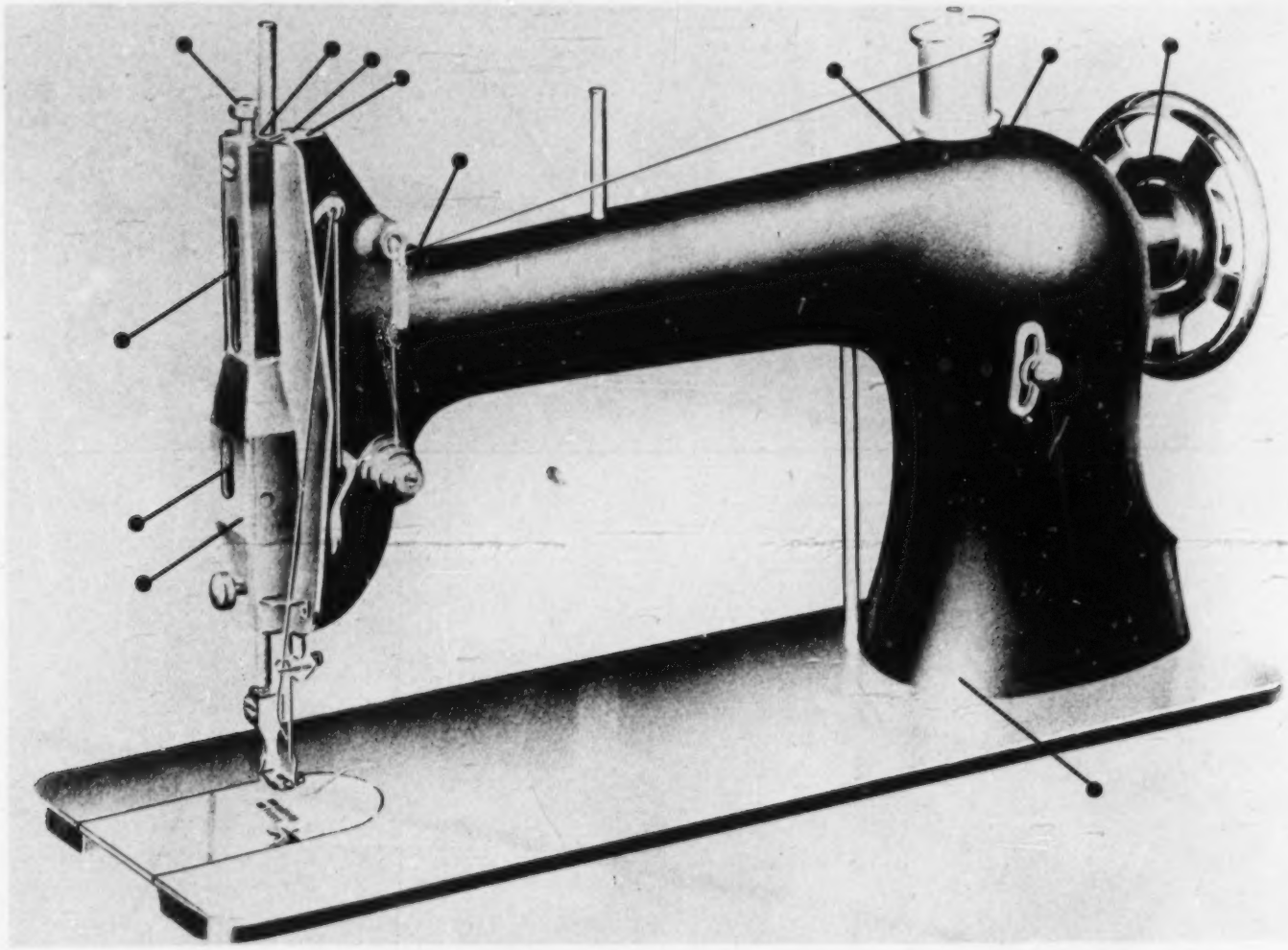

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Figure 11-3.--Oiling points at the front of the machine.

The procedure for threading the 31-15 sewing machine is illustrated in figure 11-8 and described in the following paragraph.

Pass the thread from the thread stand to the thread post on top of the machine, right to left through the bottom hole, and then right to left through the top hole. Pass the thread from right to left through the top hole in the thread retainer (1). Pass the thread from left to right through the middle hole in the thread retainer (2). Pass the thread from right to left through the bottom hole in the thread retainer (3). The thread is then passed down and under from right to left between the tension disks (4). Draw the thread up into the thread takeup spring (5), drawing the thread up and beyond the spring end so that it comes out in the center of the spring. The thread is then placed under the tension thread guard (6). Pass the thread up and from right to left through the hole in the thread takeup lever (7). The thread is now drawn down through three thread guides (8), (9), and (10). Pass the thread from left to right through the eye of the needle (11). Draw about 2 inches of thread through the eye of the needle with which to commence sewing.

Removing the Bobbin Case

Before attempting to remove the bobbin case, turn the balance wheel toward you until the needle moves upward to its highest position.

Remove the slide in the bed of the machine for visibility, reach under the table with the left hand, and using the thumb and forefinger, open the bobbin case latch (1, fig. 11-9), and lift out the bobbin case (2).

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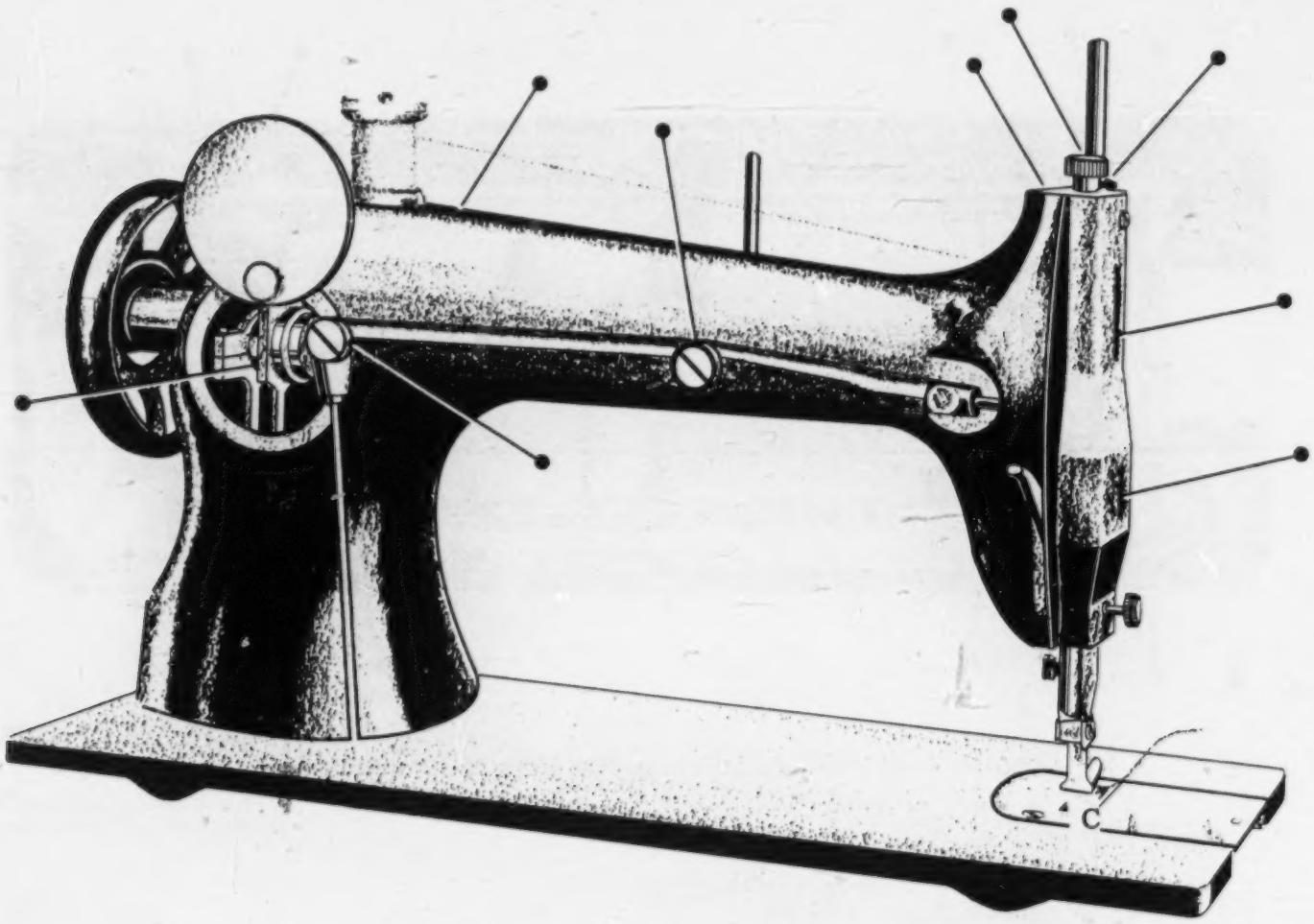

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Figure 11-4.—Oiling points at the back of the machine.

While the latch is held open, the bobbin is retained in the bobbin case. Release the latch, turn the open end of the bobbin case down, and the bobbin will drop out.

Winding the Bobbin

The bobbin winder is fastened to the table with its driving pulley in front of the sewing machine belt. The bobbin winder is so positioned to allow the pulley to drop away from the belt when sufficient thread has been wound on the bobbin.

Figure 11-10 illustrates the bobbin-winding operation. The procedure is as follows: Place the bobbin on the bobbin winder and push it on the shaft as far as it will go. Pass the thread from the spool down through the thread guide (1). Loop the thread around back and through the tension disks (2). The thread is then wound around the bobbin a few times and the pulley pushed up against the machine belt. The bobbin can be wound while the machine is being used for sewing. If there is no material under the presser foot, make certain that the presser foot is raised and not riding on the feed dog while winding the bobbin.

When sufficient thread has been wound on the bobbin, the pulley on the bobbin winder will drop back from the machine belt automatically. If the thread does not wind evenly on the bobbin, loosen the screw (3) in the tension bracket and move the bracket to the right or left as required; then tighten the screw. The amount of thread wound on the bobbin is regulated by the screw (4). To wind more thread on the bobbin, turn the screw to the right; to wind less thread on the bobbin, turn this screw to the left.

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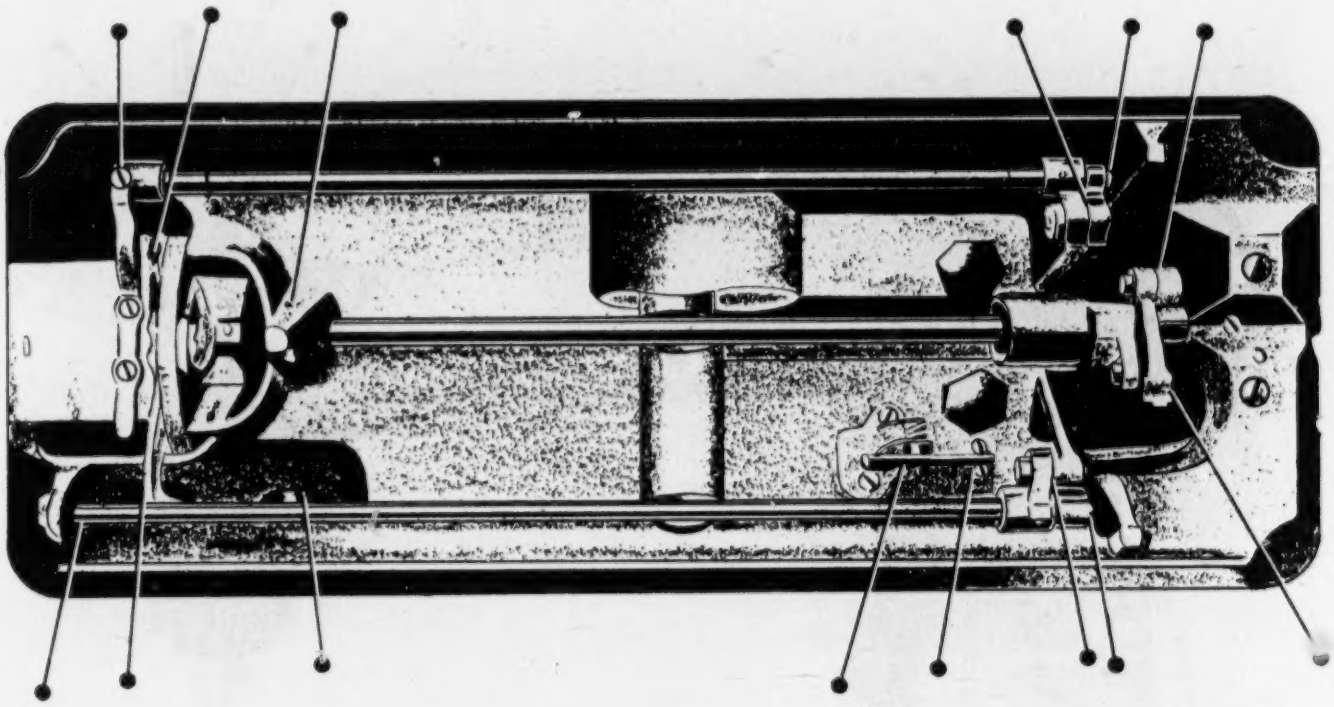

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Figure 11-5.—Oiling points at the base of the machine.

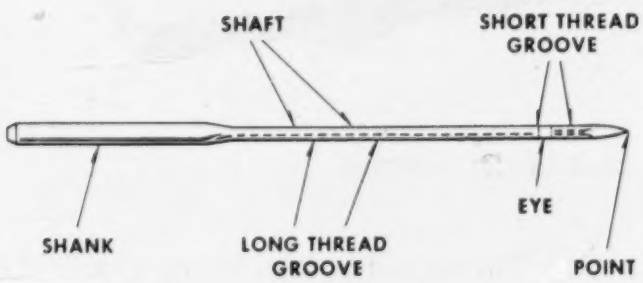

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Figure 11-6.—Sewing machine needle adaptable to the 31-15 sewing machine.

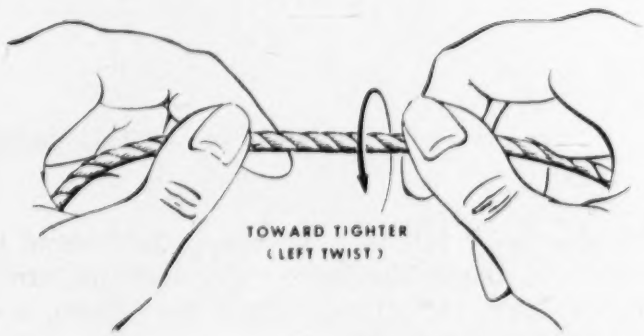

PR.267

Figure 11-7.—How to determine the twist of thread.

Threading the Bobbin Case

Hold the fully wound bobbin between the thumb and forefinger of the right hand with the thread end running over the top toward the right, as shown in figure 11-11 (A). With the left hand hold the bobbin case as shown, with the thread slot near the top.

Place the bobbin into the bobbin case and pull the thread into the slot in the edge of the bobbin case (B). Draw the thread down under the tension spring and into the delivery eye at the end of the tension spring (C). When the free end of the thread is pulled, the bobbin will rotate clockwise if the bobbin case has been threaded properly.

Replacing the Bobbin Case

Hold the latch open on the threaded bobbin case with the thumb and forefinger of the left hand, with the latch in a horizontal position.

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Table 11-1.—Relative sizes of needles and thread.

Sizes of needles	Cotton thread size	Nylon thread size
18	24 x 4	A and B.
19	24 x 4	C.
21	24 x 4	E.
22	16 x 4	E.

Place the bobbin case on the center stud of the shuttle body. Release the latch and press the bobbin case back until the latch catches the groove near the end of the stud.

Preparing for Sewing

With the left hand, hold the end of the needle thread, leaving it slack from the hand to the needle. Turn the balance wheel toward you until the needle moves down and catches the bobbin thread. Continue to turn the balance wheel forward until the needle comes up and brings the bobbin thread up with the needle thread.

With the thread takeup lever at its highest position, lay both threads back under the presser foot.

Commencing to Sew

Place the edge of the material beneath the presser foot, lower the presser foot, turn the balance wheel by hand until the needle is in the material, and press lightly on the treadle. To prevent fouling the needle thread in the bobbin case, hold the ends of both threads until the first few stitches are made.

While sewing, hold the work flat, but do not pull or push on the material. Let the feed dog carry the work evenly under the presser foot and needle. If the operator pulls on the material, the needle bends, strikes the throat plate, and is either dulled, or more likely, broken. When the needle is about to cross a seam or other unusually thick or uneven place in the work, disengage the clutch, and hand-turn the machine over the rough place; otherwise, the needle may be broken or thrown out of time.

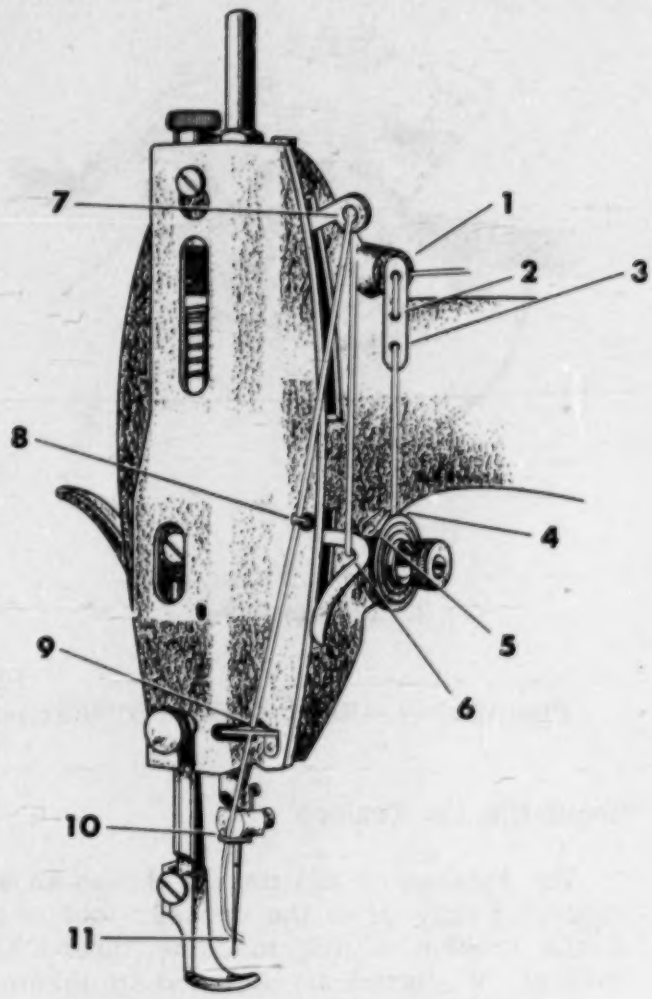

1. Top hole of thread retainer.
2. Middle hole of thread retainer.
3. Bottom hole of thread retainer.
4. Tension disks.
5. Thread takeup spring.
6. Tension thread guard.
7. Thread takeup lever.
8. Thread guide.
9. Thread guide.
10. Thread guide.
11. Needle eye.

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Figure 11-8.—Threading the 31-15 sewing machine.

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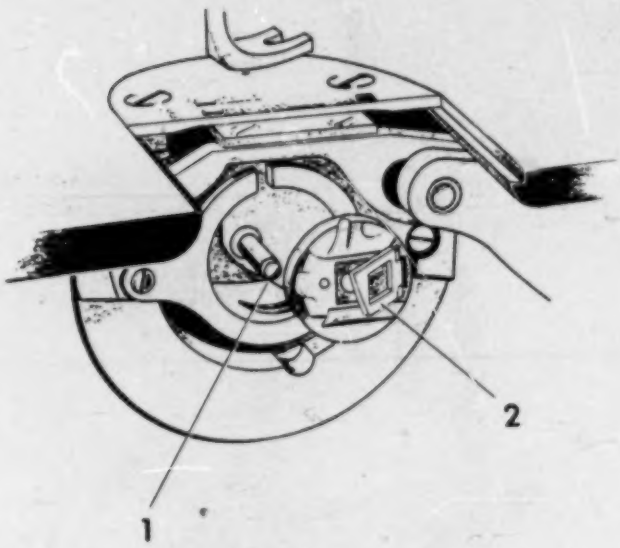

1. Bobbin case latch.
2. Bobbin case.

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Figure 11-9.—Removing the bobbin case.

Regulating the Tension

The tension on the needle thread should be regulated only when the presser foot is down. If the tension of the machine thread is not correct, it should be adjusted by turning the tension adjusting nut, as shown in figure 11-12. To INCREASE THE TENSION, turn the nut clockwise, to DECREASE THE TENSION, turn the nut counterclockwise.

The tension on the bobbin thread is regulated by the small screw in the bobbin case tension spring. To increase the tension turn the screw clockwise; to decrease the tension turn the screw counterclockwise.

This screw is very small and is easily lost if extreme care is not exercised in backing it out when decreasing the tension. If the screw is tightened excessively or is slightly too long, it will penetrate into the inside of the bobbin case and prevent removal of the bobbin.

When the tension on the bobbin thread has once been properly adjusted for a particular size of thread, it is seldom necessary to change it. A correct stitch can usually be obtained by varying the tension on the needle thread, which is an easier adjustment.

For ordinary stitching, the needle and bobbin threads should be locked in the center of the thickness of the material as shown in figure 11-13 (A). When adjusting the tensions, you will not have a cross section of the stitch.

If the tension on the needle thread is too tight, or if the bobbin tension is too loose, the thread will lie straight along the upper surface of the material and appear as small loops (fig. 11-13 (B)).

If the tension on the bobbin thread is too tight, or if that on the needle thread is too loose, the bobbin thread will lie straight along the underside of the material (fig. 11-13 (C)).

Regulating the Length of Stitch

The length of stitch can be checked at the time the tension of the stitch is checked, as a trial run of stitches is necessary during both procedures.

The length of stitch is regulated by the thumbscrew in the slot on the front of the upright of the machine. To LENGTHEN the stitch, loosen the thumbscrew and move the lever DOWN. To SHORTEN the stitch, loosen the thumbscrew and move the lever UP. When the desired length of stitch has been obtained by test running the machine on scrap material, tighten the thumbscrew.

Regulating the Pressure on the Material

Pressure on the material is regulated by the pressure regulating thumbscrew on top of the machine face. To increase the pressure, turn the thumbscrew clockwise. The pressure should be just heavy enough to enable the feed dog to move the work along evenly.

Removing the Work

Hand-turn the balance wheel toward you until the thread takeup lever is at its highest position. Raise the presser foot, either by the hand lever or by the knee lift, and draw the work and threads straight behind the presser foot. Cut the threads close to the material, leaving about 2 free inches of bobbin and machine thread.

Adjusting the Thread Takeup Spring

The thread takeup spring (fig. 11-12) should be set so that when the eye of the needle reaches the material on the downward stroke of the needle bar, the spring will be through acting on the thread, and will rest against the stop of the thread takeup spring regulator.

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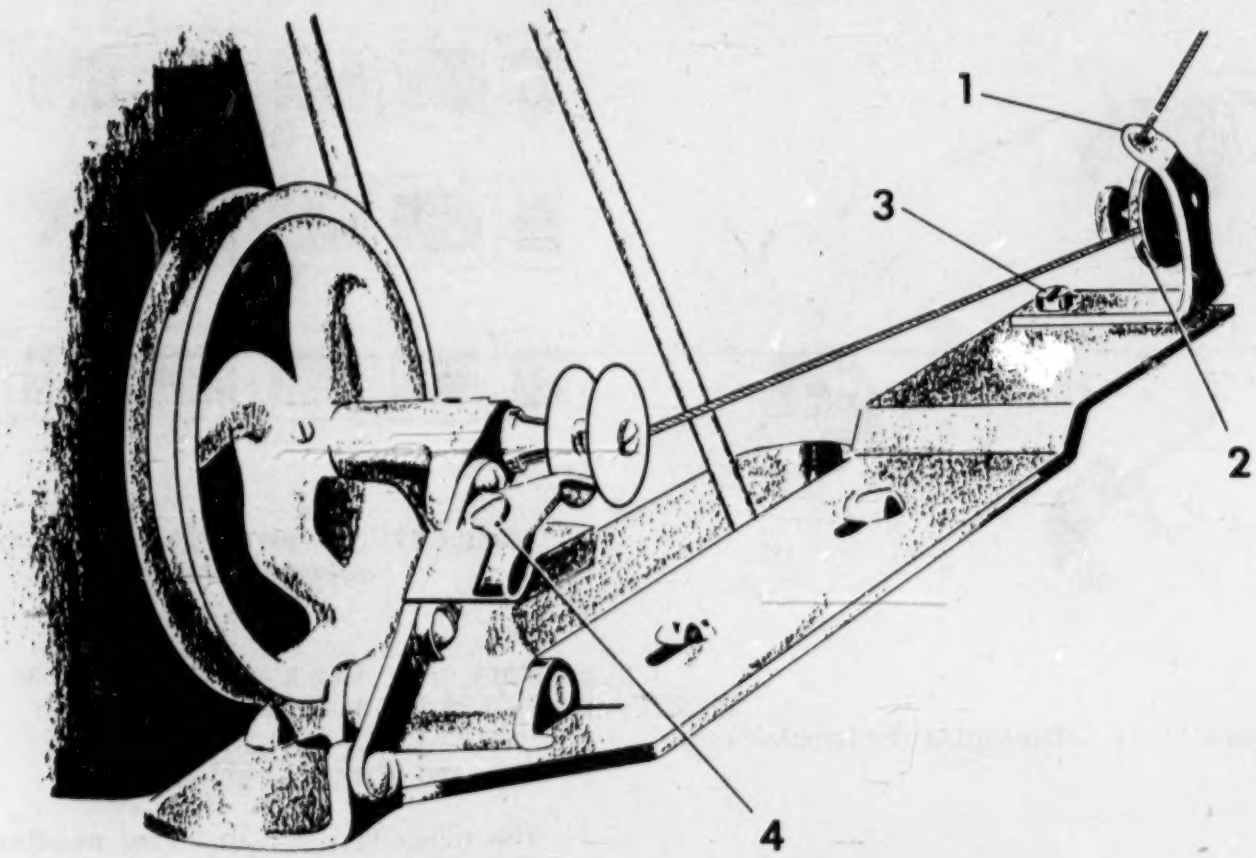

1. Thread guide.
2. Tension disk.
3. Setscrew.
4. Bobbin winder stop latch screw.

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Figure 11-10.—Winding the bobbin.

If the thread takeup spring is not correctly set, loosen the setscrew (2) in the arm of the machine and turn the tension adjusting stud to the right for more movement of the spring, or to the left for less movement. When the spring is correctly set, retighten the setscrew.

The tension on the thread takeup spring should be just sufficient to take up the slack of the needle thread until the eye of the needle reaches the material on its descent. To increase the tension on the thread takeup spring, loosen the tension adjusting stud and move the takeup spring from the recess in the regulator to the right between the regulator and the tension disks. When the required tension is obtained, securely tighten the tension adjusting stud and move the spring back into its position in the regulator recess. To decrease the tension, move the spring to the left between the regulator and the tension disks.

SINGER SEWING MACHINE 7-33

The class 7-33 sewing machine is a lockstitch heavy duty machine and is intended for use in sewing heavy canvas, webbings, and other material not adaptable to the lighter duty sewing machines. The only difference between the 7-31 and the 7-33 is that the 7-33 has the clutch on the motor, while the 7-31 has the clutch on the balance wheel. The operation and maintenance techniques are identical.

As on any Singer Sewing Machine, the balance wheel of the 7-33 should always turn toward the operator.

Lubrication

The 7-33 machine is oiled at all the oiling points shown in figures 11-14 and 11-15. The machine should be oiled twice daily when it is in

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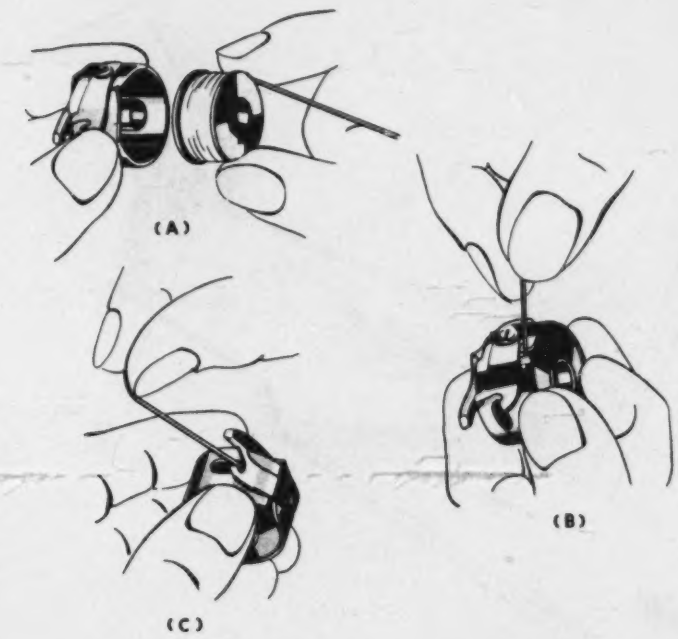

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Figure 11-11.—Threading the bobbin case.

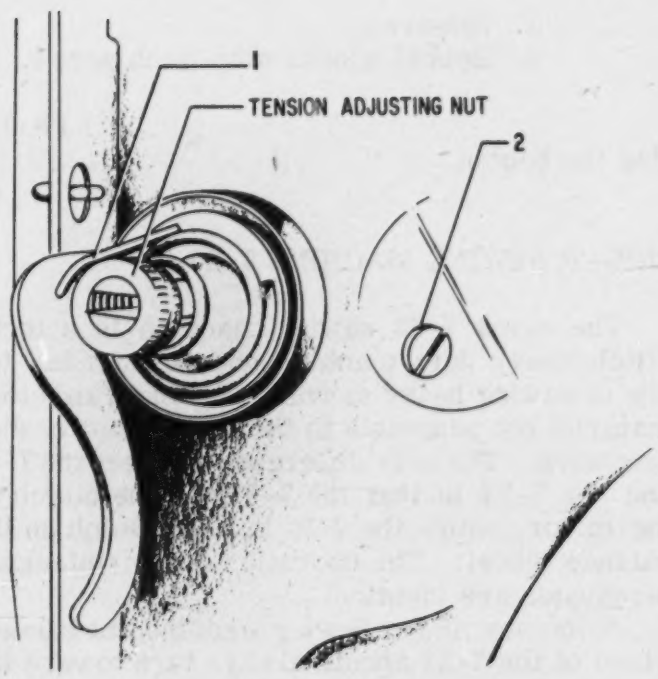

1. Thread takeup spring
2. Setscrew

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Figure 11-12.—Adjusting the machine thread tension.

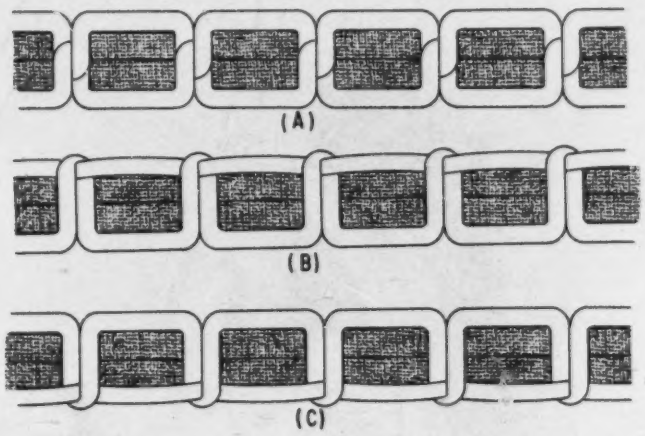

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Figure 11-13.—Properly and improperly adjusted tensions.

constant use. Use a castor base oil as recommended by the manufacturer.

Needles and Thread

The procedure for ordering needles is the same for the 7-33 machine as for the 31-15 sewing machine. Refer to table 11-2 for the relative sizes of needles and thread.

Operation

The procedure for operating the 7-33 sewing machine is the same as for the 31-15 sewing machine.

Setting the Needle

The same procedure may be followed with this machine as for the 31-15 sewing machine.

Threading the Machine

Turn the balance wheel toward you until the thread takeup lever (7, fig. 11-16) moves up to its highest position. Pass the thread from the thread stand to the thread post, right to left through the bottom hole then right to left through the top hole. Pass the thread through the two thread guides (1) and (2). Continue the passage of thread between the retainer disks (3), down and under the tension disks (4). Pass the thread into the loop of the thread takeup spring (5), under the wire loop (6), up, and from

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forming network. The driver-hard-tube modulator forms the pulse in the driver; the pulse is then amplified and applied to the modulator. The hard-tube modulator has been replaced by the line-pulsed modulator. The reasons for this replacement are that the hard-tube modulator has lower efficiency, its circuits are more complex, higher power supply voltage is required, and it is more sensitive to voltage changes.

The line-pulsed modulator is easier to maintain because of its less complex circuitry and, for a given amount of power output, it is more compact and light. Since it is the principally used modulator in aviation radar, it is the only type that will be discussed at great length.

Before discussing the line-pulsing modulator, it is well to consider briefly the various types of charging circuits and to note their advantages and limitations. To do this, study figure 16-22 which shows the various types of charging circuits.

In the d-c resistance charging circuit (A), the pulse line or storage capacitance is represented as C_{st}. It is charged through R_{ch} to the value of the d-c voltage. During the pulse one-half the d-c voltage is applied to the magnetron (assuming the line impedance is matched to that of the magnetron) for a period of time determined by the line components. This is only 50 percent efficient. Therefore, it is necessary that the d-c voltage be twice the value needed for the magnetron. The time constant $R_{ch}C_{st}$ must be large in comparison to the period of the repetition frequency. This insures that the line will fully charge between pulses but will not discharge appreciably through the source and R_{ch} during the pulse.

In the d-c resonance charging circuit (B), resistor R_{ch} is replaced by an inductance L_{ch}. As C_{st} charges, the current through L_{ch} builds up a magnetic field. This field causes current to continue after C_{st} is charged to E_{bb}. The charge will reach a peak of approximately 1.9 times E_{bb} after which it starts decreasing. If the modulator is triggered at the instant of maximum charge, the voltage applied to the magnetron is about 95 percent of E_{bb}. This necessitates that the resonant frequency of L_{ch} and C_{st} be one-half the PRF of the radar. The firing time is very critical if advantage of the maximum voltage is to be obtained.

The difficulty encountered in the preceding circuit is overcome by adding a diode in series with the charging element. Circuit (C) prevents the line from discharging after reaching its peak. This means that the time of firing can occur any time after the peak is reached. Therefore, the frequency at which L_{ch} and C_{st} resonate is equal to or greater than one-half the PRF. The disadvantage of making the firing time less critical is that the voltage to which the pulse forming line charges is decreased by the drop across the diode to about 1.8 times E_{bb}. This makes the efficiency of this circuit about 90 percent.

Circuit (D) has the pulse line charging from an a-c source. In this circuit, the charging line is prevented from discharging by a diode in series with it. Further, in this circuit it is necessary that every trigger pulse come at a time when the diode plate is negative; otherwise the diode and the switch will short circuit the a-c source. Therefore,

$$T_r = NT_{ac}$$

where

T_r = time between trigger pulses

N = 1 or some other whole number

T_{ac} = time of a cycle of the a-c source voltage

The voltage to which the line charges is almost the peak value of the a-c wave so that the efficiency is about 70 percent.

In circuit (E), the diode is replaced by the inductance L_{ch}. This inductance, along with C_{st}, forms a resonant circuit which is resonant at the frequency of the a-c supply voltage. In this circuit the switch may be closed at any peak of oscillations. Usually it is closed at the first peak. At this time the voltage is approximately π times the peak value of the a-c voltage. In addition $T_r = T_{ac} = 2\pi \times \sqrt{L_{ch}C_{st}}$. If the switch is closed at the second peak, the voltage will be nearly twice as high. This type of charging gives voltages higher than the source voltage.

The Line-Pulsing Modulator

This discussion will serve a dual purpose—it will explain the theory of operation of a typical line-pulsing modulator and will also summarize the function of the various modulator components already explained in this chapter.

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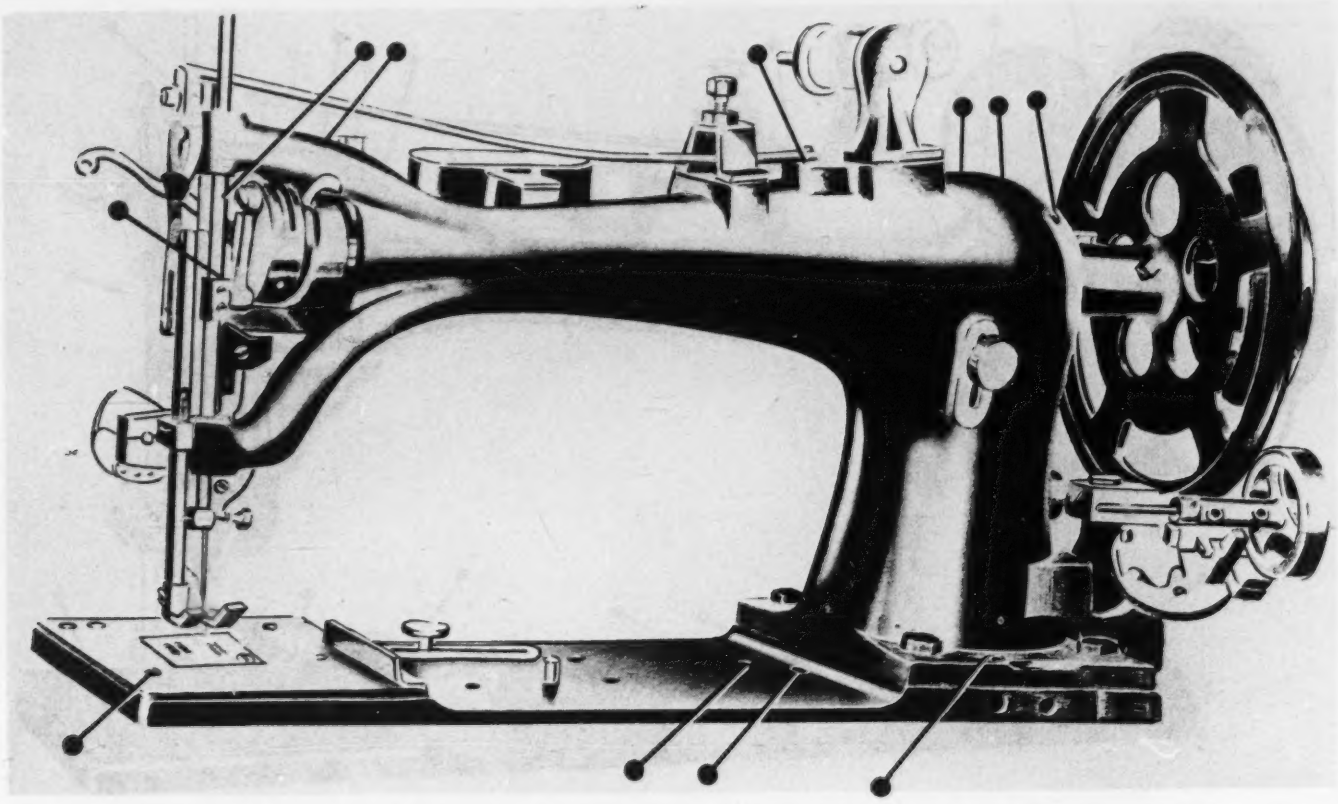

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Figure 11-14.—Oiling points at the front of the 7-33 sewing machine.

back to front through the hole in the thread take-up lever (7). Now pass the thread down through the thread guide (8), into the slot in the vibrating presser bar (9), and on down through the thread guide (10) which is located on the needle clamp. The needle is now threaded from left to right through the eye of the needle (11). After the needle is threaded as shown in figure 11-16, pass the thread down through the hole in the lifting presser foot (12). Draw about 4 inches of thread through the hole in the lifting presser foot with which to commence sewing.

Notice that the lubricating cup has been by-passed. No lubricant is used on the threads and cords used in the manufacture or repair of parachutes.

Removing the Bobbin

Turn the balance wheel forward to bring the needle bar and thread takeup lever to its lowest position. With the aid of the shuttle opening tool or a small screwdriver, insert the blade end in the slot in the spring latch beneath the shuttle cylinder (fig. 11-17). Press the latch away from the cylinder and it will swing out. The bobbin will then slide out of the shuttle cylinder.

Winding the Bobbin

Place the bobbin on the bobbin winder spindle and push it up closely against the shoulder. The small pin in the shoulder must enter the slot in the bobbin.

Pass the thread from the thread stand through the hole in the left side of the bobbin from the inside. Push the bobbin winder pulley up against the balance wheel and place the bobbin winder latch in position. Raise the presser foot and start the machine. The end of the thread should be held until a few turns are wound on the bobbin to prevent slipping. When sufficient thread has been wound on the bobbin, the bobbin winder will stop automatically.

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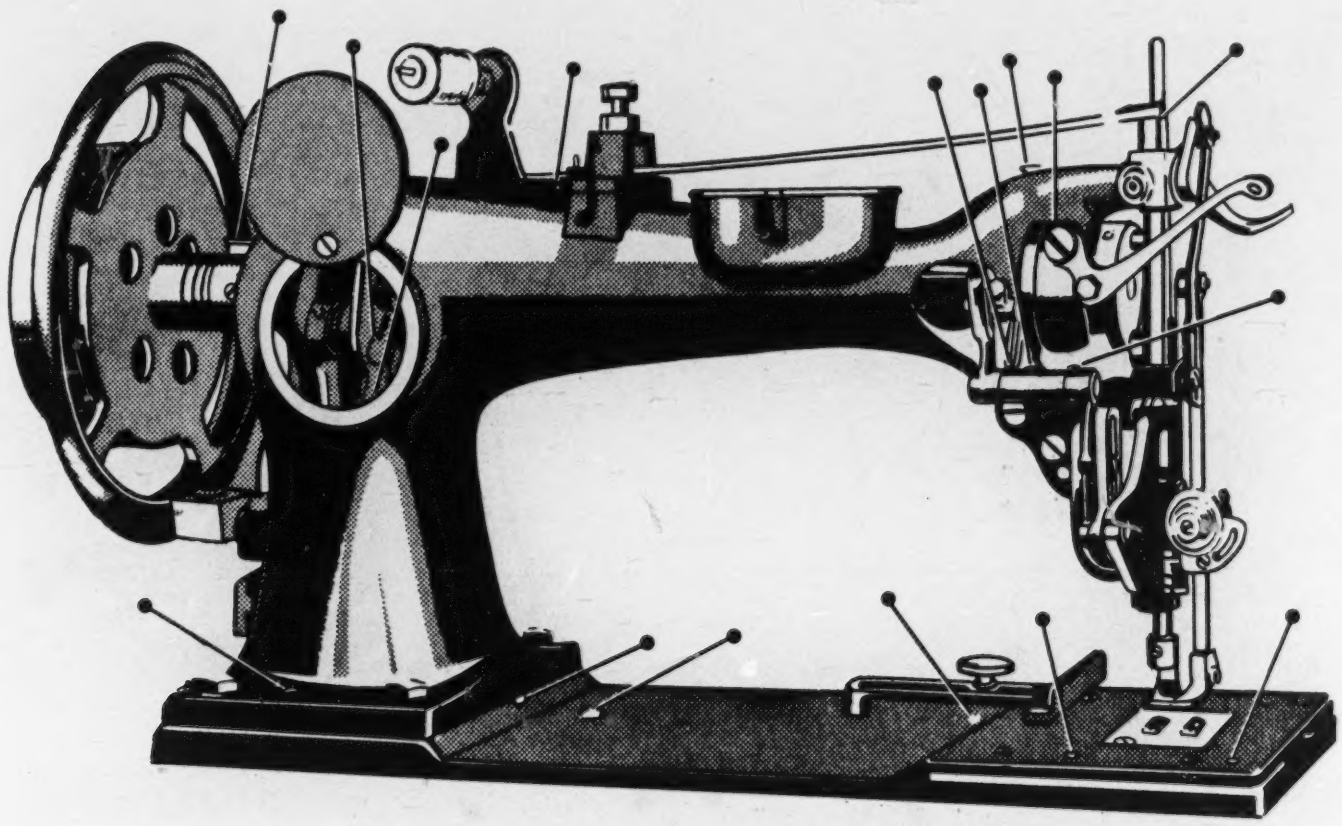

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Figure 11-15.—Oiling points at the back of the 7-33 sewing machine.

Replacing the Bobbin and Threading the Shuttle

Take the bobbin between the thumb and forefinger of the left hand as shown in figure 11-18. The free end of the thread should be drawn off from the underside toward the right. Place the bobbin in the shuttle cylinder as far as it will go. Draw the thread into the slot in the cylinder (1) and under the tension spring into the delivery eye (2). Push the shuttle cylinder in until it is locked by the spring latch. There should be about 3 inches of thread hanging free from the shuttle with which to commence sewing.

Regulating the Tension

The tension on the needle thread is regulated by the thumb nut at the front of the thread retainer disks. The tension on the thread retainer disks should be just enough to cause the tension wheel to turn when the thread is taken from the spool.

The tension on the bobbin thread is regulated by the small screw which holds the tension spring to the shuttle cylinder. To increase the tension, turn the screw clockwise. To decrease the tension, turn the screw counterclockwise.

The tension on the machine and bobbin threads should be checked by test running a row of stitches on scrap material. The lockstitch should lock in the center of the material as described for the 31-15. When sewing webbings with the 7-33 sewing machine, the specifications for webbing sewing should be checked to determine at what ply of the webbing the stitch should lock.

Regulating the Length of Stitch

The procedure for regulating the stitch on the 7-33 sewing machine is the same as for the 31-15.

Regulating the Pressure on the Material

The pressure on the material is regulated by means of the hexagon head screw (1, fig.

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Table 11-2.—Relative sizes of needles and thread.

Machine	Needle class and variety	Needle sizes	Classes of work	Needle size	Cord size
7-31 or 7-33	7 x 1	19, 21, 22, 23, 24 25, 26, and 27.	Medium to heavy canvas.	24	3-cord
7-31 or 7-33	7 x 5	28, 29, 30, and 31.	Heavy canvas and webbing.	28	6-cord

11-19). Loosen the hexagon head locknut (2) and turn the adjusting screw clockwise to increase the pressure or counterclockwise to decrease the pressure on the spring (3). When the desired pressure has been obtained, hold the adjusting screw with a wrench to keep it from turning while the locknut is being tightened against the bracket (4).

The pressure should be just heavy enough to enable the feed dog to move the work along evenly, and to prevent the work from rising with the needle.

Preparing for Sewing

The same sewing preparatory procedures are used for the 7-33 as for the 31-15 sewing machine except there is no knee lifting device. The hand presser bar lifter is the only device provided for lifting the presser foot on the class 7-33 sewing machine.

Removing the Work

Stop the machine and raise the thread takeup lever to its highest position. Draw about 3 inches of thread through the thread retaining disks. Raise the presser foot and draw the work back, cutting the threads close to the material. Leave the ends of the threads under the presser foot.

Modification of Presser Foot for Webbing Sewing

The modification of a presser foot is illustrated in figure 11-20. The presser foot should be cut along the dotted line, removing the right portion of the foot. After cutting, the edges should be filed down to a smooth round finish.

Parachute harness and webbing sewing is classified as a major repair. However, there are various other sewing projects requiring webbing sewing, such as slings, bridles for tow targets, and nylon barrier repairs.

ROTARY TYPE SEWING MACHINES

SINGER SEWING MACHINES CLASS 111

111 W 150 Sewing Machine

The 111 W 150 sewing machine is a high-speed, single-needle, lockstitch, compound feed machine employing a gear driven rotary hook with a vertical axis. It is designed for sewing mediumweight fabrics such as flight clothing, nylon, twills, and lightweight canvas.

111 W 151 Sewing Machine

The 111 W 151 sewing machine is also a single-needle, lockstitch, rotary hook machine, intended for high-speed straight stitching of mediumheavy materials.

The 111 W 151 sewing machine differs from other models of the class 111 machines in that it has a single presser foot instead of the alternating presser foot.

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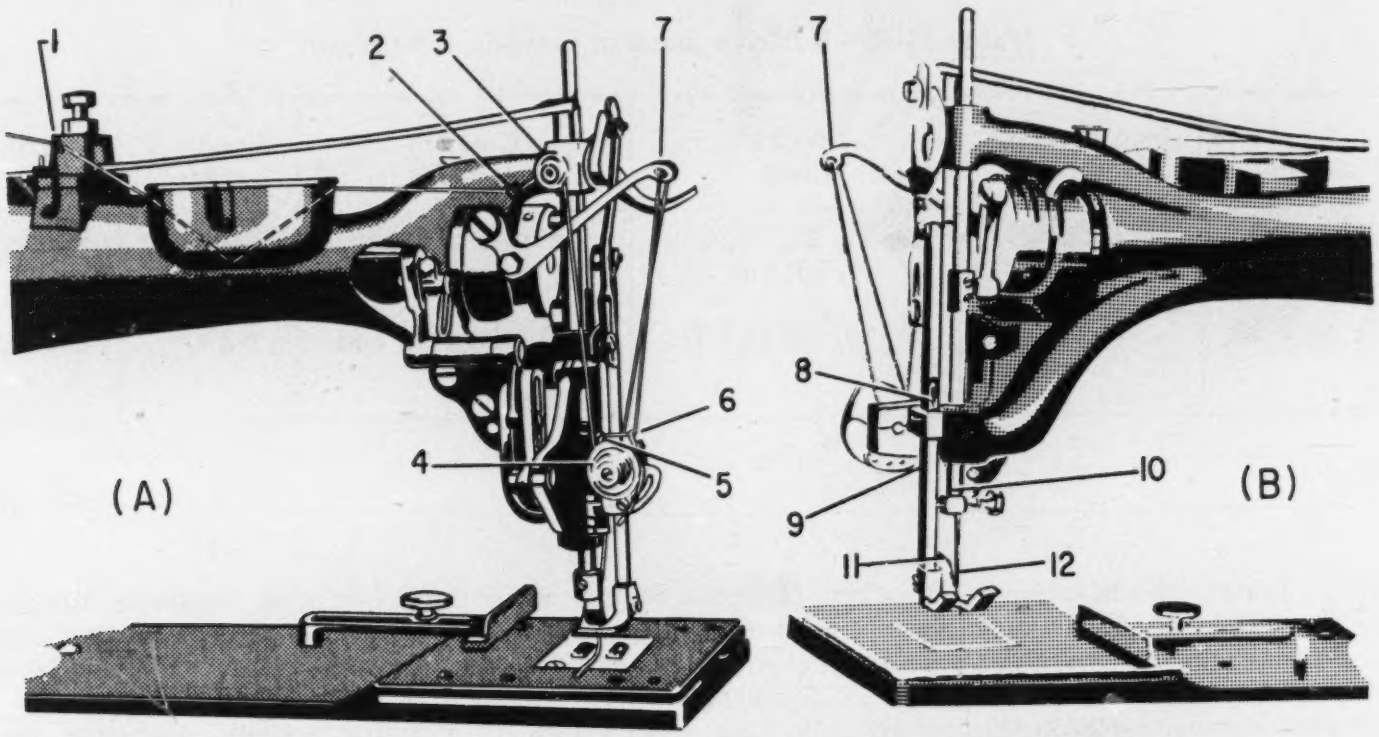

1. Thread guide.
2. Thread guide.
3. Retainer disks.
4. Tension disks.
5. Thread takeup spring.
6. Wire loop.
7. Thread takeup lever.
8. Thread guide.
9. Slot in the vibrating presser bar.
10. Thread guide on the needle clamp.
11. Eye of the needle.
12. Hole in the lifting presser foot.

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Figure 11-16. —Threading the 7-33 sewing machine.

111 W 152 Sewing Machine

The 111 W 152 sewing machine is a single-needle, lockstitch, compound feed machine with a vertical axis sewing hook. This machine has alternating pressers with a 3/8-inch lift. It has a safety clutch which prevents the hook from being damaged or getting out of time due to accidental strain.

111 W 153 Sewing Machine

The 111 W 153 sewing machine is similar to the 111 W 152, but it is used for sewing heavy work such as automobile and truck upholstery, tents, awnings, and leather flight jackets.

111 W 154 Sewing Machine

The 111 W 154 sewing machine is also similar to the 111 W 152, but its alternating pressers have a lift of 1/2 inch and the machine is designed for stitching upholstery work and leather coats and binding heavy materials such as felt padding.

111 W 155 Sewing Machine

The 111 W 155 sewing machine is similar to the 111 W 154 except that its maximum stitch length is 3 1/2 to the inch, and it has an adjustable lifting eccentric for instantly setting the alternating pressers to the minimum amount of lift required for the work to be sewn.

Lubrication of the Class 111 Sewing Machines

Figures 11-21 through 11-24 show the various lubrication points on class 111 sewing machines. Oiling points are indicated by the unnumbered

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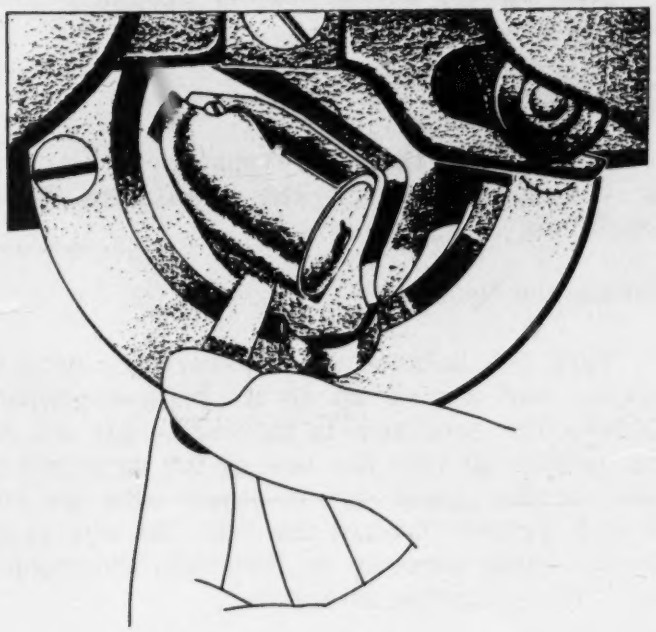

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Figure 11-17.—Removing the bobbin from the shuttle cylinder.

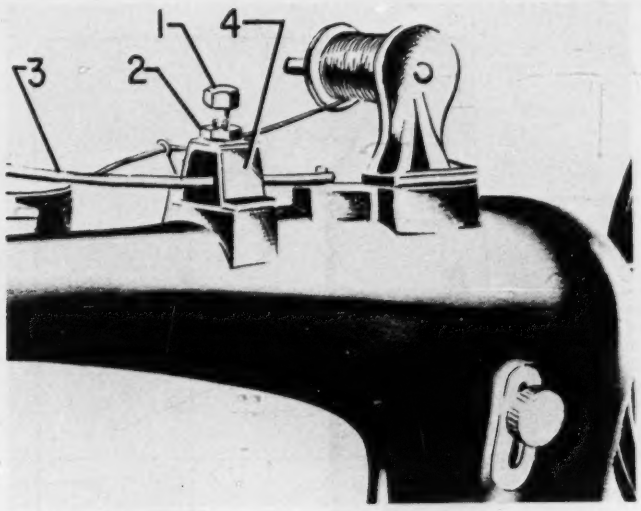

1. Hexagon head adjusting screw.
2. Hexagon head locknut.
3. Spring.
4. Bracket.

PR.279

Figure 11-19.—Regulating the pressure on the material.

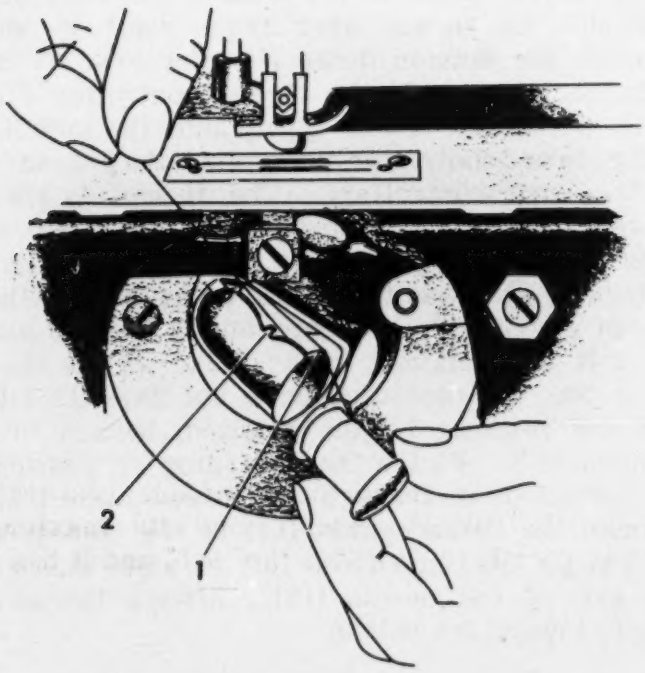

1. Thread slot in the cylinder.
2. Delivery eye and tension spring.

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Figure 11-18.—Replacing the bobbin and threading the shuttle.

arrows. Familiarization with the nomenclature of the machines may also be accomplished by studying these illustrations.

To lubricate the class 111 machine, swing back the top cover and oil the bearings, then replace the cover.

Loosen the thumbscrew in the upper end of the faceplate, turn the faceplate upward, and oil the wick and bearings as shown in figure 11-22. After oiling, turn down the faceplate and tighten the thumbscrew.

Turn the machine back on its hinges and apply oil at the places designated by the arrows in figure 11-24. All contacting parts on the bottomside of the machine should also be oiled.

To lubricate the hook, remove the bed slide and place oil in the oil well (fig. 11-23). This will lubricate the upper hook bearing and the mechanical opener mechanism.

The small green felt pad on the side of the bobbin case should be kept wet with oil to lubricate the hook race. When this pad is wet, it appears nearly black; when it appears light green, it indicates that it is dry. When a machine is new, oil should be applied to this felt pad EACH TIME A BOBBIN IS REPLACED.

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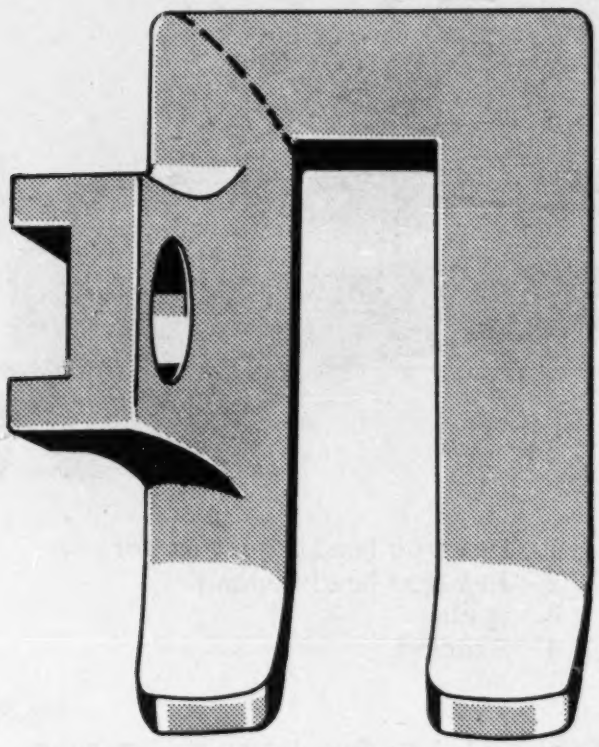

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Figure 11-20.—Modification of presser foot for webbing sewing.

Needles and Thread

The thread used on rotary type sewing machines is left twist. To determine the twist of thread, refer to figure 11-6.

Table 11-3 lists the class and variety of needle and the needle size range for each of the class 111 machines.

The size of needle to be used is determined by the size of the thread and material used. The thread must pass freely through the eye of the needle. If rough or uneven thread is used, or if it passes with difficulty through the eye of the needle, the machine will not function properly.

Needles used on rotary type sewing machines are ordered the same way as those for oscillating type sewing machines.

The needles for the rotary type sewing machines have 7 parts. This is one more part than the needles for the oscillating machines. The additional part is the SCARF, which is a small indention just above the short thread groove. The purpose of the scarf is to permit the point of the sewing hook to come close enough to pick up the needle thread without striking the needle.

Operation

Operation of the rotary type sewing machines is the same as for the oscillating sewing machines.

Setting the Needle

Turn the balance wheel toward you until the needle bar moves up to its highest position. Loosen the setscrew in the needle bar and slip the needle up into the bar as far as it will go. The needle must be inserted with its long thread groove toward the left; the eye of the needle being directly in line with the machine bed. Retighten the setscrew.

Threading the Machine

Pass the thread from the thread stand from back to front through the lower hole (1, fig. 11-25) in the thread post on top of the machine, then from right to left through the upper hole (2) in the post. Pass the thread down through hole (3), up through hole (4), and down through hole (5) in the thread guide on the front of the machine. Continue the thread over from right to left between the tension disks (6), and down, from right to left around the thread controller (7). Then the thread should go up into the fork (8) in the thread controller disk against the pressure of the wire controller. The thread is then passed up through the thread guide (9), and from right to left through the hole in the thread take-up lever (10). Pass the thread down through the thread guide (11), and between the felt pad and the felt pad retainer finger (12). (If the machine you are threading does not have the felt pad and retainer finger installed, bypass this component.) Finish the threading by passing the thread down through the thread guide (13), through the thread guide (14) at the bottom of the needle bar, and from left to right through the eye of the needle (15). Always thread a needle toward the bobbin.

Removing the Bobbin

To remove the bobbin draw out the right-hand slide plate in the bed of the machine. Insert the fingernail of the forefinger under the latch, raise the latch, and lift the bobbin out. (See fig. 11-26.)

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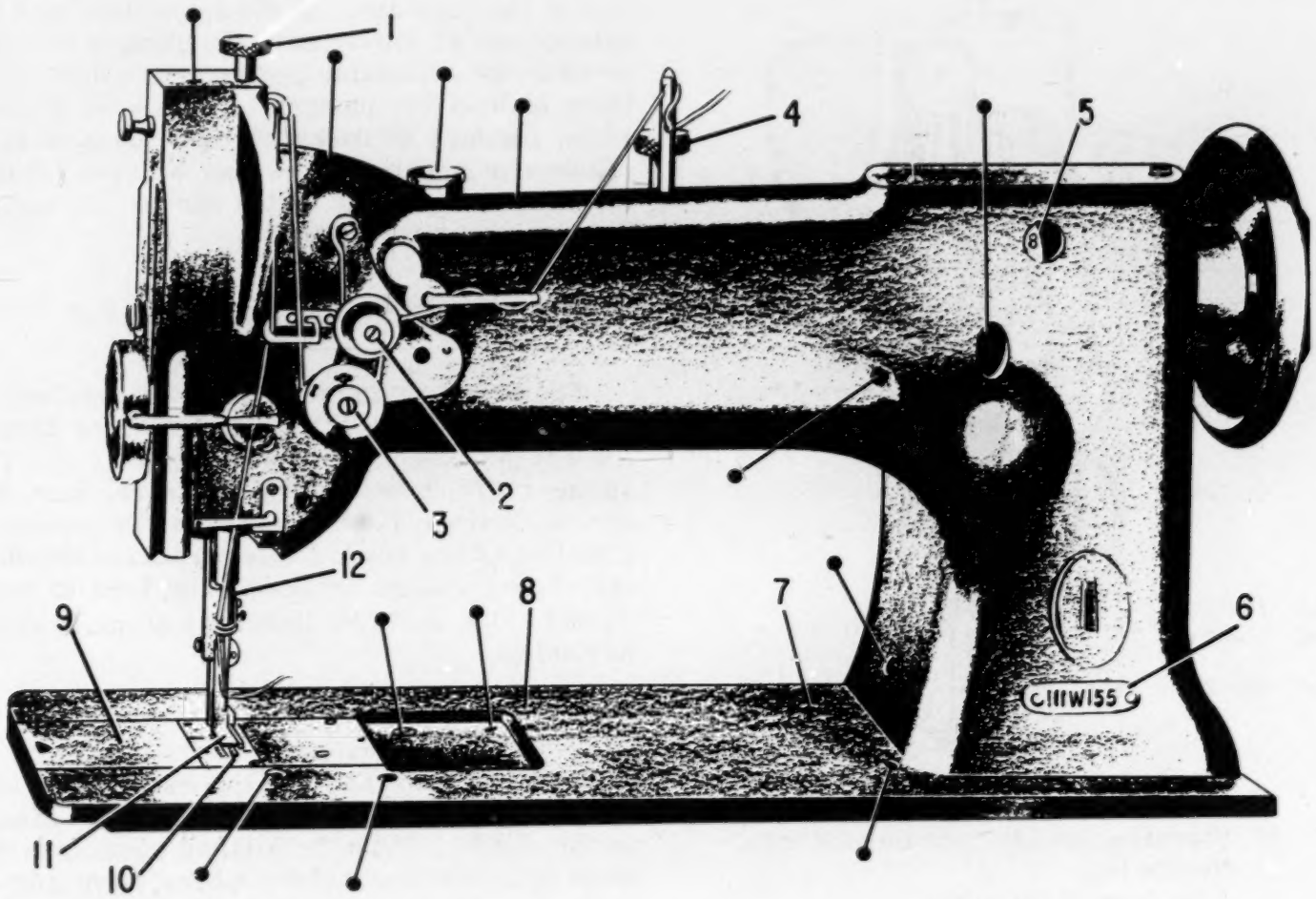

1. Vibrating presser bar thumbscrew.
2. Tension thumb nut.
3. Thread controller stud thumb nut.
4. Presser bar spring regulating screw.
5. Stitch indicator disk view hole.
6. Model number.
7. Hook driving shaft lock stud.
8. Feed regulating stud (plunger).
9. Bed slide.
10. Throat plate
11. Presser foot.
12. Needle bar.

PR.281

Figure 11-21.—Front of machine, showing oiling points.

Winding the Bobbin

To wind the bobbin and adjust the bobbin winder, follow the procedure given for the 31-15 sewing machine.

Replacing the Bobbin and Threading the Bobbin Case

Hold the bobbin between the thumb and forefinger of the right with the thread drawing out on the bottom from left to right. Place the bobbin on the center stud of the bobbin case, then push down the latch.

Draw the thread into the slot (1), and under the back of the projection (2). Leave a loose end of thread about 2 inches long above the slide. When closing the slide plate, leave just enough space for the thread to pass through when it is first picked up by the needle.

Regulating the Tension

The tension on the needle thread is regulated by the tension thumb nut located at the front of the tension disks on the front of the machine. To increase the tension, turn this thumb nut

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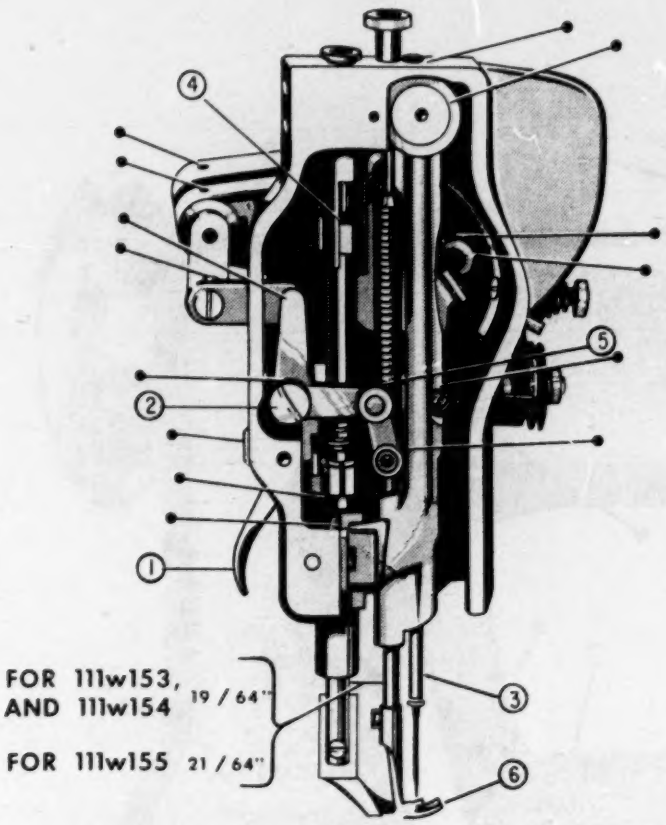

1. Hand lift for presser foot.
2. Vibrating presser bar thumbscrew.
3. Needle bar.
4. Vibrating presser bar.
5. Presser bar.
6. Presser foot.

PR.282

Figure 11-22.—End of machine, showing oiling points.

clockwise. To decrease the tension, turn the thumb nut counterclockwise.

The tension on the bottom (bobbin) thread is regulated by means of the small screw nearest the center of the tension spring on the outside of the bobbin case, as shown in figure 11-26. To increase the tension, turn this screw clockwise. To decrease the tension, turn the screw counterclockwise.

Regulating the Length of Stitch

The number of stitches per inch is stamped on the stitch indicating disk which can be seen through the hole on the uprise.

To change the length of stitch, press down the feed regulating stud (plunger), located in the bed of the machine. At the same time turn the balance wheel slowly until the plunger enters a notch in the adjustable feed eccentric disk. Continue to hold the plunger and turn the balance wheel forward or backward until the number of stitches per inch desired can be seen through the hole in the front of the uprise. Disengage the plunger by releasing it.

Regulating the Pressure on the Material

The pressure on the material is regulated by the presser bar regulating screw at the back of the sewing machine. The screw acts on a flat spring. To increase the pressure, turn this screw downward. To decrease the pressure, turn this screw upward. The pressure should be only heavy enough to enable the feed to move evenly along whatever thickness of material you are using.

Preparing for Sewing

With the left hand, hold the end of the needle (machine) thread, leaving it slack from the hand to the needle. Turn the balance wheel over toward you until the needle moves down and up again to its highest position. If the sewing machine is properly timed, this will bring the bobbin thread up with the machine thread through the hole in the feed dog. Lay the threads back under the presser foot and close the slide.

Place the material under the presser foot. Lower the presser foot either by hand or by the knee lift, and commence to sew. Start the sewing by turning the balance wheel over toward you as you depress the treadle.

Removing the Work

After the machine has stopped, move the thread takeup lever to its highest position. Raise the presser foot, draw the work back, and cut the threads close to the material. Lay the ends of the threads back under the presser foot.

SINGER SEWING MACHINE 112 W 140

The 112 W 140 sewing machine has two needles, two gear-driven rotary sewing hooks, and makes the lockstitch. It has a compound feeding mechanism, consisting of needle and

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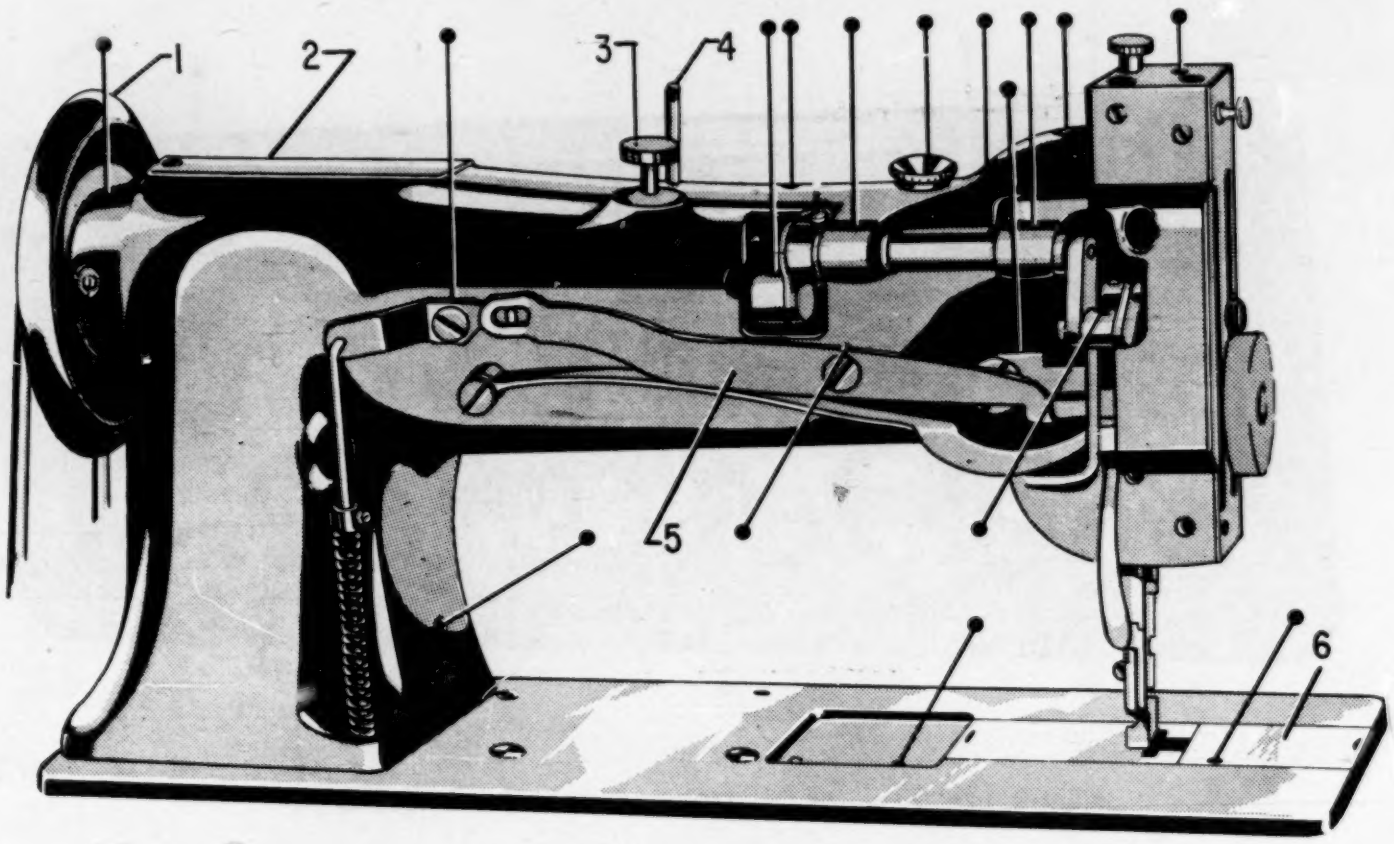

1. Balance wheel.
2. Top cover.
3. Presser bar spring regulating screw.
5. Thread post.
6. Knee lift linkage.
7. Bed slide.

PR.283

Figure 11-23.—Rear of machine showing oiling points.

drop feed. This machine is designed for stitching flight suits, coats, and other light and medium weight fabrics requiring a compound feed.

For bulky work such as tents, awnings, etc., which require two simultaneous parallel rows of lockstitching, the 112 W 116, equipped with a puller feed, is recommended.

Needles for machine 112 W 140 are of class and variety 135 x 7 and are made in sizes from 12 to 24.

When the machine is new, it should not be driven at a speed exceeding 3,000 stitches per minute. After the first few days, the machine may be driven at its recommended maximum speed of 3,500 stitches per minute. This speed depends on the nature of the work and the ability of the operator.

Lubrication

All the parts of the 112 W 140 sewing machine can be oiled without turning the machine back on its hinges. Oil should be applied to each of the places designated by arrows in figures 11-27, 11-28, and 11-29.

The type of oil to be used and the intervals of oiling are the same as given for the 111 series sewing machines.

The hook is lubricated as shown in figure 11-30. Oil should be placed in the oil well as indicated. The oil will flow to both the upper and lower bearings and also lubricate the mechanical opener mechanism.

The small green felt pads on the side of each bobbin case should be kept wet with oil to lubricate the hook races. When these pads are wet they appear nearly black; when they appear light green, it indicates they are dry. When a machine

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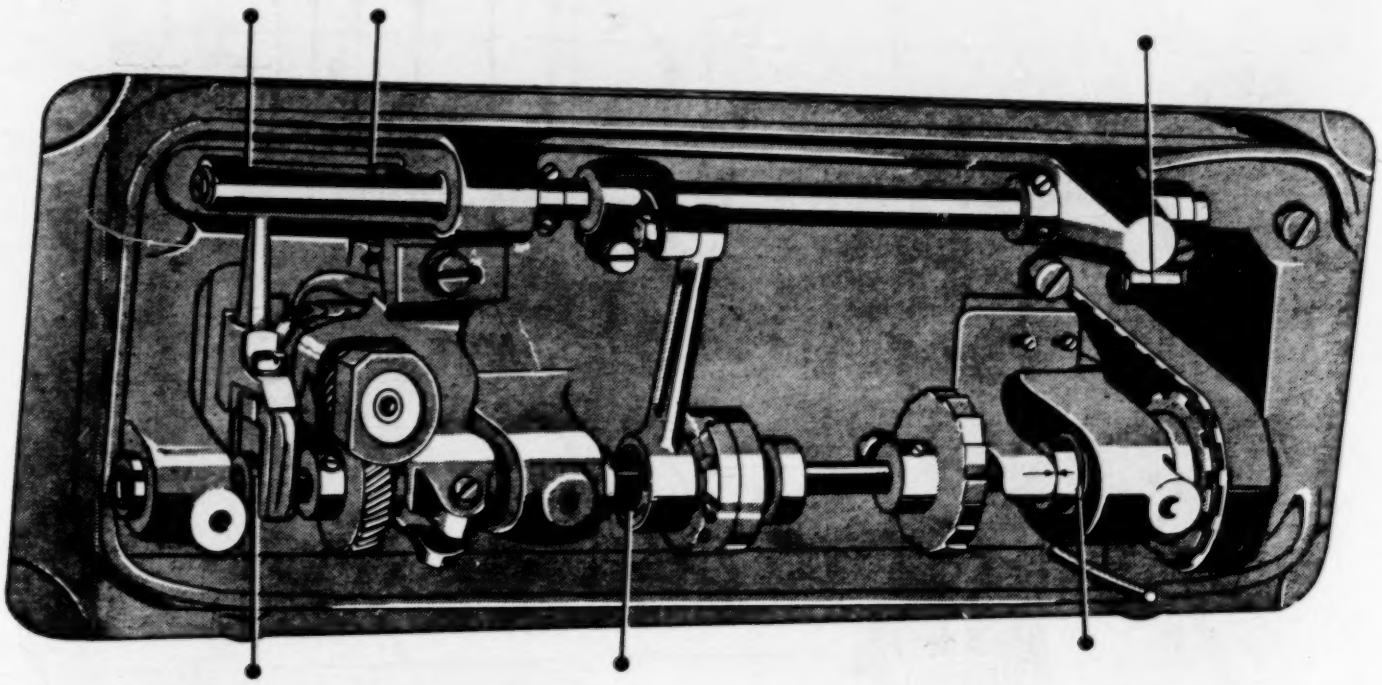

PR.284

Figure 11-24.—Base of machine, showing oiling points.

Table 11-3. —Data for class 111 sewing machines.

Sewing Machine	Stitches per minute	Stitches per inch	Needle class and variety	Needle size range
111 W 150	3,500	5 to 32	135 x 7	7 to 24
111 W 151	3,500	5 to 32	135 x 17	14 to 26
111 W 152	2,900	5 to 32	135 x 17	12 to 24
111 W 153	2,900	5 to 32	135 x 17	12 to 24
111 W 154	2,900	5 to 32	126 x 11	22 to 27
111 W 155	3,500	3 1/2 to 32	135 x 17	12 to 24

is new, oil should be applied to these felt pads each time a bobbin is replaced.

Setting the Needles

Turn the balance wheel over toward you until the needle bars and the thread takeup lever moves to its highest position. Loosen the set-screw in the needle holders and slip the needles up into the holder as far as they will go. Make sure the inside needle (one nearest the upright part of the arm) has its long thread groove toward the left. The outside needle (one farthest from the upright part of the arm) must have its long thread groove toward the right. The eyes of both needles must be directly in line

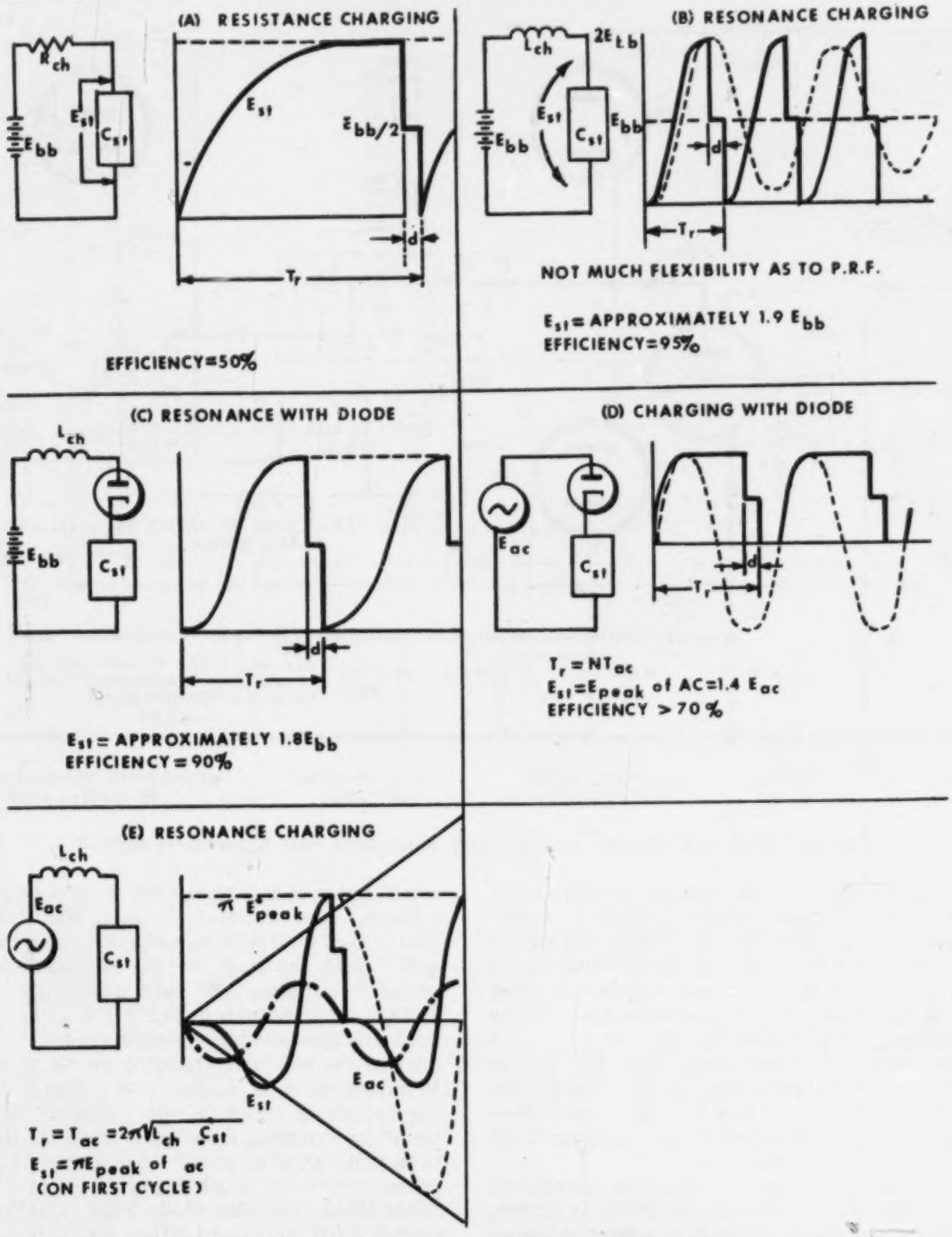

Figure 16-22.—Types of charging circuits.

The modulator (fig. 16-23) is of the line-pulsing type. The pulse-forming network undergoes a charge-discharge cycle at a rate (PRF) which is established by the master-trigger generator and which is consistent with the pulse width in use and the maximum power capabilities

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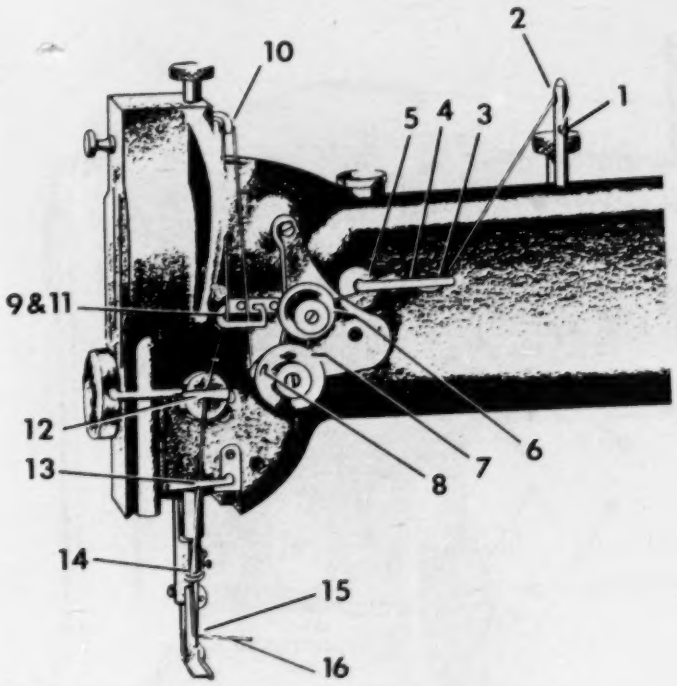

1. Lower hole in thread post.
2. Upper hole in thread post.
3. Hole in thread guide.
4. Hole in thread guide.
5. Hole in thread guide.
6. Tension disks.
7. Thread controller.
8. Fork in the thread controller.
9. Thread guide.
10. Thread takeup lever.
11. Thread guide.
12. Felt pad and retainer finger.
13. Thread guide.
14. Thread guide.
15. Eye of needle.
16. Free end of thread

PR.285

Figure 11-25.—Threading the class 111 sewing machine.

with the machine bed. After alining the needles, tighten the setscrews.

Replacing the Bobbins and Threading the Bobbin Cases

The removal and winding of the bobbins is accomplished the same as for the 111 sewing machines. Both bobbins should be wound and replaced at the same time.

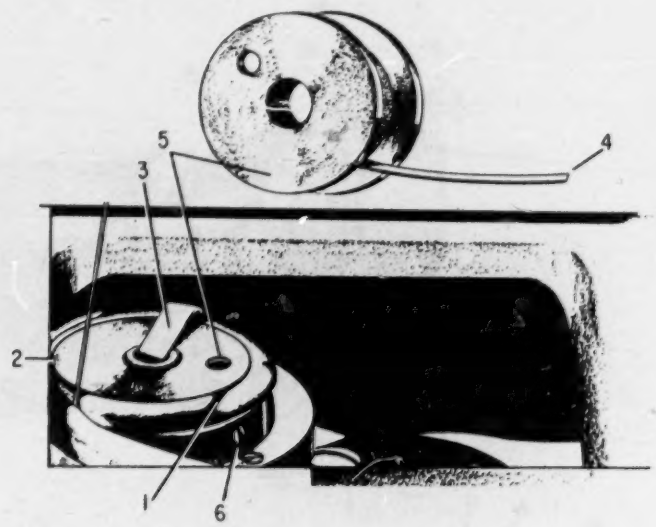

1. Slot in the bobbin case.
2. Projection on the bobbin case.
3. Bobbin case latch.
4. End of bobbin thread.
5. Bobbin.
6. Tension adjusting setscrew.

PR.286

Figure 11-26.—Bobbin case threaded.

The following instructions apply to both of the bobbin cases.

Hold the bobbin between the thumb and forefinger of the right hand, the thread drawing on the bottom from left to right. Place the bobbin on the center stud of the bobbin case then push down the latch, as shown in figure 11-31.

Draw each thread into the slot (1) located in the edge of the bobbin case, and back of the projection (2). Leave a loose end of each thread about two inches long above the slide. When closing the slides, leave just enough space for the threads to pass through when being picked up by the machine threads.

Threading the Machine

The 112 W 140 sewing machine is threaded in practically the same way as the 111 series machines. The only exception is that there are two upper thread guides and two tension disks, as shown in figure 11-32. With the exception of the upper thread guides and tension disks, the two threads run parallel. Each needle is threaded from inboard to outboard (always toward the bobbin).

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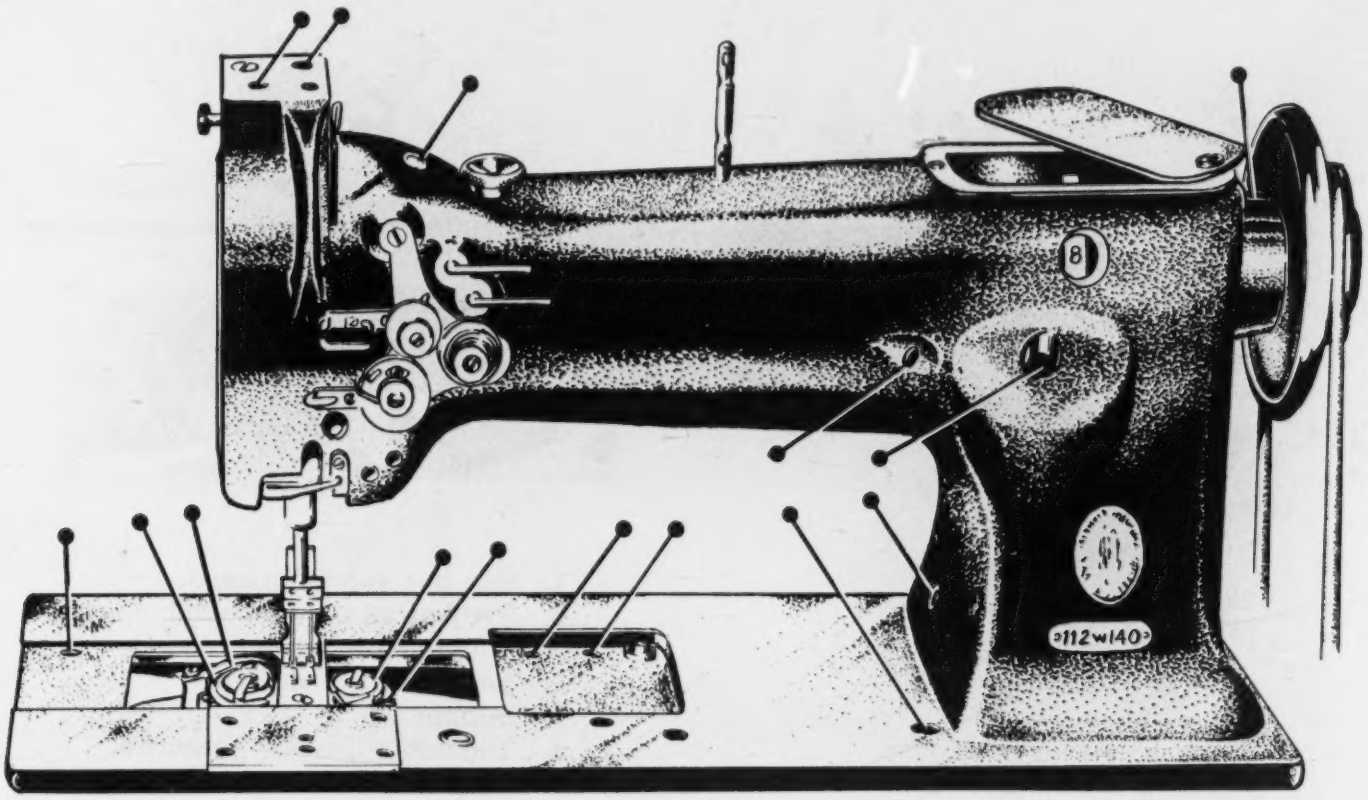

PR.287

Figure 11-27.—Oiling points at the front of the machine.

After the machine has been threaded, the preparation for sewing and removal of the work are the same as for the 111 series machines.

Adjusting the tensions, regulating the length of stitch and regulating the pressure on the material are also accomplished the same as for the 111 sewing machine.

SINGER SEWING MACHINE
143 W 2 AND 3

The zigzag sewing machine is an excellent sewing machine for the manufacture of parachutes. This type of machine is not as common as those previously described, but it has unlimited uses in the repair and maintenance of parachutes and survival equipment and will be found in many parachute lofts.

The 143 W 2 is a high-speed sewing machine which has an aluminum alloy vibrating needle bar frame and a rotary hook. It is intended for overseaming and zigzag stitching on fine and general fabrics and lightweight leather. It has ball bearings on the rear end of the arm shaft and hook driving shaft. The needle bar has a maximum throw of 3/16 inch, vibrating both sides of a centerline.

The 143 W 3 sewing machine is similar to the 143 W 2 except that the needle has a maximum throw of 5/16 inch.

The maximum speed recommended for machine 143 W 2 is 3,500 stitches per minute, and for machine 143 W 3, 3,000 stitches per minute, the speeds depending on the material being sewn.

Lubrication

Lubrication points for these machines are indicated by arrows in figures 11-33 through 11-36. When in continuous use, they should be oiled twice a day.

Needles and Thread

The needles for the 143 W 2 and 3 sewing machines are of class and variety 135 x 7; the sizes from 7 to 24.

Left twist thread should be used on these machines. To make a smooth even stitch with

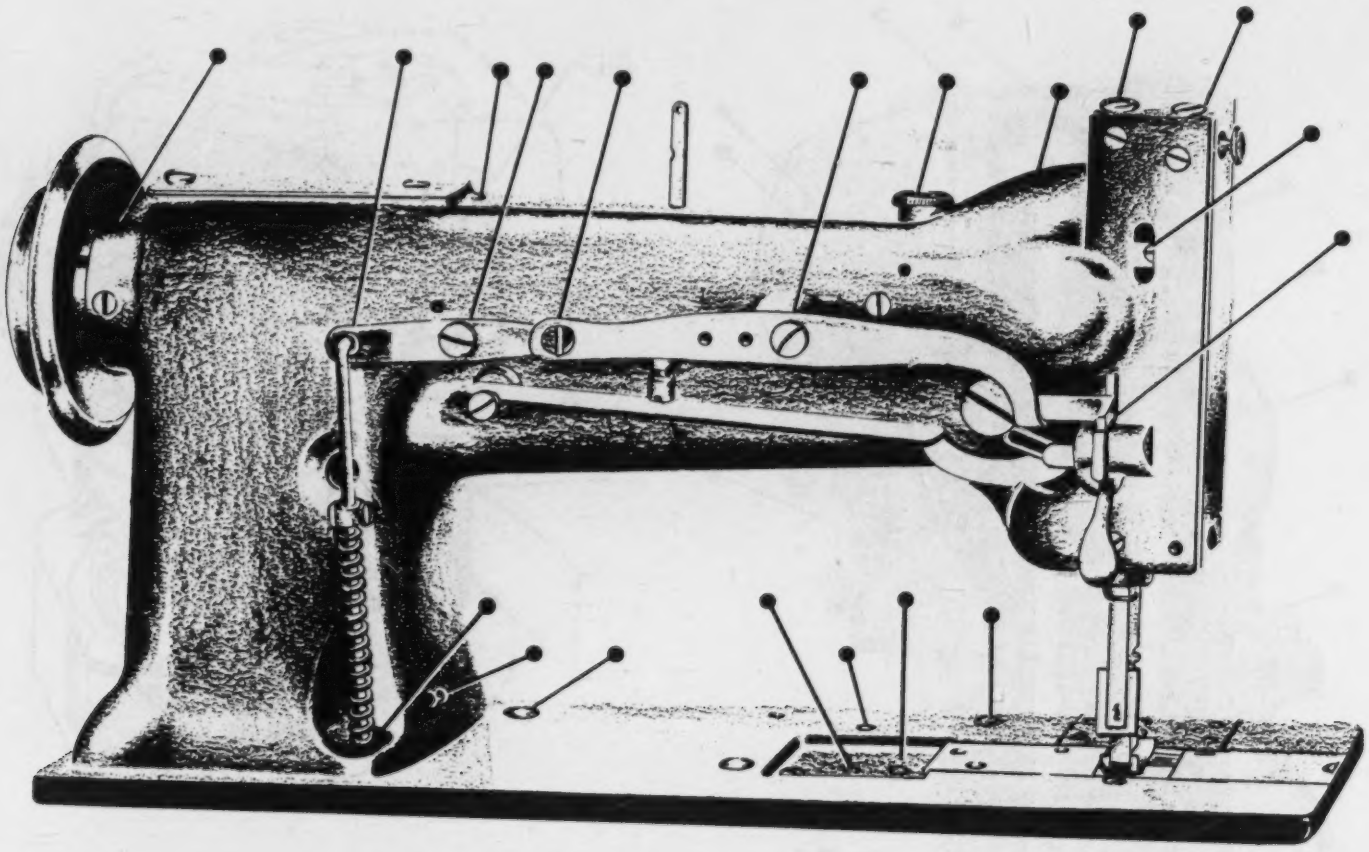

PR.288

Figure 11-28.—Oiling points at the back of the machine.

the sewing machine, use good, firmly twisted and smoothly finished thread. The thread should pass freely through the eye of the needle.

Setting the Needle

Push the needle up in the needle bar as far as it will go, with the LONG THREAD GROOVE TO THE FRONT, and secure it firmly with the setscrew. It may be necessary to turn the needle slightly to the right or left for some threads if stitches are missed.

Bobbin and Bobbin Case

The procedure for removing the bobbin case, winding the bobbin, threading the bobbin case, and replacing the bobbin case is the same as for the 31-15 sewing machine. The only exception to this is that when threading the bobbin case, the thread should draw from the BOTTOM from left to right, instead of from the top as given for the 31-15.

Threading the Needle

These machines are threaded in the same way as the 111 series machines, described earlier in the chapter. When threaded up to the needle, thread the needle from the front through the eye to the back. The long thread groove should be in front when the needle is properly set in the needle bar.

Regulating the Length of Stitch

Press the stitch regulator lever and at the same time turn the balance wheel over toward you until the lever engages the notch in the stitch regulator flange. Continue to hold the lever in the notch in the flange and at the same time turn the balance wheel backward or forward, as required. When the desired number of stitches is obtained, as indicated on the stitch regulator flange (seen through small holes on the upright above the lever), release the lever.

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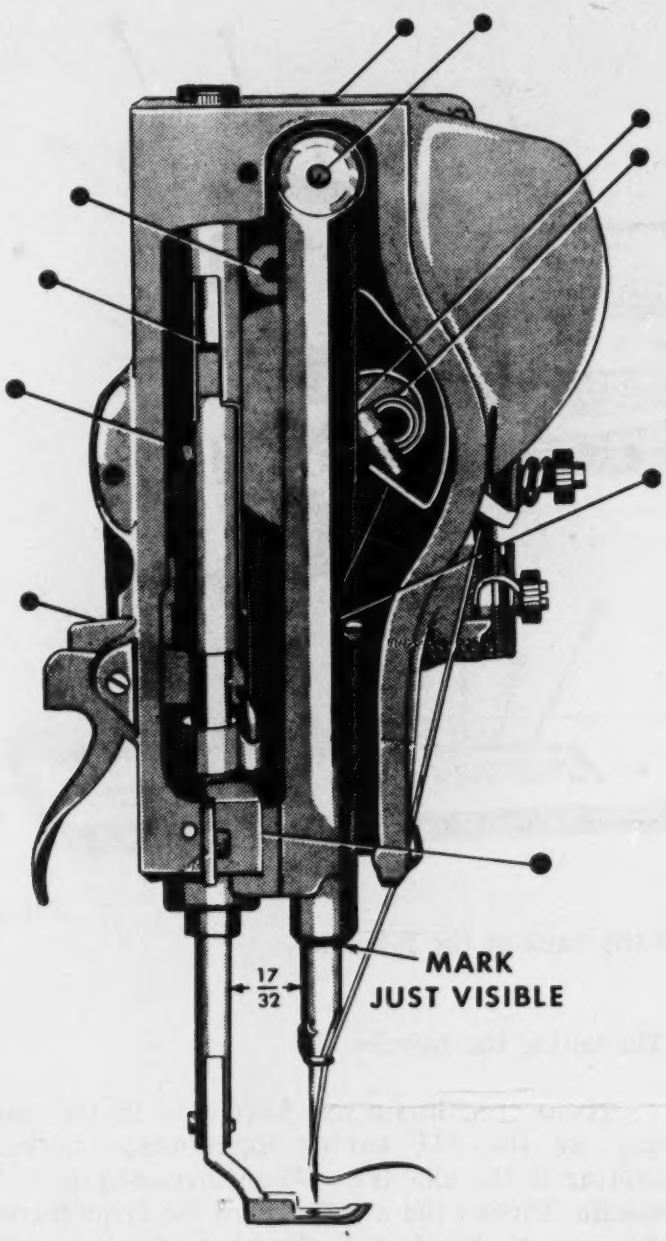

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Figure 11-29.—Oiling points at the end of the machine.

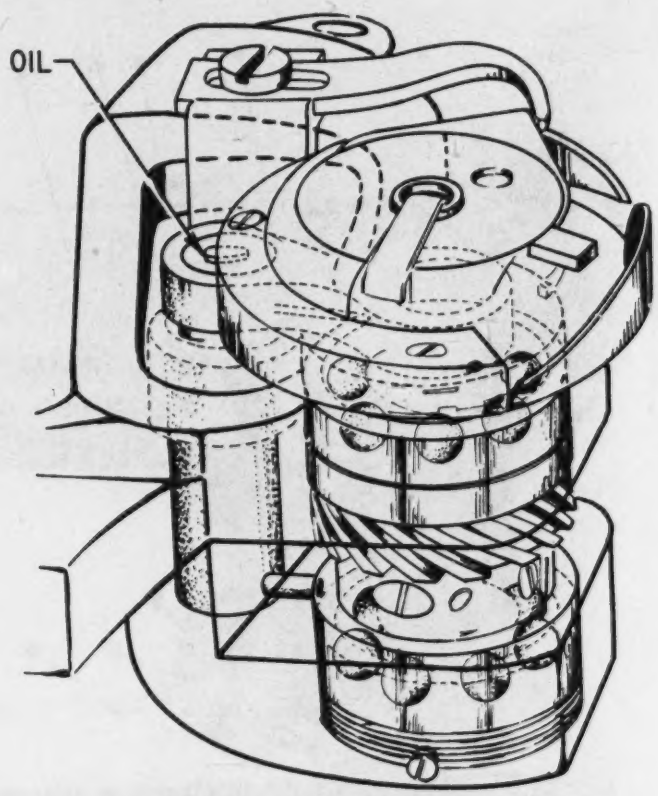

PR.290

Figure 11-30.—Hook lubrication.

Regulating the Width of Throw

The width of throw of the zigzag stitch is regulated by means of the needle vibrator regulating spindle head on the front of the machine. To increase the width of the zigzag stitch, turn the regulating spindle head counterclockwise. To decrease the width of the zigzag stitch, turn the regulating spindle head clockwise.

The thread tensions are regulated as given for the 111 class machines, and the pressure on the material is regulated by the thumbscrew, located on top of the sewing machine face.

Turning Corners

Stop the machine while the needle is rising, but before it is out of the material, raise the presser foot and turn the work. This method uses the needle as a pivot.

Removing the Work

Raise the presser lifter (either hand or knee), turn the machine by the balance wheel until the takeup lever is at its highest position and draw the work away from you. If the threads do not draw out easily, the takeup lever is not in the right position. If the machine is stopped as directed, the needle will not be unthreaded when starting to sew, even if only a short end is left through the eye of the needle.

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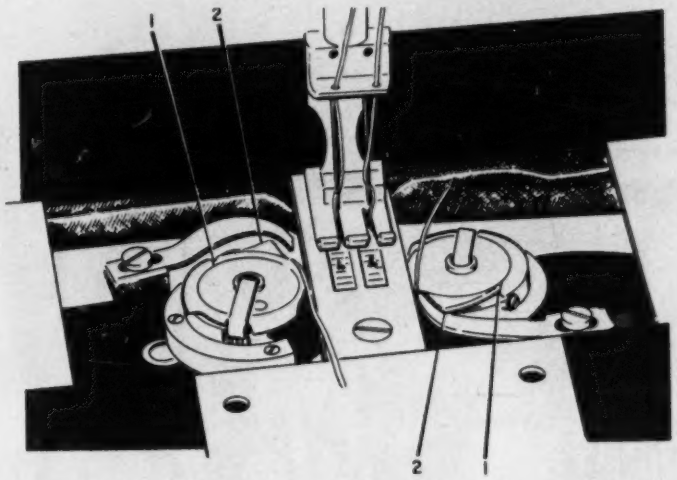

1. Slot in the edge of the bobbin case.
2. Projection on the side of the bobbin case.

PR.291

Figure 11-31.—Threading the bobbin case.

SERVICING AND ADJUSTMENT

Service manuals covering each class and variety of sewing machines are furnished with new machines. Replacement manuals may be ordered, through open purchase, from the sewing machine manufacturer. Servicing of all sewing machines is to be performed in accordance with the applicable sewing machine maintenance manual. Adjustments to sewing machines must be made only by qualified personnel.

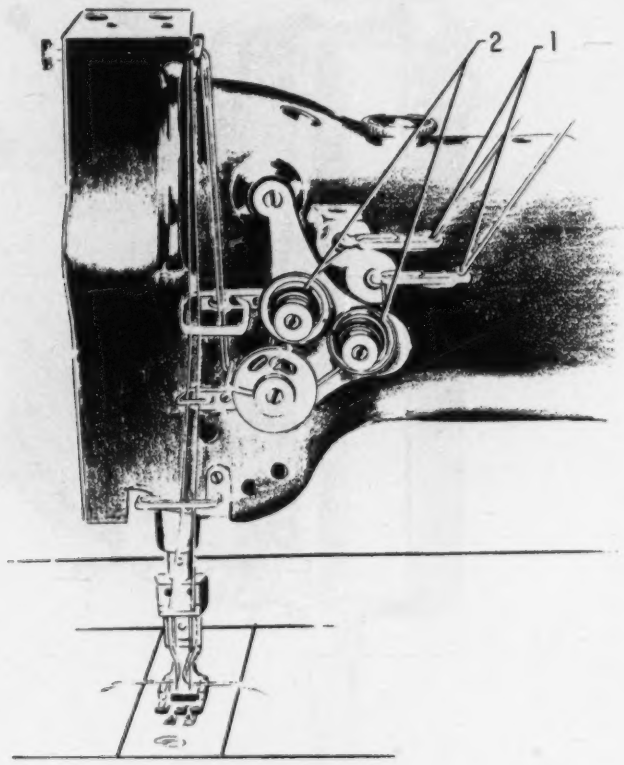

1. Upper thread guides.
2. Tension disks.

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Figure 11-32.—Threading the 112 W140 sewing machine.

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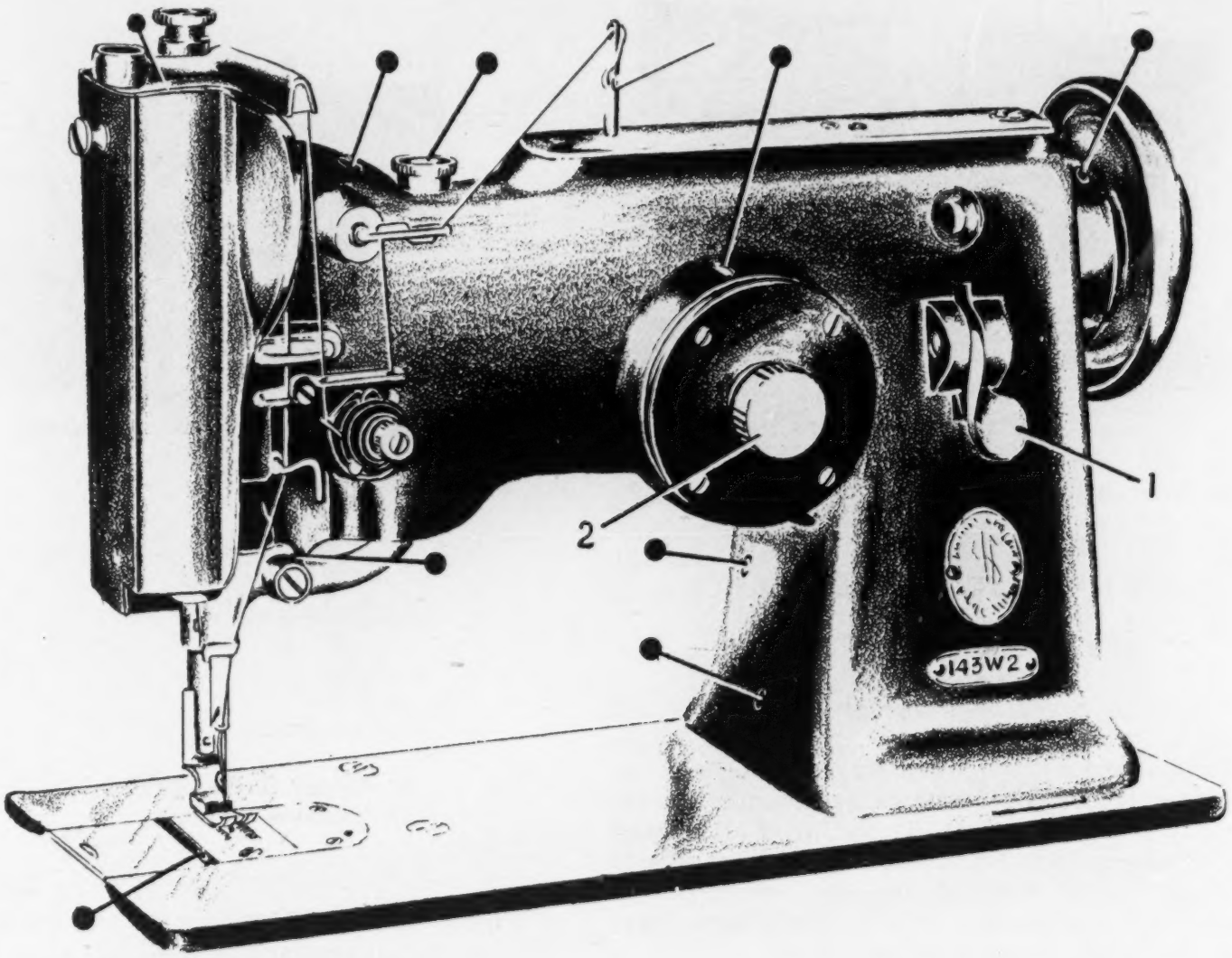

1. Stitch regulator lever.
2. Vibrator regulating spindle head.

PR.293

Figure 11-33.—Oiling points at front of machine.

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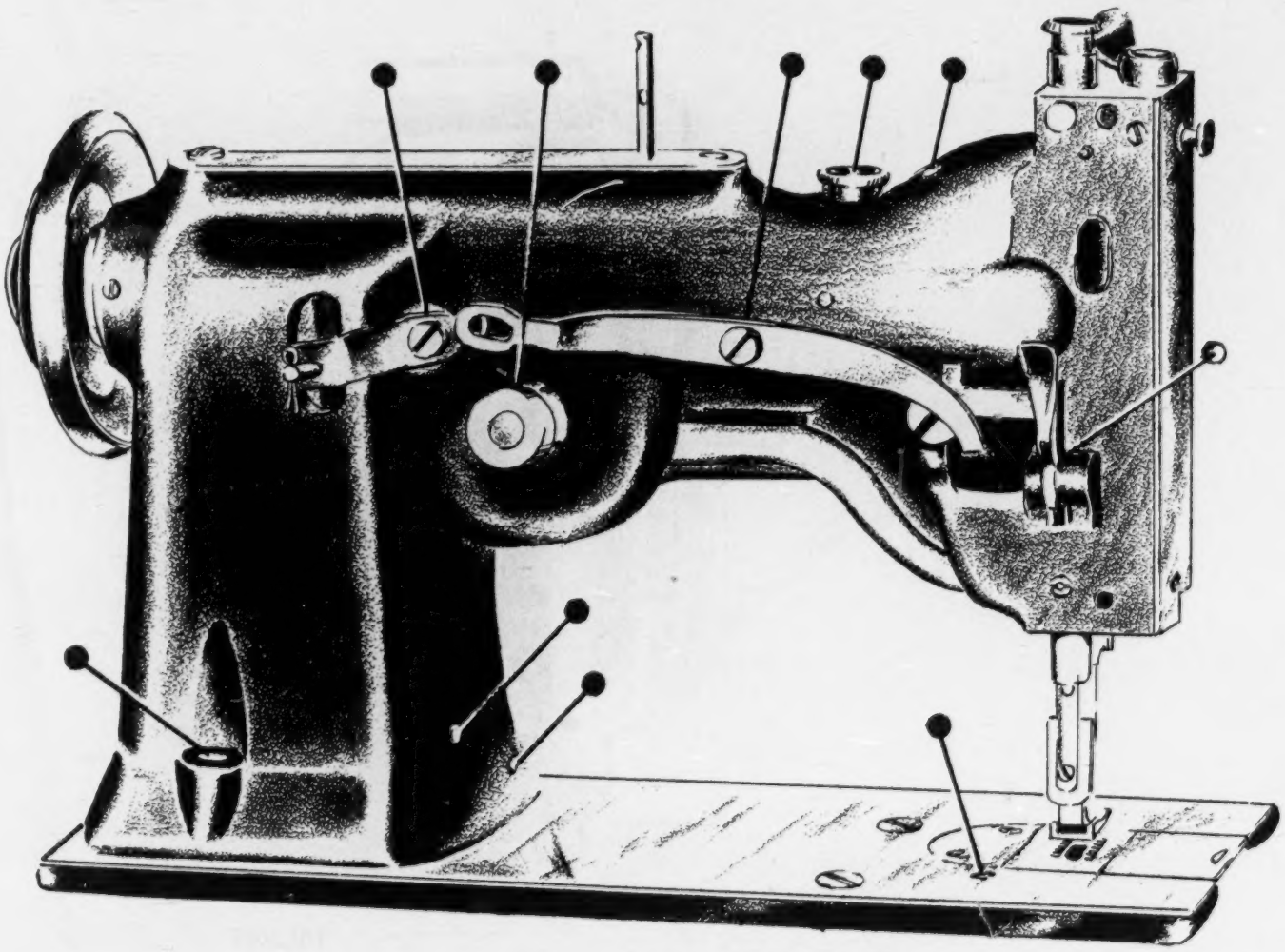

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Figure 11-34.—Oiling points at back of machine.

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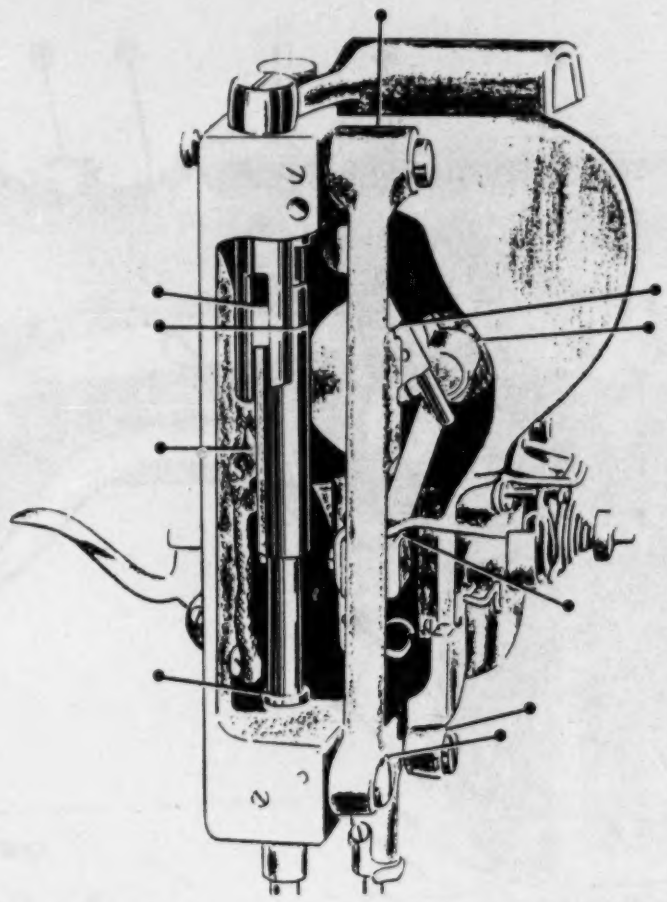

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Figure 11-35.—Oiling points at end of machine.

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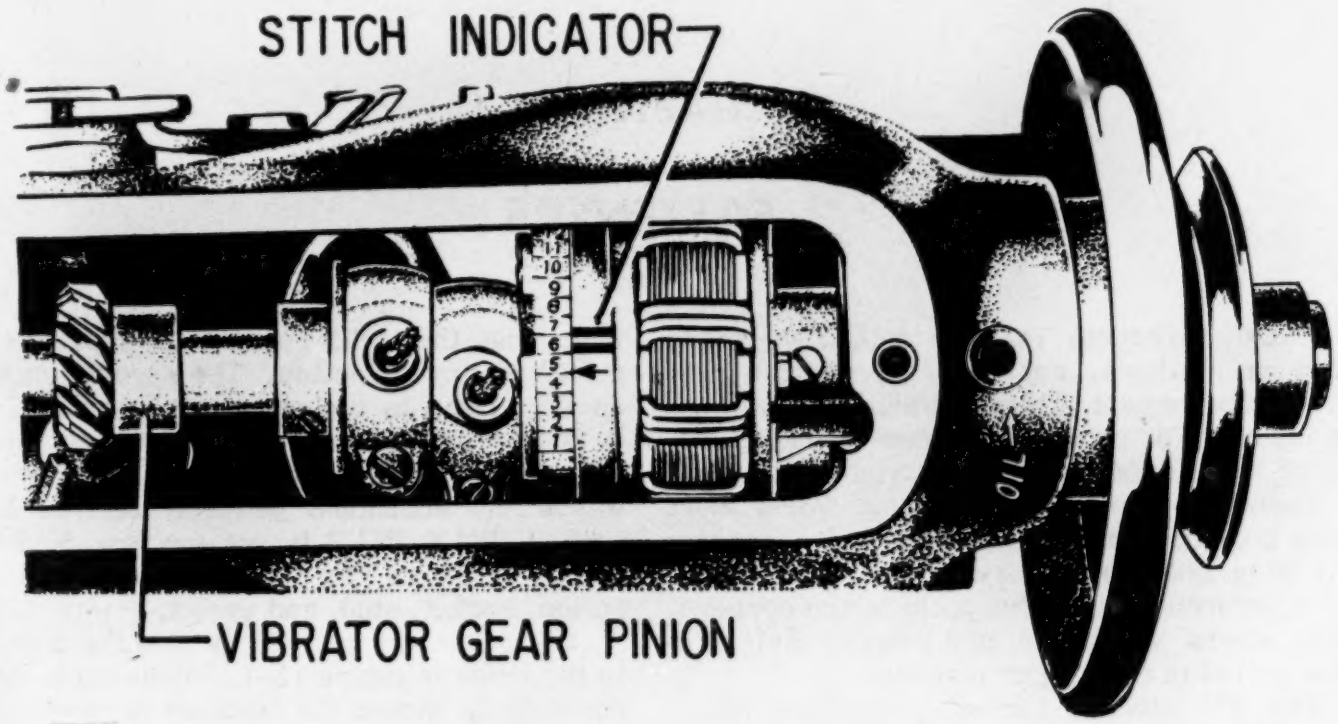

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Figure 11-36.—Oiling points at top of machine.

CHAPTER 12

FASTENERS

Textile products may be joined by many different methods, depending upon each individual requirement. These methods include sewing (by hand, or by machine), cementing, and the use of various fasteners and fastening devices.

Fasteners have been designed for almost every possible manner in which textile products may be united. Some fasteners act as anchoring and reinforcing points for pockets and corners, while others are snaps, and release their grip when pulled in the proper manner.

The PR must be throughly familiar with—and able to repair or renew—each type fastener. These fasteners include:

1. Snap fasteners.
2. Speedy rivets.
3. Grommets.
4. Slide fasteners (zippers).
5. Velcro tape fastener.

SNAP FASTENERS

The snap fasteners most commonly used in the manufacture of parachutes and for general utility work in the parachute loft are described in the following paragraphs.

WIRE SPRING CLAMP TYPE FASTENERS

The wire spring clamp type fastener is furnished in two sizes, regular (MS 27980) and small (MS 27981). In the parachute loft the wire spring clamp fastener is popularly called DURABLE DOT or DURA DOT. Figure 12-1 shows the parts of the regular wire spring clamp type fastener. In comparison to the regular size, the button of the small wire spring clamp type fastener has a dimension of 17/32 inch, with smaller corresponding parts.

Both the regular and the small wire spring clamp type fasteners are designed with a strong grip, and they will release or separate when pulled in any direction. The regular size wire spring clamp is the one most frequently used. It is used in the manufacture of back pads and parachute packs. It is also used on flight clothing where the additional security offered by the THREE-WAY SNAP is not needed. NAF blueprints refer to the parts of this fastener as button, socket, stud, and eyelet.

All parts are plated. Notice the difference in the studs in figure 12-1. These studs make it possible to mount the fastener in fabric, wood, or metal.

THREE-WAY LOCKING SNAP TYPE FASTENERS (MS 27983)

The three-way snap is manufactured in one size only, and is used on flight clothing, parachute packs, and back pads. (See fig. 12-2.) This fastener will open only when lifted from the side with the dot. It is therefore not used where any quick opening devices or quick releasing action is required. For example, the lift web keepers of a seat type parachute are equipped with the regular wire spring clamp fastener, while the two vertical keepers, which hold the shoulder straps and the back strap, are fitted with three-way locking snaps.

CURTAIN TYPE FASTENERS (MS 27977)

The curtain type fastener (lift-the-dot) is manufactured in two sizes, large and small. The parts of the large lift-the-dot, with various types of studs, are shown in figure 12-3. These fasteners have many uses, especially for truck and boat covers. The small lift-the-dot is the same as the large one, and designed on a smaller scale for use on lighter work where the bulkiness and weight of the large lift-the-dot are not desired.

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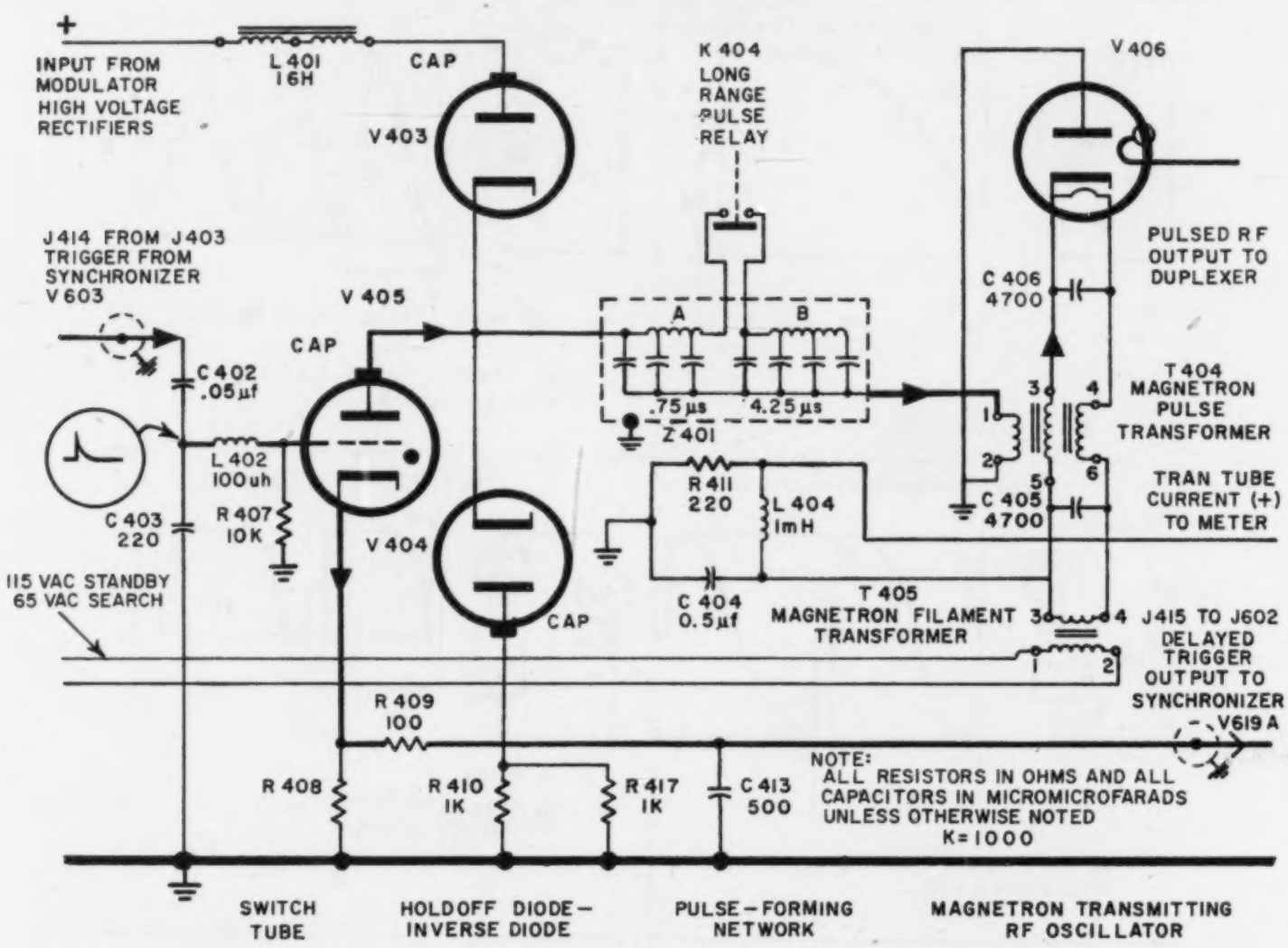

Figure 16-23.—A typical line-pulsing modulator and magnetron circuit.

of the transmitter. The modulator consists of artificial-line pulse-forming network Z401; hydrogen-thyratron switch tube V405; holdoff or charging diode V403; inverse-diode V404; resonant charging choke L401; and magnetron pulse transformer T404, the double-wound secondary of which supplies a pulse of power to the magnetron cathode circuit each time the line is discharged. The switching device which controls the discharge of the line is a hydrogen-thyratron tube controlled by the trigger from the radar's synchronizer.

When system power is applied, current to charge the pulse-forming network is drawn from the power supply through resonant charging choke L401 and charging diode V403. The flow of this current establishes a magnetic field in the resonant charging choke. Charging is rapid up to the point at which the pulse-forming network charge nearly equals the peak power supply voltage, approximately plus 2,500 volts d. c. The rate of charge drops sharply, and the magnetic field built up in the resonant charging choke collapses. By this self-inductance, a voltage approximately twice the power supply peak voltage is rapidly established. The tendency of the resonant charging choke to oscillate is halted abruptly at its first positive peak by the rectifying action of the charging diode and the pulse-forming network is held at this high potential. Discharge of the capacitors within the pulse-forming network is prevented by charging diode V403. Inverse-diode V404, and thyratron switch V405 are inoperative and hence appear as infinite impedances and do not provide a discharge path for the network.

The master-trigger generator in the synchronizer supplies a trigger voltage to the grid

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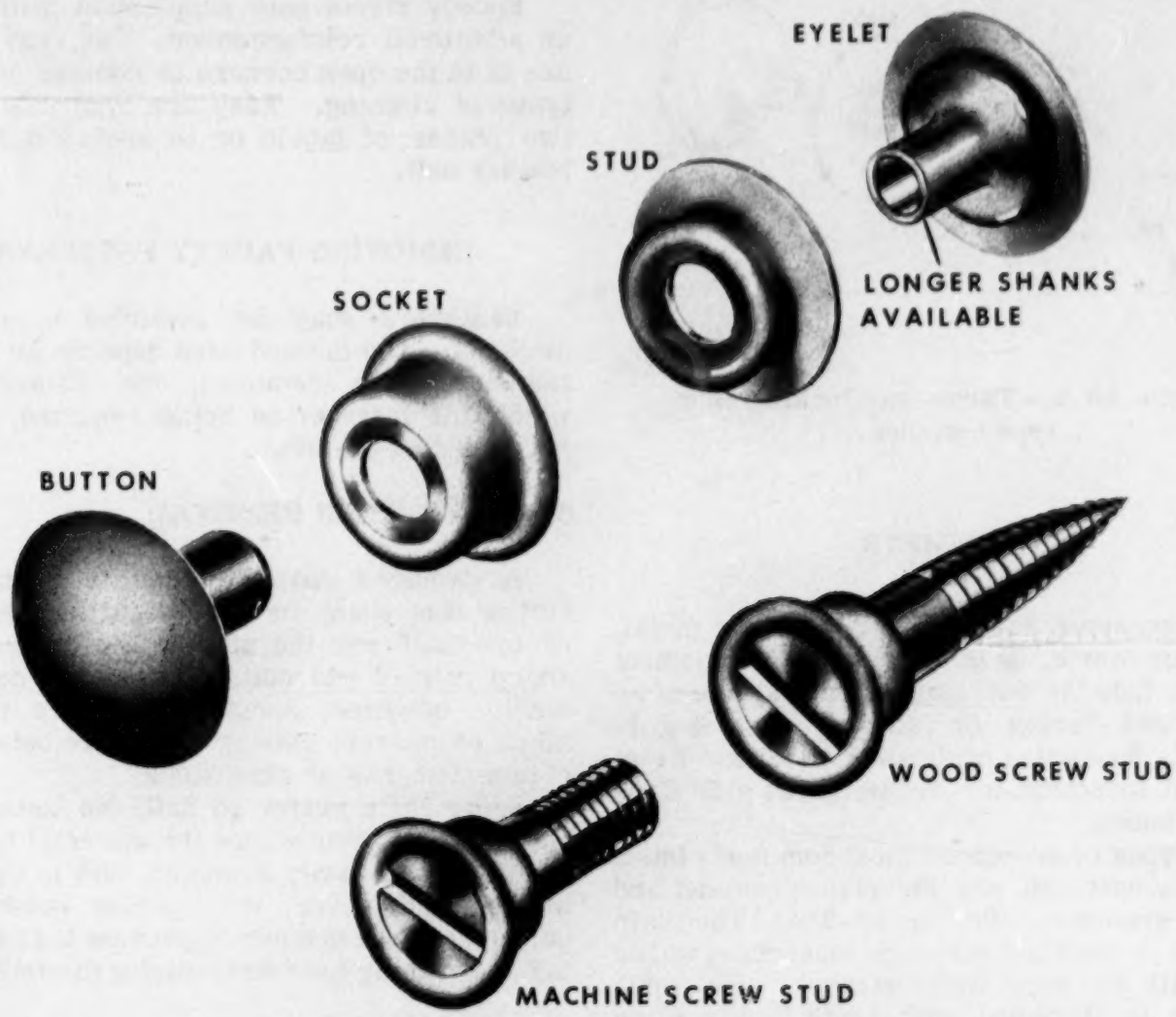

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Figure 12-1.—Regular wire spring clamp fastener.

GLOVE SNAP TYPE FASTENER (MS 27984)

Figure 12-4 illustrates this type fastener, which is generally used on lightweight flight clothing.

INSTALLATION OF SNAP FASTENERS

Figures 12-5 through 12-7 illustrate the methods and tools employed in the installation of the regular wire spring clamp type fastener, large curtain type fastener, and the glove snap type fastener.

Setting Tools

In order to properly install the various types of fasteners used in the loft, it is essential to use the proper tool (chucks and dies) for the fastener being installed.

A fastener kit which consists of a small cabinet, five drawers, and a supply of assorted fasteners and setting tools is useful in the setting of snap fasteners.

The fasteners, along with their corresponding chucks and dies, are replenishable through regular supply channels.

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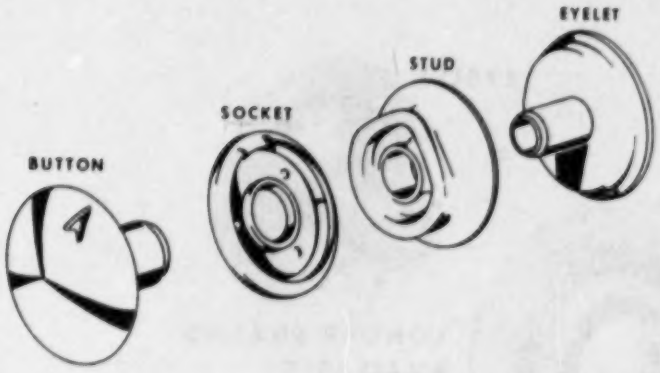

PR.298

Figure 12-2.—Three-way locking snap type fastener.

GROMMETS

The grommet is an eyelet, made of metal, rubber, or fabric. It is used as a reinforcement around a hole or cut, usually on the edge of an item where lacing or similar fastening is required. Examples of these are lacings on tent flaps and locations for securing the side flaps on parachutes.

The types of grommets most commonly found in a parachute loft are the plain grommet and the spur grommet. (See fig. 12-8 (A).) The plain grommet is used in lightweight materials, where there will be very little stress. The spur grommet is designed with teeth in the outer ring of the washer to aid in holding in heavy or loosely woven fabric and in places where considerable stress will be placed on the grommet. Design specifications for grommets are found in Air Force-Navy Aeronautical Standard Drawing AN 230.

The grommet used on parachute side flaps is a plain type, specially manufactured of chrome-plated metal. It is set in the parachute side flaps under a process which fuses the edge of the hole in the material and prevents the circular cut from fraying. This type of grommet is shown in figure 12-8(B).

Grommets may be set either by hand or by the hand press. The hand press makes a neater job and should be used whenever possible. Figure 12-9 illustrates the hand press dies and chucks used to set a plain or spur grommet. When setting grommets, the material should be reinforced with a hem or patch before the grommet is set.

SPEEDY RIVETS

Speedy rivets may supplement stitching as an additional reinforcement. One very popular use is in the open corners or pockets of certain types of clothing. They are also used to join two pieces of fabric or to secure a loop in a leather belt.

REMOVING FAULTY FASTENERS

Fasteners may be removed by different methods. The method used depends on the type fastener being removed, the material from which the fastener is being removed, and the person doing the job.

SNAP FASTENER REMOVAL

A damaged snap fastener is removed by cutting the shank or post securing the socket of one half and the stud of the other half. A sharp pair of end cutting pliers will do the job easily; however, considerable care must be taken to prevent cutting the fabric between the crimped shanks or extensions.

Some PR's prefer to drill the fastener out, and in some cases where the material is brittle or otherwise easily damaged, this is the better method. However, the fastener must be secured in some manner to prevent it from turning and tearing the fabric during the drilling.

GROMMET REMOVAL

Grommets are removed by prying the shank away from the washer until the shank is uncrimped enough to permit the washer to be withdrawn. They may also be removed by cutting the shank with a chisel. This raises the washer enough to permit gripping it with a pair of pliers for removal of the washer.

SPEEDY RIVET REMOVAL

Use a pair of diagonal cutting pliers to remove a speedy rivet. Cut the crimped shank halfway between the two parts, taking care not to damage the fabric.

SLIDE FASTENERS

The types of slide fasteners (zippers) used on flight clothing and other items of aviation

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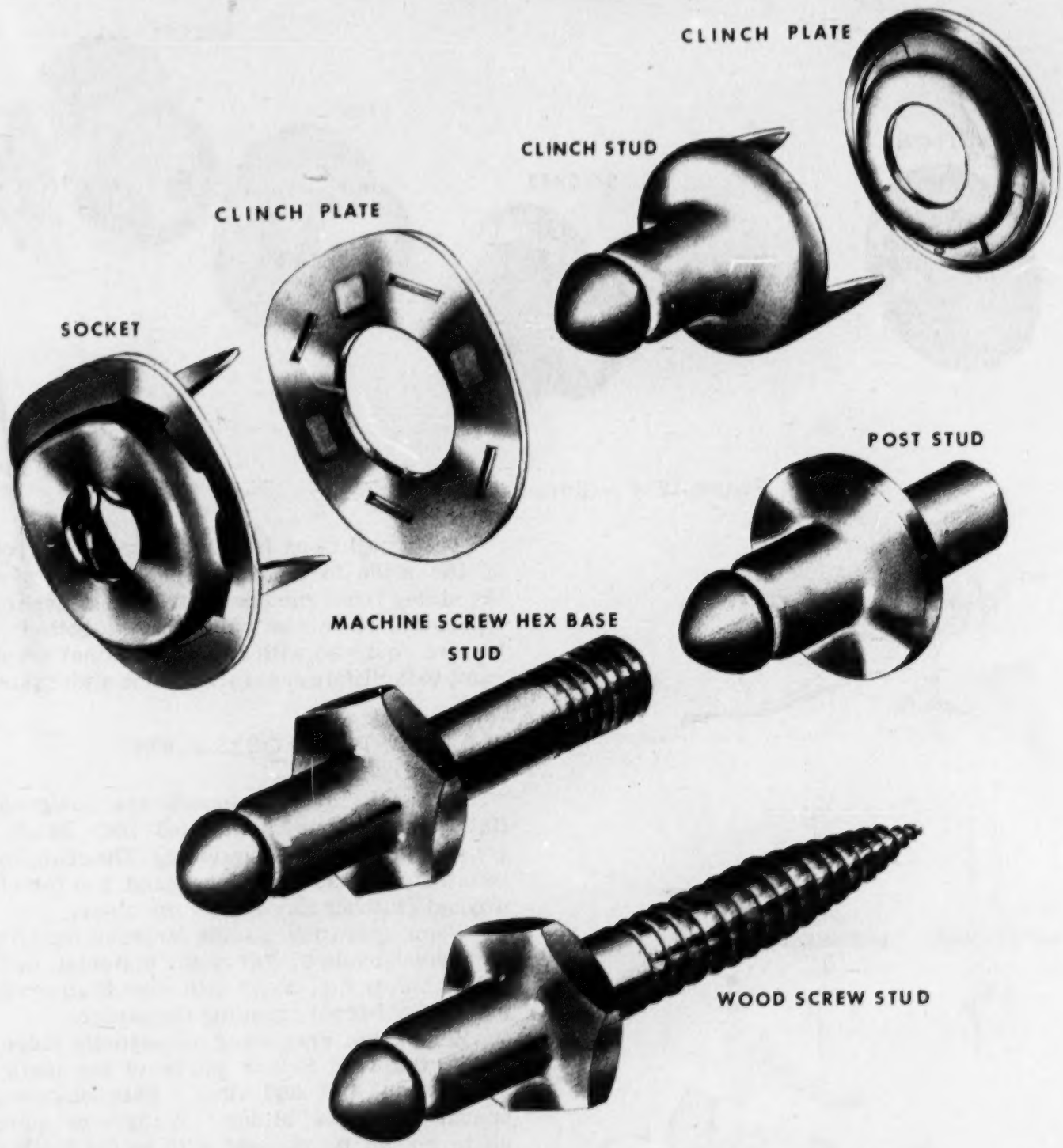

PR.299

Figure 12-3.—Large curtain type fastener (lift-the-dot).

equipment are shown in figure 12-10. Figure 12-11 shows the parts of a slide fastener.

SLIDE FASTENER CONSTRUCTION

A slide fastener consists of two rows of teeth (hollow cones or scoops) facing each other. When brought together at the proper angle, each tooth is designed to fit within the tooth opposite.

When closed, the slide fastener teeth cannot be parted except through use of the slider which, when moved, displaces the teeth at the proper angle for meshing and unmeshing.

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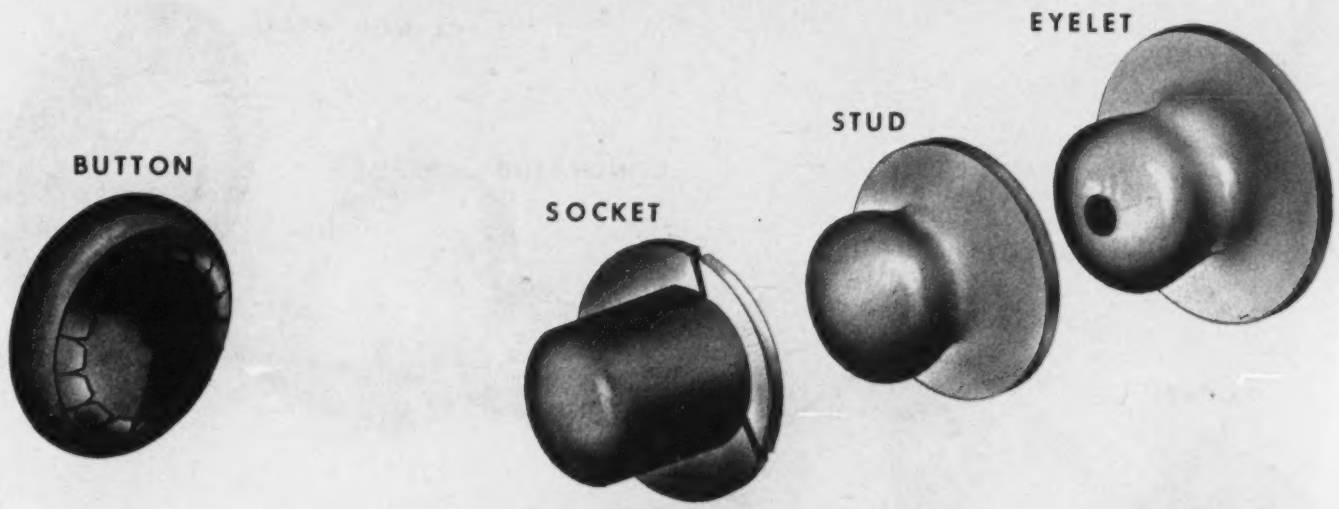

PR.300

Figure 12-4.—Glove snap type fastener.

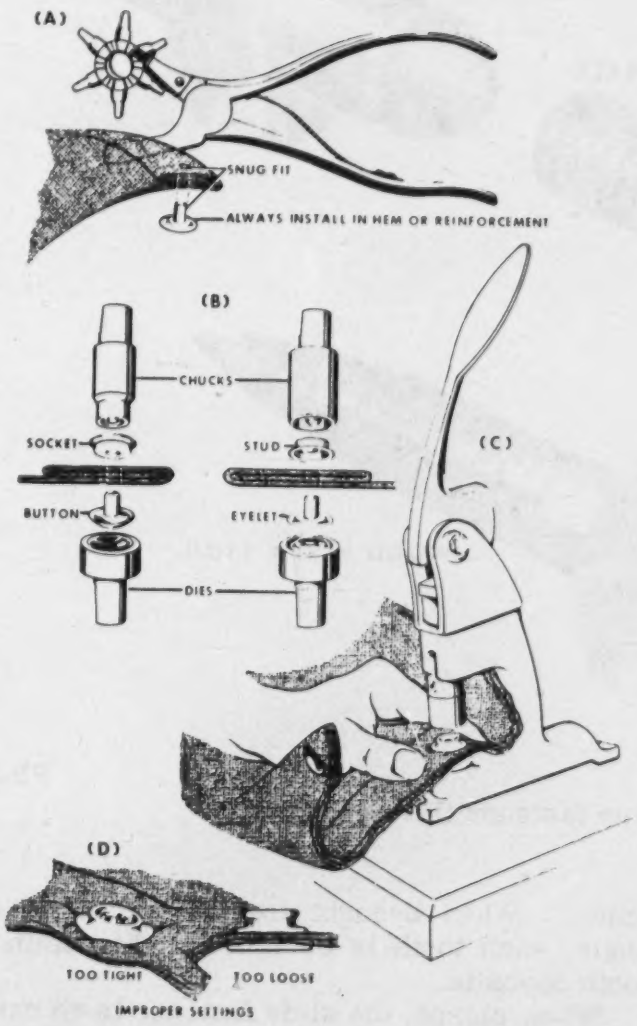

PR.301

Figure 12-5.—Installing the regular wire spring clamp type fastener.

The small clips (stops) at the top and bottom of the slide fastener are designed to prevent the slider from running off the track. Separating type slide fasteners do not have a bottom stop, but are equipped with a pin and retainer arrangement to facilitate separating of the slide fastener.

SLIDE FASTENER OPERATION

Ordinary slide fasteners are designed for flat, smooth operation, and both hands are required for proper functioning. The chain should be stretched taut with one hand and the slider worked (without force) with the other.

When operating a slide fastener installed in a garment made of soft nappy material, or lined with wool or fur, do so with care to prevent the nap or wool from jamming the slider.

Very often grease or oil deposits lodge between the tiny hollow parts of the teeth and accumulate dirt and lint. This causes stiff operation of the slider. A dirty or gummed chain should be cleaned with an old toothbrush or a pipe cleaner saturated with Stoddard solvent or other similarly approved cleaning solvent. After each cleaning, the chain should be lubricated by applying one drop of oil or a small amount of graphite between the thumb and forefinger and running the chain up and down between the fingers several times.

A brief inspection will determine whether a slider (or pull tab) is the locking or nonlocking type. Always be certain that the pull tab is lifted at right angles to the slider before attempting to remove the locking type. The

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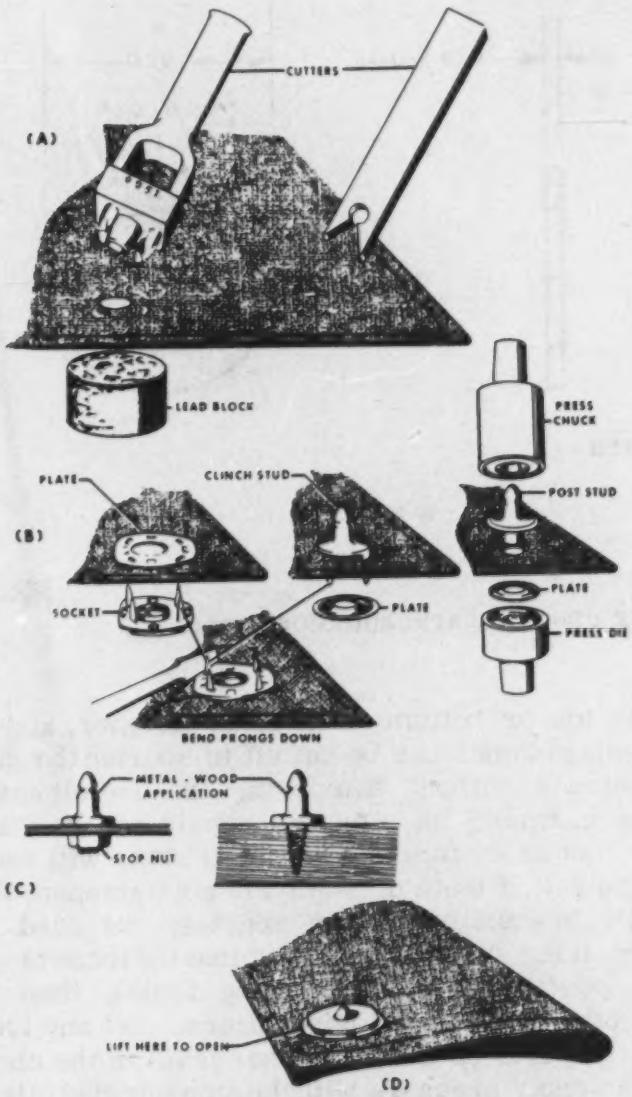

PR.302

Figure 12-6.—Installing the large curtain type fastener.

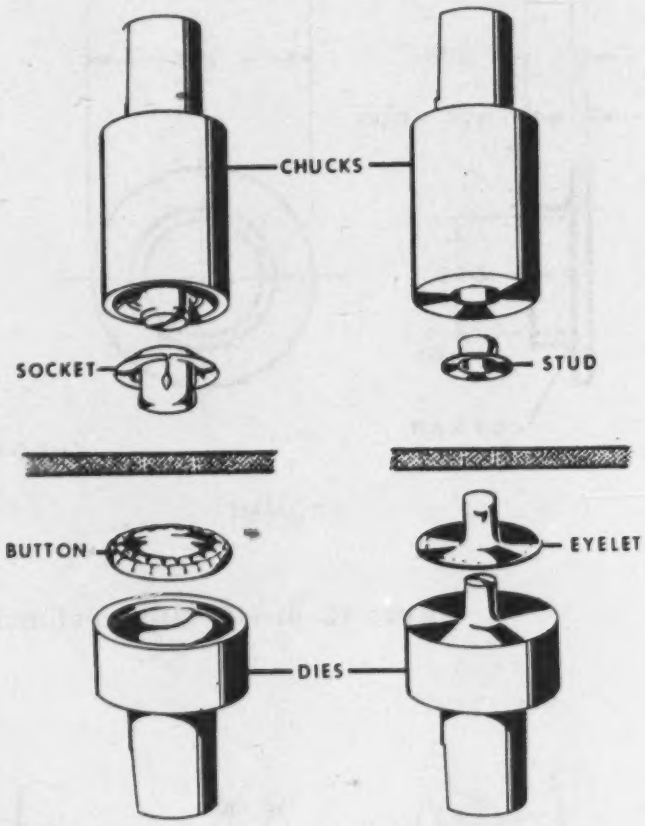

PR.303

Figure 12-7.—Installing the glove snap type fastener.

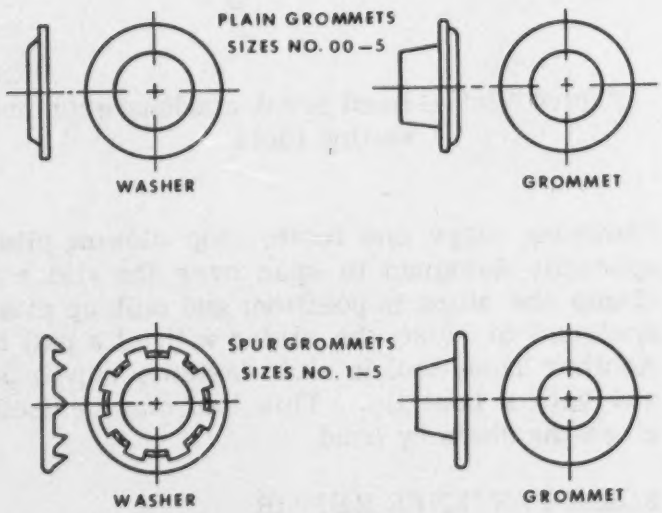

PR.304

Figure 12-8.—(A) Grommets, plain and spur.

relative positions of the pull tabs are shown in figure 12-12.

SLIDE FASTENER TOOLS

In addition to common tools such as screwdrivers, pliers, awls, knives, scissors, and needles, a well-equipped slide fastener kit should be included in the parachute loft equipment.

The slide fastener kit (zipper repair kit) contains all the parts necessary to repair any size or type slide fastener, plus the following special tools: end cutters, or nippers, used for

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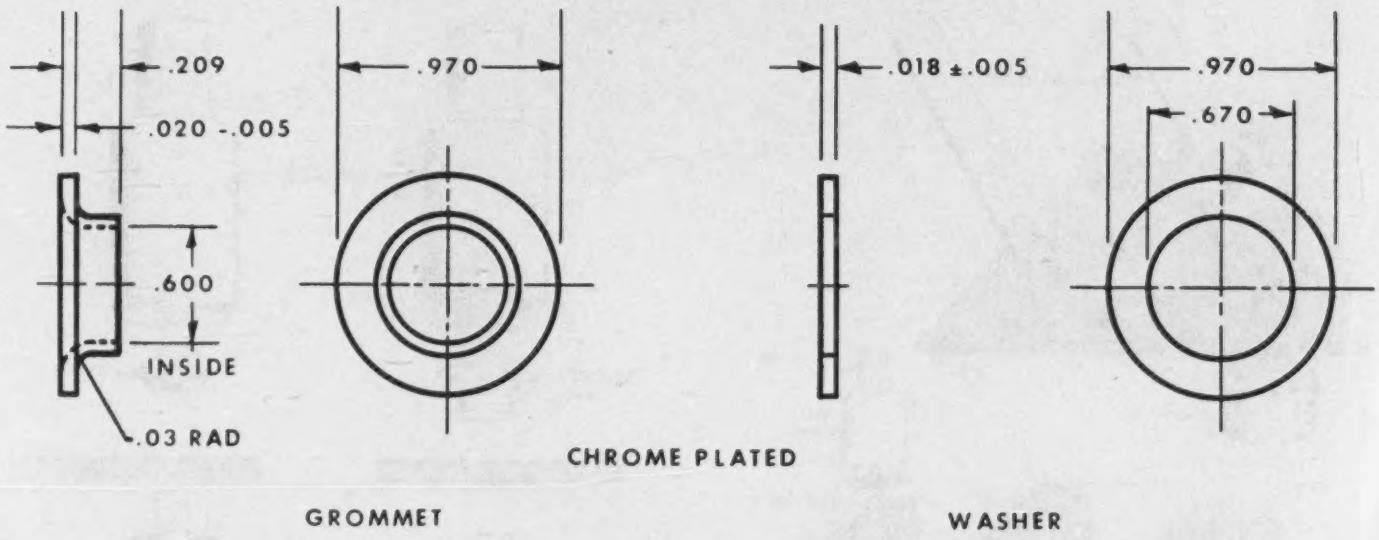

PR.305

Figure 12-8.—(B) Grommet and washer used on parachute container.

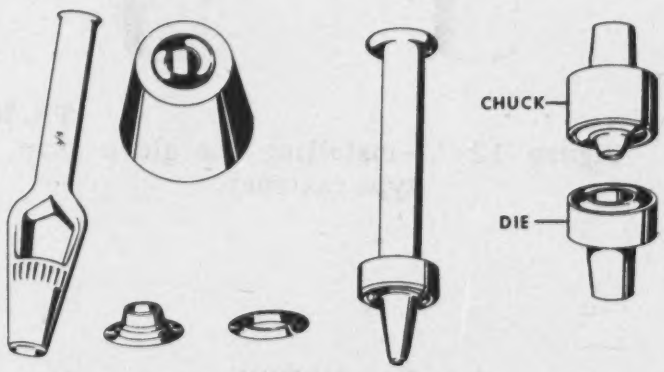

PR.306

Figure 12-9.—Hand press and hand grommet setting tools.

removing stops and teeth; stop-closing pliers, specially designed to span over the slider and clamp the stops in position; and pull-up pliers, designed to close the slider without a pull tab. Another handy tool in slide fastener repair is an awl with a bent tip. This tool may be used to close the chain by hand.

SLIDE FASTENER REPAIR

A torn or ripped zipper cord cannot be repaired, but should be replaced with a complete new slide fastener. If the cord is damaged near the top or bottom of the slide fastener, and the damaged ends can be cut off to shorten the slide fastener without hampering the usefulness of the garment, an effective repair can be made.

Loose or missing teeth and stops will cause trouble. If teeth or stops are not tightened, they will eventually be lost and tear the cord. In repairing such damage, see that the loose stop is in position (almost touching teeth), then set tightly with stop-closing pliers. Set any loose teeth parallel with the other teeth in the chain, then apply pressure with the stop-closing pliers. If a replacement stop is not available in the repair kit, a soft wire or heavy thread may be used as a temporary stop.

A missing tooth should be repaired by replacing the entire slide fastener. However, in the event that there are no spare fasteners available, a missing tooth may be replaced. This is done by carefully removing the stop from the top of the chain, taking off the top tooth, replacing the stop, and setting the tooth in place. (Use caution, do not damage the bead of the chain when resetting the tooth.)

Difficulty may be encountered in moving the slider on the chain. This is caused by the jaws of the slider being too tight, or a dirty chain may be the trouble. To loosen the slider, insert a screwdriver between the jaws, and very gently pry them apart until free operation is effected. A dirty chain is cleaned in the manner described in a preceding paragraph.

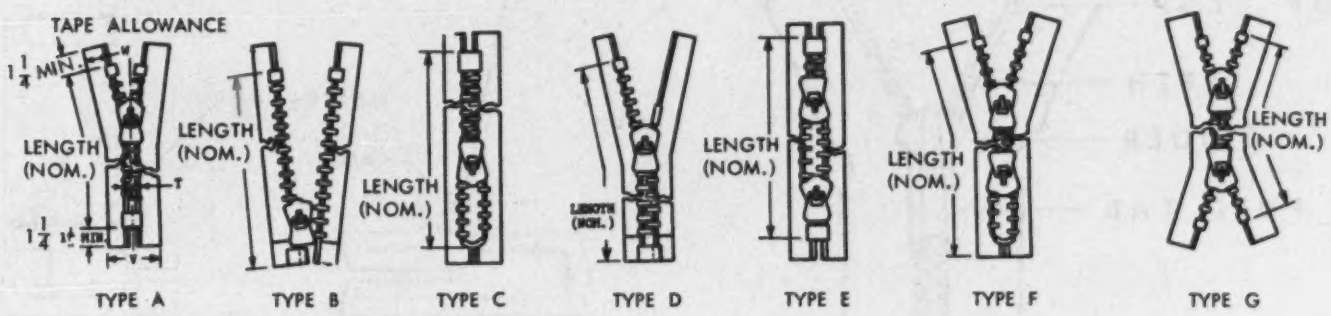

TYPE A - NON-SEPARATING, SINGLE ACTION.
TYPE B - SEPARATING, SINGLE ACTION.
TYPE C - NON-SEPARATING, SINGLE ACTION WITH BRIDGE STOP.
TYPE D - SEPARATING, SINGLE ACTION, QUICK DETACHING.
TYPE E - NON-SEPARATING, DOUBLE ACTION, CENTER OPENING.
TYPE F - NON-SEPARATING, DOUBLE ACTION WITH BRIDGE STOP.
TYPE G - SEPARATING, DOUBLE ACTION, END OPENING.

SIZE 0 - LIGHT SERVICE.
SIZE 1 - LIGHT-MEDIUM SERVICE.
SIZE 2 - MEDIUM SERVICE.
SIZE 3 - MEDIUM HEAVY SERVICE.
SIZE 4 - HEAVY SERVICE.

STYLE S - STANDARD NON-LOCKING.
STYLE L - LOCKING.

PR.307

Figure 12-10.—Slide fasteners, inlocking.

Should the slider become jammed with fur, wool, or other material, carefully remove such matter with a pin or needle while gently pulling the slider until it is released. If it is so badly jammed that it resists all efforts, remove the slider by carefully bending the jaws apart and returning the jaws to their original position. The slider is then replaced on the chain, as described later.

Most pull tabs have two small projections fitting into slots on each side of the slider. To remove the pull tab, use two pairs of pliers, one on each side, and twist in opposite directions. In replacing pull tabs, this procedure is reversed. Pull tabs furnished as replacements need only to be squeezed onto the slider.

In making repairs to a damaged slider, the slider must be removed. The proper procedure for removing and replacing a slider on the chain following repairs is explained in the following paragraphs.

To remove the slider from the regular type slide fastener (nonseparating), carefully rip the stitches from the BOTTOM of the slide fastener to expose the ends of the tape. Then remove the bottom stop, and slip the slider off the bottom of the chain and entirely off the cords and tape, as shown in figure 12-13.

To replace the slider on a regular type slide fastener, thread the two bottom cords into the wide end of the slider. Hold the tape so that the bottom teeth are correctly matched, then draw the slider upward until the teeth mesh for several inches. Without allowing the teeth to separate, clamp the bottom stop close to the teeth and over both cords. Replace the tape ends and ripped stitches by hand or by machine.

To remove a damaged slider on a separating type slide fastener, carefully rip the stitches at the TOP of the slide fastener, on the retainer side only, thus exposing the end of the tape. Remove the top stop, slip the slider off the top of the chain, and completely remove it from the cord and tape. Repair or replace the slider.

To replace the slider on a separating type slide fastener, thread the cord on the retainer side into the narrow end of the slider, and allow the slider to slip down the chain. Replace the tape end and ripped stitches by hand or machine.

To replace the slider on the top of a regular, nonseparating type slide fastener with the aid of pull-up pliers, slip the tool over the bottom stop, clamp together, and pull upward. Close the entire chain in this manner. Thread the two top cords into the narrow end of the slider, holding the teeth meshed until they enter the slider. Replace the top stops, tape ends, and ripped stitches.

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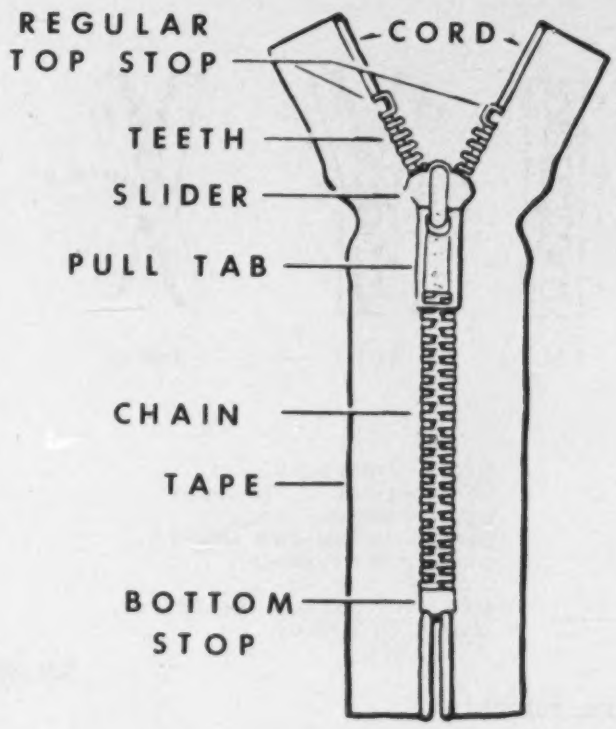

PR.308

Figure 12-11.—Slide fastener parts.

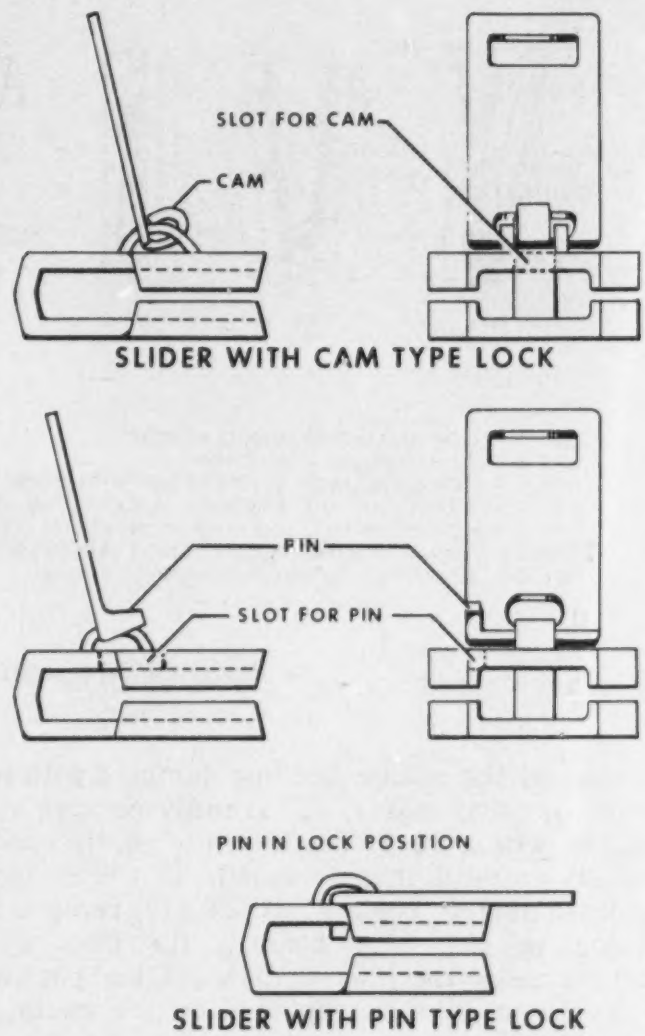

PR.309

Figure 12-12.—Slide fastener pull tabs.

Shortening a Slide Fastener

To shorten a slide fastener, first determine the length required. The chain should be about 1/2 inch shorter than the opening in the material or garment. Mark the desired length, measuring from the bottom stop upward. Open the chain to any point below this mark and cut directly across the tape about 1 inch above the mark. Cut the excess teeth from the marking point to the end of the tape, and replace the two stops, crimping them firmly.

Installing a Slide Fastener

The installation of a slide fastener will vary with the type of job. Some will be curved, some around corners, and some hidden. The installation of a straight slide fastener is illustrated in the following paragraphs.

Slide Fastener Presser Foot

In order to install a slide fastener neater and easier, a slide fastener presser foot should be used on the sewing machine. The slide fastener presser foot will serve not only as a guide for a neat row of stitches, but will also prevent the foot from riding up on the chain.

The sewing machine manufacturer can supply a regular slide fastener presser foot (right or left) for any sewing machine, or one can be made locally. File or grind the left side of an old presser foot to permit sewing to within 1/8 inch of the chain.

Fabrication

When sewing, always stretch the slide fastener and not the material, as this makes a flatter and neater job.

A simple method of installing a slide fastener when making a bag or cover with two closed ends follows: Lay the piece of material

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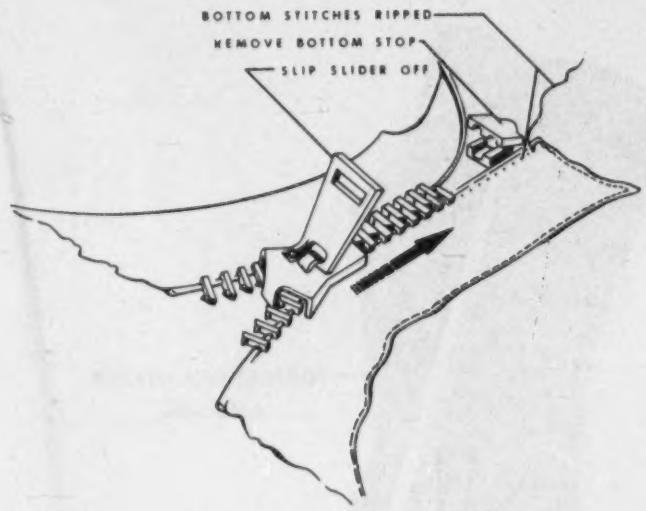

PR.310

Figure 12-13.—Removing the slider.

right side down, and place the slide fastener right side down on top of the material where the opening is to be located. Sew a row of stitches completely around the outer edge of the tape, as shown in figure 12-14.

Turn the material over. Then by feeling with the points of a pair of scissors, cut the material directly down the center of the chain and cut a V at each end, as shown in figure 12-15.

Turn the edges of the material under, thus exposing the chain. Allow sufficient space between the chain and the folded edge of the material, to prevent the slider from rubbing the edge of the hems. Cutting the V at each end of the chain permits the sewing of neat, square corners. (See fig. 12-16.)

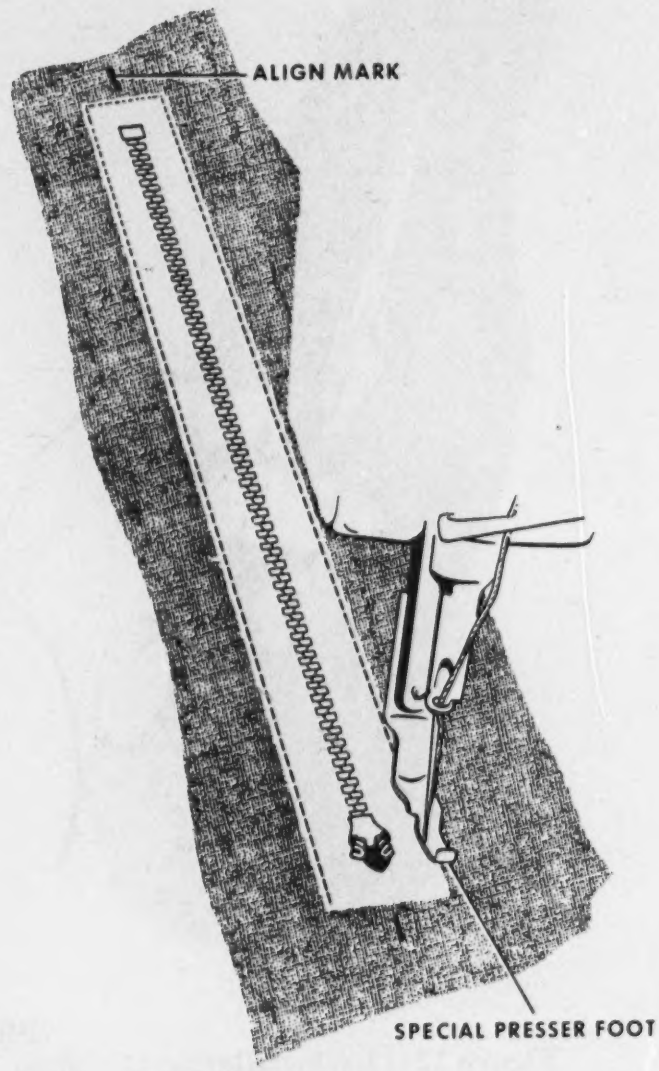

PR.311

Figure 12-14.—Installation of a slide fastener. Step 1.

PROCUREMENT OF SLIDE FASTENERS

The nonseparating slide fastener tape chain is stocked in bulk rolls of 10-foot minimum lengths in sizes 1 and 3. They are interlocked while carried in stock and will remain interlocked when shipped. The unit of issue is in feet.

The separating slide fasteners (with retainers and separating pins attached) are stocked in size 3 only, and in lengths of 24, 48, 72, and 108 inches. Unit of issue is EACH. Necessary stops and sliders are stocked in bulk. Only the style L, locking, nonreversible, single pull slider is furnished.

Size 1 medium service and size 3 extra heavy service fasteners are the only two sizes in stock.

Activities should specify the brand of chain for which stops and sliders are required. (Talon, Crown, or any other make.)

Slide fasteners in stock will be supplied in the nearest length ordered. When received, the chain should be cut to the desired length; stops can be salvaged and reused on the cut chain.

VELCRO TAPE FASTENERS (MIL-F-21840)

Velcro is a tape fastener constructed of woven nylon material. The assembly consists of two sections of tape, one composed of hooks and the

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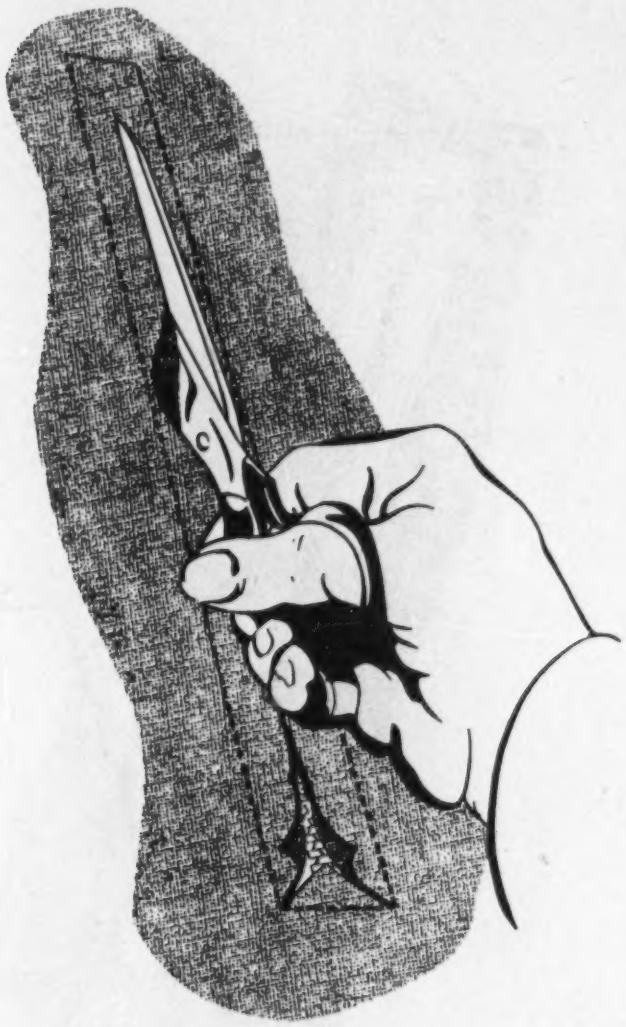

PR.312
Figure 12-15.—Installation of a slide fastener. Step 2.

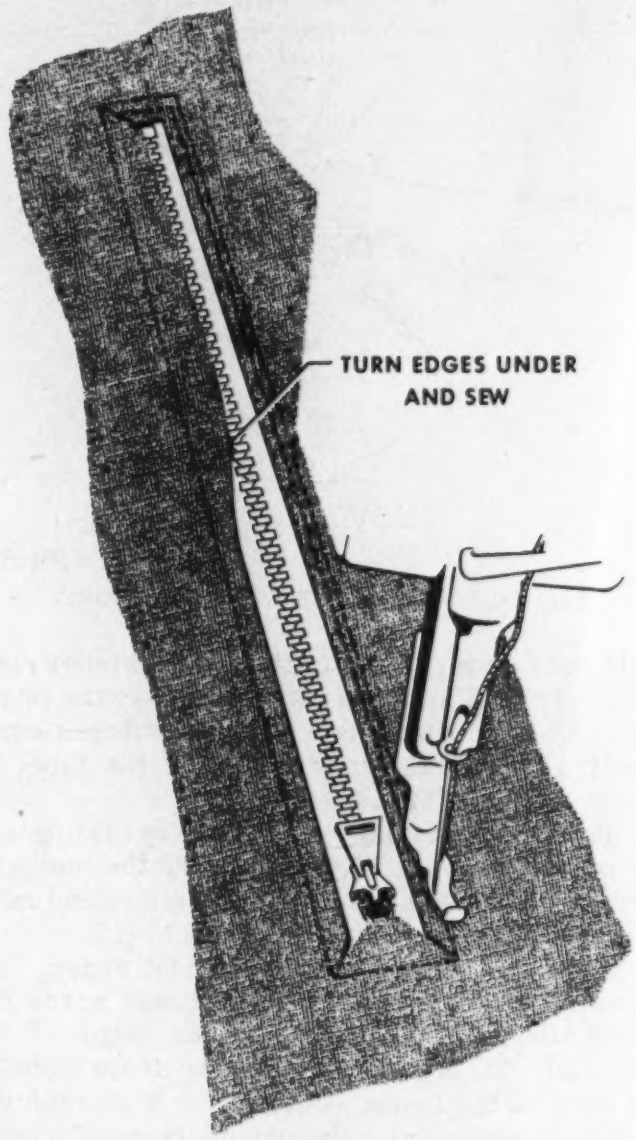

PR.313
Figure 12-16.—Installation of a slide fastener. Step 3.

other of pile loops. The hook tape contains a multitude of miniature nylon filaments woven in the form of raised loops which can be heat set to retain their shape and cut near their outer edges in order to form a hook engaging section.

The pile tape of the fastener contains a myriad of tiny, soft loops, woven of nylon threads, suitably napped to form a uniform disorientated pile surface of uncut loops capable of being engaged by the hooks of the hook tape component. (See fig. 12-17.)

A closure of the hook and pile tape can be completed by mating the two tapes and applying a slight pressure which forces the hooks into the loops of the pile causing the tapes to adhere to each other. The fastener can be opened easily by peeling apart the two tapes.

A Velcro nylon tape fastener, when properly engaged, forms a versatile, adjustable, and secure closure. It has the ability to distribute equal stress over an entire surface area.

INSTALLATION

The installation of Velcro tape will vary with the type job. It can be applied to other materials or fabrics by using approved cements or by stitching.

In the application of Velcro tape fasteners, always refer to the applicable directives concerning type of thread, stitches per inch, width, and type of Velcro tape required.

11121

of the thyratron switch tube through the d-c blocking capacitor C402. When triggered the switch tube ionizes and provides a closed circuit for the discharge of the pulse-forming network. This discharge continues for a definite period of time at a constant rate, determined by the constants of the pulse-forming network. A negative square-shaped pulse is impressed across the primary winding of the magnetron pulse transformer T404. The width of the transmitter pulse varies in a manner determined by the number of sections of the pulse line in use, as determined by the long-range pulse relay K404. Since the primary of transformer T404 is matched with the 50-ohm surge or characteristic impedance of the pulse-forming network or line, there is an equal division of voltage between these two units. Approximately 2,500 volts is impressed on the primary of T404. The turns ratio of T404 causes a voltage step-up of 1 to 5. Thus a negative pulse of approximately 12 kilovolts is placed on the cathode of the magnetron V406. The peak power of this pulse is in the order of 150 kilowatts. Output of the magnetron approximates 50 kilowatts due to losses in this tube and the associated circuits.

Gas bursts (arcing) occur occasionally within the magnetron. This condition causes momentary pulse-transformer impedance mismatching, and a small voltage of polarity opposite to that of the modulator pulse may appear across the pulse-forming network after the pulse. This small reverse voltage is in series with the power supply voltage at the start of the next charging cycle. Hence the total voltage available to produce the charging oscillation is increased, and the pulse-line voltage may build up to a value great enough to break down the thyratron. This condition is overcome by connecting inverse diode V404 in parallel with the thyratron. The diode bypasses the reversed charge of the pulse-forming network.

The pulse-forming network is composed of aircore inductors and mica capacitors. It is divided into two sections of artificial transmission line, all within the same container. Each part is a complete network. The connection of the two parts by relay K404 increases the width of the pulse. When only the first section Z401-A is in use, 0.75-microsecond pulses are generated. Addition of the second section increases the pulse period by 4.25 microseconds. With both sections connected, pulses of 5.0-microseconds duration are generated.

During long-range search operation relay, K404, is energized; thus both sections of Z401 are connected in the circuit to provide a 5.0-microsecond pulse.

Resonant charging choke L401 not only doubles the pulse-system voltage before firing, but it effectively isolates the power supply from the rest of the modulator during the relatively short periods of pulse duration. It also prevents the power supply from shorting through the switch tube during de-ionization.

Resistor R407 functions as a grid leak for the thyratron switch tube. Capacitor C403 and choke L402 form a filter network to prevent the reflection of the switch tube transients into the synchronizer. Switch tube current, flowing through the cathode resistor R408, generates a trigger pulse which is used for synchronizing the range mark start-stop multivibrator located in the synchronizer. Resistor R409 and capacitor C413 improve the trigger shape by removing ripple at the top of the pulse.

The cathode of the magnetron is internally connected to one side of the filament line. Input to the magnetron is applied by the modulator through the magnetron pulse transformer T404. The design of the pulse transformer provides two secondaries of similar electrical characteristics, one in each leg of the magnetron filament supply. This bifilar secondary winding maintains an equal and in-phase pulse voltage on both sides of the filament and effectively isolates the high-voltage modulator pulse from the low-voltage magnetron filament transformer T405. Capacitors C406 and C405 compensate for slight electrical differences between the pulse transformer output windings to prevent the appearance of high pulse voltages across the filament.

The d-c plate current of the magnetron flows through the cathode circuit of V406, pins 3 and 5 of the pulse-transformer, L404 and the 220-ohm resistor R411. Coil L404 (1 millihenry) blocks peak pulses but passes average current through the magnetron current meter. Capacitor C404 offers a low impedance to magnetron pulses and integrates them for metering. Negligible current is generated within the magnetron during quiescence, but the average of d-c current summed over a period of pulsed operation is of high magnitude. Longer pulse periods at lower PRF tend to balance shorter pulse periods at higher PRF, resulting in a nearly uniform duty cycle regardless of the radar function being performed. Note that while 115-volts is applied to the magnetron filament transformer during

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TYPES

Velcro tape is available in the following two types:

Type I—0.0065 inch monofilament diameter.
Type II—0.0080 inch monofilament diameter.

WIDTHS

The range of widths of Velcro tape is as follows:

Five-eighths inch.
Three-fourths inch.
1 inch.
2 inch.

PROCUREMENT

Velcro tape may be requisitioned through normal supply changes. The hook and pile tapes are packaged separately and may be ordered individually.

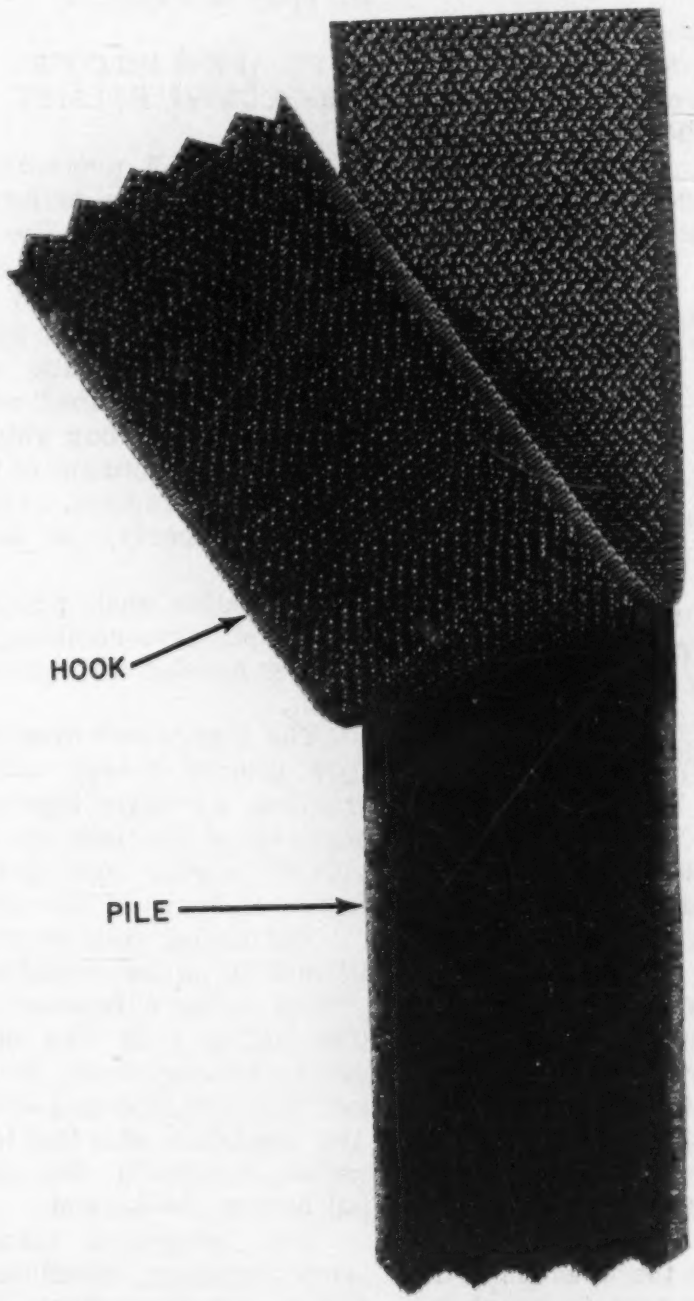

PR.314
Figure 12-17.—Hook and pile tape fastener.

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CHAPTER 13

PROTECTIVE HELMETS AND OXYGEN MASKS

PROTECTIVE HELMETS

The wearing of protective helmets during takeoff, flight, and landing by pilots and aircrewmen is required in designated types of aircraft. Helmets are constructed to distribute impact forces over the entire head and to absorb much of these forces so that a minimum amount of shock reaches the skull and brain.

Helmets have long been accepted items for head protection in athletics and certain hazardous industries. They have also been in long use in naval aviation. In early days, aviation helmets were of the same type as motor cyclists' helmets, designed primarily to give protection against windblast. Later, they were made similar to football helmets with the idea of protecting against impact. However, with advances in aircraft design and speed, the need grew for helmets that would simultaneously provide many types of protection. The advent of high-speed jet aircraft, in particular, emphasized the importance of protective helmets that would effectively reduce the likelihood of concussion of unconsciousness due to in-flight buffeting, crashing, or seat ejection.

One of the main differences between the aircraft protective helmet and the athletic type helmet is in the constituent materials. The aviation crewman's helmet is designed more for absorbing energy than for deflecting energy. Thus, in case of a very heavy blow, the helmet will absorb much of the force of this blow by partial destruction of the material of the helmet rather than by passing the force on the head. This is often important in preventing serious or fatal head injuries, as demonstrated in a number of cases in which the great forces involved damaged the helmets but left the wearers without serious injury. Another way in which the helmet prevents or reduces injury is by spreading the force of the blow over a large area of the skull instead of letting it be concentrated at the point of impact.

TYPE APH-5 PILOT'S PROTECTIVE HELMET

The APH-5 protective helmet is shown in figure 13-1. The helmet is available in large and medium sizes. The complete unit consists of an outer shell, energy-attenuating liner, sizing pads, integrated visor, earcup assemblies, communication cord, oxygen mask retention devices, nape strap, and adjustable chinstrap. Furnished with the unit is an envelope containing four shims and two screws for horizontal adjustment of the earcup assemblies. A sizing instrument, to be utilized in fitting the helmet properly, is issued with each new helmet.

The outer shell provides force-distribution and penetration-resisting properties. The outer shell is molded from glass fabric and a polyester resin.

The liners are provided to absorb or dissipate impact energy and thus minimize skull fracture or brain injury, or both. The three sections of the liner are made of cellular polystyrene sheets and molded to fit closely the inside contours of the outer shell.

The sizing pads permit fitting of the APH-5 helmet to an individual's head contour with the proper balance between stability and comfort. The sizing pads are supplied in three basic configurations—back, crown, and front; also in two basic thicknesses—thin and thick. The pads are miniature size and leather covered, reducing the discomfort that could result from internal heat in the helmet.

The integrated visor provides protection from sunglare, windblast, dust, foreign particles, and flash fires. It has excellent optical properties and resistance to cracking, and when in the UP position is protected from damage by

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Figure 13-1.—Type APH-5 pilot's protective helmet.

a housing. The housing is molded from a glass fabric and a polyester resin, similar to the outer shell.

Three colors of visors—clear, tinted, and gold—are available for use in the helmet assembly. The gold colored visor is used for additional eye protection against nuclear flashes. The tinted visor is currently supplied in various densities. This range of densities satisfies various requirements for specific visual conditions and/or individual preferences.

The relative darkness or degree of visible light transmittance is indicated by white markings on the inside edge of the visor. This

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marking can be seen more readily by removing the visor from the housing. Table 13-1 shows the markings and the percentage of light transmittance.

Due to manufacturing processes, it is impractical to control transmission of the various filter visors produced. In view of this practice, medium and large size visors with varying percentages of light transmittance are carried in the supply system under a single stock number. It is recommended that personnel check lenses at the squadron level, obtaining individual preferences before procuring from supply.

The earcup assemblies contain the earphones and improve radio reception by providing attenuation of outside noise. Each assembly consists of a phone housing of cellular polystyrene, an ear cushion assembly composed of a soft neoprene foam rubber body, and a diisocyanate foam face cushion. Later models have soft leather covered cushions. If the earcup assemblies are loose and need adjustment, the four shims and two screws contained in the envelope should be utilized to accomplish the lateral adjustment. Proper fit of the earcup is necessary for proper radio reception. The earcups have been designed with a large ear cavity to minimize the possibility of pressure discomfort of the ear. A vinyl film washer is inserted between the earcup and the shell to increase stability of the earcup assembly in the event that the shims are not necessary for lateral adjustment.

Table 13-1.—Visor marking and percentage of light transmittance.

Marking	Percentage of light transmittance
XD1	8 to 10 percent (medium dark)
XXD	6 to 8 percent (dark)
XXX	5 to 6 percent (very dark)
*D	10 to 20 percent
*XD	Under 10 percent

*In the initial quantity of helmets issued to the fleet, these two types of tinted visors were installed.

The communication cord is designed to provide electrical connections between the earphones and the aircraft radio facilities. The molded junction block connecting the four earphone leads to the cord is located in the back left center of the middle section of the cellular polystyrene energy-absorbing material.

The installation of the boom type microphone, when desired, should be accomplished as follows:

Pre-position the boom mike assembly on the side of the helmet. Swing the boom through a full arc to determine the best position for attachment of the mounting bracket. Then scribe the intended position of the bracket mounting holes, drill holes accordingly, and attach. The position will vary with the face shape and personal preference. Boom type microphones are not provided with the helmet assembly and must be ordered individually.

Type H-87A/U earphones are installed in the cellular polystyrene earcups of the ear cushion assembly. Each earphone is connected to the two wires leading out of each side of the molded junction block of the communication cord.

Fitting Technique

To properly use the sizing instrument and fit the APH-5 helmet for optimum comfort and stability, the following instructions should be applied:

Determine the head length. The helmet size and liner thickness are indicated on the horizontal bar. Determine the head breadth. When the head length dimensions provide a choice between two sizes of helmets, the head breadth should be the factor in determining the proper size. If the head breadth is over 6 inches, use the large size helmet with all thick liners (sizing pads). If the head breadth is under 6 inches, use the medium helmet with all thin liners.

After the liners have been inserted, have the pilot don the helmet. The proper way to don the helmet is to place the thumbs over the ear cushions, and pull outward on the helmet; insert the forehead in the area between the thumbs, and complete the donning by rolling the helmet backward until it is positioned satisfactorily.

COMFORT.—If the helmet is not comfortable to the pilot, make the following suggested revisions:

If a thick liner is used in the area affected, substitute a liner of lesser thickness. If the pressure point remains, choose the next larger

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size helmet and use the thick liners in the unaffected area and the thin liners in the affected area. Earcups can be modified slightly by filing a portion of the outer edge of the attaching side away to relieve pressure points and improve comfort.

STABILITY.—To obtain maximum stability, a snug fit is required. It is possible that stability has been sacrificed for comfort in relieving the pressure points. Proper stability can be determined by vigorously shaking the head. Keep in mind that the pilot must be the judge in determining the correct balance between comfort and stability of the helmet.

After the fitting has been accomplished and sufficient flights have been made to determine adequacy of fit, the unused sizing pads, shims, and sizing instruments should be returned to the local supply for reissue. In addition, clear visors that are not being used should be returned to supply for reissue.

Maintenance

There is a minimum amount of maintenance on the helmet, since the pilot keeps it in his possession. On occasions, maintenance such as recementing loose sizing pads, liners, etc., may be necessary. When not in use, the helmet should always be kept in the bag provided.

CHANGING THE VISOR.—Changing the visor on the APH-5 helmet is a simple task, but the following procedure should be followed:

Place the visor in the down position and remove the locking screw from the visor lock (the locking screw has a left-hand thread), then remove the adjustment knob (right-hand thread) and clamping washer. Turn the key assembly 90 degrees and lift out of the track slot, then remove visor from visor housing.

To insert a visor replacement, this procedure is reversed.

CLEANING THE VISORS.—The following procedure for cleaning visors is recommended:

Wash the visor with mild soap and water, using a clean soft cloth. If the visor is still soiled or if it is necessary to remove minor scratches, use polish. Specification MIL-C-18767B polish is used on acrylic plastic. To preserve the surface, use polishing wax for the final application.

REPLACEMENT OF ELECTRONIC EQUIPMENT.—To replace the communication cord, remove the ear cushion assembly from the helmet by removing the screw on each side of the outer shell. The earphones can be disconnected from the wiring harness after the ear cushion proper has been removed from the polystyrene housing. At this point, release the screw engaging the clip and junction plate at the rear portion of the helmet for complete removal of the communication cord.

To replace the communications equipment, reverse the above procedure.

Installation of the Hardman Oxygen Mask Retention Kit

The Hardman 3740 oxygen mask retention kit is provided for attaching the A-13A oxygen mask to the APH-5 pilot's protective helmet. Installation of this kit affords greater retention of the mask and helmet during high-altitude/high-speed bailouts. Instructions for installation are provided with each kit.

OXYGEN MASK AND HELMET MODIFICATION.—Before attempting to install the retention kit, make certain that the oxygen mask and the kit are of the same size. Remove all the straps and the metal yoke from the mask. Cut off the protruding rubber strap attachment loops from the mask. This is done by cutting flush at the mask surface with a sharp knife or a pair of end cutters. Remove the lip strap supporting the sealing flanges of the mask. (The removal of the lip strap is optional for comfort.) Place the stripped oxygen mask in the retainer shield assembly.

Remove the earphone assembly, the oxygen mask leather tabs, and chinstrap from the helmet.

ADJUSTMENT TO PERSONNEL.—Locate a point 1 1/8 to 1 1/4 inches below the end of the visor track and 1 to 1 1/8 inches back of the forward edge of the helmet, as shown in figure 13-2. Drill a 3/16-inch diameter hole at this location.

Place the backing plate on the inside of the helmet and the latch assembly on the outside of the helmet. Insert the long screw with lockwasher into the alined hole from the backing plate. This screw is tightened until friction against the helmet will hold the latch assembly in place. This step is repeated for the opposite side. Reinstall the earphone assembly.

Don the helmet and insert the bayonets to the third notch. Adjust the straps to provide uniform tension and proper positioning of the oxygen mask to the face.

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Adjust the latch assembly by rotating on the screw, either up or down as required, lining up the bayonet centerline with the latch assembly centerline, as shown in figures 13-2 and 13-3. This provides proper distribution of tension required to support the oxygen mask and facilitates proper release characteristics. If tension is evenly distributed between the two straps on either side, the bayonets should release with no binding tendency.

After proper positioning of the latch assembly, remove the oxygen mask and mark or scribe the location of the three additional mounting screw holes. Remove the earphone assemblies, backing plate, and latch assembly, and drill the additional holes 3/16 inch in diameter. Secure the backing plate assembly, and reinstall the earphone assemblies.

Insert the bayonet fittings to the third notch. Tighten the four adjustable straps to provide a snug fit of the oxygen mask. Maintain equal tension on all straps. When the mask has been adjusted for normal wearing, two additional steps for increasing tension are actually available since each bayonet can be tightened independently another notch.

APH-6 PILOT'S PROTECTIVE HELMET

The APH-6 helmet was designed for use by pilots and aircrewmen while flying in fixed wing aircraft.

The APH-6 serves the same function as the APH-5 with the following improvements:

1. An additional size of sizing pad—extra thin—is provided.

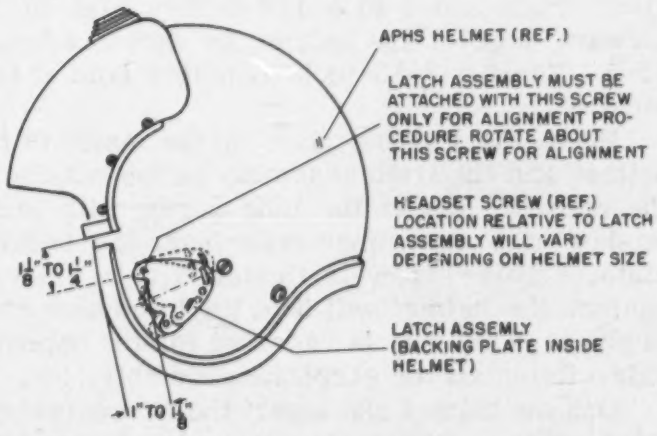

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Figure 13-2.—Alinement of the latch assembly.

2. The oxygen mask suspension system is an integral part of the helmet (the Sierra fitting is built in).
3. Edgeroll is thinner and made of rubber.
4. This helmet comes equipped with the new Shepard visor lock.
5. The visor may be removed without removing the visor housing.
6. The chin and nape strap have coverings for protection of the skin against chafing and for improved comfort to the wearer.

The APH-6 protective helmet is shown in figure 13-4.

The APH-6 is available in medium and large sizes. With modular requisitioning, the basic APH-6 helmet may be updated to the following three present models:

1. APH-6A has the improved visor tracks and earcup suspension.
2. APH-6B has the addition of sonic earcups.
3. APH-6C, dual visor adaptation.

SPH-3B PILOT'S SOUND PROTECTIVE HELMET

The SPH-3B helmet is designated as standard for use by helicopter pilots and aircrewmen. The type SPH-3B helmet is furnished in two sizes, regular and X-large. When properly fitted and adjusted, it provides the lastest in comfort and sound attenuation.

The helmet features a dual visor and provides impact protection and support of terminal communications equipment. The SPH-3B helmet is shown in figure 13-5.

The SPH-3B helmet suspension system (3 crown straps) must be adjusted to allow the head to set as far back as possible into the helmet without interfering with vision and without the crown of the head touching the energy absorbing liner.

All three crown straps, when properly adjusted, should show the same tension when the crown pad is pressed in the center, as shown in figure 13-6.

The earcup tension straps and the chin strap should be adjusted in conjunction with spacers and the sizing pads to produce a secure fit without discomfort. The sizing pads are supplied in four thicknesses (1/4", 1/2", 5/8", and 3/4") and are attached above the nape area. Use one thickness as required and mate the hook and pile tape firmly for a secure installation.

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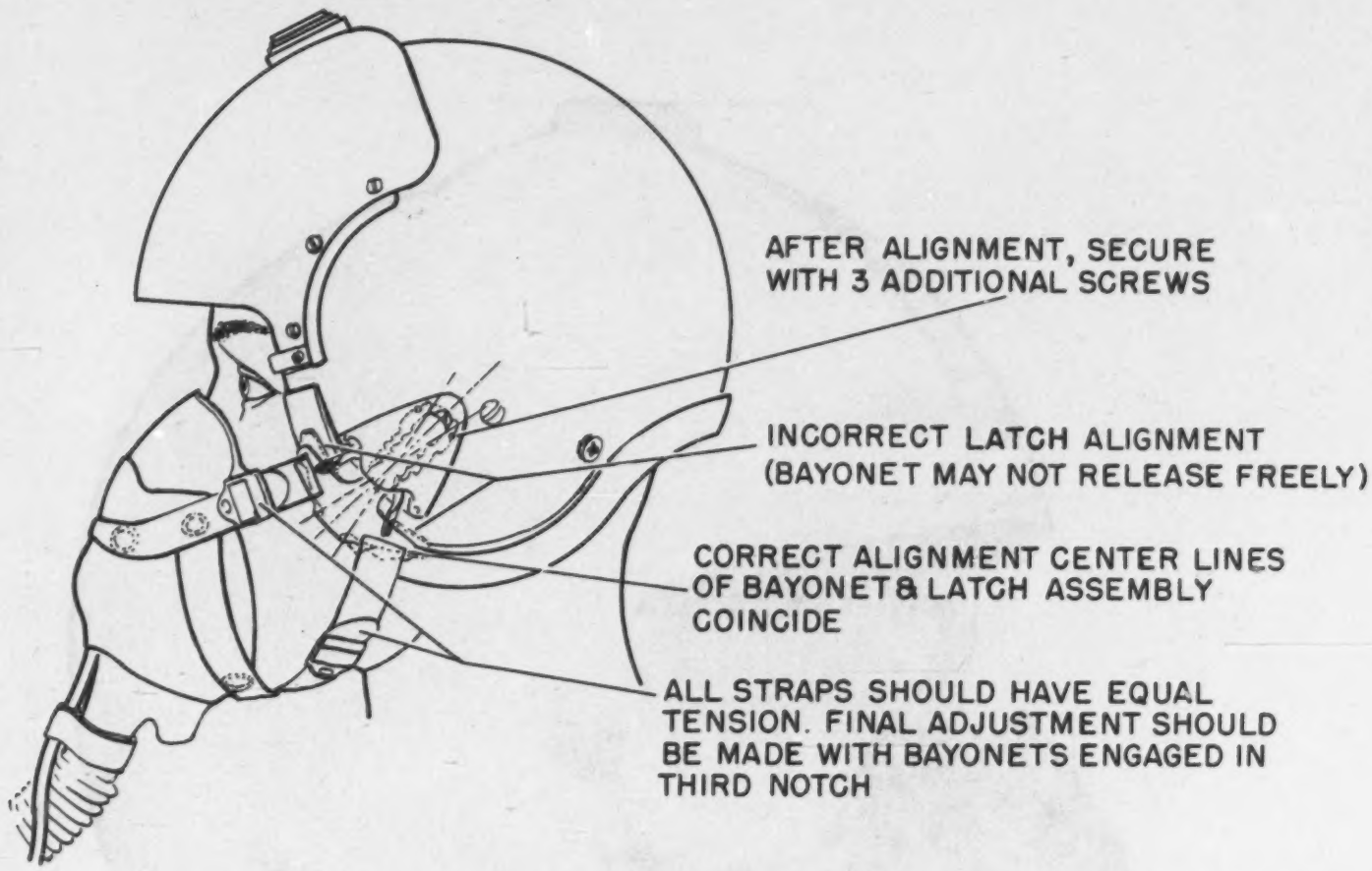

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Figure 13-3.—Alinement of oxygen mask straps and bayonets.

The nape strap may be tightened with the helmet on by pulling on the free end. To loosen, raise the protrusion on the buckle and pull the secured end. Tighten the nape strap to provide a snug fit with the chin strap fastened.

Proper helmet fit and stability can be checked by shaking the head rapidly sideways with the helmet secured as for normal flight. There should be no significant motion between the helmet and the head.

The visors may be locked at any position which suits the wearer, provided that a reasonably close fit is achieved between the visor and the facial contours. The nose indent of the visors may be carefully sanded or filed to adjust to individual contours.

Visor cleaning may be accomplished using a mild soap and water and a soft, clean cloth. For removal or minor scratches, use acrylic plastic cleaning and polishing compound.

OXYGEN MASKS

Oxygen masks are the final link in conveying oxygen from the aircraft system to the user. A satisfactory regulator and oxygen system or a full cylinder of oxygen is of little value to a pilot if his oxygen mask is not operating properly in every respect.

Oxygen masks are pilots' personal equipment; that is; after initial fitting, they are retained by the individual to whom issued. Fitting, adjustments, maintenance, cleaning, and incorporating modifications are the responsibility of the PR.

The important factor to remember about identifying any oxygen mask is its compatibility with the oxygen system with which the mask is to be mated.

Three types of oxygen masks are discussed in this chapter. They are the PRESSURE BREATHING MASK, the DEMAND OXYGEN

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Figure 13-4.—APH-6 helmet (side view).

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Figure 13-5.—SPH-3B helmet.

MASK, and the SMOKE and FULL FACE OXYGEN MASK.

PRESSURE BREATHING MASK

The pressure breathing mask used in the Navy is designated as the A-13A. This oxygen mask is used with composite diluter demand systems, with straight diluter demand systems (with no emergency valve), with automatic positive pressure diluter demand regulators, or with the miniature positive pressure 100 percent demand mask or chest mounted regulator.

The A-13A oxygen masks currently used are satisfactory for flights up to 50,000 feet altitude without regard to service life if properly maintained. The incorporation of the laminate seal (described later) improves fitting and comfort of the mask to the face.

Construction

The A-13A pressure breathing oxygen mask consists of a facepiece, inhalation valves, pressure compensating exhalation valve, microphone cavity, harness assembly, and breathing hose

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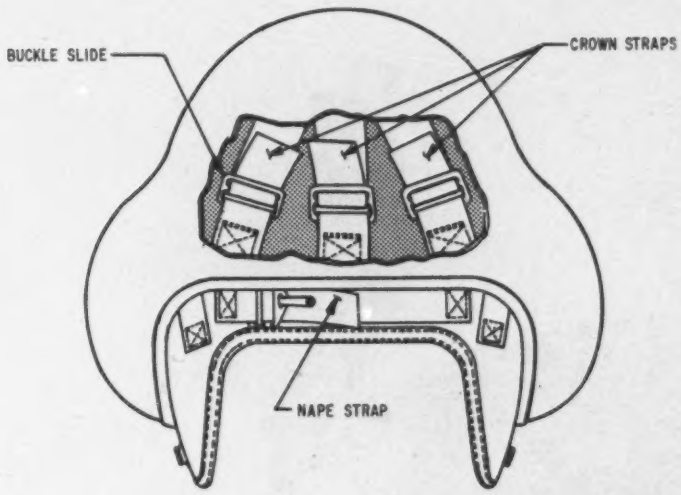

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Figure 13-6.—Suspension system adjustments.

assembly. It has two cheek flaps that protect about half the face.

The A-13A mask is supplied in sizes small, medium, and large. The mask should be selected to fit the facial features of the user.

With the exception of the retention assembly, suspension straps, and laminated face seal, the A-13A mask is molded from Buna-N rubber stock, medium green in color. This stock is compounded to resist mildew and remain flexible at a low temperature.

The A-13A silicone pressure breathing mask is constructed of elastomer materials, has a dark olive color, and is made in three sizes. The A-13A silicone mask has a longer shelf life, contains ozone resistant properties, is free of odor, and causes less facial irritation.

The inner parts and mask components are the same as all A-13A oxygen masks. Due to the make of this mask the laminar seal does NOT need to be installed.

Operation

When a flow of oxygen under pressure is supplied to the mask, the pilot must exhale at a pressure greater than that of the oxygen intake, in order to open the pressure compensated exhalation valve and complete the breathing cycle. Figure 13-7 illustrates the operation of the A-13A mask with the diluter demand system; figure 13-8 illustrates the operation of the mask with the pressure breathing system.

The inhalation value assembly is composed of a plastic valve seat, silicone flapper, silicone valve gasket, and plastic cover. The oxygen passes through an inlet hose attached to the inlet port of the mask. The oxygen is then fed through the inlet port to the interior of the mask through two inlet ducts, one on each side of the mask. The inhalation check valves prevent the exhaled air from passing back through the inhalation ducts of the facepiece. A plastic cover eliminates the collection of moisture around the valve where it may freeze under extremely cold conditions and directs the flow of incoming oxygen within the mask.

The pressure compensating exhalation valve (fig. 13-9) fits into the exhalation valve cavity of the mask and the valve stem extends through an opening in the wall that separates the exhalation port housing and the inlet tube. This arrangement permits the open end of the valve stem to be exposed to the oxygen as it passes from the inlet port into the facepiece. The stem of the exhalation valve brings oxygen pressure to bear against the lower side of the compensating diaphragm (15). This pressure, plus the pressure of a calibrated spring, causes the diaphragm to close the valve. In this position, no oxygen can escape from the facepiece.

As the pressure in the facepiece is increased against the main diaphragm (10), because of exhalation of the wearer, the combined pressure in the inlet port and the calibrated spring is overcome, and the valve opens. Exhaled air (9) escapes from the exhalation port at the bottom of the facepiece. The valve is constructed so that a pressure of only 1 millimeter of mercury greater than that of which is being supplied by the regulator will force it open.

Microphone Installation

The ANB-M-C1 microphone used with the oxygen mask is drawn from supply by the pilot at the time he draws his oxygen mask and other personal flight gear. The original installation of the microphone is the responsibility of the PR. The repair of any reported malfunctions and modifications is the responsibility of the avionics division and is to be performed by electronics technicians.

Before installing the microphone, disassemble the mask and clean the facepiece and corrugated hose in a solution of mild soap, Specification MIL-C-18687 and warm water.

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standby it is reduced to 65 volts when the high voltage is applied to the modulator.

IMPEDANCE MISMATCHES

The function of the radar antenna system is to direct the RF energy pulses from the transmitter to the antenna array, radiate this energy in a directional (or nondirectional in some applications) beam, receive the returning echo, and direct it to the receiver with a minimum of signal loss. The radar antenna system includes the RF transmission lines (couplers, junctions, rotating joints, radiating collector array, and protective devices) from the transmitter and receiver to the antenna array. To insure efficient performance with minimum loss, the antenna systems are carefully engineered and must operate within specified limits. Improper coupling between RF lines and the antenna or transmitter, for instance, may produce an impedance mismatch resulting in a high voltage standing-wave ratio (VSWR) and a general reduction in system performance.

The VSWR is measured to insure that the ratio of the power transmitted by the magnetron to the power reflected back along the transmission line is within the specific limits. Any discontinuous change along an RF line, such as a sudden change in dimensions, a change in geometry introduced by a sharp bend or dent, or an obstacle in the line will produce a mismatch resulting in a high VSWR.

If trouble in the RF transmission line (between the magnetron and the antenna) is indicated, adjustment of the magnetron tuning control should be made observing whether this improves the VSWR. If it does not, then determine if the trouble is on the antenna or transmitter side of the antenna switch (duplexer) in the following manner: With the magnetron operating into a dummy load, observe the VSWR. No marked improvement indicates that the trouble is on the magnetron side of the antenna switch, while a marked improvement indicates that the trouble exists on the antenna side. If an increase was noted in the VSWR, check the RF transmission lines for any of the common causes listed below, and for any other damage which might have occurred. Check the antenna also, since any bending in the antenna array could change its impedance and result in an increased VSWR.

Many RF transmission-line faults are visible and easily located; however, in some cases the trouble may be of such a nature that the defective part can be found only by making special tests.

Some of the most common causes of an excessive high VSWR are:

1. Moisture in the RF line.
2. Dented or bent line.
3. Burrs or poorly soldered joints.
4. Defective coupling joints.
5. Defective or distorted rotating joints.
6. Mismatched antenna.

TRANSMITTER SAFETY DEVICES

Generally, transmitter protection is present in four areas of the transmitter. These areas are the magnetron filament control circuit, modulator high voltage control circuit, transmitter overload circuit, and transmitter metering circuit.

Magnetron Filament Control Circuit

The purpose of this circuit is to allow the magnetron filament to reach the proper operating temperature prior to the application of a high voltage pulse from the modulator. The circuitry may vary from the simple time delay relay to the complex circuitry of some radar sets.

Modulator High-Voltage Control Circuit

In case of interlock failure or overloads, the primary power control is driven beyond the minimum voltage position which in turn opens a safety limit switch and the modulator voltage is removed.

Transmitter Overload Circuit

This circuit is designed to remove modulator primary power when either an excessive modulator current exists or whenever excessive reverse current flows through the reverse current relay. A manual reset circuit restores the operation of the transmitter.

Transmitter Metering Circuit

This is a visual safety system which indicates by lights and meters, magnetron filament voltage, magnetron plate current, modulator current, transmitter overload, operation of the

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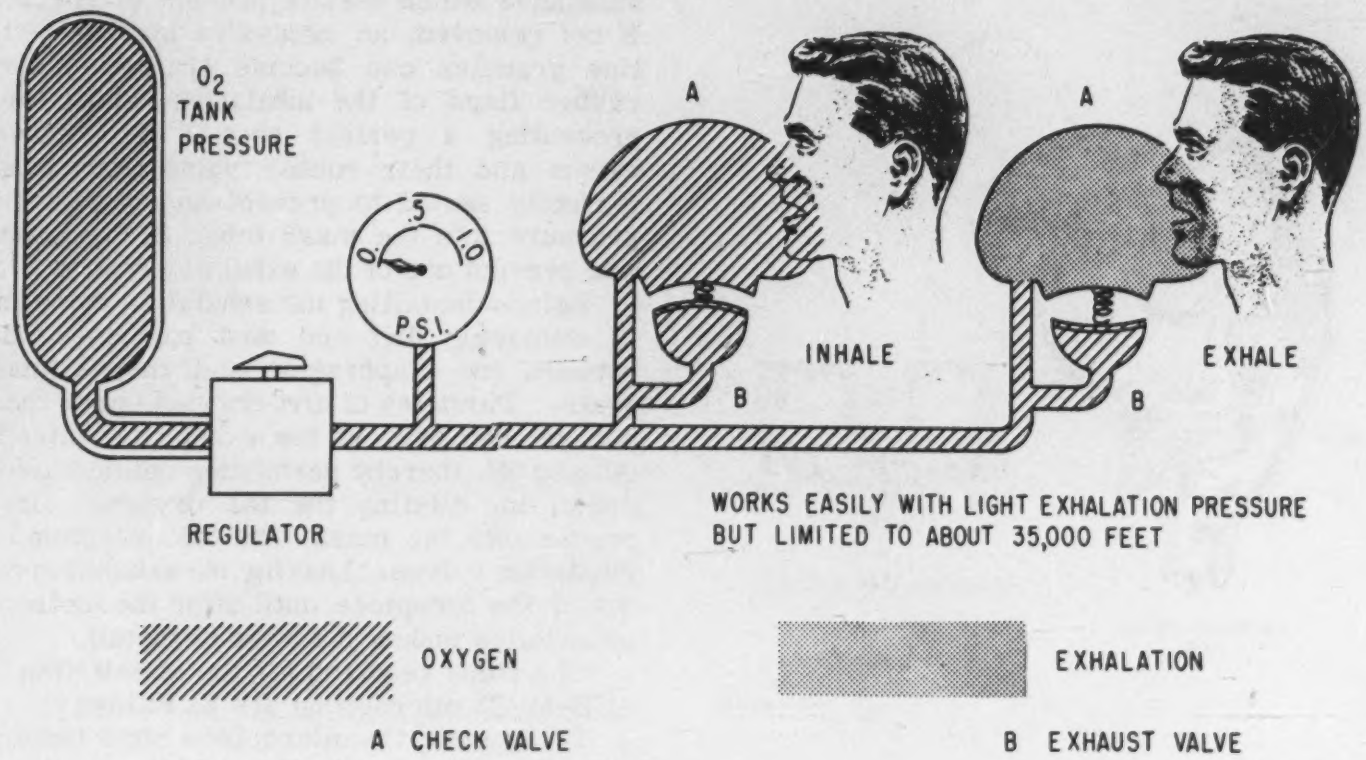

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Figure 13-7.—Operation of the A-13A oxygen mask with the diluter demand system.

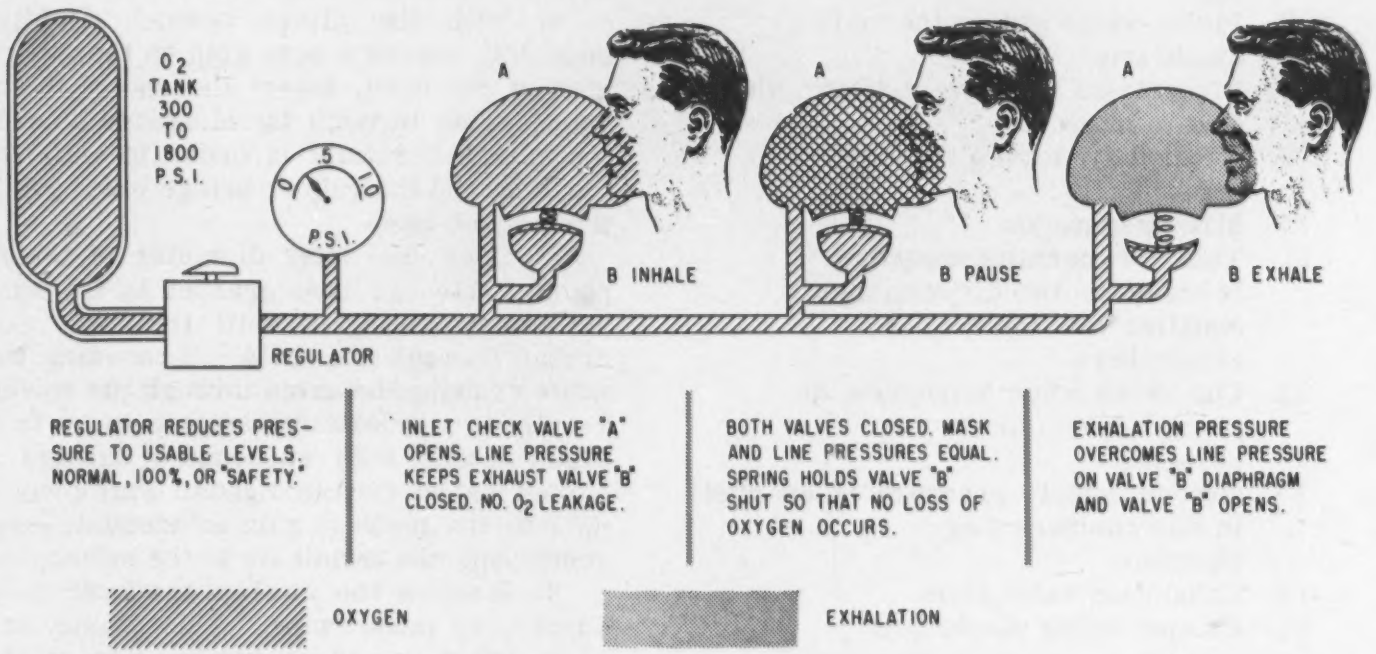

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Figure 13-8.—Operation of the A-13A oxygen mask with the pressure breathing system.

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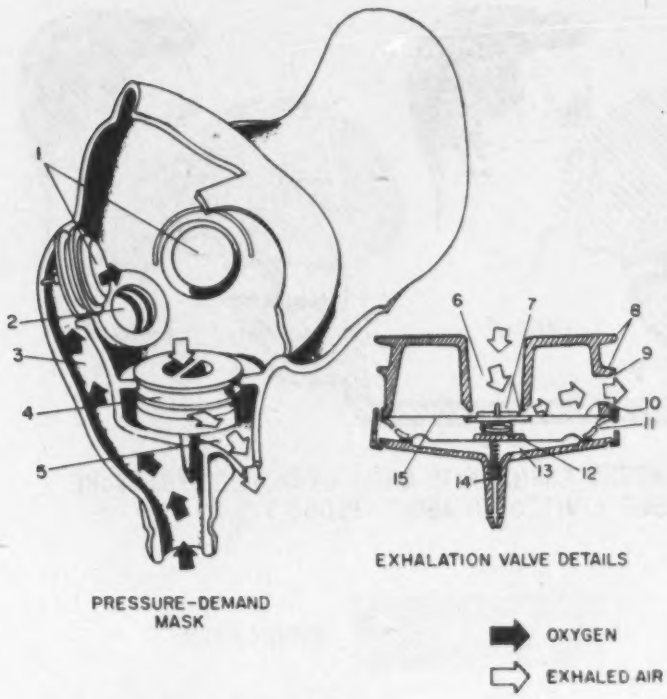

1. Inhalation valves.
2. Microphone cavity.
3. Inlet port to mask.
4. Pressure compensated exhalation value.
5. Outlet for exhaled air.
6. Exhaled air enters exhalation valve here.
7. Plates which stiffen the main diaphragm.
8. Projections on valve housing which seat in mask.
9. Exhaled air leaves the valve here.
10. Main diaphragm.
11. This port permits pressure between the two diaphragms to equalize with the outside atmosphere.
12. Cup which holds hairspring in place between the two diaphragms.
13. Oxygen supply pressure is exerted in this compensating chamber.
14. Exhalation valve stem.
15. Compensating diaphragm.

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Figure 13-9.—Cutaway of pressure-demand mask and exhalation valve details.

Remove all traces of any white granular substance which may be present in new masks. If not removed, an excessive amount of these tiny granules can become trapped under the rubber flaps of the inhalation valves thereby preventing a perfect seat. The inhalation valves and their rubber valve flaps must be perfectly seated to prevent an equalizing back pressure into the mask tube. Such a condition will prevent use of the exhalation valve.

Before installing the exhalation valve, clean it, removing dirt and dust particles that lie between the diaphragms and their contacting seats. Particles of dirt trapped under the diaphragm can prevent the exhalation valve from closing off, thereby permitting outside air to be drawn in, diluting the the oxygen. Dry and reassemble the mask with the exception of the inhalation valves. Leaving the inhalation valves out of the facepiece until after the microphone is installed makes it easier to install.

The steps required for the installation of the ANB-M-C1 microphone are as follows:

1. Remove the microphone cord "hole plug" by pulling it out at the front of the mask. Lubricate cord with soap solution.

2. Pass the microphone cable through the rubber guide at the front of the mask.

3. Insert tapered long nose pliers through mike cord hole from the inside of the mask; tips of the pliers must show at least 1/8 inch beyond the outside edge of the hole.

4. With the pliers opened slightly, just enough to permit a sure grip on the outer diameter of the cord, insert the end of the microphone cable through the elongated hole. Handle the pliers carefully in order to avoid tearing the hole and the rubber bridge piece joining the inner mask lips.

5. Once the outer diameter of the microphone cable has been grasped by the pliers, do not loosen the grip until the cable has been drawn through the hole. Loosening the grip while drawing the cable through the hole usually results in a second unseen grip on the frail terminal wires with subsequent damage to the cables and/or terminal ends. Pull enough cable up into the mask to gain an adequate length for connecting the terminals to the microphone.

6. Remove the microphone from its plastic adapter by unscrewing. This plastic case and case cover are of no further use as they are not inserted into the microphone cavity of the oxygen mask. Remove the three connections from the back side of the microphone.

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7. Attach the wire terminals to the microphone with the lockwashers beneath the terminals.

8. After the terminals have been connected, draw the mike down to its cavity in the forward position of the oxygen mask. Do not pull the cord abruptly, and stop the pulling action when the mike is flush with the rim of the cavity.

9. Using a blunt instrument (such as a pencil eraser), work the mike into its cavity slowly and progressively. CAUTION: Do not press on plastic portion of mike, press on metal edge. When a part of the mike has been entered into its seat, pull out more of the surplus cable. When doing this, be careful not to break the terminal connections. Completely seat the mike in its cavity.

10. Being exceptionally careful, pull out all the remaining surplus cable and remove the slack between the guide and where it emerges from the hole.

11. Replace the inhalation valves and covers, making certain that the arrow on the covers are pointing downward. If the inside surface of the plastic covers have not been scored, preventing the rubber valves from sticking to them, comply with the latest NavAirSysCom publication referencing the modification. All newly manufactured inhalation valve covers will already be modified, making the field change unnecessary.

12. Place the oxygen mask to your face and check for leakage around the hole where the microphone cable enters the mask. Test the breathing action of the mask on a mockup system, using safety pressure.

13. Have the installed microphone BENCH CHECKED by the avionics division, making certain that it will work properly.

Testing and Inspecting A-13A Mask

PREFLIGHT TESTS.—Preflight tests should be made to establish the security of all parts, with special attention given to the inlet check valves and exhalation valve. The plastic shields must be scored on the inside and be snap seated over the inlet valves.

The inlet valves and exhalation valve must be free from dirt and dust particles. A preflight test should be made just prior to each flight by attaching the mask to the pressure-demand regulator installed in the aircraft. The operational check should be under both demand and pressure-demand conditions. In the event any difficulty is encountered, the oxygen mask should be replaced.

Check the mask for fit and minimum mask leakage in the following manner:

1. Adjust the mask securely in place and connect the mask to the regulator breathing tube.

2. With the oxygen system turned on, place the regulator safety pressure selector lever in the ON position. Induce a severe outboard mask leakage by placing two fingers under the mask sealing surface (cheek flaps) and observe the flow indicator. It should remain in the FLOW position.

3. Reposition the mask on the face and after a few respirations, hold the breath and again observe flow indicator. If there is no mask leakage, the flow indicator will remain in the NO FLOW position. If there is any leakage, the flow indicator will assume the FLOW indication position.

4. Adjust the suspension straps until the leakage is stopped.

5. Return the safety pressure selector lever to the OFF position and continue with flight preparations.

MASK HOSE AND FITTING LEAKAGE TESTING.—Affixing the mask assembly to the face with the helmet in place and, using the mask suspension, adjust the strap for a snug comfortable leaktight fit. Attach the MC-3A connector to the oxygen supply and set regulator on 100% oxygen with supply valve off. Inhale sharply and deeply, and hold the inhalation (keep inhaling) as long as possible. If there is no inboard leakage, you will not be able to inhale.

TESTING VALVE ASSEMBLIES.—With both inhalation valves and the compensated exhalation valve installed in the mask assembly, place a clean smooth rubber stopper (size No. 1), in place of the MC-3A connector and perform the following tests:

1. Inhalation Valve: Holding the mask close to the face, but not completely sealed to the face, inhale deeply and then immediately press the mask to the face forming a tight seal and forcibly exhale through the exhalation valve. If the inhalation valves are not closing (sealing) properly, the exhalation valve will not open. If the inhalation valves are seating properly, the exhalation will be smooth and with minimum resistance.

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2. Exhalation Valve: Place an obstruction (rubberband or equal) under the rubber flapper of one of the inhalation valves in a manner to prevent it from forming a seal. Repeat the testing procedure as described in test No. 1. If the exhalation valve is functioning properly, it will not open when the subject exhales, and exhalation through the valve will not be possible.

Installation of Laminate Seal

This modification must be accomplished on all A-13A oxygen masks, (excepting the silicone type). If a pilot specifically requests the adaptation of the seal on a silicone mask, special silicone cements must be used.

This modification on the A-13A oxygen mask is accomplished as follows:

1. Thoroughly roughen the sealing surface of the facepiece with emergy paper or any other suitable abrasive.

2. Apply an even, medium coat of cement to the rough side of the laminate and to the surface of the mask previously roughened. NOTE: The container of cement should be tightly sealed when not in actual use.

3. Determine the approximate centerline of facepiece sealing surface and centerline of laminate.

4. When applied cement feels tacky, lightly lay the upper nose of the laminate and the mask sealing surface in such a manner that the points of the respective centerlines coincide. Care should be exercised so that the rest of the tacky surfaces do not contact each other until symmetrical alinement is obtained.

5. After alinement is assured, lay the laminate and press tightly against the facepiece and allow to dry thoroughly (approximate drying time 24 hours).

NOTE: If laminate is not positioned correctly, or if a wrinkle has developed in laminate, strip laminate from facepiece. Clean facepiece with solvent and repeat, using a new laminate.

Installation of Mask-Mounted Regulators

In today's high performance aircraft, space and weight are vital factors. One method of solving these problems is through the miniaturization of 100 percent demand oxygen regulators.

It is the Aircrew Survival Equipmentman's responsibility to make certain that these regulators and oxygen masks are installed properly.

Miniature oxygen breathing regulators are mask or chest mounted and used both in flight and bailout or emergency condition. The various types of mini regulators are installed on the A-13A oxygen mask as follows:

1. Firewel 1732 and the Bendix regulator may be mask mounted by disconnecting the corrugated mask tubing from the A-13A mask.

Remove the clamp, tubing, and fiber insert from the mask inlet port.

Connect the oxygen hose to the oxygen inlet port of the regulator, inserting the outlet of the regulator into the mask inlet port. Clamp the regulator to the mask with the hose clamp and replace microphone wire.

2. Firewel 2700 and the Robertshaw-Fulton regulators, mask mounting.

Disconnect the corrugated mask tubing from the A-13A mask, removing the clamp and tubing. Remove the fiber insert from the mask inlet port and connect the oxygen inlet port of the regulator. Install the small end of the elastometer on the regulator pickup tube.

Move the regulator toward the oxygen inlet of the mask and connect the large open end of the elastometer to the exhalation valve pickup tube, making certain these two parts mate.

Position the regulator into the mask inlet, and replace the clamp and microphone wire.

3. Firewel 2700-15M, Robertshaw 226-20004 and 226-20004-3 mini regulator chest mounting.

Loosen the Tinnerman clamp and remove the MC-3A fitting. Thread the locknut (TRU-SEAL) to the redar hose. The Teflon face of the locknut should face the end of the male threaded fitting.

Insert the regulator into the mask hose and tighten the clamp. Insert the redar hose into the regulator.

4. Bendix Regulator 29211C1 and 29211B1 may be mounted by loosening the Tinnerman clamp and removing the MC-3A fitting.

Thread the locknut (TRU-SEAL) to the redar hose. The Teflon face of the locknut should face the end of the male threaded fitting. Screw the right angle elbow into the regulator, positioning the female portion of the elbow so that it is alined with the axis of the regulator.

Insert the regulator into the mask hose, tighten the clamp, and insert the redar hose into the regulator.

After installing any of the above mentioned regulators, the PR must check and test each unit for proper security and operation before issuing them to flight personnel.

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Safety precautions to be observed when working with oxygen masks and regulators are as follows:

1. Handle all miniature regulators with care.
2. Never connect the regulator to an inlet source greater than 90 psi.
3. Clean regulators with only the approved cleaning solvents or solutions.
4. Remove miniature regulators from masks and bench test every 60 days.

DEMAND OXYGEN MASKS

The A-14A oxygen mask should be used with a demand system not having safety pressure features. It is designed to supply adequate oxygen even during bodily exercise in extreme cold in altitudes up to 37,500 feet. With added precautions adequate oxygen is supplied to 40,000 feet if the mask is correctly fitted.

The A-14A mask assembly consists of a mask body which completely covers the nose and mouth. It is fitted with a rubber exhalation valve of the flutter type. The adjustable straps of the suspension harness are arranged differently in comparison with the pressure type mask. The corrugated mask tube is equipped at the opposite end with a single male connector fitting. Regular snap fasteners (not the three-way snap type) are provided for attachment of the mask harness of the helmet.

The microphone is installed in a cavity similar to that in the pressure mask. Since it was not designed to hold pressure, there are no inhalation valves installed in the open ports of the A-14A mask. The exhalation valve is very simple in construction and is designed to prevent air from entering the mask upon inhalation. This means that the rubber flapper is located on the OUTSIDE of the valve.

A rubber cover, or protector, for the inhalation ports is secured to the inside of the facepiece. It is designed to prevent moisture from entering the ports and/or to prevent the formation of ice in the same vicinity.

There are no inner lips in the A-14A. The exhalation valve, seated in the bottom of the mask, permits exhaled air to flow out of the mask through two ports, one on each side of the mask exterior. One of these ports is larger than the other. The larger one allows inspection of the outer portion of the flutter valve and seating of the valve proper.

The exterior microphone cable duct on the A-14A mask is different from the cable duct on the pressure type. In order to insert the cable in the cavity, the tip of the projecting smooth molded cable duct must be cut off. In doing this, care must be taken not to cut off too much of the tip. Removing an excessive amount of duct will result in a hole too large in diameter to adequately seal itself around the cable.

The A-14A mask is available in four sizes—large, medium, small, and extra small. Maintenance of the A-14A is similar to that given for the A-13A in the preceding section.

Smoke and Full Face Oxygen Mask

This mask is replacing the A-14A oxygen mask in some types of aircraft. The operating principles of the mask are the same as the A-14A. The main difference is that the smoke mask has a full facepiece that completely covers the face. Maintenance of the smoke and full face oxygen mask is similar to that given for the A-14A and A-13A.

CLEANING OF OXYGEN MASKS

Cleaning of oxygen masks must be accomplished as often as service conditions require but not less than once every 2 months. The A-13A (silicone) cleaning must not be less than once every 3 months. After disassembling all removable components, throughly inspect each part for serviceable condition. Use the cleaning compound, aircraft surface, MIL-C-18687.

With the proper mixture of 1 1/4 ounces of liquid compound to 1 gallon of warm potable water, wash the mask facepiece using a clean soft gauze pad or brush. After all surfaces have been wiped or brushed, submerge the entire mask in the cleaning solution and agitate throughly.

NOTE: Do not use alcohol in any form to clean the mask; do not use any flammable solvents or toxicant liquids for cleaning.

Using the approved cleaning solution, wash all mask parts and components with a soft gauze pad or brush. The microphone and MC-34 connector must be cleaned with a damp gauze pad only.

Rinse all parts, after washing with the cleaning solvent, in clean, cold water. Cold water tends to form beads and is easily shaken off. Dry the mask and accessories, selecting a well-ventilated place.

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Do not hang the mask in sunlight, and do not use compressed air or oxygen to blow masks dry. The ideal storage temperature is 70° Fahrenheit.

After the mask and all components have dried, assemble the complete oxygen mask and thoroughly test the unit for serviceability.

Sanitizing (Disinfecting)

Oxygen masks that are not on a personal issue must be sanitized after each use, using the solutions discussed in the following paragraphs.

Use 1/4 pint of thimerosal as issued; this is a 1.1000 solution of clear merthiolate and distilled water. Add 25 drops of 10 percent concentration of benzalkonium chloride (MIL-B-36021) to 1 quart of potable water.

Moisten a gauze pad with the solution, squeeze to prevent dripping, and wipe out the interior of the mask exclusive of valves and the microphone.

Wipe the valves and microphone with a clean dry cloth. Place the cleaned, RFI oxygen mask in a bag for reissue.

Safety Precautions

Observe the following safety precautions when working with oxygen masks:

1. Never use a screwdriver on any mask part except the hose clamp.
2. Always use the proper cleaning compound MIL-C-18687 and potable water.
3. Never use oil or grease around oxygen masks.
4. When inspecting an oxygen mask, remember that a life depends on your work.

CHAPTER 14

FLIGHT CLOTHING AND PROTECTIVE EQUIPMENT

In keeping pace with the demands of new developments, articles of clothing worn in flight are becoming more complex. The simple coveralls (light and heavyweight) are used daily in moderate speed and low-altitude flight; however, the conditions experienced during high-speed and high-altitude flight have demanded more than a simple warm covering for the body. Consequently, the nature of flight clothing is progressing into a more overall protective stage which guards against sudden losses of cabin pressure and also maintains an oxygen pressure range necessary to life.

Besides protection from moderate to severe temperatures there are other more complicated elements and conditions to be considered. The attainment of recent higher speeds and higher altitudes has added greater problems to man's efforts to cope with the elements. To combat the danger of a sudden loss of cabin pressure (explosive decompression) and to extend the limit of high-altitude flight, the doctors and engineers of medical research have developed a full pressure suit.

The full pressure suit is designed to enclose the entire body. Its function is to provide 100 percent delivery of oxygen under a slight positive pressure for breathing and also air combined with pressure and temperature control to permit flights in the upper regions hitherto unattainable.

Another item is the antiexposure suit which is worn on all overwater flights in cold regions. The outer rubberized forms of the suit, gripping snugly around the wrists and neck, prevents water from contacting the body. An insulated liner worn close to the body provides the necessary warmth. Without a fully equipped antiexposure suit, a man could not survive in water colder than 32° F. The low limit for a 4-hour exposure with full equipment is about 45° F, and generally antiexposure equipment is required in areas where water temperatures are 59° F and lower.

This chapter is not designed to introduce all of the available articles of flight clothing and protective equipment, but offers instructions on fitting and adjusting those items which need special attention in their initial servicing. The protective helmet must be equipped for stability and be made adaptable to the oxygen mask.

In the initial fitting of clothes, the decisions revolve around the correct choice of fit, which is that of selecting the proper size. However, everyone's measurements do not conform with standard size requirements. In naval aviation, it is the PR's job to make flight and protective clothing fit as nearly perfectly as possible.

Occasionally, pilots and aircrewmen request that additional pockets or slings be incorporated in their flight clothing. However, the practice of arbitrarily attaching a sheath knife to the trouser leg of a flight suit might later endanger a smooth and uninterrupted egression. In addition to the possibility of hampering an individual's movement during escape the suspension lines of the opening parachute might foul in the sheath if it has not been attached properly.

Whatever the requests for modifying flight clothing might be, there are four basic factors which must be considered: First, the weather and climatic conditions under which the article will be used; second, the fit of the clothing, since the comfort element depends not only on the type of clothing but also on the proper fitting; third, appropriateness and safety of the modifications in relation to the purpose of the garment; and finally, the authority for the change.

FLIGHT CLOTHING

It is the responsibility of the PR to keep on hand and issue to pilots and crewmen many

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varied articles of flight clothing including flight suits, flight jackets, boots, gloves, antiexposure suits, full-pressure suits, and many other items of survival equipment.

FLIGHT SUITS (NOMEX)

The "Nomex" summer flight suit is a light weight high-temperature resistant flight suit made of polymide synthetic fabric. The color of the suit is olive green.

The Nomex suit never has to be treated or retreated with fire retardant compounds. This suit will not support combustion and will not melt or drip. It is a durable flight suit and is easily washed and dried. Chlorite or hypochlorite bleach should not be used when laundering. The bleach does not affect the fire retardancy of Nomex but over a long period of time has degrading effect on the material.

For cold weather flights, a two-piece winter type flight suit has been developed. This winter flight suit is made with a nylon cloth face, backed with dacron pile, and lined with a fire-retardant cotton fabric. The suit does not protect an individual who is submerged in cold water; however, it should be worn under the Mk 4 antiexposure suit.

FLIGHT JACKETS

The intermediate leather flight jacket is chocolate brown in color and has knitted wristlets and waistband with a moth repellent treated mouton processed sheepskin collar. It has a slide fastener closure, is nylon lined, and is available in seven sizes—36, 38, 40, 42, 44, 46, and 48.

BOOTS

Proper boots or shoes play a vital part in maintaining safety, efficiency, and comfort in any climate. Boots or high top service shoes are usually preferable for use in a survival situation. They afford greater protection from sand and insects, provide more support for walking, and are less likely to be lost during bailout than low quarter shoes.

It is the responsibility of the PR to acquaint himself with all types of flight clothing and especially shoes and boots. This will enable him to use good judgment when teaching aircrewmen as to the best methods and equipment for any emergency situation.

GLOVES

The indoctrination of flight personnel in the proper use of gloves and mittens is also an important responsibility of the PR in charge of personal equipment. Flight personnel should be made to realize that the fingers and hands are more vulnerable to frostbite than any other part of the body, and that frostbite usually results in amputation of the injured extremity. Frequent reference to NavWeps 00-80T-56, Survival Training Guide, will give a background in survival training which will enable the PR to assist with almost any situation.

REQUISITIONING

Requisitioning of flight clothing and protective equipment is a function of the supply officer. Naval and Marine Corps student pilot personnel, naval aviators, naval flight officers (including navigators, controllers, and radar), and flight surgeons in a flight status are eligible to receive any or all allowed items of flight clothing and protective equipment, not to exceed one complete outfit.

One complete outfit of flight clothing consists of the following:

1. Boots, safety flying, for issue to student pilots entering preflight training program.
2. Compass, wrist.
3. Computer, navigation, mark 8 type.
4. Coveralls, anti-g.
5. Coveralls, cotton twill for issue to student pilots when commencing pilot training.
6. Coveralls, landing signal officers', issued to personnel who have been assigned that duty.
7. Coveralls, flying, Nomex.
8. Glasses, sun.
9. Glovers, flying, leather, summer, Nomex.
10. Gloves, winter.
11. Goggles, sun.
12. Headset assembly, radio.
13. Helmet, pilots' protective.
14. Jacket, flight, leather, intermediate.
15. Jacket, flying, very light summer.
16. Kit, signal light, landing signal officers', for issue to landing signal officers.
17. Knife and sheath.
18. Mask, oxygen.
19. Microphone, oxygen mask, with cord and plug.
20. Parachute torso harness assembly.
21. Shroud clutter.

22. Wand, taxi guidance, for issue to landing signal officers.

The above articles of equipment are carried by the supply officer or delegated to an officer in charge of a flight clothing pool. Issues are made directly to the individual concerned and the supply officer or his representative makes an entry in the appropriate columns of the "Flight Clothing Record" of the Aviators Flight Log Book, OpNav Form 3760-31.

When the person is relieved of duty involving flying, he must turn in to the supply officer any flight clothing in his possession. If an article of flight clothing becomes unserviceable for any reason such as damage, wear, or other deterioration, it may be turned into the supply officer or the flight clothing pool and exchanged for a serviceable item.

If any item is lost or missing for any reason, the person charged with custody of the item is required to furnish a Survey Request Report and Expenditure (NavSup Form 154) for the missing item.

Winter flight clothing and flight clothing for nonpilot crewmen are the responsibility of the parachute loft and must be maintained in accordance with the allowances listed in the Section H Allowance List.

Requisitioning of these items is usually made by the senior PR or by another PR designated to handle stores for the aviation equipment division.

Defense Department Form DD 1348 is used by aviation activities both ashore and afloat to requisition material. It is available in card form for mechanized supply activities and in 2-, 4-, and 6-part, interleaved sets for nonmechanized use. Local requirements determine the number of copies to be prepared at nonmechanized activities. Each item of material must be requisitioned on a separate form.

RECORDS AND REPORTS

Records are important for proper accountability of flight clothing and protective equipment, as well as other materials which are assigned to the parachute loft for reissue on a subcustody basis. Other records which must be kept are logging of inspections, recording of modifications, repairs, and changes to flight clothing, protective equipment, and other survival equipment. These include Parachute Record Cards, Parachute History Cards, liferaft inspection data cards, and static load tests of safety belts and shoulder harness. These records are subject to inspection at any time by higher authority and should be kept accurate and up to date at all times.

FLIGHT CLOTHING MAINTENANCE AND REPAIR

Part of the PR job is maintaining pilot's and aircrawmen's flight clothing in a serviceable condition. This requires a good basic knowledge of the principles involved in tailoring. PR's are not expected to construct a suit of clothing from a bolt of material, but are expected to be able to make repairs and alterations to most of the available flight clothing.

What are the basic principles involved in tailoring? The first and major requirement is knowing how to sew by machine as well as by hand. Second, knowledge of the materials used and the construction of the garment in need of repairs is necessary in order for the PR to properly analyze the scope of damage and the steps to be taken in making the repair. Third, he must have the ability to apply this knowledge, which can be accomplished only by practice and experience.

There are many shapes, sizes, and types of clothing which may require repairs. It is therefore impossible to learn everything about tailoring from a textbook. The best procedure is to practice at making patches on scrap material as well as replacing a sleeve or collar on an old garment. In this way, one may become proficient at making neat, durable, and proper repairs.

Flight clothing is rarely damaged to the extent that a yoke or piece in the suit has to be replaced. The most common damages are ripped seams and small tears in the material, both of which are easily repaired. Stitching a seam or applying a small patch is no great task; however, the same principles regarding the similarity of materials apply here as well as to the parachute. Always strive to use identical materials regardless of the type of repair.

WARNING: When making an alteration or repair, do not stitch through electrical wiring, rubber bladders, or other similar appendages incorporated in certain types of clothing.

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HAND SEWING

Handstitching is seldom done by a PR but there will always remain a need for a hand-held needle application of stitching. Machines are not always readily available and often lack the flexibility inherent in handstitching. Many areas still exist in which the handstitch is the best approach to a repair or on assembling step. Realizing these possibilities, a PR should know how to make and where to use a number of the fundamental handstitches.

CLEANING OF FIRE-RETARDANT TREATED FLIGHT CLOTHING

For light or moderately soiled flight clothing, an automatic washer of the type found in the home, aboard ship, or commecrial laundry may be used. Any commercial detergent available may be used with fresh water. If salt water is used, salt water soap "Igepon T" or some other salt water detergent must be used. In neither instance is a bleach or alkali builder required.

Flight clothing heavily soiled with oil and petroleum type grease stains must be immersed in a container of clean Stoddard solvent and agitated for approximately 15 minutes. It is then air dried and laundered as for light or moderately soiled garments. If Stoddard solvent does not remove the stain, the following solution should be prepared and used:

Mix one part of solvent emulsion grease cleaning compound conforming to Specification P-C-576A (type I) with 5 parts of Stoddard solvent and agitate. Immerse the garment in the solution and agitate for 15 minutes. Remove the garment from the solution and wring it dry. Rinse the garment for 3 minutes in fresh water at 176° ±5° F and wring dry. It is then immersed in a solution of sufficient washing machine compound conforming to Specification MIL-C-5543 and water to make a watery solution (approximately 1 pound of washing machine compound to 4 gallons of water). The solution is heated to 140° ±5° F, and the garment is then agitated for 15 minutes, removed, and wrung dry. Rinse it for 3 minutes in fresh water at 176° ±5° F, and wring dry. Air dry the garment and launder in soap and water.

NOTE: Stoddard solvent evaporates rapidly and should be used in a well-ventilated area away from all open flames. Avoid prolonged inhalation.

PROTECTIVE EQUIPMENT

Included in this category are the full pressure suit, torso harness suit, anti-g suit, anti-exposure suit, arm retention sleeves, life preservers, and survival kits and related equipment. Many of these items are used in conjunction with a seat ejection system. Although the PR is not responsible for ejection system maintenance, he should be familiar with the principles of operation and understand how certain items of protective equipment are related to the ejection system. A brief description of a typical system is therefore given in the following paragraphs.

EJECTION SYSTEMS

Seat ejection systems currently used in naval aircraft are designed to provide safe escape from the aircraft at all altitudes and speeds. The system described here is used in the RA-5C series aircraft. The Martin-Baker system, used in a number of other aircraft, is described in chapter 8 of this manual.

The RA-5C ejection system consists of the following main components: seat bucket and carriage assembly, an electrical seat adjustment system, a ballistic system, a seat propulsion system, a seat stabilizing chute system incorporating a stabilizing chute separation system, a body positioning and retention system, a seat-man separation system, an integrated harness system, and a survival kit which includes the emergency oxygen supply system, LR-1 raft, and emergency equipment.

The composite disconnect shown in figure 14-1 (A) provides for the connection of pressure suit ventilation air, oxygen, anti-g suit pressurization air, and communications wiring. Manual operation of the emergency oxygen supply is provided by a green ring on the forward edge of the survival kit.

The integrated harness system performs the functions normally accomplished by the parachute harness, lap safety belt, and shoulder harness.

A harness release handle (fig. 14-1 (A)) permits manual release of the integrated harness, harness takeup inertial reel strap, survival holddown fittings, and parachute cable.

A pair of gas actuated ejector pins and a drogue chute static line with an attached cutter provide for drogue chute separation after seat-man separation and parchute deployment. The

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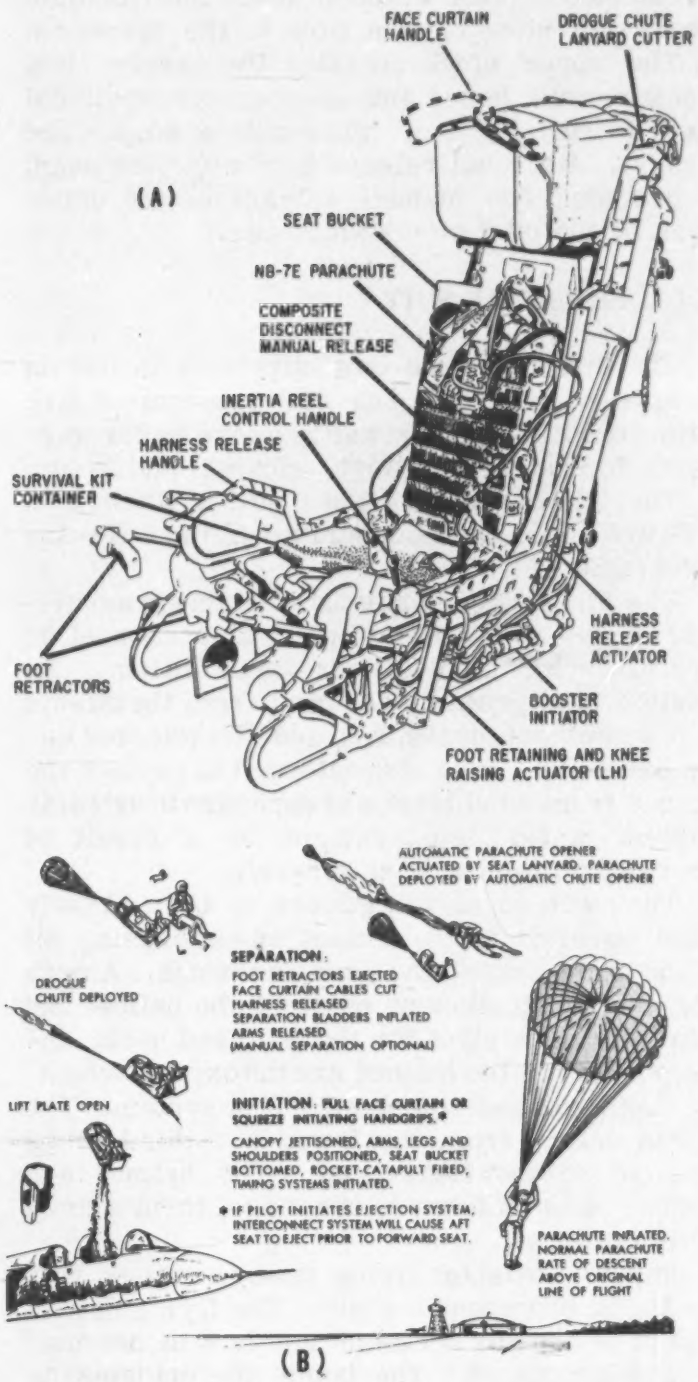

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Figure 14-1.—(A) Ejection seat and related equipment; (B) low altitute escape sequence.

parachute contains a static line ballistic-delay cutter to sever the lanyard after parachute deployment.

The ejection system is operated by pulling the face curtain handle (fig. 14-1 (A)) or by squeezing the handgrips, located on each knee raising frame. The ejection sequence is as follows: The canopy is jettisoned; the occupant's legs and shoulders are positioned; the rocket fires, propelling the seat-man combination to safe recovery. (See fig. 14-1 (B).)

If the pilot initiates his ejection seat, the aft ejection seat will automatically eject prior to the forward seat. The aft ejection seat can be actuated independently of the forward seat.

SURVIVAL KIT CONTAINER

The survival kit container assembly is a two-piece assembly which acts as a container for the survival kit, liferaft and protective cover, emergency oxygen supply, microphone adapter, adapter switch, and related plumbing, clamping, and wiring. The container acts as a cushion in the seat and has a sponge type polyurethane pad bonded to the contoured surface on top of the upper half of the container by a zipper, and the parachute harness is connected to the upper half of the container on both sides.

LR-1 Raft Configuration

The LR-1 liferaft assembly consists of a liferaft, carbon dioxide cylinder, and an inflation valve. The configuration of a packaged LR-1 liferaft assembly, complete with accessories and survival items, will vary according to application. To make up a complete packaged assembly, all required components must be individually requisitioned. The survival items must be packed in either the combination carrying case and equipment container, or in the equipment container, as applicable. The remaining space in the container may be used for specialized equipment deemed necessary for specific environmental or geographic conditons as directed by the Area Operating Commander.

The survival items for the LR-1 assembly must include the following list of equipment: Survival radio, MK-13-MOD-0 distress signals, dye marker, signaling mirror, signaling code card, rations, desalter kit, water storage bag, nylon cord, bailing sponge, Shark repellent, and sunburn ointment.

Both raft and equipment are attached to the upper half by a 25-foot nylon drop lanyard. The upper half of the container is equipped with the emergency oxygen supply.

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NOTE: Items included above are considered as typical of a survival kit and deletions or substitutions may be made as directed by area commanders.

Emergency Oxygen Supply

The emergency oxygen supply is contained in the upper half of the survival kit.

The capacity of the bottle for some aircraft is 100 cubic inches while other aircraft use bottles with a 70-cubic inch capacity.

The oxygen supply is controlled by the reducer assembly on the oxygen bottle. It is actuated automatically during ejection or may be actuated manually. The reducer assembly (when actuated) delivers a demand flow of oxygen of 0 to 140 liters per minute at an outlet pressure of 55 to 80 psi.

The components of the reducer assembly are the actuator assembly, relief valve, charging valve and cover, pressure gage, control level, and outlet port. The actuator assembly consists of a release pin, manual lanyard and ring, and automatic lanyard and sleeve disconnect. The release pin is attached to both lanyards and may be actuated by either. The operating forces required are manual 15 to 25 pounds and automatic 15 to 35 pounds. The supply of oxygen contained by the emergency bottle is sufficient to provide pressurization and breathing oxygen for the occupant for an ejection at the maximum altitude capability of the aircraft.

PERSONNEL SERVICES DISCONNECT (COMPOSITE DISCONNCT)

On most aircraft equipment with ejection systems, a composite disconnect is provided. The purpose of the disconnect is to provide a single point connection for quickly connecting and disconnecting the pilot's pressure suit or anti-g suit to the aircraft anti-g system, oxygen system, communications, and pressurization/ventilation air.

Scott Disconnect

The Scott composite disconnect is a small triangular shaped assembly comprising three blocks. The center or intermediate block is attached to the left-hand rear corner of the survival kit. The lower block is fastened to the aircraft and the upper block separates with the pilot upon leaving the aircraft. On separation from the seat after ejection, the upper block remains attached to the intermediate block, providing oxygen flow to the crewman.

The upper block contains the oxygen line, pressure suit hose, anti-g hose, and electrical leads to the pilot's or crewmember's mike and headset. A manual release handle (yellow pear) is provided for manual release of the upper block by the pilot or crewmember.

FULL PRESSURE SUIT

The full pressure suit currently in use is designated MK IV. The suit consists of five main components—the waffle weave under garment, torso unit, helmet, gloves, and boots.

The Mk IV full pressure suit is illustrated in figure 14-2, and is described in the following paragraphs.

The full pressure suit is a flexible pressure-tight garment for wear by flight personnel in aircraft with high-altitude capabilities. Its function is to protect personnel from the effects of low ambient pressures and of explosive decompression. It is also intended to protect the wearer from wind blast and exposure to extreme ambient water temperatures as a result of emergency ditching of an aircraft.

The suit torso is tailored to be a closely fitted coverall type garment encompassing all of the body except the head and hands. A neck ring is the attachment point of the helmet and also acts as a pivot for the head and neck. Incomporated in the helmet are the oxygen breathing regulator and communications system. The gloves extend from the lower one-third of the forearm to the fingertips. The helmet and gloves, when attached to the torso, form a complete assembly.

Impact-resistant flying boots are used with the Mk IV full pressure suit. The flying boot is impact and water resistant and is 8 inches high when fully laced. The boots are designed to allow lacing above the ankles, preventing their loss during bailout and offering support for the ankles upon parachute landing.

Suit accessory equipment consists of an integrated flotation garment with parachute harness and waffle weave underwear for use in cold climates. (See fig. 14-3.) An anti-g suit is worn when operational requirements warrant.

Under normal conditions, with the cockpit adequately pressurized, the pressure suit remains in an unpressurized state and any slight

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Figure 14-2.—Mk IV full pressure suit.

pressurization that occurs is due to high ventilation flows. The ventilation air is supplied from the aircraft air-conditioning system, monitored through the pilot's manual control valve, and channeled by way of a disconnect in "Trilok ducting" which is an integral part of the torso. This air flows through the ducting and exits at the wrist, ankles, crotch, and neck area. It then flows into the body of the suit so as to remove excess moisture and cool the body. The air leaves the suit exhaust port and is expelled through the relief port of the suit controller into the cockpit. In addition, to ventilation, this air also pressurizes the suit when required.

The full pressure suit system is designed to respond to, and function under, several distinct conditions that might be encountered in flight.

1. In normal flight with adequate cabin pressurization, the suit is provided with a flow of ventilation air to maintain the body at a comfortable temperature level.

2. When cabin absolute pressure falls below 3.5 psi (atmospheric pressure at 35,000 feet), the suit will immediately become pressurized by ventilation air.

3. If ventilation air is lost, the aircraft oxygen supply will pressurize the suit as well as supply the breathing oxygen.

4. During bailout, the emergency oxygen supply will pressurize the suit as well as supply breathing oxygen. The design of this oxygen breathing system is unique in that there is never any need for pressure breathing. While wearing the full pressure suit, one never has to resort to pressure breathing above a slight 0.1 inch of water pressure. The freedom afforded by this system of not having a mask tightly cinched across the face and covering the nose and mouth is a pleasant advantage. In addition to these advantages, the helmet visor offers a maximum windblast protection.

Pressure Suit Controller

The full pressure suit mounted contoller is installed on the full pressure suit torso at the exhaust port fitting. This system is necessary for functional compatibility with the pilot's universal upper block disconnect system. In addition, this system increases reliability and maintainability of the pressure control system.

The controller is an aneroid controlled exhaust valve which monitors the rate of flow of exhaust gases from the suit to obtain an absolute

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Figure 14-3.—Full pressure suit accessories.

suit pressure of 6.9 ± 0.3 inches of mercury (equivalent to 35,500 ± 1,000 feet).

In normal flight with cabin pressure, ventilating air passes through the suit to the contoller and then escapes into the cabin. If cabin pressure fails above 35,500 feet and pressure is still available from the aircraft engine, the controller maintains suit pressure at the cortect absolute altitude of 35,500 feet. If pressure from the engine is also lost, aircraft oxygen will be automatically supplied by the controller to fill the suit to 3.5 psi.

TORSO HARNESS SUIT

The integrated torso harness suit is designed for use in Navy aircraft with integrated parachute restraint harness systems. (See fig. 14-4.)

Prior to acceptance of the integrated torso harness suit as a standard item of equipment, an extensive test program was completed to determine its suitability for service usage. As a result of these tests, the integrated parachute harness was adopted for use in ejection systems. The integrated system reduced overall bulk and weight, improved comfort, mobility, and retention, and provided better donning and doffing features.

The integrated torso harness suit consists of a sleeveless, legless, fabric garment within which is incorporated the parachute and restraining harness. The garment is closed by means of a slide fastener running the length of the front panel. The harness is secured for a snug fit by an adjustable chest strap located on the upper front of the suit. This feature consists of two harness straps exposed through reinforced outlets in the suit. Adjustments in the harness are taken up through these straps. After the desired adjustment is accomplished, the loose ends of the straps are engaged with the reversible friction adapter for security.

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Figure 14-4.—Torso harness suit.

The front panel contains an oxygen hose retainer channel to eliminate the possibility of the oxygen mask being carried away by wind blast during the high-speed bailout. The parachute risers and shoulder harness restraint straps attach to the connector links located on the right and left side of the upper chest. The aircraft lap belt attachments engage the two connectors which are located on the lower front panel at the junction of the upper thigh and lower abdomen.

The front panel also contains an attachment snap on the left shoulder strap for the attachment of the oxygen mask when not in use and a protective flap for the oxygen hose coupling at the junction of the hose.

The suit is designed so that by donning one garment and subsequently attaching it at four points the pilot is equipped with a parachute, shoulder harness, lap belt, and pararaft.

Sizing

Although the torso harness suit provides restraint during both normal operation and emergencies, proper sizing to the individual is mandatory to obtain maximum protection.

The individual should don the suit to determine that the fittings at the chest and at the main sling that crosses the buttocks are in proper positions. The chest fittings should ride in the fleshy portion of the chest and not be positioned too high near the collar bone. The main sling should be positioned well beneath the buttocks when the individual is in a seated position rather than behind the individual. Final determination of proper sizing should be made by the individual entering the aircraft cockpit and hooking up at the four attachment points. The hockup should be made without excessive slack in the restraining harness. It should be noted that utilization of the adjustment feature on the harness can be best made by assuming a squatting position and wriggling the body while adjusting both sides of the chest straps.

Donning

The integrated torso harness suit is worn as an outer garment over standard flight clothing such as summer flight suit, anti-g suit, and antiexposure suit. In view of the increased bulk of the antiexposure suit, when this garment is worn, it is necessary that the individual be fitted with a torso suit generally one size larger than normally used with other flight clothing. The integrated torso harness suit is furnished in 12 sizes.

ANTI-G EQUIPMENT

Anti-g equipment is currently installed in high performance aircraft to counteract the effects of prolonged acceleration on the pilot. The ill efects of such acceleration range from

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excessive fatigue and decreased alertness to blackout and unconsciousness.

Effects of Acceleration

Although there is no limit to the speed a human can endure in straight and level flight in an aircraft, changing speed or direction can lead to reactive forces of inertia to which the body has a sharply limited tolerance. In the case of extreme stresses exerted by acceleration of the type met in seat ejection, ditching, or parachute opening shock, the short duration of the acceleration restricts its effects. However, changing the direction of flight often produces prolonged radial acceleration (longer than a second) which can have dangerous effects.

At 5 g's the pilot's body is exposed to a force of inertia which increases its "weight" and that of its components five times. This increased "weight" has many effects. The pilot is pushed down into his seat. His arms and legs feel like lead and manipulation of the controls becomes more difficult. In addition, the extra weight of the viscera (internal organs) causes abdominal and chest discomfort. Most important, however, is the effect on the circulatory system.

At 5 g's the pressure exerted by the column of blood between the head and the heart becomes just about equal to the blood pressure in the arteries. As a result, the pressure supplied by the heart is not great enough to pump an adequate supply of blood to the head.

To counteract these effects, the pressure in the arteries must be increased above the heart level. At the same time, distended vessels and tissue and fluid spaces in the regions below the heart must be restored to normal. This is accomplished by the anti-g suit. With the anti-g system, compressed air is metered to the suit in proportion to the acceleration, and the suit compresses the legs and abdomen of the wearer by an amount proportional to the acceleration. Thus, the suit prevents venous pooling in the abdomen and lower extremities and forces blood from the lower to the upper part of the body. This effect increases venous return to the heart and increases resistance to the shifting of blood to the lower limbs. In addition, it causes the diaphragm to be raised and this decreases the distance between the heart and the eyes and/or the brain. Altogether, it increases the tolerance of the pilot an average of about 2 g's.

Without an anti-g suit, the average pilot can withstand 4.5 to 5.5 g's without losing vision or blacking out. With a suit, he is capable of withstanding 6.0 to 7.0 g's. However, this protection is available only for sustained accelerations of 4 to 5 seconds or longer in maneuvers other than snap maneuvers. Anti-g equipment does not offer protection in snap maneuvers where 10 to 12 g's can be applied in approximately 1 second. Such brief forces are not as harmful to the body as lesser forces which are sustained for a number of seconds.

Anti-G Suit (Mk 2A)

The Mk 2A anti-g suit is furnished in four sizes and has five interconnected bladders as shown in figure 14-5.

Anti-g suits are made of nylon. This material offers flash burn protection equal to treated cotton and in addition affords the strength characteristics necessary in this garment and not found in the cotton fibers available to date. However, since nylon does melt and forms droplets which retain heat and can cause burns, additional clothing should be worn

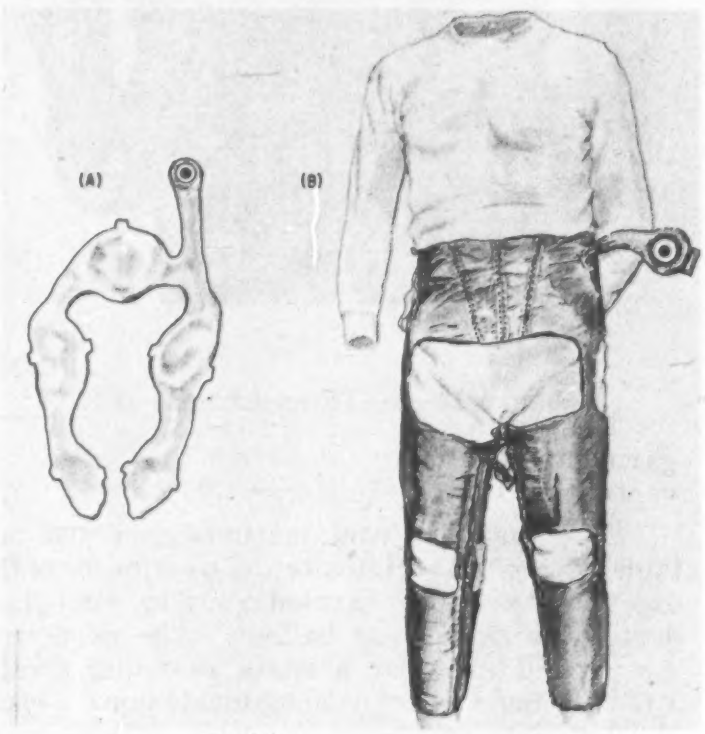

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Figure 14-5.—Anti-g suit. (A) Internal bladder arrangement; (B) Mk 2A cutaway type.

to protect against possible burns from this droplet formation.

Anti-g suits are fitted by the flight surgeon, often aided by a PR. The suit should fit snugly, especially at the waist. A snug fit means better protection and more comfort under g forces.

Experience and accident investigation have proven that burns resulting from the ignition of tight fitting material are far less severe than those resulting from loose fitting material. This is another reason why a correct fit is important.

If there is any doubt about the fit, the wearer should sit in the same position as in the aircraft and inflate the suit orally. The bladders should compress at the waist, calves, and thighs firmly and evenly.

ANTIEXPOSURE SUITS

Antiexposure suits are designed to be worn on cold weather flights by all personnel. They provide warmth and buoyancy in case of emergency bailout or crash landing at sea. They are effective on land and in the water, and without their protection from cold temperatures and near freezing water the individual would freeze to death quickly. A suit and liner have given protection from exposure for 2 hours in water at 28° F. In subzero weather on land, a suit will give protection for extended periods of time.

These suits offer a positive means of buoyancy because they are waterproof and retain air. Only when full of water will the suit reach zero buoyancy. For greater ease in swimming, one should get into an upright position and release the entrapped air by pulling the neck seal away from its seat.

Mk 5A Constant Wear

The Mk 5A coverall assembly consists of two garments—the outer shell and the insulation-ventilation liner. It offers protection from the elements and provides a means of admitting and distributing ventilating air during preflight and flight operations.

OUTER SHELL.—The outer shell is made of a nylon knit material having "stretch" qualities similar to that found in mens socks, T-shirts, etc. One side has been coated with a neoprene rubber compound for waterproofing. The suit is equipped with a long diagonal opening extending from the crotch upward over the front and slightly over the left shoulder. This opening is sealed with a waterproof slide fastener. This fastener is similar to a conventional fastener except that when closed, it forces together two overlapping rubber lips. To insure a NORMAL life and for ease in opening and closing the slide fastener, it should be kept lubricated with the appropriate silicone type compound.

A protective flap has been placed along the entire length of the slide fastener for protection against the parachute hardware, webbing straps, and other objects which might cause unnecessary damage to the slide fastener.

This flap is secured with short lengths of fastener tape. To close the flap, simply press the matching sections of tape together; to separate, and peel the tape halves apart.

Medium sized stretch socks are cemented to the legs of all suit sizes 36S through 40L and large size socks are attached to sizes 42R through 46L. Socks of both sizes are furnished in each repair kit for use when an individual requires a size other than the one attached.

The wrist seals are conically shaped and attached to the sleeve. Wrist seals are supplied in 3 sizes—small, medium, and large. Two sets of wrist seals are provided with each coverall as follows:

1. One set each of sizes small and medium with coveralls sizes 36S, 36R, 38S and 38R.
2. One set each of sizes medium and large for all of the remaining sizes.

Located at the lower pack portions of the legs is a pair of ventilation air exhaust valves which serve as the outlet for the ventilation air after it has circulated over the body. These valves were designed to exhaust air and yet function as watertight seals in the event that ditching in the water becomes necessary.

Normally, most of the ventilation air will exhaust from the open neck seal of the Mk 5A outer shell; but in the event the neck area is blocked or the neck slide fastener is closed during ventilation, the valves will serve as the sole outlet for the exhaust air.

The exposure suit neck seal is provided with Velcro fastener tape. It must be zippered up during carrier launch and recovery, takeoffs over water, and flying over water.

Two pairs of leg pockets or a total of four pockets are provided on each garment. In addition, there is also a cigaret-pencil pocket located on the left arm. Figure 14-6 shows the Mk 5A outer shell.

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Figure 14-6.—Mk 5A outer shell.

INSULATION-VENTILATION LINER.—The insulation-ventilation liner (as the name implies) offers excellent insulation as well as ventilating properties. It is made with a lightweight, closely woven nylon outer covering and an inner layer of fire-retardant cotton fabric. Sandwiched between these two layers is a dacron fiberfill batting material. When kept dry these features offer the necessary insulation for the suit.

The ventilation distribution system is integrated within the liner between the outerface material and the dacron batting. It consists of a bladder or reservoir positioned across the full width of the back and a pair of arm and leg ducts. These ducts emanate from the bladder to each of its corners, then distribute the air to points near the sleeve and leg endings of the liner. The air then passes over the body for cooling and finally exits through the open neck seal and/or the exhaust valves of the Mk 5 outer shell.

EXTRA EQUIPMENT.—Available for use with each Mk 5 antiexposure suit are a ventilation hose, an ant-g hose, gloves, footwear, an inflatable hood, and cover plates.

The ventilation hose and the anti-g hose are fitted individually, and cut and assembled in accordance with Air Crew System Change No. 15.

The ventilation hose has a spring-loaded capped disconnect at one end and an elbow fitting at the other. The elbow engages with the air inlet port under the left sleeve, while the spring-loaded disconnect engages with a fitting leading from the air-blower source.

The anti-g hose terminates with a conventional anti-g male disconnect at one end and an elbow fitting which screws onto the fitting cemented to the Mk 5 outer shell.

NOTE: Red colored fittings are for ventilation purposes, and green colored fittings are for anti-g use.

The leather gloves are fully insulated and treated to resist water penetration through the leather surface. A rubber wristlet is bonded to the opening of the glove to prevent entry of water into the glove.

Insulated rubber or leather type boots are available in the supply department for use with the Mk 5A. The rubber boot is more cumbersome, but offers greater protection than the leather boot. However, additional warmth may be obtained with the leather boot by wearing heavier wool socks.

The inflatable hood is normally folded compactly and stowed in a coverall pocket for easy accessibility. After immersion in the water, the crash (protective) helmet should be removed and the hood donned, the snap fasteners engaged, and the hood orally inflated through the oral inflator valve on the left side of the hood.

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INSPECTION AND TESTING.—When the Mk 5A is not being worn, it should be hung inside out on a broad shouldered wooden hanger in a cool, well-ventilated area.

Periodically, inspect the suit, inside and out, for deterioration and physical damage such as separations at seams abrasions, tears, pinholes, cracking due to weather, and damaged slide fasteners.

At the end of each season, and at other times when it is suspected that the Mk 5A outer shell has a leak, the following procedures are used to locate the defective areas:

1. Close the entrance and neck slide fasteners.

2. Close the ventilation air and anti-g ports with the cover plates and turn the suit inside out.

3. Seal off one of the sleeve openings by the use of C clamps and 1 1/2-inch wide strips of 1/8-inch thick steel. The steel strips must have a strip of rubber sheet bonded to one side to avoid damaging the suit.

4. The neck area is sealed by clamping a pair of aluminum strips as shown in figure 14-7. The purpose of the aluminum strips is to prevent damage to the slide fastener.

5. Inflate the suit with air, through the sleeve that is not clamped, to a pressure of 6 inches of water. Air pressure in the suit may be observed by the use of a gage attached to the air inlet line.

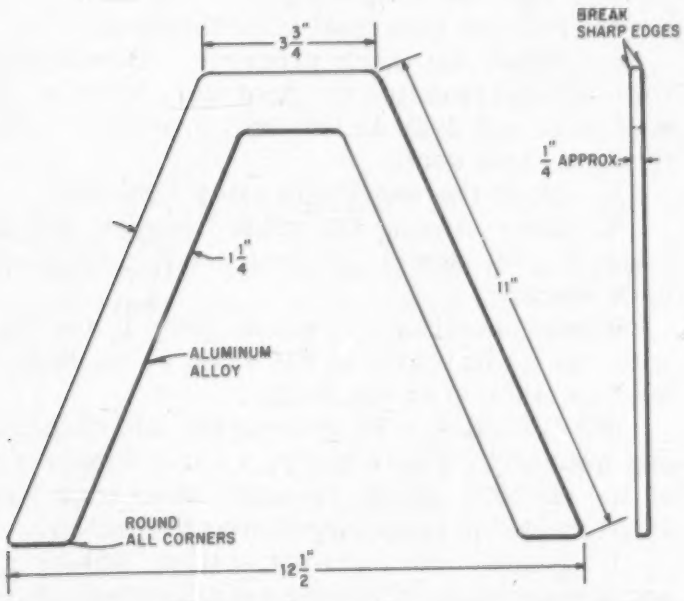

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Figure 14-7.—Neck seal test jig.

6. Shut off the air supply and read the pressure after 5 minutes. If the pressure does not drop below 5 inches, the suit should be considered satisfactory. If the pressure drops below 5 inches, maintain the pressure in the suit and apply the soap and water test as follows: Apply a solution of mild soap and water to the suit with a soft bristle brush. With a white pencil, mark all leaks that are indicated by bubbles.

7. Release the air pressure from the suit and rinse it with clean water. Allow the suit to dry 24 hours before making repairs.

8. Prior to applying adhesive to any surface, clean the area to be repaired with a dry, clean cloth or brush. A solvent (toluol) may be used in small amounts where it is absolutely necessary.

9. Three coats of cement must be applied to a fabric surface, and two coats to a rubberized surface. Allow each coat to dry one-half hour before applying the next. NEVER SKIMP ON COATS OF CEMENT.

10. Allow 24 hours cure time for the adhesive and retest the suit in accordance with the procedure described in the foregoing paragraphs.

NOTE: Overage adhesive may appear gelled, but do not discard it before attempting to restore it to a usable condition. Add to the adhesive small amounts of solvent (50 percent ethyl acetate and 50 percent toluol) and stir. If the gelled adhesive dissolves and becomes a free-running fluid, place a drop on the index finger. After 1 to 2 minutes, press the thumb against this drop and hold for a few seconds. Release the pressure and slowly separate the thumb and index finger to 1/8 inch. If the adhesive appears tacky and forms webs, the adhesive is satisfactory for use.

CLEANING.—The liners for the Mk 5A are ordinarily dry cleaned. However, when dry cleanining is not feasible, the following laundering process may be used.

To a container of clean water having a temperature of 90° F, add any neutral synthetic detergent in the proportion of 1 teaspoon per gallon. Gently dip the garment into this solution several times to loosen any foreign matter. Squeeze (do not wring) out excess cleaning solution. Place the garment on a flat surface and rub gently with a cellulose sponge or soft bristle brush until clean.

Rinse in clean cold water.

Remove excess water (squeeze).

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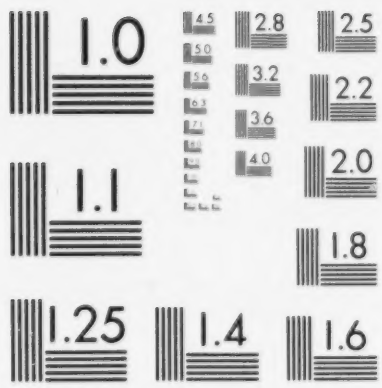

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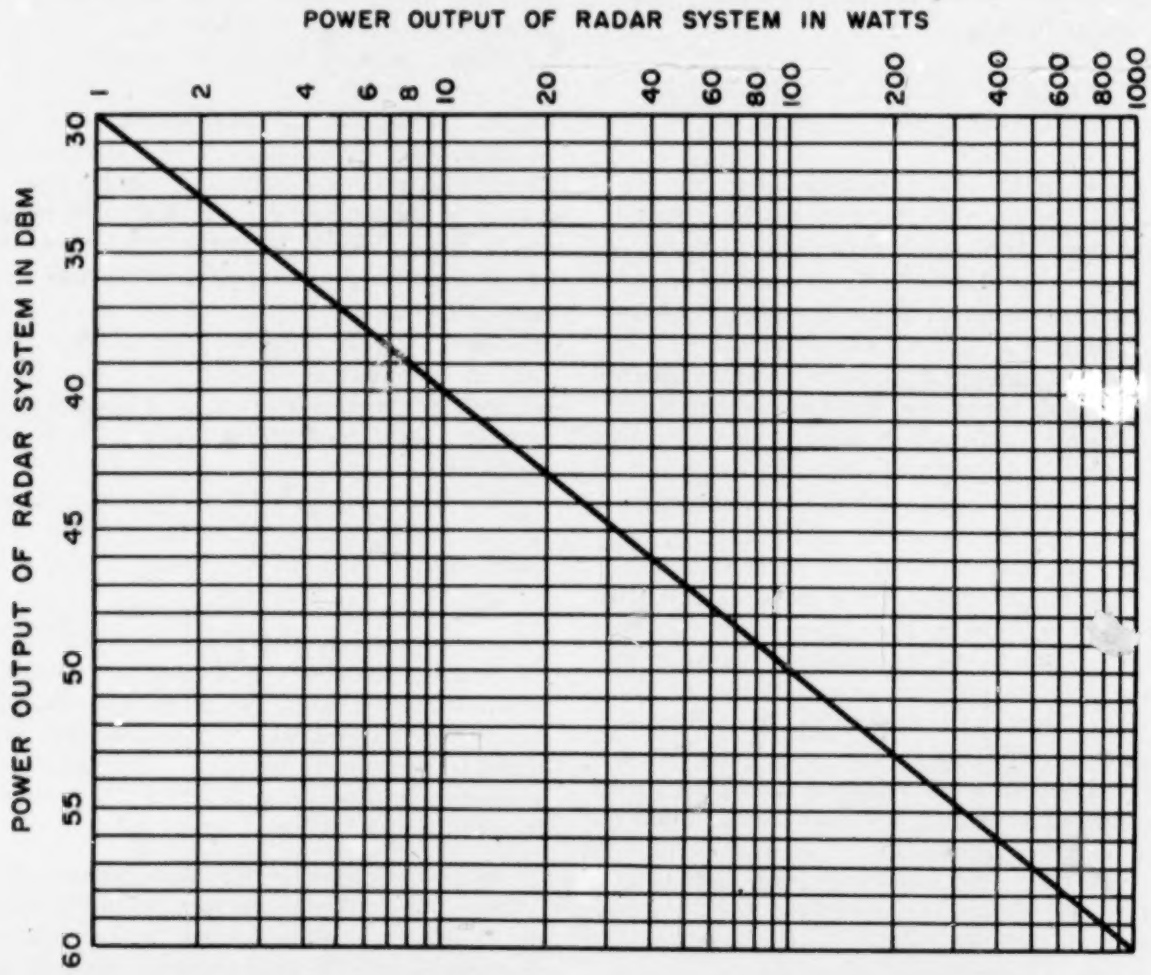

Figure 16-24. —Conversion of power in dbm to power in watts.

$$\text{dbm} = 10 \log \frac{P2}{P1}$$

where dbm is the total attenuation, P2 is the unknown output power in milliwatts, and P1 is the 1-milliwatt reference level.

SPECTRUM ANALYSIS

The measurement of frequencies employed in radar operation falls into two general categories, transmitter frequency and receiver frequency.

For the transmitter operation of any given radar system, a range of frequencies is assigned for that system. Therefore, the transmitter must operate within this band of assigned frequencies if normal operation is to be expected. Transmitter operation is restricted to a certain range of frequencies for the following reasons:

1. The associated waveguide tuning adjustments cover only a limited range of frequencies.

2. Interference between radars used for different types of services could result if all radars were permitted to operate in the same band. For this reason, airborne S-band and shipboard S-band radars usually operate in different parts of the band.

Radar transmitters may be either fixed in frequency or tunable. If the frequency of a fixed-frequency transmitter is measured and found outside the operating band, the magnetron should be replaced. Tunable transmitters may be adjusted to any frequency within the operating band. This is a very desirable feature where several radars are in use in a limited area—each one may be tuned to a different frequency to prevent interference. In addition, when jamming is present, a different frequency may be free of the jamming signal. Since the operating bands are fairly wide, transmitter frequency tests do not require extreme accuracy.

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Suspend the liner on a hanger by the shoulders and allow to dry thoroughly in the air (do not spin or use heat in drying).

CAUTION: Do not iron or press this garment.

Mk 4 Constant Wear
Antiexposure Suit

The Mk 4 antiexposure suit consists of an outer suit of watertight material with attached boots and accessories, including gloves. The outer suit is constructed of a coated fabric which is permeable to moisture vapor, but impermeable to water. The suit has elastic wrist seals, neck seals, and rubber boots.

The insulating liner, which is worn under the outer suit, is a two-piece winter flying suit (jacket and trousers). It is provided primarily for its insulating qualities.

The type 4 boots have a sealed air chamber for cold protection. This chamber expands with increasing altitude and may be vented by the small valve located on the side of the boot. This will relieve the air from the boot and also relieve discomfort at high altitude. The boot is worn over a light or medium sock.

ACCESSORIES.—Accessories used with the Mk 4 suit are gloves and g-suit hose cover. The gloves are quick-donning, sealed, insulated mittens, left and right interchangeable. To prevent loss, they are carried in the glove pocket of the outer liner and are attached to the pocket by a lanyard.

Accessories not furnished with the suit are the detachable hood and five-fingered winter or summer gloves.

The Mk 4 constant wear antiexposure suit has been designed for use by flying personnel on all flights where unprotected or prolonged exposure to the conditions of cold air and cold water as a result of abandoning an aircraft would be hazardous or could prove fatal. To receive full benefits of its design, it is important that personnel wear these suits and accessory items of clothing exactly as prescribed.

Quick-Donning Antiexposure Coverall

The quick-donning antiexposure suit provides protection against exposure and is designed for donning immediately before landing at sea. The coverall is constructed of a light waterproof material with attached foot covering and elastic type wrist seals and neck seals. It consists of three separate components—the coverall, the hood, and the glove assembly. The coverall consists of a single-piece garment which envelops the body of the wearer, with the exception of the hands and face. The hands and face are given protection by the hood and mittens. These two items are stowed in the pockets of the coverall. The suit comes in one size and is stowed in a carrying case.

USE OF THE SUIT.—When it is necessary to abandon an aircraft while over water, the quick-donning exposure suit should be worn over the flying clothes, but under the lifevest and parachute harness.

The hood of the suit is made with a sufficient fullness so that it can be worn over the headgear. Use of the hood is optional, as the suit is watertight whether the hood is worn over the head or left folded under the neck closure.

The mittens are normally worn after boarding the liferaft. They will provide protection against the cold even though wet. Figure 14-8 shows the coverall, hood, gloves, and case.

WEARING INSTRUCTIONS.—The steps listed below outline the procedures for donning the suit:

1. Exercise caution when putting on the suit. Do not damage it by snagging, tearing, or puncturing.
2. Remove the suit from the container and unroll.
3. Grasp it by the hip section and put the feet into the boots. Then pull the suit on over the shoulders while extending each arm, in turn, through the sleeve openings.
4. Pull the neck seal over the head.
5. Adjust the neck properly. Do not allow the undergarments to protrude between the neck seal and neck as this will prevent a watertight, airtight seal.
6. Close the watertight slide fastener.
7. After closing the slide fastener, the entrapped air should be vented out through the neck opening.

When contacting the water, jump in feet first with the arms close to the sides of the body or held together over the head.

INSPECTION.—To prolong the life of the suit and maintain its reliability, a careful inspection of the coverall should be made when issued and at alternate calendar inspections thereafter.

1. Inspect for cracks, tears, holes, and seam separation; defective snap fasteners, buckles, slide fastener, webbings; and deterioration from foreign substances.

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Figure 14-8.—Quick-donning antiexposure coverall, hood, gloves, and case.

2. Make all inspections on a smooth surface, free from harmful agents.

3. To insure long life and ease of operation of the slide fasteners, it is essential that the teeth of the fastener be cleaned free of talc, dirt, etc.

4. Defective suits are returned to the nearest depot-level maintenance activity.

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Antiexposure Suit (Wet Suit)

The ventilated wet suit is fabricated from a laminated cellular foam consisting of black polychloroprene cellular rubber 3/16 inch thick. The outer surface has a "grid" pattern and the inner surface is permanently bonded with knitted stretch nylon fabric.

A ventilated manifold assembly is cemented to the inner surface of the back of the suit, with spacers to permit the tubes to bridge the knees and elbows along the outer sides. To minimize body contact with the garment and to assure adequate internal ventilation, spacers are also provided at the back, seat, and rear thighs, chest, and arms.

The slide fasteners of the suit are stitched with polyester thread, and all seams are reinforced with a special tape and adhesive. Figure 14-9 shows the wet suit construction.

ACCESSORIES.—The accessories required to be worn with the suit in order to achieve 90-minute protection are special nonabsorbent two-piece 100 percent polyvinyl chloride fiber insulation underwear, exposure mittens, and an inflatable exposure hood.

The hood and mittens are stowed in the Nomex flight coverall which is worn over the suit assembly. The Nomex flight coverall also prevents the wet suit from being torn and protects the wearer from fire.

FITTING.—To assure precise fitting of the suit, eighteen sizes will be procured to fit airmen.

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Figure 14-9.—Wet suit construction.

LIFEVESTS AND PRESERVERS

Mk 2 Lifevest

The Mk 2 pneumatic lifevest was designed to be comfortable when worn in flight. To accomplish this, it is worn in its deflated state which permits the wearer all the freedom of movement necessary for the performance of his duty. When inflated, the vest must give adequate and properly distributed buoyancy. Fully inflated, the vest will provide a minimum buoyancy of 30 pounds.

Figure 14-10 shows the Mk 2 lifevest deflated.

An important feature of the vest's supporting qualities is that its back lobe (head support) maintains the wearer's head above the surface while the harness suspends him vertically in the water. Since the vest is self-righting, when properly worn and adjusted, it will float the wearer in the safest position with his head out of the water. As a further aid to rescue, small tabs and pockets are fashioned to the vest's front lobes for holding signaling equipment and shark repellant.

The body of the vest is fabricated from polychloroprene coated nylon fabric. The vest is made in three independent compartments. The

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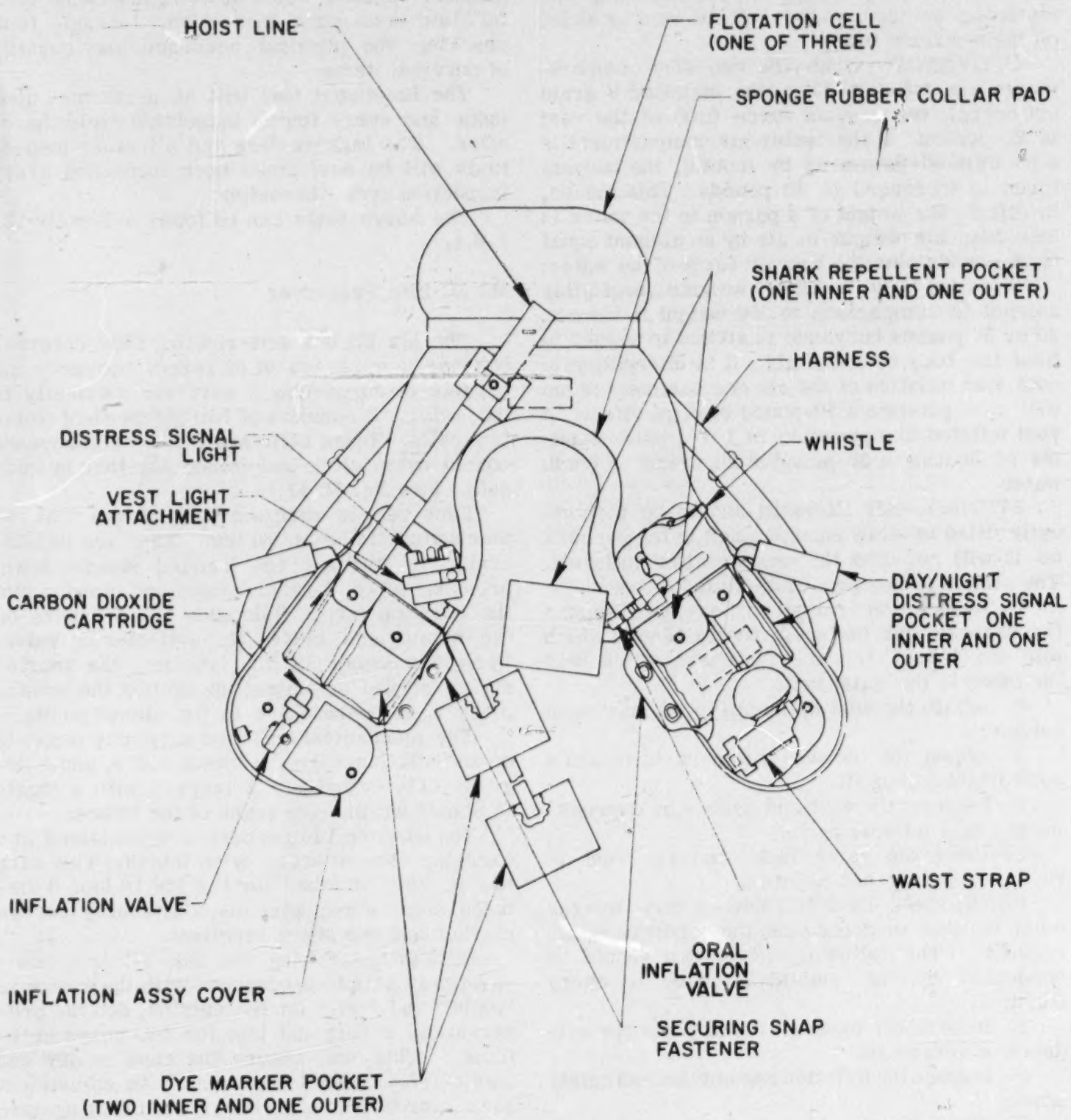

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Figure 14-10.—Mk 2 lifevest.

inside and outside compartments are inflated by carbon dioxide gas, and the middle compartment is inflated orally through an oral inflation valve and tube.

Deflation of the CO_2 compartments can be accomplished only by removing the CO_2 inflator caps. The air compartment is deflated by depressing the oral inflation valve. A nylon

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webbing harness, complete with adjusting and fastening devices, maintains the vest position on the wearer's body.

BUOYANCY.—When the two CO_2 compartments are inflated (from the standard 8-gram cylinders), the buoyant force (lift) of the vest is 20 pounds. If the center air compartment is also inflated (blown up by mouth), the buoyant force is increased to 30 pounds. This means, in effect, the weight of a person in the water is less than his weight in air by an amount equal to 30 pounds plus the buoyant force of the water.

Since the body, in water, weights a negligible amount in comparison to its weight in the air, 20 or 30 pounds buoyance is all that is needed to float the body successfully. It is interesting to note that inflation of the air compartment alone will also produce a 30-pound buoyant effect. A vest inflated to a pressure of 1 1/2 psi is capable of floating a 30-pound steel weight in fresh water.

FITTING.—All lifevests should be individually fitted to allow enough slack in the harness so it will not bind the wearer after inflation. The simple fitting procedure is as follows:

1. Have the wearer put on the vest and secure the harness link fastener, the fasteners which join the lobes, and the fasteners which hold the lobes to the waist belt.
2. Inflate the vest by mouth to its maximum volume.
3. Adjust the harness adapters to obtain a comfortable, snug fit.
4. Remove the vest and deflate by depressing the oral inflator valve.

Unscrew the valve lock, and the vest is ready for emergency inflation.

PREFLIGHT INSPECTION.—Every wearer must be able to determine the condition of his lifevest. The following inspection should be conducted by the individual prior to every flight:

1. Inspect all exposed metal parts for evidence of corrosion.
2. Inspect the inflation assemblies and safety wire.
3. Check the carbon dioxide cartridge to insure that the cartridge does not have a punctured seal.
4. Inspect the cloth seams and harness for evidence of wear, snags, tears, and abrasions.
5. Inspect all the emergency equipment for operation, security, and missing items.

CALENDAR INSPECTION.—The calendar inspection consists of the following tests: Preparation, updating configuration, functional test, inflation assembly inspection, leakage test, checking the physical condition and quantity of survival items.

The functional test will be performed upon issue and every fourth inspection cycle thereafter. The leakage test and all other inspections will be performed upon issue and every inspection cycle thereafter.

The above tests can be found in NavAir 13-1-6.1.

Mk 3C Life Preserver

The Mk 3C is a self-righting life preserver offering a minimum of 60 pounds buoyancy and capable of supporting a survivor vertically in the water. It consists of two independent flotation cells. These cells are made of chloroprene coated nylon cloth and joined together by gussets. (See fig. 14-11.)

Each cell is equipped with its own oral and mechanical inflation system. They are inflated orally by turning the knurled sleeve down, pressing in on the mouthpiece and blowing into the inflation tube. Releasing the pressure on the mouthpiece closes the self-closing valve. Upon completion of the inflation, the knurled sleeve should be turned up against the mouthpiece to lock the valve in the closed position.

The mechanical inflation assembly consists of an inflation valve, a check valve, and a 29-gram CO_2 cylinder. A lanyard with a toggle is placed within easy reach of the wearer.

The deflated life preserver is contained in a carrying case of heavy nylon fabric. This case has pockets attached for two Mk 13 Mod 0 distress signals and a means of attaching one dye marker and one shark repellent.

FITTINGS.—Fitting the Mk 3C is a comparatively simple procedure. With the markings "right" and "left" on the outside, don the preserver as a belt and join the two snaps in the front. This will secure the case snugly and comfortably around the waist. An adjustment band is provided on the back of the carrying case to facilitate individual adjustment.

INSPECTION.—The sequence of inspection tasks is to be performed is similar to the sequence for the Mk 2 life preserver and can be found in NavAir 13-1-6.1.

MAINTENANCE.—Before attempting to repack a Mk 3C life preserver, make sure that all checks and tests have been properly made and that the cells are completely deflated. Lay

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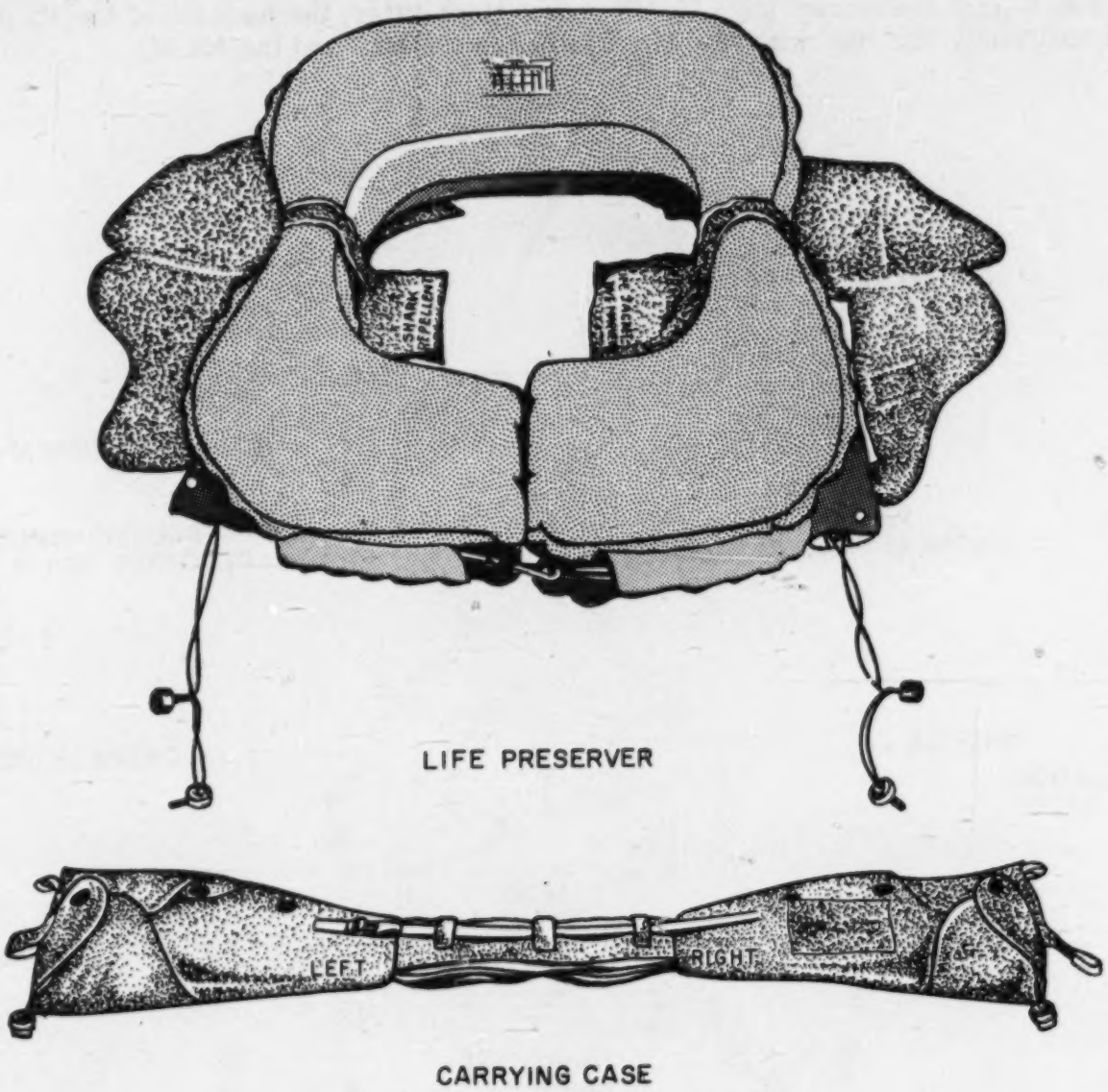

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Figure 14-11.—Mk 3C life preserver.

the empty carrying case on a flat surface with the labeled right side on your right side as you face the case. Insert the cells through the retaining webbing loops.

Fold the rear section of the cells forward to approximately the same width as the adjustment envelope of the carrying case. Lay the folded section of the cells in the adjustment envelope and fold the flaps of the envelope over the cells.

Hold the adjustment envelope closed and fold forward. Fold the flaps over the adjustment envelope and engage one span on each side of the center of the envelope.

Attach dye marker and shark repellent, insert the distress signals.

Insert CO_2 cylinder through retainer loop and screw into inflator assembly, making sure that antichafe protector is in place.

Tuck in cells and stow oral inflation tube. CAUTION: Stow inflation tube without any sharp bends.

Insert a cord through the securing loop and pull the securing loop through the eyelets of each flap. Complete passing of securing loop through flap eyelets, insert nylon pin, and remove cord.

The completely packed Mk 3C life preserver is shown in figure 14-11.

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- Mk 4 Life Preserver

The Mk 4 life preserver (fig. 14-12) was designed expressly for use with the Mk 4 full pressure suit. Although the materials used in manufacturing (as well as the design configuration) differ, the function of the Mk 4 is the same as the Mk2 and the Mk 3C.

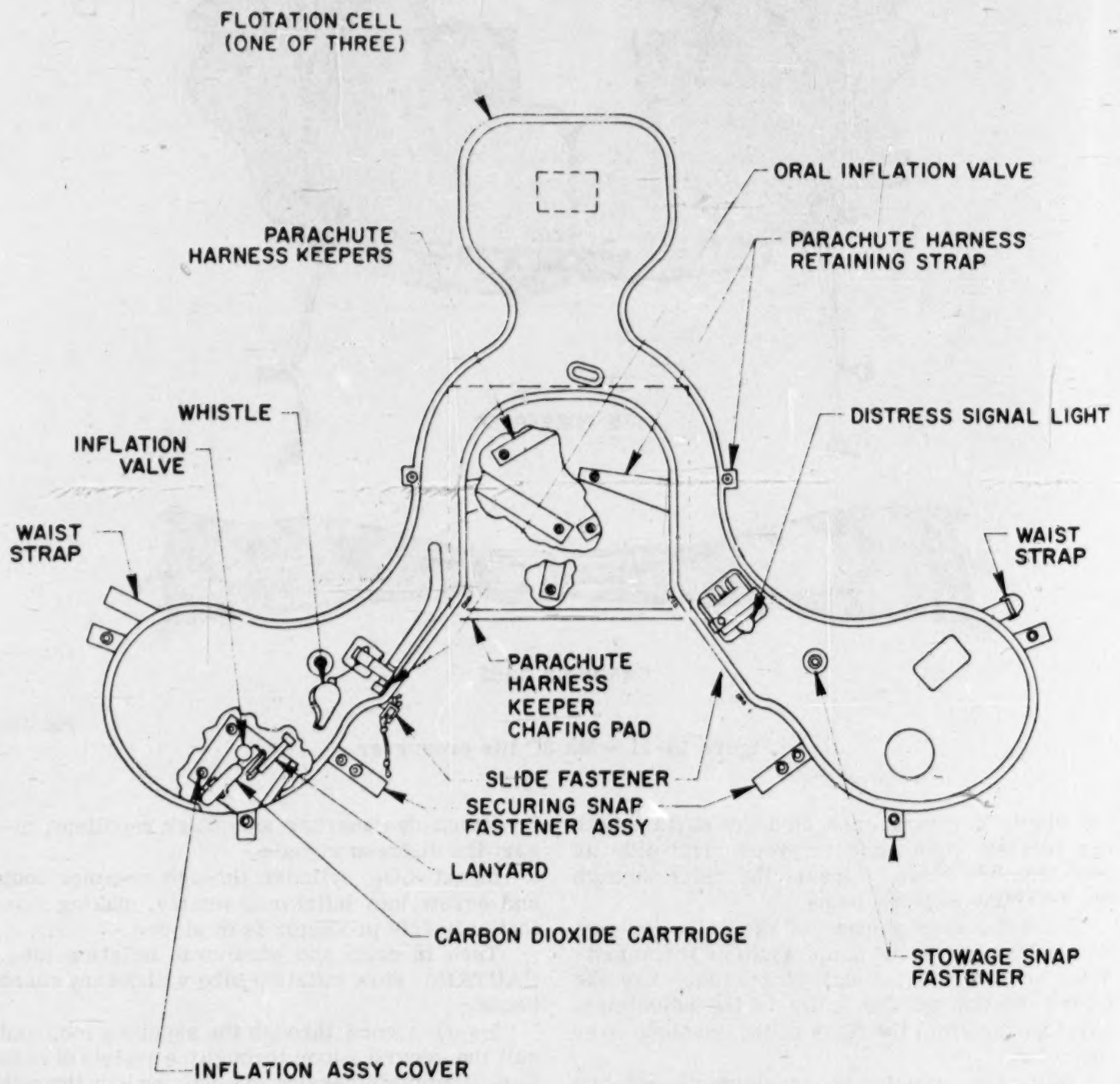

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Figure 14-12.—Mk 4 life preserver.

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The Mk 4 should be inflated periodically in accordance with current directives and checked for leaks. Remove as much air as possible after these tests to prevent unnecessary inflation at altitude from expansion of the residual trapped air in the infiltration compartments. Routine care and maintenance is the same as for other life preservers.

LPA-1 Life Preserver

The LPA-1 life preserver, shown in figure 14-13, is a new preserver which has been developed by the Aerospace Crew Equipment Department. This life preserver has a buoyancy of 65 pounds and has been found capable of use with every existing item and configuration of survival equipment of naval aviators, including the full pressure suit, nonintegrated harness and MA-2 torso harness. It may also be worn without a harness. The LPA-1 preserver will permit servicewide standardization to a single common-design life preserver for aircrewmen in lieu of the three different types in current use.

DESCRIPTION.—The preserver has a cover made of coated nylon duck which features Velcro fastener strips that permit waist-size adjustment. The cover also has an adjustable belt that anchors the buoyant thrust of the waist lobes of the preserver when the preserver is attached to the flight suit in nonintegrated parachute harness configuration or in the no-harness configuration. When used with the integrated parachute harness, the waist section of the preserver is anchored to the torso suit in the same manner as the Mk 3C preserver.

Two Mk 13 Mod 0 signal flares can be installed in a small pouch beneath the right inflation lobe cover, and two dye markers can be attached to the left inflation lobe cover.

The preserver is constructed of coated fabric and, as mentioned earlier, provides 65 pounds of buoyancy when inflated with the two 28-gram capacity CO_2 cylinders. There are also two flexible oral inflation tubes which may be used if necessary. The collar section is inflated by one CO_2 cylinder and the front buoyancy lobes are inflated by the other CO_2 cylinder. This life preserver has the capability of inflation prior to water entry.

NOTE: The LPA-1 is not designed for release and expansion by oral inflation. When it is desired to inflate the entire cell through the oral valve, it is necessary to release the body lobes by removing both cotter pins from the retaining loops and to manually separate the hook and pile tape that secures the collar lobe.

CALENDAR INSPECTION.—The LPA-1 life preserver must be inspected in accordance with the instructions for the Mk 3C life preserver detailed in NavAir 13-1-6.1.

LPP-1 Life Preserver

The LPP-1 life preserver, shown in figure 14-14 weighs 3 pounds and provides a minimum of 34 pounds of buoyancy. The LPP-1 life preserver assembly consists of a single comparement, yoke type flotation garment, a pouch and belt assembly, an inflation assembly and a storage container. The preserver is designed to support the wearer's head above the water while the body rests at an optimum 45 degree angle. In the dry wear state, the belt, which is attached to the flotation chamber through the pouch, is secured about the waist.

The LPP-1 life preserver is designed and authorized for use by civilian or service dress-attired passengers flying in cargo or transport aircraft. The LPP-1 is also authorized for use by Navy and Marine helicopter aircrewmen using the T-65 Body Armor. For this latter application, the LPP-1 must be modified in accordance with NavAir 13-1-6.1.

COMPONENT DESCRIPTION.—The LPP-1 assembly consists of the following components:

1. Inflatable buoyance chamber: The inflatable buoyancy chamber, the basic component of the LPP-1, is constructed of chloroprene-coated nylon cloth. It is an airtight bag equipped with an oral inflation assembly and a manifold for attachment of a mechanical CO_2 inflation assembly. The inflatable chamber is further equipped with loops, flaps, pockets, and patches for attachment of all its complementary devices.

2. The adjustable belt assembly: The adjustable belt assembly consists of a 53-inch webbing belt, an adjustable buckle and clasp, a toggle assembly, and a toggle assembly pocket. The belt adjusts from a waist size of 30 inches to 52 inches. A wooden toggle is attached to the belt by a 36-inch length of type 3 nylon cord. During emergency use, the toggle and line are used to secure survivors together while in the water. When not in use, the line is wrapped

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around the toggle and the assembly is stowed in the toggle pocket located on the belt.

3. Pouch: A rubber-coated nylon cloth pouch contains the buoyancy chamber and other accessory devices. The pouch has two slots on the back panel for exit of the belt.

4. Storage container: An orange colored storage container is provided with each assembly.

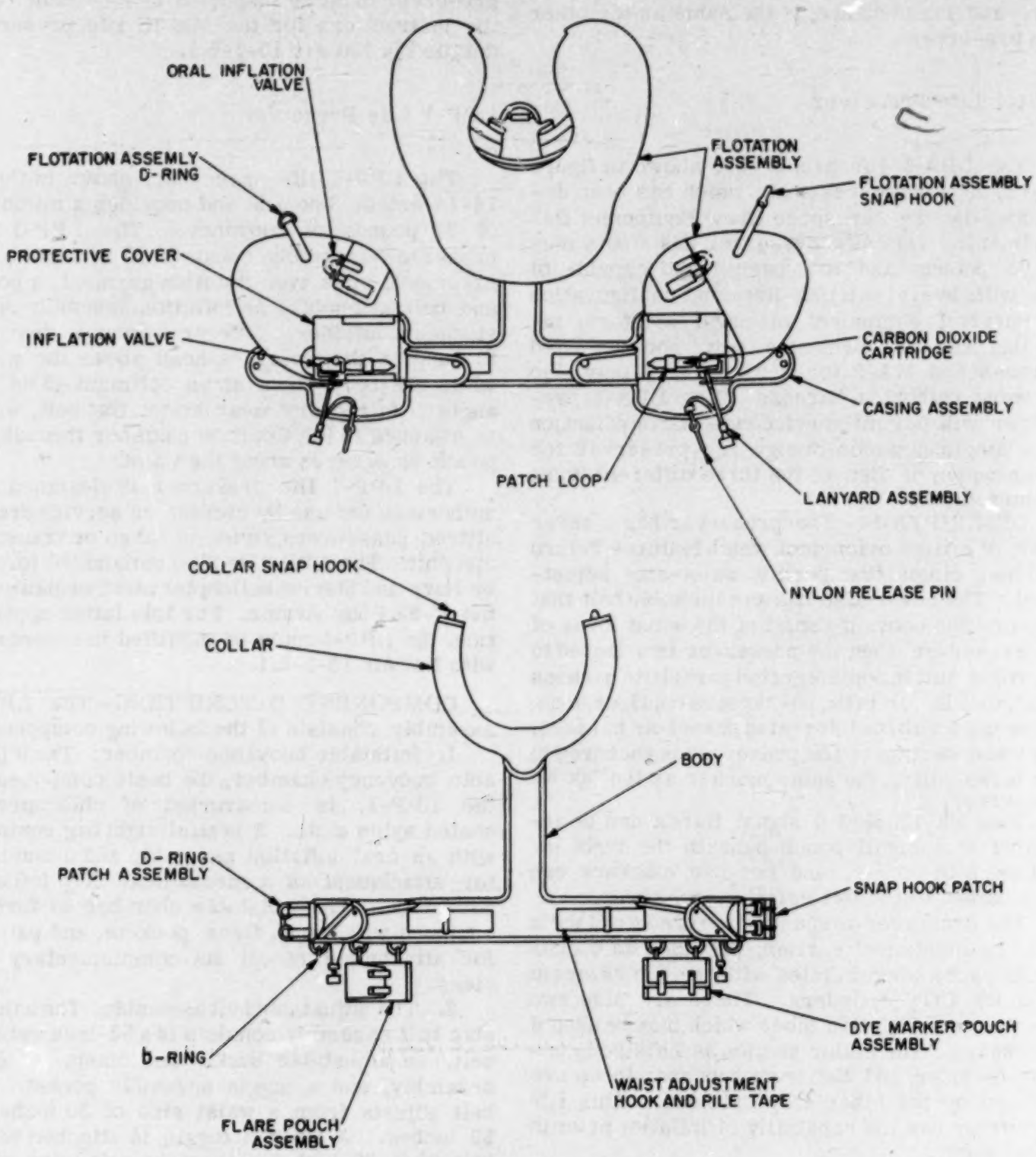

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Figure 14-13.—LPA-1 life preserver.

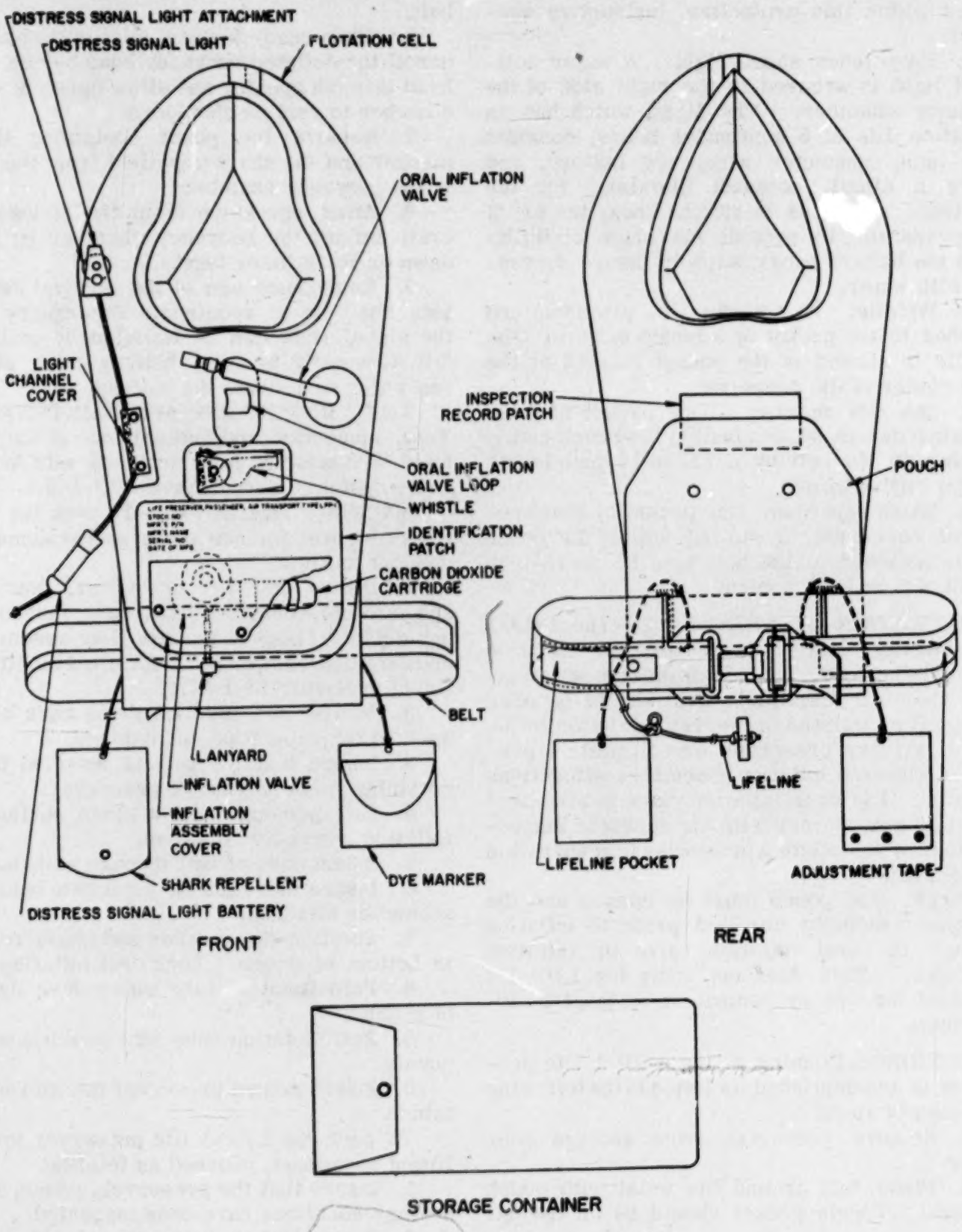

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Figure 14-14.—LPP-1 life preserver.

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The transmitter frequency is readily measured by using the resonant cavity wavemeter section of the TS-757/UPM-32. The resonant cavity functions as an absorption type wavemeter. When tuned to the frequency of the transmitter, the cavity absorbs some of the microwave power. This reduction of power is indicated as a dip on the power monitor (meter) or synchroscope.

A convenient method of coupling the radar transmitter to the frequency meter is by use of the test set's special coaxial cable. One end is connected to the radar directional coupler, while the other is connected to the frequency meter input.

This wavemeter has a direct-reading dial for frequency indication. When the cavity is tuned to resonance, the frequency is indicated in megacycles per second in the FREQUENCY window. An attenuator is also included to prevent driving the power meter off-scale. While tuning the frequency meter, the control should be moved slowly. Otherwise it is possible to pass the resonance frequency without knowing it. The reason for this is that the power is detected by a thermistor which takes a short time to heat and react to the power applied to it.

The resonant frequency of the radar may also be indicated on the synchroscope. The reduction in power caused by absorption in the resonant cavity is apparent by a decrease in pulse amplitude on the CRT. This dip is usually easier to detect than the power meter. Final tuning, however, should always be done by the meter indication. Transmitter frequency may also be measured during spectrum observation.

Spectrum observation is the display of the magnetron's output on a synchroscope. By this method the technician may readily determine visually whether or not the magnetron is operating properly. Figure 16-25 shows an ideal spectrum of a pulsed magnetron. Note that the side lobes are very low compared to the main lobe, and that the main lobe falls off to zero on either side of the carrier frequency.

Figure 16-26 shows several examples of transmitter spectral displays that are less than ideal. In general, the distortion resulting from frequency modulation (fig. 16-26 (A) and (B)) is far more undesirable than distortion resulting from amplitude modulation (fig. 16-26 (C)). Both frequency and amplitude modulation may be present in a spectral display (fig. 16-26 (D)).

TRANSMITTER TROUBLES

The major troubles or indications of trouble met with in radar transmitters are incorrect operating frequency, poor spectrum, and low output. As a further complication, the troubles may occur intermittently.

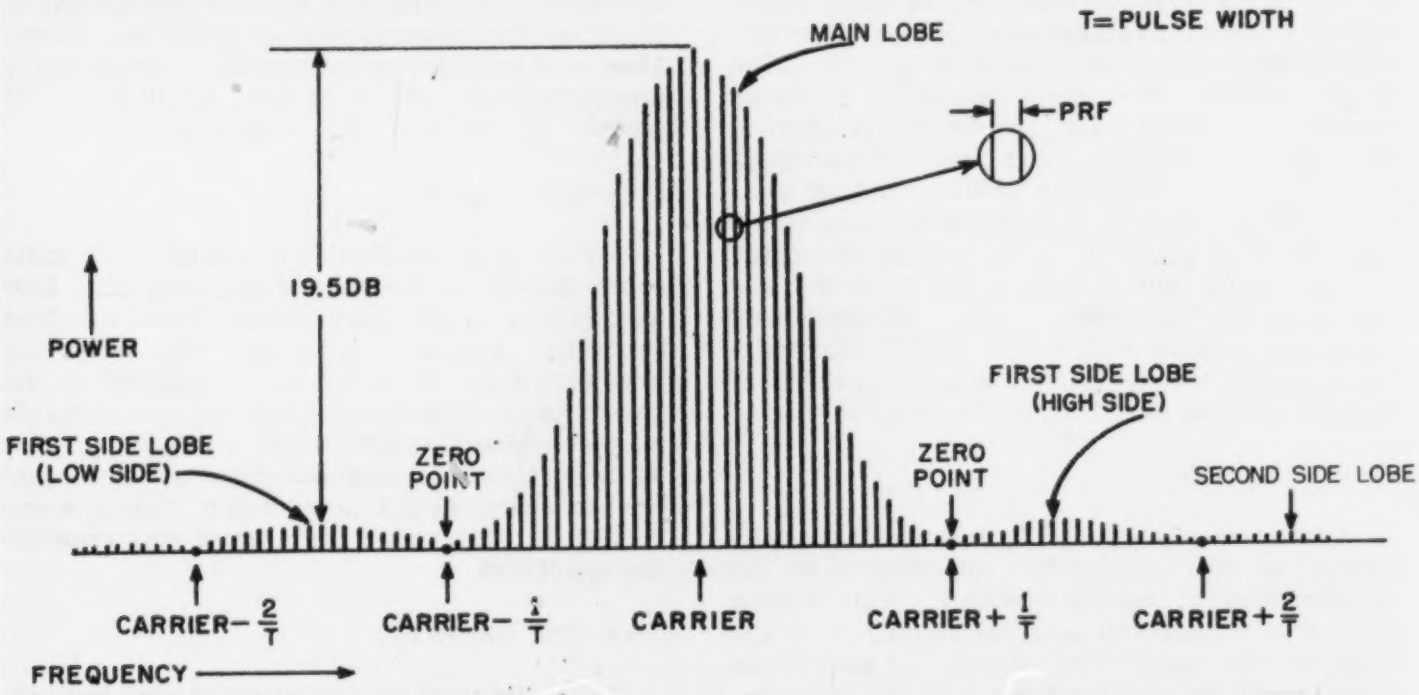

Figure 16-25. —Ideal spectrum of a pulsed magnetron.

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Instructions for donning, wearing, and operation of the LPP-1 are pictorially presented on this container. The assembly is also shipped and stored within this protective, instructive container.

5. Emergency signal light: A water activated light is secured to the right side of the buoyancy chamber. The light, which has an operation life of 8 continuous hours, consists of a lens, connector wire, and battery, and offers a small, compact illuminant for the survivor. The lens is attached near the top of the preserver to provide maximum visibility while the battery hangs below to insure its contact with water.

6. Whistle: A whistle is provided and attached to the pocket by a length of cord. The whistle is stowed in the pocket located at the front center of the preserver.

7. Sea dye marker: One packet of fluoresceine dye is stowed within the pouch and is attached to the belt by a 12- to 15-inch length of type I nylon cord.

8. Shark repellent: One packet of shark repellent compound is stowed within the pouch and is attached to the belt by a 12- to 15-inch length of type I nylon cord.

OPERATION OF THE LPP-1.—The LPP-1 is manually inflated by pulling the inflation assembly lanyard down. In an emergency situation, the oral inflation valve should be used to top off an inflated preserver, maintain inflation of a leaky preserver or to inflate a preserver when the inflation assembly malfunctions or fails. The oral inflation valve is also used to inflate a preserver with air during an inspection test or to deflate a preserver in preparation for packing.

NOTE: The pouch must be opened and the flotation assembly unrolled prior to inflation through the oral inflation valve or inflation assembly. This does not apply for LPP-1's modified for use by combatant helicopter aircrewmen.

DONNING: Donning of the LPP-1 life preserver is accomplished as listed in the following sequence of steps:

1. Remove preserver from storage container.
2. Place belt around the waist with pouch in back. Toggle pocket should be on the left side.
3. Connect the clasp and buckle and adjust the belt to size on the right side.
4. Secure the excess belt with mating hook and pile fastener tapes.
5. Rotate pouch to front and readjust the belt.
6. When ready for use, unsnap the pouch and unroll the deflated buoyancy chamber up. Place head through opening and allow upper portion of chamber to rest on shoulders.
7. Remove the pouch containing the dye marker and the shark repellent from the bottom of the buoyancy chamber.
8. After egression from the stricken aircraft inflate the buoyancy chamber by pulling down on the inflator toggle.
9. Emergency use of the survival detection aids shall be as required. Emergency use of the signal light can be initiated by pulling the tab downward to open battery port, allowing sea water to activate the battery.

TEST, INSPECTION, AND MAINTENANCE.—Test, inspection and maintenance of the LPP-1 must be conducted in accordance with Aviation-Crew Systems Manual Navair 13-1-6.1.

PACKING THE LPP-1.—To pack the LPP-1 life preserver for noncombatant personnel, proceed as follows:

1. Insure that the preserver, pouch, belt and storage container have been inspected for any defects. Inspect the complete assembly for updating and compliance with latest modification listed in Navair 13-1-6.1.
2. Insure that survival items have been inspected for expiration and damage.
3. Insure that the belt is inserted through retaining patch on rear of preserver.
4. Lay preserver on a clean surface with inflation assembly facing up.
5. Insert ends of belt through slots in pouch.
6. Insure that each survival item is properly stowed or attached.
7. Position dye marker and shark repellent in bottom of pouch. Lock oral inflation valve.
8. Fold flotation tube sides over the width of pouch.
9. Roll flotation tube into pouch and close pouch.
10. Insert packed preserver into storage container.

To pack the LPP-1 life preserver for combatant personnel, proceed as follows:

1. Insure that the preserver, pouch, belt and storage container have been inspected.
2. Insure that the belt is inserted through retaining patch on rear of preserver. Close inflation assembly protective cover.

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3. Tuck protective cover back panel through preserver neck opening.

4. Insert oral inflation valve through oral tube patch. Insert oral inflation valve loop through loop reinforcing patch. Stow oral inflation valve in loop. Insure that the oral inflation valve is locked.

5. Mate hook and pile tapes.

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CHAPTER 15

STANDARD LIFERAFTS AND EQUIPMENT

Naval aircraft making operational flights over water are required to carry rafts which will accommodate all the assigned crew plus passengers. These rafts are manufactured in various sizes and configurations to meet the demands of all types of aircraft.

Pneumatic rafts are compact assemblies, capable of being stowed in a small area. They should be stowed so as to be readily accessible, preferably near an emergency exit. Never stow a raft under other equipment or cargo or near batteries. Protect them from heaters, engines, auxiliary power units, electronic tubes, and other sources of heat.

If the aircraft flight manual designates a storage place for rafts, this space should be used, unless otherwise directed by competent authority. Whenever possible, rafts should be stowed in the same place in all aircraft of the same model. This will enable the crewmen to become familiar with their location and thus avoid confusion in the event of a ditching. Rafts are made of rubber impregnated nylon fabric and are therefore susceptible to damage from maltreatment. However, they are surprisingly strong and durable, and have tenacious stability when afloat at sea.

It is the responsibility of the PR to inspect, pack, and maintain all of the various types of rafts and related equipment.

MULTIPLACE RAFTS

All multiplace rafts are of the same construction, but vary in size and in the quantity of equipment they carry. As a safety measure they have separate air compartments. This enables the raft to maintain its buoyancy, even in the event of a puncture of one of its compartments. In the Mk 4, for example, there are three air compartments—two automatically inflated by CO_2 and a seat compartment which can be inflated with a hand pump. The two automatically inflated compartments are separated by a vertical bulkhead amidships.

Each raft is enclosed in a carrying case secured with snap fasteners or a ripcord arrangement. As the raft inflates, the case is forced apart, and the inflated raft emerges from the case. The case may be used as an additional drogue, or sea anchor.

CONSTRUCTION

The body of the raft consists of an encircling buoyant tube and a fabric bottom. All rafts are manufactured in sections to provide the specified shape. The fabric bottom of the raft is applied without tension across the enclosure formed by the flotation tube and is attached securely to the underside.

Seams

All seams and attachments are secured by self-curing rubber cement. No stitches are used in the seams or through the fabric of any compartment. However, sewing is permitted in the construction of patches, oarlocks, disks, flap seats, cylinder carriers, lifeline supports, handles, and pockets.

The minimum overlap for seams is three-fourths of an inch (+1/4-0 inch). They are reinforced both on the inside and on the outside with type R tape (1 1/4 inch wide). The tape is applied in such a way that an equal amount of width is on each side of the seam edge which it covers. The cement is applied in a straight line, parallel to the edges of the tape, and extends approximately one-eight inch beyond the tape edges.

Bulkheads

The flotation tube is separated into two compartments by internal vertical bulkheads.

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Bulkheads are constructed of type N rubberized fabric and are either hemispherical or conical in design. The bulkheads are installed amidships, equidistant from the bow and stern, in such a way that the volume of the two compartments is equal. The bulkhead-to-tube attachment is reinforced on one side with type R tape, and on the other side with a hinge of wider type N tape. A 4-inch-diameter patch of type O fabric is installed on the bulkhead for protection against abrasion by the manifold diffusers when the raft is packed in the carrying case.

On some Mk 20 rafts the internal bulkheads are positioned on each side of the boarding stations. This provides a section which is deflated and offers ease in boarding the raft.

Inflatable Seats

An inflatable seat is installed in certain multiplace rafts, for example, the Mk 4, Mk 7 and Mk 12A-1. These seats are circular in shape and are constructed of type O fabric. The ends of the seat are tailored to fit the curvature of the flotation tube. Each end of the seat is blocked with type N fabric, making the seat an independent air chamber before it is installed. These seats are independently inflated by a valve, using the hand pump provided.

The seat is attached to the bottom of the raft with a hinge tape of type N fabric, extending the length of the seat tube. This method of attachment allows for expansion, and prevents undue stresses between the bottom of the raft and the seat.

Oarlocks

Some liferafts are outfitted with oarlocks. The oarlock consists of seven plies of type O fabric cemented together. A No. 11 brass grommet is set in each oarlock, located so that the bottom edge of the hole is 1 inch above the flotation tube. Each oarlock is attached to the flotation tube outside the top centerline in such a position that the upright portion, containing the grommet, is at an angle from the vertical, inclined away from the centerline. An oarlock is also attached to the top of the flotation tube at the stern so that an oar can be inserted through the oarlock and be used as a rudder.

Mast Holder

One mast holder consisting of an upper and lower structure is constructed in each raft. The upper part of the mast holder consists of an oarlock attached in a horizontal position approximately 3 inches above the inside centerline of the flotation tube. The lower part consists of a socket made of two plies of type O fabric and is 4 inches in length. The socket is cemented to a 4-inch diameter patch consisting of two plies of type O fabric. The patch is then cemented to the raft bottom directly in line with the hole contained in the upper part. Together, these mast holder parts can support an oar handle in the vertical position. The handle passing through the upper hole in the oarlock terminates in the socket.

The Mk 20 liferaft has two mast sockets. They are cemented to the center of the raft floor on opposite sides, back to back.

Supply Pocket

Each Mk 4 and Mk 7 raft has a supply pocket which measures approximately 8 x 8 x 2 inches. It is attached to the tube surface inside the raft by stitching the pocket to a patch and cementing the patch to the tube. Each pocket should be clearly and indelibly marked SUPPLY POCKET in 1/2-inch letters.

Supply Pocket and Bailer

Another type of supply pocket is attached to each multiplace raft except the Mk 20. This pocket measures 10 x 10 x 2 inches and is constructed from type O fabric. The pocket is closed by means of a slide fastener across the top, which is sealed with tape after the equipment is packed. A loop of semihard spring wire is contained in the seam around the slide fastener so the pocket may be fashioned into a bailing container.

The pocket is secured to the flotation tube by means of two large curtain type fasteners so that it may be detached. To avoid loss of the pocket, it is secured to the nearest lifeline patch with a 5-foot length of type III suspension nylon line. The words SUPPLIES AND BAILER are stenciled in 1/2-inch letters on the pocket. Below this, stenciled in 1/4-inch letters, are the words:

KNIFE, SIGNALING MIRROR,
WHISTLE, LINE, COMPASS
and MAST CLAMP.

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Cylinder Carrier

One cylinder carrier, suitable for holding the CO_2 cylinder securely in position, is provided with each raft. The carriers are constructed and located in accordance with applicable standard drawings for each particular raft.

Lifeline

A 1/4-inch nylon or orlon lifeline encircles the perimeter of the raft. The line is attached to the raft by means of lifeline loops or supports. The lifeline is secured to the supports with overhand knots to prevent the line from running free through the supports. A 4-inch slack in the line is allowed between the supports.

The supports are constructed of type III nylon tape, 1 inch wide. A strip of webbing 5 inches long is threaded through a slot in a 3-inch-diameter type O fabric disk, forming a loop 1 inch long. The loose ends are securely stitched to the disk and two rows of stitching are made through the base of the webbing loop. This assembly is then cemented to the top outside quarter of the flotation tube midway between the horizontal and vertical centerlines of the tube. A type O fabric disk, 5 1/2-inches in diameter, with a slot in the center, is then cemented over the loop assembly to the flotation tube. Each completed lifeline patch can withstand a 200-pound pull exerted in a direction perpendicular to the base of the patch.

Righting Handles

Each raft has righting handles. Each handle is constructed of a 11-inch length of type III, 1-inch nylon tape. The handle is covered by an outer patch of type O fabric extending beyond the edge of the disk and securely cemented to the raft. A 1-inch slack is allowed in the attachment to make them easier to grasp.

Boarding Handles

Each raft has boarding handles. These boarding handles are constructed in the same manner as the righting handles. They are attached to the raft in accordance with the applicable drawings.

Topping-Off Valves

A topping-off valve is installed in each flotation tube compartment of the raft. The topping-off valve is used for hand inflation purposes in conjunction with the hand pump. It also serves as a means for relieving high internal tube pressures that may possibly build up during hot, sunny days. Both valves are installed on the same side of the raft, on the top inside quarter midway between the vertical and horizontal centerline 4 inches from the vertical (internal) bulkhead.

Stenciled instructions relative to topping-off and deflation of the raft are applied on the raft flotation tube adjacent to the topping-off valves. Appearing in 1/4-inch black letters, the instructions are stenciled on a white rubber patch as follows:

TO INFLATE COMPARTMENTS MANUALLY: Attach hand pump to valve cap, unscrew cap 1 1/2 turns to the right and then pump to inflate. When desired pressure is attained, retighten valve cap and remove pump.

TO DECREASE PRESSURE: Open valve 1 1/2 turns to the right and bleed.

Inflation System

The valve of the CO_2 cylinder is threaded into the coupling nut of the manifold. Since multiplace rafts are constructed with internal bulkheads, the purpose of the manifold is to provide a common means of directing and diffusing the flow of gas from the actuated cylinder to each of the separate compartments at the same time. To do this the manifold outlets must bridge the internal bulkhead over which they are mounted. Figure 15-1 illustrates the operation of a raft inflation system.

All the exposed metal surfaces of the inflation system which might chafe the raft fabric while in a packed condition should be suitably and securely covered with cheesecloth or suitable scrap cloth.

MK 4 RAFT

The Mk 4 raft is designed to accommodate four men plus sufficient emergency and accessory equipment to keep them alive for 1 week at sea. It is 9 feet 2 inches long and 5 feet wide. Complete with all equipment and the CO_2 inflation system, its weight is 86 pounds. The CO_2 cylinder has an internal volume of 147 cubic inches and the raft is inflated to a pressure of 1 psi by a CO_2 charge of 3.25 pounds. This

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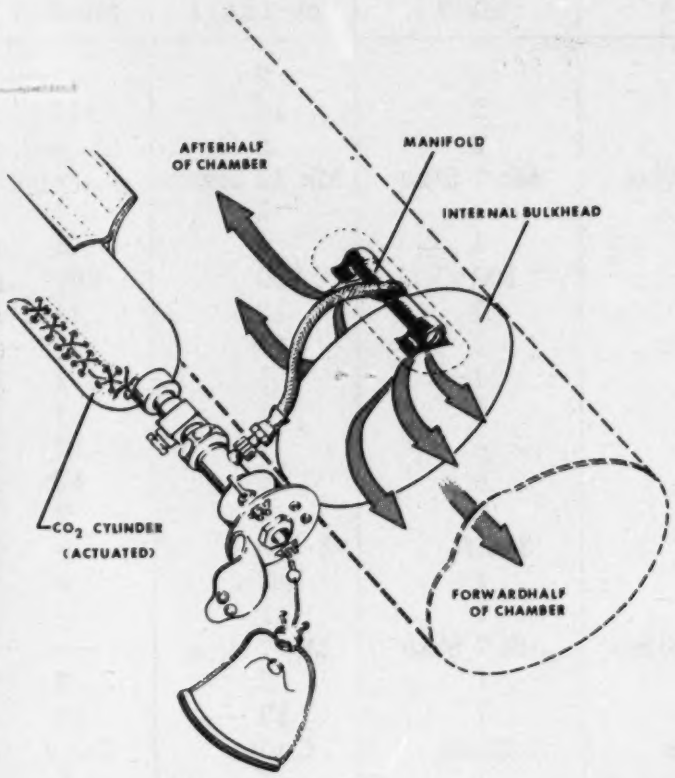

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Figure 15-1.—Multiplace raft inflation system.

pressure gives it a buoyant capacity of 1,800 pounds.

EQUIPMENT

The equipment carried in the Mk 4 raft differs from that carried in other rafts basically in the quantity carried, with a few minor exceptions. Therefore, all emergency and accessory equipment is covered here. Quantities for each individual raft are listed in table 15-1 of this chapter and NavAir 13-1-6.1.

Oars

Three complete oars and one additional section are supplied with each raft. These oars have a threefold purpose. They may be used for rowing or paddling, as reflecting blades for identification purposes in night rescue, and in varying combinations of length as a mast for rigging a shelter or in mounting a radar reflector.

The oars for the MK 4 rafts are approximately 5 feet long; whereas the oars for larger size rafts are approximately 6 feet long. The pneumatic raft sectional oar is shown in figure 15-2. The oars are constructed from aluminum alloy, and the paddle blade is coated with a retro-reflective material for night reflective purposes. Oars are stored in the accessories container of the respective rafts.

Hand Inflation Pump

Pumps are provided with all multiplace rafts and are used to inflate the rafts in case of failure of the CO_2 inflation system. The pump is also used to top off the raft after initial inflation with CO_2.

Hand pumps are stowed in the accessories container and held secure by a 3-foot length of type I nylon line.

Whistle

A whistle (police type) is provided for all rafts and is stowed in the supply pocket. The whistle is to be used by personnel for attracting attention of a rescue ship or personnel in foggy weather or at night. In still air and perfect silence, the whistle may be heard for 1,000 yards. Many successful rescues have been due to the use of a whistle. For security of the whistle, it is attached to a 3-foot line.

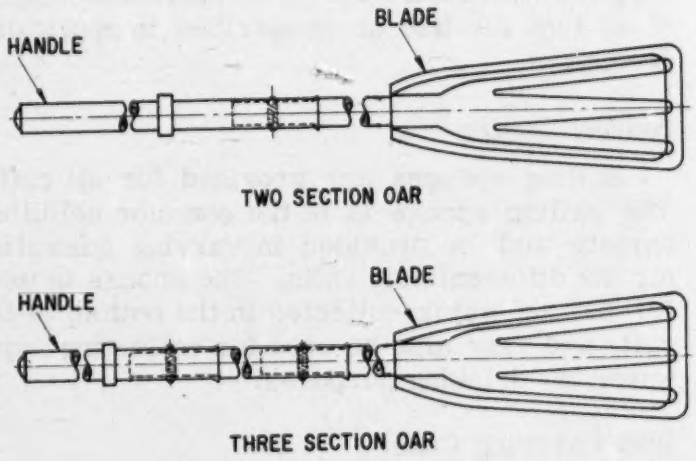

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Figure 15-2.—Pneumatic raft sectional oar.

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Table 15-1. —Emergency and accessory equipment.

Description of item	Mk 4	Mk 7	Mk 12A-1	Mk 20
Anchor, sea	1	1	2	2
Bag, water storage	4	7	12	12
Bed, hammock	1	2	2	-
	Mk 4 Size	Mk 7 Size	Mk 12 Size	-
Bucket, bailing	-	-	2	1
Compass, card type	1	1	1	1
Cord, nylon	100'	100'	200'	200'
Desalter kit	4	7	12	12
Solar distillation kit	4	7	12	12
Jackknife	1	1	1	1
Kit, first aid	1	1	1	1
Lamp assembly, flashlight type A-9	-	-	1	1
Marker, dye	6	6	6	12
Mirror, signaling	1	1	2	2
Oar	3-5 ft	3-6 ft	2-6 ft	-
Ointment, sunburn	1	1	2	3
Paulin	1	1	1	-
	Mk 4 Size	Mk 7 Size	Mk 7 Size	-
Pump, hand	1	1	2	2
Rations	4	7	12	12
	Cans	Cans	Cans	Cans
Radio set, survival	1	1	1	1
Signals, distress, Mk 13 mod 0	6	6	9	10
Sponge, bailing	2	2	2	2
Canopy rods	-	-	-	6
Whistle	1	1	1	2
Gnd/Air Emergency Code card	1	1	2	1

Nylon Cord

For utility purposes, type I nylon line is supplied with each raft. It is supplied in lengths of 50 feet for use as prescribed in applicable directives.

Bailing Sponge

Bailing sponges are provided for all rafts. The bailing sponge is of the common cellulose variety and is provided in varying quantities for the different size rafts. The sponge is used for bailing water collected in the bottom of the raft, and may also be used for collecting rainwater for drinking purposes.

Raft Carrying Case

Rafts are packed in carrying cases constructed of orange-yellow-coated fabric corresponding to the color of the rafts. The carrying case is designed to hold the raft in a deflated but ready condition for inflation wherever it is stowed. The closing hems of the case are fitted with snap fasteners, capable of being released in any direction of pull. The tenacity with which these snaps hold the raft in its case must not be too great. The pressures exerted by an inflating raft must be sufficient to "pop open" the snaps and release the raft without damage.

Retaining Line

The purpose of the retaining line is to secure the life raft to a user, thus preventing its loss before and after the raft is inflated. The retaining line is constructed of nylon cord, type III, or nylon webbing, type II, orange-yellow in color. The line varies in length, depending upon raft application. One end of the line attaches

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to the raft CO_2 cylinder while the other end terminates in a snaphook for attachment to the aircrewman.

Liferafts to be placed in wing or fuselage compartments of aircraft for remote control operation must be folded and packed WITHOUT carrying cases in accordance with the aircraft Maintenance Instructions Manual.

Righting Lines

In the event of capsizing, a righting line is installed on all Mk 4, Mk 7, and AR-4 multiplace rafts. This line is an independent piece of 1/4-inch nylon rope, 10 feet long, and is attached to the lifeline on the opposite side of the CO_2 cylinder at the center of the raft between the lifeline patches, by means of 2 half hitches.

Sea Anchor

The sea anchor furnished is a circular cone-shaped fabric device with an open bottom. The sea anchor is packed so that it falls into the water as soon as the raft is inflated. This reduces the danger of capsizing the raft by checking the drift and holding it "bow on" into a heavy sea. By reducing wind drift and slowing the raft down, the sea anchor also makes it easier for a man in the water to catch the raft. The sea anchor is also important in case of a helicopter pickup, for it helps keep the raft from drifting in the downdraft created by the helicopter rotors.

By virtue of the nature of its use, a sea anchor must be securely rigged to a strong mooring purchase. Such a mooring purchase is devised in a patch which, when cemented to the raft, is capable of withstanding a perpendicular pull of 400 pounds. Once the raft is inflated, a strong keeper line, which is longer than the one originally attached, should be secured between the raft and the sea anchor. In making the additional purchase, it should not be secured to the same mooring patch.

Hammock Bed

The raft hammock is suspended between the flotation tubes. The taut canvas provides a means of keeping off the floor when weather and sea conditions are adverse. The hammock may also be used to protect survivors from wind and rain.

The hammock is constructed of water repellent fabric, and is secured to the raft by wooden toggles and loops of webbing. One hammock is furnished with the Mk 4. Larger rafts are furnished with two. Hammocks are stowed in the accessory container.

Mast Clamp

The mast clamp is used primarily as an aid in rigging a sail. In lieu of the mast clamp, nylon cord can be used in securing a cross-member of an oar, serving as a mast. The clamp and line can also be used in securing a distress signal to an oar. The mast clamp is stowed in the raft supply pocket.

Emergency Equipment Container

The emergency equipment container supplied for the Mk 4 and Mk 7 rafts is drumlike in shape. The container has a slide fastener closure installed in one end for admittance of the equipment.

Each container is stenciled in 1-inch letters with the Mk number corresponding to the Mk number of the raft. A strip of type R tape accompanies each container. It is used for sealing the slide fastener after the container has been equipped. For shipment by the manufacturer, the empty container is secured to the raft by fastening the snap of the container line to the lifeline of the raft near the CO_2 cylinder.

Accessory Container

The accessory container is constructed of type O fabric. The oars and hand pump are among the items included and stowed in the accessory container. The container is protected at each end by a wad of felt or cheesecloth approximately three-fourths inch thick. This padding protects the equipment from damage when dropping the raft from aircraft. The hammock beds and paulin can be utilized to protect the other items stowed in the container. The following words are stenciled in 1/2-inch letters on the body of the container:

OARS, PUALIN, PUMP, HAMMOCK BED, SMOKE SIGNALS, DYE MARKERS, SPONGES.

Since multiplace rafts vary in size, the container sizes also vary to accommodate more equipment needed for the larger rafts.

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Signaling Mirror

The emergency signalling mirror is approximately 3 x 5 inches and consists of an aluminized reflecting mirror glass, a back cover glass, and a sighting device. It is used by personnel in rafts or on land to attract attention of passing aircraft or ships by reflection either in sunlight or in hazy weather. The reflections of this shatterproof mirror can be seen at a distance 3 to 5 times as great as those which a raft can be sighted at sea. On a clear sunny day, the mirror will reflect the equivalent of 8 million candlepower. Flashes from the mirror have been seen from a distance of 40 miles.

Figure 15-3 illustrates the operation of the signaling mirror. Past experience indicates that personnel may have difficulty using the mirror in a bobbing raft at sea. Practice signaling with the mirror on the ground should be encouraged as part of the training program for flight crews. Such practice will reduce the difficulty in case of emergencies. Before using the mirror, the protective coating must be removed from its surface.

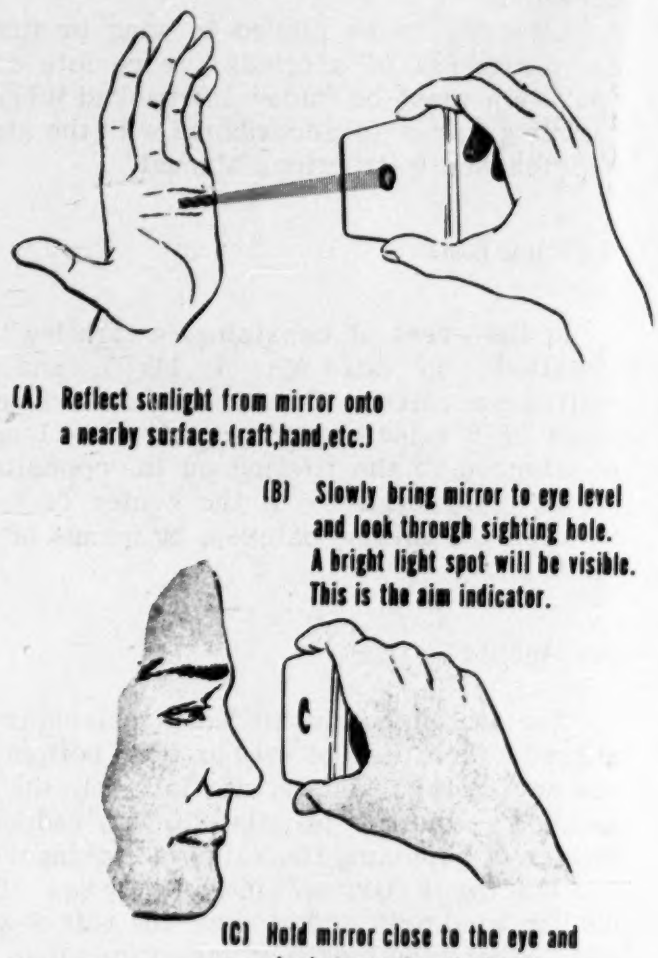

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Figure 15-3.—Operation of the signaling mirror.

Jackknife

The jackknife is a scout type, consisting of one large blade, a combination screwdriver and bottle opener, and one can opener. It is furnished with a 3-foot lanyard. One jackknife is furnished with each raft and stowed in the supply pocket. The value of a jacknife, especially under emergency circumstances, need not be emphasized as everyone can visualize its usefulness. When in a raft, one should never let the opened knife dangle from its lanyard or lie on the bottom of the raft.

Pocket Compass

The magnetic card type compass is encased in a cylindrical transparent plastic cover with a reference line inscribed on the top of the case. A circular card swings on a jeweled bearing, while a centered pivot supports and suspends the card in its free movement.

To cage the compass and protect the jeweled bearing, it is stored in an inverted position. The compass is reasonably shockproof, but it should be handled with care if one is to expect reliable readings. Damage to the case will impair its waterproof qualities, and promote corrosion in spite of its internal corrosion-resistant construction. Fittings outside of the base adapt the compass for wrist wear. One compass is provided for each raft and is stowed in the supply pocket.

Water Storage Bags

The water storage bags are made of strong transparent pliable plastic and will hold 5 quarts of water. The open end is reinforced and is designed to hold itself in a closed position. To seal the bag, use must be made of the strap and buckle located near its end. The bag can be sealed tightly by rolling or folding its opening for a short distance, and by securing the folds with the strap and buckle.

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When the bag is not being used for holding water, it can be used for stowage of items in need of protection from salt water. Protecting articles in this manner can lead to contamination; therefore, articles should be wrapped in something to prevent lubricants and other contaminants from coming in direct contact with the interior of the bag. Water storage bags can also be inflated, coupled with one another, and used as water wings for swimming. Water storage bags are stowed in the equipment containers of rafts.

Dye Markers

The dye marker packet contains a small quantity of crystalline dye compound. When the compound is exposed to the water, it slowly dissolves while producing a brillant yellowish-green fluorescence. Under good conditions the dye is exhausted in 20 to 30 minutes and ceases to be a good target after an hour. The dye is visible at an approximate distance of 10 miles at 3,000 feet altitude.

An exterior orange-yellow envelope serves the purposes of: (1) providing a water-proof container for the dye compound in a loosely woven bag; (2) acting as an anchoring point for the dye pouch which is secured to a long tape; and (3) supporting a tape across the top of the envelope which is used to tie the marker to vests and other basic items of survival. The accessories container of each raft is supplied with 6 to 12 dye markers, depending upon the size of the raft. (See table 15-1.)

Emergency Signaling Code

The Ground Air Emergency Code was designed to establish an international means of communication by the use of symbols between survivors and search and rescue parties. Its instructions and illustrations, printed on tough water-resistant paper, outline a series of conditions relative to emergencies in connection with disabled aircraft, medical problems, landing instructions for the rescue party, etc. Strips of cloth, sticks, stones, or anything available may be used to create the symbols.

The importance of the code is illustrated by the number of survival items which are equipped with it. One copy of the code is inserted in the inspection data pockets of all parachutes. The chest type parachute loses its pack upon opening; therefore, the parachute is specially equipped with a code pocket located on the yoke of its lift web assembly. A copy of the code must also be made available for navigation chart boards and in places where chart boards are not used. The code may also be posted in the flight compartment of aircraft.

One copy of the code must be packed in all rafts as follows:

1. Pump pocket of multiplace rafts.
2. Inspection pocket of PK-2 and PR-2 rafts.

Desalting Kit

The desalting kit is used for making potable water from salt water. Each package of chemical (briquets), when mixed with sea water in the plastic bag, makes about 1 pint of drinkable water. Before the chemical kits were made available, fresh water was contained in pint-sized cans. The cans of water posed many problems. They were cumbersome, weighty, became undrinkable with age, and invited rust. Although the kits represent a great advancement, their potential is limited to the number of briquets that are packed in them. Therefore, it is of utmost importance to start the solar still as soon as possible after being downed at sea.

The desalting kit consists of a hinged metal container with a retaining lanyard, seven or eight wrapped desalting briquets, a length of mending tape, and a plastic bag for processing the water to be desalted. The briquets, processing bag, and mending tape are attached to a nylon tie tape, to each other, and to the metal container. The desalting kits are stowed in the emergency equipped container.

The vinylite bag should be rinsed to decrease the taste which passes into the treated water. This is done by filling the bag one-third full of sea water and rubbing the inner surfaces of the bag gently for 2 minutes, then rinsing several times with fresh sea water.

The chemical process is purposely adjusted to leave a little salt in the desalted water to compensate for perspiration losses. If a less salty taste is desired, a smaller amount of water can be used in the bag.

The procedure for using the desalting kit follows:

1. Close valve at the bottom and fill bag to line with sea water.
2. Take out one package of chemical and close container.

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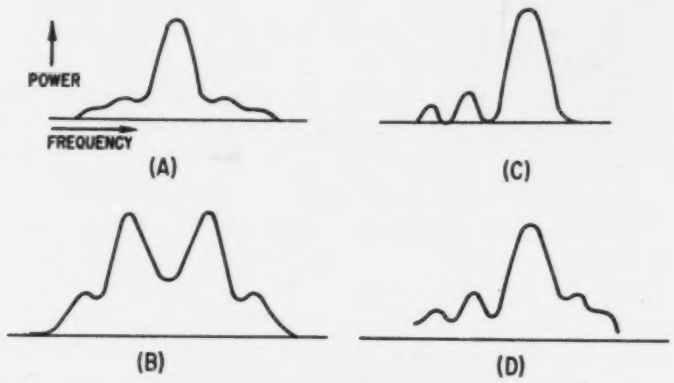

Figure 16-26. —Magnetron spectral displays showing distortion.

Incorrect Operating Frequency

The trouble of incorrect operating frequency usually breaks down into two possible causes: (1) The magnetron may be defective; or (2) pulling may exist because of some fault in the RF system or from strong reflections from a nearby object.

When a new magnetron is inserted to correct off-frequency operation, it is not necessarily true that the original magnetron is defective. Individual constructional differences of magnetrons may vary, causing one to be pulled more easily by external conditions than another of the same type number. It is seen, then, that irresponsible replacement of apparently defective magnetrons may result in the rejection of good tubes. It is first necessary to check for the presence of pulling, to determine whether the magnetron actually is at fault. This check is made by measuring the VSWR of the RF system, with the slotted line placed as close to the magnetron as possible, or by feeding the magnetron output into a dummy RF load and rechecking the frequency. When off-frequency operation occurs with a low VSWR, the indication is that the magnetron should be replaced, unless, of course, it is of the tunable type.

Poor Spectrum

As was previously discussed, spectrum analysis is of considerable importance in the maintenance of radar systems. The reason for a poor magnetron spectral display or graph may be: (1) magnetron pulling, (2) magnetron pushing, (3) defective magnet, or (4) defective magnetron.

Magnetron Pulling

The test for magnetron pulling may be made by means of VSWR measurements or by the use of a dummy antenna, as mentioned above. Magnetron pulling may cause frequency shift, but this may go unnoticed if the frequency is still within the operating band.

Magnetron Pushing

A poor spectral display or graph is frequently evidence of magnetron pushing, and this fault is the result of improper modulator operation. When the output pulse is of imporper shape or amplitude, especially at lower power levels, excessive AM or FM may be present. The test applied to the modulator is made with the aid of a synchroscope and voltage divider. The voltage divider serves the purpose of reducing the modulator pulse to a usable amplitude. This amplitude is observed and multiplied by the appropriate factor. The pulse shape is observed and compared with available waveform charts. Under certain conditions, the magnetron may cause improper loading of the modulator, and thus introduce pulse distortion. The use of a dummy load for the modulator eliminates this condition. The modulator dummy load is a resistive impedance equal to the firing impedance of the magnetron; in most cases, a voltage divider is built into the test equipment to facilitate the measurement of pulse amplitude. This load replaces the magnetron during pulse measurements, and, therefore, helps to isolate trouble definitely to the modulator.

Defective Magnet

A poor spectral display or graph often indicates defects in the magnetron magnet. Low magnetic strength may result from careless handling. Improper mounting may cause the magnetic field to enter the magnetron at the wrong angle on magnetrons utilizing a separate magnet. Mounting difficulties are quickly found on inspection, and magnetic field strength may be checked by using a gaussmeter. Under some conditions, reversal of the magnet may improve the spectrum.

Defective Magnetron

A poor spectral display or graph may indicate defective magnetron. A weak magnet may cause

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3. Remove outer wrapping of briquet, tear off one end of transparent inner wrapping, and pour all of the chemical into the bag of sea water.

4. Fold the top of the bag down tightly, rolling it towards the buckle and strap to make a watertight seal.

5. Permit the chemical to stand in the bag for a few minutes, and it will disintegrate.

6. Further pulverize the chemical by kneading it gently for 15 minutes.

7. Shake the bag gently for 30 minutes.

8. To drink the water, unscrew the valve located at the bottom of the bag, being careful not to squeeze the bag. Put the tube in the mouth, and gently squeeze the bag or suck on the tube. Spit out the first few drops if too salty.

9. When finished drinking, close valve. The remaining water can be left stowed in the bag.

10. When all the water has been drawn from the bag, rinse out the chemical with sea water. The bag is then ready for reuse.

11. In case the bag becomes damaged, dry the affected area carefully and apply a patch of the mending tape provided.

If the plastic bag becomes damaged beyond repair, or is lost, the metal container can be used. In this case, fill the container to the line marked on the inside. Then add one package of the chemical and shake the can gently for 30 minutes. Drink the water through an emergency filter, made by holding a piece of cloth over the top of the can.

Solar Still

The solar still is used for the purpose of converting salt water to potable water. It is a reliable means by which man is assured an adequate supply of fresh water for long periods at sea. The still operates most effectively in direct sunlight, and will produce approximately 2 pints of water per day. It will also work on cloudly days if the weather is hot. The water obtained is fresh and pure, and although it may have a harmless plasticlike taste, especially when the still is first used, one can survive on it.

The first distilled water may be milky because of the talc which is sprinkled on the inside of the bag at the time of manufacture to keep the plastic from sticking together. In setting up a new still, throw away the first 2-hour output, because the chemical preservative used inside the new bag will be in the water. To drink the initial output might make one sick.

The solar still is a spherical-shaped envelope fabricated of vinyl plastic film and packaged in a vinyl plastic film container. On one side of the still is an attached towline with hook. The inflating tube and fresh water drain are attached at the bottom of the still. Stills are provided one per rated man-capacity of the raft.

The procedure for operating the solar still follows:

1. Wet the cloth drain on the bottom of the still. This prevents air from escaping through the cloth until the still is fully inflated. The cloth then acts as a safety valve so that the still cannot be overinflated. Excess air escapes through the cloth.

2. Inflate orally through the inflating tube until the still is round and firm as shown in figure 15-4. The suspension points should indent, indicating that it is properly inflated. Kinks in the inflation tube will prevent inflation.

3. Place the still in the water, and while holding it upright, fill the reservoir with sea water. When the ballast tube is full, the still will float in an upright position without being held. The reservoir should always be kept full.

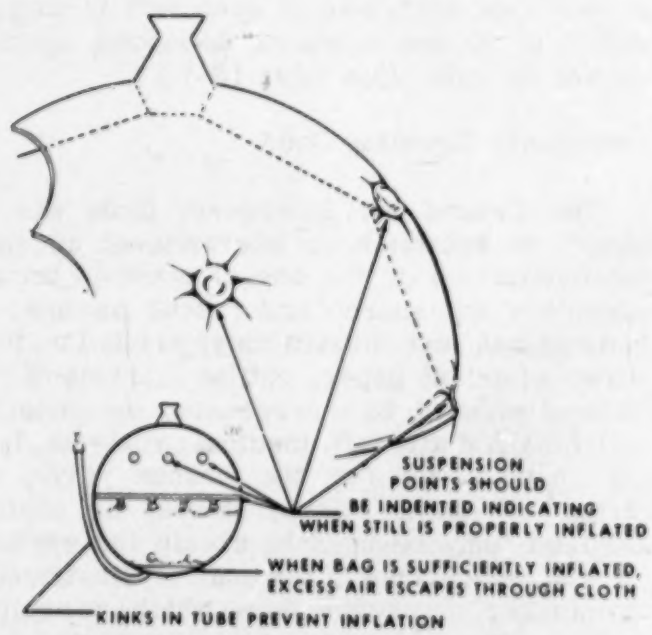

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Figure 15-4.—Inflated still, showing suspension points.

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Refill when water drops to the lower mark on the cup. This should be necessary about once every 1 1/2 hours.

The salt is distilled from the water as follows:

The sun's rays heat the sea water on the black evaporator cloth stretched across the center of each still, causing evaporation. This vapor then condenses on the sides of the plastic cover in the form of beads which run down to the fresh water trap below the ballast tube. The salts, however, do not evaporate, but remain temporarily in the black cloth until washed out the drain at the bottom of the still. The cloth is self-cleaning and need never be washed.

When operating, the still has a silvery appearance which is caused by condensation of fresh water on the inside of the bag. If the upper half of the bag loses its silvery appearance in spots, pull on the string located in the cup to clear the water feed of foreign matter.

The still has to be topped off with air periodically. The bag should be sufficiently inflated at all times to prevent the cloth from touching the outer bag, because the bag will then become contaminated with salt from the cloth.

The bag may be deflated at night. If it is, turn it upside down until the water runs out and the ballast tube is empty. Rubbing the cloth at the bottom with a dry cloth makes the still easier to deflate when pressure is applied to collapse it. When the still is put in use the next day, it should be drained of fresh water after the first 15 minutes to remove any salt water which may have accumulated inside the still after it was deflated.

While the solar still is suprisingly strong in most respects it can be cut easily. Therefore, care should be taken to avoid having it come in contact with sharp objects. If the still is cut, it should be repaired immediately with the mending tape. This tape is applied in the same manner as adhesive tape.

Raft Paulin

The paulin furnished with rafts is used for weather protection, water collection, camouflage, as a signal, or as a sail attached to an oar.

The paulin is a rubber-coated (neoprene), nylon-base cloth. When laid out flat it is rectangular in shape. A reinforced hem around the perimeter of the paulin supports a series of grommets. The grommets are provided for utility purposes, making it possible to lace the paulin into many shapes for use as cover, sail, raincatcher, or anything else devised for the occasion.

The weatherproof tarpaulin is colored neon red (older paulins are orange-yellow) on one side and nonspecular blue on the other. The Mk 4 paulin is 72 x 108 inches.

The paulin may be rigged as a sail to speed raft movement or to navigate the raft in a desired direction. Care should be taken in strong winds to prevent capsizing. The paulin can be stretched across the raft to give protection from heat and cold. Rain for drinking purposes is collected in a pocket located in the center of the paulin. In signaling with the paulin, refer to the system illustrated in figure 15-5. To insure complete familiarity with these signals it is suggested that periodic drills be conducted in the actual use of the paulin for signaling.

Distress Signals

The Mk 13 Mod 0 distress signal is used for day or night distress signaling. The signal may also be used to give wind drift information to helicopters performing pickups of downed personnel.

The Mk 13 Mod 0 distress signal is a pyrotechnic torch that burns approximately 18 seconds. It produces a red glow for night use and orange smoke for day use. Before igniting, select the signal (day or night) to be used.

The night flare can be identified in the dark by a series of small beadlike projections that are embossed around its circumference. After selecting the flare to be used, the sealing tape should then be torn off from around the end of the cylinder and the paper cap removed. Figure 15-6 illustrates the step by step procedures for using the Mk 13 Mod 0 distress signal. Grasp the pull ring and flip it over the rim of the signal case as shown in 15-6 (B). Press down the overhanging ring with your thumb until the seal snaps, as shown in (C). If the seal refuses to snap with this kind of force, continue pressing on the ring so that it bends over the rim and against the signal body as shown in (D). Flip the bend ring back to the top of the signal and press down (E), using the bend pull ring as a lever. After the seal breaks, point the signal away from your face and body and give a sharp yank on the pull ring. Hold the signal at an angle of approximately 45° from the horizontal with your arm fully extended. Care should be

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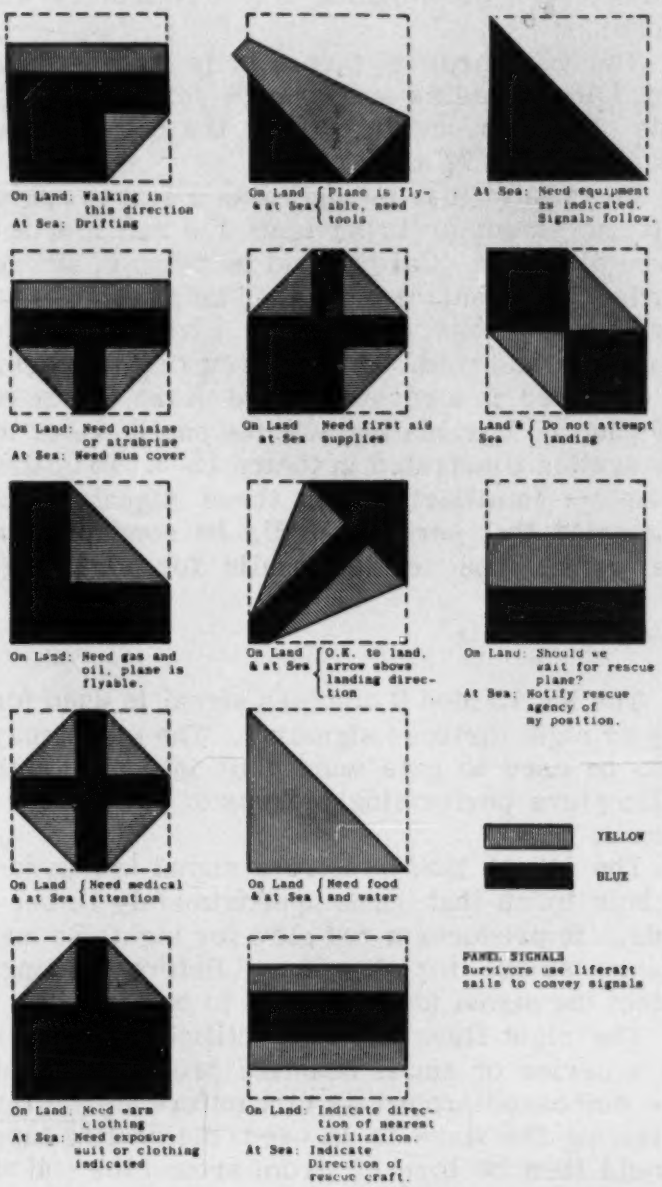

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Figure 15-5.—Paulin signals.

taken not to drop any of the contents on the user or the raft. After one end of the signal has been expended, it may be cooled by immersing in water and then saved until both ends have been used. The distress signal should be cool before being stored.

Illumination Signal Kit

The Illumination Signal Kit Mk 79 Mod 0, is a hand held signal used for day or night signaling by ground personnel or as a distress signal by downed pilots and aircrewmen.

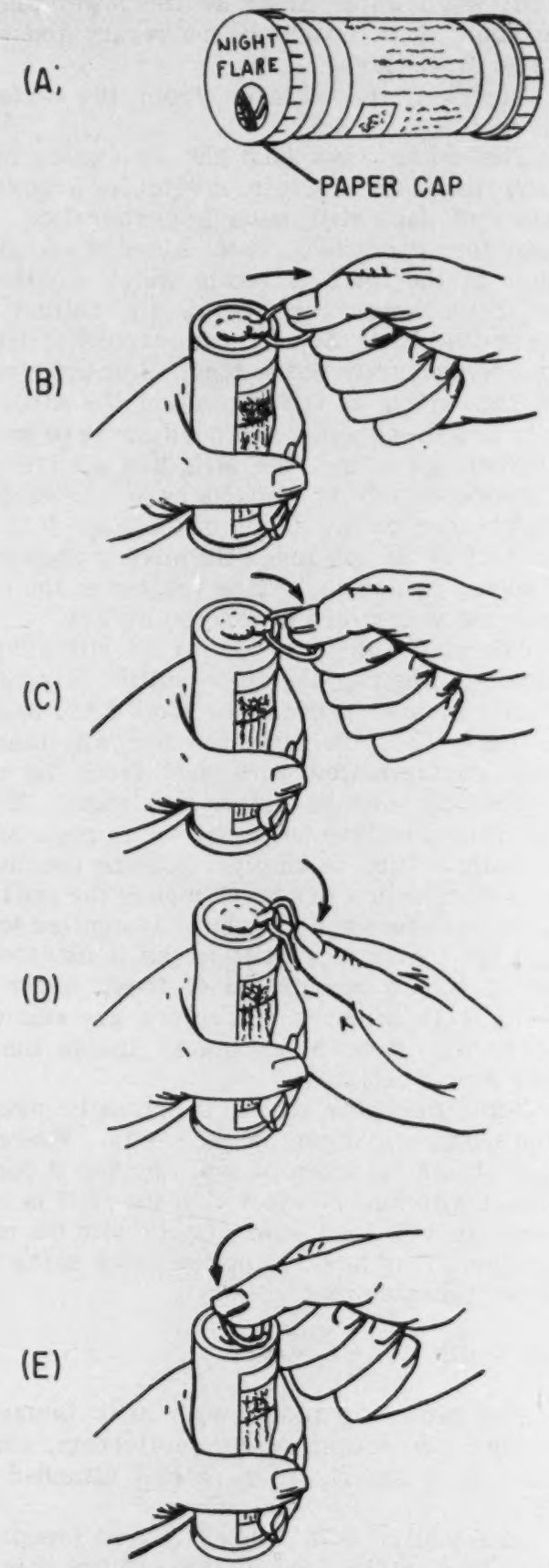

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Figure 15-6.—Igniting the Mk 13 Mod 0 distress signal.

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Each kit consists of one surface signal projector Mk 31 Mod 0 and seven hand fired signals Mk 80 Mod 0, inserted in a bandolier, as shown in figure 15-7.

The signal projector projects a 12,000 candlepower, red star, hand fired signal to altitudes in excess of 200 feet. It contains a lanyard for attaching the signal projector and bandolier of cartridges to the clothing of the pilot or aircrewman.

OPERATING INSTRUCTIONS.—Operating instructions for the Mk 79 Mod 0 kit are as follows:

1. Pull trigger screw into angular safety slot.
2. Mate projector with signal and rotate to right until signal is seated.
3. Hold projector, arm fully extended overhead.
4. Grip projector firmly. With snapping thumb action, pull trigger from safety slot and release into firing slot.
5. If signal misfires, at least one more attempt should be made to fire the signal.

First Aid Kits

One first aid kit is used with each of the multiplace rafts and is stowed in the emergency equipment container. The kit is installed when the raft is put in commission. The directions for the emergency use of the medicine and equipment can be found inside each first aid kit.

The first aid kit is a Bureau of Medicine and Surgery item.

Sunburn Ointment

Sunburn ointment is provided in a small container and should be stowed in the emergency equipment container to prevent if from deteriorating.

The sunburn ointment should be applied to all parts of the body that are exposed to the sun. For most effective results, rub the ointment well into the skin. The ointment can be used in this same way to give protection from windburn in cold areas.

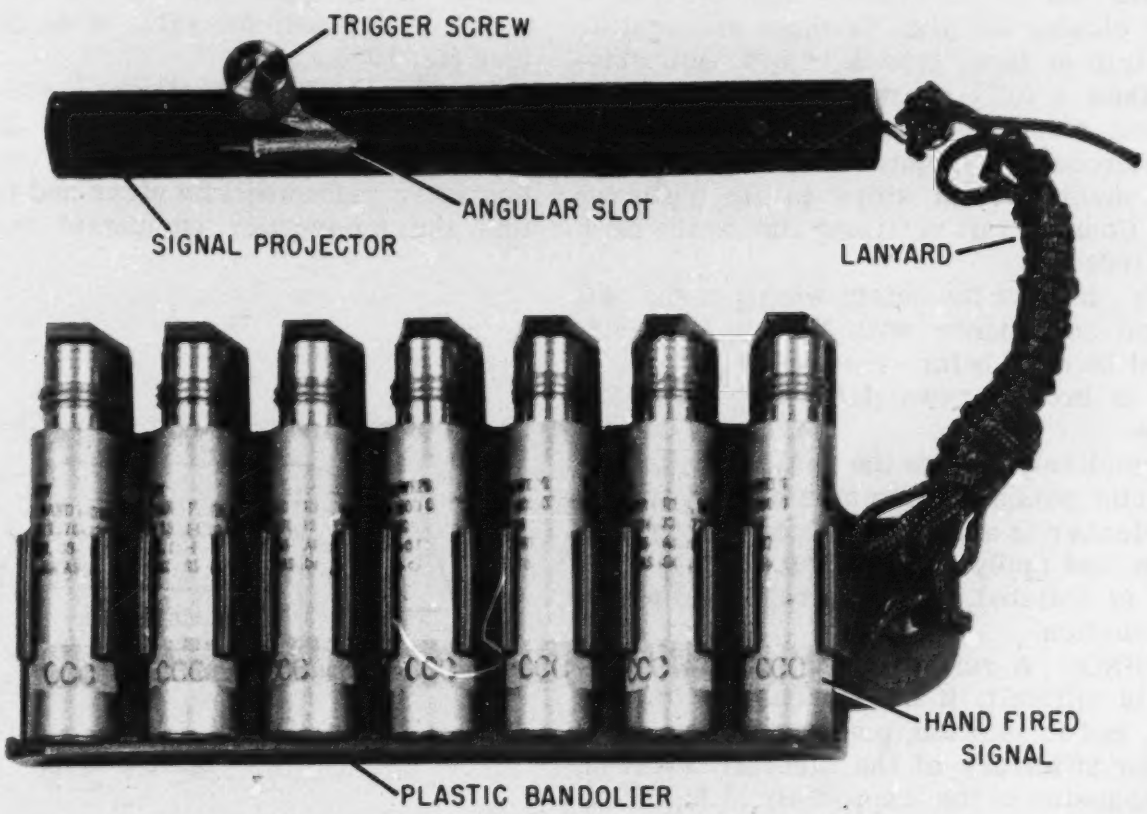

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Figure 15-7.—Illumination Signal Kit Mk 79 Mod 0.

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Rations

Tablet rations are contained in a pneumatically sealed can which can be opened with the key provided. Each unit contains the following:

5 sucrose citric acid tablets
10 sucrose lipid citric acid tablets
2 multivitamin tablets
2 sugar-coated chewing gum tablets
1 waterproof bag and 2 slips for the purpose of preserving unused portions of the rations.

One can of rations should be supplied for each man for which the raft is designed to accommodate. The rations are stowed in the emergency equipment container.

PACKING THE MK 4

Rafts must be properly folded, rolled, and packed; then stowed in the location prescribed in the aircraft flight manual. This will render them ready for immediate use in the event of an emergency over water.

The following procedure for packing applies to the Mk 4 and multiplace rafts in general:

1. Store all accessory and emergency equipment in the containers provided. Seal the supply pockets and the emergency equipment container by closing the slide fastener and sealing with a strip of tape, type R, 1 5/8 inch wide.

2. Attach a fully charged CO_2 cylinder of the proper size and type (as prescribed in Special Aeronautic Requirements-375) to the inflation manifold and store in the cylinder carrier. Connect raft retaining line to the neck of the cylinder.

NOTE: Inspect the safety wiring of the pull handle for compliance with NavAir 13-1-6.1. This must be done before the raft is packed. If the wire is broken, reweigh the CO_2 bottle and safety-tie.

3. Completely deflate the raft, using a suitable vacuum pump (the common household type vacuum cleaner is adequate). Open the topping-off valves and apply suction. As each flotation chamber is deflated, close the valve while still applying suction.

WARNING: A raft which is not completely deflated is difficult, if not impossible to pack properly, and in addition, poses a serious problem to the efficiency of the aircraft involved, due to expansion of the trapped air at high altitudes.

4. To prevent the folds of rubberized fabric from sticking together, the entire raft must be dusted with talc. Give particular attention to the area under the flotation tubes at the junction of the flotation tube and the raft bottom. This talc acts as a mild abrasive and assures a smoother and more positive unfolding action when the raft is being inflated.

5. Check the raft righting handles and the sea anchor retaining line for entanglement.

6. Inspect the emergency and accessory equipment containers for contents as listed in table 15-1. Replace any item which is missing or damaged. Check for security of retaining lines.

7. The words "Lash all equipment to raft to prevent loss" should be stenciled inboard of the top centerline on the flotation tube using black, 1-inch letters. Other paint and markings on rafts which are illegible or otherwise unreadable should be restored.

8. Lay out the raft case and inspect it for signs of wear, abrasion, rips, tears, or deterioration from acid or other damaging agents. Check the snap fasteners for operation and general condition (replace as necessary). Talc inside of case.

9. Position the accessories container in the center of the raft with the top end of the container in line with the valve of the CO_2 cylinder. (See fig. 15-8.)

10. Figure 15-9 illustrates the proper method of folding and rolling the Mk 4. Keep the raft retaining line and the emergency equipment container retaining line clear and positioned so that the emergency equipment container line

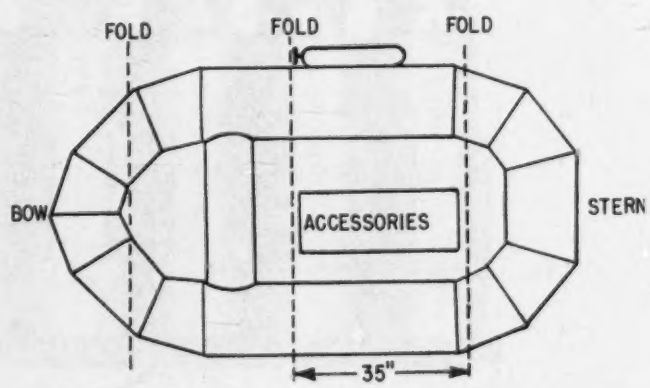

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Figure 15-8.—Position of the accessory container.

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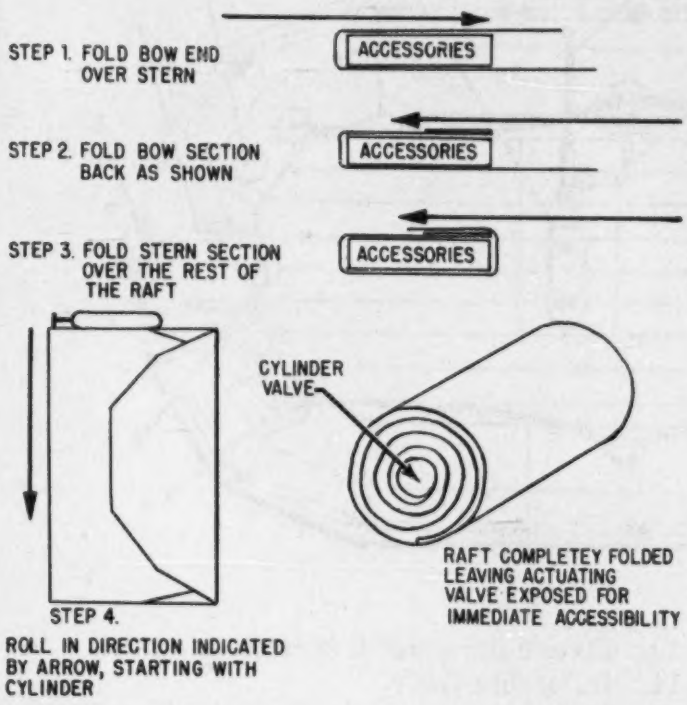

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Figure 15-9.—Folding and rolling the Mk 4.

emerges from the packed raft on the end opposite the CO_2 valve and the raft retaining line, attached to the CO_2 valve, emerges from the same end of the case.

11. After making the top fold and before starting to roll the raft, coil or fake the sea anchor retaining line on the top fold and place the sea anchor over this line.

12. Roll the raft, starting from the side with the CO_2 bottle attached. Leave the valve of the CO_2 bottle forward of the folds of the raft to permit it to emerge from the center of the end of the carrying case after the raft has been completely packed.

13. An inspection and packing data card should be signed by the person responsible for the work accomplished. This tag should be attached to the neck of the CO_2 bottle, so as to be visible at all times without unpacking the raft.

AR-4 DROPPABLE BOAT

The AR-4 droppable lifeboat is a four-man pneumatic boat of double tube construction. In the packed condition, the assembly is 41 inches in length and 16 inches in diameter. The total weight is approximately 105 pounds.

It is designed to be dropped from the bomb bays or bomb racks of aircraft at altitudes of 100 to 150 feet and at an indicated airspeed of 100 knots. It may also be carried within the fuselage of large aircraft and dropped by hand from hatches. Two adjustable supporting straps are supplied with the container so that the unit may be slung torpedo fashion between the bomb racks. These straps are attached in such a manner that in the event that only one bomb rack is released, the strap will pull free from the container and not impede the fall of the assembly.

The boat is complete with a sailing rig, mast, rudder, keel, weather shield, sun canopy, sea anchor and inflatable floor. The two-compartment, removable, inflatable floor is inflated through the topping-off valves provided, with a handpump. The floor is designed so that will not chafe the flotation tube of the boat. Removed, it can be used as an auxiliary means of flotation.

Figures 15-10 and 15-11 illustrate the AR-4 lifeboat.

An instruction booklet is stowed in the starboard bow pocket of each assembly. The booklet contains complete instructions for operating the boat.

CO_2 SYSTEM

Only the main flotation tube is inflated with CO_2. The remaining inflation chambers must be inflated with handpumps. A wrench, suitable for detaching the CO_2 cylinder from the boat, is securely attached adjacent to the cylinder.

SAILING RIG

A mast yardarm is formed from sections of oars which are the same as those used in the standard type multiplace rafts. Oar sections necessary for forming the mast yardarm are as follows:

Oar and section	No. required
6-ft oar (Section A).....	2
6-ft oar (Section B).....	6
6-ft oar (Section C).....	2

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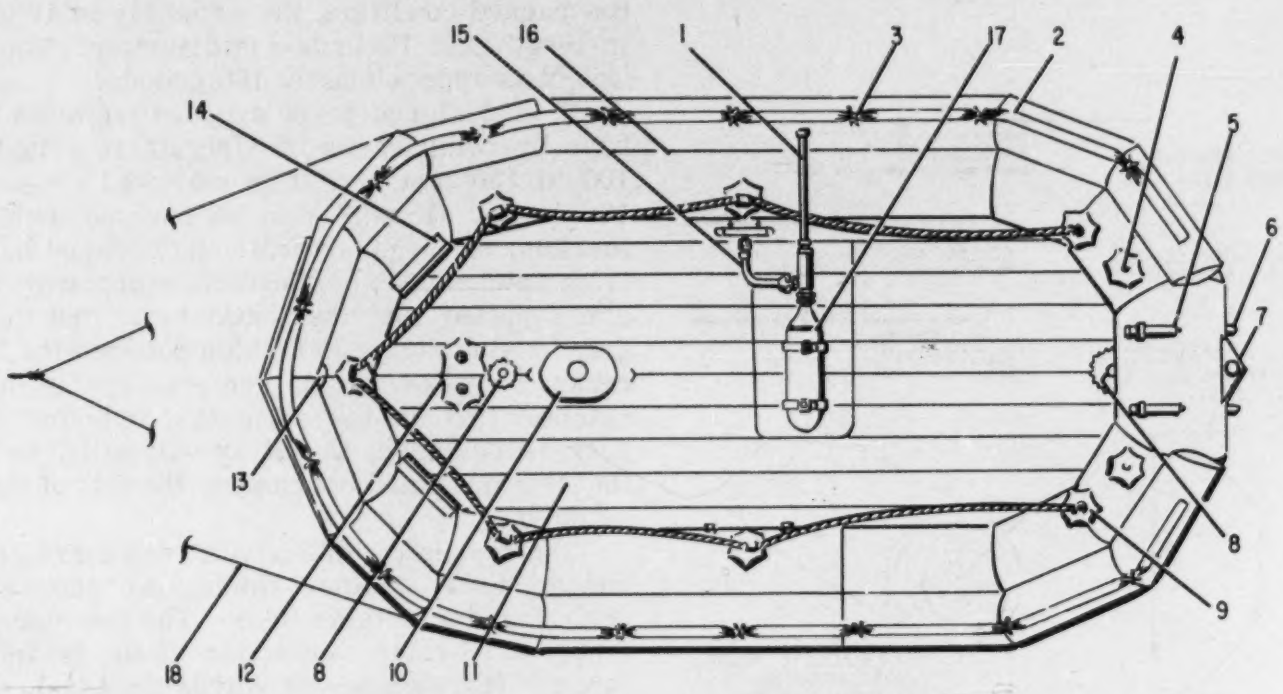

1. CO_2 valve cable.
2. Weather shield.
3. Weather shield tiedown.
4. Patch for sheet lead.
5. Motor mount buckle straps.
6. Fabric loops for motor mount.
7. Rudder lock.
8. Socket to receive oar length.
9. Lifeline patch inboard.
10. Sleeve for mast insertion into keel.
11. Inflatable floor.
12. Valves for two-compartment floor.
13. D-ring for bow mast stay.
14. Stowage pockets.
15. CO_2 hose assembly.
16. D-ring for starboard mast.
17. CO_2 cylinder and valve.
18. Sea anchor bridle.

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Figure 15-10.—AR-4 lifeboat (basic plan).

The mast is made up of 1 section A length and 2 section B lengths. The yardarm consists of 1 section A length and 4 section B lengths. Section C lengths are used with any of the other sections when paddles are needed.

MAST STAY AND HALYARD FITTING

One wooden fitting is supplied to fit the top of the mast to hold the three mast stays and receive the halyard as shown in figure 15-11.

The D-ring assemblies for the mast stays consist of 1 1/4-inch cadmium-plated D-rings secured to type O fabric patches by lengths of nylon webbing 1 inch wide, passed through the ring, and stitched to fabric patches. These rings, when installed, must be able to withstand a straightaway pull of at least 300 pounds.

The mast halyard cleat is a metal cleat designed for attachment by clamping to the mast. It is used for securing the sail hoist and yardarm securing lines.

SAIL, RUDDER, AND MOTOR

The sail material is made from 2-ounce sailcloth. Its color is blue, and the sail is equipped with a fabric sleeve to receive the yardarm. A collapsible wooden rudder folds in half, lengthwise, through the middle on hinges. No motor is supplied with the assembly; however, it is equipped to receive one of low horsepower.

MARKINGS ON THE RAFT

When markings become obliterated, consult NavAir 13-1-6.1 for information that will direct

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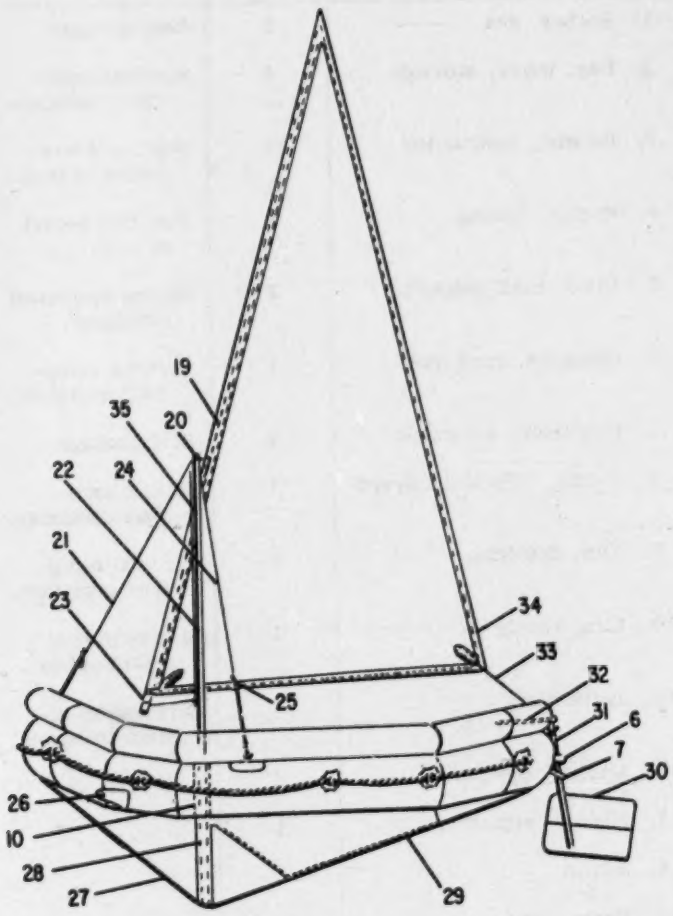

19. Yardarm sleeve in sail.
20. Mast stay and halyard fitting.
21. Bow mast stay.
22. Mast
23. Yardarm.
24. Stay.
25. Stay adjustors, wooden.
26. Sea anchor D-ring.
27. Keel cable.
28. Fabric sleeve to receive mast.
29. Fabric keel.
30. Rudder, hinged through supports.
31. Rudder post.
32. Tiller.
33. Sail sheet lead.
34. Sail.
35. Halyard.

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Figure 15-11.—AR-4 lifeboat (rigged for sailing).

the proper phrasing, size of the letters, paint or other liquid vehicle to use, and the location of the instructions to be reapplied.

MISCELLANEOUS EQUIPMENT

The following is a list of the miscellaneous equipment for the AR-4:

1. Hand pumps. Two plastic hand pumps are supplied for emergency inflation.
2. Nylon cord. The supply pocket contains 100 feet of type I nylon cord, which is intended for general utility purposes.
3. Whistle. One police type whistle is provided.
4. Bailing sponge.
5. Bailing buckets. Two bailing buckets, constructed of type N fabric, are supplied with each boat.
6. Jackknife.

EQUIPMENT CONTAINERS

Two equipment containers are supplied with each boat. One is used to contain the following sailing equipment; Sail, mast, and yardarm sections; mast stay and halyard fittings; and rudder assembly. The other container holds all other items of equipment, except the sea anchor, instruction booklet, and bailing buckets. The contents are marked on the containers in 1/4-inch letters.

CARRYING CASE

The boat is packed in the carrying case. The outer color of the case is orange yellow. The case consists of an outer ply of type II fabric (in accordance with specifications) backed up by a ply of 8-ounce cotton duck. The ends are closed by snap fasteners. The longitudinal opening is enclosed by a locking pin-and-cone assembly attached to the CO_2 valve by a snaphook fastener. This assembly is covered by a fabric flap, closed by snap fasteners. A pull on the valve cable releases the locking pins on the case before actuating the CO_2 valve. Two webbing straps are provided to suspend the unit from aircraft bomb racks. Each strap is made from webbing 2 inches wide (400-pound minimum breaking strength) equipped with a parachute harness V-ring on each end. Each strap is also equipped with buckles for adjustment. The maximum length of each strap assembly

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extended is 65 inches. A V-ring is installed at one end of the case at the base of the opening.

SEA ANCHOR

One sea anchor is supplied with each raft, attached by a bowline knot to its mooring patch. The sea anchor must not be rolled inside the boat, but must be stowed in the boat carrying case, thus permitting the sea anchor to fall into the water upon inflation of the boat. When packing, care must be taken to insure that the bowline does not foul and bind the boat during inflation.

EQUIPMENT STOWAGE

Table 15-2 illustrates where the additional equipment is stowed in the AR-4 assembly; and also where the equipment previously described is stowed.

Packing the Equipment

The bailing buckets are stowed in the port bow pocket. All rigid parts must be wrapped individually with cloth or felt paddings to protect the parts and the raft fabric from damage. The mast and oar sections must be secured together and be padded at both ends. The equipment containers are stowed adjacent to the CO_2 cylinder, one on each side of the cylinder, and each container is secured to the inside lifeline by a 6-foot length of type III nylon line.

The metal parts of the manifold and the CO_2 cylinder valve must be wrapped carefully with wads of cheesecloth or felt. The cylinder must also be padded at both ends. The CO_2 cylinder assembly is the heaviest single item of equipment for its size, and must be prevented from damaging the boat when the unit is dropped at or below 100 knots indicated airspeed.

All metal parts, such as D-rings, buckles, valves, etc., must be wrapped securely with cloth or felt padding.

The rudder is collapsed completely, bound together, and stowed (well-padded) in the equipment container.

FOLDING THE LIFEBOAT

First of all, the boat must be deflated completely. Then spread the boat flat so that gear may be stowed on it. Fold each side toward the middle and on top of all stowed gear. The CO_2

Table 15-2.—AR-4 lifeboat equipment.

Article	Quantity	Location
1. Anchor, sea	1	Boat package.
2. Bag, water, stowage.	4	Survival equipment container.
3. Booklet, instruction	1	Starboard bow pocket of boat.
4. Bucket, bailing	2	Port bow pocket of boat.
5. Cleat, mast halyard	1	Sailing equipment container.
6. Compass, card type	1	Survival equipment container.
7. Container, equipment	2	Boat package.
8. Fitting, stay and halyard.	1	Sailing equipment container.
9. Kits, desalting	4	Survival equipment container.
10. Kits, repair	1	Starboard bow pocket of boat.
11. Jackknife	1	Survival equipment container.
12. Marker, dye pack	6	
13. Mirror, signaling	1	
14. Paulin	1	
15. Pump, hand	2	
16. Solar Stills	4	
17. Rudder	1	Sailing equipment container.
18. Sail	1	Sailing equipment container.
19. Sections, oars, mast, yardarm.	2 Sec. A 6 Sec. B 2 Sec. C	
20. Signals, distress (day and night).	3	Survival equipment container.
21. Sponge, bailing	1	
22. Stays, mast	3	Sailing equipment container.
23. Whistle	1	Survival equipment container.
24. Nylon cord (type I)	100 ft	
25. Emergency signaling code.	2	

actuator control cable must fall on top of the starboard fold in such a manner that it can be operated after the boat is rolled.

Roll the boat from each end toward the CO_2 cylinder at the center. When rolling from the bow to the cylinder, care must be taken in that the keel cable does not foul during the inflation of the boat. The cable is held as near as possible to the center of the bottom during the rolling operation. The keel must be extended flat on one side. The CO_2 actuating control must be kept clear.

The boat is placed in the carrying case, folded and rolled, with the open portion up, and alined with the carrying case opening. This is to assure that the boat will float and inflate right side up on the water. After this, the case is closed as the releasing assembly is engaged.

INSPECTION TESTS

A system has been adopted whereby inflatable equipment will be functionally tested, with carbon dioxide inflation, upon issue and every fourth inspection cycle thereafter. The intervals between aircraft calendar inspection cycles must not exceed 22 weeks.

Functional Test

Insure that the area surrounding the raft is clear of foreign objects. Inflate the raft with the installed carbon dioxide inflation system so that the raft inflates to the design shape and to ascertain that all parts of the inflation assembly perform properly.

Leakage Test

Insure that all of the carbon dioxide installed in the raft during the functional test is completely removed, using a rotary vacuum pump. If a rotary vacuum pump is not available, a vacuum cleaner may be used.

Inflate the compartments of the raft with air until the compartments are inflated to the pressure indicated in table 15-3.

Allow 15 minutes for the raft pressure to stabilize and adjust the pressure if necessary to the original pressure of 2 psi. Allow the raft to remain inflated for 4 hours, then read and record the pressure. If the pressure of the raft is below the pressure required in table 15-3 under the minimum pressure column, inflate the raft to leakage test pressure and coat the compartment with a soap solution to locate the leak. Mark the leak area and rinse with clean water, air dry, and make repair.

Inspection of Physical Condition of Raft, Container, and Case

This task may be done concurrently with the leakage test. To inspect the raft, container, and case, proceed as follows:

1. Inspect all the seams, including those joining the flotation tube to the raft floor, for proper adhesion.
2. Inspect the raft floor for tears and punctures.
3. Apply a small amount of soap solution to the inlet valve and manifold and inspect for leaks; also inspect the valve and manifold for damage, wear, and corrosion.
4. Check the operation of the topping-off valve by opening it to partially deflate the raft and then close the valve. Apply a small amount of soap solution to the valve to insure that it has properly seated.
5. Inspect all patches, pockets, handles, nylon lines, sea anchor, and all other parts for sign of wear, damage, tears, security of attachment, and proper adhesion. Inspect all the hardware for proper operation, corrosion, and security. Make any necessary repairs.
6. Compare the markings illustrated in NavAir 13-1-6.1 to the raft being inspected to insure proper location, context, and legibility. Restencil the raft if necessary.
7. Inspect all accessories and survival items for damage, excessive wear, corrosion, expended contents and expiration of service life. Replace the items as necessary.

Modular Requisitioning of Equipment

Inflatable survival equipment and accessories are no longer procured as an assembly. Instead, the components making up an assembly are individually procured. For example, when the one-man raft was previously requisitioned from stock, the inflation valve, carbon dioxide cylinder, outer container and, in most cases, survival items were included. Under the new system if a raft is requisitioned, only a raft will be provided. If an inflation valve is required, it must be requisitioned separately.

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the magnetron imput to exceed rated values; if so, continued operation will result in a damaged unit. Missing lines in the spectral display are the result of magnetron arcing, and, if excessive, may completely destroy the shape of the spectrum. New magnetrons display moderate arcing until seasoning is completed, and, therefore, should be allowed a sufficient breaking-in period before the spectrum is analyzed. As mentioned previously, the end of the useful life of a magnetron is characterized by an increase in arcing and general instability. When the output power is low, it usually indicates a weak magnetron or a low modulator output. This uncertain condition may be resolved by testing the modulator output pulse; normal pulse indicates that the trouble is in the magnetron.

RECEIVER SENSITIVITY

The performance of a radar receiver is determined by several factors, most of which are evolved and established in the design engineering of the equipment. In the paragraphs to follow, only those which are concerned with maintenance are considered. The more important factors are receiver sensitivity (which includes noise figure determination and minimum discernible signal (MDS) measurement), TR recovery time, receiver recovery time, and receiver bandwidth.

Many radar receivers have circuits which are designed to serve a special function. Three of these special circuits commonly encountered are instantaneous automatic gain control (IAGC), sensitivity time control (STC), and fast time constant (FTC). These circuits may be found in combination or singly, depending upon the purpose of the radar. In the test methods and procedures described herein, the special functions should be disabled. The automatic frequency control (AFC) circuit may be permitted to operate during the receiver tests. A good check on the AFC is to make the tests specified for manual tuning, then switch to AFC. If the AFC circuit is normal, the signal indications will not change.

Inefficient range performance of a radar system can be caused by troubles in the radar receiver. This is due to the great number of adjustments and components associated with the receiver. Loss of receiver sensitivity has the same effect on range as a decrease of transmitter power. For example, a 6-db loss of receiver sensitivity shortens the effective range of a radar just as much as a 6-db loss in transmitter power. Such a drop in transmitter power is very evident in meter indications and, therefore, is easy to detect. On the other hand, a loss in receiver sensitivity, which can easily result from a slight misadjustment in the receiver, is very difficult to detect unless accurate measurements are made.

Figure 16-27 shows a comparison of radar system performance versus maximum range. The loss of system performance in db includes both transmitter and receiver losses. It should be noted that with a loss of 5-db in both receiver and transmitter (total of 10-db) performance, only 55 percent of the system's maximum range is realized.

The sensitivity of the receiver determines the ability of the radar to pick up weak signals. Greater sensitivity indicates that the receiver can pick up weaker signals. Sensitivity is measured by determining the power level of the MDS. MDS is defined as the weakest signal that produces a visible receiver output; its value is determined by the receiver output noise level which tends to obscure weak signals. It follows, therefore, that an MDS level is dependent upon the receiver noise level. (See Basic Electronics for a discussion on noise in amplifier circuits.)

The measurement of a minimum discernible signal consists of measuring the power of a pulse whose level is just sufficient to produce a visible receiver output. If a radar receiver has the specified MDS level, the noise figure should be correct also. Therefore, measurement of the MDS is a satisfactory substitute for a noise-figure determination, and is less complicated. When readings are taken for comparison purposes, correct pulse length must be used. Maintenance instructions for the radar set will usually specify the pulse length to be used in receiver sensitivity tests. In most cases it will be the same as the transmitter pulse.

Figure 7-28 (chapter 7) shows a simplified block diagram of the AN/UPM-32 test set connected for signal generator operation. When the test set is operated as a signal generator, the test set klystron oscillator supplies FM, pulse-modulated, CW, or externally modulated microwave signals.

The klystron oscillator output passes through the uncalibrated variable attenuator to a microwave tee. At this point the power splits evenly in both directions. One-half goes to the power monitor for the reference level indication and the other half passes through the calibrated variable attenuator to the RF connection and

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Table 15-3. —Liferaft pressures.

Type	Compartment	Leakage test pressure (PSIG)	Minimum pressure (PSIG)
LR-1		2	1.60
AR-4	Bow section	2	1.60
	*Stern section	2	1.60
	*Upper tube	1	.60
	*Inflatable floor	1	.60
Mk-4 and Mk-7	*Bow section	2	1.60
	*Inflatable seat	1	.60
	Stern section	2	1.60
Mk-12A-1	Bow section	2	1.60
	Stern section	2	1.60
	*Upper tube	1	.60
	*Inflatable floor sections	1	.60
	*Inflatable seat	1	.60
Mk-20	*Upper tube	3	2.60
	*Lower tube	3	2.60
	*Floor support tube	2	1.60

* Compartments may be tested simultaneously.

MK 7 RAFT

The Mk 7 raft is basically the same in design as the Mk 4, except in size and amount of equipment carried. It is 12 feet long and 5 feet 8 inches wide when inflated. Its gross weight when packed (including the CO_2 system with all equipment) is 114 pounds. The internal volume of the CO_2 cylinder is 205 cubic inches, and the CO_2 charge required to inflate the raft to 1 psi is 4.70 pounds. The raft provides a maximum buoyancy of 2,500 pounds.

EQUIPMENT

The Mk 7 is designed to accommodate seven survivors and carries accessory and emergency equipment to sustain this number for 7 days. This equipment is listed in table 15-1.

PACKING

Attach a fully charged CO_2 cylinder to the inflation manifold. NOTE: Check pull cable for compliance with NavAir 13-1-6.1. Stow equipment, dust entire raft with talc, and position raft case in the same manner as with the Mk 4.

At a point as near the filler manifold as possible, fold the bow section over the stern. At approximately 35 inches from this fold, fold the bow section back over itself. The stern section is then folded over the raft and back again to make the folded width of the raft about 35 inches.

Beginning on the side with the CO_2 bottle, roll as tightly as possible. (See fig. 15-12.) Complete the packing in the same manner as for Mk 4.

MK 12A-1 RAFT

The Mk 12A-1 inflatable raft is intended for use as emergency survival equipment for survivors of transport type aircraft forced down at sea. It consists of two buoyancy chambers (main and upper flotation tube) mounted one upon the other, with a raft body.

The raft is equipped with an inflatable seat, two removable inflatable floors, and a canopy.

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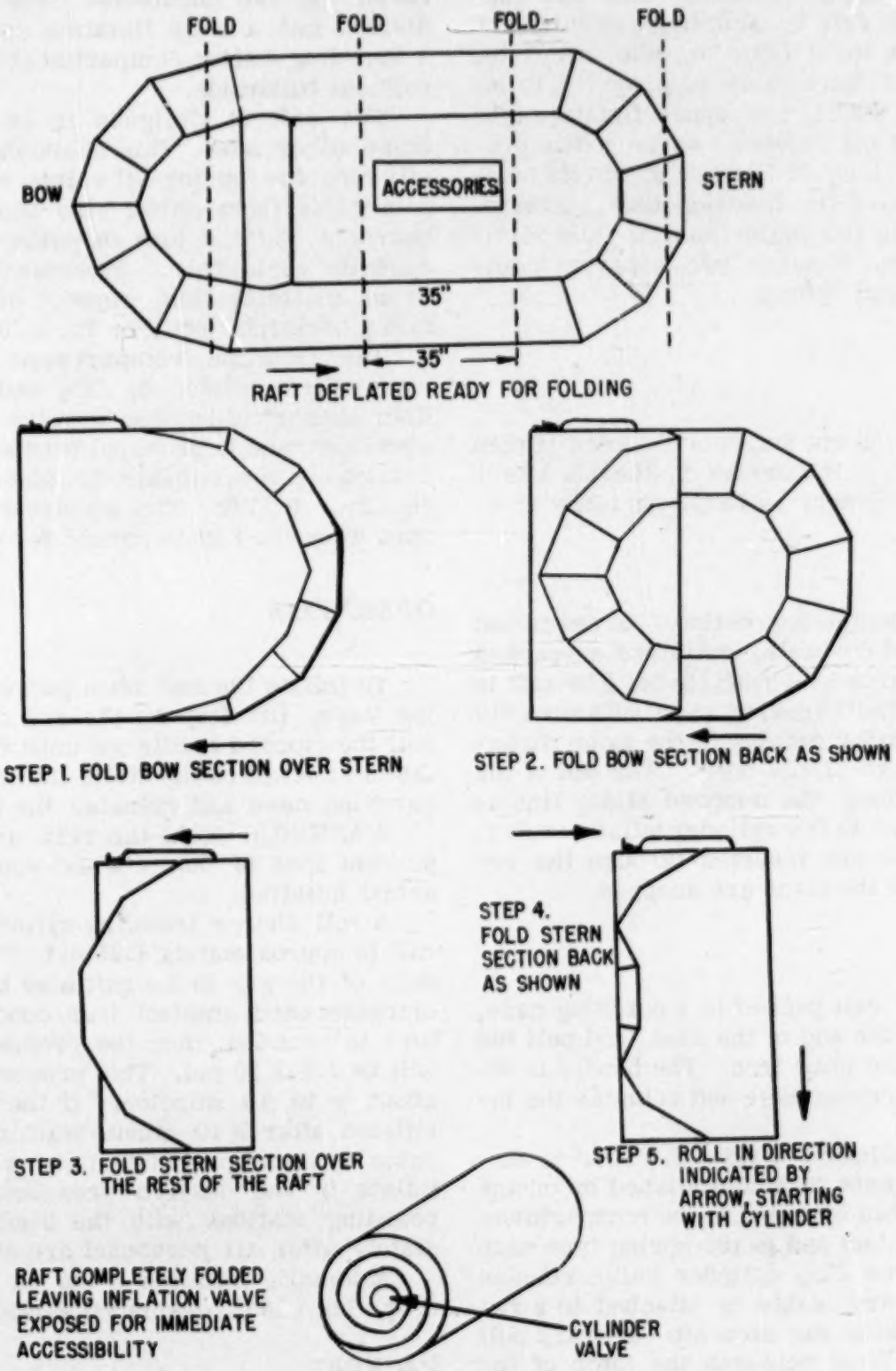

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Figure 15-12. —Folding and rolling the Mk 7 raft.

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The canopy is used for protection from the elements. The inner surface of the canopy is blue, for use when camouflage is desired, and the outer surface is fluorescent red to attract rescue craft. It is attached around the outer perimeter of the upper floatation tube and supported over the raft by aluminum bows (ribs).

Initially, the main flotation tube is inflated with CO_2 and a hand pump is provided to inflate the seat, floors, and upper flotation tube through topping-off valves. As an extra precaution against loss of the raft due to an inadvertent rupture of the flotation tubes, internal bulkheads divide the main flotation tube vertically amidships, forming two separate compartments of equal volume.

EQUIPMENT

Survival equipment sufficient to keep 12 men alive for 7 days is carried in the Mk 12A-1 raft. This equipment is listed in table 15-1.

PACKING

The raft is completely deflated as described for other multiplace rafts, and folded and packed as shown in figures 15-13 and 15-14. The raft is then placed in the carrying case with the axis of the CO_2 cylinder running in the same direction as the length of the case. The end of the cylinder containing the ripcord static line is properly attached to the cylinder inflation valve, the ripcord pins are inserted through the release cones, and the flaps are snapped.

OPERATION

To inflate a raft packed in a carrying case, lift the flap on the end of the case, and pull the ripcord handle out until free. The handle is attached to the carrying case and actuates the inflation valve.

Automatic inflation of rafts installed in aircraft compartments is accomplished by means of a control cable attached to the compartment latching mechanism and to the spring type snap on the end of the CO_2 cylinder valve release cable. The control cable is attached to a release handle inside the aircraft. A sharp pull on this handle first releases the latch of the raft compartment door, then actuates the inflation system. Rafts so installed are not packed in carrying cases.

MK 20 RAFT

The Mk 20 inflatable raft is made by mounting two buoyancy chambers of rubberized fabric (one upon the other) and suspending a floor between the two chambers. The chambers are divided into a main flotation compartment and a boarding station compartment by two internal vertical bulkheads.

The raft is designed to be right-side-up from either side. This is accomplished by positioning the topping-off valves so that they are accessible from either side and by placing the boarding stations (one on either side) directly opposite each other. Incorporated in the floor is an inflatable floor support which will maintain a horizontal position for a fully loaded raft.

The flotation compartment and boarding ramps are inflated by CO_2 and the inflatable floor support is inflated with the hand pump. An equalizer tube is provided between the two main flotation compartments to distribute the gas equally. NOTE: The equalizer tube must be open when the raft is packed for use.

OPERATION

To inflate the raft when packed in the carrying case, lift flap on the end of the case and pull the ripcord handle out until free. The handle is attached to the static line which opens the carrying case and actuates the inflation valve.

WARNING: Hold the retaining line fast to prevent loss of the raft and equipment during actual inflation.

A full charge from the cylinder inflates the raft to approximately 1.25 psi. The initial pressure of the gas in the raft may be low, but will increase until ambient (surrounding) temperature is reached, then the pressure in the raft will be 1.5-2.20 psi. This process usually takes about 5 to 10 minutes. If the raft is underinflated after a 10-minute wait, attach the hand pump to the appropriate topping-off valve and inflate to the desired pressure. Inflate the boarding stations with the hand pump immediately after all personnel are aboard the raft.

Automatic inflation of the Mk 20 is identical to the Mk 12A-1, described earlier.

PACKING

Prior to packing, inspect CO_2 cylinder for safety wiring of the inflation gear assembly, in

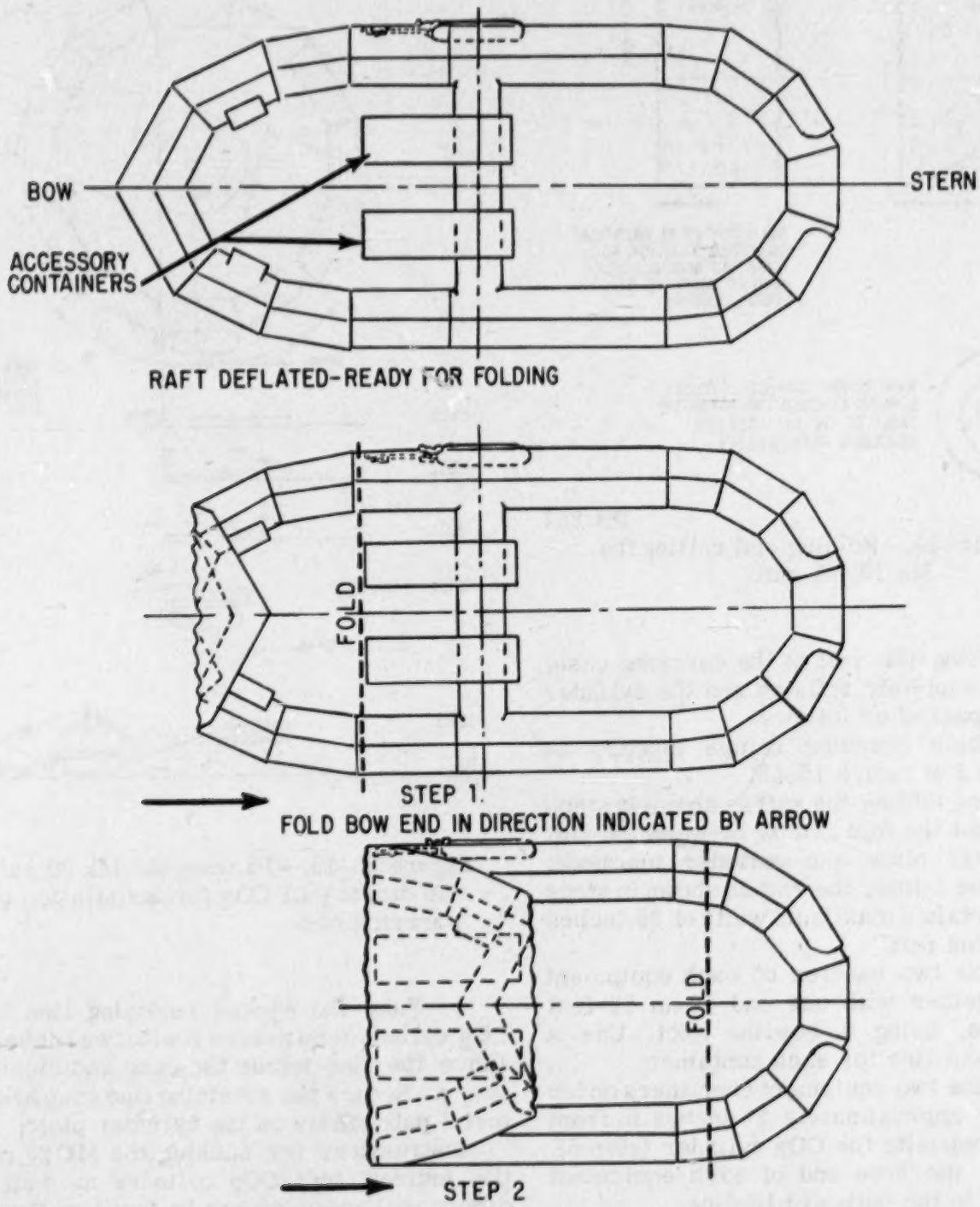

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Figure 15-13.—Folding the Mk 12A-1 raft.

accordance with instructions contained in Nav Air 13-1-6.1. Inspect the floor for stenciled instructions for erecting the canopy. These instructions must be legibly stenciled in 1/2-inch letters.

There are two different types of CO_2 cylinder actuating systems in use with the current Mk 20 raft; the direct pull and the indirect pull. The direct pull will be discussed in this chapter.

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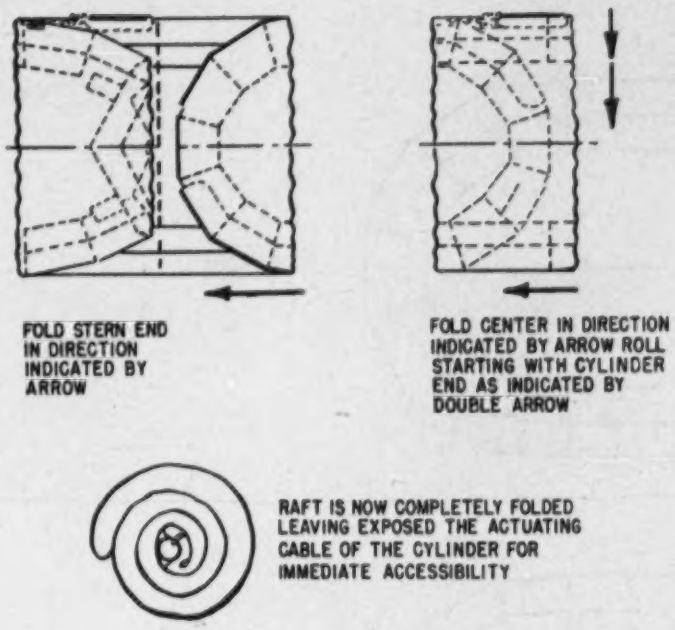

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Figure 15-14.—Folding and rolling the Mk 12A-1 raft.

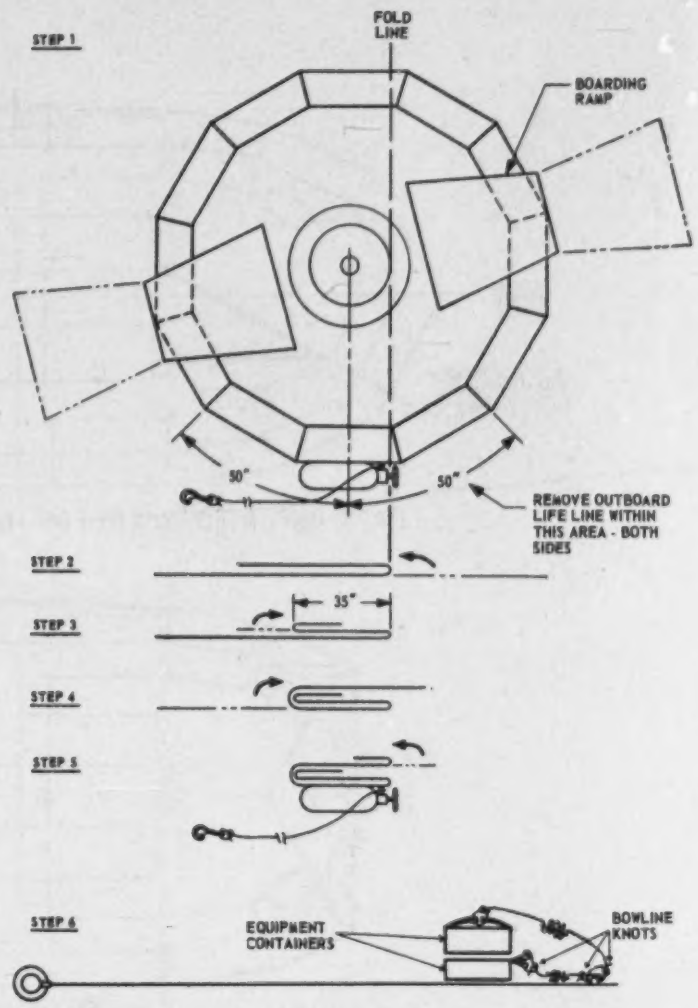

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Figure 15-15.—Packing the Mk 20 raft with the direct pull CO_2 for installation in the carrying case.

When packing the raft in the carrying case, it must be completely deflated and the cylinder attached and packed as follows:

1. Fold both boarding ramps inboard as shown in step 1 of figure 15-15.
2. Continue folding the raft as shown in steps 2 and 3, so that the fold line is between the pull handle circular plate and cylinder manifold.
3. Continue folding the raft as shown in steps 4 and 5. Maintain a maximum width of 35 inches when folding the raft.
4. Bind the two handles of each equipment container together with one end of an 18-foot retaining line, using a bowline knot. Use a separate 18-foot line for each container.
5. Place the two equipment containers on top of each other approximately 35 inches in from the raft end opposite the CO_2 cylinder (step 6).
6. Secure the free end of each equipment retaining line to the outboard lifeline.
7. Fold the end of the raft over the equipment container and roll the raft toward the cylinder.
8. Place the raft in the carrying case so that the cylinder is parallel to the length of the case, and directly under the closing snaps on top of the case. Adjust the cylinder so that the circular plate and metal pull handle will project from the case.
9. Fake the excess retaining line from the CO_2 cylinder and secure it with two rubber bands. Place the line inside the case and close all the snaps. Secure the retaining line snap hook to the metal pull handle on the cylinder plate.

Instructions for packing the Mk 20 raft with the indirect pull CO_2 cylinder as well as the direct pull cylinder can be found in NavAir 13-1-6.1; see also figure 15-15.

Installing for Ejection

In lieu of packing the Mk 20 in a carrying case for manual toss-out and inflation, the raft may be packed and installed in a compartment for ejection. The following steps apply to folding and installing the Mk 20 raft for ejection:

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1. Place the raft on a flat surface after it has been completely deflated. Because of the size of the raft, a large well-cleaned area of deck is the best place for packing. The position of the inflating cylinder will determine whether the raft is stowed in a left- or right-wing compartment. If the cylinder is facing the wrong direction, turn the raft completely over.

2. Fold the raft in thirds so that the cylinder remains at the end of the raft. (See fig. 15-16.)

3. Fold back one-half of the top fold.

4. Make five folds in accordion pleats so that the cylinder is resting on top of the rectangular bundle.

5. Set the raft into the proper compartment. (See fig 15-17.) The operating head of the raft cylinder must face inboard with the cylinder of the aft side of the compartment. Place the cylinder on the supporting rack. The accessory container may be placed in the bottom of the compartment before the raft is stowed, or on top of the folded raft.

6. Connect the release cables at the quick-disconnect fittings.

7. Connect the raft lanyard to the raft lifeline, and place the bag holding the lanyard on top of the raft.

8. Close and latch the compartment door or cover.

9. Turn the adjusting screws on the cylinder support rack so that the cylinder is held tightly against the compartment cover.

MAINTENANCE OF RAFTS

All personnel engaged in the handling, inspection, or maintenance of rafts must exercise caution to avoid stepping on or placing any unnecessary objects or items on top of them. Persons engaged in maintenance or repair of unpacked rafts must not step on any part of the raft while wearing shoes, nor on any part of the flotation tubes at any time. Rafts must not be thrown around or dropped since this may cause damage to the raft or its accessories. Particular care must be exercised to prevent hydrocarbons such as gasoline, oil, or grease from coming in contact with any part of the raft or its equipment.

Repairs

Personnel engaged in the repair of rafts and other rubberized flotation equipment must be thoroughly familiar with NavAir 13-1-6.1 and know the various types and uses of cements as well as the correct procedures to be followed when making necessary repairs to this equipment.

TYPES OF CEMENT.—The preferred cement used in the repair of pararafts and multiplace rafts is MIL-C-5539A, class 3; if not available, MIL-C-5539, type B may be used.

PATCHING PROCEDURES.—For patching holes in multiplace rafts cut a round or oval patch of rubber-coated nylon cloth approximately 2 inches larger in diameter than the damaged area. Scallop the edges of the patch if larger than 5 inches in diameter. If the damaged area is larger than 1 inch in diameter or length, both the inside and outside must be patched.

Raft patching procedure is as follows:

1. Place the patch over the damaged area and draw an outline of the patch on the raft or preserver.

2. Clean the underside of the patch and the area to be patched with four applications of toluene. Apply toluene with back and forth strokes on the first and third applications and one-way strokes on the second and fourth applications. Allow the patch and damaged area to dry between applications. NOTE: Do not touch cleaned area when handling.

3. Mix equal amounts of cement and toluene. Apply the mixture to the underside of the patch and outlined area on the raft with a soft-bristle brush. Allow the area to dry for approximately 10 minutes.

4. Apply a second coating of the mixture to the damaged area and the patch and allow them to dry for approximately 10 minutes.

5. Apply two coatings of unthinned cement to the outlined area on the raft and patch. Allow the cement to dry for approximately 10 minutes after the first coating.

6. Place the patch over the damaged area when the second coating of unthinned cement has become tacky. If the damaged area is a slit or tear, butt both edges together before applying the patch. Roll out any air bubbles with a wooden roller.

7. Allow the cement to set for 24 hours, then perform the leakage test.

8. If necessary, paint the patch with rubber base paint to match the color of the raft. Apply talcum powder to the patch after the paint has dried.

9. The repair of seams can be found in NavAir 13-1-6.1.

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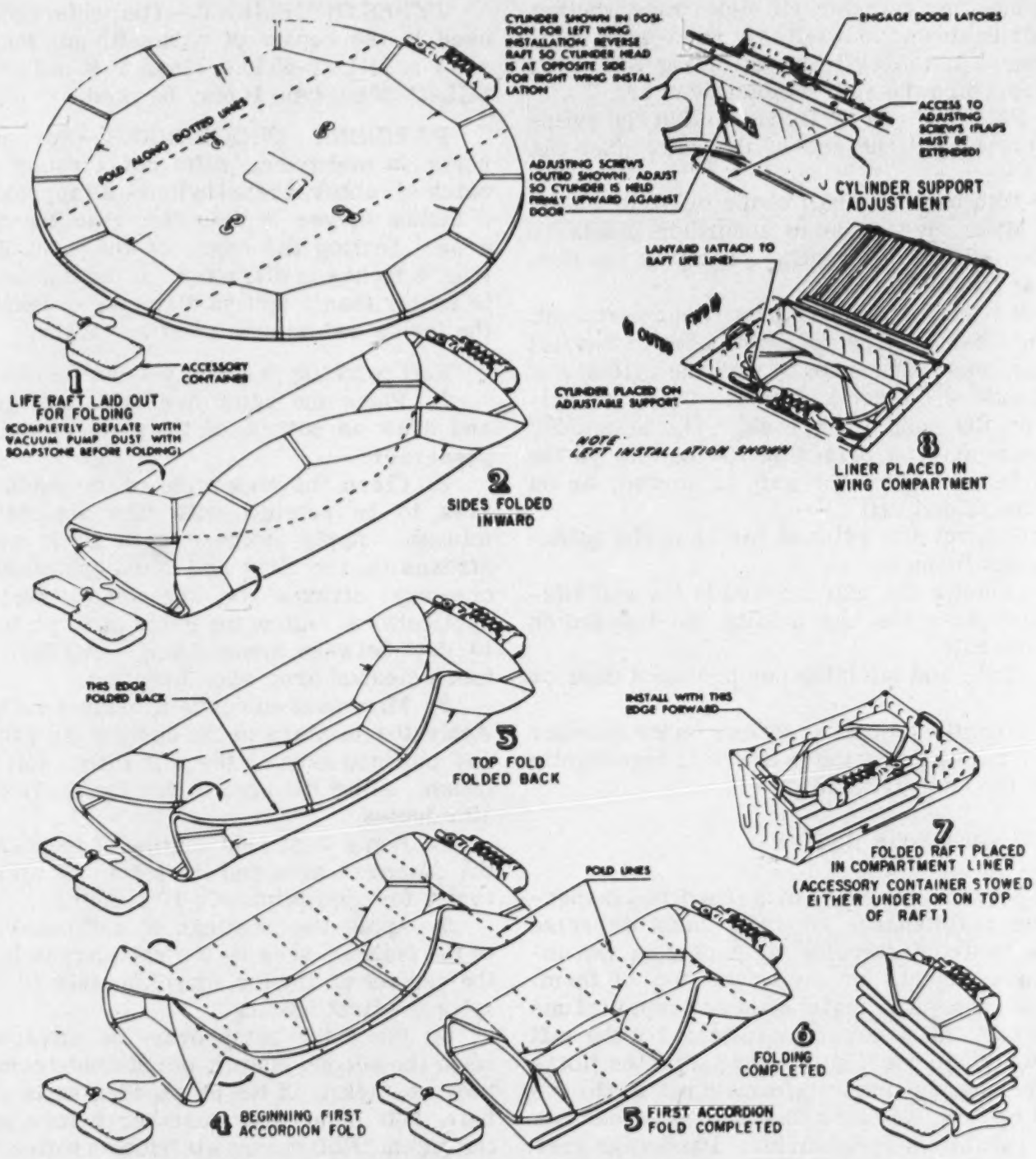

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Figure 15-16.—Packing the Mk 20 raft for installation for ejection.

Emergency Repairs

Emergency repair of the Mk 20 raft, when in the water, is accomplished by the use of the metal clamp type plugs provided in the accessory equipment container of each raft. No emergency repair equipment is provided with other types of rafts.

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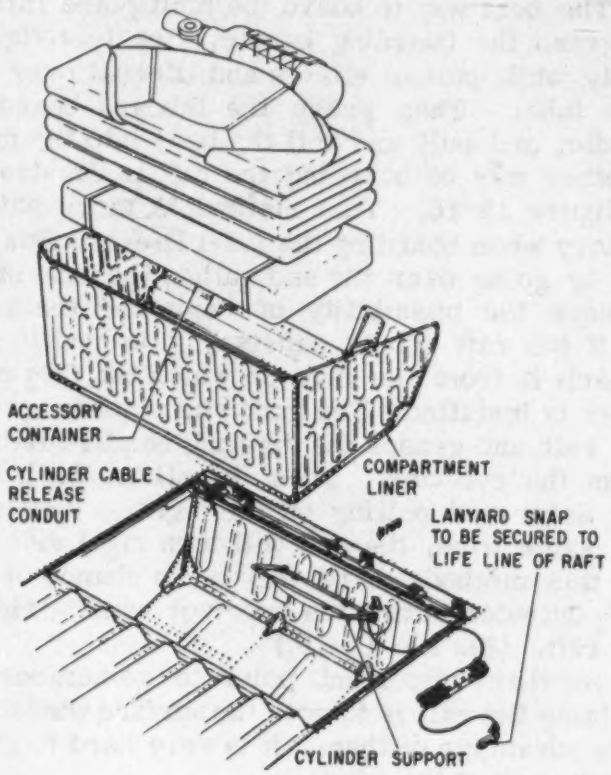

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Figure 15-17.—Placing the folded raft into the compartment.

Safety Precautions

Cements and solvents are flammable materials and must be treated as such. Never smoke nor permit any type of open flame near cements or solvents when they are being used. After completion of any repair work involving these materials, always replace caps or covers as tightly as possible. The container should be stored in a cool storeroom. Common sense and a few precautions will avoid many accidents. WHEN WORKING WITH CEMENTS AND SOLVENTS, DO SO IN A WELL-VENTILATED SPACE.

Survey of Rafts

Liferafts must be forwarded to Supply or surveyed in accordance with the Naval Supply Systems Command Manual when any of the following conditions exist:

1. Split, open, or leaky tube seam or tube seam tape.
2. Porous areas on tube.
3. Leakage test failure not resulting from a cut, tear, or puncture.
4. Extensively damaged floor.
5. Damaged, malfunctioning, excessively worn, or corroded inlet valve, oral inflation valve, oral inflation tube, or topping-off valve.
6. Internal bulkhead leak.
7. Cracked or excessively corroded manifold.

STOWAGE OF RAFTS

Pneumatic survival equipment of any kind should never be stowed near hot places, batteries, auxiliary powerplant, stoves, inverters, or the like. Frequent inspection and occasional discipline will also be necessary in order to detect and stop pilferage of the contents of stowed rafts. Nonflying squadron personnel must be made aware of the dangers which may result from pilferage.

Rafts carried in aircraft not equipped with raft compartments should be stowed in the fuselage in a manner and position that will render them readily available. This will save much valuable time for personnel in abandoning the aircraft during a ditching. Rafts stowed in the fuselage should retain their carrying cases.

Because of the nature of materials used in raft construction, both flight and maintenance personnel should avoid sitting on rafts or placing heavy tools or other equipment on them.

DEMONSTRATING THE USE OF RAFTS

Many ditchings and water crashes occur in a rough sea or at night. Only complete familiarization with the use of survival equipment will give the aircrewman a chance of survival under such adverse conditions. Therefore, intensive drill in the use of rafts and their associated equipment is essential for safety.

The survival officer will be concerned with survival techniques and should see that a survival training program is set up in the parachute loft. In most cases, the chief-in-charge of the loft will have the responsibility of setting up this training. As a PR3 or PR2 you will have many occasions to participate in this training, and in many instances may be completely responsible for the carrying out of the program. Regardless of who is in charge and must shoulder the complete responsibility, it is the duty of every PR to be completely familiar with all

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phases of survival training and be able to demonstrate the use of survival equipment.

A very effective system of training in water survival techniques is the use of the Dilbert Dunker to simulate an actual aircraft ditching as closely as possible and to teach the best escape procedure with full equipment.

Although such complete courses of training cannot be conducted in certain localities because of the lack of specialized equipment, the PR should make every attempt to give aircrewmen frequent practice in the actual use of the equipment. Discussions, demonstrations, and shop lectures are all helpful, but working with the actual raft equipment is the only way to acquire the knowledge essential to survival.

Inflating the Raft

In demonstrating the raft's use, the most important thing to stress is that the retainer lanyard snap is firmly attached to the ring on the lifevest before inflating the raft. Inflate the raft as soon as possible so that personnel can get out of the water. Inflation of the raft is effected by pulling on the short length cable attached to the CO_2 cylinder valve. After several hours, the CO_2 cylinder may be removed from the side of the raft. It tends to chafe the side of the compartment and acts as an anchor, causing the raft to orbit around it. Sometimes it is possible to back off the coupling between the cylinder and the manifold so that the cylinder releases from the mount. Once the cylinder has been removed, it will no longer be useful in any way and should be thrown over the side. This, of course, is under actual emergency conditions; in a training demonstration, the cylinder should be saved and recharged for further use on the training equipment.

In demonstrating their use, instructions should also be given on manual inflation of rafts. If nothing happens after the CO_2 cable has been pulled, the carrying case should be pulled off and the raft unfolded so that the hand pump in the oar pocket will be accessible. After the pump is removed, the first compartment to be inflated should be the seat. This will help keep the raft afloat so that the remaining compartments can be inflated with the pump. In attaching the pump, care must be taken not to screw the pump too tightly to the valve. If it is too tight, it may freeze and be impossible to loosen without some type of wrench or pliers.

Boarding the Raft

The best way to board the multiplace raft is to grasp the boarding handle, kick feet vigorously while pulling elbows and lifevest over the raft tube. Then grasp the inboard boarding handle, and pull and roll the body into the raft. Another way of boarding the raft is illustrated in figure 15-18. This method is more satisfactory when boarding the LR-1 liferaft. Boarding by going over the end rather then the side, lessens the possibility of capsizing the raft.

If the raft should capsize, it is best to approach it from the side on which the CO_2 cylinder is installed. The survivor reaches across the raft and grasps the righting handle farthest from the cylinder. Then, by sliding back into the water and pulling on the righting handle at the same time, the raft will turn right side up. By this method, there will be no chance of the CO_2 cylinder hitting the survivor when he rights the raft. (See fig. 15-19.)

Another important point to remember in righting the raft is to note the surface winds and take advantage of them. It is very hard to right a raft against the wind.

Safety Precautions in Boarding Rafts

Extreme care should be taken when boarding rafts or assisting personnel into the raft from the water. This is particularly so if such persons are wearing parachute harness or lifevests. Once in the raft, all personnel should seat themselves on the floor and remain in that position if at all possible. Movement within the raft should be restricted as much as possible to keep friction at a minimum. All sharp objects should be collected and stored, especially jeweled rings, wrist watches, etc. All loose articles of equipment should be properly packaged to protect the raft fabric.

LR-1 LIFERAFT ASSEMBLY

The LR-1 is a one man raft. The methods of rigging the raft to the various types of parachutes have been discussed in other chapters of this training manual. The configuration of a packaged LR-1 liferaft assembly, complete with accessories and survival items, will vary according to application. The survival items required must be packed in either the combination

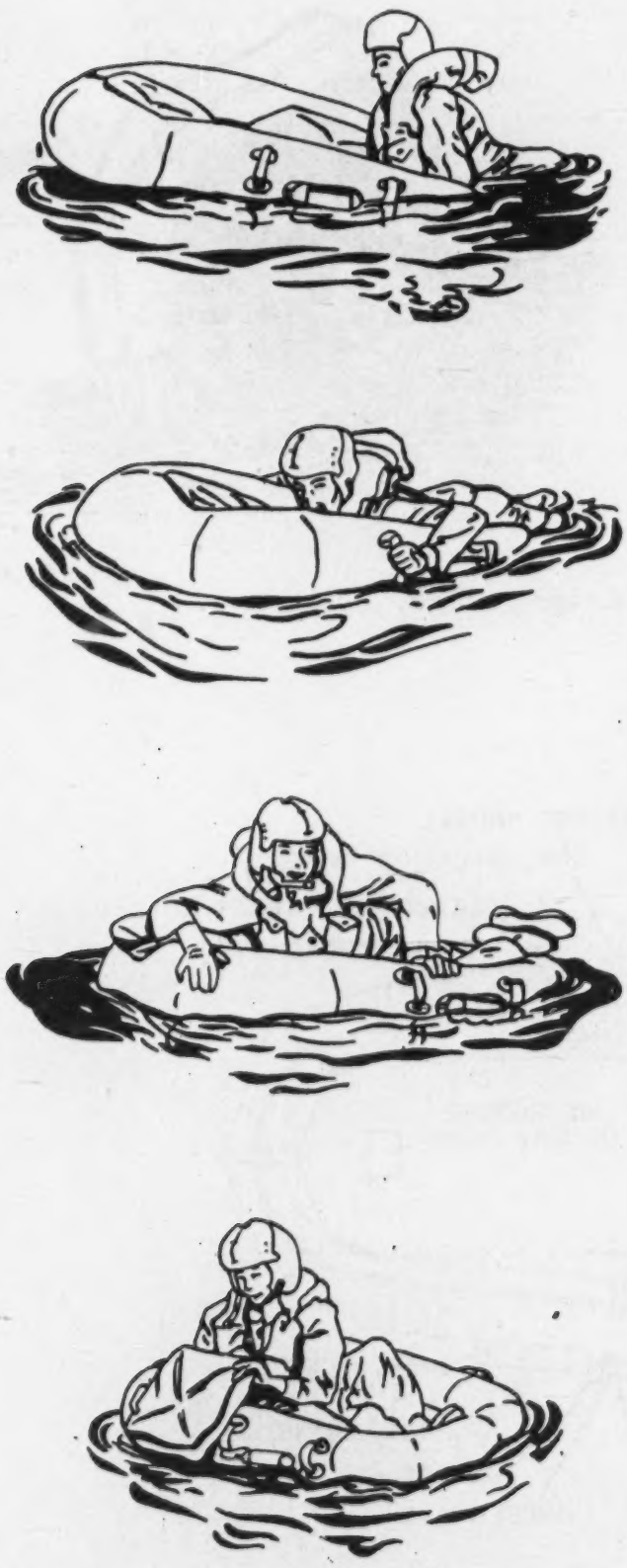

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Figure 15-18.—Boarding the LR-1.

carrying case and equipment container, or in the equipment container, as applicable. The remaining space in the container may be used for specialized equipment deemed necessary for specific environmental or geographic conditions as directed by the Area Operating Commander.

The four basic packaged LR-1 liferaft assemblies include the standard soft pack, helicopter back pack, high speed soft pack, and the rigid seat survival kit.

For specific aircraft applications of the LR-1 liferaft assemblies refer to NavAir 13-1-6.1.

This section will describe the components of the LR-1, the survival equipment, and the procedures for performing inspections and maintenance. Procedures which parallel those already outlined for multiplace rafts are not repeated.

FLOTATION TUBE

The body of the liferaft consists of an encircling buoyant tube. The flotation tube is made in one continuous chamber from type N fabric. There are no internal bulkheads as in the multiplace rafts. Various attachments and configuration of the flotation tube are shown in figure 15-20.

SEAMS

All laps used in the seam construction of the flotation tube are five-eights inch wide, covered inside and out with type R tape, three-fourths inch wide.

CYLINDER CARRIER

Figure 15-20 shows the location of the cylinder carrier on the flotation tube. The cylinder carrier is 2 inches in diameter.

ORAL INFLATION TUBE

The valve on the oral inflation tube closes automatically by spring pressure when it is not held open. The valve is locked shut by turning the mouthpiece in a clockwise direction. The 3/8-inch oral inflation tube is cemented to the valve at one end, and at the other it is equipped with a molded flange which is cemented to the flotation tube.

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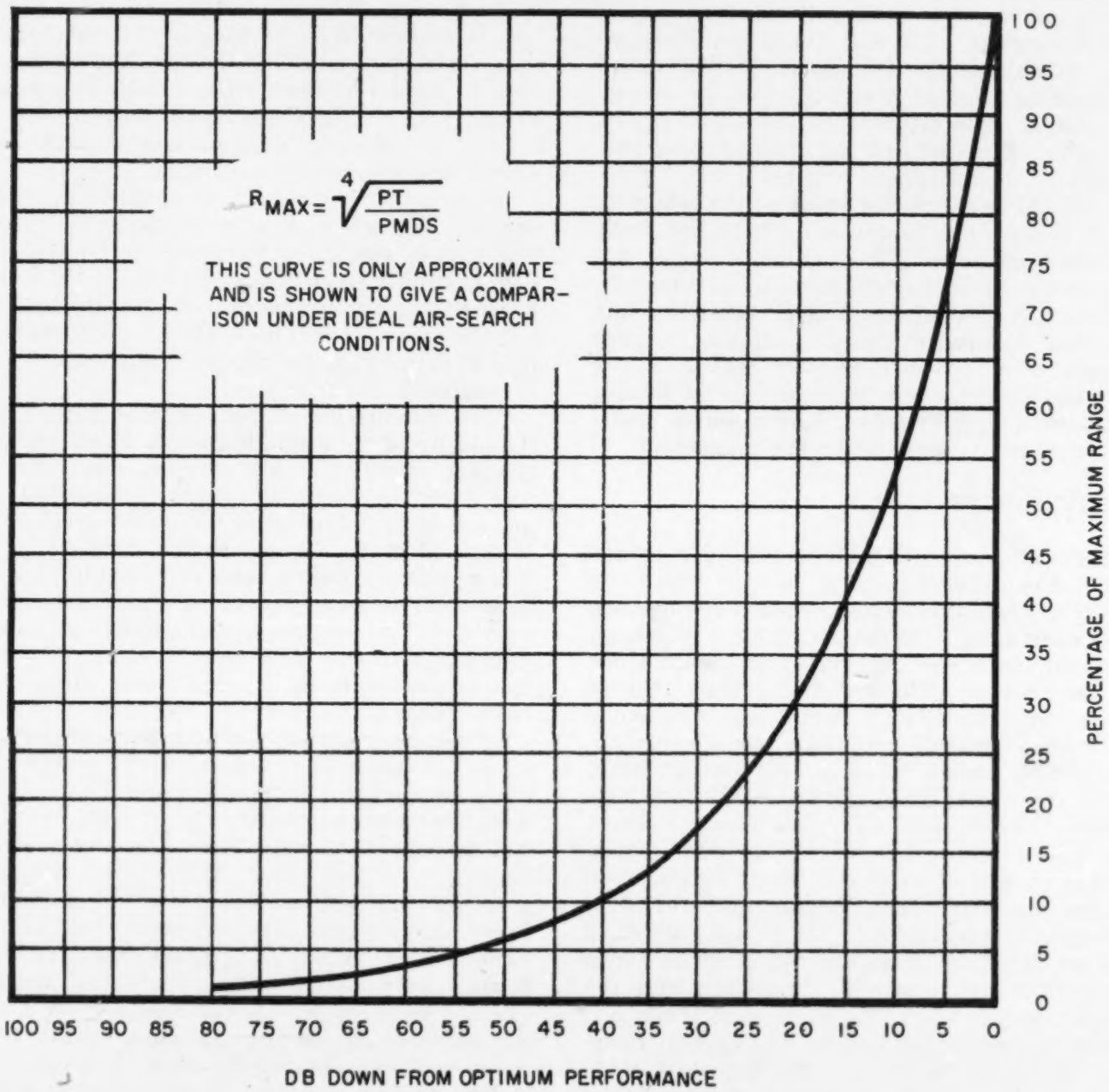

Figure 16-27.—System performance versus maximum range.

the radar set. (It should be noted that tuning the frequency meter to resonance will cause a dip in the power meter reading.)

The desired output signal is obtained by setting the test set function selector switch to the position that provides the desired waveform to the klystron oscillator reflector. Both the frequency and power of the klystron oscillator are controllable.

Before any measurements of receiver sensitivity can be made, the receiver must be accurately tuned to the radar-transmitter frequency. To measure the receiver frequency, the test set is connected to the radar set directional coupler. (Receiver frequency may be measured with the test antenna.) However to get accurate results, the sensitivity tests that usually follow frequency tests must be made using the directional coupler.

Tune the test set to the radar-transmitter frequency as described in the Operation Instruction Manual for the test set. Upon checking, if the receiver frequency is found to be different

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Figure 15-19. —Righting a capsized raft.

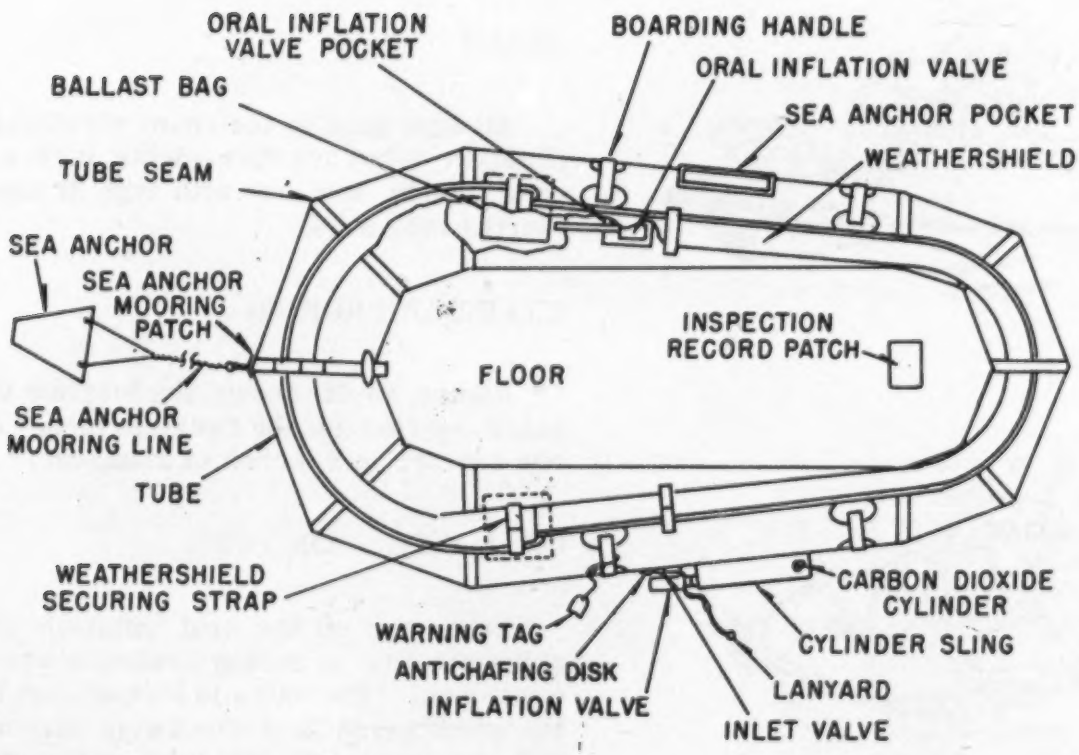

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Figure 15-20. —LR-1 liferaft assembly.

BOARDING STRAPS

Five handles or straps are provided as aids for boarding the raft.

INFLATION SYSTEM

The flotation tube is inflated with a CO_2 charge weighing 0.50 pound (+ 0.01 pound). The CO_2 cylinder is mounted in the cylinder carrier and the cylinder valve is threaded into the inlet check valve of the pararaft. The LR-1 life raft is inflated either manually by pulling the inflation assembly actuating lanyard, or automatically on LR-1 (RSSK) by gravity drop on kit actuation.

SEA ANCHOR

The sea anchor is tied to the pararaft mooring line with type III nylon line, using a bowline knot; the other end is tied to the sea anchor mooring patch with a square knot. The bitter ends of both knots are served with nylon thread to prevent them from untying. Before tying the knots, the ends of all nylon line are HEAT FUSED to prevent fraying.

Sea Anchor Pocket

The purpose of the sea anchor pocket is to prevent entanglement of survivors in the sea anchor line during boarding of the raft. Figure 15-21 shows the method of folding the sea anchor and line.

Downed aircrewmen should remove the sea anchor from the pocket and cast the anchor adrift immediately after entry into the raft.

SECURING LINE

The securing line is a 5-foot length of nylon cord. This line is used to secure the pararaft to its carrying case and equipment. The line is tied with a square knot to the pararaft sea anchor patch. The other end is also tied with a square knot through the grommet in the pararaft case. The free ends of the knots are bound or sewed with type B nylon thread.

WEBBING LANYARD

A nylon webbing lanyard 1 inch wide and 6 feet long is provided to secure the pararaft to the user. One end of the lanyard is equipped with a 1 1/8-inch snaphook. The other end is secured to the CO_2 cylinder neck by means of a loop formed at the end of the webbing, encircling the cylinder neck.

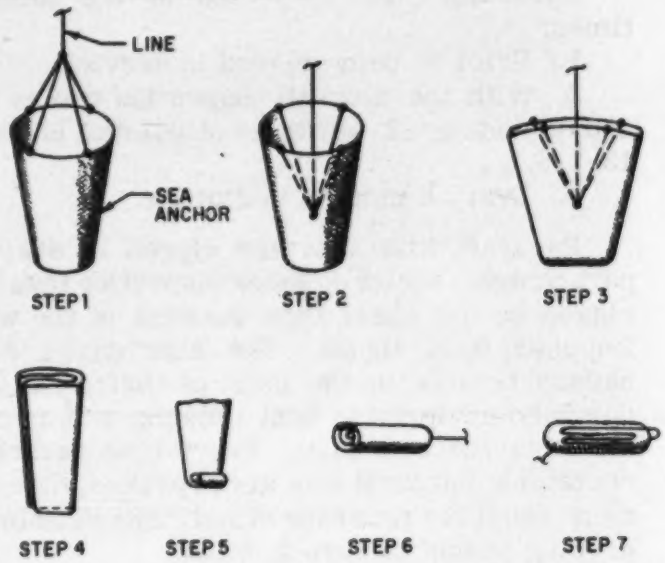

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Figure 15-21.—Method of folding the sea anchor and line.

MARKINGS

To modify the stenciled markings on the LR-1, compare the markings on the raft with NavAir 13-1-6.1. Use orange or black paint depending on the affected surfaces.

EQUIPMENT

The following equipment is considered essential and must be provided in the LR-1 liferaft: Two Mk-13 Mod 0 day and night distress signals, 2 dye markers, a signal mirror, rations, desalter kit, water storage bag, nylon cord (50 ft), bailing sponge, shark repellent, sunburn ointment, GND/AIR emergency code card, and a survival radio.

The type of survival radio used will be directed by the Fleet Commander.

In order to prevent loss of equipment carried in the equipment container, each item must be suitably attached to a common nylon cord, conforming to type 1, MIL-C-5040. One end of the cord must be fastened to the equipment container.

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INSPECTION

Pararafts are inspected at the following times:

1. Prior to being placed in service.
2. With the aircraft inspection cycles up to and including 22 weeks as stipulated in NavAir 13-1-6.1.
3. Every 6 months in storage.

Pararaft kits that are rigged to seat type parachutes require a closer inspection than those rigged to the chest type because of the weight imposed upon them. The individual's weight causes trouble in the form of chafed and badly damaged materials, bent objects, and an overall impacted condition. Every time parachutes containing pararaft kits are repacked, the equipment should be rearranged and inspected closely, keeping weight factors in mind.

In addition to the trouble caused by the applied weight, another consideration is also important. This concerns flatness and smoothness of the entire assembly. An improperly packed pararaft causes discomfort and fatigue to those who sit on it, even though they are separated by a cusion containing a metal pan.

When pararafts are being used every day, inspect the condition of each pararaft where the cylinder is liable to chafe the raft fabric. Chafing gear sometimes shifts or is worn through when subjected to hard usage. Also examine the inlet valve, where it joins the tube, for cracks or signs of breaking away. This inspection does not require the removal of the raft from its case, only the opening of the front section of the case.

The procedure for inspecting and testing the pararaft are the same as those given for the multiplace rafts (refer to NavAir 13-1-6.1). Where there are considerable differences in their construction, certain steps may be eliminated or added as necessary. For example, pararafts are not constructed with internal bulkheads. Since there is only one continuous flotation tube, the internal bulkhead test is not necessary on the pararaft. The pararaft is fitted with an oral inflation tube, but it serves the same purpose as the topping-off valves on the multiplace rafts. Therefore, the same general considerations given the topping-off valves should be applied to the oral inflation tube. Although the exposed end of the oral inflation tube has no rough edges, it is kept in a supporting pocket.

PACKING

Prior to commencing the packing procedure, make certain that the pararaft is completely deflated. Careless or improper deflation of inflatable equipment will result in expansion at high altitudes, causing severe discomfort or danger to personnel and aircraft. Higher altitudes cause progressively greater expansion. Entrapped air which merely causes discomfort at 25,000 feet may pin a pilot in his cockpit at higher altitudes. Deflation may be adequately accomplished by use of a suction pump such as an ordinary household vacuum cleaner.

Figure 15-22 illustrates the sequence of steps in packing the LR-1 raft. Each item in the equipment side of case should be secured in train to prevent loss. The looped end of the webbing lanyard, attached to the cylinder neck, must not interfere with the action of the valve pull. The valve pull-toggle must be placed in an accessible position. After the packing is completed, the packer must sign the packing card enclosed in the pararaft case.

MAINTENANCE

Repair and cleaning of the LR-1 raft is the same as that given for multiplace rafts except that for patching purposes, type N fabric is used with the lightweight fabric of the pararaft. Flotation tube seams and seams joining the tube to the bottom of the pararaft are not to be repaired.

LR-1 LIFERAFT HIGH-SPEED CONTAINER

Parachutes which utilize the high-speed container are the NB-5 and NB-7 integrated harness and parachute assembly.

To prevent the loss of the raft and equipment container on bailout or ditching, a 4-foot length of 550-pound nylon line should be used. Tie one end of the line to the slide fastener handle of the equipment container and the other end to the 1/2-inch nylon tape loop located inside the high speed container, using a bowline knot at each end. Insert the equipment container with the slide fastener inboard in the high speed container assembly. Tie a second piece of 550-pound nylon line 4 feet in length to the bow of the LR-1 raft and secure the other end to the 1/2-inch loop located inside the high speed container, using a bowline knot at each end.

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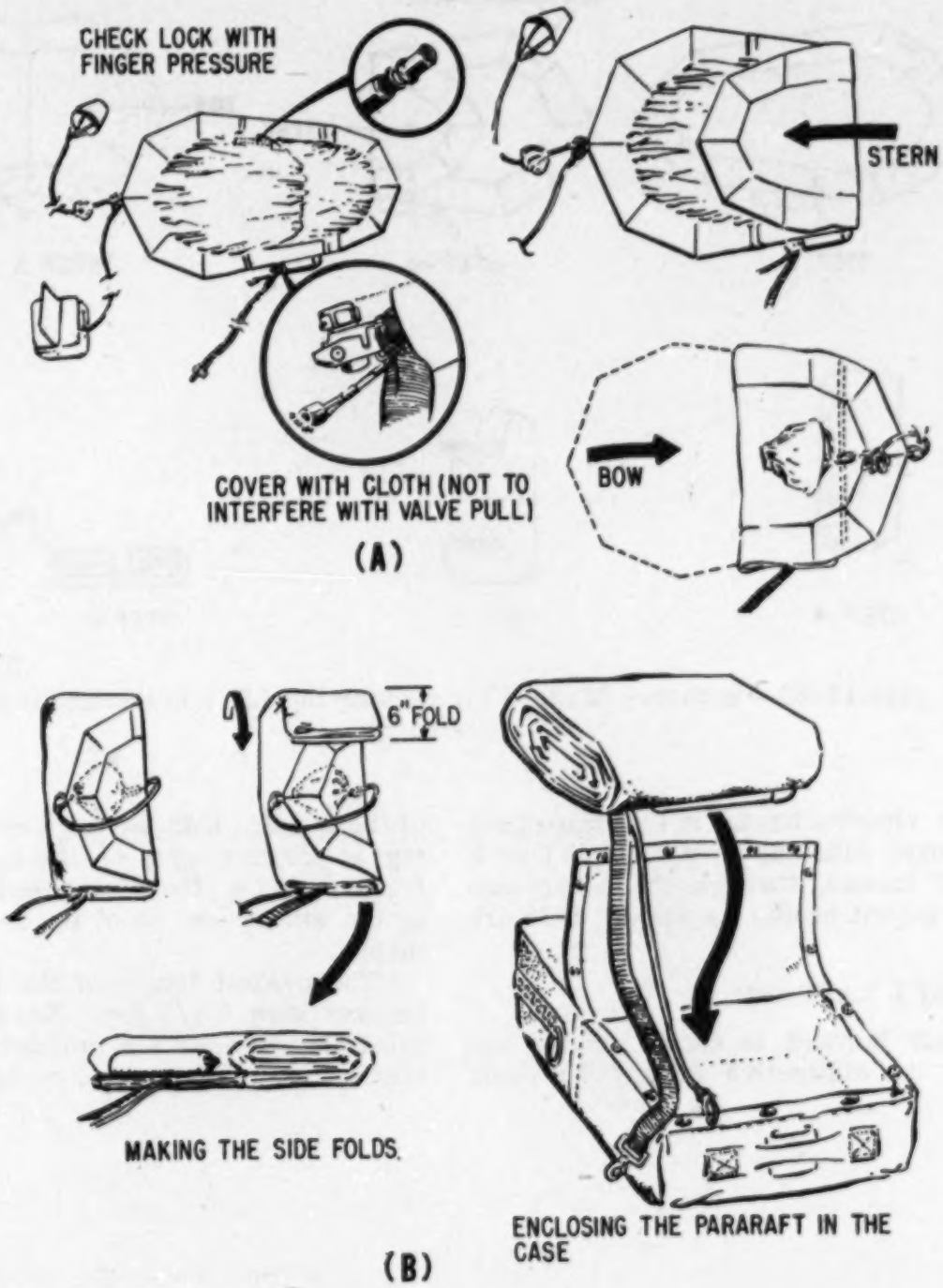

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Figure 15-22.—Sequence of steps in packing the LR-1 liferaft.

Lay the raft out for repack, exposing the CO_2 bottle. Make certain the raft is completely deflated. Figure 15-23 illustrates the sequence of steps for packing the LR-1 liferaft in the high-speed container. After the raft is completely rolled, insert the raft in the container with the ripcord assembly and handle in proper position as shown in figure 15-24. Complete the insertion of the raft in the container. Close the container using temporary locking pins. Install the ripcord assembly as shown in figure 15-25 and safety-tie the ripcord locking pin with type I or II size A thread. Close the protective coverflap using the slide fastener.

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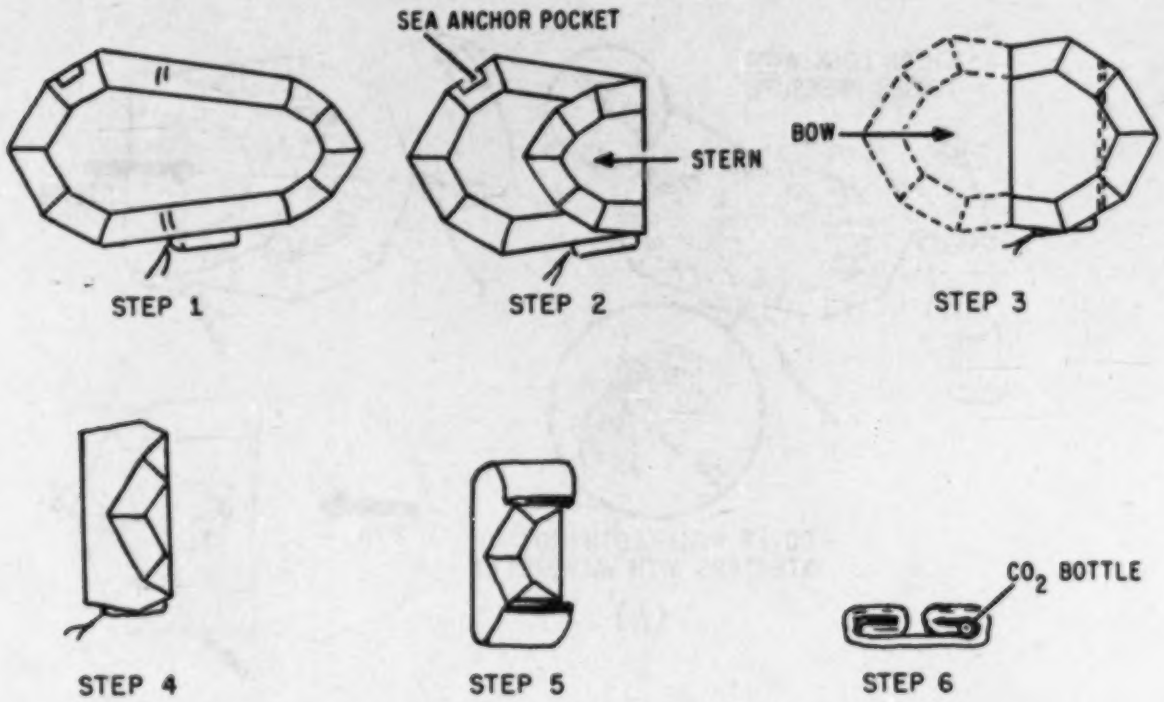

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Figure 15-23.—Sequence of steps for packing the LR-1 in the high-speed container.

Safety-tie the ripcord handle in the high-speed container pocket with one turn of type I or II size A or E thread, through the pocket and around the ripcord handle as shown in figure 15-26.

LR-1 LIFERAFT LANYARD

The liferaft lanyard is easily located and identified by its distinctive bulk. The bulk of the lanyard aids the aircrewman in maintaining a positive grip on the lanyard during its transfer from the high-speed LR-1 container to the attachment point on his personal equipment.

The overall length of the lanyard must not be less than 4 1/2 feet. NavAir 13-1-6.1 contains instructions for modifying the LR-1 raft lanyard in the high-speed container.

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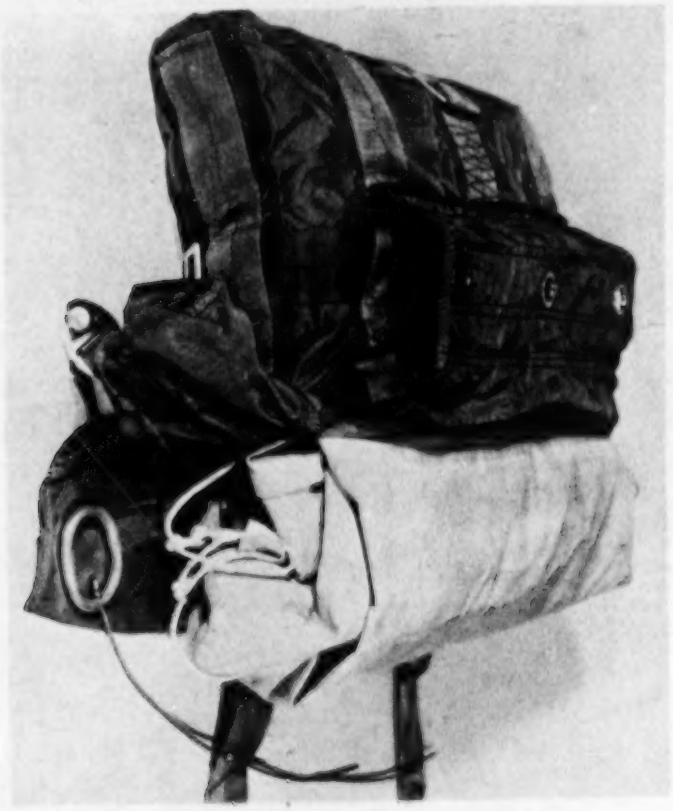

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Figure 15-24. —Raft being inserted into the high-speed container.

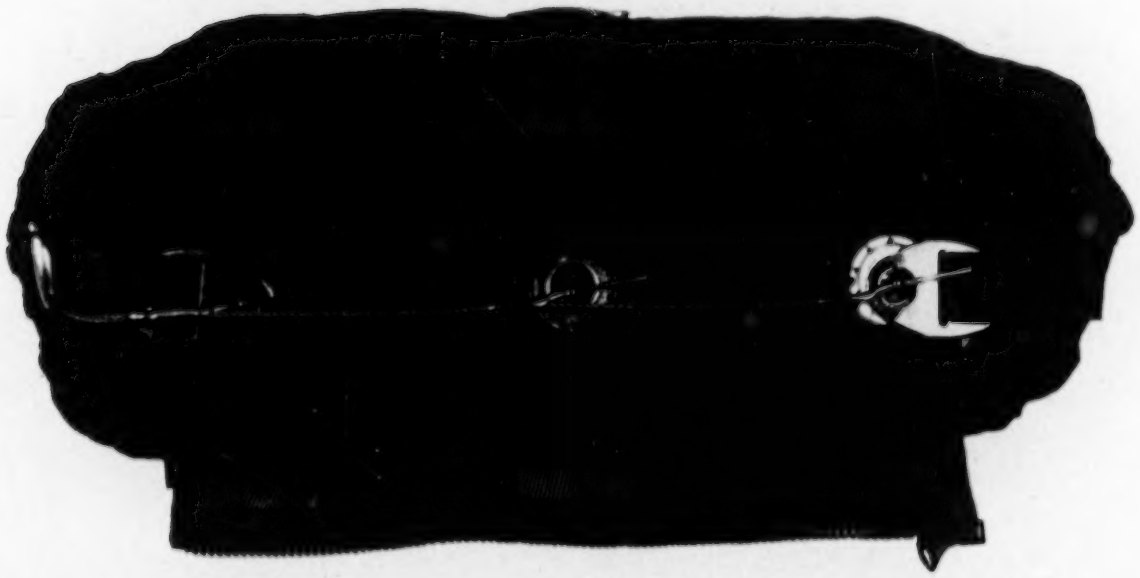

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Figure 15-25. —Ripcord assembly installed and ready to be safety-tied.

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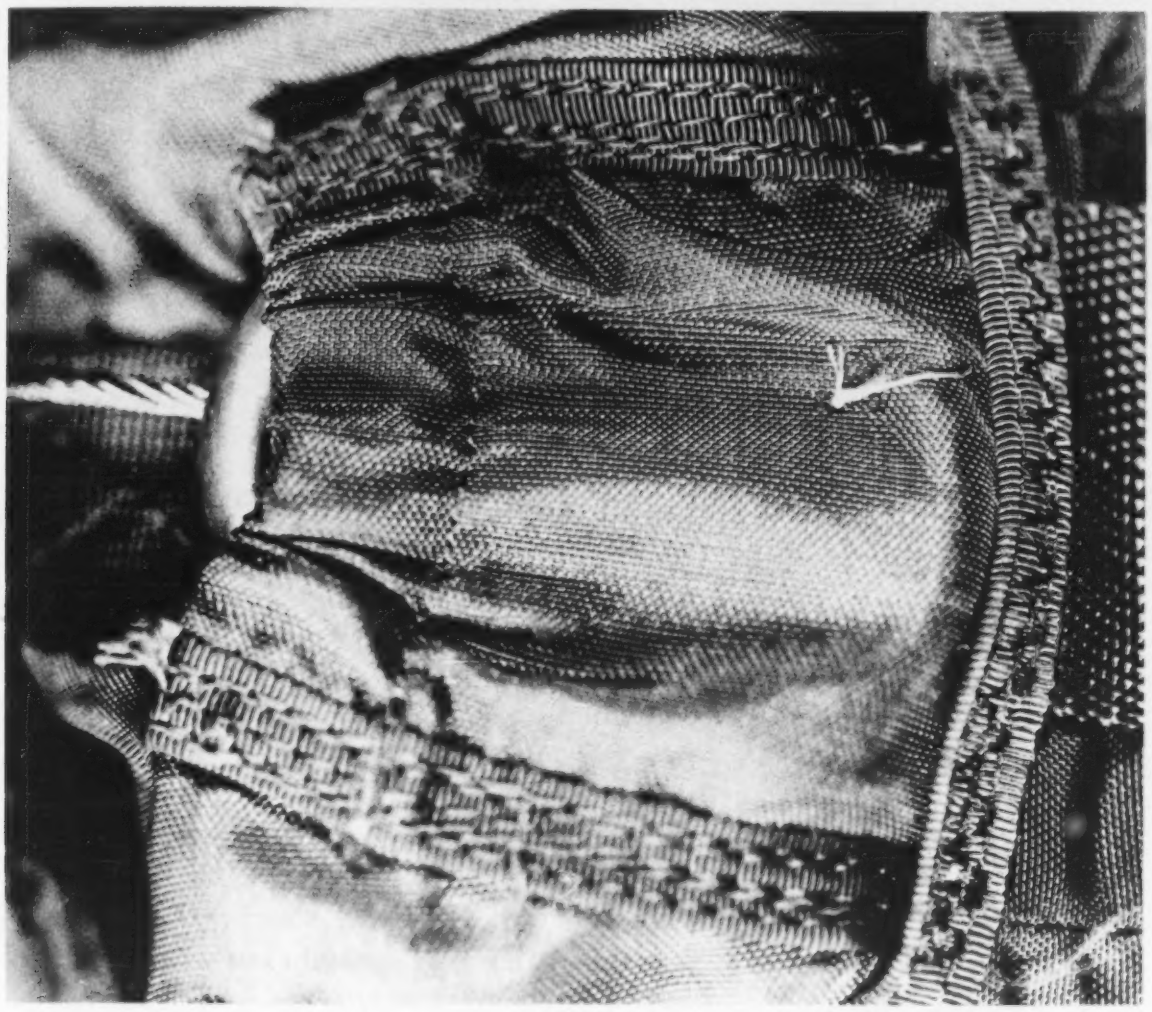

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Figure 15-26.—Ripcord handle safety-tied in the high-speed container pocket.

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CHAPTER 16

RECHARGING CARBON DIOXIDE CYLINDERS

Carbon dioxide is a component of the atmosphere. It is formed in the process of respiration, in combustion of all carbonaceous material, and in fermentation.

CO_2 (the chemical symbol for carbon dioxide) is a colorless gas, possessing a faint pungent odor and a slightly acid taste. It does not burn and does not ordinarily support combustion. However, metals such as magnesium, when ignited, will continue to burn in it while giving off oxides and liberating carbon. CO_2 gas is 1.53 times heavier than air and requires only a pressure of 600 psi below a temperature of 88° F to liquefy. It can be condensed into a colorless liquid and stored in this state under pressure in cylinders. When the cylinder valve is opened, gaseous CO_2 escapes and, because of the rapid drop in pressure and temperature, forms carbon dioxide snow. This snow, when compressed into blocks or cubes, is what we know as dry ice. Dry ice, in solid form and at atmospheric pressure (14.7 psi), evaporates, remaining at -110° F until it disappears. It is excellent for specialized refrigeration.

There are many natural carbon dioxide wells in the earth's surface. Yellowstone National Park has several of these wells. In some caves the CO_2 is so dense that animals are suffocated when they wander into them. Since CO_2, in addition to being heavier than air, is both invisible and practically odorless, it presents a particular hazard. As in caves, it tends to collect in low, unventilated places, such as below decks aboard ship. Men encountering these conditions run the risk of smothering to death. Small percentages of carbon dioxide will cause tiredness and perhaps headaches. Experiments have shown that a 3 percent concentration of CO_2 in the air will double the breathing effort, 5 percent will cause panting, 8 percent will cause marked distress, and 10 percent will cause unconsciousness very quickly.

Treatment of exposed personnel includes removal from the CO_2 laden atmosphere, artificial resuscitation, administering oxygen, and keeping the patient warm.

The PR's association will carbon dioxide is mainly in the recharging of cylinders used in the inflation of liferafts and those used in aircraft fire extinguishing systems. The servicing of the CO_2 firefighting equipment commonly used at shore establishments and aboard ship is not a part of the PR's duties.

Carbon dioxide is ordinarily procured from local commercial sources. In some locations the Navy manufactures its own. CO_2 is purchased or accounted for by the pound, since it is measured in a liquid state. Gas (CO_2 not in a liquid state) is measured on a volume basis and purchased by the cubic foot.

Standard supply cylinders are designed to contain 50 pounds of carbon dioxide and are procured through normal supply procedures. As an example, an order for 300 pounds of CO_2 would indicate a request for 6 supply cylinders.

CO_2 RECHARGE EQUIPMENT

Carbon dioxide recharge equipment is manufactured for the Navy by several different companies. The two most widely used units are those manufactured by the C-O-TWO Company of Newark, New Jersey, and the Walter Kidde Company of Belleville, New Jersey.

A typical C-O-TWO recharge unit is shown in figure 16-1 and consists of a supply cylinder containing 50 pounds of CO_2, a tilting rack for inverting the supply cylinder, a motor-driven pump, a rack for inverting the cylinder being recharged, a scale for determining the weight of the cylinder being recharged, and the necessary high-pressure hoses, control valves, adapters, etc., to properly hook up the equipment.

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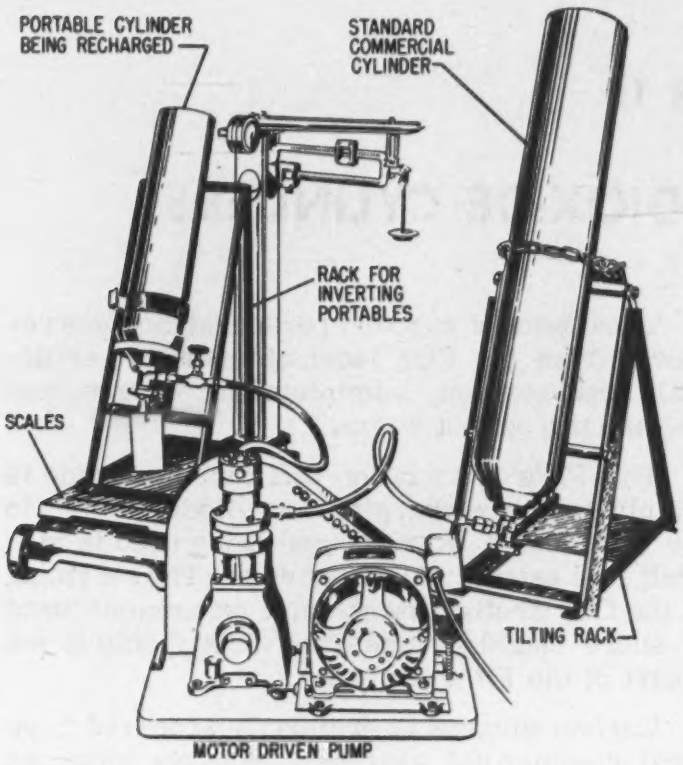

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Figure 16-1.—C-O-TWO recharge or transfer unit.

Before learning the operation of any specific type of recharge equipment, the PR should be familiar with the following general information, which applies to all units.

Carbon dioxide recharge equipment will pump CO_2 in its liquid state only, and the amount of liquid CO_2 a cylinder contains will vary with the temperature and pressure. For example, a standard 50-pound supply cylinder contains approximately 38 pounds of liquid CO_2 and 12 pounds of gaseous CO_2 at a temperature of 70° F. It follows, then, that the cooler the supply cylinder and cylinder being recharged, the more efficient the operation of the transfer equipment. For this same reason, the time required to recharge an empty cylinder increases with the temperature of the cylinders.

When recharging a cylinder, it will remain cooler and may be filled faster if inverted, rather than left in an upright position. Large cylinders, which are impractical to invert, may be placed in a horizontal position for charging.

Standard commercial supply cylinders in 50-pound sizes are obtained with or without a syphon tube. When transferring from a cylinder without a syphon tube, the cylinder must be inverted. Supply cylinders with syphon tubes should be maintained in an upright position, not more than 60 degrees from vertical.

After all the liquid CO_2 has been transferred from a supply cylinder (approximately 80 percent of net contents), the efficient transfer of CO_2 will cease. Then, a new fully charged supply cylinder must be used to finish charging a cylinder to its fully rated capacity. The major part of the CO_2 remaining in the supply cylinder can be used when recharging another empty cylinder, as the CO_2 gas will transfer itself under its own pressure until the pressure in both cylinders is equal. In this manner, the most economical use of the supply cylinder contents is made.

C-O-TWO TRANSFER UNIT

The general procedure for operating the C-O-TWO unit shown in figure 16-1 is described in the following paragraphs. For more complete details on erection, operation, and maintenance of the unit, refer to Operation and Maintenance C-O-TWO Transfer Unit, NA 19-1-516.

General Operating Instructions

1. Connect the pump inlet hose to the supply cylinder outlet.
2. Connect the pump outlet hose to the recharging adapter on the cylinder to be recharged. The pump outlet valve is fitted with a shutoff valve.
3. Check all connections and make certain that they are properly and securely made up. This is very important. When making up connections, use a 12-inch wrench with a slow, steady pull. Do not jerk or hit the wrench with a hammer.
4. Make certain that the shutoff valve in the pump outlet hose is in the tightly closed position, and that the valve of the cylinder being recharged is open. Open the valve fully and back off 1/4 turn to prevent freezing the valve in the full opened position.
5. Fully open the valve of the supply cylinder.
6. Place the empty cylinder on the scale.
7. Carefully determine the net capacity and the total weight of the cylinder to be recharged and set the scale to equal the fully charged

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weight shown either on the side of the cylinder valve, on the cylinder, or on the nameplate band.

8. Open the shutoff valve in the pump outlet hose and allow the CO_2 in the supply cylinder to transfer to the cylinder being recharged under its own pressure.

9. After the CO_2 has stopped flowing into the cylinder being recharged under its own pressure (the weight of the cylinder being recharged will stop increasing), start the transfer unit and watch the scale carefully.

10. When the full capacity of the cylinder being recharged has been reached, perform the following operations in rapid succession:

a. Stop the transfer unit motor.

b. Tightly close the shutoff valve in the pump outlet hose.

c. Close the valve of the cylinder being recharged.

CAUTION: Do not close the cylinder valve or the shutoff valve while the transfer unit is pumping.

11. Disconnect the hose from the cylinder being recharged. Do this very slowly so as to allow the pressure trapped between the shutoff valve and the cylinder being recharged to escape. Remove the adapter.

12. Weigh the recharged cylinder carefully.

13. After recharging is complete, close the supply cylinder valve tightly and open the shutoff valve in the pump outlet hose very slowly, allowing all the gas in the pump to discharge to atmosphere.

NOTE: This transfer unit is to be used for carbon dioxide only. Do not use for oxygen or other gases.

WALTER KIDDE RECHARGE UNIT

Another widely used CO_2 recharge outfit is the Walter Kidde (fig. 16-2). This unit is supplied complete with the necessary adapters, valves, safety disks and bushings, nuts, bolts, and washers for making connections to the cylinder to be recharged; connections to the supply cylinder; and the tools for making minor adjustments to the unit. The motor is equipped with a safety switch.

The following operating instructions are general in nature. For detailed instructions on recharging specific types of cylinders, refer to Operation and Maintenance Kidde CO_2 Recharge Pump, NA 19-1-501.

General Operating Instructions

1. Connect strainer adapter to the supply cylinder outlet then make up coupling adapter nut (part No. 6071) securely. Make up coupling nut (18150) to the recharging adapter, using washer (6139) between these items. (See fig. 16-3.)

2. Be sure that the cylinder valve is open and ready for charging.

3. Place the cylinder to be recharged on the scale and note reading.

4. Open shutoff valve (24650) fully; make certain blowoff valve (24650) is fully closed. Start the recharge pump.

5. Open the supply cylinder valve fully, keeping constant check on the weight of the cylinder being recharged.

6. When the cylinder is charged with the proper weight of CO_2, stop the pump and close the shutoff valve securely.

7. Close the valve on the cylinder being recharged, then open blowoff valve.

8. Check the final weight of charged cylinder.

9. Close the supply cylinder valve securely. Relieve the pressure in the recharging pump and connections by opening the shutoff valve.

CO_2 SUPPLY CYLINDERS

Figure 16-4 illustrates the standard supply cylinder used universally in recharging various types of CO_2 cylinders. A cutaway view of the cylinder valve is also shown. Table 16-1 lists some of the most pertinent data concerning supply cylinders.

Cylinder Valves

Navy standard valves are of two basic designs: Packed valves and diaphragm type packless valves. CO_2 handwheel type valves employ the packless design.

Packed valves require a packing material around the valve stem to prevent leakage, whereas valves (used mainly in high-pressure cylinders) are sealed against leakage around the valve stem by flexible metallic diaphragms securely clamped to the valve bonnets.

The basic packless design may be classified into two types: (1) the NON-BACK-SEATING type, which is designed so that the metallic sealing diaphragms may NOT be replaced

11200

than the previously measured transmitter frequency, the radar-receiver local oscillator is improperly adjusted or the transmitter frequency may have drifted.

There are two basic methods of measuring receiver sensitivity. One method is the pulse method where a pulse of measured amplitude and width is generated and coupled to the radar receiver. This method is rather difficult as consistent results require that the signal generator be tuned very accurately to the receiver frequency.

The second method employs a FM generator to sweep the signal generator across the receiver frequency. This method insures that the test signal is within the passband of the receiver. It also offers two main advantages over the pulse method; tuning the test set to the receiver frequency is not as critical, and receiver bandwidth tests can be made with relatively few changes in test set adjustments after sensitivity tests have been made.

Receiver bandwidth is defined as the frequency spread between the half-power points on the receiver response curve. Receiver bandwidth is specified for each radar, but wide variations are tolerated. If either the bandwidth or the shape of the receiver response curve is not within tolerances, a detailed check of circuit components may be necessary. Remember that a considerable change in the value of circuit components is required to alter the response materially. It is suggested that the receiver response be checked after any extensive repair to an IF amplifier.

Figure 16-28 shows a typical response curve of a radar receiver. The half-power points are shown as 3-db below maximum (midfrequency) response. Since the curve is plotted in terms of voltage, these points are also represented by the 70.7 percent voltage points ($\sqrt{1/2} = .707$) as shown in figure 16-28.

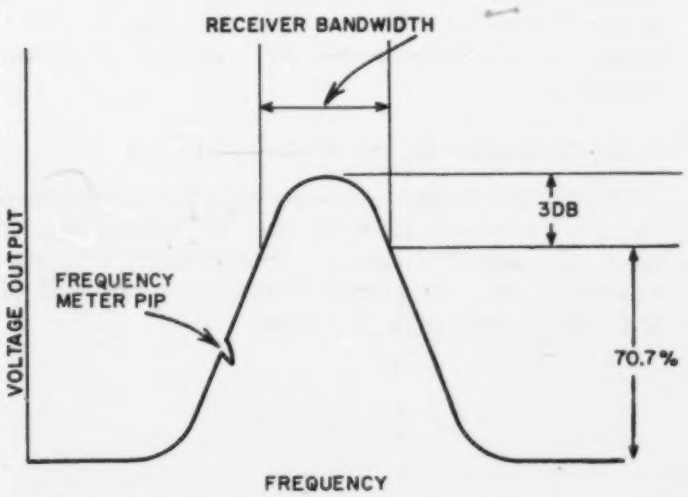

Figure 16-28.—Receiver response curve.

The time required to permit TR recovery is determined by the time it takes the TR switch to deionize after each transmitter pulse. It is usually defined as the time required for the receiver to return to within 6-db of normal sensitivity after the end of the transmitter pulse. However, some manufacturers use the time required for the sensitivity to return to within 3-db of normal or to full sensitivity. TR recovery time is the factor that limits the minimum range of a radar because the radar receiver is unable to receive signals until the TR switch is deionized. In various radar sets, the recovery time may vary from about 3 to 20 microseconds.

The primary function of the TR section is to protect the crystal detector from the powerful transmitter pulse. Even the best TR switches allow some power to leak through; but when the switch is functioning properly, the leakage power is so small that it does not damage the crystal. It has been found, however, that the useful life of a TR tube is limited because the amount of leakage and the recovery time increases with use.

To insure efficient performance, some technicians make it a policy to replace the tube after a given number of hours of use. A better practice is to measure the TR recovery time at frequent intervals and make a graph or chart, which will immediately disclose any change in performance. Figure 16-29 shows how the recovery time is correlated with leakage power. Note that the end of the useful life of the TR tube is indicated by an increase in recovery time.

This method of checking the condition of a TR tube is reliable, because the recovery time increases before the leakage power becomes excessive. In practice, the TR tube is replaced when any sharp increase in recovery time becomes apparent. Ambient temperature has an effect on recovery time. The colder a TR tube, the greater is its recovery time. When tests are conducted under widely varying temperature conditions, this effect must be considered.

One method used in testing a TR tube is to measure the keep-alive current. This current maintains the TR tubes partial ionization to make the firing more reliable, and thus helps protect the crystal. The current is usually

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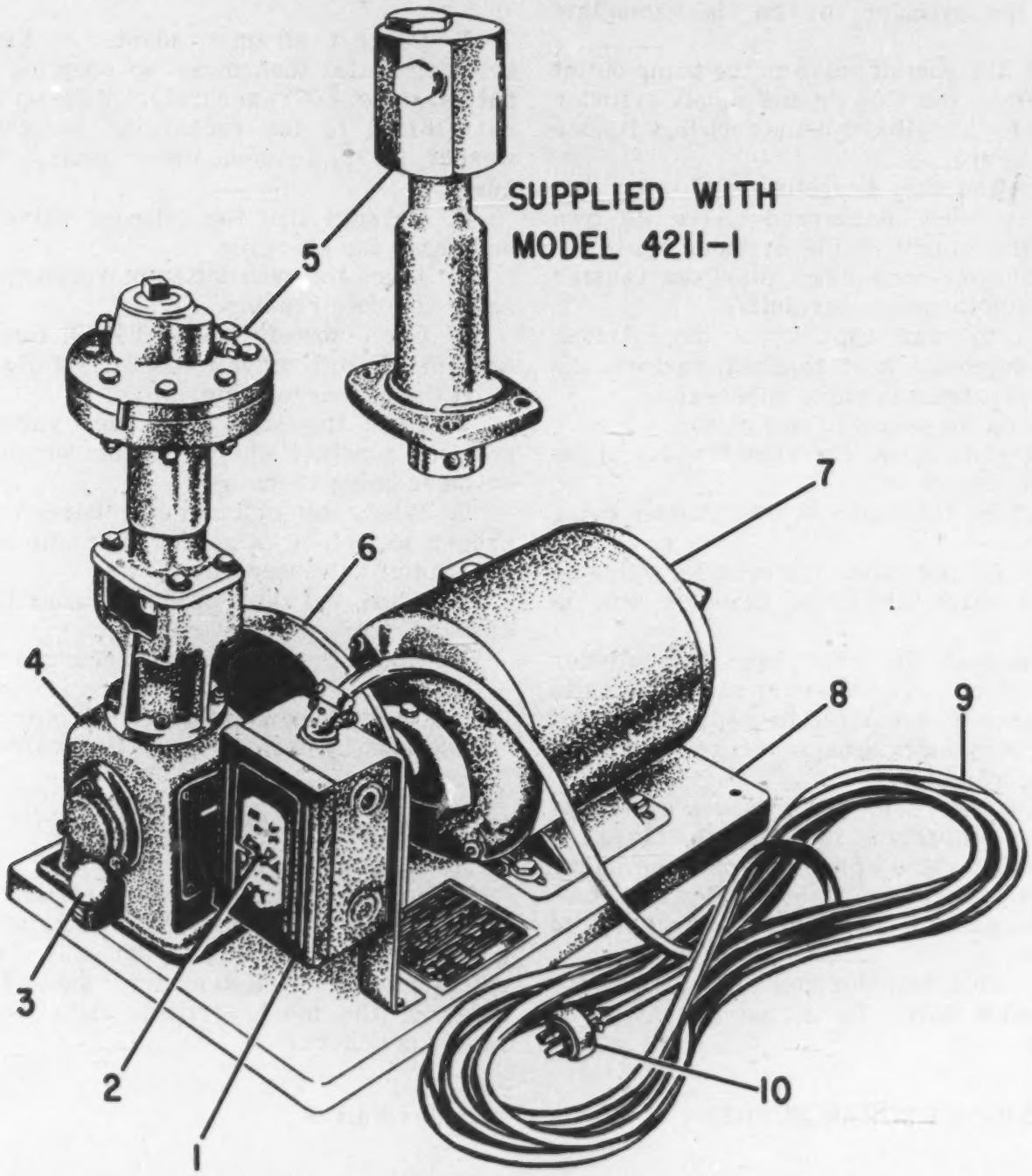

1. Multibreaker.
2. Power switch.
3. Oil filler cap.
4. Running gear assembly.
5. Compressor assembly.
6. Gear guard.
7. Motor.
8. Base.
9. Power cable.
10. Three-prong plug.

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Figure 16-2.—Walter Kidde recharge unit.

UNDER PRESSURE, and (2) the BACK-SEATING type, in which the metallic diaphragms may be replaced without undue hazard or loss of contained gases, provided the outlet cap is in place and secure. Replacement of diaphragms in packless valves should be done only by activities carrying spare diaphragms specifically designed for the valves in need of reconditioning.

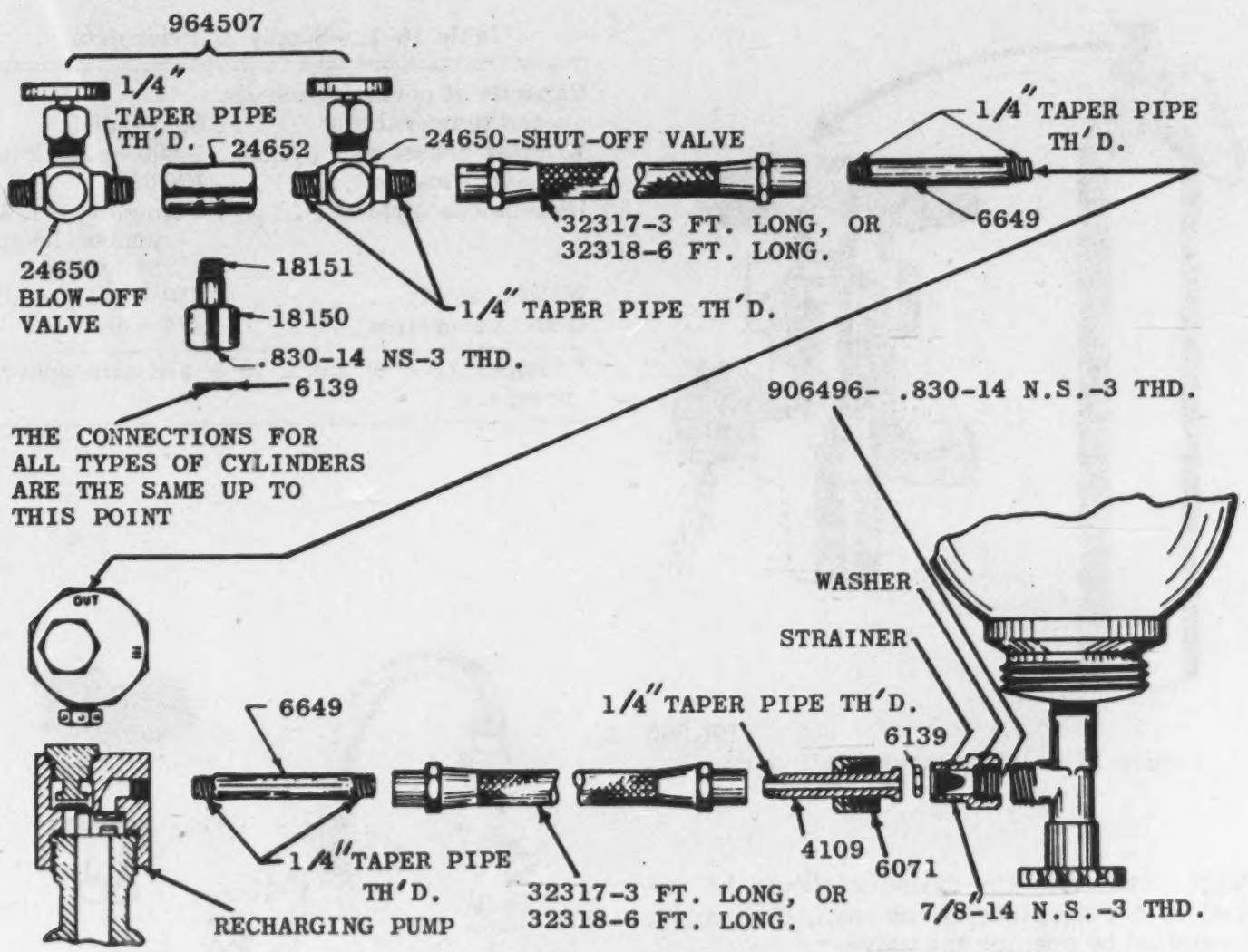

COMMERCIAL TYPE SUPPLY CYLINDER SHOWN (NO SYPHON TUBE). THIS TYPE CYLINDER MUST BE INVERTED, VALVE AT BOTTOM.
WHEN KIDDE SUPPLY CYLINDER (FITTED WITH SYPHON TUBE) IS USED, KEEP ERECT, VALVE AT TOP.
FOR BEST RESULTS KEEP SUPPLY CYLINDER COOL.
SEE RECHARGING INSTRUCTIONS.

PR.365

Figure 16-3.—Basic connections for Walter Kidde unit.

Diaphragms are fabricated from materials selected for service at high pressure while dynamically loaded. In addition, they are often of a design suitable only for use with valves fabricated by a given manufacturer and for a specific gas.

One of the features of the Navy gas valve program (also civilian agencies) is to provide noninterchangeable valve outlets and connections for different gases to prevent using the wrong gas at any time.

Leaking Valves

Cylinders with leaking or defective valves must be turned in to supply for overhaul. This is especially true in the case of stripped threads or bent stems.

Leakage is sometimes caused by the presence of dirt or other foreign particles in the valve or on the valve seat. This type leakage may sometimes be corrected by partially opening and then closing the valve to blow out the material. If

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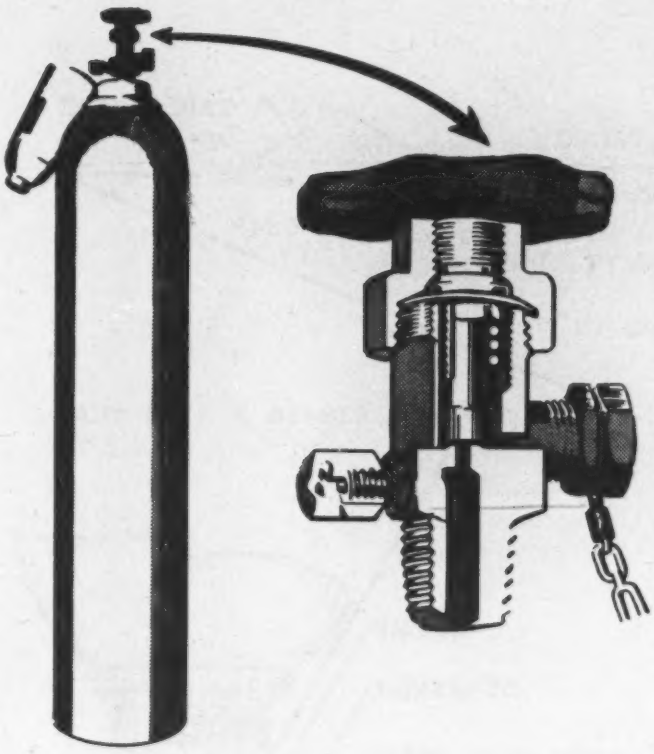

PR.366
Figure 16-4.—CO_2 supply cylinders.

Table 16-1.—Supply cylinder data.

Capacity at normal pressure and temperature*	50 pounds
Working pressure	1,800 to 2,015 psi
ICC specification	ICC3A
Dimensions (approx.)	Diameter, 8 1/2 inches; length, 51 inches
Weight, empty	110 - 115 pounds
Outlet connection	3/4 inch

*Temperature of 68° - 70° F and atmospheric pressure.

leakage continues, the cylinder should be removed to a safe place in the open, if possible, and emptied by opening the valve.

SAFETY DEVICES

Safety devices for CO_2 cylinder valves consist of an unbacked safety cap with a rupture disk. It consists essentially of a safety cap covering a safety port in the valve. The cap retains a frangible disk firmly over the safety port. Under excessive pressures ranging from 2,700 to 3,000 psi, the safety disk ruptures and allows the gas in the cylinder to vent to atmosphere.

LIFERAFT INFLATION EQUIPMENT

Figures 16-5 through 16-11 illustrate various types of liferaft inflation equipment items. These items consist of various sizes of cylinders and discharge heads and valves.

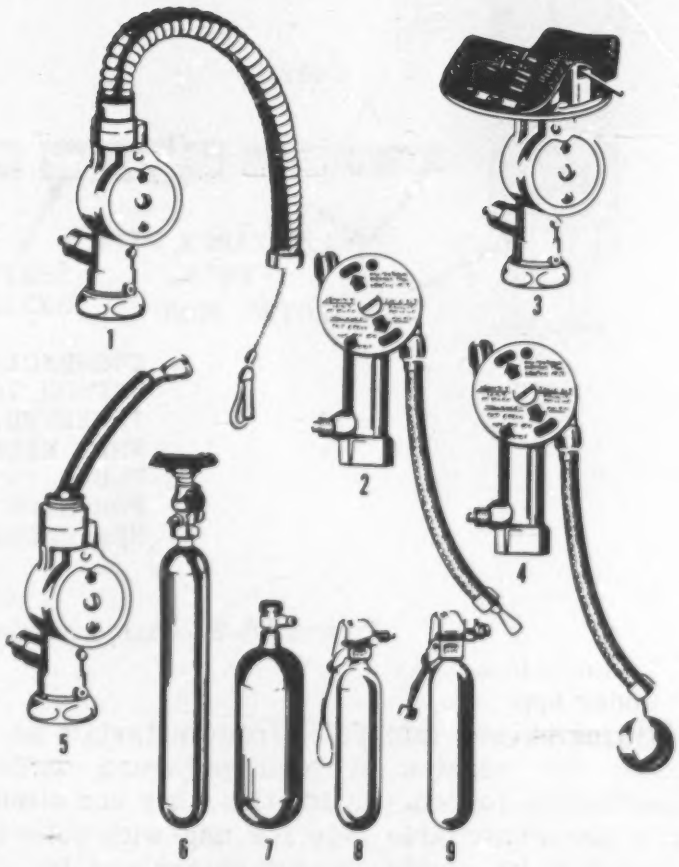

1-5. Discharge head assemblies.
6, 8, 9. Cylinder and valve assemblies.
7. Cylinder and disk body assembly.

PR.367
Figure 16-5.—Raft inflation equipment.

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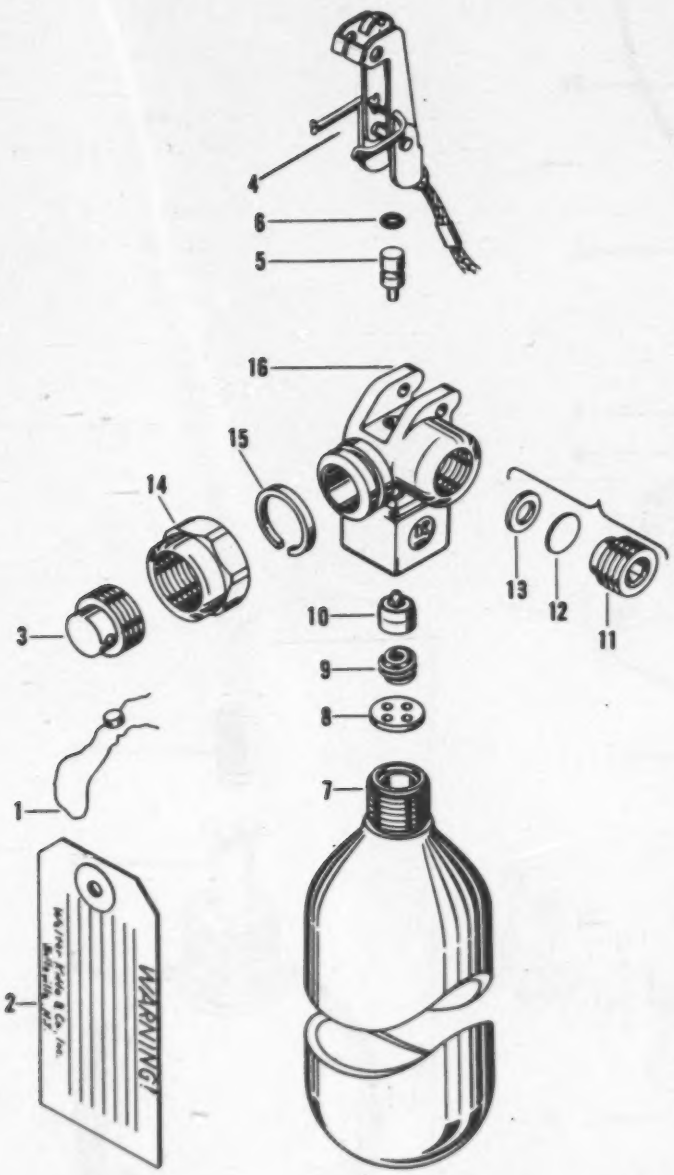

1. Wire seal.
2. Warning tag.
3. Recoil plug. NOTE: In some instances, under approval, this fitting is eliminated to conserve expense and weight.
4. Handle and pull cord assembly.
5. Plunger.
6. O-ring hydraulic packing.
7. Cylinder (20.4 cu in. capacity).
8. Bottle washer.
9. Check spring.
10. Check
11. Safety disk plug.
12. Safety disk.
13. Safety disk washer.
14. Coupling nut.
15. Brass wire.
16. Valve body.

PR.368

Figure 16-6.—Cylinder and valve assemblies used on the pararaft.

DISCHARGE HEADS

Two types of discharge heads are commonly used. These are the cutter type and the seat type. A description of the operating principles of each type follows.

Cutter Type

Pulling a cable releases the cutter which is under spring action. The cutter pierces a sealing disc in the neck of the cylinder. CO_2 discharges through the ruptured disk, bypassing the cutter and passes on through the outlet into the raft inflation compartment. A new disk must be installed in the cylinder adapter after each use. This necessitates the temporary removal of the head or bonnet during the recharging process.

Seat Type

Pulling a cable turns a cam or sheave which actuates a stem and opens a seat, thereby admitting CO_2 into the raft compartment through the outlet of the discharge head. It is not necessary to remove the discharge head for recharging after each use. A disk is not employed.

CYLINDERS

The cylinders used in conjunction with emergency equipment, designed for use in aircraft, must be shatterproof. Shatterproof cylinders must be stenciled with the phrase "Non-Shatt" longitudinally 90 degrees from the titles. Letters must be black or white and approximately 1 inch in size. The shatterproofing is accomplished by either a heat-treating process, or by a wire wrapping which encompasses the body of the cylinder throughout most of its length. Non-shatterproof CO_2 cylinders, such as some older type supply cylinders, do not carry the distinguishing white stripe. Only shatterproof CO_2 cylinders should be used in aircraft systems and related equipment.

All liferaft cylinders are equipped with a syphon tube. The syphon tube may be the straight type or the flexible type, depending on how the cylinder is to be mounted. Figure 16-12 illustrates both types of syphon tubes.

Cylinders equipped with flexible syphon tubes are marked with a black stripe; those having a straight type are marked by a spot, as shown in figure 16-12.

Nomenclature for figure 16-7.

1. Cylinder, nonshatterable (96 cu in., 147 cu in., or 205 cu in).
2. Syphon tube.
3. Pull cable.
4. Guard flap and plate.
5. Screw.
6. Washer.
7. Retainer.
8. Spring.
9. Gasket.
10. Stem.
11. O-ring packing.
12. Cover.
13. Screw.
14. Sheave.
15. Screw.
16. Camplate.
17. Plug.
18. Lever.
19. Stud.
20. Washer.
21. Lever spring.
22. Roller.
23. Retainer.
24. Plug.
25. Safety disk.
26. Safety disk washer.
27. Recoil adapter.
28. Valve body.
29. Wire seal.
30. Tag.

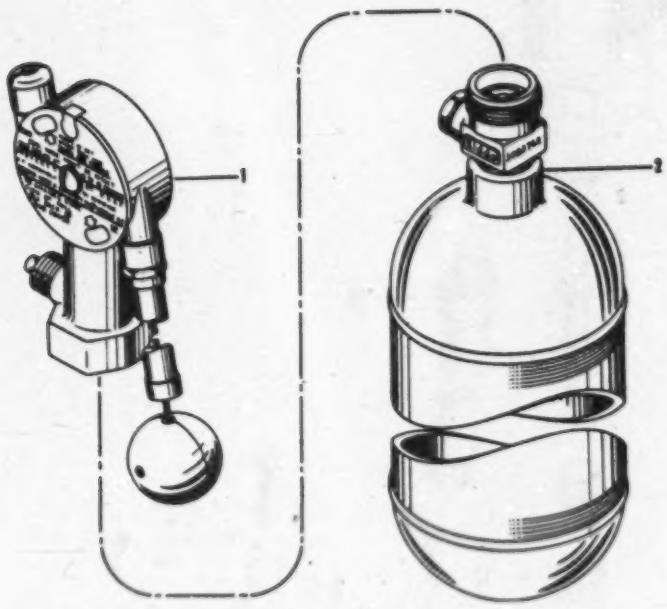

1. Discharge head assembly (seat type). (See fig. 16-9.)
2. Cylinder and disk body assemblies. (See fig. 16-10.)

PR.370

Figure 16-8.—Cylinder, disk body, and discharge head assemblies used on multiplace liferafts.

All CO_2 cylinders used in connection with aircraft fire extinguishing equipment (both portable and built-in types) must be serviced to operate throughout the temperature range of -65°F to +150° F. This is accomplished by the addition of 200 psi of dry, oil-free nitrogen to each cylinder and then adding the proper charge of carbon dioxide. Cylinders charged in this manner are referred to as winterized cylinders.

Cylinders which are to be winterized are identified by a yellow dot 3/4 inch in diameter, or larger, on opposite sides of the cylinder.

The addition of nitrogen in CO_2 cylinders provides additional pressure which expels the CO_2 at extremely low temperatures at a much higher rate than would the pressure of the CO_2 itself.

CYLINDER MAINTENANCE

Cleaning and Painting Cylinders

Cylinders should never be painted colors other than those indicated in the color code for compressed gas cylinders in Military Standard 101A. When camouflage is necessary, canvas or other materials painted with camouflage colors may be placed over the cylinders.

Cylinders should never be painted on their interior surfaces.

Valves must be kept free from paint. Navy and Interstate Commerce Commission serial numbers and test markings must not be obliterated.

Before painting cylinders, all loose paint, scale, rust, and dirt must be removed. When spark-producing tools, such as wire brushes or metallic scrapers are used, the cleaning operation should be done in the open or in a well ventilated compartment.

Before any cleaning operation, the valves, safety devices, and fusible plugs should be tested for leaks. Leaking cylinders should not be cleaned, but should be returned to an authorized repair activity.

Testing Cylinders

Interstate Commerce Commission regulations require quinquennial (5-year) retesting

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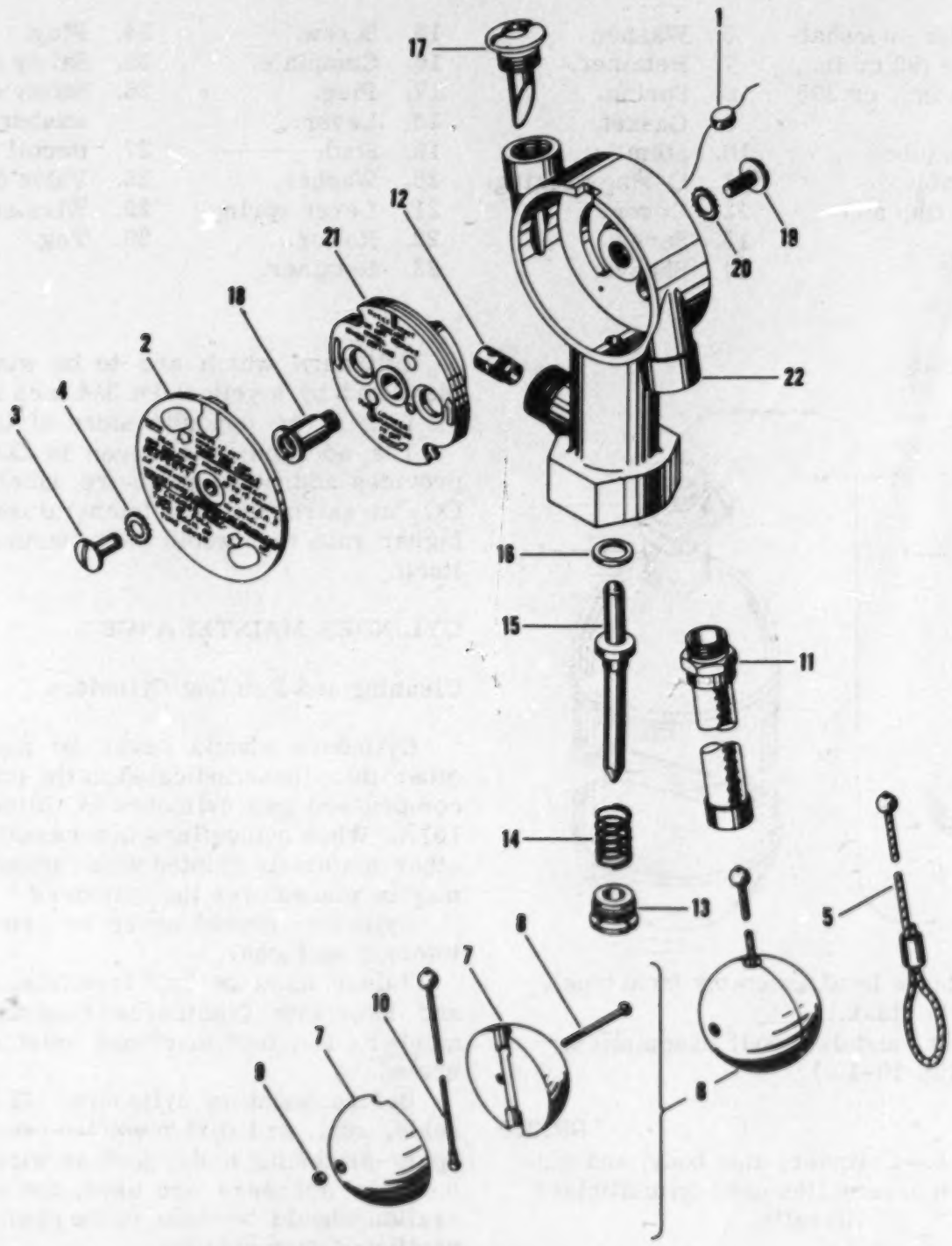

1. Wire seal, copper and lead.
2. Cover.
3. Screw.
4. Washer.
5. Cable.
6. Ball and cable assembly.
7. Half-ball.
8. Screw.
9. Brass hex nut.
10. Cable.
11. Cable housing
12. Nonrecoil outlet.
13. Retainer.
14. Spring.
15. Cutter.
16. Washer.
17. Swivel plug.
18. Stud.
19. Screw.
20. External teeth type lockwasher.
21. Sheave and cam.
22. Discharge head body.

PR. 371

Figure 16-9.—Discharge head assemblies employing cutter type action.

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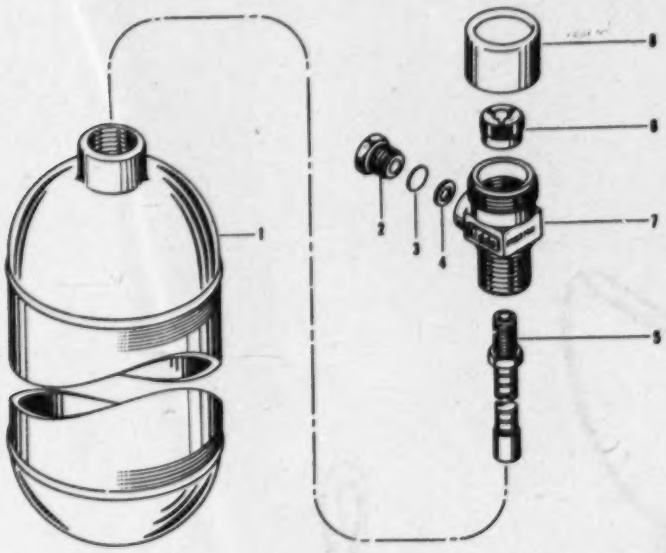

1. Cylinder (number 1 in the figure represents five sizes, each one capable of containing a specified CO_2 charge as follows: 1.80 lb, 2.05 lb, 3.25 lb, 4.70 lb, and 9.40 lb. When the 3.25-lb size cylinder is winterized with nitrogen, it contains a lesser charge—2.98 lb, and when the 4.70-lb size cylinder is winterized, it contains 4.32 lb).
2. Safety disk retainer.
3. Safety disk (two different capacities).
4. Safety disk washer.
5. Syphon tube (four different sizes).
6. Disk bushing, red or black, depending on capacity.
7. Body (three different sizes).
8. Shipping cap.

PR.372

Figure 16-10.—Cylinder and disk body assemblies adaptable to bushing disks and cutter type discharge heads.

of all CO_2 cylinders. Cylinders for which prescribed retests have become due must not be recharged until retests have been properly made. Cylinders which have been charged prior to the expiration of their retest period may be shipped and used until empty before being retested.

The 5-year hydrostatic tests are performed by naval and civilian establishments under regulations of the Interstate Commerce Commission, and specially approved testing equipment is required. Since ships are not authorized to conduct such tests, empty cylinders with expired test periods should be returned to the nearest naval supply point or cylinder testing activity marked "for retest."

Repairs

Cylinders are repaired only by activities specifically authorized to perform such work. To assure that all cylinders aboard ship are in satisfactory and serviceable condition, periodic inspections should be made. Defective cylinders should be relieved of pressure and turned in to the nearest supply point in exchange for other cylinders.

The following marks or defects require a cylinder to be turned in for repair:

1. Severely dented, gouged, or corroded.
2. Bulges (deformation from internal pressure).
3. Damaged, split, or leaky seams.

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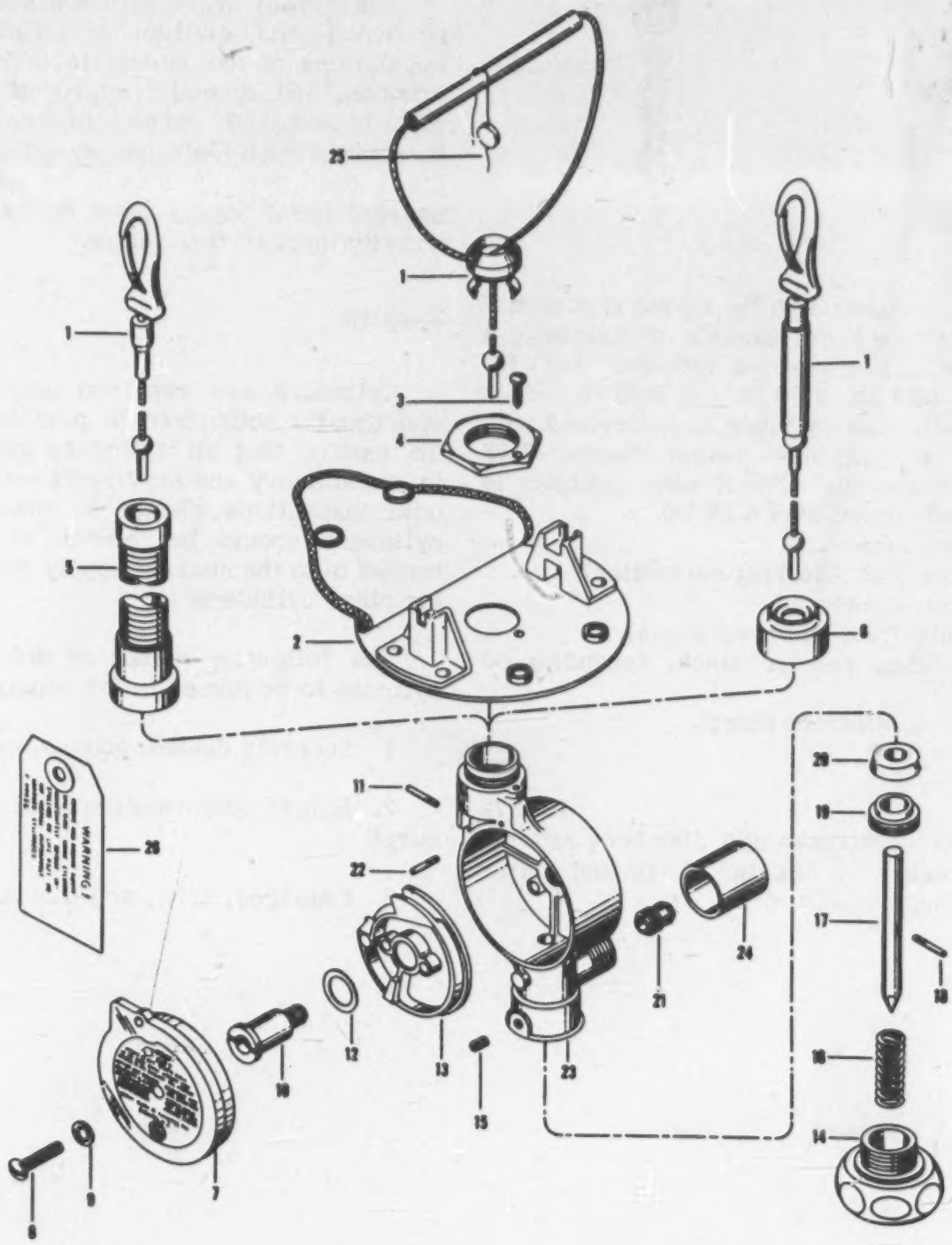

PR.373

Figure 16-11.—Discharge head assemblies employing cutter type action with hand and remote pull cables.

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Nomenclature for figure 16-11.

1. Pull cables.
2. Guard flap and plate.
3. Screw.
4. Collar.
5. Cable housing.
6. Cable outlet cap.
7. Nameplate cover.
8. Screw.
9. Washer.
10. Stud.
11. Pin.
12. Shim.
13. Cam pulley.
14. Bottom cap.
15. Screw.
16. Spring.
17. Disk cutter.
18. Pin.
19. Packing retainer.
20. U-cup hydraulic packing.
21. Recoil adapter.
22. Pin.
23. Body.
24. Protection cap.
25. Wire seal.
26. Tag.

NOTE: Pull cables (1) are adaptable to remote control systems. The use of one or the other is dependent on its adaptability to a specific aircraft in relation to its liferaft inflation system.

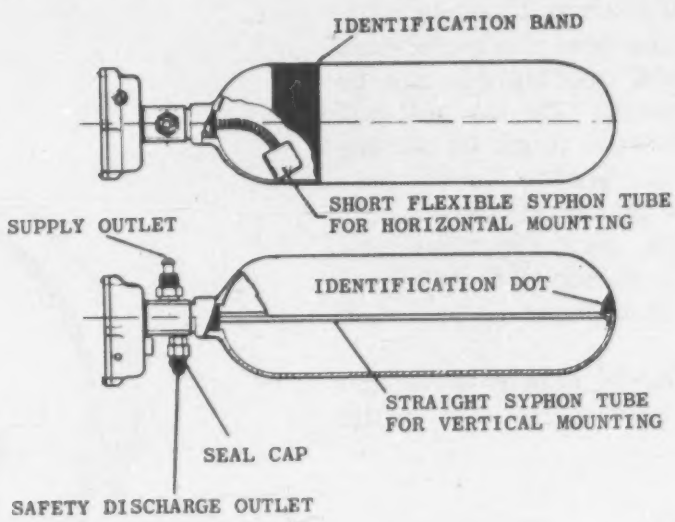

PR. 374

Figure 16-12. —Syphon tubes.

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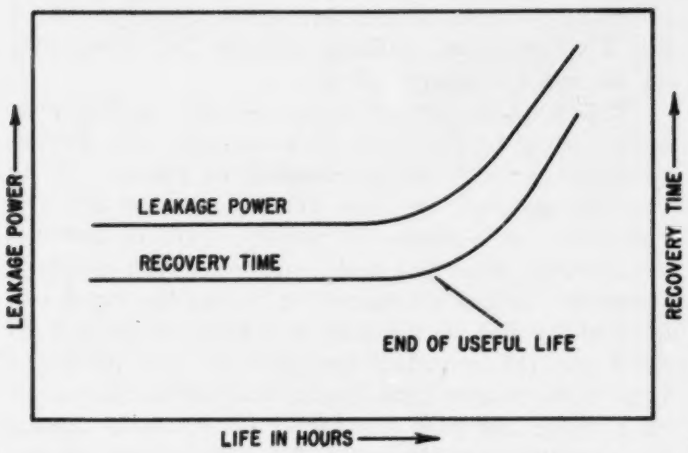

Figure 16-29.—Graphic comparison of TR recovery time and leakage power.

about 100 microamperes, and falls off as the end of the TR tube life approaches. Another method is to measure the keep-alive voltage between the plate and ground of the TR tube when the voltage source is known to have the correct output, and to record this voltage for use as reference for future checks. However, these checks are not as reliable as a recovery time test.

TR recovery time can be tested by means of a setup that utilizes a signal generator of either the FM or the pulsed type.

RECEIVER TROUBLES

Poor system performance may be caused by low receiver sensitivity (high MDS), poor AFC operation, and poor minimum range.

Low Receiver Sensitivity

Low receiver sensitivity is evidenced by a high MDS test figure. The reasons for this condition may be either excessive noise generation or excessive signal loss preceding the IF amplifier section. As long as the noise present in the receiver output is excessive, the IF amplifier cannot contribute to the sensitivity. When defective or improperly adjusted, the following items may cause low receiver sensitivity; crystal mixer, local oscillator, IF amplifier (first two IF stages), and the TR and ATR tubes.

Crystals may be tested most effectively under actual operating conditions. However, a series of crystal testers, of which the AIL Model 390 is representative, is available, and one of these testers may be used to correlate the d-c characteristics with circuit performance. Important crystal characteristics are conversion loss, noise figure, IF impedance, and RF impedance. These characteristics may be correlated with front-to-back resistance ratio and back current at 1 volt.

Poor AFC Operation

Because proper operation of the AFC circuit is primarily dependent upon coupling between the AFC crystal mixer, the local oscillator, and the output of the magnetron, this portion of the circuit should be checked first. A variable coupling is usually provided to adjust the amount of local-oscillator signal injection to the AFC crystal mixer. Care should be taken to prevent overloading of the AFC crystal mixer, and reference should be made to the applicable instruction book as to the correct crystal current for proper operation. Usually one milliampere of crystal current is the allowable limit. If the degree of coupling is found to be correct, the trouble may lie in a defective local-oscillator tube. The local-oscillator must operate smoothly over the desired pull-in frequency range if normal AFC operation is to take place. In addition, it is essential to make sure that the local oscillator is operating in the correct mode. A magnetron with an improper frequency spectrum may also cause the AFC circuit to seem defective.

Poor Minimum-Range Performance

Minimum-range performance is controlled by the recovery time of the TR tube (and, if used, the pre-TR tube). Excessively long recovery time, of course, indicates the end of the useful life of a TR tube.

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CHAPTER 17

SAFETY BELTS AND SHOULDER HARNESSES

When wearing a safety harness, pilots can survive many crashes in which the cockpit or cabin remains reasonably intact, and the harness will also hold the pilot in the seat during ejection. The pilot is held in the seat while being ejected from the aircraft and then is automatically released from the seat after ejection.

What the harness must accomplish can be condensed into one statement: The lap belt and shoulder harness combination must be strong enough to hold a man in his seat under all reasonable stress conditions that might be experienced in high-speed flight, seat ejections, arrested landings, ditchings, or noseover crashes. It must be designed so that it can be released quickly.

Testing and inspecting of safety belts and shoulder harnesses are responsibilities of the PR.

PILOT'S LAP BELT AND SHOULDER HARNESS

Pilot's safety belts may be furnished as complete assemblies, consisting of lap and shoulder straps, or as individual components. There are several types of lap belts and shoulder harnesses. Figure 17-1 illustrates a complete assembly of one type.

PILOT'S LAP BELT (MS 22033)

Figure 17-2 illustrates the pilot's lap belt (MS 22033) showing its stitching pattern, parts assembly, and other significant physical characteristics. The MS 22033 lap belt assembly is subjected to periodic proof load testing to insure proper performance and integrity.

The proof load test for the lap belt amounts to 6,000 pounds doubled load or 3,000 pounds end load. After this test, no excessive deformation of the parts of stitching is permitted in the assembly. The latch must work freely when the load is released.

The ultimate load and proof requirements applied to a lap belt immediately after its manufacture (at the plant) should not be confused

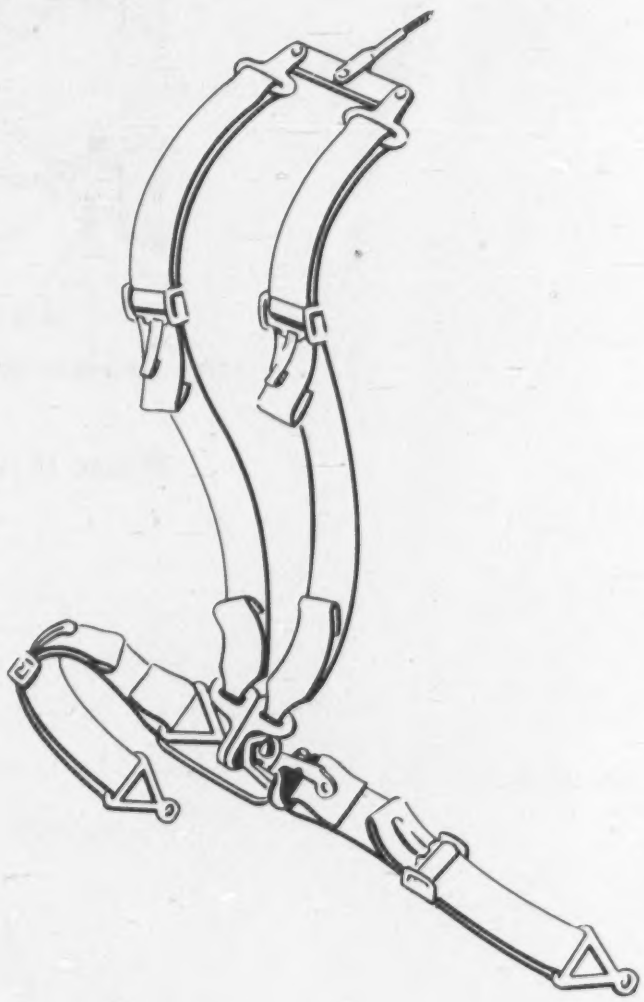

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Figure 17-1.—Pilot's lap belt and shoulder harness.

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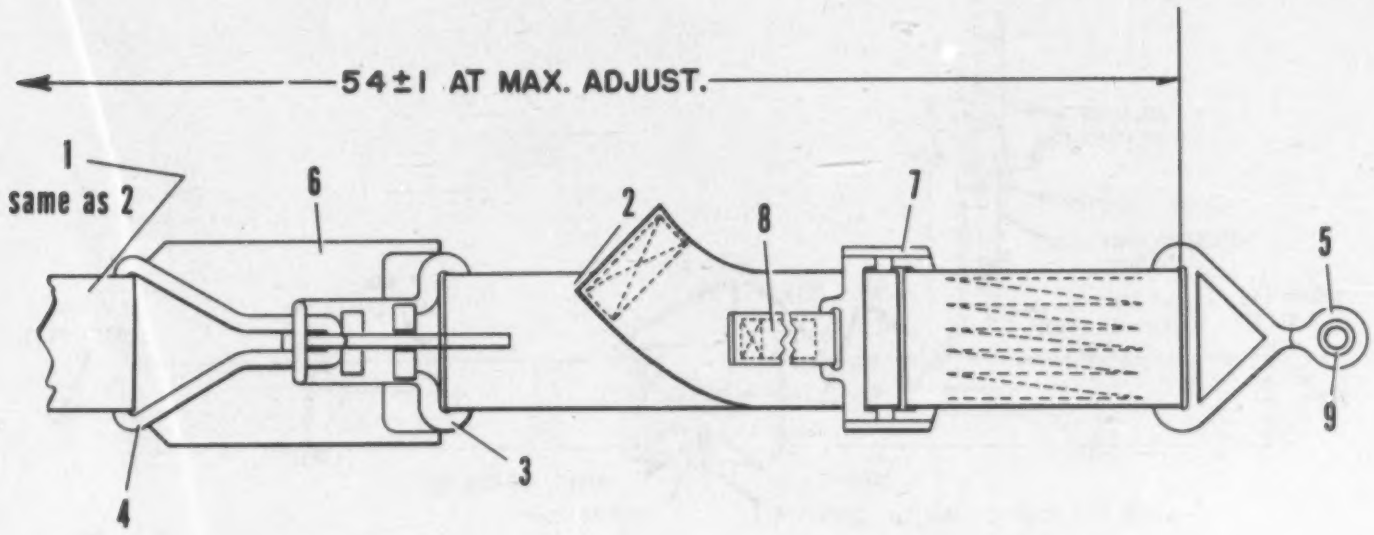

1. Right side of belt. (3-inch nylon webbing).
2. Left side of belt (3-inch nylon webbing).
3. Latch assembly.
4. Link.
5. Loop.
6. Leather protector.
7. Adjuster.
8. Pull tab.
9. Bushing.

PR. 376

Figure 17-2.—Pilot's lap belt (conventional type).

with the periodic service tests given this equipment in the field. Field test proof loads do not even approach the tensile strength capacity of the assembled belt.

All major stitching is done with 6-cord nylon thread, size E being used in the less important tensile strength areas.

LAP BELT (AUTOMATIC-RELEASE TYPE)

Safety belts installed in aircraft with ejection seats in accordance with installation MS 16036 have an automatic-release feature incorporated. Its function is to hold the pilot in the seat during ejection, then open automatically and arm the parachute actuator after the pilot and seat are clear of the aircraft. This feature is designed to eliminate the necessity of the pilot releasing his safety belt at exactly the proper time and pulling his own ripcord, thus making ejection from an aircraft a much simpler and safer task.

The automatic-release type safety belt is cartridge operated. The complete assembly consists of the two belt halves, link latch, cable assembly, actuator assembly, and actuating unit assembly, as shown in figure 17-3.

When an automatic parachute actuator is used, the cable to the actuator is attached to the belt as shown in figure 17-3. When the belt is automatically separated and the pilot leaves the seat, the parachute actuator arming link is restrained by shoulders on the belt adapter link, pulling the cable and arming the actuator.

Piston action in the actuator assembly pulls the cable which is secured to a link holding the safety belt, shoulder harness and parachute arming wire together. If the automatic release fails to operate, the belt and shoulder harness can be released manually in the normal manner and the pilot must pull his own ripcord.

During normal use, the belt halves are manually joined and separated to attach or free the parachute actuator link so that the parachute

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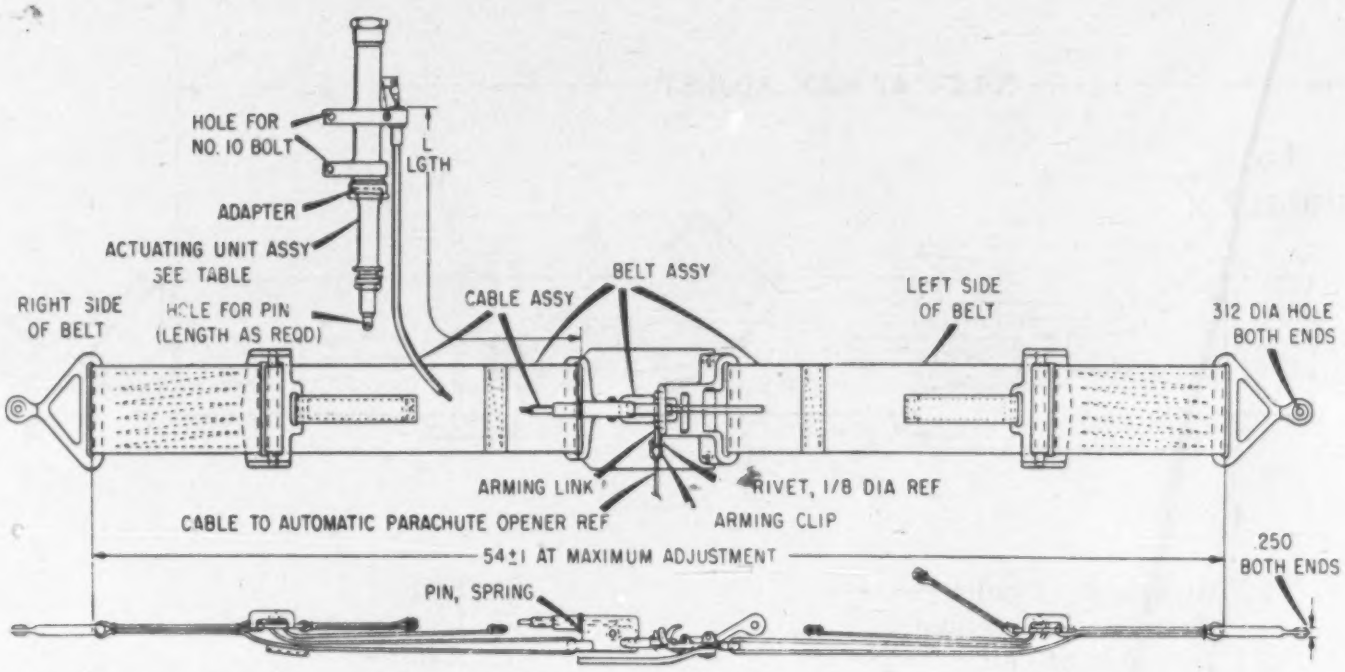

PR.377

Figure 17-3.—Lap belt, automatic-release type.

can be removed from the seat without danger of actuating the automatic actuator.

A proof load test of 235 pounds is made when the automatic-release type safety belt is safetied with 0.040 copper lockwire. With no lockwire the proof load test is 175 pounds.

SHOULDER HARNESS

Figure 17-4 illustrates the H-type shoulder harness' dimensions, its stitching pattern, how it is put together, its parts, and other significant physical characteristics. The Y- and V-types are shown in figures 17-5 and 17-6. Where the lap belt remains fairly standard in its attachment to the pilot's seat, the shoulder harness must quite often be modified to fit its anchored location. This subject will be discussed under installation.

The anchor plate of the Y-type is adjustable, making it possible to lengthen or shorten the leg of the harness for a particular aircraft installation. The length of the leg of the Y must be adjusted so that there is adequate shoulder harness adjustment available, yet the crotch of the Y is not on the pilot's neck. During the manufacture and before acceptance, shoulder straps are subjected to a 3,500-pound ultimate load. A reasonable deformation of the parts is permissible.

A proof load of 3,000 pounds is also made and the straps must not have slipped appreciably through the adjustment loops. No noticeable deformation of any kind is permitted in this test. The proof test, then, establishes the highest tensile strength load a shoulder harness will withstand and still operate satisfactorily afterwards. The ultimate test is designed to stop at a tensile strength value just short of complete destruction. With reasonable care and by applying preventive measures, the shoulder harness will give long and honored service, easily passing its field test loads. The latest straps are made of Dacron, a "miracle fiber" similar to nylon. Dacron has less stretch than nylon.

NOTE: One assembly out of every 1,000 submitted for acceptance must be subjected to the ultimate load, and any safety belts or shoulder harness subjected to the ultimate load must not be shipped under contract.

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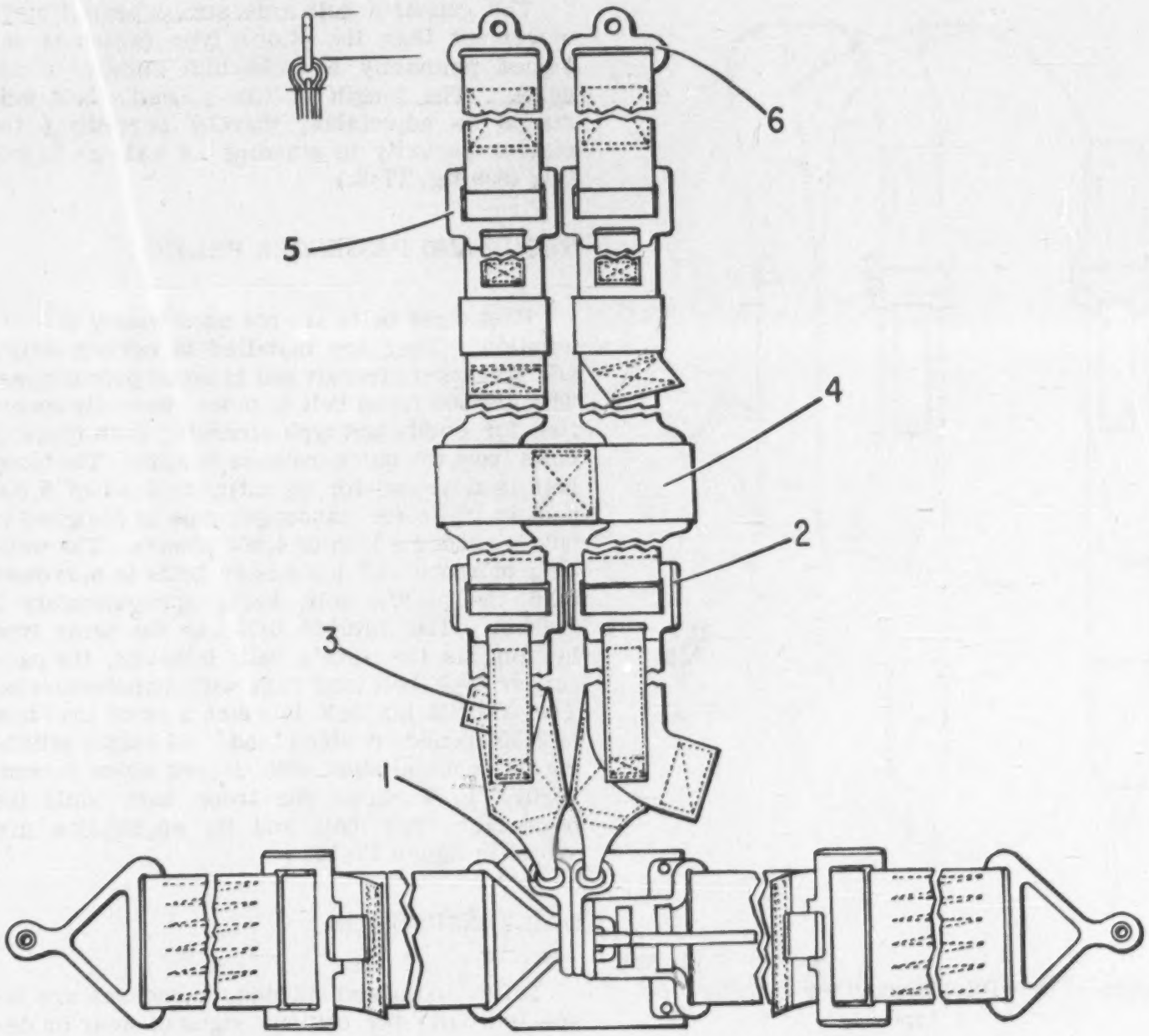

1. Link (left and right).
2. Adjuster.
3. Pull tab.
4. Keeper.
5. Adjuster.
6. Plate attachment.

PR. 378

Figure 17-4. —Shoulder harness with separating keeper.

All proof testing must be accomplished with all adjustable webbing components in the fully extended position.

Notation of compliance and date of proof load test must be recorded in the Aircraft Log Book, NavAir form 13090/4A.

MISCELLANEOUS SAFETY BELTS

CREWMAN'S BELT

The crewman's safety belt is designed to permit a reasonable amount of movement of the wearer in performing his duties while holding

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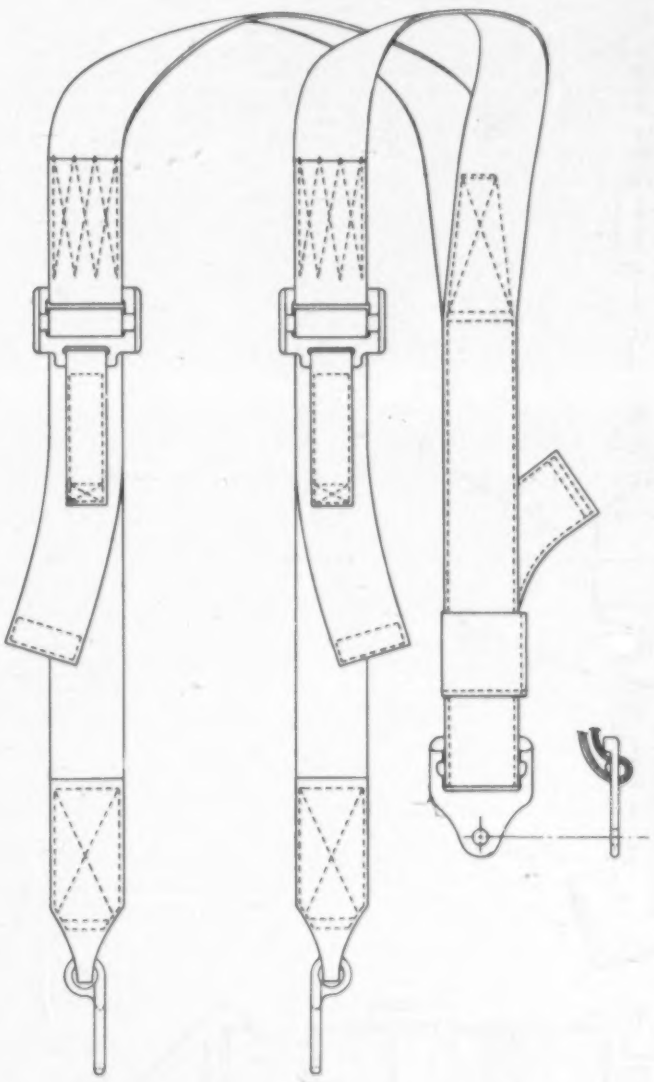

PR.379

Figure 17-5.—Pilot's shoulder harness—Y-type.

him securely in the aircraft. Figure 17-7 illustrates the MS 16070 belt. The tail strap which is adjustable (22 inches to 65 inches, approximately) can be anchored to any strong part of the aircraft's structure which is adaptable to its hook. Normally the smaller the amount of tail strap payed out, the less will be the danger of being whipped about when the aircraft is maneuvered violently.

As the crewman makes the attachment, he should anchor to a strong structural member making certain that the attachment will not mar or damage equipment.

GUNNER'S BELT

The gunner's belt side straps permit more movement than the pilot's type (which is designed primarily to hold him solidly in his seat). The length of the gunner's belt side straps is adjustable, thereby permitting the wearer security in standing as well as in sitting (See fig. 17-8.)

TROOP AND PASSENGER BELTS

Passenger belts are not used widely in naval aviation. They are installed in certain utility and transport aircraft and in some patrol types. The AN6506 troop belt is more generally specified for combatant type aircraft. Both types of belts have the quick-release feature. The troop belt is designed for an ultimate load of 5,000 pounds while the passenger type is designed to hold up under a load of 4,500 pounds. The webbing of troop and passenger belts is narrower than the pilot's belt, being approximately 2 inches. The AN6506 belt has the same type latching as the pilot's belt; however, the passenger type belt may vary with manufacturers. The AN6506 lap belt is given a proof load test of 2,500 pounds doubled load. All major stitching is accomplished with 3-cord nylon thread. Figure 17-9 shows the troop belt, while the passenger type belt and its application are shown in figure 17-10.

DAILY INSPECTION

Safety belts and shoulder harnesses are inspected daily for obvious signs of wear or deterioration of the metal parts and for wear or fraying of the webbing. Release buckles, snap-hooks, and other operating parts must be checked for proper functioning.

AIRCRAFT CALENDAR INSPECTION

Make a complete and thorough inspection of all equipment as for the daily inspection and include a close examination for corrosion, cracks, wear, fraying, rot, broken stitches or cuts in the webbing, cable or other parts.

Inspect all parts of the aircraft that the lap belts, shoulder harness, or inertia reel webbings may contact for any deformation such as

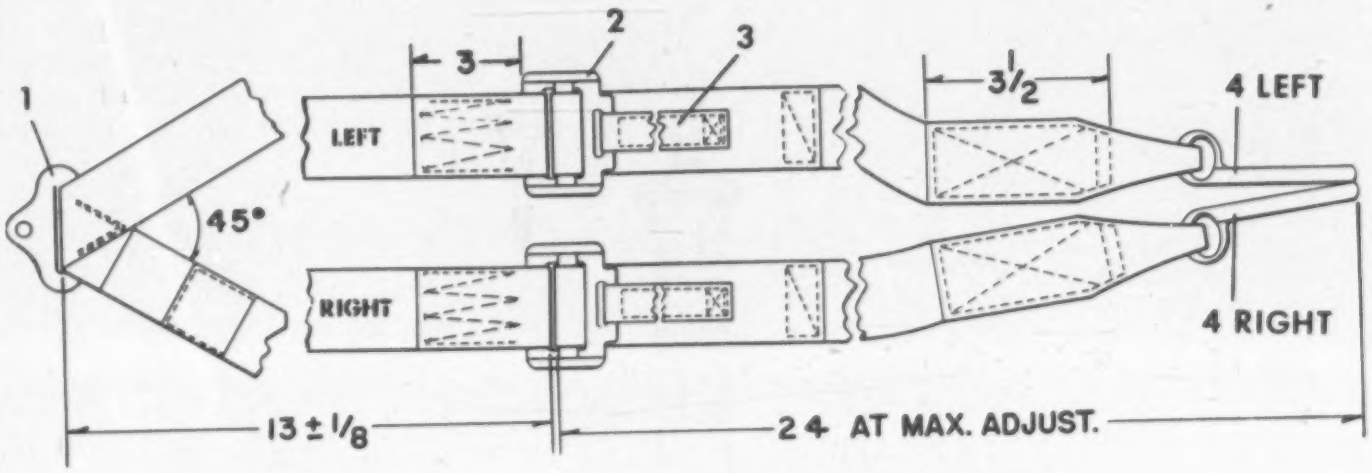

1. Anchor plate.
2. Adjuster.
3. Tab
4. Links (left and right).

PR. 380

Figure 17-6.—Pilot's shoulder harness—V-type.

sharp, jagged edges or roughness which may cause cutting or excessive abrasion.

Note the date of proof load testing of affected components. All components are to be proof load tested in accordance with Air Crew Systems Bulletin No. 2 to insure that the prescribed test intervals are not exceeded before the next calendar inspection.

Correct all discrepancies by local repair, modification, or by replacing components. If a discrepancy is found to be due to aircraft, seat, or restraint system design, submit a UR describing the defect in detail.

PAR/OVERHAUL INSPECTION

During aircraft PAR or overhaul, remove lap belts, shoulder harness and inertia reel, and takeup reel webbings. Conduct a thorough visual inspection as for aircraft calendar inspection. Perform proof load tests of all components and replace all cotton with nylon or dacron.

Test/Replacement Intervals

Lap belts, shoulder harness, and inertia reel webbings are to be proof load tested prior to installation and at intervals not to exceed the following:

Safety belts and straps which are made of cotton are removed from the aircraft, inspected thoroughly, and proof load tested every 6 months, then replaced with equipment made of nylon or dacron at the next PAR.

Safety belts and straps which are made of synthetic materials (nylon or dacron) are proof load tested during the applicable PAR cycle.

Proof Load Testing

Proof load testing is to be performed by intermediate maintenance activities and above. When components require proof load testing at other activities, they must be removed and sent to the nearest authorized activity with the capability to make the tests.

Test loads to be applied are listed in Air Crew System Bulletin No. 2.

Test equipment is to be recalibrated at intervals not to exceed 6 months.

When performing proof load tests, the load is to be applied by a loading device with a separation rate of approximately one inch per second, until the specified test load is reached. The load is to be held for 30 to 60 seconds and

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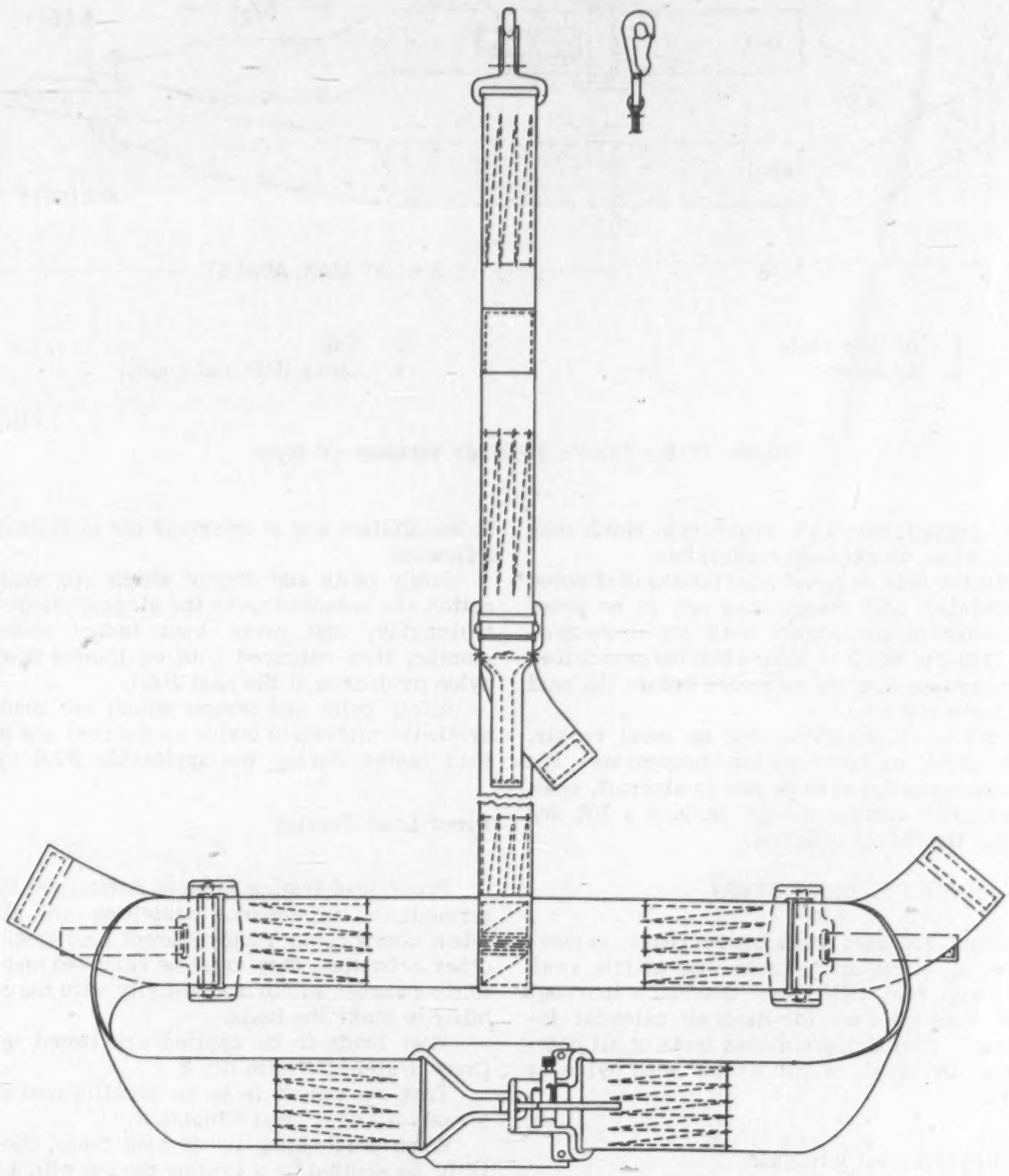

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Figure 17-7.—Crewman's safety belt.

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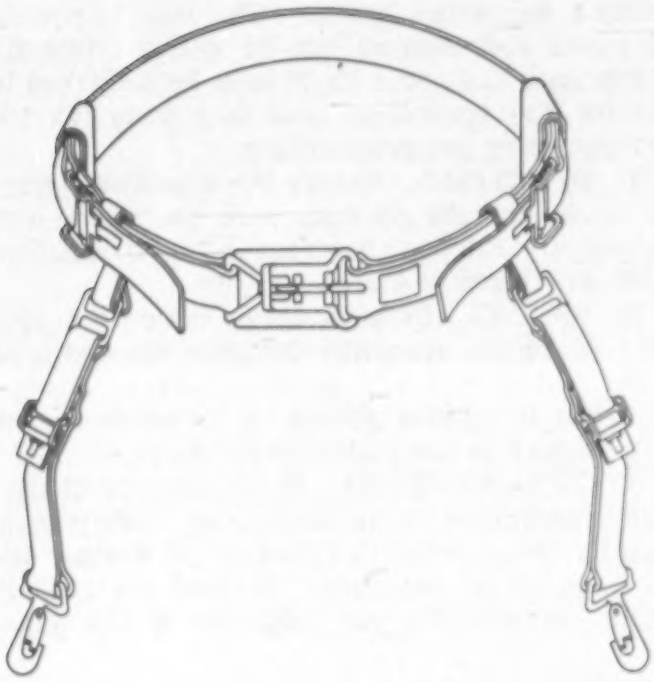

PR.382

Figure 17-8.—Gunner's safety belt.

then released. After completion of the test, inspect the item for broken stitches or other evidence of failure. There must be no perceptible slippage of the webbing through the adjustment loops, and the lap belt release must work freely. The quick release buckle of the lap belt must be operable under a pull of NOT OVER 45 POUNDS ON THE LATCH WHILE THE BELT IS SUBJECTED TO A STATIC LOAD OF 400 POUNDS.

BELT TESTING EQUIPMENT

Any one of several methods may be used for applying the prescribed proof load to the belts and straps; for example, mechanical tension tester, tripod lifts, deadweight loading, and others. The accuracy of the actual reading is more important than the manner in which the test load is applied.

A testing jig made from salvaged material is shown in figure 17-11. Its capacity is approximately 5,000 psi, a necessary reserve in power. The device can be mounted horizontally or vertically depending on the dictates of the physical plant. The movable head and the stationary head should be mounted far enough apart so that all lengths of belts and harnesses together with their necessary mounting clamps or adapters can be accommodated. In many cases, these have to be manufactured locally. Any PR can design the special jig necessary to do the job. For example, the part used in the aircraft to hold the mounting plate of a shoulder harness can be rigged to a testing jig and be used for the same purpose during test.

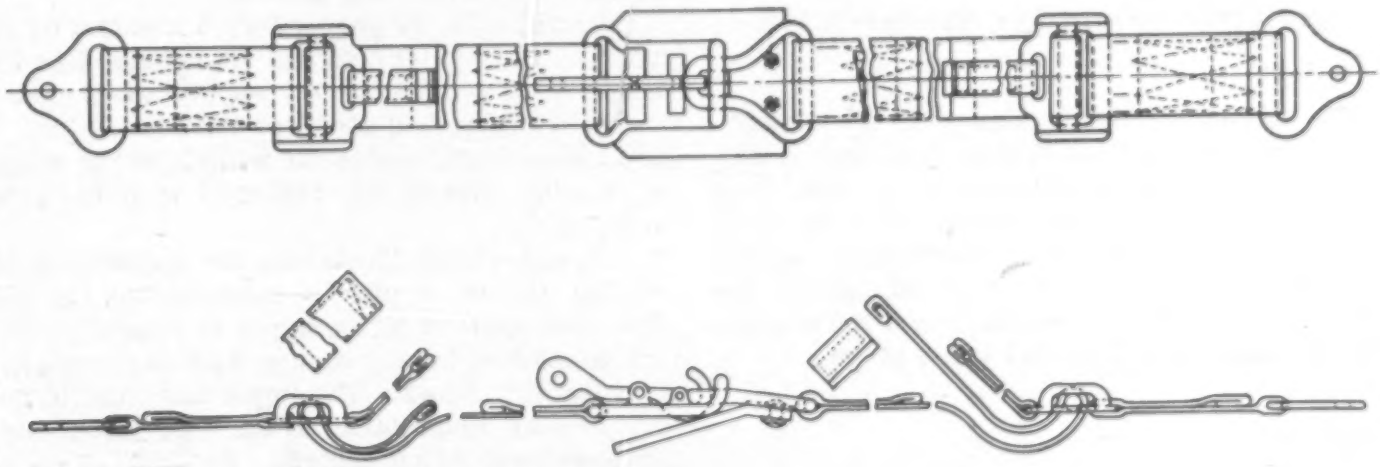

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Figure 17-9.—Troop type safety belt.

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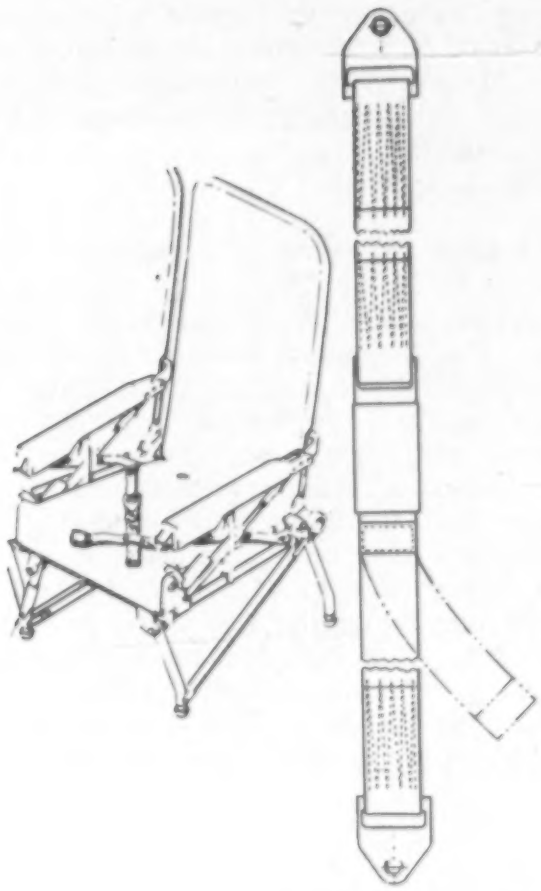

PR.384

Figure 17-10.—Passenger type safety belt.

The device shown in figure 17-11 is adequate. Its construction details need not be followed closely. As a precaution, a wire cage must be constructed and placed over the area that lies between the two attachment heads. Then the operator will be guarded against the possibilities of sudden breakage and the accompanying whipping action that takes place.

Calibration

After construction of a testing device, it will be necessary to recalibrate the pressure gage from psi to pounds. This will insure an easily read value in relation to the specified tension load. Calibration can be done by any of the methods suggested below. The load in pounds (50-pound increments) can be marked directly on the gage dial, or a chart may be prepared to indicate the equivalent load in pounds for the corresponding psi graduations.

1. DEADLOAD. Secure the actuating cylinder in an upright position with the piston rod downward. Record the pressure (psi) required to lift deadloads of known weights.

2. SPRING. Place a large capacity spring scale of known accuracy between the two jaws of the test device and apply pressure. Record the loads in pounds shown on the scale versus the pressure in psi indicated by the gage.

3. DYNAMOMETER. Place a loop or Chatillon dynamometer of approximately 5,000 pounds capacity between the two jaws of the testing device and apply pressure. Record the load in pounds against the psi indicated by the gage.

Operation

The device requires only one man to operate it. Secure one end of the belt or shoulder strap to the ratchet rod and the other end to the piston rod. The length of the adjustable ratchet and the piston rod will afford sufficient clearance for testing belts of various lengths. Turn the selector valve handle to the loading position. Apply the required load by operating the hand pump. Read the load on the calibrated gage. Hold for 30 seconds or 1 minute, as specified for the particular harness, and release the load by turning the selector valve handle to an unloading position.

Recalibrate the gage every 6 months; breakages in the system should be repaired as they occur. Replenish the oil supply when needed.

Safety belts and shoulder harnesses found to be damaged or unable to withstand the strains of testing should be replaced with the latest equipment.

Figure 17-12 illustrates the application of a testing jig to a pilot's conventional lap belt. The belt support block shown in figure 17-12 is manufactured in accordance with Air Crew System Bulletin No. 2. The important thing to consider is its adaptability to the type belt or strap arrangement being tested. As long as an anchoring adapter does not produce any twists or undue strain on the article under test, it may be considered adequate.

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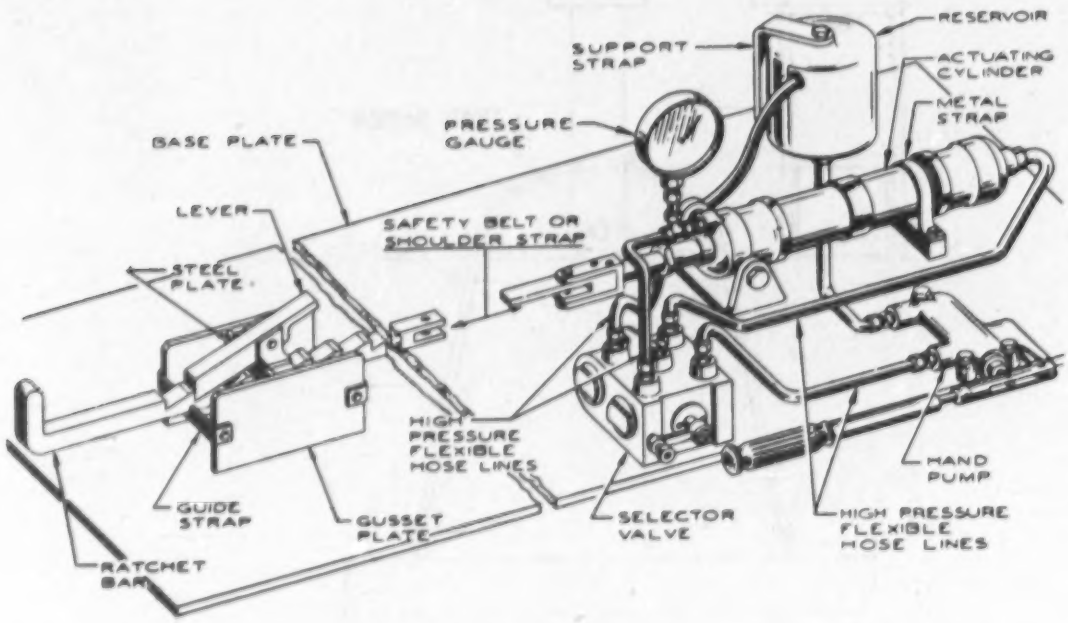

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Figure 17-11.—Safety belt and shoulder harness testing jig.

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CHAPTER 17

RADAR INDICATORS

The video-frequency signal from the output of the radar receiver is fed to the indicator unit. The indicator unit consists of an indicator scope and the electronic circuits that are necessary to present the desired information on the scope. Only the methods of presenting the desired information on the radarscope and the external operating controls for the radar indicator scope will be discussed.

The type of scope used by most radars is similar to the type used in fast-sweep test oscilloscopes. The radarscope uses a rapid linear sweep with sweep time measured in microseconds.

All cathode-ray tubes (CRT's) have a few common elements. There is an electron gun, or cathode, that produces a beam of electrons. The face of the tube is covered on the inside surface with a phosphor coating that emits light when excited by the electron beam. The walls of the tube are coated with a conducting material that is kept at a high potential with respect to the cathode. This conducting material acts as an anode and collects the electrons after they have excited the phosphor coating on the face of the scope. Most CRT's have one or more grids, as well, to regulate the electron beam in direction and intensity.

METHODS OF DEFLECTION

The basic difference between CRT's lies in the method by which the electron beam is deflected, or moved, across the face of the tube. There are two widely used method of deflecting the electron beam. One is known as ELECTROSTATIC deflection and the other as ELECTROMAGNETIC deflection.

ELECTROSTATIC DEFLECTION

Most vacuum tubes have one common feature—a centralized cathode surrounded by various other elements. The electrons emitted from their cathodes are sent out radially in all directions. However, the electrons emitted from the cathode of a CRT are confined to a parallel beam by means of what is commonly called an electron gun.

The electron gun consists of a cathode, a grid which concentrates the electrons into a beam, and anodes which focus the beam of electrons on the screen.

The cathode of a CRT is indirectly heated and consists of a small metal thimble inside of which the heating element or filament is mounted. To make the cathode a good emitter when heated, the front end is concave and oxide coated as shown in figure 17-1. It should be noted that emission is from the front end only.

The filament, which is made of tungsten wire, is wound in a double spiral so that the electron beam will not be affected by the applied a. c. In this way the magnetic field of each winding is canceled by the equal and opposite field of the other winding. The filament is electrically insulated from the cathode. However, the insulation does touch the cathode to provide good heat conduction.

The grid is essentially a metallic cylinder in the form of a cap which surrounds the cathode and has a small hole in the end. The potential applied to the grid is negative in respect to the cathode and, as a result, an electrostatic field is developed between the two as shown in figure 17-2.

An electron that starts out in the direction of KA is bent by the lines of force so that it takes the path KCP. In a similar fashion, the electron which starts out in the direction KB is bent so that it takes the path KDP. Thus the paths of these two electrons intersect at P, and all the electrons which pass through the hole in the grid are concentrated in this manner into a beam of electrons.

The lines of force between the grid and cathode prevent the emitted electrons from diverging from the cathode and cause them to

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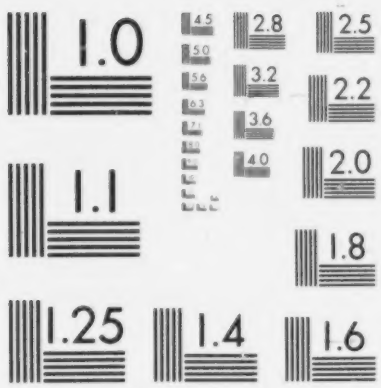

MICROCOPY RESOLUTION TEST CHART
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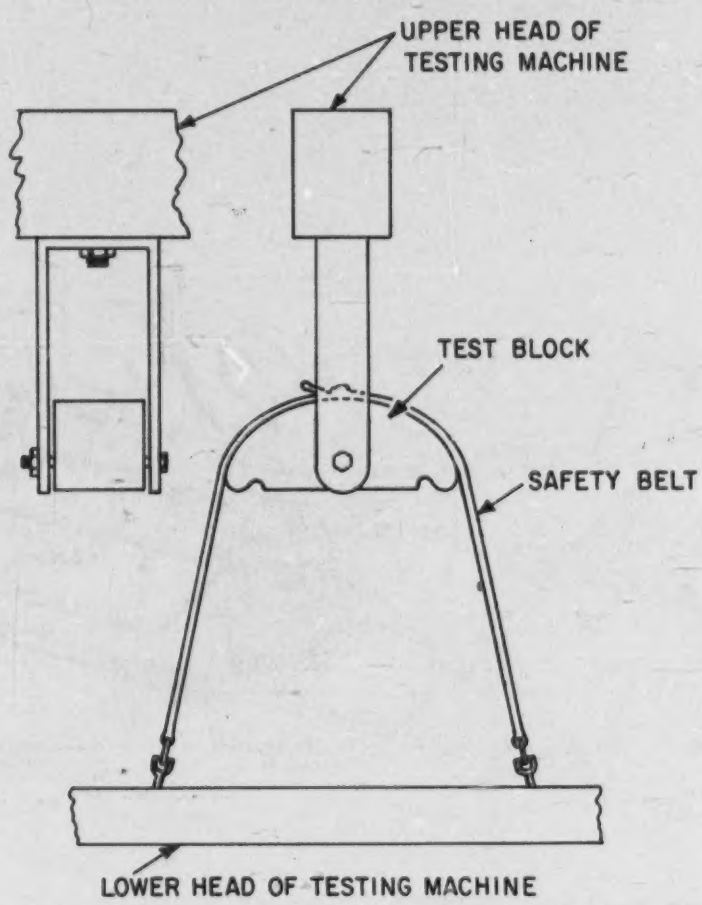

PR.386

Figure 17-12.—Application of a testing jig to a pilt's conventional lap belt.

CHAPTER 18

OXYGEN

No one can live unless he is able to get sufficient quantities of food, water, and oxygen. Of the three, oxygen is by far the most urgently needed. If necessary, a well-nourished man can go without food for many days or weeks, living on what is stored in his body. The need for water is more immediate but still will not become critical for several days. The stock of oxygen in the body is limited at best to a few minute's supply. When that supply is exhausted, death is prompt and inevitable.

Oxygen starvation affects a pilot or aircrewman in much the same way that if affects an aircraft engine. Both the man and the engine require oxygen for the burning of fuel. An engine design for low-altitude operation loses power and performs poorly at high altitudes. High-altitude operation demands a means of supplying air at higher pressure to give the engine enough oxygen for the combustion of its fuel. The supercharger or compressor performs this function.

The combustion of fuel in the human body is the source of energy for everything the aviator is required to do with his muscles and with his eyes and brain. As the aircraft climbs, the amount of oxygen per unit of volume of air decreases and the aviator's oxygen intake, therefore, is reduced. Unless he breathes additional oxygen, his eyes, his brain, and his muscles begin to fail him. He is designed for low-altitude operation and will not give satisfactory performance unless he is supplied the full amount of oxygen that his body requires. Like the engine, the body requires a means of having this oxygen supplied to it in greater amounts or under greater pressure. This need is satisfied by use of supplemental oxygen supplied directly to the respiratory system through an oxygen mask, by pressurizing the aircraft to a pressure equivalent to that at safe breathing altitudes, or both.

For purposes of illustration, an aviator's lungs may be compared with a bottle of air. If an open bottle is placed in an aircraft at sea level, air will escape from it continuously as the aircraft ascends. The air pressure at 18,000 feet is only half that at sea level; therefore, at 18,000 feet the bottle will be subjected to only half the atmospheric pressure it was subjected to at sea level. For this reason, it will contain only half the oxygen molecules it had when on the ground.

In like fashion, an aviator's lungs contain less and less air as he ascends and correspondingly less oxygen. Thus, the use of supplemental oxygen is an absolute necessity on high-altitude flights.

Above 35,000 feet, normal activity is possible up to about 43,000 feet by use of positive pressure equipment. This equipment consists of a "supercharger" arrangement by which the oxygen is supplied to the mask under a pressure slightly higher than that of the surrounding atmosphere. Upon inhalation, the oxygen is forced into the lungs by the system pressure. Upon exhalation, the oxygen pressure is shut off automatically so that carbon dioxide can be expelled from the mask. Normal activity is possible to 50,000 feet with the use of a pressure breathing oxygen regulator. Above 50,000 feet, the only adequate provision for the safety of the aviator is pressurization of the entire body.

Up to about 35,000 feet, an aviator can keep a sufficient concentration of oxygen in his lungs to permit normal activity by use of demand oxygen equipment that supplies oxygen upon demand (inhalation). The oxygen received by the body on each inhalation is diluted with decreasing amounts of air up to about 30,000 feet. Above this altitude up to about 35,000 feet, this equipment provides 100 percent oxygen. At about 35,000 feet, inhalation alone will not provide enough oxygen with this equipment.

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EFFECTS OF HYPOXIA

A decrease in the amount of oxygen per unit volume of air results in an insufficient amount of oxygen entering the bloodstream. The body reacts to this condition rapidly. This deficit in oxygen is called HYPOXIA. A complete lack of oxygen, which causes death, is called ANOXIA. If the body is returned to its normal oxygen supply, one may recover from hypoxia, but cannot recover from anoxia.

Many persons are not aware of the enormous increase in need for oxygen caused by an increase in physical activity. Strenuous calisthenics or a cross-country run results in deep and rapid breathing. Even so mild an exercise as getting up and walking around a room may double the air intake. In the case of the aviator, leaking of an oxygen mask which may go completely unnoticed while the wearer is at rest may lead to collapse and unconsciousness when he attempts to move about from one station to another in the aircraft. A walkaround (portable) oxygen bottle sufficient for 24 minutes of quiet breathing may be emptied by 17 minutes of use when the user is moving about the aircraft.

Men differ in their reactions to hunger, thirst, and other sensations. Even an individual's reactions vary from time to time under different circumstances. Illness, pain, fear, excessive heat or cold, and many other factors govern what the response will be in each particular case. The same thing is true of individual reactions to oxygen starvation. The effects of a certain degree of hypoxia on a given person cannot be accurately predicted. For instance, a person may be relatively resistant on one day, but highly susceptible the next.

It is difficult to detect hypoxia, because its victim is seldom able to judge how seriously he is affected, or often that he is affected at all. The unpleasant sensations experienced in suffocation are absent in the case of hypoxia. Blurring of vision, slight shortness of breath, a vague, weak feeling, and a little dizziness are the only warnings. Even these may be absent or so slight as to be unnoticeable.

While still conscious, the aviator may lose all sense of time and spend his last moments of consciousness in some apparently meaningless activity. In such a condition he is a menace to his crew as well as to himself. Since the aviator understands that it is the reduced air pressure at higher altitudes which determines the effect upon his body, he depends upon the altimeter rather than his sensations or judgment to tell him when he needs oxygen.

CHARACTERISTICS OF OXYGEN

Oxygen, in its natural state, is a colorless, odorless, and tasteless gas. Oxygen is considered to be the most important to life of all the elements. It forms about 21 percent of the atmosphere by volume and 23 percent by weight.

Of all the elements in the universe, oxygen is the most plentiful. It makes up nearly one-half of the earth's crust and approximately one-fifth of the air we breathe.

Oxygen combines with most of the other elements. The combining of an element with oxygen is called oxidation. Combustion is simply rapid oxidation. In almost all oxidations, heat is given off. In combustion, the heat is given off so rapidly it does not have time to be carried away; the temperature rises extremely high, and a flame appears.

Some examples of slow oxidation are the rusting of iron, drying of paints, and the changing of alcohol into vinegar. Even fuels in storage are slowly oxidized, the heat usually being carried away fast enough; however, when the heat cannot easily escape, the temperature may rise dangerously and a fire will break out. This is called spontaneous combustion.

Oxygen does not burn, but does support combustion. Nitrogen neither burns nor supports combustion. Therefore, combustible materials burn more readily and more vigorously in oxygen than in air, since air is composed of about 78 percent nitrogen by volume and only about 21 percent oxygen.

In addition to existing as a gas, oxygen can exist as a liquid and as a solid. Liquid oxygen is pale blue in color. It flows like water, and weights 9.54 pounds per gallon.

Liquid oxygen, commonly referred to as LOX, is normally obtained by a combined cooling and pressurization process. When the temperature of gaseous oxygen is lowered to -182 F under about 720 psi pressure, it will begin to form into a liquid. When the temperature is lowered to -297° F, it will remain a liquid under normal atmospheric pressure.

Once converted into a liquid, oxygen will remain in its liquid state as long as the temperature is maintained below -297° F. The liquid has an expansion ratio of 862 to 1, which means

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that one volume of liquid oxygen will expand 862 times when converted to a gas at atmospheric pressure. Thus, 1 liter of liquid oxygen produces 862 liters of gaseous oxygen.

Until a few years ago, all oxygen carried in naval aircraft was in the gaseous state. As flight durations increased, however, it was found that weight and space problems involved with carrying increasing amounts of gaseous oxygen were becoming intolerable. Liquid oxygen has proven the answer to these problems. In its liquid state, oxygen can be "packed" into containers small and light enough to be carried even in flighter type aircraft without weight and space penalty.

In the aircraft, oxygen in the liquid state is carried in a container called a converter. This is a double-walled, vacuum-insulated container similar to the common Thermos bottle. The converter is equipped with the necessary valves and tubing for vaporizing the liquid and warming the gas to cockpit temperatures prior to breathing.

TYPES OF OXYGEN

Aviator's breathing oxygen (MIL-O-27210C is supplied in two types (I and II). Type I is gaseous oxygen, and type II is liquid oxygen. Oxygen procured under this specification is required to be 99.5 percent pure. This water vapor content must not be more than 0.02 milligrams per liter when tested at 70° F and at sea level pressure. This is practically bone dry.

Technical oxygen, both gaseous and liquid, is procured under specification BB-0-925. The moisture content of technical oxygen is not as rigidly controlled as is breathing oxygen; therefore, the technical grade should never be used in aircraft oxygen systems.

The extremely low moisture content required of breathing oxygen is not to avoid physical injury to the body, but to insure proper operation of the oxygen system. Air containing a high percentage of moisture can be breathed indefinitely without any serious ill effects. The moisture affects the aircraft oxygen system in the small orifices and passages in the regulator. Freezing temperatures can clog the system with ice and prevent oxygen from reaching the user. Therefore, extreme precautions must be taken to safeguard against the hazards of water vapor in oxygen systems.

OXYGEN COMPONENT TEST STANDS

Aircrew Survival Equipmentmen are responsible for shop testing aircraft oxygen system components, including regulators, emergency oxygen systems, pressure suit controllers, and other items. The AME is responsible for checking system components in the aircraft; however, in case of a suspected malfunction and for periodic maintenance testing, the component is removed from the aircraft and brought to the oxygen shop where it is tested by the PR. This testing is accomplished with the use of various types of test equipment, some of which are discussed in this chapter.

Regulator test stands are designed for testing oxygen regulators for flow capacities, oxygen concentrations, pressure characteristics, and various leakage tests at different simulated altitudes. This chapter covers the OTS-565, the -566, and the 62-A-116-E1 test stands.

OTS-565 SERIES TEST STANDS

The OTS-565 is designed for testing oxygen regulators under simulated altitude conditions. By measuring the outlet suction or pressure for specified flows at given altitudes, as well as the ratio of air and oxygen delivered by the regulator, it is possible to determine whether or not the regulator performance conforms to service requirements.

Provisions are incorporated for making various leakage tasks and emergency flow tests on regulators. When properly modified, the OTS-565 can also be used for testing full pressure suit components.

The OTS-565 is equipped with Vol-O-Flo elements which are used to create the pressure drop necessary to actuate the fluid in the input/output manometers. Earlier types of test stands were equipped with glass wool canisters designed for the same purpose. The OTS-565 is also different in that the complete test stand is calibrated in inches of water instead of liters per minute (lpm).

Figures 18-1 and 18-2 illustrate the front and rear views of the equipment. The top cabinet consists of an altitude chamber, piping assemblies, control valves, input/output manometers, Vol-O-Flo elements, pressure-suction manometer, altimeter, and pressure gages. The lower cabinet contains a Gast vacuum pump directly coupled to a 1 hp motor. Figure 18-3 illustrates the pump and motor assembly.

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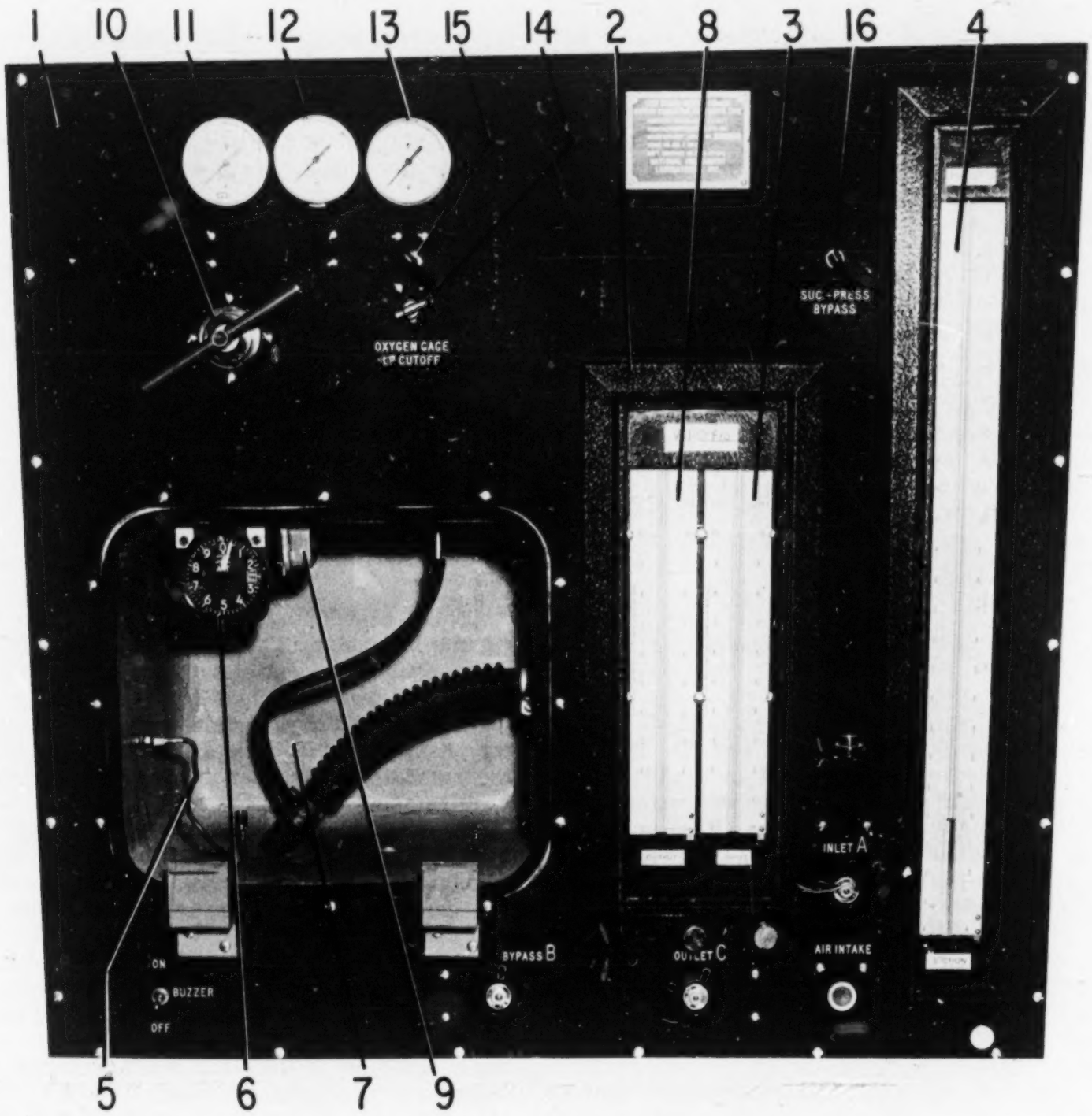

1. Case.
2. Panel.
3. Input manometer.
4. Pressure-suction manometer.
5. Oxygen inlet.
6. Altimeter.
7. Altitude chamber.
8. Output manometer.
9. Buzzer.
10. Oxygen pressure reducer.
11. Cylinder pressure gage.
12. Regulator pressure gage, high pressure.
13. Regulator pressure gage, low pressure.
14. Oxygen gage cutoff valve.
15. Relief valve (bleed valve).
16. Pressure-suction bypass valve.

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Figure 18-1. —Front view of OTS-565 test stand.

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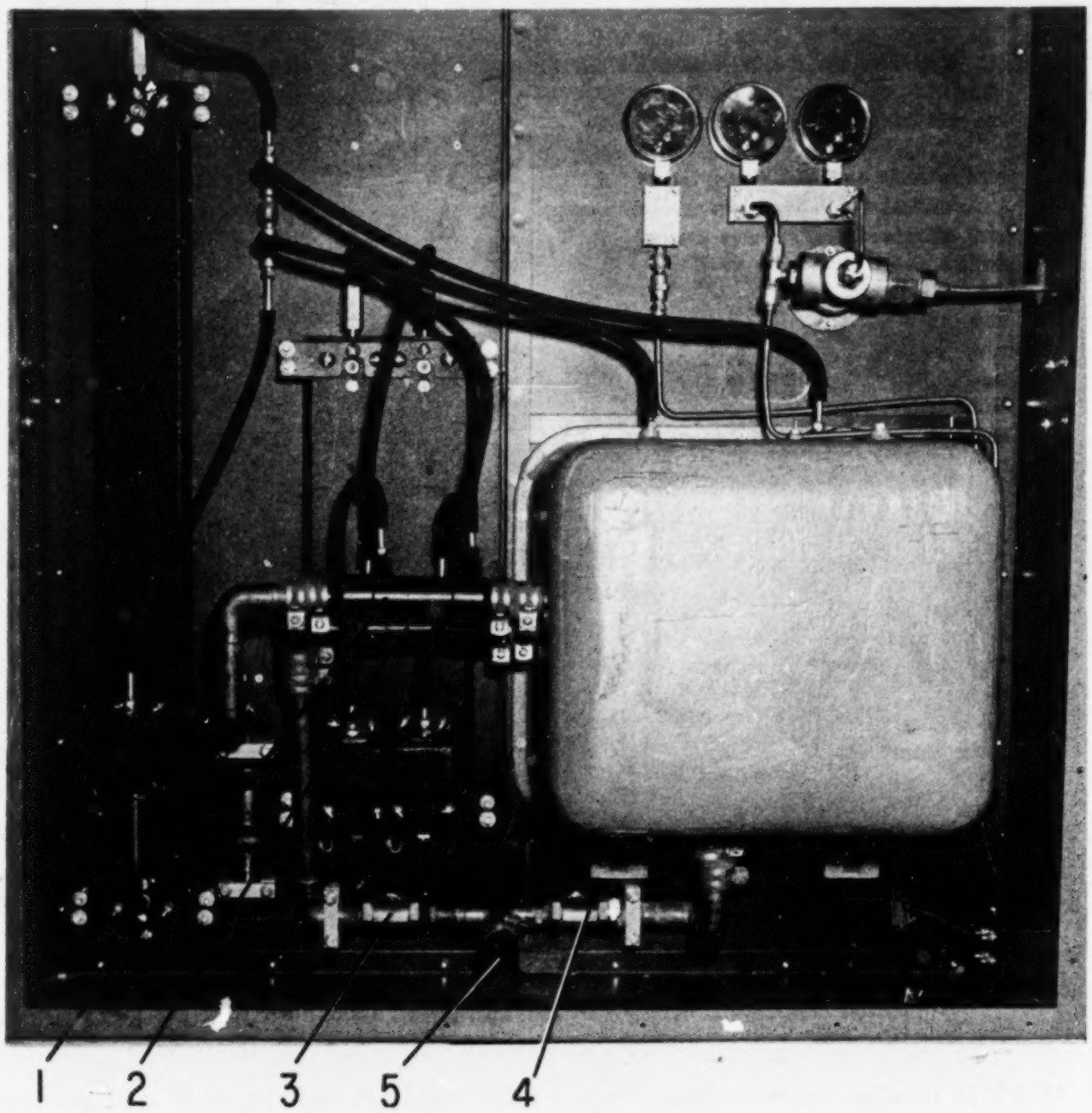

1. Vol-O-Flo inlet element.
2. Vol-O-Flo outlet element.
3. Outlet piping assembly.
4. Outlet-bypass piping assembly.
5. Vacuum outlet.

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Figure 18-2. —Rear view of OTS-565 test stand.

Principles of Operation

The OTS-565 test stand is suitable for testing demand, diluter demand, pressure breathing diluter demand, or the miniature pressure breathing demand oxygen regulators having outlet pressures up to 20 inches of water. Flows are metered over the range of 0-150 lpm. Since the input/output manometers of the OTS-565 test stand are calibrated in linear inches of water, all liter-per-minute expressions or, measurements must be converted to indicated

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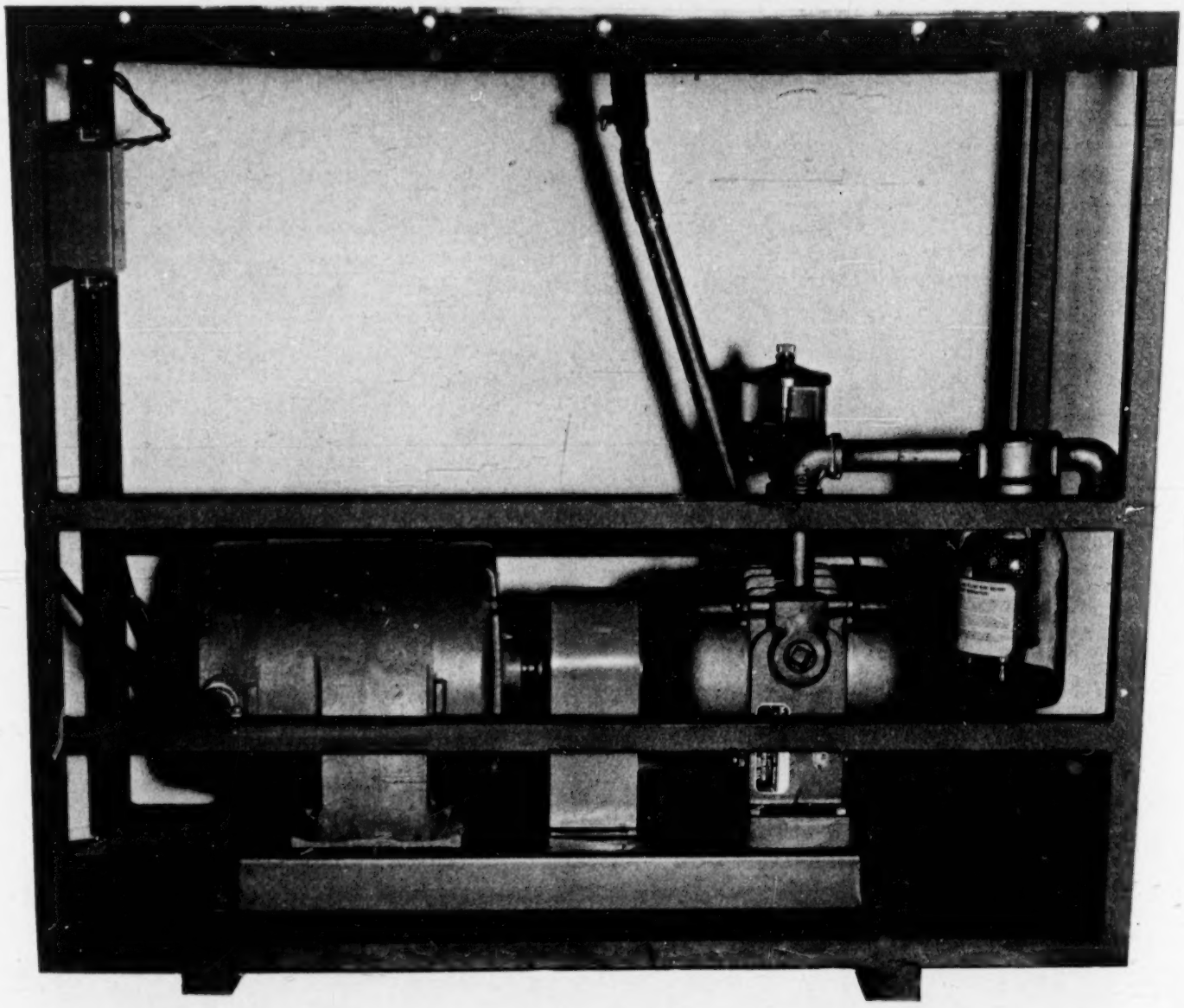

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Figure 18-3.—Front view of vacuum pump and motor assembly.

inches of water through the use of the calibration charts furnished with each test stand.

The Vol-O-Flo elements are designed to be as altitude independent as possible, but calibration charts showing various altitude lines are furnished for all altitudes and must be used to convert actual flows in liters per minute to indicate flows in inches of water. The input manometers indicate the amount of air flowing into the chamber to provide the required dilution, and the output manometers measure the amount of air-oxygen mixture flowing out of the regulator.

The outlet valves and vacuum source provide a flow demand on the oxygen regulator, which the regulator demand valve attempts to provide. The regulator outlet flow measured by the output manometer indicates whether or not the regulator is performing properly.

In a pressure breathing regulator, the pressure is provided by an aneroid element in the regulator. The pressure breathing characteristics can be determined by evacuating the altitude chamber to the desired altitude by the use of the bypass valve while the outlet valve is cracked to permit a small flow (5 to 10 lpm) through the regulator. (This small flow must be allowed to prevent overloading of the pressure-suction manometer.) The outlet valve is then adjusted for various rates of flow, and the

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amount of suction or pressure is obtained from the pressure-suction manometer.

In a diluter regulator, the flow passing through the regulator is not all oxygen, since ambient air is being drawn into the regulator from the chamber.

Altitude Chamber

An airtight chamber provides a space for simulating the various test altitudes. The chamber is sealed by a plate glass cover which rests in two brackets in front of the chamber, and is held in place by the vacuum created inside the chamber.

The altitude chamber has eight connections—a high-pressure oxygen inlet, an air inlet, two chamber pressure taps, a regulator outlet pressure tap, a bypass outlet, a regulator outlet, and an electrical connection.

Piping

The piping consists of two major assemblies—an air inlet assembly which permits air controlled by the air inlet valve to enter the altitude chamber, and a regulator outlet-bypass assembly which permits evacuation of the regulator outlet through an outlet valve, or evacuation of the chamber through a bypass valve. The air inlet hole, which is covered with a fine screen, should never be blocked nor should dirt or dust be permitted near it.

Control Valves

Three needle valves with a metal to metal seat are used. One, in the air inlet assembly, permits air to be bled into the altitude chamber either to maintain a chamber altitude when the regulator is removing air from the chamber through its diluter, or to permit bringing the chamber back to atmospheric pressure from a simulated altitude. The other two valves are in the outlet-bypass assembly. The outlet valve controls the flow of air-oxygen leaving the regulator. The bypass valve permits independent evacuation of the altitude chamber. The bypass valve and inlet/outlet valves are labeled B, A, and C, respectively, on the panel.

Pressure Reducer

The pressure reducer supplied with the OTS-565 test stand is designed to regulate supply pressures up to 3,000 psi. A low-pressure gage is incorporated with a cutoff valve for testing of regulators requiring oxygen of 0 to 200 psi.

The cutoff valve is connected at the tee where it joins the low-range (200 psi) gage line. (See fig. 18-4.) Low oxygen inputs can be accurately set on the low-pressure gage without any danger of overloading the gage. At approximately 200 psi, the relief (popoff and bleed) valve will dump excessive oxygen pressure. This relief valve can also be used to bleed the oxygen pressure in the lines after completion of the performance tests. The pressure set on the low-pressure gage (0-200) will also register on the high-pressure gage (0-3,000); but due to the extreme high-pressure range of the gage, the needle will barely move off the peg.

Figure 18-4 is a schematic diagram of the pressure reducer and the gage connections. When an adequate supply pressure is turned on, it will always register on the 0-4,000 psi cylinder pressure gage. Turning the pressure reducer handle clockwise supplies and increases the pressure delivered to the regulator and is registered on the high-pressure delivery gage. Extreme caution must be observed to assure that the low-pressure gage cutoff valve is closed when setting pressures in excess of the range (0-200 psi) of the low-pressure gage.

Input/Output Manometers

Two Vol-O-Flo manometers are used in the test stand. Each Vol-O-Flo manometer is connected to a Vol-O-Flo manometer element. The input manometer is in the air inlet line downstream from the air inlet valve. The output manometer is in the regulator outlet line upstream from the outlet valve. The two manometers are calibrated to indicate flows at simulated (chamber pressure) altitude. The manometers are of the linear type in which the pressure drop across the Vol-O-Flo element is directly proportional to the volumetric (ambient) flow. The manometers have a range of 0 to 12 inches of water and are inscribed in linear inches.

In addition to the two small manometers, there is one pressure-suction manometer. The pressure-suction manometer is calibrated from -4.0 to +20.0 inches of water. The pressure-suction manometer is designed to measure the pressure and suction required to be delivered by the regulator. Excessive pressure or suction to the manometer is equalized by operating the pressure-suction bypass valve.

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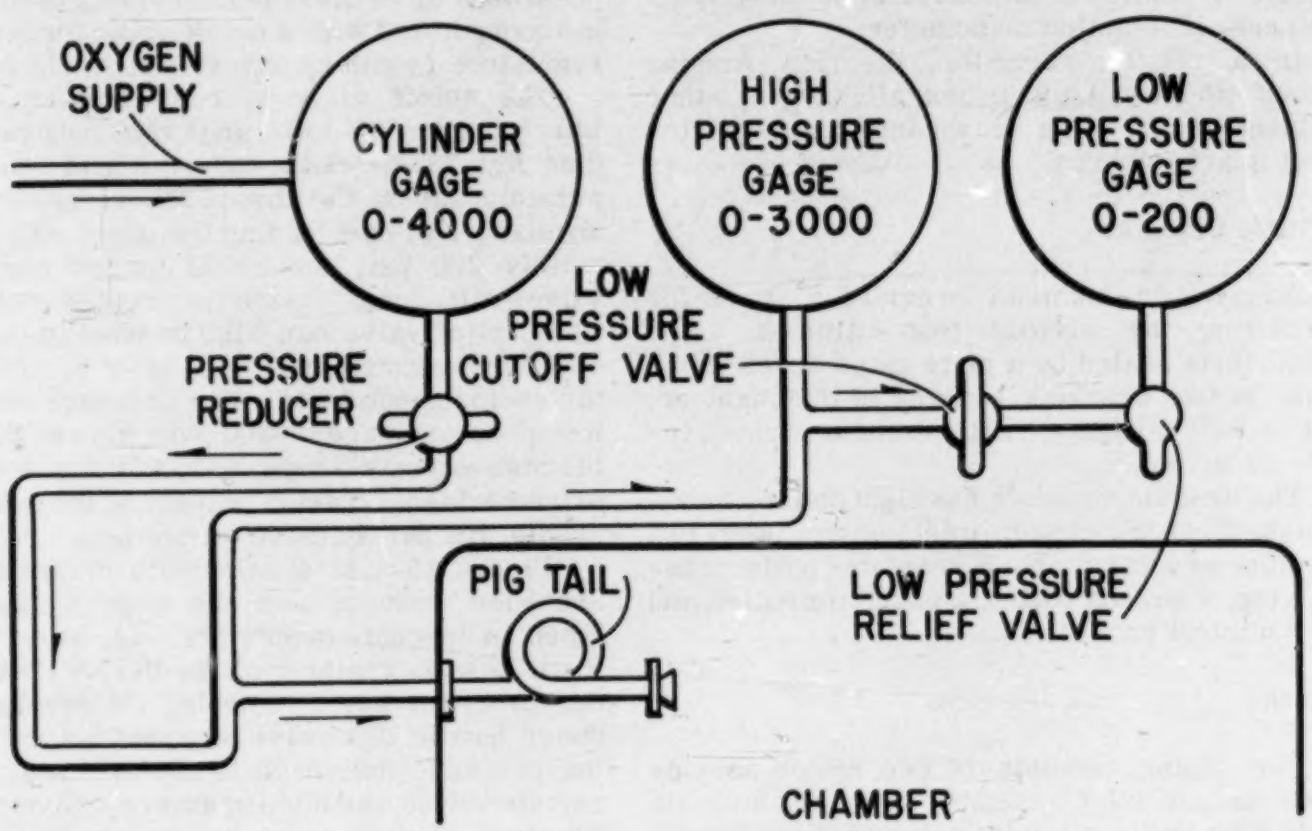

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Figure 18-4.—Schematic diagram of pressure reducer and pressure gages for OTS-565 test stand.

CALIBRATION CHARTS.—Three copies of the calibration charts are supplied with each test stand. For testing the various regulators, a table of test criteria can be set up. This table can be computed from the Vol-O-Flo element calibration charts and the performance requirements for the regulator, published in the Service Instruction Manual for the regulator to be tested.

By the use of the charts, the actual flows shown in the manual as liters per minute are converted to an indicated figure shown as inches of water. The setting made on the manometers will be affected by the density of the gas passing through the elements and by the temperature. Since oxygen is 11.5 percent heavier than air, a flow of oxygen or air/oxygen will indicate higher than the same flow of air only. The test stand is calibrated with air, hence the oxygen or air/oxygen flow must be converted on the oxygen conversion graph to add the percentage of oxygen in the mixture and correct the reading, giving a corrected indicated figure.

Once a table has been established for a particular regulator, the operator has no need to make any correction to the manometer setting, other than for temperature variation.

TEMPERATURE CONSIDERATIONS.—On the linear type Vol-O-Flo element, the reading for a given flow is dependent on the gas (air, oxygen, or mixture), altitude, pressure, and temperature. The Vol-O-Flo elements are calibrated at the factory at a specified temperature, usually 72° F. If the test stand is operated in the temperature range of 65° to 80° F temperature corrections may usually be disregarded.

If greater accuracy is required or if the test stand is used at temperatures outside this temperature range, a temperature correction may be applied as follows: Determine the temperature for which the test stand was calibrated. If the test stand was calibrated against a field standard calibrator, the temperature of calibration is that for which the field standard correction curves were made. For each degree Fahrenheit the test stand is operating above the calibration temperature, the reading will be 0.15 percent too high. For each degree Fahrenheit below the calibration temperature, the manometer reading will be 0.15 percent too low. These

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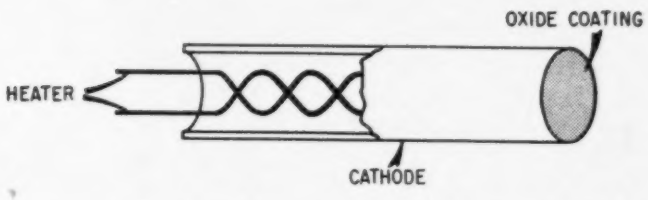

Figure 17-1. —Filament and cathode of a CRT.

bend inward along the axis of the electron gun. They may even cause the electrons to cross over and diverge on the opposite sides. The grid of the CRT also controls the number of electrons emitted by the cathode in a manner similar to the action of a grid in a conventional vacuum tube. Therefore, the grid of the CRT performs two functions—(1) it controls the emission of the cathode, and (2) it acts as a lens which concentrates the electrons into a beam.

The intensity of the spot on the fluorescent screen depends on the number of electrons in the beam. The number of these electrons, as stated previously, is controlled by the difference in voltage between the grid and cathode or grid bias. Most CRT's utilize a potentiometer to vary the bias, thus enabling the operator to control the brightness of the spot. This potentiometer may be known by several different names such as intensity, brilliance, or brightness control.

In addition to the grid and cathode, the electron gun also contains two anodes. The construction of the anodes is similar to that of that of the grid. The first anode, sometimes called the focusing anode, is closer to the grid and is positive by a few hundred volts in respect to the cathode. The second anode or accelerating anode is next in line and is at a much higher positive potential than the first anode.

As shown in the previous illustration, the electron beam is in focus at point P which is close to the grid. However, the beam must also be in focus when it strikes the screen. This is accomplished by the electrostatic field between the two anodes. (See fig. 17-3.)

An electron introduced into the field at point P would tend to follow one of the lines of force and hit the more positive anode. Because of the high voltage on the anodes, the electron travels at an extremely high velocity and does not remain in the field long enough to be pulled completely off its course. However, it is subjected to forces as it moves through the field. For example, an electron which is traveling from point P along the path PAB is curved toward the axis by the lines of force and thus takes the path PAC. In the center, the lines of force are nearly parallel to the axis and in the direction of point S. Therefore, the beam of electrons is accelerated in the direction of point S.

The point when the electron coverge may be shifted by varying the strength of the field between the two anodes. This is usually done by a potentiometer which varies the voltage on the first anode. This control is sometimes called the focus control.

The screen is made fluorescent by a coating of materials deposited on its inner surface. These materials, called phosphors, emit light when struck by a beam of rapidly moving electrons. The color and persistence of the light depend upon the composition of the particular phosphor used. Phosphors are designated by

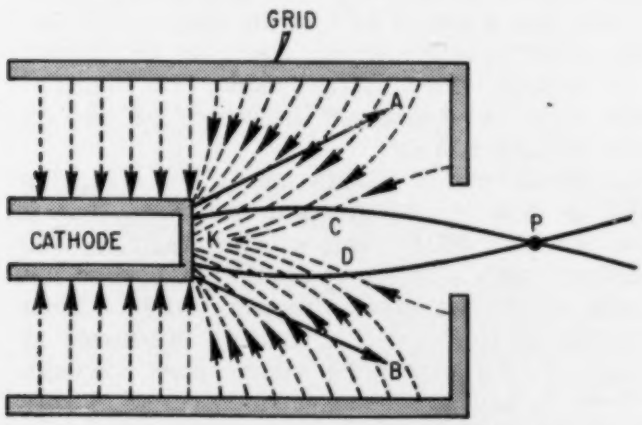

Figure 17-2. —Electrostatic field between grid and cathode.

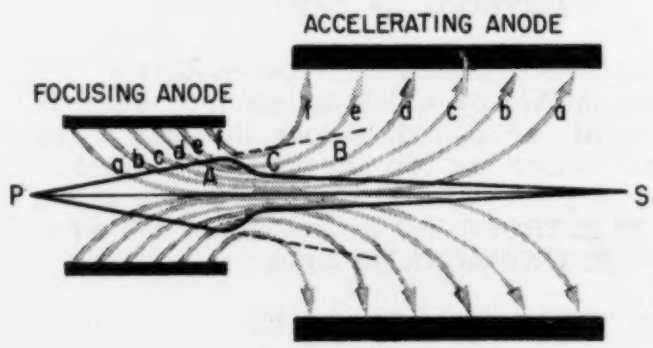

Figure 17-3. —Electrostatic field between the first and second anode.

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temperature corrections are in addition to and independent of corrections for altitude or gas mixture.

Inspection

The test stand should be inspected every 6 months as follows:

1. Inspect all rubber tubing connections. If they show signs of wear or cracking, replace them.
2. Check the rubber sealing gasket around the chamber and wash it with soap and water if necessary. Keep the chamber cover glass clean and free of chips.
3. Prior to operating the vacuum pump, insure that the oil reservoir has sufficient oil. Each time that oil is added the oil trap should be dumped and cleaned. The recommended oil is pure mineral oil without additives. The electric motor should be greased periodically with a good grade of motor grease.
4. The altimeter should be checked against a master altimeter or barometer to make certain it is within allowable limits.

System Leak Test

The system leak test is performed weekly. Cap off the oxygen inlet inside the chamber and secure the low pressure gage cutoff valve. With a supply cylinder, containing at least 1,800 psi of oxygen, hooked up to the system, open the supply cylinder valve. Adjust the pressure reducer to apply 500 psi to the system, then close the supply cylinder valve. The maximum allowable leakage is 50 psi in 30 minutes. Read from the oxygen cylinder pressure gage #2-17.

Chamber Leak Test

This test is also performed weekly. Cap the oxygen inlet, and evacuate the chamber to about 50,000 feet. Hold this altitude for 2 minutes and drop the altitude to 40,000 feet. Close the valves fingertight and time the rate of altitude loss for 5 minutes. The allowable loss must not be more than 100 feet per minute. Refer to NavAir 17-15BC-505 for procedures to follow for correcting excessive leakage.

Intercomparison Test

The intercomparison test is performed every two weeks and is done to determine whether the Vol-O-Flo elements are still in calibration. The test is performed at 5,000, 15,000, and 30,000 feet, using flows of 5, 50, and 85 liters per minute at each altitude. Convert the actual flows to indicated figures for both the output and input; the input actual flows must be within 1 liter or 2 percent, whichever is greater, of the output actual flow.

The test is performed by capping off the oxygen inlet and securing the oxygen supply cylinder. Open the outlet valve and ascend to altitude. Set the first flow to be pulled as the stand is ascending. Upon reaching the first test altitude, 5,000 feet, open the inlet valve to stabilize the altimeter. Take the reading from the input manometer. It must be within tolerance. Repeat steps for the other flows and altitudes. Readings not within tolerance require the Vol-O-Flo elements to be cleaned. Refer to the test stand manual for procedures.

NOTE: If at any time the suction side of the pressure suction manometer becomes overloaded, the intercomparison test must be performed prior to testing a regulator.

OTS-566 TEST STAND

The OTS-566 test stand is designed for testing diluter demand oxygen regulators under simulated altitude conditions. It was designed especially for use aboard ship, but can be used ashore as well. The OTS-566 incorporates pressure indicating gages instead of manometers; otherwise it is practically identical to the OTS-565. These gages require no fluid; thus the roll of the ship has no effect on the readings.

The test stand consists of an upper cabinet mounted on the lower pump stand. The upper cabinet contains the altitude chamber, control valves, flow measuring gages, pressure-suction gage, altimeter, and piping. The lower pump stand contains a Gast vacuum pump identical to the pump used with the OTS-565. Front and rear views of the stand are shown in figures 18-5 and 18-6.

Altitude Chamber

An airtight chamber, mounted from the rear of the test stand panel, provides a space within which the various test altitudes may be simulated. The chamber is sealed by a transparent cover plate, which rests on rollers, and can be clamped to the front of the chamber.

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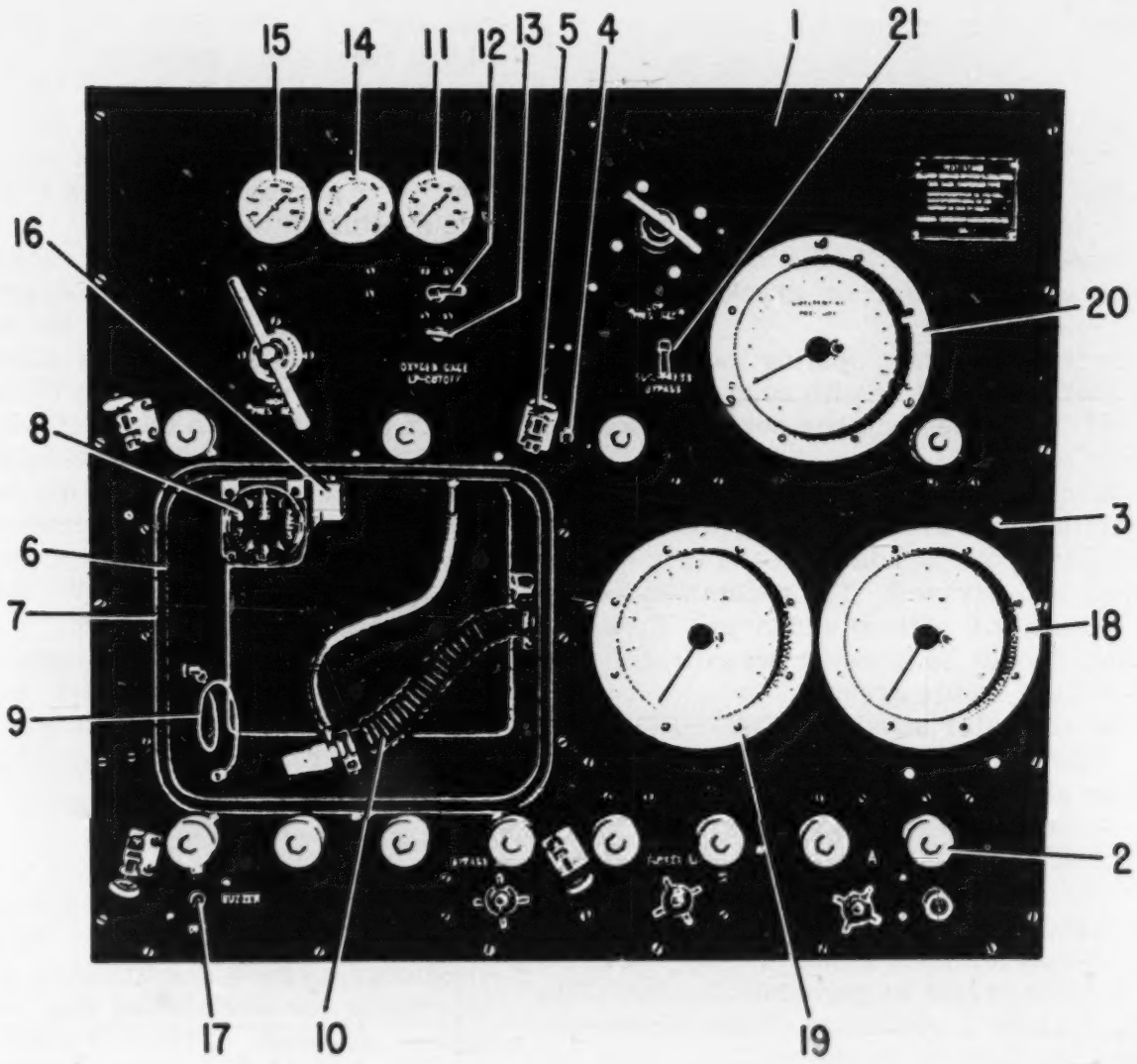

1. Instrument panel.
2. Roller supports.
3. Glass end stops.
4. Glass midstop.
5. Toggle clamps and spacers.
6. Altitude chamber.
7. Chamber seal gasket.
8. Altimeter.
9. Regulator pigtail.
10. Corrugated rubber tube.
11. 200 psi gage.
12. Relief valve.
13. Oxygen cutoff valve.
14. 3,000 psi gage.
15. 4,000 psi gage.
16. Buzzer.
17. Buzzer switch.
18. Input gage.
19. Output gage.
20. Pressure-suction gage.
21. Pressure-suction bypass.

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Figure 18-5. —Front view of the OTS-566 test stand panel.

Gages

The gages are known as sensitive diaphragm type with the output and input having the same calibration, 0 to 12 inches of water, as the OTS-565 test stand. The gages can be adjusted by removing the plug on the face of the dial and turning the zero adjusting screw. The pressure suction gage is calibrated from -2 to +20 inches of water and also incorporates the emergency bypass valve.

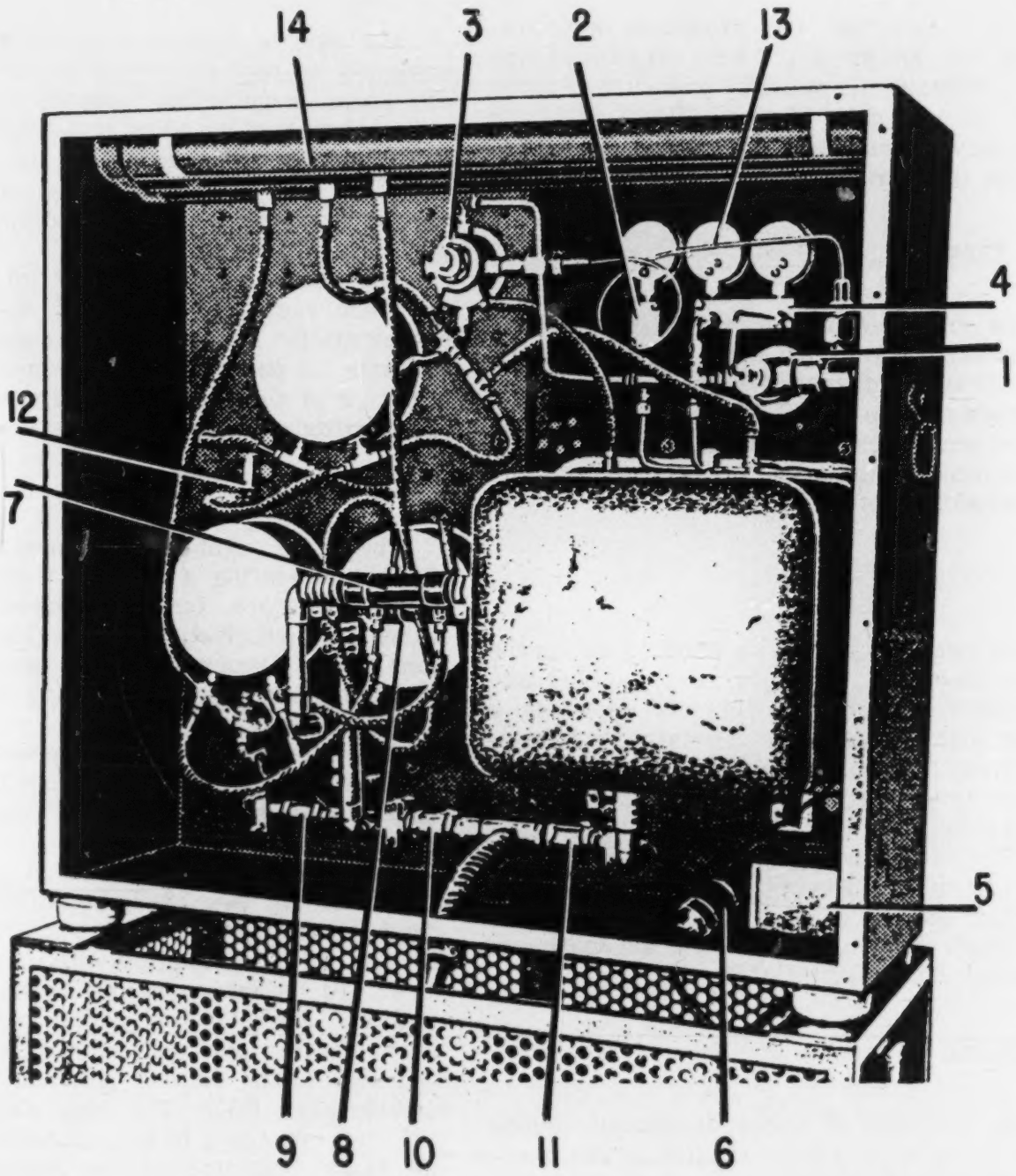

1. Oxygen pressure gage.
2. Gage mount block.
3. Oxygen pressure reducer.
4. Gage mount block.
5. Transformer, 220, 440 v.
6. Loctal plug.
7. Input Vol-O-Flo element.
8. Output Vol-O-Flo element.
9. Inlet valve.
10. Outlet valve.
11. Bypass valve.
12. Check valve.
13. Pigtail reducer.
14. Ballast tank.

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Figure 18-6. —Rear view of the OTS-566 test stand.

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Pressure Reducers

The OTS-566 has two pressure reducers. The first one, known as the high range pressure reducer, reduces the cylinder pressure of 3,000 psi down to a range of 50 to 2,000 psi. The low range pressure reducer is used to adjust inlet pressures in the range of 0 to 150 psi.

Ballast Tanks

There are three ballast tanks located inside the uppermost rear of the case. They are independent of each other and each is connected to the high side of the Vol-O-Flo elements and the pressure suction gage. The purpose of the tanks is to eliminate fluctuation of gage readings due to the sensitivity of the diaphragm.

Control Valves

Three needle valves are used. One, in the air inlet assembly, permits air to be bled into the altitude chamber, either to maintain a chamber altitude when the regulator is removing air from the chamber through its diluter air valve, or to permit bringing the chamber back to atmospheric pressure from a simulated altitude. The other two valves are in the outlet-bypass assembly. The outlet valve controls the flow of air-oxygen leaving the regulator. The bypass valve permits independent evacuation of the altitude chamber.

Gast Vacuum Pumps

There are several types of vacuum pumps used to remove air from the altitude chambers of oxygen system test stands. The major difference in the various pumps is the pumping capacity.

CONSTRUCTION.—The rotary Gast pump is a precision product with only 0.0015- to 0.0065-inch total clearance at the ends and top of the rotor. The vanes take up their own wear and last from 5,000 to 25,000 hours of operation, depending upon the application. Remember that it is designed for pumping dry air. Protect it against the entrance of dirt and excessive moisture. Lubricate it regularly and properly, and years of trouble-free service will be received.

OXYGEN SYSTEM COMPONENTS TEST STAND 62-A-116-E1

The oxygen system component test stand is designed to test and evaluate the functions of miniature regulators, console type and seat mounted regulators, diluter demand regulators, full pressure suit controllers (both kit and suit mounted), full pressure suit helmets, emergency oxygen systems, and some liquid oxygen converter components.

The test stand consists of an oxygen pressure and vacuum system with valving and instrumentation necessary to measure, test, and evaluate the performance and operating characteristics of the components described at simulated altitudes up to 150,000 feet.

Operation

The oxygen system components test stand is capable of testing a variety of system components; therefore, test procedures for specific items are not given. The preliminary operations and adjustments of the stand which must be accomplished prior to testing any component are covered.

A detailed view of the components test stand is shown in figure 18-7 and table 18-1 gives the purpose and use of the controls and instruments shown.

ALTITUDE CONTROLLER.—The altitude controller (B, fig. 18-7) is adjusted to the desired altitude for the high-altitude chamber. (NOTE: 20 psi is applied with the pressure reducer (P) before operation of the altitude controller.) Energize the vacuum pump and adjust the controller set knob (29) to position the red indicator to the desired point on the controller altitude gage (31). The high-altitude chamber will then evacuate to this altitude (indicated by the blank indicator of the controller altitude gage).

NOTE: The controller altitude gage indication is an approximation. To obtain a specific altitude, check the indication given on the controller altitude gage against the ALTM high-range (12) or the low-range (13) indicators, after a 2-minute stabilizing period.

If the indication on indicator (12) or (13) is higher, the high-altitude chamber must be bled to the proper altitude using the chamber bleed valve (K). If lower, carefully adjust the Controller Set Knob until the correct indication is observed on indicator (12) or (13).

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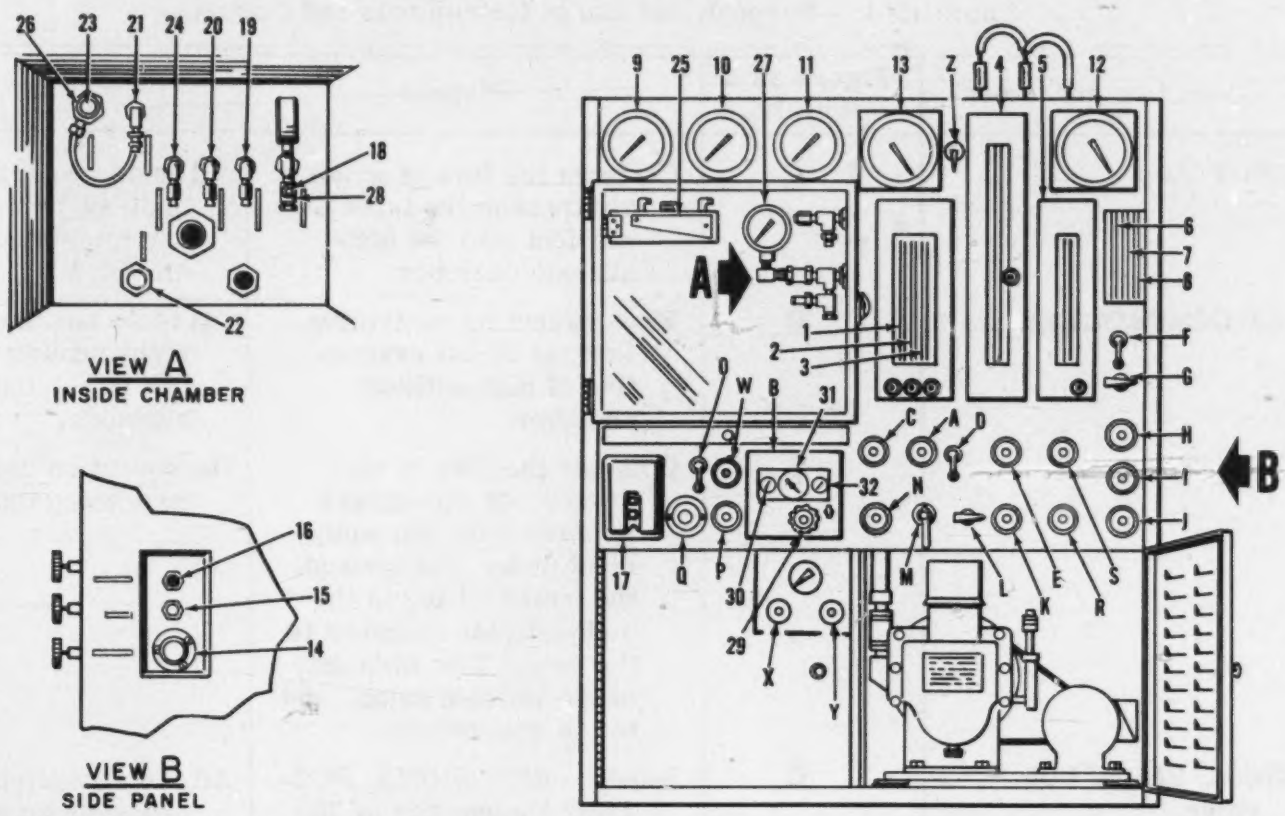

A. Input valve.
B. Altitude controller.
C. Output valve.
D. Pressure selector valve.
E. Leakage control valve.
F. Leakage Selector valve.
G. Leakage on-off valve.
H. Vent pressure valve.
I. Vent ambient valve.
J. Flutter dampener valve.
K. Chamber bleed valve.
L. Inlet pressure on-off valve.
M. Flow selector valve.
N. Low pressure regulator.
O. Reference pressure selector valve.
P. Controller regulator.
Q. High pressure regulator.
R. Suit simulator reference shutoff valve.
S. Bottle charging valve.
W. Shutoff to Q valve.
X. Pressure control valve.
Y. Vent control valve.
Z. Manometer pressure equalizer.
1. Output flow manometer.
2. Input flow manometer.
3. Vent flow manometer.
4. Pressure suction manometer.
5. HG manometer.
6. Overboard rotameter leakage flowmeter.
7. Insystem rotameter leakage flowmeter.
8. Insystem rotameter leakage flowmeter.
9. Supply pressure gage.
10. Regulated high pressure gage.
11. Regulated low pressure gage.
12. Altimeter high range indicator.
13. Altimeter low range indicator.
14. 220/440V input connector.
15. O_2 input connector.
16. O_2 filling connector.
17. Pump control switch.
18. O_2 input connection (altitude chamber).
19. Low pressure connection (altitude chamber).
20. 200cc leakage connection (altitude chamber).
21. Reference tap connection (altitude chamber).
22. Input port (altitude chamber).
23. Output port (altitude chamber).
24. Helmet reference tap connection (altitude chamber).
25. Pressure suction manometer.
26. Piezometer.
27. O_2 input pressure gage.
28. Tee connector.
29. Controller set knob.
30. Controller supply gage.
31. Controller altitude gage.
32. Controller output gage.

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Figure 18-7. —Oxygen test stand 62-A-116-E1.

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Table 18-1.—Purpose and use of instruments and controls.

Control or instrument	Figure 18-7 Item No.	Purpose	Use
INPUT Valve.	A	Controls the flow of ambient air through the input flow element into the high-altitude chamber.	All tests requiring high-altitude chamber simulated altitudes.
ALT CONTROLLER.	B	Pilot indicating controller. Control direct evacuation of high-altitude chamber.	All tests requiring high-altitude chamber simulated altitudes.
OUTPUT Valve.	C	Controls the flow of air, oxygen, or air-oxygen mixture from the equipment under test through the output fitting in the high-altitude chamber to the output flow element, to the vacuum pump, and to the atmosphere.	Dependent on component being tested.
PRESS. SELECTOR Valve.	D	Selects either PRESS. SUCTION Manometer or HG Manometer, depending on the item being tested.	All tests requiring pressure or suction observations on manometers.
LEAKAGE CONTROL Valve.	E	Regulates low pressures at low rates of flow.	Outward leakage tests on various components.
LEAKAGE Selector Valve.	F	Selects either the high-range ROTAMETER LEAKAGE Flowmeter or the low-range ROTAMETER LEAKAGE Flowmeter to be used.	Used to determine either high or low leakage flows.
LEAKAGE On-Off Valve.	G	On-Off valve for leak tests.	Used to meter leakage flows from item under test, through LEAKAGE Selector Valve to leakage flowmeters.
VENT PRESS. Valve	H	Controls vent flow to suit simulator tank at ground level.	Various tests utilizing suit simulator tank at ground level.
VENT AMBIENT Valve.	I	Controls vent flow to suit simulator tank at various simulated altitudes.	Various tests utilizing the suit simulator tank at simulated altitudes.

Table 18-1. —Purpose and use of instruments and controls—Continued.

Control or instrument	Figure 18-7 Item No.	Purpose	Use
FLUTTER DAMPENER Valve.	J	Opens suit simulator tank during certain tests.	Used during testing of miniature oxygen regulators, suit controllers, and headpieces.
CHAMBER BLEED Valve.	K	Bleeds ambient air into high-altitude chamber.	To induce air directly into high-altitude chamber, to decrease chamber altitude.
INLET PRESS. On-Off Valve.	L	Turns the test stand inlet pressure either on or off.	Used to control flow of system pressure to high-altitude chamber.
FLOW SELECTOR Valve.	M	Selects the proper flow path for the particular item under test.	Used when testing regulators, suit controllers, and seat pans.
LOW PRESS. REGULATOR	N	Regulates inlet pressure to the unit under test within a range of 0 to 180 psi.	To regulate low pressure to the high-altitude chamber.
REF. PRESS. SELECTOR Valve.	O	References pressure to either the altitude chamber or the suit simulator tank, depending on the test being performed.	Dependent on component being tested.
CONTROLLER REGULATOR.	P	Regulates inlet pressure to the altitude controller.	Used at all times when vacuum pump is to be used.
HIGH PRESS. REGULATOR.	Q	Regulates inlet pressure to the unit under test within a range of 0 to 1,850 psi, depending on the amount of oxygen pressure in the supply cylinder.	High-pressure loading.
SUIT SIMULATOR REF. SHUTOFF Valve.	R	Shuts off suit simulator tank.	Allows ALTM LOW RANGE Indicator to be used for certain component tests.
BOTTLE CHARGING Valve.	S	Pressure outlet.	Used in charging various oxygen cylinders and bleeding the test stand.

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Table 18-1.—Purpose and use of instruments and controls—Continued.

Control or instrument	Figure 18-7 Item No.	Purpose	Use
SHUTOFF TO Q Valve.	W	Shutoff oxygen to Q valve.	Directs oxygen to Q valve when pressures above 200 psi are to be used.
PRESSURE CONTROL Valve.	X	To control pressure to standby altitude controller.	All tests requiring high altitude chamber simulated altitudes when using the standby altitude controller.
VENT CONTROL Valve.	Y	To vent pressure from the standby altitude controller.	Same as above.
MANOMETER PRESSURE EQUALIZER.	Z	To prevent overloading the pressure suction manometer.	To equalize pressure in the pressure suction manometer if overloaded during testing.
OUTPUT FLOW Manometer.	1	Measures, in inches of H_2O, the amount of output flow from piezometer.	*
INPUT FLOW Manometer.	2	Measures, in inches of H_2O, the amount of dilution flow to the specific unit under test in the altitude chamber.	*
VENT FLOW Manometer.	3	Measures, in inches of H_2O, the amount of flow to the suit simulator tank.	*
PRESS. SUCTION Manometer.	4	Measures, in inches of H_2O, the amount of differential pressure from the piezometer to the altitude chamber.	*
HG Manometer.	5	Measures, in inches of HG, the differential pressure from the piezometer to the altitude chamber.	*
ROTAMETER LEAKAGE Flowmeter. Low range overboard.	6	Measures, in CC/MIN, leakage from component under test.	*
ROTAMETER LEAKAGE Flowmeter. Low range.	7	Measures, in CC/MIN, leakage from component under test.	*

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Table 18-1.—Purpose and use of instruments and controls—Continued.

Control or instrument	Figure 18-7 Item No.	Purpose	Use
ROTAMETER LEAKAGE Flowmeter. High range.	8	Measures, in CC/MIN, leakage from component under test.	*
SUPPLY PRESS. Gage.	9	Indicates the amount of input supply pressure.	*
REGULATED HIGH PRESS. Gage.	10	Indicates the amount of regulated input supply pressure.	*
REGULATED LOW PRESS. Gage.	11	Indicates the amount of regulated low input supply pressure.	*
ALTM HIGH RANGE Indicator.	12	Measures altitude chamber pressure to indicate the altitude equivalent within a 30,000- to 150,000-foot range.	*
ALTM LOW RANGE Indicator.	13	Measures altitude chamber pressure, and, under some circumstances, suit simulator tank pressure at pressures equivalent to altitudes within a 10,000- to 40,000-foot range.	*
PUMP CONTROL Switch.	17	Energizes vacuum pump.	All tests requiring chamber altitude.
PRESS. SUCTION Manometer.	25	To obtain accurate pressure indications at low pressures.	*
O_2 INPUT PRESS. Gage.	27	Indicates amount of regulated low input supply pressure.	*
Controller Set Knob.	29	Sets altitude reference point on altitude controller.	All tests requiring evacuation of the high-altitude chamber.
Controller Supply Gage.	30	Indicates amount of pressure at altitude controller input.	All tests where altitude controller is utilized.
Controller Altitude.	31	Indicates approximate altitudes to which the high-altitude chamber can be evacuated.	All tests requiring evacuation of the high-altitude chamber
Controller Output Gage.	32	Indicates amount of pressure at controller output.	Same as item 30.

*The use of these items is dependent on the component test being performed.

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Preliminary Procedures

Assuming that the test stand has been set up properly and that all necessary accessories have been attached, proceed as follows:

Oxygen pressure tests:

1. Make sure that all test stand valves and the valve at the oxygen supply cylinder are closed.

2. Place the leakage selection valve (F) in the HIGH position.

3. Open momentarily, then close the valve at the oxygen supply cylinder.

4. Observe the supply pressure gage (9) for 2 minutes. Any drop in pressure indicates leakage and must be remedied before proceeding.

5. Open the oxygen supply cylinder valve, and open valve (W).

6. Observe the regulated high-pressure gage (10) and rotate the high-pressure regulator (Q) clockwise until a pressure of 2,000 psi is indicated. Close the cylinder valve. Observe the regulated low-pressure gage (11); pressure indicated should be below 200 psi.

7. Observe the regulated high-pressure gage (10) for 2 minutes; no pressure drop should be noted. Turn valve (W) off. Bleed pressure by opening (S), then turn high pressure regulator (Q) to vent. After pressure is bled, close valve (S).

8. Rotate the high-pressure regulator (Q) counterclock wise to vent the system.

9. Place the inlet pressure on-off valve (L) in the ON position and cap the oxygen input (18).

10. Observe the regulated low-pressure gage (11) and the oxygen input pressure gage (27). Slowly open the low-pressure regulator (N) until a pressure of 70 psi is indicated on the gages.

11. Place the inlet pressure on-off valve (L) in the OFF position and the leakage on-off valve (G) in the ON position. Observe the rotometer leakage flowmeter (8). No leakage should be indicated.

12. Place the leakage on-off valve (G) in the OFF position and the inlet pressure on-off valve (L) in the ON position.

13. Observe the regulated low-pressure gage (11) and slowly adjust the low-pressure regulator (N) until a pressure of 160 psi is indicated. Observe the oxygen input pressure gage (27). Pressure indicated should be below 150 psi. Turn valve (G) to the ON position and valve (L) to the OFF position. Observe leakage rotometer (8). There should be no allowable leakage. Turn selector valve (F) to the LOW position and observe leakage rotometer (7). There should be no allowable leakage.

14. Close the pressure regulator (N), close the valve at the oxygen supply cylinder, and remove the cap from the oxygen input port (18) to vent the system. If above procedure is used, (L) will be off.

15. Place the inlet pressure on-off valve (L) in the OFF position.

High altitude chamber leakage tests:

1. Set the pressure selector valve (D) in the HG position and the leakage on-off valve (G) and the inlet pressure on-off valve (L) in the OFF position. See that a 0- to 50,000-foot altimeter is installed in the altitude chamber and that the chamber door is open.

2. Open the oxygen supply cylinder valve and set a pressure of approximately 2,000 psi on the supply pressure gage (9).

3. Adjust the controller set knob (29) to position the red indicator of the ALT controller (B) at a point below zero on the controller altitude gage (31).

4. Observe the controller supply gage (30) and adjust the controller regulator (P) to an indicated pressure of 20 psi. The same pressure should be indicated on the controller output gage (32).

5. Depress the START button of the pump control switch (17).

6. Place the reference pressure selector valve (0) in the SUIT SIMULATOR position and (M) in the controller position. Rotate the flutter dampener valve (J) and the suit simulator reference shutoff valve (R) one turn counterclockwise.

7. Remove the air inlet plug from the input fitting in the high-altitude chamber and close the chamber door.

8. Adjust the controller set knob (29) until an altitude of 30,000 feet is indicated on the ALTM low-range indicator (13). The same altitude should be indicated on the ALTM high-range indicator (12). If the indicators (12) and (13) do not agree refer to the applicable calibration instructions in NavWeps 17-15BC-11 and adjust as necessary.

9. Adjust the controller set knob (29) until an altitude of 40,000 feet is indicated on the ALTM low-range indicator (13). The same altitude should be indicated on the ALTM high-range indicator (12).

10. Adjust the controller set knob (29) until an altitude of 52,000 feet is indicated on the ALTM high-range indicator (12), then adjust the

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the letter P followed by a number which indicates its persistency. The higher the number, the longer the persistency. These numbers fall between 1 and 31 but bear no relationship to the time an image will persist on a screen. However, most airborne radar indicators use CRT's with long persistency.

CRT screens vary in size, color, and persistency. The most common size CRT screen is approximately 5 inches in diameter. Manufacturers indicate the size by using the size in inches as the first digit in the tube's designation.

The electrons reaching the screen give up energy in producing luminescence. When this is accomplished, they must be removed or a large negative charge would develop on the screen. Thus, some method must be used to return the electrons to the power supply. Since the electrons striking the screen are traveling at a very high speed, they cause other electrons to be emitted (called secondary emission). The aquadag coating, which consists of a conductive material deposited on the flare of the CRT, is connected to a very high voltage (See fig. 17-4.) Many of the secondary emission electrons are atracted by this high potential. Thus, the electrons are returned to the power supply. The aquadag coating also serves as a shield for the electron beam.

The deflection plates are the final components necessary to complete the electrostatic CRT. There are two pairs of deflection plates which are set at right angles to each other, and the electron beam passes between all four of the plates. The plates are called vertical and horizontal deflection plates according to the direction in which they deflect the beam and not according to the manner in which they are mounted. Figure 17-4 illustrates the mounting of the deflection plates.

The amount of deflection caused by a set of deflection plates depends upon the velocity of the electron beam, the voltage applied between the plates, and the spacing of the plates. A measurement of this deflection is called deflection sensitivity. Deflection sensitivity is defined as the number of millimeters the spot on the screen will be deflected when one volt is applied to the deflection plates. Thus, a deflection sensitivity of 0.22/volt means that for each volt d.c. applied between the plates causes a deflection of 0.22 mm.

A more useful measurement of deflection is known as the deflection factor—measured in volts per millimeter or volts per inch. This factor indicates the voltage that must be applied between the plates to obtain a deflection of 1 mm or 1 inch. Tube manuals give the deflection factor in volts per inch.

ELECTROMAGNETIC DEFLECTION

The electron gun of the electromagnetic CRT is very similar to the electron gun found in the electrostatic type of CRT. However, there are some differences in the two types which are primarily in the method of focusing and deflecting the electron beam. As the name implies,

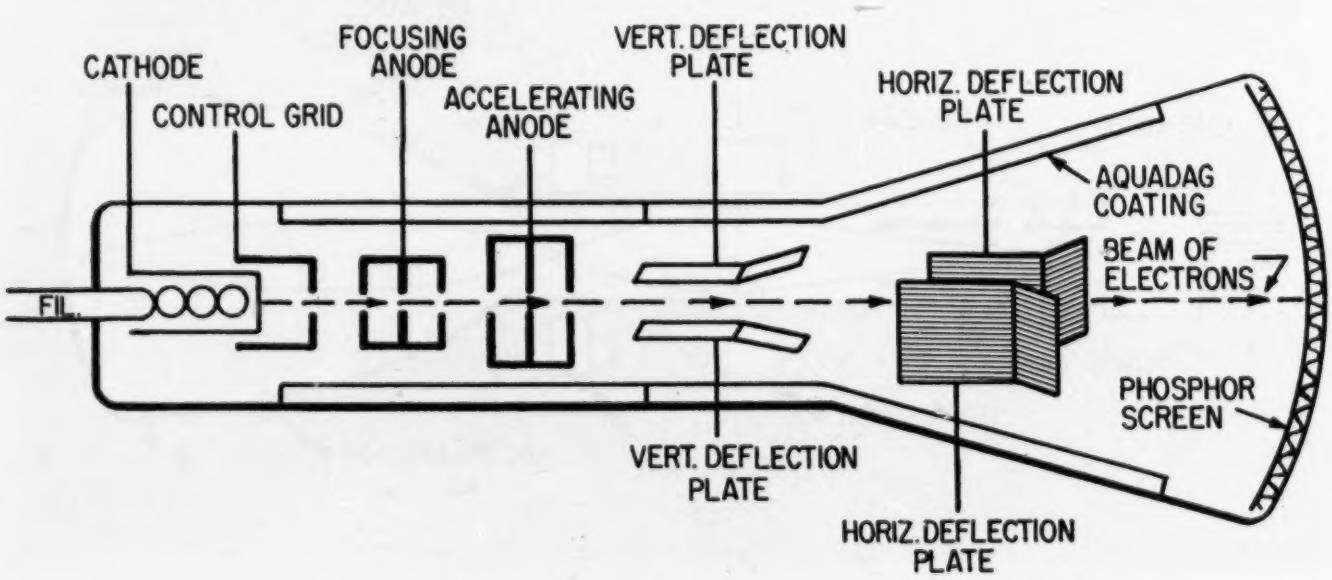

Figure 17-4. —Electrostatic CRT.

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controller set knob to reposition the red indicator at a point below zero on the controller altitude gage (31). Controller output gage (32) should indicate a pressure of 20 psi. Allow a 2-minute stabilization period.

11. When the 2-minute stabilization period has elapsed, observe the altimeter in the high-altitude chamber, and record the time required for the large hand of the altimeter to rotate counterclockwise (drop) one revolution (1,000 feet). NOTE: The allowable drop is 1,000 feet in 20 minutes.

12. Depress the STOP pushbutton on the pump control switch (17). Open the chamber bleed valve (K) to bleed the high-altitude chamber and close the valve at the oxygen supply cylinder. Close all test stand valves.

TESTING OXYGEN REGULATORS

Oxygen regulator testing is a responsibility of the PR. This chapter covers the testing procedures for the Bendix 29252-A-2 regulator and the new Navy standard pilot's miniature oxygen breathing regulator type 226-20004.

There are a number of various types of regulators used in the Navy today. The recommended testing procedures for these regulators can be found in their respective Overhaul Instructions Manuals. All regulators must be tested before they are installed in an aircraft. They are also tested any time they are disassembled for repair or adjustment and periodically at intervals specified in the appropriate manuals.

BENDIX 29252-A-2 OXYGEN REGULATOR

The Bendix 29252-A-2 regulator is one of the latest and most compact diluter demand pressure breathing automatic safety pressure regulators to be developed. It is also the first seat mounted regulator, and is used both in flight and in case of emergency. It is designed to be used with the A13-A oxygen mask. It is constructed so that with a normal inlet pressure of 70 psi, it will deliver diluted oxygen from sea level up to approximately 30,000 feet. One hundred percent oxygen is automatically delivered up to 50,000 feet, which is the service ceiling of the regulator. The regulator delivers automatic safety pressure, not in excess of 2 inches of water pressure, from sea level up to 35,000 feet. It delivers automatic pressure breathing from 35,000 feet to 50,000 feet, not to exceed 18 inches of water pressure.

All tests on the Bendix 29252-A-2 regulator are conducted with the regulator in the horizontal plane and the air dilution control knob down. The following tests are conducted on the oxygen regulator test stand, OTS-565. Figure 18-8 is a cutaway view of the Bendix 29252-A-2 regulator.

Overall Leakage Test

Place the diluter control knob on 100 percent and cap the outlet port. Apply 70 psi inlet pressure, then soap the mating surfaces of the inlet fittings and regulator body. There should be no evidence of leakage.

Relief Valve Test

Place the diluter control knob on normal and cap the inlet port. Apply 16 inches of water pressure at the outlet of the regulator. The maximum allowable leakage is 0.01 lpm. Apply 24 ±2 inches of water pressure. The relief valve must vent 40 lpm at a pressure no greater than 26 inches of water pressure. Decrease the pressure at the outlet to 15 inches of water pressure. There should be no evidence of leakage.

Safety Pressure Test

Mount the regulator in the test stand. Insure that the mask flow line is connected to the regulator outlet. Place the dilutor control knob on normal and apply 70 psi inlet pressure. Record the pressure-suction manometer reading on a performance sheet. Hold zero flow for 5 minutes and record the pressure-suction manometer reading on the performance sheet. The pressure-suction manometer reading must not exceed 2 inches of water pressure. Increase the inlet pressure to 90 psi and place the air dilution control knob on normal. Record the pressure of the suction manometer reading on the performance sheet for flows of 70 and 100 lpm at sea level and 34,000 feet. To ascend in altitude, open the outlet valve to indicate 10 lpm flow and control the ascent with the bypass valve. For flows of 100 lpm the pressure-suction manometer must not exceed 2 inches water pressure nor drop below -1 inch water

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pressure. Return to sea level, place the dilution control knob on 100 percent, and record the pressure of the pressure-suction manometer reading on the performance sheet for flows of 70 and 100 lpm at sea level, and 34,000 feet. Decrease the inlet pressure to 40 psi, maintain 34,000 feet altitude, and record the pressure-suction manometer reading for flows of 0 to 55 lpm at 34,000 feet and sea level. Repeat this procedure for flows of 0 to 100 lpm. The recorded pressure must not drop below -1 inch water pressure, nor exceed 2.0 inches of water pressure.

Aneroid Closure Test

Place the diluter control knob on normal and apply 90 psi inlet pressure. Place the glass on the altitude chamber and open the outlet valve to indicate 40 lpm. The altimeter will stop climbing when the air dilution aneroid has closed. The aneroid must close between 28,000 feet and 32,000 feet. Record the altimeter reading on the performance sheet.

Oxygen Ratio Test

Place the diluter control knob on normal and set the inlet pressure on 90 psi. Open the outlet valve and ascend to the first altitude on the performance sheet. Adjust the outlet valve for the required test flows. Adjust the inlet valve to maintain the correct test altitude. Record the input manometer reading on the worksheet for all flows on the oxygen ratio table. Repeat the above step for all test altitudes and flows on the oxygen ratio table.

NOTE: The bypass valve must be opened to climb above the aneroid closure altitude.

Check Valve Test

Place the diluter control knob on normal and set the inlet pressure to 40 psi. Ascend to test altitude (20,000 feet) and adjust the outlet valve for the required flow of 30 lpm. Adjust the inlet valve to maintain correct test altitude. Record the input manometer reading. Readjust the inlet pressure to 25 psi and adjust the outlet valve for required flow of 30 lpm. Adjust the inlet valve to maintain the correct test altitude. Record the input manometer reading on the worksheet.

Pressure Breathing Test

Place the diluter control knob on normal. Set the inlet pressure to 90 psi. Adjust the outlet valve to indicate 10 lpm. Open the bypass valve and ascend to the first test altitude on the worksheet. Record the pressure-suction manometer. The pressure-section manometer reading must fall between the minimum and maximum on the positive pressure table. Repeat the test for each altitude in the positive pressure table for the inlet pressure of 40 psi.

MINIATURE OXYGEN BREATHING REGULATOR 226-20004

The 226-20004 oxygen breathing regulator is mounted on the mask for use both in flight and bailout or emergency. The regulator integrates with the A13A oxygen breathing mask. The assembly weighs 2.3 ounces and is about 2 5/8 inches in length and 2 5/8 inches in width. It is designed so that with an inlet pressure of 40 to 90 psig it will deliver 100 percent oxygen automatically to the user between the altitudes of 0 and 50,000 feet. The regulator incorporates automatic safety pressure buildup to a maximum of 2 inches of water pressure below 35,000 feet and automatic pressure breathing for altitudes about 35,000 feet. Figure 18-9 shows a cutaway view of the 226-20004 oxygen breathing regulator.

Bench Testing the 226-20004 Regulator

Inspect the inlet port of the regulator for loose screws. Secure all loose screws and apply glyptol to screwheads so that the screws do not tend to loosen. The regulators must be subjected to the following tests every 60 days.

Overload Test

Cap the inlet of the regulator. Apply a pressure of 25 inches of water pressure to the outlet of the regulator for 2 minutes. The following test will indicate any failure.

Outward Leakage Test

Plug the inlet of the regulator and apply a pressure of 11 inches of water pressure to the outlet of the regulator. Leakage must not exceed 20 cc/minute.

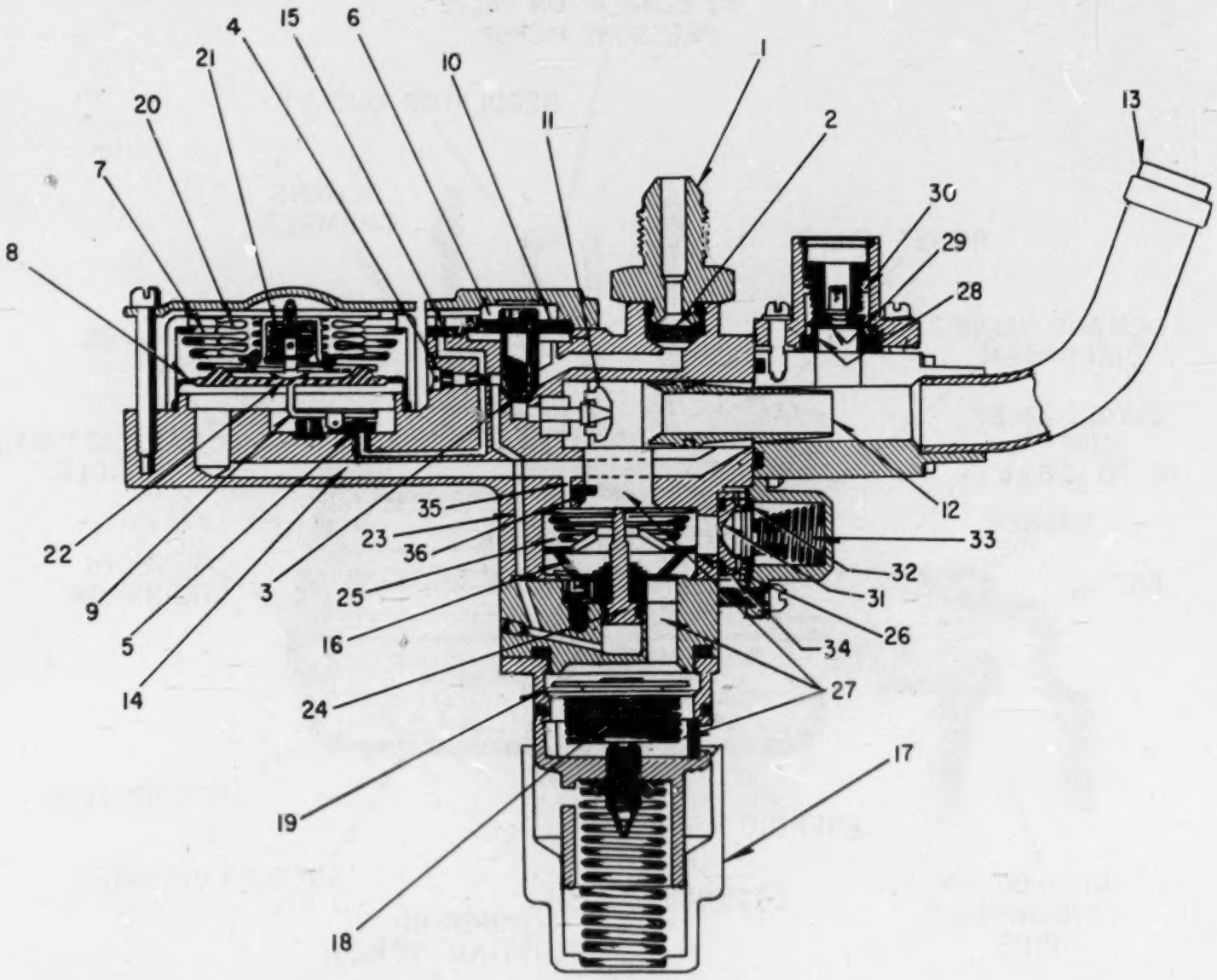

1. Inlet fitting.
2. Inlet filter.
3. Demand valve.
4. Needle valve.
5. Pilot valve.
6. Upper D. V. chamber.
7. Safety press. spring.
8. Breathing diaphragm.
9. Pilot valve lever.
10. Demand valve diaphragm.
11. Nozzle.
12. Venturi.
13. Outlet fitting.
14. Sensing line.
15. Restricting orifice.
16. Check valve.
17. Dilution knob.
18. Air ratio aneroid.
19. Throttling plate.
20. Press. breathing aneroid.
21. Max. press. spring.
22. P. B. contact screw.
23. Inlet press. chamber.
24. Piston.
25. Return spring.
26. Spring retainer.
27. Air dilution port.
28. Relief valve seat.
29. Relief valve plate.
30. Relief valve spring.
31. Dump valve seat.
32. Valve plate and diaphragm.
33. Dump valve spring.
34. Exhaust holes.
35. Booster hole.
36. Adjusting screw.

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Figure 18-8. —Cutaway view of Bendix 29252-A-2 regulator.

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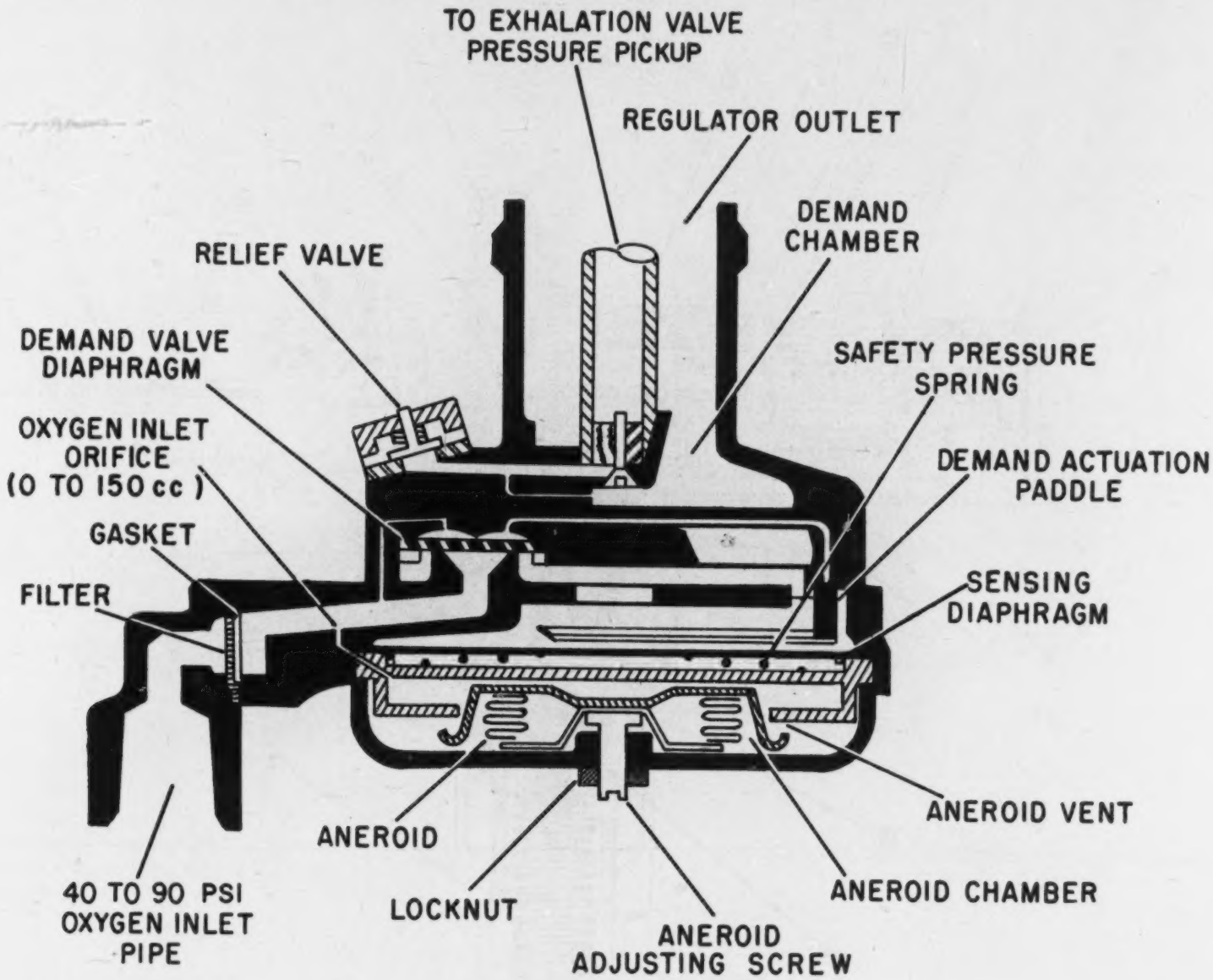

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Figure 18-9.—Cutaway view of the 226-20004 regulator.

Demand Valve Leakage Test

Apply a pressure of 70 psig to the inlet of the regulator. Maintain a static flow condition at sea level for 5 minutes. After 5 minutes the regulator outlet pressure must not have exceeded 2 inches of water pressure on the pressure-suction manometer, nor dropped below 0 inches of water pressure.

Automatic Safety Pressure Test

Set up the regulator, making sure that the regulator outlet and piezometer restrictor are 1 inch apart. Remove the rubber tube from the regulator outlet. Set the inlet pressure to 40 psig. Record the readings on the pressure suction manometer at flows of 0 and 70 lpm. Set the oxygen inlet pressure at 50 psig on the pressure gage located within the altitude chamber. Record the pressure indicated on the pressure-suction manometer for regulator outlet flows of 0, 10, and 100 ambient liters per minute at sea level, 10,000, 20,000 and 30,000 feet. Use valves A and B to regulate chamber ascent and descent respectively, and valve C as the regulator outlet flow control valve.

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Repeat the test with the oxygen inlet pressure set at 90 psig on the oxygen pressure gage located within the altitude chamber.

NOTE: The recorded pressures for the tests discussed in the preceding paragraph must not go negative nor exceed 2 inches of positive water pressure.

Automatic Positive Pressure Breathing Test

With the regulator still set up in the test stand, set the oxygen inlet pressure on the oxygen gage within the altitude chamber at 50 psig. With a flow of 10 liters per minute, vary the altitude from sea level to 43,000 feet. Record the altitude at which the automatic positive pressure breathing device cuts in. This point will be evident when the pressure-suction manometer reading increases above 2 inches of water pressure. The cut-in point must not exceed 39,000 feet. Vary the altitude between 35,000 and 43,000 feet and record the outlet pressures indicated on the pressure-suction manometer at each altitude in table 18-2, using a flow of 10 ambient liters per minute and 100 ambient liters per minute. Repeat the above test with the oxygen inlet pressure set at 90 psig on the oxygen gage within the altitude chamber. The recorded pressures must be within the limits listed in table 18-2. The pressure drop in recorded outlet pressures at 50 psig and 90 psig inlet, for flows of 10 and 100 ambient lpm at each altitude, must not exceed 0.75 inches of water.

Table 18-2.—Maximum and minimum mask pressures.

Altitude (feet)	Mask Pressures (inches of water)	
	Min.	Max.
35,000		3.5
39,000		8.0
41,000	4.0	10.2
43,000	10.0	12.5

Maximum Pressure Control

Cap the pressure pickup tube in the regulator.

Set the oxygen inlet pressure on the oxygen gage within the altitude chamber at 70 psig. With an ambient flow of 10 lpm evacuate the chamber to 50,000 feet altitude. Record the outlet pressures at 0 and 10 ambient lpm from the pressure-suction manometer. The maximum pressure control point occurs when the pressure-suction manometer indicates a constant outlet pressure. The maximum pressure control must operate at 16 ±2 inches of water at 50,000 feet. The relief valve is the maximum pressure control device for this regulator.

EMERGENCY OXYGEN SYSTEM

The purpose of the emergency oxygen system is to administer breathing oxygen and suit pressure necessary for sustaining a crewmenber during high-altitude operations under emergency conditions. This equipment includes the oxygen supply bailout bottle and the pressure reducer.

There are a number of various types of oxygen bailout bottles. The testing procedures and testing intervals may be found in their appropriate Overhaul Instructions Manuals. This chapter will cover the Firewel oxygen bailout bottle and the suit mounted pressure suit controller.

The following test procedures for testing the suit mounted controller and the oxygen supply bailout bottle are conducted on the 62-A-116-E1 test stand.

SUIT MOUNTED CONTROLLER

The suit mounted controller is an aneroid controlled exhaust valve which monitors the rate of flow of exhaust gases from the suit to maintain an absolute suit pressure of 6.9 ±0.3 inches of mercury (equivalent to 35,500 ±1,000 feet). With a minimum of resistance, 300 lpm ventilation air can be exhausted while the suit is in the pressurized condition. A water check valve is incorporated into the controller unit. The controller is designed to mount directly to the existing exhaust port fitting on the Mk 4 full pressure suit.

Test Procedures

Test procedures for testing the suit controller are discussed in the following paragraphs.

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Insure that all test stand valves are closed. Cap the input tap and the air input tap. Connect a pressure suit exhaust port fitting to the controller test fixture. (See fig. 18-10.) Then connect the suit controller. Connect the controller test fixture directly to the piezometer and the hose from the piezometer to the reference tap 21 as shown in view A of figure 18-7. Place selector valve M to the controller position, 0 to the suit simulator position, valve D to HG position and L to off. Open valve R fully, and load the altitude controller B to 20 psi, using controller regulator P. Adjust the low-pressure regulator N to the 100 psig reading on gage 11. Regulate valve H to deliver 100 and 300 lpm to the suit controller. Read the pressure rise on the Hg manometer 5 at the given setting and record on the test sheet (fig. 18-11). Close valve H and relieve pressure on the low-pressure regulator N. Close the chamber door; turn the vacuum pump on, and ascend to 33,000 feet with valve B. Open valve I to deliver 100 and 300 lpm to the suit controller.

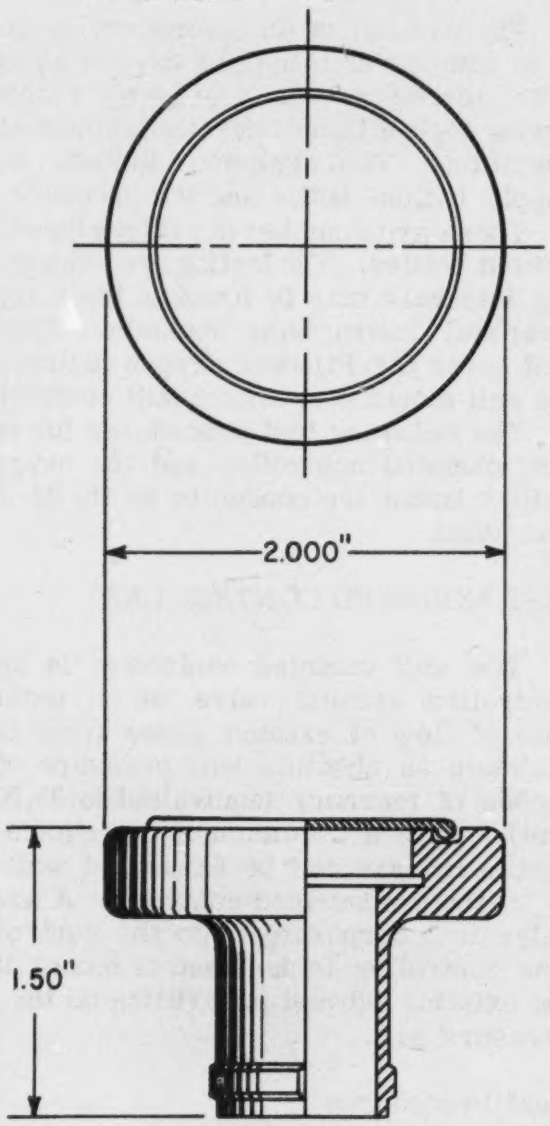

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Figure 18-10.—Controller test fixture.

Record controller hold pressure indicated as differential pressure on the Hg manometer 5. Open valve I to deliver 100 and 300 lpm to the suit controller. Read and record the suit pressure indicated on the Hg manometer 5 and the suit altitude on suit altimeter 13. Ascend to 80,000 feet with valve B. Read and record the controller hold altitude on suit altimeter 13; also record the controller hold pressure indicated as differential pressure on the Hg manometer 5. Remain at 80,000 feet for 5 minutes. The pressure drop must not be more than 0.2 inch of Hg below the original pressure recorded at the beginning of the 5-minute period. If the drop is greater, the controller is not serviceable. Descend to 40,000 feet by setting the B valve and opening the I valve. When 40,000 feet is reached, close valve I. Read and record the controller hold altitude on suit altimeter 13; also record controller hold pressure indicated as differential pressure on the Hg manometer 5. Open valve I to deliver 100 and 300 lpm to the suit controller. Read and record the suit pressure indicated on the Hg manometer 5 and the suit altitude on suit altimeter 13. Remain at 40,000 feet for 5 minutes. The pressure drop must not be more than 0.2 inch of Hg below the original pressure recorded at the beginning of the 5-minute period. If the drop is greater, the controller is not serviceable. Open valve I and descend to sea level. NOTE: Valve I must be open at all times when descending to insure that the Hg manometer 5 does not overflow. The Hg should be visible at all times. Secure from the test.

Read the pressure rise on the Hg manometer 5 at the given setting and record on the test sheet. Close valve I. Using valve B, ascend to 50,000 feet in 1 minute. The absolute suit pressure must be between the limits of 6.9 ±0.3 inches of Hg with no ventilating air supplied at any time. Read and record the controller hold altitude on suit altimeter 13; also record the controller hold pressure indicated as differential pressure on the Hg manometer 5. Ascend to 60,000 feet, using valve B. To obtain a true suit pressure hold condition when testing suit

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SUIT MOUNTED CONTROLLER TESTS

CONTROLLER RESISTANCE

Altitude (ft.)	Vent Flow (Act. lpm)	Ind. Vent Flow (in. H_2O)	Diff. Suit Press (in. Hg.)	Abs. Suit (Alt/Ft)	Resistance Tolerance (in. Hg.)
S.L.	100				.1
S.L.	300				.3
33,000	100				.1
33,000	300				.3
40,000	100				
40,000	300				*
60,000	100				
60,000	300				*

CONTROLLER HOLD AND STABILITY

Altitude (ft.)	Initial ** Diff. Suit Press. (In. Hg.)	Initial Abs. Suit Alt. (ft.)	Total Press. Drop After 5 min. Hold (in. Hg.)	Pressure Drop Tolerance (in. Hg.)
40,000				.2
50,000				
60,000				
80,000				.2

* The absolute suit pressure which is the sum of cabin pressure and suit pressure shall not exceed 7.4" Hg. with a 300 actual lpm ventilation flow.

** The absolute suit pressure shall be between the limits of 6.9 ± 0.3 in. Hg. (equivalent altitudes of 35,500 ± 1,000 ft.) with no ventilation flow at the various test altitudes.

After the five minute hold period, the pressure drop shall not exceed 0.2 in. Hg. below the initial reading.

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Figure 18-11.—Test data sheet for the suit controller.

controllers at various ambient altitudes, ventilation air must be induced (not to exceed 300 lpm ambient) for a few seconds and then shut off. Fifteen seconds after securing the ventilation air and the pressures have stabilized, the suit pressure must be recorded.

FIREWEL EMERGENCY BAILOUT BOTTLE

The Firewel emergency bailout bottle is horseshoe shaped and is designed to mount directly in the seat pan assembly. It will hold 50 cubic inches of oxygen at 1,800 psi. Figure 18-12 shows an exploded view of the bailout bottle.

The Firewel bailout bottle will be subject to the test described in the following paragraphs.

Leakage and Emergency Release Test

Secure the bottle assembly in the seat pan. Place the lever (12, fig. 18-12) to the OFF position, using a resetting tool and insert the pin (1, fig. 18-12). Connect the emergency release assembly to the pin. Charge the bottle to approximately 200 psi (adjacent to the letter "R" in the word "Refill") on the face of the pressure gage which is attached to the reducer. Attach a

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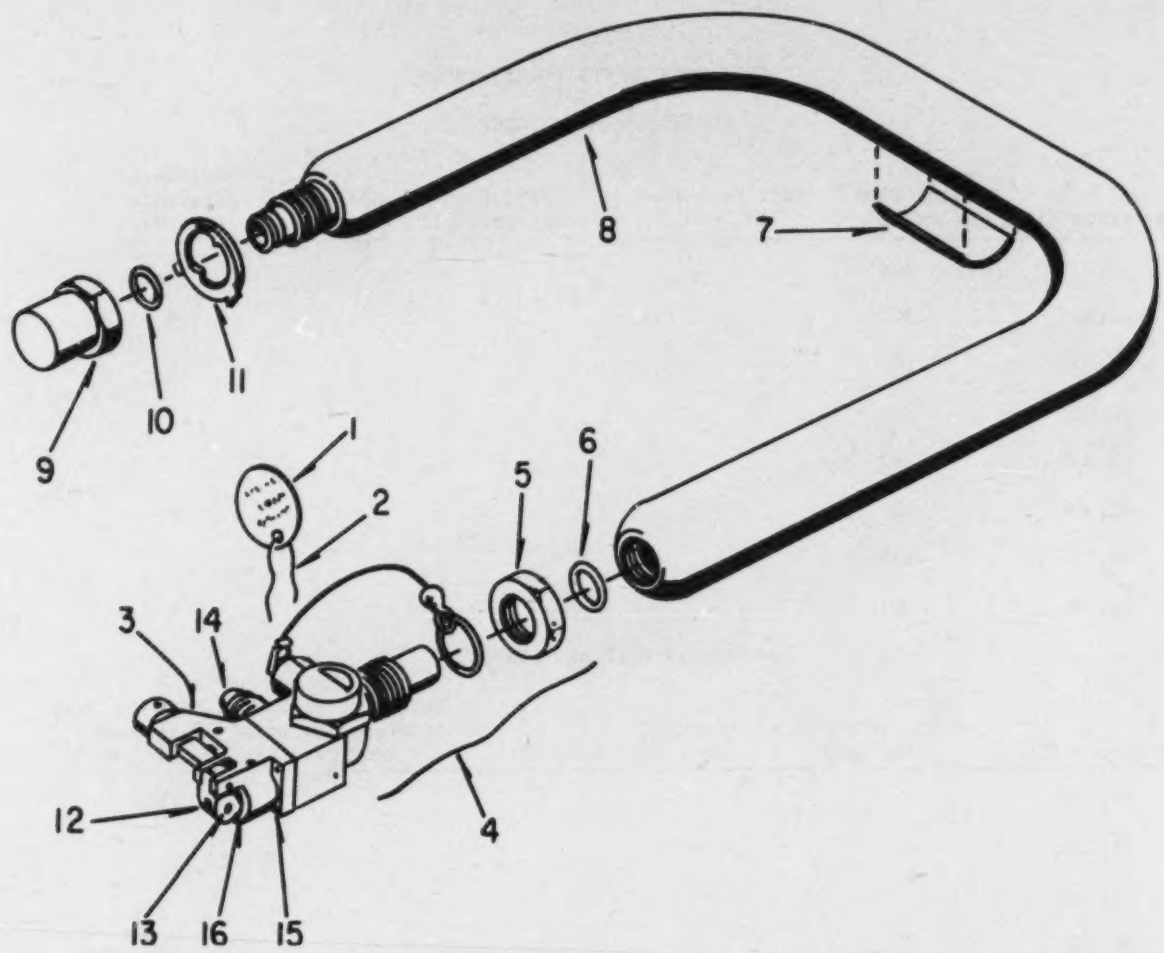

1. Tag.
2. Wire.
3. Reducer assembly.
4. Wire.
5. Nut.
6. O-ring.
7. Plate.
8. Tube.
9. Cap.
10. Packing.
11. Washer.
12. Lever.
13. Pin.
14. Fitting.
15. Screw.
16. Nut.

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Figure 18-12. —Firewel bailout bottle.

spring scale to the green apple of the emergency release cable and pull. The retainer fastener should release at 20 ±5 pounds. Check the automatic release cable to release at 20 + 15 - 5 pounds. Recharge the bottle to 1,800 psi, pull the green apple, and release oxygen. Again charge the bottle to 1,800 psi. Disconnect the emergency release from the pin and remove the reducer and bottle assembly from the seat pan. Cap the fitting (2, fig. 18-12) and submerge the bottle assembly in water so that the housing attaching screws are covered, but not the nut. If bubbles appear, slowly raise the bottle assembly out of the water to determine the exact area of the leakage and correct accordingly. Dry the bottle thoroughly and mark the gage at the exact position of the indicating arrow. Tag the bottle with the date and hour and allow 72 hours to elapse. If the gage reads within 1/32 inch of the previous mark, the bottle is acceptable.

NOTE: rapid refilling of the emergency oxygen bottle causes severe internal heating and may result in an explosion or fire. Charge bottle pressure in accordance with table 18-3.

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Table 18-3.—Bottle pressures.

To pressure	Time	Cooling period
0-500 psi	Not less than 3 minutes	2 minutes
500-1,000 psi	Not less than 3 minutes	2 minutes
1,000-1,800 psi	Not less than 3 minutes	2 minutes

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CHAPTER 19

NES-8A PERSONNEL PARACHUTE ASSEMBLY

The NES-8A personnel parachute assembly is designed for use with an integrated torso suit harness and is part of the ejection seat escape system. This assembly includes a Skysail Model "E," multicolored, 29.7-foot diameter, ringsail canopy with 24 gores. The canopy is packed in a hardshell "horseshoe" type container and installed in the ejection seat.

The integrated torso suit harness combines the aircrewman's parachute harness and lap and shoulder restraint straps. The harness is channeled through the torso suit to retain it in position and to facilitate donning. When aboard the aircraft and seated, the aircrewman connects the quick-release fittings on the parachute riser assembly to the quick-release shoulder fittings on the integrated torso suit. The survival kit is also connected to the integrated torso suit by means of quick-release fittings.

OPERATION

After ejection, the drogue parachute is deployed from the ejection seat and pulls the withdrawal line assembly from the container assembly. When the withdrawal line reaches full stretch, the ripcord locking pins are removed from the locking cones, permitting the grommets, locking cones, and end tabs to disengage. The container spring bands pull the end and side flaps apart allowing the pilot parachute to spring from the container and fill with air. If the withdrawal line assembly fails to remove the ripcord locking pins, the parachute container can be opened by manually pulling the ripcord handle. In this case, only the pilot parachute will deploy the canopy.

The aircrewman falling away from the pilot parachute and drogue parachute causes the canopy to be pulled from the container assembly, followed by the suspension lines. The canopy begins to fill with air during this operation. The tape fasteners securing the lift webs to the container releases as load is applied. The lift webs are then pulled from the container assembly and the canopy opens fully.

The aircrewman hangs suspended in his harness from the quick-release shoulder fittings during descent. The antisquid lines may break during high-speed openings. Upon landing, the aircrewman can disengage the canopy and suspension lines from the integrated torso suit harness by using the quick-release shoulder fittings.

PACKING AND RIGGING

Lay out the canopy assembly full length on the packing table. Locate the canopy gore with the nameplate and place it uppermost. Separate the suspension lines into two equal groups, counting 12 suspension lines on each side of the nameplate gore. Place the connector link holding suspension lines 1 through 6 on top of the connector link holding suspension lines 7 through 12. Place the connector link holding suspension lines 19 through 24 on top of the connector link holding suspension lines 13 through 18. Connect these two pairs of connector links to their respective tension hooks on the packing board and insert them into the packing table. Insure that the knurled portions of the connector link yoke and the plate assemblies face up and that the screwheads face outboard.

Attach the antisquid lines, pilot parachute connector cord, and withdrawal line. (This is necessary only for original issue assemblies.) Using 10 pounds of tension, measure and cut a 68.5-foot length of 1,000-pound nylon cord, MIL-C-7515, type IV. Double the cord so that both halves are equal in length; mark the center of the cord. Wrap the loop end of the doubled antisquid line twice around the vent

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focusing and deflection are by an electromagnetic deflection. (NOTE: An electromagnetic CRT could employ electrostatic focusing.)

In this type CRT, the first anode (after the control grid) serves as the accelerating element rather than as the focusing device. The second anode (rather than being the accelerating anode as in the electrostatic CRT) is the aquadag coating with a high-positive potential applied to it. It serves the same purpose as aquadag coating in the electrostatic type CRT. However, it does aid in accelerating the electrons and may sometime be referred to as an accelerating anode.

The focusing coil of the electromagnetic CRT replaces the second anode and performs the same function as the first anode in the electrostatic CRT. The deflection coils, or deflection yoke as it is sometimes called, replaces and performs the same function as the deflection plates in the electrostatic type CRT. Figure 17-5 is an illustration of the complete basic electromagnetic CRT.

The focusing coil is essentially an electromagnet which fits around the neck of the CRT as illustrated in figure 17-6. When a d-c current flows through the windings of the coil, a magnetic field is set up, part of which is within the neck of the tube. It should be noted that within the neck the magnetic lines of force have a mean direction which is along the axis of the neck. Thus, the magnetic field causes the electron beam to converge. The amount of current in the coil may be controlled by a rheostat (focus control), thus controlling the strength of the magnetic field.

The manner in which the electron beam is focused may be explained with the aid of figure 17-6. Point P is the crossover point which the electron beam is assumed to have reached after being emitted by the cathode, acted upon by the grid, and accelerated by the first anode.

The electrons traveling down the axis of the tube will not be affected by the magnetic field. Those electrons traveling at a small angle will have a force applied to them perpendicular to the magnetic field. This force will tend to bring the electrons back into the line of travel. This action, however, could cause the electrons to oscillate back and forth across the neck of the tube and gradually damp out. As shown in figure 17-6, an electron traveling along the line PAB or PDE would be forced by the magnetic field to take the paths PACS and PDFS, respectively. All electrons coming from the crossover point P and entering the magnetic field follow paths that make them meet at the common point S.

However, it is possible that an electron could be traveling off to one side or the other as well as at an up or down angle. Thus, the magnetic field could be acting on the electrons in more

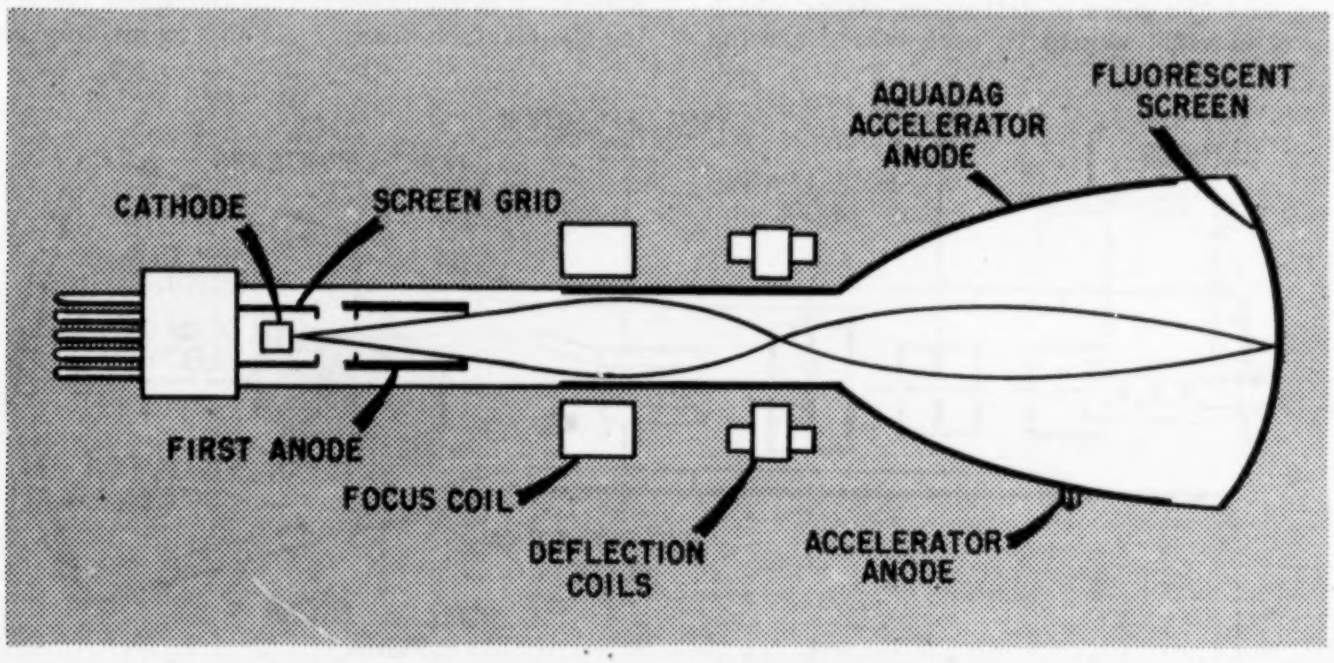

Figure 17-5. —Electromagnetic CRT.

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lines. Pass the cord ends through the loop. (See fig. 19-1.)

Pass the loop ends of the pilot parachute connector cord and withdrawal line through the two turns of the antisquid line and around the vent lines. Pass the pilot parachute through the loop in the end of the connector cord and pass the drogue link fittings through the loop in the end of the withdrawal line. (See fig. 19-2.)

Pull the pilot parachute connector cord, withdrawal line, and antisquid lines tight at the center of the vent lines. Route the antisquid line down the inside center of the canopy to the connector links. Insure that the antisquid lines are not twisted or routed through slots between the canopy sails. Secure one antisquid line between suspension lines 3 and 4 on one top connector link and the other antisquid line between suspension lines 21 and 22 on the other top connector link with a Chinese finger knot. Zigzag stitch through each knot with unwaxed size E nylon thread, single. Start 4 inches from the connector links and sew away from the connector links for a distance of 1 inch. (See fig. 19-3.)

SUSPENSION LINE CONTINUITY CHECK

To perform a continuity check, secure a loop of webbing around the vent lines, attach a strap hook to the loop and tighten. The packer and helper must grasp the canopy at the second set of sails and pull toward the canopy peak, applying tension to the suspension lines. The packer must start with suspension line number 1 on the left side of the nameplate gore and work through line 12.

The helper must be positioned at the connector links to check the suspension lines selected by the packer for continuity, dips, and twists. The same procedure is used on the right side of the nameplate gore, except that the packer will start with suspension line number 24 and work through line 13.

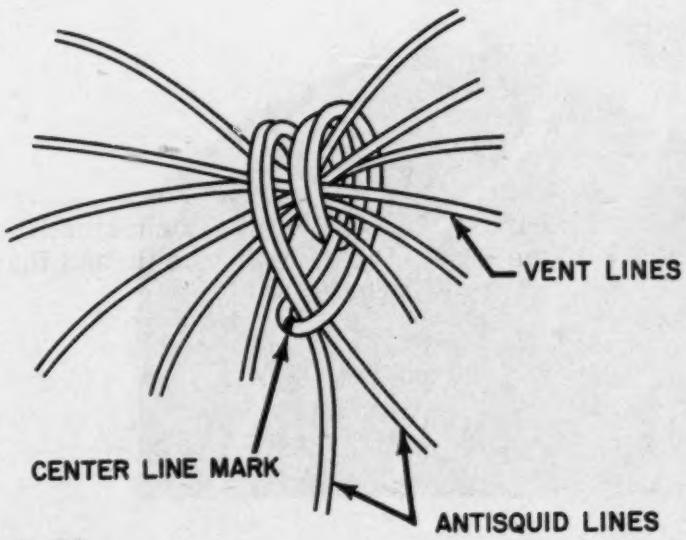

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Figure 19-1.—Antisquid line to apex.

ATTACHMENT OF CONNECTOR LINKS

Attachment of the suspension line connector links to the riser assembly and cross connector straps must be accomplished upon receipt of original issue.

Lay out the riser assembly and cross connector straps on the packing table. Corresponding lift webs must be placed on top of each other and positioned at the connector links. The ripcord assembly must face up. (See fig. 19-4.)

Remove the connector links from the tension hooks, and remove the connector link yoke and plate assembly from each connector link. Insert the bottom connector links through the loops in the corresponding bottom lift webs. Reattach the yoke and plate assemblies to the bottom connector links and tighten the screws to a torque value of 20 to 25 inch pounds; paint each screw with lacquer. (See fig. 19-5.)

Attach the top lift webs and cross connector strap to the top connector links in the same manner as described in the above paragraph. Insert the connector links into the tension hooks and tighten the tension strap at the canopy peak; recheck continuity of the suspension lines.

WHIPPING AND FOLDING THE CANOPY GORES

Route the suspension lines around the packing board spools. Tighten the packing board tension strap, applying tension to the suspension lines. (See fig. 19-6.)

NOTE: The radial tapes must run free from the skirt hem to the canopy peak. The tapes must not be twisted in the sails or around each other.

The packer and helper must lift the suspension line on each side of the nameplate gore

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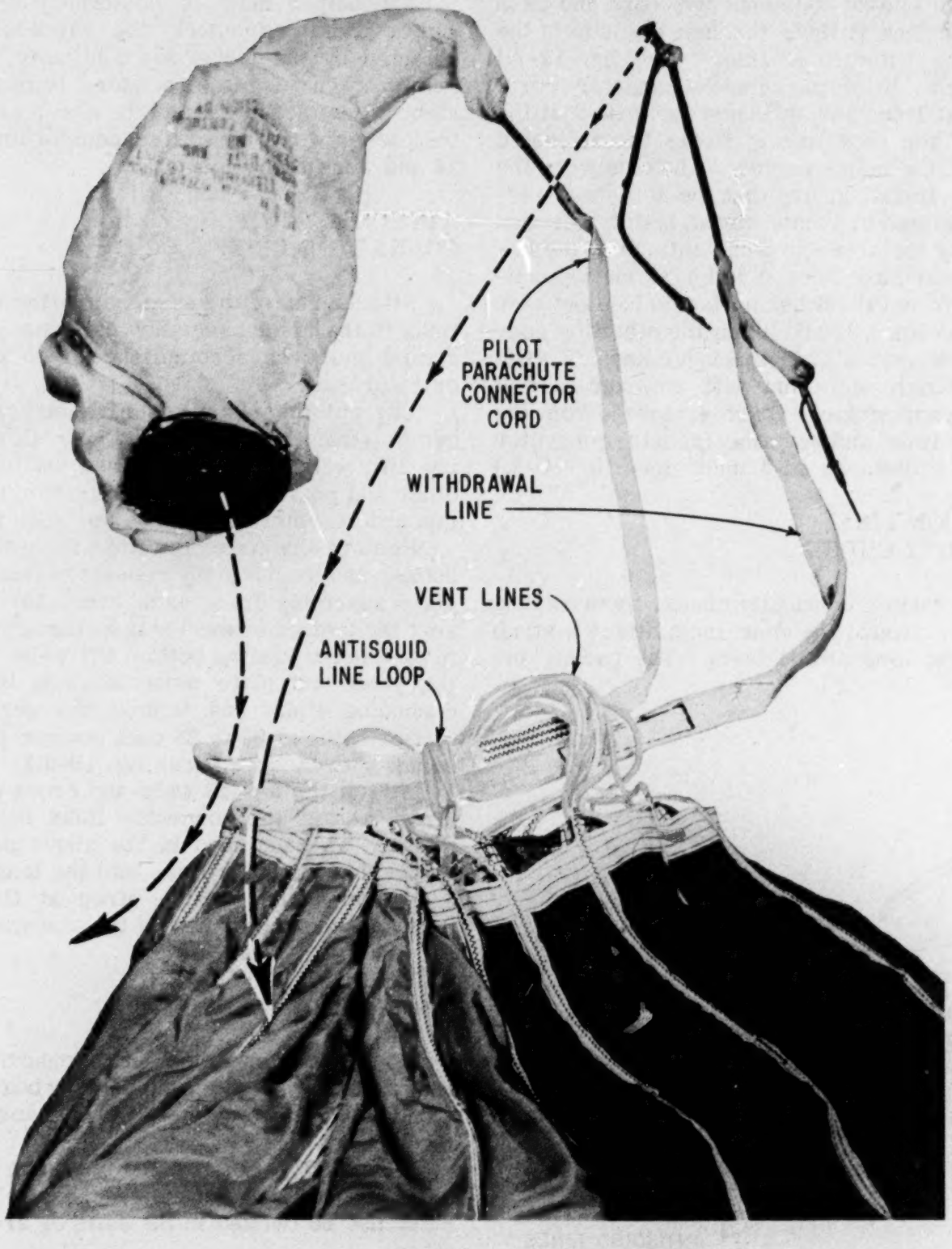

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Figure 19-2.—Attachment of the canopy drogue withdrawal line and pilot chute bridle.

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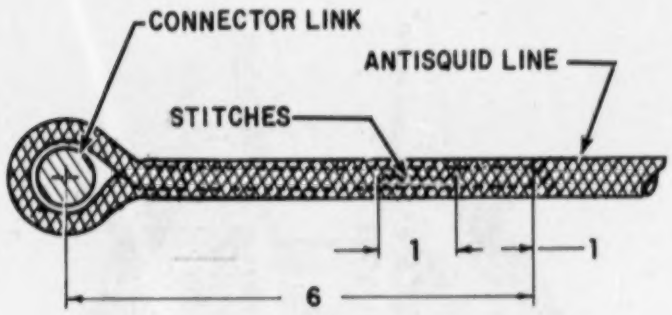

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Figure 19-3.—Attachment of antisquid lines to connector link.

up and out. The skirt hem between the lines should be taut so that the canopy peak can be seen on the inside. While holding the suspension lines up, each man will alternately whip the gores hanging from the suspension line outward to prepare the canopy for folding.

As each gore is whipped, the packer and helper must check to verify that the radial tapes run free to the canopy peak. Each man must alternately draw the next suspension line upward to the suspension line held in hand, using a rapid, circular motion. (See fig. 19-7.)

Upon completion of the whipping operation of all canopy gores, the two groups of suspension lines must be stretched to the edges of the packing table with folded gores hanging over the side. The packer must flap the top sail up and down at the skirt hem center, as the helper holds the bottom sail at the skirt hem center. On signal, both men must draw their respective sails, at centers, toward each other while at the same time bringing the suspension line groups to the center of the packing table.

Insert the suspension line groups into their respective slots in the suspension line separator. The packer and helper must fold the seventh set of sails to the suspension lines at table center, as shown in figure 19-8.

The packer and helper must straighten and smooth each sail when placing them back onto the packing table one at a time. There must be 12 sails on each side of the packing table.

S-fold the seventh set of sails, retaining the sails in the proper position by placing a shot bag on top of the S-folded sails. (See fig. 19-9.)

Straighten, smooth, and S-fold the next four sets of sails in the same manner. Straighten and smooth the top two sets of sails toward the

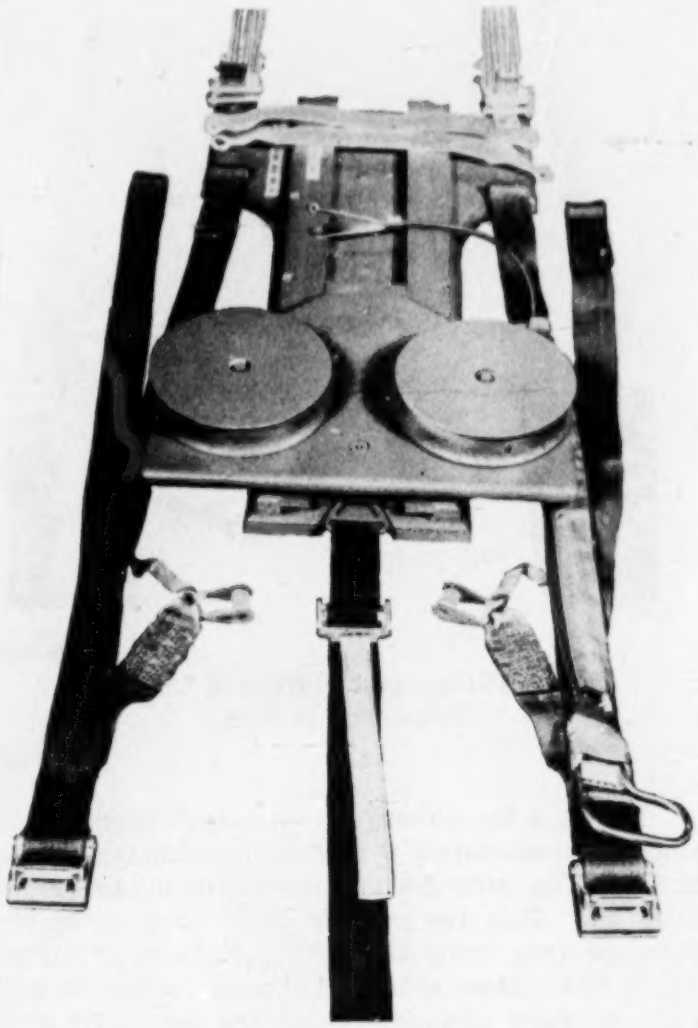

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Figure 19-4.—Layout of risers and cross connector straps.

apex in the same manner as the seventh set. Fold the second set of sails to the center of the canopy and hold them down with a shot bag. Hold the top set of sails in place by using a shot bag. (See fig. 19-10.)

STOWAGE OF SUSPENSION LINES

Remove the suspension lines from the packing board spools and S-fold them onto the packing table. Remove the canopy tension strap at the peak and remove the connector links from the tension hooks. Remove the packing board from the packing table as shown in figure 19-11.

Tie the outboard side of the connector links together with one turn of FF nylon thread, single.

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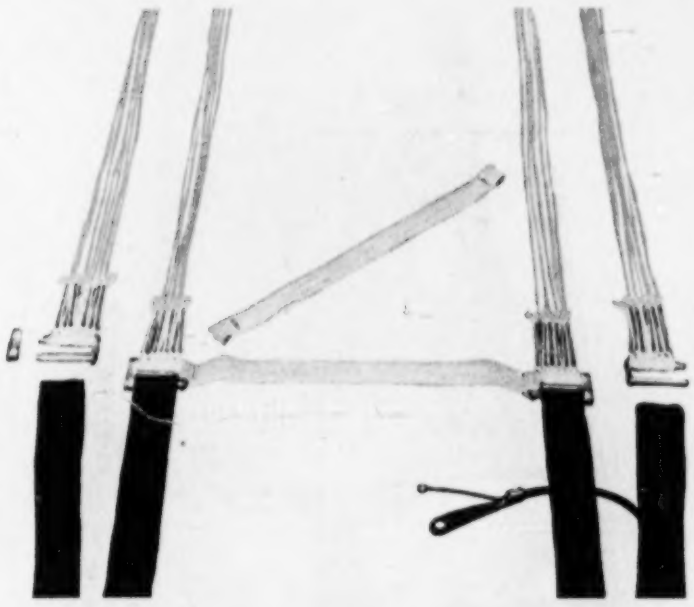

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Figure 19-5.—Installation of the cross connector straps.

Position the stowage tray under the antisquid lines approximately 9 inches from the connector links. The stowage tray retaining angles must face up. Pull the canopy peak away from the stowage tray until the antisquid lines are taut. Place the antisquid lines between the fourth and fifth stowage channels from the outboard side of the stowage tray. There must be no slack in the antisquid lines between the connector links and the packing tray. (See fig. 19-12.)

The packer and helper must each pass a length of line stowage aid through the second outboard stowage channels and form a bight in the suspension lines, as shown in figure 19-13.

The packer and helper must draw the suspension line bights through the stowage channels to the edge of the packing tray. The second and third suspension line bights are stowed in the same manner as the first stow.

Remove the antisquid lines from their present position and route them along the outboard sides and top edges of the packing tray. Form the fourth suspension line bights and at this time include the first bight of the antisquid lines. (See fig. 19-14.)

The packer and helper must form and stow bights of suspension and antisquid lines in the same manner as previous stows.

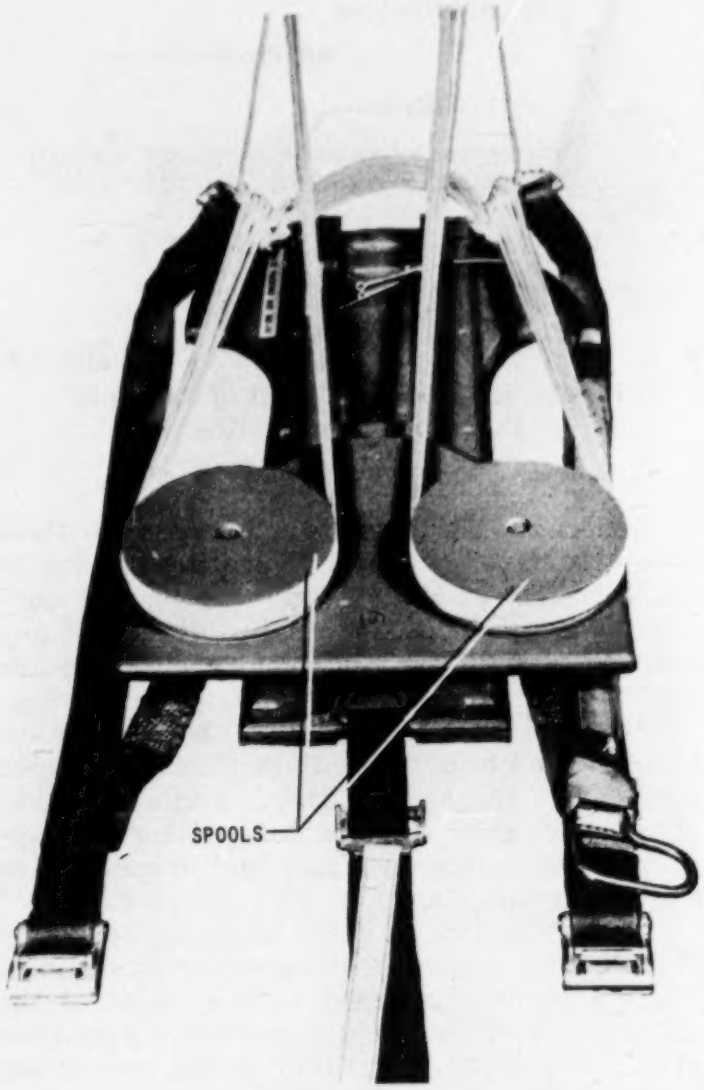

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Figure 19-6.—Routing and tensioning of the suspension lines.

Turn the packing tray so the bottom of the tray faces the canopy. Stow the suspension line and antisquid line bights in the two center stowage channels as shown in figure 19-15.

Form and stow the suspension lines and antisquid line bights in the reamining stowage channels, working from the center of the packing tray to the outer edges. Remove the shot bag and separator from suspension lines as the canopy approaches the packing tray. There should be 17 to 19 inches between the canopy skirt hem and each outboard stowage channel when all stowage channels are filled. (See fig. 19-16.)

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Figure 19-7.—Whipping the canopy.

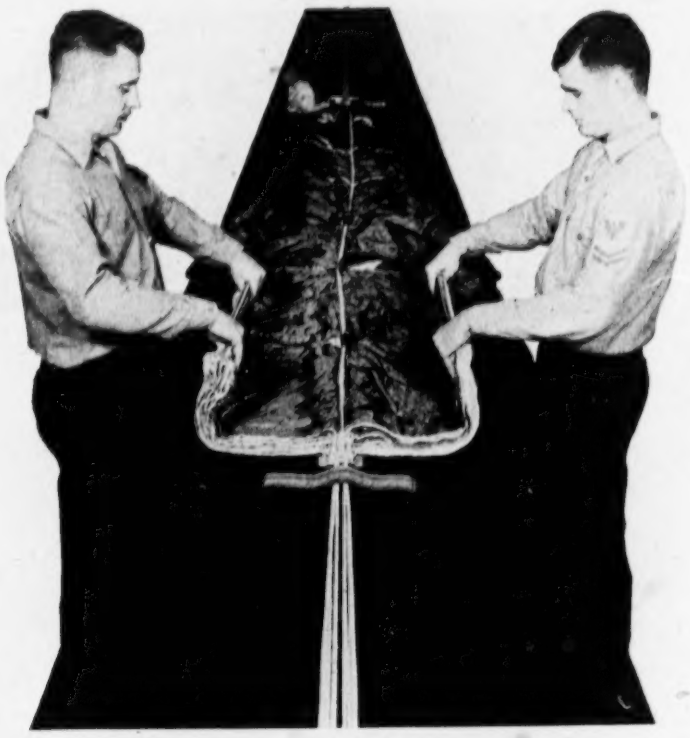

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Figure 19-8.—Folding the seventh set of sails.

Turn the packing tray under so the bottom of the tray faces the risers and the retaining angles face up. Rotate the risers and connector links over the packing tray and stow any excess suspension lines into stowage channel number 1.

ATTACHMENT OF STOWAGE TRAY AND RISERS TO THE CONTAINER

Position the container on the packing table, aft of the stowage tray, so that the side flap containing the locking cones is uppermost and the open end of the container faces the canopy. Slide the container toward the canopy, inserting the stowage tray into the container. Do not move the stowage tray toward the container. Insure that the suspension lines do not become trapped under the tray retaining angles. The pilot parachute kickplate must not be wedged between the stowage tray and the container.

Aline the threaded holes in the stowage tray retaining angles with the holes located in the bottom of the container legs.

Aline the brackets on the container retention straps above the holes in the bottom of the container legs. Insert the screws through the washers, retention strap brackets, and the holes in the container legs. Thread the screws into the retaining angles and tighten. Insure that the retention strap bracket is turned upward as shown in figure 19-17.

Place the container into a container stand. (See fig. 19-18.)

Attach the hook tape patches on the risers to the pile tape patches on the inside of the container, as shown in figure 19-19.

STOWAGE OF THE CANOPY

Remove the shot bags from the three sets of sails closest to the skirt hem. The packer and helper must fold the skirt hem under 4 inches and tuck into the container legs. The excess suspension line must be stowed in each respective container leg. Remove the remaining shot bags from the folded sails.

NOTE: The canopy sails are numbered 1 through 7, starting from the canopy peak to the skirt hem.

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Figure 19-9.—S-folding the sails.

Accordion-fold sail sets 7, 6, and 5 into the container legs. Accordion-fold the remainder of the canopy lengthwise across the top of the container so the peak is positioned at the helper's end of the container. Press each accordion fold into the container separately. (See fig. 19-20.)

PR.407

Figure 19-10.—Sail folding of canopy completed.

CLOSING OF THE CONTAINER

Pull the side flap with locking cones over the top of the folded canopy. Pull the side flap with grommets over the top side flap with locking cones and place the grommets over the locking cones. Insert the temporary locking pins.

Remove the temporary locking pins on the packer's side and place the grommet on the end flap over the locking cone between the side flaps.

Place the side flap grommet back over the locking cone and place the metal end tab over the grommet and locking cone. Reinsert the temporary locking pin as shown in figure 19-21.

S-fold the withdrawal line under the side flaps on the helper's end. Insure that the pilot parachute cloth is not twisted around or entangled in the compressed pilot parachute spring.

Insert the guide tube through the grommet in the crown of the pilot parachute and place it over the locking cone on the spring baseplate. Compress the pilot parachute fully, remove the guide tube, and insert the pilot parachute temporary locking pin into the locking cone hole.

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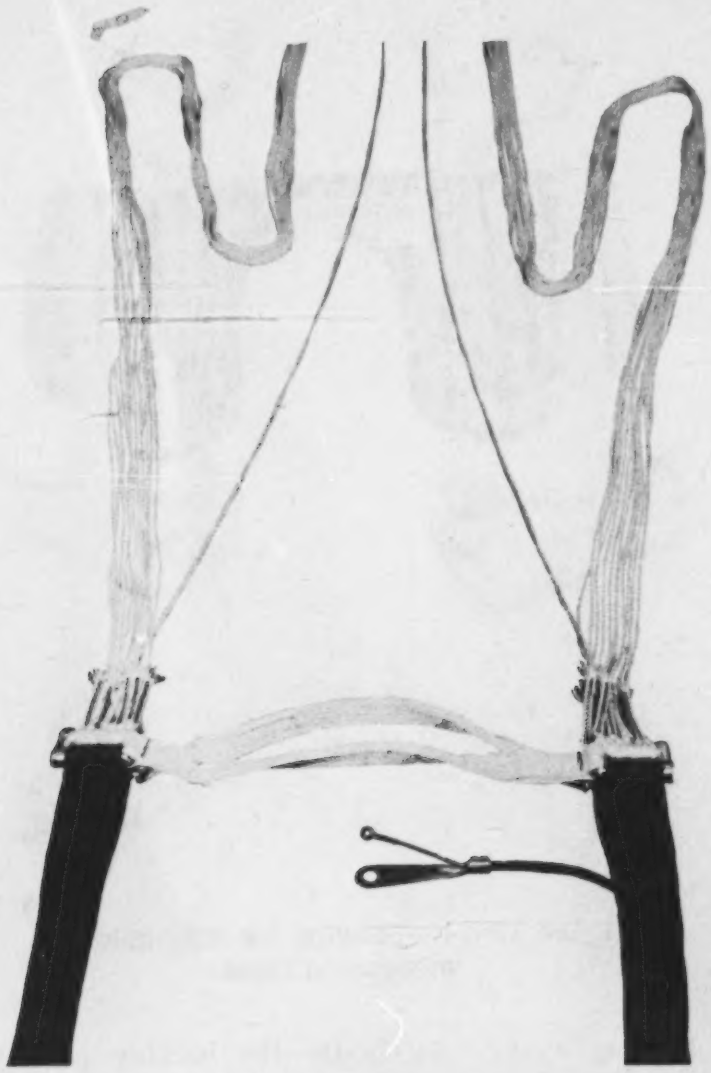

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Figure 19-11.—S-folding of the suspension lines.

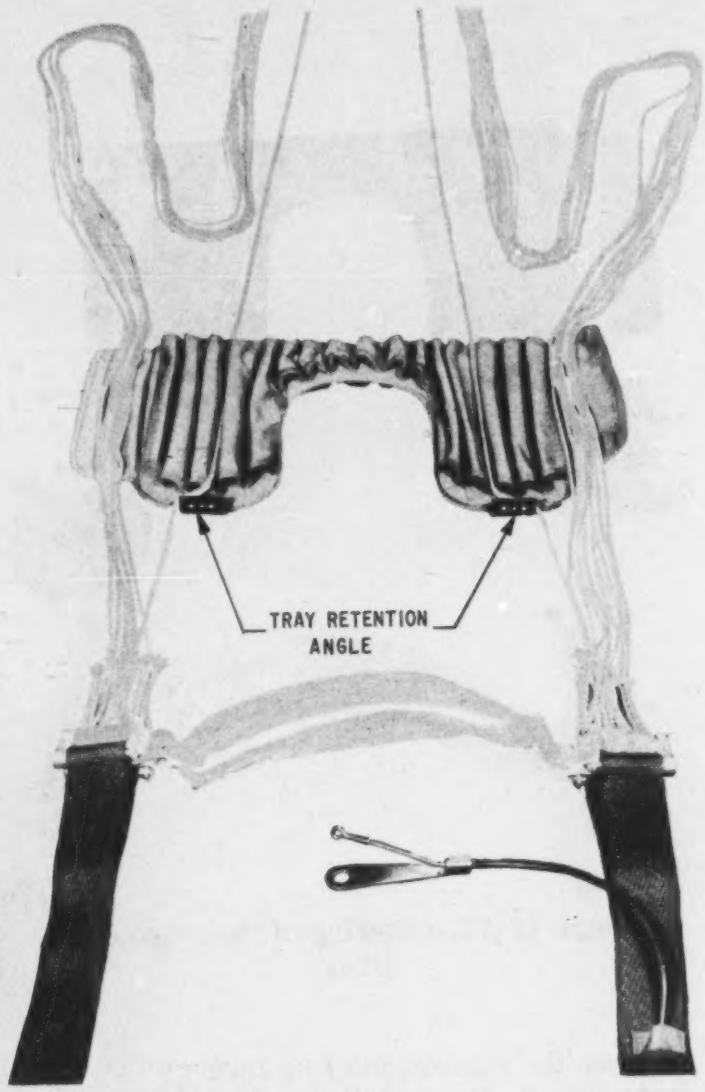

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Figure 19-12.—Antisquid lines and suspension lines positioning.

Place the pilot parachute kickplate on top of the canopy peak and withdrawal line and S-fold the pilot parachute connector cord over the kickplate. Tuck the pilot parachute cloth under the pilot parachute crown and place the pilot parachute over the folded connector cord. The withdrawal line must exit from the rear of the helper's end flap.

Remove the temporary locking pin on the helper's side and pull the end flap over the compressed pilot parachute. Route the withdrawal line out the rear of the container, remove the grommet side flap from the locking cone, and place the grommet on the end flap over the locking cone. Replace the side flap grommet over the locking cone. Place the end tab over the locking cone and reinsert the temporary locking pin.

Remove the pilot parachute temporary locking pin and insert the riser protector flaps, using a packing fid.

Insert the ripcord anchor plate through the webbing loop on the end flap. The manual ripcord cable must pass over the loop. The helper must hold the end tab over the locking cone on the withdrawal line end of the container and the packer must remove the temporary locking pin. The packer must position the anchor plate over the locking cone and insert the temporary locking pin.

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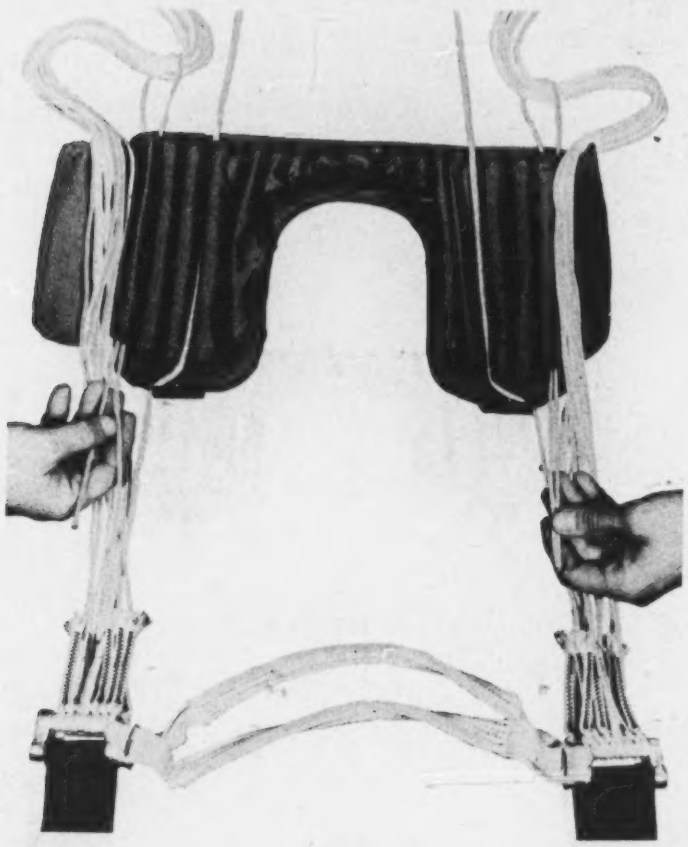

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Figure 19-13.—Stowing of the suspension lines.

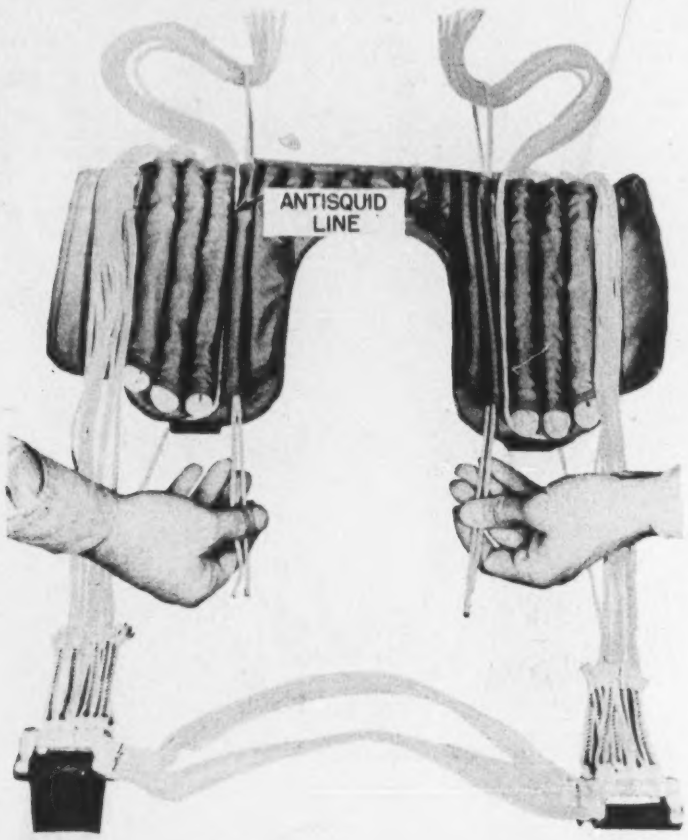

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Figure 19-14.—Stowing the antisquid and suspension lines.

Route the ripcord pin line through the alinement ring on the end flap. Insert the curved ripcord pin through the eye on the end of the manual ripcord cable. The helper must insert the curved ripcord pin in the locking cone nearest the anchor plate as the packer removes the temporary locking pin. Insert the straight ripcord pin into the second locking cone in the same manner.

Safety-tie the straight ripcord pin using size A nylon thread, unwaxed. Secure the pin by tying 3 to 4 half-hitches around the ripcord cable.

The curved pin must pass through the eye of the ripcord cable. The locking ring is installed on the locking cone and the locking pin must be inserted through the locking cone. The locking lanyard and ripcord pin line must pass through the alinement ring.

Route the locking lanyard through the alinement ring, place the locking ring over the locking cone, and insert the locking pin into the locking cone. Safety-tie the locking pin by passing a length of unwaxed size A nylon thread, single, under the end of the pin and through the loop formed by the end of the pin. Tie the ends with a surgeon's knot followed by a square knot. (See fig. 19-22.)

Close the ripcord protector flap, remove the container from the stand, and attach four container spring opening bands (two on each end of the container). Crimp the hook at the container end to the eyelet. Do not crimp the flat end hook. Position the risers on top of the container and mate the hook and pile tape patches.

Fill out and sign the parachute record card and parachute history card. Insert the GND/AIR emergency code form and parachute record card into the packing data card pocket located on the ripcord pin protector flap.

NOTE: Collateral duty inspection is a mandatory requirement in parachute packing and rigging procedures. As each phase is completed, all work must stop until a collateral duty inspector has performed the inspection.

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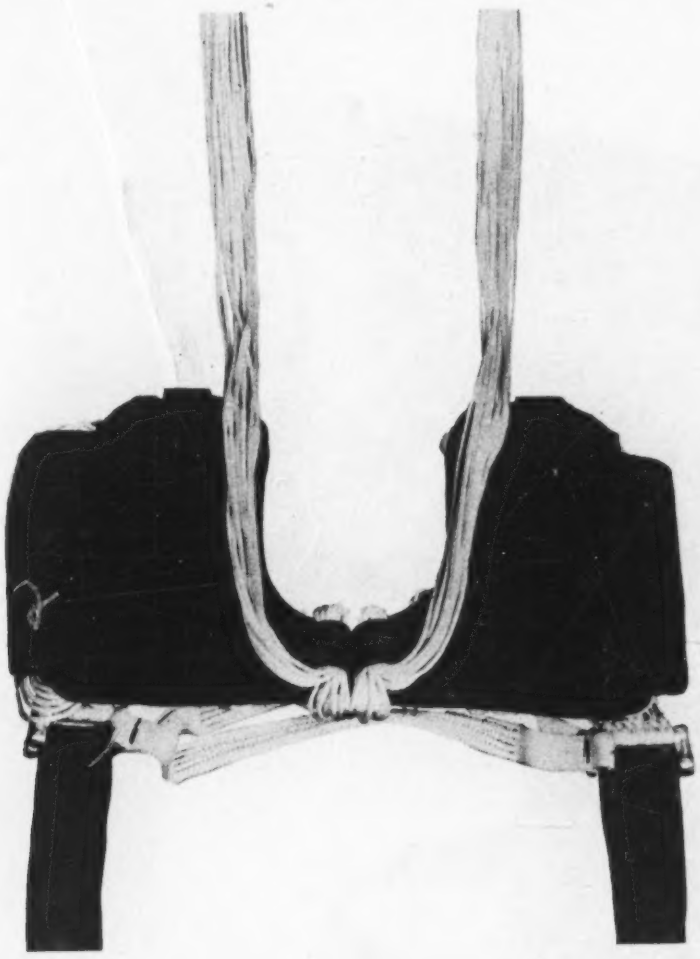

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Figure 19-15.—Suspension and antisquid line stowage on reverse side of tray.

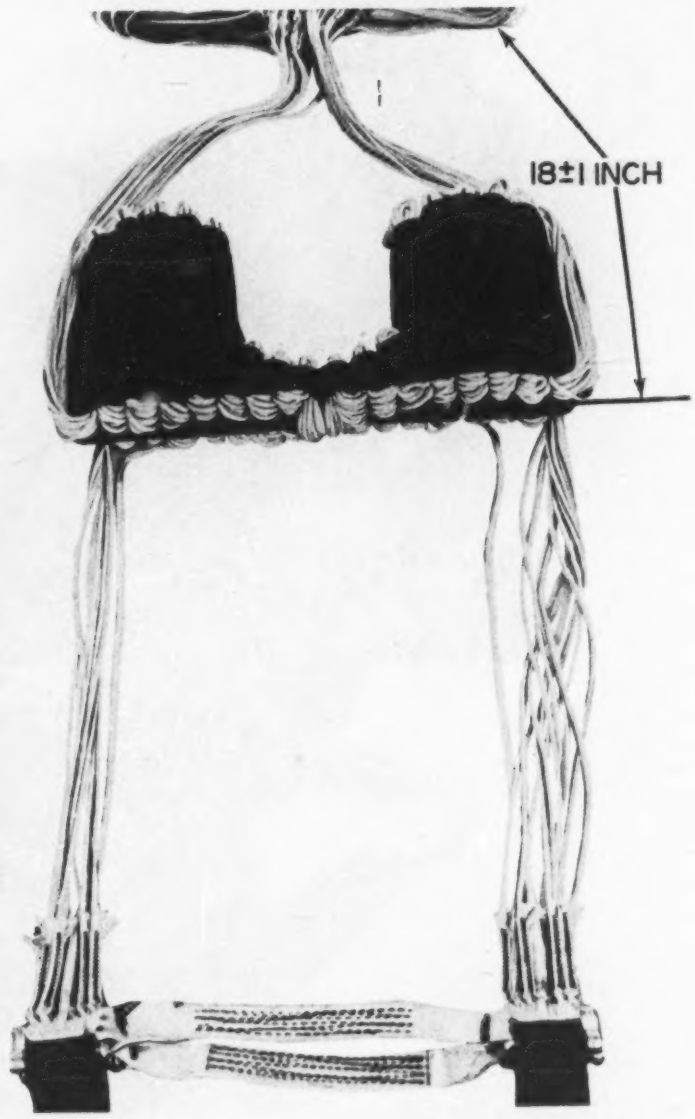

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Figure 19-16.—Suspension line stowage completed.

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Figure 19-17.—Attaching the stowage tray and container retention straps.

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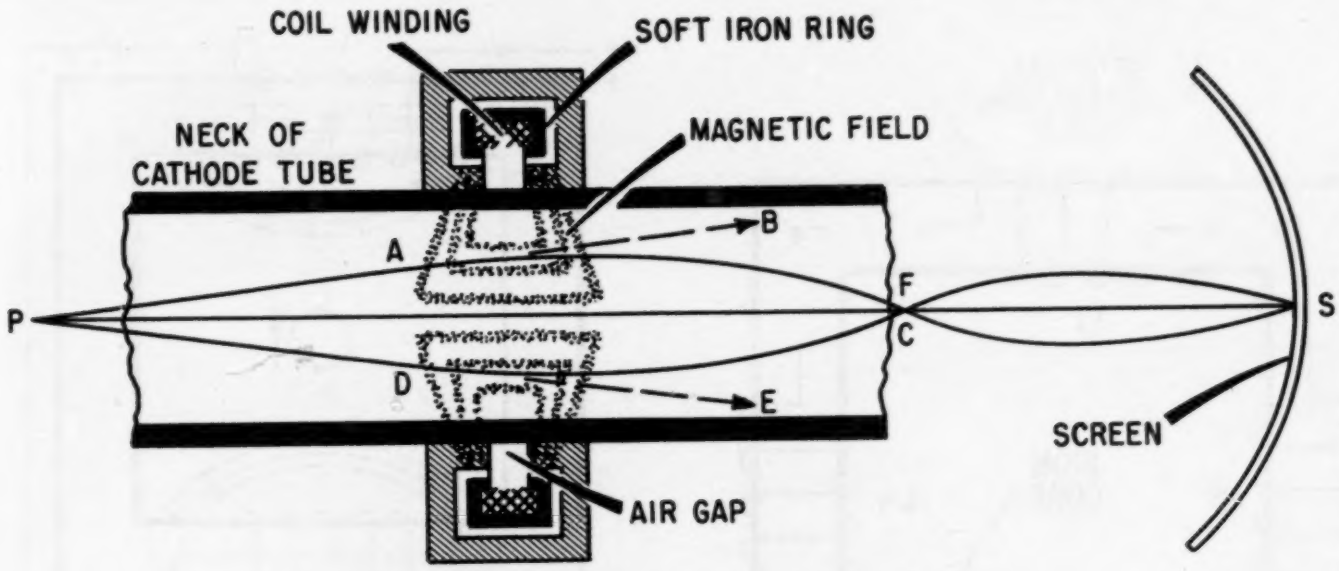

Figure 17-6. —Electromagnetic focusing.

than one direction at one time, which would effectively result in a spiral path of travel by the electrons, as illustrated in figure 17-7. If you could look down on the face of the scope and see the paths of the electrons you would see spirals such as these. Spiral (A) is the path of an electron that entered the magnetic field at a greater angle than in spiral (B). However, it travels faster and they both reach point S at the same time. In order to focus the beam, it is only necessary to adjust the strength of the magnetic field so that the common point S falls on the fluorescent screen.

Although we have considered using only electromagnets for focusing, a permanent magnet can perform the function equally as well. Some CRT indicators utilize permanent magnet focusing devices. The permanent magnet encircles the neck of the CRT in a manner similar to the focusing coil. Focusing of the electron beam is accomplished by moving the magnet along the axis of the tube until the beam of electrons is sufficiently concentrated at the face. Another means of adjusting the focus of an electron beam with a permanent magnet would require the use of a shunt. The shunt would be adjusted to increase or decrease the concentration of magnetic flux in the neck of the CRT.

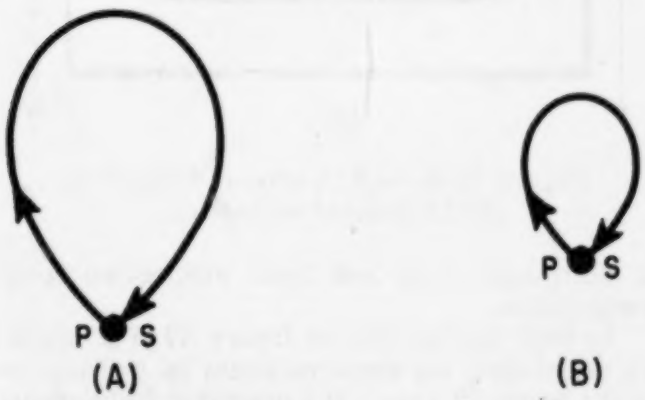

Figure 17-7. —End view of the paths of the electrons.

Electromagnetic deflection is sometimes more desirable and offers some advantages over electrostatic deflection. One big advantage is that tube construction is simpler since there are no deflection plates within the tube. Another advantage is that high amplitude deflection voltages are not required since it is a current operated device.

To understand electromagnetic deflection of an electron beam in a CRT, it is essential that the Aviation Electronics Technician understand the properties and characteristics of current carrying conductors, their magnetic fields, and the interaction between two or more magnetic fields.

The electromagnetic deflection method most commonly used employs the stationary deflection yoke. A schematic of the yoke is shown in figure 17-8.

As illustrated, the deflection yoke consists mainly of an iron core and two sets of deflection coils mounted at right angles to each other.

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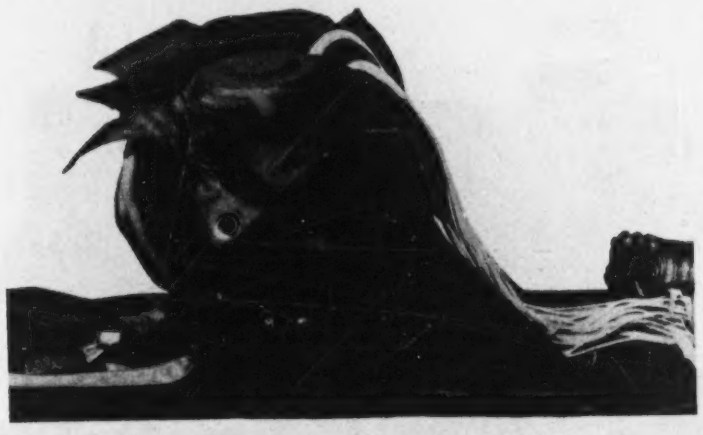

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Figure 19-18.—Container placed in a container stand.

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Figure 19-19.—Mating the hook and pile patches.

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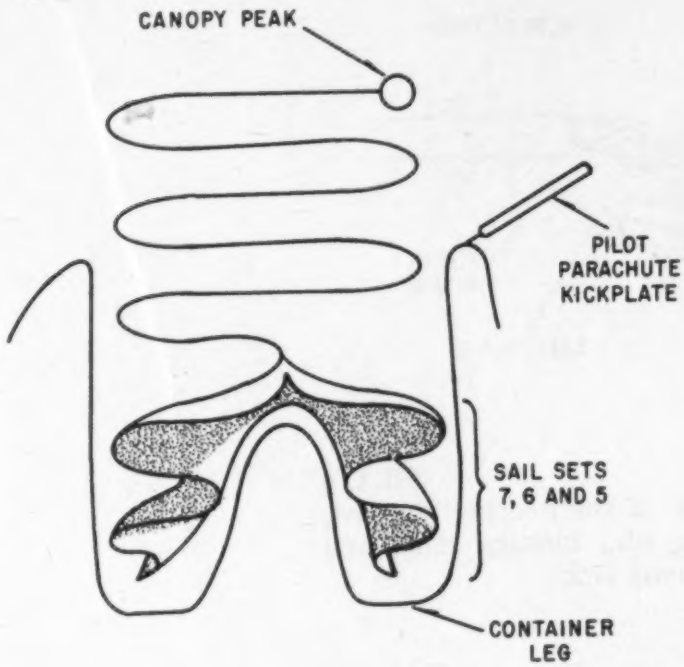

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Figure 19-20.—Position of accordion folded canopy.

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Figure 19-21.—Closing of the side closure flap.

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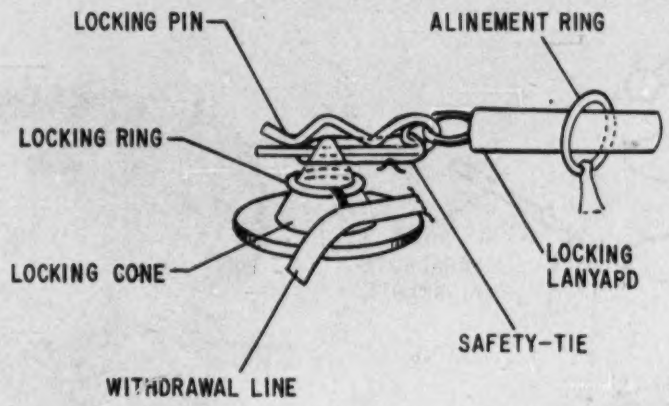

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Figure 19-22.—Position of the locking lanyard, alinement ring, locking pin, locking ring, and withdrawal line.

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CHAPTER 20

NES-8B PERSONNEL PARACHUTE ASSEMBLY

The NES-8B parachute assembly includes a multicolored, 28-foot diameter, flat, circular nylon canopy with 28 gores and a pilot parachute. The canopy is packed in a hardshell horseshoe type container for installation in an ejection seat. The NES-8B is used with an integrated torso suit harness which combines the aircrewman's parachute harness and lap and shoulder restraint straps. The harness is channeled through the torso suit to retain it in position and to facilitate donning.

When aboard the aircraft and seated, the aircrewman connects the quick-release fittings on the parachute riser assembly to the quick-release shoulder fittings on the integrated torso suit. The survival kit is also connected to the integrated torso suit by means of quick-release fittings.

The NES-8B parachute assembly is shown in figure 20-1.

OPERATION

After ejection, the ejection seat drogue gun fires a piston which deploys a controller drogue parachute. The controller drogue parachute, in turn, deploys the stabilizer drogue parachute. The stabilizer drogue parachute remains attached to the seat by a scissor shackle.

The scissor shackle is released at a preset altitude by the operation of the time release mechanism, and the aircrewman separates from the seat during this operation. When the stabilizer drogue parachute releases from the seat, it pulls the withdrawal line assembly from the container assembly. As the withdrawal line reaches full stretch, the ripcord locking pins are removed from the locking cones, permitting the grommets, locking cones, and end tabs to disengage. The container spring opening bands pull the end and side flaps apart, allowing the pilot chute to spring from the container and fill with air.

Should the ejection seat time release mechanism fail to operate, the aircrewman can manually disengage himself from the seat by pulling the emergency harness release handle. In this case the guillotine assembly will cut the withdrawal line securing the drogue parachutes to the pilot chute. The aircrewman must then push himself clear of the seat and pull the manual ripcord handle, deploying the pilot parachute which deploys the canopy.

The aircrewman falling away from the pilot parachute and drogue parachute causes the canopy to be pulled from the container assembly, followed by the suspension lines. The canopy starts to fill with air during this operation.

As load is applied, the riser fasteners are released and the lift webs are then pulled from the container assembly.

The connector link ties break and the canopy fully opens. The aircrewman hangs suspended

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Figure 20-1.—NES-8B parachute assembly.

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in his harness from the quick-release shoulder fittings during descent.

Upon landing, the aircrewman can disengage the canopy and suspension lines from the integrated torso suit harness by using the quick-release shoulder fittings.

NOTE: The pulldown vent lines may break during high speed openings.

MODIFICATIONS AND UPDATING

The NES-8B personnel parachute assembly must be modified and updated when required by comparing the configuration of the assembly with applicable directives and NavAir 13-1-6.2.

Compliance with modifications to the NES-8B parachute assembly must be performed by intermediate or depot levels of maintenance. All modifications must have the information recorded on the parachute history card and other records in accordance with NavAir Instruction 4700.2.

RIGGING AND PACKING THE NES-8B PARACHUTE

Lay out the canopy assembly full length on a clean packing table. Locate the canopy gore containing the nameplate and position it uppermost in the center of the packing table. Separate the suspension lines into two equal groups, counting 14 suspension lines on each side of the nameplate gore. The vent lines must be equally divided on each side of the nameplate gore.

The two groups, of 14 suspension lines each, are arranged as shown in figure 20-2. The numbers in figure 20-2 illustrate the location and orientation of the suspension lines as attached to the skirt hem and the connector links.

Place the connector link holding suspension lines 1 through 7 on top of the connector link holding suspension lines 8 through 14. Place the connector link holding suspension lines 22 through 28 on top of the connector link holding suspension lines 15 through 21. Connect these two groups of connector links to their respective tension hooks on the packing table.

NOTE: Insure that the knurled portions of the connector link yoke and plate assemblies face up and the screwheads face outboard.

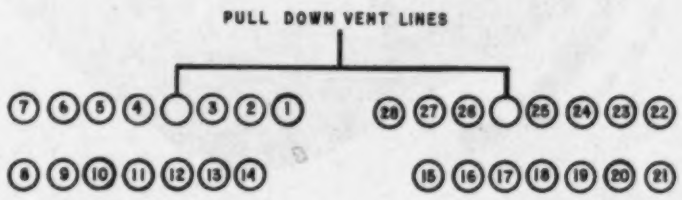

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Figure 20-2.—Suspension line continuity.

SUSPENSION LINE CONTINUITY CHECK

Attach the tension strap to the canopy vent lines and tighten. When viewed from the riser end of the packing table, the suspension lines must be arranged on the skirt hem and the connector links in accordance with figure 20-2. They must run from the skirt hem of the canopy to the connector links without dips or twists.

NOTE: On other than original issue parachutes, the pulldown vent (PDV) lines, risers, and the cross connector straps will be already attached to the connector links.

The packer, starting with suspension line 1 on the left side of the nameplate gore, must work through line number 14. The helper must be positioned at the connector links to check the suspension lines selected by the packer for continuity, dips, and twists. The same procedure is used on the right side of the nameplate gore, except that the packer will start with suspension line 28 and work through line number 15. If attached, the PDV lines are connected at the top connector links between lines 3 and 4 and lines 25 and 26, as applicable. They must run under the top suspension lines to the type III cord without twisting around any suspension line.

WHIPPING AND FOLDING THE CANOPY GORES

NOTE: During the rigging and packing procedures, the packer is positioned on the left side of the packing table and the helper is on the right when facing the canopy from the harness/riser end of the packing table.

Insure that the tension strap is tightened at the canopy peak. The packer and helper must lift the suspension line on each side of the nameplate gore up and out. The skirt hem between lines should be held taut so that the canopy peak can be seen from the inside. While holding the suspension lines up, each man whips the gore hanging from the suspension line outward

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to prepare the canopy for folding. (See fig. 20-3.)

Draw the next suspension line upward to the suspension line held in the hand, using a rapid, circular motion as shown in figure 20-4.

Continue whipping and folding the remaining gores. Move the gores rapidly back and forth across the packing table, insuring that no radial seams are overlapped by any gores.

The two groups of suspension lines must be stretched to the edges of the packing table with the folded gores hanging over the sides. The packer and helper must grasp all the folds at the outer edges on the skirt hem and hold the suspension line groups at the edges of the packing table. The packer and helper should simultaneously move the folds up and down rapidly, in a whipping motion, to eliminate any wrinkles.

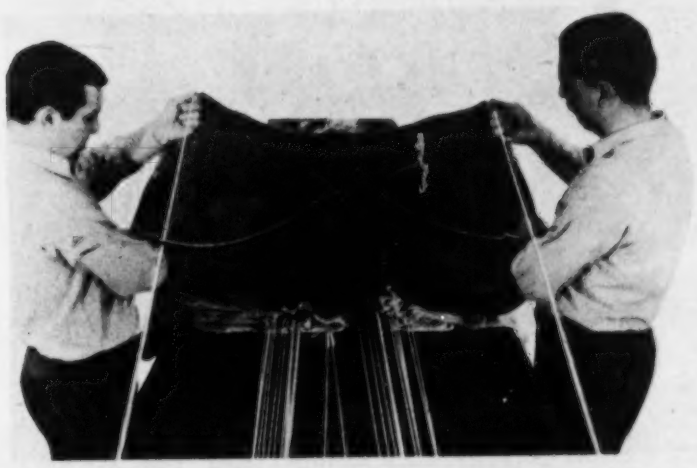

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Figure 20-3.—Whipping a canopy gore.

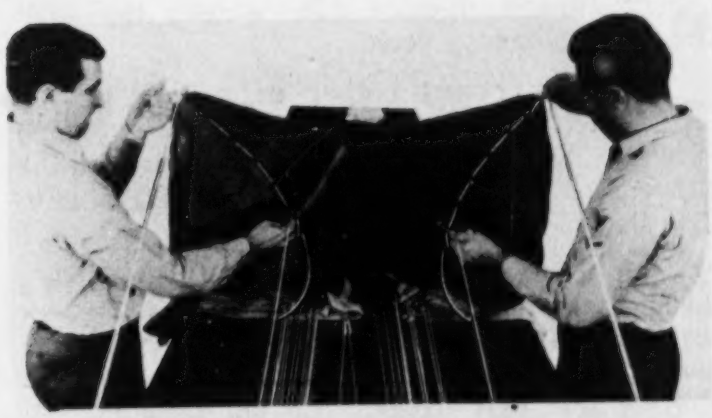

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Figure 20-4.—Folding a canopy gore.

The packer flaps the top gore up and down at the skirt hem center as the helper holds the bottom gore at the skirt hem center. On signal, both men must draw their respective gores, at the skirt hem centers, toward the table edge, while at the same time bringing the suspension line groups to the center of the packing table.

The suspension line groups are inserted into their respective slots in the suspension line separator and a shot bag is placed on the lines. The packer places a second shot bag across the skirt hem on the left side of the suspension lines, and the PDV lines are routed underneath the suspension line separator.

The helper now rotates all gores as a group, except the bottom gore, from the right over to the left side of the packing table. The helper must straighten and smooth the bottom gore on the right side of the packing table throughout its length to the peak. The packer returns the folded gores above the shot bag to the right side of the packing table and the helper straightens and smooths the top gore and places the bag on the skirt hem.

The packer must rotate all gores as a group, except the bottom gore, from left over to the right side of the packing table. The packer straightens and smooths the bottom gore on the left side of the packing table throughout its length to the peak. The helper returns all folded gores above the shot bag to the left side of the packing table and the packer straightens and smooths the top gore.

The packer and helper grasp the skirt hem at midsections of the gores and rotate towards the suspension lines. Each fold must be alined and counted when placed back onto the packing table.

The skirt hem must be made neat by having all "V" tab reinforcements alined in the same direction on top of each other. Each group of folds on the left and right of suspension lines must contain 14 gores.

The packer and helper grasp the skirt hem and folded gores and S-fold the canopy towards the center. Butt the S-folds together. The canopy cannot be S-folded throughout its entire length, but will break at a point approximately two-thirds of the distance to the peak, as shown in figure 20-5.

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Figure 20-5.—Canopy S-folded.

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Figure 20-6.—Drawing the canopy down the table.

SUSPENSION LINE STOWAGE

Remove the tension strap from the canopy peak but not from the PDV line tension cord.

The helper must grasp only the suspension lines, not the PDV lines, 14 1/2 feet from the connector links and spread each group to the edge of the packing table. (See fig. 20-6.)

While the helper holds the suspension lines at the edges of the table, the packer draws the canopy down the center of the packing table, between the suspension lines, to a point where the suspension lines between the helper's hands and the skirt hem become taut. At this point the PDV lines will protrude through the vent hem. If the PDV lines do not appear at the vent hem, the packer must pull the canopy further down the packing table until they do.

Position the stowage tray under the suspension lines 5 inches from the connector links, with the retention angles turned upward as shown in figure 20-7.

Remove the type III nylon cord from the angles turned upward and remove the PDV lines at the canopy peak.

The packer and helper must each pass a length of stowage aid line through the outboard stowage channels and form the first bight in the suspension lines. Do not stow the PDV lines. (See fig. 20-8.)

The packer and helper must draw bights through the outboard channels to the edge of the stowage tray. Continue stowing the suspension lines to the center of the tray, excluding the PDV lines. Do not stow the two center stowage tray channels. (See fig. 20-9.)

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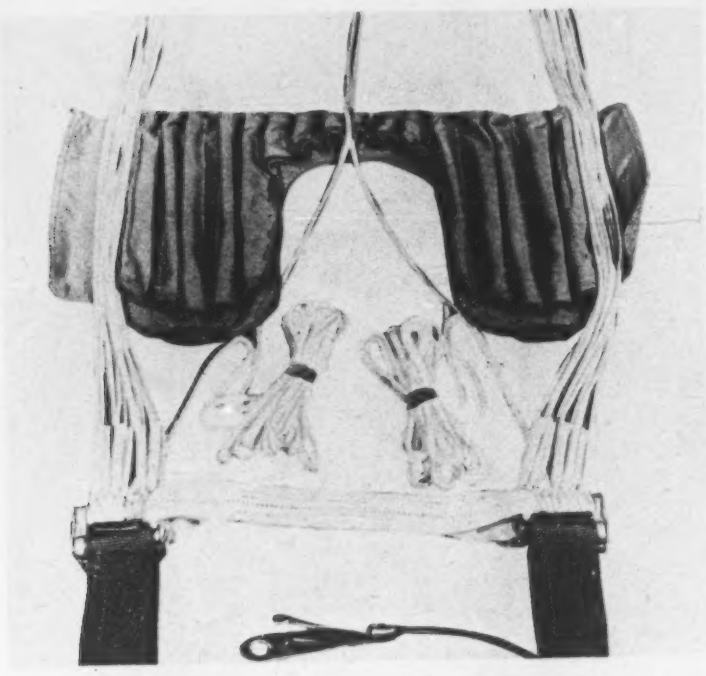

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Figure 20-7.—Stowage tray positioning.

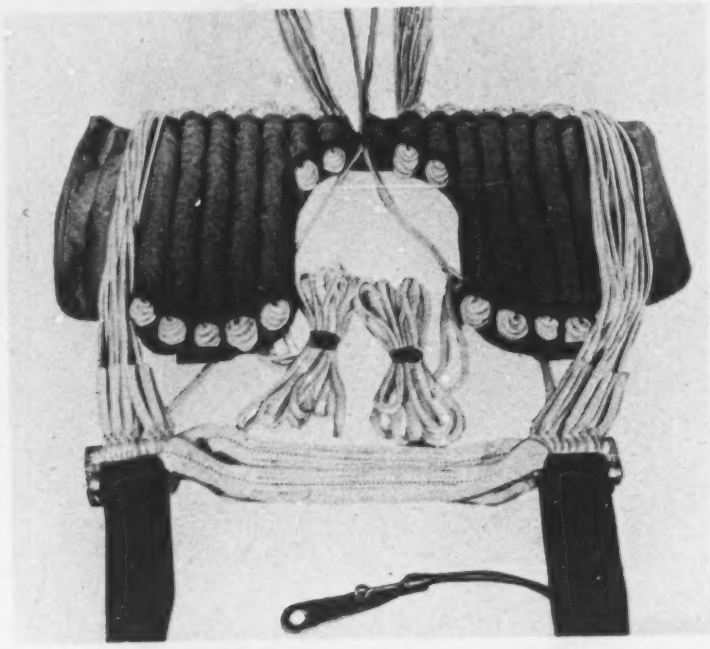

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Figure 20-9.—Suspension lines stowed to tray center.

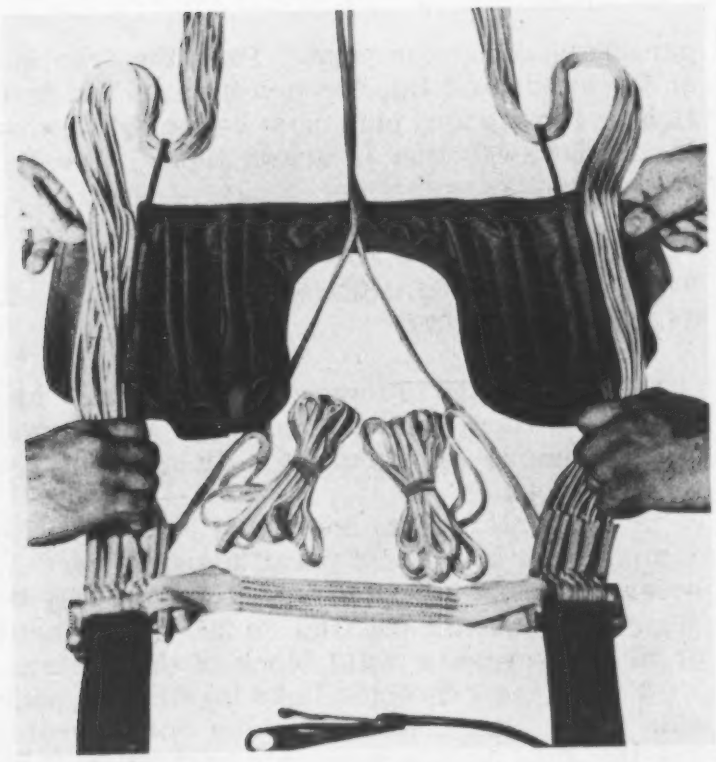

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Figure 20-8.—Forming the first bight of suspension lines.

Turn the stowage tray toward the canopy so that the retention angles face down, as shown in figure 20-10.

Begin stowing the suspension lines in the number six stowage channels, counting from the outboard edges of the tray. Do not stow the PDV lines. (See fig. 20-11.)

Continue stowing suspension lines to the outboard edges of the tray. Begin stowing the PDV lines in the third stowage channels from the outboard edges of the stowage tray, as shown in figure 20-12.

When the stowage channels are filled, there should be approximately 18 inches of line between the stowage tray and the canopy skirt hem. (See fig. 20-13.)

ATTACHMENT OF PILOT PARACHUTE CONNECTOR CORD, WITHDRAWAL LINE, AND PULLDOWN VENT LINES

Pass the pilot parachute connector cord around the vent lines and through the loops in the ends of the PDV lines. Pass the pilot parachute through the loop in the ends of the connector cord and draw tight. Pass the loop end of the withdrawal line around the vent lines and through the PDV lines to the left of the pilot

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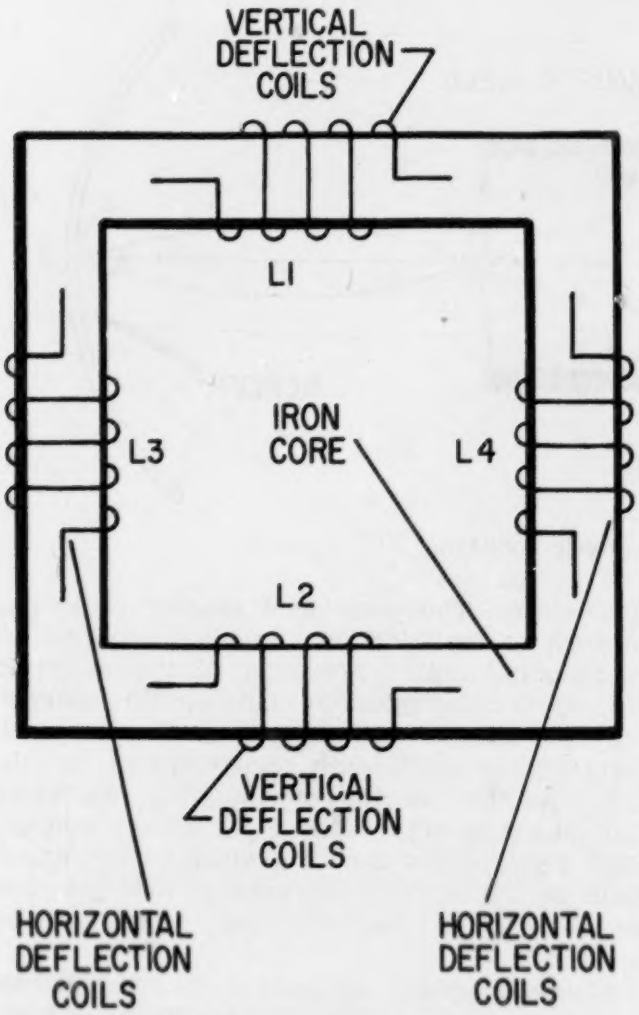

Figure 17-8. —Basic illustration of a stationary deflection yoke.

One set provides vertical deflection of the electron beam and the other horizontal deflection. Each coil is composed of many turns of wire, and the coils of each set are connected so that the magnetic fields set up by each pair of coils travel in the same direction and parallel across the neck of the CRT.

The two coils of each set are wound in series opposition to each other on the iron core. Thus, since the flux produced by each is in opposition (within the iron core), the only way in which the lines of force can form closed loops is by crossing the neck of the CRT. By using two sets of coils in this manner, two magnetic fields can be set up across the neck of the CRT which are at right angles to each other. Figure 17-9 is an illustration of the two sets

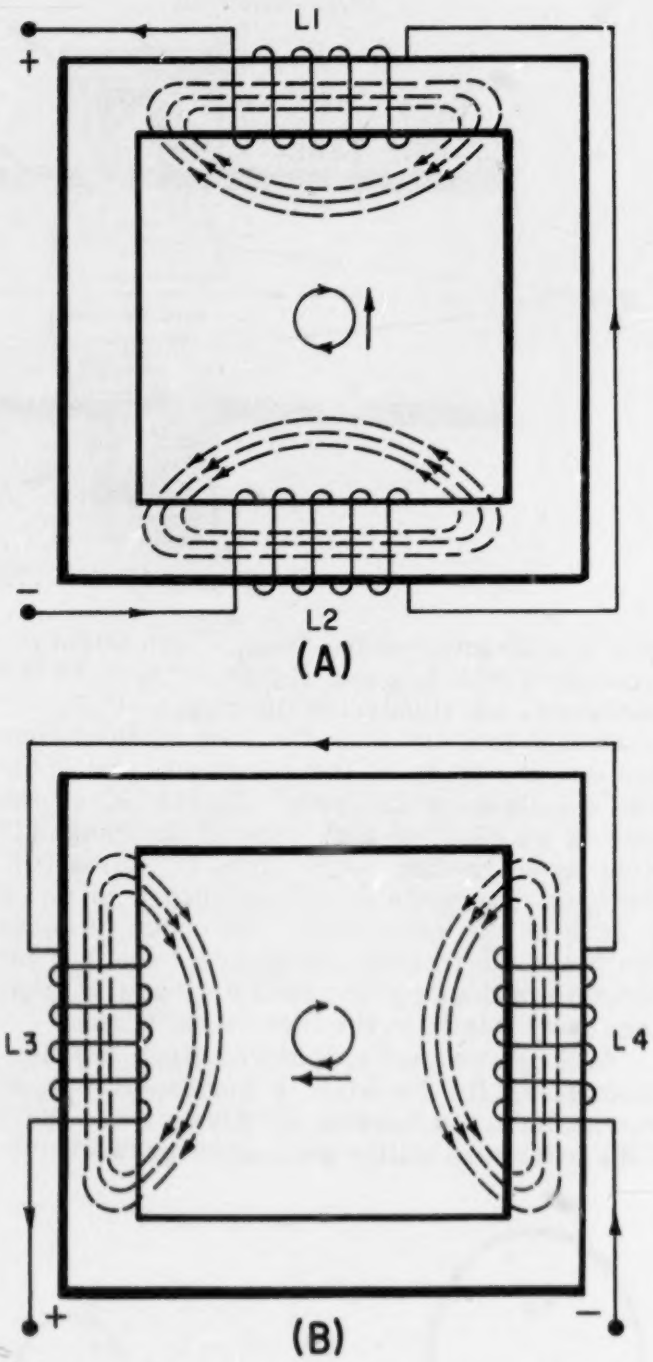

Figure 17-9. —(A) Vertical deflection; (B) horizontal deflection.

of deflection coils and their respective magnetic fields.

In both (A) and (B) of figure 17-9 it should be noted that the electron beam is coming out of the paper. Thus, the magnetic field around the beam is moving clockwise. As shown in (A) of figure 17-9, the magnetic flux set up

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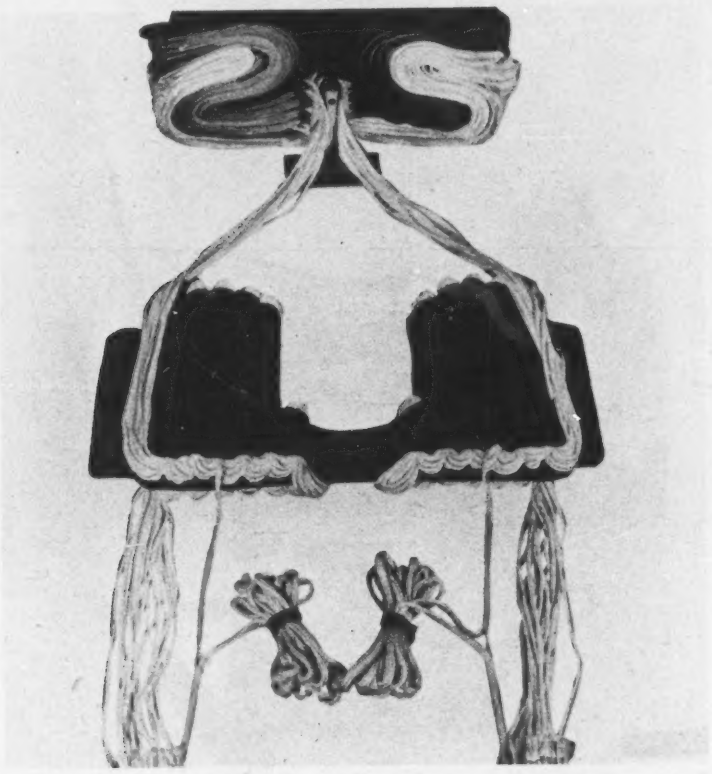

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Figure 20-13.—Stowage tray filled.

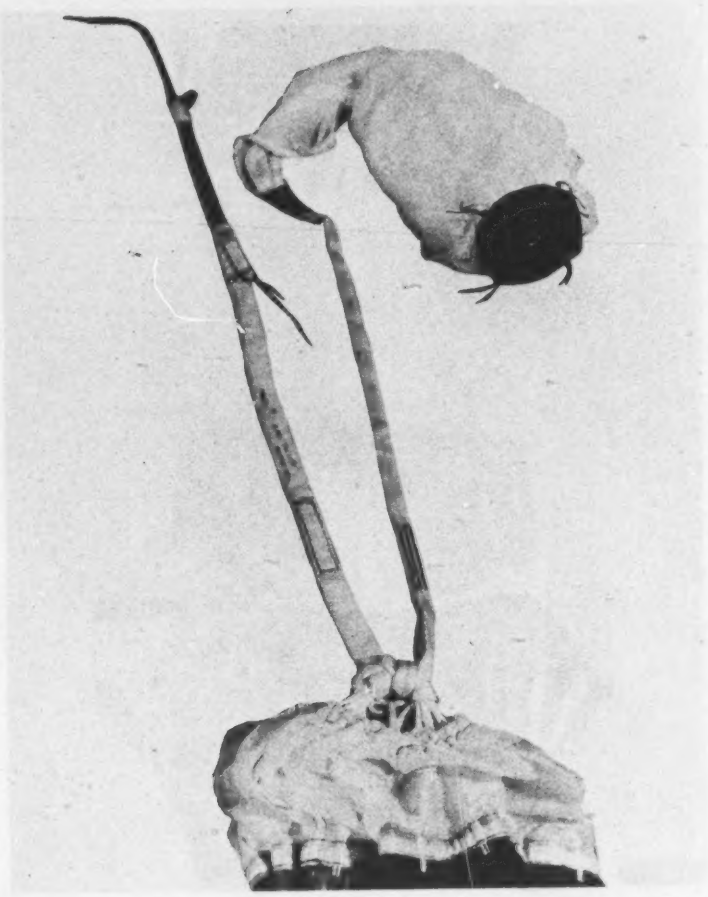

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Figure 20-14.—Attachment of pilot parachute connector cord, withdrawal line, and pulldown vent lines.

angles face up and the rounded end of the tray is turned away from the canopy. Position the container on the table with the open end facing the tray and the side flap containing the ripcord protector flap facing the packing table, as shown in figure 20-15.

4. Slide the container toward the canopy, inserting the stowage tray into the container. Do not move the tray toward the container. Insure that the suspension lines do not become trapped under the tray retaining angles. The pilot parachute kickplate must not be wedged between the stowage tray and container.

5. Aline the threaded holes in the stowage tray retaining angles with the holes in the bottom of the container legs. Aline the brackets on the container retention straps above the holes in the bottom of the container legs. Insert screws through the washers and retention strap brackets and the holes in the container legs. Thread the screws into the retaining angles and tighten. Insure that the retention strap bracket is turned upward. (See fig. 20-16.)

6. Place the container in the container stand. Attach the hook, tape patches on the risers to the pile tape patches on the inside of the container. Stow the line between the connector links and stowage tray in the bottom of the container legs. Stow the line between the stowage tray and canopy skirt hem behind the stowage tray, as shown in figure 20-17.

CANOPY STOWAGE

To stow the parachute canopy in the container, proceed as follows:

1. Remove the shot bag from the skirt hem.

2. Spread the suspension line groups approximately 6 inches and fold the skirt hem under 4 inches. Place the folded skirt hem on top of the container. Press the folded skirt hem firmly down into respective legs of the container. (See fig. 20-18.)

3. Accordion-fold all but approximately 6 feet of the canopy into the container. Separately

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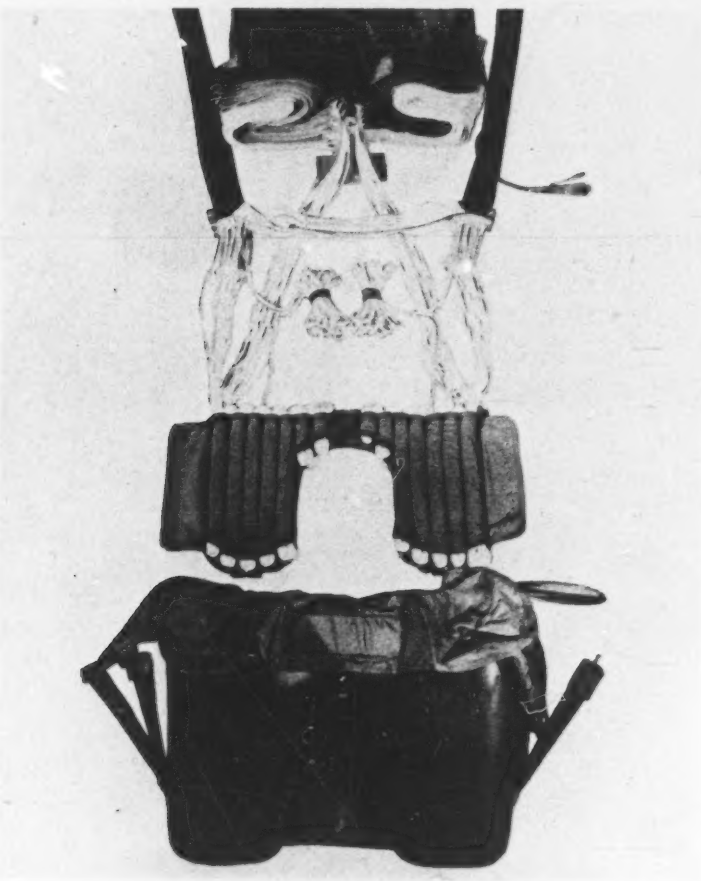

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Figure 20-15.—Positioning stowage tray and container.

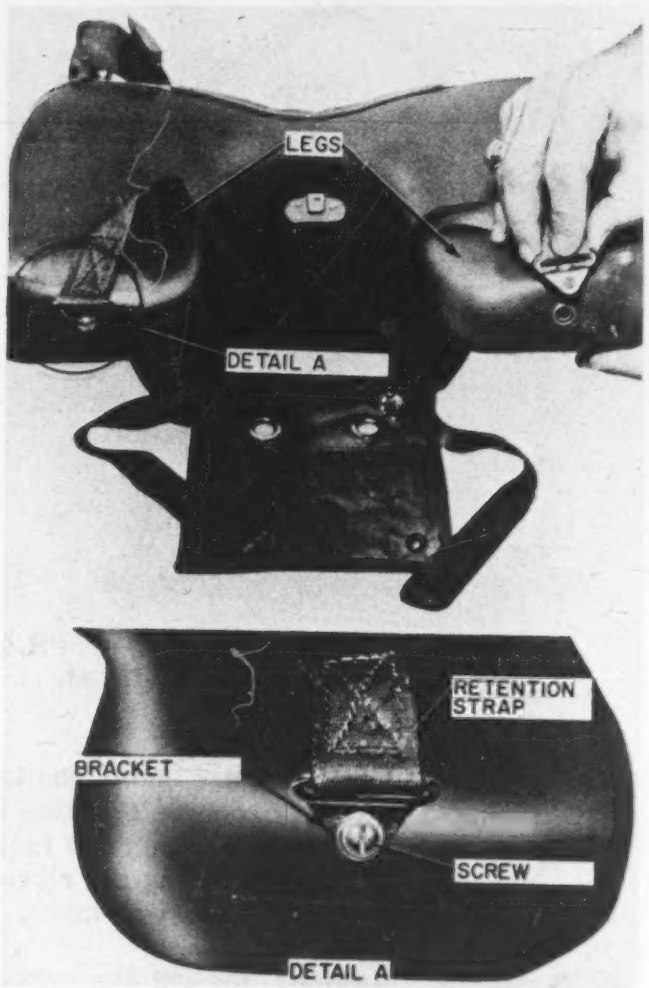

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Figure 20-16.—Alinement of stowage tray and container legs.

press each accordion fold firmly into the legs of the container. Accordion-fold the remainder of the canopy on the packing table, starting with the first fold on the packer's side and ending with the canopy peak on the kickplate side of the container. The accordion folds must extend 3 inches over the side of the container.

4. Position the accordion-folded canopy on top of the container. Insure that the canopy peak is positioned at the kickplate side of the container. Route the withdrawal line to the rear center of the container and back toward the pack. The ripcord pins must face up.

CLOSING THE CONTAINER

Pull the side flap with the locking cones over the top of the folded canopy. Pull the side flap with the grommets over the top side flap containing the locking cones and place the grommets over the locking cones. Insert the temporary locking pins into the locking cones from the proper direction.

Remove the temporary locking pin located on the packer's side and place the grommet on the end flap over the locking cone, between the side flaps.

Place the side flap grommet back over the locking cone and place the metal end tab over the grommet and locking cone. Reinsert the temporary locking pin.

Insert the guide tube through the grommet in the crown of the pilot parachute and place it

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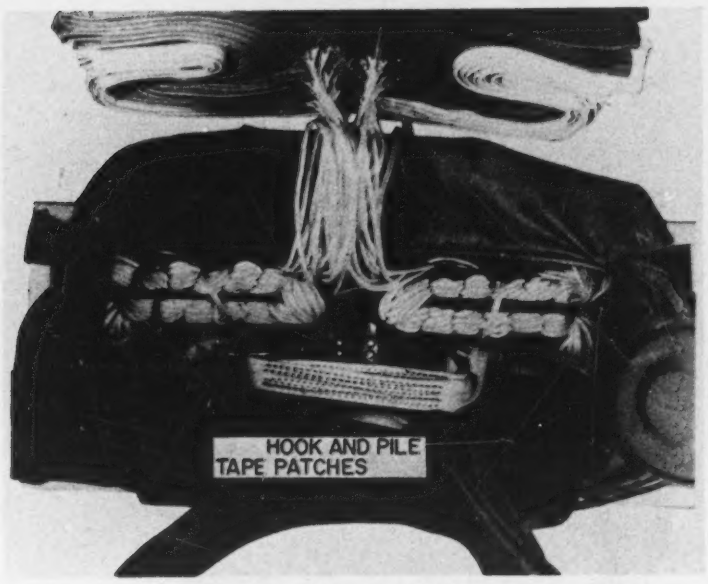

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Figure 20-17.—Suspension line stowage completed.

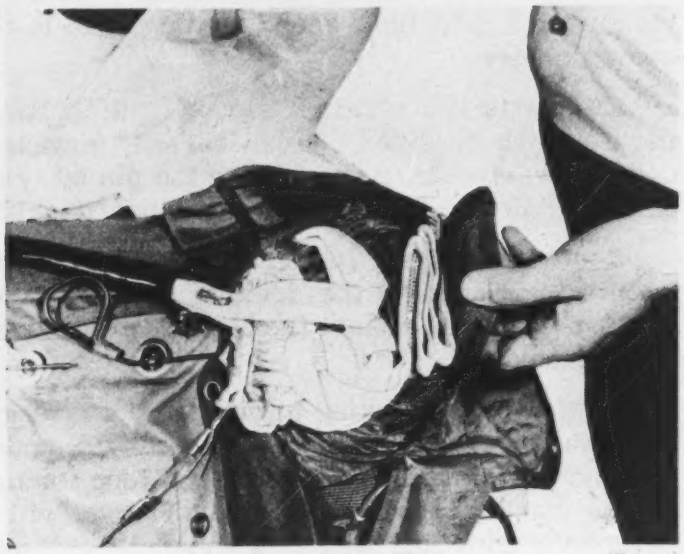

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Figure 20-19.—Positioning of the connector cord.

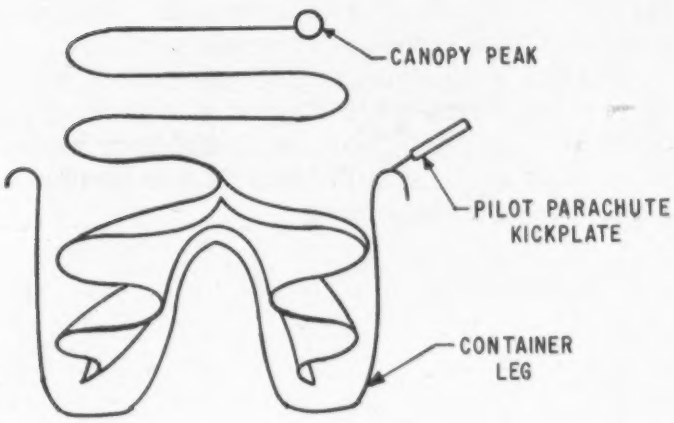

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Figure 20-18.—Stowage of canopy.

over the locking cone on the spring baseplate. Compress the pilot parachute fully, remove the guide tube, and insert the pilot parachute temporary locking pin into the locking cone hole.

S-fold the pilot parachute connector cord under the kickplate on the helper's side. The connector must exit from the rear of the kickplate. Fold the excess withdrawal line, if any, under the kickplate, as shown in figure 20-19.

Place the pilot parachute kickplate on top of the canopy peak. Tuck the pilot parachute cloth under the pilot parachute crown and place the pilot parachute on top of the kickplate. The withdrawal line must exit from the rear of the helper's end flap.

Remove the temporary locking pin on the helper's side and pull the end flap over the compressed pilot chute. Route the withdrawal line out the rear of the container. Remove the grommet side flap from the locking cone and place the grommet over the locking cone. Place the end tab over the locking cone and reinsert the temporary locking pin. Insert the riser protective flaps into the container using a packing fid.

Insert the ripcord anchor plate through the webbing loop on the end flap. The manual ripcord cable must pass over the loop. The helper holds the end tab over the locking cone on the withdrawal line end of the container and the packer removes the temporary locking pin. The packer will position the anchor plate over the locking cone and insert the temporary locking pin; removal of the pilot parachute temporary locking pin can now be made.

Route the ripcord pin line through the alinement ring on the end flap. Insert the curved ripcord pin through the eye on the end of the manual ripcord cable. The helper must insert

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a curved ripcord pin into the locking cone containing the anchor plate as the packer removes the temporary locking pin. Insert a straight ripcord pin into the second locking cone in the same manner.

Safety-tie the straight ripcord pin by looping a length of size A nylon thread, unwaxed, under the ripcord pin. Secure the pin by tying 3 or 4 half-hitches around the ripcord cable.

Route the locking lanyard through the alinement ring. Place the locking ring over the locking cone and insert the locking pin into the locking cone.

Safety-tie the locking pin by passing a length of unwaxed size A nylon thread, single, under the end of the pin and through the loop formed at the back of the pin. Tie the ends with a surgeon's knot followed by a square knot. (See fig. 19-22.)

For an illustration of proper closure of the parachute assembly container, see figure 20-20.

Close the ripcord protector flap, remove the container from the stand, and attach the four container spring opening bands (two on each end of the container).

Crimp the hook at the container end to the eyelet. Do not crimp the flap end hook. Position the risers on top of the container and mate the hook and pile tape patches.

Fill out and sign the parachute history card and the parachute record card. Insert GND/AIR emergency code form, and the parachute record card, into the packing data card pocket located on the ripcord pin protector flap.

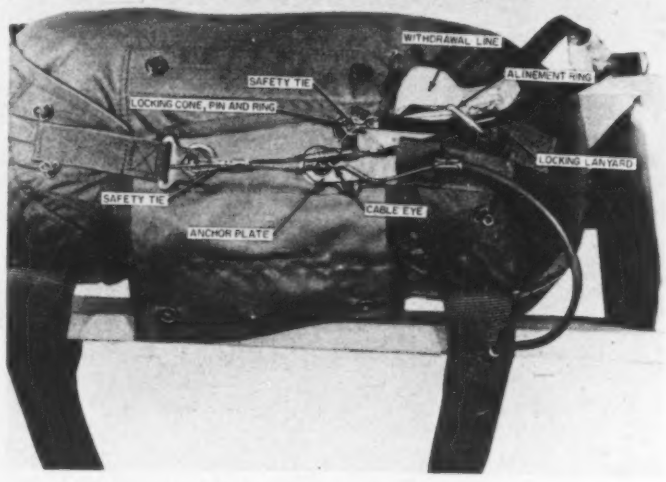

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Figure 20-20.—Proper closure of container.

NOTE: Collateral duty inspection is a mandatory requirement in rigging and packing procedures. As each phase is completed, all work must stop until a collateral duty inspector has performed the inspection.

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by L_1 covers the upper half of the tube's neck and is in opposition to the flux around the electron beam. The magnetic flux covering the lower half of the tube's neck is established by the current flowing through L_2 and is traveling in the same direction as the lines of force around the electron beam; thus they are aiding or reinforcing the flux in the lower half. The flux's resultant force on the electron beam is in an upward direction; thus, the beam will be deflected in an upward direction. Therefore, it can be seen that an electron moving perpendicular to a magnetic field is deflected at right angles to its path and to the field.

If the direction of current flow through the windings L_1 and L_2 is reversed, the direction of the flux set up by each will also be in the opposite direction. With the magnetic flux around the beam unchanged, the resultant force acting on the electron beam will also be in the opposite direction. Therefore, the electron beam will be deflected in a downward direction.

The speed at which the electron beam will be deflected across the screen of the CRT will be dependent upon the rate of change of current flow in the windings. The maximum distance that the electron beam will be deflected will be dependent upon the amount of magnetic flux established by the coils.

Part (B) of figure 17-9 is an illustration of a set of coils similar to the coils illustrated in part (A) except that they are oriented to deflect the beam in the horizontal plane. Deflection of the electron beam is accomplished by coils L_3 and L_4 in a manner similar to the deflection in the vertical plane by coils L_1 and L_2. As illustrated, the electron beam is deflected to the left; but if the current through the coils is reversed in direction, the beam will be deflected in the opposite direction across the screen of the CRT.

Thus far the vertical and horizontal deflection coils have been discussed separately. However, if they were wound on the same iron core and energized simultaneously, the electron beam could be deflected in directions other than in the vertical and horizontal plane. The operation of the stationary electromagnetic yoke is based on this principle.

Figure 17-10 is used to further illustrate the operation of the deflection coils and how the electron beam can be deflected in various directions. The electron beam is coming out of the paper and the amplitude of the current through each coil is the same for each illustration in figure 17-10.

When current flow through L_1, L_2, L_3, and L_4 is as shown in figure 17-10 (A), the beam will be deflected in the direction indicated. The direction of the movement is the result of the vertical and horizontal forces acting on the electron beam which is illustrated by broken lines. Since each of the forces is equal, the resultant force is 45° from or halfway between the two.

If current continues to flow in the same diration in L_1 and L_2 but is reversed in the horizontal coils L_3 and L_4, the effect will be as shown in (B) of figure 17-10.

With the current continuing to flow in the same direction through L_3 and L_4 but reversed in L_1 and L_2, the deflection of the electron beam will be in the direction as illustrated in (C) of figure 17-10. Reversing the current through L_3 and L_4 again, but leaving L_1 and L_2 unchanged, will cause the electron beam deflection to advance another 90° around the screen of the CRT. (See fig. 17-10 (D).)

In summary, it should be recalled that current flow in the vertical deflection coils produced either an upward or a downward deflection of the electron beam, depending on the direction of current flow. The same was true of the left or right deflection produced by current in the horizontal deflection coils. When the current flow through the two sets of deflection coils was equal, the deflection of the electron beam was 45° from the vertical and horizontal planes. However, the quadrant in which the beam was deflected depended on the direction of current flow through the coils and not the amplitude.

It should be noted that as the current in each set of coils was reversed consecutively, one after the other, the trace produced by the electron beam advanced around the screen of the CRT by an angular amount of 90°. However, to have one type of scope presentation (a PPI-type scan), the trace on the screen must appear to be continuously rotating about the center axis of the CRT. This can be accomplished by varying the amplitude of the deflection currents applied to each set of deflection coils at a sine-wave rate, but the amplitude variations in one pair of coils must be 90° out of phase with those in the other pair.

The synchro resolver, sometimes called a sweep resolver, is normally used in airborne radar equipment to provide currents of the

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ABSTRACT - To aid enlisted Navy men in preparing for advancement to Electrician's Mate 3 or 2, this training course was prepared by the Navy Training Publications Division. Chapters are: (1) Advancement, (2) The 3-M System, (3) Electrical Cables and Accessories, (4) Shipboard Lighting, (5) Searchlights, (6) Maintenance of Motors and Generators, (7) Batteries, (8) Protective Devices, (9) Control Devices, (10) Small Craft Electrical Systems, (11) Power Distribution, (12) Electric Auxiliaries, (13) Gyrocompasses, (14) Electric Propulsion, and (15) Records and Reports. A list of 33 training films is appended. (GB)

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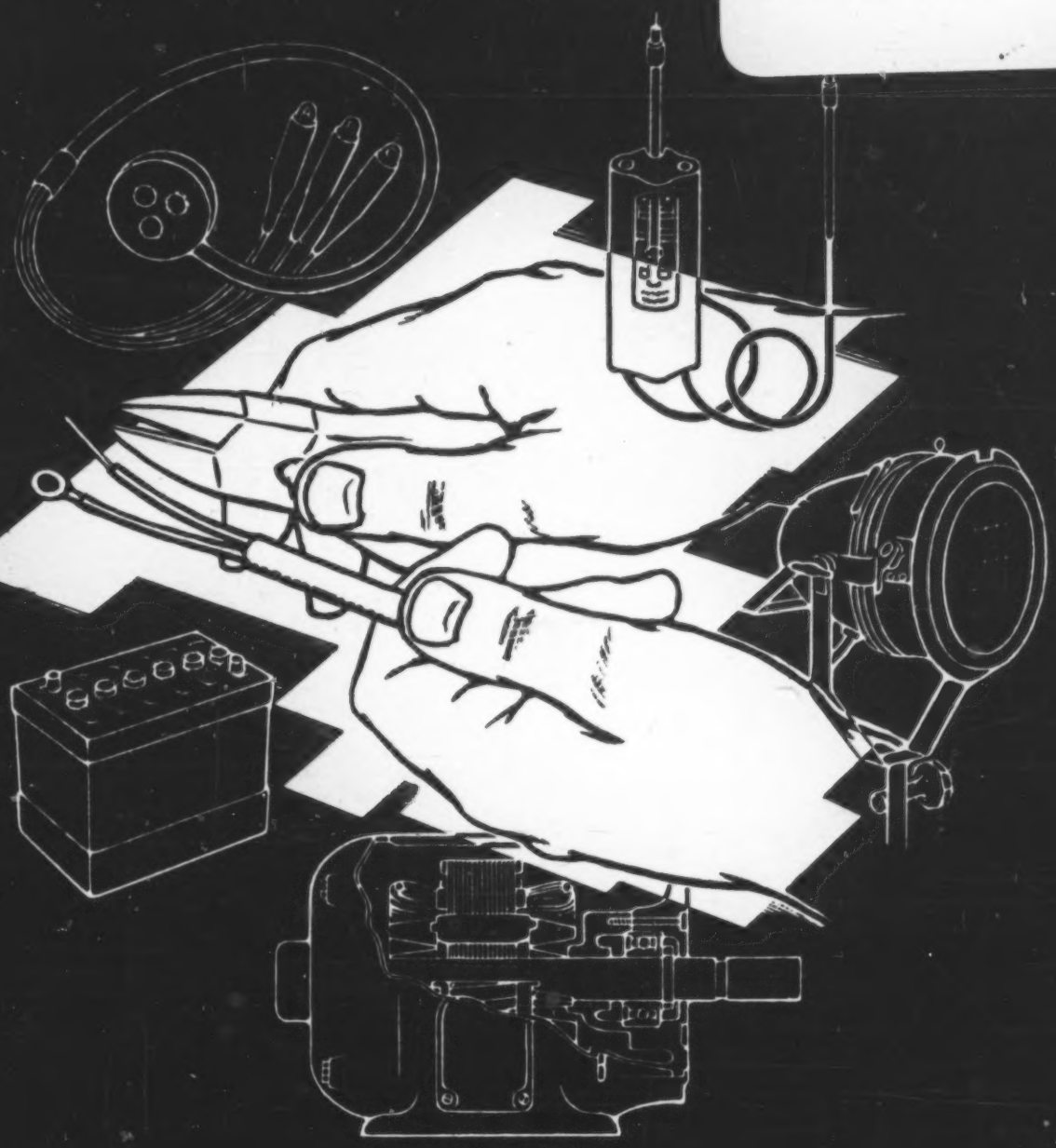

ELECTRICIAN'S MATE 3 & 2

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BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10546-B

PREFACE

This training course is written to aid enlisted men in the U. S. Navy and Navy Reserve in preparing for advancement to the rate of Electrician's Mate 3 or 2.

The subjects with which the striker or EM3 must be familiar before he can qualify for advancement to Electrician's Mate 3 or 2 are outlined in the Manual of Qualifications for Advancement in Rating. This training course contains information on each examination, and, insofar as practicable, information on each practical factor. Because examinations for advancement in rating are based on these qualifications, interested personnel should refer to them for guidance (the LATEST qualifications should always be consulted).

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

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The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

NAVY TRAINING COURSES

Basic Electricity, NavPers 10086-A
Basic Electronics (Chapters 1, 2 and 3), NavPers 10087-A
Basic Handtools (metal working skills only), NavPers 10085-A
Introduction to Electronics (chapters 1 thru 6), NavPers 10084
Standard First Aid, NavPers 10081-B
Mathematics Vol 1, NavPers 10069-C
Mathematics Vol 2, NavPers 10071-A

OTHER PUBLICATIONS

Naval Ships Technical Manual, (formerly Bureau of Ships Technical Manual), chapters 9450 (sections 1, 2, 3, and 4); 9600, 9610, 9621, 9622, 9630, 9640, 9660, 9810 (section 3); and 9880 (section 3 part 2).

USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Educational Services' Officer.* The following is a partial list of those courses applicable to your rate:

D290	Physics I
C781	Fundamentals of Electricity
C858	The Slide Rule
D435	Plane Trigonometry

*"Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI course, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified on the active duty order."

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CHAPTER 1

ADVANCEMENT

This training course is designed to aid you in preparing for advancement to EM 3 and EM 2. There are many requirements for advancement, and they will be discussed in this chapter. The professional (technical) requirements for advancement to EM3 and EM2 used as a guide in the preparation of this course are listed in group VII of the Manual of Qualifications for Advancement in Rating, NavPers 18068-B.

Chapter 2 of this course discusses the maintenance and material management (3-M) system. The 3-M system will be in use on all ships of the Navy. This chapter shows and explains the cards and forms you will be using in the 3-M system.

Chapter 3 of this training course describes the types, uses, and installation of shipboard electric cable and accessories. It includes the various tests and inspections necessary for the proper maintenance and repair of electric cables.

Chapter 4 explains the principles of light to familiarize the EM striker or EM 3 with the fundamentals and terminology of electric lighting. It describes the types of lamps and light fixtures used on naval vessels, and the practical methods of calculating illumination requirements. Lighting distribution systems are explained, including the maintenance of lighting installations and the safety precautions to be observed when working with this equipment.

Chapter 5 covers the types of Navy searchlights. It describes the construction, operation, and maintenance of these searchlights including the safety precautions involved.

Chapter 6 deals with the maintenance of motors and generators. It acquaints the Electrician's Mate with the preventive and corrective maintenance procedures used by the Navy to obtain optimum performance of these machines.

Chapter 7 presents the maintenance of batteries. It describes the types, characteristics, and installation of dry batteries and storage batteries used in the Navy. The maintenance, troubles, and storage of batteries are presented in detail, including the safety precautions to be observed when working with batteries.

Chapter 8 covers the protective devices used in electrical circuits and equipment. It includes a description of the construction and function of the various types of fuses, switches, relays, and circuit breakers. A description is also given of troubleshooting single-phase and three-phase circuits.

Chapter 9 presents control devices, which include rheostats, electric brakes, and contactors. It includes a description of the construction, operation, and maintenance of these devices. Also included is an analysis of circuit diagrams of d-c and a-c motor starters.

Electrical systems in small craft are discussed in chapter 10. This discussion includes the engine starting systems of diesel powered boats and a description of the lighting systems. This chapter also briefly covers the ignition systems of gasoline engines.

Chapter 11 covers the electric power distribution systems installed in naval vessels including the methods of interconnecting the various switchboards and the operation of automatic bus transfer equipment. It describes cross-plant (parallel) and split-plant operation and operation under casualty conditions.

Chapter 12 describes electric auxiliaries, which includes degaussing installations, anchor windlass, electric elevators, electrohydraulic steering gear, and electric galley equipment.

Chapter 13 discusses gyrocompasses and chapter 14 discusses a-c and d-c electric propulsion installations.

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Chapter 15 discusses engineering records and technical publications that concern the Electrician's Mate.

The remainder of this chapter contains information that will help you in preparing for advancement. Study this chapter carefully before beginning intensive study of the remainder of this training course.

THE ENLISTED RATING STRUCTURE

The two main types of ratings in the present enlisted rating structure are general ratings and service ratings.

GENERAL RATINGS identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

SERVICE RATINGS identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

THE ELECTRICIAN'S MATE RATING

Almost every operation aboard ship, routine or emergency, requires electric power for its accomplishment. A ship that has lost electric power has lost her capability as a fighting unit. As a member of the EM group, E division, engineering department, you will be directly concerned with the operation and maintenance of the equipment used to generate and distribute electric power. You will also be concerned with the maintenance and repair of the many lighting and power circuits and equipments throughout the ship.

The EM rating is a general rating only. Electrician's Mates are included in the personnel allowance for practically all Navy ships, including repair ships and tenders. Classification codes for the ratings are listed in group VII of the Manual of Navy Enlisted Classifications, NavPers 15105. Included are classification codes for jobs that require special training such as harbor defense electrician, minesweeping electrician, motion picture projection equipment repairman, ranging and deperming (degaussing) electrician, and gyrocompass electrician.

The Electrician's Mate must have a good working knowledge of the basic principles of electricity and mathematics. If you are lacking in these areas, the courses listed in the front of this training course will be helpful. You will gain the necessary practical experience for advancement through performance of your daily duties. Increasing your technical knowledge, however, will require some reading and studying in your spare time.

Upon advancement to EM 3 you will be graded on your leadership and supervisory ability as well as your ability to perform your technical duties. Study the leadership principles and techniques discussed in Military Requirements for Petty Officers 3 & 2. Additional material concerning leadership for petty officers is available to you as a result of the Navy leadership program. As you study the material containing leadership traits, keep in mind that probably none of our most successful leaders possessed all of these traits to a maximum degree, but a weakness in some traits was more than compensated for by strength in others. Critical self-evaluation will enable you to identify the traits in which you are strong, as well as those in which you are weak. Leadership principles can be taught, but a good leader becomes a good leader only through hard work and practice. Your success as a leader will be judged for the most part by how well you inspire others to learn and perform, and by personal example.

ADVANCEMENT IN RATING

Some of the rewards of advancement in rating are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

But the advantages of advancing in rating are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating, you increase your value to the Navy in many ways. You become more experienced in military leadership and better trained as a specialist in your own rating. Therefore, you become more valuable as an experienced Petty Officer, who can train others, and thus make far-reaching contributions to the entire Navy.

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HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement in rating? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and occupational training courses.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1. In some cases the Record of Practical Factors may contain the old form number, NavPers 760, until stocks are exhausted.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Demonstrate your KNOWLEDGE by passing a written examination on (a) military requirements and (b) occupational qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your division officer or training officer to be sure that you know the most recent requirements.

Advancement in rating is not automatic. After you have met all the requirements, you are ELIGIBLE for advancement. You will actually be advanced in rating only if you meet all the requirements (including making a high enough score on the written examination) and if the quotas for your rating permit your advancement.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement in rating? You must study the qualifications for advancement, work on the practical factors, study the required Navy Training Courses, and study other material that is required for advancement in your rating. To prepare for advancement, you will need to be familiar with (1) the Quals Manual, (2) the Record of Practical Factors, NavPers 1414/1, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052, and (4) applicable Navy Training Courses. The following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

The Quals Manual

The Manual of Qualifications for Advancement in Rating, NavPers 18068B (with changes), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals Manual," and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) occupational qualifications.

MILITARY REQUIREMENTS apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

OCCUPATIONAL QUALIFICATIONS are requirements that are directly related to the work of each rating.

Both the military requirements and the occupational qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

You are required to pass a Navy-wide military/leadership examination for E-4 or E-5, as appropriate, before participating in the occupational examinations. The military/leadership examinations for both levels are given quarterly. Candidates are requried to pass the applicable military/leadership examination only once. Each of these examinations consists of 100 questions based on Military Standards contained in the Quals Manual and information contained in the Publications listed under Military Requirement in Training Publications for Advancement in Rating, NavPers 10052.

The Navy-wide occupational examinations for pay grades E-4 and E-5 will contain 150 questions related to occupational areas of the EM rating.

If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

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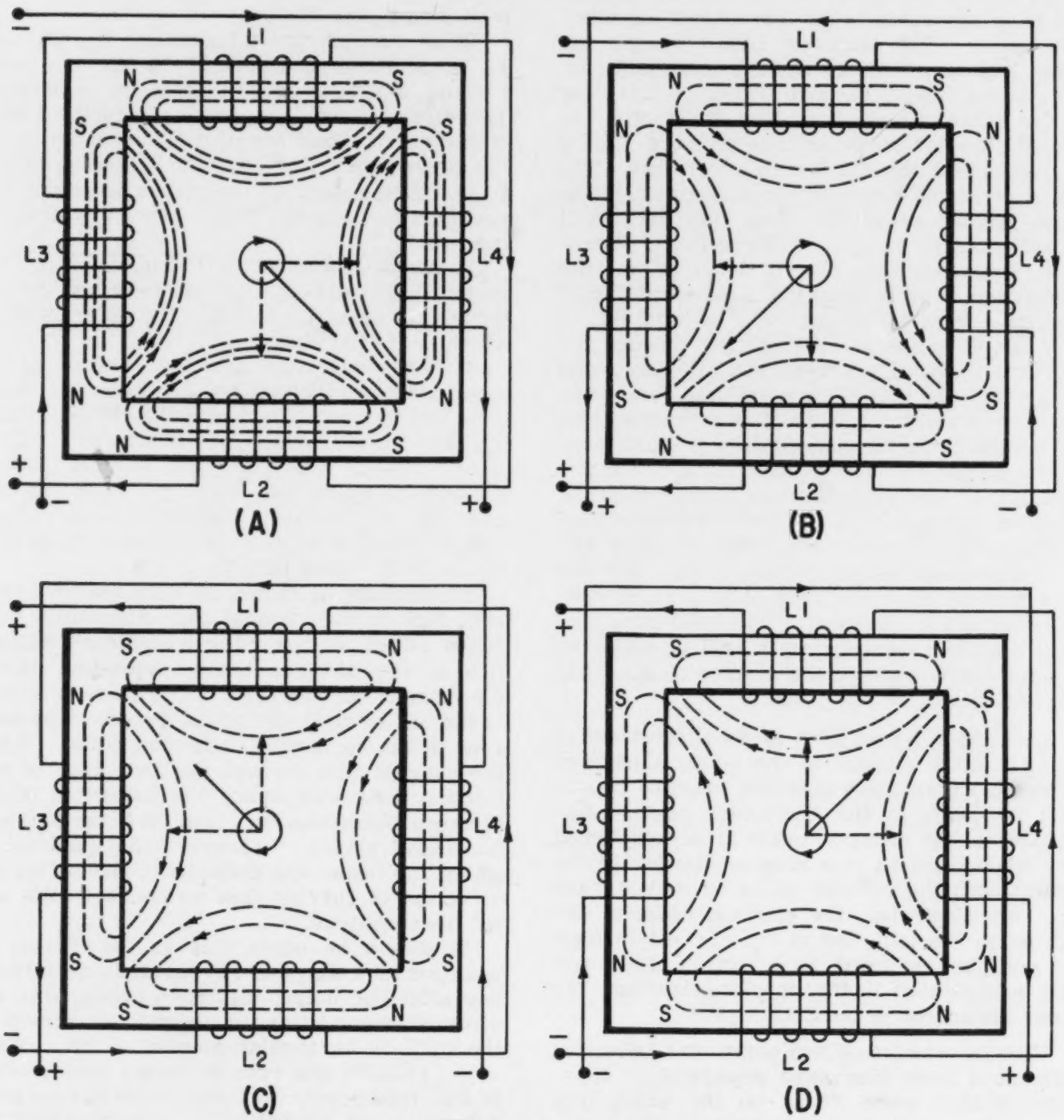

Figure 17-10. —Deflection yoke.

proper value and relationship to produce a rotating sweep.

Figure 17-11 is a schematic of a sweep resolver, the rotor of which is positioned in synchronism with the antenna. The sweep voltage from the sweep generator located in the synchronizer is applied to the rotor winding. The output amplitude and polarity from each of the stator windings will depend upon the relative position of the rotor.

If the antenna is pointing dead ahead at 0 degrees azimuth, the vertical deflection of the electron beam must be maximum upward and the azimuth deflection, zero. At 90° or 270° azimuth, the vertical deflection must be zero and the horizontal deflection maximum either

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	# E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3, AME 3, HM 3			Class B for AGC MUC, MNC.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
\# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

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Figure 1-1.—Active duty advancement requirements.

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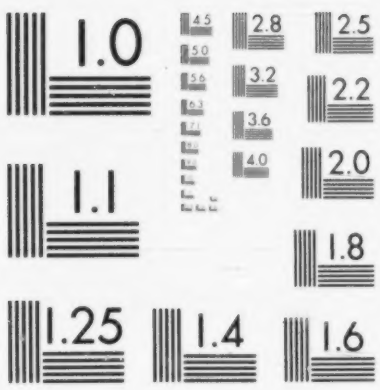

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam	Standard Exam or Rating Training.	Standard Exam required for all PO Advancements.		Standard Exam, Selection Board. Also pass Mil. Leadership Exam for E-4 and E-5.			
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center		Bureau of Naval Personnel			

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-2.—Inactive duty advancement requirements.

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The Quals Manual is kept current by means of changes. The occupational qualifications for your rating which are covered in this training course were current at the time the course was printed. By the time you are studying this course, however, the quals for your rating may have been changed. Never trust any set of quals until you have checked it against an UP-TO-DATE copy in the Quals Manual.

Record of Practical Factors

Before you can take the servicewide examination for advancement in rating, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the occupational qualifications. A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 1414/1 is used to keep a record of your practical factor qualifications. This form is available for each rating. The form lists all practical factors, both military and occupational. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement in Rating, and revised forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the Quals Manual. This Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 1414/1 form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

NavPers 10052

Training Publications for Advancement in Rating, NavPers 10052 (revised), is a very important publication for anyone preparing for advancement in rating. This bibliography lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052 for your rating.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Navy Training Courses are marked with an asterisk (*). Any course marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you can be eligible to take the servicewide examination for advancement in rating. Each mandatory course may be completed by (1) passing the appropriate enlisted correspondence course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the training course; or (3) in some cases, successfully completing an appropriate Class A course.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military requirements for advancement. Personnel of ALL ratings must complete the mandatory military requirements training course for the appropriate rate level before they can be eligible to advance in rating.

The references in NavPers 10052 which are recommended but not mandatory should also be

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studied carefully. ALL references listed in NavPers 10052 may be used as source material for the written examinations, at the appropriate rate levels.

Navy Training Courses

There are two general types of Navy Training Courses. RATING COURSES (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the professional qualifications of ONE rating. SUBJECT MATTER COURSES or BASIC COURSES give information that applies to more than one rating.

Navy Training Courses are revised from time to time to keep them up to date technically. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether any particular copy of a Navy Training Course is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists all current training courses and correspondence courses; you will find this catalog useful in planning your study program.)

Navy Training Courses are designed to help you prepare for advancement in rating. The following suggestions may help you to make the best use of this course and other Navy training publications when you are preparing for advancement in rating.

1. Study the military requirements and the occupational qualifications for your rating before you study the training course, and refer to the quals frequently as you study. Remember, you are studying the training course primarily in order to meet these quals.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training course intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training course in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the qualifications for advancement in rating?

5. When you have a general idea of what is in the training course and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training course, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Navy Training Courses or on other appropriate texts. As mentioned before, completion of a mandatory Navy Training Course can be accomplished by passing an Enlisted Correspondence Course based on the Navy Training Course. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master

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the information given in the training course, and also helps you see how much you have learned.

10. Think of your future as you study Navy Training Courses. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCES OF INFORMATION

Besides training courses, NavPers 10052 lists official publications on which you may be examined. You should not only study the sections required, but should become as familiar as possible with all publications you use.

One of the most useful things you can learn about a subject is how to find out more about it. No single publications can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional qualifications of your rating.

PUBLICATIONS YOU SHOULD KNOW

Some of the publications that you will need to study as you prepare for advancement have already been listed in the reading list at the front of this course. The publications listed with NavPers numbers are BuPers publications.

The Naval Ship Systems Command issues a number of publications that will also be helpful to you in studying for advancement.

The Naval Ships Technical Manual is the new title of the former BuShips Technical Manual and is referred to by the new title throughout this training course. This Manual is also undergoing revision which entails several new changes that are explained below. It may be some time before the revision is completed and you may encounter copies that are still titled BuShips Technical Manual but they are the same. The NavShips Technical Manual consists of three volumes as follows:

Volume 1, NavShips 0901-000-0010
Volume 2, NavShips 0901-000-0020
Volume 3, NavShips 0901-000-0030

The NavShips Technical Manual is kept up to date by means of quarterly changes.

In 1963, the Naval Ship Systems Command began to renumber individual chapters in the Manual according to the Navy - Marine Corps Standard Subject Classification System. Under this system, all chapters of the Manual will eventually be part of the 9000 series which identifies ship design and ship's material subject groups. When all chapters have been renumbered to conform to the 9000 series, the old chapter numbers will be eliminated. In the meantime, you will have to consult the cross-reference sheet in the front of the first volume of the Manual for the listing of both the old and new numbers of the various chapters. Some of the old and new numbers have the same positions in the manual while others have changed. For example, the old chapters 60, 61, 62, 63, and 64 are renumbered 9600, 9610, 9620, 9630 and 9640. However, some chapters will be both relocated and renumbered. For example the old chapter 40 will become 9005 and the old chapter 6 will be 9004. The chapters of the NavShips Technical Manual of particular importance to you as an EM are listed in chapter 15 of this training course (listing both the old and new chapter numbers).

The Naval Ship Systems Command Technical News (formerly Bureau of Ships Journal) is a monthly publication with useful articles on all aspects of shipboard engineering. This publication is particularly useful because it supplements and clarifies information contained in the NavShips Technical Manual and also presents information on new developments.

TRAINING FILMS

Training films available to naval personnel are a valuable source of supplementary information on many technical subjects. A selected list of training films that may be useful to you is given in appendix I of this training course. Other films that may be of interest are listed in the United States Navy Film Catalog, NAVWEPS 10-1-777. This catalog, published in 1966, supersedes three earlier publications: the former catalog with the same title but numbered NP 10000-A; the Supplement, NAVWEPS 10-1-772; and the Navy Classified Film Catalog, NP 10001-A.

When selecting a film, note its date of issue listed in the film catalog.

As you know, procedures sometimes change rapidly. Thus some films become obsolete rapidly. If a film is obsolete only in part, it

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may still have sections that are useful, but it is important to note procedures that have changed.

SAFETY PRECAUTIONS

After an accident has happened, investigation almost invariably shows that it could have been prevented by the exercise of simple safety precautions which are then posted for future guidance, but which never undo the consequences of the accident that has gone before. Always observe safety precautions and keep accidents from happening.

Always remember that:

1. Electricity strikes without warning.
2. Hurrying reduces caution and invites accidents.
3. Taking time to be careful saves time in the end.
4. Taking chances is an invitation to trouble.
5. If you do not know the safe way, it pays to find out before exposing yourself to danger.
6. Every electrical circuit, with but insignificant exceptions which definitely do not include circuits even as low as 35 volts and possibly even lower, is a potential source of danger and MUST BE TREATED AS SUCH.
7. Except in cases of emergency, never work on an energized circuit. It must be considered that the circuit is energized until a personal check has been made to see that the switch is opened and tagged, and the circuit has been tested with a voltmeter, or voltage tester.

Energized switchboards are a great source of danger. No work shall be undertaken on switchboards (energized or deenergized) without first obtaining the approval of the electrical or engineer officer. The Commanding Officer's approval shall be obtained prior to the commencement of work on an energized switchboard.

Records show that seven out of ten victims of electric shock were revived when artificial respiration was started in less than 3 minutes after the shock. After 3 minutes the chances of revival decrease rapidly.

All shipboard personnel should be made aware of the fact that a victim rendered unconscious by electric shock should receive artificial respiration, and that it should be started in a matter of seconds rather than minutes. To this end the person nearest the victim should start the resuscitation without delay and call or send others for assistance and medical aid. The only logical permissible delay is that required to free the man from his contact with the electricity in the quickest, safest way. This step, while it must be taken quickly, must be done with great care, otherwise there may be two victims instead of one. This should be done in the case of a portable electric tool, light, appliance, equipment, or portable outlet extension by turning off the bulkhead supply switch or by removing the plug from its bulkhead receptacle. If the switch or bulkhead receptacle cannot be quickly located, the suspected electric device may be pulled free of the victim by grasping the insulated flexible cable to the device and carefully withdrawing it clear of its contact with the victim. Other persons arriving on the scene must be clearly warned not to touch the suspected equipment until it is unplugged. Aid should be enlisted to unplug the device as soon as possible. Where the victim is in contact with stationary equipment such as a bus bar or the contacts on a machine, he should be pulled free if the equipment cannot be quickly deenergized, or if considerations of military operation or ship survival prevent immediate shutdown of the circuits. The man can be quickly and safely cleared from his contact with the electricity by carefully applying the following procedures.

To save time, the equivalent of protective insulation for the rescuer must be improvised. For example, instead of taking time to hunt for a pair of rubber gloves for use in grasping the victim, the victim can be safely pulled free if conditions are dry by grasping him by slack in his clothing or by the leather of his shoes. Instead of hunting for a rubber mat on which to stand, such nonconducting materials as deck linoleum, a pillow, blanket, mattress, dry wood, or coil of rope will suffice. In no case during the rescue should any part of the rescuer's person directly touch hull metal or metal structure of furniture.

Additional information on safety is to be found in "Electric Shock-Its Causes and Its Prevention," NAVSHIPS 250-660-42.

RESUSCITATION FOR ELECTRIC SHOCK

The following instructions on resuscitation were furnished by the Bureau of Medicine and Surgery.

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Artificial resuscitation after electric shock includes artificial respiration to reestablish breathing, and external heat massage to reestablish heart beat and blood circulation.

To aid a victim of electric shock after removing him from contact with the electricity, immediately apply mouth-to-mouth artificial respiration.

If there is no pulse, immediately apply heart massage also.

Don't waste precious seconds carrying the victim from a cramped, wet, or isolated location to a roomier, dryer, frequented location.

If desired, breathe into victims mouth through a cloth or a handkerchief placed over victim's face. If assistance is available, take turns breathing into victim and in massaging his heart. See figure 1-3, parts 1, 2, and 3.

Cardiac Arrest (Loss of Heart Beat)

If the subject has suffered an electric shock and has no heart beat he will have a cardiac arrest. This can be demonstrated by finding a complete absence of any pulse at the wrist or in the neck. Associated with this the pupils of the eyes will be very dilated, respiration will be weak or stopped. The subject may appear to be dead. Under these circumstances severe brain damage will occur in four minutes unless circulation is reestablished by cardiac massage.

Closed Chest Cardiac Massage

This method has been adopted as practical and can be learned by anyone who is properly instructed, and requires only two hands. The object in closed chest cardiac massage is to squeeze the heart through the chest wall thereby emptying it to create a peripheral pulse. This must be done about 60 times each minute.

DIRECTIONS:

Place subject on his back; a firm surface, such as the deck, is preferred. Expose subject's chest.

Kneel beside victim; feel for lower end of subject's sternum (breastbone); place one hand across breastbone so the heel of hand covers the lower part; place second hand on top of the first so that the fingers point toward neck as in figure 1-3 part 3.

With arms nearly straight, rock forward so that a controlled amount of your body weight is transmitted through your arms and hands to the breastbone. The amount of pressure to apply will vary with the subject. With an adult subject the chest wall should be depressed 2 to 3 inches with each pressure application.

Repeat application of pressure about 60 to 80 times per minute.

An assistant should be ventilating the subjects lungs preferably with pure oxygen under intermittent positive pressure; otherwise with mouth-to-mouth resuscitation. However, closed chest massage will cause some ventilation of the lungs. Therefore, if you are alone you must concentrate on the massage until help can arrive.

Direct other assistants when available to keep checking the patient's pulse. Use the least pressure that will secure an effective pulse beat. The pupils of the victims eyes will become smaller when effective cardiac massage is being performed.

Pause occasionally to determine if a spontaneous heart beat has returned.

Precautions: Make every effort to keep the hands positioned as described in order to prevent injuries to the liver, ribs, or other vital organs. Since the heart cannot recover unless supplied with oxygenated blood it is necessary to accompany cardiac massage with mouth-to-mouth artificial respiration. When there is only one operator the cardiac massage must be interrupted every half minute or so to institute rapid mouth-to-mouth breathing for three or four respirations.

Safety precautions must always be observed by persons working around electric circuits and equipment to avoid injury from electric shock and/or short circuits caused by accidentally placing or dropping a metal tool, ruler, flashlight case, or other conducting article across an energized line. The arc and fire which can be so started on even relatively low voltage circuits may cause extensive damage to equipment and serious injury to personnel.

That the danger of shock from the 450-volt a-c ship's service system is reasonably well recognized by operating personnel is shown by relatively few reports of serious shock received from this voltage despite its widespread use. On the other hand, a number of shipboard fatalities have been reported due to contact with 115-volt circuits. Despite a fairly widespread but totally unfounded popular belief to the contrary, low voltage (115 volts and below) circuits are very dangerous and can cause death where the resistance of the body is lowered by moisture and especially when current passes through the chest.

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ARTIFICIAL RESPIRATION

MOUTH-TO-MOUTH OR MOUTH-TO-NOSE RESCUE BREATHING

① **PLACE CASUALTY ON BACK IMMEDIATELY**
DON'T WASTE TIME MOVING TO A BETTER PLACE, LOOSENING CLOTHING, OR DRAINING WATER FROM LUNGS.

② **QUICKLY CLEAR MOUTH AND THROAT**
REMOVE MUCUS, FOOD AND OTHER OBSTRUCTIONS.

③ **TILT HEAD BACK AS FAR AS POSSIBLE**
THE HEAD SHOULD BE IN A "CHIN-UP" OR "SNIFF" POSITION AND THE NECK STRETCHED.

④ **LIFT LOWER JAW FORWARD**
GRASP JAW BY PLACING THUMB INTO CORNER OF MOUTH. DO NOT HOLD OR DEPRESS TONGUE.

⑤ **PINCH NOSE SHUT OR SEAL MOUTH**
PREVENT AIR LEAKAGE.

⑥ **OPEN YOUR MOUTH WIDE AND BLOW**
TAKE A DEEP BREATH AND BLOW FORCEFULLY (EXCEPT FOR BABIES) INTO MOUTH OR NOSE UNTIL YOU SEE CHEST RISE.

⑦ **LISTEN FOR EXHALATION**
QUICKLY REMOVE YOUR MOUTH WHEN CHEST RISES. LIFT JAW HIGHER IF VICTIM MAKES SNORING OR GURGLING SOUNDS.

⑧ **REPEAT STEPS SIX AND SEVEN 12 TO 20 TIMES PER MINUTE**
CONTINUE UNTIL VICTIM BEGINS TO BREATHE NORMALLY.

* **FOR INFANTS SEAL BOTH MOUTH AND NOSE WITH YOUR MOUTH**
BLOW WITH SMALL PUFFS OF AIR FROM YOUR CHEEKS.

PART 1

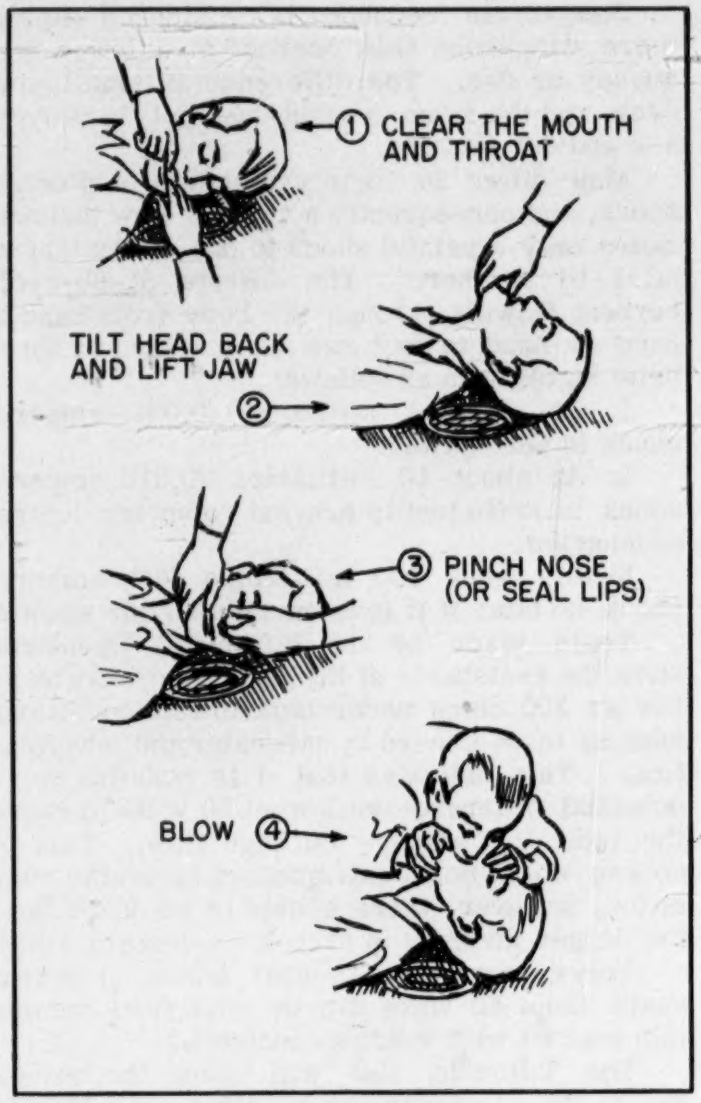

PART 2

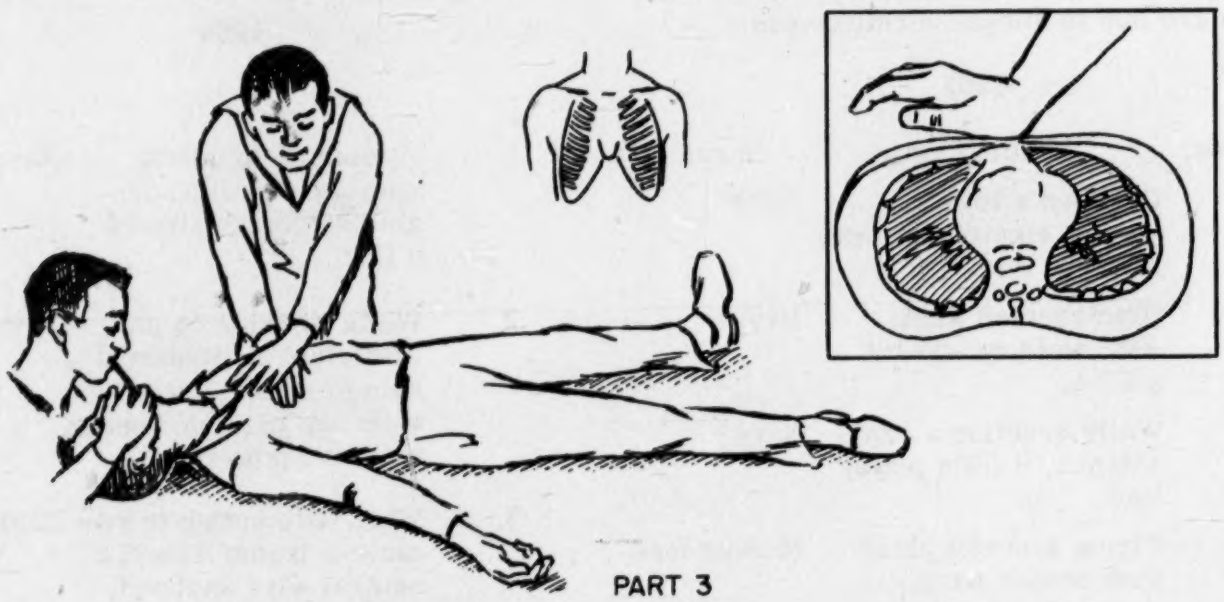

PART 3

4.224

Figure 1-3.—Artificial respiration and cardiac massage.

11297

Sixty-cycle frequency is considered slightly more dangerous than current of a lower frequency or d-c. The difference is small however, and the same precautions apply to 60 cycle a-c and d-c circuits.

Men differ in their resistance to electric shock, and consequently a current flow that may cause only a painful shock to one man might be fatal to another. The effects of 60-cycle current flowing through the body from hand to hand or hand to foot are summarized by three brief statements as follows:

1. At about 1 milliamp (0.001 ampere) shock is perceptible.
2. At about 10 milliamps (0.010 ampere) shock is sufficient to prevent voluntary control of muscles.
3. At about 100 milliamps (0.1 ampere) shock is fatal if it lasts more than one second.

Tests made by the Bureau of Standards show the resistance of the human body may be as low as 300 ohms under unfavorable conditions such as those caused by salt water and perspiration. This indicates that it is possible for a potential difference as low as 30 volts to cause the fatal 0.1 ampere current flow. This of course would be an extremely unfavorable condition, however, there should be no doubt as to the danger involved in even low voltage circuits.

There have been several deaths in recent years from 50 volts d-c by personnel coming into contact with welding electrodes.

The following list will show the recent deaths by electrocution of Navy and Marine Corps personnel. The majority of these accidents are due to simple carelessness.

1963

Death No.	Description	Service
1.	Grasped a line conducting electricity while standing on a truck.	USMC
2.	Electrocuted while ARC welding aboard a CVA.	Navy
3.	While erecting a radio antenna, it hit a power line.	Navy
4.	Flying a model plane with copper wire, crossed a high tension power line.	Midshipman

1963 (Continued)

Death No.	Description	Service
5.	Electrician in Radio Control - he came into direct contact with a fuse line of 2000-3000 volts. Aboard an APA.	Navy
6.	While working on power line.	Navy
7.	While welding, a heavy roll knocked him backward causing hot electrode to land on chest - aboard a Destroyer.	Navy
8.	Shocked while using a 1/4" electric drill.	Navy
9.	Sailboat struck power-line.	USMC
10.	Sailboat struck power-line.	USMC
11.	Aboard a Destroyer working on transmitter in fireroom, came in contact with a live wire.	Navy

1964

1.	Attempted to check rpm of pump with portable strobotac aboard a CVS.	Navy
2.	While working on an electrical switchboard aboard a submarine, his right leg came in contact with live power.	Navy
3.	While attempting to remove a transformer, a neutral wire snapped, throwing man into hot wire.	USMC

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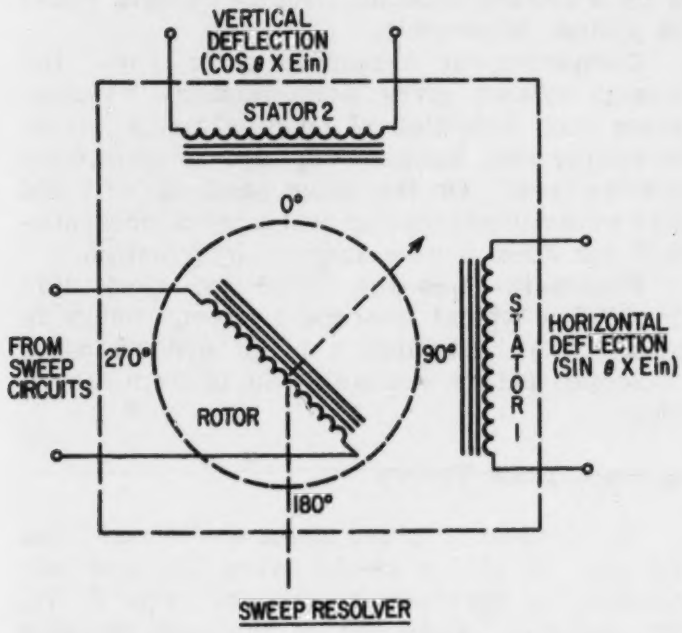

Figure 17-11. —Sweep resolver.

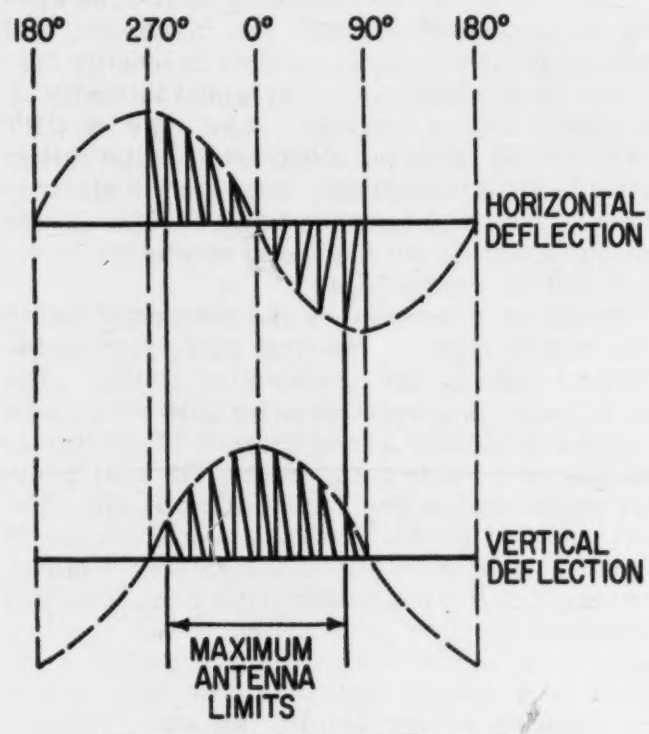

Figure 17-12. —Resolver outputs.

left or right. Thus, the outputs of the stators are:

Stator 1 (to horizontal deflection coils) $= E_{in} \times \sin \theta$

Stator 2 (to vertical deflection coils) $= E_{in} \times \cos \theta$

where θ is the antenna position.

Figure 17-12 is an illustration of the outputs from the two stator windings with the antenna rotating back and forth in azimuth between the limits indicated. It should be noted that the outputs vary at a sine wave rate 90° out of phase.

TYPES OF SCANS

The discussion of the various types of CRT's thus far has been limited to construction and operating principles. However, before the CRT can be of value in airborne radar equipment, it must be capable of presenting data to the operator.

The pattern that is produced by the scanning of the electron beam over the face of the CRT determines the type of scan or presentation. The basic terms to be used are defined below.

A sweep is the trace produced on the screen of the CRT by the linear deflection of the electron beam. The movement of the sweep across or around the screen of a CRT is called scanning. This movement may also be synchronized with the movement of the antenna which is also said to be scanning a certain area of space.

There are several types of scans employed. They are usually designated by letter. The four basic types are A-scan, B-scan, C-scan, and PPI-scan. Each is discussed in the following paragraphs. The type or types of scans employed by a radar set are determined by the function the radar performs.

Although a discussion of basic types of scans may seem too basic when considering modern radar indicators, it should be remembered that most indicators can be analyzed by their basic functions and scans.

A-SCAN

Of all the types of CRT presentations, the most common is the A-scan presentation. Its main use in present-day electronics is in test and monitoring equipments. It is generally used as a test scope in the more complex radar systems. Most test equipments employing a CRT use the A-scan presentation. One of the main reasons A-scan is so common is the fact that it is a simple and relatively trouble-free system.

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1964 (Continued)

Death No.	Description	Service
4.	While getting more working material on a roof, man got between two high voltage wires.	USMC
5.	While lifting a radio antenna on a truck, it came in contact with a 4160-volt hot line.	Navy
6.	Repairing electrical work aboard a Minesweeper.	Navy
7.	While replacing an old oil pressure switch with a new one in #7 AC Plant aboard a Cruiser.	Navy
8.	Electrocuted when he opened the door cover of a 440 volt power panel on a pier to shield himself from heavy rainfall.	Navy
9.	While putting up a television antenna it struck a high voltage line.	Navy

1965

Death No.	Description	Service
1.	While working on a transmitter, he came in contact with a circuit breaker.	Navy
2.	When he attempted to move an oxygen test stand (Diluter Demand Regulator Flowmeter) a 440-volt power cable pulled out, causing a short circuit.	Navy
3.	While repairing a cable on a Radar Circuit panel aboard a CVS.	Navy

1965 (Continued)

Death No.	Description	Service
4.	Found in hotel with electric wire wrapped around both upper arms with the other end plugged in a wall receptacle.	Navy
5.	On leave, rendering aid to a person trapped in car, backed into another car on which some power lines had fallen.	Navy
6.	Received shock while plugging an electric drill into a socket near the engine room aboard a DE.	Navy
7.	Discovered lying on a high voltage transformer outside Commissary Store, NAF.	USMC
8.	He accidentally came in contact with high voltage wire while changing clothing after swimming.	USMC
9.	Reached up to grab a Conex box and at the same time the hoist cables of mobile crane hit tension wire.	USMC
10.	Fall due to Electrical shock.	Navy

1966

Death No.	Description	Service
1.	While using an electric drill in the Ordnance Supply Storeroom aboard a Destroyer Tender.	Navy
2.	While installing radio antenna, he came in contact with a high tension wire on a field problem.	USMC

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1966 (Continued)

Death No.	Description	Service
3.	Car struck a utility pole, high voltage wire was knocked down.	Navy
4.	Car accident, he later was found lying next to a high tension wire.	Navy
5.	Grabbed for the extension cords that were used to light a yard that had just been watered.	Navy
6.	Was assisting in a detail moving a flag pole, the pole struck a power wire.	USMC
7.	Struck by lightning during thunder storm.	USMC
8.	Struck by lightning during thunder storm.	USMC
9.	Struck by lightning during thunder storm.	USMC
10.	Found with power lines wrapped around both legs.	Navy

1966 (Continued)

Death No.	Description	Service
11.	At Naval Air Station removing a shortwave radio antenna, it came in contact with high voltage wire.	Navy
12.	While cutting wire on light pole.	USMC
13.	Aboard a Destroyer performing maintenance in the Ship's Store and found dead.	Navy

Promoting safety within the E-division, or on the ship in general, will require that you become safety conscious. Through the use of safety reminders and by your personal example you will pass this safety conciousness on to others. Posters of the type shown in figure 1-4 are helpful as safety reminders. These posters should be changed or rotated regularly to different working areas so as to draw attention to them. Electrical safety posters are listed as NavShips 250-660-47 to 57, and they are available through the supply system for all ships and stations.

You should have regular discussions on safety within your division. Practice the procedures of applying cardiac massage and artificial respiration. Ask the ship's doctor or senior hospital corpsman to observe and/or demonstrate these procedures to your division. By knowing what to do and doing it quickly and correctly you may save a shipmate's life, or he may save yours.

NavShips 250-660-48

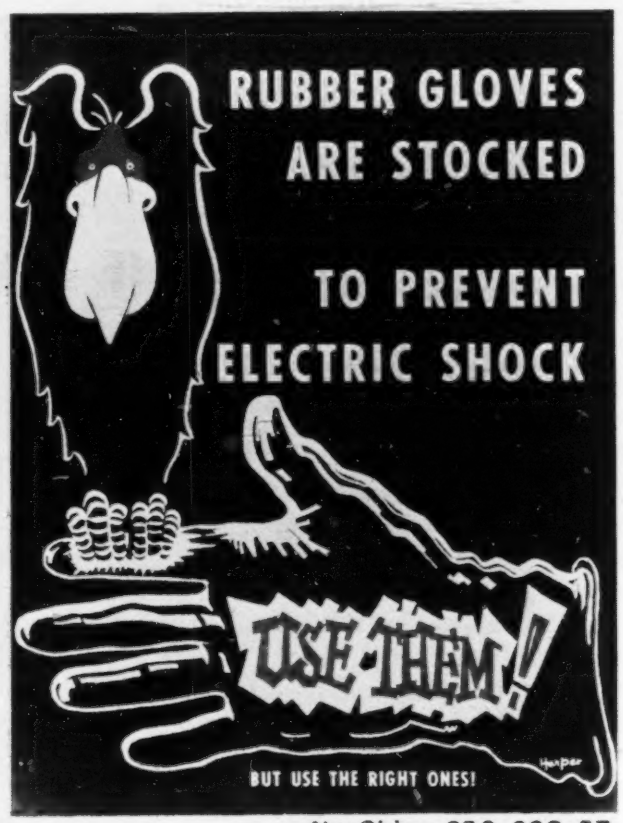

NavShips 250-660-57

NavShips 250-660-53

NavShips 250-660-52

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Figure 1-4.—Sample-electrical safety posters.

11301

CHAPTER 2

THE 3-M SYSTEM

The Navy Maintenance and Material Management (3-M) System has been implemented in the Navy as an answer to the ever-present problem of maintaining a high degree of material readiness. Although the (3-M) System is designed to improve the degree of readiness, its effectiveness and reliability are dependent upon you, the individual. The accuracy with which you perform your work, along with the neat and complete recording of required data on the prescribed forms, is one of the keys to the degree of readiness of your ship and therefore is a reflection of your success as a petty officer.

The two basic elements of the 3-M System are the Planned Maintenance System (PMS) and the Maintenance Data Collection System (MDCS). The Planned Maintenance System provides a uniform system of planned preventive maintenance. The Maintenance Data Collection System provides a means of collecting necessary maintenance and supply data, in a form suitable for rapid machine processing. A Man-hour Accounting System is used aboard repair ships and tenders in conjunction with the Maintenance Data Collection System.

Preventive maintenance should not be confused with corrective maintenance. Preventive maintenance is a scheduled check on select parts of a piece of equipment. Corrective maintenance is the repair of equipment.

As a third or second class electrician, you will be concerned with both the Planned Maintenance System (PMS) and certain portions of the Maintenance Data Collection System (MDCS) as discussed in this chapter.

THE PLANNED MAINTENANCE SYSTEM

Planned maintenance reduces casualties and saves the cost of major repairs. The PMS is designed to define the minimum planned maintenance required, to schedule and control performance, to describe the methods and tools to be used, and to aid in the prevention and detection of impending casualties.

In establishing minimum planned maintenance requirements for each piece of equipment, the NavShips Technical Manual, manufacturers' technical manuals, and applicable drawings are critically reviewed. If the planned maintenance requirements are found to be unrealistic or unclear, they are modified or completely revised before being incorporated into the PMS.

It is possible that the planned maintenance prescribed in the PMS may conflict with that prescribed in other documents such as the NavShips Technical Manual. Should this happen, it must be remembered that the PMS supersedes and takes precedence over existing requirements set forth in various technical publications insofar as preventive maintenance is concerned.

THE PLANNED MAINTENANCE SYSTEM MANUAL

A master Planned Maintenance System Manual is tailored to each department of a specific ship. It contains the minimum planned maintenance requirements for each maintainable component installed in that particular department. The department Master Manuals are normally kept in the department offices and are primarily used by the department heads in planning and scheduling the maintenance requirements in their departments.

The departmental Master Manual contains a section for each division or maintenance group within the department. Each divisional section contains a table of contents and a Maintenance Index Page (MIP) for each system, subsystem, or component involved.

Applicable portions of the PMS Manual (referred to as Space Manuals) are kept in the working space for the equipment involved and

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serve as a ready reference to the planned maintenance required. Each MIP contains a brief description of the maintenance requirements and the frequency with which maintenance is to be effected. The frequency code is: D—daily, W—weekly, M—monthly, Q—quarterly, S—semiannually, A—annually, C—overhaul cycle, and R—situation requirement. The frequency codes for the daily, weekly, monthly, quarterly, semiannual, and annual planned maintenance actions are self-explanatory. Certain planned maintenance actions are performed once each operational cycle between shipyard overhauls, during a specified quarter of the cycle, and are designated by the code C. The code R is used to identify those planned maintenance actions which are to be performed prior to getting underway, after a specified number of hours of operation, or to meet other requirements that only arise during a specific situation (prior to overhaul, for example).

Figure 2-1 shows a Maintenance Index Page (MIP) taken from a typical PMS Manual. Information to be found on the MIP includes the system or component involved, a short description of each maintenance requirement, the maintenance frequency code plus a consecutive number starting with "1" for each frequency code assigned, the rate or rates recommended to perform the maintenance, the average time required to perform the maintenance, and related maintenance requirements. The related maintenance listed is additional planned maintenance which can be completed prior to, in conjunction with, or immediately after the scheduled maintenance.

Because shipboard application of the PMS will vary slightly from one ship to another, the information found on the MIPs regarding rates recommended to perform the maintenance and the average time required for the task requires certain clarification. The maintenance tasks are actually performed by personnel available and capable, regardless of what rate is listed on the MIP. The average time required, as listed on the MIP, does not take into account the time required to assemble the necessary tools and materials nor the time required to clean the area and put away the tools at the end of the task.

SCHEDULING OF PLANNED MAINTENANCE

For each division or maintenance group, a cycle schedule which provides a visual display of the planned maintenance requirements (based on the operational cycle of the ship between shipyard overhauls) is displayed in the departmental offices. The information to be found on the cycle schedule (fig. 2-2), for any particular division or maintenance group includes the MIP number from the PMS Manual, a listing of all the equipment within that particular group for which planned maintenance is required, and the specific quarter in which the semiannual, annual, and overhaul cycle planned maintenance actions are to be performed. The cycle schedule also lists the quarterly and the situation requirement planned maintenance actions which must be scheduled, as well as the monthly planned maintenance requirements.

The cycle schedule is used by the department head, in conjunction with his division officers and leading petty officers, to make out the quarterly planned maintenance schedule. The quarterly schedule (fig. 2-3) displayed adjacent to the cycle schedule in a holder known as the maintenance control board, gives a visual display of the ship's deployment schedule and the planned maintenance to be performed during that particular quarter.

The quarterly schedule has thirteen columns, one for each week in the quarter, for the scheduling of maintenance throughout the 3-month period.

At the end of each week, the leading petty officer of the division or maintenance group will update the quarterly schedule by crossing out (with an X) the preventive maintenance performed. If a planned maintenance action is not completed during the week it is scheduled, the leading petty officer will circle the action on the quarterly schedule. The uncompleted maintenance is then rescheduled (as shown in figure 2-3) for another week within the same quarter, normally as soon as the operating schedule of the ship will allow.

At the close of each quarter, the quarterly schedule is removed from its holder and retained on board as a record of the planned maintenance completed. This record may be discarded at the beginning of the second quarter after the next shipyard overhaul.

The quarterly schedule is also used by your leading petty officer to make out a weekly planned maintenance schedule which is posted in the space where you work. The weekly schedule of planned maintenance should not be considered as the total work for the week. This schedule only covers the scheduled planned

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System, Subsystem, or Component	Reference Publications
Ship Service Generators	

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
EA	ZZZGGG1	45	8624	W	1. Clean the generator. 2. Measure the insulation resistance of the generator and excitation circuit. (See NOTES)	W-1	EM3	1.0	None
EA	ZZZGGG1	84	6012	M	1. Inspect each idle ship service generator for evidence of corrosion and electrolytic action (exciter where applicable).	M-1	EM3	0.3 unit	None
EA	ZZZGGG1	35	8625	S	1. Clean and inspect the generator.	S-1	EM2 EMFN	5.5 5.5	None
EA	ZZZGEJ1	35	8626	S	1. Clean and inspect static regulator-exciter.	S-2	EM3 EMFN	1.5 1.5	None
					NOTE 1: Perform weekly, or when securing the ship service generator. Perform before starting, if idle for more than a week.				
					NOTE 2: If the insulation resistance is less than 0.5 megohm for AC generators, take corrective action.				

MAINTENANCE INDEX PAGE
OPNAV FORM 4700-3 (4-64)

BUREAU PAGE CONTROL NUMBER EL-7/43-35

98.171

Figure 2-1.—Maintenance Index Page.

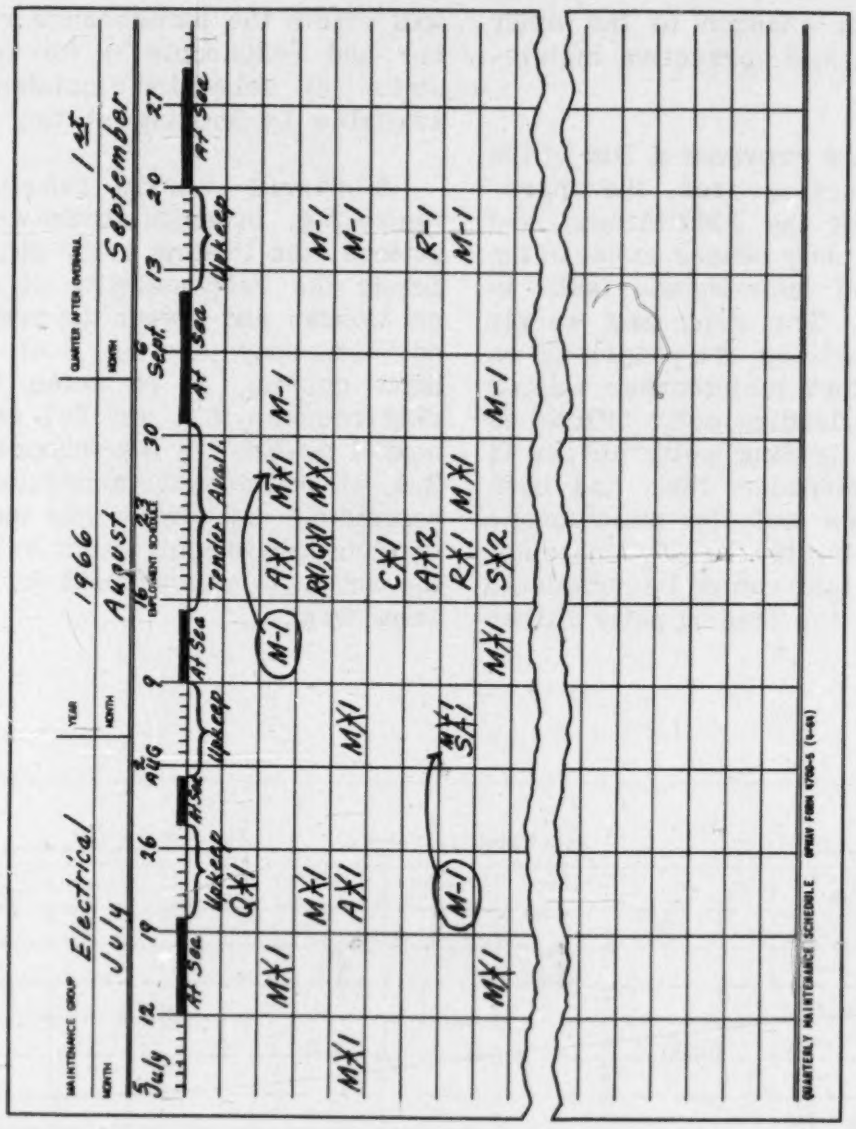

98.173

Figure 2-3.—Quarterly Maintenance Schedule.

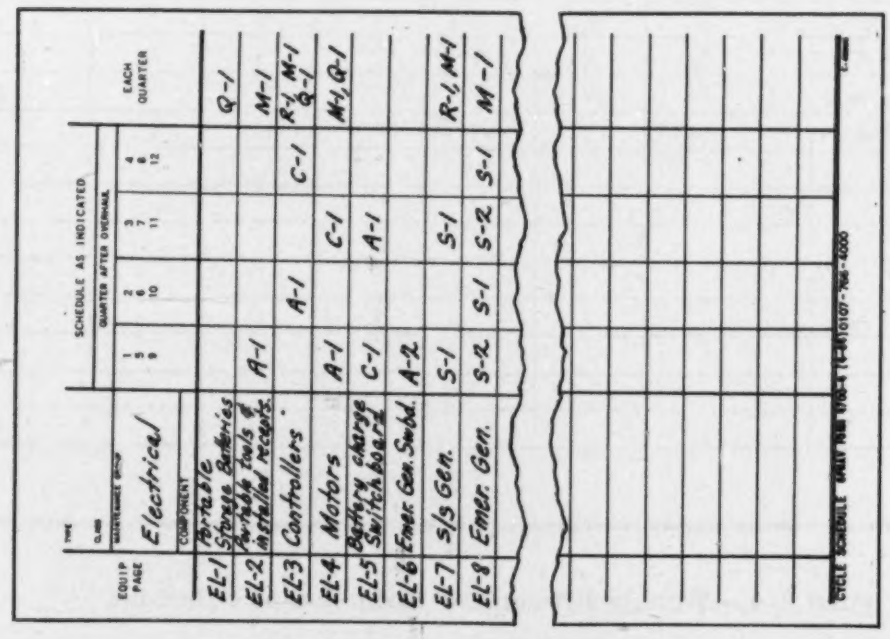

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Figure 2-2.—Cycle Schedule.

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maintenance and is in addition to the other routine work, upkeep, and corrective maintenance to be done.

The weekly schedule provides a list of the components in the working area, the appropriate page number of the PMS Manual, and spaces for the leading petty officer to use in the assignment of planned maintenance tasks to specified personnel. The daily and weekly planned maintenance actions are preprinted on the forms and the other maintenance actions are written in by the leading petty officer as required. When the leading petty officer is assured that a maintenance task has been completed, he crosses out the maintenance requirement number on the weekly schedule. If for some reason a task cannot be completed on the day scheduled, the leading petty officer will circle the maintenance requirement number and reschedule it for another day. The status of scheduled maintenance is readily available by looking at the weekly schedule.

A sample weekly schedule is shown in figure 2-4. In addition to the weekly maintenance actions, the leading petty officer has assigned Brady the responsibility of requirement M-1 on Monday and Dwyer the responsibility of S-1 on Wednesday (see fig. 2-4). In the far right-hand column, it is noted that maintenance requirements A-1 and S-1 are due within the next 4 weeks. In the schedule shown in figure 2-4, all maintenance scheduled for Monday was completed, but Brady was unable to complete the scheduled requirement A-1 for Tuesday and the action is rescheduled for Thursday of the same week.

ELECTRICAL WORK SCHEDULE FOR WEEK OF AUGUST 16-23

COMPONENT	MAINTENANCE RESPONSIBILITY	PAGE	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN	OUTSTANDING REPAIRS AND P.M. CHECKS DUE IN NEXT 4 WEEKS
Portable Storage Batteries	JONES, EM 2	EL-1	~~W-1~~						
Portable Tools	BRADY, EM 3	EL-2		(A-1)	~~W-1~~	A-1			
Controllers	EDWARDS, EM-2	EL-3							A-1
Motors	BRADY, EM-3	EL-4	~~M-1~~						
Battery Charging Switchboard	KLINE, EM-3	EL-5							
Emer. Gen. Swbd.	JONES, EM-2	EL-5							
Main Dist. Swbd.	JONES, EM-2	EL-5							
Degaussing	EDWARDS, EM-2	EL-6	~~W-1~~						
No. 1 Ship's Service Generator	DWYER, EM-2	EL-7	~~D-1~~ ~~W-1~~	~~D-1~~	~~D-1~~ ~~S-1~~	D-1 M-1	D-1	D-1	
No. 2 Ship's Service Generator	SMITH, EM-2	EL-7	~~D-1~~ ~~W-1~~	~~D-1~~	~~D-1~~ ~~M-1~~	D-1	D-1 S-1	D-1	
Emer. Gen #1	DWYER, EM-2	EL-8	~~D-1~~	~~D-1~~	~~D-1~~	D-1	D-1	D-1	S-1
Emer. Gen #2	BRADY, EM-3	EL-8	~~D-1~~ ~~S-1~~	~~D-1~~	~~D-1~~ ~~M-1~~	D-1	D-1	D-1	
Auto. Bus. Trans		EL-10							
M/G Sets		EL-11							

98.175

Figure 2-4.—Weekly Preventive Maintenance Schedule.

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THE MAINTENANCE REQUIREMENT CARD

The Maintenance Requirement Card (MRC), 5 by 8 inches, has the planned maintenance task defined in sufficient detail to enable assigned personnel to perform the task (see fig. 2-5). A master set of MRCs is maintained in the log room and those applicable to the equipment with which you are concerned are maintained in your working space. If a card in the working space becomes lost or mutilated, a new card can be made from the master set and used until a feedback report is sent in and a new card obtained.

The MRC is one of the primary tools of the PMS with which you will be concerned. Suppose that on a Monday morning Dwyer looks at the weekly schedule (fig. 2-4) and finds that he is assigned the maintenance action identified as W-1. The weekly schedule indicated that this particular maintenance action is listed on page EL-7 of the PMS Manual. The MRC which describes the task assigned is identified by the number combination "EL-7 W-1" in the upper right-hand corner. In preparation for performing the assigned task, Dwyer would pull MRC number EL-7 W-1 (fig. 2-5) from the set of cards in the working space.

The MRC identifies the component involved; gives a brief description of the maintenance requirement; lists the safety precautions to be followed; and lists the tools, parts, and materials needed to accomplish the task. This information is listed to enable you to be completely ready to perform the prescribed maintenance prior to actually working on the equipment involved. The procedure listed on the MRC is standardized and is the best known method of performing that particular task. Any related maintenance requirement listed on the MRC should be done at the same time or in conjunction with the assigned task for the purpose of time conservation.

The 16-digit number on the lower right-hand side of the MRC is the bureau card control number which can also be found on the MIP. Each MRC has a bureau card control number, which must be referred to in any correspondence concerning the card.

On some ships, two or more divisions may have identical equipment. When this occurs, each division will have separate (but identical) MRC cards for the equipment.

FEEDBACK REPORT

The PMS Feedback Report, OPNAV Form 4700-7 (fig. 2-6), is designed to report any discrepancies or suggested improvements in the PMS as installed aboard ship. The report is to be filled out by the man who discovers the discrepancy or suggests an improvement, signed by anyone designated by the commanding officer, and mailed via the type commander to the appropriate field office listed on the reverse side of the originator's copy of the form. Atlantic Fleet ships use the Norfolk address and Pacific Fleet ships use the San Diego address.

When submitting a feedback report, be sure it is filled out completely and legibly. Handwritten copies are acceptable but a ballpoint pen must be used to ensure that all copies are legible. Instructions for filling out the feedback report are listed on the back of the form and are discussed here for the purpose of clarification.

You are required to complete the "TO" line with the appropriate (San Diego or Norfolk) address. In the "FROM" line insert the hull number of your ship (DDG 11, DD789, AD 36, etc.); and in the "VIA" line indicate the type commander. The date will be the day you discover the discrepancy or suggest an improvement. The serial number indicates the number of feedback reports sent in by your ship. If your ship has previously forwarded five feedback reports, the next report will be numbered 6.

The blocks concerning the system, subsystem, component, M.R. number, and the bureau card control number should be filled in with information from the appropriate MIP and/or MRC. If the MRC or MIP is missing and the bureau card control number is not available, the equipment should be identified by its name and its APL/CID or AN number. The APL/CID number identifies the parts list for the equipment and is found in the index to the Coordinated Shipboard Allowance List (COSAL). The "Technical Publication" block in the "Discrepancy" section of the report is intended to include all Naval Ship Systems and Naval Ordnance Systems Command publications. In the event that any of these are in error, identify the publication number, volume, revision, date, change number, page paragraph, and/or figure.

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11307

SYSTEM	COMPONENT	M. R. NUMBER
Electric Plant	Ship Service Generator	EL-7 W-1
	MAINT. SIGNI-FICANT NO.	
SUB-SYSTEM	RELATED M.R.	RATES / M.H
Electric Power Generation	None	EM3 / 1.0

M. R. DESCRIPTION

1. Clean the generator.
2. Measure the insulation resistance of the generator and excitation circuit.

TOTAL M/H 1.0
ELAPSED TIME: 1.0

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Wire air starting/steam inlet valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. 500-volt Megger
2. AN-PSM-4 Multimeter
3. 8" Screwdriver
4. 8" Adjustable wrench
5. Wire, 24 gauge
6. Safety tags
7. 6" Slip-joint pliers
8. Voltage tester
9. Lint-free rags
10. Vacuum cleaner

PROCEDURE

NOTE 1: Measure the insulation resistance weekly, when securing the generator and before starting, if it has been idle for one week or more.

Preliminary

a. Wire air starting/steam inlet valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
b. Open generator circuit breaker and tag "Out Of Service." Test with voltage tester to determine generator side of circuit breaker.
c. Open disconnect links where installed and tag "Out Of Service."

1. Clean the Generator.
   a. Remove inspection covers.

(Cont'd on Page 2)

Page 1 of 2 | EA | ZZZG | GG1 | 45 | 8624

LOCATION | W

A

Procedure (Cont'd)

b. Vacuum all interior surfaces and components that can be reached without disassembly of the generator, and wipe with dry rags.

2. Measure the Insulation Resistance of the Generator and Excitation Circuit.

NOTE 2: Measure the stator insulation resistance at the generator side of the generator circuit breaker.

a. Measure the insulation resistance of the stator using 500-volt megger.
b. Lift the brushes. Measure the insulation resistance of the field from a slip-ring to ground, using 500-volt megger.

CAUTION: Do not megger the excitation circuit.

c. Measure the insulation resistance of the excitation circuit from a brush holder to ground, using the multimeter.

NOTE 3: If insulation resistance is less than 0.5 megohm, take corrective action.

CAUTION: Do not snap springs in place, as this may crack or chip the brushes.

d. Lower the brushes and reinstall cover.
e. Remove wire and tags. Reconnect starting motor, as applicable.
f. Set up for prescribed operation.

Page 2 of 2 | EA | ZZZG | GG1 | 45 | 8624 | W

B

98.176

Figure 2-5.—Maintenance Requirement Card (MRC). (A) Front Side, (B) Reverse Side.

11308

The display of information in an A-scan system is presented in both the horizontal and vertical planes. Range or time is usually displayed on the horizontal and signal intensity or amplitude on the vertical. The type of CRT used is most often the electrostatic type rather than the electromagnetic, because the electrostatic is the least complex in its design. Range measurement on an A-scan presentation is illustrated in figure 17-13.

Range is measured on the horizontal sweep from left to right. The first pulse seen on the extreme left is the transmitter firing. The second pulse is a negetive pulse used as a range mark and indicates a total time of 12.36 microseconds or 1 radar range mile. The next negative pulse would be the 2-mile marker, etc. The next pulse, a positive pulse, would be a target return at approximately 2 1/2 miles. Following this, you see a positive and a negative pulse coincident in time at 3 miles. The positive pulse is a target return; the negative pulse would be a 3-mile marker. The next pulses are negative 4- and 5-mile markers, respectively. The negative pulses could be replaced by positive pulses or by bright or dark spots (intensity modulation). Another method of obtaining markers is to etch the scope face with lines indicating certain ranges. The disadvantage of the last system is that it will not compensate for nonlinearity in the trace nor will it be a flexible system. Range changes would be almost impossible.

Comparing the A-scan to other types, the A-scan system gives very accurate ranging, gives good definition of relative target sizes, is simple and inexpensive, and is relatively trouble free. On the other hand, it will not give an easily interpreted geographical presentation nor does it give azimuth information.

Figure 17-14 is the simplified block diagram of a typical A-scope system, which is presented to establish a basic understanding of scopes before discussing the more advanced types.

Sweep Circuit Theory

The frequency of the output waveform from V1 (fig. 17-15), a single-swing blocking oscillator, is governed by the RC time of R1, R2, and C1. Since R2 is the only variable component, it is the frequency adjustment. The output of the circuit is a positive pulse developed across R3 when V1 conducts.

This positive pulse is coupled through C2 to the input of V2, a cathode follower. The input of the cathode follower is developed across its grid resistor, R4, and applied to the control grid. This causes a pulse of current through the tube, which develops a signal across R5 and R6, giving an output signal similar to the

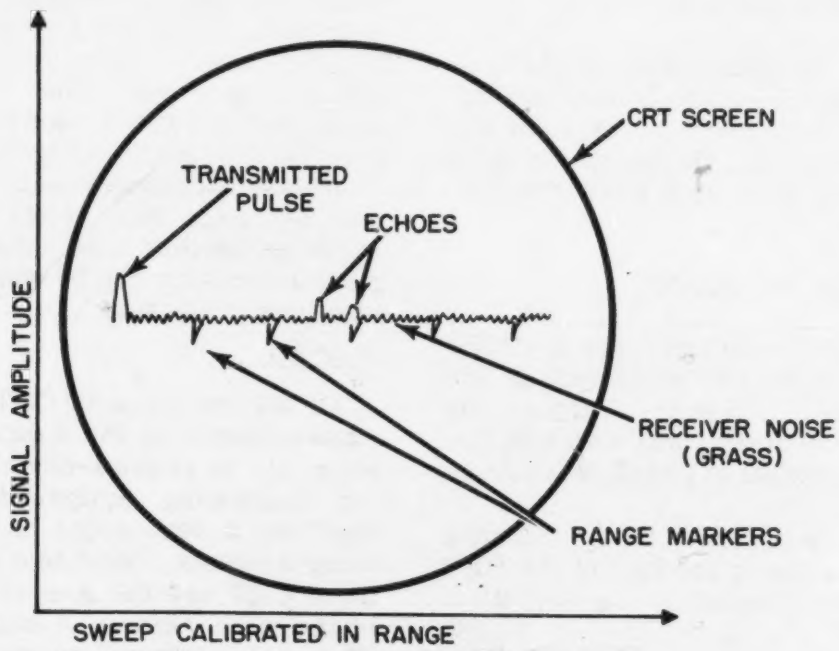

Figure 17-13. —A-scan presentation.

1128

INSTRUCTIONS ON BACK OF GREEN PAGE

FROM: DD-746

TO: Buships/Buweps Maintenance Management Field Office

SERIAL #: 6

DATE 16 August 1966

VIA: COMCRUDESLANT

SUBJECT: PLANNED MAINTENANCE SYSTEM FEEDBACK REPORT

SYSTEM	COMPONENT
Electric Plant	Ship Service Generator
SUB-SYSTEM Electric Power Generation	M.R. NUMBER EL-7 W-1
	BU. CONTROL NO. EA ZZZGGG1 45 8624W

DISCREPANCY

- ☐ M. R. Description
- ☐ Safety Precautions
- ☐ Tools, Etc.
- ☐ Missing Maintainance Requirement Card (MRC)
- ☐ Equipment Change
- ☐ Missing Maintainance Index Page (MIP)
- ☐ Technical
- ☒ Procedure
- ☐ Typographical
- ☐ Technical Publications
- ☐ Miscellaneous

1. Recommend rewording Note #1 on the MRC under procedure. Suggest the same wording as used in Note #1 on MIP EL-7.

2. Recommend the following be added under procedure (Preliminary)

   a. de-energize Stator Space Heaters, if installed, and tag "out of service"

A. B. Lea, Lt. USN

SIGNATURE OF C. O. OR DESIGNATED REPRESENTATIVE

THIS COPY FOR: ADDRESSEE

OPNAV Form 4700/7 (10-65)

40.101

Figure 2-6.—Feedback Report (OPNAV 4700-7).

Prior to the distribution of the report (as indicated on the original and each of the four carbon copies), check it for completeness. The discrepancy should always be explained clearly and a suggestion for its correction must always be offered.

THE MAINTENANCE DATA COLLECTION SYSTEM

The Maintenance Data Collection System is designed to provide a means of recording maintenance actions in substantial detail so that

11309

a great variety of information may be collected concerning maintenance actions and the performance of equipment involved. In addition, the system provides data concerning the initial discovery of a malfunction, how the equipment malfunctioned, how many man-hours were expended, which equipment was involved, what repair parts and materials were used, what delays were incurred, the reasons for delay, and the technical specialty or work center which performed the maintenance.

Codes must be used in recording maintenance actions in order to allow converting the information to a language that can be read by automatic data processing machines. As a third or second class electrician, you will be required to fill out various maintenance forms, using the codes listed in the Equipment Identification Code (EIC) Manual. The forms are sent to a data processing center where the coded information is punched into cards which are machine processed to produce the various reports for use in maintenance and material management.

The reports that are produced by the automatic data processing machines will be accurate and useful only if the information is clearly and accurately entered on the maintenance forms. Therefore it is very important that the codes which you enter on the forms be accurate and clearly written.

MAINTENANCE DATA COLLECTION SYSTEM FORMS

The MDCS forms on which you may be required to make coded entries include OPNAV Form 4700-2B (Shipboard Maintenance Action), OPNAV Form 4700-2C (Work Request), and OPNAV Form 4700-2D (Deferred Action). Detailed descriptions of the entries to be made on these forms are listed in the EIC Manual and in chapter 3 of the 3-M Manual (OPNAV 43P2). Brief descriptions of these entries are also listed here to help you become familiar with the forms, which are shown in figures 2-7 through 2-10.

Block A, Ship Name and Hull No./Activity: Enter the name and hull number of your ship—for example, USS Now (DD 746).

Block 1, Administrative Organization: Enter the 4-letter/number code (from section II of the EIC Manual) to which your ship is assigned (if your ship is assigned to DESRON 7, you would enter DO70).

Block 2, Unit Identification Code (UIC): Enter the UIC number for the ship or activity for which the maintenance was performed. This entry is obtained from NavCompt Manual, Volume 2, Chapter 5.

Block 3, Maintenance Control Number: This number is used to relate all documents submitted on a specific job and is filled in by the maintenance control section of your ship before the documents leave the ship. The numbers will be assigned consecutively beginning with 0001 and ending at 9999. Upon reaching 9999, the series will be started again at 0001.

Block 4, Date: Enter the day, month, and year the maintenance is accomplished; or, for a work request, enter the date the request is submitted.

Block B, Type Availability: This block is left blank on all forms except the Work Request, OPNAV Form 4700-2C. On the work request, this block will be filled in with a single-letter code, taken from section IX of the EIC Manual, to identify the type of availability in which the repair activity will perform the maintenance.

Block 5, Equipment Identification Code: Enter, from section X of the EIC Manual, the appropriate 7-letter/number code which identifies the system, subsystem, component, and/or lowest designated assembly on which maintenance is requested or performed. Caution must be exercised to ensure that the EIC number correctly identifies the exact item on which maintenance is requested or performed.

Block 6, Work Center: Enter the 3-letter/number code from section III of the EIC Manual which identifies the department, rating, shop, or group which performs the maintenance actions on the equipment identified in the equipment identification code, block 5.

Block 7, Assisting Work Center: Leave blank. When information is required in this block it will be filled out by your supervisor in accordance with the EIC Manual and chapter 3 of the 3-M Manual.

Block 8, Repair Activity Unit Identification Code (UIC) obtained from NavCompt Manual, Volume 2, Chapter 5.

Block 9, How Mal/MRC: If the action is a result of a malfunction, list the 3-digit code from section IV of the EIC Manual which best describes the trouble. If the action is planned maintenance (MRC), enter a 3-letter/number combination code which identifies the frequency check on the equipment. For example, if the situation is an M-1 PMS action enter MO1.

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MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2B (8-64)

SHIPBOARD MAINTENANCE ACTION

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE MONTH YEAR	B.
USS New DD-746	0070	03861	0175	16086	

5. EQUIPMENT ID CODE	6. A.C.	7. ASST. AC.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MAN-HOURS (10THS)	E.
AK07031	E40			148	C	C	01	0085	

14. SERIAL NO.	20. EQUIP. TIME	21. ALTERATION IDENTIFICATION
1-64-2		

F. DESCRIPTION/REMARKS

Vent set 1-64-2 Bearing overheating
Replaced eroded Bearing Housing

FOR LOCAL USE ONLY

L. SIG. (3) B. Brady EM3
M. SIG. (4) R. Frese EM1

D-22461

17.81B

Figure 2-7.—Shipboard Maintenance Action Form (OPNAV 4700-2B).

For all other actions three zeroes (000) will be entered.

Block 10, Discovered: Enter the appropriate code from section V of the EIC Manual which identifies when the maintenance requirement was discovered.

Block 11, Action Taken: Enter the code from section VI of the EIC Manual which best describes the maintenance action taken. "Not Repairable This Ship" (NRTS) codes will be used only by repair activities.

Block 12, Units: Enter the number of identical items, identified in block 5, on which the same maintenance action was attempted, performed, or requested. If identical alterations or significant maintenance actions are accomplished on identical equipment bearing different serial numbers, each equipment will be reported on a separate document.

Block 13, Man-hours: On completion of the maintenance action, enter the total man-hours (to the nearest tenth) expended by all shipboard personnel. If the task was completed in 1-1/2 hours, for example, you would enter "0015". Enter a "0" in any space not used.

Block E, Blank: Leave blank, (explained later).

Block 14, Serial Number: For detailed information on completing this particular block, see chapter 3 of the 3-M Manual. For mechanical/electrical equipment, the serial number is not required; instead, the shipboard numbering identification system will be used, followed by the abbreviated name of the equipment. For example, if block 5 identified a main feed pump, and the pump in question is number 1, block 14 should contain the entry "NR 1 MNFDPMP."

1Ø11

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION

1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS New DD-746	0070	03861	0176	16086	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MANHOURS	E.
AK07030	E40			080	C	J	01	0025	

14. SERIAL NO.	20. EQUIP./TIME	21. ALTERATION IDENTIFICATION
1-64-2		

F. DESCRIPTION/REMARKS

Vent Set 1-64-2 failed during operation, investigation indicated Stator windings burned out due to over-lubrication. Winding insulation was grease-encrusted.
No rewinding facilities onboard.

FOR LOCAL USE ONLY

L. SIG. (3) B. Brady Em 3

M. SIG. (4) G. Crider Em1

17.81D

Figure 2-8.—Deferred Action Form, Sheet 1, (OPNAV 4700-2D).

Blocks 15 thru 19 apply only to OPNAV Form 4700-2C, fig. 2-9.

Block 15, T/A: Leave blank.

Block 16, Requesting Work Center: Enter the letter/number code that identifies the department, rating, shop, or group that is requesting assistance from the repair activity. Work center codes may be found in section III of the EIC Manual.

Block 17, Desired Completion Date: Enter the day, month, and year that the outside repair activity must complete maintenance in order for the requesting activity to meet its operational commitments. If this date were 9 March 1966, for example, you would enter 09036.

Block 18, Service: Enter the single-letter code from section VII of the EIC Manual which identifies the type of assistance the requesting ship will furnish the repair activity in completing the requested maintenance.

Block 19, Scheduled Start Date: This entry, which is for repair activities only, is the estimated starting date of the requested maintenance.

Block D, Leave blank.

Block E and 20, Equipment Downtime and Equipment Operating Time: These entries are required only for equipment identified by green pages in the EIC Manual. Detailed instructions for these blocks may be found in section I of the EIC Manual and chapter 3 of the 3-M Manual.

Block 21, Alteration Identification: If an alteration is to be accomplished, this block will contain the alteration identification from the authorization directive.

The Shipboard Maintenance Action Form (fig. 2-7) (OPNAV Form 4700-2B) is a single-sheet document used to record the completion of planned maintenance actions, corrective maintenance actions and authorized alterations

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MAINTENANCE DATA COLLECTION
OPNAV 4700-2C (8-64)

WORK REQUEST 1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO	4. DATE	B
USS New DD-746	D070	03861	0176	16086	G

5. EQUIPMENT ID CODE	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	12. UNITS	C.
AK07030	04639	080	C	01	

14. SERIAL NO.	15. T/A	16. REQ. W.C.	17. DESIRED CMPLN. DATE	13. SERV	D.
1-64-2		E40	02226	A	

F. DESCRIPTION/REMARKS

1. Motor, AC, Fan, Heater Unit, Vent set 1-64-2 CID # 47135001. Alt. No. – N/A.
2. Stator windings burned out.
3. Rewind, dip and bake stator.

FOR LOCAL USE ONLY

G. NO. 1 CONTACT	J. SIG. (1)
R. Frese Em 1	B Brady Em 3
H. NO. 2 CONTACT	**K. SIG. (2)**
C. Dwyer Em 2	W. E. Bliss LtUSN

17.81C

Figure 2-9.—Work Request (OPNAV 4700-2C).

that have been performed at the shipboard level by shipboard personnel. All planned maintenance actions except daily and weekly planned maintenance actions must be recorded on this form in addition to checking them off on the weekly and quarterly schedules. Routine preservation such as chipping, painting, and cleaning should not be reported.

The weekly schedule shown in figure 2-4 reflects that Brady completed maintenance requirement EL-4 M-1 on Monday. Figure 2-7 shows the Shipboard Maintenance Action form which Brady completed for this maintenance requirement. Note that, in addition to giving the date (16 Aug. 1966), the man-hours (8.5), and the proper codes taken from the EIC Manual, Brady has given a brief description of the maintenance performed (in block F) and has signed the form. His leading petty officer has signed the form to indicate the information is complete and accurate.

Any corrective maintenance actions that are deferred because of the ship's operations, lack of repair parts, or the requirement of outside assistance are reported on the Deferred Action Form (fig. 2-8) (OPNAV 4700-2D). The first sheet of this 2-sheet document is used to record and report the reason for deferral and the second sheet is used to report the completion of the maintenance action. If a corrective maintenance action must be deferred, this form is required at the time a malfunction is noted. A sample sheet 1 of the Deferred Action Form which could have resulted is shown in figure 2-8. The action taken code, block 11, and the man-hours expended, block 13, on sheet 1 of the Deferred Action Form apply only to the action taken man-hours involved at the time of the discovery of the malfunction.

Figure 2-9 shows a Work Request (OPNAV Form 4700-2C) to have the motor stator

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MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 2

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS New DD-746	D 0 7 0	0 3 8 6 1	0 1 7 6	2 9 0 8 6	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. ALT	12. UNITS	13. MANHOURS	E.
A K 0 7 0 3 0	E 4 0			0 8 0	C	C	0 1	0 0 4 5	

14. SERIAL NO.	20. EQUIP/TIME	21. ALTERATION IDENTIFICATION
1 - 6 4 - 2		

F. DESCRIPTION/REMARKS

Vent set 1-64-2 failed during operation. Investigation indicated stator windings burned out due to over lubrication. Winding insulation was grease-encrusted. No rewinding facilities on board. Rewound by USS FRONTIER, AD-25, tested and returned onboard, Installed onboard 29/8/66.
Operation is satisfactory.

FOR LOCAL USE ONLY

L. SIG. (3) B. Brady Em 3
M. SIG. (4) L. Crider Em 1

17.81D

Figure 2-10.—Deferred Action Form, Sheet 2.

rewound. In completing block F (Description/Remarks) of the work request, note that:

1. The component must be identified by name.
2. The CID number of the component must be listed.
3. The alterations number must be given, if applicable. If not applicable, it must be listed as N/A.
4. A description of what is wrong with the equipment and what you desire the repair activity to do must be given.

The signature blocks G, H, and J are to be signed by three leading petty officers, one from each duty section, who are familiar with the work to be done by the repair activity. Signature block K will be used by the commanding officer or his authorized representative to indicate command approval of the request for repair assistance.

After the repairs have been completed by the repair activity, "sheet 2" of the Deferred Action Form (fig. 2-10) is completed by entering the date of completion in block 4, the action taken code in block 11, the additional man-hours in block 13, and appropriate remarks in block F. The form is then signed by the man doing the work and by his supervisor, and is then submitted to the data processing center.

The information contained in blocks A, 1 and 2 of OPNAV Forms 4700-2B, 4700-2C, and 4700-2D will be identical on all forms for any particular ship; if desired, this information may be preprinted by the ship. Each maintenance action is assigned its own unique maintenance control number; if a maintenance task requires more than one form, as in the example using figures 2-8 through 2-10, the numbers will be identical.

Personnel attached to repair activities are required to record certain information on a

1134

Work Supplement Cards (not shown) for each repair job. Work supplement cards will be explained to you by your division petty officer if you are assigned to a repair activity.

MATERIAL USAGE AND COST DATA

The documentation of material usage and cost data on maintenance transactions requires the joint effort of the supply and maintenance personnel on board your ship. Economy of effort and the elimination of duplicate recordings are highly desirable.

Any time that repair parts or materials are drawn from the supply department for shipboard maintenance, a NAVSANDA Form 1250 is used to request the materials from supply. Maintenance personnel are required to furnish the work center code and the EIC taken from the EIC Manual, the component identification (CID) number, the maintenance control number, the name of the part, quantity required, and the stock number when submitting this form to the supply department. The supply personnel will then complete the form; the cost is documented from this form if the ship does not have data processing equipment aboard. If the ship has data processing equipment, a DD Form 1348 is used instead of the form 1250.

When the material to support a maintenance action is obtained from outside the normal supply channels or from pre-expended material bins, the reverse side of the appropriate OPNAV Form (OPNAV 4700-2B, 4700-2C, or 4700-2D) is used. The reverse sides of OPNAV 4700 series forms are essentially the same. The reverse side of OPNAV Form 4700-2C is shown in figure 2-11. On this side of the form, when appropriate, you will enter the CID number, the source code taken from section VIII of the EIC Manual, the cognizance symbol taken from supply publications to identify the supply account and the inventory manager of the item used,

CID/APL/AN 55376101

SOURCE CODE	COG.	FEDERAL STOCK NO./PART NO.	REFERENCE SYMBOL/NOVN	MATERIAL REQ. UNITS	MATERIAL REQ. QUANTITY	MATERIAL USED UNITS	MATERIAL USED QUANTITY	UNIT PRICE
1	IN	5905-258-0034	R1445			EA.	2	.38

17.81ABC

Figure 2-11.—Reverse Side of OPNAV 4700-2C.

11315

the Federal Stock Number, the reference symbol taken from circuit diagrams or the name of the part being replaced, the unit of issue of the material used, quantity used, and the unit cost (except on pre-extended material) of the item.

THE MAN-HOUR ACCOUNTING SYSTEM

The Man-hour Accounting System, sometimes referred to as Exception Time Accounting (ETA), is designed and intended for use by repair activities in conjunction with Maintenance Data Collection System. It is basically a management tool and accounts for deviation from a normal working day.

As a third or second class petty officer assigned to a repair activity, your only concern with this system will be when you are absent from your assigned working space for more than 20 minutes at a time. If this occurs, your leading petty officer will hand you a Daily Exception Card on which you will be required to fill in the date of change and the number of hours concerned to the nearest tenth of an hour, and then return the card to your supervisor.

In the example card shown (fig. 2-12), Jones, K.P. EM 3 (004 code) assigned to the electrical repair shop (51A code) for direct labor (01 code) was absent for one and a half hours. This absence was to take care of personal affairs and is therefore a non-duty absence as shown by the reverse side of figure 2-12.

11312
11316

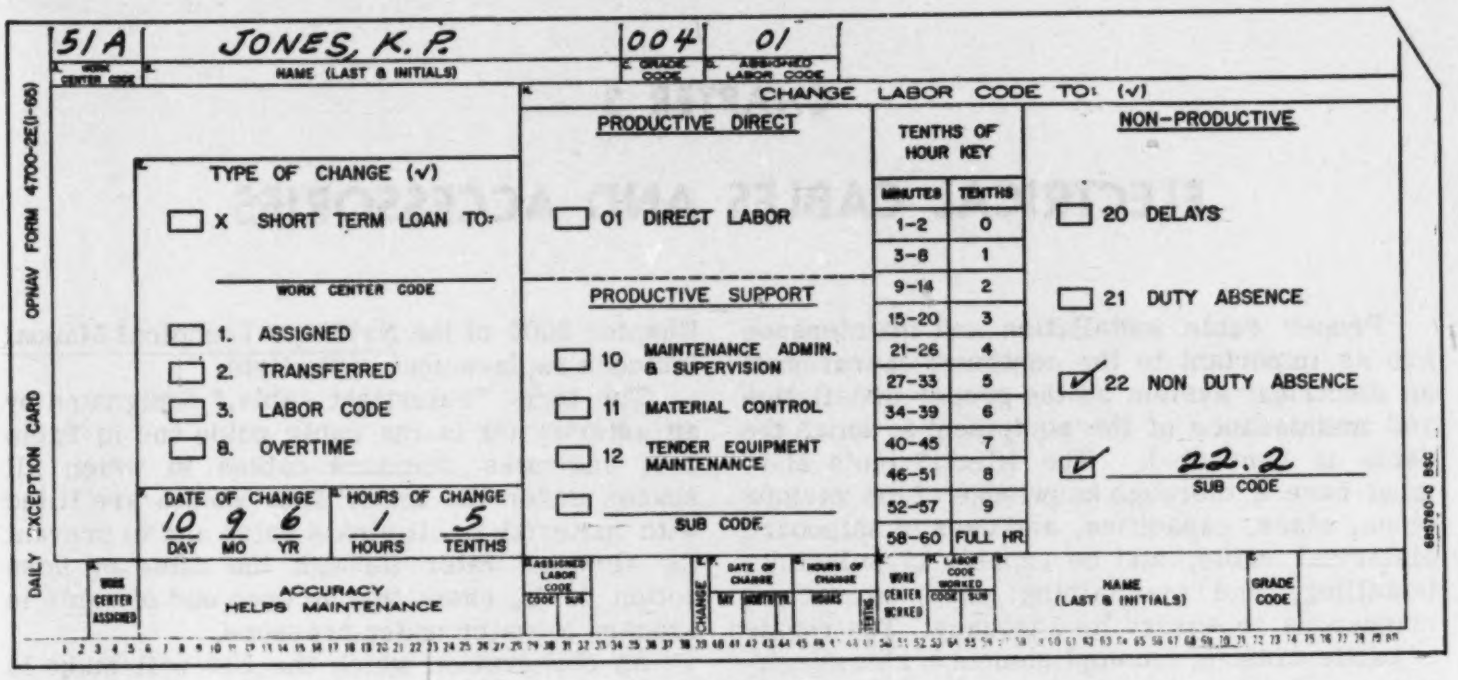

FRONT

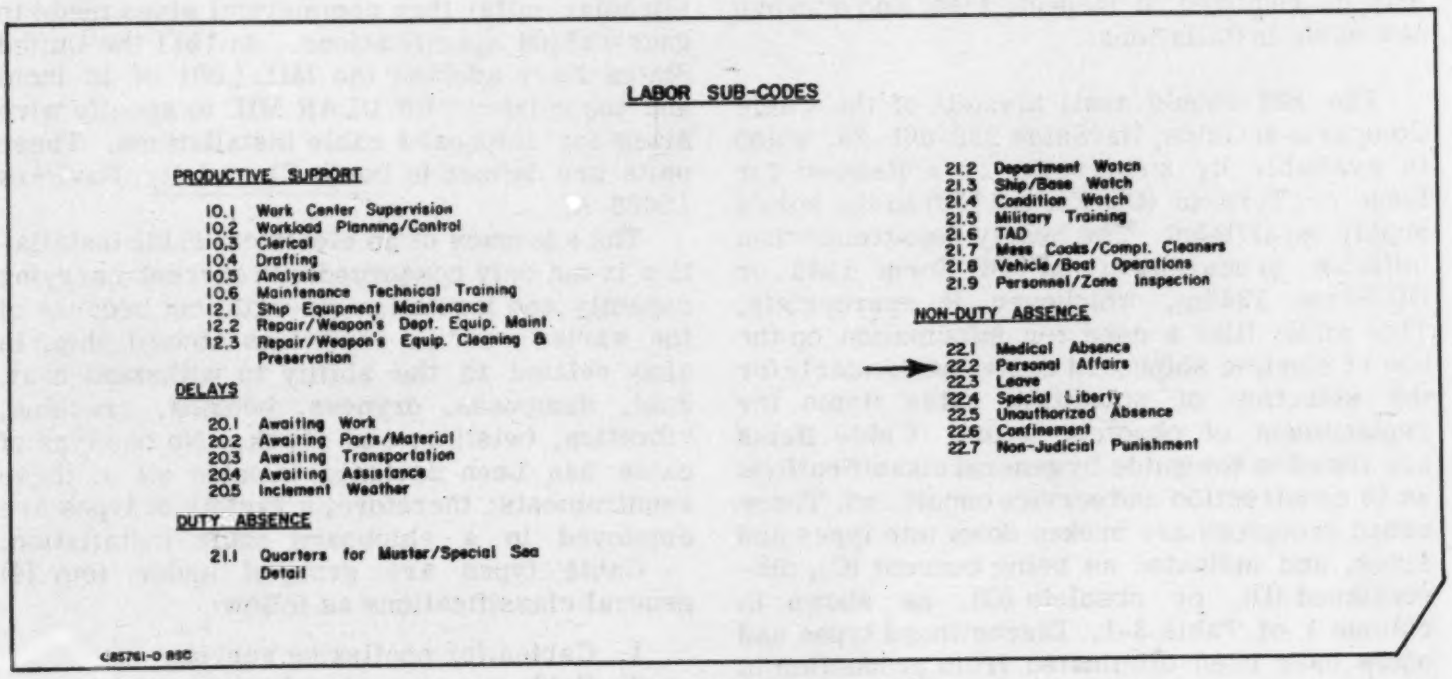

BACK

17.81E

Figure 2-12.—Daily Exception Card.

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CHAPTER 3

ELECTRICAL CABLES AND ACCESSORIES

Proper cable installation and maintenance are as important to the continued operation of an electrical system as the proper installation and maintenance of the equipment to which the cable is connected. The Electrician's Mate must have a thorough knowledge of the various types, sizes, capacities, and uses of shipboard electrical cable, and be capable of selecting, installing, and maintaining cable in such a manner as to ensure its adequacy. The repair of battle damage, accomplishment of ship alterations, and some electrical repairs may require that changes or additions to the ship's cable installation be made by the Electrician's Mate. During shipyard and tender availabilities, he may be required to inspect, test, and approve new cable installations.

The EM should avail himself of the Cable Comparison Guide, NavShips 250-660-23, which is available by submission of a Request for Issue or Turn-in (DD Form 1150) to the ship's supply department. The supply department then initiates procurement on DD Form 1348 or DD Form 1348m, whichever is appropriate. This guide fills a need for information on the use of electric shipboard cable, particularly for the selection of substitute cable items for replacement of obsolete items. Cable items are listed in the guide by general classifications as to construction and service conditions. These broad groupings are broken down into types and sizes, and indicated as being current (C), discontinued (D), or obsolete (O), as shown in column 1 of Table 3-1. Discontinued types and sizes have been eliminated from production in order to conserve certain materials, to simplify procurement, to reduce cost, to save weight and space and to secure better performance. Existing stocks should be used until depleted. Obsolete types have been superseded by current and discontinued (yet available in stock) items which are superior for Navy shipboard use. Chapter 9005 of the NavShips Technical Manual includes replacement cable lists.

The term "watertight cable," designated by an asterisk (*) in the cable guide and in Table 3-1, indicates standard cables in which all spaces under the impervious sheath are filled with material to eliminate voids and to prevent the flow of water through the cable by hose action in the event that an open end of cable is exposed to water under pressure.

An observation which the EM will make is the absence of gage numbers for specifying wire sizes of shipboard cables. This absence is partly due to naval usage of conductors that have other values of cross-sectional area (circular mils) than commercial sizes made to gage-valued specifications. In 1911 the United States Navy adopted the MIL (.001 of an inch) and the related CIRCULAR MIL to specify wire sizes for shipboard cable installations. These units are defined in Basic Electricity, NavPers 10086-A.

The adequacy of an electrical cable installation is not only concerned with current-carrying capacity and insulation strength, but because of the varied service conditions aboard ship, is also related to the ability to withstand heat, cold, dampness, dryness, bending, crushing, vibration, twisting, and shock. No one type of cable has been designed to meet all of these requirements; therefore, a variety of types are employed in a shipboard cable installation.

Cable types are grouped under four (4) general classifications as follow:

1. Cables for nonflexing service
2. Cables for repeated flexing service
3. Cables for special purposes
4. Miscellaneous cables

Reels, coils, and containers of cable shipped by manufacturers are marked to show the year of manufacture. Markings will consist of a strip approximately two inches wide and colored

11318

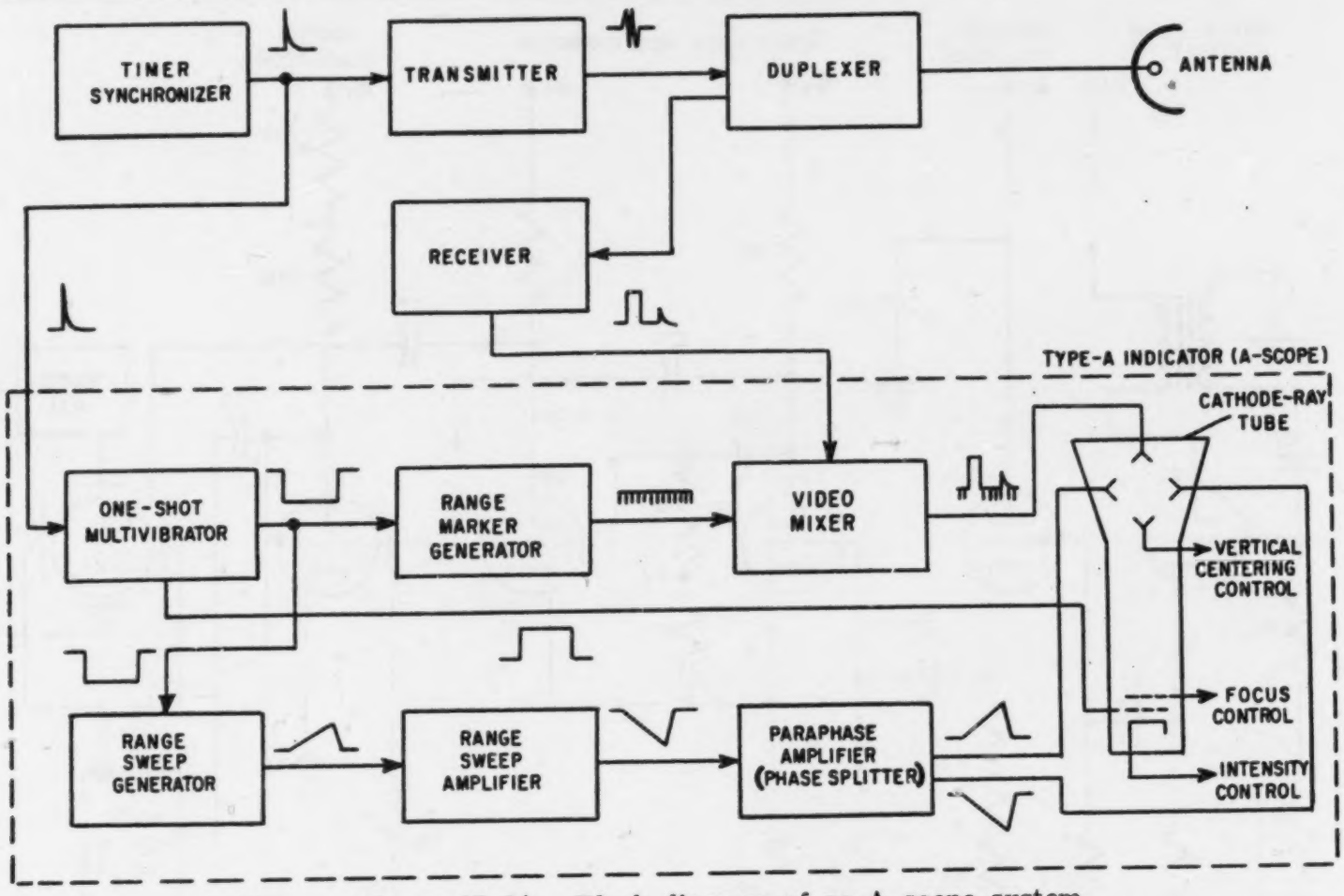

Figure 17-14.—Block diagram of an A-scope system.

input. C4 is a decoupling capacitor used to prevent signals from appearing in the B+ line. The cathodefollower output triggers the single-kick multivibartor (V3 and V4) through C3.

V3 is biased to cutoff, in the static state, due to the zero bias conduction of V4 through R9. The positive input pulse to V3 overcomes this bias, causing V3 to conduct. A negative signal is then coupled to the grid of V4 by C5. This cuts off V4 which will remain cut off until C5 has discharged through R9, R10, and R11. When C5 has discharged, both tubes will return to the static state condition. This completes one cycle of operation.

While V4 has cuttoff, a positive unblanking pulse was coupled to the scope through C7. During the time V3 is conducting, a negative pulse is coupled to the grid of V5 by C6. V5 is a sweep generator and will remain cut off as long as V3 conducts. During this cutoff period, a sawtooth voltage will be developed across C8. The sweep time is determined by the RC time of R14, R15, and C8. The sawtooth sweep voltage is coupled to the sweepamplifier through C9.

B-SCAN

Often the situation in which a radar is used calls for simplicity of circuitry and construction; therefore, B-scan is often used.

In B-scan, three variables are possible. These are range, a function of time; azimuth, a function of antenna rotation; and the intelligence received by the radar or associated equipment.

From the operator's standpoint, the ideal situation would be the presentation of an exact replica of the area scanned. This would involve complicated construction and circuitry. The B-scan represents a compromise between the extremes of simple and complex circuitry.

B-scan involves the simplest circuitry and construction of any two-dimensional presentation and yet presents information in a reasonably faithful replica of the area scanned by the

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Table 3-1.—Cables for Nonflexing Service.

Cur Dis Obs	Type & Size	No of Cdrs	Strands Per Cdr	Diam Copper Cdr	Area Cdr	Outside Diam Cable Max	Stuffing Tube Size: Deck and Bulkhead	Stuffing Tube Size: Equipment	Maximum Rating: Voltage	Maximum Rating: Ambient Temperature 40°C	Maximum Rating: Ambient Temperature 50°C	Min Radius of Bend	Est Wt Per Ft	Federal Stock No
				Inch	Cirmils	Inch			Volts rms	Amperes		Inch	Lbs.	GX6145
	LIGHTING AND POWER—Cont.													
C	DSGA-400*	2	127	.742	413,600	2.119	V	8	1000	492	453	13.0	4.28	184-5897
D	DHFA-400*	2	127	.742	413,600	2.508	Y	9	600	492	453	15.5	4.75	192-7195
O	DHFA-400	2	127	.742	413,600	2.508	Y	9	600	492	453	15.5	4.75	192-7221
O	DLPA-400	2	127	.742	413,600	2.514	Y	9	600	329	251	15.5	4.52	
O	DFPA-400	2	127	.742	413,600	2.508	Y	9	600	579	452	15.0	4.75	
C	TSGA-3*	3	7	.060	2,828	.461	B	2	1000	11	10	3.0	.127	542-6910
D	THFA-3*	3	7	060	2,828	.560	C	4	600	11	10	3.5	.171	190-7489
O	THFA-3	3	7	.060	2,828	.560	C	4	600	11	10	3.5	.171	
C	TSGA-4*	3	7	.076	4,497	.499	C	2	1000	18	17	3.0	.156	542-6903
D	THFA-4*	3	7	.076	4,497	.812	F	4	600	18	17	5.0	.334	190-7488
O	THFA-4	3	7	.076	4,497	.812	F	4	600	18	17	5.0	.334	190-7486
D	FHFA-9*	4	7	.108	9,016	.920	G	5	600	38	35	6.0	.475	299-4429
C	FSGA-23*	4	7	.171	22,800	.890	G	5	1000	61	57	5.5	.525	643-1225
D	FHFA-23*	4	7	.171	22,800	1.130	K	5	600	61	57	7.0	.746	184-1091
C	FSGA-50*	4	19	.254	49,080	1.100	K	5	1000	95	89	6.5	.995	643-1224
D	FHFA-50*	4	19	.254	49,080	1.410	N	6	600	95	89	8.5	1.31	184-1093
C	6SGA-100*	6	61	.363	99,060	1.650	R	7	1000	272	250	10.0	2.74	
C	6SGA-125*	6	61	.407	124,900	1.840	S	8	1000	299	275	11.5	3.37	
C	6SGA-150*	6	61	.457	157,600	2.010	T	8	1000	326	300	12.0	4.17	
C	6SGA-200*	6	61	.514	198,700	2.250	W	9	1000	369	340	13.5	5.19	

Maximum ratings for 6SGA cables are for 400 cycle power circuits only.
*Watertight Construction

as follows for the particular year of manufacture. These markings are repeated at five-year intervals, as follows.

Year of Manufacture	Identifying Color
1962	green
1963	orange
1964	blue
1965	white
1966	red
1967	green
1968	orange

CABLE DESIGNATIONS

Shipboard electrical cables are identified according to type and size. The type designations consist of letters that indicate construction or use. The letters in column 2 of table 3-1 are typical.

TYPE AND SIZE DESIGNATIONS

The types and sizes of lighting and power cables for shipboard applications are numerous. The initial letter of the type designation for lighting and power cables indicates the number

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of conductors the cable contains. These initial letters are S, D, T, or F and indicate, respectively, single, double, triple, or four conductors. Also included in this lighting and power group is the 6SGA type cable (with 6 conductors) which is listed in table 3-1.

The SSGA cable designation shown on table 3-2 indicates by the initial S a single conductor, the SGA part of the designation means shipboard, general use, armored.

The SGA type cable employs silicone rubber and glass as primary insulation, making it heat and flame resistant. Figure 3-1 shows the construction of a DSGA cable. The specified number of insulated stranded copper conductors (listed in columns 2 and 3, in table 3-1) are enclosed in an impervious sheath, braided metal armour, and paint. The cable has a maximum voltage rating of 1000 volts a-c or d-c, and is made watertight by the application of waterproof sealing compound to all interstices (voids) of the conductors and cable core. They supersede the type HFA (Heat and Flame resistant—Armored) whose construction contained synthetic resin and felted asbestos insulation for the smaller sizes (size 3, 4, and 9, shown in table 3-1) and contained asbestos-varnished cambric-asbestos insulation for larger sizes. SGA cables are designed to have a minimum outside diameter and weight as compared to older type cable. In table 3-1 compare the newer type TSGA-3 with the older type THFA-3. It is apparent that both cables will carry the same amperage, but the newer type TSGA-3 is approximately 18% smaller in outside diameter and the weight per foot is 25% less than the older type THFA-3.

From this comparison it can be seen that by using the newer cable we can save on space and weight which is at a premium on combatant naval vessels.

The SGA cables also supersede the type LPA (Lighting and Power, Armored) cables. The LPA contain natural rubber insulation in the smaller cables and varnished cambric insulation in the larger sizes. They are processed (cabled) with filler and binder materials, all of which is covered with a rubber-hose jacket, then armored. SGA cables also supersede the type FPA (Flame Proof—Armored) that contain natural rubber or asbestos-varnished cambric-asbestos insulation, depending on size, cabled with fillers, felt, armored.

Let us inspect further the notations in column 2 of table 3-1. The numerals immediately following the type letters indicate the size of a single conductor, by giving the approximate cross-sectional area expressed in thousands of circular mils. For example, TSGA-3 indicates approximately 3 thousand circular mils; table 3-1 shows the actual area to be 2,828 circular mils. Type SSGA cable is available in conductor sizes ranging from 2,828 through 2,097,000 circular mils (SSGA-3 through SSGA-2000); DSGA and TSGA from 2,828 through 413,600 circular mils (DSGA-3 through DSGA-400 and TSGA-3 through TSGA-400); and FSGA from 2,828 through 60,090 circular mils (FSGA-3 through FSGA-60).

Table 3-1 lists the sizes of stuffing tubes used with particular types and sizes of cable. Metal stuffing tubes are used generally for deck and bulkhead; these tubes are specified for size as shown in the first row of table 3-3 and repeated in column 4 of table 3-3 by using letters. On the other hand, numerals from 1 through 9 are used for nylon stuffing tubes that have generally replaced metal tubes for cable entry to equipment enclosures.

The Electrician's Mate must also identify cables used for degaussing service. Here the initial letters have been restricted to S and M for identifying Single or Multiple conductors, respectively. Thus, SDGA is a Single conductor, DeGaussing, Armored cable. These letters are followed by numbers that have the same significance explained above, which give the approximate cross-sectional area expressed in thousands of circular mils.

TYPE AND SIZE EXCEPTIONS

After analyzing hundreds of symbols for designating type and size as would be given in table 3-1, one becomes aware that a uniform rule for forming them has been attempted. This is true. However, such practice is not uniformly applicable.

A consistent interpretation of the letter T means THREE, as noted in table 3-1. One example of departure is observed (fig. 3-2D) for the TTHFWA-10, where T means Twisted-pair and Telephone. Elsewhere, T sometimes means Tough-jacket as used to identify the TRXF; the next initials (RXF) mean silicone-or-synthetic-Rubber, eXtra Flexible items.

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Table 3-2.—Ratings and Characteristics of Cables for Nonflexing Service (Permanent Installation) Heat and Flame Resistant.

Type	Conductors		Overall diameter (maximum) (inches)	General ampere ratings (maximum)				Minimum radius of bend (inches)	Estimated weight per foot (pounds)
				60-cycle or D.C.		400-cycle			
				Ambient		Ambient			
	Number	Area c.m.		40° C.	50° C.	40° C.	50° C.		
SSGA-									
3....	1	2,828	0.305	15	14	....	....	2.0	0.044
4....	1	4,497	.323	26	24	....	....	2.0	.053
9....	1	9,016	.371	53	49	....	....	2.5	.079
14...	1	14,340	.414	71	65	....	....	2.5	.102
23...	1	22,800	.453	92	85	....	....	3.0	.140
30...	1	30,860	.484	113	104	....	....	3.0	.165
40...	1	38,910	.515	129	119	....	....	3.5	.200
50...	1	49,080	.570	149	137	....	....	3.5	.240
60...	1	60,090	.609	170	156	....	....	4.0	.280
75...	1	75,780	.652	197	181	....	....	4.0	.340
100..	1	99,060	.719	232	214	....	....	4.5	.420
125..	1	124,900	.788	269	248	....	....	5.0	.520
150..	1	157,600	.844	314	289	....	....	5.5	.660
200..	1	198,700	.922	361	332	....	....	6.0	.810
300..	1	296,400	1.051	467	430	....	....	6.5	1.200
400..	1	413,600	1.168	575	530	....	....	7.0	1.653
500..	1	521,600	1.290	671	618	....	....	8.0	1.760
650..	1	657,600	1.421	785	722	....	....	8.5	2.530
800..	1	829,300	1.535	940	865	....	....	9.5	3.191
DSGA-									
3....	2	2,828	.441	13	12	13	12	3.0	.087
4....	2	4,497	.477	22	20	22	20	3.0	.108
9....	2	9,016	.594	44	41	44	41	4.0	.183
14...	2	14,340	.680	60	55	60	55	4.0	.258
23...	2	22,800	.781	78	72	76	72	5.0	.345

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Table 3-2.—Ratings and Characteristics of Cables for Nonflexing Service (Permanent Installation) Heat and Flame Resistant—Continued.

Type	Conductors		Overall diameter (maximum) (inches)	General ampere ratings (maximum)				Minimum radius of bend (inches)	Estimated weight per foot (pounds)
				60-cycle or D.C.		400-cycle			
				Ambient		Ambient			
	Number	Area c.m.		40° C.	50° C.	40° C.	50° C.		
DSGA-(Cont)									
30...	2	30,860	.852	94	87	94	87	5.5	.430
40...	2	38,910	.898	109	100	109	100	5.5	.520
50...	2	49,080	.961	126	116	125	115	6.0	.640
60...	2	60,090	1.031	143	132	142	131	6.5	.768
75...	2	75,780	1.124	168	155	167	154	7.0	.910
100..	2	99,060	1.217	199	183	194	179	7.5	1.139
125..	2	124,900	1.374	228	210	221	203	8.5	1.410
150..	2	157,600	1.479	267	246	254	234	9.0	1.754
200..	2	198,700	1.633	308	284	288	266	10.0	2.196
250..	2	250,500	1.759	361	332	316	291	10.5	2.680
300..	2	296,400	1.891	413	380	347	319	11.5	3.109
400..	2	413,600	2.199	492	453	337	310	13.0	4.226
TSGA-									
3....	3	2,828	.461	11	10	10	10	3.0	.104
4....	3	4,497	.499	18	17	18	17	3.0	.130
9....	3	9,016	.625	39	36	39	36	4.0	.224
14...	3	14,340	.718	51	47	51	47	4.5	.325
23...	3	22,800	.812	69	64	69	64	5.0	.430
30...	3	30,860	.902	84	77	84	77	5.5	.560

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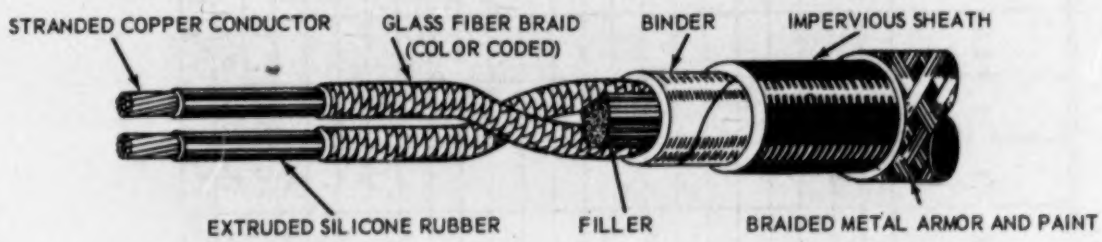

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Figure 3-1.—Type DSGA shipboard nonflexing service cable.

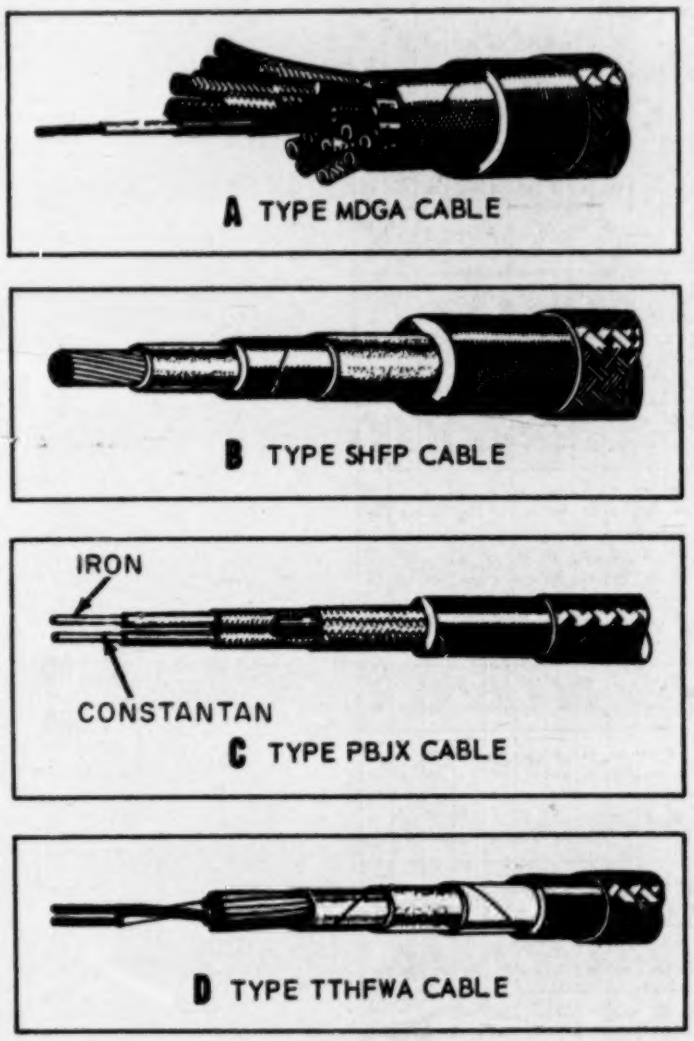

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Figure 3-2.—Nonflexing service cable for special use.

These are classified as special purpose cables, used specifically for welding and portable equipments.

Similarly, departures are noted regarding the use of numerals for "Size Designations" since the numerals may indicate one or more of the following:

1. Number of copper conductors
2. Size of copper conductor
3. Number and size of a conductor
4. Size and number of strands per conductor
5. Number of twisted pairs
6. Maximum rms rated voltage

Examples of the above are as follows:

1. Example: Type MSCA-7 is a Multiple-conductor, Shipboard, Control, Armored cable with 7 conductors. The tabulation in the cable guide would show the area in circular mils.
2. Example: Type FSGA-23 shown in table 3-1 is representative where the numerals indicate the approximate cross-sectional area of any SINGLE conductor expressed in thousands of circular mils (abbreviated in tables variously as CIRMILS or C.M. or cm). This particular item has approximately 23,000 cm (exactly 22,800 cm).
3. Example: The previously described TTHFWA-10 is applicable here. It has 10 pairs, meaning 20 conductors.
4. Example: SS5P designates Single-conductor, Shipboard, 5000 volt, Propulsion; made with silicone treated glass tape insulation, binder, impervious sheath, armored. Comparable sizes of this current (C) cable

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Table 3-3.—Spacing of Holes for Stuffing Tubes and Kickpipes. 77.3

Nominal Dia. of Kickpipe	Drill for Pipe (Medium Steel only)	Drill for Pipe (Special Treatment Steel)	Tube Size	A	B	C	D	E	F	G	J	K	L	M	N	P	R	S	T	V	W	X	Y	Z	AA	BB
3/8	23/32	.406	A	1 15/16																						
1/2	7/8	.515	B	2	2																					
3/4	1 3/32	.640	C	2 1/16	2 1/16	2 1/16																				
3/4	1 3/32	.750	D	2 1/4	2 5/16	2 3/8	2 7/16																			
1	1 21/64	.812	E	2 1/4	2 5/16	2 3/8	2 1/2	2 1/2																		
1	1 21/64	.843	F	2 1/4	2 5/16	2 3/8	2 1/2	2 1/2	2 1/2																	
1	1 21/64	.953	G	2 3/4	2 13/16	2 7/8	2 15/16	3	3	3 1/16																
1 1/4	1 45/64	1.062	J	2 3/4	2 13/16	2 7/8	2 15/16	3	3	3 3/16	3 3/16															
1 1/4	1 45/64	1.171	K	2 3/4	2 13/16	2 7/8	2 15/16	3	3	3 3/16	3 3/16	3 3/16														
1 1/4	1 45/64	1.265	L	2 3/4	2 13/16	2 7/8	2 15/16	3	3	3 1/4	3 1/4	3 1/4	3 1/4													
1 1/2	1 15/16	1.406	M	2 3/4	2 13/16	2 7/8	2 15/16	3	3	3 3/8	3 3/8	3 3/8	3 3/8	3 3/8												
1 1/2	1 15/16	1.515	N	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 9/16	3 11/16	3 3/4	3 13/16	3 13/16	3 15/16	4											
2	2 13/32	1.625	P	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 9/16	3 11/16	3 3/4	3 13/16	3 13/16	3 15/16	4 1/8	4 1/8										
2	2 13/32	1.750	R	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 9/16	3 11/16	3 3/4	3 13/16	3 13/16	3 15/16	4 1/8	4 1/8	4 1/8									
2	2 13/32	1.875	S	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 9/16	3 11/16	3 3/4	3 13/16	3 13/16	3 15/16	4 5/16	4 5/16	4 5/16	4 5/16								
2 1/2	2 29/32	2.062	T	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 9/16	3 13/16	3 13/16	3 13/16	3 13/16	3 15/16	4 7/16	4 7/16	4 7/16	4 7/16	4 7/16							
2 1/2	2 29/32	2.187	V	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16	3 15/16	4 1/16	4 1/8	4 3/16	4 1/4	4 5/16	4 7/16	4 1/2	4 1/2	4 11/16	4 3/4	4 13/16						
2 1/2	2 29/32	2.312	W	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16	3 15/16	4 1/16	4 1/8	4 3/16	4 1/4	4 5/16	4 1/2	4 1/2	4 1/2	4 11/16	4 3/4	4 7/8	4 7/8					
3	3 17/32	2.500	X	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16	3 15/16	4 1/8	4 1/8	4 3/16	4 1/4	4 5/16	4 11/16	4 11/16	4 11/16	4 11/16	4 3/4	5 1/16	5 1/16	5 1/16				
3	3 17/32	2.609	Y	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16	3 15/16	4 1/8	4 1/8	4 3/16	4 1/4	4 5/16	4 11/16	4 11/16	4 11/16	4 11/16	4 3/4	5 1/16	5 1/16	5 1/16	5 1/16			
3	3 17/32	2.781	Z	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16	3 15/16	4 1/8	4 1/8	4 3/16	4 1/4	4 5/16	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	5 1/8	5 1/8	5 1/8	5 1/8	5 5/16		
3	3 17/32	2.875	AA	3 13/16	3 7/8	3 15/16	4	4	4 1/32	4 5/32	4 1/4	4 9/32	4 5/16	4 7/16	4 15/32	4 5/8	4 19/32	4 25/32	4 31/32	4 31/32	5 1/16	5 9/16	5 9/16	5 9/16	5 17/32	
3 1/2	4 1/32	3.156	BB	4	4 1/16	4 1/8	4 3/16	4 3/16	4 7/32	4 11/32	4 7/16	4 15/32	4 1/2	4 5/8	4 27/32	5 1/16	5 1/16	5 1/16	5 13/32	5 13/32	5 13/32	5 31/32	5 31/32	5 31/32	5 31/32	6 13/32

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replace some of the type SHFP (see fig. 3-2B), especially where the SHFP items have only a 3000-volt rating. Other SHFP items have the desired 5000-volt rating with procurement discontinued (D). The Electrician's Mate should check chapter 9005 of NavShips Technical Manual whenever problems of availability arise, being very certain that the latest edition is being consulted.

NONFLEXING SERVICE

Nonflexing service cable designed for use aboard ship is intended for permanent installation and is commonly referred to as such. The cables that are described in the previous paragraphs for use with lighting and power circuits are intended for this nonflexing service. This nonflexing service can be classified further according to its application and is of two types—general use and special use.

GENERAL USE

Nonflexing service cable is intended for use in nearly all portions of electric distribution systems, including the common telephone circuits and most propulsion circuits. Special cases in d-c propulsion circuits for surface ships are excepted in which the impressed voltage is less than 1000 volts.

The previously described SGA (Shipboard, General-use Armored) cable is one type generally found in this general use, nonflexing service.

In this classification is the type MSCA which is a reduced diameter (Multiple-conductor Shipboard, fire control, Armored) watertight cable for use in interior communications, as well as in fire control circuits. This MSCA supersedes the older MHFA type cable.

Cables which are used for small-boat services also are classed within this general use, nonflexing service. Representative is the current (C) series that include the DBSP, TBSP, and FBSP cables; their first initials (D & T & F) as in table 3-1 stand for the number of conductors they contain, namely, Double, Triple, and Four conductors; the initials BSP mean small-Boat, Shielded, Plain. They are constructed with synthetic insulation, cabled with fillers, copper tape shield, gray impervious sheath overall. Numerals follow these initials as in column 2 of table 3-1, which also indicate their approximate cross-sectional area expressed in thousands of circular mils. Here you also find the DBSP-3/5 cable where the fraction 3/5 means "three-fifths of one-thousand cm", or "600 cm" approximately; the tabulation in the cable guide shows the actual area is 703 cm.

SPECIAL USE

There are many shipboard electrical circuits where special requirements of voltage, current, frequency and service must be met in the cable installation and other circuits where general-use, nonflexing service cable may meet the necessary requirements, yet be economically impracticable. For these reasons, there are many different types of nonflexing service cable for specialized use, such as degaussing, telephone, radio, and casualty power. Some of these cables are shown in figure 3-2.

Type MDGA (fig. 3-2A) is a multiconductor cable used in degaussing circuits. Type PBJX (replaced by type TCJA-mil-C-2194 on new construction) cable (fig. 3-2C) consists of one conductor of constantan (red) and one conductor of iron (gray), and is used for pyrometer base leads. Type TTHFWA (fig. 3-2D) is a multiconductor, twisted-pair cable used for telephone circuits.

REPEATED FLEXING SERVICE

Repeated flexing service cable designed for use aboard ship is commonly referred to as being portable because it is principally used as leads to portable electric equipment. It is also of two types—general use and special use.

GENERAL USE

Repeated flexing service cable, which is designed for use as leads to portable equipment and permanently installed equipment where cables are subjected to repeated bending, twisting, mechanical abrasion, oil, sunlight, or where maximum resistance to moisture is required, is distinguished by the letter designation, HOF (Heat and Oil resistant, Flexible).

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This cable contains stranded copper conductors that are insulated with butyl rubber, covered with a tape or braid. The designated number of conductors are twisted together, held by a binder, and covered with an impervious sheath (fig. 3-3).

Repeated flexing service cable designed for general use is of four different types, depending on the number of conductors.

The types are SHOF (single conductor), DHOF (two conductor), THOF (three conductor), and FHOF (four conductor). Type SHOF cable is available in various conductor sizes ranging from 2594 (SHOF-3) through 812,700 circular mils (SHOF-800); types DHOF and THOF from 2613 (DHOF-3 and THOF-3) through 413,500 circular mils (DHOF-400 and THOF-400); and type FHOF from 2613 (FHOF-3) through 137,800 circular mils (FHOF-133).

SPECIAL USE

There are many different types of repeating flexing service cable designed for special requirements of certain installations, including type TTOP and casualty power cables. Two of these types are shown in figure 3-4. Type MHFF (replaced by MHOF-Mil-C-915B) (fig. 3-4A) is used for control circuits in revolving structures, and type TRF (fig. 3-4B) is used for arc-welding circuits.

INSTALLATION

Electrical cables installed aboard U. S. Naval vessels must meet certain requirements determined by the Naval Ships Systems Command. These requirements, published in the General Specifications for Ships of the U. S. Navy, are too numerous to cover in detail in this training course; hence, only the more basic ones are included.

The job of installing nonflexing service cable may be performed by the Electrician's Mate whenever necessary to repair damage or to accomplish authorized ship alterations. Before work is begun on a new cable installation, cableway plans should be available. If repairs to a damaged section of installed cable are to be effected, information on the original installation can be obtained from the plans of the ship's electrical system, which are normally on file in the engineering department office (log room) aboard ship. If a ship alteration is to be accomplished, applicable plans not already on board can be obtained from the naval shipyard listed on the authorization for the alteration (SHIP ALT) at the planning yard for the ship.

Cables installed aboard ship must have maximum usable life under service conditions of temperature, moisture, and mechanical abuse. Also, they must have minimum weight for the service intended. The cables must be located to (1) minimize damage from battle action, (2) avoid physical and electrical interference with other equipment and cables, and (3) provide for the maximum dissipation of internally generated heat.

SELECTING CABLE

Two-conductor cable shall be installed for 2-wire, d-c and single-phase, a-c circuits. Three-conductor cable shall be installed for 3-wire, d-c or 3-phase, a-c circuits. Four-conductor cable shall be installed where two 2-wire lighting circuits are run in the same

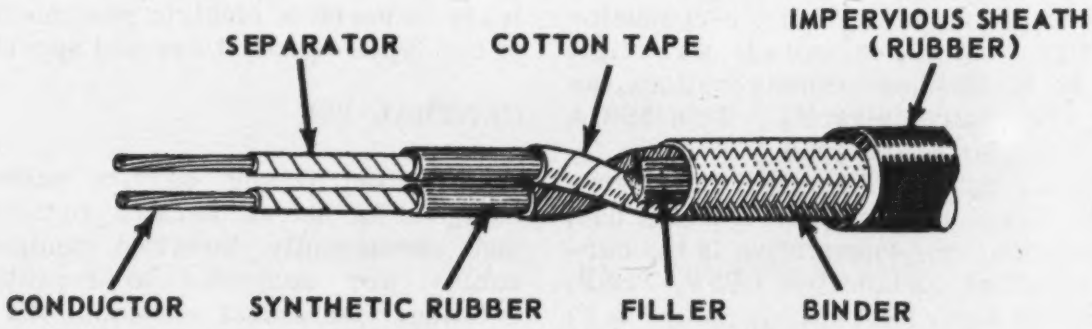

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Figure 3-3.—Type DHOF cable.

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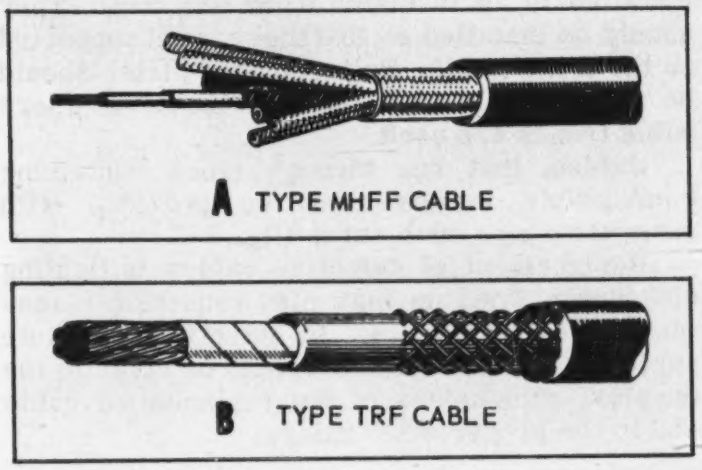

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Figure 3-4.—Repeated flexing service cable for special use.

cable. Four-conductor and multiconductor cable shall be installed for control circuits and communications circuits as necessary.

Ambient temperature, load current, and voltage drop are the principal factors that determine the proper size cable to be used in a particular installation. Ratings and characteristics tables, which specify the maximum current carrying capacities of the various types of shipboard electrical cables at 40° C and 50° C ambient temperatures, are contained in Chapter 9005 of the NavShips Technical Manual. Cables installed in U. S. Naval vessels must comply with the requirements of these tables. A portion of the table for nonflexing service cables is shown in table 1.

To select the proper size cable for a particular installation, it is necessary to know (1) the total connected load current, (2) the demand factor, (3) the resultant load current, and (4) the allowable voltage drop.

The total connected load current for d-c power circuits is determined by adding the sum of the rated current of the connected loads as listed on the identification plates of connected motors and appliances and an additional 100 watts for each receptacle not specifically indicated. For a-c power circuits the connected load current of the connected motors and appliances is added vectorially to obtain the total connected load current.

The demand factor of a circuit is the ratio of the maximum load averaged for a 15-minute period to the total connected load on the cable. If the feeder demand factor for a group of loads cannot be determined, a value of 0.9 may be assumed. For power systems supplying a single-phase load or for a lighting system branch, submain, and main circuits, the demand factor is unity.

The resultant load current is the product of the total connected load current and the demand factor of the circuit. For most installations with which the Electrician's Mate is concerned, the resultant load current and the total connected load current will be the same value. In other words, the demand factor of these circuits will be unity. Cable sizes are usually selected on the basis of maximum current-carrying capacity and allowable voltage drop. However, if the length of the cable installation is short and the total connected load is small, the resultant load current is usually the principal factor that determines the size of the cable to be used, and it is not necessary to calculate the allowable voltage drop. For other cases, however, the allowable voltage drop would be determined by design engineers, either at the time the ship was planned, or during ship alterations for addition of major equipments at the planning yard for the ship.

The voltage drop (difference in voltage between any two points in a circuit) is expressed as a percentage of the rated switchboard (or switchgear group) bus voltage or the transformer nominal voltage. The maximum percent voltage drop allowed for a circuit is specified by the Bureau of Ships and varies according to the intended service of the circuit. For example, GENERAL SPECIFICATIONS FOR SHIPS specifies that the size of cables for an a-c ship's service lighting system, when calculated using a resistivity of 12 ohms per circular mil foot (resistivity of copper at 45 degrees centigrade), will not exceed 6 percent exclusive of transformer regulation.

WIREWAYS

Before installing new cable, survey the area to see if there are spare cables in existing wireways and spare stuffing tubes that can be used in the new installation. The cable run must be located so that damage from battle will be minimized, physical and electrical interference with other equipment and cables will be avoided, and maximum dissipation of internally generated heat will occur.

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First consideration must be to protect the cable against battle damage. The protection afforded by the ship's structure must be fully used. Do not run cables on the exterior of the deckhouse or similar structures above the main deck, except where necessary because of the location of the equipment served, or because of structural interferences or avoidance of hazardous conditions or locations. Where practicable, route vital cables along the inboard side of beams or other structural members to afford maximum protection against damage by flying splinters or machine gun strafing. Where exposed runs of vital cables are unavoidable, a method of protection approved by the Bureau of Ships must be used.

Where practicable, avoid installing cable in locations subject to excessive heat, and never install cable adjacent to machinery, piping, or other hot surfaces having an exposed surface temperature greater than 150° F. In general, cables shall not be installed where they may be subjected to excessive moisture. Cable runs that are unavoidably near fire mains and water, steam, oil, or other piping should be provided with drip-proof shields or other barriers to protect against damage from leaks or high-temperature steam.

If any other location is practicable, electric cables should not be run through spaces where hazardous materials are stored or handled (hangar spaces, powder magazines, gasoline stowage compartments, etc.) or through adjacent spaces that are normally open to such spaces. If cables must be run through hazardous spaces, only heat- and flame-resistant armored cable shall be used in such spaces, and through cables shall be of unbroken length within spaces. Cables terminating at equipment in these spaces shall be of unbroken lengths; however, a single cable may be run between lighting fixtures when more than one fixture is installed in such spaces.

Cables that terminate in, or are routed solely within, highly hazardous spaces, such as gasoline pump rooms, and gasoline filter rooms, must be provided with special protection. Protect these cables by installing them in watertight or channel-shaped steel casings of sufficient strength. Air spaces must be provided between protective casings to facilitate heat dissipation and to prevent condensation of the cables. Drainage must be provided for the casings (fig. 3-5).

Cables that run through gasoline stowage compartments and spaces containing stowage for other flammable volatile liquids must be installed in an insulated trunk (fig. 3-6). They should be installed so that they are not supported on the trunk itself. Bolted access plates should be provided in each stuffing tube area where cable trunks are used.

Cables that run through tanks containing combustible liquids must be provided with concentric pipe enclosures (fig. 3-7).

Replacement of defective cables in lighting and power systems may also require replacement of cable fittings. In selecting substitute cables, careful attention should be given to the physical dimensions of the replacement cable and to the proper size fittings.

FITTINGS

Stuffing Tubes

Stuffing tubes (fig. 3-8A, B, and C) are used to provide for the entry of electric cable into splashproof, spraytight, submersible, and explosion-proof equipment enclosures. Cable clamps, commonly called box connectors (shown in figure 3-9), may be used for cable entry into all other types of equipment enclosures, except that top entry into these enclosures shall be made dripproof through stuffing tubes or cable clamps sealed with plastic sealer.

Below the main deck, stuffing tubes are used for cable penetrations of watertight decks, watertight bulkheads (fig. 3-10), and watertight portions of bulkheads that are watertight only to a certain height. Above the main deck, stuffing tubes are used for cable penetrations of (1) watertight or airtight boundaries; (2) bulkheads designed to withstand a waterhead; (3) that portion of bulkheads below the height of the sill or coaming of compartment accesses; (4) flametight or gastight, or watertight bulkheads, decks, or wiring trunks within turrets or gun mounts; and (5) structures subject to sprinkling.

Stuffing tubes are made of nylon, steel, brass, or aluminum alloys. Nylon tubes have very nearly replaced metal tubes for cable entry to equipment enclosures. Cable penetration of bulkheads and decks using nylon stuffing tubes is limited for use above the watertight level of a vessel. The watertight level is the highest expected water level (determined by the Bureau of Ships studies of stability and reserve buoyancy) and is indicated on the applicable ship's plans. The nylon tube

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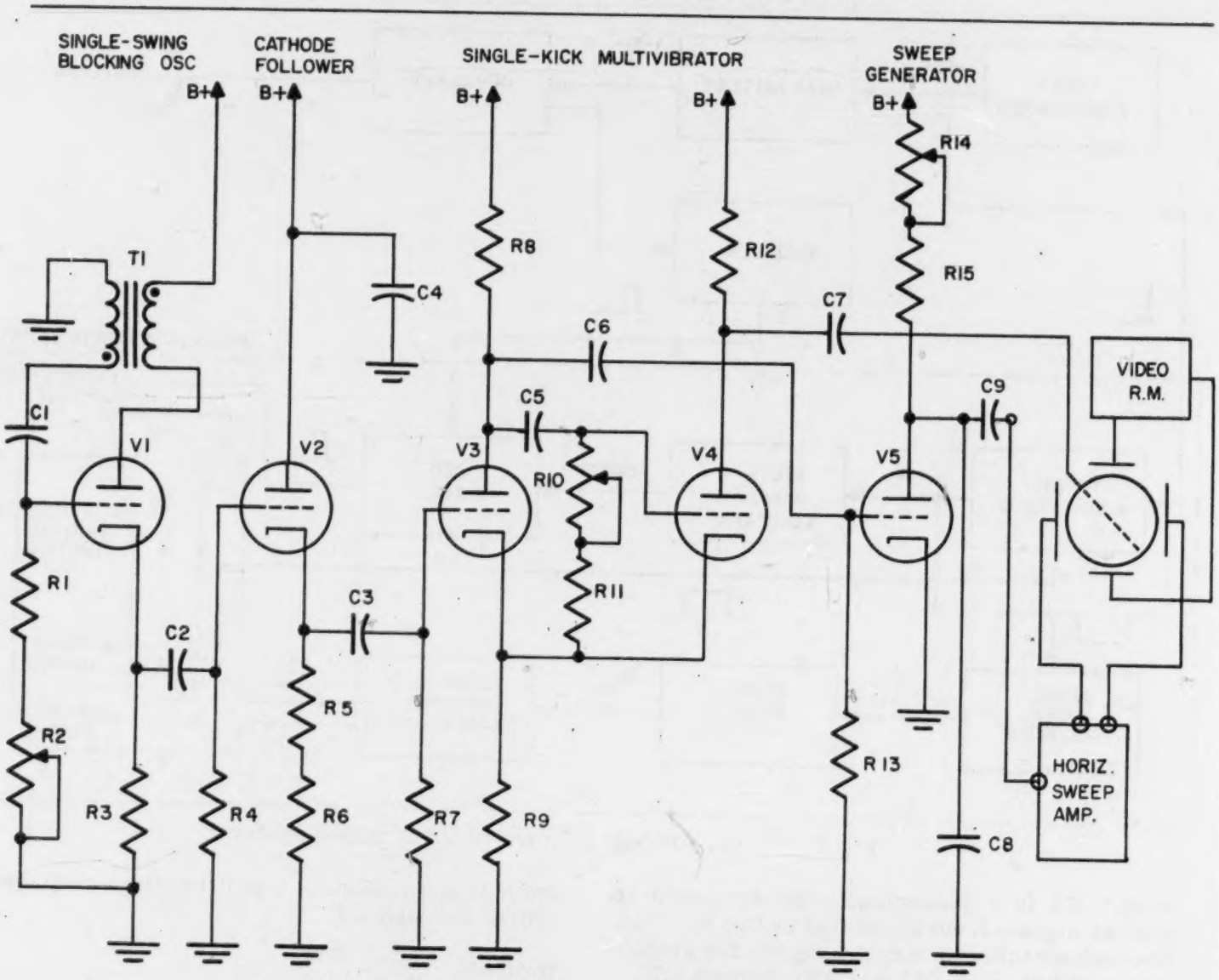

Figure 17-15.—A-scan sweep, schematic diagram.

antenna, as shown in figure 17-16. It works best under conditions where the antenna scans a sector of less than 180°, but it can be employed in a situation where a 360° area is scanned.

Range is usually presented vertically by the use of a conventional sweep circuit. Refer to the B-scope block diagram in figure 17-17. The scope presentation may be created by either magnetic or electrostatic deflection. Since electrostatic deflection is usually employed, the final amplifiers are operated push-pull to gain the advantage of good sweep linearity.

Azimuth is presented horizontally by the use of a potentiometer that is mechanically connected to the antenna. The output of the potentiometer controls the horizontal push-pull amplifiers which in turn controls the horizontal deflection.

The intelligence is presented on the indicator by intensity-modulating the sweep. The antenna scanning speed is approximately one scan per second, whereas the sweep speed is at the PRF rate; therefore, the intelligence will also have range and bearing.

Sweep Circuit Theory

The master timing pulse (MTP) is often developed by the transmitter itself so that exact synchronization is possible with a minimum of circuitry. As shown in figure 17-18, it is coupled through C1 to the grid of V6. Inspection should reveal that V6 and V7 comprise

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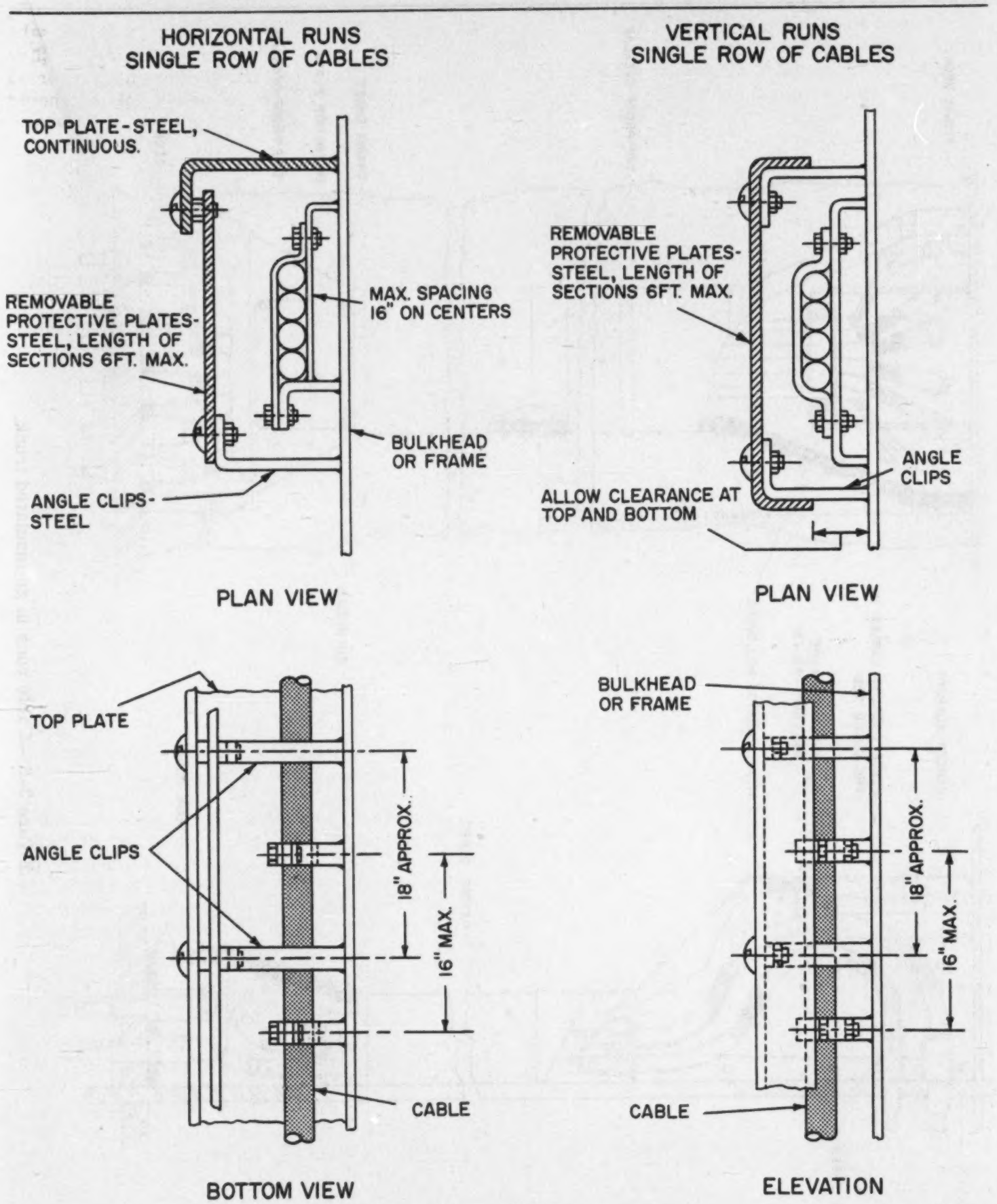

Figure 3-5.—Cable runs with protective casings.

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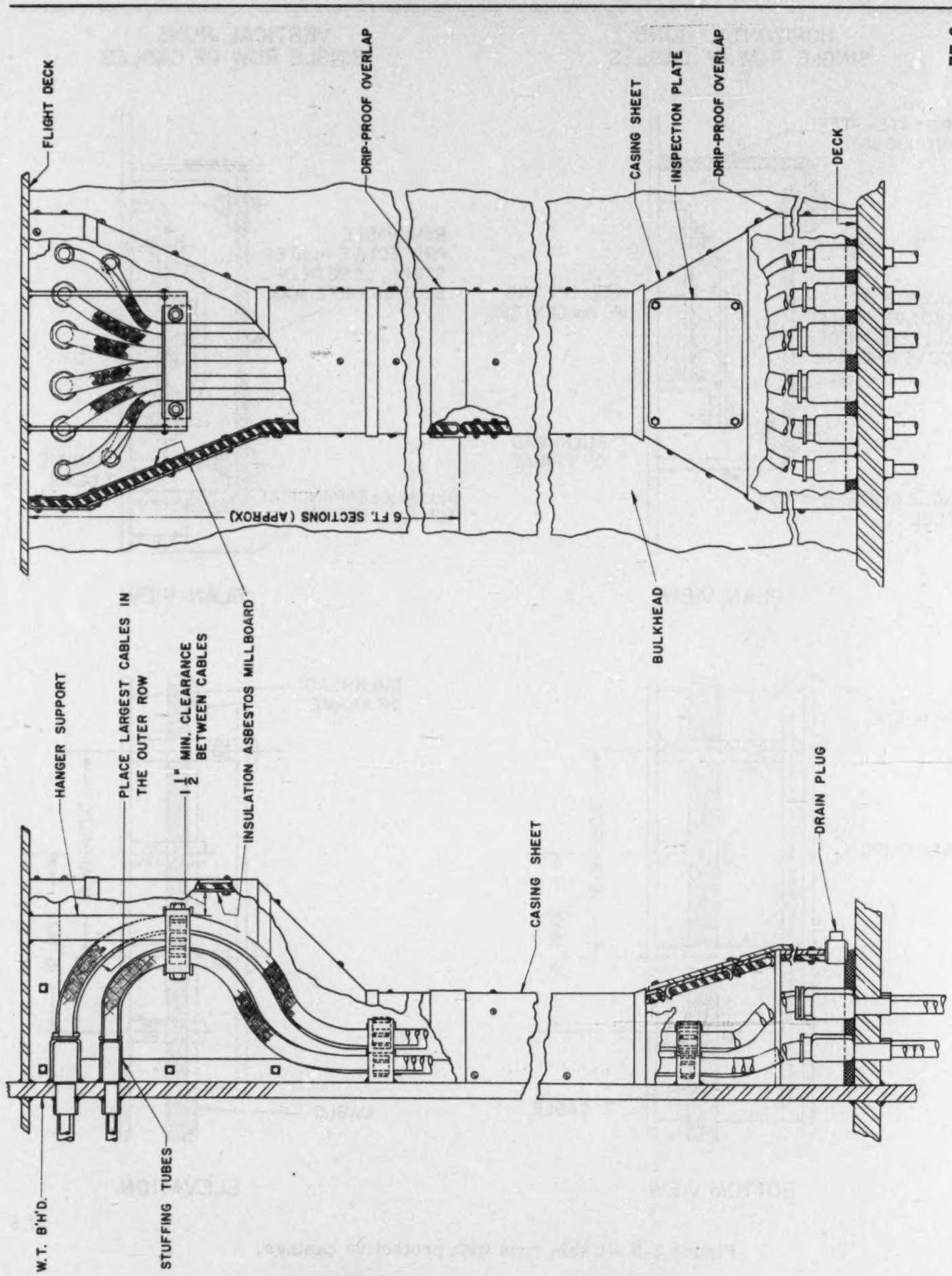

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Figure 3-6.—Cable runs in an insulated trunk.

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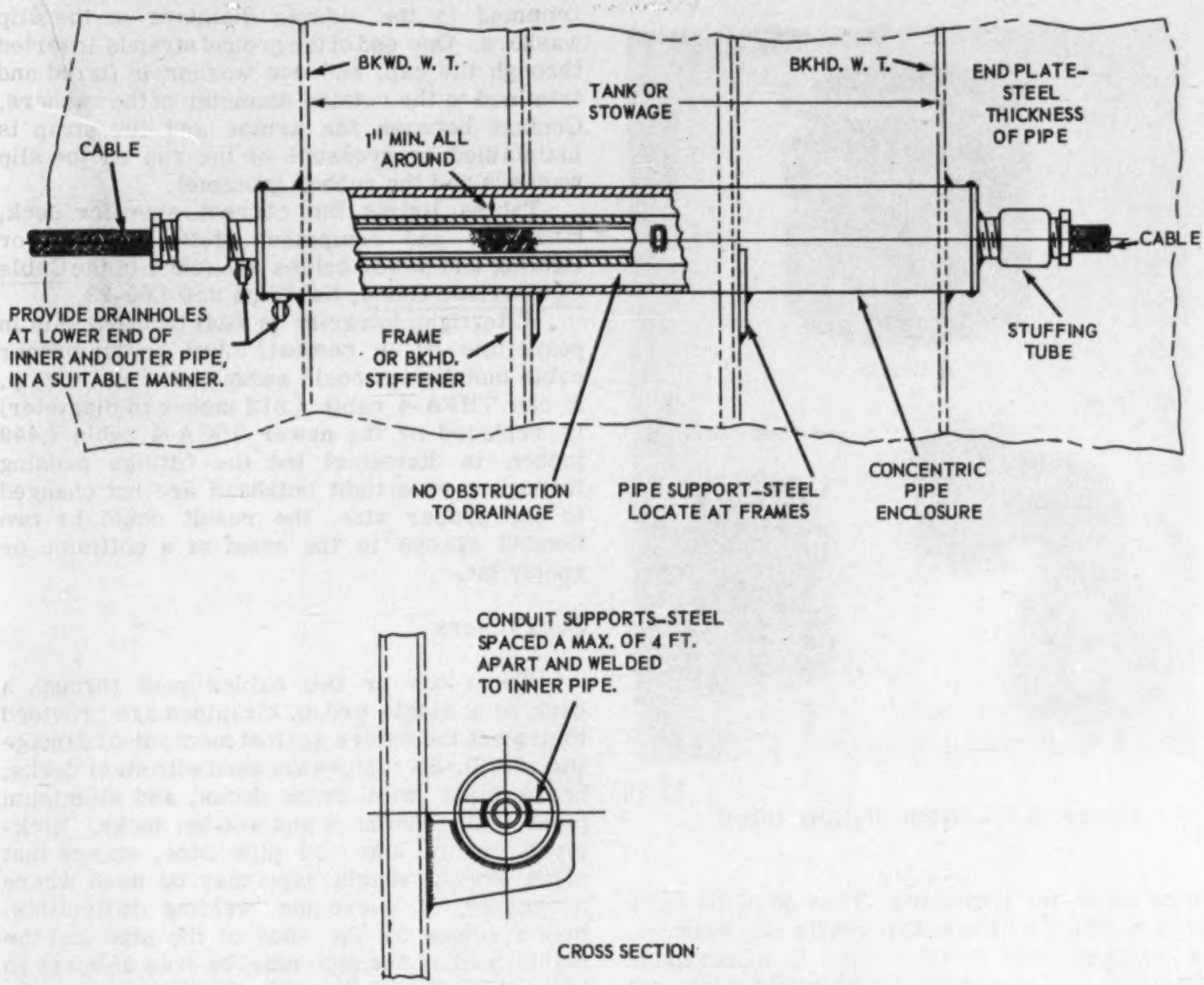

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Figure 3-7.—Concentric pipe enclosure cable installation.

is a lightweight, positive-sealing, noncorrosive stuffing tube, which requires only minimum maintenance for the preservation of watertight integrity (fig. 3-11). The watertight seal between the entrance to the enclosure and nylon body of the stuffing tube is made with a neoprene "O" ring, which is compressed by a nylon locknut (fig. 3-12A). A grommet type, neoprene packing is compressed by a nylon cap to accomplish a watertight seal between the body of the tube and the cable. Two slip washers act as compression washers on the grommet as the nylon cap of the stuffing tube is tightened. Grommets of the same external size, but with different sized holes for the cable, are available. This allows a single-size stuffing tube to be used for a variety of cable sizes, and makes it possible for nine sizes of nylon tubes to replace 23 sizes of aluminum, steel, and brass tubes.

The nylon stuffing tube is available in two parts. The body "O" ring, locknut, and cap comprise the tube; and the rubber grommet, two slip washers, and one bottom washer comprise the packing kit.

A nylon stuffing tube that provides cable entry into an equipment enclosure is applicable to both watertight and nonwatertight enclosures (fig. 3-11A). Note that the tube body is inserted

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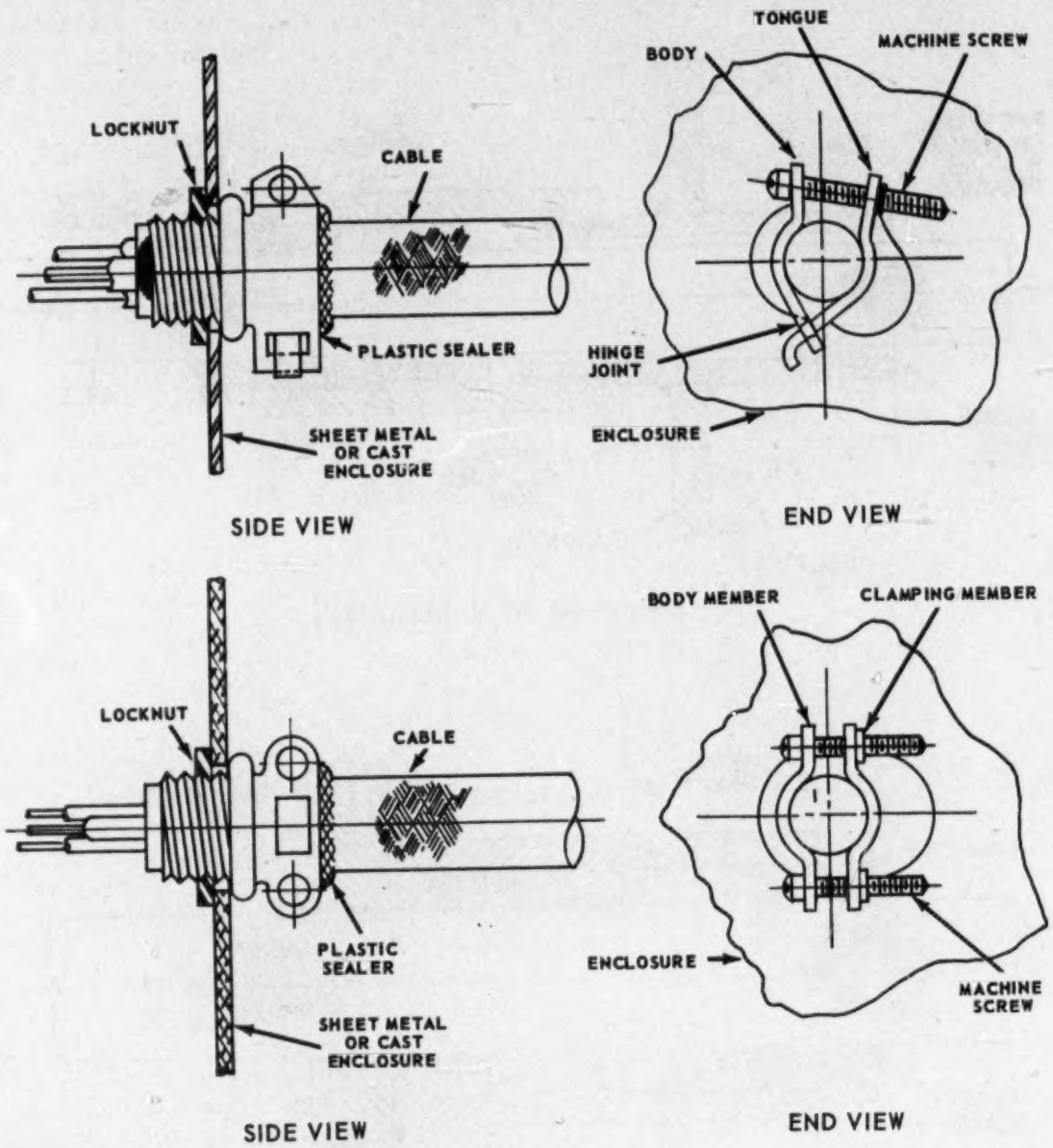

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Figure 3-9.—Cable clamps.

access plate of expanded metal or perforated sheet metal (fig. 3-15A). Stuffing tubes are not required with riser boxes for cable passage through nonwatertight decks (fig. 3-15B).

The minimum spacing of holes for stuffing tubes and kickpipes is indicated in table 3-2. Tube sizes indicated are for metal tubes. For nylon tubes, the spacing is the same as for a metal tube of comparable size.

Cable Supports

The single cable strap is the simplest form of cable support. The cable strap is used to secure cables to bulkheads, decks, cable hangers, fixtures, etc. (fig. 3-16). The one-hole cable strap (fig. 3-16A) may be used for cables not exceeding five-eighths of an inch in diameter. The two-hole strap (fig. 3-16B) may be used for cables over five-eighths of an inch in diameter.

A more complex cable support is the cable rack, which consists of the cable hanger, cable strap, and hanger support (fig. 3-17). The types of cable straps are (1) contour straps, (2) semicontour straps, and (3) cable bands. The

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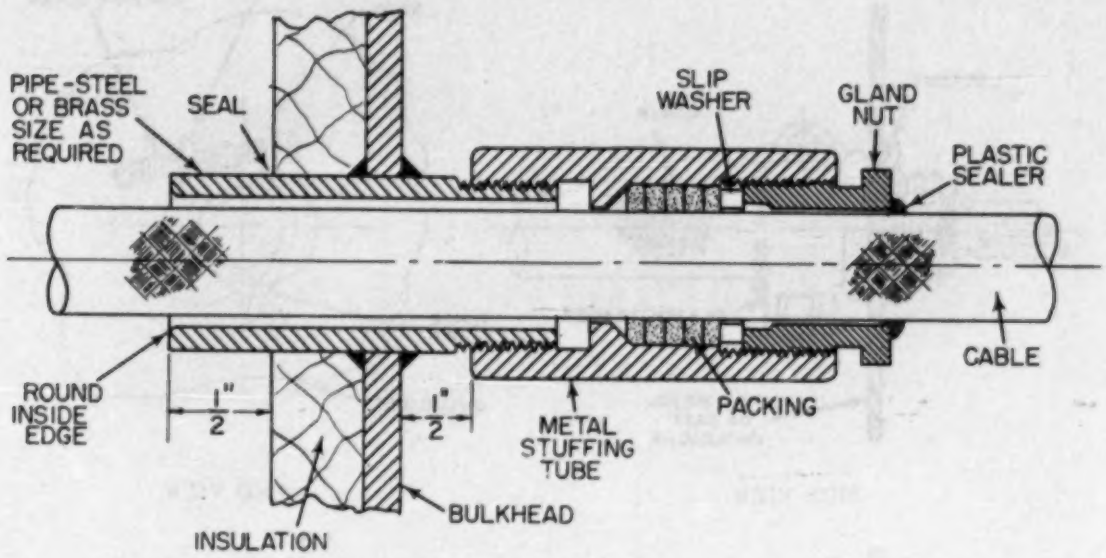

BULKHEAD WITH INSULATION

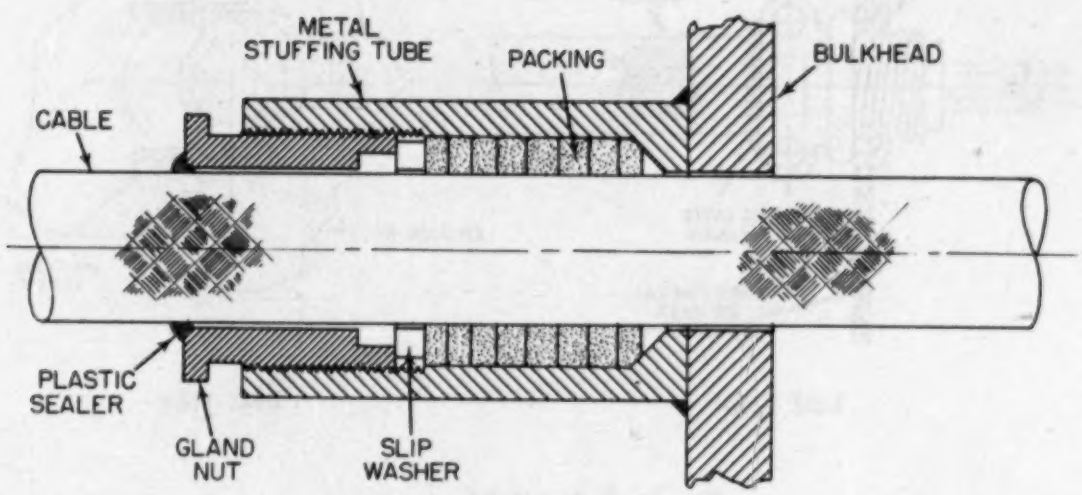

BULKHEAD WITHOUT INSULATION

77.9

Figure 3-10.—Stuffing tubes on watertight bulkheads.

contour and semicontour straps are illustrated in figure 3-17A. The cable band is illustrated in figure 3-17B. Contour straps do not require the special grouping (by size) of cables that the use of either semicontour straps or cable bands entails. However, contour straps are more difficult to fabricate than semicontour straps, and cable bands are the simplest of the three to install because they do not require preforming.

Cable bands require hangers, which are designed to contain the banding without damaging it. The one-hole hanger (fig. 3-18) is available in sizes to accommodate one or more cables up to 2 inches in diameter. The two-hole hanger (fig. 3-19) ranges in width from 3 inches to

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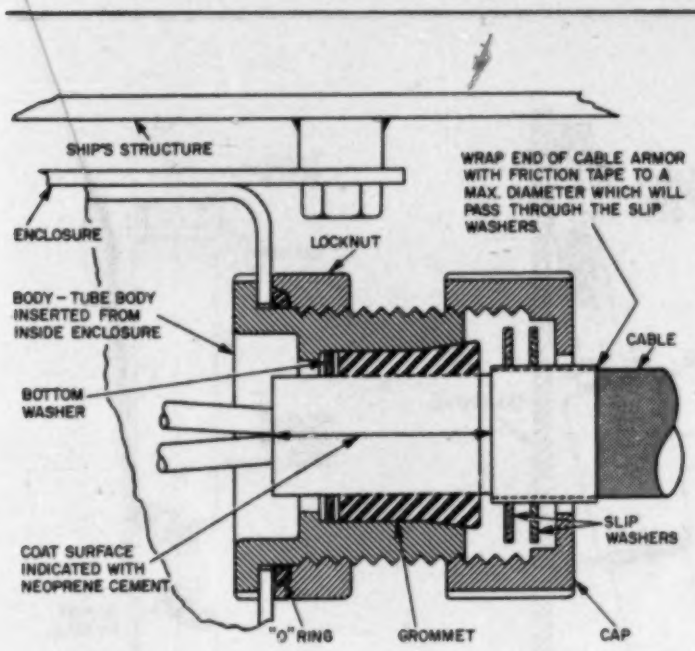

A

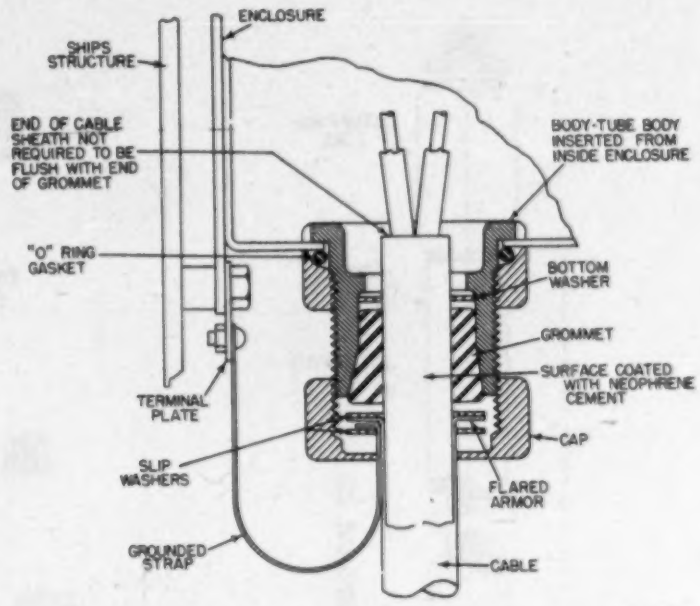

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Figure 3-12.—Nylon stuffing tube grounded installation.

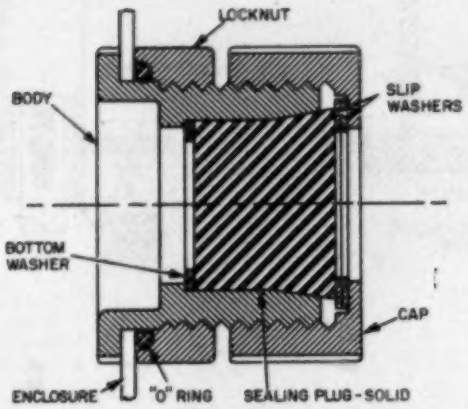

B

77.10

Figure 3-11.—Typical nylon stuffing tube installations.

a maximum of 15 inches. For all applications, the width of the banding hanger must not be less than the overall width of the cables that it is intended to support.

Banding material is five-eighths of an inch wide, and may be zinc-plated steel, corrosion resistant steel or aluminum, depending on the requirements of the installation. Apply banding material in the manner shown in figure 3-20. Apply one turn of banding for a single cable less than one inch in diameter (fig. 3-18). Apply two turns of banding for single cables of one inch or more in diameter and for a row of cables (fig. 3-19). Apply three turns of banding for partially loaded hangers where hanger width exceeds the width of a single cable or a single row of cable by more than one-half inch (fig. 3-20). Add ferrules (fig. 3-19B) before applying banding material to partially loaded hangers. The application of banding material is illustrated in figure 3-20. A steel band of 0.015 inch thick may be used for cable bands, except when the weight of the cables is supported by the band, and any cable in the row is 2 inches or more in diameter. Then a steel band 0.020 inch thick must be used. An aluminum band 0.025 inch thick may be used where cables are less than 2 inches in diameter, and cable hangers are on centers no greater than 16 inches. For weatherdeck installations, use corrosion resistant steel band with copper armored cables; zinc-coated steel with steel armor; and aluminum with aluminum armor.

Cables must be supported so that the sag between supports, when practicable, will not exceed one inch. Five rows of cables may be supported from an overhead in one cable rack, and two rows of cables may be supported from a bulkhead in one cable rack. As many as 16 rows of cables may be supported in main cableways, in machinery spaces and boiler rooms. Not more than one row of cables shall be installed on a single hanger.

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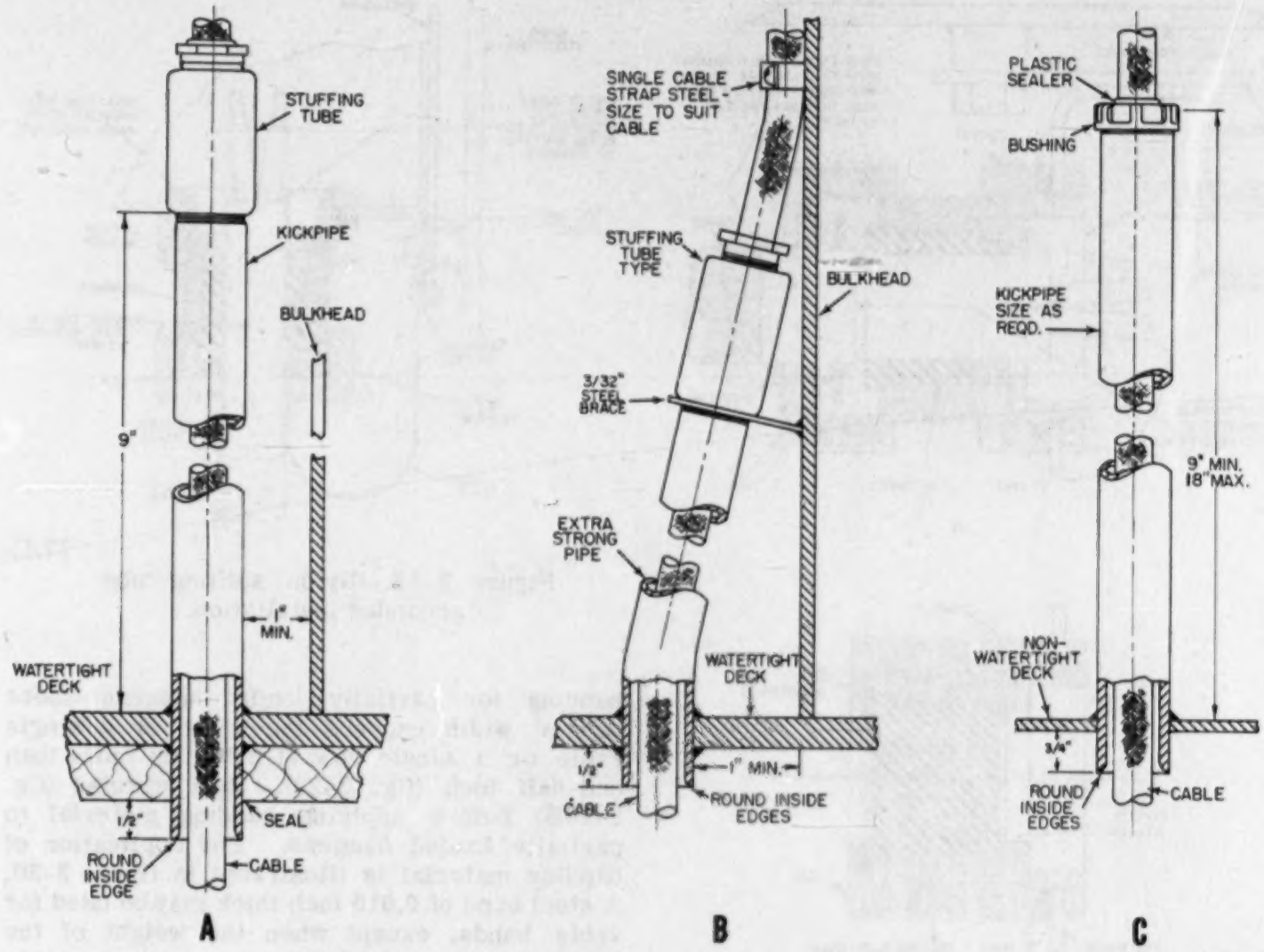

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Figure 3-13.—Typical kickpipe installations.

The spacing of simple cable supports, such as those shown in figures 3-16 and 3-18 must not exceed 32 inches center to center. Spacing of the more complex supports, such as cable racks for main cableways, depends on the requirements of the installation but must not exceed 32-inch centers.

CABLE MARKINGS

Metal tags embossed with the cable designation are used to identify all permanently installed shipboard electrical cables. These tags, when properly applied, afford easy identification of cables for purposes of maintenance and replacement.

Two systems of cable marking (the old and the new) may be found aboard naval vessels. The old system used the color of the tag to denote cable classification and the following letters to designate power and lighting cables for the different services:

C—Interior communications
D—Degaussing
F—Ship's service lighting and general power
FB—Battle power
G—Fire control
MS—Minesweeping
P—Electric propulsion
R—Radio and radar
RL—Running, anchor, and signal lights
S—Sonar
FE—Emergency light and power

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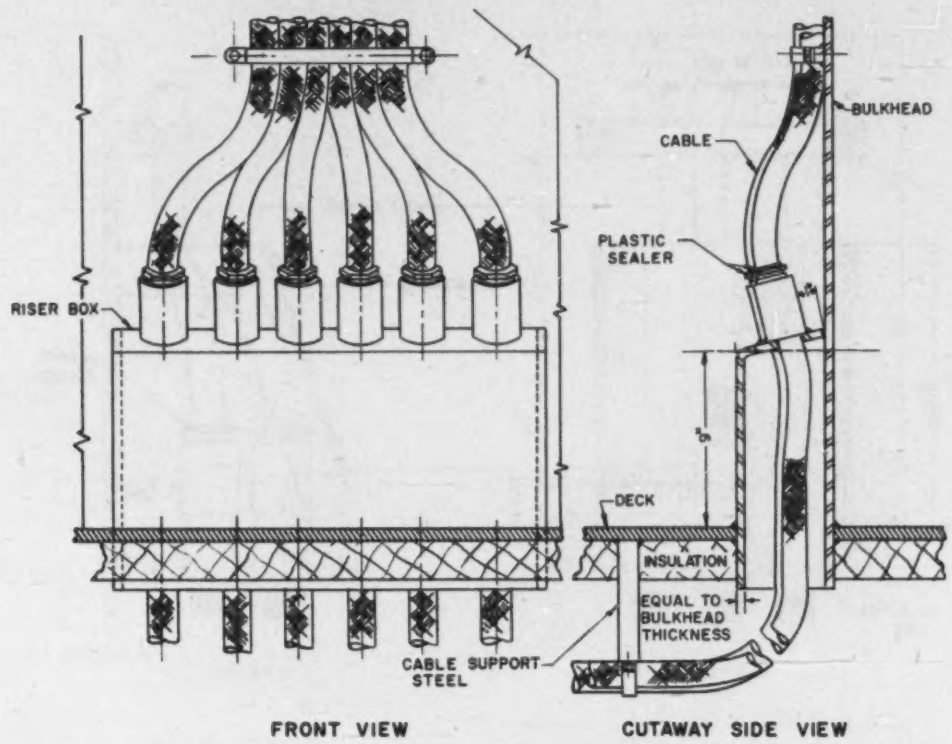

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Figure 3-14.—Watertight riser box weatherdeck installations.

Other letters and numbers were used with these basic letters to further identify the cable and complete the designation. Typical marking of a power system for successive cables from a distribution switchboard to load would be as follows: feeder, FB-411; main, 1-FB-411; submain, 1-FB-411A; branch, 1-FB-411A1; and subbranch, 1-FB-411-A1A. The feeder number, 411, is indicative of the system voltage. The feeder numbers for a 117- or 120-volt system would range from 100 to 199; for a 220-volt system, from 200 to 299; and for a 450-volt system, from 400 to 499. The exact designation for each cable is given on the electrical wiring plans of each vessel.

The new system for marking power and lighting cable indicates the source and, where practicable, the destination of the cable. Therefore, a thorough knowledge of the system for numbering electrical machinery and equipment aboard ship is necessary to fully understand the new system of cable marking. Except as otherwise specified in this chapter, the general rule for numbering machinery and equipment is used for numbering similar units of electrical machinery or equipment.

The general rule for numbering machinery and equipment states, in effect:

1. All similar units in the ship comprise a group, and each group is assigned a separate series of consecutive numbers beginning with 1.
2. Numbering begins in the lowest foremost starboard compartment, and the next compartment selected is to port of the first if it contains similar units; otherwise the next aft on the same level.
3. Proceeding from starboard to port and from forward to aft, the numbering procedure continues until all similar units on the same level have been numbered; then continues on the next upper level, and so on, until all similar units on all levels have been numbered.
4. Within each compartment, the numbering of similar units proceeds from starboard to port, forward to aft, and from a lower to a higher level.

Switchboards or switchgear groups supplied directly from ship's service generators are designated 1S, 2S, and so on as necessary to designate all ship's service switchboards. Switchboards supplied directly by emergency generators are designated 1E, 2E, and so on, as necessary to designate all emergency switchboards. Switchboards for special frequency (other than the frequency of the ship's service system) have a-c generators designated 1SF,

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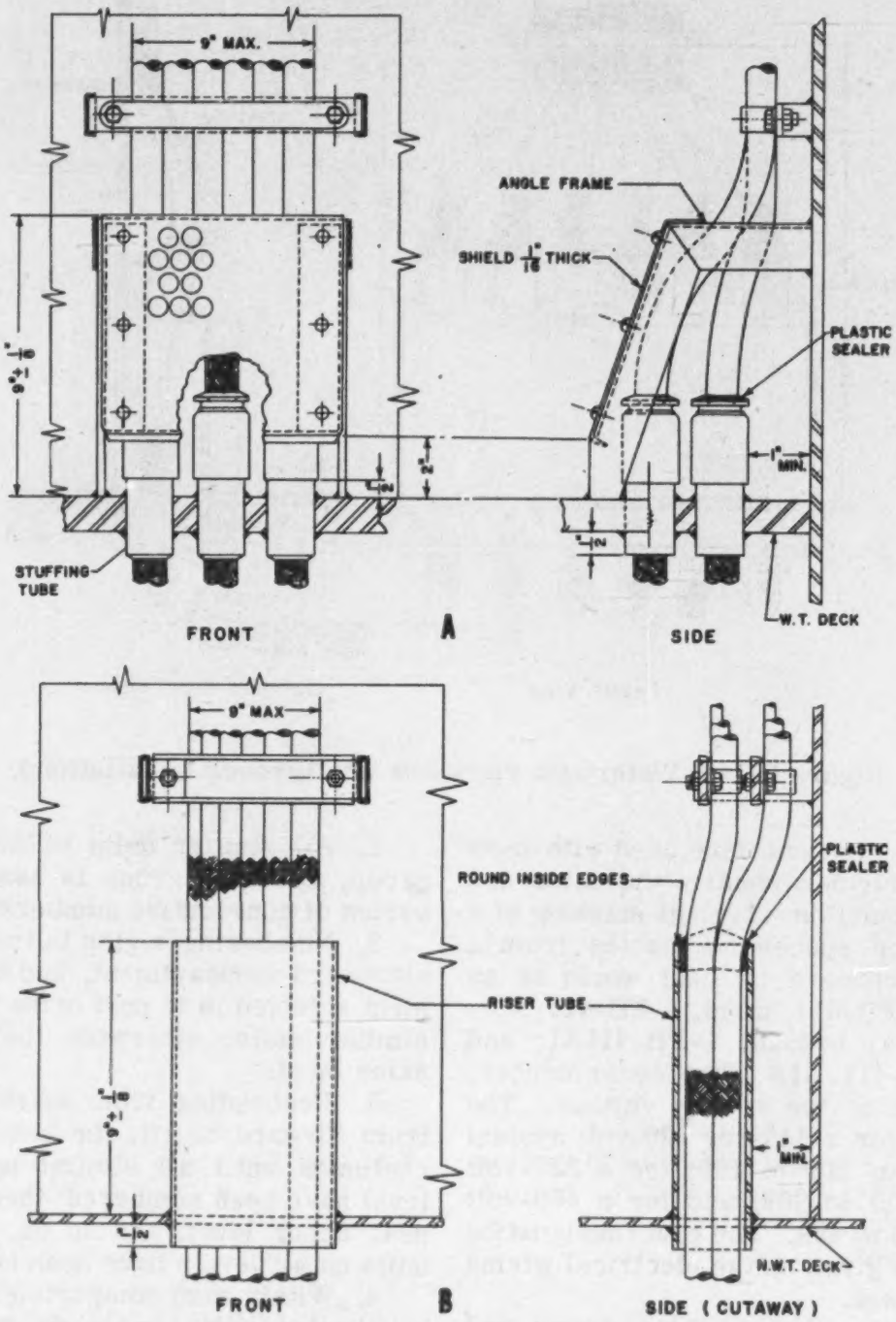

Figure 3-15.—Interior riser box installations. 77.14

2SF, and so on, as necessary to designate all special frequency switchboards. Switchboards for coolant-pumping power generators are designated 1SC, 2SC, and so on, as necessary to designate all such switchboards. These designations are used only where the coolant-pumping power generators are separate from the ship's service generators.

Sections of a switchgear group other than the generator section are designated by an additional suffix letter starting with the letter, A, and preceeding in alphabetical order from left to right (it is assumed that the viewer is facing the front of the switchgear group). See switchgear group Nos. 4S and 6S (figs. 3-21 and 3-22), respectively.

Some large naval vessels are equipped with zone control, a system of ship's service distribution wherein the ship is divided into areas generally coinciding with fire zones, as dictated by the damage control plan of the ship. Power is distributed within each zone from load center

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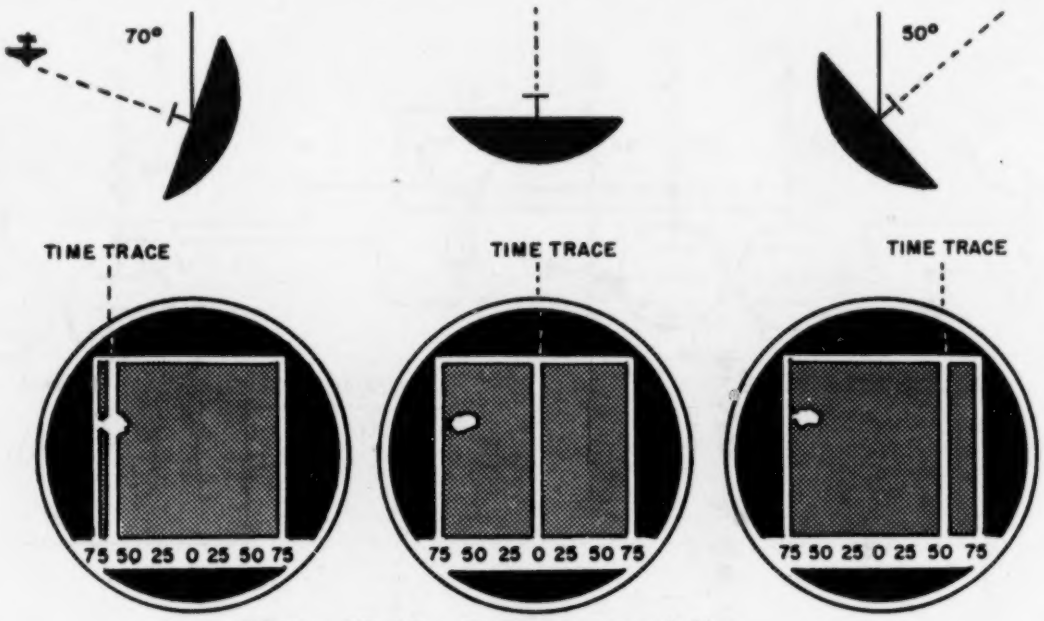

Figure 17-16. —B-scan presentation.

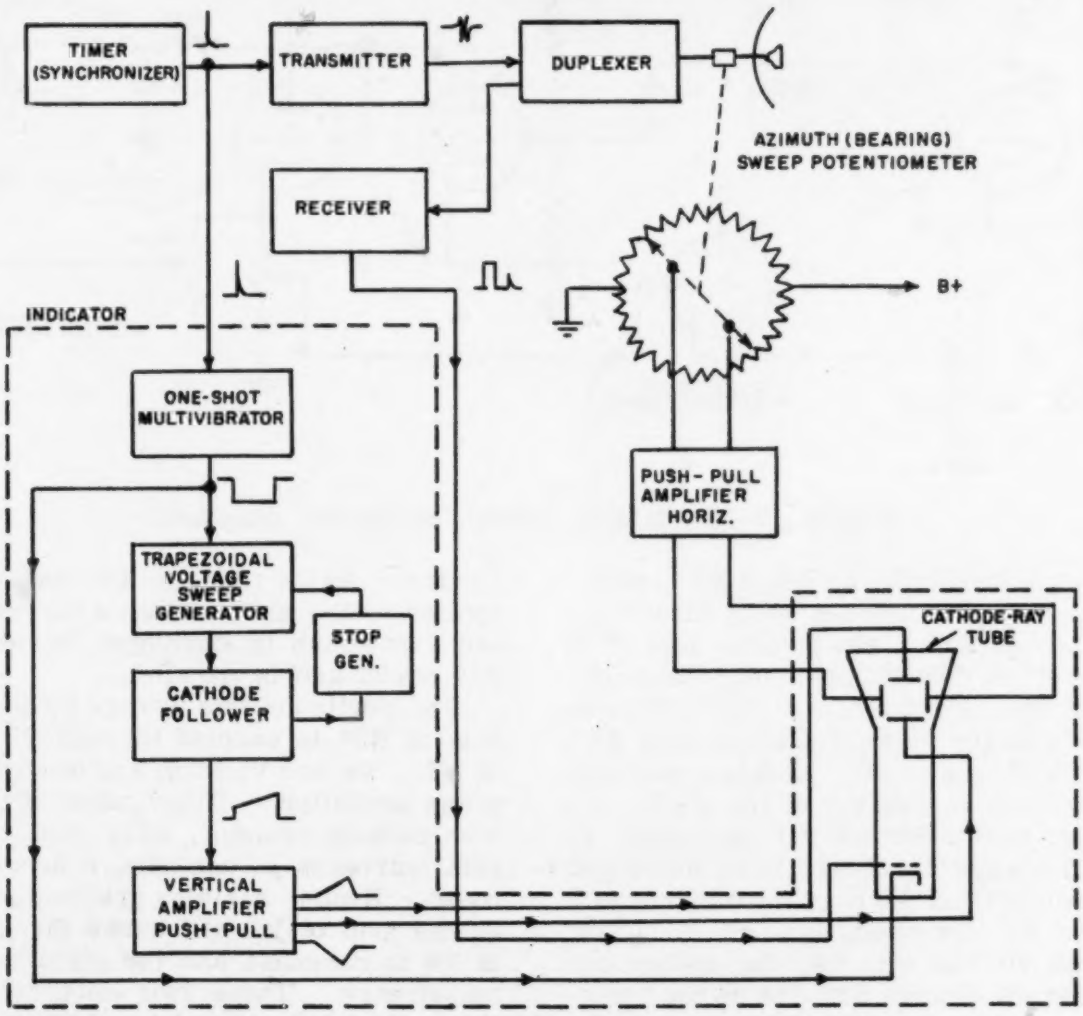

Figure 17-17. —Block diagram of a B-scope system.

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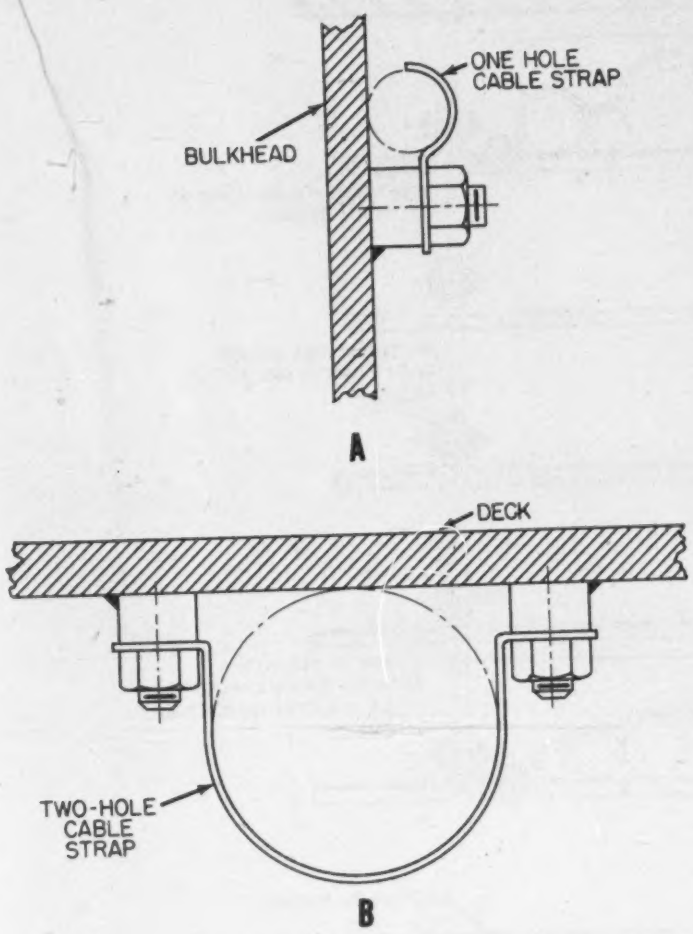

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Figure 3-16.—Single cable strap applications.

switchboards located within the zone. Load center switchboards and miscellaneous switchboards for ship's service distribution systems on vessels with zone control are given identification numbers, the first digit of which indicates the zone and the second digit the number of the switchboard within that zone, determined in accordance with the general rule for numbering machinery (fig. 3-22).

Load center switchboards and miscellaneous switchboards that are used on other than ship's service systems, all load center switchboards and miscellaneous switchboards for ship's service nonzonal distribution, and all distribution panels and bus transfer equipment are given identification numbers made up of either two or three parts in sequence, and each part is separated by hyphens. The first part indicates the vertical level, at which the unit is normally accessible, by deck or platform number. The second part indicates the longitudinal location of the unit by frame number. For duplicate units on the same deck and frame, the third part indicates the transverse location by the assignment of consecutive odd numbers for centerline and starboard locations and consecutive even numbers for port locations. The numeral 1 indicates the lowest centerline (or centermost, starboard) component. Consecutive odd numbers are assigned components as they would be observed first as being above, then outboard of the preceding component. Consecutive even numbers similarly indicate components on the port side. For example, a distribution panel with the identification number, 1-142-2, will be located on the main deck at frame 142, and will be the first distribution panel on the port side of the centerline at this frame on the main deck.

Except for the purpose of designating power cables between generators and switchboards, generators (except motor generators) are numbered to correspond to the numbering of the prime mover.

The power cables between generators and switchboards are labeled in accordance with the generators' designation. When only one generator supplies a switchboard, the generator will have the same number as the switchboard plus the letter G. Thus, 1SG denotes one ship's service generator that supplies number one ship's service switchboard. When more than one ship's service generator supplies a switchboard, the first generator determined in accordance with the general rule for numbering machinery will have the letter A, immediately following the designation; the second generator that supplies the same switchboard will have the letter B, and this procedure will be continued for all generators that supply the switchboard, and then repeated for succeeding switchboards. Thus, ISGA and ISGB denote two ship's service generators that supply ship's service switchboard 1S.

In figure 3-21 the cables from generators 3SGA and 3SGB to 3S are labeled 3SGA-4P-3S and 3SGB-4P-3S, respectively.

Motor generators, transformers, and rectifiers are designated by standard symbols, each made up of two capital letters and a numeral. The letters used are MG for motor generators, TF for transformers, and RT for rectifiers. The numeral gives the location of the equipment on the ship, in accordance with the general rule of numbering from forward aft and from starboard to port.

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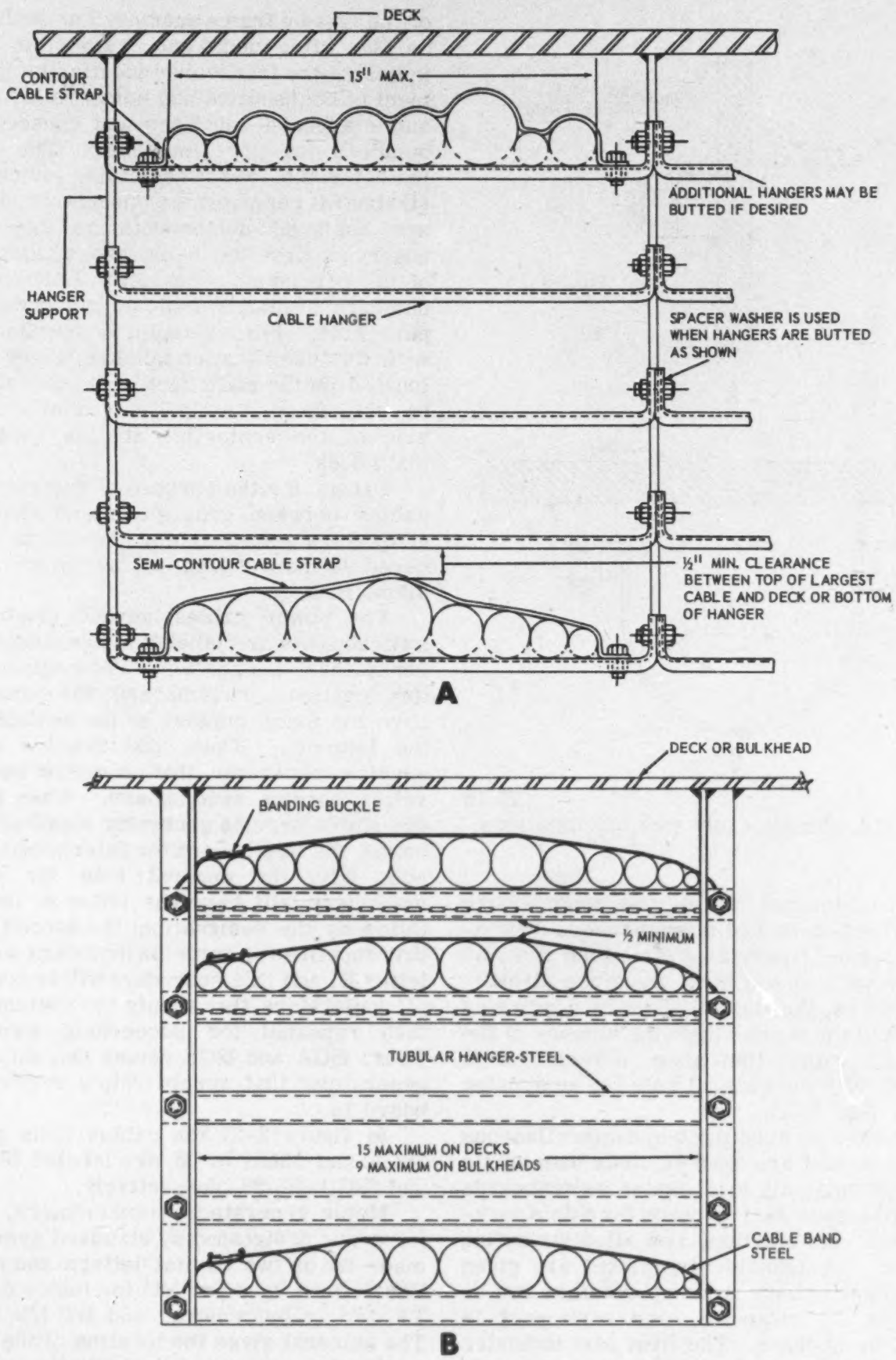

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Figure 3-17.—Cables installed in a cable rack.

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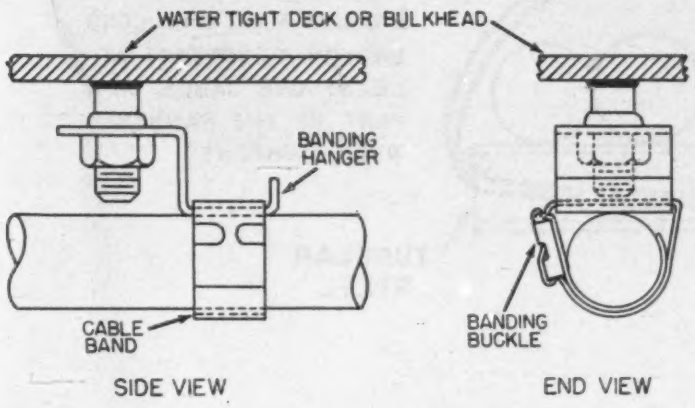

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Figure 3-18.—Single cable band.

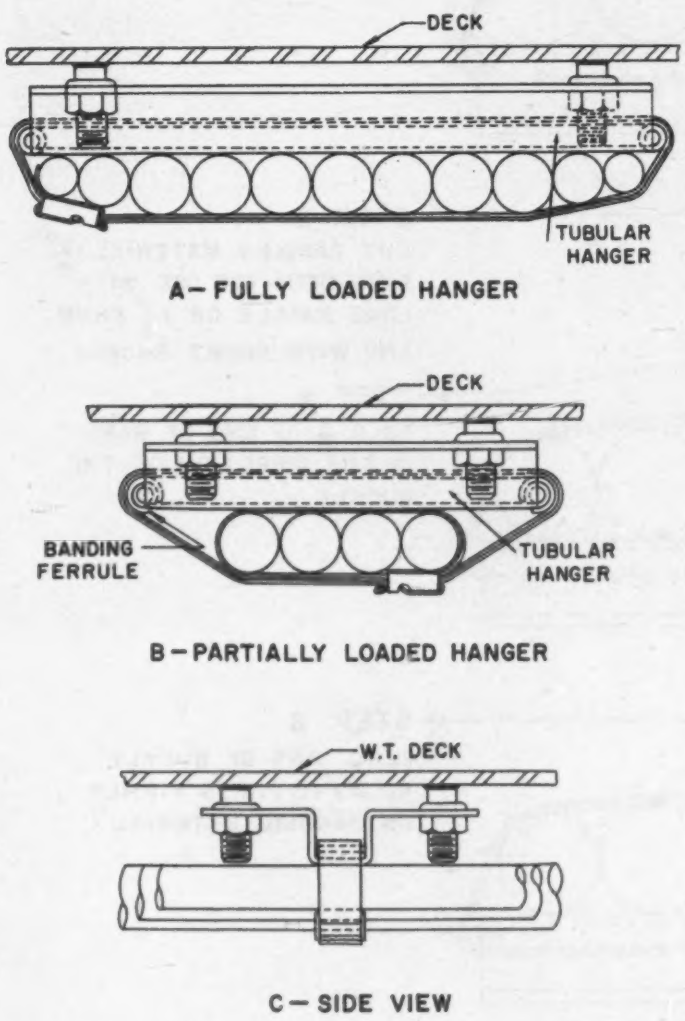

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Figure 3-19.—Two-hole banding hanger.

The new designation system for power and lighting cables consists of three parts in sequence: source, voltage and service, and, where practicable, destination. These parts are separated by hyphens.

The letters used to designate the different services are:

C—Interior communication
D—Degaussing
G—Fire control
K—Control power
L—Ship's service lighting
N—Navigational lighting
P—Ship's service power
R—Electronics
CP—Casualty power
EL—Emergency lighting
EP—Emergency power
FL—Night flight lights
MC—Coolant pump power
MS—Minesweeping
PP—Propulsion power
SF—Special frequency power

In the new system, voltages below 100 volts are designated by the actual voltage—for example, 24 for a 24-volt circuit. The number, 1, is used to indicate voltages between 100 and 199; 2, for voltages between 200 and 299; 4, for voltages between 400 and 499; and so on, through 50 for voltages between 5000 and 5999. For a three-wire (120/240), d-c system or a four-wire, 3-phase system, the number used will indicate the higher voltage.

The destination of cable beyond panels and switchboards is not designated except that each circuit alternately receives a letter, a number, a letter, and a number, progressively, every time that it is fused. The destination of power cables to power consuming equipment is not designated, except that each cable to such equipment receives a single-letter alphabetical designation, beginning with the letter, A.

Where two cables of the same power or lighting circuit are connected in a distribution panel or terminal box, the circuit classification will not be changed. However, the cable markings will have a suffix number (in parentheses) indicating the cable section—for example, circuit (4-168-1)-4P-A(1) (fig. 3-21).

For cables that have a normal and an alternate or emergency feeder, the source designation contains (first) the source of the normal feed and (second, separated by a slant line) the designation of the source of the

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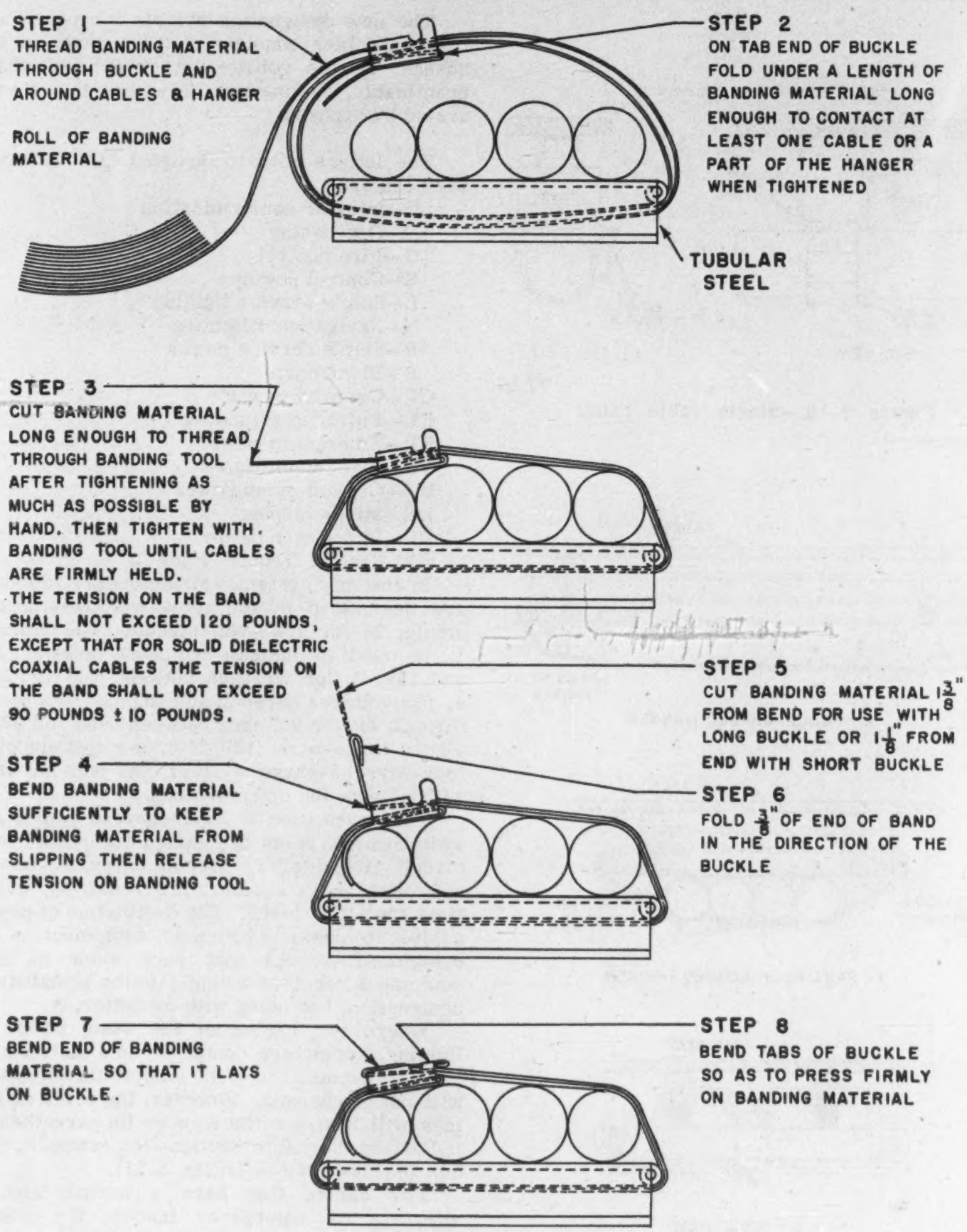

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Figure 3-20.—Applying banding material.

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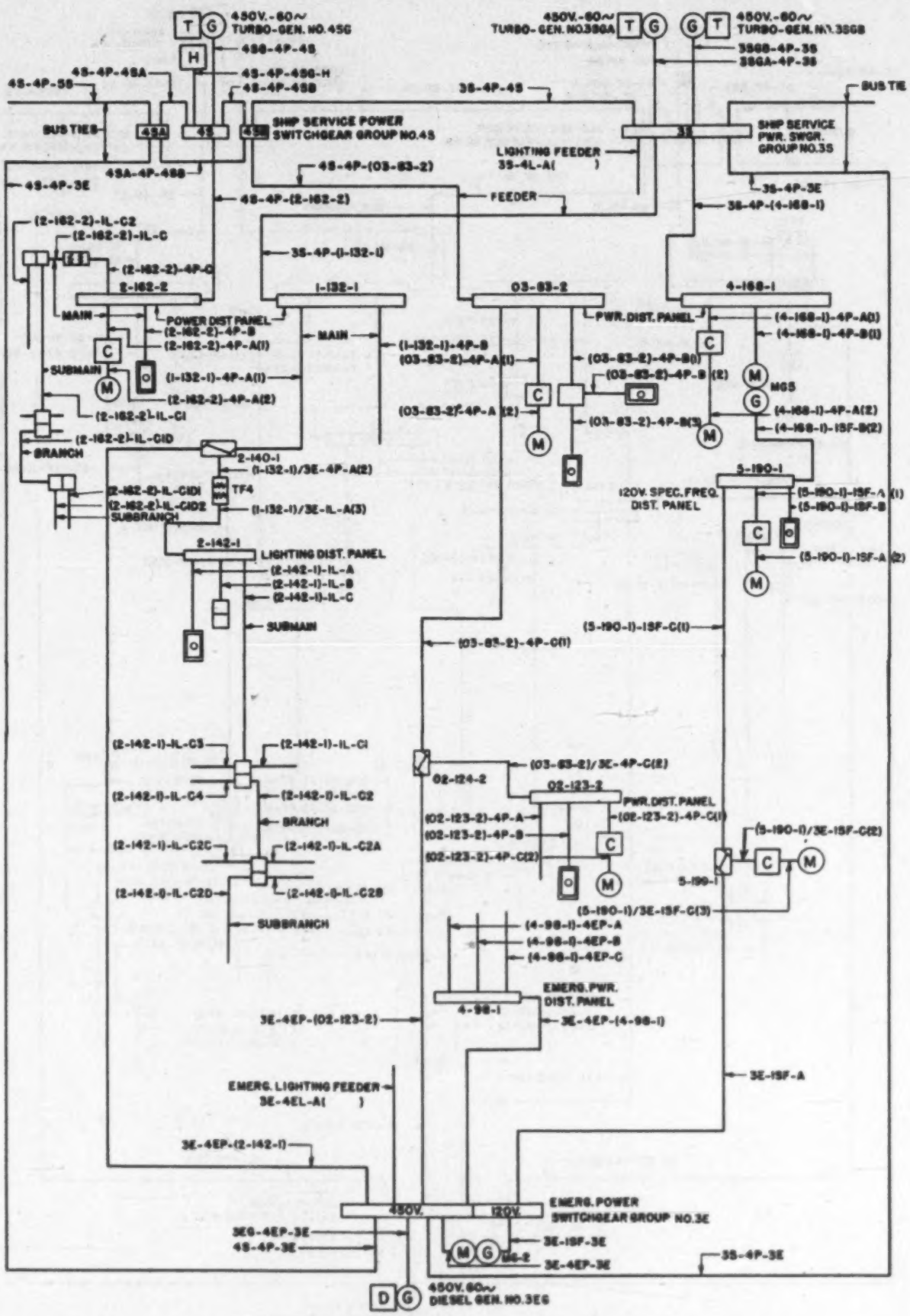

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Figure 3-21.—Typical designations for power and lighting system without zone control.

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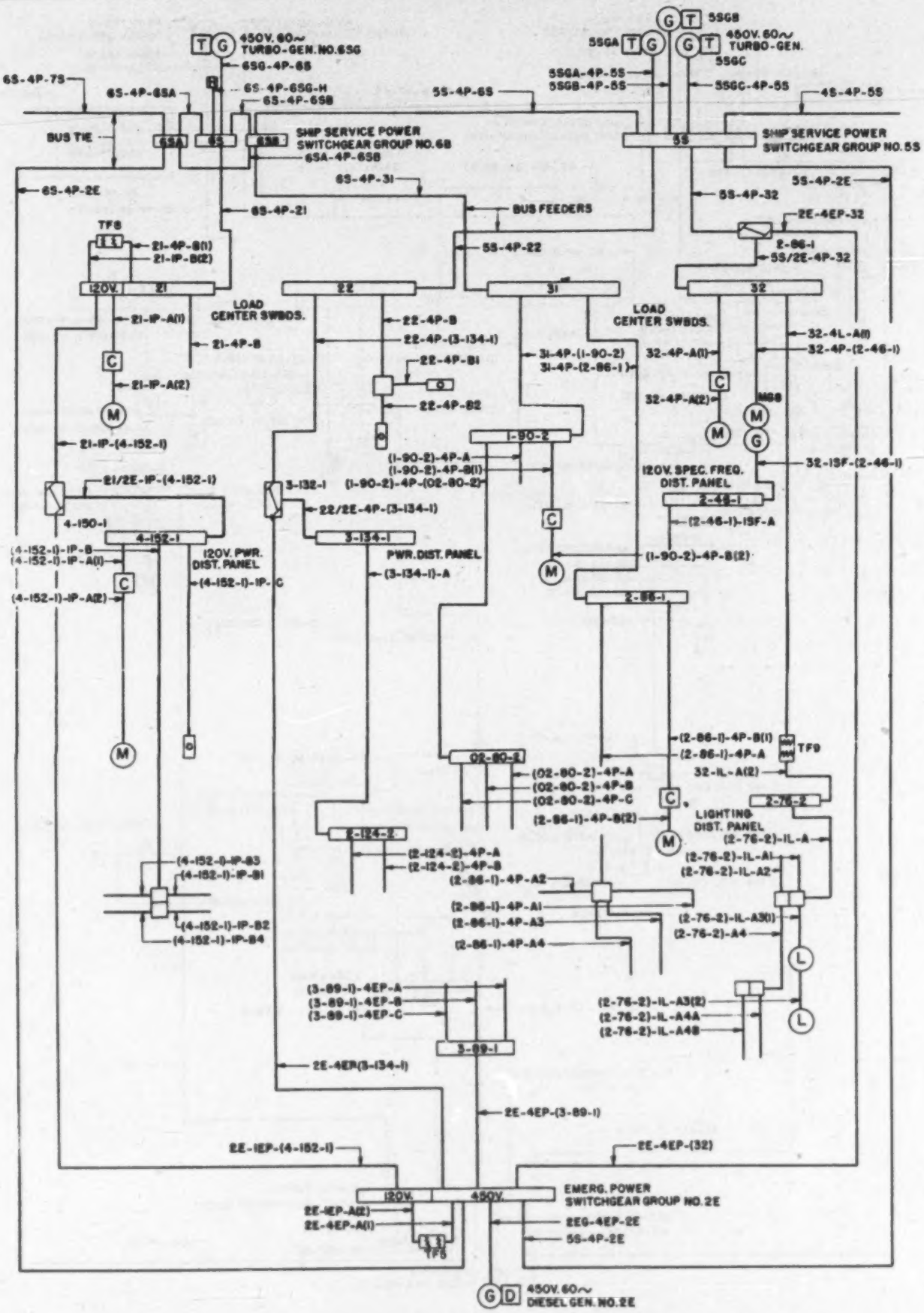

Figure 3-22.—Typical designations for power and lighting system with zone control. 77.21

alternate or emergency feed—for example, (5-190-1)/3E-1SF-C(2) in figure 3-22.

EQUIPMENT MARKING

All distribution panels and bus transfer equipment are provided with cabinet information plates. These plates contain the following information in the order listed: (1) the name of the space, apparatus, or circuits served; (2) the service (power, lighting, electronics, etc.) and basic location number; and (3) the supply feeder number. For example,

CREW LIVING SPACE, FRAMES 107-149
FIRST PLATFORM
LIGHTING PANEL 4-108-2
2S-4L-(4-108-2).

If a panel contains two or more sets of buses and each set is supplied by a separate feeder, the number of each feeder will be indicated on the identification plate.

Distribution panels are provided with circuit information plates adjacent to the handle of each circuit breaker or switch. These plates contain the following information in the order listed: (1) the circuit number, (2) the name of the apparatus or circuit controlled, (3) the location of apparatus or space served, (4) the circuit load amperes, and (5) the circuit breaker element or fuse rating. Red markers are attached to circuit information plates to indicate vital circuits. Information plates for circuit breakers supplying circle W and circle Z class ventilation systems contain, in addition to the red marker, the class designation of the ventilation system supplied. Information plates without markings are provided for spare circuit breakers mounted in distribution panels. Panel switches controlling circuits that are deenergized during darkened ship operations are marked DARKENED SHIP. The ON and OFF position of these switches are marked LIGHT SHIP and DARKENED SHIP, respectively.

Circuit information plates are provided inside fuse boxes (adjacent to each set of fuses) and indicate the circuit controlled; the phases, or polarity; and the ampere rating of the fuse.

CONDUCTOR IDENTIFICATION

Each terminal and connection of rotating a-c and d-c equipment, controllers, and transformers is marked with standard designations. This may be accomplished with synthetic resin tubing or fiber wire markers located as close as practicable to equipment terminals, with fiber tags near the end of each conductor, or by stamping the terminals.

Individual conductors may also be identified by a system of color coding. Color coding of individual conductors in multiconductor cable is in accordance with color coding tables contained in chapter 9005(40), Bureau of Ships Technical Manual. The color coding of conductors in power and lighting cables is shown in table 3-4. Neutral polarity, where it exists, is always identified by the white conductor.

Table 3-4.—Color Code for Power and Lighting Cable Conductor

System	No. of Conductors in Cable	Phase or Polarity	Color Code
3-phase a-c	3	A B C	Black White Red
	2	AB	A, black B, white
	2	BC	B, white C, black
	2	AC	A, black C, white
3-wire d-c	3	+ ± -	Black White Red
	2	+ and ±	+, black ±, white
	2	± and -	±, white -, black
	2	+ and -	+, black -, white
2-wire d-c	2	+ -	Black White

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END SEALS

Where it is possible for the sheath of shipboard electric cable to act as a conduit in carrying quantities of water from a flooded to an unflooded space beneath the watertight level of a vessel, the cable ends must be sealed to prevent the entrance and discharge of water from cable ends. Because the presently approved method of sealing cable ends requires special equipment not available to shipboard personnel, the installation of cables that require cable end seals should not be attempted by the Electrician's Mate, except in an emergency.

Exercise care when working around cables and switchboards to prevent damage to cable end seals. Make frequent inspections for visual evidence of defects in the seals. If any holes are found in the synthetic tubing used at end seals, make a temporary repair by wrapping the tubing tightly with several layers of synthetic tape (half lapped), with a serving of cord over each end of the tape. Other defects, which are noted, should be repaired as effectively as available materials and equipment permit. All cable end seals to which temporary repairs have been made and all cables that may require end sealing must be tagged and scheduled for permanent repair at a naval shipyard or shore base at the earliest opportunity.

Type SGA and other currently manufactured cables that have a waterproofing impregnant between the strands and in the material between the conductors and the inside of the sheath are not completely watertight. Cable-end sealing is required for these cables except in interior communications and weapons control systems where cable types TTHFWA, MSCA, and SGA sizes 9 and smaller are employed.

CABLE CONNECTIONS

Cable Ends

When connecting a newly installed cable to a unit of electrical equipment, the first thing to determine is the proper length of the cable. To do this, form the cable run from the last cable support to the equipment by hand, allowing sufficient slack and radius of bend to permit repairs without renewal of the cable. Carefully estimate where the armor on the cable will have to be cut to fit the stuffing tube (or connector), and mark the location with a piece of friction tape. In addition to serving as a marker, the tape will prevent unraveling and hold the armor in place during cutting operations.

Determine the length of the cable inside the equipment, using the friction tape as a starting point. Whether the conductors go directly to a connection or form a laced cable with breakoffs, carefully estimate the length of the longest conductor, add approximately 2 1/2 times its length, and mark this position with friction tape. The extra cable length will allow for mistakes in attaching terminal lugs and possible rerouting of the conductors inside the equipment. The length of the cable is now known and it can be cut.

The armor must be removed next. This may be accomplished by using a cable stripper of the type shown in figure 3-23. Care must be taken not to cut or puncture the cable sheath where the sheath will contact the rubber grommet of the nylon stuffing tube (fig. 3-11). If either a metal stuffing tube or cable connector (fig. 3-13) is used, allow the cable (with armor) to extend at least one-eighth of an inch through the tube.

Next, remove the impervious sheath, starting a distance of at least 1 1/4 inch (or as necessary to fit the requirements of the nylon stuffing tube) from where the armor terminates. The cable stripper should be used for this job. Do not take a deep cut because the conductor insulation can be easily damaged. Flexing the cable will help separate the sheath after the cut has been made. Clean the paint from the surface of the remaining impervious sheath exposed by the removal of the armor. This paint is conducting. It is applied during manufacture of the cable and passes through the interstices of the armor onto the sheath. Once the sheath has been removed, the cable filler can be trimmed with a pair of diagonal cutters.

The proper method of finishing and protecting cable ends that do not require end sealing is shown in figure 3-24. For cables entering enclosed equipment (connection boxes, outlet boxes, fixtures, etc.) the method shown in figure 3-24A, should be used. An alternate method (when synthetic resin tubing is not readily obtainable) is to apply a coat of air drying insulation varnish to the insulation of each conductor as well as to the crotch of the cable. The end of the insulation on each conductor is reinforced and served with treated glass cord, colored to indicate proper phase marking. For cables entering open equipment (switchboards, etc.) the method shown in figure

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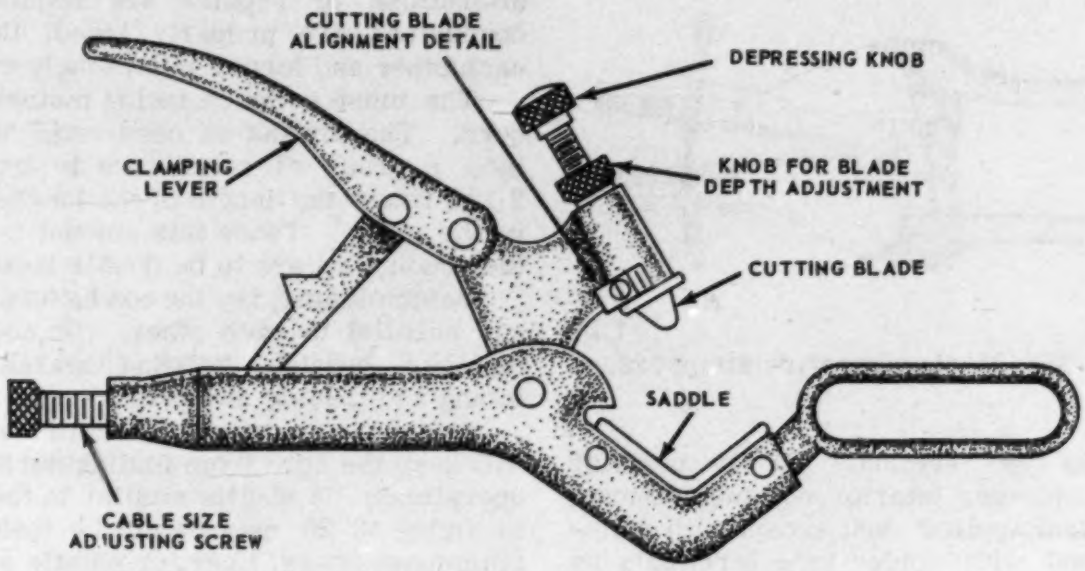

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Figure 3-23.—Cable strippers.

3-24B, should be used. An alternate method is to wrap each conductor tightly with one layer of synthetic tape (half lapped) and serve with cord as in the tubing method. Apply tape, air-drying varnish, and serve the crotch and part of the cable for a distance about 2 inches back of the crotch.

Conductor Ends

Wire strippers (fig. 3-25) are used to strip insulation from the conductors. Care must be taken to avoid nicking the conductor standing while removing the insulation. Side, or diagonal, cutters should not be used for stripping insulation from conductors.

Conductor surfaces must be thoroughly cleaned before terminals are applied. After barring the conductor end for a length equal to the length of the terminal barrel, clean the individual strands thoroughly and twist them tightly together. Solder them to form a neat, solid terminal for fitting either approved clamp-type lugs or solder type terminals. If the solder type terminal is used, tin the terminal barrel and clamp it tightly over the prepared conductor (before soldering) to provide a solid mechanical joint. Conductor ends need not be soldered for use with solderless type terminals applied with crimping tool. Do not use a side, or diagonal, cutter for crimping solderless type terminals.

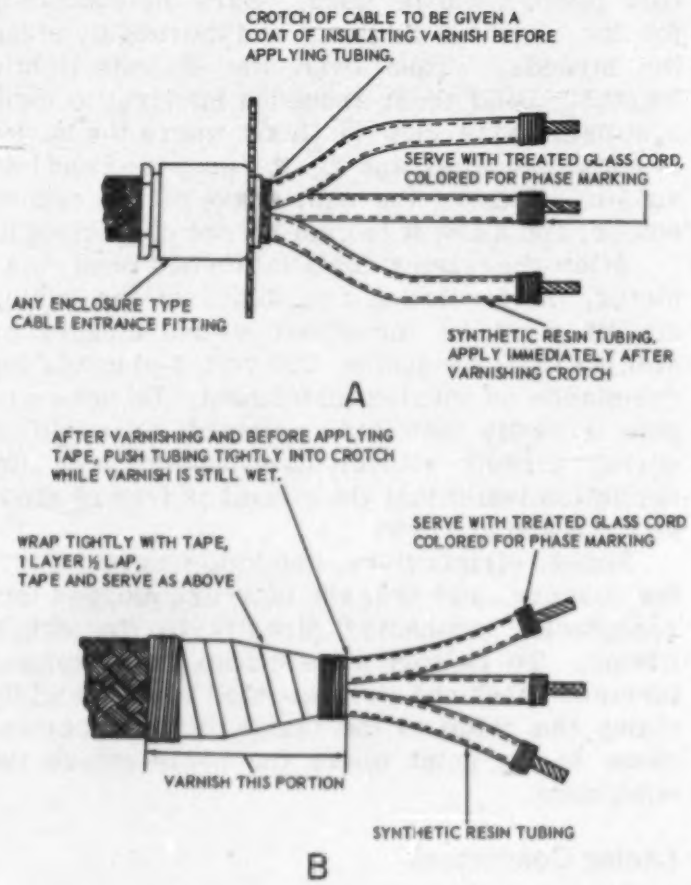

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Figure 3-24.—Protecting cable ends.

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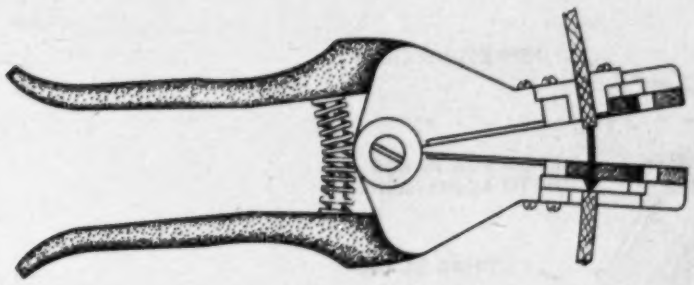

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Figure 3-25.—Mechanical wire strippers.

Solderless type terminals may be used for all lighting, power, interior communications, and fire control applications, except with equipment provided with solder type terminals by the manufacturer, and with wiring boxes or equipment in which electrical clearances would be reduced below minimum standards by the use of the solderless type terminal.

For connection under a screwhead where a standard terminal is not practicable, an alternate method can be used. Bare the conductor for the required distance and thoroughly clean the strands. Then twist the strands tightly together, bend them around a mandrel to form a suitable size loop (or hook where the screw is not removable), and dip the prepared end into solder. Remove the end, shake off the excess solder, and allow it to cool before connecting it.

After the wiring installation has been completed, the insulation resistance of the wiring circuit must be measured with a megger or similar (0-100 megohm, 500 volt d-c) insulation resistance measuring instrument. Do not energize a newly installed, repaired, or modified wiring circuit without first ascertaining (by insulation tests) that the circuit is free of short circuits and grounds.

Small refrigerators, drinking fountains, coffee makers, and bracket fans are plugged into receptacles connected directly to the ship's wiring. To remove stress from the equipment terminal block and its connected wiring, rigidly clamp the cable to the frame of the equipment close to the point where the cable enters the equipment.

Lacing Conductors

Conductors within equipment must be kept in place in order to present a neat appearance and facilitate tracing of the conductors when alterations or repairs are required. When conductors are properly laced, they support each other and form a neat, single cable.

The most common lacing material is waxed cord. The amount of cord required to single lace a group of conductors is approximately 2 1/2 times the length of the longest conductor in the group. Twice this amount is required if the conductors are to be double laced.

Before lacing, lay the conductors out straight and parallel to each other. Do not twist them together because twisting makes conductor lacing and tracing difficult.

A shuttle on which the cord can be wound will keep the cord from fouling during the lacing operations. A shuttle similar to the one shown in figure 3-26 may easily be fashioned from aluminum, brass, fiber, or plastic scrap. Rough edges of the material used for the shuttle should be smoothed to prevent injury to the operator and damage to the cord. To fill the shuttle for single lace, measure the cord, cut it, and wind it on the shuttle. For double lace, proceed as before, except double the length of the cord before winding it on the shuttle, and start the ends on the shuttle in order to leave a loop for starting the lace.

Some installations, however, require the use of twisted wires. One example is the use of "twisted pairs" for the a-c filament leads of certain electron tube amplifiers to minimize radiation of their magnetic field, thus preventing annoying hum in the amplifier output. The EM should duplicate the original layout, when replacing such twisted leads, and when relacing any wiring harness.

Single lace may be started with a square knot and at least two marling hitches drawn

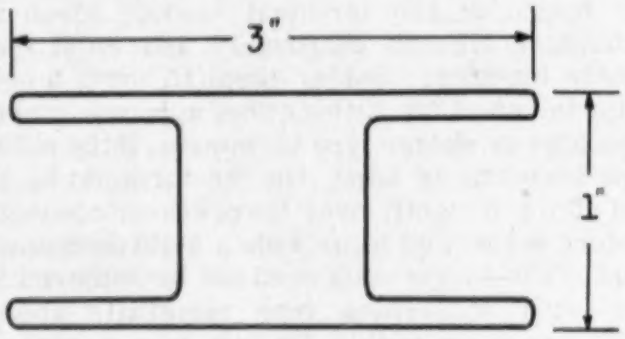

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Figure 3-26.—A lacing shuttle.

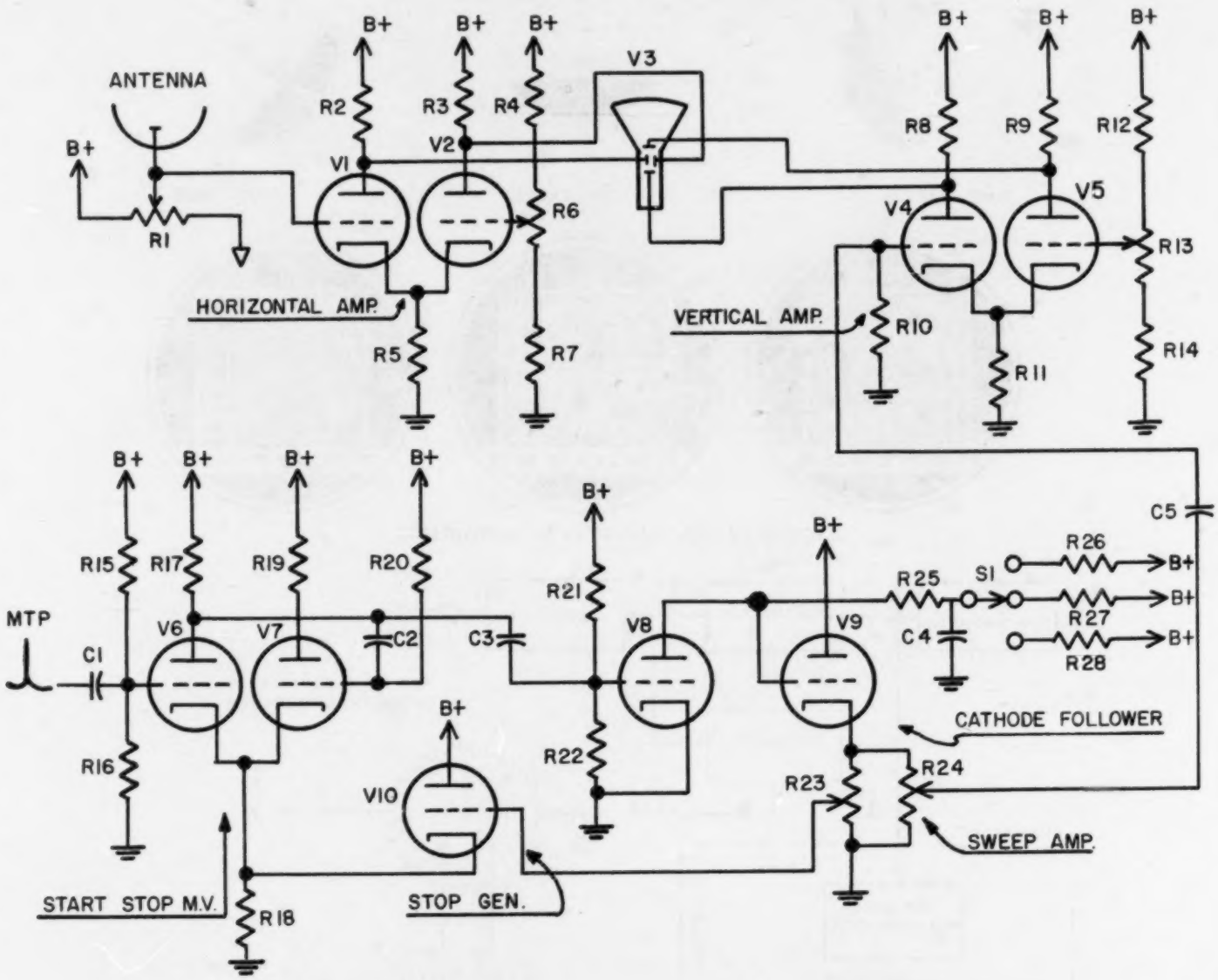

Figure 17-18.—B-scan sweep, schematic diagram.

a single-kick multivibrator in which V7 in statically conducting and V6 is cut off by the voltage developed across R18. The pulse causes V6 to conduct and V7 is then cut off by normal multivibrator action. By itself, the multivibrator would return to the static condition upon discharge of C2 through R20, but this would take a very long time in respect to the PRT. As will be seen later, this is not permitted to happen. The negative square wave developed in the plate circuit of V6 is coupled through C3 to the grid of V8, the sweep generator, cutting it off. With V8 cut off, C4, the sweep capacitor, charges through R27, the sweep resistor. R26 and R28 are alternate sweep resistors and would be used to obtain different sweep lengths. As C4 charges, the rising voltage is applied to the grid of V9, a cathode follower, and a sawtooth is developed across R23 and R24 which are in parallel.

The portion of this voltage picked off by the arm of R24 is coupled through C5 to the grid of V4. V4 and V5 form a grounded-grid paraphase amplifier. These tubes share a common cathode resistor, R11; and as the current increases in one tube, it decreases in the other. Hence, a rising grid voltage from R24 on the grid of V4 will cause the plate voltage of V4 to decrease and the plate voltage of V5 to increase. These two voltages, coupled to the vertical deflection plates of the indicator V3, cause vertical deflection of the electron spot.

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tight. Details of the square knot and the marling hitch are shown in figure 3-27. Do not confuse the marling hitch with a half hitch. In the marling hitch, the end is passed over and under the strand (step 1, fig. 3-27). After forming the marling hitches, draw them tight against the square knot (step 2, fig. 3-27). The lace consists of a series of marling hitches evenly spaced at one-half inch to one-inch intervals along the length of the group of conductors, as indicated in step 3.

When dividing conductors to form two or more branches, follow the procedure illustrated in figure 3-28. Bind the conductors with at least six turns between two marling hitches, and continue the lacing along one of the branches (fig. 3-28A). Start a new lacing along the other branch. To keep the bends in place, form them in the conductors before lacing. Always add an extra marling hitch just prior to a breakout (fig. 3-28B).

Double lace is applied in a manner similar to single lace, except that it is started with the telephone hitch and is double throughout the length of the lacing (fig. 3-29). Double as well as single lace may be terminated by forming a loop from a separate length of cord and using it to pull the end of the lacing back underneath a serving of approximately eight turns (fig. 3-30).

Lace the spare conductors of a multiconductor cable separately, and secure them to active conductors of the cable with a few telephone hitches. When two or more cables enter an enclosure, each cable group should be laced separately. When groups parallel each other, they should be bound together at intervals with telephone hitches (fig. 3-31).

Conductor ends (3000 cm or larger) should be served with cord to prevent fraying of the insulation (fig. 3-32). When conductor ends are served with glass cord colored for phase marking, the color of the cord should match the color of the conductor insulation.

Grounded Receptacles

Aboard naval vessels, grounded receptacles (fig. 3-33) are used with grounded plugs and portable cables having a ground wire, which grounds the metallic case and exposed metal parts of portable tools or equipment to the ship's structure when the plugs are inserted in the receptacles. The ground wire prevents the occurrence of dangerous potentials between

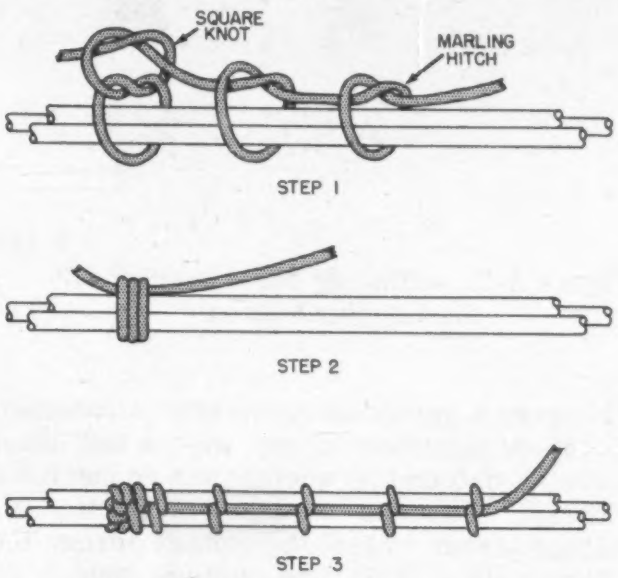

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Figure 3-27.—Applying single lace.

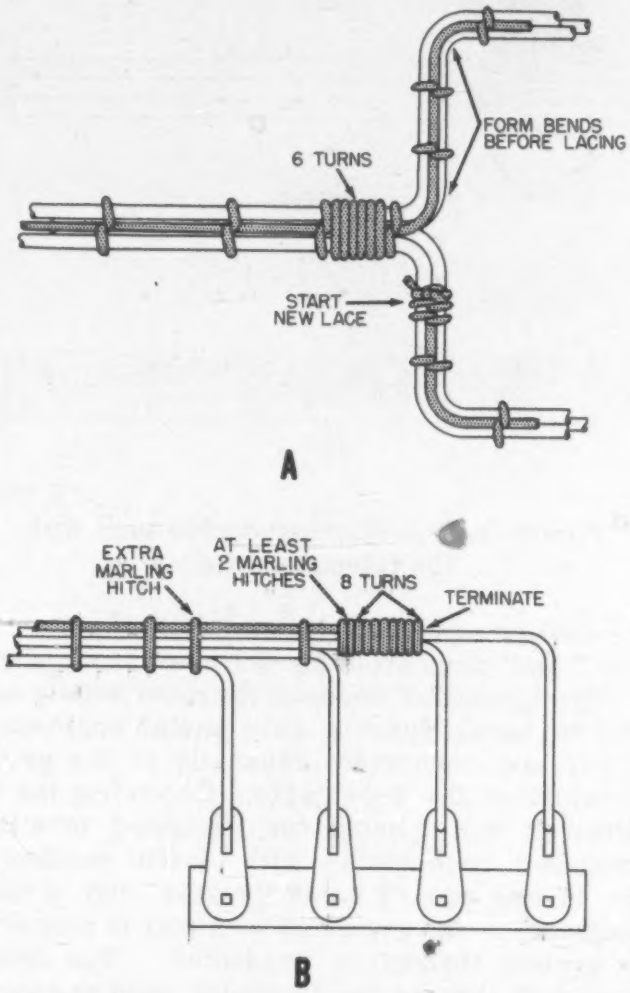

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Figure 3-28.—Lacing branches and breakouts.

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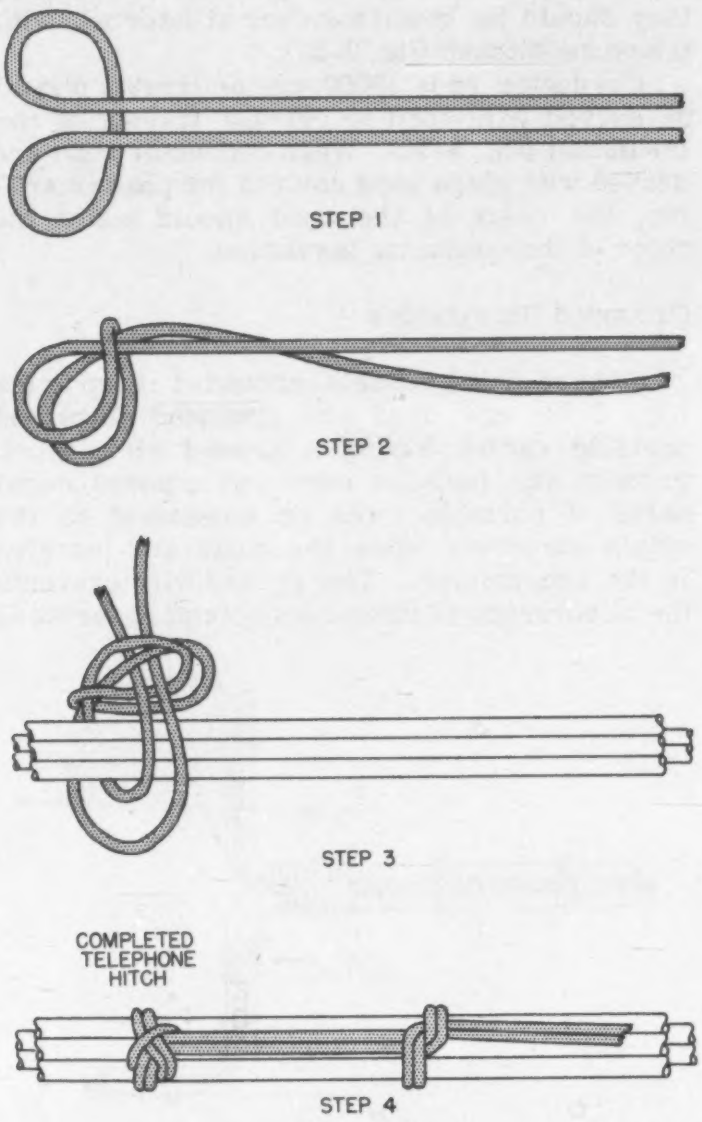

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Figure 3-29.—Starting double lace with the telephone hitch.

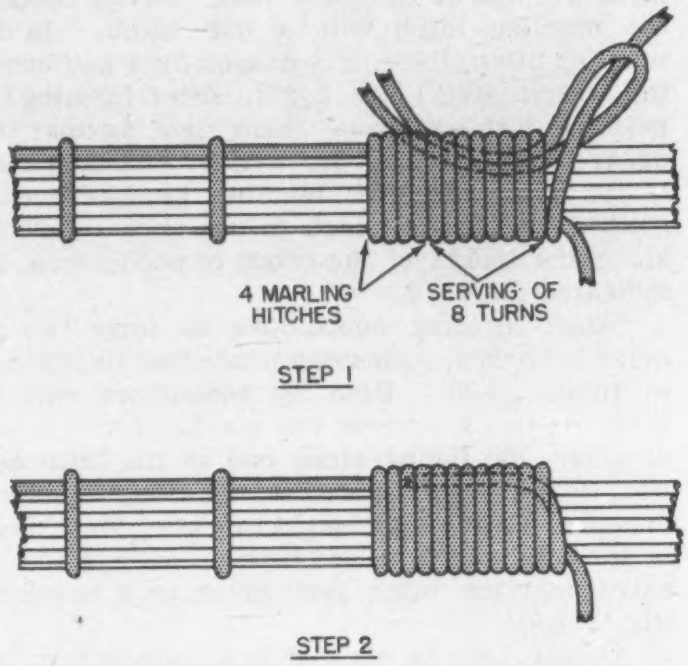

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Figure 3-30.—The loop method of terminating the lace.

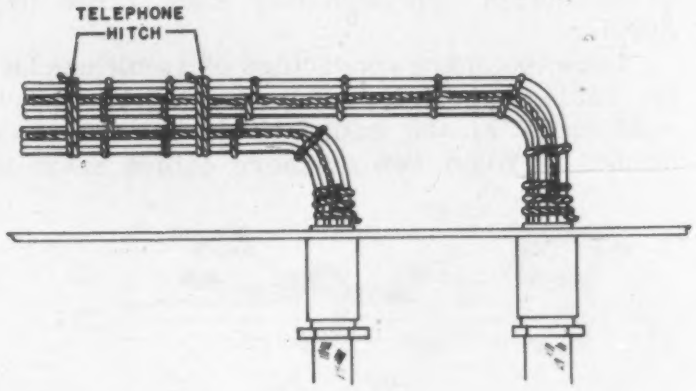

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Figure 3-31.—Binding cable groups with the telephone hitch.

the tool or equipment housing and ship's structure, and thus protects the user from shock.

The grounded receptacles most widely used aboard naval vessels have metal enclosures, which are connected internally to the ground terminal of the receptacle. Grounding the enclosures will ground the grounded terminal. Grounded receptacles with plastic enclosures are in use aboard some vessels, and in these receptacles the grounded terminal is connected to ground through a conductor. The cross-sectional area of the conductor used to connect the grounded terminal to ground must be greater than that of the conductors that supply such a receptacle.

Whenever a grounded receptacle is installed, repaired, or modified in any way, a test must be made to determine whether the connections are correct. To make this test, use a voltmeter or voltage tester to test the voltage across the line terminals. Full line voltage should be indicated. Next, test the voltage between the ground terminal in the receptacle and some metallic part of the ship's structure that is not

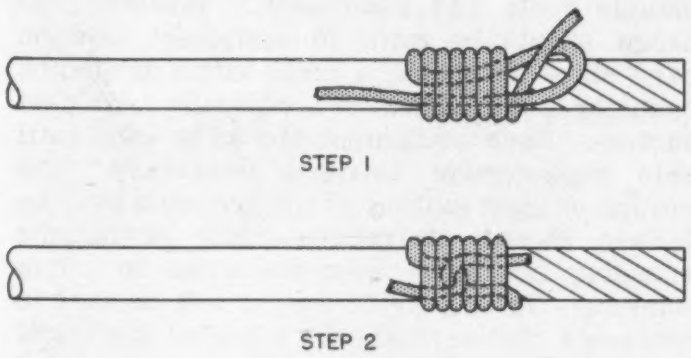

5.140.2

Figure 3-32.—Serving conductor ends.

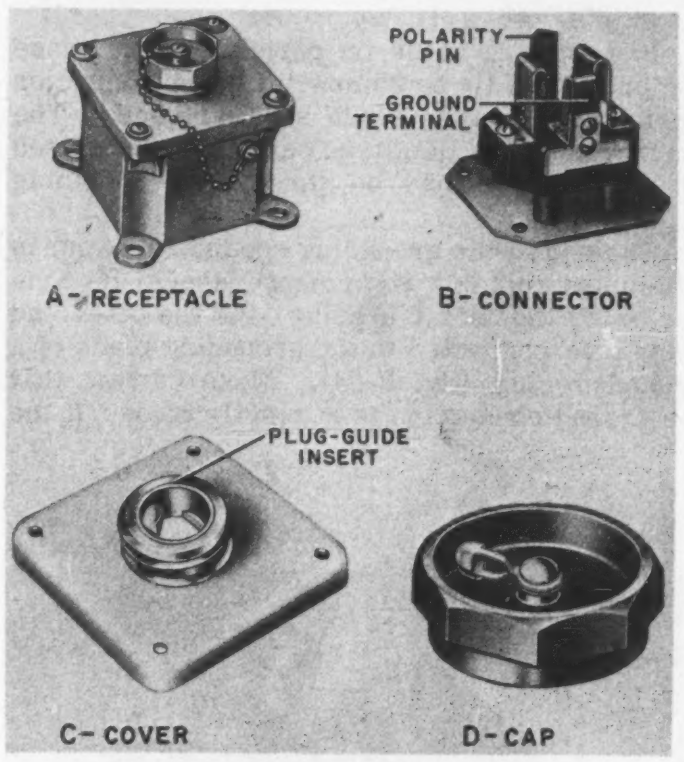

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Figure 3-33.—Watertight grounded receptacle.

a part of the receptacle. This voltage should be zero. After the voltage from the ground terminal to ground has been measured and found to be zero, (deenergize the circuit), use an ohmmeter or other low-reading (zero to a few ohms), resistance-measuring instrument such as multimeter or analyzer to measure the resistance from the ground terminal to ground. This resistance value should be not over 0.1 ohm. However, the meters generally available will not read this low. As a rough, practical check, therefore a reading of not more than one ohm may be considered as reasonable assurance that the ground path is satisfactory. Unless all of the preceding conditions are satisfied, the receptacle is not correctly connected and constitutes a safety hazard.

To determine the safety of grounded receptacles, inspect and test them. The following procedures should be followed in making monthly routine ground-continuity tests of each installed receptacle.

1. Plug in any small 115-volt portable electric tool into the receptacle to be tested.

2. Secure one ohmmeter lead to the metal of the tool housing and its other lead to the ship's hull.

3. The ohmmeter reading must be less than one-tenth (0.10) ohm to indicate a satisfactory grounding from the tool housing through the plug and receptacle to the ship's hull.

Note: Meters that will read 0.1 ohm are not commonly available, therefore a reading of not more than one ohm is reasonable assurance that the ground connection is satisfactory.

4. Unsatisfactory receptacles should be immediately repaired or tagged to indicate they must not be used.

A record book should be kept, giving the location of all grounded receptacles and the dates on which they are inspected and tested. The inspection of the receptacle should ascertain that:

1. The phenolic polarity pin in the insert of the receptacle is in place (fig. 3-33B).

2. The receptacle cover is placed so that the pointed metal polarity tab (brazed to the cover) is superimposed over the phenolic polarity pin within the receptacle.

3. The phenolic plug-guide insert in the aperture of the receptacle cover is firmly in place (fig. 3-33C). Where the inserts are missing, replace the entire cover. Correct loose inserts by cementing them.

4. The protective cap with rubber gasket is properly attached by chain to the receptacle cover (fig. 3-33D). Spraytight, watertight, and submersible receptacles must be kept covered when plugs are not inserted.

Present practice is to standardize on grounded 125/250-volt plugs and receptacles on all surface vessels and submarines.

On the older ships single 125-volt, 10-ampere, single-phase a-c (or 2-wire d-c) stub

type (like fig. 3-33) watertight receptacles are used for all applications except for electric shavers and some electronic applications. For electric shavers and some electronic applications, double 125-volt, 15-ampere, single-phase a-c (or 2-wire d-c) bladed type receptacles are used.

On new ships, general purpose grounded receptacles are provided as follows:

1. Double 125-volt, 15-ampere, single-phase a-c (or 2-wire d-c) bladed type receptacles are used for all below-deck applications.
2. Single 125-volt, 15-ampere, single-phase a-c (or 2-wire d-c) watertight bladed type receptacles are installed on radar platforms and open bridges for use of electronic test equipment.
3. Single 125-volt, 10-ampere, single-phase a-c (or 2-wire d-c) stub type submersible receptacles are used for topside and for applications where a watertight receptacle is required, except on radar platforms and open bridges.

Receptacles are required to be so spaced as to permit the use of portable tools at any place on the ship without requiring more than 50 feet of flexible cable between the tool and receptacle. The reason is twofold (1) economy: closer spacing of receptacles is wasteful (2) safety: greater spacing of receptacles results in excessively long and thus a higher resistance grounding conductor which may not protect the operator from shock if portable equipment develops derangement which places potential on the metal case.

Receptacles installed for specific applications such as radiant heaters are included in the receptacle spacing to meet the 50 foot rule and therefore may be considered as available for portable tools.

If additional receptacles are required to meet the 50 foot rule, care should be exercised to ensure that added receptacles do not result in overloading the circuits.

Grounded Plugs

The electric cable used with portable electric tools and equipment must be provided with a distinctly marked grounding conductor in addition to the conductors for supplying power. Up to this time (except for a few cases where black was used), red was used for the grounding conductor in three-conductor cables, and green in four-conductor cables. Today, Navy specifications require that green be used for the grounding conductor in cables for all new portable tools and equipment. However, no change should be made in equipment (now on board ship) which has a cable with a grounding conductor color coded in conformity with past practice. Such equipment should be used until cable replacement becomes necessary. An average of eight sailors are killed each year by electric shock. A frequent cause is that the grounding conductor was connected to a live terminal. To help avoid this, it will be easy to remember that permanently mounted electrical equipment (metal boxes, panels etc) are grounded to the ships structure by their mounting bolts. All that the grounding conductor does, regardless of its color, is simulate the mounting bolts of permanent equipment; namely; joins the metal case of portable electric equipment to the ship's hull.

In replacing cable on portable single phase a-c or 2-wire d-c equipment the three-conductor flexible cable types THOF should be used. The four-conductor FHOF type cable should be used in replacing cables on three-phase portable equipment.

The end of the grounding conductor, which is within the tool (or equipment), should be connected to the metal housing, and the other end should be connected to the grounding blade of a grounded plug (fig. 3-34). Make certain that the ground connection is correctly made. If the

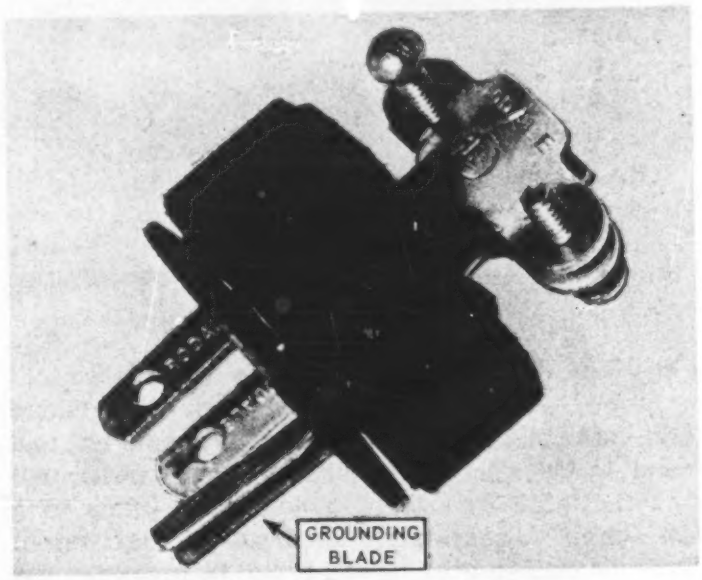

5.13

Figure 3-34.—Grounded plug.

grounding conductor is inadvertently connected to a line contact of the plug, a dangerous potential that is almost certain to be fatal to the operator will be placed on the metal equipment casing. To guard against such an occurrence, the connections should be tested after they have been made. Recently plastic cased tools (drills, sanders, grinders, etc.) have been developed for shipboard use to eliminate the risk of electric shock. In these tools the shafts and chucks are isolated electrically from the drive motors. Do not replace the two-conductor cable on plastic cased tools with a three conductor cable if the plastic cased tool has an information plate reading "grounding not required".

Portable Equipment

Prior to issue of any portable metal-cased electrical equipment (including extension cords) the attached cable with plug should be examined visually to ensure satisfactory condition. (Tears, chafing, exposed insulated conductors and damaged plugs are causes for cable or plug replacement.) Also, prior to each issue, that item should be plugged into a dummy (or deenergized) receptacle and tested for resistance (should be less than 0.1 ohm) from equipment metal housing to ship's structure. During this test, work the flexible cable with a push-pull twisting-bending motion where it enters plug and equipment. The following conditions will ensure the grounding circuit is always below 0.1 ohm.

The length of flexible cable for portable equipment should not exceed 25 feet, except the cable for portable heaters should be as required.

The length of extension cords should also be limited to 25 feet. If additional extensions are used and the length of the cable exceeds 50 feet from receptacle to portable tool, a separate (additional) grounding conductor must be connected from the tool's housing to the ship's hull.

The cables of portable equipments kept outside the electric shop must be tested weekly. A list of those equipments must be established. The following items should be included: portable hand-held electric tools that are permanently charged out or on loan to other shipboard departments or divisions; electric equipment which is frequently touched, such as hot plates, coffee makers, toasters, portable vent sets, movie projectors, and office equipment. Electric equipment which is infrequently touched, such as bulkhead mounted fans energized from receptacles, are recommended for testing once a year.

After making the preceding measurements for low resistance, WHILE STILL USING THE DEENERGIZED RECEPTACLE, connect one lead of a megger, or similar high-resistance measuring instrument to the metal case of the equipment and its other lead to either of the line terminals of the plug. Measure the resistance with the switch on the equipment in the ON position and also when it is in the OFF position. In both cases, the readings obtained will be normal insulation resistance (usually well in excess of 1 megohm) if the connections are correctly made. Repeat this procedure with the megger connected to the case of the equipment and the other line contact of the plug (or to each of the other line contacts if there are more than two). In each case the megger should read normal insulation resistance if the connections are properly made.

Two resistance-measuring instruments must be used for the foregoing test because one instrument (unless it has scales for both high and low resistance) will not give reliable results. This test should also be made on all portable equipment that has not previously been tested in this way, even though it may have been used previously without trouble. This test must be repeated weekly on all portable electrical equipment to ensure that the equipment remains in a safe condition. Instruct all personnel using the equipment not to attempt to reconnect the cable to the plug if it should ever be pulled out. This connection must always be made and tested by a competent Electrician's Mate.

Electrical equipment that is positively and adequately grounded through its mounting (such as bracket fans), or portable lights and other equipment having no exposed metal parts that may become energized may be fitted with a two-conductor repeated flexing service cable and a plug suitable for use with the grounded type receptacle. However, test to make sure that the natural grounding of the equipment is not blocked off in any way.

CASUALTY POWER CABLE

Suitable lengths of portable casualty power cables are stowed throughout naval vessels close to the locations where they may be needed for making temporary connections in the event

11353

the installed ship's service and emergency distribution systems are damaged. The casualty power system is completely described in chapter 10 of this training course. Only the portable cable is discussed here. Portable casualty power cables are equipped with metal tags, which indicate the length of the cable (in feet) and the location of the cable stowage rack (fig. 3-35).

Both ends of portable casualty power cable are made up in the same manner as shore power cable illustrated in figure 3-36 except that:

1. The outer sheath of the cable (step 1, fig. 3-36A) is removed from the cable for approximately 1 foot, or a sufficient distance to permit ready attachment to the casualty power bulkhead, riser, and switchboard terminals, and portable switches.

2. Ferrules (cable thimbles) of tubular copper material are attached to conductor ends instead of lugs (step 7, fig. 3-36B). The conductor insulation must be 3/8" from crimped copper ferrule at end of conductor (1 1/4" from extreme tip of ferrule). This permits full insertion of the tips of subject conductors into the bulkhead terminals and leaves no exposed copper.

3. Phase or polarity, as appropriate, of the conductors must be indicated by servings on the conductors. One serving of cotton cord indicates phase A, or positive polarity (black conductor); two separate servings indicate phase B, or neutral polarity (white conductor); and three separate servings indicate phase C, or negative polarity (red conductor). The servings on the conductors afford a means of identifying (by touch) the individual conductors when illumination is insufficient for visual identification.

Portable casualty power cables should be rigged only when required for use or for practice in rigging the casualty power system. At all other times, they should be stowed in the cable rack indicated on the cable tag. When portable casualty power cables are rigged, connections should be made from the load to the supply to avoid handling energized cables.

Casualty power cables are a very important part of the ship's equipment. Each year the cables and terminal connections should be closely inspected and tested.

On ships that have the planned maintenance system (PMS) installed the inspection would be a scheduled routine. If you as an EM3, while checking the weekly work schedule, find the division PO has assigned you and Jones EMFN to accomplish A-1 on casualty power cables, proceed as follows. Remove MRC EL-12, A1 (fig. 3-37) from the file or cardholder in your

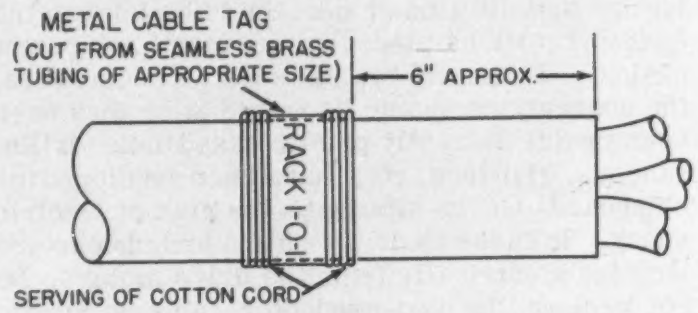

12.74

Figure 3-35.—Typical portable casualty power cable tags.

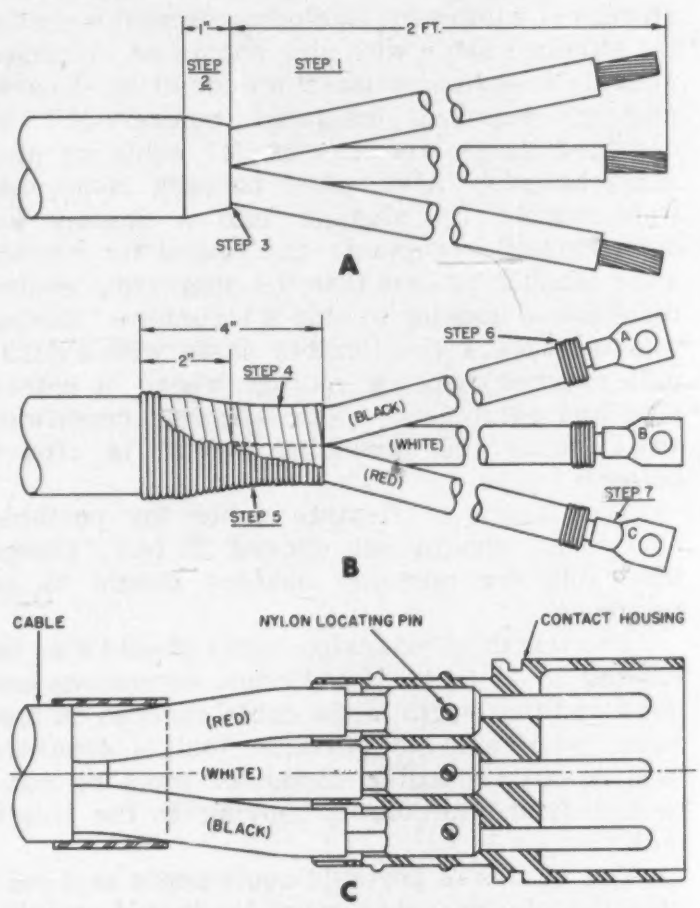

70.6

Figure 3-36.—Preparing shore power cable ends.

SYSTEM	COMPONENT	M.R. NUMBER
Electric Plant	Casualty Power Cables MAINT SIGNIFICANT NO.	EL-12, A-1

SUB-SYSTEM	RELATED M.R.	RATES	M/H
Power Distribution System	None	EM3 EMFN	16.0 16.0

M R DESCRIPTION

1. Visually inspect casualty power cables and terminal connections.
2. Measure the insulation resistance of all bulkhead biscuits and risers.

TOTAL M/H: 32.0
ELAPSED TIME 16.0

SAFETY PRECAUTIONS

1. Test each biscuit with a voltage tester to insure it is de-energized before attempting any repairs.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Scribe
2. Flashlight
3. Sandpaper 4/0
4. Voltage tester
5. 500 volt megger

PROCEDURE

1. a. Remove cables from storage rack and flake out on deck.
b. Visually inspect the insulation for cuts, cracks, or chaffing.
c. Inspect all lugs for cleanliness and sound connections. Clean with 4/0 sandpaper.
d. Report any unusual condition to the leading petty officer.
e. Return all cables to the proper stowage.
f. Test each biscuit to insure it is de-energized. Visually inspect each connection to insure cleanliness. Clean as necessary. Remove foreign matter with a scribe.
g. Measure the insulation resistance to ground of each bulkhead biscuit and riser. Report any reading below meg-ohms to the leading petty officer.

EB ZZ1G CA3 14 1557 A

LOCATION

98.176

Figure 3-37.—Maintenance Requirement Card (MRC).

shop. Read the card carefully, it tells what tools and material the job will require, safety precautions to observe, and procedures to follow. The total manhours the job should require will vary depending on your particular type ship. Upon completion of the job, return the MRC to its file and mark the job (x) on the weekly work schedule so that the division PO can see it is completed.

The same procedures for checking casualty power cables should be followed on ships that do not as yet have the PMS system installed.

After an exposure period of five years or more, the casualty power cable conductor insulation may have aged and lost its elasticity to the extent that it will crack open when bent during handling incident to emergency use. The best method of detecting overage insulation of the exposed ends of individual conductors is to sharply bend each conductor by hand. If no visual cracks develop, the insulation is satisfactory. If cracking is noted it should be reported to the leading petty officer. Cable ends with cracked insulation should be cut back and new terminals prepared in accordance with NavShips Technical Manual, chapter 9621, Section I.

The casualty power cables must be checked after any repairs to ensure that they are still of sufficient length to make connections at designated risers and equipments.

SHORE POWER CABLE

A shore terminal box is provided at a suitable weatherdeck location aboard ship. Portable cables from shore power or from a ship alongside can be attached to the shore terminal box to supply power to the ship's distribution system. This same connection can be used to supply power from the ship's service generators to a ship alongside. The shore power system is designed to handle only enough power to operate necessary machinery and provide illumination for habitability and the accomplishment of necessary work. Care must be exercised not to exceed the capacity of the system when it is in use.

Older type flexible shore power cables are connected to their shipboard terminal box(es) by bolted (fig. 3-36B) lugs. Later type cables have plug (fig. 3-36C) contacts which are plugged into 400-ampere (3-terminal) receptacles.

For a-c systems, the flexible shore power cables are 3-conductor, 400,000 cm (type THOF-400). These are rated 366-amp and 338-amp in ambient temperatures of 40° C and 50° C, respectively. Where practical for maintaining the best voltage regulation, several cables should be connected to limit each conductor's current below 250 amperes. However, all cables should be able to safely carry 400-ampere loads for 2 to 3 hours when the desired arrangement is not practical.

The lug ends of all shore-power cables (if not already prepared when received aboard ship) should be made up in the following manner:

1. Remove the outer sheath from the cable for approximately 2 feet, or a sufficient distance to permit ready attachment to the shore terminal box (step 1, fig. 3-36A). Do not damage the insulation of the individual conductors.
2. Taper the end of the outer sheath, starting about 1 inch back from the cut end (step 2, fig. 3-36A).
3. Apply a coat of air-drying, insulating varnish to the crotch of the cable and allow it to dry (step 3, fig. 3-36A).
4. Apply two layers of pressure-sensitive synthetic resin tape or friction tape (half-lap), starting about 2 inches back of the crotch and finishing about 2 inches in front of the crotch (step 4, fig. 3-36B).
5. Reinforce and seize the tape with a serving of treated glass cord, and coat the completed serving with air-drying insulating varnish (step 5, fig. 3-36B).
6. Apply a serving of treated glass cord, colored for phase marking (step 6, fig. 3-36B).
7. Attach lugs as furnished with the ship's shore terminal box (step 7, fig. 3-36B). Stamp the lugs to indicate the phase (A, B, C) or polarity (+, ±, -) of the conductors. The lug markings, the colored glass cord serving, and the color of the conductor should all agree with the phase and polarity code for light and power conductors (table 3-4).

The terminal connecting block, and terminals of the ship's shore terminal box must be plainly marked to indicate phase sequence, or polarity, as appropriate. For example, the terminal of the black conductor should be stamped (A) to indicate phase A; or stamped (+) to indicate polarity, as appropriate, and so on. The color code of cables should not be implicitly trusted because the conductors (from exposure) may become discolored or lose their original coloring.

When practicable, follow these procedures when connecting shore power cables.

1. Test the ship's shore terminal box for proper marking. Do this by energizing the shore terminal box from the ship's service generator. Check the phase sequence (a-c) markings by testing the terminals with a phase sequence indicator. Check polarity (d-c) markings by testing the terminals with a polarity-indicating voltage tester. An approved type phase-sequence indicator is shown in figure 3-38.

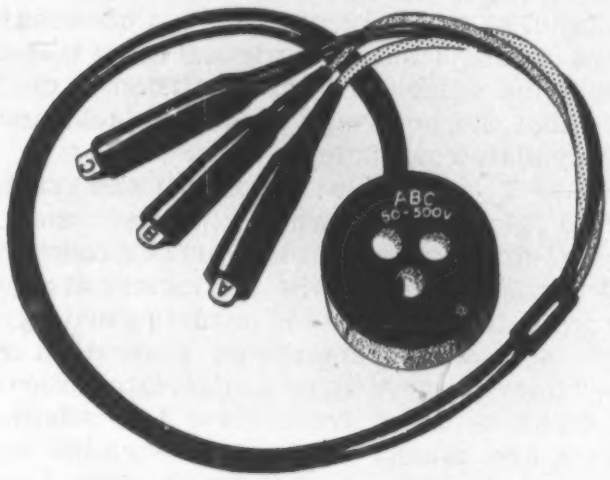

73.52
Figure 3-38.—Phase-sequence indicator.

This indicator consists of a miniature, 3-phase induction motor, which indicates phase sequence by the direction in which the rotor (moving element) turns. After it has been determined that the markings are correct, secure the ship's power to the shore terminal box by opening the ship's shore power switch. This switch should be tagged in the manner prescribed for tagging circuits (on which men are working) in the section of this chapter titled "Maintenance."

2. Rig the shore power cable and connect one end of it to the ship's shore terminal box. Make certain that the leads are properly connected in accordance with the terminal markings of the box.

3. Check the terminals on the shore connection with a voltage tester, and after it has been determined that they are energized, connect the other end of the shore power cable leads.

4. Energize the cable from the shore power supply, and test either phase sequence, or polarity, (depending on whether a-c or d-c). If the phase sequence, or polarity, matches that of the ship's power, the ship may safely switch to shore power. The procedure for switching to shore power is given in chapter 11.

Warning signs indicating the voltage of the cable should be attached to the shore power cable at intervals to warn personnel to keep clear of the cable. All connections must be tightly made to prevent damage to the terminals or leads as a result of overheating and arcing.

The procedures and precautions that follow apply to all portable cables as well as the shore power cables. Spliced portable cables are extremely dangerous and should not be used unless an emergency warrants the great risk involved. Portable cables must be of sufficient length to prevent their being subjected to longitudinal stresses and the need to be pulled taut to make connections. Current-carrying capacity must be ample for the expected power demand. The cable must be checked frequently to ascertain the degree of heating, and any cable that feels uncomfortably warm to the bare hand (placed outside the insulation) should be checked immediately for overloading. Interconnections between lengths of portable cable shall be made only on approved connection block or by other approved fittings that shall be suitably insulated and enclosed to eliminate all possible hazards from fire or shock to personnel.

Always support portable cables above decks, floor plates, and gratings. Never place them where they can be damaged by falling objects, by being walked on, or by contact with sharp corners or projections in the ship's hull or other objects. Where portable cables pass through doorways or hatches, provide steps to prevent cables from being pinched by a door or hatch cover.

CABLE MAINTENANCE

The primary purpose of electrical cable maintenance is to preserve the insulation resistance. Hence, it is important to know the insulating materials that are used in naval shipboard electrical equipment and the factors that affect insulation resistance.

INSULATION

The purpose of insulation on electric cables and equipment is to (1) isolate current-carrying conductors from metallic and structural parts, and (2) insulate points of unequal potential on conductors from each other. Normally, the resistance of such insulation should be sufficiently high to result in negligible current flow through or over its surface.

Air may be used as an insulator if a solid insulating material is used for support to maintain proper electrical clearance and creepage distances. The CLEARANCE distance is the shortest point to point distance in air between two bare (uninsulated) conductors or

between a bare conductor and ground. The CREEPAGE distance is the shortest distance between two bare (uninsulated) conductors, or between a bare conductor and ground, measured along the surface of the solid insulating material. Permissible clearance and creepage distances depend upon the voltage and current involved, the degree of enclosure, and the properties of the insulating material supporting the conductors. Minimum acceptable electrical clearance and creepage distances (in inches) are shown in tables contained in chapter 9005(40) of the NavShips Technical Manual.

The electrical insulating materials used in naval shipboard electrical equipment (including cables) are grouped according to their chemical composition; for example, class O, class A, class B, class C, class H, class E, and class T insulation.

Class O insulation consists of cotton, silk, paper, and similar organic materials when neither impregnated nor immersed in a liquid dielectric. Class O insulation is seldom used by itself in electrical equipment.

Class A insulation consists of (1) cotton, paper, and similar organic materials when they are impregnated or immersed in a liquid dielectric; (2) molded and laminated materials with cellulose filler, phenolic resins and other resins of similar properties; (3) films and sheets of cellulose acetate and other cellulose derivatives of similar properties; and (4) varnish (enamel), as applied to conductors.

Class B insulation consists of mica, asbestos, fiber glass, and similar inorganic materials in built-up form with organic binding substances, such as polyvinylacetal or polymide films. A small portion of class A materials may be used for structural purposes only.

Class H insulation consists of (1) mica, asbestos, fiber glass, and similar inorganic materials in built-up form with binding substances composed of silicone compounds or materials with equivalent properties; and (2) silicone compounds in the rubbery or resinous forms, or materials with equivalent properties. A minute proportion of class A materials may be used only where essential for structural purposes.

Class C insulation consists entirely of mica, glass, quartz, and similar inorganic material. Class C materials, like class O, are seldom used alone in electrical equipment.

Class E insulation is an extended silicone rubber dielectric used in reduced-diameter types of electric cables in sizes 3, 4, and 9. Special care should be exercised in handling the cables to avoid sharp bends and kinks that can damage the silicone rubber insulation on the old types that did not employ a nylon jacket over each insulated conductor.

Class T insulation is a silicone rubber treated glass tape, which is also used in reduced-diameter cables in sizes 14 through 800.

Propulsion generators and motors are usually insulated with class B insulating materials. Ship's service and emergency generators may have either class A, B, or H materials; however, the trend is away from class A. Auxiliary motors are usually class A, although the trend is toward class B and class H materials. Lighting transformers for 60-cycle service are class B insulated, and 400-cycle transformers are class H insulated. Miscellaneous coils for control purposes may be class A, B, or H, but the majority of such coils are class A insulated.

It is important to maintain operating temperature of electrical equipment within their designed values to avoid premature failure of insulation. Temperatures only slightly in excess of designed values may produce gradual deterioration, which, though not immediately apparent, shortens the life of the insulation. The highest temperature (hot-spot temperature) to which class O insulation may be subjected continuously with normal life expectancy (5 years) is 90° centigrade, class A insulation, 105° centigrade; class B insulation, 130° centigrade; and class H, 200° centigrade. No limit has been established for class C insulation.

The maximum allowable temperature rise and the design ambient temperature for electrical equipment are usually shown on the nameplate, on equipment drawings, and in the technical manual for the equipment. When information is not available from these sources, the maximum permissible temperature rises, shown in Chapter 9600, NavShips Technical Manual, shall be used as a guide for checking or testing windings of rotating electrical machinery.

In chapter 6 of this text; "Maintenance of Motors and Generators", additional coverage is given on insulation.

Insulation Resistance Measurements

The insulation resistance of shipboard electrical cable must be measured periodically with an insulation-resistance-measuring instrument (megger) to determine the condition of the cable.

Varying the position of the arm of R13 affects the static conduction, thus affecting vertical centering.

The arm of R23 is also picking off a portion of the sawtooth and applying it to the grid of V10. V10 shares the multivibrator cathode resistor R18 and is cut off during the same time that V7 is cut off. When the grid voltage of V10 rises enough to overcome its bias, V10 will conduct and will increase the voltage developed across R18. Let us now recall the normal multivibrator action of V6 and V7. Normally, when C2 discharges through R20 sufficiently, V7 will conduct and develop additional voltage across R18, causing V6 to cut off. The added voltage increase caused by V10 increases the bias on V6 and stops its conduction prior to the normal discharge of C2. This causes the plate voltage of V6 to rise, which allows V8 to conduct and discharge C4. The sweep is now terminated. Thus the sweep is started, developed, and terminated prior to the normal discharge of C2, and V6 is ready for the next MTP, which will come when the transmitter fires again.

Horizontal deflection is accomplished more easily. A potentiometer is connected between two potentials. As shown in figure 17-18, this potentiometer is R1 and is connected between B+ and ground. The arm is geared to the antenna mechanically so that, as the antenna scans from side to side, the arm varies this voltage between fixed limits. This developes a back-to-back sawtooth which is directly coupled to the grid of V1. Direct coupling is employed in this circuit because of the low frequencies involved. The frequency is the same as the scan rate of the antenna and would likely fall between 0.5 and 2 cycles per second.

V1 and V2 comprise a grounded-grid paraphase amplifier which functions in exactly the same manner as V4 and V5. Therefore, as the voltage at R1 rises and falls, push-pull action will be developed on the horizontal deflection plates of the indicator V3 and the vertical sweep will move from side to side with the scanning of the antenna.

Scope Presentation

When the antenna is rotated and the sweep moves away from the center position, B-scan distortion is introduced. This distortion can be best visualized by taking the wedge-shaped sector which the antenna is scanning, breaking it open at the apex, and pulling the sides outward until they are vertical. (See fig. 17-19.) The base, broken at O, shows the sector in the process of being drawn out. This illustrates the way the same sector will appear in a B-scan presentation.

Some lines have been drawn on the sector and we must observe what has happened to each one of them. Note that the point O has been stretched into the line O-O'. The line O-O' thus represents a single point located in space directly at, under, or over the antenna. All lines such as A-O, C-O, F-O, and B-O have become vertical. A homing problem is made simple by the fact that any target that can be caused to move to the bottom of the indicator will be on a collison course. Notice also the line C-G. This line indicates the path of a target passing to the left. Now notice that this line of the presentation is a sweeping curve to the

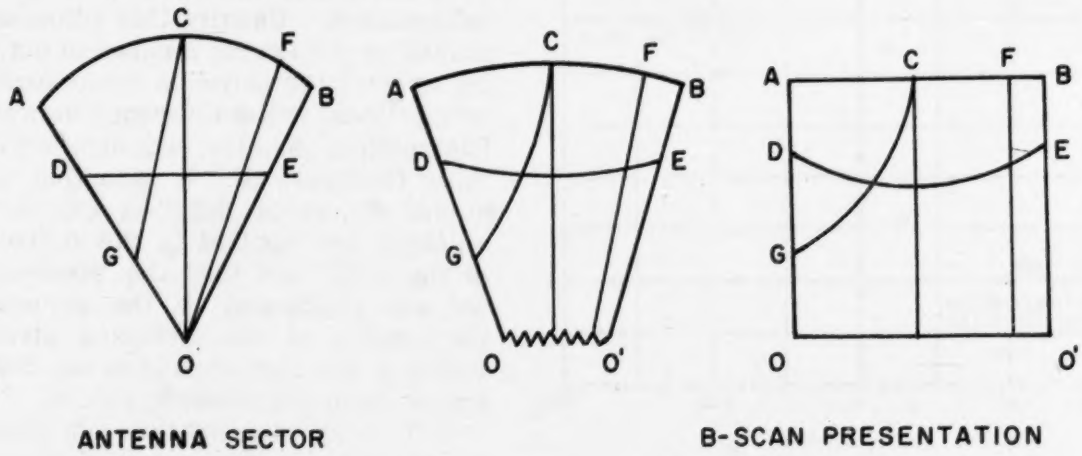

Figure 17-19. —B-scan distortion due to expanded base.

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Cable insulation measurements should be made often enough (if operating conditions permit) to ensure that power and lighting circuits will have an accurate measurement at least once every 3 months during the first year after installation, thereafter, measurements are taken only at overhaul periods or if damage to the cables is suspected. These conditions are detailed in the NavShips Technical Manual, Chapter 9600. More frequent measurements may be made if a comparison with similar earlier measurements indicates a significant decrease in insulation resistance. In addition, cognizant Bureau Directives or Instructions may require that more frequent cable insulation-resistance measurements be made on some circuits; for example, degaussing coil measurements are required weekly on some degaussing installations.

Factors that affect cable insulation resistance measurements are the length of the cable, type of the cable, temperature of the cable, and the equipment connected in the circuit. Each of these factors must be evaluated to reliably determine the condition of the cable from the measurements obtained.

Length of Cable

The insulation resistance of a length of cable is the resultant of a number of small individual leakage paths or resistances between the conductor and the cable sheath. These leakage paths are distributed along the cable. Hence, the longer the cable, the greater the number of leakage paths and the lower the insulation resistance. For example, if one leakage path exists in each foot of cable, there will be 10 such paths for current to flow between the conductor and the sheath in 10 feet of cable, and the total amount of current flowing in all of them would be 10 times as great as that which would flow if the cable were only 1 foot long. Therefore, to establish a common unit of comparison, cable-insulation resistance should be expressed in megohms (or ohms) per foot of length. This is determined by multiplying the measured insulation resistance of the cable by its total length in feet.

When measured insulation resistance is converted to insulation resistance per foot, the total length of cable to be used is equal to the length of the cable sheath for single conductor cable and for multiple conductor cable in which each conductor is used in one leg of a circuit. For example, in a TSGA cable with a cable sheath of 100 feet in which the three conductors are phases A, B, and C of a 3-phase power circuit, the total length of the cable is 100 feet, not 300 feet. The reason for this is that each conductor is measured separately. If this cable is connected, either in series or parallel, to a similar cable that has a sheath length of 400 feet, the total length is 500 feet. As another example, 200 feet of type MSCA-7 cable (7-conductor cable) connected to 200 feet of MSCA-24 cable (24-conductor cable) represents a total cable length of 400 feet.

Because degaussing cable is installed in the form of a loop and the conductors in the multiple conductor cable used are connected in series where the ends of the cable meet to form a single coil with as many turns as there are conductors in the cable, the total length of multiconductor degaussing cable is equal to the length of the cable sheath times the number of conductors. For example, the total length of a type MDGA-19 cable (19-conductor cable) with a cable sheath of 500 feet is 9500 feet (500 x 19 = 9500).

Type of Cable

Insulation resistance will vary considerably with the nature of the insulating materials used in construction of the cable. Therefore, it is possible to determine the condition of cable insulation by resistance measurements only when they are considered in relation to the typical characteristics of the particular type cable.

Figure 3-39 shows a resistance test record card to be used for power, lighting, and degaussing circuit cables. Parts A and B of figure 3-39 are the front and reverse sides of the resistance test record card, respectively.

The front of the card is filled in with the circuit designation, length, card number, and index. The vertical columns are filled in as measurements are taken. The date and measured resistance megs are listed (these are the actual megger readings). The ambient temperature assumed is listed as follows. The cable temperature shall be considered 104° F if the cable has been energized for four hours or more. If in a warm climate or a condition in which the entire cable is in a heated space and not in contact with the ship's hull (on hangers, not flush against hull), the temperature is considered to be at 70° F. If in a cold climate

INDEX	CIRCUIT				LENGTH	CARD NO.
DATE (MO, DA, YR)	MEASURED RESISTANCE MEGS.	RESISTANCE PER FOOT (CABLE) MEGOHMS	AMBIENT TEMP.-ASSUMED (104°F), 70°F, OR 40°F)	REMARKS		
	A B C					
	A B C					
	A B C					
	A B C					
	A B C					
	A B C					
	A B C					
	A B C					

RESISTANCE TEST RECORD CARD NAVSHIPS 531-1 (10-63) (FRONT)

A

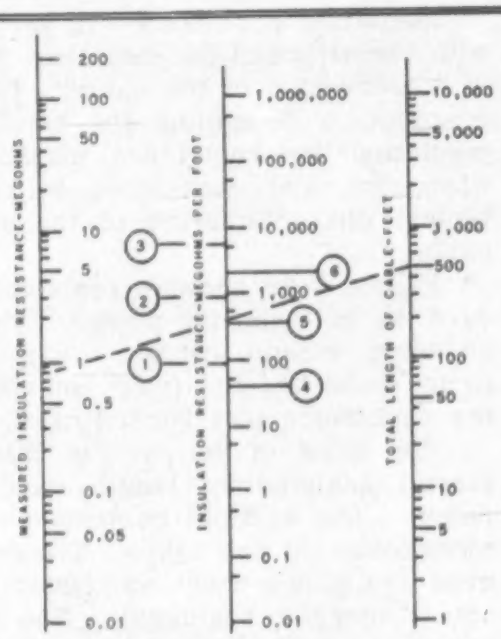

NOMOGRAPH FOR OBTAINING RESISTANCE PER. FT.

OBTAINING RESISTANCE PER FOOT - *Example*

Line is drawn on nomograph from 0.8 megohms (measured) to 500 feet (length of cable per card or plans). If points ①, ④, or ⑤ apply, cable is O.K. If points ②, ③, or ⑥ apply, cable may be in poor condition - investigate further.

MINIMUM ALLOWABLE INSULATION RESISTANCE CABLES (MEGOHMS/FT)

	TYPE OF CABLE	
	SGA, HF, DG, SCA	TTMFA, TTH, YA
JUST AFTER SHUTDOWN 104°F	95 (POINT ①)	40 (POINT ④)
↓ EQUIPMENT 4-24 HOUR SECURED HOURS		
WARM CLIMATE SUMMER OR ALL IN HEATED SPACE 70°F	920 (POINT ②)	380 (POINT ⑤)
COLD CLIMATE WINTER OR AGAINST COLD HULL 40°F	5500 (POINT ③)	2200 (POINT ⑥)

C-88884

RESISTANCE TEST RECORD CARD NAVSHIPS 531-1 (10-63) (REVERSE)

B

Figure 3-39.—Part A—front side of NavShips 531-1(10-63).
Part B—reverse side of NavShips 531-1(10-63).

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Figure 3-39.—Part A - front side of NavShips 531-1(10-63)
Part B- reverse side of NavShips 531-1(10-63)

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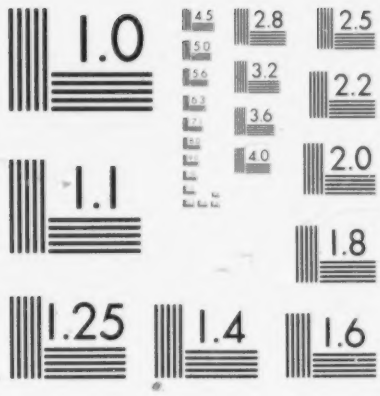

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

or a condition in which most of the cable is in an unheated space or against the ship's hull in cold waters, the temperature is considered to be 40° F.

Having marked down the assumed temperature, the reverse side (part B of figure 3-39) of the card must be used for finding the resistance per foot (cable) megohms. To perhaps clarify the example shown on part B of figure 3-39, assume you had just completed a reading of 0.8 megohms on a degaussing circuit of 500 feet in length. On the lower right-hand side of part B is a listing of minimum allowable insulation resistance for cables (megohms/ft). Under the type of cable heading note point ①, point ②, and point ③ for DG cable at 104° F, 70° F, or 40° F, respectively. Assuming the 0.8 reading was taken just after shutdown, point ① would apply and the minimum megohms/ft would be 95 as shown in the block point ①. Having found the minimum, place a mark on the insulation resistance megohms per foot scale (center scale on left side of card) at the 95 position as now shown by ①. Drawing a straight line (shown dotted) from 0.8 on the measured insulation resistance scale across to the 500 ft mark on the length of cable scale, derives the insulation resistance in megohms per foot of the circuit just read at the point of intersection of the dotted line and the center scale (at approximately 400 megohms/ft as shown). Since the minimum was 95 megohm/ft and the circuit reads 400, it is in satisfactory condition.

If the same 0.8 reading had been obtained at a temperature of 40° F, however, the minimum allowable insulation resistance would be 5500 megohms/ft as shown by point ③. Thus the 400 megohms/ft reading would be below the minimum and would require investigation.

Temperature of Cable

If the results obtained by the assumed temperature method indicate unsatisfactory cable insulation then the actual temperature should be measured.

These measurements should be made by means of thermometers attached to the sheath or armor of the cable. The thermometers should be attached at several points along the cable run and the values should be averaged. To provide accurate temperature readings, the thermometer bulb should be in direct contact with the cable sheath or armor, and any paint should be scraped away. The thermometer should be held in place with pads of felt (or other heat insulating material) placed over the bulb and secured with friction tape. The number and location of thermometers should be such that a representative average temperatures (as shown in fig. 3-40) of the entire cable sheath is obtained. To find the minimum insulation megohms/ft for temperatures of 14° F to 212° F use the graph in figure 3-41. The upper curved line marked A on the graph is to be used for SGA, HF, DG, and SCA type cables, while the lower curved line marked B is for TTHFA and TTHFWA type cables. The graph extends to 212° F, however the maximum permissible operating temperature for nonflexing service cables is 185° F at the sheath. In using this graph the same values will be derived as those given on the Resistance Test record card NavShips 531 (10-63), revision. For example, the minimum for a SGA type cable at 104° F is 95 megohms/ft on either the card or graph. Using this graph in conjunction with average sheath temperature will provide a quick method of determining if cable insulation is satisfactory or in need of repair or replacement.

Equipment Connected in a Circuit

Initial measurements of insulation resistance of complete circuits should be made to avoid unnecessarily disconnecting apparatus with resultant loss of time, and labor, and possible damage to cables by handling. For

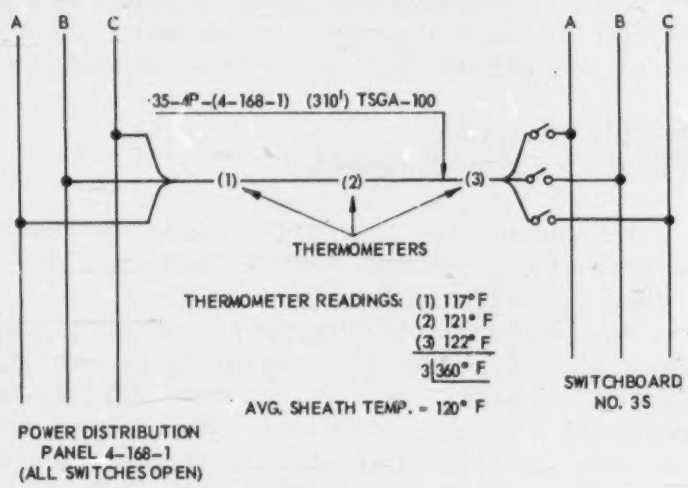

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Figure 3-40.—Simplified electrical power circuits.

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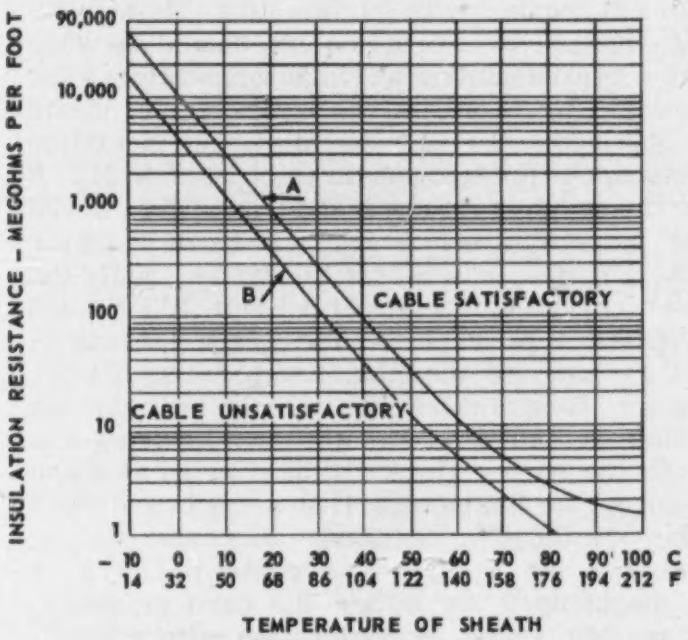

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Figure 3-41.—Minimum insulation resistance values for nonflexing service cables.

this purpose, the circuits measured should be considered as beginning at the open switch (or circuit breaker) on the switchboard from which the test potential is supplied and extending through closed switches on distribution panels and boxes, fuse clips (fuses in place), etc., to its extremity, including line terminals of controllers, light fixtures, and switches. When measuring insulation resistance, always record the exact amount of equipment included in the circuit so that accurate comparisons can be made with similar past or future measurements.

Making Insulation Resistance Measurements

Measurements should be made on each individual leg of d-c circuits and each individual phase lead of 3-phase a-c circuits.

For lighting circuits, the legs or phase leads should include all panel wiring, terminals, connection boxes, fittings, fixtures, and outlets normally connected, but with lights turned off at their switches and with all plugs removed from the outlets (fig. 3-42). If local lighting switches are double pole, the insulation resistance of the local branch circuit will not be measured when the switch is open. In such cases, making an insulation test from one leg or phase lead to ground with the local switches closed will determine whether grounds exist on the circuits and fixtures.

For power circuits, the legs or phase leads should include panel wiring, terminals, connection boxes, fittings, and outlets (plugs removed), motor controller terminals, and other equipment that remains connected when the legs or phase leads are isolated by opening switches (or circuit breakers) at the switchboard, and by leaving motor controller contactors open (fig. 3-43).

For degaussing circuits, measurements should be taken at a degaussing coil connection box; the legs measured should include the coil cables, through boxes, and feeder cables. Disconnect the supply and control equipment by opening the circuit on the coil side of the control equipment. Measure the compass-compensating coil feeder cable with all control equipment disconnected. Additional information on tests of degaussing installations is obtained in NavShips Technical Manual, Chapter 9810, and in the degaussing folder furnished with each degaussing installation.

Measurements of these circuits (lighting, power, and degaussing circuits) should be made as follows:

1. Check to see that the cable armor is adequately grounded by measuring between the cable armor and the metal structure of the vessel (step 1, fig. 3-44); normally, grounding has been accomplished by means of cable straps. If a zero reading is not obtained, ground the cable armor.

2. Select one lead to be measured, and connect all the other leads in the cable together and ground them by means of temporary wires (step 2, fig. 3-44).

3. Measure the resistance of the lead being tested to ground (step 3, fig. 3-44). The test voltage should be applied until a constant reading is obtained. Hand-driven generator type instruments (meggers) should be cranked for at least 30 seconds to ensure a steady reading.

4. Repeat steps 2 and 3 as necessary to measure each leg or phase lead to ground (steps 4 and 5, fig. 3-44). When circuits contain permanently connected paths between legs or phases, such as transformers, indicator lights, control relays, etc., measurements need be made only between one lead and ground unless low readings requiring further tests are obtained.

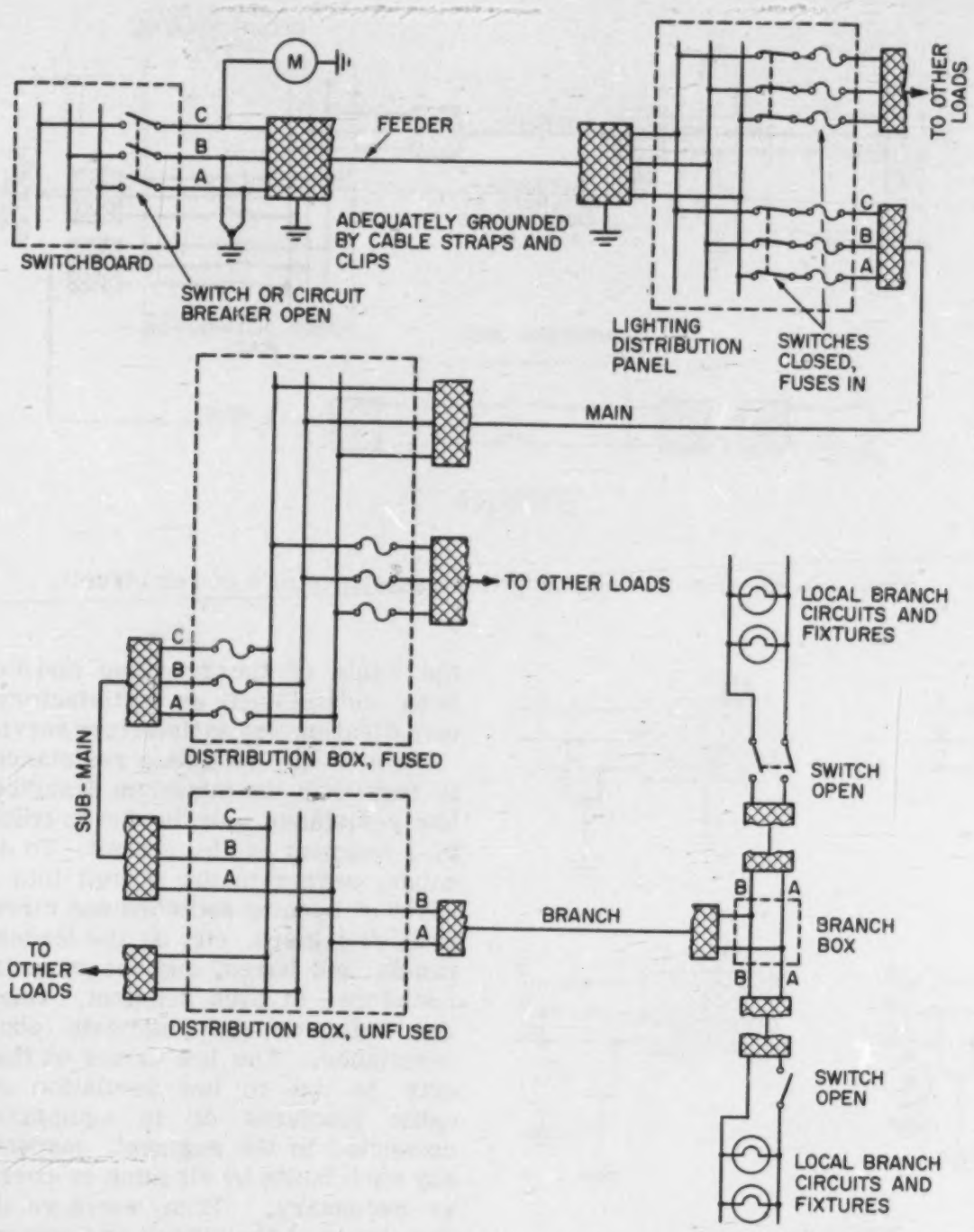

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Figure 3-42.—Measuring insulation resistance of a lighting circuit.

The readings obtained in accordance with the foregoing should be considered satisfactory if they are not less than 1 megohm for each leg or phase of a lighting or power circuit to ground, or less than 0.2 megohm from any leg, which includes the coil cables, the through boxes, and the feeder cables, of a degaussing circuit to ground. If the readings are lower than these minimum values, they should be considered satisfactory if they are not lower than previous measurements made under the same conditions (same cable with the same equipment connected and approximately the same average sheath temperature), provided

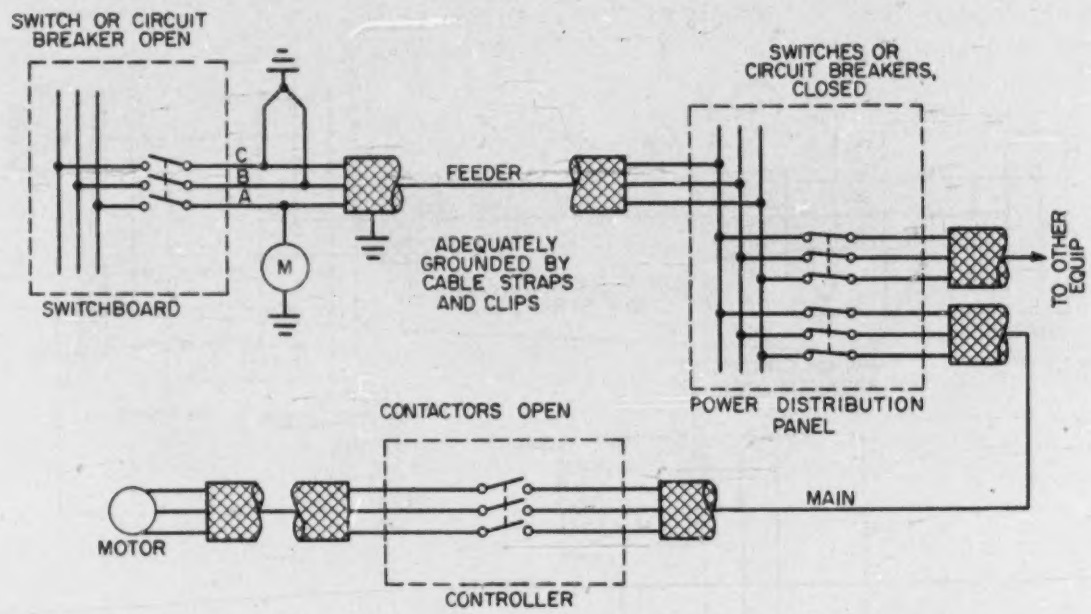

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Figure 3-43.—Measuring insulation resistance of a power circuit.

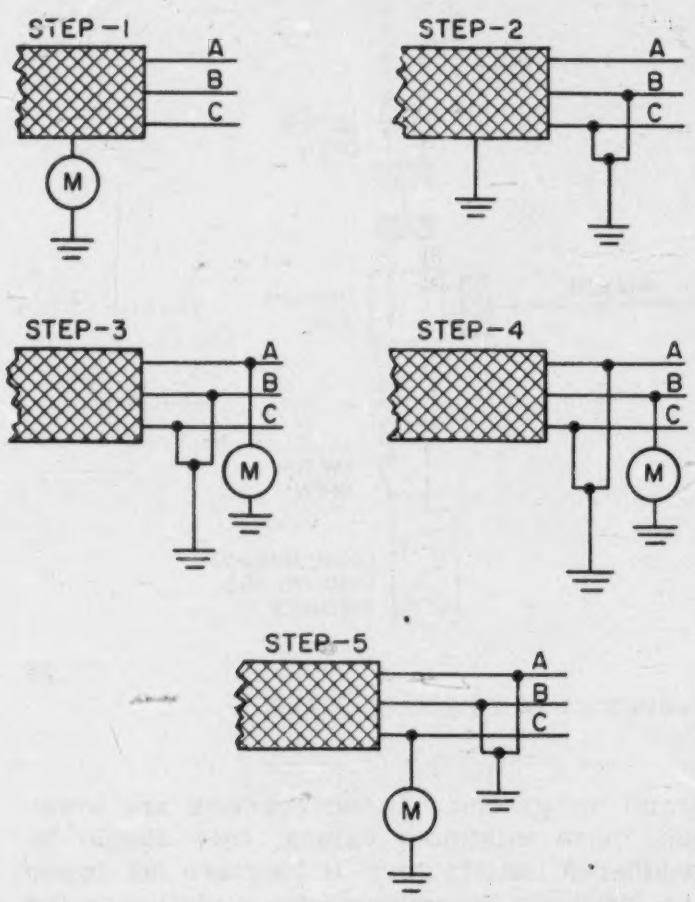

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Figure 3-44.—Measuring circuit insulation resistance.

the value of the previous measurements has been established as satisfactory by further investigation and satisfactory service operation.

Where the insulation resistance of a circuit is less than the minimum described above, the low resistance may be due to trouble localized in a segment of the circuit. To determine the cause, segregate the circuit into two or more parts by opening switches and circuit breakers, removing fuses, etc. at the feeder distribution panels and boxes, and measure the insulation resistance of each segment. One or more of the segments may indicate abnormally low resistance. The low values on these segments may be due to low insulation resistance at cable junctures or in equipment remaining connected to the segment. Inspect and correct any such faults by cleaning or corrective action as necessary. Then, measure the insulation resistance of the circuit and compare the values with readings obtained prior to the inspection and cleaning.

If the value is still low, disconnect all conductors in the questionable segment of the circuit and proceed as follows to ascertain the condition of the cable conductors:

1. Measure or closely estimate the average sheath temperature throughout the length of the cable being tested.

2. Measure the insulation resistance of each conductor in the cable.

3. Convert the measured insulation resistance to megohms per foot, and compare this value with the minimum satisfactory megohms per foot as shown (use Fig. 3-41) at the average cable sheath temperature.

4. If the megohms per foot of any conductor in the cable is less than the minimum satisfactory value indicated on the graph, an unsatisfactory condition is indicated and the cable section may require replacement or suitable corrective action.

5. If the megohm per foot of each conductor in the cable is higher than the minimum satisfactory value indicated on the graph, the circuit may be restored to the original condition by connecting the cable, replacing the fuses, and closing the switches, circuit breakers, etc. With the circuit as it was for the original measurements, measure it again. This reading should be recorded on the resistance test record card together with the notation as to which equipment remained connected.

If unsatisfactory readings are obtained, use the following procedures to determine and correct the cause of the low insulation resistance. The simplified circuit shown in figure 3-40 is used as an example.

The first step is to segregate the circuit into two parts by opening all the switches on panel 4-168-1. Additional measurements are made to determine whether the low insulation resistance is caused by that part between the switchboard and the distribution panel. The average sheath temperature, when measured by three thermometers (1, 2, and 3, fig. 3-40), is found to be 120° F, and the measured insulation resistance (for example) shows 160,000 ohms for phase A 140,000 ohms for phase B and 180,000 ohms for phase C.

The condition of the cable is determined by finding the insulation resistance per foot of the phase indicating the lowest resistance (phase B). This value is 43.4 megohms per foot (140,000 ohms x 310 ft = 43.4 megohms). The minimum safe insulation resistance of the upper curve (fig. 3-41) at 120° F is 35 megohms per foot. Because the lowest measured resistance of 43.4 megohms per foot is above the minimum safe value for type SGA cable, it appears that the condition of the cable is satisfactory.

Previous insulation resistance readings should always be compared to the present reading. Even though a circuit reads satisfactory (as the one in fig. 3-40) it should still be investigated if there is a noticeable decrease over previous readings. A circuit may read 30 megohms for several readings and then drop to 0.8 megohms and all of these readings still be within the minimum allowance. The 0.8 reading should be investigated and the cause of the decrease in insulation resistance eliminated as follows.

The next step is to further segregate the circuit by disconnecting the cable 3S-4P (4-168-1) from the distribution panel 4-168-1. An insulation resistance measurement is made on the cable, and this measurement gives a value of 1.2 megohms for the conductor with the lowest insulation resistance. This indicates that the distribution panel is probably contributing to the lowering of the resistance. An examination of the insulation around the bus bars in the panel discloses an accumulation of dust.

After the insulation of the panel is cleaned and the cable reconnected, another measurement is made, which shows a value of 1.5 megohms for the conductor with the lowest insulation resistance. This indicates that the condition has been corrected, and no further tests are necessary. The reading of 1.5 megohms is recorded on the Resistance Test Record Card (NavShips 531-1(10-63) for this circuit along with an entry giving the average sheath temperature and the equipment connected in the circuit.

It is recommended that a work log be maintained in which the date, insulation resistance, sheath temperature, equipment connected in the circuit, and other pertinent information (fig. 3-45) are recorded at the time the measurements are being made. This information will prove valuable when comparing measurements, and will provide the data required to be recorded on the resistance test record card.

CABLE FITTINGS

Stuffing Tubes

Periodic inspections should be made to determine the condition of stuffing tubes. Such inspections may be made in conjunction with other tests and inspections. Usually, visual inspection is sufficient to disclose the material condition of the fitting; however, watertightness of stuffing tubes is best determined by air tests. Loose seals occasionally develop due to one or more of several factors, such as loosening of the gland nuts, flowing of the intermediate or

USS GEAR (CA-123)

S/S SWITCHBOARD NO. 3S DATE: 6 JUNE 1960

CIRCUIT DESIGNATION	RESISTANCE IN MEGOHMS			AVG. SHEATH TEMP.	TOTAL LENGTH	MEGS. PER FOOT (MIN.)	REMARKS
	A	B	C				
3S-4P-(4-168-1)	0.25	0.2	0.3	105°F	835'	167.0	(1) complete circuit, all switches closed
							in panel 4-168-1
	0.16	0.14	0.18	120°F	310'	43.4	(2) cable 3S-4P-(4-168-1) and panel
							4-168-1 with all switches open
	2.0	1.5	1.2	120°F	310'	465.0	(3) cable 3S-4P-(4-168-1) disconnected
							from panel 4-168-1
	1.5	1.0	1.2	105°F	835'	835.0	(4) complete circuit, all switches
							closed in panel 4-168-1
							cleaned panel 4-168-1
3S-4P-(1-132-1)	2	2.5	1.5	95°F	1275'	2550.0	complete circuit, all switches closed
							in panel 1-132-1
							estimated temperature.

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Figure 3-45.—Sample resistance test work sheet.

soft packing in metal tubes, or "necking" of the cables, and by the loosening effect of alternate heating and cooling of the cables from energizing and deenergizing them.

There is only a remote chance of the stuffing tube gland nuts loosening or backing off after the compartment in which they are located has been painted, since the paint over the gland nuts will tend to keep them from turning. Loosening of the seal in metal stuffing tubes is more often caused by flow of the soft plastic packing into the interstices of the cable armor, or by depression or "necking" of the cable itself because of excessive packing pressure. Therefore, care must be taken when setting up gland nuts to avoid excessive packing pressure.

It is preferable that no stuffing-tube gland nuts be tightened except those that have obviously loosened or backed off, unless there is positive evidence of leakage through the stuffing tube. When gland nuts must be tightened, an additional turn of soft packing should be inserted if at all practicable.

Supports

The bolts and nuts that secure cable hangers, connection boxes, and wiring appliances to bulkheads and other supports may be loosened and lost because of vibration and gun fire. Periodic inspection should be made and all nuts and bolts securely tightened. Such an inspection should be made after firing, especially of those wireways in the vicinity of the guns.

TESTS AND INSPECTIONS

Certain periodic tests and inspections are necessary to ensure the satisfactory operation of shipboard electrical cable installations. The following schedule of tests and inspections should be used so far as practicable and may be supplemented by more frequent tests and inspections as unusual circumstances or conditions warrant.

1. Each watch: Use ground detector voltmeters or ground detector lamps at least once each watch to test for grounds on the circuits that are energized. Record the test and results in the electrical operation log.
2. After firing: Inspect wireways and securely tighten all nuts and bolts.
3. Weekly: Measure the insulation resistance of all degaussing cables with an insulation resistance measuring instrument.

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left. The fact that it is not on a collision course is apparent very early in a problem. Thus, homing is made quite simple. The presentation is not "maplike"; therefore, an operator must learn to interpret the presentation before he can use it to navigate efficiently. Actually, this does not take very long. All arcs around the antenna, such as A-F on the sector, tend to become straight lines. The greater the radius of an arc, the closer the arc approaches a straight line; therefore, distortion is less at longer distances and navigation at long ranges is much easier than it is at short ranges.

The distortion caused by the use of the B-scan is both good and bad, but with a little practice, the disadvantages can be greatly reduced.

C-SCAN

The C-scan type of presentation was developed primarily to be employed by the remote indicators used by pilots in earlier radar. However, the principle of the C-scan presentation is employed by many of the main indicators in aviation fire control equipment.

The basic purpose of the C-scan is to indicate the elevation and azimuth of a target relative to the attacking aircraft. (See fig. 17-20.) The relative altitude of the target aircraft is indicated by the position of the target relative to the horizontal centerline of the screen. The horizontal angle (azimuth) between the target aircraft and the heading of the attacking aircraft is represented by the displacement of the target from the vertical centerline of the indicator. Thus, the position of the target on the indicator would indicate both relative azimuth and elevation of the target aircraft.

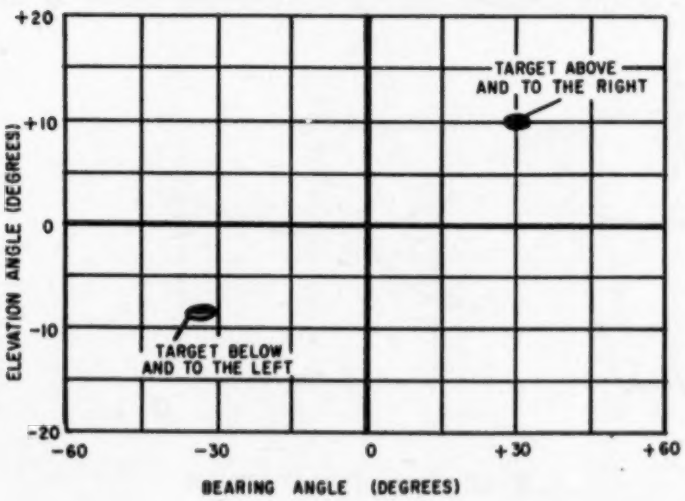

Figure 17-20. —C-scan presentation.

Like B-scopes, C-scopes provide a rectangular display on their screens. To obtain a rectangular display on the screen of a C-scope, both horizontal and vertical sweep generators are used. Since the sweep frequencies are relatively low, potentiometers (like the azimuth sweep potentiometer of the B-scope) are generally used. These potentiometers are connected to the radar antenna.

When the antenna rotates horizontally, the scanning spot on the C-scope screen is deflected horizontally. When the antenna is tilted up or down, the scanning spot is deflected vertically. Echo signals applied to the control grid (or cathode) of the CRT during the sweep period causes the brightness (intensity-modulation) of portions of the horizontal trace to be increased. The position of a bright spot indicates the elevation and bearing of a target.

Targets at different ranges, but with the same bearing and elevation, appear as a single spot on a C-scope. Targets of this kind cannot be distinguished individually on the C-scope. For this reason, an indicator that presents range date is generally used in conjunction with a C-scope. Once the range of a particular target has been determined, a range gate pulse (rectangular pulse) is applied to the C-scope. This intensifies the electron beam only for the duration of the range gate pulse. Thus, only targets within the gated range will appear on the C-scope; all other signals are blanked out. In this way, the bearing and elevation of a particular target at a specified range can be determined.

A common application of the C-scan type of presentation is the display of steering error information. Usually this information is displayed as a steering circle and dot. The steering error information is in the form of voltages proportional to the difference between the actual flightpath of the attacking aircraft and the optimum flightpath of the attacking aircraft, required to score hits on the target. These voltages are applied to the deflection system of the CRT and thus the steering circle and dot are positioned on the screen relative to the heading of the attacking aircraft. Other voltages are also applied to the deflection system to form the steering circle.

A C-scan presentation can also be used to display information obtained from an infrared (IR) detector system.

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CHAPTER 4

SHIPBOARD LIGHTING

PRINCIPLES OF LIGHT

Light is radiant energy of those wavelengths that are capable of affecting the eye to produce vision. Radiant energy is emitted from various sources and varies in wavelength from 10^{-12} centimeters for cosmic rays to 10^{6} centimeters for radio rays. This range of wavelengths comprises the complete spectrum of electromagnetic waves, which travel through space at the velocity of approximately 186,000 miles per second.

The visible spectrum constitutes a narrow portion of the complete spectrum and includes red, orange, yellow, green, blue, and violet rays (figure 4-1). The range of wavelengths in the visible spectrum varies from 0.0008 millimeters for red rays to 0.0004 millimeters for violet rays. The spectrum extends beyond these limits into regions that are invisible to the eye. Radiation of greater wavelength beyond the red end is INFRARED and that of lesser wavelength beyond the violet end is ultraviolet.

PROPAGATION

The natural sources of light are the sun, stars, moon, and planets. The artificial sources include the electric-arc lamp, incandescent lamp, and fluorescent lamp. These sources of radiation (except the fluorescent lamp) are bodies at high temperatures, which produce vibration of the particles of matter. The radiated light travels in straight lines and behaves like wave motion in which the waves are transverse to the direction of propagation.

Light waves are of different wavelengths; different colors of light correspond to different frequencies of vibration; and electromagnetic waves of all wavelengths travel with the same velocity in free space, but with different velocities in different media. Hence, light waves obey the fundamental equation of wave motion,

$$f = \frac{V}{\lambda} = \frac{3 \times 10^{10}}{\lambda} \qquad (4\text{-}1)$$

where V is the velocity of light (3×10^{10} centimeters per second), f the frequency of vibration (number of waves passing a given point per second), and λ the wavelength in centimeters.

Light waves travel in straight lines in a homogeneous medium. When these rays, or lines, of propagation encounter a medium of greater or less density, some of the energy is absorbed and the remainder is either reflected by the boundary between two media or is refracted in passing obliquely from one medium into another, or through a medium of varying density. These phenomena (absorption, reflection, and refraction) usually occur when light impinges on most objects.

ABSORPTION

Absorption is the loss of energy that occurs when light rays strike an object and are dissipated in the form of heat. The amount of absorption depends on the nature of the object, the molecular construction, the wavelength or color of the incident light, and the angle at which the light strikes the object. All objects do not absorb light of different wavelengths in the same proportion. This phenomenon accounts for the characteristic color of objects illuminated by either sunlight or artificial white light.

REFLECTION

Reflection occurs when light rays strike an object and are deflected back from the surface in a different direction. When light falls on a

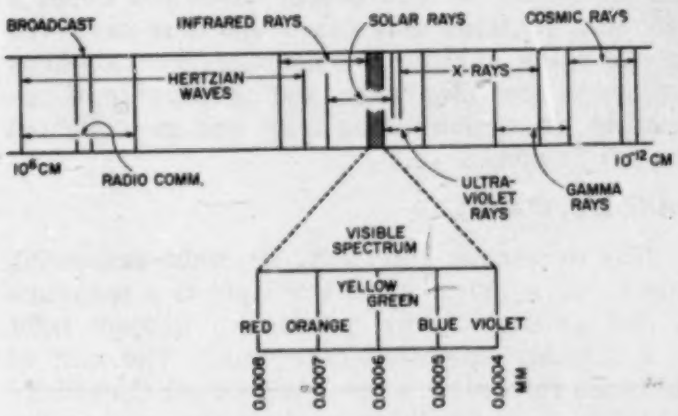

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Figure 4-1.—Spectrum of electromagnetic radiation.

smooth, polished surface, it is reflected in a definite direction and is called REGULAR reflection (fig. 4-2). The light from the source to the polished surface is the INCIDENT RAY. The point at which the incident ray strikes the polished surface is the POINT OF INCIDENCE, P. The ray that leaves the point of incidence is the REFLECTED RAY. The line perpendicular to the polished surface at the point of incidence is the NORMAL TO THE SURFACE, N. The angle between the incident ray and the normal to the surface is the ANGLE OF INCIDENCE, i. The angle between the reflected ray and the normal to the surface is the ANGLE OF REFLECTION, r.

The incident ray, reflected ray, and normal to the point of incidence lie in the same plane,

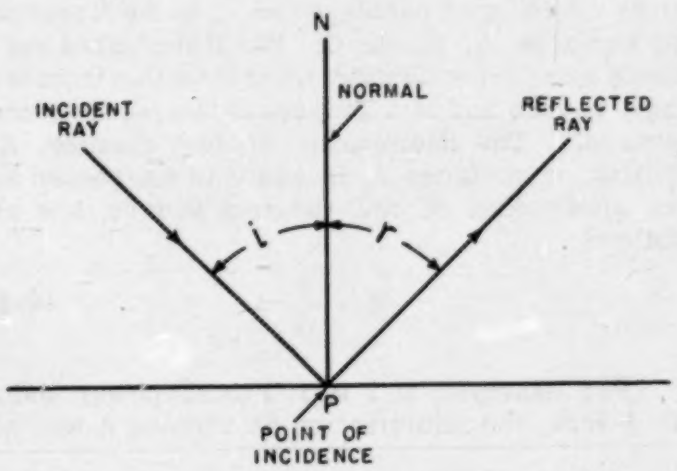

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Figure 4-2.—Reflection of a light ray.

and the angle of reflection is equal to the angle of incidence. This condition is true for both plane and curved mirror surfaces. The incident and reflected rays travel with the same velocity because they travel in the same medium.

When light falls on a rough, unpolished surface, it is reflected in all directions and is called diffuse (irregular) reflection. The only essential difference between regular and diffuse reflection is that diffuse reflection takes place from an infinite number of infinitesimal plane surfaces oriented in all directions.

REFRACTION

Refraction occurs when light rays pass obliquely from one medium to another of greater or less density and undergo an abrupt change in direction (figure 4-3). The incident ray enters the second medium at the POINT OF INCIDENCE, P. The ray that enters the second medium is the REFRACTED RAY. The line perpendicular to the surface at the point of incidence is the NORMAL TO THE SURFACE, NN'. The angle between the refracted ray and the normal to the surface in the second medium is the ANGLE OF REFRACTION, r'. The magnitude of the angle of refraction depends on the refracting medium and is not necessarily equal to the angle of incidence.

Both reflection and refraction occur in greater or less degrees at the boundary surfaces between most media. The boundary thus serves as reflecting surface for one ray and as a refracting surface for another. The normal to the surface, NN', and the incident and refracted rays lie in the same plane.

COLOR

As previously stated, light of different colors travels through space with the same velocity. Hence, in accordance with the fundamental equation of wave motion (equation 4-1), the frequencies are different for different colors and are inversely proportional to their wavelengths as,

$$\underline{f} = \frac{\underline{V}}{\lambda},$$

where $\underline{f}$ is the frequency, $\underline{V}$ the velocity, and λ the wavelength.

The impression of color depends on the frequency of the light that is reflected or transmitted to the eye. The primary colors of light

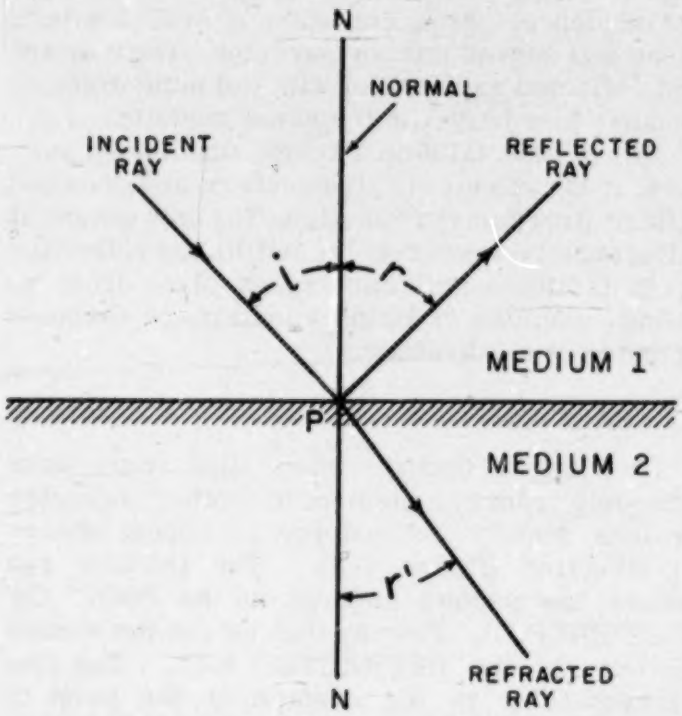

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Figure 4-3.—Refraction of a light ray.

in the visible spectrum are red, green, and blue. Light of any one of these colors cannot be produced by combining light of any other colors. However, light of any other color than these three can be produced by combining, in the proper proportion, light of any two or all three of the primary colors.

All objects absorb a certain amount of the light that falls on them, but all objects do not absorb the same proportion of light of different wavelengths. If all objects absorbed light in the same proportion, they would appear to have the same color. An object must be observed under white light for it to appear in its true colors. White light contains (in the proper proportion) all three primary colors.

If an object absorbs all or nearly all of the white light that falls on it, the object appears black in color. If it absorbs all the green and blue portions of white light that falls on it, the object appears red in color because only the red light is reflected to the eye. In other words, only the reflected light is seen. Those components of the visible spectrum absorbed by the object are not seen.

An object appears in its true colors only when the light falling on it contains light of the wavelengths that the object reflects or transmits. Thus, the light falling on a red object must contain red light for it to appear red in color. A red object observed under a light that contains only green and blue rays will appear black in color because the object absorbs the green and blue rays and is capable of reflecting or transmitting only red rays (which are not present).

CANDLEPOWER

The luminous intensity, or light-producing power, of a given source of light is a measure of the ability of the source to project light in a certain specified direction. The unit of luminous intensity is the CANDLE, or CANDLEPOWER, I, which is approximately equal to the intensity of light emitted from a seven-eighths-inch sperm (standard) candle burning at the rate of 120 grains per hour. Thus, the candlepower of light is expressed in terms of the standard candle that is considered to emit light equally in all directions. However, this condition is a theoretical concept and does not actually exist, but is necessary to develop the quantities and units used in lighting computations.

FOOT-CANDLE

The intensity of radiation is the light energy radiated or absorbed per unit time per unit area. Light energy is a flow of light waves that always originate from some source, such as the sun, a candle, or an incandescent lamp. The unit of illumination is the FOOT-CANDLE, E, which is the illumination on a surface that is 1 foot distant everywhere from a source having a luminous intensity of 1 candlepower.

INVERSE SQUARE LAW

In figure 4-4 a source of light produces a light intensity of candlepower, I, in the direction of surfaces A, B, and C. The illuminated surfaces are perpendicular to the direction from the light source and at a distance in feet, d, from the source. The illumination in foot-candles, E, falling on surfaces A, B, and C is expressed as an application of the inverse square law as follows:

$$E = \frac{I}{d^2} \qquad (4\text{-}2)$$

For example, if I is 100 candlepower and d is 1 foot, the illumination on surface A will be

$$E = \frac{100}{1^2} = 100 \text{ foot-candles.}$$

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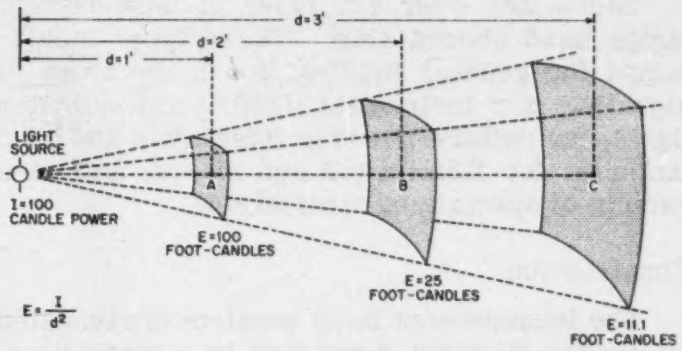

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Figure 4-4.—Inverse square law of radiation.

If $\underline{d}$ is 2 feet, the illumination on surface B will be

$$\underline{E} = \frac{100}{2^2} = 25 \text{ foot-candles.}$$

If $\underline{d}$ is 3 feet, the illumination on surface C will be

$$\underline{E} = \frac{100}{3^2} = 11.1 \text{ foot-candles.}$$

This relation results from the fact that the total quantity of light in the cone of light is the same at all distances from the source; whereas, the surface over which it is spread increases as the square of the distance. Hence, the illumination, which is the quantity of light per unit of surface, is inversely proportional to the square of the distance from the source. At any given distance from the source, the illumination is directly proportional to the candlepower.

LUMEN

Illumination is also expressed in terms of the lumen, which is the unit of luminous flux, or quantity of light. A lumen is that quantity of light flux that must fall on a surface having an area of 1 square foot in order to produce on that surface an illumination of 1 foot-candle.

The number of lumens per square foot is always numerically equal to the illumination in foot-candles, $\underline{E}$. Thus, the illumination that is produced by a total flux on an area is

$$\underline{E} = \frac{\Phi}{\underline{A}}, \qquad (4\text{-}3)$$

where $\underline{E}$ is the illumination in foot-candles, Φ the total flux in lumens, and $\underline{A}$ the area in square feet. For example, 1 lumen of flux distributed over an area of 1 square foot will produce 1 foot-candle of illumination over that surface. Similarly, 10 lumens of flux distributed over an area of 5 square feet will produce 2 foot-candles of illumination over the surface. If the distribution of flux over the area is nonuniform, equation (4-3) gives the average value of illumination. In calculating the illumination produced by a lamp in any given direction, the value of the luminous intensity used in the equation must be the value that applies in the appropriate direction.

The candlepower measured around a light source in a horizontal plane is the HORIZONTAL CANDLEPOWER. The average candlepower in this plane is the MEAN HORIZONTAL CANDLEPOWER. The mean or average value of candlepower measured in all directions about a light source is the MEAN SPHERICAL CANDLEPOWER. Unless otherwise stated, the candlepower rating of a lamp is usually given in mean spherical candlepower.

The total light flux, Φ, produced by a light source having a mean spherical candlepower, $\underline{I_o}$, is

$$\Phi = 12.57\, \underline{I_o}, \qquad (4\text{-}4)$$

where 12.57 is the surface area of a sphere of one foot radius, (The area of a sphere is $4\pi\underline{r}^2$.)

For example, a light source of 100 candlepower (mean spherical) will produce 12.57 x 100 = 1257 lumens of light flux.

If this light source is considered at the center of a sphere of one foot radius, the illumination on each square foot of surface of the sphere will be $\underline{E} = \Phi/\underline{A} = 1257/12.57 = 100$ lumens per square foot. Similarly, the illumination in foot-candles will be $\underline{E} = \underline{I_o}/\underline{d}^2 = 100/1^2 = 100$ foot-candles.

COSINE LAW OF ILLUMINATION

To find the illumination on a flat surface when the light is inclined to the normal, as illustrated in figure 4-5, the inverse square law (equation 4-2) and the cosine law are applied. The cosine law states that the illumination of a surface that is not normal to the light rays will vary as the cosine of the angle of inclination (θ). Thus, the inverse

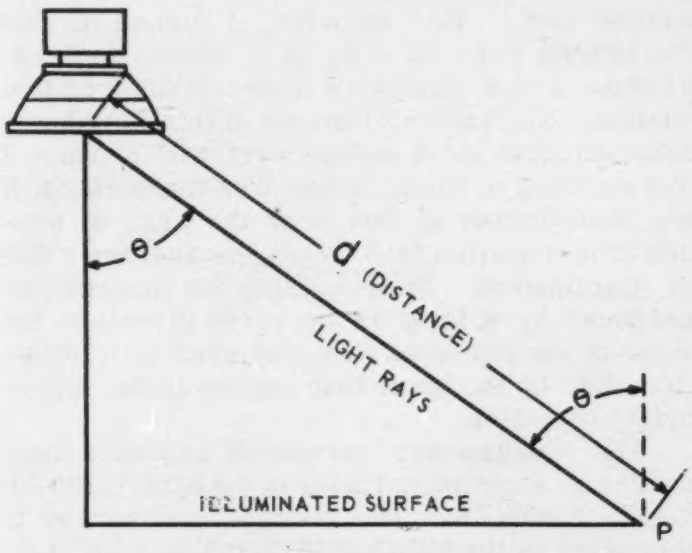

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Figure 4-5.—Cosine law of incidence.

square law and the cosine law are combined and expressed as

$$\underline{E} = \frac{\underline{I}}{d^2} \cos \theta, \qquad (4\text{-}5)$$

where $\underline{E}$ is the illumination at point $\underline{P}$ in foot-candles, $\underline{I}$ the intensity of the light source in candlepower in the direction of $\underline{P}$, and $\underline{d}$ the distance in feet to P (figure 4-5).

For example, if I is 200 candlepower, d is 10 feet, and θ is 60°,

$$\underline{E} = \frac{200}{10^2} \cos 60° = 1 \text{ foot-candle.}$$

LIGHT SOURCES

The source of electric light used in naval vessel are the (1) incandescent, (2) fluorescent, and (3) glow lamps. The incandescent lamp is the most commonly used type; however, the fluorescent lamp is used to a great extent. A complete list of lamps used by the Navy is contained in the Fleet Oriented Consolidated Stock List (FOCSL) in Federal Item Identification Number Sequence; the (FOCSL) is carried aboard all ships. The list includes the electrical characteristics, physical dimensions, applications, ordering designation, and an outline of each Navy type lamp.

INCANDESCENT LAMPS

There are over 100 types of incandescent lamps used aboard ship. These types include lamps for general lighting, for many types of signaling, for instrument lighting and indicator lights, for battery-powered flashlights and hand lanterns, for illuminated gun sights, and for a variety of specialized applications.

Construction

The incandescent lamp consists of a tungsten or carbon filament supported by a glass stem. The glass stem is mounted in a suitable base that provides the necessary electrical connections to the filament. The filament is enclosed in a transparent, or translucent glass bulb from which the air has been evacuated. The passage of an electric current through the filament causes it to become incandescent and to emit light. The filament is operated either in a vacuum or a gas-filled bulb to prevent oxidation and consequent failure of the filament, which would occur in air.

All Navy type 115- or 120-volt lamps (up to and including the 50-watt size) are of the vacuum type, except MS (military standard) 15545-2; and all lamps above 50 watts are of the gas-filled type. The use of an inert gas, which is a mixture of argon and nitrogen gases, retards the oxidation of the filament and allows it to be operated at higher temperatures that result in higher efficiencies. Lamps under 50 watts are of the vacuum type because the effectiveness of the inert gas in increasing the luminous output is less pronounced in the lower wattage lamps.

The incandescent lamp is further subdivided into tungsten- and carbon-filament types. The tungsten-filament lamps comprise most of those listed in this group.

Rating

Incandescent lamps are rated in watts, amperes, volts, candlepower, or lumens, depending on their type. Generally, large lamps are rated in volts, watts, and lumens. Miniature lamps are rated in amperes for a given single voltage and in candlepower for a voltage-range rating.

Classification

Standard incandescent lamps are classified according to the (1) shape of bulb, (2) finish of bulb, and (3) type of base.

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The classification of lamps according to the SHAPE OF BULB with the corresponding letter designation is illustrated in figure 4-6. The designation letter, which denotes the shape of the bulb, is followed by a numeral that denotes the diameter of the bulb in eights of an inch. For example, if the lamp illustrated in figure 4-6 F, is designated PS-52, it is a lamp with a pear-shaped bulb and straight sides having a diameter of 52/8, or 6 1/2 inches.

The lamps commonly used for general lighting aboard ship are 115- or 120-volt, 50-, 100-, and 200-watt rough service types. These lamps (up to and including the 150-watt size) have standard-line shaped bulbs, and those of 200 watts and above have pear shaped bulbs. The other bulb shapes are designed for lamps that are used for special types of service.

Rough-service (RS) lamps have specially constructed filaments that are supported at several points to increase their ability to withstand vibration and shock.

The classification of lamps according to the finish of bulb are the clear (CL) and the inside frosted (IF).

The CLEAR lamp consists of a bulb that is made of unclouded or luminous glass, which exposes the filament to view. These lamps are used with reflecting equipment that completely conceals the lamps to avoid glare.

The INSIDE FROSTED lamp consists of a glass bulb that has the entire inside surface coated with a frosting, which conceals the filament and diffuses the light emitted from the lamp. These lamps can be used with or without reflecting equipment.

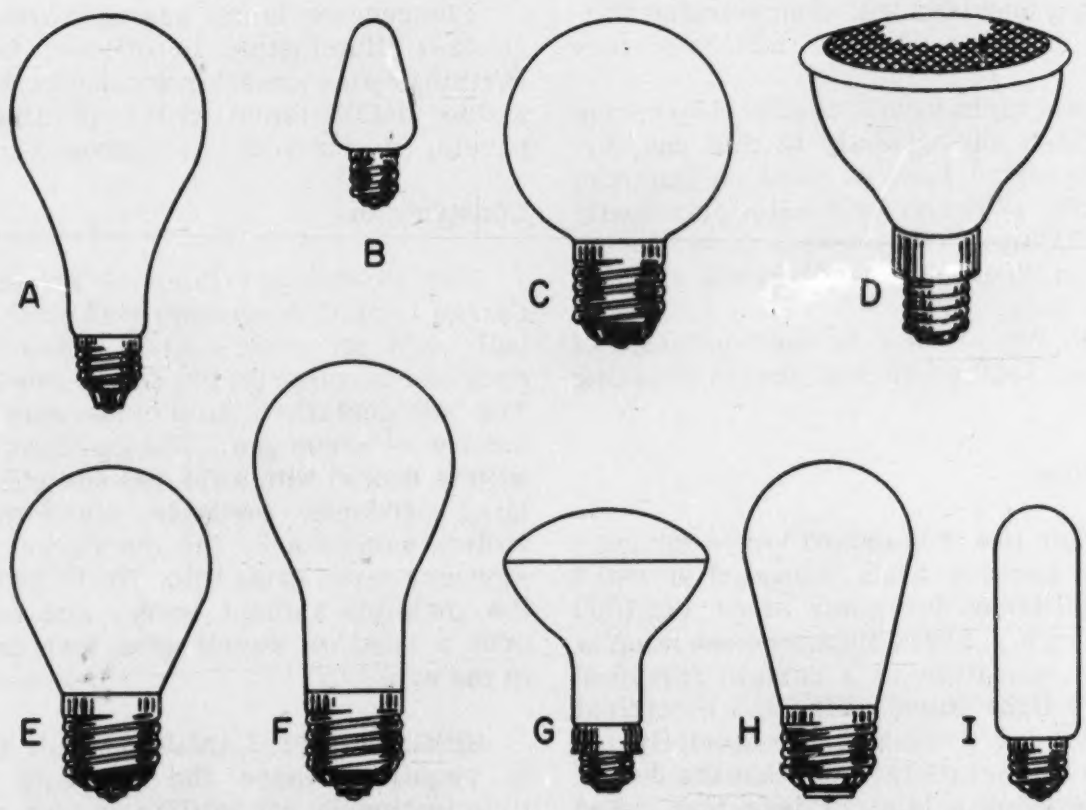

A- STANDARD LINE (A)
B- CANDELABRA (C)
C- GLOBULAR (G)
D- PARABOLIC (PAR)
E- PEAR SHAPED (P)
F- PEAR SHAPE WITH STRAIGHT SIDE (PS)
G- REFLECTOR (R)
H- STRAIGHT SIDE (S)
I- TUBULAR (T)

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Figure 4-6.—Classification of lamps according to shape of bulbs.

The classification of lamps according to the type of base is illustrated in figure 4-7. The size of the base is indicated by name, including miniature, candelabra, and intermediate; the type of the base provided with the different sizes is also denoted by name, including screw, bayonet, prefocus, and bipin.

The miniature, candelabra, and intermediate types of bases (figure 4-7 A, B, and C) are used on small-size lamps for detail lighting.

The medium base (figure 4-7E), which is the most commonly used type, is used on lamps (up to and including 300 watts) for general lighting.

The admedium base (figure 4-7D) is slightly larger in diameter than the medium base and is used on some mercury lamps.

The mogul base (figure 4-7F) is used on lamps rated above 300 watts. The three-control mogul base is used on 3-way lamps.

The medium and mogul prefocused bases are used on lamps provided with concentrated filaments, such as those used for motion picture projection.

The medium bipin base is used on fluorescent lamps described subsequently in this chapter. This medium bipost base is used on lamps of 500, 750, 1000, 1250 and 1500 watts principally for indirect fixtures. This design allows better heat radiation than can be obtained with the mogul screw base.

The mogul bipost base is used on lamps of 500, 1000 and 1500 watts and above, including floodlights.

Characteristics

The average life of standard lamps for general lighting service when operated at rated voltage is 750 hours for some sizes and 1000 hours for others. Every incandescent lamp is designed for operation at a certain specified voltage. The light output, life, and electrical characteristics of a lamp are materially affected when it is operated at other than the design voltage. Operating a lamp at less than rated voltage will prolong the life of the lamp and decrease the light output. Conversely, operating a lamp at higher than rated voltage will shorten the life and increase the light output. The characteristic curves for gas-filled incandescent lamps (figure 4-8) show how the performance is affected by operating the lamp at other than the rated voltage. For example, if a 120-volt lamp is operated at 114 volts, the voltage impressed on the lamp is 114/120 x 100, or 95 percent of rated voltage. From the characteristic curves, the lumens emitted from the lamp will be reduced to about 84 percent. Hence, a 5 percent reduction in rated voltage results in a 16 percent reduction in light output. The characteristic curves for vacuum lamps are not exactly the same, but are very similar to those of the gas-filled lamps, and, for all practical purposes can be considered to indicate their performance.

It is apparent from the characteristic curves that lamps should be operated as closely as possible to their rated voltage. Low voltage seriously decreases illumination; whereas, high voltage increases illumination, but an excess voltage of 5 percent will reduce the life of the lamp about one-half.

FLUORESCENT LAMPS

Fluorescent lamps are used aboard ship for general illumination in offices, messing and berthing spaces, machinery spaces, hangar bays, and for detail illumination in plotting rooms, for panels, and for small switchboards.

Construction

The fluorescent lamp is an electric discharge lamp that consists of an elongated tubular bulb with an oxide-coated filament sealed in each end to comprise two electrodes (figure 4-9). The bulb contains a drop of mercury and a small amount of argon gas. The inside surface of the bulb is coated with a fluorescent phosphor. The lamp produces invisible, short-wave (ultraviolet) radiation by the discharge through the mercury vapor in the bulb. The phosphor absorbs the invisible radiant energy and reradiates it over a band or wavelengths that are sensitive to the eye.

SINGLE-UNIT LAMPS.—Detail illumination is required where the intensity of general illumination is not sufficient, such as at desks, work benches, chart boards, and in engineering spaces for examination of gages. The fixtures for detail illumination commonly use single fluorescent lamps. Figures 4-9A and B illustrate the wiring arrangement for these single units.

Because of greater cost and shorter life of 8-watt fluorescent lamps, as compared to 15-watt and 20-watt lamps, fixtures with 8-watt lamps are used only for detail illumination and

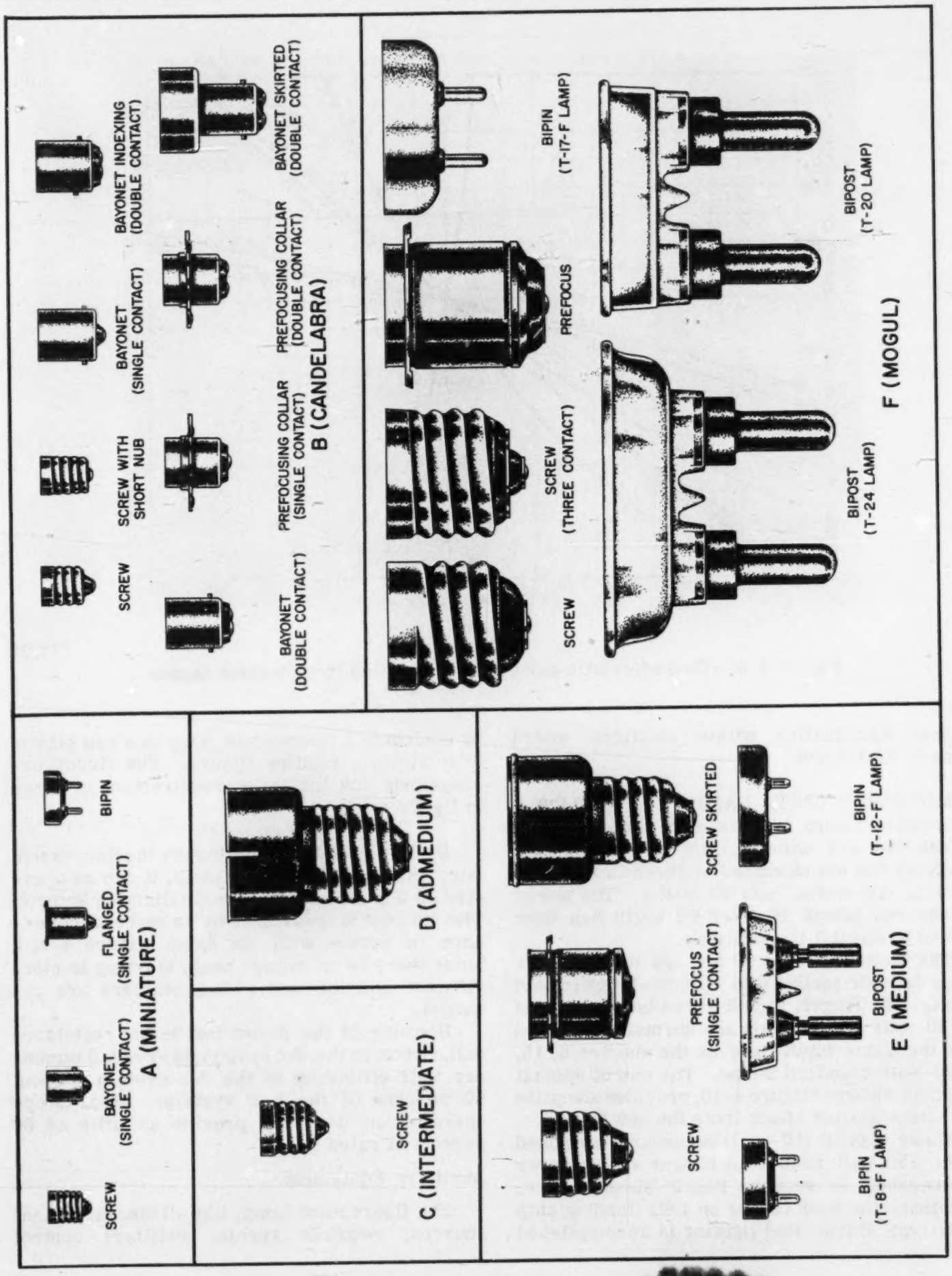

Figure 4-7.—Classifications of lamps according to type of base.

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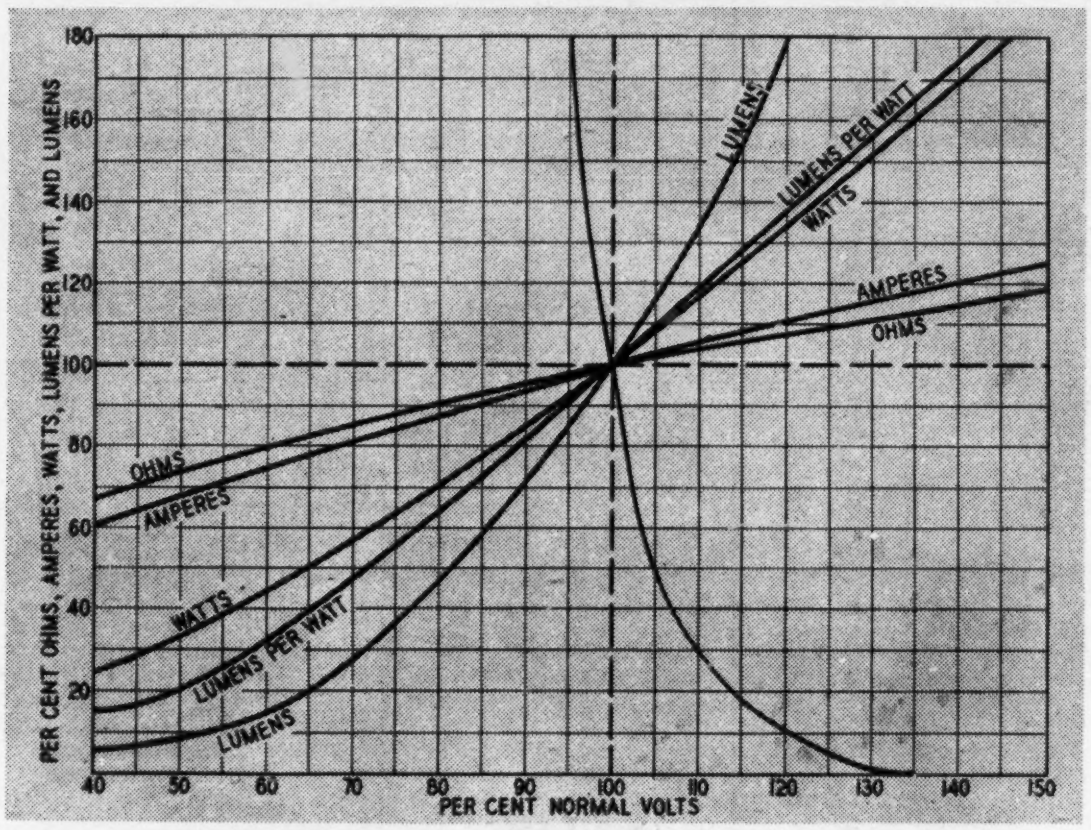

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Figure 4-8.—Characteristic curves for gas-filled incandescent lamps.

general illumination within locations where space is restricted.

MULTIPLE-UNIT LAMP FIXTURES.—Fluorescent lamps are now used for the majority of both red and white lighting on naval ships. The Navy has standardized on three lamp sizes, 8 watts, 15 watts, and 20 watts. The use of fluorescent lamps of over 20 watts has been limited to special installations.

The primary reason for not using larger lamps is their inability to withstand high impact shock. The longer, higher rated lamps such as the 40 watt and 60 watt are normally provided with the same bipin base as the shorter 8, 15, or 20-watt standard lamps. The use of special lamps as shown in figure 4-10, provides adequate protection against shock (note the new base).

These special (60-watt) lamps are being used in the 180 watt fixture in hangar spaces, over workbenches in weapons repair shops, and to illuminate the dock basins on LSD (landing ship dock) type ships. Red lighting is accomplished by enclosing a fluorescent lamp in a red plastic tube within a lighting fixture. The circuit arrangement for the latter requirement is shown in figure 4-9C.

D-C OPERATION.—Although the fluorescent lamp is basically an a-c lamp, it can be operated on d-c with the proper auxiliary equipment. The current is controlled by an external resistance in series with the lamp (figure 4-9D). Since there is no voltage peak, starting is more difficult and thermal switch starters are required.

Because of the power lost in the resistance ballast box in the d-c system, the overall lumens per watt efficiency of the d-c system is about 60 percent of the a-c system. Also, lamps operated on d-c may provide as little as 80 percent of rated life.

Auxiliary Equipment

The fluorescent lamp, like all discharge light sources, requires special auxiliary control

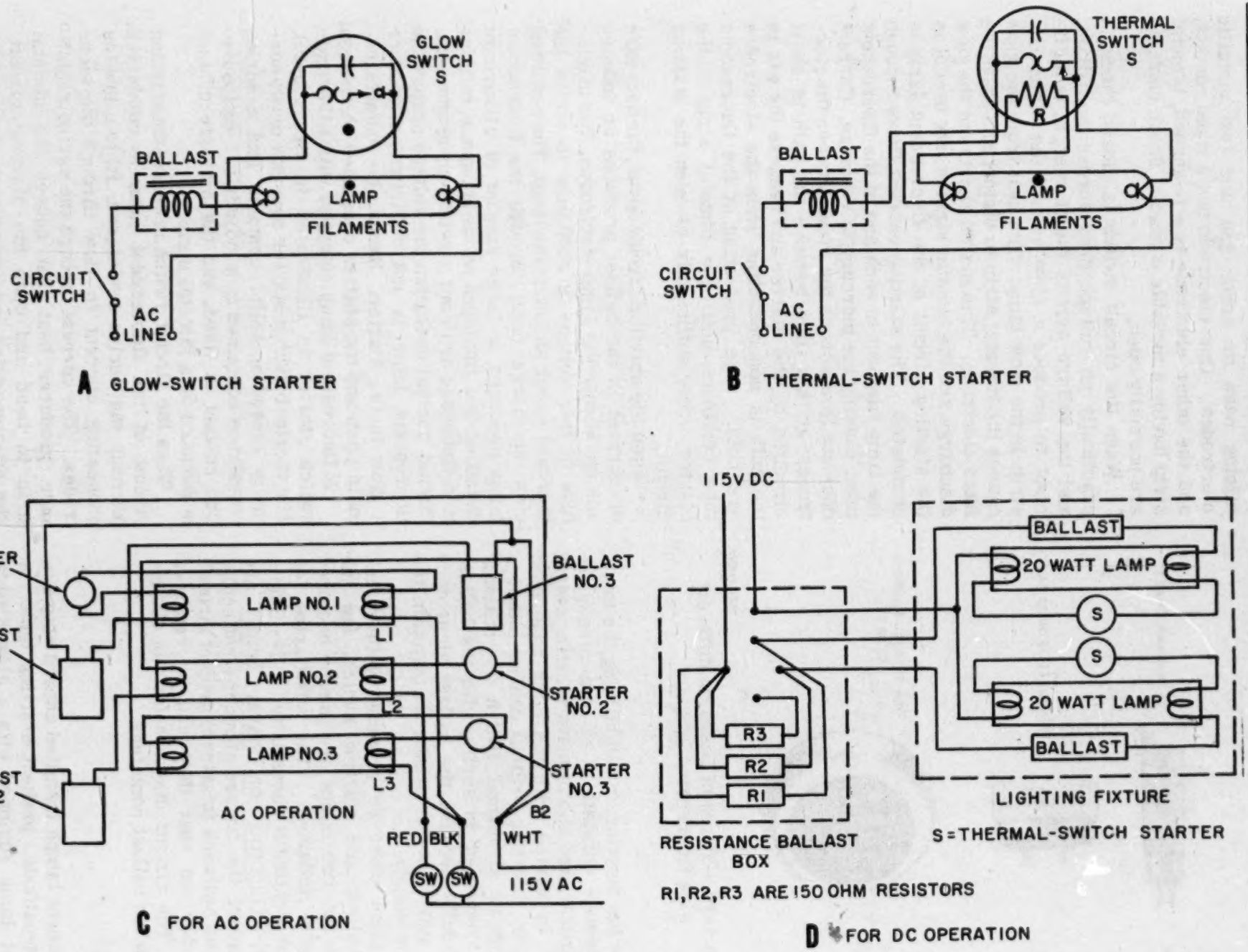

Figure 4-9.—Fluorescent lamps with auxiliary equipment.

The circuitry is not discussed because the Aviation Electronics Technician will only on rare occasions be concerned with this type presentation.

PPI-SCAN

The term PPI may be interpreted to mean plan position indicator. The PPI-scan is another type of scan developed for the purpose of presenting range and bearing information. It may be considered as a modified type of B-scan in which the rectangular coordinates are replaced with polar coordinates, thus presenting a polar maplike presentation of the area searched. Electromagnetic deflection is employed where a PPI-scan presentation is used. (See fig. 17-21.) This type of presentation is suitable for radar bombing operations. (NOTE: The PPI-scan is free of the type of distortion produced by the B-scan.)

The antenna for the PPI-scan presentation is rotated uniformly about the vertical axis, thus, searching or covering an area in the horizontal plane. The beam radiated by the antenna is usually narrow in azimuth and broad in elevation to give great slant range covered during surface and air search. However, where this type of presentation is used, the antenna can rotate through 360° or scan a pie-shape sector ahead of the aircraft. The antenna may be caused to scan back and forth through a selected sector by use of controls available to the operator. The scanning rate is quite rapid; therefore, the area scanned is covered frequently and the observed targets are presented distinctly on the screen of the CRT.

The PPI-scan is developed by causing the sweep or trace on the screen to rotate in synchronism with the antenna about the center axis of the CRT. Thus, each sweep is an indication of the instantaneous position of the antenna in azimuth. The rotation of the sweep is accomplished by varying the amplitude of the current through the vertical and horizontal deflection coils of the deflection yoke. The radial sweep is the time base and the range of a target is measured from the center of the screen (or from the sweep's starting point if depressed center is used) outward along the trace or sweep. Most PPI-scans utilize range markers to calibrate the screen. This is done by the timing system which causes the trace to be intensified at specific intervals. Thus, equally spaced concentric circles or arcs are produced which calibrate the screen in multiples of 1, 5, 10, or 20 miles or any other markers that are available for selection.

When a target echo is received, the intensity of the sweep increases, indicating the position of the target. The target may be presented in some detail, giving an indication of its size and shape. The target's range and relative position may be read directly from the screen with the aid of the range markers and an azimuth scale around the screen of the CRT.

The indicators employed in airborne radar may vary considerably in construction, types of scans, and in operating principles. However, their operation may be reduced to one or more of the basic types of scans previously discussed.

RHI-SCAN

An RHI-scope is essentially a normal PPI laid on its side so that the antenna scans vertically instead of horizontally. Range is still shown radially, but the angle that was formerly the bearing angle becomes the elevation angle. The vertical plane in which the RHI scans can be rotated about a vertical axis, as the horizontal plane of a normal PPI can be tilted around a horizontal axis. In an RHI, targets in a vertical plane only are displayed. The RHI screen shows a side view of this plane (fig. 17-22), the horizontal axis showing the range in miles and the vertical axis showing directly the height of the target aircraft in feet, and not the elevation angle. Height instead of elevation angle is obtained by electronically combining the range with the sine of the elevation angle. The height scale must be increased or stretched if significant information is to be obtained, particularly for distant aircraft. Figure 17-22 shows a height scale which has been stretched so that 5 nautical miles (30,000 feet) is equivalent to about 20 nautical miles of range.

PPI-SCAN CIRCUITRY

Figure 17-23 shows a simplified block diagram of PPI-scope. In the case illustrated, the CRT has a fixed deflection yoke. The sawtooth sweep currents required to produce the rotating radial sweep line are obtained from the trapezoidal-voltage sweep generator, a rotary transformer (synchro resolver), and two push-pull amplifiers.

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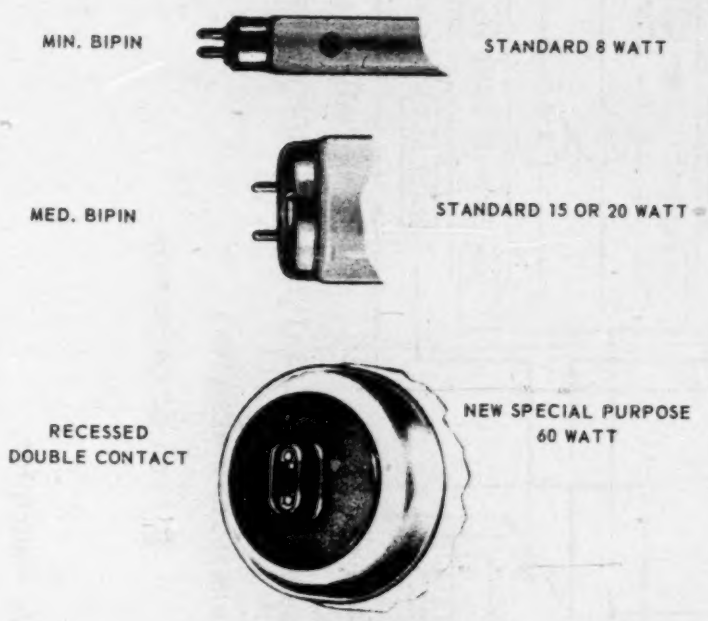

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Figure 4-10.—Types of bases on different size fluorescent lamps.

equipment for starting and stabilizing the lamp. This equipment consists of an iron-core choke coil, or ballast, and an automatic starting switch connected in series with the lamp filaments. The starter (starting switch) can be either a glow switch or a thermal switch. A resistor must be connected in series with the ballast in d-c circuits because the ballast alone does not offer sufficient resistance to maintain the arc current steady.

Each lamp must be provided with an individual ballast and starting switch, but the auxiliaries for two lamps are usually enclosed in a single container. The auxiliaries for fluorescent lighting fixtures listed in NavShip's 250-560-4, (Lighting on Naval Ships) are mounted inside the fixture above the reflector. The starting switches (starters) project through the reflector so that they can be replaced readily. The circuit diagram for the fixture appears on the ballast container.

Operation

Fluorescent lamps installed aboard ship are of the hot-cathode, preheat starting type. A fluorescent lamp equipped with a glow-switch starter is illustrated in figure 4-9A. The glow-switch starter is essentially a glow lamp containing neon or argon gas and two metallic electrodes. One electrode has a fixed contact, and the other electrode is a U-shaped, bimetal strip having a movable contact. These contacts are normally open.

When the circuit switch is closed there is practically no voltage drop across the ballast, and the voltage across the starter, S, is sufficient to produce a glow around the bimetallic strip in the glow lamp. The heat from the glow causes the bimetal strip to distort and touch the fixed electrode. This action shorts out the glow discharge and the bimetal strip starts to cool as the starting circuit of the fluorescent lamp is completed. The starting current flows through the lamp filament in each end of the fluorescent tube, causing the mercury to vaporize. Current does not flow across the lamp between the electrodes at this time because the path is short circuited by the starter and because the gas in the bulb is nonconducting when the electrodes are cold. The preheating of the fluorescent tube continues until the bimetal strip in the starter cools sufficiently to open the starting circuit.

When the starting circuit opens, the decrease of current in the ballast produces an induced voltage across the lamp electrodes. The magnitude of this voltage is sufficient to ionize the mercury vapor and start the lamp. The resulting glow discharge (arc) through the fluorescent lamp produces a large amount of ultraviolet radiation that impinges on the phosphor, causing it to fluoresce and emit a relatively bright light. During normal operation the voltage across the fluorescent lamp is not sufficient to produce a glow in the starter. Hence, the contacts remain open and the starter consumes no energy.

A fluorescent lamp equipped with a thermal-switch starter is illustrated in figure 3-9B. The thermal-switch starter consists of two normally closed metallic contacts and a series resistance contained in a cylindrical enclosure. One contact is fixed, and the movable contact is mounted on a bimetal strip.

When the circuit switch is closed the starting circuit of the fluorescent lamp is completed (through the series resistance, R) to allow the preheating current to flow through the electrodes. The current through the series resistance produces heat that causes the bimetal strip to bend and open the starting circuit. The accompanying induced voltage produced by the ballast starts the lamp. The normal operating current holds the thermal switch open.

The majority of thermal-switch starters use some energy during normal operation of the lamp. However, this switch ensures more positive starting by providing an adequate preheating period and a higher induced starting voltage.

Characteristics

The failure of a hot-cathode fluorescent lamp usually results from loss of electron-emissive material from the electrodes. This loss proceeds gradually throughout the life of the lamp and is accelerated by frequent starting. The rated average life of the lamp is based on normal burning periods of 3 to 4 hours. Blackening of the ends of the bulb progresses gradually throughout the life of the lamp.

The efficiency of the energy conversion of a fluorescent lamp is very sensitive to changes in temperature of the bulb. The maximum efficiency occurs in the range of 100° F to 120° F, which is the operating temperature that corresponds to an ambient room temperature range of 65° to 85° F. The efficiency decreases slowly as the temperature is increased above normal, but also decreases very rapidly as the temperature is decreased below normal. Hence, the fluorescent lamp is not satisfactory for locations in which it will be subjected to wide variations in temperature. The reduction in efficiency with low ambient room temperature can be minimized by operating the fluorescent lamp in a tubular glass enclosure so that the lamp will operate at more nearly the desired temperature.

Fluorescent lamps are relatively efficient compared with incandescent lamps. For example, a 40-watt fluorescent lamp produces 2400 lumens, or 60 lumens per watt. A 40-watt incandescent lamp produces approximately 400 lumens, or 10 lumens per watt. Thus the fluorescent lamp produces six times as much light per watt as does the comparable incandescent lamp.

Fluorescent lamps should be operated at voltage within ±10 percent of their rated voltage. If the lamps are operated at lower voltages, uncertain starting may result, and if operated at higher voltages, the ballast may overheat. Operation of the lamps at either lower or higher voltages results in decreased lamp life. The characteristic curves for hot-cathode fluorescent lamps (figure 4-11) show the effect of variations from rated voltage on the condition of lamp operation. Also, the performance of fluorescent lamps depends to a great extent on the characteristics of the ballast, which determines the power delivered to the lamp for a given line voltage.

When fluorescent lamps are operated on a-c circuits, the light output executes cyclic pulsations as the current passes through zero. This reduction in light output produces a flicker that is not usually noticeable at frequencies of 50 and 60 cycles, but may cause unpleasant stroboscopic effects when moving objects are viewed. The cyclic flicker can be minimized by combining two or three lamps in a fixture and operating the lamps on different phases of a 3-phase system. Where only single-phase circuits are available, leading current is supplied to one lamp and lagging current to another so that the light pulsations compensate each other.

The fluorescent lamp is inherently a high power-factor device, but the ballast required to stabilize the arc is a low power-factor device. The voltage drop across the ballast is usually equal to the drop across the arc, and the resulting power factor for a single-lamp circuit with ballast is about 50 percent. The low power factor can be corrected in a single lamp ballast circuit by a capacitor shunted across the line. This correction is accomplished in a two-lamp circuit by means of a "tulamp" auxiliary that connects a capacitor in series with one of the lamps to displace the lamp currents, and, at the sime time, to remove the unpleasant stroboscopic effects when moving objects come into view.

GLOW LAMPS

Glow lamps are electric discharge light sources, which are used as indicator or pilot lights for various instruments and on control panels. These lamps have relatively low light output, and thus are used to indicate when circuits are energized or to indicate the operation of electrical equipment installed in remote locations.

Construction

The glow lamp consists of two closely spaced metallic electrodes sealed in a glass bulb that contains an inert gas. The color of the light emitted by the lamp depends on the gas. Neon gas produces an orange-red light, and argon gas

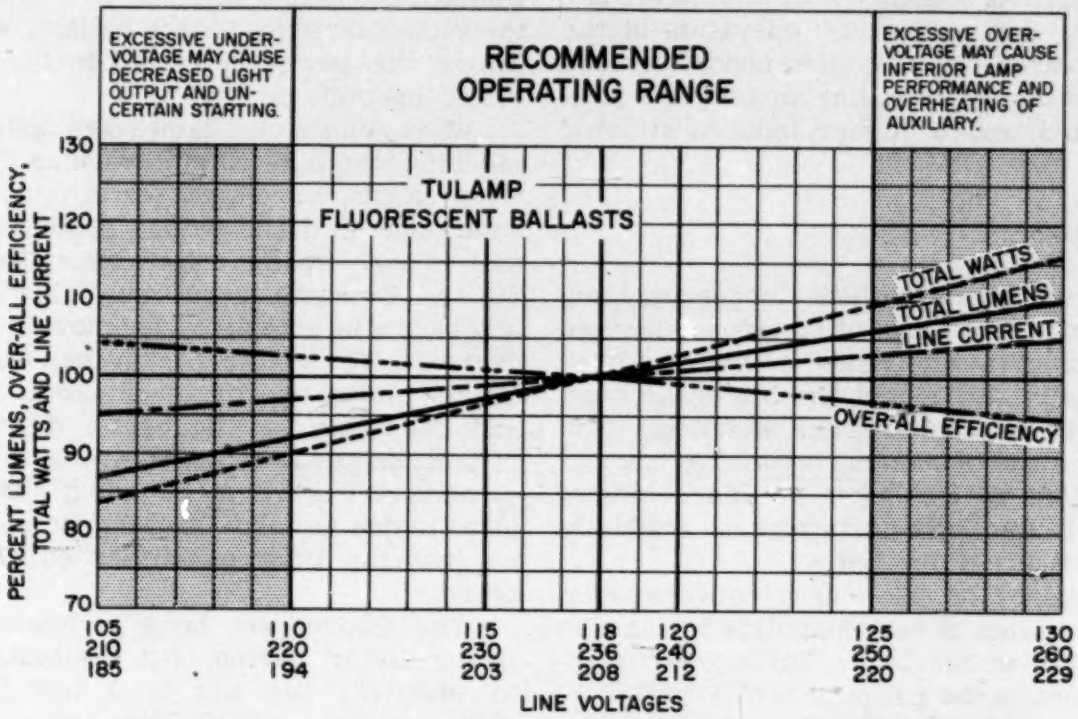

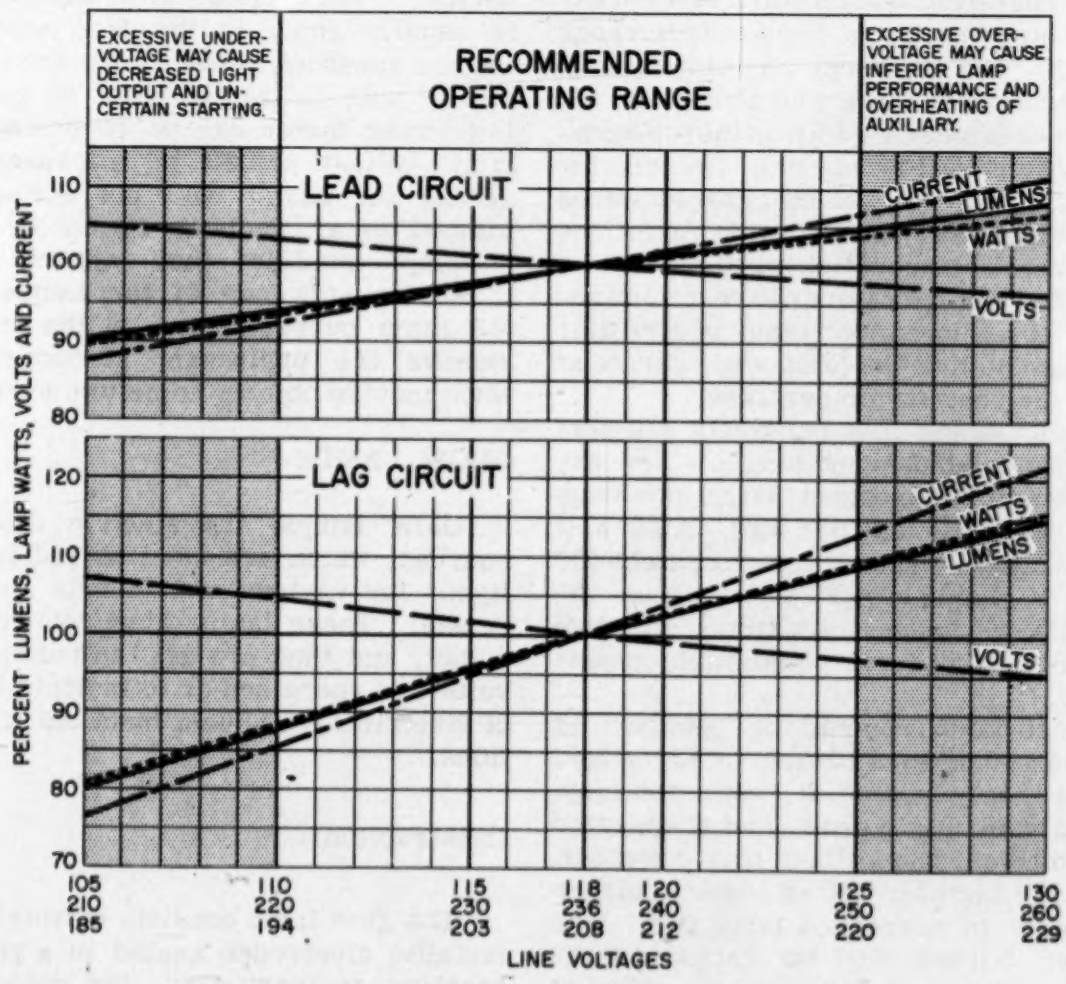

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Figure 4-11.—Characteristic curves for hot-cathode fluorescent lamps.

produces a blue light. The lamp must be operated in series with a current-limiting device to stabilize the discharge. This current-limiting device consists of a high resistance that is usually contained in the lamp base.

Characteristics

The glow lamp produces light only when the voltage exceeds a certain striking voltage. As the voltage is decreased somewhat below this value, the glow suddenly vanishes. When the lamp is operated on alternating current, light is produced only during a portion of each half cycle, and both electrodes are alternately surrounded with a glow. When the lamp is operated on direct current, light is produced continuously, and only the negative electrode is surrounded with a glow. This characteristic makes it possible to use the glow lamp as an indicator of alternating current and direct current. It has the advantages of small size, ruggedness, long life, negligible current consumption, and can be operated on standard lighting circuits.

LIGHTING FIXTURES

A lighting fixture, or unit, is a complete illuminating device that directs, diffuses, or modifies the light from a source to obtain more economical, effective, and safe use of the light. A lighting fixture usually consists of a lamp, globe, reflector, refractor (baffle), housing, and support that is integral with the housing or any combination of these parts (fig. 4-12A). A globe alters the characteristics of the light emitted by the lamp. A clear glass globe (fig. 4-12B) absorbs a small percentage of the light without appreciably changing the distribution of the light. A diffusing glass globe absorbs a little more light and tends to smooth out variations in the spherical distribution of the light; whereas, a colored-glass or plastic globe absorbs a high percentage of the light emitted by the lamp. A baffle conceals the lamp and reduces glare. A reflector intercepts the light traveling in a direction in which it is not needed and reflects it in a direction in which it will be more useful.

CLASSIFICATION

Lighting fixtures are designated according to the type of enclosure provided, as watertight, nonwatertight, pressure-proof or explosion-proof. They are classified according to use as (1) regular permanent fixtures, (2) regular permanent red-light fixtures, (3) regular portable fixtures, (4) miscellaneous fixtures, (5) navigational lights, and (6) lights for night-flight operations.

REGULAR PERMANENT FIXTURES (incandescent, figs. 4-12A and B, fluorescent fig. 4-12C) are permanently installed to provide general illumination and such detail illumination as may be required in specific locations. General illumination is based on the foot-candle intensity required for the performance of normal routine duties. See the manual, Lighting on Naval Ships, NavShips 250-560-4. Detail illumination is provided where the general illumination is inadequate for the performance of specific tasks. Sources include berth fixtures, desk lamps, and plotting lamps.

REGULAR PERMANENT RED LIGHT FIXTURES (incandescent or fluorescent) are permanently installed to provide low-level, red illumination in berthing areas, in access routes to topside battle and watch stations, and in special compartments and stations. The incandescent fixtures are equipped with steam-tight inside-acid-etched red globes.

REGULAR PORTABLE FIXTURES (incandescent) are provided for lighting applications that cannot be served by permanently installed fixtures. These units are energized by means of portable cables that are plugged into outlets in the ship's service wiring system and include bedside lights, desk lights, and flood lights.

MISCELLANEOUS FIXTURES (incandescent or fluorescent) are provided for detail and special lighting applications that cannot be served by regular permanent or regular portable lighting fixtures. These fixtures include boom lights, crane lights, gangway lights, portable flood lanterns, hand lanterns, and flashlights.

NAVIGATIONAL LIGHTS (incandescent) include all external lights (running, signal, and anchor), except searchlights, which are used for navigational and signaling purposes between ships, and for communications when underway or at anchor.

LIGHTS FOR NIGHT-FLIGHT OPERATIONS are used to assist pilots (at night) when taking off and landing. These lights also provide visual aid to pilots for locating and identifying the parent aircraft carrier.

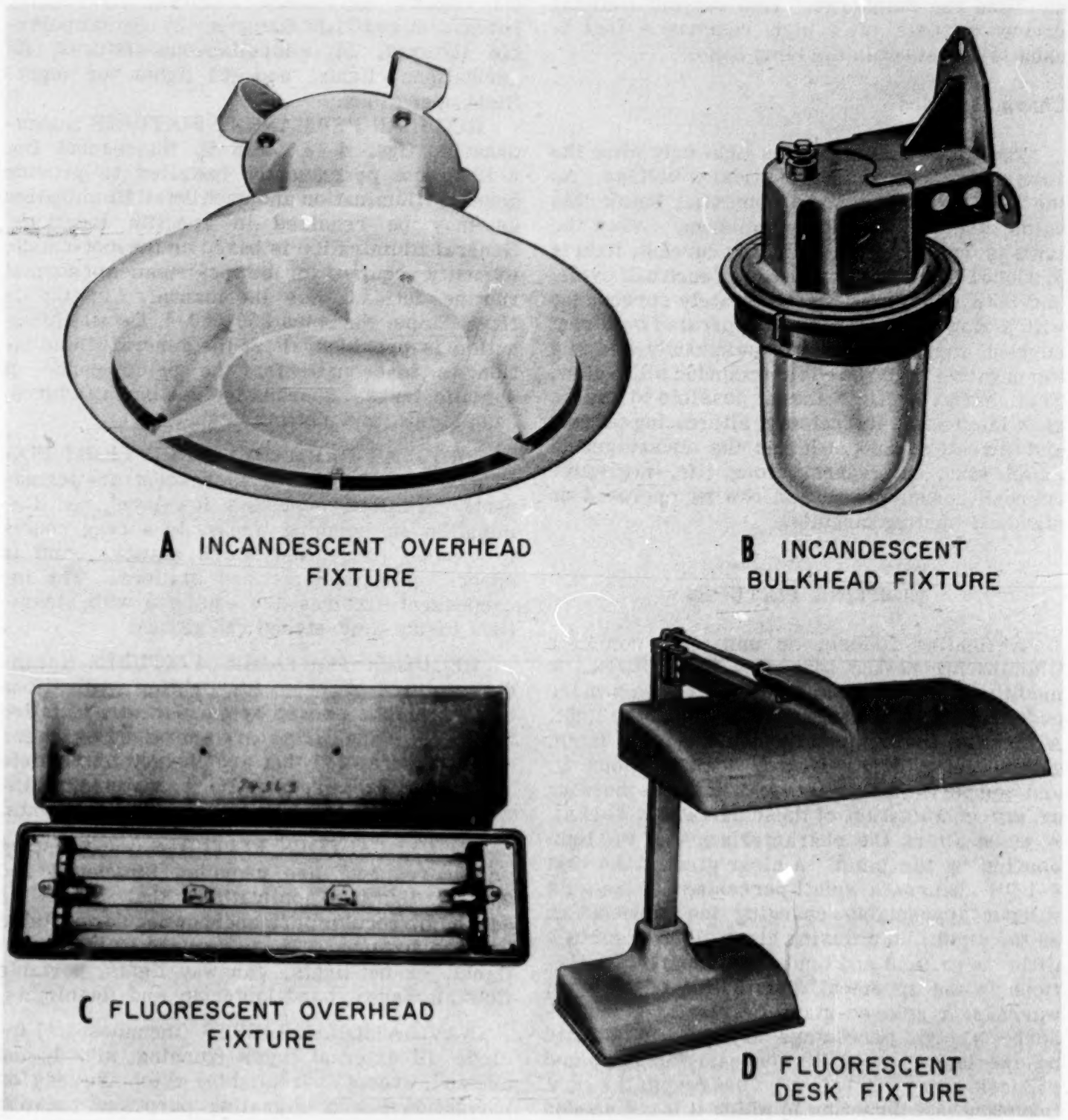

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Figure 4-12.—Lighting fixtures.

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INTENSITY DEPRECIATION CALCULATIONS

Interior lighting should provide and maintain a sufficient amount of light to supply the desired value of illumination. This condition is partly accomplished by properly designed lighting fixtures so located as to produce reasonably uniform illumination without glare; thereafter, cleanliness of equipment and compensation for depreciation of illumination are important.

The direct fixture consists of a reflecting surface, above the light source, that redirects downward practically all (90 to 100 percent) of the light from the bare lamp.

The SEMIDIRECT fixture has a metal reflector that is open at the bottom and equipped with louvers to conceal the lamps and reduce glare. The unit directs a large portion (60 to 90 percent) of the light downward to the working surface.

The SEMI-INDIRECT fixture consists of a translucent enclosure that is open at the top. The unit transmits some of the light directly to the working surface through the translucent enclosure, and the remainder (60 to 90 percent) of the light is directed to the overhead, which, in turn, reflects it indirectly to the working area.

The INDIRECT fixture is provided with a metal enclosure that is open at the top. The unit transmits 90 to 100 percent of the light to the overhead, which, in turn, reflects the light indirectly to the working area. The majority of lighting installations in naval vessels are of the direct and semidirect types.

Candlepower Distribution Graphs

As previously stated, the candlepower distribution of lamps and fixtures is not uniform. Thus, in calculating the illumination that they produce in any given direction, it is necessary to use the candlepower in that direction. Candlepower distribution curves that indicate the candlepower of the source in all directions are used for this purpose. These distribution curves or graphs are furnished by manufacturers of lighting equipment and are supplied for various types of lamps alone or for lamps when used in conjunction with lighting fixtures.

The distribution graphs of three typical Navy lighting fixtures are illustrated in figure 4-13. A distribution graph is obtained by measuring the candlepower (with a photometer) directly downward from the source. This value is indicated on the vertical to a given scale of a circular chart and represents the candlepower directly below the light (0°). Similarly, the candlepowers around the light are measured at angles of 10° above the vertical. These values are indicated on the chart and represent the candlepowers to scale at the angles above the vertical of 10°, 20°, 30°, and so on around the light. These points are joined by a continuous line that represents the complete distribution graph of the light source. Thus, the candlepower in any direction is the length of the line drawn in that direction from the source to the curve.

The principal methods used in calculating illumination are the (1) point-by-point and (2) lumen methods.

Point-by-Point Method

The illumination at any point on a surface can be calculated by using equation (4-5) in conjunction with the candlepower distribution curve of the specific lamp or lighting fixture. When several fixtures contribute illumination to a given point, the candlepower distribution must be calculated for each fixture, and the actual illumination at any point on a surface will be the sum of the foot-candles contributed by all the fixtures, plus the light that is reflected to the point by the surrounding surfaces.

For example, find the illumination produced on a horizontal surface by two 50-watt, wide-angle, distributing types of overhead fixtures if one unit is located 4 feet away in a direction 30° from the vertical and the other is 7 feet away in a direction 60° from the vertical. The first fixture delivers approximately 90 candlepower in the direction 30° from the vertical (curve B of figure 4-13). The illumination produced by the first fixture from equation (4-5) is

$$E_1 = \frac{90}{4^2} (\cos 30° = 0.866) = 4.86 \text{ foot-candles.}$$

Similarly, the second fixture delivers approximately 60 candlepower in the direction 60° from the vertical (curve B of figure 4-13), and the illumination produced is

$$E_2 = \frac{60}{7^2} (\cos 60° = 0.5) = 0.612 \text{ foot-candles.}$$

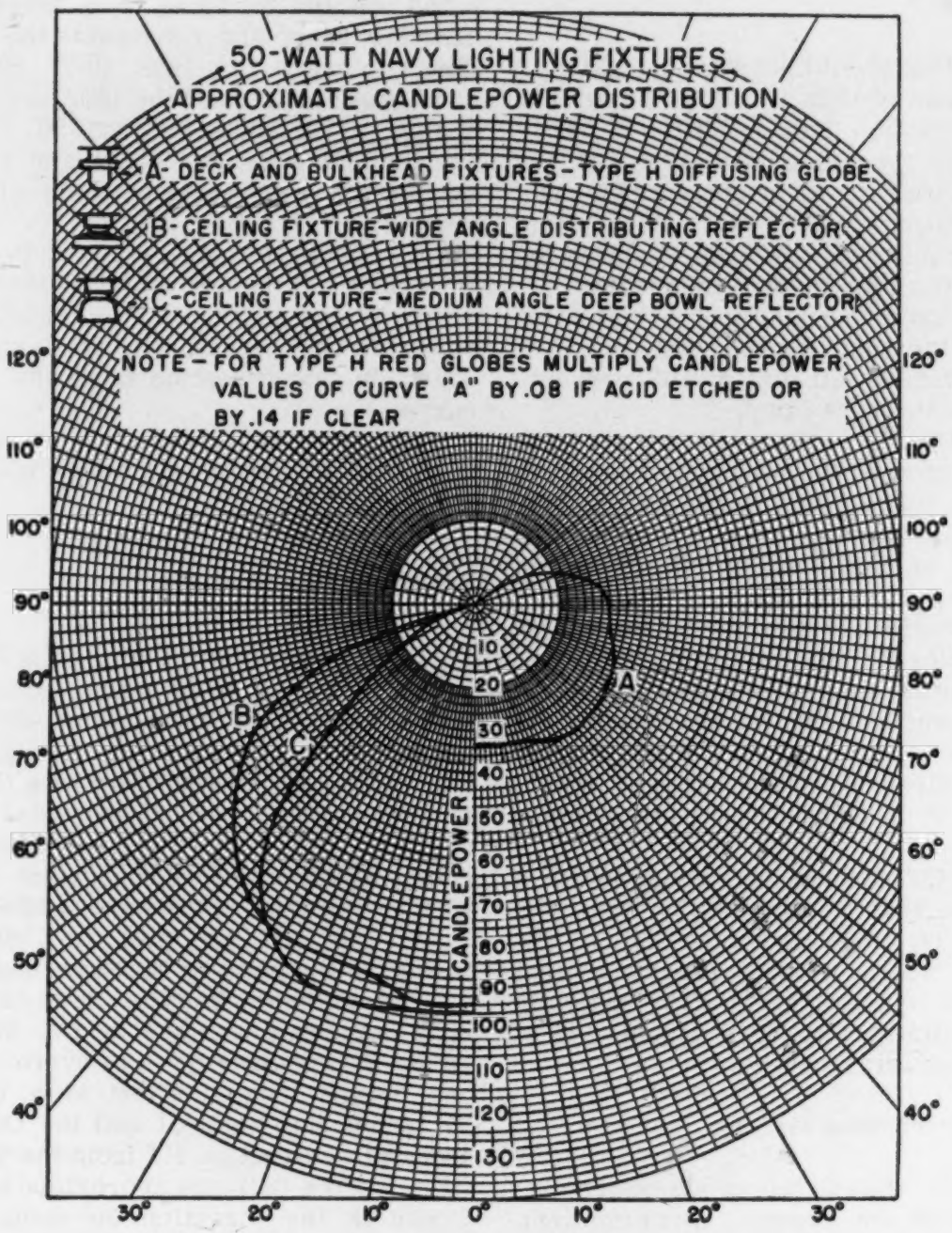

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Figure 4-13.—Candlepower distribution graphs.

Then the illumination contributed by both lamps is

$$\underline{E} = 4.86 + 0.612 = 5.47 \text{ foot-candles.}$$

The point-by-point method is useful in many shipboard lighting calculations for computing the illumination in spaces that are very irregular in shape and where there are many overhead obstructions. Also, this method is readily applicable for calculating detail lighting where only a single light source is required.

Lumen Method

The lumen method gives the average illumination on the horizontal for any system of general lighting where the light sources are spaced

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sufficiently close to each other to produce approximately uniform illumination.

This method is more practicable for calculating the illumination in larger spaces that require a greater number of lighting fixtures. In this method, a maintenance factor and a coefficient factor must be considered because the lumens required of the light source are calculated from the useful lumens desired on the working surface.

The MAINTENANCE FACTOR is applied to compensate for the difference in the average illumination obtained initially (when the lamps and units are new) and the resulting average illumination maintained in service. A maintenance factor of 70 percent shall be applied in computations, unless otherwise indicated on the standard plan of the lighting fixture being installed.

The UTILIZATION FACTOR, or coefficient of utilization, is the overall efficiency of the lighting installation and is the ratio of the useful lumens that reach the working area to the total lumens produced by the lighting fixture. Utilization factor tables for some specified types of lighting fixtures are available in the manual Lighting on Naval Ships, NavShips 250-560-4, or in the applicable manufacturer's instruction books.

NAVIGATIONAL LIGHTS

The navigational lights installed on naval vessels must be in accordance with Regulations for Preventing Collisions at Sea (Public Law 178, 82nd Congress, chapter 495) or as allowed by an existing waiver or a waiver to be issued covering the vessel being built. These lights consist of (1) running lights, (2) signal lights, and (3) anchor lights.

RUNNING LIGHTS

The running lights are similar to those used on merchant ships and include (1) masthead light, (2) range light, (3) port side light, (4) starboard side light, (5) stern light (white), and (5) upper and lower towing lights, some of which are illustrated in figure 4-14.

The MASTHEAD LIGHT (white) for ships is a 20-point (225°) light (fig. 4-14A) located on the foremast or in the forward part of the vessel. It is a spraytight fixture provided with a 50-watt, 2-filament lamp and equipped with an external shield to show an unbroken light over an arc of the horizon of 20 points—that is, from right ahead to 2 points abaft the beam on either side.

The RANGE LIGHT (white) for ships is also a 20-point (225°) light located on the mainmast or the fore part of the vessel, but at least 15 feet higher and 15 feet aft of the masthead light.

The PORT and STARBOARD SIDE LIGHTS for ships are 10-point, 112 1/2° lights (fig. 4-14B) located on the respective sides of the vessel, showing red to port and green to starboard. The fixtures are spraytight, each provided with a 100-watt, 2-filament lamp and equipped with an external shield arranged to throw the light from right ahead to 2 points abaft the beam on the respective sides.

The STERN LIGHT (white) for ships is a 12-point (135°) light (fig. 4-14C) located on the stern of the vessel. It is a watertight fixture provided with a 50-watt, 2-filament lamp and equipped with an external shield to show an unbroken light over an arc of the horizon of 12 points of the compass—that is, from dead astern to 6 points on each side of the ship.

The UPPER and LOWER TOWING LIGHTS (white) for ships not normally engaged in towing operations are 20-point (225°) lights similar to the previously described masthead and range lights. They are portable fixtures, each equipped with a type THOF-3 cable and plug connector for energizing the lights from the nearest lighting receptacle connector. When these lights are used, they are located vertically (6 feet apart) in the fore part of the vessel.

SIGNAL LIGHTS

The signal lights installed on combatant ships usually include (1) aircraft warning lights, (2) blinker lights, (3) breakdown and man overboard lights, (4) steering light, (5) stern light (blue), (6) wake light, and (7) speed lights (fig. 4-15). The supply switches for these lights located on the signal and anchor light supply and control panel (in the pilothouse) are individual ON-OFF rotary snap switches.

The AIRCRAFT WARNING LIGHTS (red) for ships are 32-point (360°) lights (fig. 4-15A) installed at the truck of each mast that extends more than 25 feet above the highest point in the superstructure. Two aircraft warning lights are installed if the light cannot be located so that it is visible from any location throughout 360° of azimuth. However, a separate aircraft warning light is not required if a 32-point red light is

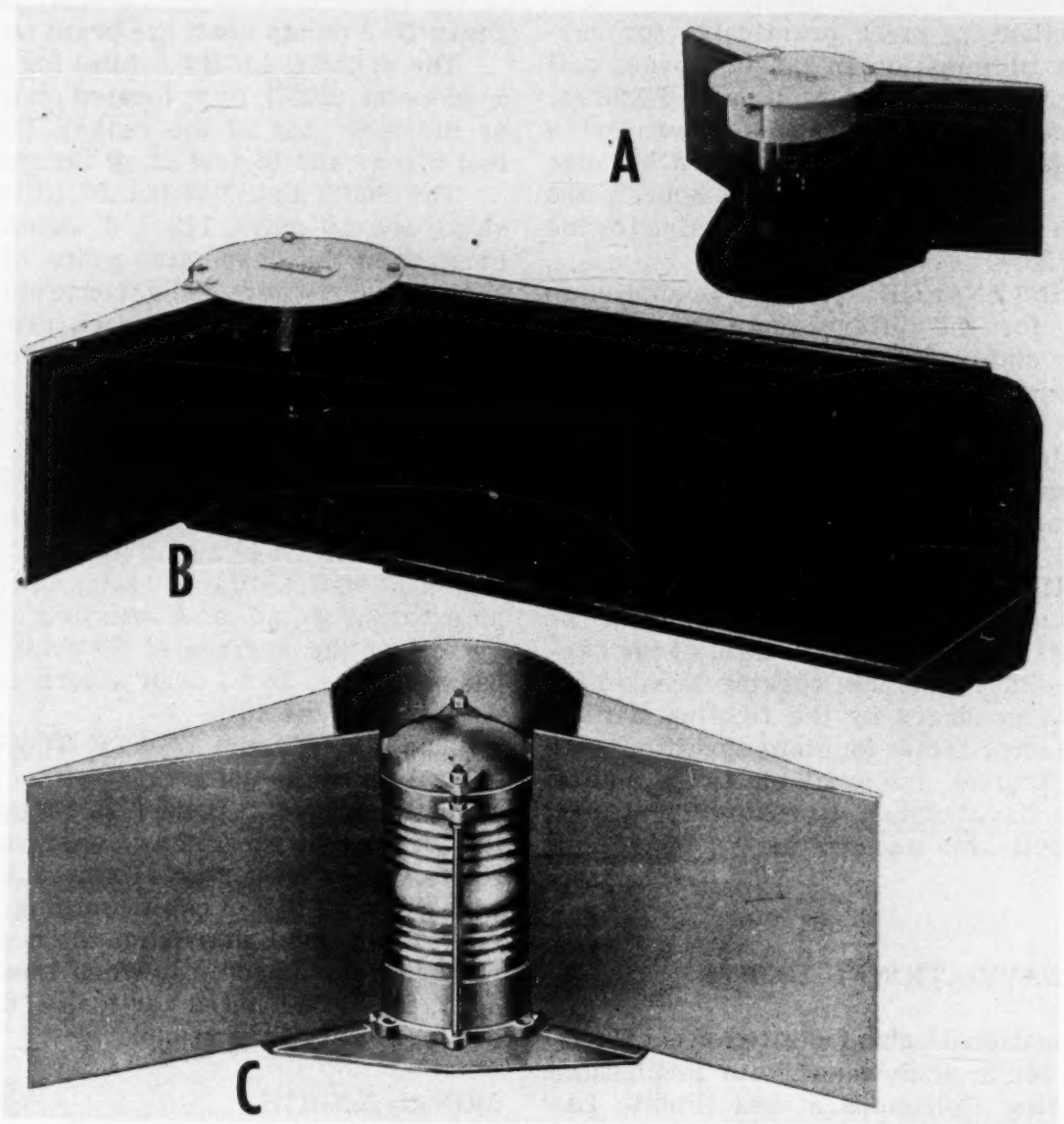

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Figure 4-14.—Running lights.

installed at the truck of a mast for another purpose. The fixtures are spraytight and equipped with multiple sockets provided with 15-watt, 1-filament lamps (fig. 4-15A). Upon experiencing a single lamp failure, all of the lamps in the cluster should be replaced.

The BLINKER LIGHTS (white) for ships are 32-point (360°) lights (fig. 4-15B) located, one port and one starboard, outboard on the signal yardarm. The fixtures are spraytight, each provided with 15-watt, 1-filament lamps and fitted with a screen at the base to prevent glare or reflection that may interfere with the navigation of the ship. These lights are operated from signal keys located on each side of the signal bridge.

Older blinker units (fig. 4-15B) have a cluster of six 15-watt lamps in a single multiple-lamp socket, similarly arranged as in the warning light (fig. 4-15A). Later units (not illustrated) are covered by NavShips drawing 815-F-1197117-B. These later units have two clusters of six lamps. Cluster No. 1 may be used singly for normal use. Cluster No. 2 may be added by switching to increase brilliance for communication at greater distance. Cluster No. 2 may be selected alone when No. 1 fails.

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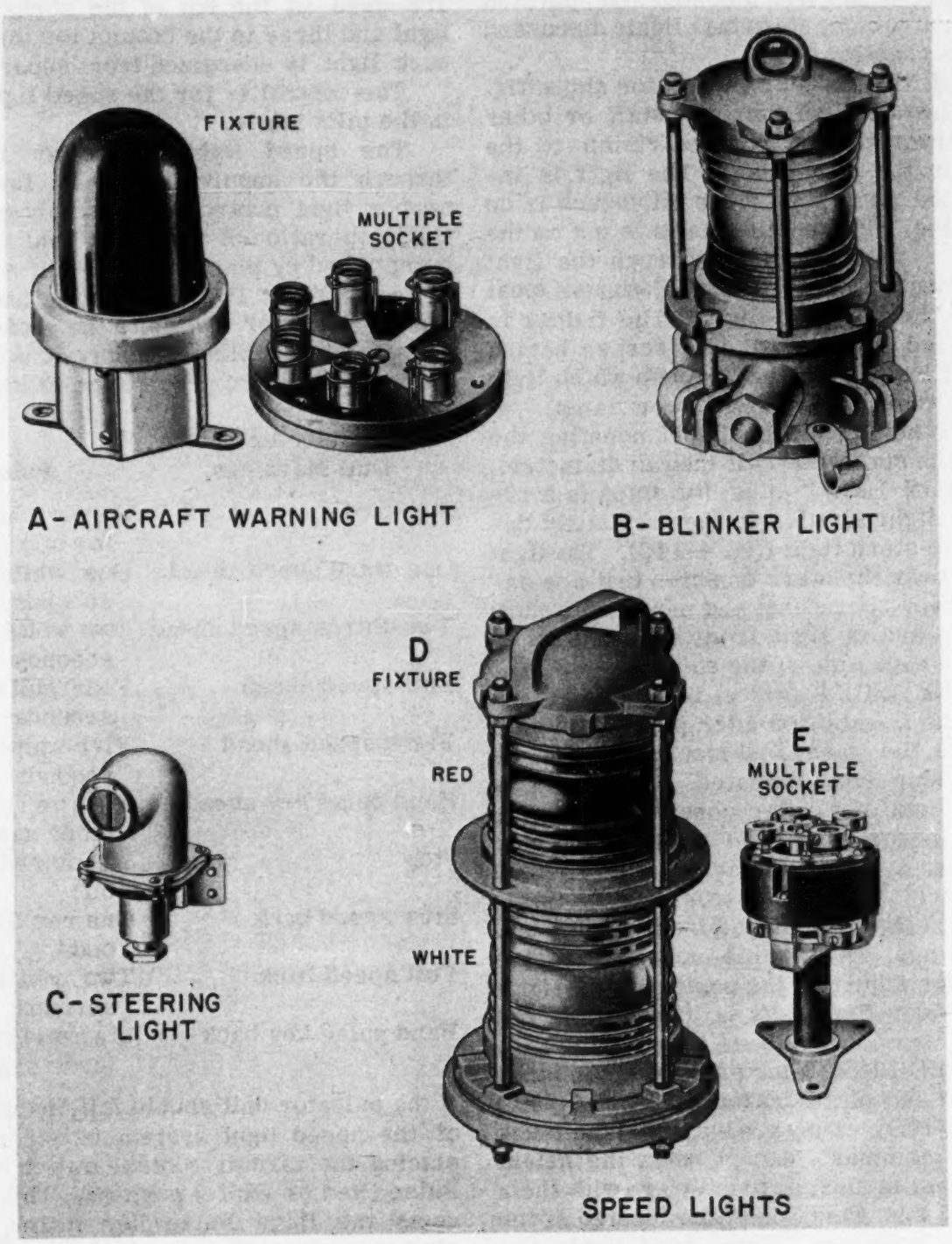

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Figure 4-15.—Signal lights.

The BREAKDOWN and MAN-OVERBOARD LIGHTS (red) for ships are 32-point (360°) lights located 12 feet apart (vertically) and mounted on brackets that extend aft of, and to starboard of the mast or structure. This arrangement permits visibility, as far as practicable, throughout 360° of azimuth. The fixtures are spraytight and equipped with 15-watt, 1-filament lamps. When these lights are used as a man-overboard signal, they are pulsed by a

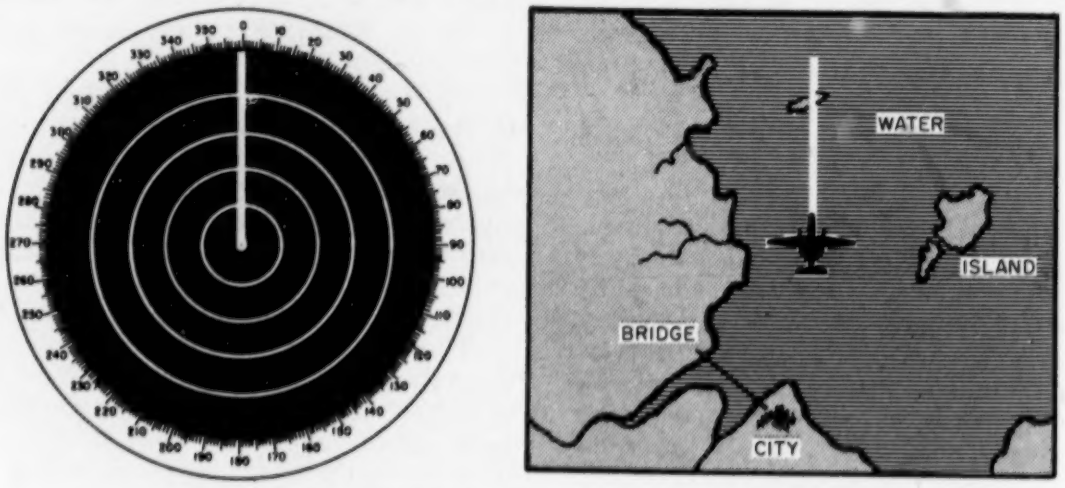

ANTENNA POINTING DIRECTLY AHEAD (0°)

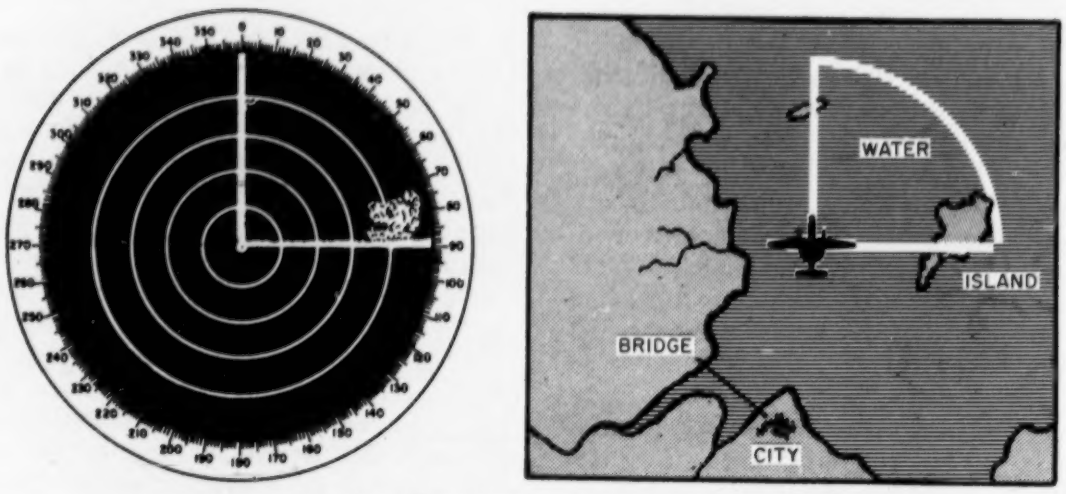

ANTENNA POINTING TO 90°

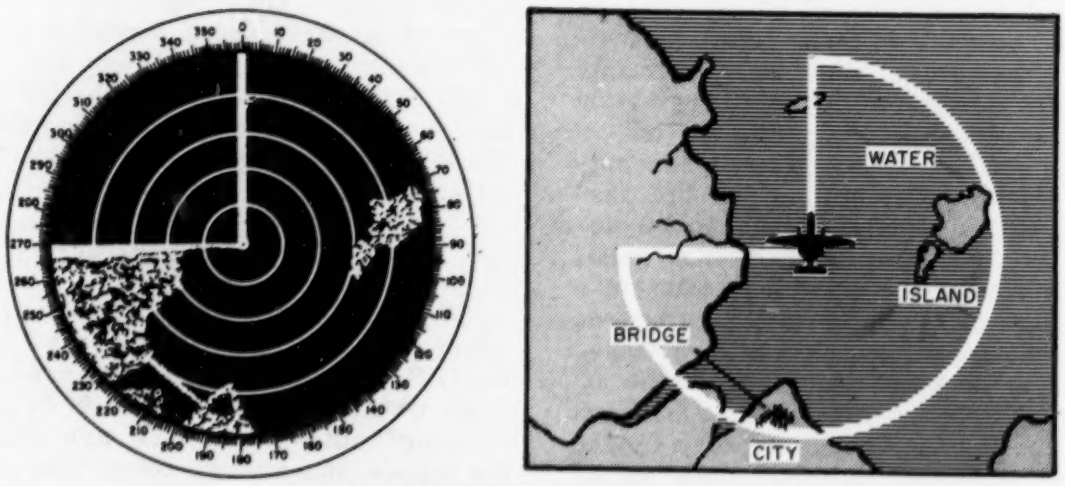

ANTENNA POINTING TO 270°

Figure 17-21.—PPI presentation.

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rotary snapswitch (fitted with a crank handle) on the signal and anchor light supply and control panel. These lights are mounted and operated in conjunction with the ships task lights discussed later in this chapter.

The STEERING LIGHT (white) for ships (fig. 4-15C) is installed on the jack staff or other spar or structure and must be visible to the helmsman in the pilothouse. The light is installed on the centerline if the pilothouse is on the centerline. If the pilot house is not on the centerline, a vertical plane through the light and helmsman's station in the pilothouse must be parallel to the keel line. The fixture is spraytight and includes a disk screen having a 3/64" x 1" slot (opening) through which light is emitted from a 2-candlepower lamp. A suitable bracket is provided for mounting the light on a jack staff (one-half inch in diameter).

The STERN LIGHT (blue) for ships is a 12-point (135°) light similar to the previously described white stern light (fig. 4-14C). The light is installed near the stern on ships that are engaged in convoy operations and mounted to show an unbroken arc of light from dead astern to six points on each side of the ship.

The WAKE LIGHT (white) for ships is installed on the flagstaff or after part of the ship to illuminate the wake, and mounted so that no part of the ship is illuminated. The fixture is spray tight and of tubular construction. One end of the fixture is fitted with an internal screen, having a 1-inch-diameter hole provided with a lens (2 5/16" diameter x 3/8" thick) through which light is emitted from a 100-watt, 2-filament lamp. A suitable mounting bracket is included for adjusting the position of the light. Thus, the wake light puts a "target" in the ship's wake.

The SPEED LIGHTS for ships are combination red (top) and white (bottom), 32-point (360°) lights (fig. 4-15D). They are located at the truck (top) of the mainmast, except when the height of the foremast is such as to interfere with their visibility; in this case, they are located at the truck of the foremast. Two speed lights are installed if their light cannot be located so that they are visible throughout 360° of azimuth.

Speed lights are provided to indicate (by means of a coded signal) the speed of the vessel to ships in formation. In other words, they indicate the order being transmitted over the engine order system. The white light indicates ahead speeds, and the red light indicates stopping and backing. The fixture is spraytight and equipped with a multiple socket (fig. 4-15E) provided with nine 15-watt, 1-filament lamps. Six lamps are used in the top of the socket for the red light and three in the bottom for the white light, each light is energized from separate circuits.

The controller for the speed lights is located in the pilot house.

The speed light controller is energized through the supply switch on the signal and anchor light controls and supply panel. Automatic operation of the speed light system is accomplished by placing the circuit control switch in the MOTOR PULSE position and the signal (speed) selector switch to the desired position. This action establishes connections to the motor-driven pulsator to provide the following signals.

Signal Selector Switch Dial Markings	Pulsations
Standard speed ahead	Steady white light (motor off)
One-third speed ahead	One white flash in 6 seconds
Two-thirds speed ahead	Two white flashes in 6 seconds
Full speed ahead	Four white flashes in 6 seconds
Flank speed ahead	Five white flashes in 6 seconds
Hand pulse key ahead	Manually controlled (code same as above)
Stop	Steady red light (motor off)
Slow speed back	One red flash in 6 seconds
Full speed back	Two red flashes in 6 seconds
Hand pulse key back	Manually controlled (code same as above)

If the pulsator unit should fail, manual operation of the speed light system is accomplished by placing the circuit control switch in the Hand Pulse (Red or White) position. This action connects the Hand Pulse key in the speed light circuit so that the signals can be transmitted manually, using the same code as that for the automatic pulsator. A schematic wiring diagram of the controller components is illustrated in figure 4-16.

The speed light is used as an aircraft warning light to provide a steady red light by placing the signal selector switch in the stop position and the circuit control switch in the AIRCRAFT WARNING position.

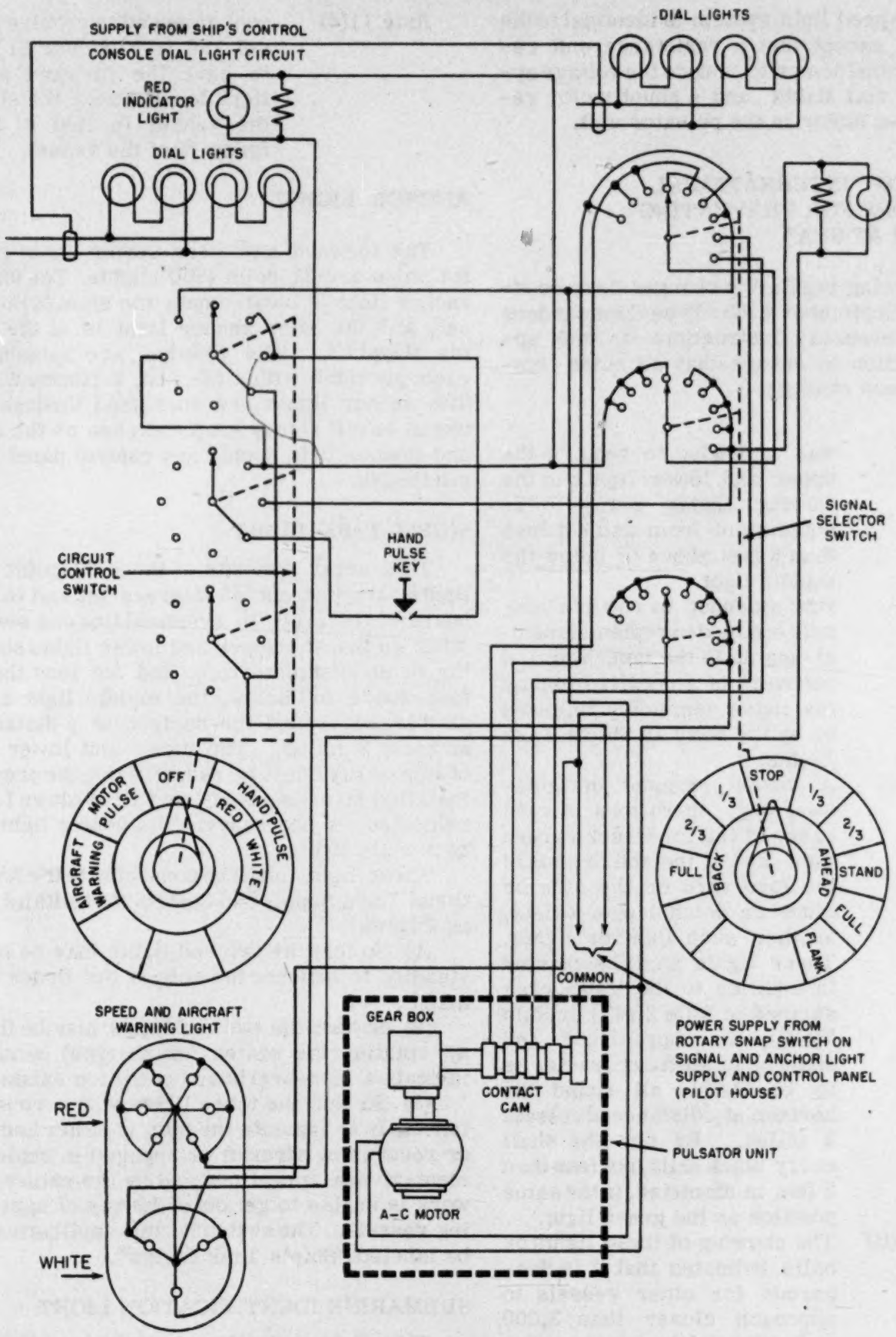

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Figure 4-16.—Speed light control, schematic diagram.

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The d-c speed light system is identical to the a-c system except that a resistance unit replaces the transformer to reduce the voltage applied to the dial lights, and a shunt motor replaces the a-c motor in the pulsator unit.

CHANGES TO "INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA"

The following regulation changes became effective on 1 September 1965. Type Commanders issued the necessary instructions or took appropriate action to ensure that all ships complied with these changes.

Rule 3(a) was amended to require the upper and lower lights in the Towing Lights array to be equidistant from and not less than 6 feet above or below the middle light.

Rule 4(c) was amended to require vessels engaged in replenishment-at-sea or in the launching and recovery of aircraft to display the lights commonly referred to by the Navy as Ship's Task Lights.

Rule 4(d)(i) A vessel engaged in minesweeping operations shall carry at the fore truck a green light, and at the end or ends of the fore yard on the side or sides on which danger exists, another such light or lights. These lights shall be carried in addition to the lights prescribed in Rule 2(a)(i) or Rule 7(a)(i), as appropriate, and shall be of such a character as to be visible all round the horizon at a distance of at least 2 miles. By day she shall carry black balls, not less than 2 feet in diameter, in the same position as the green light.

Rule 4(d)(ii) The showing of these lights or balls indicates that it is dangerous for other vessels to approach closer than 3,000 feet astern of the minesweeper or 1,500 feet on the side or sides on which danger exists.

Rule 11(d) was amended to require a vessel 150 feet or over in length to have the forward anchor light located near the stem of the vessel in lieu of in the forepart of the vessel.

ANCHOR LIGHTS

The forward and after anchor lights (white) for ships are 32-point (360°) lights. The forward anchor light is located near the stem of the vessel, and the after anchor light is at the top of the flagstaff. The fixtures are splashproof, each provided with a 50-watt, 1-filament lamp. The anchor lights are energized through individual on-off rotary snap switches on the signal and anchor light supply and control panel in the pilothouse.

SHIP'S TASK LIGHT

This array consists of three 32-point (360°) lights, stepped out 45 degrees aft and to starboard of the mast, in a vertical line one over the other so that the upper and lower lights shall be the same distance from, and not less than six feet above or below, the middle light and be visible all around the horizon at a distance of at least 2 miles. The upper and lower lights of this array shall be red, utilizing the presently installed Man-overboard and Breakdown Lights, relocated as necessary. The center light shall be a white light.

These lights shall be connected to the Navigational Light Supply and Control (no telltale) Panel as follows:

(1) So that the two red lights may be burned steadily to indicate the ship is Not Under Command

(2) So that the two red lights may be flashed by rotating the switch (crank type) handle, to indicate a man-overboard condition exists

(3) So that the three lights will burn simultaneously to indicate the ship is either launching or recovering aircraft or engaged in replenishment-at-sea operations and by the nature of its work is unable to get out of the way of approaching vessels. The switch for this application shall be labeled "Ship's Task Lights".

SUBMARINE IDENTIFICATION LIGHT

This light is displayed solely for identifying a craft on the surface as a submarine. Its display does not change any of the Rules of the Road

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nor confer any privilege on the ship showing it. The light is an amber rotating light producing 90 flashes per minute, visible all around the horizon, and located approximately six feet above the masthead light.

TESTING NAVIGATIONAL LIGHTS

All shipboard navigational lights are tested daily while at sea. The test is usually made one hour prior to sunset by the Electrician's Mate with the day's duty. Weekly test of navigational lights should include the operational test of the telltale panel.

SUPPLY, CONTROL, AND TELLTALE PANEL

The supply control and telltale panel for the running lights is a nonwatertight, sheet metal cabinet designed for bulkhead mounting (fig. 4-17).

This panel is provided to aid a ship in keeping her running lights lit as prescribed by the rules for preventing collisions at sea. It is installed in or near the pilot house and gives an alarm when one of the running lights is out or has had a failure of its primary filament and is operating on its secondary filament.

Failure of the primary filament, or its circuit, of any one of the following lights: masthead, stern, range, and side lights, deenergizes a relay. This relay effects a transfer of power to the secondary filament of the affected light, sounds a buzzer, lights an indicator light and moves an annunciator target to read, OUT (reads RESET when deenergized). The buzzer may be silenced during repairs for storing the primary filament by turning the handle of the reset switch 90° (to the horizontal position), however the indicator lamp of the affected light stays lit until the repair has been completed and the reset switch is turned back to the normal (RESET) position. Certain ships have permanent towing lights installed and connected to control switches on the telltale panel. The towing light switches are manual. When failure of the primary filament occurs in towing lights connected to this panel the switch must be manually turned to the position marked "SEC", to energize the secondary filament.

Sequence of Operations

The operations of the supply control and telltale panel are easily seen by following the schematic diagram in figure 4-18. For simplification this schematic shows only one of the five running lights, the operation is the same for all five.

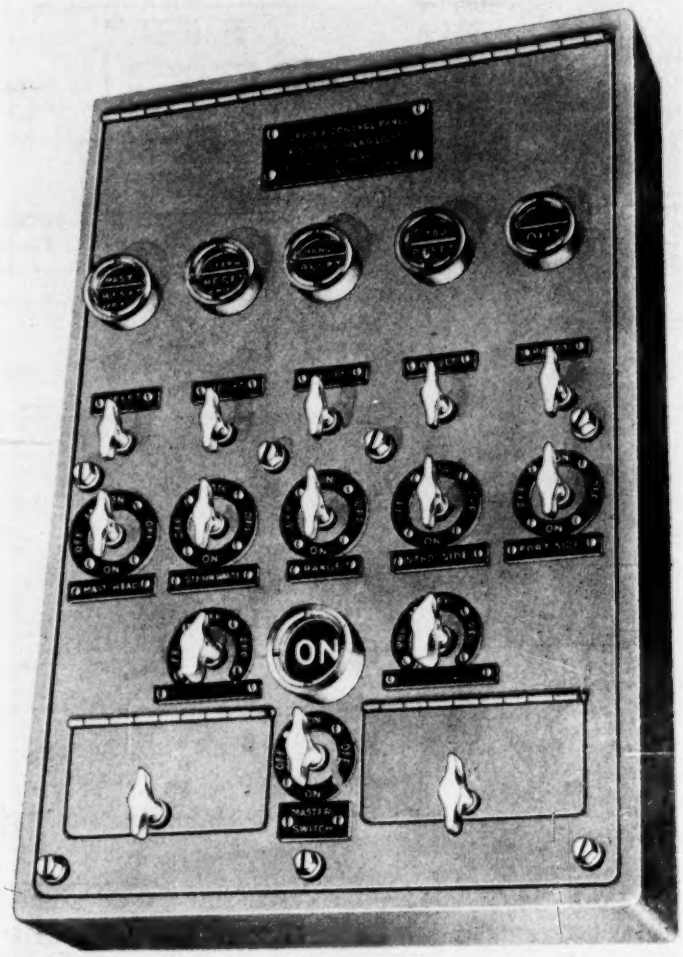

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Figure 4-17.—Supply, control, and telltale panel.

When the primary filament of a running light is lighted, relay contacts (X, Y and Z) are open, indicator lamps, annunciator and buzzer are not energized, reset switch must be kept pointing in the (vertical) "RESET" (marked position) under normal condition or buzzer will not be energized when a failure occurs.

If the primary filament circuit is opened, as when the filament burns out, the relay is de-energized closing contacts (X and Y), secondary filament is lighted, indicator lamps are lighted, annunciator target moves to "OUT" position (closing contact Z) and the buzzer sounds.

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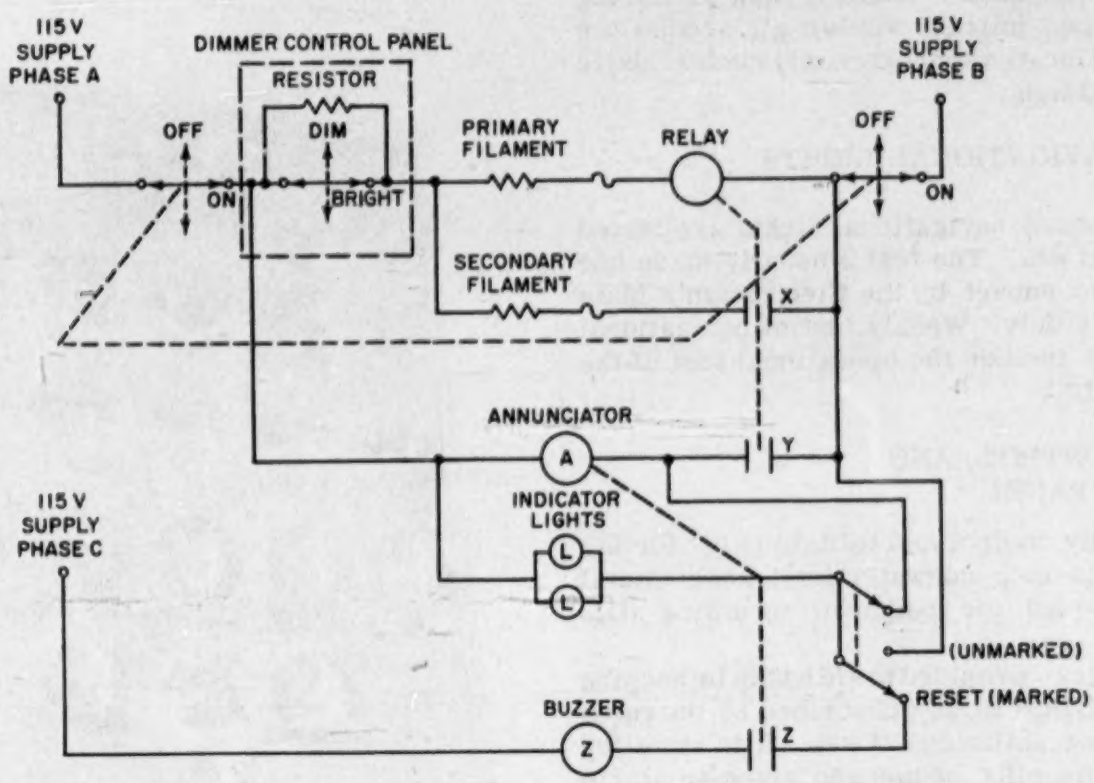

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Figure 4-18.—Running light control schematic diagram.

When the "RESET" switch handle is turned to the horizontal (unmarked) position, the buzzer is silenced but the indicator lamps remain lighted and the annunciator target is still OUT.

When the defective lamp is replaced, (or fault in primary circuit is corrected) the relay coil is energized and relay contacts (X and Y) are opened, annunciator coil is deenergized (opening contact Z) and target indicates RESET, secondary filament is deenergized, indicator lamps remain lighted.

Reset switch is returned to RESET (vertical) position, indicator lamps go out and entire unit is again in normal condition.

Dimmer Control Panel

A dimmer control panel connected as shown in figure 4-18 is provided for dimming the running lights when directed. This panel provides but one position of dimming. In the dim position the visibility of the range, masthead, side lights, and stern light is reduced to about 4000 yards. The sequence of operation of the telltale panel is the same whether the running lights are in the light or dimmed condition.

DIVERSIFIED LIGHTING EQUIPMENT

Light traps and special lights also serve useful purposes aboard ship, which equipment the EM must repair and maintain. Visibility in all directions must be restricted with most of this equipment where the EM must take into account the lighting as affected by glare and background illumination.

NIGHT-FLIGHT OPERATION LIGHTS

Night-flight operation lights are installed on aircraft carriers to assist pilots during takeoff and landing at night. They also provide visual aid to pilots for locating and identifying the parent carrier, and for rendezvousing in the vicinity of the carrier. These lights are of a confidential nature and are therefore not listed in this training course.

DARKEN SHIP EQUIPMENT

Darkened ship is a security condition designed to prevent the exposure of light, which

could reveal the location of the vessel. Darkened-ship condition is achieved by means of (1) light traps that prevent the escape of light from illuminated spaces or (2) door switches that automatically disconnect the lights when the doors are opened.

Light Trap

A light trap is an arrangement of screens placed inside access doors or hatches to prevent the escape of direct or reflected light from within (fig. 4-19). The inside surfaces of the screens are painted flat black so that they will reflect a minimum of light falling on them. Light traps that are used to prevent the escape of white light should have at least two black, light-absorbing surfaces interposed between the light source and the outboard openings. Light traps are preferred to door switches in locations where (1) egress and ingress are frequent; (2) interruption of light would cause work stoppage in large areas; (3) light might be exposed from a series of hatches, one above the other on successive deck levels; and (4) many small compartments and passages are joined by numerous inside and outside doors that would complicate a door-switch installation.

Door-Switch

A door switch is mounted on the break side of a door jamb (inside the compartment) and operated by a stud welded to the door. When the door is opened, the switch is automatically opened at the same time.

Door switches are connected in a variety of ways to suit the arrangement of the compartment concerned. In a single compartment where there are several doors or hatches, door switches are connected in series so that when any one door or hatch is opened, all the lights in the compartment will be extinguished. When an inner compartment is located so that its light is visible from the deck when the doors to both the inner and outer compartments are open, the lights in the inner compartment are usually controlled by the door switch of the outer compartment. However, if this arrangement results in an excessive number of light interruptions in the inner compartment, a separate door switch connected in parallel with the outer door switch should be provided on the inner door to control the lights in the inner compartment.

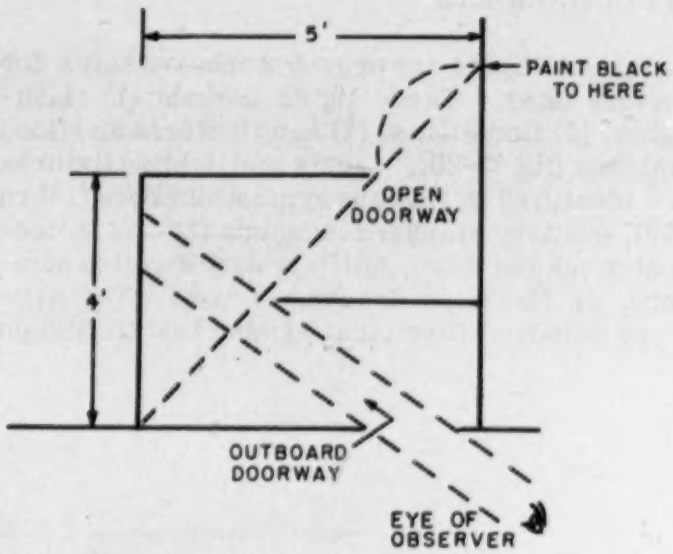

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Figure 4-19.—Light trap.

Thus, the lights in the inner compartment will be extinguished only when the inner and outer doors are open.

All door switch installations are provided with lock-in devices or short-circuiting switches to change the settings of the door switches, as required from lighted ship to darkened ship and vice versa. Each standard door switch is furnished with a mechanical lock-in device for use when only one door switch is installed. When two or more door switches are connected in series, a single, separately mounted short-circuiting switch is installed in an accessible location to avoid the possibility of overlooking any of the door switches when the changeover is made.

When a single door switch at an outer door is connected in parallel with door switches at inner doors, only the door switch at the outer door is provided with a lock-in device, and the lock-in devices are removed from the other outer doors. The location of the control switch is indicated by a plate mounted adjacent to each door switch. The control switch is marked CAUTION—DOOR SWITCH CONTROL. The portion of the short-circuiting switch that connects the door switches in the circuit is marked DARKENED SHIP, and the portion that disconnects the door switches from the circuit is marked LIGHTED SHIP. Personnel should become familiar with the location of the short-circuiting switch in all compartments and the number of doors that it controls.

SPECIAL LIGHTS

Special lights are provided onboard ships for various uses. These lights include (1) flashlights, (2) floodlights, (3) hand lanterns and flood lanterns (fig. 3-20). Lights and lighting fixtures are identified by BuShips symbol numbers (1 thru 399), military standard numbers (MS. no.), federal stock numbers, military specification numbers, or NavShips drawing number. The NavShips Standard Electrical Symbol List (NavShips 0960-000-4000 dated October 1965), lists the lights and lighting fixtures in current use on naval ships. Fixtures are listed in NavShips symbol number order along with the MS or NavShips drawing number, and federal stock number (FSN).

Floodlight

The floodlight (fig. 4-20B) is identified by NavShips symbol number 300.2, military

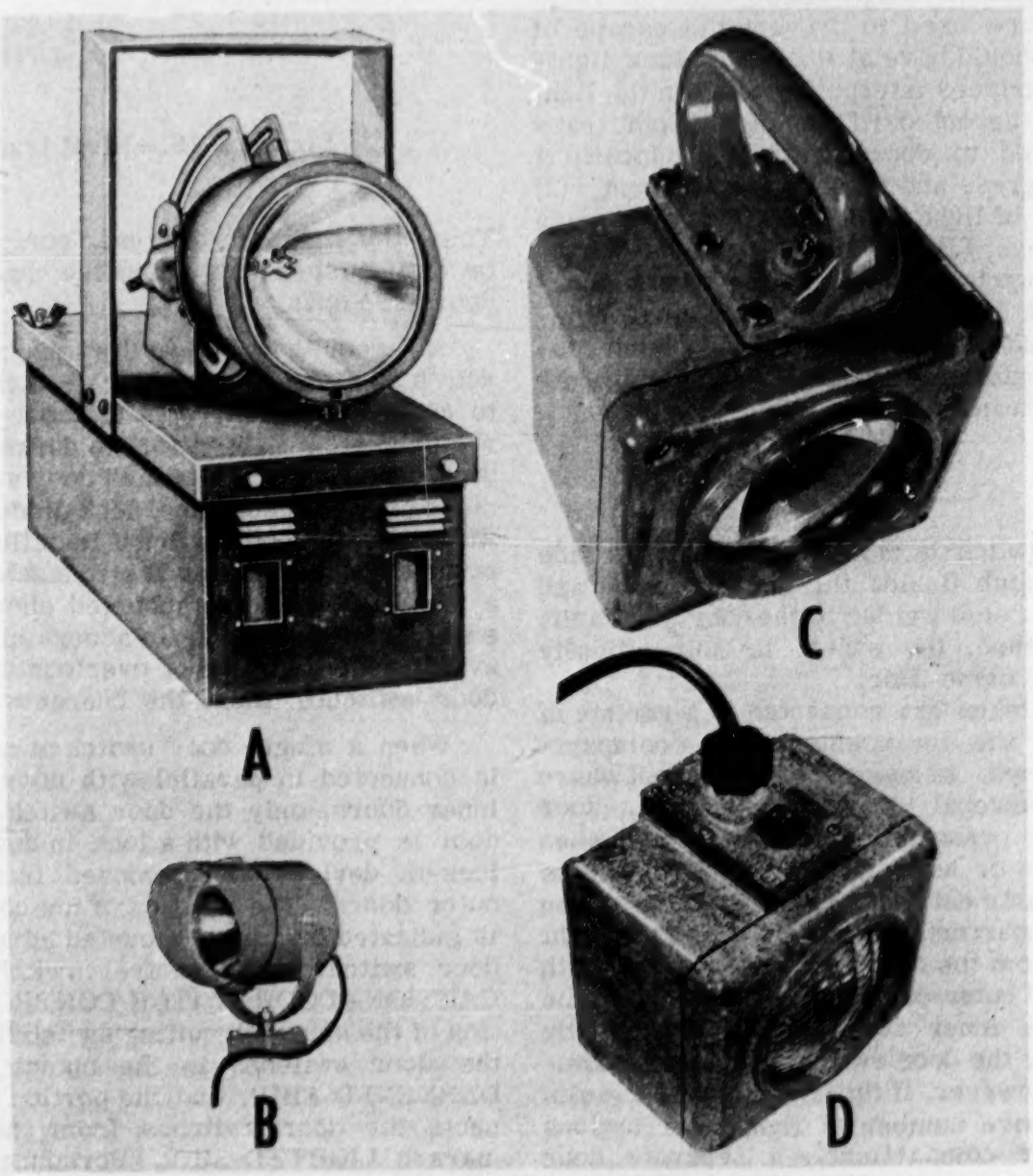

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Figure 4-20.—Special lights.

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standard (MS17338), and federal stock number H6230-889-1559. It consists of a splashproof housing equipped with a rain shielded, hinged door secured with a trunk type latch. The 300-watt lamp is a sealed-beam type.

The lamp housing is trunnioned on a yoke which in turn is mounted on a shock absorbing base. The light is secured in elevation by a clamp on the yoke. Train positioning is accomplished by friction within the shock absorbing base. Each floodlight is furnished with a three-conductor cable (including a green lead to ground the metal housing) for connection into the lighting circuit.

Larger 500-watt floodlights (not shown), using a nogul screw base lamp are also widely used. Floodlights are installed on weather decks at suitable locations to provide sufficient illumination for the operation of cranes and hoists, and the handling of boats. New high-level illuminating floodlights are being developed for evaluation by Ship System Command. Ships deployed in coastal patrol in Southeast Asia require adequate illumination for nighttime apprehension and search of small craft.

Lanterns

Two types of dry battery powered lanterns are available for installation in certain strategic locations to prevent total darkness if the lighting power fails. One model is hand operated. The other is operated automatically by a relay when the regular power fails.

HAND LANTERN, MANUALLY OPERATED—The BuShips symbol number 100.2, MS 17231, lantern (fig. 4-20C), consists of a watertight plastic case containing two type BA-200/U (6 volt), batteries CONNECTED IN PARALLEL. It includes a sealed beam lamp, rated at 5 volts, but operated at 6 volts (when the batteries are new) to increase the light output. A rigid handle is secured to the top of the case. The lantern is operated by a toggle switch, the lever of which is convenient to the thumb. When the batteries are fresh, the lantern can be used continuously for approximately 8 hours before the light output ceases to be useful.

Manually operated lanterns are installed as an emergency source of illumination in spaces that are manned only occasionally. These lanterns are also used in certain areas to supplement the relay-operated lanterns.

Manually operated hand lanterns must not be removed from the compartments in which they are installed unless the compartments are to be abandoned permanently.

NavShips symbol no. 104 (not shown) is a dry battery type (hand carrying or head attaching) lantern used for damage control purposes and is generally stored in damage control lockers. This lantern's battery container may be clipped over the wearer's belt, the lamp and reflector assembly may be hand held or worn on the head or helmet of repair party personnel by using a headband attached to the light.

Lantern, Relay Operated

The relay operated lantern is similar to the manually operated type except that the relay housing is mounted topside of the lantern case (fig. 4-20D) in place of the handle. The 115-volt a-c version is identified by symbol 101.2. Symbol 102.2 identifies the 115-volt d-c type. A three conductor cable (including a green conductor to ground the relay metal frame) is provided for connection into the lighting circuit. THE RELAY CONTROLLED LANTERN MUST ALWAYS BE INSTALLED WITH THE RELAY UPPERMOST. This specific arrangement of the relay prevents a proven fire hazard, which would be caused by liquid electrolyte (formed from battery exhaustion) draining into the (otherwise inverted) relay housing.

Relay-controlled lanterns are assigned to spaces in which it is necessary to maintain practically continuous illumination. These spaces include essential watch stations, control rooms, machinery spaces, battle dressing stations, and at accesses, companionways, and escape passageways leading from compartments (where personnel are stationed or quartered) to the weather deck. These lanterns must not be installed in magazine or powder-handling spaces in which fixed or semifixed ammunition is handled), or in any location in which explosion-proof equipment is required.

The lantern relay is connected in the lighting circuit (in the space in which the lantern is installed) on the power supply side of the local light switch that controls the lighting in the space concerned. Thus, the relay operates and causes the lamp in the lantern to be energized from its batteries only when power failure occurs, not when the lighting circuit is deenergized by the switch. If the space is supplied with both

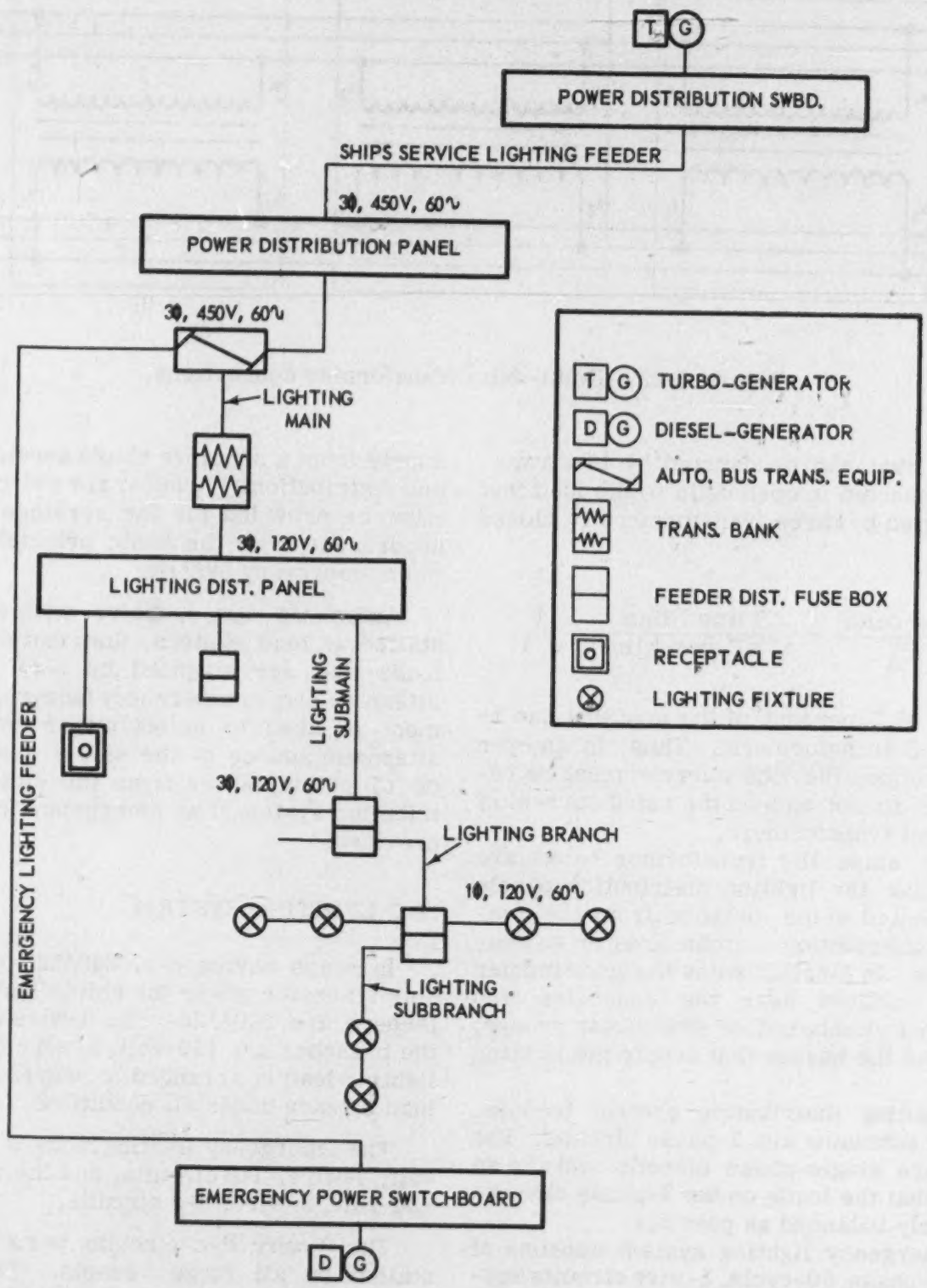

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Figure 4-21.—Lighting distribution system, schematic diagram.

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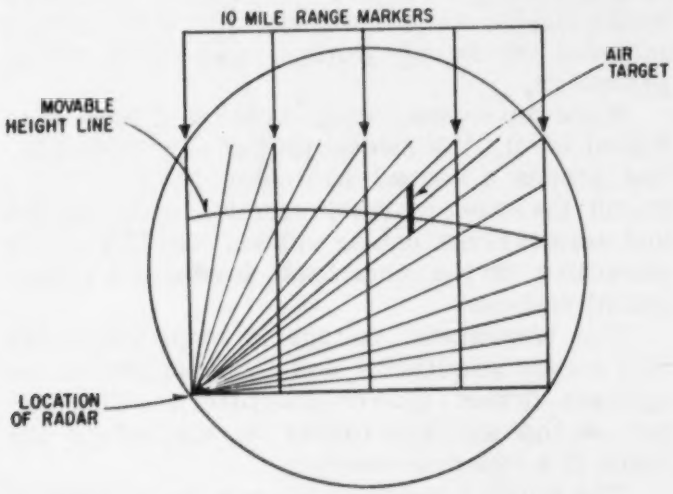

Figure 17-22. —RHI-scan presentation.

The rotary transformer is a variable-ratio transformer with one primary winding (the rotor) and two secondary windings (the stator). The voltage ratio between the primary winding and each secondary winding changes when the rotor is turned.

The rotor is connected mechanically to the radar antenna. Thus, when the antenna turns, the rotor turns, and the voltage ratio changes. One secondary voltage varies as the sine of the angle of antenna rotation; the other secondary voltage varies as the cosine of the angle of antenna rotation.

The plan position indicator operates as follows: Trigger pulses from the timer (synchronizer) are fed to both the transmitter and the one-shot monostable multivibrator. The one-shot multivibrator generates negative gate pulses that are applied to the trapezoidal-voltage sweep generator and the cathode of the CRT.

The output of the trapezoidal-voltage sweep generator is fed to a power amplifier. The output of the power amplifier is applied to the primary of the rotary transformer. The secondary voltages of the rotary transformer are trapezoidal and have amplitudes that depend on the antenna position.

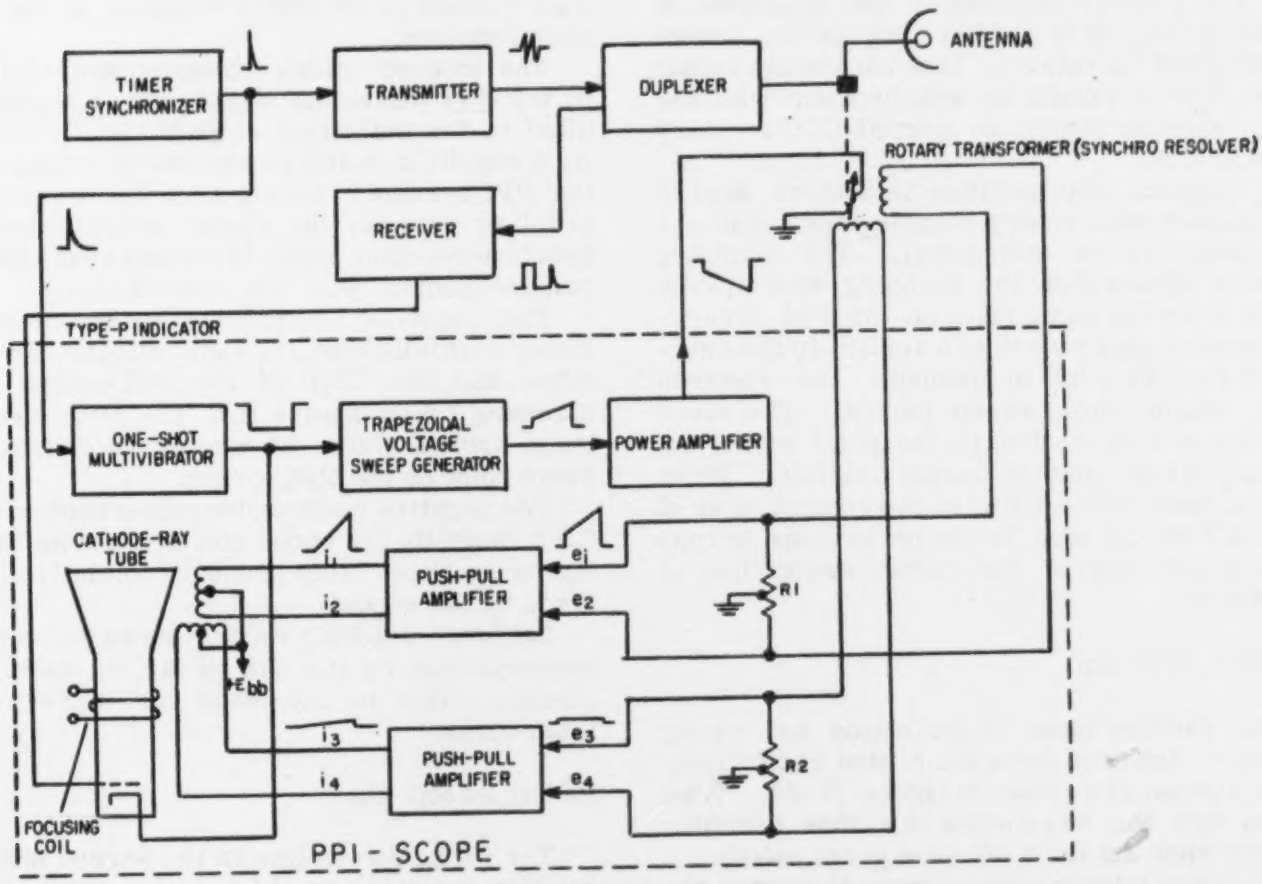

Figure 17-23. —Block diagram of a PPI-scope system.

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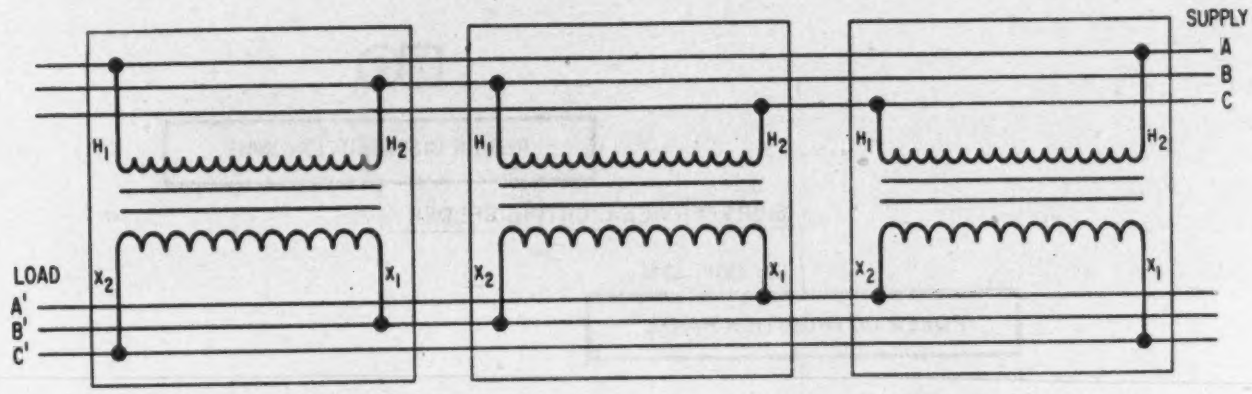

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Figure 4-22.—Delta-delta transformer connections.

of the load that can be carried by two transformers connected in open delta to the load that can be carried by three transformers in closed delta is

$$\frac{P_V \text{ (open delta)}}{P_\Delta} = \frac{\text{E line I line}}{\sqrt{3}\text{ E line I line}} = \frac{1}{\sqrt{3}}$$

= 0.577 or 57.7 percent of the load that can be carried by 3 transformers. Thus, in an open delta connection, the line current must be reduced so as to not exceed the rated current of the individual transformers.

In large ships the transformer banks are installed near the lighting distribution panels that are located some distance from the generator and distribution switchboards or switchgear groups. In smaller ships the transformer banks are located near the generator and distribution switchboard or switchgear groups, and energize the busses that supply the lighting circuits.

The lighting distribution system feeders, mains, and submains are 3-phase circuits. The branches are single-phase circuits and are so connected that the loads on the 3-phase circuits are as nearly balanced as possible.

The emergency lighting system consists of 120-volt, 3-phase, 60-cycle, 3-wire circuits supplied from the emergency generator and distribution switchboards. The circuits to the automatic bus transfer equipment, lighting mains from the emergency lighting feeders, feeder junction fuse boxes, and feeder distribution fuse boxes are 3-phase circuits. If an emergency power system is not installed, an alternate supply from a separate ship's service generator and distribution switchboard or switchgear group must be provided for the services selected in accordance with the basic principles applying to an emergency system.

Automatic bus transfer equipment is installed at load centers, distribution panels, or loads that are supplied by both normal and alternate and/or emergency feeders. This equipment is used to select either the normal or alternate source of the ship's service power, or to obtain power from the emergency distribution system if an emergency feeder is also provided.

D-C LIGHTING SYSTEM

In ships having d-c, 240/120-volt, 3-wire, ship's service power the ship's service lighting feeders are 240/120-volt, 3-wire circuits, and the branches are 120-volt, 2-wire circuits. The lighting load is arranged to provide satisfactory load balance under all conditions.

The emergency lighting feeders are 240/120-volt, 3-wire, d-c circuits, and the branches are 120-volt, 2-wire, d-c circuits.

The 3-wire d-c circuits were formerly installed on all large vessels. They are still used on older vessels, and on surface ships requiring mostly d-c power such as converted merchant ships with large deck machinery loads. Present Navy practice is NOT to ground the neutral (or either leg) of a 3-wire system, but some systems with grounded neutral may be found on older ships or conversions.

DETECTION OF FAULTS IN LIGHTING CIRCUITS

Troubles in 3-wire, d-c systems are located by making tests in their branch circuits, by using the same techniques described in chapter 7 of this training course for 3-wire a-c circuits and their branch circuits.

In addition to the usual tests for open circuits and grounds, look for possible unequal load distribution. This is done by comparing the voltage readings obtained at all branches. Unequal load distribution on the two legs of the system causes high voltage on one leg while low voltage appears on the other leg. High voltages resulting from such unbalance produce short lamp life while the low voltages cause poor illumination.

Unbalanced systems are corrected by removing one or more of the branches from the heavily loaded leg and reconnecting it to a lightly loaded leg in the same (or another) system.

MAINTENANCE

The intensity of illumination produced by a lighting installation begins to depreciate at the time the system is placed in operation. This depreciation in the lighting system is due to the decrease in efficiency of the lamp (with use) and to the decrease in reflecting efficiency of the surrounding bulkheads and overhead, resulting from the natural deterioration of the surface with age.

The deterioration of an incandescent lamp is caused by blackening of the inside of the bulb because of the oxidation of the tungsten filament. The light output of a tungsten filament lamp near the end of its normal life is about 80 percent of the initial output. The depreciation of a fluorescent lamp is caused by blackening at the ends of the tube due to the exhaustion of the active material on the electrodes.

The depreciation of the light caused by the accumulation of dirt, dust, and film on the lamps and fixtures greatly reduces the efficiency of a lighting system. The actual loss of light from this cause will depend on the extent to which oil fumes, dust, and dirt are present in the surrounding atmosphere, and on the frequency with which the fixtures are cleaned.

In the design of lighting installations, a maintenance factor is used to compensate for the difference in the average illumination obtained initially when the lamps and fixtures are new and the resulting average illumination maintained in service. The amount of depreciation will vary from 25 to 45 percent, corresponding to a maintenance factor of 55 to 75 percent and depends on the type of fixtures, the system of illumination employed, the material of the reflecting surfaces (bulkheads and overhead), the local conditions of dust and dirt, and of the frequency of cleaning the fixtures and repainting the bulkheads and overhead. As previously stated, a maintenance factor of 70 percent is used unless otherwise shown on the standard plan of the installed fixtures.

LIGHTING FIXTURES

The lighting system should be maintained at its maximum efficiency because artificial light has an important bearing on the effectiveness of operation of a naval vessel. All lighting fixtures should be adequately cleaned at regular intervals of about two to six weeks to prevent a waste of energy and low intensity of illumination. The frequency for the cleaning periods depends on the degree of prevalence of dirt, dust, and oil fumes in the surrounding atmosphere, and on the type of fixtures installed in the spaces.

Cleaning

The schedules for cleaning the lighting fixtures should be developed to suit the conditions and requirements aboard individual vessels. Lamps and fixtures should be inspected at frequent intervals and cleaned when dirt, oil film, or salt incrustation are first detected. The bulkheads and overhead should be kept clean also as an aid in maintaining the deficiency of the lighting system.

When a fixture requires cleaning, turn off the light and remove the glassware (if any), the lamp, and, if practicable, the reflector (if any). Wash the glassware, lamp, and reflector with soap and water. Avoid the use of strong alkaline and acid detergents when washing aluminum reflectors. Rinse the washed parts with clean, fresh water to which a few drops of ammonia are added to remove the soap film. Dry the parts with a soft cloth and replace them in the fixture.

REPLACING LAMPS, SEALS, AND GASKETS

The NavShips symbol number 92.2 (FSN, H6210-299-7703) watertight fixture (fig. 4-23) consists of a flanged globe that is secured to the base of the fixture by a securing ring. Two globes are available for use with this fixture, the white diffusing globe (FSN H6210-702-5773) or red diffusing globe (FSN H6210-702-2263). The inside surface of the flange fits against a molded-rubber gasket (one-fourth of an inch square) fitted in a circular groove in the bottom of the base. The outside surface of the flange is provided with a centering, molded-rubber gasket. A brass slipring is inserted between the centering gasket and the securing ring. The purpose of the slipring is that of a compression washer when the securing ring is tightened on the base. The entire assembly serves as a watertight seal. Always be very certain that the finished assembly serves that purpose.

To replace a burned-out lamp in this fixture, unscrew the securing ring with a spanner wrench, remove the globe, and replace the burned-out lamp with a new one. Inspect the one-fourth of an inch gasket in the base, and the centering gasket on the outside of the flange and replace with new gaskets if they are worn or deteriorated. Insert the globe and tighten the securing ring onto the base.

To avoid unnecessary waste, use judgment to determine when an old lamp should be replaced. If blackened, but still operative, lamps that are removed from service should be retained on board until allowances of new lamps are received. Then the old lamps should be destroyed or turned over to shore activities, depending on the circumstances.

The majority of the difficulties encountered with fluorescent lights are caused by either wornout or defective starters, or by damaged or expended lamps. Hence, when abnormal operation of a fluorescent fixture is observed, the difficulty can usually be remedied by replacing either the starter or the lamp or both.

HAND LANTERNS

To ensure satisfactory operation of hand lanterns, the batteries should be checked at least once every 3 months. The batteries are checked by operating the lantern and observing the brightness of the lamp. When observed, if the emitted light is dim, the batteries should be replaced immediately.

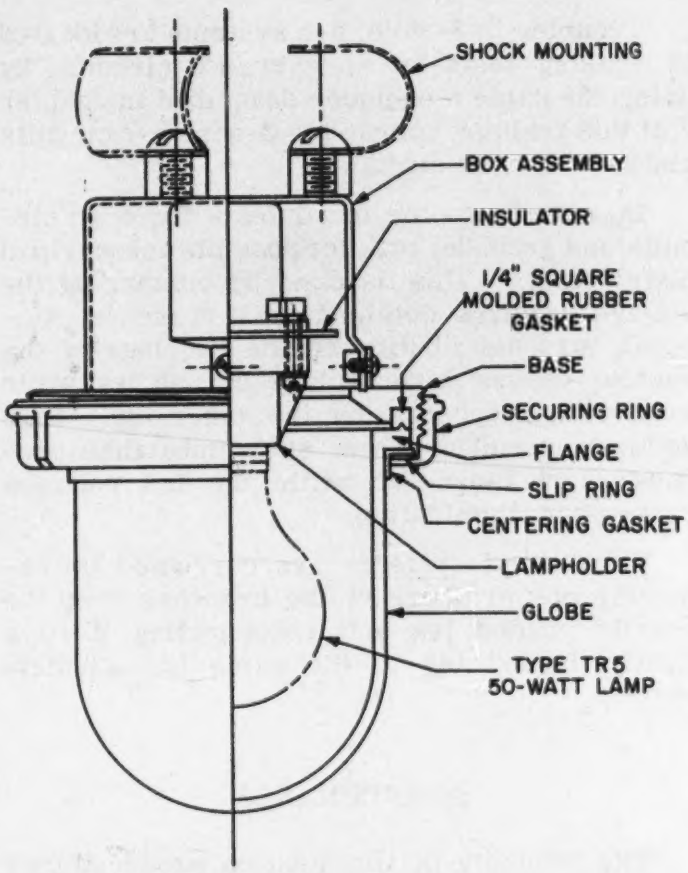

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Figure 4-23.—Symbol 92.2 watertight fixture.

Lanterns that are located in spaces in which the normal temperature is consistently above 90° F should be checked more often. For example, in boiler rooms it may be necessary to replace the batteries weekly to ensure adequate service from the lanterns.

In addition to checking the batteries, the operation of the relays in lanterns should be checked at least once every 3 months, by deenergizing the lighting circuit to which the relay is connected. When the circuit is deenergized, the relay should operate and automatically turn on the lantern. The circuit may be deenergized by pressure exerted on the push switch located on the relay housing.

PORTABLE FLOOD LANTERNS

As previously stated, the degree of charge in a portable flood lantern is determined by observing the charge indicator balls through the

plastic windows in the battery case. The batteries should be charged as soon as possible after the green ball (10 percent discharged) has sunk to the bottom. The lanterns should be checked at least once a week to determine if the green indicator balls are floating. If they are not floating, the battery should be charged at a rate of 1 1/2 to 2 amperes until all indicator balls are floating at the indicator line. If the battery is completely discharged, it will require from 20 to 25 hours to recharge it. After the charging voltage has remained constant at 10 volts for one hour, discontinue the charging.

When necessary, add pure water to keep the electrolyte level at the indicator line marked on the front of the cell. Do not add enough water to bring electrolyte level above the line because overfilling nullifies the nonspill feature of the battery and may cause the electrolyte to spurt out through the vent tube. However, if the electrolyte level is not at the indicator line, the charge indicator balls will not indicate correctly the state of charge of the battery.

FLASHLIGHTS

Flashlights are checked by switching them on for 3 minutes. If there is a noticeable decrease in light intensity during the interval, the batteries should be replaced with fresh cells. All flashlights should be given this test every 6 weeks.

SAFETY PRECAUTIONS

When a lighting system is installed, the illumination is a fixed rather than a controllable factor. This is especially true if the work cannot be located or positioned to improve the seeing task. It is natural to move the work closer to the light source when seeing is difficult, and when this can be done, improvement in visibility usually results. When the seeing task is prolonged to any appreciable length of time, improvement in visibility is not the only factor to be considered. It is also necessary to take into account the quality of the lighting as affected by glare and the background illumination.

GLARE

Glare is light that hinders, rather than aids vision. It may come from an exposed light source in the field of view (direct glare) or from some shiny surface that reflects a bright source of light toward the eye (reflected glare). In either case, glare is objectionable because it is unpleasant and can cause eyestrain, headache, and fatigue.

Many navy lighting fixtures provide some protection against direct glare from the usual viewing angles, but in many locations it is impossible to mount fixtures so that no part of a bare lamp is in the field of view. Other fixtures have no shielding at all. In a naval vessel it is more important for the lighting fixtures to be simple and rugged, and to provide the essential illumination than to produce entirely adequate and comfortable illumination.

The best protection against the harmful effects of glare aboard ship is the realization by all hands that prolonged exposure to glare should be avoided. Usually, it is possible to position the work and place yourself so that you will not face any of the exposed lamps or uncomfortably bright, reflected-glare spots. If this is not practicable, shield your eyes with a visor.

Always use the proper size lamp in every fixture. For example, glare is invariably produced if a 100-watt lamp is used in a fixture that is designed for a 50-watt lamp. Install shielded fixtures in areas where extended critical seeing tasks are required. Never use exposed lamps or unshielded globes in such spaces. Replace burned out lamps immediately.

If a lamp shatters in its socket, turn off and tag the switch that controls the fixture before attempting to remove the lamp base. Always install and remove fuses with fuse pullers, never with your bare hands. Wiring and rewiring fixtures should be accomplished only by qualified Electrician's Mates and only after authorization has been obtained from the proper authority. When repainting compartments, do not spray paint on the reflecting surfaces of lighting fixtures. Paint will materially reduce the reflection factor of the reflecting surfaces and decrease the illumination.

BACKGROUND ILLUMINATION

The quality of the lighting is affected by the ratio of illumination on the working area to the illumination on the surroundings. The eyes do not remain constantly fixed on any task until it is completed. Instead, they frequently (often involuntarily) glance from the work for a few seconds. If a great difference exists between the brightness of the work area, the pupils of the eyes (which automatically adjust to the amount

of light entering the eyes) must make an adjustment every time the eyes glance away from, and back to, the work. The muscles of the eyes ordinarily will not be overworked if the ratio of brightness of the work to brightness of the surroundings does not exceed 10 to 1. However, if the ratio of brightness is appreciably greater than 10 to 1, eye fatigue will result if the work is continued for a prolonged period. Avoid extreme brightness contrasts between work and background. When lighting fixtures are installed beyond the work area that would illuminate the background, turn on these lights.

DARK ADAPTATION

When a person leaves a brightly lighted area and enters a darkened (not completely dark) area, he immediately experiences an impairment of vision. At first he sees little or nothing but as his eyes become adapted to the darkness, objects become discernible, and gradually more and more of the objects are visible, depending on the level of illumination. For most practical purposes, dark adaptation can be considered complete after approximately 25 to 30 minutes. The time required to reach a given state of dark adptation depends on the intensity of the previous stimulation. The higher the intensity, the longer is the period required for dark adaptation.

When dark adaptation must be maintained, the eyes should be guarded against exposure to white light. If it is necessary to enter an area illuminated by white light, wear red goggles. If the red goggles are not available, close one eye because dark adaptation in one eye is independent of that in the other.

DARKENED-SHIP CONDITION

When darkened-ship condition is ordered, check every door switch installation aboard ship to determine that all lock-in devices or short-circuiting switches are set at the DARKENED SHIP position.

Inspect the light traps to determine that they are free of all obstructions. A light colored object of any appreciable size placed in a light trap might be sufficiently illuminated by the interior lighting to be visible beyond the safe limit. Note the positions of the hand lanterns when entering a compartment so that you can find them without delay when they are needed.

ELECTRICAL HAZARDS

Safety precautions must always be observed by persons working around electrical circuits and equipment. Shipboard conditions are particularly conducive to the severity of shock because the body is likely to be in contact with the ships metal structure and the body resistance may be low because of perspiration or damp clothing.

Despite a fairly widespread but totally unfounded popular belief to the contrary, low voltage (115 volts and below) circuits are very dangerous and can cause death where the resistance of the body is lowered by moisture and especially when current passes through the chest. Show the same respect for the 115-volt lighting circuits as you show for the 450-volt circuits. Practice safety as if your life depended on it, because it does.

CHAPTER 5

SEARCHLIGHTS

This chapter describes the types of searchlights now used in the Navy and acquaints the Electrician's Mate with their proper operation, care, and maintenance.

Naval searchlights are used to project a narrow beam of light for the illumination of distant objects and for visual signaling. To accomplish its purposes the searchlight must have an intense, concentrated source of light, a reflector that collects light from the source (to direct it in a narrow beam), and a signal shutter (to interrupt the beam of light).

Searchlights are classified according to size of reflector and light source. The three general classes are the (1) 24-inch, (2) 12-inch, and (3) 8-inch searchlights. The 24-inch searchlight is of the carbon-arc type; the 12-inch light is either of the incandescent or inert-gas type; and the 8-inch light is of the sealed-beam incandescent type.

New developments in searchlights are now being made. At this time the Naval Ship Systems Command is testing new 18 inch and new 12 inch searchlights. These new lights will use xenon lamps, operate on direct current, and be capable of instant restart while hot.

24-INCH CARBON-ARC SEARCHLIGHT

The 24-inch carbon-arc searchlight (fig. 5-1A) is used primarily for signaling, and secondarily for navigational purposes. It consists of a (1) stationary pedestal, (2) turntable with arms, (3) drum with iris and signaling shutters, and (4) carbon-arc lamp. The turntable is supported on the pedestal and can rotate continuously in train; and the drum, which provides a housing for the lamp, is trunnioned on the turntable arms and can be elevated or depressed through angles of 110° and 30°, respectively.

PEDESTAL

The pedestal is secured to the searchlight platform, or base, and provides a mounting for the turntable and main power switch. The turntable shaft is supported on two large ball-bearing assemblies inside the pedestal (not shown) to allow the turntable and arms to rotate continuously in train.

The Main Power Switch is mounted inside the pedestal and is operated by a handle that protrudes from the switch cover. Terminal tubes through the pedestal provide entrances to the searchlight for the d-c supply cable and the remote signaling key circuit (fig. 5-1A).

TURNTABLE AND ARMS

The turntable and arms, which support the drum, provide a mounting for the shutter switch, train clamp, elevation clamp, and elevation stowing lock. Three collector rings mounted on the turntable shaft (not shown) supply power to the lamp and the remote signaling key circuit.

SHUTTER SWITCH.—The shutter switch is an indicating snap-action rotary switch located on the turntable below the (removable) access plate to the terminal board inside the turntable. This switch must be in the ON position to operate the signaling shutter mechanism by means of the local or remote signal key.

TRAIN CLAMP.—The train clamp is mounted on the turntable below the shutter switch (fig. 5-1B). The searchlight can be secured in any position of train by turning the clamp clockwise.

TRAIN STOWING LOCK.—The train stowing lock is located on the turntable opposite the train clamp (fig. 5-1A). It consists of a spring-loaded pin that engages one of four slots located 90° apart in the top of the pedestal. The

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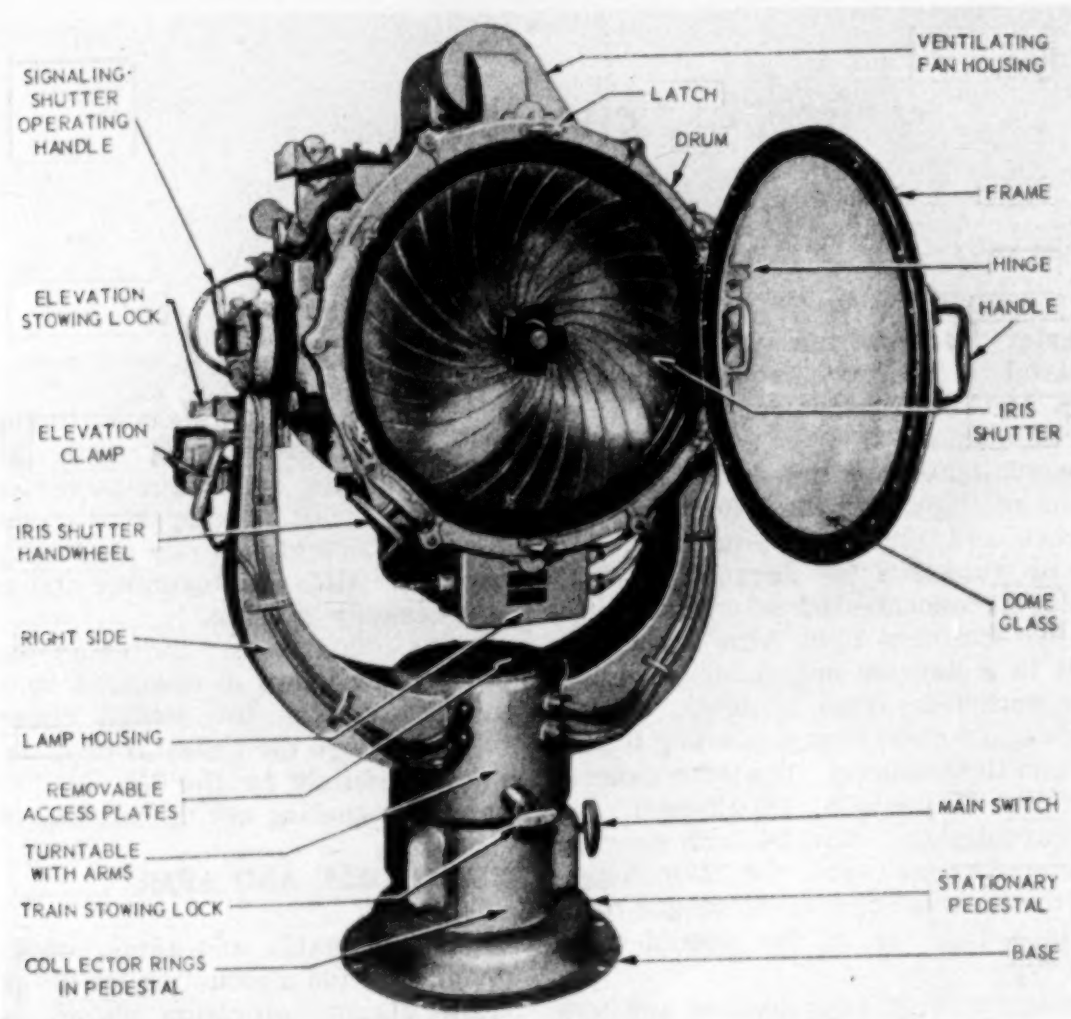

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Figure 5-1A.—24-inch carbon arc searchlight. (Front View.)

searchlight is located by dropping the pin into any one of these slots. To unlock the searchlight, pull out the pin and turn it clockwise.

ELEVATION CLAMP.—The elevation clamp is mounted on the upper part of the right turntable arm (fig. 5-1A). The searchlight can be secured in any position of elevation (between stops) by turning the clamp clockwise.

ELEVATION STOWING LOCK.—The elevation stowing lock is located on the right turntable arm near the elevation clamp (fig. 5-1A). It consists of a spring-loaded pin (similar to the train stowing lock) for locking the searchlight in either the horizontal (normal) or vertical position.

DRUM

The drum, or barrel, is essentially a sheet-steel shell that provides an enclosure for the lamp. It is equipped with trunnions that are supported by bearings mounted on the turntable arms to allow the drum to be elevated or depressed through angles of 110° and 30°, respectively. Handles are provided at the front and rear of the barrel for swinging the searchlight in train and in elevation to direct the beam of light. The barrel includes the (1) lamp housing, (2) front door and dome glass, (3) iris shutter, (4) sector-vane (signaling) shutter, (5) rear door and reflector, and (6) ventilating system.

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LAMP HOUSING.—The lamp housing is a rectangular section welded on the bottom of the barrel to provide an enclosure for the lamp base. The lamp base, or box, is equipped with four mounting lugs that fit on rails to support the lamp box inside the lamp housing.

FRONT DOOR AND DOME GLASS.—The front door is mounted on hinges welded to the left side of the barrel (fig. 5-1A). It can be latched in the fully open position and is secured in the (normally) closed position by means of six latches.

The dome glass is mounted in the front door by means of a retaining ring to close the front end of the drum and protect the light source. The glass is heat resistant; its surface is precision ground to a curve (dome) that results in only a slight increase in beam spread, and a shape that is highly resistant to shock. However, the latest 24-inch searchlights are equipped with a flat, tempered glass that is considerably stronger and less susceptible to breakage from gunfire than is the dome glass.

IRIS SHUTTER.—The iris shutter is mounted as a removable assembly inside the drum directly behind the front door (fig. 5-1A). It is provided to maintain the drum substantially light-tight when it is desired to shut off the beam of light without extinguishing the arc. It can be used also to vary the size of the drum opening and hence the amount of light in the searchlight beam. The iris shutter must not be used as a signaling shutter.

SIGNALING SHUTTER.—The signaling shutter is a radial-vane shutter mounted inside the drum behind the iris shutter (fig. 5-1B). It is spring actuated to close and is manually opened by an operating handle on the forward right-hand side of the drum. It can be automatically opened by local and remote signaling keys in the shutter operating circuit. If the shutter switch is in the ON position, the signaling shutter will open when the key is closed. The shutter can be latched in the OPEN position when the light is used for illumination.

REAR DOOR AND REFLECTOR.—The rear door is hinged to the left side of the barrel (fig. 5-1B). Similar to the front door, it can be either latched in the fully OPEN position or secured in the (normally) CLOSED position by means of six latches.

The reflector is mounted in a recess of the rear door by means of spring clips and stops. It has a parabolic reflecting surface with the concave side turned toward the light source. The light rays that pass from the light source to the reflector surface are reflected back in a beam essentially parallel to the axis of the reflector. The light source must be small and at, or close to, the focal point of the reflector to obtain a sharp beam in which all of the reflected light rays are parallel to each other and to the reflector axis.

The materials used in searchlight reflectors are Stellite, Hastelloy, aluminum with a special Alzac finish, chromium-plated steel, and rhodium-plated copper. Stellite is the most satisfactory reflector material and is used in all 24-inch searchlights. It has a reflectivity of about 65 percent, is relatively unaffected by arc fumes, and is highly resistant to corrosion by salt water.

ARC-IMAGE SCREEN.—The arc-image screen is located on the upper right-hand side toward the rear of the drum (fig. 5-1B). It is a ground-glass screen upon which a lens system projects an image of the arc. A line is inscribed on the screen to indicate the correct position of the end of the positive carbon when it is at the focal point of the reflector.

The arc-image screen is equipped with a hinged cover. A mirror, mounted on the inside of the cover, can be adjusted so that the operator at the rear of the searchlight can observe the arc image in the mirror.

PEEP SIGHT.—The peep sight (not shown) is located below the arc-image screen on the center line of the drum directly opposite the arc. It contains a dense-colored glass light filter through which can be observed the arc and heads.

The peep sight is provided with a cover that is pivoted on the drum. The cover is closed when the peep sight is not in use to protect the glass and to prevent the emission of light.

VENTILATING SYSTEM.—The ventilating system is necessary to remove the gases produced by the arc and to prevent deterioration of the parts exposed to the intense heat of the arc. The lamp must be extinguished if the ventilating system does not operate satisfactorily.

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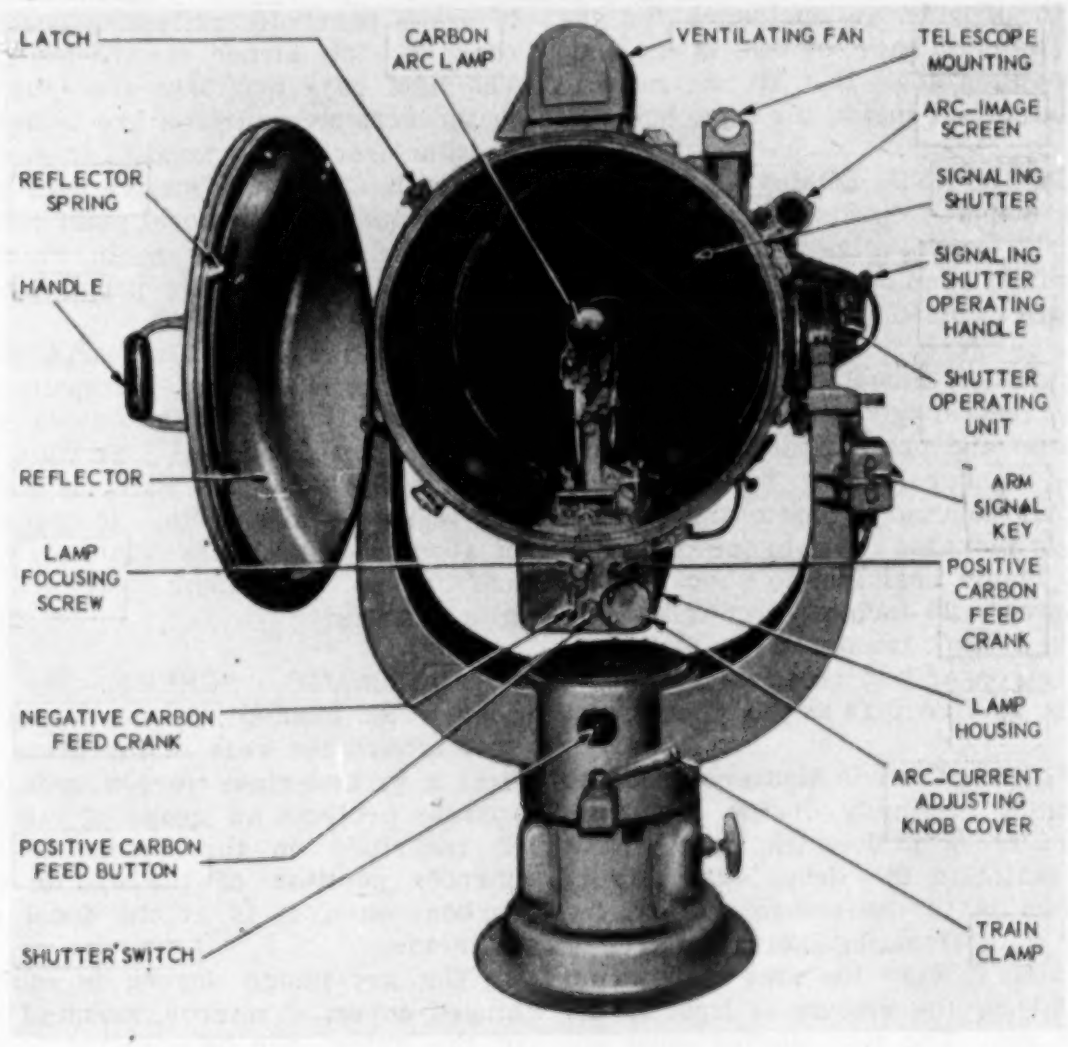

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Figure 5-1B.—24-inch carbon-arc searchlight. (Rear View.)

The ventilating system is mounted on top of the drum and consists of a d-c motor that drives an exhaust fan. The motor is connected across the arc terminal studs and is controlled by the main power switch. It is rated at one-sixth horsepower and operates on 125 volts when the lamp is starting, and it operates on 65 to 70 volts when the lamp is in continuous operation.

The air enters baffled openings in the bottom of the lamp housing and at the sides of the drum. It passes over the inside of the dome glass, the front and rear of the reflector, and directly upward through the center, along the inner surface of the drum, and up through the head-supporting column. The air that is drawn up through the head-supporting column is exhausted through a small vent in the top of the obturator on the positive head. All of the air is drawn through the fan at the top of the drum and is exhausted downward over the outer surface on the left side of the drum.

CARBON-ARC LAMP

The carbon-arc lamp utilizes a high intensity d-c arc between special cored carbon electrodes. It is designed for operation with an arc-ballast resistor (located below deck) supplied from the ship's 120-volt, d-c power. The arc current is adjusted for 75 to 80 amperes with an arc voltage of 65 to 70 volts. The arc-ballast resistor is connected in series with the arc to limit the starting current, stabilize the arc, and absorb the difference between the line voltage and arc voltage.

The function of the lamp mechanism is to hold and control the carbons to produce a source of light (always) at the focus of the reflector. The lamp consists of the positive head, negative head, and lamp operating mechansim (fig. 5-2). The positive and negative heads are secured to the head-supporting column mounted on the lamp base, or box, that contains the mechanism for automatically operating the lamp. The automatic features of rotating and feeding the positive carbon, feeding and retracting of the negative carbon, starting the arc, and providing ventilation are accomplished by the lamp (feed) motor and associated equipment contained in the lamp base.

Carbon Arc

As previously stated, the lamp utilizes a high-intensity, d-c arc between special carbon electrodes. The carbons, consisting of hard-carbon shells with cores of special materials, are mounted in geared heads. The current is conducted to the carbons through spring-backed, metal brush contacts that press against the carbons. The head assemblies are insulated so

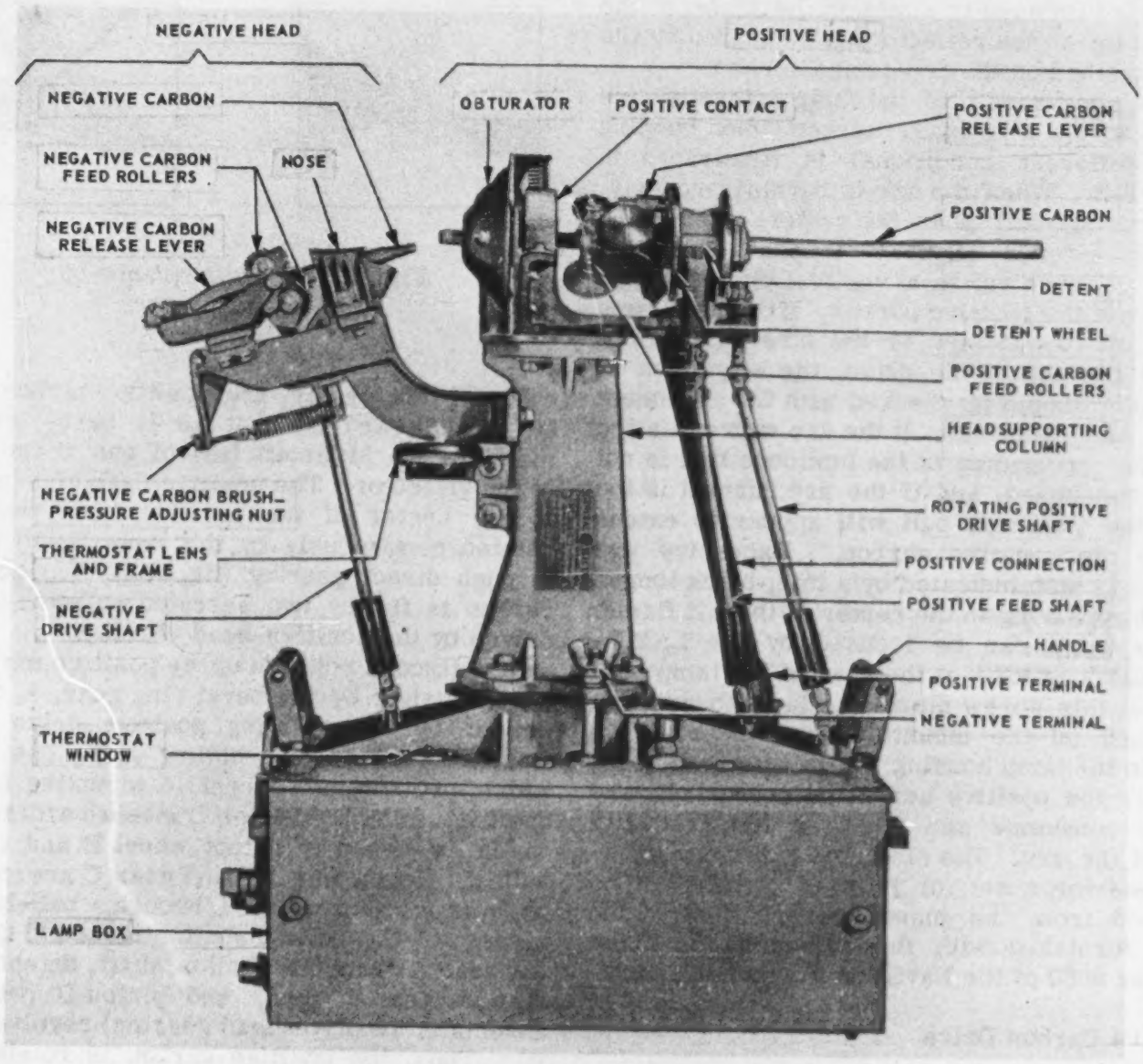

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Figure 5-2.—Carbon-arc lamp.

To apply trapezoidal voltages to the two push-pull amplifiers, a center-tapped resistance network is connected across each of the two secondary windings of the rotary transformer. Network R1 produces two voltages (e_1 and e_2) of equal amplitude and opposite polarity, which are applied to one push-pull amplifier. Likewise, network R2 produces two voltages (e_3 and e_4) of equal amplitude and opposite polarity, which are applied to the other push-pull amplifier. For simplicity, only the waveforms of e_1 and e_3 are shown in figure 17-23.

Trapezoidal voltages e_1 and e_2 produce sawtooth sweep currents i_1 and i_2, respectively. Trapezoidal voltages e_3 and e_4 produce sawtooth sweep currents i_3 and i_4, respectively. The angular position of the radial sweep line at any instant depends on the relative amplitudes and the phase relationship of the sawtooth sweep currents at that instant.

Sawtooth sweep currents i_1 and i_2 are equal in amplitude, but opposite in polarity. Likewise, i_3 and i_4 are equal in amplitude, but opposite in polarity. For simplicity, only the waveforms of i_1 and i_3 are shown in figure 17-23. The relative amplitudes and polarities of i_1 and i_3 (also of i_2 and i_4) vary as the rotary transformer is rotated. This causes the radial sweep line to rotate in synchronism with the radar antenna (which is geared to the rotary transformer).

In general, plan position indicators used in conjunction with rotary transformers also use clamping circuits (clampers). The clamping circuits insure that the scanning spot always starts from the same point on the PPI screen.

Negative gate pulses are applied to the cathode of the PPI CRT to intensify the electron beam during each sweep period. The electron beam is intensified to the point where the radial sweep line is barely visible. When echo signals are applied to the control grid of the CRT during each sweep period, the brightness of portions of the radial sweep line is increased.

SWEEP SYSTEM

The various types of deflection and sweep circuitry required for a simplified radar indicator system are shown in figure 17-24. Also shown are the waveforms for this indicator system when set for a 30-mile range sweep.

Negative trigger pulses from the timer are applied to the sweep multivibrator. When a negative trigger pulse is applied to it, the sweep multivibrator causes a switching action which initiates the sweep voltage in the PPI sweep generator.

When the sweep voltage reaches a predetermined level, the sweep-limiter tube conducts, and causes a second switching action. As a result, the sweep multivibrator produces positive and negative rectangular pulses. The PPI sweep generator, on the other hand, produces a trapezoidal voltage.

The trapezoidal voltage is amplified by the PPI sweep amplifiers, and then applied to the synchro driver (power amplifier). The output of the synchro driver is applied to the rotor of a synchro resolver.

The synchro resolver has two stator windings and one rotor winding. The rotor shaft is mechanically coupled to the radar antenna. When the antenna rotates, the synchro-resolver rotor turns, and trapezoidal-sweep voltages of varying amplitude are induced in the synchro-resolver stator windings. The amplitude of the induced sweep voltages, at any instant, depends on the angular position of the rotor winding with respect to the stator windings of the synchro resolver.

The induced sweep voltages are amplified by the PPI deflection amplifiers, and then applied to the deflection coils of the PPI-scope. As a result, a radial sweep line is produced on the PPI screen. Because of the mechanical coupling between the radar antenna and the synchro-resolver shaft, the radial sweep rotates in synchronism with the antenna.

The negative rectangular pulses from the sweep multivibrator are applied to the clamping tubes and the CRT of the PPI-scope. The clamping tubes insure that the PPI electron beam always starts its sweep trace from the same point on the PPI screen.

The negative rectangular pulses applied to the CRT intensify the scope electron beams during the sweep time. This produces a faintly visible trace on the scope.

Indicator blanking during nonsweep time is accomplished by the use of an intensity gate circuit. This is discussed in chapter 16 of this course.

Radial Sweep Line

The radial sweep line on the screen of a plan position indicator is obtained by sweeping the electron beam from the center to the edge of

that only the brush contacts can conduct current to the carbons.

The positive carbon is aligned with the optical axis of the reflector, and the negative carbon is inclined at an angle of 16° to the positive carbon. In operation, the negative carbon burns away to a taper and is fed forward to maintain substantially constant voltage across, or current through, the arc. On the other hand, the core of the positive carbon vaporizes and forms a hollow crater that contains an intensely luminous ball of gas. The positive carbon is rotated continuously about its axis to prevent unsymmetrical burning away of the carbon around the crater and the consequent spilling out of the luminous ball, which is the major source of light. The positive carbon is also fed forward to maintain the crater at the focal point of the reflector, as indicated by the line inscribed on the arc-image screen.

The appearance of the high-intensity arc viewed in the arc-image screen (when burning under different conditions) is illustrated in figure 5-3. When the arc is burning properly, the luminous ball is in the crater, and a TAIL FLAME extends about 6 inches above the positive-carbon tip in a vertical plane through the axis of the positive carbon. If the tail flame shoots off to one side or the other, instead of toward the top of the drum, the alignment of the heads should be checked with the alignment gages, and corrected. If the arc current is too low, the appearance of the luminous ball is not very pronounced, and if the arc current is too high, the luminous ball will appear to extend toward the negative carbon. Excessive arc current is also indicated by a thin, black tongue of soot appearing in the center of the tail flame.

The lamp can be focused by the LAMP-FOCUSING SCREW at the rear of the lamp box. Turning this screw moves the lamp forward or backward on the mounting lugs that slide on rails in the lamp housing.

Both the positive and negative carbons are slowly consumed and must be fed gradually toward the arc. The electrode sizes and burning time for a set, or trim, of carbons can be obtained from the manufacturers' instruction book, furnished with the equipment, or from Chapter 9660 of the NavShips Technical Manual.

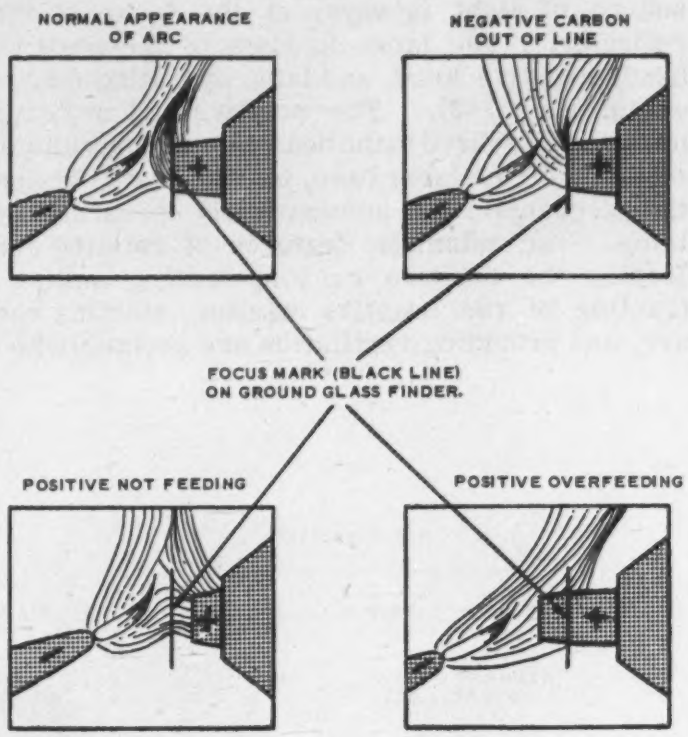

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Figure 5-3.—Appearance of high-intensity arc.

Positive Carbon Drive

In addition to continuously rotating the positive carbon to prevent unsymmetrical burning away of the crater, the positive carbon must be fed forward as fast as it burns away to maintain the luminous ball of gas at the focus of the reflector. The positive carbon is carried in the center of the positive head, which is rotated continuously by the lamp (feed) motor through direct gearing (fig. 5-4). The positive carbon is fed by two serrated rollers that are driven by the positive-head gearing.

Continuous rotation of the positive carbon is accomplished by the bevel ring gear, A, that is driven by the rotating positive drive shaft. Gear A is keyed to a hollow shaft, one end of which provides an eccentric mounting for the shaft of pinion D. Pinion D meshes with gear C, which is keyed to detent wheel B and rotates with it. Detent wheel B and gear C are mounted on, and friction coupled through, a ball-bearing sleeve to the hollow shaft attached to gear A. As gear A turns the hollow shaft, detent wheel B and gear C turn, and pinion D (with the associated positive-head gearing) revolves with it. Thus, the positive carbon is rotated, but does not feed (move along its axis) because pinion D does not turn on its own axis.

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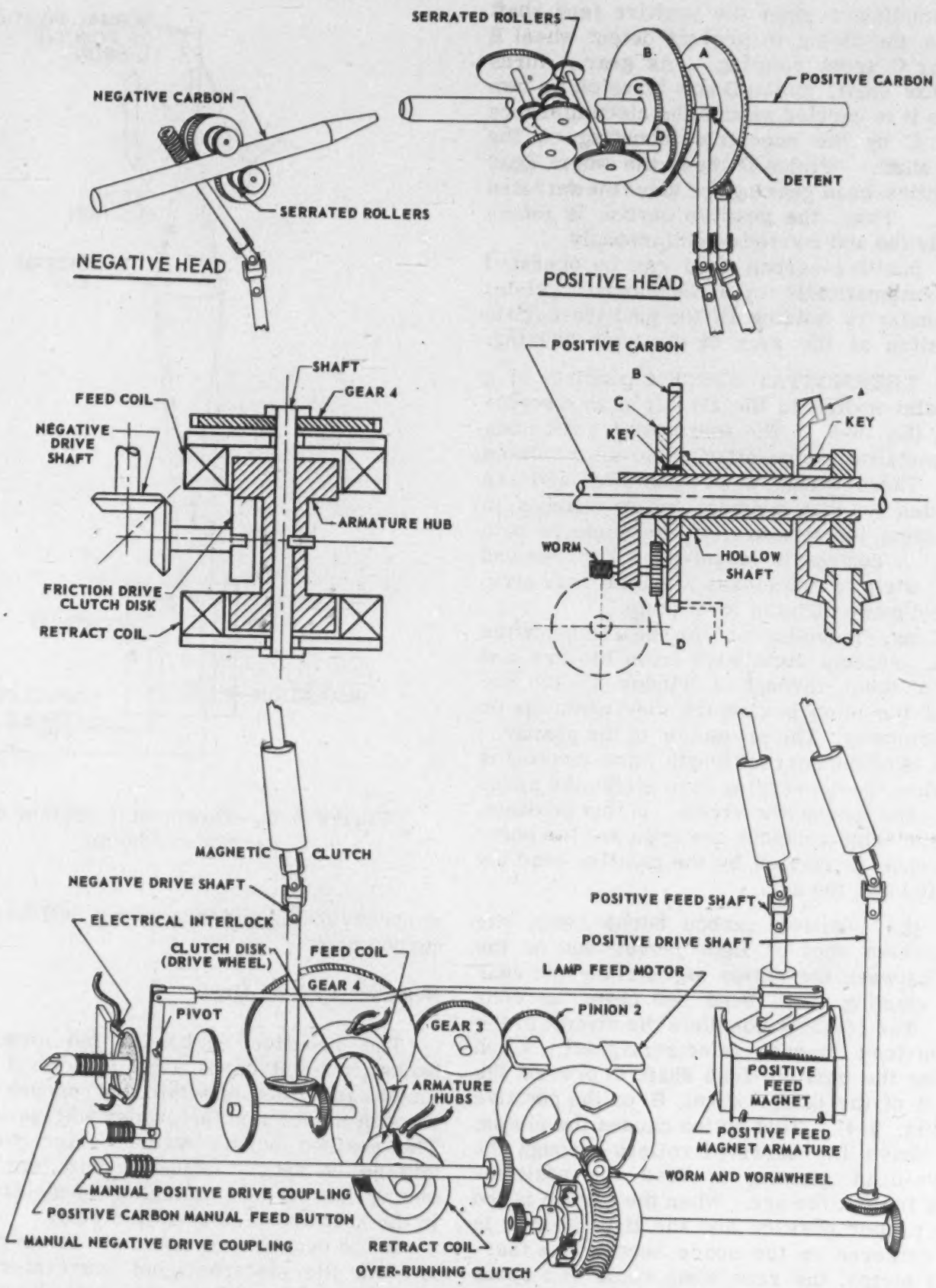

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Figure 5-4.—Schematic diagram of carbon-arc lamp.

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Intermittent feeding of the positive carbon is accomplished when the positive feed shaft operates the detent to prevent detent wheel B and gear C from rotating. As gear A turns the hollow shaft, pinion D now turns on its own shaft as it is carried around the circumference of gear C by the eccentric mounting on the hollow shaft. Pinion D turns the worm gear and positive-head gearing that drive the serrated rollers. Thus, the positive carbon is intermittently fed and rotated simultaneously.

The positive-carbon feed can be operated either automatically by a thermostat system, or manually by holding IN the positive-carbon feed button at the rear of the lamp housing.

The THERMOSTAT SYSTEM consists of a thermostat switch in the circuit of an electromagnet (fig. 5-5). The thermostat switch has two bimetallic strips attached to an insulated block. These strips bend with heat and are assembled so that bending, due to changes in the ambient temperature, is the same in both strips. A contact is mounted on the free end of each strip, which closes when the rear strip is heated more than the front strip.

A lens, mounted on the head-supporting column, collects light rays from the arc and projects them through a window in the top plate of the lamp box where they converge on the thermostat. The projection of the positive-carbon is of the correct length (nine-sixteenths inch) when the converging rays strike the space between the thermostat strips. In this position, the thermostat contacts are open and the positive carbon is rotated by the positive head but is not fed into the arc.

As the positive carbon burns away, the concentrated spot of light moves out of the space between the strips and strikes the rear strip, causing it to bend and close the contacts. The contacts complete the circuit to the positive-feed magnet (electromagnet), which operates the positive-feed shaft to prevent the rotation of the detent wheel, B, on the positive head (fig. 5-4). This action causes the pinion, D, to drive the serrated rollers through the positive-head gearing to feed the positive-carbon toward the arc. When the carbon is fed to the proper position and the light source is again centered on the space between the thermostat strips, the rear strip cools and opens the contacts to deenergize the circuit of the electromagnet and stop the forward feeding of the positive carbon. The positive-carbon feed is nonreversing and thus cannot pull the positive carbon back.

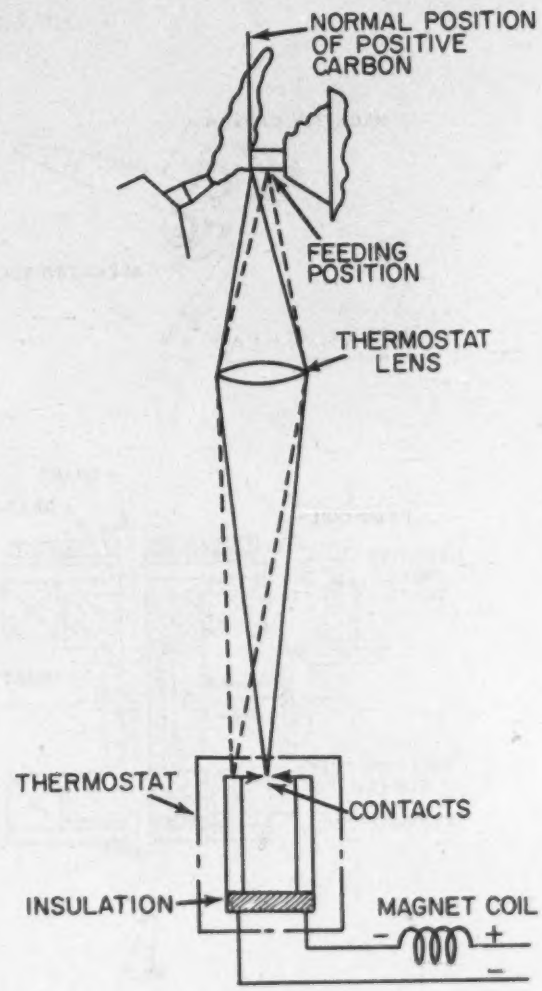

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Figure 5-5.—Thermostat system of carbon-arc lamp.

Negative Carbon Drive

The negative carbon is fed forward and backward as it burns away to control the arc length and thus maintain the proper current through the arc, or the proper voltage across it. The desired normal value of arc current or voltage is set by adjusting the tension of a spring that opposes the pull of an electromagnet in the negative-feed control circuit.

If the negative-carbon drive is current controlled, the electromagnet (current-regulator coil) is connected in series with the arc. The arc current is fixed by the setting of the negative-feed control and is independent of the

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line voltage and the resistance connected in series with the arc, provided they do not vary too widely from their normal values. Conversely, if the negative-carbon drive is voltage controlled, the electromagnetic (voltage-regulator coil) is connected across the arc. The arc voltage depends on the line voltage and the setting of the arc-ballast resistor, which is adjusted to the value that provides the most efficient operation.

Although the principle of operation is similar for both the current and voltage control of the negative-carbon feed, only the current control is explained in this chapter.

The negative carbon is carried in the non-rotating negative head and is fed forward or backward by two serrated rollers that are driven by the lamp (feed) motor through gearing (fig. 5-4). The direction of motion is controlled by a feed coil and a retract coil in the negative-drive mechanism.

The negative-drive mechanism contains a shaft that is geared to the feed motor and rotates continuously (fig. 5-4). The shaft is supported on needle bearings in the frames of the FEED COIL and RETRACT COIL. An armature is pinned to the shaft through a slot and is free to slide a limited distance along the shaft and it rotates with the shaft. The clutch disk is located between two hubs on opposite ends of the armature. When neither coil is energized, the hubs rotate free of the clutch disk.

When the feed coil is energized, the armature is pulled back so that an armature hub bears against the rim of the clutch disk. This action transmits motion (caused by friction between the rim of the clutch disk and the armature hub) to the serrated rollers to drive the negative carbon toward the positive carbon. When the retract coil is energized, the armature is pulled in the opposite direction, causing a reversal of the direction of rotation of the clutch disk. This action reverses the direction of rotation of the serrated rollers to drive the negative carbon away from the positive carbon.

Current Regulator

The series-current-regulator coil provides the automatic control of the negative-carbon feed. It consists of an electromagnet connected in series with the arc (fig. 5-6). The current through the arc is changed by adjusting the tension of the armature spring that opposes the pull of the electromagnet. The spring tension is adjusted by means of the ARC-CURRENT ADJUSTING KNOB at the rear of the lamp housing. Turning the knob clockwise increases the spring tension and the arc current. Conversely, turning the knob counterclockwise decreases the spring tension and the arc current.

The arc current flows through the series coil and as the carbon burns away; the length of the arc is increased, thereby increasing the resistance and decreasing the current flow. This action actuates the armature, which carries the movable contact, A, to complete the circuit to the magnetic clutch that drives the negative carbon.

When the lamp is operating at the proper current, the movable armature contact A, is held midway between contacts 1 and 2 by the balanced pull of the armature spring and the current coil.

When the arc current is low, the pull of the spring is greater than that of the current coil and pulls the movable contact, A, against contact 1. This action places voltage from taps L and M of the resistor across the negative feed coil of the magnetic clutch.

When the arc current is high, the pull of the current coil exceeds that of the spring and pulls the movable contact, A, against contact 2. This action places voltage from taps L and M of the resistor across the retract coil of the magnetic clutch.

When the lamp is started, the negative carbon is in contact with the positive carbon, the starting current is high, and the voltage across the electrodes is low. In this case the pull of the current coil greatly exceeds the pull of the spring, and regulator contact A is pulled against contacts 2 and 3. This action short circuits the 140-ohm resistor, thereby compensating for the reduction in voltage across the carbon electrodes and allowing approximately normal current to flow through the negative retract coil. Retracting the negative carbon forms the arc.

Lamp Circuits

The ship's 120-volt, d-c power is supplied to the searchlight through the searchlight switchboard. The 2-conductor supply cable from the switchboard enters the pedestal through a terminal tube and is connected to a rotary, snap-action, ON-OFF, main-line power switch (fig. 5-7). The 2-conductor, remote-signal

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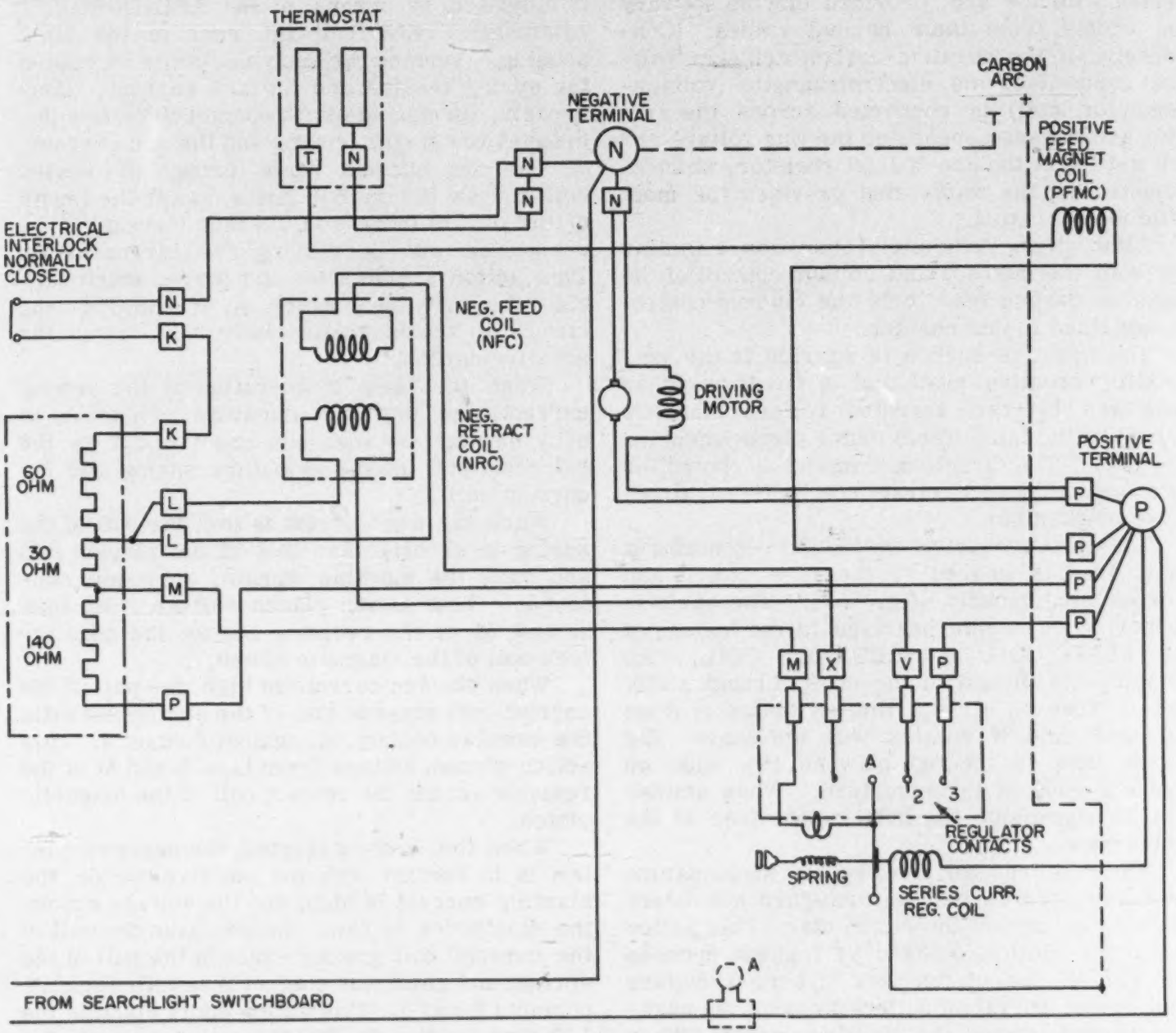

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Figure 5-6.—Schematic wiring diagram of lamp control circuit.

cable also enters the pedestal through a terminal tube. The supply and signal circuits are fed through three collector rings, as indicated in the figure.

The negative and R (remote-signal) terminals on the turntable terminal board are connected to the shutter operating unit through the shutter switch. The signaling keys are connected across the incoming signal circuit and if the shutter switch is in the ON position, the signaling shutter will open when the key is closed.

Shutter Operating Mechanism

The SHUTTER OPERATING MECHANISM consists of a limited-rotation, d-c motor that is connected mechanically through gears to the sector vanes of the shutter. The armature of the shutter motor is supplied with 65 to 70 volts through the signaling keys. The field of the shutter motor is energized when the shutter switch and the power switch are in the ON positions.

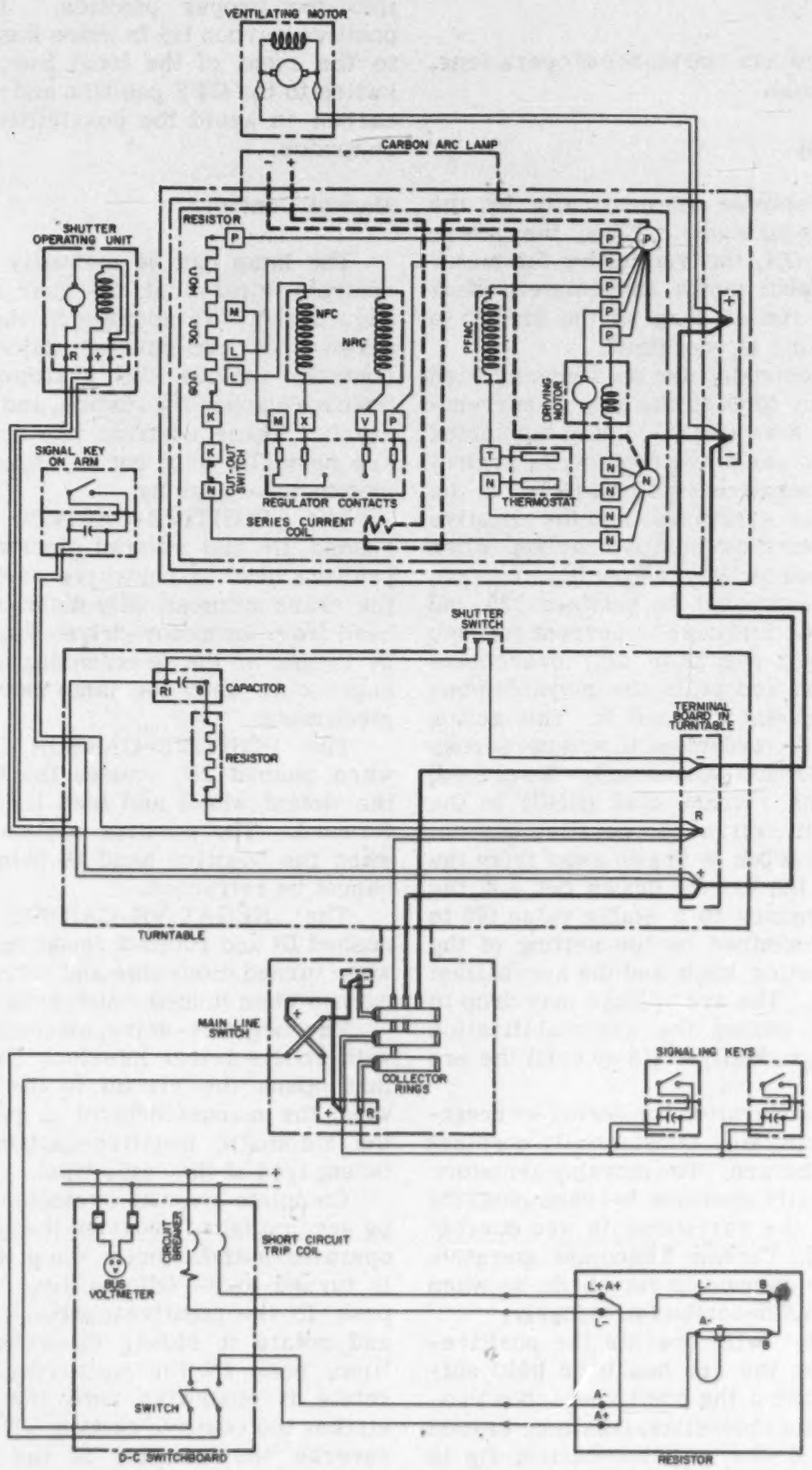

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Figure 5-7.—Wiring diagram of 24-inch carbon-arc searchlight.

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OPERATION

The searchlight has two modes of operations, automatic or manual.

Automatic Control

The arc is started automatically by the negative-feed mechanism. When the power switch is turned ON, the ventilating fan motor and the lamp (feed) motor immediately start and continue to run as long as the circuit to the carbon-arc lamp is energized.

The carbon electrodes are not touching each other; the current through the series-current-regulator coil is zero (fig. 5-6), and the spring holds the movable armature contact, A, against contact 1. The negative feed coil (NFC) in the magnetic clutch is energized, and the negative carbon moves toward the positive carbon. When the negative carbon strikes the positive carbon, the arc current increases to between 125 and 200 amperes. The increase in current through the series-current-regulator coil overcomes the spring tension and pulls the movable contact, A, against contacts 2 and 3. This action compensates for the reduction in voltage across the carbon electrodes (previously described) and energizes the retract coil (NRC) in the magnetic clutch to retract the negative carbon. As the negative carbon is drawn away from the positive carbon, the arc is drawn out and the arc current decreases to a stable value (75 to 80 amperes), determined by the setting of the arc-current adjusting knob and the arc-ballast variable resistor. The arc voltage may drop to 40 or 50 volts during the arc-stabilization period and then gradually build up until the arc is stabilized.

During normal operation the series-current-regulator coil maintains substantially constant current through the arc. The movable armature contact, A, normally operates between contacts 1 and 2 because the variations in arc current are usually small. Contact 3 becomes operative only when the arc current is very high, as when starting the arc, as described previously.

The thermostat will operate the positive-carbon feed when the arc has been held sufficiently long to burn the positive-carbon projection to less than nine-sixteenths inch beyond the obturator. If the positive-carbon tip is slightly ahead or back of the focal line on the arc-image screen after the arc has been established, the automatic feed will quickly bring it into the proper position. However, if the positive-carbon tip is more than one-eighth inch to the right of the focal line, turn the power switch to the OFF position and reset the positive carbon to avoid the possibility of burning the obturator.

Manual Control

The lamp can be manually operated by the controls located at the rear of the lamp box (fig. 5-1B). In addition to the lamp-focusing screw and arc-current adjusting knob, the controls include the positive-carbon crank, positive-carbon feed button, and negative-carbon crank. These controls are spring loaded and are normally held out of engagement with the motor-drive gearing.

The POSITIVE-CARBON CRANK, when pushed IN and rotated clockwise, rotates the positive head and positive carbon. Rotation of the crank automatically disengages the positive head from the motor-driven nonreversible worm by means of the overrunning clutch, which engages only when the lamp motor is driving the mechanism.

The POSITIVE-CARBON FEED BUTTON, when pushed IN, causes the detent to engage the detent wheel and feed the positive carbon forward. The positive carbon can be fed only when the positive head is being rotated, and it cannot be retracted.

The NEGATIVE-CARBON CRANK, when pushed IN and rotated, feeds the negative carbon when turned clockwise and retracts the negative carbon when turned counterclockwise.

The negative-drive mechanism is provided with an electrical interlock (figs. 5-4 and 5-6) that opens the circuit to the magnetic clutch when the manual control is pushed IN so that the automatic negative-carbon control cannot be engaged at the same time.

Complete manual operation of the lamp can be accomplished provided the ventilating system operates satisfactorily when the power switch is turned to the ON position. To start the arc, push IN the positive-carbon crank (fig. 5-1B) and rotate it slowly clockwise; at the same time, push IN the negative-carbon crank and rotate it clockwise until the negative carbon strikes the positive carbon. Then immediately reverse the rotation of the negative-carbon crank to draw out the arc and reduce the current. Excessive current will cause the arc to sputter and give off black soot.

Continuously rotate the positive-carbon crank and note the position of the positive-carbon tip on the arc-image screen. The positive carbon can be fed into the arc by holding IN the positive-carbon feed button as the positive-carbon crank is rotated. Thus, the tip of the positive carbon is maintained at the focal line on the arc-image screen. The positive-carbon crank must be continuously rotated irrespective of the feeding.

To extinguish the arc, turn the power switch to the OFF position.

PREVENTIVE MAINTENANCE

Electrician's Mates must be competent to operate and maintain the several types of searchlights used in the Navy. Repairs and adjustments to searchlights aboard ship are accomplished only by Electrician's Mates who are specifically assigned to such work by the Electrical or Engineer Officer.

Signalmen and other personnel who frequently use searchlights must be carefully instructed on how to operate them. When operating carbon-arc searchlights, personnel must be impressed with the importance of renewing carbons before the positive carbon has burned so short that it cannot be gripped by the feed rollers and fed toward the arc. If the positive carbon is permitted to burn after this condition occurs, the arc burns closer to the positive nose (obturator) and will finally cause it to melt.

Operators must frequently observe the arc of an operating searchlight through the peep sight. They should renew the carbons when the positive carbon is no longer fed forward or when the positive-carbon tip projects less than one-half inch beyond the obturator. An alternate procedure to determine when to recarbon is to look into the drum through the front door, taking care to keep out of the searchlight beam. Replace the carbons when the trailing end of the positive carbon (end not in contact with the arc) disappears into the positive head.

Renewing Carbons

An Electrician's Mate must remove the old carbons and replace them with a new pair. Carbons are always renewed by pairs to ensure optimum performance. Normally, the front and rear doors must be kept tightly closed during the operation of the searchlight. The doors should not be opened for any purpose until the drum is placed in the horizontal position and the searchlight is locked both in train and elevation. Before changing carbons or attempting any work on a searchlight, turn the power switch to the OFF position. Open the rear door until the latch engages. Make sure that the components are cool before touching with the bare hands. Lift the negative-carbon release lever upward and remove the negative carbon by pushing it out through the rear of the negative head. Lift the positive-carbon release lever and remove the stub by pulling it out over the negative head. If the stub is hot, use pliers to remove it.

The positive and negative heads should be reamed before each recarboning to remove the material deposited by the preceding carbons. When using the reamers, the carbon-feed rollers and contacts should be released to prevent the cutting edges of the reamers from damaging these parts. The positive-nose reamer should be inserted from the obturator end, and the negative-head reamer should be inserted from the rear, or release-lever end. Reamers should not be used while the heads are hot unless it is absolutely necessary. However, if it is necessary to ream while the heads are hot, the reamer should be kept turning continuously to prevent its seizure by cooling and contracting of the metal parts.

When the reaming is completed, run the new set of carbons through the heads to be certain that they do not jam. Crooked carbons or those having long cracks, or loose cores should be discarded. Rough spots and blisters can be removed with sandpaper. Adjust the protrusion of the positive carbon from the nose cap, and adjust the arc length in accordance with the values specified for the equipment in the manufacturers' instruction book. The carbons must be centered in their heads and must not touch the nose caps.

After the carbons are renewed, wipe the reflector, front-door glass, thermostat lens, and thermostat window with a clean, dry cheesecloth to remove any carbon deposit. Close the lamp housing, turn the power switch to the ON position and operate the searchlight for about 5 minutes to form the crater in the positive carbon and establish a normal arc. The first 5 minutes is the critical period of operation after a carbon renewal. During this interval, closely observe the arc and all lamp parts for any malfunctioning.

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Cleaning

Each week all of the carbon arc searchlights must be tested by actual operation and the insulation resistance measured. Figure 5-8 shows the front and reverse sides of a maintenance requirement card covering the required minimum weekly maintenance of carbon arc searchlights.

Each month the maintenance listed on figure 5-9 front and reverse are required.

Lubrication

The trunnion and turntable bearings should be greased in accordance with the applicable manufacturers' instruction book as often as an inspection shows this to be necessary.

Lubrication of the lamp mechanism should be limited to the parts specified in the manufacturers' instructions unless they are superseded by Naval Ship Systems Command.

Figure 5-10 lists the required minimum quarterly maintenance to be carried out on each carbon arc searchlight. Remember the MRC contains only the minimum required maintenance. Certain maintenance actions and adjustments are not covered in the MRC's.

Painting

The exterior parts of the drum, trunnion arms, and base of all searchlights must be painted to preserve the metal. Paint must not be applied to bearing surfaces; working members of any part; or to any bolt; locking nut, or part that must be removed for access to the interior. Nameplates, oil cups, and oil holes must be kept free of paint.

The interior surfaces of the drum, including the signaling shutter blades, must be painted a dull black to minimize stray light.

When painting aluminum alloy parts of searchlights, follow the painting instructions issued by the Naval Ship Systems Command.

CORRECTIVE MAINTENANCE

The majority of searchlight repairs are performed by the ship's force. However, reflectors are not repaired aboard ship. If a reflector deteriorates enough to appreciably diminish the candlepower of the light beam, the reflector must be surveyed in accordance with existing instructions and replaced at a naval shipyard.

Removing and Replacing the Reflector

When it is necessary to replace a reflector, engage the train and elevation stowing locks of the searchlight. Remove the rear-door hinge pins and lay the door on blocks with the reflector side up. Remove the eight bolts (fig. 5-1B), each of which is provided with a clip and vertical stop, and lift the reflector from the door.

Install the new reflector in the door and replace the eight bolts. Position the inside edge of the reflector tightly against the vertical stops on the two bottom points of suspension, and tighten the eight bolts. A shim holder is provided on each of the four bottom stops to prevent the reflector from shifting. Replace the hinge pins and close the door. Start the arc lamp and direct the beam perpendicular to a screen or any other suitable plane surface from 10 to 30 feet distant.

Observe the shape of the beam projection on the screen. If the projection is round, the reflector is properly positioned and requires no further adjustment. If it is not round, adjust the point that corresponds with the portion of the beam that is either inside or outside of the projected circle. This adjustment is accomplished by means of a locking screw and a pressure screw located on the outside of the reflector door and opposite the eight securing bolts. These screws are countersunk in the rear door and protected by cover screws.

If a portion of the contour of the beam projection is inside the remainder of the circle, remove the cover screws and loosen the locking screw corresponding to this point and release the pressure screw. Conversely, if a portion of the contour of the beam projection is outside the remainder of the circle, increase the pressure screw corresponding to this point by tightening it. Continue these adjustments until the beam is round, then tighten all eight of the locking screws and replace all of the cover screws.

Adjustments

Proper ALIGNMENT OF THE HEADS is necessary for satisfactory operation of the lamp. The alignment should be checked after the lamp has been removed from, and replaced into, the drum and after the heads have been

SYSTEM	COMPONENT	M.R. NUMBER
Communications and Control	Carbon Arc Searchlight	EL-9 W-1
SUB-SYSTEM	RELATED M.R.	
Navigation Equipment	None	

RATES	M/H
EM3	0.3
EMFN	0.3
TOTAL M/H:	0.6
ELAPSED TIME:	0.3

M.R. DESCRIPTION

1. Test operate carbon arc searchlight.
2. Measure the insulation resistance of the carbon arc searchlight.

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Use asbestos gloves.
3. Do not open drum while arc is struck.

(Cont'd on Page 2)

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Used set of carbons
2. Asbestos gloves
3. Voltage tester
4. Safety tags
5. 500-volt Megger
6. Soft cotton rag

PROCEDURE

Preliminary

a. Obtain permission from OOD to test operate searchlight.
b. De-energize circuit and tag "Out Of Service."
c. Ensure drum is locked in horizontal position and cannot be trained.

1. Test Operate Carbon Arc Searchlight.
   a. Open rear door. Test with voltage tester to ensure circuit is de-energized.
   b. Remove carbons.
   c. Insert set of used carbons; ensure feed rollers grip the carbons firmly. Wipe thermostat lens and arc image screen with soft cotton rag. Close the rear door and remove tag.

WARNING: Do not open drum while arc is struck.

(Cont'd on Page 2)

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Safety Precautions (Cont'd)

4. De-energize circuit and tag "Out Of Service."
5. Ensure drum is locked in horizontal position and cannot be trained.

Procedure (Cont'd)

d. Energize circuit. Observe striking of the arc as viewed at the arc image screen. Maintain constant watch for five minutes to ensure carbons are feeding properly and positive carbon tip remains in focus.
e. De-energize circuit and tag "Out Of Service." Open rear door. Test with a voltage tester to ensure circuit is de-energized.
f. Use asbestos gloves and remove used carbons.
g. Install fresh set of carbons; ensure feed rollers grip the carbons firmly.
h. Shut rear door. Ensure drum is tightly closed.

2. Measure the Insulation Resistance of the Carbon Arc Searchlight.
   a. De-energize searchlight at the switchboard and tag "Out Of Service." Test with voltage tester to ensure circuit is de-energized. Turn lamp switch ON and measure the insulation resistance of entire searchlight circuit at the switchboard.

NOTE: For insulation resistance readings below one megohm take corrective action.

   b. Turn lamp switch OFF.
   c. Remove tags and set up for prescribed operation.
   d. Notify OOD that maintenance on searchlight is completed.

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Figure 5-8.—Weekly MRC front and reverse sides.

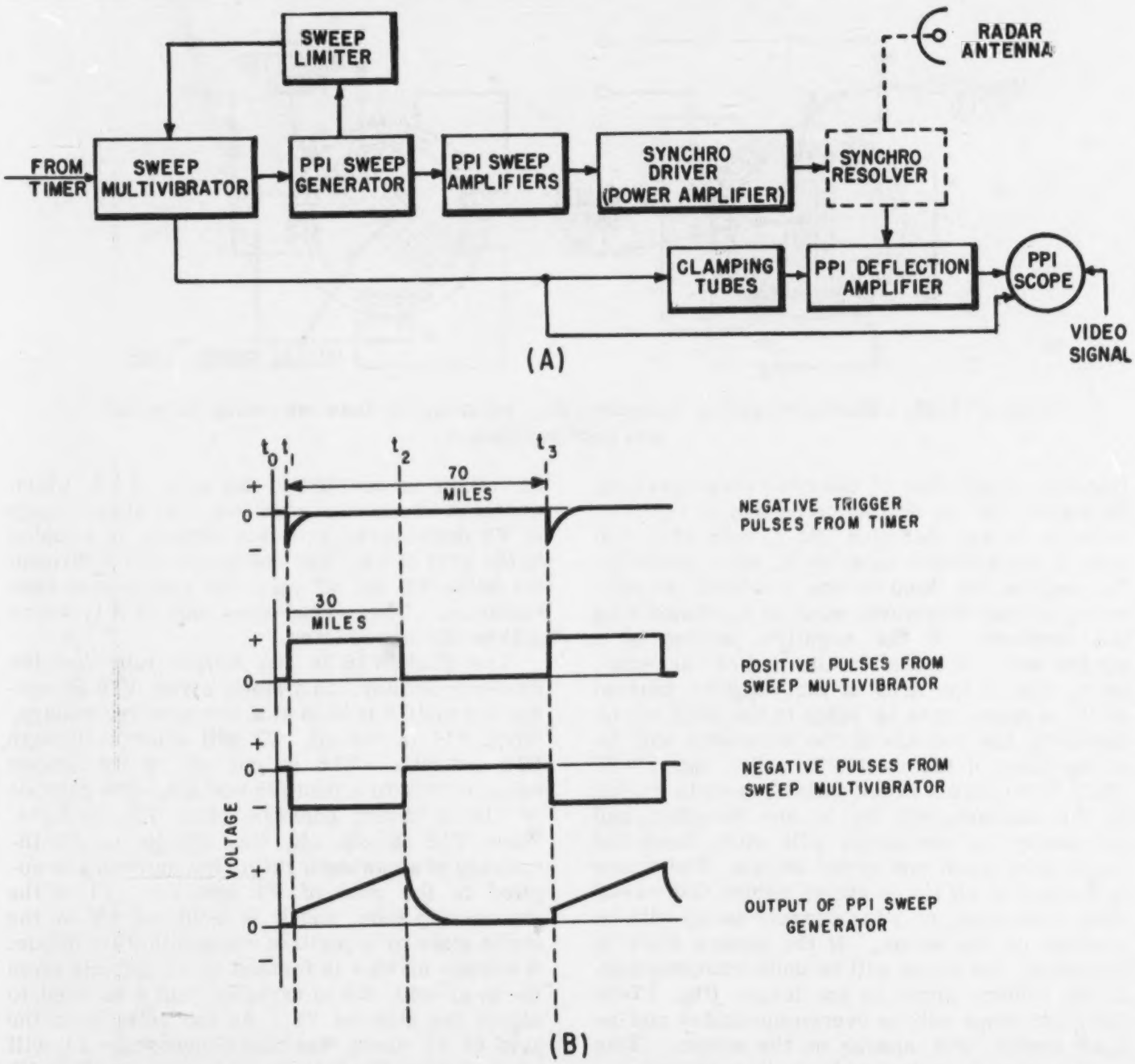

Figure 17-24.—(A) Simplified indicator, block diagram; (B) waveforms for a 30-mile sweep.

the PPI screen. To obtain azimuth (bearing) indication, the radial sweep line is rotated about the center of the screen, like a spoke of a wheel.

When a sawtooth sweep current is applied to the deflection coil, as shown in figure 17-25, a magnetic field is produced. The magnetic field causes the electron beam to be deflected, thereby producing a radial sweep line. The amount of beam deflection and, consequently, the length of the radial sweep line depend on the amplitude of the sawtooth sweep current.

The direction of beam deflection, and consequently, the position of the radial sweep line, is always perpendicular to the magnetic field. This system uses a fixed deflection yoke with horizontal and vertical deflection coils. Sawtooth sweep currents are applied simultaneously to the two deflection coils. The direction of the radial sweep line obtained depends on the

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SYSTEM	COMPONENT	M.R. NUMBER
Communications and Control	Carbon Arc Searchlight	EL-9 M-1

SUB-SYSTEM	RELATED M.R.	RATES	M/H
Navigation Equipment	W-1	EM3	0.8

M.R. DESCRIPTION
1. Clean, inspect, and lubricate feed rollers and brush contact blocks.
2. Lubricate signal shutter, iris shutter, and drum trunnion bearings.

TOTAL M/H: 0.8
ELAPSED TIME: 0.8

SAFETY PRECAUTIONS
1. Observe standard safety precautions.
2. De-energize circuit and tag "Out Of Service."
3. Ensure drum is locked in the horizontal position and cannot be trained.
4. Do not open drum while arc is struck.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT
1. 6" Adjustable wrench
2. 3", 6" Screwdrivers
3. Half-round file
4. Oil, Symbol 2190 TEP
5. Clean, dry rag
6. Voltage tester
7. Safety tags

PROCEDURE

Preliminary

a. Obtain permission from OOD to perform maintenance on the searchlight.
b. De-energize circuit and tag "Out Of Service."
c. Ensure drum is locked in the horizontal position and cannot be trained.

1. Clean, Inspect, and Lubricate Feed Rollers and Brush Contact Blocks.

a. Open rear door. Test with voltage tester to ensure circuit is de-energized.
b. Remove, clean, and inspect the metal contact blocks for the carbons. If blocks are rough, smooth them very carefully with a half-round file, taking care not to damage the contour of the contacts. Reinstall contact blocks. Ensure the contact blocks are free to move in their slides.

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Procedure (Cont'd)

c. Clean and inspect the carbon feed rollers. Ensure the knurled edges are sharp enough to grip the carbons securely and do not slip when the lamp is feeding.
d. Apply two drops of oil to the positive hand feed button, manual positive feed, rotating knob, manual negative feed knob, carbon feed motor bearings, and drive rod bearings in base of lamp. Wipe off excess oil with a rag.
e. Inspect all electrical and mechanical fastenings and tighten loose connections. Use lockwashers or jamnuts where necessary to keep connections tight.

2. Lubricate Signal Shutter, Iris Shutter, and Drum Trunnion Bearings.

a. Lubricate signal shutter, iris shutter, and drum trunnion bearings.
b. Shut rear door and ensure drum is tightly closed.
c. Remove tags and set up for prescribed operation.
d. Notify OOD that maintenance on searchlight is completed.

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Figure 5-9.—Monthly MRC front and reverse sides.

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SYSTEM	COMPONENT	M.R. NUMBER
Communications and Control	Carbon Arc Searchlight	EL-9 Q-1

SUB-SYSTEM	RELATED M.R.	RATES	M/H
Navigation Equipment	W-1, M-1	EM3	1.5

M.R. DESCRIPTION

1. Clean and inspect carbon arc searchlight.

TOTAL M/H: 1.5
ELAPSED TIME: 1.5

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. De-energize circuit and tag "Out Of Service."
3. Ensure drum is locked in the horizontal position and cannot be trained.

(Cont'd on Page 2)

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Dusting brush
2. Clean, soft cotton rags
3. 1 pt Alcohol
4. Graphite
5. Oil, Symbol 2190 TEP
6. Vacuum cleaner
7. 1 pt Diesel oil
8. 6" Screwdriver
9. Voltage tester
10. Safety tags

(Cont'd on Page 2)

PROCEDURE

Preliminary

a. Obtain permission from OOD to perform maintenance on the searchlight.
b. De-energize circuit and tag "Out Of Service."
c. Ensure drum is locked in the horizontal position and cannot be trained.

Clean and Inspect Carbon Arc Searchlight.

a. Train drum and set train brake to allow access to glass door and reflector.
b. Open rear door. Test with voltage tester to ensure circuit is de-energized. Use white line and secure door to handrail to prevent the door from swinging with the ship's movement.
c. Remove carbons and set aside.
d. Ream positive and negative heads to clean out obstructions. When using reamer, release the contacts and feed rollers to prevent contact with reamer.

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Safety Precautions (Cont'd)

4. Do not open drum while arc is struck.

Tools, Parts, Materials, Test Equipment (Cont'd)

11. Set of fresh carbons
12. 3 ozs Precipitated chalk
13. 6" White line
14. Reamer for positive and negative heads

Procedure (Cont'd)

CAUTION: Do not ream heads when hot unless absolutely necessary. In reaming hot heads, continuous turning is required to prevent seizure by cooling and contraction of the metal parts.

e. Remove lamp element.
f. Use the brush attachment and vacuum the interior of drum. Remove the white deposits with the clean soft rag. Wipe the interior of the drum with a clean rag.

NOTE 1: Cleaning agent for stellite reflectors is standard bright work polish; for glass dome, doors, and glass reflectors, the cleaning agent is absorbent cotton soaked in denatured alcohol dipped in precipitated chalk.

CAUTION: Do not attempt to clean glass door or reflectors when they are hot. Allow them to cool until palm of hand can be held on the surface for half a minute.

g. Apply cleaning agent to the reflector from center to rim. Do not use rotary motion. Before cleaning agent has completely dried, rub lightly with cotton cloth. Use radial motion from center to rim.

NOTE 2: When repeated normal cleaning methods do not remove mars or spots, take corrective action.

h. Vacuum the carbon refuse from the thermostat lens and the top of the lamp element. Use the dusting brush to loosen dirt.

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Procedure (Cont'd)

i. Remove the lamp element side plates. Clean the close fitting working parts of the lamp mechanism by wiping and vacuuming carbon dust and fragments. Lubricate with oil and wipe up excess oil.
j. Reinstall side plates.
k. Wash the lamp heads thoroughly with alcohol to remove all hard graphite.
l. Dry and coat the wearing parts of the lamp head with a mixture of flaked graphite thinned with diesel oil.
m. Inspect all electrical and mechanical fastenings and tighten loose connections. Use lockwashers or jamnuts where necessary to keep connections tight.
n. Reinstall lamp element in drum.
o. Install fresh set of carbons:
p. Remove white line steadying door and shut rear door.
q. Open glass dome door and secure door to handrail with the white line.
r. Repeat step g to clean one side of glass at a time.
s. Remove white line steadying door and shut glass dome door. Ensure drum is tightly closed. Release train brake, train drum to the normal position, and set up for normal operation.
t. Remove tags.

WARNING: Do not open drum while arc is struck.

u. Energize circuit, strike arc, and observe for proper focus. Set up for prescribed operation.
v. Notify OOD that maintenance on searchlight is completed.

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Figure 5-10.—Quarterly MRC front and reverse sides.

reassembled. The alignment (fig. 5-11) is checked according to the following procedures:

1. Release the positive-carbon release lever.
2. Insert the positive-head gage with the pin snug against the obturator.
3. Secure the positive-carbon release lever.
4. Rotate the positive-carbon crank (fig. 5-1B) to bring the gage pin to the vertical (judged by the eye) so that the indication "top" appears upright.
5. Release the negative-carbon release lever.
6. Insert the negative-head gage with the point forward.
7. Secure the negative-carbon release lever (as shown in the figure).
8. Rotate the negative-carbon crank (fig. 5-1B) until gages touch.
9. Loosen screws and shift negative head to bring negative-head gage point to alignment with positive-head gage punch mark.
10. Secure screws.

The ALIGNMENT OF THE OBTURATOR is accomplished by loosening the two screws that secure it to the positive head, adjusting it so that the positive carbon is approximately centered in the opening of the obturator, and tightening the screws. The obturator must not touch the positive carbon.

The ADJUSTMENT OF THE ARC CURRENT is accomplished while the lamp is in operation by means of the arc-current adjusting knob (fig. 5-1B) at the rear of the lamp box. The nominal arc current is set from 75 to 80 amperes by adjusting the knob and using a portable ammeter, A (fig. 5-6) in series with

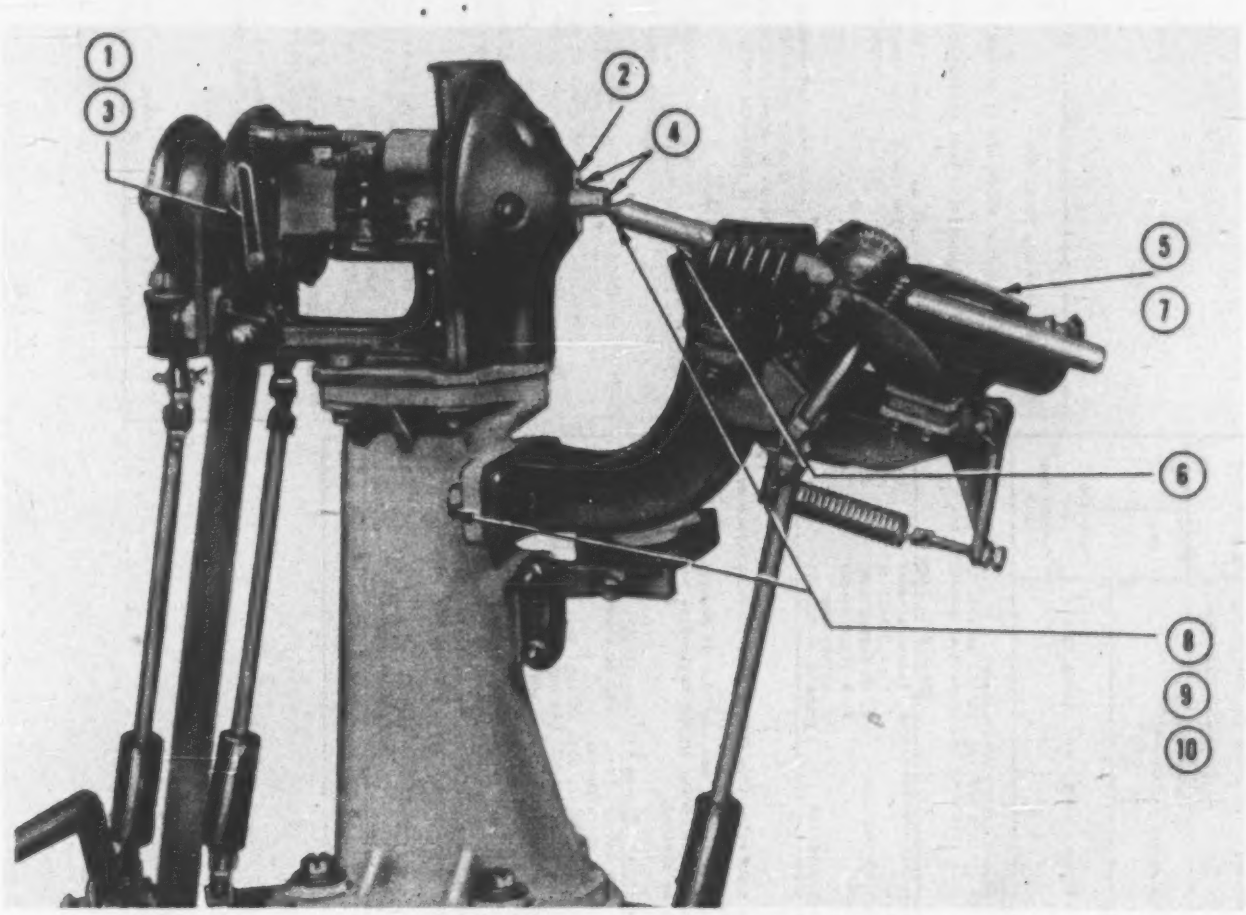

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Figure 5-11.—Alignment of heads.

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either leg of the d-c power supply for checking the current readings.

When the arc-current adjusting knob is changed at the searchlight, the arc-ballast resistor must also be adjusted to hold the arc voltage between 65 and 70 volts. Turning the arc-current adjusting knob varies the spring tension on the armature of the series-current-regulator coil (fig. 5-6). To increase the arc current, turn the arc-current adjusting knob clockwise, and to decrease the arc current, turn the knob counterclockwise.

All arc-voltage measurements referred to are taken at the searchlight. If readings of the arc voltage are taken at a distance from the searchlight, the voltage drop in the cables must be considered to obtain accurate adjustments.

The ADJUSTMENT OF THE NEGATIVE CONTACT PRESSURE is accomplished by setting the spring pressure on the negative-carbon brush contact by means of the spring adjustment nut (fig. 5-2). If the spring adjustment is too tight, the negative carbon will be gripped excessively and may stick during operation of the arc. Conversely, if the pressure is too loose, a good contact surface cannot be maintained between the negative carbon and the brush contact. The adjustment should be set to obtain the maximum negative-carbon, brush-contact pressure possible without causing the negative carbon to stick during operation of the lamp.

When the proper adjustment of the lamp is attained, a pull of approximately 8 to 10 ounces parallel to the axis of the negative carbon is necessary to pull the carbon from the head with the feed rollers completely disengaged from the carbon. The positive carbon requires no adjustment.

The ADJUSTMENT OF THE THERMOSTAT LENS should be checked when the reflector is replaced and at any time the feed mechanism should fail to maintain the tip of the positive carbon at the proper distance beyond the obturator. The holes for the screws that attach the thermostat-lens frame to the head support (fig. 5-2) are slotted so that the lens can be moved toward, or away from, the support column. This adjustment is made at the factory so that the beam of light from the lens is centered in the space between the thermostat strips when the positive carbon projects nine-sixteenths inch beyond the obturator. Moving the thermostat-lens frame toward the support column decreases the positive-carbon projection; whereas, moving the lens frame away from the column increases the positive-carbon projection.

To adjust the position of the thermostat lens, start the arc and open the power switch as soon as the forward feed of the positive carbon stops. Measure the projection of the tip of the positive carbon beyond the obturator. Restart the arc and operate the lamp until the positive-carbon feed engages. Immediately stop the arc and again measure the projection of the tip of the positive carbon beyond the obturator. If the average of the two projections is equal to the value specified for the searchlight, the adjustment of the thermostat lens is correct. If the projection is not correct, move the thermostat lens until the proper value of the carbon projection is obtained.

The ADJUSTMENT OF THE THERMOSTAT CONTACTS, which are enclosed in the lamp box, is not normally required. The clearance between the contacts should be from one-sixty fourth to one-thirty second inch (fig. 5-5). Definitely ascertain that the openings between the contacts are incorrect before making any adjustments. The proper spacing can be accomplished by bending one of the strips.

The ADJUSTMENT OF THE SERIES CURRENT REGULATOR ARMATURE is accomplished by adjusting the armature contacts so that the clearances between contacts A and 1, and A and 2, are approximately 0.006 inch (fig. 5-6). The clearance between contacts 2 and 3 should be approximately 0.008 inch.

The arc-image screen focal line can be adjusted to divide evenly the position of the positive carbon tip by means of four screws that secure the arc-image screen assembly to the drum.

The ADJUSTMENT OF THE ARC IMAGE SCREEN is correct when the focal line is at the mean of travel of the positive-carbon tip with the positive-carbon projection adjusted to nine-sixteenths inch beyond the obturator and with the lamp focused properly, as subsequently described. During the normal cycle of positive-carbon feeding and burning off, the positive-carbon tip will move along the positive-carbon axis. This movement, when reviewed on the arc-image screen, should not extend more than 0.05 inch either way from the focal line.

The FOCAL POINT OF THE REFLECTOR is the point at which the light source must be located to obtain a concentrated beam of parallel light rays. In a carbon-arc searchlight, proper focus of the arc occurs when the image

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of the tip of the positive carbon appears on the focal line of the arc-image screen. The lamp is adjusted to this position by the lamp-focusing screw (fig. 5-1B) at the rear of the lamp box. This focusing screw is threaded into the lamp housing of the drum and connected to the lamp by a focusing latch attached to the lamp base. Removing the focusing latch from the guides frees the lamp from the focusing screw. The lamp-focusing screw has a lock collar that must be backed off when turning the screw, and set up when the proper position of the lamp has been obtained. Turning this screw clockwise moves the lamp away from the reflector, and turning it counterclockwise moves the lamp toward the reflector. If the tip of the positive carbon does not fluctuate about the focal line on the arc-image screen, focus the lamp by turning the lamp-focusing screw until this condition is obtained.

The focal adjustment can be checked by observing the beam at night. If the lamp is focused properly the beam will appear to consist of parallel rays. If the lamp is too near the reflector the beam will spread, and if the lamp is too far from the reflector the beam will converge into an hour-glass shape. The appearance of the beam should be judged from a distance.

TROUBLES.—The conditions that result in operating difficulties of carbon-arc searchlights are considered to facilitate their detection and correction.

If the ARC CURRENT IS HIGH OR LOW and the arc voltage is normal, set the supply voltage to the proper value and adjust the arc-current adjusting knob to obtain the proper current. This adjustment of the arc current changes the arc voltage, thus it is necessary to reset the arc-ballast resistor to obtain the proper voltage (previously described).

If the ARC VOLTAGE IS HIGH OR LOW and the arc current is normal, set the supply voltage to the proper value and reset the arc-ballast resistor to obtain the proper voltage.

The ARC-BALLAST RESISTOR is provided with a clamp-type adjustable connection to permit variation of the amount of resistance in the circuit (fig. 5-7). Proper adjustment of the arc-ballast resistor is necessary for satisfactory operation of the carbon-arc lamp. The adjustable connection on the resistor permits adjustment of the arc voltage of the searchlight. When the arc-ballast resistor adjustable connection is changed, the effect of the change on the arc must be noted immediately.

The arc-ballast resistor must be used only to compensate for permanent changes in the ship's 120-volt, d-c power to the searchlight. It must not be used for making adjustments for transient conditions in the supply voltage.

If the POSITIVE HEAD FAILS TO ROTATE, push IN the manual positive drive coupling, and turn it clockwise (fig. 5-1B). If the coupling cannot be turned and the head does not rotate, inspect the positive-head gearing for mechanical interference of foreign material in the gears. If the head still does not rotate, remove the lamp from the drum and apply 65-volt test leads to the lamp terminals (without the carbons). Determine that the lamp motor drives the worm gear, and also determine that the motor will operate with no load.

If the POSITIVE CARBON DOES NOT FEED, hold IN the positive-carbon, manual feed button (fig. 5-1B). If the carbon feeds with the button held IN, determine that the positive-feed shaft and its detent are free to operate and are free from mechanical interference with the positive terminal. Observe through the front door to determine that the thermostat lens focuses the arc on the center of the glass thermostat window on top of the lamp box when the positive-carbon tip is on the focal line of the arc-image screen. If the arc is not focused on the center of the thermostat window, turn the power switch to the OFF position, lock the drum in elevation, open the rear door, and adjust the position of the thermostat lens. Be certain that the thermostat window is clean.

If the arc is focused on the center of the thermostat window and the carbon still does not feed, remove the lamp from the drum and determine that the armature of the positive-carbon feed magnet is mechanically free, the thermostat contacts have the proper clearance, and the contact surfaces are clean. Apply 65-volt test leads to the lamp terminals without the carbons, and short circuit the thermostat by connecting a lead across the thermostat terminals. Determine that the positive-carbon feed magnet operates. If it does not operate, the magnet is probably open circuited and should be replaced.

If the positive carbon does not feed when the feed button is held IN, observe through the front-door dome glass and determine if the rotation of the positive-head detent wheel has been arrested by the positive carbon feed shaft.

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If the detent wheel is not turning, determine that the feed rollers are gripping the positive carbon. If the rollers are digging into the carbon, ream out the positive head. Inspect the rollers and replace them if the teeth appear to be worn. Determine that the positive-carbon brush contact is free to move up and down in its slide.

If the POSITIVE CARBON FEEDS CONTINUOUSLY, determine that the armature of the positive-carbon feed magnet is mechanically free; that the thermostat contacts have the proper clearance and the contact surfaces are clean; and that the positive-carbon brush contact has freedom of movement.

If the POSITIVE CARBON TIP IS HELD AT A POINT AWAY FROM THE FOCAL LINE on the arc-image screen, determine that the positive-carbon projection is correct. The correct positive-carbon projection is obtained by adjusting properly the position of the thermostat lens and the focus of the lamp.

If the MOVEMENT OF THE POSITIVE-CARBON TIP ON THE ARC IMAGE SCREEN IS GREATER THAN ONE-SIXTEENTH INCH FROM EITHER SIDE OF THE FOCAL LINE, remove the lamp from the drum and inspect the thermostat contacts for the proper clearance.

If the NEGATIVE CARBON DOES NOT FEED AT THE START, determine that the negative carbon release lever is in the secured position and then determine if the negative-carbon drive shaft turns. If the shaft turns determine that the rollers are gripping the negative carbon. If the rollers are digging into the carbon, ream out the negative head and decrease the pressure on the negative-carbon brush contact by means of the negative-carbon, brush-pressure adjusting nut (fig. 5-2). Inspect the drive rollers and replace them if the teeth appear to be worn.

Inspect the negative-carbon brush contact for freedom of movement. If the shaft is not turning, remove the lamp from the drum and check the series-current-regulator contacts. Check the resistance of the feed and retract coils of the magnetic clutch. The resistance of these coils should be 57 ohms with an allowable variation of ±4 ohms. Check the electrical interlock (cutout switch) on the negative manual feed and determine that it is closed.

If the NEGATIVE CARBON FEEDS SLUGGISHLY, examine the serrated rollers and determine that they grip the carbon firmly. Remove the carbon and examine the contacts and hose, and ream out any obstructions. Replace the negative carbon if it is damp because a damp carbon will cause sluggish feeding.

If the NEGATIVE CARBON DOES NOT RETRACT AFTER STRIKING THE POSITIVE CARBON, turn the power switch to the OFF position and check the circuit breaker on the searchlight switchboard (fig. 5-7) to determine if it has opened, and set the trip mechanism to a higher value (not exceeding 300 amperes). Reclose the circuit breaker and check the alignment of the heads. Ream the negative head and check the negative-drive mechanism to determine that it is free from mechanical binding.

Remove the lamp from the drum and check the spacing of the series-current-regulator contacts. Check the resistance of the feed and retract coils in the magnetic clutch and replace them if they are open circuited, or if their resistance is not within ±4 ohms of 57 ohms each. Check the resistor that feeds the magnetic clutch coils (fig. 5-6) to determine that proper contact is made and that the resistor is not open circuited. Renew the carbons and set the arc-current adjusting knob, replace the lamp in the drum, and recheck the current setting.

If the ARC BREAKS REPEATEDLY, check the arc voltage and current at the time the arc breaks. The current is usually low when the arc breaks repeatedly, and the arc-current adjusting knob should be turned clockwise until rated current flows. Adjust the arc-ballast resistor to maintain 65 to 70 volts while adjusting the arc current.

If the arc continues to break, remove the lamp from the drum and check the alignment of the heads. Ream the negative head if any obstructions are present. Check the resistances of the feed and retract coils of the magnetic clutch.

If the ARC CURRENT VARIES MORE THAN 5 AMPERES when the lamp is in normal operation, check the contacts on the series-current regulator coil. Adjust the contacts for proper clearances and determine that the contacts are clean. Check the supply voltage and install new carbons if they have become damp.

The length of the arc can be used as a rough check on the current flow. Measure the arc along a straight line from the center of the carbon tips. This is a rough check and no adjustment should be made unless the arc length is off one-eighth inch or more. The arc length can be increased by changing the tap connections

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to the arc-ballast resistor to decrease the resistance in the circuit.

If the arc length is one-eighth inch or more off when measured between the center of the carbon tips, the arc length can be decreased by changing the connection to the arc-ballast resistor to increase the resistance of the circuit.

SAFETY PRECAUTIONS

The general instructions and operating precautions must be adhered to by Electrician's Mates, Signalmen, and other personnel when operating or maintaining searchlights.

The assigned Electrician's Mate or lamp operator must be certain that the carbons are properly placed, are firmly gripped by the feed rollers, and make good electrical contact with the current contacts before starting the lamp mechanism of a carbon-arc searchlight. Do not operate the lamp if the ventilating system does not function properly. Do not turn the power switch to the ON position when the carbons are touching, except in the older searchlights that are provided with a hinged negative head for striking the arc.

Frequently observe, on the arc-image screen of an operating lamp, to determine that the positive carbon is properly focused to avoid damage to either head (caused by failure of the carbons to feed properly). A continual or frequent adjustment of the arc focus by means of the lamp-focusing screw indicates a failure of the positive-carbon feed to function properly or other maladjustment that must be corrected.

Turn off the arc and recarbon when the feed rollers fail to engage, and feeding has stopped, or when the positive carbon projects less than one-half inch beyond its nose. Never look directly at the arc. Always view it through the peep sight or arc-image screen.

Under normal conditions the drum must be kept tightly closed during operation of the arc.

Lock the searchlight securely in train and elevation and be certain that the drum is in the horizontal position before opening the front or rear door of a 24-inch, carbon-arc searchlight.

Be certain that the power supply to the shutter motor is deenergized before opening the front door or performing any work inside the drum of a searchlight provided with an electrically operated shutter.

Before attempting to train or elevate a searchlight, be certain that the stowing brakes and locks are disengaged and that the searchlight is free to move.

Be certain that the power switch is in the OFF position before changing carbons. Always use asbestos gloves to remove hot carbon stubs. Recarbon with a pair of carbons and do not use broken or bent carbons. Be certain that the positive carbon does not touch its nose cap and keep the nose cap free from dirt and deposits of carbon dust. Keep the thermostat lens and window clean.

Do not operate the signaling key on the 24-inch searchlight when the signaling shutter is latched open and do not keep a signaling shutter open by holding down on the signaling key.

Keep all electrical contact surfaces clean and free from oil, grease, dust, and moisture. Do not use oil or grease on the positive or negative heads.

When reaming the heads, release the contacts and feed rollers, and do not allow these parts to come in contact with the reamer.

The carbons must be kept sealed in their containers until required. They must be kept dry and protected from any jarring that can cause them to crack or to loosen the cores.

Searchlights that are not in use must be locked in their securing positions by means of the brakes and stowing locks. All openings into the drum must be kept tightly closed unless otherwise ordered.

In case of threatening or inclement weather at sea, canvas covers must be applied and lashed down on all searchlights, except for those designated as ready lights. During heavy weather at sea, searchlights must be secured with the front-door glasses turned inboard.

12-INCH INCANDESCENT SEARCHLIGHT

The 12-inch incandescent searchlight is used primarily for signaling and secondarily for illumination.

CONSTRUCTION

The searchlight (fig. 5-12) comprises the (1) mounting bracket, (2) yoke, (3) drum, and (4) lamp (not shown). The MOUNTING BRACKET permits the searchlight to be secured to a vertical pipe or to a flat vertical surface. The YOKE is swivel mounted on the bracket to allow the searchlight to be rotated continuously

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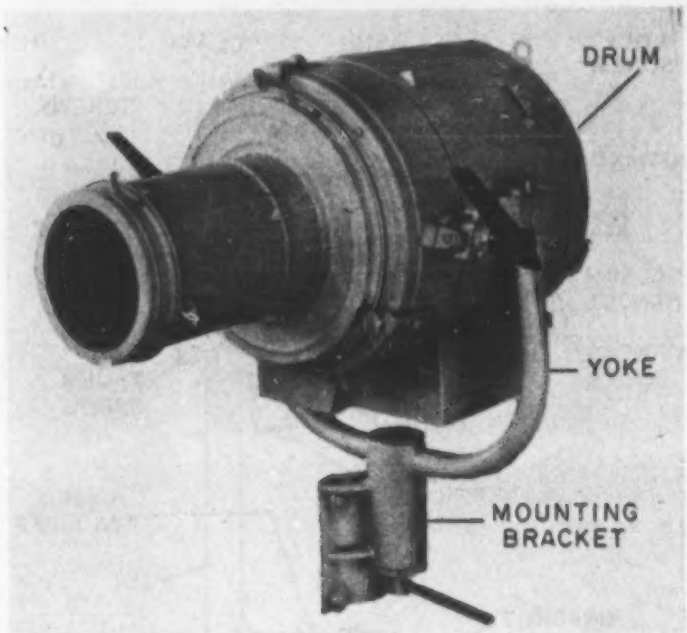

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Figure 5-12.—12-inch incandescent searchlight.

in train. The steel DRUM provides housing for the lamp and is trunnion mounted on the yoke to allow it to be elevated and depressed. Clamps are provided for locking the searchlight in any position of train and elevation.

The SIGNALING SHUTTER is a venetian-blind shutter mounted inside the drum behind the front door. It is held in the CLOSED position by two springs and is manually opened by a lever on either side of the drum. The parabolic metal reflector is mounted on the inside of the rear door.

The LAMP is usually a 1000-watt, 117-volt incandescent lamp having special concentrated filaments that reduce the area of the light beam. The lamp is mounted in a mogul bipost socket. The socket is located in front of the reflector and can be adjusted only slightly. The replacement of the lamp is accomplished through the rear door of the searchlight.

The light source must be at the focus of the reflector for minimum beam spread and maximum intensity. Some types of 12-inch incandescent searchlights are provided with focusing adjustment screws. Other types can be adjusted by loosening the screws that hold the lamp-socket support plate in position. Move the entire socket assembly toward or away from the reflector until the beam has a minimum diameter at a distance of 100 feet or more from the light, and retighten the screws. When checking the diameter of the beam, the rear door must be tightly clamped shut.

A screen hood is provided for attachment to the front door to limit the candle power of the beam, to cut down its range, and to reduce stray light, which causes secondary illumination around the main beam. The hood also provides for the use of colored filters.

TWELVE-INCH SHORT-ARC, MERCURY-XENON SEARCHLIGHT

The Naval Ship Systems Command has developed a mercury-xenon arc lamp that can be installed in the standard Navy 12-inch incandescent signaling searchlights (fig. 5-13). The mercury-xenon arc lamp, when used in these searchlights, produces a maximum beam intensity about 10 times as great as that attained by the incandescent lamp.

The lamp is a 1000-watt short-arc, mercury-xenon lamp requiring 45 amperes to start and 18 amperes to operate. It is supplied from the

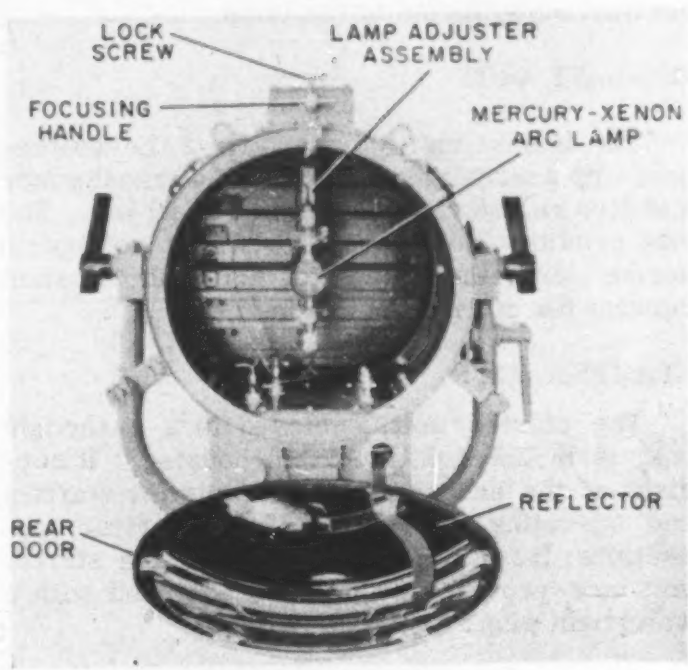

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Figure 5-13.—12-inch mercury-xenon searchlight, (rear view showing lamp).

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ship's 117-volt, 60-cycle, single-phase power. The lamp consists of two tungsten electrodes spaced about one-quarter inch apart inside a 2-inch diameter quartz bulb. The bulb contains a small quantity of liquid mercury and xenon gas at a pressure of 3 to 5 atmospheres when the lamp is cold (an atmosphere at sea level is equivalent to 14.7 psi). After the arc is started and the lamp attains a stable operating temperature, the internal pressure increases to about 20 atmospheres. The lamp does not produce full-light output until this pressure is reached and all of the mercury has been vaporized. The lamp differs from the incandescent lamp in that it requires a high voltage, r-f current for starting and a ballast for operating it at rated output.

Remember this lamp housing should never be opened while operating or energized. The high voltage (40,000 to 60,000 volts) present plus the danger of the lamp exploding requires the observance of precautions at all times.

LAMP ADJUSTER ASSEMBLY

The lamp adjuster is secured to the top of the searchlight drum and extends inside the drum to provide a mounting for the mercury-arc lamp (fig. 5-14). The assembly affords longitudinal traverse (toward or away from the reflector), horizontal (from side to side), and vertical adjustments of the lamp.

BALLAST UNIT

The ballast unit, located out of the weather near the searchlight, consists of a transformer and five resistors enclosed in a steel box. The unit provides the necessary ballast voltage in series with the lamp to maintain constant current for normal operation.

STARTER UNIT

The starter unit, enclosed in a watertight box, is mounted in the lamp housing. It consists of the necessary components for starting and operating the lamp. The electrical connections from the ballast unit to the starter unit are provided by a cable equipped with a watertight plug.

OPERATION

The electrical circuit of the 12-inch mercury-xenon arc searchlight comprises the (1) starting circuit and (2) operating circuit. The ship's single-phase, 115-volt, 60-cycle power is supplied to the ballast unit through a disconnect switch located adjacent to the searchlight (fig. 5-15).

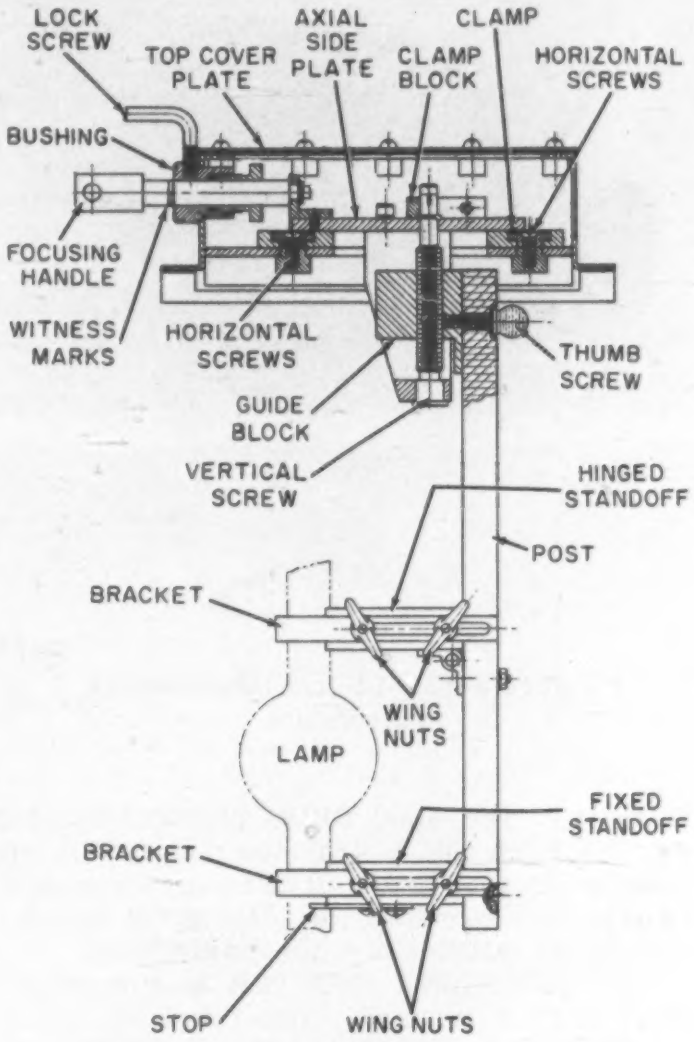

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Figure 5-14.—12-inch mercury-xenon lamp adjuster assembly.

Starting Circuit

When the lamp is extinguished, whether hot or cold, the internal resistance between electrodes is so high that the arc will not restart by applying normal line voltage. Hence, a special high-voltage r-f circuit is incorporated to provide instant starting, irrespective of whether the lamp is cold or hot. However, the lamp is harder to start while it is hot and at

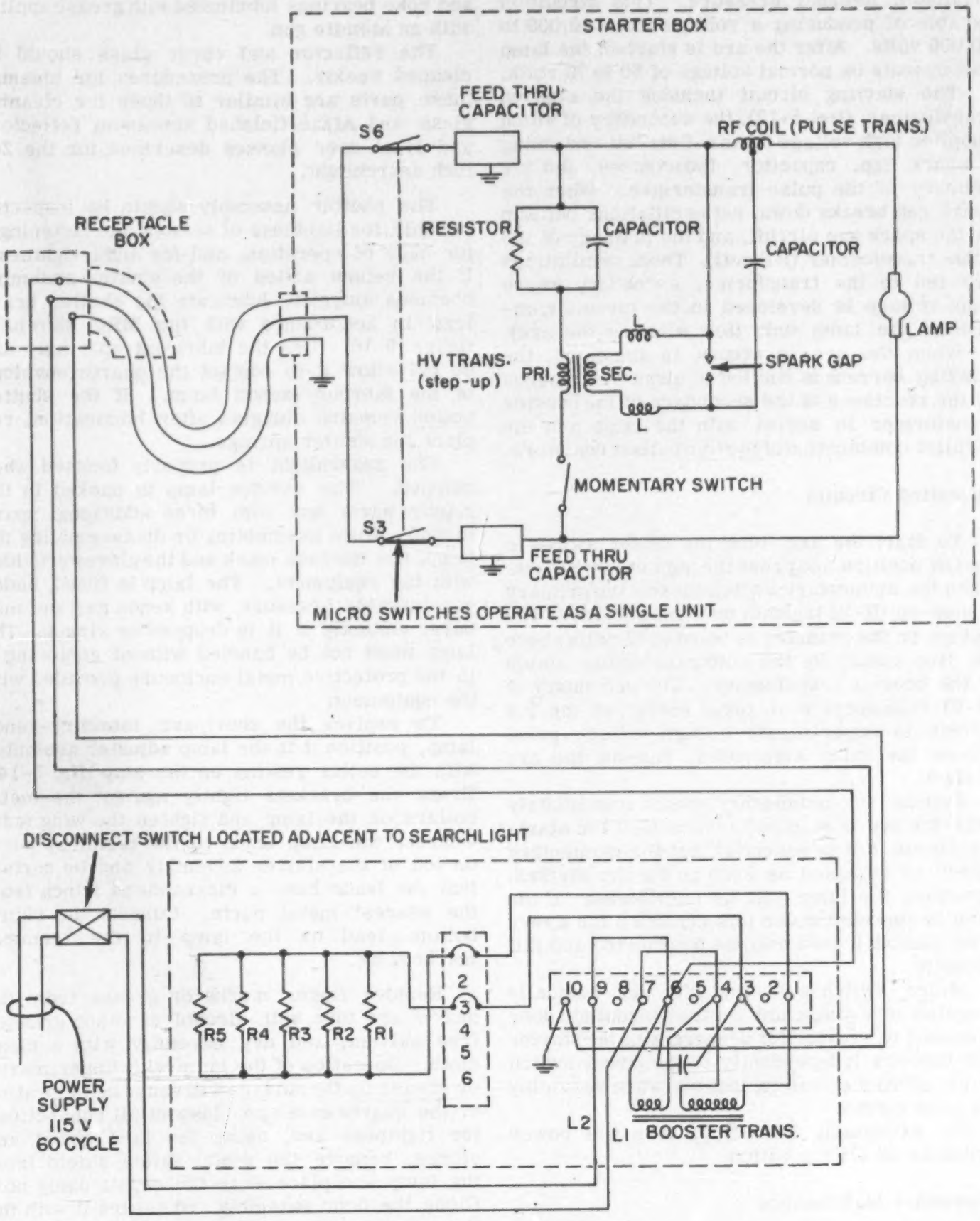

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Figure 5-15.—Wiring diagram of 12-inch mercury-xenon searchlight.

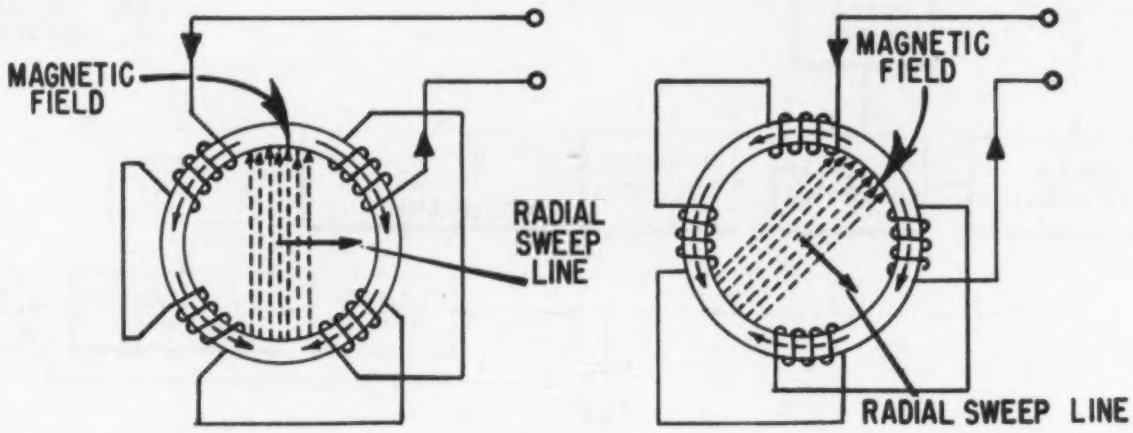

Figure 17-25.—Electromagnetic aximuth yoke, relationship between sweep direction and yoke position.

relative amplitudes of the two sweep currents. To insure that the deflection caused by the sawtooth is in one direction (fig. 17-26 (A)), the base of the sawtooth must be at zero potential. To position the base of the sawtooth at zero volts, another waveform must be combined with the sawtooth. If the negative portion of a square wave is added to the end of the sawtooth, and if the area of the negative portion of the square wave is equal to the area of the sawtooth, the average of the waveform will be at the base of the sawtooth. (See fig. 17-26 (B).) The current in the deflection coils caused by the sawtooth will be in one direction and the sweep on the scope will start from the same point each and every sweep. The scope is blanked at all times except during the sweep time; therefore, only the correct sweep will be present on the scope. If the square wave is too small, the scope will be undercompensated. If the square wave is too large, (fig. 17-26 (BC), the scope will be overcompensated and an open center will appear on the scope. This open center is undesirable in this circuit.

Circuit Theory

For the following discussion, refer to figure 17-27. The tubes V2 and V3, with associated parts, constitute a multivibrator. In the static state, V2 is conducting and V3 is cut off. An input trigger is applied to the grid of V2; since V2 is conducting in the static state, the trigger must be negative. When the conduction of V2 decreases, the plate voltage rises. This increase in voltage is coupled to the grid of V3, which is driven into hard conduction. The plate voltage of V3 decreases, and this change is coupled to the grid of V2. The discharge of C2 through R5 holds V2 cut off until the sweep-stop tube conducts. The sweep-stop tube is V1, which will be discussed later.

The diode V16 is the switch tube for the sweep generator. In a static state, V16 is conducting and C3 is held at a low-positive voltage. When V16 is cut off, C3 will charge through R12 and R10. V16 is cut off by its cathode being driven to a positive voltage. The cathode of V16 is driven positive when V3 conducts. When V16 is cut off, the charge on C3 increases at a sawtooth rate. The sawtooth is applied to the grid of V1 and V5. V1 is the sweep-stop tube, and it is held cut off in the static state by a positive voltage on its cathode. A voltage divider is formed by R1 and R2 from B+ to ground. R2 is variable, and it is used to adjust the bias on V1. As the voltage on the grid of V1 rises, the bias decreases; V1 will conduct when the bias is overcome. When V1 conducts, a drop in voltage is seen at the right end of R9 and the grid of V3. The decrease in voltage at the grid of V3 will decrease plate current. The rise in plate voltage of V3 is coupled through C2 to the grid of V2, driving V2 into conduction. The plate voltage of V2 decreases and V3 is driven into cutoff, which places the multivibrator back in the static state until another trigger arrives at the grid of V2. The sweep ends whenever V1 conducts. The amplitude of the sawtooth required to drive V1 into conduction is determined by the setting

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maximum internal pressure. This circuit is capable of producing a voltage from 40,000 to 60,000 volts. After the arc is started, the lamp will operate on normal voltage of 60 to 70 volts.

The starting circuit includes the step-up transformer, (fig. 5-12), the secondary of which supplies high voltage to an r-f circuit containing a spark gap, capacitor, inductances, and the primary of the pulse transformer. When the spark gap breaks down, r-f oscillations build up in the spark gap circuit, and the primary of the pulse transformer (RF coil). These oscillations are fed to the transformer secondary where high voltage is developed in the circuit comprising the lamp unit (for starting the arc).

When the arc is struck in the lamp, the starting current is limited to about 45 amperes by the reactance of the secondary of the booster transformer in series with the lamp and the parallel combination of the five ballast resistors.

Operating Circuits

To start the arc, turn the power switch to the ON position and press the momentary switch. When the momentary switch closes, the primary of step-up (H-V) transformer as energized. The voltage on the primary is boosted 32 volts above the line supply by the autotransformer action of the booster transformer. The secondary of (H-V) transformer in turn, energizes the r-f circuit to superimpose a high-voltage pulse across the lamp electrodes, causing the arc to start.

Release the momentary switch immediately after the arc is started to disconnect the starting circuit. It is essential that the momentary switch be released as soon as the arc strikes, otherwise the lamp will be overloaded. If the lamp is operated under this condition for a very brief period it will become overheated and fail violently.

Micro switches S3 and S6 are manually operated as a single unit as the searchlight door is opened to provide for deenergizing the starter unit circuits independently of the power switch as an additional safety feature when servicing the lamp circuit.

To extinguish the lamp, turn the power switch to the OFF position.

Preventive Maintenance

The 12-inch short-arc, mercury-xenon searchlight should be kept clean and the trunnion and yoke bearings lubricated with grease applied with an alemite gun.

The reflector and cover glass should be cleaned weekly. The procedures for cleaning these parts are similar to those for cleaning glass and Alzac-finished aluminum reflectors and front-door glasses described for the 24-inch searchlight.

The shutter assembly should be inspected monthly for tightness of screws and fastenings, for ease of operation, and for light tightness. If the return action of the shutter assembly becomes sluggish, lubricate the shutter bearings in accordance with the MRC shown in figure 5-16. Use the lubricant sparingly and do not allow it to contact the quartz envelope of the mercury-xenon lamp. If the shutter action remains sluggish after lubrication, replace the shutter springs.

The searchlight is properly focused when shipped. The service lamp is packed in the repair parts box with three additional spare lamps. When assembling or disassembling the lamp, use the face mask and the gloves provided with the equipment. The lamp is filled, under considerable pressure, with xenon gas and may burst violently if it is dropped or struck. The lamp must not be handled without enclosing it in the protective metal enclosure provided with the equipment.

To replace the short-arc, mercury-xenon lamp, position it in the lamp adjuster assembly with the collar resting on the stop (fig. 5-14). Press the brackets tightly against the metal collars on the lamp and tighten the wing nuts. Connect the lamp leads to the terminal posts on top of the starter assembly and be certain that the leads have a clearance of 1 inch from the nearest metal parts. Connect the short, bottom lead on the lamp to the terminal marked, HV.

Remove finger marks or grease from the quartz arc tube with alcohol or other grease-free solvent, and dry carefully with a clean cloth. Operation of the lamp with finger marks or grease on the surface will cause deterioration of the quartz envelope. Inspect all connections for tightness and, using the face guard and gloves, remove the metal safety shield from the lamp and place it in the repair parts box. Close the door assembly and secure it with the three thumb screws. Plug the power cable from the ballast into the receptacle on the starter box assembly.

SYSTEM	COMPONENT	M.R. NUMBER
Communications and Control	12" Mercury-Xenon Searchlights	EL-9 M-1
SUB-SYSTEM	MAINT. SIGNIFICANT NO. / RELATED M.R.	RATES / M/H
Navigation Equipment	W-1	EM3 / 0.3

M.R. DESCRIPTION
1. Lubricate trunnion and shutter bearings.
2. Lubricate shutter bearing screws and pins.

TOTAL M/H: 0.3
ELAPSED TIME: 0.3 unit

SAFETY PRECAUTIONS
1. Observe standard safety precautions.
2. Ensure lamp is de-energized and cold. Tag "Out Of Service."
3. Exercise caution when working on Mercury-Xenon lamps.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT
1. Oil can with Symbol 2110 oil
2. Grease gun with VV-G-632 Type B Grade 2 grease
3. Clean rags
4. 4" Screwdriver
5. Voltage tester
6. Safety tags
7. Face guard and gloves

PROCEDURE

Preliminary
a. De-energize circuit and tag "Out Of Service."
b. Test with a voltage tester to ensure circuit is de-energized.

WARNING: If the inside of a Mercury-Xenon lamp is blackened, it must be replaced. Enclose the lamp with the protective metal cover before removing or replacing a lamp. Wear a face guard and gloves when removing or replacing the protective metal guard. These lamps contain gas under considerable pressure and may explode under certain conditions. Do not let grease or oil contact Mercury-Xenon lamps.

1. Lubricate Trunnion and Shutter Bearings.
a. Apply a few drops of oil to the trunnion bearings.
b. Apply one squirt of grease to the zerk fitting located at the stanchion socket.
c. Remove clamps from center shutter rod.

(Cont'd on Page 2)

LOCATION

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Procedure (Cont'd)

d. Remove the left and right covers from the bearing housing assemblies to lubricate shutter bearings.
e. Apply 4 drops of oil in the hole in the hub of the bearing housing assemblies.
f. Reinstall left and right covers on the bearing assemblies and reinstall clamps.

2. Lubricate Shutter Bearing Screws and Pins.
a. Loosen knurled screws one or two turns. Rotate the entire flange assembly, which contains the lens, counterclockwise approximately 1/4". The entire lens assembly can now be removed to expose the shutter bearing screws.
b. Apply 3 drops of oil to the ends of the bearing screws and to the pins.
c. Reinstall lens assembly and tighten knurled screws.
d. Energize the circuit and remove tags.

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Figure 5-16.—Monthly MRC for 12" mercury-xenon searchlight.

To check the focus of the lamp, secure the drum in a level position with the shutter locked OPEN. Turn the power switch ON and direct the beam against a perpendicular, flat surface about 100 feet distant. The spot should be a concentrated image of the arc projected along the axis of the drum.

If the lamp is out of focus, the LONGITUDINAL TRAVERSE ADJUSTMENT is accomplished by loosening the lock screw (fig. 5-14) and sliding the plunger, or focusing handle, in or out to move the lamp toward, or away from, the reflector. This adjustment results in increasing or decreasing the diameter of the projected spot. The focusing handle is provided with two witness marks. When the first witness mark is aligned with the edge of the bushing at the top of the box, the lamp will be positioned at the focal point of the reflector and will produce a concentrated light beam of minimum divergence. When the second witness mark is aligned with this bushing, the lamp will produce a beam with a 4-degree spread. The focus should be adjusted for minimum divergence when the light is used at maximum ranges, and a 4-degree spread for close range operation.

It is seldom necessary to make the horizontal or vertical adjustments of the lamp. However, if these adjustments are required, it is necessary to remove the top cover plate.

The HORIZONTAL ADJUSTMENT is accomplished by loosening the four horizontal screws (fig. 5-14) and sliding the mounting plate to the right or left of center as required, and then retightening the horizontal securing screw.

The VERTICAL ADJUSTMENT is accomplished by loosening the socket-head cap screw and turning the vertical screw (fig. 5-14) to elevate or depress the beam, and then retightening the socket-head cap screw, and replacing the cover, making certain that the gasket is in place.

Corrective Maintenance

If the short-arc, mercury-xenon lamp should fail to light, check the wiring to be certain that the lamp leads clear any metal parts by at least 1 inch. Inspect the safety switches S3 and S6 (fig. 5-15) to determine that they are closed. Secure the shutter in the OPEN position, turn the power switch ON and rotate the starting switch knob counterclockwise; then release it. Observe, through the cover glass, the electrodes of the lamp for signs of arcing. The arc should take place just before the starting switch knob reaches the end of its travel. If arcing is observed and the lamp fails to light, replace the lamp with a new one.

If the lamp still fails to light, check the leads from the HV transformer for high-voltage leaks. Check the circuit to determine if the momentary switch closes.

Safety Precautions

The short-arc, mercury-xenon lamp must be operated with the shutter assembly secured to the drum. To avoid deterioration of the quartz arc tube, remove fingerprints or grease before operating the lamp.

The lamp contains gas under considerable pressure and if dropped or struck it may burst violently. The lamp must not be handled without enclosing it in the protective metal enclosure provided. This precaution applies to both new and burnt-out lamps. Lamps that reach the end of their useful life are potentially dangerous and must be disposed of in the sea. Always use face mask and gloves when assembling or disassembling the lamp to protect the eyes and skin from flying material should the lamp explode.

Before working on the assembly or replacing a lamp, be certain that the safety switches (fig. 5-15) are open and that the plug on the starter unit is disconnected. The safety switches must not be bridged or depressed when personnel are working inside the lamp drum for any reason.

Protect the eyes and skin from direct or reflected rays of lamp during operation. Some of the 12-inch mercury-xenon searchlights have been converted to automatic starting types while others are manually started. For detailed differences in the construction and operation of these two types see the applicable technical manual for the particular type of searchlight installed on your ship or station.

8-INCH, SEALED-BEAM SEARCHLIGHT

The 8-inch signaling searchlight utilizes an incandescent sealed-beam lamp. It is designed to withstand high vibratory shock and extreme humidity conditions, and will operate equally well in hot or cold climates.

This searchlight may be furnished for operation with either a 60-cycle 115-volt transformer

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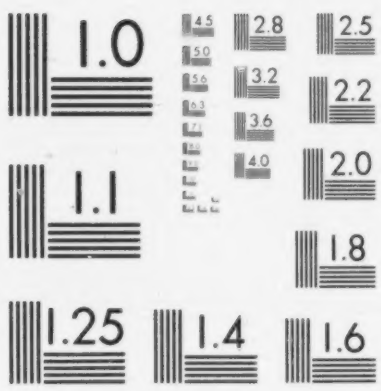

MICROCOPY RESOLUTION TEST CHART

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to step the voltage down to 23 volts, or without transformer to operate on 115 volts using the proper rated sealed beam unit. This same unit is available for use on small craft from a 28 volt power source.

Construction

The searchlight (fig. 5-17) consists of the (1) base, (2) yoke, (3) housing, and (4) lamp. The BASE is equipped with a rail clamp for securing the searchlight to the rail. The YOKE is swivel mounted on the base to allow it to be trained through 360°. The HOUSING provides an enclosure for the lamp and is composed of a front and a rear section. The front section comprises the shutter housing, and the rear section comprises the backshell housing. The two sections are held together by a quick-release clamp ring that permits easy replacement of the lamp. The backshell and lamp assembly, when detached, may be used as a portable searchlight. The entire housing is mounted on brackets attached to the shutter housing and supported by the yoke to allow the searchlight to be elevated or depressed. Clamps are provided for securing the searchlight in train and elevation.

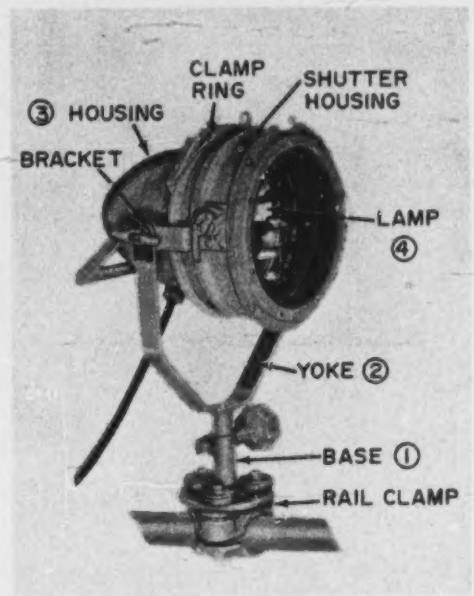

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Figure 5-17.—8-inch 60-cycle sealed-beamed searchlight.

The SHUTTER HOUSING contains the venetian blind shutter, which is held closed by springs and manually opened by a lever on either side of the housing. The front of the shutter housing is sealed by the cover glass and a gasket. The rear of the shutter housing is enclosed by a gasket and adapter assembly. The adapter assembly provides a locating seat for the lamp and incorporates a hook and key arrangement that aligns the backshell housing and retains it in position while attaching the clamp ring to hold the two sections together.

Three filter assemblies (red, green, and yellow) are provided and can be readily snapped in place over the face of the searchlight. The shutter vanes can be locked in the open position for use as a spotlight.

The backshell housing provides an enclosure for the 115/23 volt transformer.

Preventive Maintenance

The 8-inch sealed beam searchlight should be kept clean and painted. The electrical contacts should be cleaned with a soft cloth. Do not use abrasives to clean these contacts. The front face of the lamp and the cover glass should be kept clean with water or glass cleaner.

To remove the lamp from the housing for cleaning or replacement, tip the rear end of the searchlight up to its highest position and lock it in place. Release the clamp-ring toggle and remove the clamp ring (fig. 5-17). Remove the backshell assembly by raising it up to disengage it from the hook and tab. Pull the gasketed lamp out of the shutter adapter assembly by gripping the lamp gasket on its periphery and lifting it out to disengage the gasket lugs from the notches in the adapter assembly.

To replace the lamp in the lamp gasket, be certain that the TOP marked on the lamp and on the gasket are aligned and that the lugs of the lamp are firmly seated in the recesses provided in the gasket. To replace the gasketed lamp in the housing, be certain that the lugs are set into the notches in the adapter assembly located inside, and at the rear of, the shutter housing. Set the backshell assembly over the shutter assembly, engaging the shutter hook into the slot of the backshell. Using the hook

as a hinge, carefully swing the lower part of the backshell down to the shutter assembly, engaging the shutter tab into the notch in the rolled edge of the backshell. Be careful to swing the backshell down in a straight line to make direct engagement and to ensure proper positioning of the lamp contacts on the terminals of the lamp. Replace the clamp ring, being certain to have the hinge pin set into the notches of the adapter and backshell assemblies.

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CHAPTER 6

MAINTENANCE OF MOTORS AND GENERATORS

This chapter describes procedures for the maintenance of motors and generators. Additional information is contained in chapters 9610 and 9630 of the NavShips Technical Manual.

Proper maintenance is important in ensuring long, satisfactory service of electric motors and generators. The most important factor in the maintenance of electric motors and generators is to keep the equipment clean and free of oil, water, dirt, and other foreign particles. Oil vapor, metallic dust and moisture are present in the air inside a ship. These elements are especially prevalent in the air of machinery spaces where major electric motors and generators are located. All machines require ventilation to dissipate the heat generated by their operation, and since most motors and generators utilize the air within the compartments in which they are located for this purpose, it is apparent that a considerable amount of these destructive elements will accumulate on, and inside, these machines within a relatively short time. Motors and generators must be cleaned frequently, both internally and externally, and particular care must be taken to keep all air ducts clean.

CLEANING MOTORS AND GENERATORS

The importance of keeping all insulation clean must be emphasized. Dust, dirt, and foreign matter (carbon, copper, mica, etc.) tend to block ventilation ducts and increase resistance to the dissipation of heat, causing local or general overheating. If the particles are conducting or form a conducting paste through the absorption of moisture or oil, the winding may be eventually shortcircuited or grounded. Abrasive particles may puncture insulation, iron dust is particularly harmful since the dust is agitated by magnetic pulsations.

The four acceptable methods of cleaning motors and generators are wiping, use of suction, use of compressed air, and use of a solvent.

Wiping with a clean, lint-free, dry rag (such as cheese cloth) is effective for removing loose dust or foreign particles from accessible parts of a machine. When wiping, do not neglect such parts as the end windings, mica cone extensions at the commutator of d-c machines, slip-ring insulation, connecting leads, and terminals.

The use of suction is preferred to the use of compressed air for removing abrasive dust and particles from inaccessible parts of a machine because it lessens the possibility of damage to insulation. If a vacuum cleaner is not available for this purpose, a flexible tube attached to the suction side of a portable blower will serve as a satisfactory substitute. Always exhaust the blower to a suitable sump or overboard when used for this purpose. Grit, iron dust, and copper particles should be removed only by suction methods whenever possible.

Compressed air must be clean and dry when used for cleaning electrical equipment. Air pressure up to 30 pounds per square inch may be used on motors or generators of 50 hp or 50 kw respectively, or less. Pressures up to 75 pounds per square inch may be used to blow out machines that are over 50 hp or 50 kw. A throttling valve should be used on air lines that carry higher pressure than is suitable for blowing out a machine. Before the air blast is turned on the machine, any accumulation of water in the air pipe or hose must be thoroughly blown out, and both ends of the machine must be opened to allow a path of escape for the air and dust. The use of compressed air will be of small benefit if the dust is not suitably removed from the machine. The most suitable method is to attach a suction blower to an opening in the opposite end from the air jet to remove the dirt-laden air.

The use of solvents for cleaning electrical equipment should be avoided whenever possible, however their use is necessary for removing grease and pasty substances consisting of oil and carbon or dirt. Alcohol will injure most types of insulating varnishes and should not be used for cleaning electrical equipment. Solvents containing gasoline or benzine must not be used for cleaning purposes under any circumstances. Carbon tetrachloride is not to be used because of its extremely high toxicity.

APPROVED SOLVENTS

Inhibited methyl chloroform (trichloroethane), FSN GM 6810-664-0388, is one of the principal approved solvents for cleaning electrical equipment. This solvent is less toxic than carbon tetrachloride; liberal ventilation, however, must be provided by exhaust fans or portable blowers if this solvent is used for more than a few minutes.

In the rare cases when means of ventilation are impractical, an air line respirator or oxygen breathing apparatus (OBA) must be used if exposure to the solvent vapors is for more than a few minutes.

Inhibited methyl chloroform is very corrosive in its action on metal and may prove injurious to certain insulation. Before using any solvent, apply it to a small area or sample of the insulation to be cleaned. If it injures the insulation, do not use it. Clean fresh water, preferably warm or hot, may be used as an emergency substitute for inhibited methyl chloroform. Water should be used only as an emergency substitute and the equipment must be thoroughly dried after any application of water.

Do not spray inhibited methyl chloroform on windings. It will collect in pools and do more harm than good. The solvent should be applied by moistening a lintless cloth with the fluid and lightly rubbing the surfaces to be cleaned; repeat the process if necessary to loosen the dirt. After wiping the insulation with solvent it should be thoroughly dried with a clean lintless cloth.

Inhibited methyl chloroform is detrimental to good commutation and should be kept from coming in contact with the commutator or brushes of d-c machines.

Inhibited methyl chloroform should never be used on hot equipment as the accelerated evaporation will increase the toxic hazards.

Trichloroethylene (FSN G6810-184-4794) is another approved solvent, widely used in a vapor process for degreasing metals. It should not be used for cleaning electrical insulation because of its strong solvent action on these materials. The toxic effects of trichloroethylene are similar to those of inhibited methyl chloroform.

Dry cleaning solvent, type II, (FSN W6850-274-5421) is an approved safety type solvent. The fire and health hazards of this solvent have been minimized. The efficiency of this solvent is somewhat less than the previously discussed chlorinated solvents but the hazards to personnel are also reduced.

PRECAUTIONS

During the use of any solvent the following precautions must be observed.

1. Guard carefully against fire.
2. Use vapor-proof or watertight portable lights if supplementary lighting is required.
3. Have fire extinguishers available for immediate use.
4. Prevent possible sparks caused by one metallic object striking another.
5. If a spray or atomizer (not normally used for routine cleaning) is used, ground the nozzle.
6. Avoid saturation of the operator's clothing with the solvent.
7. Provide liberal ventilation by means of exhaust fans or portable blowers.
8. When using inhibited methyl chloroform or trichloroethylene, protect against breathing the fumes, (a chemical cartridge respirator such as a gas mask will not prevent suffocation since the vapors from these solvents displace air and oxygen), cleaning should be done under the observation of someone familiar with artificial respiration.
9. Do not apply solvents on hot equipment or in the presence of open flames. The chlorinated solvents form highly toxic phosgene gas on contact with open flame.
10. No less than two persons should be assigned to cleaning operations in a single compartment.

General signs of fume poisoning by chlorinated hydrocarbons include headache, nausea, mental confusion, and in some instances a kind of drunken behavior similar to that caused by alcohol. When any of the above symptoms are observed, the person should immediately be removed from the toxic atmosphere to fresh air or a well ventilated space.

For additional information on cleaning of equipment by the use of compounds, sprays, or

immersion in solvents refer to NavShips Technical Manual, chapter 9600.

GENERAL MAINTENANCE

The essential points in the maintenance of electric generators and motors are: keep insulation clean and dry and of high resistance, keep electrical connections tight, and keep machines in good mechanical condition.

Keep all small pieces of iron, bolts, and tools away from the machines. Where it is necessary to do any soldering, make sure that no drops of solder get into the windings and that there is no excess of solder on soldered joints which may later break off due to vibration and fall into the windings.

Do not disturb the commutator clamping bolts on d-c machines. Interference with these may make it necessary to turn or grind the commutator to restore it to service.

Other bolts and mechanical fastenings on both the stationary and rotating members should be tightened securely when the machine is installed, checked after the equipment has run for a short time, and thereafter checked at regular intervals to make sure that they are tight. Particular attention should be given to the bolts used to clamp any insulation.

If an inspection of a rotor shows that there is looseness of keys, bolts, or other fastenings, a check should be made for evidence of damage due to this looseness. Such looseness may result in worn dovetail keys, damaged windings, or broken dovetails on the end plates. Two or three drivings (with a punch and hammer) usually will ensure the tightness of the keys, but nevertheless they should be checked regularly.

The banding wire on d-c armatures should be checked at regular intervals to make sure that it is tight.

The outboard bearing on some generators (both a-c and d-c) is electrically insulated from the frame; or the bearing pedestal is insulated from the base and the bearing oil piping to prevent the flow of shaft currents through the bearing. In the former case, insulation is accomplished by means of a shell of insulating material installed between the bearing shell and the bearing housing. In the latter case, the bearing insulation is accomplished by using insulating shims under the pedestal and insulated holding down bolts and dowels. Also insulated couplings are provided in the bearing inlet and outlet oil piping flanges (for force feed bearings). Special attention should be taken to ensure that this insulation is not damaged or that conducting paths around this insulation are not inadvertently provided. For instance, care should be taken when painting machines furnished with insulated pedestals not to paint over the insulating shims, washers, and oil piping couplings. Bearing currents, if of sufficient magnitude, will rapidly ruin a bearing. These currents are caused by electromotive force generated in the shaft and structural parts of a generator unless it is carefully designed and constructed to minimize their occurrence. An insulated bearing (or pedestal) breaks the circuit and protects the bearings from damage so long as the insulation is effective.

Inspect all electrical connections (particularly terminals and terminal board connections) at frequent intervals to make sure they are tight. Loose connections result in increased contact resistance and increased heating which may result in breakdown. Use lock nuts, lock washers, or other means to lock connections which tend to become loose because of vibration. Inspect soldered terminal lugs for looseness or loss of solder, and tighten solderless terminal lugs occasionally. When electrical connections are opened, clean all oil and dirt from contact surfaces before reconnecting. If the contact surfaces are uncoated copper, sandpaper and clean immediately before joining. If the contact surfaces are silver plated, do not use sandpaper. Use silver polish or a cloth moistened slightly with an approved solvent. Coat the finished joint with insulating varnish. Steel bolts for making electrical connections should be zinc or cadmium plated. Make sure that exposed electrical connections are adequately insulated to protect against water and moisture and injury to personnel. This applies especially to exposed connections at terminal straps extending outside the frames of propulsion motors and generators.

When it becomes necessary to disassemble and reassemble a motor or generator, follow the procedures outlined in the manufacturer's instruction book, exercising care to prevent damage to any part of the machine. The machine rotors (a-c revolving field or d-c armature) should be supported, while being moved or when stationary, by slings or blocking under the shaft or by a padded cradle or thickly folded canvas under the core laminations. To lift the rotor, rope slings (separated by a spreader to prevent the slings coming in contact with the a-c rotor

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or d-c armature coils) should be placed under the shaft, clear of the bearing journals. If construction of the shaft provides no room for a sling except around the journals, they must be protected with heavy paper or canvas before applying the sling. When the whole unit (stator and rotor) is to be lifted by lifting the stator, the bottom of the air gap must be tightly shimmed unless both ends of the shaft are supported in bearings. It is easily possible, by rough handling or careless use of bars or hooks, to do more damage to a machine during disassembly and assembly than it will receive in years of normal service.

Excessive vibration in electric motors and generators may be caused by an unbalanced rotating part (d-c armature, a-c revolving field, cooling fan, etc.). Therefore, when it is necessary to repair a rotating part in such a manner as to remove or add weight at any point around its periphery, the part must be tested for balance. An unbalanced condition can be corrected by dynamically balancing the part. In dynamic balancing, the test for unbalance is made, with the part turning at normal speed, by determining the exact lengthwise location where whip is maximum, and by spotting the exact radial point at which excessive weight appears. Balancing is effected by removing weight at this point or by the addition of counterweight at a point directly opposite the point of excessive weight. Dynamic balancing requires special equipment operated by specially trained personnel. Repair ships and shipyards are equipped to perform this task.

SLEEVE BEARINGS

Bearings are of two types: SLIDING and ROLLING. The three types of sliding bearings are the right line bearing, in which the motion is parallel to the elements of the sliding surface; journal bearing, in which two machine parts rotate relatively to each other; and thrust bearings, in which any force acting in the direction of the shaft axis is taken up. The type of sliding bearing employed in electric motors and generators is the journal bearing commonly called the SLEEVE bearing. These bearings are used in large equipment, such as turbine-driven ship's service generators and propulsion generators and motors. The bearings may be made of bronze, babbitt, or steel-backed babbitt.

Preventive maintenance of sleeve bearings requires periodic inspections of bearing wear, and lubrication.

WEAR

Propulsion generators and motors and large ship service generators are usually provided with a gage for measuring bearing wear. Bearing wear on sleeve bearing machines not provided with a bearing gage can be obtained by measuring the air gap. It is usually not necessary to measure air gaps on machines which have ball bearings because the construction of the machine is such as to assure bearing alinement. Bearing wear of sufficient magnitude to be readily detectable by air gap measurements would be more than enough to cause unsatisfactory operation of ball bearings and would be detected in this way.

Air gaps on a sleeve bearing machine not provided with a bearing gage should be measured at each end of the machine. Air gaps can be measured with an air gap feeler. This is a machinist's tapered feeler gage with a blade long enough to reach into the air gap without removing the end brackets of the machine. Before making the measurements, clean the varnish from a spot on a pole or tooth of the rotor. A spot should also be cleaned at the same relative position on each field pole of a d-c machine. For a-c machines, at least three and preferably four or more spots spaced at equal intervals around the circumference should be cleaned on the stator. The air gap measurements should be taken between the cleaned spot on the rotor and the cleaned spot on the stator, turning the rotor to bring the cleaned spots on the rotor opposite each of the cleaned spots on the stator.

If one end of the machine is accessible only with difficulty, either of the following procedures may be used.

1. Take several measurements at one end in accordance with the procedure described above, and two measurements approximately 90° apart at the less accessible end. If these two do not differ greatly from the mean of the measurements at the other end, the air gap is reasonably uniform at both ends.

2. Take several measurements at one end of the machine in accordance with the procedure described above, and average these to obtain the average air gap, or obtain the average air gap

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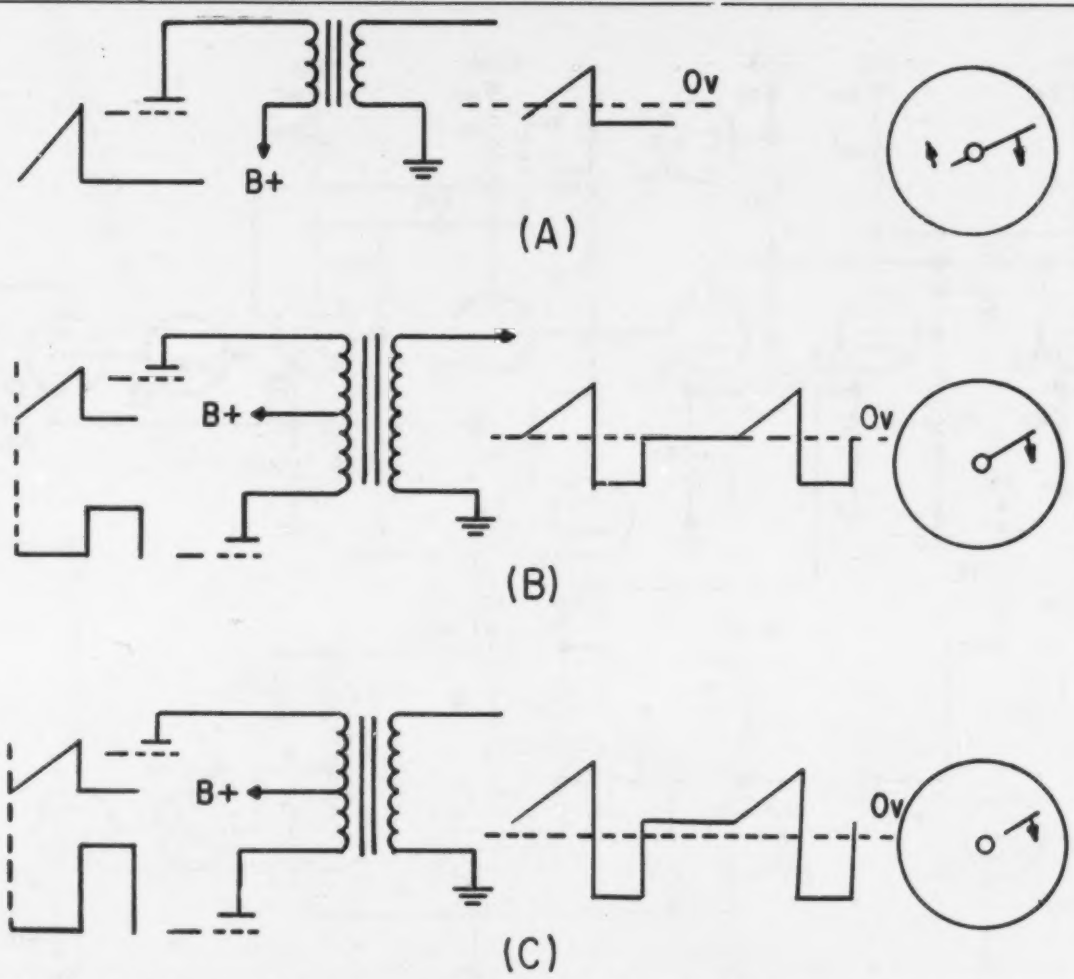

Figure 17-26.—PPI-scope deflection saveforms. (A) No compensation or undercompensation; (B) balanced compensation; (C) overcompensation.

of R2. If the arm of R2 is moved down, the voltage at the cathode of V1 increases and the sawtooth on the grid of V1 must rise to a higher amplitude to fire V1. The sweep capacitor must charge for a longer time; therefore, the sweep time and amplitude will increase. R2 is adjusted for the correct amplitude and then R10 is adjusted for the correct sweep time. R2 is the amplitude control and R10 is the sweep time control. If R2 is adjusted first, the two controls will not interact.

The sawtooth at the grid of V5 is amplified and the negative-going sawtooth at the plate is coupled to V7, amplified, inverted, and coupled to the grid of V9. The positive sawtooth applied to the grid of V9 causes the current to increase through the tube at the sawtooth rate. The sawtooth of current through the plate winding of V9 induces a voltage into the secondary, and this voltage causes a sawtooth of current in the secondary.

The sawtooth at the cathode of V6 will be amplified; and from the plate of V6, a positive-going sawtooth will be fed back to the top of R10. The voltage at the top of R10 rises during sweep time, holding the effective voltage constant. The diode V4 is the disconnect tube for the bootstrap circuit.

At the cathode of V9, V6, and V5, a sawtooth of voltage is developed across the unbypassed cathode resistor. In parallel with R27 from the cathode of V5, another network is tied to the ground. This network consists of R22, R21, V13, and R19 to ground. A capacitor C8 is tied from the junction of R22 and R21 to ground. C8 charges to the average of the sawtooth at the top of R21. Therefore, a constant voltage at the plate of V13 will rise to the charge of C8. At the plate of V13, a square wave will be developed as V13 is cut off and on. This square wave is amplified and coupled to the grid of V15. A square wave of current

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from records of preceding measurements. The average air gap is one-half the difference between the inside diameter of the stator (or field pole arrangement) and the outside diameter of the rotor (or armature), and is not affected by bearing wear. Procure a long, narrow strip of steel. The thickness of the steel strip should be 20 percent less than the average air gap for average air gaps smaller than 0.040 inch; it should be 10 percent less for average air gaps larger than 0.040 inch. Test the air gap by trying to push this strip all the way from one end of the air gap to the other. This test should be made at four points 90° apart, if possible, and if not, at a number of points (not less than three) spaced at approximately equal intervals around the circumference. The test can be repeated with a slightly thicker strip if a closer estimate is needed.

It is more important to have uniformity of air gaps at all points than to have the gap conform exactly to the specified limits. If the air gap at any of the places tested differs from the average air gap by more than 20 percent for average air gaps smaller than 0.040 inch, or by more than 10 percent for average air gaps larger than 0.040 inch, the bearings should be realigned, repaired, or replaced. Usually an inequality of air gaps which is not greater than specified above will not cause unsatisfactory operation. If, however, trouble is experienced, such as vibration or excessive noise which cannot be traced to any other cause than unequal air gaps, it is advisable to realign, repair, or replace bearings to equalize air gaps, even if the measured inequalities are within the limits given.

LUBRICATION

Every precaution should be taken to keep the oil and bearings clean and free from water or foreign particles.

Do not add oil while the machine is running. This affords an opportunity for oil mist or spray to escape from the bearing housing and be blown on the machine windings.

Bearings having an overflow gage should be filled until the oil is about one-sixteenth inch from the top of the gage. If the machine is equipped with an oil filter gage, the gage should be filled to the manufacturer's oil level mark, or (if no mark is available) the gage should be between two-thirds and three-quarters full at all times. Be sure that the gage glass and piping to the gage are clean or the glass will give false indications of the oil level. If the bearing has neither an overflow gage nor an oil filter gage, fill to a level such that the oil ring dips into oil to a depth of about half the shaft diameter.

When the bearing and bearing housing are in good condition, there should be no loss of oil. If the proper oil level cannot be maintained without adding oil, it is probable that oil is leaking from the bearing. Be sure the oil sight gage connection to the bearing is tight. Much of the oil that leaks out of a bearing is drawn into the machine by the cooling air and sprayed onto the windings where it causes oil soaked dirt to collect. This condition tends to cause insulation failure. If oil leakage is suspected, carefully clean and chalk the shaft outside the bearing, the outside of the bearing housing, and the parts of the rotor adjacent to the bearing. If the machine is throwing oil, discoloration of the chalk will so indicate after a short run. This test will not be dependable unless the chalked part is perfectly clean at the beginning of the test. If leakage is found, the labyrinth seal in the bearing housing should be corrected to make it effective. Another possible source of leakage is from the vent with which some labyrinths are provided. Make sure that any such vent is not stopped up and that it terminates in still air of atmospheric pressure where there is no current of air over the vent that will suck oil out of the bearing housing or oil vapor out of the vent into the machine. Such oil leakage is often due to overfilling the bearing or trying to fill the bearing through the vent.

Bearing oil should be renewed semiannually. Drain the oil off by removing the drain plug, then flush the bearing with clean oil until the drained oil flows clean.

OIL RINGS AND BEARING SURFACES

An opening is provided in the top of the bearing for checking the condition of the oil rings and bearing surfaces (fig. 6-1). Periodic inspections are necessary to make certain that the oil ring is rotating freely when the machine is running and is not sticking due to the motion of the ship. With the machine stopped, the bearing surfaces should be inspected for any signs of pitting or scoring.

TROUBLE ANALYSIS

Earliest indication of sleeve bearing malfunction normally appears as an increase in the operating temperature of the bearing. This

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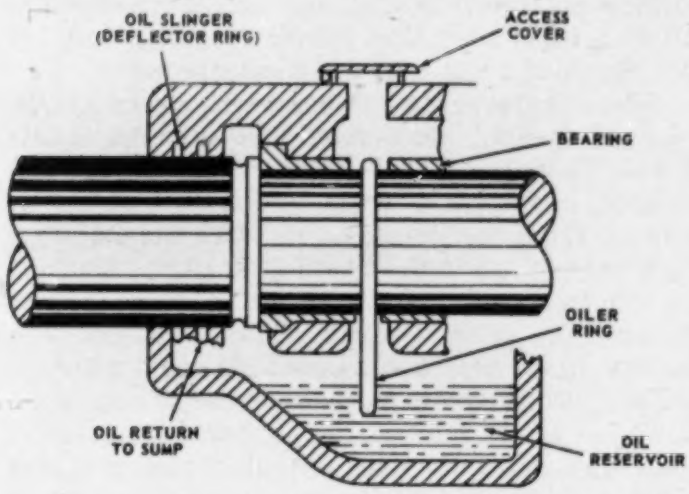

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Figure 6-1.—Diagram of an oil-ring lubricated bearing.

increase is due to the heat generated in the extremely sensitive oil film separating the rotating journal from the bearing surface and is governed by the slipping or shearing of the oil molecules. When the bearing is operating satisfactorily, the film temperature remains stable; but when the equilibrium of the oil film is interrupted, rapid and sharp changes occur in the temperature of the oil film. Oil is supplied under pressure from a central system to sleeve bearings in some large machinery, such as turbine-driven ship's service generators.

Thermometers are usually inserted in the discharge line from the bearing as a means of visually indicating the temperature of the oil as it leaves the bearing. Thermometer readings are taken hourly on running machinery by operating personnel. However, a large number of bearing casualties have occurred in which no temperature rise was detected in thermometer readings, and, in some cases, discharge oil temperature has actually decreased. Therefore, after checking the temperature at the thermometer, a follow-up check should be made by feeling the bearing housing whenever possible. Operating personnel must thoroughly familiarize themselves with the normal operating temperature of each bearing so that they will be able to recognize any sudden or sharp changes in bearing-oil temperature. Many large generators are provided with bearing temperature alarm contactors which are incorporated in the ship's alarm system. The contactor is preset to provide an alarm when the bearing temperature exceeds a value detrimental to bearing life. If bearing malfunction is indicated, the affected machinery should be secured as soon as possible. A motor with overheated sleeve bearings should be unloaded, if possible, without stopping the motor. If stopped immediately, the bearing may seize. The best way to limit bearing damage is to keep the motor running at light load and supply plenty of cool, clean oil until the bearing cools down.

Any unusual noise in operating machinery may also indicate bearing malfunction. Whenever a strange noise is heard in the vicinity of operating machinery, a thorough inspection must be made to determine its cause. Excessive vibration will occur in operating machinery with faulty bearings, and inspections should be made at frequent intervals in order to detect its presence as soon as possible.

Corrective maintenance of sleeve bearings is accomplished by personnel of machinery ratings aboard ship or by shipyard personnel. Usually, repairs of this type are of such magnitude as to require lengthy shipyard availability for accomplishment; hence, the importance of practicing proper preventive maintenance of sleeve bearings must be emphasized.

BALL BEARINGS

Rolling, antifriction bearings are of two types: ball and roller bearings. Basically, all rolling bearings consist of two hardened steel rings, hardened steel rollers or balls, and separators. The annular, ring-shaped, ball bearing is the type of rolling bearing used most extensively in the construction of electric motors and generators used in the Navy. This bearing is further divided into three types dependent upon the load it is designed to bear—(1) radial, (2) angular contact, and (3) thrust. Examples of these three bearings are shown in figure 6-2.

The rotating element of an electric motor or generator may subject a ball bearing to any one or a combination of three loads — radial, thrust, and angular. Radial loads are the result of forces applied to the bearing perpendicular to the shaft; thrust loads are the result of forces applied to the bearing parallel to the shaft; and angular loads are the result of a combination of radial and thrust loads. Because the load carried by the bearings in electric motors and generators is almost entirely due to the weight

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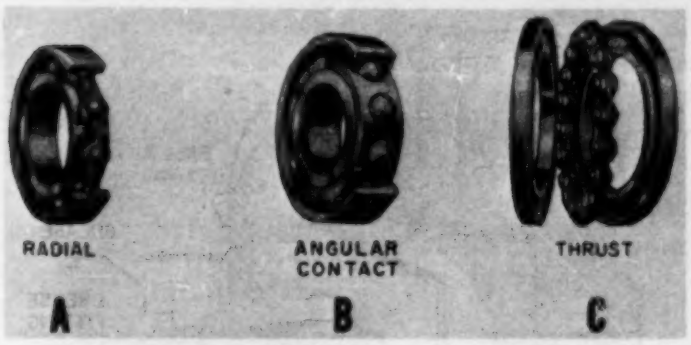

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Figure 6-2.—Typical ball bearings.

of the rotating element, it is apparent that the method of mounting the unit is a major factor in determining the type of bearing employed in its construction. In a vertically mounted unit, the thrust bearing would be used; while the radial bearing is common to most horizontal units.

The preventive maintenance of ball bearings requires periodic checks of bearing wear, and adequate lubrication.

WEAR

Measuring air gaps to determine bearing wear is not necessary on machines equipped with ball bearings because the construction of the machine is such as to ensure bearing alignment. Ball bearing wear of sufficient magnitude as to be readily detected by air-gap measurements would be more than enough to cause unsatisfactory operation of the machine.

The easiest way of determining the extent of wear in these bearings is to periodically feel the bearing housing while the machine is running to detect any signs of overheating or excessive vibration, and to listen to the bearing for the presence of unusual noise. The indications thus obtained are comparative, and caution must be exercised in their analysis.

When testing for overheating, the normal running temperature of the bearing must be known before the test can be reliable. Rapid heating of a bearing is indicative of danger. While a bearing temperature uncomfortable to the hand may be a sign of dangerous overheating, it is not always so. The bearing may be all right if it has taken an hour or more to reach that temperature; whereas, serious trouble can be expected if that same temperature is reached within the first 10 or 15 minutes of operation.

The test for excessive vibration relies to a great extent on the experience of the person conducting the test. He should be thoroughly familiar with the normal vibration of the machine in order to be able to correctly detect, identify, and interpret any unusual vibrations. Vibration, like heat and sound, is easily telegraphed, and a thorough search is generally required to locate its source and to determine its cause.

Ball bearings are inherently more noisy in normal operation than sleeve bearings, and this fact must be borne in mind by personnel testing for the presence of abnormal noise in the bearing. A good method for sound testing is to place one end of a screwdriver or steel rod against the bearing housing and the other end against the ear. If a loud, irregular grinding, clicking, or scraping noise is heard, trouble is indicated. As before, the degree of reliance in the results of this test depends on the experience of the person conducting the test.

The one sure method of checking ball bearing wear is also the most difficult. In this test, the bearing caps or other covers provided are removed and the actual condition of the bearing is observed. Each ball bearing should be inspected in this manner at least every two years. The condition of the lubricant in the bearing may be checked at this time; however, no attempt must be made to disassemble double-shielded or sealed-for-life bearings (fig. 6-3).

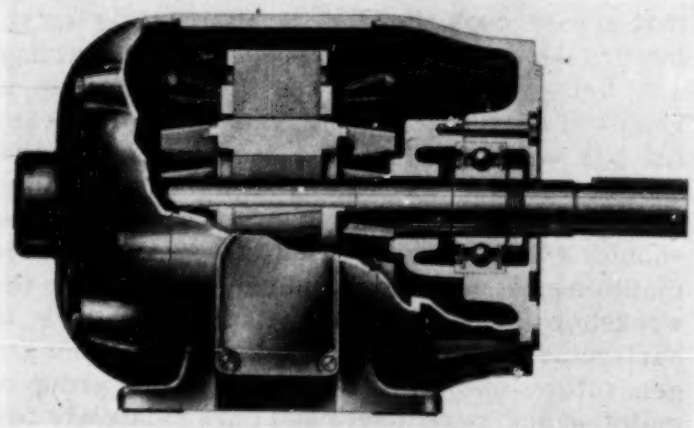

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Figure 6-3.—Motor equipped with permanently lubricated ball bearings.

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LUBRICATION

IMPROPER GREASING PROCEDURES ARE A FREQUENT CAUSE OF DERANGEMENTS TO ROTATING ELECTRICAL MACHINERY PROVIDED WITH GREASE-LUBRICATED BALL BEARINGS. The trouble is generally caused by forcing an excessive quantity of grease into the bearing housing, with either one or both of the following results:

(1) Grease is forced through the bearing housing seals and onto the windings and, in the case of d-c machines, onto the commutators where it causes deterioration of insulation and eventually results in grounds or short circuits.

(2) The excessive quantity and pressure of grease in the bearing housing result in churning, increased temperatures, rapid deterioration of the grease, and ultimate destruction of the bearing.

The following instructions apply to equipment except oil-lubricated bearings, synchros, and similar devices where friction must be maintained at an absolute minimum, and equipment for which approved lubrication charts or other specific instructions are furnished by the Navy. Except for the equipment to which they do not apply, the following instructions should be carefully observed in order to avoid failure of electrical equipment because of improper greasing practices:

Motors and generators provided with bearings that should be lubricated with grease are now normally delivered from the manufacturer with the grease cups removed from the bearing housings and replaced with pipe plugs. The grease cups are delivered with the onboard repair parts or special tools. It is recommended that grease cups (fig. 6-4) be attached to electric motors and generators only when the bearings are being greased. When the grease cup is removed from the bearing housing after a bearing has been greased, the hole which remains should be plugged with a suitable pipe plug. When this procedure is used, the grease cups should remain in the custody of responsible maintenance personnel and can be stored in the workshop or toolroom. This procedure is particularly advantageous when the motors and generators maintained by a particular group of maintenance personnel need only relatively few different sizes of grease cups. This procedure should also be followed for motors and generators which have been supplied with grease cups attached to the machine. CARE SHOULD BE TAKEN TO MAKE SURE THAT A GREASE CUP IS CLEAN BEFORE IT IS USED TO ADD GREASE TO A BEARING AND THAT THE PIPE PLUG USED TO REPLACE THE GREASE CUP AFTER GREASING IS ALSO CLEAN.

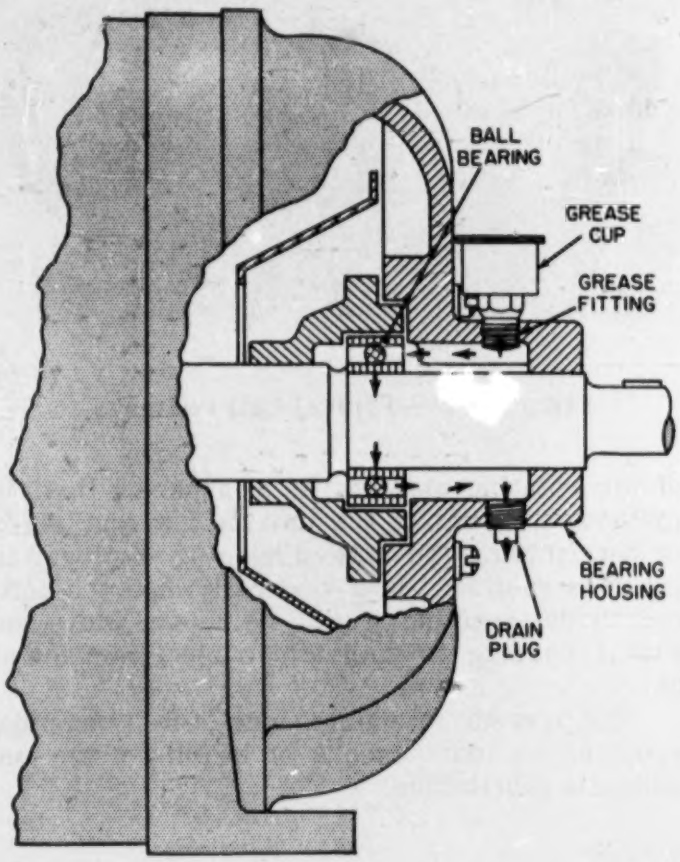

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Figure 6-4.—Grease-lubricated ball bearings.

Some electric motors and generators may be equipped with oil-lubricated ball bearings. Lubrication charts or special instructions are generally furnished for this type of bearing and should be carefully followed by personnel maintaining the equipment. In the absence of other instructions, the oil level inside the bearing housing should be maintained approximately level with the lowest point of the bearing inner ring. This will provide enough oil to lubricate the bearing for a considerable operating period, but not enough to cause churning or overheating.

One common method by which the oil level is maintained in ball bearings is the wick-fed method. In this method, the oil is fed from an oil cup to the inside of the bearing housing through an absorbent wick, which also filters the oil and prevents leakage through the cup in

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the event momentary pressure is built up within the housing. A typical wick-fed, oil-lubricated ball bearing is shown in figure 6-5.

The frequency with which grease must be added depends upon the service of the machine and the tightness of the housing seals, and should be determined for each machine by the engineer officer. Ordinarily, the addition of grease will not be necessary more often than once in six months. When a bearing housing is too full of lubricant, the churning of the grease generates heat which in turn causes deterioration of the grease. Under these conditions the grease separates into oil and minute abrasive particles, becomes increasingly stickly, and tends to seal the bearing against fresh lubricant until the resulting friction, heat, and wear cause failure of the bearing.

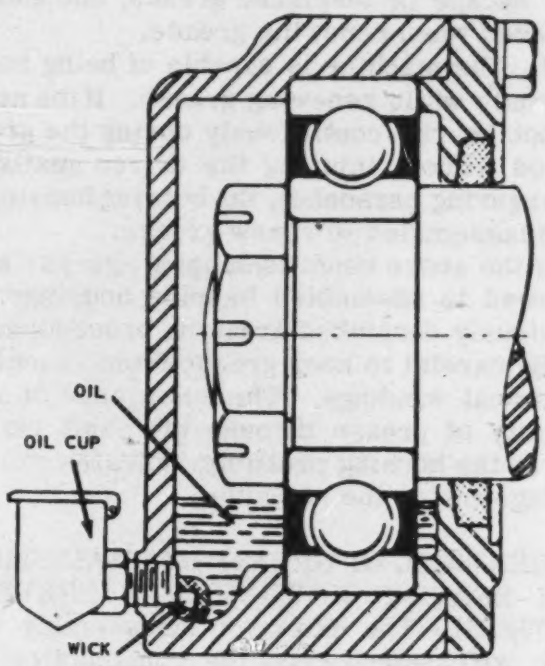

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Figure 6-5.—Wick-fed ball bearing.

Greasing Procedures

Bearings which normally operate at a temperature of 194° F (90° C) or below should be lubricated with grease in accordance with Military Specification MIL-G-18709, Stock Nos. W9150-235-5544 and W9150-235-5564.

To avoid the difficulties caused by an excessive amount of grease, grease should be added only when necessary, and, when grease is added, it should be done as follows:

1. Run the machine to warm up the bearings.
2. Wipe the outside of grease fitting and drain plug free of all dirt.
3. Remove bearing drain plug, and make sure the passage is open by probing with a clean screw driver or similar implement.
4. Remove pipe plug on top of the grease pipe (open grease pipe by probing as above). Select the proper grease cup, empty and clean out the grease cup (top and bottom). Install the bottom portion of the grease cup on the grease pipe.
5. Fill the bottom portion of the grease cup with clean grease, fill the top portion (cap) of the grease cup only half full of grease.
6. Thread the half filled cap of the grease cup onto the fully filled bottom of the grease cup and screw it down as far as it will go (by hand). Keep the machine running continuously while adding grease.
7. Repeat steps (5) and (6) above until clean grease begins to emerge from the drain hole.
8. Continue to run the machine and let grease run out of drain hole until drainage stops (normally about 30 minutes). Remove grease cup and replace pipe plug.
9. Replace the drain plug.
10. DO NOT USE A GREASE GUN TO LUBRICATE BEARINGS UNLESS THERE ARE NO OTHER MEANS AVAILABLE. If a grease gun must be used, remove the drain plug in the bearing housing while greasing and use extreme care to avoid inserting too much grease or applying more than just enough pressure to get the grease into the housing.

RENEWAL OF GREASE WITHOUT DISASSEMBLING THE BEARING HOUSING.—Renewal of grease without at least partial disassembly of the bearing housing is not recommended. In any case, renewal of grease without at least partial disassembly of the bearing housing should not be attempted unless the following conditions apply:

1. The machine is horizontal. In vertical machines, there is no adequate means of protecting the windings against displaced lubricant.
2. A suitable fitting is provided for admitting grease. If a grease-gun fitting is provided, it should be replaced by a grease cup.

3. The drain hole on the bearing housing is accessible. Drain pipes do not permit satisfactory escape of displaced grease, and should be removed when renewing grease.

4. The machine is capable of being run continuously while renewing grease. If the machine cannot be run continuously during the greasing period without injuring the driven auxiliary or endangering personnel, the bearing housing must be disassembled to renew grease.

If the above conditions apply, grease may be renewed in assembled bearing housings by the previously described greasing procedures.

Be careful to keep grease from reaching the electrical windings. The emergence of a large quantity of grease through the shaft extension end of the housing probably indicates excessive leakage inside the machine.

RENEWAL OF GREASE BY DISASSEMBLING THE BEARING HOUSING (THE PREFERRED METHOD).—The extent of disassembly necessary will depend upon the construction of the bearing. For the usual construction, (bearings with outer bearing caps), the following method should be used:

1. Remove the outer bearing cap after thoroughly wiping all exterior surfaces.

2. Remove old grease from all accessible portions of the housing and clean these parts thoroughly. Be careful not to introduce dirt or lint into the housing of bearing.

3. Flush out the bearing cap with clean hot (about 120° F.) kerosene, Diesel fuel oil, or dry-cleaning fluid (federal Specification P-S-661a). Follow this by flushing out with a light mineral oil (not heavier than SAE 10, similar to Diesel lubricating oil, symbol 9110).

4. Where practicable, plug all holes leading into the interior of the machine and flush out the complete housing with the outer bearing cap removed. Use the solvents and procedure described in the preceding paragraph. This should not be done where the conditions are such that the cleaning fluids may leak into the windings. In such cases, this step should be omitted.

5. Drain the mineral oil thoroughly; then pack housing half full with fresh, clean grease.

High Temperature Grease

Bearings which normally operate at a temperature above 194° F (90° C) should be lubricated with a silicone grease in accordance with Military Specification MIL-L-15719A, Stock No. W9150-257-5358. Machines which require this special grease have a caution plate stating "USE HIGH TEMPERATURE GREASE" which is attached near the grease fitting by the manufacturer.

Overheated Bearings

The temperature of sleeve bearings and the outer races of ball bearings should not be allowed to exceed the following values.

1. Sliding contact (sleeve) bearings 82° C (180° F).

2. Rolling contact (ball) bearings on class A or B insulated motors 90° C (194° F).

3. Rolling contact (ball) bearings on class H insulated motors 150° C (300° F).

The permissible operating temperature is too high to be estimated by sense of touch. Temperature measurements are needed to determine whether a bearing is overheated. A thermometer securely fastened to the bearing cover or housing will usually give satisfactory measurements. A thermometer should not be inserted into a bearing housing, it may break and necessitate disassembly to remove glass and mercury.

CORRECTIVE MAINTENANCE

DOUBLE SHIELDED OR DOUBLE SEALED BALL BEARINGS SHOULD NEVER BE DISASSEMBLED OR CLEANED. These bearings are prelubricated and cleaning will remove the lubricant from the bearings or at least dilute the lubricant until it no longer possesses its original lubricating qualities.

Permanently lubricated ball bearings require no greasing. Equipment furnished with these bearings can be recognized by the absence of grease fittings or provision for attaching grease fittings. When permanently lubricated bearings become inoperative, they should be replaced with bearings of the same kind. If not already provided, nameplates reading "DO NOT LUBRICATE" should be attached the bearing housings of machines with sealed bearings.

Open, single shielded, or single sealed ball bearings can be cleaned, but this should be done only in an emergency when a suitable replacement is not available. It is difficult to remove dirt from ball bearings. Unless carefully done, more dirt may get into the bearings than is removed.

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If cleaning an open, single shielded, or single sealed bearing is necessary, the bearing should be taken off the shaft with a bearing puller applied to the inner race of the bearing or to a sleeve which applies pressure to the inner race. Removal of bearings by pulling on the outer race tends to make the balls dent the raceway even if the puller is used. In instances where faulty operation has subjected the bearing to such extreme temperatures as to distort the race and balls and cause the race to shrink to the shaft more tightly than the original fit, care must be taken not to injure the shaft when removing the bearing.

After removal, the bearing should be thoroughly cleaned. A good cleaner to use is Stoddard solvent or clean oil. Soak the bearing in the cleaner for as long as necessary to dislodge dirt or caked grease from around balls and separators. After the bearing is cleaned, wipe it carefully with a dry, lint-free cloth. If compressed air is used for drying, direct the air stream across the bearing so that the bearing does not spin. Because dry bearings rust quickly, protect the bearing at once by coating it with clean, low-viscosity lubricating oil from an oil can.

Rotate the inner ring slowly by hand, and if the bearing feels rough, repeat the cleaning. If the bearing still feels rough when turned slowly by hand, it is not fit for use.

When installing either cleaned or new bearings, observe the precautions in chapter 9430, NavShips Technical Manual. Install double shielded or double sealed, cartridge type bearings as they are received because these are pre-lubricated. With open, single shielded, or single sealed bearings, however, the protective compound should be washed away, and the operating lubricant added to the bearing. Even after the bearings have been cleaned and inspected, the following points must be checked before actual bearing installation.

1. Shaft and housing diameters must conform to dimensional tolerances in the applicable specification.
2. Shaft and bearing seats must not be out-of-round or tapered.
3. Housings must be inspected for splits or cracks.
4. Shafts must be inspected for straightness.
5. Shaft and housing shoulders must be adequate and not out-of-square with the shaft.
6. Shafts, bearing housings, keyways, splines, etc., must be clean and lightly oiled.

There are four acceptable methods for mounting bearings.

1. Arbor press method. If available and adaptable, an arbor press can be used if proper precautions are taken. Place a pair of flat steel blocks under the inner ring or both rings of the bearing. Never place blocks under the outer ring only. Then line up the shaft vertically above the bearing, and place a soft pad between shaft and press ram. After making sure the shaft is started straight in the bearing, press the shaft into the bearing until the bearing is flush against the shaft or housing shoulder.

2. Infrared method. If a bearing is heated to expand the inner ring for assembly, heating can be done by the use of an infrared oven. The bearing should not be heated above 200° F. This method ensures uniform heating all around the bearing.

3. Oven method. Alternatively, bearings can be heated to expand the inner ring for assembly in a temperature controlled furnace at a temperature not to exceed 200° F. The bearing should not be left in the furnace beyond the time necessary to expand the inner race the desired amount, since heating for an excessive period of time would give rise to the possibility of deterioration of the grease with which the bearing is prelubricated.

4. Hot-oil method. A fourth method used in installing bearings is the hot-oil method which consists of heating the bearing in oil at 200° F until expanded and then slipping it on the shaft. This method is not desirable and should not be used unless absolutely necessary. The disadvantages of the hot oil method are:

1. The possibility of grease deterioration.
2. The possibility of bearing growth.
3. Inadequate or no temperature controls.
4. The possibility of contaminating the grease by use of dirty oil.

A most important point to be remembered and strictly followed is that when pressing a bearing onto a shaft, pressure must be applied to the inner ring, but when pressing a bearing into a housing, pressure must be applied to the outer ring.

Before the final assembly has been completed, the entire unit should be thoroughly checked for alignment.

The bearing should be packed with the proper lubricant and the cleaned bearing housing should be half filled with the same lubricant. The housing must be properly assembled and care must be exercised to prevent omission of bearing

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parts, lubricant seals, grease pipes, plugs, and fittings. These parts must be securely assembled to complete the housing closure and protect against the entrance of foreign materials. Bolts should be tightened evenly. Any "V" grooves in the housing lip should be filled with grease which will act as an additional seal to protect against entrance of dirt.

BRUSHES

The brushes used in electric motors and generators are one or more plates of carbon, bearing against a commutator, or collector ring (slip ring) to provide a passage for electrical current for an external circuit. The brushes are held in position by brush holders mounted on studs or brackets attached to the brush-mounting ring, or yoke. The brush holder studs or brackets, and brush-mounting ring comprise the brush rigging. The brush rigging is insulated from, but attached to, the frame of the machine. Flexible leads (pigtails) are used to connect the brushes to the terminals of the external circuit. An adjustable spring is generally provided to maintain proper pressure of the brush on the commutator in order to effect good commutation. A d-c generator brush holder and brush-rigging assembly are shown in figure 6-6.

Brushes are manufactured in different grades to meet the requirements of the varied types of service. The properties of resistance, ampere-carrying capacity, co-efficient of friction, and hardness of the brush are determined by the maximum allowable speed and load of the machine in which it is used.

CORRECT BRUSH TYPE

The correct grade of brush and correct brush adjustment are necessary to avoid commutation trouble.

Use the grade of brush shown on the drawing or in the technical manual applicable to the machine, except where Naval Ship Systems Command Instructions issued after the date of the drawing or technical manual (such as the instructions for brushes to be used in electric propulsion and magnetic minesweeping equipment) state otherwise. In such cases, the Naval Ship Systems Command Instructions should be followed. Most of the brushes in shipboard service are of a grade which has satisfactorily passed rigid tests at a Government laboratory and appear on the Qualified Products List as complying with one of six Military grades, S, A, H, D, G, and E. In the case of propulsion and magnetic minesweeping equipment, only one grade of each of two different brush manufacturers is permitted for any machine. This restriction on brush interchangeability is based on the vital nature of the machines involved and on the impracticability of factory testing these machines while operating with several manufacturers' grades which have been qualified under any one of the six military grades.

CARE

All brush shunts should be securely connected to the brushes and the brush holders.

Brushes should move freely in their holders but should not be loose enough to vibrate in the holder.

The following brushes should be replaced with new brushes, the replacement being preceded by cleaning all dirt and other foreign material from the brush holder.

1. Brushes which are worn or chipped to such an extent that they will not move properly in their holders.
2. Brushes which have damaged shunts, shunt connections, or hammer clips.
3. Brushes having riveted connections or hammer clips and are worn to within 1/8 inch of the metallic part.
4. Brushes having tamped connections and without hammer clips and worn to one-half or less of the original length of the brush.
5. Brushes having spring-enclosed shunts and worn to forty percent or less of the original length of the brush exclusive of the head which fits into one end of the spring.

Where brush springs are of the positive gradient (torsion, tension, or compression) type and are adjustable, they should be adjusted as the brushes wear, in order to keep the brush pressure approximately constant. Springs of the coiled band, constant pressure type and certain springs of the positive gradient type are not adjustable except by changing springs. Brush pressure should be in accordance with the manufacturer's technical manual. Pressures as low as 1 1/2 pounds per square inch of contact area may be specified for large machines and as high as 8 pounds per square inch of contact area may be specified for small machines. Where technical manuals are not available, a

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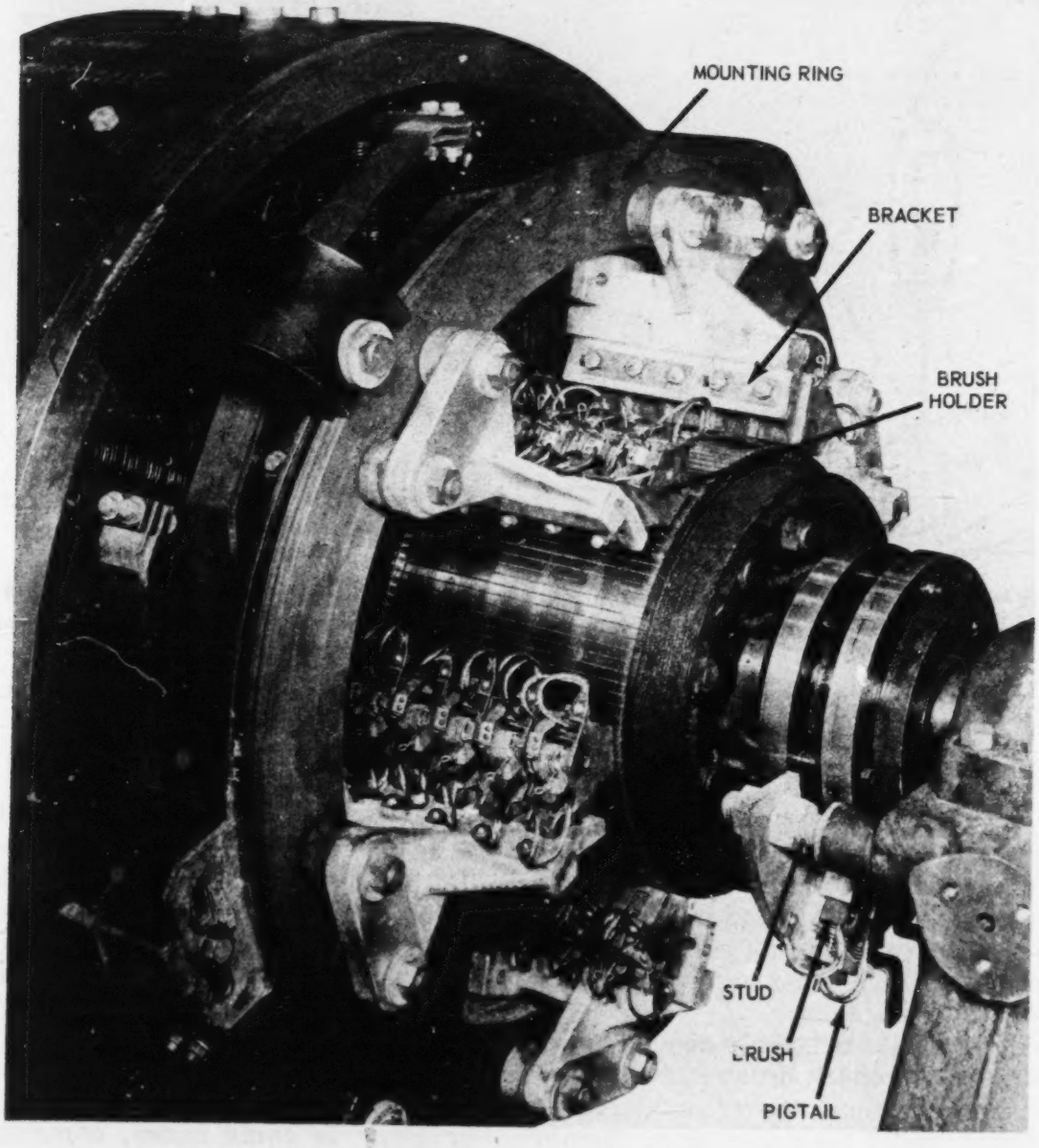

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Figure 6-6.—Brush holder and brush-rigging assembly.

pressure of 2 to 2 1/2 pounds per square inch of contact area is recommended for integral horsepower and integral kilowatt machines, and about twice that pressure for fractional horsepower and fractional kilowatt machines. To measure the pressure of brushes operating in box type brush holders, insert one end of a strip of paper between the brush and commutator; use a small brush tension gage (such as the 0 to 5 pound indicating scale carried in General Stores under Stock No. GS6670-583-0063) to exert a pull on the brush in the direction of the brush holder axis as shown in fig. 6-7. Note the reading of the gage when the pull is just sufficient to release the strip of paper so that it can be pulled out from between the brush and commutator without offering resistance. This reading divided by the contact area may be considered to be the unit operating pressure. Taking correction factors into consideration, the actual pressure will be a few percent lower in the case of brushes operating in the leading position and a few percent higher in the case of brushes operating in the trailing position.

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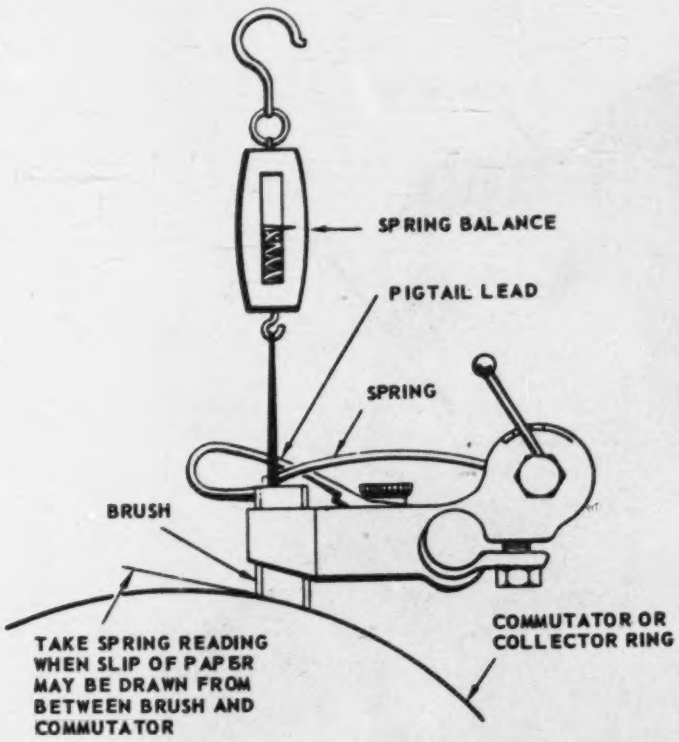

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Figure 6-7.—Measuring brush tension.

All brush holders should be the same distance from the commutator, not more than one-eighth inch, nor less than one-sixteenth inch.

The toes of all brushes on each brush stud should line up with each other and with the edge of one commutator segment.

The brushes should be evenly spaced around the commutator. To check brush spacing, wrap a strip of paper around the commutator and mark the paper where the paper laps. Remove the paper from the commutator, cut at the lap, and fold or mark the paper into as many equal parts as there are brush studs. Replace the paper on the commutator and adjust the brush holders so that the toes of the brushes are at the creases or marks.

Brushes should be staggered as shown by the correct method in figure 6-8A to prevent grooving of the commutator. The incorrect method of staggering, shown in figure 6-8B gives unsatisfactory results because the pitting effect is different under positive and negative brushes. For machines having a number of poles equal to two times an odd number, it will obviously not be possible to stagger all the brushes in accordance with the correct method. Stagger all but

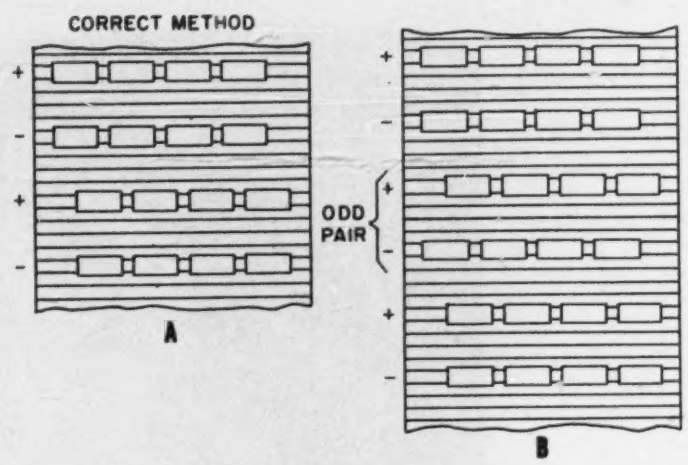

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Figure 6-8.—Method of staggering brushes.

the odd pair of positive and negative brushes in accordance with the correct method, and the odd pair in accordance with any two adjacent rows in the method of figure 6-8B.

SETTING ON NEUTRAL

When a machine is running without load and with only the main-pole field windings excited, the point on the commutator at which minimum voltage is induced between adjacent commutator bars is the no-load neutral point. This is the best operating position of the brushes on most commutating-pole machines. Usually, the brush studs are doweled in the proper position, and the correct setting is indicated on a stationary part of the machine by a chisel mark or an arrow. In some cases, commutation may be improved by shifting the brushes slightly from the marked position.

The correct neutral position can be found by the use of:

(a) The mechanical method.
(b) The reversed rotation method.
(c) The inductive kick method.

The mechanical method is an approximate method. Turn the armature until the two coil sides of the SAME armature coil are equidistant from the center line of one MAIN field pole. The commutator bars to which the coil is connected give the position of the mechanical neutral.

Use of the reversed rotation method is possible only where it is practicable to run a machine

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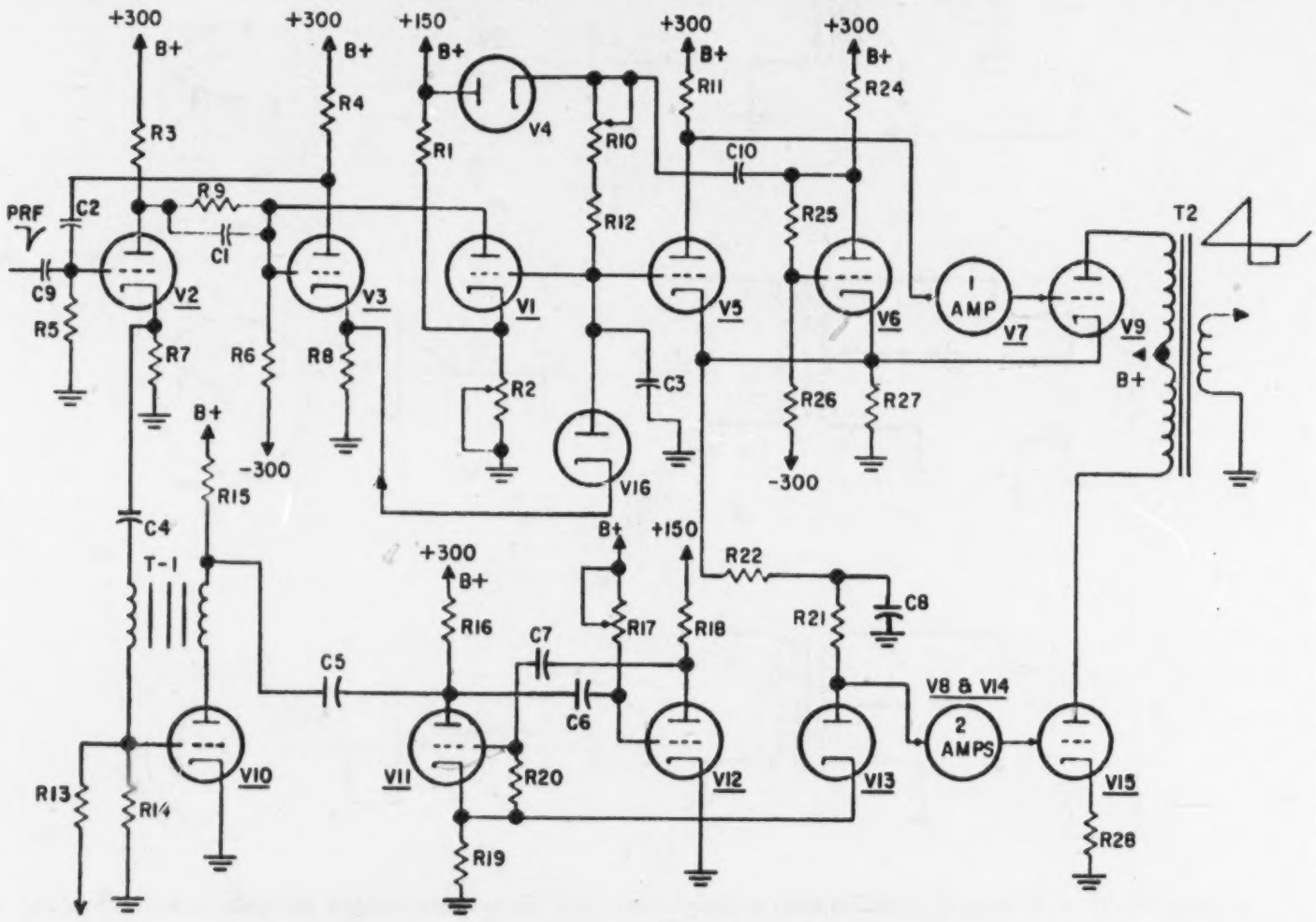

Figure 17-27. —PPI sweep circuit, simplified schematic.

is developed in the plate winding of V15 and a voltage is induced in the secondary. This voltage will cause a square wave of current in the secondary, in the opposite direction to the sawtooth of current. The square wave must be developed at the end of the sweep time. V13 is cut off with a positive voltage on its cathode. The positive voltage to cut off V13 is developed by driving V11 into conduction. V11 is driven into hard conduction by the positive-going voltage from the plate of V12, when V12 is cut off. V12 is cut off by a negative pulse from a single-cycle blocking oscillator, V10. V11 and V12, with associated parts, constitute a free-running multivibrator. The time that V11 is conducting is equal to the time that V12 is cut off. This time is controlled by the setting of R17. R17 is adjusted for the proper compensation. If the arm of R17 is moved up, the time duration of the compensation gate will increase. Too much compensation results in an open-center presentation on the scope.

To insure that the compensation gate is generated at the end of the sweep, a square wave of voltage is taken from the cathode of V2; the negative portion of the square wave occurs during sweep time. The square wave is differentiated by the coupling capacitor C4 and R14. At the end of sweep time, a positive pulse will trigger V10 and a negative pulse is coupled from the bottom of R15 through C5 and C6 to the grid of V12. This pulse will synchronize the free-running multivibrator (V11 and V12). Therefore, the compensating gate always occurs at the end of sweep time.

MARKER CIRCUITS

Marker circuits consist primarily of range marks (fixed and variable), an azimuth marker, and a marker-mixer circuit.

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in either direction of rotation, with rated load applied. This method differs for motors and generators. For motors, the speed of the motor is, at first, accurately measured when the field current becomes constant under full load at line voltage with the motor running in the normal direction. Then, the rotation of the motor is reversed, full load is applied, and the speed is again measured. When the brushes are shifted so that the speed of the motor is the same in both directions, the brushes will be in the neutral position. Generators are run at the same field strength and same speed in both directions, and the brushes are shifted until the full-load terminal voltage is the same for both directions of rotation. To ensure accuracy, a reliable tachometer must be used to measure the speed of the machines for this method.

The kick method should be used only when the other methods are inadequate and the conditions are such as to warrant the risks involved, and then only when sufficient resistance is connected in series with the field coils to reduce the field current to approximately 10 percent of normal value.

The rapid interruption of full field current induces voltages which are dangerous to personnel and which may cause the breakdown of insulation. With a lead pencil or other means that will not damage the surface, mark A on a commutator bar under one set of brushes. Mark B on another bar one pole pitch away from the center of the bar marked A. A pole pitch is the angular distance from the center of one main pole to the center of the next main pole. Raise all brushes. Connect bars A and B to a low range voltmeter having two or three scales (for example, 0-0.5, 0-1.5, 0-15 volts). Use leads with pointed prongs to connect the bars. Separately excite the shunt field winding from a d-c source connected to the winding in series with a high resistance and a quick-break switch. Start with the minimum obtainable value of field current and the high range scale of the voltmeter.

Close the knife switch, wait for the momentary deflection to disappear, open the knife switch, and note the momentary deflection or kick of the voltmeter. If insufficient deflection is observed on the lowest range scale of the voltmeter, decrease the resistance connected in series with the shunt field winding and repeat the procedure until an adequate deflection is obtained on the voltmeter when the switch is opened. Retain this setting of the resistor for remainder of the test. Turn the armature slightly until the position is found at which the minimum kick is produced when the field current is broken. Bars A and B will then be on neutral. If one pole pitch from the center of bar A does not fall on a bar, but on the mica between two bars, mark the bars next to the mica, C and D. Then measure the kick when bar A and bar C are connected to the voltmeter, and again when A and D are connected to the voltmeter. Adjust the position of the armature until these two deflections are equal and opposite. The center line of bar A and the mica between bars C and D will then be on neutral.

SEATING

Accurate seating of the brushes must be assured where their surfaces contact the commutator. Sandpaper and a brush seater are the best tools to accomplish a true seat.

All power must be disconnected from the machine, and every precaution must be taken to ensure that the machine will not be inadvertently started before using sandpaper to seat the brushes. The brushes to be fitted are lifted, and a strip of fine sandpaper (No. 1) approximately the width of the commutator, is inserted (sand side up) between the brushes and the commutator. With the sandpaper held tightly against the commutator surface to conform with the curvature and the brushes held down by normal spring pressure, the sandpaper is pulled in the direction of normal rotation of the machine (fig. 6-9).

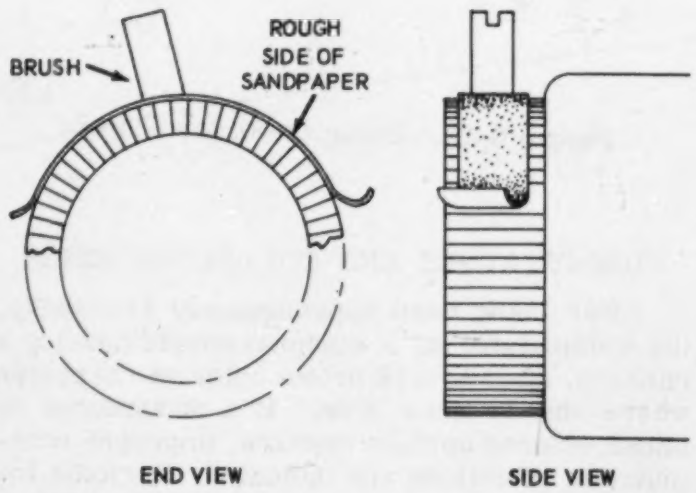

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Figure 6-9.—Method of sanding brushes.

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When returning the sandpaper for another pull, the brushes must be lifted. This operation is repeated until the seat of the brush is accurate. Always finish with a finer grade of sandpaper, No. 0. A vacuum is required for removing dust while sanding. After sanding, the commutator and windings must be thoroughly cleaned to remove all carbon dust.

The brush seater is compounded of a mildly abrasive material loosely bonded, and is formed in the shape of a stick about 5 inches in length. The brush seater is applied to the commutator while the machine is running, and every precaution should be taken to prevent injury to the person applying it. The brush seater is touched lightly, for a second or two, exactly at the heel of each brush (fig. 6-10). If placed even one-fourth inch away from the heel, only a small part of the abrasive will pass under the brush. Pressure may be applied to the brush by setting the brush spring tension at maximum or by pressing a stick of insulating material against the brush. The dust is removed during the operation, and the machine is thoroughly cleaned afterwards in the same manner as for sanding brushes.

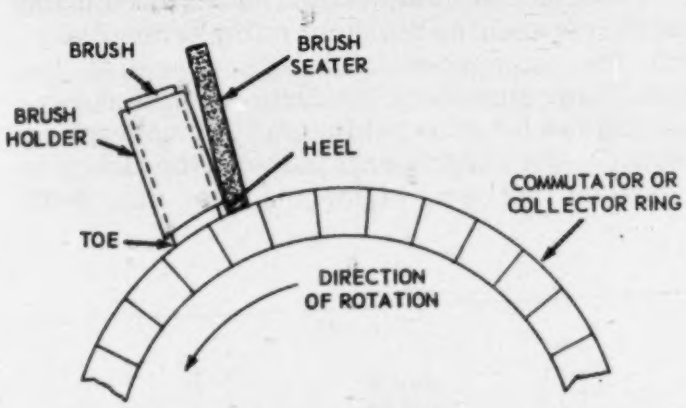

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Figure 6-10.—Using the brush seater.

COMMUTATORS AND COLLECTOR RINGS

After being used approximately two weeks, the commutator of a machine should develop a uniform, glazed, dark brown color on the places where the brushes ride. If a nonuniform or bluish colored surface appears, improper commutation conditions are indicated. Periodic inspections and proper cleaning practices will keep commutator and collector-ring troubles at a minimum.

CLEANING

One of the most effective ways of cleaning the commutator or collector rings is to apply a canvas wiper while the machine is running. The wiper can be made by wrapping several layers of closely woven canvas over the end of a strong stick between one-fourth and three-eighths inch thick (fig. 6-11). The canvas may be secured with rivets if they, in turn, are covered with linen tape to prevent the possibility of their contacting the commutator. When the outer layer of canvas becomes worn or dirty, it is removed to expose a clean layer. The wiper is most effective when used frequently. On ship's service generators, it may be desirable to use the wiper once each watch. When using the wiper, exercise care to keep from fouling moving parts of the machine. The manner of applying the wiper to a commutator is illustrated in figure 6-12.

When machines are secured, a toothbrush can be used to clean out the commutator slots, and clean canvas or lintless cloth may be used for wiping the commutator and adjacent parts.

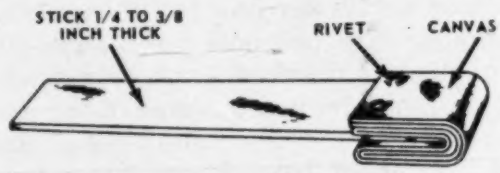

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Figure 6-11.—Canvas wiper.

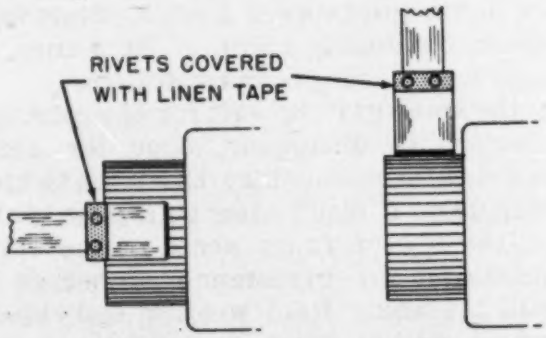

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Figure 6-12.—Using the canvas wiper on a commutator.

In addition to being cleaned by wiping, the commutator should be periodically cleaned with a vacuum cleaner or blown out with clean, dry air.

A fine grade of sandpaper, No. 00, may be used to clean a commutator that is only slightly rough, but not out of true. Sandpapering is recommended for reducing high mica, and for finishing a commutator that has been ground or turned. The sandpaper, attached to a wooden block shaped to fit the curvature of the commutator, is moved slowly back and forth across the surface of the commutator while the machine is running at moderate speed. Rapid movement or the use of coarse sandpaper will cause scratches. Emery cloth, emery paper, or emery stone should never be used on a commutator or collector ring.

CARE OF COMMUTATORS

Commutators must be true within close limits. For the most satisfactory operation, runout (eccentricity) of the commutator surface (as checked on the radius with an indicator) should not exceed two mils (0.002 inch). Handstoning, grinding with a rigidly supported stone, and turning the commutator are measures that will correct some or all out-of-true conditions of the commutator.

For handstoning, the machine should be running at, or only slightly below, rated speed. For motors, remove all except enough brushes to keep the armature turning at the proper speed. The stone to be used should fit the curvature of the commutator and have a surface substantially larger than the largest flat spot to be removed. Hold the stone in the hand and move it very slowly back and forth, parallel to the axis of the commutator, applying only enough pressure to keep the stone cutting (fig. 6-13). Crowding the stone will roughen the surface. Care must be exercised to avoid electric shock and to prevent jamming the stone between fixed and moving parts of the machine.

Either a nonrotating or a revolving stone can be used when grinding the commutator with a rigidly supported stone (fig. 6-14). Irrespective of which stone is used or whether the grinding is done with the commutator within the machine or in a lathe, extreme care must be taken to align the supports so that the motion of the stone is accurately parallel to the axis of the commutator. Failure to properly align the supports will taper the commutator, and failure to maintain the support rigid will cause the stone to dig into the commutator.

For turning, the armature should be supported in a lathe (fig. 6-15). A cutting tool that is rounded sufficiently so that the cuts will overlap must be used to make the cut. Proper cutting speed is about 100 feet per minute with the feed about 0.010 inch per revolution. Depth of the cut should not exceed 0.010 inch.

The windings of the machine must be adequately protected from grit during stoning and grinding operations conducted with the commutator in the machine. Afterwards, the brushes, brush holders, and commutator must be thoroughly cleaned, and a complete insulation test should be made to determine that no grounds or short circuits exist. After the truing-up operation has been completed, regardless of the method used, always finish with a fine grade of sandpaper, undercut the mica to a depth no greater than one-sixteenth inch, and slightly bevel the edges of the commutator bars.

When the oxide film (dark brown color) has been removed by truing operations, it can be replaced by burnishing the commutator with a hardwood block. After the end grain of the block has been shaped to the curvature of the armature, the block is pressed hard against the surface of the commutator while the machine is running. A commercial burnishing stone may also be used for this purpose. Less pressure is required in applying the stone because friction is greater, and the heat developed is high. Do not raise the commutator temperature above its normal operating level.

Commutator mica that has become carbonized loses its insulating value. The carbonized portion should be scraped out and replaced with sodium silicate or other insulating cement. Poor commutation will develop if the commutator bars are worn down to, or below, the level of the mica. The mica should be undercut to a depth of between three sixty-fourths inch and one-sixteenth inch below the level of the commutator bars. A small motor-driven, circular saw especially designed for this purpose, a slotting file having an angle of 60° between faces, or a hacksaw blade that has been ground to the right thickness and fitted to a handle may be used for undercutting mica. Before using the motor-driven circular saw, install a canvas cover around the armature in a manner to prevent copper dust from becoming embedded in the armature windings. When undercutting has been

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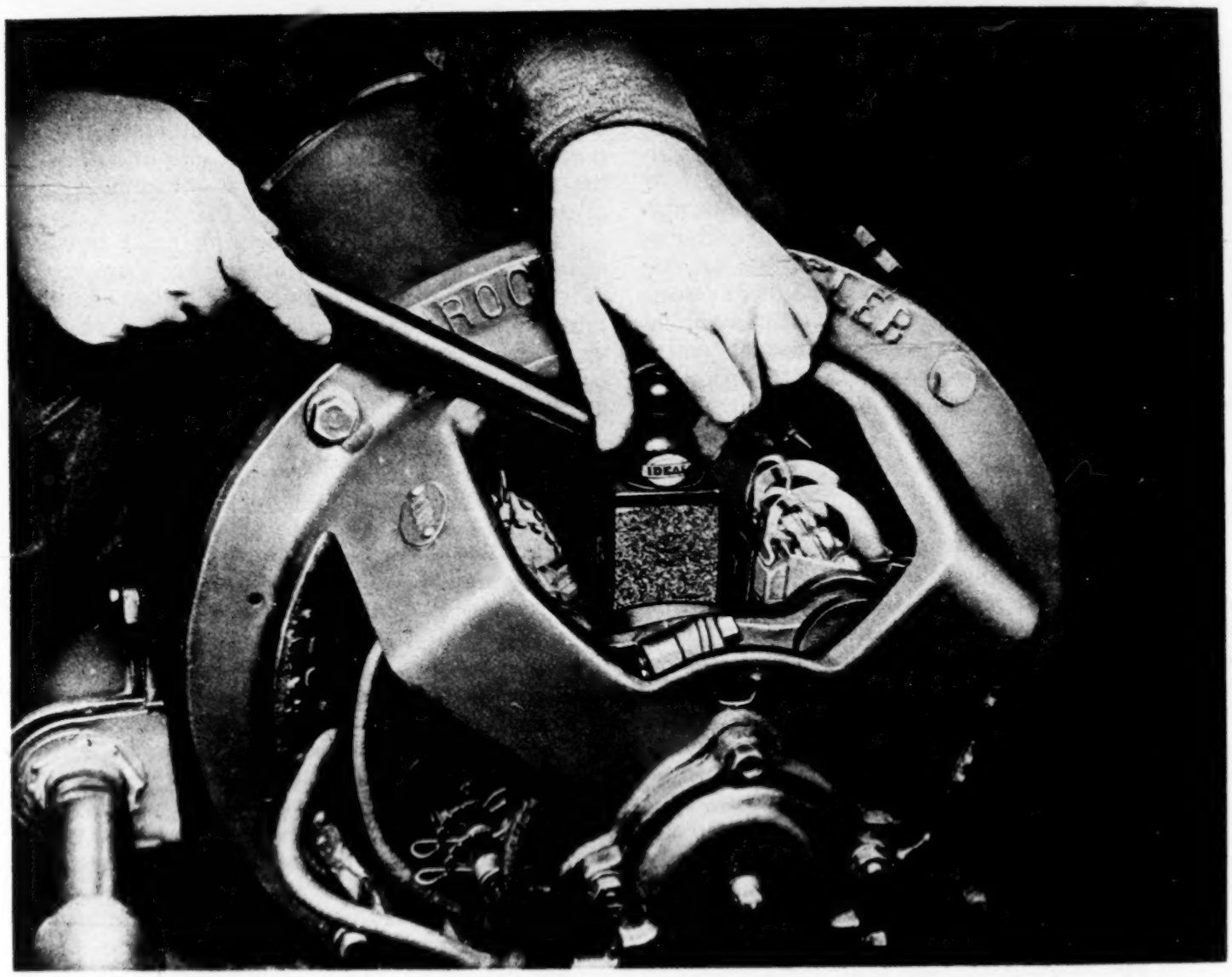

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Figure 6-13.—Handstoning the commutator.

completed, the edges of the bars should be beveled to a depth about one thirty-second inch below the surface. Finally, all mica, copper dust, and other foreign materials must be cleaned from the slots and commutator.

CARE OF COLLECTOR RINGS

Collector rings (slip rings) require the same careful attention as the commutator. Out-of-round conditions of the rings may be corrected in the same manner as for commutators, except for the fact that crocus cloth is used to apply a mirror-like finish following any turning, grinding, or sanding operations.

Pitting can develop because of the electrolytic action on the surface of collector rings caused by current flow. It may occur in only one ring, but will be general over the whole ring area. This condition can be corrected by reversing the polarity of the rings every few days. Reversing the polarity of the a-c field of a 3-phase generator will not affect the phase rotation of the generator.

Field current must not be left on while a machine is secured because it will cause spot pitting and burning of the rings beneath the brushes.

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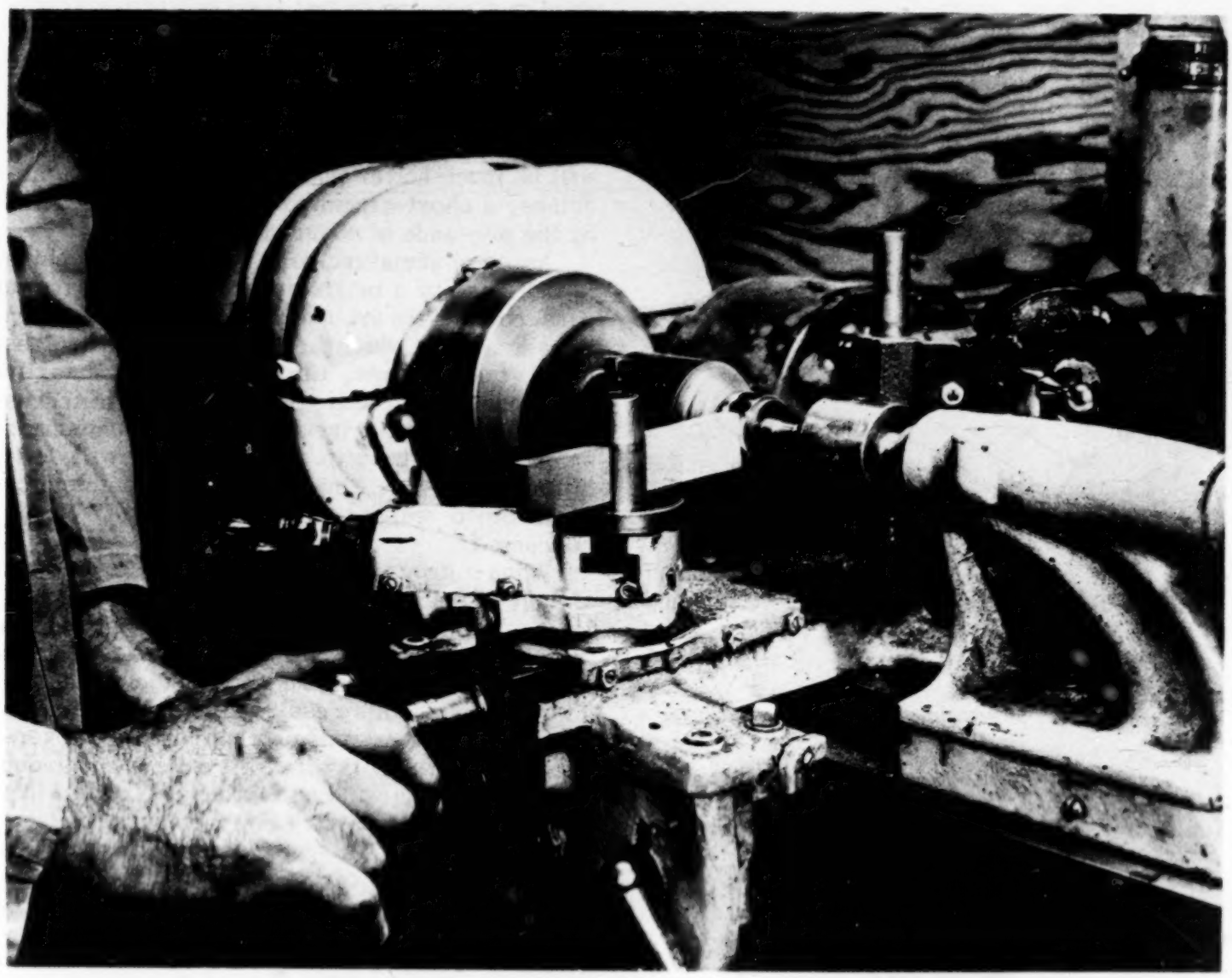

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Figure 6-14.—Grinding the commutator with a rigidly supported stone.

ARMATURES

Preventive maintenance of an armature consists of periodic inspections and tests to determine its condition, and proper cleaning practices to preserve the insulation.

Frequent checks must be made of the condition of the banding wire that holds down the windings of the d-c armature to see that the wires are tight, undamaged, and have not shifted (fig. 6-16). At the same time, the clips securing the wires should be checked to see if solder has loosened. When repairs are required, banding-wire size, material, and the method of original assembly should be duplicated as far as possible. Only pure tin must be used for soldering banding wire.

Periodically, all end windings should be inspected and cleaned (fig. 6-16). Allow sufficient clearance between the end windings and end brackets or any air deflecting shields to prevent chafing or other damage. In cases where shop overhaul is not feasible, air-drying varnish may be applied to the windings by brush after they have been cleaned and dried.

Risers must be inspected periodically to determine the condition of the solder that secures the windings to the segments (fig. 6-16). All dirt

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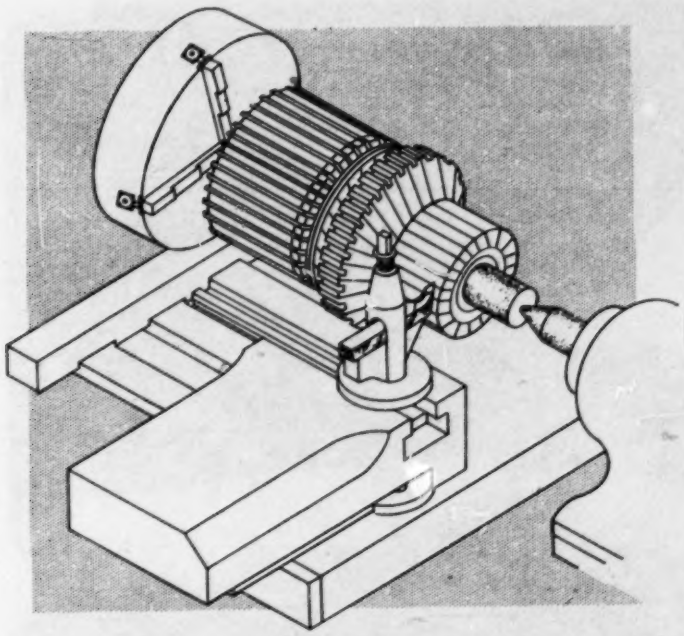

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Figure 6-15.—Truing commutator by turning.

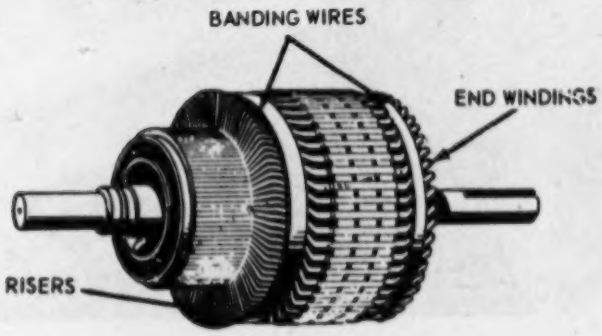

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Figure 6-16.—D-c armature.

and lint should be removed by thorough cleaning to ensure that cooling passages will not be clogged. It may be necessary in the case of generators to do this each time the machine is secured. Cleaning is easier when performed while the machine is warm.

TROUBLE INDICATIONS

Some armature troubles may be detected while making inspections of running machines. Heat and the odor of burning insulation may indicate a short-circuited armature coil. In a coil that has some turns shorted, the resistance of one turn of the coil will be very low, and the voltage generated in that turn will cause a high-current flow, resulting in excessive heating, which will cause the insulation to burn. If the armature is readily accessible, the short-circuited coil can be detected immediately after stopping the machine because the shorted coil will be much hotter than the others. In idle machines, a short-circuited coil may be identified by the presence of charred insulation.

An open armature coil in a running machine is indicated by a bright spark, which appears to pass completely around the commutator. When the segment to which the coil is connected passes under the brushes, the brushes momentarily complete the circuit; when the segment leaves the brushes, the circuit is broken, causing a spark to jump the gap. Eventually, it will definitely locate itself by scarring the commutator segment to which one end of the open coil is connected.

When a ground occurs in an armature coil of a running machine, it will cause the ground test lamps on the main switchboard to flicker on and off as the grounded coil segment passes from brush to brush during rotation of the armature. Two grounded coils result in the same effect as a short circuit across a group of coils. Overheating will occur in all of the coils in the group and burn out the winding. Grounded coils in idle machines can be detected by measuring insulation resistance. A megger, or similar insulation measuring device can be connected to the commutator and to the shaft or frame of the machine in order to properly measure the resistance of the insulation of the coils.

LOCATING TROUBLES

D-c armature troubles are usually confined to one coil or group of coils, and if not readily apparent, the segments to which they are connected can be located by a bar-to-bar test. In some cases, this test may be conducted with the armature installed in the machine. A low-voltage, d-c source, such as a storage battery, lighting circuit, or welding set, is required for this test. The machine must be disconnected from its normal power supply before the test is made and all except one pair of brushes lifted from the commutator. The voltage is applied across the + and - brush through a resistance, lamp, lamp bank, or rheostat. A low-reading voltmeter or millivoltmeter is necessary for taking measurements.

To locate a ground in a d-c armature coil, one lead of the voltmeter is connected to the shaft, and, with the armature in a fixed position, the other lead is touched to each commutator bar in turn. If there is a ground, two or more bars will indicate practically zero readings. Some of these will be real and others will be phantom grounds (fig. 6-17 A). All such bars should be marked with chalk. The armature is then rotated a few degrees and tested again. The real grounds will remain in the same bars while the phantom ones will shift to other bars (fig. 6-17 B). For example, in figure 6-17 B, the phantom ground has shifted from bar b to bar c, while the real ground has remained in bar a. The ground will be in a coil connected to the bar, showing a real ground with the lowest voltage reading.

To locate an open or short circuit in a d-c armature, remove all brushes except those of one positive brush holder and an adjacent negative brush holder. Connect the low-voltage potential to these brushes and adjust the current, if need be, so that the readings obtained with the millivoltmeter will be roughly one-third to one-half full scale. The current must not exceed one-fourth that normally carried by one set of brushes. The voltage drop between two adjacent commutator bars is measured with a millivoltmeter. The armature is held in a fixed position, and the meter leads are moved from one pair of adjacent bars to the next until a test has been made of all the pairs of bars included between the brushes (fig. 6-18). The armature is then turned to bring different bars between the brushes, and these bars are tested. This is repeated as necessary to test all around the commutator. In a simplex winding, an open coil is located where the meter reading is a maximum, and a shorted coil where the reading is a minimum.

For most armatures in use aboard naval vessels, the windings will be free from fault if all the voltage readings are a small fraction of the voltage between the brushes and are equal within the limits of measurement. However, in some cases, a duplex winding may be encountered. This type of winding is indicated when the readings are only a small fraction of the voltage between the brushes and follow each other in a regularly repeating pattern, such as O, R, O,R,O,R, and so on, where R is a reading different from zero. When this happens, a further test must be made by measuring the voltage drop between alternate bars—1 and 3, 2 and 4, 3 and 5, 4 and 6, and so on. If these readings are

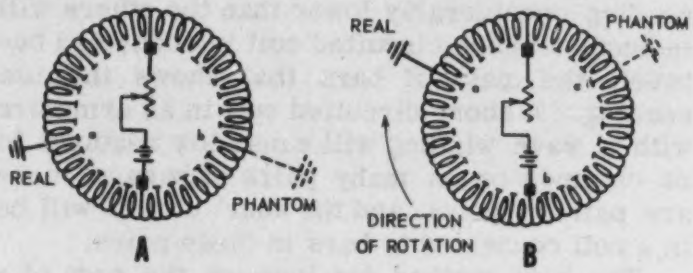

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Figure 6-17.—Real and phantom grounds in bar-to-bar test.

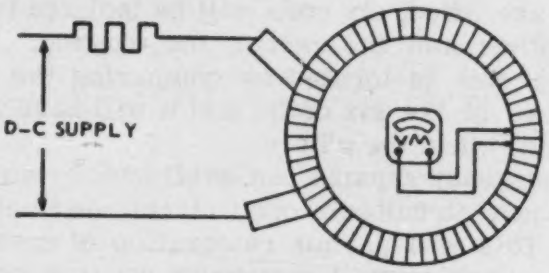

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Figure 6-18.—Testing for an open coil.

equal within the limits of measurement, the winding will be free from faults.

When an open circuit is present, the voltmeter reading across one pair of adjacent bars will be approximately equal to the voltage between the brushes, and zero readings will be obtained on several pairs of bars on each side of the pair with the high reading. The open-circuited coil will be connected to one or both of the bars in the pair with the high reading. Should the voltmeter readings taken between adjacent pairs of bars increase or decrease in magnitude and be alternately plus and minus, a duplex winding is indicated. A further test by measuring the voltage drop between alternate bars is then necessary to locate the open circuit. When a reading approximating the voltage between the brushes is thus obtained, the open-circuited coil will be connected to one or both of the bars in the pair with the high reading.

When a short circuit is present, the interpretation of the indication given by readings between adjacent bars or between alternate bars (duplex windings) depends upon whether the

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armature has a lap or a wave winding. In an armature having a lap winding, a voltmeter reading considerably lower than the others will indicate a short-circuited coil is connected between the pair of bars that shows the low reading. A short-circuited coil in an armature with a wave winding will cause low readings to be obtained on as many pairs of bars as there are pairs of poles, and the short circuit will be in a coil connected to bars in these pairs.

The best method for locating the ends of a faulty coil in a wave-wound armature is to separate the coil from the rest of the winding in the following manner. In a six-pole machine, a short-circuited coil in a wave-wound armature would be indicated at three positions during the test. These positions should be marked with chalk. When the riser connections on these segments are lifted, six coils will be isolated from each other and the rest of the winding. The shorted coil is located by comparing the resistances of the six coils, and it will have less resistance than the others.

Emergency repairs can be effected by cutting out a short-circuited or open-circuited armature coil. This will permit restoration of the machine to service until permanent repairs can be made. However, permanent repairs should be made as soon as possible. The coil is cut out by disconnecting both ends of the coil and installing a jumper between the two risers from which the coil was disconnected. The coil itself is then cut at both the front and rear of the armature to prevent overheating of the damaged coil. A continuity test from one end to the back of the coil will locate the turns of the faulty coil. If a pin or needle is used to puncture the insulation for this test, insulating varnish can be used to fill the tiny hole in the event the wrong coil is pierced. All conducting surfaces exposed by the change in connections should be insulated and all loose ends should be tied securely to prevent vibration.

A-C ROTORS

Basically, the rotors in a-c motors are of two types - the squirrel cage rotor (fig. 6-19) and the wound rotor. The squirrel cage rotor usually consists of heavy copper or aluminum bars fitted into slots in the rotor frame. These bars are connected to short-circuiting end rings by being cast or brazed or welded together (fig. 6-19 A). In many cases, the cage rotor is manufactured by die-casting the rotor bars, end rings, and cooling fans into one piece (fig. 6-19 B). The cage rotor requires less attention than the wound rotor. However, the cage rotor should be kept clean, and the rotor bars must be checked periodically for evidence of loose or fractured bars and localized overheating.

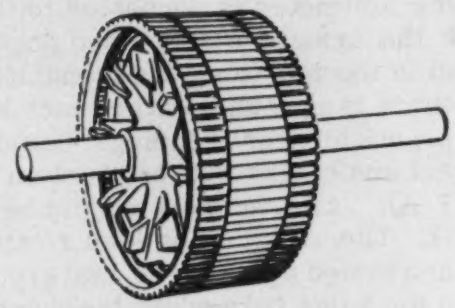

A - WELDED ROTOR BARS AND END RINGS

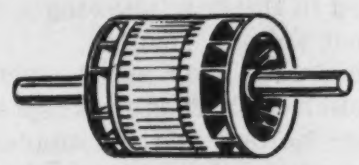

B - DIE-CAST ROTOR BARS AND END RINGS

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Figure 6-19.—Cage rotor.

In the wound rotor, the uninsulated bar winding of the cage rotor is replaced with a distributed winding of preformed coils similar to those of a d-c armature. The windings are wye-connected and the ends are brought out to collector rings (fig. 6-20). Wound rotors, like other windings, require periodic inspections, tests, and cleaning. The insulation resistance determine if grounds are present.

An open circuit in a wound rotor may cause reduced torque accompanied by a growling noise, or failure to start under load. In addition to reduced torque, a short circuit in the rotor windings may cause excessive vibration, sparking at the brushes, and uneven collector ring wear. With the brushes removed from the collector rings, a continuity check of the rotor coils will reveal the presence of a faulty coil. Emergency repair of a faulty coil in a wound rotor

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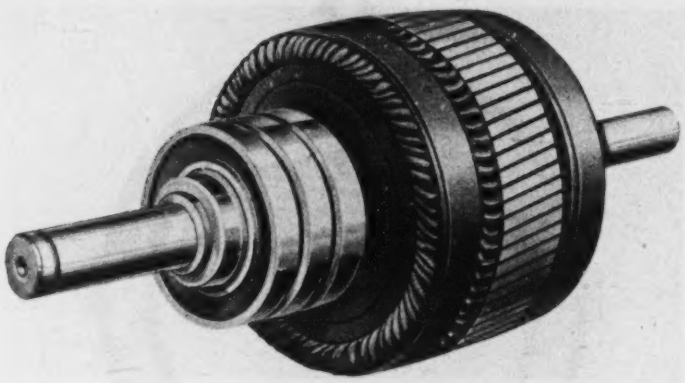

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Figure 6-20.—Wound rotor.

may be effected in the same manner previously prescribed for cutting out a damaged armature coil.

Capacitors used with single-phase motors for starting should be checked by means of a capacity tester. This also applies to the capacitor-start capacitor-run type capacitors.

Some single-phase, a-c motors, such as the split-phase motor, are equipped with a centrifugal switch mounted on the rotor or rotor shaft. This device functions to open the starting winding circuit when the motor has reached almost normal speed. The condition of the device must be checked periodically to determine that the switch contacts are clean and that all moving parts function properly. Stalling while starting or failure to start may indicate a faulty centrifugal switch. If this happens, power to the motor must be secured immediately or the starting winding will soon overheat and burn out.

FIELD COILS

Preventive maintenance of field coils requires periodic inspections and tests to determine the condition of the coil. Coils should be cleaned periodically to remove any foreign particles, which might have collected on them.

LOCATING TROUBLES

The insulation on field coils should be tested periodically to determine its condition. A megger or similar resistance-measuring device may be used for this purpose. If a ground is detected in the field circuits (shunt, series, and interpole) of a d-c machine, the circuits must be disconnected from each other and tested separately to locate the grounded circuit. Then all the coils in that circuit must be opened and tested separately to locate the grounded coil, which can be repaired or replaced as necessary.

If an open circuit develops in the field windings of an a-c or d-c generator that is carrying load, it will be indicated by immediate loss of load and voltage. An open in the shunt field winding of an operating d-c motor may be indicated by an increase in motor speed, excessive armature current, heavy sparking, or stalling of the motor. When an open occurs in the field circuit of a machine, it must be secured immediately and examined to locate the faulty circuit. The open circuit will usually occur at the connections between the coils and can be detected by visual inspection. An open in the coils generally causes enough damage to permit detection by visual inspection. If the faulty coil is not readily apparent, it can be located by applying a low-voltage source (dry batteries) to the terminals of the field winding and using a low-range voltmeter to measure the difference of potential between the terminals of each coil (fig. 6-21). The open-circuited coil will develop the greatest difference in potential between its terminals.

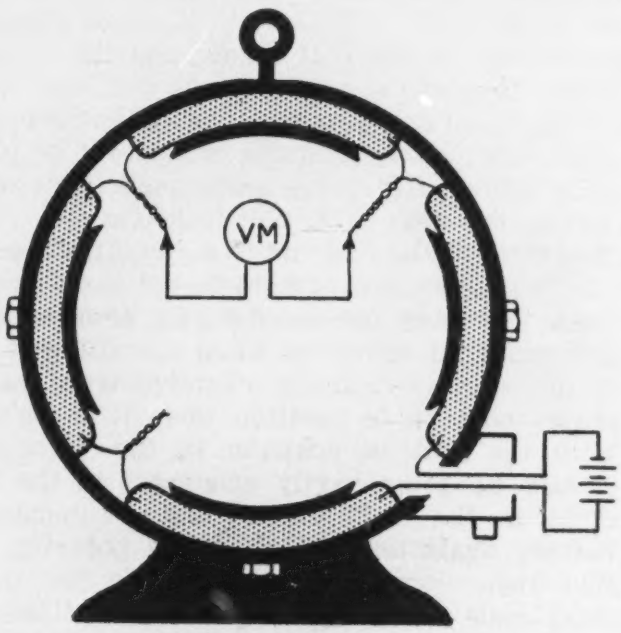

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Figure 6-21.—Testing for an open-circuited field coil.

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A short-circuited field coil in a machine develops an unbalanced magnetic pull and causes vibration. If the short circuit is severe, smoke or the odor of burning insulation will be present. In a generator, a shorted field coil is indicated when it becomes necessary to increase field current in order to maintain voltage with the machine running at normal speed. A machine with a shorted field coil must be secured immediately. The faulty coil can be located by passing normal current through the field circuit and measuring the voltage drop across each coil. The coil indicating the lowest voltage will be the shorted coil.

REPLACING COILS

A field coil may be removed from a large machine without removing the armature. However, the armature should be covered with heavy paper or canvas to prevent damaging it while the coil is being removed. To remove the coil, the field windings are disconnected, and then the bolts securing the pole piece to the frame are removed. The coil and pole piece can be slid from the machine intact. Care must be taken not to lose or misplace any of the shims found on the pole piece.

Before installing a new or repaired coil, its polarity must be determined and it should be tested for shorts, opens, and grounds. A small magnetic compass may be used to determine the polarity of a field coil. A small battery is connected to the coil leads, and the compass points toward the center of the coil, the face of the coil nearest the compass will be a north pole. This will indicate that the coil should be placed on a north pole in the same position it was in during the test, and the field current should flow through the coil in the same direction.

To protect the armature, the same precautions that were observed during removal of the coil must be observed when installing it. All of the shims originally removed from the pole piece must be in position when it is replaced. With the coil in position in the machine, it should be temporarily connected to the other coils in the field circuit and a compass and battery again used to check its polarity. For this test, connect the battery to the proper field leads and check the polarity of all the coils with the compass (fig. 6-22). Adjacent poles must be of opposite polarity. If need be, polarity of the new coil can be reversed by reversing its leads. When the polarity is correct, the coil is connected, and the pole-piece bolts are tightened. Air gaps should be measured to ensure uniformity. Before starting the machine, test it thoroughly to ascertain that no grounds, shorts, or opens exist as a result of the repairs.

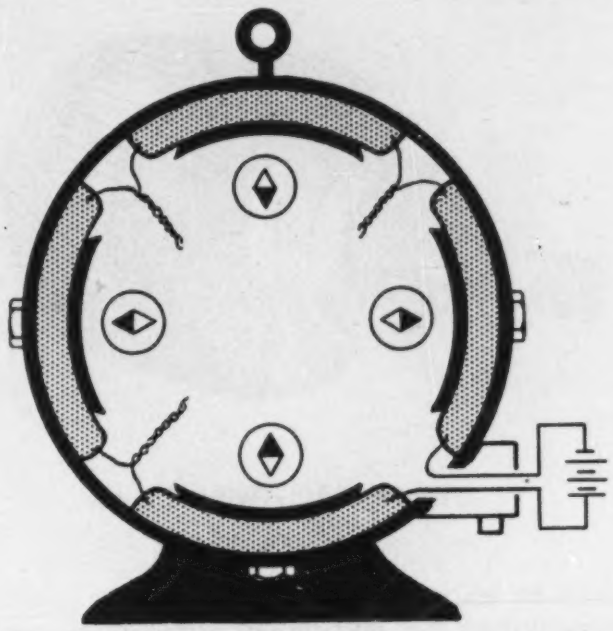

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Figure 6-22.—Testing polarity of field coils.

REWINDING FIELD COILS

Review all available information concerning the machine before rewinding a field coil. This includes reviewing the material history card (NavShips 527A), the resistance test card (NavShips 531), the master drawings, and technical manuals. The old field coil is removed from the pole piece and, if spare coils are available, a new one is installed. If a new coil must be made, record all pertinent coil data as the old coil is stripped down.

This data should include the (1) dimensions of the coil, both with the tape on and with the tape removed, (2) weight of the coil without the tape, (3) size of wire, and (4) type of insulation.

The two general classes of coils are (1) shunt field coils, which consist of many turns of fine wire and (2) series and commutating field coils, which consist of fewer turns of heavy wire. For coils of comparatively few turns, it is essential that exactly the same number of turns of wire are rewound on the coil as were contained in the original coil.

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The primary function of the range marker circuit is to provide range markers to be used in determining range to targets. It also supplies a gating pulse to the intensity gate circuit on normal operation. It consists of a range marker gate, range marker gate cathode follower, range marker switch, range marker oscillator, range marker squaring amplifier, and the final amplifying and shaping circuit called the range marker generator. The output of the range marks are fed to a marker mixer.

The discussion of range marker circuits is contained in chapter 16 of this course.

The azimuth marker is a line produced once each scan to provide the operator with the necessary bearing information. The azimuth-marker circuit generates the electrical pulses which appear as azimuth markers. However, these pulses are not fed directly to the indicators but are fed through the marker-mixer circuit where they are combined with other markers.

The inputs to the marker-mixer circuit are range marks from the range marker circuits and azimuth markers. The function of this circuit is to further amplify these markers before they are fed to the indicators.

Azimuth Marker

The azimuth-marker synchro in the antenna is excited by the azimuth-marker exciter, which is a Hartley type oscillator whose 4000-cycle sine-wave output is applied across the rotor of the azimuth-marker synchro. The rotor of the azimuth-marker synchro, in any position, induces in the stator a 4000-cycle voltage. This voltage varies in amplitude in a sinusoidal manner from zero to maximum in each 180° of rotation of the antenna. The 4000-cycle voltage is then applied to the stator of the differential synchro in the antenna control. The voltage induced in the rotor of the differential synchro is shown in figure 17-28.

The output of the differential synchro is connected to two grid limiters which limits the 4000-cps voltage until it appears as shown in figure 17-29. This action causes the nulls at 180° and 360° to be very narrow.

Consider the static condition of V149 and V151 in figure 17-30 before the arrival of the signal at the grid of V149. The bleeder network R291, R292, and R293 places a bias voltage on the grid of V149, which causes this grid to be at or very near cutoff. The voltage divider R295,

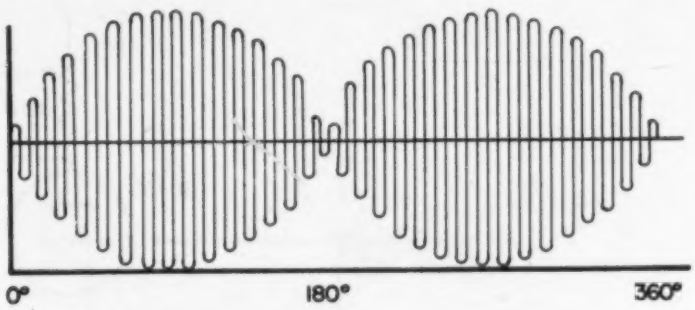

Figure 17-28.—Azimuth-marker exciter output.

R296, and R297 places the grid of V151 at or near zero bias; in this condition, it will oscillate. Therefore, in the rest or static condition, we may consider V149 cut off and V151 oscillating. When the envelope of 4000-cycle voltage is applied to the grid of V149, it will conduct on the positive half of each 4000-cycle alternation. As V149 conducts, its plate voltage is lowered and C187 and C188 assume a d-c average charge corresponding to the average voltage at the plate of V149. This voltage drop lowers the potential at the junction between R296 and R298 and also lowers the voltage at the grid of V151 so that it will not oscillate. Therefore, when a signal is present that will drive the grid of V149 far enough in a positive direction, V151 is biased far enough negative so that there is no output. When the signal drops to zero or into a null point, the grid of V149 goes to cutoff and no plate current is drawn. The grid of V151 will be driven to or near zero potential and V151 will oscillate, causing a marker on the scope. It is obvious that the mark will only be seen during a null, and a relay is provided to eliminate the unwanted null.

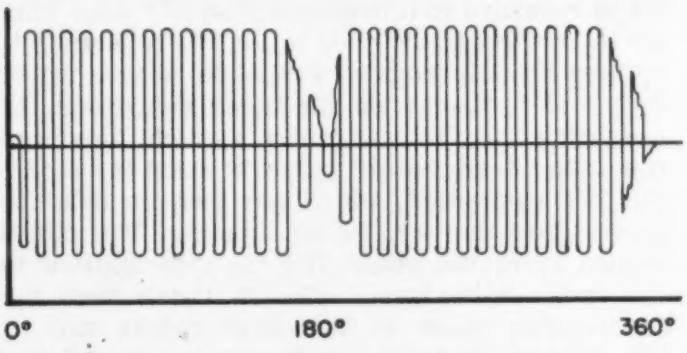

Figure 17-29.—Azimuth-marker differential synchro output.

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The exact number of turns in a shunt coil having many turns of fine wire is not especially important. A slight error would be a very small percentage of the total. The number of turns in a shunt coil can be determined by mounting the defective coil on a lathe face plate, which is attached to a revolution counter, and counting the number of turns as the coil is unwound.

SHUNT COILS.—The equipment for rewinding shunt coils includes a lathe or suitable face plate, which can be turned at any desired speed, and an adequate supply of the proper size wire wound on a spool, which can be supported on a shaft so that it is free to turn. Friction should be applied to the spool to provide tension on the wire. A coil form having the exact inside dimensions of the coil is secured to the lathe or face plate. The form for shaped field coils can be made from a block of wood shaped exactly to the required size and provided with flanged ends to hold the wire in place (fig. 6-23). One of the flanges should be removable so that the finished coil can be taken from the forming block.

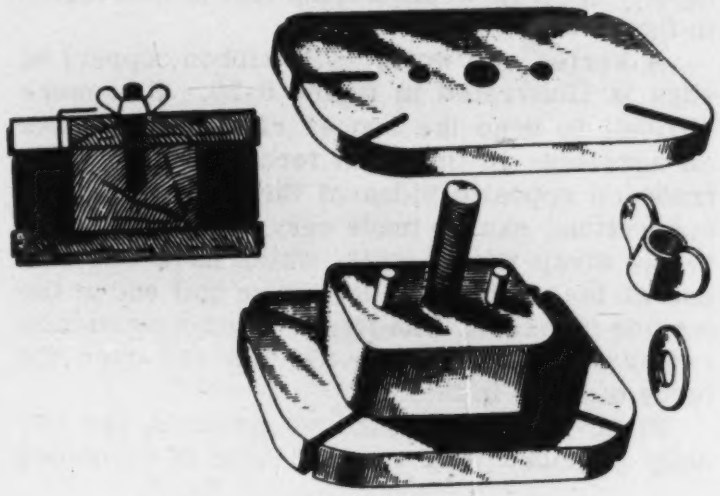

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Figure 6-23.—Coil form for field coils.

The wire is now wound from the spool onto the forming block for the required number of turns. The turns must be evenly spaced, one against the other, until the winding procedure is completed. The turns of the completed coil are secured by tape, and the wire leading to the spool is cut, leaving sufficient length to make the external connections.

The inside lead is led across the coil side, and a piece of fish paper is inserted between the lead and the coil to provide insulation. The inner and outer leads are insulated from the coil with cotton or reinforced mica tape and are secured with tape or cord to prevent shifting (fig. 6-24). The terminal leads are usually heavier than the coil ends and consist of stranded wire, which must have a good soldered connection that is electrically and mechanically secure.

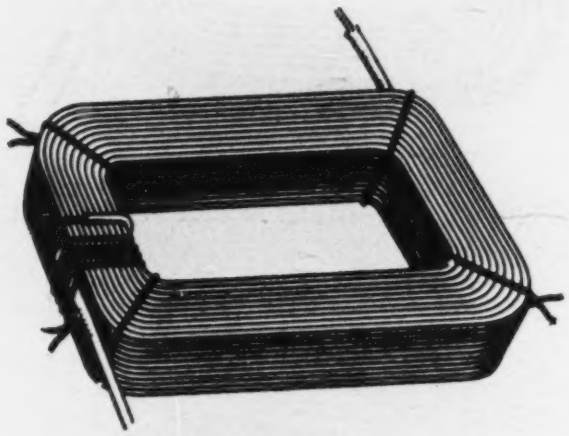

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Figure 6-24.—Rewound shunt coil.

The coil end is doubled back to form a loop, thus increasing its mechanical strength before soldering to the terminal lead. The binder insulation consisting of cotton or glass tape (class A or class B insulation) is applied to the entire coil surface, and the shape of the coil is carefully preserved. The completed coil must be checked electrically for continuity and for shorted turns.

The coil is now prebaked and varnish treated. When varnish treated, the finished field coil should withstand a high-potential test of twice the rated excitation voltage +1,000 volts.

If it is necessary to shape the field coil to fit the inside curvature of the machine frame, it should be bent into shape before applying the varnish. A satisfactory method of bending the field coils is to make a wooden form having two parts that are properly curved. The coil is placed between the two parts and pressed into the required curvature.

SERIES AND COMMUTATING COILS.—Series and commutating field coils are frequently wound with strap (rectangular) or ribbon copper instead of round wire. These coils have only a

few turns that are wound in a single turn per layer. A strap-wound series coil is illustrated in figure 6-25.

A series coil wound (with ribbon copper) on edge is illustrated in figure 6-26. It is more difficult to bend the copper ribbon, but it has an advantage in that both terminal leads protrude on opposite sides of the coil. Thus, the connections can be made very easily compared to the strap-wound coils, which have one coil end at the center and the other coil end at the outside of the coil. The strap-wound construction requires leading the inside coil end over the turns of strap in the coil.

Strap-wound and edge-wound coils are usually provided with a single layer of varnished cambric between the turns, and the entire coil surface is wound with cotton or glass tape (class A or class B insulation). Heavy banding wire well insulated from the turns is usually necessary to retain the ribbon copper turns in place. After the winding is completed, the coil is tested electrically for continuity and shorted turns. It is then prebaked and varnished.

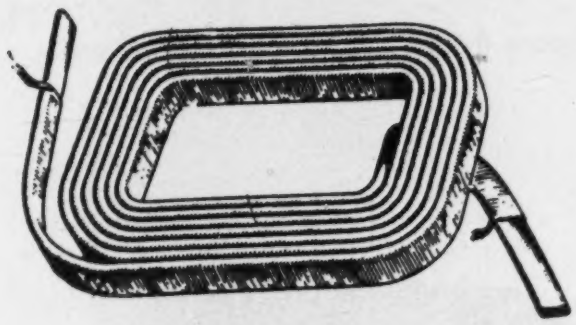

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Figure 6-25.—Strap wound series coil.

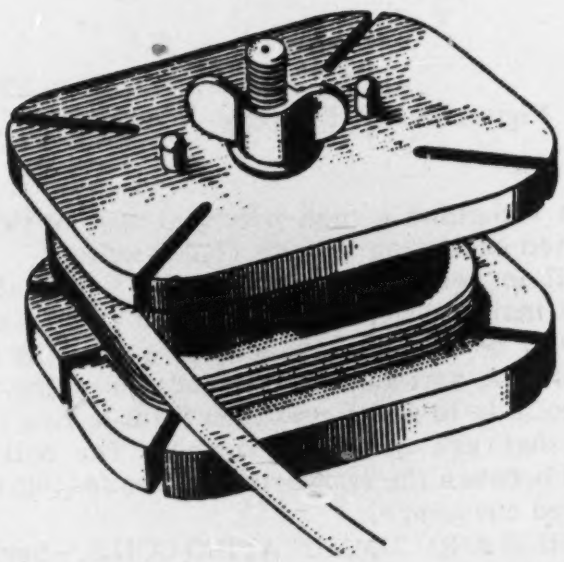

77.84

Figure 6-26.—Edge-wound series coil.

The completed coil must be tested (fig.6-22) for polarity, grounds, opens, and shorts. The polarity test automatically indicates whether or not the coil has an open.

The current should be sent through all the field coils in series (to test for a short), and the voltage drop measured across each coil separately. The new coil should have about the same voltage drop as the other coils. However, if the voltage drop is less than the other coils, the new coil has too few turns or it has been wound with wire that is too large. The growler can also be used as a quick check for shorts.

A-C STATOR COILS

A-c stator windings require the same careful attention as other electrical windings. For a machine to function properly, the stator windings must be free from grounds, short circuits, and open circuits. Frequent tests and inspections are necessary to determine the condition of the windings, and they must be kept clean to preserve the insulation.

A short circuit in the stator of an a-c machine will produce smoke, flame, or the odor of charred insulation. The machine must be secured immediately; the faulty coil may be located if the coil ends are felt before they have time to cool. The shorted coil ends will feel perceptibly hotter than those adjacent to it. Emergency repairs of a faulty stator coil may be effected by cutting it out in the same manner as cutting out a faulty armature coil. However, a new coil must be installed as soon as possible.

Open circuits in a-c stator windings can sometimes be found by visual inspection because the open is usually the result of damaged connections where the coils and circuits are connected together. Should visual inspection fail, resistance measurements between the phase terminals will reveal the presence of open-circuited coils. The coil ends in the faulty phase are tested with an ohmmeter to locate the open-circuited coil. When the open circuit is in an

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maintenance schedule should be prepared and maintained. To be effective, the checkoff list must identify the equipment and indicate when and by whom the maintenance was accomplished. The list should be inspected periodically by the Electrical Officer or Engineer Officer, and when applicable, entries to the effect that certain maintenance has or has not been performed should be made in the appropriate electrical history, current ships maintenance project, or operating logs.

It may not be possible to carry out a complete maintenance schedule on some shipboard equipment because of its inaccessible location. However, the Naval Ship Systems Command required maintenance schedule for motors and generators which follows, should be carried out so far as practicable, and if experience or manufacturer's instructions dictate, should be supplemented by additional or more frequent tests and inspections.

DAILY

1. Check oil level and condition of oil rings in oil-lubricated bearings, and the flow of oil (by sight gage) in force-feed lubricated bearings.
2. Inspect motor and generator surroundings for dripping water, oil, steam, acid, excessive dirt, dust, or chips, and any loose gear that might interfere with ventilation or jam moving parts.
3. Observe running motors for vibration and unusual or excessive noise.
4. Examine each running generator set for cleanliness, vibration, unusual or excessive noise, heating; and condition of brushes, commutators, collector rings, bearings, bolts, and mechanical fastenings.

WEEKLY

1. Check temperatures of bearings and frames. Estimate by touch, and if temperature appears to be excessive, measure with a thermometer.
2. Inspect for leakage of lubricant from generator and motor bearings, as shown by oil or grease on the shaft extension or lubricant creeping towards the winding.
3. Inspect for leakage of lubricant from the bearings of prime movers that drive generators.
4. Inspect commutators of idle machines for commutator condition.
5. Inspect collector rings of idle machines for evidence of corrosion.
6. Inspect all running motor for unusual sparking.
7. Run each generator at partial or full load for at least 30 minutes once a week, and record in log. If it is not practicable to run each set every week because of naval shipyard work, extensive overhaul, or casualty, an entry shall be made in the log stating the facts.
8. Blow out generators that have been in use with clean, dry, compressed air, and wipe with a lintless cloth.
9. Measure the insulation resistance of generators and excitation circuits.

Figure 6-28 is a representative maintenance requirement card which covers the cleaning and insulation resistance readings as required weekly on an emergency generator. Note however, the Maintenance Requirement Card does not include the weekly load testing of the generator, but lists only the minimum required maintenance.

Keep in mind the fact that completion of the requirements as shown on the MRC cards does not cover all of the tests and inspections which are required on your equipment.

MONTHLY

1. Run each generator continuously for at least 4 hours once a month at full-rated load and voltage. Record in log. If it is not practicable to apply full load, the maximum load possible should be used, and an entry should be made in the log, giving the load used, and the reason why full load was not practicable. If it is not practicable to run each generator for this test every month, an entry should be made in the log stating the facts.
2. Inspect the zincs in motors and generators equipped with air coolers.
3. Remove the drain plugs provided in Navy Class A spraytight, watertight, and submersible motor enclosures to drain off water that may have collected in the enclosures. Be sure to replace the drain plugs immediately after draining the motor enclosures. The draining of the motor enclosures should be entered in the log or electrical history, as appropriate, together with an entry giving a rough idea of the amount of water drained off.
4. If operating conditions permit, measure the insulation resistance of each ship's service and emergency generator and exciter, and of

SYSTEM	COMPONENT	M. R. NUMBER
Electric Plant	Emergency Generator	EL-8 W-1
	MAINT. SIGNIFICANT NO.	
SUB-SYSTEM	RELATED M.R.	RATES / M/H
Electric Power Generation	None	EM3 / 1.0

M. R. DESCRIPTION

1. Clean the generator.
2. Measure the insulation resistance of the generator and excitation circuit.

TOTAL M/H 1.0
ELAPSED TIME: 1.0

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Wire air starting valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. 500-volt Megger
2. AN-PSM-4 Multimeter
3. 8" Screwdriver
4. 8" Adjustable wrench
5. Wire, 24 gauge
6. Safety tags
7. 6" Slip-joint pliers
8. Voltage tester
9. Lint-free rags
10. Vacuum cleaner

PROCEDURE

NOTE 1: Measure the insulation resistance weekly, when securing the generator, and before starting a generator that has been idle for one week or more.

Preliminary

a. Wire air starting valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
b. Open generator circuit breaker and tag "Out Of Service." Test with voltage tester to ensure generator side of circuit breaker is de-energized.
c. If installed, open disconnect links and tag "Out Of Service."

1. Clean the Generator.
   a. Remove inspection covers.
   b. Vacuum all interior surfaces and components that can be reached without disassembly of the generator; wipe with dry rags.

(Cont'd on Page 2)

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LOCATION | W

Procedure (Cont'd)

2. Measure the Insulation Resistance of the Generator and Excitation Circuit.

NOTE 2: Measure the stator insulation resistance at the generator side of the generator circuit breaker.

a. Measure the insulation resistance of the stator, using 500-volt megger.
b. Lift the brushes. Measure the insulation resistance of the field from a slip ring to ground, using 500-volt megger.

CAUTION: Do not megger the excitation circuit.

c. Measure the insulation resistance of the excitation circuit from a brush holder to ground, using the multimeter.

NOTE 3: If insulation resistance is less than 0.5 megohm, take corrective action.

CAUTION: Do not snap springs in place; this may crack or chip the brushes.

d. Lower the brushes and reinstall cover.
e. Remove wire and tags. Reconnect starting motor, as applicable.
f. Set up for prescribed operation.

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Figure 6-28.—Maintenance Requirement Card.

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propulsion generators, motors, and exciters in electric drive ships. Record results of the tests on the appropriate megger cards.

QUARTERLY:

1. Inspect pulleys, belts, belt guards, mounting-frame bolts, end-shield bolts, and mechanical fastenings for mechanical soundness and tightness.
2. Check clearance between bearings and shaft on machines with sleeve bearings.
3. Check air gaps, if accessible for measurement, on machines with sleeve bearings. Record measurements taken on appropriate electrical history card.
4. Check end play of motor and generator shafts.
5. Rotate motors through one complete turn and inspect the commutator.
6. Replace wornout brushes.
7. Inspect and tighten brush "pigtails."
8. Check brush alignment parallel to commutator segments.
9. Check distance of brush holders from the commutator.
10. Check bush pressure.
11. Make sure that brush holders are clean and that the brushes move freely in the holders.
12. Blow out and clean motors thoroughly to remove dirt from the commutator, ventilation ducts, and insulation.
13. Measure and record the insulation resistance and temperature of motors.
14. Operate motors at normal load and temperature.

SEMIANNUALLY:

1. Drain, flush out, and renew oil in sleeve bearings.
2. Add grease to ball bearings if required. Record the date and the fact that the machine was lubricated.
3. Inspect all gaskets, particularly lubricant seals. Replace worn gaskets and seals.
4. Inspect armature banding and slot wedges.
5. Inspect the connections of armature coils to commutator risers.
6. Inspect and tighten all electrical connections.
7. Inspect commutator clamping ring.
8. Clean out slots in the commutator and undercut mica if necessary.
9. Inspect the ends of cage rotors for evidence of loose or broken bars or localized overheating.
10. Inspect fans for loose or broken blades.
11. Thoroughly clean all generators.

ANNUALLY:

Inspect all windings and insulation. Clean and repair insulation as necessary.

EVERY TWO YEARS:

Remove bearing caps or other covers as may be provided and observe the condition of ball bearings and lubricant. If no repairs are indicated, flush out the old grease, and replace with fresh, clean grease.

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CHAPTER 7

BATTERIES

This chapter further describes the principles of battery operation contained in Basic Electricity, NavPers 10086-A, and also includes battery maintenance procedures. The EM must give the same careful attention to the operation of storage batteries as he gives to the operation of any other power unit.

DRY BATTERIES

A dry (primary) cell is a unit source of d-c electrical energy derived from chemical action. Dry cells are of the (1) Leclanche, (2) mercury, and (3) low-temperature types. One or more dry cells constitute a dry battery. A dry battery is not completely reversible, and therefore cannot be recharged economically after it has been discharged. Dry batteries are easily transported from place to place and are used as a source of electrical energy to supply circuits that require a low and intermittent current.

LECLANCHE CELL

The Leclanche cell has a nominal open-circuit voltage of 1.5 volts. The positive electrode is a mixture of manganese dioxide and powdered carbon in contact with a carbon rod or plate. The negative electrode may be a piece of zinc sheet, compressed zinc powder or a zinc can. The electrolyte is a paste consisting of ammonium chloride (sal ammoniac), a small amount of zinc chloride and mercuric chloride, water, and starch. The electrical energy is obtained from reactions between the zinc, sal ammoniac, and manganese dioxide, as described under "Battery Chemistry, Dry (primary) Cells" in Basic Electricity, NavPers 10086-A.

MERCURY CELL

The mercury cell has a nominal open-circuit voltage of 1.3 volts. The positive electrode is a mixture of mercuric oxide and carbon. The negative electrode is a zinc plate, compressed zinc powder, or zinc foil. The electrolyte is an aqueous solution of potassium hydroxide. The battery is enclosed in a steel container. The electrical energy is obtained from the reduction of mercuric oxide to metallic mercury and the oxidation of zinc to zinc oxide.

ALKALINE-MANGANESE DIOXIDE CELLS

Cold weather operation at -40° F will reduce the capacity of these cells to approximately 9% of the 70° F capacity, whereas the Leclanche cells are inoperative at -10° F. At 70° F this battery provides about double the capacity requirement for the standard Leclanche cell of similar volume. These cells have a greater cost than Leclanche cells.

HIGH-TEMPERATURE CELL

Magnesium type dry cells have been developed which are capable of withstanding temperatures over 115° F for longer periods of storage time without excessive capacity loss. This type battery is for special purpose use primarily in hot humid climates.

The mercury cell, alkaline manganese dioxide and magnesium cells have superior characteristics for special applications, but are not used as extensively as the Leclanche cell because of the greater cost.

CLASSIFICATION

Dry cells are usually cylindrical or flat, and are manufactured in a wide variety of sizes

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and weights. The classification and requirements for dry batteries used in the Navy are contained in the Military Specification MIL-B-180, dry batteries. This specification lists the type/number, voltage, initial and delayed performance under a specified load, size, and weight of military dry batteries.

Label

In addition to specification sheets for individual battery types, all dry batteries are labeled to provide installation and replacement data (fig. 7-1). This data includes the type designation and code number.

The TYPE DESIGNATION comprises (1) the battery component, (2) battery type number, and (3) installation indicator.

The battery component denoted by the symbol, BA, identifies a dry battery.

The battery type number, 236, following the component symbol, identifies the basic design of the battery and the kind of cell with which it is assembled. Battery type numbers 1 to 999 inclusive indicate Leclanche cells; 1,000 to 1,999 inclusive indicate mercury cells; and 2,000 to 2,999 inclusive indicate obsolete type low-temperature cells.

The installation indicator denoted by the symbol, /U, indicates general utility service. This symbol follows battery type numbers of 200 and above.

The CODE NUMBER, 036, identifies the date of manufacture. The first two digits, 03, indicate the third month (March) and the last digit, 6, indicates the year (1966).

The remainder of the label data includes the manufacturer's name and address.

Terminal Markings

The terminals of a dry battery are indicated with the proper polarity markings, which appear on the top or side of the battery as close as possible to the applicable terminal. The location of the polarity markings depends on the type of terminal, which can include wire leads, Fahnestock clips, binding posts, sockets, and flat caps.

CHARACTERISTICS

Dry cells are rated in volts and hours for various conditions of operation. In other words, the capacity of a dry cell is determined by the length of time required before the terminal voltage drops to a specified end value when the cell is discharged continuously through a fixed resistance. The time is in hours and the load is in ohms. The operating conditions that determine the discharge characteristics of a dry battery are the (1) initial capacity, (2) delayed capacity, and (3) high-temperature storage capacity.

MIL BATTERY BA-236/U
1958-PHILA.-51-7
036
J & J MFG. CO.
PLAINFIELD, N. J.

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Figure 7-1.—Dry battery label.

Initial Capacity

The initial capacity is the time required at normal temperature for the battery voltage to fall below the specified test end voltage, or to show evidence of electrolyte leakage, or swelling of the case when discharging through a specified load.

Delayed Capacity

The delayed capacity is the time required at normal temperature for the battery voltage to fall below the specified test-end voltage, or to show evidence of electrolyte leakage, or swelling of the case after the battery has been stored for a period of time.

High-Temperature Storage Capacity

The high-temperature storage capacity is the time required, after three months humid storage at 113° F., for the battery voltage to fall below the specified test-end voltage, or to show evidence of electrolyte leakage or swelling of the case.

INSTALLATION

Applicable installation practices and safety precautions must be followed when installing

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dry batteries. Fresh batteries of the proper type, size, and shape should be installed initially or as a replacement for a specific installation. They must be connected in accordance with the instructions furnished with the equipment, and all electrical connections should be clean, tight, and well insulated.

If equipment is idle for two weeks or more, remove the batteries, and if such batteries are fairly fresh, return them to storage, with a record showing how long they have been used. Remove and scrap batteries that have had long and hard use.

STORAGE

Dry batteries are perishable and will deteriorate when not in use. To minimize deterioration, they should be stored at temperatures (equal to or less than 35° F in refrigerated spaces that are not dehumidified (dry)). If a refrigerated space is not available, they should be stored in the coolest space possible where they will not be subjected to excessive dampness or large variations in temperature.

Specifications require dry batteries to be wrapped in small unit packages, the unit packages are then sealed in polyethylene plastic bags. This method of wrapping helps to protect the batteries from outside temperature and humidity. The polyethylene bags should not be removed until the batteries are needed for actual use.

Any battery taken from refrigerated storage should be allowed to warm up to between 65° F and 80° F before use in order to obtain maximum battery capacity.

Batteries should not be shipped or stored in the equipment with which they are to be used because they may become discharged by internal chemical reaction or by leakage currents across normally open contacts. These conditions generate water within the cells, and electrolyte may leak out and corrode the equipment. To ensure reliable operation, install fresh batteries in the equipment as near as possible to the time that it will be operated. To avoid damage from electrolyte leakage, remove dead batteries from the equipment.

Shelf Life

The shelf life of dry batteries is the length of storage time beyond which a group of batteries will contain so many dead cells that the entire group is considered unusable. Shelf life depends not only on the kind and size of a cell but also on the application. Batteries containing the smaller cells do not retain their capacity as well as those containing the larger cells. As to use, the shelf life is less for a battery that requires a high initial capacity and a low internal voltage drop on discharge than for a battery that requires less initial capacity retention and a high internal voltage drop on discharge. Shelf-life tables are issued by the various supply offices. These tables are based on general use requirements and indicate a longer shelf life than is tolerable for more critical applications.

The assignment of a certain shelf life to a specific type of battery signifies that a substantial percentage, but not all, of the batteries in the group will be usable if the end of the shelf life is not reached. Test the usability of an individual battery by trying it out in the equipment for which it is to be used or by connecting it to an equivalent load and measuring the closed-circuit voltage. If this voltage is above that required for satisfactory equipment operation, the battery is suitable for use. Always survey batteries when they have reached the end of their shelf life.

Issue

No known nondestructive tests will show the amount of capacity remaining in a battery after it has been partially discharged or stored for a considerable length of time. It is usually good practice to issue the oldest batteries first if they are to be used in the close proximity of the warehouse where replacement stock is readily available. However, batteries issued for use aboard ship where premature failure would cause serious inconvenience, should be less than 6 months old.

SAFETY PRECAUTIONS

Certain types of batteries generate hydrogen, which is very explosive. When working with these batteries, interrupt the current at a remote point before disconnecting them from the equipment.

When a battery is disconnected from the operating equipment, the wire lead terminals of the battery should be insulated to prevent the possibility of a short circuit, which might generate sufficient heat to cause a fire. Also,

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the discharge caused by a short circuit usually produces excessive water in the cells, thereby causing them to burst and spill corrosive electrolyte onto the equipment.

Multicell dry batteries should not be used after the closed-circuit voltage has dropped below 0.9 volt per cell. If the battery is further discharged, current will be forced through some cells that may be completely discharged. This action will generate hydrogen and oxygen due to the electrolysis of the water, with the consequent danger of a hydrogen explosion.

The 300-volt B section of the Navy type 19026 pack battery is capable of imparting a very serious, if not fatal, shock to anyone coming in contact with its terminals.

Mercury-cell batteries may explode if improperly handled. Never discharge a mercury-cell battery after the battery fails to operate the equipment or the voltage falls below 0.9 volts per cell. Never impose a "dead short circuit" on a mercury cell or allow a battery to become overheated. A 400° F temperature is sufficient to cause a mercury cell to explode. Exhausted mercury-cell batteries should be discarded as soon as possible. If not swollen, the steel jackets should have holes punched into them to release any gas which might be formed. If the cells are swollen, either bury them or discard them at sea.

STORAGE BATTERIES

A wet (secondary) cell is a unit consisting of positive and negative plates, separators, cell covers, and electrolyte, properly assembled in a single jar or in one compartment of a monobloc case (molded in one piece). A tray consists of one or more cells assembled in a common container or monobloc case. One cell, one tray of cells, or a number of trays of cells connected in series, parallel, or series-parallel constitutes a storage battery. A storage battery is reversible because the active materials consumed during discharge can be restored by passing a charging current through the battery. The storage cells in general use are the nickel-cadmium and lead-acid types.

NICKEL-CADMIUM CELL

The nickel-cadmium (Ni-Cad) cell is an alkaline storage cell. It is used in aircraft, guided missiles, space satellites, electronic consoles, and for the initial pulse to excite generator fields in some installations. The construction and general arrangement of the cell are similar to that of the lead-acid cell. The negative plate assembly is a cadmium-oxide compound; the positive plate assembly is a nickel-oxide compound; and the electrolyte is a 30 percent solution of potassium hydroxide. Separators between the positive and negative groups prevent internal short circuits. The cell components are assembled in a single plastic jar. The battery case is of fabricated steel. A 6-volt battery contains 5 series-connected cells. When fully charged, the cell voltage ranges from 1.39 to 1.45 volts.

The sealed Ni-Cad battery requires only recharging, no water is added, no hydrometer readings are taken. These batteries are supposed to last a lifetime.

At first glance, the Ni-Cad battery appears to be the answer to all portable power requirements. These batteries are available in sizes ranging from a small button of 20-milliampere-hour capacity to a large 160-ampere-hour cell. Cells are connected in series to obtain higher voltages. The batteries may be vented or hermetically sealed to make them leakproof and capable of operating in almost any position. With proper design, gassing due to overcharging is practically nil.

The Ni-Cad battery may be used over a wide temperature range. It may be stored at -40° F to 140° F and discharged at a maximum temperature of 160° F or a minimum of -60° F if necessary.

The Ni-Cad battery has been tested under extreme weather conditions in Alaska and Arizona for use in automotive equipment. The electrolyte in the Ni-Cad batteries will withstand the same temperature extremes in either the charged or discharged condition. The avoidance of freezing of the battery in the discharged condition has resulted in its increased use in airplanes. With all the decided advantages of the Ni-Cad battery, its use is still limited to a few applications onboard naval ships. The disadvantages of the battery must be weighed against the desirable characteristics. For example, a size D (flashlight size) Ni-Cad battery costs 40 to 60 times as much as the ordinary dry cell. A savings from using small rechargeable batteries on shipboard could not be demonstrated. For engine-starting batteries, the Ni-Cad battery costs 5 to 10 times as much as the lead acid battery. Depth of discharge,

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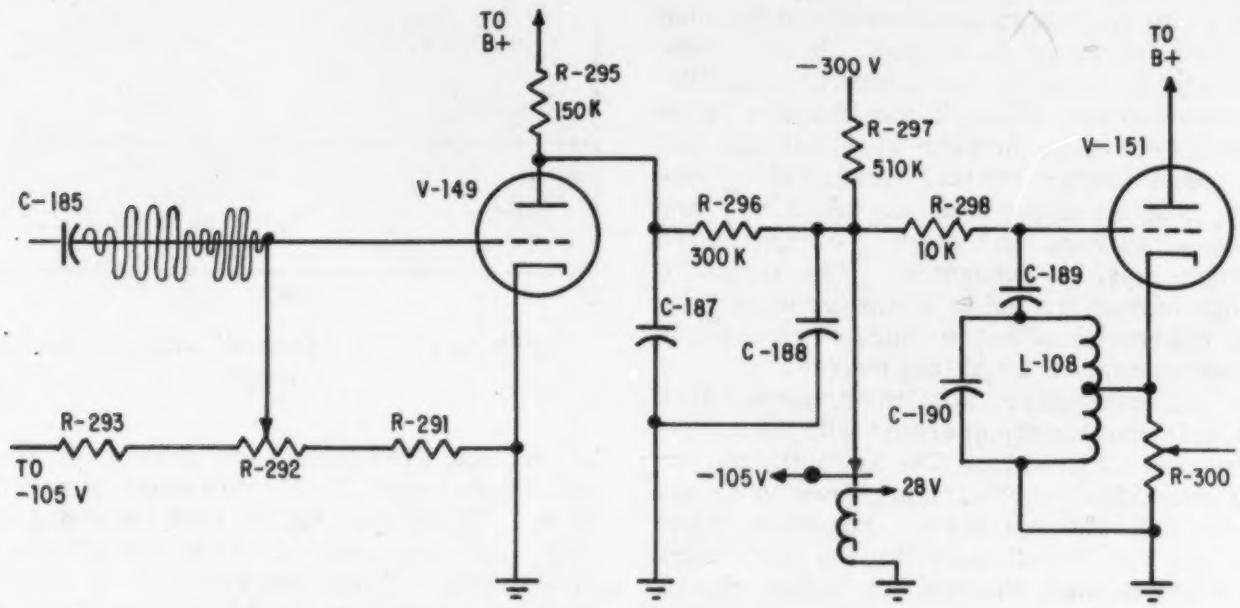

Figure 17-30. —Azimuth-marker oscillator circuit.

Marker Mixer

The method of combining all the various markers is accomplished by the tubes V1, V2, and V3. (See fig. 17-31.) V1 has the range markers applied to its left grid and the right grid is returned to the variable-delay trigger tube. The TD marker is fed directly to the right grid of V1 and will appear on the indicator as a variable marker when the control unit controls are properly set up for TD marker operation.

V2 has its left grid returned to a cable marked L. A. B. This cable would normally be coupled to the low-altitude bombing equipment and place the tracking pip from the bombing equipment on the radar indicators. The right grid of V2 is returned to a cable marked IFF-IR. This cable, normally attached to the IFF equipment, applies the interrogator response return, which is the IFF display on the radar indicators. In operating the IFF and radar system together, the radar transmitter pulse is used to trigger the IFF equipment, which can then be used to interrogate another IFF equipment. The coded return from the other IFF is then applied to the radar indicators. The distance from the transmitter pulse to the first return will be the distance from the radar to the target and the bearing will be determined by the position of the return on the indicators.

V3 has its grid returned to R300 (fig. 17-30), the azimuth-marker amplitude control. The output of the azimuth-marker circuit, a 1-megacycle sine wave, is applied to this grid and will appear on the indicators as a sudden reduction in bias for several sweeps, giving the appearance of a bright line at the marker control heading.

The markers are all combined in the common cathode circuits of the marker mixers and at the junction point of the two cathode resistors R5 and R6. The signal across R6 is coupled through C2 to the grid of V4, one of the marker-output tubes. Also, the signal or signal are coupled through C3 to the grid of V5, the other marker-output tube. Each of these marker-output tubes controls the markers applied to an indicator.

The combining point in any radar system is its indicating device. V6 combines the video from the receiver and the markers from the marker-output tubes. V6 and V7 would be located in the indicator.

The video from the receiver is positive-going video pulses, which have been acted on by the video mixing circuit and the receiver. These positive-going video signals appear negative in the plate of the video-marker mixer V6. Into the right-hand grid of the video-marker mixers are fed the range markers, the amplitude of these markers being controlled by the marker brilliance control R11. Note that the cathode of V6 is unbypassed, so that the

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temperature, and recharging have a drastic effect on the cycle life of these batteries. Claims of a lifetime of use from these batteries do not tell the whole story. If operated at the optimum temperature of 75° F the Ni-Cad battery may be charged and discharged 5,000 to 7,000 times, if the discharge does not exceed 25 percent. However, if the same battery is discharged 75 percent the cycle life is reduced to a few hundred cycles. If the battery is operated at below 0° F, the life cycle is lowered to less than 100, even with shallow discharges. At temperatures above 100° F the electrolyte reacts with the separator material, causing shorting and loss of capacity.

Unbalanced cells in a Ni-Cad battery are a source of possible trouble during charging. A phenomenon known as "thermal runaway" may occur when these batteries are placed on constant voltage charge. As the end of the charging cycle is reached, the overcharging current produces heat. Increased temperature reduces the electrolyte resistance which, in turn, permits a greater current flow, and more heat develops. Constant current charging avoids thermal runaway but may lead to hydrogen evolution. Unless compensated for in the battery design, this can lead to bulging cases or even an explosion of sealed batteries.

The only possible way to determine the state of charge of a Ni-Cad battery is to keep a record of the ampere-hours that have been taken out of the battery since it was fully charged. A voltage test only indicates if the battery has a charge or is discharged. The specific gravity would be meaningless in determining the state of charge; however, since many batteries are sealed, no hydrometer reading can be taken on those batteries anyway. The only answer is to keep the batteries fully charged, ready for use at all times. This alone can be a maintenance problem. Ni-Cad cells should not be connected in parallel due to minor differences in the internal resistance of the cells. This could result in excessive currents in some cells during charging and perhaps polarity reversals in others. If more ampere hours are desired a battery of greater capacity should be used. As technology improves, the undesirable characteristics of the Ni-Cad battery will be minimized and you will find them in wider use onboard ship. As previously stated many Ni-Cad batteries are sealed, however the more expensive, vented type are also in use and may be found in certain installations.

Charging Ni-Cad Cells

The effect of the charging current is to change the active material of the negative plate (cadmium-oxide) to metallic cadmium (Cdo to Cd). The active material of the positive plate (nickel-oxide) is changed to a higher state of oxidation NiO to Ni_2O_3. As long as the charging current continues, this action occurs until both plates are completely converted. Toward the end of the charging process and during overcharge, the cell will gas due to the electrolysis of the water in the electrolyte. This action liberates 4 atoms of hydrogen gas ($2H_2$) at the negative plate for every 2 atoms of oxygen gas (O_2) liberated at the positive plate. The amount of gas liberated depends on the charging rate.

The electrolyte does not enter into any chemical reaction with the positive or negative plates. It acts simply as a conductor of current between the plates, and its specific gravity does vary appreciably with the amount of charge. The effect of the reactions during charge is a transfer of oxygen from the negative to the positive plates. In this respect the nickel-cadmium storage battery is similar to the lead-acid storage battery. Unlike the lead-acid storage battery the specific gravity of the electrolyte remains constant, except at the end of a charge or on overcharge, when it increases because of the electrolysis of the water. The proper specific gravity on vented cells can be obtained by adding distilled water.

Nickel-cadmium batteries can be charged by the (1) constant voltage, (2) constant current, and (3) stepped constant-current methods. The most efficient performance is obtained when the charging rate is such that 140 percent of the rated ampere-hour capacity of the cell is delivered to the cell within a 3-hour interval.

Discharging Ni-Cad Cells

When the cell is connected to an external circuit containing a resistance, the chemical action which occurs is the reverse of that of the charging process. The negative plate gradually regains oxygen (Cd to CdO), and the positive plate gradually loses oxygen (Ni_2O_3 to NiO); that is, the action during discharge effects a transfer of oxygen from the positive to the negative plates. There is no gassing on discharge due to the interchange of oxygen. The discharge process is the conversion of the chemical energy of the plates into electrical

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energy. The rate at which this conversion occurs is determined by the external resistance, or load, to which the battery is connected. The internal resistance of the cell is extremely low because of the cell construction.

LEAD-ACID CELL

The lead-acid cell is the storage battery most extensively used in the Navy. As explained in Basic Electricity, NavPers 10086-A, the positive-plate assembly consists of lead peroxide; the negative-plate assembly is pure sponge lead; and the electrolyte is a mixture of sulphuric acid and distilled water.

Charging

The effect of the charging current is to change the lead sulphate formed on both the negative and positive plates by the reaction of the electrolyte with the active material, back to the original active form of lead peroxide ($PbSO_4$ to PbO_2) on the positive plate and sponge lead ($PbSO_4$ to Pb) on the negative plate. At the same time the sulphate is restored to the electrolyte, and the specific gravity of the electrolyte increases. When all of the sulphate is restored to the electrolyte, the specific gravity is maximum and the cell is fully charged. Toward the end of the charging process, hydrogen (H_2) is liberated at the negative plate, and oxygen gas (O_2) is liberated at the positive plate. This action is due to the electrolysis of the water in the electrolyte. Hydrogen is an odorless highly explosive gas. Care must be taken to avoid sparks of any kind. Adequate ventilation is also important to reduce the hazard of explosion.

Discharging

When the cell is connected to an external circuit containing a suitable load resistance, the action of the electrolyte on the active material of the negative and positive plates causes a current to flow. Thus, the chemical energy stored in the plates is transformed into electrical energy as the cell discharges. The reaction of the electrolyte with the active material forms lead sulphate on both the negative and positive plates. As the discharge continues, the acid content of the electrolyte becomes less as it is used in forming lead sulphate, and the specific gravity of the electrolyte decreases. When so much of the active material in the cell has been converted into lead sulphate that it can no longer produce sufficient current to be of practical value, the cell is discharged.

CLASSIFICATION

The classification and requirements for storage batteries used in the Navy (except for aircraft and automotive vehicles) are contained in the Miltary Specification for Portable Lead-Acid Storage Batteries, MIL-B-15072B (ships). This specification includes other pertinent information concerning these batteries.

Storage batteries are classified as Class ER, electrolyte-retaining and Class FE, free-electrolyte batteries. Class ER batteries have separators and plates that absorb and retain within the cell at least 80 percent of the electrolyte, and operate with not more than 20 percent of the electrolyte in a free condition. Class FE batteries operate with at least 50 percent of the electrolyte in a free condition. The automotive type batteries are contained in the Military Specification for Lead Acid Storage Batteries, MIL-B-11188C. The Navy type batteries under MIL-B-15072B (ships) are of heavier construction and provide longer life.

Nameplate

Supplementary to the specification sheets supplied for the individual battery types, all storage batteries are provided with nameplates that contain installation and replacement data (fig. 7-2). The TYPE DESIGNATION contained on the nameplate is in the same form as that previously described for dry batteries. It comprises the battery component, battery type number, and installation indicator.

The battery component denoted by the symbol, BB, identifies a lead-acid storage battery.

The battery type number, 256, following the symbol, identifies the basic design of the battery. Batteries designed for low-temperature operation are identified by increasing the established battery type number by 2,000. For example, a low-temperature battery is identified if the established battery type number, 256, is increased to 2256.

The installation indicator denoted by the symbol, /U, indicates general utility service. Battery type numbers of 200 and above have this /U symbol appended.

Prior to the Military Specification (MIL-B-15072B), Navy standard batteries were identified

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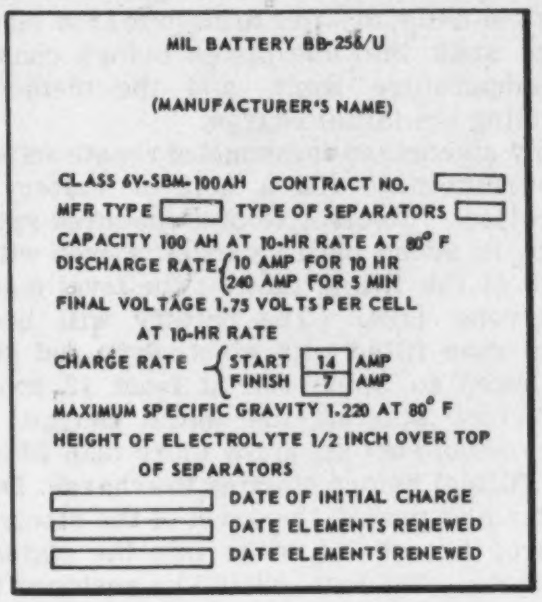

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Figure 7-2.—Storage battery nameplate.

according to voltage, use, and rating. This former type designation, CLASS 6V-SBM-100AH, also appears on the nameplate (fig. 7-2).

The voltage of the fully charged battery denoted by the symbol, 6V, identifies a 6-volt battery.

The use of the battery denoted by the symbol, SBM, identifies a monobloc storage battery. Other uses denoted by symbols, SBP and SBMD, identify portable and monobloc diesel-starting storage batteries, respectively.

The rating of the battery denoted by the symbol, 100AH, identifies a battery that can supply 100 ampere-hours when discharged at the 10-hour rate (10 amperes x 10 hours = 100 ampere-hours).

The remainder of the data contained on the nameplate requires no explanation.

Terminal Markings

The positive and negative terminals of storage batteries are legibly indicated by POS or P and NEG or N, respectively. These polarity markings are raised or depressed characters placed on, or as close as possible to, the applicable terminal. For further identification of the battery polarity, portions of the positive and negative terminals that are not contact surfaces can be painted red and black, respectively.

CHARACTERISTICS

Capacity

The capacity of a storage battery is the constant current that the battery can supply continuously at a definite rate of discharge before the voltage drops below a specified limiting (final) voltage. This capacity varies with the rate of discharge; that is, the lower the rate of discharge the greater the capacity, and vice versa.

Discharge Rate

Navy storage batteries are rated at the 10-hour discharge rate, which is the constant current in amperes that the battery (starting with an initial electrolyte temperature of 80° F) can supply continuously for 10 hours before the voltage drops to the low-voltage limit. Other hourly discharge rates are defined similarly.

Final Voltage

The final voltage, or low-voltage limit, is that (set by the manufacturer) beyond which very little useful energy can be obtained from the battery. Generally, the low-voltage limits for batteries at different rates of discharge vary slightly with the size and make of the battery. At the conclusion of a discharge at the 10-hour rate, the closed-circuit voltage will be approximately 1.75 volts per cell, and the specific gravity will be approximately 1.060. At the completion of a charge, the closed-circuit voltage at the finishing rate will be approximately 2.4 to 2.6 volts per cell, and the specific gravity will be from 1.210 to 1.220 at 80° F.

INSTALLATION

Lead-acid storage batteries are shipped (1) filled and charged and (2) dry. When shipped to naval ships they are usually in the filled and charged condition. When shipped to replenish stock at naval shipyards or other shore establishments, or on board repair ships or tenders, they are usually in the dry condition.

Charged And Wet

When batteries are shipped (filled and charged), the cells are completely assembled, contain electrolyte, and are sealed ready for use. When batteries are received in this

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condition, the height of the electrolyte should be examined, and specific gravity and temperature readings should be taken of all cells to ascertain the state of charge.

If there is no evidence of spilling or leakage, and the height of the electrolyte is below the bottom of the filling tube or the level mark on polystyrene cells, sufficient distilled water should be added to bring the level even with the bottom of the filling tube or the level mark. Unless otherwise specified, the electrolyte level should be three-eighths of an inch above the separators.

If the electrolyte has been spilled during shipment, it should be replaced with electrolyte of 1.215 specific gravity corrected to 80° F.

Charged And Dry

The instructions for charged and dry batteries are similar to those for the uncharged and dry with a few exceptions. When the electrolyte is placed in the cells they will have a 70 - 80% charge and are available for immediate use in case of emergency. It is preferable to first give it a thorough equalizing charge after filling. The charged and dry batteries must be stored in a cool dry location until ready for use, and under these conditions the plates will retain most of their charge for perhaps as long as two years. Once it has been properly prepared, its capacity, life and characteristics are the same as a new "wet" battery.

If water or electrolyte is added, the battery should be charged at the finishing rate until specific gravity readings, corrected for temperature, are constant for a period of 5 hours. If the battery is not to be placed in service immediately, an equalizing charge should be given at 1-month intervals, or sooner if the specific gravity has dropped to 1.180, and again just before placing it in service.

Uncharged And Dry

When batteries are shipped dry, the cells are completely assembled and sealed, but contain no electrolyte, and the plates are in the uncharged condition. When batteries are received in this condition and are not to be placed in service, the vent plugs must be kept tightly in place and the batteries stored in a clean dry space until they are required.

If the battery is to be placed in service, follow the instructions contained on the accompanying tag. These instructions specify the specific gravity of the electrolyte to be used in filling the cells, the time to allow for the electrolyte to soak into the plates before charging, the temperature limit, and the method for conducting the initial charge.

Only authorized personnel at repair activities are permitted to fill a cell or battery with electrolyte. Electrolyte of a specified specific gravity is added until its level is even with the bottom of the filling tube or the level mark on polystyrene jars. The battery will become heated when filled with electrolyte and should be allowed to stand for at least 12 hours to cool before starting the initial charge. The battery should not stand for more than 24 hours (after filling) before starting the charge. During the standing period the level of the electrolyte will drop because it soaks into the plates and separators. The level should be restored to the prescribed height by adding electrolyte of the same specific gravity as used initially, before starting the charge.

Placement in Service

When batteries are to be placed in service, the trays are arranged so that the positive terminal of one tray can be connected to the negative terminal of the next tray throughout the battery. If the battery terminals, or posts, are not properly marked, the polarity can be determined by means of a d-c voltmeter across the terminals. If a voltmeter is not readily available, immerse the terminal leads in salt water, holding them about one-half inch apart. Bubbles will collect on the negative lead. Do not allow the leads to touch each other when conducting this test.

The contact surfaces of battery terminals are usually covered with a thin film of acid, which should be neutralized and removed to prevent corrosion before making the connections. For this purpose, diluted ammonia or a solution of bicarbonate of soda can be used, exercising care not to allow the solution to enter the cells. After the contact surfaces have been neutralized, they should be brightened with a wire brush or fine sandpaper. The contact surfaces are then bolted together and coated with petrolatum or cup grease.

All connections should be checked to make certain that the polarity is correct and that all exposed metal in the connectors is protected with petrolatum or cup grease. The top and sides of the battery should be cleaned with a

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cloth dampened in a solution of dilute ammonia or bicarbonate of soda, after which the battery should be thoroughly washed with pure water.

Battery Numbering

Batteries must be assigned a number to provide a systematic method of identification and to facilitate the maintenance of battery records. This identification is accomplished by assigning a number to each tray. For example, if a ship has a total of 100 trays of portable storage batteries for all purposes, each tray is numbered consecutively from S62-3(1), S62-3(2) and so on, to S62-3(100). In addition, the cells of a tray are numbered consecutively, beginning at the positive end.

The battery number should be stenciled in a conspicuous place on the side of the container for ready identification. When a new tray replaces an old one, give it the number of the old tray, and begin a new log.

Pilot Cells

Pilot cells (one from each tray) must be selected at random from which cell readings are taken during routine inspections and tests. The cell readings provide an approximate indication of the battery condition without the necessity of taking readings of all the individual cells.

Records

Where applicable, ship maintenance card will be used in lieu of form NavShips 151, Storage Battery Tray Record. This form will be inspected and approved monthly by the electrical officer or in the case of radio batteries by the radio officer and note of such inspection and approval will be made on the form at that time. The record shall accompany the battery tray whenever transferred. It may be destroyed when the service of the battery is terminated. NavShips 151 will be kept when ship Maintenance Cards are not used.

STORAGE

Storage batteries, like dry batteries, deteriorate when not in use. Batteries in a wet condition should not be stored for considerable periods of time. When batteries are to be stored temporarily, they should be placed in a clean, dry space at an average temperature of 75° F and never subjected to temperatures below 50° F or above 100° F. Batteries that have a capacity of 80 percent or more when taken out of service should be maintained in a fully charged condition and issued at the first opportunity.

Wet Storage

When placing batteries in wet storage, give them an equalizing charge, and coat (with petrolatum) all exposed terminals to prevent corrosion. The batteries are then placed on racks, located in the battery locker, to allow free circulation of air around the top and sides.

Batteries in wet storage must be inspected at frequent intervals, and the electrolyte level maintained above the tops of the separators. Give these batteries an equalizing charge each month, or more often if the specific gravity falls below 1.180, and maintain a battery tray record during the period that the battery is in wet storage.

Acid

Carboys containing sulphuric acid must be stored in spaces where freezing cannot occur. The freezing temperatures of sulphuric-acid electrolyte depend on the specific gravity of the solution and vary over a wide temperature range, as indicated by the specific gravity versus temperature curve shown in figure 7-3. For example, the freezing temperature of sulphuric acid having a specific gravity between 1.614 and 1.667 is indeterminate (drops rapidly) below -40° F. On the other hand, if the specific gravity of concentrated acid is reduced from 1.835 to 1.800, the freezing temperature changes from -29° F to +42° F.

Because sulphuric acid is highly hygroscopic (readily absorbs and retains moisture), the carboys must be kept absolutely airtight. If a small quantity of water is allowed to enter a carboy containing sulphuric acid, it can reduce the specific gravity sufficiently to freeze (in cold weather) the solution, causing the carboy to break, with the consequent danger of acid burns to personnel. At any temperature, the addition of a small quantity of water to concentrated sulphuric acid can cause an explosion with the sudden evolution of heat.

MAINTENANCE

Lead-acid storage batteries will deteriorate rapidly if they are not maintained properly and

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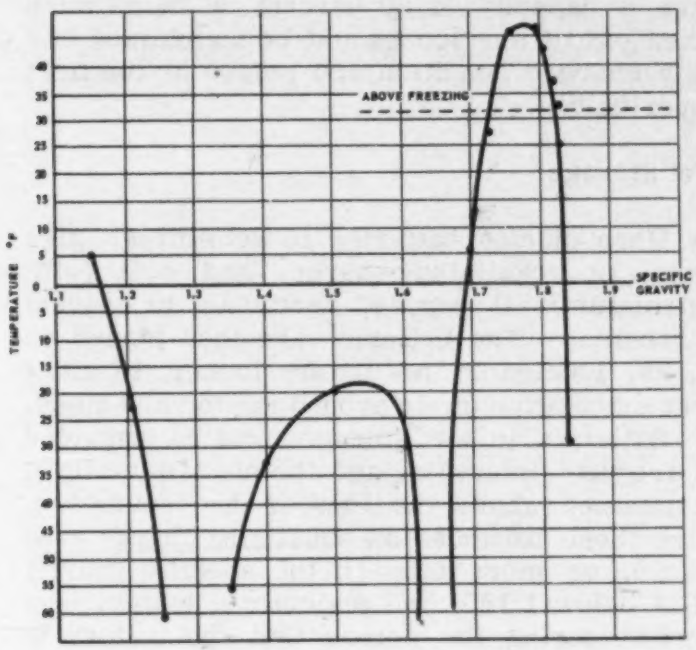

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Figure 7-3.—Specific gravity versus temperature curve.

kept fully charged. The actual life of these batteries is indeterminate, but when properly cared for the Navy types should give a useful life of four or more years, depending on the type and use.

Care

The service for which a battery is used primarily determines the nature of the care and maintenance that will ensure maximum reliability and life.

ENGINE-STARTING BATTERIES.—Batteries that are used to start propulsion engines, motor-boat engines, and ship's service engine-generator sets are subjected to moderately heavy use and may require frequent charging in addition to the charging provided by the engine generator. If the specific gravity has dropped 30 points below the prescribed operating value of specific gravity, give the battery an equalizing charge, taking care that it is not overcharged by the engine generator. To prevent overcharging, set the charging rate of the engine generator to maintain the specific gravity of the electrolyte about 20 points below the prescribed operating specific gravity.

AUXILIARY LIGHTING AND POWER BATTERIES.—Batteries on stand-by service for auxiliary lighting and power are seldom discharged by actual use. A normal battery on open circuit will discharge 50 percent or more in a period of 3 or 4 months. This is a normal condition and is usually called local action or self-discharge. The lead sulphate formed during self-discharge is more difficult to reduce by charging than the lead sulphate formed during a regular discharge. Therefore, stand-by batteries should be given an equalizing charge when the specific gravity drops to 1.180, and at 30-day intervals, irrespective of the specific gravity (if the batteries are on open circuit and not delivering power). If the monthly equalizing charges fail to maintain the prescribed specific gravity, the batteries should be cycled to restore them to a normal condition.

TELEPHONE, F.C., AND I.C. BATTERIES.—Batteries on stand-by service for dial telephones, fire control, and interior communications are usually floated on a low-voltage supply line from motor-generators through reverse-current circuit breakers. Batteries for automatic telephones are intermittently charged automatically from motor-generators that supply the telephone system.

GUNFIRING BATTERIES.—Batteries used for gunfiring and sight-lighting purposes are idle a large part of the time. These batteries should be given an equalizing charge once a month, or when the specific gravity drops to 1.180. These batteries should also be cycled to restore them to a normal condition if the monthly equalizing charge fails to maintain the specific gravity of the electrolyte above 1.180.

COUNTER E.M.F. CELLS.—Counter E.M.F. cells are normally the responsibility of the IC Electrician as they are used in automatic telephone circuits. However, the Electrician's Mates on certain ships may be required to stand watches in the IC room and should therefore be aware of the appearance and purpose of the counter E.M.F. cells.

These cells have the same outward appearance of the usual storage battery tray, but they are distinguished by the letters "C.E.M.F." on the nameplates. The cells consist of electrodes immersed in an electrolyte but have no storage capacity. The cells are used to produce an opposing voltage in order to reduce the voltage

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of one circuit to the desired lower voltage on a dependent circuit. Counter E.M.F. cells perform substantially the same functions as a rheostat but differ from the latter by interposing a fairly constant voltage. In operation, the counter E.M.F. cells, decompose the water in the electrolyte practically in proportion to the ampere-hours which pass through them. This results in the evolution of gas, and, therefore the cells need to be filled with distilled water from time to time.

ROUTINE INSPECTIONS

Routine inspections of batteries should follow along with the Planned Maintenance System as well as with Naval Ship Systems Command instructions.

Routine inspections of batteries are necessary to ascertain good operating conditions. The following schedule of inspections is considered to be the minimum requirements consistent with good engineering practice for batteries used under average operating conditions. However, if experience indicates that these inspections are not sufficient to ensure that the batteries are capable of performing their functions when needed, the frequency of inspections should be increased as necessary. For example, in cold weather operations, it may become necessary to make daily inspections of boat batteries.

Daily Inspections

The ventilation system in battery rooms and battery lockers should be inspected daily to ascertain that all parts of the system are in properly operating condition. Also, battery hydrometers should be cleaned daily to prevent the accumulation of sticky substances that collect on the float inside the barrel, and result in inaccurate readings. The hydrometer parts should be cleaned with an ammonia solution, flushed with clear water, dried, and allowed to air before they are reassembled.

When assembling or disassembling a hydrometer, a heavy piece of cloth should be wrapped around the glass barrel to prevent injury in case of glass breakage. During reassembly, the rubber-bulb should be moistened slightly with water where the rubber contacts the glass barrel. This will reduce the amount of pressure or torque required to replace the bulb.

Weekly Inspections

The specific gravity and temperature readings of pilot cells for all batteries should be taken and recorded each week. The batteries should be watered if the height of the electrolyte in the pilot cells is at the low mark. Pure distilled water can be added to a battery at any time to replace that which has spilled or evaporated. However, it is preferable to add water just prior to placing the battery on charge in order to mix it with the electrolyte. Otherwise, in cold weather, if the water is allowed to remain on top of the electrolyte, it may freeze and crack the monobloc cases or jars. The charging rate of engine battery-charging generators and the voltage at which batteries are being floated should be checked each week to prevent overcharging.

Monthly Inspections

All batteries, except those that are charged by an associated engine generator or those that are being floated, should be given an equalizing charge each month. A complete set of voltage, temperature, and specific gravity readings should be taken on these batteries at the completion of the equalizing charge. Batteries should be cleaned and inspected for broken or cracked cases. The terminals should be coated with petrolatum, if necessary, to prevent acid from coming in contact with the connections. Sulphate is formed when acid attacks these parts, making it difficult to disconnect leads from the terminals. Also, the sulphate increases the resistance of the terminal connections, with a consequent reduction of the voltage on discharge. Battery connections should be examined and all faulty conditions corrected.

Quarterly Inspections

All batteries that are charged from an associated engine generator or are being floated should be given an equalizing charge each quarter. A complete set of voltage, temperature, and specific gravity readings should be taken on these batteries at the completion of the equalizing charge.

Functional Testing

1. A functional test is a method to determine if a battery is sufficiently operational to

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provide energy to operate specific equipment for a period of time. Test discharges are the most reliable means of determining a storage battery's condition. Functional testing may be done in lieu of a test discharge only when authorized by a Ships Maintenance Card.

2. Functional testing of Navy type portable storage batteries for various shipboard applications vary with usage, size of battery and load. The test requirements are as follows:

a. Engine starting batteries
The batteries will be capable of starting an engine at least once a week.

b. Portable lantern batteries
The batteries will be capable of providing sufficient light for a period of one minute without any diminuation of intensity and be tested at least once a week.

c. Gyrocompass batteries
The gyrocompass batteries will be functionally tested for a 20 minute period on battery power alone monthly.

d. Telephone batteries
Telephone batteries will be functionally tested during a peak load period for 4 hours on battery power alone monthly.

e. Functional testing of other portable storage battery service not covered above may be obtained upon request from the Naval Ships Engineering Center. This information will be required for new types of applications.

3. If the functional test fails, the batteries shall be given an equalizing charge and retested. If the retest fails the failed batteries shall be replaced.

CHARGING

It is not possible (in one chapter) to cover all of the different types of battery chargers or charging switchboards found on various ships or stations. However the following types are representative of those in use.

Battery Charging And Discharging Switchboards

The battery charging and discharging switchboard of a large aircraft carrier is a good illustration of the type of control required for charging a variety of portable storage batteries. The main features of the switchboard may best be analyzed by examining the schematic diagram in figure 7-4.

The various charging circuits of the switchboard are fed through a manually operated circuit breaker from either a 450-volt a-c supply through a rectifier (120 v d-c) or from a 120-volt d-c supply from one of the d-c switchboards. The circuit breaker is equipped with reverse current trip to prevent feedback from the batteries should there be a power failure. Indicating lights are provided to show when power is available.

Trickle charging circuits are provided for charging batteries at a slow rate. The representative system shown in figure 7-4 can charge several batteries at the same time through the charging resistor circuits.

Double-pole double-throw transfer switches are used for charging and discharging batteries through a fixed resistance and a variable rheostat. Setting the variable rheostat controls the magnitude charging or the discharging current.

The charging current or discharging current of any battery circuit can be read from an ammeter when the ammeter selector switch is closed to the proper circuit. There are two ammeters for this purpose. One is connected to battery circuits having a maximum charging rate of 40 amperes and the other to circuits having a maximum charging rate of 20 amperes. A third ammeter (not shown) is connected directly in the source circuit for reading the total current supplied to the board.

A voltmeter (not shown) with two selector switches is installed with connections to the various charging circuits. The two selector switches are interconnected to provide the number of positions required.

The front view of a typical battery charging-discharging switchboard for an aircraft carrier is shown in figure 7-5.

The latest type battery charging switchboards being furnished to the fleet are constructed with self-contained rectifier circuits and operate directly from 440-volt, 3-phase, 60-cycle alternating current ship's service system. This design eliminates the need for a separate rectifier, and in some cases has permitted deletion of a ship's service direct current system. Outputs of the charging circuits are controlled by magnetic amplifiers or, in smaller ratings, by rheostats. Figure 7-6 is a typical circuit of a switchboard using integral rectifiers. The switchboards with integral rectifiers are very similar to the older type in appearance and operation. They require no

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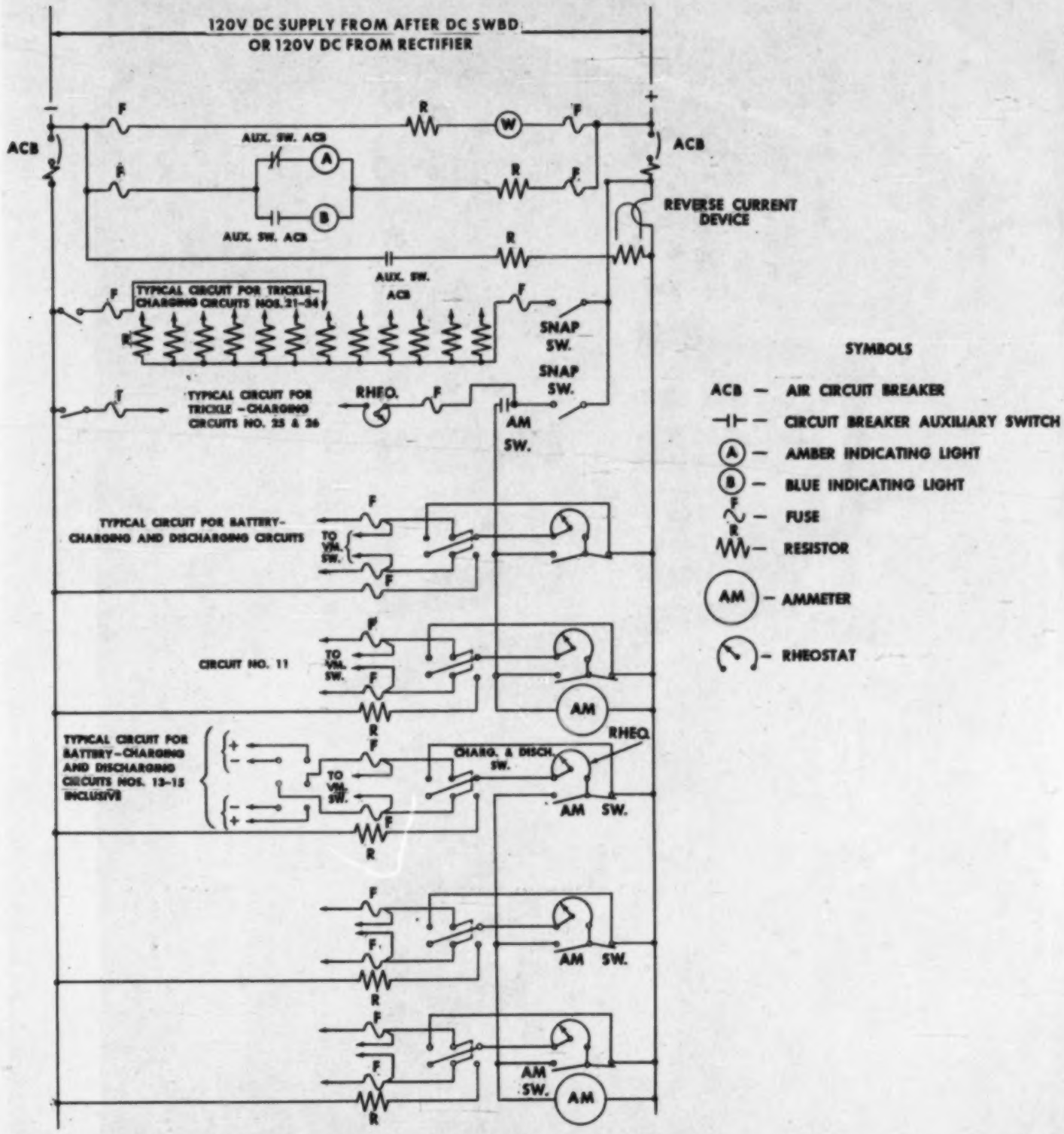

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Figure 7-4.—Elementary wiring diagram of battery charging and discharging switchboard.

reverse current relays, since the rectifier elements prevent the discharge of connected batteries into the switchboard. Because it is impossible to discharge a battery with a rectifier type switchboard charger, battery dischargers (usually portable) are furnished where required. Figure 7-7 is a typical battery discharger.

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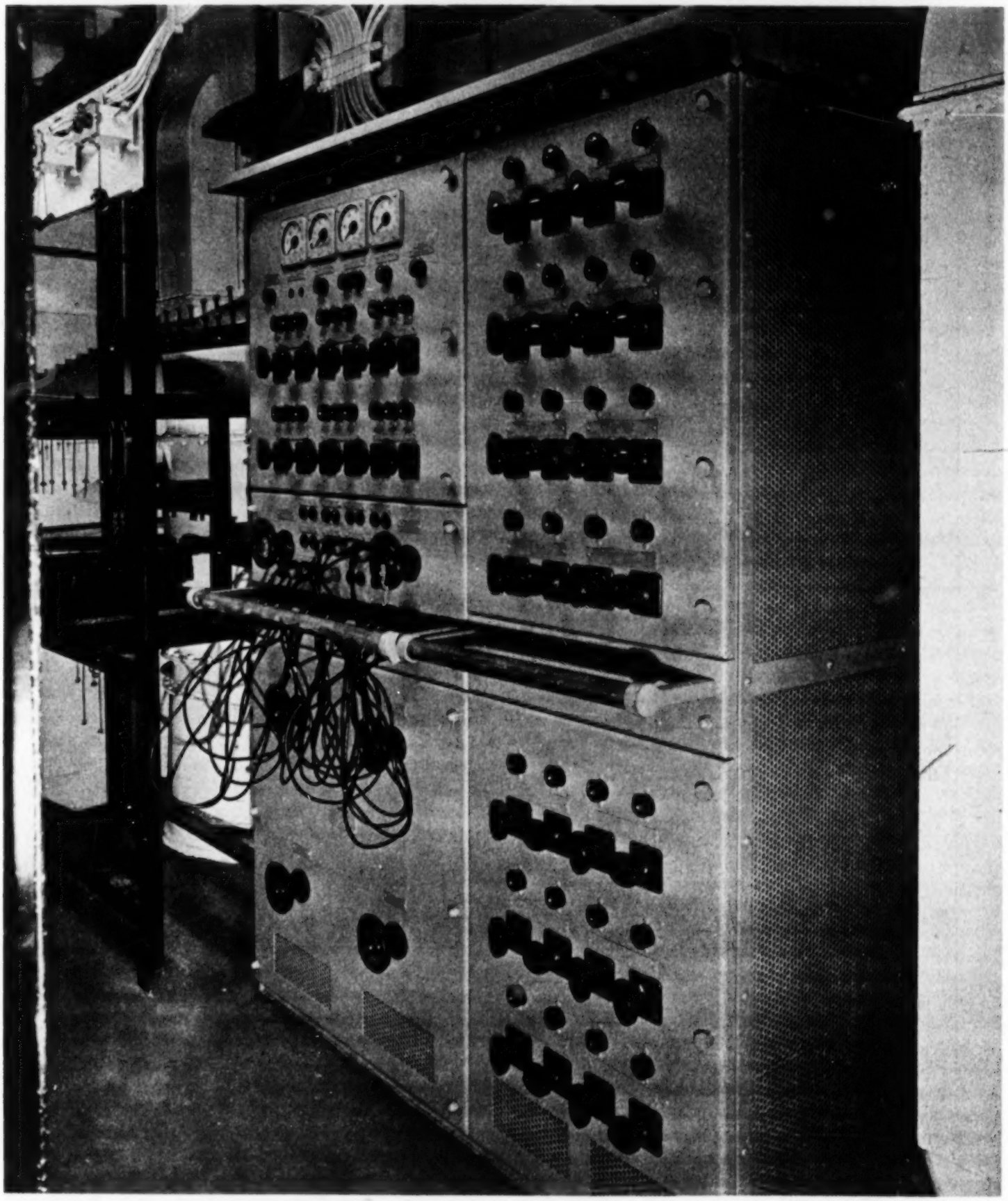

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Figure 7-5.—Battery charging switchboard, front view.

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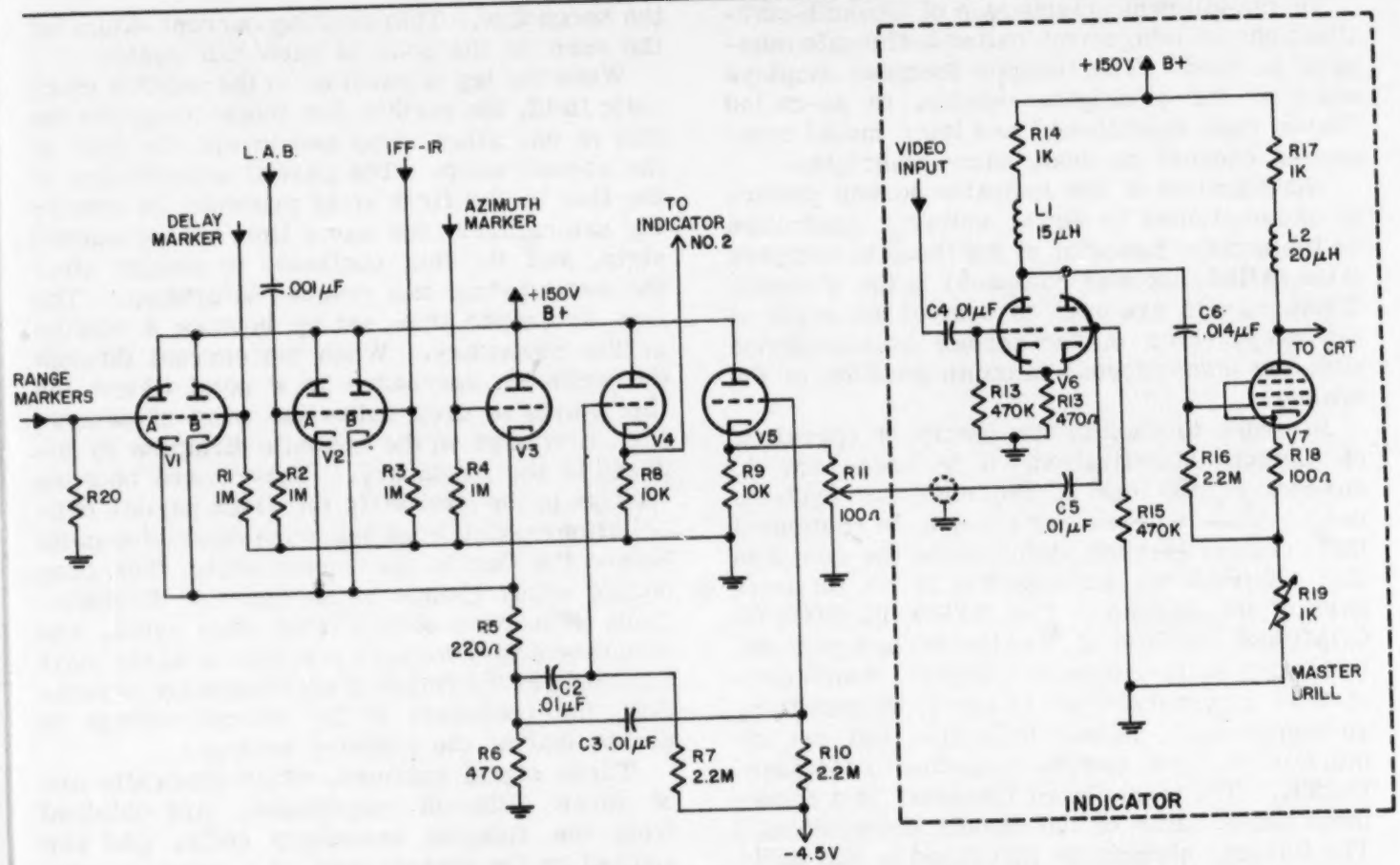

Figure 17-31.—Marker and video mixer schematic.

cathode would tend to follow the video-frequency rise on the grids of both sides of the tube. This degeneration improves the fidelity, or frequency response, as cathode degeneration will do, although the cathode resistor, R13, is quite small by comparison with the plate-load impedance. Also to improve the frequency response in the plate is the high frequency response peaking circuit of L1.

The negative-going video and markers are coupled through C6 to the grid of the video amplifier, V7. The signals in the plate would be positive-going. In the cathode circuit is the degeneration control, R19, the master brilliance control. In order to simplify the explanation of this control, it should be pointed out that adjusting the resistance of R19 will in no way change the bias on the tube, but by controlling the amount of degeneration present in the cathode, the amplitude of the plate signals can be controlled. The simple deduction would be to say that the increased resistance of R19 would decrease conduction through the amplifier, or reduce the output, and that a decrease in the resistance of R19 would increase the amplitude of the signals in the plate of this amplifier. In the plate circuit are the high frequency peaking components, L2. The positive output from V7 is fed to the final video amplifier.

AZIMUTH STABILIZATION

Most azimuth stabilization systems are similar, and an understanding of one system will provide information that will be helpful in the comprehension of other systems.

An azimuth stabilization system stabilizes the indicator screen presentation, causing the display to remain rotationally fixed despite changes in the heading of the aircraft. By this means, a definite compass relationship is established for the indicator screen, and radar target echoes appear in proper position with respect to the top center of the screen, which represents magnetic north. The stability of the indicator presentation also facilitates search during rough weather or moderate maneuvering of the aircraft.

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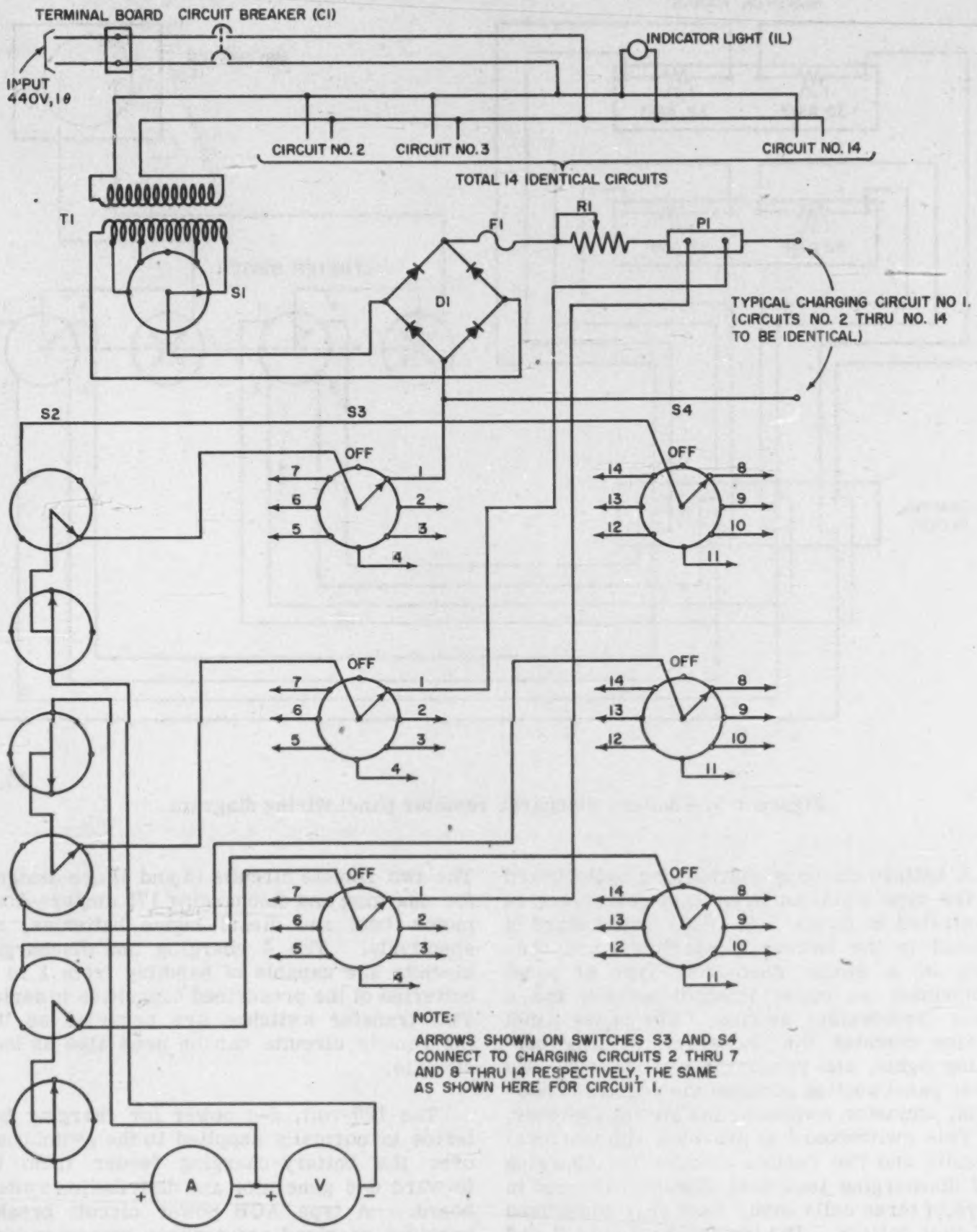

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Figure 7-6.—Battery charging circuit, schematic diagram.

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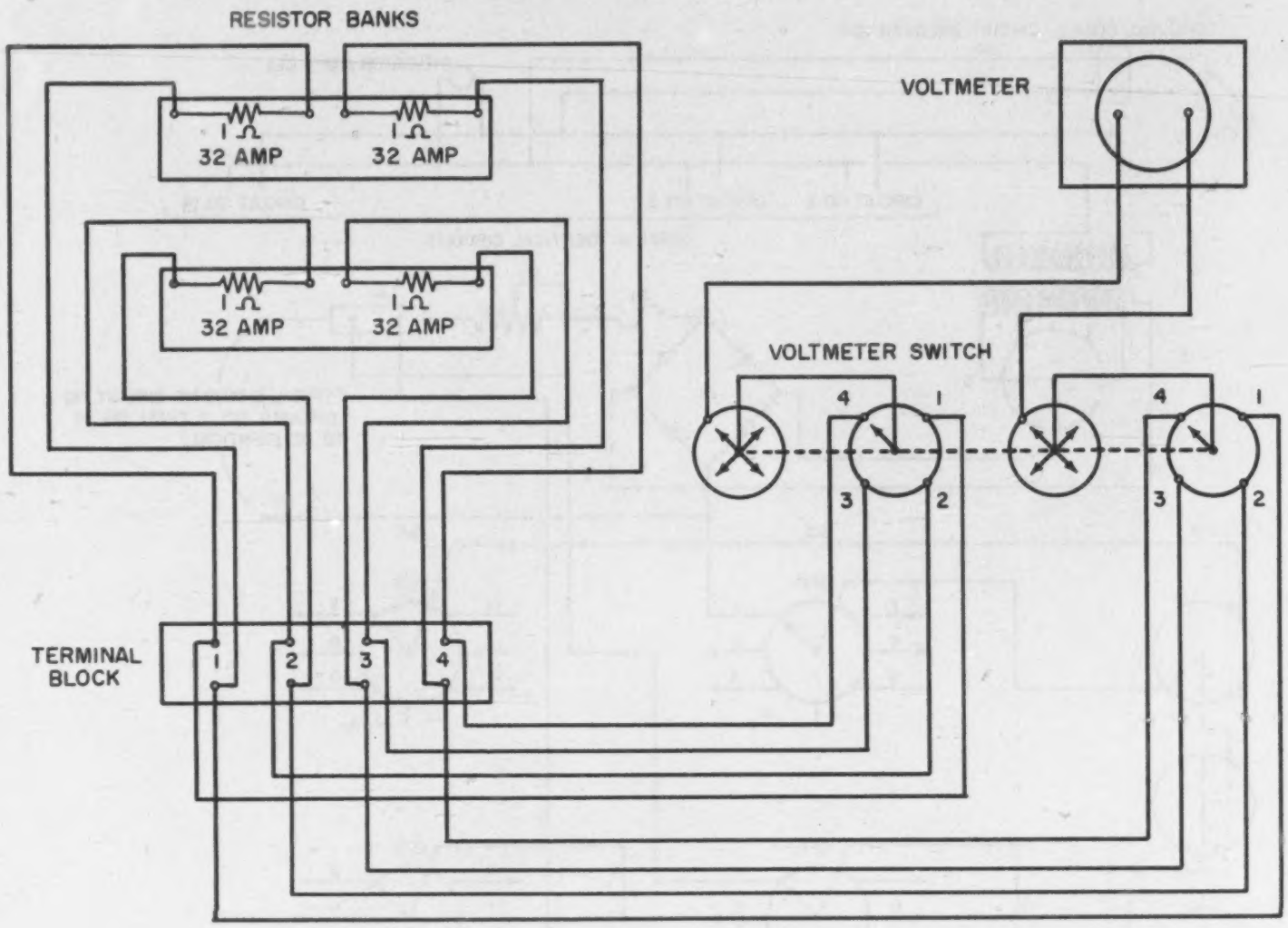

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Figure 7-7.—Battery discharge resistor panel wiring diagram.

A battery charging-discharging switchboard of the type installed in certain destroyers is illustrated in figure 7-8. This switchboard is located in the battery compartment and consists of a single dead-front type of panel comprising an upper (hinged) section and a lower (removable) section. The upper panel section contains the necessary meters, indicating lights, and power circuit breaker. The lower panel section contains the required rheostats, ammeter switches, and circuit switches.

This switchboard is provided with two local circuits and two remote circuits for charging and discharging lead-acid storage batteries in trays of three cells each. Each tray comprises a 6-volt battery. The two local circuits (1 and 2) are designed for charging and discharging 50 ampere-hour and 100 ampere-hour batteries. The two remote circuits (3 and 4) are designed for charging and discharging 175 ampere-hour, motor boat and diesel-engine batteries, respectively. The 4 charging and discharging circuits are capable of handling from 1 to 12 batteries of the prescribed capacities in series. Two transfer switches are provided so that the remote circuits can be used also as local circuits.

The 120-volt, d-c power for charging batteries is normally supplied to the switchboard over the battery-charging feeder from the forward d-c generator and distribution switchboard. A type ACB power circuit breaker provides overload and reverse current protection, as indicated by the schematic diagram (fig. 7-9).

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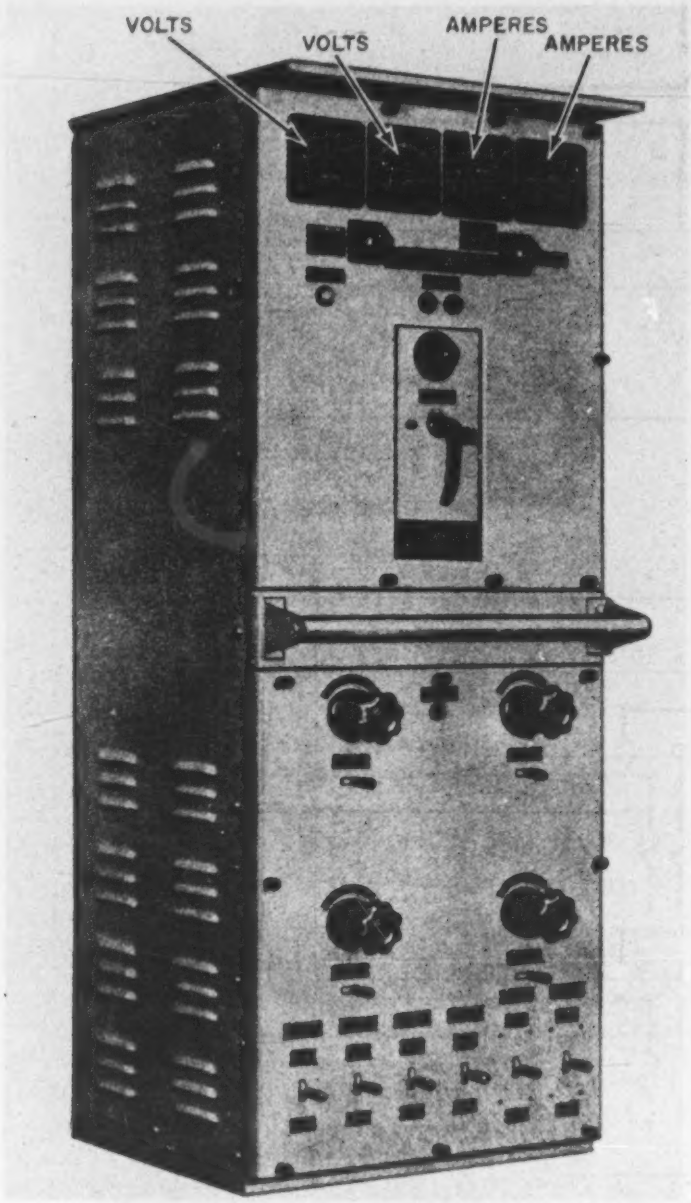

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Figure 7-8.—Battery charging and discharging switchboard.

When the normal power supply is not available, a limited supply (20 amperes, maximum) can be obtained from the I.C. switchboard over a limited capacity feeder. This limited power is supplied through a DPDT selector switch, the midpoint of which is connected to the charging circuit through the power circuit breaker on the switchboard. This selector switch is mounted on the base of the power circuit breaker, and its position can be changed only by opening the upper (hinged) section of the panel. A white indicator light (w) indicates when power is available from the I.C. switchboard. The majority of battery charging-discharging switchboards are not designed to supply the limited power from the I.C. switchboards, and therefore are not equipped with the feeder selector switch and white indicator light.

The power circuit breaker, located in the center of the upper section, is a manually operated, 2-pole, 250-volt, 100-ampere, type ACB breaker. It is equipped with two over-current coils and an undervoltage coil. The over-current coils can be calibrated from 100 to 200 percent of the breaker rating, and the undervoltage coil functions to trip the breaker on low voltage to prevent discharging the batteries. An amber (A) and a blue (B) light located directly above the circuit breaker indicate the OPEN and CLOSED positions, respectively, of the breaker.

A double-scale voltmeter having scales of 0 to 15 volts and 0 to 150 volts is located at the top on the left-hand side of the upper section. This voltmeter is provided with a 6-position switch for (1) cutting out the voltmeter, (2) reading the voltage of only one of the four switchboard circuits, or (3) reading the bus voltage. A scale-changing switch is also provided for changing to the low-voltage scale when taking voltage readings on only one or two batteries. The scale-changing switch must remain in the high-scale position, except when actually taking low-voltage readings, because of possible overloading, with consequent damage to the voltmeter.

A single-scale voltmeter having a scale of 0 to 3 volts is located adjacent to the double-scale voltmeter. This voltmeter is connected to a jack receptacle centrally located near the top of the lower section. A 15-foot cord having a plug at one end and battery test clips at the other end is provided for taking voltage readings of single cells in a battery. The test leads of this cord and plug must not be connected to more than one cell at a time because of possible overloading of the voltmeter.

Two ammeters having scales of 0 to 20 amperes and 0 to 40 amperes are located at the top on the right-hand side of the upper section. These ammeters are provided for taking current readings of circuits 1 and 2 and 3 and 4, respectively.

A SPDT, spring-loaded ammeter switch, located directly below the associated rheostat handle on the lower section, is provided for

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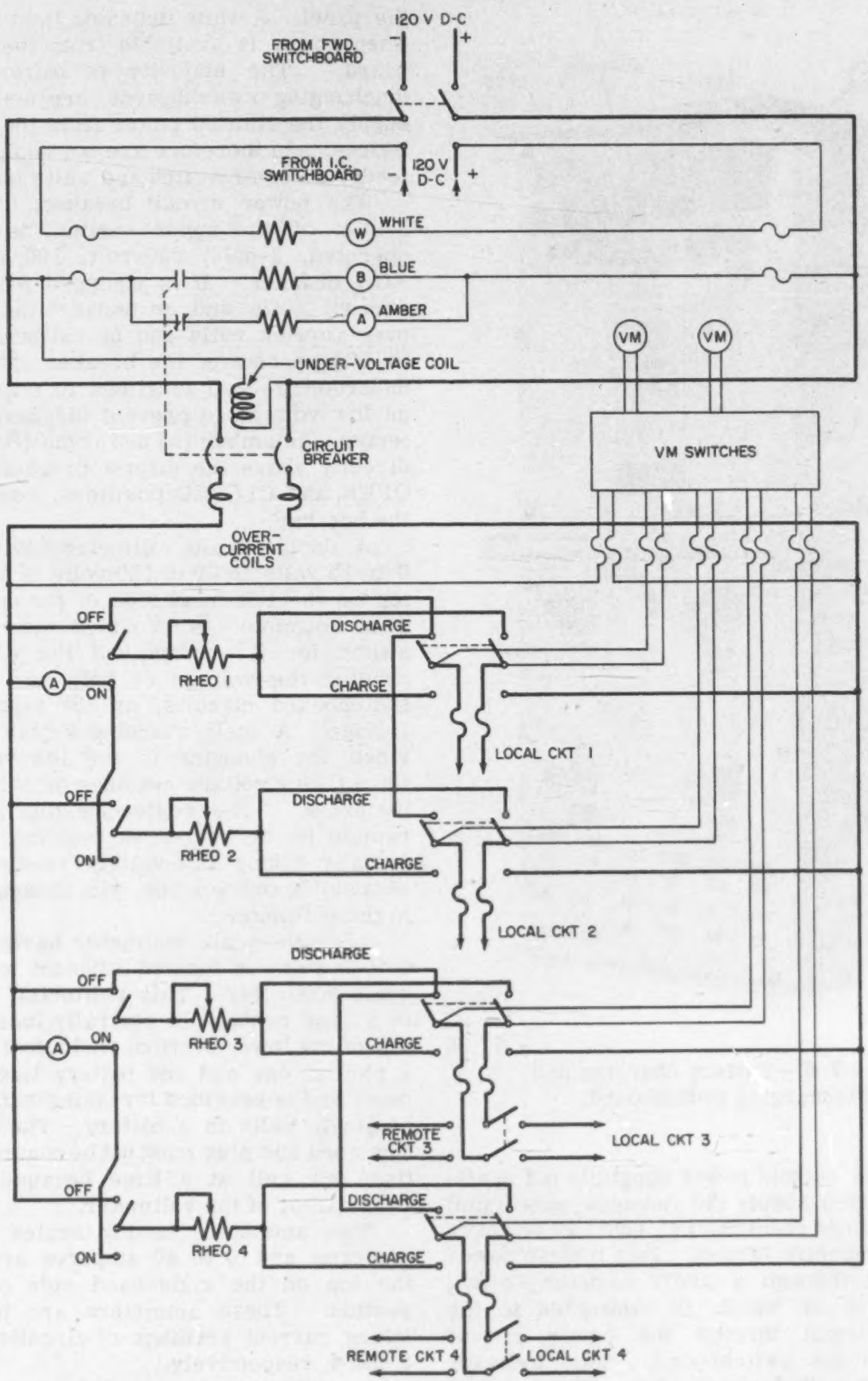

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Figure 7-9.—Schematic wiring diagram of battery charging and discharging switchboard.

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each of the four switchboard circuits. The ammeter switch is used to take readings of the charging and discharging current for the associated circuit when the switch is held in the ON position. Only one ammeter switch of each set of circuits (1 and 2 or 3 and 4) should be closed at any one time because of the possibility of overloading and damaging the ammeter.

A rheostat, located on the lower section, is provided for each of the four switchboard circuits. These rheostats are used when charging or discharging batteries to cut IN or to cut OUT sufficient resistance in order to obtain the necessary current flow for the number of batteries connected in the associated circuits at the time.

A DPDT, charging and discharging switch for each of the four switchboard circuits and a DPDT local and remote transfer switch for each of the two remote circuits (3 and 4) are located at the bottom of the lower section. The local battery charging and discharging circuits are connected to a terminal block in the rear of the battery switchboard. The remote battery charging and discharging circuits are connected to the common terminal (stud) of the two local and remote DPDT switches.

The charging and discharging rates for the battery switchboard are contained in the manufacturer's instruction book. These rates should not be exceeded because overloading can damage either or both the switchboard circuits and batteries.

When batteries are charged, the voltage of the charging line must exceed the total voltage of the batteries connected in series to be charged. When more than one tray is to be charged in series, the negative terminal of one tray is connected to the positive terminal of the next tray, irrespective of the number of trays connected. After the trays are connected in series addition, the remaining positive terminal on the first tray and the remaining negative terminal on the last tray are connected to the corresponding positive and negative terminals of the charging circuit. If the batteries are of different sizes, the charging rate in amperes must not exceed the maximum charging rate of the lowest rated battery in the series. The maximum charging rates are obtained from the battery nameplates. For example, a series-connected line containing two 6-volt batteries and one 12-volt battery with maximum charging rates of 5, 7, and 10 amperes respectively, must be charged at a 5-ampere rate.

Gassing

When a battery nears full charge, the voltage rises to about 2.35 volts per cell and the battery begins to gas freely. When gassing begins near the end of the charge, the charging current must be decreased to the finishing rate to avoid heavy gassing.

Excessive gassing is an indication that the battery is being charged too rapidly, and the rate must be reduced. Otherwise, the gas bubbles will tend to loosen the active material from the plates and eventually cause disintegration of the positive grids. This loosened, active material is precipitated to the bottom of the cell, resulting in loss of battery capacity. An internal short circuit will result if this accumulation of active material reaches the bottom of the plates. Also, excessive gassing increases the danger of a hydrogen explosion.

Initial Charge

An initial charge is a long, low-rate, forming charge that is given to a new battery (uncharged and dry) to place it in service.

To conduct an initial charge, fill the battery with electrolyte of the proper specific gravity, and replace the vent plugs, making certain that the vent holes are clear. The battery should be allowed to cool before beginning the charge.

The battery is connected to the charging and discharging switchboard, and all the resistance is cut in by means of the rheostat.

The battery switch is closed to the charging position, and the rheostat is adjusted until three-fourths of the finishing rate (obtained from the nameplate) is indicated by the ammeter. The rheostat is further adjusted when necessary to maintain the proper charging rate.

Hourly readings of the voltage, temperature, and specific gravity are taken. If the temperature of the battery reaches 125° F, the charging rate is either reduced or discontinued until the battery cools. The charge is continued after the battery cools until the voltage and specific gravity have remained constant for a period of at least 5 hours.

The number of ampere-hours for the initial charge should never be less than five times the rated capacity at the 10-hour rate, as specified on the nameplate. If this rate is maintained, the battery will require approximately 84 hours of charging.

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After the initial charge is completed, the specific gravity should be adjusted (corrected to 80° F) to that specified on the nameplate, as explained in Basic Electricity, NavPers 10086-A. The capacity of all Navy standard portable batteries, except Class 2V-SBP-20AH, is based on a fully charged electrolyte between the limits of 1.210 and 1.220 specific gravity at 80° F. Class 2V-SBP-20AH batteries are always operated with electrolyte specific gravity between the limits of 1.270 and 1.285. If the electrolyte has been mixed carefully, very little adjustment should be necessary.

The date of the initial charge must be stamped or scribed legibly in the space provided on the nameplate. The date of the initial charge is important because it indicates the beginning of the useful life of the battery.

Normal Charge

A normal charge is a routine charge that is given in accordance with the nameplate data during the ordinary cycle of operation to restore a battery to a fully charged condition.

To conduct a normal charge, ascertain the proper charging rates for starting and finishing the charge from the nameplate data. Add distilled water to each cell to bring the electrolyte to the proper level, and replace the vent plugs. Connect the battery to the switchboard (the positive terminal to the positive side and the negative terminal to the negative side) and cut in all the resistance. The battery switch should be closed to the charging position and the rheostat adjusted until the proper charging rate is indicated by the ammeter. As the battery voltage rises, the rheostat is adjusted to maintain this charging rate.

Hourly readings are taken of the voltage, temperature, and specific gravity of the pilot cells during the charge. The battery temperature should not exceed 125° F. The charging rate is decreased to the finishing rate when the battery begins to gas freely or when the voltage reaches 2.35 volts per cell. The finishing rate should not exceed that specified for the particular battery.

The normal charge is completed when the specific gravity, corrected for temperature, has reached a value within five points (0.005) of that obtained on the preceding equalizing charge.

Equalizing Charge

An equalizing charge is an extended normal charge that is given a battery at the finishing rate. It is given periodically to ensure that all the sulphate is driven from the plates and that all the cells are restored to a uniform maximum specific gravity. To conduct an equalizing charge, continue the normal charge at the finishing rate and take 30-minute readings of the temperature and specific gravity.

The equalizing charge is continued until the hydrometer readings, corrected for temperature, show no increase in corrected specific gravity for any cell over a period of 4 hours.

All Navy standard batteries are given an equalizing charge at 30-day intervals, except for engine-starting batteries and batteries normally on floating charge, which are given an equalizing charge at 90-day intervals.

Floating Charge

A floating charge is given a battery that is standing idle or used on stand-by service to maintain it in a fully charged condition.

To conduct a floating charge, connect the battery across a power line that has a voltage maintained between the limits of from 2.13 to 2.17 volts per cell in the battery. The charging rate is determined by the battery voltage, not by a definite rate of current. The voltage is adjusted periodically to maintain an average of 2.15 volts per cell. Special equipment is necessary to give a battery a floating charge. If this equipment is not included with the battery-charging panel, a battery is maintained by giving it monthly equalizing charges.

Emergency Charge

An emergency charge is given to recharge a battery in the minimum amount of time. The charging rate is much higher than is normally used for charging. This charge can be accomplished by using the (1) constant-potential and (2) modified constant-potential (multiple-step) methods.

The constant-potential method employs a starting rate sufficiently high to bring the voltage up to about 2.35 volts per cell. If gassing starts, lower the voltage until gassing occurs only slightly, and use this voltage as the charging voltage. Maintain this voltage, with a steady decreasing current, until the finishing

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rate is reached. The finishing rate is held constant until the charge is completed. The charge can be stopped at any time, but it should be completed if possible.

The modified constant-potential method is started at about 2.25 to 2.30 volts per cell. The current rate obtained at this starting voltage is maintained until the voltage increases to 2.35 volts per cell. At this time the charging rate is dropped to a lower rate. This lower rate is continued until the voltage again increases to 2.35 volts per cell, and the charging rate is again dropped to a lower rate. The charge is continued in successive steps until the finishing rate is reached. At this time no further reduction in the charging rate is made.

The constant-potential and modified constant-potential methods of conducting an emergency charge cannot be used for charging cells of different sizes.

TESTS

State of Charge

The specific gravity of the electrolyte gradually decreases on discharge and gradually increases on charge. This decrease and increase is nearly in direct proportion to the number of ampere-hours taken out of, or put back into, the battery, and is thus a check on the state of charge at any time. As explained in Basic Electricity, NavPers 10086-A, the state of charge, or the number of ampere-hours, expended by a battery can be determined from the (1) specific gravity when fully charged; (2) specific gravity after the battery has been discharged; and (3) reduction in specific gravity per ampere-hour. The voltage alone is not a reliable indication of the state of charge, except when approaching the low-voltage limit on discharge, and hence should not be used for this purpose.

Test Discharge

A test discharge is the best method of determining the capacity of a battery. All Navy standard portable batteries must be given a test discharge at least once every 6 months. Also, a test discharge must be given when the cell voltage and specific gravity fall below specified limits at the completion of a periodic equalizing charge. The cell voltage readings are compared with the values indicated by the cell voltage versus electrolyte temperature curve (fig. 7-10).

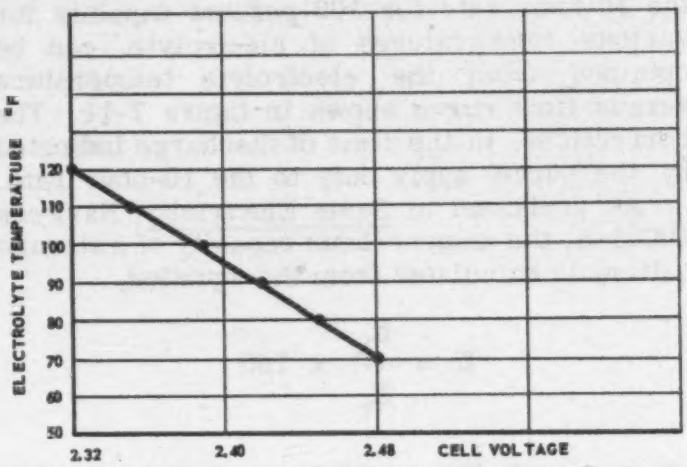

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Figure 7-10.—Cell voltage versus electrolyte temperature curve.

The battery should be given a test discharge if any cell has a voltage that is less than that shown on the curve for the corresponding electrolyte temperature, or if the specific gravity of one or more cells cannot be brought up to within 0.010 of the full charge, irrespective of whether the voltage after the equalizing charge is satisfactory (equal to or greater than the value indicated on the curve). To ensure that reliable data is obtained, a test discharge must be preceded by an equalizing charge.

To conduct a test discharge, connect the battery to the charging and discharging switchboard, and cut in all the resistance by means of the rheostat. The battery switch is closed to the discharging position, and the rheostat is adjusted for the proper 10-hour discharge rate. For example, the correct discharge rate for a 200 ampere-hour battery is 200/10, or 20 amperes. The 10-hour discharge rate is continued until (1) the total battery voltage drops to a value that is equal to 1.75 times the number of cells in series, or (2) the voltage of any individual cell drops to 1.65 volts, whichever occurs first.

If a battery has 100-percent capacity, the discharge will continue for a period of 10 hours before reaching the low-voltage limit, provided the temperature of the electrolyte at the beginning of the discharge is exactly 80° F. Otherwise, the time duration of the discharge for 100-percent capacity must be corrected for the actual electrolyte temperature existing at the start of the test.

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The corrections, in the time to be applied to the 10-hour rate for 100-percent capacity for various temperatures of electrolyte, can be obtained from the electrolyte temperature versus time curve shown in figure 7-11. The corrections, in the time of discharge indicated by the curve, apply only to the 10-hour rate.

As explained in Basic Electricity, NavPers 10086-A, the ampere-hour capacity of a storage battery is calculated from the equation,

$$C = \frac{H_a}{H_t} \times 100$$

where C is the percentage of ampere-hour capacity available, H_a the total hours of discharge, and H_t the total hours for 100-percent capacity. If the ampere-hour capacity is 80 percent or more, the battery should remain in service; whereas, if it is less than 80 percent, the battery may be discarded.

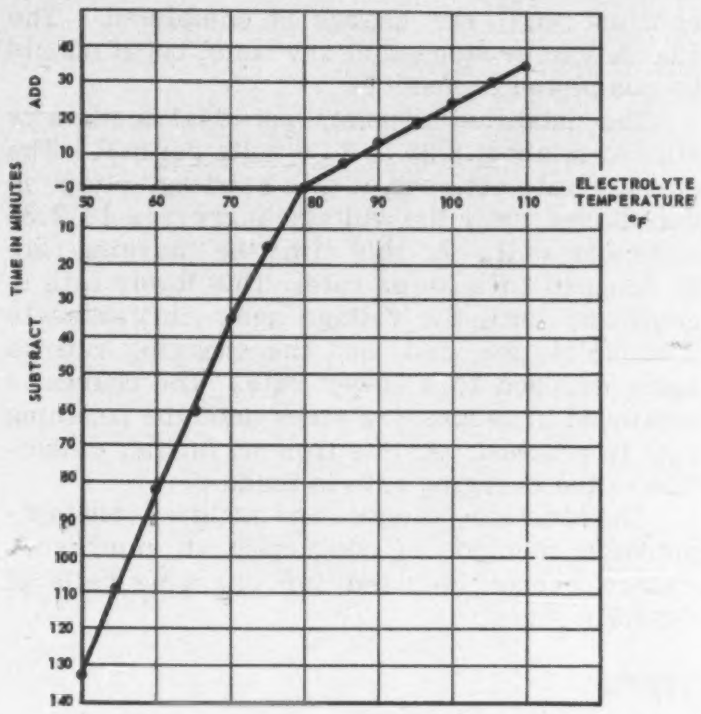

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Figure 7-11.—Electrolyte temperature versus time curve.

TROUBLES

The most common trouble encountered in the operation of storage batteries is that of low cells. The specific gravity of low cells is usually below that of the other cells, both on charge and discharge; hence, the expression, LOW, refers to specific gravity. This condition is caused by poor connections, sulphation, loss of active material, local action, short circuits, loss of electrolyte, hardened negative plates, disintegration of positive grids, broken positive pencils (iron-clad), and impure electrolyte. Low cells can be detected by progressive loss of capacity, low voltage on discharge, low specific gravity, abnormally high or low voltage on charge, and abnormally high temperature.

When trouble is experienced with any cell, it should be examined immediately for low electrolyte, poor connections, and voltage readings should be taken at the cell terminals while the battery is being charged or discharged. If the voltage readings are appreciably higher or lower than that of normal cells, the trouble is probably within the cell and must be investigated further.

SULPHATION

Sulphation is one of the most common causes for the failure of cells to maintain their normal charge. Consequently, low cells are often erroneously attributed to sulphation, with the result that the actual defective condition is not remedied but aggravated by the sulphation treatment.

Sulphated cells are indicated by a falling off of the specific gravity, low voltage on discharge, and loss of capacity.

A sulphated condition will result in batteries that are given undercharges or partial charges, or if they are not given periodic equalizing charges. In normal battery operation it is difficult to determine when sulphation begins. The only way that sulphation can be detected in its early stages and corrected or prevented is by giving the required equalizing charges and comparing the specific gravity and voltage readings of individual cells.

A battery that is allowed to stand in a partially charged condition will become sulphated when the sulphate deposited on the plates hardens and closes the pores in the material. Batteries should be charged as soon as practicable after discharge, and they should never be allowed to stand in a completely discharged condition for more than 24 hours.

If the level of the electrolyte is permitted to fall below the tops of the plates, the exposed surfaces will harden and become sulphated. Also, a cell in which sulphation exists becomes aggravated with the addition of acid.

In general, sulphation is more likely to occur and will be more difficult to reduce in fully charged cells that have high values of specific gravity. The possibility of sulphation is increased in cells that have a specific gravity of 0.015 or 15 points above the average. High temperatures accelerate sulphation, particularly in idle, partially charged batteries.

Sulphation of a battery, except in extreme cases, may be reduced by a long charge, finished at a low rate. The charge should be started at the highest available rate that can be utilized without excessive gassing, and continued at progressively reduced rates to keep within the allowable temperature limits before the charging current is reduced to the finishing rate. This procedure breaks down the sulphate that has not been reduced by previous normal charges. The finishing rate is approximately

$$\underline{FR} = \frac{1.1 \times AH_{10}}{20} \qquad 0.055 \times \underline{AH}_{10}$$

where $\underline{FR}$ is the finishing rate in amperes, and $\underline{AH}_{10}$ is the ampere-hour capacity at the 10-hour rate. The charge is continued at this rate until the specific gravity and voltage are constant for a period of 5 hours.

To measure the results of this treatment, compare the specific gravity and voltage readings with similar readings of healthy cells in the battery. These readings are also considered in conjunction with the capacity of the battery, as indicated by a test discharge. If the comparison is satisfactory, the battery has been restored to a normal condition, and no further treatment is necessary. Otherwise, the sulphation treatment should be repeated.

Loss of Active Material

A normal loss of active material occurs in all batteries due to erosion caused by gassing at the end of a charge. An excessive loss of active material can be caused by too much gassing, overcharging, and expansion due to high temperatures.

Excessive shedding results in a reduction of capacity. It is a sign of wear and is often evident in batteries that have given long service. One of the first indications of shedding is a slightly muddy appearance of the electrolyte caused by the lead peroxide in suspension. There is no remedy for active material that has already left the plate. Additional shedding can be prevented by reducing the rate of charge, particularly at the end of a charge. Some batteries are provided with a mat of spun glass placed against the positive plate to retard the loss of active material after it has become soft and muddy.

Local Action

Local action, or internal discharge, is indicated by an excessive drop in the specific gravity of the electrolyte when the cell is on open circuit. This condition is also indicated by excessive gassing when the cell is on discharge. In general, the higher the specific gravity, the greater will be the tendency for local action, and the more rapidly the specific gravity will fall when the battery is standing idle.

Internal discharge is caused by impurities and non-homogeneity of the material in the plates or by impurities in the electrolyte. Internal discharge is sometimes caused by sediment in the bottom of the jar or by broken separators, which also cause considerable gassing.

Iron is the most common impurity. If impurities are suspected, the electrolyte should be dumped, and the plates should be rinsed with distilled water. The cells should be refilled with new electrolyte of the same specific gravity as that discarded and given an equalizing charge.

Short Circuits

Short circuits are indicated by abnormal temperature, low specific gravity, low voltage, and reduced gassing on charge. Short circuits can be caused by (1) faulty separators, (2) lead particles or other metal forming a circuit between the positive and negative plates, (3) buckling of the plates, (4) excessive accumulation of sediment in the bottom of the jar, (5) mossing that usually occurs between the tops of the negative plates and the positive straps, and (6) a cracked partition between cells in a monobloc case.

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A cell that contains a short circuit will gradually discharge and will become unduly heated on charge. The element should be removed and examined to determine the cause of the short circuit. If mossing or sediment caused the faulty condition, the cell should be removed and the element replaced in the container. The element should be replaced also if the separators are damaged or if the plates are badly worn.

Loss Of Electrolyte

Loss of electrolyte is indicated by an excessive drop in the level of electrolyte compared with that of normal cells, and this indicates a crack in the jar or case.

Hardened Negatives

Hardened negatives are the result of the formation of a hard, nonporous material on the negative plates. This condition could be detected if the battery was disassembled by scratching the active material. A healthy plate is easily scratched and shows a bright metallic luster. A hardened plate contains a hard, insoluble coating, which is difficult to remove. Normally this condition is only viewed at repair activities where batteries are repaired.

Reversal of Cell Voltage

A low cell, in series with other cells, may reverse its polarity when discharged considerably below its low-voltage limit. If this action occurs before the adjacent cells are near their low-voltage limit, it should be assumed that the condition is caused by faults within the cell.

A reversed cell can be detected by a voltage reading of the cell and it (reversed cell) will cause a rapid fall in the battery voltage. This fall in battery voltage may be as much as 3 or 4 volts because the cell voltage may change from 1.7 volts in the proper direction to as much as 2.0 volts in the reverse direction in a short time. Except in an emergency, as soon as a reversed cell is detected, the battery must be taken out of service until the cell is repaired.

REPAIRS

Major repairs to batteries must be performed only by authorized personnel at naval shipyards or other shore establishments.

For information on battery repairs, read chapter 9622 of the NavShips Technical Manual.

Electrolyte is mixed and added to batteries only by authorized personnel at repair activities or on tenders and repair ships.

Mixing Electrolyte

The preparation of electrolyte requires special facilities and precautions. To prepare electrolyte, lead or rubber vessels and stirring rods are necessary. Every effort must be made to keep all impurities from the electrolyte while mixing, since impurities shorten battery life. Only pure distilled water and sulphuric acid (Federal Specification O-S-811) shall be used. NavShips Technical Manual (chapter 9622) includes a table showing the amounts of water and acid to be used to make electrolyte of a desired specific gravity. Personnel handling or mixing electrolyte must wear rubber aprons, rubber boots, and rubber gloves, so that the acid may not come in contact with the skin or clothing. In particular, the eyes must be protected by goggles. In mixing electrolyte the acid must be poured into the water. NEVER pour the water into acid. The acid must be poured slowly into the water to prevent excessive heating. The solution should be stirred continually while the acid is being poured, this prevents the heavier acid from flowing to the bottom without mixing. When concentrated acid is diluted, the solution becomes very hot even when properly mixed. If the solution is not continually stirred while mixing or is mixed wrong (pouring the water into acid) an explosion may occur resulting in serious injury to personnel and damage to equipment.

In the event of an accident or carelessness in handling electrolyte or acid, prompt treatment for acid burns is essential. Should a man get concentrated acid or electrolyte on his skin, wash the affected area freely with large quantities of fresh water, apply vaseline, petroleum jelly, boric acid, zinc ointment, or, if none of these are available, clean lubricating oil, and send him to sick bay. A small amount of water may not only be ineffective in preventing a serious burn, but may even do more harm than good.

If acid or electrolyte gets into the eye, first wash with plenty of fresh water. Repeatedly squeeze out a saturated gauze pad or wad of cotton held above the eye, the water being directed into the pocket formed by pulling the

In the following discussion of azimuth stabilization, an instrument called a fluxgate compass is used. The fluxgate compass employs most of the principles relative to so-called "earth field inductors," and later model compasses operate on those same principles.

Stabilization of the indicator screen pattern is accomplished by signal voltages controlled by the master indicator of the fluxgate compass (also called fluxvalve compass) in the aircraft. These signals are used to control the angle of the sweep trace on the screen in accordance with the instantaneous azimuth position of the scanner.

In order to explain the theory of operation of azimuth stabilization, it is necessary to analyze briefly one of the compass systems used. This is necessary since in an equipment that contains azimuth stabilization the compass that controls the stabilization is an intricate part of the system. The GYRO FLUXGATE COMPASS SYSTEM of the aircraft is a remote-indicating earth-indicator compass, which consists of a gyrostabilized fluxgate, transmitter, an amplifier, a master indicator, and one or more synchro remote-indicator repeaters. (NOTE: The term "gyro fluxgate" is a registered trade name of the Bendix Corporation.) The fluxgate element is stabilized in the horizontal plane by an electrically driven horizon gyro. The gyro head contains a rolling-ball type of erecting system, which maintains the gyro axis in the vertical plane by setting up a restoring force when the axis becomes displaced.

The transmitter portion contains the sensitive element of the system, the fluxgate unit, which consists of three equal legs forming a triangle; this unit is established and maintained in the horizontal plane by the action of the gyro. Each leg consists of two strips of a magnetic alloy used as a core upon which are wound a primary and a secondary coil. The primary coils are connected in series and are excited by an oscillator circuit in the amplifier. The secondary coils are delta connected, with leads tapped off at the points where the three coils join. These leads, and the single lead which supplies the excitation current, are brought out through hairsprings on the gimbal rings. The primary coil of each leg is wound in such a manner that when the leg is at right angles to the magnetic field of the earth the exciting alternating current produces opposing fluxes in each strip which neutralize each other and induce no voltage in the secondary. This exciting current saturates the core on the peak of each half cycle.

When the leg is parallel to the earth's magnetic field, the earth's flux tends to oppose the flux in one alloy strip and to aid the flux in the second strip. The partial cancellation of the flux in the first strip prevents its reaching saturation at the same time as the second strip, and its flux continues to change after the second strip has reached saturation. The flux difference thus set up induces a voltage in the secondary. When the current through the primary decreases to a point where the flux starts to drop below the point of saturation, a voltage in the opposite direction is induced in the secondary. This occurs because the flux in the first strip (in which partial cancellation exists) drops below the saturation point before the flux in the second strip, thus producing a flux change in the opposite direction. Since saturation occurs twice each cycle, and since secondary voltages are induced at the start and again at the finish of each period of saturation, the frequency of the induced voltage is double that of the primary voltage.

Three signal voltages, which generally are of three different magnitudes, are obtained from the fluxgate secondary coils, and are applied to the stator coils of a coupling synchro contained in the master indicator.

The voltage induced in the rotor winding of this synchro is fed to the fluxgate amplifier, which develops sufficient power to operate a 2-phase induction motor which is also in the master indicator. The fluxgate amplifier includes an extremely stable oscillator that is used to furnish excitation power for the fluxgate and another oscillator which provides voltage for the continuously excited winding of the 2-phase induction motor in the master indicator. The excitation voltage applied to the induction motor is necessarily at a frequency of twice that of the fluxgate excitation voltage in order to equal the frequency of the fluxgate output.

The 2-phase induction motor in the master-indicator phase unit has its stator wound in quadrature (two windings at right angles to each other). The control winding is energized by the amplified signal from the synchro rotor, and the exciting winding receives its power from the oscillator in the amplifier. When both windings of the induction motor are energized by voltages having a phase difference of 90°, the motor rotates and drives the synchro rotor

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lower eyelid outward. Do not use a syringe nozzle or any other pressure method for this purpose because of the danger of mechanical injury to the eye. The eye should be washed again with a solution made by mixing two tablespoonfuls of sodium bicarbonate (baking soda) in a pint of clean fresh water. After washing the eye, apply clean mineral oil or petrolatum and send the man to sick bay. In case an ample supply of fresh water is not available, electrolyte or sulphuric acid may be neutralized by applying quickly to the affected place a solution of sodium bicarbonate.

Increasing the Specific Gravity

If the specific gravity of any cell is dropped below the 1.210-1.220 limit, the affected cells are given a 4-hour equalizing charge. At the end of this charge, determine accurately the specific gravity and correct it for the electrolyte temperature existing at the time. For each point that the actual specific gravity of the cell is below 1.215, the amount of electrolyte to be withdrawn must be approximately equal to 1 percent of the total volume of electrolyte normally contained in the cell. For example, if the specific gravity of the low cell is 1.195, it will be (1.215-1.195) x 1000, or 20 points below normal. Thus, the amount of electrolyte to be withdrawn will be 20 x .01, or 20 percent, of the normal volume of electrolyte in the cell. The withdrawal must never lower the electrolyte level below the tops of the separators.

To ensure thorough mixing, the level of the electrolyte is restored to normal by adding electrolyte of 1.300 specific gravity while the cells are being charged and are gassing.

The affected cells are charged at the finishing rate for a 1-hour period. At the end of this period the specific gravity is accurately determined and corrected for the electrolyte temperature existing at the time.

The foregoing procedure is repeated as many times as necessary to increase the specific gravity of the affected cell within the limits of 1.210 to 1.220 at 80° F.

Decreasing the Specific Gravity

If the specific gravity of any cell is above the upper limit of 1.220, the affected cells must be given a 4-hour equalizing charge. At the conclusion of this period, the specific gravity is accurately determined and corrected for the electrolyte temperature existing at the time. For each two points that the specific gravity of the cell is above 1.215, the amount of electrolyte to be withdrawn must be approximately equal to 1 percent of the total volume of electrolyte normally contained in the cell. For example, if the specific gravity of the high cell is 1.230, it will be (1.230-1.215) x 1000, or 15 points, above normal. Thus, the amount of electrolyte to be withdrawn will be 15/2 x .01, or 7.5 percent, of the normal volume of electrolyte in the cell.

To ensure thorough mixing, the level of the electrolyte is restored to normal by adding pure distilled water while the cells are being charged and are gassing.

The affected cells are charged at the finishing rate for a 1-hour period. At the end of this period, the specific gravity is accurately determined and corrected for the electrolyte temperature existing at the time.

The foregoing procedure is repeated as many times as necessary to decrease the specific gravity of the affected cell below the 1.220 limit at 80° F.

SURVEY

It is the policy of Naval Ship Systems Command to discard batteries when it has been definitely ascertained that they cannot be made to give more than 80 percent of their rated capacity. Since a battery may be only temporarily low in capacity, care must be used in determining its true condition.

Scrapping Procedure

Batteries should not be scrapped unless it is definitely known they cannot be made to give further useful service. On the other hand, care must be taken to prevent loss of time and money in a effort to keep in service batteries that should be scrapped. When it is believed that a battery is unfit for further use, the following confirmatory procedures should be followed.

1. Give the battery an equalizing charge.
2. Discharge the battery at the 2-hour rate in accordance with NavShips Technical Manual, Chapter 9622. Compute the capacity obtained and compare it with the rated (nameplate) capacity.
3. If the battery delivers at least 80 percent of its rated capacity on test discharge and is

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in otherwise good condition; it should be recharged and returned to service.

4. Batteries which do not deliver at least 80 percent of their rated capacity on test discharge should be scrapped by the ship or activity using the battery upon approval of the electrical officer.

When portable storage batteries contained in hard-rubber monobloc cases are surveyed, the elements can be scrapped, but the cases should be cleaned, set aside, and credited in the Appropriation Purchases Account (APA). These cases are sent to repair ships and tenders for replacing damaged cases in reassembled or rebuilt batteries.

DATA REQUIRED

All requests for survey of portable storage batteries must contain the following information for each tray to be surveyed:

1. Name of manufacturer.
2. Navy type and manufacturer's type.
3. Purchase contract or order number.
4. Date of initial charge.
5. Service for which used.
6. Details of special treatments given to bring the battery (tray) to 80 percent of rated capacity or over.
7. Complete description of the condition of the battery at time of survey.
8. The Storage Battery Tray Record, NavShips 151, must accompany the survey request.

SAFETY PRECAUTIONS

Battery charging stations must be provided with adequate ventilation to remove the explosive mixture of hydrogen and air. As previously explained, when batteries are being charged, hydrogen gas is liberated; if the surrounding air contains from 4 to 8 percent hydrogen, a mixture is formed that will burn, if ignited. If the mixture contains more than 8 percent hydrogen, it will explode. Hence, ample ventilation is necessary to keep the hydrogen concentration below an established safe limit of 3 percent.

When a large number of batteries are concentrated in a single compartment, the ventilation problem becomes serious, and care must be exercised to ensure that the ventilating system is operating at all times. The system should be supplied with fresh air from the exterior of the ship, and the exhaust from the battery compartment should lead overboard. Battery explosions are dangerous and will result in serious injury to personnel, and in damage to equipment.

The ventilating system, in addition to preventing the formation of the explosive mixture, provides a means of keeping the temperature of the battery-charging station down to 95° F or lower; and thus facilitates the charging of batteries (the charging rate is limited to a value that will cause the electrolyte temperature not to exceed 125° F).

After a battery compartment that has been sealed is opened, it must be thoroughly ventilated before light switches are turned on, any other electrical connections made or broken, or work of any kind performed. Flames and sparks must be kept away from the vicinity because storage batteries give off a certain amount of gas at all times.

The ventilating system must be operating properly before starting a charge. The charge must be stopped if ventilation is interrupted; except in an emergency, the charge should not be resumed until the ventilation has been restored.

All batteries must be kept clean and free from the accumulation of acid and dirt; otherwise corrosion will occur and eventually lead to troublesome grounds. Grounds are formed by the collection of dirt and acid on the cell tops and sides of a battery. They will result in dissipation of battery energy and disarrangement of the circuit in which the battery is connected. Also, a ground in the vicinity of a battery can furnish a spark that will ignite an explosive mixture.

Acid that has collected on a battery can be removed with a cloth moistened in a solution of dilute ammonia or bicarbonate of soda. Also the top and sides of a battery should be cleaned after each watering.

A battery should always be charged at the prescribed rates; never at a higher finishing rate than that indicated on the nameplate. When charging more than one battery at the same time, the voltage of the charging line should be known to exceed the total voltage of all the batteries being charged in series. Also, the charging rate in amperes should be known not to exceed the maximum charging rate of the battery having the lowest ampere-hour capacity in the charging line. The charging rate should be lowered as soon as the battery begins to gas or the temperature reaches 125° F. Except

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in an emergency, a battery should not be discharged below the low-voltage limit. As previously stated, a battery should never be allowed to stand in a completely discharged condition for more than 24 hours.

Only tools with insulated handles should be used while servicing a battery, and care should be exercised not to short circuit the terminals. No repairs to battery connections should be made when current is flowing in the circuit, and batteries should never be connected to, or disconnected from, the charging line without first turning off the charging current. When batteries are used with one terminal grounded, the grounded terminal should be disconnected (first) when replacing the battery. This action will avoid the possibility of grounding the hot terminal and shorting the battery when the ungrounded terminal is disconnected first.

Never allow salt water to enter a battery cell, as chlorine gas, which is extremely toxic, will be evolved.

Electrolyte having a specific gravity greater than 1.350 should never be added to a battery.

Keep on hand in the battery locker materials for treating acid burns.

Never permit smoking in the battery locker.

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CHAPTER 8

PROTECTIVE DEVICES

The electrical distribution system and its associated generators can be easily damaged unless protected from various sources of trouble. Considerable protection can be acquired from automatic protective devices, provided they are not misused. However, it is extremely important for operating personnel to realize that no provision is made for automatic protection of a generator from damage by long continued operation at a current only moderately in excess of rated capacity. Sole reliance for this type of protection is placed upon the vigilance of the operator.

This chapter describes how and why protective devices are used. Because an important part of your duties is to maintain uninterrupted operation of equipment, you must understand the purpose of each device.

This knowledge will help you find the cause of interruption, clear the trouble, and restore operation with minimum loss of time.

Any trouble, whether due to overload or fault, must be cleared before a new protective device (for example, a fuse) is installed. Otherwise the new device will be ruined by the same defect that caused the original breakdown.

Protective devices may differ considerably in appearance and construction. Regardless of their appearance or construction, they are used only to protect equipment or personnel.

Most protective devices are designed to interrupt the power to a circuit when circuit conditions become dangerous.

The purpose, construction, and testing of protective devices will be described. When two devices are used on the same circuit, the purpose and operation of each device will be explained. By studying the equipment in this manner, you should be able to visualize power supply systems and the methods used to protect entire systems as well as individual branches.

FUSES

The simplest protective device is a fuse. All fuses are rated according to the amount of current that is safely carried by the fuse element. Usually, the current rating is in amperes, but some instrument fuses are rated in fractions of an ampere. When a fuse blows, it should be replaced with another of the same rated voltage and current capacity, including the same current-versus-time characteristic.

The most important fuse characteristic is its current-versus-time or "blowing" ability. Three time ranges for existence of overloads can be broadly defined as fast, medium, and delayed. FAST, may range from 5 microseconds through one-half second; MEDIUM, 1/2 to 5 seconds; DELAYED, 5 to 25 seconds.

Normally, when the circuit is overloaded, or a fault develops, the fuse element melts and opens the circuit that it is protecting. However, all fuse openings are not the result of current overload or circuit faults. Abnormal production of heat, aging of the fuse element, poor contact due to loose connections, oxides or corrosion forming within the fuse holder, and the heated condition of the surrounding atmosphere will alter the heating conditions and the time required for the element to melt.

DELAYED-ACTION FUSES

Some equipment, such as an electric motor, requires more current during starting than for normal running. Thus, a fast-time or medium-time fuse rating that will give running protection might blow during the initial period when high starting current is required. Delayed-action fuses are used to handle these situations.

One type of delayed action fuse has a heater element connected in parallel with the fuse element in order to get the delayed action. During normal operation the heat developed in the fuse

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link is not great enough to melt the link. The melting, or opening, of the fuse link depends on the transfer of heat to the link from the heater. Therefore, more time is needed to melt the link than would be required if the link were directly heated.

Because the heater and fuse element are in parallel, the opening of the fuse element will cause the total circuit current to flow through the heater. The high current will cause the heater to burn out and completely open the circuit.

Another type of delayed-action fuse has the fuse element and heater connected in series. Current above that of the rated value for a short time will have no effect on the fuse or heater. However, prolonged overloads cause the heater section to become hot enough to melt the junction between the elements; this action opens the circuit.

Delayed-action fuses are sometimes call Time-Lag fuses, and three trade names "Slo Blo," "Fusestat," and "Fusetron" are in common use.

PLUG FUSES

The plug fuse is constructed so that it can be screwed into a socket mounted on the control panel or distribution center. The fuse link is enclosed in an insulated housing of porcelain or glass. The construction is so arranged that the fuse link is visible through a window of mica or glass. Therefore, an open element may be located by visual examination. The plug fuse is used primarily to protect low-voltage, low-current circuits. The operating ratings range from 0.5 to 30 amperes up to 150 volts.

Except in certain older gyrocompass repeater panels, the plug fuse is seldom found aboard naval ships. It is used extensively in shore installations. When found to be defective, the fuse is discarded and a new fuse installed in its place.

CARTRIDGE FUSES

In operation, the cartridge fuse is exactly the same as the plug fuse. In construction, the fuse link is enclosed in a tube of insulating material with metal ferrules at each end (for contact with the fuse holder). The dimensions of cartridge fuses vary with the current and voltage ratings.

Table 8-1 lists some of the fuses in use on board naval ships. Note the different dimensions and ratings.

Because an arc is produced when excessive current causes the fuse link to open, the fuse tube is filled with materials, such as shredded asbestos or boric acid, which act as an arc quencher.

BLOWN-FUSE INDICATORS

It is not always possible to detect a blown fuse by a visual examination. Hence, fuses are often equipped with a device that will provide a visual indication so that a blown-fuse condition can be readily detected (fig. 8-1). These devices consist of the spring-loaded and the neon-lamp types of blown-fuse indicators.

In the spring-loaded type (fig. 8-1A) when the link opens, it releases a spring that is held under tension. This action exposes an indicator, which makes the visual location of the blown fuse possible.

The neon-lamp type (fig. 8-1B) is designed to be mounted on the fuse. When the link opens, a neon lamp glows to show a blown fuse.

When no indicator is used, it is necessary to test the fuse continuity with a megger, ohmmeter, or voltmeter. Various methods of testing will be described later in this chapter.

Most fuse panels and switchboards are of the enclosed panel type. The term "dead-front," means that all fuses and bus connections are enclosed in a metal cabinet when the cover is closed. The use of this type of construction reduces the possibility of equipment damage and danger to personnel. Modern switchboards are of the "dead-front" type.

However, the complete enclosure of the equipment makes it less accessible for test purposes. Therefore, most fuses used on "dead-front" switchboards have indicators that show when a fuse is blown. The fuse holder consists of a molded phenolic base, plug, and cap with a built-in indicator lamp (blown-fuse indicator). The lamp is usually a small neon bulb, which normally is shunted by the fuse element. When the fuse opens, the shunt is removed, causing an increase in the voltage across the neon lamp. The lamp then glows, indicating the open fuse.

TROUBLESHOOTING FUSED CIRCUITS

The complete electrical system of a ship may consist of a comparatively small number of

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Table 8-1.—Fuse Characteristics

Style	Available current ratings (amperes).	Maximum permissible voltage of circuit in which used.	Blowing characteristics on overload when mounted in open clips (all fuses must blow promptly on short circuit).
F03 (1-1/4" long by 1/4" dia)	0.01-30	125	Within 1 hour on 135% rated current. Time lag: Within 6 seconds on 300% rated current.
F09 (1-1/2" long by 13/32" dia)	.1-30	125	Within 1 minute on 150% rated current. Time lag: Within 6 seconds on 300% rated current.
F60 (1-1/2" long by 13/32" dia)	1-30	500	Within 1 minute on 150% rated current.
F15 (2" long by 9/10" dia)	0.125-30	500	Within 1 hour on 135% rated current. Time lag: Within 10-25 seconds on 500% rated current.
F16 (3" long by 13/16" dia)	35-60	500	Within 1 hour on 135% rated current.
F62 (3" long by 13/16" dia)	35-60	500	Within 1 hour on 135% rated current.
F19 (5-7/8" long, knife blade)	70-100	500	Within 2 hours on 135% rated current. Time lag: Within 10-25 seconds on 500% rated current.
F63 (5-7/8" long, knife blade)	70-100	500	Within 2 hours on 135% rated current.
F20 (7-1/8" long, knife blade)	110-200	500	Within 2 hours on 135% rated current. Time lag: Within 10-25 seconds on 500% rated current.
F64 (7-1/8" long, knife blade)	110-200	500	Do

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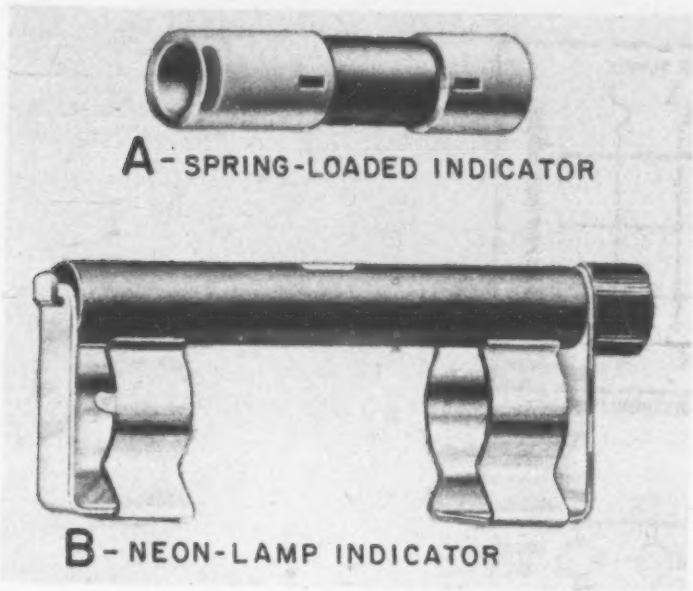

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Figure 8-1.—Blown-fuse indicators.

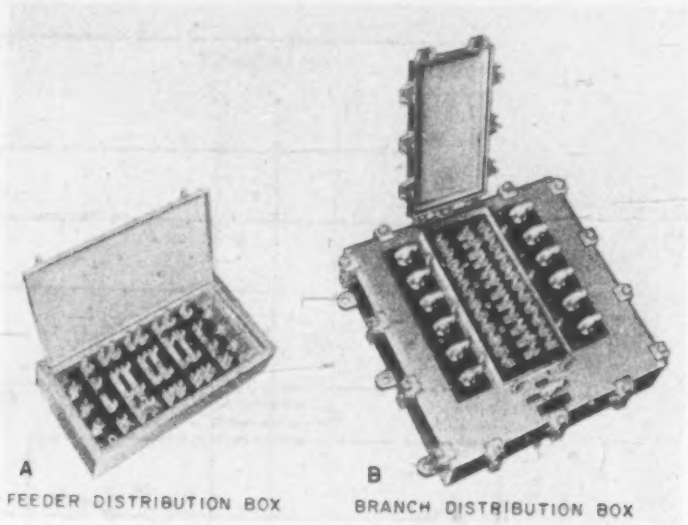

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Figure 8-2.—Distribution boxes.

circuits or, in the larger ships, the installation may be equal to that of a fair sized city.

Regardless of the size of the installation, an electrical system consists of a source of power (generators or batteries) and a means of delivering this power from the source to the various loads (lights, motors, and other electrical equipments).

From the main power supply the total electrical load is divided into several feeder circuits and each feeder circuit is further divided into several branch circuits. Each final branch circuit is fused to safely carry only its own load while each feeder is safely fused to carry only the total current of its several branches. This reduces the possibility of one circuit failure interrupting the power for the entire ship. The distribution boxes are illustrated in figure 8-2. The feeder distribution boxes (fig. 8-2,A) and the branch distribution boxes (fig. 8-2,B) contain fuses to protect the various circuits.

The distribution wiring diagram showing the connections that might be used in a ship's lighting system is illustrated in figure 8-3. A ship's installation might have several feeder distribution boxes, each supplying six or more branch circuits through branch distribution boxes.

Fuses F1, F2, and F3 (fig. 8-3) protect the main feeder supply from heavy surges such as short circuits or overloads on the feeder cable. Fuses A-A1 and B-B1 protect branch No. 1. If trouble develops and work is to be done on branch No. 1, switch S1 may be opened to isolate this branch. Branches 2 and 3 are protected and isolated in the same manner by their respective fuses and switches.

BRANCH CIRCUIT TESTS

Usually, receptacles for portable equipment and fans are on branch circuits separate from lighting branch circuits. Test procedures are the same for any branch circuit. Therefore, a description will be given of the steps necessary to (1) locate the defective circuit and (2) follow through on that circuit and find the trouble.

Voltage Testers

The most commonly used voltage tester is the solenoid type shown in figure 8-4. This type of tester has two indicators, one is a plunger type which moves into the coil (against spring tension) of the tester. The distance the plunger is pulled into the coil varies according to the amount of voltage applied to the coil. This tester is designed for operation on 115 to 550 volts AC or 115 to 600 volts DC. In the center of the tester is a neon glow lamp indicator. The glow lamp is used to indicate if the circuit being tested is AC or DC. When the tester is operated on AC, light is produced only during a portion of

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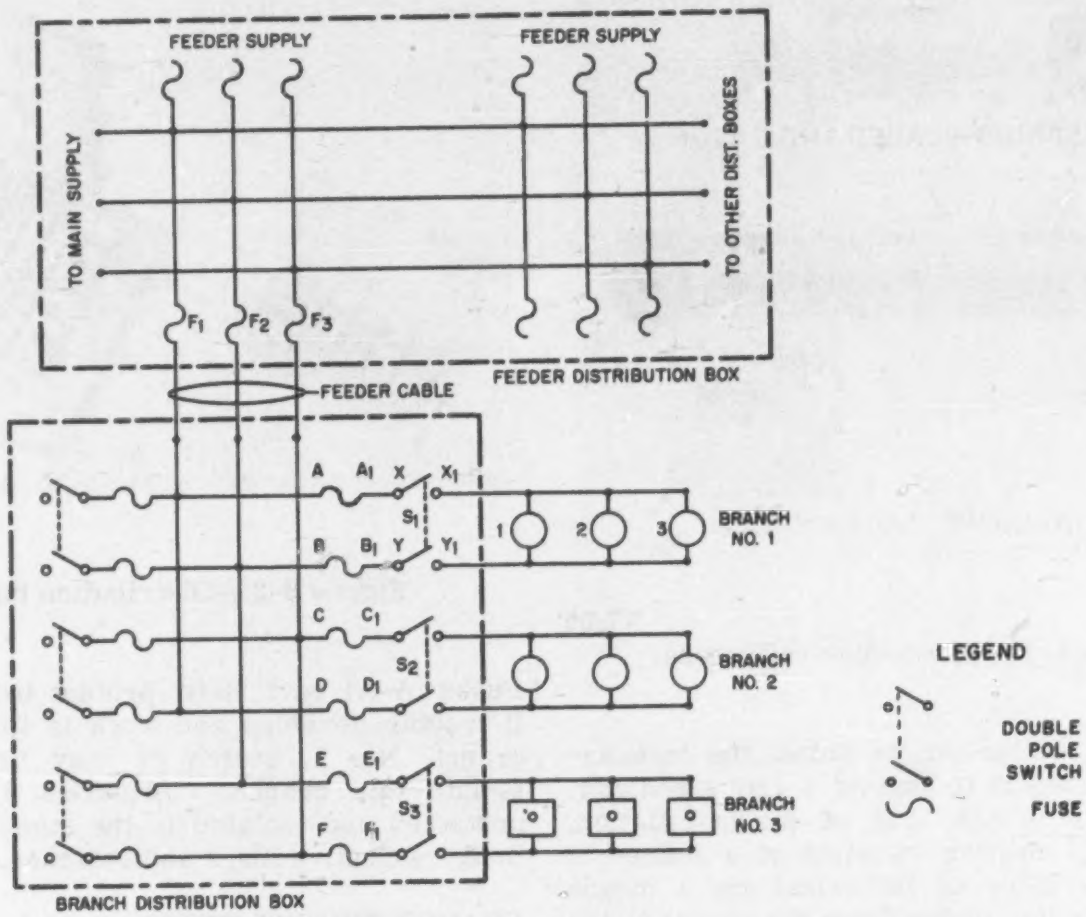

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Figure 8-3.—Three-phase distribution wiring diagram.

each half-cycle, and both electrodes of the glow lamp are alternately surrounded with a glow. When the tester is operated on DC, light is produced continuously, and only the negative electrode glows. Therefore the tester will indicate polarity on d-c circuits. The test probes are colored red and black and the glow lamp enclosure is labeled red and black as shown in figure 8-4. If while testing a d-c circuit the electrode of the glow lamp on the side labeled black is glowing, this indicates the black probe of the tester is on the negative side of the circuit; likewise the opposite electrode would glow if the red probe of the tester was on the negative side of the circuit.

Prior to being taken from the electric shop to be used on a circuit, a voltage tester must be tested for proper operation on a known voltage source such as the electric shop test panel.

If your voltage tester is inoperative, give it to your division P. O. to be repaired or replaced. The solenoid type voltage tester gives an audible hum and noticable vibration when applied to a source of AC.

It is easy to fall into the habit of assuming that normal voltage is present when you feel the vibration and hear the hum. However, these indications only mean that SOME voltage is present. It is necessary to actually READ the scale to determine the amount of voltage because certain defects will cause less than normal voltage. Unless this is done, you may assume that normal voltage is present when the actual voltage is less than normal. Less than normal voltage on certain tests (shown later) is a definite clue to the location of faults.

A newer type voltage tester now available to the fleet is the multi-frequency type shown in figure 8-5. This tester utilizes electronic circuitry and seven neon glow lamps to indicate voltage, frequency, and polarity. This tester may be used on 60- or 400-cycle a-c, or on d-c.

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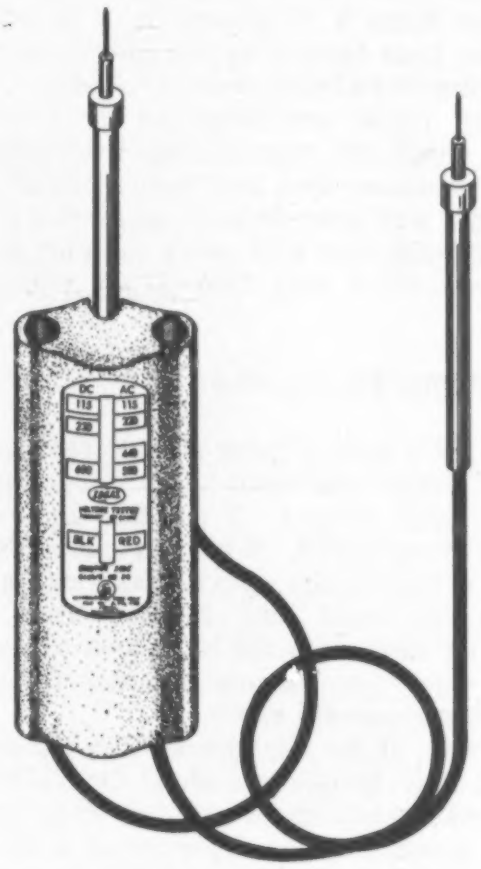

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Figure 8-4.—Voltage tester.

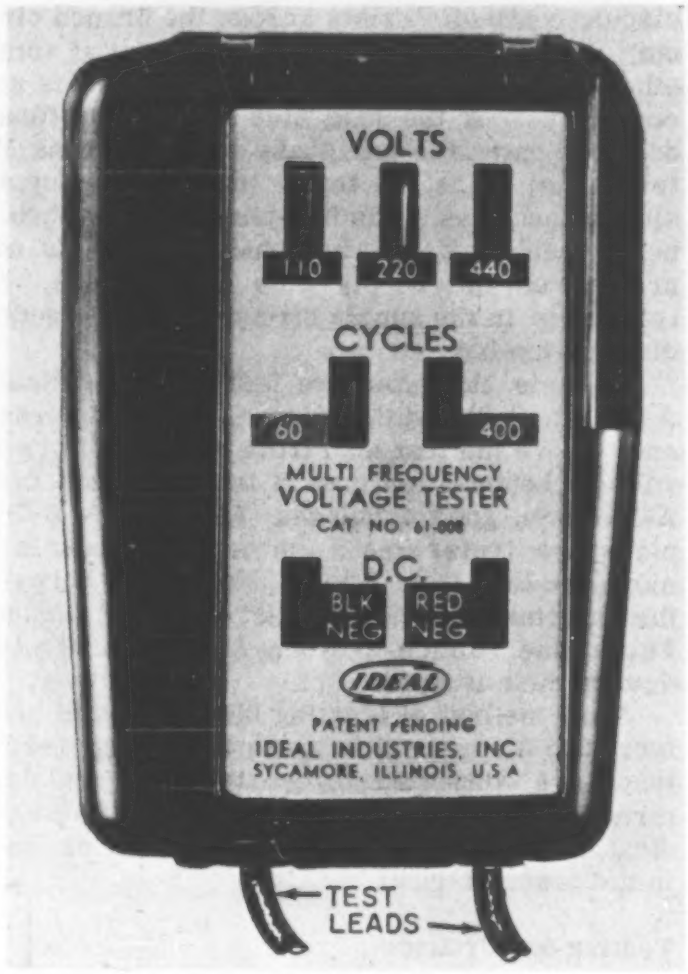

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Figure 8-5.—Multi-frequency voltage tester.

One or more of three lamps light to indicate the amount of voltage, labeled as 110, 220, or 440 volts. At the same time one of the remaining four labeled lamps lights to distinguish the a-c frequency, whether 60 cycles or 400 cycles, or whether having negative polarity applied to either the tester's "red probe" or its "black probe" when the tested circuit carries d-c.

Never use a lamp in a "pigtail" lamp holder as a voltage tester. Lamps designed for use on low voltage (120 v) may explode when connected across a higher voltage (440 v). In addition, a lamp would only indicate the presence of voltage, not the amont of voltage. Learn to use and rely on standard test equipment.

Locating the Defective Circuit

Assume that, for some reason, several of the lights are not working in a certain compartment. Because several lights are out, it will be reasonable to assume that the voltage supply has been interrupted on one of the branch circuits.

To verify this assumption, you must first locate the distribution box feeding the circuit that is inoperative. Then make sure that the inoperative circuit is not being supplied with voltage. Unless the circuits are identified in the distribution box, you will first need to measure the voltage at the various circuit terminations. For the following procedures, use the circuits shown in figure 8-3 as an example circuit.

To pin down the trouble, connect the voltage tester to the load side of each pair of fuses in the branch distribution box. No voltage between these terminals indicates a blown fuse or a failure in the supply to the distribution box. To find the defective fuse, make certain S1 is closed, then connect the voltage tester across A-A1, and next across B-B1 (fig. 8-3). The full-phase

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voltage will appear across an open fuse, provided circuit continuity exists across the branch circuit. However, if there is an open circuit at some other point in the branch circuit, this test is not conclusive. If the load side of a pair of fuses does not have the full-phase voltage across its terminals, place the tester leads on the supply side of the fuses. The full-phase voltage should be present. If the full-phase voltage is not present on the supply side of the fuses, the trouble is in the supply circuit from the feeder distribution box.

Assume that you are testing at terminals A-B (fig. 8-3) and that normal voltage is present. Move the test lead from A to A1. Normal voltage between A1 and B indicates that fuse A-A1 is in good condition. To test fuse B-B1, place the tester leads on A and B, and then move the lead from B to B1. No voltage between these terminals indicates that fuse B-B1 is open. Full-phase voltage between A and B1 indicates that the fuse is good.

This method of locating blown fuses is preferred to the method in which the voltage tester leads are connected across the suspected fuse terminals because the latter may give a false indication if there is an open circuit at some point in the branch circuit.

Testing for Grounds

If no voltage is supplied to the branch circuit, determine the type of circuit: lighting, portable equipment, receptacles, or other. This is necessary to avoid false interpretations of tests made later.

To test for grounds with a megger, find or prepare a spot on the bare metal of the ship's hull to avoid the insulating effect of paint or enamel. This spot should be on a bulkhead or overhead to ensure a good ground. To protect yourself while making tests, leave BOTH fuses out of the holder. Then, close switch S1 in order to make the ends of the circuit accessible inside the cabinet. In addition, if you close the unfused switch, its contacts and internal connections are included in the tests.

Connect one test lead of the megger to the bare spot prepared on the metal and the second test lead to terminal X (fig. 8-3).

A resistance of 1 megohm or more is tolerable and it indicates that the lead from terminal X to the end of the circuit is free from grounds. The next part of the test is to move the test lead from terminal X to terminal Y. The second test lead should remain connected to ground. If the resistance from Y to ground is 1 megohm or more, the lead from Y to the end of the circuit may be considered free from grounds.

If both leads are found to be free from grounds, check for overloading. This might happen if a machine tool had been connected to a circuit that was already near maximum loading. The additional load will cause the fuse to blow. Therefore, move that tool to an underloaded circuit.

Other Trouble Finding Hints

Make it a part of your circuit-testing steps to check if any additional loads were connected when the fuse opened. If you find an overload, it should be removed. If no overload is present, go back to the branch distribution box, open S1, and replace A-A1 and B-B1. Then, close S1. If the fuse does not blow, you can assume that the first fuse failure was due to aging or some other transient effect.

However, if the replacement fuse blows, the overload may be due to a short circuit between conductors, which would not show up in a megger test for grounds. A megger is not suitable for checking low resistance, and it will be necessary to use an ohmmeter (lowest range scale) in making further tests. Because an ohmmeter can be damaged by connecting it in a circuit that is carrying current, open S1 and remove fuses A-A1 and B-B1 before starting the tests. Then close S1 so that it will be included in the tests.

The ohmmeter test leads should be connected to terminals A1 and B1. Zero resistance between these terminals indicates a direct short circuit across the line. However, you should be careful in interpreting the results of this test. For example, consider a case where 10 lamps are connected in parallel.

The number of lamps and the individual wattage of the lamps will determine the circuit resistance measured between A1 and B1. The resistance checked in this manner is the "cold" resistance of the lamp filaments. This resistance is not the same value that you would obtain in an Ohm's law calculation, using rated voltage and power because for this condition the filament is hot, and for tungsten resistance increases as the temperature increases.

For example, the cold resistance of a 40-watt, 120-volt lamp may vary between 40 and 50 ohms; whereas, the hot resistance is of the order of 360 ohms. Ten of these lamps connected in

through a gear train until the null position is reached. When this occurs, the voltage induced in the rotor drops to zero; The output of the amplifier also becomes zero; and since only the excitation winding of the induction motor is energized, the motor stops. The position of the synchro rotor is therefore determined by the position of the fluxgate with respect to the earth's magnetic field; consequently, when the aircraft turns, changing the azimuth relation of the fluxgate to the earth's magnetic field, the synchro rotor and attached indicator pointer are turned by the induction motor through the same angle in the same direction. When the synchro rotor reaches the null position, the master indicator shows the magnetic heading of the aircraft. A transmitting magnesyn, which is also turned by the induction motor, provides controlling voltages for remote-indicating repeaters.

Analysis of Azimuth Stabilization

A simplified schematic of the azimuth stabilization section of the radar that will be used in this analysis is shown in figure 17-32. The MASTER INDICATOR of the fluxgate compass system contains the transmitting synchro used with this azimuth stabilization system. The rotor of the transmitting synchro is mechanically coupled to the shaft that drives the pointer of the master indicator. As the aircraft changes its heading, the rotor correspondingly changes position at a one-to-one ratio. The stator of the transmitting synchro is electrically coupled to the contacts of relay K2101. This relay is energized by the operation of the bearing switch on the control unit of the radar system. By referring to figure 17-32, it can be seen that K2101 must be energized before the output of the transmitting synchro can be utilized in stabilization.

The ZERO SET SYNCHRO is utilized to zero set the PPI sweep position when the output of the transmitting synchro is not used, which is during relative bearing operation. The stabilization system will first be described as it relates to relative bearing operation; later it will be shown how azimuth stabilization is provided when the transmitting synchro of the aircraft compass system is connected to the azimuth followup synchro. When on relative bearing operation, the indicators are nonstabilized and the top of the indicator represents the heading of the aircraft; the targets are displayed with respect to the heading of the aircraft.

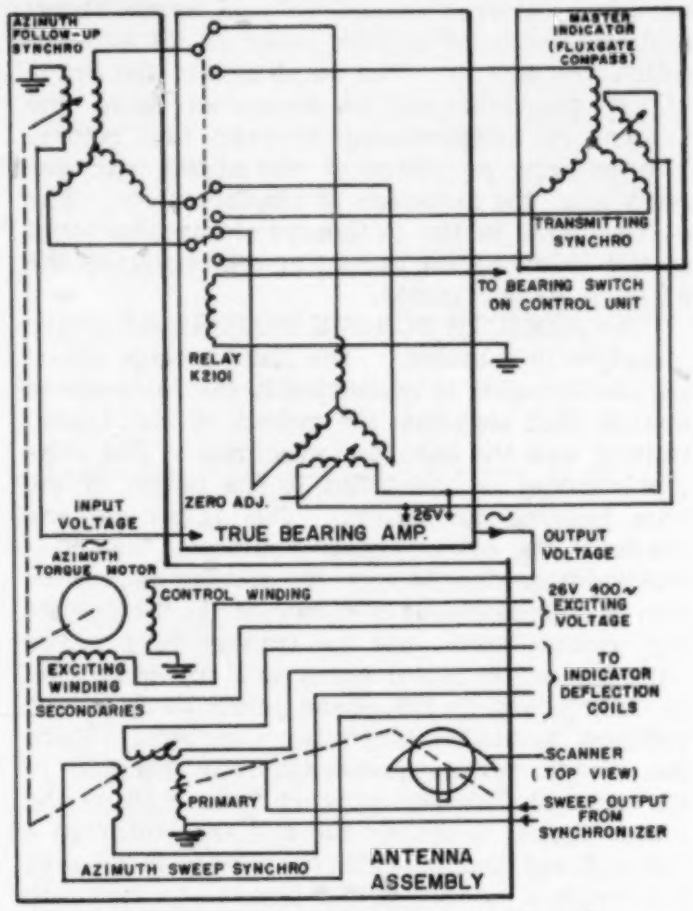

Figure 17-32.—Analysis of azimuth stabilization.

The rotors of the zero set synchro and the transmitting synchro of the fluxgate compass are supplied excitation voltage from the same source. The zero set synchro is adjusted manually. Its positioning will be discussed later.

The stator of the AZIMUTH FOLLOWUP SYNCHRO is electrically coupled to either the stator of the transmitting synchro in the fluxgate compass or the stator of the zero set synchro. The stator that is used for coupling depends upon the position of K2101. The rotor of the followup synchro is mechanically connected to the azimuth torque motor and the secondaries of the azimuth sweep synchro. The phase relationship between the rotor of the transmitting synchro or the zero set synchro determines the amplitude and polarity of the signal developed at the rotor of the followup synchro. When, for example, the rotors of the followup and the zero set synchros are 90° displaced, as shown in figure 17-32, there will be no signal at the rotor of the followup synchro. If, however, the

parallel will have a "cold" resistance between 4 and 5 ohms. These low values are difficult to measure unless you use considerable care in setting up the ohmmeter and in reading the indicated value. Unless these precautions are taken, you may easily mistake the normal "cold" resistance of a parallel connected group of lamps for a short circuit.

Assume that your resistance tests have shown a short circuit. How do you locate the trouble?

Although branch No. 1 (fig. 8-3) shows three lamps, an actual circuit may contain more or less than this number. Choose a lamp that appears to be near the center of the affected group and open the housing to expose the leads.

The wire leads are attached to the fixture with screw-type fasteners. The socket shell screws are inserted in metal bars, which serve to connect the lamp socket terminals to the line. Two other screws anchored in the socket insulation serve as feed-through terminals for line wires entering and leaving the outlet box. Therefore, it will be easy to "pair up" the leads for testing. Disconnect each pair of leads from the fixture terminals.

As a safety precaution, when you open a box or outlet, always check for voltage at that location; never assume that the circuit is dead.

It is possible to determine the direction of the fault from the opened outlet box. To do this, connect the ohmmeter to the pair of leads that go back to the distribution box. If the meter indicates a short circuit, the fault is in that direction. If an open circuit is indicated, the ohmmeter leads should be removed and connected to the pair of wires running toward the end of the circuit. Remember to take lamp resistance into account or remove the lamps from the sockets.

If no short circuits show up when you make this test, the short is in the fixture that has been disconnected. The trouble will naturally disappear when the defective fixture is disconnected.

Assuming that your tests at the opened box have shown a fault toward the end of the line, open another outlet box at a point approximately halfway between the first opened outlet box and the end of the line. The leads in the second opened outlet should be disconnected from the fixture. Each pair of wires should be tested for a short circuit. This will show whether the trouble is between the two open boxes or between the second open box and the end of the circuit.

If the trouble is found to be between the two opened outlet boxes, open any boxes between them, disconnect the fixture, and make the tests for short circuits at each box and at the end of the line. Bear in mind that the trouble may be in the cable running between the two boxes. When it is, usually it is necessary to pull in new cable. However, some cables have a spare wire, which might be used to save running a new cable.

On circuits for portable equipment, disconnect each item. If a short circuit disappears, the trouble is in some of the portable equipment. In this case, the defective fuse can be replaced and the circuit energized. If the short remains with the portable equipment disconnected, the circuit should be tested, as described for lamp circuits.

Of course, if the trouble is due to defective portable equipment, each item should be carefully checked before it is reconnected to the line. Any defective equipment should be repaired.

To test a circuit for portable devices, it is sometimes helpful to connect an ohmmeter at the distribution box and watch the meter (or have someone watch it for you) as each portable device is disconnected from the line. If the short circuit disappears when one item is disconnected, assume that this item was the cause of the trouble.

THREE-PHASE FUSED CIRCUITS

The tests previously described relate to individual branch circuit troubles. However, branch circuit faults may not always be confined to an individual branch. Instead, the trouble may be in the feeder distribution system.

For example, assume that you get a report that one-third of the lights in a section or compartment are normal and the remaining two-thirds are dim. Because these lights are on different branch circuits, use the report information to determine possible causes of trouble.

The feeder supply circuit is 3-phase, and the lighting branches are single-phase circuits. The changeover from 3-phase to single-phase is made in the branch distribution box by connecting the various branch circuits to the proper feeders. Figure 8-3 illustrates how these connections are made.

Now, assume that a fuse in the feeder distribution box opens. This fuse will open one leg of the 3-phase supply. When this happens, the loads will then form two branch circuits in series across a single-phase branch circuit. It will be easier to visualize this condition by examining figure 8-6, which is a simplification of the figure shown in figure 8-3.

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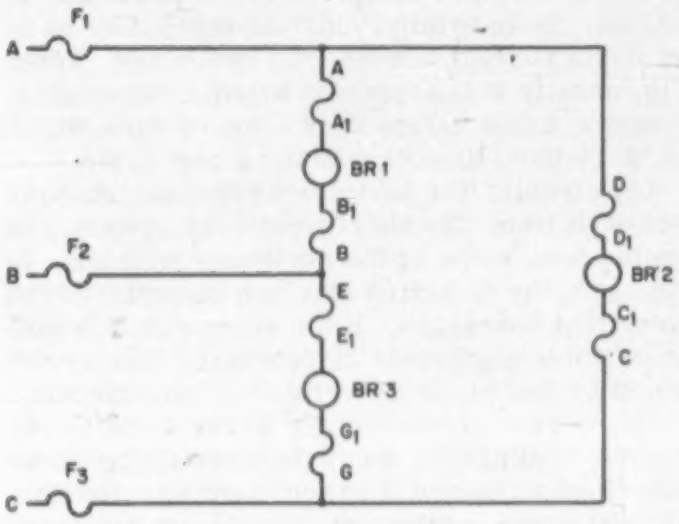

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Figure 8-6.—Simplified main and branch wiring.

In this circuit, consider that fuse F1 is open. Branch circuit 3 still has normal connections to phase B-C. Therefore, it will receive normal voltage, and all lamps on this circuit will light to normal brilliancy. However, because of the open fuse, F1, branches 1 and 2 cannot receive normal voltage. They do, however, receive voltage from terminals B and C. The supply path is from terminal B through fuse F2, branch 1 to branch 2, to fuse F3 and terminal C. Therefore, branches 1 and 2 are in series across the terminals (E and G in fig. 8-6) that supply branch 3.

If the wattages of the series-connected lamps are equal, the voltages will divide equally across each load, and lights connected in these circuits will light to about half brilliancy. However, any load unbalance will cause unequal voltage division in the branch circuits so that, in an actual case, there may be several degrees of lamp brilliance in lighting circuits connected to the same distribution box.

The same action will be noted if fuse F3 opens, except that branch 1 will have normal voltage, and the voltage of this branch will divide across branches 2 and 3 because they will be in series across the supply voltage.

If fuse F2 opens, branch 2 will receive normal voltage, and branches 1 and 3 will be in series across the voltage supply.

Thus, you can see that an open fuse in any leg of the 3-phase supply mains will give an immediate indication as to the cause of the trouble. In this example, the first clue is the dimming of lights on some circuits and full brilliance of lights on others. Suspicions of an open-phase fuse can then be confirmed by voltage measurements.

Voltage Tests

At the feeder distribution box (fig. 8-3) determine which fuse is defective. To do this, connect the test leads of the voltage tester across fuse F1. If the fuse is open (fig. 8-6), the full voltage of that phase will be indicated by the tester, provided circuit continuity is maintained through connected loads in branches 1, 2, and 3. If the fuse is in good condition, it will shunt the voltage indicator, and no voltage will be shown.

There is, however, an exception to this test. If an open circuit is at another point in that circuit, no voltage will appear across an open fuse. However, this condition is not likely to exist in tests at the feeder distribution box because of the relatively large number of connected loads compared with the number of loads at the distribution box (fig. 8-6).

Open-Circuit Tests

If fuse F1 is open and branches 1 and 2 are in good condition and located, the full voltage will appear across the open fuse (fig. 8-6). If an overload on branch 1 has caused fuses A-A1 and F1 to open, a test across F1 will show full voltage because of a path through branch 2 and its associated fuses.

If F1 and D-D1 open but A-A1 stay closed, the path will be completed through branch 1 and its fuses.

Assuming there is no burned, cut, faulty, or other open wire in the system the only other condition that prevents voltage across an open feeder distribution fuse is simultaneous open circuits in two branch circuits.

Simultaneous open circuits in branches 1 and 3 will prevent voltage from appearing across the open fuse F2. No voltage will appear across the open fuse F3, if branches 2 and 3 open simultaneously.

Kirchoff's law states that, in a series circuit, the full source voltage will appear across an open circuit. No voltage drop will appear across any load resistance in the circuit because no current can flow in an open circuit. In order

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for a voltage drop to appear across a resistance (load), current must be flowing in the circuit.

If only one branch circuit is interrupted, it is safe to assume that the feeder distribution box fuses are in good condition and that a fuse is blown in the branch distribution box. However, do not overlook the necessity for actually measuring voltage. As mentioned before, do not mistake vibration or hum in the voltage tester as an indication that normal voltage is present.

If two branch circuits are affected but each branch has some voltage, check the feeder distribution box fuses.

As another example, you might find that all lights on branch 1 (fig. 8-3) are out. First, try to decide which parts, if defective, will open the circuit.

If S1 is open, it is obvious that the lights will be out. If the switch is in the OFF position, the trouble is readily apparent, and the cure is to turn the switch ON. However, if the switch is in the ON position but open circuited because of an internal defect, the trouble will not be apparent through a visual examination.

Another cause of circuit failure could be a blown fuse, A-A1 or B-B1. They should be tested as described for branch circuit tests.

If these tests prove that fuses A-A1 and B-B1 are in good condition, the open circuit will be between the fuses and the first light on the circuit. If it were at some other point, one or more of the lights on the circuit would be operating.

Check the switch by removing the front of the distribution box so that terminals X1 and Y1 are exposed (fig. 8-3). The switch wafer can be turned to the ON position with a screwdriver. The voltage tester leads should be connected to X1-Y1. No voltage means one or both switch arms are open. To check, connect your voltage tester to X-Y. This phase voltage should be present. Leave one lead on X and move the other lead to Y1. Normal line voltage between these points is an indication that switch arm Y-Y1 is in good condition. No voltage means that the switch arm or contacts are defective, and the switch should be replaced. Arm X-X1 is tested by placing one test lead on Y and the other on X1.

If the switch is in good condition and voltage is present at X1-Y1, the open circuit is between X1-Y1 and the first light.

The foregoing discussion shows that the effect is a clue to the type of trouble. If only one circuit is out of commission, look for a blown fuse in the branch distribution box. If one circuit is normal and two other circuits have less than full voltage, look for a blown fuse in the feeder distribution box.

When operated electrically, the operation is usually in conjunction with a pilot device such as a relay or switch. Electrically operated circuit breakers employ an electromagnet, used as a solenoid, to trip a release mechanism that causes the breaker contacts to open. The energy to open the breaker is derived from a coiled spring. The electromagnet is controlled by the contacts in the pilot device.

CIRCUIT BREAKERS

Circuit breakers have three fundamental purposes: First, they are used to provide circuit protection and to perform normal switching operations. Second, they are used to isolate a defective circuit while repairs are being made. Third, circuit breakers are used in manual and automatic bus transfer, also as starters for large motors.

Air circuit breakers are used in switchboards, switch gear groups, and in distribution panels. The types installed on naval ships are ACB, AQB, AQB-A, AQB-LF, NQB-A, ALB and NLB. They are called air circuit breakers because the main current carrying contacts interrupt in air.

Circuit breakers are available in manually or electrically operated types. Some types may be operated both ways, while others are restricted to one mode. Manually or electrically operated types may or may not provide protective functions; the following sections describe the differences and uses of the various types of circuit breakers.

ACB

The ACB type of circuit breaker may be for either manual local closing or electrical remote closing. It has an open metallic frame construction mounted on a drawout mechanism and is normally applied where heavy loads and high short circuit currents are available.

Figure 8-7 shows the external appearance of a type ACB circuit breaker.

Type ACB circuit breakers are used to connect ship's service and emergency generators to the power distribution system. They are also

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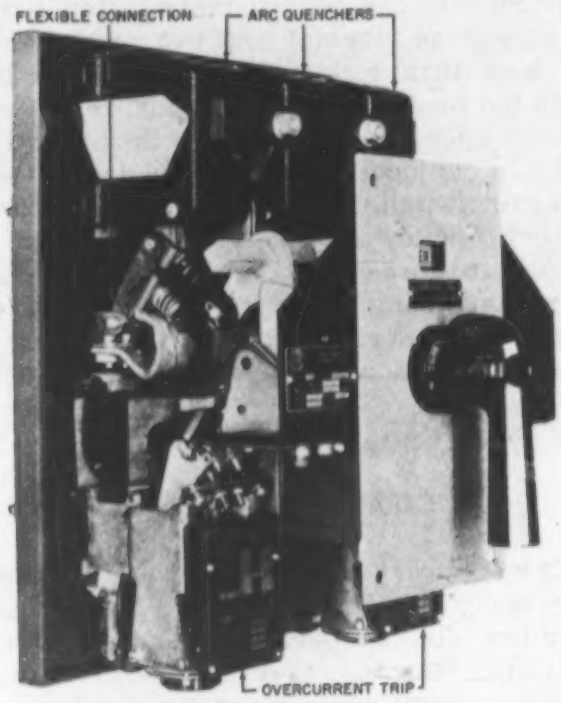

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Figure 8-7.—Type ACB circuit breaker.

used on bus ties and shore connection circuits, and on some feeder circuits from the ship's service switchboard.

When used in these applications the pilot device may be a reverse-power relay or any of the control devices discussed later in this chapter of the training manual. The reverse-power relay is mounted on the panel close to the circuit breaker. Other automatic controls may be located at remote points to give maxmum protection to the circuit.

Circuit breakers designed for high currents have a double-contact arrangement. The complete contact assembly consists of the main bridging contacts and the arcing contacts. All current carrying contacts are high-conductivity, arc-resisting silver or silver alloy inserts.

Each contact assembly has a means of holding the arcing to a minimum and extinguishing the arc as soon as possible. The arc control section is called an arc chute or arc runner. The contacts are so arranged that when the circuit is closed, the arcing contacts close first. Proper pressure is maintained by springs to ensure the arc contacts close first. The main contacts then close.

When the circuit opens, the main contacts open first. The current is then flowing through the arc contacts, which prevents burning of the main contacts. When the arc contacts open, they pass under the front of the arc runner. This causes a magnetic field to be set up, which blows the arc up into the arc quencher and quickly opens the circuit.

Type ACB circuit breakers are divided into manually and electrically operated types. The only difference is that the manually operated types must be operated by hand. However, all ACB circuit breakers may be operated electrically if the magnet and armature mechanism is installed. The heavy-duty types are electrically operated because it is then unnecessary for personnel to approach them in order to open or close the circuit.

No circuit breaker, regardless of type, should be worked on without opening the circuit. Remember that certain terminals may have voltage applied to them even though the breaker is open.

AQB

Type AQB circuit breakers are mounted in supporting and enclosing housings of insulating material and have direct-acting automatic tripping devices. They are used to protect single-load circuits and all feeder circuits coming from a load center distribution panel.

Where the requirements are low enough, the type AQB may be used on generator switchboards. Figure 8-8 illustrates one of the older type AQB breakers. This type of circuit breaker is being replaced by a newer AQB-A type breaker as repair becomes necessary since these circuit breakers and their repair parts are no longer being manufactured. In accordance with BuShips Inst 9620.78 of 21 February 1966, Navy type AQB circuit breakers, specifically Westinghouse type ABN and General Electric type AF-IN are obsolete types. Many older type ships such as the DD-445 class and World War II type DE's still use these now obsolete breakers. When it becomes necessary to repair or replace one of the obsolete type circuit breakers, it should be replaced by the newer AQB-A101, AQB-A250, AQB-A400, or AQB-A800 as required.

AQB-A250

The newer AQB type circuit breakers such as the AQB-A250 in figure 8-9 have several advantages over the older type shown in figure 8-8.

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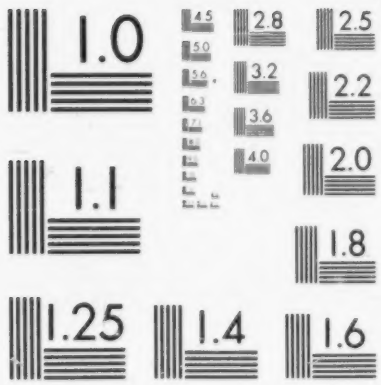

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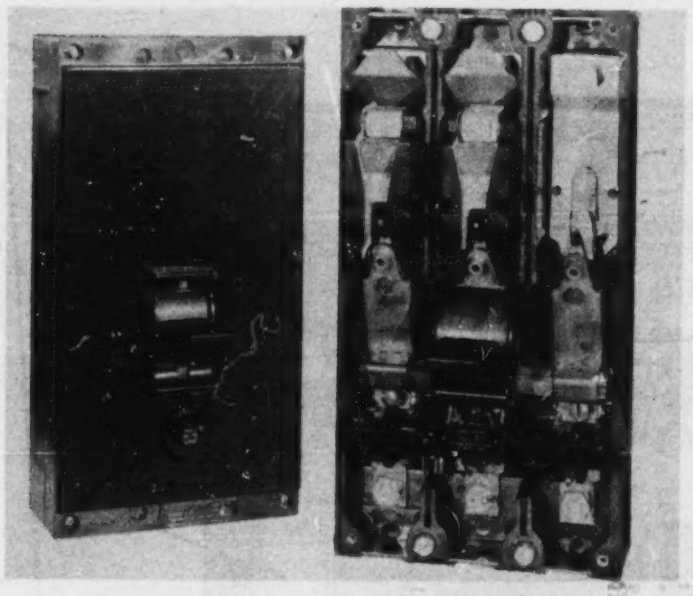

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Figure 8-8.—Type AQB circuit breaker.

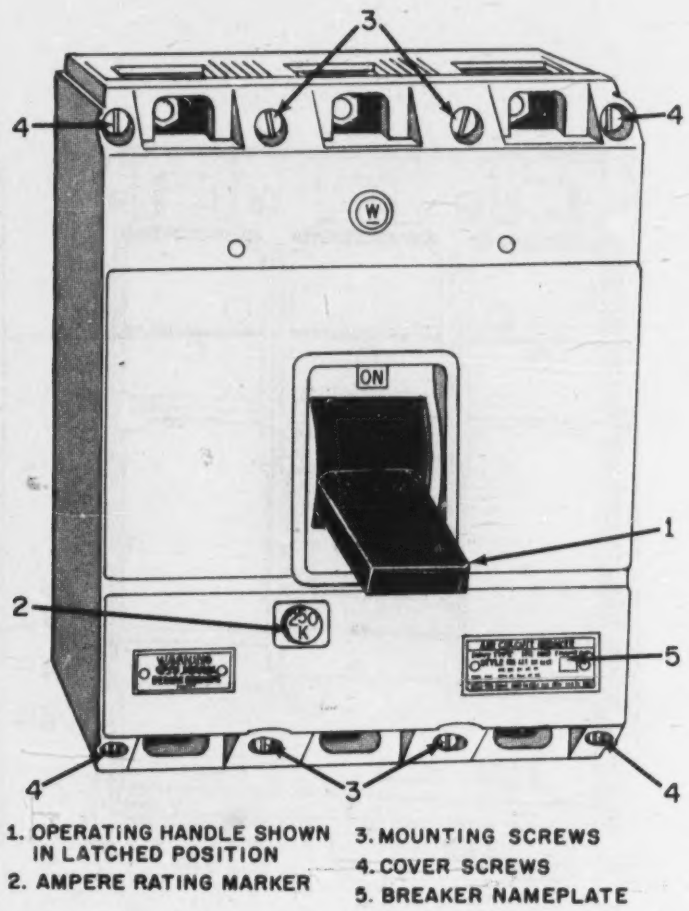

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Figure 8-9.—AQB-A250 circuit breaker complete, front view.

The outside dimensions of these new breakers are the same for both the two-pole and three-pole circuit breakers. They are designed for front or rear connections as required and may be mounted so as to be removable from the front without removing the circuit breaker cover. The voltage ratings of the AQB-A250 are 500 volts AC, 60 cycles, or 250 volts DC.

The 250 part of the circuit breaker type designation indicates the frame size of the circuit breaker. When we say a 250 ampere frame size circuit breaker, this means the current carrying parts of the breaker have a continuous rating of 250 amperes. Trip units (fig. 8-10) for this breaker are available with current ratings of 125, 150, 175, 225 and 250 amperes.

The trip unit houses the electrical tripping mechanisms, the thermal element for tripping the circuit breaker on overload conditions, and the instantaneous trip for tripping on short circuit conditions.

In addition 100, 160, and 250 ampere rating trip units with a special calibration are available for use with generator circuit breakers. Regardless of the trip unit used the breaker is still a 250 ampere frame size. The automatic trip devices of the AQB-A250 circuit breaker are "trip free" of the operating handle; in other words the circuit breaker cannot be held closed by the operating handle if an overload exists. When the circuit breaker has tripped due to overload or short circuit, the handle rests in a center position. To reclose after automatic tripping, move the handle to the extreme OFF position which resets the latch in the trip unit, then move the handle to the ON position.

The AQB-A250 circuit breaker may have auxiliary switches, shunt trip (for remote tripping), or undervoltage release attachments when so specified. However, a shunt trip cannot be provided in the same breaker with an undervoltage release. Figure 8-11 shows a trip unit with shunt trip and figure 8-12 shows a trip unit with undervoltage trip. The coil for a shunt trip has a dual rating for a-c and d-c voltages whereas the undervoltage trip coils are wound for a specified voltage such as 450 a-c or 250 d-c and have rated pick-up and drop-out values. The instantaneous trip setting of the AQB-A250 trip units may be adjusted by the instantaneous trip adjusting wheels shown in figure 8-10.

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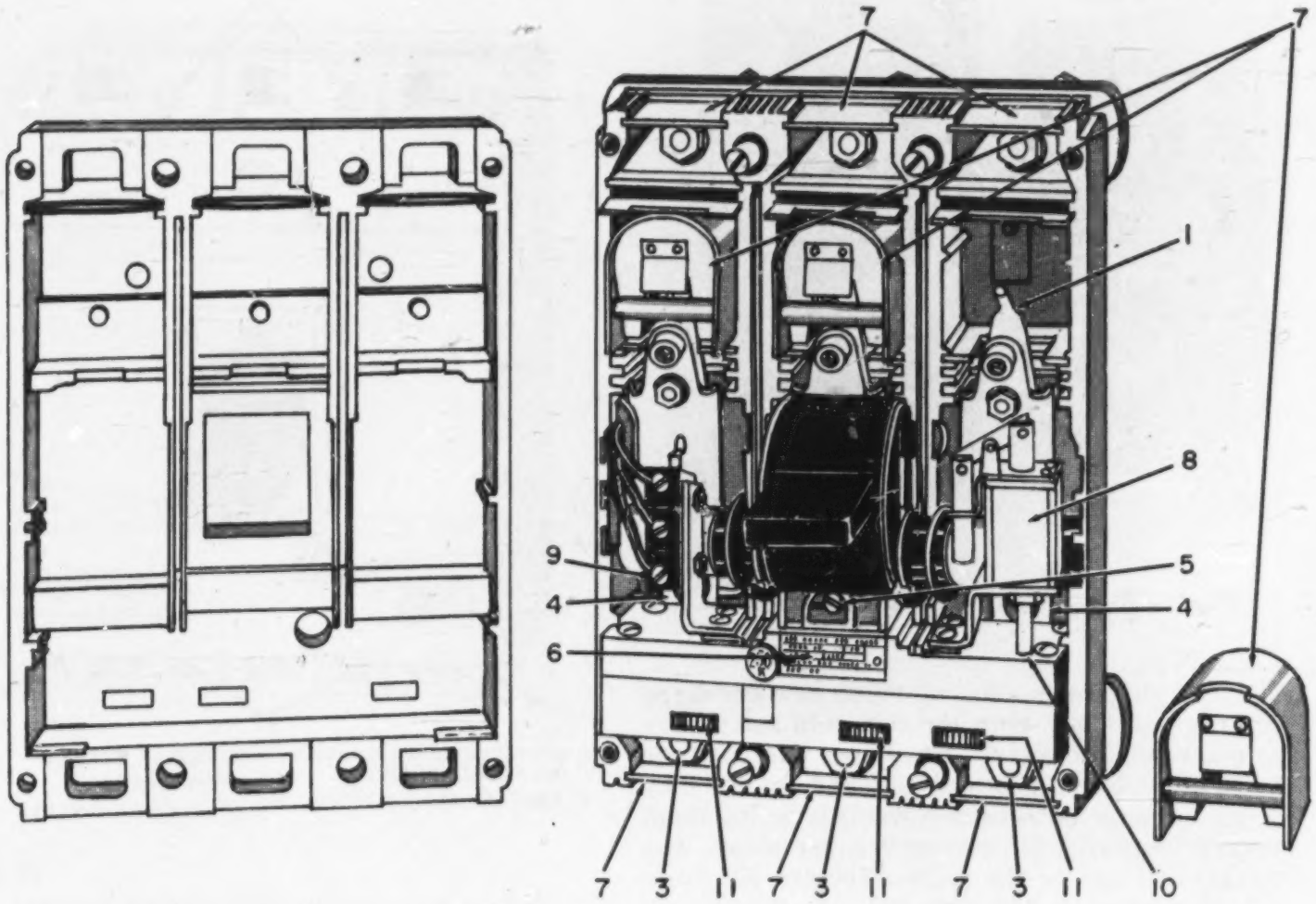

(1) STATIONARY CONTACT
(2) ARC SUPPRESSORS
(3) TERMINAL STUD NUTS AND WASHERS
(4) TRIP UNIT LINE TERMINAL SCREW-OUTER POLES
(5) TRIP UNIT LINE TERMINAL SCREW-CENTER POLE
(6) TRIP UNIT NAMEPLATE
(7) TERMINAL BARRIERS
(8) SHUNT TRIP
(9) AUXILIARY SWITCH
(10) HOLE FOR SHUNT TRIP UNDERVOLTAGE RELEASE PLUNGER
(11) INSTANTANEOUS TRIP ADJUSTING WHEELS

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Figure 8-10.—AQB-A250 circuit breaker front view, cover and arc suppressor removed.

Though not shown in the figure these trip adjusting wheels are marked for five positions, LO-2-3-4-HI, the trip unit label (not shown) will list the instantaneous trip value obtainable for each marked position. Identical settings must be made on each pole of the circuit breaker. NEVER remove a circuit breaker cover to perform adjustments while the circuit breaker is in the closed (ON) position.

Terminal mounting block assemblies used in conjunction with the circuit breaker (fig. 8-13) for drawout mounting, consist of terminal studs in terminal mounting blocks of insulating material. The terminals of the circuit breaker have slip type connectors which engage the terminal studs as shown in figure 8-13. Two mounting blocks are usually required for each circuit breaker. This method of connecting a circuit breaker to a bus or circuit is known as a "back connected circuit breaker." Circuit breakers which have solderless connectors attached to their terminal are commonly called

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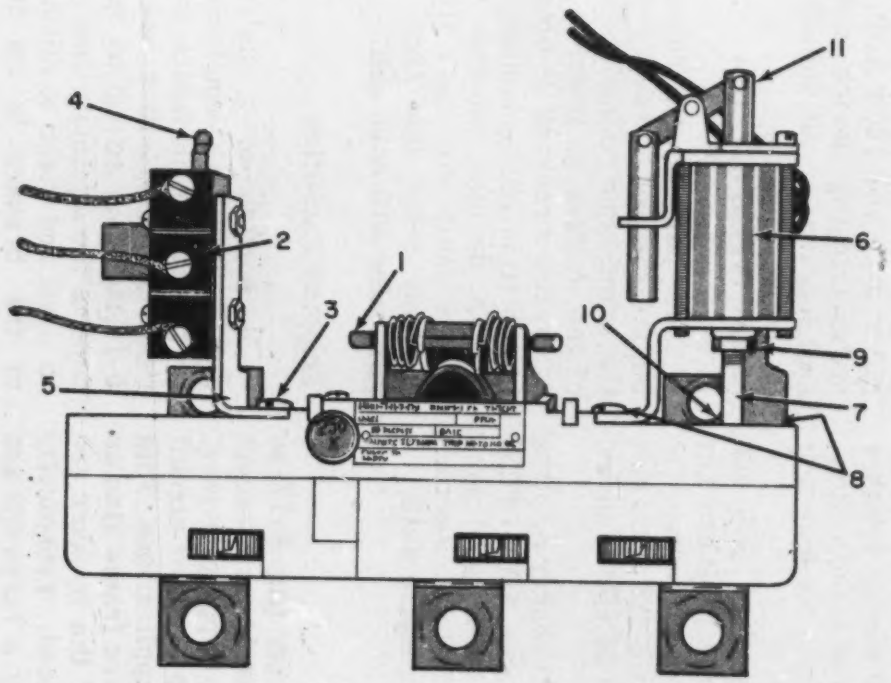

(1) TRIP UNIT LATCH PIN
(2) AUXILIARY SWITCH
(3) AUXILIARY SWITCH MOUNTING SCREWS
(4) AUXILIARY SWITCH LEVER
(5) AUXILIARY SWITCH MOUNTING BRACKET
(6) SHUNT TRIP
(7) SHUNT TRIP TUBULAR CORE
(8) SHUNT TRIP MOUNTING SCREWS
(9) TUBULAR CORE LOCK NUT
(10) HOLE FOR SHUNT TRIP PUSH PIN
(11) SHUNT TRIP PLUNGER

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Figure 8-11.—AQB-A250 trip unit with shunt trip and auxiliary switch.

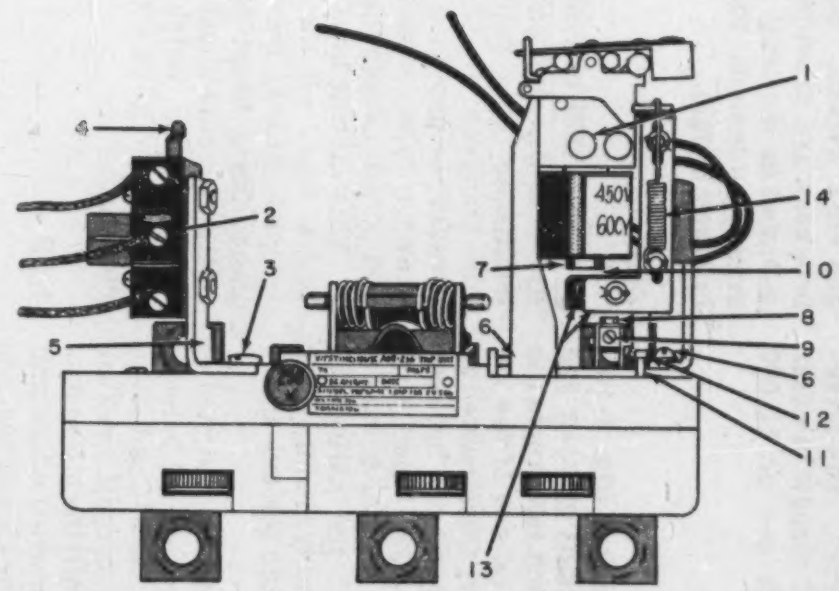

(1) UNDERVOLTAGE RELEASE
(2) AUXILIARY SWITCH
(3) AUXILIARY SWITCH MOUNTING SCREWS
(4) AUXILIARY SWITCH LEVER
(5) AUXILIARY SWITCH MOUNTING BRACKET
(6) UNDERVOLTAGE RELEASE MOUNTING SCREWS
(7) UNDERVOLTAGE RELEASE MAGNET
(8) ARMATURE TRAVEL ADJUSTING SCREW
(9) SET SCREW FOR ARMATURE TRAVEL ADJUSTING SCREW
(10) ARMATURE - MAGNET AIR GAP
(11) UNDERVOLTAGE RELEASE PUSH ROD
(12) LOCK NUT FOR PUSH ROD
(13) UNDERVOLTAGE RELEASE ARMATURE
(14) ARMATURE RETAINING SPRINGS

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Figure 8-12.—AQB-A250 trip unit with undervoltage release and auxiliary switch.

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"front connected circuit breakers". The interrupting rating of the AQB-A250 circuit breaker is 20,000 amperes at 500 volts a-c or 15,000 amperes at 250 volts d-c.

AQB-LF 250

The AQB-LF250 circuit breaker (fig. 8-14), combines the standard ABQ circuit breaker and a current limiting fuse unit which interrupts the circuit when the current is in excess of the interrupting rating of the breaker. Constructed as one compact unit, the AQB-LF circuit breaker incorporates the current limiting fuses (fig. 8-15) as integral parts of the circuit breaker. The common trip features of the AQB-A250 circuit breaker are retained and trip units from 125 to 250 amperes and available for use in the AQB-LF250.

The current limiting fuse unit is designed so that it trips the breaker and opens all poles if any current limiting fuse (fig. 8-16) is blown. After a fuse has blown, the circuit breaker Fig. 8-16 cannot be reclosed until the blown fuse is replaced. Any attempt to remove the fuse unit when the circuit breaker is in the closed position will automatically trip the breaker.

The AQB-LF250 circuit breaker is interchangeable with the AQB-A250 circuit breaker except a larger cutout is required in the switchboard front panel to accommodate the fuse unit of the AQB-LF250.

The AQB-LF250 circuit breaker is a 250 ampere frame size, however the circuit breaker has an interrupting rating of 100,000 amperes at 500 volts a-c whereas the AQB-A250 circuit breakers interrupting rating is 20,000 amperes at 500 volts a-c.

While the AQB-A250 circuit breaker could be either front or back connected, the AQB-LF250 is designed only for back (drawout type) connection, using the same type of slip connectors and terminal studs as shown in figure 8-13.

NQB-A250

The NQB-A250 circuit breaker (fig. 8-17) is similar to the AQB-A250 circuit breaker except the NQB-A250 has no automatic tripping devices. This type of circuit breaker is used for circuit isolation and manual transfer applications. This NQB-A250 is still a 250 ampere frame size as the current carrying parts of the breaker are capable of carrying 250 amperes. Technically this circuit breaker is simply a large ON and and OFF switch. Some types of AQB and NQB breakers are provided with electrical operators mounted on the front of the breaker. These are simply solenoids for remote operation of the breaker handle.

ALB

Type ALB circuit breakers are designated low-voltage, automatic circuit breakers. The continuous duty rating ranges from 5 through 200 amperes at 120 volts a-c or d-c. The breaker is provided with a molded enclosure, drawout type connectors, and nonremoveable and nonadjustable thermal trip elements.

This circuit breaker is a quick-made, quick-break type. If the operating handle is in the tripped (midway between ON and OFF) position, indicating a short circuit or overload, the operating handle must be moved to the extreme off position, which automatically resets the overload unit and the breaker can again be closed.

NLB

Circuit breakers type NLB are small and are used on low voltage systems (24 v d-c, 120 v d-c, and 120 v a-c). They have no automatic tripping device and are used only as switches for circuit isolation.

SELECTIVE TRIPPING

The purpose of selective tripping is to isolate the faulty section of the system and at the same time to maintain power on as much of the system as possible. Selective tripping of circuit breakers is obtained by coordination of the time-current characteristic of the protective devices so that the breaker closest to the fault will open first, and the breaker farthest from the fault and closest to the generator will open last.

Tripping Facilities

A portion of a distribution system with circuit breakers employing selective tripping is illustrated in figure 8-18,A. The tripping time characterisitics are indicated in figure 8-18,B. The so-called instantaneous tripping time is the minimum time required for a breaker to open and clear a circuit when the operation of the breaker is not intentionally delayed.

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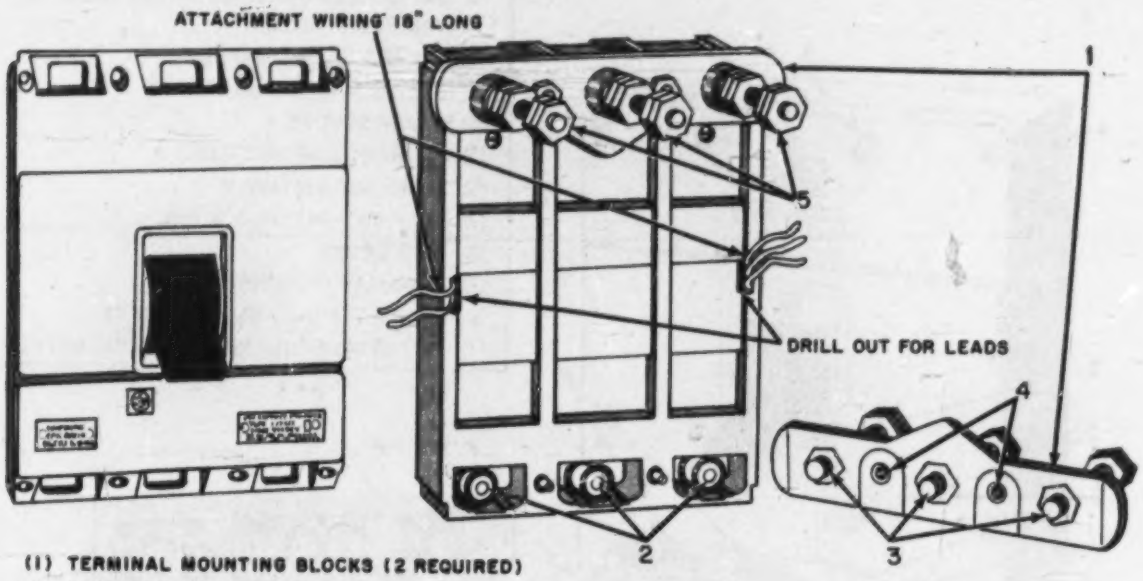

(1) TERMINAL MOUNTING BLOCKS (2 REQUIRED)
(2) SLIP TYPE CONNECTORS
(3) TERMINAL STUDS
(4) TERMINAL MOUNTING BLOCK INSERTS FOR BREAKER MOUNTING BOLTS
(5) TERMINAL STUD NUTS

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Figure 8-13.—AQB-A250 circuit breaker rear view with terminal mounting blocks.

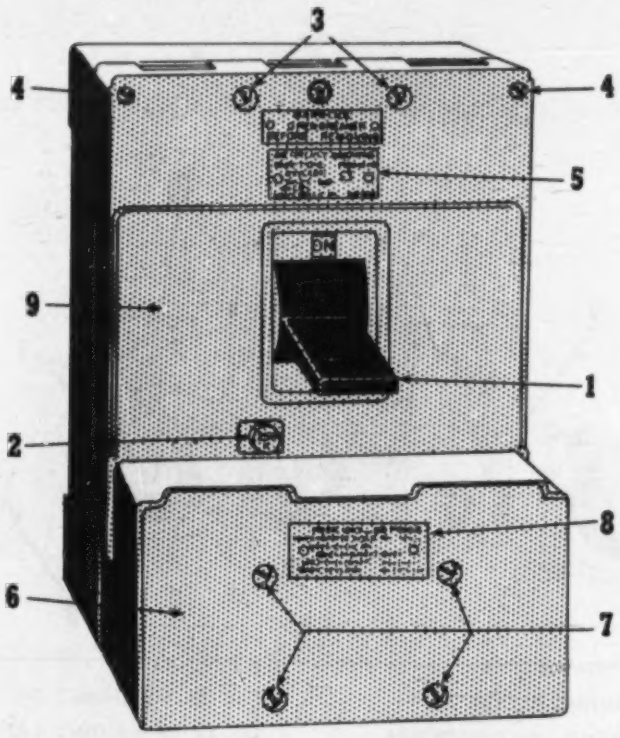

(1) OPERATING HANDLE SHOWN IN LATCHED POSITION	(5) BREAKER NAMEPLATE
(2) AMPERE RATING MARKER	(6) FUSE UNIT ASSEMBLY
(3) BREAKER MOUNTING SCREWS	(7) FUSE UNIT MOUNTING SCREWS
(4) COVER SCREWS	(8) FUSE UNIT NAMEPLATE
	(9) BREAKER COVER

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Figure 8-14.—AQB-LF250 complete circuit breaker front view.

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zero set rotor is turned 10°, an error signal will be introduced into the rotor of the azimuth followup synchro. The amplitude of the error signal produced will be dependent upon the amount of displacement between the rotors. The polarity or phase of the signal will depend upon the direction of displacement. The error signal is fed to the servoamplifier input of the true bearing amplifier which drives the azimuth torque motor.

The AZIMUTH TORQUE MOTOR is a 2-phase induction type motor. The fixed voltage winding of this motor is connected to the same power source that supplies the rotors of the transmitting and the zero set synchros. The control winding is connected to the output of the true bearing amplifier. The amplitude and phase of the error signal applied to the control windings depend upon the amount and direction of displacement of either of the two exciting rotors (zero set or transmitter). The azimuth torque motor turns in a direction that is determined by the phase relationship of the voltages applied to these two windings. Since the torque motor is mechanically coupled to the azimuth followup synchro rotor and as the motor turns, it drives the followup rotor to a new null relationship with the rotor of the zero set synchro. As the rotors once again approach their 90° relationship, the amplitude of the error signal decreases, thus decreasing the amplitude of the voltage applied to the control winding of the torque motor. When the rotors of the zero set and the followup synchros are once again displaced by 90°, there is no longer a signal applied to the control winding and the torque motor stops. As previously stated, the azimuth torque motor also turns the secondaries of the azimuth sweep synchros; thus, shifting the position of the azimuth sweep secondaries changes the position of the sweep on the indicators. For example, assume that the antenna is in a dead ahead position, with the sweep pointing to the top of the indicator. Then, by adjusting the zero set synchro to a setting of 10°, which shifts the sweep secondaries by 10°, the sweep position would move to 10°.

The primary (rotor) of the azimuth sweep synchro is mechanically coupled to the antenna; thus, when the antenna rotates, the primary winding is also rotated. The primary winding is supplied with sweep voltages from the radar synchronizer. These voltages are induced into the secondary coils with a variation of phase and amplitude for each coil, depending upon its instantaneous angular relationship with the primary. The secondary voltages are applied to the vertical and horizontal coils of the PPI indicator. By means of these voltages, the angular deflection of the sweep trace on the PPI indicator is controlled in accordance with the instantaneous azimuth position of the radar antenna.

The example cited previously utilized the movement of the zero set synchro (manual adjustment) to move the secondaries of the azimuth sweep synchro and hence the PPI sweep. The same comparison may be made with the transmitting synchro. This synchro changes as the heading of the aircraft changes, and this action coupled with the operation of the system just discussed is the analysis of azimuth stabilization.

Comparison of the True and Relative Bearings

As already explained, changing the aircraft heading changes the positions of the sweep secondaries of the azimuth sweep synchro. This occurs on azimuth stabilization only and the change is automatic. On manual operation the only change that can be made is by varying the position of the zero set synchro. This is not stabilization, for it has no relationship to the movement of the aircraft. The zero set synchro is adjusted on manual or relative bearing operation. The antenna is set on 0° with respect to the aircraft and the zero set synchro is adjusted until the sweep appears at the dead ahead position.

During relative bearing operation, with the azimuth indicating device at the top of the scope, and targets appearing thereon, a change in the bearing of the aircraft will result in a change of position of targets. This is an undesirable feature due to the fact that during the time the targets are shifting position they are hard to observe on the indicators. Refer to figure 17-33 for a visual explanation of this condition. The top of the scope indicates the heading of the aircraft and all targets are displayed relative to this heading; thus, on relative bearing operation, the top of the indicator indicates the heading of the aircraft. In other words, when the aircraft is heading north, the top of the scope is north. When the aircraft is heading in any particular direction, the top of the scope is also that direction.

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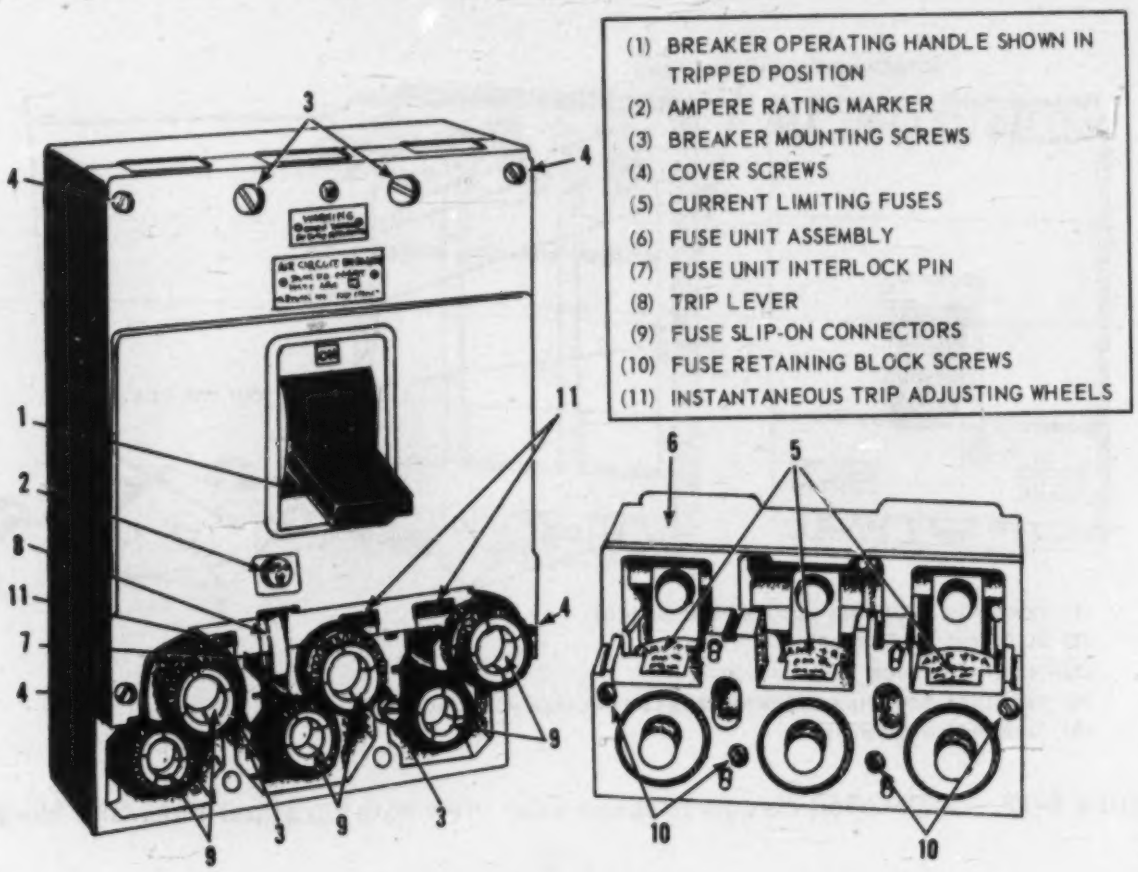

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Figure 8-15.—Complete circuit breaker, front view with fuse unit removed.

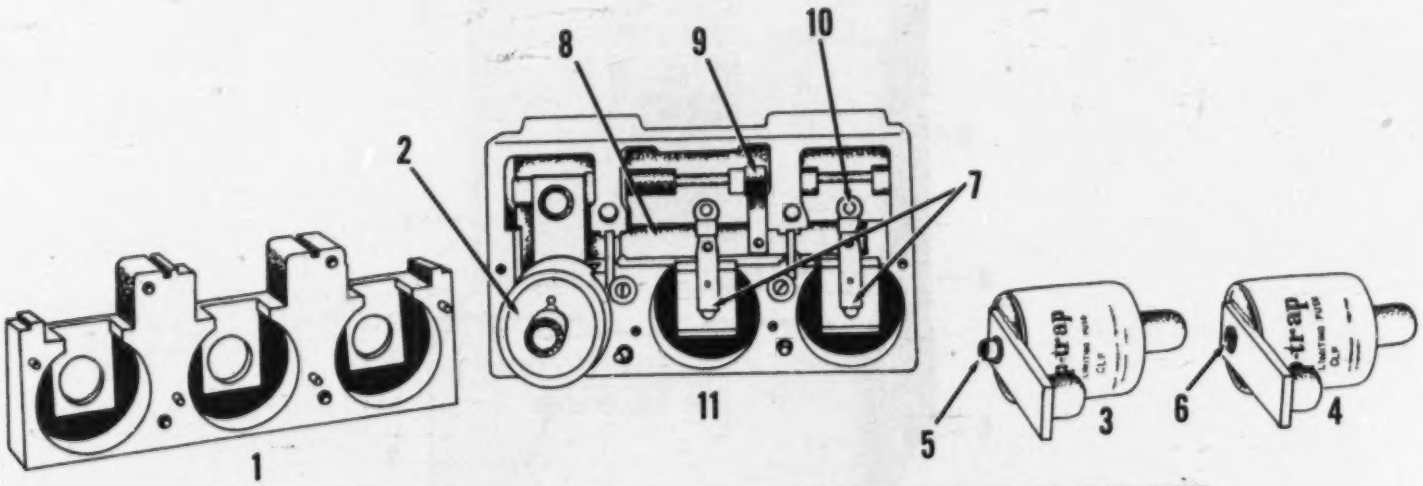

(1) FUSE RETAINING BLOCK	(8) FUSE UNIT TRIPPER BAR
(2, 3 & 4) CURRENT LIMITING FUSES	(9) FUSE UNIT TRIPPER BAR LEVER
(5) EXTENDED PLUNGER OF BLOWN FUSE	(10) FUSE INTERLOCK PIN
(6) RETRACTED PLUGER OF UNBLOWN FUSE	(11) FUSE UNIT HOUSING
(7) FUSE PLUNGER LEVER	

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Figure 8-16.—Current limiting fuse unit assembly.

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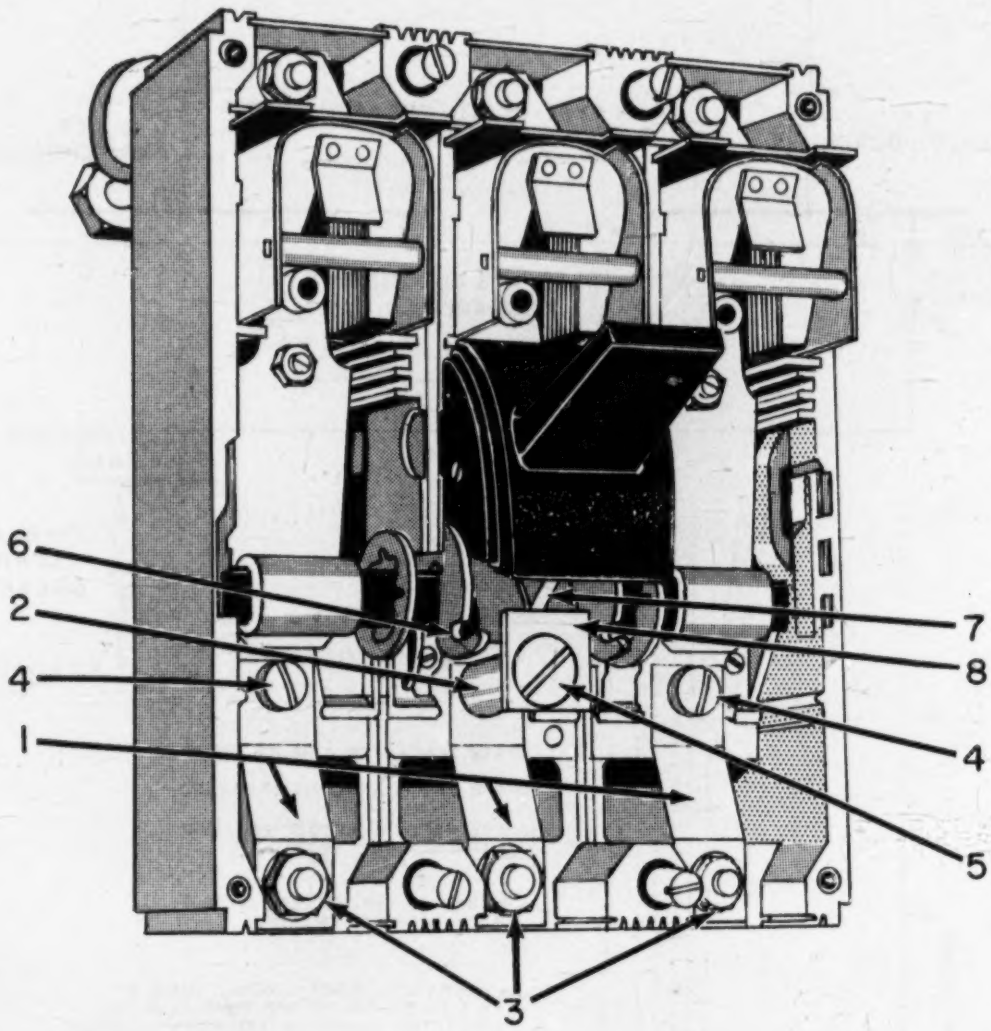

(1) CONNECTOR STRAPS
(2) LATCH POST
(3) TERMINAL STUD NUTS & WASHERS
(4) TRIP UNIT LINE TERMINAL SCREWS - OUTER POLES
(5) LATCH MOUNTING SCREWS
(6) TRIP UNIT LATCH PIN SLOT
(7) MECHANISM TRIGGER
(8) MECHANISM TRIGGER LATCH

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Figure 8-17.—NQB-A250 circuit breaker front view, cover removed.

Each circuit breaker will trip in less than 0.1 second (almost instantaneously) when the current exceeds the instantaneous trip current setting of the breaker. The individual breakers in a group (generator breakers, bus tie breakers, feeder breakers, etc.) may differ slightly with each other because it is necessary to allow some tolerance in the adjustment, but all breakers in the group will have characteristics that fall within the band. The band is the relation between current and tripping time for a group of circuit breakers that have the same nominal setting.

Generator circuit breakers are usually set to trip instantaneously at a current that is GREATER than the short circuit current of

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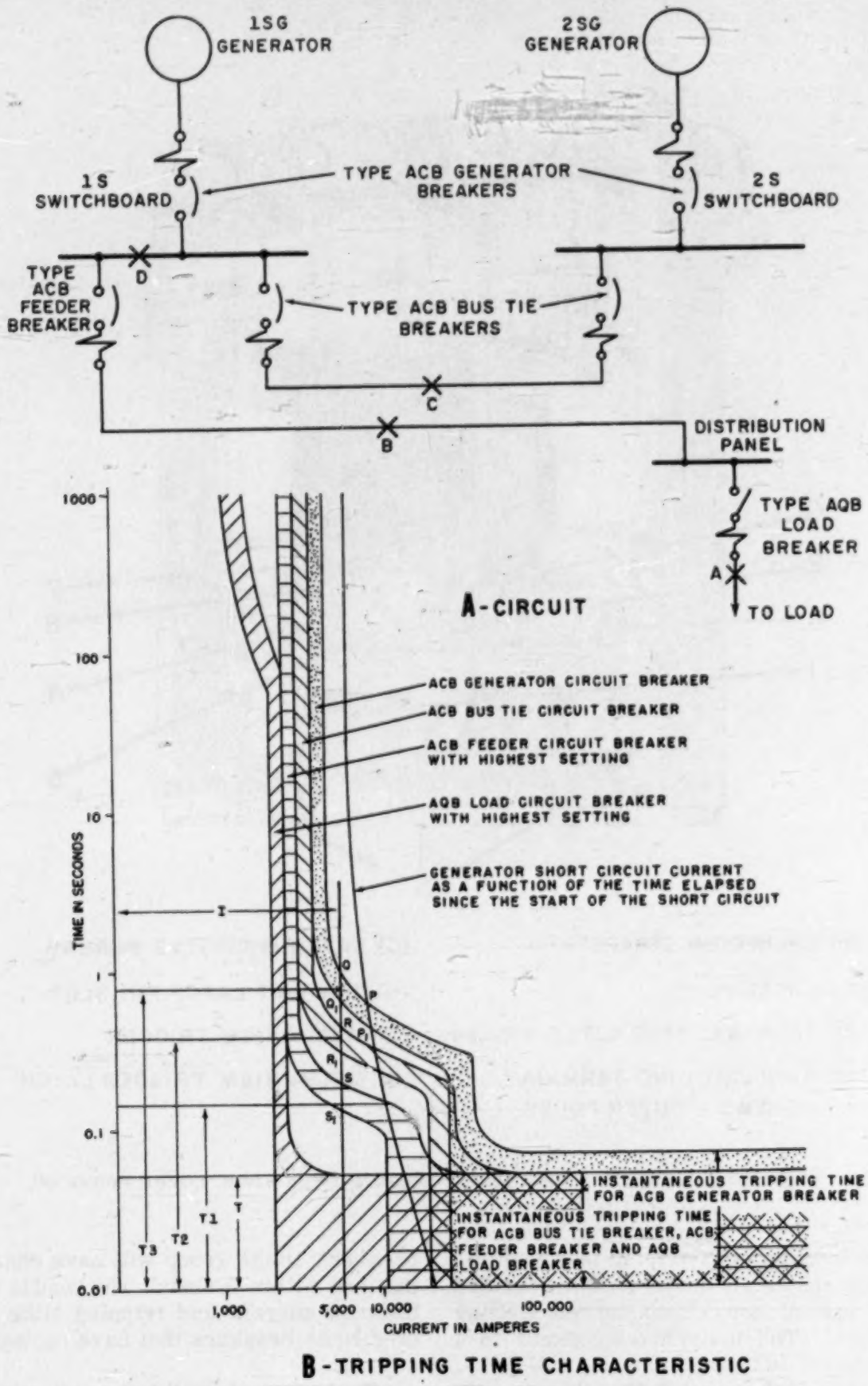

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Figure 8-18.—Selective tripping of circuit breakers.

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the generator, and therefore will not trip instaneously on the generator short circuit current. However, it will trip on the generator short circuit current at some definite interval of time within the tolerance of the breaker (points P_1 to P).

Bus tie circuit breakers are usually set to trip after a prescribed time dalay (which is less than the generator circuit breaker time delay), at a current that is nearest to, but not less than 150% of the bus tie breaker coil rating (for multigenerator switchgear groups) or the nearest to but not more than 80% of the generator breaker short-time delay setting (for single generator switchgear groups). Instantaneous tripping is not normally used on bus tie circuit breakers.

The construction of circuit breakers for selective tripping, for currents less than the instantaneous trip current setting, is such as to cause an intentional delay in the operation of the breaker. The time delay is greater for small currents than for large currents and is therefore known as an inverse time delay. The current that would trip the AQB load circuit breaker instantaneously and clear the circuit will not trip the ACB feeder circuit breaker unless the current flows for a greater length of time. The same sequence of operation occurs for the other groups of circuit breakers adjusted for selective tripping in the system. The difference between the tripping times of the breakers is sufficient to permit each breaker to trip and clear the circuit before the next breaker starts to operate.

Assume that a fault or defect develops in the cable insulation at point A (fig. 8-18,A) and allows an overcurrent I (fig. 8-18,B) to flow through the AQB load circuit breaker and the ACB feeder circuit breaker. The AQB load breaker will open the circuit and interrupt the current in an interval of time, T, that is less than the time, T1, required to open the ACB feeder circuit breaker. Thus, the ACB feeder breaker will remain closed when the AQB breaker clears the circuit. However, if the fault current should exceed the interrupting capacity of the AQB load breaker (for example, an excess of 10,000 amperes), this breaker would be unable to interrupt the fault current without damage to the breaker. To prevent damage to the AQB load breaker, the ACB feeder breaker (on switchboard 1S) serves as a BACK UP breaker for the AQB load breaker and will open almost instantaneously in time, T.

A fault at point B with overcurrent I would trip the ACB feeder breaker in time T1 but not the ACB generator or bus tie breakers, which require longer time intervals, T3 and T2 respectively, in which to trip. A fault at point C with overcurrent I would trip both ACB bus tie breakers at time T2. A fault at D with overcurrent I on switchboard 1S would trip the associated ACB generator breaker in time T3 and one or both of the ACB bus tie breakers in time T2. In each case, the faulty section of the system is isolated, but power is maintained on as much of the system as possible with respect to the location of the fault.

The attainment of selective tripping requires careful coordination of the time-current characteristics for the different groups of circuit breakers. For example, if the system illustrated in figure 8-18 is operating split plant (bus ties open) and if the time-current characteristics of the ACB feeder breaker and the ACB generator breaker were interchanged, a fault at B with overcurrent I would trip generator 1SG off the line in time T1 but would leave the feeder connected to the switchboard (the time required to trip the ACB feeder breaker would be T3). This action would disconnect power to all equipment supplied by switchboard 1S and also would not isolate the faulty section. Therefore, no unauthorized changes should be made to circuit breaker trip settings because these changes may completely disrupt the scheme of protection based on selective tripping. The adjustments for selective tripping of the circuit breakers are made and sealed at the factory.

It is not feasible to provide system protection by selective tripping of circuit breakers in all types of naval ships or for all circuits. For example, d-c distribution systems in older ships and all lighting circuits use fuses to a great extent. Time delay can be incorporated only to the extent that is permitted by the characteristics of the fuses. The use of progressively large fuse sizes from the load to the generator provide some degree of selectivity for overload or limited fault protection.

MAINTENANCE

Metal locking devices are available that can be attached to the handles of AQB type circuit breakers to prevent accidental operation. All breaker handles are now provided with a 3/32" hole permitting fastening the locking device with a standard cotter pin. NavShips Technical

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Manual, Chapter 9600, lists the stock numbers for three different sizes of breakers.

Circuit breakers require careful inspection and cleaning at least once a year (more frequently if subjected to unusually severe service conditions). The special inspections follow.

No work shall be undertaken on circuit breakers without first obtaining approval of the electrical or engineer officer. See article 60-37(10) in NavShips Technical Manual. Be very certain you understand and follow every requirement outlined in articles 60-35 through 60-46 of that technical manual. These vital safety regulations shall be enforced.

Before working on a circuit breaker be aware of its time delay characteristics, whether short time, long time, or instantaneous tripping-time is required. The adjustments that produce selective tripping of the circuit breakers are made and sealed at the factory; no unauthorized changes should be made to their trip settings because these changes may completely disrupt their intended functions of protection. Improper tripping action is corrected best by replacement of the entire breaker assembly, especially where trouble is encountered in the compact assemblies.

A special inspection should be carefully made of each pair of contacts after a circuit breaker has opened on a heavy short circuit. Before working on a circuit breaker, deenergize all control circuits to which it is connected; the procedure differs somewhat with the type of mounting which is employed. For example, before work is performed on drawout circuit breakers, they should be switched to the open position and removed. Before working on fixed-mounted circuit breakers, open the disconnecting switches ahead of the breakers. If disconnecting switches are not provided for isolating fixed-mounted circuit breakers, deenergize the supply bus to the circuit breaker, if practicable, before inspecting, adjusting, replacing parts, or doing any work on the circuit breaker.

Contacts are the small metal parts especially selected to resist deterioration and wear from the inherent arcing. The arcing occurs in a circuit breaker while its contacts are opening and carrying current at the same time. When firmly closed, the contacts must not arc.

Contact materials have been subjected to constant research, resulting in various products, ranging from pure carbon or copper, to pure silver, each being used alone and also as alloys with other substances. Modern circuit breakers have contacts made of pure silver, or pure silver mixed with cadmium oxide, or pure silver and tungsten. The two latter silver alloys are extremely hard and resist being filed. Fortunately, such contacts made of silver or its alloys conduct current when discolored (blackened during arcing) with silver oxide. The blackened condition, therefore, requires no filing, polishing, or removal. As with a pure silver contact, silver oxide is formed during arcing and it has been found that the addition of cadmium oxide greatly improves operation of the contact because it minimizes the tendency of one contact to weld to another, retards heavy transfer of one material to another, and inhibits erosion.

Usually, a contact containing silver is serviceable as long as the total thickness worn away is on the order of 0.015 to 0.030 inch.

Severe pitting or burning of a silver contact is another matter. It may require some filing (with a fine file or with fine sandpaper, No. 00) to remove raised places on surfaces that prevent intimate and overall closure of the contact surfaces. If necessary, use a CLEAN cloth moistened with INHIBITED methyl chloroform. Be very certain to provide ample ventilation to remove all DEADLY and TOXIC fumes of the solvent.

When cleaning and dressing copper contacts, maintain the original shape of each contact surface and remove as little copper metal as possible. Inspect and wipe the copper contact surfaces for removal of the black copper-oxide film and, in extreme cases, dress and clean only with fine (No. 00) sandpaper to prevent scratching the surfaces. (To avoid scratches, NEVER use emery cloth or emery paper.) Because this copper-oxide film is a partial insulator, follow the sanding procedure by wiping with a clean cloth moistened with inhibited methyl chloroform solvent. Provide VERY LIBERAL ventilation by means of exhaust fans or with portable blowers to entirely remove all traces of the deadly fumes of the solvent.

Calibration problems on circuit breakers should be handled in accordance with chapter 9600 of NavShips Technical Manual.

The function of arcing contacts is not necessarily impaired by surface roughness. Remove excessively rough spots with a fine file. Replace arcing contacts when they have been burned severely and cannot be properly adjusted. Make a contact impression and check the spring pressure in accordance with the

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manufacturers' instructions. If information on the correct contact pressure is not available, the contact pressure should be checked with that of similar contacts. When the force is less than the designed value, the contacts either require replacing because they are worn down, or the contact springs should be replaced. Always replace contacts in sets; not singly, and replace contact screws at the same time. Do not use emery paper or emery cloth to clean contacts, and do not clean contacts when the equipment is energized.

Clean all surfaces of the circuit breaker mechanism, particularly the insulation surfaces, with a dry cloth or air hose. Before directing the air on the breaker, be certain that the water is blown out of the hose, that the air is dry, and that the pressure is not over 30 psi. Check the pins, bearings, latches, and all contact and mechanism springs for excessive wear or corrosion and evidence of overheating. Replace parts if necessary.

Slowly open and close circuit breakers manually a few times to be certain that trip shafts, toggle linkages, latches, and all other mechanical parts operate freely and without binding. Be certain that the arcing contacts make before and break after the main contacts. If poor alignment, sluggishness, or other abnormal conditions are noted, adjust in accordance with the manufacturer's instructions for the particular circuit breaker.

Oil-piston type overcurrent tripping devices (grade B timers) are sealed mechanisms and normally do not require any attention. When oil-film (dashpot) overcurrent tripping devices are used, the oil should be removed and the interior of the oil chambers should be cleaned with kerosene and refilled with new oil every six months. Be certain that the dashpot is free of dirt, which destroys the time-delay effect, and that the tripping device is clean, operates freely, and has sufficient travel to trip the breaker. Do not change the air-gap setting of the moving armature because this would alter the calibration of the tripping device. Lubricate the bearing points and bearing surfaces (including latches) with a drop or two of light machine oil. Wipe off any excess oil.

Before returning a circuit breaker to service, inspect all mechanical and electrical connections, including mounting bolts and screws, drawout disconnect devices, and control wiring. Tighten where necessary. Give the breaker a final cleaning with a cloth or compressed air. Operate manually to be certain that all moving parts function freely. Check the insulation resistance.

The sealing surfaces of circuit-breaker contactor and relay magnets should be kept clean and free from rust. Rust on the sealing surface decreases the contact force and may result in overheating of the contact tips. Loud humming or chattering will frequently warn of this condition. A light machine oil wiped sparingly on the sealing surfaces of the contactor magnet will aid in preventing rust.

Oil should always be used sparingly on circuit breakers, contactors, motor controllers, relays, and other control equipment, and should not be used at all unless called for in the manufacturer's instructions or unless oil holes are provided. If working surfaces or bearings show signs of rust, disassemble the device and carefully clean the rusted surfaces. Light oil can be wiped on sparingly to prevent further rusting. Oil has a tendency to accumulate dust and grit, which may cause unsatisfactory operation of the device, particularly if the device is delicately balanced.

Arc chutes or boxes should be cleaned by scraping with a file if wiping with a cloth is not sufficient. Replace or provide new linings when they are broken or burned too deeply. Be certain that arc chutes are securely fastened and that there is sufficient clearance to ensure that no interference occurs when the switch or contact is opened or closed.

Shunts and flexible connectors, which are flexed by the motion of moving parts, should be replaced when worn, broken, or frayed.

Operating tests that consist of operating the circuit breakers in the manner in which they are intended to function in service should be conducted regularly. For manually operated circuit breakers, simply open and close the breaker to check the mechanical operation. To check both the mechanical operation and the control wiring, electrically operated circuit breakers should be tested by means of the operating switch or control. Exercise care not to disrupt any electric power supply that is vital to the operation of the ship, or to endanger personnel by inadvertently starting motors and energizing equipment under repair.

OVERLOAD DEVICES

A prolonged overloaded electrical system can be damaged beyond repair by the resulting heat

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and flame. Therefore, it is expedient to use a device which can detect an overload before damage occurs, that either warns the EM of the hazardous condition or automatically turns off the power. Relays have been designed (for both d-c and a-c systems) which are capable of accomplishing these protective functions. The basic difference between a-c and d-c relays is in the armature and magnet core construction.

MAGNETIC TYPE

A magnetic type overload relay for a d-c system is illustrated in figure 8-19. A pictorial view and a diagram identifying the various parts are shown in figure 9-19, A and B respectively.

In an installation, the operating (series) coil ⑥ is connected in series with the protected circuit (fig. 8-19,B). Normal current through the coil will have no effect on relay operation. If an overload occurs, increased current will flow through the coil and cause an increase in the magnetic flux around the coil. When the flux becomes great enough, the iron plunger ⑤ will be lifted into the center of the coil, opening contacts ⑨ and ⑩. This action opens the control circuit to the main contactor in series with the motor terminals, thereby disconnecting the motor from the line.

To keep the relay from operating when the motor is drawing a heavy but normal starting current, an oil dashpot mechanism ① and ② is built in. This gives a time delay action that is inversely proportional to the amount of overload.

Overload relays may use either single or double coils. In addition, the single-coil overload relay may be obtained with or without a manual "latching" control. Relays with manual

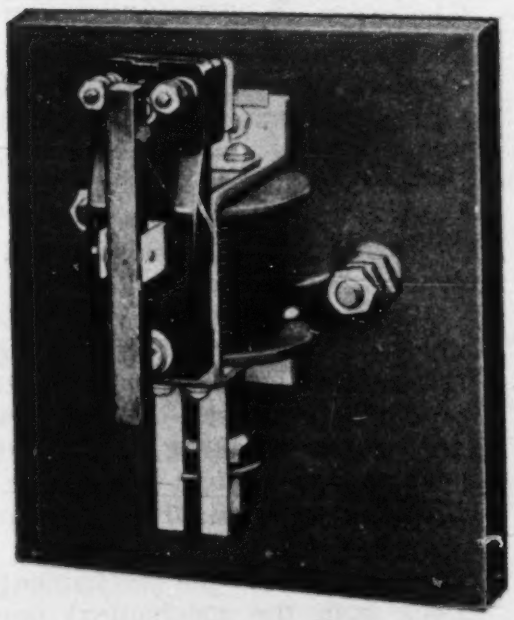

A

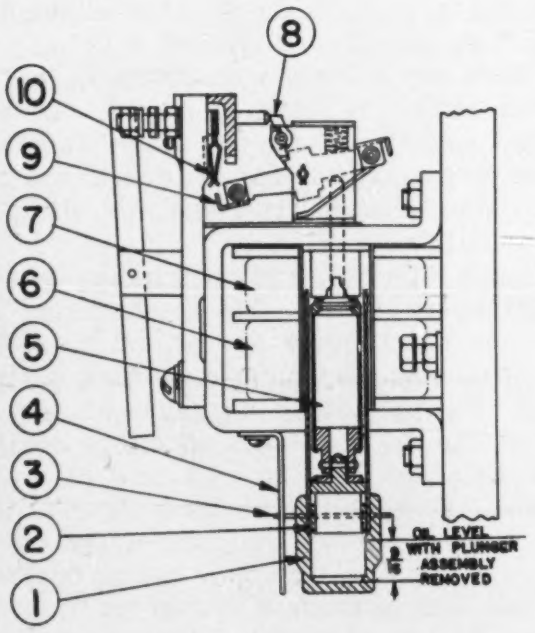

B

1. Dashpot
2. Piston
3. Indicating plate
4. Calibration plate
5. Plunger
6. Series coil
7. Shunt coil (when used)
8. Latch
9. Movable contact
10. Stationary contacts

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Figure 8-19.—Magnetic overload relay.

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latching are used on three-wire controls and reset automatically after an overload has occurred. Double-coil overload relays are used for two-wire control. They have a series coil ⑥ carrying the load current and a shunt holding coil ⑦ mounted above the series coil. These two coils are connected so that their respective fields aid each other. Then, when an overload occurs the plunger moves up into the shunt-connected coil field and is held in the tripped position until the shunt coil is deenergized by the pressing of a reset button or some other form of contact (switch) device.

Before placing the overload relay in service, raise the indicating plate ③ to allow the dashpot ① to be unscrewed from the relay. Lift out the plunger ⑤ and make certain all of the internal parts are clean. Place about 9/16 of an inch of dashpot oil (furnished with the relay) in the dashpot. Replace the plunger and indicating plate, and then screw the dashpot on the relay to the desired setting.

The relay is calibrated at the factory for the individual application, and the current values for which it is calibrated are stamped on the calibration plate ④. The marked values are minimum, maximum, and midpoint currents.

The operating points may be set by first raising the indicating plate ③ which allows the dashpot to be turned. Then, to lower the tripping current, raise the dashpot by turning it. This action raises the plunger further into the magnetic circuit of the relay so that a lower current will trip the relay.

The current at which the relay trips may be increased by turning the dashpot in a reverse direction. This action reduces the magnetic pull on the plunger and requires more current to trip the relay. After the desired settings have been obtained, lower the indicating plate over the hexagonal portion of the dashpot to again indicate the tripping current and lock the dashpot in position.

Figure 8-20 shows two magnetic types of a-c overload relays. Part A is the nonlatching type, and part B is the latching type. In part C the various components are identified.

The operating (series) coil ⑥ is connected in series with the protected circuit (fig. 8-20,C). Therefore, the load current flows through the coil. If the circuit current rises above normal because of overload conditions, it will cause an increase in the magnetic lines of flux about the coil. The increased flux lifts the iron plunger ⑤ into the center of the coil and opens the contacts ⑨. This, in turn, causes the main contactor (not shown) to open, and disconnects the motor or other device from the line. An oil dashpot mechanism ① and ② is used to prevent the operation of the relay on motor starting current surges.

If the relay does not have manual latching, a three-wire control is provided to give automatic reset after an overload occurs. The manual-latch relay is generally used with two-wire control. The latch ⑦ holds the contacts

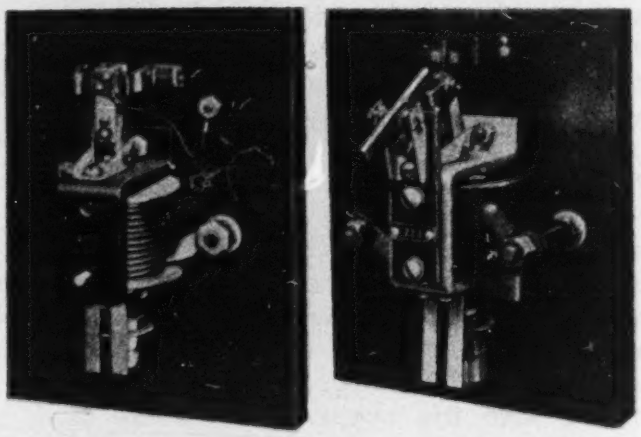

A-NONLATCHING B-LATCHING

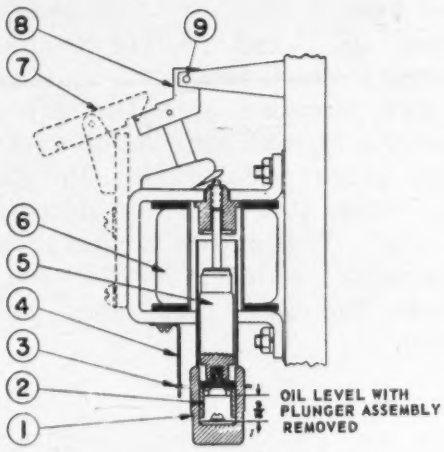

C-DIAGRAM

1. Dashpot
2. Piston
3. Indicating plate
4. Calibration plate
5. Plunger
6. Series coil
7. Latch (when used)
8. Insulating splitter
9. Contacts

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Figure 8-20.—A-c overload relays.

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in the open position after an overload has occurred and the circuits have been deenergized. It is necessary for the operator to manually reset the overload relay at the controller.

THERMAL TYPE

Thermal type overload relays (a-c and d-c) are designed to open a circuit when excessive current causes the heater coils to reach the temperature at which the ratchet mechanism releases. The heater coils are connected in series with the supply line to the load, and normal circuit current will have no effect on them.

The essential operating parts of a d-c thermal overload relay (fig. 8-21) are the two heater coils ④, two solder tube assemblies ⑤, and control contacts ①. Under normal conditions the splitter arm ⑦ (so called because it splits the contacts) completes a circuit with the contacts. The spring is then under compression and the operating arm ③ tends to rotate the splitter arm out of the circuit. This action is prevented by the ratchet assembly, which is held by the solder film between the outer and inner part of the solder tubes.

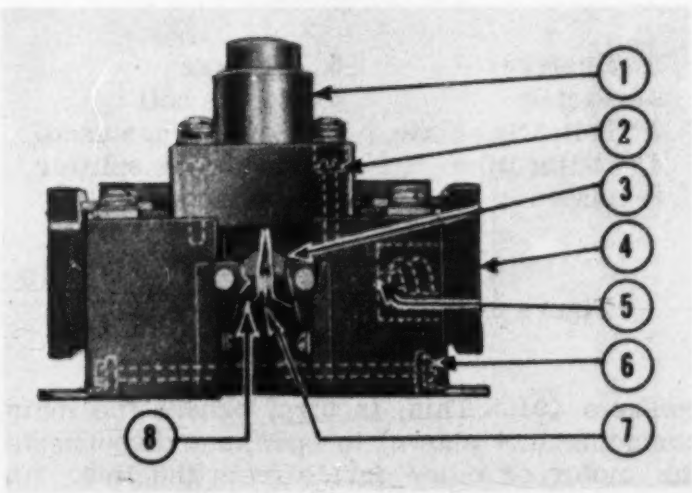

1. Contact structure
2. Screw
3. Operating arm
4. Heater coil
5. Solder tube
6. Screw
7. Splitter arm

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Figure 8-21.—Thermal overload relay.

When current flows through the heater coils and produces enough heat to melt the solder film, the inner part of the solder tube assembly rotates and releases the ratchet mechanism to open the control circuits. When this happens, the circuit to the coil handling the power contacts (not shown in the figure) opens and disconnects the load. As soon as the load is disconnected, the heaters cool, and the solder film hardens. When the hardening is complete, the relay is ready to be reset with the rest button.

An adjustable type thermal relay with magnetic reset is illustrated in figure 8-22. This relay may be adjusted to trip at a value between 90 and 110 percent of the rated coil current. To change the operating point, loosen the binding screws that hold the relay heater coil ④ (fig. 8-21) so that the coil position may be changed. Moving the coil away from the relay will increase the amount of current needed to trip the relay. Moving the coil closer to the relay will decrease the current needed to trip the relay. This range of adjustment is available only within the range of 90 to 110 percent of coil rating. Each rating has a different manufacture part number. The correct rating is installed when the controller is installed in the ship. Do not use another rating. Make sure both heater coils in each overload relay are the same rating.

The terminal plates and the underside of the slotted brackets of the heater coil assembly are serrated so that the coil is securely held in position when the binding screws are tightened. Some thermal overload relays have reset magnet assemblies attached. It may become necessary to replace the heater coils from the relay. Then remove the four screws that hold the overload relay to the mounting plate. When removing the relay from the mounting plate, use care not to lose the phenolic pin and bearing block located between the thermal blocks on the underside of the relay.

Next, remove the four large countersunk screws that hold the mounting plate and the reset magnet assembly to the square posts. Remove the four screws in the mounting plate, which support the reset magnet. Take care not to lose the lever and spring, items ⑧ and ⑨. Remove the two screws ⑪ and pull out the plunger guides. Remove the old coil ⑩ and install the new coil. Then insert the plunger

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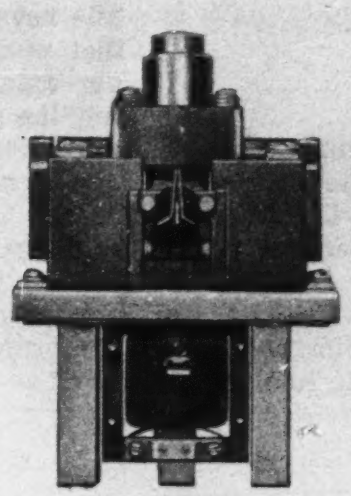

RESET MAGNET ASSEMBLY

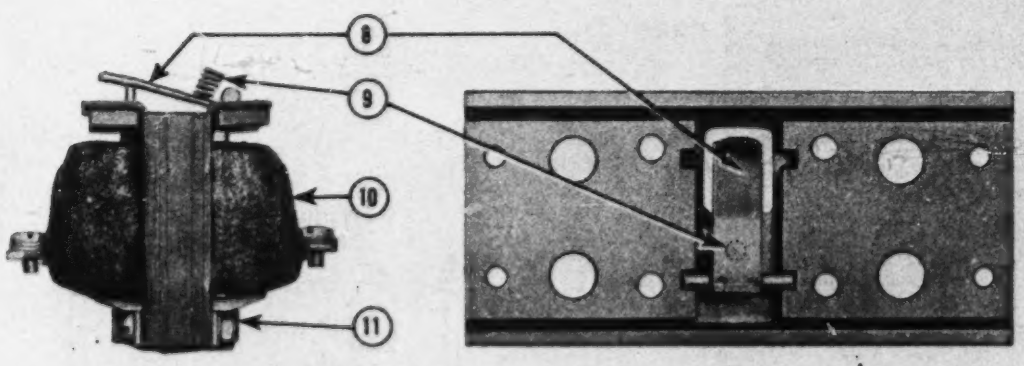

DETAILS OF RESET MAGNET

8. Lever
9. Spring
10. Coil
11. Screws

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Figure 8-22.—Adjustable thermal relay with magnetic reset.

guides and replace the screws (11). Reassemble the magnet, spring, and lever to the mounting plate. Mount the plate on the posts and then mount the overload relay on the mounting plate. Replace the heater coils as the last operation.

Overload relays are PROTECTIVE DEVICES. After an overload relay has performed its safegarding function it must be reset by the EM before the system can again be run with overload protection. The several procedures for using them safely are presented in chapter 9 of this manual, in connection with CONTACTORS and other control devices.

REVERSE CURRENT AND PHASE-FAILURE DEVICES

An electrical distribution system can be overheated and damaged when two or more generators are employed, provided a condition exists which reverses the CURRENT in a d-c system, or reverses the POWER in an a-c system. Obviously, devices are needed to provide protection against these hazards.

To "plug" a motor is to stop the motor by setting the controls for reversing its direction of rotation. This practice is used with electric propulsion. Because propulsion type a-c motors

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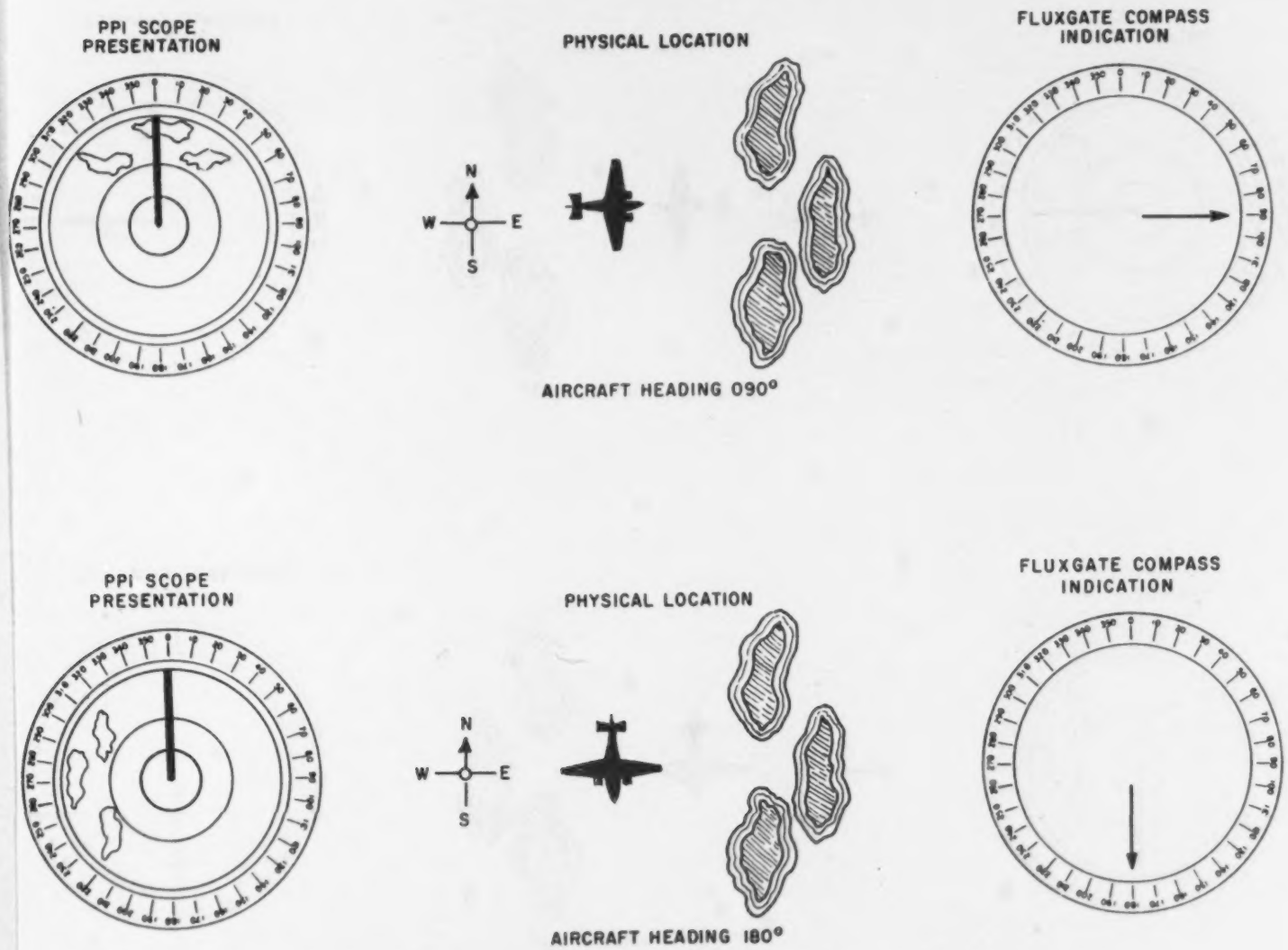

Figure 17-33.—PPI-scope, relative bearing presentation.

The fluxgate compass controls the position of the sweep on the indicators during true bearing operation. As the fluxgate compass follows the aircraft's changes in heading, the error signals coupled to the azimuth stabilization system change the position of the sweep. These changes in position occur at a one-to-one ratio. Thus, if the aircraft heading changes a certain number of degrees, the sweep secondaries will also change a like amount. Refer to figure 17-34 for a comparative analysis of true bearing operation.

In this operation the azimuth indicating device, as on relative operation, represents the heading of the aircraft provided the marker control on the radar control box is set to 0°. The action of moving the sweep secondaries to correspond with changes in the heading of the aircraft causes the azimuth indicating device to shift. Hence, the azimuth indicating device will always indicate the heading of the aircraft and, when on true bearing operation, the top of the scope always indicates north (provided the marker control on the radar control box is set to 0°). As the aircraft changes its heading, the targets remain in their position on the scope and only the azimuth indicator moves. Thus, the targets remain fixed, are always visible, and their relationship to the aircraft can be checked with the azimuth indicating device.

The top of the indicator represents magnetic north when the VARIATION is not set in, and true north when the variation has been set in. Variation is the angle between magnetic north and true north and differs at different points on the earth. The number of degrees of variation may be obtained from navigational charts.

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require full voltage and current from all three phases supplied by the generator, phase-failure protection is a requirement where this type of shipboard propulsion is used.

REVERSE-CURRENT RELAY

Two or more d-c generators may be connected in parallel to supply sufficient power to a circuit. Each d-c generator is driven by its own prime mover. If one prime mover fails, its generator will slow down and draw power from the line. The generator will then operate as a motor and instead of furnishing power to the line, it will draw power from the line. This can result in damage to the prime mover and overloading of the generator. To guard against this possibility, reverse-current relays are used. The reverse-current relay connections are such that when the reverse power reaches a definite percentage of the rated power output, it will trip the generator circuit breaker, disconnecting the generator from the line.

Normally, the reverse-power settings for d-c relays are about 10 percent of rated generator capacity for d-c generators. The reverse-current relay (one for each generator) is located on the generator switchboard. The mechanical construction of a d-c relay designed to limit reverse-current flow is illustrated in figure 8-23.

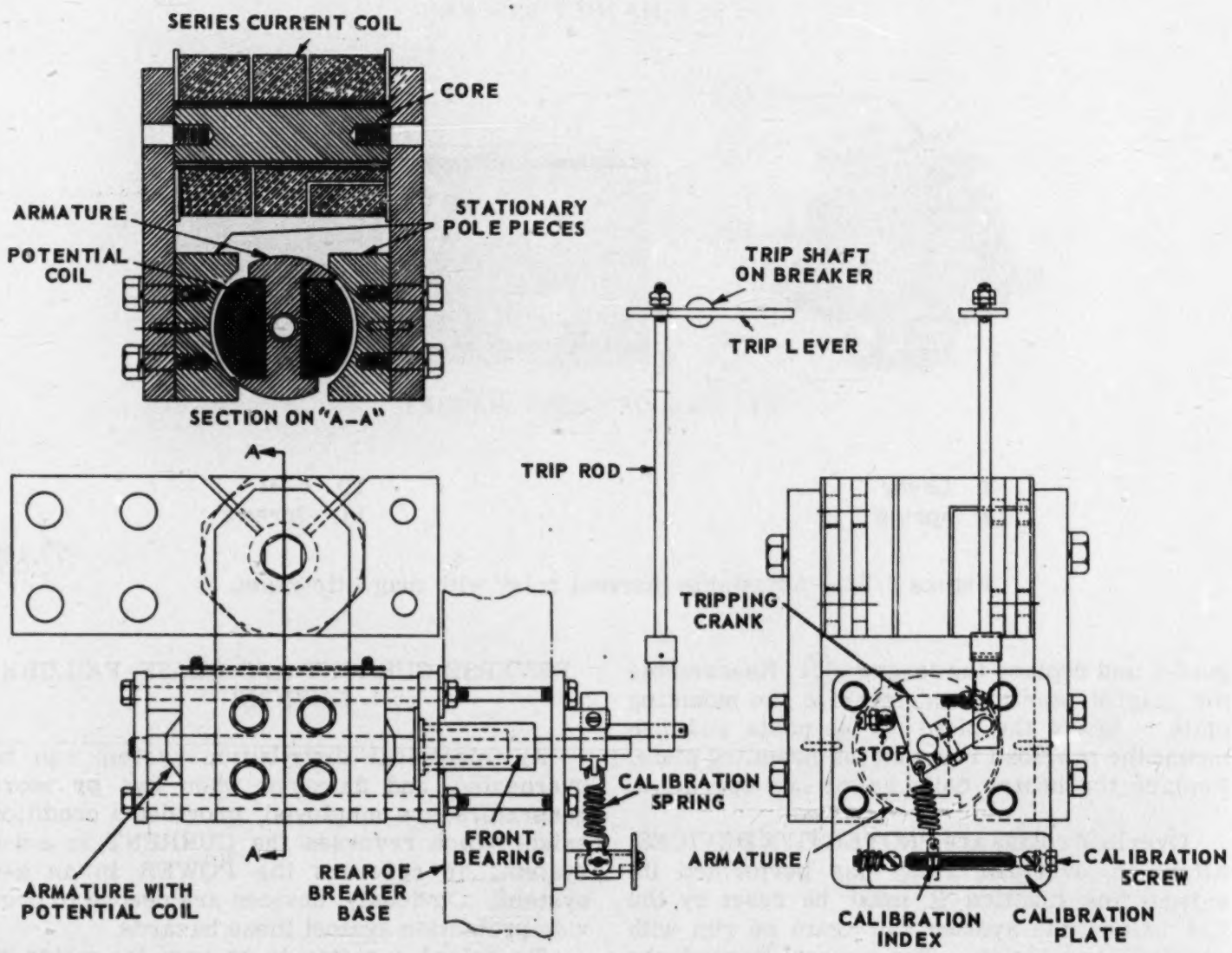

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Figure 8-23.—Mechanical construction of d-c reverse current relay.

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Note that the construction is similar to that of a bipolar motor with stationary pole pieces and a rotating armature.

The potential coil is wound on the armature, and a current coil is wound on the stationary pole pieces. When used as a protective device, the current coil is in series with the load, and the potential coil is connected across the line, as shown in figure 8-24. If the line voltage exceeds the value for which the potential coil is designed, a dropping resistor is connected at point X in the circuit.

When the line is energized, current flowing through the series coil produces a magnetic field across the air gap. Voltage applied to the armature winding produces a current in the armature coil, which interacts with the magnetic field, thereby developing a torque that tends to rotate the armature in a given direction. The construction of the relay is such that the armature cannot turn through 360 degrees as in a motor. Instead, the torque produced by the two fields plus the force from the calibrated spring tends to hold the tripping crank on the armature shaft against a fixed stop. This pressure is maintained as long as current flows through the line in the right direction.

However, if one generator fails, the voltage output of that generator will drop. When the voltage drops below the terminal voltage of the bus to which it is connected, the generator terminal current (through the relay series coil) will reverse. However, the polarity of the voltage applied to the potential coil remains the same. As soon as the reversed current exceeds the calibration setting of the relays, the armature rotates, and through a mechanical linkage, trips the circuit breaker that opens the bus. This action disconnects the generator from the line.

REVERSE-POWER RELAY

Reverse-power protection is required when two or more a-c generators are connected to the same line. Unless such protection is provided, failure of a prime mover can result in the generator running as a motor. An a-c reverse-power relay differs in construction from d-c reverse current relays. The a-c type consists of two induction disc type elements. The upper element is the timer, and the lower one is the direction element.

Figure 8-25 shows the coil and induction disc arrangement in the induction type relay timer element. The disc is four inches in diameter and is mounted on a vertical shaft. The shaft is mounted on bearings for minimum friction.

An arm is clamped to an insulated shaft, which is geared to the disc shaft. The moving

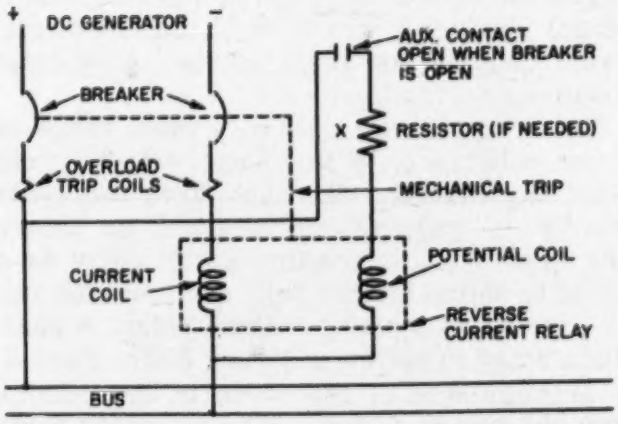

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Figure 8-24.—D-c reverse current relay connections.

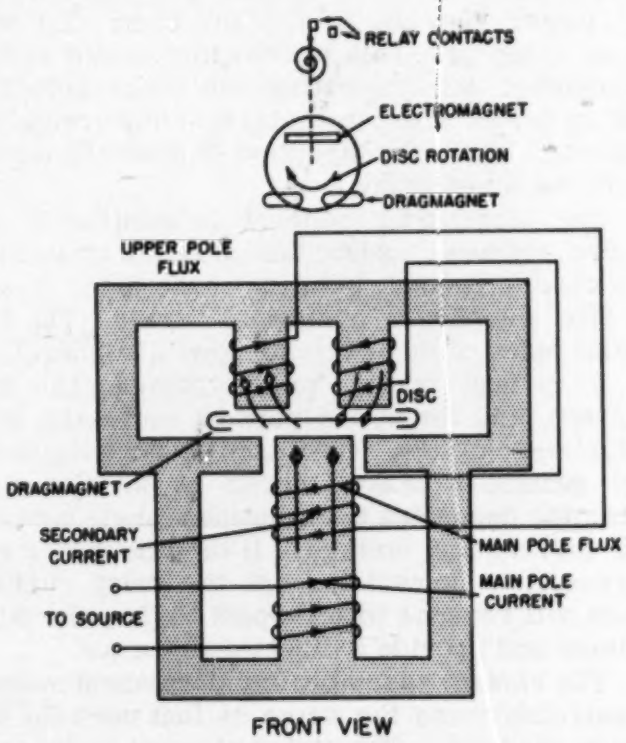

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Figure 8-25.—Coil and disc arrangement, a-c reverse power relay.

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contact, a small silver hemisphere, is fastened on the end of the arm. The electrical connection to the contact is made through the arm and a spiral spring. One end of the spring is fastened to the arm and the other end to a slotted spring adjuster disc fastened to a molded block mounted on the element frame. The stationary contact is attached to the free end of a leaf spring. The spring is fastened to the molded block, and a setscrew makes it possible to adjust the stationary contact position.

The main relay contacts (not shown in the figure) will safely handle 30 amperes at 250 volts d-c and will carry the current long enough to trip a breaker.

The induction disc is rotated by an electromagnet in the rear of the assembly. Movement of the disc is damped by a permanent magnet in front of the assembly.

The operating torque of the timer element is obtained from the electromagnets (fig 8-25). The main-pole coil is energized by the line voltage. This coil then acts as the primary of a transformer and induces a voltage in the secondary coil. Current then flows through the upper pole coils and thus produces a torque on the disc because of the reaction between the fluxes of the upper and lower poles.

The timer element cannot be energized unless the power flow is in the direction that will cause tripping. This interlocking action is accomplished by connecting the timer potential coil in series with the contacts of the directional element. Thus, the direction of power flow controls the timer relay.

The directional element is similar to the timing element, except that different quantities are used to produce rotation of the disc. There is also a different contact assembly. The two upper poles of the electromagnet are energized by a current that is proportional to the line current, and the lower pole is energized by a polarizing voltage. The fluxes produced by these two quantities cause rotation of the disc in a direction depending upon the phase angle between the current and voltage. If the line power reverses, the current through the relay current coils will reverse with respect to the polarizing voltage and provide a directional torque.

The contact assembly and permanent magnet construction are the same as that used for the timer element. The timer element is rated at 115 volts, 60 cycles. The minimum timer element trip voltage is 65 volts, and its continuous rating is 127 volts.

The directional element has a power characteristic such that, when the current and voltage are in phase, maximum torque is developed. The potential coil is rated at 70 volts, 60 cylcles.

The current coil rating is 5 amperes, and the minimum pickup current is 0.1 ampere through the coil. This current is in phase with 65 volts (minimum) across the potential coil. These are minimum trip values, and the timing characteristic of the timing relay may be erractic with low values.

For maximum protection and correct operation, the relay should be connected so that maximum torque occurs for unity power factor on the system. Because the directional element has power characteristics, this connection may be accomplished by using line to neutral voltage for the directional element potential coil (polarizing voltage) and the corresponding line current in the series coils. If a neutral is not available, a dummy neutral may be obtained by connecting two reactors, as shown in figure 8-26. When connected in this manner, the directional element voltage coil forms one leg of a wye connection, and the reactors from the other two legs of the wye. The voltage-operated timer element should be connected across the outside legs of the transformer secondaries.

PHASE-FAILURE RELAY

This type of relay is used to detect short circuits on alternating current propulsion systems for ships. Ordinary instantaneous trip relays cannot be used because, under certain conditions, for example when the motor is plugged (direction of rotation reversed on full voltage) during a crash stop, the momentary current may be as great as the short circuit current.

The relay in use operates when there is a current unbalance. It is connected in the control circuit so that it will shut down the system instantly in case of an external or internal fault. However, operation of the relay is not limited to short-circuit detection, and the relay may be used as a phase-failure relay. A phase-failure relay is shown in figure 8-27. Part A is the arrangement of the parts in the complete assembly, and part B is a closeup of the contact assembly. The entire unit is enclosed in a cover to prevent dirt and dust from interfering with its operation.

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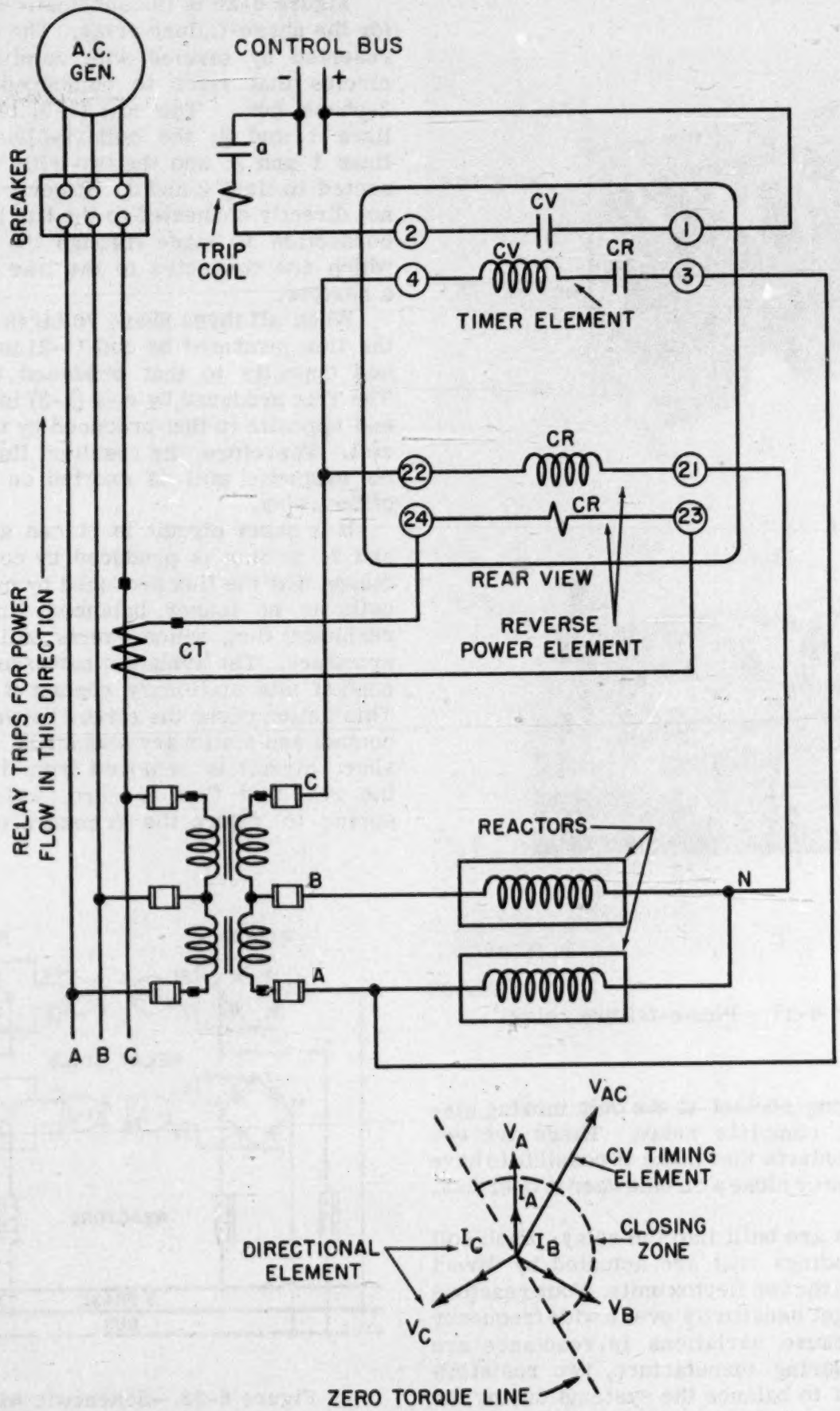

Figure 8-26.—Schematic wiring diagram of an a-c reverse power relay. 77.106

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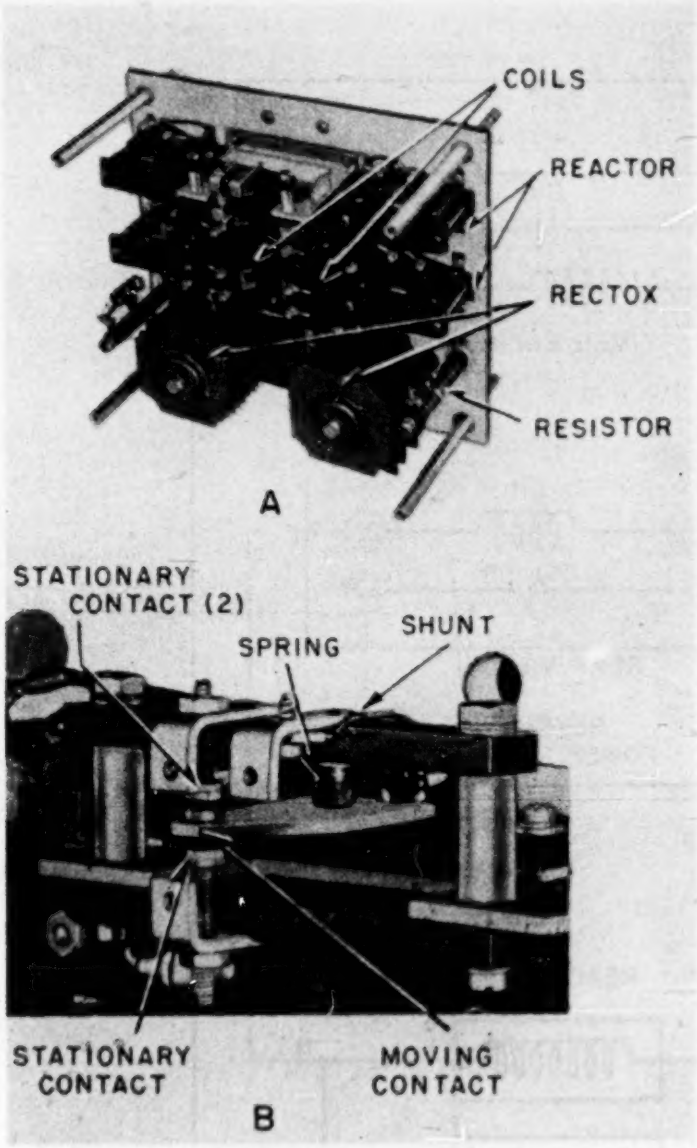

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Figure 8-27.—Phase-failure relay.

The moving contact is the only moving element in the complete relay. There are two stationary contacts that make it possible to have the relay open or close a circuit when it operates.

Two coils are built into the relay. Each coil has two windings that are actuated by direct current from the two Rectox units. Four reactors are used to get sensitivity over a wide frequency range. Because variations in reactance are introduced during manufacture, two resistors are provided to balance the systems during the initial adjustment.

Figure 8-28 is the schematic wiring diagram for the phase-failure relay. The coils are represented by circles with numbers inside the circles that refer to numbered leads in the 3-phase bus. The coil (1-3) is connected to lines 1 and 3; the coil (1-2) is connected to lines 1 and 2; and the two coils (2-3) are connected to lines 2 and 3. However, the coils are not directly connected to the bus lines. Instead, connection is made through the Rectox units, which are connected to the line in series with a reactor.

When all three phase voltages are balanced, the flux produced by coil (1-2) is exactly equal and opposite to that produced by coil (2-3). The flux produced by coil (1-3) is exactly equal and opposite to that produced by the other (2-3) coil. Therefore, the resultant flux is zero, and no magnetic pull is exerted on the armature of the relay.

If a short circuit is placed across lines 1 and 2, no flux is produced by coil (1-2). This means that the flux produced by one of the (2-3) coils is no longer balanced, and there is a resultant flux, which exerts pull on the relay armature. The armature moves until the moving contact hits stationary contact 2 (fig. 8-27,B). This action opens the circuit between the moving contact and stationary contact 1. As soon as the short circuit is removed from lines 1 and 2, the resultant flux is zero, which allows the spring to return the armature to its original

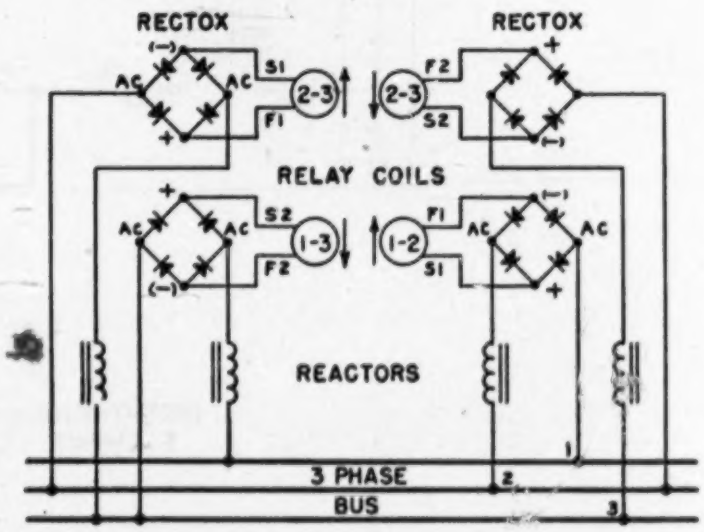

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Figure 8-28.—Schematic wiring of phase-failure relay.

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position. Similarly, if shorts occur on lines 2 and 3 or lines 1 and 3, the resultant flux is no longer zero, and the relay will operate.

A heavy copper tube is placed on each magnet core to damp out the triple-frequency ripple caused by the 120-degree displacement of the 3-phase voltages.

Figure 8-29 illustrates a wiring diagram of the relay, and figure 8-30 represents a vector diagram showing what happens to the line voltage when two lines are short-circuited. Suppose a short occurs across lines 1 and 2. The voltage on coil 1-2 will then be zero and the average voltage on coils 1-3 and 2-3 will be 100% sin 60°/1.11 = 78 percent of the normal rms value with no short. This voltage unbalance is enough to trip the relay.

The reactor in series with each coil keeps the coil current essentially constant over a frequency range of 12 to 90 cycles so that the relay sensitivity is as great at 12 cycles as at 90 cycles.

Mention was made of the use of resistors to achieve magnetic balance. If the reactor reactances are essentially equal, the resistors are

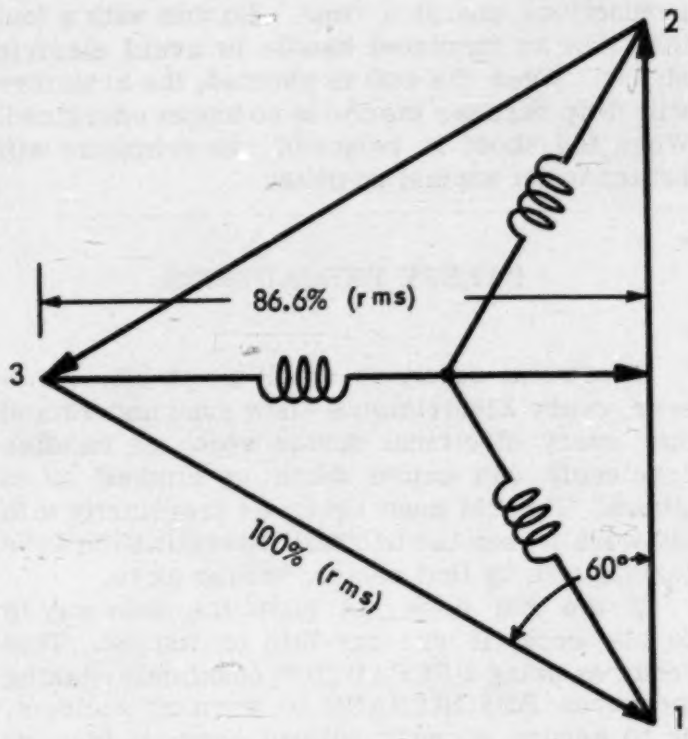

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Figure 8-30.—Vector diagram showing perfect short circuit on 3-phase system.

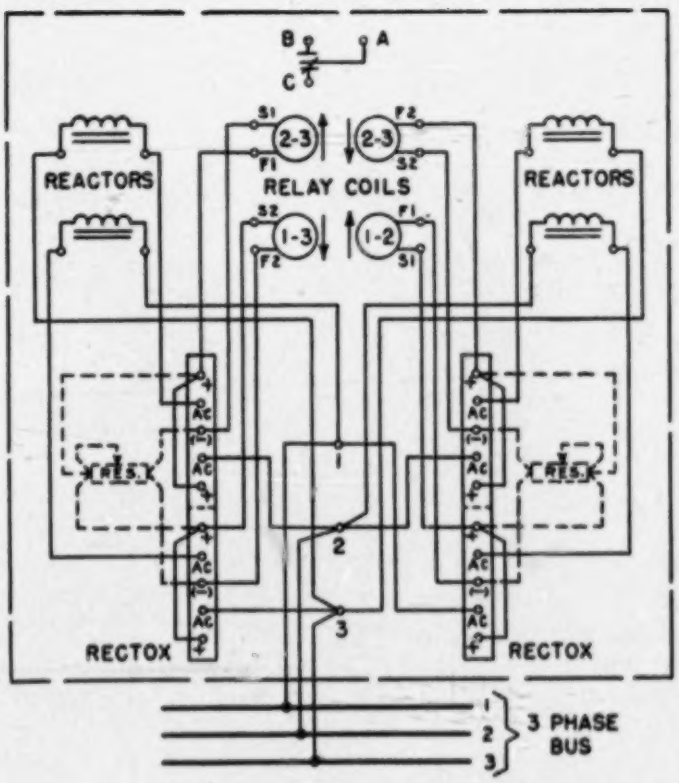

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Figure 8-29.—Wiring connections for phase-failure protection.

not needed. However, if manufacturing tolerances are such as to introduce unbalance, the resistors are necessary. To determine if the resistors are needed, connect a 3-phase, 115-volt, 60 cycle voltage to terminals 1, 2, and 3, as shown in figure 8-29. Short coils 1-3 and 2-3 (on a common core), and then remove the armature spring for that relay. Put the armature against the core. No pull should be exerted on it. If there is pull, a resistance is needed. Repeat this test for coils 2-3 and 1-3 with the coils 2-3 and 1-2 shorted.

Never open the d-c circuit to the Rectox rectifier while the voltage is being applied to the a-c side. This precaution is necessary because the voltage across the Rectox is only a small portion of the total voltage drop due to the reactor being in the circuit. If the d-c side is opened, full voltage is applied across the Rectox, which may cause it to break down.

Very little maintenance is required for this relay. No lubrication is needed. However, the relay should be kept clean so that dirt and dust will not interfere with its operation.

Because the relay rarely operates, it is advisable to check its operation every one or

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two months. To do this, short circuit the coil connections one at a time. Do this with a tool that has an insulated handle to avoid electric shock. When the coil is shorted, the armature will drop because the coil is no longer energized. When the short is removed, the armature will return to its normal position.

SAFETY PRECAUTIONS

Electrical safety is an all hands job. However, every Electrician's Mate must understand that every electrical device which he handles carelessly can cause death to himself or to others. The EM must never let familiarity with his work lessen the habitual determination to be careful and, by that means, to stay alive.

If the EM does not know the safe way to do his work, it will pay him to find out. This requires using PRECAUTION constantly—taking measures BEFOREHAND to ward off accident, or to secure success without harm to himself or others. Some specific precautions, which apply while handling protective devices, are presented herewith for the three-phase distribution system of figure 8-3.

Figure 8-3 illustrates that all fuses are "hot" when power is being furnished by the main supply. Therefore, use extreme care while working at fuse locations. Always remove and replace fuses with an approved fuse puller. This tool is insulated so that there is less danger from electric shock to the electrician while he is working with fuses.

Fuses of a rating greater than 10 amperes should be removed and replaced only after the circuit has been deenergized. This action prevents drawing an arc when the fuse is removed.

Branch circuits are made safe to work on by opening the switch associated with that circuit. These switches should be tagged, "WARNING SHOCK HAZARD This circuit was opened for repairs and shall not be closed except by direct order of _____." If more than one repair party is engaged in repair work on an electrical circuit, a tag for each party should be placed on the supply switch.

After work has been completed, each party should remove its own tag, but no other.

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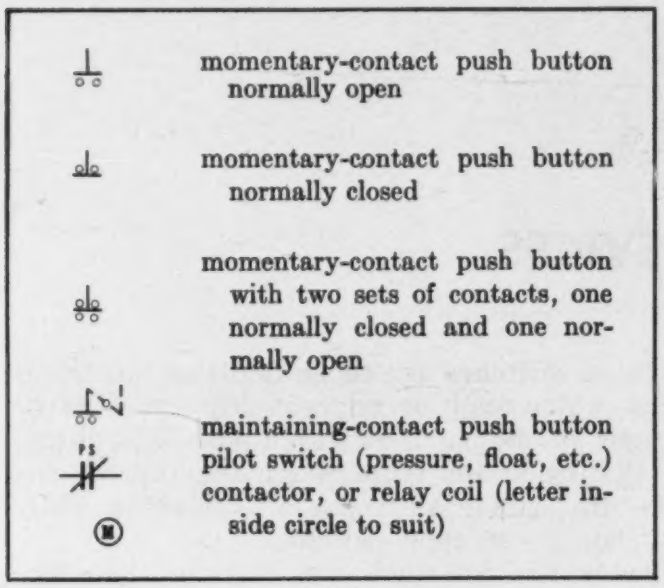

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Figure 9-1.—Pushbutton symbols.

bar and button, for the purpose of opening the electrical circuit after the manual pressure is released.

Another arrangement for getting spring action is to use a strip of springy metal that is firmly mounted only at one end, leaving its other end free to move when its free end is pushed by the insulated button. This arrangement may be modified in practice where a pushbutton control may take one of many forms. A very common practice is to affix one contact to the springy bar, while the remaining terminal of the pair remains fixed. The one symbol shown at the top of figure 9-1, of course, serves all variations that may be found in actual practice for a very simple switch to turn current ON momentarily, then OFF when physical pressure is released from the pushbutton.

Pushbutton controls are shown on equipment schematics, and figure 9-1 illustrates and describes the symbols used to indicate the buttons and the contact arrangement at each button.

Pushbutton control is suitable for momentary application or interruption of current. When a pushbutton is used to apply current for a considerable time, a latching device is incorporated to hold operation (maintain contact) until the latch is released.

KNIFE SWITCHES

Knife switches no longer are used for modern ship applications but their representative symbols (fig. 9-2) are basic standards for other similar switches.

In its simplest form, a knife switch has a movable conductive arm (usually copper), which is hinged or pivoted to a fixed support that forms one terminal of the switch. The second switch terminal is fixed in position so that it may be engaged by the moving arm. Usually, this contact is made of copper and is arranged so that it contacts both sides of the switch arm when the switch is closed. The second terminal has a natural spring to provide a tight contact that is self-wiping. That is, each time the switch is opened or closed, the moving arm will be rubbed by the fixed contact, keeping the contact surfaces clean and bright.

Another type of knife switch may have the arms and contacts arranged to perform a number of actions. This type, with one moving arm and one closed position, is a single-pole, single-throw (SPST) switch, and may be used to open or close one conductor only. In many cases, it

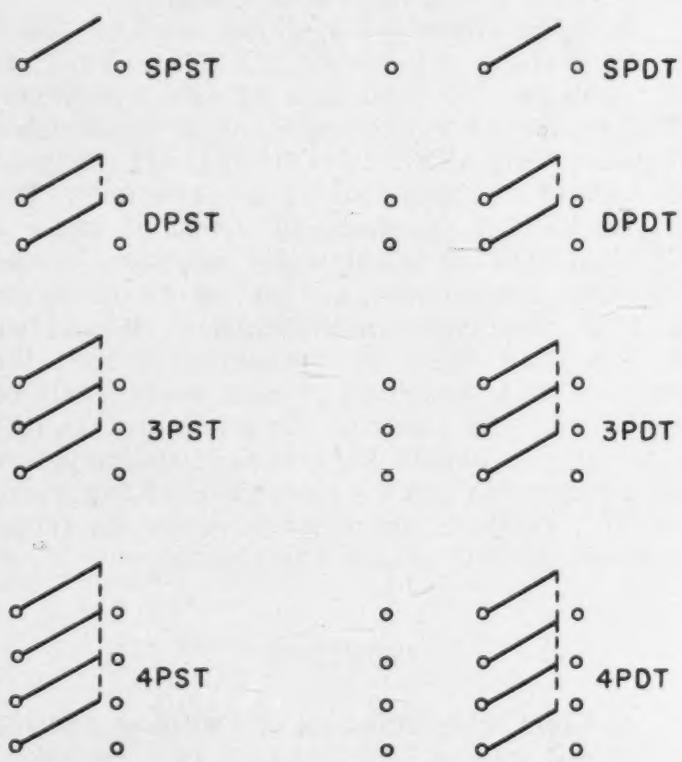

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Figure 9-2.—Schematic switch symbols.

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is necessary to open or close two conductors simultaneously. Switches for this purpose are double-pole, single-throw (DPST) and have two moving arms connected by an insulating bar. This type has two hinged and two fixed contacts.

The number of arms on a switch is determined by the number of conductors it controls. Thus, we may have three-pole, single-throw (3PST) or four pole, single-throw (4PST) switches. In each case, the moving arms will be connected by an insulated bar, for simultaneous operation.

A knife switch may be mounted on a base of bakelite, hard rubber, or slate in order to insulate the conducting parts of the switch from other surfaces. However, open switches can be extremely dangerous because the conductors are exposed. Therefore, most switches are enclosed in a metal cabinet. The switch arm or arms are then operated by an external lever, which is mechanically coupled to the insulating bar on the switch arms.

Knife switches may be used to supply power to two different circuits (loads). When they are used in this manner, the moving arms are arranged so that when they are thrown in one direction one set of contacts is engaged and when the arms are thrown in the other direction, a second set of contacts is engaged. These switches may have any number of poles and are identified as single-pole, double-throw (SPDT); double-pole, double-throw (DPDT); triple-pole, double-throw (3PDT); or four-pole, double-throw (4PDT). The schematic symbols for each designation are illustrated in Figure 9-2.

ROTARY SWITCHES

One type of switch used to open or close one or more conductors is the rotary type. This type is constructed so that the moving arm or arms are pivoted in the center. These arms are insulated from each other and from the pivot post. The contact arrangement is such that a moving arm is connected to two fixed contacts at the same time. Because the circuit wires are connected to the fixed contacts, the arm closes the circuit.

It is possible to construct a rotary switch in a very compact form. However, the amount of current and voltage to be handled by the switch determines the size of the switch arms and contacts as well as the spacing between them. The advantage of a rotary switch is that the number of positions and the number of poles can be increased by arranging the fixed contacts on wafers.

Because there are 360° in a circle, it is possible to have 35 contacts and an OFF position, each position spaced 10° apart. For applications requiring low voltage and current, one set of contacts can be placed on one side of the wafer and another set of contacts placed on the opposite side of the same wafer. Because wafers may be separated as little as 3/8 of an inch in some applications, it is possible to have an 8-pole, 36-position switch in a space approximately 2 inches in diameter and 1 1/2 inches deep. This kind of rotary switch is used in many electronic applications. However, one type of rotary switch is rated at 500 volts a-c at 200 amperes and may be used on power applications.

MASTER SWITCHES

The switches encountered in naval equipment will fall into the three general types that have been described. However, special applications change the previously described simplified forms. A master switch (pushbutton, knife, or rotary) starts or stops a sequence of operations. A device that is controlled by a master switch cannot be used until the switch is closed. The actual closing of the switch may be done manually or automatically. In some circuits, the master switch may be followed in sequence by other controls that are designed for a specific purpose. These will be described later.

Master switches are used with the faceplate and cam-type controllers. The principal difference is in the method of making contact between the fixed and moving terminals. A schematic diagram of face-plate internal connections is given in the d-c motor starter circuit of figure 9-3.

In the face-plate switch, connection is made from one side of the line to a handle-operated lever that carries a contact brush or shoe. Pushing the handle (fig. 9-3) moves the brush over a series of contacts (fixed), which are connected to resistors. As the lever arm moves clockwise across the contacts, the amount of resistance in series with the armature gradually decreases. At the last contact, all series resistance is out of the circuit, and the armature receives full voltage.

When the lever closes the circuit at the first contact, it establishes a circuit to an electromagnet. The current flowing through the magnet

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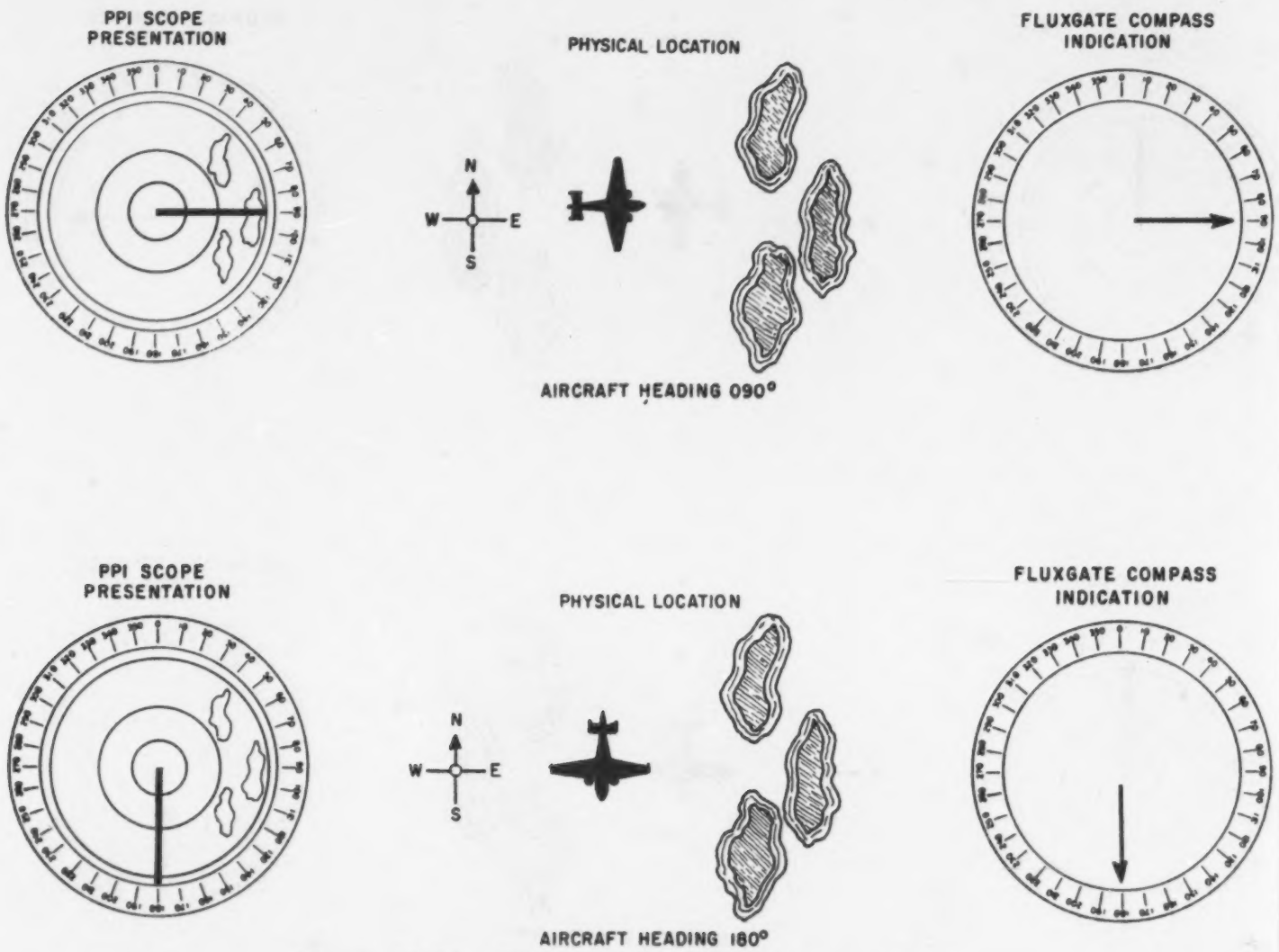

Figure 17-34. —PPI-scope true bearing presentation.

Some compass systems provide a means whereby variation may be added into the system; thus the compass will then indicate true north, and a radar slaved to the compass will also indicate true north. In some aircraft installations that are equipped with a compass that does not provide this correction feature, a variation differential generator is included. This generator is between the transmitting synchro of the compass and the azimuth followup synchro in the radar. By adjusting this generator to the local variation, it is possible to correct the radar to true north.

True Bearing Amplifier

The input to the true bearing (servo) amplifier (fig. 17-35) is obtained from the rotor of the azimuth followup synchro. This error signal is applied across resistor R1 (sensitivity adjustment) which is paralleled by the primary of input transformer T1. The amplitude of this signal is determined by the amount of change in the aircraft heading, and the phase is determined by the direction of the change. The signal is transformer coupled to the grids of V1 which is the true bearing amplifier discriminator. The signals on the grids of V1, due to the transformer action, will always be 180° out of phase. The plate voltages, due to the transformer connections, are always in phase. Thus, the grid that is in phase with the plate will determine which half of the duotriode conducts the hardest.

When the grid and plate of V1 (A) are in phase, its conduction charges the capacitors in the plate circuit. The plate current circuit is from the plate of V1 (A) through the

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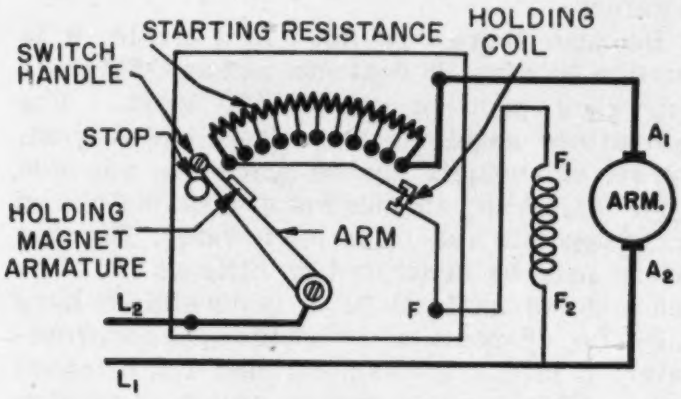

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Figure 9-3.—D-c motor starter circuit.

winding produces a magnetic flux, which holds the lever at the last contact.

Face-plate switches are used on older ships as starting switches in d-c motor circuits. They will seldom be found on ships that have a-c electrical systems. In the three-terminal type (fig. 9-3) the current through the holding magnet winding is actually the shunt field current of the motor being controlled. Therefore, if the voltage supply for the motor field is interrupted for any reason, the reduction in field current will reduce the strength of the holding magnet, and the lever will be released. Because the lever is spring loaded, it will return to the OFF position. This feature makes it impossible to open a motor field circuit at some point and then close the circuit (with the motor connected to the line). As soon as the holding coil magnet releases the lever, it returns to the OFF position, and the motor cannot be started without going through the entire starting procedure.

Cam-type switches (fig. 9-4) are suitable for use with multispeed, reversing, and nonreversing controllers.

Cam-type switches are manually operated by turning a handwheel or lever located on one side of the switch housing. Turning the handwheel rotates the shaft on which the operating cams are mounted. These cams engage rollers mounted on the switch contact levers and cause the switch contacts to open or close.

Some cam switches are self-centering. That is, it is necessary for the operator to hold the operating control at the desired position. When the control is released, it returns to the OFF position. In the nonself-centering type, the operating control remains in the position selected until the operator turns it to another position. A star wheel mechanism provides positive positioning on the nonself-centering type of master switch given in figure 9-4A. Parts A and B show how rotation of the cam causes the switch contacts to open and close, and part C illustrates how the star wheel latches the switch in position.

The operating cams are made of phenolic material and are mounted on a hexagonal steel shaft. The operating sequence of the switch contacts is determined by the shape of the cams and their orientation on the shaft. Cam-type master switches may be mounted on a bulkhead, deck, or pedestal. Regardless of the type of mounting or the number of poles or positions, the method of operation is the same.

MAGNETIC SWITCHES

Magnetic switches are switching devices actuated by means of an electromagnet, controlled either manually or automatically, which perform functions for making, breaking, or changing the connections of an electric circuit. Since relays and contactors fall under this general definition, those magnetic switches are presented later in this chapter.

LIMIT SWITCHES

In certain applications the ON-OFF switch does not give enough control to ensure safety of equipment or personnel. A limit switch is incorporated in the circuit in order that operating limits are not exceeded.

The limit switch is installed in series with the master switch and the voltage supply. Any action causing the limit switch to operate will open the supply circuit.

One application of limit switches is in equipment that moves over a track. It is possible to apply power so that operation will continue until the carriage hits an obstruction or runs off the end of the track.

If limit switches are installed near the end of travel, an arm or projection placed on the moving section will trip a lever (as shown in figure 9-5) on the limit switch. The switch then opens the circuit and stops the travel of the carriage. This type of control is a direct-acting, lever-controlled limit switch. Another type, an intermittent gear drive limit switch, may be coupled to a motor shaft to stop action

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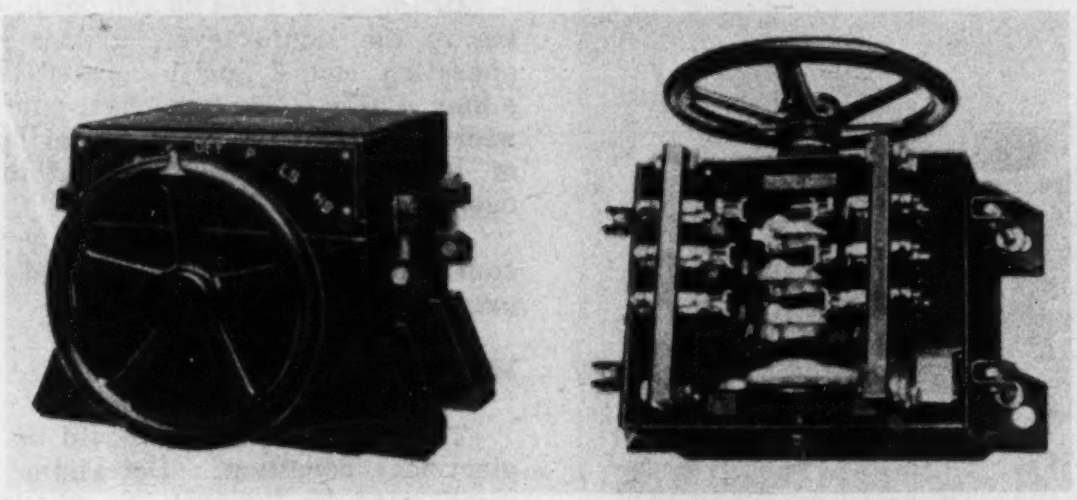

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Figure 9-4.—Cam-type switch mechanism.

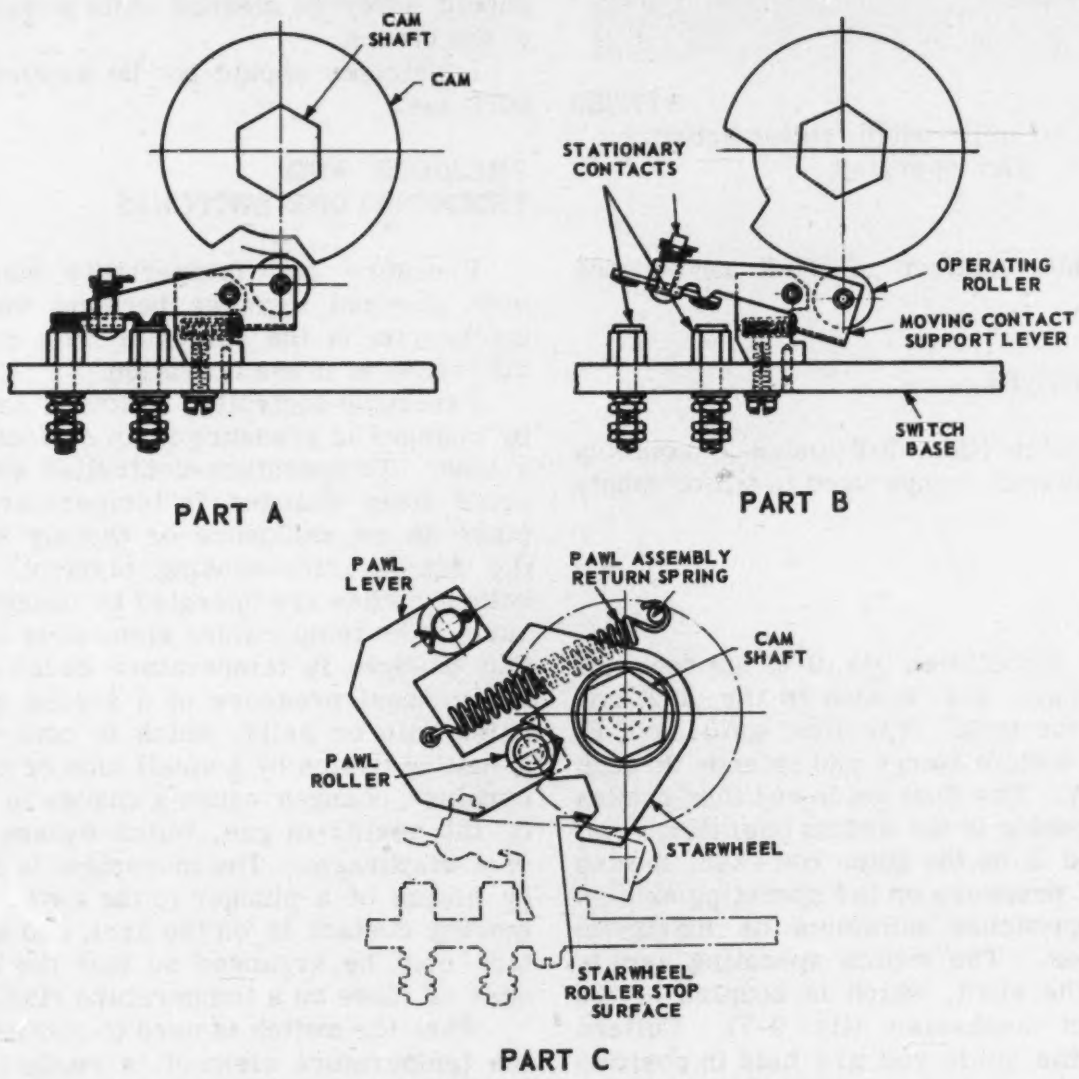

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Figure 9-4A.—Nonself-centering cam switch.

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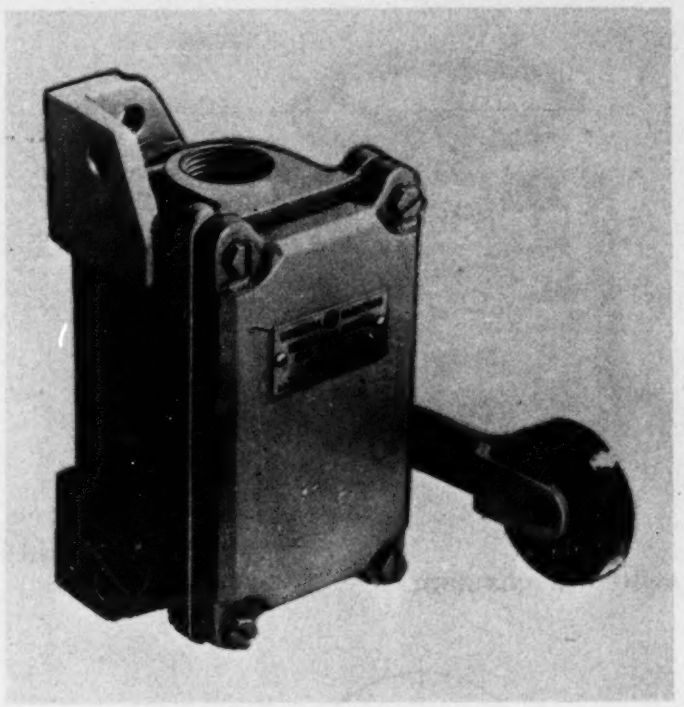

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Figure 9-5.—Limit switch, roller actuator arm operated.

when a definite number of shaft revolutions is completed.

FLOAT SWITCHES

A float switch (figs. 9-6 and 9-7) controls electrically driven pumps used to fill or empty tanks.

Construction

In a tank installation (fig. 9-6) the deck and overhead flanges are welded to the deck and overhead of the tank. The float guide rod, E, fits into the bottom flange and extends through the top flange. The float guide rod then passes through an opening in the switch operating arm. Collars A and E on the guide rod exert upward or downward pressure on the operating arm as the float approaches minimum or maximum depth positions. The switch operating arm is fastened to the shaft, which is coupled to the switch contact mechanism (fig. 9-7). Collars C and D on the guide rod are held in position by set-screws so that their positions can be changed to set the operating levels to the desired points.

As the float goes up and down, corresponding to the liquid level, it does not move the operating rod, E, until contact is made with either collar. When the float comes in contact with either collar, the external operating arm of the switch is moved and the switch is operated.

Although the switch assembly is of rugged construction, it must be checked regularly for proper performance.

Maintenance

The switch contacts should be kept in good electrical condition. Determine the kind of metal used for the contacts, whether copper or silver, and apply applicable procedures outlined in chapter 8 for maintenance of the kind of contact metal in use. Of course, contacts should never be cleaned while power is applied to the circuit.

Lubricants should not be applied to contact surfaces.

PRESSURE AND TEMPERATURE SWITCHES

Pressure and temperature controls have been grouped together because the switching mechanism is the same for both controls; the difference is in the operation.

Pressure-controlled switches are operated by changes in pressure in an enclosure such as a tank. Temperature-controlled switches operate from changes in temperature that take place in an enclosure or the air surrounding the temperature-sensing element. Actually, both switches are operated by changes in pressure. The temperature element is arranged so that changes in temperature cause a change in the internal pressure of a sealed gas or air-filled bulb or helix, which is connected to the actuating device by a small tube or pipe. Temperature changes cause a change in the volume of the sealed-in gas, which causes movement of a diaphragm. The movement is transmitted by means of a plunger to the switch arm. The moving contact is on the arm, and a fixed contact may be arranged so that the switch will open or close on a temperature rise.

When the switch is used to control pressure, the temperature element is replaced by a tube that leads to the pressure tank. The pressure inside the tank then operates the switch mechanism.

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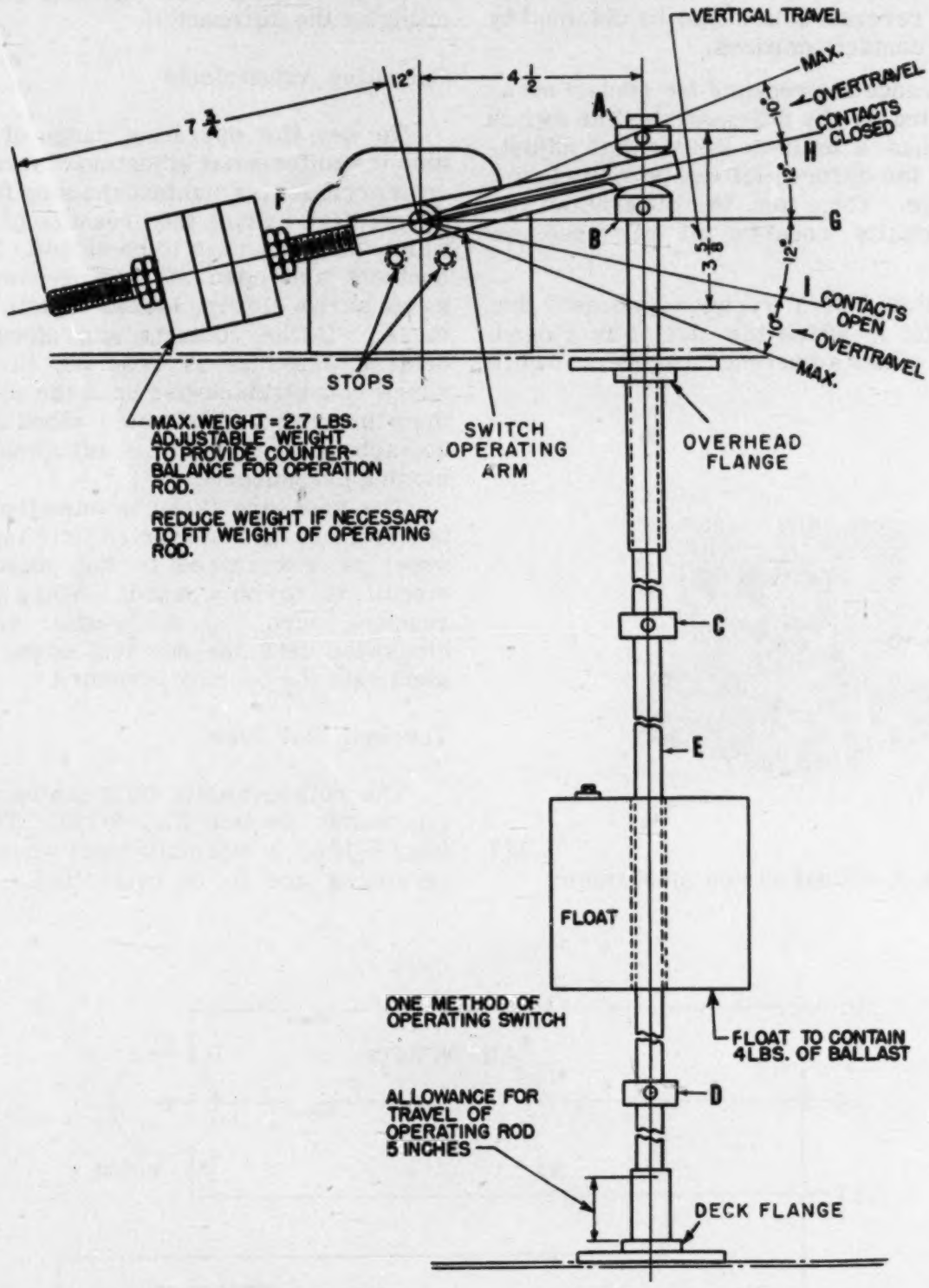

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Figure 9-6.—Float switch tank installation.

Pressure or temperature controls may be used as a pilot device (fig. 9-8). The circuit operation is exactly the same regardless of the kind of pilot device used to control the circuit. To maintain more or less constant temperature or pressure, switch contacts are arranged to close when the pressure or temperature drops to a predetermined value and to open when the

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pressure or temperature rises to the desired value. The reverse action can be obtained by changing the contact positions.

The difference in pressure for contact opening and closing is the differential. The switch mechanism has a built-in differential adjustment so that the differential can be varied over a small range. Once set, the differential remains essentially constant at all pressure settings.

Each switch has a range adjustment that sets the point at which the circuit is closed. Changing the range adjustment raises or lowers both the closing and opening points without changing the differential.

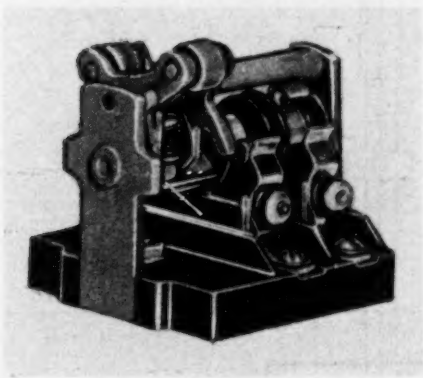

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Figure 9-7.—Float switch mechanism.

Operating Adjustments

To set the operating range of the switch, turn the differential adjustment screw (fig. 9-9) counterclockwise against the stop for minimum differential. Bring the pressure to the value at which the circuit is to be closed. If the switch contacts are open at this pressure, turn the range screw slowly clockwise until the contacts close. If the contacts are closed when the desired pressure is reached, turn the range screw counterclockwise until the contacts open; then turn the screw slowly clockwise until the contacts close. These adjustments set the closing pressure.

The pressure (keep in mind that changes in temperature are converted to changes in pressure) is now raised to the point where the circuit is to be opened. When this point is reached, turn the differential screw slowly clockwise until the contacts open, this adjustment sets the opening pressure.

Thermal Unit Type

The bulb and helix units can be connected to the switch section (fig. 9-10). The bulb unit (fig. 9-10A) is normally used when liquid temperatures are to be controlled. However, it

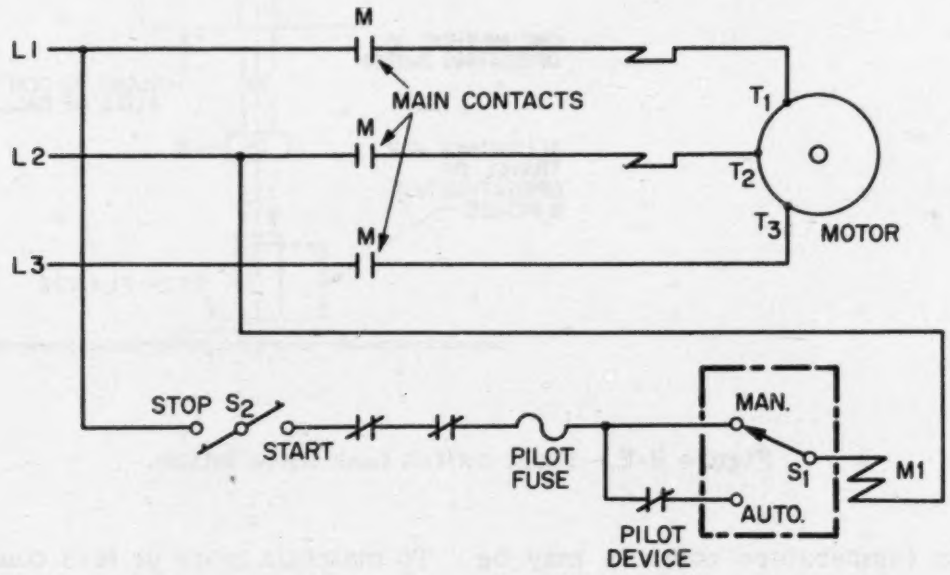

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Figure 9-8.—Typical pilot device control circuit.

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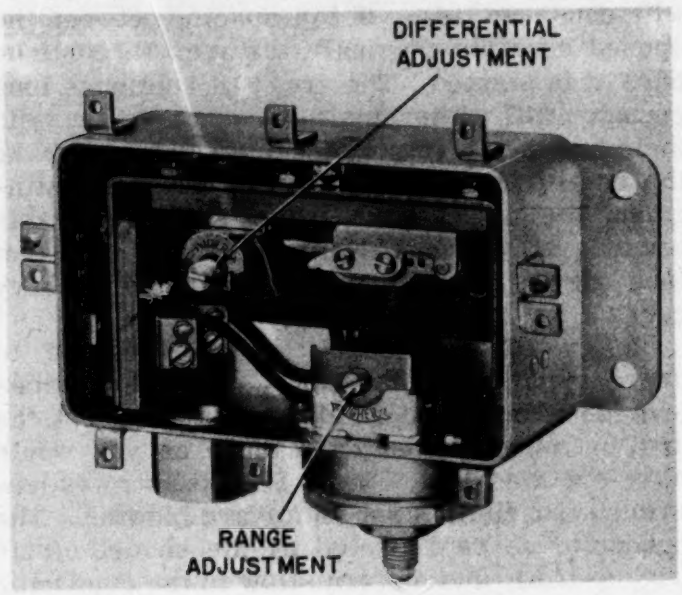

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Figure 9-9.—Pressure-operated switch.

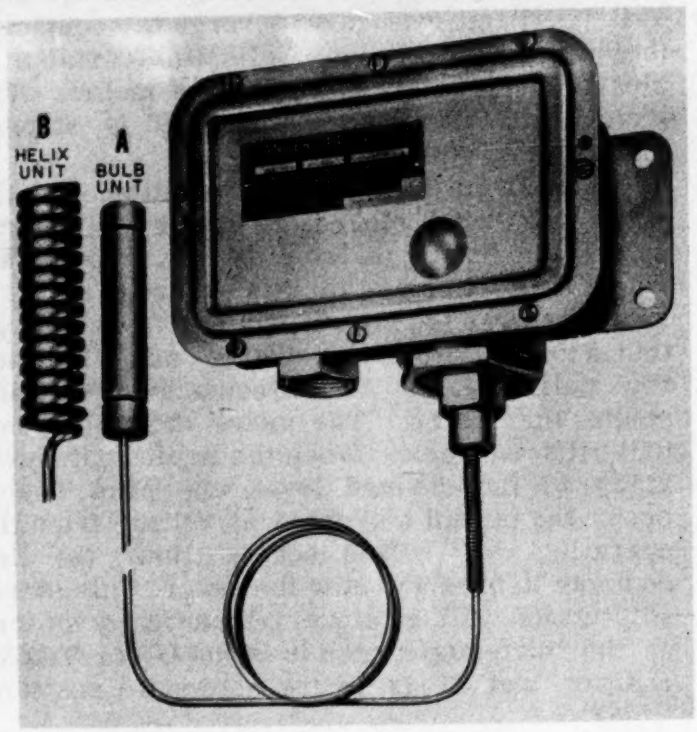

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Figure 9-10.—Thermal units.

may control air or gas temperatures, provided the circulation around it is rapid and the temperature changes at a slow rate.

The helical unit (fig. 9-10B) has been specifically designed for air and gas temperature control circuits. To be most effective, the thermal unit must be located at a point of unrestricted circulation so it can "feel" the average temperature of the substance that is to be controlled.

Some switches are stamped, "WIDE DIFFERENTIAL." They are adjusted in the same manner described for the regular controls. However, because of slight design changes it is possible to get wider variation in differential settings.

Maintenance

When adjusting temperature controls, allow several minutes for the thermal unit to reach the temperature of the surrounding air, gas, or liquid before setting the operating adjustments. After adjusting the operating range of pressure or temperature controls, check the operation through at least one complete cycle. If you find variation from the desired operating values, go through the entire procedure again and observe operation through a complete cycle.

PILOT CONTROL DEVICE

A pilot is defined as a director or guide of another thing (or person). You may be familiar with ship pilots, pilot rudders, and pilot flames. In this text, a pilot is a small device that controls a relatively larger device or mechanism, usually doing so by electrical means. The previously described float switch and pressure operated switches are representative examples of such pilot devices. Pilot devices are limited in their ability to handle large currents and voltage required to operate shipboard motors or power-handling units. Therefore, it is customary for a pilot device to actuate only a magnetic switch. The magnetic switch can be chosen with characteristics suitable for handling the desired amount of power in the motor circuit.

Use of a Pilot Device

Float switches used as pilot devices control the pump operation through other controls. A typical control circuit is shown in figure 9-8.

Switch S1 makes it possible to have either manual or automatic operation of the motor-driven device. When this switch is in the manual

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position (the circuit is closed by the start-stop switch, S2) current flows through the contactor (holding coil M1) which pulls line contacts M closed and applies power to the motor. The motor will then operate until it is stopped manually.

With S1 in the automatic position, and the start-stop switch closed, the motor will not run unless the switch on the pilot device is closed. When the pilot device (in this example, the float switch) closes the circuit, current flows through the arm of S1 to the operating coil, M1, which then pulls the line switch contacts closed and starts the motor. The motor drives a pump that fills the tank. When the liquid in the tank rises to the desired level, the pilot device opens the circuit and removes voltage from the operating coil. This action allows the line contacts to open and stop the motor. This start-stop action will continue automatically as long as the start-stop switch is in the ON or START position and S1 is in the automatic position.

RELAYS AND CONTACTORS

The RELAY and CONTACTOR are small and large versions, respectively, of a magnetically operated device. Some Navy contactors can switch 10,000 amperes.

The basic difference in these devices designed for use on alternating current and those designed for direct current is in the armature and magnet core construction.

D-C RELAYS AND CONTACTORS

The d-c relays described in chapter 8 are primarily used with pilot devices to operate the larger contactors or circuit breakers.

The complete contactor is composed of an operating magnet, which is activated by either switches or relays, fixed contacts, and moving contacts. It may be used to handle the load of an entire bus, or a single circuit or device. However, when heavy currents are to be interrupted, larger contacts must be used. The contacts must snap open or closed to reduce contact arcing and burning. In addition to these precautions, other arc-quenching means are used.

Magnetic Blowout

When a d-c circuit carrying appreciable current is interrupted, the collapse of the flux linking the circuit may induce a voltage, which will cause an arc. If the spacing between the opened contacts is small, the arc will continue once it is started. The arc, if it continues long enough, will either melt the contacts or weld them together. To correct this condition, make the open contact spacing great enough to extinguish the arc. This may be impracticable because of space limitations and the fact that long stroke operating magnets require heavy current for operation.

Magnetic "blowouts" were developed to overcome these objections. These devices provide a magnetic field, which blows out the arc in much the same manner as you would blow out a match. Figure 9-11 illustrates how a magnetic field is set up for arc blowout. The conductor is represented by the shaded circle (fig. 9-11A), and electron flow in the conductor is assumed to be flowing away from you as you look at the drawing. The direction of the magnetic flux around the wire is then counterclockwise, as shown by the circled arrows, and the blowout flux is established from left to right, as shown by the horizontal straight arrows.

The flux around the conductor and the blowout flux oppose each other above the conductor and combine into a strong field below the conductor. This action produces a force on the conductor in an upward direction, as shown by the vertical vector (fig. 9-11B). If the conductor (fig. 9-11A) is formed by contacts and the contacts are opened, the air between them becomes a conductor while the contacts are arcing. The resultant magnetic field created by the arc and the blowout field forces the conducting air upward. This lengthens the conductive path (fig. 9-11B) and extinguishes

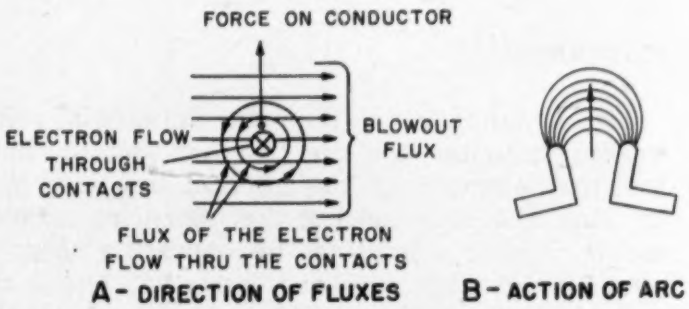

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Figure 9-11.—A magnetic field is set up for arc blowout.

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the arc. The effective arc gap is several times as large as the gap measured straight across from one contact to the other.

The magnetic blowout operation is illustrated in figure 9-12. It is important that the fluxes remain in the proper relationship. Otherwise, if the direction of the current is changed, the blowout flux will be reversed and the arc will actually be pulled into the space between the contacts.

When the direction of electron flow and flux are as illustrated in figure 9-12, the blowout force is upward. The blowout effect varies with the magnitude of the current and with the blowout flux. The blowout coil should be chosen to match the current so that the correct amount of flux will be obtained. The blowout flux across the arc gap is concentrated by a magnetic path provided by the steel core in the blowout coil and the steel pole pieces extending from the core to either side of the gap.

Arcing Contacts

Because arcing at contacts wears away the usable surface, a second set of contacts (arcing contacts) is shunted across the main contacts.

A shunt-type contactor that will handle 600 amperes at 230 volts is pictured in figure 9-13. The blowout shield is removed in the pictorial view (fig. 9-13A). The diagram (fig. 9-13B) shows the main sections of the contactor. The arcing contacts ⑦ are made of rolled copper, which has a heavy protective coating of cadmium. These contacts are self-cleaning because of a sliding or wiping action after the initial contact is made. The wiping action keeps the surface bright and clean and thus maintains a low contact resistance.

The contactor is operated by connecting the coil ① directly across a source of direct voltage. When the coil is energized, the movable armature ② is pulled toward the stationary

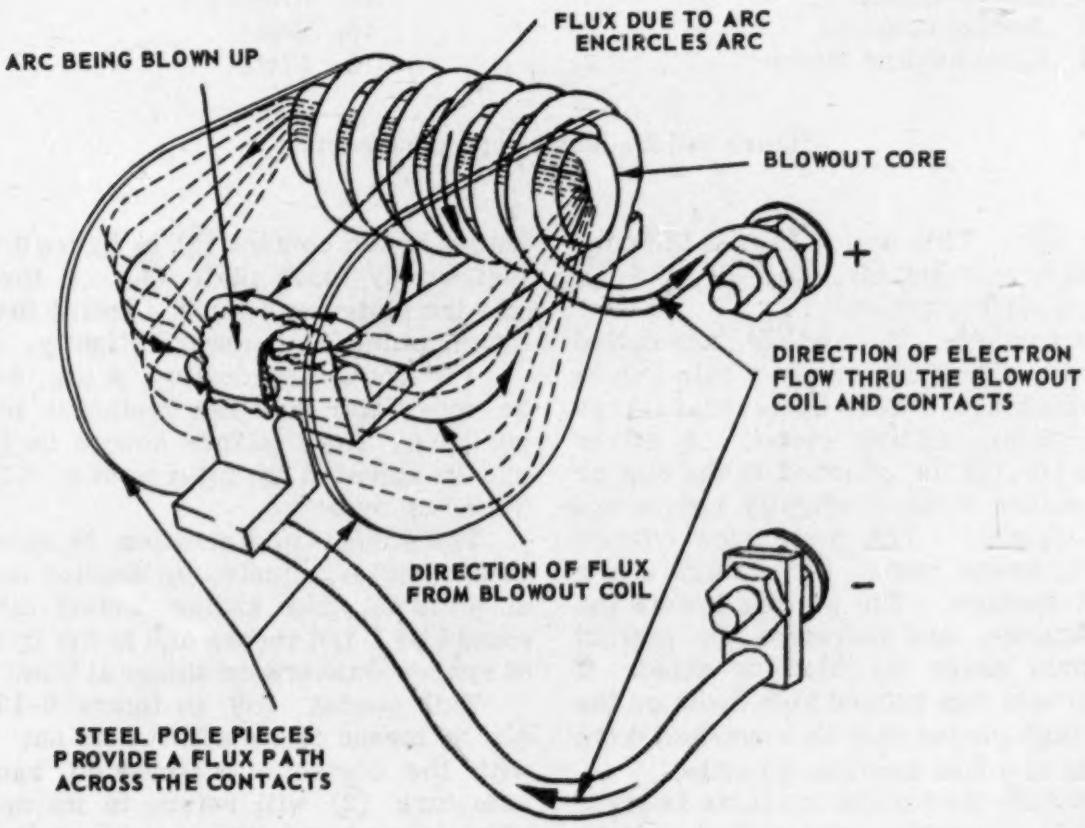

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Figure 9-12.—Action of magnetic blowout coil.

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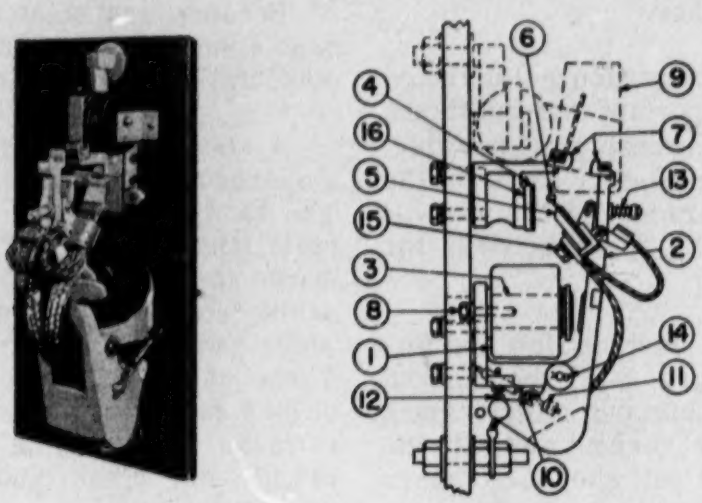

1. Coil
2. Armature
3. Magnet core
4. Stationary contact
5. Main brush contact
6. Brush arcing tip
7. Arcing contacts
8. Core holding screw
9. Blowout assembly
10. Tail spring
11. Spring adjustment nut
12. Armature stop pin
13. Finger spring
14. Hinge pin
15. Bolt
16. Plate

77.123

Figure 9-13.—Shunt-type contactor.

magnet core ③. This action causes the contacts that carry current ④, ⑤, ⑥, and ⑦ to close with a sliding action.

The main contacts, ④ and ⑤, are called brush contacts. They are made of thin leaves of copper, which are backed by several layers of phosphor bronze spring metal. A silver brush arcing tip ⑥ is attached to the copper leaves and makes contact slightly before the leaf contact closes. The stationary contact consists of a brass plate ⑯, which has a silver-plated surface. The plating lowers the surface resistance, and therefore the contact surfaces should never be filed or oiled. If excessive current has caused high spots on the contact, the high places may be smoothed down by careful use of a fine ignition-type file.

A detailed side view of the contacts is given in figure 9-14. Operation and contact spacing may be checked by manually closing the contactor (be sure the power is off). The lowest leaf of brush contact ⑤ in figure 9-13B, should just barely touch plate ④. If the lower leaf hits the plate too soon, the entire brush assembly should be bent upward slightly.

The contact dimension, A (fig. 9-14), should be measured with the contactor in the OPEN position. The distance should be 1 1/2 inches and is adjusted by moving stop ⑫ in figure 9-13B up or down.

The arcing tip dimension, B, should be 1 1/4 inches and is adjusted by bending the arcing tip at point C. The arcing contact dimension, D, should be 1 1/4 inches and is set by the addition of spacer washers or shims at point E.

Tail spring ⑩ in figure 9-13 should be set by means of the adjustment nut ⑪ so that with the contactor inclined 45° backward, the armature ② will return to its open position when closed and then quickly released. This adjustment gives the tail spring the minimum tension required. If the contactor cannot be

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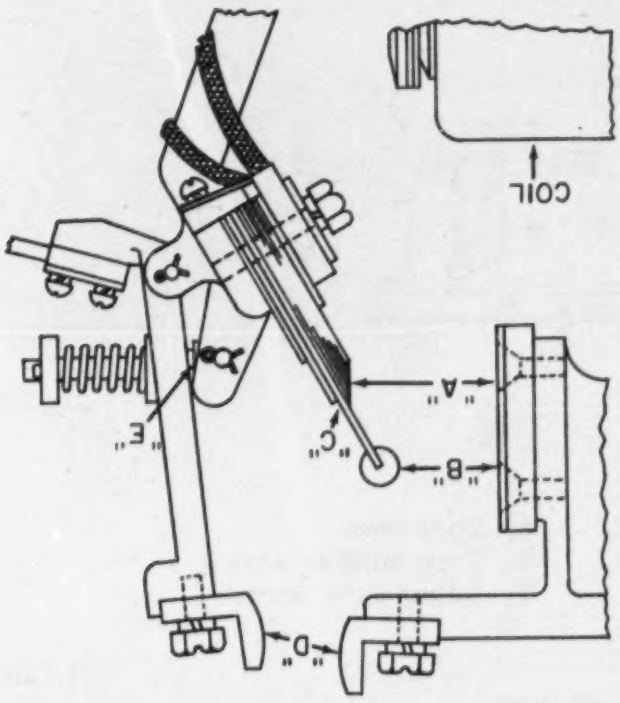

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Figure 9-14.—Detailed view of contacts.

tilted 45° backward, the tail spring should be adjusted so that the contactor will pick up at 70 percent of the line voltage.

Main Contacts

The main contacts, ④ and ⑤, in figure 9-13 carry the d-c current drawn by the load during the operating cycle. The contact dimensions vary in accordance with the current handled by them. However, in most cases the same principles are used and the only difference is in physical size.

The moving main brush contact ⑤ is hinged to the armature. A rod fastened to the armature extends through the slot in the moving contact arm. A finger spring ⑬ is held under compression between the washer at the end of the rod and the moving contact arm. With the armature open, the spring holds the moving contact arm against the armature, which drops back and opens the contacts. When the armature is attracted, the contacts touch before the armature is pulled against the pole piece. The continued pull of the magnet compresses the spring so that it adds to the pressure, holding the moving contact against the fixed contact.

Electric Interlock

The voltages present in most electrical enclosures are dangerous. An electrically operated interlock is sometimes used to safeguard personnel and prevent opening of the d-c or a-c enclosure while it is energized.

A pictorial view and a diagram of an electric interlock are shown in figure 9-15, A and B respectively.

The components of this electric lock are identified in part B. The coil of the lock is connected to the line terminals. As soon as the power is turned on, voltage is applied to the lock coil (1), the armature (2) is pulled toward the magnet core (3), and the latch (4) engages the door hook (5) in the enclosure door. The door of the enclosure cannot be opened as long as the coil is energized.

When the contactor is deenergized, the lock magnet releases the armature, which disengages the latch from the door hook.

Mechanical Interlock

When contactors are designed for two-speed or forward and reverse operation, it is possible to actuate the FAST or forward control at the same time the SLOW or reverse control is in operation unless precautions are taken. Simultaneous operation of the two controls is prevented by the use of a mechanical interlock arranged so that as one contactor closes, the other contactor is mechanically locked open.

Shunt D-C Contactors

Contactors for motor control are designed to energize or deenergize a circuit repeatedly without failure. Figure 9-16 is a d-c shunt contactor. Part A is the external view, and part B illustrates the mechanical construction.

The contactor is operated by energizing coil ①, which is composed of a large number of turns of wire and connected directly across a source of voltage. Armature ② is pulled against core ③, which closes the main contacts, ④ and ⑤. The contacts are shaped to give a sliding motion when they close. Shunt-type d-c contactors are generally used as main-line or accelerating contactors. However, they are not restricted to this usage and can be used for many other power-control applications.

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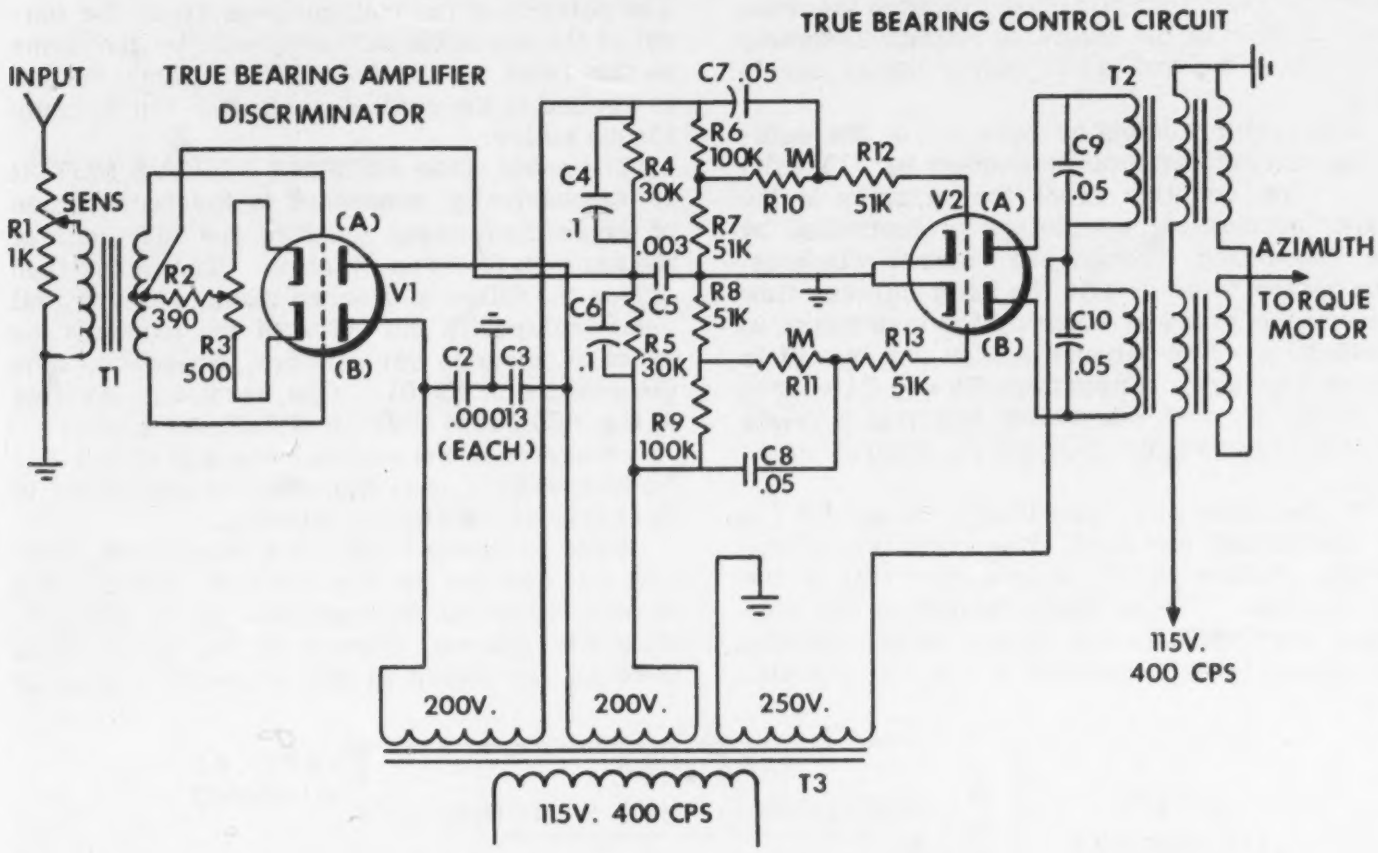

Figure 17-35. —True bearing amplifier.

source potential winding, plus to minus, then up through resistor R5. The current flowing through R5 develops a negative voltage at the bottom and charges capacitor C6. C6 in conjunction with C5 provides an a-c filter path to ground. The current flows from the junction point to resistors R4 and R5 back to the center tap of transformer T1. The path is then completed back to the cathode through the resistor R2 and the balance pot R3. During this same time, although V1 (B) has its grid negative and plate positive, it may still conduct a little. Its conduction path from the plate through the source potential causes current to flow through resistor R4 and develop a negative voltage at the top of R4. The negative voltage developed at the bottom of R5, however, far exceeds the negative voltage developed at the top of R4. Thus the voltage measurement from R5 is negative to positive. The voltage thus developed is coupled to the grids of the output control tubes.

The grid of V2 (B) is more negative than the grid of V2 (A). Any portion of the a-c signal not filtered out through capacitors C4, C5, and C6 is coupled through C7 and C8 to the grids of V2. In addition, the d-c signal developed across R6, R7, R8, and R9 is taken from the junction of the resistors and also applied to the grids. Hence, the grids contain both a-c and d-c components.

When the amplitude of the signal on either grid is too great, grid current is drawn; this limits the conduction of the tube. For example, when the amplitude of the signal on the grid of V2 (A) is excessively positive, grid current will flow through R10 and R12, thus adding to the bias on V2 (A).

The cathode of V2 is tied directly to ground. The voltages applied to the plates of V2 are in phase and conduction depends upon the grid signals that are developed in the discriminator circuit. In the case cited previously where V1 (A) conducted the hardest, the voltages developed in the output resistors made the grid of V2 (B) most negative. Under these conditions, the current flowing through the plate windings of the bottom control winding of the SATURABLE REACTOR assembly, T2, will be less than the current flowing through the upper

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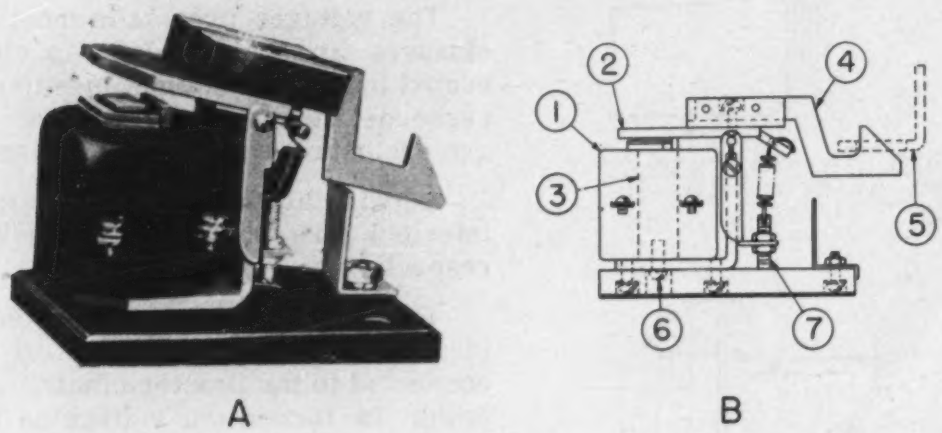

1. Coil
2. Armature
3. Magnet core
4. Latch
5. Door hook
6. Core holding screw
7. Adjustment screw

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Figure 9-15.—Electric interlock.

Series Lockout D-C Contactors

A delay in circuit closing is desirable in some motor-control applications. The contactor used for this purpose is called a lockout type because the delay action is obtained by using a lockout coil. This coil gets its name from the fact that it locks the main contacts open on initial surges of heavy currents and then allows the contactor to close after the current has fallen to a predetermined value. A lockout-type contactor is used as an accelerating contactor on current-limit acceleration controllers.

Single-Coil Lockout

As may be seen from figure 9-17 the upper part of the contactor is very similar to other magnetic contactors. However, the lower part incorporates the lockout mechanism, which consists of an armature ② (an integral part of the closing armature ③), a lockout coil ①, and a means of adjusting the air gap so as to obtain the desired operation with respect to motor current. The contactor has two magnetic circuits with the magnetic paths shown by the dashed lines in figure 9-17B. The upper part of the control consists of the closing coil ④, the closing armature ③, and the contacts.

In operation, both coils are energized at the same time. The closing coil ④ may be connected across the line (shunt or in series) with the motor which is being controlled. The lockout coil ① is connected either across part of the motor circuit or in series with the motor circuit.

The high starting current surge causes a strong magnetic field in the lockout. This strong field overcomes the field about the closing coil ④ and holds the contactor in its open position. As the motor accelerates, the heavy starting current decreases, and, at a predetermined current value, releases the lockout armature ② and allows the contacts to close. The adjustment of the magnetic air gap, B, determines the current at which the lockout coil releases the armature.

This current is set by the screw disc ⑥. Turning the disc clockwise decreases the magnetic air gap, B, which means that fewer ampere turns will be needed to lock open the contactor. Thus, a longer interval is required to allow the current to reduce to the lower release point. The motor will then accelerate more slowly.

Double-Coil Lockout

Although the contactor just described has two coils (lockout and holding), it is known as

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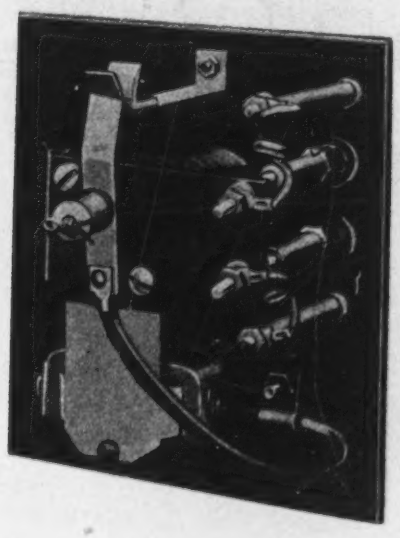

A

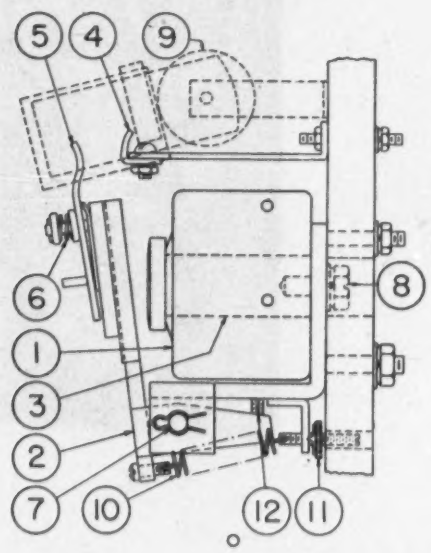

B

1. Coil
2. Armature
3. Magnet core
4. Post contact
5. Finger contact
6. Finger spring
7. Hinge pin
8. Core holding screw
9. Blowout assembly
10. Tail spring
11. Spring adjustment nut
12. Armature stop pin

77.126

Figure 9-16.—D-c shunt contactor.

a single-coil lockout contactor. The type that will now be described is a double-coil lockout contactor (fig. 9-18).

As shown in the figure, the double-coil unit has a series up-coil and a series down-coil in addition to a shunt coil. The series up-coil ① and the series down-coil ② are connected in series with each other and the motor armature. The series down-coil serves to hold the contactor armature ④ in the open position during the motor starting high-current surge. When the current drops to the predetermined value, the combined magnetic pull of the up-coil and the shunt coil is greater than the magnetic pull of the down-coil, and the armature ④ closes the main contacts, ⑤ and ⑥. The shunt coil ③ is used to hold the contactor closed when the load on the motor is light. Because it is designed for connection across the line, it has many turns of fine wire. The contacts of this relay have the same shape and construction as those used on contactors previously described.

Coils

The coils used in contactors operate as electromagnets. The basic theory of electromagnet operation is given in Basic Electricity, NavPers 10086 (revised). Study or review this material so that you will be familiar with the operating principles.

Dashpot

One type of d-c overload relay is called a dashpot relay because of its construction (fig. 9-19). Part A is a photograph of a dashpot relay and part B is a diagram showing the various parts.

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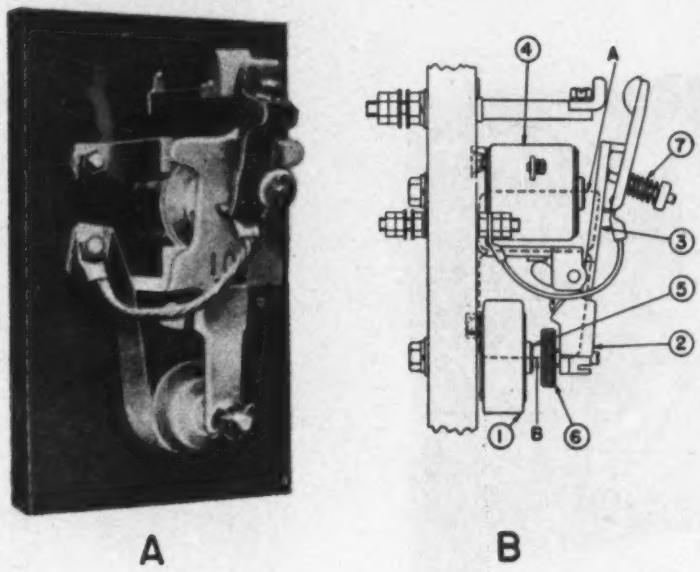

1. Lockout coil
2. Lockout armature
3. Closing armature
4. Closing coil
5. Lockout coil core
6. Adjusting screw
7. Main contact spring

77.127

Figure 9-17.—D-c lockout contactor.

The contacts ② are normally closed, and any circuit in which the relay is connected will be closed. The relay coil ① is normally connected in series with the line to be protected so that changes in the line current will influence the magnetic flux of the coil.

Dashpot assembly ⑦ is filled with oil, and the dash ⑬ is a disc that has a slightly smaller diameter than the inside diameter of the pot. The dash is connected to a plunger assembly ③, which is a part of the solenoid assembly. The contacts ② are mounted on this plunger.

When the current in relay coil ① exceeds the normal rated current, the magnetic force on plunger ③ pulls it slowly upward. The upward motion is slowed down because of the opposition offered the metal disc by the oil in the dashpot.

The overload current keeps exerting a pull on the plunger until the rising plunger opens the normally closed contacts, which open the control circuit. When the circuit is opened, current no longer flows through the coil and there is no pull on the plunger. The relay then resets itself as the plunger and contacts return to their normal positions.

The use of oil in the dashpot (1) acts as a time delay medium because it slows the movement of the disc; (2) because the contacts are immersed in the oil, serves as an arc-quenching or cooling medium; and (3) acts as a shock absorber because it slows the motion of dash ⑬ and contacts ② under shock impacts.

The relay is set, at the factory, to trip when the line current is slightly above the current rating of the motor it protects. This, together with the time delay feature, prevents tripping of the overload under normal starting current surges.

A-C RELAYS AND CONTACTORS

Basically, the construction, operation, and application of either an a-c contactor or an a-c relay is the same as its d-c counterpart. However, because of the characteristics of alternating current, the differences in construction must be recognized.

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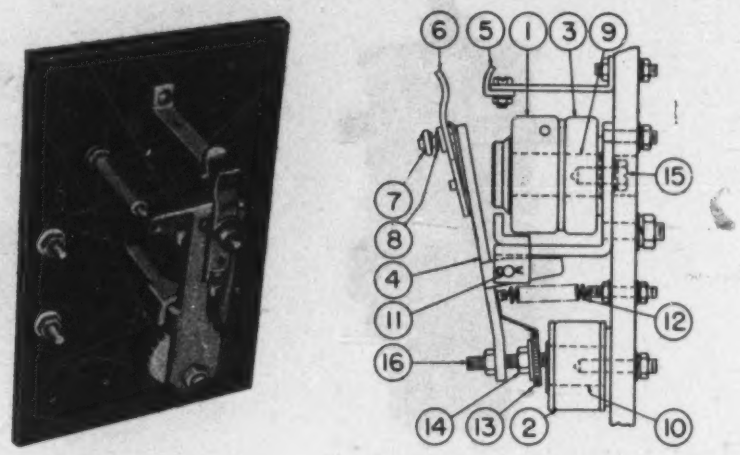

A B

1. Series up-coil
2. Series down-coil
3. Shunt coil
4. Armature
5. Post contact
6. Contact finger
7. Cotter pin
8. Finger spring
9. Upper magnetic core
10. Lower magnetic core
11. Hinge pin
12. Tail spring
13. Adjustment disc
14. Lock nut
15. Core holding screw
16. Disc stud

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Figure 9-18.—Double-coil lockout contactor.

A-C Magnets

The cores used for a-c magnets are of laminated construction so that eddy currents may be reduced.

Shading Coils

Because the flux in a single-phase magnet is in phase with the coil current, the magnetic pull at the air gap varies with the frequency of the supply voltage. Therefore, twice each cycle, the pull will go to zero, andthe armature will chatter against the core. The noise is objectionable, and the chattering causes excessive wear on the magnet core face. The noise and wear is overcome by a shading coil imbedded in one of the magnet faces (fig. 9-20).

The shading coil acts as the secondary of a transformer. The effect of the shading coil is to cause the main coil flux to be out of phase with the shading coil flux so that when the main coil flux goes through zero, the shading coil flux will be high enough to maintain pull on the armature and keep it closed.

Most d-c magnets and some a-c types have a second air gap, shown above the hinge in figure 9-20. This gap must not be closed when the armature is pulled in because its purpose is to prevent residual magnetism from holding the armature closed after the coil has been deenergized.

The design of an a-c magnet is more complicated than that for a d-c magnet. Long stroke magnets are likely to have a pull, which, at first, increases as the gap decreases, and then stays fairly constant until the gap becomes nearly closed. The pull then increases sharply as the gap decreases to zero. Figure 9-21 illustrates how the pull increases as the gap becomes smaller. Note that as the pull becomes greater, the coil current and wattage decrease.

The current decreases because the reluctance of the magnetic circuit decreases as the air gap becomes smaller; hence, the flux

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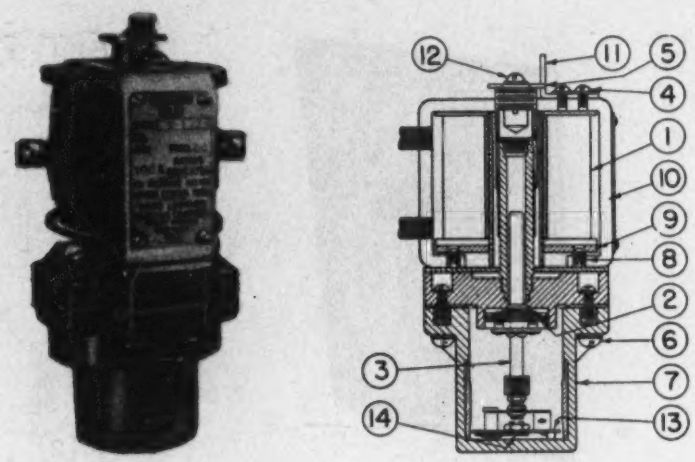

A B

1. Coil
2. Normally closed contacts
3. Plunger assembly
4. Screws
5. Rating adjuster head
6. Screws
7. Dashpot assembly
8. Screws
9. Coil clamp
10. Frame
11. Flag
12. Screw
13. Dash
14. Bi-metallic strip of metal

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Figure 9-19.—Dashpot overload relay.

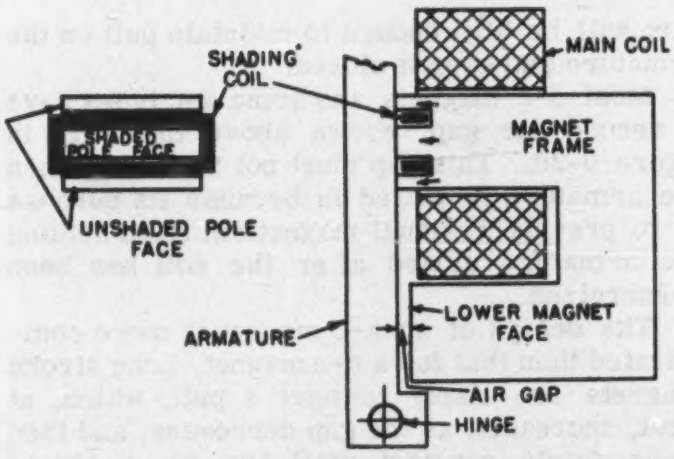

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Figure 9-20.—Core construction for a-c contactor operation.

density and reactance increase, the principal opposition to the coil current is the inductive reactance of the coil. With a rising inductive reactance and a constant potential source, the current will decrease.

Shunt A-C Contactors

Shunt type a-c contactors have laminated frame construction, and the coils are wound with many turns of fine wire. The coils are designed for connection directly across the line and are rated for either continuous or intermittent operation. Usually, shunt-type a-c contactors are used to control motor circuits. The initial control impulses may come from a pilot device or from a manual control, which serves as a master switch for the contactor.

Magnetically operated starters for a-c motors may be connected to give under-voltage protection, as shown in figure 9-22.

The circuit used for under-voltage protection with manual restart employs momentary contact pushbuttons (fig. 9-22). The motor is started by pushing the START button. This action completes the circuit from L3 through the control fuse, STOP button, START button, the overload relay contacts, OL, and the contactor coil, M, to L1. When the M coil is energized, it closes line contacts M1, M2, and M3 which connect the full line voltage to the

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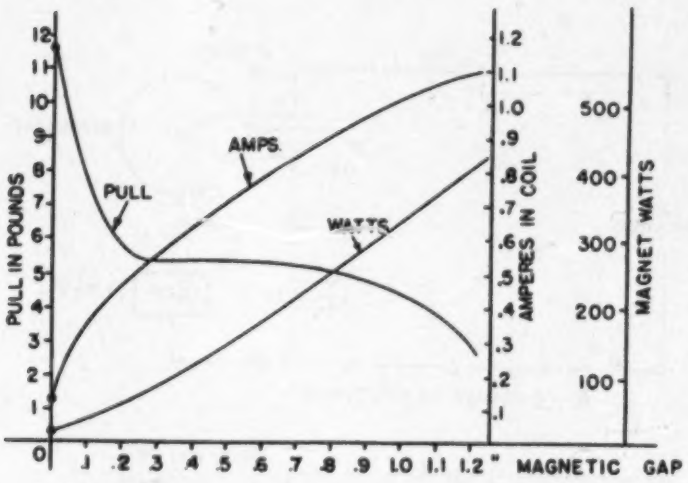

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Figure 9-21.—Curves showing relationship between magnetic pull, coil current, and wattage.

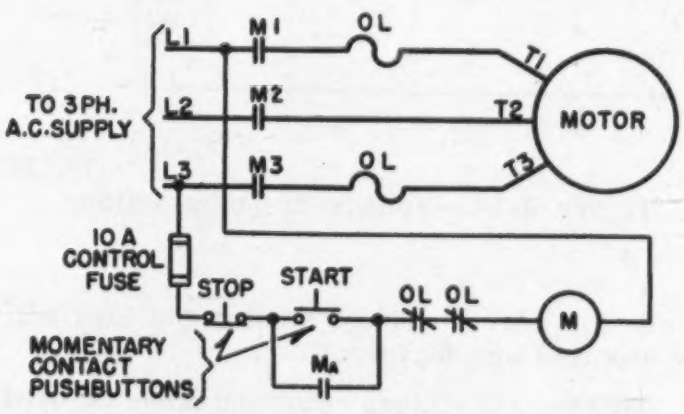

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Figure 9-22.—Under-voltage protection.

motor. The line contactor auxiliary contact, MA, also closes and completes a holding circuit for energizing the coil circuit after the START pushbutton has been released.

The motor will continue to run until the contactor coil is deenergized by the STOP pushbutton, failure of the line voltage, or tripping of the overload relay, OL.

Under-voltage protection with manual restart is provided by the use of momentary contact pushbuttons. If coil M is deenergized, the contactor will not reclose and start the motor when voltage is restored, or when the overload relays are reset until the START pushbutton is again depressed. The overload relays, OL, are reset by a reset button on the outside of the motor starter cabinet. An under-voltage release circuit with automatic restart employs a maintained contact, STOP-START, switch (fig. 9-23). The motor is started by turning the switch to the START position. This action completes a path from L3 through the fuse and maintained contact of the STOP-START switch to the overload relay contacts, OL, and the contactor coil, M, to L1. When the contactor coil, M, is energized, it closes line contacts M1, M2, and M3, which applies full line voltage to the motor. The motor will continue to run until the coil, M, is deenergized by loss of voltage, tripping of the overload relay, or by turning of the STOP-START switch to the STOP position. Under-voltage release with automatic restart is provided by the use of maintained contacts on the STOP-START master switch. If the operating coil, M, becomes deenergized through loss of voltage, the contactor will close and restart the motor as soon as voltage is restored or when the reset button for the overload relay is pressed if an overload caused the M coil to be deenergized. These forms of operation are necessary to protect motors from overheating due to under-voltage conditions.

RHEOSTATS

It is often necessary to reduce the voltage that is being applied to a motor, a generator field, a lighting circuit, or some other electrical device.

One method of reducing voltage is to introduce resistance in series with the load. The amount of resistance in the circuit may be a

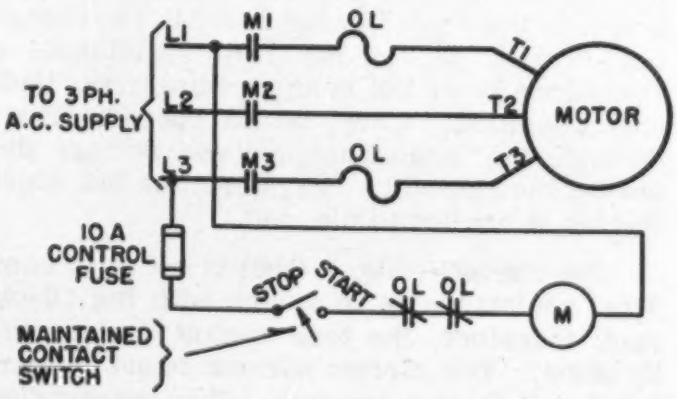

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Figure 9-23.—Under-voltage release.

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fixed value, or it may be varied mechanically. Where mechanical variation of resistance is provided and the unit is connected in series with a load, it is called a rheostat.

MANUAL

Rheostats are classified as continuously variable or step types. In the continuous type, a moving arm makes contact with a resistance wire. One end of the wire is connected to one circuit lead, and the moving arm is connected to the other circuit lead. Thus, movement of the arm over the resistance wire varies the effective circuit resistance from zero up to the full resistance of the resistance element.

In the step type, fixed resistors are connected in series, and the junctions between adjacent resistors are connected to contacts arranged either in a straight line or a circular form. When the contacts are arranged in a straight line, the moving contact is driven by a worm gear. When the contacts are arranged in circular form, the moving contact is pivoted in the center of the circle.

Because considerable current may be present in some applications, the moving contact is arranged to make contact with one fixed contact before breaking the connection to another fixed contact. This prevents arcing and momentary interruptions of current.

When a rheostat is used to lower voltage, the difference between the source voltage and the load voltage will appear across the rheostat terminals. This voltage is sometimes called a voltage drop and is equal to the resistance in OHMS times the current in amperes flowing through the resistance. The voltage-dropping action is illustrated in figure 9-24. The rheostat (fig. 9-24A) is set for zero resistance; all resistance is cut out by the moving arm. Under this condition, there is no current flowing through the resistance and no voltage drop across the rheostat. Therefore, the full source voltage is applied to the load.

The rheostat (fig. 9-24B) is set at 10 ohms. This resistance is in series with the 10-ohm load; therefore, the total circuit resistance is 20 ohms. The circuit current found by Ohm's law $I = E/R$, is 6 amperes. This current flows through the rheostat, and the IR drop across its terminals is 6 amperes times 10 ohms or 60 volts. This voltage drop must be subtracted

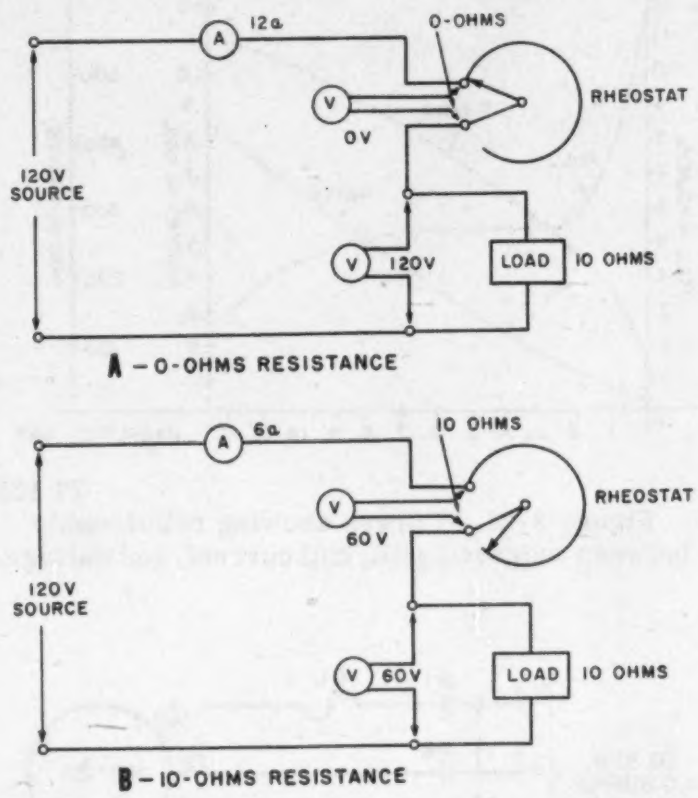

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Figure 9-24.—Voltage-dropping action.

from the source voltage so that the load will be supplied with 60 volts.

This type of voltage reduction might be used to dim lights. The rheostat could be either the continuously variable type or the step type. It would control the lamp voltage as long as it was connected in series with the load.

MOTOR DRIVEN

As the name implies, a motor-driven rheostat is a variable resistor with a motor-driven arm. The motor that drives the rheostat arm may be controlled by a manually operated switch. Motor-driven rheostats are used in certain voltage regulator installations and are discussed in more detail in chapter 11 of this course. Figure 9-25 shows a simplified motor-driven rheostat being used to control the field voltage of an a-c generator.

Motor-driven rheostats are also used in certain degaussing installations which are discussed in chapter 12 of this course.

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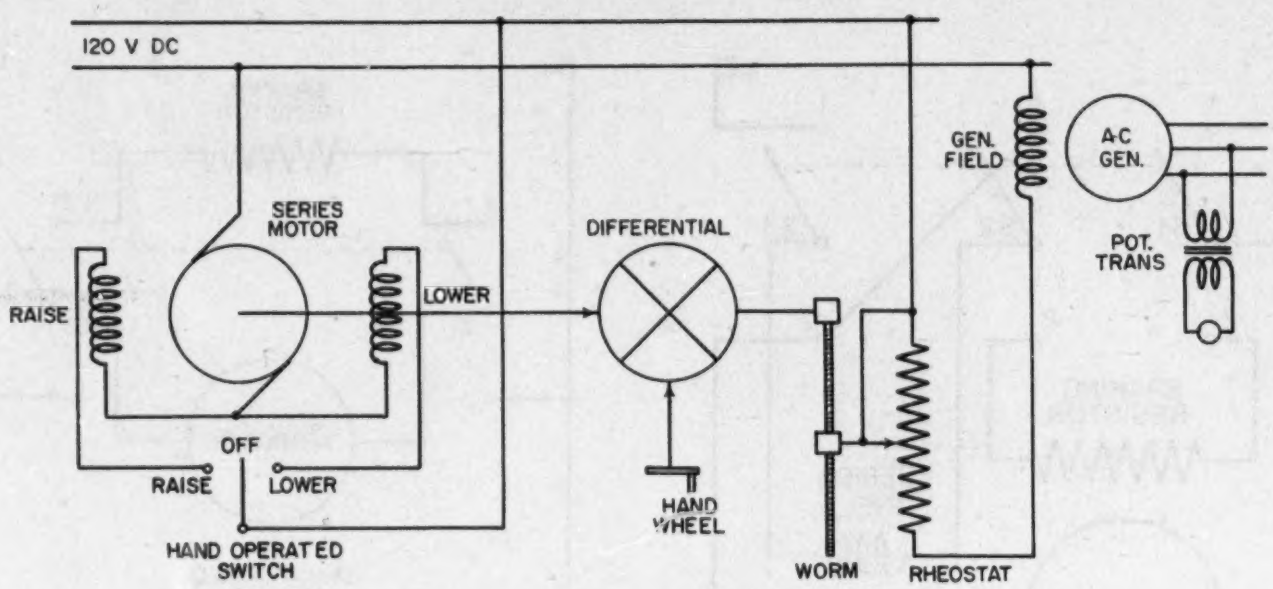

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Figure 9-25.—Connections for a motor-driven rheostat used to control generator field voltage.

ELECTRIC BRAKES

Electric brakes find their widest shipboard application on hoisting and lowering equipment where the ability to stop the motor quickly is important. Electrically operated brakes are extensively used for that purpose. Brakes are also needed to hold the load at rest after it has been stopped.

D-C BRAKES

Brake systems used with d-c motors are divided into two groups; dynamic and magnetic. The dynamic brakes use electrical principles, and the magnetic brakes use a combination of mechanical and electrical principles.

Dynamic

Dynamic braking may be compared to the use of an auto engine to slow a car going down hill. As you may know, pressure is generated by the compression, which acts as a brake. This comparison is possible because a d-c motor, if its field remains excited while it is being driven by a load, will act as a generator and return power to the line. The generator action holds the load.

However, in an actual system that uses dynamic braking with a series d-c motor, the motor is disconnected from the line, and its armature and field are connected in series with a resistor to form a loop. The field connections to the armature are reversed so that the armature counter-voltage will maintain the field with its original polarity.

Figure 9-26 shows the connections used for dynamic braking of a series wound d-c motor. The field switching is done by switches S1, S2, and S3. The three switches are part of a 3PDT assembly and are magnetically operated from a controller described later in this chapter.

With the switch arms in position 1, the motor operates from the line. When the switch arms are in position 2, the resistor is connected in series with the field, and, at the same time, the field coil connection to the armature is reversed. Thus, as long as the armature turns, it will generate a counter-voltage, which will force current through the resistor and the series field. Although the direction of current flow through the armature is reversed (because of the counter-voltage), the direction through the series field coil is the same as it was when operating as a motor. When operating in this manner, the machine is essentially a generator that is being driven by the momentum of the armature and mechanical load. This energy is

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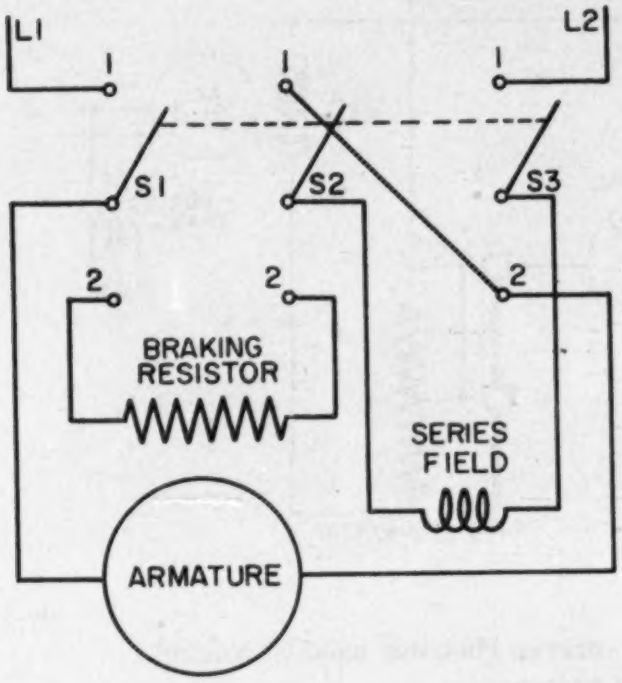

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Figure 9-26.—Connections for dynamic braking of a series-wound d-c motor.

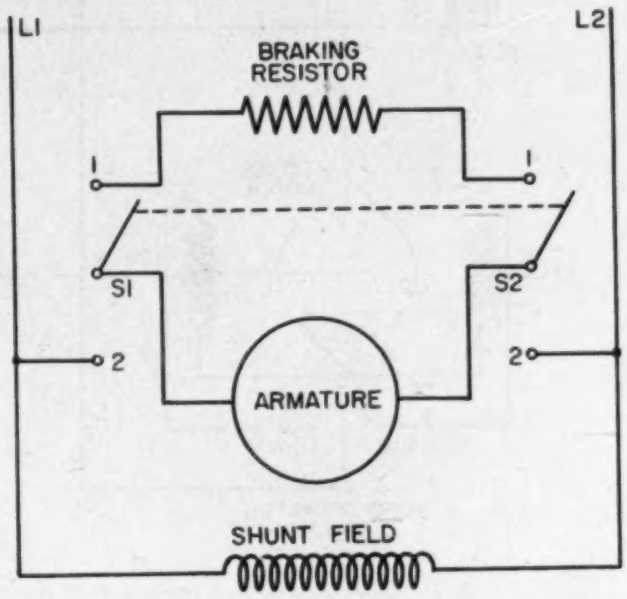

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Figure 9-27.—Connections for dynamic braking of a shunt-wound d-c motor.

quickly consumed in forcing current through the resistor, and the armature stops turning.

The time required to stop the motor may be varied by using different resistor values. The lower the resistance, the faster the braking action. If two or more resistors are connected by switches, the braking action can be varied by switching in different load resistors. Usually, the same braking resistors that are used to stop the motor are also used to reduce the line voltage during acceleration. This feature has been omitted on the drawing for simplification.

When dynamic braking is used with a d-c shunt-type motor, resistance is connected across the armature (fig. 9-27).

Switches, S1 and S2, are parts of a DPDT circuit breaker assembly. When the switch arms are connected to position 2, the armature is across the line, and motor operation is obtained. When the switch arms are in position 1, the armature is disconnected from the line and connected to the resistor. The shunt field remains connected to the line. As the armature turns, it generates a counter-voltage, which forces current through the resistor. The remainder of the action is the same as described for the circuit in figure 9-26.

Although dynamic braking provides an effective means of slowing motors, it is not effective when the field excitation fails or when an attempt is made to hold heavy loads; without rotation the counter-voltage is zero, and no braking reaction can exist between the armature and the field.

Magnetic

Magnetic brakes are used for complete braking protection. In the event of field excitation failure, they will hold heavy loads. The essential parts of a d-c magnetic brake system are the brake shoes or bands, the brake wheel or drum, the electromagnet, spring mechanism, and mounting frame. The spring applies the brakes, and the electromagnet releases them.

Disc brakes are arranged for mounting directly to the motor end bell. The brake lining is riveted to a steel disc, which is supported by a hub keyed to the motor shaft. The disc rotates with the motor shaft.

The band type brake has the friction material fastened to a band of steel, which encircles the wheel or drum and may cover as much as 90 percent of the wheel surface. Less braking pressure is required and there is less wear on the brake lining when the braking surface is large.

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D-c brakes are operated by a solenoid which may be wound for either shunt or series connection to the line. Shunt coils are wound with a large number of turns of small wire, and series coils are wound with a small number of turns of large wire.

Normally, magnetic brakes with shunt coils do not release as fast as those with series coils. This is due to the increased inductance, L, of a shunt coil. When the shunt coil is deenergized, the collapsing field of the magnet induces a voltage in the coil, which holds the relay armature for a short time after the magnet is deenergized. Coils are wound to operate at a voltage that is lower than the line voltage to speed up the operation of a shunt type magnet. With lower voltage coils, fewer turns are required and this lowers the ratio of inductance to resistance. A resistance is used in series with the coil to drop the line voltage and prevent damage to the brake coil. Usually, the coil is wound to operate on one-half the normal line voltage, but to get extremely fast release, it may be designed to operate on voltages as low as one-tenth the normal line voltage.

Series brake coils have advantages over shunt coils. They are faster in operation because they have less inductance, are wound with heavy wire (not likely to burn out), and, because the voltage per turn is low, the insulation is not likely to break down. In addition, these coils are in series with the motor armature, and if the armature circuit opens, the brake will set. However, if the load varies over a considerable range, the armature current may not always be large enough to keep the brake released. In this case, a shunt coil is preferred. Series brakes are not in general use on naval ships.

As previously mentioned, magnetic brakes are applied when the coil is not energized. A spring or weight holds the band, disc, or shoes against the wheel or drum. When the coil is energized, the armature or solenoid plunger overcomes the spring tension and releases the brake.

A magnetic brake assembly with the various parts labeled is illustrated in figure 9-28. When the coil is energized, two armatures are pulled horizontally into the coil. The armatures are mechanically linked to the levers. The levers pivot on the pins. When the magnetic pull overcomes the pressure of the coil springs, the pressure of the brake shoes on the drum releases and allows it to turn. The drum is mechanically coupled to the motor shaft or the shaft of the device driven by the motor. The coil is connected to the voltage supply lines. The method of connecting the coil (series or parallel) is determined by the coil design.

A-C BRAKES

Brake systems used on a-c equipment perform the same work as those used on d-c systems. However, there are differences in brake construction.

Solenoid

The a-c solenoid brake is designed the same as the d-c brake (fig. 9-28), except that the brake frame and solenoid are of laminated construction to reduce eddy currents. Because the magnetic flux passes through zero twice each cycle, the magnet pull is not constant. To overcome this, shading coils are used to provide pull during the change of direction of the main flux. However, even with shading coils it is difficult to design a solenoid that is completely free from vibration and quiet in operation.

The principal disadvantage of an a-c solenoid is that it draws a heavy current when voltage is first applied. This effect is caused by the large air gap that exists before the solenoid is energized. With a large air gap, the flux density and inductive reactance, X_L, are low. Because the current is limited principally by the X_L ohms of the coil, the inrush current is high as the air gap closes. When the solenoid is operated, the flux density and X_L ohms increase, thereby lowering the current to the operating value. In general, a-c solenoids are used only for small brake applications. It is possible, however, to use polyphase solenoids to brake larger motors.

Torque Motor

The torque motor brake uses a specially wound polyphase squirrel-cage motor in place of the brake release solenoids. The motor may be stalled without injury to the winding and without drawing heavy currents. The mechanical arrangement of a torque-motor brake assembly and the ball-jack assembly are given in figure 9-29.

The mechanical connection between the torque-motor shaft and the brake operating

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winding. The current flowing through the control windings of the saturable reactor assembly determines the amount of output signal developed.

The center winding or primary of the saturable reactor assembly is excited by 115 volts a.c. The coupling from the primary to the output or secondary windings is controlled by the conduction through the control windings. The control winding with the least current flow allows the greatest coupling from primary to secondary. The output windings are wound in series opposing. Capacitors C9 and C10 serve to filter the a-c component and give a fairly constant current flow through the control windings.

In the case cited previously, since V2 (B) is conducting the least, the saturation of the bottom section of T2 is less than that of the top section. Under these conditions the voltages developed in the bottom output winding far exceed those developed in the top winding. The polarity of the voltage taken from the output of the saturable assembly will be the same as that from the bottom winding. This voltage is applied to the control winding of the azimuth torque motor.

The rotor of the AZIMUTH TORQUE MOTOR is mechanically connected to the secondaries of the azimuth sweep synchro and the rotor of the azimuth followup synchro. The motor then drives the followup synchro rotor to a new null relationship with the rotor of the transmitting synchro, or zero set synchro, depending upon the position of K2101. One secondary winding of the AZIMUTH SWEEP SYNCHRO (resolver) is connected to the vertical winding of the deflection system, and the other is connected to the horizontal deflection winding.

Refer to figure 17-36 for a descriptive analysis of changes in the azimuth stabilization system when the aircraft heading is changed. With the antenna stopped in the dead ahead position, as shown in (A), an error signal is

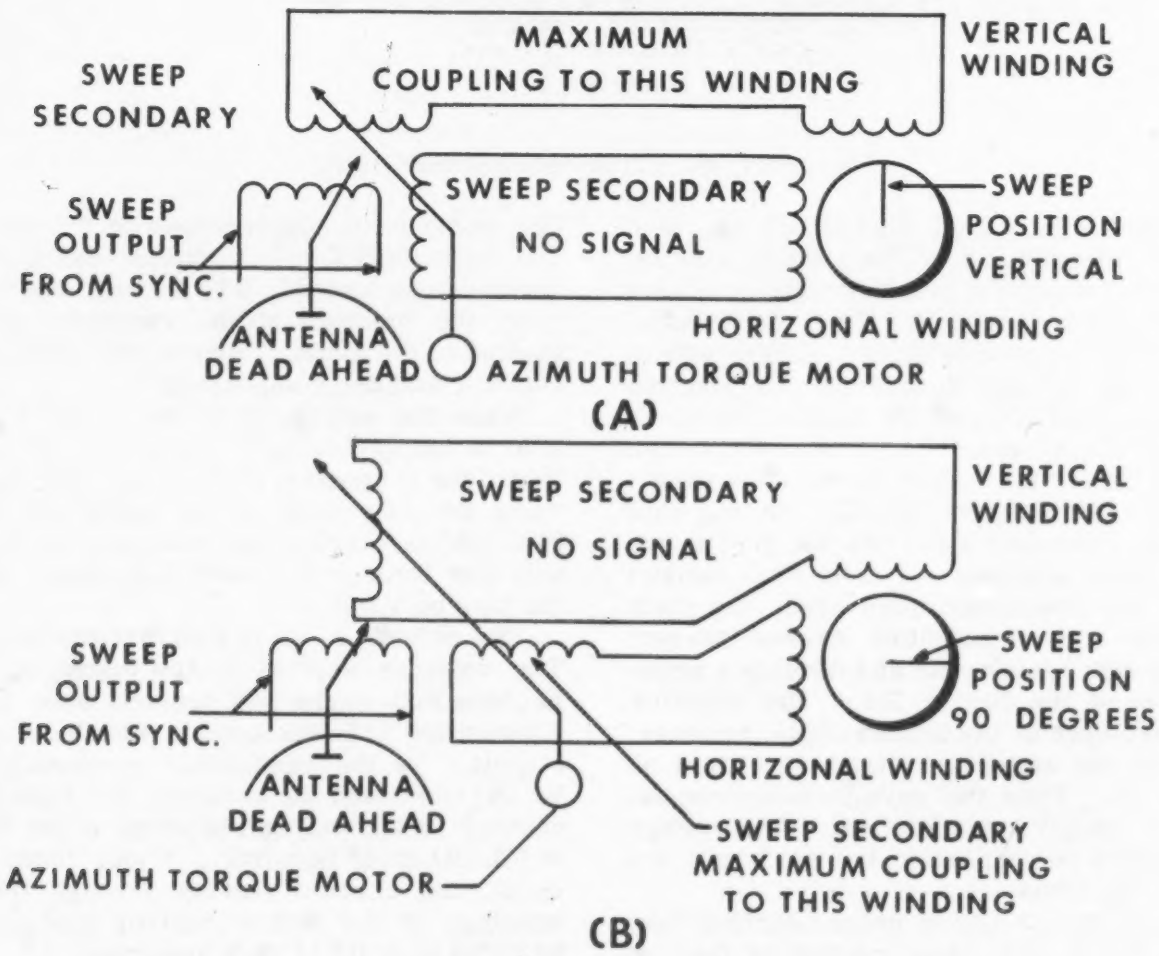

Figure 17-36. —Analysis of changes in an azimuth stabilization system.

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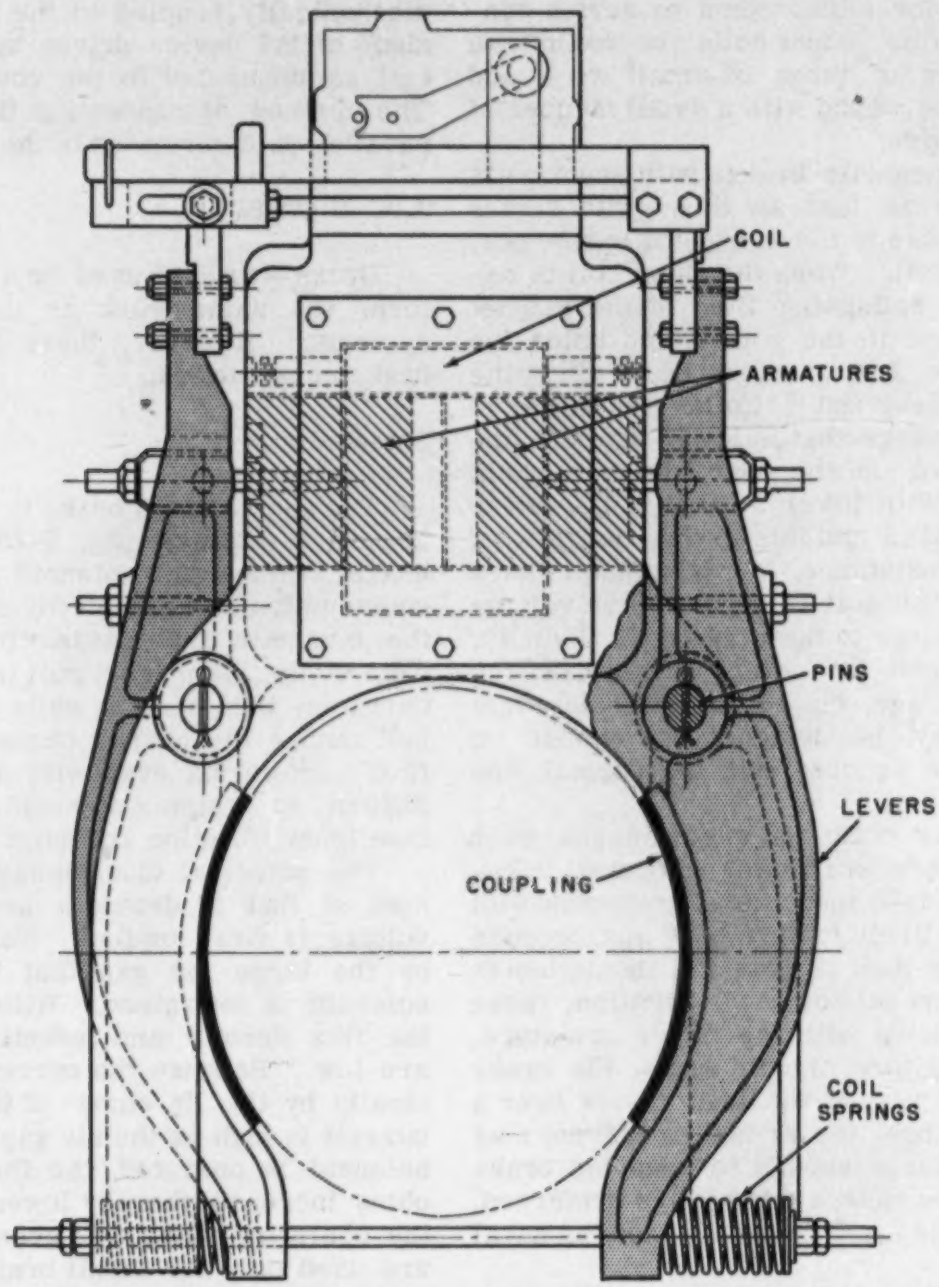

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Figure 9-28.—Magnetic brake assembly.

lever is through a device called a "ball jack" (fig. 9-29B), which converts the rotary motion of the torque-motor shaft to a straight line motion.

When power is applied to the torque motor, the shaft turns in a clockwise direction. The thrust element ① in the jack pushes against the operating lever ② in figure 9-29A, and the upward movement of the jack screw ③ (fig. 9-29B) moves the operating lever to release the brake. As soon as the brake is fully released, the torque motor stalls across the line. This holds pressure against the spring ④ in figure 9-29A, and keeps the brake released.

When the voltage supply to the torque motor is opened, the torque spring forces the brake shoes against the brake wheel. This stops and holds the motor shaft.

The torque motor brake can be released manually by raising lever ②. However, if the

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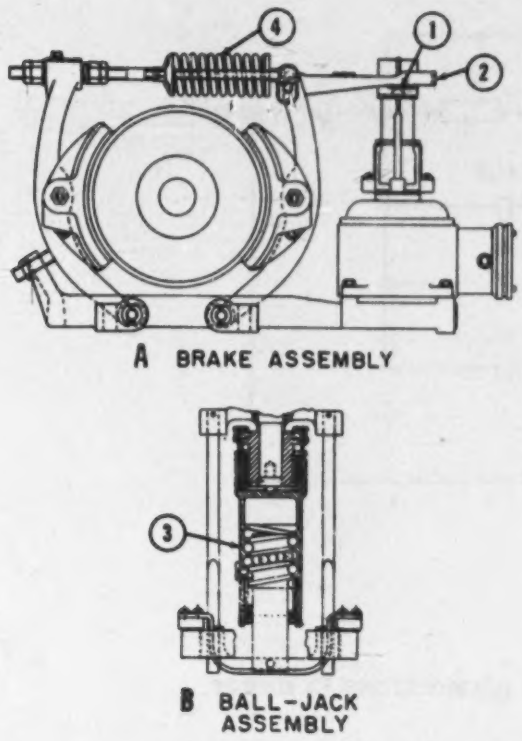

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Figure 9-29.—Torque-motor brake and ball jack assembly.

lever is not held manually in the UP position, the brake will be applied.

DISC BRAKES

The disc brake is arranged for mounting directly to the motor end bell. The brake lining is riveted to a steel disc, which is supported by a hub keyed to the motor shaft. The disc rotates with the motor. When the brake is set, a spring pulls a stationary steel member into contact with the rotating disc. Although brakes have been built with a number of discs, the use of more than one disc increases the chance of the brake's dragging when it is released.

MOTOR CONTROLLERS

A motor controller is a control device or group of control devices designed to control the operation of the motor to which it is connected. Motor controllers may have different enclosures as required by the location, atmospheric conditions, or presence of explosive vapors or liquids in the vicinity of the controller. Motor controller enclosures may be open, dripproof, spraytight, watertight, submersible, or explosionproof. The open type of motor controllers are found primarily on older auxiliary ships where they are used to control the numerous deck winches. In some installations several open type controllers may be grouped together in one space, such as all the winch controllers for one cargo hold.

The other types of controller enclosures are found on all types of ships. The more common forms of protection provided by motor controllers are low voltage protection, low voltage release, low voltage release effect, overload protection, short circuit protection, full field protection, and jamming (step back) protection.

D-C CONTROLLERS

Because of the inherent characteristics of a-c and d-c motors, d-c motors require different controls than do a-c motors. Except for small motors or motors of special design, direct current motors are not started on full line voltage.

D-c controllers insert a resistance in series with the motor armature during the starting cycle to cut down the heavy initial current that would flow in the absence of armature counter-voltage (CEMF). As the motor accelerates, the resistance is taken out of the armature circuit, and, at normal speed, the motor operates directly across the line. A d-c motor and controls are illustrated in figure 9-30, the sequence of controller operation is as follows.

When the START button is pressed, the path for current is from line terminal L2 through the STOP button, the START button, and the line contactor coil LC to line terminal L1. Current flowing through the line contactor coil LC causes the contactor armature to pull in and close the line contacts, LC1, LC2, LC3, and LC4.

When contacts LC1 and LC2 close, motor-starting current flows through the series field, the armature, A, the series relay coil, SR, the starting resistor, R, and the overload relay coil, OL. At the same time, the shunt field winding, SH, is connected across the line and establishes normal shunt field strength. When contacts LC3 close they prepare the circuit for the accelerating contactor coil, AC. Contacts LC4 close the holding circuit for the line contactor coil, LC.

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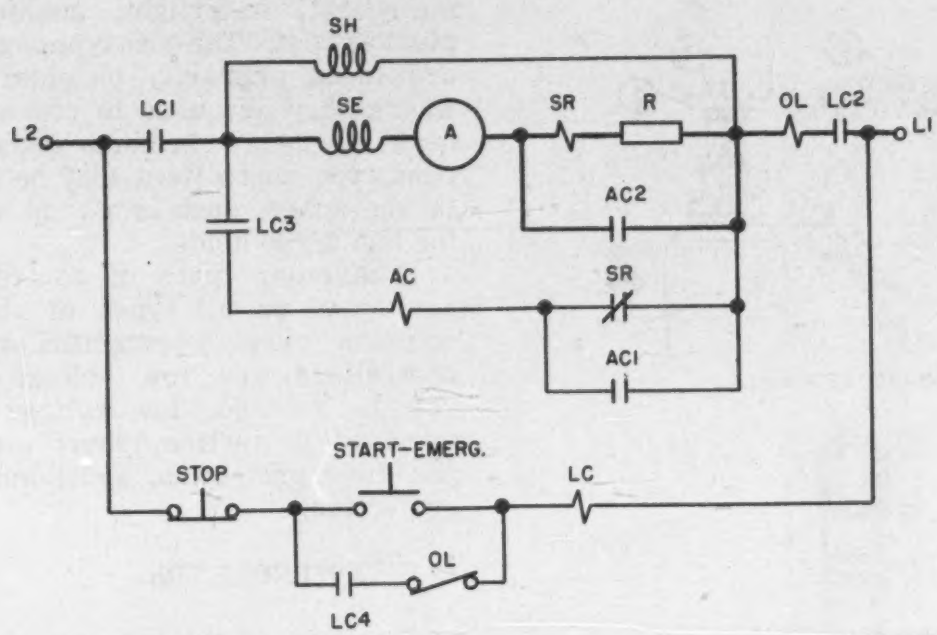

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Figure 9-30.—Schematic of d-c control connections to motor.

The armature current flowing through the series relay coil (SR) causes the armature to pull in; opening the normally closed contacts, SR. As the motor speed picks up, the armature current drawn from the line decreases. At approximately 110 percent of normal running current, the series relay current is not enough to hold its armature in; therefore, it drops out and closes its contacts, SR. These contacts are in series with the accelerating relay coil, AC, and cause it to pick up its armature, closing contacts AC1 and AC2.

Auxiliary contacts AC1 on the accelerating relay keep the circuit to the relay coil closed while the main contacts, AC2, short out the starting resistor and the series relay coil. The motor is then connected directly across the line, and the connection will be maintained until the STOP button is pressed.

Controllers for large d-c motors have two or more stages of acceleration. These stages may employ series-lockout contactors of the type discussed previously (figs. 9-17 and 9-18).

Reversing

In certain installations it is necessary to reverse the direction in which a motor rotates. In a d-c motor this is accomplished by reversing the connections of the armature with respect to the field. The reversal of connections can be done in the motor controller by adding two electrically and mechanically interlocked contactors.

A motor reversing connection is shown in figure 9-31. Note that there are two START buttons—one marked, START EMERG FORWARD and the other marked, START EMERG REVERSE. These buttons serve as master switches; and the desired motor rotation is obtained by pressing the proper button. Either (START-EMERG) button is used as a start switch by momentarily pressing it. The same button is also used as the emergency run button by holding it in the closed position, which bypasses the overload contacts, OL.

With the exception of manual controllers the emergency run feature, holding the start button in to shunt the OL contacts, is not included on auxiliary equipment aboard ships built since 1948. In newer construction certain essential equipments have emergency run features but in a different form.

In some cases the emergency run feature is obtained by holding in the overload trip reset pushbutton during emergency operation. Regardless of the type of emergency run feature, a motor should never be operated by the emergency run button except when an actual emergency exists. When operating under an

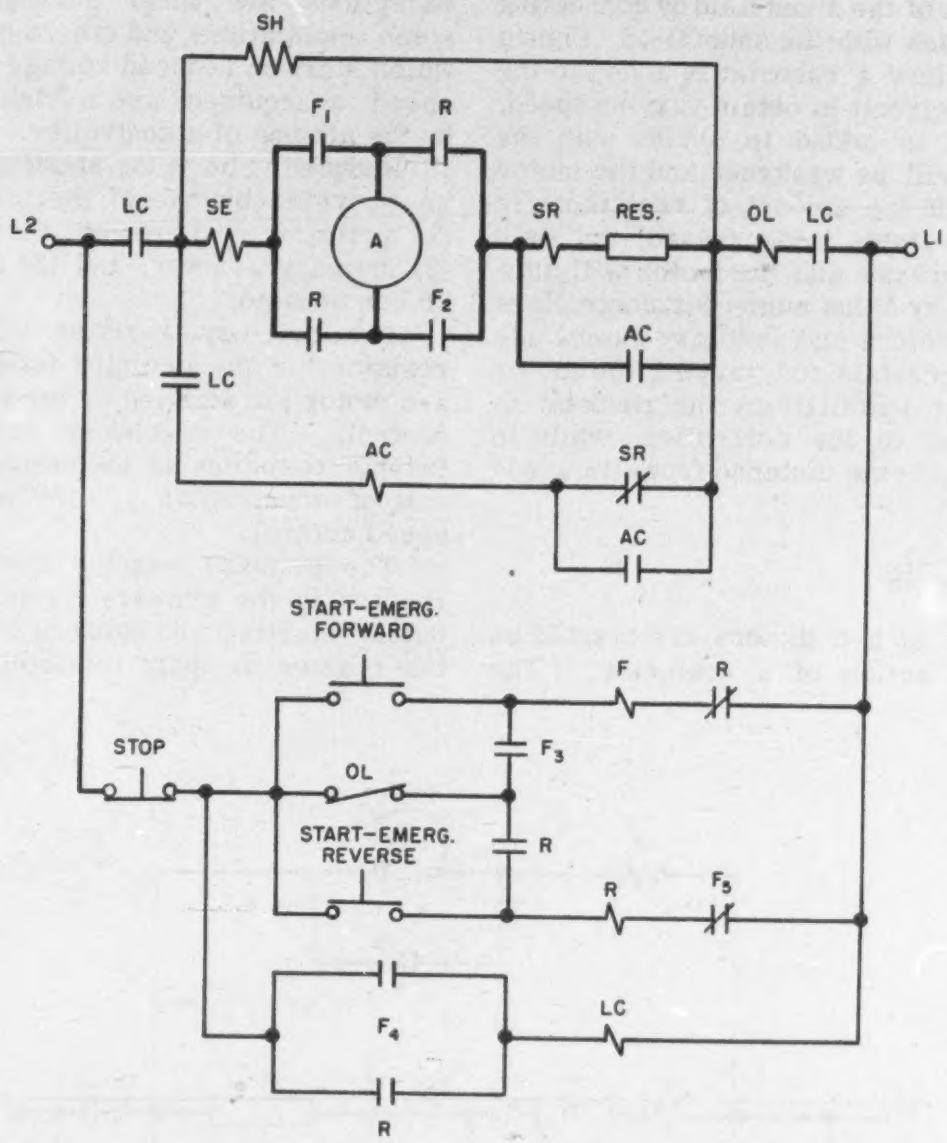

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Figure 9-31.—Motor reversing connections

emergency condition there is great danger of damage to the motor, cables, and controller. Using figure 9-31, it is easy to see the reversal of the armature connections as explained in the following paragraph.

Assuming that the FORWARD button has been pressed, the line voltage will be applied through the button to the forward contactor coil (F) which pulls in its armature and closes its normally open contacts in the motor armature circuit (F1, and F2), the forward contactor holding circuit (F3), the line contactor operating circuit (F4), and opens its normally closed contacts (F5) in the reverse contactor circuit. The normally closed contacts (F5) are an electrical interlock. With the forward contactor operated, the reverse contactor cannot be energized. After the line contactor is energized, acceleration is accomplished in the manner described for the previous starter. Now press the stop button and deenergize all contactors, then press the REVERSE button and go through the circuit in the reverse direction, note the armature circuit reversal as contacts (R) close.

Speed Control

It is often necessary to vary the speed of a d-c motor. One way to accomplish this is to

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vary the strength of the shunt field by connecting a rheostat in series with the shunt field. Figure 9-32 illustrates how a rheostat is added to the basic controller circuit to obtain varying speed.

If resistance is added in series with the field, the field will be weakened and the motor will speed up. If the amount of resistance in series with the field is decreased, the field strength will increase and the motor will slow down. On auxiliary ships numerous controllers for ventilation blowers and auxiliary pumps are equipped with rheostats for varying the motor speed. In some installations the rheostat is mounted adjacent to the controller, while in others it may be some distance from its associated controller.

A-C CONTROLLERS

The majority of a-c motors are started on full voltage by action of a contactor. The exceptions are large horsepower motors in some applications and others of special design, which start on reduced voltage and, after partial speed is acquired, are switched to full voltage by the actions of a controller.

Reduced voltage for starting a-c motors can be provided by one of the following methods; (1) primary resistor or secondary resistor, (2) primary reactor, and (3) auto transformer or compensator.

The primary resistor controller inserts resistors in the primary (stator) circuit of an a-c motor for starting or for starting and speed control. The secondary resistor controller inserts resistors in the secondary (rotor) circuit of wound rotor type motors for starting or speed control.

The primary reactor controller inserts a reactor in the primary circuit of an a-c motor during starting and subsequently short circuits the reactor to apply line voltage to the motor.

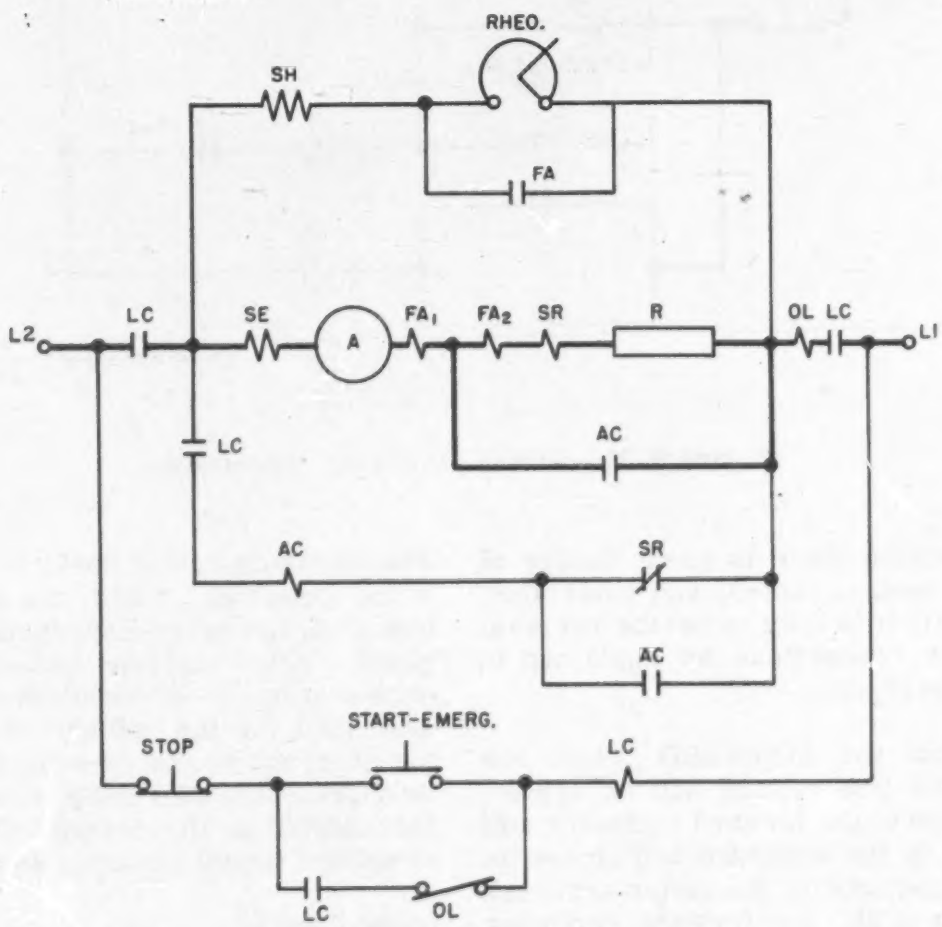

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Figure 9-32.—Field rheostat connected to control motor speed.

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A compensator or autotransformer controller starts the motor at reduced voltage through an autotransformer, and subsequently connects the motor to line voltage after acceleration. The compensator controller may be either the open-transition or closed-transition type. The open-transition type cuts off power to the motor during the transition period of shifting the motor from the autotransformer to direct connection with full line voltage. In the short time when it is disconnected, the motor may coast and slip out of phase with the power supply. When the motor is then connected directly to the line, a high transition current may result. The closed-transition type of controller keeps the motor connected to the power supply at all times during the transition period. In this method the motor does not fall out of phase and therefore there is no high transition current.

A single-phase autotransformer has a tapped winding on a laminated core. Normally, only one coil is used on each core, but it is possible to have two autotransformer coils on the same core.

Figure 9-33 shows the connections for a single-phase autotransformer being used to step down voltage. Part of the winding, that between a and b, is common to both primary and secondary and carries a current that is equal to the difference between the load current and the supply current.

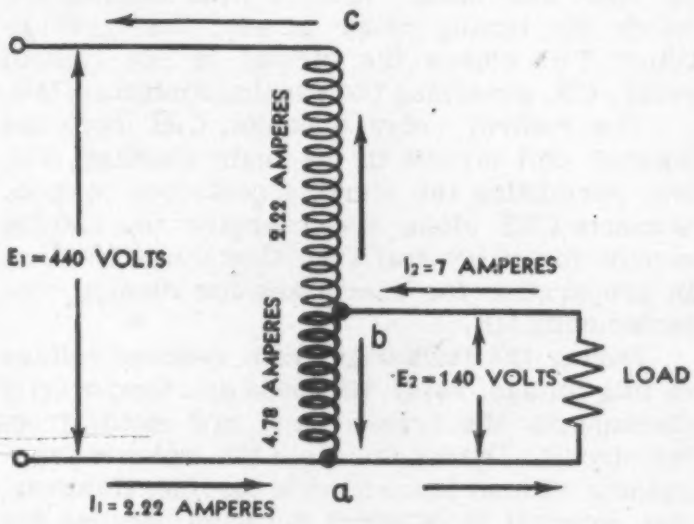

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Figure 9-33.—Single-phase autotransformer.

Any voltage applied to the terminals, a and c, will be uniformly distributed across the winding in proportion to the number of turns. Therefore, any voltage that is less than the source voltage can be obtained by tapping the proper point on the winding between terminals a and c.

One commercially available autotransformer is the Variac and is designed so that a knob-controlled slider makes contact with wires of the winding in order to vary the load voltage.

The positive directions for current flow through the line, transformer winding, and load are shown by the arrows in figure 9-33. Note that the line current is 2.22 amperes and that this current also flows through the part of the winding between b and c. In the part of the winding that is between a and b, the load current of 7 amperes is opposed by the line current of 2.22 amperes. Therefore, the current through this section is equal to the difference between the load current and the line current. If you subtract 2.22 amperes from 7 amperes you will find the secondary current is 4.78 amperes.

Autotransformer Starter

Two common uses for autotransformers are to start 3-phase induction and synchronous motors and to furnish variable voltage for test panels. Figure 9-34 shows an autotransformer motor starter, which incorporates starting and running magnetic contactors, an autotransformer, a thermal overload relay, and a mercury timer to control the duration of the starting cycle.

The autotransformer is a dual unit with separate windings on the outside legs. The windings are connected in open delta to supply reduced voltage to a 3-phase motor during the starting period. Each winding is tapped to provide starting voltages at the motor of 50 percent, 65 percent, or 80 percent of the line voltage. It is possible to change the connections to the transformer taps to get higher or lower starting voltage. It is necessary to select the tap for the desired starting voltage when making the original connections.

A complete schematic diagram of a motor starter using autotransformers as well as other control devices is given in figure 9-35. Because a number of separate controls are shown in schematic form, the action will be traced from the time the START button is pressed.

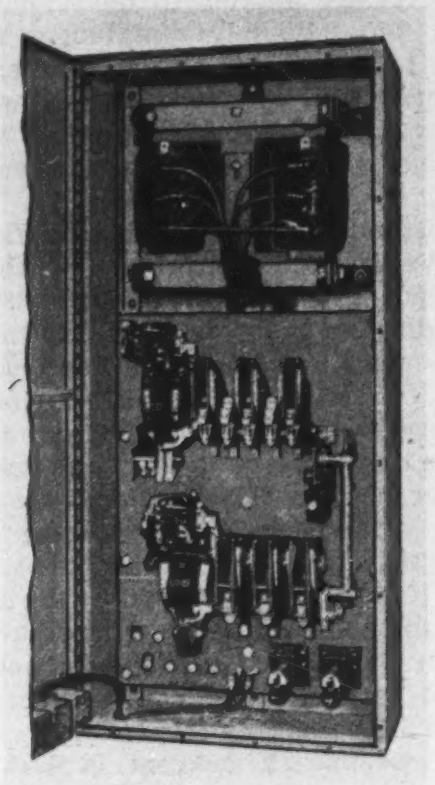

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Figure 9-34.—Autotransformer motor starter.

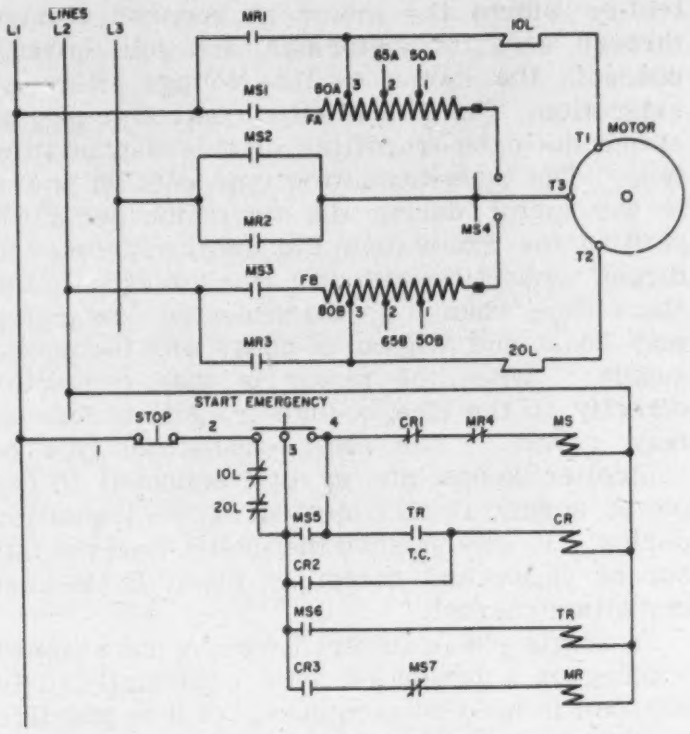

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Figure 9-35.—Schematic of motor starter using autotransformers and other control devices.

This control is a spring-loaded button, which completes the circuit between two contacts.

The START button, when pressed, completes the circuit from L1 and the button contacts through the normally closed contacts CR1 and MR4, and through the starting coil MS to L2. When the starting coil, MS, is energized, it attracts an armature, which operates seven contacts. Four of these contacts (MS1, MS2, MS3, and MS4) connect the autotransformer in open delta across the line.

The fifth contact, MS5, completes the holding circuit to the starting coil. The holding circuit is from L1 through the STOP button, to normally closed contacts 10L and 20L, through contact MS5, to normally closed contacts CR1 and MR4, and then through coil MS to L2.

The sixth contact, MS6, completes the circuit to the timer relay, TR. This circuit path is from L1 through the STOP button, through the normally closed contacts 10L and 20L, through contact MS6, and through the timer relay coil TR to L2.

The seventh contact, MS7, is normally closed, and when relay MS operates, it opens the circuit to the coil of motor running contactor, MR, so that MS7 acts as an electrical interlock. Thus, contact MS7 prevents coil MR from being energized when MS is operated. This action prevents a portion of the autotransformer winding from being short-circuited by contacts MR1 and MS1 or MR3 and MS3. After a time interval for which the timing relay is set, the mercury timer, TR, closes the circuit to the control relay, CR, governing the running contactor, MR.

The control relay contacts, CR1 open the holding coil circuit to the main starting coil, MS, permitting the starting contactor to open. Contacts CR2 close and energize the holding circuit for relay coil CR. Contacts CR3 close in preparation for energizing the running contactor coil, MR.

During the transition from reduced voltage to full voltage, relay MS opens and temporarily disconnects the transformer and motor from the circuit. During this time the motor is free-running with no connection to the line. However, this interval is of short duration because the opening of MS completes the circuit to the main running coil, MR, through the seventh or interlock contact, MS7. The MR coil then closes

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contacts MR1, MR2, and MR3 to connect the motor directly across the line. Electrical interlock MR4 opens to prevent the starting coil, MS, from being energized at the same time that MR is energized.

The starter previously described is an OPEN TRANSITION type because the motor is disconnected from the line during the transition from a low (starting) voltage to line (running) voltage.

Across-The-Line Controllers

Most a-c controllers used aboard ship are across-the-line controllers. Figure 9-36 shows a type of across-the-line controller that is presently being put into service aboard surface ships and submarines. It provides greater resistance to mechanical shock and is smaller in size for the same horsepower than previous models. The contactors (fig. 9-37) are available in five sizes—0 through 4 (designed for 5-10-25-50 and 100 hp). The contactors are essentially similar in appearance but vary in cubical size.

Reversing

Certain equipment, such as elevators, lathes, and hoists, requires a driving motor that can be reversed. It has been explained how d-c motor armature rotation may be changed by reversing the connections to either the field or armature winding. The reversal of an a-c (3-phase) induction motor is accomplished by interchanging any two of the three leads to the motor. The connections for an a-c reversing-type controller are illustrated in figure 9-38. The STOP, REVERSE, and FORWARD pushbutton

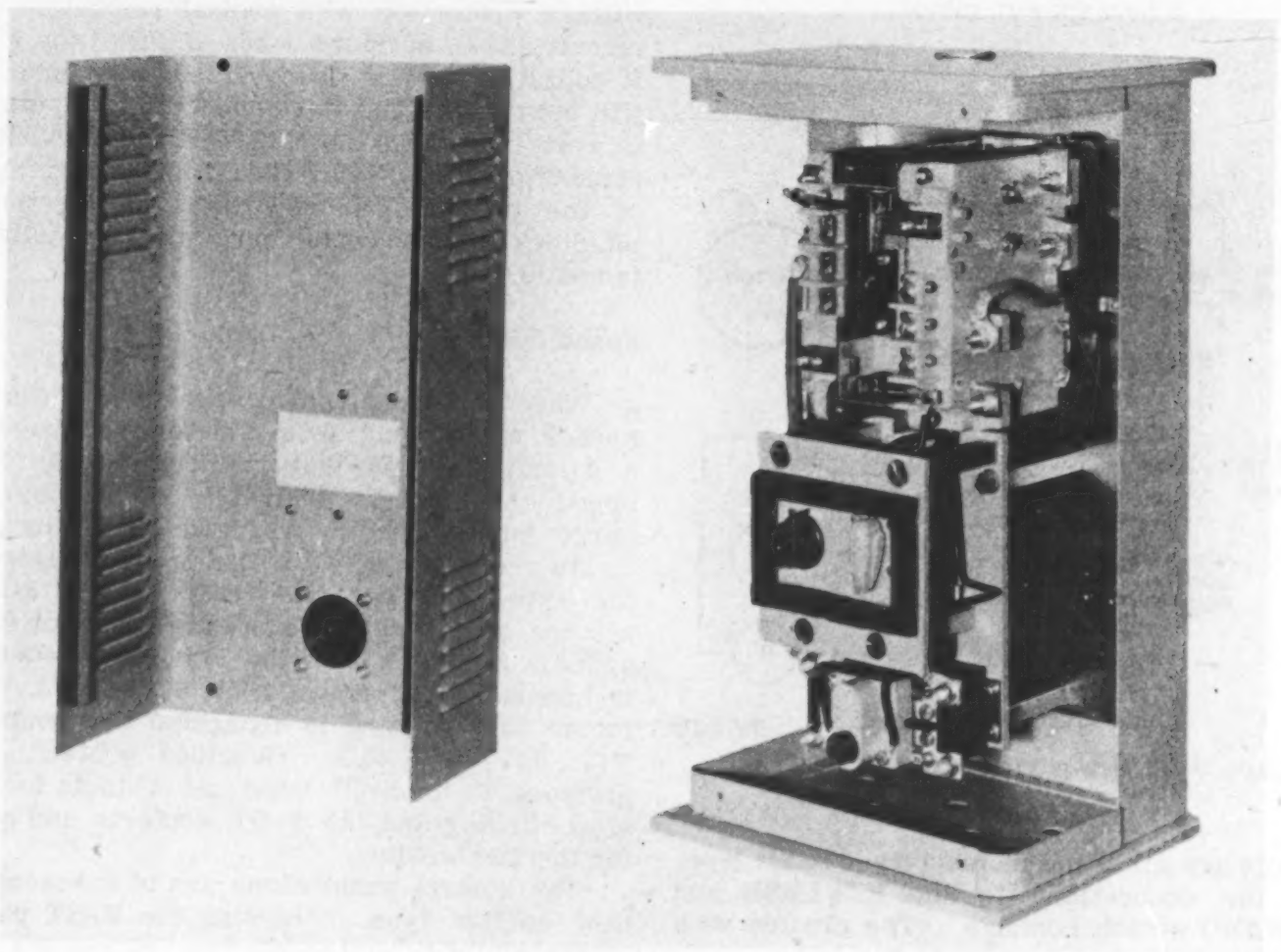

Courtesy of Cutler-Hammer Inc.

Figure 9-36.—A-c magnetic controller. 77.146X

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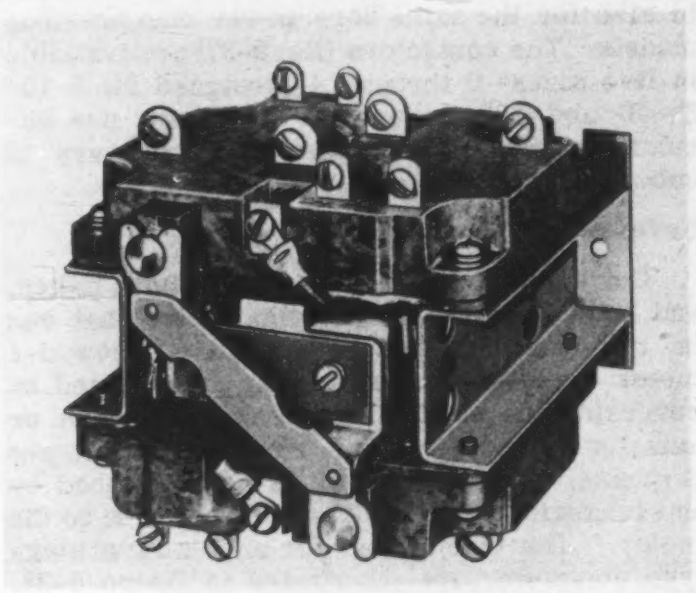

Courtesy of Cutler-Hammer Inc.

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Figure 9-37.—Size O contactor for 5 horsepower motor.

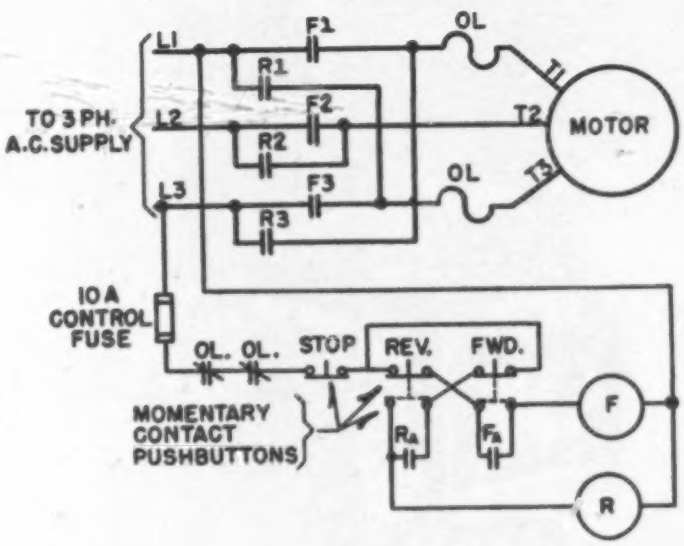

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Figure 9-38.—A-c reversing controller.

controls are all of the momentary-contact type. Note the connections to the REVERSE and FORWARD switch contacts. The circles with F and R inside represent contactor coils.

If the FORWARD pushbutton is pressed (solid to dotted position), coil F will be energized and will close its holding contacts, FA. These contacts will remain closed as long as coil F is energized. When the coil is energized, it closes line contacts F1, F2, and F3, which applies full line voltage to the motor. The motor then runs in a forward direction until the voltage supply is interrupted.

If either the STOP button or the REVERSE button are pressed, the circuit to the F contactor coil will be broken and the coil will release and open line contacts F1, F2, F3, and holding contact FA.

If the REVERSE pushbutton is pressed (solid to dotted position) coil R will be energized and will close holding contacts RA and line contacts R1, R2, and R3. Note that R contacts reverse the connections of lines 1 and 3 to motor terminals T1 and T3. This causes the motor rotor to rotate in the reverse direction. The F and R contactors are mechanically interlocked to prevent both being closed at the same time.

Momentary contact pushbuttons provide low voltage protection with manual restart in the circuit shown in figure 9-38. If either the F or R operating coil is deenergized, the contactor will not reclose and start the motor when voltage is restored unless the FORWARD or REVERSE pushbutton is pressed. The circuit arrangement of the pushbuttons constitutes an electrical interlock that prevents energizing both coils at the same time.

Speed Control

When it is desired to operate at different speeds while using an a-c motor, you may use a circuit such as that in figure 9-39. Two speed operation is desirable for anchor and cargo hoists, ventilators, and deck winches.

An a-c inductor motor that has been designed for two-speed operation may have a single winding or two separate windings, one for each speed. In figure 9-39 the motor slow winding is connected to terminals T1, T2, and T3. The motor fast winding is connected to terminals T11, T12, and T13. Overload protection is provided by the S-OL coils and contacts for the slow winding and the F-OL contacts and coils for the fast winding.

The control pushbuttons are of the momentary contact type. Pressing the FAST pushbutton (solid to dotted position) closes the fast contactor by energing coil F. This coil remains energized, after the pushbutton is released, through holding contacts FA. The coil, F,

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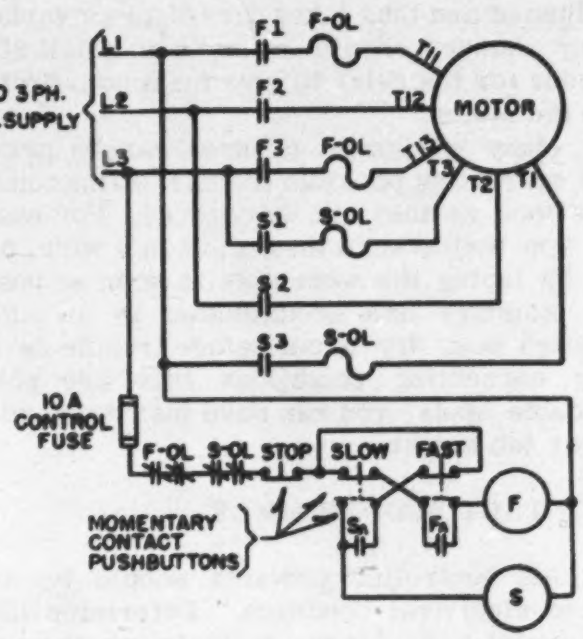

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Figure 9-39.—Speed control circuit for an a-c motor.

closes main-line contacts F1, F2, and F3, which apply full line voltage to the motor fast winding. The motor will then run at fast speed until coil F is deenergized.

Pressing the SLOW pushbutton closes the slow contactor by energizing coil S. The coil remains energized, after the button is released, through holding contacts SA. The coil, S, closes main-line contacts S1, S2, and S3, which apply full line voltage to the motor slow winding. The motor will then run at slow speed until coil S is deenergized. The F and S contactors are mechanically interlocked to prevent both being closed at the same time.

CONTROLLER MAINTENANCE AND TROUBLESHOOTING

To ensure proper mechanical operation and to decrease the possibility of failure at critical times, keep the motor control equipment clean.

On ships that have the 3-M System in effect, controller maintenance is a scheduled routine. However, since all ships do not as yet have the 3-M System installed, the following maintenance coverage is given.

The first step in an adequate maintenance program should be a thorough inspection of the equipment after it is installed and before it is operated electrically. An inspection of this type should include cables, connections, fuses, and equipment mountings. All oil and grease fittings should be checked to make sure the equipment has been lubricated.

Most motor control equipment failures are due to mechanical faults, not to electrical troubles. Dirty equipment, improperly placed parts, and parts that bind or stick are all basic mechanical faults that can cause coil burnouts, welded contacts, and circuit overloads.

The presence of foreign material will cause binding of latches, plungers, armatures, and lever mechanisms, which, in turn, will lead to coil burnouts, contact burnouts, short circuits between phases, and other electrical failures. The foreign material may be dust, dirt, gum, filings, grease, moisture, and rust or corrosion. A regular cleaning schedule should be followed to ensure dependable operation.

Slow making and breaking of the load circuit may be caused by binding of the armature, plunger, or lever mechanism. To eliminate this condition, remove rust, gum, and filings from the shafts, bearings, or guides. Shafts and bearings should be lubricated with two drops of light oil (S.A.E. 10) semiannually.

Insulation breakdowns are often caused by metal filings or excessive moisture. Short circuits across insulating barriers, grounded circuits, and high voltage breakdowns can often be avoided by regular cleaning.

The ability to make a fast analysis of conditions when faults develop is not acquired overnight. You must study individual circuit controls and then determine which part of section could, if defective, cause the trouble.

In simple circuits where the control is a simple make and break contact arrangement, motor stoppage could be due to a lack of voltage (generator failure, or an open or shorted supply line), a defective contactor (not closing or broken), or a defective motor.

Simple voltage tests at the controller input and output terminals will show if voltage is available from the line and if the contacts are in good condition. Of course, the contacts must be closed when the output terminal test is made. Voltage present at the controller output indicates that the power source is working and that the contactor is closing the circuit. These two possible trouble spots are therefore eliminated. The remaining possible trouble spots are the leads between the controller and the motor. A

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applied to the true bearing amplifier which causes the azimuth torque motor to turn. The sweep secondaries are then driven in a direction corresponding to the change in the transmitting synchro rotor, as shown in (B). When the aircraft changes its heading, the sweep position on the PPI-scope will change accordingly.

TILT STABILIZATION

The purpose of TILT STABILIZATION is to stabilize the tilt angle of the antenna of a radar system with respect to the earth. If the antenna is left unstabilized, when the aircraft changes its flight angle the antenna follows this change. If the antenna is dead ahead with respect to the aircraft and the plane begins a climb, the antenna will point up, thus losing targets. If, on the other hand, the antenna is pointing to port or starboard and the aircraft rolls to either side, the target returns will again be lost. If the antenna is stabilized with respect to the earth then the target loss, due to changes in the attitude of the aircraft, will be minimized. For example, assume that the antenna is pointing dead ahead in relation to the aircraft and the aircraft goes into a climb; if the antenna is stabilized, it will tilt down and maintain a constant angle with respect to the earth. The same holds true if the antenna is pointing to port or starboard and the aircraft is rolling; the antenna will tilt up or down, maintaining the constant reference with respect to the plane of the earth.

The stabilization range of the radar set which will be used for this explanation is such that if the TILT control is set for 0 the beam is maintained at this angle for aircraft pitch or roll up to plus 30° or minus 30°. If the TILT control is set for other beam angles, these limits vary accordingly.

The tilt stabilization system consists of a gyroscope, servoamplifier, resolver synchro, manual-tilt synchro, tilt-torque motor, damping-signal generator, and the followup synchro. (A diagram of this system is shown in figure 17-37.) The gyroscope unit is separately mounted on the aircraft structure, and the resolver synchro and the servoamplifier are mounted on the antenna-assembly frame. The tilt-torque motor, damping-signal generator, and followup synchro are contained in the tilt-servo unit mounted on the rotary section of the antenna assembly. The manual-tilt synchro is mounted in the radar set control box.

Stabilization is effected by the use of two signals, the resolver-synchro signal and the manual-tilt synchro signal. Separate pitch and roll signals originating in the gyroscope unit are combined in the resolver synchro to produce the single resolver-synchro signal. The manual-tilt synchro signal originates in the followup synchro and provides the tilt stabilization system with continuous information as to the tilt angle of the reflector. This signal passes through the manual-tilt synchro in the radar set control box where it is modified according to the setting of the TILT control. The resolver-synchro signal and the manual-tilt synchro signal, which differ in phase by 180°, are combined at the input of the servoamplifier, and the amplifier resultant, or error signal, is used to control the tilt-torque-motor in correcting the tilt angle of the reflector.

Gyroscope Unit

The gyroscope unit contains the gyro, with its drive motor, erecting mechanism, motor-driven caging and uncaging mechanism, and two synchros. The gyro, powered by a 26-volt, 400-cycle, 3-phase induction motor, establishes true vertical. The caging and uncaging mechanism is electrically operated, and is manually controlled by the GYRO switch on the radar set control. When caged, the gyro is clamped in an approximately vertical position with respect to its housing. CAGING OF THE GYRO prevents it from being damaged when the aircraft is engaged in maneuvers involving pitch or roll in excess of 60°. The gyro develops a normal operating speed of 18,500 rpm; when it is UNCAGED, the rolling-ball type ERECTING mechanism brings the gyro to true vertical and maintains it in this position. The gyro should be uncaged when in use and caged when the equipment is turned off. Although the GYRO switch may be in the UNCAGE position, the gyro is automatically caged when the POWER switch is turned off. After the equipment is turned on, the gyro remains caged during the warmup period of approximately 3 minutes, after which time the operation of the caging mechanism is dependent upon the position of the GYRO switch. The schematic diagram of the gyroscope unit is shown in figure 17-38.

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measurement for voltage at the motor terminals will show the condition of the leads. If voltage is present at the motor terminals and the motor does not run, the motor must be defective. As you gain experience in troubleshooting, you will develop your own testing techniques.

No matter how complex a complete circuit may appear, each individual section can be broken down into three parts: the source of voltage; the load (motor, relay coil, or other device); and the wires between the source and the load. Make it a habit to trace circuits when you encounter them. Start at one of the voltage supply terminals and then trace through the circuit or diagram to the other terminal. Once you are able to trace a circuit through on a diagram, you will find it easier to trace actual wiring. Eventually, you will find yourself forming a mental picture of a schematic diagram as you trace wiring. However, it takes a great deal of practice so don't become discouraged if you cannot trace a circuit the first time you try. You should find Blueprint Reading and Sketching, NavPers 10077 (revised), helpful.

There are times when a motor will fail to start and no signs of trouble will be readily apparent. In such cases, operate the overload reset button and again press the start button. Listen for the sound of the main contactor closing. If there are no results, press the stop button and check to determine if power is available at the input terminals of the controller. If power is available, the trouble is in the section from the controller input to the contact operating means (relay coil or leads). If no power is available, check the supply line and the associated fuses.

If the motor stopped because of tripping of the overload relay, and the relay tripped again after being reset, some possible causes of the overload are:

1. Jammed machinery (frozen bearings or foreign material in gears).
2. Overheated or stiff bearings in motor or motor-driven device.
3. Blown fuse in the supply circuit, causing single phasing of a 3-phase supply.

If no apparent cause for overload tripping can be found, the motor current should be carefully checked with an ammeter and the measured current compared with current value marked on the motor nameplate, the controller or overload relay coil or heater rating, and the current values specified on drawings for the equipment. Many overload relays have an adjustment, which allows the trip settings to be adjusted and thus takes care of minor variations. Any changes should be made in small steps in order for the relay to give maximum protection to the motor.

Many equipment failures can be prevented by correcting possible troublemaking conditions as soon as they are discovered. For example, if you notice worn insulation on a wire, protect it by taping the worn spot as soon as possible. If moisture has accumulated in an outlet or switch box, dry it out before trouble develops. By correcting conditions that are potential trouble spots, you can save lost time and make your job easier.

CONTACT MAINTENANCE

All controller contacts should be kept in good electrical condition. Determine the kind of metal used for the contacts, whether copper or silver, and apply applicable procedures outlined in chapter 8 of this training manual for maintenance of the kind of contact metal in use.

A troubleshooting chart is given in table 9-1. Contact burnouts or overheating of contacts may be due to foreign matter on the contact surfaces. Generally, foreign matter can be removed by using a cloth moistened with an approved cleaner. Where oxides or other corrosions are present, they can be removed by smoothing over the contact surfaces, using a fine file or 00 grade sandpaper.

PERIODIC TESTS AND INSPECTIONS

Controllers for motors and the associated equipment should be inspected monthly. During this inspection you should:

1. Disconnect the device or apparatus from its source of power.
2. Open the cover of the enclosure.
3. Make a visual check for:
   a. Dirt, oil, grease or moisture on component parts on or in the enclosure.
   b. Burned or worn contacts, charred insulation, or varnish extrusions.
   c. Torn gaskets, bent or missing cover bolts, corrosion, or rust.
4. Check manually for:
   a. Bind in plungers, armatures, fingers, levers, and other moving parts.
   b. Loose connections, parts, and cotter pins.

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Table 9-1.—Troubleshooting Chart for Contacts

TROUBLE	CAUSE	CORRECTION
Burnouts	1. Short circuits or grounds*	1. Remove grounds or shorted conditions
	2. Overheating	2. Increase low contact pressure, remove dirt, oil or grease, remove oxides or sulfides
	3. Slow "breaking"	3. Eliminate bind
	4. Low lead dimension	4. Renew contacts
	5. Excessive lead dimension	5. Reduce lead dimension
Excessive Wear	1. Excessive jogging or inching	1. Do not jog or inch controllers unnecessarily
	2. Faulty blowout assembly or arc shield	2. Replace or repair blowout coil, eliminate shorted turns
	3. Excessive overloads*	3. Eliminate cause—check current readings
	4. Slow "breaking"	4. Remove bind of parts
	5. Excessive filing	5. Do not dress or file the contacts unnecessarily
Overheating	1. Oil or grease	1. Remove with methyl chloroform
	2. Copper oxides	2. Remove with a fine file or sandpaper
	3. Low spring pressure	3. Increase pressure or replace spring
	4. Silver sulphides	4. Remove using fine sandpaper or a fine file
	5. Loose contacts	5. Tighten
Welding or Sticking	1. Ground or excessive overload*	1. Eliminate cause—check current readings
	2. High spring pressure	2. Reduce pressure
	3. Low voltage	3. Increase
	4. Slow "making" or bind	4. Remove bind
Excessive Arcing or Sputtering	1. Short circuit or ground	1. Remove grounded or shorted circuit
	2. Binding parts	2. Eliminate bind of parts
	3. Faulty blowout assembly	3. Replace or repair blowout coil, eliminate shorted turns
	4. Excessive lead dimension	4. Reduce to increase contact gap

*WARNING: Short circuits or grounds in the associated equipment necessitate a thorough inspection of the controller, as the contacts may be damaged by these conditions.

5. Check for grounds on both the main circuit and the pilot circuit.

6. If permissible, connect the equipment to a source of power and operate it in a normal manner.

a. Check for proper operation.

b. Check for excessive noise.

7. Shut off the machine and close the cover. Then tighten the cover bolts or screwpins so that the cover is held securely in place.

In addition to regular monthly test inspections, a more complete inspection should be made semiannually. The following tests should be made:

1. Check all contacts for excessive wear, proper dimensions, and proper spring pressure. If necessary, remove contact hoods or arc shields in order to reach the contacts.

2. Clean all parts thoroughly. Disassemble or partially disassemble the device, when necessary, for proper cleaning.

3. Lubricate all shaft bearings with two drops of lightweight (S.A.E. 10) oil. DO NOT LUBRICATE CONTACTS, PLUNGERS, AND

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POLE FACES OR USE EXCESSIVE QUANTITIES OF OIL ON THE SHAFT BEARINGS.

4. Check the mechanical and electrical adjustments of each device. Make any necessary readjustments.

Of course, the regular monthly and semiannual inspections do not eliminate the need for careful observation during the time the equipment is operating and the need to correct conditions that could cause trouble as soon as they are noticed.

During periodic inspections of motor controllers, or at least once a year, the overload relays should be examined to ascertain that they are in good mechanical condition and that there are no loose or missing parts. The size of the overload heaters should be checked to determine that they are of the proper size indicated by the motor nameplate current and heater rating table. Proper allowance should be made for short-time and intermittent duty motors by using undersized coils. Any questionable relays should be checked for proper tripping at the next availability and repaired if necessary. Each relay should be checked for tripping time at 300 percent rated current by a naval shipyard at intervals not exceeding 4 years.

SAFETY PRECAUTIONS

One of the first things a prospective EM should learn is that electricity is potentially a killer! A conductor carrying several hundred volts is no different in appearance that a conductor disconnected from a source of voltage. The lethal voltage that may be present on the wire has no odor and makes no sound. Yet, under certain conditions, it can snuff out your life.

If properly handled, however, electricity is not dangerous. Almost all deaths caused by electric shock could have been prevented if a few simple rules had been followed. Therefore, you should memorize these rules and then ALWAYS FOLLOW THEM.

The first rule is to always assume, until tests prove differently, that all conductors are hot. Do not assume that low voltage circuits (115 volts or less) are not dangerous. A number of shipboard fatalities have been reported due to contact with 115-volt circuits. Shipboard conditions are particularly conducive to shock because of the metal structure of the ship. Also, the body resistance may be low due to perspiration or damp clothing.

Do not lose your sense of caution because you are in a hurry to get the job done. Often taking time to make certain will save time. Except in cases of emergency, never work on an energized circuit. Safety precautions for the special cases are outlined later in this section. All circuits must be considered as energized until a personal check has been made to see that the switch has been opened and tagged and that the circuit has been tested with a voltmeter or voltage tester.

Navy specifications for portable tools require a separate ground wire, which grounds the frame of the tool. Normally, this is taken care of by using a 3-wire cable with a special plug and receptacle. Two of the wires in the cable connect the tool to the line. The third wire, distinctively marked, is connected to the tool frame at one end and to the ground contact of the plug on the other end.

Where grounded receptacles have not been installed or where the tool does not have the internal ground wire connection, the tool should be grounded by obtaining an additional wire and connecting it between the tool frame and the ship's metal structure.

Portable cables should be carefully selected and maintained. They should be of the proper length and cross-sectional area. Spliced portable cables are extremely dangerous and should not be used unless the emergency justifies the risk involved.

Always use a fuse puller when changing fuses. This precaution is necessary because one end of a fuse is hot, and, in some cases, both ends are hot even though the fuse is blown. When a fuse is blown, it should be replaced with a good fuse having the same rated voltage and current capacity.

Extreme care should always be taken to ensure safety for the operator and other personnel when operating switches and circuit breakers. Before closing any circuit breaker or switch, be sure that:

1. The circuit is ready with all equipment connected to it in condition to be energized.
2. Men working on the circuit are clear and are notified that it is to be energized.
3. All circuit protective devices (fuses, circuit breakers, and overload protectors) are in good working condition.
4. Only one hand is used to operate a circuit breaker or switch unless operating

arrangements specifically provide for the use of both hands. Keep the other hand clear because metal parts of the circuit breakers or switches may be at circuit potential.

5. For manually operated knife switches the opening or closing motion is made positively and rapidly.

Live Circuit Precautions

Military necessity may require repair or maintenance work on energized circuits. When this condition exists, extreme precautionary measures MUST BE TAKEN. Such work should be accomplished only by adequately supervised personnel fully aware of the dangers involved. Every precaution should be taken to adequately insulate the person performing the work from ground. In addition the following precautions should be taken:

1. The person doing the work should remove wristwatches, rings, watch or key chains, metal articles, or loose clothing, such as neckties or unbuttoned sleeves which might accidentally catch and throw his body into contact with live parts. All clothing and shoes should be as dry as possible.

2. Ample illumination should be provided.

3. The worker must be insulated from ground by covering nearby metal that he might contact with dry wood, rubber mats, dry canvas, or even several thicknesses of dry paper. Be sure that any material used for insulation has no holes in it and no conducting material imbedded in it.

4. Working metal tools must be covered with insulating rubber tape (not friction tape) as far as practical.

5. Insulating barriers must be provided between the work and any live metal parts immediately adjacent to the work to be done.

6. The work should be accomplished, using one hand only, if possible.

7. If the work permits, rubber gloves should be worn on both hands. If this is not possible, a rubber glove should be worn on the hand not used in handling tools.

8. Men must be stationed at circuit breakers or switches, and telephones must be manned, if necessary, so that the circuit or switchboard can be deenergized immediately in case of emergency.

9. A man qualified in first aid for electric shock should be immediately available while work is being done.

Charged Circuit Precautions

In certain cases, electrical machinery may retain a charge even though it is secured. This charge can be great enough to cause severe shock. Therefore, before touching the terminals or an apparently dead machine, discharge it to ground, using an insulated portable wire or a tool with an insulated handle.

Capacitors used to suppress radio interference and other purposes store electrical energy. Before touching the terminals of a capacitor, which is connected to a deenergized circuit or has been disconnected entirely, short circuit the terminals.

Cleaning and Painting Precautions

Never use toxic materials for cleaning in closed spaces. Carbon tetrachloride is an excellent cleaner, but extremely poisonous and dangerous to use in closed spaces. It is no longer authorized for cleaning purposes and methyl chloroform should be used in its place.

Gasoline, benzine, ether, and other similar flammable fluids should never be used for cleaning electrical equipment even though it has been deenergized. Fumes from these fluids form a highly explosive mixture when mixed with air, and a slight spark can set them off.

Because many cleaning fluids are detrimental to good commutation, they should never be poured or sprayed on commutator surfaces. Instead, any cleaner should be applied with a clean cloth, and the surface should be dried with another cloth.

Paint should never be used to refinish shafts, bearings, guides, sliding parts, magnetic pole faces, ground surfaces, contact members, or phenolic or ceramic parts.

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CHAPTER 10

SMALL CRAFT ELECTRICAL SYSTEMS

Small craft perform an important function in the daily routines of all naval vessels. Underway, they serve as duty life boats and must be ready at all times to operate instantly and efficiently. In port, they must be prepared to perform a variety of tasks, such as transporting stores and liberty parties. On some ships, such as troop transports, small craft are vital to the accomplishment of the ship's mission and the condition of these boats affects the condition of readiness of the ship.

The capability of small craft to carry out these services depends, to a great extent, on the assigned Electrician's Mate, who is responsible for the proper operation and upkeep of the electrical systems installed in these boats.

On certain ships you may be assigned to work on boats and batteries and actually be assigned to the boat shop. The boat shop is normally a part of the A division and in some ships the boat electricians are a part of the A division for work assignment, liberty section assignment, berthing and mustering. Regardless of the type or size of ship you are assigned to, working on the electrical systems of the ship's boats or vehicles is a challenging and rewarding job. And if you do your job well you will attract favorable attention to yourself. But as you probably know however, if the Admiral's Barge doesn't start, or the running lights on the Captain's Gig are inoperative, the boat electriciar will find himself in an embarrassing position.

The electrical systems on various types of small craft and ship's boats are too numerous to cover in detail in a single chapter. The systems covered however, are representative of those found on the majority of ship's boats and small craft. This chapter also gives a brief description on automotive electrical systems, although vehicles assigned to a ship are normally taken to a motor pool at shipyards or naval stations for periodic tuneup and preventive maintenance. While your ship is in a location that has automotive repair facilities, the ship's vehicles are no problem. It is when the vehicles are unloaded at some remote port that troubles seem to start. Therefore, the ship's Electrician's Mates should have a working knowledge of automotive electrical systems as well as of boats and small craft.

The electrical system on a typical small boat consists of the following:

(a) a battery charging generator driven from the propulsion engine.

(b) an engine starting system.

(c) a battery used both for engine starting and for supplying auxiliary loads when the engine is secured.

(d) a control and distribution panel having switches and fuses for the control and protection of circuits to auxiliary loads.

(e) cable for interconnecting the above.

(f) voltage regulator.

Figure 10-1,A shows a typical electrical system for small boats with wood or plastic hulls and a single propulsion engine. Figure 10-1,B is a typical electrical system for small boats with steel hulls and a single propulsion engine.

UNGROUNDED TWO-WIRE, 24-VOLT D-C SYSTEM

The electrical system used on Navy small boats is, generally, a two-wire, ungrounded, 24-volt d-c system. The two-wire system is, of course, a necessity on a nonconducting boat hull of wood or plastic. The steel boat hull, like the automobile chassis, makes a good electrical conductor and permits the use of a single-wire electrical system with a grounded or hull return. There are certain reasons, however, for the use of an ungrounded two-wire

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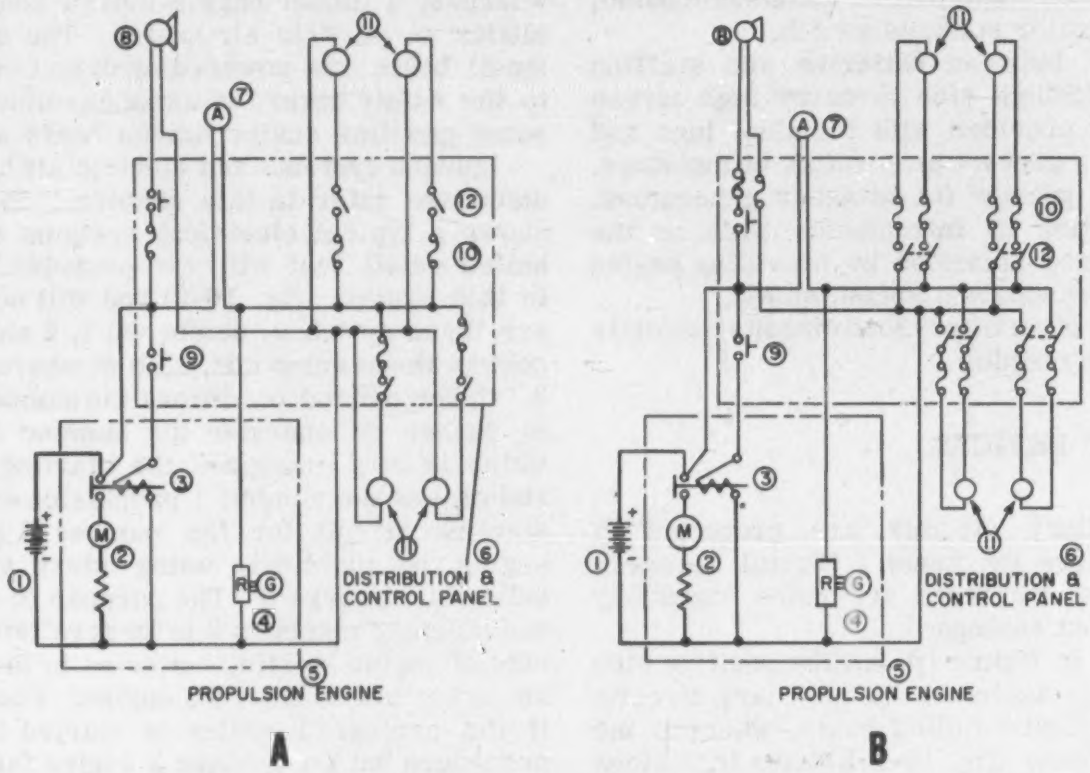

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Figure 10-1.—Electrical systems for small boats, single engine installations. A.—Typical electrical system for small boats with wood or plastic hulls. B.—Typical electrical system for small boats with steel hulls (1) storage battery; (2) starting motor for propulsion engine; (3) solenoid switch (4) generator and voltage regulator; (5) propulsion engine; (6) distribution and control panel; (7) ammeter, zero center scale; (8) horn; (9) pushbutton; (10) fuse; (11) miscellaneous auxiliary loads; (12) switch.

system on steel hull boats instead of the single-wire installation.

Because of environmental conditions (exposure to salt water spray), an unwanted (accidental) ground sometimes occurs on boat electrical systems. The Navy's service experiences reveal that fewer shutdowns occur on its ungrounded two-wire systems that on the single-wire systems. As a result, every effort is made to provide a two-wire ungrounded system and the EM must maintain it in that condition. The ungrounded systems can tolerate the temporary addition of any SINGLE grounded condition, regardless of its location, because no function is affected. A variety of troubles however, may result when two places in the system become grounded. The more common troubles include blown fuses, failure to energize the starting system, or faulty operation of any device, such as horn, voltage regulator, lights, and miscellaneous auxiliary loads.

PROTECTION OF CIRCUITS

As shown in figure 10-1,A and B, fuses are normally provided only in the circuits supplying auxiliary loads such as horns, running lights, cabin lights, spotlights, and communications equipment.

All other circuits, such as the starting motor circuit, solenoid switch control circuit, battery charging circuit, and power supply to the distribution panel, are unfused. Protection of the unfused circuits is adequate because the possibility of short circuits or leakage currents has been reduced by providing the following:

1. Two-wire ungrounded electrical system instead of single-wire grounded.
2. Two-wire ungrounded electrical components of such rugged construction as to make grounding of internal wiring or terminals most difficult under normal service conditions.

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3. Watertight components such as battery connection boxes, distribution and control panel, and starting motor solenoid switch.

4. Cables between batteries and starting motor of sufficient size to carry high inrush currents and provided with terminal lugs and end sealing to prevent penetration of moisture.

5. Splash guards for attached generators.

6. Protection of instruments such as the battery charging ammeter by providing sealed meters or a transparent splash shield.

7. Fusing of auxiliary load circuits to isolate faults in these circuits.

PROTECTIVE DEVICES

The auxiliary circuits are protected by circuit breakers or fuses. Circuit breakers are preferred, but fuses are more commonly used due to cost savings.

As shown in figure 10-1,A the positive side of the line is protected on the auxiliary circuits of wood or plastic hulled boats, whereas the steel hulled boats (fig. 10-1,B) have both sides of the line protected.

On a boat having a steel hull with a two-wire distribution system and protection in only one side of the line, malfunctioning of the electrical system could occur as follows:

1. A fault to ground on the unprotected side of the line or equipment and a second fault from the other side of the line could discharge the battery.

2. More than one leakage path to ground shorting out the fuse in the protected side of the line, and a single fault on the unprotected side of the line could overload and destroy the cable.

3. A ground on both sides of a start switch could result in false starts.

Ground detection systems are not provided on small boats, however, a degree of protection is provided on steel hulled boats by having circuit breakers or fuses in both sides of the line.

ENGINE STARTING SYSTEM

The engine starting system consists essentially of a storage battery, starting motor, and suitable controls. The engine starting system will vary, depending on whether the boat is equipped with a gasoline engine or a diesel engine. For example, a gasoline engine-driven boat includes an electrical ignition system; whereas, a diesel engine-driven boat often includes an electric air heater. The majority of small boats are powered by diesel engines due to the safety hazard of using gasoline, however some gasoline engine driven boats are in use.

Ignition systems and electric air heaters are discussed later in this chapter. Figure 10-2 shows a typical electrical systems for a steel hulled small boat with two propulsion engines. In this system (fig. 10-2) you will notice there are three switches, numbered 1, 2 and 3, which control three solenoids, also numbered 1, 2 and 3. Under normal conditions the number 1 switch is pushed to energize the number 1 solenoid which in turn energizes the starting motor M, and cranks the number 1 propulsion engine. The starting circuit for the number 2 propulsion engine is identical, using start switch and solenoid numbers 3. The purpose of the switch and solenoid numbers 2 is for paralleling the two sets of engine starting batteries in the event one set is too low to start its engine. For example, if the number 1 engine is started by normal procedure but the number 2 engine fails to start due to low batteries, it may be started by holding the number 2 switch in the closed position (to parallel the batteries) then press the number 3 switch to start the number 2 engine. The batteries for the number 1 propulsion engine should be near full charge at all times since they supply only the boat's horn and engine starting circuits.

STORAGE BATTERY

The lead acid storage battery as discussed in chapter 7 of this course provides the power source for starting small boat engines. The battery also functions as a voltage stabilizer in the electrical system, and supplies electrical power for a limited time when the electrical load exceeds the output of the boat's generator. The boat battery for a 24-volt starting system normally consists of four individual six-volt batteries connected in series. The advantages of using six-volt batteries are ease of handling the smaller batteries and easy replacement of any single battery in the event of a defective cell.

Periodic inspection of the storage battery is essential in maintaining maximum efficiency and long life of the battery. The operation and maintenance of engine-starting batteries is discussed in chapter 7 of this training course.

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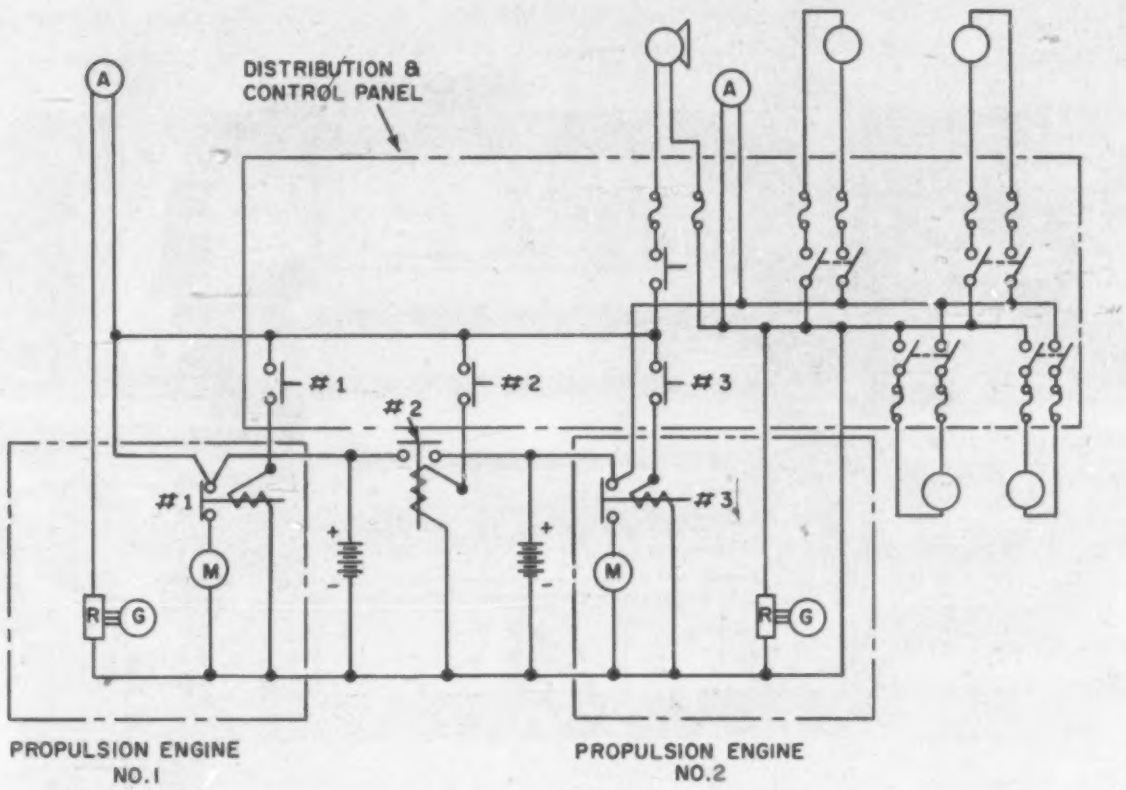

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Figure 10-2.—Typical electrical system for small boats with steel hull and two propulsion engines.

BATTERY CHARGING GENERATORS

In order to maintain the battery in a fully charged condition, it is necessary that the discharge current be balanced by a charging current supplied from an external source, such as a battery-charging generator. If the discharge current exceeds the charging current for an appreciable period, the battery will gradually lose its charge and then will not be capable of supplying the necessary current to the electrical system.

Battery-charging generators sometimes are flange mounted on the rear of the engine and driven from the timing gear train, but usually they are cradle mounted on the side of the engine and driven by a V-belt from the crankshaft pulley. These generators are rated according to the particular application, and are designed for clockwise or counterclockwise rotation. They are supplied for use with either a 6-, 12-, or 24-volt system.

Three general types of battery-charging generators are used on small boats.

1. Belt-driven d-c generator (fig. 10-3).
2. Belt-driven alternator (fig. 10-4).
3. Diesel engine-driven alternator.

The voltage and output ratings of small craft generators vary according to the needs of the particular boats. As a general rule, the boat with the smallest electrical system has a belt-driven d-c generator.

The alternator rectifier (to be discussed later in this chapter) has been used on small boats that have a large electronic load. With the d-c generator type of operation, the battery is required to supply the power demands during the low or idle-speed condition. When the engine does reach charging speed, the period of operation is often too short to permit satisfactory charging of the battery. The boat with the largest electrical system has a separate diesel engine-driven alternator.

Figure 10-5 shows an a-c/d-c system designed to supply additional electronic and other a-c loads as well as the normal d-c loads.

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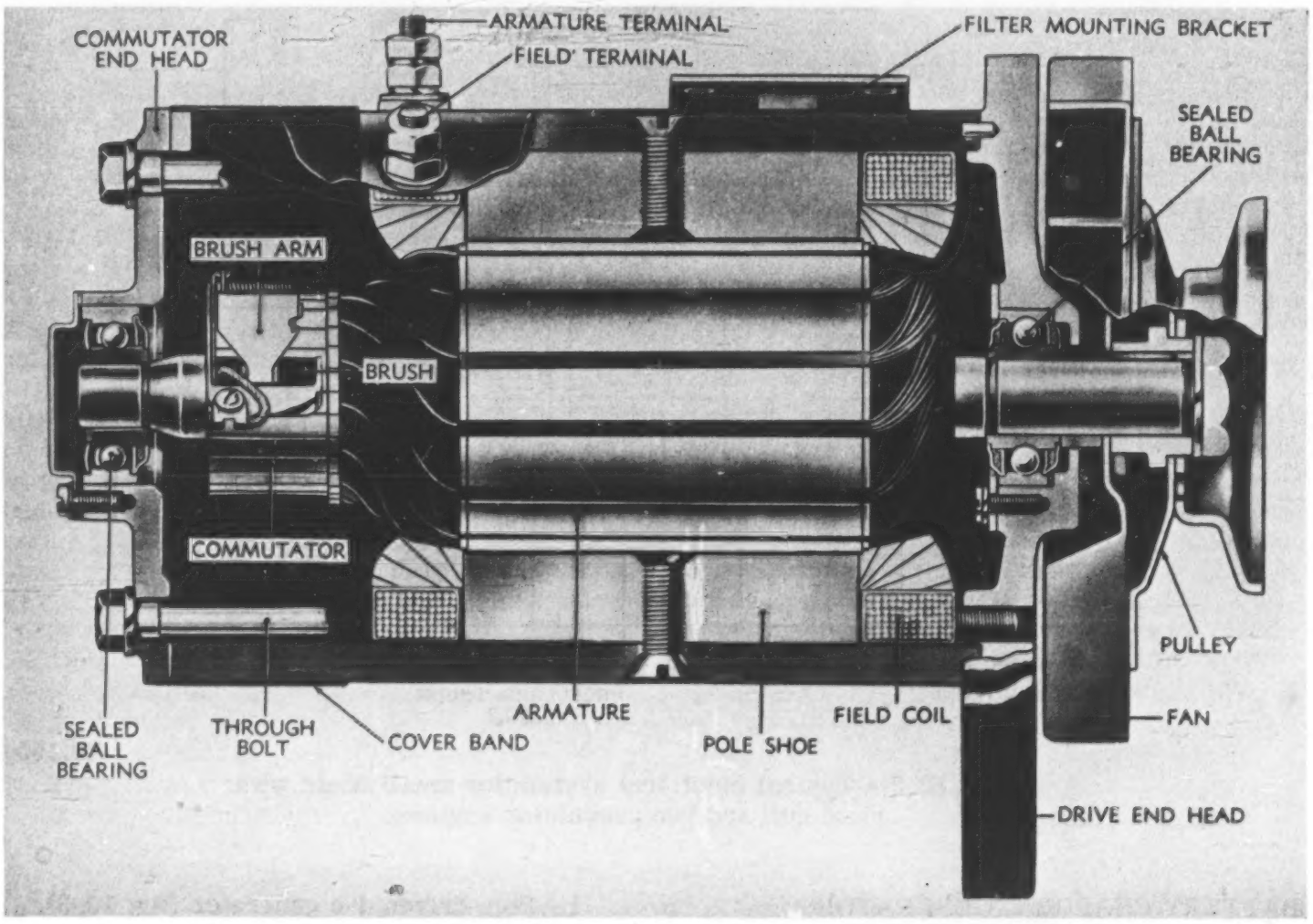

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Figure 10-3.—Sectional view of a typical belt-driven D-C generator.

SHUNT GENERATORS

Figure 10-6 shows three different battery charging systems employing shunt generators. Figures 10-6,A and B show the externally and internally grounded types of generators as formerly used on certain small craft. As explained previously, the present practice is to use an ungrounded electrical system such as shown in figure 10-6,C.

Shunt generators require some form of regulation to control the output current and prevent the generator from exceeding its maximum rated voltage when the speed increases.

Regulators operate on the principle of inserting a control resistance in series with the generator field circuit to reduce the voltage and output of the generator as required by the operating conditions. Generators are classified as externally grounded, internally grounded, and ungrounded according to the system used to connect the control resistance in the field circuit.

The externally grounded generator (fig. 10-6,A), usually has one end of the field circuit connected to the ungrounded generator brush and the other end brought out through terminal F to ground through the regulator. Thus, the field circuit is grounded outside the generator.

The internally grounded generator (fig. 10-6,B), usually has one end of the field circuit connected to a grounded generator brush and the other end brought out through terminal F and connected to terminal A through the regulator. Thus, the field circuit is grounded INSIDE the generator through the grounded brush connection.

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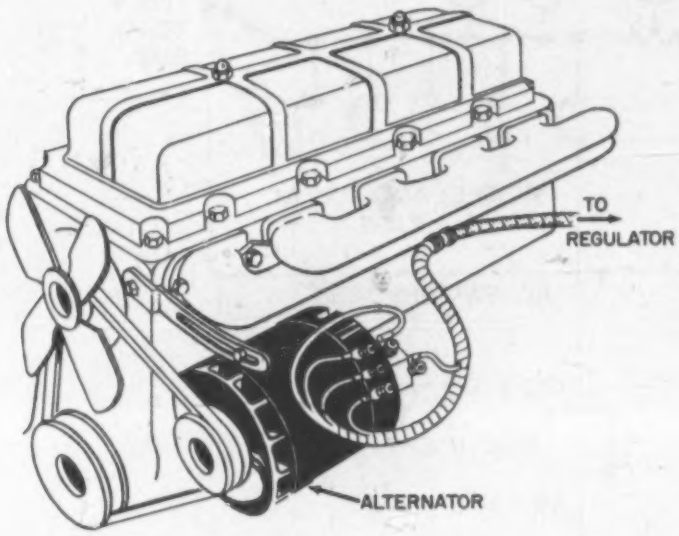

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Figure 10-4.—Typical belt-driven alternator mounting arrangement.

The ungrounded generator (fig. 10-6,C), very often has one end of the field circuit connected internally to terminal A—and the other end connected externally through terminal F and the voltage regulator to terminal A+. The essential difference between the internally grounded generator and the ungrounded generator is that in the grounded system the circuits are completed through ground (generator frame and engine); whereas, in the ungrounded system the circuits are completed through a return ungrounded wire.

Generators with the field circuits externally grounded are generally used with STANDARD regulators common to most automotive applications; whereas, internally grounded and ungrounded generators are used with HEAVY DUTY regulators. The type of generator must be determined before any generator troubles can be analyzed because the procedures for testing these generators are different.

ALTERNATORS

A belt-driven alternator is being used on certain small boats with large electronic loads. The system of using a three-phase alternator and rectifying its a-c output to charge the boat batteries and supply the d-c loads is comparable to the system found on modern automobiles. The alternator has several advantages over the d-c generator, it is smaller in size than a comparable d-c generator, requires less maintenance, and supplies charging current at idling speeds. In systems using d-c generators, the output voltage is normally too low at idle or low speeds to supply charging current.

Figure 10-7 shows a schematic wiring diagram of an alternator and its associated control unit, (normally referred to as simply the regulator).

On small boats where load requirements exceed the capacity of one (2000-watt) alternator as shown in figure 10-7, two alternators operating in parallel may be provided. Figures 10-8, A and B show the connections for parallel and single system operation, respectively. The generating system operates as though it were a conventional d-c generator and regulator.

The electrical energy taken from terminals G- and G+ (fig. 10-7) is direct current. The three-phase a-c output of the stator is fed to a rectifier bridge consisting of six silicon diodes as shown in figure 10-7. The silicon diodes are normally located in the end-bell of the alternator. The rotor of the alternator has one coil and two six-fingered rotor halves as shown in figure 10-9. This in effect is a twelve-pole rotor. Direct current (for field excitation) is supplied to the rotor coil through a pair of brushes and slip rings.

The electrical equipment is designed to operate at a specific voltage irrespective of the speed of the engine (prime mover) and the alternator. The regulator (fig. 10-10) controls the alternator output. It consists of the (1) load relay, (2) voltage regulator, (3) current limiter, and (4) feed-through capacitors to prevent radio interference.

The LOAD RELAY acts as a switch to connect the battery to the alternator system when the engine is running, and to open the circuit when the engine is not in operation. The load relay is operated by the ignition switch when a gasoline engine is employed such as in an automobile. On an automobile when the ignition switch (fig. 10-10) is turned on, it connects the load-relay coil to the battery and the contacts close.

When a diesel engine is used, the load relay may be energized through a pressure switch in the fuel oil line. Some alternators (2000-watt Navy type, fig. 10-8,B) however, are internally connected for automatic pickup of the load relay when the voltage builds up to normal value, or

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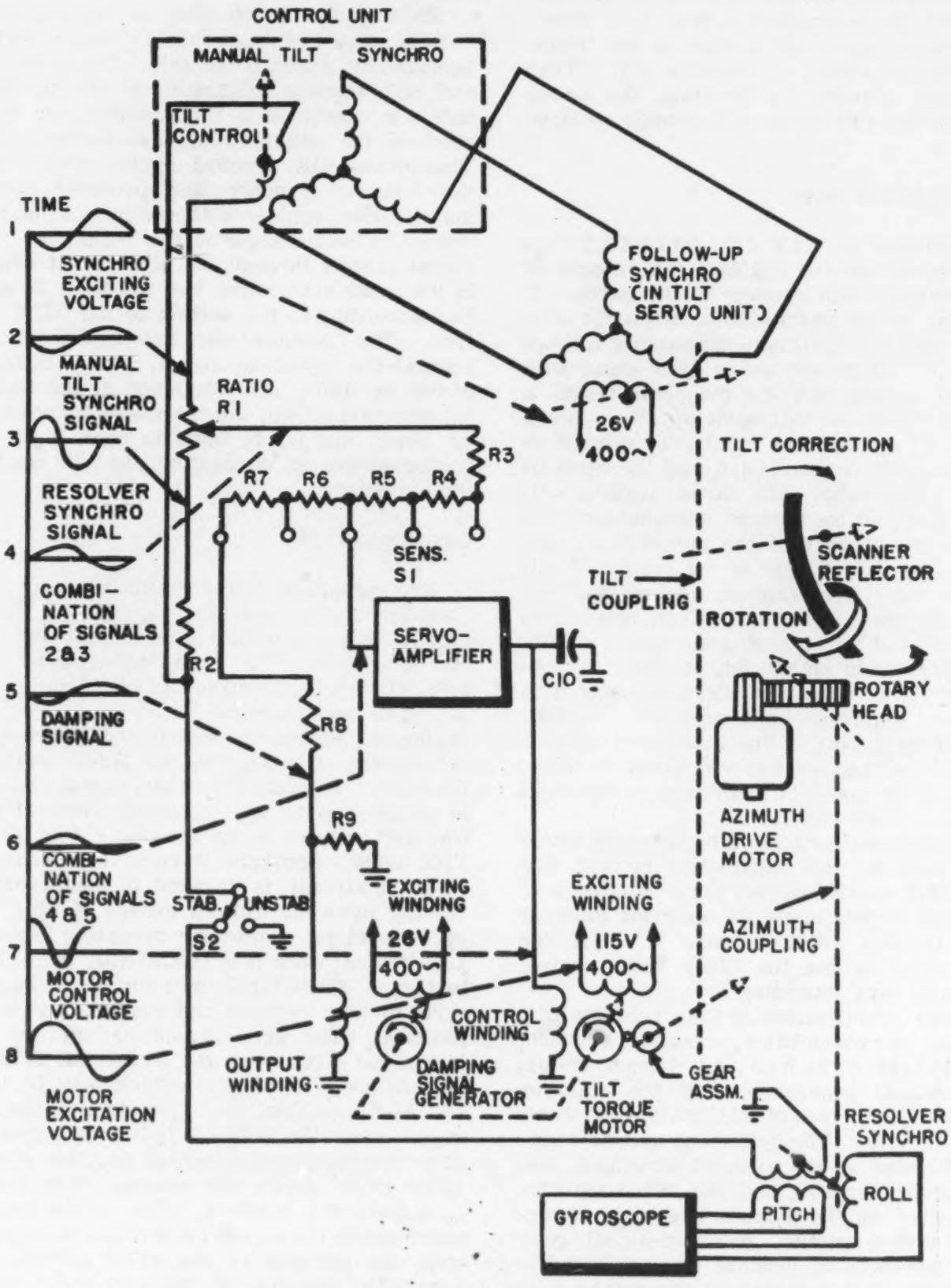

Figure 17-37. —Tilt stabilization with highspeed antihunt.

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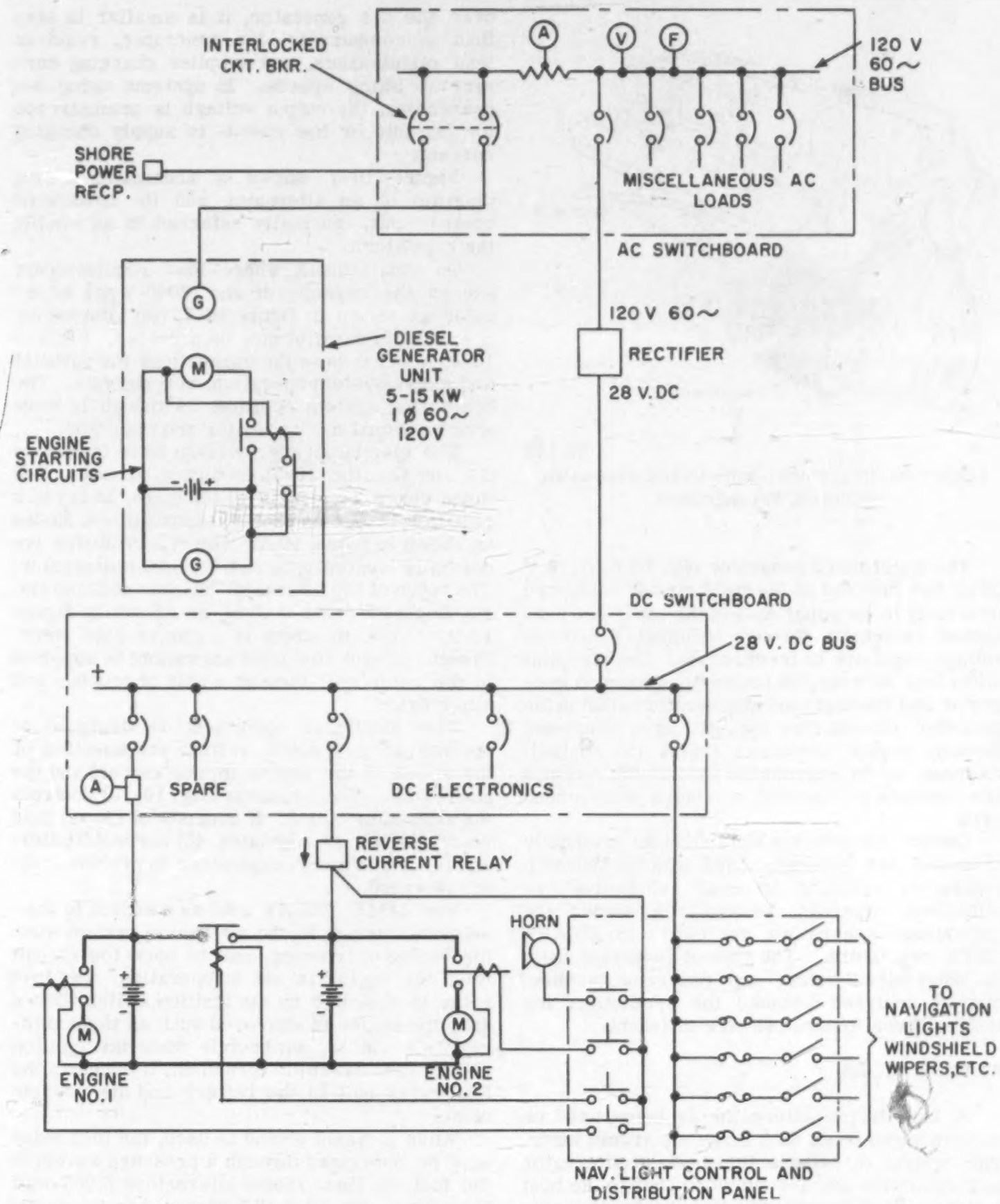

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Figure 10-5.—Small boat a-c/d-c power system, single line elementary diagram.

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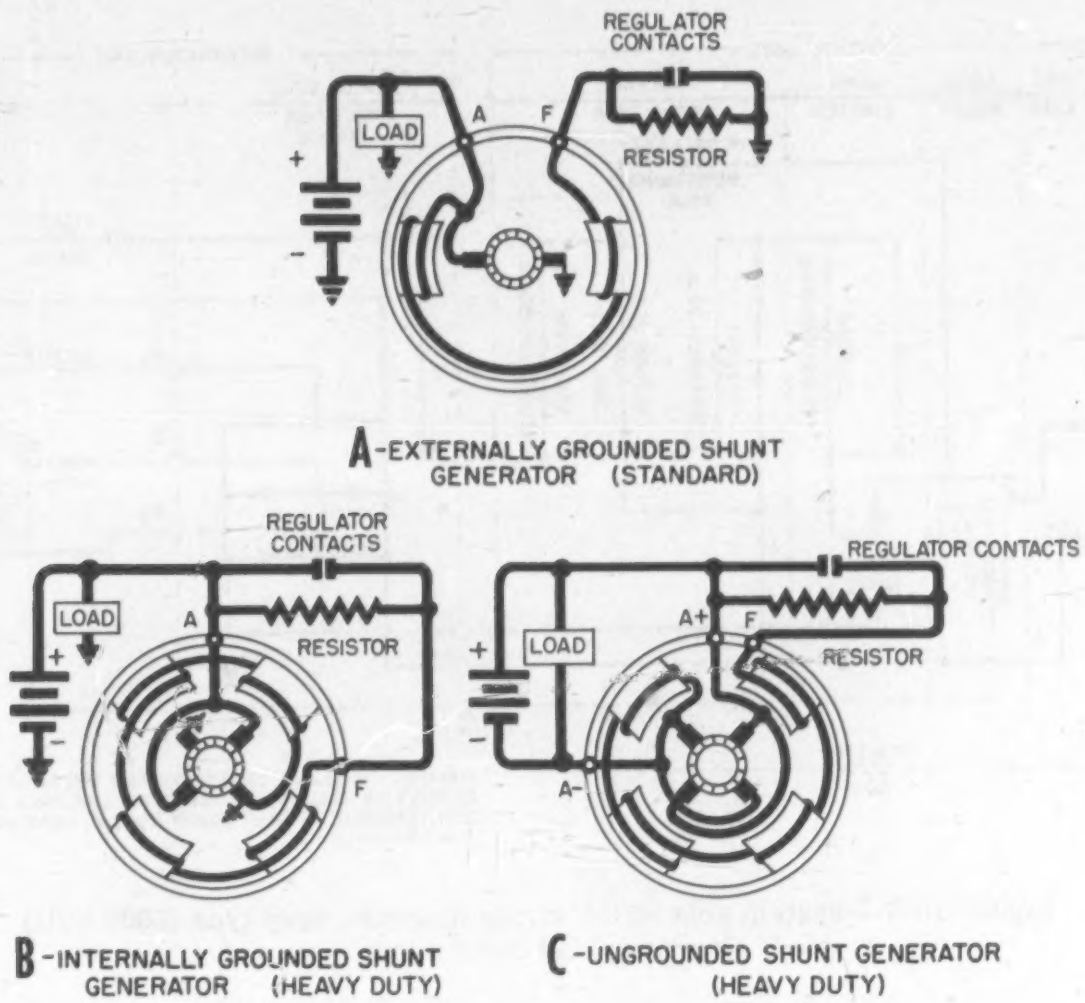

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Figure 10-6.—Battery-charging d-c generators.

the load relay may be energized by an external switch (for parallel operation) as shown in figure 10-8A.

Voltage Regulators

Regulators are usually employed with battery-charging generators or alternators to provide complete control of the generator voltage and output at all times. Regulators are classified as standard and heavy-duty regulators for use with externally grounded, internally grounded, and ungrounded generators.

A standard or heavy-duty regulator consists of two or more units mounted on a common base and located in the proximity of the generator. The units, or components, in a regulator usually include a cutout relay, voltage relay, and current relay. Regulators for alternator installations are discussed first, regulators as used on d-c generator installation are covered later in this chapter.

The automotive type voltage regulator (fig. 10-10) controls the alternator field strength and thereby regulates the output voltage. The point resistor and contacts are connected in series with the alternator rotor d-c field coil. The voltage regulator (VR) coil and its ballast resistor are series connected across the d-c output terminals (GND and G) of the rectifier via the CL coil. Therefore, any variation in output voltage will change the magnetic strength of the VR coil.

When the alternator speed is low and/or the electrical load is heavy, the VR coil will cause the VR armature to vibrate on the upper contact. This action periodically inserts the point resistance in the field circuit to control the output

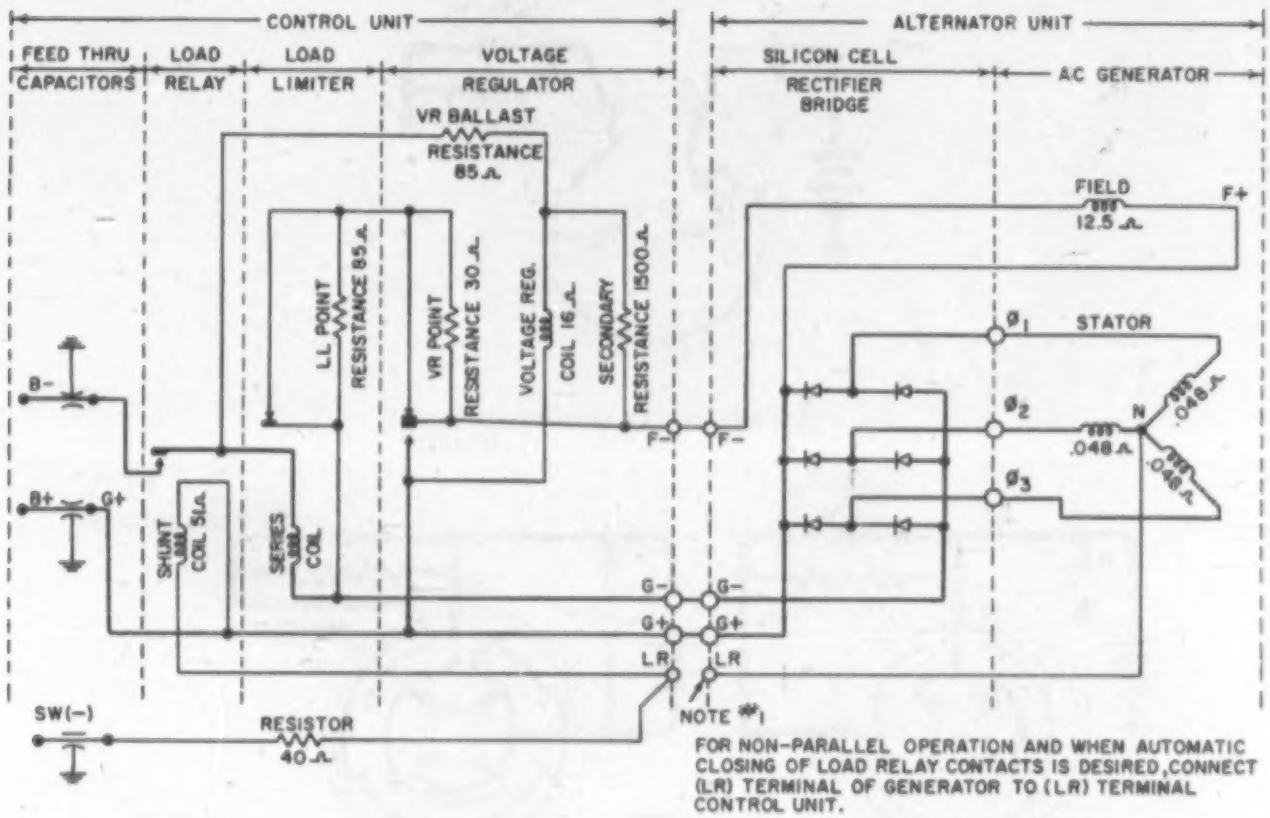

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Figure 10-7.—System schematic wiring diagram, navy type (2000 watt) alternator and control unit.

voltage. This condition is called top contact operation.

When the alternator speed is high and/or the load is light, the VR armature vibrates on the bottom contact and periodically inserts a direct short which shorts out the entire d-c field coil of the alternator. This action intermittently weakens the field magnetism sufficiently to hold the output voltage to the proper value for this load and speed condition.

The CURRENT LIMITER protects the alternator and rectifier by limiting the current output of the alternator (fig. 10-10). The current limiter (CL) coil is connected in series with the negative terminal of the rectifier and the load circuit. When the current exceeds the rating of the alternator, the CL coil will cause the CL armature to vibrate and insert enough point resistance intermittently in the d-c field to limit the output current to the proper value.

On 6-volt regulators of this type, a temperature compensator is used to adjust the voltage regulator action to different temperatures. The temperature compensator consists of a bimetalic strip, located at the spring end of the VR armature. When the temperature changes, the bimetallic strip bends thereby causing a change in the armature spring pressure.

The operation of the navy type alternator and control unit shown in figure 10-7 is basically the same as the automotive type just explained. Except for the center tapped stator winding and provisions for automatic or external switch closing of the load relay on the 2000-watt navy type (as explained previously), both regulators operate in the same manner.

Maintenance

Several different companies are manufacturing alternators and regulators for naval use. Each unit, regardless of who manufactures it, must meet certain specifications as to type of enclosure, output voltage and current, weight, size, drive, etc. In other words, you may have boats with electrical equipment from several

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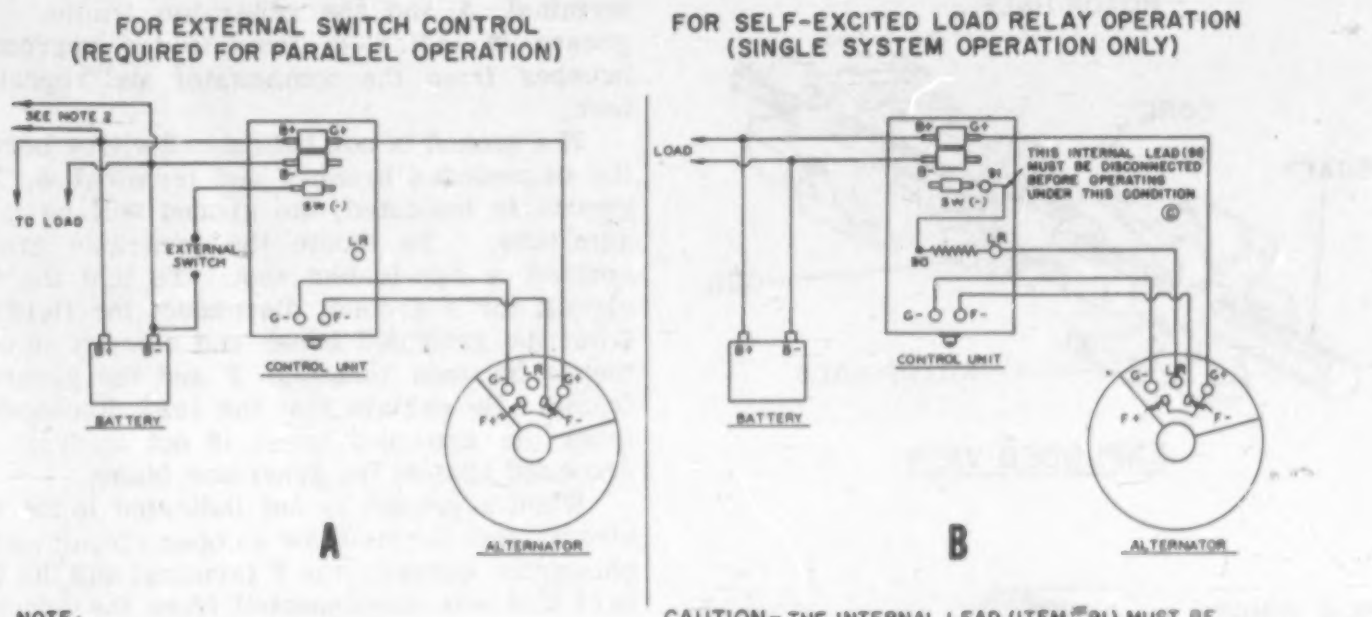

Figure 10-8.—Battery-charging alternator connection diagrams.

manufacturers doing the same job. The maintenance procedures, methods of disassembly, voltage, current, resistance values, and air gap settings of relays may be different from one type to another.

Prior to attempting any maintenance on equipment unfamiliar to you, read carefully the manufacturer's instruction manual provided with the equipment.

Battery-charging generators in small craft should be inspected periodically to obtain optimum performance. The frequency of these inspections is determined by the type of generator and the application. MRC cards are used on ships with the 3-M system installed to cover the required maintenance and inspections of small craft electrical equipments.

If a battery-charging shunt generator (fig. 10-6) does not produce rated output or if it produces excessive output and the trouble has been isolated in the generator itself, disconnect the leads from the A and F terminals and remove the generator from the engine. Then inspect the commutator and field coils to locate any visual trouble indications. If no indications of trouble are visible, conduct further tests for grounds, opens, and shorts in the generator. If the shunt generator is the externally grounded type (fig. 10-6A), remove the ground from the armature by inserting a piece of cardboard between the brush and the commutator. Test the generator for an internal ground with a megger or similar resistance-measuring device between terminal A and the generator frame. If a ground is indicated, insulate the other brush from the commutator and repeat the test. If a ground is still indicated, it will be in the field circuit. If no ground is indicated, the ground will be in the armature. To locate the ground in the armature, conduct a bar-to-bar test, as described in chapter 6 of this training course.

If a ground is not indicated in the generator, test the field for an open circuit with an ohmmeter between the A and F terminals.

If the field is not open circuited, test for a shorted field by passing normal current through the field circuit and measuring the voltage drop across each field coil. The shorted coil will be indicated by having the lowest reading on the voltmeter.

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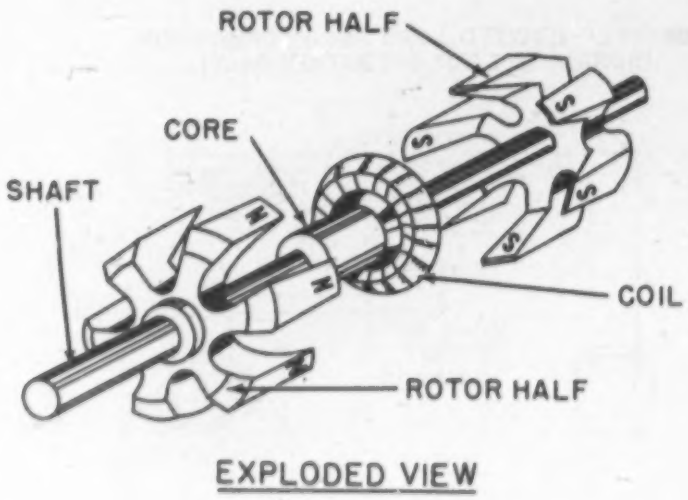

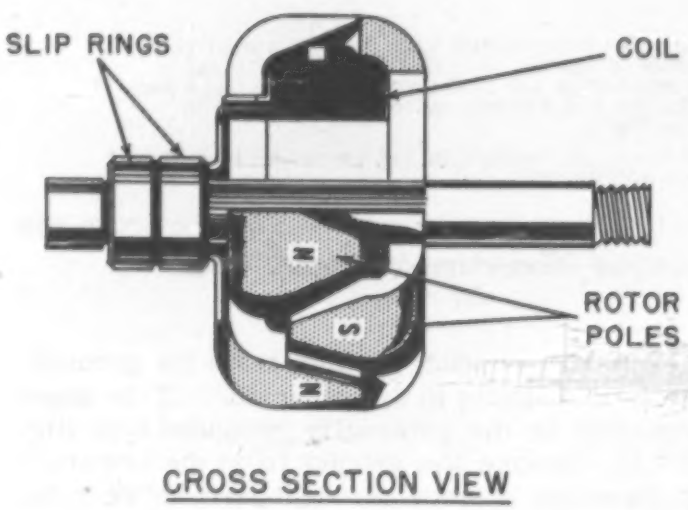

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Figure 10-9.—Typical rotor for small craft or automotive alternator.

If the trouble is not in the field, test the armature for open and short circuits by conducting a bar-to-bar test in accordance with the information contained in chapter 6.

Accidental internal grounding of the field circuit or an externally grounded generator will prevent normal regulation so that the generator may produce excessive output. To test for the accidental ground in the field circuit, first insulate the grounded brush from the commutator and then connect a megger between terminal A or F and the generator frame.

If the shunt generator is the INTERNALLY grounded type (fig. 10-6,B), insulate the grounded brushes from the commutator. Test the armature circuit for ground with a megger between terminal A and the generator frame. If a ground is indicated, insulate the ungrounded brushes from the commutator and repeat the test.

If a ground is now indicated it will be between the ungrounded brushes and terminal A. If no ground is indicated, the ground will be in the armature. To locate the armature ground, conduct a bar-to-bar test. To test the field circuit for a ground, disconnect the field lead from the grounded brush and connect an ohmmeter between terminal F and the generator frame. Be certain that the lead disconnected from the grounded brush is not inadvertently grounded against the generator frame.

When a ground is not indicated in the field circuit, test the field for an open circuit with an ohmmeter between the F terminal and the field lead that was disconnected from the grounded brush.

If the field is not open circuited, test for a short-circuited field by passing normal current through the field circuit and measuring the voltage drop across each field coil.

When the trouble has not been located, test the armature for open and short circuits by conducting a bar-to-bar test.

Excessive output produced by an internally grounded shunt generator may result from a short-circuited field coil. The test for this conditon is to establish normal current through the field circuit and to measure the voltage across each coil, as previously described.

If the shunt generator is the UNGROUNDED type (fig. 10-6,C), determine which brush is connected to the field winding and insulate it and the brush diametrically opposite it from the commutator. Test the armature circuit for grounds with a megger between terminal A+ and the generator frame. If a ground is indicated, it will be in the armature or the circuit between terminal A+ and the commutator. To locate a ground in the armature, conduct a bar-to-bar test.

When the trouble is not located in the armature circuit, test the field circuit for grounds with the megger between terminal A—and the generator frame. If a ground is indicated, it will be in the field winding or in the circuit between terminal A—and the field winding.

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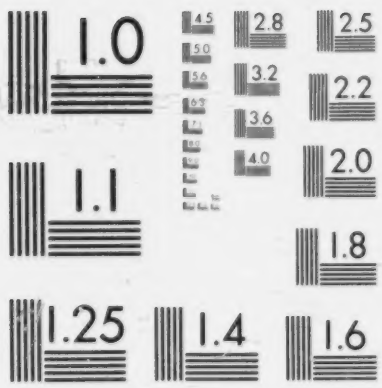

MICROCOPY RESOLUTION TEST CHART

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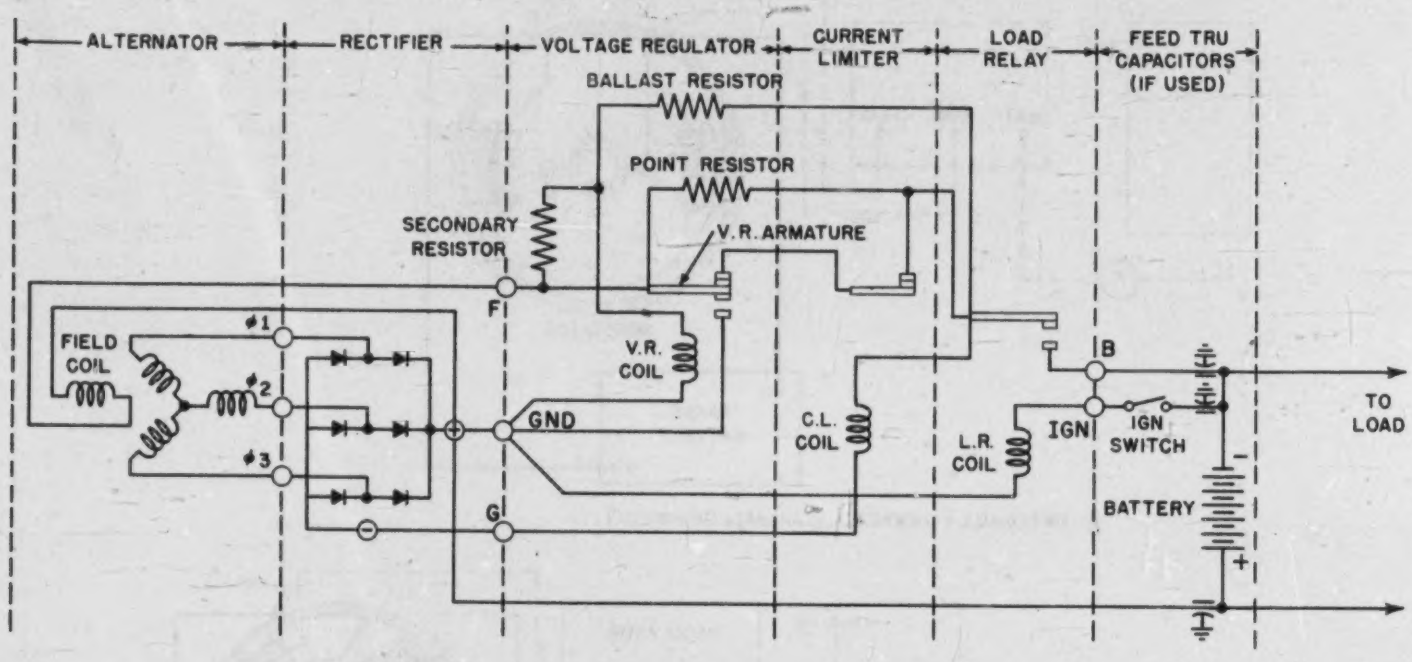

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Figure 10-10.—Schematic wiring diagram of a typical automotive type alternator and regulator.

If a ground is not indicated in the field circuit, test the field for an open circuit with an ohmmeter between terminal F and terminal A—.

If the field is not open circuited, test for a short-circuited field by passing normal current through the field circuit and measuring the voltage drop across each coil.

When the trouble has not been located, test the armature for open and short circuits by conducting a bar-to-bar test.

An UNSTEADY or LOW OUTPUT can result in any of the generators and is usually caused by a loose drive belt, or a condition of the brush rigging that prevents good contact between the brushes and commutator. Also, a rough, out-of-round, or burned commutator, high mica; or dirt in the commutator slots can cause low or unsteady output. To correct these conditions, turn down the commutator in a lathe and undercut the mica in accordance with the instructions contained in chapter 6.

A NOISY GENERATOR can be caused by a loose mounting, drive pulley, or gear. Also worn or dirty bearings, improperly seated brushes, or a bent brush holder may be the cause.

Before installing a new or repaired battery-charging, d-c generator in a boat, the generator must be POLARIZED so that it will have the correct polarity with respect to the electrical system. Failure to polarize the generator can result in burned relay contacts, a discharged battery, and even serious damage to the generator. The correct procedure to follow in polarizing a generator depends on whether the generator field circuit is externally or internally grounded, or ungrounded (fig. 10-11).

If the generator has the field circuit externally grounded and uses a standard regulator (fig. 10-11A), ascertain the polarity of the lead from the engine battery to the regulator BAT terminal. The arrows indicate the direction of electron flow (opposite to conventional current flow). In this example the polarity is negative. Insulate the generator brushes from the commutator and connect one lead from a spare battery to terminal A of the generator. The polarity of this lead must be the same as the polarity of the regulator BAT terminal (negative in this example). Momentarily touch the other lead from the spare battery to terminal F of the generator. This action allows a momentary surge of current to flow from the spare battery through the generator field to correctly polarize the generator.

If an internally grounded generator is provided with a heavy-duty regulator (fig. 10-11B), determine the polarity of the regulator BAT

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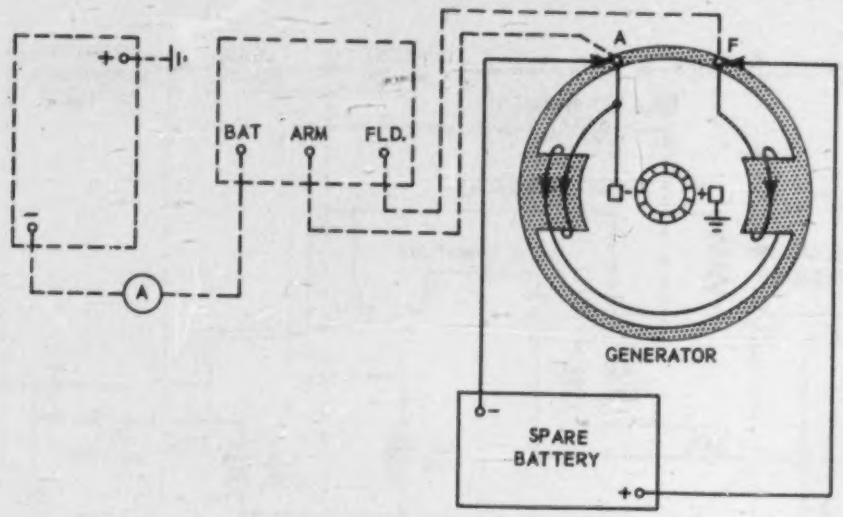

A EXTERNALLY GROUNDED (STANDARD) GENERATOR

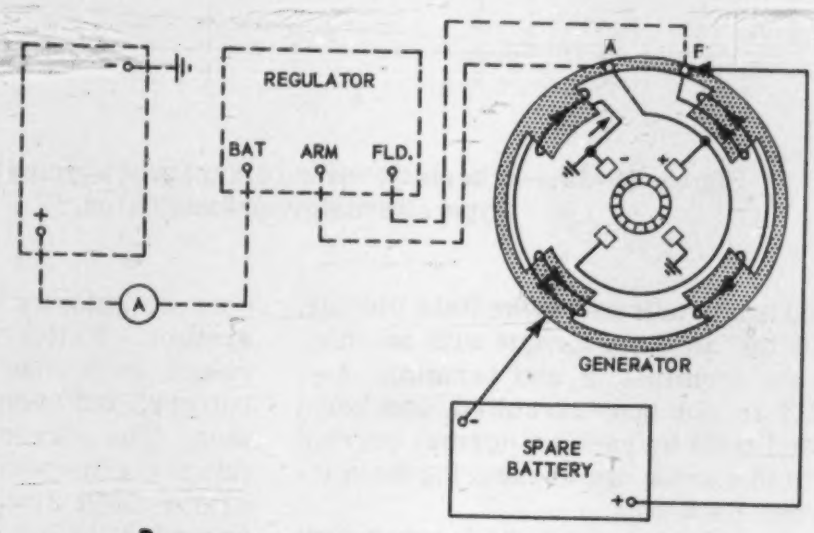

B INTERNALLY GROUNDED (HEAVY-DUTY) GENERATOR

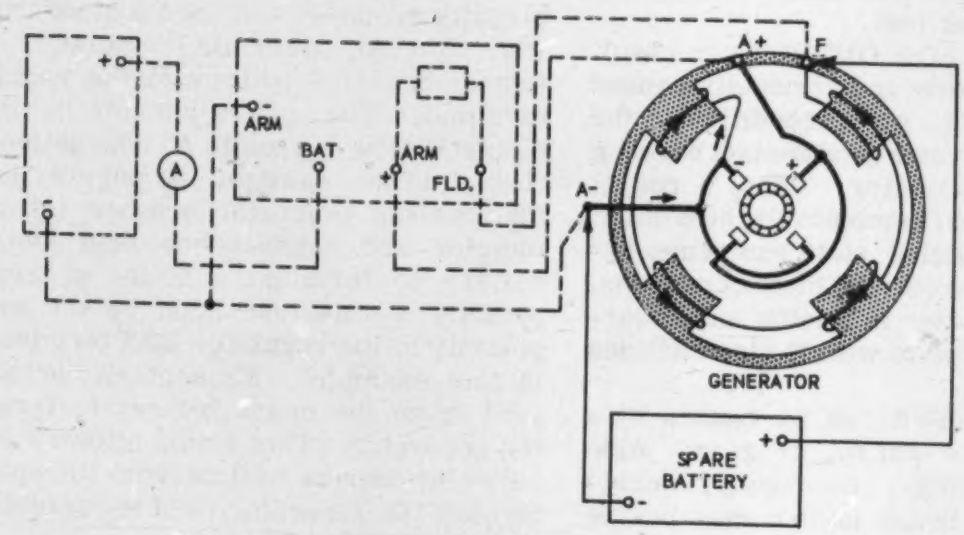

C UNGROUNDED (HEAVY-DUTY) GENERATOR

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Figure 10-11.—Polarizing generator fields.

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terminal. In this example the polarity is positive. Insulate the generator brushes from the commutator and connect one lead from a spare battery to terminal F of the generator. Be certain that the polarity of the spare battery lead corresponds to the polarity of the regulator BAT terminal (positive in this case). Clean a spot on the generator frame to ensure a good connection and momentarily touch the other lead from the spare battery to the generator at this spot. This action allows a momentary surge of current to flow from the spare battery through the generator (frame, grounded brush, and field windings) to correctly polarize the generator.

If the ungrounded generator is provided with a heavy-duty regulator (fig. 10-11C), determine the polarity of the regulator BAT terminal (positive in this case). Insulate the generator brushes and connect one lead from a spare battery to terminal F of the generator. The polarity of this lead must be the same as that of the regulator battery lead (positive). Momentarily, touch the other lead from the spare battery to terminal A—of the generator. This action allows a momentary surge of current to flow from the spare battery through the generator field to correctly polarize the generator.

Be certain that when the generator is installed on the engine that the polarity of the leads remains the same as for the polarizing procedure. Do not attempt to polarize a battery-charging generator after it is installed in the boat because of the fire hazard. There is always the possibility of explosive vapors in a small boat, which can be ignited by the arc when the generator field is flashed.

CURRENT AND VOLTAGE REGULATOR (STANDARD)

The current and voltage regulator (fig. 10-12) is a three-unit regulator designed for use with a shunt generator with externally grounded field circuit. It consists of a cutout relay, voltage regulator, and current regulator.

The CUTOUT RELAY is used to close the circuit between the generator armature and the battery when the generator is operating at sufficient speed to charge the battery. It opens the battery circuit whenever the generator slows or stops to prevent the battery current from reversing and flowing backward through the generator. Because of this function, it is also identified as a REVERSE CURRENT RELAY, or simply, a REVERSE CURRENT CUTOUT. Its action is described in BASIC ELECTRICITY, NavPers 10086-(Revised).

This CURRENT REGULATOR has only a series coil assembled on its core (fig. 10-12). The regulator is a current-limiting device that limits the generator output and prevents it from exceeding its maximum safe value. The generator output flows through this coil at all times. The core with the coil is attached to the frame, and the hinged armature is centered above the core. The armature has a contact

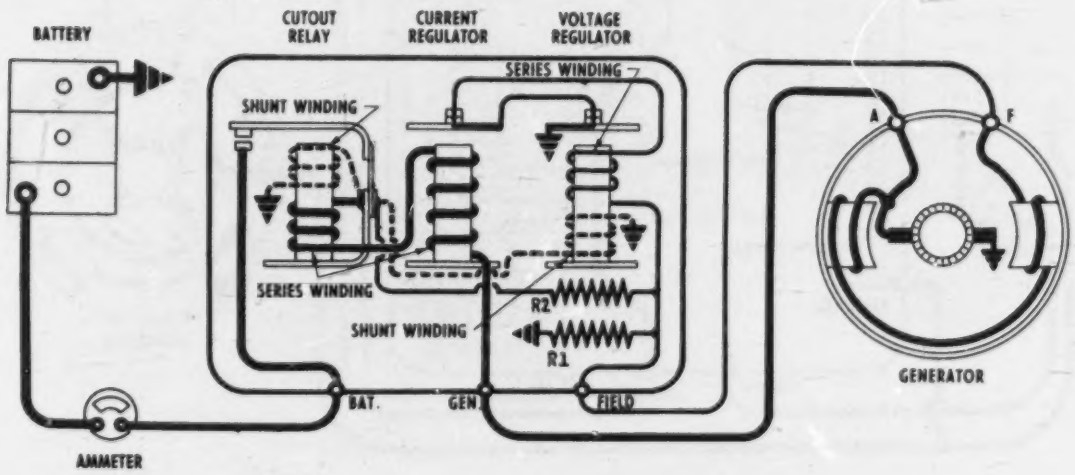

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Figure 10-12.—Three-unit current and voltage regulator (standard) wiring diagram.

located below a stationary contact that is connected to the generator field circuit. When the current regulator is not operating, the armature is held away from the core by the tension of a coil spring so that the contacts are closed, and the generator field circuit is completed to ground through the current regulator contacts in series with the voltage regulator contacts.

When the generator is operating and the electrical demands are heavy, the voltage may not increase sufficiently to operate the voltage regulator. Hence, the generator output will continue to increase until the generator reaches its maximum rated value at which the current relay is set. The output current flows through the series coil and produces a magnetic field that overcomes the spring tension and pulls the armature toward the core to open the contacts. This action inserts resistor R1 in the generator field circuit so that the generator output is reduced. The reduced output weakens the magnetic field produced by the series coil, and the spring tension pulls the armature away from the core to close the contacts. This action short-circuits R1, thereby strengthening the field and permitting the generator output to again increase. This cycle continues at a rate of from 50 to 200 times a second to limit the generator output to its maximum rated value.

When the electrical load on the generator is reduced, the voltage increases so that the voltage regulator operates and reduces the generator output. This action prevents the current regulator from operating. Either the voltage regulator or the current regulator operates, but not simultaneously.

A common resistor (R1) is used in the current and voltage regulator circuits (fig. 10-12), which is inserted in the field circuit when either the current or voltage regulator operates. A second resistor (R2) is connected between the F terminal of the regulator and the frame of the cutout relay so that it is connected effectively in parallel with the generator field windings.

The sudden reduction in field current, which occurs when either the current or voltage regulator contacts open, is accompanied by a surge of induced voltage in the field windings as the strength of the magnetic field changes. These surges are partially dissipated by the two resistors (R1 and R2) to prevent excessive arcing of the contacts.

CURRENT AND VOLTAGE REGULATOR (HEAVY DUTY)

The current and voltage regulator (fig. 10-13), is a three-unit regulator designed for use with the ungrounded shunt generator. It also consists

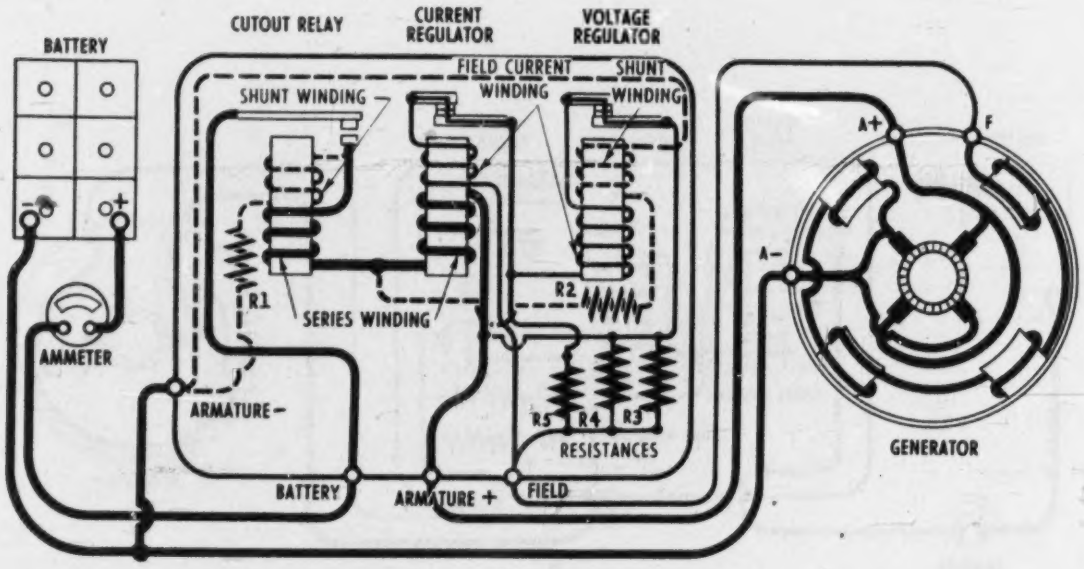

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Figure 10-13.—Three-unit current and voltage regulator (heavy duty) wiring diagram.

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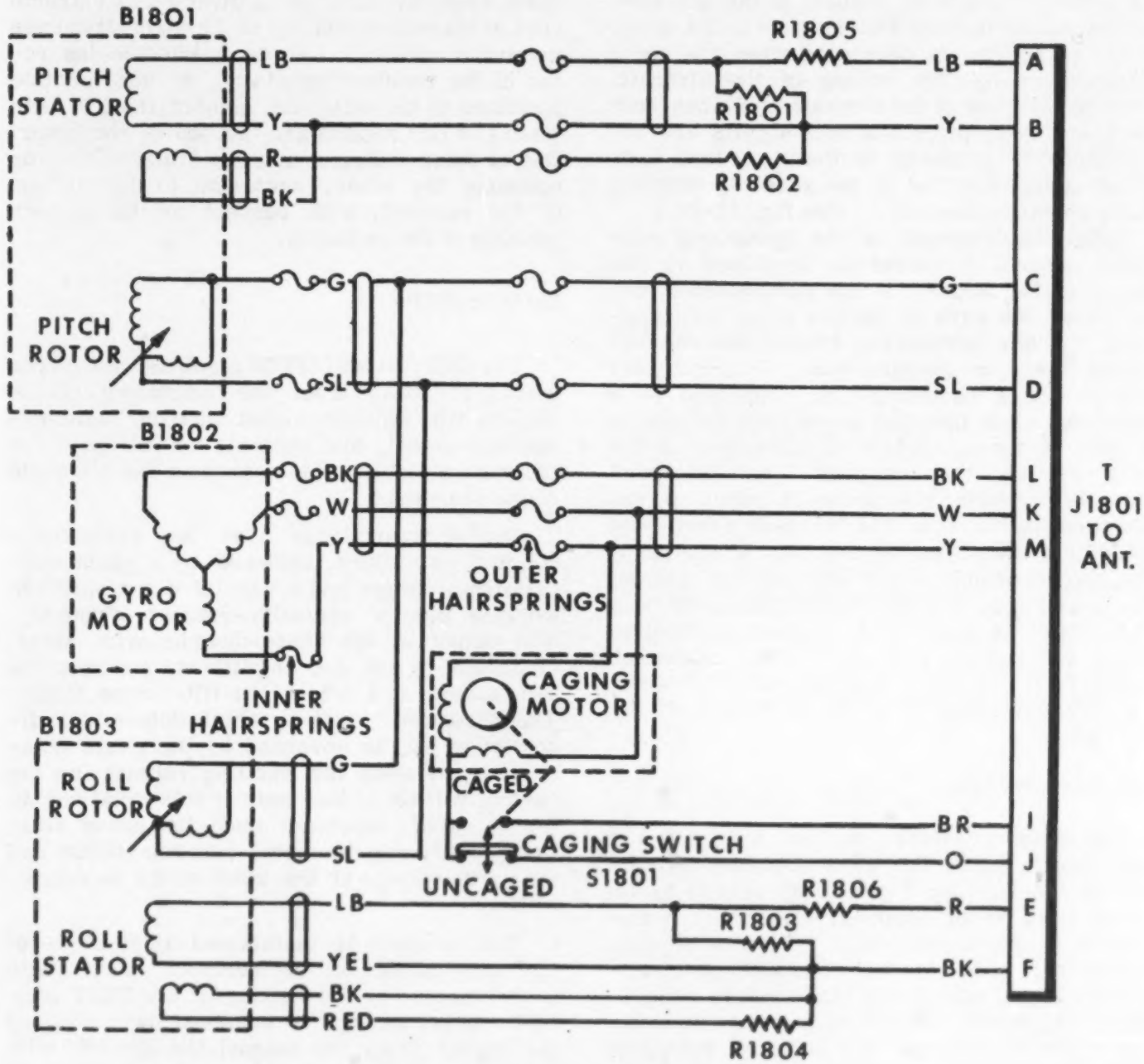

Figure 17-38. —Gyroscope unit.

The PITCH and ROLL synchros in the gyroscope unit deliver signals to the tilt stabilization system in the antenna assembly in accordance with the departure of the aircraft from level flight; these signals are used to stabilize the tilt angle of the beam with respect to the horizon. The rotor winding of each synchro is excited by 26-volt, single-phase, 400-cycle a.c. When either of the rotors is displaced from the null point, single-phase voltages are induced in the stators; the phase relationships and amplitudes of these voltages are determined by the direction and degree of displacement.

The stators of the two synchros are rigidly attached to the gyro, at right angles to each other. The rotor of the pitch synchro is mounted with its shaft horizontal, and at right angles to the line of flight of the aircraft. Since the rotor is fixed with respect to the aircraft, and the stator is fixed with respect to the gyro housing, an a-c pitch signal is developed when the rotor is displaced by the pitching of the aircraft.

The rotor of the roll synchro is also mounted with its shaft horizontal, but the shaft is parallel to the line of flight of the aircraft. Since

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of a cutout relay, voltage regulator, and current regulator.

The internal wiring is similar for all regulators of this type, except that the internal connections vary according to whether the regulator is designed for use with a grounded (one-wire) system or an ungrounded (two wire) system (fig. 10-13).

The units in the heavy-duty regulator are similarly constructed and perform the same functions as the corresponding units in the standard regulator previously described.

The cutout relay (fig. 10-13) has a shunt coil and a series coil assembled on one core. The shunt coil and resistor R1 comprise a series circuit that is connected across the generator so that generator voltage is impressed on this circuit at all times. The series coil is connected in series with the charging circuit so that the generator output passes through it. When the generator is not operating, the armature is held away from the core by the tension of a coil spring so that the contacts are open and the circuit is incomplete between the generator and battery.

When the generator is operating and the voltage reaches the value for which the cutout relay is adjusted, the magnetic field produced by the shunt coil overcomes the spring tension and pulls the armature toward the core to close the contacts of the cutout relay and complete the circuit between the generator and the battery.

If the generator slows down, or stops, and the voltage decreases to a value less than the battery voltage, a reverse current will flow through the series coil and the mmf produced by the series coil opposes the mmf produced by the shunt coil. When the reverse current increases to the value for which the cutout relay is adjusted, the spring tension overcomes the magnetic field and pulls the armature away from the core to open the contacts and open the circuit between the generator and the battery.

The voltage regulator (fig. 10-13) has a shunt coil and a field current coil assembled on one core. The shunt coil and resistor R2 comprise a series circuit that is connected across the generator, thereby placing generator voltage across this circuit at all times. The field-current coil is connected in series with the generator field circuit when the current regulator contacts are closed so that field current passes through it. The stationary contact is assembled into a flat spring that rises slightly above the fiber mounting bracket when the contacts are closed. This arrangement provides a wiping action between the contacts as they close and open to assure better contact.

When the generator voltage is low, the armature is held away from the core by the tension of a coil spring so that the contacts are closed and the resistance is shorted out of the generator field circuit, permitting the generator voltage to increase. The external field circuit connection to the generator armature by way of the regulator (when both the current-regulator and voltage-regulator contacts are closed) is from terminal F of the generator to the field terminal of the regulator, through the field-current coil and contacts of the current regulator, through the field-current coil and contacts of the voltage regulator, to the armature terminal of the regulator, and back to terminal A+ of the generator.

When the generator is operating and the voltage reaches the value for which the voltage regulator is adjusted, the magnetic field produced by the shunt and field-current coils overcomes the spring tension and pulls the armature toward the core to open the contacts of the voltage regulator. This action inserts parallel resistors R3 and R4 series within the field circuit to reduce the generator field current and voltage. The external field circuit connection to the generator armature by way of the regulator (when the voltage regulator contacts are open) is from terminal F of the generator to the field terminal of the regulator, through parallel resistors R3 and R4, to the armature terminal of the regulator, and back to terminal A+ of the generator.

The current regulator (fig. 10-13) has a series coil and a field-current coil assembled on one core. The series coil is connected in series with the charging circuit when the cutout relay contacts are closed so that full generator output passes through it. The field-current coil is connected in series with the field circuit when the current-regulator contacts are closed (assuming that the voltage regulator contacts are also closed) so that field current flows through it.

When the generator voltage is low, the armature is held away from the core by the tension of a coil spring so that the contacts are closed, and resistors R3 and R4 are shorted out of the field circuit to permit the field current and generator output to increase. The external field circuit connection to the

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generator armature by way of the regulator (when both current-regulator and voltage-regulator contacts are closed) is from terminal F of the generator to the field terminal of the regulator, through the field-current coil and contacts of the current regulator, through the field-current coil and contacts of the voltage regulator, to the armature terminal of the regulator, and back to terminal A+ of the generator.

When the generator is operating and the output reaches the value for which the current regulator is adjusted, the magnetic field produced by the series and field-current coils overcomes the spring tension and pulls the armature toward the core to open the contacts of the current regulator. This action inserts the effective parallel combination of resistors R3, R4, and R5 in series with the field circuit to reduce the generator output. The external field circuit connection to the generator armature by way of the regulator (when the current regulator contacts are open and the voltage regulator contacts are closed) is from terminal F of the generator to the field terminal of the regulator, through resistor R5, and the field current coil and contacts of the voltage regulator, in parallel with resistors R3 and R4, to the armature terminal of the regulator, and back to terminal A+ of the generator.

Maintenance

Proper maintenance of generator controls and regulators is necessary to ensure continued satisfactory performance. This maintenance consists of periodic tests and adjustments to the various components that comprise the control or regulator. The correct airgap measurements and voltage values for these tests and adjustments are specified in the manufacturers' instructions furnished with the specific equipment. Do not attempt these tests and adjustments without first obtaining the manufacturers' instruction books.

BATTERY IGNITION SYSTEM

Ignition of the fuel-air mixture in the cylinders of a gasoline engine is initiated by an electric spark. The spark is produced by the battery ignition system that functions to step up the relatively low voltage of the battery and to deliver the high voltage to the spark plugs at the proper time. The high voltage is capable of forcing current through the high resistance set up by the pressure in the combustion chamber and across the electrodes of the spark plugs. The hot spark created across the electrodes ignites the fuel-air mixture.

A battery ignition system consists of (1) the battery, (2) the ignition coil, (3) the ignition distributor, and (4) spark plugs (fig. 10-14). The battery and generator supply the voltage and current for the ignition system. The battery is required for starting, but after the engine starts, the generator carries the ignition load.

IGNITION COIL

The ignition coil (fig. 10-15) is a pulse transformer that steps up the low battery, or generator, voltage to the high voltage necessary to jump the gaps at the spark plugs in the engine cylinders. It consists of a primary winding having a few hundred turns of relatively heavy wire, a secondary winding having many thousand turns of very fine wire (up to 100 times as many turns of wire as the primary), and a laminated soft-iron core. The secondary winding is usually wound around the soft-iron core, and the primary winding surrounds the secondary winding. This subassembly is enclosed in a laminated soft-iron shell that serves to concentrate the magnetic field.

The entire subassembly is placed in a steel case, and the remaining space is usually filled with oil to improve insulation and reduce the effects of moisture. The case is hermetically sealed with a molded insulating cap that carries two primary terminals and the high-tension terminal.

The primary circuit of the ignition system (fig. 10-14) is from the battery, through the ignition switch to the primary terminal of the ignition coil, though the primary winding, and out the other primary terminal to the distributor. When the ignition switch is in the ON position and the contacts in the distributor are closed, current flows from the battery, through the primary winding of the ignition coil, through the contacts of the distributor, and back to the battery through ground. The current produces a magnetic field around the windings of the ignition coil. When current begins to flow through the winding, self-induction occurs and prevents the current and consequently the magnetic field from reaching their maximum values instantly. A small fraction of a second (called build-up

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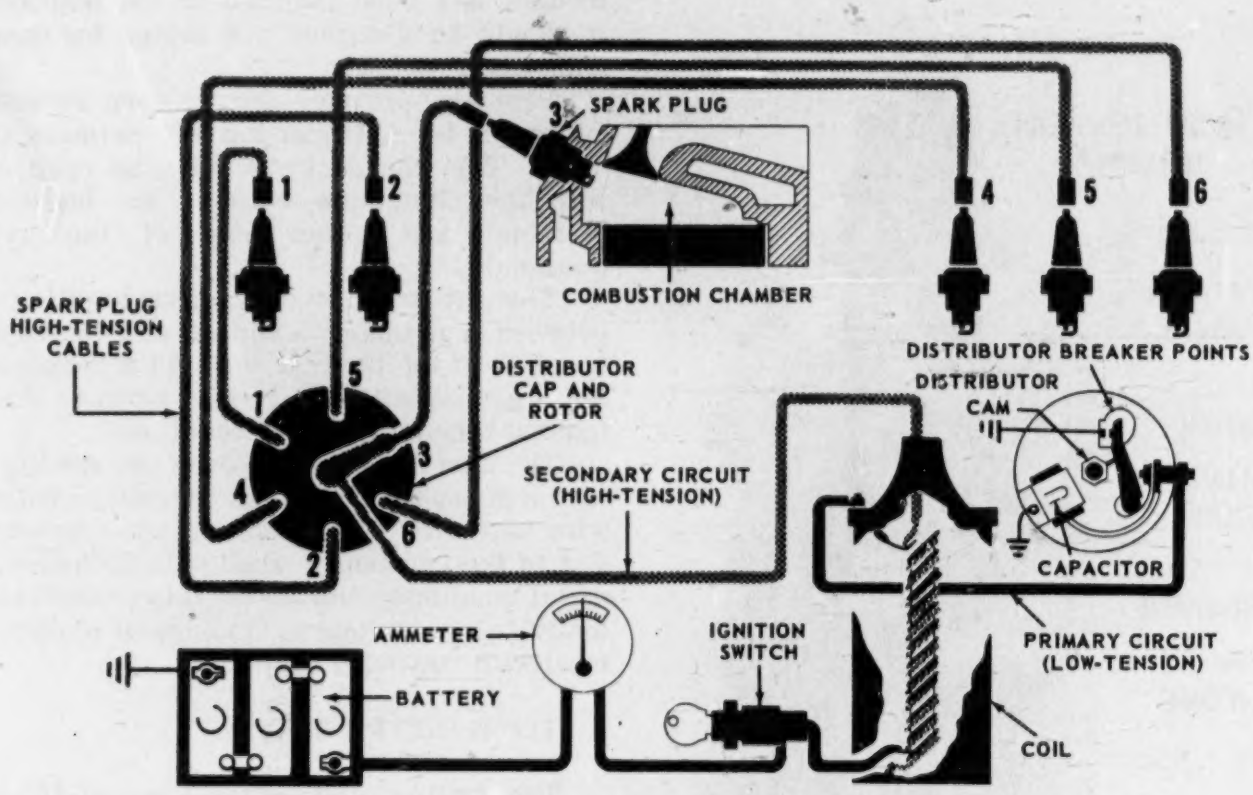

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Figure 10-14.—Battery ignition system.

time) is required for this action to occur. During this time energy is being stored in the magnetic field of the coil. When the cam lobe strikes the breaker-lever rubbing block, the breaker contact points open, thereby interrupting the primary circuit.

When the breaker contacts in the distributor begin to open, the primary current tends to continue to flow because of the self-induction of the winding. If it were not for the ignition capacitor connected across the breaker contacts, current would continue to flow between the separating points. The current would form an arc that would burn the points badly and would also drain away most of the energy stored in the coil. Thus insufficient energy would be left in the coil to produce the necessary high voltage surge in the secondary.

The ignition capacitor, however, provides a path around the points during the instant they begin to separate. Thus, the capacitor acts as a storage reservoir for the energy otherwise dissipated as an arc across the points, and also as a check on the current, quickly bringing it to a stop in the primary circuit. As a result of this action the magnetic field produced by the current quickly collapses. The rapid collapse of the magnetic field in cutting the windings of the ignition coil induces a high voltage in both the primary and secondary windings. The voltage in the primary winding may reach 250 volts (further charging the capacitor); whereas, the secondary winding (which may have 100 times as many turns as the primary) may reach 25,000 volts.

The voltage normally increases to a value sufficient to produce a spark across the spark-plug gap connected to the secondary of the ignition coil through the distributor rotor, cap insert, and high tension lead. This voltage is usually from 4,000 to 18,000 volts, depending on such variables as engine speed, engine compression, mixture ratios, width of spark-plug gap, and others.

As a spark appears at the spark-plug gap, the energy in the ignition coil drains from the coil through the secondary circuit to sustain the spark for a small fraction of a second, or for several degrees of crankshaft revolution. During this interval the capacitor discharges back

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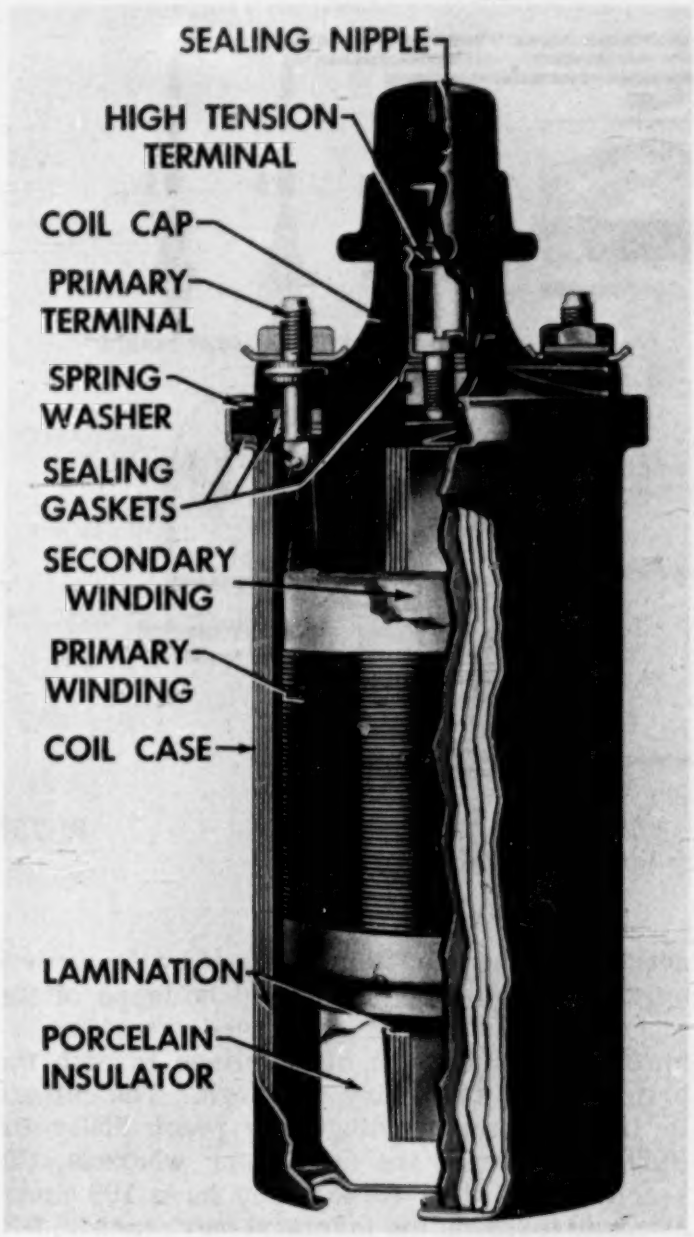

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Figure 10-15.—Ignition coil.

through the primary circuit, producing an oscillation of the current in the primary circuit during the brief interval required for the primary circuit to return to a state of equilibrium. This sequence is repeated as each lobe of the breaker cam moves under and past the rubbing block on the breaker lever to cause the contacts to close and open.

Normally, ignition coils do not require any service except to keep all terminals and connections clean and tight. If the performance of the ignition system is not satisfactory and the trouble has been isolated in the ignition coil, it should be removed and tested for open circuits and grounds.

Test the primary for an open circuit with an ohmmeter between the two primary terminals. Test the secondary for an open circuit with the ohmmeter between the high-tension terminal and either one of the primary terminals.

Test the primary for a ground with a megger between a primary terminal and the container (ground) of the ignition coil. Test the secondary for a ground with the megger between the high-tension terminal and the container.

The test for grounds does not usually apply to the secondary windings of ignition coils used with two-wire (insulated) systems because one end of the secondary winding is grounded to the metal container. However, this ground test does apply to the primary windings of ignition coils used with two-wire systems.

IGNITION DISTRIBUTOR

The ignition distributor (fig. 10-16) closes and opens the primary ignition circuit and distributes the high-voltage surge to the proper spark plug at the correct time in the engine cycle. The distributor includes a drive shaft with breaker cam and spark advance mechanism, a breaker plate with contacts, and a rotor. This assembly fits into a cast-iron housing and is usually supported on a bronze bearing. A molded phenol-resin cap, equipped with terminals for the high-tension secondary, is clamped on the top of the housing (fig. 10-16,A).

The shaft with the breaker cam is usually driven by the engine camshaft at one-half the engine speed through spiral gears. The distributor contacts are held closed by spring pressures and opened by the breaker cam, which usually has the same number of lobes as there are cylinders in the engine.

The primary circuit through the ignition distributor includes the distributor contacts and capacitor (fig. 10-16). As the breaker cam rotates, the cam lobes move around under the contact arm, causing the distributor contacts to open and close (fig. 10-16,B). Thus, the distributor contacts open and close once for each cylinder with every rotation of the breaker cam, and one high-voltage surge is produced by the ignition coil for each cylinder with every two revolutions of the crankshaft.

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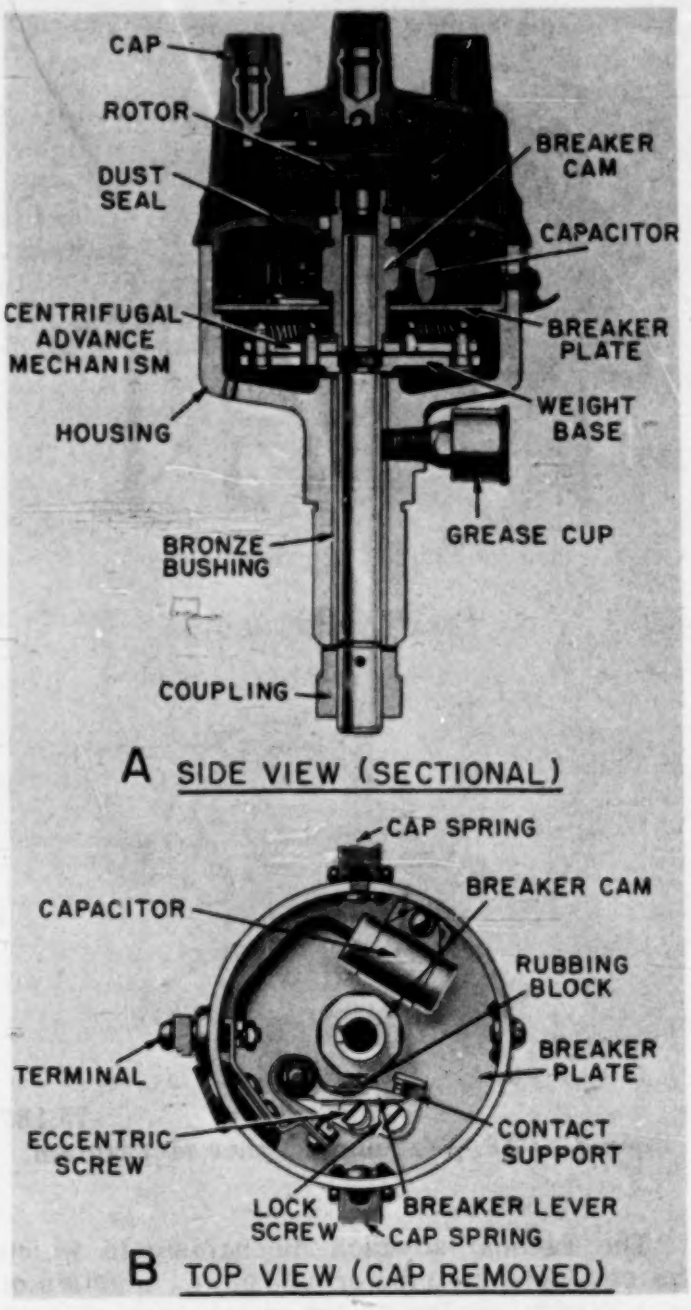

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Figure 10-16.—Ignition distributor.

As mentioned before, the capacitor connected across the distributor contacts provides a quick collapse of the magnetic field in the ignition coil in order to produce the high-voltage surge; it also protects the distributor contacts from arcing.

The secondary circuit through the ignition distributor includes the distributor rotor, distributor cap with high-tension terminals, and the spark plugs (fig. 10-14). The high voltage surge in the ignition coil secondary is conducted through the high-tension lead by way of the center terminal of the distributor cap to the rotor. The rotor is mounted on the breaker cam and rotates with it. During each revolution, a metal spring and segment on the rotor (fig. 10-16,A) connect the center terminal of the distributor cap with each outside terminal in turn. This action directs the high-voltage surges from the ignition coil to the various spark plugs in the engine according to the firing order.

SPARK ADVANCE MECHANISMS

To obtain efficient performance of an internal-combustion gasoline engine for varying conditions of operation, the spark must be timed so that it will occur at the proper time in the compression stroke. For example, when the engine is operating at part throttle, the spark must appear early (before the piston has reached top dead center) to allow sufficient time to ignite the smaller amount of fuel-air mixture (by weight), which is less highly compressed and consequently slower burning. Similarly, when the engine is operating at higher speeds, the spark must appear earlier in the compression stroke in order to give the fuel-air mixture ample time to ignite, burn, and give up its energy to the piston as it starts down on the power stroke. The timing of the spark is usually accomplished by either the centrifugal advance mechanism or the vacuum advance mechanism or both.

Centrifugal Advance Mechanism

The centrifugal advance mechanism is located in the distributor housing below the breaker plate that carries the distributor contacts (fig. 10-17). It consists of an advance cam (which is integral with the breaker cam), two weights, and two weight springs assembled on a weight base that is integral with the distributor shaft (fig. 10-17,A). Each weight is mounted on a stud of the weight base and linked by a weight spring to the advance cam. At low speeds the tension of the weight springs holds the weights in the NO ADVANCE position so that there is no spark advance, and the spark appears in the cylinder just before the piston reaches top dead center on the compression stroke.

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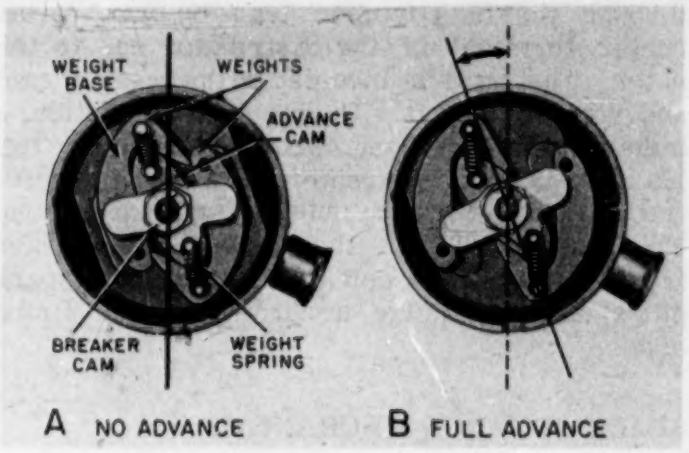

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Figure 10-17.—Centrifugal advance mechanism.

As the speed increases, the centrifugal force developed by the rotating shaft tends to move the weights outward against the tension of the springs. The faster the distributor shaft rotates, the greater the centrifugal force, and the greater the movement of the advance weights. The movement of the weights pushes the advance cam and thus the breaker cam ahead (to an advanced position in the direction of rotation) of the distributor shaft (fig. 10-17,B). This action causes the lobes of the breaker cam to open and close the contacts earlier in the compression stroke so that the spark is advanced. The broken line denotes the idle NO ADVANCE position; whereas, the solid line denotes the high-speed FULL ADVANCE position.

The centrifugal advance for any particular engine is determined initially by operating the engine at full throttle on a dynamometer and varying the spark advance at each engine speed until the advance is determined that will provide maximum power at that speed. The centrifugal advance weights, advance cam contours, and weight springs are designed to supply this advance through the speed range of the engine which varies the spark advance at each engine speed until the advance is determined which will provide maximum power at that speed.

Vacuum Advance Mechanism

The vacuum advance mechanism utilizes the vacuum in the intake manifold to provide the additional spark advance required under part-throttle operation (fig. 10-18).

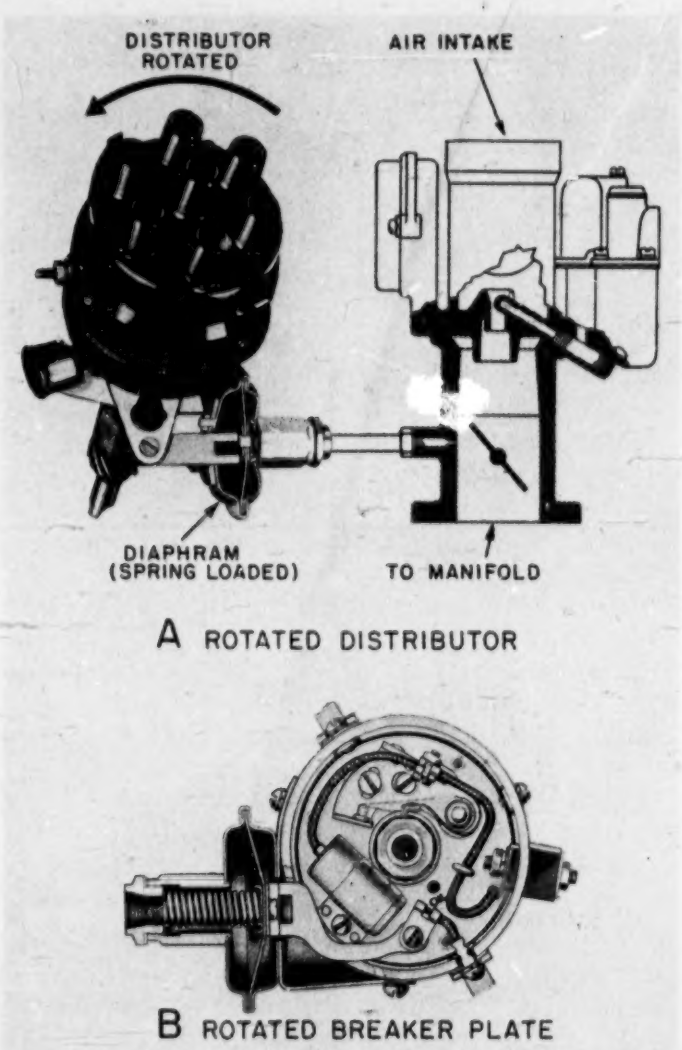

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Figure 10-18.—Vacuum advance mechanism.

The vacuum advance mechanism in which the complete distributor is rotated consists of an airtight, spring-loaded diaphragm that is linked to the ignition distributor (fig. 10-18,A). The spring-loaded side of the diaphragm is airtight and is connected by a tube to the carburetor. This opening is on the atmospheric side of the trottle valve when the throttle is in the idle position so that there is no vacuum advance. However, when the throttle is opened it swings past the opening of the vacuum passage; the intake-manifold vacuum can then act on the diaphragm to compress the spring and rotate the distributor housing in its mounting. This action moves the breaker plate and contacts along with the distributor housing in the direction of rotation of the breaker cam so that

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the contacts close and open earlier in the compression stroke to provide the desired vacuum spark advance. The amount of throttle opening determines, in part, the amount of intake manifold vacuum, and thus the amount of spark advance obtained.

The vacuum advance mechanism in which only the breaker plate is rotated (the distributor housing is stationary) has the advance mechanism mounted on the side of the distributor, and the diaphragm is linked to the breaker plate (fig. 10-18,B). The breaker plate is supported on bearings so that it can rotate independently of the distributor housing.

At any particular engine speed there is a definite amount of spark advance, resulting from the operation of the centrifugal advance mechanism due to speed, and an additional amount of advance resulting from the vacuum advance mechanism due to vacuum conditions in the intake manifold.

SPARK PLUGS

The spark plug (fig. 10-19) in a spark ignition system provides the gap across which the high-tension voltage jumps to create a spark that ignites the compressed fuel-air mixture. It consists of a center (insulated) electrode that is connected to the secondary of the ignition coil through the distributor, and a side (grounded) electrode. The center electrode extends through a porcelain insulator that is supported by a circular metal shell. The side electrode protrudes from the edge of the metal shell and is positioned so that a gap exists between it and the center electrode. The base of the shell is threaded to allow it to be screwed into a tapped hole in the cylinder head.

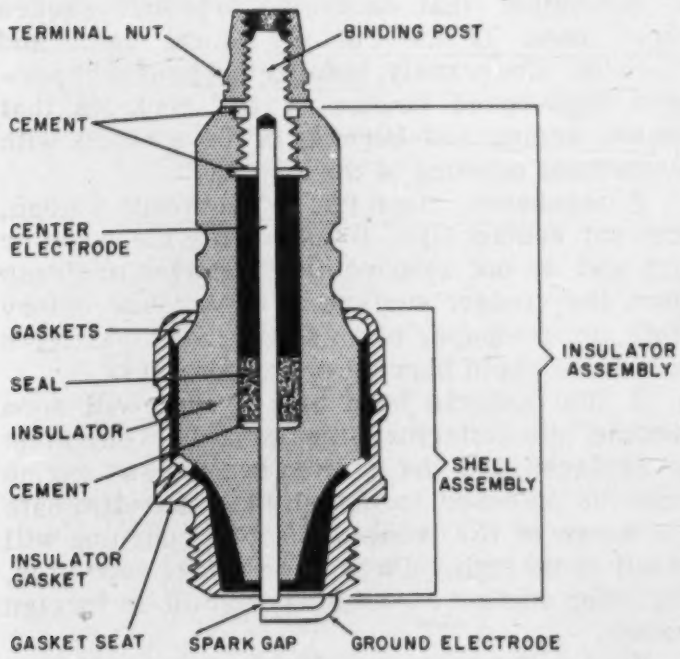

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Figure 10-19.—Spark plug.

The size of the spark-plug gap depends on the engine compression ratio, the characteristics of the combustion chamber, and the ignition system. At one time a gap of 0.025 inch was practically standard on all engines. However, manufacturers now specify gaps of from 0.03 to 0.04 inch to permit more readily igniting the increased mixtures (by weight) used in the higher horsepower engines.

Spark plugs are designed so that the temperature of the firing end is sufficiently high to burn off carbon and other combustion deposits, but not high enough to cause preignition and deterioration of the insulator and electrodes.

The temperature of the insulator depends on the characteristics of the spark plug and on the burning fuel in the combustion chamber. The temperature of the burning fuel in the combustion chamber varies with the engine design, compression ratio, fuel-air ratio, and cooling system. The heat absorbed by the tip of the spark plug from the burning fuel travels up the insulator to the metal shell, to the cylinder head, and to the water jacket. As the temperature in the combustion chamber increases, the heat absorbed by the insulator increases. The tip of the spark plug will have a lower temperature if the length of the path that the heat must travel to reach the cooling system is short as compared to the heat transfer when the path is long. Hence, plugs with short paths are called COLD PLUGS; plugs with long paths are called HOT PLUGS.

Engine manufacturers select plugs that will provide good performance for average operating conditions. However, if the engine is operated for long periods under full-load or overload conditions, the standard-equipment spark plug will operate at too high a temperature and preignition will result. Hence, it will be necessary to install a colder plug to carry off the heat more rapidly. On the other hand, if the engine is operated for long periods at part throttle, the standard-equipment plug may tend to foul due to the accumulation of carbon at

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reduced temperature, thereby resulting in poor engine performance. Hence, it will be necessary to install a hotter plug to concentrate the heat and burn off the accumulated products of combustion.

MAINTENANCE

A regular inspection and maintenance procedure is necessary to attain maximum service with minimum trouble. For the ignition distributor, the procedure includes periodic lubrication (where required) and inspection of the breaker contacts, centrifugal and vacuum advance mechanisms, connections, distributor cap, and rotor.

Test the vacuum advance mechanism to be certain it operates freely. On the type that rotates the complete distributor, manually turn the distributor in its mounting and then release it. The vacuum advance spring should return it to its original position without sticking. On the type that rotates the breaker plate only, manually turn the plate. The breaker plate should return to its original position when released.

Test the centrifugal advance mechanism for freedom of movement by turning the breaker cam in the direction of shaft rotation and then releasing it. The advance springs should return the cam to its original position without sticking.

Wipe out the inside of the distributor cap with a clean, lint-free cloth and inspect both the cap and the rotor for chips, cracks, and carbonized paths that would allow leakage of the high-tension voltage to ground. These defects require replacement of the affected part.

After installing new points, test the breaker contact opening with a feeler gage. Do not use the feeler gage to check the opening of old contacts because the contour of these contacts will be irregular, and the gage will measure only the distance between the high spots instead of between the high and low spots, which is the actual opening. To adjust the contact opening, loosen the lock screw and turn the eccentric screw (fig. 10-20). Tighten the lock screw after the adjustment is completed.

The cam (contact) angle is the number of degrees that the breaker cam rotates from the time the contacts close until they again open (fig. 10-20). The cam angle increases as the contact opening is decreased, and conversely, it decreases as the contact opening is increased.

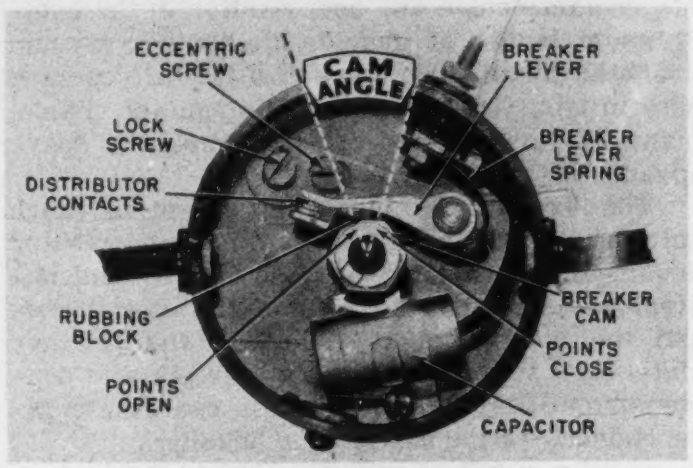

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Figure 10-20.—Distributor adjustments.

Test the breaker contact pressure with a brush tension gage (hooked to the breaker lever and the spring secured to its terminal in the distributor) and exert a pull at an angle of 90° with the contact surface. The reading should be taken just as the contacts separate. Adjust the pressure by bending the breaker lever spring. If the pressure is excessive, it can be decreased by pinching the spring carefully. If the pressure is not sufficient, remove the breaker lever from the distributor and bend the spring away from the lever. It is important to remember that excessive pressure causes rapid wear of the rubbing block, cam, and contacts. Conversely, insufficient pressure permits high-speed bounce of the contacts that causes arcing and burning of the contacts with consequent missing of the engine.

If necessary, clean the contacts with a clean, fine-cut contact file. Remove only the scale or dirt and do not remove all roughness or dress down the contact surfaces. Never use emery cloth or sandpaper because imbedded particles will cause rapid burning of the contacts.

If the contacts burn or pit, they will soon become unsatisfactory for service. They must be replaced and the ignition system and engine must be checked to determine, and eliminate the cause of the trouble. Contact burning will result from high voltage, a defective capacitor, improper contact adjustment, and oil or foreign matter.

High voltage can result from a maladjusted or inoperative voltage regulator, or an excessively advanced third brush on a third-brush generator without a regulator.

Oil or crankcase vapors that work up into the distributor and deposit a film on the contact surfaces will cause them to burn rapidly. This condition can be caused by clogged engine breather pipes, resulting in a crankcase pressure that forces the oil or vapors up into the distributor.

If the contact opening is too small (cam angle too large), the contacts will be closed over a great portion of the total operating time. The current through the contacts will be too high, causing them to burn rapidly and arcing will occur between the contacts, resulting in a low secondary voltage and engine miss.

The capacitor circuit connections should be tested to detect excessive resistance because a high series resistance in the capacitor circuit will prevent normal capacitor action and result in rapid burning of the contacts. This high resistance can be caused by a loose (capacitor) mounting or lead connection. Other capacitor tests should include allowable voltage, insulation resistance, and capacity checks.

Contact pitting will result from an unbalanced condition in the ignition system, causing a transfer of tungsten from one contact to the other to form a tip on one and a pit in the other.

If the tungsten transfers from the negative to the positive contact, one or more of the following corrections may be made: increase the capacity of the capacitor, shorten the capacitor lead, separate the low- and high-tension leads of the distributor-to-coil leads, or move these leads closer to ground (engine block or frame).

If the tungsten transfers from the positive to the negative contact, reduce the capacity of the capacitor, move the distributor-to-coil leads closer together, move these leads away from ground, or lengthen the capacitor lead.

The spark plugs should be removed and inspected for cracked porcelain and wear. If they can be retained in service, file the end of the center electrode to a flat surface, clean both electrodes and then readjust the spark gap in accordance with the manufacturers' specifications. When readjusting the gap, bend the side electrode only. Do not bend the center electrode because it may crack the insulator.

More detailed information concerning the maintenance and repair of the ignition system is contained in the manufacturers' instruction books furnished with the equipment.

AIR HEATERS

Ignition in a diesel engine is accomplished by a combination of fuel injection and compression. Diesel engines normally require a longer cranking period than gasoline engines, and at low ambient temperatures they are more difficult to start because the heat of compression may not be sufficient to ignite the fuel-air mixture. Therefore, at low temperatures it is necessary to preheat the engine by means of an electric air heater, or to furnish an auxiliary low-ignition temperature fuel during the starting period by means of a pressure primer system. The types of air heaters and primers used for starting diesel engines include the (1) grid resistor, (2) glow plug, (3) flame primer, and (4) ether capsule primer.

GRID RESISTOR

The grid resistor usually consists of a 1200-watt resistance grid mounted on a frame and supported by insulating blocks in the engine air-intake manifold. The grid is preheated by current from the starting battery before the engine is cranked and is operated during the cranking period until the engine is running smoothly.

GLOW PLUG

The glow plug consists of a coil of resistance wire enclosed in a stainless-steel tube and is installed in the combustion chamber of each cylinder. The glow plugs are preheated by current from the starting battery and require about the same amount of power and preheat period as the grid resistor.

The glow-plug and grid-resistor type heaters are not used extensively because of the heavy load imposed on the starting battery at the time that the cranking-motor load is heavy.

FLAME PRIMER

The flame primer (fig. 10-21) is the most widely used type of air heater for preheating diesel engines when starting at low temperatures. It is essentially a small, pressure oil burner with electric ignition. The fuel oil is sprayed into the engine air-intake manifold with a manually operated pump, and ignited

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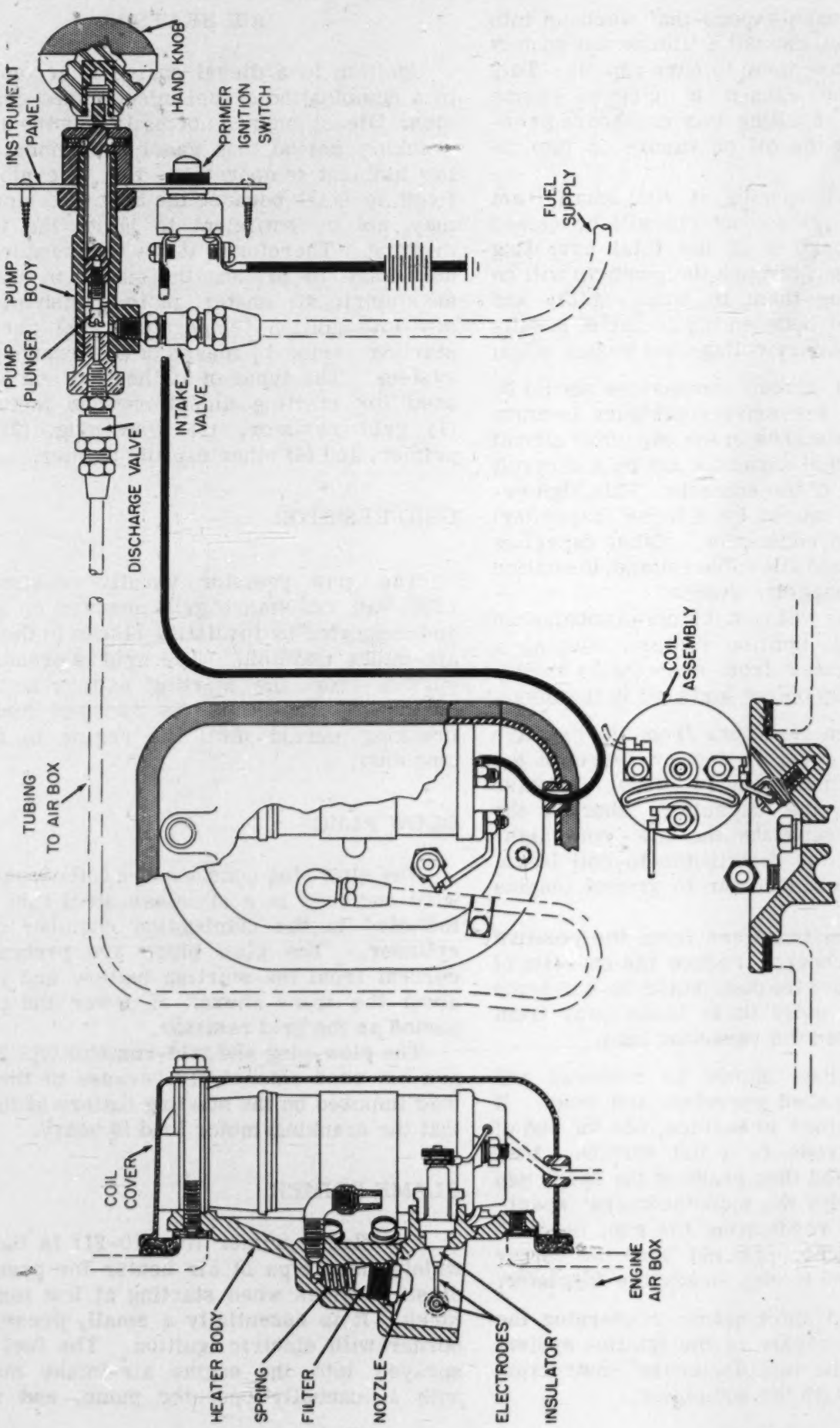

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Figure 10-21.—Flame primer.

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the rotor is fixed with respect to the aircraft, and the stator is fixed with respect to the gyro, an a-c roll signal is developed when the rotor is displaced by the rolling of the aircraft. When the attitude of the aircraft combines both pitch and roll, pitch and roll signals are simultaneously produced by the gyroscope unit. These signals are fed to the resolver synchro in the antenna assembly. (See fig. 17-37.)

When displacement of the gyroscope synchros occurs, a torque is developed at the stator coils, which, if not compensated for, will cause the gyro to deviate from true vertical, thereby introducing errors into the reflector angle of stabilization. To counteract this effect, a balancing coil connected to a load resistor is mounted along with the stator of each synchro. When displacement of the rotor occurs, the magnetic field developed about the balancing coil causes a torque in the direction opposite to that already exerted on the stator, thus insuring stability of the gyro. The gyroscope unit is mounted on the aircraft structure and is provided with a reference base plate which is adjusted to a plane parallel to that of the antenna platform. The component is also provided with a sighting surface to permit alinement parallel to the lubber line of the aircraft.

Resolver Synchro

Within the resolver synchro, the pitch and roll signals from the gyro are combined by induction in a rotor coil that is geared to the rotary head of the scanner, with which it rotates in a one-to-one ratio. Because of this mechanical coupling, the resultant resolver-synchro signal used in tilt stabilization experiences the proper variation throughout the scanning cycle to maintain the selected reflector tilt angle with respect to the aircraft for every azimuth position of the scanner. The net effect of tilt stabilization is to maintain a fixed predetermined angle of tilt between the reflector and the true horizontal, while the aircraft experiences the usual variations of normal flight.

The pitch and roll signals developed by the gyroscope unit are fed into the separate stator windings of the resolver synchro. These stator windings are mounted at right angles to each other. The orientation of the rotor is adjusted so that when the reflector is dead ahead, pitching of the aircraft causes maximum pitch signal to be induced in the rotor of the resolver synchro; when the reflector is directed to extreme port or starboard, rolling of the aircraft causes maximum roll signal to be induced in the rotor of the resolver synchro. At intermediate positions of the reflector, combinations of both pitch and roll signals are induced in the rotor. One of these voltages may be either aiding or opposing the other, according to the attitude of the aircraft, with respect to the azimuth position of the reflector.

Servoamplifier

The SERVOAMPLIFIER amplifies the error signal resulting from the combining of the manual-tilt synchro signal and the resolver-synchro signal, and controls the voltage to the tilt-torque motor, which corrects the tilt angle of the scanner.

The servoamplifier uses two resistance-coupled amplifiers, followed by a phase-discriminator stage and a pair of d-c amplifiers working into a saturable-reactor assembly. The output of the phase-discriminator stage, amplified by the d-c amplifiers, controls the a-c voltage that drives the tilt-torque motor. The direction of drive, which determines direction of tilt, is governed by the phase relationship between the exciting voltage and the control voltage of this motor; this relationship is, in turn, dependent upon the phase relationship between the motor-exciting voltage and the error voltage at the input of the servoamplifier.

The scanner is maintained at an angle of tilt with respect to the horizon. This angle is determined by the setting of the TILT control. This condition is achieved by combining the signal from the manual-tilt synchro with the one from the resolver synchro at the input of the servoamplifier. (See fig. 17-37.) The signal from the manual-tilt synchro is applied to one side of the ratio potentiometer, R1, and the signal from the resolver synchro is applied, through resistor R2, to the opposite terminal of the same potentiometer, whence they are combined in the servoamplifier. These two signals are 180° out of phase, and when of equal amplitude they cancel each other. When this cancellation is complete, there is no control voltage for the tilt-torque motor, and consequently no tilt action is applied to the scanner.

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by means of a spark plug, ignition coil, and vibrator. The device consists of two assemblies. One unit contains the burner, ignition coil, and vibrator. The other unit comprises the pressure pump and ignition switch. The principal advantage of the flame primer is that it imposes a negligible load on the starting battery.

The heater unit consists of a nozzle, filter, ignition electrodes, and ignition coil with vibrator. One side of the heater body contains the filter, nozzle, and ignition electrodes and the other side contains the ignition coil, terminals, and connection for the fuel supply. The unit is designed to replace one of the hand-hole cover plates nearest the center of the engine air box. The entire heater unit is provided with a protective metal cover. The air necessary for combustion is obtained from the charging blower, and the products of combustion including the flame-heated air are discharged into the engine cylinders (with practically no heat loss), resulting in an immediate response of the engine.

The pressure pump and ignition switch (fig. 10-21) are mounted on the instrument panel near the engine starter switch so that both the ignition switch and engine starter switch can be depressed simultaneously with one hand, thereby leaving the other hand free to operate the pump. The pump supplies fuel under pressure to the heater unit where the charge is filtered before reaching the nozzle. The suction side of the pump is either connected directly to the main fuel tank, or to the engine supply line between the main tank and the engine transfer pump. When the pump plunger is not in use, it is held in the IN position by a spring mechanism. The pump plunger is designed so that a pressure of about 10 pounds on the knob will deliver (from the nozzle) a finely atomized fuel. This fuel is readily ignited by the sparks at the electrodes in the heater unit. The rate of travel of the plunger on the pumping stroke is determined by the flow of oil from the discharge nozzle, and normally requires 3 or 4 seconds per stroke.

The ignition switch is connected in the line between the starting battery and one terminal of the ignition coil in the heater unit. The other terminal (primary) of the ignition coil is grounded to the engine.

If the engine fails to fire after two or three strokes of the primer pump while cranking the engine with the throttle wide open, stop cranking and examine the flame primer for possible causes of failure. If the engine is operating satisfactorily and the cranking speed is 80 rpm or more, test the flame primer for (1) ignition failure and (2) poor oil spray. If possible, remove the burner element from the engine so that the burner operation can be readily observed.

To test the flame primer for IGNITION FAILURE, depress the ignition switch to the ON position and observe the action of the ignition-coil interrupter inside the coil assembly. It should vibrate rapidly and a continuous hot spark should occur between the ignition electrodes. If the interrupter does not vibrate, examine the interrupter contacts for dirt or carbon. Also examine the wiring for loose or broken connections. Clean the contacts with fine sandpaper and reset the air gap to one-eighth inch with the vibrator armature held against the coil.

If the spark jumps across the porcelain of the electrode, check the gap and reset it to about one-eighth inch (if necessary) by loosening the set screw and moving the grounded electrode. If the air gap is correct, remove the threaded gland on the porcelain electrode and withdraw the electrode assembly. Wash the porcelain with a cleaning solvent and scrape off any accumulation of carbon. Reassemble the porcelain electrode after it has been cleaned properly.

ETHER CAPSULE PRIMER

The ether capsule primer (fig. 10-22) consists of a (1) discharger cell, (2) discharger nozzle, and (3) pressure primer bulb that contains a liquid ether mixture. The discharger cell and the discharger nozzle are connected together by a suitable length of 3/16" tubing. The discharger cell is a metal enclosure containing a piercing pin and provided with a removable cap for inserting the pressure primer (capsule) bulb. The cap is equipped with a discharger lever. When this lever is operated, it forces the capsule bulb against the piercing pin.

The discharger cell is installed at the control station in a vertical position so that the neck of the capsule bulb is always down toward the piercing pin. The discharger nozzle is installed through a 1/4" pipe connection at the forward end of the intake manifold.

When the ether capsule primer is used for cold-weather starting, press the engine starter

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a time, and at about two-minute intervals to allow the heat to dissipate. The starting current on most small boats is over 600 amperes.

The starting motor is equipped with a drive mechanism that transmits the power from the motor to the engine. The function of the drive mechanism is to (1) engage the drive pinion with the flywheel for cranking the engine, (2) provide a gear reduction between the drive pinion and flywheel, and (3) disengage the drive pinion and flywheel after the engine is started.

When the starting motor is operated, the drive mechanism causes the drive pinion to mesh with the teeth of the flywheel ring gear, thereby cranking the engine.

The gear reduction is necessary because the starting motor must rotate at a relatively high speed with respect to the engine cranking speed to produce sufficient output power to crank the engine. Thus, a gear reduction ratio of 15 to 1 will permit the starting motor to rotate at 1500 rpm while cranking the engine at 100 rpm.

As soon as the engine is started, the drive mechanism causes the drive pinion to disengage from the flywheel. The engine speed increases immediately and may soon attain speeds up to 1000 rpm. If the drive pinion is allowed to remain in mesh with the flywheel, the engine would drive the starting motor at speeds up to 15,000 rpm, resulting in serious damage to the motor.

The types of drive mechanisms provided on starting motors are the (1) Bendix drive, (2) overrunning clutch drive, and (3) Dyer drive.

BENDIX DRIVE

The Bendix drive provides an automatic means of engaging the drive pinion of the starting motor with the engine flywheel ring gear for cranking the engine and for disengaging the drive pinion from the flywheel after the engine starts. This drive mechanism (fig. 10-23) consist of a drive pinion mounted on a threaded sleeve, or hollow shaft, which has spiral threads that match the internal threads in the drive pinion. The sleeve fits loosely on the armature shaft of the starting motor. One end of the sleeve is bolted to the drive spring. The other end of the drive spring is keyed and bolted to the armature shaft through the drive head.

When the starting motor is not in operation, the pinion is disengaged from the flywheel ring gear. As soon as the starting switch is closed, the armature begins to rotate and its speed increases very rapidly. The threaded sleeve picks up speed with the armature as it is

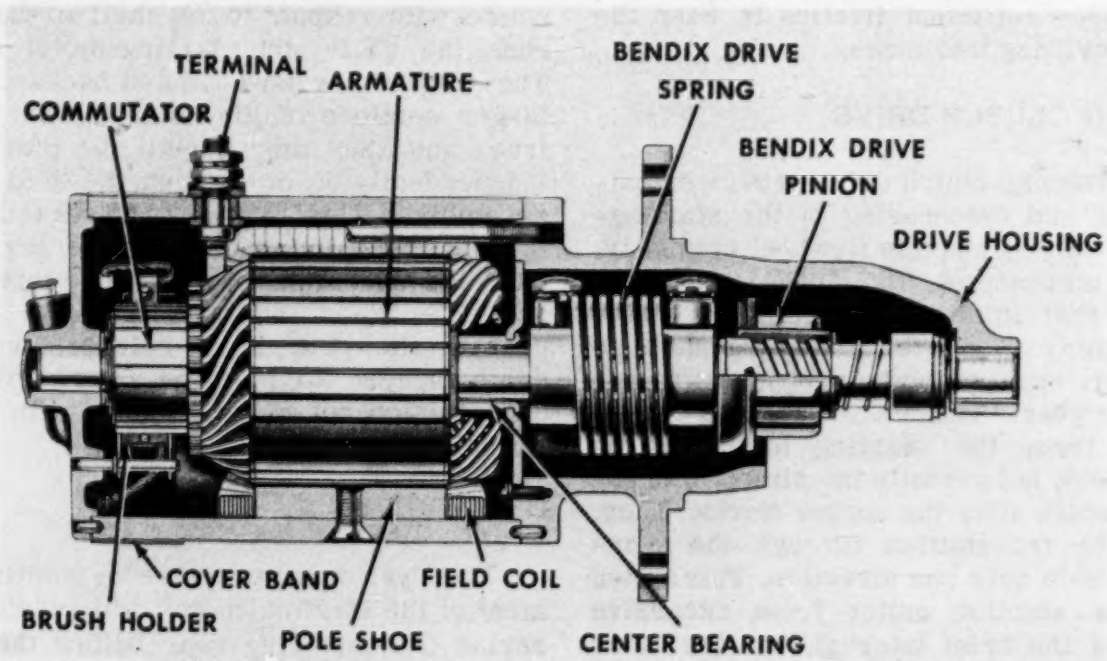

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Figure 10-23.—Bendix drive.

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driven through the drive spring. The drive pinion does not pick up speed instantly because it fits loosely on the sleeve. Hence, the sleeve turns within the drive pinion, forcing the pinion along the shaft and into engagement with the flywheel ring gear. As the drive pinion reaches the stop on the end of the sleeve, it then rotates with the sleeve and the armature so that the engine is cranked.

The drive spring compresses slightly to absorb the shock when the gears are meshed to prevent the shock from being transmitted back through the starting motor. Bendix heavy-duty drives are provided with a friction clutch interposed between the drive spring and drive pinion. The clutch comprises a series of spring-loaded clutch plates that slip momentarily during engagement to absorb the shock.

After the engine starts, the flywheel drives the pinion at a higher speed than the speed at which the armature and the threaded sleeve are revolving. This action causes the pinion to be turned relative to the threaded sleeve and in such a direction that the pinion is backed out of engagement with the flywheel ring gear.

Some Bendix drives are provided with a small antidrift spring between the drive pinion and the pinion stop. This device prevents the pinion from drifting into mesh when the engine is running. Other Bendix drives use a small antidrift pin and spring inside the pinion. This device provides sufficient friction to keep the pinion from drifting into mesh.

OVERRUNING CLUTCH DRIVE

The overrunning clutch drive provides positive engaging and disengaging of the starting-motor drive pinion and the flywheel ring gear. This drive mechanism (fig. 10-24) utilizes a shift level that slides the clutch and drive pinion assembly along the armature shaft so that it can be engaged and disengaged with the flywheel ring gear. The clutch transmits cranking torque from the starting motor to the engine flywheel, but permits the pinion to overrun the armature after the engine starts. Thus, power can be transmitted through the overrunning clutch in only one direction. This action protects the starting motor from excessive speed during the brief interval that the drive pinion remains engaged with the flywheel ring gear after the engine has started.

The overrunning clutch consists of a shell-and-sleeve assembly (fig. 10-24) that is splined internally to match the splines on the armature shaft. Thus, both the shell-and-sleeve assembly and the armature shaft must turn together. A pinion-and-collar assembly fits loosely into the shell. The collar is in contact with four steel rollers that are assembled into notches cut in the inner face of the shell. The notches taper inward slightly so that less space is in the end away from the rollers. The rollers are spring loaded by means of springs and plungers.

When the shift lever is operated, the clutch assembly is moved along the armature shaft until the pinion engages with the flywheel ring gear. If the teeth should butt instead of engage, the clutch spring compresses so that the pinion is spring loaded against the teeth of the ring gear. Thus, engagement of the teeth takes place immediately when the armature begins to rotate.

The starting-motor switch is closed when the movement of the shift lever is completed, causing the armature to rotate. This action rotates the shell-and-sleeve assembly, causing the rollers to move forward (in the direction of rotation) and jam tightly in the smaller sections of the notches. The rollers jam between the pinion collar and the shell so that the pinion is forced to rotate with the armature, and thereby crank the engine.

After the engine starts, it spins the pinion faster than the armature of the starting motor is rotating. This action causes the pinion to rotate with respect to the shell so that it overruns the shell and starting-motor armature. The rollers are now rotated backward into the larger sections of the notches where they are free, and thus they permit the pinion to spin independently of, or overrun, the shell and sleeve assembly. This feature protects the armature for the brief interval after the engine starts until the operator releases the starting-motor switch. When the starting-motor switch is opened, the shift lever releases, causing the drive spring to pull the overrunning clutch drive pinion out of engagement with the engine flywheel ring gear.

DYER DRIVE

The Dyer drive provides for positive engagement of the starting-motor drive pinion with the engine flywheel ring gear before the starting-motor switch is closed. It is used for heavy duty applications where it is important to avoid clashing of gears because of the relatively high horsepower developed in cranking these

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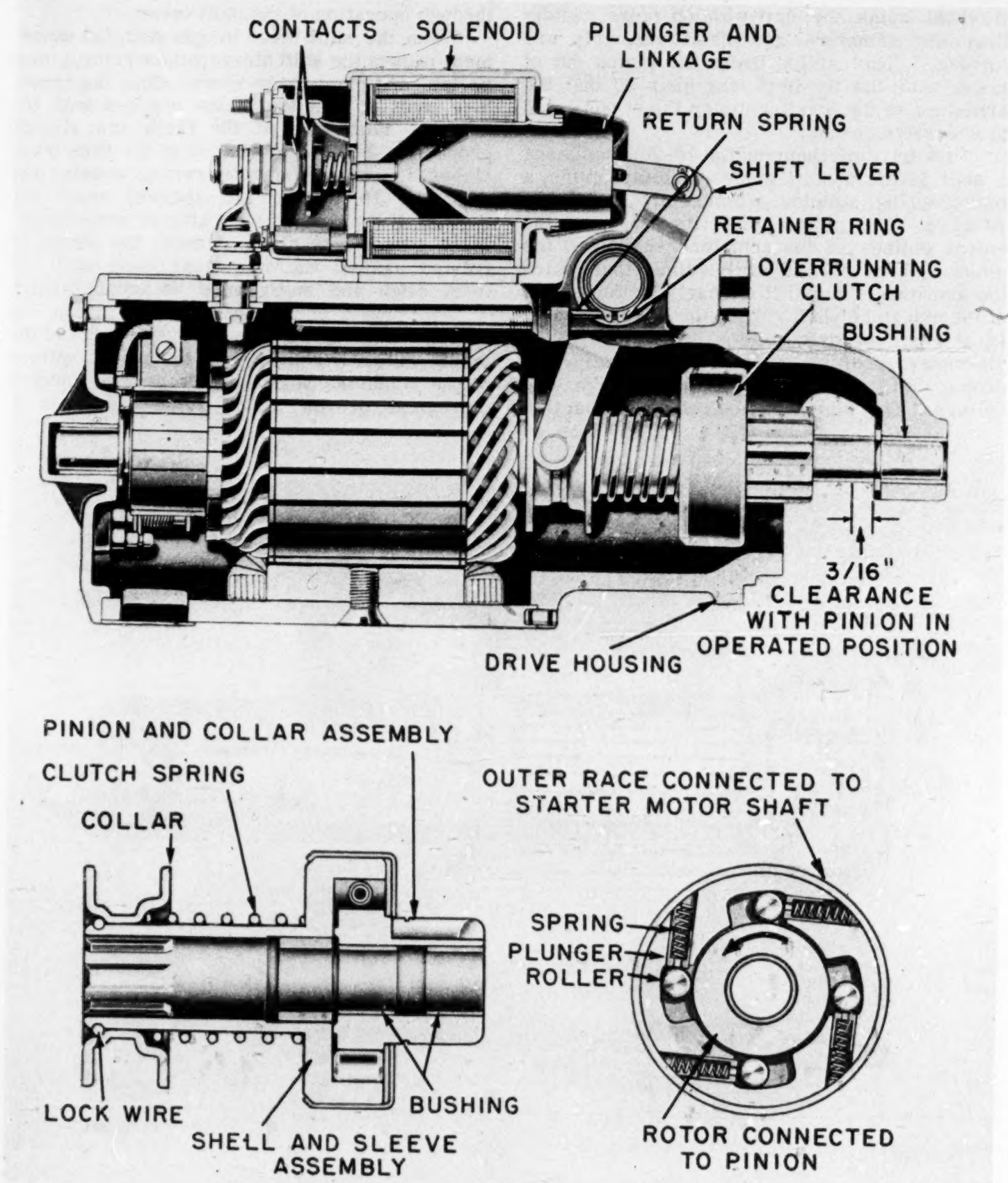

Figure 10-24.—Overrunning clutch drive with solenoid-operated switch. 75.173

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engines. As soon as the engine starts, the flywheel spins the drive pinion more rapidly than the armature and shaft assembly are turning. This action backs the pinion out of mesh with the flywheel ring gear so that the armature of the starting motor is not subjected to excessive speeds.

This drive mechanism (fig. 10-25) consists of a shift lever, a shift sleeve, a pinion guide, a pinion spring, a pinion, a pinion stop, and thrust washers. The pinion guide fits snugly on the spiral splines of the armature shaft, and the pinion (which has internal splines that match the armature splines) fits loosely on the splines of the armature shaft. When the drive assembly is at rest, the drive pinion is retained in the disengaged position by the pinion guide, which drops into milled notches in the armature splines. The pinion can be released from this position only by movement of the pinion guide through operation of the shift lever.

When the shift lever is operated, the movement causes the shift sleeve, pinion guide, pinion spring, and pinion to be moved along the armature shaft so that the pinion engages with the flywheel ring gear if the teeth are aligned properly. Further movement of the shift lever closes the starting-motor switch, causing the armature to rotate, and thereby crank the engine. If the teeth are not aligned and engagement cannot take place at once, the pinion is rotated against the ring gear teeth until the teeth align and engagement is accomplished.

The pinion rotates because the pinion fits loosely on the armature-shaft splines, and the pinion guide fits tightly on the spiral splines of the armature shaft. The continued forward movement of the pinion guide causes it to

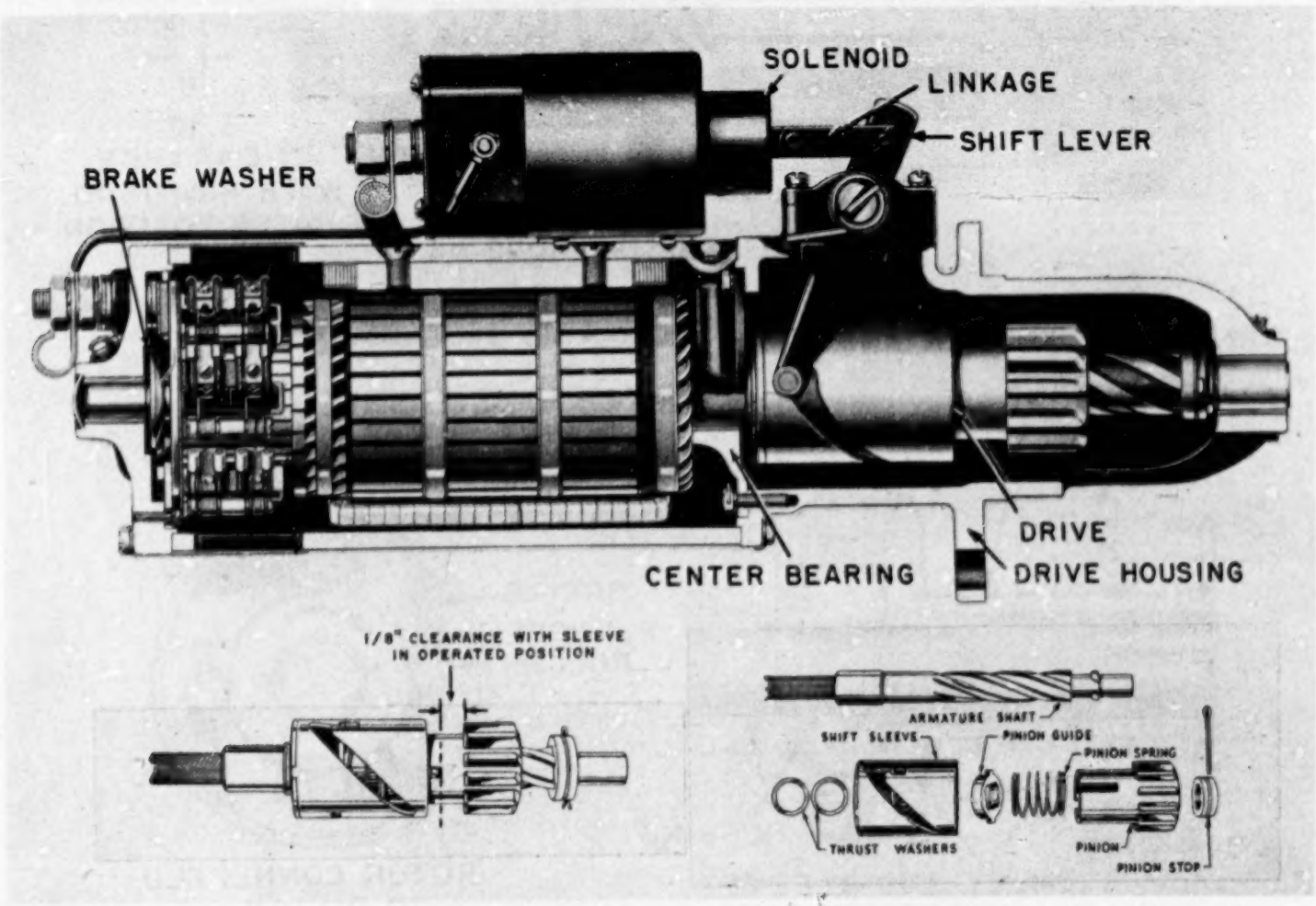

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Figure 10-25.—Dyer drive.

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rotate as it follows the spiral splines on the armature shaft. This rotation is transmitted by means of the two lugs on the pinion guide to the pinion. The pinion rotates without any forward movement until alignment of the teeth takes place, then the pinion is thrust forward into engagement with the flywheel ring gear.

The pinion stop limits the forward movement of the pinion. As the shift lever completes its travel, it closes the starting-motor switch, which is linked mechanically with the shift lever, and the armature of the starting motor begins to rotate. As soon as the armature of the starting motor begins to rotate, the friction of the armature shaft in the shift sleeve causes the shift sleeve to rotate. The stud on the end of the shift lever is in the slot in the shift sleeve so that rotation of the shift sleeve causes it to move back out of the way from the drive pinion. Cranking takes place as the shaft splines cause the drive pinion to rotate with the armature shaft.

As soon as the engine begins to operate, it spins the drive pinion faster than the armature is rotating, causing the drive pinion to be spun back out of engagement with the flywheel ring gear. As the pinion moves back out of engagement, the pinon guide drops into the milled section of the shaft splines to lock the pinion in the disengaged position. It is impossible to start another cranking cycle without completely releasing the shift lever. The shift lever must drop back to the disengaged position so that the stud can rotate the shift sleeve and reengage the flat section of the spiral slot in the shift sleeve. Movement of the shift sleeve will then cause the cranking cycle to again take place.

The drive pinion will not engage with the flywheel ring gear while the engine is operating because when the pinion teeth touch the teeth of the moving flywheel ring gear, the shift sleeve will be rotated, and the pinion will follow the splines on the armature shaft back to the located position.

CONTROLS

The controls used with starting motors in small craft are the (1) magnetic switch and (2) solenoid switch.

The magnetic switch (fig. 10-26) is used to close the motor switch on some starting motors equipped with Bendix drive. It is usually mounted on the motor frame and consists of a coil provided with a spring-loaded plunger. The coil is connected in series with a starter switch located on the instrument panel. When the starter switch is operated, the coil is energized from the battery and pulls the plunger so that the contact disk is forced across two contacts to complete the circuit between the battery and the starting motor.

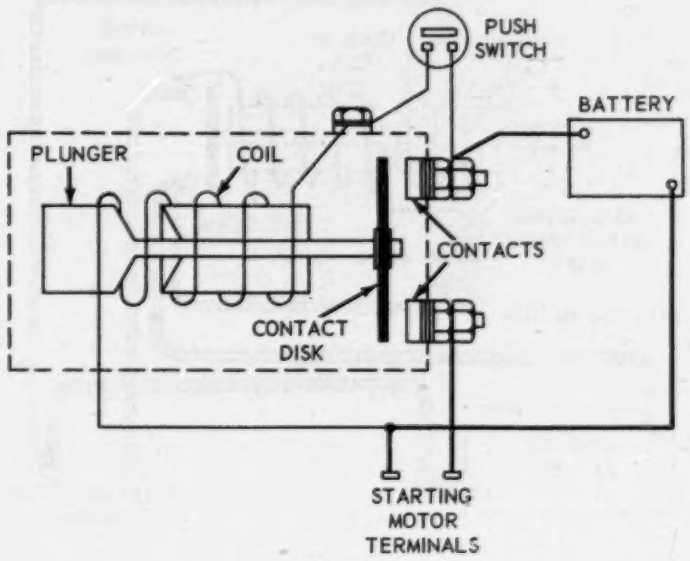

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Figure 10-26.—Magnetic switch.

The solenoid switch (fig. 10-27) is used on some starting motors equipped with overrunning clutch drives and Dyer drives to close the circuit to the starting motor and also to engage the pinion with the flywheel ring gear. It is mounted on the motor frame and consists of a pull-in coil and a hold-in coil provided with a spring-loaded plunger. A heavy contact disk is attached to one end of the plunger, and the other end is connected by linkage to the shift lever. Both coils are connected in series with a starter switch located on the instrument panel. When the starter switch is operated, both coils are energized (from the battery) and the plunger is pulled so that the pinion engages with the flywheel ring gear. The pull-in coil draws a comparatively heavy current necessary to complete the plunger movement. The hold-in coil aids the pull-in coil. Continuation of the plunger movement closes the switch contacts, thereby permitting the starter motor to crank the engine. As soon as the solenoid switch is closed (and

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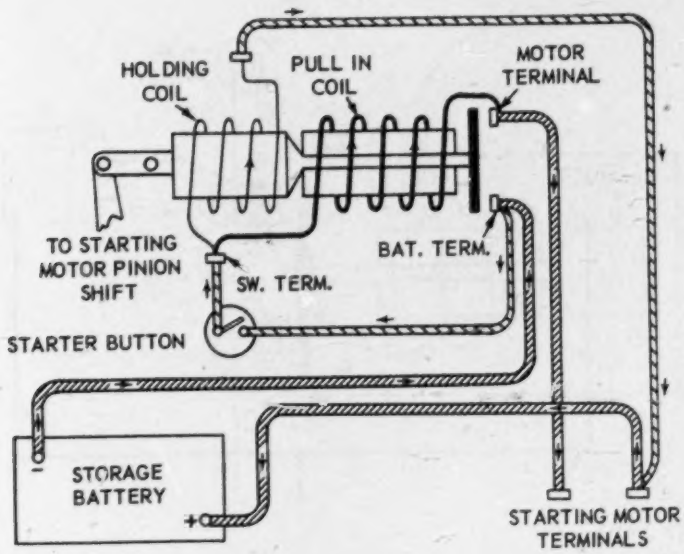

Figure 10-27.—Solenoid switch.

the pinion shifted), the pull-in coil is shorted by the switch contacts in the starting-motor circuit so that only the hold-in coil is energized to retain the plunger in the operated position.

When the starter switch is released, the tension of the return spring in the drive assembly actuates the plunger to open the circuit to the starting motor.

MAINTENANCE

A regular inspection and maintenance procedure should be followed to obtain the maximum service with minimum trouble from starting motors in small craft. Periodic inspections of the brushes, commutator, drive assembly, and lubrication (where required) are essential. Also, disassembly and thorough overhauling of the starting motor at periodic intervals are necessary to ensure against failures caused by accumulations of grease and moisture and normal wear of the parts. The external circuit between the starting motor and the battery, including the magnetic switch or solenoid switch, must be properly maintained because defective wiring, such as loose or corroded connections, will prevent normal performance of the starting system.

The following intervals of inspection are based on average operating conditions but can be adapted for specialized operations.

EACH WEEK, visually check the connections and cables between the starting motor and the battery. Also, check the mounting bolts to be certain they are secure.

EACH MONTH, lubricate the starting motor by adding a few drops of light engine oil to the hinge-cap oiler. On motors equipped with grease cups, turn the grease cups down one turn. Be certain that the cups are filled with medium cup grease. Remove the cover band and inspect the commutator and brushes. If the commutator is dirty, clean it with a strip of No. 00 sandpaper held against it with a piece of soft wood while operating the starting motor with the ignition switch in the OFF position. Blow out the dust with compressed air or a bellows. If the commutator is rough, out-of-round, or has high mica, turn it down in a lathe in accordance with the procedures described in chapter 6 of this training course.

EACH YEAR, remove and disassemble the starting motor so that all parts can be cleaned and the worn parts replaced. Check the brush holders to be certain they are free on their pivots and have the correct spring tension. Clean the bearings and repack them with the proper grease. On motors equipped with oil wicks, saturate the wicks with oil before reassembly. On motors equipped with oil-less type bushings, supply a few drops of light engine oil on the bushings at any time the starting motor is disassembled for repair or service. Avoid excessive lubrication.

The Bendix drive should be washed in kerosene and then lubricated by applying a small amount of light engine oil. Do not over oil this mechanism because it might cause the pinion to stick. Replace the pinion if the pinion teeth are burred. Inspect the drift-pin spring because, if the spring is weak, the pinion might tend to drift into engagement with the flywheel ring gear while the engine is running.

The overrunning clutch drive is packed with a special high melting-point grease when the clutch is initially assembled and requires no further lubrication. Do not clean the clutch by grease-dissolving or high-temperature methods because this would cause the clutch to lose its lubricant. Replace the clutch if the pinion does not turn freely in the overrunning direction, if the pinion tends to slip in the cranking direction, or if the pinion is excessively loose. When the overrunning clutch is operated by means of a solenoid switch, check the clearance (fig. 10-24) between the pinion and the bearing housing

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when the pinion is in the operated position. This clearance should be three-sixteenths inch and is adjusted by turning the stud in the solenoid plunger in or out as required.

The Dyer drive should be lubricated with a small amount of light engine oil after reassembly. Do not use heavy oil or grease as it might retard or prevent normal drive performance. The adjustment of the drive mechanism must be checked to be certain that the travel of the pinion against the pinion spring is correct when the pinion is in the cranking position. When the shift lever is in the cranking position, it should be possible to push the pinion one-eighth to three-sixteenths inch back against the pinion spring pressure (fig. 10-25). This free travel adjustment can be checked on the solenoid-operated starting motor by disconnecting the lead between the solenoid and starting motor and connecting a battery of the specified voltage to the two terminals on the solenoid.

Manually operate the shift lever until the switch is closed. The current from the battery will maintain the switch in the operating position so that the pinion travel can be checked. The travel is adjusted by turning the stud in the solenoid plunger in or out as required. More detailed information concerning the adjustments, tests, and maintenance of starting motors is contained in the manufacturers' instruction books furnished with the equipment.

LIGHTING SYSTEM

The lighting system in small craft includes the (1) compartment lighting, (2) hand lanterns, (3) portable multipurpose signaling light, and (4) navigational lights.

GENERAL LIGHTING

The general lighting includes the compartment lighting and hand lanterns.

Compartment Lighting

The compartment lighting for general illumination consists of units similar to that shown in figure 10-28. This fixture is non-adjustable and consists of a steel enclosure and a bowl-shaped globe. The lampholder is equipped with a bayonet candelabra double-contact base.

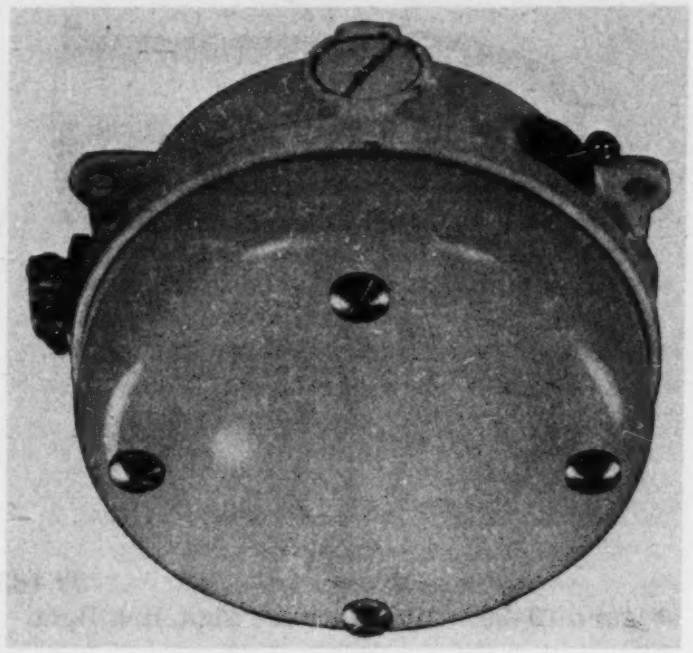

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Figure 10-28.—Compartment lighting fixture.

Hand Lantern

The hand lantern for general use is a manually operated type identical to those described in chapter 4 of this training course.

SIGNALING LIGHT

The portable multipurpose signaling light is similar to that shown in figure 10-29. It consists of a metal housing provided with a black phenolic, louvered signaling tube and a metal pistol-grip handle with trigger switch for blinker communications. A spotlight that has a 5-inch diameter parabolic-type reflector with a clear glass lens and a rheostat, for varying the light intensity, are mounted inside the metal housing. The light uses a candelabra, single-contact lamp with bayonet-type prefocusing base. A 25-foot cable with plug is connected to the light through the bottom of the handle for the power supply and remote signaling key. The power supply consists of a transformer and provision for a type BA-207/U battery mounted in a carrying kit. The remote signaling key is equipped with a cable and plug.

Also included with the multipurpose light are a buzzer for an audible signal, a short signal

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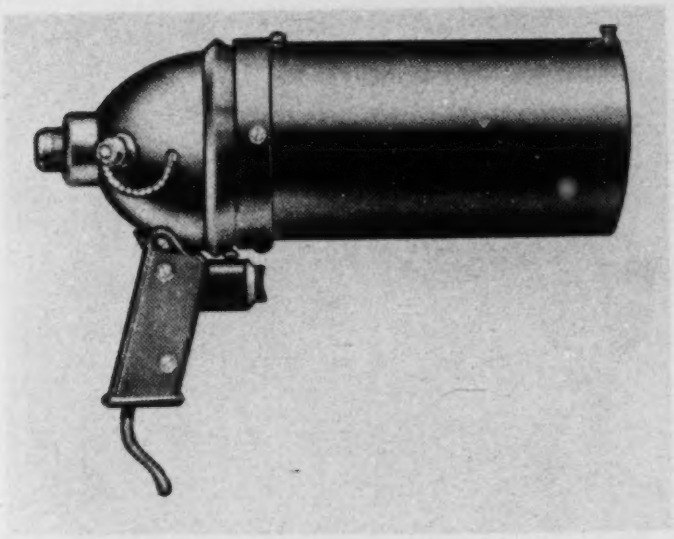

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Figure 10-29.—Multipurpose signaling light.

tube, a long signal tube, an open-type sight, and a spare parts box with two lamps and a remote signaling key.

NAVIGATION LIGHTS

The International Conference of Safety of Life at Sea made changes to the International Regulations which affect small boats. The new Regulations classify boats according to length rather than tonnage. The EM should ensure that lights are working and that they are not relocated to such a position that they do no conform to the requirements of the Regulations. The following summarizes the general requirements for the lights:

ANCHOR LIGHT: In the fore part of all boats, there should be mounted where it can best be seen, a 32-point white light visible all round the horizon at a distance of at least two miles.

MASTHEAD LIGHT: In the fore part of boats 65 feet and over in length, provide a 20-point white light to show an unbroken light over an arc of the horizon of 10 points on each side of the boat from right ahead to 2 points abaft the beam on either side and visible at a distance of at least 5 miles. Locate light at a height not less than 20 feet above the hull or if breadth of the boat exceeds 20 feet, then a height above the hull not less than such breadth.

In the fore part of boats 40 feet to 65 feet in length, provide a 20-point white light to show an unbroken light over an arc of the horizon of 10 points on each side of the boat from right ahead to 2 points abaft the beam on either side and visible at a distance of at least three miles. Locate light at a height not less than 9 feet above the gunwale and at least 3 feet above the side lights.

For boats under 40 feet in length, provide a 20-point white light to show an unbroken light over an arc of the horizon of 10 points on each side of the boat from right ahead to 2 points abaft the beam on either side. Locate light at least 3 feet higher than the side lights.

COMBINATION ANCHOR LIGHT AND MASTHEAD LIGHT: On boats less than 65 feet in length, the Masthead Light and the Anchor Light may be combined in a single combination light.

SIDE LIGHTS: For boats 65 feet and over in length, starboard side light and port side light should be located so as not to be obstructed by deck fittings or to be interfered with by personnel. These are each 10-point lights mounted to show an unbroken light over an arc of the horizon from right ahead to 2 points abaft the beam and visible at a distance of at least 2 miles. The Regulations required that on boats over 65 feet in length, the side lights shall be provided with inboard screens at least 3 feet forward from the light so as to prevent the lights from being seen across the bow. On boats which have the lights mounted on the pilot house, the pilot house can serve as the screen to prevent the lights being seen across the bow.

For boats less than 65 feet in length, the starboard side light and port side light should be located so as not to be obstructed by deck fittings or to be interfered with by personnel. These are each 10-point lights mounted to show an unbroken light over an arc of the horizon from right ahead to 2 points abaft the beam and visible at a distance of at least 1 mile. A combined green and red lantern may be used and, if used, should be carried not less than 3 feet below the 20-point white light.

STERN LIGHT: On the stern of all boats, a white light should be located so as to show an unbroken light over an arc of the horizon of 12 points, so fixed as to show the light 6 points from right aft on each side of the boat and visible at a distance of at least two miles.

In a small boat, if it is not possible on account of bad weather or other sufficient cause

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When the aircraft rolls, the resolver-synchro signal is altered in amplitude, provided the scanner is not directed dead ahead or aft (at 0° or 180° azimuth). When the aircraft pitches, the resolver-synchro signal is altered in amplitude, provided the scanner is not directed at 90° or 270° relative azimuth. As a result, the resolver-synchro signal and the manual-tilt-synchro signal no longer cancel, and an error signal is developed at the input of the servoamplifier. After amplification, this error signal is applied to a phase discriminator, which determines from the phase of the signal whether the reflector must be tilted up or down in order to correct for the roll, pitch, or combination of the two that has just caused the error signal. The output of the phase discriminator drives the proper tilt-servocontrol tube, which then applies the control voltage to the tilt-torque motor by means of a saturable reactor. As the tilt-torque motor corrects the scanner tilt angle, the rotor of the followup synchro, which is coupled to the tilt-torque motor, is turned in such a direction that the manual-tilt synchro signal changes in amplitude to compensate for the change in the resolver-synchro signal. When these two signals cancel again, the necessary correction to the reflector tilt angle has been accomplished, and the tilt-torque motor stops.

The ratio potentiometer, R1, balances the signals from the manual-tilt synchro and the resolver synchro to compensate for possible deviation from the true horizontal of the mounting plane of the gyroscope unit.

This servoamplifier functions similarly to the one discussed under "Azimuth Stabilization" in this chapter, in that the error voltage controls the saturable reactor which provides the variable voltage for the control winding of the tilt-torque motor. (See fig. 17-37.)

In this tilt stabilization system one winding of the TILT-TORQUE MOTOR is continuously excited by 115 volts a.c. The other winding, used to control the starting and operation of the motor, is supplied from the saturable reactors with a-c voltage developed whenever an error signal is amplified by the servoamplifier. The motor torque is obtained by providing approximately 90° phase difference between the control voltage and the excitation voltage, by means of capacitor C10 which is shunted across the control winding. The speed of the motor is dependent upon the amplitude of the control voltage, which in turn is dependent upon the action of the TILT control, tilt stabilization, and damping.

Manual-Tilt Control

The scanner tilt angle is controlled by the tilt synchro in the radar set control and is adjusted by means of the TILT control. The tilt synchro is connected with the followup synchro in the tilt-servo unit. Supplied with a steady a-c voltage, this synchro circuit develops the manual-tilt synchro signal in its rotor to control the tilt angle of the beam with respect to the angle of tilt stabilization (approximate horizon). The signal from the manual-tilt synchro is fed to the input of the servoamplifier, where it is combined with the resolver-synchro signal. Control of the scanner tilt angle is therefore dependent upon the resultant sum of these two voltages, and is accomplished through the system used for tilt stabilization, as just described. If the resolver-synchro signal is switched off by means of the STAB-UNSTAB switch S2 on the servoamplifier, the beam-tilt angle is then established only with respect to the aircraft.

Followup Synchro

The followup synchro and the manual-tilt synchro develop the manual-tilt synchro signal. The followup synchro is located in the tilt-servo unit of the antenna assembly. The rotor of this synchro is mechanically coupled to the tilt mechanism so that the rotor movement occurs in synchronism with the tilting of the scanner. The stator windings of the followup synchro are connected to the stator windings of the manual-tilt synchro in the radar control unit. The rotor of the followup synchro is supplied with 26-volt, 400-cycle, single-phase voltage. Voltages of unequal amplitude are induced in the stator windings (fig. 17-37). These voltages are reproduced in the stator windings of the manual-tilt synchro in the radar set control. When the rotor position of the manual-tilt synchro is such that its signal cancels the resolver-synchro signal and produces a null at the input of the servoamplifier, no control voltage is developed for the tilt-torque motor and the scanner tilt angle is not changed. When the rotor is displaced from this position in either direction by resetting

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for this light to be fixed, an electric torch or lighted lantern showing a white light shall be kept at hand ready for use and shall, on the approach of an overtaking vessel, be shown in sufficient time to prevent collision.

TOWING LIGHTS: A boat 65 feet and over in length when towing or pushing another vessel or seaplane shall, in addition to her side lights, carry two white lights in a vertical line one over the other, not less than 6 feet apart, and when towing and the length of the tow exceeds 600 feet, shall carry three white lights in a vertical line one over the other, so that the upper and lower lights shall be the same distance from, and not less than 6 feet above or below, the middle light. Each of these lights shall be of the same construction and character and one of them shall be carried in the same position as the 20-point white light.

For boats less than 65 feet in length, the above requirements apply except that the vertical spacing between lights shall be not less than 4 feet in lieu of 6 feet.

TASK LIGHTS: For any boat engaged in laying or in picking up a submarine cable or navigation mark, or a boat engaged in surveying or underwater operations, or when from the nature of her work she is unable to get out of the way of approaching vessels, shall carry, in lieu of the Masthead Light, three lights in a vertical line one over the other stepped out 45 degrees aft and to starboard of the mast so that the upper and lower lights shall be the same distance from, and not less than 6 feet above or below, the middle light. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all around the horizon at a distance of at least 2 miles.

CONTROLS: Switches and dimmers are provided, as required, for control of the Navigation Lights.

FIXTURES: Standard fixtures for small boats furnished in accordance with Military Standard MS 17847 (SHIPS) "Lights, Navigational, for Small Boats" are suitable for the required areas of visibilities indicated above. However, the fixtures must also be equipped with lamps of the proper candle power or watt rating to ensure compliance with the distance requirements.

SPOTLIGHT - FLOODLIGHT

Spotlights and floodlights installed in small boats for navigational purposes consist of a spraytight, chromium-plated copper housing equipped with a 100-watt, 7-inch diameter sealed-beam lamp. These spotlights or floodlights are standard Navy type for deck mounting and are controlled locally at the light, or provided for mounting on top of a canopy and controlled from beneath the mounting surface. The type of sealed beam lamp installed in the housing determines whether a spotlight or a floodlight is produced.

SEARCHLIGHT

The 8-inch sealed-beam signal searchlight is also available for use on small craft, as discussed in chapter 5 of this training course.

TRANSISTOR IGNITION SYSTEMS

The transistor ignition system is a relatively new development. The output of the conventional ignition system is limited to the amount of current in the primary circuit. Approximately 5 amperes can be carried in the primary circuit and still maintain a reasonable distributor contact point life. This is because the contact points will arc and burn if more current is interrupted. Because the transistor ignition system has not been widely used in the Navy, only a brief discussion is given in this chapter. In the future the shipboard electrician will see more and more equipment such as voltage regulators and motor controllers using transistors and other solid-state devices. It is therefore recommended that you read chapter 5 of Introduction to Electronics, NavPers 10084, and chapter 2 of Basic Electronics, NavPers 10087-A. These publications give good coverage of transistors. Figure 10-30 is a typical contact controlled transistor ignition system. The only differences between this and a conventional ignition system are the transistor amplifier, a special ignition coil, and the two resistors R3 and R4. The conventional distributor is used without any modification. Basically this system operates in the following manner.

When the ignition switch (fig. 10-30) is turned to the start position (assume the distributor contacts are closed) it bypasses resistor R-3 (to give maximum voltage during cranking) and current enters the amplifier and flows through the resistor R-2, the transistor TR-1, the resistor R-1, the distributor contact points and to ground, the primary of the ignition coil and

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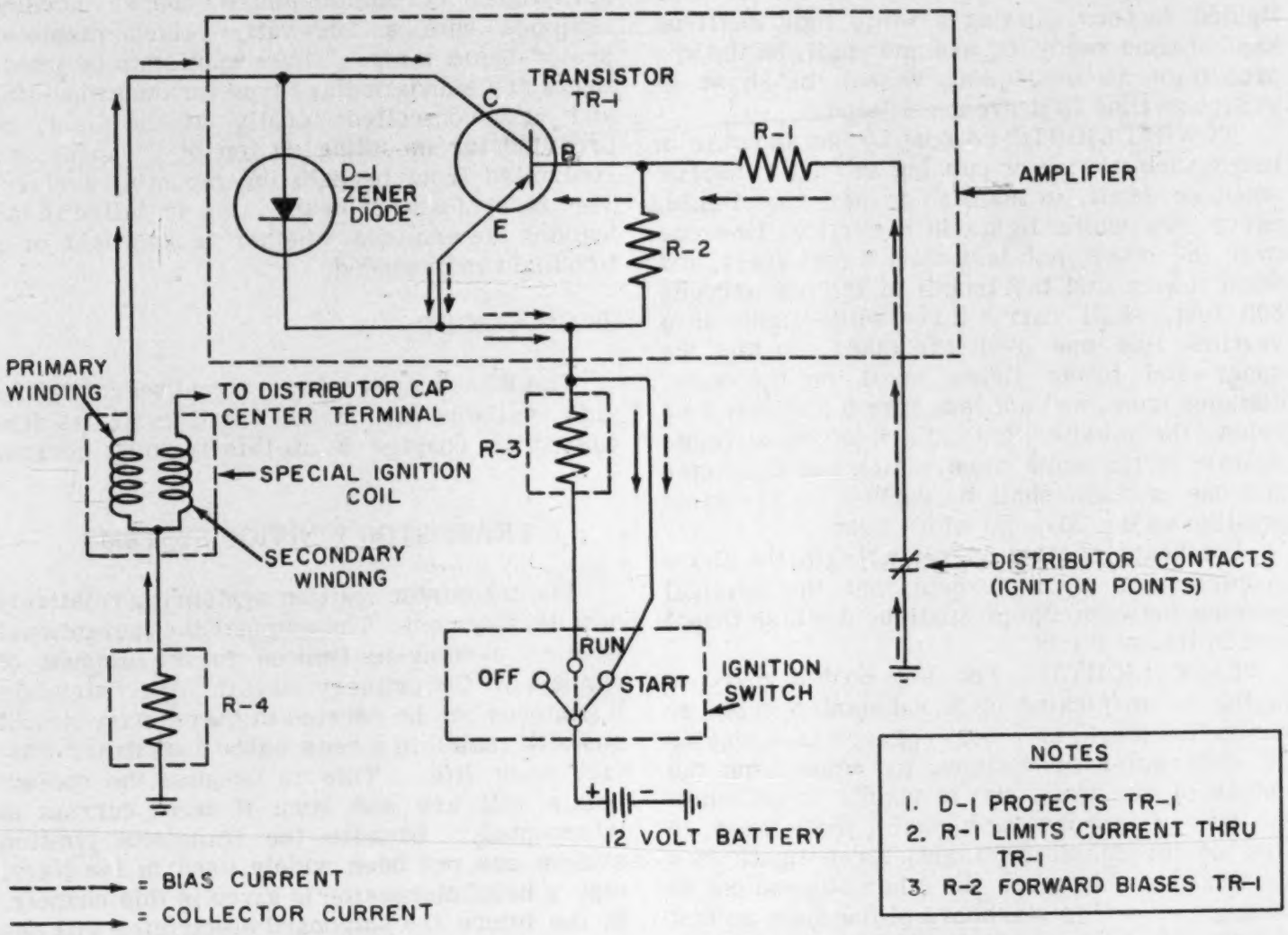

Figure 10-30.—A typical contact controlled transistor ignition system. 77.251

resistor R-4 to ground. As soon as the engine turns over and the distributor points open, interrupting the flow of current through the emitter-base of the transistor (marked E and B in figure 10-30), the transistor immediately "shuts off" the emitter-collector current (marked E and C). The flow of electrons in this system is indicated by the solid and dashed arrows on figure 10-30. The dashed arrow indicates the flow of the control (bias) current, the solid arrow the collector current. When the transistor is forward biased, as this one is when the distributor points are closed (the base is negative and the emitter is positive), the electrons flow as indicated by the arrows. When the distributor points are open, the base becomes positive and electron flow stops. When the emitter-collector current stops, the collapsing field of the primary of the ignition coil induces a high voltage in the secondary of the coil and this high voltage is fed via the distributor rotor to the proper spark plug. This procedure is repeated each time the distributor control points open and close. In this system the distributor contact points are carrying only a very small current to control the transistor (turn it on the off), thus contact life is greatly increased. At the same time the ignition coil is carrying a high primary current than is possible on a conventional system, thus a higher secondary voltage output and a better spark for improved ignition.

There are several kinds of transistor ignition systems. They may vary in design but their operating principles are similar. The main difference is that in some systems the transistor is triggered by a magnetic pulse

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generator in a special distributor instead of by contact points.

If you ever need to make repairs to a transistor ignition system, consult the manufacturer's manual and trouble-shooting chart. In these systems, one flash of current in a reverse polarity may damage some parts of the system beyond repair.

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CHAPTER 11

POWER DISTRIBUTION

Electrical power is indispensable to the operation of modern naval ships. With hydraulic systems it trains and elevates gun mounts and missile launchers, turns the rudder, and runs numerous auxiliaries. It furnishes light and power for running the ship. It operates the interior-communication, fire control, radar, radio, and sonar systems. The power is supplied by electric generating plants that may be either alternating-current or direct-current systems. A-c systems are installed in new construction carriers, cruisers, submarines, destroyers, escort ships, and numerous auxiliary ships. D-c systems are installed on new construction submarines, small surface ships, and large auxiliary ships with considerable deck machinery that requires d-c service for its operation. D-c systems are used in numerous ships converted for Navy use, and on other ships built prior to adoption of a-c ship service systems. Many of the older converted (merchant marine type) ships with d-c power distribution systems are still in the fleet. The amphibious forces have the largest number of these older converted types.

A-C ELECTRIC POWER SYSTEMS

A typical a-c power system consists of the ship service power, the emergency power, and the casualty power systems. (The coverage of casualty power systems in this chapter will be applicable to both a-c and d-c systems.)

D-c power in ships with a-c power systems is furnished either by over-size exciters for the ship service generators, by motor-generator sets or rectifier power supplies. The principal d-c loads are degaussing systems, carbon-arc searchlights, battery charging stations, and the interior-communication and fire control systems.

ELECTRIC PLANT

The ship's overall electric plant consists of the equipments installed for producing electrical power.

The electric plant includes the ship service electric plant and the emergency electric plant.

Ship Service Electric Plant

The ship service electric plant comprises the ship service generator sets, which are driven by steam turbines, diesel engines, or gas turbines. These generator sets supply power to the ship service power distribution system, which is the normal source of power to the ship's electrical equipment and machinery.

The number, type, and capacity of the ship service generators are determined by the load imposed on the generating plant by all of the connected auxiliaries under the various conditions of peacetime or wartime operations.

Emergency Electric Plant

The emergency electric plant comprises the emergency generator sets, which are driven by diesel engines or gas turbines. If power is not available from the ship service generators, the emergency generators supply a limited amount of power to vital auxiliaries through the emergency power distribution system.

The number and rating of the emergency generators must be sufficient to carry the loads that are designated to receive emergency power, but not to supply all of these loads simultaneously. The emergency generator capacity is determined by a particular combination of these loads, the choice of which depends on the type of ship. The ship service generators are required to operate in parallel; whereas, the emergency generators are not normally operated in parallel with each other or with the ship service

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generators. However, on some new construction the emergency generator is also used as a standby ship service generator. The electric plant is ungrounded except as required for ground detectors, instrument grounds, equipment frame grounds, personnel protection, or other special grounding requirements.

POWER DISTRIBUTION SYSTEMS

The power distribution systems are the connecting links between the generators that supply electric power and the electrical equipment that utilizes this power to furnish the various services necessary to operate the ship. The power distribution system comprises the (1) ship service power distribution system, (2) emergency power distribution system, and (3) casualty power distribution system.

The majority of a-c power distribution systems in naval ships are 450-volt, 3-phase, 60-cycle, 3-wire systems. The lighting distribution systems are 120-volt, 3-phase, 60-cycle, 3-wire systems supplied from the power circuits through transformer banks.

Ship Service Power Distribution System

The ship service power distribution system is the electrical system that normally supplies electric power to the ship's equipment and machinery. The switchboards and associated generators are located in separate engineering (on combatant ships) spaces to minimize the possibility that a single hit will damage more than one switchboard.

The ship service generator and distribution switchboards are interconnected by bus ties so that any switchboard can be connected to feed power from its generators to one or more of the other switchboards. The bus ties also connect two or more switchboards so that the generator plants can be operated in parallel. In large installations (fig. 11-1) distribution to loads is from the generator and distribution switchboards or switchgear groups to load centers, to distribution panels, and to the loads, or directly from the load centers to some loads.

On some ships, such as large aircraft carriers, a system of zone control of the ship service and emergency distribution is provided. Essentially, the system establishes a number of vertical zones, each of which contains one or more load center switchboards supplied through bus feeders from the ship service switchgear group. A load center switchboard supplies power to the electrical loads within the electrical zone in which it is located. Thus, zone control is provided for all power within the electrical zone. The emergency switchboards may supply more than one zone, the number of zones depends on the number of emergency generators installed.

In small installations (fig. 11-2), the distribution panels are fed directly from the generator and distribution switchboards. The distribution panels and load centers (if any) are located centrally with respect to the loads that they feed. This arrangement simplifies the installation and requires less weight, space, and equipment than if each load were connected to a switchboard.

POWER CIRCUITS.—The designations and terms for most circuits have changed in recent years. The terms "general power" and "battle power" are no longer used but their circuit designations may still be found on older ships where the tags on cables, and identification plates on panels, controllers, circuit breakers, etc., have not been changed.

The following is a listing of the old and new circuit designations.

Circuit designations (old):

- C—Interior Communication
- D—Degaussing
- F—Ship service lighting and general power
- FB—Battle power
- G—Fire control
- MS—Minesweeping
- P—Electric propulsion
- R—Radio and Radar
- RL—Running, anchor and signal lights
- S—Sonar
- XFE—Emergency lighting and power

Circuit designations (new):

- C—Interior Communication
- D—Degaussing
- EL—Lighting emergency
- EP—Power emergency
- FL—Night fluid lights
- G—Fire control
- K—Power control
- L—Lighting ship service
- LP—Power casualty
- MS—Minesweeping
- N—Lighting, navigational
- P—Power, ship service
- PP—Power propulsion

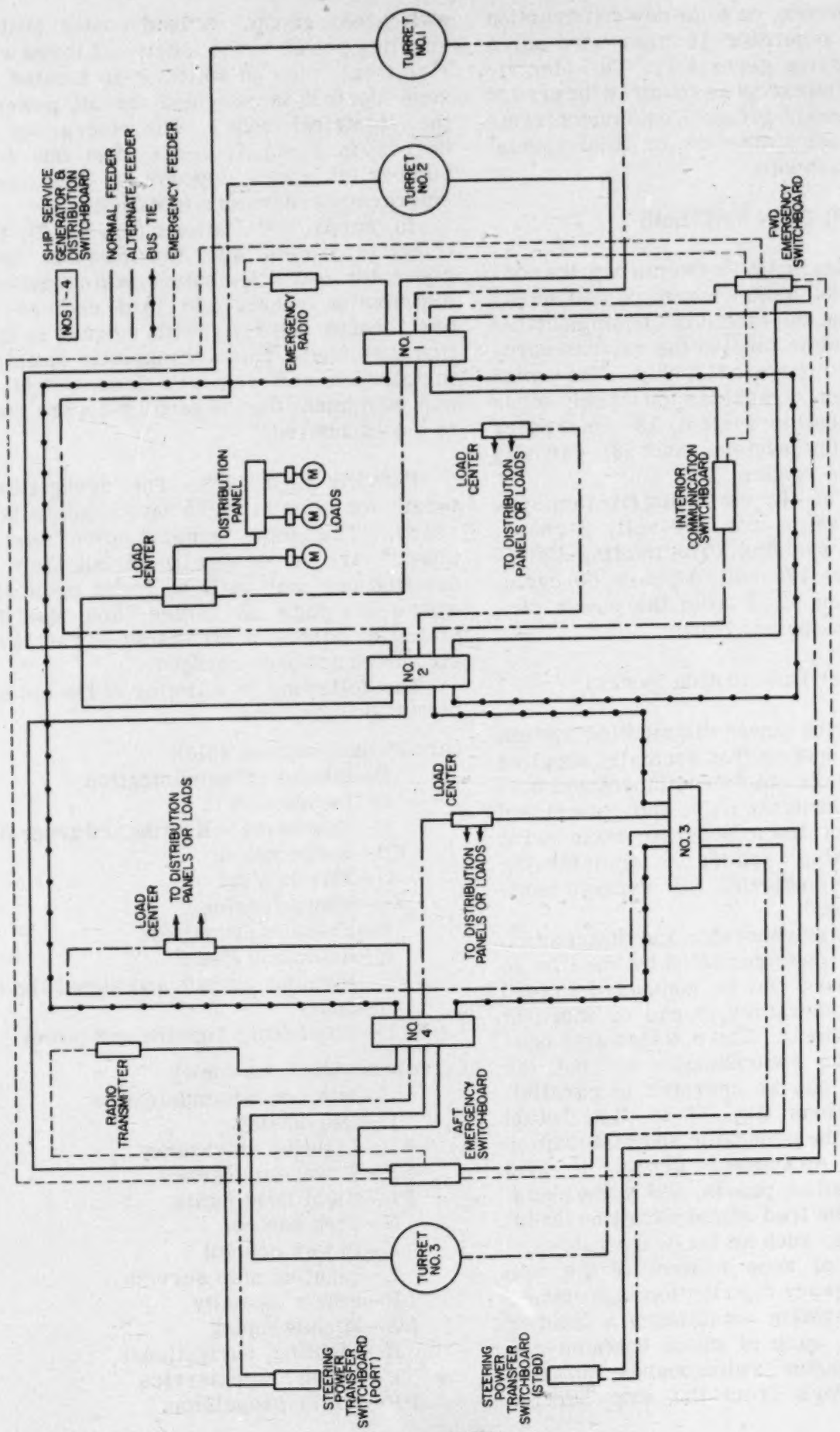

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Figure 11-1.—Power distribution in a large combatant ship.

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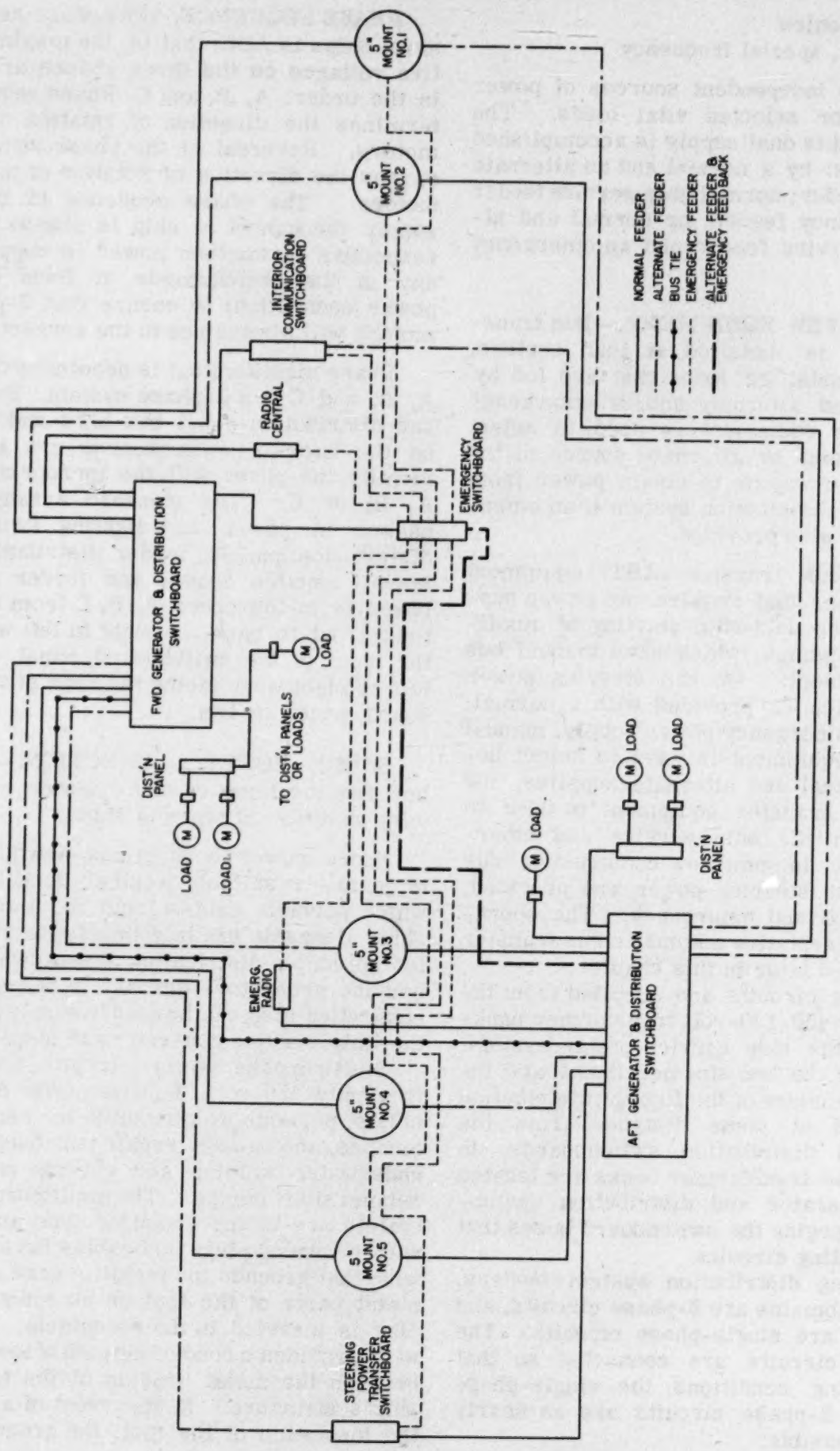

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Figure 11-2.—Power distribution in a destroyer.

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R—Electronics
SF—Power, special frequency

At least two independent sources of power are provided for selected vital loads. The distribution of this dual supply is accomplished in several ways: by a normal and an alternate ship service feeder; normal ship service feeder and an emergency feeder; or normal and alternate ship service feeder and an emergency feeder.

BUS TRANSFER EQUIPMENT.—Bus transfer equipment is installed at load centers, distribution panels, or loads that are fed by both normal and alternate and/or emergency feeders. This equipment is used to select either the normal or alternate source of the ship service power, or to obtain power from the emergency distribution system if an emergency feeder is also provided.

Automatic bus transfer (ABT) equipment is used for loads that require two power supplies, except for cold-ship starting of auxiliaries and fire pumps, which have manual bus transfer equipment. On the steering power equipment, which is provided with a normal, alternate, and emergency power supply, manual bus transfer equipment is used to select between the normal and alternate supplies, and automatic bus transfer equipment is used to select between the ship service and emergency supplies. In some new construction only two sources of steering power are provided, they are normal and emergency. The operation of a representative automatic bus transfer unit is described later in this chapter.

The lighting circuits are supplied from the secondaries of 450/120-volt transformer banks connected to the ship service power system. In large ships the transformer banks are installed in the vicinity of the lighting distribution panels located at some distance from the generator and distribution switchboards. In small ships the transformer banks are located near the generator and distribution switchboards and energize the switchboard buses that supply the lighting circuits.

The lighting distribution system feeders, mains, and submains are 3-phase circuits, and the branches are single-phase circuits. The single-phase circuits are connected so that under operating conditions the single-phase loads on the 3-phase circuits are as nearly balanced as possible.

PHASE SEQUENCE.—The phase sequence in naval ships is ABC; that is, the maximum positive voltages on the three phases are reached in the order: A, B, and C. Phase sequence determines the direction of rotation of 3-phase motors. Reversal of the phase sequence reverses the direction of rotation of three phase motors. The phase sequence of the power supply throughout a ship is always ABC (irrespective of whether power is supplied from any of the switchboards or from the shore power connection) to ensure that 3-phase, a-c motors will always run in the correct direction.

Phase identification is denoted by the letters, A, B, and C in a 3-phase system. Switchboard and distribution-panel bus bars and terminals on the back of switchboards are marked to identify the phase with the appropriate letters, A, B, or C. The standard arrangement of phases in power and lighting switchboards, distribution panels, feeder distribution boxes, feeder junction boxes, and feeder connection boxes is in the order A, B, C from top to bottom, front to back, or right to left when facing the front of the switchboard, panel, or box and left to right when facing the rear of the switchboard, panel, or box.

SHORE POWER CONNECTION.—The number and locations of shore power connections vary on different types of ships.

Shore power connections are provided at, or near, a suitable weather-deck location to which portable cables from the shore or from ships alongside can be connected to supply power for the ship's distribution system when the ship service generators are not in operation. This connection also can be used to supply power from the ship service generators to ships alongside.

Multipurpose power circuits are provided to supply 450-volt, 3-phase power for portable hoists; portable welding units for repair, maintenance, and damage repair purposes, including underwater welding and cutting; and portable submersible pumps. The multipurpose power outlets are of the grounded type and are used with grounded plugs and cables having a ground wire that grounds the metallic case and exposed metal parts of the tool or equipment when the plug is inserted in the receptacle. The ground wire provides a conducting path of low resistance between the metal housing of the tool and the ship's structure. In the event of a casualty to the insulation of the tool, the ground wire will

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shunt the operator, thereby protecting him from shock.

The outlets are located so that two portable pumps can be operated in any compartment by using 75 feet of cable for each pump. The outlets are fed from power distribution panels whenever practicable. A minimum number of outlets are fed from any one panel in order to provide as great a diversity of supply as possible. An adapter is provided with the 75-foot extension cables for making connections to the casualty power system if power is lost from the outlets.

Emergency Power Distribution

The following information applies to combatant ships. The majority of auxiliary ships are not so equipped.

The emergency power distribution system is provided to supply an immediate and automatic source of electric power to a limited number of selected vital loads in the event of failure of the ship service power distribution system. The system, which is separate and distinct from the ship service power distribution system, includes one or more emergency distribution switchboards. Each emergency switchboard is supplied by its associated emergency generator. The emergency feeders run from the emergency switchboards (figs. 11-1 and 11-2) and terminate in manual or automatic bus transfer equipment at the distribution panels or loads for which emergency power is provided. The emergency power distribution system is a 450-volt, 3-phase, 60-cycle system with transformer banks at the emergency distribution switchboards to provide 120-volt, 3-phase power for the emergency lighting system.

The emergency generators and switchboards are located in separate spaces from those containing the ship service generators and distribution switchboards. As previously stated, the normal and alternate ship service feeders are located below the waterline on opposite sides of the ship. The emergency feeders are located near the centerline and higher in the ship (above the waterline). This arrangement provides for horizontal separation between the normal and alternate ship's service feeders and vertical separation between these feeders and the emergency feeders, thereby minimizing the possibility of damaging all three types of feeders simultaneously.

The emergency switchboard is connected by feeders to at least one and usually to two different ship service switchboards. One of these switchboards is the preferred source of ship service power for the emergency switchboard and the other is the alternate source (fig. 11-3). The emergency switchboard and distribution system are normally energized from the preferred source of ship service power. If this source of power should fail, bus transfer equipment automatically transfers the emergency switchboard to the alternate source of the ship service power. If both the preferred and alternate sources of ship service power fails, the gas turbine or diesel-driven emergency generator starts automatically, and the emergency switchboard is automatically transferred to the emergency generator.

When the voltage is restored on either the preferred or alternate source of the ship service power, the emergency switchboard is automatically retransferred to the source that is available, or to the preferred source if voltage is restored on both the preferred and alternate sources. However this is only on certain types of ships. Some systems require the emergency generator to be tripped manually before the ABT will transfer back to the available preferred or alternate source. The emergency generator must be manually shut down. Hence, the emergency switchboard and distribution system are always energized either by a ship service generator or by the emergency generator. Therefore, the emergency distribution system can always supply power to a vital load if both the normal and alternate sources of the ship service power to this load fails. The emergency generator will not start automatically if the emergency switchboard can receive power from a ship service generator.

FEEDBACK TIE.—A feedback tie from the emergency switchboard to the ship service switchboard (fig. 11-2) is provided in most ships. The feedback tie permits a selected portion of the ship service switchboard load to be supplied from the emergency generator. This feature facilitates starting up the machinery after major steam alterations and repairs, and provides power to operate necessary auxiliaries and lighting during repair periods when shore power and ship service power are not available.

Because of the limited capacity of the emergency generators, it is not intended that the "feedback" tie is to be generally utilized to

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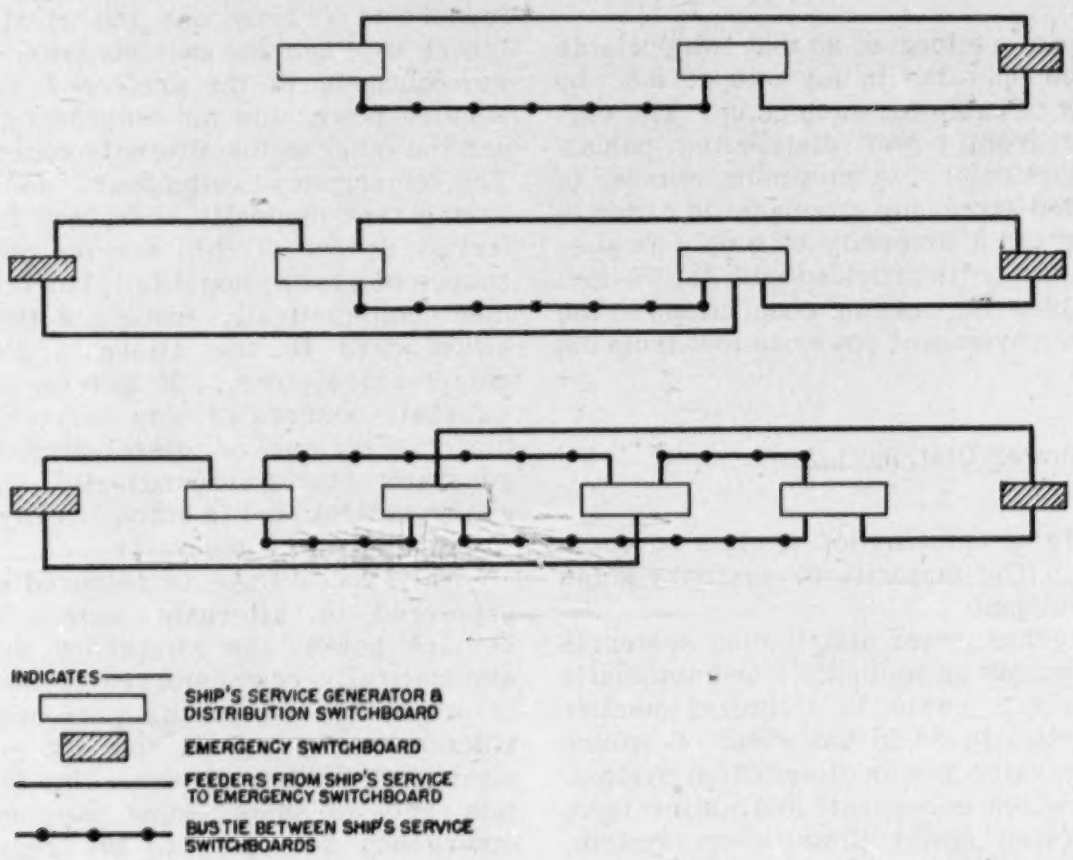

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Figure 11-3.—Emergency and ship service distribution systems interconnections.

supply power to the ship service distribution system. Use of the "feed back" tie should be limited to special circumstances such as dock conditions when it is desired to secure the ship service generators, and in cases where it is necessary to feed power through the ship service switchboards to certain auxiliaries in order to start ship service generators. When the feedback tie is used, increased vigilance is necessary to prevent overloading the emergency generators.

Casualty Power Distribution

Damage to ship service and emergency distribution systems in wartime led to the development of the casualty power system. The system provides for making temporary connections to vital circuits and equipment. The system is limited to the facilities necessary to keep the ship afloat and permit it to get out of the danger area. The system also supplies a limited amount of armament, such as antiaircraft guns and their directors to protect the ship when in a damaged condition.

The procedures for rigging and unrigging casualty power are discussed later in this chapter.

To provide you with an overall picture of power distribution, coverage is given first on one of the older DD-692 class destroyers (many of which are still in service), followed by a brief description of the DLG-23 distribution system.

A-C SWITCHBOARDS (DD 692)

A-c switchboards may consist of a single section or of several sections physically separated and connected by cables to form a switchgear group. This arrangement of sections provides greater resistance to damage due to shock. It also provides a means for localizing damage, and removal of a damaged section for repairs or replacement. Modern a-c ship service and

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the TILT control for a new beam tilt, one signal becomes larger than the other, cancellation is no longer complete, and therefore an error signal is developed which causes the servoamplifier to develop a control voltage for the tilt-torque motor. As the motor drives the scanner to the required tilt angle, a mechanical coupling from the motor turns the rotor of the followup synchro. When the manual-tilt synchro again cancels the resolver-synchro signal at the input of the servoamplifier, the tilt-torque motor stops. The beam-tilt angle thus obtained is determined with respect to the horizontal.

Damping Signal Generator

An a-c generator is geared mechanically to the tilt-torque motor and has an output voltage when the torque motor turns. This is the damping-signal generator shown in figure 17-37. The a-c voltage out of this generator is adjusted to a value equal to the error signal produced with only a few degrees of angular displacement between input and output shafts. This ANTIHUNT or DAMPING voltage is fed to the servoamplifier in such a manner as to be out of phase with the error voltage at all times. As the servo-torque motor turns the output shaft to its new position, the amplitude of error signal will be constantly decreasing to a null of voltage. At some point close to zero angular displacement between input and output shafts, the antihunt a-c voltage will be equal in amplitude but out of phase with the error voltage, so that the signal into the servoamplifier is canceled. The inertia of the output shaft mechanism carries the output shaft beyond this point to where the phase of the amplifier input signal is reversed and starts to increase in amplitude due to the damping signal generator's output exceeding the error signal. This causes a reversal of the output voltage from the servoamplifier to the torque motor prior to reaching a null of the positional error voltage. This reversal of torque causes a braking action which stops the torque motor and the load. This also stops the damping-signal generator and no further error is applied to the amplifier.

Some provision must be made to control the exact amplitude of the net input signal to the servoamplifier so that optimum stability is obtained. This may be done by varying the antihunt or damping generator output so as to cancel out the error signal at the proper angular displacement.

If the antihunt or damping signal is LOW in amplitude as compared to the error signal at the correct cancellation angle, the power to the torque motor will not be removed at the proper angular displacement point. This will cause the output shaft to overshoot the proper angle and oscillations or hunting will occur. These oscillations will gradually diminish to the correct position of the output shaft. If the antihunt or damping signal is HIGH in amplitude as compared to the error signal at the proper cancellation angle, the error signal will be canceled at too great an error angle, or too soon. The output shaft will be stopped with some degree of error angle remaining between input and output shafts. As the output shaft stops, the a-c damping voltage will fall to zero and the remaining error signal will cause the shaft to turn slowly to the correct point. It is of interest to note that the hunting of the scanner is held to a maximum of plus or minus one-half degree of tilt about the angle of stabilization. This, as you can easily understand, is a very close tolerance of error and thus, hunting is adequately eliminated.

GROUND STABILIZATION

Ground position indicating equipment continuously indicates the ground position of a flying aircraft from an initial reference point. One of its functions is to show north-south (N/S) and east-west (E/W) distances from the reference point on direct reading dials. Its primary function is to furnish voltages which will "ground stabilize" a radar display. This is accomplished by causing the PPI display to remain fixed geographically.

Unstabilized search radar produces a PPI display that constantly changes as the aircraft moves across an area. Since the sweep starting point represents the position of the aircraft in the center of an area, it follows that the PPI presentation will change as the aircraft travels. Also, any targets on the scope will move across the scope. If, however, a target is selected and the radar display is ground stabilized, the sweep starting point will change and the targets will remain fixed in place on the scope. The radar continues to "view" only the selected area in which the targets lie, as shown in figure 17-39. For each

emergency switchboards are of the dead-front type.

Ship Service Switchboards

The dead-front switchboard (fig. 11-4) utilizes sheet-steel panels or enclosures from which only the meters and operating handles of the switches and circuit breakers protrude to the front of the switchboard. This type of construction is used for all a-c distribution systems and for the d-c distribution systems in some large ships.

The equipment is grouped to form a number of units, each complete with a separate front panel and all the required appurtenances such as the a-c generator control unit, a-c bus tie unit, power distribution unit, and lighting distribution unit. A number of units mounted on a common base comprise a section or several sections that are physically separated and connected by cables to form a switchgear group.

A separate control benchboard (fig. 11-5) is provided in the switchgear groups for cruisers and aircraft carriers. This benchboard mounts all the generator controls equipment, all

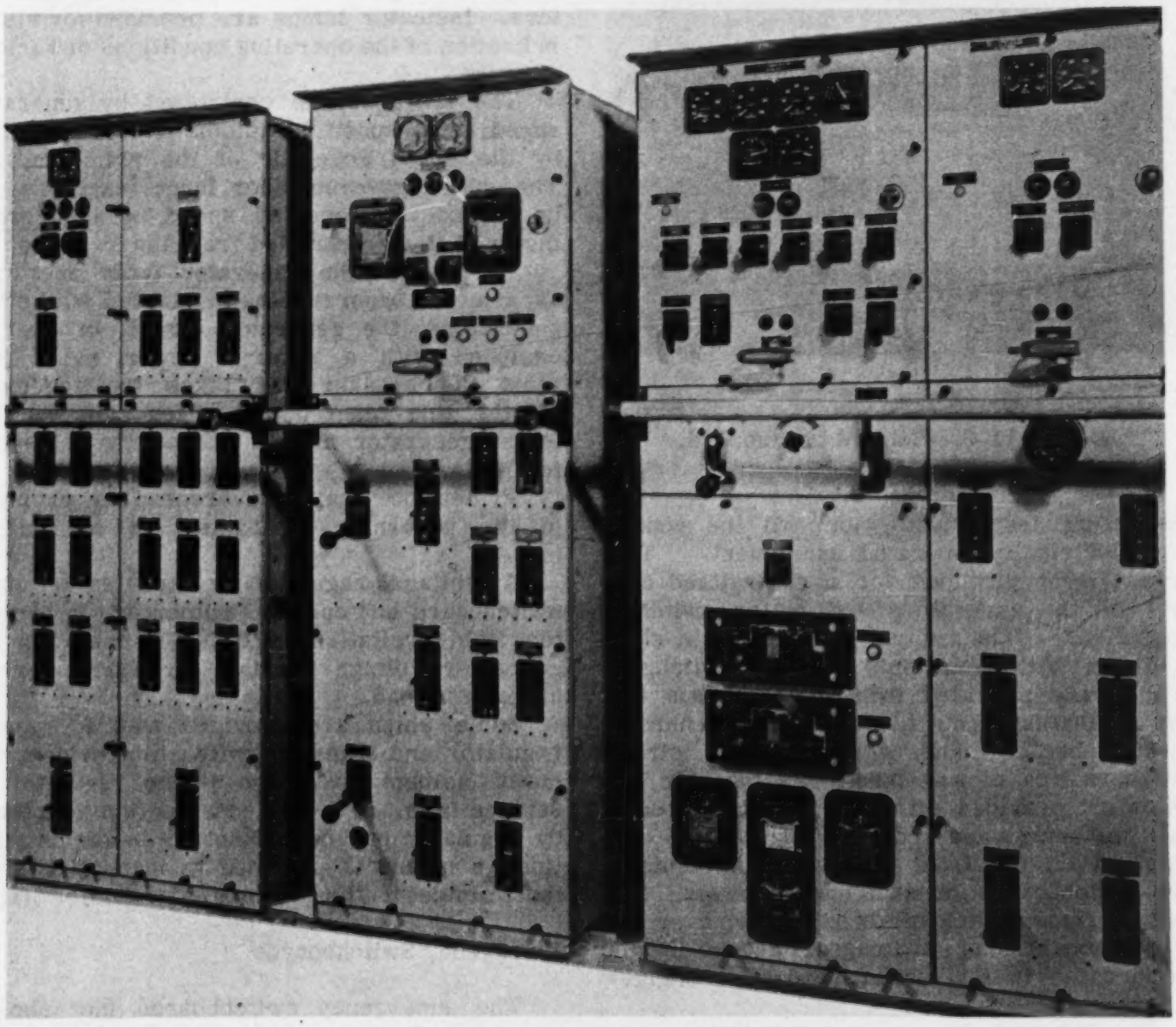

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Figure 11-4.—A-c ship service switchboard, dead front.

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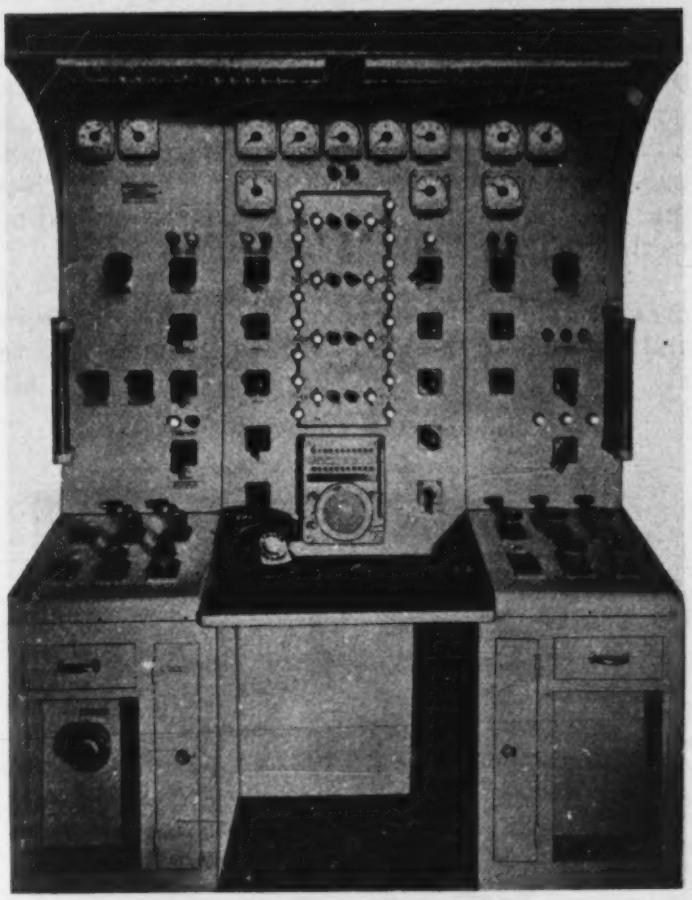

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Figure 11-5.—Control benchboard.

measuring instruments, and all the control for electrically operated equipment. This arrangement provides for a centralized control of the generators and major switching operations. The control benchboard in ships equipped with four ship service switchgear groups are provided with a mimic bus that has indicating lights to show which generator circuit breaker and which bus tie circuit breakers are closed throughout the ship. In ships not provided with a control benchboard, the metering and control equipments are mounted on the front panels of the units in the switchboards or switchgear groups. The ship service switchboards in a destroyer 692 class consists of switchgear groups 1S and 2S, located in the forward and after enginerooms respectively.

The forward ship service switchgear group (fig. 11-6) is designated as the control switchboard; it is provided with instruments and controls for the after generator to allow for dividing the load. All paralleling of the generators is accomplished at the ship service switchboard associated with the incoming generator.

The after ship service switchgear group (fig. 11-7) is similar to the forward ship service switchgear group and consists of the same number of corresponding designated panels.

Generator switchboards are equipped with meters to indicate the generator voltage, current, watts, frequency, and power factor (new construction ships do not have power factor meters). Synchroscopes and synchronizing lamps are provided for paralleling generators. Indicator lamps are provided for visual indication of the operating conditions of various circuits.

The frequency is controlled by generator speed. The speed is automatically controlled by the speed governor of the prime mover. The speed governors for large machines can be set to the required speed by a governor motor that is controlled from the switchboard.

To prevent the generator from operating as a motor when running in parallel with other generators, the generator circuit breaker is equipped with a reverse power relay that trips the breaker and takes the generator off the line when power is fed from the line to the generator instead of from the generator to the line.

Protection against overspeed is provided in the governing mechanism of the prime mover.

A voltage regulator is mounted on each switchboard and operates automatically to vary the field excitation in order to maintain the generator voltage constant throughout normal changes in load.

Some ships are provided with a standby regulator and transfer switch to provide automatic voltage regulation if the regulator in service fails. In recent construction the standby regulator has been deleted. In all installations a means is provided to manually adjust the voltage if the automatic regulator fails.

Emergency Switchboards

The emergency switchboards (not shown) are located in the forward and after emergency generator rooms respectively. The emergency switchboards provide electric power to certain vital auxiliaries and a limited

PANEL I A.C. LIGHTING
PANEL II A.C. BATTLE AND GENERAL POWER
PANEL III A.C. BUS TIES AND RESTRICTED BATTLE POWER
PANEL IV A.C. GENERATOR CONTROL
PANEL V D.C. GENERATOR CONTROL, BUS TIES AND FEEDERS

A_1 – A.C. Generator Circuit Breaker
B_1 – D.C. Generator Circuit Breaker
C_1 – D.C. Bus Tie Switch
D_1 – A.C. Bus Tie Switch
E_1 – A.C. Lighting Switch
F_1 – A.C. Battle and General Power Switch
G_1 – Emergency Generator Bus Switch

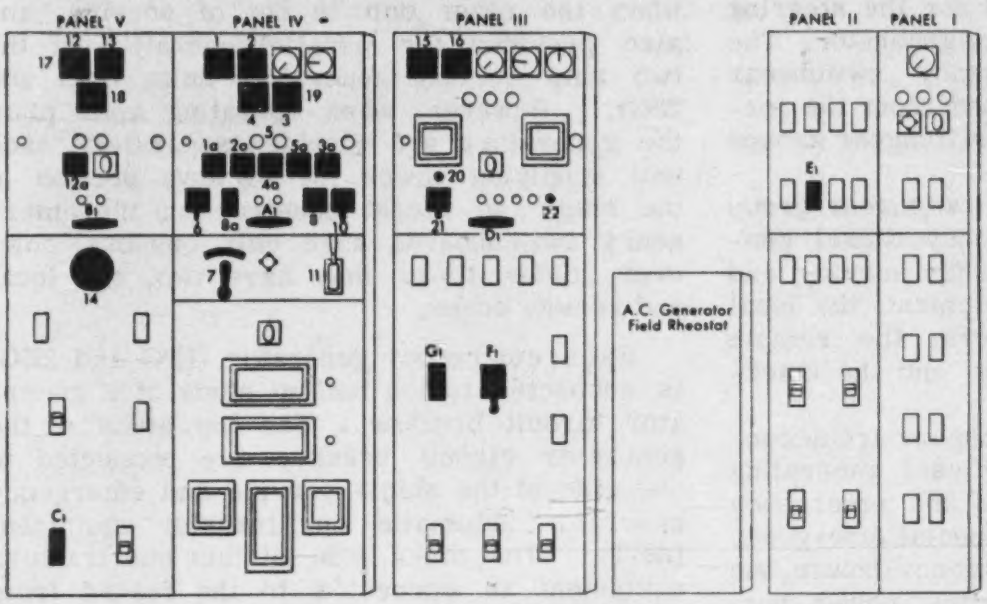

1. VOLTMETER, #1 A.C. GENERATOR
1a. VOLTMETER SWITCH
2. AMMETER, #1 A.C. GENERATOR
2a. AMMETER SWITCH
3. FREQUENCY METER, #1 A.C. GENERATOR AND BUS
3a. FREQUENCY METER SWITCH AND TRANSFER SWITCH
4. SYNCHROSCOPE
4a. SYNCHROSCOPE SWITCH
5. SYNCHRONIZING LAMPS
5a. SYNCHRONIZING LAMP SWITCH
6. A.C. VOLTAGE CONTROL (MOTOR OPERATED)
7. A.C. VOLTAGE CONTROL RHEOSTAT (MANUAL)
8. VOLTAGE REGULATOR CUTOUT SWITCH
8a. VOLTAGE REGULATOR BALANCING LIGHTS
10. GOVERNOR MOTOR CONTROL SWITCH
11. FIELD CUTOUT SWITCH, #1 A.C. GENERATOR
12. D.C. VOLTMETER
12a. D.C. VOLTMETER TRANSFER SWITCH
13. D.C. AMMETER
14. D.C. VOLTAGE CONTROL RHEOSTAT
15. A.C. BUS TIE VOLTMETER
16. A.C. AMMETER, AFTER GENERATOR
17. D.C. BUS TIE VOLTMETER (SW. 12a ON BUS)
18. D.C. AMMETER, AFTER GENERATOR
19. BUS TIE FREQUENCY METER (SW. 3a ON BUS)
20. GOVERNOR MOTOR TRANSFER LAMPS
21. GOVERNOR MOTOR CONTROL SWITCH, AFTER GENERATOR
22. INDICATING LAMP, A.C. BUS TIE

Figure 11-6.—Forward generator and distribution switchboard (1S). 77.167.1

PANEL I A.C. LIGHTING
PANEL II A.C. BATTLE AND GENERAL POWER
PANEL III A.C. BUS TIES AND RESTRICTED BATTLE POWER
PANEL IV A.C. GENERATOR CONTROL
PANEL V D.C. GENERATOR CONTROL, BUS TIES AND FEEDERS

A_2 A.C. Generator Circuit Breaker
B_2 D.C. Generator Circuit Breaker
C_2 D.C. Bus Tie Switch
D_2 A.C. Bus Tie Switch
E_2 A.C. Lighting Switch
F_2 A.C. Battle and General Power Switch
G_2 Emergency Generator Bus Switch
H_2 Shore Power Switch

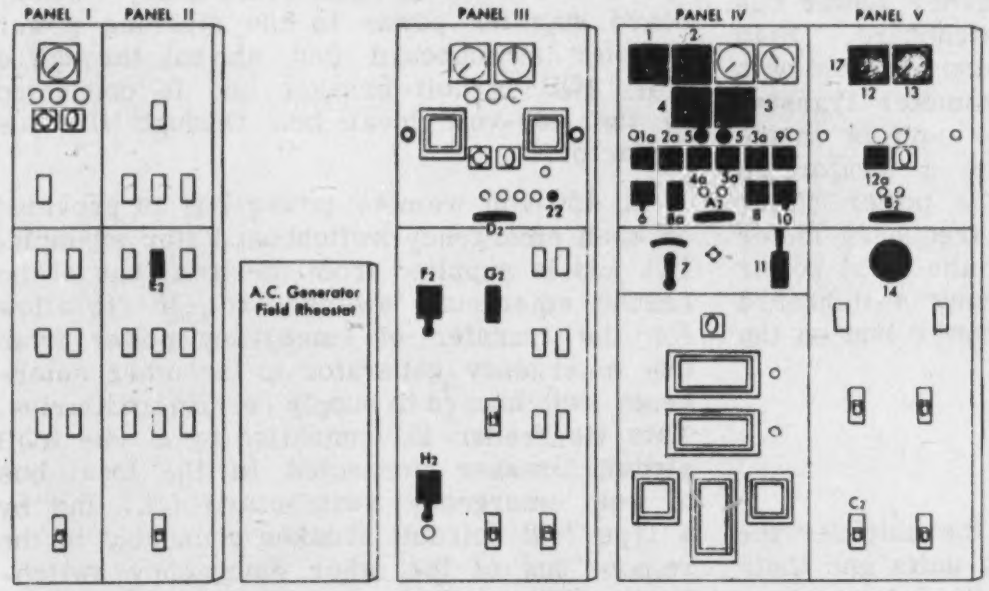

1. VOLTMETER, #2 A.C. GENERATOR
1a. VOLTMETER SWITCH
2. AMMETER, #2 A.C. GENERATOR
2a. AMMETER SWITCH
3. FREQUENCY METER, #2 A.C. GENERATOR AND BUS
3a. FREQUENCY METER SWITCH AND TRANSFER SWITCH
4. SYNCHROSCOPE
4a. SYNCHROSCOPE SWITCH
5. SYNCHRONIZING LAMPS
5a. SYNCHRONIZING LAMP SWITCH
6. A.C. VOLTAGE CONTROL MOTOR OPERATED
7. A.C. VOLTAGE CONTROL RHEOSTAT (MANUAL
8. VOLTAGE REGULATOR CUTOUT SWITCH
8a. VOLTAGE REGULATOR BALANCING LIGHTS
10. GOVERNOR MOTOR CONTROL SWITCH
11. FIELD CUTOUT SWITCH, #2 A.C. GENERATOR
12. D.C. VOLTMETER
12a. D.C. VOLTMETER TRANSFER SWITCH
13. D.C. AMMETER
14. D.C. VOLTAGE CONTROL RHEOSTAT
17. D.C. BUS TIE VOLTMETER SW 12a ON BUS
22. INDICATING LAMP, A.C. BUS TIE
9. GOVERNOR MOTOR TRANSFER SWITCH

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Figure 11-7.—After generator and distribution switchboard (2S).

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amount of lighting in the event of failure of the ship service power. The diesel generating unit starts automatically within 10 seconds after failure of the ship service power. The emergency power system is arranged for automatic transfer of the circuit for the steering power panel to the emergency generator. The forward and after emergency switchgear groups are normally energized from the forward and after ship service switchgear groups respectively.

The forward emergency switchgear group controls the forward emergency diesel generating unit; the forward ship service and emergency bus transfer equipment; the local emergency power bus feeders; the remote emergency power bus feeders; and the emergency lighting feeders.

The after emergency switchgear group controls the after emergency diesel generating unit; the after ship service and emergency bus transfer equipment; the special emergency power bus feeder; the emergency power bus contactor; the local emergency power bus; the remote emergency power bus feeders; and the emergency lighting feeders.

The generator panels of both the forward and after emergency switchboards are provided with an a-c voltmeter and a voltmeter transfer switch to permit reading the (three) phase-to-phase voltages in the a-c generators, or the voltage of the local emergency power bus on the forward emergency switchboard and the special emergency power bus on the after emergency switchboard. Both emergency switchboards are also provided with an a-c ammeter and an ammeter transfer switch to permit reading the current in the three phases of the emergency generator, an a-c wattmeter for reading the power of the emergency generator, and a frequency meter for reading the frequency of the local power bus on the forward emergency switchboard and the special emergency power bus on the after emergency switchboard.

Interconnections

The connections between the ship service and the emergency generating units and their associated switchboards and the interconnections between the switchboards are illustrated in the schematic line diagram in figure 11-8. The a-c buses on the forward and after ship service switchboards can be connected together, and the d-c buses on these switchboards can also be connected together. This arrangement enables one generating unit to supply power to both ship service switchboards when the other unit is out of service, and also provides for parallel operation of the two ship service generating units (1SG and 2SG). However, when operating split plant the generators are operated separately, each unit supplying power for its own section of the ship. In recent construction the emergency switchboards have only one bus; however, older types may have two, the local and remote buses.

Each emergency generator (1EG and 2EG) is connected to the bottom studs of a generator circuit breaker. The top studs of the generator circuit breaker are connected to one side of the ship's service and emergency generator automatic bus transfer equipment (ABT). The other side of this bus transfer equipment is connected to the feeder from the forward ship service switchboard (1S) for the forward emergency switchboard (1E) and to the feeder from the after ship service switchboard (2S) for the after emergency switchboard (2E). The midpoint of the bus transfer equipment is connected to the 450-volt local bus on the forward emergency switchboard and to the 450-volt special bus on the after emergency switchboard. The special bus on the after emergency switchboard supplies power to the steering power transfer switchboard (not shown) through a type AQB circuit breaker and is connected to the 450-volt local bus through the bus contactor.

A 450-volt remote power bus is provided on each emergency switchboard (for example, 1E) and is supplied from the local bus of the second emergency switchboard (2E) to allow for the transfer of emergency power from one emergency generator to the other emergency switchboard to supply certain auxiliaries. This tie feeder is controlled by a type AQB circuit breaker connected to the local bus of one emergency switchboard (2E) and by a type NQB circuit breaker connected to the remote bus of the other emergency switchboard (1E). Certain feeders, such as gun mounts, I.C. switchboards, and emergency lighting transformers, are connected by means of mechanically interlocked type AQB circuit

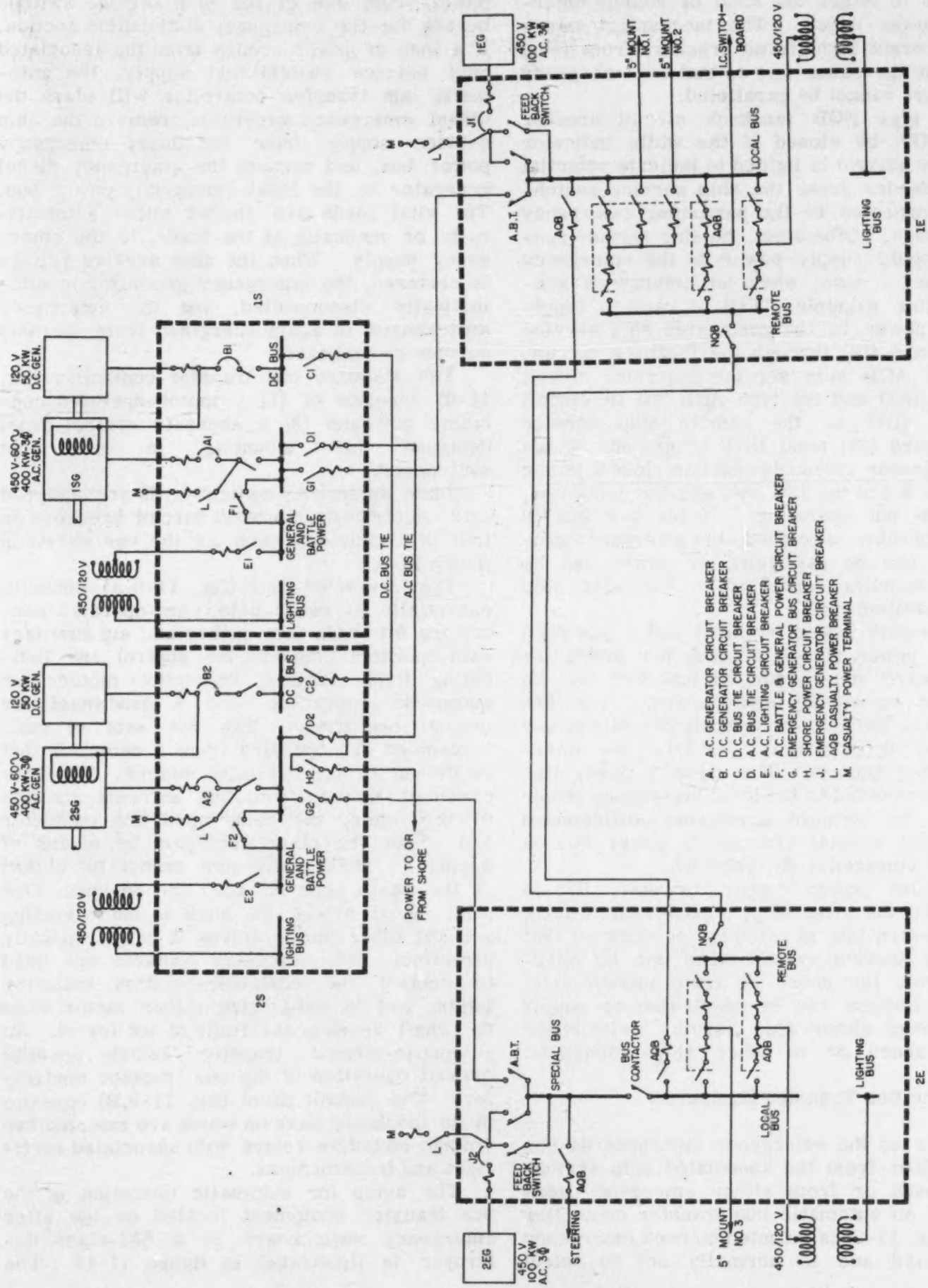

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Figure 11-8.—Ship service and emergency switchboard interconnections.

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breakers to either the local or remote emergency power buses. The mechanical interlocks prevent both circuit breakers from being closed at the same time so that the emergency generators cannot be paralleled.

The type NQB feedback circuit breaker must NOT be closed if the white indicator light (not shown) is lighted to indicate potential on the feeder from the ship service switchboard connected to the particular emergency switchboard. Otherwise, the ship service generator could supply power to the emergency generator. Also, when an emergency generator (for example, 1EG) is used to supply limited power to the associated ship service switchboard (1S) through the feedback circuit, the type ACB ship service generator circuit breaker (A1) and the type ACB bus tie circuit breaker (D1) to the remote ship service switchboard (2S) must NOT be closed. If the a-c generator circuit breaker is closed, power could be fed to the 1SG ship service generator, which is not operating. If the a-c bus tie circuit breaker is closed, the emergency generators can be paralleled or power can be fed to circuits connected to the after ship service switchboard.

A casualty power terminal and a type AQB casualty power circuit breaker are located on the forward emergency switchboard and on the after emergency switchboard. The terminals are used for connecting casualty power cables to supply power to or from the emergency switchboards. The casualty power circuit is connected to the local emergency power bus on the forward emergency switchboard and to the special emergency power bus on the after emergency switchboard.

A shore power circuit breaker, H2, is located on the after ship service switchboard. A connection box is provided on deck so that the ship service switchboards can be energized from the shore or from another ship. This connection can be used also to supply power from either ship service switchboard to the shore or to other ships alongside.

Automatic Bus Transfer Equipment

Power to the emergency switchboards can be supplied from the associated ship service switchboard or from either emergency generator. An automatic bus transfer controller (ABT, fig. 11-9) is mounted on each emergency switchboard and is normally set to select power from one of the ship service switchboards for the emergency distribution section. If a loss of power occurs from the associated ship service switchboard supply, the automatic bus transfer controller will start the diesel emergency generator, remove the ship service supply from the local emergency power bus, and connect the emergency diesel generator to the local emergency power bus. The vital loads are shifted either automatically or manually at the loads, to the emergency supply. When the ship service voltage is restored, the emergency generator is automatically disconnected, and the emergency switchboard is again energized from the ship service switchboard.

The standard bus transfer controller (fig. 11-9) consists of (1) a motor-operated contactor unit and (2) a separate control panel designed for mounting in dead-front switchgear.

Some emergency switchboards are equipped with electrically operated circuit breakers in lieu of contactors such as the one shown in figure 11-9.

The contactor unit (fig. 11-9,A) consists essentially of two 3-pole, cam-operated contactors for main line connection; six auxiliary cam-operated contacts for control and indicating light circuits; two pilot motors for automatic operation; and a handwheel for manual operation. The two sets of main contactors are operated from a camshaft that is driven by the two pilot motors. When the camshaft moves from one extreme position to the other, the cams open one contactor and close the other contactor by means of springs. Both contactors cannot be closed at the same time but both can be open. One pilot motor drives the shaft in one direction and the other motor drives it in the opposite direction. The auxiliary contacts are used to control the contactor-position indicator lights, and to deenergize either motor when the shaft reaches the limit of its travel. An automatic-manual transfer switch permits manual operation of the bus transfer controller. The control panel (fig. 11-9,B) consists of an insulating base on which are mounted two voltage-sensitive relays with associated rectifiers and transformers.

The setup for automatic operation of the bus transfer equipment located on the after emergency switchboard in a 692-class destroyer is illustrated in figure 11-10. The

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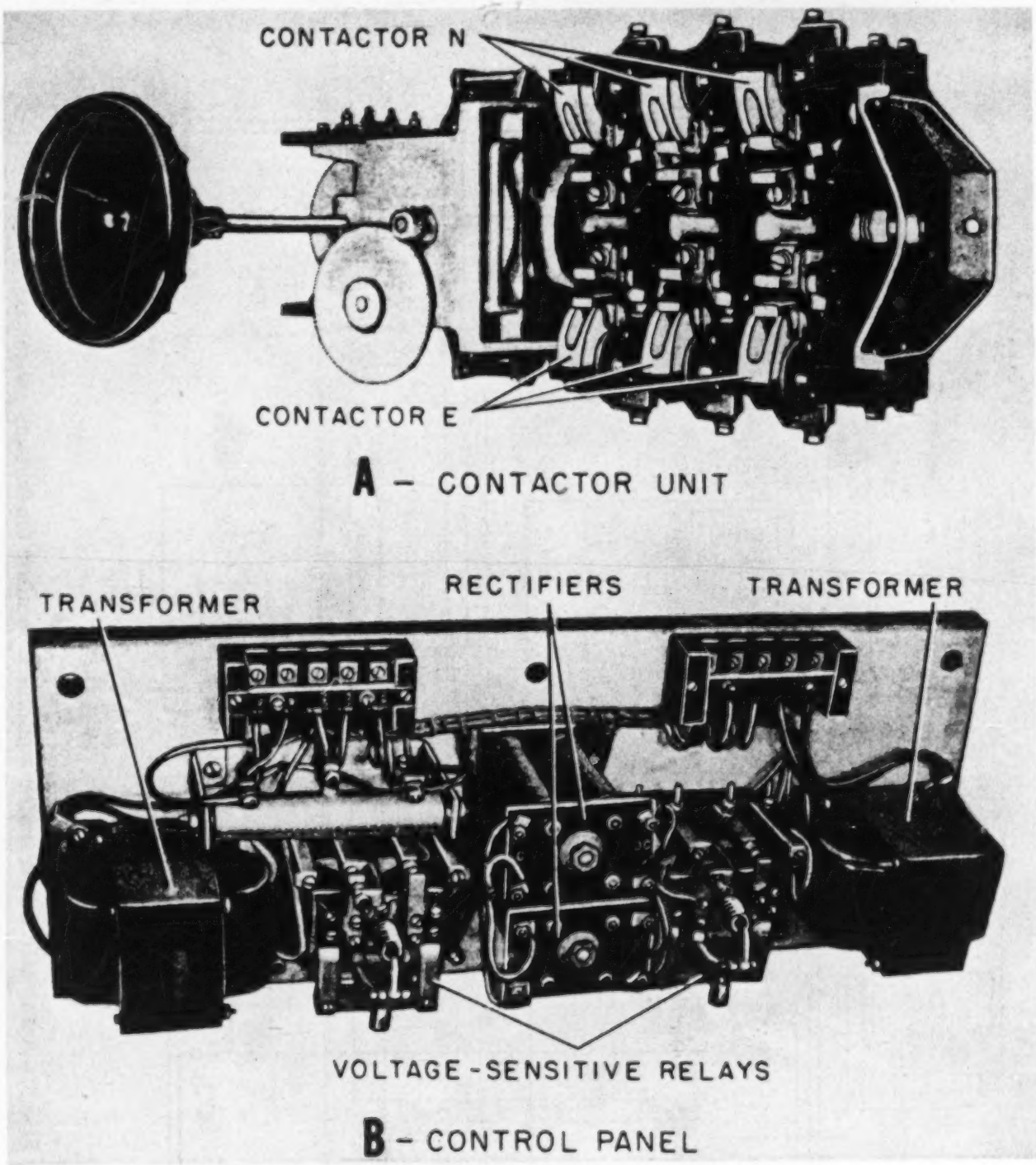

Figure 11-9.—Automatic bus transfer controller. 77.170

voltage-sensitive relays, VN and VE, have two operating coils connected in series and four (three a and one b) contacts. When the relay is energized, the a contacts are closed and the b contacts are open. Conversely, when the relay is deenergized, the a contacts are open and the b contacts are closed. Relay VN (fig. 11-10) is shown in the energized position and relay VE in the deenergized position. The relay is d-c operated by means of a 450/160-volt transformer and copper oxide rectifier. Relay VN is operated by transformer T1 and rectifier CR1 and relay VE is operated by transformer T2 and rectifier CR2. The VN relay, connected in the after ship service supply, is

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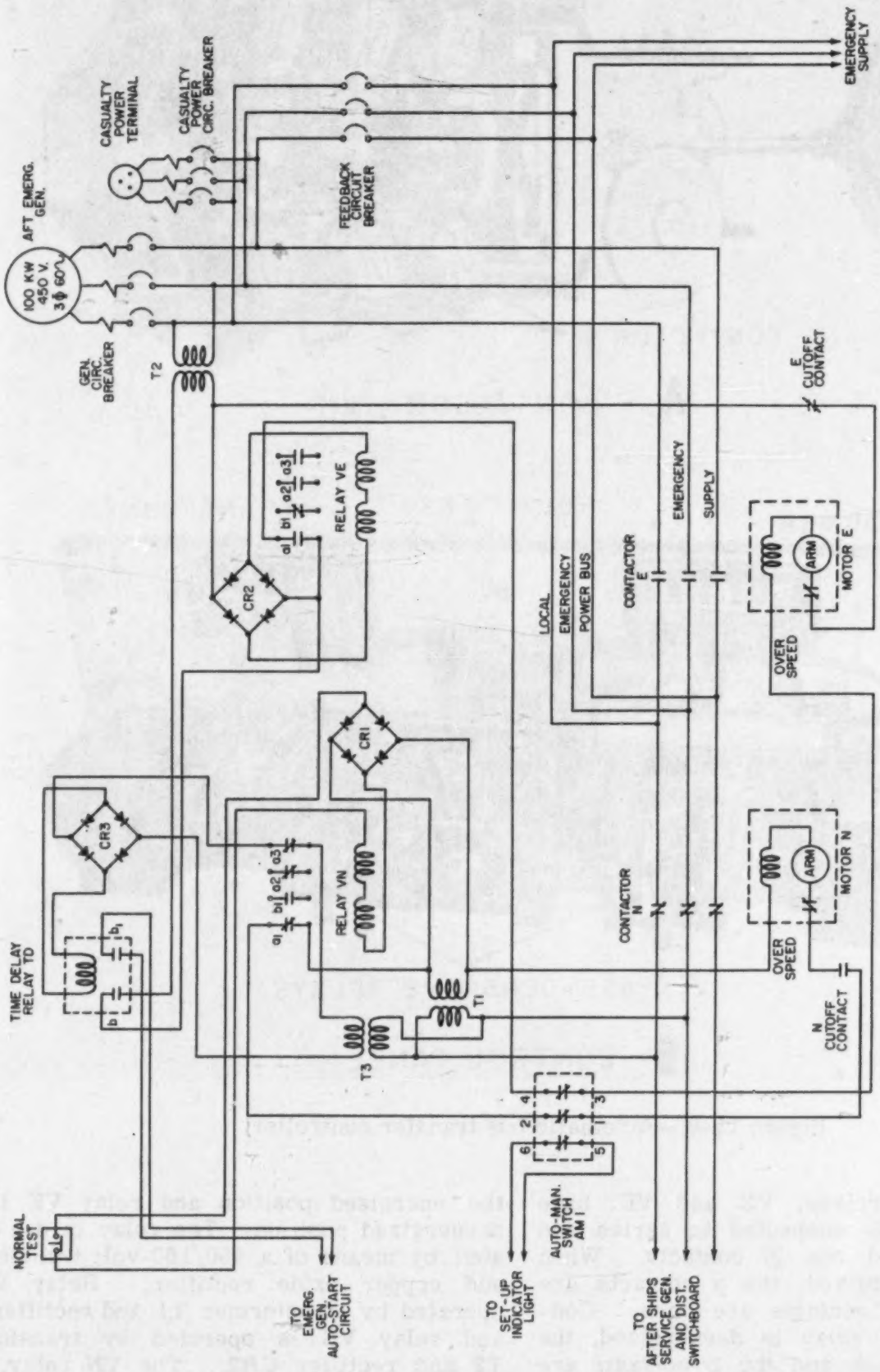

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Figure 11-10.—Automatic bus transfer equipment in after emergency switchboard.

adjusted to pick up at 395 volts and drop out at 290 volts. The VE relay, connected in the emergency supply, is adjusted to pick up at 420 volts.

The automatic-manual transfer switch (AM1) has three contacts. When the transfer switch is in the AUTOMATIC position the contacts are closed, and when the switch is in the MANUAL position the contacts are open and prevent operation of the pilot motors. This switch is shown in the AUTOMATIC position. One pair of contacts (1-2) is in the circuit of motor N, one pair (3-4) in the circuit of motor E, and the other pair (5-6) is in the circuit of the transformer supplying the setup indicator light (not shown). This light indicates when the setup is properly made for automatic operation of the emergency diesel generator and the bus transfer equipment.

A time delay relay, TD, having a single coil and two pairs of contacts, b and b1, is connected in the circuit of the bus transfer equipment to delay the starting of the emergency diesel generator, and to delay the energizing of the rectifier for relay VE. The time delay on dropout is approximately one second (not adjustable). The relay is d-c operated by means of a 450/160-volt transformer (T-3) and copper oxide rectifier (CR3).

Under normal conditions, with either or both ship service turbine generators in operation, the two emergency diesel generators will not be running, and the emergency switchboards will be supplied with power from the forward and after ship service switchboards through the ship service and emergency bus transfer equipments located on the emergency switchboards. Hence, when the supply from the after generator switchboard is 290 volts or above, relay VN will be energized, contactor N will be closed, and the 450-volt local emergency power bus will be fed from the after ship service switchboard. With contactor N normally closed, the pilot motor for contactor N will be deenergized as the cutoff contact for contactor N will be open. If the supply voltage should fall to 290 volts or below, relay VN will drop out and open its a3 contact, which opens the circuit to rectifier CR3 that supplies relay TD.

After a brief interval, relay TD closes its b contact to complete the circuit to rectifier CR2 for relay VE. At the same time contact b1 closes to complete the starting circuit to the emergency diesel generator (not shown). The b contact of relay TD is also in the circuit to the pilot motor for contactor E. However, this motor is not energized until contact a1 of relay VE closes. When the emergency generator voltage increases to 420 volts or above, contact a1 of relay VE closes to complete the circuit to the pilot motor for contactor E. Pilot motor E will rotate the cam to open contactor N and close contactor E. At the same time, auxiliary cutoff contact, N, closes. When contactor E closes, its cutoff contact opens the circuit to the pilot motor for contactor E. The 450-volt local emergency power bus on the after emergency switchboard is now supplied from the emergency generator.

If the voltage of the preferred supply should rise to 395 volts or above, relay VN will pick up and close its a1 contact to complete the circuit to the pilot motor for contactor N. Motor N will rotate the cam to open contactor E and close contactor N. When contactor N closes, its cutoff contact opens the circuit to the pilot motor for contactor N. Because contact a3 is now closed, CR3 and relay TD will be energized. Contact b of relay TD will open and deenergize the circuit to rectifier CR2, thereby deenergizing relay VE opening the circuit to pilot motor E. However, the emergency diesel generator will continue to run until it is shut down manually.

Ground Detector Lamps

A set of three ground detector lamps (fig. 11-11) connected through transformers to the main bus of each ship service switchgear group and to the emergency bus provides a means to check for grounds on any phase of the 3-phase system.

To check for a ground, turn switch S on and observe the brilliancy of the three lights. If the lights are equally bright, all lights are receiving the same voltage, and no ground exists. If lamp A is dark and lamps B and C are bright, phase A is grounded. In this case, the primary of the transformer in phase A is shunted to ground and lamp A receives no voltage. Similarly, if lamp B is dark and lamps A and C are bright, a ground exists on phase B. If lamp C is dark and lamps A and B are bright, a ground exists on phase C.

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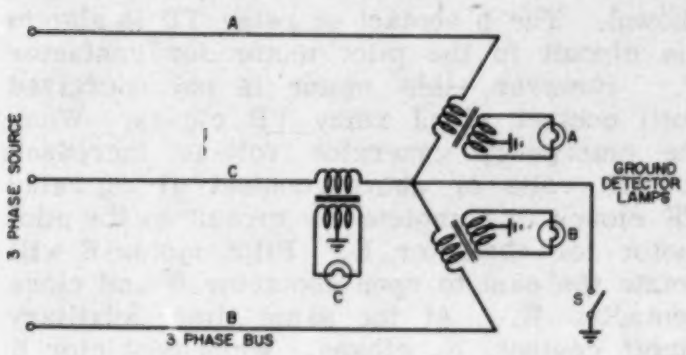

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Figure 11-11.—A-c ground detector lamp circuit.

POWER DISTRIBUTION ON A DLG

Figure 11-12 is a one line diagram of the radial type ship service power distribution system as found on the DLG-23, USS HALSEY. This diagram shows in simplified form the electrical system with its interlinking power circuits and emergency connections. All ship service 60 cycle power utilized on this class of ship passes through switchgear groups 1S, 2S and the emergency switchboards 1E and 2E.

Ship Service Electric Plants

The forward electric plant consists of ships service generators 1A, and 1B, and ship

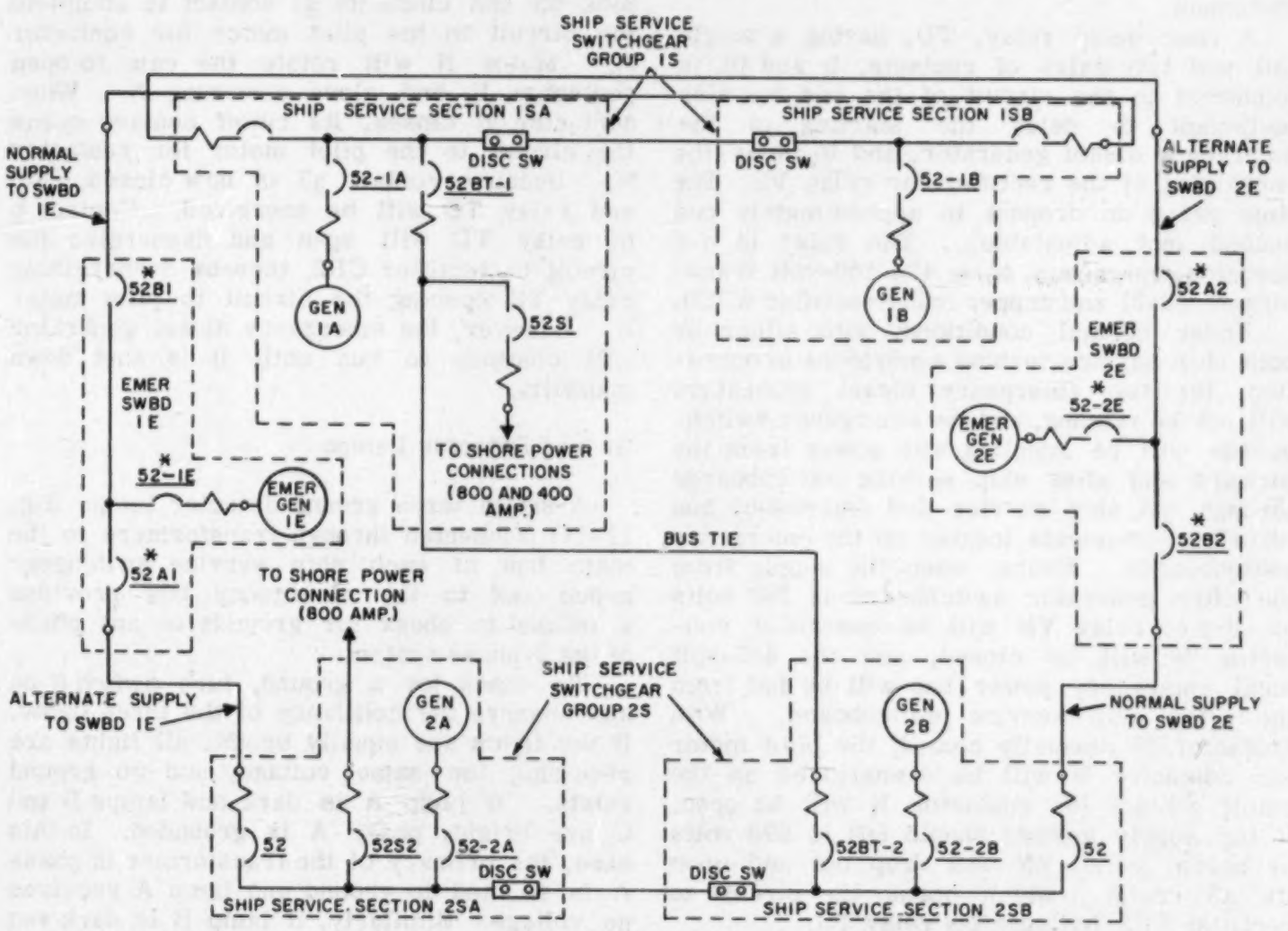

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Figure 11-12.—Power distribution (60 cycle) system on the DLG-23.

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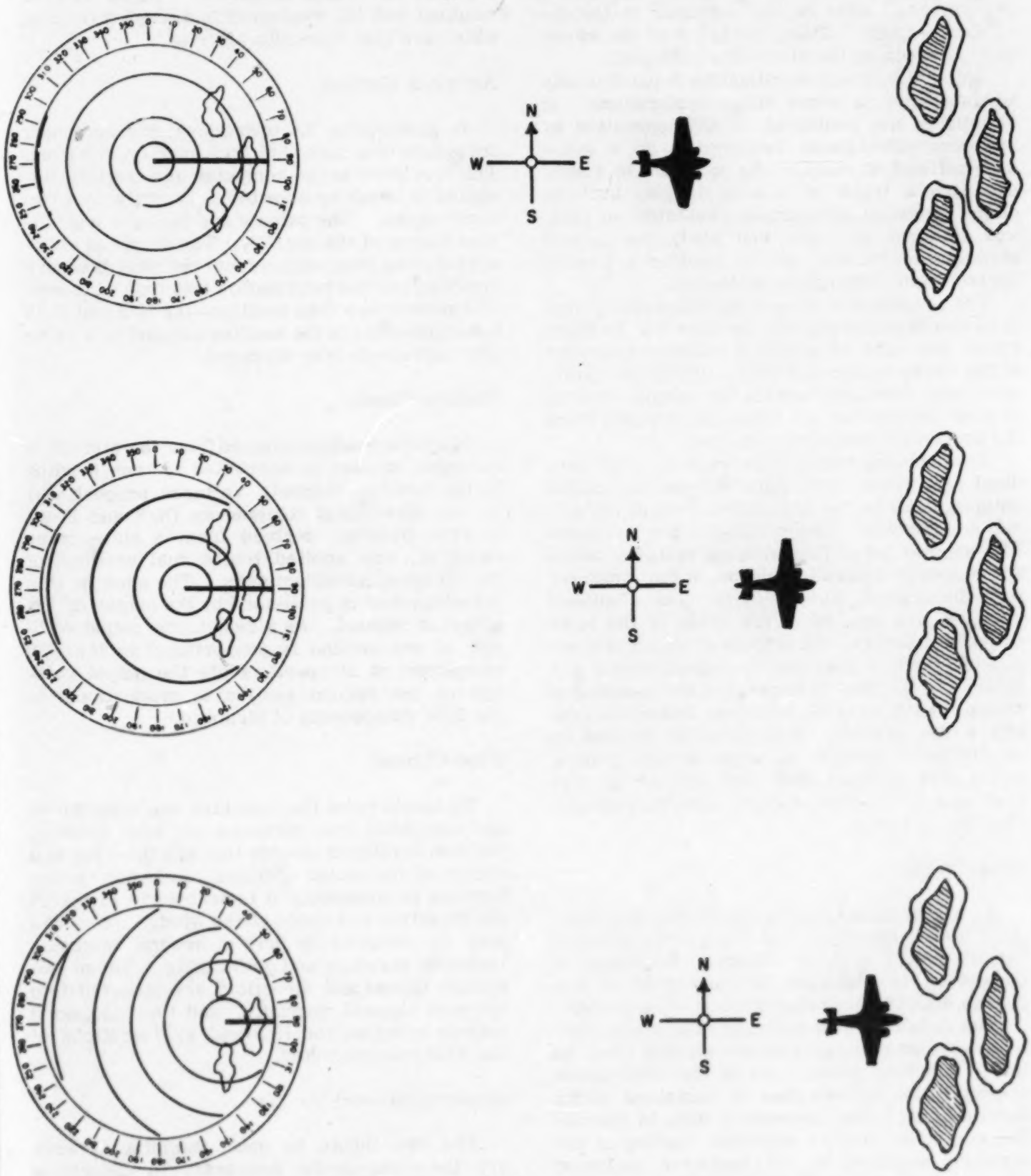

Figure 17-39. —Ground position indication display sequence.

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service switchgear group 1S, located in the forward (No. 1) engineroom.

The after electric plant consists of ships service generators 2A, and 2B, and ships service switchgear group 2S, located in the after (No. 2) engineroom.

The four ships service generators are 1000 kw, 450 volts, 1604 amperes, 3 phase, 60 cycle, steam turbine driven, totally enclosed with an air to water heat exchanger. They are class H insulated.

Emergency Electric Plants

The forward emergency plant consists of the emergency generator 1E and the emergency switchboard 1E. The emergency generators are physically separated as far as possible from the ship service generators, and each other, to protect against simultaneous damage to the ship's electrical system from a single source. Both the forward emergency generator 1E, and the after emergency generator 2E, are rated 300 kw, 450 volt, 60 cycle, 3 phase. The forward emergency generator is driven by a gas turbine and the after emergency generator is driven by a diesel engine. In figure 11-12 the normal and alternate supplies of the emergency switchboards are labeled, to show these bus feeders from the ship service switchgear groups. The three circuit breakers shown on 1E emergency switchboard are electrically interlocked when the emergency switchboard is set up for automatic operation. While 1E or 2E is set up for automatic transfer, if the normal ship service supply drops to 300 volts or below, the load is automatically transfered to the alternate supply if 400 volts or above are available from the alternate source. If 400 volts or above are restored to the normal supply the load will automatically retransfer to the normal supply. If both ship service supplies fail or their voltages drop below 300 volts, the transfer operates automatically through relays to start the emergency generator and connect it to the emergency switchboard. If the emergency generator is supplying the emergency switchboard and ship service power is restored, retransfer will not take place, but can be accomplished by manually tripping the emergency generator circuit breaker. The operation of 1E or 2E is the same.

Interconnections

When the ship service plants are secured and shore or tender power is not available, the emergency generators can "feed back" power to either switchgear group by means of a bus transfer selector switch on the emergency switchboards. The bus transfer selector switch when placed in the manual position, allows manual operation of the circuit breakers on the emergency switchboards. While the bus transfer selector switch is in the normal preferred or alternate preferred position, the three circuit breakers on the emergency switchboards are interlocked and only one of them can be closed at a time. The feedback circuits should only be used in special circumstances such as to supply power to the ship service bus for starting the ship service plant. When the feedback provision is in use, increased vigilance must be observed to prevent overloading of the emergency generators. The feed-back circuits must NEVER be used to parallel the emergency generators with each other, with the ship service generators, or with shore power.

System Operation

The ship service generators may be run either singularly or in parallel with each other. It is possible to run all four ship service generators in parallel (parallel 1S and 2S via the bus tie), however no more than three generators can be safely operated in parallel without exceeding the interrupting capacity of the circuit breakers. The ship service generators should never be paralleled with shore power or the emergency generators.

The ship service switchgear groups and the emergency switchboards are the dead-front type. Figure 11-13 shows the 1SA section of the 1S switchgear group and figure 11-14 is the 1SB section. If one section is damaged, it may be isolated from the undamaged section by using the disconnect switches as shown on figure 11-12.

Figure 11-15 shows a disconnect device in both the open and closed position. The disconnect devices should NEVER be opened or closed on a hot bus. When operating a disconnect device it should always be either

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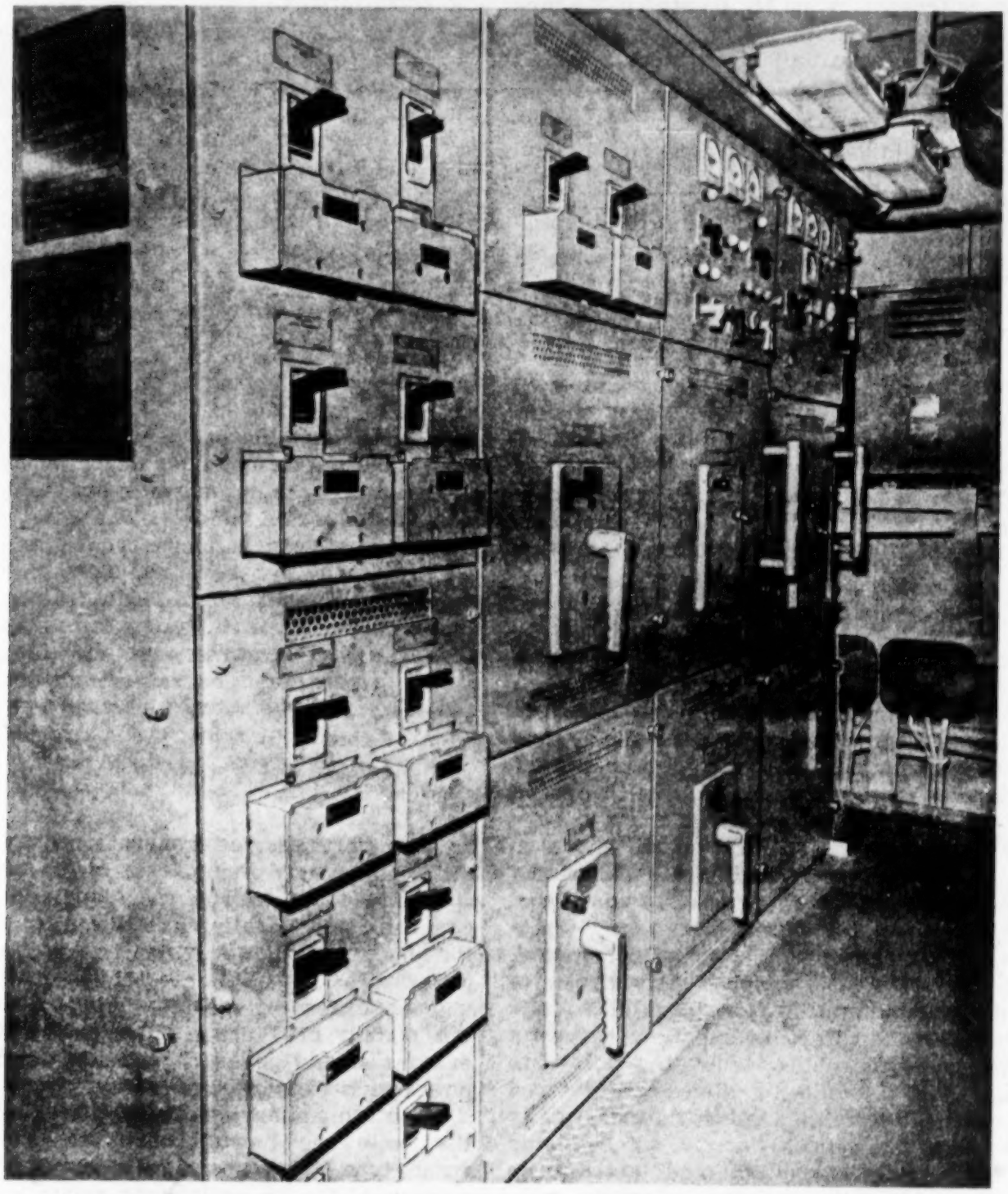

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Figure 11-13.—Ship service switchgear group No. 1S: section 1SA.

completely open or completely closed. The locking springs, as shown in figure 11-15, lock the device to prevent accidental opening or closing due to vibration, if the device is operated completely in either direction until the locking spring is compressed.

Shore Power Connections

The DLG 23 is equipped with three topside shore power terminal boxes. Two of the shore power terminals (one 800 and one 400

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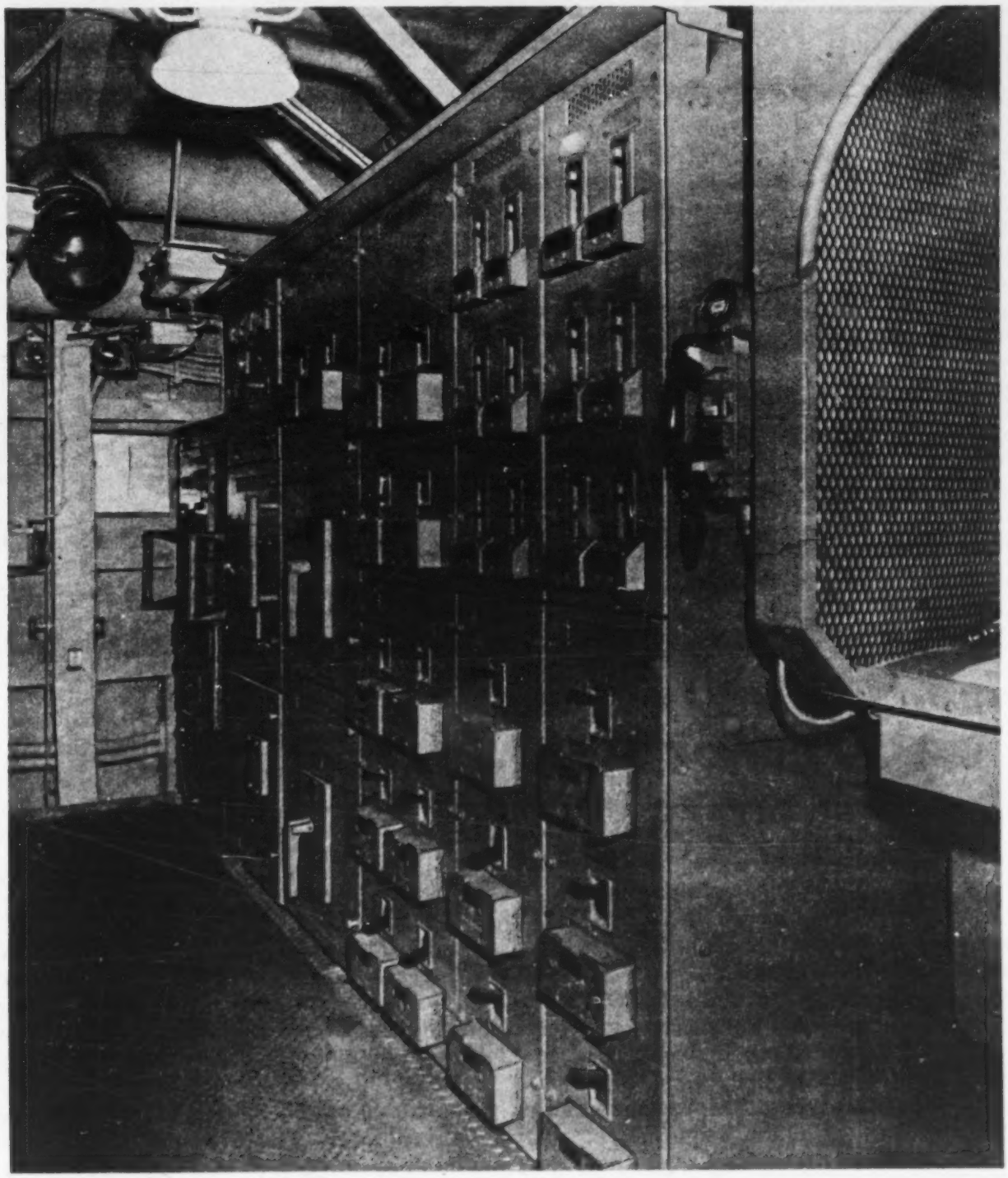

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Figure 11-14.—Ship service switchgear group No. 1S, section 15B.

amperes) connect to the bus tie circuit between 1S and 2S as shown in figure 11-12. The other shore power connection (800 ampere) is connected to the 2SA section of switchgear 2S via a AQB-A800 ampere frame circuit breaker.

The back of each emergency switchboard (fig. 11-16) is provided with one casualty power terminal and each ship service switchgear group is provided with four casualty power terminals installed on the back of the units (2 for each section (fig. 11-17)) and

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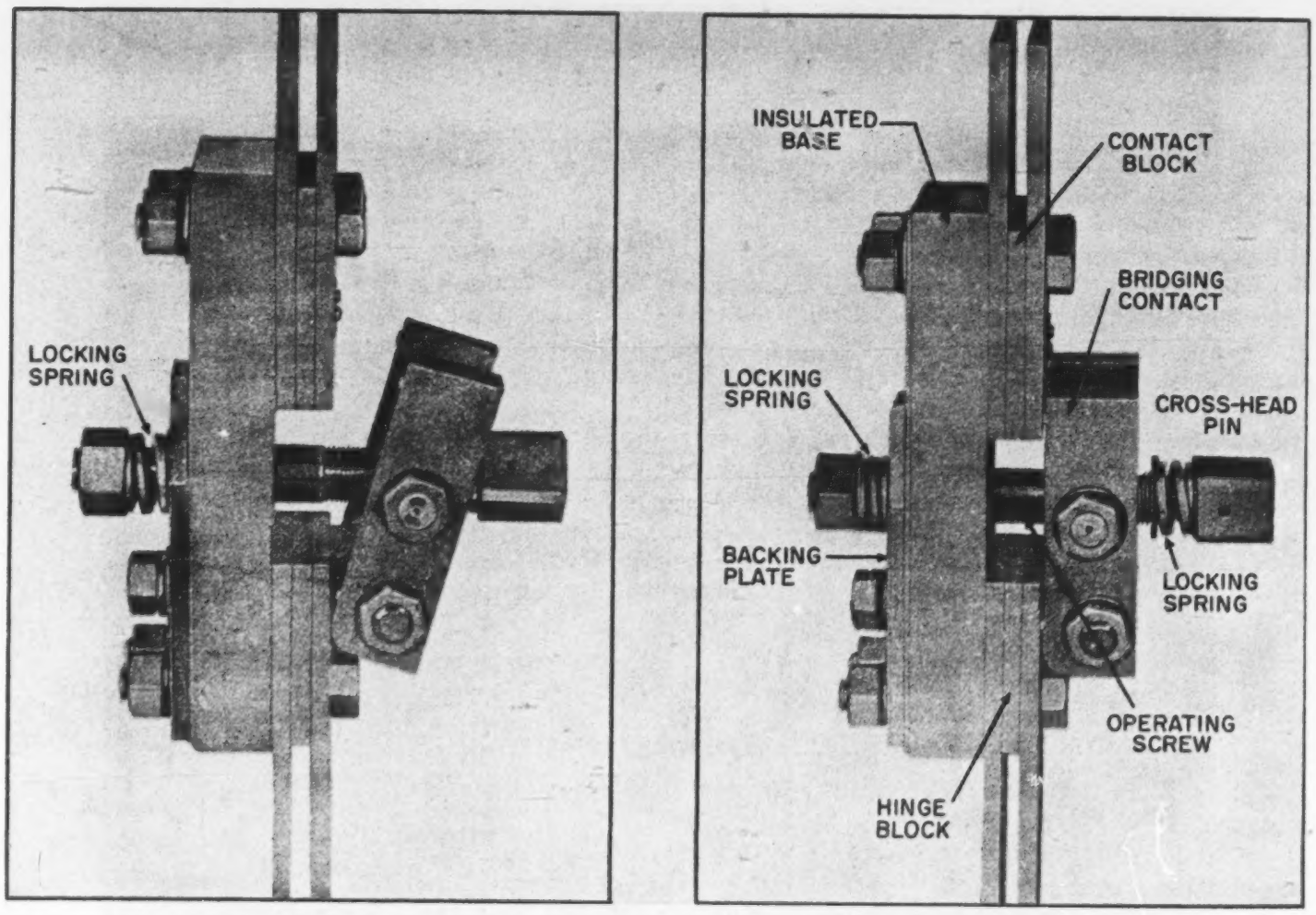

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Figure 11-15.—Disconnect device.

connected to the buses through 250-ampere frame size AQB circuit breakers.

Figure 11-18 shows an ACB-1600 circuit breaker in the normal operating position. Figure 11-19 shows the same breaker in the withdrawn position. The provision for drawing out the breaker to perform routine maintenance or even complete removal of the breaker is a great improvement over the older type ACB breakers as discussed previously in chapter 8. The DLG-23 has eight ACB-1600 circuit breakers in switchgear group 1S and seven ACB-1600 circuit breakers in switchgear 2S. The emergency switchboards also have drawout circuit breakers as shown in figure 11-20.

400-Cycle Power Distribution

In addition to the 60-cycle power supplied by the ship service and emergency generators, the DLG also has 400 cycle systems. The 400-cycle power is generated by motor generator sets and distributed via special frequency switchboards (fig. 11-21) to the various 400-cycle equipments. The DLG has three 200-kw, 400-cycle, 450-volt, 3-phase motor generators which supply the ship service 400-cycle power. These three motor generators, numbered M/G 1, M/G 9, and M/G 13 in figure 11-22, supply power to ship service special frequency switchboards 1SF, 5SF, and 6SF, respectively. Motor generator M/G 9 is considered a standby set which can supply 1SF or 6SF, or can be operated in parallel with M/G 13. M/G 9 or M/G 13 may be paralleled momentarily with M/G 1 when transferring the load. Figure 11-22 is a simplified one line diagram of the 400-cycle ship service system bus tie interconnections. The circuits being fed from the 400-cycle

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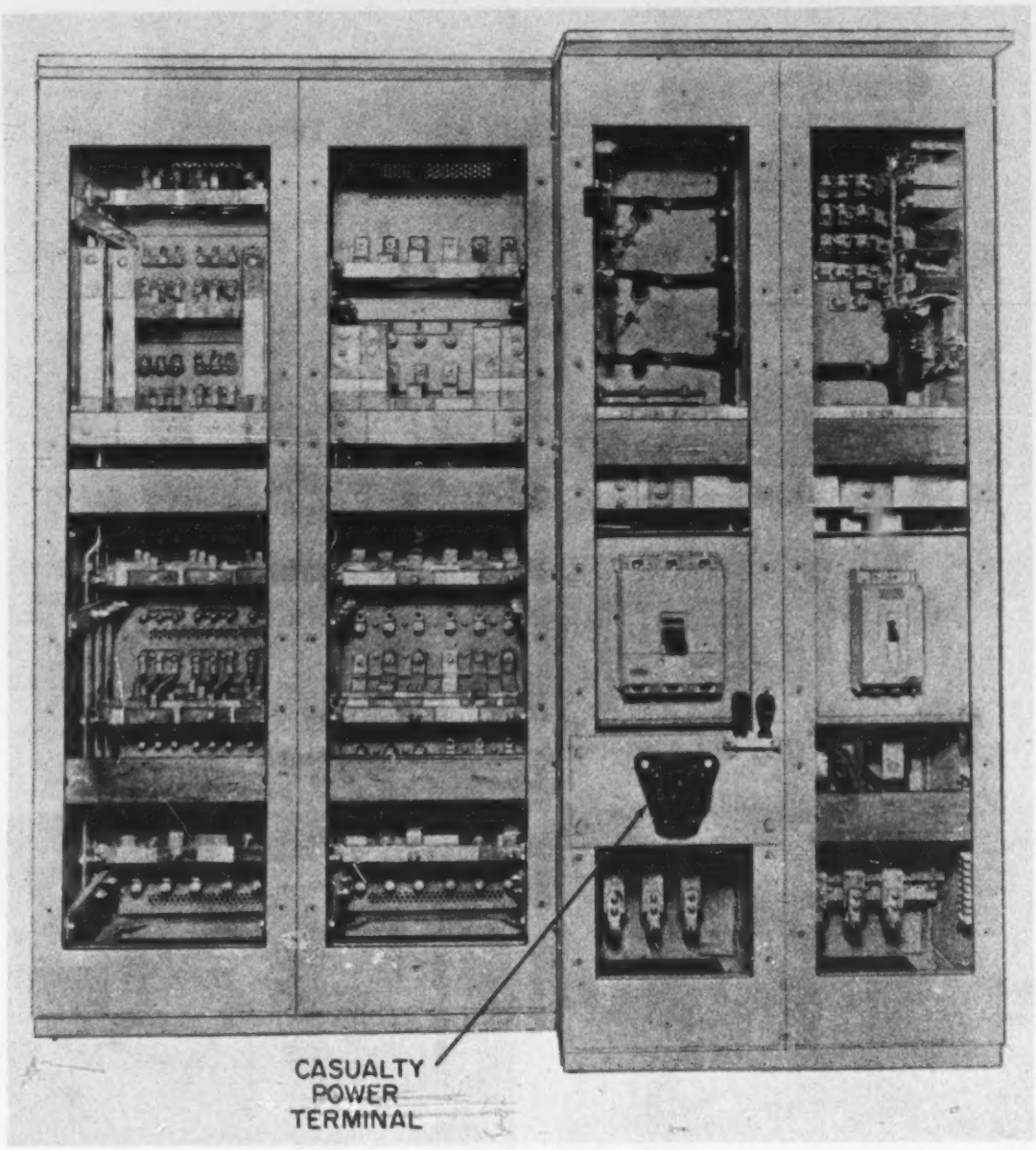

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Figure 11-16.—Emergency switchboard 1E, rear view.

ship service switchboards are deleted from the figure for simplicity. Switchboard 1SF supplies the missile, fire control, ASROC and IC circuits in the forward part of the ship, and 6SF supplies the weapons circuits in the after part of the ship. The DLG also has six 60-kw, 450-volt, 3-phase, 400-cycle motor generator sets for missile fire control radar. Three of these sets (numbered 5, 7, and 8) feed the missile illuminator power switchboard (2SF) forward, and three sets (numbered 10, 11 and 12) supply the missile illuminator power switchboard (4SF) aft. Motor generator number 8 is the forward standby set and number 12 is the after standby set. The weapons control IC switchboard receives its normal 400-cycle power from a separate 60-kw motor generator set (M/G 14) via switchboard 3SF and automatic bus transfer equipment. In the event of a power loss from M/G 14, the weapons IC switchboard power supply is transferred by automatic bus transfer

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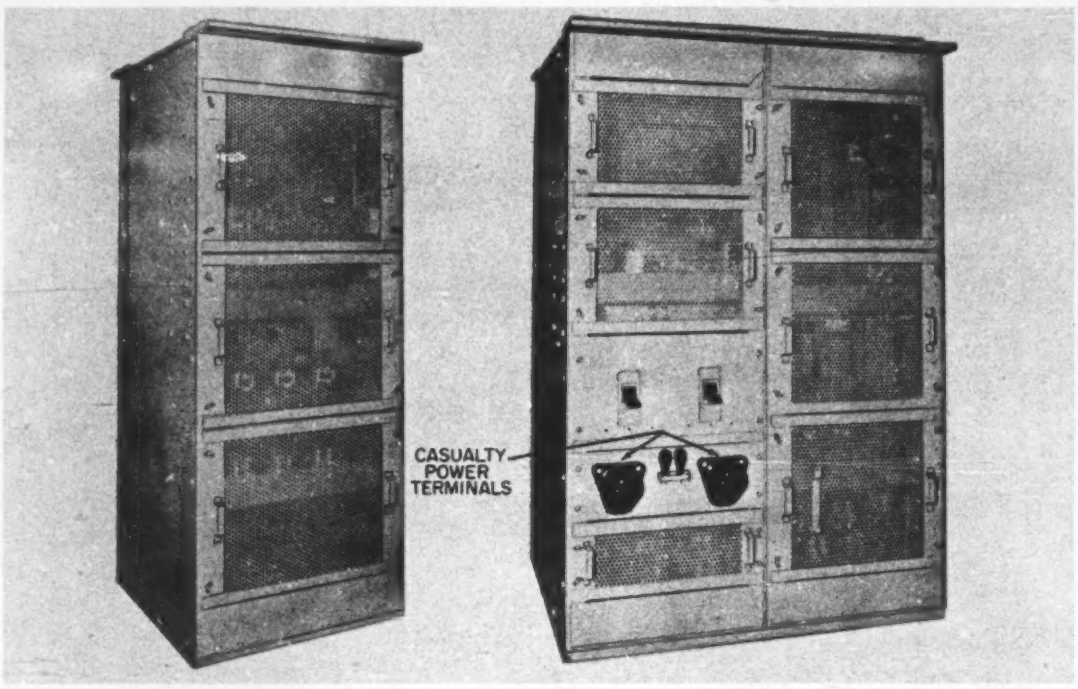

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Figure 11-17.—Ship service switchgear group 2S, a-c generator No. 2A, and distribution section rear view.

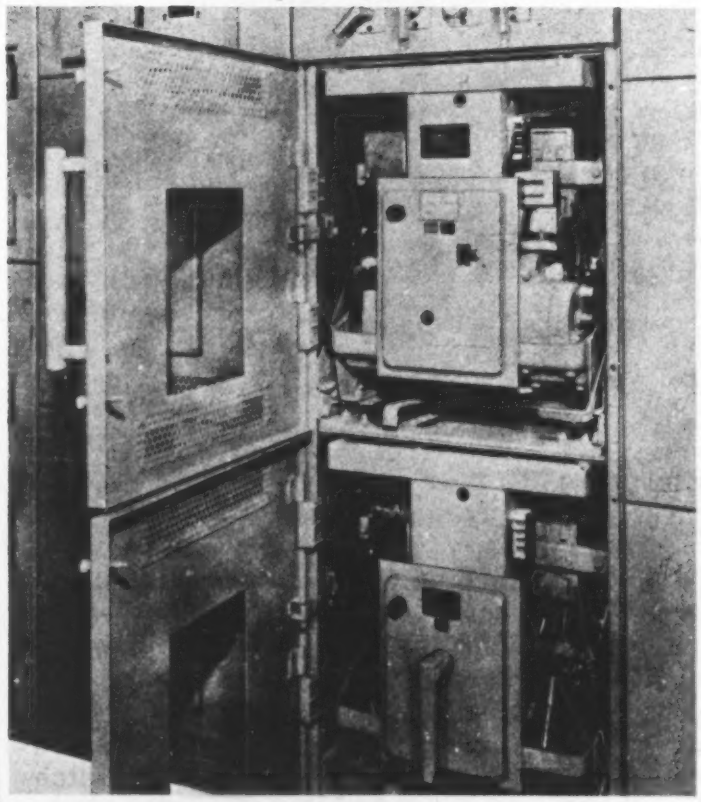

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Figure 11-18.—ACB-1600 in normal position.

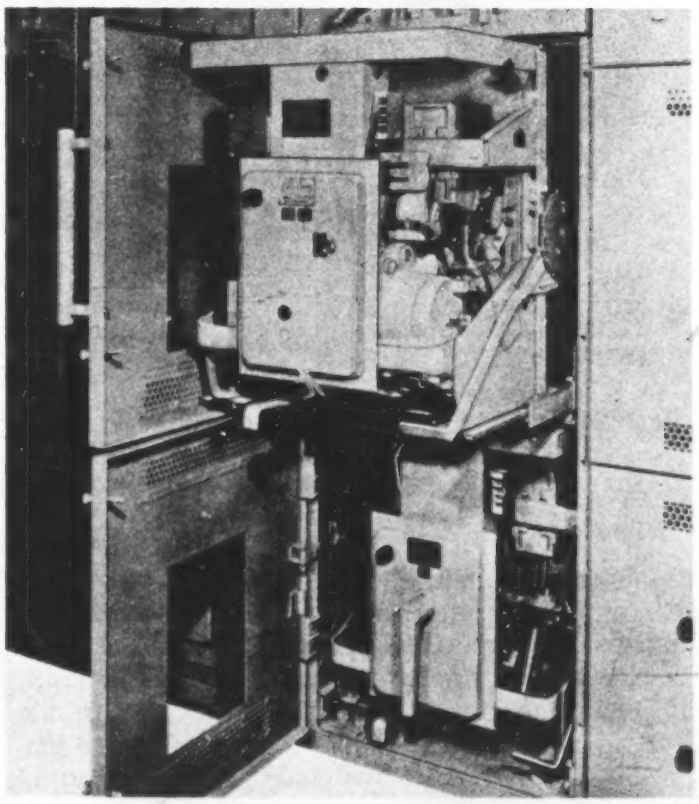

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Figure 11-19.—ACB-1600 in withdrawn position.

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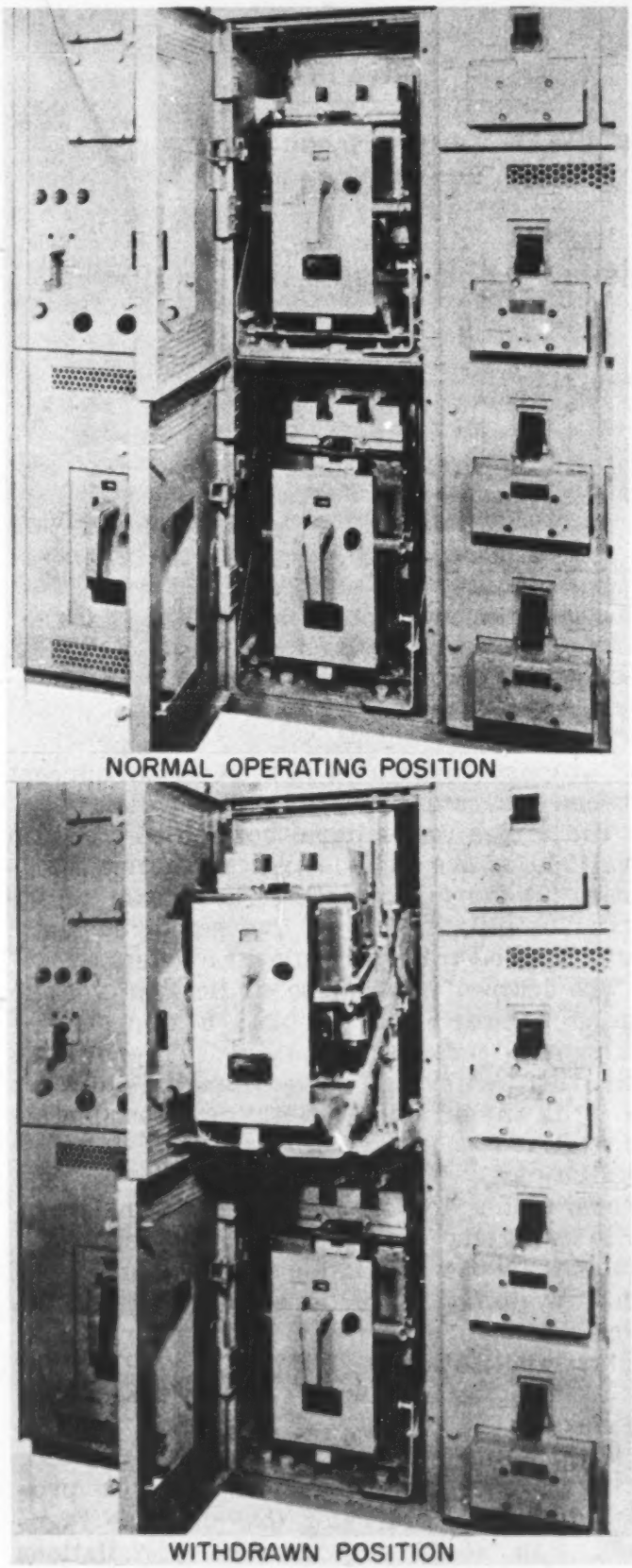

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Figure 11-20.—ACB-640 ampere circuit breaker.

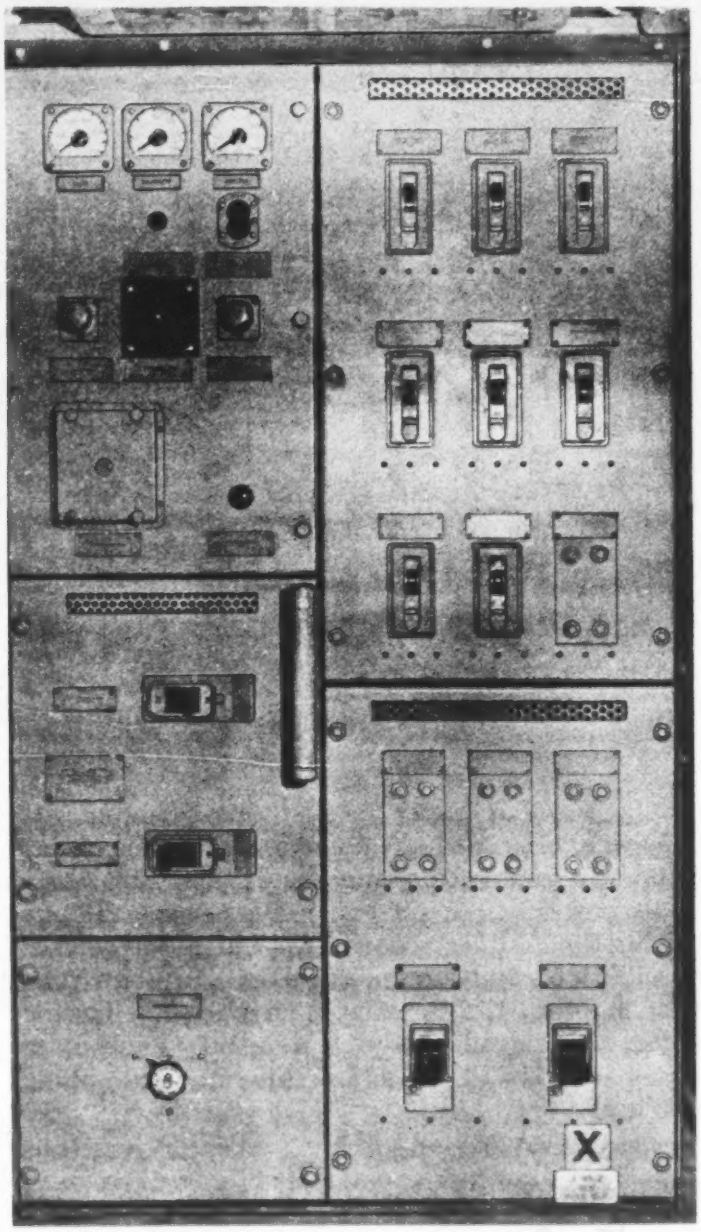

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Figure 11-21.—400 cycle switchboard - 1SF.

to its alternate power supply, which is from 6SF. Provisions are made on the DLG-23 for future installation of yet another 400 cycle motor generator set to be designated M/G 6. M/G will be the power supply for NTDS (Naval Tactical Data Systems) when installed. There has been a tremendous increase in the number and size of special frequency (400 cycle) motor generator installations in recent years, primarily due to the increased power requirements of modern weapons systems.

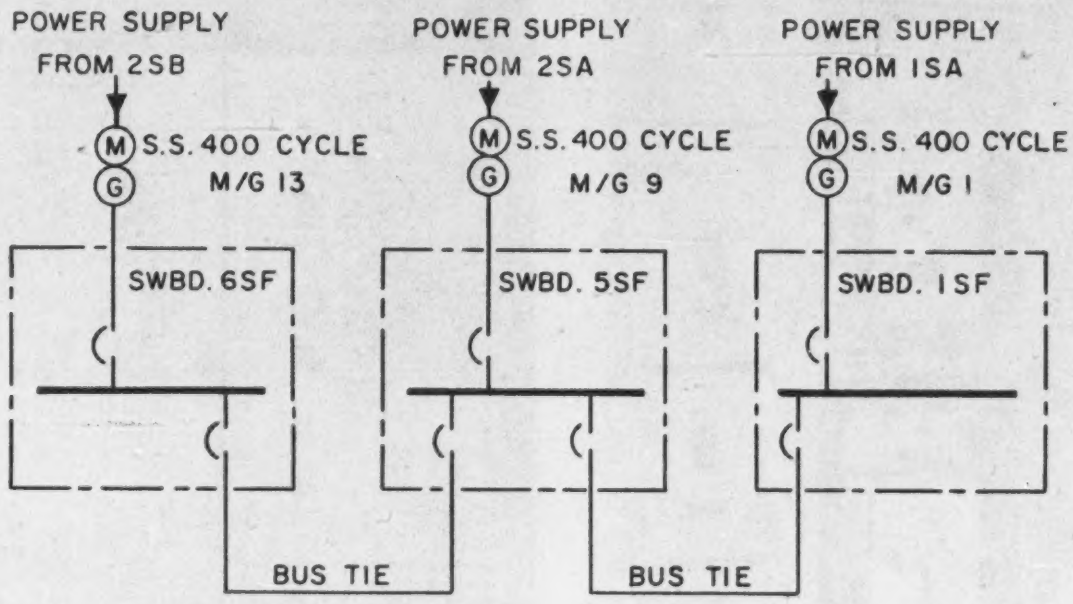

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Figure 11-22.—Bus tie connections on 400-cycle ship service system.

The DLG of today is just one of the newer type warships with a greatly increased capability for generation and distribution of electrical power, both 60 and 400 cycle. Although it is not possible to cover the entire electrical distribution system of a DLG in just part of a chapter, the lighting distribution, steering power, and circuits to vital auxiliary equipment are basically the same as on any other warship.

VOLTAGE REGULATORS

A voltage regulator consists essentially of a control element and associated mechanical or electrical means to produce the changes in the generator field current that are necessary to maintain a predetermined constant generator terminal voltage. When used on d-c generators, the functions performed by voltage regulators and their auxiliary equipment are to maintain the generator terminal voltage within specified limits and to provide for proper division of the load between generators operating in parallel. When used on a-c generators the functions performed by voltage regulators and their auxiliary equipment are to maintain the generator terminal voltage within specified limits, and to provide for proper division of the reactive current between generators operating in parallel.

The types of voltage regulators used in naval ships are (1) the indirect acting rheostatic, (2) the direct acting rheostatic, (3) the rotary amplifier, and (4) the combined static excitation and voltage regulation system.

The indirect acting rheostatic type voltage regulators were used on all a-c ship service generators and many emergency generators until 1943. Many of these voltage regulators are still in service, but the indirect acting rheostatic type is no longer used for new installations. The present practice for a-c generators is to use the direct acting rheostatic type, the rotary amplifier type, or the combined static excitation and voltage regulation system. The type used depends on which is considered most suitable for a particular application. Voltage regulators for d-c generators are usually of the direct acting rheostatic type.

When voltage regulators are used for either a-c or d-c generators, one regulator is provided for each generator that is to be regulated. In some ship service installations a spare voltage-sensitive (control) element is installed on the switchboard. The switchboard is provided with a transfer switch so that a spare element can be placed in service

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if the normal control element becomes deranged. Spare control elements are not installed for voltage regulators used on emergency generators. On later ships the spare element has been omitted.

The static excitation and voltage regulator system furnishes the a-c generator field current by rectifying a part of the a-c generator output. This output is fed to the field as a self-excited generator, after initial flashing from a battery or other source of low voltage direct current, to build up the voltage. The control element is a network of capacitors, reactors, and resistors, and it controls the field current by means of magnetic amplifiers. This system eliminates the rotating exciter and other moving parts and replaces them with an assembly of static components.

Recently developed static voltage regulators using silicon-controlled rectifiers and transsistors has reduced the size and weight of regulators as compared with designs using magnetic amplifiers. These new regulators are being evaluated on a new destroyer escort class ship. Only the indirect and direct types of voltage regulators will be described in this chapter. The other types of voltage regulators are discussed in Electrician's Mate 1 & C, NavPers 10547 (revised).

Indirect Acting Type

The indirect acting rheostatic type of voltage regulator has a voltage-sensitive element. This element controls (1) a motor-operated rheostat for changing field resistance and (2) relays that cut large blocks of resistance into or out of the field circuit in order to lower or increase the generator voltage quickly. Figure 11-23 shows the circuit for this type of voltage regulator on an alternator. When the a-c voltage is normal, the contact arm is in the vertical position, and none of its contacts touch the constantly rotating cam, because the pull of the torque motor is exactly balanced by the adjusting spring. Hence, none of the relays operate, and the rheostat motor is stationary. If the line voltage drops below normal, the pull of the torque motor becomes less and is overcome by the spring. The contact arm swings over until the decreased tension of the spring is just balanced by the torque motor. If it is a small drop in voltage, one of the contacts makes intermittent contact with the tips of the notched cam.

This action sends current impulses through the RAISE relay, which causes its contacts to open and close. This energizes the rheostat motor through its raise field, and the rheostat motor drives the sliding contacts of the field rheostat so as to shunt out more of the resistance. The impulses to the motor from the raise relay cause a stepping action of the motor, thus preventing overtravel when only a small movement of the rheostat is needed. As the field excitation increases, the a-c voltage returns to normal, and the torque motor pulls the contact arm back to the vertical position. This opens the contacts and stops the movement of the rheostat motor.

If the a-c voltage goes too high, the contact arm swings the opposite way and operates the LOWER relay, which energizes the lower field on the rheostat motor and increases the resistance, thereby decreasing the field excitation and reducing the generated voltage.

When a sudden large drop (over 5 percent) in generated voltage occurs, the contact arm is pulled over hard by the adjusting spring. This brings the front contact into continuous contact with the notched cam so that the rheostat motor runs steadily in the proper direction to correct for the voltage drop. However, to provide instantaneous compensation for this voltage drop, the high-speed relay is brought into operation. With a large deflection of the contact arm a back contact is brought into contact with a smooth surface, completing the circuit to the RAISE high-speed relay.

This relay operates, and its contacts shunt out a portion of the variable field resistance. A sudden decrease in field resistance results in a large increase in field excitation and a fast rise in the generated a-c voltage results. But when this voltage approaches normal, the torque motor opens the circuit to the high-speed relay, which in turn opens the shunted portion of the field resistance. During this time the rheostat motor continues to operate but at a steady rate instead of with its usual pulsing movements. When the generated voltage approaches within 5 percent of normal, the high-speed relay opens, and the rheostat motor completes the voltage adjustment.

Similar action takes place when the generated voltage increases over 5 percent, except that the lower relays are energized. When the high-speed lower relay operates, it removes a shunt from a fixed portion of the field resistance, which causes a large decrease

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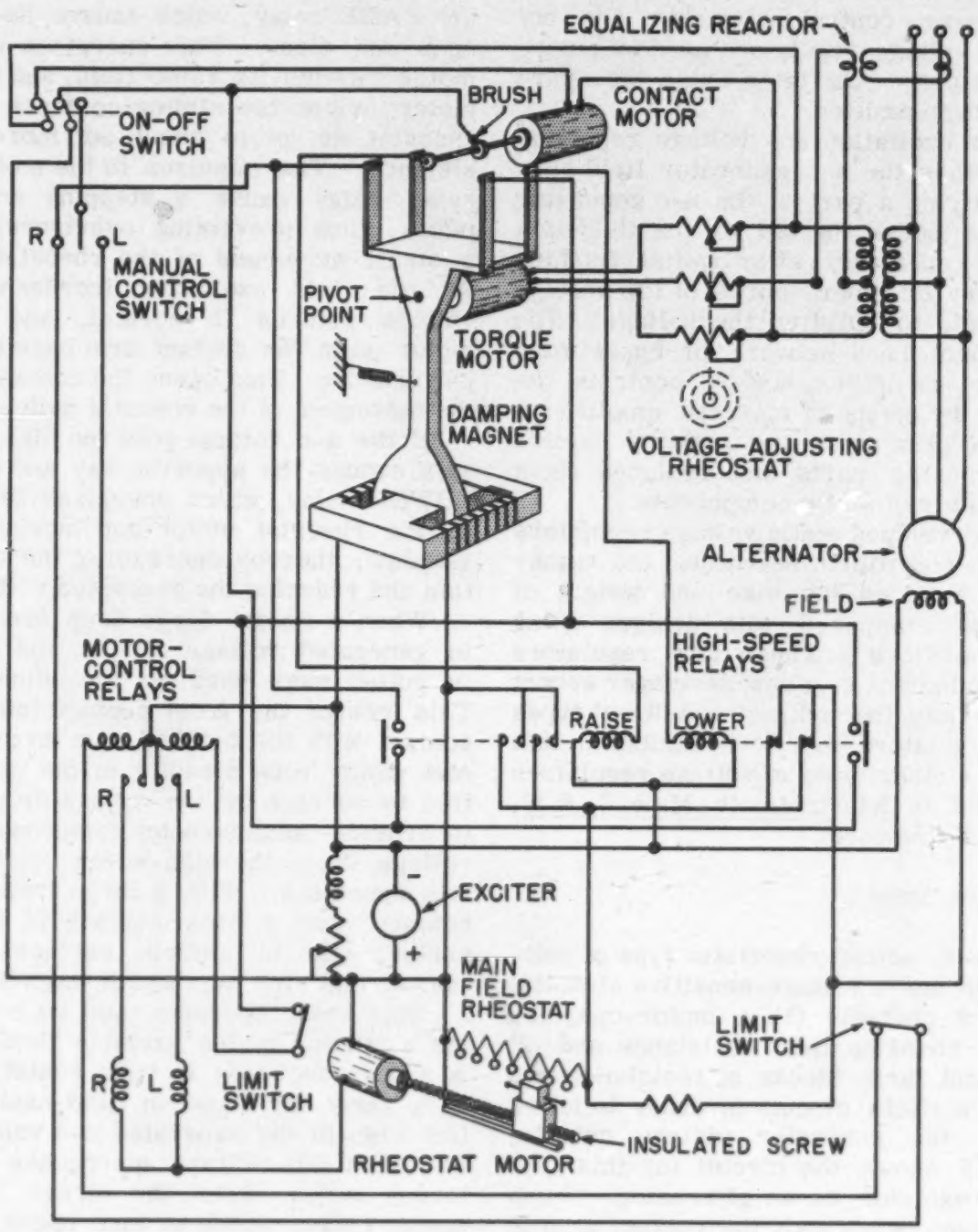

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Figure 11-23.—Indirect acting voltage regulator on a-c generator.

in field excitation and the resultant fast drop in generated voltage.

Direct Acting Type

The SILVERSTAT, a direct and quick-acting voltage regulator is used for both ship service and emergency generators (fig. 11-24). In large alternators the regulating resistance is connected in the shunt-field circuit of the exciter. In small machines that use these regulators the resistance may be connected directly in series with the alternator field. The torque element of the Silverstat regulator

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mile of flight, the origin (start) of the sweep is displaced 1 mile on the indicator in the direction of flight. Thus, the track of the sweep origins becomes the aircraft's flightpath.

Automatic ground stabilization is particularly advantageous in some radar applications. It simplifies the problems of ASW operation by reducing calculations required to fly a sonobuoy pattern; it enables the operator to easily establish a track of moving targets such as ships, surfaced submarines, vehicles on land, and airborne aircraft; and also, the ground stabilization feature can be used as a homing device from reasonable distances.

The purpose of a ground stabilization system is to combine and amplify certain d-c voltages which are used to properly position the start of the sweep on the indicator. These d-c voltages are developed either by manual control of slew helipots or by automatic control from the ground stabilization computer.

Four slewing voltages (representing the cardinal directions) are supplied and controlled automatically by the associated ground stabilization computer. These voltages are combined with another set of four slewing voltages which are manually controlled by the radar operator with the manual slew helipots. The combined voltages are applied to the grids of the input cathode followers, the outputs of which are applied to pairs of push-pull d-c amplifiers which determine the bias voltages for the associated sweep amplifiers in the indicator deflection system. The starting position of the sweeps on the indicator changes as these biases change, and varies automatically with respect to aircraft speed, direction of flight, and wind velocity. (See fig. 17-40.)

COMPUTER

As can be seen from figure 17-40, the computer unit is the "heart" of the ground position indicator (GPI) system. Since a discussion of computers is contained in chapter 10 of this course, only its block diagram will be discussed.

The airborne dead-reckoning computer continuously determines ground position from an initial starting point. All of the information necessary for its operation is contained within the aircraft. The necessary data to operate the computer are (1) magnetic heading of the aircraft, supplied by the magnetic compass; (2) airspeed, supplied by the pitot pressure; (3) local magnetic variation, which is manually inserted to change magnetic heading to true heading; and (4) windspeed and wind direction, which are also manually inserted.

Airspeed Channel

In performing its operations, the computer considers true airspeed, true heading, and time. The resolvers in the computer are circuits designed to break up a vectorial quantity into two components. The outputs are the sine and cosine values of the quantity. The airspeed channel receives information from the pitot pressure and resolves this information into true airspeed. The servomotor then positions the N/S and E/W potentiometers in the heading channel to a value that represents true airspeed.

Heading Channel

Magnetic heading obtained from the aircraft's compass system is corrected to true heading in the heading channel. Voltages proportional to the directional components (N/S and E/W) of true heading, derived from a sine-cosine resolver, are applied to the dual sections of the airspeed potentiometers. The shaft of this potentiometer is positioned by the output of the airspeed channel. As a result, the output voltage of one section is proportional to the N/S component of airspeed, while the output voltage of the second section is proportional to the E/W components of airspeed.

Wind Channel

Up to this point the computer has determined and combined true airspeed and true heading, and has developed outputs that are the sine and cosine of the vector addition. In order to determine groundspeed, it is necessary to insert the direction and speed of the wind. Wind data may be obtained by any of several methods, including aerology and drift sights. These two factors (speed and direction) are inserted into the wind channel manually, and the resolver's outputs energize the N/S and E/W sections of the wind potentiometer.

Summing Network

The two inputs to each summing network are the components necessary to determine groundspeed. The inputs are derived from true heading, true airspeed, and wind data

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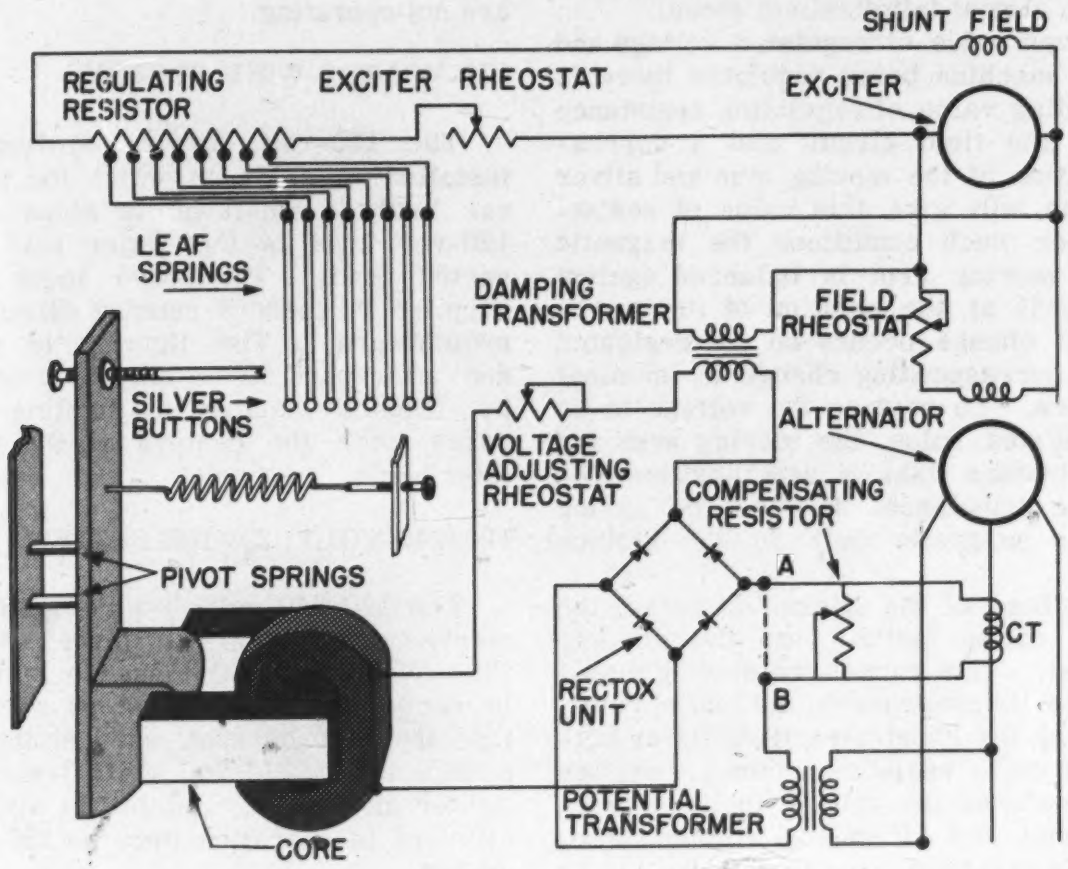

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Figure 11-24.—A Silverstat voltage regulator on an a-c generator.

consists of a control coil operated by a direct current obtained from a Rectox rectifier. A movable core is mounted on an aluminum armature in such a manner that it can move in the air gap of the magnetic circuit of the control coil. The magnetic pull on the armature is balanced by the adjusting spring. A driving member is mounted on the upper end of the armature and bears against an assembly of silver buttons. Each silver button is mounted at the free end of an individual leaf spring of conducting material. The leaf springs are individually insulated. A connection is made from the fixed end of each leaf spring to a tap on the regulating resistance, which is in series with the shunt field of the exciter.

When the top of the moving arm is at the left-hand end of its travel, the driving member allows the free ends of the leaf springs, which carry the silver buttons, to rest against a stop of insulating material. In this position the free ends and the silver buttons are separated from one another. As the moving arm travels to the right, the driving member bears against the silver-button assembly, which closes the silver buttons together successively and in sequence. When the moving arm reaches the right-hand limit of travel, all the buttons are in firm contact with one another. As the driving member travels back to the left, the buttons successively move apart, in sequence, from one another. Only a travel of a fraction of an inch is required to close or open all the buttons in sequence. Although the operation of the silver buttons in sequence appears to cut small steps of resistance in or out in a definite step-by-step manner, its operation does not actually do so. As the buttons are operated by the moving arm, there is a progressive change in pressure between the faces of the buttons. This change in pressure between the silver surfaces varies the effective

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resistance, which amounts to varying the field resistance in almost infinitesimal steps.

For a given value of regulated voltage and load on the machine being regulated there is a corresponding value of regulating resistance required in the field circuit and a corresponding position of the moving arm and silver buttons which will give this value of resistance. Under such conditions the magnetic pull on the moving arm is balanced against the spring pull at the position of its travel. When a load change occurs on the regulated machine, a corresponding change in terminal voltage occurs. To restore the voltage to its correct regulated value, the moving arm and the silver buttons take a new position because of the unbalance between the spring pull and the magnetic pull on the moving arm.

If the voltage of the alternator rises, the armature is drawn farther into the air gap of the magnet. This causes the driving member to reduce its pressure on the leaf springs, opens some of the short-circuiting silver buttons, inserts more resistance into the exciter field, and restores the voltage to its correct value. Should the alternator voltage drop, the process is reversed.

D-C ELECTRIC POWER SYSTEMS

Although a-c power systems have replaced d-c power systems in combat ships, d-c power is still widely used in auxiliary ships having considerable deck machinery. The d-c power systems in auxiliary ships are not ordinarily required to maintain the high degree of reliability required for combatant ships. However, the degree of reliability is carried out within the limits of practicability and depends on the type and size of the ship.

The d-c electric power systems installed in surface ships are the (1) low-voltage system, (2) 120-volt, 2-wire system, and (3) 120/240-volt, 3-wire system.

LOW-VOLTAGE SYSTEM

The low-voltage (12 volt or 24 volt) system is installed in motor torpedo boats, small landing craft, and small boats. Power is supplied by generators that are driven by the propulsion engines or by small auxiliary engines. Storage batteries are used to supply power to the system when the generators are not operating.

120-VOLT, 2-WIRE SYSTEM

The 120-volt, 2-wire system is usually installed in ships in which the total electrical load is small or in ships in which the 120-volt load is the major part of the connected load. The power loads are usually supplied by feeders running directly from the switchboard. The lighting in the forward and after part of the ship is usually supplied by feeders running to lighting distribution boxes near the centers of the forward and after loads.

120/240-VOLT, 3-WIRE SYSTEM

The 120/240-volt, 3-wire system was formerly installed in all large surface ships. This system is still in use in older ships and in converted merchant ships with large deck machinery loads that warrant the use of d-c power. The 120/240 volt, 3-wire system is lighter in weight, smaller in size, and more efficient in operation than the 120-volt, 2-wire system.

In the 3-wire system the power is generated by a 120/240-volt, 3-wire, d-c generator or a converted 240-volt, 2-wire, d-c generator provided with a transformer balancer (center tapped autotransformer) connected through slip rings to tapping points on the generator armature, which establishes a neutral. The present Navy practice is not to ground the neutral (or either leg) of a 3-wire system. The positive, neutral, and negative polarities of bus bars and terminals are indicated + (black), ± (white), and - (red) respectively.

Power distribution from the switchboards to the power loads is a 240-volt, 2-wire system. The 120-volt distribution from the switchboards to the distribution panels is a 120/240-volt, 3-wire system and from the distribution to the branch circuits is a 120-volt, 2-wire system. The 120-volt, 2-wire branch circuits for lighting and appliances are balanced on the two sides of the neutral.

D-C SWITCHBOARDS

An outstanding feature of reliability in combat ships is the installation of two or more independently operated ship service

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switchboards and associated generators located in different parts of the ship. On the other hand, auxiliary ships are usually provided with one switchboard and associated generators located in the main engineroom or adjacent auxiliary machinery space.

The schematic diagram of connections for a typical generator and distribution switchboard shown in figure 11-25 illustrates the following features of control and protection:

1. Generators are connected to the power distribution system through circuit breakers which are designed to automatically disconnect them from the bus under predetermined conditions for overload or short circuit.

2. Reverse current trips integral with the circuit breaker protect the generators against motorizing when operating in parallel.

3. Disconnecting switches permit the circuit breakers to be isolated from the bus for service and repair.

4. Circuit breakers with automatic tripping devices are provided on all distribution circuits to isolate circuit faults.

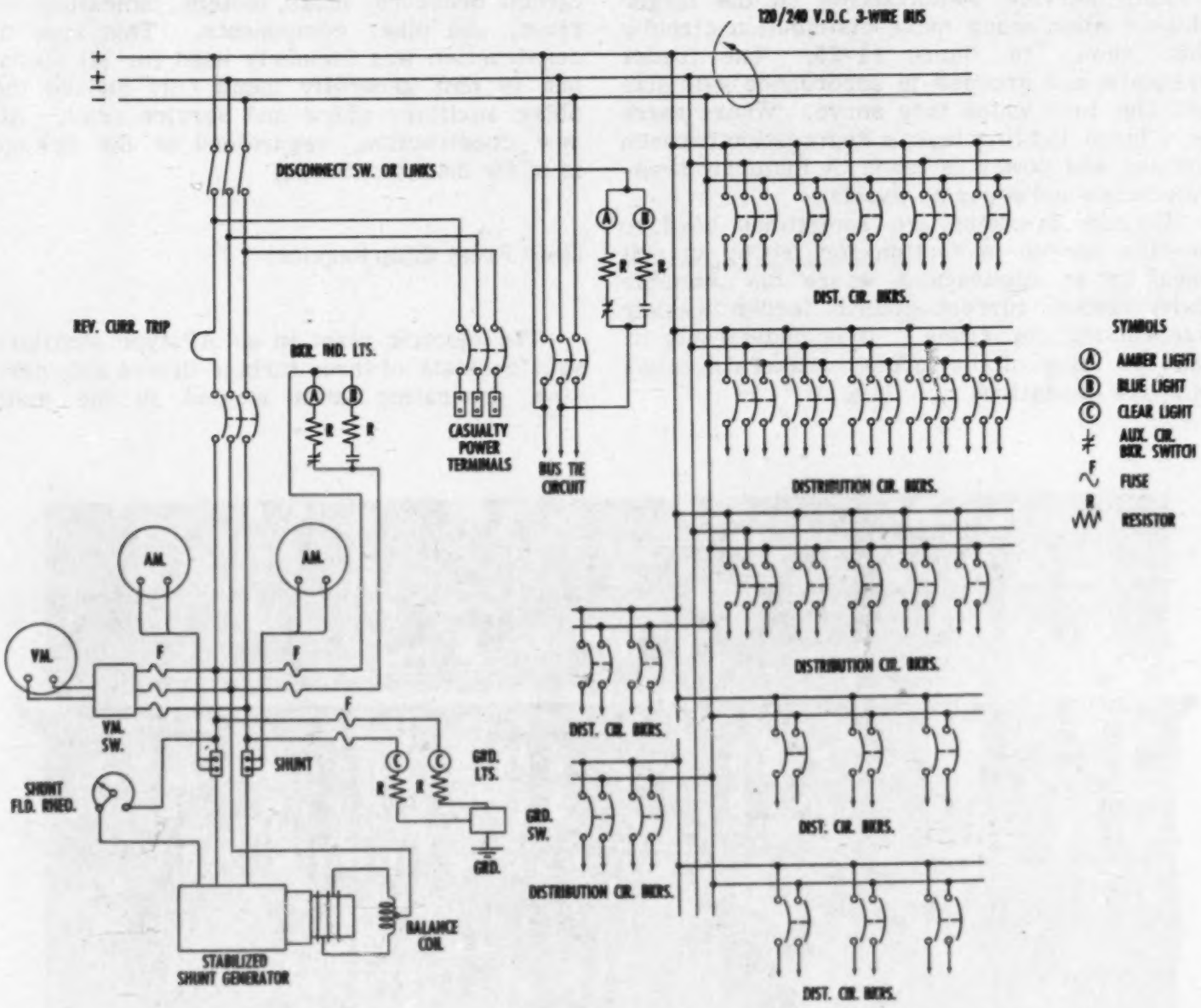

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Figure 11-25.—Simplified schematic wiring diagram of d-c switchboard.

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5. Voltmeters are connected through selector switches to measure generator and bus voltages.

6. Two ammeters are provided with three-wire generators to measure the current in the positive and negative leads. These ammeters are connected into the line through suitable shunts.

7. Generator field rheostats are connected in series with the shunt field circuits for purposes of adjusting generator voltage.

8. Indicating devices include circuit breakers, indicating lights, and ground detector lights.

Ship service switchboards on the larger ships contain many more distribution circuits than shown in figure 11-25. The feeder breakers are grouped in accordance with size and the load which they serve. Where there is a large lighting load, a segregation between lighting and power is made by including separate buses and separate panels.

Circuit breakers are sometimes used to provide backup protection for feeder circuit breakers in applications where the available short circuit current exceeds feeder breaker interrupting capacities. It is undesirable to use too many of the larger breakers because of space limitations.

Feeder breakers to machinery space ventilation panels on the larger auxiliary ships are provided with shunt trips operated from push-button stations outside the machinery spaces. This feature is included as an aid to the control of fires in the machinery spaces.

Live Front

The live-front switchboard (fig. 11-26) utilizes panels composed of an insulating material on which are mounted the knife switches, circuit breakers, fuses, meters, indicating devices, and other components. This type of construction was formerly used for all ships, but is now generally found only aboard the older auxiliary ships and service craft. All new construction, regardless of the voltage is of the dead front-type.

Dead Front (Ship Service)

The electric plant in an AP-type auxiliary ship consists of three turbine-driven ship service generating units located in the main

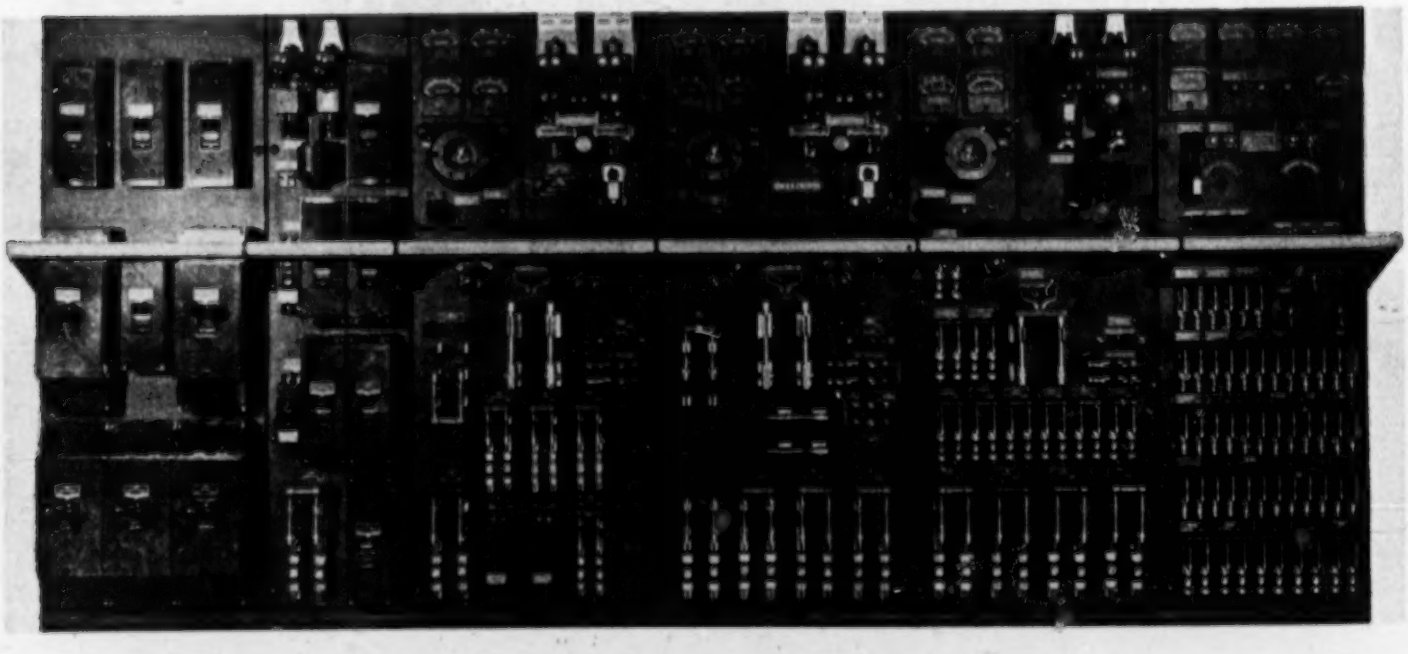

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Figure 11-26.—D-c generator and distribution switchboard, live front.

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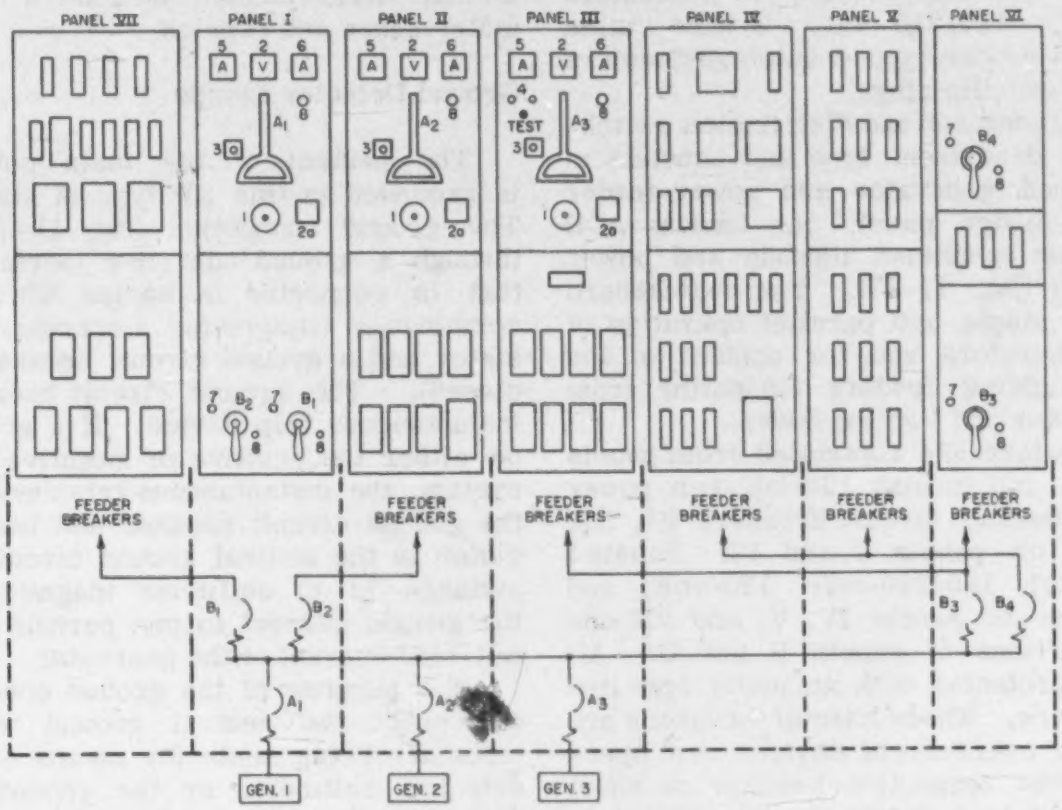

LEGEND

1.	Generator field rheostat	A_1	Circuit breaker for gen. no. 1	Panel I	Gen. 1 control and 120/240-volt power
2.	Generator voltmeter	A_2	Circuit breaker for gen. no. 2	Panel II	Gen. 2 control and 120/240-volt and 240-volt power
2a.	Voltmeter switch				
3.	Trip and hold-in device	A_3	Circuit breaker for gen. no. 3	Panel III	Gen. 3 control and 120/240-volt and 240-volt power
4.	Ground detector lamps	B_1	Backup breaker for feeder breakers on panel VII	Panel IV	120/240-volt, 120-volt, and 240-volt power
5.	Negative gen. ammeter	B_2	Backup breaker for feeder breakers on panel II	Panel V	120/240-volt lighting and 120/240-volt and 240-volt power
6.	Positive gen. ammeter	B_3	Backup breaker for feeder breakers on panels III and VI	Panel VI	240-volt backup panel
7.	Trip button	B_4	Backup breaker for feeder breakers on panels IV and V	Panel VII	120/240-volt lighting and power
8.	Mechanical position indicator				

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Figure 11-27.—D-c generator and distribution switchboard, dead front.

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engineroom. The ship service d-c generators are 300-kw, 120/240-volt, 3-wire units equipped with center-tapped autotransformers connected across slip rings.

The main generator and distribution switchboard is the dead-front type and consists of three combined generator and power-feeder panels, one feeder panel, one backup ACB panel, and two combined lighting and power feeder panels (fig. 11-27). The switchboard provides for single and parallel operation of the main generators and for control of the power and lighting feeders emanating from the backup power and lighting buses.

The generators are controlled from panels I, II, and III and furnish 120/240-volt power to the ACB backup circuit breakers B1, B2, B3, and B4 on panels I and VI. Panels I and VI furnish 120/240-volt, 120-volt, and 240-volt power to panels IV, V, and VII and the lower portions of panels II and III. All circuits are protected with manually operated circuit breakers. These circuit breakers are equipped with overcurrent devices that operate to open the respective breaker on short circuit or sustained overload. In addition to the overcurrent devices, each generator breaker is equipped with a direct-acting reverse current device, an undervoltage device, and an overspeed device to trip the breaker on current reversal, undervoltage, or overspeed, respectively.

The backup circuit breakers should be closed at all times. If the feeder breaker and backup breaker open on a short circuit, the feeder breaker should be checked to determine that it is in satisfactory operating condition before closing the backup breaker.

The switchboard meters installed for observing the performance of d-c generators usually include only voltmeters and ammeters. The generator speed is controlled by the governor of the prime mover. Remote speed control is not required, and no governor motor control switch is used on the switchboard as with a-c generators. Manual voltage control is obtained by a rheostat in the shunt field. This rheostat is operated at the switchboard. D-c generators are usually not provided with voltage regulators. The inherent characteristics of the generators provide all the voltage regulation that is necessary in most applications. Disconnect links, located on the back of the switchboard are provided for each generator circuit to isolate the generator circuit breaker and associated devices for maintenance and repairs.

Ground Detector Lamps

The neutral of the main power system is grounded in this AP type of auxiliary ship. The ground connection (fig. 11-28) is made through a ground contactor (normally closed) that is connected in series with a parallel combination comprising a current-limiting resistor and a ground circuit breaker (normally closed). The ground circuit breaker has an instantaneous trip device. If a ground occurs on either the positive or negative side of the system, the instantaneous trip device will open the ground circuit breaker and insert the resistor in the neutral ground circuit. The resistance is of sufficient magnitude to limit the ground current to one percent of the rated full-load current of the generator.

The purpose of the ground contactor is to disconnect the neutral ground when ground tests are being made (by means of the ground detector voltmeter or the ground lamps) to determine if any grounds exist on the system.

A ground lamp test pushbutton, PB, is provided for making ground tests with the ground detector lamps, A and B. When the pushbutton is held closed, the operating coil, G, of the ground contactor is energized and opens contacts G to remove the neutral ground. At the same time, contacts G1 close and place ground on one side of the ground lamp circuit.

An alarm system is provided to indicate operation of the ground circuit breaker, CB. When the ground circuit breaker is tripped

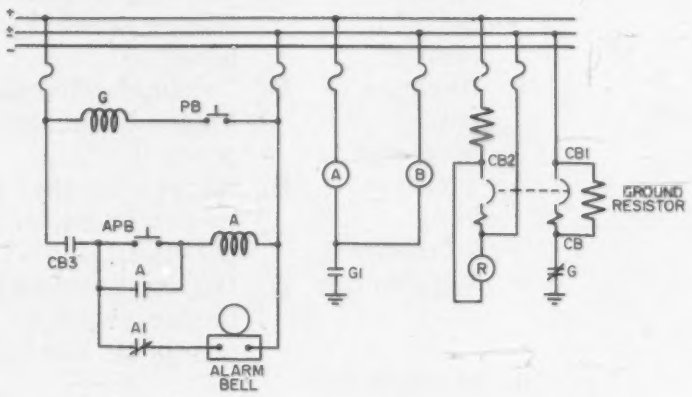

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Figure 11-28.—D-c ground detector lamp circuit.

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by a ground fault, it opens contacts CB1 and CB2 and closes contacts CB3. When contacts CB1 open, the mechanical interlock opens contacts CB2, which remove a shunt from the ground alarm lamp, R, allowing it to light. When contacts CB3 close, the circuit to the alarm bell is energized.

The alarm system includes an alarm reset relay, A, and pushbutton APB. When the reset relay pushbutton is operated, contacts A close to maintain the operating coil A energized, and contacts A1 open to deenergize the alarm bell. The alarm lamp, R, remains lighted at all times when the ground circuit breaker, CB, is open. The alarm bell does not sound when the ground circuit breaker is opened manually. For manual operation, the red alarm lamp, R, is the only indication that the ground circuit breaker is open.

Under normal operating conditions with no ground except through the grounding system (contacts G closed), the main bus is energized; the ground circuit breaker contacts, CB1 and CB2 are closed and contacts CB3 are open; the ground lamp test pushbutton is in the normal (open) position; and the ground lamps, A and B, are lighted dimly.

Emergency Switchboard

The emergency switchboard for d-c systems is comparable to the a-c system discussed earlier in this chapter. The principle rules for operation are the same. The emergency switchboard on recent construction is of the dead front type, however, a large number of the older APA and AKA type ships are still equipped with the live-front switchboard for emergency power distribution.

OPERATION OF GENERATORS

The following procedures are standards as established by NavShip Systems Command for the operation of a-c or d-c generators.

Both a-c and d-c ship service generators should be inspected before starting and also before applying load to minimize the possibility of any machinery derangement that may be caused by negligent operating personnel.

Before starting a d-c generator or an a-c generator at any time (except automatically started emergency generators):

1. See that the generator circuit breaker and field switch (if furnished) are open.
2. See that the field rheostat handle is set to cut in all the field resistance.
3. Make sure that the voltage regulator control switch (if furnished) is turned to the MANUAL position.
4. Make sure that the manual voltage control is set at the position that gives the lowest generator voltage.
5. Examine both the prime mover and generator for evidence of obstruction to moving parts.
6. See that the oil reservoir for oil ring lubricated bearings contains the proper amount of oil as indicated by the oil sight gage.

Before applying load to a d-c or a-c generator at any time:

1. See that the unit is started and brought up to speed in accordance with the instructions for the type of prime mover used. Be sure that the overspeed governor and trip and all other safety devices are tested and are functioning as required by these instructions.
2. If vibration is apparent, search for possible misalignment, sprung shafting, loose foundation bolts, or something chafing the rotating elements.
3. Check lubrication of bearings; check oil and bearing temperatures.
4. See that commutator and collector rings run true, that all brushes ride freely in the brush holders, and that there is no chattering of brushes.
5. See that there is ample clearance between all rotating and stationary parts.
6. For totally enclosed machines with coolers, see that water is flowing through the cooler, as prescribed in the manufacturer's instructions and that there is no leakage of water.
7. If the generator is equipped with heaters, see that the heaters are turned off.
8. Replace covers and all cover-holding bolts if any have been removed.

NONPARALLEL OPERATION OF D-C GENERATOR

To connect a single d-c generator and/or exciter to the bus for nonparallel operation:

1. Check before starting, start, and bring the generator up to speed in accordance with the procedures for starting an idle generator.

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2. Close the shunt field switch and gradually cut out the field resistance until normal voltage is obtained.

3. Close the line switch (if provided).

4. Close the generator circuit breaker.

To secure a d-c generator which is connected alone to a bus:

1. Reduce the load by opening feed circuit breakers.

2. Trip the generator circuit breaker.

3. Open the line switch (if provided).

4. Secure the prime mover according to instructions.

5. Cut in all the shunt field resistance.

6. Turn on heaters (if installed).

NONPARALLEL OPERATION OF A-C GENERATOR

To connect a single a-c generator to the bus for nonparallel operation:

1. Check before starting, start, and bring the generator up to speed in accordance with the procedures for starting an idle generator.

2. Adjust the generator voltage to the rated value by the manual voltage control. Observe the generator voltmeter while manually adjusting the voltage and do not allow it to build up above its rated value. Be certain that the voltmeter indicates the voltage of the generator being regulated. Exercise care when regulating the generator because the voltage may build up high enough to damage the windings.

3. Check the frequency on the frequency meter and raise or lower the speed of the prime mover, as necessary, by means of the governor motor control switch until the normal frequency of 60 cycles is indicated. Observe the frequency meter while adjusting the frequency and be certain that the meter indicates the frequency of the generator being adjusted.

4. Place the voltage regulator in control by turning the control switch to the NORMAL or AUTOMATIC position. Check the generator voltage and, if necessary, adjust it to the desired value by means of the voltage adjusting rheostat. Normally, the voltage regulator should be placed in, and then out of, service only under steady-load or no-load conditions.

5. Turn the voltmeter switch to read the voltage on the bus. Check the bus voltage for all three phases if the connections to the voltmeter switch will permit.

6. If the bus is deenergized, turn the handle of the synchronizing switch to the ON position. The synchroscope is not needed for synchronizing because the bus is dead, but in many installations an interlock necessitates that the synchronizing switch must be in the ON position before the generator circuit breaker can be closed. Other installations are provided with an interlock defeater switch which must be passed when closing to a dead bus.

7. Close the generator circuit breaker to energize the bus and then apply load to the generator.

8. Turn the synchronizing switch to the OFF position.

To secure an a-c generator which is connected alone to a bus:

1. Reduce the load on the generator as much as practicable by opening feeder circuit breakers on the power and lighting circuits.

2. Trip the generator circuit breaker by pushing its trip button.

3. Turn the voltage regulator control switch to the MANUAL position.

4. Turn the manual voltage control as far as it will go in the DECREASE VOLTAGE direction.

Some installations require the generator to come to rest before turning the manual control to decrease voltage.

PARALLEL OPERATION OF D-C GENERATORS

If the bus is already energized and it is desired to connect another generator and/or exciter to the line:

1. Check before starting, start, and bring the generator up to speed in accordance with the procedures for starting an idle generator.

2. Close the shunt field switch (if installed).

3. Gradually cut out field resistance until the generator voltage is from 1 to 4 volts higher than the bus voltage.

4. Close the line switch (if open).

5. Close the generator circuit breaker.

6. Adjust the field rheostat to cause the generator to take its proper share of the load. Turning the field rheostat in the INCREASE VOLTAGE direction will cause a generator to take more load.

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To secure a d-c generator that is operating in parallel with another generator, or other generators:

1. Gradually cut in the shunt field resistance to reduce the load to a minimum.
2. Trip the generator circuit breaker.
3. Secure the prime mover in accordance with the instructions for the type of prime mover used.
4. Cut in all the shunt field resistance.
5. Turn on the heaters (if any) within the generator enclosure.
6. Shut off the flow of water through the air coolers (if any).

PARALLEL OPERATIONS OF A-C GENERATORS

On new construction "synchronizing monitors", are being used on 60 cycle ship service systems to prevent the paralleling of generators which are not synchronized. On systems using this type of monitoring it is not possible to close the circuit breaker on the incoming generator unless the phase angle, frequency and voltage are within predetermined limits as follows:

1. Phase angle between -30° and +0°.
2. Frequency difference less than .2 cycles per second.
3. Voltage difference less than 5%.

On this type of system the above conditions must be met to complete the circuit breaker closing control circuit.

Do not close the generator circuit breaker unless the incoming generator and the bus have approximately equal voltages and are in synchronism. To synchronize generators for parallel operation, proceed as follows:

1. Bring the generator up to approximately normal speed and voltage, and place the voltage regulator in control, as previously described for connecting a single generator to a dead bus.
2. Turn the voltmeter switch on the incoming generator to indicate the generator voltage on the voltmeter.
3. Turn the voltmeter switch on the adjacent generator panel to indicate the bus voltage.
4. Turn the voltage adjusting rheostat of the voltage regulator until the incoming generator voltage is equal to the bus voltage.
5. Compare the frequency of the incoming generator with that of the bus and adjust to correspond with the bus frequency.
6. Turn the synchroscope switch to the ON position. The synchroscope will rotate in one direction or the other. Adjust the speed of the generator by means of the governor motor control switch until the synchroscope rotates very slowly in the clockwise direction.
7. Be certain that the voltages of the bus and the incoming generator are still equal, and close the generator circuit breaker just before the synchroscope pointer passes very slowly through the zero position (pointing vertically upward).
8. When synchronizing lamps are used instead of the synchroscope, close the circuit breaker just before the midpoint of the dark period of the lamps is reached. The midpoint of the dark period corresponds to the vertical position of the synchroscope pointer.
9. Turn the synchronizing switch to the OFF position.

When a-c generators are operated in parallel, the kilowatt and reactive kva load should be divided between them in proportion to the generator ratings. The desired division of the kilowatt load is obtained by adjusting the governor, which controls the generator speed. To balance the reactive kva load, the generator line currents should be equal for equally rated generators and divided in proportion to generator ratings for unequally rated generators. Where power factor meters are provided, the power factors for all generators in parallel should be equal. Equality of power factor or correct division of generator line currents is obtained by adjusting the voltage-adjusting rheostats of the voltage regulators. These adjustments are made as follows:

1. Turn the governor control switches until the wattmeters have equal readings (if the generators have the same ratings) or the kilowatt load is divided in proportion to the generator ratings (if the generator ratings differ from each other).

   a. If the frequency is above normal, turn the governor control switches for the heavily loaded generators in the DECREASE SPEED direction.

   b. If the frequency is below normal, turn the governor control switches for the lightly loaded generators in the INCREASE SPEED direction.

   c. If the frequency is normal, make the adjustment in small steps, turning the governor control switches for the lightly loaded

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generators in the INCREASE SPEED direction and for the heavily loaded generators in the DECREASE SPEED direction.

2. Turn the voltage adjusting rheostats of the voltage regulators until generator line currents are divided in proportion to generator ratings or power factor readings are equal.

a. If the voltage is above normal, turn the voltage adjusting rheostats for the generator with the highest line current, (lowest power factor) in the DECREASE VOLTAGE direction.

b. If the voltage is below normal, turn the voltage adjusting rheostats for the generator with the lowest line current (highest power factor) in the INCREASE VOLTAGE direction.

c. If the voltage is normal, make the adjustments in small steps, turning the voltage adjusting rheostats for the generators with the highest line current (low power factor) in the DECREASE VOLTAGE direction, and for the generators with the lowest line current (highest power factor) in the INCREASE VOLTAGE direction.

The reason for the procedure in step (b) above may be explained by considering two equally rated generators operating in parallel (fig. 11-29). Generator G1 (fig. 11-29) is in parallel with generator G2. The power factors are not equal; G1 has a power factor of 0.99, and G2 has a power factor of 0.67. Although both generators are assumed to have the same rating, the load current, I_1 (fig. 11-29), of G1 is smaller than the load current, I_2, of G2. Both generators supply inductive loads. The voltage, E_2', is larger than E_2 by an amount equal to E_r. Voltage E_r causes an undesirable circulating component of current I_s to flow between the two generators. Current I_s lags E_r almost 90° because of the large ratio of reactance to resistance in the local circuit between the two generators. Note that I_s lags E_2' by 90° and leads E_1 by 90°.

The circulating current, I_s, comprises a part of the total current of each generator. Thus, in G1 the total current, I_1', is made up of components I_s and I_1. Current I_1 is the current of G1 when the generator voltages are equalized, and there is no unbalanced voltage, E_r. Current I_2' is made up of components I_s and I_2. Current I_2 is the current of G2 when E_r is zero.

Equalization of the generated voltage may be obtained by lowering the field strength of G2 until E_2 is equal to E_1. For this condition I_s is reduced to zero. The current of G1 is increased from I_1' to I_1, and the current of G2 is decreased from I_2' to I_2.

The power factor of G2 is increased from cos 48° = 0.67 to cos 30° = 0.866, and the power factor of G1 is decreased from cos 1° = 0.99 to cos 30° = 0.866. Thus, if the voltage is above normal and G2 has the lower power factor, turn the voltage adjusting rheostat of G2 in the DECREASE direction. This action weakens the field of G2 and lowers its generated voltage until the circulating current is reduced to zero and the power factors are equalized.

Note that the circulating current that exists when the power factors are unequal cannot be read on either generator ammeter. However, there will always be a circulating current when the power factors are unequal, and the ammeter readings are not the same (for equal kva ratings of both generators). This current is undesirable because it causes heating and limits the output of the generator having the higher generator voltage.

To secure an a-c generator that is operating in parallel with another generator or other generators:

1. Turn the governor motor control switch of the generator being secured in the DECREASE SPEED direction and the governor motor control switch (or switches) of the other generator (or generators) in the INCREASE SPEED direction until all the load is shifted from the generator being secured. This condition can be checked by the indications on the wattmeters. If the total connected load is greater than can be carried by the generators that are to continue in operation, it will be necessary to decrease the load by opening feeder circuit breakers.

2. Trip the circuit breaker of the generator being secured.

3. Turn the voltage regulator control switch to the MANUAL position. Unless otherwise indicated in the manufacturer's technical manual, the voltage in the automatic position should be at or close to rated value prior to switching to the manual position.

4. Turn the manual voltage control as far as it will go in the DECREASE VOLTAGE direction.

OPERATION OF ELECTRIC PLANTS

The ship's electric power and lighting systems are designed to provide a high degree of

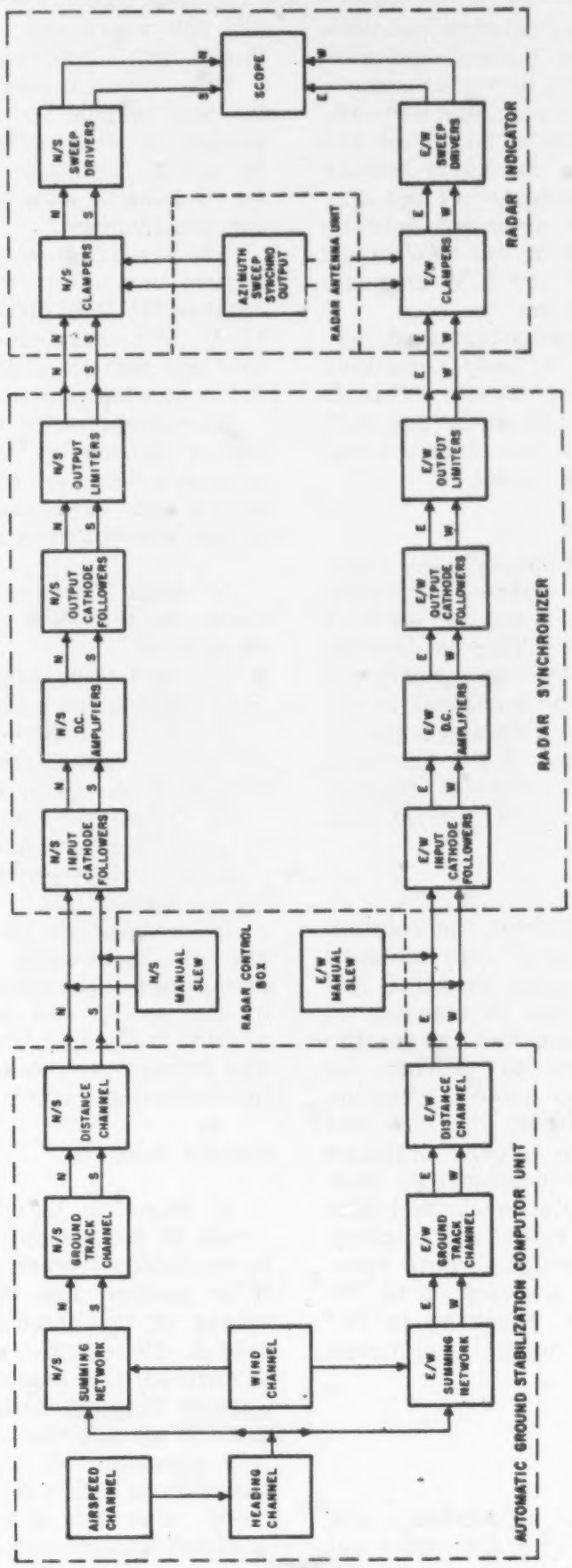

Figure 17-40.—Ground position indicator stabilization system, block diagram.

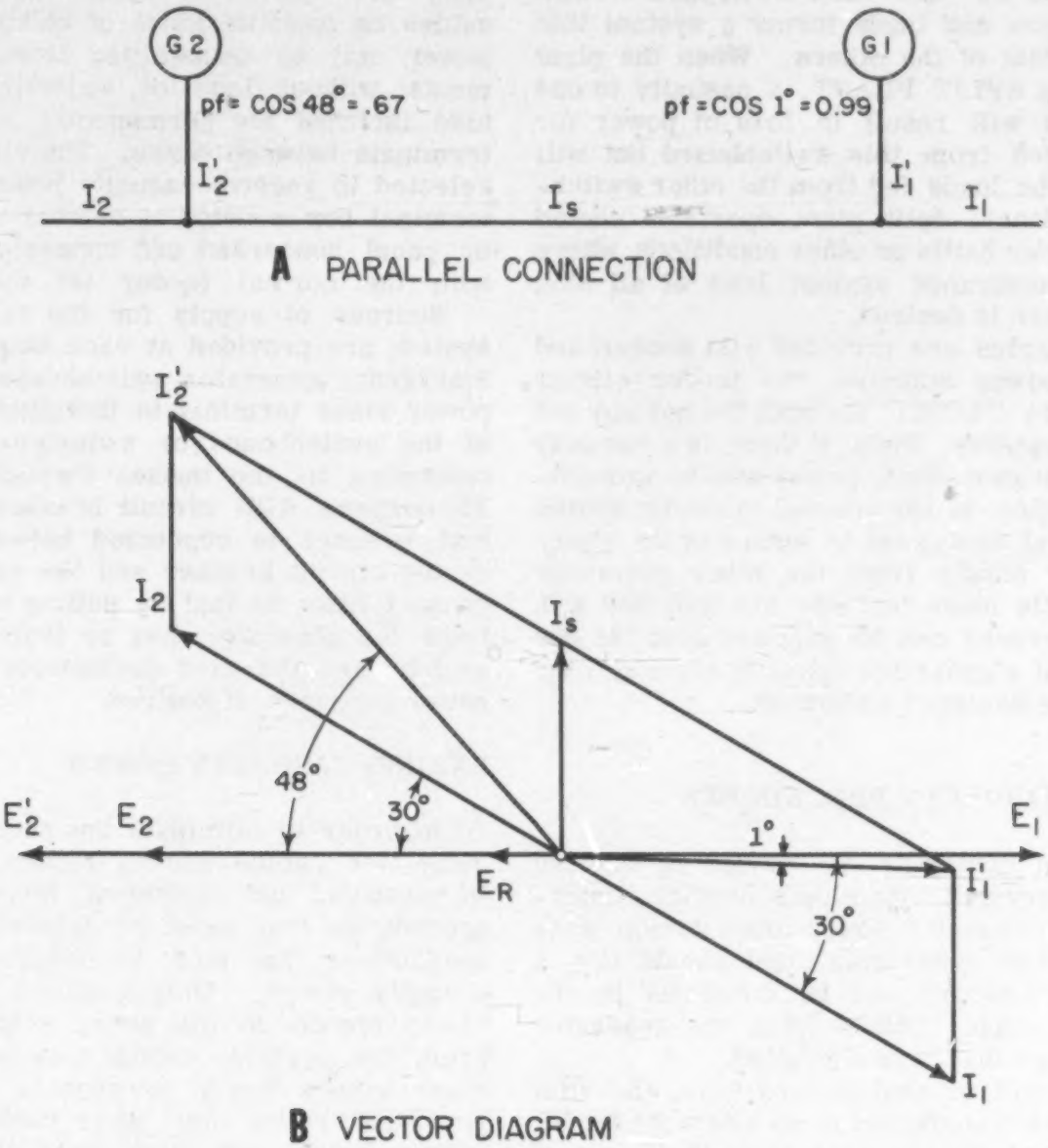

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Figure 11-29.—Equalizing the power factor between generators when the voltage is above normal.

flexibility to ensure continuity of service to vital power and lighting loads under normal and casualty conditions. The distribution systems in most naval ships are arranged so that the electric plants can be operated in parallel (cross plant) or separately (split plant).

CROSS PLANT OPERATION

The setup for cross plant operation is to CLOSE all the bus ties between the ship service switchboards with the generators running in parallel so that any switchboard or several switchboards can supply electric power to any other switchboard. However, when the plant is operating CROSS PLANT, a casualty to one switchboard or load center may cause a short circuit that could trip all the generators off the line and result in temporary loss of all ship service power.

SPLIT PLANT OPERATION

The setup for split plant operation is to OPEN the bus ties between the ship service

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switchboards so that each switchboard with its generators and loads forms a system that is independent of the others. When the plant is operating SPLIT PLANT, a casualty to one switchboard will result in loss of power for the loads fed from this switchboard but will not affect the loads fed from the other switchboards. Hence, split plant operation should be used under battle or other conditions where maximum assurance against loss of all ship service power is desired.

If auxiliaries are provided with normal and alternate power supplies, the feeder circuit breakers are CLOSED for both the normal and alternate supplies. Thus, if there is a casualty to one generator plant, power will be immediately available at the manual transfer switch for this vital equipment by means of the alternate power supply from the other generator plant. Battle loads that are not provided with alternate feeders can be supplied over the bus tie feeder if a generator casualty occurs, after isolating the damaged equipment.

CASUALTY PROCEDURES

Optimum continuity of service is ensured in ships provided with ship's service, emergency, and casualty power distribution systems. If one generating plant should fail, a remote switchboard can be connected by the bus tie to supply power from the generator or generators that have not failed.

If a circuit or switchboard fails, the vital loads can be transferred to an alternate feeder and source of ship service power by means of a transfer switch near the load.

If both the normal and alternate sources of the ship power fail because of a generator, switchboard, or feeder casualty, the vital auxiliaries can be shifted to an emergency feeder that receives power from the emergency switchboard.

If the ship's service and emergency circuits fail, temporary circuits can be rigged with the casualty power distribution system and used to supply power to vital auxiliaries if any of the ship service or emergency generators can be operated.

The casualty power system includes suitable lengths of portable cable stowed on racks throughout the ship. Permanently installed casualty power bulkhead terminals form an important part of the casualty power system. They are used for connecting the portable cables on opposite sides of bulkheads, so that power may be transmitted through compartments without loss of watertight integrity; also included are permanently installed riser terminals between decks. The vital equipment selected to receive casualty power will have a terminal box mounted on or near the equipment or panel concerned and connected in parallel with the normal feeder for the equipment.

Sources of supply for the casualty power system are provided at each ship service and emergency generator switchboard. A casualty power riser terminal is installed on the back of the switchboard or switchgear group and connected to the busses through a 225- or 250-ampere AQB circuit breaker. This circuit breaker is connected between the generator circuit breaker and the generator disconnect links so that by pulling the disconnect links the generator may be isolated from the switchboard and used exclusively for casualty power purposes, if desired.

RIGGING CASUALTY POWER

In order to eliminate the necessity of handling live cables and to reduce the hazards to personnel and equipment, there are definite procedures that must be followed and safety precautions that must be observed in rigging casualty power. Only qualified Electrician's Mates should do the actual connecting; however, the portable cables may be laid out by other repair party personnel. The repair party electrician must wear rubber goves and rubber boots, and stand on a rubber mat (if available,) while making connections. He must further test each casualty power riser or bulkhead terminal with a voltage tester before making a connection to that terminal. It is the duty of the repair party Electrician's Mate to determine that all sources of power to the equipment concerned are lost before rigging casualty power. The portable cable connections for casualty power should always be made by first connecting at the load, then working back to the source of power.

On large ships, casualty power runs will involve more than one repair party. All repair parties should rig simultaneously, but the rule of "rig from load to source" should always be observed. Each repair party must report its section rigged from riser or bulkhead terminal number to riser or bulkhead

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terminal number to damage control central, which reserves the authority to order the system energized. In making casualty power connections at a load where there are no circuit breakers or transfer switches to interrupt the incoming feeder cable, it must be disconnected or cut at the equipment. It is quite possible that this cable may be damaged by the casualty which caused the loss of power, and such a damaged cable if energized would probably trip the casualty power circuit breakers. If not disconnected, this incoming feeder cable may be reenergized, presenting a hazard to personnel handling the casualty power cables. Care should be exercised, in making all connections, to keep the phase sequence correct in a-c systems. The riser terminals, bulkhead terminals, and portable cable ends are marked to identify the A, B, and C phases either visually or by touch when illumination is insufficient for visual identification. If the load includes motors in either a-c or d-c systems, the connections should be made so as to include the motor controller in the circuit.

Ordinarily portable casualty power cables may be run along the deck. Where they form an obstruction in a passageway or working area, or where they may be subject to damage, they should be tied to the overhead. High voltage signs should be attached at each connection and the word passed over the ship's 1 MC system, informing all hands to stand clear of the casualty power cables when they are energized.

As previously stated, power panels supplying equipment designated for casualty power service will have a power terminal box mounted on the panel so that power may be fed into the panel. It is well to remember that these panels also can be used as a source of power for the casualty power system should power still be available from the permanent feeder or feeders to the panel. Some judgement should be exercised, however, in the choice of panels to be used for supplying casualty power loads. Heavy loads should be connected to power panels having large incoming feeders for greater assurance that circuit breakers will not trip and that the cable will not be overheated. For casualty power purposes, a current loading which will allow the cable to be grasped by the hand without burning is not considered excessive. Portable cable used in a-c casualty power systems is Navy THOF 42, and while the normal current carrying capacity of this cable is 43 amperes, its casualty rating is 200 amperes. Under normal conditions this cable will carry 200 amperes for 4 hours without damage to the cable. Cables may be run in parallel to circuits which overload a single cable.

Recommended SAFE procedures to be used in Rigging Casualty Power include:

1. Upon report of loss of power, damage control central orders the repair party nearest the equipment concerned to investigate.

2. The repair party Electrician's Mate in the investigating team tests immediately to determine if all sources of power to the equipment are lost.

3. Upon determining that all power is lost, the Electrician's Mate opens all supply switches to the equipment and reports all power lost to damage control central.

4. Upon receiving report of all power lost, damage control central requests main engine control to designate a source of casualty power for the equipment concerned. The request for a casualty power source may be made to the electrical officer on ships having a combined main engine control and damage control central or where the electrical officer is stationed in damage control central to control generators and power distribution.

5. Main engine control or the electrical officer as appropriate, informs damage control central of the casualty power source to be utilized (giving riser terminal number) and at the same time informs the Electrician's Mate on the appropriate switchboard that his board has been designated as a source of casualty power to the riser terminal by number.

6. Upon receiving this information, damage control central orders the repair parties concerned to rig casualty power from the equipment to the designated source.

7. Repair parties rig casualty power and report each section as completed, to damage control central.

8. When all sections have reported rigging completed, damage control central then requests the main engine control electrical officer to "energize casualty power."

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9. Upon receiving the request to energize, main engine control or the electrical officer directs the designated switchboard to "connect and energize casualty power," and to report compliance.

10. The Electrician's Mate on the designated switchboard rigs the first cable from the source of the system, closes the casualty power circuit breaker, and reports "casualty power energized," to main engine control or the electrical officer. Main engine control then reports compliance to damage control central.

UNRIGGING CASUALTY POWER

Unrigging casualty power can be hazardous if not handled correctly.

To unrig casualty power lines proceed as follows:

1. Damage control central requests main engine control to deenergize the casualty power system.

2. Main engine control directs the designated switchboard to "deenergize and disconnect casualty power," and to report compliance.

3. The Electrician's Mate at the switchboard opens the casualty power circuit breaker, unrigs both ends of the first portable cable, and reports "casualty power deenergized," to main engine control. Main engine control reports compliance to damage control central.

4. Upon receiving the deenergized report, damage control central then orders casualty power disconnected at the equipment.

5. The repair party Electrician's Mate then disconnects both ends of the last portable cable in the system at the load and reports, when completed, to damage control central.

6. Damage control central now requests main engine control to energize normal circuits to the equipment and orders repair parties concerned to unrig and restow the remainder of the portable cables.

7. Main engine control directs the designated switchboard to energize all normal circuits to the equipment and to report compliance. Main engine control reports compliance to damage control central. The exercise is considered completed when damage control central receives the report that the equipment is operating on normal power, and that all portable cables are restowed on their proper racks.

Speed is desirable in all casualty power operations; however, safety precautions must never be sacrificed to attain speed. A thorough knowledge of the casualty power system and frequent drills by all personnel involved are necessary for safe and expeditious results.

Casualty power systems require proper inspection and maintenance to ensure safe and dependable operation.

The insulation of casualty power cables should receive close inspection at least once a year. These cables are exposed to shipboard ambient temperatures and perhaps oil, oil fumes, and accidental damage. After an exposure period of 5 years or more, the conductor insulation may have aged and lost eleasticity to the extent that it will crack open when bent during handling incident to emergency use. The best method of detecting overage insulation of the exposed ends of individual conductors is to sharply bend each conductor by hand. If no visual cracks develop the insulation is satisfactory. If cracking is noted, the cable ends should be cut back and new terminations prepared in accordance with NavShips Technical Manual, chapter 9620, section I.

The casualty power cables should be checked after any repairs to ensure they are still of sufficient length to make proper connections to designated risers and equipments.

During the annual inspection of the portable casualty power cables, all risers and terminals should be checked and cleaned of all foreign matter.

Numerous damage control charts and diagrams that are very helpful to damage control personnel are prepared for all ships. Among these charts and diagrams there should be a casualty power supply and emergency communication system chart for your ship. This chart will show the ship's casualty power and emergency communication systems in detail. Another chart that should be available to all personnel concerned with electrical damage control is one for vital damage control electrical equipment and power supply. This chart supersedes the electric wiring table that was included in damage control diagrams and charts at the end of World War II. Figure 11-30 shows a portion of a vital damage control electrical equipment chart for a representative ship. These charts and diagrams are usually prepared by the building activity when a ship is built, however, extra copies

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PANEL		SWITCH		ENERGIZED FROM				EQUIPMENT ENERGIZED									
NO.	COMPT. NO.	ABT	MBT	MAIN DISTR		EMER DISTR		MULTI-PURPOSE OUTLET	VENT SYS	PUMPS	GUNS OR DIRECT	ELEC TRONIC	ELEV OR HOISTS	CIRCUIT		MISC	VALVES
				FWD	AFT	FWD	AFT							IC	FC		
AQB	A-406-3E		3-45-1	FB 403(N)	FB 404(A)	XFE-403				FIRE #1							
3-33-2	A-303L		2-29-1	FB 407(N)	FB 408(A)	XFE-407					GUN #51		5" AMM HOIST #1 & 2				
2-48-2	A-204-5L		1-48-1	FB 409(N)	FB 410(A)	XFE-409					GUN #52		5" AMM HOIST #3 & 4				
2-60-2	A-205L			FB 413				2-18 1&3 2-45 2&4 1-72 2&4	(E) 1-60 (E) 1-65 (E) 1-71								
2-77-2	B-1-1			FB 423					(S) 2-76 (E) 1-83	FOS #1							
2-97-2	B-2			FB 425						FW #1							
2-99-2	B-2			FB 425						F&F #1						TORPEDO TUBE TRAIN MOTOR	
2-105-1	B-2			FB 427(N)	FB 428(A)				(S) 2-94 (S) 2-106 (E) 1-93-3 (E) 1-108-1								

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Figure 11-30.—Section of vital damage control electrical equipment and power supply chart.

are available upon request to Naval Ship Systems Command.

MAINTENANCE

The purpose of maintenance is to ensure that the equipment is ready for service at all times. Three fundamental rules for the maintenance of electrical equipment are: (1) keep equipment clean and dry, (2) keep electrical connections and mechanical fastenings tight, and (3) inspect and test at sufficiently short intervals to ensure that the equipment is in operating condition.

Chapter 6 of this course discussed maintenance of motors and generators. For additional information read chapters 9600 and 9610 of the NavShips Technical Manual.

GENERATORS

In chapter 6 of this course a typical Maintenance Requirement Card for weekly maintenance of an emergency generator was shown. Figure 11-31 is a Maintenance Requirement Card for a ship service generator; it covers the monthly required maintenance. Since all ships do not as yet have the 3-M System in effect, they will follow the instructions of the NavShips Technical Manual. Section 1 of chapter 9620 of NavShips Technical Manual gives additional coverage on power distribution systems.

Generator maintenance is directed primarily to keeping the electrical insulation in good condition. It must be clean, dry, and of high resistance.

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SYSTEM	COMPONENT	M.R. NUMBER
Electric Plant	Ship Service Generator	EL-7 M-1
SUB-SYSTEM: Electric Power Generation	RELATED M.R.: None	RATES: EM3 — M/H: 0.3

M.R. DESCRIPTION
1. Inspect each idle ship service generator for evidence of corrosion and electrolytic action (exciter where applicable).

TOTAL M/H: 0.3
ELAPSED TIME: 0.3 unit

SAFETY PRECAUTIONS
1. Observe standard safety precautions.
2. Tag generator throttle valve "Brushes Raised, Do Not Operate."

(Cont'd on Page 2)

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT
1. 6" Adjustable wrench
2. 8" Screwdriver
3. Flashlight
4. Safety tags

PROCEDURE

Preliminary
a. Tag generator throttle valve "Brushes Raised, Do Not Operate."
b. Open generator disconnect links on main switchboard and tag "Out Of Service."
c. Ensure generator circuit breaker is open.

NOTE 1: If a generator is allowed to stand secured for extended periods, an electrolytic action may take place between the brushes and slip rings, causing a rough imprint of the brushes on the rings. The area of the slip rings under the brushes may corrode.

NOTE 2: When it is known the generator will be idle for a period of one month or longer, all brushes should be raised and set on paper.

1. Inspect Each Idle Ship Service Generator for Evidence of Corrosion and Electrolytic Action (exciter where applicable).

(Cont'd on Page 2)

LOCATION

Page 1 of 2 | EA | ZZZG | GG1 | 84 | 6012 | M

Safety Precautions (Cont'd)
3. Open generator disconnect links on main switchboard and tag "Out Of Service."
4. Ensure circuit breaker is open and tagged "Out Of Service."
5. De-energize stator space heater where installed.

Procedure (Cont'd)
a. Remove the inspection cover or screen and inspect the commutating surface for evidence of corrosion, a light verdigris.
b. Lift each brush and inspect the area covered by the brush for electrolytic action: abnormal discoloration, roughness, or pitting.
c. If abnormally discolored, rough, or corroded, corrective action must be taken.
d. Close generator disconnect links and remove tags.

Page 2 of 2 | EA | ZZZG | GG1 | 84 | 6012 | M

Figure 11-31.—Monthly MRC for ship service generator. 98.176

The insulation resistance of each ship service, emergency, and exciter generator should be measured weekly or when securing and the results recorded on the Resistance Test Record card, NavShips 531. The armature and field should be measured separately on all generators except d-c generator having an internally connected shunt field. When measuring d-c armatures and a-c revolving fields, make the ground connection to a metallic part of the rotor to eliminate the insulating effect of the bearings. Normally the insulation resistance is measured immediately after a generator is shut down. Periodic measurements on idle generators will detect any moisture absorption in the windings.

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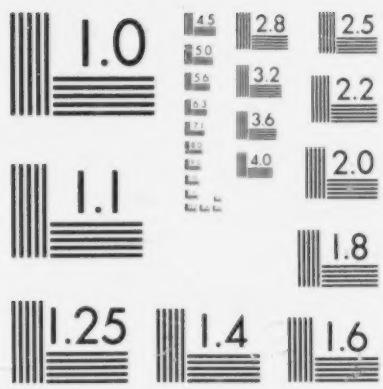

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Portable electric lights (with guard) may be placed inside idle generators not provided with space heaters to keep the insulation dry. Only enough heat to keep the temperature inside the generator, about 5° to 10° above ambient temperature is required.

Taking air gap readings on ship service and emergency generators, and other information concerning generator maintenance appears in chapter 6 of this training course.

SWITCHBOARDS

Numerous derangements of electrical equipment have been caused by loose electrical connections or mechanical fastenings. Loose connections can be readily tightened, but a thorough inspection is necessary to detect them.

Inspection

At least once a year and during each overhaul, each switchboard propulsion control cubicle, distribution panel, and motor controller should be deenergized for a complete inspection and cleaning of all bus work equipment. The inspection of deenergized equipment should not be limited to visual examination but should include grasping and shaking electrical connections and mechanical parts to be certain that all connections are tight and that mechanical parts are free to function. Be certain that no loose tools or other extraneous articles are left in or around switchboards and distribution panels.

Check the supports of bus work and be certain that the supports will prevent contact between bus bars of opposite polarity or contact between bus bars and grounded parts during periods of shock. Clean the bus work and the creepage surfaces of insulating materials, and be certain that creepage distances (across which leakage currents can flow) are ample. Check the condition of control wiring and replace if necessary.

Be certain that the ventilation of rheostats and resistors is not obstructed. Replace broken or burned out resistors. Temporary repairs can be made by bridging burned out sections when replacements are not available. Apply a light coat of petrolatum to the face plate contacts of rheostats to reduce friction and wear. Be certain that no petrolatum is left in the spaces between the contact buttons as this may cause burning and arcing. Check all electrical connections for tightness and wiring for frayed or broken leads. Service commutators and brushes of potentiometer-type rheostats in accordance with the instructions for d-c machines.

The pointer of each switchboard instrument should read zero when the instrument is disconnected from the circuit. The pointer may be brought to zero by external screwdriver adjustment. Caution: This should not be done unless proper authorization is given. Repairs to the switchboard instruments should be made only by the manufacturers, shore-repair activities, or tenders.

Be certain that fuses are the right size; clips make firm contact with the fuses; lock-in devices (if provided) are properly fitted; and that all connections in the wiring to the fuses are tight.

In addition to the foregoing inspections, switchboards and distribution panels should be deenergized after firing, if practicable, and thoroughly inspected for tightness of electrical connections and mechanical fastenings. Emergency switchboards should be tested regularly in accordance with the instructions furnished with the switchboard in order to check the operation of the automatic bus transfer equipment and the automatic starting of the emergency generator. This test should be made in connection with the weekly operating test of emergency generators.

Control Circuits

Control circuits should be checked to ensure circuit continuity and proper relay and contactor operation. Because of the numerous types of control circuits installed in naval ships, it is impracticable to set up any definite operating test procedures in this training course. In general, certain control circuits, such as those for the starting of motors or motor-generator sets, or voltmeter switching circuits, are best tested by using the circuits as they are intended to operate under service conditions.

Protective circuits, such as overcurrent, reverse power, or reverse current circuits, usually cannot be tested by actual operation because of the danger involved to the equipment. These circuits should be visually checked, and, when possible, relays should be operated manually to be certain that the rest

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of the protective circuit performs its intended functions. Exercise extreme care not to disrupt vital power service or to damage electrical equipment.

Cleaning

Bus bars and insulating materials can usually be cleaned sufficiently by wiping with a dry cloth. A vacuum cleaner, if available, can also be used to advantage. Be certain that the switchboard or distribution panel is completely dead and will remain so until the work is completed; avoid cleaning live parts because of the danger to personnel and equipment.

Use a dry cloth, not soap and water, on the front panels of live-front switchboards or on other panels of insulating material. The front panels of dead-front switchboards can be cleaned without deenergizing the switchboard. These panels can usually be cleaned by wiping with a dry cloth. However, a damp, soapy cloth can be used to remove grease and fingerprints. Then wipe the surface with a cloth dampened in clear water to remove all soap and dry with a clean, dry cloth. Cleaning cloths must be wrung out thoroughly so that no water runs down the panel. Clean a small section at a time and then wipe dry.

BUS TRANSFER EQUIPMENT

Bus transfer equipment should be tested weekly. For manual bus transfer equipment, manually transfer a load from one power source to another and check the mechanical operation and mechanical interlocks. For automatic bus transfer equipment, check the operation by means of the control push-switches. The test should include operation initiated by cutting off power (opening a feeder circuit breaker) to ascertain if an automatic transfer occurs.

OPERATING RULES

There are a few simple operating rules which should be observed on all installations; these are:

Watch the switchboard instruments. They show how the system is operating, reveal overloads, improper division of kilowatt load or of reactive current between generators operating in parallel, and other abnormal operating conditions.

Keep the frequency (on a-c systems) and voltage at their correct values. Departure from either affects, to some extent at least, the operation of all equipment supplied with electric power. Low or high voltage has a particularly pronounced effect on lights since low voltage results in a marked decrease in illumination, while high voltages materially shorten lamp life. The operation of vital electronic, interior communication, and fire control equipment is also seriously affected. This sensitive equipment requires careful adjustment of voltage regulators and prime mover governors to obtain satisfactory performance.

Use judgment when reclosing circuit breakers after they have tripped automatically. If a circuit breaker trips immediately upon the first reclosure, it is desirable to investigate before again reclosing. The circuit breaker may, however, be closed a second time without investigation if the immediate restoration of power to the circuit is important and the interrupting disturbance when the breaker tripped was not excessive. It should, however, be kept in mind that repeated closing and tripping may result in damage to the circuit breaker and, hence, may increase the repair or replacement work needed to get the circuit back in operation again.

Use the hold-in device on circuit breakers with judgment and only when necessary. The hold-in device enables an operator to hold a trip free circuit breaker closed when the current is in excess of the tripping value. The circuit breaker will open automatically as soon as the hold-in device is released if the current is above the tripping current. In an emergency it may be vitally important to obtain power even at the risk of burning out equipment. The hold-in device makes it possible to do this. However, when holding a circuit breaker closed, it must be kept in mind that the circuit is deprived of protection against damage by excessive current and the longer the circuit breaker is held closed, the greater is the change of permanent damage to circuits or equipment.

A circuit breaker should never be held closed unless there is an emergency which justifies the risk.

Never parallel ship service generators until they have been brought into synchronism.

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Never close the bus tie circuit breakers to parallel the buses on two energized switchboards until the buses have been brought into synchronism.

Never close the bus tie circuit breaker to restore power to a switchboard which has lost power because of failure of a local generator that was supplying power to the switchboard prior to the generator failure, unless the generator circuit breaker has first been tripped by hand, or unless it has been definitely established that the generator circuit breaker is in the open position.

Never parallel ship service generators with shore power except for the short interval required to transfer the load from one source of power to the other. Never parallel ship service generators with shore power of a different frequency such as 50 cps. Never parallel with shore power without the use of synchroscope or synchronizing lights. On ships where a synchroscope is not provided for synchronizing between shore power and the bus, the generator breakers shall be opened first and then the shore power breaker shall be closed. On some ships, shore power may be connected to the bus tie with the bus tie breakers open and synchronizing can be accomplished across the bus tie breakers. When placing the shore power and the ships service generators in parallel, the normal synchronizing process is reversed. The incoming shore power is the controlling source and the voltage and frequency of the ship service generators must be made to match the shore power voltage and frequency. There are several precautions to be taken when paralleling with shore power in addition to the usual ones when paralleling two ship's service generators. The shore power connection phase rotation must be the same as the ship phase rotation. If there is to be more than one shore power connection and they are to be paralleled, the actual phases of the shore power should not only be in the same rotation but must be connected to match the ship's phases in order to avoid a short circuit through the ship's system. When paralleling with shore power for purposes of transfering the load, bring the ship's voltage up to the shore power voltage or as close thereto as possible. In some cases, the shore power voltage may be around 480 volts.

Increase the ship's generator to 480 volts. Now bring the ship's frequency to that of the shore power. Turn on the synchroscope, synchronize the ship's power with the shore power, and close the shore power breaker. Quickly transfer load to the shore power. Trip the ship service generator breakers.

Never parallel an emergency generator with any other generator except on certain ships where the emergency generator also serves as a "standby set" and, as such, provisions have been made for paralleling with the ship service power system.

Always check phase sequence before making connection to a shore power supply and be sure to make connections so that the phase sequence on the shore power will be A, B, C. If the shore power connection is made so that it gives the wrong phase sequence on the ship, motors will run in the wrong direction.

Always observe electrical safety precautions. Never adjust a ventilation opening for personal comfort of watchstanders to a position where spray or solid water entering the system through weather openings can be discharged onto switchboards, distribution panels, bus bars, or other electrical equipment.

Always operate switchboards and distribution system equipment as if no automatic protective devices were installed. Trouble will sooner or later be the inevitable consequence of careless and slipshod operating practices based upon the assumption that automatic protective devices either will prevent incorrect operation or will prevent damage from incorrect operation. They will not because they are not designed or intended to do this. The protective devices used with the distribution system are intended to afford protection against damage as a consequence of equipment failure, not of operator failure. The intelligence which is needed for the operation of the distribution system is not built into the system but must be furnished by the operator. You must, therefore, read and follow the instructions on warning plates and indicator lights, must know the system and operate it correctly, and must never depend upon automatic devices to keep you from making a mistake or to save you from the consequences of a mistake.

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readings. The N/S summing network receives the cosine outputs from the heading and wind channels. The E/W summing network receives the sine outputs. In the N/S summing network, the N/S components of airspeed and wind are combined, and the result is an output voltage equivalent to the N/S groundspeed of the aircraft. Similarly, the E/W summing network has an output voltage equal to the E/W speed of the aircraft. The N/S and E/W channels are identical from this point on.

After groundspeed has been determined, adding the factor of time is the only remaining factor in order to compute distance. This is done in the ground track channels, and both channels operate in exactly the same manner with their respective voltage inputs.

Ground Track Channel

The ground track channel converts the component of groundspeed into distance by taking into account the length of time the aircraft travels at the groundspeed. This is done by a motor-driven tachometer (or rate generator) which rotates at a speed proportional to the groundspeed of the aircraft. This rotation is in a direction corresponding to the direction of travel. A ground track synchro, coupled to the motor-generator, provides output data at 2 miles per revolution.

Distance Channel

The distance channels convert the rotation of the ground track synchros into distance counter information. By using synchros and servomotors, the information is transferred through a gearing mechanism that causes the stabilization potentiometers to provide the proper voltages to the radar sweep deflection system. These voltages (from the N/S and E/W stabilization pots) will ground stabilize the display so that the radar continues to view the area selected. The distance channel also positions the dials of the Veeder-root counter to indicate the distances traveled. Some computers will ground stabilize a sweep up to 300 miles. Beyond this range, resetting is required, resulting in the PPI origin being moved to a new position.

RADAR SECTION

The computer section is an auxiliary unit that works in conjunction with the radar set and the remaining GPI circuitry is self contained within the radar set.

The internal slewing circuits are identical for both manual and automatic operation. The amount of slew available for manual slew is 50 miles maximum in any one quadrant, and for automatic slew is 150 miles maximum in any one quadrant.

The manual slew helipots are located on the control box. Only N/S circuitry is discussed because the E/W circuitry is identical. Figure 17-41 is a simplified schematic and presents only that portion of the circuitry that pertains to the slewing function.

The synchronizer provides the circuitry necessary to convert the input voltages into the push-pull d-c output voltages necessary for slew indications. This conversion is accomplished by the following four main stages:

1. Input limiters—which provide the safety factor for the input cathode followers and d-c amplifiers.
2. Input cathode followers—which isolate the input circuits from the d-c amplifiers.
3. D-c amplifiers—which are used in conjunction with their degenerative feedback loop to control the gain.
4. Output cathode followers—which are used to isolate the d-c amplifiers from the indicator circuits and to provide degenerative feedback for the amplifiers.

In the indicator section, the sweep voltages are combined with the slew voltages. The clampers in the indicator section are controlled by the sweep and slew voltages and in turn provide the proper bias for the sweep drivers. The drivers provide the proper sweep currents for the deflection coils.

Circuit Analysis

In order to determine the position of the origin of the sweep on the indicator, the bias on the sweep drivers must be controlled. When it is desired that the sweep origin be in the center of the indicator, all four drivers are held at -19 volts d-c grid bias. Whenever slew is desired, this bias is changed in a push-pull manner in the direction desired. Helipots (R1 and R2) provide the manual slew input for the N/S channels. A maximum of 50 volts push-pull may be obtained from the two ganged controls. One volt, at this point, provides 1 mile of slew (displacement) on the indicator.

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CHAPTER 12

ELECTRIC AUXILIARIES

Electrician's Mates 3 and 2 are required to man electrical equipment in the steering gear room, anchor windlass room, at the degaussing switchboard, and at electric elevator and hoist stations. They are also required to service electric galley equipment and appliances by taking resistance and current measurements, cleaning switches and relays, replacing defective heating units, thermostats, and control or unit wiring.

The purpose of this chapter is to explain the operating principles of these electric auxiliaries and to describe the proper methods and procedures for maintaining this equipment.

DEGAUSSING INSTALLATIONS

The German development and use of magnetic mines initiated the development of degaussing systems. In September 1939, the Germans began laying magnetic mines in shipping lanes off the east coast of England. Within three months 44 ships were sunk by these mines. Thus the British Admiralty made the development of countermeasures a problem of highest priority. The magnetic mine outdated with one blow the countermine and sweeping techniques developed in World War I.

The United States was quick to recognize the threat presented by magnetic mines in the hands of a potential enemy. On December 6, 1939 the Bureau of Ordnance (now Ordnance System Command) met with experts to consider the related problems of sweeping magnetic mines and building some sort of defensive mechanism into the hulls of mine sweepers. Since that meeting there has been continual and ever increasing improvements of equipments for countering magnetic mines and torpedoes.

The detonation of a magnetic mine or torpedo depends on a localized disturbance or distortion of the earth's magnetic field. This distortion is caused by a ship passing over or near the mine or torpedo. The purpose of the degaussing installation is to reduce the magnitude of the distortion caused by the ship, and thus minimize the danger of firing the magnetic mine or torpedo.

A ship is a magnet because of the presence of magnetic material in its hull, machinery, and other equipment. Therefore it is surrounded by a magnetic field, which is large near the ship and small at a considerable distance from the ship. The earth's magnetic field is uniform at any particular point on the surface of the earth. When a ship passes over a point on the earth's surface, the ship's magnetic field is superimposed on the earth's magnetic field, thus tending to distort the earth's field around the ship. If the ship is close to a magnetic mine or torpedo, the distortion caused by the ship's field will activate the firing mechanism to detonate the mine or torpedo.

Degaussing equipment is installed aboard ship to neutralize the disturbance of the earth's magnetic field caused by the ship and thus to reduce the possibility of detonating a magnetic mine or torpedo. A shipboard degaussing installation consists of one or more coils of electric cable in specific locations inside the ship's hull, a d-c power source to energize these coils, and a means of controlling the magnitude and polarity of the current through the coils. Compass-compensating equipment, consisting of compensating coils and control boxes, is also installed as a part of the degaussing system to compensate for the deviation effect of the degaussing coils on the ship's magnetic compasses.

EARTH'S MAGNETIC FIELD

Figure 12-1 shows the earth as a sphere with imaginary lines of force leaving the north magnetic pole and entering the south magnetic pole. The south magnetic pole is near the north

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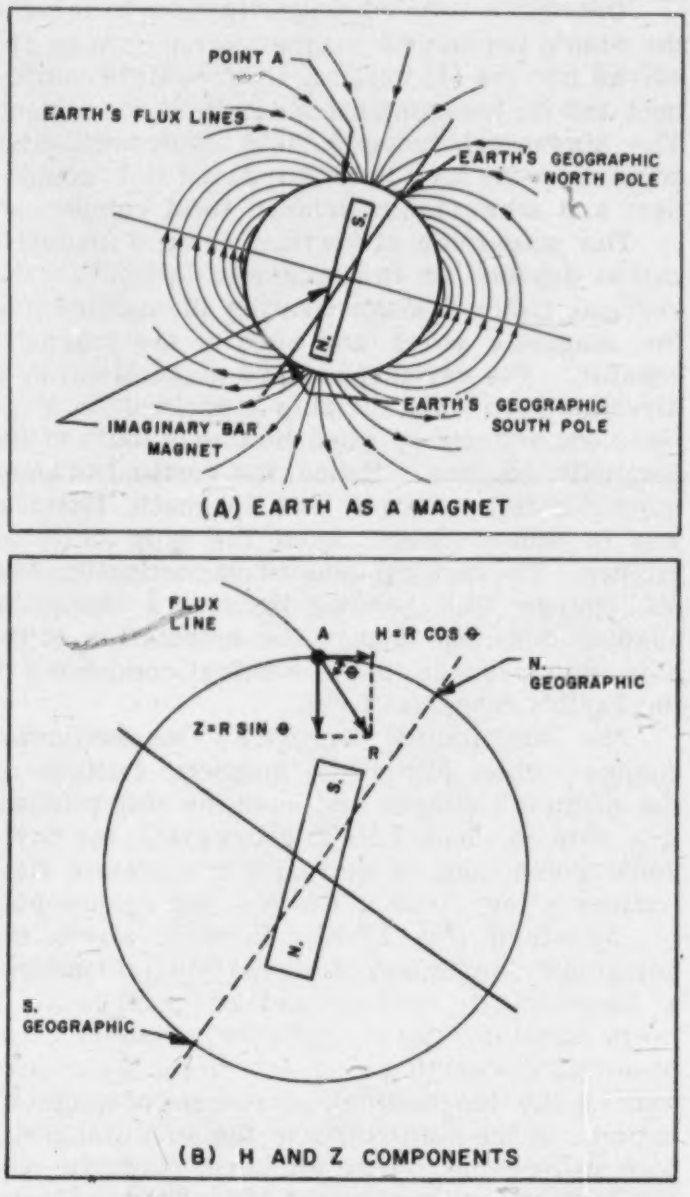

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Figure 12-1.—Earth's magnetic field.

geographic pole and the north magnetic pole is near the south geographic pole. The apparent contradiction is clarified by the imaginary bar magnet in (fig. 12-1) whose axis lies approximately along the earth's axis of rotation and whose poles are by definition north near the earth's geographic south pole and south near the earth's geographic north pole.

The magnetic field is strong where the lines of force are close together (near the magnetic poles) and weak where they are far apart (away from the magnetic poles). The lines of force in the earth's magnetic field extend vertically outward at the north magnetic pole, vertically inward at the south magnetic pole, horizontally midway between the magnetic poles, and at varying angles at all other points.

The unit of magnetic flux density is the gauss, and the unit of magnetic field intensity is the oersted. The relation between the gauss and oersted is expressed by the equation.

$$B = \mu \underline{H}$$

where $\underline{B}$ is the magnetic flux density in gausses, $\underline{H}$ the magnetic field intensity in oersteds, and μ the permeability of the surrounding media. For all practical purposes with respect to degaussing, the permeability μ, is taken as 1, and the magnetic field strength (intensity) $\underline{H}$, is measured in terms of the gauss (rather than oersteds), which is incorrect but does not lead to serious misunderstanding in degaussing terminology. One milligauss is one-thousandth of a gauss. At any point on the earth's surface the earth's magnetic field can be resolved into a horizontal component and a vertical component.

Horizontal Component

The horizontal component (also designated by the symbol, $\underline{H}$) of the earth's magnetic field is always directed from south to north, is zero at the magnetic poles, and is maximum at the magnetic equator.

Vertical Component

The vertical component ($\underline{Z}$) of the earth's magnetic field is directed radially outward (upward) south of the magnetic equator, is directed radially inward (downward) north of the magnetic equator, is zero at the magnetic equator, and is maximum at the magnetic poles.

The angle at which the flux lines strike the earth's surface (horizontal) depends on the magnetic latitude. Hence, for a given total field strength, the magnitudes of the horizontal and vertical components depend on the angle that the field makes with the horizontal. For example, the horizontal and vertical components of the earth's magnetic field at point A (fig. 12-13) are $\underline{H} = \underline{R} \cos \theta$ and $\underline{Z} = \underline{R} \sin \theta$ respectively, where $\underline{H}$ is the horizontal component, $\underline{Z}$ the vertical component, $\underline{R}$ the total earth's field, and θ the angle at which the flux lines strike the earth's surface.

SHIP'S MAGNETIC FIELD

The magnetic field of a ship is the resultant of the algebraic sum of the ship's permanent magnetization and the ship's induced magnetization. The ship's magnetic field may have any angle with respect to the horizontal axis of the ship, and any magnitude.

Permanent Magnetization

The process of building a ship in the presence of the earth's magnetic field develops a certain amount of permanent magnetism in the ship. The magnitude of the permanent magnetization depends on the earth's magnetic field at the place where the ship was built, the material of which the ship is constructed, and the orientation of the ship at time of building with respect to the earth's field. This magnetization after construction is independent of the varying or immediate earth's magnetic field, the heading, and the roll and pitch of the ship. The permanent magnetism of a ship may vary over long periods of time.

The ship's permanent magnetization can be resolved into the (1) vertical permanent field component and (2) horizontal permanent field component. The horizontal permanent field component comprises the longitudinal permanent field component and athwartship permanent field component. The vertical, longitudinal, and athwartship permanent field components are constant, except for slow changes with time, and are not affected by changes in heading or magnetic latitude.

All ships that are to be fitted with a shipboard degaussing installation and some ships that do not require degaussing installations are depermed. Deperming is essentially a large scale version of demagnetizing a watch. The purpose is to reduce permanent magnetization and bring all ships of the same class into a standard condition so that the permanent magnetization, which remains after deperming, is approximately the same for all ships of the class.

Induced Magnetization

After a ship is built, its very existence in the earth's magnetic field causes a certain amount of magnetism to be induced in it. The ship's induced magnetization depends on the strength of the earth's magnetic field and on the heading of the ship with respect to the inducing (earth's) field.

The ship's induced magnetization, similar to the ship's permanent magnetization, can be resolved into the (1) vertical induced field component and (2) horizontal induced field component. The horizontal induced field component also comprises the longitudinal induced field component and athwartship induced field component.

The magnitude of vertical induced magnetization depends on the magnetic latitude. The vertical induced magnetization is maximum at the magnetic poles and zero at the magnetic equator. The vertical induced magnetization is directed down when the ship is north of the magnetic equator and up when the ship is south of the magnetic equator. Hence, the vertical induced magnetization changes with magnetic latitude, and to some extent, when the ship rolls or pitches. The vertical induced magnetization does not change with heading because a change of heading does not change the orientation of the ship with respect to the vertical component of the earth's magnetic field.

The longitudinal induced magnetization changes when either the magnetic latitude or the heading changes, and when the ship pitches. If a ship is headed north geographic, the horizonal component of the earth's magnetic field induces a north pole in the bow and a south pole in the stern (fig. 12-2). In other words, the horizontal component of the earth's field induces a longitudinal or fore-and-aft component of magnetization. The stronger the horizontal component of the earth's magnetic field, the greater will be the longitudinal component of magnetization. If the ship starts at the south magnetic pole and steams toward the north magnetic pole the longitudinal component of induced magnetization starts at zero at the "south" magnetic pole, increases to a maximum at the magnetic equator, and decreases to zero at the "north" magnetic pole. Hence, for a constant heading the longitudinal component of induced magnetization changes when the ship moves to a position where the horizontal component of the earth's magnetic field is different—that is, when the ship changes its magnetic latitude.

If at a given magnetic latitude the ship changes heading from north to east, the longitudinal component of induced magnetization changes from a maximum on the north heading to zero on the east heading. When the ship changes heading from east to south, the longitudinal component increases from zero on the east heading to a maximum on the south heading. On southerly headings a north pole is induced at

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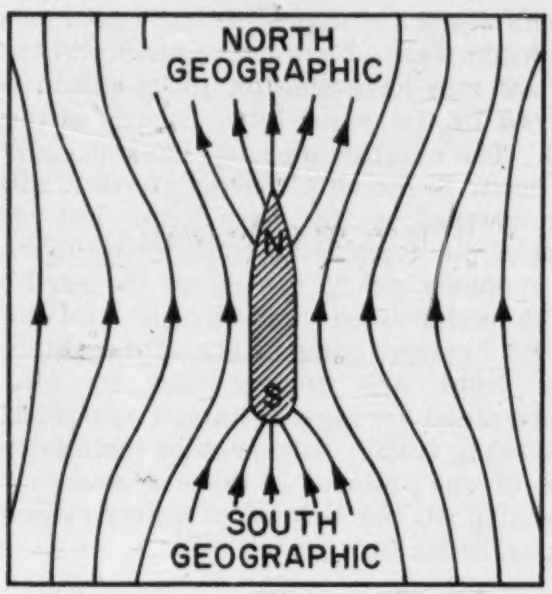

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Figure 12-2.—Horizontal component of earth's field induces longitudinal magnetization in the ship.

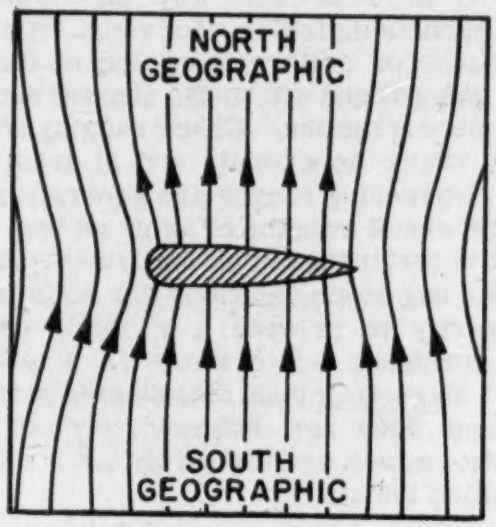

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Figure 12-3.—Athwartship component of earth's field induces athwartship magnetization in the ship.

the stern and a south pole at the bow, which is a reversal of the conditions on northerly headings when a north pole is induced at the bow and a south pole at the stern. The longitudinal component of induced magnetization also changes, to some extent, as the ship pitches.

The athwartship induced magnetization changes when either the magnetic latitude or the heading changes, and when the ship rolls or pitches. When a ship is on an east heading, a north pole is induced on the port side and a south pole on the starboard side (fig. 12-3), which is the athwartship component of induced magnetization. The magnitude of the athwartship magnetization depends on the strength of the horizontal component of the earth's magnetic field at that latitude. This component is maximum at the magnetic equator and zero at the magnetic poles.

The athwartship component of induced magnetization also changes when the ship's heading changes. The magnitude of the athwartship component of induced magnetization is maximum when the ship is headed magnetic east or west, and zero when the ship is headed magnetic north or south. The athwartship component of induced magnetization also changes, to some extent, as the ship rolls or pitches.

MAGNETIC RANGES AND RANGING

A magnetic range is a station equipped to measure the magnetic field of ships which pass over measuring equipment located at or near the bottom of the channel in which the ships travel. The magnetic range is more commonly called a Degaussing Range or Degaussing Station. The number of degaussing stations in operation has varied from time to time but the Navy at one time had seventy-five degaussing stations at various locations throughout the world.

A ship is said to be "ranged" when its magnetic field is measured at a magnetic range. Ranging has two classifications; calibration ranging and check ranging.

Calibration Ranging

Calibration ranging provides information for degaussing charts, determines initial degaussing coil current and indicates if changes or modifications are required to the ship's degaussing installation.

Check Ranging

Check ranging determines the adequacy of current settings and the performance of degaussing equipment and personnel.

For accurate ranging the ship must pass directly over the range at a constant speed and heading. The degaussing coils must be set

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correctly in accordance with the values given in the degaussing folder. The range officer must be notified of coil settings and of the ship's draft, forward and aft, to the nearest six inches, for depth correction. Check ranging should be run at every opportunity and at least once a year. Degaussing ranges are generally situated to allow check ranging of ships as they pass in and out of port in the course of normal operations.

Some degaussing stations use coils installed temporarily to provide a magnetic treatment which furnishes some measure of protection against magnetic mines. Degaussing by magnetic treatment does not, however, protect against magnetic mines as effectively as a shipboard degaussing installation.

DEGAUSSING COILS

As stated previously, the ship's permanent magnetization can be resolved into the (1) vertical permanent magnetization, (2) longitudinal permanent magnetization, and (3) athwartship permanent magnetization components. Similary, the ship's induced magnetization can be resolved into the (1) vertical induced magnetization, (2) longitudinal induced magnetization, and (3) athwartship induced magnetization components. Each of the six components of the ship's magnetization produces a magnetic field in the vicinity of the ship.

The distortion of the earth's field caused by the superimposing of the six components of the ship's field is neutralized by means of degaussing coils. The degaussing coils are made with either single-conductor or multiconductor cables. Coils with single-conductor cables have only one turn or a small number of turns. Single-conductor coils or a combination of some single-conductor and some multiconductor coils are usually specified for large vessels. Coils with multiconductor cables have the conductors in one or more cables connected in series to give a considerable number of turns. Multiconductor coils are usually specified for the smaller ships. The coils must be energized by direct current, which is supplied from 120-volt or 240-volt, d-c ship's service generators or from degaussing power supply equipment installed for the specific purpose of energizing the degaussing coils.

The degaussing coils consist of coils of cable wound on the ship, each having the required location and the number of turns to establish the required magnetic field strength when energized by direct current of the proper value and polarity. The coils will then produce magnetic field components equal and opposite to the components of the ship's field. Each coil consists of the main loop and may have smaller loops within the area covered by the main loop, usually at the same level. The smaller loops oppose localized peaks that occur in the ship's magnetic field within the area covered by the main loop. The resultant effect of the degaussing coils when the currents are properly set is to restore the earth's field to the undistorted condition around the ship.

The various components of the ship's magnetic field are compensated by means of standardized arrangements and combinations of degaussing coils. A degaussing installation consists of one or more of these degaussing coils, depending on the degree of safety required for the particular ship (fig. 12-4).

M Coil

The M or main coil (fig. 12-4.A) encircles the ship in a horizontal plane, which is usually at the waterline. The function of the M coil is to produce a magnetic field, which counteracts the magnetic field produced by the vertical permanent and the vertical induced magnetization of the ship. If the M coil field were everywhere exactly equal and opposite to the field produced by the vertical magnetization, the resultant of the two magnetic fields everywhere would be equal to zero. In practice, it is not possible to attain a perfect match, but the resultant is much less than the field produced by the vertical magnetization of the ship.

The permanent vertical magnetization of a ship is constant, but the vertical induced magnetization varies with the magnetic latitude and with the roll and pitch of the ship, but not with the heading. The resultant of the permanent and induced vertical magnetization will also vary with the magnetic latitude and with the roll and pitch of the ship. Hence, the M coil current must be changed when the ship changes magnetic latitude in order to keep the M coil field as nearly as possible equal and opposite to the field produced by the ship's vertical magnetization. The change in vertical magnetization caused by roll and pitch of the ship is relatively small, and only in special cases is it necessary to compensate for this change.

F and Q Coils

The F or forecastle coil encircles the forward one-fourth to one-third of the ship and is

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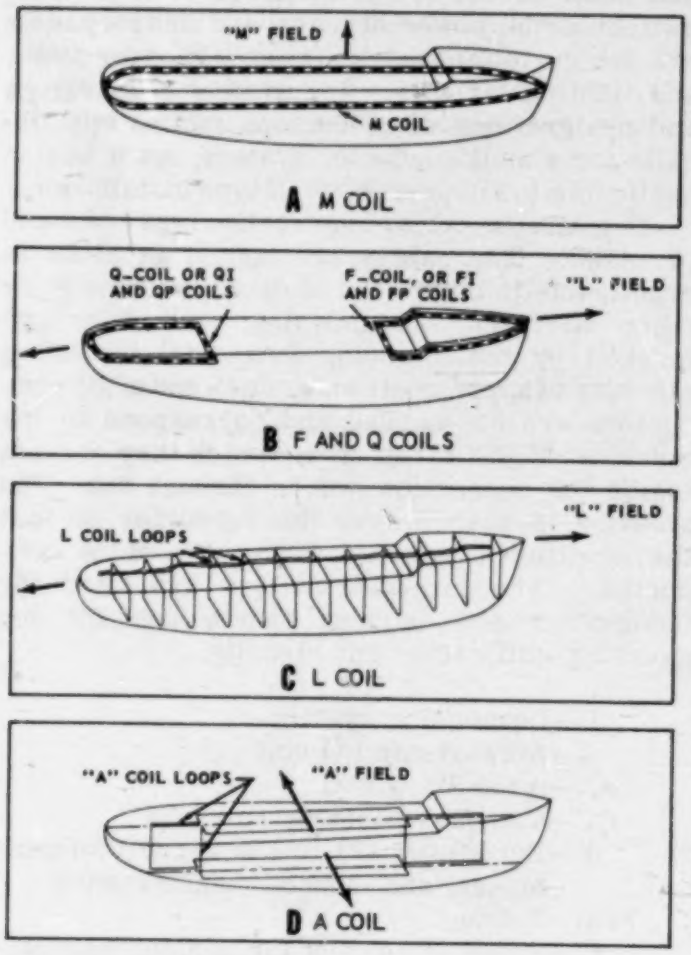

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Figure 12-4.—Types of degaussing coils.

usually just below the forecastle or other uppermost deck; whereas, the Q or quarterdeck coil encircles the after one-fourth to one-third of the ship and is usually just below the quarterdeck or other uppermost deck (fig. 12-4.B). The function of the F and Q coils is to counteract the magnetic field produced by the ship's longitudinal permanent and longitudinal induced magnetization. The resultant F and Q coil strengths are then equal to the algebraic sums of their permanent and induced current requirements. The shape of the magnetic field produced by the F and Q coils is somewhat different from the magnetic field produced by the ship's longitudinal magnetism, but the two fields are, in general, oppositely directed below the bow and stern of the ship. The F and Q coils are not used to compensate for changes in the magnetic field resulting from the pitch of the ship.

The ship's longitudinal permanent magnetization is constant but the longitudinal induced magnetization changes with the heading and magnetic latitude. Therefore, the F and Q coil currents must be changed when the ship changes its course or magnetic latitude in order to keep the coil strengths at the proper values to counteract the changes in the ship's longitudinal induced magnetization. Two adjustments are necessary, one to change the F coil current and one to change the Q coil current. In many installations the conductors of the F and Q coils are connected to form two separate circuits designated as the FI-QI coil and the FP-QP coil (fig. 12-4.B).

The FI-QI coil consists of an FI coil connected in series with a QI coil so that the same current flows in both coils. The FP-QP coil is similarly connected.

The FI-QI coil is used to counteract the magnetic field produced by the ship's longitudinal induced magnetization. The longitudinal induced magnetization changes when the ship changes heading or magnetic latitude, and the FI-QI coil current must be changed accordingly.

The FP-QP coil is used to counteract the magnetic field produced by the ship's longitudinal permanent magnetization. The longitudinal permanent magnetization does not change when the ship changes heading or magnetic latitude, and no change is needed in the strength of the FP-QP coil. In contrast to the F and Q coils, the FI-QI and FP-QP coil currents require only one adjustment, instead of two when the ship changes heading or magnetic latitude.

L Coil

The L or longitudinal coil (fig. 12-4) consists of loops in vertical planes that are parallel to the frames of the ship. The function of the L coil is to counteract the magnetic field produced by the ship's longitudinal permanent and longitudinal induced magnetization. The L coil is more difficult to install than the F and Q coils or FI-QI and FP-QP coils, but provides better neutralization because it more closely simulates the longitudinal magnetization of the ship. The L coil is often used in minesweeper vessels.

The longitudinal induced magnetization changes when the ship changes heading or magnetic latitude, and the L coil current must be changed accordingly. When compensation for pitch is required, the L coil current must also be changed as the vessel pitches.

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is illustrated in figure 12-5. A detailed description of the marking for degaussing-coil loops, circuits, conductors, and cables and for degaussing feeder cable and feeder-cable conductors is contained in Chapter 9810, Section III of the NavShips Technical Manual.

Connection And Through Boxes

Connection and through boxes are similarly constructed watertight boxes, but they are used for different purposes (fig. 12-5).

A CONNECTION BOX is a watertight box with a removable cover used to connect loops together to connect conductors in series, and to reverse turns. The power supply connection for a coil and all adjustments of ampere-turn ratios between loops are made within connection boxes. The power supply cable and interconnecting cable for the FI-QI and FP-QP coils terminate in connection boxes. The marking of the conductors in the single-loop M coil connection box (Box D5 of fig. 12-5) is illustrated in figure 12-6.

A THROUGH BOX is a watertight box with a removable cover used to connect conductors without changing the order of conductor connections. Also, a through box is used when it is necessary to connect sections of cable. In some cases splicing in lieu of through boxes is used.

Connection and through boxes in the M, MX, F, Q, FI-QI, and FP-QP coils are considered to be in one group. They are NUMBERED D1, D2, D3, etc., in sequence, starting at the bow and going around the ship in a counterclockwise direction when viewed from above (fig. 12-5).

Boxes for the A coil have the next higher numbers after the numbering of the M, F, FI, FP, QI, and QP boxes. The A coil boxes are numbered in sequence, starting with the highest forward box and continuing aft on the upper limbs of both the A1 and A2 loops, then down to and forward on the lower limbs, and then up (fig. 12-5).

Boxes for the L coil have the next higher numbers after the numbering of the A coil boxes. The L coil boxes are numbered in sequence, starting with the highest forward box on the port side and continuing around the vessel in a counterclockwise direction when viewed from above. Boxes on the centerline are considered to be on the port side for the assignment of numbers.

Connection and through boxes are provided with IDENTIFICATION PLATES that include:

1. Degaussing box numbers (D1, D2, D3, etc.).
2. Connection box and/or through box as applicable.
3. Coil and loop designations (M1, M2, F12, Q12, etc.).

For example,

	D1	
Connection Box		Through Box
M1		F1
M2		

identifies the No. 1 degaussing box serving as a connection box for the M1 and M2 loops and as a through box for the F1 loop.

A wiring diagram of the connections in the box is pasted on the inside of the cover and coated with varnish or shellac. The wiring diagram for connection boxes should (1) designate the conductors that may be reversed without reversing the other loops, (2) indicate the arrangement of parallel circuits so that equal changes can be made in all parallel circuits when such changes are required, and (3) show the spare conductors. Spare conductors should be secured to connectors and should be connected to form a closed or continuous circuit. All conductors in a connection box should be 1-1/2 times the length required to reach any terminal within the box. Connection boxes should also be fitted with drain plugs to provide accessibility for periodic removal of accumulated moisture from the boxes.

COIL-CURRENT CONTROL

Degaussing installations, as previously stated, consist of different combinations of degaussing coils and manual or automatic degaussing equipment for control of the current in these coils. The selected combination depends on the size and the intended use of the particular ship.

The currents in the degaussing coils must be changed when there are changes in the ship's heading, magnetic latitude, or both. The control of the coil currents is accomplished manually in the older installations and automatically in all new installations.

Manual Control

Degaussing installations that have the coil currents manually controlled are energized from

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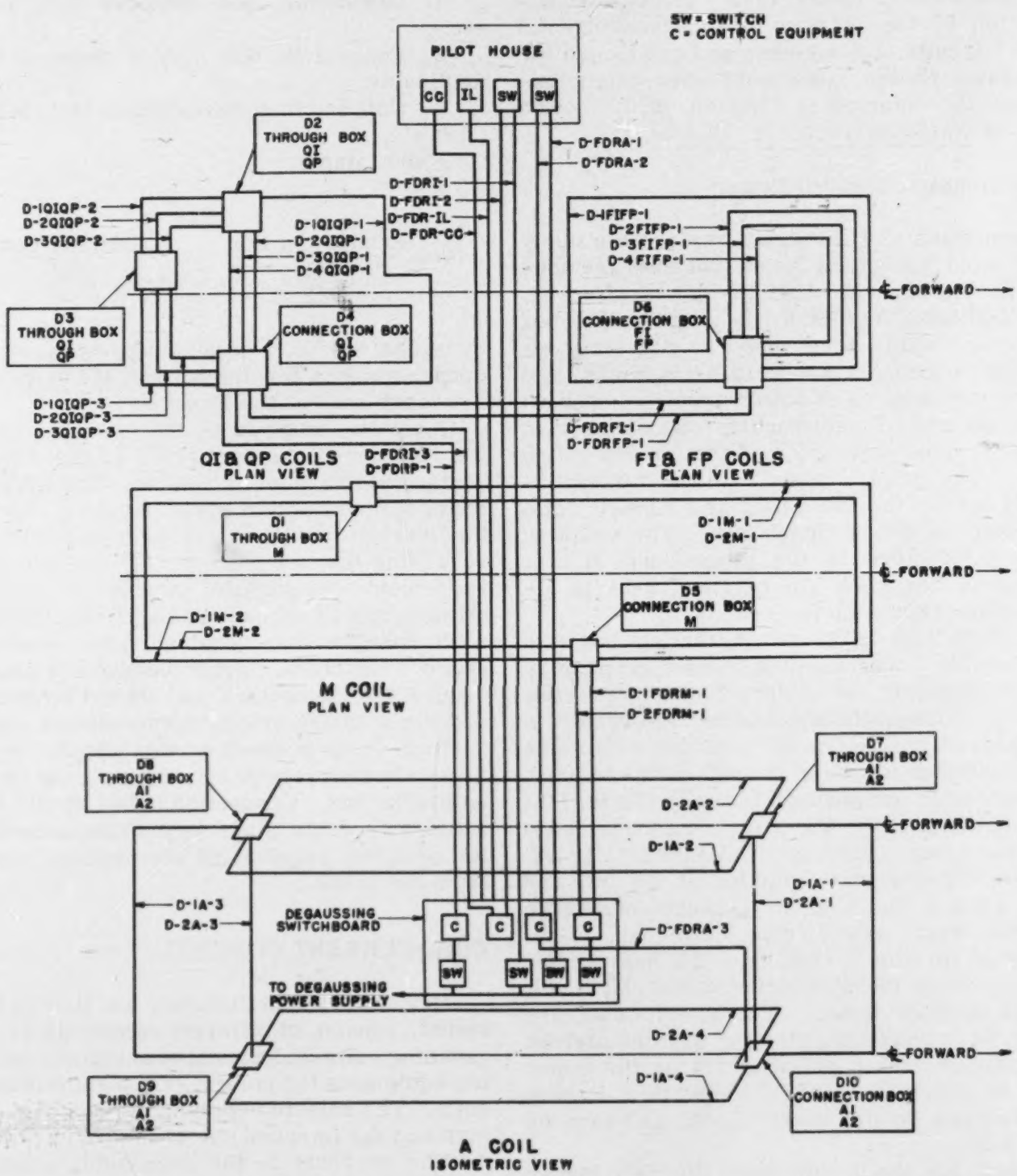

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Figure 12-5.—Marking scheme for degaussing coil cables, feeder cables and connection and through boxes.

constant voltage d-c generators or from variable voltage motor-generators and are called (1) rheostat and (2) motor-generator installations, respectively.

Reversing switches are used to change the polarity of the coils, except where provision is made to accomplish this change in the design of the rheostat for the constant voltage supply

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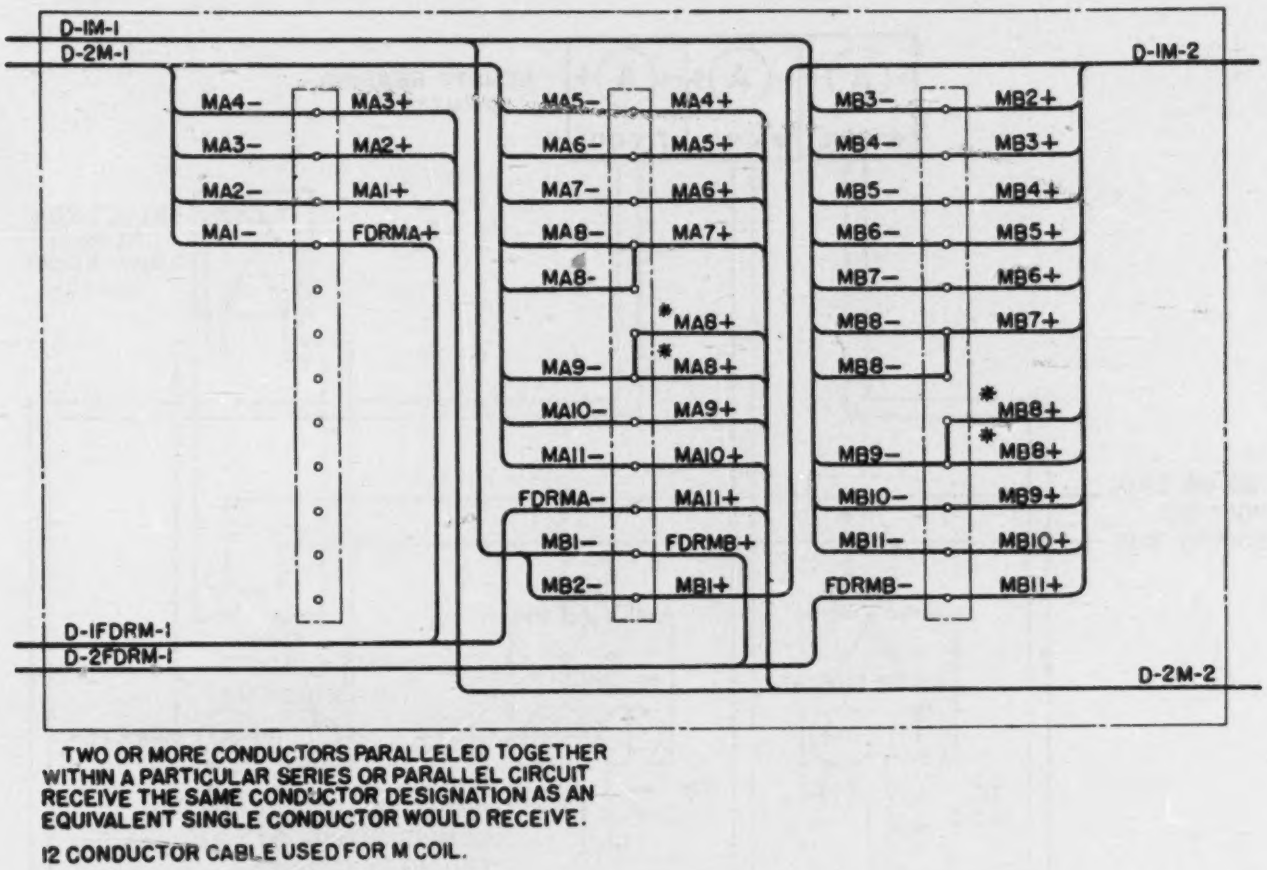

TWO OR MORE CONDUCTORS PARALLELED TOGETHER WITHIN A PARTICULAR SERIES OR PARALLEL CIRCUIT RECEIVE THE SAME CONDUCTOR DESIGNATION AS AN EQUIVALENT SINGLE CONDUCTOR WOULD RECEIVE.

12 CONDUCTOR CABLE USED FOR M COIL.

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Figure 12-6.—Marking of conductors in the single loop M coil connection box.

or in the generator control for the variable voltage supply.

In a Rheostat Installation the power for the degaussing coils is supplied by a constant-voltage d-c generator, and the coil currents are controlled by adjusting a rheostat connected in series with the coil and power supply. An installation in which rheostats are used to control the M, FI-QI, and FP-SP coil currents is illustrated in figure 12-7. Manually operated rheostats are used in some installations and motor-operated rheostats in other installations. In the manual type, the rheostat is adjusted locally at the degaussing switchboard by turning the rheostat handle. In the motor-operated type, the rheostat shaft is turned by a motor controlled from a remote station by means of a push-button. Motor-operated rheostats are equipped for manual operation in the event of an emergency.

In a motor-generator installation the power for the degaussing coils is supplied by a motor-generator, and the coil currents are controlled by adjusting a rheostat in the generator field circuit to vary the output of the generator. A single-line diagram of this type installation is illustrated in figure 12-8. The rheostats in the generator fields can be operated manually or by means of a motor to change the generator voltage and thereby adjust the coil current to the desired value.

An installation in which a combination rheostat and motor-generator is used to supply the coil currents is illustrated in figure 12-9. The M coil current is controlled by means of a variable-voltage motor-generator, and the FI-QI and FP-QP coil currents are controlled by means of rheostats.

The Degaussing Folder aboard each ship contains the forms which show the number of coils and type of circuit installed in the ship. Further details of the degaussing installation are shown on the degaussing plans carried aboard each ship.

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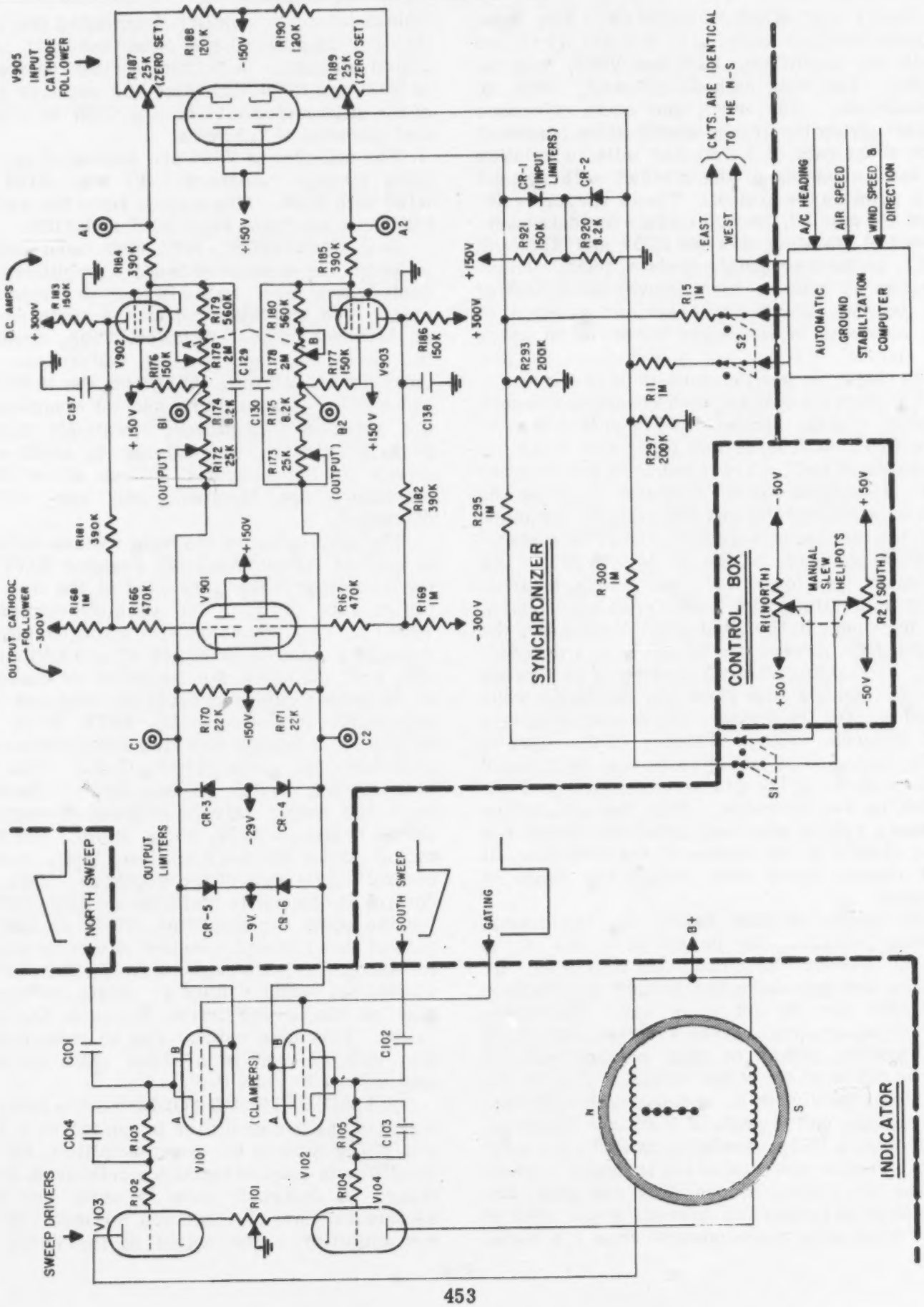

Figure 17-41.—GPI schematic (radar section).

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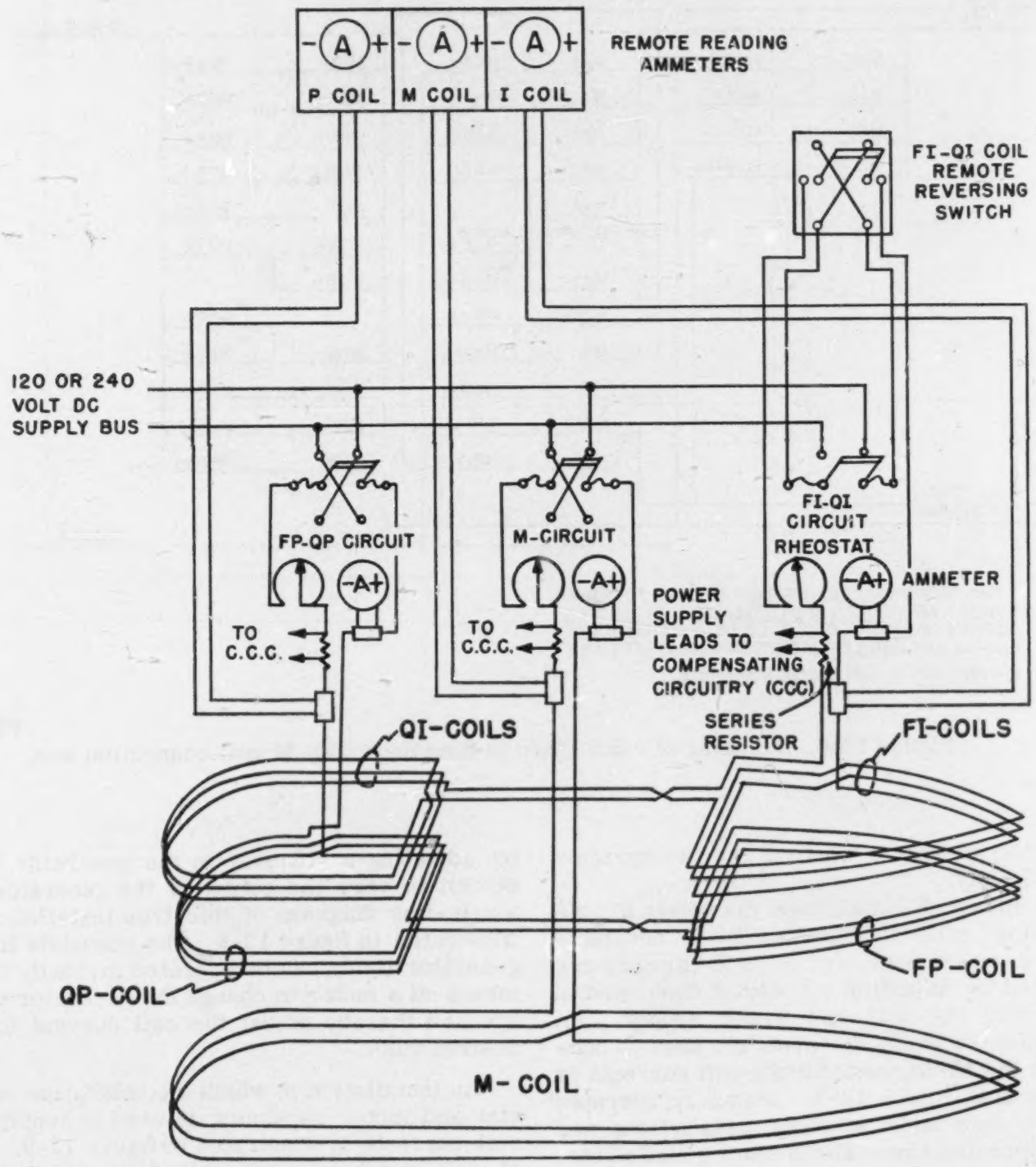

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Figure 12-7.—M, FI-QI, and FP-QP coil degaussing installation with rheostat control.

The Degaussing Folder contains current setting charts that are prepared by the Degaussing Range when the ship is ranged and gives the degaussing coil currents to be used for any position on the earth's surface and any heading of the ship.

In most degaussing installations now in use the degaussing coil currents are set to the required values by an Electrician's Mate or other-authorized personnel. The current should be checked hourly and readjusted to the correct value when necessary. Degaussing coil currents

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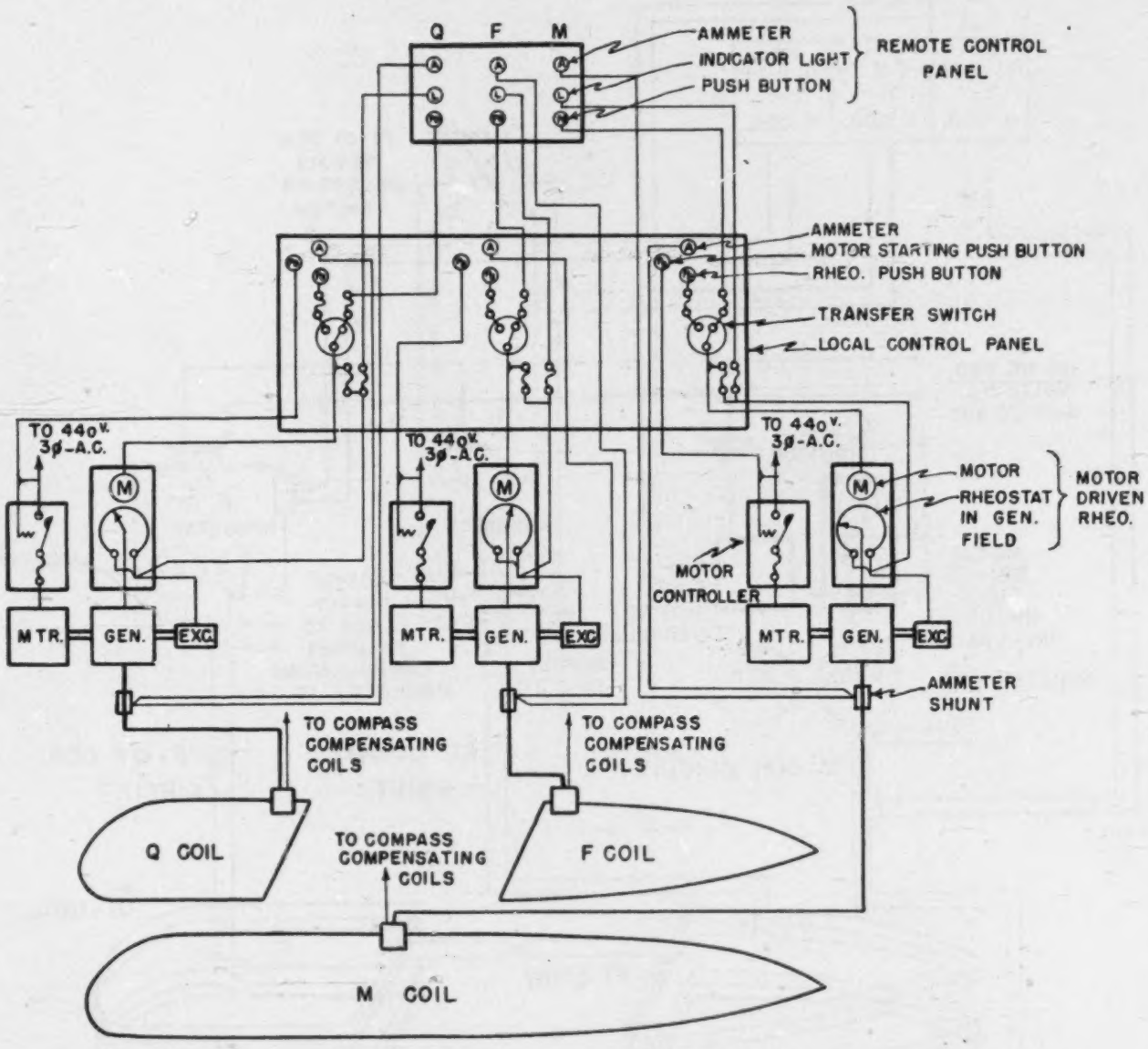

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Figure 12-8.—M, F, and Q coil installation with motor-generator control.

will change and require readjustment because of changes in degaussing-coil resistance caused by changes in cable temperature and changes in the voltage of the power supply for the degaussing coils.

POLARITY

The polarity of the degaussing coil currents is of particular importance. If the polarity of any of the degaussing coils is incorrect, the ship may very likely be in much greater danger from magnetic mines than if no degaussing were installed. The polarity of a coil should be checked by observing whether the pointer of the ammeter for the coil is on the POSITIVE (right) or NEGATIVE (left) side of the zero-center ammeter. Also, the polarity of a coil can be checked by observing whether the positive or negative plate glows in the neon indicator light for the coil. For positive polarity the right-hand electrode glows, and for negative polarity the left-hand electrode glows.

The direction of current in a degaussing coil is normally indicated by zero-center ammeters located on the degaussing control panel. The pointer will deflect to the right for positive (direction) current through the coil and to the left for negative current. The direction of

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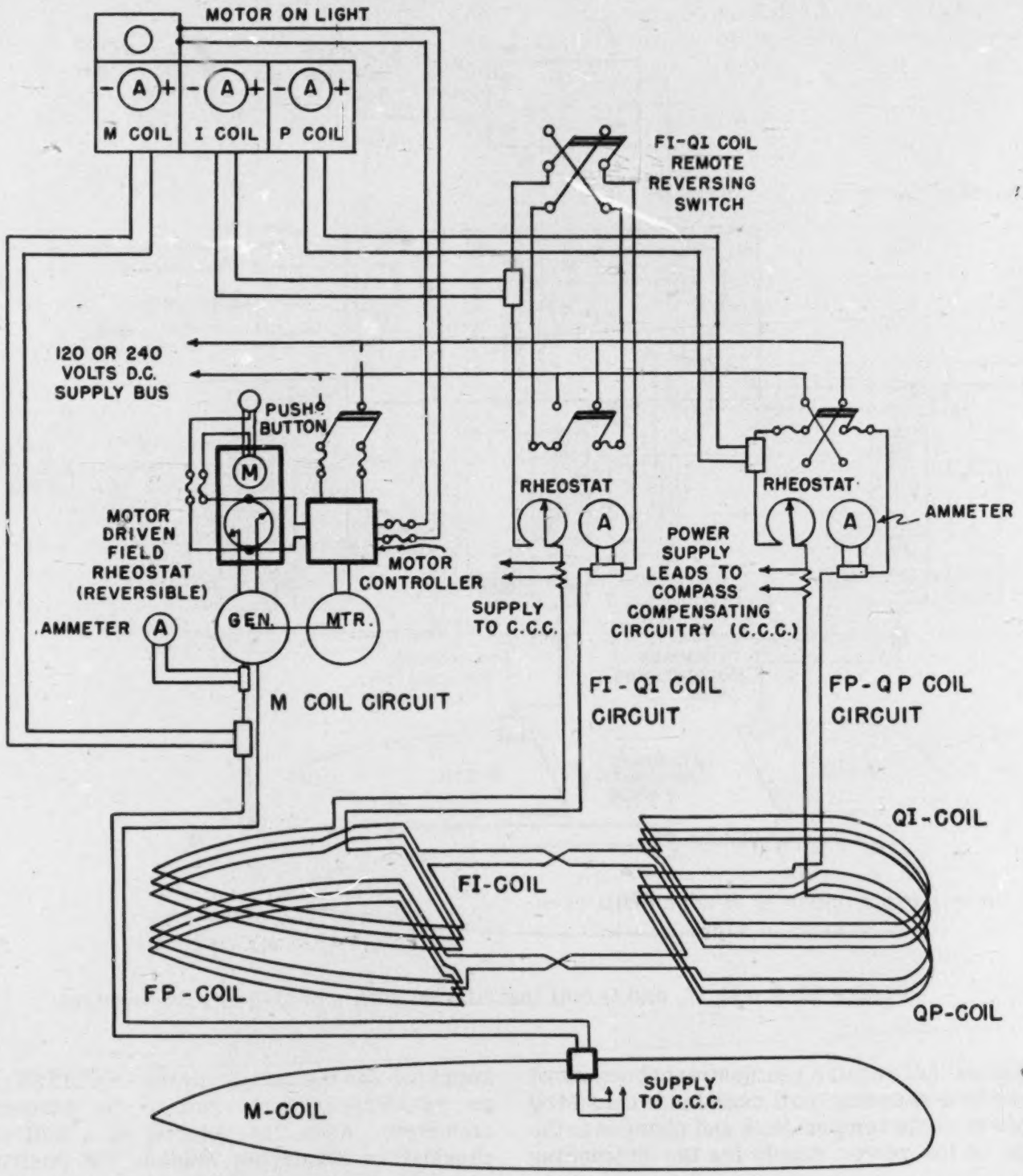

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Figure 12-9.—M, FI-QI, and FP-QP, and FP-QP coil degaussing installation with combination rheostat and motor-generator control.

current can be checked by a degaussing polarity indicator or a small compass. The polarity indicator dial is marked to denote the direction of current. When taking polarity readings with the indicator or small compass, move the device toward the degaussing coil until a good deflection is obtained, and no closer. The needle in the indicator or compass will reverse its

11656

magnetic polarity if the device is held too close to the coils. The indicator or compass should be checked after each test to be certain that the magnetic polarity of the needle has not reversed.

CHANGING COIL CURRENTS

The Degaussing Folder for each ship gives the current needed for each coil for all positions on the earth's surface and for all headings. One or more of the coil currents must be changed when one of the following conditions occurs:

1. When the ship passes from one Z zone to another.

The vertical intensity (Z component) of the earth's field, which is maximum at the magnetic poles and zero at the magnetic equator, is divided into a number of Z zones. The number of Z zones will vary, depending on the amount of compensation provided by the particular installation. Degaussing Chart No. 1 (fig. 12-10) illustrates the Z zones for the Atlantic and Indian Oceans. The reverse side of this chart contains the same number of Z zones for the Pacific Ocean. The coil settings are filled in for the various zones after the ship has been ranged.

2. When the ship passes from one H zone to another.

The horizontal intensity (H component) of the earth's magnetic field, which is maximum at the magnetic equator and zero at the magnetic poles, is divided into a number of H zones. Similar to the Z zones, the number of H zones will vary, depending on the degree of compensation provided by the degaussing system. A Degaussing Chart No. 2 (fig. 12-11) illustrates the H zones for the Atlantic and Indian Oceans and the reverse side contains the same number of H zones for the Pacific Ocean.

3. When the ship's heading changes from one sector to another.

The entire range of headings from 0 to 360° is divided into a number of sectors, each covering a part of the whole range of courses.

The Degaussing Course Corrections Setting Diagrams No. 1 for the FI-QI coil and No. 2 for the FI-QI and A coils are illustrated respectively in figures 12-12 and 12-13.

The Degaussing Course Correction Setting Tables No. 1 for the F and Q coils and No. 2 for the F, Q, and A coils are illustrated respectively in figures 12-14 and 12-15.

None of the degaussing coil currents are changed as long as the course remains in one sector (if the Z zone and H zone remain unchanged). The FP-QP coil current is NOT changed when the ship's heading or the ship's position changes. The following changes are necessary when changing from one sector to another or from one zone to another:

1. The M coil current must be changed when the ship moves from one Z zone to another. The M coil current is not changed when the ship moves from one H zone to another or when the heading changes from one sector to another.

2. The F, Q, FI-QI, L, and A coil currents are not changed when the ship moves from one Z zone to another, but must be changed if the ship moves to a different H zone, or if the heading changes to a different sector.

In a few ships, exceptional conditions may require a departure from the foregoing changes. In all cases, the Degaussing Folder will show the currents to be used.

Rheostat Installation

The degaussing coils in rheostat installations are energized by closing the main degaussing feeder switch and the individual coil switches in the proper polarity position with all rheostats set for maximum resistance. Set the current in each coil by cutting out resistance.

Adjust the rheostats for the M and FP-QP coils (if provided) until the M and FP-QP coil currents have the values specified in the Degaussing Folder for the ship's position. Adjust the rheostats for the F, Q, FI-QI, L, and A coils (if provided) until the coil currents have the values specified in the Degaussing Folder for the ship's position and heading. Check the coil currents periodically, and change the coil currents as required by changes in the ship's position and heading.

In installations employing motor-driven rheostats the polarity is changed only when the current is zero either by means of a motor-driven polarity changer and pushbutton, or by operating the rheostat through and beyond the position of maximum resistance. At this point, reversal of current will occur automatically because of the internal cross-wiring of the rheostat buttons on either side of this point, or by means of a motor-driven polarity changer actuated by the rheostat arm.

11-57

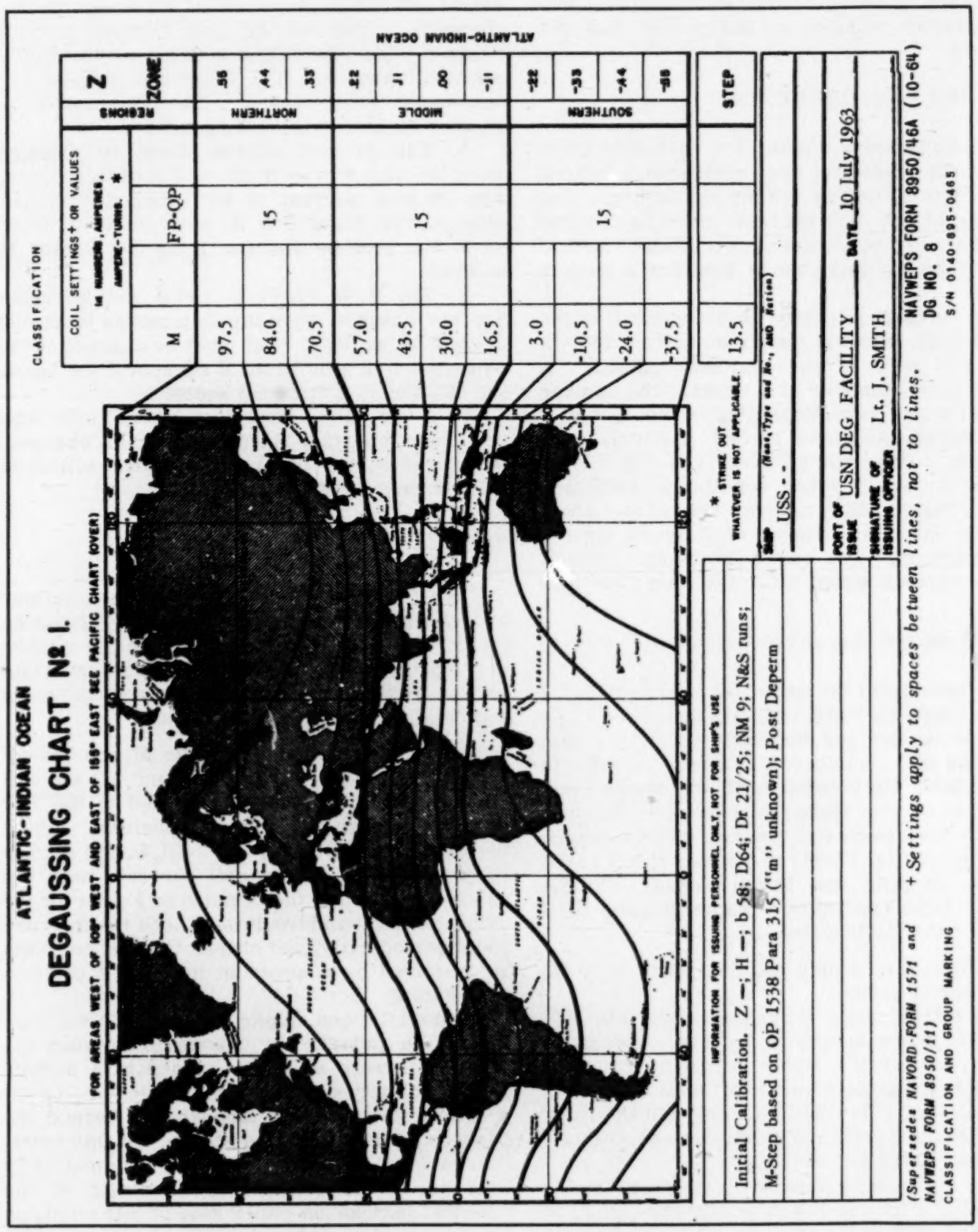

Figure 12-10.—Degaussing chart No. 1.

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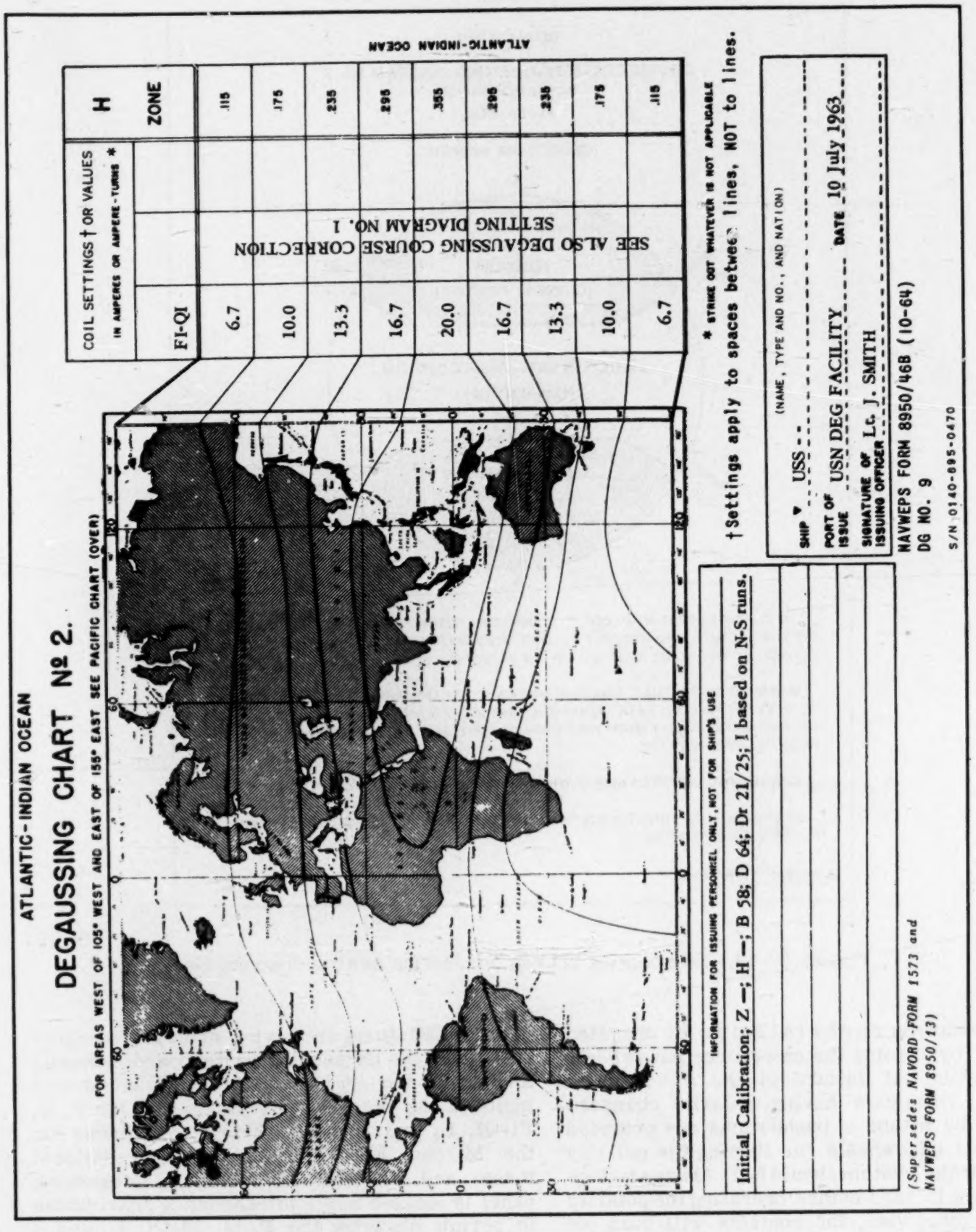

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Figure 12-11.—Degaussing chart No. 2.

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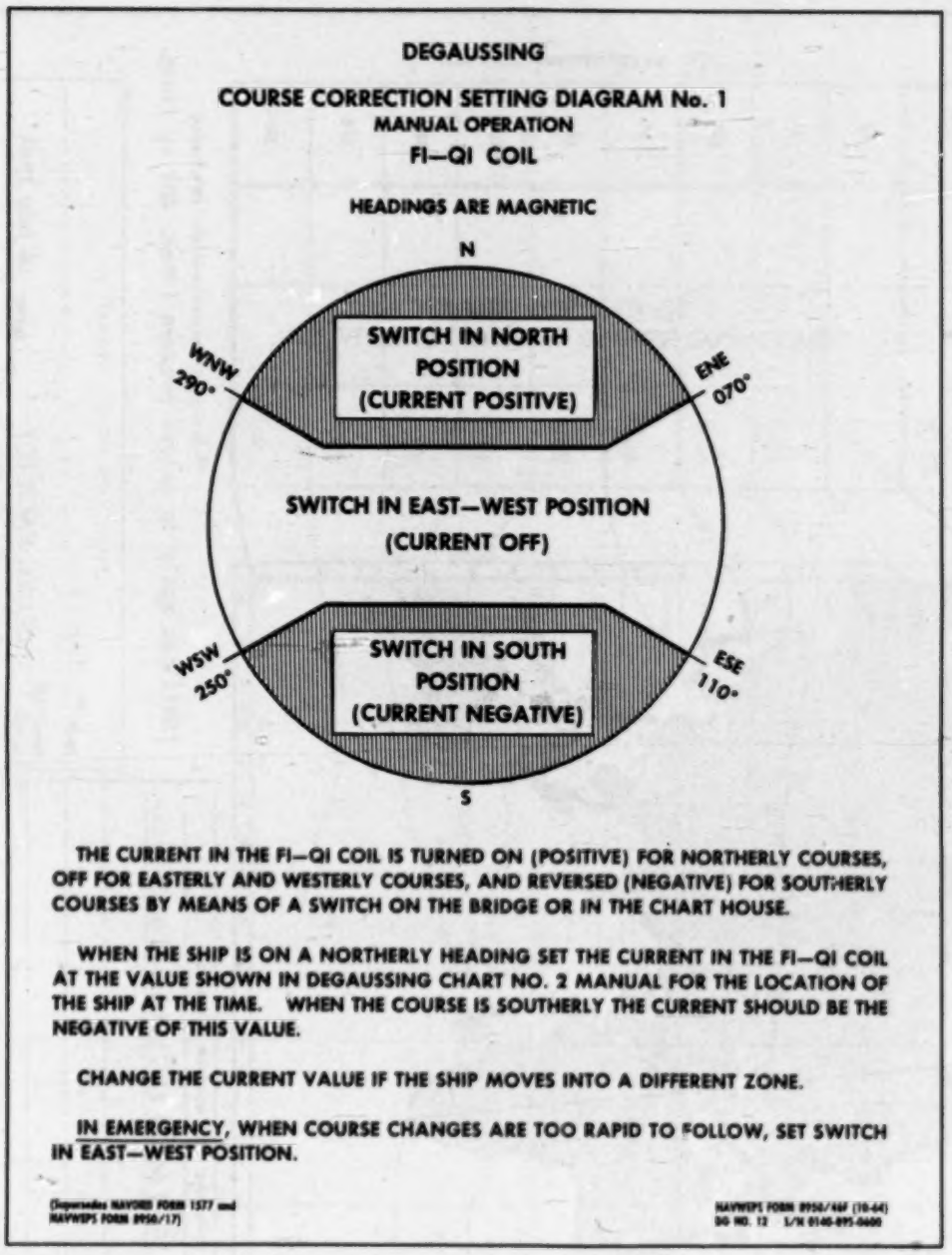

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Figure 12-12.—Degaussing course correction setting diagram No. 1.

Motor-driven rheostats can be operated manually by turning the emergency handwheels in the event of failure of the motor-drive system. Rheostats having polarity changers operated by means of pushbuttons are provided with small handwheels for turning the polarity changer if the system should fail. Always reduce the current to zero before operating the polarity changer: otherwise, the contacts will burn out from operation under load.

In installations employing manually operated rheostats, the degaussing switchboard is usually located in the engineroom. This switchboard includes the disconnect switches for the F, Q, FI-QI, L, and A coils; reversing switches for the M and FP-QP coils; series resistors; fuses; and ammeters. A remote degaussing panel is located in the pilot house or chart house to permit changing the F, Q, FI-QI, L, and A coil currents as the ship changes heading.

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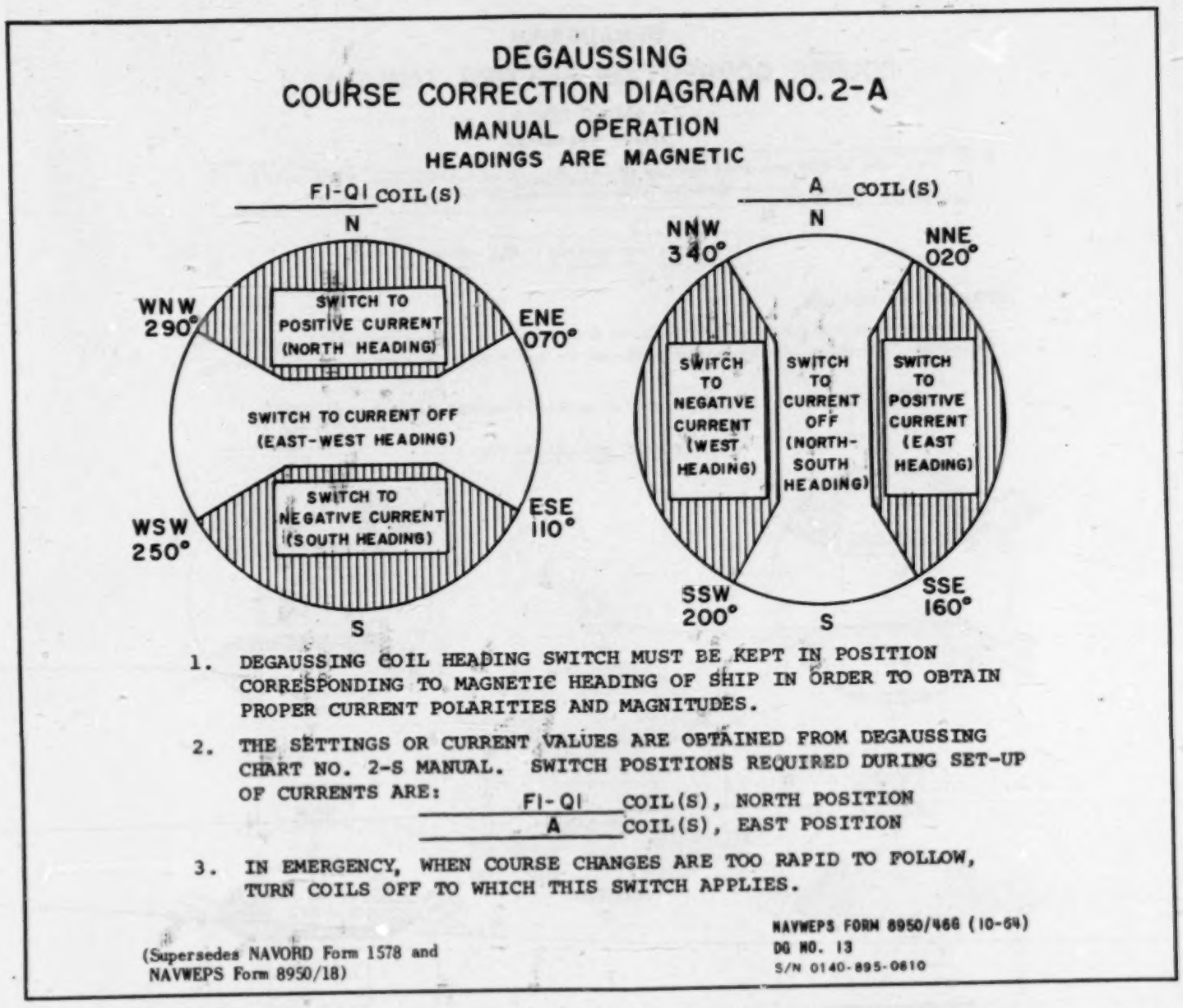

69.17G

Figure 12-13.—Degaussing course correction setting diagram No. 2.

This panel includes ammeters or polarity indicator lights for all coils and rheostats (rheostat pushbuttons); and reversing switches for the F, Q, and L coils or reversing switches for the FI-QI and A coils.

Telephone communications are provided between the remote and main panels. When the degaussing system is to be energized, the remote position (pilot house) may call the main degaussing switchboard station and have all currents set to the values called for in the degaussing folder. The remote position will then continue to maintain the currents in the FI-QI and A coils according to the ships location and heading changes.

MOTOR-GENERATOR INSTALLATION

The degaussing coils in motor-generator installations are energized by closing the disconnect switch to the motors with the generator field rheostats set for the maximum resistance, and operating the pushbutton to start the motor. The degaussing switchboard is usually located

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DEGAUSSING
COURSE CORRECTION SETTING TABLE Nº I.
(F AND Q COILS)
MANUAL OPERATION

* ~~This Table is to be used ONLY when the ship is in the _____ region shown on Degaussing Chart Nº 1. Separate Tables are provided for the other two regions.~~

* This Table is to be used in ALL regions.

INSTRUCTIONS FOR USE:

By reference to Degaussing Chart Nº 2, select the circle diagrams below which correspond to the H zone for the position of the ship. The actual settings to be used are then found in the appropriate course sectors.

SETTINGS BELOW ARE IN ~~AMPERES~~ / ~~AMPERE TURNS~~ *

HEADINGS ARE MAGNETIC

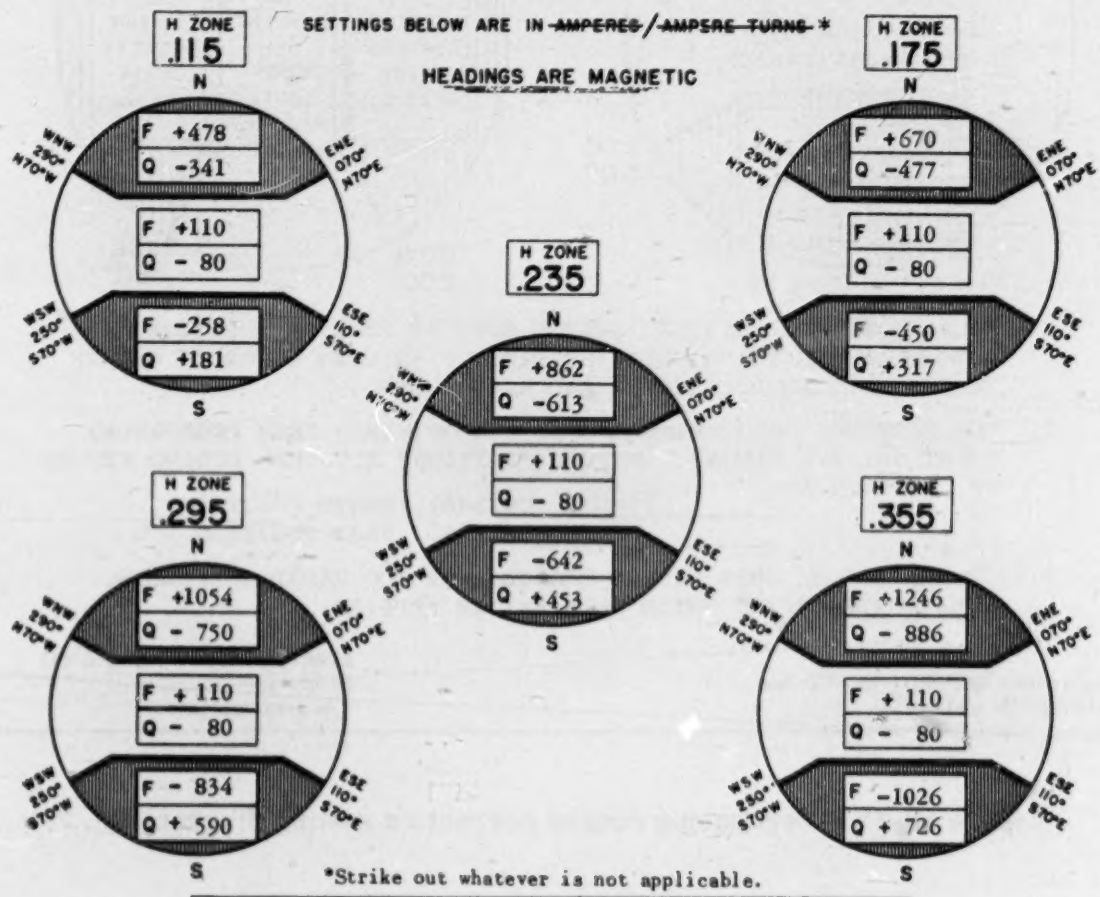

*Strike out whatever is not applicable.

NAME OF SHIP	NATION
USS - -	U.S.
PORT OF ISSUE	DATE
USN DEG. FACILITY - -	21 Aug 1965
	SIGNATURE OF ISSUING OFFICER
	Herbert Wilson

(Supersedes NAVORD FORM 1574 and NAVWEPS FORM 8950/14)

NAVWEPS FORM 8950/46D (10-64)
DG NO. 10
S/N 0140-895-0480
A-34023

Figure 12-14.—Degaussing course correction setting table No. 1. 69.17D

11[redacted]1-1

in, or in the vicinity of, the engineroom near the degaussing motor-generators. This switchboard includes ammeters, pushbuttons for starting the motors, and the motor-driven field rheostat for the generator. In many installations in which the motor-generators are not located together, a separate switchboard is provided for each group of motor-generators.

After the motor has started, the currents in the coils are set by the pushbuttons that control the motor-driven field rheostats for the generators. The pushbuttons are located on the remote control panel in the pilot house or chart house, or on the degaussing switchboard. Zero-center ammeters mounted above the pushbuttons are used to determine whether the positive or negative pushbutton should be operated to obtain the specified currents. The positive pushbutton will operate the motor-driven generator field rheostat to increase the current in the positive direction (decrease the current in the negative direction). Conversely, the negative pushbutton will operate the motor-driven rheostat to increase the current in the negative direction (decrease the current in the positive direction).

SECURING

Degaussing coils should be secured according to instructions in the Degaussing Folder for the installation concerned. To cancel any residual magnetism due to the degaussing current, most installations require one or more of the coils to be secured by reversals. The procedure for securing a degaussing coil by reversals is as follows: (1) Starting with the maximum current specified in the Degaussing Folder, reduce the current to zero then increase to the starting value in the reverse direction. (2) Reduce the current to zero and then increase to 3/4 value in the original direction. (3) Reduce the current to zero and then increase to 1/2 value in the reverse direction. (4) Reduce the current to zero and then increase to 1/4 value in the original direction. (5) Reduce the current to zero and then increase to 1/8 value in the reverse direction. (6) Reduce the current to zero and secure.

AUTOMATIC DEGAUSSING

Automatic degaussing equipment is now installed in all new construction ships which require the coil current to be changed when the ship's heading changes.

Most automatic degaussing equipment aboard navy ships provides automatic compensation for the induced magnetization due to changes in ship's heading only. Mine warfare ships, however, require installations which also provide automatic compensation for the induced magnetization caused by the ship's roll and pitch. A brief discussion of degaussing installations for mine warfare ships is included later in this chapter.

A block diagram of a type SM or SSM automatic degaussing control equipment for HEADING COMPENSATION only is illustrated in figure 12-16. A heading signal is obtained from the ship's gyrocompass system. For an L coil or an FI-QI coil, the type SM control equipment derives a signal that is proportional to the cosine of the ship's heading. This signal is amplified and fed to the appropriate power supply so that its output is proportional to the cosine of the ship's heading. This is the variation needed to compensate for changes in the longitudinal induced magnetization caused by changes in the ship's heading. For the A coil, the type SM control equipment maintains the coil current proportional to the sine of the ship's heading.

A block diagram of a type GM automatic degaussing control equipment, installed on minesweepers for HEADING, PITCH, and ROLL COMPENSATION, is illustrated in figure 12-17. The additional signals needed to compensate for pitch and roll are obtained from the gyrocompass stabilizer system and fed to the automatic degaussing control equipment. A computer element in the control equipment utilizes the heading signal and the pitch and roll signals, and causes the degaussing coil currents to vary so that they compensate for changes in the ship's induced magnetism resulting from changes in heading, pitch, and roll of the ship.

All types of gyrocompass-controlled automatic degaussing control equipment require manual settings for magnetic latitude and magnetic variation. Also, all types of degaussing control equipment are equipped with manual controls for use if the automatic controls should become inoperative.

DEGAUSSING FOR MINE WARFARE SHIPS

The extremely low field requirements for mine warfare ships necessitates special ship design, proper control and stowage of magnetic materials, and degaussing protection that maintains accurately regulated currents at any angle of roll, pitch, and heading.

INPUT CATHODE FOLLOWER.—The input cathode-follower circuit is for the north and south d-c amplifiers, V902 and V903, respectively. The input cathode follower, V905, is a duotriode. The north and south reference voltages from the ground stabilization computer vary at the rate of 1 volt per mile in relation to the movement of the aircraft with respect to a point on the ground. These varying voltages are applied, through voltage dividers comprised of resistors R15 and R293 and R11 with R297, to the appropriate grids of V905. These changes in voltage slew (move) the origin of the sweeps, which represent the position of the aircraft, in the same direction in which the aircraft is flying and a distance indicative of its change in position measured in miles.

The other slewing voltages are applied through similar voltage dividers, composed of resistors R295, with R293 and R300 with R297, to the grids of V905. These voltages are supplied from the control box by manually adjusting the N/S slew control (R1 and R2) and are combined with the slewing voltage from the ground stabilization computer at the grids of V905. The automatic function of the slewing voltages from the ground stabilization computer is not affected; but by means of the local slewing voltages, the origin of the sweeps can be moved in any direction, so that the desired portion of the sweep can be brought into view and the target centered on the indicator. By means of relays and different voltage dividers in the input to V905, the indicator sweep range may be changed without affecting the ground stabilized presentation on the indicator. With the proper resistance values selected, after the target has been slewed to the center of the indicator, it will remain there even though the range is changed.

By means of slew switch S1, the manual slewing voltages can be cut in or out of the circuit; and with the ground GPI switch S2, the slewing voltages from the ground stabilization computer can be cut in or out. Therefore, by opening or closing these switches separately or together, either or both slewing voltages can be cut in or out of the circuit. If both are cut out of the circuit by opening both switches, the voltages on the grids of V905 are balanced. This gives a PPI presentation in which the start of the sweep is centered on the indicator screen.

The two silicon diodes, CR1 and CR2, are employed as limiters to prevent either grid of V905 from going more positive than 7.8 volts. This avoids the possibility of damaging this tube, the d-c amplifier, and other tubes in associated circuits. A voltage divider comprised of R921 and R920 maintains the negative sides of the silicon diodes (CR1 and CR2) at a positive potential of 7.8 volts.

The cathodes of V905 are connected to -150 volts through resistors R187 with R188 and R189 with R190. The outputs from the cathode followers are taken from R187 and R189.

D-C AMPLIFIER.—With each input cathode follower are associated two d-c amplifiers. A pentode type tube is used in each d-c amplifier stage. The amplifier fed by the north section of the input cathode follower, V905, amplifies the north d-c input slewing voltage and provides a north-slewing voltage for the indicator. The north d-c amplifiers and its complement, the south d-c amplifier, effectively from a push-pull circuit which affects the north-south sweep in the indicator. Since all of these amplifiers are identical, only one will be discussed.

The north output of the input cathode follower is applied through variable resistor R187 and fixed resistor R184 to the grid of the d-c amplifier tube, V902. The variable resistor N ZERO SET is adjusted, with all input slewing voltages at zero (slew switch off and GPI switch off), until the north d-c amplifier is operating at the proper quiescent level for centered presentation. Resistors R170, R172, R174, and R176 form a voltage-divider network between a +150 volts d-c and a -150 volts d-c. The N/S gain control, R178A, adjusts the d-c feedback from the output cathode follower through the series resistors R172, R174, R178A, and R179 to the grid of the d-c amplifier, V902, thereby controlling the gain of the amplifier. This gain control is ganged to a similar control, R178B, for the south d-c amplifier, V903, so that the gain of these complementary stages is always the same. Variable resistor R172, N OUTPUT, adjusts the output voltage to obtain the proper bias on the sweep driver stages in the indicator. This bias voltage can be measured at test jack C1 and in a static state (no slew applied) is -19 volts d-c.

OUTPUT CATHODE FOLLOWER.—Since the output of the d-c amplifier is applied to a low-impedance input in the sweep amplifier, the d-c amplifier is coupled through a cathode-follower stage. A duotriode tube is used, and each section functions as a cathode follower for one d-c amplifier. The output of the north d-c

1164

DEGAUSSING

COURSE CORRECTION SETTING TABLE №2.

(F, Q, AND A COILS)

MANUAL OPERATION

* This Table is to be used ONLY when the ship is in the NORTHERN region shown on Degaussing Chart №1. Separate Tables are provided for the other two regions.

* ~~This Table is to be used in ALL regions.~~

INSTRUCTIONS FOR USE:

By reference to Degaussing Chart №2 select the circle diagrams below which correspond to the H zone for the position of the ship. The actual settings to be used are then found in the appropriate course sectors.

SETTINGS BELOW ARE IN AMPERES /~~AMPERE TURNS~~ *

HEADINGS ARE MAGNETIC

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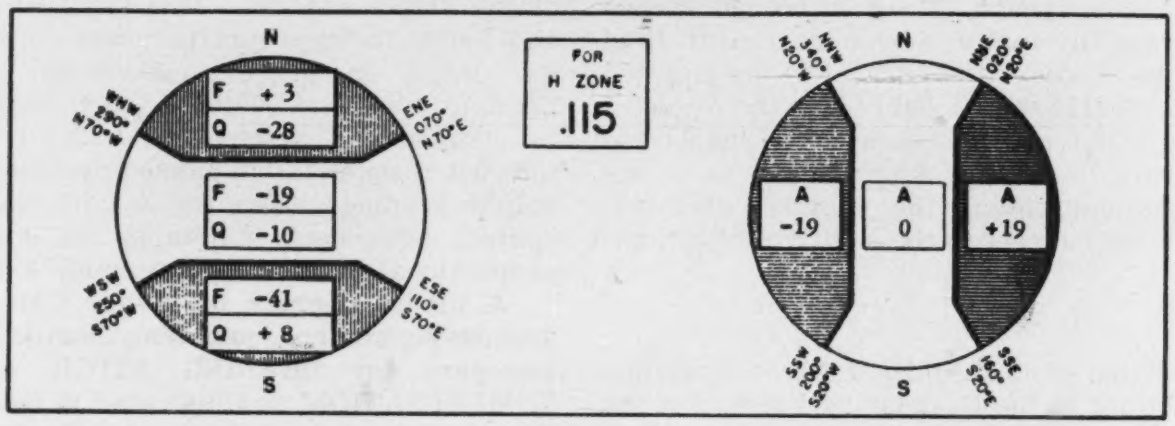

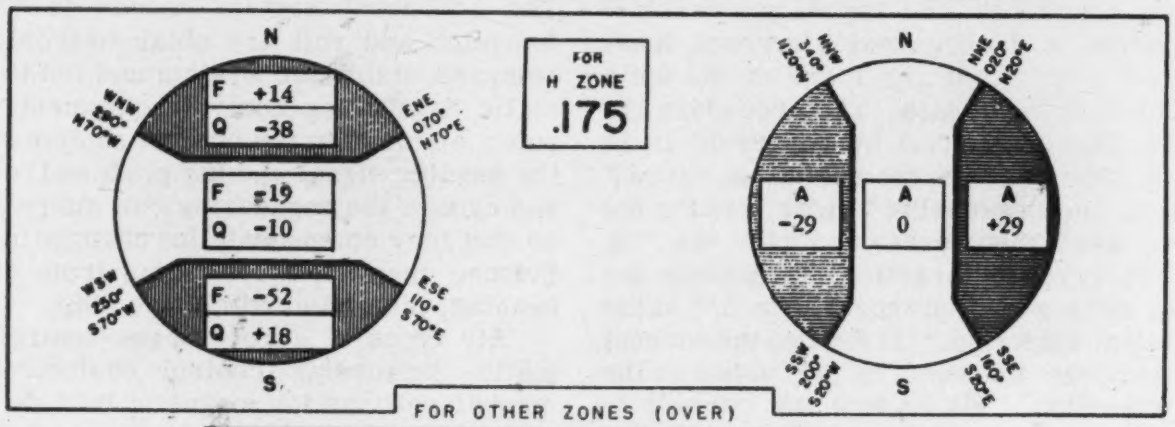

FOR OTHER ZONES (OVER)

NAME OF SHIP	NATION
USS - -	U.S.
PORT OF ISSUE	DATE
USN DEG. FACILITY - -	18 Oct 1965
	SIGNATURE OF ISSUING OFFICER
	Herbert Wilson

(Supersedes NAVORD FORM 1575 and NAVWEPS FORM 8950/15)

**Strike out whatever is not applicable.*

NAVWEPS FORM 8950/46E (10-64)
DG NO. 11
S/N 0140-895-0490

Figure 12-15A.—Degaussing course correction setting table No. 2. (Front) 69.17E

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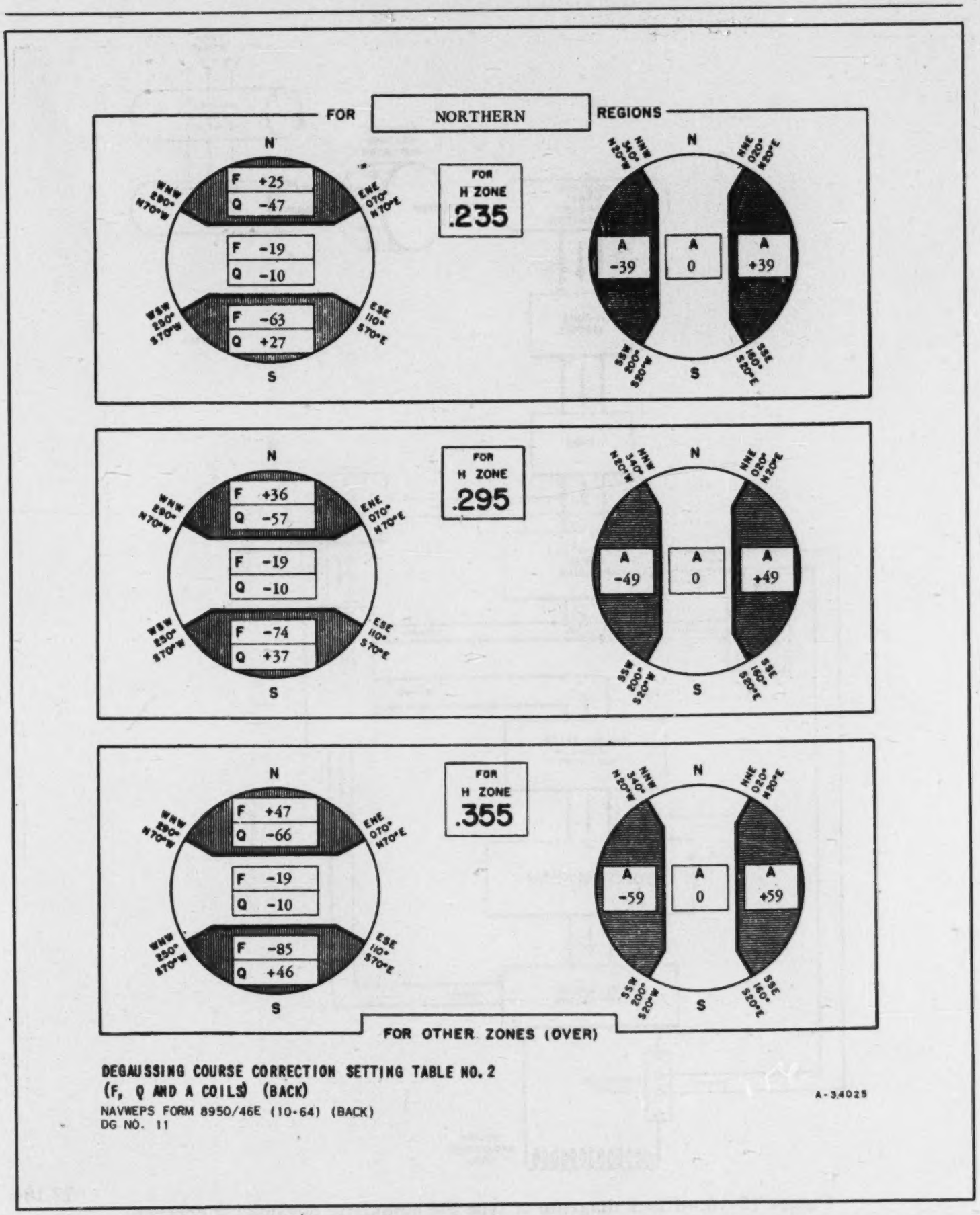

Figure 12-15B.—Degaussing course correction setting table No. 2. (Back) 69.17E

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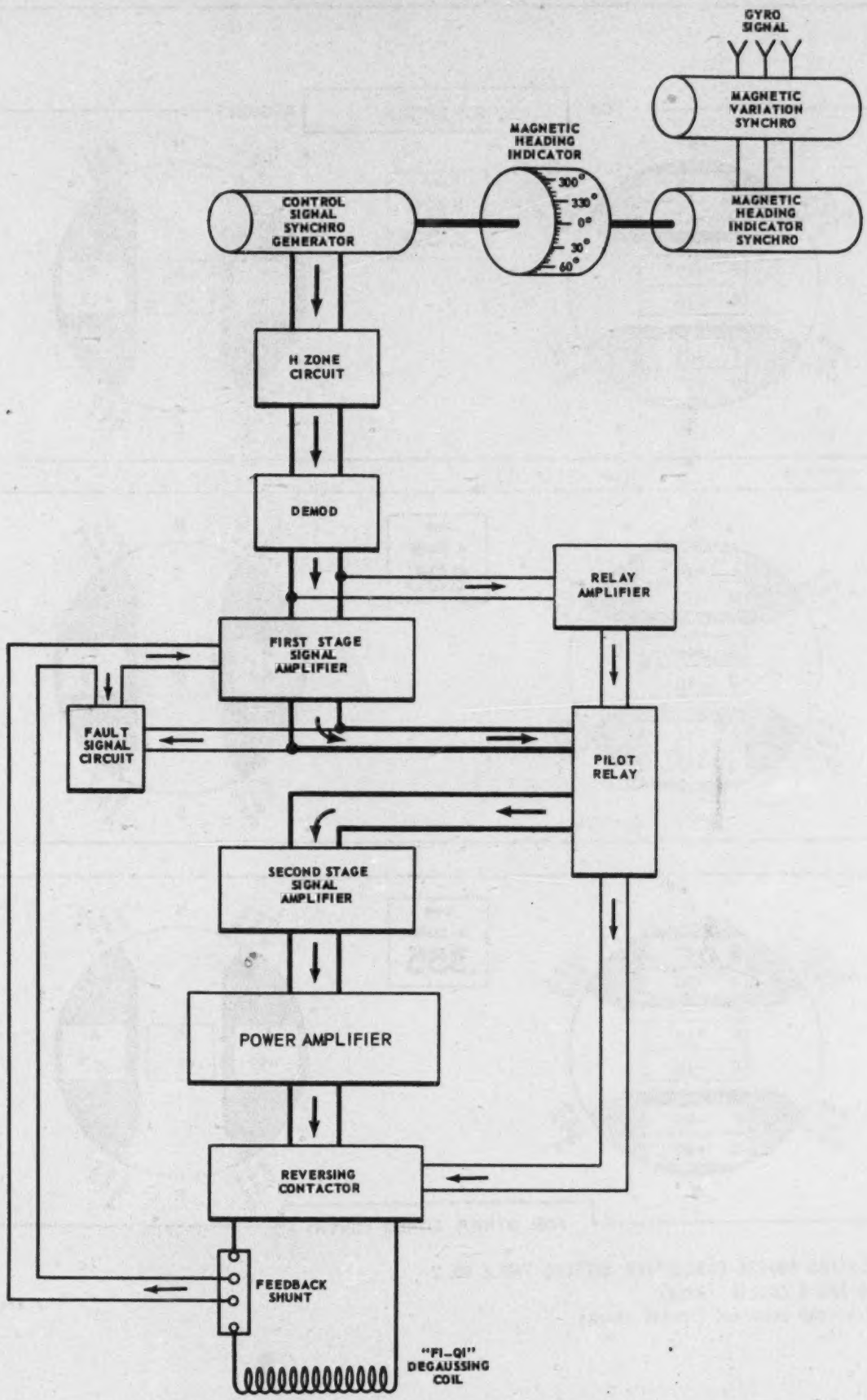

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Figure 12-16.—Block diagram of type SM automatic degaussing control equipment for heading compensation.

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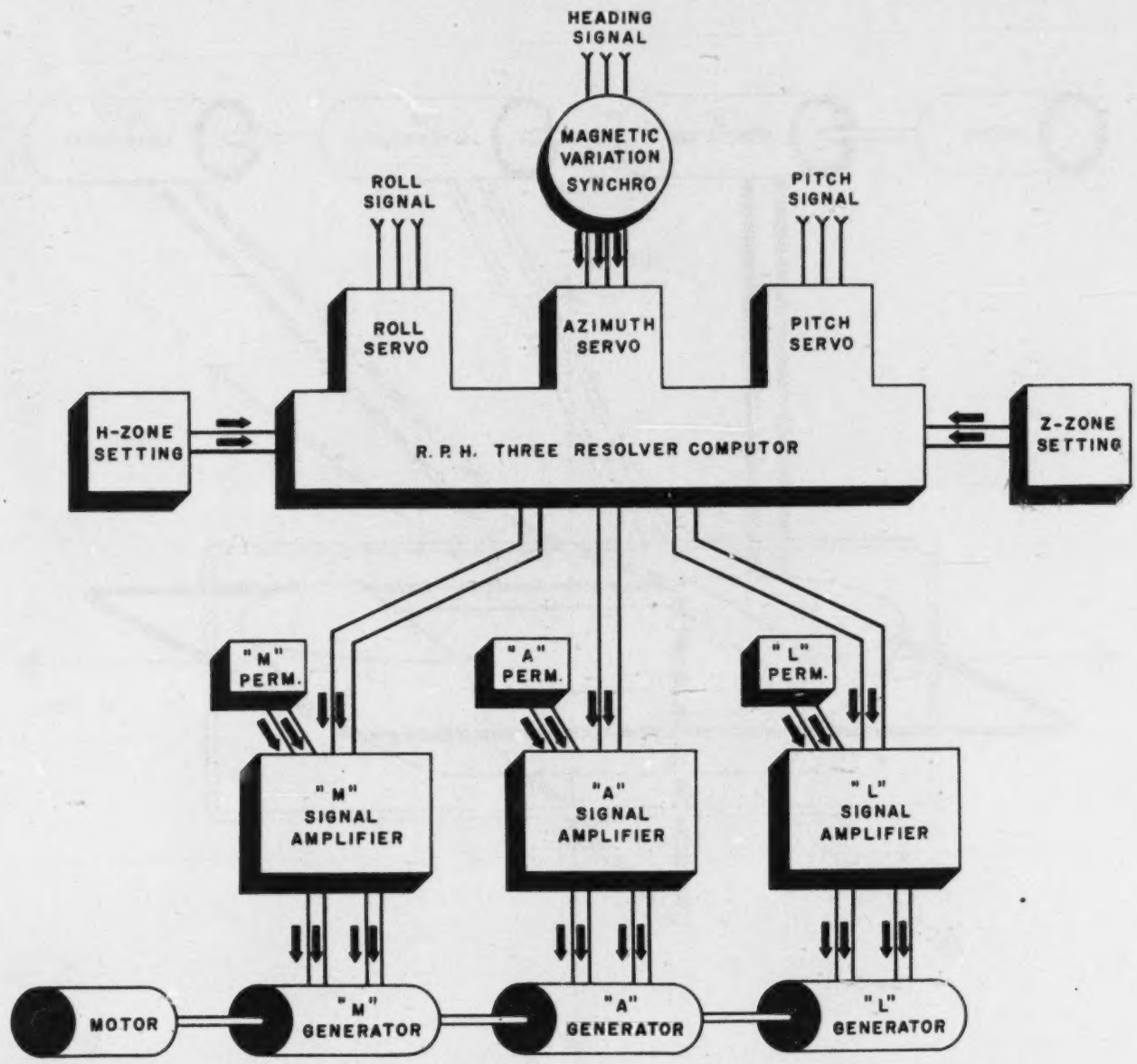

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Figure 12-17.—Block diagram of type GM automatic degaussing control equipment for heading pitch, and roll compensation.

Four basic types of degaussing coils are installed in mine warfare ships (fig. 12-18). The M, or main coil, is located in a horizontal plane and compensates for the induced vertical magnetism of the ship. The A, or athwartship coil, is located in a vertical fore and aft plane and compensates for the induced athwartship magnetism of the ship. The L, or longitudinal coil, is located in a vertical athwartship plane and compensates for the induced longitudinal magnetism of the ship.

Each M, A, and L coil has an associated and identically located P, or perm coil (not shown) which compensates for the permanent portion of the ship's magnetism.

Mine warfare ships were initially provided with gyro controlled automatic degaussing control systems. A magnetometer controlled system has now been developed which is replacing the gyro controlled systems.

GEM-2 System

The GEM-2 automatic degaussing control system is a magnetometer controlled system that is replacing the gyro controlled GM-2

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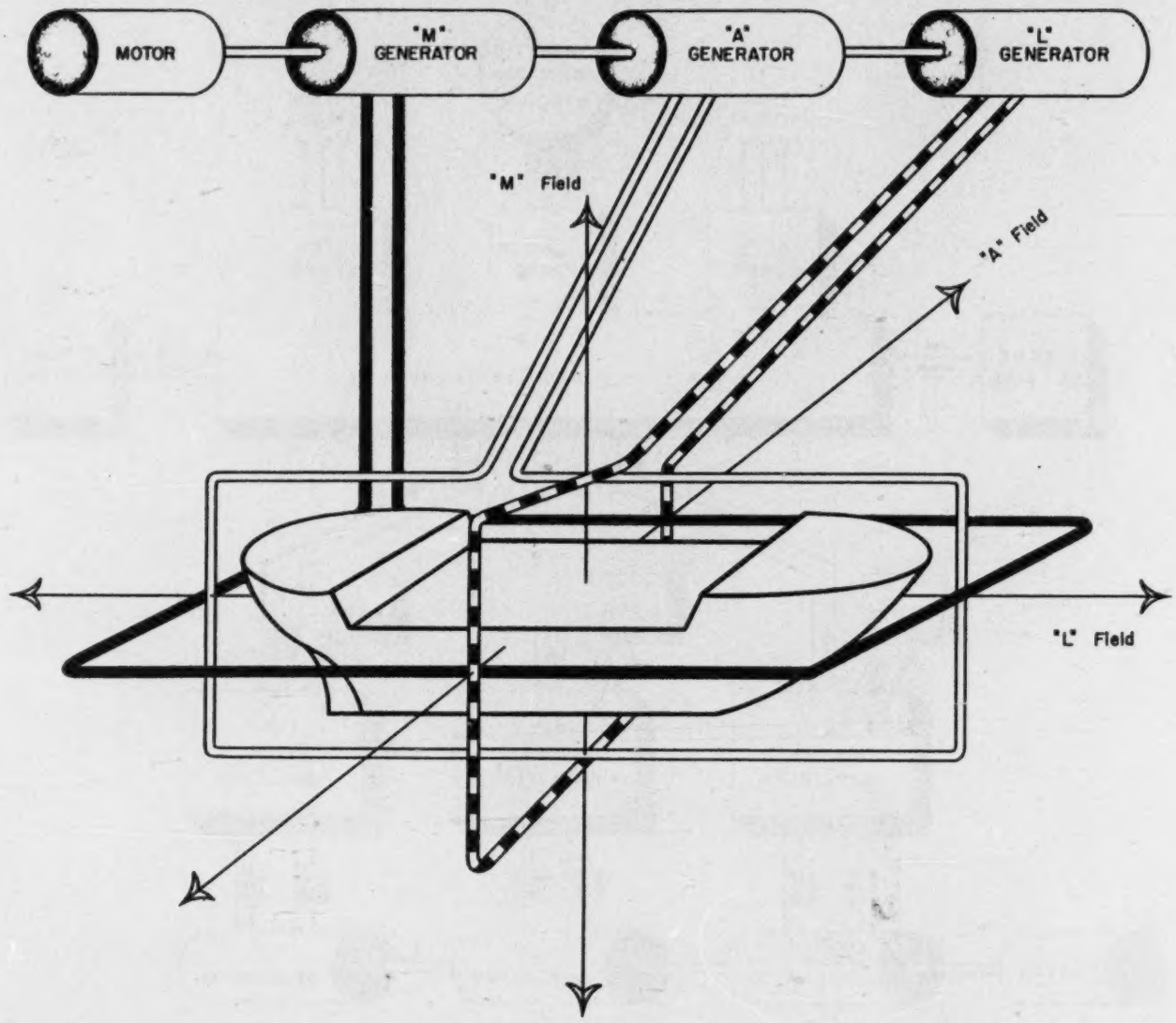

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Figure 12-18.—M, A, and L degaussing coils.

system used on coastal minesweeper ships (MSC) and coastal minehunter ships (MHC).

The change from GM-2 to GEM-2 is a conversion rather than a complete system replacement. The GM-2 system (fig. 12-17) did not always provide continuous satisfactory degaussing protection. Operator errors in making proper H-zone, Z-zone, and magnetic variation settings often gave unsatisfactory compensation. Mechanical faults in the computer, stabilizer or gyro could also contribute to unsatisfactory protection. The GEM-2 system (fig. 12-19) removes these objectionable features. The possibility of operator error is reduced considerably; after the ship is calibrated at a degaussing range, the controls are locked in place and the operator only turns the equipment on and off.

The new system also removes the mechanical features that were subject to failure. The advantages of the new system are clear when figures 12-17 and 12-19 are compared.

MAGNETOMETER PROBE.—The magnetometer probe assembly (fig. 12-20) contains three mutually perpendicular elements which

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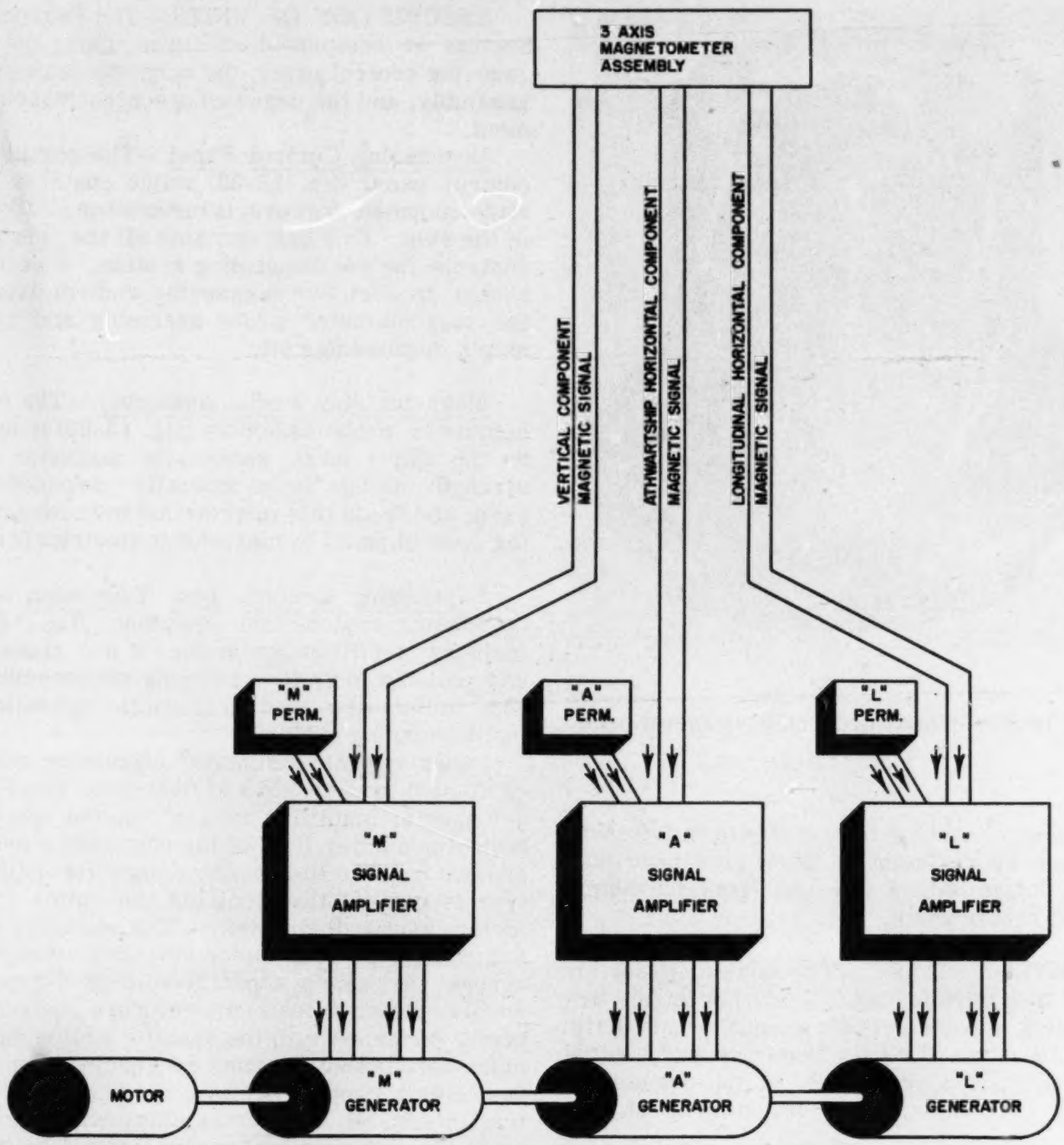

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Figure 12-19.—Block diagram of GEM-2 automatic degaussing control system.

furnish signals proportional to the earth's field to the M, A, and L channel signal amplifiers.

MAGNETOMETER SIGNAL AMPLIFIER.—The signal amplifiers convert the low power level signal received from the sensing elements of the magnetometer to signals appropriate for driving the two stages of magnetic amplifiers for each automatic channel. These amplifiers are of the transistor type and are contained on printed circuit boards. All subassemblies are plug-in type printed circuit boards. Go-no-Go testing facilities are incorporated in the equipment so that the cause of a failure can be found in a manner similar to the operation of a simple tube tester.

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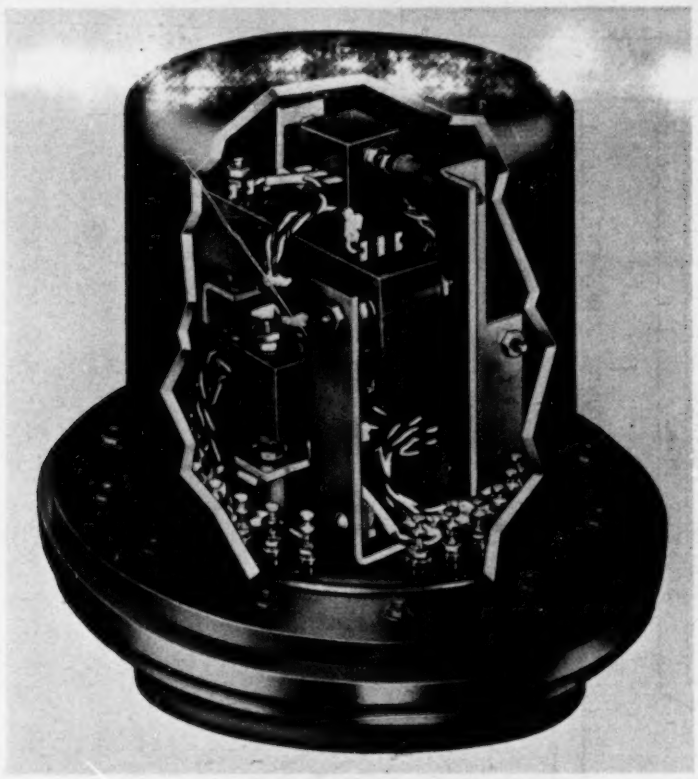

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Figure 12-20.—Three-axis magnetometer probe assembly.

The equipment can be restored to satisfactory operation by replacing a faulty plug-in printed circuit board with a new one from the ship's onboard repair parts.

CONTROL PANEL.—The control panel for the GEM-2 system (fig. 12-21) shows the arrangement and controls for manual or automatic operation of the system. Under manual control the magnitude and polarity of the degaussing current is controlled by adjustments on this panel.

EMS Systems

Automatic electronic degaussing systems designated EMS have been developed and installed on various mine warfare ships of the MSI, MSC, and MSO classes.

All the EMS systems are magnetometer controlled. These systems utilize transistors with printed circuits and static type power supplies. The following coverage is on the EMS-4 system which is being installed on all MSO-421 class minesweepers.

DESCRIPTION OF UNITS.—The Degaussing System is comprised of three units: the degaussing control panel, the magnetometer probe assembly, and the degaussing control test equipment.

Degaussing Control Panel.—The degaussing control panel (fig. 12-22) which contains four slide-mounted drawers, is mounted on a bulkhead in the ship. This unit contains all the operating controls for the degaussing system. Electrical cables connect the degaussing control panel to the magnetometer probe assembly and to the ship's degaussing coils.

Magnetometer Probe Assembly.—The magnetometer probe assembly (fig. 12-22) mounted on the ship's mast, senses the magnetic field strength along three mutually perpendicular axes, and feeds this information to the degaussing control panel by means of an electrical cable.

Degaussing Control Test Equipment.—The degaussing control test equipment (fig. 12-22) includes a milligauss meter, a d-c ammeter, and pull-out tools for removing subassemblies. The meters are used to check the operation of the degaussing system.

Other types of automatic degaussing control equipment are the FM and RM types. The FM is a magnetic amplifier type of control that controls the exciter field of the degaussing motor-generator. The RM is also a magnetic amplifier type of control that controls the motor of the motor-operated rheostat. The rheostat is in series with the degaussing coil that is connected across the ship's constant-voltage d-c power supply. Refer to the manufacturers' instruction books furnished with the specific equipment for more detailed information concerning automatic degaussing control equipment. Also, the Electrician's Mates 1 and C training course contains additional information on automatic degaussing control equipment.

COMPASS COMPENSATION

Degaussing coils (either manual or automatic types) must produce large magnetic fields in order to provide satisfactory degaussing. Unless neutralized in the vicinity of the magnetic compass, these fields may be of sufficient magnitude to make the compass useless for navigation. The purpose of compass compensating coils is to set up a "compensating" magnetic

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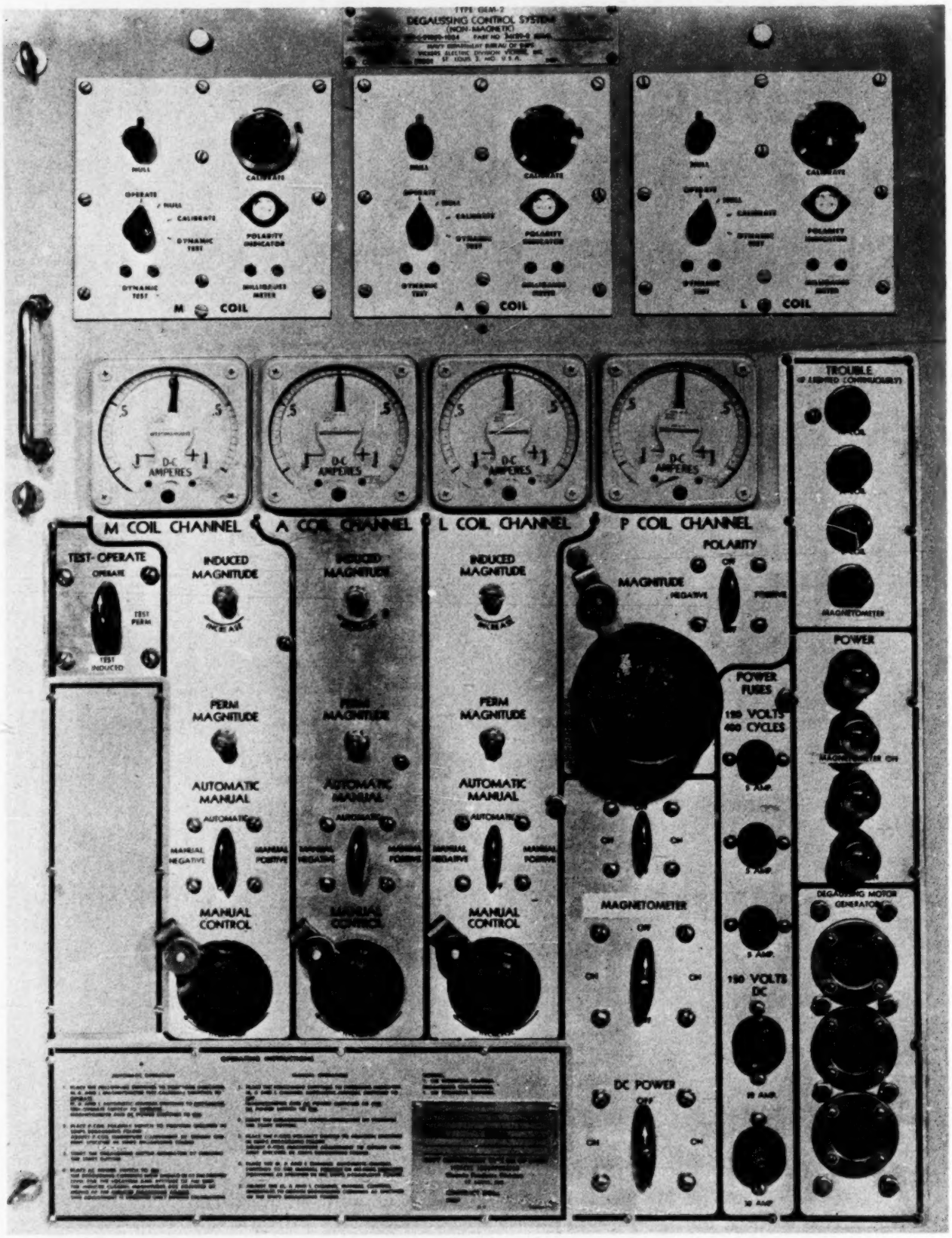

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Figure 12-21.—Front panel of control unit for GEM-2 automatic degaussing control system.

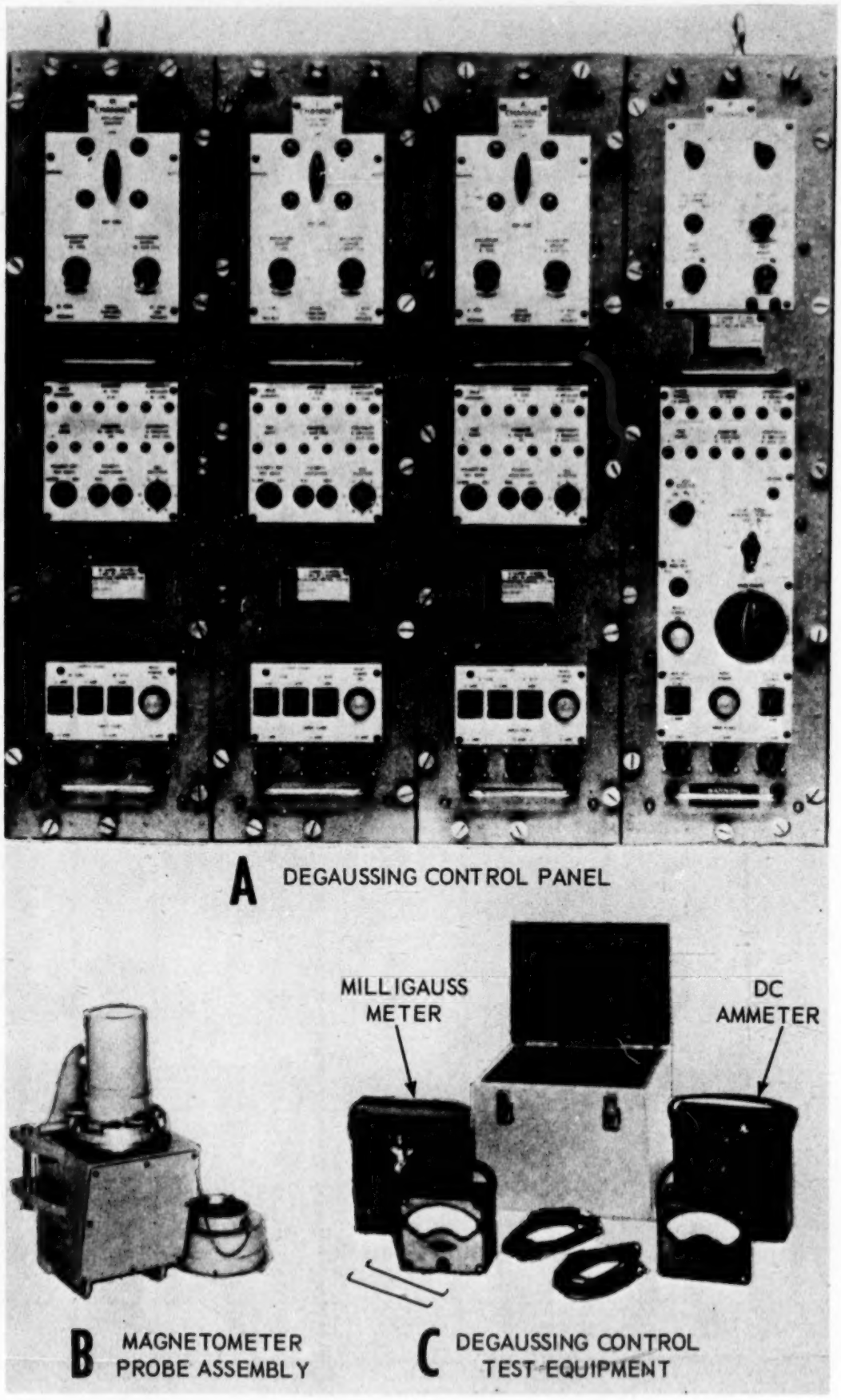

Figure 12-22.—Automatic electronic degaussing system, type EMS-4. 27.284

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field which is equal and opposite to the degaussing coil field in the immediate vicinity of the compass.

Almost all degaussing coils create a vertical component of magnetic field at the compass. A vertical component at the compass causes the compass to deviate when the ship heels even though it will usually cause no deviation when the ship is on an even keel. To compensate for the vertical component of magnetic field caused by the degaussing coils, a compass compensating coil, called the heeling coil, is used. The heeling coil is placed in a horizontal plane around the binnacle usually at the level of the magnetic compass needle, with its vertical axis passing through the center of the compass. A heeling coil is used in all types of compass compensating coil assemblies.

In addition to the vertical component of magnetic field, degaussing coils also create a horizontal component of magnetic field at the compass. The horizontal component of magnetic field at the compass causes compass deviations whether or not the ship is on an even keel. The "deviation due to degaussing" on any heading can be obtained by subtracting the magnetic compass reading with degaussing "off" from the magnetic compass reading with degaussing "on". The horizontal component of magnetic field is compensated by two mutually perpendicular vertical coils or pairs of coils.

The magnitude of the magnetic field produced at the compass by a degaussing coil varies with the degaussing coil current. To compensate this field, the magnetic field produced by the compass compensating coils must also vary in the same way. This is arranged by connecting the equipment so that the compass compensating coil current is always the same fraction of the degaussing coil current. When this fraction is so adjusted that the magnetic fields produced by the degaussing coil and the compass compensating coil are equal and opposite, the balance between them is maintained no matter how the degaussing coil current varies. Doubling the degaussing coil current, for example, would double the magnetic field produced at the compass by the degaussing coil, and would also double the field produced by the compass compensating coils used to compensate the degaussing coil.

The supply used for the compass compensating coils is usually the voltage drop across a fixed resistor connected in series with the degaussing coil or the voltage drop across a number of turns of the degaussing coil. This voltage is proportional to the degaussing coil current, hence, the current which the supply sends through the compass compensating coils is also proportional to the degaussing coil current. This is the condition which must be satisfied to insure that compass compensation will not be disturbed by a change in degaussing coil current.

Compass compensating coils are usually installed by the personnel at a naval shipyard or degaussing activity, not by ship's forces. If it is ever necessary for ship's forces to install compass compensating coils, the installation should be made in accordance with the instruction manual furnished with the coils.

Compasses are usually compensated for degaussing by personnel at a naval shipyard or a degaussing activity. At times, however, ship's forces may have to compensate compasses after repairs to the compass compensating coil installation. For this reason, instructions on compass compensation listed in BuShips Technical Manual chapter 9810 Section III, should be followed.

Basically, compass compensation for degaussing consists of adjusting the resistors in the control boxes so that the compass points in the same direction irrespective of whether the degaussing coils are turned on or off.

The general term "compensation" includes the three following distinct steps or procedures:

(a) A preliminary or "dockside" compensation.

(b) A "final" compensation.

(c) A swing for deviations.

Each of these three steps is described in BuShips Technical Manual chapter 9810.

MAINTENANCE

The degaussing installation should be carefully maintained particularly to prevent deterioration resulting from moisture gradually entering the cables. Since the degaussing system consists of electrical cables, rheostats, ammeters, connection boxes, motor-generator sets, and costly automatic control equipment it must be maintained in conformity with the instruction for the maintenance of electrical equipment given in applicable chapters of the NavShips Technical Manual (Chapters 9600 and 9810) and applicable technical manuals for the equipment installed.

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amplifier, V902, is applied through resistors R181 and R166 to the grid of one section of the cathode-follower tube V901, and the output of the complementary south d-c amplifier is applied to the other section of V901. The resistor network, composed of resistors R183, R181, and R168, forms a voltage divider to obtain the proper plate voltage for the d-c amplifier and, together with resistor R166, determines a fixed bias for the output cathode follower. Capacitor C129 provides a low-impedance path for any a-c ripple which may be present from the cathode of the output cathode follower back to the grid of the d-c amplifier. This feedback greatly attenuates any a-c ripple and prevents "jitter" of the presentation on the indicator.

The output is taken from the cathode of V901 (north), and is used to establish the bias on the north sweep driver. Similar outputs from the other output d-c amplifiers establishes the bias on the south, east, and west sweep drivers for the indicator. By varying these bias voltages, the start of the sweep on the indicator can be changed as desired, or as dictated by the position of the aircraft.

OUTPUT LIMITER.—In order to limit, at the proper peak and minimum values, the slewing bias from the output cathode follower, two parallel diode limiters are used. Four silicon diodes are employed with two in the north d-c amplifier circuit and two in the south d-c amplifier circuit. A potential of approximately -9 volts is applied to the negative sides of CR5 and CR6 by a voltage divider. A potential of approximately -29 volts is applied to the positive sides of CR3 and CR4 by another voltage divider. The double limiting provided by these circuits limits the available slew range to approximately 2 radii at the output and, in addition, protects the sweep drivers in the indicator from being overdriven by limiting their bias to a range from -9 volts d.c. to a -29 volts d.c. The output limiters, along with a maximum local slewing voltage of ±50 volts and a maximum ground stabilization slewing voltage of ±150 volts, determine the overall slewing ranges of the indicator.

SWEEP DRIVER AND CLAMPER.—There are four identical sweep-driver circuits in the indicator. Each sweep-driver circuit affects one phase of the sweep; that is, either north, south, east, or west. The sweep voltages from the sweep synchro in the antenna are passed directly into the indicator. These voltages are applied to the sweep-driver stages for amplification prior to being coupled to the appropriate deflection coil of the indicator. Since all the circuits are identical, only one circuit will be discussed.

A phase of the sweep input is fed through C101 to the "A" cathode and the "B" plate of V101, a duotriode operated as a two-way clamper, and through C104 to the grid of the sweep driver, V103. The negative-going clamp-gate square wave is applied to the grids of the duo-clamper. The duration of the negative half cycle of this square wave is equal in time to the duration of the sweep sawtooth waveform. The slew voltage is applied to the "A" plate and the "B" cathode of V101. Since the clamp-gate and sweep waveforms are equal in duration, application of the clamp-gate waveform to the clamp tube, V101, cuts it off and allows the sweep voltage waveform to be felt on the grid of the sweep driver, V103, and varies its conduction. During the blanking time of the sweep, the clamp action (known as synchronized clamping) is such that the grid of the sweep driver is clamped to a desired slew potential, to insure the proper starting point of the sweep. This desired slew potential determines the quiescent plate current in the driver tube, and thus controls the starting point of the sweep seen on the indicator. In this manner, the origin of the sweep can be moved or slewed on the indicator to view any portion of the sweep. If the bias on the sweep driver is made less negative, more current will flow through its associated section of the yoke. Therefore, the origin will move in the direction and distance represented by the amplitude of the output of the sweep driver; R101 is the N/S centering adjustment for the indicator.

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Preventive Maintenance

When the system is not in normal use, all coils should be energized at least once a week to the maximum current specified in the Degaussing Folder and operated for at least four hours with the current in one direction. Then reduce the current to zero and energize the coils momentarily with maximum current in the opposite direction.

Check each degaussing coil for grounds by insulation resistance measurements using a 500-volt megger. When the source of supply for degaussing coils is from rectifiers, the rectifiers must be disconnected prior to using a 500-volt megger on the degaussing coils to prevent damage to the rectifiers. These measurements should always be made with the same degaussing equipment connected in the circuit and as closely as possible under similar conditions of temperature and humidity. The date and reading of the insulation resistance to ground should be recorded each week on the Ship's Force Degaussing Maintenance Record in the Degaussing Folder. These measurements should be taken between the coil disconnect switch and ground. In the F, Q, and A or I, P, and A coils that have a reversing switch on the coil side of the disconnect switch, the measurement should be made with the reversing switch in the CLOSED position. Also, this measurement should be made just before the weekly energizing of the coils so that the comparative readings are obtained under similar conditions. By comparing these weekly readings it is possible to detect abnormal decreases in resistance and take the necessary corrective action before failure occurs. When abnormal decreases are indicated the various components of the circuit should be isolated and the insulation resistances checked individually to determine the cause of the low reading.

The connection boxes may accumulate considerable amounts of water due to condensation and leakage through improperly seated gaskets. The moist atmosphere in the box will gradually force moisture into the cable ends and reduce the insulation resistance. If this condition is not checked in time, the cable may be ruined and require replacement. Therefore, remove the connection and through-box drain plugs once a month to allow any accumulated water to run out. The date that each box is drained should be recorded on the Ship's Force Degaussing Maintenance Record (NavShips Form 1009) in the Degaussing Folder. Boxes that have abnormal accumulations of water should be opened, dried out, and the gaskets checked and replaced if necessary.

Remove corrosion on rheostat contact buttons with fine sandpaper and coat the buttons lightly with a graphite lubricant. Remove accumulations of dirt and dust from automatic degaussing control equipment to facilitate the natural flow of air around the components, and thus eliminate the possibility of overheating. Use a vacuum cleaner or bellows; do not use compressed air.

The maintenance requirements for manual degaussing systems are not as extensive as the automatic degaussing systems. Figure 12-23 shows a semi-annual maintenance requirement for cleaning and inspecting a manual degaussing switchboard. Automatic degaussing switchboards and remote panels require more frequent cleaning and inspection as shown by the quarterly maintenance requirement card (fig. 12-24) for the automatic degaussing switchboard and remote panel.

Observe the preventive maintenance requirements for automatic control equipment and motor-driven rheostats, as outlined in the applicable technical manual. Also, observe the maintenance of electrical equipment and electrical safety precautions, as required by Chapter 9600 of the NavShips Technical Manual.

Conduct weekly linearity checks, as required on ships equipped with automatic degaussing units in accordance with the applicable technical manual. Make weekly entries on the Ship's Force Degaussing Maintenance Record (NavShips 1009) in the Degaussing Folder.

Corrective Maintenance

Corrective maintenance consists principally of locating and eliminating grounds in the various coils, circuits, and components of a degaussing system.

Grounds in a degaussing conductor can be located by breaking the conductor into its component sections by opening connections at connection and through boxes, and testing each section of the conductor individually. Grounds in FEEDERS and control equipment CIRCUITS can be located by isolating the different components.

When making these tests, reconnect all ungrounded connectors to their terminals immediately after they have tested clear, to prevent misconnection later. To locate grounds in degaussing circuits, proceed as follows (observe

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SYSTEM	COMPONENT	M. R. NUMBER
Communications and Control	Degaussing Switchboard	EL-6 S-1
SUB-SYSTEM	**RELATED M. R.**	**RATES / M/H**
Countermeasure	None	EM3 1.5 EMFA 1.5

M. R. DESCRIPTION

1. Clean and inspect the switchboard.

TOTAL M/H 3.0

ELAPSED TIME: 1.5

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. De-energize the degaussing switchboard power supplies and tag "Out Of Service."

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Vacuum cleaner
2. Voltage tester
3. 500-volt Megger
4. 4/0 Sandpaper
5. Lint-free rags
6. 8" Normal duty screwdriver
7. Air-drying varnish
8. 1" Paintbrush
9. Flashlight
10. 1/2" Drive socket set
11. Grease, MIL-G-15793
12. Safety tags
13. Dusting brush
14. Oil, Symbol 2110 TH

PROCEDURE

Preliminary

a. De-energize the degaussing switchboard power supplies and tag "Out Of Service."

1. Clean and Inspect the Switchboard.
   a. Open or remove access covers as applicable.
   b. Test with voltage tester to ensure all power supplies are de-energized.
   c. Vacuum the switchboard and components. Use dusting brush to remove dirt from hard to reach areas.
   d. Wipe the switchboard and components with a rag to remove grease deposits.
   e. Grease the rheostat shaft bearings and oil the bearing points on switches. Wipe off excess lubricants.
   f. Inspect rheostat faces for evidence of overheating and pits. Clean with sandpaper as necessary.
   g. Inspect mechanical components to ensure freedom of all moving parts. (Cont'd on Page 2)

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LOCATION | DATE 1 October 1965

MAINTENANCE REQUIREMENTS CARD
OPNAV FORM 4700-1 (REV. 7/68)

Procedure (Cont'd)

h. Inspect resistors for evidence of overheating and cracks. Renew where necessary.
i. Inspect all electrical and mechanical fastenings and tighten loose connections. Use lockwashers or jamnuts where necessary to keep connections tight.

NOTE: Never apply varnish to a dirty surface. Avoid building up excess varnish.

j. Inspect degaussing cables and switchboard wiring for frayed insulation. Touch up with air-drying varnish.
k. Remove all tools and cleaning equipment from the switchboard.
l. Close or reinstall covers. Remove safety tags.
m. Set up switchboard for prescribed operation.

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Figure 12-23.—Semi-Annual maintenance requirement card.

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SYSTEM	COMPONENT	M.R. NUMBER
Communications and Control	Automatic Degaussing Switchboard	EL-6 Q-1
	MAINT. SIGNIFICANT NO.	
SUB-SYSTEM	RELATED M.R.	RATES / M/H
Countermeasure	None	EM2 1.5 EMFN 1.5

M.R. DESCRIPTION

1. Clean and inspect switchboard and switchboard equipment.
2. Clean and inspect remote panel

TOTAL M/H: 3.0
ELAPSED TIME: 1.5

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. De-energize degaussing switchboard and tag "Out Of Service."
3. Avoid prolonged contact with inhibited methyl chloroform. Provide adequate ventilation.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Vacuum cleaner
2. AN/PSM-4 Multimeter
3. Flashlight
4. 4",6",10" Screwdrivers
5. Clean dry rags
6. 1/4" Socket set
7. Insulated grounding cable
8. 3/8",7/10",9/16" Wrenches
9. Inhibited methyl chloroform
10. Safety tags

PROCEDURE

Preliminary

a. Obtain permission from Engineer Officer to secure the switchboard for inspection and cleaning.
b. Secure power at ship service switchboards and tag "Out Of Service."

1. Clean and Inspect Switchboard and Switchboard Equipment.

a. Open front panels and remove rear panels.
b. Test power transfer switch and interconnection block with the multimeter to ensure power is de-energized.
c. Connect insulated grounding cable to good ground and ground out all connections in switchboard.
d. Vacuum all components within the switchboard to remove dust and dirt.

WARNING: Avoid prolonged contact with inhibited methyl chloroform. Provide adequate ventilation.

e. Wipe any grease or oil deposits using a rag dampened with inhibited methyl chloroform.

(Cont'd on Page 2)

LOCATION

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Procedure (Cont'd)

f. Wipe cables and lead wires with clean dry rags.
g. Inspect and tighten all electrical and mechanical connections.
h. Ensure that mechanical moving parts are free to function.
i. Inspect rectifiers, porcelain faces, and resistor supports for cracks or burned spots. Renew as necessary.
j. Inspect switchboard and remove all tools, rags, and loose gear from switchboard.
k. Close front panels and reinstall rear panels.

2. Clean and Inspect Remote Panel.

a. Open remote panel door.
b. Vacuum meters, wiring, and interior to remove dirt and dust.
c. Tighten all connections.
d. Close panel door.
e. Energize degaussing system, set up for prescribed operation, and remove tags.
f. Notify Engineer Officer that switchboard is back in service.

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Figure 12-24.—Quarterly maintenance requirement card.

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precautions required when using a 500-volt megger on rectifier circuits):

1. Open the supply switch for the degaussing coil and close the reversing switch in either position.

2. Disconnect the feeder conductors from the degaussing coil at the feeder connection box.

3. Measure the insulation resistance to ground for each of the feeder conductors. If the insulation resistances are satisfactory in accordance with the manufacturer's technical manual and Chapter 9600 of NavShips Technical Manual, the feeder conductors and the equipment connected to them are clear of objectionable grounds. If the insulation resistance to ground is unsatisfactory for either one or more of the feeder conductors, proceed in accordance with the method for locating grounds in feeder conductors, as described in the instruction book accompanying the installation.

4. Measure the insulation resistance from the degaussing coil to ground. If the insulation resistance of the degaussing coil is satisfactory in accordance with Chapter 9600, NavShips Technical Manual, no further insulation tests on the coil are necessary.

DEGAUSSING DEFINITIONS

DEGAUSSING COIL.—One or more loops of degaussing cable; each loop encircles a different total area and is connected in series with other loops to form the required coil.

PARALLEL CIRCUIT.—An arrangement of conductors connected such as to provide two or more complete and independent electrical paths through a coil or loop and having a common source of supply.

COIL SECTION.—A section of a degaussing coil cable is the length of cable between two successive connections or through boxes.

PERMANENT MAGNETISM.—That portion of the magnetic field of a ship due to the earth's magnetic field and the orientation of the ship with respect to this field at the place where the ship was built, the material of which the ship was constructed, and other factors.

INDUCED MAGNETISM.—That portion of the magnetic field of a ship which is proportional to the strength of the earth's field through the ship.

EFFECTIVE TURNS.—The number of turns which are effective in producing a magnetic field under the ship. The difference between the number of series conductors in a coil or loop in which the current flows in a counterclockwise direction and the number of series conductors in which the current is flowing clockwise (called reverse turns) when viewed in accordance with polarity convention for each coil.

AMPERE TURNS.—The product of the current flowing through the coil or loop and the number of effective turns.

LOOP.—One or more turns of the conductors of a degaussing cable encircling a specific area. Different loops connected in series form a degaussing coil, for example: FI, FI2, QI, and QI2 loops are connected in series to form a FI-QI coil. In conserving cable, the conductors used for different loops encircling the same area may be contained in the same cable, for example, an FP and FI loop may both be contained in an F cable.

TURN.—One complete lap around the perimeter of a specified area by a coil or loop. One turn consists of one conductor or 2 or more conductors connected in parallel.

SERIES RESISTORS.—A resistor connected in series with the degaussing coil and used to limit the coil to its maximum design current. Where series resistors are used, the power for the compass compensating coil is usually provided by utilizing, in part, the voltage drop across this resistor and thereby varying the effect of the CC coils proportionally with the degaussing coil currents.

"THREE-COURSE EMERGENCY."—A manual three-step course correction, accomplished by a switch or switching system which provides for changes in the polarity and magnitude of the current in the FI-QI, L and A coils to compensate for changes in induced magnetism due to changes in the heading of the ship. For this purpose, three values of ampere turns are used. With an FI-QI coil, for example, zero ampere turns are used for headings in the general direction of magnetic East, a positive value for heading in the general direction of Magnetic North and a negative value of equal magnitude for heading in the general direction of magnetic South.

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REMOTE CONTROL PANEL.—This unit contains the necessary meters, electrical circuits, and controls to enable an operator to monitor all degaussing coil currents and to control manually by Three-Course Emergency the degaussing coil currents normally controlled automatically by the AUTODEG control unit.

AUTOMATIC DEGAUSSING — CONTROL UNIT.—This unit, by utilizing a signal from the ship's gyro compass system (heading only) or (heading, roll, and pitch) varies the ampere turns with changes in heading, or heading, roll, and pitch automatically. This equipment incorporates a "Three-Course Emergency" control and generally an additional manual control.

COMPASS COMPENSATING CONTROL BOX.—A watertight enclosure having a removable cover and containing three sets of control resistors. Each set of control resistors consists of fixed resistors, a variable resistor, and jumpers. By means of adjusting the control resistors, the compass compensating coil currents are regulated to give the desired compass compensation.

DEGAUSSING FOLDER.—The degaussing folder (NavWeps 8950/40) is an official ship log which contains instructions for operation of the degaussing system, degaussing charts and values for coil settings, Installation Certificates, and a log section showing all pertinent details of action taken on the ship's degaussing system for the information of degaussing authorities. The Degaussing Folder is issued to a ship by the Degaussing Facility which renders the initial magnetic treatment. Minesweepers use degaussing folder (NavWeps 8950/50) which is classified confidential when filled in.

INSTALLATION CERTIFICATES.—Installations Certificates are official NavWeps forms. Each form is divided into five parts; layout, schematic electrical diagram, circuit data, remarks, and certification. BuWeps Instruction 8950.2B of 19 April 1966, Degaussing Instructions, Forms, Records And Reporting Procedures, contains additional information and sample NavWeps forms.

ANCHOR WINDLASSES

Anchor windlasses are installed on ships primarily for handling and securing anchor and chain used for anchoring the ship. In addition, most windlasses are provided with capstans or gypsy heads for handling line and for mooring and warping operations.

Windlasses are located in the bow of the ship for handling the bow anchors.

Landing ships capable of beaching and retracting from the beach are provided with a separate anchor winch to handle the stern anchor used during these operations.

Anchor windlasses are designed to meet specified conditions as follows:

a. Hoist the anchor and chain from 60 fathoms depth at specified speed.
b. Hoist anchor and chain from 100 fathoms at no specified speed.
c. Stop and hold the anchor and chain by means of the wildcat brake.
d. Develop a specified rope speed on the capstan or gypsy head.
e. Withstand a static load on the capstan or gypsy head equal to the minimum breaking strength of the specified size of rope.

TYPES AND CLASSES

Two general types of windlasses are installed on naval ships. These are the horizontal shaft type and the vertical shaft type. These types are subdivided into classes depending on the power source. These classes include the following:

a. Electric hydraulic drive
b. Electric drive
c. Steam drive
d. Hand drive

The essential parts of a windlass, regardless of type and class, are the prime mover, gear transmission, chain wildcat and brake, head for handling line and control means.

Horizontal shaft windlasses are usually made as a self-contained unit with the windlass and prime mover mounted on the same bedplate.

Vertical shaft windlasses have the power source located below deck with only the wildcats and heads showing above the deck.

Electric-Hydraulic Windlasses

Electric-hydraulic windlasses are installed on ships having alternating current power supply. They are particularly adapted for anchor handling with its varying load conditions due to the wide range of speed and torque characteristics afforded. The hydraulic drive was developed to overcome all the operating and

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installation objections inherent with either steam or direct electric driven windlasses. The electric hydraulic windlass drive is similar to the electric drive except, instead of having the electric motor coupled direct to the reduction gearing, the power is transmitted from the electric motor through a variable stroke hydraulic transmission to obtain a wide range of output shaft speed.

The electric motor for a hydraulic windlass is usually a single-speed, squirrel-cage type. Electric control is required only for light starting duty as the motor is started under no load condition. The motor is direct coupled to the pump unit of the hydraulic transmission also known as the A-end. Fluid under pressure is delivered from the A-end to the hydraulic motor unit, B-end, through piping. The B-end is coupled to a suitable reduction gear which drives the windlass shaft.

Windlass speed is determined by varying the stroke of the pump A-end. This is done by control handwheels, located on the weather deck and at the pump. These handwheels also control the direction of rotation of the windlass and are suitably marked. The stroke at which the A-end is set determines the quantity of hydraulic fluid delivered to the B-end, which in turn determines the speed at which the B-end rotates as its displacement is constant.

The power plant of a typical hydraulic windlass installation for large combatant or auxiliary vessels consists of two units. Each unit comprises a constant-speed, horizontal, squirrel-cage, electric motor driving a variable stroke hydraulic pump through suitable reduction gearing. The electric motors are provided with magnetic brakes designed to hold 150 percent of the motor-rated torque and to set on loss of power to prevent the anchor dropping in case of power failure. The power units are arranged, port and starboard, in the windlass room. Normally the port unit drives the port windlass half, and the starboard unit, the starboard half. Transfer valves, however, are provided in the oil lines which, when properly set, allow the port power unit to operate the starboard windlass, and vice versa.

Electric Windlasses

Electric windlasses are powered by an electric motor which drives a wildcat(s) and head(s) direct through suitable reduction gearing. The electric power for the motor is either alternating current or direct current.

Destroyers are provided with a direct motor-driven windlass with a single wildcat mounted vertically and a working head located above the wildcat and keyed to the vertical shaft. This system is discussed in more detail later.

Cargo ships, transports, and auxiliary ships are generally provided with horizontal shaft, self-contained, electric drive windlasses with the motor and reduction gearing located on the windlass bed plate on the open deck. These windlasses have combined facilities for anchor handling and warping and consist of two declutchable wildcats on the main shaft and two warping heads on the shaft ends, all driven through suitable reduction gearing by the electric motor.

The motors are reversible, variable speed, 230-volt d-c and are provided with magnetic brakes to hold the load in case of power failure or under service conditions. Controls are of dual magnetic type to provide both straight reversing characteristics for warping and dynamic lowering characteristics for anchor handling. Transfer switches allow selection of the proper characteristics. When used for anchor handling, the control usually provides five speeds in each direction with adequate torque in hoist directions and dynamic braking in all lowering points. For warping, the control characteristics are substantially identical in both directions. A single controller master switch is provided and located on deck adjacent to the windlass.

DESTROYER ANCHOR WINDLASS

The anchor windlass installed aboard certain destroyers consists of a two-speed motor directly connected through reduction gears to a vertical shaft on which are mounted a capstan and a wildcat (fig. 12-25.) The capstan and wildcat are located on the weather deck, and the electric motor and the across-the-line starter are located in the windlass room on the next deck below. The windlass is designed to operate in both directions to raise or lower either the starboard or port anchor.

Construction

The windlass is driven by a two-speed (full speed and one quarter speed), 3-phase, 440-volt, 60-cycle motor connected to the reduction gear by a controlled torque coupling. The controlled torque coupling is provided to prevent

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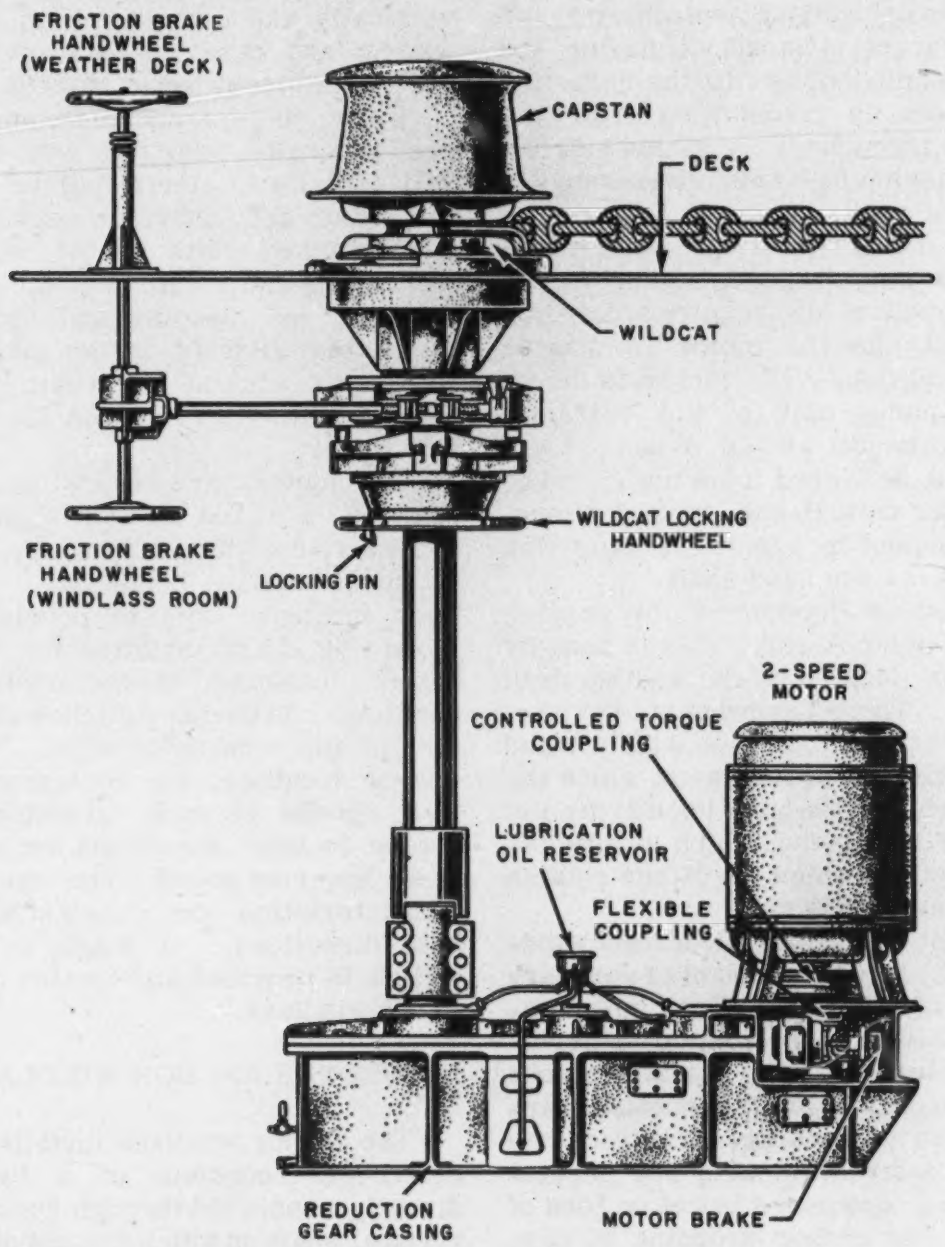

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Figure 12-25.—Anchor windlass.

undue stresses when the anchor is being housed. In all cases the anchor should be housed by shifting the drum master switch to the low speed position before the anchor enters the hawsepipe.

An electric brake, mounted just below the controlled-torque coupling, will release when power is applied and will set when power is disconnected or fails. The electric brake is designed to stop and hold 150 percent of the rated load when the anchor and chain are being lowered at maximum lowering speed, in the event of power failure.

The wildcat is designed to hoist one anchor and 60 fathoms of 1 1/4-inch dielock chain in not more than 10 minutes on the high speed connection without exceeding the full-load rating of the motor. On the low-speed connection the wildcat is designed to hoist the anchor and 60 fathoms of chain without overloading the motor, and to exert a pull on the chain at least three times that required to hoist the anchor and 60 fathoms of chain.

The capstan is designed to heave a 6-inch circumference manila line at a speed of 50 feet

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per minute with a line pull corresponding to the full-load motor torque.

The capstan head is keyed directly to the drive shaft while the wildcat is connected to the drive shaft through a driving head and a locking head. The wildcat is keyed to the driving head and the locking head is keyed to the drive shaft. Vertical blocks sliding in slots in the locking head are raised (by the locking handwheel) into slots in the driving head to connect the two heads. The mechanism is called the locking gear. The wildcat and sleeve run free on the same shaft until connected to the shaft by a locking head located below the weather deck. The capstan can be run independently for warping by disconnecting the locking head and holding the wildcat by means of the brake band on the brake drum. The handwheel can be pinned in the LOCKED or UNLOCKED positions and should always be fully locked or fully unlocked.

A handbrake is provided on the wildcat shaft to control the anchor handling. It is designed to operate in either direction of rotation of the wildcat and to stop and hold the anchor when dropped from a depth of 45 to 60 fathoms. The brake is operated by means of a handwheel located on the weather deck and a duplicate handwheel in the windlass room.

Operation

The windlass is operated by a drum master switch on the weather deck and a duplicate switch in the windlass room. It is important to remember that if the windlass is run with the locking handwheel in the LOCKED position, the wildcat will revolve. In this case, if the chain is engaged in the whelps on the wildcat, the chain should be free to run. Exercise care to select the proper direction of rotation and be certain that the windlass is properly lubricated.

The motor can be operated from either master switch No. 1 (on the weather deck) or from master switch No. 2 (in the windlass room) but master switch No. 1 predominates. When the associated on-off selector switch located on master switch No. 1 is operated to the ON position, master switch No. 1 takes over control from master switch No. 2 (if both switches are operated simultaneously).

The anchor windlass is used alternately to handle either the starboard or the port anchors. The windlass is operated by a reversible motor in either of two directions. These directions may be hoist for the starboard anchor (lower for the port anchor) and hoist for the port anchor (lower for the starboard anchor). However, only one anchor can be handled at a time. The nomenclature on the controllers refers to the hoist directions for both anchors.

The motor starter (fig. 12-26) is equipped with four thermal overload relays to protect the motor against overloads. Overload relays 1SOL and 2SOL are in the slow-speed motor circuit and overload relays 1FOL and 2FOL are in the fast-speed motor circuit. If an overload occurs in the slow-speed or fast-speed circuit, the SOL or the FOL relays will operate to trip the slow-speed, S, or the fast-speed, F, contactors respectively. The motor can be operated in the event of an emergency by holding either of the EMERG-RUN pushbuttons down and operating the master switch in the usual manner. To reset the overload relays, press the OVERLOAD RESET pushbuttons in the event of an overload or voltage failure. The master switch must be returned to the OFF position to restart the motor.

To start the motor in the port (hoist) direction for slow speed by master switch No. 1, operate the associated on-off switch to the ON position and move the controller handle forward to the SLOW PORT (hoist) position. This action closes contacts MS11 momentarily to energize the operating coil of relay CR1 and to close its contacts CR1a to provide a holding circuit for relay CR1, and to open its normally closed contacts CR1d to prevent operation of relay CR2 at this time. At the same time, contacts CR1b close to prepare the circuit to controller contacts MS12 and MS13, and contacts CR1c close to prepare the circuit to controller contacts MS14 and MS15.

When the controller handle is moved further toward the SLOW PORT position, contacts MS11 open; controller contacts MS12 close to energize the operating coil, P, and close the port contactor in the motor starter; also, contacts, Pa, close to provide the circuit to the motor brake relay, BR. At the same time, controller contacts MS14 close to energize the operating coil, S, and close the slow-speed contactor in the motor starter. Contacts Sa close to energize the brake relay, BR, and close its contacts to release the motor brake. Also, the normally closed contacts, Sb (in the circuit to the operating coil, F, of the fast-speed contactor), open. The motor is now connected for hoisting the port anchor at slow speed.

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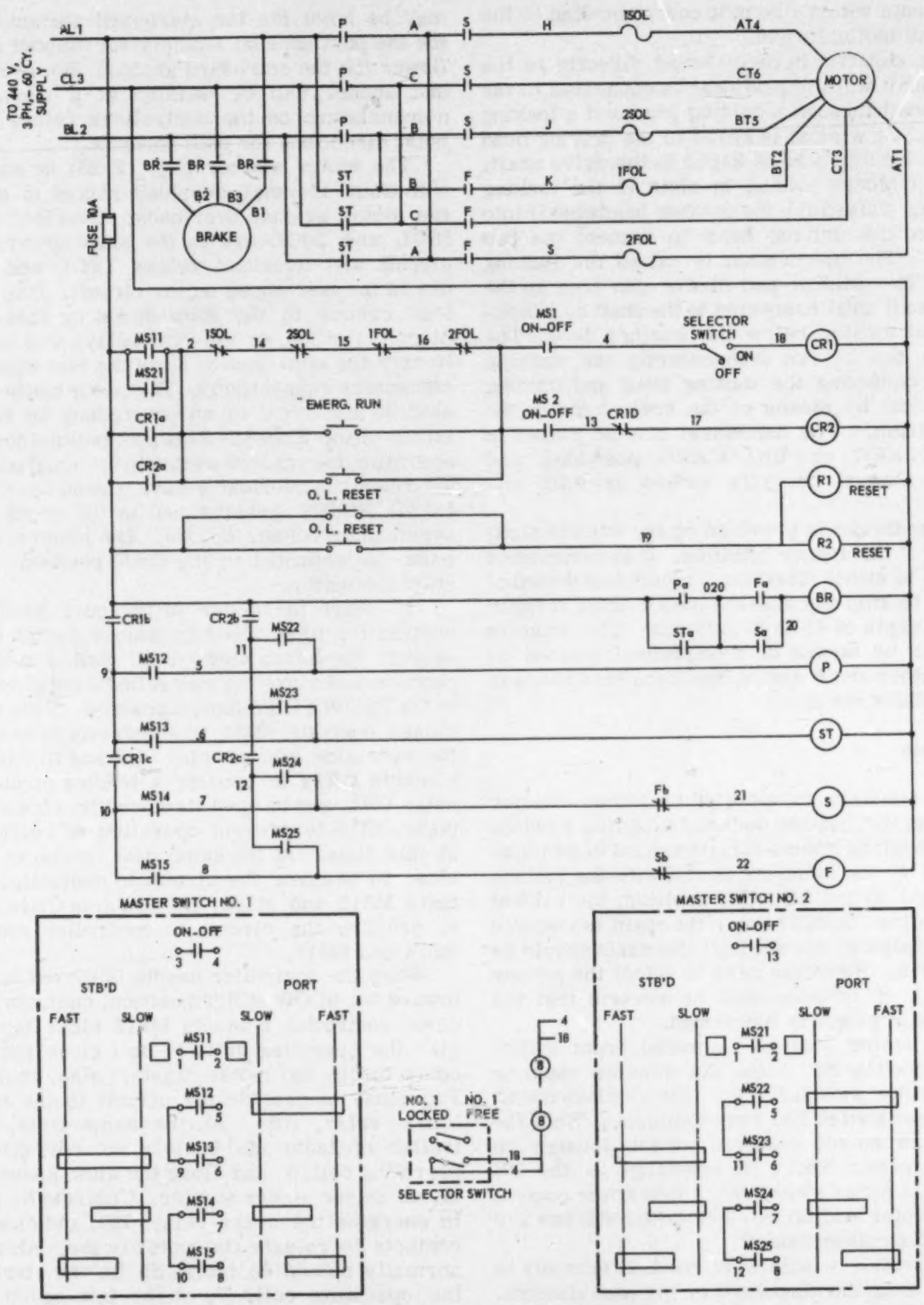

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Figure 12-26.—Reversing across-the-line starter for two-speed anchor windlass.

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When the controller handle is moved further to the FAST PORT position, contacts MS15 close and contacts MS14 open. Contacts MS15 close before contacts MS14 open so that the operating coil, S, is kept energized through the normally closed contacts, Fb. When contacts MS14 open, operating coil, S, deenergizes and closes contacts Sb to energize the operating coil, F. This action opens contacts Fb to deenergize the operating coil, S, and open the slow-speed contactor. When the slow-speed contactor opens, contacts Sb close to complete the circuit to the fast-speed contactor in the motor starter. The motor is now connected for hoisting the port anchor at fast speed.

To hoist the starboard anchor, the same sequence occurs, except that controller contacts MS13 energize the operating coil, ST, to close the starboard contactor instead of controller contacts MS12 energizing the operating coil, P, to close the port contactor.

If it is desired to operate the motor by master switch No. 2, operate the associated on-off switch to the ON position and move the controller handle to the PORT or STARBOARD SLOW position. This action closes contacts MS21 momentarily to energize the operating coil of relay CR2 (if relay CR1 is not energized). The sequence of operation for master switch No. 2 is the same as that for master switch No. 1, except that contactors P, ST, S, and F are energized through the CR2 contacts instead of through the CR1 contacts. Master switch No. 1 can be locked out by turning the selector switch to the No. 1 LOCKED position. In this position the selector switch opens the circuit to relay CR1 and prevents its operation.

Maintenance of the electrical components of the anchor windlass should be in accordance with the instructions listed in chapters 6 and 9 of this training course. More detailed information concerning the maintenance of this equipment is contained in the manufacturers' instruction books furnished with the specific equipment.

ELEVATORS

The elevator installations aboard aircraft carriers usually consists of hydraulic or electric types for airplane elevators and electro-hydraulic or electromechanical types for freight, mine, bomb, torpedo, and ammunition elevators. Only the electric elevator and the electro-hydraulic elevator will be discussed in this chapter.

ELECTRIC ELEVATORS

The platform on electric elevators is raised and lowered by groups of cables which pass over sheaves and then to the hoisting machinery drums. The hoisting drums, coupled together, are driven through a reduction gear unit by an electric motor.

The motor is of the two-speed type. The control arrangements being such that the elevator starts and runs on the high speed connection, the low speed being used for deceleration as the elevator approaches the upper or lower limit of travel.

The 2-speed electric motor is controlled through a system of contactors, relays, limit switches, and selector switches. Automatic operation is obtained by selecting the levels between which the platform is to run. The start pushbutton can then be used to close contactors through safety switches to accelerate the platform from low speed to high speed. Just before reaching the desired level, the control transfers the motor to the low-speed winding through the action of cam-operated limit switches. On reaching the desired level, the control circuit is disconnected by a cam-operated stop switch, thus releasing the contactors and setting the brake to stop the platform.

For safety in operation, all doors at each level are interlocked to prevent operation unless they are closed. Also, all hatch covers are interlocked to prevent elevator operation unless they are fully opened. The protective features incorporated in the control are (1) slack-cable switches to prevent operation of the elevator if any cable should become slack, (2) emergency stop switches at each level served, (3) over-travel switches to stop the elevator if it should fail to stop at the uppermost level, and (4) overload protection.

Elevator controllers are designed with a double-break feature that prevents maloperation if any one contactor, relay, or switch should fail to function properly. Pushbuttons are interlocked to prevent operation of the elevator unless the platform is at the same level as the pushbutton. Some elevators are equipped with hatchway door mechanical interlocks to prevent opening the door unless the platform is at the same level.

APPENDIX I

FILM LIST

MN-10130A The Naval Aircraft Maintenance Program—Introduction. (24 minutes.) Applicable to chapter 2.

MN-10130C Aircraft Maintenance Program—Planned Maintenance System—Maintenance Requirements Cards. (27 minutes.) Applicable to chapter 2.

MN-8248 Paperwork Management in the Navy. (17 minutes.) Applicable to chapter 3 and 5.

FN-9433G Principles of Paperwork Management—The Navy Directives System. (18 minutes.) Applicable to chapters 3 and 5.

MN-8242 Security—Your Personal Responsibility. (16 minutes.) Applicable to Chapters 3 and 5.

MN-6754 Safety Precautions for Electronics Personnel—Introduction. (15 minutes.) Applicable to chapter 5.

MN-8050 Functional Teaching in Electricity and Electronics. (16 minutes)) Applicable to chapter 5.

MN-8366A Aircraft Accident Prevention-Ground Accident. (14 minutes.) Applicable to chapter 5.

MV-8730A Strength of the Chain—On the Job Training. (28 minutes.) Applicable to chapter 5.

MV-9333 Electrical Maintenance. (15 minutes.) Applicable to chapter 5.

MN-9682A Radio frequency Hazards—Personnel Hazards and Safety. (17 minutes.) Applicable to chapter 5.

BuWeps 51-61 Corrosion in Aircraft. (20 minutes.) Applicable to chapter 6.

MN-6926 Reduction of Radio Interference. (20 minutes.) Applicable to chapter 6.

MA-7812B Circuit Testing With Meters and Multimeters—Practical Application. (33 minutes.) Applicable to chapters 6 and 7.

MC-5135 Use of the Echo Box for Maintaining Radar Performance. (21 minutes.) Applicable to chapter 7.

MC-9532 Infrared (15 minutes.) Applicable to chapter 8.

MN-8483A Magnetic Amplifiers—Theory of Operation. (18 minutes.) Applicable to chapter 9.

MN-8483B Magnetic Amplifiers—Circuits and Applications. (17 minutes.) Applicable to chapter 9.

MN-8479F Transistors—Switching. (14 minutes.) Applicable to chapter 10.

MN-8969B Digital Computer Techniques—Computer Logic—Part 1—Binary Numbers. (16 minutes.) Applicable to chapter 10.

MN-8969C Digital Computer Techniques—Computer Logic—Part 2—Logic Symbology. (16 minutes.) Applicable to chapter 10.

MN-8969D Digital Computer Techniques—Computer Units. (25 minutes.) Applicable to chapter 10.

MN-8969E2 Digital Computer Techniques—Logic Element Circuits. (17 minutes.) Applicable to chapter 10.

MN-9314B Ground Position Indicator—Operation and Uses. (9 minutes.) Applicable to chapters 10 and 17.

MA-9717 Traveling Wave Tubes—Types—Principles of Operation and Application. (36 minutes.) Applicable to chapter 12.

MA-9332A2 Microwave Oscillators. (20 minutes.) Applicable to chapters 12 and 15.

MN-8614 Electromagnetic Cathode Ray Tube—Theory of Operation. (20 minutes.) Applicable to chapters 14, 16, and 17.

MN-8814D Electronics—Special Circuits and Devices—Free Running Blocking Oscillator Circuit—Operation. (7 minutes.) Applicable to chapters 14, 16 and 17.

MN-8814E Electronics—Special Circuits and Devices—Triggered Blocking Oscillator Circuits—Operation. (7 minutes.) Applicable to chapters 14, 16, and 17.

MN-119L Weather and Radar. (17 minutes.) Applicable to chapter 15.

MN-1540K Radio Technician Training—Standing Waves on Transmission Lines. (23 minutes.) Applicable to chapter 15.

A governor-actuated safety device is provided under the platform to grip the guide rails and stop the platform in the event of overspeed in the DOWN direction. Also, spring bumpers are provided at the bottom of the hatchway to prevent mechanical damage to the hull or platform due to overtravel in the DOWN direction.

Operation

The operation of the elevator depends on the position of the selector switch, which determines between which decks the elevator will run. This switch also renders all master switches inoperative, except those pertaining to the selected levels.

Suppose the selector switch is set in the second paltform to the third deck position (fig. 12-27). In this position the control is set up for the elevator to operate between the second platform and the third deck and closes contacts ①, ②, ④, ⑤, and ⑦. (The third deck is above the second platform.) Contact ② shorts out the first platform stop pushbutton, contact ① places the third deck pushbutton station in the circuit, and contacts ④ and ⑤ short out the first platform DOWN-STOP switches, respectively. Contact ⑦ places the second platform pushbutton station in the circuit.

If the overtravel, slack cable, door switches, stop pushbuttons, and overload relay contacts are in their normally closed positions, the control circuit is energized and set up for operation.

When the second platform UP pushbutton (Fig. 12-27) is momentarily pressed, the UP auxiliary relay, UR, and the UP control relay CRU are energized. This action closes contacts CRU and UR1, which energizes the up contactor, U, in the across-the-line starter. The UP auxiliary relay, UR, also closes contacts UR2, (and opens UR3) which energizes the high-speed contactor, HS. Contactor HS applies voltage to the motor and energizes the brake-release solenoid. The elevator moves upward until it mechanically operates the UP-SLOW limit switch located at the third deck. Operation of the limit switch deenergizes the up auxiliary relay, UR. This action closes contacts UR3 and energizes the LS coil, which transfers the motor from the high-speed, HS, to the low-speed, LS, contactor. The elevator continues upward at low speed until it mechanically operates the UP-STOP limit switch located at the third deck. Operation of the limit switch deenergizes the up contactor, U, which deenergizes the brake-release solenoid and operates the motor brake to stop the motor. An indicating light shows when the elevator reaches the selected deck.

The elevator can be stopped at any time by pressing the stop lever at the pushbutton station located on the selected level, or, in this case, the third deck. To restart the elevator, press the UP pushbutton lever at the second platform or the DOWN lever at the third deck.

In the event of an overload, one of the overload relays will open the control circuit, set the brake, and deenergize the motor. The overload relay must be reset for normal operation by pressing the reset button that projects through the door of the enclosing case.

In the event of supply voltage failure, the line contactors will open and deenergize the motor. To resume operation of the elevator, an UP or DOWN pushbutton lever must be pressed.

As mentioned before, additional protection is provided through a system of series-connected interlocks in the control circuit consisting of door, slack cable, and overtravel switches. If a cable should become slack or if the elevator should overtravel, the elevator can be operated by holding in the SLACK CABLE bypass pushbutton PBS, located inside the controller case. When either one of these pushbuttons is operated, the motor will run only on low speed.

If an overload should occur, the elevator can be operated (in case of an emergency) in the usual manner if the EMERG-RUN lever of either pushbutton station is held in the depressed position.

The up and down current control relays, CRU and CRD, respectively, are provided to ensure proper operation in the event of malfunctioning of other relays or contactors.

ELECTROHYDRAULIC ELEVATOR

The electrohydraulic elevators use hoisting cables and drums in much the same manner as the electric elevator. In this system however, the cable drums are driven through reduction gears by a hydraulic motor.

Raising, lowering or speed changes are accomplished by varying the stroke of the variable delivery hydraulic pump through differential gearing. Figure 12-28 shows a typical arrangement scheme for operation of the electro-hydraulic bomb elevators.

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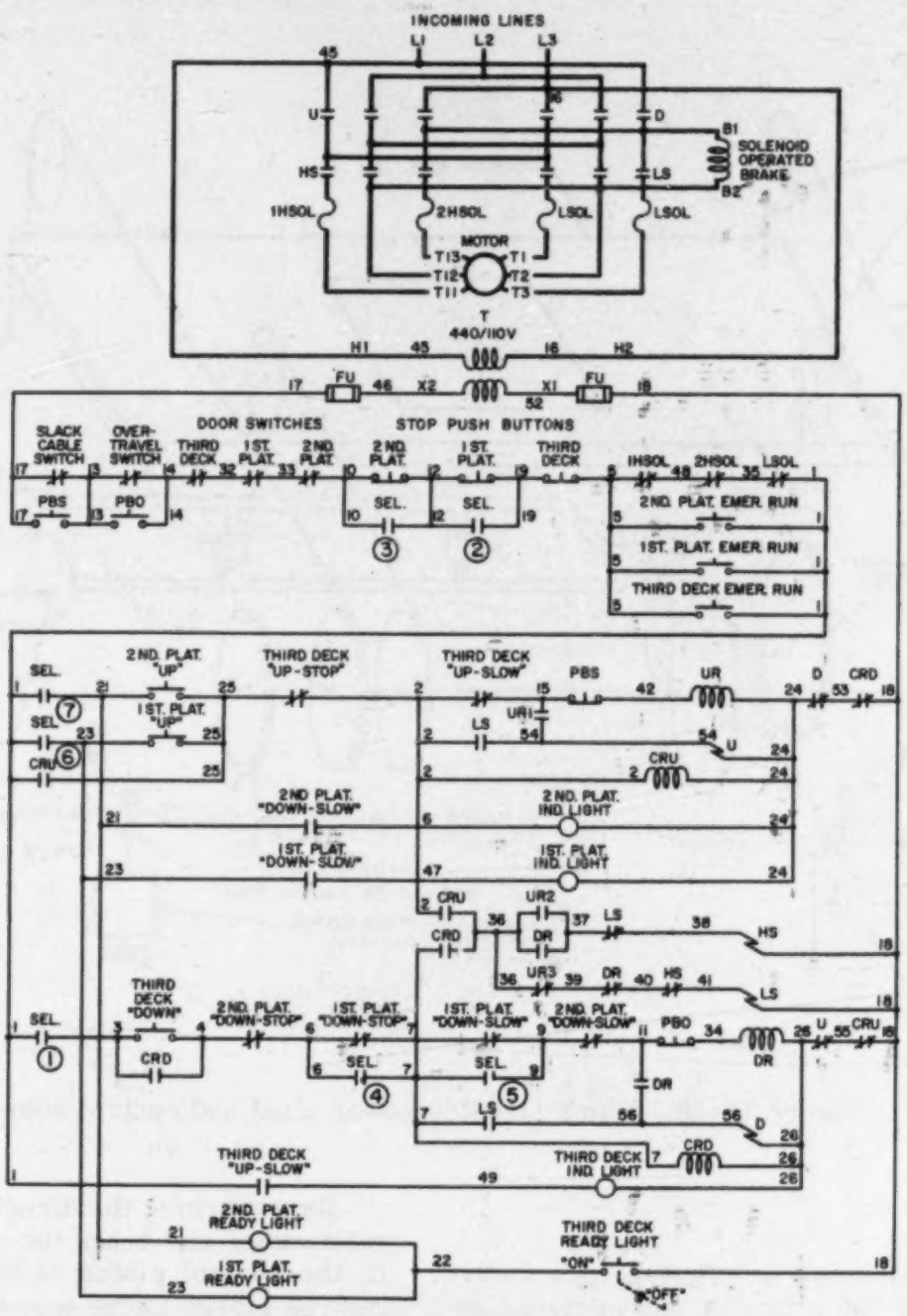

	SELECTOR SWITCH		
	CONTACT NOS. HANDLE END OFF	2ND PLATFORM TO THIRD DECK	1ST PLATFORM TO THIRD DECK
A	① ⊣⊢	X	X
	⊣⊢ ②	X	
B	③ ⊣⊢		X
	⊣⊢ ④	X	
C	⑤ ⊣⊢	X	
	⊣⊢ ⑥		X
D	⑦ ⊣⊢	X	
X - INDICATES CONTACTS CLOSED			

NOMENCLATURE

U – UP CONTACTOR
D – DOWN CONTACTOR
HS – HIGH SPEED CONTACTOR
LS – LOW SPEED CONTACTOR
UR – AUXILIARY UP RELAY
DR – AUXILIARY DOWN RELAY
T – CONTROL TRANSFORMER 440/110V
LSOL – LOW SPEED OVERLOAD RELAY
FU – CONTROL FUSE – 10 AMP.
PBO – OVER TRAVEL BY-PASS SWITCH
SEL – SELECTOR SWITCH. FOR CONTACTOR SEQUENCE SEE ABOVE SCHEMATIC
PBS – SLACK CABLE BY-PASS SW
1HSOL, 2HSOL – HIGH SPEED OVERLOAD RELAYS
CRU & CRD – CONTROL RELAYS – UP & DOWN

MOTOR CONNECTION TABLE

SPEED	L1	L2	L3	OPEN	DIRECTION
LOW	T1	T2	T3	T11, T12, T13	UP
HIGH	T11	T12	T13	T1, T2, T3	
LOW	T3	T2	T1	T11, T12, T13	DOWN
HIGH	T13	T12	T11	T1, T2, T3	

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Figure 12-27.—Schematic diagram of electric elevator, automatic control selective from one station.

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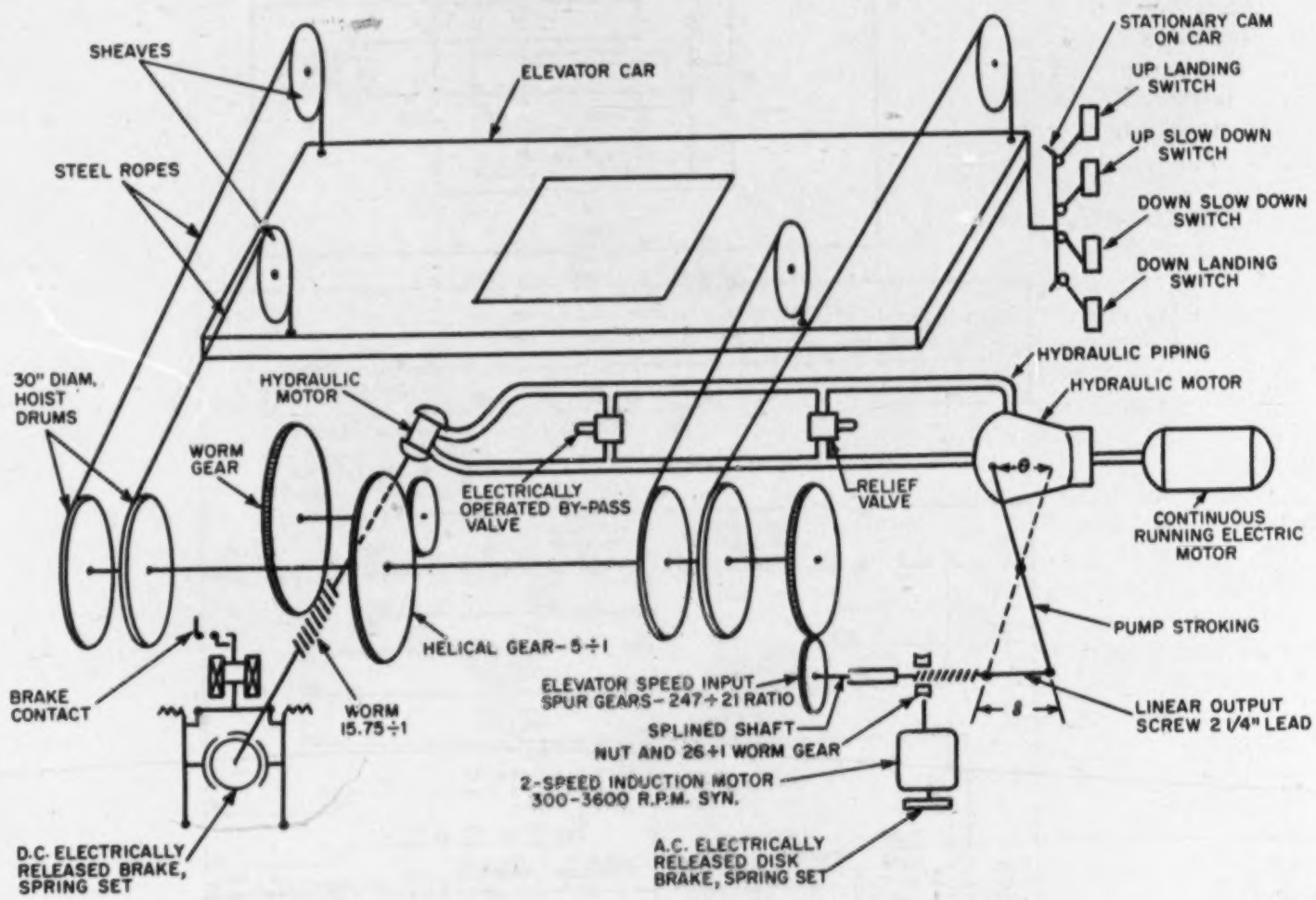

Figure 12-28.—Bomb elevator power plant and control scheme.

Control

The elevators use a followup type control system so that the pump is put on stroke by a pilot motor and the stroke is taken off by the motion of the platform working on the followup control.

On some elevators the pilot motor is started by depressing an operating pushbutton. The pilot motor moves the pump control piston to the ON-STROKE position and the elevator accelerates to full speed. Upon approaching the selected level a platform mounted cam trips a slow-down switch which deenergizes the pilot motor. Movement of the platform then returns the stroke of the pump to the netural position and on reaching the selected level a stop switch deenergizes the brake solenoid to set the brake and stop the elevator.

By reversing the direction of rotation of the pilot motor and hence the direction of movement of the control piston of the pump, the elevator may be moved in the opposite direction.

Another system, where the pilot motor is a d-c motor the speed of which is varied by a rhesotat type control, gives an infinite number of platform speeds ranging from approximately 3 to 90 feet per minute. In installations of this type, a rheostat control is provided on the platform and a duplicate control is provided in the elevator machinery room.

Several methods are used for stroking the pump for emergency operation.

By declutching the "followup" control system from the control stroking unit and manually holding in a pushbutton, thereby releasing the electric motor brake to free the machinery, a handwheel may be used to stroke the pump.

Another method is to rotate the pilot motor armature by attaching a handwheel to an extension on the armature shaft, and thus stroking the pump.

Elevators in some new construction use static controls (no moving parts.) Electronic devices (transistors, SCR's, etc.) perform the functions of previously used relays, contactors, and limit switches.

MAINTENANCE

Adjustments to the machinery and electrical equipment of elevators should be in accordance with the procedures contained in the appropriate manufacturer's instruction books. In addition to these maintenance procedures, the following items should be checked during each shipyard overhaul.

1. Inspect wire cable for wear, corrosion, and broken strands.
2. Check equipment for worn parts and replace those parts that are excessively worn.
3. Inspect and test all safety mechanism to ensure that they are in operable condition.
4. Perform operating tests of the elevator to ensure that it is operating and in satisfactory condition.
5. Check the enclosures of all limit switches (except explosion proof) to be certain that the 1/4-inch drain holes are open to permit draining.
6. Inspect the brake for evidence of excessive wear on the linings and replace as necessary. Adjust the brake in accordance with the manufacturer's instructions. When the brake is adjusted, check the leveling of the platform and correct any inaccuracy in leveling by moving the stop limit switches.
7. Inspect limit switches to determine that the arms are adjusted properly. Adjust each limit switch arm so that approximately one-half of the travel of the arm is taken up by the application of the cam to the switch arm roller. This adjustment will prevent damage to the arm or prevent failure of the switch to operate properly due to the shifting of the platform in the hatchway or movement of the guide rails with the working of the ship's structure.

ELECTROHYDRAULIC STEERING GEAR

The steering gear is one of the most vital auxiliaries aboard ship. It must be thoroughly dependable and have sufficient capacity for maximum maneuverability. The types of steering gear listed in the sequence of their development are the (1) steam, (2) electromechanical, and (3) electrohydraulic types. The electrohydraulic steering gear was developed to meet the excessive power requirements of naval vessels having larger displacements and higher speeds with the attendant increase in rudder torques.

The majority of steering gear installations in new construction naval vessels are of the electrohydraulic type.

CONSTRUCTION

The electrohydraulic steering gear installed in a destroyer (fig. 12-29) consists essentially of a (1) ram unit; (2) power unit; and (3) remote control system (not shown).

Ram Unit

The ram unit is mounted athwartship and consists of a single ram that operates in opposed cylinders. The ram is connected by links to the tillers of the twin rudders and is moved by the oil pressure built up in either of the cylinders, the oil from the opposite cylinder flowing to the suction side of the pump.

The tie rods that connect the two cylinders also serve as guides for a sliding bracket attached to the ram to prevent the ram from rotating. The bracket also provides mechanical limits to the ram travel at 42° of rudder angle. At this position the bracket contacts copper facing on the stop collars and prevents further movement.

A rack is attached to the ram and engages two gears, the rotation of which is transmitted to the respective differential control boxes through the follow-up shaft.

Power Unit

The power unit consists of two pumping systems, which include two motor-driven pumps, a hand pump, two 4-way transfer valves with operating gear, relief valve, two differential control boxes, two "trick" wheels, and a hand emergency gear all mounted on a bedplate, which is the top of an oil reservoir. Steering power is derived from either pumping system acting alone. The system not in use serves as a standby source in case of emergency.

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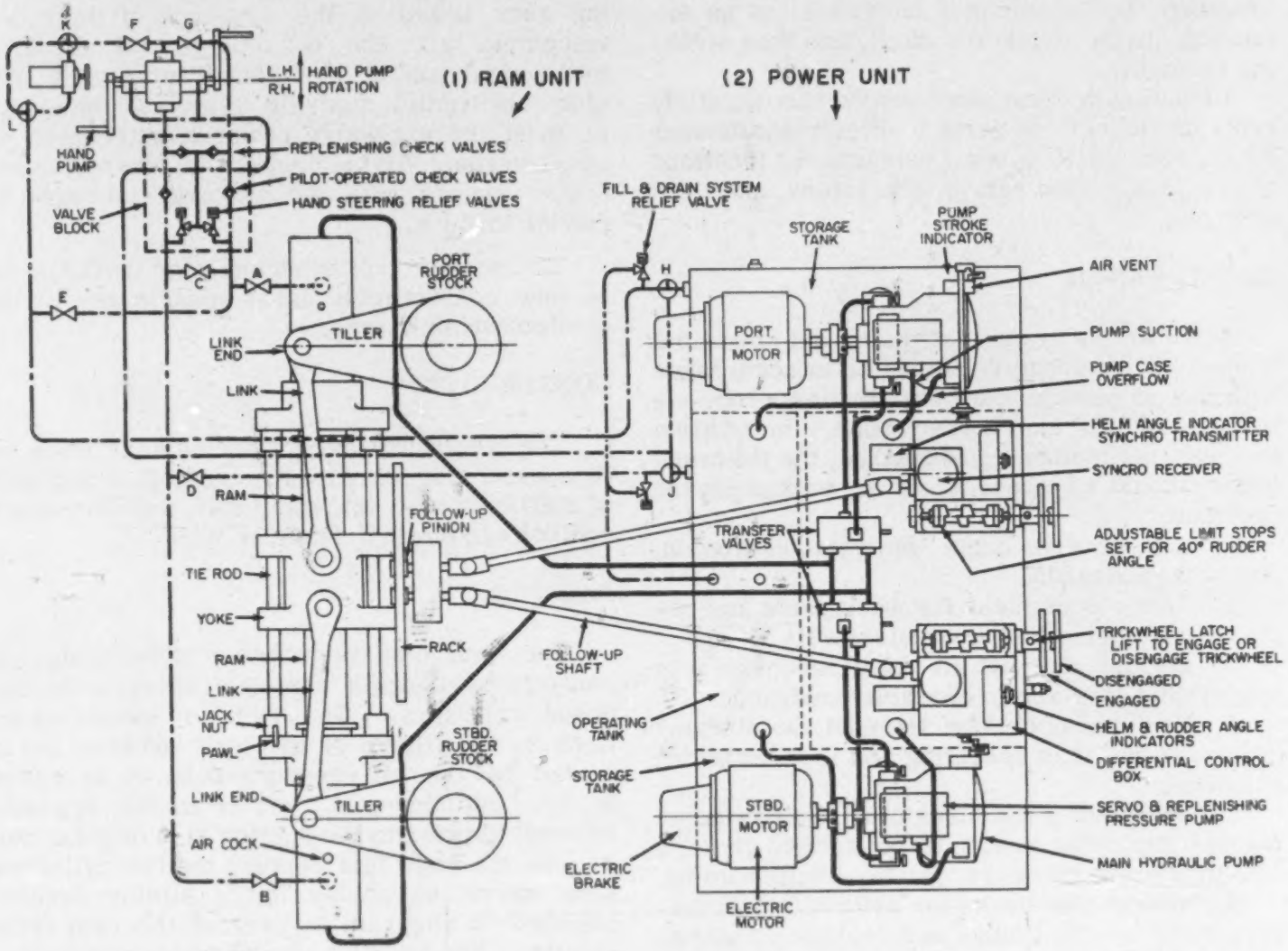

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Figure 12-29.—Electrohydraulic steering gear.

The two pumps (port and starboard) are identical in size and design, and are of the variable delivery axial piston type. Each main pump unit includes a built-in vane-type servo pump, pressure control and replenishing valves, and two main relief valves. Each main pump is stroked through a rotary servocontrol.

Each pump is driven by a 20-hp, 1200-rpm, 440-volt, 3-phase, 60-cycle induction motor through reduction gears and a flexible coupling. A disk type electric brake, which is automatically secured when deenergized, is provided on each motor.

The pumps of the power unit are connected to the ram cylinders by a high pressure piping system. The two 4-way transfer valves are interposed in this piping, and their positions determine which pump is connected to the cylinders in the ram unit. The hand lever, which moves both valves simultaneously, is located on the power unit between the "trick" wheels, and has three latched positions. The latched positions are marked P, N, and S, which denote port pump connected, neutral (ram locked), and starboard pump connected, respectively.

The transfer valves, which are of the ported piston type, are mounted on the power unit bedplate between the motors. When the valves are in the neutral (RAM LOCKED) position, the ports of the pipes to the ram cylinders are blocked, and the two pipes from each pump are connected through ported passages in their respective valves. If either or both pumps are started and put on stroke, oil will circulate through the

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valve and back to the pump. Movement of the transfer valves in either direction connects the selected pump to the ram cylinders, and the opposite pump remains bypassed.

The drain pipes from the ram cylinders lead to the reversible hand pump, which provides a means for emergency steering under limited rudder torques. The relief valve in the emergency steering system is set at 500 psi. The oil flow is through pilot-operated blocking valves that prevent the ram from overhauling the pump and kicking back the handles. When moving the ram with the hand pump, the main transfer valves must be set in the RAM LOCKED position, and the drain valves beneath the cylinders must be open.

The stroking lever and output shaft on each differential control box actuate a rotary servo valve that controls the associated main pump on the power unit. In response to movements transmitted through the control box, the pump discharge is varied between zero and maximum, and in either direction of flow.

In normal steering from the pilot house, a synchro transmitter is turned by the steering wheel. This synchro transmitter is electrically connected to a synchro receiver in the steering gear room. The synchro receiver is geared to the LOWER bevel gear in the differential control unit, and its rotation is transmitted through gearing to a cylindrical cam. A follower roller, which engages a groove in the cylindrical cam, is mounted on an arm keyed to the output shaft of the control box.

For example, assume that the rudder is amidship and it is desired to obtain 20° right rudder. The rotation of the lower bevel gear causes rotation of the cylindrical cam, which, in turn, imparts a motion to the servocontrol valve through the cam roller. This motion of the servocontrol valve puts the pump on stroke. Oil pressure is then applied in the port cylinder, forcing the ram to starboard to give right rudder.

A rack, attached to the ram, rotates the follow-up shaft, which is geared to the UPPER bevel gear in the differential control unit. The movement of the ram and rudders (in response to the stroking of the pump) causes the upper bevel gear to rotate in a direction opposite to that of the lower bevel gear. This action rotates the cylindrical cam in the opposite direction, tending to cancel the movement of the control input and bring the servocontrol valve back to the neutral position to return the pump stroke to neutral and stop the pumping of oil.

Thus, the rudders are at 20° right rudder, the cam is returned to neutral, and the pump is returned to zero stroke until further movement of the steering wheel causes repetition of the cycle. The same sequence occurs if the control is from the trick wheel in the steering compartment.

An engraved dial, graduated in rudder degrees, is mounted on top of the differential control box. Two concentric pointers (one geared to the control pump input and the other geared to the rudder followup) indicate the positions of the helm and rudders, respectively. A helm-angle synchro transmitter, also mounted on the differential control box, actuates a synchro receiver in the steering console in the pilot house. This receiver positions a pointer to indicate to the helmsman the helm angle.

Remote Control System

The remote control system (fig. 12-30) provides control from the pilot house for normal steering. This system consists of a synchro transmitter mounted in the steering console and a synchro receiver mounted on each pump differential control box (port and starboard). A cable selector switch in the pilot house and a similar switch in the steering compartment permit a choice between the port or starboard steering cables. The selection of the control cable is made by the operation of the cable selector switches in the pilot house and in the steering gear room to the desired (port or starboard) position.

The synchro-receiver selector switch in the steering gear room is then set to connect the synchro receiver, on the active power unit, to the steering console synchro transmitter. The rotary motion of the synchro receiver is transmitted through gearing to the input of the differential control box (stroking mechanism) previously described.

The helm angle-indicator synchro transmitters on the differential control boxes in the steering gear room are electrically connected to their associated steering-control synchro receivers. These transmitters under all conditions of operation actuate their associated helm-angle indicator synchro receivers in the pilot house console through their associated cables.

The 120-volt, single-phase power for the remote control system is supplied to the steering power panel through a 450/120-volt

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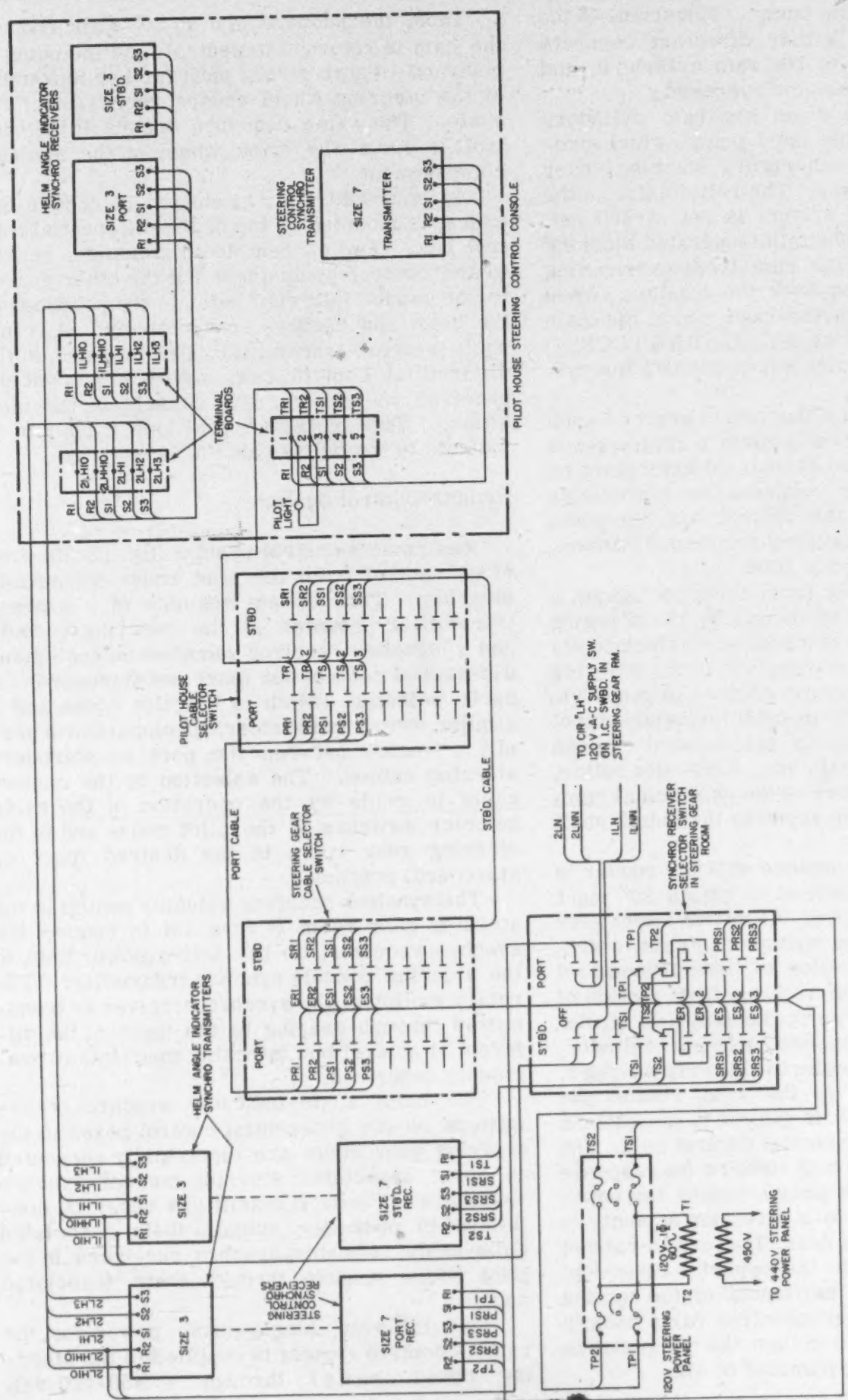

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Figure 12-30.—Remote control system for steering gear.

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transformer from the steering power transfer switchboard. The 120-volt, single-phase power for the indicator synchro transmitters is supplied from the I. C. switchboard through circuits L (rudder order system) and N (rudder angle indicator system).

Magnetic Controller

The motor of each steering gear pump is provided with a nonreversing across-the-line starter and a maintained-contact master switch (fig. 12-31). The starter is supplied with 440-volt, 3-phase, 60-cycle power from the steering power transfer switchboard located in the steering engineroom.

The pump motor on either power unit is started or stopped by operating the maintained-contact pushbutton, on the associated pushbutton station, to the desired position. When the maintained-contact start pushbutton is pressed, the circuit is completed to the operating coil, M, of the line contactor. This action energizes the operating coil and closes the contactor in the motor starter to connect the motor to the line. The motor will continue to run until the contactor operating coil, M, is deenergized because of loss of voltage, tripping of the overload relay, or by pressing the stop pushbutton.

The motor starter is provided with overload and low-voltage release protection. The overload relays are of the thermal type, similar to those installed in the previously described anchor windlass starter. The low-voltage release protection is provided by use of the maintained-contact master switch.

If the operating coil, M, is deenergized due to failure of the line voltage or tripping of an overload relay, the contactor will reclose and restart the motor when voltage is restored or when the overload relays are reset by means of the reset pushbutton.

In an emergency the motor can be run (even though the overload relays have been tripped) by holding the EM-RUN pushbutton closed with the start pushbutton in the operated position. If the overload condition has not been corrected, the motor will operate only as long as the EM-RUN pushbutton is held closed.

OPERATION

The steering gear is normally secured with the rudders amidship and with the transfer valve shift lever in the neutral (N) position, which hydraulically locks the ram and rudders.

To operate the port power unit, using the port steering cable:

1. Set the valves and plug cocks of the hydraulic system in accordance with the operating diagram for the steering gear for normal power operation.
2. Set the transfer valve shift lever in the neutral (N) position.
3. Press the start pushbutton to start the port pump motor.
4. Engage the trick wheel and turn it until the helm indicator (pointer) corresponds with the rudder angle indicator.
5. Move the transfer valve shift lever to the PORT (P) position to connect the port pump unit to the ram.
6. Close the port and starboard circuit breakers on the 120-volt steering power panel to energize the synchro receiver selector switch and the cable selector switch in the steering gear room.
7. Turn the synchro-receiver selector switch and the cable selector switch (in steering gear room) to the PORT positions.
8. Turn the cable selector switch (in pilot house) to the PORT position to energize the remote control synchro transmitter to steer from the bridge.
9. Disengage the trick wheel on the port unit and engage the trick wheel on the idle (starboard) unit.

To shift from the port power unit, using the port steering cable, to the starboard power unit, using the starboard steering cable:

1. Press the start pushbutton to start the starboard (idle) pump motor.
2. Notify the pilothouse to keep wheel motionless during change of units.
3. Allow rudder angle indicator to line up with helm indicator; then operate the transfer valve shift lever to the starboard (S) position to connect the starboard pump to the ram. Transfer the remote control from the port to the starboard unit by operating the synchro-receiver selector switch (in steering gear room).
4. Transfer the cable selector switch (in steering gear room) and cable selector switch (in pilot house) to the STARBOARD positions.
5. Disengage trick wheel and steer from the bridge.
6. Press the stop pushbutton to stop the port motor and engage the trick wheel on this unit.

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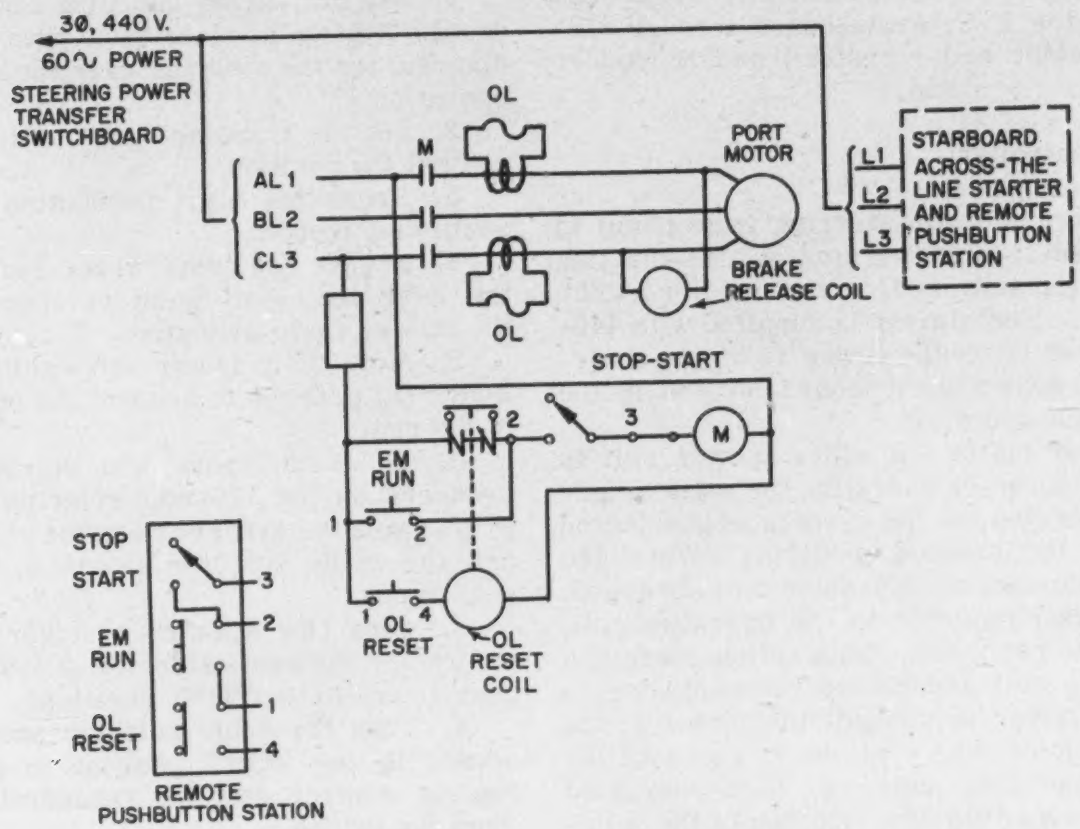

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Figure 12-31.—Nonreversing across-the-line starter for steering gear pump motor.

To steer from the trick wheel:

1. Select the power unit to be used and follow the procedures described previously for operating the port power unit.

2. Engage the trick wheel of the selected power unit.

3. Deenergize the remote control system by operating the synchro-receiver selector switch in the steering gear room to the OFF position.

4. Steer the ship as directed from the bridge.

To operate by hand emergency steering:

1. Set the valves and plug cocks of the hydraulic system in accordance with the operating diagram for the steering gear for hand steering.

2. Set the transfer valve shift lever in the NEUTRAL (N) position.

3. Crank the hand pump in the proper direction until the desired rudder angle is obtained.

When the hand pump is used for emergency steering, the ship's speed and rudder angles must be controlled so that the pressures in the ram cylinders will not exceed the setting of the relief valve, which is installed in the emergency steering system.

To secure the steering gear when steering under power operation:

1. Request the pilothouse to put rudders on zero angle or use the trick wheel for this purpose.

2. Operate the transfer valve shift lever to the NEUTRAL (N) position.

3. Deenergize the remote control system by turning the synchro-receiver selector switch and the cable selector switch (in the steering gear room) and the cable selector switch (in the pilot house) to the OFF positions. Open the port and starboard circuit breakers on the 120-volt steering power panel.

4. Stop the pump motor by pressing the associated STOP pushbutton.

The maintenance of the steering gear must be in accordance with the instructions contained

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in the manufacturers' technical manuals for the equipment installed aboard your ship.

ELECTRIC GALLEY EQUIPMENT

Electric galley equipment comprises the heavy duty cooking and baking equipment installed aboard naval vessels and consists essentially of ranges, griddles, deep fat fryers, roasting ovens, and baking ovens (fig. 12-32). This equipment is supplemented by electric pantry equipment, which includes coffee urns, coffee makers, griddles, hotplates and toasters. The number and capacity of the units comprising a galley installation depends on the size and type of ship. Galley equipment is normally designed for operation on 115-volt or 230-volt, d-c power or 440-volt, 3-phase, 60-cycle, a-c power. A type A range is illustrated in figure 12-32A. A roasting oven is pictured in figure 12-32B, and a deep fat fryer) is shown in figure 12-32C.

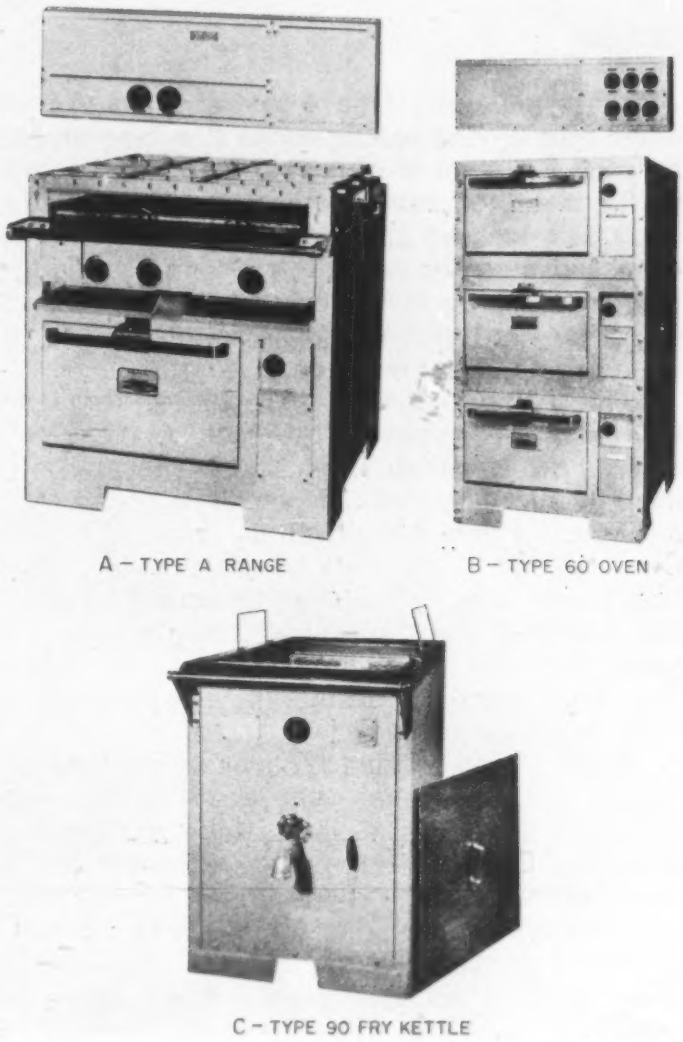

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Figure 12-32.—Electric galley equipment.

RANGES

Electric galley ranges are provided in type A (36-inch), type B (20-inch, and type C (30-inch). The ranges consist of a range-top section and an oven section assembled as a single unit, and a separate switchbox designed for overhead or bulkhead mounting (fig. 12-32, A).

The RANGE TOP SECTION (type A range) is provided with three 6/R-kw surface units consisting of combination griddle hotplates with cast-in, enclosed heating units or with enclosed heating units fastened to the underside. The surface units are individually controlled by a high temperature thermostat, the bulb of which is covered and clamped to the underside of the griddle hotplate. Each thermostat is connected in series with the operating coil of an associated heavy-duty contactor. When the thermostat contacts close, the contactor coil is energized and closes the contactor to energize the heating unit. The thermostat controls for the surface units are located on a panel at the front of the range-top section.

The OVEN SECTION is provided with two 3-kw enclosed heating units, one located in the top and one in the bottom of the oven compartment. The oven units are separately controlled to regulate the relative temperature at the top and bottom of the oven by individual 3-heat rotary switches located in the overhead switch-box. The oven is also provided with an adjustable temperature control (thermostat) to establish the average temperature that is to be maintained in the oven. The thermostat control for the oven units is located on a panel at the right of the oven.

A compartment at the right of the oven contains a terminal board for making the connections between the range and the switchbox. The compartment is equipped with a removable cover for access to the interior.

The SWITCHBOX consists of a sheet-steel enclosure provided with a hinged or removable cover for access to the interior and a panel on which are mounted the two oven switches. The switchbox houses the cutout blocks, fuses, contactors, and the line terminal block. A

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MA-6000A Technical Principles of Radar—Part 1—Introduction. (22 minutes.) Applicable to chapter 15.

MB-6005A Radar Weather—Part 1. (20 minutes.) Applicable to chapter 15.

MB-6005B Radar Weather—part 2. (15 minutes.) Applicable to chapter 15.

MN-7901 Radar Set AN/APS-42—Operation. (23 minutes.) Applicable to chapter 15.

MN-8412 Radar Set AN/APS-44—Operation (20 minutes.) Applicable to chapter 15.

MN-9121 Radar and Weather—A Team for Action. (40 minutes.) Applicable to chapter 15.

MN-9768 Airborne S and X Band Radar Propagation. (18 minutes.) Applicable to chapter 15.

MN-8606A LIN/LOG Receiver—Theory. (10 minutes.) Applicable to chapters 15 and 16.

MN-8606B LIN/LOG Receiver—Operation. (10 minutes.) Applicable to chapters 15 and 16.

MN-9447 Defense Acquisition Radar Performance Checks. (35 minutes.) Applicable to chapters 15 and 16.

MN-5050A Radar—Accuracy and Resolution—Range. (10 minutes.) Applicable to chapter 16.

MN-5050B Radar—Accuracy and Resolution—Bearing. (16 minutes.) Applicable to chapters 16 and 17.

MN-8814C Electronics—Special circuits and Devices—Sawtooth Oscillator Circuit—Operation. (8 minutes.) Applicable to chapters 16 and 17.

MN8814A Electronics—Special Circuits and Devices—Waveguides. (18 minutes.) Applicable to chapters 16 and 17.

MN-9885 Plan Position Indicator. (20 minutes.) Applicable to chapter 17.

MN-1540W Radio Technician Training—Synchro System—Part 1. (15 minutes.) Applicable to chapter 17.

MN-1540X Radio Technician Training—Synchro System—Part 2. (13 minutes.) Applicable to chapter 17.

MN-2104A The Cathode Ray Tube-How It Works. (15 minutes.) Applicable to chapter 17.

MN-9314A Ground Position Indicator. (11 minutes.) Applicable to chapter 17.

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simplified wiring diagram of a type A range is illustrated in figure 12-33.

OVENS

The type 4 and type 6 baking ovens are the older type having baking decks (the type number denotes the number of decks) that are not thermally insulated from each other. The heating units are located at the top and bottom of the oven and between each deck. Each heating unit is controlled by individual 3-heat switches located in a switch box enclosure mounted on the right-hand side of the oven.

The type 12 and type 18 baking ovens are sectional type ovens with each section consitituting a separate oven that is thermally insulated and operated independently of the other sections. Each section of the type 12 or type 18 ovens has a capacity of six standard five-loaf bread pans. The type 12 oven consists of two sections and the type 18 oven consists of three sections mounted one above the other. The type numbers denote the total bread pan capacity of the oven.

Type 60 and type 125 roasting ovens are sectional type ovens with each section constituting a separate oven that is thermally insulated and operated independently of the other sections (fig. 12-32, B). The type number denotes the capacity in pounds of raw meat per section. The roasting ovens are provided in either 2 or 3 sections mounted one above the other.

The type 12 and type 18 baking ovens have the same general construction of the type 60 and type 125 roasting ovens except that the oven compartments of the roasting ovens are about four inches higher. Each oven section of both the baking and roasting ovens is provided with two heating units, one located in the top and one in the bottom (underneath the deck) of the oven compartment. The heating units are usually of the enclosed type but some ovens have open-coil type heating units consisting of resistance wire wound on reinforced porcelain rods that are mounted in a steel frame. The oven units are controlled by individual 3-heat rotary switches (two for each section). Each oven section is also provided with an adjustable thermostat for automatic control of the average temperature. The operation of the 3-heat switches and the temperature control is the same as for the type A range previously described.

The type 60 and type 125 roasting ovens are provided with a separately mounted switch box which contains the fuses, contactors, and 3-heat switches for each section. Figure 12-34 is a wiring diagram of the type 60 oven. The types 12 and 18 baking ovens do not have a separate switch box because all control devices are mounted in a compartment at the right of each oven. The compartment is provided with a hinged, or removable, cover for access to the interior.

DEEP FAT FRYERS

Electric deep fat fryers, are normally provided in the type 23, type 45, and type 90 sizes rated at 5 kw, 10 kw, and 18 kw, respectively. The fryer consists of a rectangular sheet-steel enclosure that houses a polished-steel fat container (fig. 12-32, C). The fat container is rectangular and is equipped with a drain valve for draining the fat.

The heating units, which are of the enclosed type, are immersed directly in the fat to ensure maximum efficiency. The fryer is equipped with an adjustable automatic temperature control to maintain the fat at the desired temperature. The thermostat control, located on a panel at the front of the fryer, is provided with an OFF position and the adjustable temperature range of 250°F to 40°F is graduated on the control knob.

The thermostat operates contactors, which, in turn, control the circuits to the heating units. The later models of type 45 and 90 fryers are equipped with an upper temperature limit thermostat which operates in the event of failure of the main thermostat. The contacts of the upper limit thermostat are connected in series with a 25-ohm, 25-watt resistor and in parallel with the operating coil of the main power contactor. In the event the temperature reaches 460 degrees F., the thermostat contacts will close, blow a 1-ampere fuse in the control circuit, and de-energize the fryer.

A rotary switch also located on the front panel is provided for disconnecting the fryer from the line. As a safety measure, the switch should be turned to the OFF position when the fryer is not in use.

A compartment located inside the fryer contains the contactors, thermostat, heating unit terminals, line terminal block, fuses, and line switch. The compartment is equipped with a removable panel for access to the control devices. Figure 12-35 is a simplified wiring diagram of the type 90 fryer.

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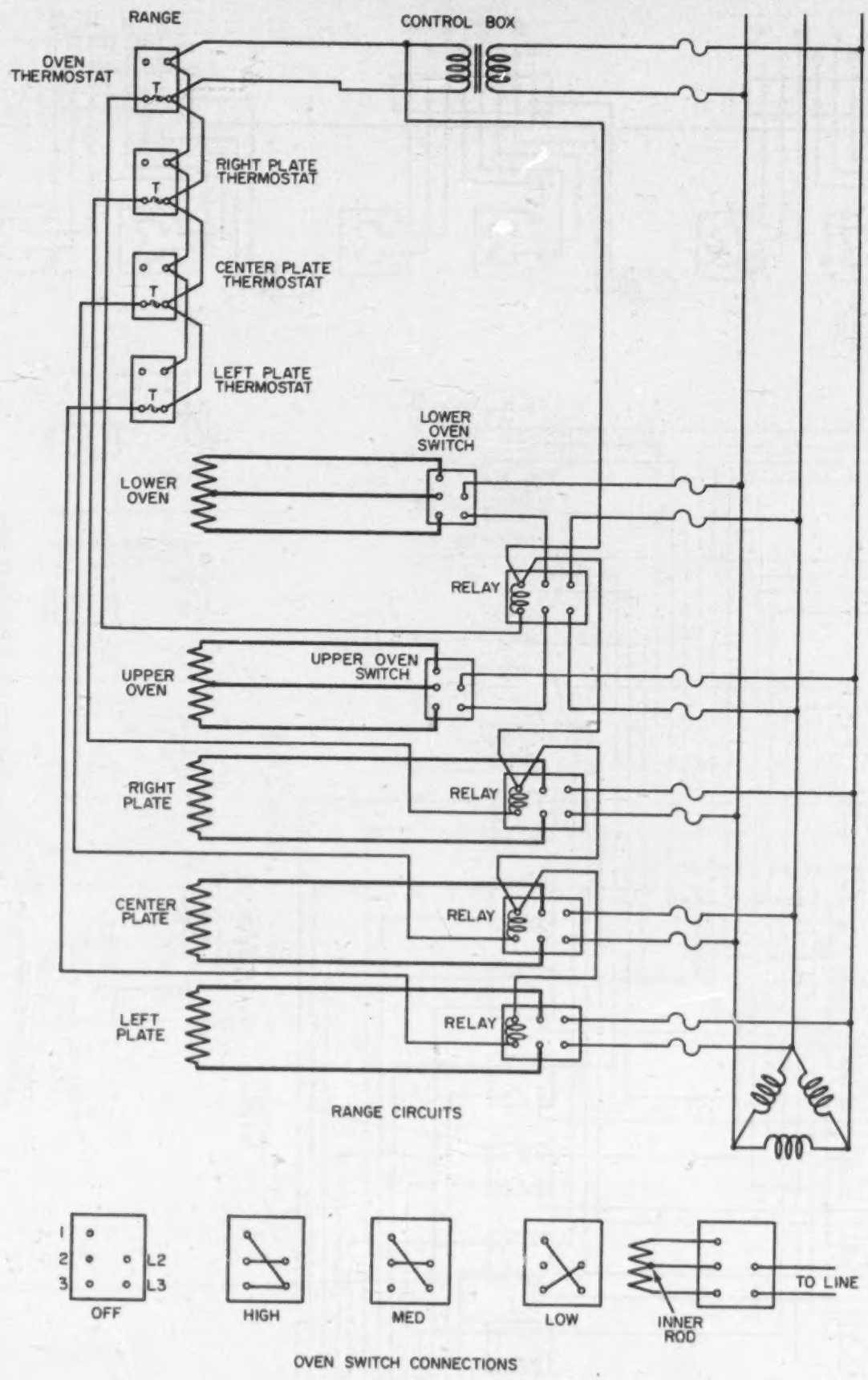

Figure 12-33.—Schematic diagram of type A range.

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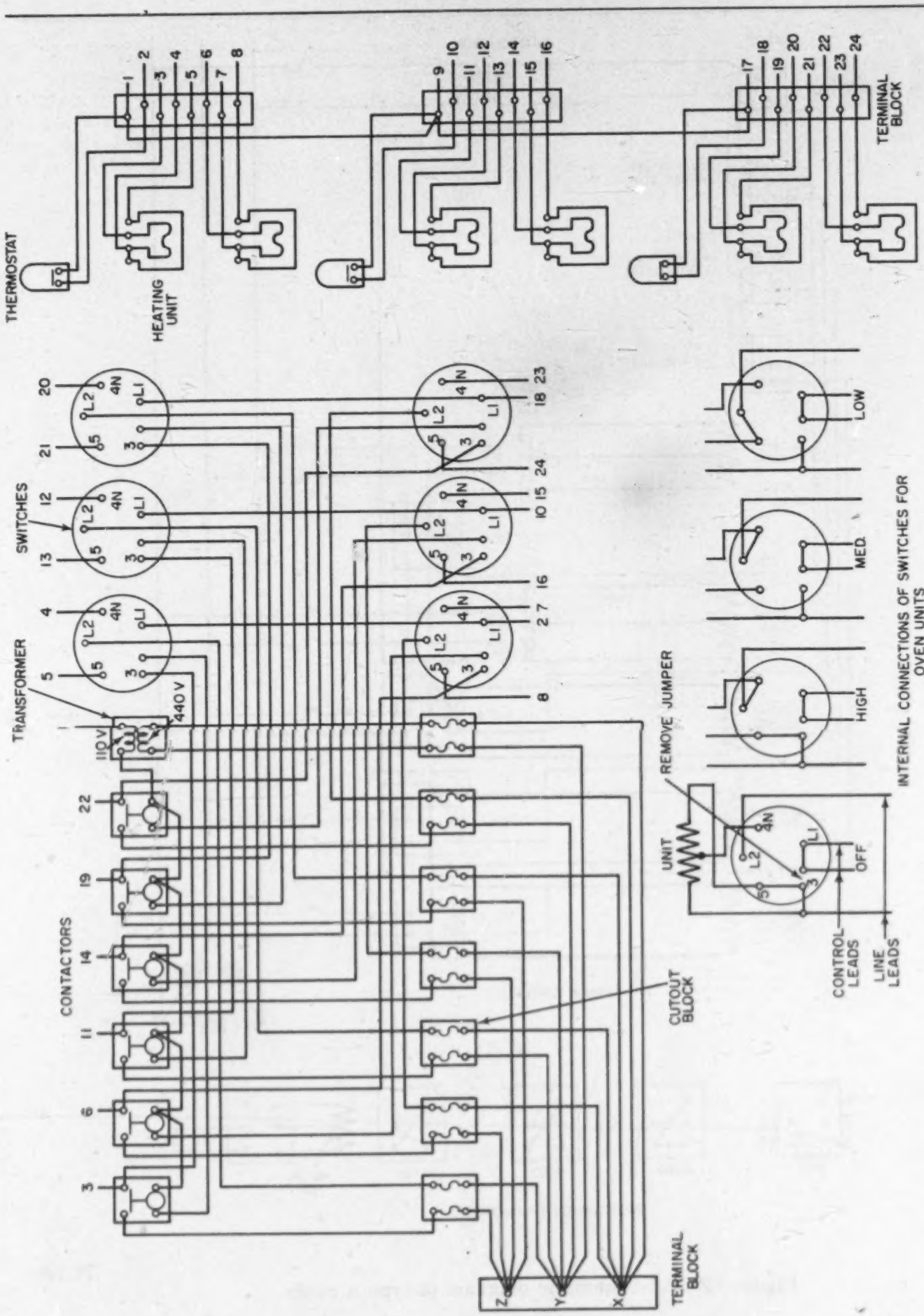

Figure 12-34.—Wiring diagram of type 90 fry kettle.

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MAINTENANCE

Before starting any service work on electric galley equipment be certain that the equipment is disconnected from the power supply. Electrical circuits in the equipment should be inspected and tested at least once each month.

Refer to the manufacturers' manuals for instructions concerning the servicing of the electric galley equipment installed aboard your ship. These manuals also include the methods of removing and replacing the various heating units, thermostats, switches, contactors, and other components of electric cooking equipment.

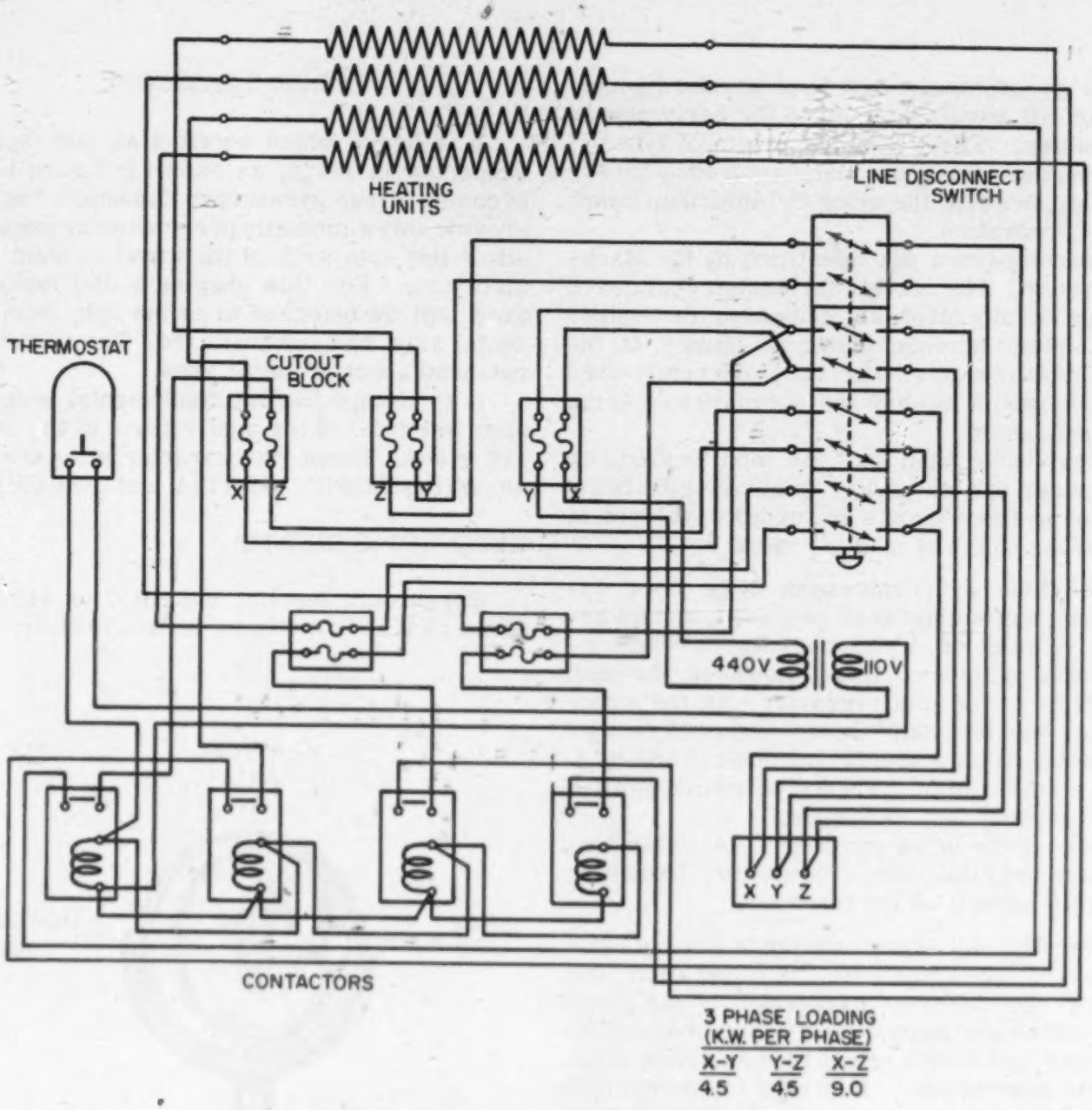

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Figure 12-35.—Wiring diagram of type 90 fry kettle.

CHAPTER 13

GYROCOMPASSES

The gyrocompass has been standard equipment on all naval ships since the early part of the century. There are two principal types of gyrocompass in use, one manufactured by Sperry Rand Corporation, the other by American Bosch Arma Corporation.

Gyrocompasses are identified by the Mark-Mod system. The mark (Mk) number designates a major development of a compass, the modification (Mod) number shows a change to the major development. The Navy currently uses seven marks of Sperry and six marks of Arma gyrocompasses.

There have been various modifications to most marks of both types. Some are still being modified and new marks are under development to meet the needs of modern ships.

The early gyrocompasses were used exclusively for navigational purposes, and an accuracy of plus or minus one degree was considered satisfactory. Today, however, the need for accuracy is much greater, as the gyrocompass supplies ship's course inputs to various systems such as complex fire control and missile systems, radar and sonar systems, plotting and dead-reckoning equipment.

Some of the latest gyrocompasses also furnish roll and pitch data, continuously indicating the zenith as well as the meridian.

Basically, all gyrocompasses depend upon four natural phenomena for their operation. The first two are inherent properties of the gyroscope called gyroscopic inertia and precession. The third and fourth relate to the earth's rotation and gravitation. It is only in the methods whereby these phenomena are utilized that we distinguish one type of gyrocompass from another.

This chapter will discuss these phenomena, and show how a free gyroscope is adapted to a gyrocompass, using the Sperry Mk 11 Mod 6 gyrocompass as a representative compass.

FREE GYROSCOPE

If a heavy wheel rotating at high speed is supported in rings, as shown in figure 13-1, it becomes a true gyroscope. The supporting rings provide three mutually perpendicular axes which allow the spin axis of the wheel to point in any direction. For this chapter's discussion, the axes will be referred to as the spin axis, horizontal axis, and vertical axis. The assembly is balanced about all three axes.

A gyroscope has two fundamental properties upon which all of the applications of the devices are based. These two characteristics are known as GYROSCOPIC INERTIA and PRECESSION.

GYROSCOPIC INERTIA

Gyroscopic inertia, stability, or rigidity of plane as it is sometimes called, is that property

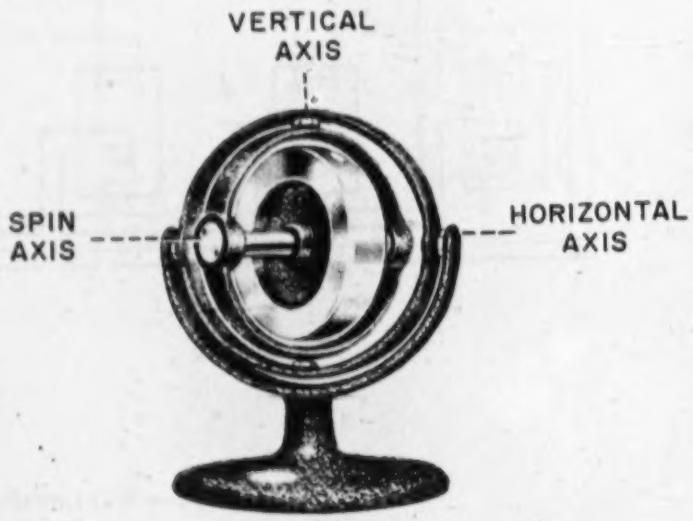

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Figure 13-1.—The gyroscope has three axes of angular freedom.

of a gyroscope which makes it try to keep the spin axis parallel to its original position. This property is explained by Newton's first law of motion which states that a body in motion will continue to move at constant speed in a straight line unless it is acted upon by an outside force. Any point on a spinning wheel is moving in a circular path. Because of inertia (Newton's first law), such a point will tend to move in a straight line, tangent to its circular path. But molecular attraction within the wheel holds the particles together and confines all the particles in the wheel to circular paths. (However, any wheel will fly apart if it is spun with sufficient speed.) Although each particle is confined to a circular path, the entire wheel is free to change its plane; but because each particle tends to stay in a straight line, the inertia of every particle causes it to resist leaving that plane. Thus the rotating wheel tends to rotate in the same plane and to resist any force which tries to change its plane of rotation. In figure 13-2 consider the particles in the rotor at points a, b, c, and d. A momentary force, F, exerted on the axle attempts to change the direction of the path of points c and d—that is, point c tends to move upward and point d downward. Because of the very high kinetic energy, these points resist any attempt to change their paths or directions of motion. The energy and momentum of the rotor attempts to keep the plane of the rotor and the alignment of the axle fixed in space. Gyroscopic inertia may be illustrated by slowly tipping the base of the gyroscope as shown in figure 13-3. With the rotor spinning, the ZZ^1 axis will remain horizontal. The rotor will continue to maintain its original plane of rotation no matter how much the base of the gyro is tipped about the X axis, as long as it continues to spin with sufficient velocity.

Gyroscopic inertia depends upon angular velocity, weight of the rotating mass, and radius at which the weight is concentrated. Maximum effect is obtained, therefore, from a weight rotating at high speed with its principal weight concentrated near the rim.

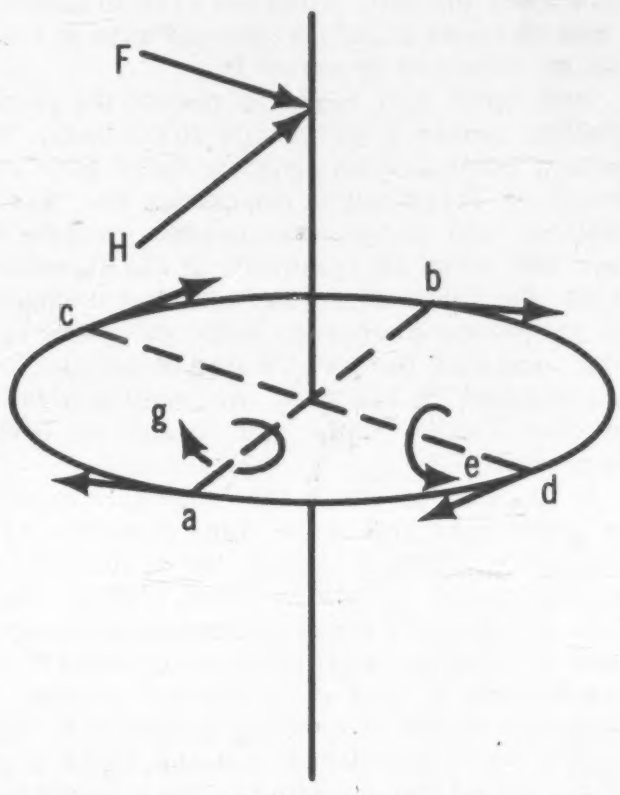

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Figure 13-2.—Spinning rotor with a vertical axle.

PRECESSION

Precession is that property of a gyroscope which causes the spin axis to change direction when subjected to any force that tends to change its plane of rotation. Because of gyroscopic inertia, it has been shown that moving the outer supporting frame has no effect on the direction in which the axle of a spinning gyroscope points. To change this direction, it is necessary to apply a force to the gyroscope rotor or its axle. A horizontal force, F, on one end of the axle (fig. 13-2) produces a turning effect which attempts to tilt the gyroscope about the axis ab in the direction of arrow g. If the rotor were not spinning, the axle would tilt in that manner. When the rotor is spinning, however, its rigidity causes it to resist any attempt to tilt the axle about ab and instead it turns about the axis cd in the direction of arrow e. Conversely a force attempting to turn the gyroscope about the axis cd is similarly resisted and results in a tilt about the axis ab. If the force is applied in direction H, rotation will occur in the direction of arrow-g.

This rotation of a gyroscope about an axis perpendicular to the axis about which a force is exerted is called PRECESSION. Precession takes place whenever any force tends to tilt the axle of a spinning gyroscope rotor. The precession caused by the applied force is always about an axis at right angles to the axis about which

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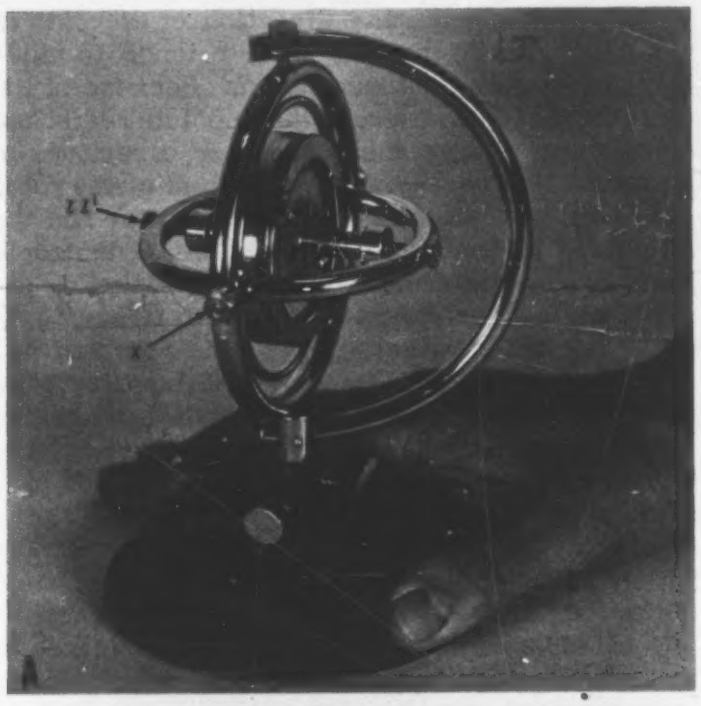

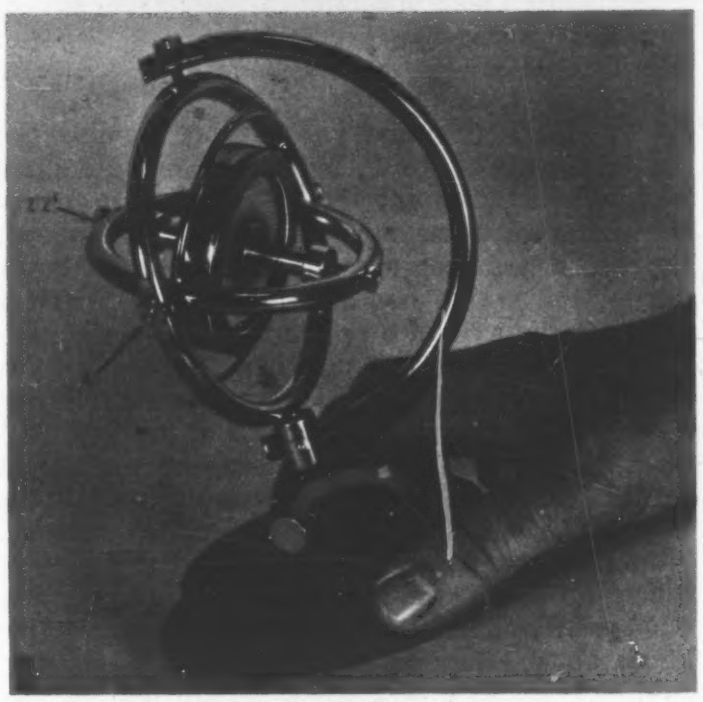

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Figure 13-3.—Rigidity of plane of spinning gyroscope.

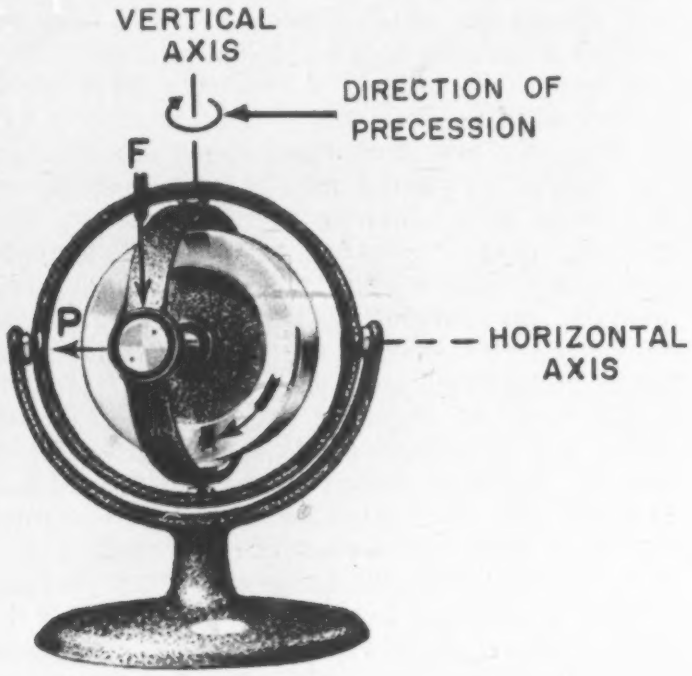

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Figure 13-4.—Precession about the vertical axis.

the force is applied. A simple way to remember the direction in which precession takes place is to regard the force F as though it acted at a single point on the rim of the wheel (in at point X, figure 13-4). This point will not move in response to force F, but a point 90 degrees beyond, in the direction of the wheel's rotation, will move away instead. Thus the gyro in figure 13-4 will precess about its vertical axis in the direction indicated by arrow P.

Any force that tends to change the plane of rotation causes a gyroscope to precess. Precession continues as long as there is a component of force acting to change the plane of rotation; and precession ceases immediately when the force is removed. If the direction in which the force is acting remains unchanged, the gyroscope precesses until the plane of the rotor contains the force's line of action. When this position is reached, the force is about the spinning axis and can cause no further precession.

If the line in which the force acts moves at the same rate and in the same direction as the precession which it causes, the precession will be continuous. This is illustrated by figure 13-5, in which the force attempting to change the plane of rotation is provided by a weight W suspended from the end of the horizontal axle. Although the weight is exerting a downward force, it must be remembered that the force it produces against the particles in the spinning wheel is horizontal. This force is imparted to the particles in the wheel as exemplified by arrows F and F^1. If the wheel rotates clockwise as seen

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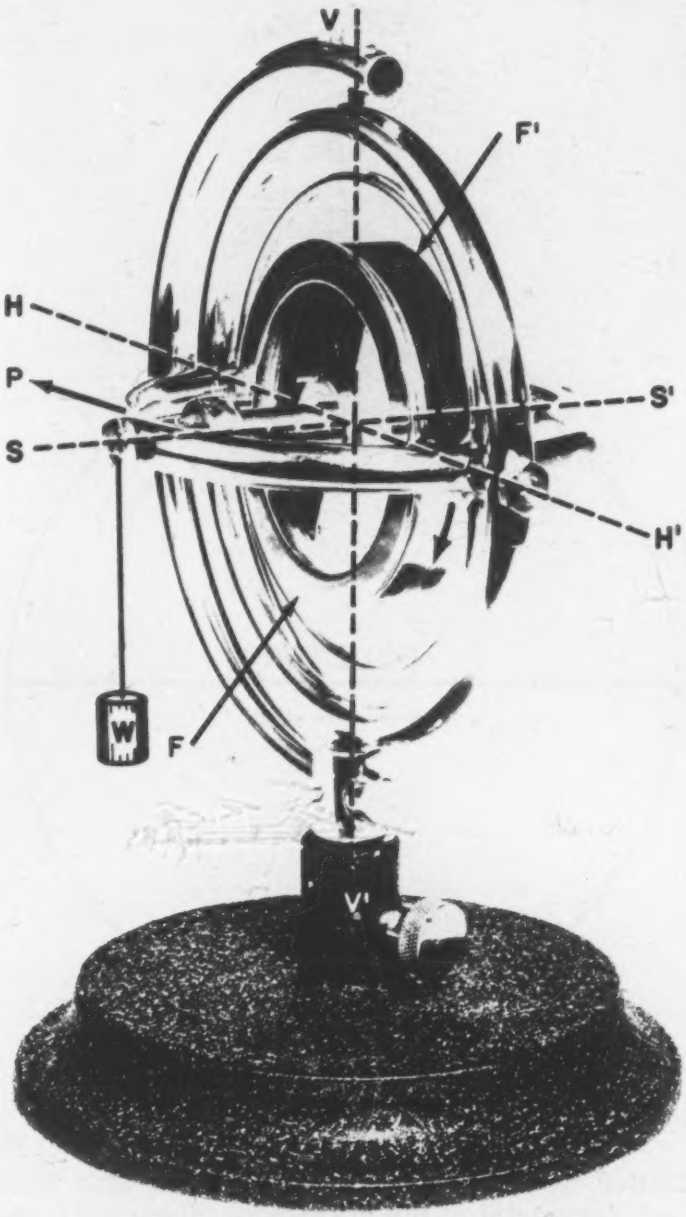

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Figure 13-5.—Continuous precession.

from the weighted end, precession will occur in the direction of arrow P. As the gyroscope precesses, it carries the weight around with it so that forces F and F^1 continuously act at right angles to the plane of rotation and precession continues indefinitely.

A valid explanation of why precession occurs requires the use of vector representations of torques and angular motions and is beyond the scope of this text. However, the concept of torque should be understood since that term is used extensively in the discussion of gyrocompasses.

Torque is defined as the product of a force which tends to produce rotation and the perpendicular distance from the line in which that force is acting to the axis about which the rotation tends to occur. Whereas force acts in a straight line at or on a point, torque occurs in a plane, and is referred to as being applied about an axis. A force acting on the axle of a gyroscope produces a torque about either, or both of the gyro's other two axes. For a given amount of force, the greater its distance from the axis of rotation, the greater the torque. If the force is acting on the axis of rotation, the torque is zero (F X 0 = 0).

FORCE OF TRANSLATION

Any force operating through the center of gravity of the gyroscope does not change the angle of the plane of rotation but moves the gyroscope as a unit without changing its position in space. Such a force operating through the center of gravity is known as a FORCE OF TRANSLATION. Thus, the spinning gyroscope may be moved freely in space by means of its supporting frame, without disturbing the plane of rotation of the rotor. This condition exists because the force that is applied through the supporting frame acts through the center of gravity of the rotor and is a force of translation. It produces no torque on the gyro rotor.

EFFECT OF EARTH'S ROTATION

As explained previously, a free-spinning gyroscope can be moved in any direction without altering the angle of its plane of rotation. If this free-spinning gyroscope is placed on the earth's surface at the equator with its spinning axis horizontal and aligned east and west, an observer in space below the south pole would note that the earth rotates clockwise from west to east and carries the gyroscope along. As the earth rotates, rigidity of plane keeps the gyroscope wheel fixed in space and rotating in the same plane at all times. Figure 13-6 shows how this gyroscope would appear to the observer in space. Assume that the gyroscope is set spinning at 0000 hours with its spinning axis aligned east and west and parallel to the earth's surface. At 0600, 6 hours after the gyroscope was started, the earth has rotated 90° and the axle of the gyroscope is aligned with the original starting position. At 1200 the earth has rotated 180° while the gyroscope retains its original position.

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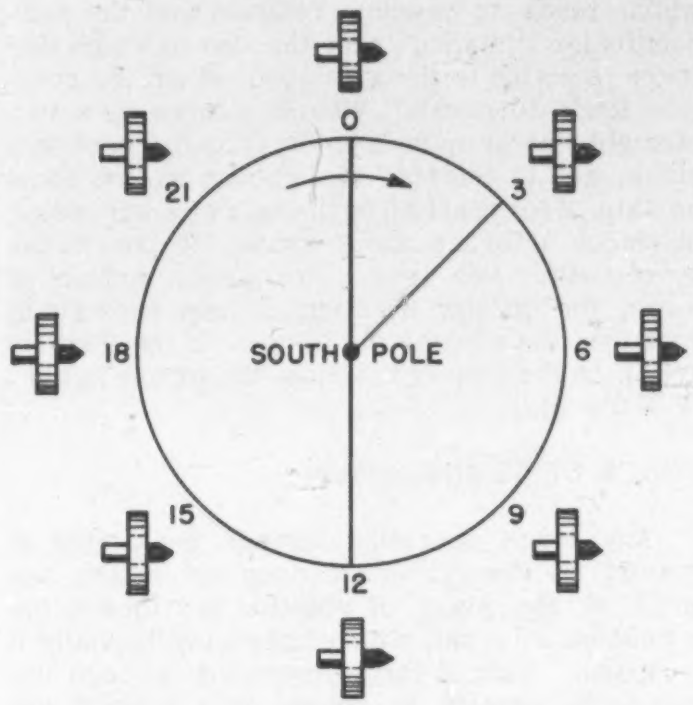

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Figure 13-6.—A gyroscope with its spin axis set in the east-west position at the equator, observed from a point in space beyond the south pole. (Horizontal earth rate.)

At 0000 the earth has rotated 360° and the gyroscope is back in its original position.

This rigidity of plane appears quite different to an observer on the earth's surface. As the earth rotates, the observer moves with it and the gyroscope wheel appears to rotate about its horizontal axis. By rotating the page counterclockwise and observing the successive pictures of the gyro as they come to the top of the figure, the changes as seen by the observer on the earth's surface become readily apparent. Note that if the gyro had been originally set with its axle pointing north and south, there would be no effect apparent to the observer. This apparent rotation or tilt of the gyro horizontal axis is referred to as HORIZONTAL EARTH RATE effect. This effect varies with the cosine of the latitude, and is maximum at the equator and zero at the poles.

Now assume that the spinning gyroscope, with its spinning axis horizontal, is moved to the North Pole (fig. 13-7). To an observer on the earth's surface the gyroscope appears to rotate about its vertical axis. To an observer in space the gyroscope axle appears to remain fixed and

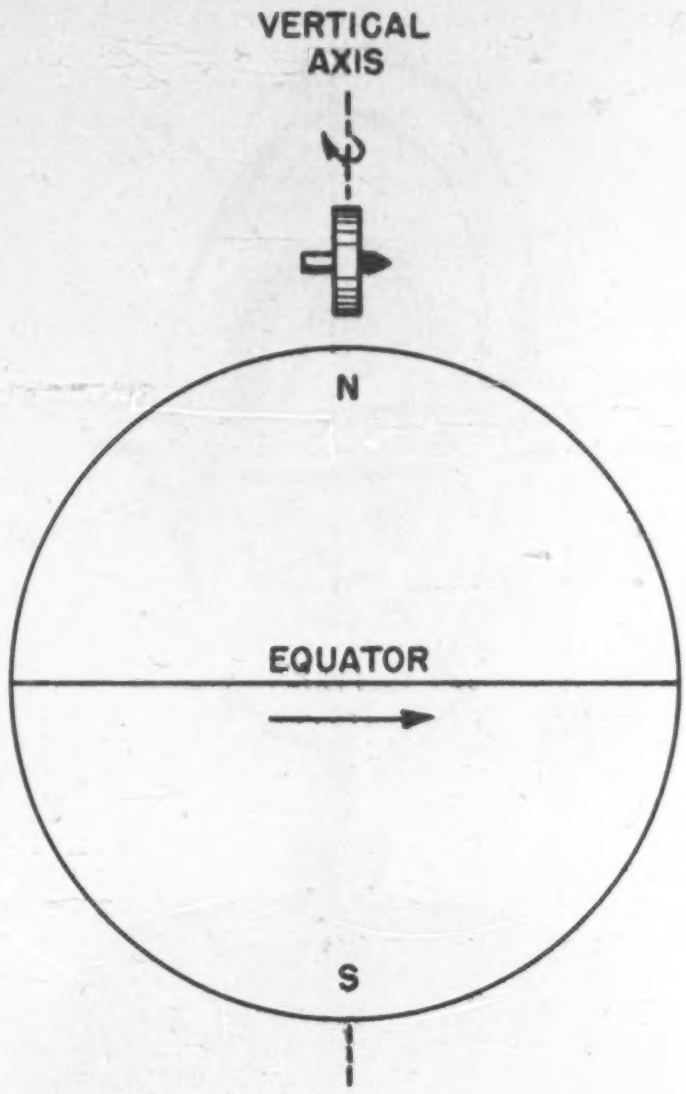

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Figure 13-7.—A gyroscope with its spin axis set horizontal at the north pole, observed from a point in space beyond the equator. (Vertical earth rate.)

the earth appears to rotate under it. This apparent rotation about the vertical axis is referred to as VERTICAL EARTH RATE effect, and varies with the sine of the latitude. It is maximum at the poles and zero at the equator.

APPARENT ROTATION OF THE GYROSCOPE

The rotation of the gyroscope axle as seen by the observer on the earth's surface is known as APPARENT ROTATION. Apparent rotation is caused by rigidity of plane which tends to

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maintain the plane of the gyroscope wheel parallel to its original position in space.

In general, the horizontal earth rate causes the gyro to tilt and the vertical earth rate causes the gyro to move in azimuth with respect to the earth. If it is recalled that the apparent motion of the stars through the sky is a counterclockwise rotation about the North Star, a convenient reminder of the effect of the earth's rotation on a free gyroscope is to consider the gyro axle pointing at a star. The axle will continue to point at the same star (since the stars are fixed in space) and will describe a circle about the North Star. Thus the difference between gyroscopic inertia and apparent rotation is simply one of point of view. As far as space is concerned, the gyro remains fixed; with respect to the earth, however, the gyro actually rotates as described above. As will be seen later, it is this rotation of the gyro with respect to the earth which makes it possible to apply the force of gravity so as to convert the free gyroscope into a north-seeking gyrocompass.

When the gyroscope axle is placed parallel to the earth's axis at any location on the earth's surface, the apparent rotation is about the axle of the gyroscope and cannot be observed. At any point between the equator and either pole, a gyroscope whose spinning axis is not parallel to the earth's spinning axis has an apparent rotation that is a combination of the apparent rotation at the pole and at the equator. This apparent rotation is about both the horizontal and the vertical axes. Apparent rotation is illustrated by placing a spinning gyroscope with its axle on the meridian (aligned north-south) and parallel to the earth's surface at 45° north latitude and 0° longitude, as shown in figure 13-8. As the earth rotates, the positions of the gyroscope at 0000, 0600, 1200, and 1800 show the apparent rotation about the vertical and horizontal axes. Both views are of the same gyroscope, but they are from different angles in order to show the movement about both axes. In both views the observer is above the earth's surface, but he is rotating with the earth. Both views should be considered together because they show the same movement although in different planes.

A and B of figure 13-8 show the spinning gyroscope at 0000. The axle is on the meridian and is parallel to the earth's surface. The apparent movement of the gyroscope at 0600 (C and D of fig. 13-8) is due to the rotation of the earth. The gyroscope axle has moved from alignment

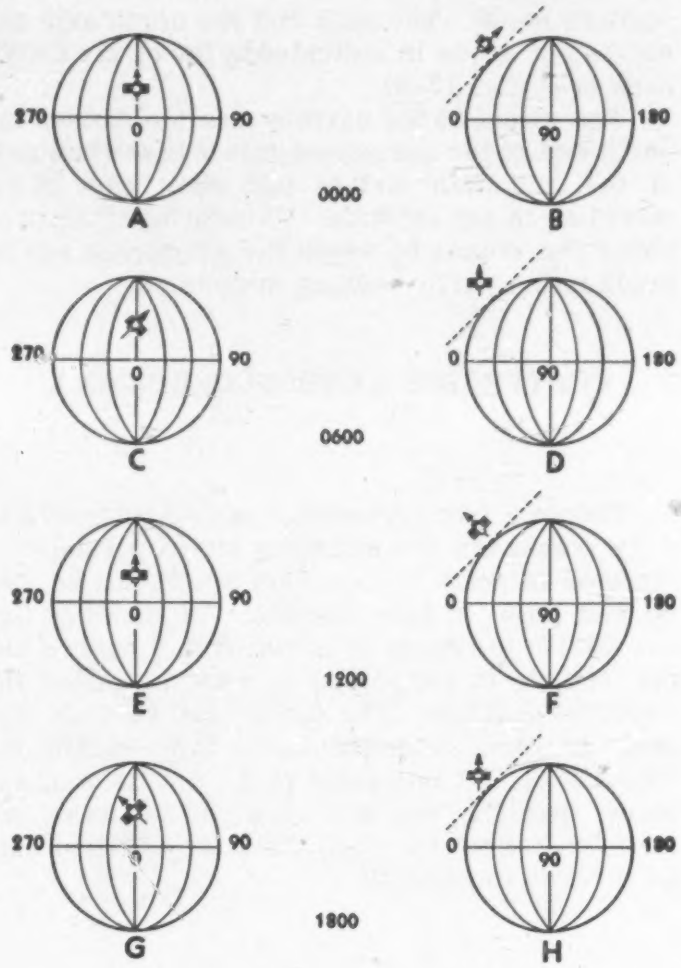

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Figure 13-8.—Apparent rotation of a gyroscope at 45° N latitude.

with the meridian to a position 45° east of the meridian, and the axle apparently has tilted 45° from the horizontal. At 1200 (E and F of fig. 13-8) the gyroscope axle has moved back to the meridian, but it is tilted now at an angle of 90° from the horizontal. At 1800 (G and H of fig. 13-8) the axle has swung 45° west of the meridian, and the tilt of the axle has decreased 45°. After 24 hours, at 0000 the next day, the axle is back on the meridian and is horizontal (A and B of fig. 13-8). The action of any free gyroscope at any latitude between 0° and 90° is similar. This apparent rotation is caused by the earth's rotation.

A gyroscope, if set on any part of the earth's surface with the spinning axle not parallel to the earth's polar axis, appears to rotate, over the center of the gyroscope and parallel to the

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APPENDIX II

ELECTRONIC SYMBOLS

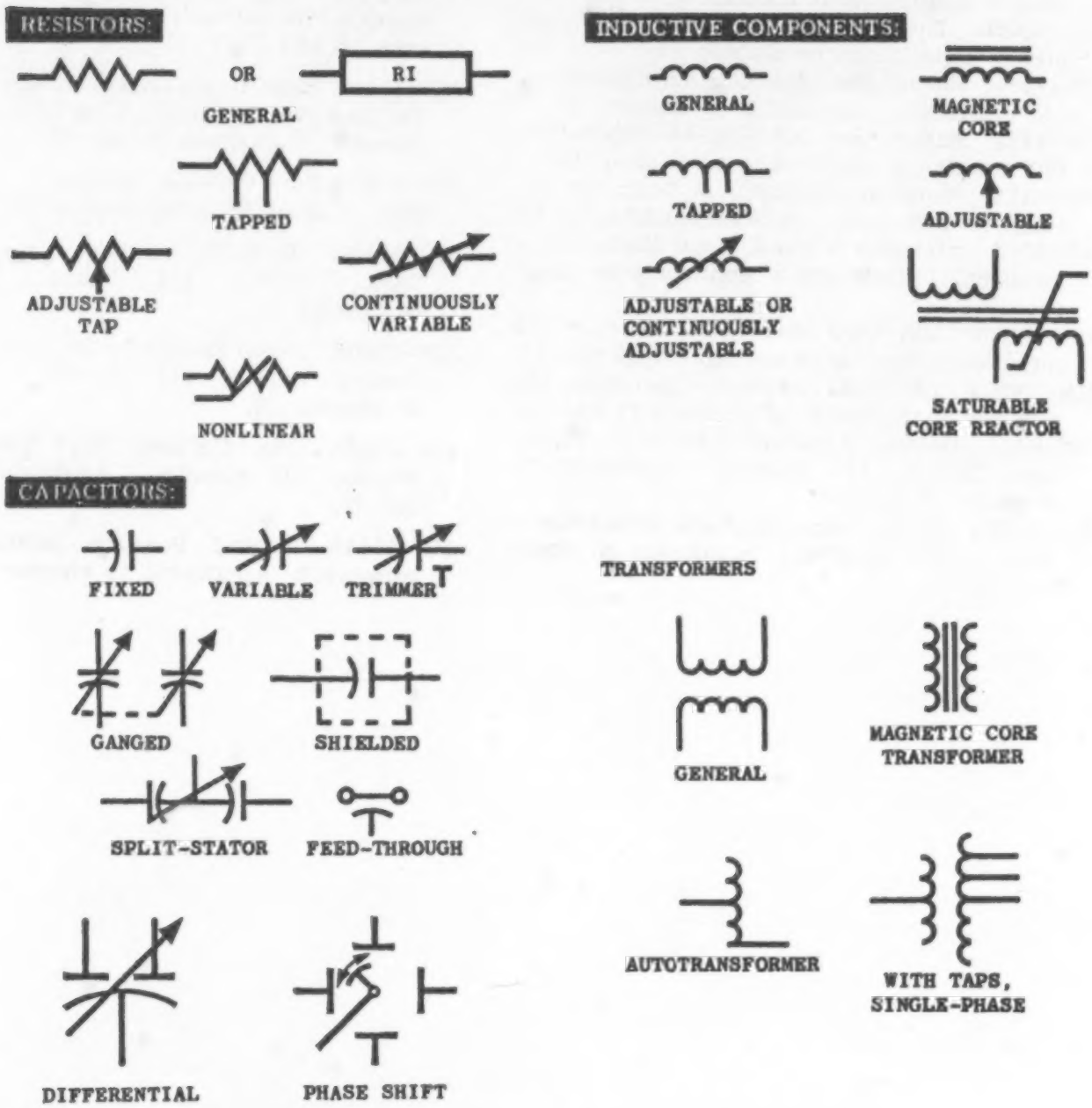

(WHEN CAPACITOR ELECTRODE IDENTIFICATION IS NECESSARY, THE CURVED ELEMENT SHALL REPRESENT THE OUTSIDE ELECTRODE IN FIXED PAPER-DIELECTRIC AND CERAMIC-DIELECTRIC, THE NEGATIVE ELECTRODE IN ELECTROLYTIC CAPACITORS, THE MOVING ELEMENT IN VARIABLE AND ADJUSTABLE CAPACITORS, AND THE LOW POTENTIAL ELEMENT IN FEED-THROUGH CAPACITORS.)

earth's axis. This apparent rotation is in a counterclockwise direction when viewed from south to north. The path that the north axle describes in space is indicated by the circle EAWB back to E (fig. 13-9).

The effect of the earth's rotation causes the north end of the gyroscope axle to rise when east of the meridian and to fall when west of the meridian in any latitude. This tilting effect provides the means by which the gyroscope can be made into a north-seeking instrument.

CONVERTING A GYROSCOPE INTO A GYROCOMPASS

Before a free gyroscope can be converted into a gyrocompass the mounting structure must be changed slightly for reasons which will be discussed later in this chapter. As shown in figure 13-10, the rotor is mounted in a sphere and the sphere is supported in what is called the VERTICAL RING. The sphere and vertical ring are, in turn, mounted in a base called the PHANTOM. At this point in the discussion, assume that the vertical ring and phantom are made to follow the gyro about the vertical axis as it turns in azimuth.

With no further additions, the gyroscope shown in figure 13-10, is still a free gyro. To make a gyroscope into a gyrocompass, the gyroscope has to be made to seek and maintain a true north indication. Since north is the direction represented by a horizontal line in the meridian plane from the point of observation to the North Pole, some means must be provided to: (1) make the gyro axle seek the meridian (point to the North Pole) and (2) keep the axle horizontal.

SEEKING THE MERIDIAN

At the equator, a free gyroscope, if set with its spinning axle horizontal and parallel to the earth's axis, remains in that position because the apparent rotation produced is about the gyroscope axle. Thus, it becomes a direction-indicating device. Once set, it continues to point north as long as no disturbing forces cause it to precess out of the plane of the meridian. Such an instrument, however, is not useful as a compass because any slight friction sets up torques that cause it to precess away from the meridian. Except at, or near, the equator an excessive tilt in relation to the earth's surface is required to keep the gyroscope axle parallel to the earth's axis. In high north or south latitudes,

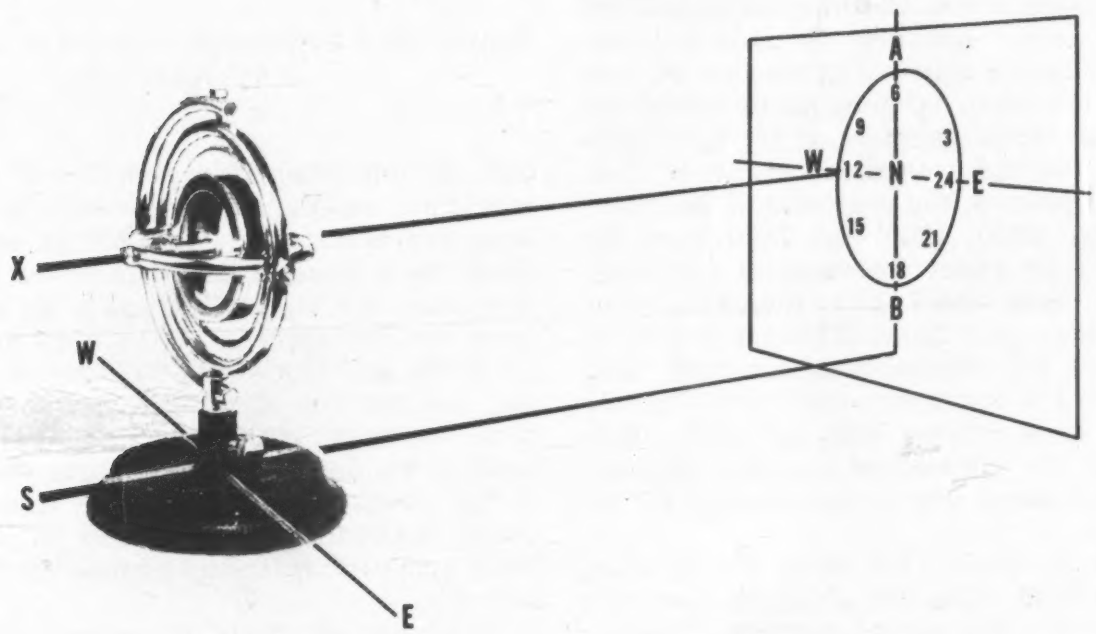

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Figure 13-9.—Path of the spinning axle of a free gyroscope.

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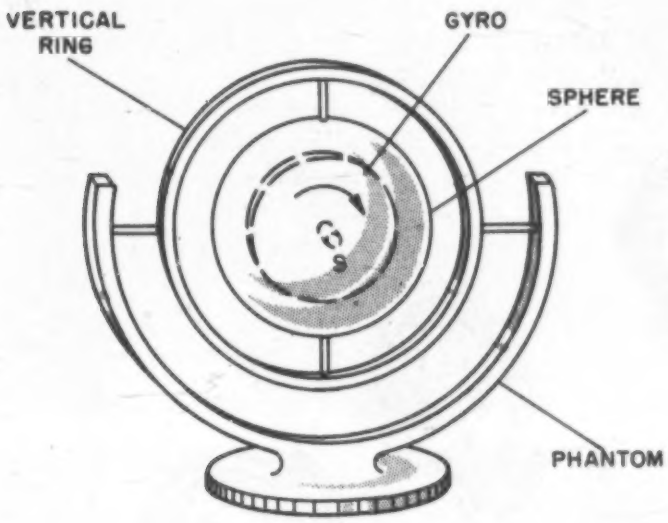

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Figure 13-10.—Modified model gyroscope.

if the axle is set sufficiently level for the instrument to be useful as a compass, the earth's rotation causes it to turn away from the meridian, as illustrated in figure 13-8.

The first step in making a gyroscope a gyrocompass is to make the gyro seek the meridian. To do this, a weight W is added to the bottom of the vertical ring, as shown in figure 13-11. This causes the vertical ring to be pendulous about the horizontal axis.

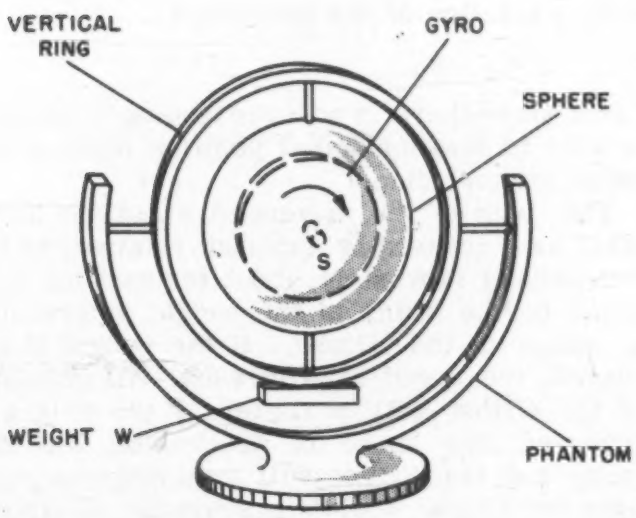

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Figure 13-11.—Making the gyroscope seek north by the addition of a weight to the vertical ring.

The manner in which weight W causes the axle to seek north is shown in figure 13-12, A through E. Assume the gyro to be at the equator with axle horizontal, pointing east-west. This represents the "worst case", or maximum deviation from the desired end result of the axle pointing north-south. Also assume the wheel to be spinning clockwise when viewed from the west. At point A, in figure 13-12, the gyro and vertical ring are vertical and no torque is created by the added weight. At this point both properties of the gyroscope, gyroscopic inertia and precession, are brought into play. As the earth rotates, the axle and therefore the vertical ring become inclined to the horizontal as shown at B in figure 13-12. The weight W is raised against the pull of gravity and consequently causes a torque about the north-south axis of the gyro. This torque causes precession about the vertical axis in the direction indicated at C in figure 13-12; the gyro then has moved out of its original east-west position.

As the end of the gyro which was first pointing east (which will now be referred to as the north end) continues to rise, the torque on the gyro caused by the weight becomes greater since the moment arm through which the weight acts gets longer due to the greater tilt. Since the speed of precession is closely proportional to the tilt, the gyro turns about the vertical axis as shown at D in figure 13-12 (in azimuth) at an increasing speed until the axis is on the meridian (E in fig. 13-12).

At the meridian, the tilt, the torque caused by the weight, and speed of precession are all at a maximum. It should be noted here that it is the righting couple applied to the tilted axle by the pendulous weight which causes the compass to precess past the meridian, the kinetic energy of precession being entirely negligible. After the north end of the gyro axle crosses the meridian, the higher (north) end of the tilted axle is to the west of the meridian. As a result, referring back to figure 13-8, the earth's rotation reduces the tilt. As the tilt becomes less, the speed of the precession in azimuth decreases. Finally the axle becomes horizontal and precession to the west stops; the weight on the vertical ring causes no torque about the horizontal axis since it is hanging straight down. At this point, the axle has precessed as far west of the meridian as it was east originally.

As the earth continues to rotate, the north end of the axle starts to dip. The weight W is raised on the opposite side of the horizontal

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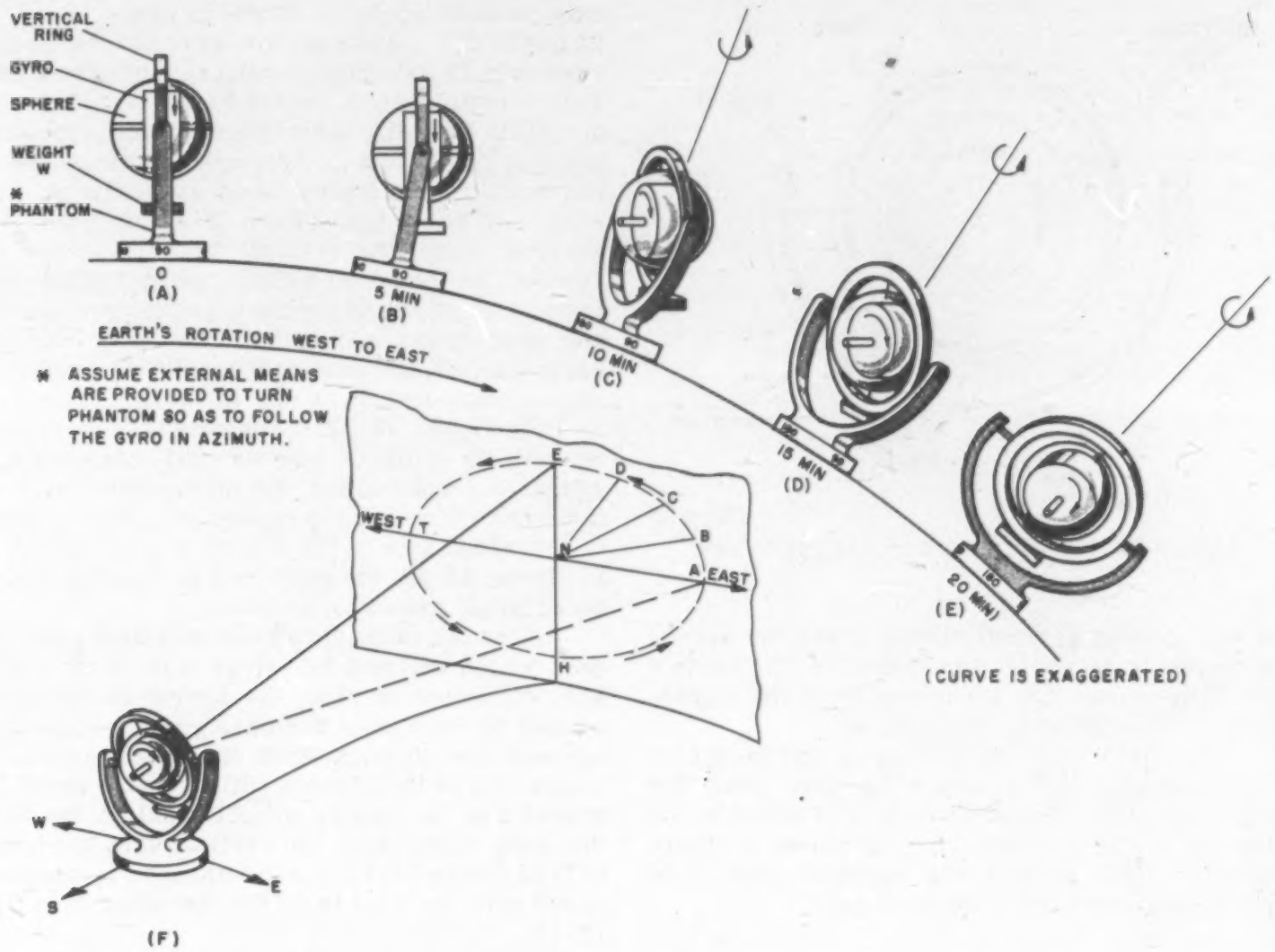

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Figure 13-12.—Effect of the weight and earth's rotation on the gyroscope.

axis in the opposite direction to what it was originally. Precession takes place in the opposite direction carrying the gyro axle back across the meridian to its original position. At this point, the cycle is repeated and will go on indefinitely. The oscillation about the meridian may be understood by referring to F in figure 13-12 which shows the movement of the gyro axle projected on a vertical plane. The ellipse in figure 13-12F is the result of a displacement of the gyro axle only a few degrees from the meridian. If the gyro axle were pointing east-west of the beginning of the cycle as shown at A in figure 13-12, precession would take place through 180 degrees in each direction, and at one extreme the axle would point east, at the other, west. In any case, the gyro never comes to rest since there is no force tending to restore the axle to the horizontal position until it has passed the meridian.

The ratio of the movement about the horizontal axis (caused by apparent rotation) to the precessional movement about the vertical axis caused by the swing of the weight determines the shape of the ellipse. If the weight is increased, the speed of precession will increase and the ellipse will be flatter. If the weight is decreased, the speed of precession will decrease and the ellipse will diminish to a point where the ellipse would, theoretically, be almost circular. The time, in minutes, required for one complete oscillation is called the period of oscillation. For any given wheel and speed at a certain spot on the earth, the period will be

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nearly the same regardless of the angle through which the wheel oscillates. The period can be changed by changing the amount of weight on the bottom of the vertical ring.

With such a gyroscope modified by hanging a weight on the vertical ring, the first condition required to make a gyroscope into a gyrocompass, that of making the gyro axle seek the meridian, has been fulfilled. However, some means must be provided for suppressing the oscillations so the gyro wheel will quickly come to rest with its axle level in the north-south position.

SETTLING ON THE MERIDIAN

To suppress the oscillations of the gyro about the meridian a small weight W_1 (fig. 13-13) is added to the sphere in which the gyro is housed. This weight is placed on the east side of the gyrosphere for the gyro rotates clockwise when viewed from the south. With the gyro axle level, the torque produced by gravity acting upon the weight W_1 is restrained by the vertical axis bearings. When the gyro axle tilts because of earth rate, the vertical axis is no longer vertical; the force of gravity, however, still pulls straight down on the weight. This allows the torque to act about the vertical axis.

Now, with both weights, the gyro will begin to tilt because of earth rate and as soon as it tilts, the gyro precesses in azimuth toward the meridian and downward toward the level position. As a result of the leveling action of weight W_1, the gyro axle is not tilted up as much when it reaches the meridian as it was with only weight W. Since the gyro axle is not tilted as much, the torque produced by weight W is not as great. Therefore, the gyro axle will not precess as far to the west of the meridian as it was east of the meridian when it was started.

After reaching a point where the axle is level and as far west of the meridian as it is going due to the action of weight W, earth rate is still causing the axle to tilt downward. As a result, torques are created which precess the gyro to the east and up. The same action takes place in the reverse direction. The gyro, this half of the cycle, is not precessed as far to the east as it was to the west. Thus, the added weight W_1 causes the ellipse to be reduced each successive oscillation; the north end of the gyro axle will follow a spiral path as shown in figure 13-14 instead of an elliptical path as previously described.

A careful consideration of the action of the two weights will make it apparent that the only position of rest that the gyro can find will be with the gyro axle horizontal and on the meridian. In other words, the free gyroscope has been converted into a true meridian-seeking gyrocompass. The period of the compass can be changed by varying the weight W, and the speed with which it settles to a level position can be changed by varying the weight W_1.

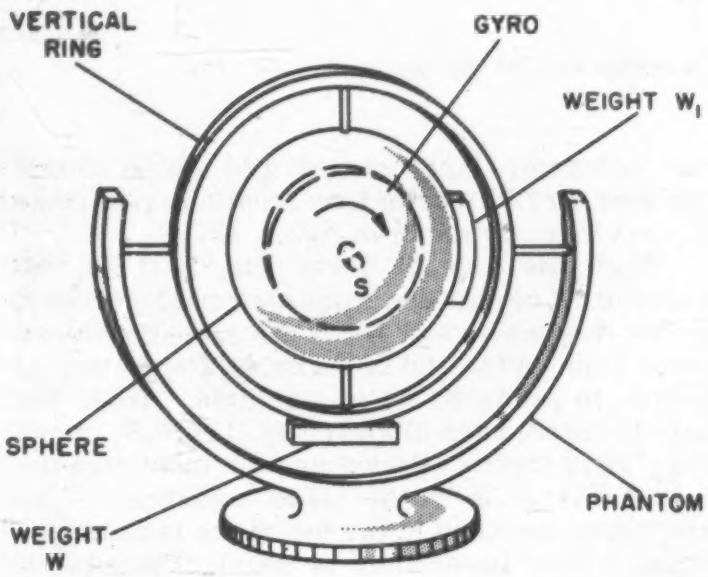

Figure 13-13.—Modified model gyroscope with weights on the vertical ring and sphere.

GRAVITY REFERENCE SYSTEMS

Three types of compasses are used by the Navy. They differ mainly in the manner in which they utilize the force of gravity to cause the desired precession. The NONPENDULOUS type of compass, manufactured by Sperry Gyroscope Company, Inc., uses a device called a liquid ballistic; whereas the PENDULOUS type of compass manufactured by Arma Corporation has more of the weight of the rotor and case below the center of support, making it in effect pendulous. The Sperry Gyroscopes Mks 19 and 23 use neither a liquid ballistic nor a pendulous type of gravity reference system. Instead, they use an electrolytic level to develop an electric signal, which is amplified and converted to torque electromagnetically. The electrolytic level generates a signal voltage that is proportional to the tilt of the gyro axle. This signal

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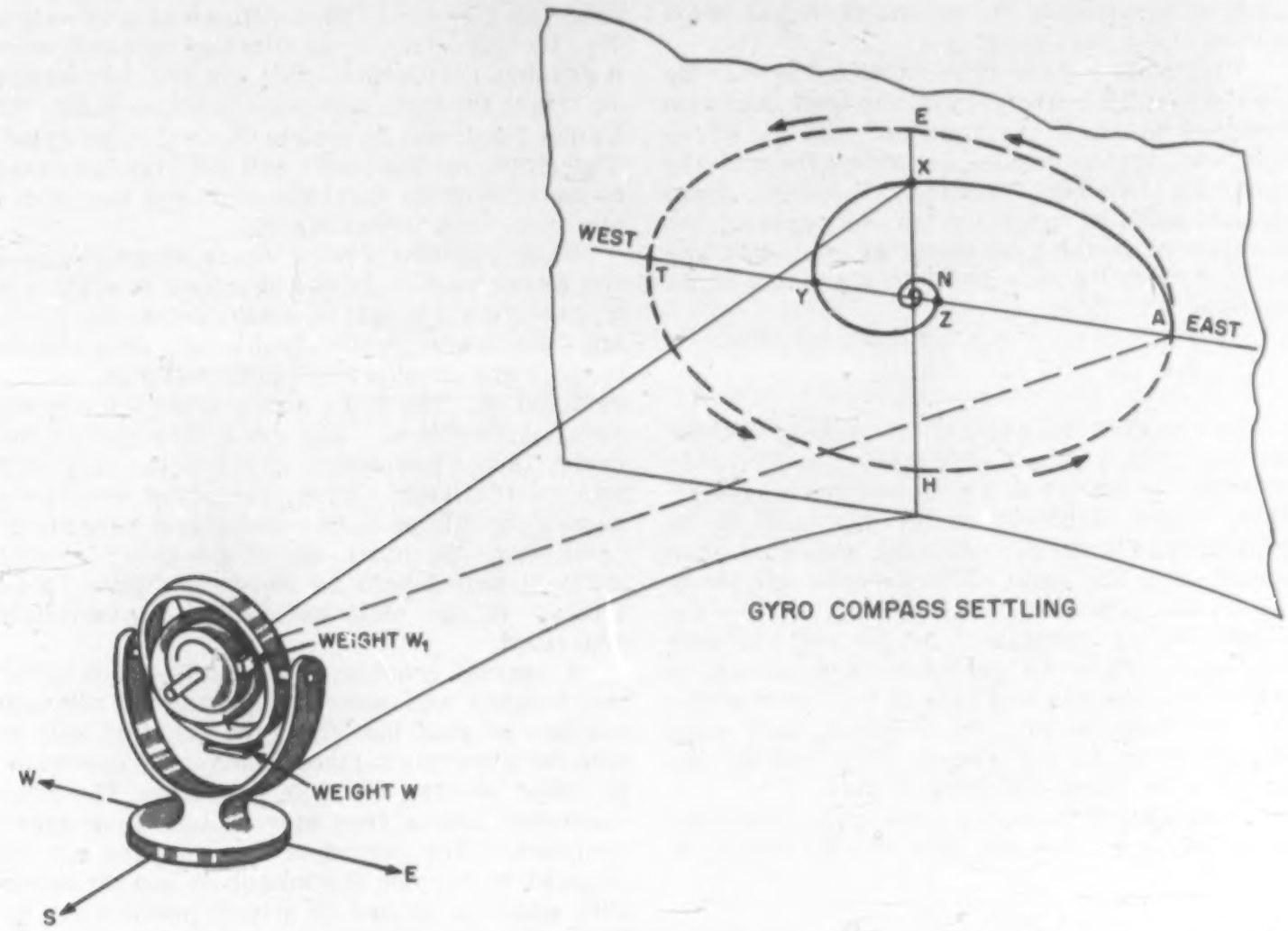

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Figure 13-14.—Effect of both weights on the gyroscope.

is amplified, then fed to the torquers which provide the necessary torques to make the compass seek and settle on the true meridian.

SPERRY PRINCIPLES

Sperry gyrocompasses (with the exception of the Mks 19 and 23) employ a mercury ballistic, or liquid ballistic in the case of the Mk 22, which provides necessary torques to make the compass continuously seek the meridian (true north).

Mercury Ballistic

In its simplest form, the mercury ballistic consists of two mercury-containing reservoirs, one mounted at each end of the rotor axle. The two reservoirs are connected by a pipe so that the mercury is free to flow from one reservoir to the other, as shown in figure 13-15.

When the axle is level (fig. 13-15A), the reservoirs contain the same amount of mercury, weigh the same, and exert the same downward force each on the end of its axle. Therefore, no torque is produced about any axis. When the axle is tilted, even slightly (fig. 13-15,B), mercury runs through the connecting tube from the higher container to the lower container. The amount of mercury in the two tanks is no longer equal. The lower tank is heavier because it contains more mercury. Therefore, the lower tank exerts more force against its axle than does the upper tank, and produces a torque about axis H-H'. This torque, which seemingly

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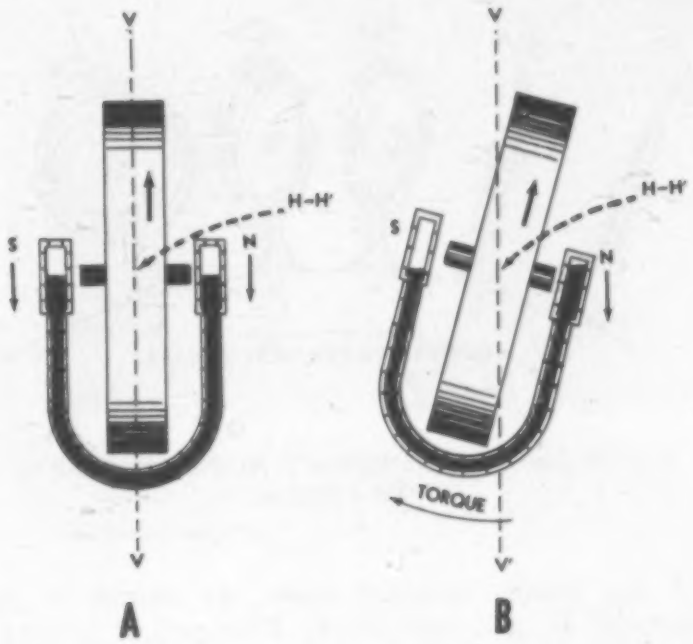

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Figure 13-15.—Action of a mercury ballistic.

tends to increase the tilt, instead, causes precession about the vertical axis, V-V'.

The rotor in a Sperry gyrocompass spins counterclockwise when viewed from the south end of the axle. When the north end is low, the excess mercury in the north tank exerts a downward pressure on the north end of the axle and causes precession to the east, or clockwise. When the north end is high the excess mercury in the south tank exerts a downward pressure on the south end of the axle and causes precession to the west, or counterclockwise.

As you have learned, when the north end of the rotor axle is east of the meridian, the earth's rotation causes it to rise. When a mercury ballistic is added to the gyroscope, the elevation of the north axle produces a torque about the horizontal axis that causes counterclockwise, or westerly, precession. When the north end of the axle is west of the meridian, the earth's rotation causes it to drop. A low north axle causes the mercury ballistic to exert a torque about the horizontal axis that gives clockwise, or easterly, precession.

If this gyroscope with its mercury ballistic is set on the equator with the axle pointing to the east of the meridian and with the rotor spinning counterclockwise (fig. 13-16,A) the north end of the axle tilts upward because the

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Figure 13-16.—Elementary Sperry gyrocompass at the equator.

earth rotates under it. When this tilt occurs mercury flows from the north to the south tank, and the south tank becomes the heavier. The south tank applies a torque around the horizontal axis (fig. 13-16, B). This torque results in a precessional motion around the vertical axis toward the meridian and the west. Because the earth is constantly turning, the gyroscope continues to tilt upward, more mercury flows to the south tank, and the torque around the horizontal axis gradually increases with a corresponding increase in the precession about the vertical axis (fig. 13-16, C & D). This upward tilting continues until the gyroscope axle is on the meridian (fig. 13-16, E). The south tank contains more mercury than the north tank, and the gyroscope is tilted upward its greatest amount. At this point the rate of precession is at its peak.

After the gyroscope axle crosses the meridian it begins tilting downward so that mercury flows from the south tank to the north tank. This transfer of mercury gradually reduces the torque about the south end of the axle with a corresponding gradual reduction in the rate of precession of the gyroscope about the vertical axis. When the gyroscope axle is once more level, it points to the west of the meridian, the mercury is distributed equally in both tanks, no torque is applied to either the north axle or the south axle, and precession ceases.

As the earth continues moving, the north end of the gyroscope axle tilts downward, and mercury flows into the north tank, which applies a torque to the north end of the spin axis. Hence, the direction of precession is reversed and is now toward the east. The downward tilt of the

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spinning axis continues, and the torque and rate of precession increase. By the time the gyroscope axle reaches the meridian, it has attained its maximum rate of precession again, but it now has a downward tilt. After the gyroscope passes the meridian, the rotation of the earth starts the north end of the gyroscope axle tilting upward. As this action occurs the torque about the north axle gradually diminishes to zero and the precessional motion around the vertical axis slows down until the gyroscope axle is once more horizontal and precession ceases. When the gyroscope axle becomes horizontal, the axle points in its original starting position. Figure 13-17 shows that the path followed by the north axle of the gyroscope has the shape of an ellipse. The gyroscope continues these oscillations indefinitely as long as the wheel is spinning.

ARMA PRINCIPLE

The Arma compass is north-seeking because it is given a force of precession by a pendulous weight. To understand how this compass operates, assume again that the gyroscope is on the equator and that its spinning axis is horizontal and points to the east of the meridian. Instead of having a mercury ballistic, the gyroscope has a weight, W, at the bottom of the rotor case, as shown in figure 13-18. The north end of the gyroscope appears to tilt upward because the gyroscope wheel maintains its plane in space as the earth revolves under it. Gravity attracts the weight toward the center

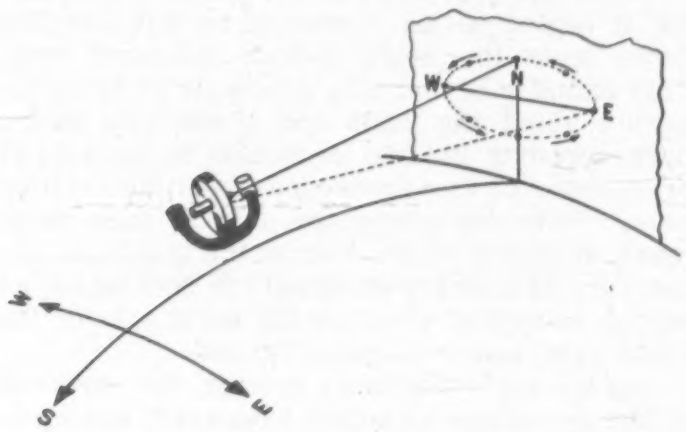

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Figure 13-17.—Undamped period of the Sperry compass at the equator.

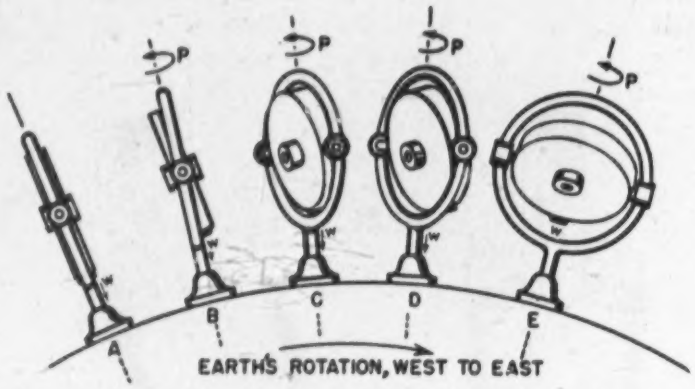

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Figure 13-18.—Elementary Arma compass at the equator.

of the earth, straight down, as shown in A through E of figure 13-18. This pull of gravity has the same effect as a torque about the horizontal axis.

The mercury ballistic of the Sperry compass as shown in B of figure 13-16 applies a downward force on its SOUTH axle to cause precession to the west. Conversely, the weight W of the Arma compass has the same effect as a downward force on its NORTH axle to cause precession to the west. Because both types of compasses must precess in the same direction—that is, to the west—the rotors obviously must rotate in opposite directions to give this precession. The rotor of the Sperry compass rotates counterclockwise whereas the rotor of the Arma compass rotates clockwise when viewed from the south axle.

As the upward tilt increases, the torque, or pull of gravity, increases with the rate of precession to the west. When the gyroscope is on the meridian (E of fig. 13-16), the axis has reached the maximum in both tilt and the rate of precession. After the gyroscope has swung across the meridian, the tilt and the rate of precession diminish until the north end of the axle is at its farthest point west of the meridian and is again horizontal. At this point there is no precession because the weight is acting through the center of gravity of the rotor and therefore does not produce torque. However, the earth continues to rotate under the gyroscope. The north end of the axle drops below the horizontal, and, as the pendulous weight no longer hangs vertically down from the center of the rotor, a torque is again produced around the

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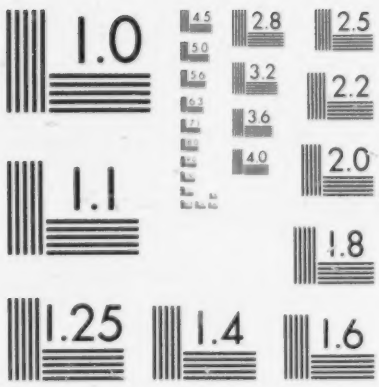

MICROCOPY RESOLUTION TEST CHART

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horizontal axis. The precession resulting from this torque is toward the east. The downward tilt and the rate of precession increase until they are at a maximum value, when the axle is again on the meridian. As the axle crosses the meridian, the downward tilt decreases because the earth rotates under the gyroscope. The angle of tilt and the rate of precession decrease and become zero when the rotor is at its point of farthest travel to the east and is in the horizontal. Now the gyroscope axle is horizontal once more at the point where the oscillation first started. Oscillations continue as long as the gyroscope wheel continues to spin. As in the Sperry compass, the north axis of the Arma compass moves along an elliptical path.

Whatever the starting position may be, oscillations take place for both types of gyroscopes. The gyroscope precesses one way or the other until the axis is made level by the effect of the earth's rotation. The gyroscope then swings toward the meridian, crosses it, continues to the other side, becomes level again, swings back to the starting position, and continues the oscillations indefinitely.

PERIOD OF OSCILLATION

The time required for one complete cycle of this movement of the gyroscope wheel is called PERIOD OF OSCILLATION. The time is conveniently expressed in minutes. For a given wheel at a particular spot on the earth's surface the period is the same regardless of the angle through which the wheel oscillates.

The period of a north-seeking gyroscope is determined by the (1) size and shape of the rotor, (2) rotor speed, (3) torque developed by the mercury or liquid ballistic, or torquers (Sperry compasses), or the pendulous weight (Arma compasses), and (4) latitude. If a short period of oscillation is used, the gyrocompass is disturbed too greatly by ship motions such as speed and course changes, roll and pitch. Lengthening the period reduces the effect of these forces. Too long a period however, causes the compass to take an excessive amount of time to settle on the meridian after starting and after a disturbance.

Both Arma and the ballistic type Sperry gyrocompasses are built with an undamped period of 85 minutes at 40.7° north (New York) latitude. An undamped period of 85 minutes is long enough to prevent excessive disturbances of the compasses from the motions of the ship.

A graph representing the oscillations of a north-seeking gyroscope with a period of 85 minutes is shown in figure 13-19. Such a graph is known as an undamped curve. The original displacement of the gyroscope axle is 30° east of the meridian. In 21 1/4 minutes the axle reaches the meridian; after 42 1/2 minutes it is 30° west; at 63 3/4 minutes it is again on the meridian; and after 85 minutes it is back at its starting position, 30° east. The cycle is then repeated and continues indefinitely.

A gyrocompass with an undamped period of 85 minutes in one latitude has a different period in any other latitude. The nearer the gyrocompass is to the equator the shorter is the period; the farther away the gyrocompass is from the equator, the longer is the period. This is true because the tilt of the axle caused by the earth's rotation when the axle is not on a meridian is greatest at the equator. With zero tilt at the north pole there is no restraint to keep the gyrocompass axle from apparently turning about the vertical axis. Maximum tilt at the equator causes maximum restraint and maximum directive effort to cause the gyrocompass to precess toward the meridian.

To be useful as a compass, a north-seeking gyroscope must be made so that its axle settles in a position that is parallel to the meridian and to the surface of the earth, or nearly so. At any location except at the equator the north end of a level gyroscope normally is moved to the east or west by the effect of the earth's rotation. If a gyroscope is started with its axle level and pointed north in a north latitude, the rotation of the earth causes the north end of the axle to turn slowly toward the east and rise. Conversely, if a gyroscope is started with its axle level and pointed north in a south latitude, the rotation of the earth causes the north end of the axle to slowly turn toward the west and fall. It must, therefore, be made to precess to the west in a north latitude and to the east in a south latitude at the proper rate to cancel this effect of the earth's rotation. The rate of precession required is so slow that only a small angle of tilt is necessary in any latitude.

DAMPING THE OSCILLATIONS

The north-seeking gyroscope can never settle in the desired position as long as it oscillates across the meridian. Therefore, some means must be provided to suppress, or damp, the

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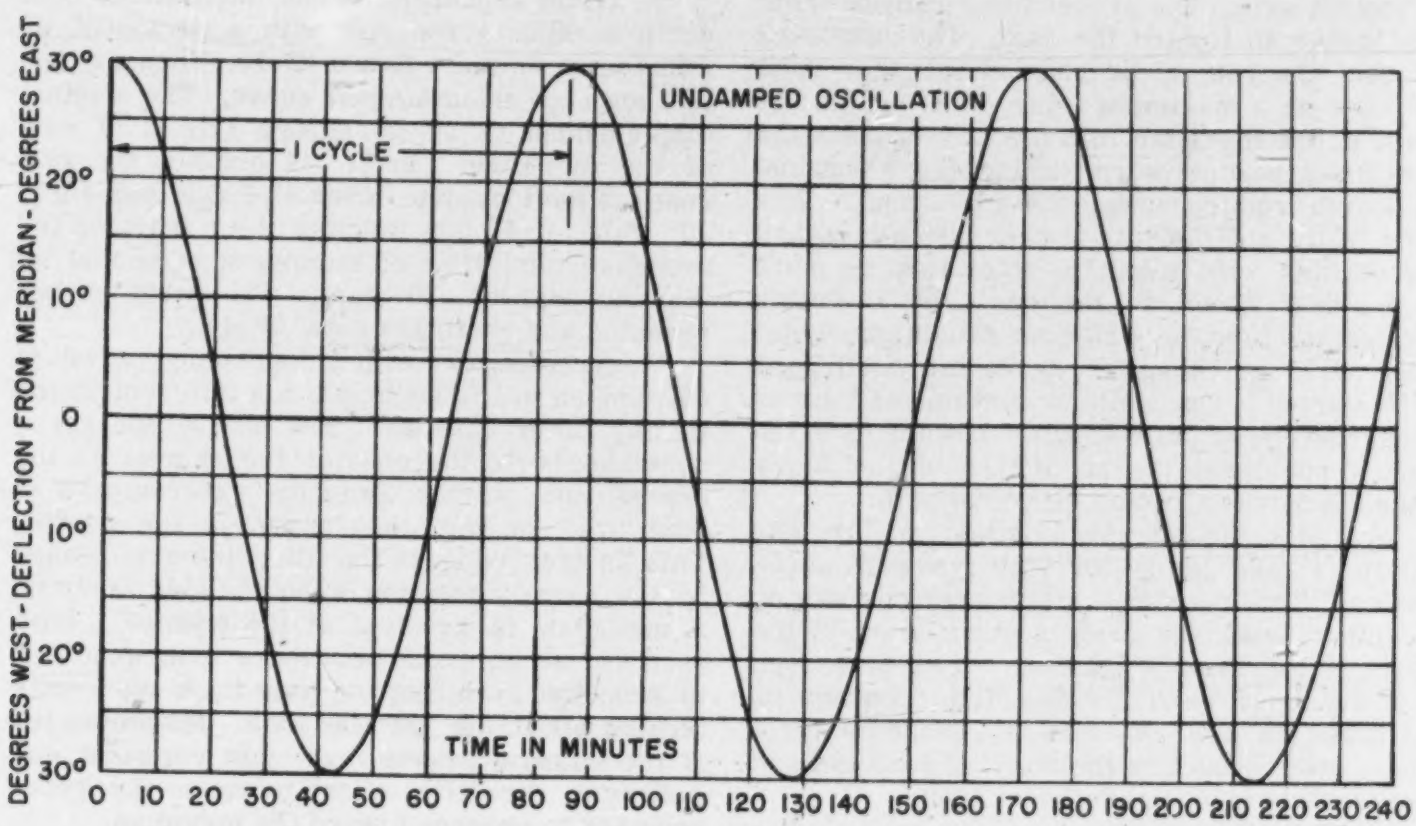

77.205

Figure 13-19.—Oscillation curve of an undamped compass.

oscillations by reducing the size of successive swings past the meridian until the swinging is stopped. When damped, the north-seeking gyroscope (1) settles with the tilt that is necessary to cancel the effect of the earth's rotation and (2) gives a continuous indication of true north. The time required for effective damping is about 4 hours for Arma and ballistic type Sperry compasses. The Sperry Mks 19 and 23 gyrocompasses are provided with fast settling systems which greatly reduce the time required for damping during starting.

Sperry Methods

Oscillations are damped in the Sperry gyrocompasses utilizing the mercury ballistic by employing a portion of the torque produced by the action of gravity upon the mercury ballistic to remove some of the tilt given the rotor axle by the rotation of the earth.

In the previously described mercury ballistic, the tanks are attached directly to the bearings at the ends of the shaft. In the actual compass the ballistic is pivoted on studs and bearings on an outside ring, called the PHANTOM RING, in such a way that its only point of contact with the gyroscopic element is through a connecting arm, or link, which bears against the bottom of the case in which the rotor spins (fig. 13-20). The rotor case corresponds to the inner ring of a gyroscope and holds the bearings on which the axle turns.

If the point of connection between the mercury ballistic and the rotor case is in the line of the vertical axis the only torque that can be exerted by the mercury ballistic is about the horizontal axis, and the resulting precession is only about the vertical axis. Thus, the compass would oscillate only back and forth across the meridian. However, if this point of connection between the ballistic and the rotor case is set a fraction of an inch to the east of the vertical axis (fig. 13-20), the force exerted by the mercury ballistic is applied about both the horizontal and the vertical axes, and torque is exerted about both the axes. Precession then results about both the vertical and the horizontal axes.

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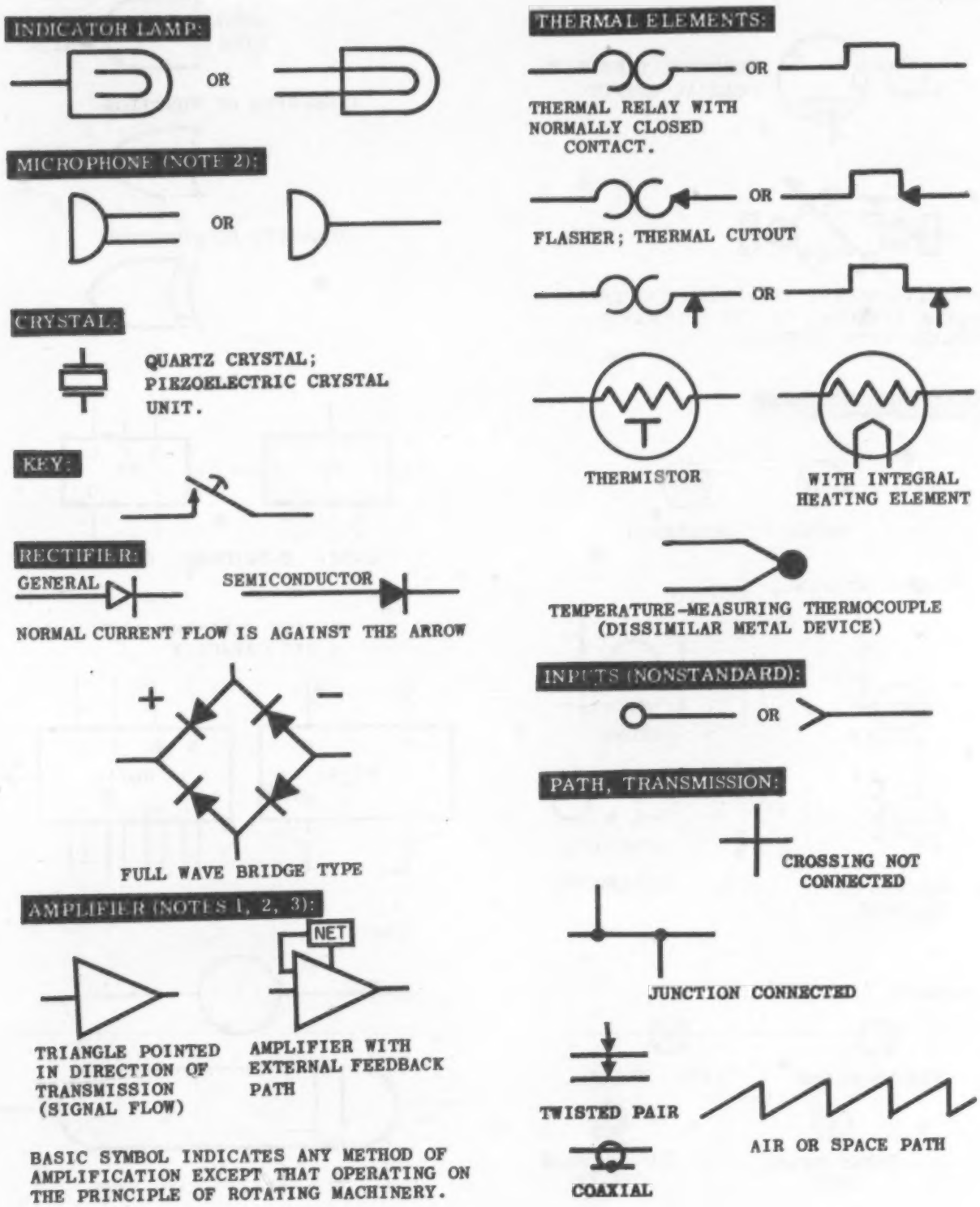
INDICATOR LAMP:
OR
MICROPHONE (NOTE 2):
OR
CRYSTAL:
QUARTZ CRYSTAL; PIEZOELECTRIC CRYSTAL UNIT.
KEY:
RECTIFIER:
GENERAL
SEMICONDUCTOR
NORMAL CURRENT FLOW IS AGAINST THE ARROW
+
−
FULL WAVE BRIDGE TYPE
AMPLIFIER (NOTES 1, 2, 3):
NET
TRIANGLE POINTED IN DIRECTION OF TRANSMISSION (SIGNAL FLOW)
AMPLIFIER WITH EXTERNAL FEEDBACK PATH
BASIC SYMBOL INDICATES ANY METHOD OF AMPLIFICATION EXCEPT THAT OPERATING ON THE PRINCIPLE OF ROTATING MACHINERY.
THERMAL ELEMENTS:
OR
THERMAL RELAY WITH NORMALLY CLOSED CONTACT.
OR
FLASHER; THERMAL CUTOUT
OR
THERMISTOR
WITH INTEGRAL HEATING ELEMENT
TEMPERATURE-MEASURING THERMOCOUPLE (DISSIMILAR METAL DEVICE)
INPUTS (NONSTANDARD):
OR
PATH, TRANSMISSION:
CROSSING NOT CONNECTED
JUNCTION CONNECTED
TWISTED PAIR
AIR OR SPACE PATH
COAXIAL

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The Sperry Mk 22 gyrocompass utilizes a fraction of the weight of the followup pickoff armature to provide the torques for damping. Damping is accomplished for the Mks 19 and 23 gyrocompasses by the electronic control system mentioned previously.

Arma Method

In the Arma compass the oscillations are reduced by slowing down the rate of precession during each swing away from the meridian so that, in the time required for the axle to become level and start to swing back, the compass does not travel very far.

The damping arrangement used in the Arma compass consists of a fluid ballistic, as shown in figure 13-22. Two tanks, partly filled with a light oil, are secured to the rotor case in line with the north-south rotor axle on opposite sides of the rotor. The tube that connects the tanks has a small opening so that the oil flows slowly from one tank to the other. Unlike the action of the Sperry mercury ballistic the action of the Arma damping is delayed because of the small opening in the tube. The effect of this damping lags behind that of the pendulous weight.

If the north end of the gyroscope axle is elevated, the pendulous weight exerts a downward force on the high, or north, axle. At the same time oil begins to (1) flow from the north tank to the south tank and (2) exert a small force on the low, or south, end. Because of the small opening in the tube, the flow of oil is not effective for some time. If the tilt is maintained long enough, however, sufficient oil accumulates in the south tank to reduce the effect of the pendulous weight on the high end of the axle. The longer the tilt is maintained, the greater is the amount of oil in the south tank and the smaller is the net force exerted by the pendulous weight on the north axle.

If the tilt is reversed and the south axle is elevated, the excess oil in the south tank acts on the high end of the axle. The small opening in the tube prevents the oil from flowing immediately into the north tank. Hence, for a short time after the tilt is reversed the weight of the oil in the south tank adds to the force exerted by the weight on the high south axle.

In A of figure 13-23, the axle has just been tilted with the north end up, and the oil has not had sufficient time to run into the south tank in any great amount. In B of figure 13-23 the tilt has been maintained long enough for a large amount of oil to flow into the south tank, and the resultant force is greatly reduced. In C of figure 13-23 the tilt has just been reversed and there is still excess oil in the south tank. This excess oil adds to the pendulous weight and results in an increased force. In D of figure 13-23 the south axle has been tilted up for some time and the oil has built up in the north tank so that the effect of the weight has been reduced. The length of the arrows indicates the magnitude of the force that is being exerted.

Starting with the compass displaced 30° to the east of the meridian and level (point A, figure 13-24) the earth's rotations will cause the north axle to rise. This causes the pendulous weight to become elevated, the north axle up. This will produce a torque about the horizontal axis causing precession about the vertical axis to the west. However, due to the elevation of the north axle, it will cause the north tank to be elevated. This will cause a transfer of oil to the south tank. This transfer of oil to the south tank will be very slow because of the restriction in the connecting line and will not have much effect at the beginning.

As time goes on however, the oil accumulating in the south tank produces a torque about the horizontal axis opposing the torque produced by the pendulous weight making the net torque less than that produced by the pendulous weight

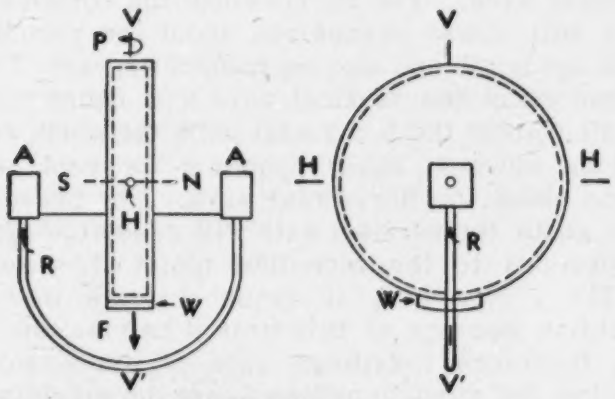

S, N —SPINNING AXIS
V, V' —VERTICAL AXIS
H, H' —HORIZONTAL AXIS
A, A —OIL TANKS WITH PIPE CONNECTION
R —RESTRICTED OPENING IN OIL LINE
W —WEIGHT OR PENDULOUS CHARACTERISTIC
F —GRAVITATIONAL FORCE

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Figure 13-22.—Damping arrangements of the Arma compass.

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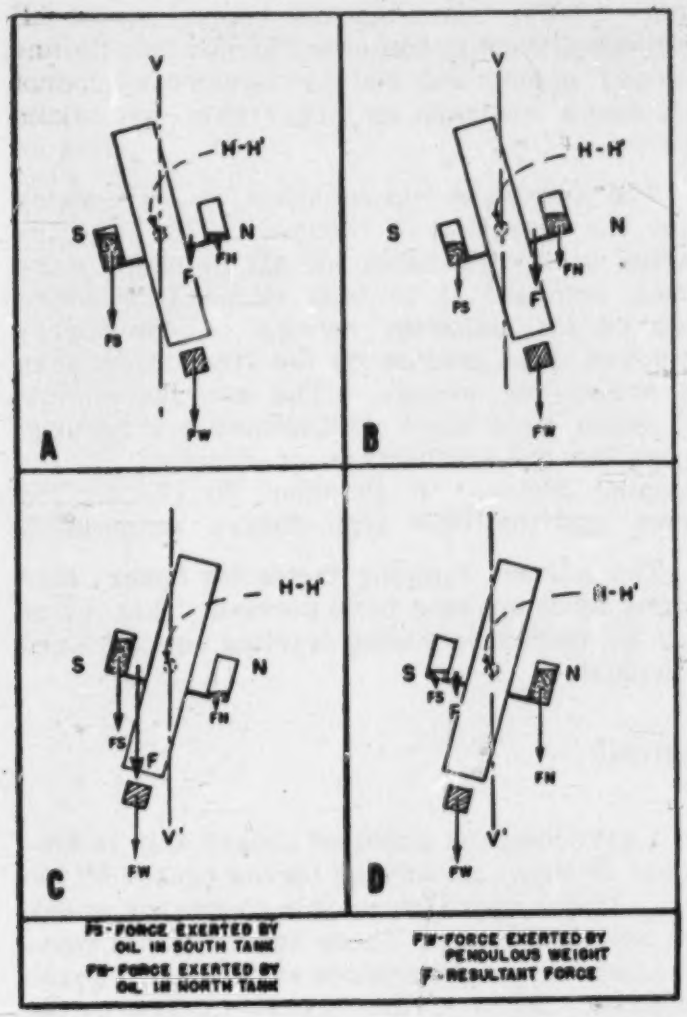

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Figure 13-23.—Action of Arma damping tanks.

above. The rate of precession will be less because there is now less torque causing precession. The north axle of the compass will continue to rise as long as it remains east of the meridian so that the pendulous weight will always exert enough torque to cause it to reach the meridian (point B, figure 13-24). However, it cannot remain on the meridian because at this time it has maximum tilt, therefore maximum rate of precession. As the north axle of the compass crosses the meridian to the west, the earth's rotation will now cause the north axle to fall. This action further reduces the effect of the pendulous weight. As oil has been transferring to the south tank all this time because of the elevation of the north axle, a point is soon reached at which the torque produced by the oil ballistic is exactly equal and opposite to

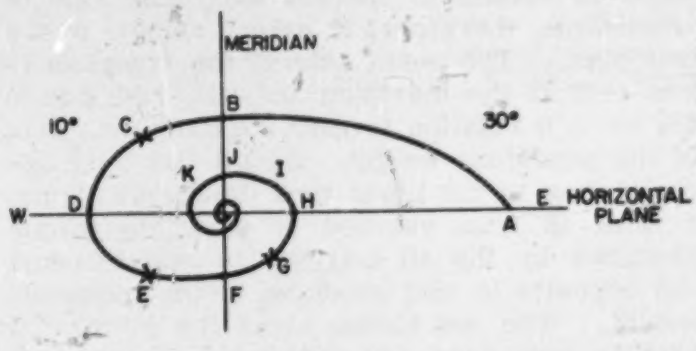

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Figure 13-24.—Path followed by the north axle of a damped Arma compass.

the torque produced by the pendulous weight. At this time the net torque about the horizontal axis is zero (point C, figure 13-24). Therefore precession to the west ceases. The north axle of the compass (being west of the meridian), continues to fall due to the earth's rotation however, further reducing the torque produced by the pendulous weight. The torque produced by the oil ballistic is now greater than that produced by the pendulous weight and causes precession to the east even though the axle has not yet become level. As the north axle becomes level (point D, fig. 13-24) there is still an excess of oil in the south tank due to the restriction in the oil line. This excess of oil in the south tank causes it to continue to precess to the east. The north axle continues to fall due to the rotation of the earth, however elevating the south axle. The pendulous weight now produces a torque about the horizontal axis that also causes precession to the east. At this time the oil ballistic and pendulous weight are exerting torques that are aiding each other. As the south axle is now elevated, however, oil will be transferring to the north tank until a point is reached where there is equal oil in both tanks (point E, figure 13-24). Precession continues to the east however, because of the torque produced by the pendulous weight. The south axle being elevated causes oil to continue to transfer to the north tank. This action produces an excess of oil in the north tank, causing a torque about the horizontal axis opposing that torque produced by the pendulous weight.

As long as the north axle remains west of the meridian, however, it will continue to fall, producing enough torque to cause it to reach the meridian (point F, figure 13-24). At this time,

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there is maximum tilt and maximum rate of precession, therefore, it cannot remain on the meridian. The north axle of the compass is now east of the meridian and will rise due to the earth's rotation further reducing the effect of the pendulous weight. As oil has been accumulating in the north tank during this time, a point is soon reached at which the torque produced by the oil ballistic is exactly equal and opposite to that produced by the pendulous weight. The net torque about the horizontal axis is now zero and precession to the east ceases (point G, figure 13-24). The north axle continues to rise due to the earth's rotation further reducing the effect of the pendulous weight. The oil ballistic is now producing a greater torque than the pendulous weight and causes precession to the west even though the north axle is not yet level. When the north axle becomes level (point H, figure 13-24), there is still an excess of oil in the north tank because of the restrictor in the connecting line which causes the compass to continue to precess to the west. As the north axle becomes elevated due to the earth's rotation, it raises the pendulous weight to the north which produces a torque about the horizontal axis that also causes precession to the west. The torques produced by the pendulous weight and the oil ballistic now aid each other. However, as the N-axle is now elevated, oil will transfer to the S-tank. A point is soon reached at which there is equal oil in both tanks (point I, figure 13-24). Precession continues to the west due to the pendulous weight. However, oil continues to transfer to the south tank which now produces a torque about the horizontal axis opposing the torque produced by the pendulous weight. The north axle will continue to rise as long as it remains east of the meridian. As it reaches the meridian it has maximum tilt and therefore maximum rate of precession and therefore cannot remain on the meridian (point J, figure 13-24). This action continues for about 2 1/2 oscillations at which time the compass has settled and is on the meridian.

Because of the restriction of the flow of oil, the effect of the damping tanks always lags behind the effect of the pendulous weight. This lag makes the oil ballistic useful as a damping device because the ballistic permits the weight of the oil to act at just the right time to oppose the oscillations away from the meridian.

The oscillation curve of an undamped compass compared to the oscillation curves of a damped Sperry and Arma compass are shown in figure 13-25. Note that the damped period for both compasses is somewhat larger than the undamped period and that the damped period of the Arma compass is larger than that of the Sperry.

The amount by which each successive swing past the meridian is reduced by the damping device is not the same for all swings. In the Arma compass it is less on the first swing than on the following swings. In the Sperry compass it is greater on the first swing than on succeeding swings. The average amount by which successive oscillations are reduced is called the percentage of damping or the damping factor. It is about 70 percent for Arma and ballistic type Sperry compasses.

The normal damping factor for Sperry Mks 19 and 23 compasses is 65 percent. This factor may be increased during starting as mentioned previously.

ERRORS

A gyrocompass installed aboard ship is subjected to many disturbing forces caused by the ship's linear speed, changes in course and speed, and roll and pitch. These forces, if not compensated for, would produce errors in the gyrocompass. Some errors are eliminated by the design of the compass, others are eliminated by calculating the amount of the error and correcting the compass either manually or automatically to the correct reading. Gyrocompass errors and the methods of correcting them differ depending upon the type and mark of gyrocompass concerned.

SPERRY MK 11 MOD 6 GYROCOMPASS

The Sperry Mk 11 Mod 6 gyrocompass is used principally on destroyers. The complete system consists of the master compass, the control system, alarm system, followup system, and the transmission system. The master compass includes five major components: (1) Sensitive element, (2) Mercury ballistic, (3) Phantom element, (4) Spider, and (5) Binnacle and gimbal rings. The binnacle and gimble rings enclose and support the other four major components (fig. 13-26).

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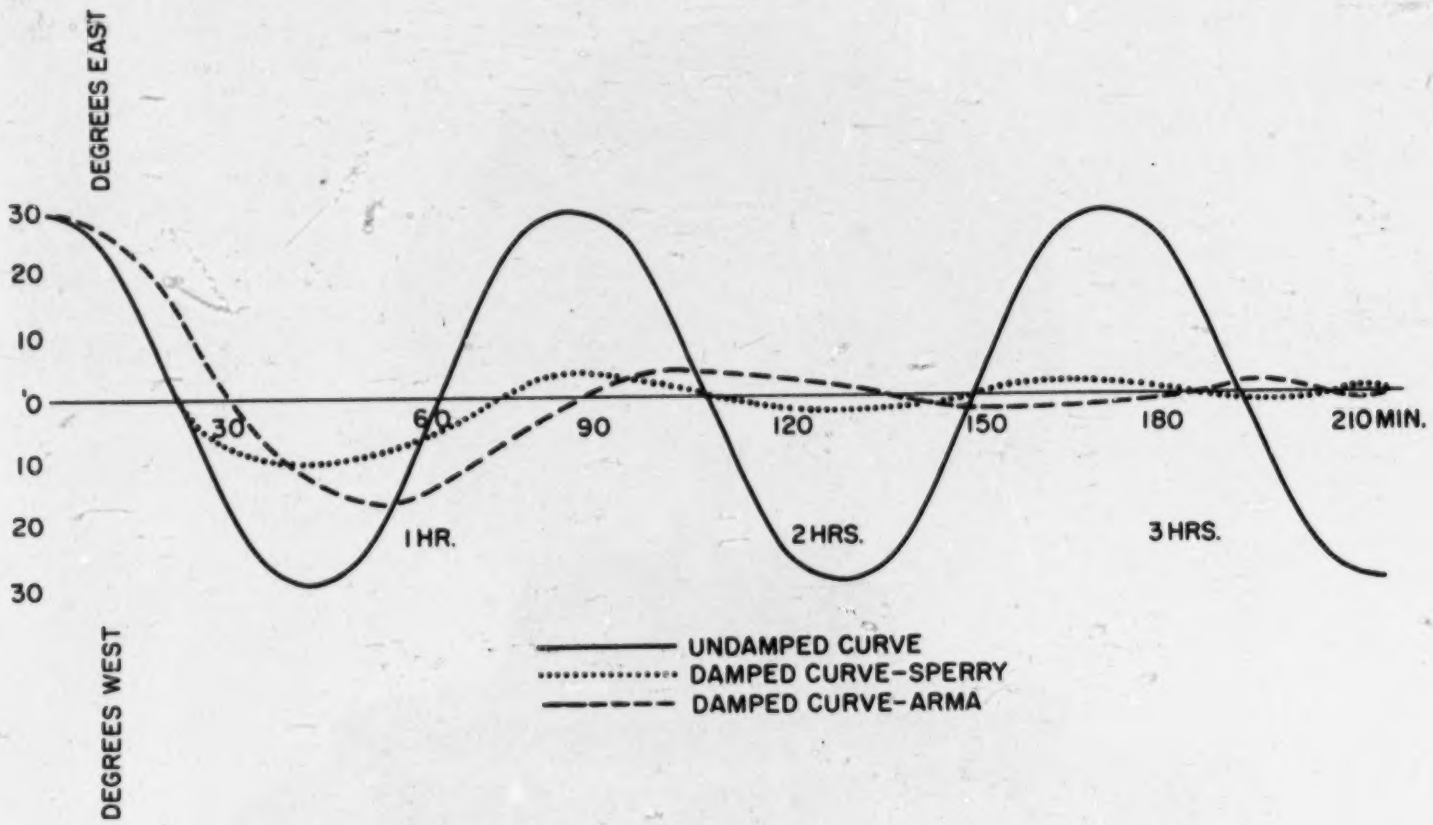

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Figure 13-25.—Oscillation curves of undamped and damped compasses.

SENSITIVE ELEMENT

The sensitive element (fig. 13-27) is the north-seeking element of the master compass. It consists of the gyro unit, vertical ring, compensator weights, followup indicator, and suspension.

Gyro Unit

The gyro unit provides the directive force for the sensitive element that makes the compass north-seeking. The unit consists of the rotor and case (fig. 13-28). The gyro rotor (fig. 13-28B) is 10 inches in diameter, 4 1/2 inches wide, and weighs approximately 72 pounds. It is machined and balanced to rotate on special ball bearings at a normal speed of 11,000 rpm.

The gyro case (fig. 13-28A and C) includes a 3-phase, double-stator winding, one stator being mounted in each half of the case.

The case is made airtight and the rotor operates in a vacuum (26 to 30 inches of mercury) to reduce the friction caused by air resistance. A vacuum gage (not shown) is mounted near the top of the north half of the case to indicate the degree of vacuum.

A spirit level (gyro case level in fig. 13-27) is mounted on the lower part of the north side of the case to indicate the tilt of the rotor.

A small window (not shown) is provided in the south half of the case through which the spinning rotor can be observed during starting.

Vertical Ring

The vertical ring (fig. 13-27) is attached to a wire suspension from the head of the phantom element. The phantom ring is concentric with the vertical ring and surrounds the entire sensitive element. It is kept in alignment with the vertical ring, while the compass is in operation, by the action of the followup system, discussed later.

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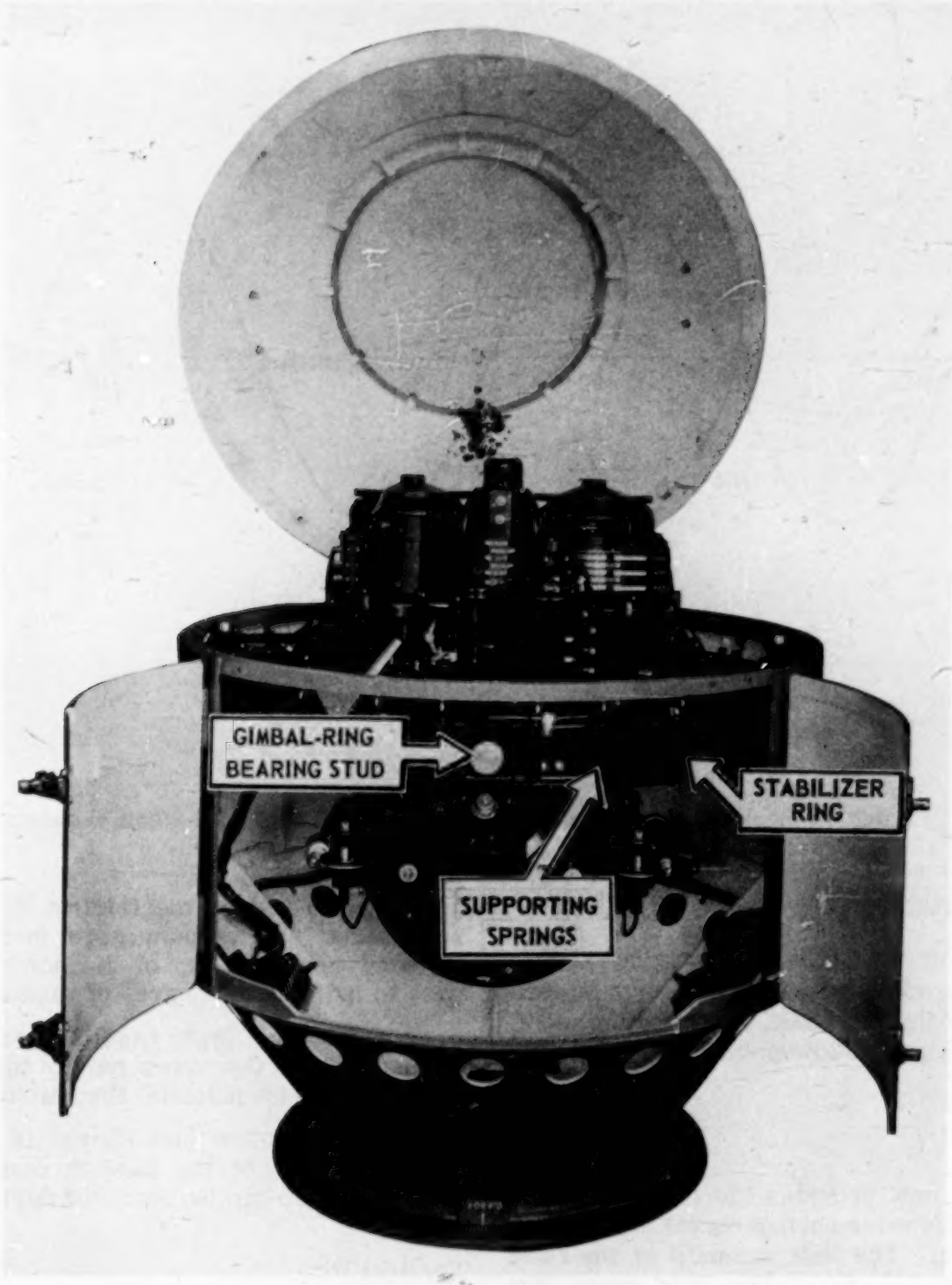

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Figure 13-26.—Sperry Mk 11 Mod 6 gyrocompass showing binnacle and gimbal rings.

An upper and a lower guide bearing prevent the vertical ring from moving laterally within the phantom ring.

The upper guide bearing has its outer race secured in the phantom ring. The inner race is formed by the lower stud of the suspension. The lower guide bearing has its outer race secured in the bottom of the vertical ring. The inner race is formed by a vertical stud that projects upward from the bottom of the phantom ring.

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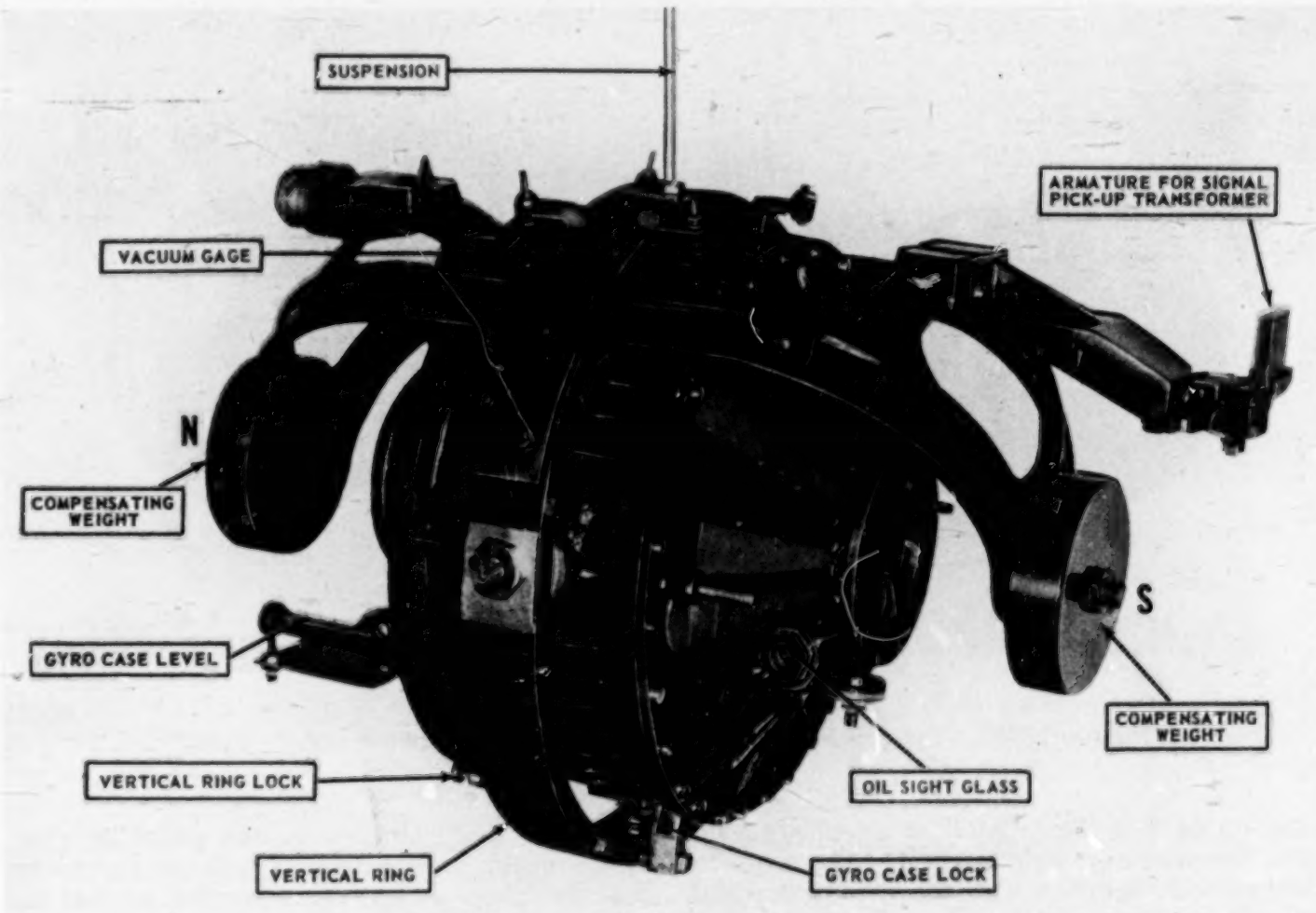

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Figure 13-27.—Sperry MK 11 Mod 6 sensitive element.

A gyro case lock (fig. 13-27) is provided to prevent the gyro case from tilting about its horizontal axis when the compass is not operating. This latch should be disengaged only when the rotor is running at normal speed. It is located on the lower part of the south side of the vertical ring.

A vertical ring lock (fig. 13-27) is provided to keep the vertical ring in line with the phantom ring when the compass is not operating. This lock prevents the wire suspension from acquiring a permanent set which would affect the settling point of the compass.

Compensator Weights

The compensator weights (fig. 13-27) are supported by two frames that are attached to the vertical ring. These frames project out beyond each end of the rotor axle. The weights are mounted concentrically on their studs, and their positions can be adjusted in the direction of the axis of the gyro rotor. The function of the weights is to provide an even distribution of the weight of the gyrocompass about the vertical axis.

The armature of the signal pickoff or followup transformer is attached to an arm that protrudes horizontally from the upper part of the south compensator-weight frame (fig. 13-27).

Followup Indicator

The followup indicator (not shown) indicates the position of the phantom element with relation to the sensitive element. This indicator consists of a scale and a pointer. The scale is attached to the phantom element below the

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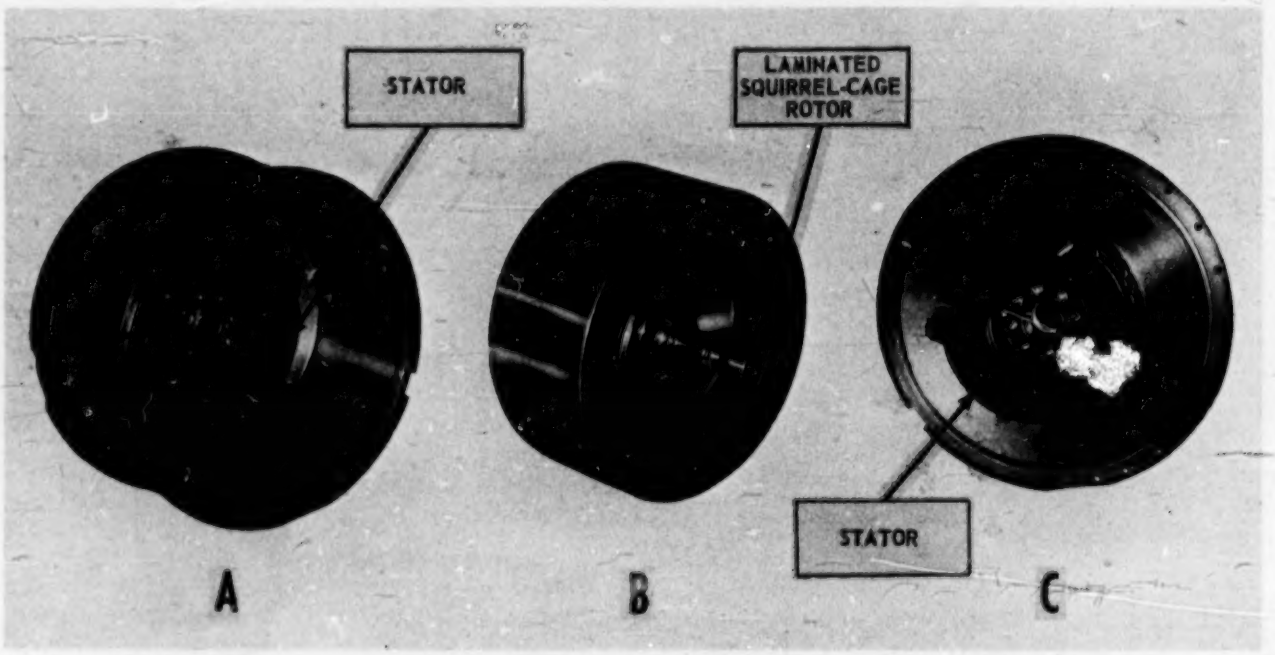

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Figure 13-28.—Sperry MK 11 Mod 6 gyro unit. B, rotor; A and C, case.

spider table and the pointer is attached to the north compensator weight frame. The scale is calibrated in degrees with the center marked "O". Thus, a misalignment between the phantom element and sensitive element is indicated in degrees.

Suspension

The suspension (fig. 13-27) suspends the entire sensitive element from the phantom element. It consists of a number of small steel wires secured at the upper end to a support stud and at the lower end to a guide stud. A nut and checknut secure the support stud to the phantom element, and provide a means to adjust the sensitive element vertically. The guide stud passes through a hole in the upper part of the vertical ring and is clamped to the ring by a nut. This stud also serves as the inner race of the upper guide bearing of the ring.

MERCURY BALLISTIC

The mercury ballistic (fig. 13-29) is that group of parts which applies the gravity controlling force to the gyro unit and makes it north-seeking. It consists of a rigid frame supported on bearings in the phantom ring. These bearings are in line with the horizontal case bearings in the vertical ring so that the mercury ballistic is free to tilt about the east-west axis of the sensitive element.

The frame supports a mercury reservoir in each of its four corners. The N and S reservoirs on the east side of the compass are connected by a U-shaped tube and the N and S reservoirs on the west side are similarly connected. The gravity controlling force of the mercury ballistic is applied to the bottom of the gyro case through an adjustable offset bearing stud mounted on the ballistic connection arm.

The connection bearing is offset to the east from the vertical axis by a short distance to provide the damping adjustment. When it is desired to eliminate damping, a solenoid (damping eliminator magnet) is energized by an automatic damping eliminator switch (discussed later) that attracts a plunger which moves the pivoted connection arm until the connection bearing is in line with the vertical axis of the gyro. In addition, each mercury reservoir is offset from its supporting stem so that each can be rotated around its stem through an arc of about 110° in order to vary the lever arm of

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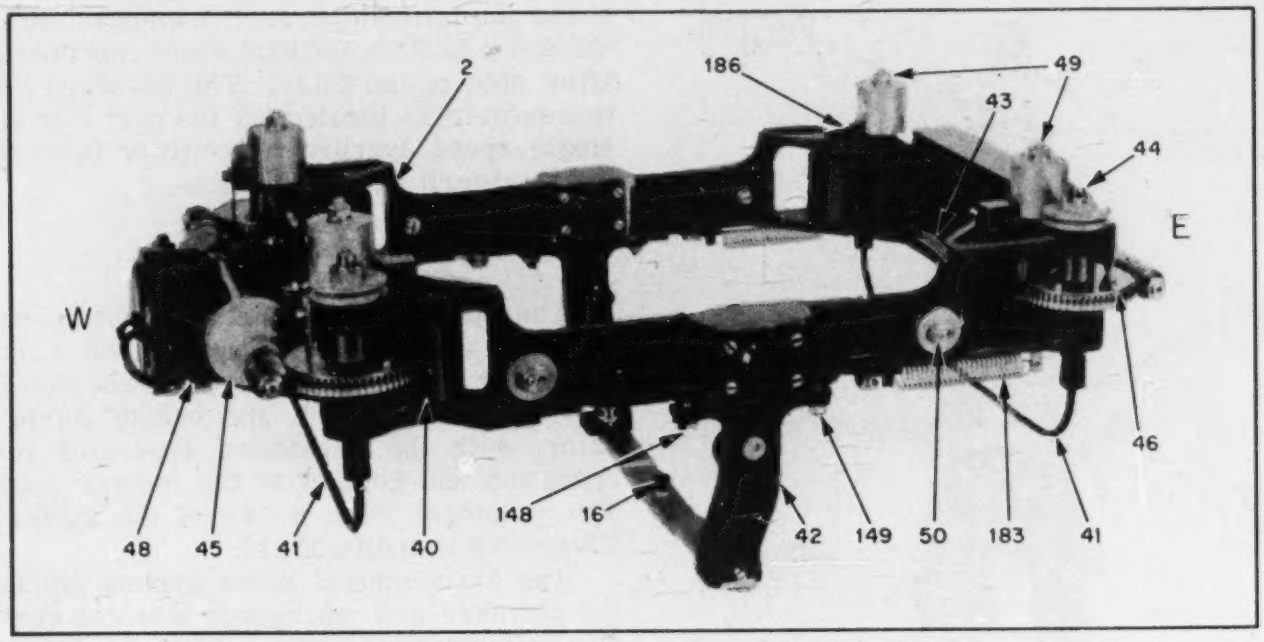

2 MERCURY BALLISTIC FRAME	46 LATITUDE SCALE
16 OFFSET CONNECTION BEARING STUD	48 DAMPING ELIMINATOR MAGNET
40 MERCURY RESERVOIRS	49 NON-PENDULOUS BALANCING WEIGHTS
41 MERCURY TUBE	50 HORIZONTAL BALANCING WEIGHTS
42 CONNECTION ARM	148 NO-DAMPING ADJUSTMENT SCREW
43 MERCURY BALLISTIC SUPPORT STUD	149 DAMPING ADJUSTMENT
44 MERCURY RESERVOIR SUPPORT STEM	183 MAGNET LINK SPRING
45 LATITUDE SETTING THUMB WHEEL	186 LEVELING SCREW HOLES

40.32

Figure 13-29.—Sperry Mk 11 Mod 6 mercury ballistic.

each tank. Thus the period of an undamped oscillation of the gyrocompass is maintained constant in all latitudes by adjustment of the mercury reservoirs. This adjustment is referred to as the ballistic latitude adjustment.

PHANTOM ELEMENT

The phantom element (fig. 13-30) is a group of parts that acts to support the sensitive element. It consists essentially of a hollow cylindrical stem that projects radially from the phantom ring, which is mounted in the spider and extends below the central hub of the spider table.

The phantom element supports the sensitive element by means of the suspension. The phantom element has no north-seeking properties of its own, however it does continuously indicate north, because it is made to follow all movements of the sensitive element by the action of the followup system.

A thrust bearing on the top of the stem (fig. 13-30) rests in the hub of the spider table and supports the weight of the phantom and sensitive elements. The upper and lower stem bearings keep the stem in alignment with the vertical axis of the spider but permit the phantom element to rotate about its own vertical axis.

The phantom ring also carries bearings that support the mercury ballistic. The axis of these bearings coincides with the axis of the horizontal bearings of the gyro case. Collector rings are mounted on the phantom stem below the upper stem bearing to connect the various electrical circuits from the fixed to the moving parts of the compass. The large and small azimuth gears are included in the azimuth followup mechanism (to be discussed later).

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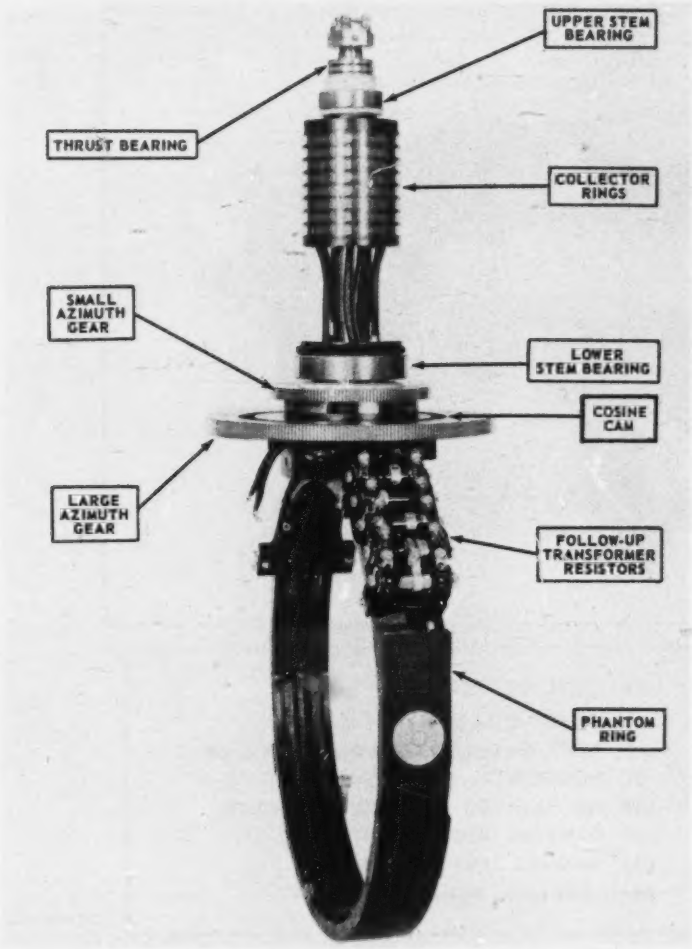

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Figure 13-30.—Sperry Mk 11 Mod 6 phantom element.

An eccentric groove called the cosine cam is cut into the upper surface of the large azimuth gear. The cosine cam is associated with the speed and latitude correction mechanism.

SPIDER

The spider (fig. 13-31) is a circular table of cast aluminum alloy that supports the entire inner, or moving, member of the compass by means of the hub on which the thrust bearing that supports the phantom element rests. The spider is supported in the inner, or cardan, ring of the two rings that comprise the gimbal system. A boss in the center of the table supports the thrust bearing and the upper and lower stem bearings.

The azimuth followup motor and the automatic damping eliminator switch are mounted on the forward side of the spider table. The speed and latitude correction mechanism and the auxiliary latitude corrector are mounted on the after side of the table. The 36-speed synchro transmitter is located on the port side and the single-speed synchro transmitter is located on the starboard side of the table.

CONTROL AND ALARM SYSTEM

The Sperry Mk 11 Mod 6 gyrocompass control and alarm system consists of a motor-generator, speed regulator, control panel, battery throwover panel, and bridge alarm indicator, with the necessary apparatus for the operation and control of the master compass. The principal components of the system are illustrated in figure 13-32.

The gyrocompass drive system consists of the primary and emergency sources of power. The primary power source is the ship's 3-phase, 120-volt, 60-cycle supply, and the emergency power source is the 24-volt battery supply.

Motor-Generator

Two separate motor-generator sets are provided with each complete Sperry gyrocompass equipment. Each set consists of an induction motor, a d-c emergency motor, an a-c generator, and a d-c generator (fig. 13-32). The induction motor and the d-c emergency motor are mounted on a common shaft in a single frame. The a-c generator and the d-c generator are also mounted on a common shaft in a single frame. The shafts of these two units are directly coupled together. Each motor-generator set is assembled as a complete unit and mounted on a single bedplate.

The INDUCTION MOTOR is a 3-phase, 120-volt, 60-cycle, wound-rotor motor with sliprings. Under normal operating conditions, the induction motor drives the d-c motor, the a-c generator, and the d-c generator. It operates at a constant speed of 1460 rpm (necessary for the a-c generator to deliver a constant 3-phase output of 55 volts at 195 cycles), which is maintained constant by means of a speed regulator that compensates for a maximum of ±10% variations in the ship's primary power supply frequency.

The d-c MOTOR is a shunt-wound machine. Under normal conditions of induction motor drive, the d-c motor operates as a self-excited d-c generator for charging the battery with

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TYPICAL MAGNETRONS AND KLYSTRONS: (Continued)

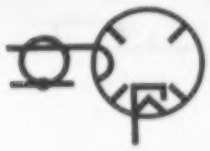

RESONANT TYPE WITH COAXIAL OUTPUT

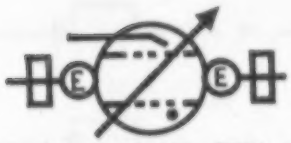

TRANSMIT-RECEIVE (TR) TUBE GAS FILLED, TUNABLE INTEGRAL CAVITY, APERTURE COUPLED, WITH STARTER

ROTATING MACHINES:

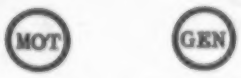

MOTOR GENERATOR

TYPES OF WINDINGS

SERIES

SHUNT

SEPARATELY EXCITED

DYNAMOTOR

WINDING SYMBOLS

SINGLE-PHASE

TWO - PHASE

THREE-PHASE (WYE)

THREE-PHASE (DELTA)

LOGIC FUNCTIONS:

AND FUNCTION

INCLUSIVE OR FUNCTION

EXCLUSIVE OR FUNCTION

FLIP-FLOPS

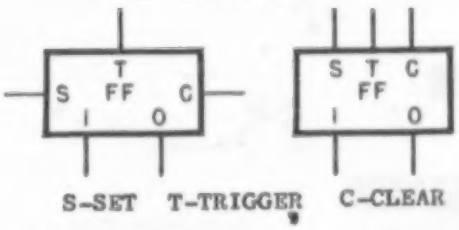

BINARY REGISTER WITH 4 BIT CAPACITY

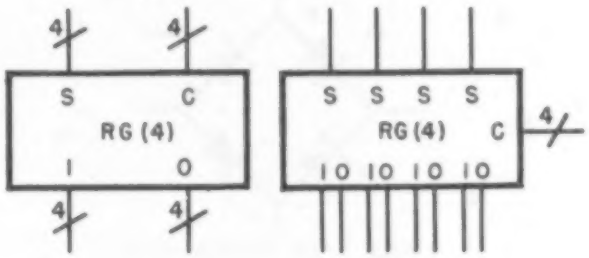

INHIBIT

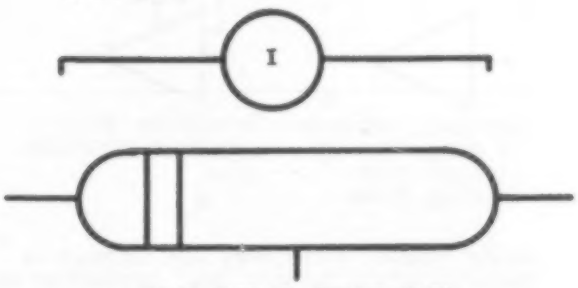

TIME DELAY (WITH TAP)

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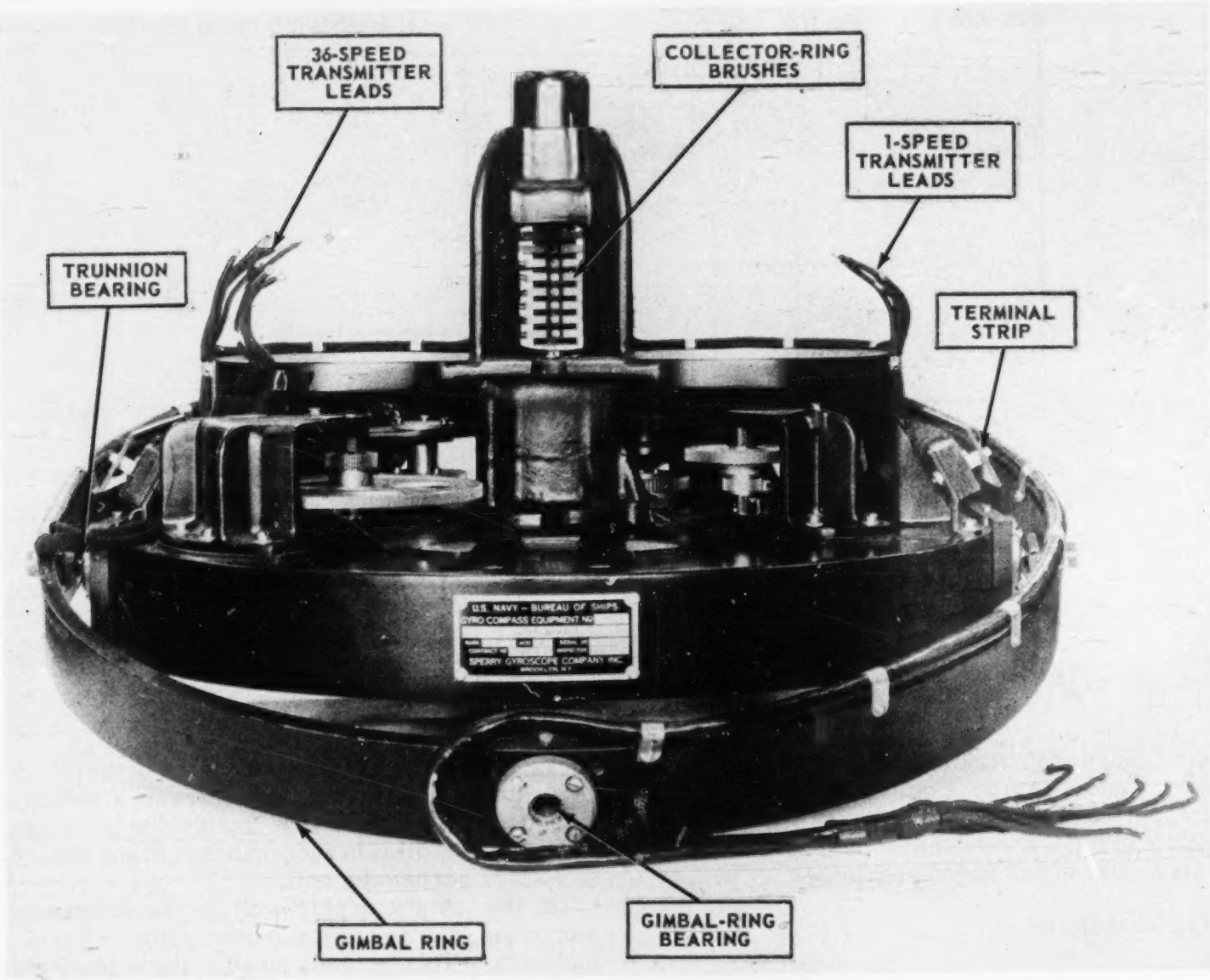

40.34

Figure 13-31.—Sperry Mk 11 Mod 6 spider.

a continuous-duty rating of 27 volts at 7 amperes.

Under emergency operating conditions because of failure in the ship's 3-phase supply to the induction motor, the d-c motor operates from the battery supply to drive the a-c and d-c generators. As a d-c motor, it has an intermittent-duty rating of 22.5 volts at 70 amperes.

The a-c GENERATOR is a 3-phase, 60-volt, 195-cycle, inductor type generator having 16 polar projections. Both the field and the armature are stationary. The 16 polar projections (inductors) rotate continuously at approximately 1,460 rpm, thereby varying the magnetic field flux through the armature windings and generating a-c voltages at a frequency of 195 cps. The armature consists of a wye-connected, 3-phase winding, and the field consists of a single d-c winding. Sliprings are not required with this type of generator. The machine supplies power to drive the gyro rotor and to energize the amplifier and the followup system.

The d-c GENERATOR is a 120-volt, compound-wound, interpole, self-excited generator. This machine supplies excitation for its own

11723

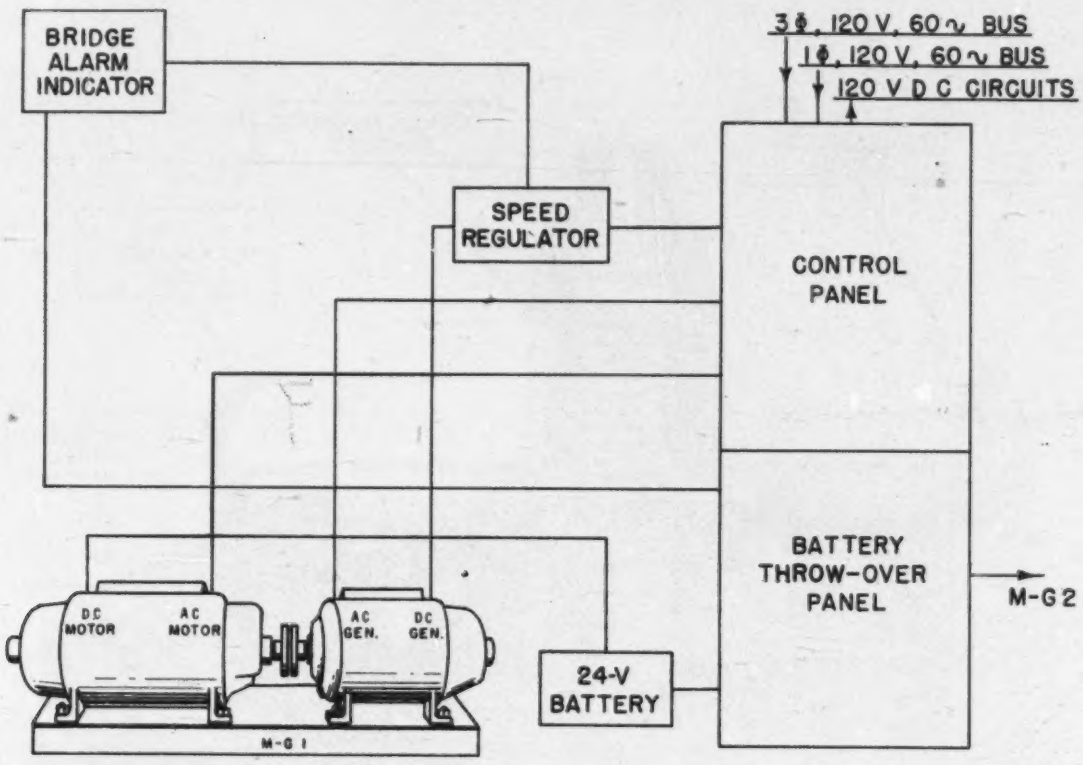

40.36

Figure 13-32.—Sperry Mk 11 Mod 6 gyrocompass control and alarm system.

fields, the a-c generator field, and the azimuth-motor field. It also supplies d-c power for the damping eliminator, the azimuth-motor cutout relay, the dead reckoning equipment, and the voltage coil of the speed regulator.

Speed Regulator

The speed regulator (fig. 13-33) is a separate unit located adjacent to the motor-generator sets. It compensates for variations in the ship's supply voltage or frequency to maintain the speed of the induction motor constant and thereby causes the a-c generator to deliver a constant output to drive the gyro motor. The same speed regulator is used for each of the two motor-generator sets because they are not operated simultaneously.

The speed regulator consists of a wye-connected, carbon-pile voltage regulator connected in the form-wound rotor circuit of the 3-phase induction motor by means of sliprings.

The actuating coil of the speed regulator is connected in a shunt circuit across the output terminals of the d-c generator. It therefore responds to changes in d-c output voltage occasioned by any changes in speed of the motor generator. The voltage coil attracts a spring-loaded pressure arm that varies the pressure on the carbon piles in accordance with any change in voltage across the coil.

If the ship's supply voltage or frequency increases, the induction motor-rotor currents increase. This action causes a slight increase in the speed of the motor-generator. The consequent slight increase in d-c generator voltage causes the voltage coil of the speed regulator to attract the spring-loaded arm. This action decreases the pressure on the carbon piles. The accompanying increase in rotor-circuit resistance restores the rotor currents to their normal value and checks the rise in speed and d-c generator output voltage.

A dashpot damper is connected in the pressure arm to prevent hunting when rapid changes occur in the voltage or frequency.

Compass Control Panel

The compass control panel is located at the upper left-hand section of the gyrocompass switchboard (fig. 13-34). The control panel is

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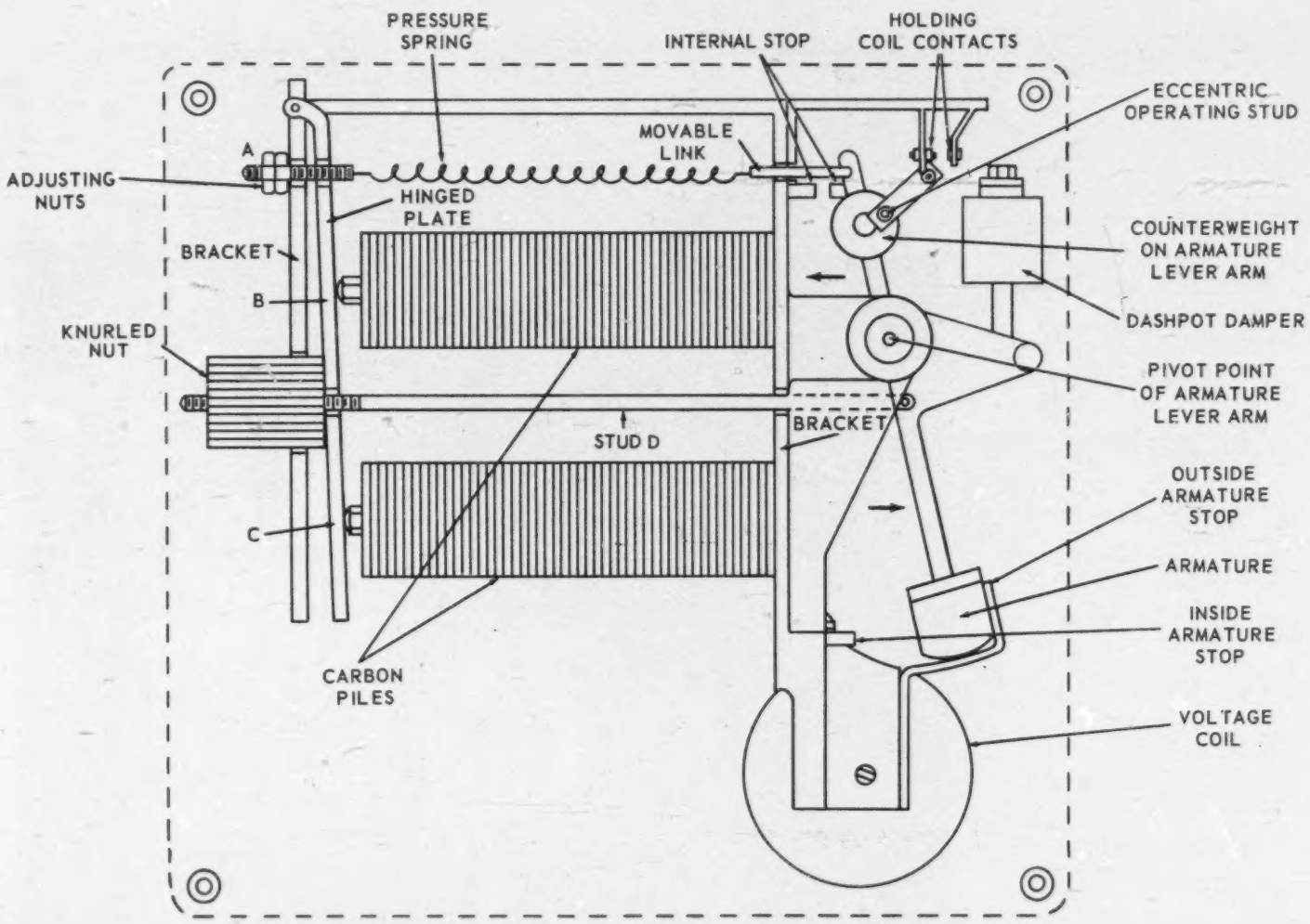

40.38

Figure 13-33.—Speed regulator schematic.

used to control and indicate the operating conditions of the master compass. The ship's 3-phase, 120-volt, 60-cycle power supply and the ship's single-phase, 120-volt, 60-cycle power supply are connected directly to terminals on the back of the compass control panel. The 3-phase, 120-volt, 60-cycle power supply is fed from these terminals on the control panel through the battery throwover relay on the battery throwover panel to the motor-generator transfer switch on the compass control panel. The switches and fuses necessary for these power supplies are included on the IC switchboards, but are not provided on the gyrocompass switchboard.

The a-c ammeters and an a-c voltmeter are mounted at the top of the control panel to indicate the operating conditions of the master compass. One ammeter indicates the 60-cycle alternating current supplied to the synchro repeater system by the master compass transmitter, and the other ammeter and the voltmeter indicate the 195-cycle current and voltage respectively, supplied by the 3-phase, a-c generator to the gyrocompass rotor.

The azimuth-motor cutout detent release, the single and 36-speed overload signal lamps and the volt-ammeter selector switch are mounted just below the two ammeters and the voltmeter.

The azimuth motor cutout detent release is provided to reset the cutout after a fault has been cleared on the followup system.

The volt-ammeter selector switch is a 3-position rotary switch. The three switch positions provide for shifting the ammeter and voltmeter to any one of the three phases of

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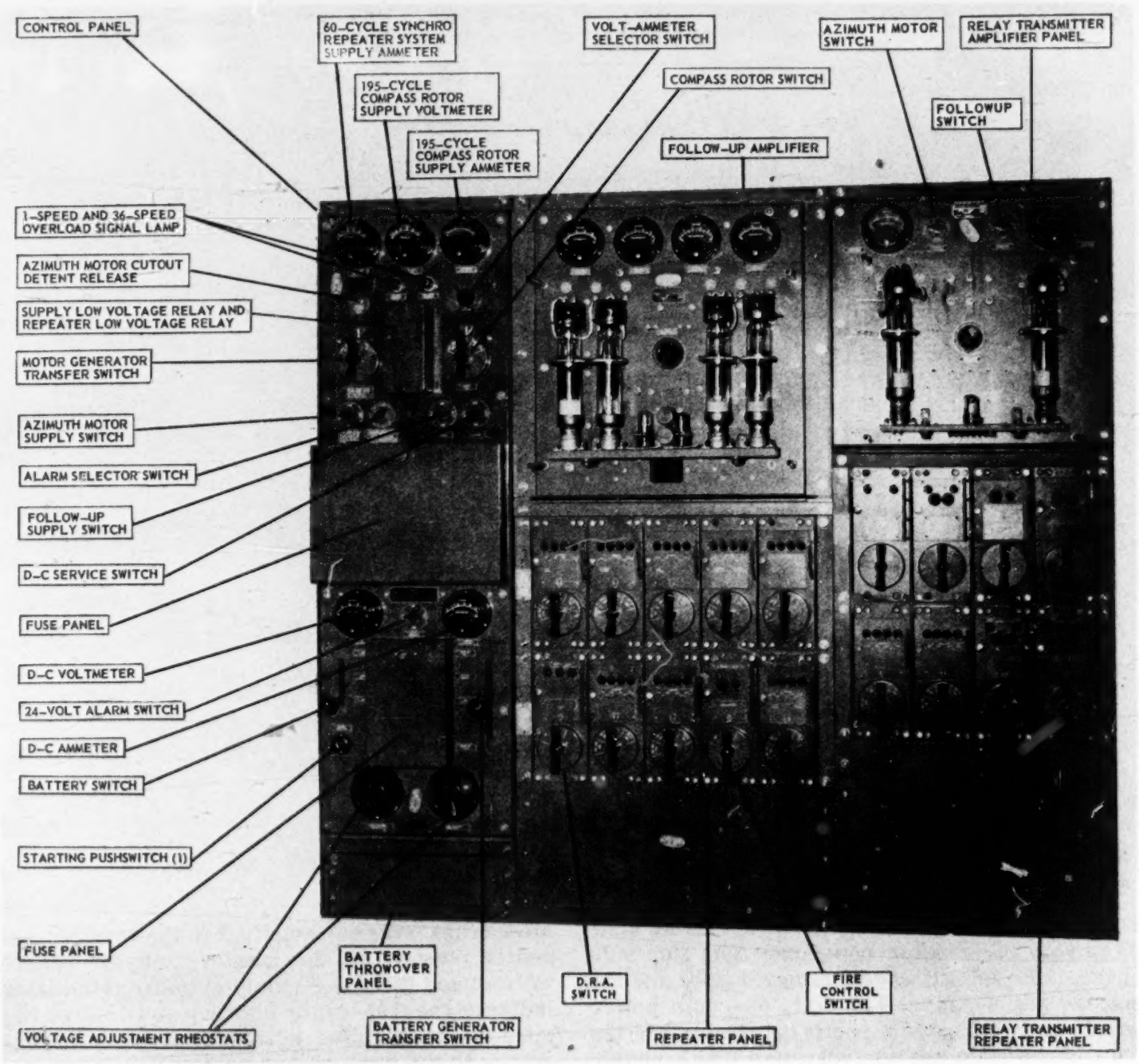

40.39

Figure 13-34.—Sperry Mk 11 Mod 6 gyrocompass switchboard.

the a-c gyro rotor supply to obtain current and voltage readings of the selected phase.

The motor-generator transfer switch and the compass rotor switch are mounted on the third row from the top.

The motor-generator transfer switch is a double-throw rotary switch provided for selecting either one or the other of the two motor-generators.

The compass rotor switch connects the 3-phase, 55-volt, 195-cycle power from the a-c generator to the gyrocompass rotor.

The azimuth-motor switch, the alarm selector switch, the followup supply switch and the d-c service switch are located at the bottom of the control panel.

The azimuth-motor switch controls the (1) rectified a-c supply circuit to the azimuth

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motor armature and (2) the d-c supply to the azimuth-motor field.

The alarm selector switch is a rotary switch with four positions marked (1) normal, (2) low frequency, (3) repeater supply, and (4) ship's supply. In the NORMAL position, the alarm bell sounds if the ship's supply or the repeater supply fail or if the supply voltage or frequency fall below a predetermined value. The alarm bell is silenced by turning the selector switch to the position indicating the trouble.

The followup supply switch is an on-off switch. In the ON position it energizes the followup panel from one phase of the 3-phase gyro supply, and heats the filaments of the amplifiers and rectifier tubes in the followup system.

If the followup switch is in the OFF position, the compass supply ammeter and voltmeter indicate the current and voltage to the gyro rotor only; whereas, if this switch is in the ON position, the meters will indicate the 195-cycle current and voltage to both the gyro rotor and the followup panel.

The d-c service switch is the master switch for the 120-volt, d-c circuit. It supplies the (1) damping eliminator circuits, (2) azimuth-motor field, and (3) azimuth-motor cutout relay coil.

The fuses for the compass control panel are within an enclosure located at the bottom of this panel.

Battery Throwover Panel

The battery throwover panel is located directly below the compass control panel (fig. 13-34). It is used to transfer automatically the gyrocompass circuits from the ship's 3-phase supply to the battery supply in the event of failure of the ship's supply. The 24-volt storage battery is normally connected to the battery-charging generator of the motor-generator set and floats on the line.

If the ship's 3-phase supply voltage or frequency drops below the predetermined value (± 10% of the normal value), the movement of the pressure arm on the carbon piles of the speed regulator will open the battery throwover relay holding coil contacts, thereby deenergizing this relay. When this relay is deenergized, the (1) ship's 3-phase supply is disconnected from the motor-generator set, (2) battery is connected to the d-c motor (charging generator) as a primary power source so that the d-c motor becomes the prime mover for the motor-generator set, and (3) alarm bell rings.

When the ship's 3-phase power supply is restored, retransfer of the drive to the induction motor must be accomplished manually.

A 24-volt alarm supply switch and a battery voltmeter and ammeter are mounted at the top of the battery throwover panel.

The 24-volt alarm supply switch is a separate switch provided for cutting out the supply to the entire alarm system.

The d-c ammeter and the d-c voltmeter connected between the battery switch and the battery-generator transfer switch, indicate the current and voltage respectively in the battery line.

The fuses for the battery throwover panel are within an enclosure located in the center of the panel.

The battery switch and the battery-generator transfer switch are located on the left-hand and the right-hand sides of the fuse enclosure, respectively.

The battery switch is a DPST lever-switch that connects the 24-volt battery supply to the battery throwover panel.

The battery-generator transfer switch is a DPDT lever-switch that connects the battery to one or the other of the two battery generators.

The starting pushswitch is mounted below the battery switch. It is used to start the motor-generator and also to restore the circuit to the holding coil of the battery throwover relay after the system has been interrupted because of a failure of the ship's supply or low voltage and/or frequency.

An additional pushswitch in parallel with the starting pushswitch on the battery throwover panel is located on the bridge alarm indicator so that, if desired, the ship's power supply can be restored to the compass equipment from this station.

Two voltage adjustment rheostats, one for each of the battery charging generators, are mounted at the bottom of the panel. These rheostats are used to adjust the generator-field resistance to control the charging rate of the battery when the machine operates as a generator. The rheostats are cut out when the machine operates as a motor, and the resistance that is cut into the field by the battery throwover relay automatically increases the speed to the proper value.

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Bridge Alarm Indicator

The bridge alarm indicator (fig. 13-35) is located in the pilot house. The indicator includes a red, a blue, and a green indicator lamp, a damping-eliminator pushswitch and a starting pushswitch. These components are enclosed within a metal case provided for bulkhead mounting. An external alarm bell is located adjacent to this indicator.

The red indicator lamp in the battery supply indicates operation of the compass equipment from the 24-volt battery supply.

The blue indicator lamp is in the damping-eliminator circuit as a warning whenever the damping-eliminator coil is energized.

The green indicator lamp in the ship's a-c supply is lighted as long as the ship's supply is connected to the compass equipment.

Each indicator lamp is provided with a series variable resistor to control the intensity of illumination.

The starting pushswitch is in parallel with the pushswitch on the battery throwover panel as mentioned previously.

The damping-eliminator pushswitch is in parallel with the automatic damping-eliminator switch on the master compass and may be manually operated to energize the damping-eliminator coil and thus remove damping.

FOLLOWUP SYSTEM

The followup system includes the followup mechanism, the followup transformer, the azimuth motor, and the followup panel. The system functions to detect any misalignment between the phantom and sensitive elements and to drive the phantom element in the proper direction to restore alignment. Any misalignment between the phantom and sensitive elements results in a signal voltage output from the followup transformer. The amount of misalignment determines the magnitude of this signal voltage and the direction of misalignment determines its phase. The signal output from the followup transformer is amplified by a voltage amplifier and used to control the output of a power amplifier which operates the azimuth motor. The azimuth motor in driving the

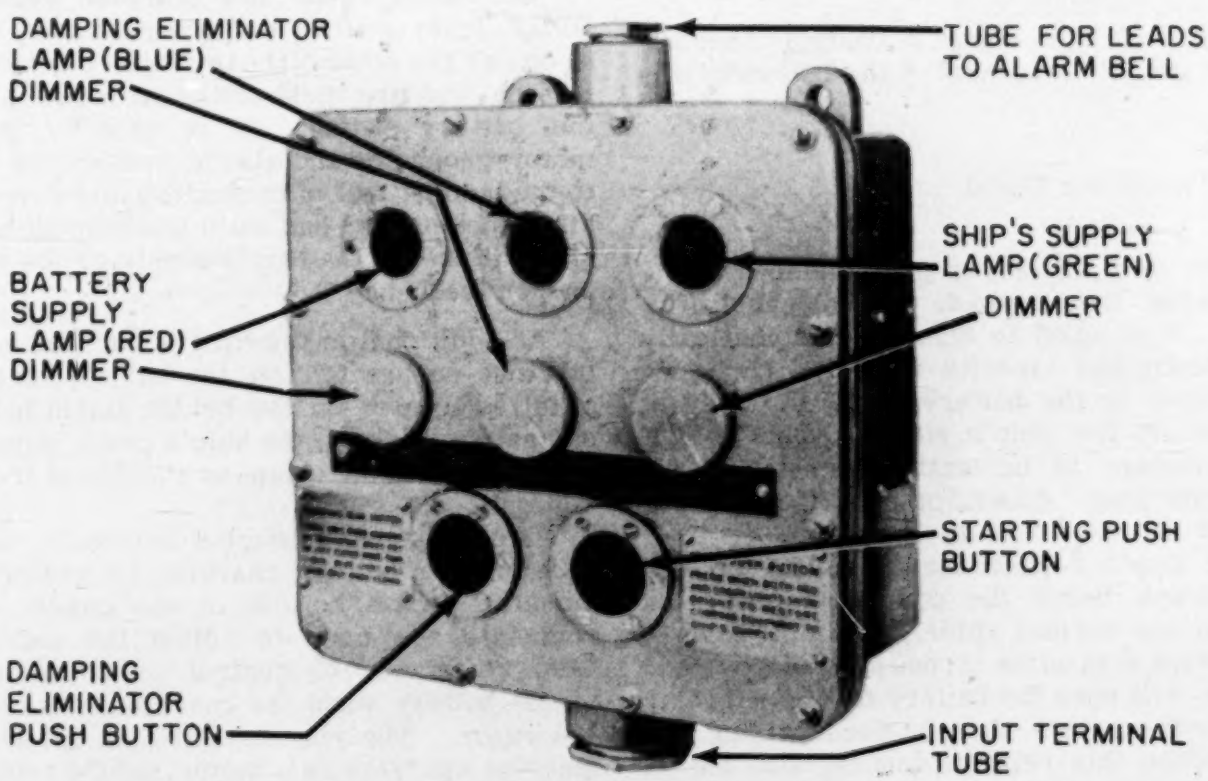

77.212

Figure 13-35.—Bridge alarm indicator.

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phantom element back into alignment with the sensitive element also drives the single and 36-speed synchro transmitters, and a lost motion device through the azimuth followup gearing mechanism (fig. 13-36).

The azimuth motor is a d-c motor having its field excited from the 120-volt d-c output from the motor generator. Its armature is connected in either one or the other of the two output rectifier circuits of the power amplifier. The direction of rotation depends upon which pair of output rectifiers is conducting when the plates of the voltage amplifiers are positive.

Followup Panel

The followup panel (fig. 13-34) is located adjacent to the compass control panel. It includes a voltage amplifier and a power amplifier.

The voltage amplifier contains two twin triodes that amplify the weak signal voltage from the followup transformer. The power amplifier

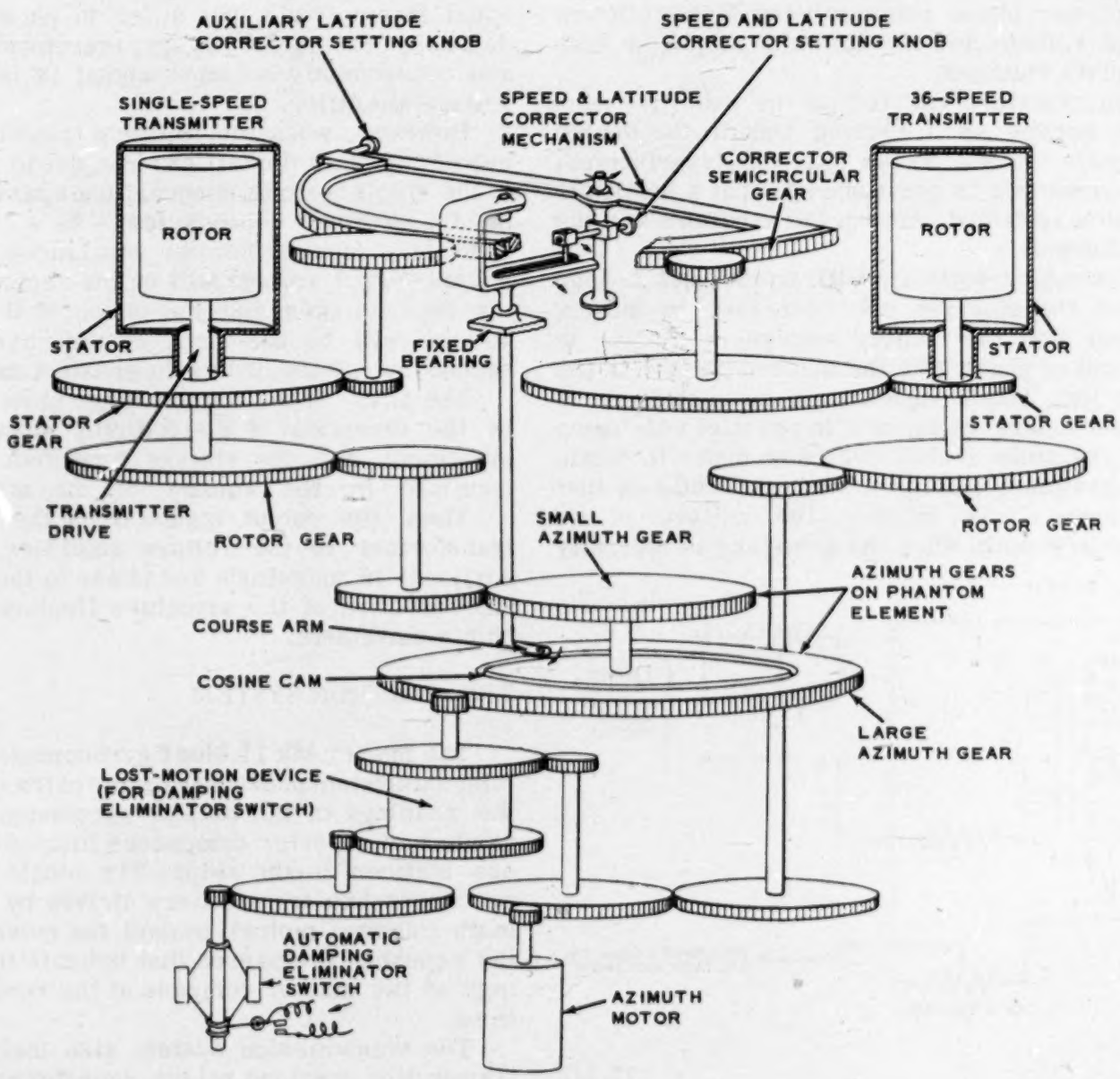

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Figure 13-36.—Azimuth followup mechanism gearing.

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contains two pairs of thyratron rectifiers that supply the azimuth motor armature current.

Followup Transformer

The followup transformer comprises three coils wound on an E-shaped laminated core (fig. 13-37). The primary coil (P) mounted on the center leg, is connected to the 3-phase, 195-cycle compass rotor supply. One primary lead is connected to one phase through resistor R1 which limits the primary current to a few ma. The other primary lead ties to the common connection of phasing resistors R2 and R3 across the other two phases. This provides the proper phase relation between the followup signal voltage and the followup amplifier bias and plate voltages.

An armature carried on the sensitive element serves as a closing link in the double magnetic circuit of the followup transformer. The armature is positioned so that a small air gap is maintained between the armature and the transformer.

Secondary coils A and B on the outside legs of the transformer are connected in such a manner that the induced voltage is one leg is 180° out of phase with the induced voltage in the other leg. Small capacitors C connected across the secondary coils, are in parallel resonance with the coils at 195 cycles in order to obtain the maximum voltage across the coils at that frequency. To balance the voltage of the secondary coils when the armature is centrally located, two fixed resistors (not shown) are connected across the capacitors.

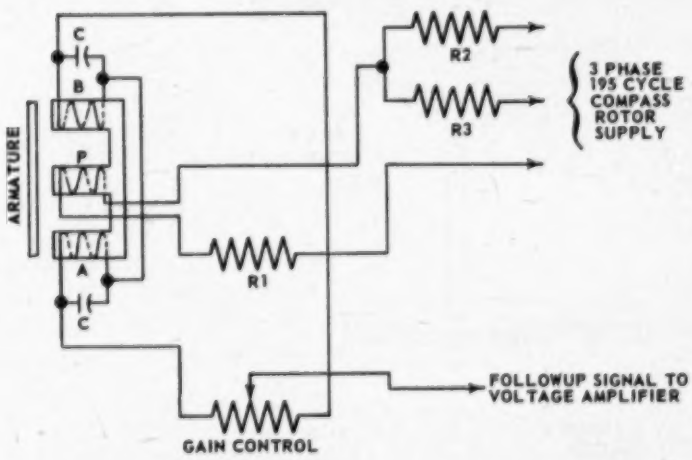

77.213

Figure 13-37.—Simplified schematic diagram of followup transformer, Sperry Mk 11 Mod 6 gyrocompass.

The E-shaped followup transformer is mounted on the phantom element and will move with a change in the ship's heading. The armature, however, is mounted on the sensitive element or the north-seeking part of the compass and does not move once the compass has settled on the meridian.

With the compass settled on the meridian the phantom element is in alignment with the sensitive element, and the compass card will indicate the ship's heading. In this neutral position the voltages induced in the two secondaries of the followup transformer will be equal in amplitude, but differ in phase by 180 degrees. The output voltage, therefore, is zero and consequently no input signal is fed to the voltage amplifier.

However, when the followup transformer is moved either to the left or right, due to a change in the ship's heading, unequal fluxes pass through the transformer secondaries. As a result the secondary voltages become unbalanced. The resultant output voltage will be the vector sum of the two voltages and the phase of the output voltage will be the same as the phase of the secondary voltage having the greatest amplitude.

The phase of the output voltage is determined by the direction of the followup transformer movement and the voltage amplitude is determined by the amount of the movement.

Thus, the output signal from the followup transformer to the voltage amplifier is proportional in magnitude and phase to the amount and direction of the armature displacement or ship's movement.

TRANSMISSION SYSTEM

The Sperry Mk 11 Mod 6 gyrocompass transmission system provides a means of transmitting the readings of the master gyrocompass to a number of repeater compasses located at various stations in the ship. The single and 36-speed synchro transmitters (driven by the azimuth followup motor) control the movement of the repeater compasses that indicate the readings of the master compass at the remote stations.

The transmission system also includes the transmitter overload relays, repeater panel, relay transmitter repeater panel, relay transmitter, relay transmitter amplifier panel, differential alarm relay, and repeater compasses.

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Transmitter Overload Relays

Two similar transmitter overload relays, mounted on the back of the compass control panel, provide a visual alarm when an overload occurs in the transmitter circuits. One relay is connected in the single-speed transmitter circuit, and the other relay is connected in the 36-speed transmitter circuits. The relay consists of three legs with a coil on each leg. Each coil is connected in series with a transmitter stator lead. An increase in the current through any or all of the coils above a critical value attracts the relay armature, causing it to move. This action closes a contact that lights a red signal lamp on the panel front, indicating trouble in the transmitter circuit. A stepdown transformer (115 volts to 7 volts) on the panel supplies the indicator lamp circuits.

Repeater Panel

The repeater panel (fig. 13-34) is located below the followup panel. It comprises an assembly of rotary switches, and auxiliary equipment. Each switch with its associated fuses and overload indicating devices is assembled as a unit and can be withdrawn from the front of the panel for inspection and repair.

Each compass repeater switch is arranged to connect the circuits of two repeater compasses so that either one, or both, may be driven by the master compass transmitters.

Each repeater circuit is provided with an overload indicator, comprising a transformer and a neon lamp. The transformer has two primaries, which are connected in series respectively with two of the three secondary leads to the repeater. The transformer secondary is connected across the neon lamp. When the repeater is approximately alined with the transmitter, the very small current in the transformer primaries does not generate sufficient voltage across the secondary to illuminate the lamp. However, excessive current in the transformer primaries causes the lamp to glow and thus indicate trouble in this repeater circuit.

Associated with each of the repeater circuit switches are four fuses, access to which is through the hinged door just above the switch handle. Two of the fuses are in the primary circuit to the 1-speed repeater, and the remaining two are in the primary circuit to the 36-speed repeater.

The rotary type switch designated on the panel as the fire control switch is not provided with an overload alarm because connections are made from this switch to the fire control switchboard, which has an alarm for each circuit leaving the board. However, at the fire control switch on the repeater panel the two indicators are (1) a pilot lamp, connected across the a-c supply to this switch and therefore illuminated as long as this supply is available, and (2) a transformer and neon lamp arranged to indicate when one or both of the a-c supply fuses blow.

The rotary type switch designated on the panel as the dead reckoning analyzer switch is provided to operate the DRA from the underwater log transmitter and the 1-speed transmitter on the master compass. This switch also supplies single-phase, 120-volt, a-c power and 120-volt, d-c power necessary for the operation of the DRA. Each of these circuits is provided with two fuses. A neon lamp across each fuse in the d-c circuit is lighted when a fuse blows.

Relay Transmitter Repeater Panel

The relay transmitter repeater panel (fig. 13-34) is located adjacent to the repeater panel. This panel and the repeater panel are arranged so that the repeater compasses can be connected to either the master-compass transmitter or to the relay transmitter.

The relay transmitter repeater panel includes eight rotary switches. These include a checking repeater switch, a fire control switch, a relay transmitter supply switch, an emergency navigation transfer switch, two compass repeater switches, and two radar mast (special) switches.

The checking repeater switch connects the gyrocompass room checking repeater to either the master compass or to the relay transmitter. Two fuses are connected in series with the primary leads on the load side of the switch. Two transformer and neon-lamp overload indicators (one for each circuit) are connected in the transmitter secondary circuits to indicate an overload in these circuits.

Relay Transmitter

In order to actuate a number of repeater compasses without imposing this load directly on the compass transmitters, an intermediate instrument known as a relay transmitter is used. The relay transmitter (fig. 13-38) consists

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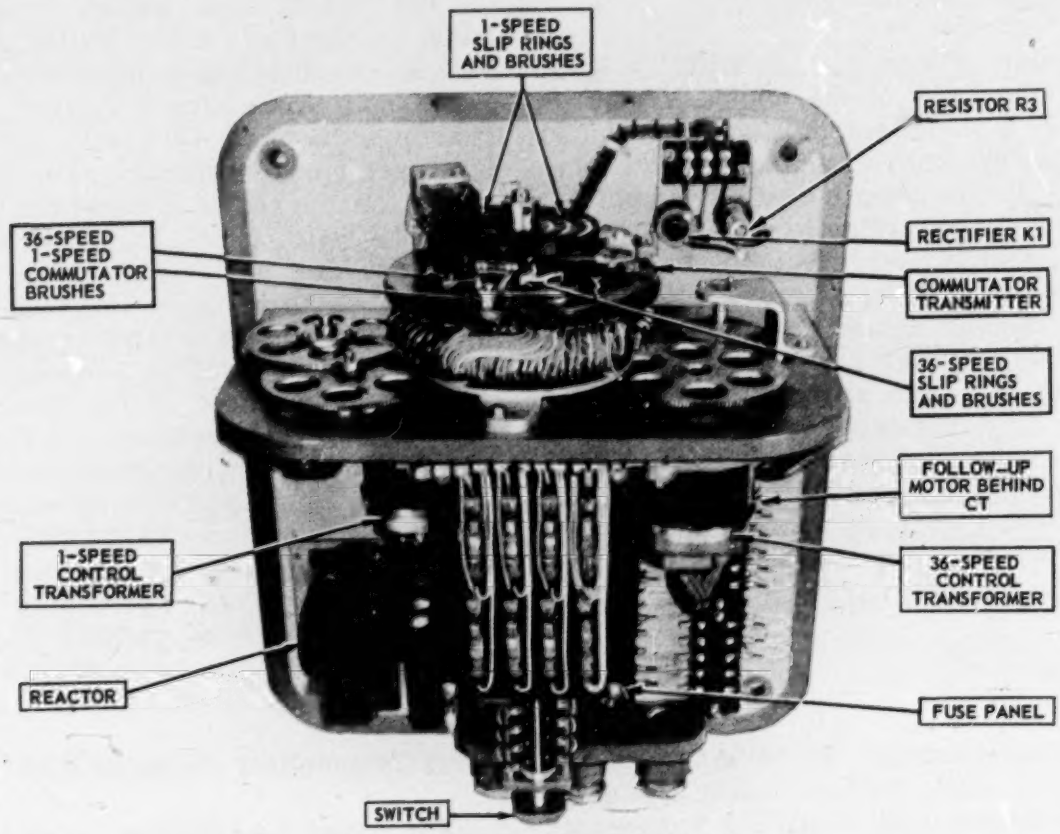

A. INTERNAL VIEW

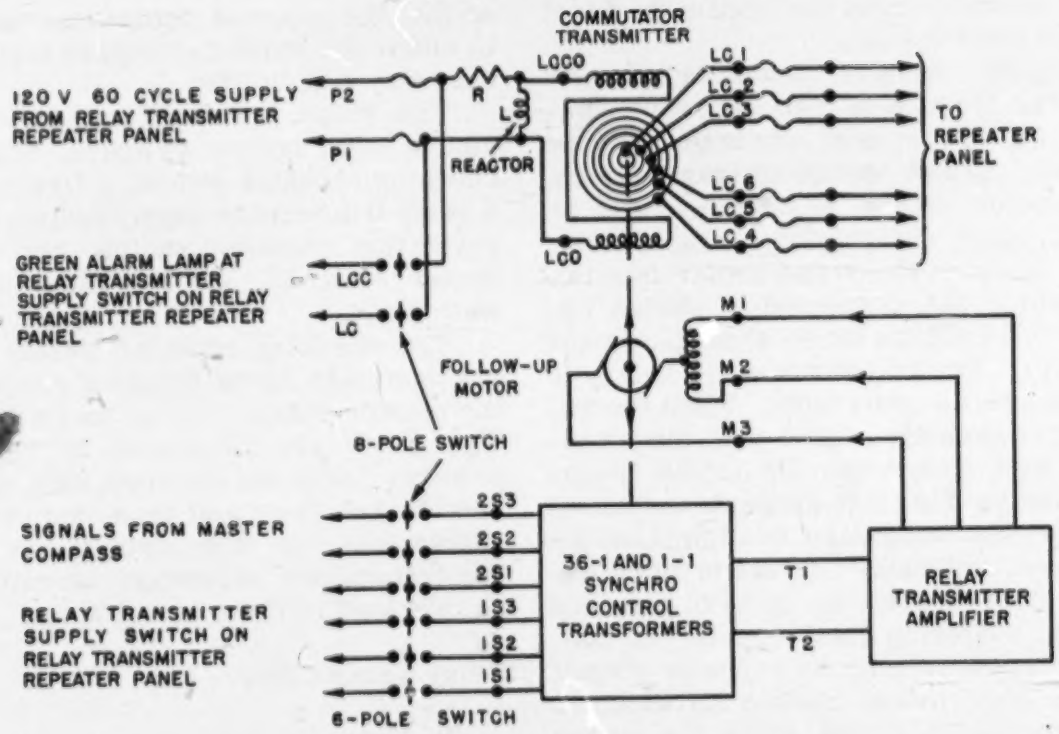

B. SCHEMATIC DIAGRAM

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Figure 13-38.—Sperry Mk 11 Mod 6 gyrocompass relay transmitter.

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GROUPING OF WIRES IN BUNDLES:

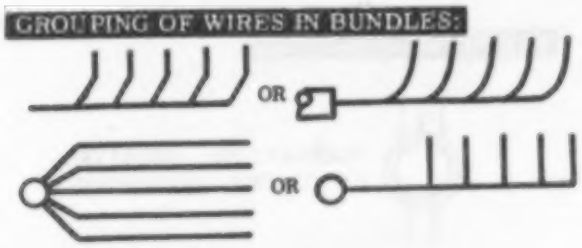

GROUPING OF WIRES IN CABLES:

CABLES

FIVE-CONDUCTOR CABLE

SHIELDED FIVE-CONDUCTOR CABLE

GROUNDED SHIELD

NUMBER OF CONDUCTORS MAY BE ONE OR MORE AS NECESSARY

SWITCHES:

GENERAL (SINGLE THROW)

GENERAL (DOUBLE THROW)

TWO POLE DOUBLE THROW SWITCH

KNIFE SWITCH

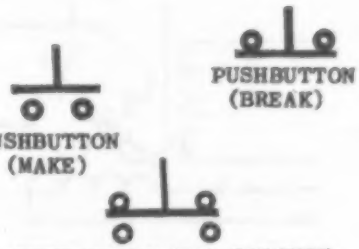

PUSHBUTTON (BREAK)

PUSHBUTTON (MAKE)

PUSHBUTTON TWO CIRCUIT

SELECTOR SWITCHES

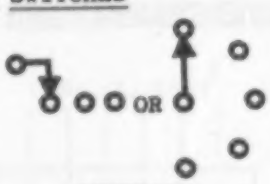

GENERAL

ANY NUMBER OF TRANSMISSION PATHS MAY BE SHOWN. ALSO BREAK BEFORE MAKE SWITCH.

MAKE BEFORE BREAK

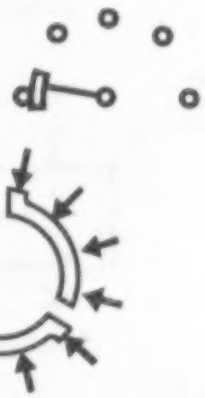

WAFER, TYPICAL 3-POLE, 3-CIRCUIT SWITCH. VIEWED FROM END OPPOSITE CONTROL KNOB. FOR MORE THAN ONE SECTION, #1 IS NEAREST CONTROL KNOB.

CIRCUIT RETURNS (SEE APPENDIX I):

CHASSIS CONNECTION

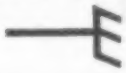

(THE CHASSIS OR FRAME IS NOT NECESSARILY AT GROUND POTENTIAL.)

GROUND

CONTACTS (ELECTRICAL):

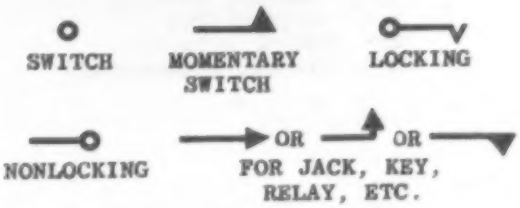

SWITCH

MOMENTARY SWITCH

LOCKING

NONLOCKING

FOR JACK, KEY, RELAY, ETC.

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of a single-speed and a 36-speed synchro control transformer (CT), a commutator transmitter, a followup motor, and a reactor. These components are enclosed within a metal case provided for bulkhead mounting (fig. 13-38A).

The relay transmitter is synchronized with the master compass by means of the synchro control transformer followup motor, and relay-transmitter amplifier (fig. 13-38B). The controlling signal voltage from the master compass energizes the primaries of the control transformers. The output of the control transformers is fed to the amplifier, the output of which controls the followup motor. The followup motor drives a commutator type transmitter, the output of which energizes the repeaters, causing them to follow the master compass. The followup motor also drives the secondaries of the control transformers to the zero-voltage position, thereby synchronizing the relay transmitter with the master compass.

Relay Transmitter Amplifier Panel

The relay transmitter amplifier panel (fig. 13-34) is located adjacent to the followup panel. It consists of a voltage amplifier and a power amplifier. The voltage amplifier receives the signal from the control transformers, and the output is fed to the power amplifier. The power amplifier provides the controlled power necessary to operate the followup motor in response to the signals from the voltage amplifier.

Differential Alarm Relay

The differential alarm relay (fig. 13-39) is a device for sounding an alarm whenever the relay transmitter loses synchronism with the master compass. The amount by which the transmitter is allowed to diverge, before the alarm is sounded, is adjustable from 0° to 2.5°.

The device comprises a synchro differential receiver. The stator receives its signal from the 36-speed output of the relay transmitter; the rotor circuit receives its signal from the 36-speed transmitter at the master compass. As long as the two outputs are in agreement, the rotor remains at the neutral position. Failure of the relay transmitter to keep in synchronism causes the rotor to move from the neutral position to that amount corresponding to the divergence from synchronism.

A bakelite disk that has a metallic segment is mounted on the shaft of the differential receiver (fig. 13-39A). Two trolleys are arranged so that rotation of the disk causes one trolley to contact the metallic segment. This action closes the 120-volt, a-c circuit to a relay (fig. 13-39B), which in turn, closes the 120-volt, a-c supply to the alarm bells located in the pilot house.

An 8-pole switch on the relay transmitter repeater panel is provided for disconnecting the differential synchro receiver and the alarm circuit (fig. 13-39B). The toggle switch disconnects only the alarm circuit.

AUTOMATIC CORRECTION DEVICES

The Sperry Mk 11 Mod 6 gyrocompass is provided with two automatic devices associated with error correction. They are (1) an automatic speed corrector associated with speed course, latitude error correction, and (2) an automatic damping eliminator which prevents the introduction of ballistic damping errors during rapid changes in ship's speed or course.

Automatic Speed Corrector

The SPERRY AUTOMATIC SPEED CORRECTOR (fig. 13-40) automatically transmits corrections for the ship's speed to the speed correction mechanism on the master compass. The step-by-step motor geared to the corrector spindle on the speed correction mechanism (fig. 13-41) is remotely controlled by a step-by-step transmitter in the automatic speed corrector. A switch is mounted on the compass for opening the motor circuit when setting the correction device by hand.

The automatic speed corrector is contained in a metal box, mounted on the bulkhead in the vicinity of the master compass.

The ship's speed is introduced into the automatic speed corrector by a synchro motor controlled by the underwater log. In operation, the rotor of the synchro motor takes a position representing the ship's speed and correspondingly locates a pair of trolleys bearing on a followup ring assembly (fig. 13-42).

When the position of the trolleys is not on the gap in the followup contact rings, the followup motor is energized. The motor drives a three-dimensioned cam, which, by means of a follower and gears, drives the followup contact rings into synchronism with the trolleys. The cam is

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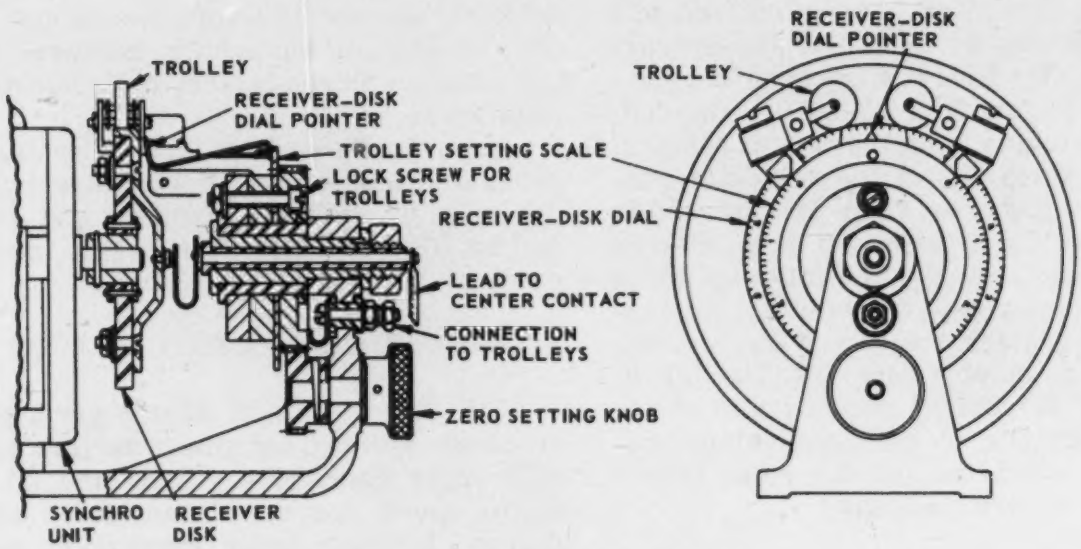

CONTACT MECHANISM

A

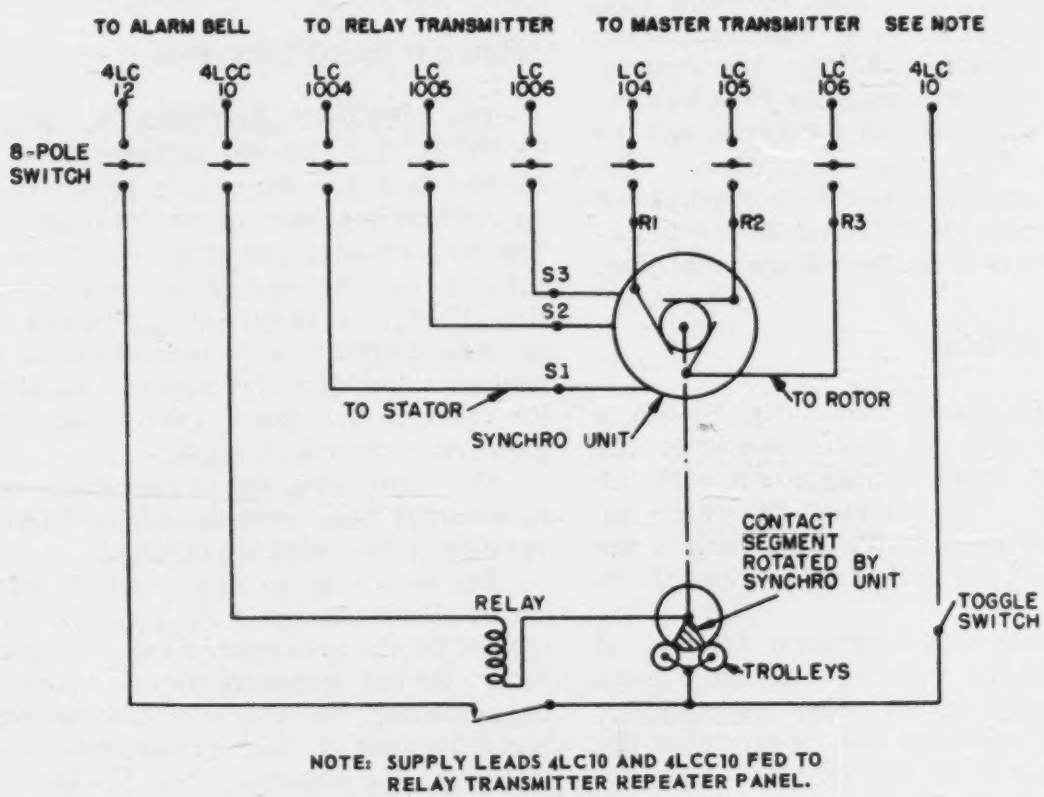

NOTE: SUPPLY LEADS 4LC10 AND 4LCC10 FED TO RELAY TRANSMITTER REPEATER PANEL.

SCHEMATIC DIAGRAM

B

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Figure 13-39.—Sperry Mk 11 Mod 6 gyrocompass differential alarm relay.

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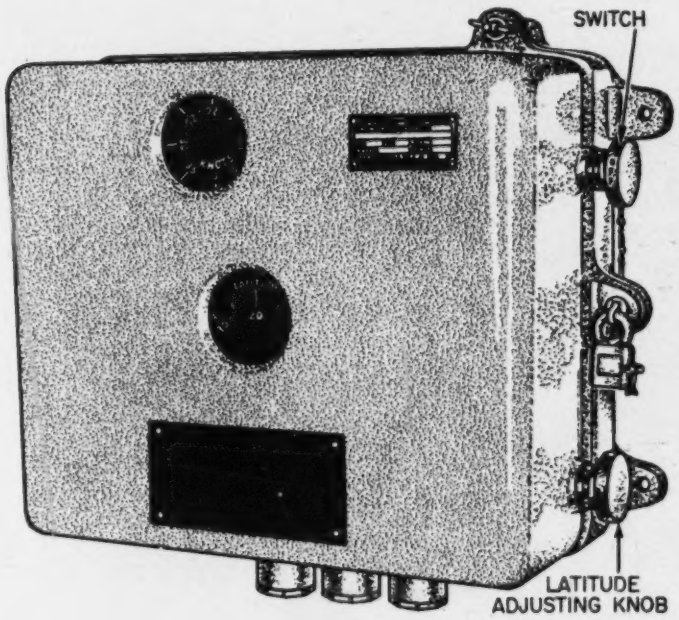

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Figure 13-40.—Sperry automatic speed corrector.

designed so that when it is correctly positioned lengthwise for the local latitude, the amount it must turn to synchronize the trolleys and rings is proportional to the speed correction that must be set into the compass. This correction is transmitted to the step-by-step motor on the compass by a step-by-step transmitter driven by the followup motor that rotates the cam. The followup motor also drives a centrifugal type damping-eliminator switch to eliminate damping during rapid changes in speed.

The instrument (fig. 13-40) is provided with a dial to indicate the ship's speed, graduated in knots, and visible through a window in the cover. The latitude adjustment, which determines the lengthwise position of the three-dimensioned cam, is shown on another dial, also visible through a window in the cover.

Automatic Damping Eliminator

The automatic damping eliminator used with the Sperry Mk 11 Mod 6 (fig. 13-43) consists of two centrifugal switches, one geared to the azimuth motor, and one to followup motor of the automatic speed corrector; and an electromagnet that moves the mercury ballistic connecting arm from its offset position to a true vertical position.

The switch geared to the azimuth motor takes care of changes in course where no change in speed is involved. This switch consists of a flyball governor driven through a gear train which speeds the governor shaft to about 4300 revolutions to one revolution of the phantom. To eliminate constant starting and stopping of the governor when the ship is yawing, a lost-motion mechanism and a helical driving spring are inserted between the switch driving gear in the azimuth motor train and the first gear in the train to the governor shaft. As the ship yaws, the lost-motion mechanism comes into play. This mechanism prevents transmission of motion to the governor shaft.

If the ship turns more than 15 degrees, the helical spring is wound in one direction or the other until there is sufficient tension in the spring to set the governor in motion. As the governor spins, the balls fly up, raising a sliding collar on the governor shaft which engages an arm operating the magnet circuit contact, thus closing the 115-volt, d-c supply circuit to the damping eliminator magnet.

A friction brake on the governor, and a spring disk friction clutch in the gear train, prevent the governor from spinning too fast. The contacts are adjusted so that the circuit is closed when the ship turns at a rate of more than 40 degrees per minute.

The gearing arrangement from the azimuth motor through the lost motion device to the flyball governor is also shown in figure 13-36.

The damping-eliminator switch (fig. 13-42) driven by the followup motor in the automatic speed corrector operates in a similar manner to eliminate damping during rapid changes in ship's speed.

OPERATION

Operating the compass consists of starting, stopping, adjusting correction devices, and making checks for any indications of abnormal operation conditions.

Starting the Compass

If possible the compass should be started at least four hours before it is needed for service. Before starting make sure that all switches on the compass and repeater switchboards are off. Ensure that the gyro case lock and vertical ring lock (fig. 13-27) are in the locked position, and that the vacuum gage (not shown) indicates

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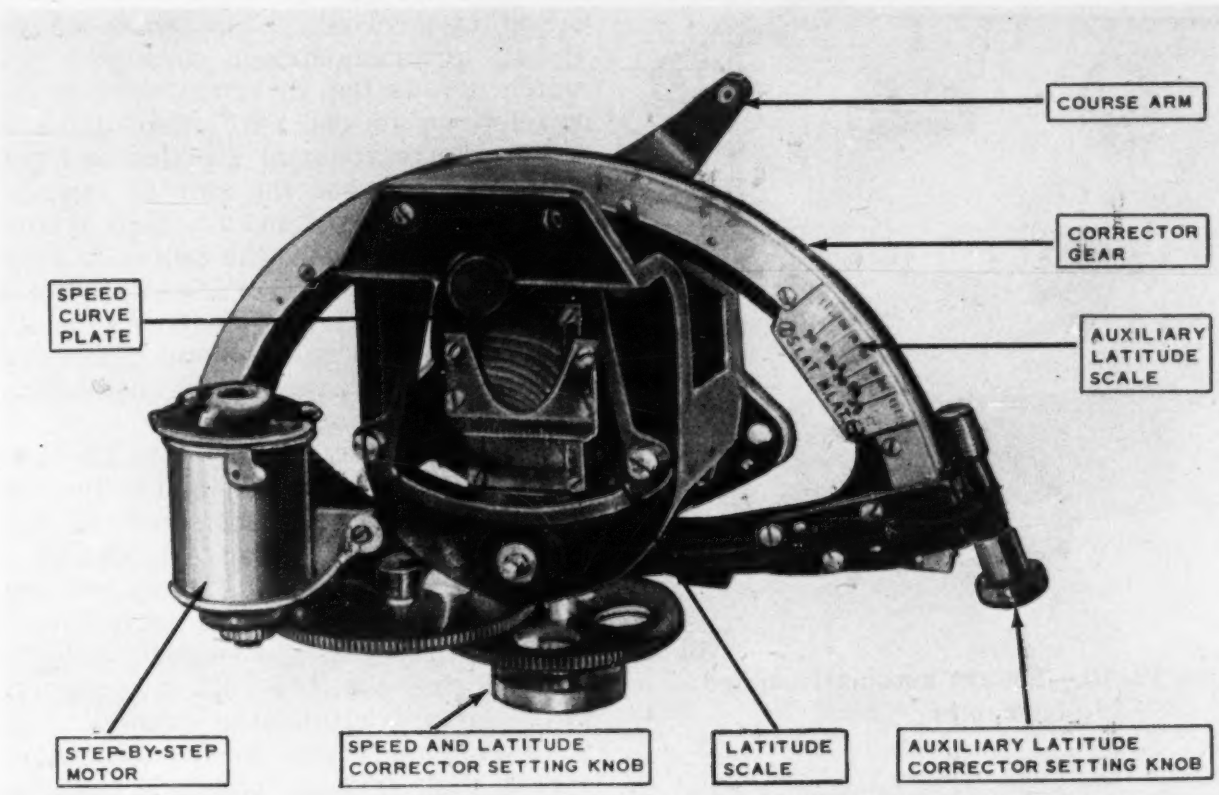

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Figure 13-41.—Speed correction mechanism.

approximately 28 inches. Take hold of both sides of the phantom and vertical rings and turn slowly until the compass card indicates the approximate heading of the ship. Never turn the compass by exerting pressure on the compensating weights or mercury ballistic. Check the oil sight glass to ensure that the rotor bearings will be supplied with oil. Set the auxiliary latitude corrector, and the ballistic latitude adjustment to the proper settings (discussed later). After completing the above checks, proceed to start the compass as follows:

1. After closing the necessary supply switches on the IC switchboard, turn the MOTOR-GENERATOR TRANSFER switch on the control panel (fig. 13-34) to the motor-generator set desired.

2. Press the STARTING PUSH-BUTTON, turn the COMPASS ROTOR switch to the motor-generator set in use, then close the D-C SERVICE switch.

3. When the gyro rotor has been running for about 30 minutes, close the followup supply switch, then wait approximately 15 minutes for the gyro rotor to come up to normal speed. Normal speed will be indicated by a reading of approximately 60 volts of the COMPASS ROTOR SUPPLY VOLTMETER (fig. 13-34), and from 2 to 3 amperes on the COMPASS ROTOR SUPPLY AMMETER when the VOLTAMMETER SELECTOR switch is in the number 1 phase position.

4. Release the VERTICAL RING LOCK (fig. 13-27), then release the GYRO CASE LOCK. Be sure to release the VERTICAL RING LOCK first.

5. Turn the AZIMUTH MOTOR SUPPLY switch on the control panel (fig. 13-34) to ON, and note whether the azimuth motor starts operating. It may be necessary to press the AZIMUTH MOTOR CUTOUT DETENT RELEASE (fig. 13-34) to complete the circuit to the azimuth motor.

6. Turn the BATTERY GENERATOR TRANSFER switch on the battery throwover panel to the motor-generator set in use, close

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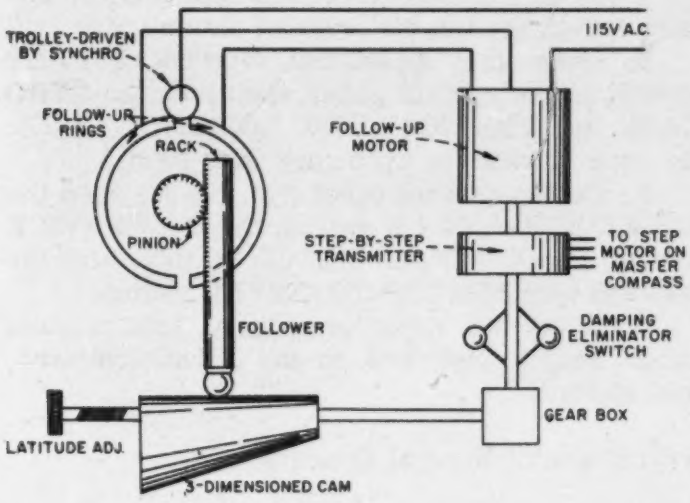

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Figure 13-42.—Schematic diagram of Sperry automatic speed corrector.

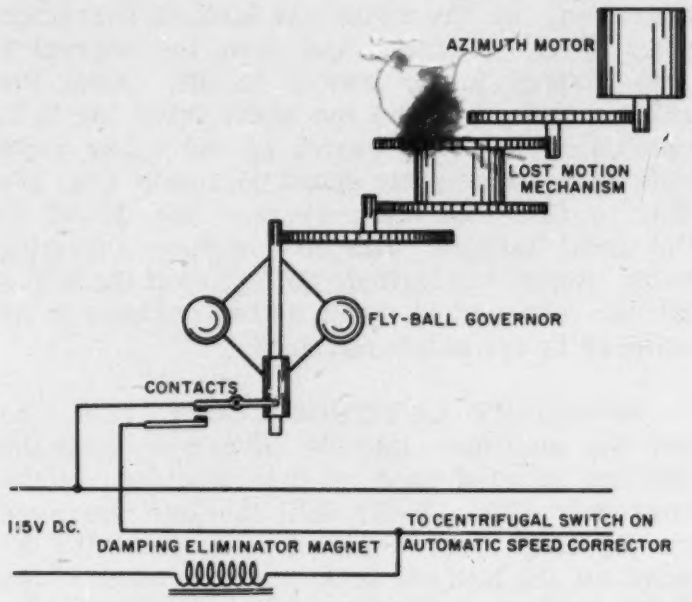

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Figure 13-43.—Schematic diagram of Sperry automatic damping eliminator.

the BATTERY switch, and adjust the battery charging rate with the VOLTAGE ADJUSTING RHEOSTAT.

7. Level the rotor case, then precess the compass to the approximate heading of the ship. To level the rotor case, apply a slight pressure on one side of a rotor case bearing housing as if to turn the compass in azimuth. If the rotor case starts to tilt in the wrong direction, apply the pressure to the other side of the housing. To precess the compass in azimuth, apply a slight downward pressure from the top of a rotor case bearing housing. If the compass starts to precess in the wrong direction, apply the pressure upward from the bottom of the housing.

8. Close the repeater supply switch on the IC switchboard (not shown), the 24 VOLT ALARM switch on the battery throwover panel (fig. 13-34), and the rotary switches for the relay transmitter supply and differential alarm relay on the relay transmitter repeater panel (not shown).

9. Close the switch on the relay transmitter (fig. 13-38).

10. Close the FOLLOWUP switch on the relay transmitter amplifier panel (fig. 13-34), wait about one minute for the tube filaments to heat up, then close the AZIMUTH MOTOR switch. The relay transmitter should synchronize immediately to the same heading as the master compass.

11. Close the toggle switch on the differential alarm relay (fig. 13-39), and turn on all repeaters.

Setting Correction Devices

The gyrocompass operator must ensure that all error correction devices are properly set before starting the gyrocompass. While the ship is underway, he is further concerned with adjusting these devices. For the Sperry Mk 11 Mod 6 gyrocompass system, these devices include the Speed and Latitude Corrector, the Automatic Speed Corrector, the Auxiliary Latitude Corrector, and the Ballistic Latitude Adjustment.

SPEED AND LATITUDE CORRECTOR.—To set the speed and latitude corrector (fig. 13-41) without utilizing the automatic speed corrector, turn the knurled knob at the upper center of the corrector until the point on the latitude scale corresponding to the local latitude intersects the speed curve corresponding to the ship's speed. For maximum accuracy the corrector should be kept within 2 degrees of the local latitude and within 2 knots of the ship's speed. It is impractical, however, to attempt to keep the speed settings within these limits without utilizing the automatic speed corrector.

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To put the automatic speed corrector in operation, set the speed and latitude corrector (fig. 13-41) at zero, and turn the corrector step-by-step motor switch to ON. After the ship is underway and the underwater log is in operation, turn the switch on the upper right side of the automatic speed corrector (fig. 13-40), to ON. Set the corrector (fig. 13-40) to the local latitude with the latitude adjusting knob. Adjust the latitude setting when the ship's latitude changes as much as two degrees or as ordered by the ship's navigator.

AUXILIARY LATITUDE CORRECTOR.—To set the auxiliary latitude corrector, turn the smaller knurled knob on the right side of the corrector (fig. 13-41) until the line engraved on the large gear segment coincides with the point on the latitude scale corresponding to the local latitude. Change this adjustment for changes in ship's latitude of 2 degrees, or as ordered by the ship's navigator.

BALLISTIC LATITUDE ADJUSTMENT.—To make the ballistic latitude adjustment, turn the knurled latitude setting thumbwheel (fig. 13-29) until the pointer on the ballistic frame points to the local latitude on the latitude scale located on top of the mercury reservoir. Make the same adjustment on the opposite side of the ballistic. Make these adjustments for changes in latitude of 10 degrees, or as ordered by the ship's navigator.

Stopping the Compass

To stop the Sperry Mk 11 Mod 6 gyrocompass, proceed as follows:

1. Turn the switch on the automatic speed corrector, and the step-by-step speed corrector motor switch on the master compass to OFF.
2. On the battery throwover panel (fig. 13-34) open the 24-volt alarm switch, the BATTERY switch, and the BATTERY GENERATOR TRANSFER switch.
3. Open the toggle switch on the differential alarm unit, then open the AZIMUTH MOTOR switch and the FOLLOWUP switch on the relay transmitter amplifier panel.
4. Open all repeater switches, and the rotary switch for the differential alarm unit.
5. Open the AZIMUTH MOTOR SUPPLY switch on the control panel, then lock the GYRO CASE, and VERTICAL RING LOCKS (fig. 13-27). Be sure to lock the gyro case lock first.
6. On the control panel (fig. 13-34) open the FOLLOWUP SUPPLY switch, the D-C SERVICE switch, the COMPASS ROTOR switch, and the MOTOR GENERATOR TRANSFER switch.
7. Open the repeater supply, and control panel supply switches on the IC switchboard, (not shown).

Indications of Normal Operations

Normal operating conditions for the compass system are indicated by the various electrical meters and overload indicators on the gyrocompass switchboard (fig. 13-34). Normal readings for the electrical meters are listed in the manufacturer's technical manual, NavShips 324-0020. As these readings may vary slightly for different installations, the average meter readings during actual normal operation should be recorded and used as the normal readings.

Normal operating conditions are also indicated by the gyro case level and vacuum gauge on the sensitive element, and the presence of the blue frame in the compass followup and relay transmitter power amplifier thyratrons.

Study the gyrocompass installation on your ship and become familiar with all indications of normal operation. This will enable you to recognize any abnormal condition immediately.

You may be assigned to a ship with a large complement of IC electricians and therefore not be required to concern yourself with the gyro watches. You should bear in mind however, that your next duty station may be on a small ship that has no IC electrician onboard, and you as an EM 3 or 2 may be the one required to carry out the duties of the gyro watch.

Regardless of the type of ship to which you are assigned ask your division PO to assign you some familarization watches with the IC gang or use your off duty time if necessary to learn the proper procedures for starting, adjusting and securing the gyrocompass.

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CHAPTER 14

ELECTRIC PROPULSION

Electric propulsion installations use rotating electrical machinery for the transmission of power from the prime movers to the ship's propeller(s). Electric generators driven by the propulsion prime movers supply electric power to the propulsion motors, which are connected to the propeller shafting, either directly or through reduction gear units. The electric power generated is either a-c or d-c power and the installation is classified accordingly as an a-c or d-c system.

Steam turbines and diesel engines are used as prime movers in electric drive installations on naval vessels. Turbines are generally used only with a-c generators because turbine speeds are high for d-c generators. Diesel engines can be used with either a-c or d-c generators, but almost all diesel electric installations in naval vessels use d-c generators.

In the era of transition between the slow-speed steam reciprocating engine and high-speed steam turbines for ship propulsion, large reduction gears had not been sufficiently developed to provide reliable service on naval capital ships. Electric propulsion, on the other hand, had successfully proved itself on the first electrically propelled naval surface ship, the collier Jupiter, which was later converted to the aircraft carrier Langley. The favorable service record of this vessel strongly influenced the application of a-c turboelectric propulsion on two aircraft carriers and seven battleships completed shortly after World War I.

Soon after the completion of these vessels, turbine-geared drive came into extensive use on merchant and passenger vessels and proved itself highly successful. While electric drive permitted greater flexibility in arrangement of machinery and proved more economical at cruising speeds, the greater savings of weight and space with reduction gears outweighed these advantages in large surface ships. Thus, when construction of capital ships was resumed after 1930, the use of reduction gears for propulsion plants in the higher ranges of power capacity had been standardized by the Navy, and no further installations of electric propulsion were made on capital ships.

This standardization of turbine reduction-gear drive for large combatant ships did not, however, eliminate electric propulsion from consideration on vessels requiring propulsion of medium or small capacities. The Navy has continued to install electric propulsion on certain types of surface vessels for the following reasons:

1. Direct-current electric propulsion provides exceptional operating flexibility at reduced speeds and under towing conditions; thus it is highly desirable for tugs, icebreakers, salvage ships, net-laying ships, and survey ships.

2. Propulsion generators of an electrically propelled vessel may be used to provide power for large pumps, cargo-handling gear, and other purposes. They have been used to advantage on tugs equipped with large motor-driven fire pumps, tankers equipped with large cargo pumps, and mine sweepers with magnetic sweeps. Submarine tenders such as the AS-31 and 32 provide a-c power to nuclear powered submarines while alongside by means of the tender's propulsion generators.

3. In World War II, the availability of reduction gears for propulsion became critical. Because electric propulsion could serve the same purpose of reducing speeds between the propulsion engines and the propeller shafts and could be procured more readily than reduction gears, it was widely used on several classes of vessels, particularly on escort vessels (DE).

4. Electric propulsion permits maximum flexibility in the number, size, speed, and type of prime movers. This feature was of special importance during World War II when the choice of diesel engines was limited to those most readily available. Electric propulsion not only provided the necessary speed reduction but

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permitted shipboard machinery arrangements best adapted to the types of vessels involved.

There are three types of electric drive in use aboard naval vessels today: diesel d-c drive, diesel a-c drive, and turbine a-c drive. Adaptability of these types to various horsepower requirements and their applications to naval surface vessels is discussed below.

1. Diesel d-c drive is suited to vessels in the horsepower range from 300 up to 21,000 shaft horsepower. It has been installed in approximately 175 escort vessels and 500 surface vessels of other types, including mine sweepers, icebreakers (the AGB-4 has two 10,500-hp d-c motors), 11,500-hp submarine tenders, fleet and harbor tugs, fuel-oil tankers and barges, rescue and salvage vessels, net-laying ships, freighters, coast guard vessels, ferries, and miscellaneous unclassified vessels.

2. Diesel a-c drive is best adapted to medium horsepower installations ranging from about 4000 to 15,000 shaft horsepower. Its application so far has been limited to submarine tenders AS12, AS31, and AS32.

3. Turbine a-c drive is best suited to installations of about 6000 shaft horsepower or more. Approximately 350 naval vessels have been equipped with a-c turbine electric drive. These include escort vessels (DE), cargo and troop transports (AP, APD, APA, AKA), and oilers (AO).

This chapter will discuss the turbine electric a-c propulsion system used on DE-51 class escort ships, and the diesel electric d-c system used on fleet tugs. A number of APDs (high speed transports), have the same propulsion system as the DE-51 class.

TURBINE ELECTRIC A-C PROPULSION

The arrangement of a turbine electric a-c propulsion installation in U.S. DE51 class escort vessels is illustrated by the block diagram in figure 14-1. The installation consists of two turbine-driven propulsion generators, which furnish power through two individual control cubicles to two propulsion motors, which in turn, drive the propellers. Each generator normally supplies power to one of the propulsion motors. The motors are directly connected to their respective propeller shafts. The turbine generators always rotate in the same direction. Reversal of the motors is accomplished by

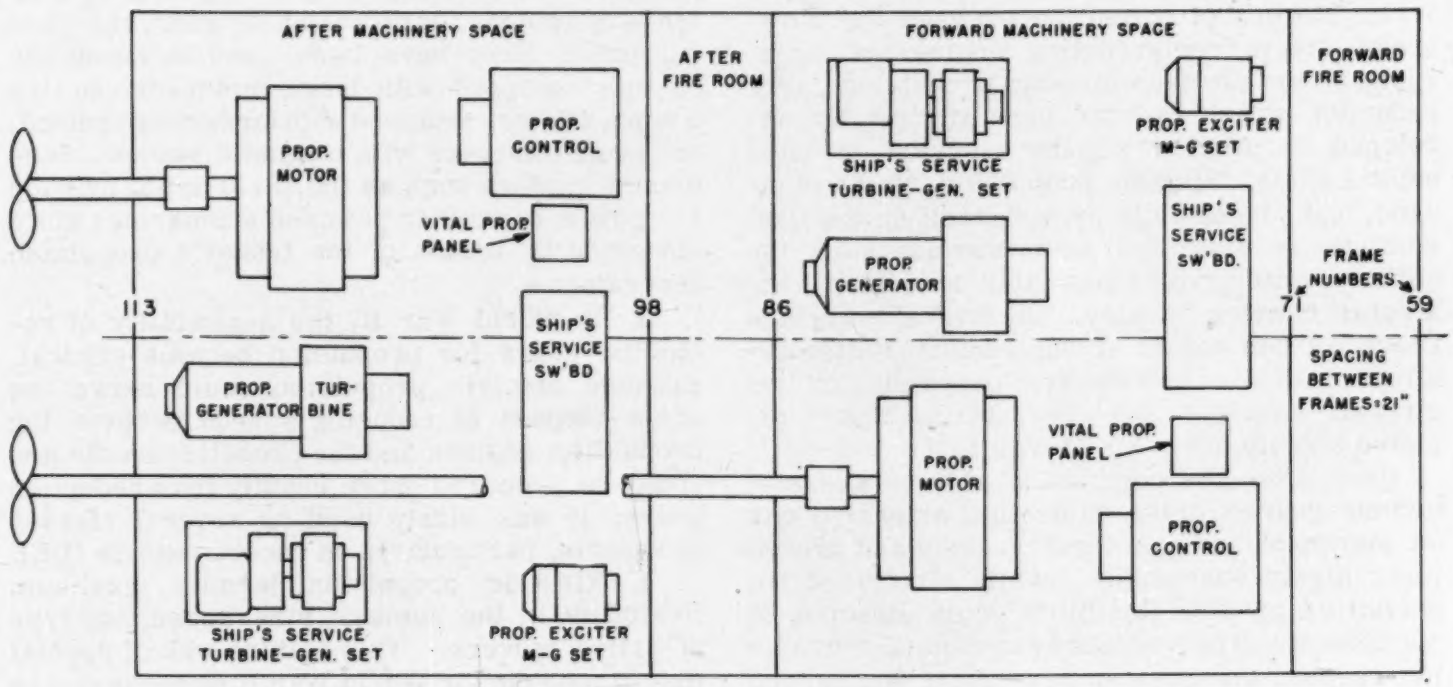

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Figure 14-1.—Turbine electric a-c propulsion installation in destroyer escort.

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interchanging two of the phase connections to the motors. Speed control is accomplished by control of the turbine speed.

Two similar propulsion control panels are provided, one for the forward engine room and one for the after engine room. Operation of the equipment is by means of levers mounted in the control panel.

In addition, two ship's service turbine-generator sets and associated switchboards are provided, one in the forward engine room and one in the after engine room. These generators supply the ship's lighting and power requirements and the power for the propulsion exciter motor-generator sets through the vital propulsion auxiliary panel (fig. 14-2).

PROPULSION GENERATORS

The two propulsion generators are 3-phase, 3-wire, 2-pole, separately excited, self-ventilated machines. Each generator is directly coupled to a steam turbine through a solid coupling forged to the shaft. Ventilation is provided by a fan mounted on each end of the rotor shaft. The air is recirculated through a single section cooler located on top of the generator frame. Electric heaters are mounted in the generator under the end windings to prevent condensation in the windings when the generator is secured.

Each propulsion generator is rated at 4600 kva, 2700 volts, 93.3 cycles, 1.0 power factor, and 5600 rpm. At reduced turbine speed the generator frequency and voltage are reduced proportionately.

PROPULSION MOTORS

The two propulsion motors are 3-phase, 3-wire, 28-pole separately excited, self-ventilated synchronous motors. Each motor is flanged-coupled to a propeller shaft. A fan mounted on each end of the rotor forces air through the motor and recirculates it through a cooler located on top of the stator frame. To prevent the accumulation of moisture in the windings during periods of inoperation, electric heaters are mounted in the lower part of the motor frame.

Each propulsion motor is rated at 6,000 horsepower, 2,700 volts, 984 amperes, 93.3 cycles, 1.0 power factors, and 400 rpm. The motor speed is 2/28, or 1/14, of the generator speed. Thus, the motor operates at its synchronous speed of 400 rpm at the rated generator speed of 5600 rpm. A squirrel cage winding is provided for use when the motor is operated as an induction motor during starting periods.

PROPULSION EXCITERS

The two propulsion exciter motor-generator sets are identical. Each set consists of an 85-hp 440-volt, 3-phase, 60-cycle motor and a 60-kw, 110-volt, d-c exciter mounted on the same shaft. A 3-kw, 125-volt, amplidyne generator is mounted above the main exciter and is belt-driven from its shaft, the main exciter provides the field current for both the propulsion motor and generator.

The main exciter field is energized from the amplidyne generator on regulator control and from the 120-volt, d-c vital bus on manual control.

Under automatic control, the voltage regulator is connected to the three amplidyne generator fields, which govern the amplidyne generator armature current, and thus control the exciter field current. During synchronous operation the regulator holds the voltage proportional to the speed.

PROPULSION CONTROL PANELS

The two propulsion control panels are similar. Each panel (fig. 14-3) consists of the various instruments, handwheels, operating levers, and protective devices necessary for the operation of the propulsion equipment. A brief description of the operation of each unit shown in figure 14-3 follows.

1. Phase Balance Relays.—Protect the main propulsion generator and motor against phase faults resulting from a short circuit between phases or to ground or from an open circuit in one phase. The relays compare the current in each of the three phases and operate if there is 25 percent or more unbalance between phases. Closing of the relay contacts energizes the trip coil of the motor and generator field contactors, causing them to open.

2. Ground Protective Relay.—Protects the generator in case of a ground. It has a single operating coil which is connected to a current transformer in the generator neutral line to ground. Should one of the generator phases become grounded, current will flow in the neutral line energizing the operating coil of the ground protective relay, causing the relay to close its contacts and completing the trip circuit for the motor and generator field contactors.

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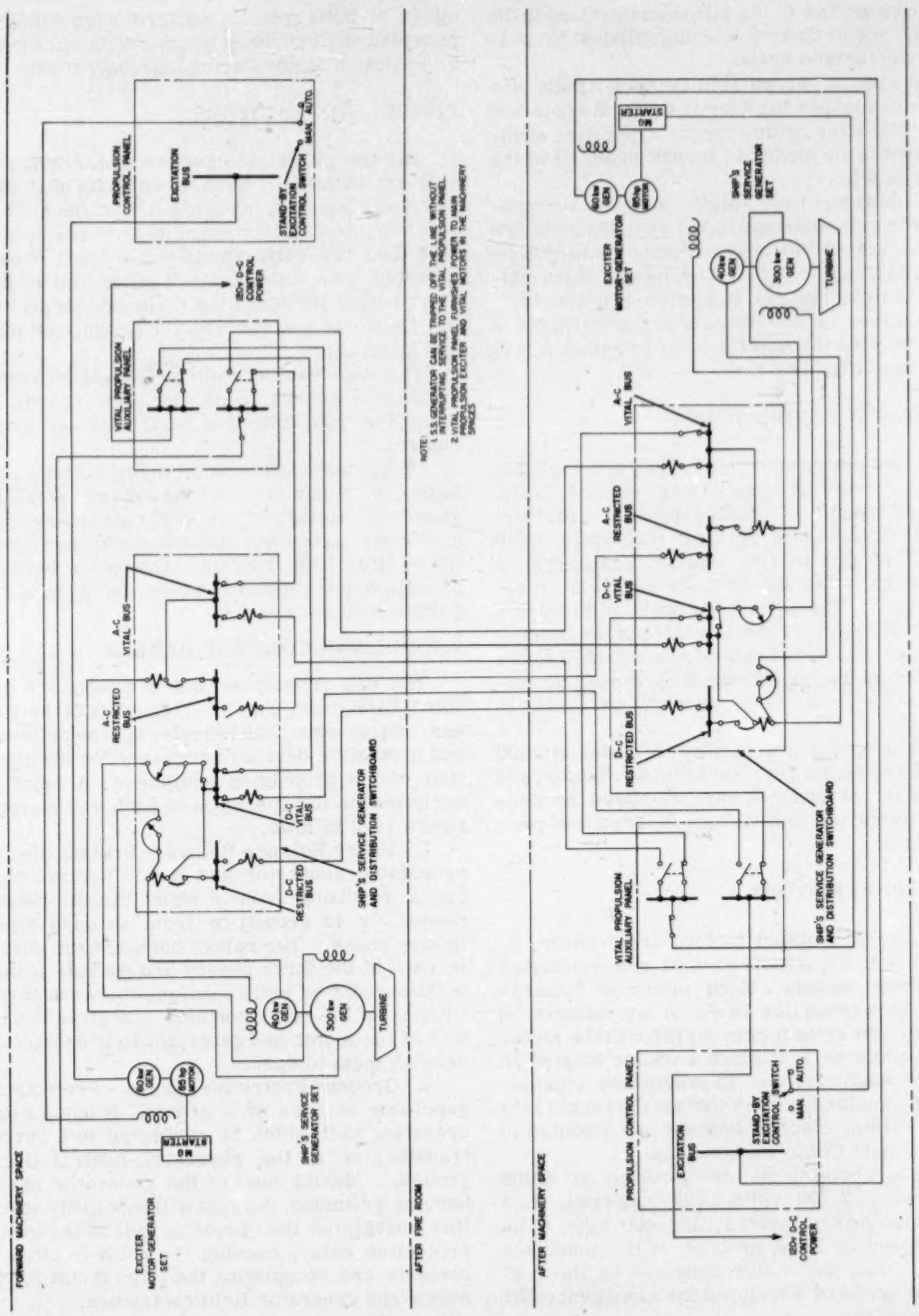

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Figure 14-2.—Switching arrangement and bus ties between ship's service switchboards and propulsion control panels.

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LOGIC FUNCTIONS: (Continued)

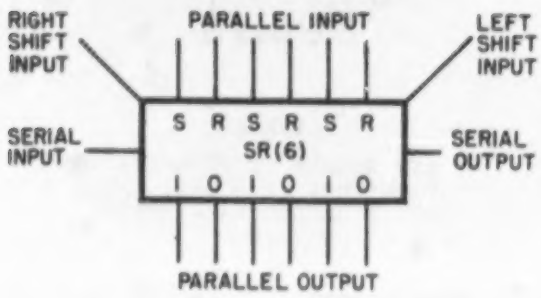

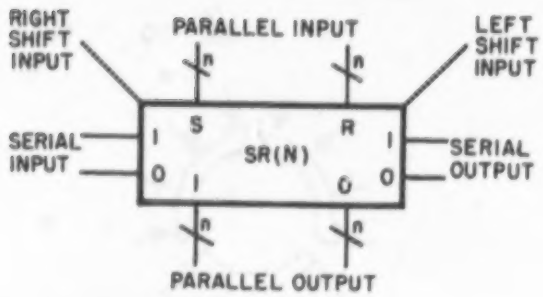

SYNCHROS:

GENERAL

A LETTER COMBINATION FROM THE FOLLOWING LIST MAY BE PLACED ADJACENT TO THE SYMBOL TO INDICATE THE TYPE OF SYNCHRO:

- TX - TORQUE TRANSMITTER
- TDX - TORQUE DIFFERENTIAL TRANSMITTER
- CX - CONTROL TRANSMITTER
- CDX - CONTROL DIFFERENTIAL TRANSMITTER
- TR - TORQUE RECEIVER
- CT - CONTROL TRANSFORMER

SYNCHROS: (Continued)

TRANSMITTER, RECEIVER, OR CONTROL TRANSFORMER

DIFFERENTIAL TRANSMITTER OR RECEIVER

RESOLVER (SYNCHRO)

SINGLY-WOUND ROTOR

DOUBLY-WOUND ROTOR

RESOLVER

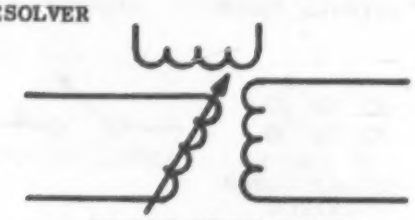

SINGLY-WOUND ROTOR

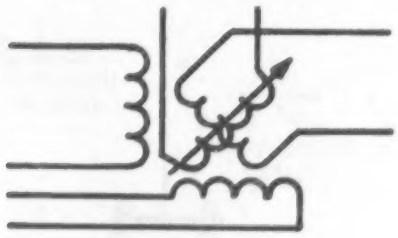

DOUBLY-WOUND ROTOR

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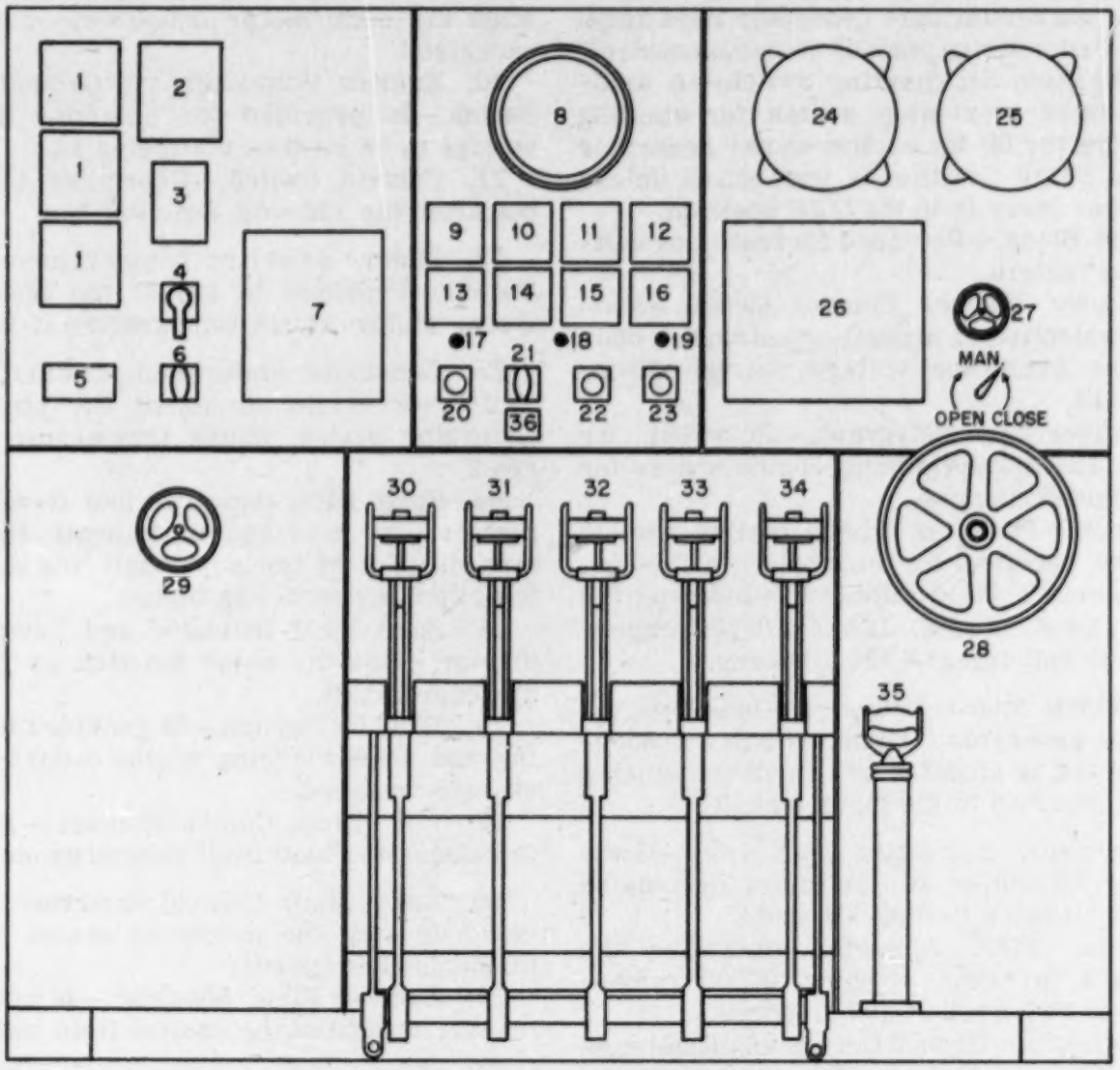

1. PHASE BALANCE RELAYS
2. GROUND PROTECTIVE RELAY
3. NAMEPLATE FOR GEN FIELD AMP
4. EXCITATION SET STARTING SWITCH
5. TEST BLOCK
6. STANDBY EXCITER CONTROL SWITCH
7. ENGINE ROOM TELEGRAPH
8. CLOCK
9. GENERATOR FIELD AMMETER
10. TURBINE SPEED INDICATOR
11. GENERATOR INDICATING WATTMETER
12. MOTOR FIELD AMMETER
13. EXCITER AND GROUND DETECTOR VOLTMETER
14. GENERATOR AMMETER
15. GENERATOR VOLTMETER
16. STATOR COIL TEMPERATURE INDICATOR
17. INDICATING LAMP CONTROL BUS
18. INDICATING LAMP WRONG DIRECTION INDICATOR
19. INDICATING LAMP HEATER
20. EXCITER VOLTMETER AND GROUND DETECTOR SWITCH
21. CONTROL SWITCH
22. MOTOR STATOR TEMPERATURE INDICATOR SWITCH
23. GENERATOR STATOR TEMPERATURE INDICATOR SWITCH
24. SHAFT RPM INDICATOR AND REVOLUTION COUNTER (PORT)
25. SHAFT RPM INDICATOR AND REVOLUTION INDICATOR (STBD)
26. RPM TELEGRAPH
27. LOAD LIMIT CONTROL RELEASE
28. LOAD LIMIT CONTROL HANDWHEEL
29. EXCITER FIELD RHEOSTAT
30. MOTOR SET UP LEVER
31. FIELD LEVER
32. REVERSER LEVER
33. GOVERNOR CONTROL LEVER
34. EMERGENCY LEVER
35. TURBINE TRIP HANDLE
36. NAMEPLATE FOR EMERGENCY OPERATION

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Figure 14-3.—Propulsion control panel.

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3. Nameplate for Generator Field Amp.—Shows the maximum safe generator field amps for a given rpm during periods of manual control.

4. Excitation Set Starting Switch.—A manually operated start-stop switch for starting and stopping the 60-kw exciter motor generator set. The STOP position is ineffective unless the reverser lever is in the OFF position.

5. Test Block.—Provided for testing or calibrating the meters.

6. Standby Exciter Control Switch.—Provided for selection of manual or automatic control of the excitation voltage for the 60-kw exciter field.

7. Engineroom Telegraph.—Provided for receiving and acknowledging engine orders for standard speed changes.

8. Clock.—Provided to indicate time at which orders are received for recording in the log.

9. Generator Field Ammeter.—Indicates the generator field current. It has a 0-300 ampere scale and is red-lined at 122 amperes.

10. Turbine Speed Indicator.—Indicates the rpm of the generator turbine. It has a 0-6000-rpm scale and is actuated by a small tachometer generator attached to the turbine shaft.

11. Generator Indicating Wattmeter.—Indicates the kw output of the main propulsion generator. It has a 0-7000-kw scale.

12. Motor Field Ammeter.—Indicates the motor field current. It has a 0-300 ampere scale and is red-lined at 200 amperes.

13. Exciter and Ground Detector Voltmeter.—Provided to indicate the voltage output of the 60-kw exciter and for use as a ground detector to check for grounds on the various control circuits. It has a 0-300 volt scale.

14. Generator Ammeter.—Indicates the generator line current. It has a 0-2000 ampere scale and is red-lined at 984 amperes.

15. Generator Voltmeter.—Indicates the voltage output of the main propulsion generator. It has a 0-3500 volt scale and is red-lined at 2700 volts.

16. Stator Coil Temperature Indicator.—Is used in conjunction with test switches 22 and 23 to indicate the temperature of the main motor and main generator stators.

17. Indicating Lamp Control Bus.—Green lamp glows when the control bus is energized.

18. Indicating Lamp Wrong Direction Indicator.—Red lamp glows when the reverser lever is operated in the wrong direction in response to an engine order signal from the bridge.

19. Indicating Lamp Heater.—Red lamp glows when the main motor and generator heater are energized.

20. Exciter Voltmeter and Ground Detector Switch.—Is provided for selecting the circuit voltage to be read on voltmeter 13.

21. Control Switch.—Energizes the control bus from the 120-volt d-c vital bus.

22. Motor Stator Temperature Indicator Switch.—Provided to select the phase in the motor stator whose temperature is to be used.

23. Generator Stator Temperature Indicator Switch.—Provided to select the phase in the generator stator whose temperature is to be read.

24. Shaft RPM Indicator and Revolution Indicator.—Is provided to indicate the instantaneous rpm of the port shaft and to count the total rpm the shaft has turned.

25. Shaft RPM Indicator and Revolution Indicator.—Has the same function as 24 for the starboard shaft.

26. RPM Telegraph.—Is provided for receiving and acknowledging engine orders for small changes in speed.

27. Load Limit Control Release.—Is provided to release the load limit control handwheel.

28. Load Limit Control Handwheel.—Is provided to limit the maximum steam flow to the turbine at low speeds.

29. Exciter Field Rheostat.—Is provided for manual control of the exciter field voltage.

30. Motor Setup Lever.—Is provided to connect the two main motors in parallel for two-motor operation or connect them separately for single-motor operation.

31. Field Lever.—Is provided to energize the main motor and generator fields.

32. Reverser Lever.—Is provided for connecting the phases of the main motor for ahead or astern rotation.

33. Governor Control Lever.—Is provided for controlling the main generator turbine speed and thus controlling the main motor speed.

34. Emergency Lever.—Is provided for controlling the generator turbine speed in the event of a casualty to the governor control lever 33.

35. Turbine Trip Handle.—Is provided for tripping the turbine steam throttle valves closed in an emergency that requires stopping the turbine.

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Operating Levers

The operating levers comprise the motor setup lever 30, field lever 31, reverser lever 32, turbine governor lever 33, and emergency control lever 34. These levers are interlocked mechanically and electrically to prevent improper operation of the equipment. Figure 14-4 summarizes this interlocking.

OPERATION

In order to follow the schematic diagram of control circuits that appear later in this chapter and to fully understand the operation of the system, one must realize the need for regulating the voltage output of the main propulsion generator at varying propeller speeds. The need for this voltage regulation, and how the 3GNA8A voltage regulator operates to satisfy this need, is discussed below.

In contrast with the usual alternating current power systems in which the voltage and frequency are maintained constant, the turbine electric propulsion system operates with variable voltage and frequency. The propulsion synchronous motors start as induction motors on reduced voltage and accelerate to a speed equal to synchronous speed minus the slip. Direct current is then applied to the motor fields, pulling the motor into synchronism with the generator. Thereafter propeller speed is controlled by changing the speed of the turbine which in turn changes the frequency and voltage output of the generator. For desirable operating characteristics the main propulsion generator voltage must be maintained, as near as posssible, at constant volts per cycle; that is, the generator voltage must be maintained at such a value that the voltage divided by the frequency is constant. Recalling the voltage generated per phase in alternating current generators, one might surmise that constant volts per cycle would be maintained by the main propulsion generator without adjustment of generator field strength. However, such is not the case with varying loads.

The propulsion motors must supply sufficient torque to start and accelerate the shaft, to turn the shaft for steady running conditions, and to turn the shaft when reversing or maneuvering. The "break away" torque required to overcome friction and start the shaft varies from 5 to 15 percent of full-load torque. However, after the propeller starts to rotate, the torque required to overcome friction decreases rapidly. When a ship is steaming a straight course on a smooth sea at constant speed and with all external conditions which affect the torque also constant, the torque required to turn the propeller is approximately proportional to the square of the propeller rpm, and the horsepower required is

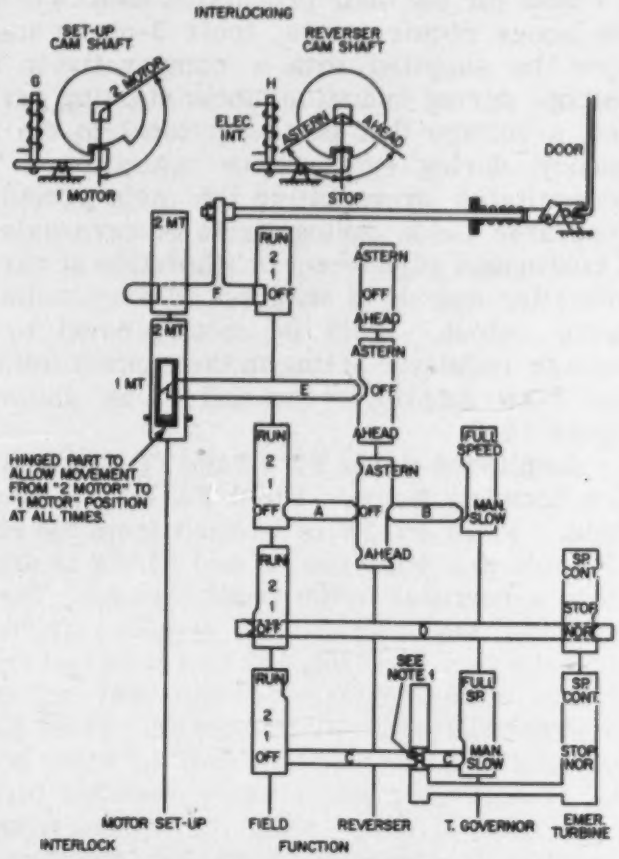

INTERLOCK	FUNCTION
A	THE REVERSER LEVER CAN NOT BE OPERATED UNLESS THE FIELD LEVER IS IN "OFF". THE FIELD LEVER CAN NOT BE OPERATED WHEN THE REVERSER LEVER IS IN "OFF"
B	THE TURBINE GOVERNOR LEVER CAN NOT BE MOVED BEYOND THE 2/3 SPEED POSITION WHEN THE REVERSER LEVER IS IN ASTERN.
C	THE TURBINE GOVERNOR LEVER CAN NOT BE MOVED BEYOND MANEUVERING SPEED UNLESS THE FIELD LEVER IS IN "RUN" EXCEPT THAT IF THE EMERGENCY LEVER IS IN STOP OR A SPEED CONTROL POSITION THIS INTERLOCK IS INEFFECTIVE. THE FIELD LEVER CAN NOT BE MOVED FROM THE RUN POSITION UNLESS THE TURBINE GOVERNOR LEVER IS IN "MANEUVERING" OR "SLOW SPEED", EXCEPT THAT IF THE EMERGENCY LEVER IS IN "STOP" OR SPEED CONTROL POSITION THIS INTERLOCK IS INEFFECTIVE. SEE NOTE 1 BELOW.
D	THE EMERGENCY LEVER CAN NOT BE MOVED TO A SPEED CONTROL POSITION UNLESS THE FIELD LEVER IS IN OTHER THAN THE "OFF" POSITION. THE FIELD LEVER CAN NOT BE MOVED TO "OFF" IF THE EMERGENCY LEVER IS IN A SPEED CONTROL POSITION.
E	THE SET-UP LEVER CAN NOT BE MOVED TO 2 MOTOR POSITION UNLESS THE REVERSER LEVER IS IN "OFF".
F	THE CUBICLE ACCESS DOOR CAN NOT BE OPENED UNLESS THE FIELD LEVER IS IN "OFF" AND THE SET-UP LEVER IN 1 MOTOR POSITION. THE FIELD LEVER CAN NOT BE MOVED FROM "OFF" OR THE SET-UP LEVER IN TO 2 MOTOR POSITION UNLESS THE CUBICLE DOOR IS CLOSED.
G	THE SET-UP LEVER CAN NOT BE MOVED IN TO 2 MOTOR POSITION UNLESS THE REVERSER IN THE OTHER ENGINE ROOM IS IN STOP. (ELECTRICAL)
H	THE REVERSER LEVER CAN NOT BE MOVED FROM THE STOP POSITION UNLESS THE REVERSER IN THE OTHER ENGINE ROOM IS IN STOP OR ONE OF THE TWO SET-UP LEVERS IS IN 1 MOTOR POSITION. (ELECTRICAL)
NOTE 1	WHEN EMERGENCY LEVER IS IN OTHER THAN THE NORMAL POSITION THE BALL DROPS CLEAR ALLOWING THE "C" BARS TO APPROACH EACH OTHER.

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Figure 14-4.—Control lever interlocking.

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approximately proportional to the cube of the propeller rpm.

Thus for the main propulsion motors to meet the above requirements, their 3-phase stators must be supplied with a comparatively high voltage during induction motor starting periods and a voltage that is proportional to the frequency during synchronous operation. This necessitates overexciting the main propulsion generator fields during starts or reversals and a continuous adjustment of excitation at varying propeller speeds to ensure a constant volts per cycle output. This is accomplished by the voltage regulator acting in the control fields of the 3-kw amplidyne generator, as shown by figure 14-5.

Amplidyne fields F1-F2 and F7-F8 (fig. 14-5) are boosting fields. Field Fe-F4 is a bucking field. Field F7-F8 is excited from the ship's 120-volt d-c vital bus. Field F1-F2 is excited from a rectifier in the regulator unit. The a-c input to the rectifier is supplied from the secondary of the 2700/115 volt potential transformer whose primary is connected across the main propulsion generator output. Field F3-F4 (bucking field) is excited from the same potential transformer and another rectifier through a saturable reactor. When the voltage from the potential transformer secondary (the voltage being controlled) is low, the amplidyne boost fields predominate, but as the voltage rises, the reactor in series with the bucking field saturates causing a rapid rise in the bucking field strength. Thus an equilibrium is established between the fields, leaving a net boosting value of ampere turns sufficient to excite the amplidyne to hold 100 percent volts per cycle. Referring to figure 14-5, the complete sequence of operation of the system for one motor ahead is described below.

One-Motor Operation

In one-motor operation each motor is supplied simultaneously by its associated generator. Assume that the main propulsion turbine is running at idling speed, the auxiliary ship's service generators are supplying 450 volts a-c on the vital a-c bus, and 120 volts d-c on the vital d-c bus, and that the 60-kw exciter motor generator set is running. Assume the throttleman is in the after engineroom. The positions of the control levers are as follows:

Setup lever—one motor
Reverser lever—off
Field lever—off
Turbine govenor lever—maneuvering speed
Emergency turbine governor lever—normal
Turbine load limit handwheel—open
Exciter control switch—off

Turn the exciter control switch to the automatic position. This action connects the voltage regulator in the amplidyne field circuits and the armature output of the amplidyne to the 60-kw exciter field. Since the main propulsion generator field is open there will be little or no voltage from the potential transformer secondary and consequently amplidyne fields F1-F2 and F3-F4 will not be excited.

Field F7-F8 is excited from the 120-volt d-c vital bus through resistors R12-R14 to supply a small amount of boosting excitation just sufficient to raise the exciter voltage to a value which will ensure correct polarity and a fairly rapid rise of generator field current when the field lever is moved to position one.

Move the reverser lever to the ahead position. This action closes the main line contactors 1, 3, and 5 connecting the generator and motor with the proper phase sequence for ahead rotation.

Move the field lever to position one. The generator field contactor 21 closes and contactor 20 closes to bypass resistor R6 in the generator field circuit. Contactor F3 closes and F2 opens to insert maximum saturable reactor turns in series with amplidyne field F3-F4 allowing approximately 120 percent volts per cycle generator output. Contactors F4 and F5 close, increasing the excitation supplied to field F7-F8 to about 4 times its normal value. The amplidyne armature voltage increases to about 3 times normal, the exciter and main propulsion generator fields increase to a value approaching 3 times normal. During this time the main propulsion motor is starting as an induction motor. The motor field is not energized but is closed on itself through discharge resistor R5. This resistor is connected across the motor field only while the motor field contactor 22 is open. Discharge resistor R1 is connected across the generator field only while the generator field contactor 21 is open. Discharge resistor R8 is a special type thyrite resistor and is permanently connected across the exciter field. During the period while the motor is starting and accelerating as an induction motor, the line current indicated by the generator ammeter will increase rapidly and may go off scale. When the current decreases to approximately 1300 amperes, move the field lever to position two. Contactor 22 closes to energize the motor field

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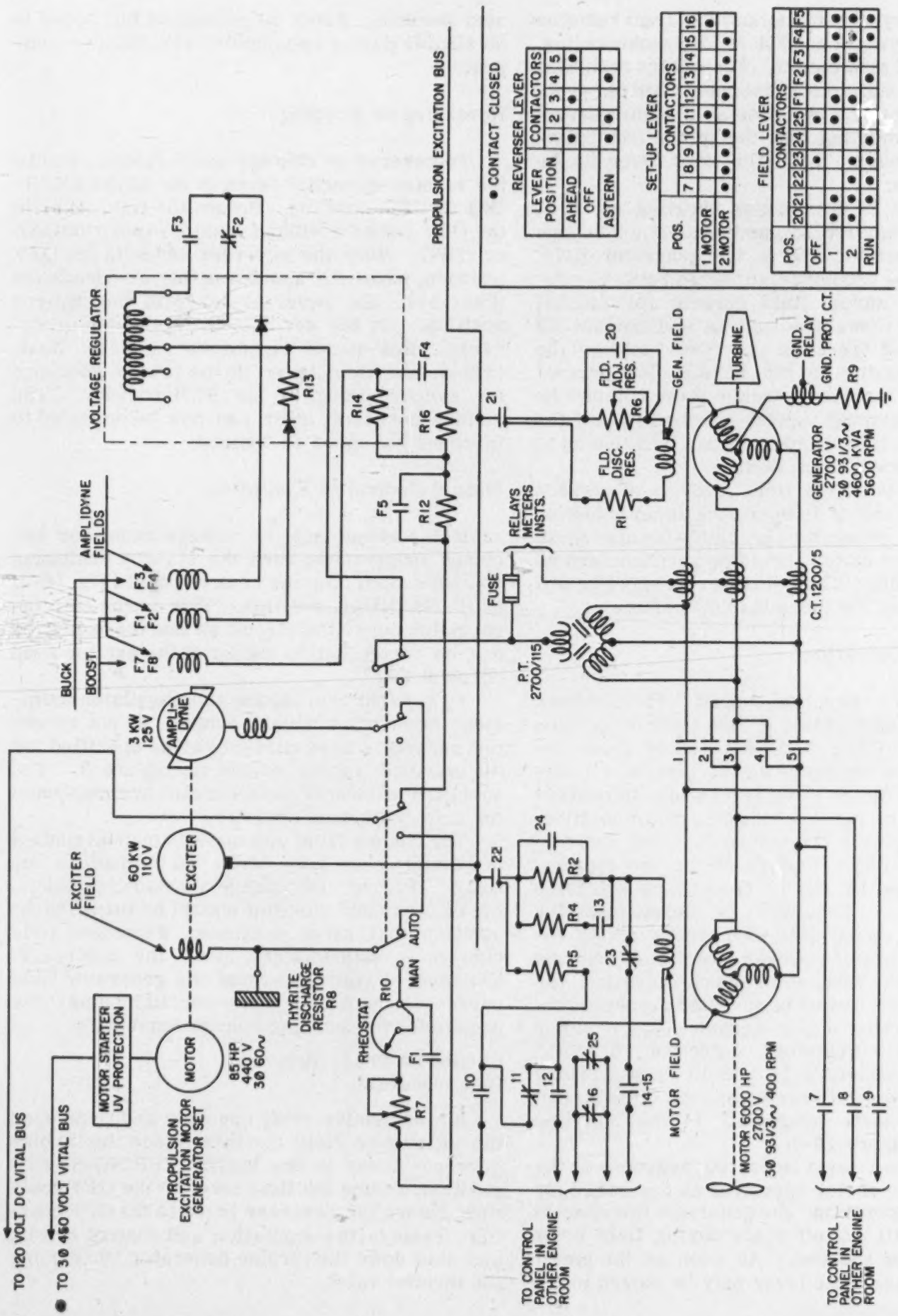

Figure 14-5.—Simplified schematic diagram of control circuits for one screw.

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through the synchronizing current limit resistor R2 to obtain proper conditions for synchronizing. Contactor 23 also closes. The voltage regulator continues to maintain 120 percent volts per cycle on the generator. As soon as the line current steadies, indicating that the motor has pulled into synchronism, move the field lever to the RUN position.

Contactor 24 now closes shorting out synchronizing resistor R2, and contactor 20 opens inserting resistor R6 in the generator field. This sets the proper relationship between generator and motor field current for normal operation. Contact F3 opens and contact F2 closes setting the volts per cycle held by the voltage regulator to the normal 100 percent value. The turbine governor lever can now be moved to increase speed as desired and the turbine load limit handwheel can be adjusted to give the desired steam flow.

NOTE: When the field lever is in position one and the motor is operating as an induction motor, the generator is highly overexcited; therefore, the motor should be synchronized as soon as possible. The field lever must not be left in position one for more than one minute.

Two-Motor Operation

Two-motor operation consists of both motors in parallel and supplied by one main propulsion generator. Control is excercised from the engineroom in which the active generator is located. The motor setup levers in both engine-rooms must be moved to the two-motor position. This action closes contactors 7, 8, and 9 paralleling the 3-phase stators of the two motors.

Contactors 14 and 15 close paralleling the motor fields. Contactor 13 closes inserting resistor R4 in parallel with synchronizing resistor R2 to provide proper motor field current adjustment for two-motor synchronization. As the two motors cannot be operated properly during the induction motor period with a common field discharge resistor, contactors 10 and 12 close and contactors 11 and 13 open allowing separate field discharge resistors. This circuit cannot be shown completely in the one line diagram in figure 14-5.

The control lever operating sequence is the same for two-motor operation as described for one-motor operation. The generator line current ammeter will go off scale during field lever positions one and two. As soon as the meter returns to scale the lever may be moved to the next position. About 80 percent of full speed is obtainable during two-motor operation (one generator).

Reversing or Stopping

To reverse or stop the drive system, return the turbine governor lever to the MANEUVERING SPEED position. Return the field lever to the OFF position without pausing in position ONE or TWO. With the reverser lever in the OFF position, pause for approximately 5 seconds and then move the reverser lever to the desired position. In the event of a crash stop or reversal, this pause should be omitted. Next, operate the field lever in the proper sequence for synchronizing to the RUN position. The turbine governor lever can now be operated to increase the speed as desired.

Manual Control of Excitation

In the event that the voltage regulator becomes inoperative, turn the standby excitation control switch 6 on the control panel (Fig. 14-3) to the MANUAL position. This action cuts the regulator out of the circuit so that the excitation can be controlled by means of the exciter field rheostat 29.

To prevent overloading the propulsion equipment when under manual control, do not exceed the generator field current values specified for the various speeds on the nameplate 3. The specified values of field current are maximum for safe continuous operation.

The change from automatic to manual control of excitation or vice versa can be made at any time. Before the change is made, however, the exciter field rheostat should be turned to the position that gives maximum generator field current. Immediately after the control is switched to manual, adjust the generator field current to the proper value corresponding to the propeller rpm indicated on the nameplate.

Ground or Phase Balance
Relay Operates

If a protective relay operates and trips open the propulsion field circuits, place the turbine governor lever in the MANEUVERING-SPEED position, return the field lever to the OFF position, return the reverser lever to the OFF position, remove the excitation and control power, and shut down the turbine generator by tripping the throttle valve.

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If the setup levers were in the TWO-MOTOR position at the time the relay operated, the setup levers should be returned to the ONE-MOTOR position. Remove the generator neutral ground connection by disconnecting the ground current limit resistor R9 (fig. 14-5). With all circuits deenergized use an insulation-resistance tester to locate the ground or fault. If the motors were operating in parallel at the time the relay operated, the fault may be in either motor circuit.

Emergency Excitation

If failure of one or both of the 60-kw propulsion exciter motor-generator sets occurs, an emergency connection can be made to utilize one of the 40-kw, 120-volt d-c ship's service generators to provide the necessary propulsion excitation. This emergency connection requires disconnecting the 60-kw exciter from the propulsion excitation bus and connecting the 40-kw ship's service generator through its circuit breaker to the propulsion excitation bus by a temporary cable. With this emergency connection the 40-kw generator will supply power to only the excitation bus in the same engineroom.

Thus, if one 60-kw propulsion exciter motor-generator set is out of service, the 40-kw ship's service generator in that engineroom can be connected to the propulsion excitation bus. The ship can then be operated at approximately full power with the regular propulsion exciter motor-generator set supplying propulsion excitation for one screw and the 40-kw d-c ship's service generator supplying emergency excitation for the other screw.

If both 60-kw propulsion exciter motor-generator sets are out of service, either the after or forward 40-kw generator can be connected to the corresponding propulsion excitation bus and one propulsion generator, to obtain two-motor operation.

Assume that the forward 40-kw ship's service generator is to be used to supply emergency excitation for the propulsion system (fig. 14-6). Operation of the ship will then be from the forward engine room using the forward propulsion generator and the two propulsion motors on two-motor operation. The ship's service a-c and d-c power must be obtained from the after engineroom. Similarly, the after 40-kw ship's service generator and after propulsion generator could be connected and operated. The forward ship's service generator would then be required to provide ship's service power.

It is obvious that both 40-kw ship's service generators cannot be used for propulsion excitation at the same time. Likewise, it will not be possible to use a remote ship's service generator for the excitation supply.

The operation of the propulsion plant will be different from normal and somewhat restricted because the 40-kw generator does not have as large an overload rating as the 60-kw exciter.

To connect the forward 40-kw generator to supply propulsion excitation, it is necessary to first have the after ship's service turbine-generator set warmed up and ready for operation. Then, in the forward engineroom, perform the following steps in sequence.

At the vital propulsion auxiliary panel, transfer all a-c and d-c loads to the remote source of vital power and open the excitation motor-generator circuit breaker.

At the ship's service generator and distribution switchboard, transfer all auxiliary a-c and d-c loads to the remote source of power. Open the a-c generator circuit breaker 1, open the generator field switch 2, open the d-c generator circuit breaker 3, open the d-c breaker for the forward vital propulsion auxiliary switchboard 4, open the d-c breaker for the after vital propulsion auxiliary switchboard 5, turn the 40-kw generator field rheostat 6 to minimum d-c volts, and open the d-c bus tie breaker 7. After testing for zero volts, open the disconnect switch links 8 on the load side of the d-c generator circuit breaker.

At the 60-kw exciter, disconnect the armature and field leads. Tape all the leads from the exciter and the two field line leads. Connect one end of the shore power cable to the armature line lead 9 and the other end to the disconnect link 8 at the switchboard. Be sure to maintain proper polarity. To reduce heating of the shore power cables, parallel two leads for one leg and use the third conductor for the other leg.

At the d-c restricted bus section of the forward ship's service and distribution switchboard, close the d-c bus-tie circuit breaker 7; close the 40-kw, d-c generator circuit breaker 3 and lock it; and adjust the propulsion excitation by means of the ship's service generator field rheostat 6.

A similar procedure is followed when connecting the after 40-kw generator to supply emergency power for propulsion excitation. When either 40-kw generator is used, very little torque will be available for starting or reversing because overexcitation (normally supplied to

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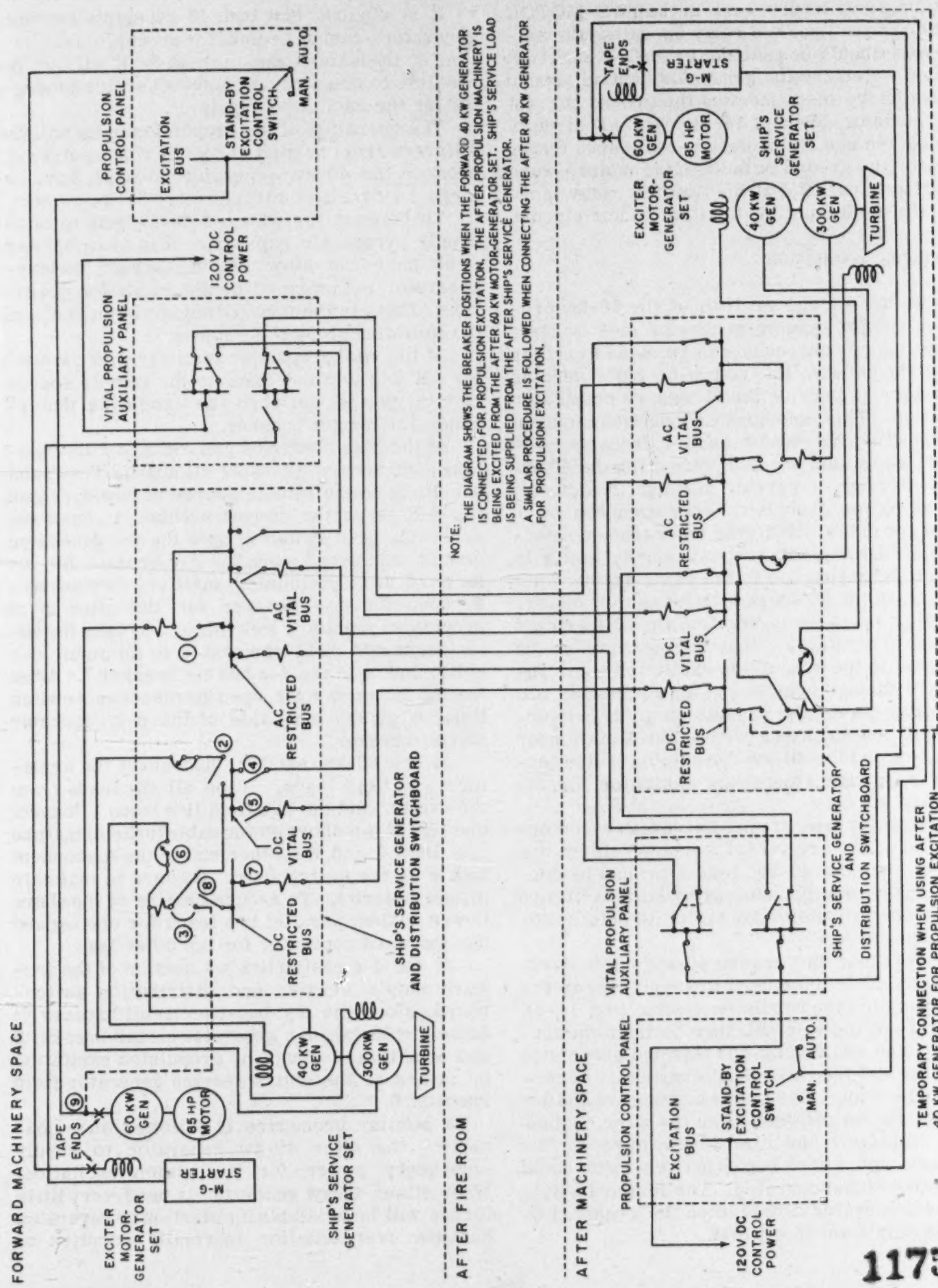

Figure 14-6.—One-line diagram of emergency power for propulsion field excitation. 27.99

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the generator field during starting) cannot be obtained from the 40-kw generator. However, if the operations are properly executed, one motor can be started and synchronized successfully even though the ship is dead in the water. One motor can be successfully reversed when there is a small headway on the ship. During starting and reversing, the current from the 40-kw generator will exceed the rating of the machine for short intervals of time. As soon as possible after synchronizing, the propulsion generator excitation current should be reduced to the recommended value for manual control of excitation.

To START and RUN one motor, move the propulsion control levers to the positions for normal starting on one motor. Turn the standby excitation control switch to the MANUAL position. Be certain that the 40-kw generator is running at rated speed. Raise the d-c generator volts as high as possible by means of the d-c generator field rheostat (this voltage can be read as exciter volts on the propulsion control panel). Place the field lever in position ONE. When the shaft rpm and line current are steady. move the field lever quickly from position ONE to the RUN position without pausing in position TWO. The propulsion motor should synchronize and run.

Lower the excitation voltage until the propulsion generator field current corresponds to the specified value for the existing propeller rpm. Adjust the propeller rpm by means of the turbine governor lever. When raising the propeller rpm, watch the 40-kw generator current. When it reaches 330 amperes, the propeller rpm (and therefore the propulsion generator field current) should not be raised any further. The idle propeller will turn unless locked. If allowed to turn, be certain that lubricating oil is supplied to the thrust block and line shaft bearing.

To reverse the direction of the ship when operating on one motor, drop the propeller rpm to 100 or less and allow the ship to settle down to this speed. Place the turbine governor lever in the MANEUVERING-SPEED position. Move the field lever to the OFF position. Move the reverser lever in the desired direction. Raise the d-c generator volts as high as possible by the d-c generator field rheostat.

Place the field lever in position ONE. When the shaft rpm and line current are steady, move the field lever quickly from position ONE to the RUN position without pausing in position TWO. The propulsion motor should synchronize and run.

Lower the excitation voltage until the propulsion generator field current corresponds to the specified value for the existing propeller rpm. Adjust the propeller rpm by means of the turbine governor lever. When raising the propeller rpm, watch the 40-kw generator current and do not allow it to exceed 330 amperes.

To run on two motors with reduced excitation for the turbogenerator in use, first get the ship underway on one motor. Raise the speed until the idle propeller turns without power. Remove power from the active screw and allow the ship to slow down until both propeller rpms are equal. Move the setup levers in both engine-rooms to the TWO-MOTOR position. Restart the motors, as previously explained, for ONE-MOTOR operation.

Adjust the propeller rpm by means of the turbine governor lever. Adjust the propulsion generator field current to the value specified for manual excitation control. When raising the propeller rpm do not permit the 40-kw generator current to go beyond 330 amperes.

A reversal of the direction of the ship should not be attempted when operating on two motors. Reversal can be accomplished when operating on two motors, however, by placing both setup levers to the ONE-MOTOR position and allowing the shafts to slow to 100 rpm and then follow the procedures previously explained for reversal on one motor.

Emergency Blocking of Electrical Interlocks

The electrical interlocks previously described can be blocked out manually in an emergency when control power is lost.

If control power is lost in the forward engineroom and it is desired to operate on one motor alone, the forward engineroom reverser interlock must be blocked out.

If it is desired to operate on two motors and the after engineroom is to control, the forward engineroom setup lever interlock must be blocked out. The reverser in the forward engineroom must be left in the OFF position. On the other hand, if the forward engineroom is to control, the forward engineroom setup lever interlock and the reverser interlock must be blocked out. The reverser in the after engineroom must be left in the OFF position.

The propulsion system requires routine maintenance to keep it in reliable operating

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condition. Figures 14-7 and 14-8 show the maintenance requirement cards for a representative a-c propulsion generator and propulsion motor, respectively. Note that these cards cover only the weekly requirements and that each requires less than one hour to complete, with two men assigned to perform the work. The propulsion generators and motors are vital to the operation of the ship and must be maintained in a high state of readiness for operation. Simple cleaning and testing procedures as shown by the maintenance requirement cards will permit you to spot minor troubles and prevent what could develop into serious damage to vital and costly equipment.

DIESEL ELECTRIC D-C PROPULSION INSTALLATION

A representative diesel electric d-c propulsion installation in a U.S. fleet tug consists of four diesel engine-driven propulsion generators, which furnish power through the control equipment to one propulsion motor, which in turn drives the propeller. Each generator is provided with an exciter mounted on an extension of the generator shaft. The four generating units are located amidship, two on the port side and two on the starboard side.

The propulsion motor is directly connected to a single propeller shaft and located on the

SYSTEM	COMPONENT	M.R. NUMBER
Propulsion	Propulsion Generator	EL-15 W-1
SUB-SYSTEM	RELATED M.R.	RATES / M/H
Propulsion Units	None	EM3 0.8 EMFN 0.8

M.R. DESCRIPTION

1. Clean and inspect slip rings.
2. Measure insulation resistance.

TOTAL M/H 1.6
ELAPSED TIME: 0.8

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Wire air starting/steam inlet valve shut and tag "Do Not Open."
3. On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
4. De-energize all power supplies and tag "Out Of Service."
5. Wear rubber gloves and test with multimeter to ensure all power supplies are de-energized.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. 4/0 Sandpaper
2. Wire, 24 gauge
3. Multimeter, CVS 260
4. 6" Normal duty screwdriver
5. 5000/7000-volt Rubber gloves
6. 1/2"-drive Socket set
7. Flashlight
8. Safety tags
9. Lint-free rags
10. 500-volt Megger
11. 6" Slip-joint pliers

PROCEDURE

NOTE 1: Measure insulation resistance weekly, when securing, and before starting, if idle for more than a week.

Preliminary

a. Wire air starting/steam inlet valve shut and tag "Do Not Open."
b. On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
c. Ensure excitation supply switches are open and tagged "Out Of Service."
d. De-energize all power supplies to cubicle /switchboard and tag "Out Of Service."

(Cont'd on Page 2)

LOCATION | DATE 16 August 1965

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Procedure (Cont'd)

1. Clean and Inspect Slip Rings.
   a. Open or remove access covers.
   b. Set multimeter on appropriate scale and test to ensure all power supplies are de-energized.
   c. Wipe slip rings and housing with a rag.
   d. Inspect slip rings for pits, grooves, and corrosion. Clean, if necessary.

2. Measure Insulation Resistance.

NOTE 2: Use megger to measure insulation resistance.

a. Measure field insulation resistance at slip rings.

NOTE 3: If insulation resistance is less than 1.0 megohm for stator or 0.5 megohm for field, take corrective action.

b. Open or remove access covers of cubicle/switchboard.

WARNING: Wear 5000/7000-volt rubber gloves and have safety man standing by.

c. Set multimeter on appropriate scale and test to ensure all power supplies are de-energized.
d. Measure stator insulation resistance. See NOTE 3.
e. Ensure no loose items are left inside unit.
f. Close or reinstall access covers.
g. Remove wire or reconnect starting motor.
h. Remove tags and set up for prescribed operation.

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Figure 14-7.—Weekly MRC for A-C propulsion generator.

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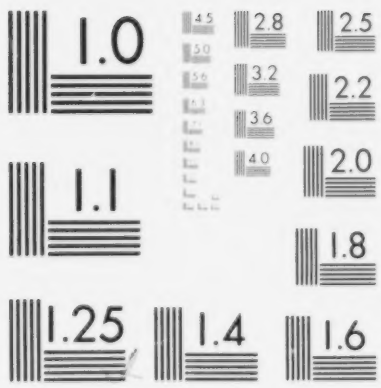

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

centerline of the ship in a separate compartment immediately aft of the generating units.

The control equipment consists of an engineroom control station and a pilothouse control station with instrument panel. A transfer switch is provided to control the drive system from either the engineroom or the pilothouse. The control provides for controlling the outputs of the four propulsion generators and associated exciters, and the speed and direction of rotation of the propulsion motor.

The diesel engines and generators rotate in the same direction for both ahead and astern rotation of the propeller. Primary control of the direction and speed of the propeller rotation is obtained by changing the polarity and magnitude of the generator terminal voltage. The polarity and magnitude of the generator terminal voltage are changed by controlling the direction and magnitude of the generator field current. The speed over certain ranges is also controlled by varying the speed of the diesel engines and associated generators.

The control is effected by means of a speed controller in the engineroom or by a speed controller in the pilothouse. The speed controller is connected to a rheostat and reversing contacts for controlling the magnitude and direction of the generator field current and to an engine speed transmitter for controlling the engine speed.

SYSTEM	COMPONENT	M.R. NUMBER
Propulsion	Propulsion Motor	EL-16 W-1
SUB-SYSTEM: Propulsion Units	RELATED M.R.: None	RATES / M/H: EM3 0.8; EMFN 0.8

M.R. DESCRIPTION
1. Clean and inspect slip rings.
2. Measure insulation resistance.

TOTAL M/H: 1.6
ELAPSED TIME: 0.8

SAFETY PRECAUTIONS
1. Observe standard safety precautions.
2. Ensure motor starting lever/set-up handwheel is in the OFF position; tag "Out Of Service."
3. De-energize all power supplies and tag "Out Of Service."
4. Wear rubber gloves; test with multimeter to ensure all power supplies are de-energized.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT
1. Flashlight
2. Safety tags
3. 4/0 Sandpaper
4. Lint-free rags
5. 500-volt Megger
6. CVS 260 Multimeter
7. 1/2"-drive Socket set
8. 6" Normal duty screwdriver
9. 5000/7000-volt Rubber gloves

PROCEDURE

NOTE 1: Measure insulation resistance weekly, when securing, and before starting, if idle for more than a week.

Preliminary
a. Ensure motor starting lever/set-up handwheel is in the OFF position; tag "Out Of Service."
b. Ensure excitation supply switches are open; tag "Out Of Service."
c. De-energize all power supplies to cubicle/switchboard and tag "Out Of Service."

1. Clean and Inspect Slip Rings.
a. Open or remove access covers.
b. Set multimeter on appropriate scale and test to ensure all power supplies are de-energized.
c. Wipe slip rings and housing with a rag.

(Cont'd on Page 2)

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Procedure (Cont'd)

d. Inspect slip rings for pits, grooves, and corrosion. Clean, if necessary.

2. Measure Insulation Resistance.

NOTE 2: Use megger to measure insulation resistance.

a. Measure field insulation resistance at slip rings.

NOTE 3: If insulation resistance is less than 1.0 megohm for stator or 0.5 megohm for field, take corrective action.

b. Open or remove access covers of cubicle/switchboard.

WARNING: Wear 5000/7000-volt rubber gloves and have safety man standing by.

c. Set multimeter on appropriate scale and test to ensure all power supplies are de-energized.
d. Measure stator insulation resistance. See NOTE 3.
e. Ensure no loose items are left inside unit.
f. Close or reinstall access covers.
g. Remove tags and set up for prescribed operation.

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Figure 14-8.—Weekly MRC for A-C propulsion motor.

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The system is designed to permit operation of any combination from one to four generators with the motor. Also, either generator 2 or 3 but not both at the same time, can be used to supply auxiliary power for salvage operations. When this is done the generator cannot be used in propulsion service.

PROPULSION GENERATORS

The four propulsion generators are d-c, separately excited, 2-wire, split-frame, self-ventilated machines. They are heavy duty marine type units designed for operation over the speed range of the diesel engines. Commutating poles are provided to improve commutation. Each generator is rated at 610 kw, 375 volts, 1625 amperes, and 700 rpm.

PROPULSION EXCITERS

As previously stated, each propulsion generator is equipped with a directly connected exciter, which provides excitation for the associated generator field. The exciters are d-c, separately excited, 2-wire, self-ventilated units provided with commutating poles. Each exciter is rated at 3 kw, 70 volts, 43 amperes, and 350/700 rpm.

PROPULSION MOTOR

The propulsion motor is a d-c, separately excited, adjustable speed motor having commutating and compensating windings (fig. 14-9). It is actually two identical motors with their armatures mounted on a common shaft. The armatures are operated in series at all times. Each half of the motor is rated at 1500 horsepower, 750 volts, 1610 amperes, and at 112/140 rpm. The power is supplied from the propulsion generators, which are connected with their armatures interposed with those of the propulsion motor so that the maximum voltage across any part of the propulsion loop does not exceed 750 volts. The shunt type fields of the propulsion motor are excited from the ship's 240-volt (auxiliary), d-c supply. The two armatures are mounted on a single shaft with their commutators adjacent. The direction of rotation is determined by viewing the commutator end of each armature. The stator frames are independently foot mounted and are also identical except for the brush rigging and the polarities of the shunt field leads, which are made to suit the opposite direction of rotation of the armatures.

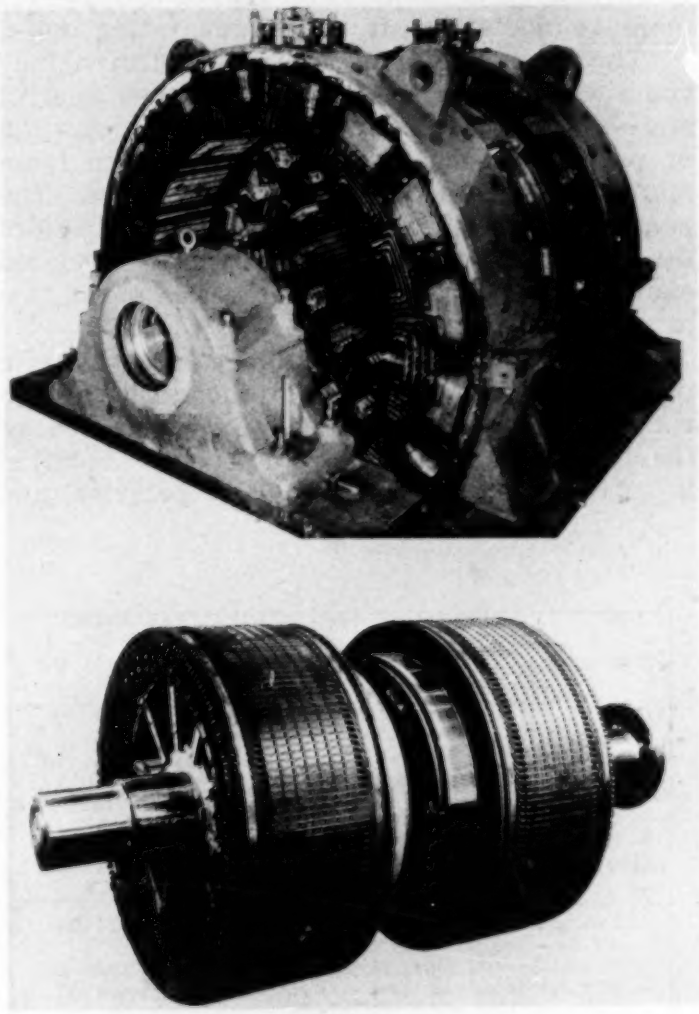

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Figure 14-9.—Propulsion motor.

The propulsion motor is designed so that either armature can be conveniently bridged to remove it from the propulsion loop in the event of an emergency. When one armature is removed from the propulsion circuit, the capacity of the motor is reduced one-half, and not more than two generating units should be operated for propulsion service.

The propulsion motor is provided with induced ventilation by means of a separately mounted blower through a duct connected to an opening in the enclosing cover of the commutator at the top of the machines. The air is drawn in through openings in the end bells at both ends of the motor and flows through radial ducts in the armature cores, over the armature surfaces and between the field coils where it passes over the commutators and out the opening at the top.

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The blower is driven by a 15-horsepower, 230-volt stabilized shunt, d-c motor. The motor is controlled by a magnetic starter (mounted in a separate cabinet), which is controlled from the main propulsion control board. The starter is equipped with a START-STOP pushbutton for local operation.

PROPULSION CONTROL EQUIPMENT

The propulsion control equipment (fig. 14-10) is assembled as a unit and located on the platform level in the engineroom. The indicating instruments and the handles of the manually operated devices are mounted on the front of three 2-section panels that comprise the control board. The first two are the generator panels and the third is the motor panel. The third panel does, however, mount some devices that are not directly associated with control of the propulsion motor. Referring to figure 14-10, the four voltmeters M1 mounted on the generator panels indicate the voltages of the four main propulsion generators. The two exciter voltmeters M2 indicate the voltages of the four exciter generators. One voltmeter is for exciters 1 and 2 and one is for exciters 3 and 4. These voltmeters are also used as ground detectors. The two exciter voltmeter and ground detector transfer switches SW1 are used to transfer the two voltmeters to the circuits whose voltages are to be read. The excitation voltmeter M9 indicates the voltage of the ship's 240-volt d-c supply. This voltmeter is also used as a ground detector.

The excitation voltmeter and generator field ground detector transfer switch SW4 are used to transfer the voltmeter to the various circuits. The auxiliary power ammeter M3 on the first generator panel indicates the current supplied to the auxiliary power circuits by the generator being used to furnish auxiliary power.

The four engine speed indicators M5 indicate the speeds of the four diesel engines. The auxiliary power control switch SW2 operates the auxiliary field contactor which energizes the exciter field circuit of the generator supplying auxiliary power. The auxiliary power generator field rheostat RH1 is provided to control the strength of the exciter field of the generator supplying auxiliary power.

The four small handwheels SW11 are the generator control switches that control the field circuits of the four generators and associated exciters to apply or remove excitation. The four large handwheels SW9 and SW10 control the setup switches of the four generators. The switching arrangement is such that generators 1 and 4 may be used only for propulsion service, whereas generators 2 and 3 may be used for either propulsion or auxiliary power service. Operating in conjunction with each generator setup switch, is an engine speed-exciter field setup switch SW5, not shown in figure 14-10.

The motor voltmeter M4 mounted on the motor panel indicates the voltage across the two motor armatures and also functions as a ground detector in the generator and motor armature circuits. The motor voltmeter and ground detector transfer switch SW3 is used to transfer the voltmeter to the circuits to be read.

The motor field ammeter M6 indicates the current in the motor field circuits. The motor ammeter M8 indicates the current in the propulsion circuit.

The control transfer switch SW8 is provided to transfer control of the propulsion system from the engineroom to the pilot house.

The excitation control switch SW7 operates the exciter contactor which energizes the exciter and motor fields from the ship's 240-volt d-c supply.

The motor field rheostat handwheel RH2 controls the excitation of the motor field. Engineroom controller handwheel P1 controls the operation of the propulsion system from the engineroom. The controller has 24 ahead and 24 astern speed operating positions. An emergency stop-release button is located at the 22nd controller position. The operator must press the release button to move the controller beyond this point.

OPERATION

By the use of disconnect blocks (fig. 14-11 part 1) either motor armature may be bridged and removed from the propulsion loop in an emergency. When one armature is removed the motor voltage rating is reduced one-half, consequently not more than two generators should be operated in the series propulsion loop.

The overload relays OR1 and OR2 are designed to operate in case of a short circuit in the propulsion or auxiliary power circuit. When a short circuit occurs in the propulsion circuit, relay OR1 closes its contacts and energizes the tripping coil for excitation contactor K2, (part 4). When a short circuit occurs

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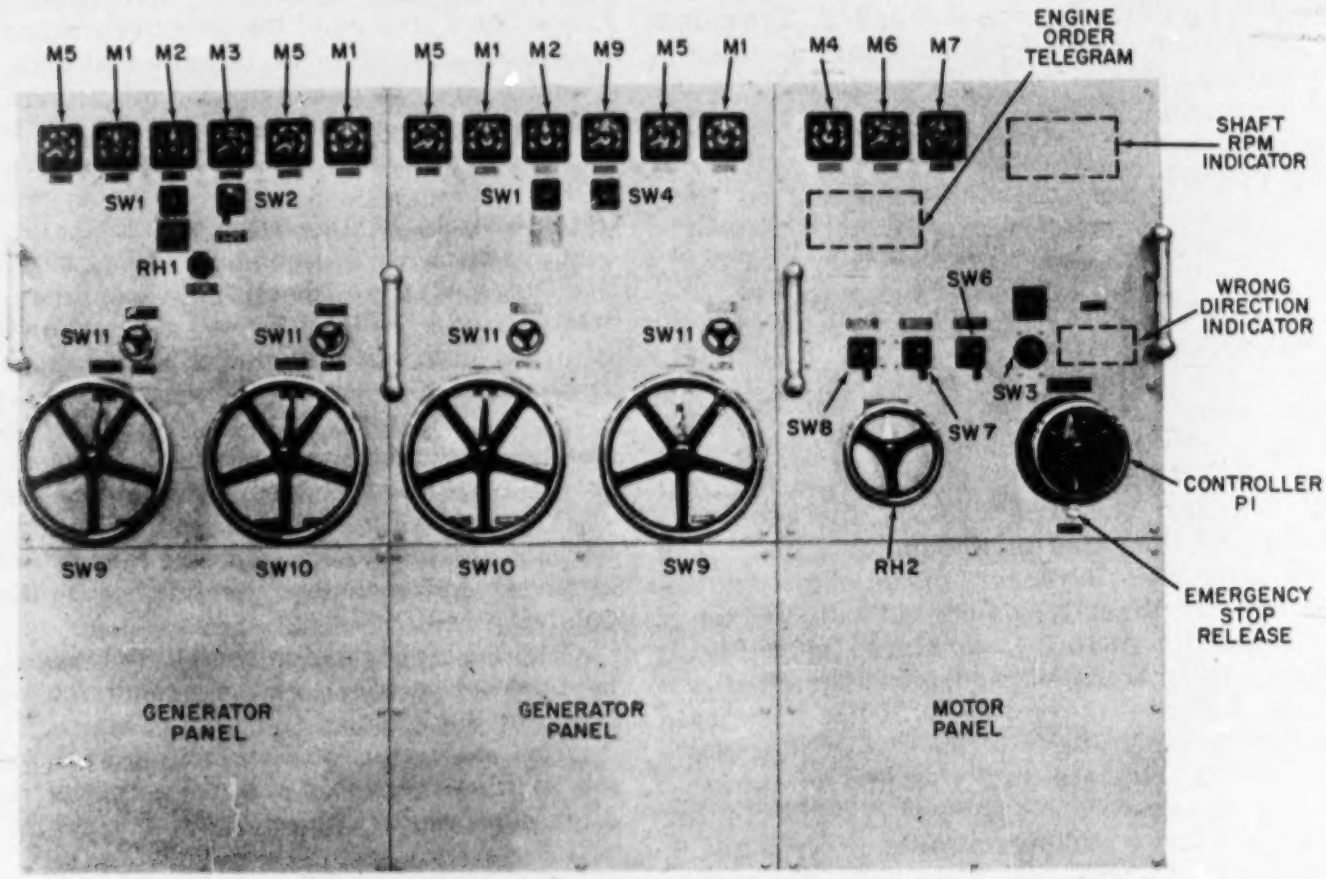

M1-GENERATOR VOLTMETER, 500-0-500
M2-EXCITER AND GROUND DETECTOR VOLTMETER, 100-0-100
M3-AUXILIARY POWER AMMETER, 0-2000
M4-MOTOR AND GROUND DETECTOR VOLTMETER, 1000-0-1000
M5-ENGINE SPEED INDICATOR, 0-1000
M6-MOTOR FIELD AMMETER, 0-150
M7-MOTOR AMMETER, 3000-0-3000
M8-PILOT HOUSE MOTOR AMMETER, 3000-0-3000 (NOT SHOWN)
M9-EXCITATION VOLTMETER (SHIP'S SERVICE), 0-300
SW1-EXCITER VOLTMETER AND GROUND DETECTOR TRANSFER SWITCH
SW2-AUXILIARY POWER GENERATOR FIELD CONTROL SWITCH
SW3-MOTOR VOLTMETER AND GROUND DETECTOR TRANSFER SWITCH
SW4-EXCITER VOLTMETER AND GENERATOR FIELD GROUND DETECTOR TRANSFER SWITCH
SW5-ENGINE SPEED-EXCITER FIELD SWITCH ON GENERATOR SET-UP SWITCH (NOT SHOWN)
SW6-ENGINE SPEED CONTROL SWITCH
SW7-EXCITATION CONTROL SWITCH
SW8-PILOT HOUSE-ENGINEROOM TRANSFER SWITCH
SW9-10-GENERATOR SET-UP SWITCHES
SW11-GENERATOR CONTROL SWITCH
RH1-AUXILIARY POWER GENERATOR FIELD RHEOSTAT
RH2-MOTOR FIELD RHEOSTAT
P1-ENGINEROOM CONTROLLER

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Figure 14-10.—Propulsion control equipment.

in the auxiliary power circuit, relay field contactor K1.

The two resistors R11 in series with RH 2 (part 2) and the two motor fields are provided to adjust the excitation of the motor fields so that the two motor armatures divide their loads equally. As the two armatures are identical the excitation currents should be approximately the

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same. Once correctly adjusted, these resistors need not be changed.

Adjustable resistors R4 in the exciter field circuits are provided to equalize the performance characteristics of the generators as they, too, need not be changed after they are properly adjusted. Motor field discharge resistor R10 (part 2) is connected across the motor fields only while the excitation contactor K2 is in the open position. Exciter field discharge resistors R2 are connected across the exciter fields while the associated generator setup switch SW5 is in the OFF position. The main propulsion generator field discharge resistors R1 are thyrite resistors and are permanently connected across the generator fields. An engine speed transmitter rheostat RH5 (part 3) is provided with the engineroom and pilot house controllers. These two transmitters consist of three rheostats mounted together and operated by a common shaft, which is a projection of the propulsion controller operating shaft (fig. 14-12). The three rheostats are adjusted so that each has a different value for any controller position and are connected to a receiver on the engine speed govenor.

A third transmitter, the auxiliary power engine speed transmitter RH6, mounted behind the generator panels, controls the speed of the diesel engine which is being used to supply auxiliary power. This transmitter has a fixed setting and each time the transmitter assumes control the engine speed is brought to the predetermined value of 450 rpm.

The engine speed circuits are series circuits. For this reason loading resistors R5 and R6 (fig. 14-16 part 3) are provided to maintain the circiut resistance constant, thereby keeping the synchros in calibration. The resistors are switched in and out of the circuit by the generator setup switches SW5.

Starting

Before starting the system determine that the engineroom controller and the pilot house controller are in the STOP position; the excitation control switch SW7 (fig. 14-16, part 4) is in the OFF position; the engine speed control switch SW6 (part 3) is in the OPEN position; the auxiliary power control switch SW2 (part 4) is in the OFF position; the auxiliary power generator field rheostat RH1 (part 2) is in the MAXIMUM RESISTANCE position, and the generator setup switches SW9 and SW10 (part 1), and the generator control switches SW11 (part 2) are in the OFF position. (This does not apply to a generator already in auxiliary power service.) Assume the system is to be controlled from the pilot house.

To start the system, turn the handwheel of each generator setup switch SW9 and SW10 to the position corresponding to the service that the generator is to supply. This action connects the main propulsion generator and motor armatures in a closed series propulsion loop. Setup switches SW5 operating in conjunction with SW9 and SW10 close contacts 14 and 16 (part 2) in the exciter field circuits whose generators are selected for propulsion service and contacts 2, 4, 6, 8, 10, 11, and 12 (part 3) in the engine speed circuits for the associated engines.

NOTE: Generators 2 and 3 setup switches are interlocked so that only one or the other may be placed in the auxiliary power position at a time; also a setup switch cannot be moved from the propulsion to auxiliary power position unless the associated generator control switch SW11 is in the OFF position. Place the motor field rheostat RH2 (part 2) in the position corresponding to the number of generators to be put in service.

Close the generator control switches SW11 of the generators to be operated. This action closes relays K4 and K5 in the respective exciter and generator field circuits. Start the diesel engines to be used. The engine speeds should reach and remain at 350 rpm. Turn the control transfer switch SW8 to the PILOT HOUSE position. (This switch cannot be moved to transfer control unless the excitation control switch SW7 is in the OFF position.)

Contacts 16 and 18 (part 4), contacts 20, 22, 24, 26, and 28 (part 3) and contacts 2, 4, 6, 8, 10, 12, and 14 (part 2), close. Contacts X (part 4), are closed only while the controller is in the STOP position. Close the excitation control switch SW7 (part 4). This action completes the circuit to the excitation contactor K2 closing coil (part 4) and the excitation contactor K2 (part 2), closes and latches, making available the ship's 240-volt d-c power for control and excitation. Excitation contactor K2 will not close unless the controller selected by the control transfer switch is in the STOP position. The circuit to the motor field weakening contactor coil (part 4), is also completed at this time and the K3 relay operates opening the K3 contact (part 2) allowing light excitation to be applied to the motor fields while the controller is in the STOP position. Place the exciter voltmeter and ground detector switch, SW4 (fig. 14-10) in the first position to determine

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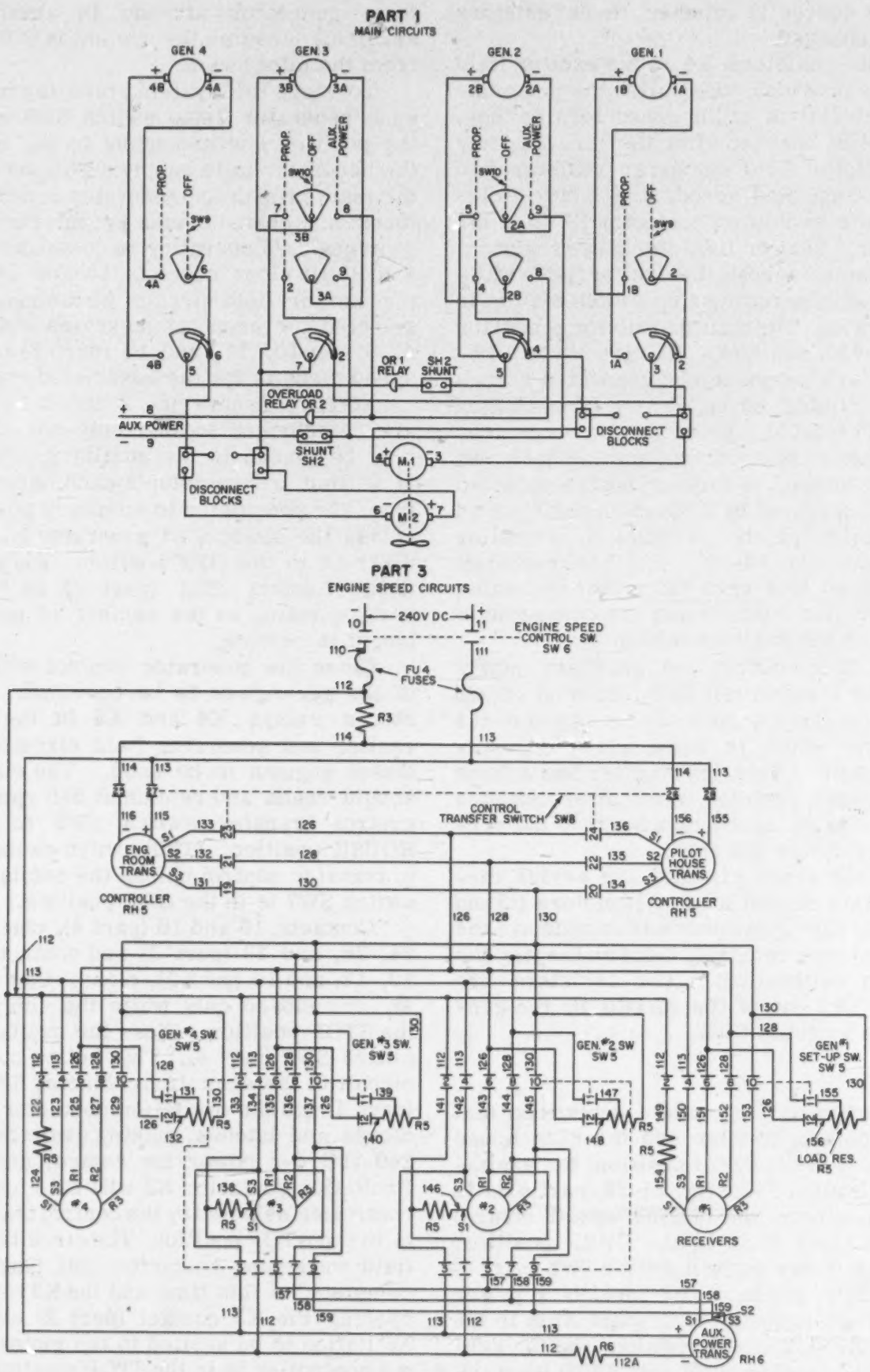

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Figure 14-11A.—Simplified propulsion circuits-fleet tug.

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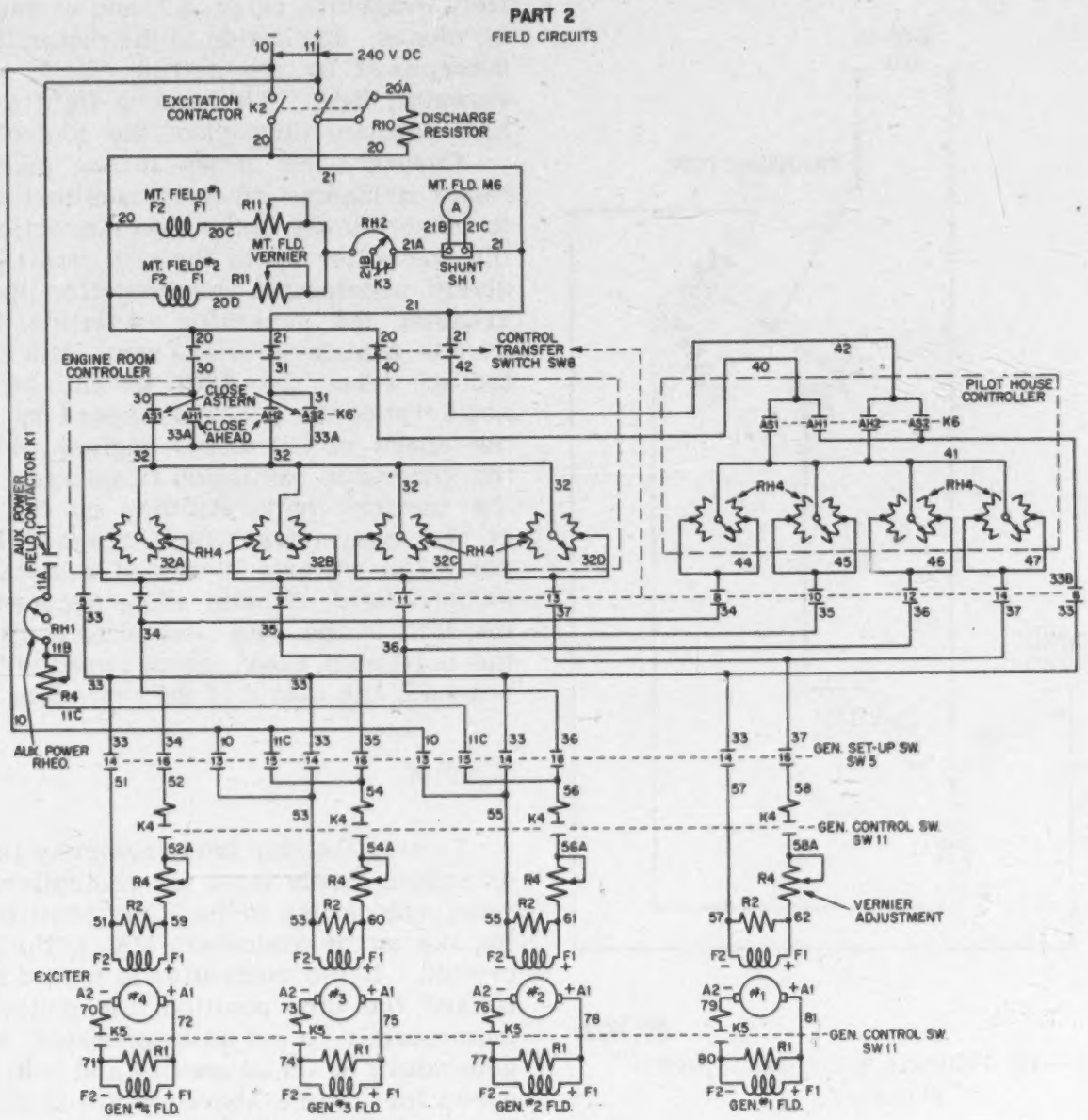

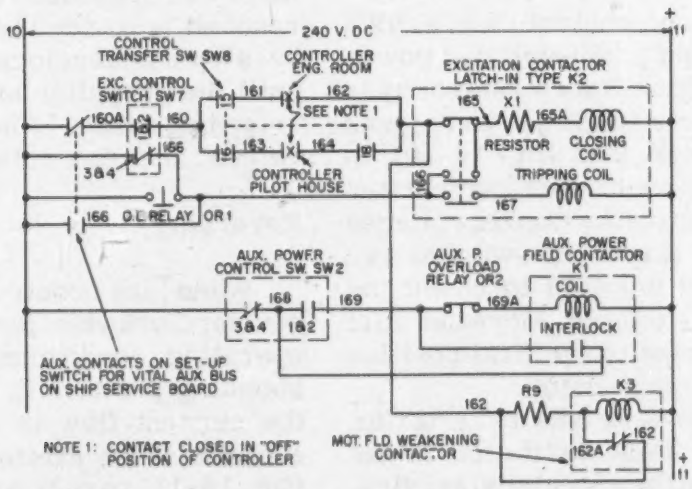

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Figure 14-11B.—Simplified propulsion circuits-fleet tug.—Continued

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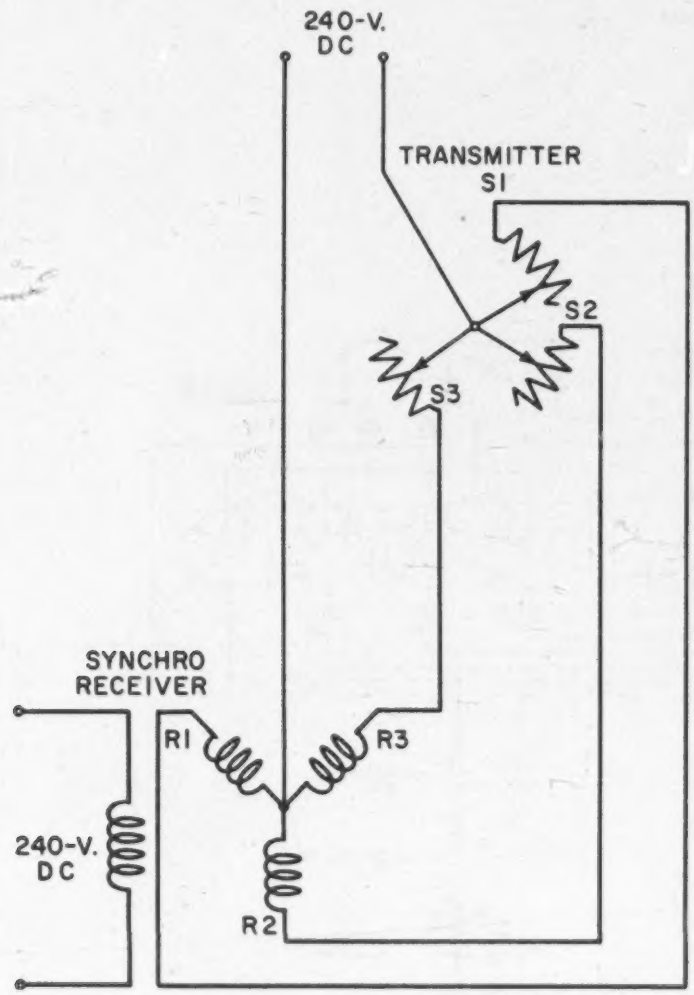

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Figure 14-12.—Engine speed transmitter and receiver.

by voltmeter, M9, that the 240-volt d-c supply is available.

Close the engine speed control switch, SW6 (fig. 14-11, part 3) to apply 240-volt d-c power for operation of the engine speed control system. Place the two exciter voltmeter and ground detector transfer switches, SW1 (fig. 14-10), in the first position. In this position the two exciter voltmeters, M2, will indicate the exciter voltages for two of the exciters. Later the switches can be placed in the second position to check the voltages of the other two exciters. Move the pilot house controller clockwise to the first position in the ahead direction of propulsion.

This action closes contacts AH1 and AH2 (fig. 14-11, part 2) to apply light excitation to the fields of the generators in the propulsion service. Contact X (part 4), opens to deenergize the motor field weakening relay K3, and contact K3 (part 2), closes. Excitation to the motor fields is not determined by the setting of the motor field rheostat, RH2. This motor field excitation is held constant throughout the controller range.

Current now flows in the generator and motor armature circuits causing the propeller to rotate slowly in the ahead direction. Moving the controller up to the 11th position progressively accelerates the propeller speed by increasing the generator excitation, the engine speeds remaining at 350 rpm. Moving the controller from the 12th to the 24th position accelerates the propeller speed by increasing the speed of the diesel engines while holding the generator excitation constant. To prevent the exciters from building up the excitation of the generators with increased speed, the controller inserts blocks of resistance in the exciter field circuits when progressing from the 12th to the 24th controller position. When the maximum rated engine speed of 700 rpm is reached, the output of the system is maximum.

Stopping

To stop the ship from underway in the ahead direction, slowly move the controller handwheel counterclockwise to the STOP position, observing the motor ammeter, M8, in the propulsion circuit. If the controller is moved too rapidly toward the stop position, the motor will tend momentarily to act as a generator, causing the generators to act as motors and hold the engine speed for a time above the speed called for by the controller position. No useful purpose can be gained by bringing the controller too rapidly to the STOP position. When the STOP position is reached, advance the controller gradually step-by-step counterclockwise in the astern direction until the propeller exerts the desired amount of retarding force. When the ship has come to rest, return the controller to the STOP position.

Reversing

When the controller handwheel is turned counterclockwise for astern rotation, the same operating conditions exist as for the corresponding position in the ahead direction, except the current flow is reversed in the excitation circuits of the exciters by contacts AS1 and AS2 (fig. 14-11, part 2), and, hence, a reversal occurs in the motor and generator armature circuits.

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To reverse the ship from underway in the ahead direction to underway in the astern direction, follow the same procedures for stopping the ship. Continue advancing the controller in the counterclockwise direction for astern propulsion until the desired propelling speed is obtained. An astern ship speed for this type ship should not exceed 10 knots because of the limitations of the steering gear.

Removing Generator From Propulsion Service

The controller is not necessarily moved to the STOP position to cut a generator in or out of the propulsion circuit. However, under normal conditions, the controller should be moved to the 11th position so that the engines are operating at the idling speed of 350 rpm. In an extreme emergency a generator can be cut out of the circuit while the engine is above the idling speed because the generators are designed to withstand short circuiting a full rated speed of 700 rpm with no field current on the generator.

If it is necessary to cut out a generator, open control switch SW11, then pause several seconds to allow the generator field current to decay to zero before operating the associated setup switch, SW9, or SW10. This time interval is necessary for the generator field excitation to decrease sufficiently to avoid the possibility of motoring the generator and to reduce the current surges in the propulsion circuit to a minimum.

Placing Generator in Propulsion Service

Before cutting an additional generator in the propulsion circuit, the motor field rheostat, RH2, must be adjusted to the correct setting for the total number of generators to be operated in propulsion service. For example, if two generators are in service and another machine is required in the propulsion loop, set the motor field rheostat at the correct position for the operation of the generators before cutting in the third machine. This action is essential and if not performed will result in greatly overloading the diesel engines, generators, and motor immediately when the third generator is cut in the circuit. The effect of this overloading can be serious. Therefore, always adjust the motor field rheostat, RH2, for the number of generators that are to be used and then cut the generators in the circuit one at a time, as previously explained.

Placing Generator in Auxiliary Power Service

To place a generator in auxiliary power service, turn the setup switch, SW10, of either generator 2 or 3 to the AUXILIARY POWER position. This will connect the generator output to the auxiliary power bus, 8 and 9 (fig. 14-11, part 1). Associated setup switch, SW5, will close contact 1, 3, 5, 7, 9, 11, and 12 (part 3), bringing the associated diesel engine under the control of the auxiliary power engine speed transmitter, RH6, which brings the engine speed to 450 rpm, as mentioned previously.

Contacts 13 and 15 (part 2) in the exciter field circuit for the generator selected will also close (contacts 14 and 16 remaining open). Close the generator control switch, SW11, of the generator to be used, which will close contactors K4 and K5. Remember the setup switch, SW10, cannot be moved from the auxiliary power position to the propulsion position unless this generator control switch, SW11, is first turned to the OFF position. Close the auxiliary power control switch, SW2 (part 4), energizing the auxiliary power field contactor, K1, which will close contact, K1 (part 2). The generator voltage may now be adjusted to normal by the auxiliary power rheostat, RH1.

D-C propulsion systems require routine weekly maintenance as shown by the maintenance requirement cards (figs. 14-13 and 14-14) for a d-c propulsion generator and motor, respectively. Note the a-c propulsion system weekly maintenance requires two men, note only one EM3 is required to do the weekly maintenance on the d-c propulsion system.

Also note the differences in the minimum allowable resistance readings as shown on figures 14-7 and 14-8 and figures 14-13 and 14-14. The d-c propulsion generators and motors require a complete quarterly cleaning and inspection as shown by the maintenance requirement cards 14-15 and 14-16, whereas the a-c propulsion system requires cleaning weekly and semi-annually.

The maintenance requirement cards shown do not cover all the required maintenance for electric propulsion systems, they cover only the cleaning, inspection, and resistance readings of the major units, the propulsion generators,

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SYSTEM	COMPONENT	M. R. NUMBER
Propulsion	Propulsion Generator	EL-15 W-1

SUB-SYSTEM	RELATED M.R.	RATES	M/H
Propulsion Unit	None	EM3	1.0

M. R. DESCRIPTION

1. Clean the generator.
2. Measure insulation resistance.

TOTAL M/H 1.0
ELAPSED TIME: 1.0

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Wire air starting/steam inlet valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
3. De-energize all power supplies and tag "Out Of Service."

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Rags
2. Safety tags
3. Wire, 24 gauge
4. Vacuum cleaner
5. Voltage tester
6. 500-volt Megger
7. 6" Slip-joint pliers
8. 8" Adjustable wrench
9. 6" Normal duty screwdriver

PROCEDURE

NOTE 1: Measure insulation resistance weekly, when securing generator, and before starting generator, if it has been idle for more than a week.

Preliminary

a. Wire air starting/steam inlet valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
b. Ensure excitation circuit is de-energized; tag "Out Of Service."
c. De-energize heaters and inspection lights, if installed, and tag "Out Of Service."

1. Clean the Generator.
   a. Remove access covers.
   b. Test with voltage tester to ensure all power supplies are de-energized.

(Cont'd on Page 2)

LOCATION | DATE 2 August 1965

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Procedure (Cont'd)

c. Vacuum interior surfaces that can be reached without disassembly of generator.
d. Wipe surfaces with a rag.

2. Measure Insulation Resistance.
   a. Measure insulation resistance of armature and field circuits.

NOTE 2: If insulation resistance is less than 0.6 megohm for armature circuit or 2.0 megohm for shunt field circuit, take corrective action.

   b. Reinstall access covers.
   c. Remove wire or reconnect starting motor.
   d. Remove tags and set up for prescribed operation.

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Figure 14-13.—Weekly MRC for D-C propulsion generator.

and motors. Routine maintenance is also required on the exciters, regulators, air filters, and control devices of any propulsion system.

For additional information on electric propulsion systems read Chapter 9410, Section IV of NavShips Technical Manual.

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PICKUP HEADS:

GENERAL

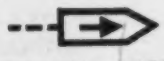

WRITING; RECORDING; HEAD, SOUND RECORDER

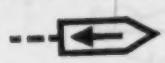

READING; PLAYBACK; HEAD, SOUND REPRODUCER

APPLICATION: WRITING, READING, AND ERASING

ERASING; ERASER, MAGNETIC

BATTERIES:

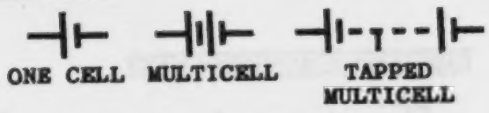

ONE CELL MULTICELL TAPPED MULTICELL

(LONG LINE IS ALWAYS POSITIVE)

CIRCUIT PROTECTORS (NOTE 2):

FUSE

CIRCUIT BREAKERS

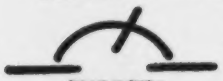

SWITCH

GANGED

PUSH PULL OR PUSH

CURRENT LIMITER

ATTENUATORS (NOTES 2 AND 3):

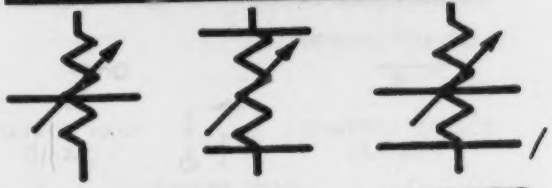

GENERAL BALANCED UNBALANCED

DELAY FUNCTION:

ATENNAS (NOTE 2):

GENERAL DIPOLE

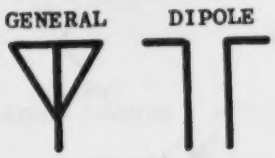

PARABOLIC

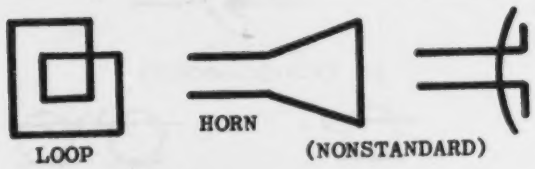

LOOP HORN (NONSTANDARD)

METERS (NOTE 1):

A - AMMETER

CRO - OSCILLOSCOPE

G - GALVANOMETER

MA - MILLIAMMETER

OHM - OHMMETER

V - VOLTMETER

HEADSET:

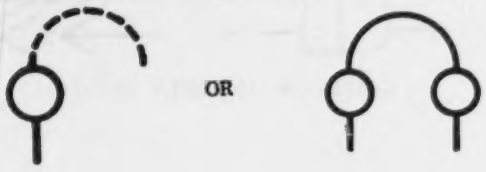

OR

SYSTEM	COMPONENT	M. R. NUMBER
Propulsion	Propulsion Motor	EL-16 W-1
SUB-SYSTEM	RELATED M. R.	RATES / M/H
Propulsion Units	None	EM3 / 1.0

M. R. DESCRIPTION
1. Clean the motor.
2. Measure insulation resistance.

TOTAL M/H 1.0
ELAPSED TIME: 1.0

SAFETY PRECAUTIONS
1. Observe standard safety precautions.
2. Ensure motor disconnect device is open; tag "Out Of Service."
3. De-energize all power supplies and tag "Out Of Service."

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT
1. Rags
2. Safety tags
3. Vacuum cleaner
4. Voltage tester
5. 500-volt Megger
6. 8" Adjustable wrench
7. 6" Normal duty screwdriver

PROCEDURE

NOTE 1: Measure insulation resistance weekly, when securing motor, and before starting motor, if idle for more than a week.

Preliminary
a. Ensure motor disconnect device is open; tag "Out Of Service."
b. De-energize excitation circuit and tag "Out Of Service."
c. De-energize heaters and inspection lights, if installed, and tag "Out Of Service."

1. Clean the Motor.
a. Open or remove access covers.
b. Test with voltage tester to ensure all power supplies are de-energized.
c. Vacuum interior surfaces that can be reached without disassembly of motor.
d. Wipe surfaces with a rag.

(Cont'd on Page 2)

PAGE 1 OF 2 | MB | ZZZG | MDO | 75 | B710 | M

LOCATION | DATE 2 August 1965

Procedure (Cont'd)

2. Measure Insulation Resistance.
a. Measure insulation resistance of armature and field circuits.

NOTE 2: If insulation resistance is less than 0.6 megohm for armature circuit or 2.0 megohm for shunt field circuit, take corrective action.

b. Close or reinstall access covers.
c. Remove tags and set up for prescribed operation.

PAGE 2 OF 2 | MB | ZZZG | MDO | 75 | B710 | M

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Figure 14-14.—Weekly MRC for D-C propulsion motor.

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SYSTEM	COMPONENT	M. R. NUMBER
Propulsion	Propulsion Generator	EL-15 Q-1
SUB-SYSTEM	RELATED M.R.	RATES / M/H
Propulsion Units	W-1	EM2 4.0 EMFN 4.0

TOTAL M/H 8.0
ELAPSED TIME: 4.0

M. R. DESCRIPTION

1. Clean and inspect generator.

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Wire air starting/steam inlet valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
3. De-energize all power supplies and tag "Out Of Service."
4. Avoid prolonged contact with, or inhalation of, inhibited methyl chloroform. Provide adequate ventilation.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Rags
2. 6" Scale
3. Flashlight
4. Safety tags
5. 1" Paintbrush
6. 4/0 Sandpaper
7. Dusting brush
8. Vacuum cleaner
9. Wire, 24 gauge
10. Voltage tester
11. 500-volt Megger
12. Tongue depressor
13. Air-drying varnish
14. Brush tension scale
15. 6" Slip-joint pliers
16. 1/2"-drive Socket set
17. 6" Normal duty screwdriver
18. Inhibited methyl chloroform

PROCEDURE

Preliminary

a. Wire air starting/steam inlet valve shut and tag "Do Not Open." On electric start system, disconnect starting motor at battery terminals and tag "Out Of Service."
b. Ensure excitation circuit is de-energized; tag "Out Of Service."
c. De-energize heaters and inspection lights, if installed, and tag "Out Of Service."

1. Clean and Inspect Generator.

CAUTION: Do not damage windings.

(Cont'd on Page 2)

LOCATION | DATE 2 August 1965

PAGE 1 OF 3 | MB | ZZZG | GGO | 75 | B709 | Q

Procedure (Cont'd)

a. Remove access covers.
b. Test with voltage tester to ensure all power supplies are de-energized.
c. Vacuum accessible parts; use dusting brush to loosen dirt in hard-to-reach areas.

WARNING: Ensure at least two persons are in the work area when using inhibited methyl chloroform. Provide adequate ventilation.

CAUTION: Keep inhibited methyl chloroform from coming in contact with commutator and brushes.

d. Use a rag dampened with inhibited methyl chloroform to remove oily deposits.
e. Inspect brushes for uniform wear, condition of brush shunts, and shunt connections.
f. Remove and inspect brushes. Renew any brush that measures less than half its original length or is chipped or worn to such an extent that it will not travel freely in the holder. Inspect the brush contact area for proper contact surface. Wipe brushes and brush holders with a dry rag.
g. Clean commutator risers; use a tongue depressor or suitable small wedge wrapped in one thickness of rag.

NOTE 1: Commutator color will vary with conditions. Long periods at light load or improper spring tension will change the film. A full power reversal will sometimes cause burned spots along a row of brushes, but these will disappear after about a week of normal running.

h. Inspect commutator for pits, burrs, and grooving. Correct as necessary.
i. Adjust brush holders to the same distance from commutator, not more than 1/8" or less than 3/32".

CAUTION: If 10 percent of brushes are worn short, renew all brushes.

NOTE 2: Use BuShips-approved brushes and all of the same grade.

CAUTION: Do not snap springs in place, as this may crack or chip the brushes.

(Cont'd on Page 3)

PAGE 2 OF 3 | MB | ZZZG | GGO | 75 | B709 | Q

Procedure (Cont'd)

j. Reinstall brushes. Ensure they travel freely in the holders.

NOTE 3: Ensure new brushes are properly seated.

k. Adjust brush pressure from _____ to _____ ounces.
l. Inspect armature fans for loose, cracked, or broken parts. Correct as necessary.
m. Inspect all electrical and mechanical fastenings and tighten loose connections. Use lockwashers or jamnuts, where necessary, to keep connections tight.
n. Measure insulation resistance of armature and field circuits. See MRC W-1.

NOTE 4: Never apply varnish to a dirty surface. Avoid building up excess varnish.

o. Inspect for chipped, cracked, or frayed insulation. Touch up with air-drying varnish, where necessary.
p. Ensure no loose items are left inside generator.
q. Reinstall access covers.
r. Remove wire or reconnect starting motor.
s. Remove tags and set up for prescribed operation.

PAGE 3 OF 3 | MB | ZZZG | GGO | 75 | B709 | Q

Figure 14-15.—Quarterly MRC for D-C propulsion generator.

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SYSTEM	COMPONENT	M.R. NUMBER
Propulsion	Propulsion Motor	EL-16 Q-1
SUB-SYSTEM	RELATED M.R.	
Propulsion Units	W-1	

RATES	M/H
EM2	4.0
EMFN	4.0
TOTAL M/H	8.0
ELAPSED TIME:	4.0

M.R. DESCRIPTION

1. Clean and inspect motor.

SAFETY PRECAUTIONS

1. Observe standard safety precautions.
2. Ensure motor disconnect device is open; tag "Out Of Service."
3. De-energize all power supplies and tag "Out Of Service."
4. Avoid prolonged contact with, or inhalation of, inhibited methyl chloroform. Provide adequate ventilation.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Tongue depressor
2. Air-drying varnish
3. Brush tension scale
4. 1/2" Drive socket set
5. 6" Normal duty screwdriver
6. Inhibited methyl chloroform
7. Rags
8. 6" Scale
9. Flashlight
10. Safety tags
11. 1" Paintbrush
12. 4/0 Sandpaper
13. Dusting brush
14. Vacuum cleaner
15. Voltage tester
16. 500-volt Megger

PROCEDURE

Preliminary

a. Ensure motor disconnect device is open; tag "Out Of Service."
b. De-energize excitation circuit and tag "Out Of Service."
c. De-energize heaters and inspection lights, if installed, and tag "Out Of Service."

1. Clean and Inspect Motor.

CAUTION: Do not damage windings.

a. Remove access covers.
b. Test with voltage tester to ensure all power supplies are de-energized.

(Cont'd on Page 2)

LOCATION | DATE 2 August 1965

PAGE 1 OF 3 | MB | 222G | MDO | 75 | B711 | Q

Procedure (Cont'd)

c. Vacuum accessible parts; use dusting brush to loosen dirt in hard-to-reach areas.

WARNING: Ensure at least two persons are in the work area when using inhibited methyl chloroform. Provide adequate ventilation.

CAUTION: Keep inhibited methyl chloroform from coming in contact with commutator and brushes.

d. Use a rag dampened with inhibited methyl chloroform to remove oily deposits.
e. Inspect brushes for uniform wear, condition of brush shunts, and shunt connections.
f. Remove and inspect brushes. Renew any brush that measures less than half its original length or is chipped or worn to such an extent that it will not travel freely in the holder. Inspect the brush contact area for proper contact surface. Wipe brushes and brush holders with a dry rag.
g. Clean commutator risers; use a tongue depressor or suitable small wedge wrapped in one thickness of rag.

NOTE 1: Commutator color will vary with conditions. Long periods at light load or improper spring tension will change the film. A full power reversal will sometimes cause burned spots along a row of brushes, but these will disappear after about a week of normal running.

h. Inspect commutator for pits, burrs, and grooving. Correct as necessary.
i. Adjust brush holders to the same distance from commutator not more than 1/8" or less than 3/32".

CAUTION: If 10 percent of brushes are worn short, renew all brushes.

NOTE 2: Use BuShips approved brushes and all of the same grade.

CAUTION: Do not snap springs in place, this may crack or chip the brushes.

j. Reinstall brushes. Ensure they travel freely in the holders.

(Cont'd on Page 3)

PAGE 2 OF 3 | MB | 222G | MDO | 75 | B711 | Q

Procedure (Cont'd)

NOTE 3: Ensure new brushes are properly seated.

k. Adjust brush pressure to_____to_____oz.
l. Inspect armature fans for loose, cracked, or broken parts. Correct as necessary.
m. Inspect all electrical and mechanical fastenings and tighten loose connections. Use lockwashers or jamnuts, where necessary, to keep connections tight.
n. Measure insulation resistance of armature and field circuits. See NRC W-1.

NOTE 4: Never apply varnish to a dirty surface. Avoid building up excess varnish.

o. Inspect for chipped, cracked, or frayed insulation. Touch up with air-drying varnish, where necessary.
p. Ensure no loose items are left inside motor.
q. Reinstall access covers.
r. Remove tags and set up for prescribed operation.

PAGE 3 OF 3 | MB | 222G | MDO | 75 | B711 | Q

Figure 14-16.—Quarterly MRC for D-C propulsion motor.

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CHAPTER 15

RECORDS AND REPORTS

Records are those papers required to be compiled and retained on board ship for prescribed periods of time for reference in administrative and operational matters. Reports are summaries or narratives submitted to interested activities to assist in forming policy, controlling operations, evaluating performance, and maintaining historical records. Some reports are required to be submitted at set intervals, and are referred to as recurring reports. Other reports are submitted only on the occurrence of a given situation, and are referred to as one-time reports.

The engineer officer is responsible for maintaining various records and submitting various reports concerning the engineering department. As an EM 3 or 2 you will be required to maintain certain records concerning the electrical equipment. This chapter discusses those records that concern you. Discussed also are various technical publications that contain valuable information for Electrician's Mates.

MAINTENANCE AND MATERIAL MANAGEMENT SYSTEM (3-M)

The maintenance and material management (3-M) system discussed in chapter 2 of this course) will eventually be installed on every ship in the Navy. At this time however, some ships have the 3-M system and some have partial installation of 3-M; others have not started the system as yet. Some ships that have the 3-M system are deleting some of the paperwork involved in keeping the old type material history, while other ships are keeping both the 3-M and material history. The decision to still maintain or delete some of the material history entries after installation of the 3-M system is made by the type commanders of the various forces. Since many naval ships do not as yet have the 3-M system and some that do have it are still required to maintain the material history and CSMP, the following coverage is included.

MATERIAL HISTORY AND CSMP RECORDS

The material history and current ship's maintenance project (CSMP) records provide a record of all repairs, alterations, inspections, derangements, parts renewed, hours in use, and other pertinent data on each machinery unit. These records are perhaps the most valuable records in the engineering department. The records are kept on cards filed in looseleaf binders. The following material history and CSMP record cards are available for maintaining the records.

- NavShips 527—Machinery history
- NavShips 527A—Material history card - electrical
- NavShips 528—Unit record card
- NavShips 529—Repair record card (CSMP)
- NavShips 530—Alteration record card (CSMP)
- NavShips 531-1 (10-63)—Resistance test record - power, lighting, and degaussing circuits
- NavShips 531 (Rev. 8-48)—Resistance test record - electrical rotating machinery
- NavShips 532—Blank utility card
- NavShips 533—Bearing record
- NavShips 536—Electronic equipment history card
- NavShips 537—Record of field changes (CSMP)
- NavShips 539—Hull history card

Cards NavShips 536 and 537 concern electronic equipment and are maintained by the operations department. As an Electrician's Mate you will be concerned with material

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history cards NavShips 527A, 531-1, and 531, and CSMP cards NavShips 529 and 530.

NAVSHIPS 527A

A separate Material History Card-Electrical, NavShips 527A (fig. 15-1) is maintained for each major unit of electrical equipment. The history recorded on the card should include a record of all tests and measurements such as full load tests and air gap measurements; a record of all troubles, failures, and methods used to restore the equipment to service; dates showing when the equipment was greased; and of all repairs affected whether by by ship's force or a repair activity. When a card for a particular unit is full (front and back) the history is continued on another card.

To fill out the NavShips 527A proceed as follows: Numbers referred to correspond to those circled in figure 15-1.

1. Enter in this space the machinery index number (S group number) of the unit for which the card is being prepared.
2. Name of the unit.
3. Service the unit performs.
4. Original cards are number 1, and additional cards are numbered consecutively.

5, 6, 7, and 8. Enter in these spaces the location of the unit as to deck, frame, name and number of compartment, and position (port, stbd, or center line).

9 through 15. These spaces are self-explanatory.

16, 17, and 18. Enter in these spaces the part, group, and page number of the Revised Individual Allowance List (RIAL) where the unit is listed. This page of the RIAL contains the complete nameplate data for the unit. If the ship uses the Coordinated Shipboard Allowance List (COSAL) enter NA (not applicable) in these spaces.

19. Enter in this space the NavShips number of the manufacturer's technical manual for the unit.
20. Enter the CID number for the unit if the ship uses the COSAL. This number identifies the allowance parts list in the COSAL where the unit is listed.
21. Enter CD sheet No. if applicable. This sheet contains data concerning the unit not included on the MFG or BuShips drawing.
22. Enter here any ShipAlts applicable to the unit.

The entries under "Remarks" should be in chronological order. Make your remarks as specific and clear as possible. List federal stock numbers for all parts used for repairs.

Enter in the "Hrs. in use" space the number of hours the unit has been in operation since the last major overhaul. This applies only to major equipments such as ship's service and emergency generators, main propulsion motors and generators, steering gear motors, motor-generator sets, and degaussing equipment.

NAVSHIPS 531-1 (10-63) and 531 (Rev. 8-48)

Resistance test record cards (531-1) are maintained for each power, lighting, and degaussing circuit as previously discussed in chapter 3 of this training course. The resistance test record card 531 (rev. 8-48) is maintained on each piece of rotating electrical equipment. Figure 15-2 shows a typical resistance test record card for a propulsion generator.

CURRENT SHIP'S MAINTENANCE PROJECT (CSMP)

The CSMP is a method of tabulating all outstanding repairs and alterations as well as periodic tests and inspections that can only be accomplished during a scheduled upkeep or overhaul period. The primary purpose of the CSMP is to ensure that no item of work will be overlooked and to facilitate the planing of shipyard and tender work requests. The secondary purpose of the CSMP is to provide data for the material history. A CSMP is normally maintained by each department of a ship and may consist of those items that can only be accomplished by a shipyard or tender. Repair items that are performed by the ship's force as soon as possible after being discovered are normally handled by a memorandum work request; use of the Repair Record is optional, data for the Material History being obtained from the work request.

The following three basic cards comprise the CSMP:

1. Repair Record, NavShips 529 (blue).
2. Alteration Record, NavShips 530 (pink).
3. Record of Field Changes (to electronic equipment) NavShips 537 (white).

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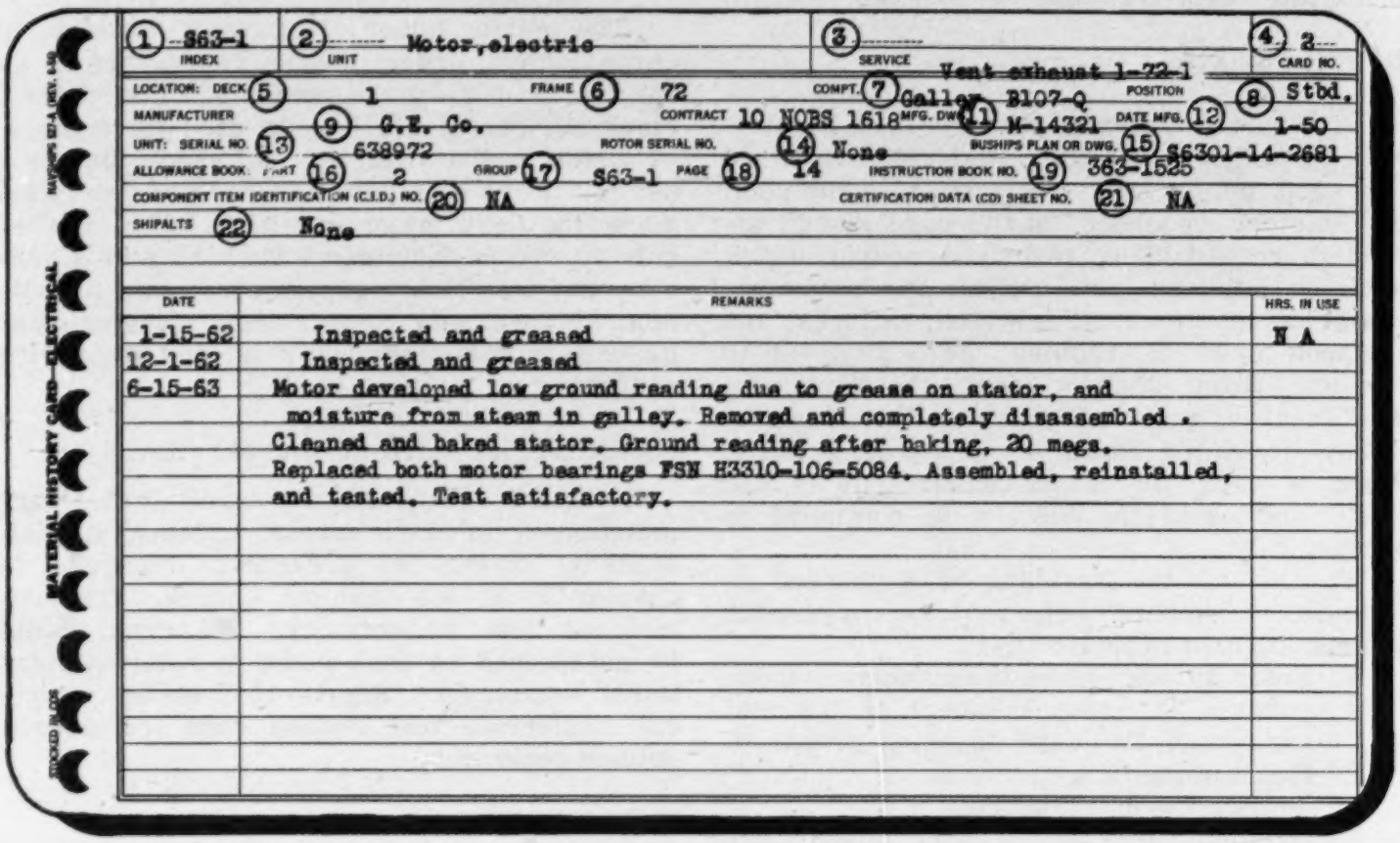

NAVSHIPS 527-A (REV. 6-58)

MATERIAL HISTORY CARD—ELECTRICAL

STOCKED IN JOB

(1) INDEX: S63-1 (2) UNIT: Motor,electric (3) SERVICE: Vent exhaust 1-72-1 (4) CARD NO.: 2

LOCATION: DECK (5) 1 FRAME (6) 72 COMPT. (7) Galley POSITION (8) Stbd.

MANUFACTURER (9) G.E. Co. CONTRACT 10 NOBS 1618 MFG. DWG. (11) B107-Q M-14321 DATE MFG. (12) 1-50

UNIT: SERIAL NO. (13) 638972 ROTOR SERIAL NO. (14) None BUSHIPS PLAN OR DWG. (15) S6301-14-2681

ALLOWANCE BOOK: PART (16) 2 GROUP (17) S63-1 PAGE (18) 14 INSTRUCTION BOOK NO. (19) 363-1525

COMPONENT ITEM IDENTIFICATION (C.I.D.) NO. (20) NA CERTIFICATION DATA (CD) SHEET NO. (21) NA

SHIPALTS (22) None

DATE	REMARKS	HRS. IN USE
1-15-62	Inspected and greased	N A
12-1-62	Inspected and greased	
6-15-63	Motor developed low ground reading due to grease on stator, and moisture from steam in galley. Removed and completely disassembled. Cleaned and baked stator. Ground reading after baking, 20 megs. Replaced both motor bearings FSN H3310-106-5084. Assembled, reinstalled, and tested. Test satisfactory.	

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Figure 15-1.—Material history card-Electrical NavShips 527-A.

As a repair is required, or an alteration or field change is authorized, the applicable card is filled in and placed in the material history binder adjacent to the appropriate history card. As the binder is examined, the distinctive colors of the CSMP cards readily indicate outstanding work. When the work has been completed and notations to this effect entered on the material history card, all the cards except the Record of Field Changes are removed from the binder and placed in a "completed work" file.

Repair Record Cards and Alteration Record Cards are retained for a period of two years after the work is completed and entries made in the material history. After the two-year period, these cards may be destroyed at the discretion of the commanding officer. When a ship is decommissioned or placed out of service, the active cards are retained onboard the ship.

NavShips 529

The Repair Record card, NavShips 529 (fig. 15-3) is filled in as soon as the need for the repair becomes evident.

Entries on this card are as follows: (Numbers listed correspond to the circled numbers on the card shown in figure 15-3.

1. An "X" to indicate the type of repair work. (It will be mechanical, electrical, or hull for the engineering department's work.)
2. The number and the name of the unit on which the repair is to be made. This information can be obtained from the corresponding Electrical History card.
3. The index number, taken from the corresponding Electrical History Card, for the unit to be repaired.

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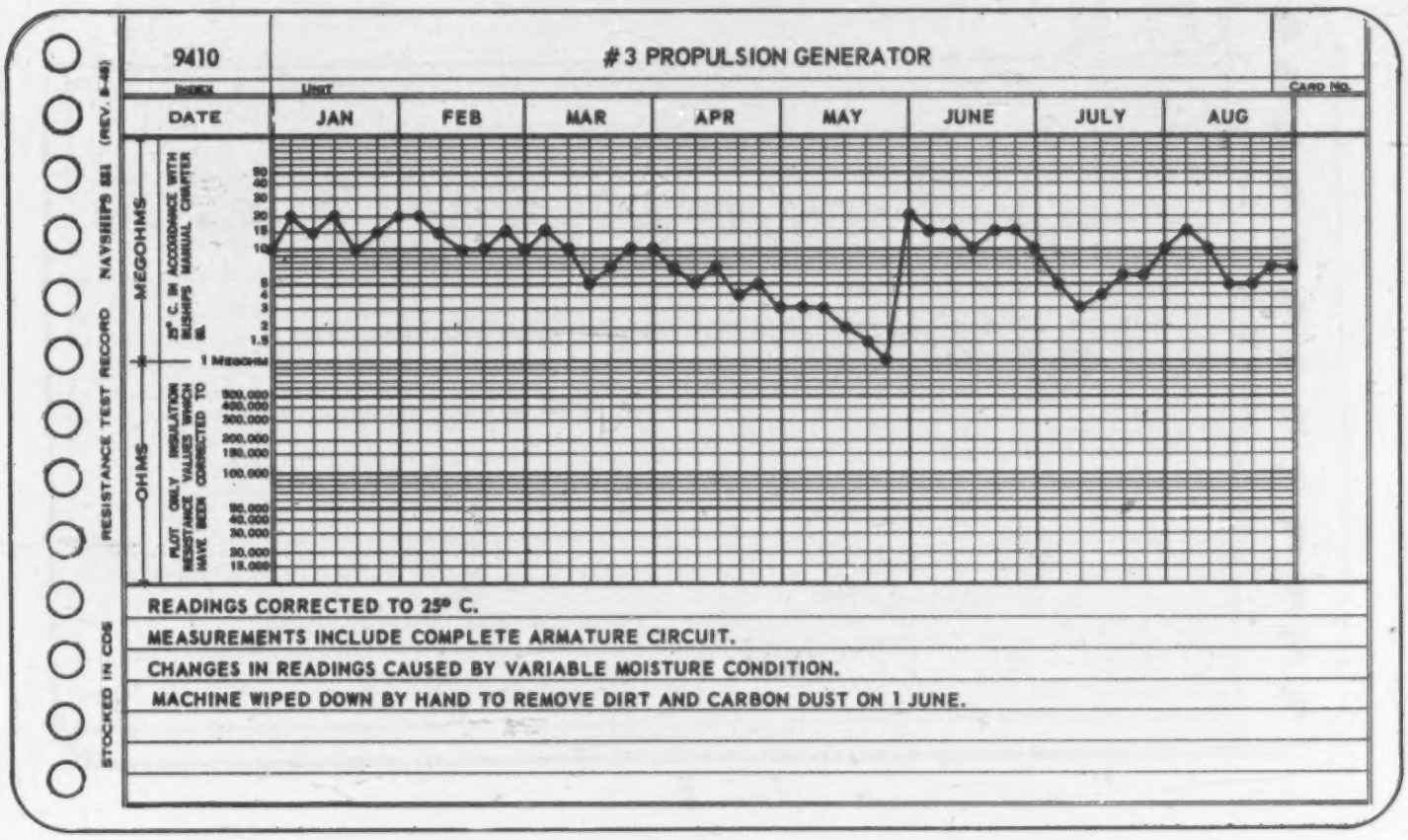

1.3

Figure 15-2.—Resistance Test Record, NavShips 531 (Rev. 8-48).

4, 5, and 6. An "X" indicates the priority of the repair (deferred, routine, or urgent) assigned by the ship.

7. The location of the unit to be repaired. The compartment name and number should be given. Where necessary, the location in the compartment and frame numbers are given.

8. Date the card is started. (The card should be started when the need for the repair is first noticed.)

9. Originally, this space was provided for the title to which a repair was charged. This information is no longer applicable.

10, 11, and 12. An "X" indicates whether the work is to be performed by the ship's force, by the repair ship, or by the naval shipyard.

13. A brief description of the condition of the item to be repaired. List any authorizing reference for the work to be done if applicable.

14. State specifically what work is to be done to effect the repair. If the repair is to be done by a repair activity, include what assistance will be given by the ship's force, and the name of at least one individual who can be contacted for additional information concerning the repair.

15, 16, and 17. Repair parts known to be needed, plan no. of such part or parts if applicable, and federal stock no. for parts.

18, 19, 20, and 21. These spaces are self-explanatory.

22. The Board of Inspection and Survey item number, if such an inspection has been held. This number is entered on the Repair Record Card when a list of repairs is made for an inspection by the Board of Inspection and Survey.

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NAVSHIPS 529 (REVISED 3-56) — REPAIR RECORD — STOCKED IN CDS

(1) BUAER / BUORD / BUSHIPS / MACH. / X ELECT. / HULL / ELECTRONICS	UNIT TITLE (2) Exhaust Vent Motor 1-72-1	INDEX NO. (3) S 63-1	DEF. (4)	ROU. (5)	URGENT (6) x
LOCATION (COMP'T NO. DECK LEVEL SIDE) (7) B-107-Q 1-72-1		DATE LISTED (8) 6-5-63	TITLE (9) NA	S. FC. (10) x	REP. S. (11) / N. YD. (12)

CONDITION, AUTHORIZING REFERENCE AND/OR DIRECTIVE REQUIRING WORK (13) Resistance Test Record card shows a decrease in insulation resistance from 30 megx. to 1 meg. since Dec. 62

REPAIRS REQUESTED—WORDED AS A JOB ORDER (AMPLIFYING REASONS MAY BE GIVEN) (14)

1. Remove, disassemble, clean, and bake motor stator. Take ground test.
2. Replace both motor bearings.
3. Assemble motor, reinstall and test.

REPAIR PARTS REQUIRED (15) 2 ball bearings	PLAN NO. (16) NA	PART NO./STD. STOCK NO. (17) FSN H3310-106-5084
APPLICABLE BLUEPRINTS (18) S6301-14-2681	STATUS OF MATERIAL (19) on board	
NAME PLATE DATA (20) 15. H.P. 440 volts, 3 phase, 20 amps.	APPLICABLE INSTR. MANUAL (NAVSHIPS NO. IF POSSIBLE) (21)	
BD. I & S NO. (22) NA	FORCES NAVY MAT INSPECTION (23) NA	QUAR. 19 NA (24) / ITEM NO. (25) NA
SHIPS REQUEST FOR AUTHORIZATION FILE NO. (26) NA		OF (27) NA

Previous editions may be used.

A

GPO: 1959—O-382242

AUTHORIZING REFERENCE (28) NA		OF (29) NA	
JOB ORDER NO. (30) NA	PERCENT COMPLETION ON 31 NA		DATE FAILURE REPORT (NAVSHIPS 3621) SUBMITTED (36) 6-15-63
DATE WORK STARTED (32) 6-12-63	MANHOURS TO COMPLETE (33) 32	DATE COMPLETED (34) 6-14-63	ENTERED IN MCH. HIST. OR OFFICE LOG (35) 6-15-63

WORK DONE, MATERIAL USED, COSTS, ETC.

Ships force removed motor, disassembled, cleaned, and baked stator. Stator winding was coated with film of grease. Cleaned with trichloroethylene. Stator was baked for 12 hours at 180 degrees F. Ground reading after cooling to room temperature was 20 megs. Replaced both motor bearings, FSN H3310-106-5084, price$10.80 each.

NAVSHIPS 529 (REV. 3-56)—BACK

B

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Figure 15-3.—Repair record, NavShips 529; A (front), B (back).

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23. The title of the type, or force, commander convening a forces afloat material inspection, if such an inspection has been held.
24. The number of the quarter and the year in which the forces afloat inspection was held.
25. The forces afloat material inspection item number, when applicable. This number is entered on the Repair Record Card when a list of repairs is made up for a material inspection.
26. The file number of any letter that may have been received or written in regard to the repair item. A copy of this letter, when sent, is placed in the log room file.
27. The date of such a letter (No. 26).
28. On the back of the card (fig. 15-3B) the file number of any reply to a letter that may have been written (No. 26).
29. The date of such a reply (No. 26).
30. The job order number if the repair is to be done by a repair activity.
31. For repair jobs that have not been fully completed by a repair activity by the end of the availability. Enter the percentage of completion for reference for the next availability.
32, 33, 34, 35, and 36. These spaces are self-explanatory.

NavShips 530

The Alteration Record Card, (fig. 15-4), is used to record all authorized alterations pending. While an alteration is pending the card is placed behind the Electrical History Card of the unit affected, with the pink tab extending above the top of the history card.

Entries that should appear on this card are based on information contained in the SHIPALTS which are sent to the ship concerned, and these entries are similar to those on the Repair Record Card. There is this difference in recording information on the two cards: the Repair Record Card is made

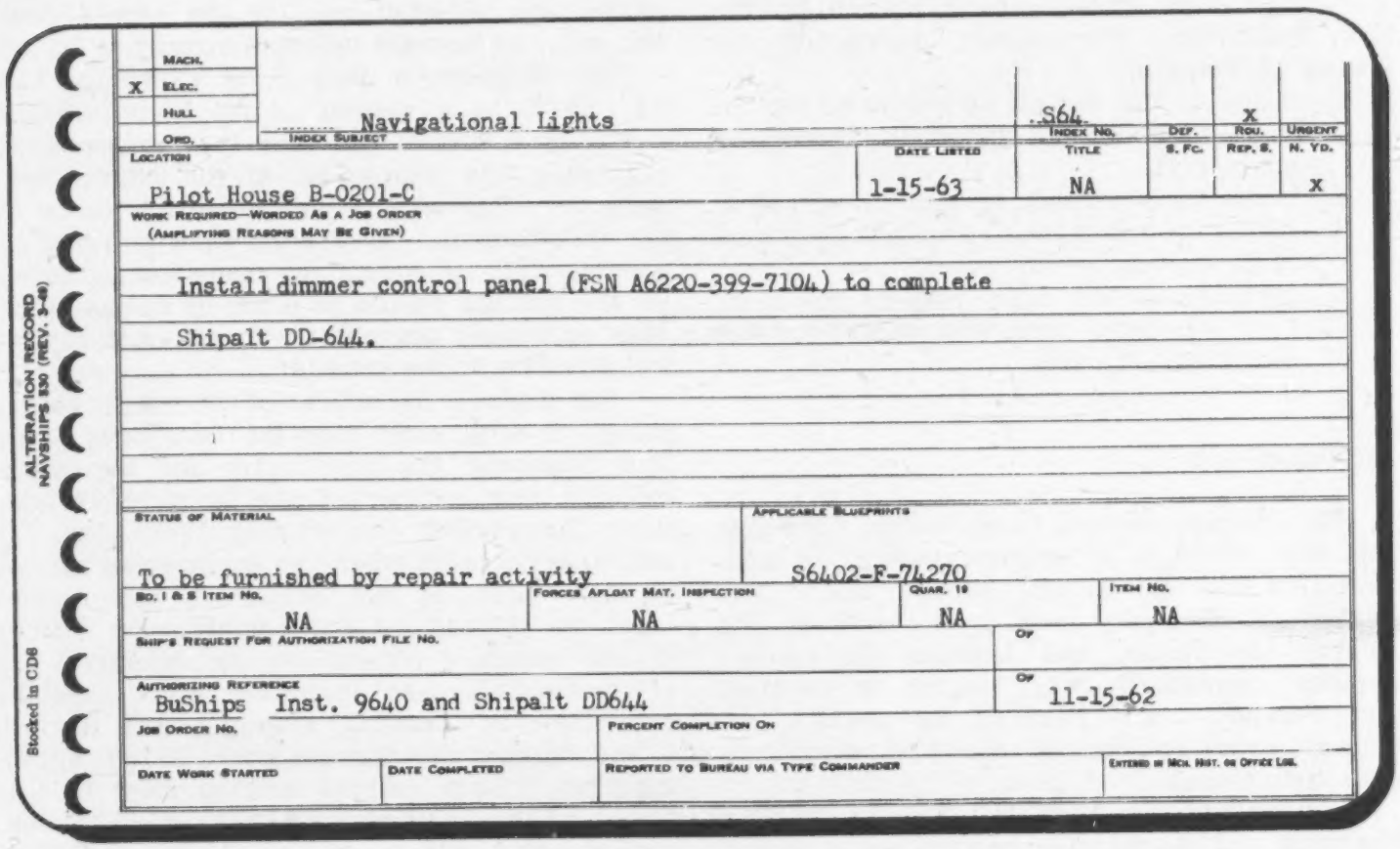
ALTERATION RECORD
NAVSHIPS 530 (REV. 9-49)

Stocked in CD8

	MACH.						
X	ELEC.						
	HULL	Navigational Lights	S64		X		
	ORD.	INDEX SUBJECT	INDEX NO.	DEP.	ROU.	URGENT	
LOCATION		DATE LISTED	TITLE	S. FC.	REP. S.	N. YD.	
Pilot House B-0201-C		1-15-63	NA			X	

WORK REQUIRED—WORDED AS A JOB ORDER (AMPLIFYING REASONS MAY BE GIVEN)

Install dimmer control panel (FSN A6220-399-7104) to complete Shipalt DD-644.

STATUS OF MATERIAL	APPLICABLE BLUEPRINTS
To be furnished by repair activity	S6402-F-74270

BO. I & S ITEM NO.	FORCES AFLOAT MAT. INSPECTION	QUAR. 19	ITEM NO.
NA	NA	NA	NA

SHIP'S REQUEST FOR AUTHORIZATION FILE NO. — OF

AUTHORIZING REFERENCE: BuShips Inst. 9640 and Shipalt DD644 — OF 11-15-62

JOB ORDER NO. — PERCENT COMPLETION ON

DATE WORK STARTED — DATE COMPLETED — REPORTED TO BUREAU VIA TYPE COMMANDER — ENTERED IN MCH. HIST. OR OFFICE LOG.

8.108

Figure 15-4.—Alteration record, NavShips 530.

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out when the need for a repair becomes evident, or when it is decided that a repair should be undertaken at a future date; the Alteration Record Card, on the other hand, is filled out upon receipt of the approved SHIPALT. Space is provided on the back of card (not shown) for describing the work done to complete the alteration.

MAINTENANCE RECORDS

Electrician's Mates are required to maintain a number of maintenance records, such as ground test sheets, storage battery tray records, periodic tests and inspections, work request records, and others. These records at present are kept on official NavShips forms, forms prepared by type commanders, and forms prepared by the engineering department of the individual ship concerned.

GROUND TEST SHEETS

Ground test sheets are prepared by the individual ship. They should include the following information:

1. Name of the circuit or unit to be tested.
2. Frequency of tests (weekly, monthly, or quarterly).
3. Location of circuit or unit to be tested.
4. Insulation resistance reading in megohms of the circuit or unit tested.
5. Initials of the man making the test.
6. Date readings are transferred to the NavShips 531 card.

NAVSHIPS 151

The Storage Battery Tray Record, NavShips 151 (fig. 15-5) is a complete history of each lead-acid storage battery aboard ship. The record is normally kept up to date by the battery electrician, and includes the battery number, nameplate data, record of service, and charges. The back of the record (not shown) provides spaces for test discharge data and repairs.

In addition to NavShips 151, a battery charging and discharging record and a weekly pilot cell reading record are required. These records are prepared by the individual ship concerned.

SHIP'S MEMORANDUM WORK REQUEST

The Ship's Memorandum Work Request (fig. 15-6) is an interdepartmental form used by any department that requires work to be performed by another department. This memorandum ensures the proper routing of work requests between heads of departments. The work requests list the work to be done and include an estimate of the man-hours and material required to complete the job. Space is provided also for the shop that performs the work to list the material used, the man-hours expended, the date of completion, and the approximate cost. Similar forms are filled in when a ship requires work to be done by a shipyard or tender.

LEGAL RECORDS

The Engineer's Bell Book and the Engineering Log are official legal records. They can be used in any military or civilian court as final proof of any action taken on or by the ship, and as evidence for or against any officer or enlisted man of the ship's crew who may be brought before the court or board.

The Engineer's Bell Book (NavShips 116, fig. 15-7) is a record of all bells, signals and orders, and of the time they are received regarding the movement of the ship's propellers. The entries are generally made by the throttleman. However, when entering or leaving port, or during any maneuvering activity the entries should be made by an assistant. This procedure permits the throttleman to give full attention to the signals.

The engineering officer of the watch, before going off duty, must sign the Bell Book in the line following the last entry for his watch and the next officer of the watch must continue the record immediately thereafter. In machinery spaces where an engineering officer of the watch is not stationed, this record must be signed by the senior petty officer of the watch. Alterations or erasures are not permitted. An incorrect entry must be corrected by drawing a single line through it and making the correct entry on the following line. Such deleted entries must be initialed by the engineering officer of the watch, senior petty officer of the watch, or O.O.D. (in the case of ships and craft equipped with controllable reversible pitch propellers) as appropriate.

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CONTACTS (ELECTRICAL): (Continued)

CONTACT ASSEMBLIES

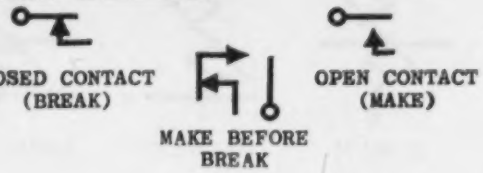

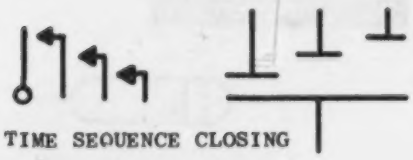

TIME SEQUENCE CLOSING

DISCONNECTING DEVICES:

MALE
(PIN CONTACT)

FEMALE
(SOCKET CONTACT)

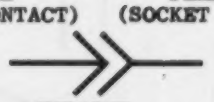

ENGAGED
(PIN-TO-SOCKET)

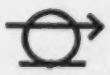

COAXIAL
(MALE)

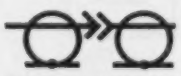

COAXIAL CONNECTORS
MATED

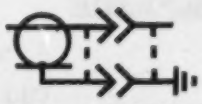

COAXIAL CONNECTED
TO SINGLE CONDUCTOR

THE CONNECTOR SYMBOL IS NOT AN ARROWHEAD. IT IS LARGER AND THE LINES ARE DRAWN AT A 90° ANGLE.

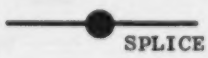

SPLICE

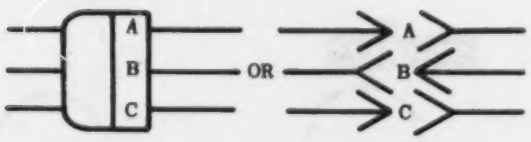

CONNECTOR ASSEMBLY (GENERAL)

ELECTRON TUBES:

COMPONENT TUBE SYMBOLS

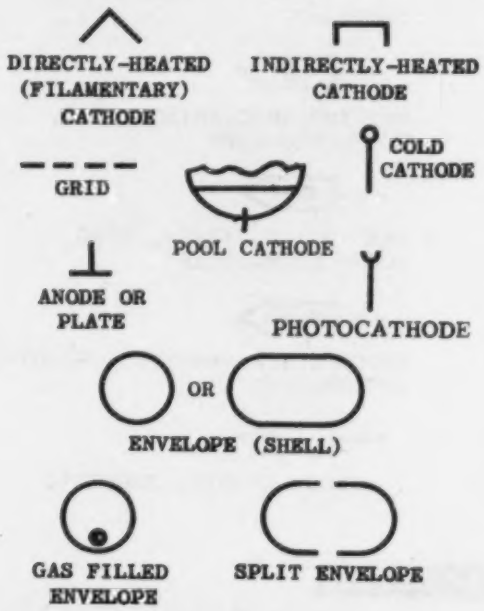

SEMICONDUCTOR DEVICES:

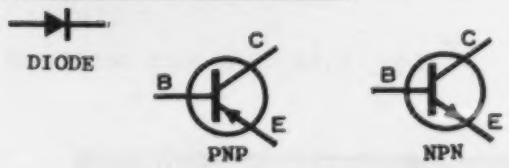

TRANSISTORS

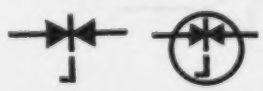

BREAKDOWN DIODE,
BIDIRECTIONAL

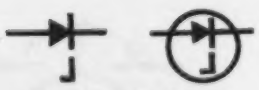

BREAKDOWN DIODE,
UNDIRECTIONAL
(ALSO BACKWARD DIODE)

PHOTODIODE

NAVSHIPS (NBS) 151
(Rev. 9-44)

Page 1

(USE SEPARATE SHEET FOR EACH TRAY)

STORAGE BATTERY TRAY RECORD

U. S. S. WETDECK, DE-183 Service for which used LCVP No. 1 Tray No. S62-3-11
(See art. 62-225, BuShips Manual)

CHARGES

Date of each charge	Specific gravity and number of lowest cell at start of charge	Starting rate (amps.)	Finishing rate (amps.)	Specific gravity and number of lowest cell at finish of charge	Was battery watered	Type of charge (if equalizing, state total time at finishing rate)	Service tray has performed since previous charge	Approval of engineer officer or electrical officer
1-15-63	NA	7	7	1220	yes	initial	new	
2-10-63	1100	30	10	1220	yes	normal	VP#1	
4-15-63	1200	30	10	1220	yes	4 hrs.	VP#1	

NOTE.—All specific gravity readings to be corrected to 80° F. (art. 62-274, BuShips Manual).

The following information is to be copied from the tray name plate: Contract No. NX-4125
Navy class 6V-SBM-175AH Manufacturer Willard Manufacturer type 3-MVAL-15
Date initial charge 1-15-63

10—19124-6

77.229

Figure 15—5.—Storage battery tray record, NavShips 151.

The records for each throttle control station for each day must begin with a new sheet, and the day's records for all stations must be clipped together and filed as a unit.

Instructions for keeping the Engineer's Bell Book are as follows:

1. A separate sheet shall be used for each shaft each date except on small ships and craft where the keeping of separate sheets for separate shafts is not practicable. All sheets for the same date should be filed together as a single record. (Entries in the Bell Book shall be made at the time of receipt of each order.)

2. In column 1, times shall be entered according to the system used in the Engineering Log.

3. In column 2, enter the signal received.

a. If the signal is transmitted by the engine (motor) order telegraph, use the following symbols:

Z—stop
1/3—ahead one-third speed
2/3—ahead two-thirds speed
I—ahead standard speed
II—ahead full speed
III—ahead flank speed

Backing signals for 1/3 and 2/3 speed shall be entered as "B 1/3" and "B 2/3", respectively. Signals for full back and emergency back shall be entered as "BF" and "BEM", respectively. On small ships and

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CL83 FORM 301

U.S. S. MANCHESTER (CL83)
WORK REQUEST
(SHIP'S FORCE)

CL83 - 6/24/49

Date 7 May 19—

FROM: Electrical Officer

TO: Repair Off., R Div. Off., First Lt. or CHBOSN.

1. It is requested that the following work be accomplished.

Item upon which work is to be done:	Location:	J.O. Number:
Battle Telephone System - 49 JY	Mount 40-7	413-52

Work to be done: (Furnish sketch, dimensions, plans, etc., where applicable.)

Cut off old 20 wire connection box mounted on gun shield. Manufacture brackets to fit new switch box and weld in place. Dimensions of brackets to be taken from work.

Work to be inspected / ~~received~~ by: Whaley I. C.C.

R. Christopher
Signature

CElect
Rank or Rate

Priority: (1) 2 3 Urgent Deferred

(XX) Approved
( ) Disapproved

Entered in Repair Office Work Log RRK

W. K. Belvins
Repair Off., R Div. Off., First Lt. or CHBOSN.

Shop Routing:

( ) Carpenter Shop
(XX) Shipfitter Shop
( ) Electrical Workshop
( ) Steam Fitters & Htg.
( ) W.T. Integrity Force
( ) Plumbers
( ) Sail Locker
( ) Paint Locker
( ) Machine Shop
( ) Bosn's Locker

Date work started 9 May 19—
Date work completed 10 May 19—
Man hours 8
Signature shop CPO Blount

Work received/completed R. H. Whaley I.C.C.

Weight added/removed None Lbs. Tons

Entered in Machinery History Report R.W.W. CSMP

Repair Record Book R.K.K. Master Weight Record

YN

Figure 15-6.—Ships memorandum work request.

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ENGINEER'S BELL BOOK—ALL VESSELS
NavShips 116 (Rev. 11-56)

ENGINEER'S BELL BOOK

(SEE INSTRUCTIONS ON COVER)

U. S. S. BARNEY (APD-1) SHAFT NO(S). ONE (1) DATE 6 JUNE 19--

En route from NORFOLK, VIRGINIA to CADIZ, SPAIN

Record of all "BELLS," SIGNALS, and ORDERS received regarding movement of propellers this date

TIME ZONE DESCRIPTION +5 QUEBEC AND +4 PAPA Clocks set ~~back~~ ahead 1 hrs. 0 min., at 2300

(1) TIME	(2) SIGNAL	(3) R. P. M.	(4) COUNTER OR PITCH SET	(1) TIME	(2) SIGNAL	(3) R. P. M.	(4) COUNTER OR PITCH SET	(1) TIME	(2) SIGNAL	(3) R. P. M.	(4) COUNTER OR PITCH SET
16	ENGAGED TURNING GEAR		214122								
16	MECHANICAL COUNTER		999210								
1742	DISENGAGED TURNING GEAR		214631								
1744	TESTED MN. ENGINE		214634								
1758	UNDERWAY		214651								
18	COUNTER		214660								
1801	1/3	32	214660								
1803	2/3	78	214730								
1804	Z		214738								
1805	B2/3		214870								
1805	Z		214883								
1805	BF	100	214891								
1806	BEM	110	214913								
1807	Z		214999								
1818	1/3	32	215030								
1814	2/3	70	215151								
~~1900~~	~~AHM~~										
19	COUNTER		218343								
1902	I	110	218500								
1920	122		220480								
B. L. Montier LT USN											
20	COUNTER		225360								
2009	110		226352								
21	COUNTER		232952								
22	COUNTER		239552								
JM Houle LTJG USN											
24	COUNTER		246150								
B Morrow Ens, USN											

Figure 15-7.—Engineer's Bell Book, NavShips 116.

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craft, using a single sheet for two or more shafts, the above symbols shall be used with an additional preceding symbol "P," "S," or "C" (for port, starboard, or center shaft, respectively) if the signal is directed to other than all shafts.

b. If the signal is transmitted by the engine revolution telegraph without change in the engine (motor) order telegraph, the number of propeller revolutions signaled shall be entered in column 2. In this case, entries shall not be made in column 3.

4. An entry in column 3 shall be made for all signals received on the engine order telegraph and shall be the propeller corresponding to the engine order telegraph signal. When a signal is received simultaneously on the engine order telegraph and the engine revolution telegraph, appropriate entries shall be made in both column 2 and column 3.

5. The rpm entries in either column 2 or column 3 are the propeller rpm ordered; not rpm resulting from the order.

6. In column 4 enter the engine counter reading at the time the change is made. Also, enter the counter reading each hour on the hour.

The Engineering Log (NavShips 117) is a midnight-to-midnight daily record of the ship's engineering department. It is a complete daily record, by watches, of important events and data pertaining to the engineering department and the operation of the ship's propulsion plant. The log must show the average hourly speed in revolutions and knots, the total engine miles steamed for the day, and all major speed changes; draft and displacement; fuel, water, and lubricating oil on hand, received and expended; the engines, boilers, and principal auxiliaries in use, and all changes therein. All injuries to personnel occurring within the department and casualties to material assigned to the department, and such other matters as may be specified by competent authority, are entered into the engineering log.

The original entries in the log, neatly prepared in pencil or ink, is the legal record. The remarks must be prepared and signed by the engineering officer of the watch, or day, before leaving his station or being relieved. Any errors must be overlined and initialed by the person preparing the original entries.

The engineer officer must verify the accuracy and completeness of the entries and sign the log daily. The commanding officer must sign the log on the last calendar day of each month, and on the date of relinquishing command.

The Engineer's Bell Book and the Engineering Log must be preserved as a permanent record on board for a three-year period unless they are requested by a naval court or board, or the Navy Department. In such a case, a copy (preferably photostatic) of such sheets that are sent away from the ship are prepared and certified as a true copy by the engineer officer for the ship's files. At the end of the three-year period these records may be destroyed. When a ship is stricken, if either record is less than three years old, it should be forwarded to the nearest Naval Records Management Center.

OPERATING RECORDS

A constant check of all machinery and units in operation must be made by the men on watch in the machinery spaces. The data obtained by the watchstanders is entered on records referred to as operating records. These records, in addition to ensuring frequent observation of all machinery in operation, provide a basis for analyzing machinery performance.

Operating records that will concern you are the Electrical Log-Ship's Service Electric Plant, NavShips 3649, and the A-C/D-C Electrical Propulsion Operating Record, NavShips 3647.

NAVSHIPS 3649

The Electrical Log, NavShips 3649 (fig. 15-8) is a complete daily record (from midnight to midnight) of the operating conditions of the ship's service electric plant. The log sheet must be kept clean and neat. Any corrections or changes to entries for a watch must be made by the man that signs the log for that watch. However, corrections or additions must not be made after the log sheet has been signed by the engineer officer without his permission or direction. The station logs are turned in to the log room every morning for the engineer officer's signature and for filing.

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ELECTRICAL LOG—SHIP'S SERVICE ELECTRICAL PLANT (NavShips 3649)
NAVSHIPS 3649 (REV. 11-57)
ALL PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE
RETAIN FOR 2 YEARS—THEN DISPOSE IN ACCORDANCE WITH CURRENT REGULATIONS
PAGE 1

U. S. S. SPEERELL--CVS-33 | GENERATOR NO. 2 | DATE 9 June 1963

INSTRUCTIONS
CROSS OUT INAPPLICABLE FOR PRIME MOVER
* E. P. M. OF CHLORIDE = 0.261 × METER READING IN G. P. G. OF SEA SALT
* * FOR AMPS. ON SHIPS HAVING 3-WIRE D. C. GENERATORS
* * * REFERRED TO 30" BAROMETER

DIESEL TURBINE	TURBINE						CONDENSATE				LUB. OIL															
	STEAM PRESSURE P. S. I.	STEAM TOTAL TEMP. °F.	VACUUM ***	TEMP EXHAUST TRUNK °F.	INJECTION TEMP °F.	OVERBOARD TEMP. °F.	PRESSURE P. S. I.	TEMP. °F.	SALINITY IN E. P. M. *	BOOST DISCH. PRES. P. S. I.	TO COOLER °F.	FROM COOLER °F.														
	TEMPERATURES								PRESSURES				3-PHASE A. C.					D. C.			TOTAL KILOWATTS		
HOUR	TACH.	PHI °F.	FRESH WATER IN °F.	FRESH WATER OUT °F.	LUB. OIL IN °F.	LUB. OIL OUT °F.	NUMBER AND TEMP HOTTEST CYL. °F.	L. O. TO ENGINE P. S. I.	F. O. TO ENGINE P. S. I.	S. W. PUMP DISCH. P. S. I.	S. W. PUMP DISCH. P. S. I.	SCAV. ENGINE P. S. I.	FREQ.	P. F.	AMPS.	VOLTS	K. W.	AMPS.	VOLTS	**	A. C.	D. C.	
0100	580		29		55	67	38	95	.01		135	115	60	.80	800	450	489	75	120		489	9	
0200	580		29		55	67	38	95	.01		135	115	60	.84	805	450	491	75	120		491	9	
0300	580		29		55	66	37	95	.01		135	115	60	.81	820	450	494	90	120		494	10.8	
0400																							
2300																							
2400																							

ADDITIONAL

0000-0400
Number 2 generator in operation.
0200 shifted and cleaned lube oil strainers.
Routine auxiliary watch—
J. A. Smith EM3

0400-0800

0800-1200

(SEE REVERSE SIDE)

77.231

Figure 15-8.—Electrical Log-Ships service electrical plant, NavShips 3649.

The back of the log (not shown) is a continuation of the front, and also provides spaces for the engineer officer's and senior Electrician's Mate's signatures.

NAVSHIPS 3647

The A-C/D-C Electric Propulsion Operating Record, NavShips 3647 (fig. 15-9 A&B), is used on all surface ships equipped with a-c or d-c electric drive. The record is maintained by the Electrician's Mate standing the throttle watch. Spaces are provided on both the front and the back for data concerning the main propulsion equipment.

The general instructions for keeping this record are the same as those mentioned previously for the NavShips 3649.

EQUIPAGE AND REPAIR PARTS RECORDS

The basic types of material aboard ship are (1) consumable supplies, (2) equipage, (3) repair parts, and (4) ship's machinery and equipment. As an EM 3 or 2 you may be assigned division supply petty officer. This duty will require you to use the ship's allowance list in requisitioning consumable supplies and repair parts for the division. You may also be called upon to assist in the inventory of the electrical repair parts and equipage. Allowance lists, requisitioning material, inventories, and the associated forms and records are discussed in Chapter 12 of Military Requirements for Petty Officer 3 & 2, NavPers 100056-B.

MISCELLANEOUS RECORDS

Additional records that you may be required to maintain are listed below.

DEGAUSSING RECORDS

Degaussing records are contained in the degaussing folder, NavShips 1009, discussed in chapter 12 of this training course.

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TESTS OF SAFETY DEVICES

A record of the weekly tests of all electrical safety devices.

TROUBLE CALL RECORD

A record of electrical trouble calls showing the time of the call, nature of trouble, men assigned, and the time the trouble was corrected.

ROUGH WORKBOOKS

Rough workbooks are ledger type notebooks maintained by the men in charge of a particular shop, space, or circuit. They should contain rough notes on a day-by-day basis of all work done. Material and repair parts used should be recorded along with sufficient details concerning repairs to support appropriate entries on the Material History Card, NavShips 527A. Rough workbooks should be kept up to date, and as neat as possible.

TECHNICAL PUBLICATIONS

The Naval Ship Systems Command publishes various technical publications concerning the operation and maintenance of electrical and electronic equipment. Publications of interest to Electrician's Mates include the NavShips Technical Manual, Naval Ship Systems Command Technical News, Manufacturers' technical manuals, Ship Information Books, Damage Control Books, and others.

NAVSHIPS TECHNICAL MANUAL

The NavShips Technical Manual is one of the most important Naval Ship Systems Command publications. This manual contains the administrative and engineering instructions for the use of the engineering department. It describes methods of conducting tests, procedures for making repairs, and many helpful maintenance suggestions. It is the official authority on operating procedures.

As an Electrician's Mate, you should be familiar with the following chapters of the NavShips Technical Manual.

Chapter New No.	Chapter Old No.	Title
9003	4	Allowance, surveys, and requests for material
9004	6	Inspections, records, and reports
9200	20	Winches and capstans
9220	22	Steering gear
9310	31	Spare parts
9340	34	Commissary equipment
9005	40	Tables of engineering data
9410	41	Main propelling machinery, section IV
9450	45	Lubricants and lubrication systems
9600	60	Electric plant--general
9610	61	Electric generators and voltage regulators
9621	62	Electric Power Distribution System
9622	62	Portable Storage Batteries and Dry Batteries
9630	63	Electric motors and controllers
9640	64	Lighting
9660	66	Searchlights
9690	69	Electrical measuring and test instruments
9810	81	Mine protection, section III
9830	83	Elevators
9880	88	Damage control, section III, part 2

MANUFACTURERS' TECHNICAL MANUALS

Manufacturers' technical manuals provide detailed information concerning the operation and maintenance of specific equipment. They are, in most cases, prepared by the manufacturers of the equipment concerned. Military Specification MIL-M-15071E, of 15 April 1962, establishes four types of manufacturers' technical manuals and provides instructions for their preparation. The types of manuals are: type 1, electrical and mechanical; type 2, electronic and special equipment; type 2a, experimental equipment; and type 3, systems.

You will be using the type 1 manual. The material in this manual is arranged in the following order:

1. Front matter

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2. Section one—general information
3. Section two—installation
4. Section three—operation
5. Section four—troubleshooting
6. Section five—maintenance
7. Section six—parts list
8. Index

When a piece of equipment is installed and the technical manual is not received the installation should not be accepted as complete.

SHIP INFORMATION BOOK, VOLUMES 3 AND 5

The General Specifications for Ships of the United States Navy required that the building shipyard for each combatant ship and many larger auxiliary ships, furnish to each such ship it builds copies of Volumes 3 and 5 of the Ship Information Book. Volume 3, Power and Lighting Systems, of the Ship Information Book serves a particular ship, and replaces the Record of Electrical Installations and Electrically Operated Auxiliaries, previously required. Volume 3 consists of two parts. Part 1 contains a general description, and design information of each electrical auxiliary and equipment. Part 2 contains the manufacturers' and shipbuilder's test data. This part is particularly valuable as a basis for comparison of test results obtained after the equipment has operated over a period of time. Volume 5 of the Ship Information Book covers the interior communication and fire control systems. As an EM3 or 2 you may find this volume helpful in assisting the IC gang.

DAMAGE CONTROL BOOKS

Damage control books are furnished to all combatant, miscellaneous, and auxiliary ships over 220 feet in length, and to certain smaller fleet-operated ships. A detailed description of the damage control book is set forth in chapter 9880, of NavShips Technical Manual.

ADDITIONAL PUBLICATIONS

Additional publications that contain valuable information for Electrician's Mates are NavShips Standard Electrical Symbol List, NavShip 0960-000-4000, Lighting on Naval Ships, NavShips 250-560-4, and the Cable Comparison Guide, NavShips 250-660-23.

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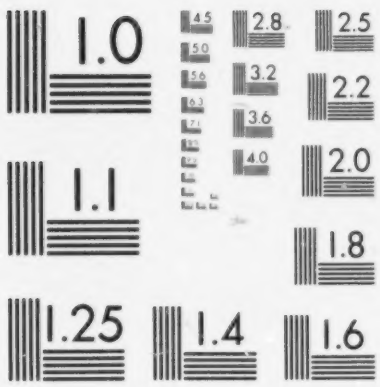

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX I

TRAINING FILM LIST

Training films that are directly related to the information presented in this training course are listed below. Under each chapter number and title the training films are briefly described. Other training films that may be of interest are listed in the United States Navy Film Catalog, NavWeps 10-1-777.

The films listed in appendix 1 are unclassified. The information listed after the title gives date of film release, color or B/W (black and white), run time in minutes, and indicates either sound or silent film.

Example:

1962	B/W	16 min	Sound
Release date	Color	Run Time	Sound/Silent

Chapter 1

ADVANCEMENT

MN 8990 115 Volts—Deadly Shipmate. (1960—Color—19 min.—Sound) Reenactment of actual accident cases. Emphasizes the disastrous effects of low voltage electrical shock when basic rules of electrical safety are violated or ignored.

Chapter 2

THE 3-M SYSTEM

MN 9958A Planned Maintenance System—Concept. (1963—color—24 min—sound) Implements OPNAVINST 4700.16.

MN 9958B Planned Maintenance System—Application. (1963—B&W—12 min—sound) Use in shipboard maintenance.

Chapter 4

SHIPBOARD LIGHTING

ME 8445 Electrical Circuit Faults. (1945—B&W—19 min—sound) How to test for and locate common circuit faults.

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SEMICONDUCTOR DEVICES: (Continued)

TEMPERATURE DEPENDENT DIODE

PNPN SWITCH

TUNNEL DIODE

TYPICAL ELECTRON TUBES:

COLD CATHODE GAS TUBE

PHOTOTUBE SINGLE UNIT, VACUUM

DIODE

PENTODE

TWIN TRIODE ILLUSTRATING ELONGATED ENVELOPE

DIODE SHOWING BASE CONNECTIONS

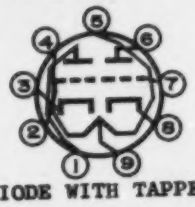

TWIN TRIODE WITH TAPPED HEATER

TYPICAL CATHODE RAY TUBES:

MAGNETIC DEFLECTION

ELECTROSTATIC DEFLECTION

WAVEGUIDES:

CIRCULAR

RECTANGULAR

RIDGED

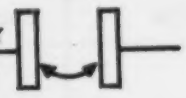

ROTARY JOINT

DIRECTIONAL COUPLERS

GENERAL

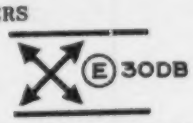

E PLANE APERTURE COUPLING, 30 DB TRANSMISSION LOSS

COUPLING METHODS:

GENERALLY USED FOR COAXIAL AND WAVEGUIDE TRANSMISSION.

COUPLING BY APERTURE WITH AN OPENING OF LESS THAN FULL WAVEGUIDE SIZE. TYPE OF COUPLING WILL BE INDICATED WITHIN CIRCLE (E, H, OR HE).

COUPLING BY LOOP TO SPACE

COUPLING BY LOOP TO GUIDED TRANSMISSION PATH

COUPLING BY PROBE FROM COAXIAL TO RECTANGULAR WAVEGUIDE WITH DIRECT-CURRENT GROUNDS CONNECTED

TYPICAL MAGNETRONS AND KLYSTRONS:

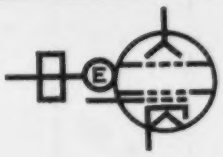

REFLEX KLYSTRON, APERTURE COUPLED

TUNABLE MAGNETRON, APERTURE COUPLED

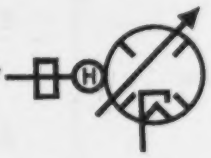

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Chapters 6

MAINTENANCE OF MOTORS AND GENERATORS

MN 9333 Electrical Maintenance. (1952—B&W—15 min—sound) Emphasizes safety in electrical maintenance.

MC 7356 Commutation of D-C Machines. (1951—B&W—24 min—sound) Theory and maintenance.

MA 9697A Motors and Generators—Part 1—D-C-Motor and Generators. (1961—B&W—35 min—sound) Principles of operation.

MA 9697B Motors and Generators—Part 2—A-C Motors and Generators. (1961—B&W—25 min—sound) Design, characteristics, and operation.

Chapter 7

BATTERIES

MN 2333C Electricity and Magnetism—Part 3 Voltaic Cell, Dry Cell, and Storage Battery. (1943—B&W—18 min—sound) Shows basic principles of the Voltaic Cell, storage batteries, and dry cells. Explains what a cell does when current is being used, internal resistance and method of checking and recharging a battery. Demonstrates combining of materials affecting the voltage and method of increasing voltage.

MA-2333D Electricity and Magnetism—Part 4—Charging Storage batteries. (1943—B&W—15 min—sound) Explains by animation, what happens when a battery is charged, and how to bring a battery back to full charge, how to tell if the battery is overcharging, constant current method of charging a battery, and how to prepare electrolyte in the field.

MA-8371 Why Battery Should Always Be Clean. (1955—B/W—6 min—sound) How to clean battery—washing, wiping dry, checking electrolyte level, greasing terminals.

MN-8592 Theory of Lead-Acid Storage Battery. (1959—B&W—25 min—sound) How chemical energy is converted into electrical energy, to produce electromotive force.

Chapter 9

CONTROL DEVICES

MN-3485F Electric Power Afloat-Operating A-C and D-C Motors and Controllers. (1945—B&W—16 min—sound) Animation and diagrams present operating principles of a-c and d-c motors and controllers. Shows how to perform daily, operational, and periodic checks of the mechanisms. Demonstrates how to operate and maintain the motors and and explains emergency procedures in the event of operational failure.

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Chapter 11

POWER DISTRIBUTION

SN-3485C Electric Power Afloat—Starting and Applying Load. (1945—B&W—12 min—sound) Using 2200 destroyer as an example, shown general placement of forward and after generators and relates them to their prime movers, the steam turbines. Detail steps in starting generator, and in making inspections before starting turbo generator, are included in the films.

MN-3485E Electric Power Afloat—Operating—Direct Current Generators. (1945—B&W—15 min—sound) Illustrates main units of the Direct current generator, switchboard, and devices of the panel. Demonstrates step-by-step procedure for starting generator no. 1, performing prestart run, paralleling generators 1 and 2, and securing. Animation shows flow of current in the units.

Chapter 12

ELECTRIC AUXILIARIES

MN 6731A Shipboard Degaussing Systems—Installations. (1952—B&W—20 min—sound) Installations of shipboard degaussing systems are discussed under four headings: theory of degaussing, installation procedures, tests and installation certificates.

MN 6731B Shipboard Degaussing Systems—Operation and Maintenance. (1952—B&W—20 min—sound) Demonstrates the operation of shipboard degaussing systems, ranging, preventive maintenance, and inspections.

MN 6731C Shipboard Degaussing Systems—Compass Compensation. (1952—B&W—20 min—sound) Demonstrates how to compensate the magnetic compass for the effects produced by degaussing coils. Discussion is taken up under four headings: theory, installation, compensation, and swing for deviation.

MN 9679A EMS Magnetometer Controlled Degaussing System-Principles Of Operation. (1962—B&W—22 min—sound) How to set up equipment for shipboard operation.

MN 9679B EMS Magnetometer Controlled Degaussing System-Maintenance and Repair. (1962—B&W—15 min—sound) Preventive maintenance and repair. Can be applied to EMS 1-4 and GEM 2 and 3 units.

MN 8208 Electrohydraulic Steering Gear. (1956—B&W—15 min—sound) Explains functions of the components of the electrohydraulic steering system aboard ship. Demonstrates the operation of the electrical type transmission linkage to the dual power unit, the differential control of the hydraulic pump, and the delivery of power to the hydraulic rams.

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Chapter 13

GYROCOMPASSES

MN 1792C The Gyro-Compass—The Gyroscope and Gravitation. (1944—B&W—12 min—sound) Theory and operation of pendulous and mercury ballistic type compasses. Effect of gravity upon gyroscope.

MN 1792D The Gyro-Compass—The Gyro Becomes A Compass. (1944—B&W—15 min—sound) Models of pendulous and mercury ballistic type compasses to explain why gyroscope turns toward the meridian. How its motion is damped, and how it is kept on the meridian.

MN 1792E The Gyro-Compass—The Compass System. (1944—B&W—16 min—sound) Five assemblies—sensitive, phantom, and spider elements mercury ballistic and binnacle of a Sperry mark 14 gyro compass. Operation of follow-up and repeater systems.

Chapter 14

ELECTRIC PROPULSION INSTALLATION

MN 2385B Turbine-Electric AC Drive (Destroyer Escort)-Operation—Part I. (1944—B&W—15 min—sound) Setting up propulsion equipment before and during first part of the turbine warm-up period is demonstrated. Teaches correct names of the operating levers and switches, and various instruments which give indications of operation of the equipment. Schematic drawings review principles of operation of this drive.

MN 2385C Turbine-Electric AC Drive (Destroyer Escort)-Operation—Part 2. (1944—B&W—23 min—sound) Operations for getting underway and method of testing propulsion motors are taught. Demonstrates procedures to start moving ahead, increasing or decreasing speed, and stopping. Engine-room duties when underway are covered.

MN-2385D Turbine-Electric AC Drive (Destroyer Escort)-Operation Notes. (1944—B&W—15 min—sound) Function of the interlocks, their importance, and procedures for operating in slow and top speed ranges are explained. Operation in full speed astern is observed. Function and operation of load limit handwheel are shown.

MN-2385E Turbine-Electric AC Drive (Destroyer Escort)-Operation in Case of Casualty-Part 1. (1944—B/W—17 min—sound) Illustrates some of the methods that have been found practical in meeting casualties on the DE and maintaining the transmission of power to the screws.

MN 2385F Turbine-Electric AC Drive (Destroyer Escort)-Operation in Case of Casualty-Part 2. (1944—B/W—18 min—sound) Continuation of MN-2385E, illustrating methods that have been found practical in meeting casualties on the DE and keeping power to the screws. Deals with operation when there is trouble in the electrical equipment.

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Chapter 15

RECORDS AND REPORTS

FN-7849A Material History Records—Introduction. (1955—B&W— 13 min—sound) How to maintain the material history records.

FN-7849C Material History Records—Electrical Record Cards. (1955—B&W—9 min—sound) Describes the Electrical History Card and the Resistance Test Card. Shows how to find the right card, how to use it and how to keep it up to date.

FN 7849E Material History Record—Repair Record Card. (1956—B&W—10 min—sound) Describes the repair card and its use in a current ship's maintenance project. Covers the proper notation of basic information on the need for a repair, progress information while the job is being done and entries when the job is complete.

FN 7849F Material History Records—Alteration Record Card. (1955—B&W—11 min—sound) Describes the Alteration Record Card and the step by step procedure of its use before, during and after a typical alteration.

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APPENDIX III
GREEK ALPHABET

Name	Capital	Lower Case	Designates
Alpha	A	α	Angles.
Beta	B	β	Angles, flux density.
Gamma . . .	Γ	γ	Conductivity.
Delta	Δ	δ	Variation of a quantity, increment.
Epsilon . . .	E	ϵ	Base of natural logarithms (2.71828).
Zeta	Z	ζ	Impedance, coefficients, coordinates.
Eta	H	η	Hysteresis coefficient, efficiency, magnetizing force.
Theta	Θ	θ	Phase angle.
Iota	I	ι	
Kappa	K	κ	Dielectric constant, coupling coefficient, susceptibility.
Lambda . . .	Λ	λ	Wavelength.
Mu	M	μ	Permeability, micro, amplification factor.
Nu	N	ν	Reluctivity.
Xi	Ξ	ξ	
Omicron . . .	O	o	
Pi	Π	π	3.1416
Rho	P	ρ	Resistivity.
Sigma	Σ	σ	
Tau	T	τ	Time constant, time-phase displacement.
Upsilon . . .	Υ	υ	
Phi	Φ	φ	Angles, magnetic flux.
Chi	X	χ	
Psi	Ψ	ψ	Dielectric flux, phase difference.
Omega	Ω	ω	Ohms (capital), angular velocity ($2 \pi f$).

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ABSTRACT - Intended primarily as a reference guide for school custodians, this guide also presents school administrators and teachers with information on proper maintenance and cleaning procedures essential to keeping school facilities safe and sanitary. In addition to a chapter on selection, training, and responsibilities of the school custodian, contents cover: (1) general information on cleaning procedures, materials, and equipment, (2) care of restroom facilities, (3) maintenance and care of hard floors, (4) maintenance and care of carpets, and (5) climate control, including heating, air conditioning, and ventilation. Suggested time schedules for performance of tasks are provided for each section. (AW)

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SCHOOL HOUSEKEEPING

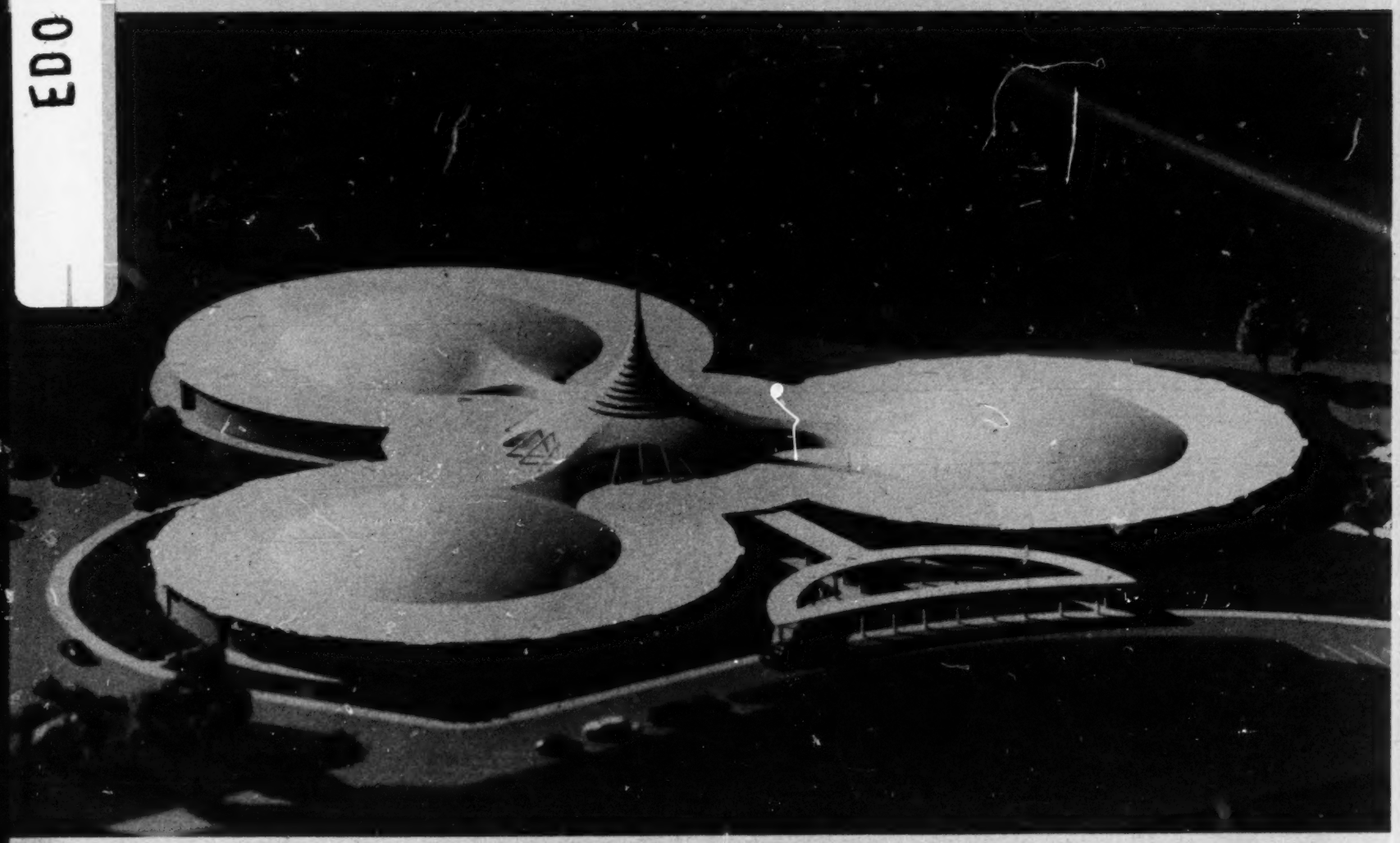

A GUIDE FOR THE MODERN CUSTODIAN

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SCHOOL PLANNING LABORATORY
THE UNIVERSITY of TENNESSEE

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A Guide for the Modern Custodian

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INTRODUCTION

This guide was prepared to assist school board members, superintendents, principals, teachers, custodians, and other personnel charged with the responsibility of keeping school facilities clean and safe for students. The need for this manual is compounded because of the increasing importance being placed upon the modern school custodian.

The physical environment of the school has a direct effect on the behavior and learning responses of students. Cleanliness is a vital part of this environment; therefore, the importance of this guide is indispensable if proper care and cleaning procedures of school facilities are to be assured.

This manual was prepared as a reference guide primarily for custodians. It also attempts to serve as a means to acquaint the school administration with the various responsibilities of the modern custodian. In bold outline, it presents essential information needed by school personnel in regards to proper cleaning and maintenance procedures. The physical composition of school buildings is made up virtually of every type building material,

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which makes proper cleanliness extremely complicated. Significant tenets of proper cleaning, cleaning materials, and suggested time schedules are stressed in this guide. Additional information is included on the treatment of materials and equipment, safety, and the proper care of special facilities, ranging from the care of carpet to the total plant itself.

It is hoped that this guide may be of assistance to the many progressive schools which are becoming fully cognizant of the importance that an immaculate facility has on the implementation of a successful educational program.

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PREFACE

This book is a welcome addition to the few existing publications intended to be directly useful to the custodial staff of a school plant. Only in recent years have educators realized the great impact that building custodians have on the morale of staff and students. Proper attention to the maintenance of such factors as safety, cleanliness, climate control, and aesthetic appearance are in evidence in any good teaching-learning situation; and where they are in evidence there is always a quality custodial staff.

The great advances in school planning now in progress have resulted in innovative, functional school plants which use a great variety of materials and equipment. These changes demand an equally great variety in the kinds of custodial practices, and a generally higher level of custodial competence. Educators are now faced with a new set of problems regarding custodial care such as: a program of continuing re-education for the custodian, diversification in duties and developing a custodial staff team concept, and securing adequate materials, supplies and equipment specifically designed to meet new custodial needs.

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Supply companies have been quick to respond to new requirements, thus providing administrators an opportunity to make wise choices in providing for the needs of their custodial staff.

This manual reflects the combined wisdom of many years of experience. Each of the contributors is an experienced teacher or administrator with considerable experience in school planning and in the effective use and maintenance of school plants. Their combined experience permits them to view custodial problems from such positions as teacher, principal, superintendent, school plant director, and college business manager. All have worked together as research associates in the University of Tennessee School Planning Laboratory.

The manual is direct in its approach to the problems of school building custodial care and management. Revision of such a manual is inevitable since new materials and equipment will become obsolescent with accelerating advances in school plant planning. In the meantime, this manual should be a must in every school and school system. Its proper use should result in enhancing the functional and aesthetic qualities of the educational environment and in the custodial staff receiving justly deserved recognition and respect.

Orin B. Graff

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APPENDIX IV
FORMULAS

Ohm's Law for D-C Circuits

$$I = \frac{E}{R} = \frac{P}{E} = \sqrt{\frac{P}{R}}$$

$$R = \frac{E}{I} = \frac{P}{I^2} = \frac{E^2}{P}$$

$$E = IR = \frac{P}{I} = \sqrt{PR}$$

$$P = EI = \frac{E^2}{R} = I^2R$$

Resistors in Series

$$R_T = R_1 + R_2 + \ldots$$

Resistors in Parallel

Two resistors

$$R_T = \frac{R_1R_2}{R_1 + R_2}$$

More than two

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

RL Circuit Time Constant

$$\frac{L \text{ (in henrys)}}{R \text{ (in ohms)}} = t \text{ (in seconds), or}$$

$$\frac{L \text{ (in microhenrys)}}{R \text{ (in ohms)}} = t \text{ (in microseconds)}$$

RC Circuit Time Constant

R (ohms) x C (farads) = t (seconds)

R (megohms) x C (microfarads) = t (seconds)

R (ohms) x C (microfarads) = t (microseconds)

R (megohms) x C (micromicrofarads) = t (microseconds)

Capacitors in Series

Two capacitors

$$C_T = \frac{C_1C_2}{C_1 + C_2}$$

More than two

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$$

Capacitors in Parallel: $C_T = C_1 + C_2 + \ldots$

Capacitive Reactance: $X_C = \frac{1}{2\pi fC}$

Impedance in an RC Circuit (Series)

$$Z = \sqrt{R^2 + (X_C)^2}$$

Inductors in Series

$L_T = L_1 + L_2 + \ldots$ (No coupling between coils)

Inductors in Parallel

Two inductors

$L_T = \frac{L_1L_2}{L_1 + L_2}$ (No coupling between coils)

More than two

$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots$ (No coupling between coils)

Inductive Reactance

$$X_L = 2\pi fL$$

Q of a Coil

$$Q = \frac{X_L}{R}$$

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CHAPTER I

SELECTION, TRAINING, AND GENERAL RESPONSIBILITIES OF THE CUSTODIAN

The custodian is enmeshed in a rapidly changing occupation due to new materials, methods, and demands being forced upon him by a dynamic educational scene. The fact that larger sums of money are now being expended on school plant construction, and that these buildings are greater in size, value and complexity make it necessary for a corresponding improvement in the caliber of men serving as custodians. It is the purpose of this chapter to enumerate some general attributes and responsibilities, as well as some guidelines in selecting the "modern" custodian.

Custodians are responsible to the principal. Systems large enough to justify the establishment of adequate supervision from the central office over custodial services have an advantage in that such supervision will usually establish better methods and standards of work and check on adequate performance. In most systems, however, the principal, as head of the school, is directly responsible for the total operation and success of his

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institution. The custodian in these cases often becomes the principal's right hand man. This type of principal usually recognizes how important the custodial role is and appreciates the fact that a clean, well kept, and properly heated and ventilated building influences favorably the teaching and learning process. The custodian in return respects the wishes of the principal and carries out his suggestions and requests, and assists in every way possible to assure a clean and well-organized building.

The relationship should be friendly, courteous and obliging. Part of the custodian's responsibility is to serve teachers and pupils. He must also treat these people with courtesy and respect; with a sense of friendliness being maintained in a dignified, professional manner. From time to time, teachers and pupils will ask the custodian to do a special task in connection with their school work. The custodian should strive to assist them in a cheerful and pleasant manner without lamentation, and without attempting to excuse himself from such additional duties. Although a teacher or a principal may occasionally appear caustic, the custodian should attempt to overlook this. Teachers occasionally become nervous and irritable when working with 30

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active, peppy and sometimes mischievous children. At a time like this, a pleasant obliging attitude on the part of the custodian may help to cheer her up.

There will be times when a custodian must enter a classroom during recitation and study periods. He must do so quickly and quietly and perform whatever task necessary with as little disturbance as possible.

Since it is part of the custodian's job to serve teachers, there will be times when he must alter his routine and go out of his way to see that they are accommodated. For instance, if a teacher keeps pupils in after school for a special reason, the custodian should avoid going into the room at that time to do his routine cleaning. There may be other times when a teacher is working alone in her room after school and would not want to be disturbed. Even though his work is extremely important, in most cases it is up to the custodian to accommodate the teacher, rather than the teacher accommodate the custodian. As a general rule, however, the teacher will usually cooperate with the custodian and not interfere with the performance of his duties. Should a teacher try to monopolize a custodian's time, it is up to the principal, not the custodian, to tactfully correct the situation.

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Relationships with pupils should be friendly and pleasant but should not destroy the adult-child relationship. By being friendly and earning the respect of the pupils, the custodian will find them cooperating with him in his work. It must be remembered that it is the responsibility of the teacher to correct or give direction to pupils and not the custodian.

The custodian is a part of the public relations program. There will be many occasions when it is necessary for the school to be open after regular school hours for school or community events. An obliging, helpful and friendly attitude on the part of the custodian will do much to establish rapport between the school and community.

School Custodian. Normally, the custodian is entrusted with the community's largest single investment. But the responsibility doesn't stop with the care of the school building; it includes the safety, health, and comfort of all persons who utilize the building. A good custodian is not just a person who cleans the building; he is all of the above and more. A custodian who is fully meeting his responsibility is a man of many talents; but his importance is probably

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underestimated more by the custodian himself than by others. The good custodian must believe in himself and in the job he is doing. If he has a personality that attracts the respect and appreciation of his fellow workers and students, he will usually find they are more likely to cooperate with him in carrying out his duties.

CHARACTERISTICS OF A GOOD CUSTODIAN

1. A custodian believes in himself and in the importance of his job.
2. The custodian is dependable and punctual.
3. The custodian is loyal to his school and his fellow workers.
4. The custodian is fair, friendly, and impartial in his dealings with others.
5. The custodian is courteous and pleasant.
6. The custodian has few, if any, objectionable traits.
7. The custodian is a peaceful and loyal citizen in the community.
8. The custodian wears conservative work clothes which are neat and well kept. He also gives daily attention to his personal cleanliness and appearance.

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9. The custodian seeks new and better ways of doing his job, and when he finds them, he puts them into practice.

10. The custodian realizes that he sets an example for many children, and he strives to be worthy of their trust.

QUALIFICATIONS FOR CUSTODIANS

1. Character and Habits
2. Health
3. Intelligence
4. Age
5. Variety of Ability
6. Previous Experience
7. Appearance
8. Education (formal)
9. Pride (self-respect)
10. Marital Status
11. Citizenship
12. English Proficiency

Character and Habits. Good character traits are essential for a custodian. He must be the type of person with whom parents

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are willing to have their children associate. He should be dependable and always show courtesy. He should never use intoxicating liquors, drugs, or abusive language around students.

Health. A custodian should be given preference if he is vigorous, strong, alert, and healthy. There is a certain amount of carrying, lifting, and climbing that must be done in his duties. A previous health record can serve as a valuable guide. Good health is important. Most schools require an annual physical examination. The custodian must be free from contagious diseases and from any physical defect that would handicap him in his work. It should be pointed out, however, that many disabled people make excellent custodians.

Intelligence. A custodian must be able to think for himself. The demands of a modern school facility are tremendous.

Age. The minimum age limits normally preferred by those who employ custodians range from 21 to 25, and the maximum age limits from 45 to 50. While these are age

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Impedance of an RL Circuit (Series)

$$Z = \sqrt{R^2 + (X_L)^2}$$

Impedance with R, C, and L in Series

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Parallel Circuit Impedance

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

Sine-Wave Voltage Relationships

Average value

$$E_{ave} = \frac{2}{\pi} \times E_{max} = 0.637E_{max}$$

Effective or r.m.s. value

$$E_{eff} = \frac{E_{max}}{\sqrt{2}} = \frac{E_{max}}{1.414} = 0.707E_{max}$$
$$= 1.11E_{ave}$$

Maximum value

$$E_{max} = \sqrt{2}\,(E_{eff}) = 1.414E_{eff}$$
$$= 1.57E_{ave}$$

Voltage in an a-c circuit

$$E = IZ = \frac{P}{I \times P.F.}$$

Current in an a-c circuit

$$I = \frac{E}{Z} = \frac{P}{E \times P.F.}$$

Power in A-C Circuit

Apparent power: $P = EI$

True power: $P = EI \cos\theta = EI \times P.F.$

Power Factor

$$P.F. = \frac{P}{EI} = \cos\theta$$

$$\cos\theta = \frac{\text{true power}}{\text{apparent power}}$$

Transformers

Voltage relationship

$$\frac{E_p}{E_s} = \frac{N_p}{N_s} \text{ or } E_s = E_p \times \frac{N_s}{N_p}$$

Current relationship

$$\frac{I_p}{I_s} = \frac{N_s}{N_p}$$

Induced voltage

$$E_{eff} = 4.44 \times BAfN \times 10^{-8}$$

Turns ratio

$$\frac{N_p}{N_s} = \sqrt{\frac{Z_p}{Z_s}}$$

Secondary current

$$I_s = I_p \times \frac{N_p}{N_s}$$

Secondary voltage

$$E_s = E_p \times \frac{N_s}{N_p}$$

Three-Phase Voltage and Current Relationships

With wye connected windings

$$E_{line} = \sqrt{3}(E_{coil}) = 1.732E_{coil}$$

$$I_{line} = I_{coil}$$

With delta connected windings

$$E_{line} = E_{coil}$$

$$I_{line} = 1.732I_{coil}$$

limits desired for new men, it should not have any influence on those already in positions because some of our most reliable custodians do not fall within these age limits.

Variety of Abilities. Because of the varied nature of a custodian's work, he must be able to do a multitude of things, and, hence, he must possess a diversity of skills. He should have some mechanical ability; he should be able to make minor plumbing repairs; he must have a knowledge of electrical work which will enable him to avoid such errors as overfusing; and often, he may be called upon to be a painter.

Previous Experience. Preference is usually given to a custodian who has had previous experience, other things being equal. Experience in a field related to custodial work is valuable if there has been no actual experience as a custodian.

Appearance. A custodian should be neat in his dress and personal appearance. When this is true he will usually take greater pride in his job. A distinctive uniform, consisting of shirt, trousers and tie will tend to enhance the importance of the position. Visitors and teachers will react more favorably

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toward the custodian and the school in general if he presents a neat appearance.

Education. It is desirable that a custodian have as much formal education as possible. Many schools give preference to those having at least an eighth grade education. If one has gone through high school he can better appreciate the problems of education and will probably be more cooperative toward the educational program.

Pride. Pride in one's personal appearance and job should be characteristic of a good custodian.

Married Status. In most cases, school personnel prefer a custodian who is married because they feel he is more reliable and more sympathetic to children.

Citizenship. He should be a citizen of the United States and an active resident of the community in which he is custodian. A local resident, as a rule, will take greater interest and pride in his work.

English Requirements. Because custodians have to read extensive directions and other written materials, he must be

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able to comprehend the English language. He must keep records and furnish reports; therefore, he must be able to read and write proficiently.

SAFETY AND HEALTH

The safety and health of the teachers, pupils, and personnel. Although this responsibility belongs to the administration, the necessary sanitation and care of the building falls within the job description of the custodian. He must keep close scrutiny over the optimum control of temperature and ventilation, as well as all factors of safety.

GENERAL SAFETY RULES

Know your fire extinguishers. The directions on every type of fire extinguisher in the building must be read, and now is always the best time to do it. It can potentially save the lives of many pupils. Know which extinguisher to use on various kinds of fires, especially electrical fires. People are often electrocuted by using the wrong extinguisher on an electrical fire. Extinguishers must be checked (recharged as needed) and tagged each year.

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Exit doors. Keep doors free of chains, locks, and other obstructions while students or visitors are in the building. Passageways must also be kept free of obstructions.

Heating and electrical equipment. Keep electrical and heating equipment in optimal working condition. The custodian can make many minor repairs himself but for those he cannot, he should promptly make a written request for maintenance assistance. (It is helpful to keep a carbon copy of such requests.)

Trash and debris. Dispose of trash and debris daily by burning it in an incinerator or by daily collection.

Catch-all. Don't let any area of the school become a catch-all for items of little or no value. Dispose of them.

Flammable liquids. Liquids such as gasoline, mineral spirits, lacquer thinner, paint thinner, turpentine, kerosene, and alcohol should not be stored in the school if it can be avoided. If it is absolutely necessary, they must be kept in safety cans stored in locked or ventilated storerooms, or in locked metal cabinets.

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Oily rags and dirty mop heads. Oily rags and dirty mop heads should be laundered regularly, or burned if they have no value. Oily rags and dirty mops to be laundered should be kept in air-tight metal cans.

SCHEDULE

In order to be functional any schedule must be flexible enough to allow for emergencies. A pre-arranged schedule is often disrupted by special programs or events, particularly around the holidays. Rainy weather, sickness, breakage of glass or equipment, vandalism to school property, special visits by the nurse, doctor, dentist and others often create special cleaning problems that must be given special attention and fitted into a functional schedule.

EPILOGUE

As one can readily see, the roles and responsibilities demanded of the modern-day custodian are many and varied. It is indeed false economy for any school administration to build a multimillion dollar building, and then expect to keep

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it functioning at an optimal level with cheap or minimal tools and equipment. It is equally false economy to believe that a school administration can hire a highly dependable custodian for minimum wages. Any discerning person, even with a minimum number of college courses in business and finance, can readily see the necessity for purchasing both qualitative and quantitative tools and materials for a well-paid custodial staff.

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CHAPTER II

GENERAL CLEANING

The old adage that an ounce of prevention is worth a pound of cure is the very essence of general cleaning. General cleaning brings the custodian into regular contact with practically every segment of the school plant and enables him to be fully aware of the conditions and needs of the entire building. Few, if any, custodians are truly effective unless they are systematic in their approach toward the total cleaning program. A Custodial Master Cleaning Schedule, which includes not only every cleaning task to be performed, but when it is to be performed, is not an easy task to develop. It usually requires deliberate study in a joint effort on the part of the custodian and school principal, and includes many trial-and-error approaches before it becomes totally satisfactory. The custodian must thoroughly understand the schedule and have a working knowledge of all the tools and materials necessary in carrying out the cleaning program.

Once the custodian has developed a reliable and workable cleaning schedule, which includes every cleaning task to be performed and when, he must then make sure that the schedule is

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adhered to at all times, and that the tools and materials necessary to do the job efficiently are kept in sound working condition. If the custodian is determined to see that these two things are well in hand, he is on his way to doing his job in an orderly and effective manner.

One of the most helpful aids to any well organized custodian is a custodian cart. These carts are relatively inexpensive, and in many cases are home made. Their use is invaluable in assisting the custodian in his daily cleaning chores. Carts may be used to store and to carry all the tools and materials that are normally required for daily cleaning. The custodian should make sure that the cart is properly equipped with everything that he will need in order to complete his daily cleaning tasks. This will keep him from having to return to the supply room for additional materials or supplies once he has started his regular cleaning duties.

General cleaning is a broad term that includes both immediate and long range cleaning tasks. Most cleaning tasks such as classroom cleaning are normally done each working day. However, some tasks are performed weekly, monthly, semi-annually, or annually. An important thing to remember is that no matter

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when or how often a cleaning task is performed, it should be placed on the Master Cleaning Schedule in order to insure proper attention and care. Cleaning tasks which are performed daily are commonly referred to as Daily Cleaning Operations, while the other tasks are called Other Cleaning Operations.

This chapter is divided into three general areas. The first deals with tools, equipment, and materials which are essential to good custodial care. The second recommends a time schedule for certain cleaning tasks and the order in which the tasks should be performed. The third section describes some of the better methods used by effective custodial staffs, and concludes with recommended precautions concerning the storage and handling of tools, equipment, and cleaning materials.

Although it is generally recognized that custodians have their own special way of doing certain cleaning tasks, it is hoped that they give serious consideration to the methods outlined in this chapter on cleaning. The suggestions and guides presented have been tried and proven by many knowledgeable custodial staffs across the country and should be of considerable assistance.

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The difference between being an average custodial staff or a superior one is often determined by whether or not a staff is open to new ideas and suggestions. This choice is yours!

TOOLS, EQUIPMENT AND MATERIALS

As indicated previously a custodial staff can be only as effective as the tools and materials that it has to work with. This is one of the major shortcomings in custodial services today. Millions of dollars are spent to construct a school building but frequently only a few hundred dollars are allotted for the tools and equipment to operate and maintain it. The custodial staff that has adequate materials and supplies is indeed fortunate.

The kinds of tools, equipment and materials which are necessary in maintaining a clean, functional school building are broken into two general categories. One is concerned with the necessary equipment and materials to carry out the day-by-day tasks and the other concentrated on the non-daily cleaning operations.

Daily cleaning operations frequently necessitate some kind of custodial cart which will hold the necessary cleaning

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With wye or delta connected winding

$$P_{coil} = E_{coil} I_{coil}$$

$$P_t = 3P_{coil}$$

$$P_t = 1.732 E_{line} I_{line}$$

(To convert to true power multiply by $\cos \theta$)

Resonance

At resonance

$$X_L = X_C$$

Resonant frequency

$$F_o = \frac{1}{2\pi\sqrt{LC}}$$

Series resonance

$$Z \text{ (at any frequency)} = R + j(X_L - X_C)$$

$$Z \text{ (at resonance)} = R$$

Parallel resonance

$$Z_{max} \text{ (at resonance)} = \frac{X_L X_C}{R} = \frac{X_L^2}{R}$$

$$= QX_L = \frac{L}{CR}$$

Band width

$$\Delta = \frac{F_o}{Q} = \frac{R}{2\pi L}$$

Tube Characteristics

Amplification factor

$$\mu = \frac{\Delta e_p}{\Delta e_g} \text{ (i_p constant)}$$

$$\mu = g_m r_p$$

A-c plate resistance

$$r_p = \frac{\Delta e_p}{\Delta i_p} \text{ (e_g constant)}$$

Grid-plate transconductance

$$g_m = \frac{\Delta i_p}{\Delta e_g} \text{ (e_p constant)}$$

Decibels

NOTE: Wherever the expression "log" appears without a subscript specifying the base, the logarithmic base is understood to be 10.

Power ratio

$$db = 10 \log \frac{P_2}{P_1}$$

Current and voltage ratio

$$db = 20 \log \frac{I_2 \sqrt{R_2}}{I_1 \sqrt{R_1}}$$

$$db = 20 \log \frac{E_2 \sqrt{R_1}}{E_1 \sqrt{R_2}}$$

NOTE: When R_1 and R_2 are equal they may be omitted from the formula. When reference level is one milliwatt

$$dbm = 10 \log \frac{P}{0.001} \text{ (when P is in watts)}$$

Synchronous Speed of Motor

$$r.p.m. = \frac{120 \times \text{frequency}}{\text{number of poles}}$$

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materials. These materials include, among other things, a portable vacuum cleaner that can be used for general dusting and vacuuming, a waste container lined with a disposable plastic liner, and a clip board with an attached maintenance memo pad. The following items also should be placed on the cart before the custodian starts on his regular classroom and general cleaning tour: treated dust mop with a 16" to 18" head on a swivel, a wet mop weighing about 20 ounces with a 60" handle, a 30" to 36" floor broom for the corridor, a 16" to 18" floor broom for classrooms (the corridor and classroom broom are often referred to as floor brushes and are pretreated before using them), dust pan, sponges, absorbent cloths, pretreated dust cloths, chamois cloths for chalkboard and windows, counter brushes, chalk and erasers (for exchanges), waste cans (for exchanges), buckets or pails for the cleaning solution and rinse water, and a general purpose detergent and a neutral cleaner in plastic spray bottles. The custodian cart should also have a small tool chest used for preventive maintenance and include such things as: chair glides, lubricant, pencil sharpener cutter replacements, putty knife, pliers, hammer, screwdrivers (regular and phillips head), wrench

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(adjustable), and a small amount of sandpaper, nails, and screws. The custodian should also make sure that he has the following equipment and materials for his non-daily cleaning operations: drop cloths, variety of mops and brooms, squeegee, ladders, mop wringers, extension cords, heavy duty cleaning solutions, neutral cleaning solutions for window cleaning, window covers, and other necessary materials.

It would be difficult to list all the tools, equipment, and materials that is required for any given custodial staff. The important thing is to make a comprehensive survey of the school cleaning problems and acquire those materials and supplies which will enable the custodian to do a superior job.

GENERAL CLEANING TASKS: ORDER AND SCHEDULE

This section outlines most of the cleaning tasks normally classified under General Cleaning. Recommendations are made describing the order in which these tasks should be performed.

DAILY CLEANING OPERATIONS

These include all cleaning chores which are normally performed each school day.

Classroom Cleaning. Classroom cleaning normally should

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never take place while class is in session. Most classrooms should be cleaned before or after school. In some instances, if classrooms are vacated near the end of the school day, they can be cleaned separately. However, classroom cleaning normally should be a total and distinct operation and nothing should interfere with the orderly process from the cleaning of the first classroom through the cleaning of the last one.

When cleaning classrooms, the custodian should park the custodian cart (which should be fully equipped for the total classroom cleaning task) outside the classroom door. Upon entering the individual classroom he should do the following: empty pencil sharpener shavings and wipe off cover and handle; look around the room and pick up large pieces of scrap paper and trash and empty these along with the waste basket contents into the waste container on the custodian cart, and then clean the waste basket if necessary. Next, the custodian should erase the chalkboard thoroughly and dry clean it. He should then clean or exchange the erasers and replenish the chalk supply, after having dusted or vacuumed the chalkboard tray and surrounding area. The custodian should then dust the entire room, including window areas, and furniture and equipment in the most

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time saving manner. When a vacuum cleaner is available, these areas should be vacuumed rather than dusted. Following the dusting the custodian should then do any necessary spot cleaning; such as removing soiled spots from the walls or furniture, or cleaning the sinks and other areas. He should then give attention to any minor preventative maintenance task, and write down any needed major tasks on his memo pad so that he can take care of them later. The custodian should then dust mop or vacuum the entire classroom, working toward the door. He should then empty the debris into the waste container located on the custodian cart. Following this he should straighten the furniture and equipment, adjust the window covers (while locking the windows), check the thermostat and adjust it if necessary, turn off the lights and lock up the room. The same procedures should be carried out in every classroom.

Other Areas. The library, gymnasium, cafeteria, work rooms, lounge, offices, and generally all other Daily Cleaning Areas follow the same procedures as outlined above. The trash or debris that is swept into the corridor is normally left as the last area to be swept and cleaned.

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Corridors. The walls, fire extinguishers and lockers should be vacuumed or dusted from top to bottom. Soil spots and other tasks such as water fountains should be cleaned, checked, and the faucets adjusted. The corridors should then be vacuumed or swept with a treated dust mop.

OTHER CLEANING OPERATIONS

The cleaning tasks described in this section do not normally require daily attention. Regardless of how often they are cleaned, they must be entered on the Master Cleaning Schedule in order to insure that they are systematically checked and attended to. Local conditions, such as the amount of dust, rain, vandalism, and quality of the physical plant have an import on these cleaning operations. The frequency of cleaning recommended in this section refers to average conditions and should not be construed as being absolute.

Chalkboards. Chalkboards should be thoroughly erased everyday. About once each week the chalkboard should be thoroughly dry cleaned. Wet cleaning (washing the chalkboard) should be avoided where possible and should never be wet cleaned over once a year as wet cleaning is harmful to the writing surface.

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Window Covers. Window shades and venetian blinds are the two most widely used window covers in school buildings. They both require dusting on an average of once a week, but may require a more thorough cleaning about twice a year. This is normally done during the Christmas holidays and during the summer months.

Windows. Windows normally require cleaning about as often as window covers and both should be cleaned at the same time. Because of rain, wind and snow, outside windows usually do not require a thorough cleaning more than once a year, but they should be cleaned as often as necessary. Thorough cleaning of windows should always be done each summer.

Light Fixtures. Light fixtures which are dirty are not only distasteful to the eye but greatly affect the learning environment of children by cutting down on the intensity of the light. They should be vacuumed or dusted several times a year and thoroughly cleaned twice a year. This cleaning task is usually tied in with the cleaning of windows and window shades and is normally done during the Christmas holidays and summer months.

Furniture and Equipment. Furniture and equipment should be vacuumed or dusted daily. During the summer months they

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should be moved into the corridor and checked over carefully for needed repairs and given a thorough cleaning.

Walls and Ceilings. Both of these areas should be vacuumed or dusted thoroughly at least once a month. Under normal conditions they are not cleaned more than once a year, usually during the summer months when the furniture and equipment have been moved to the corridor for cleaning.

PROCEDURES FOR INDIVIDUAL CLEANING TASKS

This section considers each individual cleaning task separately under General Cleaning, and discusses the procedures, tools, equipment, and materials necessary in accomplishing the task.

Pencil Sharpener. Each day the pencil sharpener should be wiped clean with a cloth or sponge dampened with a neutral cleaner. Occasionally, it may be necessary to squirt a drop of machine oil on the moving parts, replace the cutters, or install a completely new pencil sharpener.

Waste Basket. After emptying the waste basket it should be checked and cleaned (inside and outside) with a neutral cleanser. Old or unserviceable waste baskets should be replaced.

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as necessary without waiting for special requests.

Chalkboards, Chalk, and Erasers. The daily cleaning requirement for most chalkboards is normally satisfied by thoroughly erasing with a clean, dry eraser. About once a week however, many chalkboards, especially where teachers use them extensively (such as in math classes), require a more thorough cleaning. The dry cleaning method usually does an effective job. This involves erasing the board thoroughly with a good clean eraser, and then going over the chalkboard again with a dry chamois or similar cloth. In both of these cleaning methods the chalkboard will continue to appear chalky looking; this is as it should be. The third and final method, short of replacing the chalkboard with a new one, is referred to as the wet method. Generally, it is a good rule to apply the wet method only to slate chalkboards, and then only as the need demands it. Slate is a natural stone which has been quarried, ground, and polished into sheets of about one-half inch thickness. When the chalkboard fails to reflect or accept the writing of the chalk after being dry cleaned, it may be necessary to use the wet method. After the chalkboard has been erased and chamoised thoroughly,

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take an abrasive cloth and dampen it with clear warm water only and wash the chalkboard. After the board has dried thoroughly, completely chalk the entire board, just as would be done in breaking in a new board, and then erase the chalking. Rechalk the board a second time, from top to bottom and then from side to side, and then again erase thoroughly. The board should now be ready for use. Should some stubborn spots (ghosts) still remain, use a chemical such as pumice on a damp rag and attempt to remove the spots. If the color of the chalkboard appears on the cleaning rag then it is time to stop, as considerable damage may occur.

One of the best methods of keeping a chalkboard in good condition is to use the right kind of chalk. The best kind is usually white chalk made of limestone, composed of 95-97 per cent whiting, and only 3-5 per cent glueing or binding.

Erasers are equally important as chalk. A good felt eraser attached to a durable back is the most popular one on the market and is quite satisfactory. Another popular eraser is the rubber-leather combination which cleans with the aid of static electricity by attracting the chalk dust.

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Dusting. One of the most effective and best all around dusters on the market today is the portable vacuum cleaner. It can be used for practically every dusting task. It is lightweight, relatively inexpensive, and does an extremely thorough job when used with proper attachments. It can be used to clean erasers, vacuum chalkboard trays, walls, windows, window covers, furniture and equipment. A second but less effective dusting technique is to pretreat an abrasive cloth with a good neutral cleaning solution. The abrasiveness of the cloth tends to cut and hold the dust, while the cleaning solution serves to free stubborn dust or dirt loose from the surface. There are various kinds of dusters on the market today: glove type which can be worn over the hand securely, the back-pack portable vacuum cleaner which weighs less than ten pounds, and the mop duster which is used primarily to pick up dust from the floor.

Soiled Areas and Special Areas. Any area within the General Cleaning domain which requires special attention beyond dusting, such as soiled spots on walls or furniture, water fountains, sinks and other equipment are best cleaned by using an abrasive cloth or sponge and a neutral cleaning solution.

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Comparison of Units in Electric and Magnetic Circuits

	Electric circuit	Magnetic circuit
Force.	Volt, E, or e.m.f.	Gilberts, F, or m.m.f.
Flow	Ampere, I	Flux, Φ, in maxwells
Opposition.	Ohms, R	Reluctance, $\mathcal{R}$
Law.	Ohm's law, $I = \frac{E}{R}$	Rowland's law, $\Phi = \frac{F}{\mathcal{R}}$
Intensity of force	Volts per cm. of length.	$H = \frac{1.257IN}{L}$, gilberts per centimeter of length.
Density.	Current density—for example, amperes per cm^2.	Flux density—for example, lines per $cm.^2$, or gausses.

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After these areas have been cleaned they should be wiped dry with another clean cloth or sponge.

Window Covers. Venetian blinds are dusted best by turning the slats all one way and then vacuuming or dusting that side and then the other. Washable covers and venetian blinds are best cleaned with a sponge and neutral cleaning solution by removing the window covers from the walls and placing them on a clean flat surface. If the slat tapes are of non-shrinkable material, the entire blind can be cleaned thoroughly by placing it in a tank of water mixed with a neutral cleaning solution, and then removing it and placing it into another tank of clear rinsing water. Blinds should be allowed to dry thoroughly before rehanging.

Light Fixtures. Light fixtures can be effectively dusted with either a portable vacuum cleaner or a pretreated dust cloth. A more thorough cleaning job is accomplished by removing the light fixture covers and placing them in a tank of water mixed with a neutral cleaning solution, and then transferring them into another tank of clear warm rinse water. A sponge or abrasive cloth will serve to cut the dirt and a chamois or absorbant cloth should be used to dry the cover

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before replacement. The apparatus around the lights can also be wiped with a damp sponge or cloth that has been treated with a neutral cleaning solution. The cleaning of light fixtures is normally a two man operation. While one man is removing the covers and cleaning the lighting apparatus, the other man is on the floor cleaning the covers and rinsing them. This is also an ideal time to replace old bulbs.

Windows. The most widely used tools and materials in window cleaning are warm water, sponge, squeegee, and a good chamois. Occasionally, it may be necessary to add alcohol or ammonia to the water if the windows are extremely dirty. A good sponge can work on any part of the window area without damaging it and can get to difficult areas. The squeegee is an effective tool for removing the water from the window, but a good chamois can thoroughly dry and polish at the same time. However, the polishing of windows takes excessive time which could be better used to clean additional windows. Precautions should be taken to make sure drop cloths are placed at the base of the windows to catch excess water or drippings. Extension rods should be used to reach difficult outside windows.

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Furniture and Equipment. All furniture and equipment should be moved to the corridor (or similar area) for a thorough cleaning. This allows another cleaning crew to move inside the classroom and clean the windows, window covers, light fixtures, and ceiling and walls while the furniture and equipment are being cleaned. One important aspect of annual furniture cleaning is the maintenance task that can be performed at the same time. Gliders can be removed and replaced, new bolts or screws can be inserted, and rough places can be sanded and smoothed. Gum and other foreign materials should be removed from the underside of the furniture and equipment while the cleaning is taking place. A good sponge or abrasive cloth and a neutral cleaner are effective materials in cleaning furniture and equipment. Two buckets are required; one for the cleaning solution and the other for warm rinse water.

The furniture and equipment should be wiped dry after cleaning.

Wall and Ceiling Cleaning. Periodic dusting or vacuuming will help maintain the proper appearance of these two areas. Many walls and ceilings are not washable and

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special precaution should be taken to ascertain the type of material and paint used on these areas. Spots normally can be removed from acoustical ceilings with art gum or wall paper cleaner. Extremely soiled walls and ceilings are often less expensive to paint than to clean, and this cost factor should be highly considered. When washing these two areas a neutral cleaning solution will usually do the job, and can be applied either with a sponge or abrasive cloth. In some cases a brush might be necessary. Drop cloths should be placed around the work area, and the walls should be cleaned from the bottom up, and the ceilings from the corners inward. Areas three-to-four square feet should be cleaned at a time; and they should be rinsed off and dried before moving to the next three-to-four square foot area. Special precaution should be taken to see that there is no overlapping of areas at the borders, as this tends to highlight the overlapped areas. Special attention should also be given to drippings and streaks. Both should be removed immediately before they dry, as they too tend to show up after the wall has dried.

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Cleaning Solutions. A neutral cleaning solution will generally accomplish most cleaning tasks around the school without too much difficulty. Custodians should be fully aware of the chemical make-up of all the cleaning detergents and solutions which they use. Most of the neutral solutions have an ammonia, alcohol, tri-polyphosphate, or similar base. Chemical solutions with an unknown base should be avoided. When a custodian mixes his own cleaning detergent or solution he must follow the exact directions of the manufacturer.

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SUGGESTED TIME SCHEDULE

Task	Daily	Weekly	Semi-Weekly	Annually
Pencil Sharpener	x			
Waste Basket	x			
Chalkboard:				
Erased	x			
Dry Cleaned		x		
Wet Cleaned				x
Dusting or Vacuuming:				
Chalkboard Tray	x			
Walls (reachable)	x			
Window Area	x			
Furniture and Equipment	x			
Spot Cleaning:				
Soiled Spots	x			
Sinks	x			
Water Fountains	x			
Floors (mop dusted)	x			
Window Covers			x	
Windows			x	
Light Fixtures			x	
Furniture and Equipment				x
Walls & Ceilings				x

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STORAGE OF CUSTODIAL EQUIPMENT AND MATERIALS

A custodial storage room that is well organized and large enough to store all the materials, tools, and equipment is highly recommended. A large pegboard and plenty of shelf space are necessary. A running inventory of all materials, tools and equipment should be kept in an accessible place.

Shelf space adequate for the storage and rotation of paper goods, cleansers, small equipment and other supplies should be provided. Racks for brooms, mops and brushes are also needed. This aforementioned rotation should be done by marking the date each new shipment arrives and placing it behind existing materials and supplies, in order that the older materials are used first to avoid ageing and spoilage. The following recommends appropriate procedures for the storage and maintenance of tools and equipment:

Brushes (Floor). These brushes should have the head turned frequently to eliminate deforming. Hang the brushes with the bristle down. This will allow a wet brush to drip dry properly.

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Buckets. Each bucket should be marked or identified as to purpose, such as scrubbing, rinsing, or waxing, and should not be interchanged. Buckets should be rinsed and wiped dry after use to prevent rust and corrosion.

Carts. All custodian carts should be stored in a place that will not interfere with foot traffic or create a safety hazard.

Chamois (Chalkboard). These should be shaken out well after use, and stored in a place free from oil, grease, water, wax and other foreign materials.

Chamois (Window). These should be washed, rinsed and allowed to dry on a rack provided for this purpose, and not dried in the sun or next to a heating unit.

Cleaning Materials. All cleaning materials, other than flammable liquids, should be stored on shelves and clearly marked as to content.

Corn Brooms. Should be hung on suitable hangers with the bristle down but not touching the floor. Wet the bristles of a new broom prior to the first usage. When using the broom turn frequently to eliminate deforming.

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Counter Brushes. These brushes should be hung on hooks to allow them to retain their shape.

Dust Cloths. These should receive the same treatment as dust mops, and stored where they will not come in contact with other materials.

Ladders. Ladders should be kept in good repair and in a room away from the reach of children. Long ladders should be hung on pegs attached to the wall.

Liquids (Flammable). Alcohol, gasoline, paints, thinners, kerosene, and similar flammable materials which are kept in the school building should be stored in a metal fire proof cabinet. Where possible, these items should not be kept in the school building.

Mops (Dust). These mops should be treated with a non-oily treatment and stored in an air tight metal container for a 24-hour period prior to usage. Shake and fluff mops after using and place on hanger. Never clean mops by striking against a wall or other hard object. The mop heads should be changed, laundered and retreated once a week or as necessary.

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Mops (Wet). Each mop should have a hanger marked for its specific purpose, such as scrub, rinse, or wax. Each mop should then be rinsed, combed and fluffed before storing. These mops can be hung with the head either up or down but always hung, and never touching the floor.

Mop Wringers. Mop wringers should be rinsed and cleaned, and the strings and debris removed after each usage. They should then be placed on the mop buckets to dry.

Rags (Oily). These rags should be stored in an air tight metal container. When no longer serviceable, they should be destroyed by burning.

Rags (Wet). Wet rags should be rinsed and spread on a rack to dry in a well ventilated area. Do not hang over equipment.

Sponges. Sponges should be rinsed daily and placed on a rack to dry.

Squeegees. Wipe squeegees clean and hang so that the rubber blade will not touch other materials.

Vacuums. Vacuums should be kept in a storage room with the hose and other attachments on a pegboard or a storage board.

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CHAPTER III

RESTROOMS AND RELATED FACILITIES

No single area of the school plant reveals the quality of the custodial program more readily than does the restroom and shower area. The remainder of the school plant may demonstrate excellent custodial service, however, if the restrooms and showers are soiled and odorous, the total program may be severely critized. The general efficiency of the custodial staff is often judged by the maintenance of these areas.

Public health, public relations and professional pride demand that the restroom maintenance be of acceptable quality. The excellence of this service has educational implications for habits and attitudes of the pupils. It may be of a positive or negative influence on student behavior and thus offers an educational challenge to the custodial program of the school. Pupils tend to respect a clean orderly restroom, but have little regard for one that is soiled and untidy.

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PROBLEMS OF RESTROOM SANITATION

The greatest problems in maintaining restroom and shower sanitation are bad odors, poor lighting, and improper temperature.

Poor Ventilation. Bad odors are of two types: (1) the temporary odors that result from the process of removing waste materials from the body, and (2) permanent, lingering odors arising from unclean fixtures, urinal traps, urine stained floors, stained partitions and decayed organic compounds. The first type of temporary odor generally is quickly removed by an adequate exchange of fresh air, or ventilation. The serious type of odor, the permanent lingering type, is the result of unclean conditions, improper building materials, and improper care of the urinals and commodes. Four particular sources of bad odors are noted: (1) soiled toilet seats and stools, (2) soiled urinals and traps, (3) soiled and stained floors (especially concrete and terrazzo floors), and (4) soiled wainscot and certain partition materials.

Bad odor constitutes one of the main problems of restrooms and shower room sanitation. The two ways to

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eliminate this problem are (1) proper ventilation to remove polluted air, and (2) good cleanliness to remove the source of the odor.

The use of deodorants has been highly questioned. The purpose of a deodorant is to neutralize or offset the disagreeable effects of a bad odor. It is not, however, a disinfectant but merely substitutes one odor for another. In most cases, deodorant blocks or sprays are merely used to cover up a dirty restroom or shower room. Since clean restrooms and showers do not smell, deodorants (perfumes) are not needed or recommended.

Special attention should be paid to the ventilation of the shower room and adjoining dressing rooms. Lockers should be designed and located for maximum ventilation.

Poor Lighting. Poor lighting has been noted as another problem in restroom and shower area sanitation. Where there is poor illumination, the occupants tend to take less care of the facilities. Consequently, light bulbs should be cleaned or replaced when necessary. When painting, light colors should

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be chosen since light hues reflect more light. Epoxy paint in high use areas, such as restrooms, offers more protection and ease of maintenance than latex or enamel type paint.

Improper Temperature. Under certain temperature and air movement conditions, there is little exhaust action even when the windows are open. For example, on cold days the warm air within a building may tend to rise through open stairwells and create a suction action that will cause the outside air to be drawn in through the open toilet room window, driving the toilet room odors into the building corridors. If a custodian must depend on window ventilation, he should study the various conditions that will influence the ventilation and make proper adjustments.

Restroom odors become more noticeable as the temperature within the room rises. Consequently, the temperature should be maintained at an optimal level. While the noted desirable temperature for classroom areas is 70 to 75° Fahrenheit there is no reason why restroom temperatures should be that high. Children are not expected to remain in these rooms for any extended period, and loitering

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should be discouraged. A temperature of 67° Fahrenheit is not unhealthful for the limited time children must remain there and the odor conditions are vastly improved.

The temperature for the shower room and dressing rooms should be maintained at 70° to 75° Fahrenheit; keeping in mind that the heat from the showers will raise the temperature in the immediate shower area.

TOOLS, EQUIPMENT, MATERIALS AND SUPPLIES

Tools and Equipment	Number Needed
Buckets (10 quart size)	2
Sponge (cellulous)	1
Rags (clean)	2
Pot Brush	1
Putty Knife	1
Mirror (small handle type)	1
Rubber gloves (pair)	1
Plunger or plumber's friend	1
Floor Bucket (32 quart size)	2
Wringer to fit bucket	1

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Tools and Equipment Continued:	Number Needed
Wet Mop	1
Dust Pan	1
Radiator Brush	1
Squeegee	1
Hose	1
Toilet Brush (curved handle)	1

Materials (Chemical)

Neutral Cleaning Agent/Solution

Acid Bowl Cleaner

Supplies for Replacement

Towels

Toilet Paper

Hand Soap

Sanitary Napkins

Light Bulbs

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PROCEDURES

RESTROOM CLEANING

Remove waste daily. Collect all loose debris and trash. Empty waste cans.

Check and refill dispensers. Towels, toilet paper, hand soap, sanitary napkins.

Sweep floor. Remove loose material and gum from floor.

Dust. Include all ledges, toilet partitions, and surfaces requiring dusting.

Clean fixtures and wash basin. First wet down the basin. Using the pot brush, and neutral cleaner solution, clean the basin inside, outside, and underneath. Be sure to wash surrounding wall area and piping under basin. Do not use an abrasive cleaner or acid cleaner on sinks. Rinse solution from basin. Wipe basin with a wet sponge of clear water. Wipe chrome with a paper towel. Inspect for maintenance needs as it is being washed.

Cleaning mirrors. Mirrors in the restroom should be cleaned with clear water and a clean cloth. After washing, the glass should be wiped dry with a chamois or paper

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towel, wiping vertically from top to bottom of mirror.

Cleaning urinals. The urinals and all adjacent areas should be cleaned at least once a day. Flush urinal and check water inlets and traps. Using a paper towel or pair of gloves, remove waste found in urinal. Using a neutral cleaner solution and a pot brush, wash outer surface of urinal and adjacent wall areas. Wash the urinal, including metal plumbing. Be sure to wash thoroughly the hidden under surfaces of the rim. Use the hand mirror to check cleanliness of hidden surfaces. Flush urinal and rinse the exterior with the sponge. Wipe the chrome with a dry rag or paper towel to polish.

Traps. Weekly, check and clean the urinal and floor traps. One cup of detergent solution may be left in traps overnight on occasion to combat odor and soil buildup in the trap.

Toilet cleaning. Flush the toilet and look for stoppage, clogging, and foreign objects. Use the plunger if needed. Force as much of the water over the trap as possible. Use the bowl brush and a rapid downward pumping action.

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A "plumber's friend" can be used to reduce the diluting of the cleaner, which will be added next. Proceed to each stool, repeating the same procedures. Return to the first stool. Using the small hand mirror, check the groove of the stool which is hidden from sight. If it shows a dark soiled stain or ring, use an acid bowl cleaner on the johnny mop or curved toilet brush and clean thoroughly. This is one source of permanent lingering odor. Don't allow the acid cleaner to splash on the exterior; if this occurs, wash it immediately with water. Flush toilet; while flushing, wash the acid cleaner from the underside of the rim. Rinse the bowl brush while flushing. Inspect under the rim or groove with a small hand mirror for cleanliness. Repeat the acid cleaner if soil is found. Wash the seat, hinge fittings, and exterior of the commode with neutral cleaner and pot brush. Wipe the areas with clean water and sponge. Wipe the chrome parts with a paper towel or dry rag for a polished effect.

Spot Cleaning. Remove finger prints, stains, and other markings from toilet partitions, doors, frames and walls

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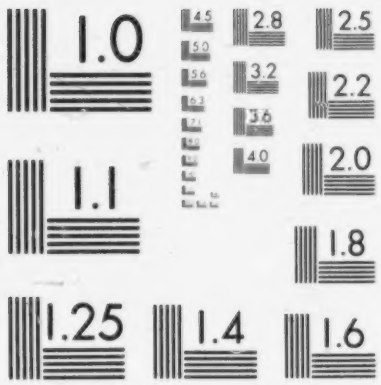

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with the neutral detergent solution and wipe with clear water and sponge.

Maintenance check. Check all light fixtures and other mechanical equipment, such as ventilation, for cleanliness and proper working order.

Floors. Using the materials, equipment and procedures described in Chapter IV on floors, clean the floors daily.

SHOWER ROOM CLEANING

Inspection. Check and refill hand soap.

Dust. Include all ledges and horizontal surfaces in adjacent areas.

Clean fixtures. Include shower heads, soap dishes and adjacent wall and floor areas, using a neutral cleaning solution and pot brush. Rinse all ceramic tile in the shower area including walls, and ceilings, with warm water and hose. Wipe the fixtures with a dry cloth or paper towel.

Clean floors. See Chapter IV.

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CLEANING OF RESTROOMS

The recommended time for cleaning the restrooms is the late afternoon when most of the building occupants have left the school. Shower rooms should be cleaned after the last use of the showers in the afternoon.

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SUGGESTED TIME SCHEDULE

Task	Daily	Weekly
Restrooms		
Dust	x	
Clean basins	x	
Clean urinals	x	
Clean toilets	x	
Clean floors	x	
Replace supplies	x	
Perform needed maintenance	x	
Spot clean walls and toilet partitions	x	
Check urinal trap		x
Check floor trap		x
Wash walls		x
Shower Room		
Clean shower heads and fixtures	x	
Clean walls	x	
Clean floors	x	
Dust	x	
Sweep appropriate areas	x	

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PRECAUTIONS

Special attention should be given to toilet facilities cleanliness because of the germ spreading factor found in unclean restrooms and shower rooms. Custodians should be careful to wash their hands after cleaning these areas before continuing cleaning operations in other parts of the building.

Special caution should be used when cleaning the toilet and metal shower dividers. Dividers should be dried thoroughly with special attention given to the ledges at the bottom.

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CHAPTER IV

CARE AND MAINTENANCE OF HARD FLOORS

Floors are the custodian's showcase. With the exception of the building exterior, probably no other area of the school plant portrays the quality of the custodial staff as conspicuously as the floors. The visitor sees the corridor floors immediately upon entering the school. His opinion of the entire school is at that time beginning to formulate.

If a good image is to be created with clean floors, the custodian will need to know floors and floor cleaning techniques. The quality of floor maintenance will improve as the custodian improves his knowledge and skill.

Common resilient floors include asphalt, asphalt tile, linoleum, rubber tile, vinyl, vinyl asbestos and cork. The physical characteristics of any flooring material always govern the methods of maintenance and the products which are chosen to properly treat and maintain it.

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TOOLS AND EQUIPMENT

Treated Dust Mops

Treated dust mops are the most important single item in the maintenance program of a school. The best types have swivel handles. Untreated dust mops are not recommended, as they merely stir up the dust, rather than pick it up.

Types of Dust Mops. The first expenditure for equipment should be treated, dry dust mops. One treated mop, size 16" to 18", will adequately dust five classrooms.

Care of Treated Mops. Treat the mops one day prior to using them. Mops 30" or wider should be used for corridor areas. Hang the mops in a head-down position overnight so that capillary action will move the treatment to the ends of the strands. Only a mop treatment solution that has been recommended by a reliable janitorial house should be used.

To clean the mop place it in an appropriate solution, and allow it to soak overnight. Then wash and rinse the mop in an old washing machine for four to five minutes, if possible. Untangle the snarls and hang the mop to dry before retreating it.

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Wet Mops

Each custodian needs a minimum of four wet type mops. These will be used as follows: one for scrubbing, one for rinsing, one for waxing, and one for sealing.

Types of Wet Mops. The best type of wet mop is a synthetic. Rayon is commonly used as it will normally last a little longer. Tests have indicated that it does a much better job, has the same absorbent factor as cotton, and will not streak or leave fibers as cotton mops often do. Several types of mops are available: flip top, spring type, big bulky type with wing nut (not recommended as it may rust rapidly), granny type with knot on top (rots quickly), and screw type.

The best weight in a wet mop is 20 ounce for most tasks such as mopping, sealing, and waxing. A male custodian normally requires a 60" handle, but a maid can better utilize a 54" handle on a 16 ounce mop. The 32 ounce mop is too large for anyone, and may create backache or twisted-spine problems.

Care of Wet Mops

Wet mops should be cared for in the same manner as

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dust mops. The cleaning process works equally well for both kinds.

Scrub Buckets

The best type is one with a 32 quart capacity. It should be on casters, and a wringer (push-down type) should be attached on the side. The wringer should accommodate a 20 ounce mop. Each custodian should have a minimum of two buckets because one should be used for mopping and the other for rinsing.

Push Brooms

Each custodian should have at least two push brooms. These should be the natural bristle type with a 16" - 18" head. These brooms are used mainly for restrooms and heavily littered areas.

Floor Machines

The larger the machine the easier it is to operate (up to a size of 23"). A 17" machine is designed to take care of approximately 10,000 square feet; a 20" machine will service 15,000 square feet; and the 23" machine will handle 20,000

square feet and over. A 23" machine can ordinarily do an area in half the time it requires a 17" machine to do.

Floor machines come in different weights and sizes, and the revolutions per minute will vary with weight and manufacturer. A floor machine should be wired for both 110 and 220-volt circuits so that it can be converted by merely flipping a switch.

The floor machine is designed to create friction. This implies that you need to know how much pressure per square inch is on the brush since this determines the machine's value. It should have approximately 2.3 pounds per square inch. If the motor is off-center, the machine will often be off-balance. The better kinds of machines are built low.

A stiff wire brush instead of a scrubbing or polishing brush should be purchased. Nylon pads can then be used on the brush for different jobs. Pads are designed for stripping, light scrubbing, buffing, combination, and high gloss. Three to four dozen pads can be purchased for the cost of only one scrubbing brush. Nylon also does a better job and lasts longer. The best way to economize on materials is to standardize.

A floor squeegee or wet/dry vacuum is helpful when using

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a floor machine. Wet/dry vacuums are rated by the amount of water sucked up per minute. The motor should be one to one and one-half horsepower.

Miscellaneous Tools

Some of the other tools which are desirable in the care and maintenance of hard floors are: counter brush, dust box, dust pan, putty knife, corn broom (for outside areas), and clean cloths (an ample supply). These tools should be carried in the custodian's cart, if one is available.

PROCEDURES

Sweeping Classroom Floors

If there is a secret to efficient room cleaning, it is -- BE SYSTEMATIC. Have the equipment and materials needed to do the job; have it organized to eliminate unnecessary steps and lost motion; and know how to use them. An inexperienced custodian may use as much as forty per cent of his time in needless and unproductive efforts to transport materials and equipment, i.e., looking for things, or trying to figure out what to do next.

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In sweeping classroom floors a swivel-head treated dust mop (16 to 24 inches) should be used. Begin at the door and work around the edge of the room to the far corner. Work under and around the furniture, and push the dirt into the aisles without lifting the dust mop. Use a circular (figure eight) motion. After cleaning under a row of desks or chairs, mop the aisle, finishing up at the doorway entrance. When the dust mop becomes full with dirt and dust, push it through the door into the corridor, lift it a few inches and give it a sharp, quick shake. Do this far enough away from the corridor wall so that dust will not be deposited on the baseboard or door ledges. Pick up the dirt with the dust pan and floor brush and place it in the dust box. This should not be done directly in front of the door as a draft may scatter some of the dirt. One treated dust mop will normally sweep five classrooms adequately.

Sweeping Corridors

Place the tools at one end of the corridor away from the walls and woodwork. Take the floor brush and sweep the outer edges of the corridor (12-15 inches from the wall), insuring removal of dirt from corners, and under lockers. If the

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corridor is in use, the first round trip should be along the walls so that foot traffic will have a clean place to walk. Continue sweeping until the corridor is completely swept, shaking the dust out of the mop at the completion of each round trip. Each trip should overlap the previously swept strip by about four inches.

Sweeping Stairways

There are different types of stairs and treads that may require slightly different tools or procedures for sweeping. Most modern stairways can be swept with a treated sweeping mop. However, there are some stairs so constructed they may require the use of a floor brush. Stairs having square corners or rough, grooved treads are more difficult to sweep than stairs with rounded corners and smooth treads. A floor brush is the best tool to use on stairs of this description.

In sweeping stairs situated between two walls, the sweeping operation should begin at the bottom of the stairway. Sweep the dirt from one side toward the center of the tread on the way up. When the top of the stairway is reached, the dirt is then swept from the other side toward the center; then down to the

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next lower step, using a slight jerking motion in the corners. This procedure is continued downward to the foot of the stairs where the accumulated dirt can be picked up in the usual manner. This method can also be used on stairs having an open grill on one side and a wall on the other; but in this case, the side next to the grill should be swept on the way up. This method of sweeping allows traffic to use one side of the stairway while the other side is being swept.

When sweeping stairways situated between two rails, it is necessary to sweep from each side to the middle of the stair. This will keep the dirt away from the edge and prevent it from falling to the floor below. Stairs having a traffic rail in the middle sometimes offer an additional inconvenience for sweeping, but can usually be swept by the same method indicated above. Wide entrance stairs offer a different problem but are not too difficult to sweep unless the total width exceeds twelve to fourteen feet. The best method of sweeping is to sweep from the bottom on one side toward the top, taking about one-half the width of the stairs on the way up, and the other half on the way down. However, if the stairs are extremely wide, it

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may be necessary to sweep from the middle toward the edges all the way up, and bring the dirt down at the wall side of the stairs, making a trip to complete the opposite side.

Quietness is an important factor in the process of sweeping stairs, especially if done during school hours.

Sweeping Gymnasiums

Place the tools at one end of the gymnasium away from the walls and woodwork. If there is soil around the edges, take a floor brush and sweep the outer edges first, insuring removal of dirt from corners, and other confined areas. Begin at one end where it would be better to pick up the debris. Return trips should overlap previously swept strips by at least 4-6 inches. Continue sweeping in this manner until the gymnasium is completely covered, shaking the dust out of the mop at the completion of each round trip. Pick up the dirt, using the floor brush and the dust pan and deposit it in the dust box.

Mopping Floors

Damp Mopping. Sweep the floor first and remove any foreign matter sticking to the surfaces. Arrange movable

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furniture in a manner which will simplify the mopping. Dip one mop in the neutral solution and wring out slightly. Mop along the edge of the floor for a distance of about fifteen feet, coming no closer than six inches to the baseboard. Swing mop with a side-to-side (figure eight) motion until the entire floor area is covered. Dip a second mop in clean rinse water, wring out slightly and rinse floor, again using the figure eight motion for application. Redip the second mop in clean water and wring out thoroughly. Dry the floor as much as possible with this mop by repeated rinsing and wringing of the mop, covering the entire area.

Wet Mopping. This process is the same as damp mopping, except the mop head is saturated with cleaning solution in the beginning. It is then mopped onto the floor and allowed to remain for a short period of time in order to loosen the dirt. The solution is then removed with the mop and rinsed with clean hot water just as in the damp mopping process.

Scrubbing Resilient Floors

On new floors allow sufficient time for the tile to become tightly adhered to the floor before washing. The

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original scrubbing after installation should leave the floor absolutely free of any surface coating or foreign matter.

Utilizing a proper cleaning solution, use a floor machine to loosen dirt and old wax. Use a Number 2 steel wool pad or a nylon pad for stubborn dirt. Using a curved squeegee, push the water into an area where it can be picked up (either with a mop or a wet/dry vacuum). Use an 18" straight squeegee to pull the water into the pick-up pan (or use the wet/dry vacuum).

Rinse the floor with a fresh mop and clean water as each area is scrubbed. Do not overwet the floor or allow the water to stand. Change the rinse water often to insure a thorough job. Never mix the rinse mop with the scrubbing mop. Allow the floor ample time to dry.

Waxing Resilient Floors

Use a sheepskin applicator (for small areas only) or a clean rayon mop (for larger areas) to apply a thin coat of water emulsion wax. If necessary, apply a second coat after the first coat is thoroughly dry.

The wax used should contain no drying oils, no brittle

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shellacs, resins, paint ends or other quick-dry materials to hurry the natural process and cause the finish to be brittle. If possible, keep foot traffic off the floor for a few days to enhance the beauty of the floor. Color hues in the floor surface will be brought into high relief, and the floor should require no further waxing for several months, except in entrance ways.

In using the sheepskin applicator, a small open pan is needed for the wax. Both the floor and the applicator must be clean. Apply the wax in thin, even coats using smooth strokes. Taper the end of the stroke, and do not rub or brush in the wax. Allow to dry thoroughly before applying a second coat.

In using a rayon mop to apply the wax, the mop should first be soaked in water to soften it and wrung out dry. The 20 ounce size is ideal for waxing large areas. Place the liquid wax in a clean mop bucket with a wringer attached. Dip the mop into the wax and wring out about three-fourths dry. Apply the wax in thin coats. Avoid heavy waxing in order to prevent milky streaks. Allow the wax to dry overnight before polishing for maximum lustre.

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Sealing Resilient Floors

Make sure that the newly-laid floor is absolutely clean and dry, and that the surface is free of all foreign matter. Apply the undercoat seal in a thin, even coat with a sheepskin applicator or clean rayon mop to fill all pores and pits in the surface. To insure that the seal is thoroughly dry before waxing, allow it to cure overnight.

Care of Resilient Floors

When the condition of the floor warrants care (usually twice annually), scrub it with a light solution of neutral cleaner. After permitting it to dry, polish to a rich lustre.

The floor should be swept daily (see work schedule) with a treated dust mop. Frequently shake the mop to free clinging dust and dirt particles.

The wax finish should be periodically mopped with a neutral cleaning solution (see damp mopping instructions). This can then be followed by buffing instead of re-waxing in order to bring out the lustre of the floor. This eliminates frequent stripping of the wax.

After several months traffic you will want to patch in

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traffic lanes or heavily-used areas. Doorways and halls are examples of such areas. It is unnecessary to re-wax the entire surface because buffing will blend in the patched areas.

Twice annually (more often if necessary) the floor should be stripped by thorough scrubbing and re-waxing. Use a heavier solution of neutral cleaner than required for light mopping. Spread the solution onto the floor with a rayon mop and work the area well with a floor machine and a nylon scrubbing pad. After removing the solution, and rinsing well, allow the floor to dry completely before re-waxing.

Care of Terrazzo Floors

Follow the general directions for maintaining resilient floors. The only exception is in damp mopping. If all residue is carefully picked up, it is not necessary to rinse after mopping since the clean film of a cleaner actually enhances the lustre of the terrazzo. For white terrazzo scrub and mop with a solution which keeps the floors white.

Products for Terrazzo Maintenance

A neutral cleaner (free from acids, alkalis, metallic

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salts and damaging abrasives) should be used on terrazzo or any other types of hard flooring material. A special cleaner, formulated for white terrazzo and concrete, plus a whitening agent which prevents yellowing and preserves the original whiteness of the floor should be used.

A powdered cleaner which attracts and removes grease, oil, and soap film from Portland Terrazzo and other hard-surfaced floors is highly recommended. This cleaner has a bleaching effect on many non-removable stains.

Use a buffing type of terrazzo sealer that produces a tough, trackless, slip-resistant surface and never requires waxing. This type of sealer will not flake off or show traffic lanes. It brings to life the color hues that may have become dull and lifeless and aids in preventing efflorescence, bleeding bloom and dusting. Protection against penetration by water, dirt, and traffic wear is provided. It also makes daily dusting easier and eliminates frequent scrubbing.

A non-buffing type of sealer is a water emulsion, long wearing polymer coating. This seals and finishes porous surfaces with a color restoring beauty and protection. It is

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easily applied, highly slip-resistant, repels soiling, and resists water spotting.

Use a non-buffing, penetrating, quick-dry sealer for terrazzo surfaces which are exposed to acids, oils, alcohol, grease and water. This type sealer is excellent for sealing old porous terrazzo and restores colors while resisting soiling and water spotting. This long-wearing surface facilitates cleaning and can be patched without recoating the entire floor.

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SUGGESTED TIME SCHEDULE

Cleaning Task	Daily	Weekly	Monthly	Annually
Sweeping classrooms	x			
Sweeping corridors	x			
Sweeping stairways	x			
Sweeping gymnasiums	x			
Mopping floors (damp)		x		
Mopping floors (wet)			x	
Scrubbing floors				2-3 times
Waxing floors				2-3 times

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What is a Neutral Cleaner?

We must refer to a technical scale of comparative values (see pH Table). Chemists use the term "pH" to express the relative alkalinity or acidity of a liquid.

Practically all detergents have a pH factor between 7 and 14. In other words most of them are alkaline. In a compound where the hands are exposed for any length of time, the pH should not exceed 10.5. Any greater amount of alkalinity can dry out the skin oils and cause irritation.

In the floor treatment industry the accepted "neutral cleaners" fall in a pH range of from 8 to 10. To better understand this, study the pH Table. For example, a pH of 9 is not just slightly more alkaline than a pH of 8, it is in fact 10 times more alkaline.

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pH TABLE

	Material	Approximate pH Value	Relative Acidity or Alkalinity in terms of Pure Water
		0	10,000,000
	1% Muriatic Acid	1	1,000,000
	1% Oxalic Acid	2	100,000
Acid	Vinegar	3	10,000
	Soft Drinks	4	1,000
	1% Boric Acid	5	100
	Cow's Milk	6	10
Neutral	Chemically Pure Water	7	1
	1% Sodium Bicarbonate	8	10
	1% Borax	9	100
	Neutral Liquid Soap	10	1,000
Alkaline	1% Ammonia	11	10,000
	1% Trisodium Phosphate	12	100,000
	1/2% Caustic Soda	13	1,000,000
	4% Caustic Soda	14	10,000,000

Advantages of Neutral Cleaners

Neutral cleaners can be used safely on any washable surface. They contain nothing injurious to floor surfaces and are effective in hard or soft water (hot or cold). Another advantage lies in its gentle, thorough cleaning ability. Whereas most cleaning products depend on one or two cleaning processes, a good neutral cleaner provides 100% cleansing action by combining many different processes.

The use of wetting action breaks the surface tension and gets the liquid directly on the contact surface. Penetrating action gets the solution down into the pores and crevices of the surface. The sudsing action attracts (pulls) dirt particles into the suds. The suspending action holds insoluble particles in suspension and does not allow solid particles to settle, which makes it easy to remove them from the surface. Emulsifying action breaks up fats and oils and mixes them into the water. It actually separates oil and makes it easier to remove. The dissolving action causes a breakdown of soluble materials which gravitate into the solution and reduces the cleaning time in half.

Just because the pH factor falls within the neutral range

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does not mean that the cleaner is safe. A cleaner which contains phosphates can form destructive crystals that often break up floor surfaces.

For the pH of some common substances refer to the preceding table (pH Table). When purchasing a neutral cleaner contact a reliable janitorial supply house.

PRECAUTIONS

General

In order to avoid soilage, do not place soiled tools against walls or furniture as this will cause the custodian extra work in keeping the building clean.

Wash, rinse, and dry all mops after each usage in order to prolong their life. An adequate supply of mops should be available to permit usage of a fresh mop each day. This allows proper time for cleaning and drying of all used mops.

Keep the sweeping mop clean and treated. After treating, the mop should be left overnight to allow the treatment to properly set. This prevents smearing the treatment on the floor.

11876

Do not shake mops near baseboards or furniture. This causes the dust to settle on these areas and adds to the work load of the custodian.

Make sure that all windows on the first floor (and in the basement) are securely locked. This is a general rule to discourage vandalism and break-ins.

Store sweeping mops (clean and treated) with the head down, preferably with the head in a metal box. This prevents the treatment from getting on the handle, and the metal box will prevent the treatment from rapid evaporation.

Sweeping Floors

Do not empty floor sweepings into paper containers, use a dust box. Paper containers have a tendency to allow dirt particles to "spill", whereas a dust box is specifically designed to hold floor sweepings until the custodian is ready to dispose of them.

Sweep corridors and gymnasiums in the direction in which they are laid out. By sweeping these types of floors in the prescribed manner, the custodian will pick up the dirt that normally gathers in the seams of these floors.

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Carry a counter brush to use in corners and under lockers. These areas are difficult to reach with brooms or mops, and the dirt and dust will gather if not removed regularly.

To erase streaking, run the sweeping mop over the floor where dirt has been picked up. If these streaks are allowed to remain, they will be ground into the floor and will require extra effort to remove them.

Mopping and Scrubbing Floors

When mopping, remove the cleaning solution thoroughly. If the solution remains on the floor, it may cause the floor to deteriorate rapidly.

When mopping immediately remove all water splashed on furniture and baseboards. This water may cause spotting and could lead to permanent damage.

Use a cleaning solution that is strong enough to clean, but mild enough to prevent stripping. If the solution is too weak, the custodian is wasting his effort. If the solution is too strong, the wax may be stripped from the floor and necessitate re-waxing.

Do not drag objects over a wet floor. This can cause

1878

streaking and may harm the wax or the floor. It may also cause permanent damage to the floor surface.

When scrubbing, do not attempt to scrub too much area at one time (limit to area approximately 4 ft. x 6 ft.). If too much area is covered, the solution will dry before it can be removed, and can permanently damage the floor.

Do not leave cleaning solution on the floor over five to eight minutes. The solution may penetrate the floor and cause permanent deterioration or a loosening of the binding materials in the floor.

When mopping and scrubbing avoid tracking of clean areas, and watch for slippery floor surfaces. Any areas which are tracked will need to be re-mopped or re-scrubbed. A wet floor is slick and can easily contribute to accidents.

Waxing Floors

When waxing floors a water-emulsion wax is superior to a spirit-solvent wax:

(1) water emulsion wax presents no fire hazard.

(2) water emulsion wax may be used on all types of flooring materials.

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(3) water emulsion wax does not require buffing to produce a good lustre.

(4) water emulsion wax is less slippery.

Use different mops and pails for each operation such as mopping, rinsing, sealing, and waxing. This technique will prolong mop life as well as insure that the floors will remain in sound condition.

The temperature of the rooms and the materials to be used should be above 70° Fahrenheit. This caution should be followed when sealing or waxing a floor.

Do not clean resilient floors with gasoline, turpentine, benezene or naphtha. These agents will soften and discolor the flooring materials. Soaps and cleaners containing fats, oils, alkali, or acids should never be used on asphalt or rubber tile.

Never use strong soaps or cleaners instead of a good neutral cleaner for proper floor care. Strong soaps are the frequent contributors of floor trouble and cause more damage than constant wear. Fading and discoloration can result and may actually cause the floor to slowly wash away.

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Most strong soaps combine oil with a strong alkali such as lye. Alkali attacks the basic ingredients of most resilient floors, causing them to become brittle and hard and subject to easy chipping and cracking. The alkali may also cause a chemical change in color pigments and result in discoloration.

Do not use cleaning agents which are not readily soluble in water or strong detergents. These types of agents will dull the lustre and leave a white looking film.

Do not use varnishes, lacquers, shellacs or other plastic finishes on floors as these materials usually contain solvents that can permanently damage the flooring.

Sweeping compounds usually contain oil which is a fire hazard. Many of them also contain sand which is difficult to sweep and often will abrade if left on the floor.

The U. S. Bureau of Standards conducted a series of tests for several years which indicated that terrazzo floors were damaged when cleaners containing free alkalis, soda ash, and TSP)trisodium phosphate) were used on them. This damage occurred in the cement matrix where crystals formed from deposits of the cleaning agent and "exploded" the floor.

11881

Supervisors, administrators, and custodians should become fully cognizant of the many pitfalls and dangers of purchasing supplies and equipment from dubious janitorial supply firms. Secondly, each new or unfamiliar product, even from reputable firms should be given special caution and attention. Knowledgeable custodians will never guess at the amount of a product to use but will always abide by the manufacturer's directions.

11882

CHAPTER V

CARE AND MAINTENANCE OF CARPET

The use of carpet in schools has grown substantially in recent years. Carpet enhances the learning environment of a school. It aids in sound control, adds beauty, makes the school safer; and more importantly to the custodian, it cuts maintenance time.

The succinct fact that carpet cuts maintenance time does not mean that it is carefree. The most important aspect of carpet maintenance is daily care. A good program of daily care will maintain the appearance level of the carpet and lengthen the time between cleanings. A program of daily care insures that the sound control properties of the carpet are maintained, and the life of the carpet is prolonged.

To maintain carpet, an important factor for success is the availability and proper use of the correct tools, equipment, and materials. No procedure will work if the proper tools and supplies are not available. For proper carpet maintenance the custodian should be equipped with the following tools and equipment:

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Vacuum Cleaner. Proper selection of a vacuum cleaner is of utmost importance. A heavy duty commercial type, available from most manufacturers, is a must. This upright type of heavy duty vacuum is necessary for the large carpeted areas of a school. There are several important features which the school vacuum cleaner should include: (1) separate motors to drive the suction system, and the beater brush or turbulator, (2) a one-horsepower motor for suction, and at least a one-half horsepower motor for the beater brush, (3) a turbulator or beater brush, and (4) a heavy duty cord long enough to provide coverage of an area without excessive transferring of the plug.

Pile Brush. A machine which has two relatively stiff nylon brushes rotating toward each other serves two purposes: This type machine can be used for the dry powder method of maintaining carpet (which is discussed later). Such a machine also serves to brush up the face of the carpet where heavy traffic tends to mat down the pile.

Lightweight Vacuum. A lightweight vacuum (of the tank or back-pak variety) is most useful for sweeping under fixed furniture. A lightweight vacuum is also useful for cleaning

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in corners and along baseboards.

The following supplies are needed by the custodian in order to do an effective job of caring for carpet.

Dry Powder Cleaner. This material (which looks like fine sawdust) is the backbone of the supplies needed to take care of carpet. It is also used in maintaining larger areas of carpet, as well as serving as a valuable spotting material. This compound is chemically treated and must be stored in an airtight container to prevent evaporation of the chemical components.

Spotting Kit. The spotting kit should consist of a supply of dry powder cleaner and a small G. I. type brush. For stains which have an oily base, a petroleum solvent cleaning agent is needed. For water-soluble stains, which the dry powder will not absorb, a sudsing type detergent cleaner is effective. These solvents are available from most janitorial supply houses.

Clean Cloths. Only absorbent type cloths should be used in order to absorb as much of the liquid stain as possible.

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To maintain both the life and appearance of carpeting, efficient vacuuming at established frequencies is an absolute must for any effective maintenance program.

The question of how often to vacuum carpeting depends to a great extent on the general layout of the building, the type of carpet, its color, traffic load, and type of outside soil commonly brought into the building. However, it is possible to classify the different areas of a building and use these classifications as a general rule for establishing the vacuuming frequencies that will assure satisfactory results for the care of the carpet.

Heavy Traffic Areas. These are the areas which receive the heaviest dirt loads and consequently should be vacuumed daily for maximum protection. These areas include entranceways, lobbies, regions around steps, first floor corridors and rooms, cafeterias, and other highly frequented areas. Not only should these areas be vacuumed daily, but in some instances (such as during periods of bad weather) a second or even third daily vacuuming is often necessary.

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Medium Traffic Areas. Medium traffic areas (because of their location) are normally subject to lighter dirt loads. By the time people reach these areas, most of the dirt brought in on shoes has been deposited in the heavy traffic areas. These medium traffic areas are generally on the upper floors of a building, or in rooms which are far removed from entrance-ways. Depending again on the type and volume of traffic, color of the carpeting and nature of the native soil, normally three vacuumings a week are usually sufficient to keep these areas clean and protected against wear.

Light Traffic Areas. Light traffic areas are the ones which have little or no spillage, and are usually so far removed from entrances that very little dirt is deposited there. These areas should be vacuumed as needed, usually not more than once or twice a week.

As the custodian vacuums, there are some important things to remember: A steady movement of the vacuum is better than quick jerky movements, since the vacuum must have time to work. The beater brush must have time to separate the pile, and the suction must have time to get the

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dirt out. With the proper type of vacuum cleaner only one smooth steady pass is usually required to do a thorough job of cleaning. Occasionally, the custodian should re-arrange the placement of the furniture in order to change the walk-way patterns and prevent one area of the carpet from receiving excessive wear.

SPOTTING

Before discussing spotting methods, it is necessary to become familiar with several types of stains which will most likely be encountered in a school building. These stains are generally placed into four categories:

Dry Stains. This type of stain is defined as loose stains. These are stains which do not adhere stubbornly to carpet fibers and normally can be removed by merely vacuuming. Stains in this category include sand, grit, cigarette butts, cigar ashes, and other types of non-oily and non-sticky stains.

Water Soluble Stains. These stains include sweets, starches, mud, and non-greasy food stuffs. Water soluble stains adhere to carpet fibers and do not normally respond

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to just vacuuming. These stains can be removed with water soluble based chemicals, such as the foaming type of detergent cleaners.

Petroleum Soluble Stains. These stains include grease, salad oils, tars, asphalt, shoe polishes and waxes. These may originate from spillage, an excess of oil laden dust in the air, or may be tracked in from the outdoors. These types of stains adhere stubbornly to the carpet fibers and can be removed with petroleum solvent chemicals.

Other Stains. These stains usually result from spillage or similar accidents. Such stains include a wide variety of substances such as alcohol, coffee, tea, soft drinks, blood, urine, fruits and juices, ink, paint, and a variety of other liquids. Depending on the nature of the stain, the stain remover will vary.

The first thing to do when a stain is discovered is to remove (immediately) the excess staining material. If it is a solid material then a putty knife may have to be used to scrape up the loose staining material. Always work toward the center of the stain to avoid spreading the staining material.

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If the stain is a liquid, an absorbent cloth or paper towel should first be used to blot up the excess liquid.

For non-oily liquids and dry stains, the dry powder cleaner method is an effective spot remover. In using the dry powder, first absorb the excess stain, then rub a hand full of powder into the stain with a small stiff bristled brush. Allow the powder to dry at least 30 minutes (longer, if possible) and then vacuum.

For stains which do not respond to the above treatment and which are non-oily, it may be necessary to use a foaming detergent type spot remover. Use the cleaner according to the directions of the manufacturer. Most of these cleaners are diluted with water. A sponge can be used to work the solution into suds. The suds are then applied to the spot with the sponge and rubbed toward the middle to keep from spreading the spillage. It is important to use only the suds and not the liquid, as excess moisture can damage the carpet. After the suds have evaporated, the spot should then be blotted to absorb any excess moisture.

If the stain is of the oily type, a petroleum solvent cleaning agent is needed. First, wipe up as much of the excess

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spillage as possible by using a clean absorbent cloth (wipe from the outer edges of the spot toward the center). Then apply a small amount of the petroleum solvent cleaner to the spot and wipe with a clean cloth, again working from the outer edge to the center of the stain. Repeat the process until clean. If the spot is difficult to remove, and it is necessary to apply an excess amount of the solvent, it is recommended that a pad of absorbent cloth be applied over the spot, weighted down and left overnight to dry. This will help the spot to dry quicker and lessen the danger of the solvent attacking the latex compound on the backing of the carpet.

CLEANING

Even with a properly carried out maintenance program it will be necessary to thoroughly clean the carpet on occasion. The dry powder method of cleaning is highly recommended. This method is considered safe because it eliminates the use of moisture which may damage the carpet. Second, dry cleaning does not require skilled operators, and

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it has the advantage of allowing immediate use of the cleaned area.

To use the dry powder method of cleaning, the first step is to remove all loose furniture from the room. Sprinkle the powder over an area of about 10' by 10'. The powder should be used in the amount stated by the manufacturer. The next step is to apply the motor driven pile brush on the powdered area. Push the pile brush machine first in one direction, and then reverse and brush at a 90 degree angle across the first direction. Allow the powder to remain on the carpet until the chemicals have evaporated or until the odor is no longer present. Then vacuum the area thoroughly (any stray powder left on the carpet can be removed in subsequent vacuumings). A lightweight vacuum should be used to remove the powder close to the baseboard, in doorways, under radiators, and in other difficult places.

When the dry powder method of cleaning is no longer effective in maintaining the appearance level of the carpet, it may then be necessary to clean the carpet with some other method which employs liquid in the cleaning process. It is

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recommended that an outside contract be given to a company which employs and specializes in the steam cleaning method. This method is recommended because it does an efficient cleaning job and leaves very little moisture in the carpet.

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SUGGESTED TIME SCHEDULE

Cleaning Task	Daily	Every Other Day	Twice Weekly	As Needed
Spotting	x			
Vacuuming Heavy Traffic Areas	x			
Vacuuming Medium Traffic Areas		x		
Light Traffic Areas			x	
Cleaning (Dry method)				x(a)*
Cleaning (Wet method)				x(b)
Pile Brushing Walkways				x(c)

*(a) Approximately every 30 days for heavy traffic areas, 45-60 days for other walkways, and every 90-180 days for other areas.

*(b) Once a year maximum.

*(c) Heavy traffic walkways every 30 days. Medium traffic walkways every 45 days.

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CHAPTER VI

THE THERMAL ENVIRONMENT

Recent developments in school planning have revolutionized temperature management in school plants. Heating, ventilating, and air conditioning systems have literally changed the classroom environment. A successful custodian can no longer be considered merely the clean-up man. He must be a well-trained technician in many fields. The area of operation and maintenance of the heating and cooling facilities is among the most expensive part of school plant maintenance cost. No single problem is more controversial than proper room temperature. Since optimum temperature varies with different kinds of activities, it is imperative that the successful custodian ascertain as quickly as possible the proper temperature for each teaching area. A desirable temperature level for each kind of teaching space is included herein as a suggested guide.

The custodian should know the optimum temperature range for his building. There are conditions, however, over which he has very little control unless the school administrator is

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thoroughly aware of the principles involving heating and cooling problems. The most frequent thermal problem in a school building is overheating; and the person who contacts the custodian most often on heating matters is usually the classroom teacher. It is an established medical fact that the rate of body heat decreases as age increases, therefore, the older teacher is inclined to request for more heat than is actually healthful for her students.

DESIRED TEMPERATURES FOR VARIOUS AREAS

Area	Temperature	Overnight Temperature
Classrooms	70-75°	55°
Offices	70-75°	55°
Assembly Hall (when used)	68-70°	55°
Industrial Arts Shop	65-68°	55°
Corridors	65-68°	55°
Gymnasiums	60-65°	55°
Toilets	60-65°	55°
Bathroom and shower room	75-80°	55°
Swimming pools	75-80°	55°
Open Air Rooms	60-64°	55°
Kindergarten	72-76°	55°

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AIR CONDITIONING

Air conditioning systems for schools are used to provide a comfortable and healthful learning environment. Most of these air conditioning units are provided with individual room controls. Various units such as roof vents, grill covers, motors, fans, air filters, and controls require special attention of the custodian, and each component requires periodic inspection by specialists.

Care of Filters. Dirty filters contribute to inefficient and faulty performance of air conditioning systems. Periodic inspection is necessary to determine when filters should be replaced or advanced.

Lubrication. The manufacturer's instructions must be followed since requirements vary from unit to unit.

Seasonal Maintenance. General inspection, maintenance, cleaning, and repairing should be done as required. Periodic inspection must be made to assure proper functioning of belts, blowers, fans, linkages, and dampers.

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VENTILATION

A principle of proper ventilation is to produce adequate air movement within the classroom, while not creating undesirable air-drafts. The ventilation system should also displace foul air in the classroom and bring in a sufficient amount of fresh air from the outside to satisfy the needs of the occupants.

Systems. There are several types of ventilation systems which can be classified under the heading of gravity systems. The gravity system depends on the differences in the weight of hot and cold air for the air-movement. This system is economical to install and has good results under certain conditions. A modified system is one in which the gravity system principle is used, but which is accelerated by the use of radiators in the ventilating stacks, or by the use of small fans at certain intervals.

The mechanical system is one in which the air movement is controlled by fans which remove the air from the building. The mechanical system appears to be very efficient if properly installed and maintained.

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Ducts. Another method of ventilation is to provide ventilator ducts for each room from the building roof. Many of these ducts are installed in the cloakroom closet, while some are installed in the lower part of the wall in the classrooms. When ducts are used each room should be provided with a separate duct. The ducts should also be fire resistive to restrain the spread of fire from one part of the building to another.

Corridor Ventilation. Under this method, the stale air is taken out of the classroom through the door or through louvers and grills in the lower part of the door and deposited in the corridors. The air then circulates through the corridors and is removed from the building via the roof. This type of system is relatively inexpensive and has proven satisfactory for many buildings. Ventilation ducts should be equipped with dampers that can be opened or closed, however, they should not be kept closed during the school day. The closing of dampers during the day can prevent obtaining the desired amount of air required for proper circulation.

Unit Ventilator. Another type of ventilation system is

the unit ventilator. This type unit is normally installed in the classroom on the outside wall to provide both necessary heat, and proper ventilation. The entire operation of the unit ventilator is automatically controlled by a thermostat located on the inside wall of the classroom. This type of ventilation is essential in many areas since gravity ventilation is seldom satisfactory for toilets and locker rooms.

HEATING

A proper heating system is vital to a school. Detailed instructions on the appropriate care and operation of the heating equipment are equally essential. In maintaining high operating efficiency, the custodian must know how to intelligently operate and maintain the heating equipment and accessories. Neglect of the heating system will result in unnecessary repairs, increased fuel bills, and decreased heating efficiency.

Boilers are usually classified as low pressure or high pressure ones. Most school boilers are of the low pressure type. But, improper operation, neglect of valves and controls,

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and general dirty conditions can make the low pressure boiler a potentially high pressure problem. High pressure boiler usage is decreasing in schools. Custodians should not attempt to use them unless they are thoroughly qualified.

Gauges should be checked out and tested while under pressure during the working season. Safety devices should be inspected during the down season and replaced as needed. Steam pressure and water level should be checked continuously while in operation. All electrical controls should be checked periodically by a competent electrician and kept clean at all times. In case of a low water problem in the boiler, the fuel and air supply should be stopped and the boiler allowed to cool. A thorough inspection should be made for cracks and other damage before reusing.

General Maintenance. The boiler and boiler room should be continually kept clean. Dirty boilers demand more fuel. Boiler flues should be cleaned thoroughly with wire brush as often as needed. Boiler water can be kept clean by using the blow down method when necessary. The boiler should be periodically inspected during the down season and repaired as needed. Sludge should be removed from oil tanks annually.

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ABSTRACT - This unit of study, designed for students lacking satisfactory computational and quantification skills, was prepared by the Department of Vocational Education, University of Kentucky. To develop ability to measure, weigh, and calculate agricultural units, the unit is organized into these competency areas: (1) determining length, (2) calculating area, (3) determining weight, (4) calculating volume, and (5) calculating cubic area. Each competency area contains a suggested teaching outline, learning activities, references and instructional materials. A bibliography is included. (FM)

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AGRICULTURAL MECHANICS

UNIT: AGRICULTURAL WEIGHTS AND MEASUREMENTS

Major Teaching Objective

To develop in students the effective ability to measure, weigh, and calculate units of common agricultural products, structures, and resources

Suggested Learnings (Competencies) To Be Developed

1. To determine length
2. To calculate area
3. To determine weight
4. To calculate volume
5. To calculate cubic area

Prepared by
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Disseminated by
Instructional Materials Laboratory

December, 1969

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AGRICULTURAL MECHANICS

UNIT: AGRICULTURAL WEIGHTS AND MEASUREMENTS

Suggested Teaching Time

Number of class periods for group teaching:

In classroom, at school . . . . . _____
Outside classroom, at school . . . . . _____
Field trip (away from school) . . . . . _____

Total . . . . . _____

Place of the Unit in the Course of Study

This unit should be used with students lacking satisfactory computational and quantification skills. Students having disadvantages and learning problems often need to improve competencies similar to those suggested in this unit. Many of these mathematical skills are essential to satisfactory performance on the job, both during the time they gain occupational experience and after entering the job.

These learnings should be taught as more than a classroom session in mathematics. Actual structures, products, resources, and other items should be measured and quantified. Only those illustrations most appropriate for your students should be used in teaching. All of the examples listed should not be used, but generalizations can be made to these and to many more situations. Perhaps many of these learnings can be integrated into other units and this would allow teaching these learnings as part of a more comprehensive objective.

Suggestions for Introducing the Unit

Perhaps the best way to introduce this unit with students having academic disadvantages is a field trip to various situations where use of mathematics is needed in order to successfully carry out a job. Also, have students list computational problems they have experienced. Get them to understand the necessity of basic skills necessary to be successful individuals.

Have students experience real and common problems in order for all to feel the need for striving to improve their mathematical skills. Introduce mathematical concepts as needed to solve problems, but use the community as a classroom. Many situations at school can be planned to show students their needs and the use of mathematics.

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Suggested Teaching-Learning Activities

a. Suggested demonstration: How To Measure Length
b. Obtain objects to measure, proper measuring tools, and adequate materials for students to apply the skill after the demonstration by the teacher.

Suggested References and Instructional Materials

References

Vocational Agriculture Notebook, p. 6
The Farm Shop, pp. 215-222
Shopwork on the Farm, pp. 43-44
Metalwork Technology and Practice, pp. 435-436

2. To calculate area (square measure)

Area is the surface included within a given boundary -- a two dimensional concept. Examples of areas that might be measured for demonstrations include the following.

a. Acres of land within a boundary
b. Squares of building materials (roofing, greenhouse plastic, etc.)
c. Housing space for livestock

Tools for measuring area

a. Linear measurement tools are used to determine length of boundaries needed to calculate area (see the previous learning).
b. Calculating area involves linear measures and mathematical manipulations to determine the number of units.
c. Tools to measure length

Relationships of various square measures

a. One acre equals 10 square chains (10 chains x 1 chain).
b. Ten chains squared (10 chains x 10 chains) equal 10 acres.
c. One square mile ($5,280^2$) equals 640 acres.
d. One "square" of materials equals 100 square feet (10 feet x 10 feet).

Measuring land

a. Measuring land is really measuring area, but "sides" of the area must be determined. Two basic shapes of areas bounded with straight lines are rectangular and triangular land plots.

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-- Rectangular shapes

1. Determine length in chains (average length of the two longest sides).
2. Determine width in chains (average length of the other two sides).
3. See learning on measuring length.

-- Triangular shapes

1. Determine length of altitude; altitude is distance from one corner of triangular area to the point on base line that allows the line measured to be perpendicular to the base.
2. Take one-half of base line -- the line the altitude measurement perpendicular to.
3. See learning on measuring length.

-- Draw the shape of area measured and record the length on the paper.
-- Various ways the number of chains can be determined (pegs, marking with foot, counting, etc.)

b. Calculating area or square measure

-- Rectangular areas (and squares)

1. Determine length and width in chains (average two opposing sides) of boundaries.
2. Multiply average length of area in chains by average width in chains and divide by ten (point off one extra place to the left).
3. For example, an area 10 chains long and 1 chain wide contains 1 acre.

-- Triangular areas

1. Determine altitude (the distance of the line perpendicular to the base) and the length of the base in chains; the altitude becomes a side of a right angle.
2. Multiple length of altitude in chains by one-half the base line of the area and divide by ten.
3. For example, a triangular area with an altitude of ten chains and a base of two chains contains 1 acre.

Other measurements

a. Other surfaces and objects

-- Row feet per acre for crops (plants per acre)
-- Taking a sample of yield (portion of acre)
-- Capacity of machines at a certain rate of speed
-- Floor space of a building
-- Roofing materials required

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-- Calibrate planting rates of machines
-- Determine amount of inputs needed (fertilizer, lime, pipes, tile, seed, paint)

b. The number of feet of row crops in an acre

-- Determine the average distance (in feet) between rows.
-- Divide the number of square feet in one acre (43,560) by the distance between rows in feet. For example, 30 inch rows, 2.5 feet wide, have 17,424 feet of rows per acre.

Suggested Teaching-Learning Activities

a. Suggested demonstration: How To Calculate Area
b. Find a real problem for students and have them apply the results of their calculations to the situation. Have them discuss the importance of the right answer and the need for mathematics in determining the solution.

Suggested References and Instructional Materials

References

Vocational Agriculture Notebook, pp. 6-7
Farm Management, pp. 428, 432

3. To determine weight

Weight is a numerical way of expressing the relative heaviness of an object. Some examples of important weights to obtain are as follows:

a. Yield per acre of crops
b. Livestock production (gain, pounds per head, etc.)
c. Ingredients, feeds, seeds
d. Amount of actual product in mixture or compound

Times when weight of products might be determined

a. Harvesting period (crops)
b. Selling dates (livestock)
c. Mixing ingredients and application of inputs
d. Inventory of stored products (seeds, feeds, fertilizers, etc.)

Some tools for measuring weight of objects

a. Scales
b. Unit weight (bushels, bales, loads)

Relationship of various weights

a. One ton equals 2,000 pounds.

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b. One pound equals 16 ounces.
c. One pound equals 454 (453.6) grams.
d. One bushel equals the following number of pounds of seeds (only to be used as a source of information).

Pounds	Crops
-- 68-70	Corn, Ear (husked)
-- 60	Alfalfa
-- 60	Clovers
-- 60	Potatoes, Irish
-- 60	Wheat
-- 60	Soybeans
-- 60	Vetch
-- 50-60	Grain Sorghums
-- 56	Corn, Shelled (grain)
-- 56	Rye
-- 55	Potatoes, Sweet
-- 48-50	Millet
-- 48	Barley
-- 45	Timothy
-- 32-40	Sudan Grass
-- 32	Oats
-- 25	Lespedeza
-- 14-40	Redtop
-- 14	Other Grasses

Percentages or ratios (parts)

a. One percent is one part of a hundred -- 1/100 or 0.01
b. The many ways to write a percent (1%)
c. Examples of calculations involving percents

-- Pounds of TDN and digestible protein in a ration
-- Calculating interest rates
-- Pounds of pure elements in a given amount of fertilizer
-- Number of pure seeds and number that will germinate
-- Mixing parts into a whole with given consistency (supplement to add to grains, insecticides to mix with water, etc.)

Suggested Teaching-Learning Activities

a. Suggested demonstration: How To Determine Weight
b. Obtain weighing instruments and find some problematic situations for students to apply the skills needed in weighing various objects.

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AVERAGE WEIGHT OF GRAINS AND FEED INGREDIENTS

Grain or Feed Ingredient	One Quart Weighs (Pounds)	One Pound Measures (Quarts)
Corn, whole	1.7	0.6
Corn, meal	1.5	0.7
Corn, bran	0.5	2.0
Corn and cob meal	1.4	0.7
Gluten meal	1.7	0.6
Gluten feed	1.3	0.8
Germ meal	1.4	0.7
Wheat, whole	1.9	0.5
Wheat, ground	1.7	0.6
Wheat, bran	0.5	2.0
Wheat middlings (stand)	0.8	1.3
Oats, whole	1.0	1.0
Oats, ground	0.7	1.4
Rye, whole	1.7	0.6
Rye, meal	1.5	0.7
Rye, bran	0.8	1.3
Rye, middlings	1.6	0.6
Barley, whole	1.5	0.7
Barley, meal	1.1	0.9
Buckwheat	1.4	0.7
Buckwheat, middlings	0.9	1.1
Soybeans	1.8	0.6

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AVERAGE WEIGHT OF GRAINS AND FEED INGREDIENTS (Continued)

Grain or Feed Ingredient	One Quart Weighs (Pounds)	One Pound Measures (Quarts)
Alfalfa meal	0.6	1.7
Molasses	3.0	0.3
Linseed meal, old process	1.1	0.9
Linseed meal, new process	0.9	1.1
Cottonseed meal	1.5	0.7

Suggested References and Instructional Materials

References

Vocational Agriculture Notebook, pp. 6-7
Farm Management, p. 432

4. To calculate volume of stored grains and roughages

Volume and cubic space are similar. However, the amount stored in the space often becomes the critical problem, and volume is usually converted to weight.

Problems of calculating volume:

a. The cubic space (or volume) must be calculated.

-- Cubic space is gotten by measuring and multiplying the length, width, and average depth (all usually in feet) of the structure or amount stored. The radius (one-half the inside diameter) and height must be determined for cylindrical structure.
-- For example, the cubic feet of grain in a rectangular bin that is 20 feet long, 8 feet wide, and 7 feet deep equals 1,120 cubic feet.

b. Cubic space or volume must be converted to units of measurement.

-- Divide the total cubic feet by the number of cubic feet for each unit of the type of product being calculated.

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1.	Corn (grain)	1.25 cubic feet per bushel
2.	Corn (ear)	2.50 cubic feet per bushel
3.	Silage, high silos	*Approximately 40 cubic ft. per ton
4.	Silage, shallow silo	*Approximately 67 cubic ft. per ton
5.	Concentrates	*Approximately 45 cubic ft. per ton
6.	Hay, baled tight	*Approximately 100 cubic ft. per ton
7.	Hay, baled loose	*Approximately 133 cubic ft. per ton
8.	Baled straw	*Approximately 167 cubic ft. per ton

*Bulky materials vary in weight because of leafiness, moisture content, degree of packing, maturity, and type of crops.

-- For example, 1,120 cubic feet of capacity with 1.25 cubic feet per unit equals 896 units.

c. Formula for calculating volume of cylinders such as a silo, tanks, and the like

-- $V = \pi r^2 h$ (or $V = \pi d^2 h/4$)
-- $\pi = 3.1416$
-- Meanings of other symbols

1. Radius
2. Diameter
3. Height

Suggested Teaching-Learning Activities

a. Suggested demonstration: How To Calculate Volume
b. Measure and calculate the capacity of storage structures for grain and roughages. Also determine the actual amount stored in different shaped structures and with different products.

Suggested References and Instructional Materials

References

Vocational Agriculture Notebook, pp. 6, 9
Farm Management, pp. 427, 432

5. To calculate cubic area

Volume is the capacity (storage) or space occupied in cubic area.

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APPROXIMATE CAPACITY OF CYLINDRICAL SILOS

Depth of Silage in Feet	Inside Diameter in Feet					
	10 Tons	12 Tons	14 Tons	16 Tons	18 Tons	20 Tons
8	11	16	21	28	35	43
10	14	20	27	35	44	55
12	17	24	33	43	54	67
14	20	29	39	51	64	80
16	23	33	45	59	75	92
18	26	38	51	67	85	105
20	29	42	58	75	95	118
22	33	47	64	84	106	130
24	36	52	70	92	116	144
26	39	56	77	100	127	157
28	43	61	83	109	138	170
30	46	66	90	118	148	184
36	56	81	110	143	181	221
42	66	95	130	169	214	259
48	76	110	150	195	247	296

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Cubic measures include three-dimensional objects. Examples of cubic structures include the following:

a. Cube
b. Cylinder
c. Cone
d. Pyramid
e. Rectangular prism
f. Sphere

Examples of typical measures of cubic area

a. Storage structures

-- Amount of materials (feed, seed, fertilizers, etc.) stored in a given space
-- Storage capacity of barns, bins, silos, and the like

b. Building materials

-- Board feet of lumber
-- Cubic yards of concrete
-- Cement, sand, and gravel to mix one cubic yard of concrete

c. Ponds, water requirements, and liquid measures

-- Measurements

1. One gallon of water weighs approximately 8 pounds 5 ounces.
2. One cubic foot of water contains about 7.5 gallons.
3. One gallon equals 231 cubic inches.

-- Computing capacity of oblong tanks

1. To figure capacity in cubic feet -- length times width times depth, then this figure (product) minus the width squared times depth times .2146
2. To figure capacity in gallons, capacity in cubic feet times 7.5

-- Computing capacity of round tanks

1. To figure capacity in cubic feet -- radius squared times depth times 3.1416
2. To figure capacity in gallons -- capacity in cubic feet times 7.5
3. Stock tank capacity, height of 2 feet -- round type

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Diameter (In Feet)	Capacity (In Gallons)
3	100
3.5	140
4.0	185
4.5	235
5.0	290
5.5	350
6.0	420
6.5	495
7.0	570
7.5	660
8.0	750
9.0	950
10.0	1,170

(4) Stock tank capacity, 2 feet -- round end type

Width (In Feet)	Length (In Feet)	Capacity (In Gallons)
2	4	95
2	5	120
2	6	140
2	7	185
2	8	195
2	10	250
3	5	175
3	6	220
3	7	260
3	8	300
3	10	385
3	12	475
3	14	560

Lumber

a. One board foot of lumber is 1 square foot and one inch thick, or its equivalent.

b. Examples of boards containing 1 board foot:

-- 2" x 6" x 1' long
-- 1" x 6" x 2' long
-- 2" x 4" x 1.5' long
-- 1" x 4" x 3' long

c. Formula for figuring board feet

$$\text{No. of boards} \times \text{thickness in inches} \times \text{width in inches} \times \frac{\text{length in feet}}{12 \text{ (when length is in feet)}}$$

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-- Example, 3 boards 2" x 4" x 10' = $\frac{3 \times 2 \times 4 \times 10}{12} = \frac{240}{12} =$

20 board feet

Concrete

a. Order of numbers for mixture is cement, sand, and gravel. By volume, a 1:2:3 mixture means 1 part cement, 2 parts sand, and 3 parts gravel.
b. Each cubic yard of mixed cement requires about 1.6 times as much unmixed cement, sand, and gravel. For example, one cubic yard (27 cubic feet) of cement requires about 43 cubic feet of unmixed cement, sand, and gravel.
c. If a wall is to be built that is 1 foot thick, 60 feet long, and 5 feet high, 300 cubic feet (or over 11 cubic yards) of concrete are needed.

-- Around 18 cubic yards (11.1 X 1.6) of unmixed materials would be needed
-- The following ingredients would be needed for a 1:2:3 mixture:

1. 1/6 x 18 = 3 cubic yards cement
2. 2/6 x 18 = 6 cubic yards sand
3. 3/6 x 18 = 9 cubic yards gravel

Liquid measures of volume

a. Water

-- One gallon equals 231 cubic inches.
-- One barrel equals 31½ gallons.
-- One cubic foot equals 7.48 gallons; equals 62.3 pounds.

b. Small liquid measures

-- One ounce equals 2 tablespoons or 8 teaspoons.
-- Eight ounces equal 1 cup or one-half pint.
-- One pint equals 16 ounces or two cups.

Dry volume measures

a. Cubic feet

-- One cubic foot equals .8 bushel.
-- One bushel equals 1.25 cubic feet.

b. Quarts

Suggested Teaching-Learning Activities

a. Suggested demonstration: How To Calculate Cubic Area

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b. Many of these materials can be brought into the classroom and laboratories for students to use.

Suggested References and Instructional Materials

References

The Vocational Agriculture Notebook, p. 6
Shopwork on the Farm, pp. 36, 312-314
The Farm Shop, pp. 213-214, 362, 379
Farm Management, p. 432

Evaluation

Attitudes, knowledge, skills, and other behavioral modifications of individuals should be used to evaluate this unit. Mathematical skills and desirable attitudes should be student outcomes from teaching the learnings suggested in this unit.

REFERENCES

Books

Farm Management; Robertson (J. B. Lippincott Company, Chicago, Illinois -- 1958), 445 pp.

Metalwork Technology and Practice; Ludwig and McCarty (McKnight and McKnight Publishing Company, Bloomington, Illinois -- 1969)

Shopwork On the Farm; Jones (McGraw Hill Book Company, Inc. -- 1955), 626 pp.

The Farm Shop; Wakeman and McCoy (The Macmillan Company -- 1960), 597 pp.

The Vocational Agriculture Notebook (The Interstate Printers and Publishers, Inc. -- 1968)

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VT 012 777
Collins, Wilson Glenn
Farm Animals. Unit: Beef Production.

Kentucky Univ., Lexington. Instructional Materials Lab.
MF AVAILABLE IN VT-ERIC SET.
HS 45
Instructional Materials Laboratory, Room 151, Taylor Education Building, University of Kentucky, Lexington, Kentucky 40506 (one copy free on request for state directors of agricultural education).
PUB DATE - Jun70 63p.

DESCRIPTORS - *AGRICULTURAL EDUCATION; UNIT PLAN; VOCATIONAL AGRICULTURE; *AGRICULTURAL PRODUCTION; *ANIMAL SCIENCE; TRANSPARENCIES; *LIVESTOCK; *UNITS OF STUDY (SUBJECT FIELDS); LEARNING ACTIVITIES

ABSTRACT - Developed by the Instructional Materials Laboratory at the University of Kentucky, this teaching unit is designed to assist agriculture instructors in planning and teaching competencies in beef production. Contents include: (1) opportunities in beef production, (2) kind of beef production, (3) selecting, (4) feeding, (5) castration and dehorning, (6) internal and external parasites, (7) common diseases, and (8) marketing. References, instructional materials, and teaching activities are suggested for the unit lessons. Appended are 16 overhead transparency masters. (AS)

VT 012 777

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FARM ANIMALS

UNIT: BEEF PRODUCTION

Major Teaching Objective

To develop the effective ability to produce beef

Learnings (Competencies) To Be Developed

1. To see the possibilities for beef production in our experience programs
2. To determine the kind of beef production to have
3. To select a desirable breed or kind of beef animal
4. To select the breeding animal
5. To select feeder cattle
6. To breed beef animals
7. To feed the breeding cows and heifers
8. To feed young animals
9. To feed fattening animals
10. To care for the cow and calf at calving time
11. To castrate beef calves
12. To dehorn beef calves
13. To control external parasites
14. To control common stomach worms
15. To control common diseases
16. To market beef animals

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Revised by Wilson Glenn Collins
Instructional Materials Laboratory
Division of Vocational Education
College of Education
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June, 1970

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FARM ANIMALS

UNIT: BEEF PRODUCTION

Suggested Teaching Time

Number of class periods for group teaching:

In classroom, at school . . . . . _____
Outside classroom, at school . . . . . _____
Field trips (away from school) . . . . . _____
Total . . . . . _____

Month(s) _____

Place of the Unit in the Course of Study

Before dealing with any area in this unit, the General Livestock units relating to this area should have been dealt with. This unit is designed to follow the general units. When the how of carrying out certain practices is discussed in the general unit, it is not discussed in this unit. Therefore, it will be necessary to refer to the general units when using this unit.

Some learnings of this unit may be omitted. The thing that will help determine whether a teacher uses a learning is how well it applies to the students' situation. If most students in the class do not have feeder cattle, do not deal with the learning on selecting feeder cattle. The same principle should apply to any other learning.

Suggestions for Introducing the Unit

In introducing this unit, the importance of getting a good start in beef production should be seen. Many farmers do a poor job in beef production. This results in low profit, or no profit.

When sufficient interest is created in the class, ask the students to suggest the things or phases in beef production which will need to be considered. A list similar to the learnings in this unit should be developed. By asking questions and making suggestions, the teacher, with the help of the class, should arrange the learnings in the best order for considering them. If most of the learnings in the unit are secured, perhaps 20 to 30 days will be needed to complete the unit.

Learnings (Competencies) To Be Developed

1. To see the possibilities for beef production in our experience programs

Importance of beef production

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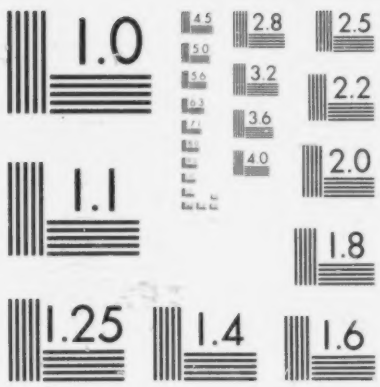

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

a. Beef is one of the more important meats in the American diet.
b. Kentucky ranks fourteenth nationally in beef cattle numbers.
c. An average of 110 pounds of beef per person was consumed in 1969.
d. There were 2,227,000 beef animals (including calves) on Kentucky farms on January 1, 1970.
e. Kentucky farmers received $209,080,000 cash receipts from cattle and calves in 1968.
f. Twenty-five and three-tenths percent of the total receipts from farm marketings in Kentucky is from sale of cattle and calves (1968 figures). (Source, Animal Science Department, University of Kentucky)

Opportunities in beef

a. Feeder production

-- Feeder production is usually carried on by producers located on land that is generally not suitable for intensive crop production. The land is suitable for producing grass.
-- The calves are usually dropped in early spring and run with the cows on the pasture during the grazing season.
-- The calves are sold as feeders in the fall.
-- Successful feeder production depends largely on having a good supply of cheap forage crops available.

b. Production of slaughter cattle

-- Profits from fattening cattle come from two sources

(1) The selling price above purchase price, which is known as "margin"
(2) The value of increased weight over the cost of the grain

-- The principal reasons cattle feeders have for buying and fattening cattle are:

(1) To receive a higher price for their grain when sold as beef
(2) To market forages and receive income from them that otherwise would be wasted

c. Production of purebred cattle

-- Quality, purebred animals usually bring premium prices.
-- Skill, knowledge, and patience are required for success in the purebred business.
-- A large amount of capital is needed.
-- Large amounts of grain are not essential. Some fattening grains may be desirable.

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d. The Kentucky cow and calf plan

-- Calves should be dropped in December, January, and February and sold in the fall without wintering them.
-- Cows can be wintered on roughages that are medium to poor quality.
-- This plan requires very little labor.
-- Calves should weigh 600 to 650 pounds when sold.
-- Less capital is needed for this plan than for the purebred business.
-- This plan is designed to use some of the lower quality cows and heifers found in Kentucky.

Personal Interest

a. Beef animals are a source of enjoyment.
b. The producer should be interested in developing an efficient herd.
c. Producers should be enthusiastic in their work.

Advantages of beef production

a. Beef is a very important part of the American diet.
b. Beef animals have the ability to convert coarse forage crops into a palatable and nutritious food.
c. Beef production requires a limited amount of labor.
d. Beef fits well in diversified farming programs.
e. Beef aids in maintaining soil fertility.
f. Beef requires a comparatively small investment in buildings and equipment.
g. Beef production is well adapted to Kentucky farm land.

Disadvantages of beef production

a. Considerable capital is required for the beef business.
b. Income is not distributed evenly throughout the year.
c. A good beef herd cannot be built up quickly.
d. Cattle fattening is often a risky venture.

Suggested Teaching-Learning Activities

a. Suggested problem: What are the possibilities for beef production in our experience programs?
b. Discussion of the learning with the class may be all that is needed in securing this learning.
c. Involve the less able student in terms of explaining and pointing out the importance of the beef industry to the economy of Kentucky Agriculture.
d. Use transparency HS-45-1 as the basis for discussing the various kinds of beef enterprises available.

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Suggested References and Instructional Materials

Books

Animal Science, Chapter 9.
Beef Cattle Science, Chapters 1 and 2.
Beef Production, Chapter 1.
Beef Production in the South, Chapter 1.
Experience Programs for Learning Vocations in Agriculture, pp. 203.
Introduction to Livestock Production, Selected references.
Livestock and Poultry Production, Chapter 11.

Publications

"Making Beef Cattle Pay, The Southern States Way" - pp. 7-14.

Visual Materials

Transparency HS-45-1

2. To determine the kind of beef production to have

Possible kinds

a. Feeder production
b. Producing slaughter cattle
c. Purebred production
d. The Kentucky cow and calf plan
e. Others

Available feeds

a. There is a beef program which can be adapted to the conditions found on almost any Kentucky farm.
b. The kind, amount, and cost of feed are important in planning the beef program.
c. Farms that are best adapted to the production of forage crops are generally suited to a beef program that involves the raising of calves and yearlings to be sold as feeder cattle.
d. Land that is well adapted to grain production is suited to fattening feeder cattle.
e. Use farm produced feeds wherever possible, this will keep production costs lower.

Buildings and equipment

a. Buildings and equipment must be considered in any plan for a beef cattle program.
b. The kind and amount of equipment necessary in Kentucky depend upon the type of program planned.
c. Warm barns for calving are not necessary in this state.
d. Cattle feeders need adequate lots, strong fences, plenty of feed bunks, hayracks, and field-storage facilities.

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e. Equipment that will permit the effective use of labor is essential for economical production.
f. Provide adequate watering facilities.
g. Provide some kind of windbreak for bad weather conditions.
h. A tobacco barn can be used as a shelter in very bad weather.

Needed capital

a. Some programs require more capital than others and involve greater risk.
b. If we have little capital and cannot afford to take much risk, probably the best program to follow will be the cow and calf program. (This program may be started with a few cows and a good bull. Retain the heifers for breeding and eventually develop a good-size herd. This program is slow, but reasonably safe.)
c. Light cattle ordinarily cost less per head than heavy cattle.
d. Purebred cattle are the most expensive to buy.
e. A well-planned beef program can be financed, so capital should not stand in the way of a sound program.

Available markets

a. We produce cattle to sell and make a profit.
b. Markets develop in areas according to the predominant kinds of animals produced there.
c. The closer one is to an available market, the greater his net sales price will be (price less shipping and other expenses, after shrinkage).
d. The feeder calf sales have proven to be a good market for cattle suitable for those production requirements.

Suggested Teaching-Learning Activities

a. Suggested problem: What kind(s) of beef production should we engage in on our farm?
b. Consider each kind of beef production with the class. Discuss the various aspects of each kind of beef production, and encourage each student to evaluate and decide on a type best suited to the farm situation.
c. Work with the less able student in evaluating these factors, encouraging an objective evaluation. Such special help should result in mastery of the learning.
d. Use transparency HS-45-2 to discuss the learning.

Suggested References and Instructional Materials

Books

Animal Science, Chapter 10.
Beef Cattle Science, pp. 32-37, 642-649, 682-685, 731-732.

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Beef Production, pp. 8-14.
Beef Production in the South, pp. 27-29.
+Introduction to Livestock Production, Chapter 31.
Livestock and Poultry Production, Chapter 11.

Publications

Kentucky Circular 494 - pp. 3-7.
Kentucky Circular 554 - p. 3.
Kentucky Leaflet 301 - pp. 2 and 5.
U.S.D.A. Farmer's Bulletin 2126 - Selected references.
"Making Beef Cattle Pay, The Southern States Way" - pp. 27-28.

Visual Materials

Transparency HS-45-2

3. To select a desirable breed or kind of beef animal

Different breeds or kinds of animals

a. Hereford
b. Angus
c. Shorthorn
d. Charolais
e. Crossbreds
f. Animals suitable for the Kentucky cow and calf plan
g. Others

Important characteristics of different breeds or kinds of beef cattle

a. Hereford

-- Body form - low set, muscular, compact, broad, and smooth
-- Vigorous animals that are good foragers
-- One breed is polled, the other breed has horns.
-- Good mothers
-- Large animals at maturity
-- Very prolific

b. Angus

-- Polled
-- High resistance to certain eye diseases
-- Calves small at birth, but weaning weights are equal to or greater than those of other breeds
-- Calving difficulties are few
-- Body form -- smooth, broad, low-set, blocky, compact, and well-muscled.
-- Angus cattle frequently bring a slight premium price on Kentucky livestock markets.

c. Shorthorn

-- They are rectangular and compact.
-- They are good milkers.

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-- Typically are large animals at maturity
-- They are good foragers.
-- There are both horned and polled strains.

d. Charolais

-- White or cream colored
-- Horned
-- Heavily built and rugged
-- Especially noted for large size at maturity
-- Rapid gainers
-- Efficient foragers
-- Breeding animals are usually high-priced.

e. Crossbreds

-- Vary in characteristics according to breeds involved
-- Usually efficient gainers, "hybrid vigor"

f. Animals suitable for Kentucky cow and calf plan

-- Usually cattle of relatively low quality
-- The dam has considerable dairy blood
--

g. Others

Personal Likes

a. Most cattle breeders have a liking for certain breeds of livestock.
b. Dollar value alone should not determine which breed of cattle one selects. Personal satisfaction and pleasure derived from the work are part of a satisfactory vocation.

Availability of breeding stock

a. Cattle breeders must be continually on the lookout for animals they can bring into the herd to improve their present breeding stock.
b. Good breeding stock should be kept from one's own herd for improvement.

Outlet for surplus animals

a. The number of breeders in an area contributes much to the sale of surplus animals.
b. It is important that one consider the demand before selecting a breed.
c. Grade-herd producers generally find cattle feeders their best market outlet.
d. Purebred producers have more alternative markets available to them.

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Environmental conditions under which the animals will be raised

a. Weather, grazing, disease, and insect conditions are important factors in selecting a breed of cattle.
b. Select cattle adapted to the conditions under which they will be raised.
c.

Suggested Teaching-Learning Activities

a. Suggested problem: What breed (or kind) of beef animals should we have?
b. Discuss the relative characteristics of each breed or kind of animal with the class. Have pictures of each breed available for discussion.
c. A field trip to see animals of the various breeds (kinds) would be most helpful with this learning.
d. The pictures and the field trip to see the real animals would be particularly valuable to the less able student. Such visual reinforcement of the audible presentation would be helpful to them.
e. Use transparency HS-45-3 as the basis for launching a discussion of the breeds or kinds of beef animals.

Suggested References and Instructional Materials

Books

Animal Science, Chapter 10.
Beef Cattle Science, Chapter 3, and pages 75-76, 83-95.
Beef Production, Chapter 2.
Beef Production in the South, Chapter 3.
+Introduction to Livestock Production, Chapter 6.
Livestock and Poultry Production, pp. 193-210.

Publications

Kentucky Circular 494 - p. 8.
Kentucky Leaflet 314 - pp. 1-6.
U.S.D.A. Farmers' Bulletin 2126 - pp. 5-6.
U.S.D.A. Farmers' Bulletin 2228 - Selected references.
"Breeder's Reference Guide" - Selected references.
"Charolais -- For Progress in Beef Production" - Selected references.
"The Future Cattleman" - Selected references.
"Making Beef Cattle Pay, The Southern States Way" - pp. 15-23.

Visual Materials

Transparency HS-45-3

4. To select the breeding animal

Type (body conformation)

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a. Animals should be relatively compact and uniform in fleshing.
b. A wide, deep body with good lines, and all parts smoothly blended together are desirable.
c. Evenly fleshed animals with superior development in the regions of the high-priced cuts are desirable.
d. Legs should be straight, strong, and squarely set on the body "corners."
e. Good style, balance, symmetry, and an abundance of quality are very desirable features in a beef animal.
f. Cows should show femininity and breediness, and the bull should show masculinity.
g. Animals should be at least average in size for the breed, with good body length.

Pedigree

a. Family names are important, but do not be misled by them.
b. Poor individuals should not be kept, regardless of the excellence of relatives.
c. When selection is being made between animals of comparable individual merit, the pedigree should be the determining factor.
d. In making use of pedigree selections, ancestors closely related are much more important than those many generations removed.
e. Pedigree records are more important in the purebred business than in commercial beef production.

Performance testing

a. Production testing is the most infallible basis of selection.
b. Performance testing measures the birth weight, weaning weight, daily rate of gain, efficiency of feed utilization, and body type of an animal.
c. Purchase of a "performance tested" bull takes much of the guesswork out of sire selection. Use this means if it is available.

Health

a. Thrifty
b. Vigorous
c. Free from diseases and parasites
d. The cow should appear capable of producing good calves.
e. Tests should be made to be certain the animal is free from tuberculosis, brucellosis, and other contagious diseases.
f. A health certificate from a licensed veterinarian should accompany the animal.
g. Newly acquired animals should be isolated for several days before being turned with the rest of the herd.

Size

a. The most practical size of cattle will vary according to:

-- The kind and amount of feed available
-- The kind of markets available

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b. Medium-size cattle tend to combine the gaining ability of large cattle and the finishing ability of small cattle without sacrificing efficiency of gain.
c. Perhaps, under most conditions, medium-type animals are best from the standpoint of widest adaptability, general vigor, reproductive efficiency, milk production, longevity, and marketability.

Age and longevity

a. When buying animals, buy cows with promising calves at their side and that are rebred to a good bull. (A three-in-one proposition.)
b. Heifers may be non-breeders.
c. Heifers usually require more assistance during calving than older cows.
d. Producing cows are culled from the breeding herd at an average age of 9.6 years. Keep a beef cow in the herd as long as she produces good calves.

Condition

a. Avoid buying extremely thin animals.
b. Very fat animals should not be purchased, either.

Defects

a. Poor feet and legs
b. Wry face and tail
c. Blindness
d. Poor teeth
e. "Runty," unthrifty appearance

Reliable source

a. Buy from a reputable breeder.
b. Buy from a source where health and immunization factors are guaranteed.

Reproductive ability

a. Only about 80 percent of bred cows and heifers drop calves. Thus, the other 20 percent are nonproducers (temporarily or permanently).
b. Calf crop percentage is the biggest single factor affecting profit in beef cattle production.
c. Overfeeding or underfeeding may result in temporary sterility.
d. The most common causes of permanent sterility are old age and diseased reproductive organs.

Milking ability (Kentucky cow and calf plan)

a. Good milkers produce heavy, thrifty calves.
b. Poor milkers should be culled.

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c. Select cows and bulls whose sire and dam have both produced good milking daughters.
d. Cows producing more milk than the calf can take results in spoiled udders and the loss of a cow.
e. Select a cow with good udder and teat development.

Suggested Teaching-Learning Activities

a. Suggested problem: What kind of breeding animals should we select?
b. This learning may be handled as a well-planned field trip to see some good quality beef animals. Be sure that every important factor in beef cattle selection is covered, if this procedure is used.
c. The field trip setting would be the best way to handle the learning for the less able student.
d. Use transparency HS-45-4 as a summary slide in regard to the four primary factors involved in beef animal selection for breeding purposes.

Suggested References and Instructional Materials

Books

Animal Science, Chapter 11.
Beef Cattle Science, pp. 95-99.
Beef Production, Chapter 3.
Beef Production in The South, Chapter 4.
+Introduction to Livestock Production, Chapter 14 and 38.
Livestock and Poultry Production, pp. 193-194 and 204-217.

Publications

Kentucky Circular 494 - p. 12.
Kentucky Circular 554 - pp. 3-5.
Kentucky Leaflet 301 - pp. 4-5.

Visual Materials

Transparency HS-45-4
Breed pictures (if available)

5. To select feeder cattle

Grades of feeder cattle

a. Prime
b. Choice
c. Good
d. Standard
e. Commercial
f. Utility
g. Inferior

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Kind and amount of feed available

a. Liberal amounts of feed grains and good quality forage are usually essential, if high quality beef is to be produced.
b. A cattle feeder with plenty of grain and high quality hay may well consider buying choice grades of beef.
c. It takes both quality cattle and quality feed to produce top beef. (A standard feeder calf will not make a prime slaughter steer.)
d. Low-grade calves, regardless of how well they are fed, will not make high grade slaughter cattle.
e. Commercial to utility grades of beef cattle are well suited for poor-quality feeds.
f. The kind of feed available should determine, to a large extent, the grade of cattle to buy.

Price of feed

a. The price of feed will help determine the size and quality of beef to buy.
b. When feed prices are high and feeder prices low, the cattle feeder expects to make his profits on the margin rather than the gain in weight. Under these conditions heavy cattle (800-1,000 pounds) may be best. These cattle are ready for market after a gain of 200 to 300 pounds.
c. When feed is cheap and feeder cattle high, then the chance for profit is greater on the gain than on the margin. Light feeders (300 to 500 pounds) may then be bought.

Price spread between feeder and slaughter cattle

a. If feeder price is low compared to the price of slaughter cattle, heavy cattle will usually be more profitable.
b. If slaughter price is low compared to the price of feeder cattle, heavy feeders will ordinarily be the best buy.

Future market outlook

a. If the immediate future outlook is good but the long-time outlook is very uncertain, heavy cattle are more certain to make a profit. These cattle may be fed 90 to 120 days and moved before the expected price break.
b. Speculation on the beef market is a risky business.

The length of time cattle are to be fed

a. Amount of feed available usually determines the length of time cattle are fed.
b. Large amounts of feed available are conducive to the purchase of smaller cattle.

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Feeder cattle produced on the farm

a. Keep feeders that have the capacity to make economical gains.
b. Select animals that will be one grade higher as slaughter cattle than they were as feeders.
c. Select feeders for grain feeding that would make a feeder cattle grade of Choice or Prime.
d. Select calves that come from good beef-type cows and are sired by a good, meaty bull. (A purebred bull is usually the best.)
e. Select calves that have all beef blood, are large for their age, have good conformation, are thrifty and vigorous, and have reasonably good fleshing.

Suggested Teaching-Learning Activities

a. Suggested problem: What kind of feeder cattle should we select?
b. Study a chart of feeder cattle grades carefully with the class. Explain carefully the major factors which differentiate the grades. The students certainly should know, and be able to recognize, the differences between a Good and Prime animal, for example.
c. A trip to a Stockyard would be most helpful to the class, perhaps as a follow-up to class discussion.
d. Discuss the feeder cattle grades from Transparency HS-45-5.

Suggested References and Instructional Materials

Books

Animal Science, Chapter 11.
Beef Cattle Science, pp. 682-738 (selected pages).
Beef Production, Chapter 4.
Beef Production in the South, Chapter 12.
+Introduction to Livestock Production, pp. 563-566.
Livestock and Poultry Production, pp. 210-217.

Publications

Kentucky Leaflet 301 - Selected references.

Visual Materials

Transparency HS-45-5
A Feeder Cattle Grade Chart (if available)

6. To breed beef animals

Age to breed heifers

The normal age of puberty (when breeding is first possible) is from 8 to 12 months.

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b. Breed heifers when they are 15 to 20 months of age.
c. Heifers bred too early will usually have difficulty at calving.

Size to breed heifers

a. Size at first breeding is more important than age.
b. Heifers should weigh 600 pounds or more before they are bred.
c. Heifers bred as yearlings may never reach normal mature size.

The breeding season

a. Turn the bull with the cow herd 9 to 10 months in advance of the desired calving date.
b. Remove the bull from the herd in 90 days. This will help control calving dates and help eliminate late and slow breeders. Females who did not "settle" during this time should be sold.
c. Breed cows (Kentucky cow and calf plan) to calve in December, January, or February.
d. In feeder- calf production, breed cows and heifers to calve in January, February, and March.
e. Fall calving is justified only under special circumstances.
f. Other calving periods may be desirable under certain conditions.

Method of mating

a. Hand mating

- Controlled mating of bull and cow by manually directing the activity.
- Hand mating requires a considerable amount of man labor.
- Is not practical with large commercial herds.

b. Pasture mating

- Turn the bull with cows 9 to 10 months before the desired date of calving.
- Do not leave the bull with the herd more than 90 days
- Probably the most important and useful method for the beef producer.

c. Artificial insemination

- Desirable for a small farm herd of up to 30 cows.
- Probably impractical for large commercial herds with all cows, but could be valuable for the best cows in the herd.
- A bull would prove more economical for large herds, especially under commercial range conditions.

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Publications

Kentucky Circular 494 - p. 9.

Visual Materials

Transparency HS-45-6

7. To feed the breeding cows and heifers

Kind of feed

a. Use home-grown feed as much as possible.
b. Feed for beef animals may include:

-- Pasture
-- Hay
-- Silage
-- Grain
-- Protein supplement
-- Mineral mixture
-- Water
-- Feed additives

c. If some poor-quality roughage is to be fed, feed it first and save the best roughage for late winter and the calving season.
d. Pasture is the natural feed for beef cattle, and is all that is usually needed.
e. The breeding cow and heifer must be properly fed and managed if a good calf crop is to be expected.
f.

Amount of feed needed

a. Provide plenty of palatable, nutritious, pasture throughout most of the year.
b. Pregnant beef cows getting plenty of high-quality roughages need no grain or supplement.
c. Mature cows need approximately 2½ pounds of good mixed hay each day per 100 pounds of body weight.
d. Bred heifers need good mixed hay and 3 to 4 pounds of grain per head each day.
e. Providing 8 to 9 months pasture for cows and heifers under Kentucky farm conditions is a reasonable goal.

Suitable rations for cows and heifers

a. Winter rations (cow)

Ration 1
Legume hay, full feed

b. Winter rations (700-1,000 pound heifer)

Ration 1
Good legume hay, 12-15 pounds per day
Poor quality hay, 3-5 pounds per day

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- Use of higher quality bulls can result in superior calves from the dam.
- The Breed Associations generally prohibit registration of animals sired by artificial insemination.

Heat period

a. The symptoms of a heat period are:

-- Nervousness
-- Attempts to mount other cows
-- Swelling of the vulva
-- Frequent urination
-- Mucous discharge
-- An inflammed appearance about the lips of the vulva

b. The duration of heat period is usually 12 to 18 hours, although it may vary from 6 to 30 hours.
c. Cows bred near the end of the heat period are more likely to conceive than if bred at other times.
d. The heat period recurs at approximately 20-day intervals.

Gestation period

a. The period of gestation for beef cows is usually around 283 days or about 9½ months.
b. Supply only good pasture and possible some good hay and minerals to the pregnant female. (Special rations are not ordinarily needed.)

Suggested Teaching-Learning Activities

a. Suggested problem: When should we breed our beef animals?
b. Discuss this learning well with the class, for many good beef herds are severely hindered by a poorly managed breeding season.
c. This learning may prove difficult for the less able student to master, as it is rather conceptual in its content. Explain it well, and involve the less able student as far as a potential visual aid, field trip, or some other means of material presentation.
d. Use Transparency HS-45-6 to discuss the three primary methods of beef cattle mating.

Suggested References and Instructional Materials

Books

Animal Science, Chapter 12.
Beef Cattle Science, pp. 206-213.
Beef Production in the South, Chapter 7.
+Introduction to Livestock Production, Chapters 21 and 31.
Livestock and Poultry Production, pp. 231-233.

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Ration 2
Legume hay, full feed
Hay of straw, free choice

Ration 3
Corn silage, 20 pounds per day
Legume hay, free choice

Ration 4
Corn silage
Protein supplement
Low quality roughage

Ration 5

Grass silage
Low quality roughage
Grain

Ration 2
Corn silage, 20 pounds per day
Poor quality hay, 8-10 pounds per day
Protein supplement, 1 pound per day

Ration 3
a. Mixed hay, 18-20 pounds per day
Ground ear corn, 1-2 pounds per day
b. Mixed hay, 17 pounds per day
Ground ear corn, 1-2 pounds per day
Protein supplement, 1 pound per day

Minerals to be included in a good ration:

a. Sodium chloride (salt)
b. Calcium
c. Phosphorous
d. Magnesium
e. Others, as needed

Feed mixed minerals free choice and have an adequate amount of water conveniently located.

Method of feeding

a. Feed minerals free choice to all beef animals.
b. Hay should be fed free choice.
c. The condition, age, and size of the animal will determine the amount of grain to feed. When grain is limited, hand feed cows that need grain.

Suggested Teaching-Learning Activities

a. Suggested problem: How should we feed our female breeding animals?
b. The basic principles of feeding beef cattle are listed in this learning. A more detailed discussion is given in the Unit, "Feeding Livestock," HS-35.
c. Thorough discussion and explanation is needed for the less able student to master this learning. Use the least detailed reference with this student.
d. Transparency HS-45-7 may be used for discussion purposes regarding the kinds of feed to use for the beef breeding animals.

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Suggested References and Instructional Materials

Books

+Animal Nutrition, Chapters 16 and 17.
Animal Science, pp. 423-441.
Beef Cattle Science, pp. 315-322, and Chapter 8.
Beef Production in the South, Chapter 10.
Feeds and Feeding, Abridged, Selected references.
+Introduction to Livestock Production, Chapters 23, 27 and 31.
Livestock and Poultry Production, pp. 220-231.

Publications

Kentucky Circular 494 - pp. 10-11, and 13.
Kentucky Circular 554 - pp. 5-9.
Kentucky Leaflet 301 - pp. 2-4.
Kentucky Miscellaneous 105 - pp. 1-3.
Kentucky Miscellaneous 140-B - Selected references.

Visual Materials

Transparency HS-45-7

8. To feed young animals

Creep-feeding

a. Creep-feeding calves have the following advantages:

-- Calves weigh more at weaning.
-- Cows are less "suckled down."
-- Calves will not miss their mothers as much at weaning time.
-- Calves may be more uniform in size.
-- Calves will be in better condition when they go into the feed lot, and the fattening period may be shortened.
-- Heifers and bulls kept for breeding animals will have more growth.
-- Fat is a good seller of cattle.
-- Creep-feeding permits marketing of early calves on a higher market, usually.

b. Creep-fed calves should gain approximately 1/3 pound per day more than the average calves receiving only milk and pasture.

c. Creep-feeding calves has these disadvantages:

-- Late calves probably will benefit very little from the practice.
-- Under average farm conditions, creep-feeding does not always pay.
-- Creep-fed calves do not gain as well in the feedlot as calves not creep-fed.

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-- Manytimes the cost of the feed is such that it, plus the labor required to feed it, is just not a paying proposition.
-- Occasionally calves do not start on the creep well, and much hand labor is needed to get them started.
--

d. Do not creep-feed calves that are to be pastured for 4 months or more after weaning.
e. Creep feeding is somewhat questionable practice under small farm conditions in Kentucky.

Feeds

a. A large variety of feeds may be successfully fed to young animals.
b. The grain mixture for feeding suckling calves on good pasture need not be rich in protein.
c. There is no advantage in grinding corn or oats for suckling calves.
d. When a calf is getting plenty of milk and is on good pasture, it is difficult to get it to eat grain.
e. Corn, oats, barley, sorghum grain, and wheat are good grains for suckling calves.
f. Unless a mixed ration including a protein or antibiotic supplement is to be fed, grinding or rolling corn and oats is not necessary.
g. When calves are kept in a dry lot, it is important that they have a high-grade forage available at all times. Legume hay is preferred.
h. It seems advisable to include aureomycin and stilbestrol in the ration.
i. If the calves do not have access to the mineral mixture fed to the cows, feed minerals in the creep.
j. It takes 3 to 5 pounds of grain to produce a pound of gain on creepfed calves.

Some suggested rations for creep-feeding suckling calves

a. With good pasture and normal milking cows, creep-feeding is not needed because it will not "pay for itself."
b. With poor pasture, low-protein forage, and/or poor-milking cows:

-- Ration 1 -

(1) Shelled or cracked corn - - - - - - - - - 1800 pounds
(2) Soybean meal or (other protein source)- 200 pounds
(3) Antibiotic, per ton of feed - - - - - - 40 grams of aureomycin or its equivalent

-- Ration 2 -

(1) Ground barley - - - - - - - - - - - - - - 800 pounds
(2) Ground sorghum grain - - - - - - - - - - 1000 pounds

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(3) A 40 percent commercial protein
Supplement - - - - - - - - - - - - - - - - - - 200 pounds
(4) Antibiotic (as in Ration 1)

Starting Calves to eat

a. Feed cows and calves together for a few days until the calves learn to eat.
b. Place a small amount of feed in the troughs. Remove surplus feed each day. Keep the feed fresh.
c. Begin feeding grain in a creep when calves are 3 to 4 weeks old.
d. The creep should be near shade and water.
e. It should be located in an area frequented by the cows.

Suggested Teaching-Learning Activities

a. Suggested problem: How feed our calves?
b. The students should become aware of the importance of feeding the young animal well. Details on feeding may be found in the Unit, HS-35, "Feeding Livestock."
c. The less able students will be interested in this learning if they have an opportunity to actually feed some animals. A school or class project on feeding might be a very good way to handle this learning.

Suggested References and Instructional Materials

Books

+Animal Nutrition, Chapters 13 and 15.
Animal Science, pp. 441-442.
Beef Cattle Science, pp. 671-681.
Beef Production, pp. 88-91, and 157-160.
Beef Production in the South, pp. 361-369.
Feeds and Feeding, Abridged, Selected references.
+Introduction to Livestock Production, Chapter 24.
Livestock and Poultry Production, pp. 238-239.

Publications

Kentucky Circular 494 - p. 11.
Kentucky Circular 554 - pp. 14-16.
Kentucky Leaflet 301 - p. 6.
Kentucky Miscellaneous 140-B - Selected references.
"Making Beef Cattle Pay, The Southern States Way" - Selected references.

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9. To feed fattening animals

Dry-lot fattening

Roughages

a. Kind of roughages

-- Legume hay
-- Silage
-- Mixed hay or grass hay
-- Stovers and fodders
-- Haylage
-- Cubed roughages

b. The maximum use of silage can best be obtained early in the fattening period.
c. Add protein supplement when a non-legume dry roughage or silage is used. (See general unit for kind and amount of protein supplement.)

Grains

a. Kind of grain

-- Corn
-- Barley
-- Rye (Not more than 1/3 of the grain ration)
-- Oats (Not more than 1/2 of the grain ration)
-- Wheat
-- Grain sorghum

b. The choice of the concentrate ration should be determined by the availability and price of feeds.
c. It usually requires 40 to 50 bushels of corn (or equivalent amount of other grain) and 1/2 ton of good legume hay to fatten a beef steer to Choice grade.
d. Cattle should have free access to salt, and other minerals as well.

Pasture fattening

a. Systems

-- Pasture alone
-- Limited grain allowance
-- Full-feeding grain during the entire pasture period
-- Full or limited grain feeding on pasture following the period of peak pasture growth.
-- Short feeding (60 to 120 days) in the dry lot at the end of the pasture period.

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b. Advantages of grain feeding on pasture

-- Pasture gains are cheaper than dry-lot gains.
-- Less labor is required.
-- The maximum fertility value of manure is conserved.
-- Pasture fattening eliminates the need for buildings.

c. Disadvantages of grain feeding on pasture

-- Feeder steers purchased in the spring are usually scarce and high in price.
-- Less labor is available in the summer months.
-- Heat and flies may reduce gains.
-- Pasture may become dry and parched.
-- It takes longer for cattle to reach a desirable finish on pasture.

Getting cattle on full feed

a. Cattle should be started on feed slowly, and gradually brought to full feed.
b. Do not allow cattle to overeat at the start of a fattening ration.
c. Provide plenty of water and comfortable quarters for cattle.
d. Cattle should become adjusted to their new home before grain feeding is started.
e. Feed cattle all the good hay they will eat for 10 to 15 days before starting them on grain.
f. If cattle have never eaten grain, placing grain over roughage will help to get them started.
g. Add one pound of grain per head daily until the cattle are eating 1½ pounds per 100 pounds live weight. Then increase the amount of grain one pound every four days until they are receiving 2 pounds per 100 pounds live weight.
h. If protein supplement is fed, it should be started with the grain.
i. The rate of increase of protein fed will depend on the kind of roughage used.

Some sample rations for four different types of fattening cattle:

a. An emergency wintering ration for young cattle.

-- Legume hay, 5 lbs. per day
-- Low-quality hay, free choice
-- Protein supplement, 1 lb. per day
-- Grain, 2 lbs. per day

b. A wintering ration for steers to be grain-fed on pasture.

-- Legume hay, full feed
-- Grain, 5 to 6 lbs. per day
-- Expected gain, 1.3 lbs. per day

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c. A ration for steers on pasture.

-- Pasture (good), 60 to 120 days
-- Grain, full feed on pasture or drylot to 120 days
-- Protein supplement, 2 lbs. per day
-- (Reduce supplement to 1 lb. if 4 to 5 lbs. of legume hay is fed)

d. A dry-lot ration for yearling steers (180-200 days)

-- Corn, full feed
-- Protein supplement, 2 lbs. per day
-- Low quality roughage, 5 to 6 lbs. per day
-- (Reduce protein to 1 lb. when 4 to 5 lbs of legume hay is fed)

e. The above rations were adapted from Kentucky Miscellaneous 140-A.

Economy of feeding

a. Use home-grown feeds when possible.
b. Supply much of the needed protein through good-quality roughages.
c. Determine the most economical protein feed to buy, and feed it.
d. Select the most economical quality mineral mixture to use.

Feed additives

a. Inject steers to be fed with (two 12-mg.) stilbestrol pellets in the fall and again (two 12-mb.) in the spring.
b. Antibiotics and hormones may be used to an advantage if feeding.
c. Consider the use of a tranquilizer in the ration.

Suggested Teaching-Learning Activities

a. Suggested problem: How feed fattening beef animals?
b. The importance of feeding slaughter animals a good ration cannot be overemphasized. Further details may be found in the Unit, HS-35, "Feeding Livestock."
c. An actual feeding test would be very useful in securing this learning, particularly with the less able student. A visit to a commercial cattle feeder would be helpful. Remember, real life situations are the best means of teaching the less able student, or other students for that matter.
d. Use Transparency HS-45-9 as a discussion motivator, exposing each type of feed and discussing them at that time.

Suggested References and Instructional Materials

Books

+Animal Nutrition, Chapters 12, 13, 15, and 16.
Animal Science, pp. 442-463.

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Beef Cattle Science, Chapter 13 (Selected references).
Beef Production, Chapter 8 (Selected references)
Beef Production in the South, Chapter 11.
Feeds and Feeding, Abridged, Selected references.
+Introduction to Livestock Production, Chapters 27, 28, 29, 30 and 31.
Livestock and Poultry Production, Chapter 14.

Publications

Kentucky Miscellaneous 140-B - Selected references.
Kentucky Miscellaneous 331 - pp. 1-6.
U.S.D.A. Farmers' Bulletin 2196 - Selected references.
"Making Beef Cattle Pay, The Southern States Way" - Selected references

Visual Materials

Transparency HS-45-9

10. To care for the cow and calf at calving time

Signs of parturition

a. Probably the first sign is the falling away or sinking in the regions of the tailhead and pin bones and a softening of the flesh in this area.
b. Second, the lips of the vulva will appear swollen and inflammed.
c. Third, there will be an enlargement of the udder and a change from a watery secretion to the thick yellow-colored colostrum.
d. The immediate indications that the cow is about to calve are extreme nervousness, uneasiness, separation from the rest of the herd, and muscular exertion and distress.
e. After a time, the "water bag" appears on the outside and ruptures from the weight of its own contents.

Preparation for calving

a. Provide a good place for the cow to calve

-- During warm weather, a good place for calving is a clean open pasture away from other livestock.
-- A clean, well-bedded, disinfected stall should be provided for cows calving in the barn.

b. Hogs should not run with the cow for they are likely to injure or kill the young calf.

Assisting the cow

a. Observe closely for signs of calving and help cows that are in trouble.

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b. After the cow starts to labor, observe closely to see if she is progressing normally. If the cow has severe labor for more than 1 to 2 hours without result, assistance usually is needed.
c. If the cow has difficulty, call the veterinarian or help the cow yourself.
d. When assistance is given:

-- Determine if the calf is in proper position. The front legs should be extended forward with the head resting on or between them. It may be necessary to correct the calf's position.
-- When the calf is in proper position, pull gently outward and upward.
-- Pull only when the cow attempts to labor.
-- The hand and arm should be disinfected before making entry.
-- Be sure there are no scratches or cuts on the hands and arms before entering the cow.

The newborn calf

a. It may be necessary to wipe the mucus from the nostrils to premit breathing.
b. Disinfect the navel of the newborn calf with tincture of iodine to help prevent navel infection.
c. The calf should be rubbed dry if the cow fails to lick it.
d. A weak calf may need help in order to nurse.
e. It is important that young animals receive plenty of sunshine and exercise.

Care of the cow

a. Provide plenty of water for the cow to drink.
b. Remove the afterbirth as soon as the cow has been cleaned, to prevent her from eating it.
c. If the cow does not expel the afterbirth within 48 hours, call the veterinarian.
d. Heavy milkers may need to be milked the first few days.
e. Feed a normal ration in a few days after calving.
f. Poor producers will need extra feed and care.
g. Be on the lookout for milk fever and grass tetany, both are caused by mineral imbalances in the cow. They are not as common in beef cattle as in dairy, however.

Suggested Teaching-Learning Activities

a. Suggested problem: How care for the cow and calf at calving time?
b. The student should understand that rarely is it necessary to assist a cow in calving. In severe cases always contact a veterinarian for professional help.
c. This is a valuable learning in beef cattle production. The less able student should be able to master this learning relatively easily.

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Suggested References and Instructional Materials

Books

Animal Science, pp. 407-410.
Beef Cattle Science, pp. 213-222.
Beef Production, pp. 141-144.
Beef Production in the South, pp. 535-539.
+Introduction to Livestock Production, Chapters 21 and 31.
+Veterinary Guide for Farmers, Selected references.

Publications

Kentucky Circular 494 - p. 10.
Kentucky Circular 554 - pp. 9-10.
"Making Beef Cattle Pay, the Southern States Way" - pp. 58-60.

11. To castrate beef calves

Reasons

a. More desirable beef development ("marbling" in the lean meat)
b. Longer and more economical gains than with bulls, unless a tranquilizer is used.
c. The animal is quieter and easier to handle.
d. The market presently discriminates against "bull beef," bringing less per pound.

Age

a. From 1 to 3 months old is probably the best time to castrate.
b. The older the animal at the time of the operation, the greater the shock and risk.
c. It is best to castrate in the early spring or late fall to avoid infestation from flies.

Methods

a. Removing the lower end of the scrotum (knife)
b. Slitting the scrotum down the sides (knife)
c. The bloodless methods

Equipment

a. Sharp knife
b. Clamps
c. Elastrator
d.

Materials

a. Disinfectants
b. Smear 62
c. Other good medications

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Precautions

a. Disinfect hands, equipment, and scrotum before castrating.
b. Thoroughly clean the calf stall and pen before the calf is castrated.
c. Apply Smear 62 to the scrotum after the operation, to prevent screw-worm infestation.

Suggested Teaching-Learning Activities

a. Suggested problem: How castrate beef calves?
b. Much of this learning can be taught by demonstration.

Steps to follow in preparing for the demonstration.

(1) Select a farm near the school and make proper plans for visiting the farm.
(2) Another possibility is to have a boy in class bring the calves to school for demonstration.
(3) Secure the needed equipment and materials for the demonstration. Do not allow boys to handle the equipment and materials until they are ready to use them.
(4) Arrange the demonstration so that all boys will be able to see.
(5) Demonstrate the method that the boys in class should be using.
(6) The teacher should practice the demonstration before performing it.

Performing the demonstration

(1) Review things discussed in class. Much of this review will be the "why" aspect of castrating.
(2) Explain thoroughly each step performed. Each boy should understand how and why it should be done this way.
(3) Observe the precautions already listed.

c. The demonstration is the best way to secure this learning with all students. The less able student should be able to master this, with adequate teacher help.
d. Transparency HS-45-11 should be helpful in discussing the various castration measures.

Suggested References and Instructional Materials

Books

Beef Cattle Science, pp. 413-417.
Beef Production, pp. 152-153.
Beef Production in the South, pp. 540-543.
+Introduction to Livestock Production, Chapter 31.
Livestock and Poultry Production, pp. 235-236.
+Veterinary Guide for Farmers, Selected references.

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Publications

Kentucky Circular 554 - pp. 10-11.
Kentucky Miscellaneous 103-B - pp. 1-3.
U.S.D.A. Farmers' Bulletin 2141 - Selected references.

Visual Materials

Transparency HS-45-11
Demonstration
- Chart
- Form (To show procedure, steps and materials needed)

12. To dehorn beef calves

Advantages of dehorning

a. Horned cattle are discriminated against on the market, bringing a lower price.
b. More room is needed for horned cattle.
c. Cattle with horns inflict more damage on equipment.
d. There is more danger to the operator in handling cattle with horns.
e. Horned cattle are inclined to keep others away from the feed.
f. Cattle with horns inflict bruises on each other that may result in heavy losses.

Disadvantages

a. Dehorning gives the animal a set-back.
b. Labor and equipment are required.
c. Some death losses occur.
d. Scars may result if the operation is not carefully done.

When to dehorn

a. The age to dehorn depends on conditions and method used in performing the operation.
b. Generally the sooner it can be done the better (a few days after calving).
c. When open wounds result from dehorning, it is better to perform the operation in cool weather. Otherwise, use a good fly repellent on the wound.

Methods (The age of the calf and available facilities determine which to use.)

a. Chemical method

-- Horn buttons may be prevented from growing.
-- A chemical should be used before the calf is 10 days old.

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-- The chemicals most commonly used are caustic potash and caustic soda.
-- Care should be used to prevent severe burns to the calf.
-- Cover the horn button with a dime's thickness of paste. Apply the paste with a stick.

b. Electric dehorners

-- Calves should not be over 3 months old when electric dehorners are used.
-- Apply the electric dehorner to the horn button for 10 seconds.
-- Have someone hold the animal's head securely.

c. Spoons and tubes

-- May be used on calves up to 3 months of age.
-- Sharp tubes of the proper size should be selected.
-- Use a fly repellent on the wound after this method is used.

d. Clippers and saw

-- Use when older cattle are to be dehorned
-- To prevent bleeding, tie off or pull out the main horn artery.
-- Remove about 1/2 inch of skin in order to remove the horn roots.

e. Rubber band

-- The chief advantage of this system is that a large open wound is avoided.
-- The rubber band shuts off circulation and the horn gradually comes off.

f. Preventing horns by breeding to polled bulls is a practical measure.

Precautions to follow in dehorning

a. Apply one of the following

-- Pine-tar
-- Pine-tar and tannic acid
-- EQ 335
-- Smear 62
-- Other good disinfectants

b. Disinfect equipment before dehorning

Suggested Teaching-Learning Activities

a. Suggested problem: How dehorn beef cattle?

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b. A demonstration should follow the class discussion. The preparation for the demonstration and performing the demonstration should be similar to preparing for castrating (listed under learning 11).
c. Once again, a demonstration is the best way to secure this learning with the students. The less able student should be able to master this learning with little difficulty.
d. Use of Transparency HS-45-12 should aid the discussion as to the various methods of dehorning beef cattle.

Suggested References and Instructional Materials

Books

Beef Cattle Science, pp. 406-413.
Beef Production, pp. 144-151.
Beef Production in the South, pp. 543-548.
+Introduction to Livestock Production, Selected references.
Livestock and Poultry Production, pp. 233-234.
Veterinary Guide for Farmers, Selected references.

Publications

Kentucky Circular 554 - pp. 12-14.
Kentucky Miscellaneous 100-B - pp. 1-2.
U.S.D.A. Farmers' Bulletin 2141 - Selected references.

Visual Materials

Transparency HS-45-12

13. To control external parasites

Common external parasites

a. Screwworm
b. Grubs
c. Cattle lice
d. Flies (horn, stable, face)
e. Ticks
f. Mites
g. Others

Consider these points for each parasite:

a. Parasite
b. Life history
c. Materials
d. How to use materials
e. When to use materials

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Some information about the life cycle of each is listed below.

a. Screwworm

-- Adult lays eggs along edge of open wound.
-- Eggs hatch into maggots and burrow into flesh.
-- Maggots feed from 4 to 7 days.
-- Adult worms drop to ground and burrow into soil.
-- They emerge as adult flies a few days later.
-- The life cycle of the screwworm is 21 days.

b. Grubs

-- Adult lays eggs and attach to hair on the heels and legs of cattle in spring and summer.
-- Eggs hatch in a few days, and burrow into the skin.
-- Grubs work their way upward through the muscles and into the body cavities.
-- They finally reach a position just beneath the skin on the back, and make a breathing hole.
-- Six weeks later the larva matures.

c. Cattle lice

-- Adult females glue their eggs to the hair of the host.
-- Eggs hatch in 7-18 days.
-- They reach maturity in 11-23 days.

d. Flies (horn, stable, face)

-- The life cycles of flies are somewhat different; however, they follow the same general pattern (egg, larva, pupa, adult).

e. Ticks

-- Ticks get on the animals to suck blood.

f. Mites

-- The entire life cycle is on the animal's body.

In the unit, Keeping Livestock Healthy, some general factors of controlling external parasites are discussed. The teacher should review with the class the factors listed under Learning 8, before handling a problem on controlling external parasites in beef cattle.

Suggested Teaching-Learning Activities

a. Suggested problem: How control external parasites of beef cattle?
b. Combining all the common external parasites of beef cattle together in one learning seems to be the most efficient use

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of time. Thorough discussion of the parasites in question should secure a desirable degree of learning for the class. Special attention to the less able student and involving him in the discussion should cause him to master the learning.

c. Use Transparency HS-45-13-1 to point out the parasites of most concern to beef producers. Transparency HS-45-13-2 may be used as a slide for a chart to be completed on the blackboard by the class. Discussion and use of Kentucky Miscellaneous 280-F is most valuable in completing the chart.

Suggested References and Instructional Materials

Books

+Animal Diseases, 1956 Yearbook of Agriculture, Selected references.
Animal Science, Selected references.
Beef Cattle Science, pp. 577-631 (Selected references).
Beef Production, pp. 232-240.
Beef Production in the South, pp. 680-708.
+Introduction to Livestock Production, Chapters 29, 30, 31, and 43.
+Veterinary Guide for Farmers, Selected references.

Publications

Kentucky Circular 502 - Selected references.
Kentucky Leaflet 301 - pp. 6-7.
Kentucky Miscellaneous 280-F - pp. 1-2.
Kentucky Miscellaneous 307-C - pp. 1-4.
"Making Beef Cattle Pay, The Southern States Way" - pp. 93-94.

Visual Materials

Transparencies HS-45-13-1 and HS-45-13-2

14. To control common stomach worms

Symptoms

a. Lack of growth
b. Loss of weight
c. A fluid accumulation in the lower jaw ("bottled-jaw")
d. Rough hair coat, large abdomen, anemia, and diarrhea

Prevention

a. Proper management and medication
b. Supply the medication to the animals
d. Sanitation is the most important means of prevention.

-- Placing water and feed where it will not be contaminated by droppings
-- Rotate pasture

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Treatment

a. Give the medication (use the latest University of Kentucky recommendations)
b. Repeat treatment, as needed.
c. After treatment turn animals on clean pasture.
d. Follow directions on the material that is being used.

Life cycle

a. Eggs of microscopic size pass in feces.
b. Eggs hatch in a few hours under favorable conditions.
c. Larvae reach infective state in 3 to 5 days.
d. Larvae taken into body with food or water.
e. Three to 4 weeks later the larvae reach maturity and produce eggs.

Factors affecting parasite infestation, damage done by parasites, and ways animals become parasite infected are discussed in the Unit, HS-36, Keeping Livestock Healthy.

Suggested Teaching-Learning Activities

a. Suggested problem: How control stomach worms in beef cattle?
b. Securing some samples of stomach worms would be a very helpful teaching aid for this learning.
c. Discuss the economic costs of stomach worms with the class, and be sure that the less able student grasps the importance of a good control program.
d.

Suggested References and Instructional Materials

Books

+Animal Diseases, 1956 Yearbook of Agriculture, Selected references.
Beef Production, pp. 240-241.
Beef Production in the South, pp. 659-670.
+Introduction to Livestock Production, Chapter 43.
Livestock and Poultry Production, pp. 413-414.
+Veterinary Guide for Farmers, pp. 189-195.

Publications

"Making Beef Cattle Pay, The Southern States Way" - pp. 91-92.

15. To control common diseases

Some common infectious diseases

a. Brucellosis
b. Blackleg
c. Shipping Fever
d. Foot Rot
e. Pink Eye

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Some common noninfectious diseases

a. Bloat
b. Grass tetany
c. Plant poisoning
d. Tetanus

Consider these aspects of each disease:

a. Disease
b. Cause
c. Symptoms
d. Prevention
e. Treatment

Selected information on common diseases is found below.

a. Brucellosis

-- Caused by Brucella abortus
-- Major symptoms are:

(1) Retained afterbirth
(2) Sterility
(3) Dead fetus
(4) Weak calves

-- Preventive measures are:

(1) Calfhood vaccinate calves
(2) Raise replacements
(3) Practice sanitation
(4) Follow eradication plan recommended by State Department of Agriculture

-- Treatment measures are:

(1) Test
(2) Slaughter infected animals

b. Blackleg

-- Caused by Clostridium chauvoci
-- Major symptoms are:

(1) High fever
(2) Loss of appetite
(3) Lameness
(4) Rapid breathing
(5) Gas-filled swellings on neck, shoulders, and chest
(6) When the swelling is stroked, it makes a cracking sound.
(7) Convulsions before death

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-- Preventive measures include:

(1) Vaccinate calves
(2) Burn or bury dead

-- Treatment measures include:

(1) Use anti-blackleg serum
(2) High dosage of antibiotics

c. Shipping fever

-- Caused by Pasteurella bouiseptica
-- Primary symptoms are:

(1) High fever
(2) Loss of appetite
(3) Discharge from nose
(4) Occational cough
(5) Swollen and watery eyes
(6) Stiffened gait
(7) Tongue is sometimes swollen
(8) Difficulty in breathing
(9) Bloody discharge from nostrils

-- Some preventive measures:

(1) Vaccinate with bacterins at least 10 days before shipping
(2) Avoid overexposure and drafty means of transportation

-- Some treatment measures

(1) Use antiserums
(2) Sulfa drugs
(3) High dosage of antibiotics

d. Foot rot

-- Caused by Actinomyces necrophorus
-- Symptoms include:

(1) Lameness
(2) Intense pain
(3) Loss of weight
(4) Milk production falls off
(5) Watery fluid runs from the infected area
(6) Grayish, cheesy discharge
(7) Foul odor

-- Preventive measures:

(1) Dry pastures and clean, dry barns help prevent foot rot
(2) Clean the premises after the trouble, to prevent spreading

-- Treatment measures:

(1) Trim away rotting portion
(2) Apply copper-sulphate solution
(3) Formaldehyde, etc.

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e. Pink eye

-- Caused by a virus (?)
-- Primary symptoms are:

(1) Animal sensitive to light
(2) Weakened eyes
(3) Watery eyes and swelling of the lids
(4) Eyeballs may become covered with a white film
(5) Severe pain

-- Preventive measure, segregate infected animals
-- Treatment measures, treat with silver nitrate

f. Bloat

-- Caused by overeating wet clover or lush grass
-- Symptoms include:

(1) Swelling of left flank
(2) Animal moves uneasily
(3) Difficult breathing
(4) Stomach may rupture
(5) Death may come within a few hours

-- Preventive measures:

(1) Feed animal dry hay before turning on legume pasture
(2) Have grass in the pasture mixture
(3) Keep good hay in the fold
(4) Keep cows off legume pasture after a rain

-- Treatment measures:

(1) Walk the animal
(2) Administer a kitchen detergent
(3) Puncture the paunch with a knife in severe cases only
(4) Use latest control measures

g. Grass tetany

-- Caused by a mineral imbalance, primarily related to the magnesium metabolism.
-- Symptoms are:

(1) Nervousness
(2) Loss of coordination
(3) Appetite loss
(4) Staggering and falling
(5) Some symptoms similar to tetanus
(6) If no treatment, coma and usually death
(7) Usually occurs only in early spring on lush, moist pasture conditions.

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-- Preventive measures include:

(1) Cleanliness
(2) Keep beef cows in clean quarters or on fresh pasture after parturition
(3) Check all wounds and treat if needed
(4) Keep animal area free of sharp objects
(5) Preventive immunization of animals can be done

-- Treatment includes:

(1) Administer tetanus toxoid
(2) Begin treatment early
(3) Call a veterinarian to administer the toxoid.

In the Unit, "Keeping Livestock Healthy," HS-36, some general measures of controlling common diseases are discussed. The teacher should review with the class the factors involved in Learnings 6 and 7 before handling a problem on controlling common diseases of beef cattle.

Suggested Teaching-Learning Activities

a. Suggested problems: How control common infectious diseases of beef animals? How control common noninfectious diseases of beef animals?
b. The two suggested problems would be useful if thorough discussion was made of each area of beef cattle diseases. Handling them as separate problems would appear to give a more desirable degree of relatedness. A teacher may deal specifically with any diseases that are presently giving trouble in the community. Specific problems on each major disease is probably the best method for teaching the less able student. The general approach will require much more teacher explanation for the less able student.
c. Transparency HS-45-15-1 and HS-45-15-2 should help in focusing the class attention on the two types of beef cattle diseases. They list more common diseases under each type.
c. Use Transparency HS-45-15-3 as an outline for a teacher-student "blackboard conclusion" in chart form. Permit the class to help complete the chart.

Suggested References and Instructional Materials

Books

+Animal Diseases, 1956 Yearbook of Agriculture, Selected references.
Animal Science, Chapter 5 (Selected references).
Beef Cattle Science, pp. 529-576 (Selected references).
Beef Production, pp. 231-232, and 242-256.
Beef Production in the South, Chapter 18.
+Introduction to Livestock Production, Chapter 43.
Livestock and Poultry Production, pp. 414-426.
+Veterinary Guide for Farmers, Selected references.

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-- Preventive measures:

(1) Feed good quality legume roughages in spring.
(2) Supply Magnesium oxide mineral to the animals, particularly in early spring.

-- Treatment measures:

(1) Call veterinarian
(2) Intravenous injections of calcium gluconate and magnesium.
(3) Treat within 8-12 hours, otherwise recovery chances are slight.

h. Plant poisoning

-- Many plants may cause poisoning. Most plants are more poisonous at certain stages of growth. An example is fescue (fescue foot).
-- Symptoms include <u>some</u> of the following:

(1) Lameness (fescue foot)
(2) Temperature changes
(3) Nervousness
(4) Unsteady gait
(5) Hemorrhage (usually small)
(6) Diarrhea
(7) "Slobbers"

-- Preventive measures:

(1) Provide good forage, as animals tend not to consume the poisonous plants, as they are not as palatable as pasture plants
(2) Keep an eye on the pastures to look for such problems.

-- Treatment measures:

(1) Call a veterinarian
(2) Remove the animals from the pasture, immediately.

i. Tetanus (lockjaw)

-- Caused by <u>Clostridium tetani</u>
-- Symptoms include:

(1) Often follows deep puncture wounds and operations
(2) Chewing is difficult
(3) Muscle spasms - rigid
(4) Jaws become set - "locked"
(5) Legs spread and stiffen
(6) Tail and ears are elevated and stiff
(7) Death occurs in 7-10 days in up to 90% of untreated cases

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Publications

Kentucky Circular 494 - p. 13.
Kentucky Leaflet 123 - pp. 1-4.
Kentucky Leaflet 192-A - pp. 1-4.
Kentucky Leaflet 301 - pp. 6-7.
"Making Beef Cattle Pay, The Southern States Way" - pp. 89-91

Visual Materials

Transparencies HS-45-15-1, HS-45-15-2 and HS-45-15-3

16. To market beef animals

Grades

a. Slaughter grades (steers and heifers)

-- Prime
-- Choice
-- Good
-- Standard
-- Commercial
-- Utility
-- Cutter
-- Canner

b. Stocker and feeder grades

-- Prime
-- Choice
-- Good
-- Standard
-- Commercial
-- Utility
-- Inferior

Market demand

a. The market demands the kind of beef that will furnish a high percentage of the quality cuts that the consumer wants.
b. The consumer wants red meat, with a minimum of fat.
c. High Good to Choice grades furnish the quality of meat the consumer demands.

Time to Sell

a. The amount and kind of feed available will help determine the time to sell.
b. When grain is abundant, the tendency is for long feeding periods.
c. A knowledge of the number of cattle available at a given time, feed conditions, prices of slaughter cattle, and the employment situation will help one determine when to sell.
d. Sell cattle when they are ready to sell.
e. Sell cattle when the market is high.

Factors affecting the market to use

a. Current price per hundred weight
b. Transportation costs
c. Selling price
d. Shrinkage
e. Service rendered by the market
f. Weighing conditions

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Handling losses (bruises)

a. Causes of bruises

-- Crowding, bumping and rushing
-- Trampling
-- Cane, whip, and club
-- Horned cattle
-- Other

b. Where bruises occur

-- Bruised areas in the carcass must be trimmed out.
-- The area of the carcass removed cannot be sold for human consumption.
-- The highest percent of bruises occurring on beef animals is in the regions of the most valuable cuts.

(1) loins, 45 percent
(2) rump, 7 percent
(3) round, 12 percent
(4) ribs, 17 percent
(5) shoulder, 11 percent
(6) plates, 8 percent

c. Reducing bruises

-- Drive carefully
-- Inspect load frequently
-- Unload slowly
-- Use canvas slappers
-- Use proper kind of loading chute
-- Do not overload

Suggested Teaching-Learning Activities

a. Suggested problem: How market beef animals?
b. Marketing beef animals is a complex matter, as there are numerous variations as to grades, type of market, and so on. Study of the beef grades and discussion relating to the market use of the animals is helpful in securing high quality learning.
c. Involve the less able student in the discussion relatively early so they will be able to participate.
d. A field trip to a stockyard or cattle sale would be very helpful in securing this learning.
e. Transparency HS-45-16-1 will be helpful in getting the grades before the class for discussion purposes.
f. Use Transparency HS-45-16-2 as a summary once the learning is completed.

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VT 008 496
Radio and Television. Curriculum Guides in Trade and Industrial Education.

District of Columbia Public Schools, Washington, D.C.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 64 52p.

DESCRIPTORS - *CURRICULUM GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *ELECTRONICS; ELECTRONIC TECHNICIANS; *RADIO; *TELEVISION; ELECTRICITY; INSTRUCTIONAL MATERIALS; TEACHING GUIDES; VOCATIONAL EDUCATION; ELECTRIC CIRCUITS; TESTS

ABSTRACT - Developed by the Trade and Industrial Education Division of the District of Columbia public school system in cooperation with curriculum committees, this curriculum guide was developed for instructor use in providing a 3-year (1,620 hours) training program for radio and television technicians at the high school level. Specific objectives include teaching students to read and interpret electronic circuit diagrams, to operate and calibrate test instruments used in electronics, and to perform the skills required of electronic technicians efficiently. Suggested organization, management, and teaching techniques are presented, along with sample instruction sheets and tests. Subject matter blocks, accompanied by a time allotment for each unit outline are: (1) Basic Electronics, (2) Radio Servicing, (3) General Television Servicing, and (4) Television Bench Servicing. (GEB)

VT 008 496

Suggested References and Instructional Materials

Books

Animal Science, Chapter 15 (Selected references).
Beef Cattle Science, Chapter 15 (Selected references).
Beef Production, Chapter 11.
Beef Production in the South, Chapter 21.
+Introduction to Livestock Production, Chapters 37, 38, and 39.
Livestock and Poultry Production, Chapter 15.

Publications

Kentucky Circular 494 - pp. 12 and 14-16.
Kentucky Circular 554 - pp. 16-19.
Kentucky Circular 574 - pp. 3-11.
Kentucky Circular 615 - Selected references.
Kentucky Leaflet 301 - p. 7.
Kentucky Miscellaneous 312 - Selected references.
"Making Beef Cattle Pay, The Southern States Way" - pp. 25-26.

Visual Materials

Transparencies HS-45-16-1 and HS-45-16-2

Evaluation

Evaluate the unit as to the usefulness in securing desired student learning activities.

The approved practices list developed by the class members should be useful in evaluating the unit. Work with each student in keeping production and feed records accurate and up to date. Figure the feed cost per unit of production with each individual student having a beef enterprise. Teacher visits to the individual student's farm setting is essential in getting the practices adopted by the student.

References

Books

+Animal Diseases, 1956 Yearbook of the Department of Agriculture, U.S.D.A. (United States Government Printing Office, Washington, D. C., 1956) 591 pp.

+Animal Nutrition, Sixth edition; Maynard and Loosli (McGraw-Hill Book Company, New York, 1969) 613 pp.

Animal Science, Sixth edition; Ensminger (The Interstate, Danville, Illinois, 1969) 1253 pp.

Beef Cattle Science, Fourth edition; Ensminger (The Interstate, Danville, Illinois, 1968) 1020 pp.

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Beef Production, Second edition; Diggins and Bundy (Prentice-Hall, Inc., Englewood Cliffs, N. J., 1962) 341 pp.

Beef Production in The South, Fowler (The Interstate, Danville, Illinois, 1969) 858 pp.

Experience Programs for Learning Vocations in Agriculture, Binkley and Hammonds (The Interstate, Danville, Illinois, 1970) 604 pp.

Feeds and Feeding, Abridged, Ninth edition; Morrison (The Morrison Publishing Company, Ithaca, New York, 1958) 684 pp.

+Introduction to Livestock Production, Second edition; Cole (W. H. Freeman and Company, San Francisco, California, 1966) 827 pp.

Livestock and Poultry Production, Third edition; Bundy and Diggins (Prentice-Hall, Inc., Englewood Cliffs, N. J., 1968) 723 pp.

+Veterinary Guide for Farmers, Third Edition; Stamm and Burch (Windsor Press, 200 East Ontario Street, Chicago, Illinois, 1957) 371 pp.

Publications

Kentucky Circular 494 - "The Kentucky Cow and Calf Plan," 16 pp.
Kentucky Circular 502 - "Some Plants of Kentucky Poisonous to Livestock," 57 pp.
Kentucky Circular 554 - "Feeder Calf Production," 19 pp.
Kentucky Circular 574 - "What Makes the Price of Beef," 11 pp.
Kentucky Circular 615 - "Beef Carcass Evaluation," 17 pp.

Kentucky Leaflet 123 - "Black Leg of Cattle," 4 pp.
Kentucky Leaflet 192-A - "Wipe Out Brucellosis," 4 pp.
Kentucky Leaflet 301 - "Producing Feeder Calves in Kentucky," 8 pp.
Kentucky Leaflet 314 - "Kentucky 'On The Farm' Bull Performance Testing," 6 pp.

Kentucky Miscellaneous 100-B - "Dehorning Beef Calves," 2 pp.
Kentucky Miscellaneous 103-B - "Castration of Beef Cattle," 3 pp.
Kentucky Miscellaneous 105 - "A Mineral Feeder for Cattle," 3 pp.
Kentucky Miscellaneous 140-B - "Kentucky Beef Cattle Facts," 16 pp.
Kentucky Miscellaneous 280-F - "Insecticide Recommendations for Beef Animals," 2 pp.
Kentucky Miscellaneous 307-C - "Making and Using a Cattle Backrubber," 4 pp.
Kentucky Miscellaneous 312 - "Organizing and Conducting Special Feeder Calf Sales," 16 pp.
Kentucky Miscellaneous 331 - "Feed Additives and Implants for Beef Animals," 6 pp.

+Kentucky Progress Report 176 - "Animal Sciences Research Report, 1968"; 88 pp.
+Kentucky Progress Report 181 - "Animal Sciences Research Report, 1969"; 78 pp.

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U.S.D.A. Farmers' Bulletin 2126 - "The Farm Beef Herd," 16 pp.
U.S.D.A. Farmers' Bulletin 2141 - "Dehorning, Castrating, Branding, and Marking," 16 pp.
U.S.D.A. Farmers' Bulletin 2196 - "Finishing Beef Cattle," 30 pp.
U.S.D.A. Farmers' Bulletin 2228 - "Beef Cattle Breeds," 28 pp.

"Breeders' Reference Guide," The American Angus Association, St. Joseph, Missouri, 72 pp.
"Charolais--For Progress in Beef Production," American - International Charolais Association, 923 Lincoln Liberty Life Building, Houston 2, Texas, 18 pp.
"The Future Cattleman," The American Hereford Association, Hereford Drive, Kansas City 5, Missouri, 60 pp.
"Making Beef Cattle Pay, The Southern States Way," Southern States Cooperative Information - Publications Service, (Available through the local Southern States Cooperative Dealerships) 94 pp.

Visual Materials

Transparency masters were developed for this unit and accompany it. They are keyed to specific learnings and should be very helpful at the point indicated.

+Teacher Reference Only.

11962

OPPORTUNITIES IN THE BEEF BUSINESS

Feeder Production

Purebred Production

Kentucky Cow and Calf Plan

Slaughter Production

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saeff

FACTORS DETERMINING THE KIND OF BEEF OPERATION

A. AVAILABLE FEEDS

B. BUILDINGS AND EQUIPMENT

C. CAPITAL NEEDED = $

D. MARKETS AVAILABLE

E. PERSONAL PREFERENCES

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COMMON BREEDS OR KINDS OF BEEF ANIMALS

ANGUS
("Black" and
Red Angus)

HEREFORD

SHORTHORN
Horned
Polled

CHAROLAIS
Charlais
Charbray

BRAHMAN

SANTA GERTRUDIS

CROSSBREEDS
(Many combinations)

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SELECTING A BREEDING ANIMAL

TYPE (Body Conformation by Visual Inspection)

PEDIGREE — (Ancestral Record of the Individual)

PERFORMANCE (Performance Testing by Unbiased Source)

OTHERS (Includes Individual Specific Factors)

Health	Soundness
Size	Source
Age	Reproductive Ability
Condition	Milking Ability (Female)

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FEEDER CATTLE GRADES

Prime

Choice

Good

Standard

Commercial

Utility

Inferior

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METHODS OF MATING

Hand Mating

Pasture Mating

Artificial Insemination

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ED0 56238

CURRICULUM GUIDES
In Trade and Industrial Education

VT008496

Public Schools of the District of Columbia

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FEEDING FATTENING BEEF CATTLE

ROUGHAGES
- Legume Hay
- Silage
- Mixed or Grass Hay
- Stovers and Fodders
- Haylage
- Cubed Roughages

CONCENTRATES
- Grains
  - *Corn
  - Barley
  - Rye
  - Oats
  - Wheat
  - Grain Sorghum

Minerals

Vitamins

Feed Additives
- Stilbestrol
- Antibiotics
- Tranquilizers

Protein Supplements
- Soybean Meal
- Urea
- Commercial Supplements
- Others

PASTURES

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METHODS OF CASTRATION

KNIFE

A Removing lower end of scrotum

B Slitting sides of scrotum

CLAMPS

- Crushing cords (bloodless)

ELASTRATOR

- Tying off with a rubber band (bloodless)

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METHODS OF DEHORNING

CHEMICAL DEHORNING

ELECTRIC DEHORNING

SPOON AND TUBE

DEHORNING CLIPPER

HANDSAW

RUBBER BAND

USE OF POLLED BULLS

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COMMON EXTERNAL PARASITES OF BEEF CATTLE

Screwworm

Grubs

Cattle lice

Flies (horn, stable, face)

Ticks

Mites

Others

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CONTROL EXTERNAL PARASITES

PARASITE	LIFE HISTORY	MATERIALS	HOW - TO USE	WHEN TO USE

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HS-45-13-2

COMMON INFECTIOUS DISEASES OF BEEF CATTLE

Brucellosis

Blackleg

Shipping Fever

Foot Rot

Pink Eye

HS-45-15-1

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COMMON NONINFECTIOUS DISEASES OF BEEF CATTLE

Bloat

Grass Tetany

Plant Poisoning

Tetanus

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HS-45-15-2

CONTROL OF COMMON _____ DISEASES

DISEASE	CAUSE	SYMPTOMS	PREVENTION	TREATMENT

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HS-45-15-3

BEEF CATTLE GRADES

Slaughter grades (steers and heifers)

Prime
Choice
Good
Standard
Commercial
Utility
Cutter
Canner

Stocker and Feeder grades

Prime
Choice
Good
Standard
Commercial
Utility
Inferior

HS-45-16-1

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BEEF MARKETING NOTE

There is an old saying in
regard to beef cattle marketing:

"Buy when prices are low,
Sell when prices are high,
And you will make money."

- Author Unknown

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Public Schools of the District of Columbia

CARL F. HANSEN, Superintendent of Schools

Curriculum Guides in Trade and Industrial Education

RADIO AND TELEVISION

TRADE AND INDUSTRIAL EDUCATION

HAROLD A. CLARK, Assistant Superintendent, Adult, Industrial Educatioon

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ROBERT J. VOLLAND, Supervising Director

BERTHA H. BOLDEN, Assistant Director

JOHN M. RIECKS, Deputy Superintendent

LUVERNE C. WALKER, Director of Curriculum

1964 Reprint

1195

VT 012 780
Hayes, Anne C.
Waiter, Waitress, Hostess. Post Secondary Food Service Guide.

Kentucky Univ., Lexington. Instructional Materials Lab.
MF AVAILABLE IN VT-ERIC SET.
Instructional Materials Lab., Room 151, Taylor Education Bldg., Univ. of Kentucky, Lexington, Ky. 40506 (one copy free to State Directors and Head Teacher Educators in Home Economics).
PUB DATE - 70 33p.

DESCRIPTORS - *OCCUPATIONAL HOME ECONOMICS; *FOOD SERVICE WORKERS; JOB TRAINING; FOOD SERVICE INDUSTRY; BIBLIOGRAPHIES; EDUCATIONAL RESOURCES; POST SECONDARY EDUCATION; *TEACHING GUIDES; JOB SKILLS

ABSTRACT - This teaching guide was developed by a home economics specialist of an instructional materials laboratory to provide a 100-hour postsecondary training and practice program for potential waiter/waitress and hostess work. Behavioral objectives, broad and supporting generalizations, teaching and evaluating strategies, and resources are provided for these units: (1) Orientation, (2) Personal Characteristics, (3) Functions of a Waiter, Waitress, and Hostess, (4) Supplemental Duties, (5) Safety, Sanitation, Health, and Hygiene, and (6) Host/Hostess Responsibilities. Sources of resource materials and a bibliography are included. (SB)

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WAITER

WAITRESS

HOSTESS

Post Secondary Food Service Guide

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Home Economics Specialist
Instructional Materials Laboratory
for
Vocational Education
University of Kentucky
Lexington, Kentucky 40506

1970

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FOREWORD

This Waiter, Waitress, Hostess guide has been developed for Vocational Home Economics postsecondary training programs in food service occupations.

The guide was prepared by:

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The material was prepared in consultation with Miss Mary Bell Vaughan, State Director and Mrs. Sarah T. Henry, Assistant State Director, Home Economics Education, State Department of Education, Frankfort, Kentucky.

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Final editing for the guide was done by Dr. Herbert Bruce, Director, Instructional Materials Laboratory.

The cover was designed by Mr. Raymond Gilmore, Artist, Instructional Materials Laboratory, University of Kentucky.

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VIII.	Safety, Sanitation, Health, and Hygiene	23
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INTRODUCTION

This guide has been developed to provide training and practice for potential waiter/waitress and hostess work for postsecondary food service training programs for Vocational Home Economics in Kentucky. Upon completion of this course, the trainee should be able to apply general knowledge to specific situations so that he will be a more valuable and a more productive employee in the food service industry.

This guide is used interchangeably with the Basic Food Service Guide. Cross references to the Basic Guide for supporting generalizations, teaching-evaluating strategies, and resources are given in particular units as Orientation; Personal Characteristics; and Safety, Sanitation, Health and Hygiene to avoid repetition. The teaching-learning strategies selected for use should be appropriate for and adapted to meet the needs of the group being taught.

The units included in this guide are: Orientation; Personal Characteristics; Functions of a Waiter, Waitress, Hostess; Supplemental Duties; Safety, Sanitation, Health and Hygiene; and Host/Hostess Responsibilities.

It is the perogative of the teacher as how this material is adapted and used to accomplish the desired objectives for the occupation being taught.

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Waiter, Waitress, Hostess

Entry Requirement: Commitment to food service for gainful employment. Meets requirement for food handlers permit.

Program Objective: Train for salable skills as a waiter, waitress, and hostess in restaurants, coffeeshops, cafeterias or other dining services.

Behavioral Objectives: As a result of this program the trainee will:

- identify available occupations.
- demonstrate poise and an attractive appearance.
- practice good working relationships with others.
- demonstrate ability to greet people and escort them to a table
- demonstrate skill in waitress functions such as:
    - presenting menus
    - taking orders
    - relaying orders to kitchen
    - serving courses of food
    - totaling bills
    - accepting payment
- be able to set up and serve banquets.
- identify menu terms and food combinations.
- demonstrate skill in clearing and resetting tables.
- demonstrate skill in loading and carrying trays.
- be able to perform supplemental duties such as:
    - sidework
    - ladling soup
    - tossing salads
    - portioning desserts
    - brewing coffee and tea

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- use equipment correctly.
- develop an attitude of good public relations.
- practice acceptable work habits.

Length of Course: 100 clock hours.

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Course Outline

I. Orientation

A. Course objectives

B. Job opportunities

C. Requirement for entering food service occupations

D. Applying for a job

E. Benefits

II. Personal Characteristics

A. Physical characteristics

B. Personality traits

C. Work habits

III. Functions of a Waiter, Waitress, Hostess

A. Definition

B. Duties

C. Greeting guests

D. Menus

1. Presenting menu

2. Terminology

3. Interpreting

E. Taking the order

F. Setting up for service

1. Tables

2. Booths

3. Counters

4. Special service

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G. Unusual and difficult customers

H. Relaying and assembling the order

I. Loading and carrying trays

J. Clearing the table

K. Preparation and presentation of guest check

L. Accepting payment

M. Cashier - customer relations

N. Tips

O. Lost and found articles

IV. Supplemental Duties

A. Side work

B. Special parties

C. Special forms of service

D. Table decorations

E. Busboy

V. Safety, Sanitation, Health, and Hygiene

A. Storage of food

B. Housekeeping procedures

C. Accidents

VI. Host/Hostess Responsibilities

A. Definition

B. Duties

C. Telephone

D. Information

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UNIT I: Orientation

BEHAVIORAL OBJECTIVE: The student will:

- be able to name available occupations in the food service industry.
- analyze employment policies in a written report.
- practice procedures involved in looking for and interviewing for a job.

BROAD GENERALIZATION: Waiter/Waitress employment affords active, varied, and interesting work for the individual who has the physical ability and personal qualifications to undertake it.

Supporting Generalizations	Teaching-Evaluating Strategies	Resources
1. Refer to Basic Guide, pages 8-10, Supporting Generalizations 1-8. 2. A waiter-waitress may choose a location best suited to his interests. 3. The demand for experienced food service personnel exceeds the supply.	1. Refer to Basic Guide, pages 8-10, Teaching-Evaluating Strategies: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 as they apply to waiter, waitress, hostess training. 2. Discuss the changes in modern life which have affected the use of food service operations and the types of service they offer. 3. Refer to Basic Guide, pages 10-11, Teaching-Evaluating Strategies: 14, 15, 16, 17, 18. 4. Develop and discuss an organization chart for more common types of food service operations showing the relation of various functions and the lines of authority. 5. Refer to Basic Guide, page 11, Teaching-Evaluating Strategies: 19, 20, 21, 22.	Refer to Resource List, Basic Guide, pages 8-10. BULLETINS: Training Food Service Personnel Training Yourself for Food Service Cinda Service Speaks Out About Your Career As a Sales Hostess The Correct Waitress The Waiter and His Public Making the Most of Your Job Interview

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Elmer H. Aylor
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Alvin Rosen
Radcliffe A. Harewood
Donald A. Smith
Edwa.d B. Smith

4. Employers consider training which gives employees a background knowledge of food and understanding of suitable methods of service invaluable because it enables the customer to be served more intelligently and efficiently.

5. Refer to Basic Guide pages 11-12, Supporting Generalization, 9-10.

6. Use local paper and study want ads to analyze the demand for food service workers.

7. In small groups analyze the advantages of vocational training for food service sales work and share findings with class.

8. Refer to Basic Guide, pages 11-13, Teaching-Evaluating Strategies: 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33.

BOOK:

<u>Professional Restaurant Service</u>

POSTERS:

"Tips to Make More Tips"

FILMSTRIP:

"Food Service: A Career To Consider"

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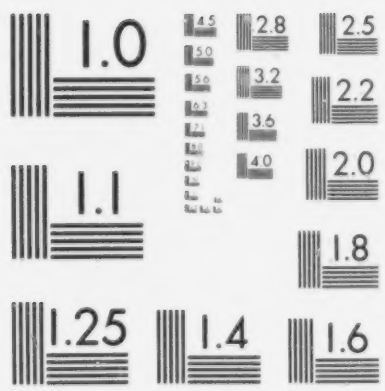

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

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UNIT II: Personal Characteristics

BEHAVIORAL OBJECTIVE: The student will:

- apply the principles of poise and attractive appearance.
- practice good working relations with others.
- develop acceptable personal qualities important for successful employment in food service.

BROAD GENERALIZATION: Appearance, physical condition, and conduct of a waiter/waitress affects their initial employment, job rating, and possible promotions.

Supporting Generalizations	Teaching-Evaluating Strategies	Resources
1. Refer to Basic Guide, pages 19-20, Generalizations: 1, 2, 3, 4, 5, 6.	1. Refer to Basic Guide, pages 19-21, Teaching-Evaluating Strategies: 1, 2, 3, 4, 5, 6, 7, 8, 9.	Refer to Basic Guide, Resources, pages 19-21.
2. The well-groomed waiter/waitress is one who carefully attends to all details of health, manners, hair, figure, makeup, clothes, posture, cleanliness.	2. Discuss sales psychology from terms of: -- appearance -- mannerisms -- speech -- courtesy and tact -- acknowledging customer's presence Role play how each item affects a customer.	BULLETINS: <u>The Waiter and His Public</u> <u>Cinda Service Speaks Out About Your Career As a Sales Hostess</u>
3. A waiter/waitress may advertise the business favorably by his appearance, his actions, his interest, and his enthusiasm.	3. Refer to Basic Guide, pages 21-22, Teaching-Evaluating Strategies: 10, 11.	FILMSTRIP: "Serve 'Em Right"
4. Refer to Basic Guide, page 22, Generalizations: 7, 8, 9, 10.		FILM: "How Do You Look When It Counts?"

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5. A waiter/waitress should possess the characteristics of interest, initiative, capability, loyalty, honesty, dependability, and willingness to accept direction. 6. Refer to Basic Guide, page 23, Generalizations: 11, 12, 13, 14 7. Waiter/waitress work makes great demands upon the food service worker's tolerance and patience. 8. The waiter/waitress has an obligation to be pleasant to the management, the customer, and fellow workers.	4. Discuss actual cases or incidents from experience where good will was created or destroyed with a customer by a waiter/waitress. 5. Dramatize customer-employee relationships that help create good will. 6. Refer to Basic Guide, pages 22-23, Teaching-Evaluating Strategies: 12, 13, 14, 15, 16, 17, 18, 19, 20, 21.	BOOK: <u>Professional Restaurant Service</u>

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UNIT III: Functions of a Waiter, Waitress, Hostess

BEHAVIORAL OBJECTIVE: The student will:

- demonstrate ability to greet people and escort them to a table.
- demonstrate skills in waiter/waitress functions.
- use equipment correctly.

BROAD GENERALIZATION: Waiter, waitress, and hostess functions include all activities concerned with customer relations, primarily the selling or merchandising of food and services.

Supporting Generalizations	Teaching-Evaluating Strategies	Resources
1. A waiter/waitress sells service, esteem and satisfaction as well as food. 2. The primary function of the host/hostess is to offer hospitality as a representative of the management. 3. Food service units are usually classified by type of services rendered. 4. The efficienty of the waiter/waitress is measured by the completeness with which he performs his duties before the meal service, before taking the customer's order, after the meal service, and after the customer has left the table.	1. Define - Identify waiter, waitress, and hostess work 2. Discuss the various types of waiters - waitresses such as: - curb waitress - fountain waitress - cafeteria waitress - floor waitress - other 3. Identify the various duties of a waiter - waitress as: - welcoming guests - seating guests - setting up tables - sidework	BULLETINS: Training Food Service Personnel The Waiter and His Public Training Yourself for Food Service Waiter-Waitress Judy The Waitress Nick The Waiter Essentials of Good Table Service

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	- order taking - serving orders - cleaning up - others	BOOK: Professional Restaurant Service
	4. Set the classroom up into a restaurant type situation to carry out waiter/waitress functions.	
5. It is the responsibility of food service personnel to meet and seat customers.	5. Role play the reception and seating of customers by a: - waiter - waitress - hostess - others	BULLETINS: Training Food Service Personnel The Waiter and His Public Cinda Service Speaks Out.
	6. Discuss the differences and similarities of the seating of guests by each of the above.	
6. The waiter/waitress should be familiar with the menu content, its arrangement and its prices. 7. The menu tells the customer what is available, how it is prepared and how much it costs.	7. Demonstrate and practice the correct method for presenting a menu to a customer. 8. Discuss reasons why waiters/waitresses need to be familiar with items on the menu. 9. Define various terms used on menus as: - appetizer - entrée - au jour - à la mode - au jus - others 10. Using a matching quiz, have trainees check their knowledge of menu terms.	BOOKS: Professional Restaurant Service A Cook's Quiz Menu Dictionary, Multilingual Glossary of French Culinary Terminology, Foods and Confections

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	11. Show the difference in table d'hôte and à la carte menus and service using actual menus or charts.	
8. The waiter/waitress should know basic information regarding items on the menus.	12. Have class members develop a check list for checking through the menu. Things to be included might be: - availability of items - neatness, cleanliness, legibility - terminology of items - à la carte and table d'hôte items - food substitutions on à la carte and dinner items - prices	
9. The waiter/waitress should be informed concerning the methods of preparing the food item he serves.	13. Dramatize situations in which a waiter/waitress gives an explanation about the menu to a customer. 14. Use a tape recorder to evaluate class members' ability to speak clearly and to provide correct information. 15. Demonstrate and role play the taking of a customer's food order.	BULLETINS: <u>Training Food Service Personnel</u> <u>The Waiter and His Public</u> <u>Cinda Service Speaks Out</u> . FILM: "Taking The Order"
10. A waiter/waitress may help the customer by either giving him information or making suggestions regarding food selection.	16. Discuss or role play how to assist a customer in making a decision and when he asks, "What's good today?" 17. Discuss: "What information does a customer have a right to expect from a waiter/waitress?" 18. Demonstrate the proper method for writing up of orders on an order pad.	

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11. A check is used as a means of recording the order, as the customer's bill, and as a source of information about the sale.

12. Good service is an important factor in attracting and keeping patronage.

13. Each food service operation has certain policies of operation and standards of service.

14. There are several methods of table service and each food service unit should follow the method suitable to its particular conditions.

19. Have class members practice taking orders and checking written orders for:

- proper technique
- table number
- abbreviations
- systematic system
- legibility
- combined or separate checks
- when to serve beverage

20. Discuss techniques that add to making a meal more pleasant such as:

- prompt service
- pleasant attitude
- refilling of water glass
- refilling of beverages
- ease in caring for accidents
- attentive attitude

21. In relation to table set-ups define:

- cover
- edge of cloth
- set line

22. Research, demonstrate, and discuss typical table settings as:

- simple breakfast
- complex breakfast
- lunch
- simple dinner
- complex dinner
- soup and sandwich
- salad
- salad and sandwich
- dessert
- side dish placement

BULLETIN:

Correct Waitress

BULLETINS:

Cinda Service Speaks Out . .

The Correct Waitress

The Waiter and His Public

FILMSTRIP:

"Food Service"

SLIDES:

"Table Setting"

FILM:

"Table Settings"

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15. The waiter/waitress should provide tables that are properly set before service is given.

23. Have class members draw each setting and practice each type of setting.

24. Use diagrams, transparencies, flannelboard, etc. of a series of cover set ups to illustrate table settings. Discuss each and the reason for each appointment.

25. Have class members to practice setting a variety of table settings using various menus to determine appointments used.

26. Demonstrate and practice the placement of additional silverware for a dinner menu requiring pieces such as:

- cocktail fork
- soup spoon
- dessert spoon
- parfait spoon
- butter knife
- others

27. Using sample menus consisting of three or four courses, have class members make a list of equipment and accompaniments needed to serve each course.

28. Demonstrate and have trainees practice until they can quickly lay linen and fold napkins in the standard form and with fancy variations.

BOOK:

Professional Restaurant Service

BULLETINS:

Training Food Service Personnel

The Waiter and His Public

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16. There are several methods of table service and each food service unit should follow the appropriate method suitable to the unit.	29. Demonstrate and practice the correct hand procedure to use in table service.	BULLETINS:
	30. Role play or use actual meals to practice correct serving techniques.	Cinda Service Speaks Out . . Correct Waitress
	31. Demonstrate methods for special service such as: - offering hot breads - bowl of salad for self service - relish dishes - crumbing a table - compartment serving dishes from which a choice is made - others	Training Food Service Personnel
	32. Have class members practice special service.	BULLETIN:
	33. Discuss and demonstrate acceptable techniques for serving children.	The Correct Waitress
	34. Research the correct method for booth service.	
	35. Discuss booth service in relation to: - number of guests - placement of food - proper service techniques - clearing wall booths or table	BULLETIN: Cinda Service Speaks Out . . Correct Waitress
	36. Research the correct method for counter service.	
	37. Practice setting up and serving a counter customer.	

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FOREWORD

A General Statement of the Trade

Electronics has steadily and progressively transformed the Modern Age, from which we are currently moving, into an age of wonder; a world of dreams come true; a fairyland in which there lives a race of men who can see beyond the horizon and great distances; communicate great distances. These men travel to the "Never Never Land" of space; their mechanical slaves obey their wishes, solve their problems and predict the future. The difference between this age and the magic of fairytales is that instead of fast-moving giants, all-knowing fairies, all-hearing witches, all-seeing elves, and crystal balls, there are gadgets called television, radio, radar, computers and a host of other electronic devices.

It seems likely that this new age will be referred to by future generations as the "Age of Electronics." Our progress in this new age will depend upon the quality and number of scientists, engineers, and technicians we can produce. The need for technicians to construct, install, maintain and service electronic equipment continues to grow as more and more products are produced.

This course is designed to help fulfill the need for technicians by providing students with the knowledge and skills needed for successful entrance into the trade areas of Television and Radio. It will also provide them with a foundation on which they can build additional competence in these areas and those allied to them.

Prerequisites of Entrance Into the Trade

A thorough knowledge of mathematics and science is needed by the technician to aid in the solution of problems in the daily performance of duties. Jobs sometime require long hours of painstaking manipulation. Therefore, students entering training in this trade should have an aptitude for math and science, and a willingness to work hard. Instruction begins with the assumption that the student has completed the ninth grade and can do average or better than average work.

Time Required to Complete the Course

The time requirement for a high school diploma and a certificate in the Radio and Television course is three (3) years. Laboratory practice or shop work is scheduled for three (3) clock hours daily, 15 hours per week. One and one-half hours per day are spent in related subjects--science, mathematics and/or art. One and one-half hours are spent in academic subjects. Five hundred and forty (540) hours are spent in shop work per year -- a total of 1620 hours for the three year course.

17. Unusual and difficult customers should be handled with intelligence, tact, and good judgment.	38. Identify unusual and difficult customers such as: - blind people - deaf people - diabetics - hand injury - intoxicated people - boisterous people - others	FILM: "Courtesy: The Inside Story"
	39. Role play correct methods to use in assisting and serving an unusual and difficult customer.	
	40. Provide class members mimeographed outlines of detailed serving instructions.	BULLETIN: <u>Training Food Service Personnel</u>
	41. Evaluation: Have class members select a menu for a special group and make out the linen order, dish list, table setting, work schedule and serving directions.	FILM:
	42. Resource person or chef from an established restaurant to explain the method of placing kitchen orders.	"Introducing Alice: A Good Waitress"
18. Giving and collecting orders in the kitchen vary with the organization, layout, and regulations of the food service unit.	<u>Field Experience</u> 43. Visit several types of food service establishments to observe kitchen ordering system, proper assembling of an order and sequence used for ordering and picking up order.	
	44. Have students demonstrate good and bad methods of calling orders.	BULLETINS: <u>Training Food Service Personnel</u>

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19. The kitchen and dining room layout and the type of food service affect the duties assigned to waiters/waitress and the manner in which these duties are performed.	45. Record calling of orders and have class evaluate them.	The Waiter and His Public Cinda Service Speaks Out . .
	46. Observe various kitchen and dining room layouts illustrating the location of various departments and how this affects the giving and assembling of an order.	
	47. Demonstrate and have class members practice assembling an order, loading, and carrying a tray.	BOOK: Professional Restaurant Service
	48. Discuss: "What is the arm service method?"	
	49. Demonstrate and have class members practice the arm service method in terms of: - stacking technique - posture - walking - precautions	
20. A tray should be loaded so that it is evenly balanced and objects will not slip or spill while being carried.	50. Demonstrate and have class practice: - loading a tray with soiled dishes - unloading a tray with soiled dishes in the dish room - carrying a tray with both hands at waist level - balancing a tray at shoulder level - clearing a table when guests are seated - changing the cloth and resetting the table when guests are seated - performing various cleaning operations	BULLETIN: Training Food Service Personnel
21. The check should be accurately totaled, laid face down on the table or on a small change tray and presented after the last course has been served or as soon as the guest has finished eating.	51. Discuss the basic techniques of presenting a check with consideration given to: - a timing procedure - house policy for writing final check - answering questions about charges on the check	BULLETINS: Training Food Service Personnel Cinda Service Speaks Out . .

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22. The cashier should be careful and honest in handling money, quick and accurate in making change and courteous and considerate in dealing with customers.

23. The cashier should be intelligent and tactful in meeting various situations related to handling of the money.

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52. Practice presenting a check for a variety of situations as:

- two or more people -- men and women
- couples
- group - age, men, women, both
- others

53. Demonstrate cashing methods for payment of bill.

54. Practice using equipment such as:

- adding machine
- cash register
- change maker

55. View film, "Handling Money".

56. View slides, "Making Change".

57. Role play situations illustrating a cashier-customer relation in situations as:

- receiving cash and making change
- cashing a traveler's check
- giving directions to a local point of interest
- accepting praise or compliments about the food or service

58. Visit local tourist attractions to increase information about local points of interest.

59. View filmstrip, "Change on the Table".

BOOKS:

<u>Professional Restaurant Service</u>

<u>The Correct Cashier for Hotels and Restaurants</u>

FILM:

"Handling Money"

SLIDES:

"Making Change"

24. The tip is a gratuity for services rendered.	60. Discuss tips considering: - observing house rules - acknowledgement - relationship with other employees - etiquette in collecting tips 61. Discuss the correct procedure for dealing with articles found on the restaurant premises.	BOOK: Professional Restaurant Service FILMSTRIP: "Change on the Table"
25. The good will of the customer is based on his confidence in the quality of the food and his appreciation of the excellence of the service.	62. Evaluate: Summarize or develop a check list of desirable functions and practices a capable waiter/waitress will demonstrate and use.	BOOK: Professional Restaurant Service BULLETIN: The Correct Waitress

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UNIT IV: Supplemental Duties

BEHAVIORAL OBJECTIVE: The student will:

- develop ability to perform supplemental duties.
- demonstrate setting up and serving banquets.

BROAD GNERALIZATION: The functions of a waiter/waitress varies with the size of the operation and the standards of service.

Supporting Generalizations	Teaching-Evaluating Strategies	Resources
1. Waiter/waitress have certain duties to perform other than actual serving of food referred to as "side work."	1. Define and identify side work duties. 2. Discuss side work duties stressing: - emptying and refilling sugar bowls - filling salt and pepper shakers - filling syrup jugs - cleaning condiment bottles - folding napkins - arranging menus - arranging flowers - filling creamers - cleaning ashtrays - cleaning serving trays - preparing ice - cutting butter - dusting chairs - cleaning flatware - checking cracker containers	BULLETINS: Waiter - Waitress Training Food Service Personnel Correct Waitress BOOK: Professional Restaurant Service

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2. The waiter/waitress can make the task easier and more valuable by adapting good work habits.	3. Have an experienced person demonstrate the correct method for performing "side work" duties such as: - ladling soup - tossing salads - portioning desserts - others	SLIDES: "Cutting a Pie" "Dipped Salad Assembly"
	4. Have class members practice performing various "side work" duties.	
3. The service station saves many trips to the kitchen. 4. Service stations should be kept neat and orderly and well stocked.	5. Collect photographs of dining room service stations and discuss arrangement, equipment, and supplies needed. 6. Discuss and practice in class the cleaning and storage of supplies in the service station.	FILM: "The Side Stand"
	7. Discuss types of special parties and the service for these as: - small dinner party - banquet - buffets 8. Practice making out reservation forms for special events. 9. Observe and discuss: "What is a buffet type of service?" 10. Discuss the purpose of the buffet service. 11. Study the table settings for buffet service.	BULLETINS: Training Food Service Personnel The Waiter and His Public

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	12. Have class members practice setting a buffet service for: - breakfast - luncheon - dinner	
	13. Prepare a buffet meal and practice serving for a group of people.	
	14. Discuss "What is a banquet type of service?"	
	15. Study table set up for banquets.	
	16. Discuss and set up a work plan for serving a banquet.	
	17. Arrange to serve at a banquet for a local organization.	
5. Room service is an important part of the food service operation in hotels.	18. Discuss room service and the correct procedure for this form of meal service.	
6. There are several forms of service in use in restaurants and dining rooms with the set-up and service procedure characteristic of each type.	19. Discuss special forms of service which might be used in restaurants and dining rooms such as: - English service - American service - French service - Russian service	BOOK: <u>Professional Restaurant Service</u> BULLETINS: <u>Training Food Service Personnel</u> <u>Cinda Service Speaks Out--- About Your Career as a Sales Hostess</u>
	20. Visit various restaurants and observe special forms of service in use.	
7. Table decorations add to a more pleasant surrounding during mealtime.	21. Have resource person to demonstrate inexpensive table decorations using flowers, candles, etc. Practice using these during class laboratory work.	BULLETIN: <u>Training Food Service Personnel</u>
8. Busboys help prepare the dining rooms for service, provide equipment, and supplies for waiters/waitresses and assist in restoring order to the dining room after the serving period has ended.	22. Observe the duties of a busboy in relation to various types of operations.	FILM: "Mr. Busboy"

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UNIT V: Safety, Sanitation, Health and Hygiene

BEHAVIORAL OBJECTIVE: The student will:

- develop an appreciation for safety, good work habits, health laws, and sanitation as they apply these to food service.

BROAD GENERALIZATION: High standards of hygiene and sanitary work habits must be maintained by all workers if food service is to meet its obligation of serving safe, wholesome foods.

Supporting Generalizations	Teaching-Evaluating Strategies	Resources
1. Refer to Basic Guide, pages 40-45, Generalizations: 1, 2, 3, 4, 5, 7, 9, 11, 12.	1. Refer to Basic Guide, pages 40-45, Teaching-Evaluating Strategies: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 16, 17, 20, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39.	Refer to Basic Guide, pages 40-45, Resources. FILM: "The Invaders" BULLETIN: <u>Sanitation Follies</u>

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UNIT VI: Host/Hostess Responsibilities

BEHAVIORAL OBJECTIVE: The student will:

- understand responsibilities to be performed by a hostess in a food service establishment.

BROAD GENERALIZATION: The responsibilities of the host/hostess include working with all personnel in the food service establishment, to maintain relationships with customers and to assist in providing an efficient food service operation.

Supporting Generalizations	Teaching-Evaluating Strategies	Resources
1. The food service host/hostess generally supervises dining room service and waiters/waitresses.	1. Define the position of a host/hostess in the food service industry.	BULLETINS: <u>Training Food Service Personnel</u> <u>Waiter-Waitress</u>
2. The host/hostess should be poised, well-groomed, use good English, and have a working relationship with all individuals concerned with food service.	2. Discuss desirable qualities for a host/hostess.	
3. The host/hostess is responsible for the appearance, cleanliness, and order of the dining room during the serving period.	3. List and discuss the duties of a host/hostess.	
	4. Demonstrate and practice the duties of a host/hostess: - inspecting the dining room - inspecting personnel - checking menus - instructing waiters/waitresses in daily activities - greeting and seating guests - taking reservations by phone - others	

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4. The host/hostess functions include pre-service, service and post service activities.

5. The host/hostess represents management in the minds of most poeple.

6. The techniques used with telephone customers determine if he will frequent the food service establishment.

7. A host/hostess should be familiar with local attractions and needed directions for tourists.

5. Display and discuss schedules of work, station diagrams, and serving directions.

6. Practice making out work schedules and instructions diagrams, and serving directions.

7. Study and discuss making out timesheets, linen reports, sales analysis, and rating sheets for waiters/waitresses.

8. Research and role play situations illustrating a point of conduct for a host/hostess such as:

   - explaining new regulations to waiters/waitresses
   - manager - host/hostess conference in which the manager gives friendly, constructive criticism and the hostess accepts it
   - host/hostess soothing a troublesome guest
   - host/hostess meeting an emergency situation such as spilled soup, etc.

9. Discuss closing duties for a host/hostess.

10. Role play the proper techniques for talking to customers over the telephone. Use tape recorder and analyze.

11. Role play giving information about direction, local attractions, accommodations, etc.

12. Visit each local tourist attraction to increase information about local points of interest.

BULLETIN:

Cinda Service Speaks Out . .

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RESOURCE MATERIAL

Waiter, Waitress, Hostess Guide

Books and Bulletins

Title	Author	Publisher	Date	Cost
A Cook's Quiz	Antionette and Francois Pope	The MacMillan Company 866 Third Avenue New York, New York 10022	1952	
Cinda Service Speaks Out -- About Your Career As A Sales Hostess	David W. Field	The Ohio Restaurant Association 40 South Third Street Columbus 15, Ohio 43215		$1.00
Correct Cashier for Hotels and Restaurants, The	Janet Lefler and Salvatore Calanese	Ahrens Book Company, Inc. 116 West 14th Street New York 11, New York 10011	1952	2.00
Correct Waitress, The	Susan M. Dietz	Ahrens Book Company, Inc. 116 West 14th Street New York 11, New York 10011	1952	1.25
Essentials of Good Table Service, The	School of Hotel Administration	Cornell University Press Ithaca, New York 14851	1966	
Glossary of French Culinary Terminology, Foods, and Confections	Bernard L. Lewis, Inc.	Empire State Building New York, New York 10001		
Judy The Waitress	Kipniss	Webster Division McGraw-Hill Book Company Manchester, Missouri 63011	1966	

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Making the Most of Your Job Interview		New York Life Insurance Company 51 Madison Avenue New York, New York 10010		Free
Menu Dictionary, Multi Lingual	Voegle and Woolby	Ahrens Publishing Company, Inc. 116 West 14th Street New York 11, New York 10011		
Nick The Waiter	Norman Borisoff	Webster Division McGraw-Hill Book Company Manchester, Missouri 63011	1966	
Professional Restaurant Service	Ellen Adeline Harris	McGraw-Hill Company of Canada Limited Toronto, Canada	1966	
Sanitation Follies	The Public Health Committee	Place, Cup, and Container Institute 250 Park Avenue New York, New York 10017		.02
Training Food Service Personnel	U. S. Department of Health, Education and Welfare	U. S. Government Printing Office Washington, D. C. 20402	1969	.65
Training Yourself for Food Service	Restaurant Hotel Aids, Inc.	Loring Building 1709 Willow Minneapolis, Minnesota 55403	1965	
Waiter and His Public, The				
Waiter - Waitress	U. S. Department of Health Education and Welfare	U. S. Government Printing Office Washington, D. C. 20402		

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Films	Source	Address	Date	Cost
"Introducing Alice: A Good Waitress"	College of Home Economics	Department of Institutional Management Cornell University Ithaca, New York 14850		$ 7.00 Per Day Rental
"Courtesy: The Inside Story"				
"Handling Money"				
"How Do You Look When It Counts"				
"Mr. Busboy"	National Educational Media, Inc.	3518 West Cahuenga Boulevard Hollywood, California 90028		10.00 Rental 2 Days
"Table Settings"				20.00 Rental 1 Week
"Taking the Order"				
"The Sidestand"				
"The Invaders"	The Diversey Corporation	212 West Monroe Street Chicago, Illinois 60606		Return Postage

Filmstrips	Source	Address	Date	Cost
"Change On The Table"	Readers Digest Services, Inc.	Sales Marketing Division Pleasantville, New York 10570		10.00
"Food Service"	American Hotel Association	221 West 57th Street New York, New York 10019		48.42
"Serve 'Em Right"	Carnation Company	5045 Wilshire Boulevard Los Angeles, California 90036		

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"Food Service: A Career To Consider" (Guidance Kit)	Educational Department	National Restaurant Association 1530 North Lake Shore Drive Chicago, Illinois 60610		$ 3.50 (Kit)
Posters	**Source**	**Address**	**Date**	**Cost**
"Tips To Make More Tips" (24 in color)	The Alligator Press	5401 West Fargo Avenue Skokie, Illinois 60076		$27.95
Slides	**Source**	**Address**	**Date**	**Cost**
"Cutting a Pie"	Food Service Industry Work Instruction Program	Kansas State University Manhattan, Kansas 66502		7.00
"Dipped Salad Assembly"	Food Service Industry Work Instruction Program	Kansas State University Manhattan, Kansas 66502		7.00
"Making Change"	Food Service Industry Work Instruction Program	Kansas State University Manhattan, Kansas 66502		7.00
"Table Setting" (Catalogue No. LS-251)	Visual Instruction Service	Iowa State College Ames, Iowa 50012		

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Waiter, Waitress, Hostess Guide

Division of Vocational Education. Basic Guide for Food Service Training. Raleigh, North Carolina: Department of Public Instruction, 1965.

Division of Vocational-Technical and Adult Education. Supervised Foods Service: A Suggested Guide. Tallahassee, Florida: State Depart-Ment of Education, March, 1969.

Dietz, Susan M. The Correct Waitress. New York: Ahrens Book Company, Inc., 1952.

Food Service, A Guide for Teachers. Columbia, Missouri: University of Missouri.

Harris, Ellen Adeline. Professional Restaurant Service. Toronto, Canada: McGraw-Hill Company of Canada Limited, 1966.

Lefler, Janet, Louis Sack, and Francois Blanc. The Waiter and His Public. New York: Ahrens Book Company, Inc., 1959.

U. S. Department of Health, Education and Welfare. Training Food Service Personnel for the Hospitality Industry. Washington, D. C.: United States Government Printing Office, 1969.

U. S. Department of Health, Education and Welfare. Waiter - Waitress. Washington, D. C.: United States Government Printing Office.

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VT 012 781
Collins, Wilson Glenn
Unit (Module): Agricultural Business in the American Economic System.

Kentucky Univ., Lexington. Instructional Materials Lab.
MF AVAILABLE IN VT-ERIC SET.
HS 76
Instructional Materials Laboratory, Room 151, Taylor Education Building, University of Kentucky, Lexington, Kentucky 40506 (one copy free on request for State Directors of Agricultural Education).
PUB DATE - Nov69 26p.

DESCRIPTORS - *AGRICULTURAL EDUCATION; *RURAL ECONOMICS; UNIT PLAN; SECONDARY GRADES; TRANSPARENCIES; MARKETING; *UNITS OF STUDY (SUBJECT FIELDS); *BUSINESS; FARM MANAGEMENT; *COOPERATIVES

ABSTRACT - Individually authored in cooperation with the University of Kentucky, Department of Vocational Education, this unit is for teacher use in planning and teaching a 10-12 day unit for grade 11 or 12, which is concerned with agricultural business in marketing, purchasing, and using agricultural goods and services. Designed tc be the major tool for teaching economics where production agriculture is limited or where farm management is not taught, the unit is organized into eight competency areas. Suggested references, instructional materials, and teaching-learning activities are included as well as nine transparency masters keyed to the competency areas. (RR)

VT 012 781

ED0 56238

UNIT (MODULE): AGRICULTURAL BUSINESSES IN THE AMERICAN ECONOMIC SYSTEM

Major Teaching Objective

To develop the understanding necessary for students to make effective use of agricultural businesses in marketing, purchasing, and using agricultural goods and services.

Suggested Learnings (Competencies) To Be Developed

1. To know the importance of agriculture in our total economy
2. To know what it takes to make an agricultural business function
3. To be aware of the different kinds of businesses serving agriculture
4. To understand how a business (owned by one person or by a partnership) is set up and operated
5. To understand how a business corporation is set up and operated
6. To understand how cooperative businesses are set up and operated
7. To know how the member-patron of a cooperative business differs from the customer of a business that is not a cooperative
8. To make use of farmer cooperatives to increase net farm income

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UNITS (MODULE): AGRICULTURAL BUSINESSES IN THE AMERICAN ECONOMIC SYSTEM

Suggested Teaching Time

Number of class periods for group teaching:

In classroom, at school . . . . . _____
Outside classroom, at school. . . . . _____
Field trips (away from school). . . . . _____
Total . . . . . _____

Month(s) _____

Place of the Unit in the Course of Study

This unit is designed to teach some basic understanding of business and economics as they relate to agriculture in the high school vocational agriculture courses of study. It should generally be a part of a senior, or possibly junior, course of study. It may be the major Economics teaching tool in areas where production agriculture is limited, or where farm management is not taught. It may be used to complement a good farm management course, as well. Regardless of where it is used, it should develop the understanding necessary for students to make effective use of agricultural businesses in marketing, purchasing, and using agricultural goods and services.

Suggestions for Introducing the Unit

In introducing this unit, the students should be caused to understand how important the business field is in the marketing, purchasing, and supplying of agricultural goods and services. They should be made aware of the fact that there are four major ways of organizing businesses, with the government constituting perhaps a fifth major type. The student should be made aware that each type of business has some advantages and disadvantages.

This unit has three learnings on cooperatives. Learnings seven and eight are included for the convenience of the departments who choose to participate in the Kentucky Youth Seminar program sponsored by the University of Kentucky, The Kentucky Cooperative Council, Inc., and the State Department of Education. They are sound in their content, and should prove valuable even if a department chooses not to offically enter the Seminar program.

It is envisioned that this unit may be handled in from ten to twenty days, depending upon the objective of the teacher.

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Learnings (Competencies) To Be Developed

1. To know the importance of agriculture in our total economy

Agriculture is more than farming

a. About 35-40 percent of all gainfully employed workers in the United States work in industries that serve agriculture.
b. Approximately 25 percent of our total national income is from farm-related businesses.
c. Farming is only one kind of agricultural business.

Agriculture is a vital part of our total business economy

a. Many basic commodities come from the farm.
b. Advances in processing, storing, and distribution have made basic farm products produced in any area readily available to all United States consumers.
c. Kentucky ranks twenty-third among the states in cash receipts from Farm Marketings- (1968 - $825,000,000).

Farming continually makes important contributions to our national development

a. The productivity of our farmers helped make it possible for our great industrial business development.
b. The key leaders in the founding history of our country were farmers (George Washington, Thomas Jefferson, etc.)
c. Although fewer people are engaged in farming each year, the average size of the individual farm continues to increase. The average size farm in the U.S. in 1968 was 369 acres. (Kentucky-126 acres.)
d. Today, fewer U.S. Farmers produce more than ever before in any nation's history.
e. Farm employment in 1968 was listed as 3,800,000..

Business serves people

a. Business interactions provide the basic necessities of life--food, clothing, and shelter.
b. The many goods and services made possible by businesses in the United States has resulted in our people enjoying one of the highest levels of living in the world.
c. Business provides important services to people--education, transportation, communication, health, etc.
d. Through specialization and mass-production methods, business produces goods and services at prices people can afford to pay.

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Our economy is big and complex, and the various parts are dependent on each other

a. Farming is dependent on many other industries (petroleum, machinery, chemicals, etc.)
b. These industries depend on farming for much of their income.
c. Specialization has led to mechanization and efficiency in industrial businesses, as well as in agricultural businesses.
d. An individual farmer exercises little influence in buying or selling. He is small in relationship to the businesses with which he must deal.

Suggested Teaching-Learning Activities

a. Suggested problem: How important is agriculture in our economy?
b. Discuss this learning well. Use of a problem may not be necessary if you get good class discussion.
c. In introducing this unit, ask the more obvious questions and pull the simpler ideas from the disadvantaged and handicapped students in your class. These students can respond to simple questions, so you may desire to give them an opportunity to participate.

Suggested References and Instructional Materials

Books

Exploring Agribusiness, pp. 1-7.

Publications

"How We Organize To Do Business in America," pp. 8-9.
Kentucky Circular 586 - pp. 2-6.

2. To know what it takes to make an agricultural business function

The production of goods and services is a complex process. This process is dependent primarily upon these basic factors:

a. National resources--are those physical and climatic features of the earth which cannot be created (or changed to any great degree) by man.

(1) Soil and climatic conditions are basic to all agricultural production.
(2) The production efficiency of some natural resources can be increased by man through such practices as irrigation, drainage, mechanization and soil fertilizations.
(3) The earth's surface is the source of oil, coal, and metal ores.

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I. OBJECTIVES

Note: It should be kept in mind that vocational-industrial education, as it is known today, is not designed to develop skilled craftsmen as such. It is intended, through preparatory programs in basic fundamentals, to bring students to the entrance point of wage-earning ability at advanced apprenticeship level. Rapid advancement thereafter (toward thorough understanding and skilled craftsmanship levels) is accomplished through actual work on the job and night supplementary trade-extension courses.

General

The general objectives of the courses of study in Trade and Industrial Education are to develop in the students the abilities to:

Do the various manipulative skills that will permit their initial employment in the industry, rapidly increase their efficiency, and promote their advancement in the salary scale.

Understand the application of basic principles of the science, mathematics, and related technical knowledge that condition the manipulative skills.

Appreciate the social and industrial relationships in connection with the contribution which a worker can make in the areas of health, effective services, and general social-industrial and public relations.

Specific

The specific objectives of the course of study in Radio and Television are designed to enable students to:

Read and interpret electronic circuit diagrams.

Operate and calibrate test instruments used in electronics.

Select and use the tools and equipment of the trade effectively and efficiently.

Understand the language of the trade and read and interpret trade literature.

Understand the health and safety hazards involved in electronics and to observe safe work practices.

Amend their knowledge and skills.

Profit from advanced courses in Radio-Television or allied courses requiring a strong foundation in electronics.

Perform the skills required of electronic technicians efficiently.

Make intelligent decisions in the performance of his duties.

Appreciate the accomplishments of thinkers in the field and the progress that has been and will be made.

Work harmoniously with others and be good citizens in their communities.

b. Labor--is an essential factor in any business.

(1) Labor is a very critical factor in agricultural production.
(2) Agricultural labor is often hard work, and other employment offers equal or better wages for a less demanding type of labor.
(3) Labor specialization usually develops skill and efficiency.

c. Capital is needed for all forms of business. Providing services requires capital.

(1) Capital is primarily in three forms--property (land, building, machines, tools, etc.), investments, and cash.
(2) Capital resources are essential for the operation of any business and may be a matter of national and state concern (railroads, highways, etc.).

d. Management is the biggest challenge in any business.

(1) Without good management, the other resources are of little value.
(2) Management is usually involved with profitability.
(3) Management involves putting the other resources to work and using them to achieve the greatest results or production level, or long-term profitability.

e. Effective marketing and purchasing increase farming income.

(1) The difference between what the farmer gets and what the consumer pays for agricultural products (and the things made from them) goes to the marketing firms and agencies.
(2) Opportunities exist for farmers to bargain collectively or to do more of the marketing job or purchasing job and thereby increase their net income.

Suggested Teaching-Learning Activities

a. Suggested problem: What causes an agricultural business to function?
b. Use of Transparency HS-76-2-1 should help understanding of this learning. It should prove valuable for understanding by the handicapped and disadvantaged group as it simplifies production greatly.
c. Use of Slides 1 and 2 from "Cooperatives and Their Business Neighbors" Slide Set would also be helpful on this learning.

Suggested References and Instructional Materials

Books

Exploring Agribusiness, pp. 9-20.

Publications

"How We Organize To Do Business in America," pp. 16-17.

Visual Materials

Transparency HS-76-2-1
Slides 1, 2 from Slide Set - "Cooperatives and Their Business Neighbors."

3. To be aware of the different kind of businesses serving agriculture

Broadly speaking, there are four functional types of business involving agriculture.

a. Production of basic materials (farming, mining, etc.)
b. Processing or manufacturing businesses (Meat Packing Company, Cloth producing company, etc.)
c. Distribution of goods (Southern States Coop, etc.)
d. Providing services (finance, education, entertainment, etc.)

All these share features in common

a. Competition is an essential feature of American business.
b. The operation of business from within its own organization, competition, and private ownership (rather than State ownership) are essential features of American business.

Business in the United States is conducted by:

a. Individual ownership (single proprietorship).
b. Partnerships
c. Regular business corporations
d. Cooperative business corporations
e. Government (the Nation's number 1 employer, as well as consumer of goods)

Suggested Teaching-Learning Activities

a. Suggested problem: What are the different kinds of businesses serving agriculture?
b. Use of HS-76-3-1 Transparency should prove helpful in making clear to the handicapped and disadvantaged what the "Four Main Functional Types of Business are. The labels on the sample businesses should aid them in retaining this material.
c. Use of HS-76-3-2 Transparency should be useful in pointing out the Five Basic Types of Businesses to the less able student, as well as the average and superior student. The pictures and label-on each type of business should be helpful to the less able student.

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d. Use of HS-76-3-3 Transparency should be helpful in challenging the able student to do additional individual work. It may prove useful to the less able student as well as guiding his thinking on "Questions Relative to Any Business." Read over and explain each question thoroughly.
e. The Slide Set, "The American Private Enterprise System," may be used here to show the entire business spectrum from beginning to end. It may be more easily understood by the able student than the less able student.
f. Use Slide number 3, of the Slide Set, "Cooperatives and Their Business Neighbors." This slide should prove valuable to the less able student in helping him to conceptualize the types of businesses in our country.

Suggested References and Instructional Materials

Books

Exploring Agribusiness, pp. 17-20.
*American Capitalism-An Introduction, pp. 26-32.

Publications

"Cooperatives in Agribusiness," pp. 5-9.
*1969 Directory of Agriculturally Related Cooperatives in Kentucky, selected references. Teacher may use the information in dealing with the cooperative managers and other local businessmen as desired.

Visual Materials

Transparencies - HS-76-3-1, HS-76-3-2, and HS-76-3-3.
Slide number 3 from the Slide Set, "Cooperatives and Their Business Neighbors"
The entire Slide Set, "The American Private Enterprise System"

4. To understand how a business (owned by one person or by a partnership) is set up and operated

Ownership and management features

a. Business is owned by one person or by partners, who share in ownership and management.
b. The owners have complete control of the business (as long as they operate on a legal basis).
c. All decisions are made by owner(s).
d. Policy is determined by owner(s)

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Financial responsibility of the business

a. The responsibility to supply the necessary capital rests with the owner(s).
b. All risks are assumed by the owner(s).
c. The profits are received by the owner(s).
d. The liability of the business rests upon the owner(s). The owner(s) suffer any loss which may occur.

Special features of individual proprietorships

a. This is the simpliest form of business to own or operate.
b. As business expands, over all management becomes a problem.
c. There are limited employee opportunities as the business is not permanent.
d. Business ordinarily ends if anything happens to owner.

Special features of partnerships

a. General partnerships. All partners participate in the operation of business, sharing all responsibilities including unlimited liability for debts, etc. Each partner is held personally responsible for all the debts of the business, even those incurred by the other partner(s) and without the first partner's consent. Each partner is also bound by the agreements made for the business by the other partner(s).
b. Limited partnerships. This partnership is characterized by limited liability of one or more partners. However, there must always be at least one partner in a limited partnership who is subject to unlimited personal liability. There is no limitation on the number of limited partners, providing there is at least one general partner in the firm. Withdrawal of a limited partner may not dissolve the firm, but withdrawal of a general partner does.

Single proprietorships and partnerships are the most common type of business in the United States. There is also a tendency for these types of business to be relatively small.

a. The farm is usually a sole proprietorship or a partnership business.
b. Many agricultural businesses dealing directly with farmers are owned and operated as single proprietorships or partnerships.

Suggested Teaching-Learning Activities

a. Suggested problem: How does a single owner or partnership business function?
b. Invite a representative of one of these types of business to talk with the class.

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c. Use of Transparency, HS-76-4-1, should be very helpful in pointing out the similarities, and differences, of these two important types of business. Seeing this visual should prove useful to the handicapped and disadvantaged student in conceptualizing this learning in his mind.
d. Use Slide numbers 4, 5, 6, and 7 from the Slide Set, "Cooperatives and Their Business Neighbors." These slides should prove valuable in making concrete this learning to the class. Careful explanation of this series of slides is important in teaching the less able student.

Suggested References and Instructional Materials

Publications

"How We Organize To Do Business In America," pp. 20-23.
"Four Methods of Doing Business," pp. 3-10, 12-18.
"Cooperatives in Agribusiness," pp. 5, 7.

Visual Materials

Transparency HS-76-4-1
Slide numbers 4-7 from Slide Set, "Cooperatives and Their Business Neighbors"

5. To understand how a business corporation is set up and operated

One unique feature is that this type of business is treated by law as a "legal person." Members own the corporation by holding shares of stock, and are not individually responsible to the law like owners in a partnership.

Business corporations are the symbols of America's capitalistic system, free enterprise, and the world of "big business." Corporations produce about 57 percent of the total income, more than all other sources combined. About fifty percent of the labor force, excluding farm workers, are on corporation payrolls.

A corporation continues to operate smoothly with the death or withdrawal of some of the owners.

A corporation may be either a stock or a non-stock corporation.

a. A stock corporation is one that issues capital stock representing shares of ownership.
b. A non-stock corporation is a private corporation that is not necessarily concerned with profit. It may have no capital and issue no ownership shares. (A farm corporation would be of this type.)

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Features of a business corporation

a. Ownership is by shares of stock.
b. The business is operated and policy determined by an elected board of directors. This board employs a president, secretary, treasurer, and other officers to manage the business.
c. Capital for the business comes from the sale of stock and from returns of goods and services provided.
d. Voting by stockholders and dividends (returns) paid to the stockholders are in proportion to their ownership (the number of shares of stock they own).
e. In a business failure the corporation is liable to the full extent of its assets. Each stockholder, however, cannot lose more than he has invested in stock, plus his share of the growth value of the business.
f. The services and goods provided by a regular business corporation are for the most part not primarily for the stockholders, but are for the general public. The stockholder's primary motive in the regular business corporation is profit (investment).
g. Corporations are subject to taxation in much the same way as is an individual. Corporations usually pay Federal Tax at a rate of 22% on the first $25,000 profit, and 48% on the remaining profit.

Suggested Teaching-Learning Activities

a. Suggested problem: How is a corporation operated?
b. Invite in a representative of a local business corporation to discuss with the class some aspects of the business.
c. The use of Transparency HS-76-5-1 should help in getting the students to see the essential and unique features of a corporation business. This visual should help the less able student see the uniqueness of a business corporation.
d. Use slide numbers 8, 9 and 10 from the Slide Set, "Cooperatives and Their Business Neighbors." By careful explanation and discussion with the class, they will be able to see the features of a corporation clearly. Thorough discussion is essential to help the less able student see those points.

Suggested References and Instructional Materials

Publications

"How We Organize To Do Business In America," pp. 18-19, 24-25.
"Four Methods of Doing Business," pp. 3-19.
"Cooperatives in Agribusiness," pp. 7-8.

Visual Materials

Transparency HS-76-5-1
Slide numbers 8-19 from Slide Set, "Cooperatives and Their Business Neighbors"

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6. To understand how cooperative businesses are set up and operated

Cooperatives are planned and developed to meet the needs of certain groups of people. The central concept is a group of people acting together to meet a common need.

As with the regular business corporation, the cooperative business corporation has these features:

a. The cooperative business is a "legal person" in terms of administration and operation under the laws of government.
b. It can sue or be sued in its own name.
c. Its life goes on uninterrupted by the death or withdrawal of members of stockholders.
d. A cooperative needs capital, facilities, and management just as does any business.

Unique features of the cooperative business corporation

a. Cooperatives are primarily to serve their members.
b. Basic policy is determined at general meetings open to all members. Operational policy is set by the board of directors.
c. The members elect a board of directors who make the management decisions.
d. Each member has one vote, regardless of the number of shares of stock he owns. (This is in a pure cooperative.)
e. Excess net margin from the business is returned to the members (owners) as patronage refunds. The size of the refund depends upon the amount of business the member has transacted through the cooperative. Earnings may also be used to pay dividends on stock.

Other characteristics of a cooperative business

a. The members are the owners of the business.
b. Cooperatives pay all taxes as required by law. They do not pay taxes on profits because they are non-profit businesses. Refunds are paid to the members when a profit--net margin--is made. The refund is taxable to the individual member as income.
c. The board of directors hire a manager, who in turn hires the needed staff to run the business.
d. The manager is the key person in any cooperative. He either makes it work, or it fails. He must operate within the guidelines given him by the elected board of directors.
e. Cooperatives tend to increase competition, create bargaining power for groups by offering an alternative place to purchase and to supply needed services not always available from other sources.

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Mutual aid among people is as old as man. Economic institutions based on cooperative aid have appeared throughout human history.

a. The earliest cooperatives were groups of primitive people who, together, tended fires and hunted animals they could not possibly kill or face alone.
b. Many of the present aspects of cooperation existed in the Early Greek Era.
c. During the Renaissance, mutual cooperative insurance organizations were organized in London and Paris. The German Landschaften System was an ancestor of the Farm Credit System now in use in the United States.
d. It was during the Industrial Revolution that Modern Cooperation began with the "Society of Equitable Pioneers" in Rochdale, England, in 1844.
e. In the United States, the cooperative enterprise had its beginning with Benjamin Franklin's Fire Insurance Society in Philadelphia in 1752.
f. After the Civil War a notable cooperative movement was that of the Grange.
g. During the Roosevelt New Deal, cooperatives received strong encouragement through federal legislation. Below are some types who began or grew through those years.

(1) Rural Electric Cooperatives - (RECC) (1935)
(2) Farm Supply Purchasing Cooperatives (S.S. Coop)
(3) Federal Land Bank Associations - (FLBA) (1917)
(4) Production Credit Associations - (PCA) (1933)
(5) Artificial Breeding Cooperatives - (KABA)
(6) Milk Marketing Cooperatives - (KYANA)
(7) Farmers Mutual Insurance Companies - (Farm Bureau Mutual)
(8) Commodity Credit Corporation (Tobacco) ("Pool")
(9) Livestock Cooperatives
(10) Others

The specific form of cooperative business organization most common in the world today is one patterned on the "Rochdale Principles."

These were developed by 28 textile workers in Rochdale, England, in 1844. They are:

a. Open membership.
b. Democratic control - (one member--one vote).
c. Limited return on capital.
d. Payment of patronage refunds.

<u>Suggested Teaching-Learning Activities</u>

a. Suggested problem: How do cooperative businesses operate?
b. Invite in a representative of a local cooperative to discuss cooperatives with the class.

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c. Using Transparency HS-76-6-1 can help the class visualize the cooperative business. This can be very helpful in teaching something about cooperatives to the less able student, who often has trouble understanding verbal material.
d. Use Transparency HS-76-6-2 to put into a historical frame the origins in the development of our modern cooperatives. Explain this carefully for the benefit of the less able student.
e. Use slide numbers 11 and 12 from the Slide Set, "Cooperatives and Their Business Neighbors." This teaching tool is very specific for this learning, and very valuable for the less able student as it clearly makes some points about the value of cooperative businesses.

Suggested References and Instructional Materials

Books

*Cooperatives: Today and Tomorrow, pp. 125-164.
*Marketing, The 1954 USDA Yearbook of Agriculture, pp. 239-242.

Publications

"Cooperatives in Agribusiness," pp. 8-12.
"How We Organize To Do Business In America, " pp. 26-29.
*Kentucky Miscellaneous 305, pp. 1-11.
"Basic Cooperative Features," pp. 1-8.
"Farmer Cooperatives--Farm Business Tools," pp. 26-36.
"Four Methods of Doing Business," pp. 3-19.

Visual Materials

Transparency HS-76-6-1 and HS-76-6-2
Slide numbers 11 and 12 from Slide Set, "Cooperatives and Their Business Neighbors"

7. To know how the member-patron of a cooperative business differs from the customer of a business that is not a cooperative

Factors relating to the cooperative member-patron

a. The member-patron is both an owner and a user of the services.
b. He helps provide capital that the cooperative must have in order for it to do jobs for him that help increase his net income from farming.
c. In a cooperative, members can change things relating to management, etc. This can be done by working through the members of the board of directors.
d. The member-patron is interested in paying a fair price for cooperative goods or services. He is also interested in getting a good price for commodities sold through the cooperative. This is the same goal anyone who is buying or selling tries to achieve from his business dealings.

The law requires a full and complete accounting of the cooperative business to its members at least once a year.

a. This is usually done at the Annual Membership Meeting.
b. The manager, accountant, and others give much of the report, but it is primarily a report of the board of directors to the members as to how they have handled the business of the cooperative.
c. In contrast, the customer of a non-cooperative business gets no accounting of earnings by the business during the year.

Suggested Teaching-Learning Activities

a. Suggested problem: How does a member-patron of a cooperative business differ from a regular business customer?
b. It may be desirable to invite in a representative of a cooperative business to explain to the class the essential differences relating to this learning.
c. The use of Transparency HS-76-7-1 should help clarify these differences. Be sure you thoroughly explain the transparency, as it should help the student understand the material more completely.
d. A blackboard list of "Differences vs Similarities" may be useful here. Allow the class members to complete it, permitting the less able student to participate at the beginning.

Suggested References and Instructional Materials

Publications

"How We Organize To Do Business In America," pp. 26-27.
"Cooperatives in Agribusiness," pp. 27-33.
"Basic Cooperative Features," pp. 8-11.
"Farmer Cooperatives--Farm Business Tools," pp. 1-3.

Visual Materials

Transparency HS-76-7-1

8. To make use of farmer cooperatives to increase net farm income

The modern American farmer is more of a specialist in physical production than he is, or can expect to be, in marketing or purchasing. Cooperatives can help him.

a. Cooperative marketing of some crops is the accepted method (tobacco, etc.).
b. The average farmer spends over half his gross income for the purchase of various goods and services needed in farming.

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II. GENERAL ORGANIZATION

General Statement of Methods of Instruction

To teach best the variety of skills, the related technical knowledge and the social-industrial relationships needed to equip students entering this trade, many methods of teaching are necessary. Each method had distinctive features that cause its use to be best suited for the teaching of a specific type of skill or knowledge.

In teaching shopwork, the following methods are used:

Demonstration	Individual Projects
Explanation	Directed Technique Study
Visual Aids	Group Projects
Questioning	Problem-Solving Activities
Instruction Sheets	Field Trips

In teaching the related technical knowledge and social-industrial relationships, the following methods are used:

Discussion	Written Reports
Directed Study	Visual Aids
Questioning	Field Trips
Individual Reports	

Time Schedule Allotment

BLOCK I - BASIC ELECTRONICS	468 hours
Unit 1 - Basic Shop Practices	48 hours
Unit 2 - Static and Dynamic Electricity	48 hours
Unit 3 - Electrical Circuits	66 hours
Unit 4 - Instruments and Test Equipment	75 hours
Unit 5 - Electrical Measurement	75 hours
Unit 6 - Electrical Circuit Components	48 hours
Unit 7 - Tubes and Transistors	54 hours
Unit 8 - Electronic Controls	54 hours
BLOCK II - RADIO SERVICING	612 hours
Unit 1 - Audio Amplifier Systems	100 hours
Unit 2 - Radio Circuit Construction and Analysis	85 hours
Unit 3 - Receiver Construction	160 hours
Unit 4 - Receiver Servicing	267 hours
BLOCK III - GENERAL TELEVISION SERVICING	215 hours
Unit 1 - Television Test Instruments	15 hours
Unit 2 - Television Circuit Construction and Analysis	30 hours
Unit 3 - Field Servicing	120 hours
Unit 4 - Color Television Receivers	50 hours

c. Frequently farmers are able, through their cooperatives, to improve the quality of goods or services and also reduce their costs.
d. Cooperative purchasing must be conducted just as efficiently as that of any competing business, if any real economic benefit is to be realized by farmers using the cooperative.

No farmer cooperative can serve its members well unless they use it.

a. Cooperatives are user organizations.
b. As business volume goes up, costs usually come down.
c. Frequently the cooperatives, operating at "actual cost," are able to sell at lower prices than do competing businesses. This is not always the case, but will often prove out this way.
d. Cooperative prices may be much the same as those of competing businesses. The farmer should understand that the picture might be much different if cooperatives were to fade out of the picture.
e. Any farmer cooperative belongs to the farmers who are members of it. They have the legal control of it. No farmer cooperative "belongs to everybody."
f. Cooperatives serve the general public to the extent that service does not detract from its basic aim, serving the membership.

Suggested Teaching-Learning Activities

a. Suggested problem: How make effective use of farmer cooperatives?
b. Use slide numbers 13, 14 and 15 from the Slide Set, "Cooperatives and Their Business Neighbors." These slides should be helpful in summing up the unit, and in pointing our how business (including farming), is dependent on other businesses for their earnings.
c. A field trip to a representative cooperative may be made before or after this learning is complete. It might be desirable to allow the students to formulate their conclusion while visiting the cooperative. Be very careful to point out the features to the less able student so he will be able to participate in the group conclusion at school after the trip.

Suggested References and Instructional Materials

Books

*Marketing, The 1954 USDA Yearbook of Agriculture, pp. 249-253.

Publications

"Cooperatives in Agribusiness," pp. 17-20.
"How We Organize To Do Business in America," pp. 28-29.
"Farmer Cooperatives--Farm Business Tools," pp. 3-25, 45-55.
Kentucky Miscellaneous 283, pp. 1-7.
*"Farmer Cooperatives in The United States," Selected references.

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Visual Materials

Slide numbers 13-15 from Slide Set, "Cooperatives and Their Business Neighbors."

Evaluation of the Unit

This unit should be evaluated in terms of the objectives the teacher desires to attain. Most of these learnings may be measured in terms of understandings, participation, and attitudes toward businesses in the community. The techniques, aids, and materials should be carefully evaluated after the unit has been completed.

REFERENCES

Books

Exploring Agribusiness: Roy (The Interstate, Danville, Illinois, 1967) 295 pp.

*American Capitalism - An Introduction, Third Edition; Leamer and Thomson (Council for Advancement of Secondary Education, 1201 Sixteenth Street, N.W., Washington, D. C., 1968) 116 pp.

*Cooperatives: Today and Tomorrow, Roy (The Interstate, Danville, Illinois, 1967) 612 pp.

*Marketing, The 1954 Yearbook of the United States Department of Agriculture; (USDA, U. S. Government Printing Office, Washington, D. C., 1954) 506 pp.

Publications

"How We Organize To Do Business in America," Published by the National Education Association and American Institute of Cooperation. 34 pp. (May be supplied free to departments who elect to enter the Kentucky Youth Seminar Program. Others may write to the Department of Rural Education, National Education Association, 1201 - Sixteenth Street, N.W., Washington 6, D. C.) 34 pp.

"Four Methods of Doing Business," Published by the Farmers Regional Cooperative, Fort Dodge, Iowa, 1968) 24 pp.

"Cooperatives in Agribusiness," Farmers Cooperative Service, USDA, Educational Circular 33. 60 pp.

"Basic Cooperative Features," Bulletin Reprint 3, Farmers Cooperative Service, USDA. 11 pp.

"Kentucky's Agricultural Industry," Kentucky Circular 586. 6 pp.

12031

*"1969 Directory of Agriculturally Related Cooperatives in Kentucky," Published by The Kentucky Cooperative Council, Inc., 120 South Hubbard Lane, Louisville, Kentucky 40207. 75 pp.

"Farmer Cooperatives--Farm Business Tools," Agricultural Information Bulletin 275, Farmers Cooperative Service, USDA. 58 pp.

"Efficiency In Both Selling and Buying Has a Direct Effect on Net Income From Farming," Kentucky Miscellaneous 283. 7 pp.

"The Cooperative As a Bargaining Power Tool," Kentucky Miscellaneous 305, 11 pp.

*"Farmer Cooperatives in the United States," Farmers Cooperative Service, USDA, FCS Bulletin 1. 374 pp.

Visual Materials

Slide Set, "Cooperatives and Their Business Neighbors," (15 slides, $2.50), from the American Institute of Cooperation, 1200 17th Street, N.W., Washington, D. C. 20036.

Slide Set, "Cooperatives in the American Private Enterprise System," (48 slides, $6.50, from the American Institute of Cooperation, 1200 17th Street, N.W., Washington, D. C. 20036.

Transparency masters are included with this unit. Each of the nine transparencies are specifically designed to go with a learning.

*Teacher Reference

FOUR MAIN FUNCTIONAL TYPES OF AGRICULTURAL BUSINESSES

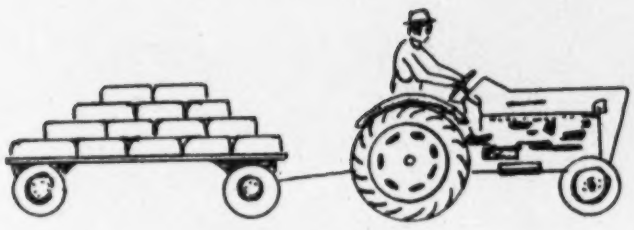

PRODUCTION OF BASIC MATERIALS

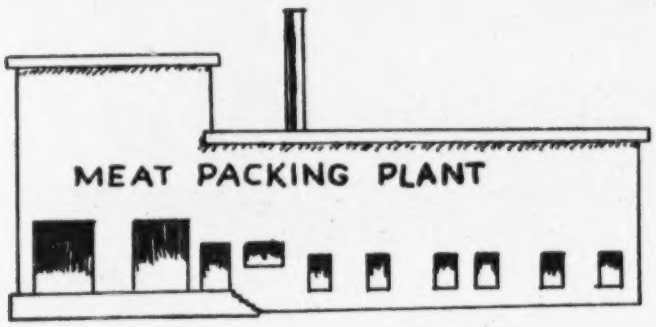

PROCESSING INDUSTRY

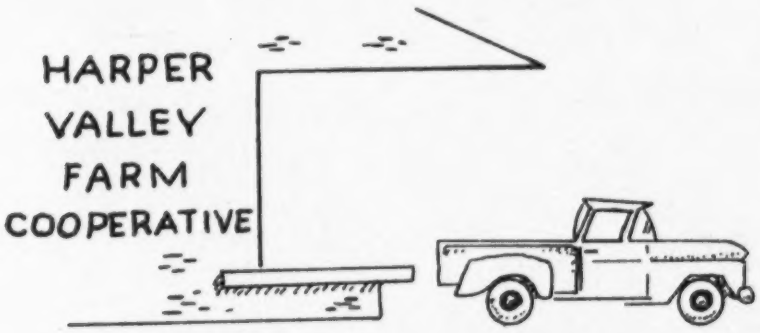

DISTRIBUTION OF GOODS

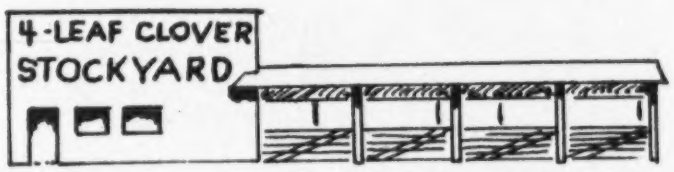

PROVIDING SERVICES

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12034

THE FIVE BASIC TYPES OF BUSINESS

INDIVIDUAL

ONE MAN-HIS

PARTNERSHIP

2 OR MORE INDIVIDUALS-SHARING

CORPORATION

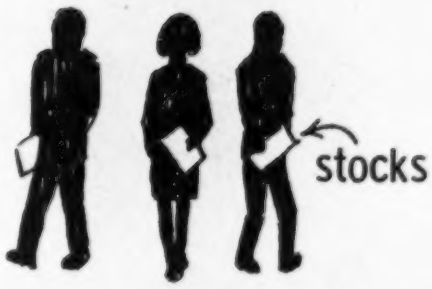

BIG BUSINESS
(stock ownership)

COOPERATIVE

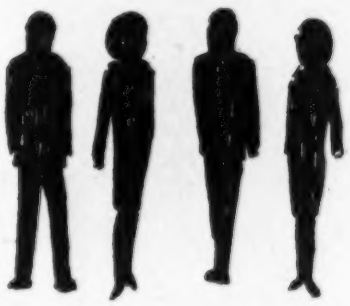

JOINING TOGETHER
(serve selves and others)

GOVERNMENT

Uncle Sam

WORKS FOR US

WE WORK FOR HIM

P. GILMORE, INST. MATL. LAD., UK.

HS-76-3-2

12035

QUESTIONS RELATIVE TO ANY BUSINESS

WHO OWNS THE BUSINESS?

WHO PROFITS FROM THE BUSINESS?

WHO MANAGES THE BUSINESS?

HOW IS THE BUSINESS FINANCED?

HOW DOES THE BUSINESS EXPAND?

WHAT TAXES ARE PAID?

WHO ABSORBS ANY BUSINESS LOSSES?

WHAT HAPPENS UPON DEATH, OR WITHDRAWAL, OF AN OWNER?

HS-76-3-3

12036

SINGLE PROPRIETORSHIP

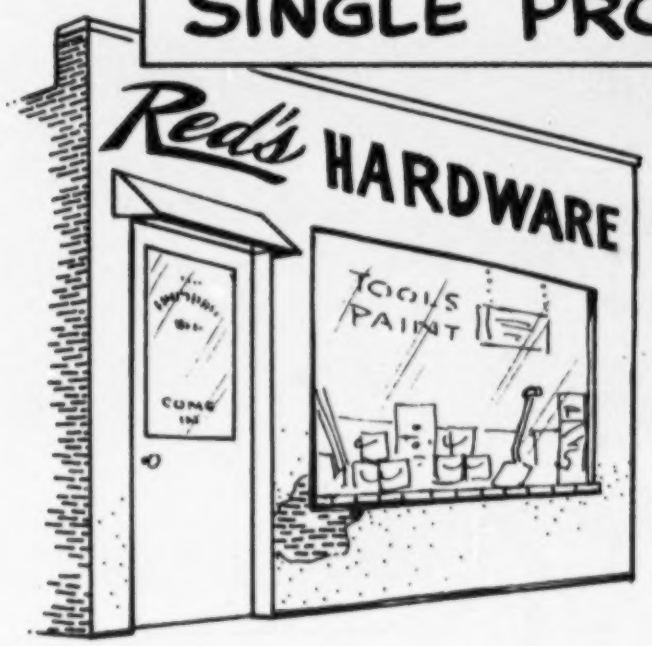

INDIVIDUAL BUSINESS

INDIVIDUALLY OWNED
And OPERATED

6 out of 10 Businesses In the U.S.A. (59%)

PARTNERSHIP

PARTNERSHIP BUSINESS

OWNED And OPERATED
By 2 or MORE
INDIVIDUALS

1 out of 8 Businesses In the U.S.A. (12%)

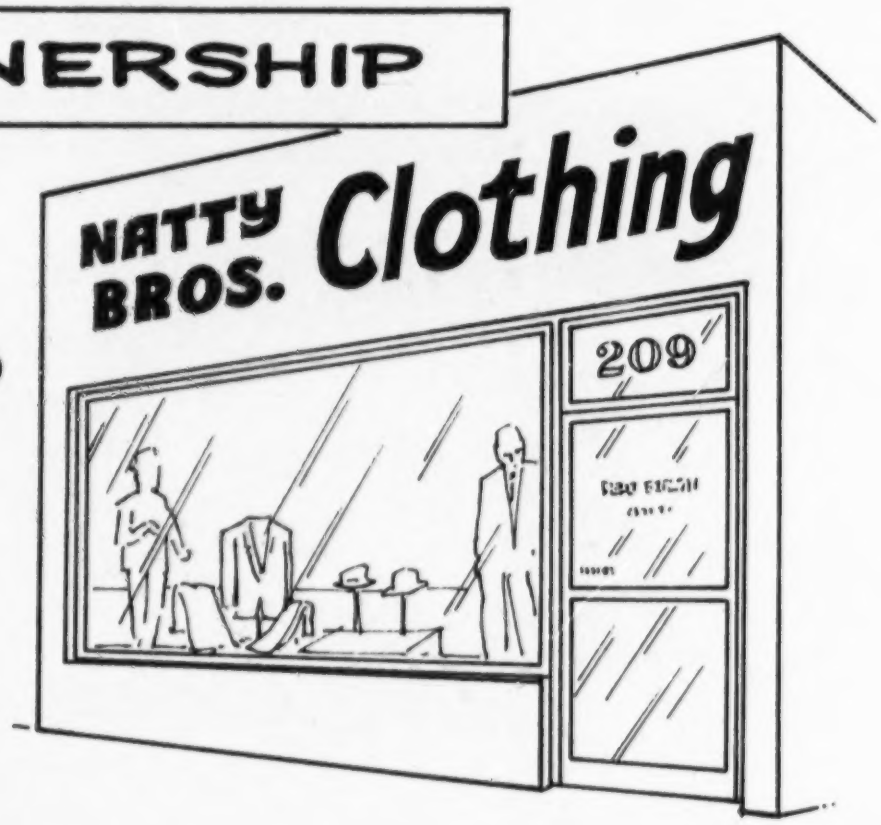

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HS-76-4-1

12037

CORPORATION BUSINESSES

CORPORATION FIRMS OFTEN HAVE Many Owners

3 out of 10 Businesses in the U.S.A.

(29 %)

T. VANTREESE, INST. MAT'L. LAB., U.K.

HS-76-5-1

12038

THE COOPERATIVE BUSINESS

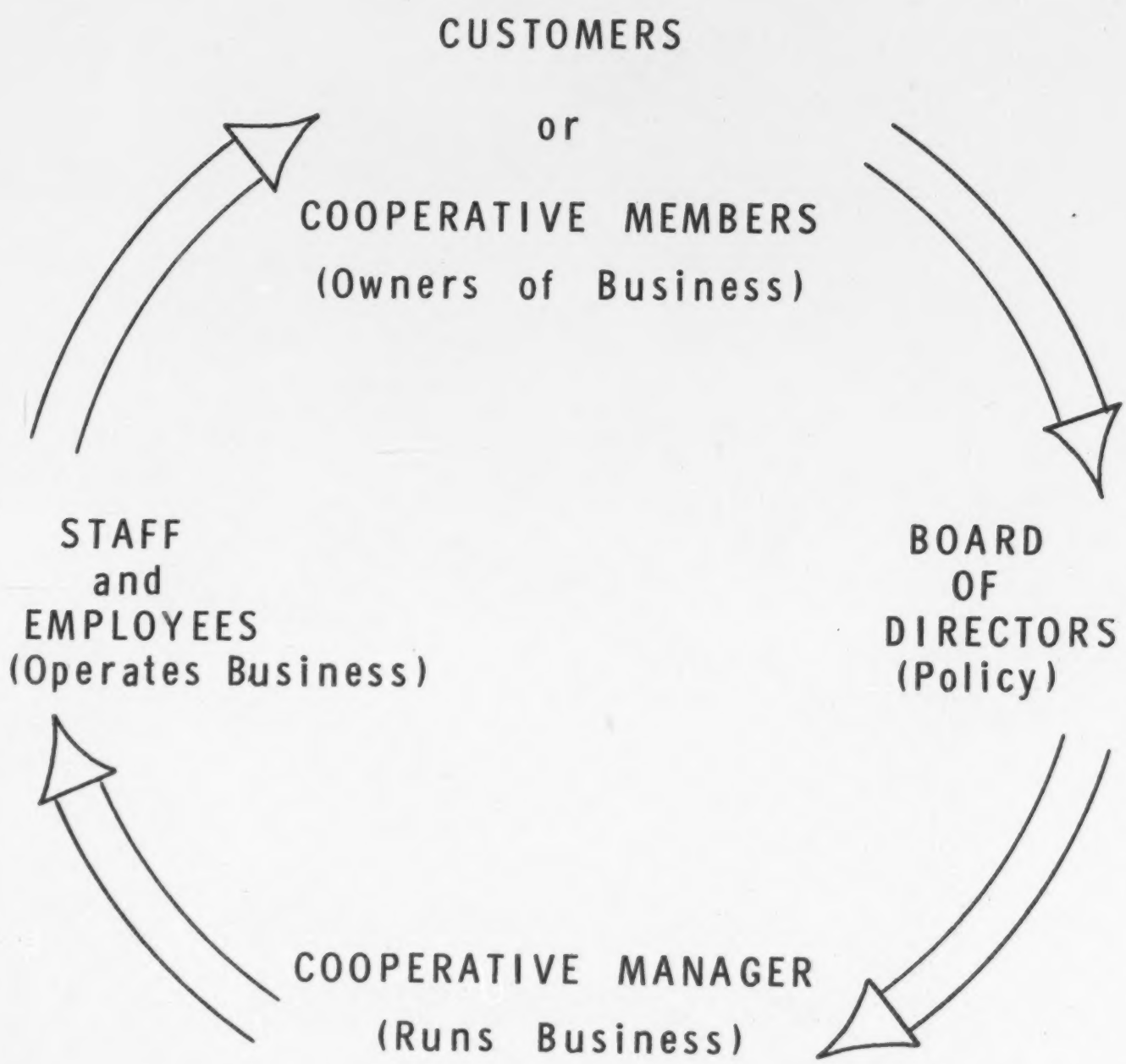

HS-76-6-1

12039

BLOCK IV - TELEVISION BENCH SERVICING . . . . . 325 hours

Unit 1 - Vertical Sweep Section	33 hours
Unit 2 - Horizontal Sweep Section	33 hours
Unit 3 - Synchronization Section	36 hours
Unit 4 - Video Section	38 hours
Unit 5 - High Voltage Circuits	25 hours
Unit 6 - Automatic Gain Control Section	30 hours
Unit 7 - Sound Section	30 hours
Unit 8 - Low Voltage Supplies	25 hours
Unit 9 - Front End Section	30 hours
Unit 10- Alignment Techniques	45 hours
Total	1620 hours

Type of Testing Program Used

More than one instrument is used to determine the effectiveness of teaching and to evaluate the achievement of students in the areas of manipulative skills, related technical knowledge, and social-industrial relationships. These are under the general headings of performance and written tests. One sure way to determine whether a student can do something is to have him actually try to do it. Hence, manipulative skills are tested continually in connection with every job. These tests are referred to as performance. In evaluating total performance, consideration is given to the various elements that are significant in the trade area involved. For example:

Safety
Techniques
Finished Product
Time and Effort Expended
Use and Care of Tools, Equipment, and Materials

The rate of progress in the assimilation of related information is revealed in the ability of the student to apply such knowledge to pertinent jobs and in his achievement on written tests which are given at regular intervals. Written tests may be Objective or Essay in form or a combination of both. Sample tests are included in this course of study in a separate section.

Evaluation of Student Progress

Students progress in the manipulative skills according to their demonstrated ability to meet minimum trade standards. They are required to repeat a job until minimum proficiency is reached before they are permitted to advance to the next job. Their rate of progress and the evaluation of it are recorded on a progress chart.

DATES IN THE HISTORY OF COOPERATIVES

PERIOD OF DEVELOPMENT	NATURE OF DEVELOPMENT
3,000 to 540	Cooperative tenant farming
200 B. C.	Loan Societies
476 to 700	Age of violence, cooperation in monasteries
1750 to 1844	Mutual fire associations were begun in Europe and America. Mercantilism replaced by capitalism in Europe. Capitalism gradually modified
1810	First farmers' cooperatives in USA
1844 to 1894	Modern Era of cooperation began with organization of "Society of Equitable Pioneers" by 28 weavers in Rochdale, England in 1844
1900	Beginning of farmers' marketing cooperatives in the U. S.
1917	Federal Land Banks established
1920-30	Most of the regional agricultural marketing and farm supply regional cooperatives in the U. S. were founded in this decade
1933	Cooperative Farm Credit System, including Federal Intermediate Credit Banks and 13 Banks for Cooperatives established by Acts of Congress
1935	Rural Electrification Administration and beginning of rural electric cooperatives

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12040

COOPERATIVE BUSINESS

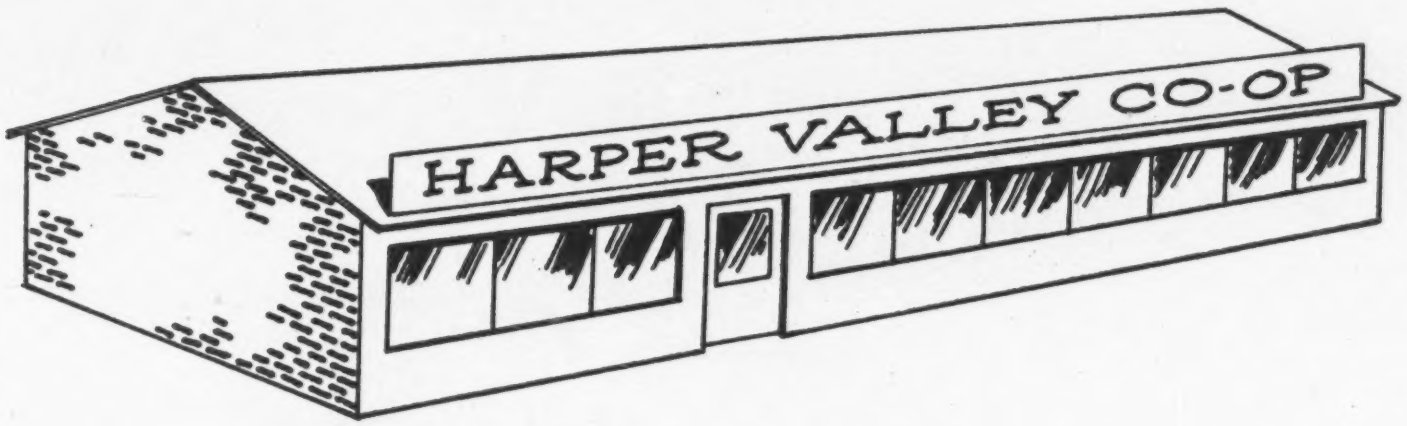

CO-OP MANAGEMENT
REPORTS TO MEMBER - PATRON

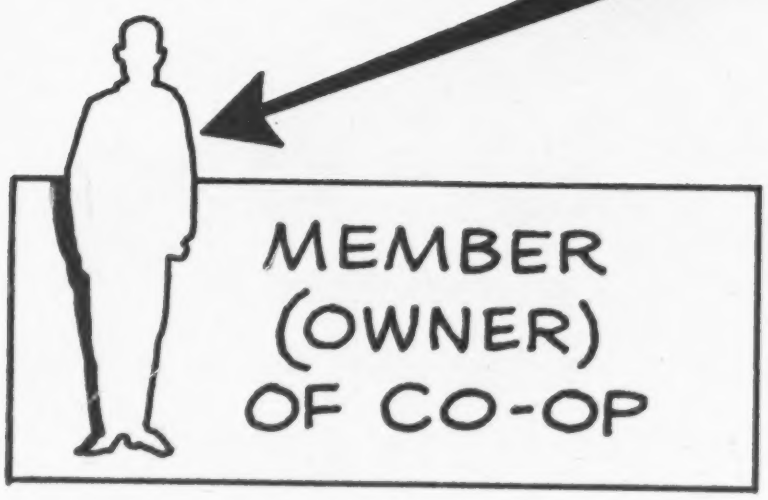

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VT 012 785
Machinist's Mate 1 and C. Navy Training Course.

Department of the Navy, Washington, D.C. Bureau of Naval Personnel.
MF AVAILABLE IN VT-ERIC SET.
NAVPERS 10525-C
Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (D208.11:M18/3/968, $2.75).
PUB DATE - 68 206p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *STUDY GUIDES; *ENLISTED MEN; *MACHINISTS; *TECHNICAL EDUCATION; ILLUSTRATIONS; MECHANICS (PROCESS); FILMS; ADULT EDUCATION

ABSTRACT - Prepared by the Training Publications Division of the Navy, this training course has been prepared for enlisted men who are studying for advancement to Machinist's Mate First and Machinist's Mate Chief. Contents are: (1) Advancement, (2) Maintenance and Material Management, (3) Turbines, (4) Reduction Gears, (5) Steam-Driven Generators, (6) Heat Exchangers and Air Ejectors, (7) Pumps, (8) Piping and Valves, (9) Distilling Plants, (10) Air Conditioning and Refrigeration, (11) Auxiliary Equipment, (12) Administration, Supervision, and Training, (13) Propulsion Plant Efficiency, (14) Engineering Casualty Control, (15) Inspections and Trials, (16) Ship Repair, and (17) Records and Reports. A training film list is appended. A related document in this issue is available as VT 012 786. (GB)

VT 012 785

ED0 56238

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MACHINIST'S MATE 1 & C

VT012785

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10525-C

PREFACE

This training course has been prepared for men of the Navy and of the Naval Reserve who are studying for advancement to Machinist's Mate First and Machinist's Mate Chief.

As one of the Navy Training Courses, this book was prepared by the Training Publications Division, Naval Personnel Program Support Activity, Washington, D.C., for the Bureau of Naval Personnel. Information provided by numerous manufacturers and technical societies is gratefully acknowledged. Technical assistance was provided by the Naval Ship Systems Command, and the Service School Command and Naval Examining Center, Great Lakes, Illinois.

First Edition 1955

Revised 1960

Revised 1964

Revised 1968

12044

THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 - Price $2.25

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CREDITS

The illustration indicated below is included in this edition of Machinist's Mate 1 & C through the courtesy of the designated company. Permission to use this illustration is gratefully acknowledged. Permission to reproduce illustration and other materials in this publication should be obtained from the source.

Source:	Figure:
Velan Engineering Companies	8-2

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CHAPTER 1

ADVANCEMENT

This training course is designed to help you meet the occupational qualifications for advancement to Machinist's Mate First Class and Chief Machinist's Mate. Chapters 2 through 17 of this training course deal with the technical subject matter of the Machinist's Mate rating. The present chapter provides introductory information that will help you in working for advancement in rating. It is strongly recommended that you study this chapter carefully before beginning intensive study of the chapters that follow.

REWARDS AND RESPONSIBILITIES

Advancement in rating brings both increased rewards and increased responsibilities. The time to start looking ahead and considering the rewards and the responsibilities of advancement is right now, while you are preparing for advancement to MM1 or MMC.

By this time, you are probably well aware of many of the advantages of advancement in rating—higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen career. By this time, also, you have probably discovered that one of the most enduring rewards of advancement is the personal satisfaction you find in developing your skills and increasing your knowledge.

The Navy also benefits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating you increase your value to the Navy in two ways. First, you become more valuable as a technical specialist in your own rating. And second, you become more valuable as a person who can supervise, lead, and train others and thus make far reaching and long lasting contributions to the Navy.

In large measure, the extent of your contribution to the Navy depends upon your willingness and ability to accept increasing responsibilities as you advance in rating. When you assumed the duties of an MM3, you began to accept a certain amount of responsibility for the work of others. With each advancement in rating, you accept an increasing responsibility in military matters and in matters relating to the occupational requirements of the Machinist's Mate rating.

You will find that your responsibilities for military leadership are about the same as those of petty officers in other ratings, since every petty officer is a military person as well as a technical specialist. Your responsibilities for technical leadership are special to your rating and are directly related to the nature of your work. Operating and maintaining the ship's main propulsion plants is a job of vital importance, and it's a teamwork job; it requires a special kind of leadership ability that can only be developed by personnel who have a high degree of technical competence and a deep sense of personal responsibility.

Certain practical details that relate to your responsibilities for engineroom administration, supervision, and training are discussed in chapter 12 of this training course. At this point, let's consider some of the broader aspects of your increasing responsibilities for military and technical leadership.

YOUR RESPONSIBILITIES WILL EXTEND BOTH UPWARD AND DOWNWARD. Both officer and enlisted personnel will expect you to translate the general orders given by officers into detailed, practical on-the-job language that can be understood and followed even by relatively inexperienced personnel. In dealing with your juniors, it is up to you to see that they perform their work properly. At the same time, you must be able to explain to officers any important needs or problems of the enlisted men.

YOU WILL HAVE REGULAR AND CONTINUING RESPONSIBILITIES FOR TRAINING. Even if you are lucky enough to have a highly skilled and well trained engineroom force, you will still find that training is necessary. For example, you will

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always be responsible for training lower rated men for advancement in rating. Also, some of your best workers may be transferred and inexperienced or poorly trained personnel may be assigned to you. Or a particular job may call for skills that none of your personnel have. These and similar problems require you to be a training specialist who can conduct formal and informal training programs to qualify personnel for advancement and who can train individuals and groups in the effective execution of assigned tasks.

YOU WILL HAVE INCREASING RESPONSIBILITIES FOR WORKING WITH OTHERS. As you advance to MM1 and then to MMC, you will find that many of your plans and decisions affect a large number of people, some of whom are not in the engineroom and some of whom are not even in the engineering department. It becomes increasingly important, therefore, to understand the duties and responsibilities of personnel in other ratings. Every petty officer in the Navy is a technical specialist in his own field. Learn as much as you can about the work of other ratings, and plan your own work so that it will fit in with the overall mission of the organization.

AS YOUR RESPONSIBILITIES INCREASE, YOUR ABILITY TO COMMUNICATE CLEARLY AND EFFECTIVELY MUST ALSO INCREASE. The basic requirement for effective communication is a knowledge of your own language. Use correct language in speaking and in writing. Remember that the basic purpose of all communication is understanding. To lead, supervise, and train others, you must be able to speak and write in such a way that others can understand exactly what you mean.

A second requirement for effective communication in the Navy is a sound knowledge of the Navy way of saying things. Some Navy terms have been standardized for the purpose of ensuring efficient communication. When a situation calls for the use of standard Navy terminology, use it.

Still another requirement of effective communication is precision in the use of technical terms. A command of the technical language of the Machinist's Mate rating will enable you to receive and convey information accurately and to exchange ideas with others. A person who does not understand the precise meaning of terms used in connection with the work of his own rating is at a disadvantage when he tries to read official publications relating to his work. He is also at a great disadvantage when he takes the written examinations for advancement in rating. Although it is always important for you to use technical terms correctly, it is particularly important when you are dealing with lower rated men; sloppiness in the use of technical terms is likely to be very confusing to an inexperienced man.

YOU WILL HAVE INCREASED RESPONSIBILITIES FOR KEEPING UP WITH NEW DEVELOPMENTS. Practically everything in the Navy—policies, procedures, equipment, publications, systems—is subject to change and development. As an MM1, and even more as an MMC, you must keep yourself informed about all changes and new developments that might affect your rating or your work.

Some changes will be called directly to your attention, but others you will have to look for. Try to develop a special kind of alertness for new information. Keep up to date on all available sources of technical information. Information on sources of primary concern to the Machinist's Mate is given later in this chapter.

THE MACHINIST'S MATE RATING

The Machinist's Mate rating is a general rating; there are no service ratings.

Machinist's Mates operate and repair a wide variety of equipment. Those who are assigned to the engineroom (M division), operate and maintain the ship's main engines and associated equipment such as: pumps, distilling plants, compressors, valves, oil purifiers, heat exchangers, governors, reduction gears, and main shafts and shaft bearings.

Machinist's Mates, who are assigned duties other than in enginerooms, maintain and repair machinery such as: steering engines, anchor windlasses, cranes, winches, elevators, laundry and galley equipment, and air conditioning and refrigeration equipment. Machinist's Mates also perform duties in the generation, stowage, and transfer of some industrial gases.

Machinist's Mates are assigned to all types of steam-driven surface ships, and the nature of the duties of a particular MM will depend largely on the type of ship to which he is assigned. The duties of a Machinist's Mate assigned to a tender or repair ship may consist mainly of repairs and services to other ships assigned to the tender or repair ship. A Machinist's Mate may choose a specialized area such as air conditioning and refrigeration or the manufacture of industrial gases. These two fields require special training which he may get in the appropriate schools.

Duty at most shore stations is related to training in your field of specialization. You may be assigned as an instructor either at one of the schools

Performance and written test achievement are interpreted as follows:

A	Outstanding	95 - 100
B	Above Average	85 - 94
C	Average	75 - 84
D	Below Average	70 - 74
F	Unsatisfactory	Below 70

Text and Reference Materials

Practical Training Manual - Volume I; Howard Sams and Company and Coyne Electrical School; Howard Sams and Company, Indianapolis, Inc., 1955.

Elements of Radio, Abraham Marcus, William Marcus, Ralph E. Horton; Prentice-Hall, New York, 1953.

Practical Radio Communications, Arthur R. Nilson, J. L. Hornung; McGraw-Hill, New York, 1951.

Understanding Radio, Herbert M. Watson, Herbert E. Welch, George S. Eby; McGraw-Hill, New York.

Introductory Radio, H. J. Hicks; McGraw Hill, New York.

Advanced Television Servicing Techniques (Textbook), Paul B. Zbar and Sid Schildkraut.

Advanced Television Servicing Techniques (Laboratory Workbook), Paul B. Zbar and Sid Schildkraut.

Radio and Television Receiver Troubleshooting and Repair, Alfred A. Ghirardi and J. Richard Johnson

or at a recruit training station. To qualify for instructor duty you must successfully complete a course in instructor training.

Machinist's Mates may get duty at the Naval Examining Center, Great Lakes, Illinois. Personnel assigned to the Exam Center assist in the preparation of the servicewide examinations prepared for advancement in rating.

Another shore billet for a Machinist's Mate is located at the Training Publications Division, Naval Personnel Program Support Activity, Washington, D.C. Personnel assigned to this activity assist in the preparation and revision of Navy training courses and other training materials.

Other assignments ashore may include attache duty and recruiting duty.

REQUIREMENTS FOR ADVANCEMENT

In general, to qualify for advancement you must:

1. Have a certain amount of time in grade.
2. Complete the required military and occupational training courses.
3. Demonstrate the ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1.
4. Be recommended by your commanding officer.
5. Demonstrate your KNOWLEDGE by passing a written examination based on (a) the military requirements for advancement and (b) the occupational qualifications for advancement in the Machinist's Mate rating.

Advancement in rating is not automatic. Meeting all the requirements makes you eligible for advancement but it does not guarantee your advancement. Some of the factors that determine which persons, out of those who take the examination, will actually be advanced in rating are the scores made on the written examination, the length of time in service, the performance marks, and the quotas for the rating.

Remember that the requirements for advancement may change from time to time. Check with your division officer or with your training officer to be sure you have the most recent requirements when you are preparing for advancement and when you are helping lower rated men to prepare for advancement.

To prepare for advancement, you need to be familiar with (1) the military requirements and the occupational qualifications given in the Manual of Qualifications for Advancement in Rating, NavPers 18068-B (with changes); (2) the Record of Practical Factors, NavPers 1414/1; (3) appropriate Navy Training Courses; and (4) any other material that may be required or recommended in the current edition of Training Publications for Advancement in Rating, NavPers 10052. These materials are discussed later in the section of this chapter that deals with sources of information.

SCOPE OF THIS TRAINING COURSE

Before studying any book, it is a good idea to know the purpose and the scope of the book. Here are some things you should know about this training course:

- It is designed to give you information on the occupational qualifications for advancement to MM1 and MMC.

- It must be satisfactorily completed before you can advance to MM1 or MMC, whether you are in the regular Navy or in the Naval Reserve.

- It is NOT designed to give you information on the military requirements for advancement to PO1 or CPO. Navy Training Courses that are specially prepared to give information on the military requirements are discussed in the section of this chapter that deals with sources of information.

- It is NOT designed to give you information that is related primarily to the qualifications for advancement to MM3 and MM2. Such information is given in Machinist's Mate 3&2, NavPers 10524-C.

- The occupational Machinist's Mate qualifications that were used as a guide in the preparation of this training course were those promulgated in the Manual of Qualifications for Advancement in Rating, NavPers 18068-B, change 1. (Change 2, 1967, and change 3, 1968, did not affect the MM qualifications.) Therefore, changes in the Machinist's Mate qualifications occurring after this change may not be reflected in the information given in this training course. Since your major purpose in studying this training course is to meet the qualifications for advancement to MM1 or MMC, it is important for you to obtain and study a set of the most recent Machinist's Mate qualifications.

- This training course includes information that is related to both the KNOWLEDGE FACTORS and the PRACTICAL FACTORS of the qualifications for advancement to MM1 and MMC. However, no

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training course can take the place of actual on-the-job experience for developing skill in the practical factors. The training course can help you understand some of the whys and wherefores, but you must combine knowledge with practical experience before you can develop the required skills. The Record of Practical Factors, NavPers 1414/1, should be utilized in conjunction with this training course whenever possible.

- This training course deals almost entirely with the main propulsion plants and associated equipment installed on conventional steam-driven surface ships. It does NOT contain information that is primarily related to nuclear-powered ships, to diesel-driven ships, or to submarines.

- Chapters 2 through 17 of this training course deal with the occupational subject matter of the Machinist's Mate rating. Before studying these chapters, study the table of contents and note the arrangement of information. Information can be organized and presented in many different ways. You will find it helpful to get an overall view of the organization of this training course before you start to study it.

SOURCES OF INFORMATION

It is very important for you to have an extensive knowledge of the references to consult for detailed, authoritative, up-to-date information on all subjects related to the military requirements and to the occupational qualifications of the Machinist's Mate rating.

Some of the publications discussed here are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been entered.

BUPERS PUBLICATIONS

The BuPers publications described here include some which are absolutely essential for anyone seeking advancement in rating and some which, although not essential, are extremely helpful.

THE QUALS MANUAL—The Manual of Qualifications for Advancement in Rating, NavPers 18068-B (with changes), gives the minimum requirements for advancement to each rate within each rating. The Quals Manual lists the military requirements which apply to all ratings and the occupational qualifications that are specific to each rating.

The Quals Manual is kept current by means of numbered changes. These changes are issued more frequently than most Navy Training Courses can be revised; therefore, the training courses cannot always reflect the latest qualifications for advancement. When preparing for advancement, you should always check the LATEST Quals Manual and the LATEST changes to be sure that you know the current requirements for advancement in your rating.

When studying the qualifications for advancement, remember these three things:

1. The quals are the MINIMUM requirements for advancement to each rate within each rating. If you study more than the required minimum, you will, of course, have a great advantage when you take the written examination for advancement in rating.

2. Each qual has a designated pay grade—E-4, E-5, E-6, E-7, E-8, or E-9. You are responsible for meeting all quals specified for advancement to the pay grade to which you are seeking advancement AND all quals specified for lower pay grades.

3. The written examinations for advancement to E-6 and above contain questions relating to the practical factors and the knowledge factors of BOTH military/leadership requirements and occupational qualifications. Personnel preparing for advancement to E-4 or E-5 must pass a separate military/leadership examination prior to participation in the Navy-wide occupational examination. The military/leadership examinations for the E-4 and E-5 levels are given according to a schedule prescribed by the commanding officer. Candidates are required to pass the applicable military/leadership examination only once.

A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 1414/1, is used to record the satisfactory completion of the practical factors, both military and occupational, listed in the Quals Manual. Whenever a person demonstrates his ability to perform a practical factor, appropriate entries must be made in the DATE and INITIALS columns. As an MM1 or MMC, you will often be required to check the practical factor performance of lower rated men and to report the results to your supervising officer. To facilitate

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record keeping, group records of practical factors are often maintained aboard ship. Entries from the group records must, of course, be transferred to each individual's Record of Practical Factors at appropriate intervals.

As changes are made periodically to the Quals Manual, new forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement. Keep this in mind when you are training and supervising lower rated personnel. If a man demonstrates proficiency in some skill which is not listed in the Machinist's Mate quals but which falls within the general scope of the rating, report this fact to the supervising officer so that an appropriate entry can be made.

The Record of Practical Factors should be kept in each man's service record and should be forwarded with the service record to the next duty station. Each man should also keep a copy of the record for his own use.

NAVPERS 10052.—Training Publications for Advancement in Rating, NavPers 10052, is a very important publication for anyone preparing for advancement in rating. This publication lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE you have the most recent edition.

The required and recommended references are listed by pay grade level in NavPers 10052. It is important to remember that you are responsible for all references at lower pay grade levels, as well as those listed for the pay grade level to which you are seeking advancement.

Navy Training Courses that are marked with an asterisk (*) in NavPers 10052 are MANDATORY at the indicated pay grade levels. A mandatory training course may be completed by (1) passing the appropriate Enlisted Correspondence Course based on the mandatory training course, (2) passing locally prepared tests based on the information given in the mandatory training course, or (3) in some cases, successfully completing an appropriate Navy school.

It is important to notice that all references, whether mandatory or recommended, listed in NavPers 10052 may be used as source material for the written examinations, at the appropriate pay grade levels.

NAVY TRAINING COURSES.—Navy Training Courses are written for the specific purpose of helping personnel prepare for advancement in rating. Some courses are general in nature and are intended for use by more than one rating; others (such as this one) are specific to the particular rating.

Navy Training Courses are revised from time to time to bring them up to date. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether a Navy Training Course is the latest edition by checking the NavPers number and the letter following the number in the most recent edition of the List of Training Manuals and Correspondence Courses, NavPers 10061 (revised).

There are three Navy Training Courses that are specially prepared to present information on the military requirements for advancement. These courses are:

Basic Military Requirements, NavPers 10054 (current edition).

Military Requirements for Petty Officer 3 & 2, NavPers 10056 (current edition).

Military Requirements for Petty Officer 1 & C, NavPers 10057 (current edition).

Each of the military requirements courses is mandatory at the indicated pay grade levels. In addition to giving information on the military requirements, these three books give a good deal of useful information on the enlisted rating structure; how to prepare for advancement; how to supervise, train, and lead other men; and how to meet your increasing responsibilities as you advance in rating.

Some of the Navy Training Courses that may be useful to you when you are preparing to meet the occupational qualifications for advancement to MM1 and MMC are discussed briefly in the following paragraphs. For a complete listing of Navy Training Courses, consult the List of Training Manuals and Correspondence Courses, NavPers 10061 (revised).

Basic Handtools, NavPers 10085-A. Although this training course is not specifically required for advancement in the Machinist's Mate rating, you will find that it contains a good deal of useful information on the care and use of all types of

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handtools and portable power tools commonly used in the Navy.

Blueprint Reading and Sketching, NavPers 10077-B, contains information that may be of value to you as you prepare for advancement to MM1 and MMC.

Mathematics, Vol. 1, NavPers 10069-C, and Mathematics, Vol. 2, NavPers 10071-A. These two training courses may be helpful if you need to brush up on your mathematics. Volume 1, in particular, contains basic information that is needed for using formulas and for making simple computations. The information contained in volume 2 is more advanced than you will need for most purposes, but you may occasionally find it helpful.

Machinist's Mate 3 & 2, NavPers 10524-C. Satisfactory completion of this training course is required for advancement to MM3 and MM2. If you have met this requirement by satisfactorily completing an earlier edition of Machinist's Mate 3 & 2, you should at least glance through the C revision of the training course. Much of the information given in this edition of Machinist's Mate 1 & C is based on the assumption that you are familiar with the contents of Machinist's Mate 3 & 2, NavPers 10524-C.

Navy Training Courses prepared for other Group VII (Engineering and Hull) ratings are often a useful source of information. Reference to these training courses will increase your knowledge of the duties and skills of other men in the engineering department. The training courses prepared for Boilermen, Enginemen, and Boilermakers are likely to be of particular interest to you.

OFFICER TEXTS.—Officer texts that you may find helpful when you are preparing for advancement to MM1 and MMC include Engineering, Operation and Maintenance, NavPers 10813-B; Engineering Administration, NavPers 10858-C; and Principles of Naval Engineering, NavPers 10788-A.

CORRESPONDENCE COURSES.—Most Navy Training Courses and Officer Texts are used as the basis for correspondence courses. Completion of a mandatory training course can be accomplished by passing the correspondence course that is based on the training course. You will find it helpful to take other correspondence courses, as well as those that are based on mandatory training courses. For example, the completion of the correspondence course based on Engineering, Operation and Maintenance is strongly recommended for personnel preparing for advancement to MMC. Taking a correspondence course helps you to master the information given in the training course or text and also gives you a pretty good idea of how much you have learned from studying the book.

OTHER BUPERS PUBLICATIONS.—Additional BuPers publications that you may find useful in connection with your responsibilities for leadership, supervision, and training include the Manual for Navy Instructors, NavPers 16103-C, and the Naval Training Bulletin, NavPers 14900 (published quarterly).

NAVSHIPS PUBLICATIONS

A number of publications issued by the Naval Ship Systems Command will be of interest to you. While you do not need to know everything that is given in the publications mentioned here, you should have a general idea of where to find information in NavShips publications.

The Naval Ships Technical Manual is the basic doctrine publication of the Naval Ships Systems Command. The Manual is kept up to date by means of quarterly changes. All copies of the Manual should have all changes made in them as soon as possible after the changes are received.

Beginning with the quarterly changes dated 15 July 1963, the Naval Ship Systems Command began to renumber individual chapters in the Naval Ships Technical Manual according to the Navy-Marine Corps Standard Subject Classification System. Under this system, all chapters of the Manual will eventually be part of the 9000 series which identifies ship design and ship's material subject groups. When all chapters have been renumbered to conform to the 9000 numbering system, the old chapter numbers will be eliminated. In the meantime, you will have to consult the sheets in the front of the first volume of the Manual which cross-reference the new numbering system and the old. Some of the Manual chapters remain in their old positions, so the new and the old numbers have a definite relationship to each other. For example, the old chapter 51 will in time be renumbered as 9510, and the old chapter 48 will be renumbered as 9480. However, some of the chapters will be moved to new locations, as well as being renumbered; in these cases, there is no clear relationship between the old numbers and the new. For example, the old chapter 6 has been moved to a new location and is now numbered 9004.

The following chapters of the Naval Ships Technical Manual, identified by both old number and new numbers are of particular importance to you.

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Chapter Number Old	New	Title
4	9003	Allowances, Surveys, and Requests for Material
6	9004	Inspections, Records, and Reports
20	9200	Winches and Capstans
21	9210	Hydraulic Speed Gears
22	9220	Steering Gear
23	9230	Industrial Gases
39	9390	Thermal Insulation
40	9400	Tables of Technical Data
41	9410	Main Propelling Machinery (Sections I, II, III, and V)
42	9420	Reduction Gears
43	9430	Bearings and Shafting
45	9450	Lubricants and Lubrication Systems
46	9460	Condensers and Air Ejectors
47	9470	Pumps
48	9480	Piping Systems
49	9490	Compressed Air Plants
50	9500	Auxiliary Steam Turbines
58	9580	Distilling Plants
59	9590	Refrigerating Plants
88	9880	Damage Control (Section III, Engineering Casualty Control)
95	9950	Gaskets and Packing

It should be noted that chapters of Naval Ships Technical Manual are referred to throughout this training course by both the old chapter number and the new chapter number. If you have any trouble locating the chapter by the number given in this training course, check the cross-reference sheets given in the front of the first volume of the Naval Ships Technical Manual.

The Naval Ship Systems Command Technical News is a monthly publication which contains interesting and useful information on all aspects of shipboard engineering. The magazine is particularly useful because it presents information which supplements and clarifies information contained in the Naval Ships Technical Manual and because it presents information on new equipment, policies, and procedures.

The manufacturers' technical manuals that are furnished with machinery units and many types of equipment are valuable sources of information on operation, maintenance, and repair. The manufacturers' technical manuals for main propulsion plants and other engineroom equipment are usually given NavShips numbers.

TRAINING FILMS

Training films available to naval personnel are a valuable source of supplementary information on many technical subjects. A selected list of training films that may be useful to you is given in appendix I of this training course. Other films that may be of interest are listed in the United States Navy Film Catalog, NavWeps 10-1-777, published in 1966. This catalog is now listed in the NavSup Forms and Publications Catalog, NavSup 2002, as NavAir 10-1-777. Beginning in 1967, Supplements to the Film Catalog carry the number NavAir 10-1777.

When selecting a film, note its date of issue in the film catalog. As you know, procedures sometimes change rapidly. Thus, some films become obsolete rapidly. If a film is obsolete only in part, it may sometimes be shown effectively if before or during its showing you carefully point out to trainees the procedures that have changed. For this reason, if you are showing a film to train other personnel, take a look at it in advance if possible so that you may spot material that may have become obsolete and verify current procedures by looking them up in the appropriate sources before the formal showing.

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CHAPTER 2

MAINTENANCE AND MATERIAL MANAGEMENT (3-M)

Maintenance of ships can be divided into two broad categories: preventive maintenance and corrective maintenance. Preventive maintenance consists of routine shipboard procedures designed to increase the effective life of equipment or forewarn of impending troubles. Corrective maintenance includes procedures designed to analyze and correct material defects and troubles. The main objective of shipboard preventive maintenance is the prevention of breakdown, deterioration, and malfunction of equipment. If, however, this objective is not reached, the alternative objective of repairing or replacing the failed equipment—corrective maintenance—must be accomplished.

Shipboard maintenance programs in the past have varied from one command to another, resulting in various degrees of operational readiness. A relatively new, uniform system of scheduling, recording, reporting, and managing ship maintenance is now in use. This system, the Navy Maintenance and Material Management (3-M) System, is designed to upgrade the operational readiness of ships. The system is introduced in Machinist's Mate 3 & 2, NavPers 10524-C.

Before studying this chapter, a review of that material is recommended.

The 3-M System is not to be considered a "cure-all" for your equipment and maintenance problems. The system does, however, provide a logical, efficient approach to these problems by launching a forthright attack on electrical, mechanical, and electronic disorders. The system also produces a large reservoir of knowledge about equipment disorders, which, when fed back to the appropriate sources for analysis, should result in the distribution of information regarding corrective steps to prevent recurrences.

The 3-M System, like any other system or program, is only as good as the personnel who make it work. Your role in the system as a PO1 or CPO will include the training of lower rated personnel in its use, as well as the scheduling and supervision of maintenance. General information concerning all aspects of the system is included in this chapter but, as a leading petty officer, you should keep abreast of all developments and changes to the system. In addition to the information found in Machinist's Mate 3 & 2, details on the system and changes related to it are available in the Maintenance and Material Management (3-M) Manual, OPNAV 43P2 (revised). Other sources of information include OPNAV Instruction 4700.16 (revised), the Naval Ship Systems Command Technical News, and directives issued by type commanders.

SCHEDULING OF PLANNED MAINTENANCE

The planning and scheduling of planned maintenance is accomplished through the Planned Maintenance Subsystem (PMS). In addition, the PMS defines the minimum maintenance required, controls its performance, describes the methods, materials, and tools to be used, and aids in the detection and prevention of impending casualties. These factors should prove to be a definite asset to the leading petty officer in forecasting future material requirements and in the proper utilization of available manpower.

It should be noted that the PMS does not cover certain operating checks and inspections that are required as a normal part of the regular watchstanding routine. For example, you will not find such things as hourly pressure and temperature checks or routine oil level checks listed as maintenance requirements under the PMS. Even though these routine operating checks are not listed as PMS requirements, you must of course still perform them in accordance with all applicable watchstander's instructions.

The Planned Maintenance Subsystem is based upon the proper utilization of PMS Manuals, Maintenance Requirement Cards (MRCs), and schedules for the accomplishment of planned maintenance actions.

EQUIP PAGE	TYPE DD CLASS 445/692/710 MAINTENANCE GROUP AUXILIARY COMPONENT	SCHEDULE AS INDICATED QUARTER AFTER OVERHAUL 1 5 9	2 6 10	3 7 11	4 8 12	EACH QUARTER
A-1	STBD STEERING UNIT	A3, A4	S1,S2	A1,A2 C1,C4(7)	S1,S2	
A-1	PORT STEERING UNIT	A3, A4	S1,S2	A1,2 C1,C4(7)		
A-2	FWD EMERGENCY DIESEL ENGINE	A1				R1 M1,Q1
A-2	AFTER EMERGENCY DIESEL ENGINE	A1				R1 M1,Q1
A-3	H.P. AIR COMP.		A1 C1,C3(6)	A2	A3	Q1,2,3 M1
A-4	L.P. AIR COMP.	C13(8)	A2,A3		A1	Q1,M1
A-5	WINDLASS & WINCHES		C1,C3(2)	A1		M1,2,Q1
A-6	#1 MAIN REFRIG. UNIT		S1	A 1,A2	S1 C1,C2(4)	Q1 M1,2
A-6	#2 MAIN REFRIG. UNIT	S1	C1,C2(10)	A1,A2 S1		Q1 M1,2
A-6	#1 AIR COND. UNIT	C1,2(1)	A1,A2 S1		S1	Q1 M1,2
A-6	#2 AIR COND. UNIT	S1	A1,A2	C1,2(7) S1		Q1 M1,2
A-7	WASHING MACHINE	S1		S1		M1
A-8 A-9	LAUNDRY EXTRACTOR LAUNDRY DRYER		S1		S1	
A-10	COMBINATION WASHER EXTRACTOR					Q1 M1,2
A-11	LAUNDRY PRESS		S1	A1	S1	
A-12	DISHWASHING MACH.	A1,2				Q1
A-13	COMMISSARY EQUIP.	S1	C1(2)	S1	A1 C2,C3(12)	M1,2
A-14	MOTOR WHALE BOAT ENG.	A1	S1,2		S1,2	R1,M1
A-15	ZINCS					M1
A-16	LATHE & DRILL PRESS	C1(1)				M1
A-17	JP-5 FUEL SYSTEM	A1,S1		A2,S1		R1,M1
A-18	DIESEL OIL PURIFIER			A1		
A-19	EMERGENCY FIRE PUMP	S1		S1		Q1
A-20	PORTABLE GAS DRIVEN PUMP P-500		A1			Q1 R1,M1
A-21	EMERG. DIESEL S.W. & VACUUM PUMP	A1	A2			
A-22	DIESEL OIL TRANSFER PUMP			A1	C1(8)	
A-23	AIR CONDITIONING SALTWATER PUMP	S1		S1		Q1,M1
A-24	AIR CONDITIONING CHILLED WATER PUMP	S1		A1,S1		
A-25	HOT WATER CIRC PUMP		A1,S1		S1	
A-26	DAMAGE CONTROL TEST & INSPECTIONS	S1	C1(2)	S1		Q1,R1 M1-13
A-27	PIPING & VALVES	A2 C1(1)	A1		C2(12)	Q1,2,3 M1,2
A-28 A-29	RADAR COOLING PUMP SONAR COOLING PUMP	A1				
A-30	MISC. REFRIG. EQUIPMENT	C1(1)			C2(12)	Q1,2,3 M1,2
A-33	BOAT WINCH			C1(7)		
A-34 A-35	PORTABLE PUMP P-250 PORTABLE PUMP P-60		A1			Q1 M1,R1
A-50	VACUUM PRIMING PUMP	A1,A2 C1(1)				
A-53	AUX VENTILATION	S1		S1		Q1 2 3 M1

CYCLE SCHEDULE GPMAV FORM 6700-4 (6-61) C-40094

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Figure 2-1.—Cycle schedule.

CYCLE SCHEDULE

Through the use of a cycle schedule (fig. 2-1), the Planned Maintenance Subsystem is designed to simplify the scheduling of planned maintenance. All required planned maintenance actions are programmed throughout the overhaul cycle of a ship. In addition, the system is flexible enough to readily accommodate any changes in a ship's employment schedule.

The cycle schedule contains a list of the components for each division or maintenance group and indicates the quarter after overhaul in which the semiannual, annual, and overhaul cycle, maintenance requirements are to be scheduled. The cycle schedule also lists the quarterly, monthly, and situation requirements that must be scheduled every quarter. The department head, in conjunction with division officers and leading petty officers, uses the cycle schedule in making out the quarterly schedule.

By definition, the day a ship leaves the shipyard is in the first quarter after overhaul. A ship is not necessarily expected to perform all of the planned maintenance listed for the first quarter after overhaul, but the amount performed must be in proportion to the time remaining in that particular quarter. The steps to follow in using the cycle schedule can best be explained by reference to figure 2-1. Consider, for example, the planned maintenance required for the #1 main refrigeration unit. As indicated on the cycle schedule, a short description of the maintenance required may be found on page A-6 of the Planned Maintenance Subsystem Manual. From the cycle schedule, it is apparent that the maintenance must be scheduled as follows:

M 1 and M 2	Each Month
Q 1	Each Quarter
S 1	2nd, 4th, 6th, 8th, 10th, and 12th quarters after overhaul
A 1 and A 2	3rd, 7th, and 11th quarters after overhaul
C 1 and C 2	4th quarter after overhaul (denoted by the numeral "4" in parenthesis on cycle schedule).

QUARTERLY SCHEDULE

The quarterly schedule is a visual display consisting of two identical quarterly schedule forms,

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one for the current quarter and one for the subsequent quarter. Figure 2-2 is an example of a quarterly schedule. The cycle schedule and both quarterly schedule forms are contained in the same visual display holder, and correspond line for line. The entire display is called the maintenance control board and is maintained in the departmental office. The maintenance control board shows the overall status of planned maintenance within the department.

The quarterly schedule has thirteen columns, one for each week in the quarter, for scheduling of maintenance throughout the three month period. Each of the weeks is divided into days by tick marks (see fig. 2-2) to depict more accurately the operating schedule, thus allowing maintenance requirements to be scheduled in conjunction with ship's operations.

A suggested procedure for the preparation of a quarterly planned maintenance schedule is to first black out the dates which the ship is expected to be underway during the quarter. Then, with the aid of the cycle schedule and the Planned Maintenance Subsystem Manual, fill out the quarterly schedule accordingly. Monthly planned maintenance requirements should be scheduled at approximately the same time each month and other planned maintenance actions should be scheduled at equal intervals in so far as practical. After the quarterly schedule is completely filled in, it is a good practice to look it over closely to see if the work load is balanced throughout the quarter. If there appears to be less work scheduled during one week of the quarter than the others, some of the maintenance requirements should be rescheduled to balance the work load throughout the quarter.

The quarterly schedule is updated weekly. The leading petty officer of the division or maintenance group will cross out all maintenance requirements which have been accomplished and will circle all requirements which have not been accomplished. All circled requirements are to be rescheduled by drawing an arrow to a later week as indicated in figure 2-2.

The quarterly schedule is kept on board as a record of all completed maintenance actions. This record may be destroyed at the beginning of the second quarter following the next shipyard overhaul period.

WEEKLY SCHEDULE

The quarterly schedule is also used by the leading petty officer of each division or maintenance group to prepare a weekly planned maintenance schedule (fig. 2-3). The weekly schedule is posted in each working space and is used by the leading petty officer to assign specific maintenance tasks to specific personnel.

The weekly schedule provides a list of the components, the appropriate page number of the Planned Maintenance Subsystem Manual, and spaces for the assignment of maintenance tasks to specific personnel. The daily and weekly planned maintenance actions are preprinted on the weekly schedule forms. All other planned maintenance requirements which are to be performed during a specific week are obtained from the current quarterly schedule.

The preparation of a weekly planned maintenance schedule requires you to take into consideration the manpower available, the time involved in each maintenance task, and the ship's operations. In the assignment of specific personnel to maintenance tasks, it must be remembered that the average time required to perform a task, as listed on the Maintenance Index Page and the Maintenance Requirement Card, does not take into account the time required to assemble the tools and materials to do the maintenance action nor the time required to clean the area and put away the tools at the end of the task. Therefore, related maintenance requirements which are due should be scheduled and performed together to conserve time. Any corrective maintenance, cleaning, and upkeep to be performed is in addition to the planned maintenance prescribed by the Planned Maintenance Subsystem.

The weekly schedule offers flexibility for all planned maintenance actions except those which must be performed daily. When a planned maintenance task is completed, the leading petty officer will cross out the requirement on the schedule. Maintenance that cannot be completed on schedule is circled and rescheduled on the basis of workload and the ship's operations.

The weekly schedule is designed for convenient preparation and effective reuse. At the end of each week, the leading petty officer of the division or maintenance group will take the weekly schedule to the departmental office, update the quarterly schedule, erase the plastic-covered weekly schedule, and prepare a schedule for the following week.

RECORDING OF MAINTENANCE ACTIONS

The Maintenance Data Collection Subsystem (MDCS) is designed to provide a means of recording information concerning planned and corrective

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MAINTENANCE GROUP AUXILIARY | YEAR 196- | QUARTER AFTER OVERHAUL 4

MONTH APRIL | MONTH MAY | MONTH JUNE

EMPLOYMENT SCHEDULE

	S-1,2											
~~M-1,Q-1~~					M-1	R-1				M-1		
	M-1,Q-1				M-1	R-1				M-1		
		A-3	M-1	Q-1			M-1	Q-2,3				M-1
A-1 ~~M-1~~					M-1	Q-1				M-1		
			M-1,2				M-1,2	Q-1				M-1,2
~~M-1,Q-1~~	C-1	S-1	Q-1		M-1,2	C-2			M-1,2			
	M-1,2			Q-1		M-1,2				M-1,2		
~~M-1,Q-1~~		S-1	Q-1		M-1,2				M-1,2			
	M-1,2			Q-1		M-1,2				M-1,2		
				M-1			M-1					M-1
				S-1								
		M-1,2					Q-1	M-1,2			M-1,2	
											S-1	
											Q-1	
			M-1,2				M-1,2				A-1	M-1,2
~~M-1~~					M-1				S-1,2	M-1	R-1	
		M-1				M-1					M-1	
				M-1			M-1					M-1
											Q-1	
			M-1,Q-1,R-1				M-1,R-1					M-1,R-1
		M-1					M-1	Q-1			M-1	
				S-1								
~~M-1,Q-1~~	M-5,6,7,8	M-10,11,12	M-9-13	Q-1,R-1	M-1,2,3,4	M-5,6,7,8	M-10-11-12	M-9-13	M-1,2,3,4	M-5,6,7,8	M-10,11,12	M-9-13
			M-1,2	Q-1,3			M-1,2		Q-2			M-1,2
			M-1,2				M-1,2	Q-1,2,3				M-1,2
				M-1			M-1		Q-1,R-1			M-1
	M-1				M-1			Q-1,2		M-1	Q-3	

QUARTERLY MAINTENANCE SCHEDULE OPNAV FORM 4700-5 (4-64)

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Figure 2-2.—Quarterly schedule.

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GROUP AUXILIARY WORK SCHEDULE FOR WEEK OF 11 APRIL 196-

COMPONENT	MAINTENANCE RESPONSIBILITY	PAGE	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN	OUTSTANDING REPAIRS AND P.M. CHECKS DUE IN NEXT 4 WEEKS
STARBOARD STEERING UNIT	ROBERTS	A-1	W-1 D-1	S-1 D-1	S-1 D-1	D-1	D-1	D-1 D-1	
PORT STEERING UNIT	ROBERTS	A-1	W-1 D-1	D-1	D-1	D-1	D-1	D-1 D-1	
FWD. EMERGENCY DIESEL ENGINE	JONES	A-2	W-1						
AFT. EMERGENCY DIESEL ENGINE	JONES	A-2	W-1	M-1	Q-1				
COMPRESSED AIR PLANT (H.P.)	SMITH	A-3	M-1 D-1	D-1	D-1	D-1	D-1	D-1 D-1	A-1
COMPRESSED AIR PLANT (L.P.)	WOODS/SMITH	A-4	W-1	A-1	A-1				
WINDLASS WINCHES	WATERS	A-5	W-1, Z						
#1 MAIN REFRIG. UNIT	WOODS/PAYNE	A-6	W-1			C-1			
#2 MAIN REFRIG. UNIT	PAYNE	A-6	W-1 M-1				M-2		
#1 MAIN AIR COND. UNIT	PAYNE	A-6	W-1						
#2 MAIN AIR COND. UNIT	PAYNE	A-6	W-1	M-1		M-2			
BOAT WINCH	WATERS	A-33	W-1						
PORTABLE GAS DRIVEN PUMP P-250		A-34							
PORTABLE GAS DRIVEN PUMP P-60		A-35							
VACUUM PRIMING PUMP	WATSON	A-50	W-1						
AUXILIARY VENTILATION	WATSON	A-53	M-1	D-1	D-1	D-1	D-1 M-1	D-1 D-1	

OPNAV FORM 4700-6

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Figure 2-3.—Weekly schedule.

maintenance actions. Maintenance performed is recorded by code in sufficient detail to permit the collection of a great variety of information concerning maintenance actions and the performance of the equipment involved. The use of codes in recording and reporting maintenance actions permits machine processing with automatic data processing equipment. The system also provides data concerning the initial discovery of a malfunction, how the equipment malfunctioned, how many hours the equipment was in operation, which equipment was involved, what repair parts and materials were used, what delays were incurred, the reason for delay, and the technical specialty or work center which performed the maintenance. Each maintenance action is reported in this manner except for routine preservation actions (chipping, painting, and cleaning) and daily or weekly maintenance actions.

The shipboard installation of the Maintenance Data Collection Subsystem includes a central, functional data collection center. The primary function of the shipboard data collection center is to screen all documents for completeness and accuracy before they are forwarded to the data processing center. During the screening process, the data collection center adds a four-digit maintenance control number to each document unless the person doing the task has already received and entered a maintenance control number to obtain parts or materials from the supply department.

The effectiveness of the Maintenance Data Collection Subsystem depends initially upon the individual performing the maintenance action and the accuracy with which it is reported. Leading petty officers are responsible for ensuring that all forms used in connection with the Maintenance Data Collection Subsystem are complete and accurate. Leading petty officers must also ensure that a form is submitted for each applicable action and that no action is reported more than once.

EQUIPMENT IDENTIFICATION CODE MANUAL

It is essential that all personnel having any responsibility for maintenance actions be indoc-

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III. OUTLINE OF INSTRUCTION

Block I - Basic Electronics

Unit 1 - Basic Shop Practices

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
	Explanations of Study of Electronics
	Advantages, job opportunities, requirements, armed forces' opportunities
	Limitations and mental capabilities required
	History of radio, and accomplishments in the field
	Future needs and yet unsolved or embryo applications in the field
	Introduction to class
	Shop requirements
	Shop policy and limitations
	Shop fees
	Placement and/or position of equipment when in use
	Stock room rules, and student duties
	The work group
	Shop organization and attire
Projects involving:	
Cutting, hack saw	Blade selection and use
Cutting, shears	Basic cutting tools and their use
Filing, external	Selection and use of files
Filing, internal	Filing methods
Cutting, circle	Types of circle cutters
Reaming	Selection and use of reamers

1204
1203

trinated in the proper use of the Equipment Identification Code Manual as it contains many codes used in the reporting of maintenance actions. Each major system is coded and the codes are broken down to the lowest part necessary for positive equipment identification. The manner in which the equipment identification code is obtained from the manual is described in the following example.

Assume it is desired to determine the code for the casing wearing rings and impeller wearing rings of a main condensate pump in the main steam propulsion system. By referring to the index pages (section X) of the Equipment Identification Code Manual, it is found that the MAIN PROPULSION SYSTEM, STEAM is identified by the code "Z" and the index page will be X - Z - 1 or 2. By referring to page X - Z - 1, the subsystem (in this case the feed and condensate system) is identified by the code "ZQ". The next step is to turn to the pages of the manual with the ZQ codes and go down the list of equipment until you come to the listing for the main condensate pump. Under this listing you will find the 7-digit codes for the casing wearing rings and impeller wearing rings. The first digit of the code identifies the system, the second digit identifies the subsystem, the third and fourth digits identify the equipment, and the last three digits identify the assembly. If the assembly requires further breakdown, the last digit identifies the subassembly.

In addition to the equipment identification codes, the Equipment Identification Code Manual contains other codes and information of equal importance to the equipment identification codes. Section I of the manual contains general instructions for the preparation of forms when reporting maintenance actions. Other sections of the manual contain additional codes as follows:

Section II	Administrative Organizations
Section III	Work Centers
Section IV	How Malfunctioned
Section V	When Discovered
Section VI	Action Taken
Section VII	Service
Section VIII	Source
Section IX	Type Availability

These codes make possible the recording of a wide variety of information in a relatively small space. At the data processing level, the codes permit use of automatic data processing operations which provide pertinent direct reading information summaries. The summaries can be profitably employed only if accurate information has been recorded; therefore, familiarity with the coding system is a must and the importance of accuracy in the recording of codes must be continually stressed.

MDCS DOCUMENTATION

Documentation in the Maintenance Data Collection Subsystem is accomplished by the completion, as applicable, of one or more standard forms. Forms used to record and report information related to maintenance actions aboard ship and within repair activities include, OPNAV Form 4700-2B (Shipboard Maintenance Action), OPNAV Form 4700-2D (Deferred Action), and OPNAV Form 4700-2C (Work Request). Detailed descriptions of the entries to be made on these forms are listed in Section I of the Equipment Identification Code Manual and in chapter 3 of the Maintenance and Material Management (3—M) Manual, OPNAV 43P2.

Shipboard Maintenance Actions

A sample Shipboard Maintenance Action Form (OPNAV 4700-2B) is shown in figure 2-4. This form is a single-sheet document used to record the completion of planned maintenance actions, corrective maintenance actions, and authorized alterations that have been performed at the shipboard level by shipboard personnel. All planned maintenance actions except daily and weekly actions must be recorded on this form. Routine preservation such as chipping, painting, and cleaning should not be reported.

The Shipboard Maintenance Action Form is also used to report work done aboard ship by an outside activity which does not report under the Maintenance Data Collection Subsystem. When a repair activity such as a civilian contractor or a shipyard (except for regular overhauls) which is not under the Maintenance Data Collection Subsystem provides ship maintenance assistance, duplicate 4700-2B documents are prepared. Block 7 of the original document is left blank and the code for the assisting work center is entered on the duplicate. Only those manhours actually spent by the shipboard personnel in assisting the outside activity are entered in block 13 of the original; manhours spent by the outside activity in assisting the shipboard work center are documented in block 13 of the duplicate.

Deferred Actions

The Deferred Action Form (OPNAV 4700-2D) is a two-sheet form used to report corrective maintenance actions that are deferred because of

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MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2B (8-64)

SHIPBOARD MAINTENANCE ACTION

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE MONTH YEAR	B.
USS DOE DDG 100	0070	03861	0824	19097	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. WC.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MAN-HOURS (10THS)	E.
AG00000	EEN			Q01	0	A	01	0005	

14. SERIAL NO.	20. EQUIP. TIME	21. ALTERATION IDENTIFICATION
NR2		

F. DESCRIPTION/REMARKS

PERFORMED PLANNED MAINTENANCE AS OUTLINED ON MRC A-2, Q-1.

FOR LOCAL USE ONLY

L. SIG. (3) EN-3 X A. Jones

M. SIG. (4) ENC F. Woods

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Figure 2-4.—OPNAV Form 4700-2B.

the ship's operations, the lack of repair parts, or the requirement for outside assistance. The first sheet (fig. 2-5) is used to record and report the reason for deferral and the second sheet (fig. 2-6) is used to report the completion of the deferred action.

If a corrective maintenance action is beyond ship's force capability and outside assistance is required, a work request is prepared and forwarded. This situation will always require that an OPNAV Form 4700-2D be submitted. The manhours that have been expended by the ship's force in connection with the maintenance action, even if they consist of only the time required to fill out the form, are documented on the OPNAV Form 4700-2D. The manhours involved in the investigation and the removal of the equipment are documented on the first sheet of the form. The manhours involved in the reinstallation of the equipment are documented on the second sheet when the task is completed.

If a shipboard maintenance action must be deferred due to the lack of necessary repair parts or because of the ship's operations, an OPNAV Form 4700-2D is prepared and the first sheet is submitted using the appropriate action taken code from section VI of the Equipment Identification Code Manual and the manhours expended are entered in block 13. When the maintenance action is completed, the second sheet is submitted using the appropriate action taken code and the manhours expended in completing the action are entered in block 13.

Work Requests

The Work Request (OPNAV 4700-2C) is a four-sheet document which is presently used to request outside assistance from repair ships and tenders. Part I of the Work Request is shown in figure 2-7. Part II of the form is shown in figure 2-8, and is a continuation of Part I to provide additional space for written descriptions, diagrams, or sketches.

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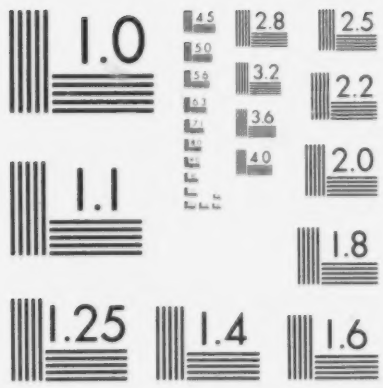

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS DOE DDG100	0070	038611	0815	170997	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MANHOURS	E.
ZQ02100	EMM			381	C	H	01	0005	

14. SERIAL NO.	20. EQUIP/TIME	21. ALTERATION IDENTIFICATION
NR1MF8P		

F. DESCRIPTION/REMARKS

NO. 1 MAIN FEED BOOSTER PUMP HAS EXCESSIVE LEAK OFF AND PACKING GLAND IS UP-TIGHT. REPACK UPON ARRIVAL IN PORT.

FOR LOCAL USE ONLY

L. SIG. (3) MM3 H. Wilson

M. SIG. (4) MMC J. P. Jones

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Figure 2-5.—OPNAV Form 4700-2D, Sheet 1.

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 2

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS DOE DDG100	D070	038611	0815	240997	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MANHOURS	E.
ZQ02100	EMM			381	C	D	01	0015	

14. SERIAL NO.	20. EQUIP/TIME	21. ALTERATION IDENTIFICATION

F. DESCRIPTION/REMARKS

NO. 1 MAIN FEED BOOSTER PUMP HAS EXCESSIVE LEAK OFF AND PACKING GLAND IS UP-TIGHT. REPACK UPON ARRIVAL IN PORT.
REPACKED PUMP, TESTED, AND ADJUSTED PACKING GLAND.

FOR LOCAL USE ONLY

L. SIG. (3) MM3 H. Wilson

M. SIG. (4) MMC J. P. Jones

* NOTE: LIST C.I.D # & PARTS NOT DRAWN FROM SUPPLY DEPT. ON REVERSE

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Figure 2-6.—OPNAV Form 4700-2D, Sheet 2.

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MAINTENANCE DATA COLLECTION
OPNAV 4700-2C (9-64)

WORK REQUEST

1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO	4. DATE	B.
USS DOE DDG 100	D070	03861	0936	01117	E

5. EQUIPMENT ID CODE	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	12. UNITS	C.
ZQ0103 0	0463 8	020	G	01	

14. SERIAL NO.	15. T/A	16. REQ. W.C.	17. DESIRED CMPLN. DATE	18. SERV	D.
NR1		EMM	10117	A	

F. DESCRIPTION/REMARKS

NO. 1 MAIN CONDENSATE PUMP - DE LAVAL
CID # 016160192 ALTERATION - N/A
SHAFT SLEEVE WORN EXCESSIVELY, REPLACE SHAFT SLEEVE

* ADDITIONAL INFORMATION AS REQUIRED BY TYPE COMMAND

FOR LOCAL USE ONLY

G. NO. 1 CONTACT	J. SIG. (1)
MM1 J. Smith	MMC J. P. Jones
H. NO. 2 CONTACT	**K. SIG. (2)**
MM2 M. Roberts	Lt. J. E. Brown USN

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Figure 2-7.—Work Request, OPNAV Form 4700-2C.

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2C (9-64) PART II

WORK REQUEST

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE MONTH YEAR	B.
USS DOE DDG 100	D070	03861	0936	01117	E

F. DESCRIPTION/REMARKS (Continued)

PAGE 1

17.81C

Figure 2-8.—OPNAV Form 4700-2C, Part II.

WORK SUPPLEMENT OPNAV FORM 4700-2F (7-65)

1 ADM ORG	2 SHIP	3 MCN	8 T/A	5 EIC	6 WC	9 MAL	10 DISC
D070	03861	0936	E	ZQ01030	31A	020	G

REMARKS:

* - DO NOT ENTER IF SAME AS ABOVE

4.	DATE	0 5 1 1 7
5.	EIC *	
7.	AWC	
9.	HOW MAL *	
10.	WHEN DISCOVERED *	
11.	ACTION TAKEN	
12.	UNITS COMPLETED	
13.	MANHOURS (TENTHS)	
	READY TO PICK UP (✓)	
	DELIVERED (✓)	

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Figure 2-9.—OPNAV Form 4700-2F.

The information to be given in block F (Description/Remarks) of the work request includes the name of the component, the CID/AN number of the component, and the alteration number. If the alteration number is not applicable, it must be listed as N/A. Block F should also contain a description of the existing defects, the repairs required on the component and all other information as required by the Type Command.

Sheet 1 of the work request is retained by the requesting activity and sheets 2, 3, and 4 are forwarded to the assigned repair activity via the designated chain of command. Information concerning the administrative procedures to be taken on a work request by repair activities may be found in chapter 4 of the Maintenance and Material Management (3—M) Manual, OPNAV 43P2.

When the work request is accepted by the repair activity, sheet 3 of the document is used as a job order and is sent to the assigned work center. Prepunched Work Supplement Cards (OPNAV 4700-2F) are also sent to the assigned work center. A sample OPNAV 4700-2F is shown in figure 2-9.

The assigned work center performs the job, records the maintenance data on the Work Supplement Cards, and records the material obtained outside of normal supply channels on the reverse side of the card. If more than one work day is required to complete the action, or if assisting work centers are needed, the lead work center will utilize the additional Work Supplement Cards provided to record daily manhours expended. (The lead work center is that work center which has the primary responsibility for the completion of the task described on the work request.)

When a repair job is completed, sheet 3 of the work request is completed by the lead work center and is signed by the man who performed the maintenance. An inspector from the requesting activity is contacted for final inspection and signs off the work request. After obtaining the signature of the inspector, the lead work center supervisor forwards the completed work request to his division officer.

MANHOUR ACCOUNTING SYSTEM

The Manhour Accounting System, sometimes referred to as Exception Time Accounting (ETA), is designed and intended for use by the repair department of a repair activity in conjunction with the Maintenance Data Collection Subsystem. It is basically a management tool and accounts for deviations from a normal seven-hour working day.

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Exception Time Accounting includes the use of codes, the preparation of a Master Roster Listing, and the preparation and submission of Daily Exception Cards (OPNAV Form 4700-2E). A sample Daily Exception Card is shown in figure 2-10. Detailed procedures for the use of the card may be found in chapter 5 of the Maintenance and Material Management (3—M) Manual, OPNAV 43P2.

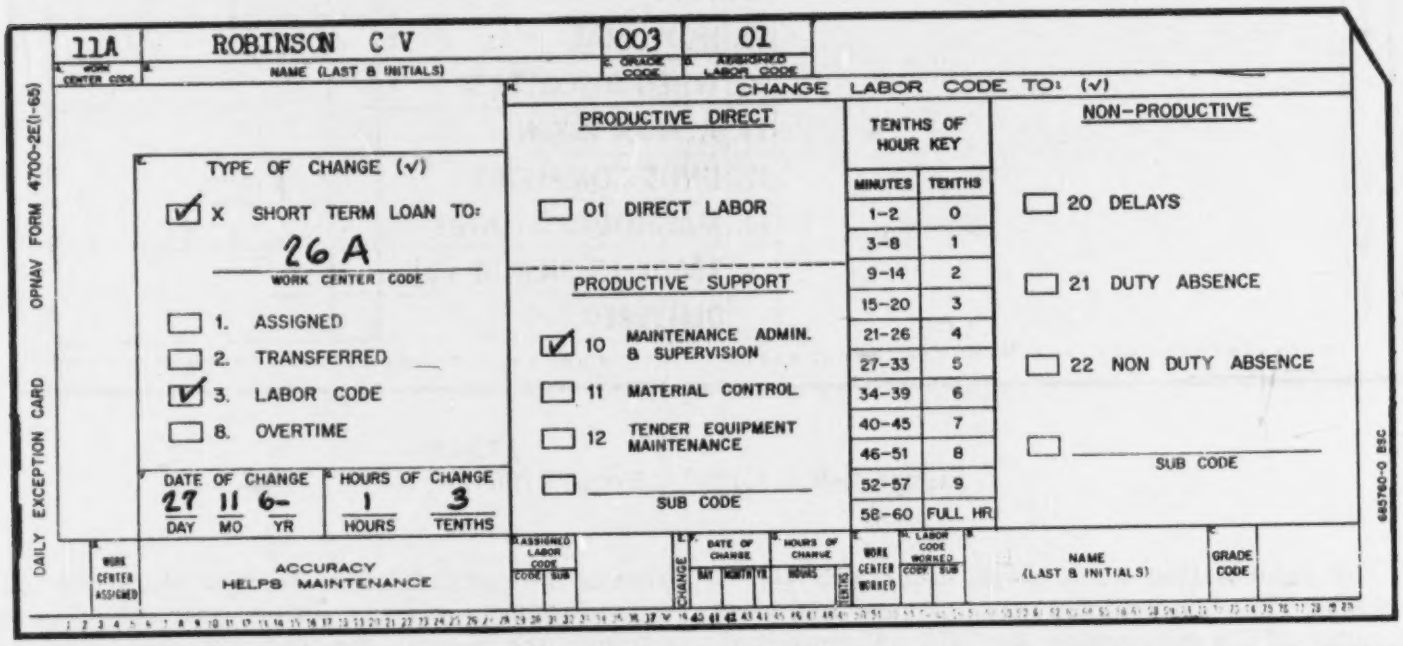

LABOR SUB-CODES

PRODUCTIVE SUPPORT

10.1 Work Center Supervision
10.2 Workload Planning/Control
10.3 Clerical
10.4 Drafting
10.5 Analysis
10.6 Maintenance Technical Training
12.1 Ship Equipment Maintenance
12.2 Repair/Weapon's Dept. Equip. Maint
12.3 Repair/Weapon's Equip. Cleaning & Preservation

DELAYS

20.1 Awaiting Work
20.2 Awaiting Parts/Material
20.3 Awaiting Transportation
20.4 Awaiting Assistance
20.5 Inclement Weather

DUTY ABSENCE

21.1 Quarters for Muster/Special Sea Detail
21.2 Department Watch
21.3 Ship/Base Watch
21.4 Condition Watch
21.5 Military Training
21.6 TAD
21.7 Mess Cooks/Compt. Cleaners
21.8 Vehicle/Boat Operations
21.9 Personnel/Zone Inspection

NON-DUTY ABSENCE

22.1 Medical Absence
22.2 Personal Affairs
22.3 Leave
22.4 Special Liberty
22.5 Unauthorized Absence
22.6 Confinement
22.7 Non-Judicial Punishment

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Figure 2-10.—OPNAV Form 4700-2E.

CHAPTER 3

TURBINES

Reliability is the paramount requirement of naval propulsion plant installations. If a ship is to be ready at all times for unlimited operations, the main units of the propulsion machinery, such as turbines, must constantly receive the best of care in operation, maintenance, and repairs.

This chapter presents selected information on operation, maintenance, and repairs of the most common types of main turbines. The MMC or MM1 should refer to the manufacturer's technical manuals and detail drawings in connection with inspection and repair of turbines. The manufacturer's recommendations regarding operation and methods of assembling and fitting parts should be followed whenever practicable. NavShips Technical Manual, chapter 9410 (41), contains information of a more general nature about turbines.

TYPES OF TURBINES

There are various types of turbines installed on naval ships; six major types are:

1. Type I (single-casing unit).—The Type I propulsion unit consists of one or more ahead elements, each contained in a separate casing and identified as a single-casing turbine. Each turbine delivers approximately equal power to a reduction gear.

2. Type II-A (straight-through unit).—The Type II-A propulsion unit is a two element straight-through unit, and consists of two ahead elements, known as a high pressure (HP) element and a low pressure (LP) element. The HP and LP elements are contained in a separate casing and are commonly known as the HP and LP turbines, respectively. The HP and LP turbines deliver power to a single shaft through a gear train and are coupled separately to the reduction gear. Steam is admitted to the HP turbine and flows straight through the turbine axially without bypassing any stages (there is partial bypassing of the first row of blades at high power), and then is exhausted to the LP turbine through a crossover pipe.

3. Type II-B (EXTERNAL bypass unit).—The Type II-B propulsion unit is similar to the Type II-A, except that provision is made for bypassing of steam around the first stage or first several stages of the HP turbine at powers above the most economical point of operation. Bypass valves are located in the HP turbine steam chest, with the nozzle control valves.

4. Type II-C (INTERNAL bypass unit).—The Type II-C is similar to the Type II-A, except that provision is made for bypassing steam from the first-stage shell around the next several (one or more) stages of the HP turbine at powers above the most economical point of operation. Bypass valves and steam connections are usually integral with the HP turbine casing; however, some installations have the valves separate, but bolted directly to the casing, with suitable connecting piping between the first-stage shell and valve to the bypass belt.

5. Type III (series-parallel unit).—The Type III propulsion unit consists of three ahead elements, known as the HP element, intermediate pressure (IP) element, and LP element. The HP and IP elements are combined in a single casing, and known as the HP-IP turbine. Steam is admitted to the HP-IP turbine and exhausted to the LP turbine through a crossover pipe. For powers up to the most economical point of operation, only the HP element receives inlet steam, with the IP element being supplied in series with steam from the HP element exhaust. At powers above this point of operation, both elements receive inlet steam in a manner similar to that in a double-flow turbine. During ahead operation no ahead blading is bypassed. Series-parallel units are being used on some of the more recent naval combatant vessels, such as DEs, DDs, and CVAs.

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6. Type IV (cruising geared and vented unit).—The Type IV propulsion unit consists of a cruising element, HP element, and LP element—each contained in a separate casing. The cruising turbine is connected in tandem through a cruising reduction gear to the forward end of the HP turbine. The cruising turbine contributes power to the propeller shaft for powers up to the most economical point of operation, and for higher powers it is idled in a partial vacuum and supplied with cooling steam to prevent overheating. For cruising power, steam is admitted to the cruising turbine and then exhausted to the HP turbine inlet, and thence from the HP turbine exhaust into the LP turbine through a crossover pipe. The arrangement of the HP and LP turbine is identical to the Type II units. It is possible to disconnect the cruising turbine to allow for repair. Once disconnected, the HP turbine may be placed in service.

All of these six types of propelling units contain an astern element for backing or reversing. An astern element is located in each end of a double flow LP turbine casing or can be in either end of each single-casing turbine or single flow LP turbine.

Another classification which affects turbine life requirements and construction is:

Class A—Turbines for use in naval submarines.
Class B—Turbines for use in naval surface ships (warships, mine warfare ships and patrol ships).
Class C—Turbines for use in naval ships (amphibious warfare ships and auxiliary ships).

TURBINE OPERATION

When the turbines are started from a cold condition they are subject to expansive movements due to the temperature of the incoming steam. Exercise care in warming up the unit in order to ensure uniform heating of the components of the turbines. While the turbines are warming up, inspect for proper axial rotar position, freedom from rubbing, correct oil flow to bearings, and effective gland sealing.

Maximum economy is obtained from turbine installations by various means: (1) by the use of cruising turbines, (2) by having cruising stages built into the high pressure turbine, or (3) by hand-controlled nozzle valves. Information on cruising turbines and cruising stages can be found in chapter 3 of Machinist's Mate 3 and 2, NavPers 10524-C.

On some auxiliary ships, hand-controlled valves are used to control the number of nozzles used to admit steam to various stages of the high pressure turbine. By the use of a minimum number of nozzles necessary to deliver the required speed, it is possible, for any given speed (power), to maintain nearly full designed steam pressure on the nozzles in use. In addition to operating the nozzles at their most optimum pressure, the throttling loss is reduced to a minimum because there is practically no pressure drop across the throttle valve. Minor variations in speed within any nozzle combination are, however, taken care of by the throttle valve. Although many auxiliary ship turbines use hand-controlled inlet nozzles, some (reaction) turbines in service incorporate stage bypass valves for high speed operation. Optimum positioning of valves is associated with the use of first stage shell pressure as the operating criteria.

Modern plant installations incorporate the operation of opening and closing nozzle control valves, and bypass valves on a single camshaft. Where nozzle control valves are cam-operated, the throttle valve is omitted; however, in such cases, the control wheel for the cams is usually referred to as the "throttle."

LUBRICATION OF TURBINES

One of the more important factors in the operation and maintenance of main turbines is an adequate supply of lubricating oil having the correct physical and chemical qualities. The main lubricating oil system serves (1) to provide a continuous supply of oil to turbine and reduction gear bearings at the temperature for proper lubrication of the bearings; (2) and to remove heat generated in the bearings.

Turbines are provided with one of the following: (a) NEEDLE VALVES that permit adjustment of the oil flow to all journal and thrust bearings, (b) NONADJUSTABLE ORIFICES in the oil supply lines to each journal bearing, (c) a NONADJUSTABLE ORIFICE in the inlet to or discharge from each thrust bearing, or (d) BEARINGS so constructed that the oil clearance around the journal acts as an orifice. The needle valves are adjustable but the setting should never be changed except in an emergency, and then only by experienced

personnel. These valves are so constructed that they cannot fully cut off the flow of oil to the bearing. With the needle valves properly set, the oil flow to the bearings is such as to provide adequate lubrication, but if a bearing is wiped to such an extent that the oil flows freely out of the sides of the bearing, its needle valve will not permit the damaged bearing to take an excessive amount of oil away from the others.

Under normal operating conditions, the temperature of the oil leaving the lube oil cooler should be between 120° F and 130° F. The outlet temperature of the bearing should be about 140°-160° F but never greater than 180° F. The maximum temperature rise allowable in the bearing (oil) is 50° F, even though such a rise may cause a final temperature of lower than 180° F.

Various means are provided for maintaining a continuous check on the supply of oil to the bearings, and on the bearing temperature as indicated by the temperature of oil flowing from the bearings. On some older installations, a pressure gage is connected to the oil supply line to each bearing, or a spinner-type flow indicator is connected in the supply line. A thermometer is fitted in each bearing as near as possible to the point from which the oil drains from the bearing shell. On modern ships, journal bearings and thrust bearings have four types of temperature indicators presently being used: the mercury bulb thermometer, the bimetallic thermometer, the thermocouple, and the resistance thermometer element (RTE).

The bimetallic thermometer uses the principle of operation that two dissimilar metals expand differently or unequally when heated, and indicates the temperature on a calibrated gage. The bimetallic thermometer can be used to replace the mercury bulb thermometer for direct reading.

Thermocouples have been installed in some bearings to indicate the temperature of the babbitt material. The thermocouples are monitored automatically by an electrical scanning device or monitor, briefly described as follows: The thermocouples are connected to lamps and an alarm in the scanner through contacts. These contacts are made and broken by a rotary stepping switch pulsing circuit which provides the power pulses to operate the rotary stepping switch so that all thermocouple channels can be scanned within 10 seconds. Should the temperature on any bearing exceed 250° F, the lamp corresponding to the bearing will light and the alarm will sound. The alarm may be reset manually, but the light will remain on until the temperature returns to normal. Provision is also made for a meter in the scanner which can be connected to read the actual temperature on any one bearing at a given time.

It should be understood that there will ordinarily be some difference between the temperatures as indicated by the mercury bulb or bimetallic thermometers (where installed) and the scanner meter. These temperatures, however, are due primarily to the difference in position of the sensing elements for the bearing. If the temperature, as read by the thermometer or scanner, should suddenly rise without there having been a change in speed, there may be a distressed bearing, and the speed should be reduced, if possible, and the cause ascertained.

The RTE is an electrical resistance type thermometer installed within the bearing and used to measure the temperature of the babbitt material. The RTE uses the same type monitoring system as the thermocouple.

The bearings and gears of a modern warship require a high grade mineral oil (2190 TEP). The oil must be kept free from water and impurities by means of the purifier and the settling tank. In keeping a continuous check on the condition of the lubricating oil, a routine procedure of taking oil samples should be followed. In addition, the oils should be tested at regular intervals whenever shore testing facilities are available, to determine the neutralization number, flash point, viscosity, and other physical or chemical properties which govern the effectiveness of oil as a lubricant. When operating the turbines, do not rotate the turbines with a lube oil temperature below 90° F except in an emergency. Operate the lube oil purifiers at least 12 hours per day when the ship is under way.

PROCEDURES FOR AN OVERHEATED BEARING

The rotor of every turbine must be supported in bearings, which serve the double purpose of carrying the weight of the rotor and maintaining the correct radial clearances between rotor and casing. All main turbines have a journal bearing at each end of the rotor, and a thrust bearing, to maintain correct axial clearances, usually at the forward end. Modern naval ships have adjustable spherically seated, self-aligning journal bearings and pivoted-shoe type thrust bearings.

Bearing temperatures depend on the viscosity of the oil being used, the design of the bearing,

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Block I - Basic Electronics

Unit 1 - Basic Shop Practices (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Chipping	Types of chisels and their uses
Drilling	Comparison between numbered and letter-sized drills
Tapping	Thread sizes and specifications
Soldering with iron	Types of solders and fluxes
Torch soldering	Torch soldering applications
Wire splicing	Types of splices - application
Soldering lugs and pins	Factors that affect the electrical conductivity of joints
Attaching tube sockets	How pins are numbered
Chassis alterations	Types and functions of chassis
Sharpening cutting tools	Sharpening techniques
Sharpening drills	
Cleaning and tinning a soldering iron	Care of soldering iron
Constructing a "Buss-bar" box	Soldering techniques
Constructing two types of wire harnesses, or cables	Types of wire splices
Constructing four types of wire splices	Types of soldering irons and their limitations
Waterproofing electrical cables using available waterproof varnish, or glyptol	Anti-corrosion operations
	Lacing cables
	M.F.P. moisture, fungus-proofing operations used by the Armed Forces

the running speed, and the oil clearances. Watchstanders should be familiar with the normal operating temperatures of all bearings in their respective spaces. Watchstanders should also understand the precautions and procedures to prevent possible bearing troubles, and what procedures to follow when bearing troubles do occur.

Generally a hot bearing may be traced to one of the following causes:

1. Improper or insufficient lubrication.
2. Grit or dirt in the lubricant.
3. Bearing out of alignment.
4. Bearing improperly fitted.
5. Poor condition of bearing or journal surface.
6. Obstruction in the oil lines.

If the temperature of a bearing increases above its normal running temperature, the quality and quantity of the lubricant supplied to that bearing should be checked immediately. If the trouble is due to improper or insufficient lubrication, and is discovered before the metal has wiped, an abundant supply of lubricant should gradually bring the bearing back to its normal operating temperature. Should the trouble be caused by grit or dirt in the bearing, an increased supply of lubricant may flush out the impurities sufficiently to permit continued operation. The supply of oil should be increased by opening the needle valve, if a needle valve is provided, or by increasing the delivery pressure of the oil pumps, where practicable. The lubricants should be further cooled by increasing the flow of circulating water through the oil cooler. If these measures are not effective, the speed of the unit should be reduced or stopped. Spraying water on a bearing should not be resorted to except in an emergency, as cold water causes contraction of the bearing, further reducing the clearance, and may cause the bearing caps to become distorted.

If the bearings are out of alignment, improperly fitted, or bearings and journals are not in proper condition, the only effective treatment is to operate the turbine at low speed until such time as the proper adjustments or repairs can be made.

The most effective treatment of a hot bearing will probably be the operation of the turbine at low or moderate power. Usually an abnormal temperature in a bearing can be lowered by decreasing the amount of work of the bearing. The temperature of a bearing should never be allowed to exceed 250°F nor the oil return from the bearing allowed to exceed 180°F, since the babbitt will become soft and the bearing will wipe.

If the temperature of a bearing does exceed the maximum allowed, the turbine should be immediately slowed down. The turbine should be kept turning at a minimum speed to prevent the molten metal from adhering to the journal. When the temperature drops below the maximum allowable, the turbine should be stopped, the main shaft locked, and the lubrication system kept in operation.

Bearing depth gage readings should be taken to determine if any wear of the bearing has occurred. If the readings indicate no wear of the bearing, operation of the turbine at low speeds can be attempted, or the bearing can be disassembled for a complete inspection. If the bearing readings show that abnormal wear has occurred, the bearing must be disassembled for repair. Operation of a wiped bearing can result in serious damage to the turbine.

When a bearing overheats, the lube oil strainers should be carefully checked for traces of babbitt. The lube oil should be inspected and the purifier started.

In recent years, the pivoted-shoe type bearing has been adapted to journal bearings. If the shoes are properly pivoted, they will have a freedom of motion which permits them to automatically align themselves to the shaft, and yet hold the shaft to a smaller amount of motion than do sleeve bearings.

ABNORMAL NOISE OR VIBRATION

Turbine rotors shall not be permitted to remain at rest for a period longer than 5 minutes while steam, including gland steam, is being admitted to the turbine. In ships having turning gear, this gear shall be rolling the turbine rotor before steam is admitted to the turbine glands. Turbines not provided with turning gear shall commence

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spinning operations as soon as gland steam is admitted to the turbine. Maintain a vacuum of about 25 inches of mercury by using the second-stage air ejector during warmup. Higher vacuum during the warming-up period will retard heating and may cause distortion due to uneven temperatures.

If the rotor and casing are not evenly heated, unequal expansion, resulting in the distortion of the rotor or the casing or both, will take place. The results of this distortion are very noticeable in large turbine installations. Unless extreme care is taken to warm up the turbine properly, serious damage will be done.

If at any time while the turbine is in operation it suddenly begins to vibrate abnormally, the trouble may generally be traced to any one or a combination of the following troubles:

1. Water in the turbine.
2. Bearing failure.
3. Bent or broken propeller blades.
4. Broken or missing turbine blades or rubbing of blades.
5. Rubbing of carbon packing, labyrinth packing, or oil seal rings.
6. Bowed rotor.
7. Excessive differential expansion between rotor and casing.

If a rumbling sound is heard from the turbine when it begins to vibrate, the trouble is probably due to water or foreign matter in the turbine. Water in the turbine casing may be caused by either boiler priming or improper casing and steam line drainage. The turbine should be immediately slowed down until the abnormal noise disappears. If, after slowing down, correcting boiler operation and checking casing and HP drains, the vibration still exists, the turbine shall be shut down and the interior of the turbine shall be inspected at the earliest opportunity. If a sharp metallic sound is heard after the rumbling noise, it may be assumed that the thrust bearing has failed and part of the blading has been damaged.

When bearing troubles occur, the turbine should be stopped as soon as practicable to prevent damage to the turbine blading. The bearings should be inspected, and replaced or repaired as necessary. The cause of the trouble should be determined and appropriate steps should be taken to prevent similar troubles from recurring.

Rubbing of labyrinth or carbon packing or oil seal rings is usually caused by one of the following:

1. Excessive bearing wear.
2. Bowed rotor.
3. Improper installation of packing rings or oil seals.
4. Excessive differential expansion between rotor and casing.

Rubbing of shaft packing or oil seal rings will cause the shaft to overheat in the rubbing area, due to friction; and the shaft will start to show heating discoloration. An immediate inspection should be made to determine the cause of the trouble. If defective bearings are found, they should be replaced. A bowed rotor can be straightened by operating the turbine at low speeds. The shaft packing or oil seals may require refitting or renewal to give proper clearances.

It is also possible for the gland sealing system to cause the seal casing to become "egg" shaped and to cause vibration. This occurs when the turbine is operating at a speed sufficient to permit self-sealing and is slowed to a point where external gland sealing steam is required. When the engine is operating self-sealing, moisture may collect in the external gland seal supply piping if it is not draining properly through the LP drain traps. When the external gland seal supply valve opens, the accumulated condensate is forced into the shaft seal area, causing rapid cooling and distortion. This problem can be prevented by proper drainage of the gland seal line.

When rubbing of turbine blading occurs, the cause will probably be a bowed rotor, a defective thrust bearing assembly, a wiped journal bearing, foreign material inside the casing, or differential expansion of turbine rotor and casing. When a rubbing noise in a turbine is heard, the turbine should be stopped immediately and the cause of trouble determined.

When warming up a turbine, or after a turbine has been warmed up, a vacuum shall not be maintained on the turbine unless the glands are properly sealed. Air leaking in along the shaft, particularly when standing still, tends to cause distortion of the shaft and rotor. If the rotor becomes distorted while standing by, close the drains to the condenser and bring the pressure of the gland steam to between 1/2 and 2 psi above atmospheric pressure, and spin the rotor alternately astern and ahead.

Foreign matter may enter a turbine casing through a defective steam strainer, or because of improper protection of a turbine that has been opened for inspection or repair. When any part of a turbine has been opened, the greatest care shall be exercised to prevent the entry of foreign matter. Inspection plates shall not be left off overnight, or for any length of time unless the openings are well covered. Before reassembling a turbine after it has been opened, a very careful examination shall be made of the rotor and interior of the casing for any articles left behind. An examination shall be made before the rotor is lowered in place, and another examination made before the casing cover is lowered in place.

Another cause of vibration in the turbine is bent or broken propeller blades. Normally, this condition is first indicated by excess vibration of the main shaft and by a lesser vibration in the main reduction gears. When these conditions exist, the main turbines should be slowed until the noise and vibration stops or is within safe limits. An immediate inspection should be made to determine the cause of vibration.

If vibration of the turbine is caused by bent or broken turbine blading, the turbine should not be used until effective repairs can be made by experienced personnel.

ASTERN POWER LIMITATIONS

The MM1 and MMC must be familiar with astern power limitations for his ship. Each ship has its own designed operating requirements for maximum astern power, contained in the manufacturer's technical manual. For older type ships, the information concerning astern power limitations can be found in chapter 9410 (41) of NavShips Technical Manual.

It is important that the main condenser vacuum be maintained at the best obtainable value during all astern operations to reduce astern windage heating in idle ahead elements. To reduce astern heating in idle ahead elements, keep astern exhaust temperature to a minimum. In order to do this, ships having superheat control shall enter and leave port with superheaters secured; only saturated steam should be used. Upon receipt of an astern bell, ships having superheat control must immediately commence lowering superheat at the rate of 10° F per minute. Watch ahead turbines closely for signs of overheating during prolonged astern operation. Overheating requires immediate slowing down.

ROTOR BALANCE

The turbine rotors are carefully balanced, both statically and dynamically. If, under any circumstances, a rotor becomes unbalanced, it will be necessary to have the rotor rebalanced.

It may be possible that corrosion, erosion, or incrustations on the turbine rotor cause unbalance and vibration. Any damage to the turbine rotor blading and balance weights will, understandably, cause unbalance of the rotor. Causes of turbine vibration should be thoroughly investigated before an attempt is made to balance the rotor.

LEAKING NOZZLE CONTROL VALVES

On most modern naval ships the amount of steam admitted to the turbine is controlled by a series of nozzle valves. The nozzle valves are controlled by a single handwheel and operated by individual cams or a lifting bar. The nozzle valves are opened in sequence and the preceding nozzle must be fully opened before the next nozzle begins to open. On older ships and most auxiliary ships, the nozzle control valves are individually operated by hand and have two positions—fully open or fully closed. Variations in speed, with certain nozzle combinations, are controlled by a separate throttle valve controlling the steam pressure to the nozzles.

If not detected in time, leaking nozzle control valves for the main turbine will affect the propulsion operation by ahead elements overheating during astern operations. When the nozzles are leaking excessively, it is possible for the shaft to rotate in the ahead direction when the throttle valve is closed. This abnormal rotation can only be stopped by securing the guarding valve or by opening the astern throttle.

A test for leaking nozzle control valves can be made when the main plant is secured. The guarding

valve and throttle valve (handwheel controlling the nozzle valves camshaft) are closed in a normal manner. Secure the turbine casing drain valves and the gland sealing valves. Next remove the lagging pad and inspection cover from the high pressure turbine; with the inspection cover off, crack the guarding valve bypass valve. Then make a visual inspection for steam leakage. There should be no steam being emitted from the turbine casing. If there is steam leakage, all valves and lines should be rechecked to make certain that the steam is coming from the nozzle valves and not from another source; the amount of steam being emitted from the inspection opening will indicate the condition of the nozzle control valves.

TURBINE MAINTENANCE

The maintenance of maximum operational reliability and efficiency of steam propulsion turbines requires a carefully planned and executed program of inspections and preventive maintenance, in addition to strict adherence to prescribed operating instructions and safety precautions. If proper maintenance procedures are followed, abnormal conditions may be prevented.

When not under steam and not in drydock, main *engines shall be turned over daily at least* 1 1/4 revolutions. Care must be taken not to bring the turbine rotor to rest in the same position for two consecutive days. This procedure prevents freezing of bearings, bowing and spot corrosion of the rotor, and permits lubrication of all gear teeth.

When the propulsion machinery is not in use, lubricating oil that is free from impurities should be circulated through the entire system for at least 15 minutes each day. It is essential that an oil film be maintained in all bearings while the turbines are being turned.

Corrosion and rusting of the turbines may be almost entirely prevented by continuing the operation of the second-stage air ejector to dry the inside of the turbines after they have been shut down and while they are still hot.

The interior of main turbines shall be inspected annually if practical, or more frequently if necessary. During this inspection, the effectiveness of the procedures in keeping the turbine dry and free from corrosion should be noted.

The maintenance required on the main engine turbines, as shown in figure 3-1, should be made and appropriate entries made in the Engineering Log.

MEASUREMENTS AND ADJUSTMENTS

The oil clearance of bearings of all types, whether journal or thrust bearings, should be checked at regular intervals and the readings recorded in accordance with the 3—M System. For a detailed procedure on taking bearing measurements, refer to the appropriate section of Machinist's Mate 3 and 2, NavPers 10525-C.

TURBINE BEARING MAINTENANCE

When a bearing is opened, it should be carefully inspected for ridges, scores, and amount of wear. It should be noted whether or not the babbitt lining has remained anchored to the shell. If the bearing is only slightly wiped, it can probably be scraped to a good bearing surface and restored to service. In this case the clearance reading of the reconditioned bearing should be fairly close to its original value.

Thrust Bearing Repairs

When trouble occurs or is suspected in a thrust bearing, the oil clearance in the bearing should be measured before the bearing is disassembled. If the readings are beyond allowable tolerances, the bearing should be disassembled for inspection.

When it is necessary to disassemble a thrust bearing, a careful inspection should be made of all parts. If there is slight rusting of the collar surfaces, the rust can be removed with a fine oilstone. The work should be done slowly and carefully by experienced personnel. When thrust shoes are reconditioned and reinstalled, check whether too much bearing metal has been removed during reconditioning. Renew the shoes if wear is evident and it exceeds allowable limits. The manufacturer supplies a spare thrust collar and 12 spare shoes to the ship. There should be no problem encountered in using the manufacturer's spare thrust shoes since they are accurately machined and surfaced to the proper dimensions. Whenever taking measurements of the

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System, Subsystem, or Component	Reference Publications
High-Pressure, Low-Pressure and Cruising Turbines	

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
MB	ZZZFTR6	B5	3037	D	1. Circulate oil through lube oil system. 2. Jack over idle turbines and reduction gears.	D-1	MM3	0.5	None
MB	ZZZFVA0	55	9752	M	1. Lubricate and operate all valve operating linkage.	M-1	MM3	0.5	None
MB	ZZZFTR6	A4	5409	Q	1. Take depth micrometer readings on the journal bearings of the main propulsion turbines.	Q-1	MM1	0.5	None
MB	ZZZFTR6	25	7724	Q	1. Lift the turbine sentinel relief valves by hand.	Q-2	MM3	0.2	None
MB	ZZZFTR6	65	A197	S	1. Measure thrust clearances of main propulsion turbines.	S-1	MM1 MM2 FN	8.0 8.0 8.0	None
MB	ZZZFTR5	94	5415	A	1. Inspect interior of turbine casings.	A-1	MMC MM2 FN	1.0 1.0 1.0	D-1
MB	ZZZFTR6	A4	5510	C	1. Clean, inspect, and preserve exterior of turbine casing.	C-1	MM2 FN	1.0 1.0	None
MB	ZZZFTR6	49	4052	C	1. Sound and tighten foundation bolts.	C-2	MM3	0.5	None
MB	ZXVFVA1	65	7727	C	1. Remove and test turbine sentinel relief valves.	C-3	MM3	2.5	None
MB	ZZZFTR6	65	A198	C	1. Inspect turbine thrust bearings.	C-4	MMC MM2 FN	4.0 8.0 8.0	S-1
MB	ZZZFTR6	65	A199	C	1. Inspect main propulsion bearings, journals, and oil deflectors. Measure clearances.	C-5	MMC MM2 FN	5.0 10.0 10.0	S-1 C-4
MB	ZZZFTR6	65	A500	C	1. Measure nozzle clearances of main propulsion turbines.	C-6	MMC MM2 FN	1.0 2.0 2.0	S-1 C-4
MB	ZZSFST5	74	4687	C	1. Clean and inspect main steam strainer.	C-7	MM1 FN	2.0 2.0 unit	None
MB	ZZZFTR6	65	A501	C	1. Inspect shaft packing and journals. Measure clearances.	C-8	MMC MM2 FN	3.0 5.0 5.0	C-5

MAINTENANCE INDEX PAGE
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BUREAU PAGE CONTROL NUMBER E-1/55-A5

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Figure 3-1.—Maintenance Index Page.

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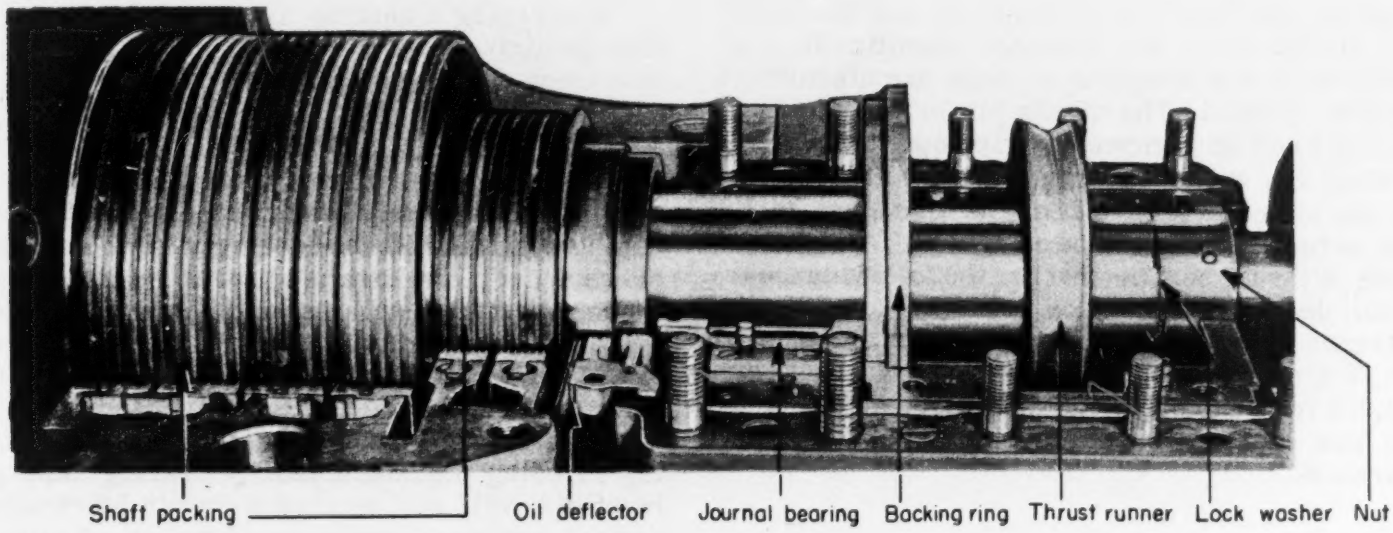

96.1

Figure 3-2.—Forward end of a high pressure turbine (base rings, leveling plates, and thrust shoes removed).

shoes, consult the detail drawing for the place and design value of such a measurement.

If thrust shoes are damaged and require rebabbitting and machining, the detailed measurements can be found by referring to the applicable blueprints. Damaged thrust shoes which cannot be reconditioned by the ship's force are sent to a repair activity to be rebabbitted and machined. The radial edges of the shoes should be slightly rounded, otherwise the sharp edges will tend to scrape the oil film off the thrust collar.

Frequently a set of shoes is slightly burnished or partially worn. If this happens when no spares are available, shift the astern shoes to the ahead side (if they are interchangeable). Stone any ridges cut in the collar (the greatest care must be taken here as to the thickness; tolerance is only 0.005 inch). Spot in the worn shoes and install on the astern side. After the bearing is reassembled, check for any change in thrust clearance.

If a thrust collar is found to be badly scored or if deep rust pits are present, the collar should be removed for repairs. On most turbines the thrust collar can be removed without lifting the casing and without disturbing the lower half of the forward journal bearing.

The propulsion turbine thrust collars on older ships are keyed to the shaft and held in place by a thrust nut threaded on the end of the shaft. To prevent the thrust nut from loosening and backing off, a lockwasher is placed between the thrust nut and the keyed sleeve. The lockwasher ears must be bent squarely into the thrust nut notches to prevent the thrust nut from backing off. On modern installations, the collar is held in place by checknuts.

From a study of figure 3-2, it is apparent that the lower half of the inner casing will have to be removed before the thrust collar can be removed from the shaft. The lower inner casing, together with the thrust bearing, is shown in figure 3-3. The lower inner casing is removed from the outer thrust bearing housing by rotating it 180°, and lifting it from the journal. This is accomplished much the same as is removing the lower half of a journal bearing.

When a thrust collar is to be remachined, the bore should be square with the faces. The faces

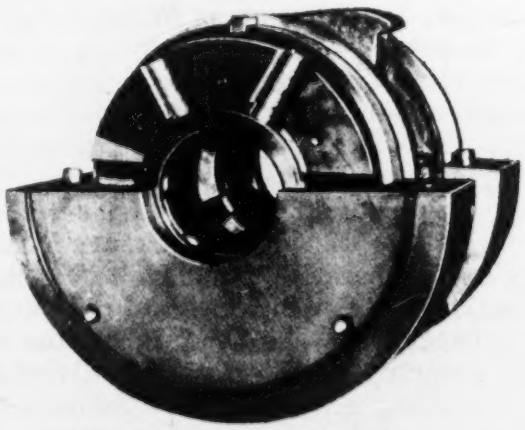

96.2

Figure 3-3.—Thrust bearing (assembled) and lower inner casing.

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should be machined flat and smooth, and the thickness should meet the required specifications as stipulated on the blueprint or in the manufacturer's technical manual. The marks left by machining or grinding must be removed by lapping.

When the thrust bearing has been reassembled and the oil clearance taken, the thickness of the shim to be added should be computed. Take, for example, a thrust bearing that has the following clearances: designed clearance 0.010 inch; maximum clearance 0.020 inch; minimum clearance 0.007 inch. If a reading of 0.025 inch was obtained, a shim of 0.015 inch should be installed. Never may more than one shim be used to obtain the proper oil clearance.

Bearing Journal Repairs

Bearing journals should be smooth, even, and free from rust at all times. With the increased emphasis on noise reduction in the Navy today, it is impossible to maintain, by hand methods of reconditioning, the roundness required for satisfactory operation. Any journal showing rust, ridges, or sharp edges that would be detrimental to bearings should be sent to a repair activity for machining.

Fitting of Bearings

A bearing should have sufficient bearing area of fit in order to withstand maximum designed load. If the bearing area is reduced by any considerable amount, more heat than the metal can withstand will be generated in the bearing; and extreme measures will have to be taken to keep the bearing cool and prevent it from wiping.

Modern bearings are usually finish bored to a diameter equal to that of the journal plus the desired oil clearance, and little or no fitting should be necessary. However, where hand fitting is required, a mandrel should be used; the mandrel should have a diameter equal to that of the journal plus the oil clearance. The first step in hand fitting is to coat the mandrel with a compound such as Prussian blue. One half of the bearing is placed on the mandrel and turned slightly with a light pressure to cause the coloring on the mandrel to adhere to the high spots on the bearing. These high spots should be removed with a scraper and the fitting operation repeated until the coloring matter is uniformly distributed over the bearing surface, which indicates that all of the bearing surface is in contact with the journal. When bearing contact with the journal is checked, contact should be limited to a small area, about 30°, in the bottom of the bearing.

In scraping a bearing, care must be taken to see that the lining is kept concentric with the shell, and that taper runout is avoided.

REPLACEMENT OF JOURNAL BEARINGS.—When a bearing surface is found to be scored, uneven, considerably worn, wiped, or burned out, or if the metal is loose, the bearing must be rebabbitted or replaced. The detailed procedure for replacing turbine bearings will vary somewhat for different sizes and types of turbines. Where the upper and lower half of a bearing may be accidentally interchanged, or the axial position reversed, care must be taken to properly mark all parts, while the bearing is being disassembled. A bearing improperly installed, will not receive adequate lubrication. A typical turbine bearing is shown in figure 3-4.

When a spare bearing is being readied for installation, it should be carefully cleaned and inspected. The two bearing halves should be bolted or clamped together and the inside diameter of the bearing measured with an inside micrometer. The inside diameter of the bearing should equal the outside diameter of the journal plus the designed oil clearance. The dimensions for a bearing may be found by checking the manufacturer's technical manual or the applicable blueprints. Ensure that a bearing that has been rebabbitted complies with dimensional specifications. Thermal distortion from heating and cooling the bearing shells during rebabbitting often results in dimensional variations of the spherical

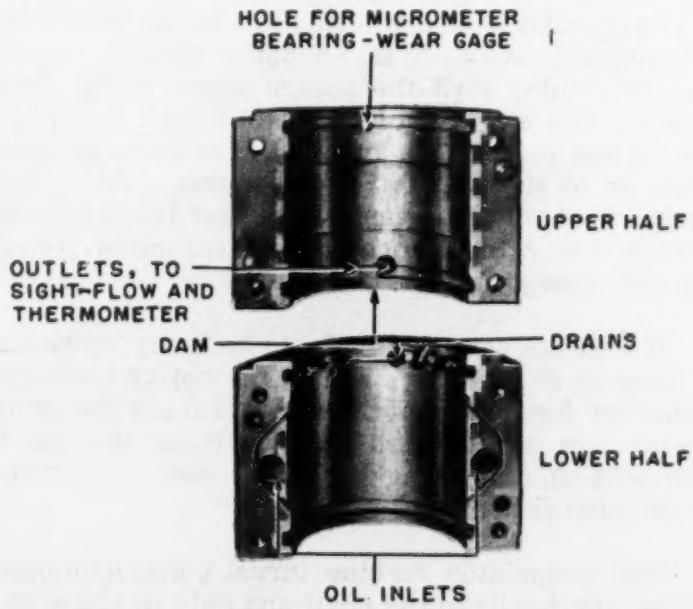

96.3

Figure 3-4.—A typical propulsion turbine journal bearing.

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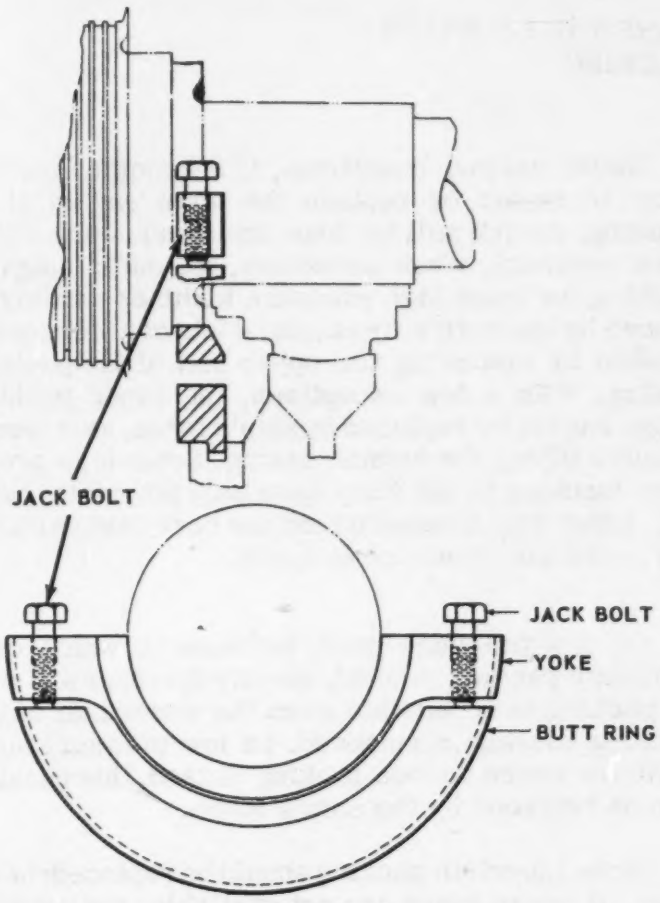

96.4

Figure 3-5.—Special jack used for removing lower half of a journal bearing.

contour. The method of taking crown thickness readings is given in chapter 4 of Machinist's Mate 3 and 2, NavPers 10524-C.

After the bearing cap and the upper half of the bearing have been removed, the weight of the rotor is lifted by a jacking device (fig. 3-5). Lift the rotor vertically about .005", as determined by a dial indicator if available, to permit the lower half of the bearing to be rolled out. Lifting the rotor excessively will damage the shaft packing, and the bearing half might bind. Before removing the lower half bearing, ensure that the thermocouples are removed (if applicable). When the lower half of the spare bearing is installed, the jack is removed and the bearing reassembled. A depth gage reading is then taken to reestablish a constant.

A bearing being used for the first time should be used at low speed; and the oil temperature should be checked at frequent intervals. A temperature rise of more than 1° F per minute usually indicates that the rubbing surfaces have been scored. An interval of 10 minutes is usually sufficient to determine the rate of temperature change.

When a defective bearing has been replaced by a spare, the old bearing should be rebabbitted as soon as possible if it is a reusable type. The usual procedure is to have a repair ship or shipyard rebabbitt and machine the bearing. The appropriate blueprints or manufacturer's technical manual will have to be furnished to the repair activity, for the necessary detailed information concerning the bearing dimensions.

NOZZLE CONTROL VALVE REPAIRS

The nozzle control valves (fig. 3-6) for the main high pressure turbine normally will operate for a long period of time without maintenance or repairs. However, the nozzle control valves are subjected to high steam pressures and temperatures, and in time they will require repairs. The MM1 and MMC should be familiar with the detailed construction of the nozzle control valves installed on his ship and the types of troubles that may occur.

One of the more common troubles that may occur to nozzle control valves is the leakage of steam between the valve seat and disk. On some ships, the complete disassemble of the operating mechanism is not necessary. The steam chest cover is lifted and carefully placed on wooden blocks to prevent damage to the valves. This will permit

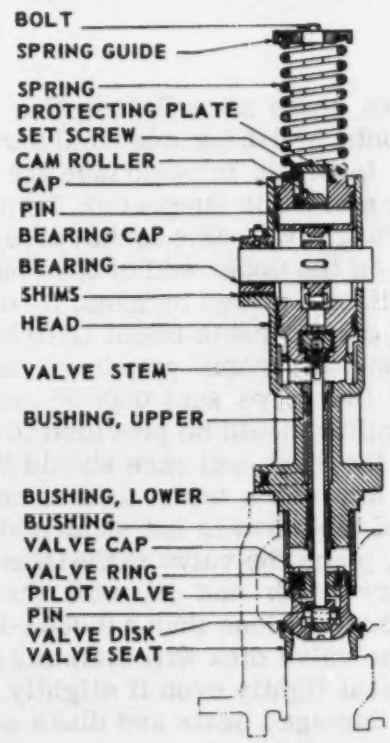

96.5

Figure 3-6.—A turbine nozzle control valve.

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inspection of valve disks and seats for damage. If leakage is suspected, the contact area of each valve with its seat should be checked by bluing the valve. If the valve does not make a good contact with its seat, do not use the valve to lap the seat as this makes a flat spot on both the valve and seat and destroys the spherical surface of the valve. Figure 3-7 shows an enlarged section of one type of nozzle control valve.

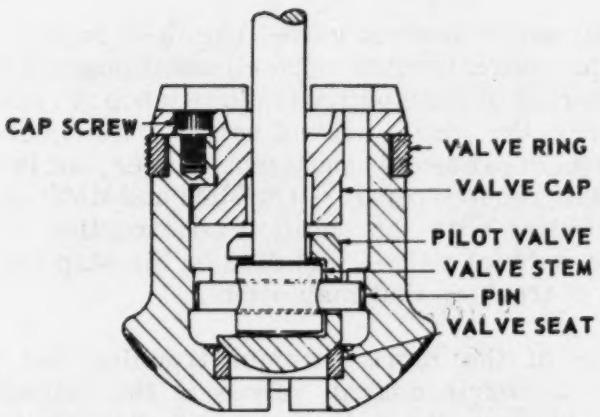

96.6

Figure 3-7.—Section of a nozzle control valve (pilot valve details).

Most valve seats have flat angular surfaces at the line of contact with the spherical surfaces of the valve disks. In order to resurface the valve seat, the following method is suggested: Turn a cast-iron cone with an angle the same as the valve seat angle. Leave a tip on the upper end of the cone so that it can be held in and turned by hand, or driven by an air motor if considerable metal is to be removed. With this cone and some grinding compound, the flat angle of the valve seat may be resurfaced. A mechanical guide should be provided to keep the lap square with the seat and care should be taken not to grind off any more metal than is necessary. If the surface of the valve is not spherical because of pits or wear, place the valve in the lathe and polish it with emery cloth and oil until the surface is smooth and there is less than a 0.0005-inch runout. In this way the valve disk will maintain a spherical surface and seat tightly even if slightly out of line. Badly cut or damaged seats and disks are replaced rather than reconditioned.

RENEWAL OF SHAFT PACKING

Under normal conditions, if it becomes necessary to repair or replace the main engine shaft packing, the job will be done during a routine shipyard overhaul. When necessary, the outer rings of packing for most high pressure turbines can be replaced by the ship's force, since this can be accomplished by removing the upper half of the packing casing. With a few exceptions, the inner packing rings cannot be replaced by ship's force, as it would require lifting the turbine casing. Some high pressure turbines in the Navy have only labyrinth packing. Other high pressure turbines have carbon packing in the low pressure end only.

On low pressure main turbines in which only labyrinth packing is used, usually the inner and outer packing is accessible when the upper half of the packing housing is removed. On low pressure main turbines where carbon packing is used, this packing can be replaced by the ship's force.

Worn labyrinth packing should be replaced; however, if spare rings are not available, the packing may be repaired by using a chisel bar and a hand chisel as shown in figure 3-8. These tools are placed as indicated in the figure, the chisel is struck with a hammer, and then advanced around the periphery of the packing a trifle less than the tool's width. Care must be taken that each new position of the chisel overlaps the preceding position. This procedure expands the "tooth" in height and draws it out to its original featheredge. The drawing out of the

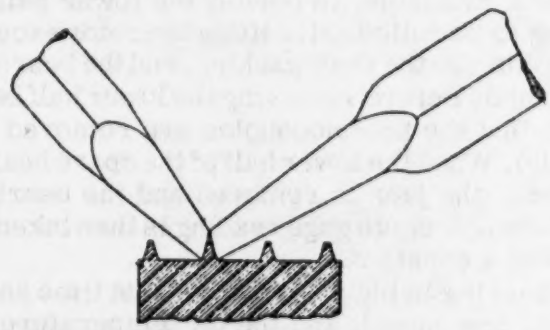

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Figure 3-8.—Restoring height of labyrinth packing "lands."

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"teeth" must be continued to give the packing clearance specified on manufacturer's drawings or in manufacturer's technical manuals. If the clearance is not available from plans or instructions, the drawing of "teeth" should be continued until they come within 0.005 inch of touching the shaft.

When it becomes necessary for the ship's force to overhaul carbon packing, it is recommended that the removed segments be placed in a box in such a manner that adjacent segments of a ring will be next to each other. Each segment of carbon packing is marked on each end with the number of the ring of which it is a part. As each segment is removed, an examination should be made for scores, grooves, and general condition. The rings can be refitted or renewed, whichever is necessary.

The retainer springs must be carefully inspected and tested. If they are weak or corroded, they must be renewed.

Refitting or renewing carbon packing rings is a rather difficult and tedious job. You can simplify the work considerably by making up a jig or mandrel, similar to the one shown in figure 3-9, and a checking gage. The jig can be made from a square steel plate or from round bar stock; it should be approximately 3/8 inch thicker than the ring to be fitted, and about 1 1/2 inches greater in diameter (or perimeter, if you are using a square plate) than the inside diameter of the ring. The upper part should be turned down to a diameter which is about 0.001 or 0.002 inch LESS than the final bore required for the carbon ring, and a cutting edge should be raised around the periphery of the turned surface. The cutting edge is made by making diagonal cuts about 0.003 inch deep, with a pitch of about 1/2 inch,

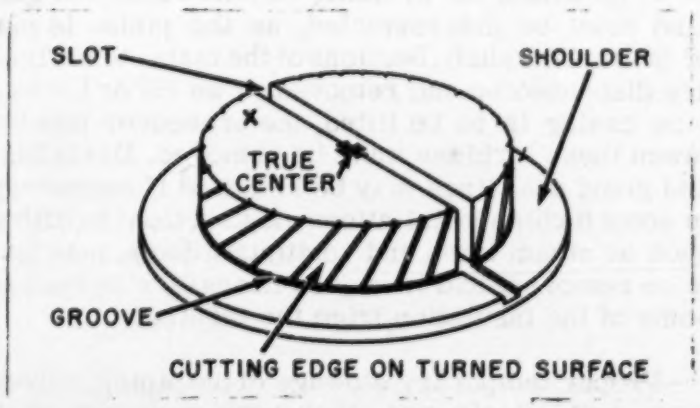

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Figure 3-9.—Jig for fitting carbon packing rings.

on the turned surface. The final diameter of the turned surface, including this raised cutting edge, should be the same as the required inside diameter of the carbon ring.

The width of the turned surface should be about 1/8 inch greater than the width of the carbon ring to be fitted. A small groove should be cut in the shoulder, as an extension of the turned surface; this groove will provide a space in which loose carbon particles can collect, so that they will not interfere with the fitting of the carbon ring.

Cut a 5/16-inch slot through the turned surface, and continue it about 1/8 inch into the shoulder or flange below the turned surface. One edge of the slot must pass EXACTLY through the center, forming a true diameter of the circular face of the jig; the other edge of the slot will therefore be slightly off-center. Be sure to mark that part of the face which forms a true half-circle after the slot has been cut. Remove all sharp edges from the turned surface of the jig and make sure that the edges of the slot are smooth.

The checking gage can be made by turning a piece of steel to the same diameter as the shaft to which the carbon ring is to be fitted. The checking gage should be 1/8 inch thicker than the width of the ring.

Assemble the segments of the carbon ring on the checking gage, and hold them in place with the garter spring. Check the fit of the joints and the clearance between the ring and the gage. If the joints do not fit properly, or if the bore is too large, remove the ring from the checking gage. Place each segment separately on the jig and smooth the ends with fine sandpaper wrapped around a flat file or a block. Each segment must be placed on the true half of the jig, and the true centerline must be used as a guide when removing carbon from the end of the segment. Remove carbon from the ends of each segment until the assembled ring is TOO SMALL to fit over the checking gage. Then assemble the entire ring, with its garter spring, on the fitting jig. Hold the ring against the bottom of the jig and turn it by hand until the cutting edge on the jig has removed enough carbon to allow the ends of the segments to make proper butt joints.

Remove the carbon ring from the jig and try it on the checking gage. If the ring is too small, put it back on the jig and remove some more carbon from the inner surface of the ring. If the ring is too large, replace each segment on the jig and remove

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Block I - Basic Electronics

Unit 2 - Static and Dynamic Electricity

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Constructing a wet cell battery (sulphur acid)	Nature of matter
	Cells and batteries
Constructing a simple battery circuit using ammeter	Current flow
Constructing a multiple battery circuit using voltmeter and flashlight bulb	Electron flow Effects of electric currents
	Conductors and insulators
Finding and organizing parts according to technical symbols and terms	Circuits and symbols
	Applications to ohm's law
Measuring resistors and proving their value according to color code	Resistance of conductors and D. C. circuits
Laying out and measuring circuits of resistors in series	Watt's law
Measuring circuits with resistors in paralleled and series-paralleled circuit arrangements	Voltage dividers, rheostats, and potentiometers
Construct a circuit using power resistors to find wattage rating required	

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carbon from each end until the ring is the correct size.

When carbon rings are fitted in the manner just described, the ends of the segments will make firm butt joints and there will be a small clearance between the inner surface of the ring and the shaft. On some auxiliary turbines, the carbon rings are designed to rub against the shaft and have a clearance between the butting ends of the segments. When fitting these rings, make the jig with a diameter which is, including the raised cutting edge, the same as the diameter of the shaft. Rings cut on this jig should make contact with the shaft along the full length of each segment, and the ends of the segments should be filed down to make the proper butt clearance.

LIFTING THE TURBINE CASING AND ROTOR

Although shipyard personnel are responsible for lifting turbine casings and rotors, the MM1 and MMC should have a good understanding of the procedures involved. Before a turbine casing is lifted, preliminary work has to be done. All the turbine lifting gear, special tools, and equipment should be inventoried and inspected at least one day before the actual work is to begin. The manufacturer's technical manuals and Coordinated Shipboard Allowance List (COSAL) can be used for inventory of the lifting gear. Ship's force should be ready (if necessary) to furnish turbine lifting gear which includes: casing guides, casing supports, rotor guides, rotor supports, lifting brackets, and other items that the ship will have aboard. On some ships the turbine lifting gear has been removed, and therefore will be available only in naval shipyards and on tenders and repair ships. The ship's blueprints will have listed on them all of the lifting gear placed aboard the ship.

The decision as to when casings should be lifted will be made by the type commander. This decision will be based upon the past performances of the particular type of turbine, data furnished by the CO of the ship, and recommendations made by the forces afloat. In an emergency, turbine casings may be lifted before permission is granted, but a detailed report must be promptly submitted to NavShips.

Regulations for Lifting Turbines

Three months prior to each regular overhaul, a report by the CO of the ship on the condition of each propulsion turbine shall be submitted to the type commander. NavShips Technical Manual, chapter 9410 (41), should be consulted for the information required to be contained in the report.

Any answer from NavShips involving a recommendation to disassemble the casing or to perform additional tests or inspections will be directed to the type commander with copies to the reporting ship, the planned overhaul activity, Ships Parts Control Center (SPCC), and any other activities concerned. Final authority for disassembling the casing is the responsibility of the activity (usually the type commander) controlling the operating schedule and overhaul funds of the ship.

Lifting Casing and Rotor

Whenever turbine casings are lifted for any purpose, advantage should be taken of the opportunity to observe the condition of all nozzles, blading, packing rings, and other internal parts. When practicable, such examinations should be made when adequate facilities are available for necessary repairs which are beyond the capacity of the ship's force.

All turbine measurements and clearances should be taken before and after repairs; a permanent record of these measurements should be maintained. (Fig. 3-10 shows the method of checking the rotor position with a taper gage.) The record must also include the material condition revealed when the turbine is opened and after repairs are made. A report of the above facts must be forwarded to the Naval Ship Systems Command, with copies to the ship concerned and to her home yard.

Before the casing can be lifted, the preliminary work can be started. The covers over the flexible couplings, between the turbines and the reduction gears, must be removed. If a cruising turbine rotor is to be lifted, the cruising turbine reduction gear also must be disassembled, as the pinion is part of the turbine shaft. Sections of the main steam lines are disconnected and removed. If an HP or LP turbine casing is to be lifted, the crossover line between these turbines must be removed. Drain lines and gland seal lines may be removed if necessary. In some turbine installations, obstructions to lifting, such as steam lines and ventilation ducts, may have to be removed, and it may be necessary to remove some of the insulation from the turbine.

Proper temporary stowage of the piping, valves, nuts, bolts, tools and other necessary materials must be provided, either in or out of the engineroom. Passageways and working areas must be

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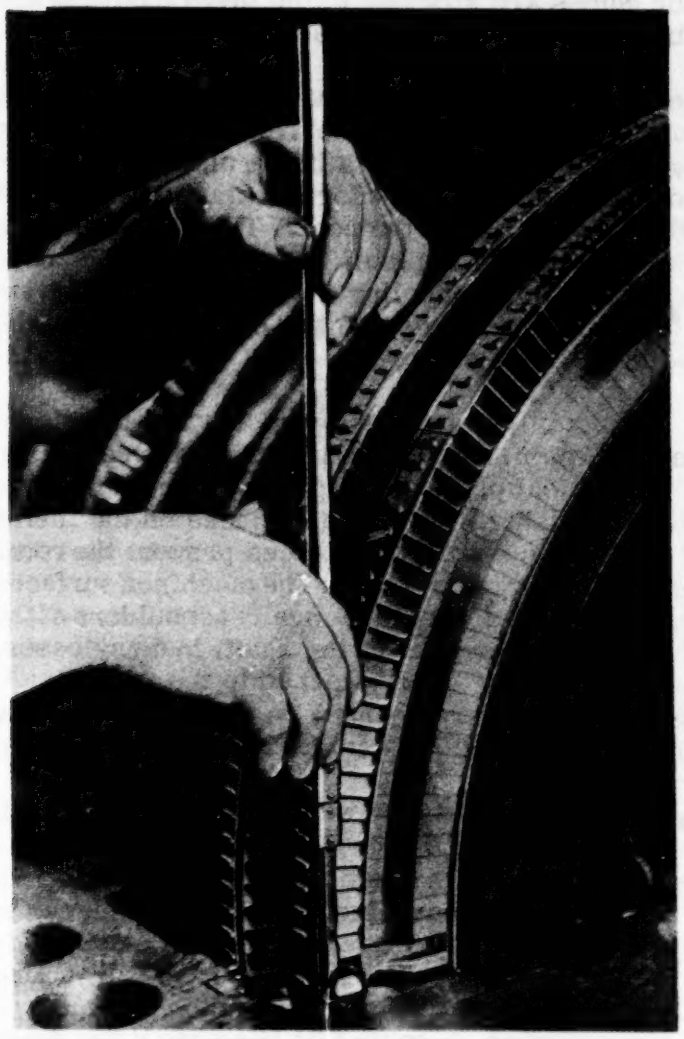

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Figure 3-10.—Using a taper gage to check the position of a rotor.

kept free of tools and materials being used. Avoid damage to the piping, gages, gage lines, lagging, and other material.

After the preliminary work has been completed, the turbine casing horizontal joint bolts are removed. As a rule, the vertical joint bolts on the high pressure turbine are not removed, except where repairs require the joint to be opened. Most inspection covers have caution plates which call attention to internal bolts or fittings which must be removed. The upper housings and upper halves of main turbine bearings must be removed. When disassembling turbine casing bolts that were tightened by heat, it is important that heat be applied when loosening these bolts; the heat will prevent galling the threads. If there is a tendency for the joint to spring open at disassembly, it is good practice to loosen the first few bolts, then tighten them lightly; these bolts can be removed last. After all the bolts have been removed, the joint can be broken loose by means of jack bolts, if necessary.

When a ship is built, padeyes are welded in the overhead of the engineroom for attaching chain falls for lifting heavy objects. The manufacturer's technical manual and the ship's blueprints will give detailed information on the arrangement, number and size of the chain falls, wire slings, and shackles to be used to lift any particular piece of machinery. The lifting arrangement for a turbine casing will allow the four corners of the upper casing to be lifted in a plane parallel to the flange of the lower casing. Four upper casing guide pins are installed. If there is a scale on a guide pin, this scale should face outboard where it can be readily seen. The location of the upper casing guide pins is shown in figure 3-11. The guide pins are used to prevent any damage to the turbine blading and shaft packing. As the turbine casing is raised or lowered, it should be handled in a manner to prevent tilting or swaying so as not to strike the turbine blading or shaft packing.

When the turbine casing is ready to be lifted, men are assigned to the various jobs and stations. It usually requires 10 or 12 men to raise or lower a main turbine casing. (Four men operate the chain falls. Four men, one at each corner of the turbine

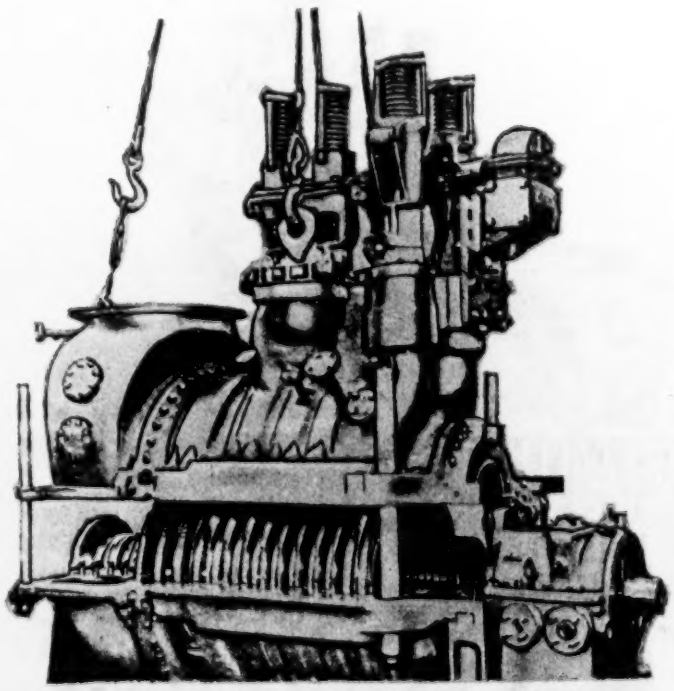

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Figure 3-11.—Lifting or lowering upper casing of a high pressure turbine.

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casing, take measurement readings from the guide pins. Usually an observer is stationed at each side of the turbine, and one man will supervise the entire operation.)

The casing is slowly raised, keeping uniform heights at the graduated guide pins to ensure that the casing is level and not tilted. The usual procedure is to slowly raise the casing about one inch at a time until the upper casing is clear of the rotor. As a safety precaution, blocks are inserted under the upper casing flange as the casing is raised. When the casing is clear of the rotor, it can be either swung clear of the turbine, or secured in a position above it as shown in figure 3-12.

After the casing has been raised to the desired height (not higher than the guide pins), and if it is not to be swung clear, the four upper casing supports are installed, as shown in figure 3-12. Applicable blueprints should be on hand to show the exact location for installing the various turbine supports and guide pieces. The upper casing support pieces are bolted to the upper and lower casing flanges. Figure 3-12 shows a turbine opened for inspection.

A similar procedure is used for lifting a turbine rotor as is used in lifting the upper casing. Four rotor guides are attached to the lower casing of the turbine, as shown in figure 3-13. There are different methods of attaching the wire slings to the turbine rotor. One method, shown in figure 3-13, is used for a small turbine rotor. Another method uses a special lifting yoke and a lifting plate to raise the rotor. The lifting yoke, a form of clamp, is attached to the forward end of the rotor. The lifting plate, a padeye welded to a plate, is attached to the after face of the shaft coupling flange. Shackles are attached to lifting devices so that chain hoists may be used in lifting the rotor.

The rotor guide pieces perform two functions: when the rotor is being raised, the guide pieces keep it in a vertical plane passing through the centerline of the rotor shaft; machined surfaces on the inside corners of the rotor guide pieces prevent the rotor from moving forward or aft. The machined surfaces bear with a small clearance against shoulders of the forward and after ends of the shaft. In many cases, special bushings are attached to the rotor shaft. These bushings are located on the sections of the shaft between the pairs of rotor guide pieces.

After all preliminary work has been completed, the turbine rotor is slowly lifted from the lower casing. The rotor is lifted approximately one inch ~~at~~ a time and measurements taken at each end to ensure that both ends have been raised evenly. Adjustments in height are made as necessary. This procedure is repeated until the rotor has cleared the lower casing. A rotor that has been lifted clear of the casing is shown in figure 3-13.

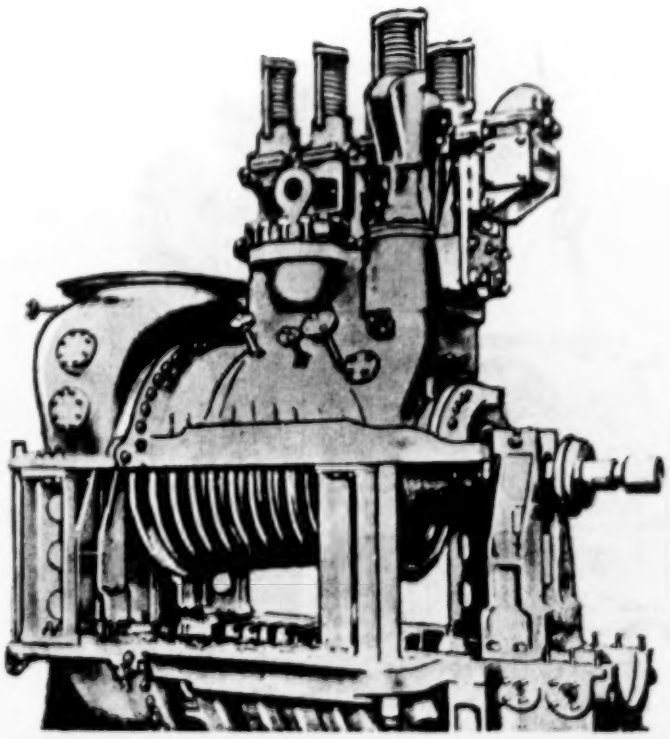

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Figure 3-12.—Upper casing and rotor resting on supports.

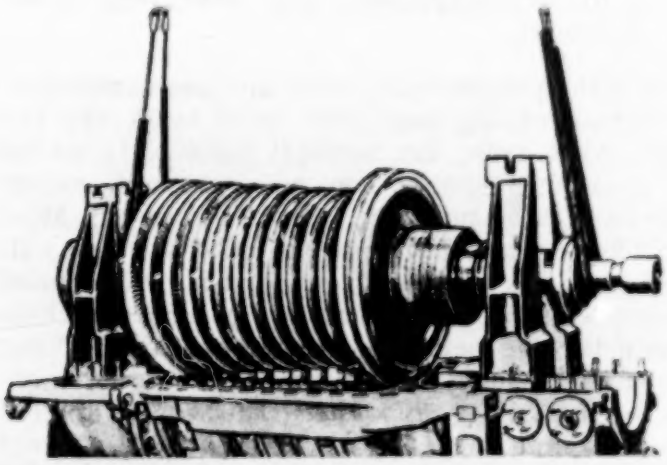

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Figure 3-13.—Lifting a high pressure rotor.

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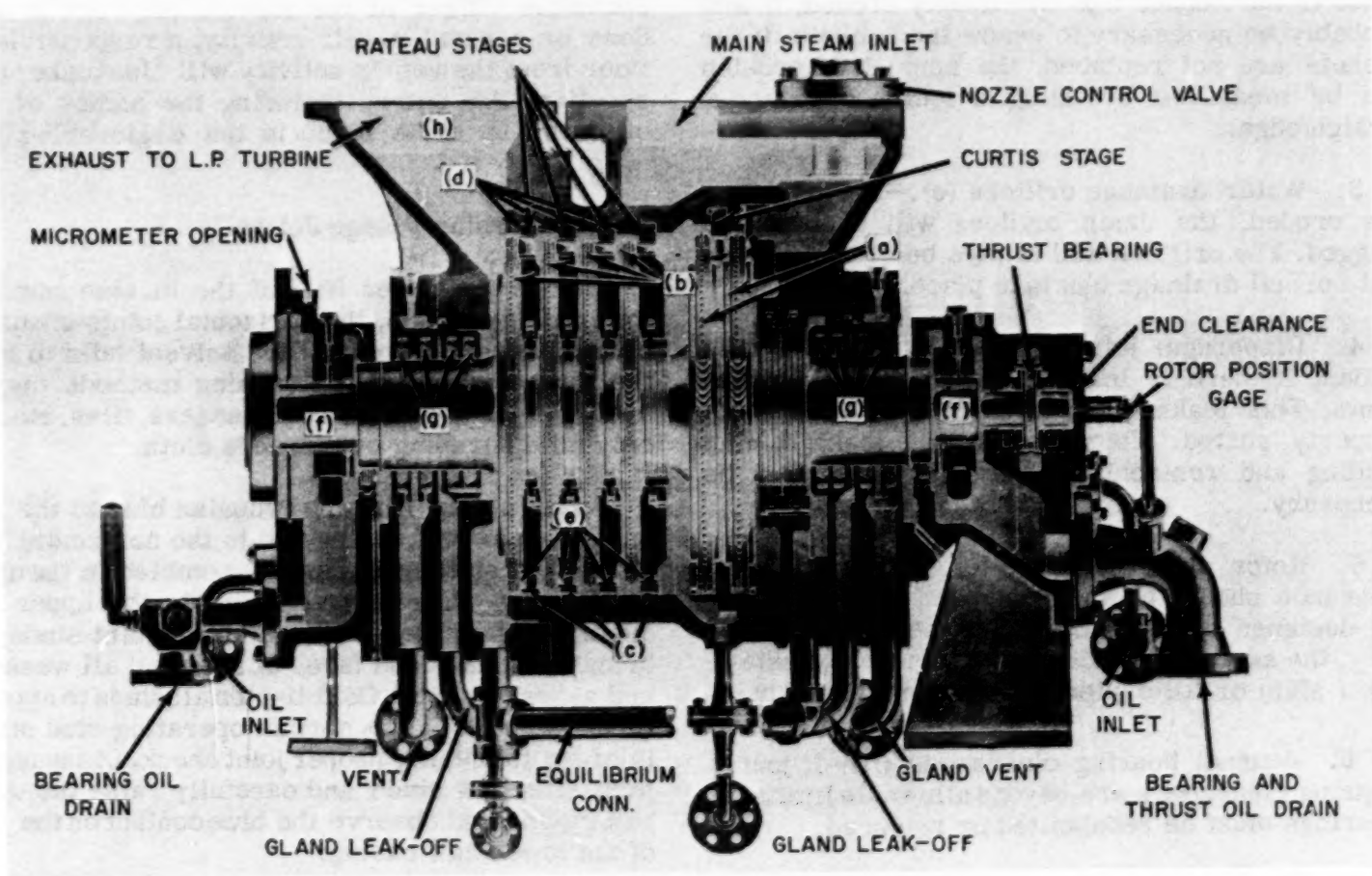

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Figure 3-14.—Required overhaul checks.

When a turbine rotor is to be placed in its raised position, special securing devices such as rotor guide saddles, rotor supporting bars, rotor guide tie brackets, and rotor guide spacer bolts are used. These attachments are secured in place so as to properly support the weight of the rotor. The same procedures are used to lift and support the high pressure and the low pressure turbine rotors.

CHECKING ROTOR BALANCE

If turbine rotor unbalance is suspected, the rotor should be checked for balance while still in the casing. The normal procedure is to notify the type commander who will determine the repair activity which will conduct the necessary tests and inspections. All turbine rotors must be rebalanced when any of their blading has been renewed or their balance has been altered by repairs.

MAJOR OVERHAUL CHECKPOINTS

When a turbine casing has been lifted for repair, there are several tests and inspections required by the Naval Ship Systems Command. A complete turbine repair guide list can be found in chapter 9410(41) of NavShips Technical Manual. Some of the important points (see a through g, fig. 3-14) to be checked are as follows:

1. High pressure buckets (a).—Scale may be found here. It may usually be removed by washing with water; however, several other methods are employed for hard-to-remove deposits. It is not recommended to use chemical solvents in removing scale.

2. Low pressure buckets (b).—Steam entering the low pressure turbine, having lost heat in the high

pressure turbine, may contain water. The water may cut the bucket tips, especially near the entrance edge. If the bucket tips are deeply eroded, it will probably be necessary to renew the buckets. If the buckets are not replaced, the amount of erosion can be measured by using a feeler gage and a straightedge.

3. Water drainage orifices (c).—If the blading has eroded, the drain orifices will probably be plugged. The orifices will always be cleaned out so that normal drainage can take place.

4. Diaphragm joints (d).—Flow marks will be evident if there is leakage across the diaphragm joints. This leakage indicates that the joint is not properly seated. To correct severe leakage, clad welding and remachining the joint faces may be necessary.

5. Rotor axial clearance (e).—The rotor axial clearance should be measured and compared with the designed clearance. If adjustments are necessary, the axial clearance can be adjusted by installing a shim or filler piece of the proper thickness.

6. Journal bearing clearances (f).—If journal bearing clearances are beyond allowable limits, the bearings must be rebabbitted or replaced.

7. Shaft packing rings (g).—If the clearance of the shaft packing is beyond the manufacturer's specified tolerance, the packing rings should be renewed or reconditioned.

8. Casing interiors.—If erosion is found here, it may be necessary to make repairs to the eroded parts. In most instances, the casings can be welded to restore the eroded surfaces.

REASSEMBLING A TURBINE

When a turbine is opened for a major overhaul, the repair guide list in NavShips Technical Manual, the type commander's instructions, the manufacturer's technical manual and the instructions issued by the Shipyard Commander should be checked—and followed where applicable—before the turbine is reassembled.

Before reassembly of a turbine that has been opened, a very careful examination should be made of the rotor and the interior of the casing for any articles left behind. This examination should be made before the rotor is lowered into place and again before the upper casing is lowered and secured in place. This examination should be made by a responsible officer of the ship. If the work is being done by a naval repair activity, a responsible officer from the repair activity will also make an inspection. An entry, including the names of both officers, is to be made in the Engineering Log.

Sealing Turbine Flange Joints

Before the upper half of the turbine casing is lowered into place, the horizontal joints should be cleaned with a solvent. If the solvent fails to clean the flange, mechanical cleaning methods may be necessary. DO NOT use belt sanders, files, etc. Use only mild scraping or a crocus cloth.

Apply a thin film of Prussian blue to the joint on the upper half casing and to the horizontal joint of internal stationary parts assembled in the upper half casing. Carefully reassemble the upper half casing on the lower half. Install all joint studs; lubricate threads and faces of nuts and all washers, and assemble nuts. Cold tighten all studs to approximately one-half the normal operating stud stress in order to obtain a proper joint check. Disassemble joint nuts and studs and carefully raise the upper half casing and observe the blue contact on the joint of the lower half casing.

If the blue check indicates a poor contact due to local high areas, these areas should be either scraped or stoned so as to obtain a proper blue check in this area when using a surface plate not over 6 inches in diameter. In some cases, the joint may contain eroded areas and grooves caused by steam leakage. To seal these areas and grooves and prevent subsequent leakage, it may be necessary to apply a small amount of weld. The welding should be done under the supervision of a capable welding engineer.

When the joints on both the upper and lower halves of the casing show at least a continuous (approximately 85 percent) contact on the surface between the bore of the turbine casings and the bolt holes and also an intermittent (approximately 50 percent) contact on the surface between the bolt holes and the outer edge of the casing flanges, the joints should be cleaned of all foreign material and the upper half casing lowered into position for assembling.

The entire joint surface on each casing shall be lightly coated with a thin even film of joint compound. This compound should be a triple boiled lin-

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seed oil or an approved compound in accordance with MIL-S-15204. (Sealing compounds are presently being tested for high temperatures in use today.) The use of sheet packing for flange joints is prohibited.

The main horizontal and vertical joints in some turbine casings have a system of grooves in the joint faces for pressure pumping with sealing compound during emergency repairs. These grooves shall not be filled with sealing compound during routine overhaul.

Tightening Turbine Flange Joints

With high steam pressures and temperatures it is difficult to make the turbine casing joints (when cold) sufficiently tight by using sledges or extension wrenches. Bolts are given an additional stress by tightening after heating. The heating is usually done with an acetylene torch or with electric heating elements; because acetylene torches are available on most ships, they are more commonly used. Almost all horizontal joint bolts of cruising and high pressure turbines are drilled their full length for the application of heat. In applying the heat, a standard acetylene torch is fitted with an attachment which is provided with a 1/16-inch orifice. For complete details on applying the heat and tightening the bolts, rever to the manufacturer's technical manual and NavShips Technical Manual.

DOCK TRIALS

When a main propulsion turbine has been opened for inspection and repair, the work is not considered complete until a DOCK TRIAL and a POST REPAIR TRIAL have been satisfactorily completed and any deficiencies found have been corrected.

The engineer officer of each ship may issue instructions for operating the plant during a dock or post repair trial; however, the general procedure will be as follows:

Before oil is circulated through the lube oil system, muslin bags are fitted in the lube oil strainers. The muslin bags, available at naval shipyards, will prevent very fine particles of dirt from entering the bearings and gears. A lube oil pump is started and oil is circulated through the system. The muslin bags must be changed often (the interval of time between changes is usually set by the engineer officer). When dirt or other foreign matter is no longer found in the muslin bags, the turning gear should then be engaged. Personnel will be stationed at various points around the turbine to listen for unusual noises. If no abnormal conditions are detected, the turbine can be considered ready for a dock trial.

During a dock trial, the ship will remain tied to a pier and the engines turned by steam. The commanding officer usually determines the maximum number of rpm the engines will be permitted to turn. On a ship having two engines, one engine should turn in the ahead direction and the other engine must turn in the astern direction; then the engines should be reversed.

The main plants are warmed up in accordance with the engineer officer's instructions. When the engines are ready to be tested, the special sea detail should be stationed. The officer of the deck will shift his watch from the quarter deck to the bridge and personnel will be stationed around the turbines to detect unusual noises or other abnormalities. When all stations are manned and the engineering plant is ready, the engineer officer will request permission from the bridge to test main engines. When the OOD is certain that the area around the fantail is clear of boats, mooring lines, etc., he will grant permission to test main engines. When the main engines have been tested and found satisfactory the engineer officer will report to the bridge, that the main engines are ready for dock trial. One main engine will then be designated to go in the ahead direction and the other main engine will be designated to go in the astern direction. The appropriate orders will be rung up on the engine order telegraph and the required rpm will be indicated on the engine order telegraph. When these orders are received in the engineroom, the engine itself will be turned, by steam, at the indicated rpm. If no abnormal conditions are found, the engineer officer will request an increase in speed. The OOD will order the rpm increased (about 5 rpm each change) until the maximum allowable rpm is reached. If no abnormal conditions are detected, the main engines may be considered ready for a post repair trial.

Information on Post Repair Trials is given in a later chapter of this training course.

SAFETY PRECAUTIONS FOR TURBINES

Turbine installations in the Navy vary to such an extent that detailed safety precautions for each

type cannot be covered in this training course. The following general safety precautions are prescribed by NavShips and should be observed:

1. Be sure that the lubrication system is operating properly before turning over the main engines.

2. Keep the rotors turning over continuously while the main engines are being warmed up.

3. Never fail to investigate any unusual noise coming from a turbine.

4. Do not put way on the ship when turning over the main engines during warmup.

5. If a turbine vibrates, slow it down, investigate and locate the cause.

6. Except in an emergency, do not admit steam to the astern turbine until steam to the ahead turbine is secured, and vice versa.

7. Before getting under way, be sure that all steam lines are drained properly.

8. When steam pressure drops, do not open the throttle to such an extent that the operating pressure of the steam drops to a dangerously low point.

9. Stop the engines immediately if the oil supply fails.

10. If the throttle valve sticks, close the guarding valve as soon as possible. In an emergency, the guarding valve can be used as a throttle.

11. Exercise care to prevent the entry of foreign matter into a turbine when it is opened for inspection.

CHAPTER 4

REDUCTION GEARS

This chapter contains information on the operation, care, and maintenance of reduction gears found on Navy ships. The MM1 and MMC must be familiar with the design and construction details of naval reduction gears. To acquire this information a review of chapter 4 of Machinist's Mate 3 and 2, NavPers 10524-C, plus information contained in chapter 9420 (42) of NavShips Technical Manual will be useful. For details of any particular reduction gear installation, a thorough study of the manufacturer's technical manual will be necessary.

MAIN REDUCTION GEARS

The main reduction gear is one of the largest and most expensive units of machinery found in the engineering department. Main reduction gears that are installed properly and operated properly will give years of satisfactory service. However, a serious casualty to main reduction gears, will either put the ship out of commission or force it to operate at reduced speed. Extensive repairs to the main reduction gear can be very expensive because they usually have to be made at a shipyard.

OPERATION OF MAIN REDUCTION GEARS

Some things are essential for the proper operation of reduction gears. Proper lubrication includes supplying the required amount of oil to the gears and bearings, plus keeping the oil clean and at the proper temperature. Locking and unlocking the shaft must be done in accordance with the manufacturer's instructions. Abnormal noises and vibrations must be investigated and corrective action taken. Gears must be inspected in accordance with the current instructions issued by NavShips, the type commander, or other proper authority.

Proper Lubrication of Gears and Bearings

Proper lubrication of reduction gears and bearings is of the utmost importance. The correct quantity and quality of lubricating oil must, at all times, be available in the main sump. The oil must be CLEAN; and it must be supplied to the gears and bearings at the pressure and temperature specified by the manufacturer.

In order to accomplish proper lubrication of gears and bearings, several conditions must be met. The lube oil service pump must deliver the proper discharge pressure. All relief valves in the lube oil system must be set to function at their designed pressure. On most older ships, each bearing has a needle valve to control the amount of oil delivered to the bearing. On newer ships, the quantity of oil to each bearing is controlled by an orifice in the supply line. The needle valve setting or the orifice opening must be in accordance with the manufacturer's instructions or the supply of oil will be affected. Too small a quantity of oil will cause the bearing to run hot. If too much oil is delivered to the bearing, the excessive pressure may cause the oil to leak at the oil seal rings. Too much oil may also cause a bearing to overheat.

Lube oil must reach the bearing at the proper temperature. If the oil is too cold, one of the effects is insufficient oil flow for cooling purposes. If the oil supply is too hot, some lubricating capacity is lost.

For most main reduction gears, the normal temperature of oil leaving the lube oil cooler should be between 120° F and 130° F. For full power operation, the temperature of the oil leaving the bearings should be between 140° F and 160° F. The maximum TEMPERATURE RISE of oil passing through any gear or bearing, under any operating conditions, should not exceed 50° F; and the final temperature of the oil leaving the gear or bearing should not exceed 180° F. This temperature rise and limitation may be determined by installed thermometers or resistance temperature elements.

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Cleanliness of lubricating oil cannot be overstressed. Oil must be free from impurities, such as water, grit, metal, and dirt. Particular care must be taken to clean out metal flakes and dirt when new gears are wearing in or when gears have been opened for inspection. Lint or dirt, if left in the system may clog the oil spray nozzles. The spray nozzles must be kept open at all times. Spray nozzles must never be altered without the authorization of the Naval Ship Systems Command.

The lube oil strainers perform satisfactorily under normal operating conditions, but they cannot trap particles of metal and dirt which are fine enough to pass through the mesh. These fine particles can become embedded in the bearing metal and cause wear on the bearings and journals. These fine abrasive particles passing through the gear teeth act like a lapping compound and remove metal from the teeth.

MAIN SUMP OIL LEVEL.—Lubricating oil is supplied to the gears from the main engine lubrication system, with a connection to each bearing and with nozzles located so that a constant spray of oil is directed to the gears. This constant spray of oil over the gears lubricates and cools the gears. For reduction gears, where the maximum oil level in the sump may reach the bottom of the bull gear, positive means are taken to ensure that the bull gear does not dip into the oil. An oil excluding pan is fitted around the bottom of the bull gear to prevent oil from reaching it, during normal operation.

If the gear is allowed to dip into the oil, the churning action of the gear may cause the oil to foam. Under normal conditions, only a small quantity of oil comes in contact with the bull gear, therefore no dangerous vibration and no churning effect will occur. Oil from the gears is swept out of the pan by the bull gear and drained into the sump. A drain hole is provided on the bottom of the pan so located that drainage of any accumulated water is assured when the ship is on an even keel. When there is too much oil in the sump, the gear will churn and aerate the oil. Because the aerated oil is a poor lubricant, there will be an increase in temperature. If this occurs, the engines must be slowed or stopped until the excess oil can be removed and normal conditions restored. Routine checks should be made to see that the lubricating oil is maintained at the proper level. Any sudden loss or gain in the amount of oil, in the main sump, should be immediately investigated.

EFFECTS OF ACID AND WATER IN OIL.—Water and acid in oil are extremely dangerous. The oil must be tested frequently for water and at regular periods for acid. Even a small amount of water in oil can cause pitting and rusting. Fresh water can accumulate, due to leaking turbine packing glands or from condensation. Where main sump tanks are located at the skin of the ship, salt water may leak into the lube oil. Salt water may also enter through leaks in the lube oil cooler. When salt water is found in a lube oil system, corrective steps must be taken. The source of the salt water must be found and sealed off. The contaminated oil must be removed from the system by adequate flushing with clean oil.

When oil is contaminated with fresh water adequate purification will prevent an accumulation of water in the oil but the source of water must be found and eliminated. Under normal operating conditions, operating the lube oil purifier 12 hours a day, while under way, will be sufficient; however, if the presence of fresh water is noted, the purifier will have to be operated until there is no visual indication of water in the oil and no water is discharged from the purifier. If, with additional purifier operating time, the oil does not clear up, the purifier should be checked for improper operation. The presence of salt water or fresh water in lube oil should never be ignored. The system should be checked immediately and the source of contamination should be eliminated.

When the main engines are secured, a lube oil pump should be kept running and the jacking gear should be engaged and kept turning until the engines have reached approximately room temperature (ambient). While oil is circulating, the lube oil cooler should be left in use and the purifier should be operated. Circulating oil will carry away the heat from the engines which might otherwise reach the bearings. Jacking the engines will prevent the rotors from becoming bowed. Operating the purifier will eliminate water caused by condensation on the interior of the reduction gear casing.

Ships should take advantage of every opportunity to have laboratory tests made of the lube oil. Good engineering practice dictates that this be accomplished every 3 months or more frequently if unusual conditions prevail. Samples should be tested for water, acid, and sediment content. When the neutralization number exceeds 0.50, the lube oil should be replaced.

All petroleum products deteriorate (oxidize) in the presence of air and heat. The products of oxidation include organic acids which, if present in sufficient concentration, have deleterious effects on (1) alloy bearings at elevated temperatures, (2) galvanized surfaces, and (3) the demulsibility of the oil with respect to fresh and salt water.

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OIL EMULSION.—With continuous use, the lube oil will increase in acidity, and the free fatty acids will form mineral soaps which can form a stable oil and water emulsion. Once the emulsion has formed, the removal of water becomes more difficult, and of more importance, the oil loses its lubricating quality. The formation of an oil film becomes impossible and the oil must be renovated. Operating with emulsified oil will result in wiped bearings and worn gear teeth.

Locking And Unlocking The Main Shaft

In an emergency, or in the event of a casualty to the main propulsion machinery of a turbine-driven ship, it may be necessary to stop and lock a propeller shaft to prevent damage to the machinery. When the shaft is stopped, engaging the turning gear and then applying the brake is the most expeditious means of locking a propeller shaft while under way.

LOCKING THE MAIN SHAFT.—By carrying out actual drills, engineroom personnel should be trained to safely lock and unlock the main shaft. Each steaming watch should have sufficient trained personnel available to stop and lock the main shaft. NavShips requires the following procedure:

1. Reduce the ship's speed to one half of full power or less; if the ship is doing less than one half of full power, the speed should not be changed.
2. Close the ahead throttle and slowly open the astern throttle until the shaft stops. Ensure that the shaft does not turn astern.
3. Note the astern steam pressure on the stopped shaft and the rpm on the operating shaft(s). Record these readings as soon as conditions permit.
4. When the main shaft is stationary, engage the turning gear and set the brake.
5. Close the astern throttle slowly; ensure that there is no movement of the shaft.
6. Indicate, by means of a warning sign or an indicating device at the main throttle board (ahead throttle), that the shaft is in locked position to prevent accidental opening of the throttle when the turning gear is engaged.
7. Record the time when the main shaft was stopped.

CAUTION: During drills the shaft should not be locked more than 5 minutes, if possible. The ahead throttle should NEVER be opened when the turning gear is engaged. The torque produced by the ahead engines is in the same direction as the torque of the locked shaft; to open the ahead throttle would result in damage to the turning gear.

The maximum safe operating speed of a ship with a locked shaft can be found in the manufacturer's technical manual. Additional information on the safe maximum speed that your ship can steam with a locked shaft can be found in NavShips Technical Manual, chapter 9410(41).

UNLOCKING THE MAIN SHAFT.—The recommended procedure for unlocking the main shaft is as follows:

1. Reduce the temperature of the main steam, on the shaft to be unlocked, as much as practicable, by lowering the superheat (where superheat control is provided).
2. Bring the operating shaft(s) to the same rpm as recorded in step 3 of the shaft locking procedure. If necessary allow time for the ship to settle down at this speed.
3. Apply a steady disengaging force to the turning gear clutch lever and slowly open the astern throttle until the astern steam chest pressure equals that recorded in step 3 of the shaft locking procedure.
4. If the turning gear has not disengaged, continue the pressure on the clutch lever and slowly open the astern throttle until the clutch disengages.
5. Slowly close the astern throttle, after the turning gear has disengaged.
6. Release the brake of the turning gear.
7. Remove the warning sign or change the indicating device at the main throttle board. (See step 6 of the shaft locking procedure.)
8. Open the ahead throttle and slowly bring the main shaft up to the speed required for the operation of the ship.

CAUTION: If the shaft has been locked for 5 minutes or more, the turbine rotors may have become bowed, and special precautions are recommended. Before the shaft is allowed to turn, men should be stationed at the turbines to check for unusual noises and vibration. When the turning gear is disengaged, the astern throttle should be slowly closed, the torque produced by the propeller passing through the water will start the shaft rotating. If, when the propeller starts to turn, vibration indicates a bowed rotor, the ship's speed should be reduced to the point where little or no vibration of the turbine is noticeable and this speed should be maintained until the rotor is straightened. If operation at such a slow speed is not

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Block I - Basic Electronics

Unit 3 - Electrical Circuits

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
	What is electricity?
	The atom Protons Electrons Neutrons Electrons and conductors
Constructing a simple circuit	The nature of electricity
	Why electrons flow The volt The ampere The ohm
Constructing a series circuit	Current flow in a series circuit
Constructing a parallel circuit	Current flow in parallel circuits
Constructing series-parallel circuits	Current flow in series-parallel circuits

Unit 4 - Instruments and Test Equipment

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Adjusting and calibrating milliameters	Milliameter: purpose, use, theory of operation, limitations
Adjusting and calibrating voltmeters	Voltmeters: purpose, use, theory of operation, limitations
Adjusting and calibrating ohmmeters	Ohmmeters: purpose, use, theory of operation, limitations
Adjusting and calibrating of oscilloscopes	Oscilloscopes: purpose, use, theory of operation, limitations
Adjusting and calibrating signal generators	Signal generators: purpose, types, use, theory of operation, limitations
Adjusting and calibrating sweep generator	Sweep generators: purpose, types, use, theory of operation, limitations
Adjusting and calibrating multimeters	Multimeters: purpose, types, use, theory of operation, limitations

practicable, the turbines should be slowed by use of the astern throttle, to the point of least vibration but with the turbines still operating in the ahead direction. When the turbines are slowed to the point of little or no vibration, the shaft should be operated at that speed and the ahead throttle should be opened slightly to permit some steam flow through the affected turbine. The heat from the steam will warm the shaft and aid in straightening it. Lowering the main condenser vacuum will add additional heat to the turbines; this will increase the exhaust pressure and temperature.

As the vibration decreases, the astern throttle can be closed gradually, allowing the speed of the shaft to increase. The shaft speed should be increased slowly and a check for vibration should be maintained. The turbine is not ready for normal operation until vibration has disappeared at all possible speeds.

Noises and Vibration

On steam-turbine driven ships, noises may occur at low speeds or when maneuvering, or when passing through shallow water. Generally, these noises do not result from any defect in the propulsion machinery and will not occur during normal operation. A rumbling sound which occurs at low shaft rpm is generally due to the low pressure turbine gearing floating through its backlash. This condition has also been experienced with cruising reduction gears. The rumbling and thumping noises which may occur during maneuvering or during operation in shallow water, are caused by vibrations initiated by the propeller. These noises referred to are characteristic only of some ships and should be regarded as normal sounds for these units. These sounds will disappear with a change of propeller rpm or when the other causes mentioned are no longer present. These noises can usually be noticed in destroyers when the ship is backing, especially in choppy seas or in ground swells.

UNUSUAL NOISES.—A properly operating reduction gear has a definite sound which an experienced watchstander can easily learn to recognize. At different speeds and under various operating conditions, the operator should be familiar with the normal operating sound of the reduction gears on his ship.

If any abnormal sounds occur, an investigation should be made immediately. In making an investigation, much will depend on how the operator interprets the sound or noise.

The lube oil temperature and pressure may or may not help an operator determine the reasons for the abnormal sounds. A badly wiped bearing may be indicated by a rapid rise in oil temperature for the individual bearing. A certain sound or noise may indicate misalignment or improper meshing of the gears. If unusual sounds are caused by misalignment of gears or foreign matter passing through the gear teeth, the shaft should be stopped and a thorough investigation should be made before the gears are operated again.

For a wiped bearing, or any other bearing casualty that has caused a very high temperature, this procedure should be followed: If the temperature of the lube oil leaving any bearing has exceeded the permissible limits, slow or stop the unit and inspect the bearing for wear. The bearing may be wiped only a small amount and the shaft may be operated at a reduced speed until the tactical situation allows sufficient time to inspect the bearing.

VIBRATION.—The most common causes of vibration in a main reduction gear installation are: faulty alignment, bent shafting, damaged propellers, and improper balance.

A gradual increase in the vibration in a main reduction gear that has been operating satisfactorily for a long period of time can usually be traced to a cause outside of the reduction gears. The turbine rotors, rather than the gears, are more likely to be out of balance.

When reduction gears are built, the gears are carefully balanced (both statically and dynamically). A small amount of unbalance in the gears will cause unusual noise, vibration, and abnormal wear of bearings.

When the ship has been damaged, vibration of the main reduction gear installation may result from misalignment of the turbine, the main shafting, the main shaft bearings, or the main reduction gear foundation. When vibration occurs within the main reduction gears, damage to the propeller should be one of the first things to be considered. The vulnerable position of the propellers makes them more liable to damage than other parts of the plant. Bent or broken propeller blades will transmit vibration to the main reduction gears. Propellers can also become fouled with line or cable which will cause the gears to vibrate. No reduction gear vibration is too trivial to overlook. A complete investigation should be made, preferably by a shipyard.

MAINTENANCE OF MAIN REDUCTION GEARS

Under normal conditions, major repairs and major items of maintenance on main reduction

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gears should be accomplished by a shipyard. When a ship is deployed overseas and at other times when shipyard facilities are not available, emergency repairs should be accomplished, if possible, by a repair ship or an advanced base. Inspections, checks, and minor repairs should be accomplished by ship's force.

Bearing Maintenance

Under normal conditions, the main reduction gear bearings and gears will operate for an indefinite period. If abnormal conditions occur, the shipyard will normally perform the repairs. Spares are carried aboard sufficient to replace 50 percent of the number of bearings installed in the main reduction gear. Usually each bearing is interchangeable for the starboard or port installation. The manufacturer's technical manual must be checked to determine interchangeability of gear bearings.

Special tools and equipment needed to lift main reduction gear covers, to handle the quill shaft when removing bearings from it, and to take required readings and measurements, are normally carried aboard. The special tools and equipment should always be aboard in case emergency repairs have to be made by repair ships or bases not required to carry these items.

The manufacturer's technical manual is the best source of information concerning repairs and maintenance of any specific reduction gear installation.

JOURNAL BEARINGS.—Each babbitted bearing shell of the reduction gear may be considered as having a pressure bearing half and a nonpressure bearing half. The nonpressure bearing half has a radial scribe line at one end of the geometric center. The pressure bearing half has three radial scribe lines at one end; the central scribe being at the geometric center and the additional scribes located on either side of the central scribe at an angle of 45°. These scribes are placed by the manufacturer. The crown thickness of each shell, at these scribe points, is measured with a micrometer, usually 1 1/4 inches from the end of the shell. Such measurements are taken during the initial alignment by the manufacturer, and are stenciled adjacent to each scribe line to be used as constants for future alignment checks. In this way the amount of wear can always be determined, whether the wear is against the upper or lower half of the shell.

On older ships not equipped for checking alignment by the crown-thickness and proof-staff method, the gear is first checked for alignment by measuring the percentage of tooth contact in accordance with NavShips Technical Manual, article 42.53. After alignment is established, bearings are removed and marked and the crown thickness of the bearing measured and stenciled adjacent to each scribe line. Bearing wear is measured subsequently by using the crown-thickness method based on the constants as stenciled.

The amount of bearing clearance allowed should not be great enough to allow incorrect gear tooth contact. The designed bearing clearances are given in the manufacturer's technical manual. These clearances are also given in the blueprints for the main reduction gears. The maximum allowable clearance can be determined by referring to NavShips Technical Manual, chapter 9005 (40).

Replacing bearings in the main reduction gear is a major undertaking. When a casualty (such as the loss of lube oil) occurs, the high speed pinion shaft bearings are more likely to be wiped than the other main gear bearings. These high speed pinion shafts, which are coupled to the high pressure and low pressure turbines, will have a higher rotary speed than other shafts in the reduction gear. If the bearings are inspected, the high speed pinion bearings should be checked first. If these bearings are not wiped, it is safe to assume that the bearings which rotate at lower speeds are not wiped. If repairs are to be made, the first step would be to study the manufacturer's technical manual and the blueprints for the reduction gear. The MM1 or MMC should be able to decide whether the repair work should be attempted and should have a clear understanding of the construction details and repair procedures before starting a repair job. Other factors to be considered are: location of the ship, available repair facilities, available repair parts, and the operating schedule of the ship.

In making repairs, the first step is to engage the turning gear and set the brake to ensure that the shaft will not turn while repairs are being made. All oil must be pumped out of the main sump tank. A clean settling or storage tank can be used to store the oil until it is ready for use again. Then a section of the reduction gear cover is lifted by using chain-falls and wire slings. When the gear cover is moved out of the way, the bearing cover can be removed. Next the bearing must be turned so that the bearing split is on the horizontal plane and the top half of the bearing can be lifted off. The gear shaft must be supported when the bottom half of the bearing is removed. A dummy bearing is rolled in while the lower half is rolled out. The dummy bearing supports the

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weight of the shaft and keeps the shaft in position. Special precautions should be taken to prevent the shaft from being turned or lifted so that the gear teeth do NOT become unmeshed. If the gear teeth become unmeshed and are not matched marked, it is necessary to follow a complicated and detailed procedure to reassemble and time the gears. The setting up of the locked train gear system is done at the factory and at shipyards.

If the bearing has excessive clearance, is badly wiped, or heavily scored, examine other representative bearings to determine the extent of the damage. Replace all bearings on that particular shaft to maintain correct gear alignment.

To replace a bearing, proceed as follows:

1. Review the maintenance history of the reduction gears to determine if special bearings are necessary.
2. Measure the diameter of the journal (with a micrometer) and compare the present readings with the original readings, as recorded.
3. Check the crown thicknesses of installed and replacement bearings and compare readings. If scraping is required for the replacement bearing, use a full-sized mandrel and prussian blue to check the work. Shaft parallelism must be maintained.
4. To maintain shaft parallelism, bearings on the ends of gear or pinion shafts shall not differ more than 0.002 inch.
5. When a spare bearing is installed or a damaged bearing is scraped to maintain correct tooth contact, the crown thickness shall be stamped on the bearing shell.
6. Dowels are used, between the bearing halves, to locate the bearings in the upper casing. Upper and lower bearing halves must be mated parts. Interchanging of upper and lower bearing halves is prohibited.
7. Examine the condition of the journal whenever bearings are removed. If the surface of the journal is slightly scored, it must be stoned very lightly and polished. Only experienced personnel should stone a journal. Always oil a journal before rolling in a new bearing.

NOTE: If journals are badly scored, they may be ground undersize or restored to design diameter by chrome plating. If a journal is ground undersize, it might be necessary to provide undersize bearings. This should be accomplished only by a shipyard and in accordance with existing NavShips instructions. The new journal diameters and bearing clearances must be recorded.

When installing a spare bearing, make sure that it is well oiled, then roll the lower half into position, removing the dummy bearing. The upper half can be placed in position, and then the complete bearing can be shifted to its proper position. Ensure that the dowels are in place and that the bearing assembly is in its required position, in accordance with the manufacturer's instructions. The bearing cap can be lowered into position and securely bolted down.

Before the gear cover is lowered into position, a careful inspection should be made to see that the inside of the gear installation is free of all dirt, tools, rags, and other foreign matter that would be harmful to the gears. After the gear cover is lowered into position and bolted down, the lube oil can be pumped to the sump. Before the oil is circulated through the system, MUSLIN bags should be placed in oil strainers. The muslin bags will trap any dirt or foreign matter that is too fine to be stopped by the strainer. A lube oil service pump should be started to circulate oil through the system. The muslin bags should be changed at 30-minute intervals until they no longer pick up dirt. The turning gear can then be engaged and started.

THRUST BEARINGS.—This chapter contains only general information on different methods of taking end play readings on the main thrust bearing. See the manufacturer's technical manual for specific information on any given unit.

Checking the end play for any six- or eight-shoe thrust bearing must always be done with the top half of the bearing bolted down solidly, otherwise the base rings will tilt because of the freedom of movement given the leveling plates, and a false reading will be obtained.

A record of the main thrust readings must be kept and referred to when checking the main thrust bearing. Over a period of years, the normal wear of a pivoted-shoe thrust bearing is negligible. However, when the bearing is new, there may be a slight settling of the leveling plates. Any increase in the end play of a main thrust bearing indicates that the surfaces of the thrust shoes should be inspected, and necessary repairs made.

In some main thrust bearings, a port is provided (in the main thrust bearing cap over the thrust shoes) for inspection purposes. This port has a removable cover of sufficient size to permit the withdrawal of thrust shoes that are in line with it.

Checking Thrust While Under Way.—The simplest means of checking end play is to use a dial indicator on any accessible flange on the main

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shaft while the engines are going slowly ahead and then astern. This can usually be done when the ship is maneuvering to approach a pier or an anchorage. The speeds should be slow enough to avoid adding deflections of bearings parts and housing to the actual end play. But, the speed should be sufficient to ensure that the full end play is actually taken up.

Some ships have the main thrust bearing located at the forward end of the main reduction gear, and constructed as a component part of the gear. A spring-loaded pin gage (located in the bearing end cover housing) and a micrometer depth gage are used to measure the end play. The pin gage cover is removed and the anvil of the depth gage is placed on the machined surface of the pin gage housing. The micrometer is carefully turned so that the spindle pushes the installed pin against the main shaft. All slack must be taken up; but excessive force must not be used, as it will lift the micrometer anvil from the machined surface.

Another reading is taken with the main shaft operating in the opposite direction. The difference between the two readings is the end play. It is always good practice to take more than one set of readings to ensure that the total end play was taken up and that the readings are accurate.

Jacking an A Shaft Flange.—If it is not practical to measure the end play while running, the next choice is to jack the shaft (while it is still warm) fore and aft at some convenient main shaft flange. A dial indicator is mounted on a rigid support, convenient to some main shaft flange and the shaft is jacked forward and then astern. Make certain that the shaft movement is free—but do not use too great a force; excessive force might cause deflections of metal parts to be added to the actual end play. The main difficulty in using the jacking method is finding suitable supports where no structural damage will be done.

Gear Teeth

The importance of proper gear tooth contact cannot be overemphasized. Any abnormal condition which may be revealed by operational sounds or by inspections should be corrected as soon as possible. Any abnormal condition which is not corrected will cause excessive wear which may result in general disintegration of the tooth surfaces.

If proper tooth contact is obtained when the gears are installed, little wear of teeth will occur. Excessive wear cannot take place without metallic contact. Proper clearances and adequate lubrication will prevent most gear tooth trouble.

WEAR-IN OF GEAR TEETH.—Gears which have been realigned and new gears should be given a wearing-in period at low power before being subjected to the maximum tooth pressure at full power.

TOOTH CONTACT.—For proper operation of the gears, it is essential that the total tooth pressure be uniformly distributed over the total area of the tooth faces. This uniform pressure is accomplished by accurate alignment and adherence to the designed clearance.

The designed center-to-center distance of the axes of the rotating elements should be maintained as accurately as practicable but the axes of pinions and gear shafts must always be parallel. If the shafts are not parallel, the load is concentrated on one end of a helix; the result may be flaking, galling, pitting, featheredges on teeth, deformation of tooth contour, or breakage of tooth ends.

CHECKING TOOTH CONTACT.—The length of tooth contact across the face of the pinion is a means of determining if reduction gear alignment is satisfactory. One method used to static check the length of tooth contact is to apply a thin coat of prussian blue to a band of teeth on one element and coat a similar band on the mating element with red lead. The coatings must be thin and even. Rotate the two bands into contact by jacking back and forth 3 or 4 times.

Either copper sulphate or blue or red Dykem is used to determine tooth contact for operating conditions. Dykem should be used for dock trials as it will show markings for light load conditions. Copper sulphate markings will remain visible after longer and higher power operations than will Dykem markings. Lubricating oil must be removed from the gear teeth by a cleaning agent, before the compound is applied; after the tooth contact is determined, the compound must be removed from the gear teeth to prevent possible contamination of the lubricating oil. The gear teeth should then be oiled.

Remember that some gear teeth are cut with a very slight taper to offset the effects of torsional twist and bending. In such gearing, full contact across the teeth will not be obtained.

TOOTH CONTOUR.—The designed tooth contour must be maintained. A lack of this tooth contour can cause load concentrations with consequent scoring.

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TOOTH SURFACE WEAR.—If proper contact is obtained when the gears are installed, the initial wearing, which takes place under conditions of normal load and adequate lubrication, will smooth out rough and uneven places on the gear teeth. This initial wearing-in is referred to as NORMAL WEAR or RUNNING IN. As long as operating conditions remain normal, no further wear will occur.

Small shallow pits starting near the pitch line, will frequently form during the initial stage of operation; this process is called INITIAL PITTING. Often the pits (about the size of a pinhead or even smaller) can be seen only under a magnifying glass. These pits are not detrimental and usually disappear in the course of normal wear.

Pitting which is progressive and continues at an increasing rate is known as DESTRUCTIVE PITTING. The pits are fairly large and are relatively deep. Destructive pitting is not likely to occur under proper operating conditions, but could be caused by excessive loading, too soft material, or improper lubrication. It is usually found that this type of pitting is due to misalignment or to improper lubrication.

The condition in which groups of scratches appear on the teeth (from the bottom to the top of the tooth) is termed abrasion, or scratching. It may be caused by inadequate lubrication, or by the presence of foreign matter in the lubricating oil. When abrasion or scratching is noted, the lubricating system and the gear spray fixtures should immediately be examined. If it is found that dirty oil is responsible, the system must be thoroughly cleaned and the whole charge of oil centrifuged.

The term "scoring" denotes a general roughening of the whole tooth surface. Scoring marks are deeper and more pronounced than scratching and they cover an area of the tooth, instead of occurring haphazardly, as in scratching or abrasion. Small areas of scoring may occur in the same position on all teeth. Scoring, with proper alignment and operation, usually results from inadequate lubrication, and is intensified by the use of dirty oil. If these conditions are not corrected, continued operation will result in a general disintegration of the tooth surfaces.

SPOTTING GEAR TEETH.—Any abnormal conditions which may be revealed by operational sounds or by inspections should be corrected with the least possible delay. Rough gear teeth should be stoned smooth if it is certain that the roughening was caused by the passage of some foreign matter. Any tooth deterioration which cannot be traced to a casualty should be investigated, giving special attention to the condition of the bearing, to lubrication, and to the possibility of a change in the supporting structure, which has disturbed the parallelism of the rotors.

To spot-in surfaces of reduction gear teeth, the pinion teeth are coated lightly with prussian blue. Then the gear is turned in its ahead direction by using the jacking gear. As the gear teeth come in contact with the marked pinion teeth, an impression is left on the high part of the gear tooth. After the gear is turned 1/4 turn, or is in a convenient position for stoning, all high spots indicated by the marks are removed with a small handstone. It will be necessary to replace the bluing on the pinion teeth repeatedly, but if the bluing is applied too thickly, false impressions will be left on the teeth.

It is permissible to scrape gear teeth to remove a local hump or deformation, however, scraping of gear teeth to obtain contact is not permitted. Scraping, to obtain contact, will not be done without the approval of the Naval Ship Systems Command.

ROOT CLEARANCE.—The designed root clearance with gear and pinion operating on their designed centers can be obtained from the manufacturer's blueprints. The actual clearance can be found by taking leads or by inserting a long feeler gage or wedge. The actual clearance should check with the designed clearance. If the root clearance is considerably different at the two ends, the pinion and gear shaft will not be parallel. Provided there is still sufficient backlash, and the teeth are not meshed so closely that lubrication is adversely affected or that clearance is reduced below specified limits, the tolerance will be satisfactory.

BACKLASH.—Backlash is the play between the unloaded surfaces of the teeth in mesh on the pitch circle. Backlash increases with wear, and can increase considerably without causing trouble.

SHAFT ALIGNMENT

Under normal conditions all alignment inspections and checks, plus the necessary repairs, are accomplished by naval shipyards. Incorrect alignment will be indicated by abnormal vibration, unusual noise, and wear of the flexible couplings or main reduction gears. When misalignment is indicated, a detailed inspection should be made by shipyard personnel.

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Main Propeller Shafting

Two sets of readings are required to get an accurate check of the propulsion shafting. One set of readings is taken with the ship in drydock and another set of readings is taken with the ship waterborne—under normal loading conditions. The main shaft is disconnected, marked, and turned so that a set of readings can be taken in four different positions. Four readings are taken (top, bottom, and both sides). The alignment of the shaft can be determined by studying the different readings taken. The naval shipyard will decide whether or not corrections in alignment are necessary.

Turbine Shafting

The high pressure turbine shaft and the low pressure turbine shaft are connected to their respective first reduction pinions by flexible couplings. Each of the first reduction couplings consists of two sleeves having internal teeth which mate with external teeth on a distance piece or extension shaft. One sleeve is bolted to the turbine flange and the other is bolted to the first reduction pinion flange. Lubricating oil is fed to the meshing-sleeve and distance-piece teeth from nozzles supplied with oil from the adjacent bearing. The couplings are fitted with rings which dam the oil flow through the teeth. This causes the oil level to be as deep as the tooth height and ensures lubrication to all contacting surfaces.

Flexible couplings permit axial motion and expansion of turbine rotors but will compensate for only a very small amount of misalignment; therefore, correct alignment of turbine shafts and first reduction pinion shafts is extremely important. When a new unit is installed properly, little difficulty is experienced with misalignment; however, abnormal clearance in a turbine bearing or pinion bearing will cause misalignment of the flexible coupling.

CRUISING TURBINE REDUCTION GEARS

All of the information contained in this chapter up to this point, has dealt with main reduction gears. As most destroyers and some other ships have cruising turbines and cruising turbine reduction gears, Machinist's Mates are required to understand the construction, operation, and maintenance of cruising turbine reduction gears.

CONSTRUCTION OF CRUISING TURBINE REDUCTION GEARS

Cruising turbine reduction gears differ from main reduction gears mainly because they are SINGLE REDUCTION. This type of reduction gearing consists of one pinion and one reduction gear enclosed in a housing and fitted with the necessary bearings, thermometers, oil lines, and other fittings. The cruising turbine reduction gear described in the following sections is of the type installed on a few of the DLs.

Casing

The gear casing is constructed of steel. It is made up of an upper half and a lower half, bolted together at a horizontal, oiltight joint. Bearing seats, which support the gear and pinion, are integral with the casing and are split at the casing joint. The upper half of the gear casing includes caps for all bearings. All gear teeth may be examined through an inspection opening which is fitted with a hinged cover.

Pinion

The pinion (fig. 4-1) and its shaft are forged as one piece, and supported by a journal bearing at each end. At the forward end of the pinion shaft is a forged, solid coupling which bolts rigidly to the cruising turbine shaft coupling. The rigid coupling, between the pinion and turbine shafts, permits the pinion bearing to support the after end of the cruising turbine rotor. The after end of the pinion shaft has a small extension which protrudes through an oil deflector mounted on the gear casing to indicate rotation.

Gear Wheel

The gear wheel and its shaft are machined from a solid forging. Journal bearings are provided at each end of the gear shaft. A flexible type coupling is used to connect the after end of the gear shaft to the forward end of the high pressure turbine. The shaft is bored to allow an operating rod for the disconnect coupling, to pass through it.

Bearings

The bearings are babbitt lined, split shells with dowels to prevent incorrect assembly of the halves. The bearings are locked in their seats

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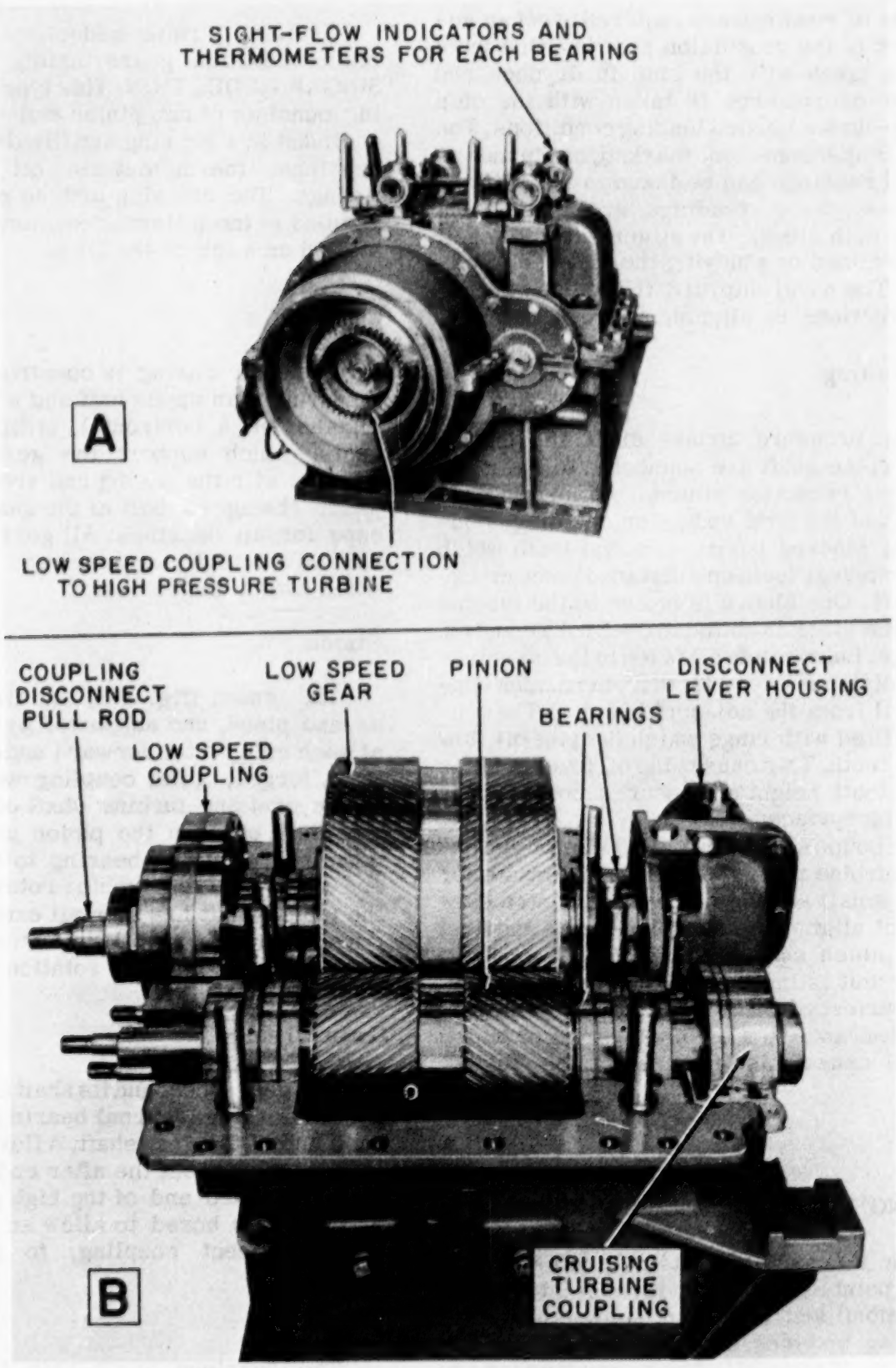

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Figure 4-1.—Cruising reduction gear.

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to prevent rotation, by an interference fit between the bearing seat and the cap and bearing itself. Axial position is maintained by lock washers screwed into the horizontal joint of the gear casing.

No thrust bearing is installed in the gear case. The cruising turbine thrust bearing locates the fore and aft position of the gear and pinion shafts in the gear casing and the double helical arrangement eliminates the end thrust.

Disconnect Device

The cruising reduction gear is equipped with a mechanism which permits the disconnection of the flexible coupling between the cruising reduction gear and the high pressure turbine, and provides a means for locking the cruising turbine rotor against rotation. This is an emergency feature to be used only in the event of damage to the cruising turbine which necessitates removing the cruising turbine from operation without taking the main turbines out of service.

Figure 4-1 shows two views of the cruising reduction gear; part A, the assembled gear, after end, showing the disconnect coupling; and part B, the gear, cover off, showing bearings, pinions, and gear. Referring to these views as you read this section will help you understand the operation of the coupling and disconnect device.

The low speed shaft of the cruising gear is coupled to the forward end of the high pressure turbine by a flexible coupling consisting of a distance piece meshing with a sleeve on the gear shaft and a sleeve on the high pressure turbine shaft. The distance-piece teeth are crowned on the tooth flank in the axial direction and also crowned at the outside diameter in the axial direction. Crowned tooth flanks provide greater flexibility between coupled elements than do straight teeth. The gear end sleeve has longer teeth than the turbine end sleeve, which keeps the distance piece always engaged at the gear end. When the coupling is disengaged, the gear teeth on the turbine end of the distance piece disengage from the gear teeth on the turbine sleeve.

A double thrust-face and a journal surface are provided in the bore of the distance piece, into which are assembled a double thrust bearing and a journal bearing. (See part A of fig 4-2.) An engaging lever (pull rod) (part C of fig. 4-2) connects to these bearings, and is used to locate the distance piece in either the engaged or disengaged position. Lubrication is furnished to the thrust bearings through the drilled pull rod.

An alignment bearing (part A of fig. 4-2), or centering ring, is mounted in the coupling guard to maintain alignment of the coupling distance piece with the high pressure turbine sleeve, when the coupling is disconnected. This permits easy re-engagement of the coupling.

The distance piece at the turbine end, and the turbine sleeve have tapered teeth, which makes it possible to re-engage the coupling without jogging the rotors to position the teeth.

The disconnecting mechanism is located at the forward end of the reduction gear casing. This mechanism consists of a double lever arrangement. The smaller lever, pinned to the end of the pull rod, is machined integral with a shaft which is supported in a bushing. The end of the shaft is splined to match the engaging lever. Another bearing support for the assembly is a bushing which contacts the hub of the engaging lever. A seal (part B of fig. 4-2) prevents leakage of oil from the casing. It is supported by an enclosed fabricated casing, split vertically to permit disassembly. A lock lever (part B of fig. 4-2) permits the coupling to be locked when the engaging lever is removed from the assembly.

Pinion Lock

A lock at the after end of the pinion prevents the cruising turbine from rotating after the cruising gear is disconnected from the high pressure turbine.

The after end of the pinion is splined to receive a lock, also splined, which is moved to its locking position by a crank. Engagement of the splined lock is facilitated by a knurled pin which is used to rotate the lock by hand sufficiently to align the spline of the lock with the spline of the pinion.

MAINTENANCE OF CRUISING REDUCTION GEARS

Maintenance for cruising reduction gear installations is basically the same as for main reduction gears. Repair work for a cruising gear may be easier because there are fewer bearings in a cruising gear, which may mean less work if the bearings need replacing. Having only one pinion and one gear, cruising gears do not have to be timed as do main reduction gears. The casing of a cruising reduction gear is easier to lift than a main gear casing.

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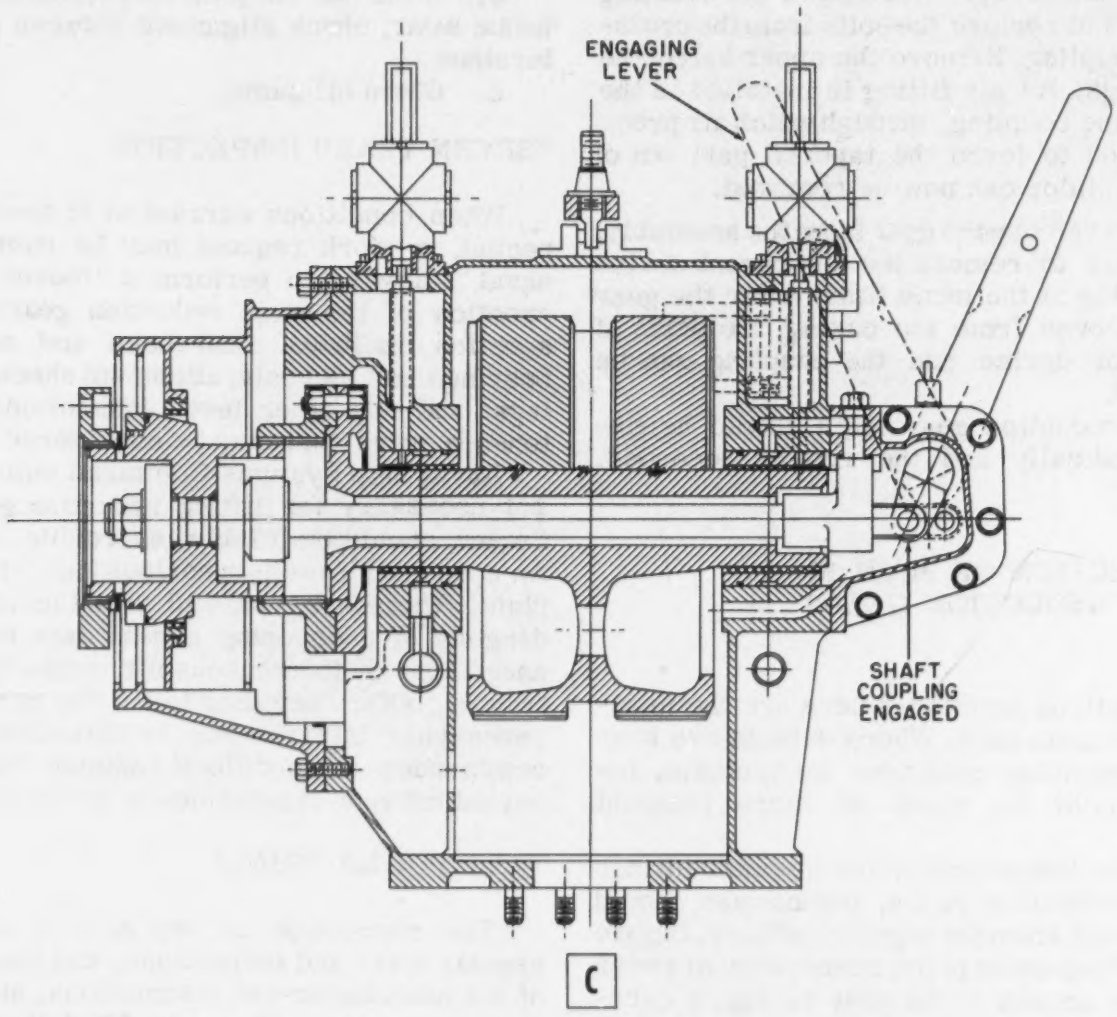

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Figure 4-2.—Sectional views of the disconnect-device assembly—Continued.

Bearing Maintenance

In some cruising reduction gear installations, the bearing shells are very thin and are not suitable for rebabbitting. Such bearings, if damaged, must be replaced with new bearings.

To replace cruising gear bearings, proceed as follows: Remove the bolts in the horizontal and vertical joints of the coupling guards. Remove the upper half of the coupling guards; the alignment bearing (centering ring) may raise with the low speed coupling guard. Remove the bolts in the vertical joint, between the disconnect lever housing and the gear casing. Remove the nuts from the bearing cap studs, these studs extend through the upper half of the gear casing. Remove all bolts from the horizontal joint of the gear casing. Lift the upper half of the gear casing; then the bearings can be removed for inspection.

Gear Tooth Maintenance

As with main reduction gear teeth, crusing gear teeth must be kept in correct alignment at all times. Uniform distribution of wear over the entire length of the gear and pinion teeth is an indication of correct contact. Any evidence of poor tooth contact is an indication of worn bearings or misalignment of the gears.

The pinion should not be removed from the assembly unless it is necessary to replace it. The pinion can be lifted by the following procedure: Remove the upper half of the reduction gear casing, as previously explained in this chapter. Place the

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Block I - Basic Electronics

Unit 5 - Electrical Measurement

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Constructing a simple "magnetic loop" voltmeter	Construction and theory of operation of a voltmeter, ammeter, ohmmeter, multimeter
Constructing an ammeter circuit	Wheatstone bridge
Constructing an ohmmeter circuit	Vacuum tube voltmeters
Checking the functions of the vacuum tube voltmeter with special attention to its limitations and necessary care.	Electrical circuits
Measuring resistors using the Wheatstone bridge	Magnetic poles and fields
Finding the correct polarity of permanent magnets	Magnetic circuits and electro-magnetism
Constructing an electromagnet	Series and parallel magnetic circuits
Measuring and finding the polarities of series and parallel magnetic circuits	Functions and care of the vacuum tube voltmeter
Finding direct current measurements with a milliammeter	Effects of resistance on current
Finding D C voltage measurements with a vaccum tube voltmeter	Effects of connecting dry batteries in series and parallel
Finding resistance measurements with an ohmmeter	Color code for resistors
Finding measurements of resistance, current, and voltage in a simple circuit	Ohms' law
Finding the total resistance of series-connected resistors	Current in a series circuit
Finding the total resistance of parallel-connected resistors	Current in a parallel circuit
	Voltage drop in the legs of series-parallel circuits
	Operation of simple D.C voltage dividers
	Effects of a load on voltage distribution in a D C voltage divider

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support yoke under the after end of the cruising turbine shaft and remove the bolts from the cruising turbine coupling. Remove the upper half of the pinion bearings. An air fitting is installed in the cruising turbine coupling, through which air pressure is applied to force the tapered part out of position. The pinion can now be removed.

In order to remove the gear from the assembly, it is necessary to remove the disconnect device and the coupling at the same time. After the gear has been removed from the casing, the parts of the disconnect device and the coupling can be disassembled.

Cruising reduction gear teeth should be examined periodically and the results recorded.

INSPECTION OF MAIN ENGINE REDUCTION GEARS

The inspections mentioned here are the minimum requirements only. Where defects are suspected, or operating conditions so indicate, inspections should be made at more frequent intervals.

To open any inspection plates or other fittings of the main reduction gears, permission should first be obtained from the engineer officer. Before replacing an inspection plate, connection, or cover which permits access to the gear casing, a careful inspection shall be made by an officer of the engineering department to ensure that no foreign matter has entered or remains in the casing or oil lines. If the work is being done by a repair activity, an officer from the repair activity must also inspect the gear casing. An entry of the inspections and the name of the officer or officers must be made in the Engineering Log. The inspections required on the main engine reduction gears are shown on the Maintenance Index Page, figure 4-3.

NAVAL SHIPYARD OVERHAUL

During shipyard overhauls, the following inspections should be made:

a. Inspect condition and clearance of thrust shoes to ensure proper position of gears. Blow out thrusts with dry air after the inspection. Record the readings. Inspect the thrust collar, nut, and locking device.

b. If turbine coupling inspection has indicated undue wear, check alignment between pinions and turbines.

c. Clean oil sump.

"SEVEN YEAR" INSPECTION

When conditions warrant or if trouble is suspected, a work request may be submitted to a naval shipyard to perform a "seven year" inspection of the main reduction gears. This inspection includes clearances and condition of bearings and journals; alignment checks and readings; and any other tests, inspections, or maintenance work that may be considered necessary.

Naval Ship Systems Command authorization is not necessary for lifting reduction gear covers. Covers should be lifted when trouble is suspected. An open gear case is a serious hazard to the main plant, therefore, careful consideration of the dangers of uncovering a gear case must be balanced against the reasons for suspecting internal trouble, before deciding to lift the gear case. The seven-year interval may be extended by the type commander if conditions indicate that a longer period between inspections is desirable.

FULL POWER TRIALS

The correction of any defects disclosed by regular tests and inspections, and the observance of the manufacturers' instructions, should ensure that the gears are ready for full power at all times.

Before Trials

In addition to inspections which may be directed by proper authority, open the inspection plates, examine the tooth contact, the condition of teeth, and the operation of the spray nozzles. It is not advisable to open gear cases, bearings, and thrusts immediately BEFORE trials.

After Trials

In addition to the inspections which may be directed by proper authority, open the inspection plates, and examine the tooth contact and the condition of the teeth to note changes that may have occurred during the trials. Running for a few hours at high power will show any possible condition of improper contact or abnormal wear that would not have shown up in months of operation at lower power. Check the clearance of the main thrust bearing.

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System, Subsystem, or Component						Reference Publications			
Reduction Gears									
Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
MB	ZZZFGE5	35	5025	Q	1. Inspect the reduction gear including spray nozzles.	Q-1	EO MM1 MM3	 1.0 1.0	None
MB	ZZ2FSC1	65	4290	Q	1. Measure main shaft thrust clearance.	Q-2	EO MM1 MM2	 0.3 0.3	None
MB	ZZZFGE1	84	5064	S	1. Inspect and clean oil sump and reduction gear casing.	S-1	EO MM1 MM3 2FN	 5.0 6.0 12.0	None
MB	ZZ1FCW4	65	A188	A	1. Inspect flexible couplings. Measure clearances.	A-1	MMC MM1 2FN	2.0 8.0 16.0	None
MB	ZZZFGE5	78	6669	A	1. Sound and tighten foundation bolts.	A-2	FN	1.0	None

Figure 4-3.—Maintenance Index Page. 98.171

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SAFETY PRECAUTIONS

1. If there is churning or emulsification of oil and water in the gear case, the gear must be slowed down or stopped until the defect is remedied.

2. If the supply of oil to the gear fails, the gears should be stopped until the cause can be located and remedied.

3. When bearings have been overheated, gears should not be operated, except in extreme emergencies, until bearings have been examined and defects remedied.

4. If excessive flaking of metal from the gear teeth occurs, the gears should not be adjusted, except in an emergency, until the cause has been determined.

5. Unusual noises should be investigated at once, and the gears should be operated cautiously until the cause for the noise has been discovered and remedied.

6. No inspection plate, connection, fitting, or cover which permits access to the gear casing should be removed without specific authorization by the engineer officer.

7. The immediate vicinity of an inspection plate should be kept free from paint and dirt.

8. When gear cases are open, precautions should be taken to prevent the entry of foreign matter. The openings should never be left unattended unless satisfactory temporary closures have been installed.

9. Lifting devices should be inspected carefully before being used and should not be overloaded.

10. When ships are anchored in localities where there are strong currents or tides, precautions should be taken to lock the main shaft.

11. Where the rotation of the propellers may result in injury to a diver over the side, or in damage to the equipment, propeller shafts should be locked.

12. When a ship is being towed, the propellers should be locked, unless it is permissible and advantageous to allow the shafts to trail with the movement of the ship.

13. When a shaft is allowed to turn or trail, the lubrication system must be in operation. In addition, a careful watch should be kept on the temperature within the low pressure turbine casing to see that windage temperatures cannot be built up to a dangerous degree. This can be controlled either by the speed of the ship or by maintaining vacuum in the main condenser.

14. The main propeller shaft must be brought to a complete stop before the clutch of the turning gear is engaged. (If the shaft is turning, considerable damage to the turning gear will result.)

15. When the turning gear is engaged, the brake must be set quickly and securely to prevent the shaft turning and damaging the turning gear.

16. When a main shaft is to be unlocked, precautions must be taken to disengage the jacking gear clutch before releasing the brake. If the brake is released first, the main shaft may begin to rotate and cause injury to the turning gear and to personnel.

17. In an emergency, where the ship is steaming at a high speed, the main shaft can be stopped and held stationary by the astern turbine until the ship has slowed down to a speed at which the main shaft can be safely locked.

18. Where there is a limiting maximum safe speed at which a ship can steam with a locked propeller shaft, this speed should be known and should not be exceeded.

19. Before the turning gear is engaged and started, a check should be made to see that the turning gear is properly lubricated. Some ships have a valve in the oil supply line leading to the turning gear. The operator should see that a lube oil service pump is in operation and that the proper oil pressure is being supplied to the turning gear before the motor is started.

20. It should be definitely determined that the turning gear has been disengaged before the main engines are turned over.

21. While working on or inspecting open main reduction gears, the person or persons performing the work should not have any article about their person which may accidentally fall into the gear case.

22. Tools, lights, mirrors, etc. used for working on or inspecting gears, bearings, etc. should be lashed and secured to prevent accidental dropping into the gear case.

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CHAPTER 5

STEAM-DRIVEN GENERATORS

Electrical power, a vital part of today's modern Navy, is provided throughout naval ships by steam-driven turbogenerators. Many factors, such as maximum power requirements, safety, and reliability, determine the number of generators that are installed aboard each class of ship. With the ever increasing use of electrical and electronic components of advanced design, the demand for turbogenerator reliability is greater than ever on modern ships.

Inspection, maintenance, and repair of steam-driven generators—all factors which contribute to reliability—are discussed in this chapter. Before studying the material presented in this chapter, you may find it helpful to review the operation of steam-driven generators given in Machinist's Mate, 3 & 2, NavPers 10524-C.

TURBOGENERATOR MAINTENANCE

Satisfactory operation of turbogenerators depends largely on the care that is given the units. All tests, inspections, and preventive maintenance should be performed in accordance with the requirements of the 3-M System. Repairs should be made in accordance with instructions issued by the manufacturer and by NavShips.

One operating trouble that may result from improper maintenance is vibration. Before going into the actual details of maintenance, therefore, we will take a look at some of the causes of vibration.

VIBRATION

If excessive vibration occurs in a turbogenerator, a thorough investigation should be made to determine the cause or causes. If the trouble is not promptly located and corrected, the casualty will probably become more serious and may result in complete failure of the unit.

All rotating parts are balanced statically and dynamically before the unit is installed. Excessive vibration is not usually the result of improper balancing. Rather, excessive vibration can almost always be traced to one or more of the following defects which result from improper maintenance:

1. Improper alignment.
2. Defective foundations.
3. Rubbing of packing or other parts.
4. Excessive wear of journal bearings.
5. Excessive wear of thrust bearings.
6. Incrustations on the turbine rotor or dirt in the generator field.
7. Shaft distortion caused by differential expansion.

If a turbine vibrates to such an extent that unbalance is suspected, the following steps should be taken:

1. Examine all journal bearings and renew any bearings that have excessive clearances.
2. Examine the thrust bearing. Adjust or renew the thrust bearing if the clearance is excessive.
3. Inspect the turbine rotor for signs of damage, if inspection ports are provided.
4. Check the shaft packing clearance. If the clearance is too small, the vibration will become worse and the shaft will overheat. Refit or renew packing if necessary.
5. Check the shaft coupling bolts.
6. Check the coupling alignment.
7. Look for loose bolts in the unit. Replace or tighten bolts as necessary.
8. After completing steps 1 through 7, reassemble the unit and operate it at normal speed to see if the excessive vibration has been eliminated.

If the turbine continues to vibrate excessively, it is probably out of balance. In this event, a balance test must be made. Portable vibrational test equipment, available on tenders and repair ships, may be used to make a balance test with the turbine in place; or the unit may be tested at

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a shipyard. Only experienced personnel should be permitted to balance a turbogenerator, and the instructions of the manufacturer must be followed carefully. Details of the balancing must be recorded.

TURBINE MAINTENANCE

After each extended period of steaming, and at least once each quarter, the following tests and inspections should be made.

The turbine foundation and the unit itself should be inspected for loose or broken bolts and nuts. If any are found, they should be tightened or replaced. Broken or loose foundation bolts can lead to serious vibration or misalignment.

The turbine casing should be inspected, especially near glands and in locations where water may collect in pockets or in lagging. Experience has shown that where water or dampness is permitted to remain in contact with the casing, corrosion can seriously weaken the casing. Drain holes provided in pockets must be kept open and should be of sufficient size. When corrosion is evident, the lagging should be removed and the surface of the casing should be scraped down to good metal, then dried, and painted with two coats of approved paint. Lagging should then be replaced and steps taken to prevent recurrence of corrosion

All sliding contacts and pivot points in the governor and the overspeed tripping mechanism should be kept well oiled and free of dirt, paint, and rust, so that there will be no sticking which will prevent the devices from functioning properly.

When a turbine is new, or after extensive repairs have been made to a unit, the oil in the sump should be renewed or purified frequently. For normal operation, renew the oil or purify it often enough to ensure that it is clean and free of water, sediment, and other foreign matter which would damage the bearings or gears. When the oil is pumped out of the sump for any reason, the inspection plates should be removed and the sump tank inspected. The sump should be wiped with lint-free rags. Extreme care should be taken to ensure that no rags or other foreign matter are left in the sump when it is closed.

When it is necessary to flush out the lubrication system, operate the turbine slowly for several minutes, using an approved flushing oil to thoroughly clean out all lines, bearings, etc. Then drain out the flushing oil and fill the sump to the normal level with clean oil.

Gland Packing Maintenance

One of the reasons for losing vacuum in the auxiliary condenser is that the gland packing is excessively worn or badly fitted. The gland packing used in generator turbines may be carbon packing, labyrinth packing, or a combination of both. When ordering carbon or labyrinth packing, always order complete sets.

To prevent leakage of steam from (or air into) the turbine, the joints and bores of carbon packing must be fitted accurately. Fitting packing on turbine shafts is a difficult job which must be done by hand after the original installation. A jig and gage may be used to reduce the time required and to simplify the job of fitting carbon packing. Detailed instructions on how to construct the jig and gage and on how to use them are given in NavShips Technical Manual and in chapter 3 of this training course.

To remove the carbon packing rings, remove the bolts from the upper halves of the packing boxes at horizontal and circumferential joints. Carefully lift the upper halves vertically to prevent damage to the sealing surfaces. Unhook the spring from the clip and remove the upper segment of the packing ring. Then remove the two remaining segments and pull the spring around the shaft.

To reassemble the packing, push the spring through the lower half of the packing box. Install the two lower segments between the spring and the shaft. Install the top segment and hook the spring into the clip. Ensure that the sealing side of each ring is installed against the proper side of the cell.

The individual segments are marked on each end; the packing ring when assembled must have corresponding markings adjacent to each other. The segments are not interchangeable within the same rings or in other rings. Complete rings may be interchanged in the various cells with other similar rings but the sealing side must always be assembled as indicated in the manufacturer's technical manual.

Turbine Casing Joints

The horizontal joint of some generator turbines is grooved, in the lower half, to provide a means for pressure-pumping the groove with a sealing compound. These grooves shall not be filled except in case of emergency. They shall not be filled during routine overhaul unless the flange surfaces are in poor condition, and time and facilities do not permit resurfacing. Only

approved compounds may be used to fill these grooves.

To fill the grooves, remove one end plug and the adjacent plug. Start at the end hole and pump in the sealing compound, with the gun provided, until it flows out of the adjacent hole. Now, plug the first hole and place the gun in the adjacent hole, remove the plug from the next hole and fill the next section of the groove in the same manner. Continue until the entire groove is filled. With the gun in the next to last hole, and the sealing compound flowing from the last hole, plug the end hole and put pressure on the entire groove. Then remove the gun and plug the next to last hole.

Once this operation has been started, it must be carried out rapidly and continuously in order to finish filling the groove before the sealing compound hardens.

Rotor Clearances

Axial flow turbines are usually provided with an opening in the casing for the purpose of checking blade clearance. As with main propulsion turbines, a tapered gage is inserted between the nozzle diaphragm and the adjacent row of blades for measurement of blade clearance. If the blade clearance is found to be outside the limits prescribed by the manufacturer, the position of the rotor should be adjusted by inserting a shim in the thrust bearing before the unit is operated again. After each rotor adjustment, the unit should be rotated by hand to make sure that there is no rubbing, binding, or undue friction. The gear tooth contact of the reduction gear must also be checked.

Nozzle Diaphragm Maintenance

Nozzle diaphragms (fig. 5-1) are installed as part of each stage of a pressure-compounded impulse turbine. In order to seal against steam leakage, labyrinth packing is used between the inner bore of the nozzle diaphragm and the rotor.

To inspect or renew the labyrinth packing in a nozzle diaphragm, it is necessary to remove the upper half of the turbine casing. When the casing is lifted, the upper half of the diaphragms and the labyrinth packing will remain in the upper half of the turbine casing. When the casing has been moved to a convenient location, the segments of labyrinth packing can be removed by pushing them around in their grooves, away from the stop pin.

Although repairs of labyrinth packing in nozzle diaphragms are normally performed by shipyard, tender, or repair ship personnel, Machinist's Mates should be familiar with the procedures involved. All necessary information is available in the manufacturer's technical manual.

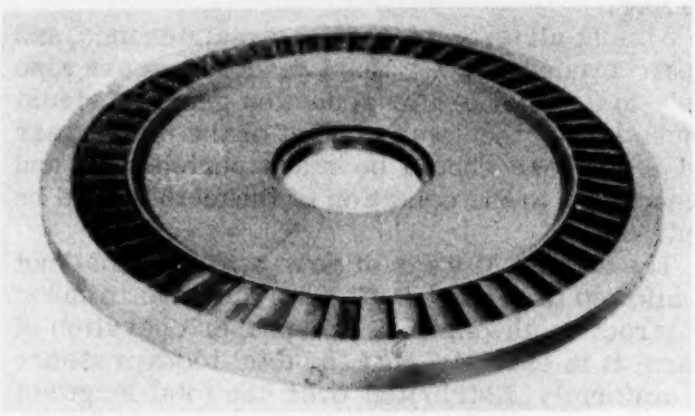

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Figure 5-1.—Nozzle diaphragm with labyrinth packing.

REDUCTION GEAR MAINTENANCE

Turbogenerator reduction gears are generally of the single-reduction, single-helical type, having a reduction of about 8 to 1. In three-bearing designs, the pinion is forged and cut integral with its shaft. One end of the pinion shaft is provided with a flange that bolts rigidly to the turbine shaft, and one end of the turbine rotor is supported by the pinion bearing. The other end of the pinion shaft has an extension on which is assembled the high speed thrust bearing. In four-bearing designs, the pinion shaft is flexibly coupled to the turbine shaft, with two bearings supporting each shaft. A flexible coupling of the double-ended dental type is usually employed in these four-bearing designs.

The gear wheel is forged, shrunk, and keyed to the shaft. One end of the shaft is coupled to the generator shaft, and part of the weight of the generator rotor is carried by the gear bearing at that end. The turbine end of the gear shaft is extended to carry the worm gear; the worm gear drives the oil pump and the governor.

The gear casing is of fabricated construction and is split at the horizontal centerline of the rotor. The bearing seats are welded integral with the lower half of the gear casing. In most installations, cross members and ribs are welded into the casing to form a rigid structure for supporting

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the rotating elements, the oil pump, and the thrust bearing.

Almost all tests, inspections, maintenance, and repair procedures for main reduction gears also apply to turbogenerator reduction gears. A visual inspection of the tooth contact of the pinion gear and main gear should be made periodically and a record as to the condition of the teeth should be kept.

The amount of wear of gear bearings shall not be allowed to become sufficiently great as to cause incorrect tooth contact. For proper operation of gears, it is essential that the total tooth pressure be uniformly distributed over the total length of the tooth faces. This can only be accomplished by accurate alignment and strict adherence to the designed clearances.

Gear misalignment occurring after prolonged operation is usually traceable to a sudden wearing or wiping of the bearings. This misalignment can be corrected by bearing replacement, but the installation of new bearings requires a thorough check on the alignment of the gear mesh to assure at least 90 percent contact. Replacement of bearings that exceed tolerances because of normal wear can be very detrimental to the operation of the turbogenerator. The gears wear to essentially a conjugate tooth form after prolonged operation; therefore, replacement of the bearings may cause the gears to operate at different center distances, and noisy operation may result. Whenever bearings are replaced, the gear alignment must be checked and any corrective action should be accomplished by competent naval repair personnel.

Initial pitting of gear tooth faces during the early operation of the unit in service may be caused from poor alignment or machining errors in gear tooth profile and helices. The pitting will be localized and indicate the tooth areas subjected to excessive load concentrations. Such conditions should be corrected or progressive pitting will continue and general deterioration can occur. Minute high spots in the gear tooth produced by gear hobbing or finishing techniques will also cause initial pitting, but in this case, the pitting will be distributed over the active face and the pitting should cease with continued service operation. In order to properly evaluate the cause of pitting and whether or not it is progressive, the necessity for keeping complete and adequate records cannot be over emphasized.

Where pitting of the elements occurs, metal particles from the pitted areas may be entrapped in the mesh forming raised and depressed areas. To remove the high spots, a fine grade of carborundum stone should be used. Files and coarse stoning can damage the tooth contour and should not be used.

Another source of damage to the gears is the presence of foreign particles in the lubricating oil. The continued passage of these particles will destroy the original involute tooth profile. Noisy operation will result due to the dynamic forces produced by tooth tips contacting the wear shoulder in the flanks of the mating gear teeth. Such noise is most pronounced under lightly loaded conditions when the oil film thickness of the bearing causes the gear elements to operate at minimum center distance. Under heavy loads, the bearing oil film thickness diminishes and the gears operate under maximum center distance. Under the heavy load conditions, the mating elements withdraw from each other causing the interference of tooth tips of one element with the wear shoulder of the mating tooth to be diminished. This type of wear results in the gears having to be replaced or recut.

Foreign particles will also cause high spots which have a highly polished appearance after prolonged operation. Such areas of heavy contact can eventually result in fatigue failure of the highly loaded portion of the tooth. Only experienced personnel should make corrections to the tooth profile to alleviate these conditions.

BEARING MAINTENANCE

In general, repairs of bearings for propulsion turbines and for ship's service turbogenerators are performed similarly. Turbogenerator journal bearings, journals, and thrust bearings (thrust collars and thrust plates) must be inspected and clearance readings taken at regular intervals, to ensure that clearances are within allowable tolerances.

Most journal bearings are cylindrical and of the steel-backed, babbitt-lined type. They are split on the horizontal centerline to facilitate installation and removal. Some newer turbogenerators employ the pivoted segmental journal bearing. Most journal bearings are prevented from rotating by setscrews or by dowel pins. Journal bearings that are installed properly, and operated properly, and that receive sufficient preventive maintenance will give many years of satisfactory service. The manufacturer's technical manual and NavShips Technical Manual contain information on the operation and maintenance of these bearings.

On most turbogenerators, the reduction gear casing must be removed before the pinion gear bearings, the main gear bearings, and the slow speed thrust bearing are accessible. The forward

turbine bearing, the generator pedestal bearing, and the high speed thrust bearing can be removed by lifting the bearing caps and removing the bearings.

Many turbogenerator thrust bearings differ radically from main propulsion thrust bearings. On many installations, the thrust bearing (fig. 5-2) consists of a thrust collar and two thrust plates. The thrust collar is locked to the pinion shaft and the thrust plates are bolted to the casing. The axial position of the thrust collar is determined by the spacer or shim, which is ground to the desired thickness at assembly. The recommended total running clearance between the stationary plates and the rotating element of the thrust bearing is from 0.008 to 0.010 inch. This clearance is adjusted by removing or adding shims to the two stationary thrust plates.

The axial position of the generator rotor is maintained by the thrust faces on the gear bearings, which bear against the thrust surfaces machined on the ends of the gear hub. The recommended total running clearance is from 0.008 to 0.010 inch; clearance is adjusted by means of shims between the thrust shoulders of the gear bearings and the gear casing. The low speed thrust bearing will experience little wear, under normal operating conditions. The original clearance will change very little in service. If the thrust surfaces do wear, as the result of faulty operation or improper lubrication, they should be replaced or rebabbitted when the total running clearance reaches 0.020 inch. Instructions for adjusting the thrust clearance or renewing the thrust bearings are given in the manufacturer's technical manual. The applicable blueprints and technical manuals should be carefully checked before attempting any adjustments or repairs to these bearings.

In most installations, to remove the high speed thrust bearing for inspection or repair, proceed as follows:

1. Remove the thrust bearing cover, upper and lower halves.
2. Remove the four bolts from the outer thrust plate.
3. Remove the outer thrust plate.
4. Remove the locknut and the securing nut from the pinion shaft.
5. The thrust collar and the inner thrust plate can now be removed.

If the high speed thrust bearing needs adjustment, the following procedure may be followed:

1. Remove the thrust bearing cover.
2. Remove the four bolts from the outer thrust plate.
3. Remove the outer thrust plate.
4. Move the turbine rotor axially in the direction of the generator, until the first-stage turbine wheel hits against the nozzles.
5. The distance between the face of the thrust collar and the land of the inner thrust plate is then set to the clearance desired (between the first-stage turbine wheel and the nozzle), plus the running clearance of the thrust bearing. The clearance is obtained by machining the locating spacer to the proper thickness.
6. Replace the locating spacer and lock the thrust collar in position on the shaft.
7. Replace the outer thrust plate.
8. Take a thrust clearance reading to determine total clearance of the thrust bearing.
9. If the thrust reading is satisfactory, replace the bearing cover and rotate the unit by hand. If there is no undue friction or binding, the unit may be turned by steam.

After the high speed thrust bearing has been set, the position of the generator rotor is set so that the face of the gear is centered with the face of the pinion—when both are in a loaded position.

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Figure 5-2.—Collar and plate type thrust bearing.

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The turbine rotor is moved in the direction of the generator, and the generator rotor is moved in the direction of the turbine as far as the thrust bearings will permit; the gear rotor is set in this position and the proper clearance is obtained by using the proper thickness of shims behind the thrust shoulder of the gear bearings.

On turbogenerator installations that use a Kingsbury thrust bearing, the tests, inspections, maintenance, and repairs are carried out in the same manner as are those for main propulsion turbines, described in chapter 3 of this training course, in the manufacturers' technical manuals, and in NavShips Technical Manual.

LUBE OIL SYSTEM MAINTENANCE

Oil pressure for operating the constant speed governor and for lubricating the bearings and gears is supplied by a gear type pump (part A, fig. 5-3) which is located in the base of the gear casing and driven from the low-speed gear shaft.

The separate hand-operated oil pump (part B, fig. 5-3) for supplying oil to the bearings and to the valve gear for starting, is located on the gear casing.

Some recent ships include a third oil pump, which is driven by an electric motor. This pump, mounted on the generator foundation, is used to supply lube oil to the generator while starting or securing; it is normally started and stopped manually. The pump may also be used as an emergency pump. Once the generator is running, the electric pump may be set so that if the oil pressure should fall to a predetermined point (below normal) a pressure sensing device located in the oil system will start the electric pump.

A system of oil piping conveys the oil to the speed governing mechanism and the bearings and gears. A diagram of the oil piping can be found in the manufacturer's technical manual.

All of the oil supplied to the bearings, except that supplied by the hand pump before starting, passes through the oil manifold and the strainer. The strainer assembly is of the duplex type; the shift lever diverts the oil to only one strainer at a time. The lever carries a notation or an arrow to enable the operator to know which strainer is in use. The arrow or notation points to the strainer in use and all oil is passing through this element. A spring-loaded relief valve and a hand valve are built into the manifold. The relief valve is set to function at approximately 50 psig. The hand valve controls the flow of oil to the gear and bearings. It is slotted so that all oil flow cannot be shut off.

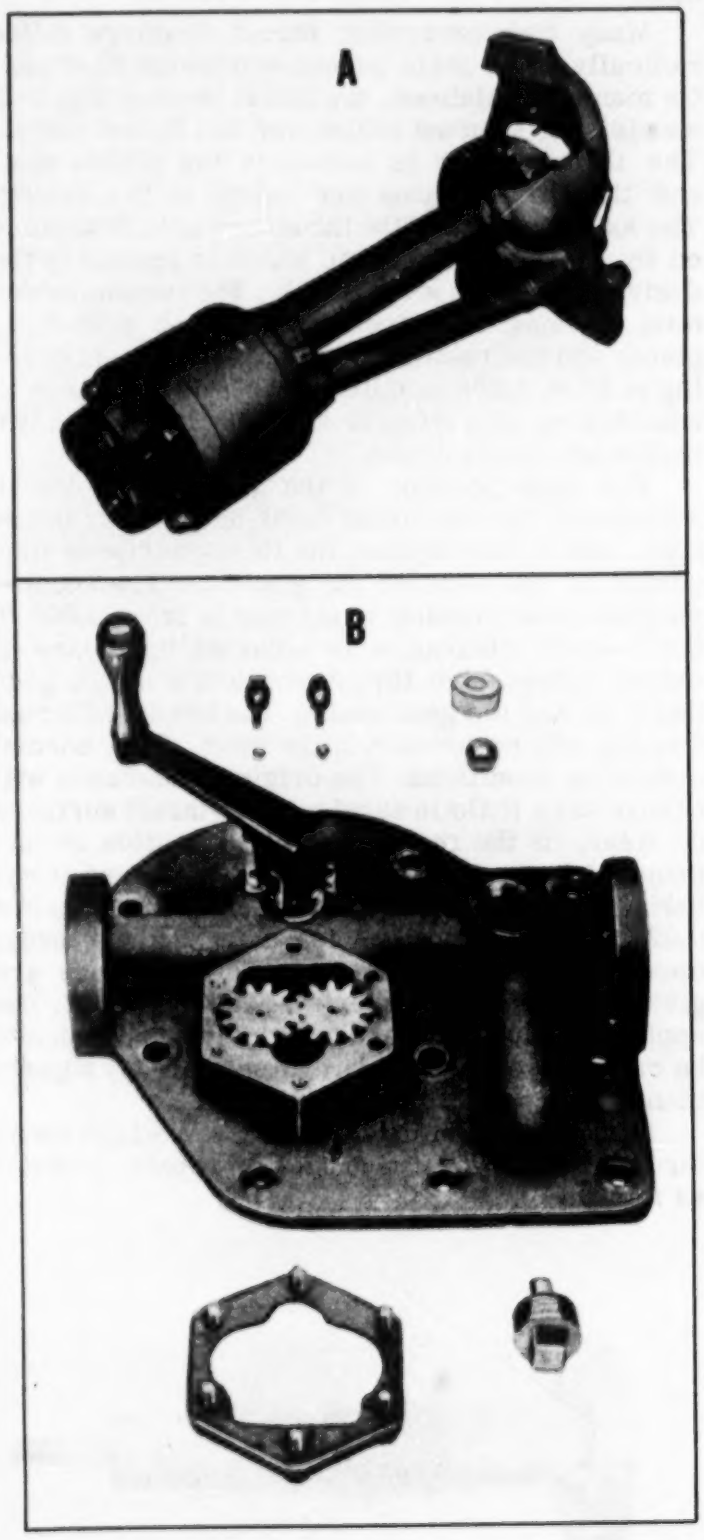

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Figure 5-3.—A. Main oil pump. B. Hand-operated oil pump.

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The hand valve should be set to maintain about 8 psig on the lube oil system.

In connection with the lube oil system, the following instructions should be observed:

1. See that the oil and lube oil system are clean and the proper oil level is maintained.
2. Maintain an ample reserve supply of oil for emergency use and for making up any deficiency.
3. Periodically take samples of oil from the lube oil system and have them analyzed.
4. Do not allow water to mix with the oil. Any water accumulating in the sump tank can be removed by using the purifier. The source of water must be determined and eliminated.
5. Calibrate all pressure gages at least quarterly or at any time there is reason to believe that the gages should be calibrated. Throttle the gage shutoff cocks to reduce needle vibration and consequent wear on the internal mechanism. Inspect gage lines for tight connections and ascertain that there are no kinks in the tubing.
6. Daily, check the oil cooler for leaks. This can be done by taking a sample of water from the discharge side of the cooler and checking for the pressence of oil.

If the oil supply to the bearings is interrupted, stop the unit immediately and then take the necessary steps to restart the oil circulation. These steps may include any one or a combination of the following:

1. Clean the strainers.
2. Repair any broken line.
3. Remove any obstruction from line.
4. Add oil to the sump tank.
5. Increase the oil pressure by increasing the setting of the relief valve.

If a bearing overheats, the unit should be slowed down, but kept turning over at a low speed until the bearings have cooled sufficiently to prevent the bearing metal from adhering to the shaft.

If the oil pressure falls below normal, immediately examine the bearings, the lines, the strainers, and the oil level in the sump tank. If temporary repairs cannot be made satisfactorily with the unit operating, the unit must be secured.

There are several causes for OIL LEAKAGE from a turbogenerator. The majority of these causes can be remedied by operating personnel. The following paragraphs list causes of leakage with corrective measures to be taken:

1. If oil leakage occurs where a shaft emerges from a casing, the oil seals or deflectors may be excessively worn or damaged, and must be replaced to stop the oil leakage.
2. The oil return holes may become clogged with residue from the oil. As the bearings wear and the holes become clogged with dirt, a greater quantity of oil than the holes can accommodate will pass through the bearings. If the bearings are badly worn, the only remedy is to fit new bearings. When the bearings are disassembled for inspection or overhaul, the oil passages and oil return holes should be cleared of all sediment.
3. If the relief valve setting is too high, the oil pressure will be excessive and may cause oil leaks at the bearing ends; if so, the relief valve setting can be slightly reduced to allow some of the oil to be bypassed back to the sump tank.
4. Oil leakage frequently occurs at flanges in the discharge piping. In some instances, tightening the flange will stop the leak. In others, the gasket must be renewed. In extreme instances, the flanges must be taken apart and the contact surfaces must be machined true. A coating of shellac on the flange faces will sometimes stop minor leaks.

When the turbogenerator is operating, the lube oil strainers must be cleaned at least once each watch. Excessive pressure drop across the strainer indicates the need for cleaning. Two strainers are installed for each unit but only one strainer is in the operating position. The idle strainer can be removed and cleaned. When cleaning a strainer, care should be taken to remove any metal particles adhering to the magnets in the strainer basket. When replacing a strainer, ensure that the inner circular face is against its proper shoulder. If the strainer does not readily fit in the manifold body, do not try to tighten the cover plate; fit the strainer properly against its shoulder.

After putting the cover plate in place, fill the idle strainer with oil by opening the vent and turning the transfer valve slightly toward the idle strainer until oil comes out of the vent. After you have closed the vent valve, the strainer is ready to be put in service.

Any change in the oil temperature drop through the oil cooler, when all other conditions remain the same, is a positive indication that the water or oil side of the cooler requires cleaning. Even without this indication, the oil cooler tube bundle should be cleaned at regular intervals. To clean the cooler, proceed as follows:

1. Turn the cooler bypass valve to full bypass position. Shut off the water to the cooler and drain the water side and then the oil side of the cooler.

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Block I - Basic Electronics

Unit 5 - Electrical Measurement (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Finding the total resistance of resistors connected in series-parallel	Loading effects of a voltmeter
	Current meter shunt calculations
Measuring frequency in an A C circuit using frequency meter	Alternating currents
	Cycles, frequency, sine waves, phase
Measuring voltages generated by A C type generators	Ratios, induction
Measuring reactances in inductive circuits	Coils, reactance
Measuring and observing phase of inductive reactance circuits using an oscilloscope	Effects and phase of inductive reactance
	"Q" of a coil

2. Remove the main head and the floating (lower) head.

3. Remove the gland and the packing.

4. Press upward on the floating (lower) tube sheet. Grasp the main tube sheet when it passes out of the shell and draw the tube bundle straight up, taking care not to let it get out of direct line with the cooler bore and thus damage the baffles.

5. The external surfaces of the oil cooler may then be cleaned with a jet of hot water. The internal surfaces of the tubes should be cleaned with a round bristle brush (never use a wire brush for this purpose). The internal surfaces should be cleaned while still wet; if the surfaces are allowed to dry, the salt water deposits will be difficult to remove.

6. In replacing the tube bundle, care should be taken that the baffles do not catch on the shell, as this will cause them to carry the entire weight of the tube bundle.

7. Vent the air from the water and oil circuits, after circulation has been started.

8. When the cooler is put in use (after reassembly), the gaskets and packing should be carefully checked for leaks. When it has been determined that there are no leaks, the cooler is ready for routine use.

A LUBE OIL LOW PRESSURE ALARM is installed on all turbine-driven generators. The alarm contactor is located in the lube oil line leading to the bearings. The contactor is connected to an audible alarm and to a signal light; the arrangement is such that the contactor will close an electrical circuit to the alarm, when excessively low lube oil pressure occurs. The circuit is closed when the unit is not in operation. Therefore, a manual switch must be opened to keep the alarm from sounding. When the unit is brought up to speed, the manual switch must be closed to make the alarm operative.

The contactor is set at the factory to operate when the oil pressure drops to 4 psig and this setting should be maintained. The instructions contained in the manufacturer's technical manual should be followed when making any adjustment to the contactor.

There are at least two pressure gages installed to indicate oil pressures throughout the system.

The high pressure gage indicates the oil pressure delivered by the pump. This is the pressure that is applied to the governor and to the oil strainers. This gage is labeled OIL PUMP PRESSURE and the normal reading is about 50 psig.

The low pressure gage indicates the oil pressure in the lube oil lines to the bearings and the reduction gears. This gage is labeled BEARING OIL PRESSURE and the normal reading for this gage is about 8 psig.

PENCIL ZINCS are installed in the lube oil cooler to prevent damage by electrolytic action. These small zinc cylinders are mounted on pipe plugs and inserted in the cooling water circuit. Electrolytic action between the zinc and the cooling water will gradually dissolve the zinc. Therefore the zincs should be inspected periodically, and renewed when they are about 1/2 dissolved.

ALIGNMENT

Successful operation of the turbogenerator set requires accurate alignment of the entire unit. Proper alignment of the unit requires accurate setting of the gear casing, turbine casing, and generator pedestal bearing to maintain the centerlines of the reduction gear and pinion gear in the same plane. This is essential to obtain satisfactory tooth contact and proper load distribution on the bearings. It is also necessary that the pinion and turbine shafts, when coupled together, run true with one another. Incorrect alignment may cause vibration, unsatisfactory contact of the gear and pinion teeth, unsatisfactory operation—and finally, complete failure of the unit.

Under normal circumstances, alignment of turbogenerators will be done by shipyard, tender, or repair ship personnel. If the services of a shipyard, tender, or repair ship are not available, the following checks may be made by ship's force.

1. Check all foundation bolts to see that they are tight.

2. Check tooth contact by applying very thin layers of prussian blue to several gear teeth and applying red lead to several pinion teeth. Next rotate the pinion in a clockwise direction (when looking at the unit from the turbine end). The resulting contact markings should cover at least 90 percent of the length of the tooth and be equally heavy at both ends of the helix.

3. If the tooth contact is unsatisfactory, the extent of bearing wear can be determined by measuring the crown thickness of the bearings. The clearances of the high speed and the low speed thrust bearings should be measured.

4. If it is found that one of the pinion bearings or one of the main gear bearings is worn more than the other bearing, replace the defective bearing(s). If the crown thicknesses of these bearings are satisfactory and misalignment is suspected, the unit will have to be realigned by shipyard, ten-

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der, or repair ship personnel. The designed and maximum clearances of bearings are shown on applicable blueprints and given in the manufacturer's technical manuals. If blueprints and technical manuals are not available, it is recommended that the limits given in chapter 9005(40) of NavShips Technical Manual be followed. These limits are to be used as a guide; bearings should be renewed or other applicable repairs should be made if a smaller amount of bearing wear causes vibration, misalignment, or other abnormal operating conditions.

CONTROL AND SAFETY DEVICES

Turbine-driven generators are equipped with the following control and safety devices:

1. Constant speed governor.
2. Overspeed trip (emergency governor).
3. Manual trip (emergency tripping device).
4. Lube oil low pressure alarm.
5. Relief valve.
6. Sentinel valve.
7. Back-pressure tripping device.
8. Automatic steam seal regulator (on newer ships).

The principles of operation of a CONSTANT SPEED GOVERNOR are explained in Machinist's Mate 3 & 2, NavPers 10524-C. The following paragraphs will deal only with maintenance and adjustment in regard to constant speed governors.

Maintenance consists mainly of keeping all moving parts free of paint, rust, and dirt so that there will be no undue binding or friction. The governor is set at the factory and the setting should not be changed. Damaged governors should be sent to the factory for repair and adjustment.

Any change in speed range or regulation should be made by adjusting the fulcrum. REGULATION is a term used to express the change in speed that occurs with a change in load. Regulation is usually stated as a percent change in speed that occurs when passing from no load to full load, and based on full-load speed. The governor-lever fulcrum is set properly at the factory and should not be changed unless absolutely necessary.

Figure 5-4 shows part of one type of governor that is in use on Navy ships. If it is necessary to readjust this type governor, the regulation may be changed by shifting the position of the fulcrum pin in the holes in the restoring lever. To increase the percent regulation, use the holes farther away from the trunnion pin. To decrease the percent regulation, use the holes closer to the trunnion pin. Do not decrease the regulation to the extent that hunting and instability result.

HUNTING is a speed variation at constant load and is the result of a timelag between a change of conditions and the correction. Although hunting is

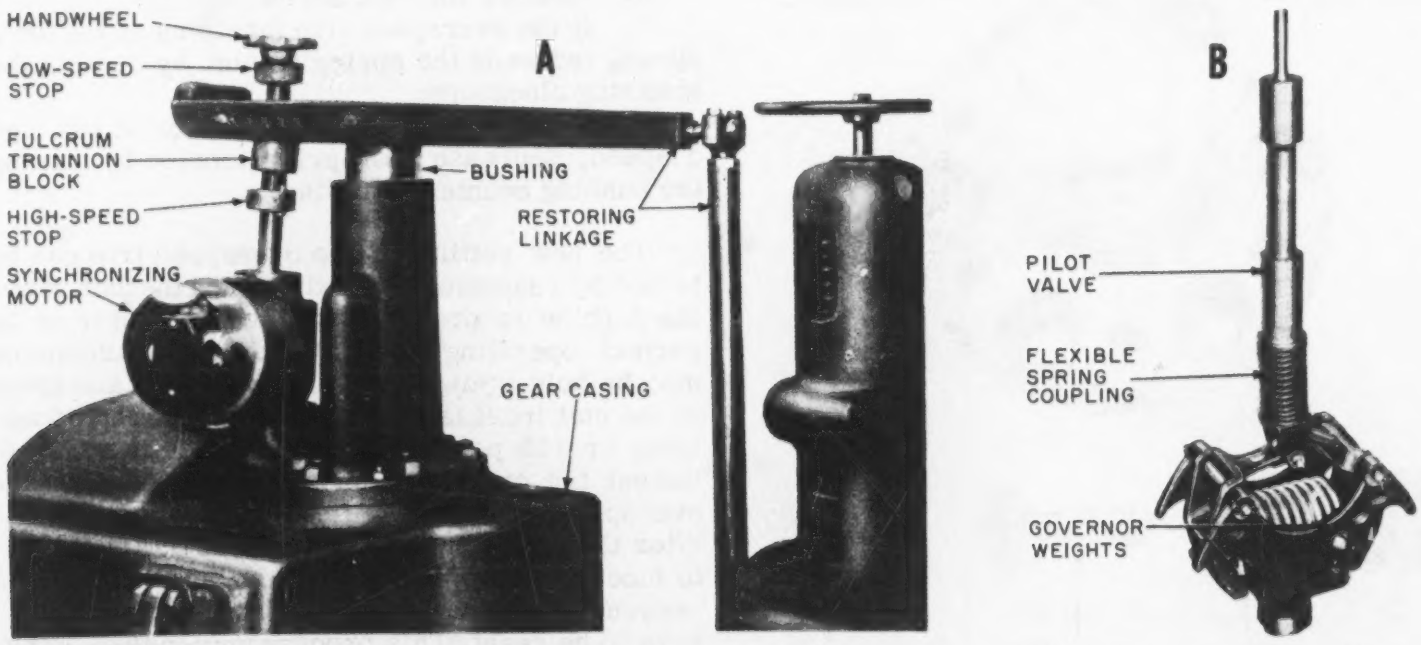

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Figure 5-4.—Governor. A. Synchronizing device and operating linkage. B. Pilot valve, springs, and governor weights.

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usually caused by too narrow regulation, it may result from excessive friction or lost motion in the working parts, low oil pressure, or the use of oil of poor quality.

No adjustment or repair work should be undertaken on a constant speed governor without first carefully checking the manufacturer's technical manual for details on maintenance.

The OVERSPEED TRIP is a device which stops the turbine, by tripping the throttle valve and shutting off the steam to the turbine, in the event of overspeed that is not checked by the constant speed governor. The most common type of overspeed trip for turbogenerators is shown in figure 5-5.

Under normal operating conditions, the constant speed governor will not allow the speed of the unit to go beyond 100 percent of rated speed. If, because of some abnormal condition, the speed of the unit should increase to 100 ± 2 percent of rated speed, the overspeed trip will function and shut off the flow of steam to the turbine. The overspeed trip operates independently of the constant speed governor.

Overspeed trips are set at the factory and no additional adjustments should be necessary. No adjustments should be made without first having checked to make sure that all parts are clean and in proper operating condition, and then only if it has been determined by several successive trials that the tripping speed is incorrect.

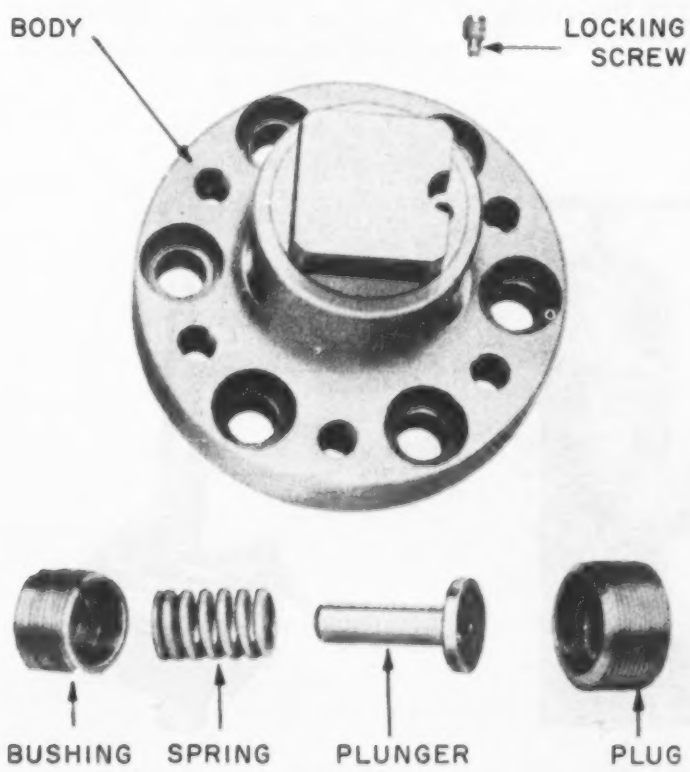

Figure 5-5.—Overspeed trip for turbogenerator.

The overspeed trip, sometimes called an emergency governor, is a centrifugal device of the plunger type and is attached to a flange on the outboard end of the turbine shaft. At rest, the plunger is held in position by the spring. A sufficient increase in turbine speed over the normal related speed increases the centrifugal force on the plunger to an amount that overcomes the force of the spring. The plunger moves away from the center of the shaft and strikes the trigger of the tripping mechanism. The bushing has been adjusted and locked in position at the factory so that the plunger will strike the trigger when the turbine speed reached 8 to 12 percent above normal.

If the overspeed trip should fail to function at 110 ± 2 percent of operating speed, or should it stop the generator at less than this speed, the necessary adjustments can be made as follows:

1. Remove the manual trip lever.
2. Disconnect the reset lever.
3. Remove the end plate from turbine bearing (No. 1).
4. Remover the top half of the bearing cap.
5. Turn the turbine rotor (if necessary) so that the lock screw is accessible.
6. Remove the lock screw.
7. If the overspeed trip functions at too low a speed, increase the spring tension by turning the brushing clockwise.
8. If the overspeed trip functions at too high a speed, decrease the spring tension by turning the bushing counterclockwise.

The new setting of the overspeed trip can be tested by reassembling and starting the unit. When the turbine is properly warmed up, and is up to normal operating speed, a portable tachometer may be held against the generator shaft and speed of the unit increased until the overspeed trip functions or 115 percent of rated speed is reached. Repeat the operation several times because the overspeed trip tends to function at a lower speed after the first actuation. Then, if the trip continues to function at a speed greater or less than 110 ± 2 percent of normal operating speed, the trip will have to be reset. This process may have to be repeated several times in order to obtain the proper setting.

THE EMERGENCY TRIPPING DEVICE, or manual trip (fig. 5-6) is installed to provide a quick

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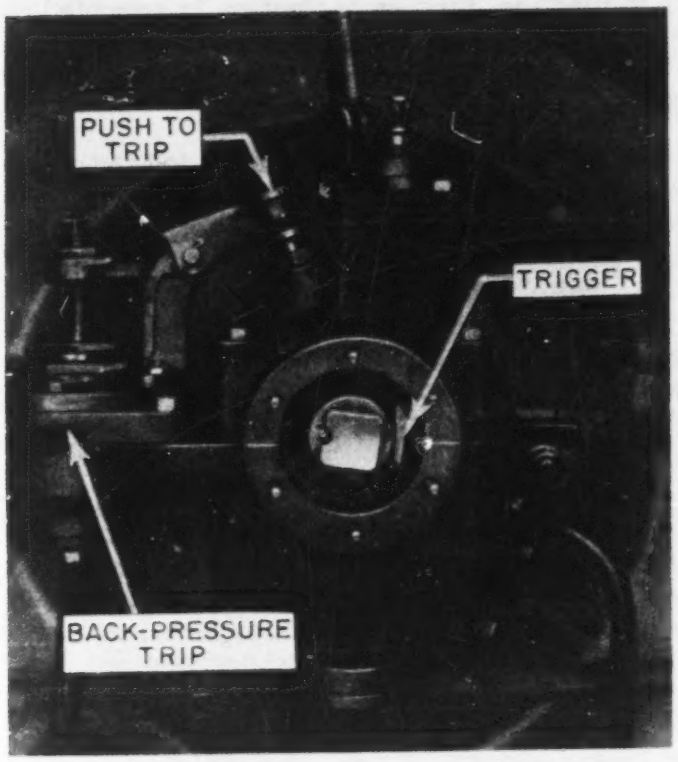

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Figure 5-6.—Emergency tripping mechanism, showing manual trip, overspeed trip, and back-pressure trip.

means of stopping the flow of steam to the turbine in an emergency. The device also is used when securing the unit in a normal manner.

Under normal operating conditions, the parts are held in the latched position, ready to operate when the trigger is struck by the overspeed trip or the back-pressure trip or when the mechanism is operated by hand by striking the button. Newer turbogenerators have throttle valves that are spring loaded closed and are held open by oil pressure. The oil supply to the throttle valve is metered so that the oil can be drained faster than it can be supplied. Whenever any of the protective devices are activated, the resulting oil pressure drop permits the spring to close the throttle valve.

To reset the EMERGENCY TRIPPING MECHANISM after it has tripped and has closed the throttle valve, proceed as follows:

1. Turn the throttle valve handwheel to the valve closed position. This will allow the latch of the trigger stud to engage. (In newer sets, close the valve and press the reset button; this closes the oil drain and allows oil pressure to build up thus permitting the throttle valve to open when the handwheel is turned in the open direction.)

2. Do not attempt to reset the emergency tripping mechanism until the speed of the turbine has decreased 10 to 15 percent below rated speed. This allows the overspeed trip weight to return to its normal position.

3. Carefully move the reset handle sufficiently to make it latch in its reset position.

4. The emergency device and the valve are now in the latched position and steam may be admitted to the turbine by opening the throttle valve, provided the speed of the unit is high enough to maintain 20 psig oil pressure at the operating cylinder. If the oil pressure is less than 20 psig, the valve will have to be opened by turning the hand oil pump, and then opening the throttle valve. After fully opening the throttle valve, always turn the handwheel 1/2 turn in the closing direction, this action keeps the valve from freezing in the open position.

The LUBE OIL LOW PRESSURE ALARM is a safety device installed to warn the operator when the lube oil pressure drops to a dangerously low point. The operation of this device is described in this chapter under the heading "lube oil system maintenance." Under normal conditions, the maintenance of this device will be performed by Electrician's Mates.

To protect the turbine against excessive exhaust pressure, three devices are installed: a sentinel valve, a back-pressure tripping device, and a relief valve.

A small (usually 1/2 inch) SENTINEL VALVE is mounted on the upper half of the exhaust casing, to warn the operator of excessive exhaust pressure. The valve is spring loaded and set to function at 2 psig; this setting should be maintained.

Another device installed to protect the turbine against excessive exhaust pressure is the BACK-PRESSURE TRIP (fig. 5-7). The device is set at the factory to function at 5 psig; and this setting should not be changed.

When a loss of vacuum in the auxiliary condenser occurs, the sentinel valve will lift when the pressure reaches 2 psig. If the deficiency is not corrected, and the pressure continues to increase, the back-pressure trip will function.

Pressure in the exhaust casing exerts a force on the lower plate of the valve, which is opposed by the spring. When this force overcomes the spring tension, the lower plate is pushed upward, actuating the pin and the trip arm, which in turn pushes down on the trip button. This action trips the emergency tripping device, closing the throttle valve and shutting down the turbine.

In the event that the back-pressure trip should

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Figure 5-7.—Back-pressure tripping device.

fail to function, further protection is provided by the relief valve which will function at a pressure of 5 psig above the setting of the back-pressure trip.

The RELIEF VALVE is spring loaded and opens if the exhaust pressure becomes excessive. The valve is mounted on the exhaust end of the turbine, which permits the turbine to exhaust through it.

The relief valve is normally set to open at 10 to 15 psig (5 psig above the setting of the back-pressure trip). Most relief valves are fitted with a water gage. The presence of water in the gage indicates that the valve is closed and properly sealed with water.

Loss of vacuum in the auxiliary condenser is the most frequent casualty to turbogenerators. Insufficient gland sealing steam (or complete loss of gland sealing steam) is a major cause of this casualty. Many of the newer ships have automatic steam-seal regulators on turbogenerators (and also on main propulsion turbines) to automatically control gland sealing steam and thus help to prevent loss of vacuum in the condensers.

One type of steam-seal regulator, shown in figure 5-8, is described here briefly. The regulator operates in response to pressure changes

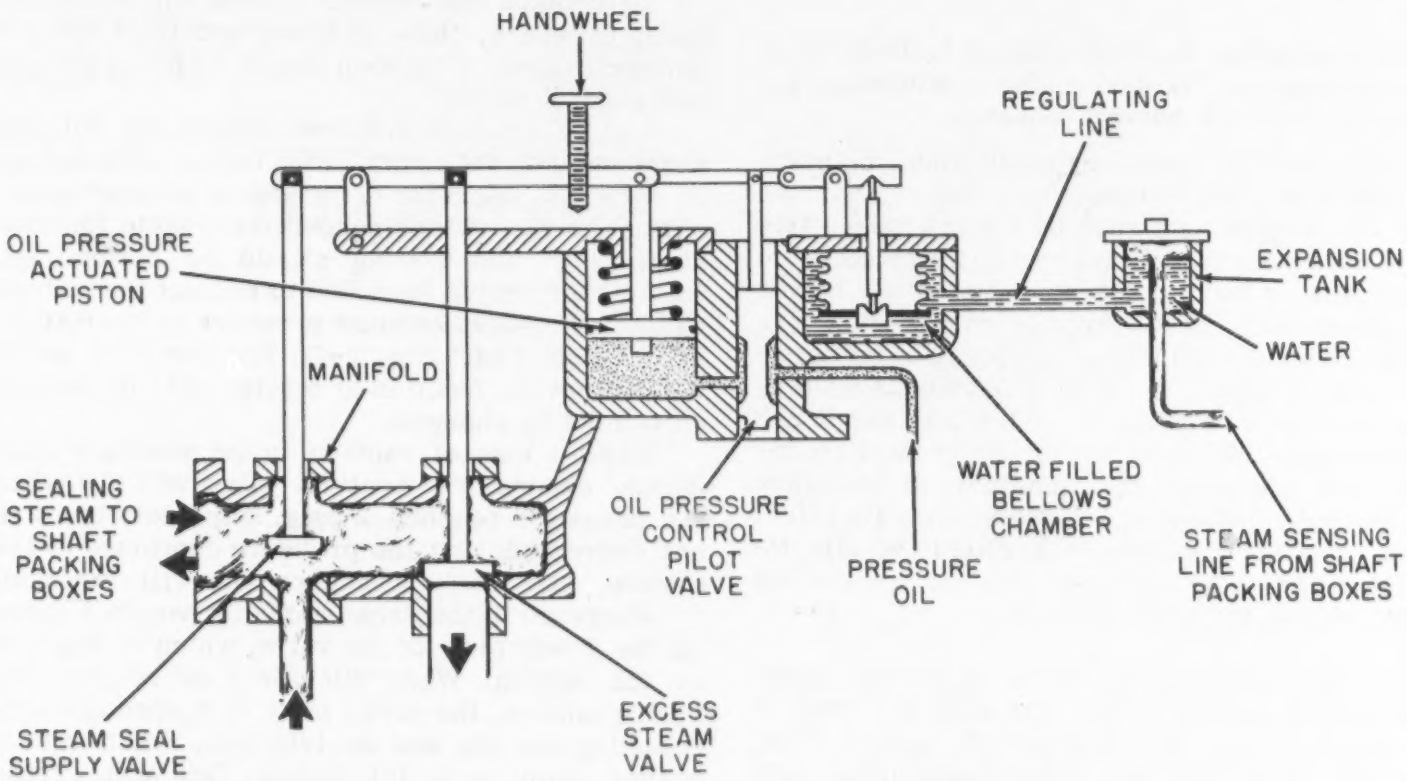

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Figure 5-8.—Steam-seal regulator.

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in the turbine gland seal system. The regulator consists of the following.

1. A manifold, which contains a flange fitting and two valves—one an external gland seal steam supply valve, and one an excess gland seal steam valve.
2. A water-filled bellows assembly.
3. An oil-pressure control pilot.
4. A spring-loaded oil-pressure actuated piston.

An arrangement of linkages connects these components.

The vertical flange on the manifold is connected to the two turbine shaft gland-seal packing boxes. The excess gland seal steam is piped to the turbine exhaust from the gland seal manifold. The other connection to the manifold is to the ship's gland sealing steam supply. The oil, which serves as an operating medium for the regulator, is piped to the pilot valve direct from the oil pump included in the turbine set. The steam sensing line from the turbine shaft gland seal packing boxes is connected to a water-filled expansion tank. A regulating line connects the water-filled expansion tank and the bellows chamber (which is also filled with water). To dampen the effect of sudden surges, a needle valve (not shown in fig. 5-8) is normally installed in this line. The needle valve can be regulated to restrict flow to and from the bellows to the point where the smoothest operation is obtained.

Under low load conditions, when the pressure in the gland sealing system falls below 2 psi, pressure on the bellows assembly is reduced and the bellows moves downward, pulling the linkage down. This movement, transmitted through the linkage, raises the pilot valve and drains the oil from beneath the piston, causing it to move downward and close the excess gland seal steam valve. After this valve is closed, the sealing steam supply valve opens and admits steam to the sealing system to increase the pressure. When the pressure in the system rises above 2 psi, as would normally occur under conditions of greater load, the reverse of the above action takes place.

If the bellows fails, it will move downward as a result of the force exerted by the spring. This movement, transmitted through the linkage, lifts the pilot valve and dumps the oil from beneath the piston. The piston moves downward, closing the excess steam valve and opening the steam supply valve. This action provides a supply of sealing steam to both turbine gland seal packing boxes. The position of the excess steam valve and the steam supply valve can then be controlled manually by means of the handwheel. Turning the handwheel clockwise opens the excess steam valve and closes the steam supply valve.

To protect the steam-seal system from excessive pressure, a relief valve set at 10 psig is connected to the regulating line between the water-filled expansion tank and the bellows.

Frequent inspections of the steam-seal regulator should be made to ensure that all linkage pins are clean and free, to ensure reliable operation. If the turbogenerator has been secured for an extended period of time (such as the time that might be required for major repairs) the water-filled expansion tank should be checked to make sure that there is enough water. Starting the unit without a sufficient supply of water in the expansion tank could cause serious damage to the bellows.

LIFTING TURBINE CASING AND GEAR CASING

The procedure to be followed in dismantling the turbine may be determined by studying the manufacturer's technical manual and the applicable blueprints. The instructions listed here are general rather than specific. However, most generator turbine casings may be lifted by using the following procedure:

1. Remove all piping to the throttle valve.
2. Remove the throttle valve.
3. Disconnect the restoring lever from the pilot valve and synchronizing devices.
4. Remove the insulation from the upper turbine casing.
5. Remove the bolts from the horizontal joint of the turbine casing. The bolts in the circumferential joint need not be removed.
6. Remove the upper halves of the high pressure and low pressure packing boxes. Remove the packing from the high and the low pressure packing boxes.
7. Attach the proper lifting gear, using the padeyes welded in the overhead and the eyebolts in the casing, and lift the casing. Jack screws may be used to help break the horizontal joint. In most installations, the upper halves of the diaphragms and the diaphragm packing are fastened to the upper half of the casing and will be lifted with it.

If the turbine rotor is to be removed, the upper half of the reduction gear casing must be removed first. This can be accomplished as follows:

1. Remove the pilot valve body and the synchronizing device.

2. Remove the cover from the high speed thrust bearing, and the two studs that hold the thrust bearing to the upper half of the casing (if applicable).

3. Remove all gages and thermometers from the upper half of the casing.

4. Remove all parting flange bolts. Remove any end plates which may be bolted to the upper and lower halves of the gear casing.

5. Remove the bolts holding the oil deflector halves together (if applicable).

6. Remove all bolts that connect the upper and lower casing flanges. Then use the jacking bolts to break the joint. Failure to break the joint in this manner may distort the casing.

7. Lift the casing by means of the padeyes, eyebolts, and chain hoists provided for this purpose. Lift the casing straight up to avoid striking the gear.

8. Since the pilot valve remains connected to the governor, be sure to lift the casing high enough to clear the pilot valve.

9. Remove the upper halves of the journal bearings that support the turbine pinion rotor.

10. Remove the high speed thrust bearing.

11. Lift the turbine rotor and the pinion shaft as a single element.

PREVENTIVE MAINTENANCE

Turbogenerator units must be maintained in accordance with the requirements of the 3-M System, in order to ensure safe and reliable operation.

At the required intervals, idle turbines should be run with steam (if available) or turned by hand. Oil should be circulated through the system by means of the hand pump. The trip mechanism and other working parts should be lubricated. The lubricating oil should be sampled, tested for the presence of water, and checked to determine its general condition; when necessary, the lubricating oil should be purified. All relief valves should be operated by hand at the required intervals, in order to make sure that they will operate when necessary.

At somewhat less frequent intervals (usually quarterly) the relief valves should be tested by steam (except on turbines that do not have exhaust stop valves). Also, the position of the rotor should be checked and the thrust bearing oil clearance should be measured.

SAFETY PRECAUTIONS

Operating instructions and safety precaustions for turbogenerators should be posted in the vicinity of the units. The safety precautions listed in this chapter are the MINIMUM required. More complete information on safety precautions should be obtained from NavShips Technical Manual and the manufacturer's technical manual furnished with each unit.

1. Do not operate a turbogenerator that has an inoperative speed limiting governor, backpressure trip, or constant speed governor.

2. Keep all relief valves and the sentinel valve in good operating condition, and keep them set at the pressures specified by the manufacturers.

3. Test the exhaust casing relief valve by hand before admitting steam to the turbine. At least quarterly, test the exhaust casing relief valve by steam.

4. Keep the oil sump filled with clean oil at all times.

5. Avoid water hammer and damage to turbine blading by properly draining steam lines and opening steam valves slowly.

6. Before putting a turbogenerator in service, test the overspeed trip.

7. Before starting a turbogenerator, check to see that it is clear of all foreign matter.

8. Do not pass steam through a turbine at rest, admit enough steam to immediately start the unit rolling.

9. Do not allow air to be drawn through the turbine glands when the rotor is at rest.

10. Keep the governor operating mechanism, valve stems, and other moving parts clean and free of corrosion.

11. Keep oil pressures at the amounts specified by the manufacturer.

12. Examine and clean the lube oil strainers at least once each four hours of operation and more often if operating conditions indicate the need for more frequent cleaning. Always ensure that the strainer caps are properly secured prior to use.

13. Do not admit any steam (exhaust or drains) to the auxiliary condenser before an adequate flow of cooling water is passing through the condenser tubes.

14. Do not admit steam to the auxiliary air ejectors before the auxiliary condensate pump is started.

15. Never operate a turbogenerator that is known to have defective safety devices, defective control devices, or excessive journal or thrust bearing clearances.

16. Frequently inspect all firemain and cooling water lines in the vicinity of the generator for leaks.

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CHAPTER 6

HEAT EXCHANGERS AND AIR EJECTORS

As a Machinist's Mate 1 or Machinist's Mate C you should be familiar with maintenance of heat exchangers and air ejectors installed on Navy ships. Information concerning construction and operation of these units may be found in Machinist's Mate 3 and 2, NavPers 10524-C and in NavShips Technical Manual.

Most of the information given in this chapter concerns maintenance and repair of main and auxiliary condensers, deaerating feed tanks, and lube oil coolers. Since you are required to know how to maintain air ejectors, information on repairing, testing, and maintaining air ejectors is also included in this chapter.

MAINTENANCE OF MAIN AND AUXILIARY CONDENSERS

Although shipyard, repair ship, or tender personnel are usually responsible for such repair work as retubing condensers and overhauling injection and overboard valves, you should have a good understanding of the procedures involved and should be qualified to act as a ship's inspector to see that all work is being performed satisfactorily. Machinist's Mates will be involved in inspecting and cleaning main and auxiliary condensers, checking for leaks, plugging tubes, and operating the units.

INSPECTING AND CLEANING CONDENSERS

Under normal operating conditions, the salt water side of a main condenser should be inspected once each month or immediately after an extended cruise. The steam side of a main condenser should be inspected each quarter when the inspection covers are removed from the low pressure turbines.

Conditions may arise which will necessitate more frequent inspections of main condensers. The ship may operate in shallow water, or may operate in waters where there are large amounts of seaweed, schools of small fish, or large amounts of oil. When any of these conditions occur, the condenser should be opened for inspection and cleaning.

The sea water sides of condensers must be carefully maintained to prevent failures due to deposits on tubes and also to prevent loss of heat transfer due to accumulations of these deposits. The sea water sides of condensers must be inspected and cleaned at the following times:

1. Once each month if permitted by ship's operations.
2. At any time the condenser is opened for inspection or the replacement of zincs.
3. During drydocking or at any other time the salt water side of the condenser is drained.
4. Before initial sea trials and before full power trials.
5. After an extended cruise.

Before opening the salt water side of a condenser, read and observe all precautions listed in this chapter and in chapter 9460(46) of NavShips Technical Manual.

Some of the more important condenser parts which require periodic inspection and cleaning are zincs, tubes, and steam sides.

Zincs

If dissimilar metals, immersed in an electrolyte (such as salt water) are connected, a simple galvanic cell is formed and an electric current flows from one metal to the other through the electrolyte. The metal from which the current is flowing to the electrolyte will tend to corrode rapidly, and the metal to which the current is flowing from the electrolyte will tend to be protected from galvanic corrosion. The direction in which the current will flow depends on the composition of the metals or the alloys exposed to the electrolyte.

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Since condensers and other heat exchangers using salt water have all the requirements of a simple galvanic cell, electrolytic action will take place. This action cannot be stopped, but the metal parts of the condenser can be protected by using zincs. Because of its characteristics, zinc will cause the electric current to flow from the zinc plates to the metallic parts of the condenser. The effect of the electrolytic action will be to gradually destroy the zincs, but they can easily be replaced.

Zincs installed in the salt water circuit of condensers and other heat exchangers should be inspected and cleaned (or renewed) at least once a month and more often if necessary. When the salt water side of a condenser is opened, inspecting and cleaning the zincs should be one of the first considerations.

A casual inspection of a badly scaled zinc, especially while it is still wet, may lead personnel to believe that zinc metal instead of scale is exposed. The zinc, even though it appears to be in good condition, should be tested with a chipping hammer to learn the true condition of the zinc metal. Whenever zincs are inspected or cleaned, the condition of the metallic contact between the zinc and its support should be checked.

Tubes

Deposits which lodge within a condenser tube are likely to cause failure of the tube, unless promptly removed. Particles of mud, sand, or other foreign matter which lodge in the tube cause corrosion pits to start under the particles. Once a pit is started, it will widen and deepen, even though the foreign matter is removed. Larger particles or such foreign matter as stones, shells, metal, and wood, will result in the formation of corrosion pits where the foreign matter touches the tube surface, and will cause an increase in velocity of the sea water (flowing past the obstruction) which will result in breaking down the protective film on the tube.

The resistance of condenser tubes to corrosion depends on a thin, adherent, continuous film of corrosion products on the surface exposed to sea water; therefore, extreme care must be taken when cleaning the tubes not to use abrasive tools capable of marring or scratching the surface of the tube. Wire brushes or rubber plugs having metal parts should never be used inside condenser tubes. Any scratch or perforation of the corrosion-resisting film will form a pit which will widen and deepen and eventually result in tube failure (through corrosion pitting), in the same manner as occurs when foreign matter lodges on the tube surface. Any cleaning equipment must be carefully used to avoid damaging the protective film, which will cause tube failures.

For ordinary cleaning, an air lance should be pushed through each tube, the tube sheets should be washed clean, and all foreign matter should be removed from the water chests. In installations where there is severe fouling, a water lance should be pushed through each tube to remove foreign matter. Where there is extreme fouling, a rotating bristle brush should be run through each tube—or soft rubber plugs, available at shipyards, may be driven through the tubes by use of air or water pressure—then this procedure should be followed by water lancing.

Steam Side

Whenever the manhole plates are removed from the low pressure turbine for inspection or maintenance, the steam side of the tubes should be inspected. The entire steam side should be checked for grease and dirt. If grease and dirt are found, they can be removed by boiling out the condenser, using a solution of boiler compound. Normally, condensers which serve turbines, should not require boiling out more frequently than once every two or three years. Instructions for the boiling out process may be found in Machinist's Mate 3 and 2, NavPers 10524-C, and in chapter 9460(46) of NavShips Technical Manual.

TUBE LEAKAGE

Any tube leakage, however slight, will cause serious damage if neglected. The condensate system will become contaminated and this will result in serious damage to the boiler tubes. It is not unusual for a newly tubed condenser to develop leaks due to defective tubes or tube sheets, or to improper installation. However, if the defects are corrected, the condenser will give years of satisfactory service.

The most common cause of tube leakage is deterioration which starts at the sea water side of the tube and proceeds through the tube wall to the steam side. However, leakage may also be caused by deterioration starting at the fresh water side of the tube wall, by a defective joint between the tube and tube sheet, or by cracking of the tube wall or tube sheet.

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Block I - Basic Electronics

Unit 6 - Electrical Circuit Components

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Testing resistors	How resistors are made Types of resistors Classification of resistors Resistor color code Current flow through a resistor Resistors in series Resistors in parallel Resistors in series-parallel The voltage divider Expressing resistor values
Testing coils	Low frequency coils High frequency coils Distributed inductance of a wire
Testing transformers	Transformer characteristics Primary and secondary ratios Power transformers AF transformers RF and IF transformers Television transformers Transformer losses
Testing capacitors	Electron theory of capacitor action Factors affecting capacitance Unit of capacitance Types of capacitors Variable capacitors Voltage characteristics of capacitors
Constructing a capacitor	Effects of capacity to circuits
Finding (measuring) value of capacitors using capacity meter	Types of capacitors; capacitive reactance
Measuring the peak-to-peak value of capacitive circuits	R. C. time constants
Constructing two types of R. C. timing circuits	

Impingement Erosion

Sea water flowing into the condenser tubes at high velocity tends to remove the thin protective film of corrosion products adhering to the tube walls. This protective film is replaced at the expense of further corrosion of the tube wall. As the protective film is continually removed and is replaced by corrosion products, the tube wall is gradually thinned and the joint between the tube and the tube sheet is weakened, so that a salt water leak ultimately occurs, through the failure of the tube joint or perforation of the tube wall beyond the tube sheet. This type of attack is generally confined to the region of the tube at or near the inlet end and is known as impingement erosion, inlet end attack, or bubble attack. The occurrence and rapidity of the attack is influenced mainly by water velocity through the tubes. It is also influenced by the amount of air entrained with the circulating water, and by the design of water chests and injection piping.

Tube deterioration resulting from impingement erosion of the tube ends can be minimized by proper regulation of circulating water through condensers and by proper venting of water chests.

Figure 6-1 shows a tube which has been badly damaged at the inlet end by impingement erosion.

If wet steam is permitted to impinge on condenser tubes at high velocity, the surface of the tubes will rapidly erode and this erosion will eventually result in perforation of the tube wall and leakage of sea water into the condensate. Baffles or distribution pipes are installed within the condenser shell to prevent direct impingement of water and steam from the auxiliary exhaust line, the recirculating line, and the makeup feed line.

These baffles must be installed in such a way that they do not touch the tubes, since vibration will cause tube failure. If frequent tube leaks occur in the vicinity of a steam or water connection to the condenser shell, it is evidence that the baffling system is defective or that the plant is not being operated properly.

In order to prevent tube erosion from auxiliary exhaust lines, it is essential that the line be continuously and thoroughly drained. Before you shift the auxiliary exhaust to a condenser, all drain valves on the exhaust line should be opened and every precaution taken to ensure that the exhaust line is drained properly. If there is a pocket in the exhaust line which will allow condensate to collect, a drain should be installed to ensure complete drainage of the auxiliary exhaust line.

Testing for Leaks

Several methods of testing condensers for leaks are described in Machinist's Mate 3 and 2, NavPers 10524-C. A review of one method of testing follows:

1. Drain the salt water side of the condenser and remove the water box inspection plates. This includes the small inspection plates at the top of the water boxes.
2. Place the steam side of the condenser under air pressure not to exceed 15 psig.

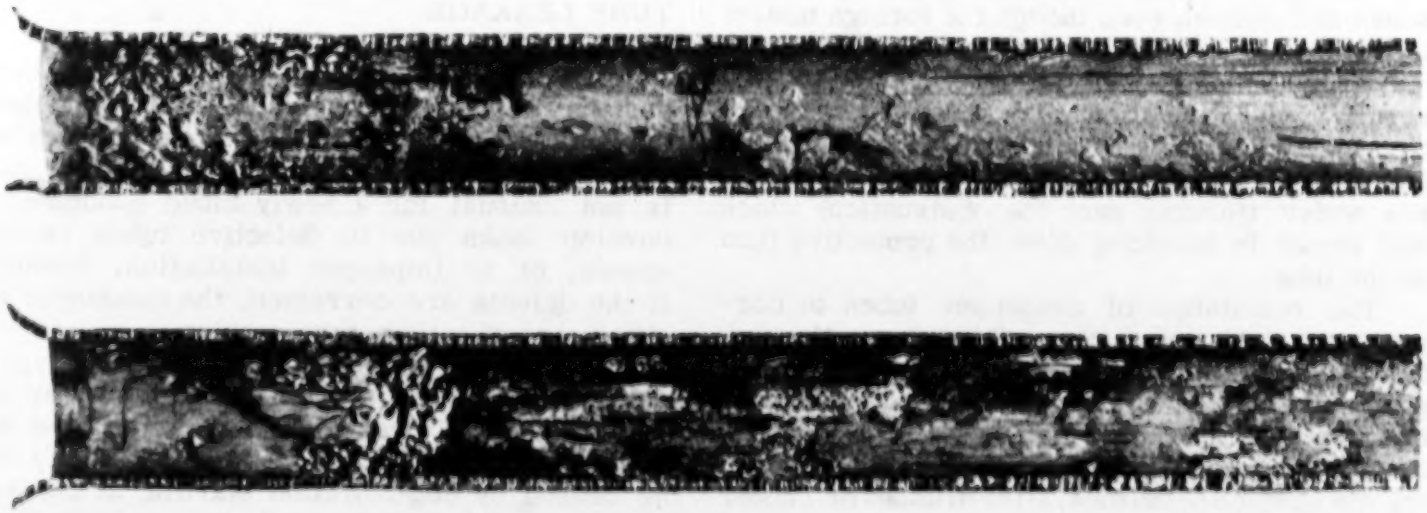

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Figure 6-1. — Tube damaged by impingement erosion.

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3. Slowly fill the salt water side of the condenser. Replace the inspection plates as the water level nears the openings.

4. Carefully observe the surface of the water near both tube sheets. Air bubbles indicate leakage.

5. A large leak will be noticed immediately. Detecting smaller leakage, especially leakage from a tube, will require more time and closer observation. Trim or list of the ship should be noted, and a close watch should be maintained on the high side of the tubes. If tubes are bowed, this should be taken into consideration when inspecting for leaks.

Salt water leaks into the condensate system cannot always be detected by the use of salinity indicators alone. The first indication of a salt water leak may be a chloride buildup in the boiler.

If leaky tubes are found, they must be plugged so that the condenser can be kept in service. Plugs, which are furnished by the manufacturer, should be driven into the tube ends with light hammer blows. If it becomes necessary to plug tube sheet holes after a tube has been removed, a short section of tube should be expanded into the tube hole before the tube plug is inserted; this will protect the tube holes from damage.

Plugged tubes should be renewed during the next shipyard availability if the water chests are removed for other work; or if more than 10 percent of the tubes are plugged, a retubing request should be submitted, via the type commander, to NavShips.

RETUBING CONDENSERS

Under normal conditions, an MM1 or MMC will not be expected to retube a condenser. Because of modern materials and manufacturing methods, condensers seldom need retubing. When they do, special tools and equipment are necessary, and the work is performed by tenders, repair ships, or a shipyard. The MM1 or MMC does have the responsibility of inspecting the job to see that it has been properly completed and tested.

In general, specimen tubes should not be drawn from a condenser or heat exchanger, for examination purposes, except when removal is specifically directed by NavShips, or by a Board of Inspection and Survey. However, under the following conditions, tubes MAY be drawn without NavShips authorization:

1. When frequent leaks have been caused by tube failures, specimen tubes should be drawn from widely separated parts of the unit in order to establish the general condition of the tubes.

2. When several tubes have failed in the vicinity of a steam or water inlet to the condenser shell, specimen tubes should be drawn unless the cause of the failure can be determined by visual inspection of the steam side of the unit.

Samples from the most badly deteriorated tubes should be carefully marked to show the top and the bottom of each sample, and the location from which the sample was drawn. The samples should be cut into lengths of about 12 inches, identified as to position along the length of the tube, split lengthwise, and opened to permit ready examination. These samples are then forwarded to NavShips, together with a complete report of the conditions found.

Retubing Request

Before any work is begun in retubing a main condenser, authorization must be obtained from NavShips. When a retubing request is submitted, the following information must accompany the request:

1. The condenser involved and the date when the condenser was last tubed or retubed.

2. Whether or not any of the tube leaks were caused by improperly expanded or packed tube joints.

3. The date when each leak occurred, the type of tube failure (usually determined when the failed tube is drawn and split for inspection), the conditions of operation, and any known or suspected contributory causes.

4. The source of supply of the tube, if known.

5. The position in the tube bundle of each failed tube and of each specimen tube drawn for inspection.

6. The part(s) of each specimen tube where defects were found (external, internal, top, bottom, ends, etc.); to meet this requirement, tube ends must be marked before removal so that the top can be located.

7. The tube, tube sheet, and water box materials, and the type of tube joints employed.

8. The condition of the zincs; the frequency of renewal, the frequently of scaling, and the method of cleaning the zincs.

9. The method and frequency of cleaning the tubes.

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10. Whether or not the unit was kept thoroughly vented during its operation.

11. Whether or not the tubes were cleaned and blown out whenever sea water was drained from the unit.

12. If severe deterioration of tube ends and tube sheets is visible and photographic equipment is available, photographs of the tube sheets should be taken and sent to NavShips for information purposes.

13. The extent of work considered necessary. Partial retubing of a condenser is not considered economical, except that authorization is sometimes given for retubing one pass of a two-pass condenser.

14. A list of materials required, specifying length, outside diameter, wall thickness, and type of tube joints at both inlet and outlet ends.

15. Recommendations and comment by authority endorsing the request.

Retubing of auxiliary condensers and other small heat exchangers may be accomplished by forces afloat or by a shipyard without obtaining authorization from NavShips. Only the type commander need approve this type of retubing. Complete reports of such retubing must be forwarded to NavShips and are to include the same information that is required for requests for retubing main condensers.

Removing Tubes

When a main condenser is to be retubed, the most efficient way of removing the old tubes is to cut them inside the shell by use of a power-driven saw, or other suitable cutting tool and then drive the ends of the tubes out of the tube sheets with a drift. Figure 6-2 shows a drift suitable for tubes which have a 5/8-inch outside diameter and a wall thickness of 0.049 inch.

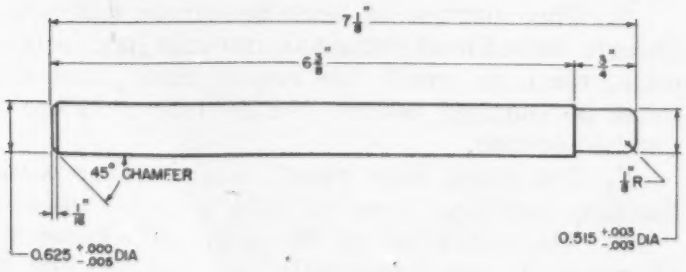

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Figure 6-2.—Drift for driving tube ends from tube sheets.

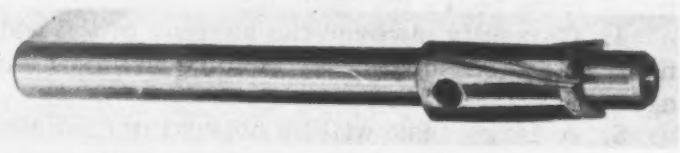

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Figure 6-3.—Reamer for removing expanded tube ends.

If serious difficulty is encountered in removing expanded tubes, it may be ncessary to ream the expanded ends so that only a thin shell remains at the outer surface of the tube.

If a reamer is used, it should be provided with a pilot which closely fits the inside bore of the tube, and extreme care must be taken to ensure that the reamer does not touch or mar the surfaces of the tube holes in the tube sheet. Figure 6-3 shows a reamer suitable for this type of work.

Regardless of the method used to remove the tubes, the tube holes in the tube sheets must not be damaged in any way.

Renewing Tubes

Before installing replacement tubes, a very careful examination of the interior parts of the condenser shell must be conducted. If there is any reason to believe that the joints between the tube sheets and the condenser shell are not in perfect condition, the tube sheets should be removed, the flanges trued, and new gaskets installed. Joints between the stay-rods and the tube sheets should be remade and the stay-rods repacked. Should any defects be found after the new tubes are installed, it may be necessary to cut out the newly installed tubes to correct the defect(s).

Only copper-nickel tubes conforming to NavShips specifications are to be used in condensers that are salt-water cooled. These tubes are furnished in stock lengths and must be cut to proper length by the installing activity. The usual practice is to cut the tubes in lengths about 1/8 inch longer that the distance between the outside faces of the tube sheets. After installation, the tubes are finished to the exact length, by using an air-driven end mill or surface grinder.

EXPANDING TUBES.—Nearly all condensers installed aboard naval ships have the inlet tube ends expanded in the tube sheet, forming a metal-

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to-metal joint. In many installations, the outlet tube ends are also expanded. If the condenser tubes are expanded at both ends, it is common practice to provide one or more grooves, or serrations, in the tube holes in order to increase the holding power of the expanded tube joint. Such grooves should be thoroughly cleaned out and any burrs removed prior to the installation of new tubes.

Tube expanders used in retubing condensers and other heat exchangers must meet Navy specifications. No type of tube expander should be used by forces afloat or shipyards, except the expanders furnished to the ship by the manufacturer and approved by NavShips. The tube expander rolls should be tapered to correspond with the taper of the expander mandrel to ensure parallel expansion of the tube walls. The inner ends of the rolls should be suitably rounded off to form a torpedo-shaped end in order to prevent ridging and cutting of the tubes at the inner end of the expanded joint. In order for a tube expander to be properly set for a given job, it is generally necessary that the overall length of the rolls be not less than 3/16 inch greater, and not more than 5/8 inch greater than the thickness of the tube sheet into which the tube is expanded. The expander should be adjusted so that the expanded portion of the tube does not extend completely through the cylindrical portion of the tube sheet hole; about 1/8 inch of the tube at the inner end of the tube hold is left unexpanded. If the tubes are expanded completely through the tube sheet, the part of the expanded joint which extends into the condenser and beyond the support of the tube hole, will bulge and the subsequent removal of tubes will be extremely difficult.

After the tubes are expanded, the inlet ends of the tubes should be belled or flared to an outside diameter of not more than 3/4 inch for 5/8-inch OD (outside diameter) tubes, and not more than 7/8 inch for 3/4-inch OD tubes.

Flaring tools must not be driven into the tube end so hard that the wall of the tube is appreciably thinned or cut. Figure 6-4 shows a flaring tool that is suitable for 5/8-inch OD tubes which have a wall thickness of 0.049 inch. It is good practice to mill or grind the projecting flared ends of the newly installed tubes flush with the tube sheet surface in order to provide a smooth entrance for the circulating water flowing into the inlet ends of the tubes. It is not necessary to flare the outlet ends of the tubes; the tube outlet ends may be allowed to project 1/16 inch from the face of the tube sheet surface.

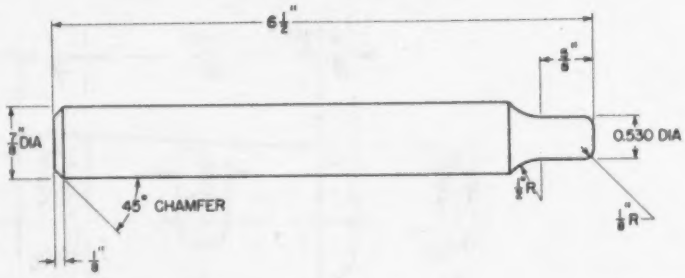

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Figure 6-4. — Tool for flaring main condenser tubes.

PACKING TUBES. — Flexible metallic packing in accordance with Navy specifications, should be used to pack the outlet ends of packed condenser tubes. The inlet ends of the tubes should be expanded into the tube sheets before the outlet ends are packed. The old packing must be completely removed and the threads and serrations of the glands thoroughly cleaned of all foreign matter.

When stuffing box glands are 3/4 inch deep, the proper packing consists of two fiber rings and two metallic rings. To facilitate the installation of packing, a loading pin (fig. 6-5) should be inserted into the outlet ends of the tubes.

After the loading pin in inserted, a fiber packing ring is placed on the pin and driven to the bottom of the stuffing box. Next, a metallic packing ring is placed on the loading pin and calked into the packing box with three or four light hammer blows, to cause the metal to flow into the threads of the gland. Then these operations are repeated, another fiber ring and another metallic ring are inserted in the same manner; each ring is calked in place separately. If the depth of the stuffing box is greater than 3/4 inch, an additional metallic ring should be installed and calked into place in order to completely fill the stuffing box with packing.

If the stuffing box is 5/8 inch deep instead of 3/4 inch deep, only three rings of packing can be used; one metallic ring is calked in place, followed by a fiber ring and a second metallic ring. The outlet ends of packed condenser tubes are never flared, expanded, or belled.

When a condenser is retubed, the tubes should be tested for leaks. The test is made by filling the shell with warm water. (Warm water must be used to avoid condensate forming on tubes and tube sheets and giving a false indication of leaking.) If any leaky tubes are found, they can be recalked with light hammer blows applied to the calking tool.

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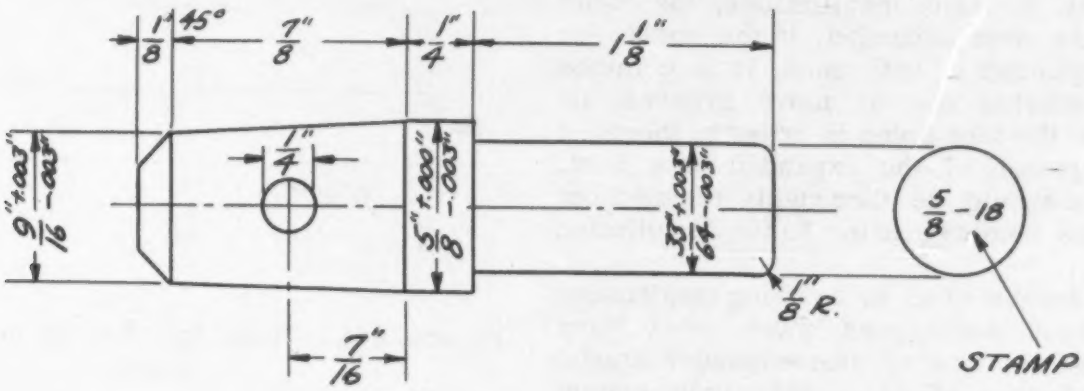

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Figure 6-5.—Loading pin for packing main condenser tubes.

The amount of force used in striking the calking tool with the hammer is extremely important. If too little force is used, the joint will leak. If too much force is used, it will "neck" the tube end so that the tube end will be held too tightly in the packing gland to allow proper movement during normal expansion. When the necked tube does move through the packing, leakage at the joint will result.

CARE OF IDLE CONDENSERS

Most condensers on naval ships have condenser tubes either expanded at both ends, or expanded at the inlet end and packed at the outlet end. These units should normally be drained and kept empty when secured. However, if the condenser is to be used within a few days, it may be completely filled with water (which should be circulated daily) unless the ship is lying in highly polluted water. When in polluted water, the condenser should be drained and thoroughly washed out whenever it is secured.

Whenever the sea water side of a condenser is drained, special care should be taken to ensure that the tubes do not have water anywhere along their lengths. Tubes frequently become sagged and water trapped in these pockets at one or more points along the tube length, if allowed to remain in a drained condenser, will gradually evaporate. The impurities left behind (after the water has evaporated) will corrode the tubes at these points, and in time will result in tube failure. This action is particularly acute when condensers are drained of highly polluted water. The best method of avoiding this type of tube deterioration, when an ample supply of fresh water is available from a pier, is to water-lance each tube with fresh water in order to wash out the polluted water and remove foreign matter from the tubes. Following the water-lancing operation, the tubes should be air-lanced and left dry until the condenser is again put in service.

If sufficient fresh water is not available for water-lancing, each condenser tube should be air-lanced and left completely dry; then the condenser should be inspected daily. If any water tends to collect in the tubes, through condensation from the atmosphere, the air-lancing operation should be repeated, as necessary, to avoid the formation of water pockets at low points along the tubes.

When a condenser is secured, the steam side should be kept empty.

SAFETY PRECAUTIONS FOR CONDENSERS

When opening a main condenser for cleaning or inspection, or when testing a main condenser, there are several safety precautions that must be observed. The following procedures and precautions, when carried out properly, will help prevent casualties to personnel and machinery:

1. Before the salt water side of a condenser is opened, all sea connections, including the main injection valve, circulating pump suction valve, and main overboard valve, are to be closed tightly and secured against accidental opening. This is necessary to avoid the possibility of flooding an engineroom. Safety gates, where provided, are to be installed.

2. On condensers having electrically operated injection and overboard valves, the electrical circuits serving these motors are to be opened and tagged to prevent accidentally energizing these circuits.

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3. Before a manhold or handhole plate is removed, drain the salt water side of the condenser by using the drain valve provided in the inlet water box. This is done to make sure that all sea connections are tightly closed.

4. If practicable, inspection plates are to be replaced and secured before work is discontinued each day.

5. Never subject condensers to a test pressure in excess of 15 psig.

6. When testing for leaks, do not stop because one leak is found. The entire surface of both tube sheets must be checked, as other leaks may exist. Determine whether each leak is in the tube joint or in the tube wall, so that the proper repairs can be made.

7. There is always a possibility that hydrogen or other gases may be present in the steam side or the salt water side of a condenser. No open flame or tool which might cause a spark should be brought close to a newly opened condenser. Personnel are not to be permitted to enter a newly opened condenser until it has been thoroughly blown out with steam or air.

8. The salt water side of a condenser must be drained before flooding of the steam side, and must be kept drained until the steam side is emptied.

9. The relief valve (set at 15 psig) mounted on the inlet water chest is to be lifted by hand whenever condensers are secured.

10. If a loss of vacuum is accompanied by a hot or flooded condenser, the units exhausting into the condenser must be slowed or stopped until the casualty is corrected. Condensate must not be allowed to collect in condensers and overflow into the turbines or engines.

11. Condenser shell relief valves are to be lifted by hand before a condenser is put into service.

12. No permanent connection which could subject the salt water side to a pressure in excess of 15 psig, is to be retained between any condenser and a water system.

13. No permanent connection which could allow salt water to enter the steam side of the condenser is to be retained.

14. Test the main circulating pump bilge suction, when so directed by the engineer officer. To conduct this test, it is generally necessary only to start the main circulating pump, open the bilge suction line stop or check valve, and then close down on the sea suction line valve to about 3/4 closed, or until the maximum bilge suction capacity is obtained.

OPERATION OF CONDENSERS

Compared with the number of casualties that occur to some units of naval machinery, relatively few casualties occur to main condensers. The most frequent casualty to a main condenser is a reduction in vacuum. Inadequate vacuum or any other casualty to a main condenser will result in failure of the propulsion turbines to produce full power or in complete failure of the main engines. Condensers should be operated to obtain a vacuum in accordance with design requirements and to obtain maximum service life and reliability of the equipment.

VACUUM REGULATION

Under normal operating conditions, condensers fitted with scoop injection should be operated to maintain the maximum vacuum obtainable and with the main injection and overboard valves wide open, except under the following conditions.

When making FULL POWER or speeds closely approaching full power, under cold injection conditions, the condenser will usually be capable of obtaining a higher vacuum than can be effectively used by the low pressure turbine. In the average installation, as the FULL POWER vacuum becomes higher than about one inch of mercury above the vacuum for which the low pressure turbine was designed, the extra steam that is required to heat the condensate will outweigh the added economy of turbine operation that is gained by the higher vacuum. The designed full power vacuum for any turbine installation may be obtained from the manufacturer's technical manual. Most turbines served by scoop injection condensers are designed for an exhaust vacuum of about 27 1/2 inches of mercury. If the INJECTION TEMPERATURE becomes low enough so that the full power vacuum tends to increase above 28 1/2 inches of mercury, the overall plant economy may be improved by using the overboard discharge valve to throttle the flow of circulating water to limit the vacuum to 28 1/2 inches of mercury.

When operating at CRUISING SPEEDS, the turbines can generally make effective use of the maximum vacuum which the condensing plant is capable of maintaining. However, with COLD INJECTION AT LOW POWER, the condenser becomes capable of producing a vacuum higher than that produced during normal operating conditions. Under STANDBY CONDITIONS when very little steam is being discharged to the condenser,

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most installations fitted with properly functioning air ejectors will produce a maximum vacuum of approximately 29 1/2 inches of mercury, with COLD injection temperature.

As the condenser vacuum approaches the maximum, when CRUISING AT LOW OR MEDIUM POWER, and with cold injection temperature, the air removal equipment tends to become unable to free the condenser of normal air leakage. The air collects in the condenser, and tends to insulate the tubes from the condensing steam and to settle in the hot well; and there is usually a noticeable increase in the condensate depression. To avoid the loss of economy and the absorption of air into the condensate under these conditions, it is good practice to throttle the flow of circulating water, as necessary to limit the vacuum to about 0.2 inch of mercury less than the maximum obtainable with full flow of circulating water, or as necessary to reduce the condensate depression to normal.

Under low power operations at MEDIUM injection temperature, if the condensate depression remains between 0 and 2°, it may be assumed that the air removal equipment is ridding the condenser of air, and, therefore, throttling the circulating water is unnecessary.

CIRCULATING WATER CONTROL

When the gate valve in the circulating water overboard piping is used to regulate the water flow through the condenser, this valve should be kept at least 1/4 open. If a gate valve used for throttling is closed more than 3/4, the gate is likely to pound against the seat rings and damage the valve so that it will not be watertight when closed. Some erosion of the valve gate and seating rings may take place if the valve is continually used for throttling. Whenever a ship is drydocked, a careful inspection of injection and overboard valves should be made in order that the valves may be kept in good working condition and watertight.

If, while an overboard valve is throttled, a sudden increase in power is needed, a slight loss in vacuum will occur but the loss will not usually be serious and can be corrected by opening the overboard valve. In the event of an unexpected demand for full power astern, the overboard valve should be opened wide as quickly as possible.

LOSS OF VACUUM

When a loss of vacuum occurs in a condenser, it means that the units of machinery exhausting into the condenser are out of commission. Maintaining proper vacuum is one of the more important duties of engineroom watchstanders. This training course cannot cover all of the reasons for loss of vacuum, however, since air leakage into the vacuum system is the most common cause of vacuum loss, some of the methods of conducting air tests are as follows:

AIR LEAKAGE into a condenser decreases the vacuum obtainable and increases the condensate depression. If air leakage becomes excessive, the units of machinery exhausting into the condenser will have to be secured.

There are many ways in which air can leak into a system under vacuum. Every FLANGE, GASKET, CONNECTION, PACKING GLAND and VALVE BONNET that connects to the vacuum system can be a source of air leaking into the condenser. Air leaks can be very difficult to locate; they can be searched for in various ways. One method is by filling the condenser and the connected piping which is normally under vacuum, with fresh water — then using compressed air, to build up a pressure of 5 to 10 psig in the turbine casing and checking the condenser and piping for water leaks. A water leak indicates an air leak.

Another method of locating an air leak is by making the CANDLE FLAME TEST. With the system under vacuum, hold a lighted candle to all areas where leaks are suspected. If the candle flame is held close to a leak, the vacuum will draw the flame toward the leak.

A more reliable method of searching for leaks is to apply SOAPSUDS to areas where leaks are suspected. The soapsuds solution should be prepared so that it has the consistency of liquid hand soap and will work up lather on a brush. With the condenser shell subjected to a five-pound air pressure, apply the lather all the way around the joints, then the joints should be carefully checked for bubbles. Doubtful spots should be lathered a second time, and if you are still in doubt about the existence of leaks, doubtful spots should be lathered several times.

Another method of testing a vacuum system for leaks is by using the AIR TEST. If the test is to be conducted on a main condenser, the procedure is as follows:

Start a lube oil service pump; engage and start the turning gear. Cut in gland sealing steam to the main turbines. Next, build up a pressure of 5 to 10 psig throughout the vacuum system. Listen carefully for air leaking out of the system. This method is more effective if all the vents and machinery in the engineroom, except the lube oil pump and turning gear, can be secured, since

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this method depends entirely on detecting the sound of air escaping.

When testing for air leaks, all places where it is possible for an air leak to exist must be investigated. Condensers have many fittings and joints which should be examined as far back in the lines as vacuum exists under any operating conditions.

Leaks at flanged joints and in porous castings can usually be stopped with an application of shellac when the condenser is under vacuum. If shellac is used, this should be considered a temporary repair—and permanent repairs should be made as soon as time and the ship's operation permit.

Main exhaust trunk flanges are generally fitted with a flange grooving system, in installations where the condenser supports the turbine, to provide for pressure pumping with a suitable sealing compound. If the shell relief valve (or its connection to the condenser shell) is suspected of leaking, it can, in most installations, be tested in place. Most shell relief valves are fitted with a small gage glass to permit introduction of water above the disk as a test for tightness.

OTHER HEAT EXCHANGERS

Condensers are but one type of heat exchanger found in enginerooms. Lube oil coolers, air coolers, and deaerating feed tanks are other heat exchangers that Machinist's Mates are responsible for maintaining. In the following sections, information will be given on maintaining these units.

DEAERATING FEED TANKS

Machinist's Mates should be familiar with the operation and maintenance of deaerating feed tanks. Information on principles of operation of deaerating feed tanks may be found in Machinist's Mate 3 and 2, NavPers 10524-C, and in chapter 9560(56) of NavShips Technical Manual.

This chapter contains general information on operation and maintenance of these units. For details on any specific unit, check the manufacturer's technical manual.

Operating a Deaerating Feed Tank

During normal operation, the only control necessary is maintaining the proper water level. (On some of the newer ships, this is done with automatic control valves.) If the water level is too high, the tank cannot properly remove the air and noncondensable gases from the feed water. A low water level may endanger the main feed booster pumps, the main feed pumps, and the boilers.

Deaerating feed tanks remove gases from the feed water by using the principle that the solubility of gases in feed water approaches zero when the water temperature approaches the boiling point. During operation, steam and water are mixed by spraying the water so that it comes in contact with steam from the auxiliary exhaust line. The quantity of steam must always be proportional to the quantity of water, otherwise, faulty operation or a casualty will result.

Overfilling the deaerating tank may upset the steam-water balance and cool the water to such an extent that ineffective deaeration will take place. Overfilling the deaerating tank also wastes heat and fuel. The excess water, which will have to run down to the condenser, will be cooled—and when it reenters the deaerating tank, more steam will be required to reheat it. If an excessive amount of cold water enters the deaerating feed tank, the temperature drop in the tank will cause a corresponding drop in pressure. As the deaerating feed tank pressure drops, more auxiliary exhaust steam enters the tank. This reduces the auxiliary exhaust line pressure, which causes the augmenting valve (150 psi line to auxiliary exhaust line) to open and bleed live steam into the deaerating feed tank.

When an excessive amount of cold water suddenly enters the deaerating feed tank, a serious casualty may result. The large amount of cold water will cool (quench) the upper area of the deaerating feed tank and condense the steam so fast that the pressure is reduced throughout the deaerating feed tank. This permits the hot condensate in the lower portion of the deaerating feed tank and feed booster pump to boil or flash into vapor causing the booster pump to lose suction until the pressure is restored and the boiling of the condensate ceases. With a loss of feed booster pump pressure, the main feed pump suction is reduced or lost entirely, causing serious damage to the feed pump and loss of feed water supply to the boiler(s). Some of the newer ships have safety devices installed on the main feed pumps which will stop the main feed pump when a partial or total loss of main feed booster pressure occurs.

The mixture of condensate, drains, and make-up feed water, constituting the inlet water to the deaerating tank, enters through the tubes of the vent condenser. The condensate pump discharge pressure forces the water through the spray valves of the spray head and discharges

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it in a fine spray throughout the steam filled top or preheater section of the deaerating feed tank.

If a spray nozzle sticks open, or if a spray nozzle spring is broken, the flow from the nozzle will not be in the form of a spray and the result will be ineffective deaeration. This condition cannot be discovered except by analysis of the feed water leaving the deaerating feed tank, or by inspecting the spray nozzles.

Inspection of the spray nozzles should be scheduled at frequent intervals.

In most deaerating feed tanks, the manhole provides access for the inspection of spray nozzles; other tanks are so designed that the spray nozzle chamber and the vent condenser must be removed in order to inspect the nozzles.

Complete information on constructing and using a test rig for spray valves can be found in chapter 9560(56) of NavShips Technical Manual.

OIL COOLERS

Oil coolers should be operated as required to maintain the oil (inlet) temperature to the bearings at the designed value. With the bearing orifices or the needle valves properly adjusted and the bearings in proper operating condition, a temperature of 120° F to 130° F on the discharge side of the cooler should satisfactorily meet all normal operating conditions.

When the system has more than one cooler, the coolers should be used alternately, and for approximately the same number of hours.

Maintenance of Lube Oil Coolers

With reasonable care lube oil coolers installed on Navy ships will remain in service for several years. When salt water is used as the cooling medium, failure is usually caused by erosion due to high water velocity or by corrosion due to electrolytic action.

All coolers are built in accordance with NavShips specifications. These specifications are designed to give adequate cooling with sea water velocities well below that which will cause appreciable erosion.

Reports of failure of this type of equipment are rare in comparison with the number of coolers installed in naval ships. Most cooler failures have occurred to units that are supplied with cooling water from a service main, with the supply of sea water available to the cooler limited only by a valve or an orifice in the cooler supply line. Under these conditions, too wide an opening of the valve, too large an orifice, or too high a pressure in the service main will cause excessive velocity through the cooler and consequent failure due to erosion. At the same time the oil temperature is usually not appreciably lower than that obtained with proper sea-water flow.

All coolers in contact with sea water are subject to corrosion. Under operating conditions, coolers are protected from corrosion by zincs, provided an adequate surface of the zinc is exposed. All zincs installed in the sea water circuits of heat exchangers should be thoroughly scaled at least once a month to ensure that active metallic zinc is exposed to the sea water.

Of the two causes of cooler failure, the more likely one is erosion from high velocity sea water. To get satisfactory service from these units, the following precautions must be observed:

1. Limit the sea water flow to the minimum that is consistent with maintaining the oil temperature within limits specified by NavShips or as given in the manufacturer's technical manual.
2. Inspect and clean zincs regularly. Replace the zincs when they are 50-percent disintegrated.
3. When securing a cooler for any extended period, drain the salt-water side and flush with fresh water, when practicable. At all other times the cooler should be kept flooded and should be periodically flushed with salt water.
4. Clean only in a manner prescribed by NavShips.

All the above precautions also apply to other heat transfer equipment such as refrigeration condensers, motor and generator air coolers, air compressor inter and after coolers, and other coolers that use sea water as a cooling medium.

Cleaning Lube Oil Coolers

If a lubricating system should become contaminated with salt water, the system must be thoroughly cleaned before it is put back into service. The cooler must be disassembled and all traces of rust, scale, and other foreign matter removed, otherwise serious damage will result.

All foreign matter in shell and tube coolers must be removed, prior to reassembly, from the inside of the shell and baffles. Removal should be done with scrapers and/or wire brushes.

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With proper use of lubricating oil purifiers, filters, and strainers, it will usually be necessary to clean only the salt water sides of the shell and tube type coolers. This cleaning should be accomplished by air-lancing or water-lancing, and if necessary, with a round, bristle brush. Under no circumstances should a WIRE BRUSH be used for this purpose.

Removed tube bundles can be cleaned, when necessary, by flushing them with hot water. However, no attempt at chemical cleaning of shell and tube type coolers should be made without the specific approval of NavShips.

AIR EJECTORS

In most ships, the first and second stages of the air ejectors and their condensers have been combined into one complete assembly. In many ships, the gland exhaust condenser has been incorporated within the shell of the after condenser. The shell is rectangular, and is divided by a longitudinal plate into the inter condenser and the after condenser sections. A baffle at the gland vapor inlet deflects the air and vapor downward over the lower bank of tubes in the after condenser section.

In order to provide for continuous operation, two sets of nozzles and diffusers are furnished for each stage of the air ejectors. Only one set is necessary for operation of the plant; the other set is maintained ready for use in case of damage or unsatisfactory operation of the set in use. The two sets can be used simultaneously when excessive air leakage into the condenser necessitates additional pumping capacity.

An inter stage valve is provided between the discharge of each first-stage ejector and the inter condenser so that the pressure built up by the first-stage jet, in operation, will not be lost back to the condenser through the idle first stage. For a similar reason, a cutout valve is located between each second-stage suction chamber and the inter condenser. By means of diaphragm plates in the inlet and outlet heads, the cooling water (condensate) is forced to make several passes through the unit before being discharged.

The atmospheric vent is usually connected to the suction of a small motor-driven fan (gland exhauster), which provides a positive discharge through piping to the atmosphere above decks. This is necessary to avoid filling the engineroom with steam should the air ejector cooling water supply fail, thereby allowing the steam to pass through the inter condenser and after condenser without being condensed.

OPERATION OF AIR EJECTORS

With each air ejector assembly installed, the manufacturer furnishes technical manuals to provide information on operation and maintenance. General information on starting, shifting, and securing air ejectors is given in Machinist's Mate 3 and 2, NavPers 10524-C, and NavShips Technical Manual. Some additional items for air ejector operation are as follows:

1. Before starting a steam air ejector, the steam line should be drained of all moisture; moisture in the steam will cut the nozzles, and slugs of water will cause unstable operation.
2. Before cutting steam into the air ejectors, make sure that sufficient cooling water is flowing through the condenser and that the condenser has been properly vented.
3. The loop seal line must be kept airtight, an air leak may cause all water to drain out of the seal.
4. If it is necessary to operate both sets of air ejectors to maintain proper condenser vacuum, air leakage is indicated. It is more desirable to eliminate the air leakage than to operate two sets of air ejectors.

Unstable operation of an air ejector may be caused by any of the following: the steam pressure may be lower than the designed amount, the steam temperature and quality may be different than design condition, there may be scale on the nozzle surface, the position of the steam nozzle may not be right in relation to the diffuser, or the condenser drains may be stopped up.

Difficulties due to low pressure are generally caused by improper functioning or improper adjustment of the steam reducing valve supplying motive steam to the air ejector assembly. It is essential that DRY steam at FULL operating pressure be supplied to the air ejector nozzles.

Erosion or fouling of air ejector nozzles is evidence that wet steam is being admitted to the unit. Faulty nozzles make it impossible to operate the ejector under high vacuum. In some instances, the nozzles may be clogged with grease, boiler compound, or some other deposit which will decrease the jet efficiency.

MAINTENANCE OF AIR EJECTORS

In general, it is possible to clean air ejector nozzles by using reamers. The proper size

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Block I - Basic Electronics

Unit 7 - Tubes and Transistors

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Cathode leakage	Characteristics of electron flow Valve action in electronic tubes Heating the cathode
Measuring cathode emission	Anode requirements Cathode emitters
Making tests for transconductance	Photo cells Controlling plate current The space charge Controlling the space charge with a grid Multi-grid tubes
Making gas tests	Gas-filled tubes
Testing open elements	Types of thermionic tubes Construction of thermionic tubes Prong numbering systems Tube numbers
Testing for interelement shorts or leakage Tube testing	Tube symbols The diode as a detector or rectifier The triode as a detector The regenerative triode detector circuit The triode as an audio frequency amplifier The triode as a R.F. amplifier Advantages of the tetrode Superiority of the pentode Advantages of the beam power tube Operation of tube checkers
Cathode ray tube testing	Electron ray tubes Cathode ray tubes Operation of the C.R.T. tester

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reamer should be used for each size of nozzle, to avoid damage to the nozzle. If it is necessary to remove the nozzle for cleaning or replacement, the internal surfaces must not be damaged. Dents or deformations of the downstream end of the nozzle, and rough or scratchy surfaces in the throat or diffuser passages, will result in improper operation of the unit. Foreign deposits present on the internal surface of the nozzle or diffuser should be removed by the use of nozzle reamers, soft copper wire, or a piece of wood.

Before disassembly or reassembly of nozzles or diffusers is undertaken, the manufacturer's technical manual should be consulted. If replacement of a nozzle or diffuser is required, gaskets of proper thickness must be used for reassembly. It is essential that the nozzle and the diffuser tube be concentric and in proper alignment and that the correct distance be maintained between the ends of the nozzle and the diffuser.

It is possible to clean or replace steam strainers, nozzles, or diffusers, of an air ejector assembly while the rest of the unit is in operation. It is necessary to isolate the unit which is to be opened from the rest of the assembly, by closing the steam supply valve and the inter stage valves of this unit, to avoid burns being suffered by personnel engaged in this work.

In installations where separate inter and after condensers are provided for each element, isolating valves are not required. In some installations where a common after condenser is provided for two second-stage elements, the internal construction of the unit is such that the steam discharged from the operating element cannot back up through the diffuser of the second-stage element, and isolating valves are omitted from the second-stage diffuser discharge.

Division Plate Leakage

Should internal leakage occur across the division plate between the inter condenser and the after condenser, the second-stage element becomes overloaded since the air-steam mixture discharged by the second-stage element leaks back to the inter condenser instead of being discharged to the atmosphere. A leak of this type rarely happens in modern air ejectors, but if it is suspected, the inter condenser and the after condenser should be hydrostatically tested and the condenser drains should be inspected to determine whether leakage is indicated. Repairs involve removal of tubes, disassembly of the unit, and replacement of internal gaskets.

Flooded Condenser

Improper drainage or leaking condenser tubes will cause flooding of the inter and after condensers, which will result in a loss of vacuum. If flooding should occur, the effective condensing surface is decreased, and a loss of vacuum occurs. Flooding may also cause condensate to be drawn into the second-stage element, which will result in erratic operation of the unit.

If flooding is suspected, drain lines should be cleared out and a hydrostatic test should be placed on the unit to check for leaks at tube joints and tube walls. Tubes rarely need replacing as most installations use condensate as a cooling medium.

If tube leakage does occur, the packed ends can be repacked by use of copper-asbestos packing rings supplied by the manufacturer. The removal of old packing rings and installation of new ones can be accomplished in the same manner as described in this chapter for packing of main condenser tubes except that copper-asbestos rings should be set up with several very light hammer blows on the calking tool. Copper does not flow into the threads of the packing box as readily as does the lead packing used in main condensers.

Emergency repair of a tube is accomplished by plugging both ends. Should retubing or other major repairs be necessary, all parts of the assembly should be hydrostatically tested to the test pressure specified by the manufacturer. It should be determined that all internal parts of the assembly are in proper working order before the new tubes are installed. A positive test should be made to establish the tightness of the gaskets between the inter and after condensers both before and after installing new tubes.

Maintaining the Loop Seal

Should an air leak be present in the U-shaped loop seal line (fig. 6-6) provided for draining the inter condenser, it will become impossible to maintain a seal between the inter condenser and the main condenser. Water from the inter condenser passes down through the small 1-inch pipe, then through the short loop, and up through the internal pipe. The larger pipe surrounding the internal pipe is 3 inches in diameter and is connected to the main condenser. Water overflowing the internal pipe fills the external pipe and the larger loop.

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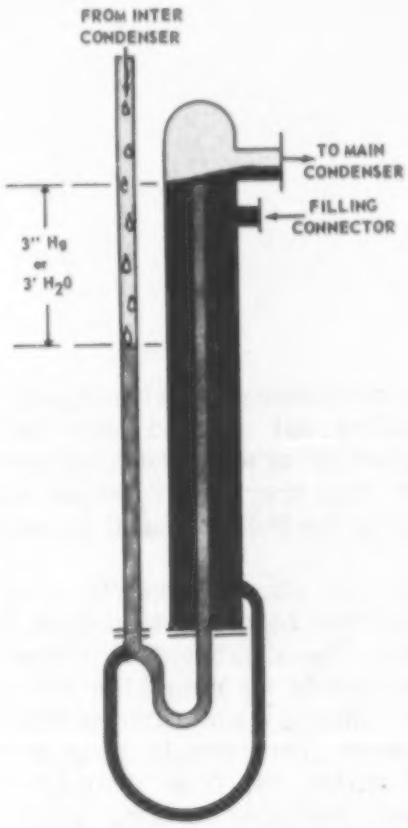

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Figure 6-6.—Loop seal.

If no vacuum existed in either condenser, and water from the inter condenser entered the internal pipe, it would maintain the same height in each leg.

When a vacuum is formed in both condensers, the difference between the vacuum maintained in the main condenser and that maintained in the inter condenser will be about 3 inches. The vacuum in the main condenser will be about 29 inches, that in the inter condenser about 26 inches. Expressing vacuum in terms of absolute pressure, a pressure of 1/2 psi will be acting down on the internal and external pipes, and a pressure of 2 psi will work down against the water level in the primary 1-inch pipe. This means that the pressure of 2 psi from the primary pipe will push water through the pipe and cause it to overflow from the external pipe into the main condenser.

When the water level in the primary leg is approximately 3 feet below that of the secondary leg, the additional weight of the water present in the secondary leg will provide the extra 1 1/2 psi necessary to counteract the 2 psi absolute pressure against the primary leg. Thus, a static condition will be obtained. If water is added, from the inter condenser, to the primary leg, the level on that side will rise, and the additional weight of the water will cause water to be pushed into the main condenser, from the secondary leg, thereby restoring the loop to its original static condition.

Adding water to one side of the loop and removing it from the other side is the means by which water is drained from the inter condenser to the main condenser. A solid body of water is maintained in the base of the loop and prevents air from passing through which would cause an equalization of vacuum.

The purpose of the filling connection is to allow condensate to be pumped from the condensate pump discharge line to the loop seal so that the loop may be filled before placing it in operation. A cutout valve is installed in the line from the loop seal to the main condenser.

If the vacuum gages on both the main and inter condensers show the same reading, this indicates that the seal has been broken. Opening the filling valve will correct this condition, if it is due to a sudden surge in vacuum, or a violent roll of the ship. If the condition is the result of an air leak, the leak will have to be corrected before the loop will remain properly sealed.

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CHAPTER 7

PUMPS

This chapter contains information on the inspection and repair of reciprocating and centrifugal pumps and on the operation and repair of pressure regulating and speed limiting governors. As an MM1 or MMC you will be responsible for operation and maintenance of pumps and governor in the engineroom and other assigned spaces.

RECIPROCATING PUMPS

Reciprocating pumps were formerly the most widely used type of pump installed on Navy ships. At present, centrifugal and rotary pumps are far more common. Reciprocating pumps are used for two purposes aboard ship; as fire and bilge pumps, and as emergency feed pumps.

MAINTENANCE OF RECIPROCATING PUMPS

When repairs are undertaken, a repair guide list should be used to make sure that every part of the pump which required attention or contributed to poor performance is put into proper condition. When a partial overhaul is undertaken, check "NOT DONE" for items that are not repaired. This will show that every part was inspected and either worked on or not worked on. Upon completion of a pump overhaul, the repair guide list can be kept as a permanent record of all measurements taken and all work done.

When a pump is disassembled for repair or inspection, all applicable blueprints and the manufacturer's technical manuals should be on hand. Micrometer measurements should be taken of the steam and water cylinders and the steam valve chest; these measurements are made on the fore and aft and athwartship diameters at the top, middle, and bottom. The results should be recorded with a sketch showing measurements taken.

Improper alignment is one of the most frequent sources of trouble with pumps. Pumps with mountings secured to a bulkhead are more subject to misalignment than those with independent bases. A pump may have been properly aligned in the shop and then pulled out of line when bolted to the bulkhead mounting; or after the pump mounting was secured, the ship may have changed shape sufficiently to warp the bulkhead and cause misalignment.

Operation of an improperly aligned pump usually scores the rods and cylinders, and breaks the followers. The alignment of pumps should be tested occasionally by removing the piston and plunger and running a line through the steam and water cylinders. This should be performed as a routine test within the first year after a ship is commissioned; and also for a pump that is scoring rods or cylinders, or breaking followers.

Before a line is run through the cylinder or any adjustments are made, the foundation must be lined up and the centerline must be determined. The centerline must divide each cylinder equally (see fig. 7-1). Fasten one end of the line to a temporary beam at the end of one of the cylinders. In figure 7-1 the beam is rigged above the steam cylinder. Run the line down the center of both cylinders, and center it at the top and bottom of the steam cylinder, so that it becomes the axis of that cylinder. Then align the water cylinder with the steam cylinder. If realignment is necessary, the water cylinder may be moved and centered on the line without affecting the centering of the line on the steam cylinder.

To make a rough check of alignment of a pump, pull the steam and liquid end rod packing and check the clearances between the piston rods and the cylinder throat bushings. Make this check with the pistons in each of three positions—top, center, and bottom of the stroke. If clearance is not uniform, but the throat bushings are not worn out of round, realign the pump as soon as possible.

In some cases, when steam cylinder foundation pad bolts are slacked off, the cylinder pads pull away from the foundation as much as 1/2 inch, indicating settling of foundations and bulkheads. Correct this by fitting shims between the foundation and the pump.

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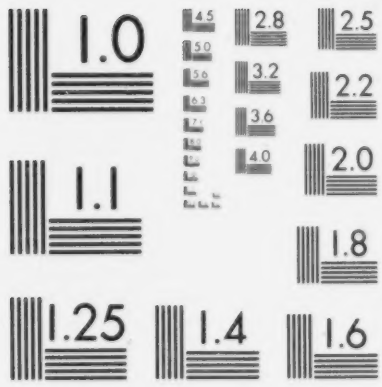

MICROCOPY RESOLUTION TEST CHART

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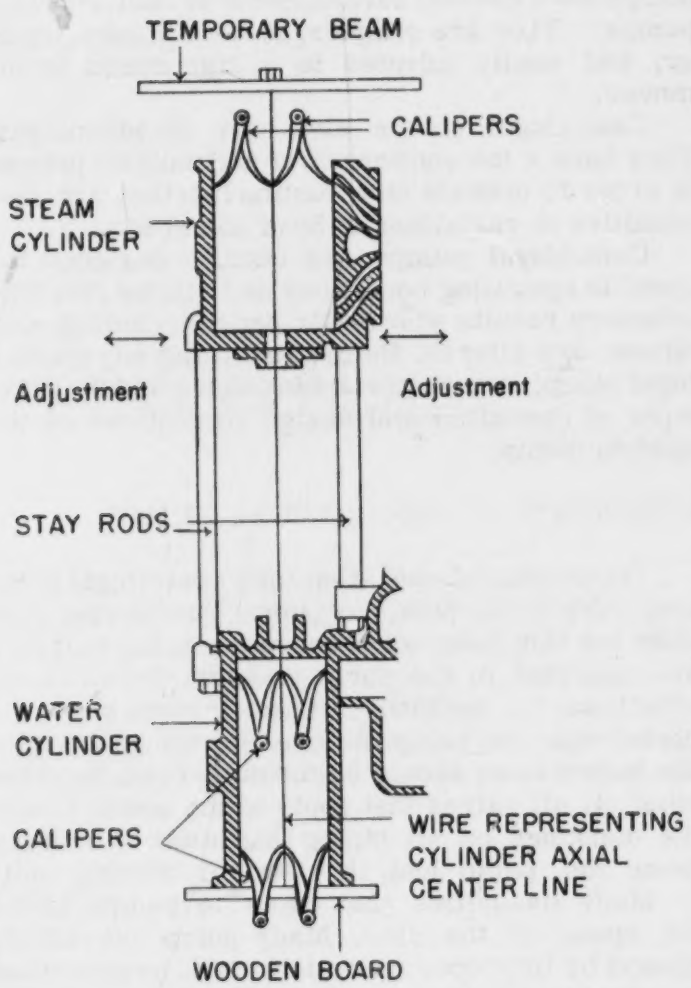

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Figure 7-1.—Centering a line through two cylinders.

A frequent cause of misalignment is the piping. The piping should line up naturally with the pump connections and should not be forced into position. Provision must be made in steam and exhaust lines to allow for expansion. All piping should be supported independently of the pump. Improperly installed piping puts a strain on the pump and forces it out of alignment. Special care should be taken to avoid vapor pockets when installing suction piping.

OPERATION OF RECIPROCATING PUMPS

Operating difficulties with reciprocating pumps will be encountered from time to time. Some of the most common causes of trouble and their remedies, are mentioned in the following sections.

Failure To Start

There may be times, after you have lined up the pump and cracked open the throttle valve, that the pump will not start. You may repeat the starting procedure, and determine that everything seems to be all right, but still the pump will not start. At this point, proceed as follows: Secure the pump. Check the suction, discharge, and auxiliary exhaust lines for a closed valve, or for a valve disk that has come off its stem. If no valves are closed, the water piston or the steam piston may be frozen, especially if the pump has been idle for some time. This may be determined by jacking the pump with a bar.

CAUTION: Never attempt to jack a reciprocating pump unless you are certain that the throttle valve and the exhaust valve are closed tightly and the steam cylinder and steam chest drains are wide open.

If there is no excessive friction, disconnect the auxiliary valve stem from the operating gear without disturbing the adjustment of the tappet collars. Open the exhaust, suction, and discharge valves and then crack the throttle. Work the auxiliary piston valve by hand (the auxiliary valve should work freely). Should the pump still not start, secure steam and water end valves. Remove the steam valve chest to determine whether the main piston valve has overridden or stuck.

If the pump still cannot be started, a complete overhaul of the working parts of the steam end will be necessary.

Failure To Take Suction

When a reciprocating pump fails to take suction, the operation will be jerky. To correct this, proceed as follows: See that all stop and check valves in the suction line are open. Ensure that the suction line is free of all obstructions. If a reciprocating feed pump should become vapor bound, shift suction to a standby feed tank and open the vent valves in the valve chest cover and the discharge line to help cool the pump. Shift to the standby feed pump, if available, until the vapor-bound pump cools off.

Pumps having a suction lift, such as bilge pumps, may require priming before they will take suction. Salt water pumps can usually be primed from the sea by opening the sea suction for a short interval.

If failure to take suction is due to defective valves in the water end, the defects will have to

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be corrected before the pump will operate satisfactorily.

Loss Of Discharge Pressure

There are several reasons for a reciprocating pump to lose discharge pressure, some of the major reasons are:

1. Low steam pressure. Loss of steam pressure will cause the pump to slow down and will result in a loss of pump capacity and discharge pressure.
2. High back pressure. If the auxiliary exhaust pressure is allowed to become abnormally high, it will cause the pump to slow down and the discharge pressure will drop.
3. Worn piston rings. Leakage of steam by worn piston rings will cause the pump to operate erratically or even to stop. When worn rings are suspected, the steam end should be disassembled and the ring and piston measurements should be taken. If measurements are below the designed allowances, the rings will have to be renewed.
4. Defective valves. If a pump is operating normally and suddenly loses discharge pressure, a defective valve should be one of the first things to suspect. A large loss in efficiency will result from defective valves. If a pump races without increasing the discharge pressure, defective valves or air leaking into the suction line will probably be the cause.
5. Worn plunger packing. Another reason for a pump losing discharge pressure is worn packing on the water end plunger. The packing will wear, over a period of time, and the maximum discharge pressure from the pump will decrease accordingly; the only remedy is to renew the packing. Worn plunger packing should be renewed in accordance with the procedure given in chapter 6 of Machinist's Mate 3 & 2, NavPers 10524-C, or in the instructions in the manufacturer's technical manual.

When you are trying to locate and correct troubles in a reciprocating pump, previous experience with a particular pump is always helpful. The first step should be to check all accessible parts. If the trouble cannot be located without disassembling the pump, the water end should be checked and determined to be satisfactory, before you remove any parts from the steam end.

CENTRIFUGAL PUMPS

Centrifugal pumps have, to a large extent, replaced direct-acting steam pumps for nonviscous liquid service aboard naval ships. Centrifugal pumps have several advantages over reciprocating pumps: They are simpler, more compact, lighter, and easily adapted to a high speed prime mover.

Centrifugal pumps also have disadvantages: They have a low suction power and must be primed in order to operate on a suction lift; they are also sensitive to variations in head and speed.

Centrifugal pumps are usually designed for specific operating conditions and will not give satisfactory results when their rated operating conditions are altered. Before installing any centrifugal pump, it is important to understand the principle of operation and design limitations of the specific pump.

OPERATION OF CENTRIFUGAL PUMPS

The details of operation for a centrifugal pump may vary from pump to pump. Pumps may look alike but this does not necessarily mean that they are operated in the same manner. Detailed instructions for operating a specific pump should be posted near the pump. Before operating the pump, the instructions should be carefully read. Read the label on all valves that apply to the pump. Check the markings on all piping that leads to or away from the pump and the pump's driving unit.

Many casualties that occur to pumps affect the speed of the ship. Many pump casualties, caused by improper operation, could be prevented by attentive watchstanding. Strict adherence to the manufacturer's instructions for starting, operating, and securing pumps will help prevent casualties.

Starting A Centrifugal Pump

The instructions contained in this chapter for the operation of pumps are general. All pumps cannot be covered because of the large number of makes and types of pumps installed aboard naval ships. Manufacturer's technical manuals are furnished with all but the simplest of pumps. These manuals contain detailed instructions concerning the specific pump and should be studied carefully before you attempt to operate the pump.

Prior to starting a centrifugal pump for the first time or after an overhaul, there are several items that should be checked. The coupling alignment must be carefully checked. Flexible couplings will take care of only very slight misalignment, usually about 0.002 to 0.004 inch. The exact figure can be found in the manufacturer's instructions. Excessive misalignment will cause the

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coupling to fail and may result in failure of the pump shaft or bearings.

If the pump is motor driven, the rotation of the unit should be checked. Most pumps have an arrow, on the pump casing, which indicates the proper direction of rotation.

Check all piping that pertains to the pump. During overhaul, most valves in the piping will have been closed. The lube oil system, the suction, discharge, vent, recirculating, and bypass valves must be lined up properly. An adequate supply of water must be available for the lube oil cooler; and inlet, outlet, and root valves should be checked.

When starting a steam-driven centrifugal pump, some of the important items to check or perform are as follows:

1. Check the level of oil in the sump tank or bearing housing. Fill oil cups or reservoirs, if fitted. If the pump is lubricated by a detached pump, open and adjust all valves in the discharge and suction lines.
2. Rotate the handle of the lube oil filter. Lubricate the linkage on the speed limiting governor.
3. Open the suction valve, the vent, and recirculating valves; open valves in gland water seal lines (if fitted). (The discharge valve should be closed when starting centrifugal pumps.)
4. Open steam and exhaust root valves.
5. Check the suction pressure (if applicable).
6. Open all steam drains.
7. Open the turbine exhaust valve.
8. Open the bypass around the governor (if fitted).
9. Crack the turbine throttle valve.
10. Increase the steam chest pressure until the pump is turning fast enough to ensure adequate lube oil pressure.
11. Check packing glands for proper leak-off.
12. When the pump vent blows a solid stream of water, close the vent.
13. Close pump governor bypass and test the constant pressure governor.
14. When lube oil temperature reaches 90° F, open valve for cooling water to the lube oil cooler.
15. When ordered to put the pump (not fitted with a pressure governor) on the line, increase the pump discharge to the required amount by opening the throttle valve to necessary speed. If the pump is fitted with a constant pressure governor, set the governor to give the required discharge pressure.
16. When the pump is delivering the required discharge pressure, open the pump discharge valve.

Note: These items are not necessarily listed in any proper order and all items do not apply to all steam-driven pumps.

Operating A Centrifugal Pump

When a pump has been started, it should not be left unattended. An experienced man should be on hand to check for abnormal operation. Frequent checks should be made on the temperature of the lube oil leaving the cooler and leaving each bearing. The suction and discharge pressures may become too high or too low. Packing glands may overheat and burn out.

The principal troubles that may occur with centrifugal pumps are:

1. Low discharge pressure. There are several reasons why a pump will not discharge at maximum capacity or pressure. The pump may be improperly primed, thus the proper quantity of liquid does not reach the pump casing. The speed of the pump may be too slow. On a turbine-driven pump, the speed limiting governor may be set too low, or the constant pressure governor may need adjusting. The pump may have mechanical defects such as worn wearing rings, worn bearings, a bent shaft, or a damaged impeller.
2. Loss of suction. If a pump has been operating satisfactorily and loses suction, air may be entering the suction line or packing glands. The suction strainer may have become clogged, or dirt or other foreign matter may have entered the impeller opening. In a main feed pump, the main feed booster pump may not be operating at its normal discharge pressure.
3. Excessive vibration. In a pump, excessive vibration may be due to one of the following causes: misalignment of the unit, a sprung foundation, worn impeller rings, worn bearings, a bent shaft, an improperly balanced impeller, or a broken impeller.

When putting a main feed pump on the line, make sure that the main feed booster pump is maintaining the required pressure. Boiler feed water is discharged under pressure from the main feed booster pump to the suction side of the main feed pump, which in turn discharges the feed water through the feed line to the boiler at a high pressure.

There are two sets of wearing rings in each stage, since the impellers are double entry. These wearing rings are designed with a minimum of clearance, as are the rings in a main feed booster pump, but the rotation of a main feed pump is five times as great as that of a main feed booster

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pump, so the possibility of seizure of the main feed pump wearing rings is much greater.

Water entering the suction of the main feed pump has its pressure reduced while passing through the entrance ports; since this water is at a temperature of about 240° F, this reduction in pressure might easily cause the water to flash into steam. If this occurs, the pump will become vapor bound, which prevents the flow of water through the pump and therefore prevents the removal of heat from the pump casing. A vapor-bound feed pump will require about 15 seconds to overheat, causing the wearing rings to seize.

The main feed booster pump discharge should be maintained at as near the designed value as possible. For an installation designed to operate at 50 psi of booster pressure, the main feed pump should not be turned over when there is less than 40 psi of booster pressure.

When main feed pumps are running, ensure that the oil temperature and pressure at the bearings are in accordance with the manufacturer's operating instructions. If a detached lube oil pump is provided, it will automatically cut in if the lube oil pressure falls below a predetermined amount. If low lube oil pressure develops after the detached lube oil pump starts, shift to the standby unit, secure the faulty unit, and determine and correct the cause of low lube oil pressure. On installations where no detached lube oil pump is provided and low lube oil pressure occurs, shift immediately to the standby unit and do not operate the faulty pump until the proper lube oil pressure has been restored.

There is a common tendency to tighten packing glands too tightly. This causes the packing to burn and leads to scoring of the shaft sleeves. The packing glands should be adjusted so that a small amount of water is leaking out of the stuffing boxes. This water lubricates and cools the packing and packing gland. The packing gland should always be parallel to the face of the stuffing box and not cocked at an angle. If a stuffing box leaks excessively, and it becomes necessary to tighten the gland, take up evenly on the gland bolts a slight turn. Wait a reasonable time, and if the leakage is still excessive, tighten the gland bolts another slight turn. This procedure should be continued until there is only a trickle of water from the stuffing box.

When a main feed pump is running do not change from hot to cold water or vice versa, unless there is an extreme emergency. Make periodic checks for vibration of the pump and driving unit. If vibration becomes excessive, stop the pump and investigate.

Securing a Centrifugal Pump

To secure a steam-driven centrifugal pump, proceed as follows:

1. Close the pump discharge valve.
2. Close the throttle valve.
3. Close the exhaust valve.
4. Close the suction valve.
5. Close the vent, recirculating, and gland sealing valves. (On some units, recirculating and vent valves are locked open.)
6. Open the turbine casing drain.
7. Close the steam and exhaust root valves.
8. Close the turbine casing drain after the turbine is completely drained.

MAINTENANCE OF CENTRIFUGAL PUMPS

This chapter contains some of the information you must have in order to given proper care and maintenance to centrifugal pumps. Before attempting to repair any pump, the manufacturer's technical manual and the maintenance records for the pump should be studied carefully.

Bearing Maintenance

Pump bearings must receive approximately the same tests, inspections, and maintenance as bearings installed in other units of naval machinery. Pump bearings must be supplied with an adequate amount of oil at the right temperature and of the viscosity designated for that particular pump. The manufacturer's technical manual contains information on lubrication of each pump.

THRUST BEARINGS should be examined quarterly. The condition of the bearing and the position of the rotor should be checked. When checking the rotor position, allowance should be made for expansion of the shaft from cold to hot condition. There are many types of thrust bearings installed in pumps; and the manufacturer's technical manual should be checked before attempting disassembly of any thrust bearing.

JOURNAL BEARINGS should be checked at least every 6 months. The condition of the journal and the bearing surface should be checked and any deficiencies corrected. Lead readings should be taken and bearing clearances should be maintained as shown in the manufacturer's plans. If the manufacturer's technical manual is not available, the instructions in chapter 9005(40) of NavShips Technical Manual should be followed.

WATER-LUBRICATED BEARINGS are installed in main condensate pumps and main circulating pumps. In main condensate pumps, the bearing is located in the casing, between the first-stage and second-stage suction compartments, where it also serves as an interstage seal. Vertical movement of the bearing is prevented by shoulders in the casing; and a stop pin prevents angular movement. During normal operation of the pump, the bearing is lubricated by a constant flow of water through the bearing which is maintained as a result of the pressure differential between the two suction compartments.

In main circulating pumps (fig. 7-2), the water-lubricated bearing is located immediately above the propeller and is designed for a radial load only. The bearing is held in place by shoulders in the casing and is lubricated by the flow of water through the pump.

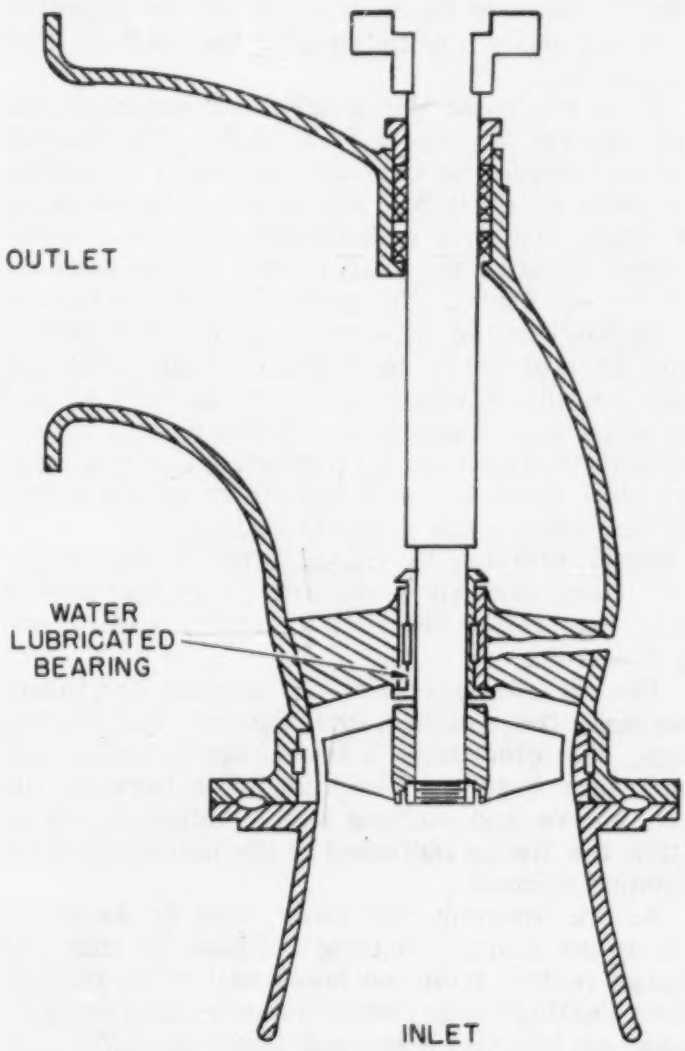

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Figure 7-2.—Main condenser circulating pump, showing internal water-lubricated bearing.

A number of materials have been used for water-lubricated bearings, such as leaded bronze, graphited bronze, lignum vitae, and Bearium; most water-lubricated bearings are now made of rubber or phenolic composition.

The condition of water-lubricated bearings should be checked frequently to guard against excessive wear which would cause shaft misalignment and possible bearing wear or shaft breakage.

BALL and ROLLER BEARINGS are used in many shipboard pumps, especially in small pumps, and in main condensate, main feed booster, and lube oil service pumps. These bearings must be handled as carefully as any other piece of precision equipment. The following precautions will aid in proper bearing maintenance:

1. Do not remove the bearing from its container until you are ready to install it.
2. Be certain that the journal, housing, or any other mating part is of the correct dimensions.
3. Avoid damage during handling; do not drop the bearing; keep dirt and moisture away from the bearing, shaft, and housing.
4. Use proper tools for removing the old bearing and installing the new bearing.
5. Use the correct lubricant and the proper amount. After assembly the journal should be rotated by hand to ensure that there is no undue friction.

In rolling contact bearings, the journal is supported by the races and rolling elements, rather than the oil film; however, lubrication still plays an important part in the operation because it dissipates heat and prevents corrosion. The oil film also helps prevent foreign matter from entering the bearing. Enough grease or oil should be supplied to provide a protective film over the bearing parts; using an excessive amount of lubricant will cause it to churn and the bearing will overheat.

When a roller or ball bearing fails in service, it must be renewed as it cannot be repaired. The replacement bearing must be carefully installed if it is to give satisfactory service.

Lubricating Systems

Lack of lubrication or improper lubrication is a major cause of pump failure. Before a pump is started, the level of oil in the sump should be checked—not only for the amount of oil, but also

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for the quality of oil it contains. If water is found in the oil sump, check for leakage from turbine glands, a leaky oil cooler, or any other possible source of water contamination. The oil filters or strainers must be checked frequently; in those with edge filtration (such as in the Cuno type filter), the sediment, which will collect in the bottom of the filter, must be cleaned out frequently. Housings of grease-lubricated bearings should be checked occasionally to ensure that they are free of water, dirt, and other foreign matter. If water is found in the bearing housing, it should be traced to its source. The frequency with which grease is added to a bearing must be determined by the type of service and the effectiveness of the grease seals.

When starting a pump, check the oil pressure and the flow of oil to all bearings. Make sure that the lube oil pump is discharging at the designed pressure. Ensure that cooling water is flowing through the oil cooler and that all air is vented from the cooler. It may be necessary to vent the lube oil system. To do this, open the vent on the highest point in the lube oil system and close the vent when oil appears.

When water or other foreign matter is found in a lube oil system, the unit should not be operated until the system has been drained, cleaned, and filled with the proper quantity and quality of oil.

Replacing Pump Rotors

Pumps, like all machinery, in time, will need overhauling. Much of the work on pumps involves removing the rotor from the casing. To renew wearing rings, bearings, packing, sleeves, or impellers, the casing must be removed and the rotor lifted out.

In order to disassemble a MAIN FEED PUMP the following procedure is recommended:

1. Close and wire shut all suction, discharge, vent, and recirculating valves. Drain water from the casing.
2. Remove all suction, discharge, vent, and recirculating lines that will interfere with lifting the casing and rotor.
3. Remove the bearing caps and the bearings (journal and thrust).
4. Disconnect the coupling between the turbine and pump.
5. Remove the packing glands and the packing.
6. Remove the pump casing horizontal joint bolts.
7. Break the horizontal casing joint by tightening the jack screws.
8. Attach the lifting gear to the upper half of the casing (eyebolts are provided for this purpose).
9. Lift the upper half of the casing until it is clear of the rotor. Change the lifting gear and swing the upper casing half clear of the pump.
10. Attach cables around the shaft at both ends, making certain that you do not lift on a journal surface, and lift the rotor out of the lower half of the casing.
11. The rotor can then be moved to a location where it can be disassembled. In order for you to have access to all rotor parts, the rotor should be placed on a workbench, or if available, two wooden sawhorses.

Remove all rotor parts in the sequence and in the manner recommended by the manufacturer.

It may be necessary to heat the impellers in order to remove them. If so, warm the impeller evenly all around, while keeping the shaft as cool as possible.

When the rotor parts are disassembled, the shaft should be checked carefully. The journal surfaces should be checked for burrs or nicks. If a lathe is available, the shaft can be swung in the lathe, and with a dial indicator, you can determine whether the shaft is bent or the journals are out of round. The journal surfaces can be measured with an outside micrometer to determine whether there is wear. If the journals are worn or out of round, they can be built up and machined to the designed diameter, at a repair activity. If the wearing rings are to be renewed, they will have to be fitted either in the ship's machine shop, or at a repair activity.

Before starting to REASSEMBLE the rotor make sure that all parts are clean and free of burrs (especially the faces of the impeller and the sleeves).

The oil clearances of the journal and thrust bearings, the running clearance of the wearing rings, the clearance between the impeller and diaphragm bushing, and clearance between the shaft sleeve and stuffing box bushing should be within the limits indicated in the manufacturer's technical manual.

Before lowering the rotor, roll in the lower half of the journal bearings. Clean all dirt and foreign matter from the lower half of the casing. A new parting flange gasket should be used to avoid leaks, as internal leaks will lower the efficiency and maximum capacity of the pump.

Attach the lifting gear and lower the rotor into the casing. Make sure that all stationary rotor

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Block I - Basic Electronics

Unit 7 - Tubes and Transistors (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Testing transistors	Functional description of transistors The transistor-tube relationship Operation of transistor testors
Constructing an A.C. diode rectifier tube circuit	Diodes, rectifiers, voltage regulators, selenium rectifiers
Constructing an inductive power supply	Triodes, voltage amplifiers, power amplifiers
Measuring electron emission	Vacuum tube characteristic curves
Measuring the characteristic curve of a triode tube	Types of pentodes Pentode circuits
Checking for the reversal of phase in a triode circuit	Power supplies
Constructing a single-ended audio-power amplifier circuit	Tube testers
Checking for types of phase required to drive amplifier circuits	Resistance-coupled amplifiers and detectors
	Transformer coupling
	Audio amplifiers
	Phase inverters
	Class A and B amplification

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parts: diaphragms, casing rings, and stuffing box bushings will enter their respective fits in the casing without binding. If force has to be applied to the rotor parts, in order for them to enter the casing, remove the rotor and check all parts for dirt and burrs.

When the rotor is in place, lower the upper half of the casing. Ensure that the casing fits over the rotor easily. If it does not, remove the upper casing half and examine it for dirt and burrs. When the upper and lower casing halves contact each other properly, insert the casing dowels. Next, tighten the parting flange nuts, tighten them evenly by going over them several times. Assemble the thrust bearing, then place the upper half of the bearings in position and bolt the two halves of each together. Adjust the flingers; they should be close to the face of the bearings but MUST not rub. Tighten the flinger setscrews and close up the bearings by placing the caps over them and tightening the bolts. Take a reading on the thrust bearing clearance.

The pump shaft and turbine shaft MUST be in correct alignment. For information on pump alignment, refer to the manufacturer's technical manual, NavShips Technical Manual, or chapter 6 of Machinist's Mate 3 & 2, NavPers 10524-C.

All water lines MUST be in place and tightened before you attempt to align the unit, otherwise tightening the lines may cause misalignment of the unit. Pack the stuffing boxes with the proper packing; then the unit is ready to be tested.

Rotate the pump several times, by hand, before steam is cut into the driving unit. Ensure that there is no undue binding or friction.

The procedure for replacing a MAIN CONDENSATE PUMP ROTOR or a MAIN FEED BOOSTER PUMP ROTOR is similar. These pumps are usually vertically mounted and the rotor can be disassembled without disturbing the driving unit. The procedure is as follows:

1. Obtain the applicable manufacturer's technical manual and blueprints. Study the construction details and procedures for assembly and disassembly. Note the manufacturer's data on wearing ring clearances, bearing clearances, and other necessary dimensions. Check the maintenance records; alterations may have been made.
2. Remove the new rotor from its storage place. Clean and inspect the new rotor, take all necessary measurements.
3. Assemble all necessary lifting gear and tools, including special tools.
4. Remove the nuts at the parting flange and remove the casing half. Take off the bearing cap, unbolt the bearing housing, disconnect the coupling, and lift out the old rotor.
5. Inspect the interior of the casing, clean all flanges and make new gaskets. (New gaskets should be used on all flanges as any leakage through a main condensate pump flange will result in a loss of vacuum in the main condenser.)
6. After the cleaning and inspecting are done, lower the new rotor into place.
7. Place the casing in position and tighten the parting flange nuts. If the casing binds or does not fit properly, remove the casing and correct the trouble.
8. When the casing has been secured in place, the rotor should be rotated by hand to ensure that there is no binding or undue friction.
9. Reassemble the bearing housing and connect the coupling. If the pump still turns freely, the unit is ready to be tested by steam (or motor). If all conditions are satisfactory, bring the pump up to operating speed and pressure. When the pump is used for the first time, it should be kept under close observation for several hours and should not be considered ready for unlimited operation until it has carried the required load with the ship under way.

Prepare a work request for the necessary repairs to the defective rotor. All necessary details, including balancing, should be written up and the rotor taken to the appropriate repair activity. All pump and driving unit rotating parts are balanced dynamically for all speeds from at rest to 125 percent of rated speed. The parts are usually dynamically balanced on balancing machines, generally available on tenders and repair ships and at all naval shipyards.

On ships with adequate shop facilities, pump rotors may be overhauled on board. The rotor should be taken to the machine shop and dismantled. The parts should be taken off the shaft in the sequence recommended by the manufacturer. When the parts have been removed from the shaft, the shaft should be checked in the same manner as preveiously described in this chapter for shafts of main feed pump rotors.

If the shaft is not bent or out of round, the parts can be reinstalled on the shaft, using new parts as needed. Ball bearings can be shrunk or pressed on the shaft. The best practice is to heat the bearing, in an oil bath, to about 200° F (but not exceeding this temperature), then slip it over the journal and position it by means of the locknut. The locknut can be tightened as the bearing cools.

Wearing rings should be given the clearance recommended by the manufacturer. When the rotor

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is reassembled, it should be properly stowed, so as to be ready for use when needed.

REPLACING ROTARY PUMP ROTORS

Generally, it is more difficult to replace main lube oil service pump rotors than rotors in other types of pumps. The driving unit must be removed before the liquid end can be disassembled. With the drive unit removed, the pump rotor and rotor housing can be disassembled without removing the mountings or the main lube oil connections.

Under normal operating conditions, the rotors are completely covered with oil, which cuts rotor wear to a minimum. Therefore, the rotors may give years of satisfactory service without repairs. In some instances, rotor failure has been due to normal wear, air trapped in the casing, or entrance of dirt, wood, or metal objects into the casing. To replace a defective rotor, proceed as follows:

On a turbine-driven unit, remove the drive unit by breaking the steam and exhaust lines, disconnecting the coupling, removing the bolts which secure the spacing frame to the pump casing, attaching the lifting gear, and lifting the drive unit off intact.

To disassemble the liquid end (fig. 7-3), first remove the lower coupling half, the packing gland, and the upper casing head. The rotors will then be exposed and can be withdrawn. As the rotors are lifted out of their housings, the idlers must be supported; the pump is constructed in such a manner that only the housings hold the rotors in mesh. With the rotors removed, the housings are accessible. The housings fit snugly in the bore of the casing and are separated by a spacer ring. They are positioned axially by jam screws, which bear on the casing heads; and circumferentially by guide pins, which are fitted individually to ensure alignment of the housing bores. The guide pins are secured by pipe plugs. Before the rotor housings can be removed, it is necessary to take out the housing guide pins, the outer ends of which are drilled and tapped for the application of a pulling tool. Because these guide pins are fitted parts, each pin must be marked as it is withdrawn, so that it can be replaced properly.

Before the reassembling operations are started, all parts of the pump should be carefully inspected and cleaned. Also, it should be definitely ascertained that the settings of the lower housing jam screws are correct (check the manufacturer's technical manual or blueprint).

When reassembling the pump, lower the bottom housing, the spacer, and the upper housing into

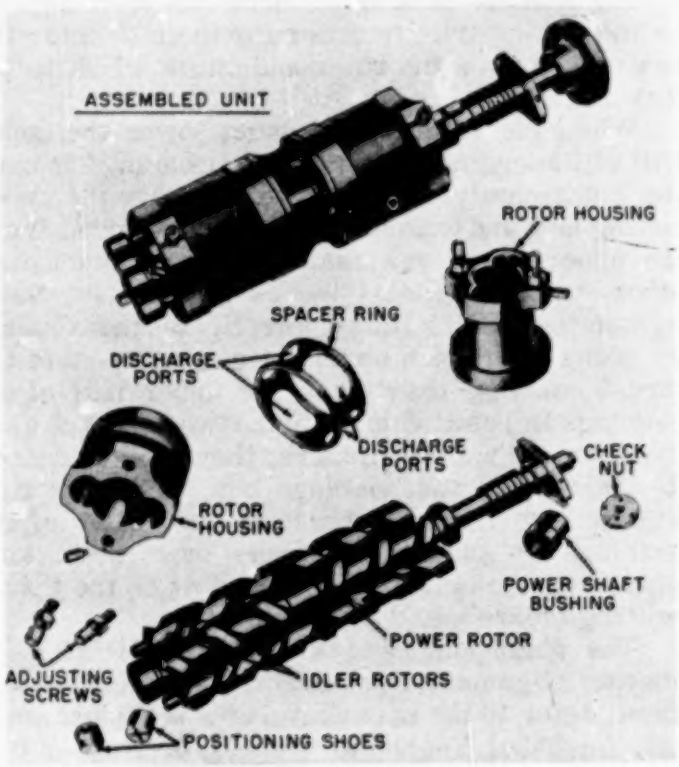

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Figure 7-3.—Rotor assembly for a lube oil service pump.

place separately. Ensure that each part seats firmly and that the guide pin slot in each housing registers with the pin hole in the casing. The special tool used for pulling the housings can also be used in assembling them. Next, install the housing guide pins and their securing plugs. If new housings are installed, the bores must be carefully aligned and new guide pins fitted to maintain alignment. The jam screws may then be set up in the upper housing.

Insert the rotors and turn them by hand to see that they are free and do not bind. Binding of the rotors is an almost certain indication that the housings bores are not in line, or that the guide pins or the housings, or both, have not been properly installed. Install the upper casing head, making sure that the thrust plate and the seal bushing are in place and that the latter is secured by the stop pin provided for that purpose.

When a pump is assembled at the factory, the locating caps on the idlers are set up to establish the proper running positions of the idlers with reference to the power rotor, and are then secured by riveting. So long as a set of rotors remains

intact, readjustment of the locating cap settings will rarely be found necessary. Even over long periods of service, wear of the hardened contact surfaces will be negligible.

Whenever new rotors are installed, the proper locating cap settings must be established. The proper cap settings are such that the lower end surfaces of all three rotors will lie in a common plane when the rotors are properly meshed and the idlers are located centrally with respect to end play in the power rotor.

The cap settings must be established before the rotors are installed, but the rotors should be inserted in one of the housings for the adjustments, to ensure proper meshing. A tapped hole is provided in the base of each cap, so that the pulling tool, or some other suitably threaded implement, can be used to jack the cap into position. After the settings have been established, the caps should be riveted into place; this entails drilling the shaft ends for the rivets. Rivet holes are provided in the caps of all idlers supplied by the factory.

SHAFT-DRIVEN LUBE OIL PUMPS are of the same size and design as the steam-driven pumps, but differ in their mountings and drive details.

Some pumps are hooked up to the main shaft through a sprocket and chain drive so that they operate continuously while the shaft is turning over. These pumps are designed with vertical shaft and horizontal shaft units.

On ships built since World War II, the attached lube oil pump is driven from the main reduction gear by an assembly of bevel and spur gears. The driving connection is made by a pinion, mounted on a hub, that is attached to the lower, low pressure, low speed pinion quill shaft coupling.

Before a chain-driven pump can be disassembled, the drive must be completely dismantled as follows:

1. Disconnect the oil lines leading to and from the chain housing.
2. Remove the chain cover.
3. Break and remove the chain. The manufacturer supplies a special tool and detailed instructions for breaking the chain.
4. Remove the lower section of the chain casing from its supporting frame.
5. For a vertical unit, remove the frame which supports the chain casing and houses the drive gears. The drive shaft mounting need not be disturbed for this operation.

With the driving mechanism out of the way, the horizontal pump can be dismantled in place, provided there is sufficient clearance for the withdrawal of the rotors. The vertical unit must be detached from its base and transferred to a location where both ends of the casing are accessible so that the rotors can be withdrawn.

If space permits, the rotors can be withdrawn from either end of the casing, but it is easier to withdraw them from the outer end (the end away from the drive unit), because this method does not require the removal of the inner casing head. (Removal of the outer casing head is a necessary step in the disassembling operation.)

Removal of the rotors from the outer end of the casing entails removing the sprocket, removing the outer casing head, freeing the rotors, and withdrawing them.

PUMP CONTROL DEVICES

Turbine-driven pumps are fitted with devices to control or limit the speed of the unit, or to regulate the discharge pressure of the unit.

SPEED LIMITING GOVERNORS

Speed limiting governors are set to give a rated speed at rated load conditions. With the governor properly set, the turbine speed should not exceed the rated speed by more than 5 percent, for any condition of load. If the governor will not function within the prescribed limit, it must be overhauled, and the cause of faulty operation located and corrected. Speed limiting governors should be tested at least every 3 months and more often if ordered by NavShips, the type commander, or any other proper authority.

Chapter 6 of Machinist's Mate 3 & 2, NavPers 10524-C, contains information on the principles of operation of a centrifugal weight type of speed limiting governor; briefly review this chapter if necessary. To set a governor of this type, remove the governor lever, and the governor cover. The governor spring will then be accessible. If it is desired to increase the maximum speed of the unit, the tension of the governor spring must be increased by tightening the adjusting nut. With increased spring tension, more centrifugal force will be required to move the weights outward—which in turn moves the sleeve outward against one end of the governor lever (moving the other end of the governor lever inward), closing down on the poppet valve, and decreasing the amount of steam flow to the turbine.

Decreasing the tension on the governor spring will allow the governor weights to move outward

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with less centrifugal force, thus decreasing the maximum speed of the unit.

Very little wear is experienced in a speed limiting governor; however, preventive maintenance is required. The governor must be kept clean. Dirt or other foreign matter can foul the spring, and thus require more force to move the weights, which will allow the pump to overspeed. Rust on the governor lever fulcrum pin will cause the lever to bind and not function properly. All pins in the linkage and the valve stem must be kept free of paint, rust, and dirt so that the linkage can move freely. Occasionally, a test should be made to determine whether the poppet valve is leaking. The test may be made by pushing the valve onto its seat by hand. If the valve is leaking the turbine will continue to rotate.

CONSTANT PRESSURE PUMP GOVERNORS

Turbine-driven main feed pumps and fire pumps are fitted with constant pressure governors which control the discharge pressure of the unit by automatically controlling the amount of steam admitted to the turbine. (The principles of operation of a constant pressure governor are explained in chapter 6 of Machinist's Mate 3 & 2, NavPers 10524-C.)

The instructions for operation, care, and repair of constant pressure governors contained in this chapter are general for all types of governors. For specific instructions, consult the applicable manufacturer's technical manual.

One of the most common causes of trouble with a constant pressure governor is sluggishness due to dirt or foreign matter interferring with free movement of the working parts. To correct sluggishness, the governor must be taken apart and cleaned as follows:

1. Unscrew the connector union, remove the bottom nuts from the bolts holding the superstructure to the top cap, and then lift off the superstructure above the lower diaphragm. (When the superstructure is reassembled, care must be taken that the diaphragm stem, diaphragm stem cap, and diaphragm disk are put back in proper position. Make sure that the connecting rods are free and do not bind in their guides.)
2. Unscrew the controlling valve with the special wrench provided for this purpose, remove the controlling valve and controlling valve spring.
3. Remove the top cap and lift out the piston end cylinder liner. Remove the bottom cap and take out the main valve and main valve spring.
4. Clean all parts thoroughly. See that the main valve and the controlling valve seat properly and that the piston rings are free in their grooves. Clean the seat for the cylinder liner so that the cylinder liner does not project above the top flange of the main body. Clean the bore of the main valve guide and stem. If necessary, grind in the main valve seat and disk. Make certain that the stem of the controlling valve does not project above the diaphragm seat. The correct clearance between the controlling valve stem and the diaphragm is 0.001 to 0.002 inch.

When renewing gaskets and diaphragms of governors, be sure to use only parts made by the manufacturer of the governor. The diaphragm must be of the correct thickness and installed WITHOUT gaskets. Do not use graphite or other such substances on gaskets.

The control valve is another frequent cause of trouble in a Leslie pump governor. Steam passing through the control valve is continuously throttled; and the valve is subjected to considerable erosion (wire drawing). The control valve and control valve seat should be inspected frequently. When reassembling the control valve or installing a new one, it is very important to maintain the correct clearance between the control valve stem and the lower diaphragm. If the clearance is excessive, the lower diaphragm cannot fully open the control valve, and the pump capacity is reduced. If there is not enough clearance, the diaphragm will hold the control valve open and the pump cannot be stopped without closing the throttle valve. It is also necessary that there be no steam leakage through the control valve or under the control valve bushing because the leaking steam will hold the main valve open, allowing steam to flow to the turbine.

Faulty governor operation is sometimes due to the piston rings wearing grooves in the cylinder liner. The grooves will limit the travel of the main valve and reduce the capacity of the pump, or will cause failure of the governor. Whenever a constant pressure governor is disassembled, the liner should be carefully checked; and if it is grooved, it should be renewed.

Control valve springs should be inspected frequently. If the spring breaks or is weak, it cannot close the control valve, which allows a full flow of steam to the turbine.

AUTOMATIC CONTROL FOR MAIN FEED PUMPS

Main feed pumps on many recent ships are equipped with automatic controls that operate pneumatically. One type of control system for main feed pumps is discussed briefly in the

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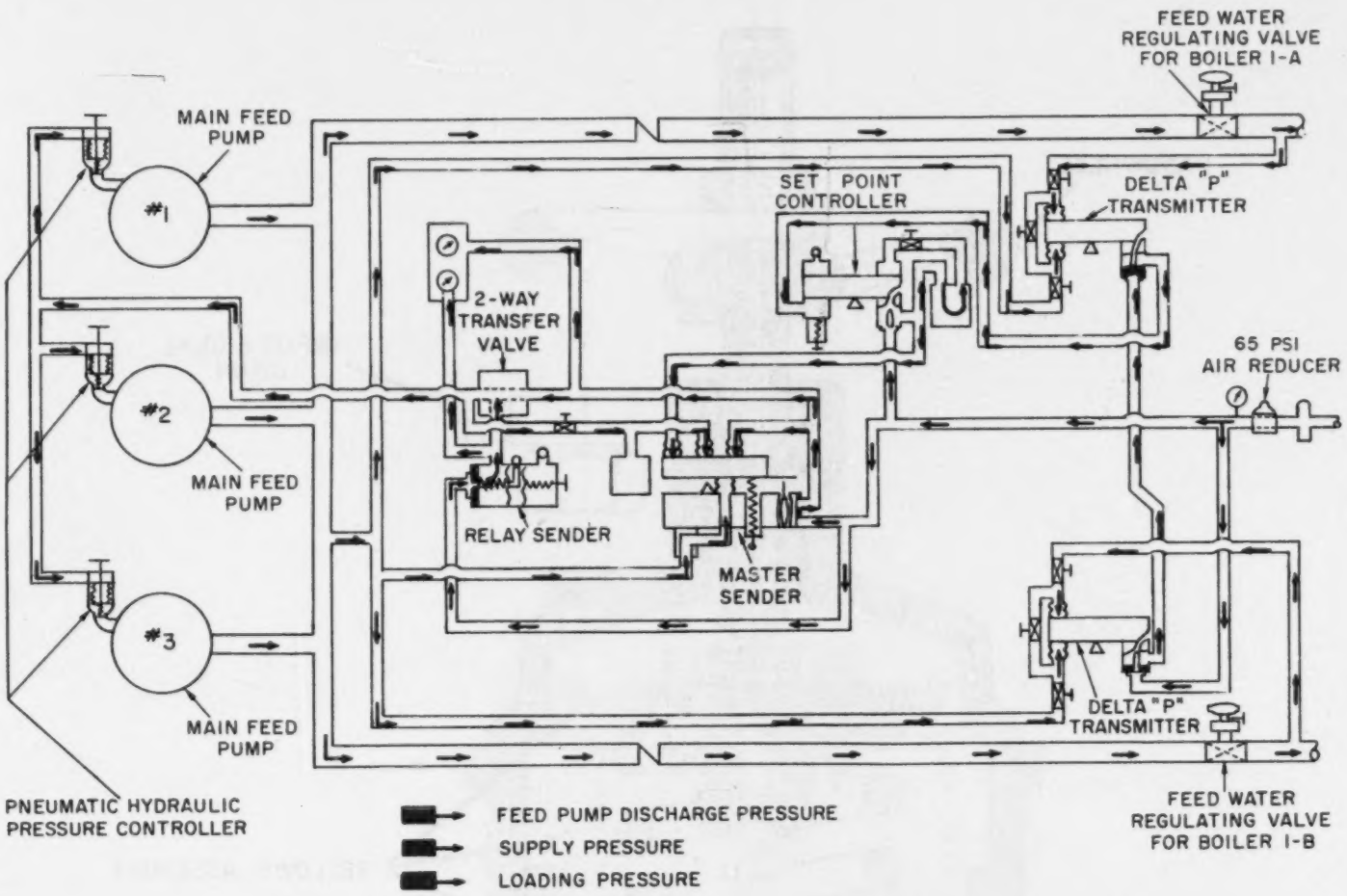

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Figure 7-4.—Hagan pneumatic control system for main feed pumps.

following paragraphs. For additional information on this control system, and for information on main feed pump controls manufactured by other companies, consult the manufacturer's technical manual for the particular installation.

The Hagan differential pressure control system (fig. 7-4) for the control of main feed pumps measures the differential pressure across the feed water regulating valve and transmits a proportional pneumatic signal (air pressure) to the pneumatic hydraulic pressure controller that controls the speed of the pump. As an example of how this system works, let's assume that the normal feed pump discharge pressure to two 1200-psi boilers, 1-A and 1-B, is 1275 and that a pressure differential of 75 psi is normally maintained across the feed water regulating valve. Now let's open the feed water regulating valve wider to boiler 1-B, thus reducing the pressure differential across the valve from 75 psi to 50 psi. The Delta "P" transmitter for boiler 1-B measures this change in the pressure differential. The resulting unbalance of the transmitter causes an air valve to close, decreasing the pneumatic pressure to the 1-A boiler Delta "P" transmitter, which is in balance. (The Delta "P" transmitters are interconnected in such a way that when either boiler demands feed water the opening of the feed water regulating valve for that boiler will control the feed pumps.)

A proportional decrease in incoming pneumatic pressure to the 1-A boiler transmitter causes a proportional decrease in outgoing pneumatic pressure to the set point controller. A proportional decrease in input pneumatic pressure to the set point controller permits the spring to close the air valve, thus reducing the proportional pneumatic pressure to the master sender. This unbalances the master sender and causes the air valve to close, decreasing the proportional output

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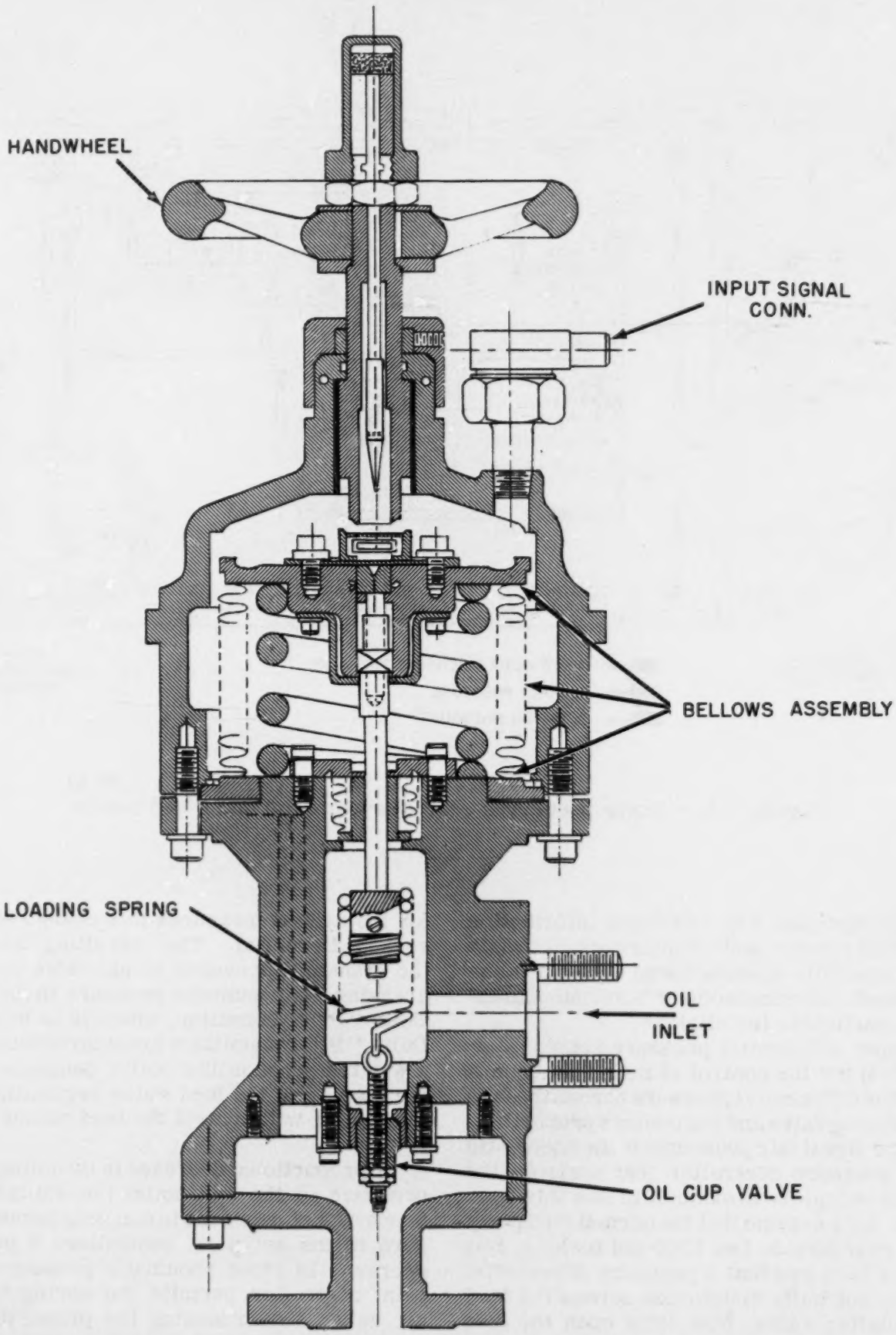

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Figure 7-5.—Hagan hydraulic pressure controller.

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loading pressure to the pneumatic hydraulic pressure controller (fig. 7-5). This action permits the bellows to contract and move upward, changing the compression of the loading spring and thus closing the oil cup valve. This action, in turn, permits oil pressure to build up, increasing the opening of the steam admission valves and thereby increasing the speed and discharge pressure of the main feed pump(s). As the water level in the boiler returns to normal, the feed water regulating valve closes down to maintain the proper feed flow. Since every change in position of the feed water regulating valve causes a change in the pressure drop across the valve, and since the Delta "P" transmitter is continuously measuring this pressure drop, the proportional output pneumatic pressure from the transmitter varies to control the speed of the main feed pump(s) in accordance with the demand for feed water.

SAFETY PRECAUTIONS FOR OPERATING PUMPS

1. Do not operate a pump with a defective overspeed trip, speed limiting governor, or speed regulating governor. If, in an emergency, a main feed pump or fire pump must be operated with a defective constant pressure governor, a man MUST be stationed at the throttle valve of the pump to regulate the discharge pressure.
2. Ensure that overspeed trips, where fitted, are set to shut off steam to the pump when the rated speed is exceeded by 10 percent.
3. See that speed limiting governors are set to limit the speed of the unit at not more than 105 percent of rated speed.
4. Check all pump control devices at least once each quarter, and more often if so ordered by proper authority.

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CHAPTER 8

PIPING AND VALVES

CARE OF PIPING SYSTEMS

Reasonable care must be given the various piping assemblies as well as the units connected to the piping. Unless the piping system is in good condition, the connected units of machinery cannot be operated efficiently and safely. Machinist's Mates need not be Shipfitters, but they should be familiar with the recommended procedures and safety precautions to observe when maintaining piping systems. This chapter presents general information on the maintenance and repair of piping systems.

The most important factor in maintaining piping systems in satisfactory condition is keeping joints, valves, and fittings tight. To ensure tightness it is necessary to make frequent tests and inspections.

When a ship is in operative status, piping should be tested at the frequency and test pressure specified in NavShips Technical Manual. These tests must be carried on for a period of time long enough to disclose any leaks or other defects in the system.

Where instruction books are available for piping systems and associated equipment, they should be followed. However, if the manufacturer's instructions are not available, NavShips Technical Manual should be referred to for details of piping maintenance.

MAINTENANCE AND INSPECTIONS

Maintaining the operational reliability of ships requires that all piping systems be in good operating condition; therefore, early detection and correction of piping defects are of the utmost importance. Fresh water, lube oil, fuel oil, aviation gas, jet fuel, and refrigerant gas are critical items—and any unnecessary loss of them must be avoided. Early correction of leaks, such as repair of faulty seats and disks, will reduce the amount of work, time, and material required for repairs. The following items are of extreme importance for the proper operation of valves and piping systems.

1. Piping systems should be inspected at regular intervals in order to detect and correct leaks as soon as they develop.
2. NavShips Technical Manual and the manufacturer's technical manuals for component systems should be referred to for specific information on a particular piping system or component.
3. If specific instructions are not available, all piping in an operating status aboard ship should be tested quarterly under full working pressure. In addition, a periodic hydrostatic test of 150 percent of the system designed pressure shall be applied to piping. The period between tests shall not exceed a maximum of 5 years; the test should be conducted prior to or during a scheduled major overhaul of the ship.
4. On ships in the reserve fleet, all piping not in use shall be kept thoroughly drained and should not be put under pressure for test purposes.
5. Drain holes which are provided in some systems to permit continuous drainage, should be checked periodically to guard against their becoming plugged with dirt or other foreign matter.
6. Before pressurizing any portion of a piping system for operation or for test purposes, operate all valves except those which would pressurize the system from another source.
7. Ensure that all valves and equipment in, or connected to, the part of the piping system being tested are in the required position or condition. Admitting steam to an open boiler and opening injection or overboard valves to an open condenser are to be particularly guarded against.
8. Sudden stoppage or changes in the flow, velocity, or direction of liquids in piping will generate high pressure (water ram) and may possibly damage equipment. Pumps should not be started when the discharge valve is open to a closed piping system, since the air present will be compressed and could result in damage to equipment.

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9. Sudden temperature changes in a piping system can cause uneven contraction and expansion and can develop stresses which may cause material damage or failure. Excessively rapid temperature changes are the primary cause of gasket failure.

10. Piping should never be used to provide footholds, handholds, or to support weight.

MARINE GROWTH

Rapid fouling of the firemains has been experienced on many ships, expecially ships operating in tropical waters. To minimize fouling of the firemain and to prevent valves from being stuck open or closed, the following procedure is recommended:

1. Once each quarter, flush the firemain under full pressure. High velocity flow must be used to remove marine growth. The firemain system may be lined up to direct the flow of water from more than one pump in one end of the ship, through a section of the system, while discharging through an adequate number of weather deck fireplugs. This procedure may be changed to reverse the flow through the piping. Flushing should be accomplished in areas where the sea water is clean.

2. NavShips has approved a procedure for acid cleaning of firemain piping to remove scale and marine growth. This type cleaning can be accomplished by a naval shipyard or by an approved contractor. Acid cleaning is satisfactory and is economical because it can be done without dismantling the piping.

GASKETS

It is possible to achieve a tight seal between flanges of a flanged joint; however, this requires perfect mating of machined or ground surfaces. Hence this method is costly, impractical, and generally unsatisfactory. To eliminate the necessity for producing and maintaining perfect joint—contact surfaces, relatively inexpensive and easily replacable gaskets are used as the sealing element. The seal is obtained by causing the gasket material to yield, or flow into the grooves or irregularities on the joint-contact surfaces.

For any flange, the type of gasket to be used will depend on several considerations: operating conditions, operating pressures, and mechanical features (bolting, shape of flange) of the flanged assembly. The appropriate chapter of NavShips Technical Manual contains information on selecting the proper gasket for a specific flange.

Much of the trouble experienced with leaky joints in piping is due to poor alignment or to improper allowance for expansion. Either of these faults will throw excessive strain on joints. When the joints do not line up, the piping should be realigned so that the flanges or unions meet properly without being forced. In aligning piping, you must check the pipe supports adjacent to the joint to be made up to determine that the hangers are properly supporting the line. Correcting improper hanger support can be accomplished by loosening up on the supports and then adjusting them to carry their share of the load. In some instances, it may be necessary to reface the flanges. The piping sections must be in alignment so that the flange bolts can be inserted freely without forcing either the bolts or piping.

The most practical way to cut a full-faced gasket is to lay the sheet packing over the flange and mark the cutting limits by light blows with a ball-peen hammer. The bolt holes must be cut slightly larger than the bolts so that any tendency for the gasket to bulge along the bolt circle is eliminated. A gasket cutter should be used to cut gaskets that fit inside the bolt circle.

Before making up a gasketed joint, all bearing and sealing surfaces must be cleaned thoroughly. Surfaces must be checked for signs of damage from erosion or steam cutting. Flanges showing damage must be refaced or replaced. Bolts and nuts that show signs of corrosion or other imperfections should not be reused. All bolts should be coated with an approved antiseize compound.

The first time a remade joint is put under pressure, it should be carefully inspected. If any sign of leakage is evident, all bolts should be tightened in small increments. If leakage continues after a new gasket has been used, an investigation for other possible causes should be made.

THREADED CONNECTIONS

Threaded connections have been used in piping systems in the past, to a considerable extent. Experience has proven that these connections are susceptible to shock damage and may become loose due to vibration. In new ship construction, threaded connections are not permitted in piping systems, except in a few special cases.

UNIONS

Unions are designed to seal against leakage under operating conditions; they have a ground joint, metal-to-metal surface, or for high pressure air and oxygen service, they have an O-ring seal. The threaded union nut is required only

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to furnish mechanical strength for the joint, and does not have any of the fluid in the line acting on it. With a union joint, there is no reduction in pipe-wall thickness as there is with a threaded pipe joint.

When installing new lines of silver-brazed piping, not over 2 inches in diameter, sufficient union fittings and union fitting valves should be installed to facilitate repairs or alterations. Union joints may become loose due to vibration, and they should be checked for leakage at regular intervals.

FLARELESS FITTINGS

Flareless fittings (fig. 8-1) are suitable for use in hydraulic service and air service at a maximum operating pressure of 3000 psi and 250° F. Flareless fittings are installed where their use will conserve space, reduce weight, and reduce installation time and system cleaning time. Flareless fittings should not be used where there is insufficient space for proper tightening of the nuts, or where any equipment or piping must be removed for access to the fittings. One exception to this rule is a gageboard that is designed so that it may be removed as a unit for repairs or alterations. Flareless fittings should not be used where piping cannot be deflected easily to permit assembly and disassembly.

Before assembly, the tubing end must be square, concentric, and free of burrs. In order for the fitting to be effective, the cutting edge of the sleeve or ferrule must bite into the periphery of the tube; this is accomplished by presetting the ferrule.

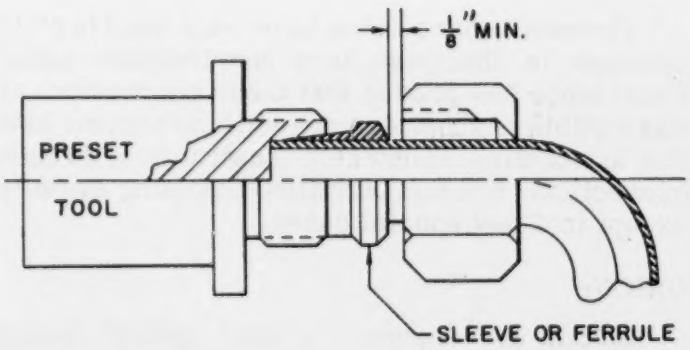

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Figure 8-1.—Typical flareless fitting.

STEAM TRAPS

Steam traps are installed in steam lines to drain condensate from the lines without allowing the escape of steam. Although there are many different kinds of steam traps, they all consist essentially of a valve and some device or arrangement that will cause the valve to open and close as necessary to drain the condensate without allowing the escape of steam. Some designs are suitable for low pressures and temperatures, others for high pressures and temperatures. Several types of steam traps are explained in Machinist's Mate 3 & 2, NavPers 10524-C. The following is a description of the bimetallic-element steam trap.

Bimetallic steam traps of the type shown in figure 8-2 are used on many ships to drain condensate from main steam lines, auxiliary steam lines, and other steam lines. The main working parts of this steam trap are a segmented bimetallic element and a ball-type check valve.

The bimetallic element consists of several bimetallic strips fastened together in a segmented fashion, as shown in figure 8-2. One end of the bimetallic element is fastened rigidly to a part of the trap body; the other end, which is free to move, is fastened to the top of the stem of the ball-type check valve.

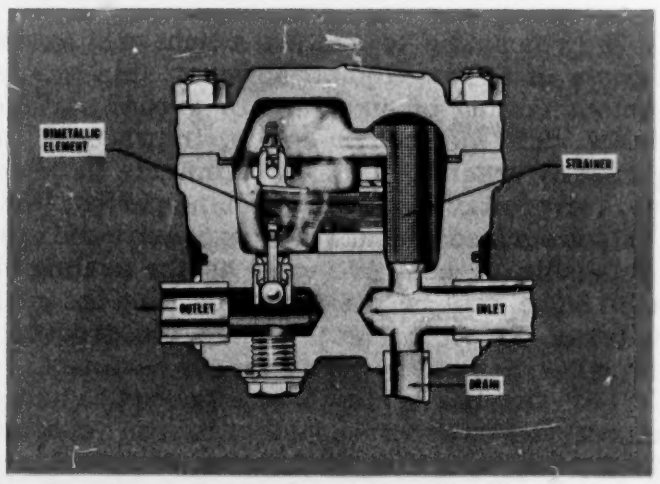

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Figure 8-2.—Bimetallic steam trap.

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Block I - Basic Electronics

Unit 8 - Electronic Controls

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Connecting rectifier to load	Rectifiers Electron flow and potential differences for rectifier Direct electron flow from alternating potential Transformers Transformer voltages Center tape Full-wave rectifiers Half-wave rectifiers
Construction of filter circuits	Capacitors for filtering Capacitor values Filter circuits Filters containing conductors
Using a thyratron to control electron flow in a load	Factors affecting resistance Heating due to electron flow Watts dissipation of resistors Gas and vapor-filled tubes Electron flow ratings
Connecting a thyratron control to a rectified power supply	Thyratron construction Control characteristics Negative and positive grid control Temperature effects A rectified power supply
Making cathode and filament connections	How alternating potentials are produced Effects of capacitor on phase difference Effect of phase shift Multiple control
Determining grid voltage changes	Vacuum tubes as amplifiers Types and construction Triode as an amplifier Thyratron control circuits
Using a time-delay circuit	Capacitor-resistor time-delay Time-delay relay
Using an ignitor control circuit	Ignitron construction and operation Ignitor control circuits
Using a phototube circuit	Phototube construction and operation Phototube relays

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The ball-type check valve is an upward seating valve. Line pressure acting on the check valve tends to keep the valve open. When steam enters the trap body, the bimetallic element expands unequally because the two metals respond differently to the heating. The bimetallic element deflects upward at its free end, thus moving the valve stem upward and closing the valve. As the steam cools and condenses, the bimetallic element moves downward, toward the horizontal position, thus opening the valve and allowing some condensate to flow out through the valve. As the flow of condensate begins, a greater area of the ball is exposed to the higher pressure above the seat. The valve now opens wide and allows a full capacity flow of condensate.

Bimetallic steam traps can be adjusted in several ways to correct leakage. If leakage occurs in one of these traps, consult the manufacturer's instructions for adjustment.

VALVES

Valves, like other units of equipment, require proper care and maintenance. Valve troubles should be corrected as soon as possible.

CAUSES AND REMEDIES OF VALVE LEAKAGE

Internal valve leakage is generally a result of the disk and the seat failing to make a tight joint; and this failure may be due to one of the following causes:

1. Foreign substances (scale, dirt, waste, or heavy grease) are lodged on the seat in such a way that the disk cannot be seated. If the obstructing material cannot be blown through, the valve will have to be opened and cleaned out.
2. Scoring of the seat or disk has been caused by attempts to close the valve on scale or dirt, or by corrosion. If the damage is slight, the valve may be made tight by grinding the disk together with the seat; if the damage is extensive, a cut will have to be made on the disk, and the valve seat ring may have to be renewed before it is ground.
3. The disk may not seat properly because of a bent spindle guide, or a bent valve stem.
4. The valve body or disk may be too weak for the purpose for which it is used, causing distortion of the valve seat or disk under pressure.
5. In valves fitted with seat rings, leakage through the valve may occur as the result of leakage around the threads of the seat rings. To correct this defect, remove the seat ring, clean the threads, and remake the joint. It may be necessary to recut the threads in the valve and to renew the seat ring to secure tightness.
6. Leakage may be caused by a loose valve disk. When a valve disk comes loose from its stem, the cause is either failure of the securing device or corrosion. The first cause is infrequent in valves of good construction, and recurrence of the failure can be prevented by minor adjustments or by greater care in reassembling valve parts.

Corrosion of the valve stems occurs mostly to valves installed in salt water lines. Stems which have shown signs of corrosion should be inspected periodically so that replacement can be made before failure occurs. Replacements should be made with Monel stems. In order to prevent failure caused by corrosion, split pins used in valve disks in the waterlines should be of nickel-copper alloy instead of iron, steel, or brass.

When a valve is disassembled for repairs, several steps must be taken to ensure that the valve will be in proper condition when it is reassembled.

During disassembly every precaution should be taken to prevent damage to gasket and O-ring sealing surfaces, to seating surfaces, and to guiding surfaces. When the valve is disassembled, all parts should be thoroughly cleaned and inspected for excessive wear. Seating surfaces should be inspected to determine whether lapping, grinding, or machining is required to restore them to a tight fit. Gasket surfaces may be corroded or steam cut. The stem must be carefully checked (1) for straightness, (2) where the packing fits, and (3) at the threaded section.

If the seating surface has become badly corroded or is so deeply scored that excessive lapping would be required to remove the damaged areas, machining will be necessary. A reseating machine may be used. The proper size cutter must be used in the reseating machine and light cuts must be taken until the damaged areas are removed. If the seating surface is made from a metal that is too hard for a reseating machine to cut, the work will have to be done in a lathe.

After the machining is completed, the seating surfaces on metal-to-metal seated valves should be lapped to ensure that it will have the smoothest possible finish. The lap must be of the exact same size and shape as the valve disk so that the valve seating surface will be true. For more information on lapping valve seating surfaces, refer to the appropriate chapter of Machinist's Mate 3 & 2, NavPers 10524-C.

An inspection should be made of the disk seating surface to determine whether lapping or ma-

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chining will be required for reconditioning. If machining is required, light cuts should be taken until the damaged areas are removed. If excessive wear or severe pitting has taken place, the machining required to remove the damage may be extensive enough to warrant installing a new disk.

Reassemble the valve using new gaskets and packing. Be sure that all parts move freely as assembly progresses. Do not tighten the packing nut more than is necessary to prevent excessive leakage.

In any instance where new parts are required for a valve, the material must be the same as was in the original parts.

PRESSURE REDUCING VALVES

Several types of pressure reducing valves are installed on Navy ships. Some of the more common types are discussed in Machinist's Mate 3 & 2, NavPers 10524-C. Some of the maintenance procedures for these valves are discussed in the following paragraphs.

Pneumatic Reducing Valves

Pneumatic pressure-controlled reducing valves are pressure-balanced type valves which require a supply of air or gas under pressure for their motive force. The most probable causes of erratic operation of these valves are incorrect pressure in the loading dome or an accumulation of dirt or other foreign matter on the surface of the moving parts. The condition of improper loading pressure is easily remedied by increasing or decreasing the pressure of the gas or air to maintain the proper outlet pressure.

If the cause of improper operation is the presence of dirt or other foreign matter, the only remedy is to disassemble the valve and clean all parts. The valve may be disassembled in place, or removed from the piping and disassembled. When the valve is disassembled, clean all parts with an approved solvent and a bristle brush or soft cloth. NEVER USE AN ABRASIVE MATERIAL TO CLEAN VALVE PARTS. If the usual cleaning methods will not remove hardened deposits of oil or other foreign matter, the part may be cleaned by scraping with a sharp tool; extreme caution is necessary to prevent damage to the surface finishes. Particular attention must be given to cleaning all guide surfaces, to ensure that all moving parts will move freely without binding.

Another possible source of trouble is leakage around the seating surfaces of the disk and seat ring and the joint between the seat ring and the body. If leakage occurs at these points the valve will not operate properly. A careful inspection must be made of these surfaces and if leakage is present, the seat ring and disk may be reconditioned by lapping or grinding. If the joint between the seat ring and the body is leaking, a new seat ring must be installed.

All parts must be inspected for excessive wear; pay particular attention to the valve spring and the diaphragm spring. If either is broken or permanently set, a new spring must be installed.

When the valve is reassembled and installed, it should be tested by opening the outlet valve and cracking the inlet valve to thoroughly warm up the valve. The dome should be pressurized with air or gas to about 10 psig more than the desired outlet pressure.

Spring-Loaded Reducing Valves

Another type of reducing valve with which Machinist's Mates will be concerned, is the spring-loaded type that is installed in flushing and cooling water mains. It is of the single-seated, direct-acting, diaphragm type and is illustrated in the appropriate chapter of Machinist's Mate 3 & 2, NavPers 10524-C.

Failure of this type valve can usually be traced to one or more of the following causes:

1. Ruptured diaphragm.
2. Leakage through the disk seat or seat ring threads.
3. Ports stopped up with dirt or other foreign matter.
4. Grooves in the bore of the sleeve.
5. Cup leather leaking.

In the event the diaphragm ruptures, there will be no control over the flow of liquid through the valve. The diaphragm can be renewed without removing the valve from the piping system.

All tension must be taken off the adjusting spring, and then the diaphragm nuts can be removed from their bolts. Next the spring chamber can be lifted off the valve body. This provides access to the diaphragm, which can be removed, then a new one can be installed and the valve reassembled. The diaphragm should always be renewed when there is indication of deterioration.

Any time disassembly of the valve becomes necessary, all parts of the valve should be cleaned

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and inspected for excessive wear. Cleaning should be done with an approved solvent and a soft brush.

Particular attention should be given to cleaning the guide surfaces between the seat ring and ring guides and to the guide surfaces of the sleeve.

The seating surface of the seat ring should need little repair but in the event it is scored or otherwise damaged, it should be lapped in, using the same process as described for other valves. If the damage to the seating area is excessive or the bore is badly worn, a new seat ring should be installed.

If there are signs of deterioration of the disk seat, it should be renewed. If a new disk seat is not available, turning the seat over will provide a new seating surface; however, this should be considered as a temporary repair, and a new disk seat should be installed as soon as it is available.

If the cup leather shows signs of leaking or deterioration, it should be renewed. The bore of the sleeve should be inspected for excessive wear or corrosion. If there is excessive damage to the sleeve, it should be renewed. If the sleeve is only slightly damaged, the damage can be corrected by machining the surface in a lathe. Use extreme care to ensure that the bore is concentric, has a smooth finish, and is not enlarged to the extent that leakage will occur when the cup is installed.

RELIEF VALVES

Relief valves are installed on piping and units of machinery where excessive pressure may build up and damage equipment or endanger personnel. Relief valves are adjusted to lift at the proper pressure by increasing or decreasing the compression of the spring.

Failure of the valve to function properly is usually due to an incorrect setting of the spring, leakage between the disk and seat, leakage around the threads of the seat ring, cocking of the disk or stem, or an accumulation of dirt or other foreign matter around the guiding parts.

In most instances, relief valves may be disassembled in place or they can be removed from the piping, when repairs are necessary. The first step in disassembling a relief valve is to release all tension on the adjusting spring. This is accomplished by loosening the locknut and then loosening the adjusting screw. (Some relief valves are fitted with a test lever which must be removed before the spring tension can be released.) The top assembly can be removed by either removing the nuts on the yoke bolts or by unscrewing the top assembly from the body of the valve (depending on the construction of the valve). The disk can then be removed and the seating surfaces can be inspected. The seating surfaces can be reconditioned by lapping, grinding, or machining in the same manner as would be done with a globe valve.

All surfaces used for guide purposes should be inspected for burrs, galling, excessive wear, or other defects which may interfere with the free movement of the working parts. Parts which are worn excessively, are bent, or are in any way unfit for futher service must be replaced. When replacing parts, those supplied by the manufacturer should be used, if obtainable.

When a relief valve has been overhauled, it is common practice to test it for leaks before installing it in the piping system or on a unit of machinery. It is far more practical to mount the valve on a test stand (if available) and conduct a hydrostatic test and then set the relieving pressure at the desired amount, than it is to test it after installation.

On some relief valves, an adjusting ring has been provided so that reseating pressure as well as the relieving pressure can be adjusted. The position of the ring may be raised or lowered in relation to the disk, by removing the adjusting ring setscrew and moving the ring to the desired position. Raising the ring will increase the blowdown period and lowering the ring will decrease the blowdown period.

Diaphragm Control Valves With Air-Operated Control Pilots

Diaphragm control valves with air-operated control pilots are being used increasingly on newer ships for various pressure-control applications. These valves and pilots are available in several basic designs to meet different requirements. The principles of operation of this type control valve are explained in Machinist's Mate 3 & 2, NavPers 10524-C.

Many of these air-operated control valves are constructed with hand wheels for manual operation in the event of a loss of air pressure or a malfunction of the control system. Depending on the specific system criteria these valves and control systems are designed to fail in one of three positions upon a loss of air pressure. They will fail in the open position, closed position, or in the position they are presently in until actuated.

The manufacturer's instruction manual should always be consulted for information on any repair or calibration of air-operated control systems.

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CONSTANT PRESSURE GOVERNOR MAINTENANCE

The principles of operation of constant pressure governors are explained in the appropriate chapter of Machinist's Mate 3 & 2, NavPers 10524-C. The following paragraphs deal with maintenance of these governors. For more complete details on operation and maintenance of constant pressure governors, consult the manufacturer's technical manual.

The most common cause of improper operation of constant pressure governors is dirt or other foreign matter being carried with the steam into the governor and interfering with the operation of the moving parts. The only remedy is to disassemble the governor and thoroughly clean all parts.

Failure of the governor to properly regulate the pump discharge pressure may also be caused by one or more of the following reasons:

1. Leakage around the seating surfaces of the control valve, the main valve, or the threads of their respective seat rings.
2. A main valve spring or a controlling valve spring that is broken, is weak, or that has taken a permanent set.
3. A broken, cracked, or excessively deformed diaphragm.
4. Improper adjustment of the needle valve.
5. Too little or too great a clearance between the control valve and its diaphragm.
6. Clogged ports in the diaphragm chamber.
7. Binding of any moving parts.

This is not a complete list of reasons for failure of constant pressure governors, but it does cover the most common causes.

Removal of Foreign Matter

When a constant pressure governor acts sluggishly or erratically because dirt or other foreign matter is interfering with the free movement of working parts, the governor must be completely disassembled, and all parts cleaned. The manufacturer's technical manual gives a step-by-step procedure for disassembly. Extreme care must be taken in the removal of all parts, and in the cleaning. The parts may be cleaned with an approved solvent and a soft brush. If this cleaning method fails to remove hardened deposits, a sharpened tool may be used with extreme caution.

Cylinder Liner

Particular attention should be given to cleaning the seat for the cylinder liner. The cylinder liner must fit properly to prevent it from projecting above the body flange. The bore of the main valve guide must also be carefully cleaned. As each part is cleaned, it should be carefully inspected for excessive wear. If it is necessary to renew parts, use only parts furnished by the manufacturer.

Control and Main Valves

If there is leakage through the control valve or its bushing, steam will flow to the top of the operating piston, opening the main valve, and holding it open, even though there is no tension on the adjusting spring. The main valve must be able to close off completely or else the governor cannot operate properly. The only remedy for this situation is to disassemble the governor and stop the steam leakage. In most instances, the control valve must be renewed. If the leakage is through the bottom of the bushing and its seat, the seat must be lapped. A cast iron lap is best for this type of work.

The lap should be rotated through a small angle of rotation, lifted from the work occasionally, and moved to a new position as the work progresses. This will ensure that the lap will slowly and gradually rotate around the entire seat circle. Do not bear down heavily on the handle of the lap, and take particular care not to bear sideways on the lap. Replace the compound often, using only clean compound. If the lap should develop a groove or cut, redress the lap. Lapping should never be continued longer than is necessary to remove all damaged areas.

When you are installing the control valve and its bushing, remember that the joint between the bottom of the bushing and its seat is a metal-to-metal contact. The bushing must be installed tightly; and when it is all the way down, the wrench should be tapped lightly with a hammer, to ensure a steamtight joint.

When the controlling valve is installed, the clearance between the top of the valve stem and the diaphragm must be checked. It is absolutely mandatory that this clearance be between .001 and .002 inch (fig. 8-3). If the clearance is less than .001 inch, the diaphragm will hold the control valve open, allowing steam to flow to the main valve at any time the throttle valve is open. If the clearance is more than .002 inch, the diaphragm will not fully open the control valve—which means that the main valve cannot open fully, and the unit cannot be brought up to full speed and capacity.

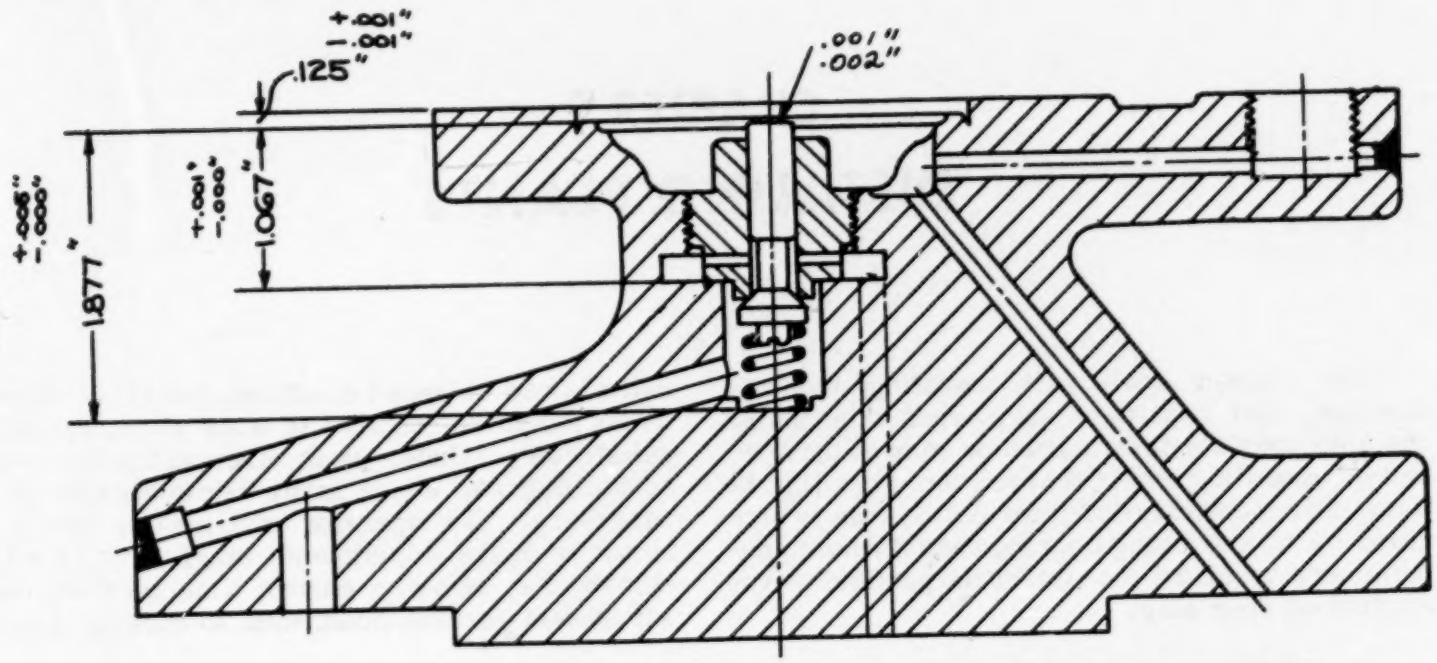

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Figure 8-3.—Important points in cleaning and reassembling a top cap assembly.

When the main valve seating area is damaged, it must be lapped in by the same process. ALWAYS lap in the main valve with the piston in the cylinder liner to ensure perfect centering.

If the damage to the seating surfaces is excessive, new parts must be installed; use only parts supplied by the manufacturer, if available.

TOP CAP

If the top flange of the top cap becomes damaged, extreme care must be taken in machining it. The manufacturer's technical manual must be consulted for the correct clearances. (See fig. 8-3.) All seating surfaces must be square with the axis of the control valve seat threads and must have the smoothest possible finish. Before the re-assembly is started, all ports in the top cap and diaphragm chamber must be free of dirt or other foreign matter. A check should be made to ensure that the piston rings are free in their grooves. The cylinder liner must be smooth and free of grooves, pits, or rust.

When installing the cylinder liner, make certain that the top of the liner does not extend above the top of the valve body. The piston must work freely in the liner; if there is binding, the governor will not operate satisfactorily. The controlling valve spring and the main valve spring should be renewed if they are weak, broken, or corroded, or if they have taken a permanent set. If necessary, renew all diaphragms; if the old diaphragms are used, they should be installed in their original position; do not reverse.

The instructions in the manufacturer's technical manual should be followed in reassembling the governor. All clearances must be as designed if the governor is to operate satisfactorily. Each moving part must be carefully checked to ensure freedom of movement.

When the governor is reassembled, it should be tested as soon as possible so that corrections, if necessary, can be made.

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CHAPTER 9

DISTILLING PLANTS

This chapter deals with operating, troubleshooting, and repair of submerged tube plants and also provides information on some of the newer type distilling plants that are being used by the Navy. For more detailed information than is provided by this training course, consult the manufacturer's technical manual for the particular type of plant on your ship.

SUBMERGED TUBE PLANTS

Low pressure, submerged tube plants will vary for different ships, but the abnormal operating conditions and the maintenance procedures are basically the same. In almost all instances, the personnel who stand watches on distilling plants are also responsible for the maintenance of the plants. This gives ample opportunity to detect abnormal operating conditions before such conditions reach advanced stages. When operating troubles occur, it is the responsibility of the MM1 or MMC to locate the trouble and to make the necessary adjustments or repairs.

GENERAL INSTRUCTIONS

Steady operating conditions are essential for satisfactory results. Except under emergency conditions, no plant should be forced beyond its rated capacity, because higher steam pressures will be required and the resulting higher temperatures will cause more rapid scaling of the evaporator tubes.

In operation, the various elements of any plant are interdependent due to the heat and fluid balances throughout the plant. Adjustment of any one control can produce widespread effects on these balances. For example, an increase in the feed to the first effect will raise the liquid level in the first effect. More heat will be required to raise the feed to the boiling point, so that less heat will be available for evaporation in the first-effect shell and a smaller amount of heat will flow to the second-effect tube nest. These changes would work out to a new balanced condition, but other adjustments would be required to make the new balance satisfactory. Under such circumstances, overcontrolling can cause many readjustments to be necessary. The operator will always find it is better to make adjustments singly and in small increments, allowing enough time between each adjustment for the conditions to become steady.

Causes of Low Plant Output

Failure to obtain full rated capacity is one of the most frequent troubles encountered during operation of a distilling plant. The trouble may be very difficult to remedy since it may result from a combination of things. The various factors which promote full output of the distilling plant are as follows:

1. Proper steam pressure above the orifice.
2. Highest possible vacuum in the first-effect tube nest.
   - a. No air leaks.
   - b. Proper water levels in the evaporator shells.
   - c. Evaporator tube nests continuously vented.
   - d. Evaporator tube nests reasonably clean.
     - (1) Continuous feed treatment and periodic chill-shocking.
     - (2) Tubes mechanically cleaned when necessary.
   - e. Density of brine overboard not over 1.5/32.
     - (1) Overboard piping reasonably clean.
     - (2) Proper valve settings.
     - (3) Proper operation of brine pump (clean piping and strainers, proper speed and direction of rotation, pump properly vented, gland properly vented, gland properly packed and sealed, no air leaks in piping).

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f. Tube nests properly drained.

(1) Proper operation of all drain regulators.
(2) Proper operation of the tube nest drain pump.

3. Highest possible vacuum in the last-effect shell.

a. No air leaks.
b. Proper air ejector operation.

(1) Clean nozzle and strainer.
(2) Steam at the required quality and quantity.

c. Ample flow of circulating water.

(1) Clean strainer, pipeline, and tubes.
(2) Proper valve settings.
(3) Proper operation of the circulating pump.

d. Effective surface in the distilling condenser.

(1) No undue deposits inside the tubes.
(2) Proper venting of the condenser tubes.
(3) Proper operation of the condensate pump.

Steam Pressure

A distilling plant cannot maintain its full output unless it is supplied with dry steam at the designed pressure. The orifices supplied are designed to pass the proper amount of steam to ensure designed plant output with a pressure of about 5 psig above the orifice. The orifice should be inspected annually. At this time the orifice should be measured and the reading compared with the figure stamped on the plate. If necessary, the orifice should be renewed.

If the steam pressure above the orifice varies, the source of trouble should be located and corrected. First the weight-loaded regulating valve should be checked, and then the pressure reducing valve (if installed), to determine whether or not the valve is operating properly. If it is functioning properly and the pressure cannot be maintained above the orifice, an insufficient amount of steam is being supplied to the plant.

The auxiliary exhaust steam supply for the distilling plants, after passing through the regulating valve, is usually slightly superheated, due to the pressure drop through the reducing valve and orifice plate. A small amount of superheat has little or no effect on operation or scale formation; however, if it is necessary to use live steam, the installed desuperheater spray connection should be used to control the superheat. The water for desuperheating must be taken from the boiler feed system, preferably from the first-effect tube nest drain pump. Water for desuperheating must never be taken directly from the fresh water distilled by the distilling plant.

Fluctuations in the first effect generating steam pressure and temperature cause fluctuations of pressure and temperature throughout the entire plant. The fluctuations may cause priming, with increased salinity of the distillate, as well as erratic water levels in the shells. Proper operation of automatic pressure regulators in the steam supply line will eliminate fluctuation of the pressure in the first-effect heat exchanger.

First-Effect Tube Nest Vacuum

The pressure maintained in the first-effect tube must be within the range of from 16 inches of mercury, with clean tubes, to 1 to 2 inches of mercury as scale forms. The output of a submerged tube type distilling plant is not greatly reduced until the deposits on the tubes have caused the vacuum to drop to about atmospheric pressure. When the first-effect tube nest vacuum is lost entirely, the reduction in output becomes very great. Assuming the reduction in vacuum is due to scale and not to improper operating conditions, the tubes must be cleaned.

Keeping the vacuum in the first-effect tube nest as high as possible helps keep scale formation to a minimum, enabling the plant to operate at full capacity.

A vacuum reduction resulting from any factor other than deposits on tube surfaces should be corrected. This will reduce deposits and greatly prolong the interval of time between cleanings. The primary factors affecting the first-effect tube nest vacuum are: air leakage, low water level in the evaporator shells, improper venting of the evaporator shells, scale or other deposits on the tubes, and improper draining of the evaporator tube nests.

Loss of vacuum resulting from deposits on evaporator tubes should be gradual. Under normal conditions, there will be no large change of vacuum for any one day's operation. A sudden drop in vacuum can be traced to causes other than scale deposits.

The generating steam circuit operates under vacuum and is subject to air leaks. Leaks from the steam side of the first-effect tube nest to the

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first-effect shell space will cause losses of capacity and economy. Air leaks from the atmosphere into the generating steam line (downstream from the orifice plate), the first-effect tube nest front header, and the first-effect tube nest drain piping will cause a loss of vacuum and capacity. Air leaks in this part of the distilling plant may be less noticeable than air or water leaks elsewhere because the effect on the plant is similar to the scaling of the tube surfaces.

Proper Water Levels

A reduced first-effect tube nest vacuum can result from too low a water level in any evaporator shell. On older plants, the water levels are controlled by manually regulating the feed valves. On newer ships, the water levels are automatically controlled by weir type feed regulators. Inability to feed the first effect is usually due to scale deposits in the sea-water sides of the air ejector condenser and the vapor feed heater, or to obstructions in the feed line. Inability to feed second or third effects is due to air leakage or heavy scale deposits in the feed lines between the effects. It is important that the gage glass and the gage glass fittings be kept free of scale or false water level indications will result. Air leaks around the gage glass will also result in false level indications in the gage glass.

Once the distilling plant is in operation, the feeding must be maintained at a steady rate. Sudden rising of the water levels or too high a water level will cause carry over of small particles of brine with the vapor (priming). The level of water in the shell must be carried at the highest level that can be held and still prevent the carrying over of salt water particles with the fresh water vapor, because scale will form rapidly on exposed tube surfaces.

The pressure differential between the first and second effects permits the second-effect feed to be discharged into the second-effect shell. A partial or total loss of pressure differential indicates that air leaks have occurred between the first and second-effect shells in the two-effect distilling plants. Large air leaks between the first effect and second effects can be readily detected because the vacuum gage for the first effect will read approximately the same as the vacuum gage for the second effect. Large air leaks of this type will disrupt the operation of the plant and must be located and repaired before the plant will operate properly.

Improper Venting of Evaporator Tube Nests

Improper venting of the evaporator tube nests causes either an accumulation of air in the tubes, with a loss of capacity, or an excessive loss of tube nest steam to the distilling condenser, with loss of economy. Troubles of this type usually result from improper operation rather than from material failures.

Scale Deposits on Evaporator Tubes

Until 1958, scale deposits on evaporator tubes had been one of the more serious operating difficulties. In 1958, a new compound was authorized for treatment of evaporator feed water. The new compound (Hagevap) is far superior to the cornstarch-boiler compound formerly used. For details on Hagevap and its use, refer to the applicable chapter in Machinist's Mate 3 & 2, NavPers 10524-C.

Last-Effect Shell Vacuum

Most manufacturers' technical manuals indicate that a vacuum of approximately 26 inches of mercury should be obtained in the last-effect shell when the temperature of the sea water is 85° F, and that the vacuum should be higher when the sea water is colder. Failure to obtain a vacuum of 26 inches of mercury, or more, can generally be traced to one of the following factors: air leaks, improper operation of air ejectors, insufficient flow of sea water, and ineffective use of heat transfer surface in the distilling condenser.

Test for Air Leaks

The importance of eliminating air leaks cannot be overemphasized. Many distilling plant troubles are direct results of air leaks. Air leaks in the shells of distilling plants cause a loss of vacuum and capacity. Extreme care must be taken in making up joints and in keeping them tight. Joints should be periodically tested under pressure and, when necessary, shellacked.

There are several methods by which tests can be made for air leaks in the tube nests, heat exchangers, shells, and the piping systems of the distilling plant. When the plant is in operation, a candleflame can be used to test all joints and parts under vacuum. With the plant secured, air pressure tests or a soapsuds test can be used on the various component parts of the distilling plant. The manufacturer's technical manual describes how the various parts of the plant can be isolated and placed under air pressure.

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Air leakage may also be detected by hydrostatically testing the various parts of the plant. When performing air tests or hydrostatic tests, precautions should be taken not to exceed the maximum limit of the test pressures specified by the manufacturer.

Testing for Salt Water Leaks

If a leak is detected in a heat exchanger, the defective tube(s) should be located by means of an air test or a hydrostatic test, in accordance with the recommended procedure in the manufacturer's instructions. Blueprints should also be used to study the construction details of the individual heat exchanger.

As soon as a leaky tube has been located, it should be plugged at both ends. Special composition plugs, which are provided in the allowance repair parts, should be used.

Since plugging the tubes reduces the amount of heating surface, the heat exchanger will fail to give satisfactory performance after a number of tubes have been plugged. It will then become necessary to retube the heat exchanger. Under normal conditions, this work should be accomplished by a naval shipyard or tender. However, repair parts and a number of special tools are included in the Ship's Allowance List, so that emergency repairs can be made to the heat exchangers and to other parts of the distilling plant.

To find which of the tubes within a REMOVABLE TUBE BUNDLE is leaking, it is necessary to test the individual bundles hydrostatically. If the leak is in a removable bundle (vapor feed heaters when within an evaporator shell, evaporator tube nests, distilling condensers on Solo-shell end-pull plants), the bundle must be withdrawn and a hydrostatic test at full pressure (50 psi) must be applied on the tube side.

If a leak occurs in a NONREMOVABLE TUBE BUNDLE (distillate coolers, air ejectors condenser, external vapor feed heaters), the tube nest covers must be removed, and the full test pressure (50 psi) applied on the shell side of the unit.

If a nonremovable distillate condenser bundle is within an evaporator shell, the tube nest covers must be removed and a full test pressure of 30 psi should be applied to the evaporator shell.

If the distilling condenser is fitted with a diaphragm-tube (Goubert) expansion joint, a test ring will be required to replace the tube nest cover for testing.

Air Ejector Operation

In operation, air ejectors require little attention. However, the following points should be noted.

1. The steam pressure at the nozzle inlet must not be less than that for which the ejector is designed (and which is stamped on the nameplate). There may be a substantial pressure drop in the steam line, and it may be necessary to carry a higher pressure on the gage. Pressures at the air ejector nozzle may be 10 to 15 psig higher than the minimum specified by the manufacturer.

2. The primary causes of air ejector trouble are low steam pressure, wet steam, an obstructed nozzle, or a clogged steam strainer. Such trouble is indicated by failure to obtain or to maintain the required vacuum. If the trouble is due to low steam pressure or to wet steam, it will be necessary to increase the steam pressure or to provide suitable drainage, either by installing a trap or by manual means. If the nozzle or steam strainer is clogged, it must be removed and cleaned. Most plants are provided with two sets of air ejectors; this permits the use of the plant on one unit while the second is available for cleaning or repair. However, some of the latest plants have only one set of air ejectors.

When it becomes necessary to clean air ejector nozzles, they can be cleaned with the special nozzle reamers furnished each ship for this purpose. Sharp-edged tools should never be used for cleaning nozzles. The nozzle surfaces will be damaged and the efficiency of the air ejectors will be impaired.

A procedure for testing air ejectors can be found in the manufacturer's technical manual. In general, the same maintenance procedures should be followed for distilling plant air ejectors as for air ejectors for main condensers.

The air ejector strainer is usually an integral part of the air ejector inlet. It should be inspected regularly and cleaned when necessary. When a new plant is first put into operation, the strainer may require cleaning every day or even more frequently, but once the lines have been thoroughly cleaned, monthly inspections should be adequate. Failure to keep the strainer clean will cause a reduced or fluctuating vacuum. In the event a strainer or a nozzle becomes damaged, it should always be replaced with a new one.

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Insufficient Circulating Water

An insufficient flow of circulating water is indicated if the temperature of the water rises more than 20° F in passing through the condensing section of the distiller condenser. The last-effect shell pressure is directly dependent upon the distiller condenser vacuum. The vacuum is dependent upon the temperature and quantity of the circulating water, and the proper operation of the air ejectors. Too low an overboard discharge temperature of the distiller condenser circulating water is accompanied by efficiency losses in the distilling plant. The overboard discharge temperature should be kept as high as possible, without exceeding the desired 20° F temperature rise through the distiller condenser. In addition, limiting the quantity of circulating water tends to prolong the service life of the tubes and tube sheets. When troubles occur which do not result from improper operating procedures, an inspection should be made of the condenser circulating water system to determine the cause of faulty operation.

Routine preventive maintenance procedures should be carried out to ensure that the circulating water pump is maintained in good material condition. The maintenance and repair procedures for this pump are similar to those for the other pumps of the plant.

Routine procedures should be carried out to ensure the proper setting and maintenance of the back-pressure regulating valve. If this valve is not functioning properly, the valve should be disassembled, the valve parts replaced, and repairs to the valve made (as found necessary), before its faulty operation interferes with the operation of the distilling plant.

To ensure that the condenser circulating water system is clean and free from scale and foreign matter, the piping should be inspected at regular intervals. The operators of the distilling plant should periodically inspect and clean the strainers to prevent accumulations of foreign matter from interfering with the proper operation of the plant.

Improper Drainage

Failure of the distilling plant to produce designed output when the pressure above the orifice is 5 psig and the first-effect tube nest vacuum is several inches of mercury always indicates improper drainage of the distiller condenser or of one of the evaporator tube nests subsequent to the first effect. Complete flooding of the flash chamber gage glass is also a positive indication of improper draining of the condenser, but the fact that the level appears to be in the gage glass or below, is not necessarily an indication of improper drainage because air leaks at the gage glass fittings may indicate a false liquid level.

A temperature difference of more than 5° F to 10° F between the last-effect shell temperature and the temperature of the distillate at the distillate cooler inlet is another indication of improper drainage; however, the fact that the temperature difference is within the proper range does not necessarily indicate proper drainage.

Scale deposits are unlikely to form in the distilling condenser tubes if the plant is properly operated and a full flow of circulating water is maintained. However, if scale deposits do occur, the tubes must be cleaned.

Venting of the vapor side of the distiller condenser is continuously accomplished by the air ejector. Venting of the salt water side of this and other units of the distilling plant need not be continuous. While starting the plant and once every watch thereafter, the vents on all salt water heads should be opened until all air is expelled and a solid stream of water appears, then the vents should be closed.

Constant Brine Density

The concentration of brine in the evaporators, to a certain extent, has a direct bearing on the quality of the distillate, and since varying quantities of brine discharged overboard may affect the operating conditions, the quantity of brine discharged and the brine density must be kept as constant as possible.

If the brine concentration is too low, there will be a loss in capacity and economy. If the brine concentration is too high, there will be an increase in the rate of scaling of the evaporator heating surfaces, and the quality of the distillate will be impaired.

The brine density, which should never exceed 1.5/32, is dependent mainly on the quantity of brine pumped overboard and the amount of fresh water being produced. The density must be checked frequently during each watch and adjusted to the required density. On older distilling plants the brine density is adjusted by means of a hand-controlled valve located in the discharge line of the brine overboard pump. In plants equipped with weir control valves and in basket type plants, the brine density is controlled by adjusting the first-effect feed valve. Increasing the rate of feed decreases the brine density, and decreasing the rate of feed increases the brine density.

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Block II - Radio Servicing

Unit 1 - Audio Amplifier Repairs

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Constructing basic amplifiers	Basic principles of amplifiers Phase relationships Gain Bias classifications Signal classifications Output classifications Distortions Noise Circuit analysis Single ended Parallel Push pull Push push Cathode follower
Repairing microphone	Sound transmission Types of microphones Microphone principles and functional description
Repairing speaker	Reproduction of sound Analysis of cone design Dynamic speaker design problems Mechanical resonance in dynamic speakers Frequency and wattage characteristics Design characteristics of permanent magnet speakers Speaker impedance Woofers Tweeters Extended-range speakers Mid-range speakers Coaxial speakers Triaxial speakers Accoustical problems of high fidelity reproduction Functions of speaker enclosures Sound wave paths in enclosures Sound diffusers Bass-reflex enclosures Folded-horn enclosures

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Frequent changes of brine density have a tendency to disrupt steady performance of the plant, therefore, only very small changes should be made. The proper setting for a specific plant should be learned from experience; and this setting should be maintained as practicable.

Use of the Salinometer

The salinometer is an instrument (on the principle of a float) for measuring the degree of salinity or the concentration of the brine. It is a hollow, metal vessel weighted at the bottom, and having a projecting stem which is graduated in four scales to read the salinity for various temperatures of the brine. The graduations are marked in thirty-seconds. When the salinity of a sample of brine is to be measured, the temperature of the sample should be brought to a temperature corresponding to that of one of the scales on the instrument in order than an accurate reading may be obtained. The accuracy of the salinometer should be checked occasionally by placing it in distilled water; if it is accurate, it should sink to the zero mark on the scale corresponding to the temperature of the water.

A pot is provided for holding the sample of brine. The pot must be amply deep so that there is no danger of breaking the bottom of the salinometer when it is placed in the pot. To use the salinometer proceed as follows:

1. Draw off a sample of brine, from the test cocks on the discharge side of the brine pump, then insert the thermometer into the sample.
2. Allow the sample to cool to the temperature of one of the scale temperatures.
3. Put the salinometer in the pot and read the degree of salinity.
4. Remove the salinometer and wipe off all moisture since accumulations of salt or dirt will result in false readings.

FLASH TYPE DISTILLING UNITS

Many ships built since World War II are equipped with flash type distilling plants. Information on principles of operation of this type distilling plant can be found in Machinist's Mate 3 & 2, NavPers 10524-C. This training course contains information on maintenance procedures, but for details on any specific plant, consult the manufacturer's technical manual.

The flash type evaporator, like all distilling plants, removes salts and other impurities from raw sea water by the process of evaporation and condensation. This is accomplished by boiling the water to convert it to steam and condensing this steam to form distilled water. The flash evaporator is different from other distilling plants, because evaporation takes place at temperatures well below the normal boiling point of water and without the use of submerged heat transfer surfaces.

In the flash type distilling plant, the temperature of the water is never raised beyond 175°F, and is only raised to this temperature within the last pass of tubes of the salt water heater. Flash evaporation takes place at temperatures as low as 104° F. In addition, no boiling occurs on heat transfer tube surfaces, as a result this greatly reduces scale formation and prolongs operation at maximum efficiency.

The term "flash evaporation" means that water is converted to steam as it enters an evaporating chamber, without further addition of heat. Flashing at low temperatures is possible only when a vacuum is maintained in the chamber, since the boiling point of water decreases as the pressure in the chamber is reduced. As in other methods of distillation, a portion of the water remains behind in the evaporating chamber and is taken off as a concentrated waste (brine).

PRINCIPAL COMPONENTS

The unit discussed in this section is a five-stage plant in which feed water is flashed to vapor in five evaporator stages at successively lower pressures.

Connections, or passages, that exist between evaporator stages are the feed water and distillate loop seals, which permit the flow of feed water and distillate from stage to stage while preserving the varying degrees of vacuum in each stage.

The condensers are mounted on top of each stage between the front and rear water boxes. Feed water flows through the tubes in six passes, entering at the lowest tubes at the front of the condenser, reversing direction at the water boxes three times and leaving at the top of the tubes in the condenser. Each condenser has a pet cock for venting entrained air or noncondensable gases.

The evaporator stages become larger in the direction of reduced pressure. The feed water loop seals which extend from the bottom of evaporator stage one through four are visible as cylinders. An evaporator drain is located in the center of the dished bottom of each loop seal. The flanged brine outlet from the evaporator is at the bottom of the fifth stage.

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The distillate loop seal between the distillate collection trough of one stage and the condensers of the following stages also protrude below the bottom of the evaporator.

If the salinity of the distillate reaches .065 EPM per gallon a warning device indicates the high salinity. The salinity cell shutoff valves permit withdrawal and descaling of the salinity cells without securing the unit.

Although each stage condenser produces an equal amount of distillate, the amount flowing from each stage is larger than the preceding, as the distillate accumulates in its flow toward the distillate cooler. Consequently, the loop seal piping grows progressively larger.

The total distillate production of the five stages is withdrawn from the bottom of stage five and pumped into the shell of the distillate cooler, and on to the storage tanks.

THE DISTILLATE COOLER is a heat exchanger of the shell and tube type, in which the heat of the hot distillate flowing around the tubes is transferred by conduction to the cooler feed water flowing through the tubes.

Distillate flows into the shell space surrounding the tubes through an inlet near the feed water outlet. The distillate is retained in the cooler long enough to efficiently transfer its heat through the tubes by vertically placed baffles, as it flows from top to bottom of the cooler.

Thermometers are mounted on the inlet and outlet piping of the cooler. Another thermometer is mounted on the feed water inlet piping.

As the distillate leaves the cooler it is pumped to storage tanks, providing the salinity does not exceed .065 epm per gallon. (If the salinity exceeds .065 epm per gallon, a solenoid trip valve operated by a salinity indicating cell, dumps the distillate to the bilges or waste tank until the salinity is again back to or below .065 epm per gallon.)

Pet cocks are located on each end of the cooler so as to bleed off any accumulation of air or noncondensable gases.

THE FEEDWATER PREHEATER is a gas or liquid heat exchanger of the shell and tube type, similar in design to the distillate cooler. The preheater is located in the feed water line between the condenser of the first evaporator stage and the salt water heater.

High pressure ship's steam, first used by the air ejectors to evacuate the stage evaporators, is piped into the preheater shell. A series of five baffles, spaced close together in the top steam outlet reduces the velocity of the steam which condenses on the outside of the heat transfer tubes.

Feed water that has already been partially heated in the tubes of the distillate cooler and the five-stage condensers flows through the tubes of the preheater via the front water box in a single pass, acquiring the heat of condensation of the air ejector steam before leaving the preheater at the rear water box outlet.

A salinity cell, set to energize at 0.10 epm operates a shutoff valve in the piping below the condensate outlet to dump high salinity water to bilge or drain tank. A 6-inch loop seal in the condensate line is necessary to ensure that the salinity cell is submerged at all times.

A thermometer is located on the front of the preheater, a pet cock for venting is also located on the water box.

THE SALT WATER HEATER is a gas or liquid heat exchanger designed to raise the feed water temperature prior to its entrance into the flash chamber of the first evaporator stage. The salt water heater is mounted on the operating end of the evaporator and extends the full width of the unit. Feed water enters and leaves the heater from the front water box after making four passes through the heater.

Four thermometers are installed on the heater, two to measure the feed water inlet and outlet temperature; a third, mounted on the heater shell to measure the steam temperature surrounding the tubes; a fourth is mounted on top of the heater shell to measure the temperature of the desuperheating temperature in the steam side.

Low pressure steam in the heater passes through an orifice which provides, within limits, a uniform flow of steam. It then flows past the desuperheater nozzle, which reduces steam temperature in the shell of the heater. Steam pressure is indicated by a pressure gage on the operating panel.

The entering steam is directed along the length of the tubes by impingement baffles, which prevent erosion of the tubes. Steam condenses on the tubes and falls to a condensate well at the bottom of the heater shell. (A drain regulator of the float-type controls the level of the condensate in the well. A salinity cell, set to energize at 0.10 epm controls a shutoff valve located in the ship's piping between the drain pump and regulating valve.) The desuperheater atomizes the heater condensate in the low pressure steam side of the heater.

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ejector. The discharge of the third ejector is flanged to piping, containing a check valve, which runs diagonally across the top of the evaporator shell to the air ejector steam inlet of the preheater shell near the front water box.

The pressure of ship's steam piped to the ejectors is indicated on the independently mounted pressure gage panel. Line pressure to the air ejectors must be maintained at or above 135 psig, as a lower pressure will cause unstable operation of the ejector and will affect the vacuum in the evaporator.

A DUPLEX STRAINER, located in the ship's feed water inlet piping, removes solid matter from sea water by filtering through one of two perforated and screened bronze baskets. Basket wells are located in the body or housing of the strainer on either side of the centrally located flanged inlet and outlet.

A lever handle between the wells directs the feedwater into the left-or right-hand well. When one basket becomes clogged, flow is switched to the other and the clogged basket should be removed and cleaned.

An inlet and outlet angle-type RELIEF VALVE is flanged into the feed water inlet between the feed water pump and the air ejector precooler. The valve is set to open at 75 psig to prevent pressure buildup from an obstruction in the feed water lines or accidental operation of the feed water pump with the feed water control valve closed.

Two FLOWRATORS are mounted on the unit to measure the amount of feed water and cooling water pumped into the system. Since the amount of fluid to be measured in both cooling and feed water lines is large, the flowrators are mounted in bypass piping arrangements, measuring a small portion of the actual main stream flow but providing a reading on the graduated scale in bypass piping arrangements, measuring a small portion of the actual main stream flow but providing a reading on the graduated scale of the cylinder for the entire flow. Main stream and range orifices are provided for each flowrator.

The flowrators serves as manometers. The pressure drop across the manometer is equal to the pressure drop created by the constriction of the main stream orifice. The range orifice at the inlet of the flowrator constricts the bypass flow so that a maximum main stream flow will register a maximum reading on the flowrator scale.

MAINTENANCE OF FLASH TYPE UNITS

Many maintenance procedures for a flash type distilling plant are similar to the maintenance procedures required for a submerged tube plant. Both types of plants are subject to air leakage, salt water leakage, and malfunctioning of pumps and other auxiliary equipment. Some of the more important maintenance problems will be discussed in the following paragraphs.

Air Leakage

Since all parts of the distilling plant are designed to operate under a vacuum except the circulating, feed, and fresh water lines, extreme care must be taken to prevent leakage of air which might seriously interfere with the proper operation of the plant.

The brine overboard and distillate pumps take their suction from points of relatively high vacuum. Air leakage in the piping to these pumps is particularly objectionable and must be eliminated. A small amount of air entering these lines, even though it is insufficient to affect the distilling plant vacuum, may cause the pump to lose suction. Leaks in the lines to the pump suction gages must not be overlooked.

An 8 to 10 psig, low pressure hydrostatic test should be applied to the entire system at least once a month, and at any other time when there is an indication that air leakage may exist. The salt water circulating pump can be used to apply the pressure.

Pumps

Proper operation of all pumps is essential for the successful operation of the distilling plant. The effect of air leakage into the suction line of the pumps has been discussed in the preceding paragraph. Proper operation of the water sealed gland lines and proper maintenance of the glands themselves are necessary for dependable operation of the pumps. General information on operation and maintenance of pumps may be found in Machinist's Mate 3 & 2, NavPers 10524-C, and in this training course; however, for details of any specific pump, consult the manufacturer's technical manual.

Salt Water Leakage

Salt water to distillate or salt water to condensate leaks at any of the various tube bundles

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will be immediately indicated by an alarm bell and a red light which shows at which cell a conductivity increase has occurred. The cells are located downstream from each tube bundle. Tube leaks usually result from damaged or corroded tubes or from improper expansion of tubes into tube sheets.

Faulty tubes may be sealed with plastic tube plugs or may be removed and replaced in accordance with standard Navy procedures, as given in chapter 9460 (46) of NavShips Technical Manual.

Cleaning Heat Exchangers

The tubes of the distillate cooler, air ejector condenser, and the stage condensers operate with comparatively cool salt water inside them and will seldom require cleaning. The sea water in the salt water heater is at a higher temperature and these tubes will occasionally require cleaning to remove the hard scale on the inside of the tubes. A special tool is furnished for this purpose; this cleaning tool is shown in figure 9-1.

The procedure for cleaning salt water heaters is as follows: Remove the waterheads. Insert the special cleaning tool in the tube and drive it with a 250 to 300 rpm motor. The motor should be of the reversible type. Feed a light stream of water into the opposite end of the tube to wash the scale from the cutting tool and out of the tube. A light stream of compressed air may be substituted in place of the water. Care should be taken not to drive the tool too fast and to be certain that the tool is straight when inserted into the tube.

An 8 to 10 psig hydrostatic test should be performed on the shell of the salt water heater before replacing the heads. If a greater test pressure is used, the relief valve will have to be plugged or removed.

Cleaning Feed Boxes

If feed flow is below normal and the distiller feed pump discharge is normal, the first-stage flash orifices may be plugged. Fouling of the second-stage orifices may be evidenced by water backing up into the first stage; however, the second-stage orifices are larger and will not be as readily plugged. Water backing into the first stage may also be caused by insufficient pressure difference between the stages.

Since the temperatures that exist in the feed boxes are well below the range in which salt water scale forms, the only plugging or fouling expected at the orifices would come from the introduction of foreign matter into the system. Should the orifices in either stage become plugged, it will be necessary to remove the access plate at the front of the unit, remove the perforated plates from the feed box and remove the obstructing material from the orifices. The feed boxes are constructed so that the front can be readily removed for access to the orifices.

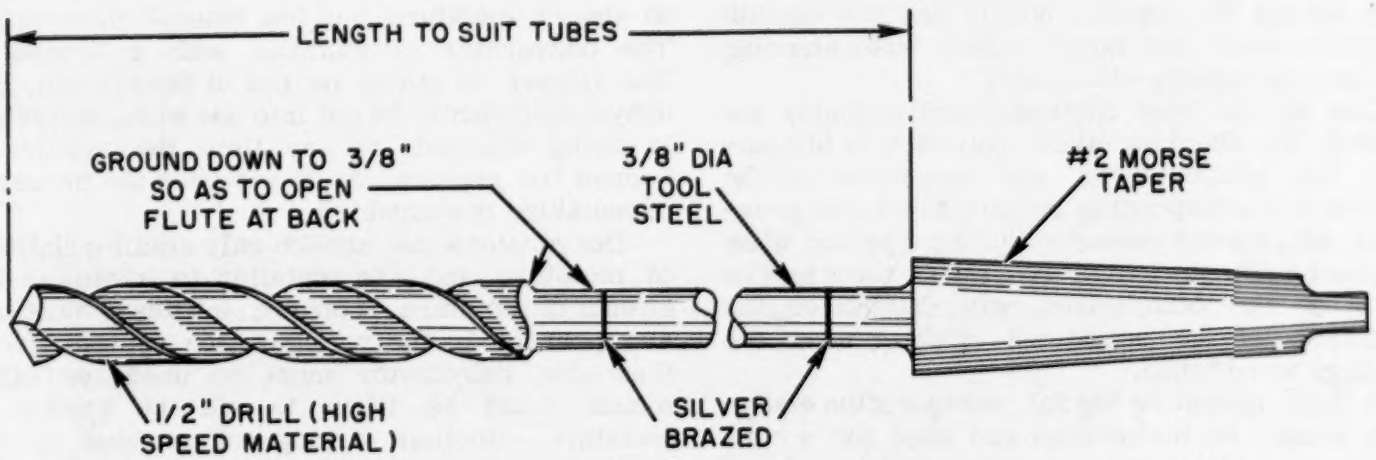

Figure 9-1.— Tool for removing scale inside tubes.

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CHAPTER 10

AIR CONDITIONING AND REFRIGERATION

On some Navy ships, the proper operation and maintenance of air conditioning and refrigeration plants are responsibilities of the MM1 and MMC assigned to the A division. This chapter deals with some of the major operational and maintenance problems encountered with R-12 plants aboard ship. The plants installed aboard Navy ships vary in many respects; for details on any specific plant, the manufacturer's technical manuals are the prime source of information.

OPERATION

Proper operation of any unit of machinery is an important part of maintenance. Efficient performance of the refrigeration plant requires that the operator have a thorough knowledge of the operating principle, make periodic inspections, and perform maintenance at prescribed intervals. The temperature and pressures throughout the system and the oil level in the compressor crankcase should be checked hourly and the results recorded every two hours unless watchstanding instructions specify otherwise.

One of the best methods, and probably the easiest, for checking plant operation is to compare the temperatures and pressures of the plant with corresponding temperatures and pressures which were recorded during a period when the plant was known to be operating properly. The value of the comparison will depend on the similarity of the conditions existing when the readings were taken.

A daily operating log for refrigeration equipment should be maintained and used for a continuous analysis of the operating conditions found in a refrigeration plant. Record readings in log every two hours. A sample of the log, NavShips 4731 (6-57), may be found in Machinist's Mate 3 and 2, NavPers 10524-C.

Refrigeration plants are equipped with automatic controls and once the plant is in normal operation, very little attention is required. However, these plants are, like all units of machinery, liable to casualties, so periodic checks must be made to ensure that the plant is operating normally. The main purpose of the operating log is to ensure that abnormal operating conditions do not go undetected.

Usually the personnel assigned to operate and maintain refrigeration plants are graduates of an air conditioning and refrigeration school. However, on small ships, the men assigned to make the periodic checks on the refrigeration plants may or may not have attended this school. These men must be properly indoctrinated as to how to take and record the temperatures and pressures in a refrigeration plant and also as to why these readings are important for the operation of the plant.

USING THE DEHYDRATOR

A dehydrator is installed in the liquid line between the receiver and the expansion valve to absorb moisture that has entered the system. The dehydrator is installed with a bypass so that it may be cut in or out of the system. The dehydrator should be put into use when the system is being charged, at any time the system is opened for repairs, or at any time the presence of moisture is suspected.

Dehydrators can absorb only small quantities of moisture and are installed to minimize the effects of moisture. If large quantities of moisture are present in the refrigeration system, more than one dehydrator must be used, or other means must be taken to rid the system of moisture. Another drying-out process is described in this chapter under "Evacuating and Dehydrating the System."

V-BELT DRIVE

Belts must be properly tightened. Excessive looseness will cause slippage, rapid wear, and deterioration of V-belts. On the other hand, a

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belt that is too tight will result in excessive wear of both the belt and main bearing of the compressor. In extreme cases, it may cause a bad seal leak. If a belt is properly tightened, it should be possible to depress it, by the pressure of one finger, as much as 1/2 to 3/4 inch, at a point midway between the flywheel and motor pulleys.

When replacement of one belt of a multiple V-belt drive is necessary, a complete new set of matched belts should be installed. Belts stretch considerably during the first few hours of operation. Replacement of a single belt will upset the load balance between the new and old belts and be a potential source of trouble. It is a better practice to run the unit temporarily with a defective belt removed than to attempt to operate a new belt in conjunction with two or more seasoned belts.

V-belts, motor pulleys, and compressor flywheels should be kept dry and free of oil. Belt dressing should never be used.

CHECKING COMPRESSOR OIL

If the apparent oil level observed immediately after a prolonged shutdown period is lower than normal, it is almost certain that the actual working oil level is far too low. After a sufficient quantity of oil has been added to raise the apparent oil level to the center of the bull's-eye sight glass, on the side of the compressor, the actual oil level should be checked as follows:

1. Operate the compressor on manual control for at least one hour. Then slowly close the suction line stop valve. If the compressor is operating on a water cooler or other coil which is apt to freeze, observe the temperature and interrupt compressor operation as necessary to prevent freezing. Repeat cycling until the total running time (one hour) is obtained.
2. Stop the compressor and immediately observe the oil level in the sight glass.

To check the oil level when the compressor has been running on its normal cycle, with no abnormal shutdown, proceed as follows:

1. Wait until the end of a period of operation; if the operation is continuous, wait until the compressor has been in operation at least 1/2 hour.
2. As soon as the compressor stops, observe the oil level in the sight glass.

Do not remove oil from the crankcase because of an apparent high level unless it is known that too much oil has been previously added, or unless it is apparent that oil from the crankcase of one compressor of the plant has been inadvertently deposited in the crankcase of another.

However, if the oil level is lower than its recommended height on the glass, additional oil should be added. Do not add more oil than is necessary to obtain the desired level. Too much oil can result in excessive oil transfer to the cooling coils.

Adding Oil

There are two common methods of adding oil to a compressor. In one type of installation a small oil-charging pump is furnished for adding oil to the compressor crankcase. In another type, oil is placed in the compressor by means of a clean, well-dried funnel. In either case, care must be taken to prevent the entrance of air or foreign matter into the compressor.

When performing hourly checks of the compressors, you may observe no oil in the crankcase, or a very low oil level on the sight glass. This indicates that the oil has left the compressor and is circulating in the system; and that it will be necessary to add oil to the normal level and operate the system. After the compressor has reclaimed the excessive oil in the system, the added oil should be drained.

Removing Oil

To remove oil from the compressor crankcase reduce the pressure in the crankcase to approximately 1 psi by gradually closing the suction line stop valve. Then stop the compressor and close the suction and discharge line valves. Before loosening the oil drain plug, check the pressure to ensure it is not increasing due to refrigerant being released from the oil at this lower pressure. If the pressure does increase, it may be necessary to pump the compressor down again before removing the excess oil. LOOSEN the lubricating oil drain plug near the bottom of the compressor crankcase, and allow the required amount of oil to drain out. Since the compressor crankcase is under a slight pressure, do not fully remove the drain plug from the compressor, but allow the oil to seep out around the threads of the lossened plug. When the desired amount of oil has been removed, tighten the drain plug, open the suction and discharge line valves, and start the compressor. If an oil drain valve is provided in lieu of a plug, the required amount of oil may

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be drained without the necessity of pumping down the compressor. Used refrigeration oil should be handled as a refrigerant.

Changing Oil

When clean copper tubing is employed for the mains and evaporators, and reasonable care has been taken to prevent the entrance of foreign matter during installation, the oil in the compressor crankcase will probably not become sufficiently contaminated to require renewal. When iron or steel pipe and fittings are used in the system, a sample of oil from the compressor crankcase should be withdrawn into a clean glass vessel every three months. If the sample shows contamination, the entire lubricating oil charge should be renewed. It is a good practice to check the cleanliness of the lubricating oil after each cleaning of the compressor suction scale trap.

MAINTENANCE

As an MM1 or MMC, maintaining the refrigeration and air conditioning plants may be one of your responsibilities. In order for you to perform the required maintenance you must understand the proper operating and maintenance procedures. In most instances, personnel who are assigned to maintain refrigeration plants are graduates of the Navy's Air Conditioning and Refrigeration School. While this school teaches most operating and maintenance procedures, the manufacturer's technical manuals should be referred to for the details of the plants on your ship.

COMPRESSOR MAINTENANCE

Refrigeration compressors vary to such an extent that this training course could not cover each type. The manufacturer's technical manuals must be referred to for details of any specific unit. Compressors range from small reciprocating types (for drinking water coolers) to very large centrifugal units used for air conditioning on large ships. Compressors may be splash lubricated or forced-feed lubricated. Centrifugal compressors are seldom used on plants smaller than 110 tons. They operate on the same principle as a centrifugal pump, except that they are designed to pump a gas instead of a liquid. Reciprocating compressors are used for air conditioning on most ships.

If a compressor cannot be pumped down and is damaged to the extent that it has to be opened for repairs, it is necessary to first close the suction and discharge stop valves and then allow all refrigerant in the compressor to vent to the atmosphere, through a gage line.

To service a compressor correctly, it is necessary to be familiar with the manufacturer's technical manual. These manuals usually give a step-by-step procedure for disassembling the compressor and for renewing any part of the unit.

Before disassembling a compressor, make certain that the faulty operation of the unit is not caused by trouble in some other part of the system. Disassemble only the part of the compressor that is necessary to correct the fault. As internal machined parts are removed, every precaution should be taken to protect them from being damaged in handling and from corrosion.

Before starting to reassemble a compressor, all parts—including replacement parts—should be carefully washed in an approved solvent and permitted to dry in air. The final rinse should be made with clean solvent. The parts should be wiped with a lintfree cloth before the unit is assembled. Every precaution should be taken to prevent dirt, lint, water, or other foreign matter from entering the compressor during reassembly.

When it becomes necessary to remove, replace, or repair internal parts of the compressor, the following precautions should be observed:

1. Carefully disassemble and remove parts, noting the correct relative position so that errors will not be made when reassembling.
2. Inspect all those parts that become accessible due to the removal of other parts requiring repair or replacement.
3. Make certain that all parts and surfaces are free of dirt and moisture.
4. Apply compressor oil freely to all bearing and rubbing surfaces of parts being replaced or reinstalled.
5. If the compressor is not equipped with an oil pump, make certain that the oil dipper on the lower connecting rod is in correct position for dipping oil when the unit is in operation.
6. Position the ends of the piston rings so that alternate joints come on the opposite side of the piston.
7. Care should be taken not to score gasket surfaces.
8. Renew all gaskets.
9. Clean the crankcase and renew the oil.

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Whenever repairs to a compressor are of such a nature that any appreciable amount of air enters the unit, the compressor should be evacuated, after assembly is completed. The proper procedure is as follows:

1. Disconnect a connection in the compressor discharge gage line, between the discharge line stop valve and the compressor.
2. Start the compressor and let it run until the greatest possible vacuum is obtained.
3. Stop the compressor and immediately open the suction stop valve slightly in order to blow refrigerant through the compressor valves and purge the air above the discharge valves through the open gage line.
4. Close the discharge gage line and open the discharge line stop valve.
5. Remove all oil from the exterior of the compressor and test the compressor joints for leakage; use a halide leak detector or an electronic leak detector.

Testing Suction and Discharge Valves

Faulty compressor valves may be indicated either by a gradual or a sudden decrease in the normal compressor capacity. Either the compressor will fail to pump at all, or else the suction pressure cannot be pumped down to the designed value, and the compressor will run for abnormally long intervals or even continuously. If the compressor shuts down for short periods, the compressor valves may be leaking.

If the refrigeration plant is not operating satisfactorily, it will be best to first shift the compressors and then check the operation of the plant. If the operation of the plant is satisfactory when the compressors have been shifted, the trouble is in the compressor, and not in the system.

The compressor discharge valves may be tested by pumping down the compressor to 2 psig, and then stopping the compressor and quickly closing the suction and discharge line valves. If the discharge pressure drops at a rate in excess of 3 pounds in a minute and the crankcase suction pressure rises, there is evidence of compressor discharge valve leakage. If it is necessary to remove the discharge valves with the compressor pumped down, open the connection to the discharge pressure gage in order to release discharge pressure on the head. Then remove the compressor top head and discharge valve plate, being careful not to damage the gaskets.

If the discharge valves are defective, the entire discharge valve assembly should be replaced. Any attempt to repair them would probably involve relapping, and would require highly specialized equipment. Except in an emergency, such repair should never be undertaken aboard ship.

The compressor internal suction valves may be checked for leakage as follows:

1. Start the compressor by using the manual control switch on the motor controller.
2. Close the suction line stop valve gradually, to prevent violent foaming of the compressor crankcase lubricating oil charge.
3. With this stop valve closed, pump a vacuum of approximately 20 inches Hg. If this vacuum can be readily obtained, the compressor suction valves are satisfactory.

Do not expect the vacuum to be maintained after the compressor stops, because the Refrigerant-12 is being released from the crankcase oil. Do not attempt to check compressor suction valve efficiency of new units until after the compressor has been in operation for a minimum of 3 days. It may be necessary for the valves to wear in.

However, if any of the compressor suction valves are defective, the compressor should be pumped down, opened, and the valves inspected. Defective valve(s) or pistons should be replaced with spare assemblies.

Crankshaft Seal Repairs

On reciprocating compressors, the crankshaft extends through the compressor housing to provide a mount for the pulley wheel. At this point the shaft must be sealed to prevent leakage of lubricating oil and refrigerant. There are several types of crankshaft seals, depending on the manufacturer. The crankshaft seal is bathed in lubricating oil at a pressure equal to the suction pressure of the refrigerant. The first indication of crankshaft seal failure is excessive oil leaking at the shaft.

When the seal requires replacement, or signs of abnormal wear or damage to the running surfaces are present, a definite reason for the abnormal conditions exists and an inspection should be made. It is very important to locate and correct the trouble or the failure will reoccur.

Seal failure is very often the result of faulty lubrication, usually due to the condition of the crankcase oil. Dirty or broken oil is generally caused by one or both of the following conditions:

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1. Dirt or foreign material in the system or system piping. Dirt frequently enters the system at the time of installation. After a period of operation, foreign material will always accumulate in the compressor crankcase, tending to concentrate in the oil chamber surrounding the shaft seal. When the oil contains grit, it is only a matter of time until the highly finished running faces become damaged, causing failure of the shaft seal.

2. Moisture is frequently the cause of an acid condition of the lubricating oil. Oil in this condition will not provide satisfactory lubrication and will promote failure of the compressor parts. If the presence of moisture is suspected, a dryer should be used when the compressor is put into operation. At any time foreign material is found in the lubricating oil, the entire system (piping, valves, and strainers) should be cleaned thoroughly.

REMOVING SHAFT SEAL.—In the event a shaft seal must be repaired or renewed, proceed as follows:

If the seal is broken to the extent that it permits excessive oil leakage, do not attempt to pump the refrigerant out of the compressor, air (containing moisture) will be drawn into the system through the damaged seal. Moisture in the air may cause expansion valves to freeze. If oil is leaking excessively, close the compressor suction and discharge valves and relieve the pressure to the atmosphere by loosening a connection on the compressor discharge gage line. If the condition of the seal does permit, pump down the compressor as previously explained in this chapter.

Next drain the oil from the compressor crankcase. Since the oil contains refrigerant, it will foam while being drained. The oil drain valve or plug should be left open while you are working on the seal, so that refrigerant escaping from the oil remaining in the crankcase will not build up a pressure—and unexpectedly blow out the seal while it is being removed.

Remove the compressor flywheel (or coupling) and carefully remove the shaft seal assembly. If the assembly cannot be readily removed, build up a slight pressure in the compressor crankcase by slightly opening the compressor suction valve, taking the necessary precautions to support the seal to prevent it from being blown from the compressor and damaged.

INSTALLING SHAFT SEAL.—When the replacement is made, the entire seal assembly should be cleaned and replaced in accordance with the manufacturer's instructions.

Wipe the shaft clean with a linen or silk cloth, do not use a dirty or lint-bearing cloth. Unwrap the seal, being careful not to touch the bearing surfaces with the hands. Rinse the seal in an approved solvent and allow to air-dry. (Do not wipe the seal dry.) Dip the seal in clean refrigerant oil. Insert the assembly in accordance with the instructions found in the manufacturer's technical manual and bolt the seal cover in place, tightening the bolts evenly. Replace the flywheel and belts and test the unit for leaks by opening the suction and discharge valves and using a halide leak detector.

LAPPING A SHAFT SEAL.—Due to the difficulty of properly lapping the rubbing surfaces of a shaft seal, a seal leak should be corrected by renewing the assembly. If, however, a new shaft seal is not available, and it is possible to use the existing seal by refinishing the rubbing surfaces, the seal can be lapped as follows:

1. Thoroughly clean the surfaces of the shaft shoulder and seal collar.

2. Lap the back of the shaft seal collar to the crankshaft shoulder. This joint must form an absolute seal so the importance of this lapping cannot be overemphasized. Only jeweler's rouge or the equivalent should be used for the lapping. The abrasive must be used sparingly to avoid getting it into the shaft bearings or crankcase. As the lapping proceeds, use less and less abrasive and finish the lapping with the compressor lubricating oil.

3. After the lapping has been completed, thoroughly clean the shaft shoulder and permit it to dry without wiping. With the shaft seal shoulder and collar dry and clean, lap the two surfaces together as a final lapping operation.

4. The surfaces are properly lapped when the surface of both the shaft shoulder and the shaft seal collar form a perfect contact and are free of all mars, scratches, or other imperfections. It is good practice to make the final examination with the aid of a good magnifying glass.

5. In some instances, a molded synthetic rubber gasket is provided instead of the metal-to-metal joint between the shaft seal collar and the crankshaft shoulder. In any case, it is extremely important that these parts be properly fitted and that the gasket be kept in good condition in order that a tight seal be maintained at this point.

When a shaft seal is lapped in, it should be regarded as a temporary repair and a new

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Block II - Radio Servicing

Unit 1 - Audio Amplifier Repairs (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Repairing phono pickups and record players	Types of players Components involved Motor, drive and speed control Pickup arms and cartridges Magnetic units Variable-reluctance Crystal Light beam Input networks Wireless players
Repairing automatic record changers	General design features of changers Methods of record handling Sequence of mechanical operations Slicer-type changer Pusher-type changer Intermix and both-side players Lp record changers 45 rpm changers Three and four speed changers
Repairing and replacing record-playing equipment	Approach to record-changer servicing Equipment useful in record changer repair Methods of changing records Sources of information General record changer servicing Troubleshooting and performance tests Test records and pickup response Testing phono pickups and checking Equalization Troubleshooting changer mechanisms Lubrication Replacement of needles Pickup replacement Motor repairs and adjustments Special problems in servicing 45 changer Special problems in servicing 33 changer Special problems in servicing lp changer Servicing wireless record players Customer education

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assembly should be installed as soon as possible.

SYSTEM MAINTENANCE

A refrigeration system that has been properly installed and properly operated will need little maintenance. However, certain tests, inspections, and maintenance procedures must be carried out to ensure that the system will operate at its rated capacity.

Learning to start and secure a refrigeration system is not enough to do your job properly. As a Machinist's Mate you must know the operating principles of the entire system, how each unit of the system operates, and why it is necessary; how each control and safety device works, and the reason for its being installed on the system. This understanding can best be attained by attending the Air Conditioning and Refrigeration School or by studying the manufacturer's technical manuals.

For men who have not attended the Navy's Air Conditioning and Refrigeration School, a training program should be set up to ensure an adequate number of qualified personnel to operate and maintain the air conditioning and refrigeration equipment aboard each ship.

Charging the System

Information concerning the charging of refrigeration systems may be found in chapter 9590 (59) of NavShips Technical Manual. The amount of refrigerant charge must be sufficient to maintain a liquid seal between the condensing and evaporating sides of the system. When the compressor stops, under normal operating conditions, the receiver of a properly charged system is about 85 percent full of refrigerant. The proper charge for a specific system or unit can be found in the manufacturer's technical manual or on the ship's blueprints.

A refrigeration system should not be charged if there are leaks or if there is reason to believe that there is a leak in the system. The leaks must be found and corrected. Immediately following—or during —the process of charging, the system should be carefully checked for leaks.

A refrigeration system must have an adequate charge of refrigerant at all times; otherwise its efficiency and capacity will be impaired.

Checking for Noncondensable Gases

In order to check the condenser for the presence of air or noncondensable gases, it is essential that gages and thermometers be accurate and that the system has sufficient refrigerant charge so that the liquid refrigerant present in the receiver will seal the liquid line connection.

To check for noncondensable gases, proceed as follows:

1. Close liquid line valve.
2. Shut off compressor and close suction line valves.
3. Determine the actual condensing temperature.

A service gage should be installed in the compressor discharge connection when a discharge pressure gage is not already provided. An approximation of the actual condensing temperature will be reached when no further decrease is noted in the discharge pressure. The reduction in pressure can be accelerated on water-cooled condensers by permitting circulation of condenser water until discharge pressure is reduced. The thermometer in the liquid line at the receiver, provided on most vessels, will then indicate the actual condensing temperature. If a thermometer is not installed in an air-cooled condenser application, a thermometer should be placed near the condenser to record the ambient temperature at that location. When the pressure and temperature of the air-cooled condenser have lowered to the ambient temperature, a reading of the thermometer will approximate the actual condensing temperature.

4. Read the condensing temperature which corresponds to the condensing pressure registered by the high pressure gage. It is the condensing temperature of pure R-12 at this pressure.
5. Subtract the existing condensing temperature from the condensing temperature of pure R-12 at the existing condenser pressure. If the difference between these two temperatures is more than 5° F, it is necessary to purge.

Purging Noncondensable Gases

If the above test indicates the presence of air or noncondensable gases in the condenser, stop the compressor for 10 or 15 minutes with all valves in their normal position; then, slowly release gases by means of the purge valve provided or by opening the discharge gage connection when no purge valve is furnished.

The proportion of R-12 gas that will mix with the noncondensable gases and escape while the condenser is being purged will depend upon the

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rate of purging and concentration of the noncondensable gases in the condenser. Furthermore, no practical test is available aboard ship to determine definitely when an excess proportion of refrigerant gas is being purged with the noncondensable gases or when the purging operation should be discontinued. To keep the R-12 loss to a minimum while purging, purge slowly and continually check the condenser for the presence of noncondensable gases as explained above.

Cleaning Suction Strainers

When putting a new unit into operation, the suction strainers should be cleaned after a few hours of operation. Refrigerants have a solvent action and will loosen any foreign matter in the system. This foreign matter will eventually reach the suction strainers. After a few days of operation, the strainers will need another cleaning. They should be inspected frequently during the first few weeks of plant operation, and then cleaned as found necessary.

The suction strainers are located in the compressor housing or in the suction piping. The procedure for cleaning the strainers is as follows:

1 Pump down the compressor.
2. Remove the strainer and inspect it for foreign matter.
3. Clean the strainer screen by dipping it in an approved solvent and then allow it to dry.
4. Replace the strainer and evacuate the air from the compressor.
5. Test the housing for leaks by wiping up all oil and then using a halide leak detector.

Cleaning a Liquid Line Strainer

Where a liquid line strainer is installed, it should be cleaned at the same intervals as the suction strainer. If a liquid line strainer becomes clogged to the extent that it needs cleaning, a loss of refrigeration effect will take place. The tubing after the strainer will be much colder than the tubing ahead of the strainer.

To clean the liquid line strainer, secure the receiver outlet valve and wait a few minutes to allow any liquid in the strainer to flow to the cooling coils. Then close the strainer outlet valve and very carefully loosen the cap which is bolted to the strainer body. (Use goggles to protect the eyes.) When all of the pressure is bled out of the strainer, remove the cap and lift out the strainer screen. Clean the strainer screen, using an approved solvent and a small brush. Reassemble the spring and screen in the strainer body, then replace the strainer cap loosely. Purge the air out of the strainer, by blowing refrigerant through it, then tighten the cap. After the assembly is complete, test the unit for leaks.

Cleaning Oil Filters and Strainers

Compressors arranged for forced feed lubrication are provided with lubricating oil strainers in the suction line of the lube oil pump and an oil filter may be installed in the pump discharge line. A gradual decrease in lubricating oil pressure indicates that these units need cleaning. This cleaning may be accomplished in much the same manner as described for cleaning suction strainers.

When cleaning is necessary, the lubricating oil in the crankcase should be drained from the compressor and measured. A new charge of oil of equal amount should be added before restarting the unit. When the compressor is put back into operation, the lube oil pressure should be adjusted to the proper setting by adjustment of the oil pressure regulator.

CONDENSERS

The compressor discharge line terminates at the refrigerant condenser. In shipboard R-12 installations, these condensers are usually of the multipass shell-and-tube type, with water circulating through the tubes. The tubes are expanded into grooved holes in the tube sheet so as to make an absolutely tight joint between the shell and the circulating water. Refrigerant vapor is admitted to the shell, and condenses on the outer surfaces of the tubes.

Any air which may accidentally enter the refrigeration system will be drawn through the piping and eventually discharged into the condenser with the R-12 gas. The air accumulated in the condenser is lighter than the refrigerant gas and will rise to the top of the condenser when the plant is shut down. A purge valve, for purging accumulated air from the refrigeration system (when necessary), is installed at the top of the condenser, or at a high point in the compressor discharge line.

Checking Condenser Performance

An overall check for water-cooled condenser performance may be used after, AND ONLY AFTER, the condenser has been properly purged. After the condition of the condensing surface has been determined, make preliminary prepa-

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rations to the system as outlined in the procedure, discussed earlier in the chapter, used to check for noncondensable gases. Then proceed as follows:

1. Record the condensing temperature which corresponnds to the pressure in the condenser, while the compressor is in operation.
2. Record the temperature of the water leaving the condenser.
3. Subtract the temperature of the water leaving the condenser from the condensing temperature obtained in (1). The temperature of the water leaving the condenser will be several degrees below the condensing temperature of pure R-12.
4. Clean the water side of the condenser, if the difference between the temperature of the outlet circulating water and the temperature corresponding to the condensing pressure increases 5° F to 10° F above the temperature difference obtained when the condenser was in good condition and operating under similar heat loads, and if this difference is not caused by an overcharge of refrigerant or noncondensable gases.

Cleaning Condenser Tubes

In order to clean the condenser tubes properly, it is necessary first to drain the cooling water from the condenser and then to remove the water connections and water chests. When the water chests are removed, be careful not to damage the gaskets between the tube sheet and the water side of the water chest. Tubes should be inspected as often as practicable and be cleaned as necessary by the use of an approved method for cleaning steam condenser tubes, as stated in chapter 9460 (46) of NavShips Technical Manual. Rubber plugs and an air or water lance should be employed when necessary to remove foreign deposits. It is essential that the tube surfaces be kept clear of particles of foreign matter; however, care must be taken not to destroy the thin protective coating of corrosion products on the inner surfaces of the tubes. If the tubes become badly corroded, they should be replaced in order to avoid the possibility of losing the R-12 charge and admitting salt water to the R-12 system.

Cleaning Air-Cooled Condensers

Although the large plants are equipped with water-cooled condensers, auxiliary units are commonly provided with air-cooled condensers, and this eliminates the necessity for circulating water pumps and piping.

The exterior surface of the tubes and fins on an air-cooled condenser should be kept free of dirt or any matter that might obstruct heat flow and air circulation. The finned surface should be brushed clean with a stiff bristle brush as often as necessary. When installations are exposed to salt spray and rain through open doors or hatches, care should be taken to minimize corrosion of the exterior surfaces. The finned surface is usually coated with solder and should never be painted; it may be retinned if necessary.

Testing for Leaks

To prevent serious loss of refrigerant through leaky condenser tubes, the condenser should be tested for leakage once every two weeks. The test should always be conducted on a condenser that has not been in use for the preceding 12 hours. Slowly open the vent valves on the water side, one at a time, and insert the exploring tube of a leak detector. If this test indicates that R-12 gas is present, the exact location of the leak may be detected by the following method:

1. Remove the water heads and listen at each section for the hissing sound that indicates gas leakage. If the leak cannot be definitely located, all the tubes must be checked. However, if the probable location of the leaky tubes is found, treat that section as follows:
2. Wash the tube heads, and with a cloth or ball of cotton clean all tubes (while wet) until the inner walls are dry and shining. Then hold the exploring tube in one end of each condenser tube for about 10 seconds. As soon as fresh air is drawn into the tube, drive a cork into each end of the tube. If necessary, repeat this procedure with all the tubes in the condenser. Before proceeding further, allow the condenser to remain in this condition for 48 hours.
3. After the tubes have been corked up for 48 hours, put three men on the job, one to remove corks at one end, another to remove corks at the other end and handle the exploring tube, and the third man to watch the color of the flame in the lamp. Start with the top row of tubes in the section being inspected, remove the corks simultaneously at each end of the tube, and insert the exploring tube for 5 seconds.
4. Mark any leaky tubes for later identification.

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5. Leakage of any of the tube joints is indicated by the presence of oil at the joint, after the 48-hour period.

To date, this procedure has been found to be the only method which gives conclusive evidence; in most cases, this method has given satisfactory results.

Retubing Condensers

The general procedure for retubing condensers has been outlined in chapter 6 of this training course. One specific illustration of retubing a refrigerant condenser is as follows:

1. Drill into both ends of the faulty tube, or tubes, with a 19/32-inch drill, to a depth of 1/16 inch less than the actual thickness of the tube sheet.
2. Insert the condenser knockout bar. Then insert, in the other end of the tube, a bar 1/2 inch x 6 inches.
3. Proceed to the other end of the condenser and drive out the faulty tube by using the knockout bar.
4. Follow the above procedure for any further tube removal.
5. Cut the new tube 1/8 inch longer than the overall length of the condenser (heads removed).
6. Both ends of the tubes must be square and all inside and outside burrs removed.
7. Insert the new tube in the condenser, leaving 1/16 of an inch protruding from each end.
8. Secure the spacing bar over one end of the tube.
9. Oil the rolling tool, insert it in the tube, and roll the tube into serrations.
10. Remove the spacing bar and roll that end of the tube by the above method.
11. Insert the belling tool and keep rotating while belling. Do not strike too hard on the belling tool.
12. After belling both ends of the tube, grind off the ends flush with the tube sheet.
13. Open the discharge line valve into the condenser, and open any other valves necessary to get gas from the compressor into the condenser.
14. Using the pressure thus obtained, test the condenser for leaks, with the halide torch.
15. If any small leaks exist, reroll the leaking tube. (Spacers are used on the rolling tool to prevent the use of maximum rolling effect on a preliminary rolling operation. Additional rolling effect may be obtained by removing one of these spacers.)
16. Reassemble the condenser.

EXPANSION VALVES

In order to diagnose troubles in a ship's refrigeration plant, it is essential that the MM1 or MMC have a thorough understanding of the principles and operation of expansion valves.

Thermostatic Expansion Valve

FUNCTION.—The thermostatic expansion valve controls the quantity of refrigerant admitted to the cooling coil and reduces the pressure of this refrigerant to that pressure maintained in the coil. The valve also operates to feed into the coil the amount of refrigerant necessary to keep the coil working at maximum effectiveness and in accordance with heat load variation, and to prevent the flooding back of liquid refrigerant to the compressor.

OPERATION.—It is apparent that, if the suction gas leaving the cooling coil is at the saturated vapor temperature of the refrigerant and the R-12 in the control bulb is also at this temperature, the control bulb pressure transmitted to the top of the valve diaphragm will be equal to the suction pressure transmitted to the lower side of the diaphragm through the equalizing line. The valve needle will be in the closed position, because of upward pressure exerted by the valve spring. The continued operation of the compressor maintains or lowers the cooling coil suction pressure, but since the valve is closed and no liquid refrigerant is supplied to the coil, the temperature of the coil rises because of the heat absorbed from the space being cooled. The R-12 in the control bulb is in turn heated; and its pressure increases to maintain a saturated pressure corresponding to the cooling coil suction gas temperature. The pressure on top of the power element diaphragm increases, overcomes the spring pressure, and causes the valve needle to open, thus permitting the flow of refrigerant liquid into the coil.

The liquid refrigerant is evaporated during its passage through the coil. Upon leaving the outlet end, the cold vapor cools the R-12 in the control bulb and decreases the upper diaphragm pressure, tending to close the valve. This reduction in valve opening reduces the quantity of refrigerant fed to the cooling coil

and permits evaporation of all the liquid be-before the refrigerant reaches the outlet end where the control bulb is located. The refrigerant vapor becomes superheated during its passage through that part of the coil beyond the point where all liquid is evaporated.

The amount of superheat depends on the valve spring pressure exerted on the diaphragm. For a given spring setting, the valve maintains a relatively constant degree of superheat at the coil outlet, ensuring that all R-12 liquid is evaporated before it leaves the coil to return to the compressor.

EXTERNAL EQUALIZER.—The external equalizing connection is provided for relatively large cooling coil installations where a considerable pressure loss may be expected to occur because of the length of coil travel or the distribution method. This equalizing line is connected to the cooling coil at a convenient point where the desired operating pressures will be reflected.

For small installations the pressure drop through the coil is correspondingly small, and the refrigerant pressure at the valve outlet is practically equal to that at the coil outlet where the control bulb is located; in such an installation the external equalizing line is unnecessary. Instead, the expansion valve is provided with an internal equalizing port, to adjust the pressure on the lower side of the diaphragm so that it will equal the pressure at the valve outlet.

TESTING AND ADJUSTMENT.—When the thermostatic expansion valve is operating properly, the temperature at the outlet side of the valve is much lower than that at the inlet side. If this temperature difference does not exist when the system is in operation, the valve seat is probably dirty and clogged with foreign matter.

Once a valve is properly adjusted, further adjustment should not be necessary. The major trouble encountered can usually be traced to moisture or dirt collecting at the valve seat and orifice.

By means of a gear and screw arrangement, the thermostatic expansion valve is adjusted to maintain a superheat ranging approximately from 4° F to 12° F at the cooling coil outlet. The proper superheat adjustment varies with the design and service operating conditions of the valve, and the design of the particular plant. Increased spring pressure increases the degree of superheat at the coil outlet and decreased pressure has the opposite effect. Many thermostatic expansion valves are initially adjusted by the manufacturer to maintain a predetermined degree of superheat, and no provision is made for further adjustments in service.

If expansion valves are adjusted to give a high degree of superheat at the coil outlet, or if the valve is stuck shut, the amount of refrigerant admitted to the cooling coil will be reduced. With an insufficient amount of refrigerant, the coil will be "starved" and will operate at a reduce capacity. Compressor lubricating oil carried with the refrigerant may tend to collect at the bottom of the cooling coils, thus robbing the compressor crankcase, and providing a condition whereby slugs of lubricating oil may be drawn back to the compressor. If the expansion valve is adjusted for too low a degree of superheat, or if the valve is stuck open, liquid refrigerant may flood from the cooling coils back to the compressor. Should the liquid collect at a low point in the suction line or coil, and be drawn back to the compressor intermittently in slugs, there is danger of injury to the moving parts of the compressor.

In general, the expansion valves for air conditioning and water cooling plants (high temperature installations) must be adjusted for higher superheat than are the expansion valves for cold storage refrigeration and ship's service store equipment (low temperature installations).

If it is impossible to adjust expansion valves to the desired settings, or if it is suspected that the expansion valve assembly is defective and requires replacement, appropriate tests must be made. (First be sure that the liquid strainers are clean, that the solenoid valves are operative, and that the system is sufficiently charged with refrigerant.)

The major equipment required for expansion valve tests is as follows:

1. A service drum of R-12, or a supply of clean dry air at 70 to 100 psig. The service drum is used to supply gas under pressure. The gas used does not have to be the same as that employed in the thermal element of the valve being tested.

2. A high pressure and a low pressure gage. The low pressure gage should be accurate and in good condition so that the pointer does not have any appreciable lost motion. The high pressure gage, while not absolutely necessary, will be useful in showing the pressure on the inlet side of the valve. Refrigeration plants are provided with suitable spare and test pressure gages.

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The procedure for testing is as follows:

1. Connect the valve inlet to the gas supply with the high pressure gage attached so as to indicate the gas pressure to the valve, and with the low pressure gage loosely connected to the expansion valve outlet. The low pressure gage is connected up loosely so as to provide a small amount of leakage through the connection.

2. Insert the expansion valve thermal element in a bath of crushed ice. Do not attempt to perform this test with a container full of water in which a small amount of crushed ice is floating.

3. Open the valve on the service drum or in the air supply line. Make certain that the gas supply is sufficient to build up the pressure to at least 70 psi on the high pressure gage connected in the line to the valve inlet.

4. The expansion valve can now be adjusted. If it is desired to adjust for 10° F superheat, the pressure on the outlet gage should be 22.5 psig. This is equivalent to an R-12 evaporating temperature of 22° F, and since the ice maintains the bulb at 32° F, the valve adjustment is for 10° superheat (difference between 32 and 22). For a 5° superheat adjustment, the valve should be adjusted to give a pressure of approximately 26.1 psig. There must be a small amount of leakage through the low pressure gage connection while this adjustment is being made.

5. To determine if the valve operates smoothly, tap the valve body lightly with a small weight. The low pressure gage needle should not jump more than 1 psi.

6. Now tighten the low pressure gage connection so as to stop the leakage at the joint, and determine if the expansion valve seats tightly. With the valve in good condition, the pressure will increase a few pounds and then either stop or build up very slowly. With a leaking valve, the pressure will build up rapidly until it equals the inlet pressure.

7. Again loosen the gage so as to permit leakage at the gage connection; remove the thermal element, or control bulb, from the crushed ice, and warm it with the hand or place it in water that is at room temperature. When this is done, the pressure should increase rapidly, showing that the power element has not lost its charge. If there is no increase in pressure, the power element is dead.

8. With high pressure showing on both gages as outlined above, the valve can be tested to determine if the body joints or the bellows leak. This can be done by using a halide leak detector. When performing this test, it is important that the body of the valve have a fairly high pressure applied to it. In addition, the gages and other fittings should be made up tightly at the joints so as to eliminate leakage at these points.

REPLACEMENT OF VALVE.—If it is evident that the expansion valve is defective, it must be replaced. Often it is possible to replace a faulty power element or other part of the valve without having to replace the entire assembly. When replacement of an expansion valve is necessary, it is important to replace the unit with a valve of the same capacity and type designed for R-12 systems.

Automatic Expansion Valve

Automatic expansion valves are generally similar in construction to thermostatic valves, except that the thermostatic element is omitted. The refrigerant pressure in the cooling coil operates on the lower side of the diaphragm and atmospheric pressure operates on the upper side. The amount of valve opening depends upon the pressure existing in the coil.

As the operation of the compressor lowers the coil pressure, there is a corresponding decrease in pressure on the lower side of the diaphragm; when this pressure becomes less than the atmospheric pressure on the upper side, the diaphragm is depressed and the valve opens. The pressure at which the valve will open can be predetermined by an adjustment of the valve. As the compressor continues to operate, the needle valve remains open enough to maintain the refrigerant evaporating pressure. When the compressor stops, the coil pressure increases and the valve automatically closes. Thermostatic expansion valves have proved to be more satisfactory than automatic expansion valves for refrigeration plant applications required for naval ships.

Hand Expansion Valve

A bypass line equipped with a manually operated expansion valve is installed around the strainer and the cooling coil liquid control valve assembly to permit repair or cleaning. The hand expansion valve is generally similar in design to the other refrigerant stop

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valves installed in refrigeration systems, except that the valve disk is sometimes specially shaped to permit accurate adjustment of flow. Hand expansion valves should be used only for emergency purposes, since there is the possibility of flooding liquid refrigerant back to the compressor. A man should be on watch at all times when the hand expansion valve is in use.

SWITCHES

In order to trouble-shoot or diagnose switch troubles, it is essential that you have a good understanding of pressurestats and thermostats. A pressurestat is an electric switch actuated by pressure from an outside source. The thermostat is actuated by temperature or heat on a specially prepared thermo-bulb, filled with a substance that expands and contracts with any change in temperature.

A switch that cuts out when there is an increase in pressure or temperature is known as a direct acting switch. When the pressure or temperature is decreased, the switch cuts in. The high pressure switch is a direct acting switch. A reverse acting switch is one that cuts in on an increase of pressure or temperature and cuts out on a decrease of pressure or temperature. The low pressure cutout, thermostat, and water-failure switches are reverse acting switches.

EVACUATING AND DEHYDRATING THE SYSTEM

Where moisture accumulation must be corrected, the system should first be cleared of refrigerant and air. The time required for these processes will depend upon the size of the system and the amount of moisture present. It is good engineering practice to circulate heated air through a large dehydrator and system for several hours, or as long as the dehydrator drying agent remains effective, before proceeding with the evacuation process. If possible, the dehydrated air should be heated to about 240° F.

Large dehydrators, suitable for preliminary dehydration of R-12 systems, are usually available at naval shipyards, and aboard tenders and repair ships.

After the preliminary dehydration, remaining moisture is evacuated by means of a two-stage high-efficiency vacuum pump having a vacuum indicator. (These vacuum pumps are available aboard tenders and repair ships.)

The vacuum indicator shown in figure 10-1 consists of an insulated test tube containing a wet bulb thermometer with its wick immersed in distilled water. The indicator is connected in the vacuum pump suction line. The suction line from the vacuum pump is connected to the charging connection in the refrigeration system. The refrigerant circuit should be closed to the atmosphere and the charging connection opened to the vacuum pump.

A two-stage pump is started for operation in parallel so that maximum displacement may be secured during the initial pump-down stages. When the indicator shows a temperature of about 55° F (0.43 inch Hg, absolute), the pumps

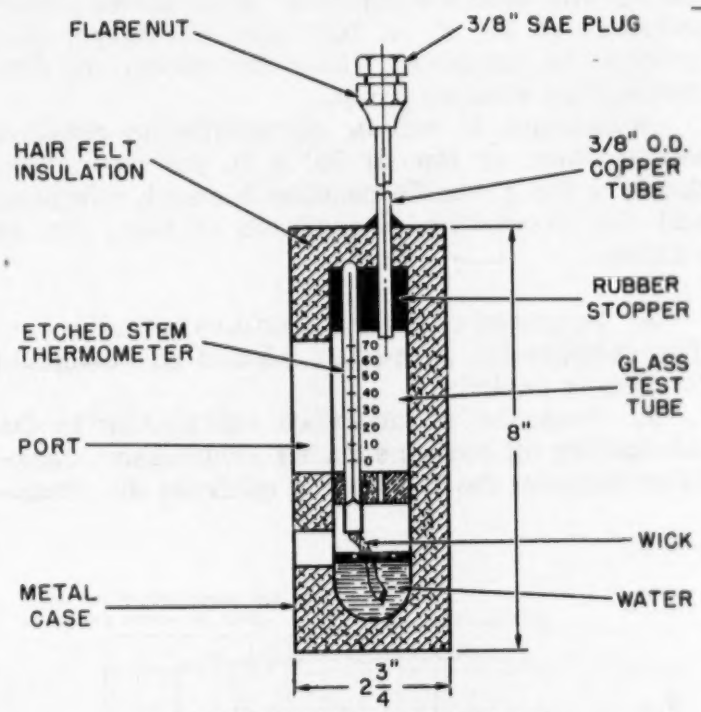

CONVERSION TEMPERATURE °F TO ABSOLUTE PRESSURE INCHES MERCURY

TEMPERATURE °F	ABSOLUTE PRESSURE INCHES MERCURY
60	0.521
55	0.436
50	0.362
45	0.300
40	0.248
35	0.204
32	0.181

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Figure 10-1.—Dehydrator vacuum indicator.

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are placed in series operation (wherein the discharge from the first step enters the suction of the second step pump). The dehydration process will be reflected in the temperature drop of the vacuum indicator, as shown in figure 10-2. Readings wil initially reflect ambient temperatures, then show rapidly falling temperatures until the water in the system starts to boil.

When most of the evaporated moisture has been evacuated from the system, the indicator will show a decrease in temperature. When the temperature reaches 35° F (0.2 inch Hg, absolute), dry air should be admitted through a chemical dehydrator into the system at a point farthest from the pump. Continue operating the pump. The dry air will mix with and dilute any remaining moisture. Secure the opening feeding the dry air to the system. Continue evacuating the system until the indicator again shows a temperature of 35° F. At this time, the dehydration process is complete. Close the valves and disconnect the vacuum pump.

Sometimes it will be impossible to obtain a temperature as low as 35° F in the vacuum indicator; the probable reasons for such a failure, and the corrective procedures to take, are as follows:

1. Presence of excess moisture in the system. The dehydration procedure should be conducted for longer periods.

2. Presence of absorbed refrigerant in the lubricating oil contained in the compressor crankcase. Remove the lubricating oil from the crankcase before proceeding with the dehydration process.

3. Leakage of air into the system. The leak must be found and stopped. It will be necessary to repeat the procedure required for detecting leaks in the system.

4. Inefficient vacuum pump or defective vacuum indicator. The defective unit(s) should be repaired or replaced.

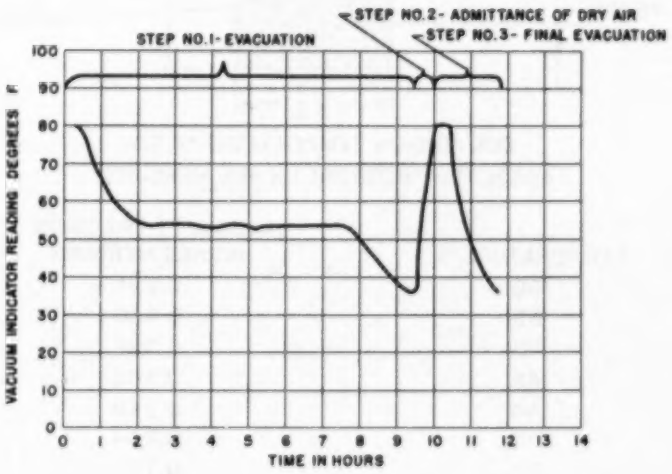

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Figure 10-2.—Vacuum indicator readings plotted during dehydration.

Reactivating the Drying Agent

Immediately after each period of use, or after the system has been opened for repairs, the drying agent in the dehydrator should be replaced. If a replacement cartridge is not available, the drying agent can be reactivated and used until a replacement is available.

Reactivation is accomplished by removing the drying agent and heating it, for 12 hours, to a temperature of 300° F to bake out the moisture. The drying agent may be placed in an oven, or a stream of hot air may be circulated through the cartridge. These methods are satisfactory for reactivating commonly used dehydrating agents such as activated alumina and silica gel. Where special drying agents are employed, they should be reactivated in accordance with specific instructions furnished by the manufacturer.

After reactivation, the drying agent should be replaced in the dehydrator shell and sealed as quickly as possible, in order to prevent absorption of atmospheric moisture. When the drying agent becomes fouled or saturated with lubricating oil, it must be replaced by a fresh spare charge, or dehydrator cartridge, taken from a sealed container.

Remember that the dehydrators permanently installed in R-12 systems for naval ships are designed to remove only the minute quantities of moisture unavoidably introduced into the system. Extreme care must be taken to prevent moisture, or moisture-laden air, from entering the system.

Cleaning the System

Systems may accumulate dirt and scale as a result of improper techniques used during repair or installation. If such dirt is excessive and a tank-type cleaner is available, connect the cleaner to the compressor suction strainer. Where such a cleaner is not available, a hard wool felt filter, about 5/16 inch

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Trouble	Possible Cause	Corrective Measure
High condensing pressure.	Air on non-condensable gas in system.	Purge air from condenser.
	Inlet water warm.	Increase quantity of condensing water.
	Insufficient water flowing through condenser.	Increase quantity of water.
	Condenser tubes clogged or scaled.	Clean condenser water tubes.
	Too much liquid in receiver, condenser tubes submerged in liquid refrigerant.	Draw off liquid into service cylinder.
Low condensing pressure.	Too much water flowing through condenser.	Reduce quantity of water.
	Water too cold.	Reduce quantity of water.
	Liquid refrigerant flooding back from evaporator.	Change expansion valve adjustment, examine fastening of thermal bulb.
	Leaky discharge valve.	Remove head, examine valves. Replace any found defective.
High suction pressure.	Overfeeding of expansion valve.	Regulate expansion valve, check bulb attachment.
	Leaky suction valve.	Remove head, examine valve and replace if worn.
Low suction pressure.	Restricted liquid line and expansion valve or suction screens.	Pump down, remove, examine and clean screens.
	Insufficient refrigerant in system.	Check for refrigerant storage.
	Too much oil circulating in system.	Check for too much oil in circulation. Remove oil.
	Improper adjustment of expansion valves.	Adjust valve to give more flow.
	Expansion valve power element dead or weak.	Replace expansion valve power element.

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Figure 10-3.—Trouble-diagnosis chart.

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Trouble	Possible Cause	Corrective Measure
Compressor short cycles on low pressure control.	Low refrigerant charge.	Locate and repair leaks. Charge refrigerant.
	Thermal expansion valve not feeding properly.	Adjust, repair or replace thermal expansion valve.
	(a) Dirty strainers.	(a) Clean strainers.
	(b) Moisture frozen in orifice or orifice plugged with dirt.	(b) Remove moisture or dirt (Use system dehydrator).
	(c) Power element dead or weak.	(c) Replace power element.
	Water flow through evaporators restricted or stopped. Evaporator coils plugged, dirty, or clogged with frost.	Remove restriction. Check water flow. Clean coils or tubes.
	Defective low pressure control switch.	Repair or replace low pressure control switch.
Compressor runs continuously.	Shortage of refrigerant.	Repair leak and recharge system.
	Leaking discharge valves.	Replace discharge valves.
Compressor short cycles on high pressure control switch.	Insufficient water flowing through condenser, clogged condenser.	Determine if water has been turned off. Check for scaled or fouled condenser.
	Defective high pressure control switch.	Repair or replace high pressure control switch.
Compressor will not run.	Seized compressor.	Repair or replace compressor.
	Cut-in point of low pressure control switch too high.	Set L.P. control switch to cut-in at correct pressure.
	High pressure control switch does not cut-in.	Check discharge pressure and reset H.P. control switch.
	1. Defective switch.	1. Repair or replace switch.
	2. Electric power cut off.	2. Check power supply.
	3. Service or disconnect switch open.	3. Close switches.

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Figure 10-3.—Trouble-diagnosis chart—Continued.

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Block II - Radio Servicing

Unit 2 - Radio Circuit Construction and Analysis

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Constructing power supplies	B+ and filament supply Series-filament hookup and B+ supply in three way portables Filament circuit connections for AC-DC operation Filament circuit connections for battery operation Basic rectifiers The diode rectifier Full-wave rectifier Equivalent circuits for rectifiers Power supply to furnish B+
Constructing and analyzing audio frequency, intermediate frequency, and radio frequency circuits	Two-stage RC-coupled amplifier using high gain a-f voltage amplifier Two tubes in parallel used in output stage of and a-f amplifier Push-pull amplification Phase-inverter circuits Volume and tone controls Inverse feedback Direct coupled amplifier Decoupling circuits in a-f amplifiers Circuit diagrams of modern i-f amplifier systems Previously used intermediate frequencies Resonant circuit coupling for r-f amplifiers R-F input circuits R-F output circuits Pentode class A r-f amplifier
Constructing and analyzing oscillator circuits	Pentagrid converter Phase-shift oscillator Hartley oscillator

Trouble	Possible Cause	Corrective Measure
Compressor will not run. (Cont'd)	4. Fuses blown.	4. Test fuses and renew if necessary.
	5. Over-load relays tripped.	5. Re-set relays and find cause of overload.
	6. Low voltage.	6. Check voltage (should be within 10 percent of nameplate rating).
	7. Electrical motor in trouble.	7. Repair or replace motor.
	8. Trouble in starting switch or control circuit.	8. Close switch manually to test power supply. If OK check control circuit including temperature and pressure controls.
	9. Compressor motor stopped by oil pressure differential switch.	9. Check oil level in crankcase. Check oil pump pressure.
Sudden loss of oil from crankcase.	Liquid refrigerant slugging back to compressor crank case.	Adjust or replace expansion valve.
Capacity reduction system fails to unload cylinders.	Hand operating stem of capacity control valve not turned to automatic position.	Set hand operating stem to automatic position.
Compressor continues to operate at full or partial load.	Pressure regulating valve not opening.	Adjust or repair pressure regulating valve.
Capacity reduction system fails to load cylinders.	Broken or leaking oil tube between pump and power element.	Repair leak.
Compressor continues to operate unloaded.	Pressure regulating valve not closing.	Adjust or repair pressure regulating valve.

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Figure 10-3.—Trouble-diagnosis chart—Continued.

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thick, should be inserted in the suction strainer screen. The plant should be operated with an operator in attendance for at least 36 hours or until cleaned, depending upon the size and condition of the plant.

DETECTING AND CORRECTING TROUBLES

Faulty operation of the refrigerating plant is indicated by various definite symptoms. These symptoms may indicate the presence of one or more conditions in the plant. Each condition must be eliminated by specific corrective measures. Space does not permit a detailed discussion here of abnormal plant conditions, but you can find complete information in the manufacturer's technical manual furnished with each refrigeration plant.

Figure 10-3 lists the symptoms of some operational problems, their causes, and the corrective measures to be taken. A knowledge of this information may aid you in correcting faulty operation quickly and efficiently.

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CHAPTER 11

AUXILIARY EQUIPMENT

This chapter provides general information on the care and maintenance of steering and hoisting mechanisms, hydraulic systems, and compressed air systems.

STEERING GEAR

Aboard modern naval vessels, practically all steering mechanisms are hydraulically driven. Since you may be responsible for maintenance or repairs on steering gears, particularly on variable-stroke hydraulic pumps and other component parts of the hydraulic system, you should familiarize yourself with this type of equipment. Your best source of information will be the manufacturers' instruction books.

REMOTE CONTROL

The remote control of steering gears on most modern ships is accomplished electrically, by means of alternating-current synchronous transmission. However, you may encounter some systems in which remote control is accomplished hydraulically by means of a telemotor system.

THE HYDRAULIC TELEMOTOR type of remote control is installed aboard many auxiliary ships of the Navy. On this type of control, maintenance usually consists of nothing more than the prevention of leaks in the hydraulic system and the proper care of the fluid.

Frequent inspections of the valves and joints will greatly help in eliminating and preventing leaks in the system. If the piston of an internally packed telemotor is leaking, check the condition of the leathers and make certain the springs, if installed, keep the leather in contact with the inside wall of the telemotor cylinders. Leaks in an externally packed telemotor can usually be stopped by tightening the glands just enough to cause the packing to be compressed about the rams.

HYDRAULIC RAMS

Since portions of the rams in an electro-hydraulic steering gear are exposed where they fit into the cylinders, it is necessary to take precautions against possible damage to such surfaces. The exposed surfaces of rams should not be used as walkways. In addition, they should be protected from water and from rolling or falling objects, and should be kept covered with a coat of prescribed rust-preventive compound or with the appropriate Navy Symbol oil. Frequent inspections should be made during operation, in order to detect any evidence of damage. A guard placed over the exposed parts will offer protection against rolling objects, and the compartment should be kept free of loose gear that might slide into the rams.

Regardless of the precautions taken, rust may accumulate on hydraulic rams when the steering gear is not used for an extended period. Such accumulations should be removed from the rams with crocus cloth. After rams are cleaned with crocus cloth, they should be thoroughly cleaned before the steering gear is operated. Otherwise pieces of rust and dirt may stick to the rams and be drawn into the cylinders.

Packing glands should be kept only tight enough to maintain sufficient pressure on the rings to prevent leakage. Overtightening should be avoided, since excessive pressure usually results in rapid wear and improper functioning of the packing.

The oil in the high-pressure hydraulic system of a steering gear should be filtered about every six months. Poor filtering results in the accumulation of foreign matter injurious to the rams and to the variable stroke pumps. Make-up oil should be filtered before it is added to the system. When the system is drained into the base tank, accumulated foreign matter can be filtered out by pumping the oil through the filters to the expansion tanks. The oil is then drained back into the storage

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tanks and the system refilled with the filtered oil.

ANCHOR WINDLASSES

Even though used intermittently and only for relatively short periods of time, a windlass must be capable of handling the required load under extremely severe conditions. To prevent deterioration and to provide dependable operation whenever required, maintenance and adjustment must be continued during the periods when the machinery is not in use.

Windlass brakes must be maintained in satisfactory condition if they are to perform their function properly. Because of wear and compression of brake linings, the clearance between the brake drum and band will increase after a windlass has been in operation. Means of adjustment are provided on all windlass brakes. Since maladjustment of a windlass brake could result in the loss of the anchor and chain, it is advisable that you become familiar with maintenance procedures as recommended by the manufacturer.

Lubrication instructions furnished by the manufacturer should be carefully followed. If a windlass has been idle for some time, lubrication of the equipment should be accomplished before operation is attempted. After a windlass has been used, the equipment should be lubricated to protect finished surfaces from corrosion.

The hydraulic transmissions of electrohydraulic windlasses and other auxiliaries are manufactured with close tolerances between moving and stationary parts. If these tolerances are to be maintained and unnecessary wear prevented, every precaution possible must be taken to prevent the entry of dirt and other abrasive material. When the system is replenished or refilled, only clean oil should be used and the oil should be strained as it is poured into the tank. If a hydraulic transmission has been disassembled, all parts should be thoroughly cleaned before reassembly. Before piping or valves are installed, their interiors should be cleaned to remove any scale, sand, or other foreign matter.

WINCHES AND CRANES

In several respects, the maintenance of a winch is similar to that of a windlass. Where band brakes are used on the drums, the friction linings should be inspected regularly and replaced when necessary. Steps should be taken to prevent oil or grease from accumulating on the brake drums. The operation of brake-actuating mechanisms, latches, and pawls should be checked periodically.

The sliding parts of positive clutches must be properly lubricated, and the locking device on the shifting gear should be checked to determine if it will hold under load. The oil of gear reduction units should be checked for proper amount and purity. Periodic inspections should be made of the pressure lubrication fittings normally installed on slow-moving parts. On installations which use hydraulic transmission, the pumps and lines are maintained in the same way as those of any other hydraulic system.

As with many other auxiliary units, the cranes you maintain may be driven by hydraulic transmissions, by electric motors, by Diesel engines, or by hand. Maintenance should be accomplished in accordance with manufacturers' instructions. In general, the maintenance of electrohydraulic cranes requires that the oil in the replenishing tanks be kept at the prescribed levels, and that the system be kept clean and free of air. The limit stop and other mechanical safety devices must be checked regularly for proper operation. When cranes are not in use, they should be secured in their stowed positions and all electric power to the crane controllers disconnected at the power distribution panel.

ELEVATORS

Carriers are provided with two or more electrohydraulic elevators, capable of handling airplanes between the flight and hanger decks at relatively high speed. As an MM1 or C, you may not be called upon too frequently to maintain this type of machinery. However, if you are required to maintain electrohydraulic elevators, you will find maintenance procedures relatively the same as for other auxiliaries which use fluid to transmit power.

Elevator cables and fittings should be inspected frequently, and the tension of the cables in each group kept equal. Frequent inspections must be made to ensure that (1) there is proper oil level in the pressure and exhaust tanks, (2) there is no excessive leakage in the sump leak-off connections, (3) the pistons seal properly in the hydraulic cylinders, and (4) the entire system is clean.

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HYDRAULIC SYSTEMS

The over-all efficiency of hydraulic installations used to control or drive auxiliary machinery is basically dependent upon size of installation, oil pressure, speed, and condition of the equipment. The care given the hydraulic components of the system is an important factor. Major repair of hydraulic gear, except for piping and fittings, is generally performed at a naval shipyard or by the manufacturer. Routine maintenance, keeping the oil clean, and maintaining proper fluid levels is the responsibility of the operator.

Hydraulic transmissions are sturdy, proven machines, inspected and tested with such care that casualties seldom occur except as a result of faulty assembly, installations, or maintenance. If a properly installed hydraulic system is operated regularly and maintained with proper care, it will retain its design characteristics of power, speed, and control, and the need for costly repair and replacement will seldom occur.

MAINTENANCE

Regular operation, proper lubrication, proper maintenance of all the units, and cleanliness of the fluid are principal requirements for keeping a hydraulic transmission in satisfactory operating condition. Regular operation of hydraulic equipment prevents corrosion, sludge accumulation, and freezing of adjacent parts. The need for proper lubrication and cleanliness cannot be too strongly emphasized.

Detailed instructions concerning the maintenance of a specific unit may be obtained from the appropriate instruction book; however, the general information which follows will also be helpful.

Piping and Fittings

Properly installed hydraulic piping and valves are seldom a source of trouble, except for leakage. Some leaks may become serious enough to cause a reduction in the efficiency of the unit(s). Frequent inspections should be made and necessary steps taken to eliminate leakage.

If leaks occur at a flanged joint in the line of a hydraulic system, tighten the flange bolts evenly, but not excessively. If the leaks persist, use the standby unit, if available, or shut down the equipment while the gasket of the leaking flange is being replaced. Make certain that the flange surfaces are cleaned carefully before the gasket is applied.

Relief valves or shuttle valves of a hydraulic system may be sources of trouble. The seats of leaking relief valves should be reground. Loss of power may indicate a leaking relief valve. Shuttle valves may stick and fail to cut off. Existence of this condition is indicated when oil escapes from the high-pressure side of the line into the expansion tank, or when the pressure control fails. When a shuttle valve fails to operate, the stop valves should be closed and the defective valve removed for repair.

Fluid System

When inspection of an oil sample drawn from a hydraulic system reveals the presence of water, sludge, or acidity, the system must be drained, cleaned with the prescribed flushing oil, and filled with clean oil. The system may be drained and cleaned as follows:

1. Remove permanent type filters and wash them in flushing oil. Use low-pressure air for drying purposes. If filters have replaceable elements, install new elements.
2. Drain the system, as completely as possible, of old oil.
3. Close all connections and fill the system with flushing oil.
4. Start and operate the unit under idling conditions, in order to fill the system thoroughly with the flushing oil.
5. Secure the unit and allow it to stand idle for approximately one hour. This idle period permits the flushing oil to dissolve any sludge.
6. Start and operate the unit under light load for 3 to 5 minutes, unless otherwise specified. Then allow the equipment to remain idle for about fifteen minutes, and repeat the entire process. Do this two or three times.

Never operate a hydraulic unit under full load when it is filled with flushing oil, and keep the operating pressure as low as possible.

After each short operating period, turn the cleaning handles of edge type filters (if installed) and drain from the filter an amount of oil equal to its volume.

7. If time permits, allow the system to stand idle for an additional hour following the series of short operating periods.
8. Drain the system of flushing oil. (Reclean permanent type filters, if necessary; install new replaceable filters.) Close the system and fill it with the proper hydraulic oil.

As the system is being filled, the oil should be strained through a fine wire screen of 200 mesh. If the oil is not clean, it should be run through a

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centrifuge. Adequate protection should be provided against dust and moisture. Moisture should be expelled from oil before it is poured into a system. Oil with noticeable water content should be rejected or centrifuged.

When a hydraulic system is being filled, sufficient fluid should be used to completely fill the active parts of the mechanism, leaving no air pockets. During the filling procedure, air valves should be opened so that air can escape to the oil expansion tank. After the system has been filled, the valves should be closed tight.

Pumps and Motors

An electric motor is provided to rotate the hydraulic pump. Oil under pressure is delivered from the pump to the hydraulic motor of the variable speed transmission through piping. The hydraulic motor rotates the individual unit or equipment through suitable reduction gearing. Whether the pumps and motors of hydraulic transmissions are of the axial — or radial—piston type, maintenance procedures and operating principles are relatively the same. In general, maintenance information on other type pumps also applies to hydraulic pumps and motors.

On some modern hydraulic transmissions, the SHAFT STUFFING BOX PACKING is of the square-braided pure asbestos type. This type packing is easily removed. Care must be taken to ensure that it is not replaced too tightly; if properly installed, this packing makes a tight joint with light pressure. If packing wears out quickly, the shaft should be inspected for roughness. If a machine shop is available, roughness may be eliminated from a shaft by a finishing cut to smooth the surface; otherwise, it may be necessary to replace the shaft.

Packing should be renewed at prescribed intervals, to prevent the packing from becoming hard and scoring the shaft. When packing is being replaced, make certain that there is a uniform thickness around the shaft. Stuffing boxes should be packed loosely and the packing gland set up lightly, allowing adequate leakage for cooling and lubrication.

There is less likelihood of POOR ALIGNMENT BETWEEN THE DRIVING AND DRIVEN MEMBERS of a hydraulic transmission if the wedges, shims, jacking screws, or adjusting setscrews are properly set and secured when connected units are installed. However, because of a casualty, misalignment may occur that will cause severe stress and strain on the coupling and connected parts. Excessive misalignment should be eliminated as soon as possible by replacing any defective parts and readjusting the installed aligning devices. If this is not done, pins, bushings, and bearings will have to be replaced frequently.

Since there is no end play to either the pump or motor shaft, flexible couplings are generally used in hydraulic transmissions. Such couplings permit satisfactory operation with a slight misalignment, without requiring frequent renewal of parts.

TROUBLE SHOOTING

In attempting to locate the source of any trouble in an electrohydraulic system, remember that all troubles which occur will be in one of three categories-hydraulic, electric, or mechanical. Isolating a trouble into one of these categories is one of the primary steps in locating the source of trouble.

Hydraulic Casualties

These casualties are generally the result of low oil levels, external or internal leakage, clogged lines or fittings, or improper adjustment of valves and other working parts. Do not disassemble a unit unless certain that the trouble exists within that unit. Unnecessary disassembly can lead to additional trouble, because of the dirt which may enter an open system.

Leaks are a frequent cause of trouble in hydraulic equipment. Leaks are generally caused by excessively worn parts, by abnormal and continuous vibration, by excessively high operating pressures, or by faulty or careless assembly. External leaks usually have little effect on the operation of equipment other than a steady draining of the oil supply; but even a small leak wastes oil, and the resulting unsightly appearance of a machine is indicative of poor maintenance procedures.

External leaks may result from any of the following causes: improperly tightened threaded fittings; crossed threads in fittings; improperly fitted or damaged gaskets; distorted or scored sealing rings, oil seals, or packing rings; scored surfaces of working parts; improperly flared tube ends; or flanged joints not sealing squarely.

Internal leaks, however, generally result in unsatisfactory operation of the equipment. Large internal leaks are indicated by loss of pressure and failure of equipment. While large internal leaks can usually be located by installing a pressure gage in various parts of the equipment, the location of small leaks generally requires disassembly and visual inspection of the parts.

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Internal leaks may result from worn or scored valves, pistons, valve plates, or bushings; or from improperly fitted or damaged gaskets.

The symptoms of trouble in a hydraulic system are frequently in the form of unusual noises. Some noises are characteristic of normal operation and can be disregarded, while others are evidence of serious trouble. Even though the exact sound indicating trouble can be learned only through practical experience, the following descriptive terms will give a general idea of the noises which are trouble warnings.

The occurrence of POPPING and SPUTTERING noises is an indication that air is entering the pump intake line. Air entering the system at this point may be the result of too small an intake pipe, an air leak in the suction line, a low oil level in the supply tank, cold or heavy oil, or possibly the use of improper oil.

If air becomes trapped in a hydraulic system, HAMMERING will occur in the equipment or in the transmission lines. If hammering occurs, check for improper venting. In some cases, a POUNDING or RATTLING noise occurs as a result of a partial vacuum produced in the active fluid during high-speed operation or when a heavy load is applied. This noise may be unavoidable under the conditions stated and can be overlooked if it stops when speed or load is reduced. If the noise continues at low speeds or light loads, the system should be vented of air. Air in a hydraulic system can also cause uneven motion of the hydraulic motor.

The cause of a GRINDING noise is most likely to be dry bearings, foreign matter in the oil, worn or scored parts, or overtightness of some adjustment.

The term HYDRAULIC CHATTER is sometimes used to identify noises caused by a vibrating spring-actuated valve, by long pipes improperly secured, by air in the lines, or by binding of some part of the equipment.

If the packing is too tight around some moving part, SQUEALS or SQUEAKS may occur. This type of noise might also indicate that a high-frequency vibration is occurring in a relief valve.

Electrical Casualties

Although the EM is responsible for checking electrical equipment troubles, the MM can facilitate maintenance of electrical equipment by making a few simple tests when electrical troubles occur. Such an oversight as not having a switch in the ON position may be the reason for equipment failing to operate. If the circuit is closed and the equipment still fails to operate, check for blown fuses and tripped circuit breakers. These troubles generally result from an overload on the equipment. If a circuit breaker continues to cut out, the trouble may be damaged equipment, excessive binding in the electric motor, obstruction in the hydraulic transmission lines, or faulty operation of the circuit breaker. Another source of electrical troubles may be in the circuit; check for open or shorted leads, faulty switches, and loose connections.

Mechanical Casualties

When an electrohydraulically driven auxiliary becomes inoperative because of a mechanical failure, a check should be made for improper adjustment or misalignment of parts, shearing of pins or keys, or breakage of gearing, shafting or linkage. Elimination of troubles resulting from any of these causes should be accomplished in accordance with the manufacturer's instructions for the specific equipment.

COMPRESSED AIR SYSTEMS

As an MM3 or 2, you used compressed air for blowing out and cleaning various units, and for operating numerous pneumatic tools. In working with any of the three types of compressed air systems (low-, medium-, and high-pressure), you probably found that the primary source of any trouble was the compressor. Although the design and capacity of compressors vary, the maintenance procedures are essentially the same. However, remember that the care and maintenance of high-pressure compressors require additional safety precautions, and the procedures recommended by the manufacturer should be followed.

Some portions of the discussion which follows may serve as a review. Other portions of the discussion should be beneficial in your study for advancement, and helpful when you are called upon to train men.

While modern auxiliary machinery is rugged and dependable, it is not designed to withstand abusive treatment. Gasketed joints, pipe joints, and bolts are designed to safely withstand the strain required for a tight connection when the specified torque is applied with the correct tool. The application of a force in excess of that prescribed usually results in breakage. If a joint or bolt cannot be tightened without using an oversized wrench or wrench handle extension, there will probably be something wrong with the assembly.

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CARE AND MAINTENANCE OF AIR COMPRESSORS

The over-all problem in maintaining compressed air systems is to take the necessary steps to prevent a reduction in compressor capacity. To keep a ship's air compressor operating efficiently at all times and to prevent as many troubles as possible, it is necessary to know how to care for air intakes and filters; how to maintain and replace air valves; how to take care of air cylinders, pistons, and wrist pins, how to adjust bearings, couplings, etc.; and how to properly maintain the lubrication, cooling, control, and air systems.

Air Intakes and Intake Filters

Satisfactory operation of any compressor requires a supply of clean, cool, dry air. To help keep the air supply clean, filters are fitted to compressor intakes. Unless these filters are inspected and cleaned regularly they will become clogged and cause a loss of capacity.

To clean filter elements remove them from the intake and wash them with a jet of hot water or steam, or immerse them in a strong solution of sal soda. The filter body should be drained and replaced. Filter elements of the oil-wetted type should be dipped in clean oil after cleaning. Before replacing the element in the intake, let excess oil drain from it. The use of gasoline or kerosene is prohibited for cleaning air filters, because of explosive fumes which may collect in the compressor or air receiver.

Air Valves

The inlet and discharge valves of compressors require special attention. When valves leak, compressor capacity is reduced and pressure is affected. Deviation from normal intercooler pressure may indicate a leaking or broken valve; rise in pressure indicates a defective inlet valve, decrease in pressure indicates a defective discharge valve. Another sign of valve trouble is an unusually hot valve cover.

Dirt is generally the cause of leaking valves. When valves become dirty, the source of trouble can usually be traced to dirty intake air; use of an excessive amount, or of an improper grade, of cylinder oil; or excessively high air temperature, resulting from faulty cooling. Periodic inspection and cleaning of valves and valve passages minimizes the number of air valve troubles.

When air valves are removed for inspection, mark each valve to ensure that it will be replaced in the same opening from which it was removed. Inspect valves carefully and do not disassemble them for cleaning unless their condition necessitates such action. Dirt or carbon can usually be removed from valve parts without disassembling the valve. If it becomes necessary to disassemble the valve, note the arrangement of the various parts so that the proper relationship will be kept when the valve is reassembled. To remove carbon from valve parts, soak the individual part in a suitable solvent and then brush or scrape lightly. After drying and reassembling the valve parts, test the operation of the valve to see if it opens and closes freely.

Before replacing air valves in a cylinder, inspect the gaskets. If other than copper, replace any which are damaged. Copper gaskets should always be replaced. Since it may be difficult, in many cases, to distinguish between suction and discharge valves, extreme care must be taken when the valves are being inserted in the cylinder. Make certain that suction valves open TOWARD, and discharge valves AWAY FROM, the center of the cylinder; otherwise serious damage or loss of capacity will result. In most instances, special lock nuts are provided to seal against leakage at the threads of the valve setscrew.

Cylinders, Pistons, and Related Parts

You should be familiar with the safety precautions to be followed in maintaining an air compressor, and with the procedures for cleaning cylinders, removing pistons, fitting new piston rings, replacing cylinders, checking piston end clearances, adjusting bearings, replacing wrist pins, packing stuffing boxes, and caring for couplings and V-belts. It is essential, therefore, to consult the maintenance procedures as recommended by the manufacturer.

Control Devices

Because of the great variety of control, regulating and unloading devices used with compressors, detailed instructions on their adjustment and maintenance must be obtained from manufacturer's instruction books.

If a control valve fails to operate properly, disassembly and a thorough cleaning will usually be necessary. Some control valves are fitted with filters filled with sponge or woolen yarn, to prevent dust and grit from being carried into the valve chamber. These filters also remove the gummy deposit which comes from the oil used in the compressor cylinders. The filter element should be replaced with the specified material

each time a valve is cleaned. Do not use cotton, because it will pack down and stop the air flow.

Since relief valves are necessary to ensure safe operation of a compressed air system, they must be maintained in satisfactory operating conditions at all times. Relief valves should be set as specified by the manufacturer. They should be tested by hand each time the compressor is started, and the valve setting should be checked periodically by raising the pressure in the spaces to which the valves are attached. Chapter 15 of Machinist's Mate 3 & 2, NavPers 10524-C contains information on the principles of operation of reciprocating air compressors.

ROTARY-CENTRIFUGAL AIR COMPRESSORS

The one non-reciprocating type of air compressor that is found aboard ship is variously referred to as a rotary compressor, a centrifugal compressor, or a "liquid piston" compressor. Actually, the unit is something of a mixture, operating partly on rotary principles and partly on centrifugal principles; most accurately, perhaps, it might be called a rotary-centrifugal compressor.

The rotary-centrifugal compressor is used to supply low pressure compressed air. Because this compressor is capable of supply air that is completely free of oil, it is often used as the compressor for pneumatic control systems and for other applications where oil-free air is required.

The rotary-centrifugal compressor, shown in figure 11-1, consists of a round, multibladed rotor which revolves freely in an elliptical casing. The elliptical casing is partially filled with high-purity water. The curved rotor blades project radially from the hub. The blades, together with the side shrouds, form a series of pockets or buckets around the periphery. The rotor, which is keyed to the shaft of an electric motor, revolves at a speed high enough to throw the liquid out from the center by centrifugal force, resulting in a solid ring of liquid revolving in the casing at the same speed as the rotor but following the elliptical shape of the casing. This action alternately forces the liquid to enter and recede from the buckets in the rotor at high velocity.

To follow through a complete cycle of operation, let us start at point A. The chamber (1) is full of liquid. The liquid, because of centrifugal force, follows the casing, withdraws from the rotor, and pulls air in through the inlet port. At (2) the liquid has been thrown outward from the chamber in the rotor and has been replaced with atmospheric air. As the rotation continues, the converging wall (3) of the casing forces the liquid back into the rotor chamber, compressing the trapped air and forcing it out through the discharge

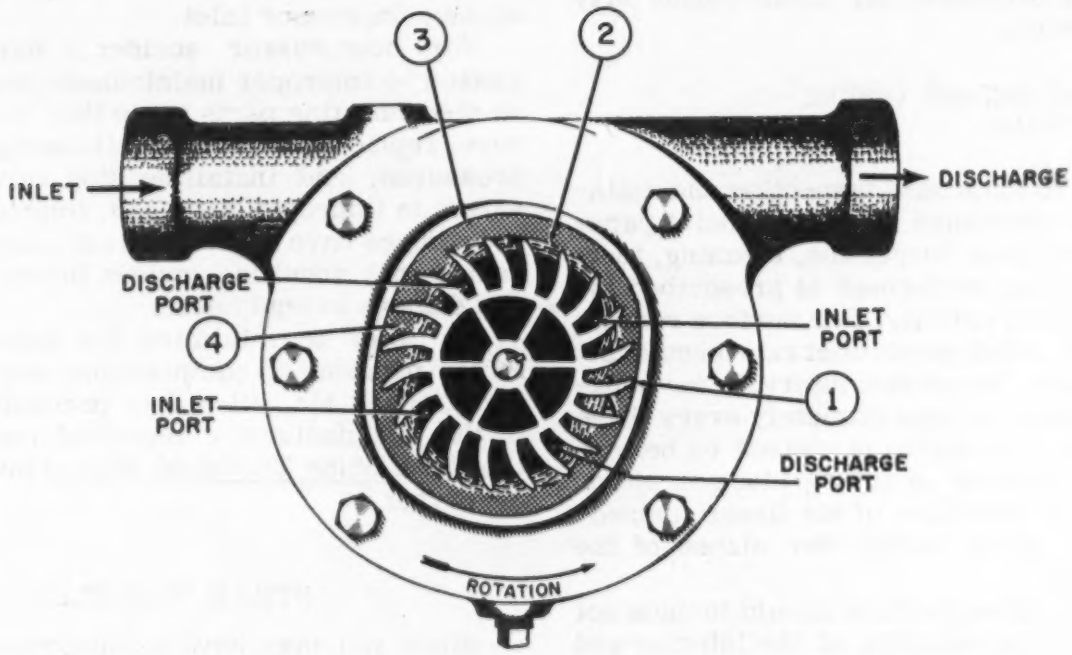

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Figure 11-1.—Rotary—centrifugal compressor.

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port. The rotor chamber (4) is now full of liquid and ready to repeat the cycle which takes place twice in each revolution.

A small amount of seal water must be constantly supplied to the compressor to make up for that which is carried over with the compressed air. The water which is carried over with the compressed air is removed in a refrigeration-type dehydrator.

CARE AND MAINTENANCE OF AIR SYSTEM EQUIPMENT

Surface Inspections and Maintenance

The air flasks and separators of surface ships must be given a surface inspection every three months. These inspections are made to determine if there is any external corrosion or damage to flasks or piping. High pressure piping must be inspected at each regular overhaul and cleaned if oil is found. Air flasks must be blown down weekly. Moisture separators installed down stream of the compressor must be blown down hourly during operation of the compressor. Filter elements must be changed in accordance with existing instructions.

The drainage of air system equipment must be sufficiently frequent to prevent excessive accumulations of moisture and oil. Such accumulations not only cause internal corrosion and fouling of moving parts, but also create a serious hazard in that excessive oil accumulation may cause an explosion.

Inspection, Cleaning, and Testing by Repair Activities

In addition to shipboard inspection and maintenance of high-pressure air flasks and separators, there must be an inspection, cleaning, testing, and repainting performed at prescribed intervals by a repair activity. For surface vessels the initial and subsequent intervals should not exceed six years. Inspection intervals for separator flasks should be approximately every three years. However, if there is reason to believe that serious corrosion is taking place in either the exteriors or interiors of air flasks, inspection should be made before the elapse of the normal interval.

The periodic examinations should include not only a complete examination of the interior and exterior surfaces of flasks and separators, but a thorough cleaning, ultrasonic inspection, and the performance of hydrostatic tests. Flasks which pass the hydrostatic test are given the prescribed internal protective coating, and the exterior surfaces are painted if necessary. Detailed information on the inspections and maintenance performed by naval shipyards can be found in the Naval Ships Technical Manual.

INSPECTIONS AND MAINTENANCE

Minimum requirements for the performance of inspections and maintenance on high pressure air plants are shown on the maintenance index page figure 11-2.

It is the responsibility of the engineer officer to determine if the condition of the equipment, hours of service, or operating conditions necessitate more frequent inspections and tests. Details for outline tests and inspections may be obtained from the appropriate manufacturer's instruction book or from the Naval Ships Technical Manual.

SAFETY PRECAUTIONS

There are many hazards associated with the process of air compression. Serious explosions have occurred in high pressure air systems because of a diesel effect. Ignition temperatures may result from rapid pressurization of a low pressure dead end portion of the piping system, malfunctioning of compressor after coolers, leaky or dirty valves, and many other causes. Every precaution must be taken to have only clean, dry air at the compressor inlet.

Air compressor accidents have also been caused by improper maintenance procedures such as disconnecting parts while they are under pressure, replacing parts with units designed for lower pressures, and installing stop valves or check valves in improper locations. Improper operating procedures have also caused air compressor accidents, with resulting serious injury to personnel and damage to equipment.

In order to minimize the hazards inherent in the process of compression and in the use of compressed air, all safety precautions outlined in the manufacturers' technical manuals and in the Naval Ships Technical Manual must be strictly observed.

STEAM WHISTLES

Since you may have to supervise the maintenance and repair of steam whistles installed on your ship, you should be familiar with the installation and maintenance of these units.

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Block II - Radio Servicing

Unit 2 - Radio Circuit Construction and Analysis (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge -Instruction Sheets or Information Topics
Plotting the resonant frequency settings of a "tank circuit."	Mixer tubes (pentagrid converters)
	Intermediate frequency
Measuring the frequency of a "tuned grid" circuit	The tuned radio frequency receiver
Adjusting the "I.F." coils	The superheterodyne receiver
Measuring the basic frequency and harmonics with a frequency standard	Frequency standards
	Radio frequency transmitters
Using two frequency generators to produce a "null."	Modulators
Operating an oscilloscope to peak a given frequency	Bandwidth, frequency drift, stability of crystals
	Introduction to radio servicing

System, Subsystem, or Component

High-Pressure Air Compressor

Reference Publications

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
AP	ZZZFCH1	35	4935	W	1. Operate compressor by power. 2. Blow down all air flasks, separators, and filters. 3. Sample and inspect lube oil.	W-1	MM2	0.5	None
AP	ZZPFVA1	84	4936	M	1. Lift relief valves by hand.	M-1	MM3	0.1	None
AP	ZZZFCH1	65	4937	Q	1. Clean suction filter. 2. Test inlet and outlet valves by operation. 3. Test temperature switch by operation. 4. Test automatic start and stop switch by operation.	Q-1	MM2	0.5	None
AP	ZZZFCH1	65	9223	Q	1. Test operation of speed-limiting governor and overspeed trip. 2. Test operation of temperature control.	Q-2	MM2 FN	1.0 1.0	None
AP	ZZZFCH1	65	7659	A	1. Clean lubricator reservoir.	A-1	FN	0.3	None
AP	ZZDFCUO	55	A142	C	1. Clean and test air coolers and oil cooler. 2. Inspect internal parts for wear.	C-1	MM1 FN	24.0 24.0	None
AP	ZZPFVA1	84	4941	C	1. Test relief valves by pressure.	C-2	FN	1.3	None
AP	ZZ6FTRO	25	7652	C	1. Clean, inspect, and preserve exterior of turbine casing.	C-3	MM3	1.0	C-4
AP	ZZ6FTRO	25	7656	C	1. Inspect carbon packing for wear.	C-4	MM1 MM3	4.0 4.0	C-3
AP	ZZZFPGF	B5	2894	C	1. Inspect high-pressure air system for oil contamination.	C-5	MM2 FN	1.5 1.5	W-1

MAINTENANCE INDEX PAGE
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Figure 11-2.—Maintenance Index Page.

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The diaphragm type of steam whistle is typical of the type used on modern ships. Before testing the whistle, remove the diaphragm leaves by unscrewing the back cover, and turn on the steam at least 30 minutes, with all drains open and traps operating. With the diaphragm removed, operate the whistle valve several times in order to blow out the pipe lines thoroughly. Replace the proper number of leaves and tighten the back cover before testing. The leaves are marked so that they may be installed properly; all leaves must have the high side facing towards the nozzle.

If water comes out through the horn or around the stem of the operating valve while the whistle is being tested, or if the note is not clear from the beginning of the first blast, immediately check all associated traps. If the traps are not functioning properly, they should be by-passed until put into working order.

The diaphragm of a steam whistle must be inspected and cleaned every three months. Damaged leaves must be removed and replaced. After the leaves have been cleaned and positioned properly, the whistle must be restested.

The operating valve should also be checked when the diaphragm is examined. If the operating valve is leaking, it should be removed and ground in to obtain a good clean seat. The seat is generally locked in place with a setscrew and can be removed only with a proper wrench and after the setscrew has been loosened.

On the installation of a whistle valve, the following factors should be considered:

1. Steam supply must be taken either directly from a boiler or from a point on a steam line where there is a continuous flow of steam at all times.

2. There must be no horizontal piping between the whistle and the point where the steam supply line is connected.

3. A drain must be installed at the lowest point of a long lead of piping below decks.

4. The drain line from the whistle must be connected to a continuous flow trap connected to the atmosphere (never to the high-pressure drains).

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CHAPTER 12

ADMINISTRATION, SUPERVISION, AND TRAINING

The higher you go in the Navy, the more responsibility you will have for administration, supervision, and training. This chapter deals briefly with some of your administrative and supervisory responsibilities and then takes up certain aspects of your responsibility for training others.

Although it is possible to consider administration, supervision, and training as three separate areas of responsibility, it is important to remember that the three things cannot be totally separated. Much of your work requires you to administer, supervise, and train, all at the same time. For example, consider a pump overhaul job. As an administrator, you will schedule the job, check on the history of the pump, and see that the required entries are made in appropriate logs and records. As a supervisor, you will actually oversee the work and make sure it is done correctly. As a trainer, you will provide information and instruction on repair parts, repair procedures and policies, safety precautions, and other matters.

These administrative, supervisory, and training tasks have a direct relationship to the job at hand—namely, the overhaul of the pump. But the pump overhaul job can't even get started unless a variety of administrative, supervisory, and training functions are performed on a continuing basis. Materials, repair parts, and tools must be available when they are needed; jobs must be scheduled with due regard to the urgency of other work; records must be kept and reports must be submitted; and personnel must be in a continuous state of training so that they can assume increasingly important duties and responsibilities. The only way to keep things running smoothly is to take your administrative, supervisory, and training responsibilities seriously.

ADMINISTRATION AND SUPERVISION

As a Machinist's Mate, you will have administrative and supervisory responsibilities in connection with engineroom operations and in connection with engineroom maintenance and repair.

OPERATIONAL RESPONSIBILITIES

The engineering department administrative organization is set up to provide a means for the proper assignment of duties and for the proper supervision of personnel. However, no organization can run itself. Personnel—including you—are needed to see that all pertinent instructions are carried out; that all machinery, equipment, and piping systems are operated in accordance with good engineering practice; that operating instructions and safety precautions are posted by machinery and obeyed by all engineroom personnel; that all watchstanders are properly supervised; that records and reports are filled in correctly and submitted as required; and that the entire engineering plant is operated with maximum reliability, efficiency, and safety.

MAINTENANCE AND REPAIR RESPONSIBILITIES

To fulfill your administrative and supervisory responsibilities in connection with maintenance and repair, you must have the ability to plan ahead. By following procedures prescribed by the 3-M System (discussed in chapter 2 of this training course), maintenance planning should be considerably easier than it was prior to the installation of the system. But some administrative and supervisory duties will not be affected by the 3-M System, and you will always find some engineroom maintenance and repair work that just won't fit into a schedule but must be done whenever the opportunity arises. So, in addition to having the ability to plan, you must have a certain amount of flexibility so that you can alter your plans to fit the existing circumstances. A few administrative and supervisory considerations that apply particularly to maintenance and repair are noted in the following sections.

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Materials and Repair Parts

The responsibility for maintaining adequate stocks of engineroom repair parts and repair materials belongs at least as much to you as it does to the supply department. The duties of the supply officer are to procure, receive, stow, issue, and account for most types of stores required for the support of the ship. However, the supply officer is not the prime user of repair parts and repair materials; the initiative for maintaining adequate stocks of repair materials, parts, and equipment must come from the personnel who are going to use such items.

Basic information on supply matters is not included here because it is given in Military Requirements for PO 3 & 2, NavPers 10056-B, and Military Requirements for PO 1 & C, NavPers 10057-B. However, a few points are noted here concerning the identification of repair parts and materials. Identification is not usually any great problem when you are dealing with familiar equipment on your own ship; but it may present problems when you are doing repair work for other ships, as you would be if assigned to the machine shop on a repair ship or tender.

The materials and repair parts to be used are specified for many repair jobs but not for all. When materials or parts are not identified in the instructions accompanying a job, you will have to do some research to find out just what material or part should be used. When you must make the decision yourself, select materials on the basis of the service conditions they must withstand. Operating pressure and operating temperature are primary considerations in selecting materials and parts for most engineroom repair work. Special considerations may also apply; for example, high temperature steam piping must be made of material that has the property of creep resistance.

When materials and repair parts are not specified in the instructions accompanying a job, this does not always mean that you are free to use your own judgment. Instead, it may merely mean that you are expected to know where to look for information on the type of material or repair parts to be used. The shipboard sources of information that will be most helpful to you in identifying or selecting materials and repair parts include (1) nameplates on the equipment, (2) manufacturer's technical manuals and catalogs, (3) stock cards maintained by the supply officer, (4) ships' plans, blueprints, and other drawings, and (5) allowance lists.

NAMEPLATES on equipment supply information regarding the characteristics of the equipment and are therefore a useful source of information concerning the equipment itself. Nameplate data seldom, if ever, includes the exact materials required for repairs; however, the information given on the characteristics of the equipment and on pressure and temperature limitations may provide useful clues for the selection of materials.

MANUFACTURERS' TECHNICAL MANUALS are furnished with all machinery and equipment aboard ship. Materials and repair parts are sometimes described in the text of these technical manuals; more commonly, however, details of materials and parts are given on the drawings. Manufacturers' catalogs of repair parts are also furnished with some shipboard equipment; when available, these catalogs are a valuable source of information on repair parts and materials.

The set of STOCK CARDS that is maintained by the supply officer is often a useful source of information on repair materials and repair parts. One stock card is maintained for each type of machinery repair part carried on board.

SHIPS' PLANS, BLUEPRINTS, and other drawings available on board ship are excellent sources of information on materials and parts to be used in making various kinds of repairs. Many of these plans and blueprints are furnished in the regular large sizes; but microfilm is being used increasingly for these drawings. Information obtained from plans, blueprints, and other drawings should always be checked against the information given on the ship's COORDINATED SHIPBOARD ALLOWANCE LIST (COSAL), to be sure that any changes made since the original installation have been noted on the drawings.

The COSAL for each ship is a basic source of information on repair parts and materials. The COSAL gives nomenclature and Federal Stock Numbers for all hull, machinery, electrical, ordnance, and electronics materials.

To request materials and repair parts from the supply department aboard ship, you must fill out and submit a NAVSUP Form 1250, Single Line Item Consumption/Management Document. If the item is not stocked aboard ship, the supply department will requisition the material from a supply activity, using the identifying information that you have given on the NAVSUP Form 1250.

Whenever you find it necessary to request materials or repair parts, remember two things:

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1. If at all possible, find the correct Federal Stock Number for each item requested. All materials now in the supply system have been assigned Federal Stock Numbers, and you should be able to locate them by using the COSAL and the other sources of information available to you.

2. Work informally with the supply department personnel who are actually responsible for identifying and requisitioning material. You have the technical knowledge, and you know what you need. If you cannot find the correct stock number, however, your problem is to give enough standard identification information so that supply personnel on board ship or ashore can identify the item you want. Experienced supply personnel are familiar with identification publications and can help you to locate the correct stock numbers and other important identifying information.

Scheduling Work

Careful planning is required to keep up with all engineroom maintenance and repair work. Detailed information on scheduling work is given in chapter 2 of this training course. Some of the factors that may be helpful in scheduling maintenance and repair work are:

1. Size up each job before you let anyone start working on it. Check the applicable Maintenance Requirement Cards so that you will know exactly what needs to be done. Also, check all applicable drawings.

2. Check on materials before you start. Be sure that all required materials are available before your men start working on any job. Do not overlook small items—nuts, bolts, washers, packing and gasket materials, tools, measuring devices, and so forth. A good deal of labor can be saved by the simple process of checking on the availability of materials before a job is actually started. An inoperable piece of machinery may be useless; but it can become a positive nuisance and a safety hazard, as well as useless, if it is spread around the engineroom in bits and pieces while you wait for the arrival of repair parts or materials.

3. Check on the priority of the job and of all other work that needs to be done before scheduling any job.

4. When assigning work, give careful consideration to the capabilities and experience of your men. As a rule, the more complicated jobs should be given to the more skilled and more experienced men. When possible, however, the less experienced men should be given difficult work to do under supervision so that they may acquire skill in such jobs.

When assigning work, be sure that the man who is going to do a job is given as much information as necessary. An experienced man may need only a drawing and a general statement concerning the nature of the job. A less experienced man is likely to require additional instructions and, as a rule, closer supervision.

5. Keep track of the work as it is being done. In particular, check to be sure that proper materials and parts are being used, that the job is properly laid out or set up, that all tools and equipment are being used correctly, and that all safety precautions are being observed.

6. After a job has been completed, make a careful inspection to be sure that everything has been done correctly and that all final details have been taken care of. Check to be sure that any necessary records or reports have been prepared. Remember that job inspections can serve at least two very important purposes: first, to make sure that the work has been properly performed; and second, to increase the skills and knowledge of the person who has done the work. Do not overlook the training aspects of a job inspection. When your inspection of a completed job reveals any defects or flaws, be sure the man understands what is wrong, why it is wrong, and how to avoid similar mistakes in the future.

Estimating Work

You will often be required to estimate the amount of time, the number of men, and the amount of material that will be required for repair jobs. Actually, you are making some kind of estimate every time you plan and start a repair job, as you consider such questions as: How long will it take? Who can best do the job? How many men will be needed? Are all necessary materials available?

However, there is one important difference between the estimates you make for your own use and those that you make when your division officer asks for estimates. When you give an estimate to someone in authority over you, you cannot tell how far up the line this information will go. It is possible that an estimate you give to your division officer could ultimately affect the operational schedule of the ship; it is essential, therefore, that such estimates be as accurate as you can possibly make them.

Many of the factors that apply to the scheduling of all maintenance and repair work apply also to estimating the time that will be required for a particular repair job. You cannot make a reason-

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able estimate until you have sized up the job, checked on the availability of materials, checked on the availability of skilled personnel, and checked on the priority of the various jobs for which you are responsible. In order to make an accurate estimate of the time required to complete a specific repair job, you must also consider (1) what part of the work must be done by other shops, and (2) what kinds of interruptions and delays may occur. These factors are also important in the routine scheduling of maintenance and repair work; but they are particularly important when you are making estimates of time that may affect the operational schedule of the ship.

If part of the job must be done by other shops, you must consider not only the time actually required by these other shops but also the time that may be lost if one of them holds up your work. Each shop should make a separate estimate, and the estimates should be combined in order to obtain the final estimate. Do NOT attempt to estimate the time that will be required by other personnel. Attempting to estimate what someone else can do is risky because you can't possibly have enough information to make an accurate estimate.

Consider all the interruptions that might cause delay, over and above the time required for the work itself. Such things as drills, inspections, field days, and working parties can have quite an effect on the number of men who will be available to work on the job at any given time.

Estimating the number of men who will be required for a certain repair job is, obviously, closely related to estimating time. You will have to consider not only the nature of the job and the number of men available but also the number of men who can work EFFECTIVELY on a job or on part of the job at the same time. On many jobs, there is a sort of natural limit to the number of men who can work effectively at any one time. On a job of this kind, doubling the number of men will not cut the time in half; instead, it will merely result in confusion and aimless milling around.

Perhaps the best way to estimate the time and the number of men that will be required is to divide the total job into the various phases or steps that will have to be done, and then estimate the time and the men required for each step.

Estimating the materials required for a repair job is often more difficult than estimating the time and labor required for the job. Although your own past experience will be your best guide for this kind of estimating, a few general considerations should be noted:

1. Keep accurate records of all materials and tools used in any major repair job. These records serve two purposes: first, they provide a means of accounting for materials used; and second, they provide a guide for estimating materials that will be required for similar jobs in the future.
2. Before starting any repair job, plan the job carefully and in detail. Make full use of manufacturers' technical manuals, blueprints, drawings, and any other available information and try to find out in advance all the tools and materials that will be required for the accomplishment of each step of the job.
3. Make a reasonable allowance for waste when calculating the amount of material you will need.

TRAINING

By the time a man has reached the MM2 or MM1 level, he has acquired a great many practical skills and a large amount of theoretical knowledge. Among other things, he has learned a good deal about—

Construction details, operating principles, and operating characteristics of all types of naval propulsion plants and associated engineroom auxiliary machinery; propulsion plant layout and piping system arrangement; principles of steam engineering, including theory or combustion, theory of energy transformations, and factors governing engineroom and fireroom efficiency; nature and theory of engineroom operations; operational troubleshooting; engineering casualty control; engineroom maintenance and repair; characteristics of metals and alloys; tests and inspections of main engines; characteristics and tests of lube oil; and records, reports, and other administrative requirements.

As you well know, this is only a partial list of the skills and knowledges you must have in order to qualify as an expert Machinist's Mate. But even a very wide range of abilities and an extensive theorectical knowledge will not, in themselves, guarantee your success as an instructor. You must be technically competent before you can teach others; but your technical competence must be supplemented by the ability to organize information, to present it effectively, and to arouse and keep the interest of your students.

You will find excellent general information on how to plan, carry out, and evaluate an instructional program in the Manual for Navy Instructors, NavPers 16103-C; in Military Requirements for Petty Officer 3 & 2, NavPers 10056-B; and in Military Requirements for Petty Officer 1 & C, NavPers 10057-B. The present discussion does

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not include basic information of the type given in these references; instead, it deals with some of the difficulties peculiar to the training of engineroom personnel and some of the ways in which you can overcome or minimize these difficulties.

What kinds of things cause special problems in the training of engineroom personnel? For one thing, the interrelationship of propulsion plant operations may present a training problem. Each man must be trained to perform certain duties, but the duties of all watchstanders are very closely related and the actions taken by each person depend in some way upon the actions taken by the others. The man in charge of the watch must see that the throttlemen, the pumpmen, and the messenger function not only as individuals but also as a team.

From a long-range point of view, however, the teamwork required for engineroom operations can actually be turned to a training advantage. As a man is being trained for one specific duty, he must of necessity be learning something about the other duties. As a rule, therefore, the first part of a man's engineroom training may take quite a while but the last part will be comparatively fast.

The procedures for training a new man in engineroom operations vary considerably, depending upon such factors as the ship's steaming schedule, the condition of the engineroom machinery, the number of experienced men available to assist in the training program, and the amount of time that can be devoted to the training program. In general, however, you will probably train a man first to act as messenger, then pumpman, and finally throttleman. Before a man is assigned to any actual duty, of course, he should be given a general introduction to the engineroom so that he can become familiar with the location of all machinery, equipment, piping, and valves. He must also be instructed in certain basic safety precautions. He must be specifically warned about the dangers of turning valve wheels or otherwise tampering with machinery. LOOK BUT DON'T TOUCH! is a pretty good rule for any new man in the engineroom to follow.

When a man is ready to be trained in the duties of messenger, show him all the gages that are in use. Tell him what the gages indicate and show him how to take readings. Explain why the readings are important. Be sure he understands exactly how often each gage must be read. Show him how to make accurate entries in the engineroom log. When he has the gage situation under control, show him where and how to check lube oil levels and how to clean metal-edge type filters and basket-type strainers.

For a while you will have to keep a close watch on the man as he performs these duties. When he has become proficient in the duties of messenger, you can start training him in the pumpman's duties. When he is not busy taking the hourly readings or performing his other duties as messenger, have him observe the pumpman. Show him how to start and secure the different pumps, if conditions permit.

While the man is learning the pumpman's duties, he should also be learning the relationship between the duties performed by other watchstanders. After the man has demonstrated his ability to handle all duties on the lower level, he is ready to be trained in the throttleman's job. As far as manual skills are concerned, the throttleman's job is probably easier than either the pumpman's or the messenger's job. But the throttle watch requires the utmost vigilance and reliability, and a new man will have a lot to learn before he can be trusted to stand the throttle watch alone. He should always be started out under the supervision of an experienced throttleman, and he should remain under this supervision until the petty officer in charge of the engineroom is fully satisfied that the new man is completely qualified for this duty.

In training engineroom personnel who have not had previous engineroom experience, remember that an engineroom can be a complicated and confusing place to someone who walks into it for the first time. A lot of equipment is crammed into a small space, and a lot of complex actions are going on at once. When training new personnel, try to think back to the time when you first went into an engineroom. What aspects of engineroom operations were most confusing to you at first? What kind of help did you have in learning your duties? What kind of training would have made your learning easier and faster? By analyzing your own early experience and reactions, you can get a bearing on what a new man may be experiencing and you may be able to figure out ways to help him learn more effectively.

When you are training new personnel, remember that men vary widely in their methods of learning and in their rates of learning. Some men will learn most effectively if you give them an overall view of main engine operations, including a certain amount of theory, before going into the details of the hardware and the manual operations.

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Others will learn most effectively if they are taught some manual skills before getting too much involved with theory. Some men learn manual skills rapidly but take a long time to absorb the theory; for others, the reverse is true. And, of course, some men learn everything rapidly and some learn everything slowly. Some men benefit from patient, almost endless repetition of information; others may become bored and restless if you go over the same point just once too often. The important thing to remember is that your training efforts will be most successful if you are able to observe and allow for the individual differences that are bound to exist. Closely related to this point is another: Don't make snap judgments about a man's ability as a Machinist's Mate until he has had a chance to DEMONSTRATE his ability. You may turn out to be very wrong if you make snap judgments on the basis of a general impression, the man's appearance, or the rate at which he learns when he first comes into the engineroom.

When you are training personnel who have already had some engineroom experience but who have been on some other type ship, you may find that a certain amount of retraining is needed before the men can qualify as engineroom watchstanders on your ship. No two enginerooms are precisely alike in all details, and no two main engines that appear to be identical—behave in precisely the same way under all conditions. You might say that each engine has its own individuality, and that operating personnel must adjust to the engine in order to obtain the best results. Practically all Machinist's Mates learn this sooner or later; you can speed up the learning process by encouraging engineroom personnel to notice and to discuss differences between engines.

Because of the necessity for strict observance of safety precautions, all engineroom operational training must be rigidly controlled and supervised. To some extent, this increases the difficulty of setting up and running an engineroom training program. On-the-job training is necessary if a man is to acquire the actual skills needed for main engine operation; but you can't let anybody learn by trial and error, since errors would be too dangerous and too costly. Safety precautions should be taught from the very beginning and should be emphasized constantly throughout the training program.

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CHAPTER 13

PROPULSION PLANT EFFICIENCY

The military value of a naval ship depends to a large extent on its cruising radius, which in turn depends upon the efficiency with which a propulsion plant is operated. Economical operation involves making fuel, lubricating oil, boiler feed water, potable water, and consumable supplies last as long as possible. A ship is not ready for wartime steaming unless the engineering department can and does operate reliably and efficiently. It is, therefore, important that engineering personnel maintain propulsion equipment in a reliable condition and that the equipment be operated at maximum efficiency.

The primary purpose of the peacetime Navy is to train and prepare personnel for wartime conditions. However, in peacetime, maximum economy must be practiced to keep operating and maintenance costs at a minimum.

The operation of an engineering plant cannot be considered reliable when machinery casualties occur frequently. Some of the more common causes of machinery casualties are:

1. Changing the setup of the plant at high speeds.
2. Radical maneuvering of the ship.
3. Inexperienced or improperly trained personnel.
4. Lack of inspections or improper inspections.
5. Inattentive watchstanding.
6. Poor supervision.
7. Failure to establish responsibility.
8. Inadequate repairs, maintenance, and preventive maintenance.

Accurate knowledge and continuous effort are required to keep propulsion plants operating reliably and efficiently. It is necessary for the personnel concerned to be familiar with the chapters of NavShips Technical Manual which deal with main propulsion plants and associated auxiliary equipment. It is also necessary for personnel to have an accurate knowledge of the appropriate manufacturer's technical manuals, official publications, and directives on operational procedures and material upkeep.

When a ship is underway, the MMC or MM1 will normally stand watch as the petty officer in charge of an engineroom. The MM2 must be capable of operating any specific unit of machinery or piping system. As the senior petty officer of the watch, the MMC or MM1 must be capable of supervising all the operations of the propulsion and auxiliary machinery and piping systems that are applicable to any watch station to which he may be assigned. The senior petty officer must also be capable of supervising the overall operation of the entire propulsion plant, which includes the other engineroom(s) and the firerooms.

On ships having more than one main propulsion plant, the associated engineroom and fireroom are usually operated together as one unit. On some auxiliary ships this one unit constitutes the entire propulsion plant; on combatant ships, this unit may be one of two or four separate propulsion plants. The physical characteristics of compartments and bulkheads, or the location and arrangement of machinery and equipment, do not change the operating principles of a main propulsion plant. On older ships, it was necessary to operate two separate spaces as one basic unit; however, on most new large combatant ships, NavShips has changed this arrangement. The present machinery arrangement has the basic propulsion plant, consisting of boilers, main engines, turbogenerators, and auxiliary machinery of the associated engineroom and fireroom, in one compartment. This compartment is called a main machinery room.

In operating the associated engineroom and fireroom as one complete propulsion plant, maximum reliability and efficiency cannot be obtained unless there is cooperation, understanding, and teamwork between engineroom and fireroom personnel. A great deal depends upon the knowledge and supervisory ability of the senior watchstander in each main machinery space. The MM

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in charge of the engineroom should have a practical knowledge of fireroom operation, of safety precautions, and of the casualties that may occur during operation of the engineering plant.

On destroyers, most auxiliary ships, and most small ships, the MM in charge of the control engineroom will also be in charge of the entire engineering plant and will assume the duties of the officer of the watch. When the MM assumes the officer of the watch duties, he must have a thorough understanding of the routine procedures and regulations concerning the entire engineering department.

The MM in charge of a watch must see that the officer of the deck (OOD) and the engineer officer are immediately informed of all important facts concerning the operation of the main engines. The MM of the watch is responsible for reporting to the engineer officer and the OOD such items as casualties to machinery, the number of boilers available, the number of generators available, and the maximum speed of which the ship is capable. He must also report such operations as placing a major unit of machinery in or out of commission, starting a generator, lighting fires under a boiler, and securing a generator or boiler. The MM of the watch must also be capable of carrying out appropriate engineering casualty control procedures for the overall operation of the propulsion plant. Each individual casualty will be handled by the personnel on watch; the Machinist's Mate in charge of the watch will take such steps as may be necessary to minimize the effect of the casualty on the overall operation of the plant.

ENGINEERING PERFORMANCE

During peacetime, the objective of engineering department training in the fleet is to create and maintain readiness to deliver the designed performance of the engineering plant at all times. Such readiness includes the ability to operate free of breakdowns, to control engineering damage, to make prompt and effective emergency repairs, and to operate the engineering plant safely and economically. Administrative instructions are provided each ship for the purpose of furnishing a general and uniform guide by which type commanders or their subordinates may estimate or evaluate the engineering performance and readiness of the ships assigned to their command.

ENGINEERING RELIABILITY

A ship must be capable of performing any duty for which it was designed. A ship is considered reliable when it meets all scheduled operations and is in a position to accept unscheduled tasks. In order to do this, the ship's machinery must be kept in good condition so that the various units will operate as designed. Some of the steps to promote reliability are:

1. A good preventive maintenance program must be carried out at all times. This involves regular tests, inspections, and repairs.
2. Machinery and piping systems must be operated in accordance with good engineering practices. Operating instructions and safety precautions should be posted for each unit of machinery.
3. Supervisory personnel must have a thorough knowledge of the ship's machinery and piping systems. Information on construction, operation, maintenance, and repair of machinery can be obtained from the manufacturer's technical manuals and blueprints.
4. A good engineering department administrative organization will ensure proper assignment of duties and responsibilities and proper training and supervision of personnel. The MMC and MM1 will have administrative and supervisory duties. As a supervisor, the MMC or MM1 must see that all pertinent instructions and procedures are carried out in regard to the proper operation, maintenance, and repair of machinery.
5. Personnel must be thoroughly trained. This can be best accomplished by a combination of methods. An effective method of training is to have the students learn by doing; a good example of this is watchstanding. Another method of training is carrying out regularly scheduled and well planned instruction periods. These instruction periods are not limited to classroom instruction—they may be conducted by holding engineering casualty control drills while under way.

ENGINEERING PLANT ECONOMY

In order to obtain economy, the engineering plant, while meeting prescribed requirements, must be operated so as to use a minimum amount of fuel. The FUEL PERFORMANCE RATIOS are good overall indications of the condition of the engineering plant and the efficiency of the operating personnel. The fuel performance ratio is the ratio of the amount of fuel oil used as compared to the amount of fuel oil allowed for a certain

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Block II - Radio Servicing

Unit 3 - Receiver Construction

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Constructing simple crystal detector	Converting radio waves into audio waves
Amplifiers and T R F receivers	Reception of modulated waves Essential functions of an aural receiver Simple detector receiver T R F amplifier operation Causes of amplifier feedback and oscillation Neutralizing and losser methods Use of tetrode and pentode RF amplifier Intentional use of regeneration Basic types of interstage coupling Tracking Types of detectors used in T R F sets Volume control methods employed Audio amplifier and loudspeaker Commercial T R F receivers Basic design disadvantages of T R F's
AM superheterodyne receivers	Principals of the superhet receiver Advantages of the superhet receiver Single and double conversion sets Frequency conversion Tube element arrangement employed Pentagrid converter tubes Triode-heptode converter tubes Separate mixer and oscillator tubes Noise in the converter sections The local oscillator Hand-switching arrangements Intermediate-frequency amplifiers I.F. stage gain Detector, A-F amplifier and loud-speaker
AM detector and AVC systems	The demodulation process Diode detectors Simple diode detector circuits Dual purpose tubes in the detector section Automatic volume control Time constant for A V C

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speed or steaming condition. The fuel performance ratio, which is reported on the Monthly Summary, is a general indication of the ship's readiness to operate economically and within established standards. In determining the economy of a ship's engineering plant, the same consideration is given to the amount of water used on board ship. Water consumption is computed in (1) gallons of makeup feed per engine mile, (2) gallons of makeup feed per hour at anchor, and (3) gallons of potable water per man per day.

The increase or decrease in a ship's fuel economy depends largely on the operation of each unit of machinery; economical operation further depends on personnel understanding the function of each unit and knowing how units are used in combination with other units and with the plant as a whole.

Good engineering practices and safe operation of the plant should never be violated in the interest of economy—furthermore, factors affecting the health and comfort of the crew should meet the standards set by the Navy.

Indoctrination of the ship's crew in methods of conserving water is of the utmost importance, and should be given constant consideration.

Economy Versus Safety

Aboard naval ships, economy measures cannot be carried to extremes, because there are several safety factors that must be considered. Unless proper safety precautions are taken, reliability may be sacrificed; and in the operation of naval ships, reliability is one of the more important factors. In operating an engineering plant as economically as possible, safety factors and good engineering practice must not be overlooked.

Notes on Efficient Operation

There are several factors that, if given proper consideration, will promote efficient and economical operation of the engineering plant. Some of these factors are: (1) maintaining the designed steam pressure, (2) proper acceleration of the main engines, (3) maintaining high condenser vacuum, (4) guarding against excessive recirculation of condensate, (5) maintenance of proper insulation and lagging, (6) keeping the consumption of feed water and potable water within reasonable limits, and (7) conserving electrical power, (8) using the correct number of boilers for best efficiency at the required load levels, and (9) maintaining minimum excess combustion air to the boilers.

MAINTAINING A CONSTANT STEAM PRESSURE is important to the overall efficiency of the engineering plant. Wide or frequent fluctuations in the steam pressure or degree of superheat above or below that for which the machinery is designed will result in a considerable loss of economy. Excessively high temperatures will result in severe damage to superheaters, piping, and machinery.

PROPER ACCELERATION AND DECELERATION OF THE MAIN ENGINES is an important factor in the economical operation of the engineering plant. A fast acceleration will not only interfere with the safe operation of the boilers but will also result in a large waste of fuel oil. The Machinist's Mate in charge of an engineroom watch, or standing throttle watch, can contribute a great deal to the economical and safe operation of the boilers.

A HIGH CONDENSER VACUUM can be obtained only by the proper operation and proper maintenance of the condenser. A low exhaust pressure (high vacuum) is an important factor in obtaining maximum engineering efficiency. Steam exhausting into a low pressure area has a greater range of expansion and therefore is capable of accomplishing more useful work. The total available energy in the steam is much higher per pound of pressure difference in the lower range of pressures than in the upper range. This is the most important reason why the condenser vacuum should be maintained as high as possible.

EXCESSIVE RECIRCULATION OF CONDENSATE should be avoided as it cools the condensate, which then has to be reheated as it enters the deaerating feed tank. This reheating process causes an excessive amount of steam to be used to maintain the proper temperature in the deaerating feed tank. The principle of operation of the thermostatically controlled recirculating valve is discussed in Machinist's Mate 3 and 2 and in NavShips Technical Manual. The use and operation of this valve should be thoroughly understood by operating personnel.

MAINTENANCE OF PROPER INSULATION AND LAGGING not only increases the overall economy of the engineering plant but also is a safety measure and increases the comfort of personnel. In every power plant there is a heat loss as heat flows from heated surfaces, such as piping and machinery, to the surrounding air and cooler objects. This heat loss can be kept to a minimum by proper insulation.

While increasing the economy of the plant,

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insulation also reduces the quantity of air necessary for ventilating and cooling the space. Proper insulation also reduces the danger of personnel receiving burns from contact with the hot parts of the piping, valves, and machinery. Good insulation, elimination of steam leaks, and a clean ventilation system contribute to good economy and to the comfort and safety of personnel.

CONSERVATION OF FEED WATER AND POTABLE WATER has a direct bearing on the overall efficiency and economy of the ship. Feed water and potable water consumption rates are entered on the Monthly Summary. Type commanders use these consumption rates as a factor for judging the efficiency of ships operating under their command. Ships having excessive feed water consumption rates should take immediate steps to eliminate all steam and water leaks which contribute to the uneconomical operation of the plant. Improving feed water consumption rates will also improve the fuel oil performance ratio.

The consumption of potable water by the ship's crew bears a direct relationship to the efficient operation of the engineering plant; the greater the amount of fresh water distilled, the greater the amount of steam used. Conservation of fresh water requires the close cooperation of all personnel aboard ship, since large amounts may be wasted by improper use of the laundry, scullery, galley, and showers.

FAILURE TO CONSERVE ELECTRICAL POWER is a very common source of waste aboard ship. Lights are frequently left on when not needed, and bulbs of greater wattage than required are often used.

If the ship's ventilation system is improperly operated or improperly maintained, the result is a waste of electrical power. Vent sets are often operated on high speed when low speed operation would provide adequate ventilation and cooling. Dirty and partially clogged ventilation screens, heaters, cooling units, and ducts will result in inefficient operation and power loss.

In checking the operation of the engineering plant for efficiency, the proper operation and maintenance of all units of auxiliary machinery must be considered. Economical operation of the distilling plants and of the air compressors will contribute a great deal to the overall efficiency of the plant. Because of the large number and various types of pumps aboard ship, their operation and maintenance are important factors. Units of machinery that operate continuously (or most of the time) must be given careful attention with respect to efficient operation and maintenance.

The following are specific recommendations for the efficient operation of engineering plants:

1. Use the minimum number of forced draft blowers. It is more economical to run one blower at or near its designed speed than to run two blowers at a lower speed.
2. Do not operate with excessive feed water pressures. Excessive pressure results in a wasteful amount of steam being used to drive the pump.
3. Maintain proper fuel oil temperature. Do not operate more fuel oil heater units than are necessary for proper heating. Overheating fuel oil wastes steam and overheated fuel oil fouls the heaters.
4. Maintain superheated steam temperature as close to the designed temperature as operating conditions permit.
5. Steam with a light brown haze, whenever permissible; 10 to 15 percent excess air is approximately right for this kind of steaming. If smokeless steaming is required, slightly more than 10 to 15 percent excess air will be necessary.
6. Boiler casings should always be tight. Leaky casings result in excessive fuel consumption because additional steam is required to increase blower capacity and heat is conducted away from the boiler by leaking air.
7. High feed water consumption indicates an uneconomical plant. No feed water leak is too small to be neglected.
8. Blow tubes in steaming boilers at least twice each day at sea and at least once each day when steaming boilers in port for auxiliary purposes. Also blow tubes before securing a boiler.
9. Keep the steam pressure and temperature as steady as is feasible at all times.
10. Throttlemen must carefully follow the acceleration and deceleration table posted on the throttle board.
11. Check the condensing system frequently for proper operation and tightness.
12. Check the operation of the deaerating feed tank frequently.
13. Keep all drain valves, drain lines, and steam traps in good working condition.
14. All orifice plates in piping systems should be checked for good material condition, proper size, and proper operation.
15. Keep the steam pressure to the air ejectors steady and at the designed pressure.

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16. Keep the thermostatically controlled recirculating valve in good working condition and operate it properly.

17. Keep the auxiliary exhaust pressure at the designated value by maintaining the automatic dumping valves in good working condition.

18. Follow the proper procedures in taking on makeup feed.

19. Maintain all insulation and lagging in good condition.

20. Keep the bilges dry. Water in the bilges will add to the humidity of the air, necessitating more ventilation, and causes bilge piping to corrode.

21. Keep ventilation systems clean at all times.

22. Ventilation motors should be run on low speed unless high speeds are necessary.

23. Whenever the ship's electrical load will permit, one generator, rather than two, should be operated. It is more economical to operate one generator at near full load than to operate two generators at light loads.

24. Maintain proper lubricating oil temperatures. Cold lube oil can be an indirect cause of excess fuel oil consumption.

25. Use the proper number of boilers for best efficiency at the required load condition.

26. Use the proper setup of pumps and other auxiliaries at all times.

27. Keep heat exchangers, such as lube oil coolers, operating efficiently.

28. Keep the condensate depression between 0° F and 2° F.

29. Never sacrifice safety for economy. Personnel may be injured and machinery may be damaged.

Trial Performances

Trial performances, such as full power and economy trials, are conducted to furnish evidence of the ship's engineering plant readiness for peacetime or wartime steaming conditions. By studying the trial performance reports, the type commander and NavShips can evaluate the ship's readiness to make required speeds and economy of operation. Information on conducting trial performances will be given in a later chapter of this training course.

CONTROL OF ENGINEERING CASUALTIES

The ability of engineering department personnel to control engineering damage and make emergency repairs is measured by PERFORMANCE OBSERVED during training exercises and actual emergencies. The first consideration in judging the effectiveness of engineering casualty control lies in evaluating the ability of the ship's force to maintain and repair the ship's machinery and equipment. For complete evaluation, allowances must be made for the age, service, and character of the installed machinery, for time and facilities allotted for maintenance and repair, and for experience and training of engineering personnel.

Another means of judging the readiness and ability of a ship and the ship's crew to perform the operations which might be required of them in time of war is by conducting an OPERATIONAL READINESS INSPECTION (ORI). The ORI consists of conducting battle problems and other operational exercises which involve all divisions aboard ship. The results of the engineering casualty control exercises greatly reflect the condition of the machinery and the effectiveness of the personnel. During such an exercise, too much dependence should not be placed on a few key men, all men should be trained so that smooth teamwork and reliable performance may be obtained.

Careful and continuous efforts by the MM1 and MMC must be carried out to train men on steaming watch. In peacetime, almost all of the engineering casualties occur during a steaming watch, at which time the key men may not be present. These casualties must be handled by the men on watch at the time when they occur. The senior watchstanders should check the training of their watchstanders and have a thorough knowledge of both their ability to stand watch and to handle casualties. The senior watchstanders should take all practical steps to instruct and train men on watch.

GETTING READY TO GET UNDERWAY

Getting a ship underway, especially a large ship, in a smooth and efficient manner depends to a great extent upon the administrative procedures and organization of the engineering department. Posting the steaming watch, the advance supply of information to the supervisory personnel, dissemination of instructions to watchstanders, the mustering and checking of watchstanders on stations, and warming up the main plant and standing by to get underway, require certain procedures, coordination, and instructions by supervisory personnel.

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To prevent misunderstanding and confusion, forms and checkoff lists are used in getting the engineering plant ready to get underway. The purpose of checkoff sheets for warming up or securing a main plant is to provide a convenient and simple procedure for checking the required steps in proper sequence. Checkoff sheets will ensure that no important step is overlooked or forgotten.

STEAMING ORDERS

Steaming orders are usually written by the engineer officer or the main propulsion assistant. Steaming orders are necessary, especially on large ships, to supply advance information to supervisory personnel and to enable administrative personnel to make necessary preparations.

Steaming orders list the various units of machinery and the readiness requirements of the engineering department. This form usually includes the major machinery to be used, the lighting-off times, the cutting in of boilers, spinning main engines, the times of warming up and putting ship's service generators on the line, standard speed, the name of the engineering officer of the watch, the name of the leading petty officer of the watch, and any additional information that the engineer officer thinks necessary. The steaming orders are generally written the night before the ship is to get underway and left in a convenient location, such as the log room or central control, for the duty officers and duty petty officers to sign. When a petty officer signs the steaming orders, it means that he has read and understood the orders and therefore is fully responsible for carrying out any and all orders applicable to him. The early posting of such orders is essential in getting a large propulsion plant underway with a minimum of confusion.

On smaller ships, such as destroyers, steaming orders are usually brief and simplified. The first part of the engineroom lighting-off sheet is generally used as the steaming orders. Key personnel, such as the MMC, BTC, and EMC, are notified by the engineer officer or by the assistant engineer officer as to the time the ship will get underway. The duty MMC, who has received all the necessary information and instructions, is responsible for making preparations for getting underway.

WARMING UP THE PROPULSION PLANT

When all watchstanders have been mustered in the engineroom or machinery room, the petty officer in charge of the watch should inform main engine control that his space is manned and ready to light off. The officer of the watch or the senior petty officer in main engine control must check to see that all spaces are manned and ready to warm up the main propulsion plant. The officer of the watch or the petty officer who is assuming the duties of the officer of the watch must also see that all other required reports are made to main engine control.

At the time specified by the steaming orders, the senior watchstander will direct the spaces to start warming up the plant in accordance with the engineer officer's orders. A general checkoff sheet, to be followed in getting the plant ready to get underway, is provided for each ship. Checkoff sheets will differ in accordance with each installation and the orders of the engineer officer. A typical warming up procedure is described in Machinist's Mate 3 and 2, NavPers 10524-C.

Many casualties that have occurred during warming up the plant can be traced directly to lack of cooperation between engineroom and fireroom personnel, misunderstanding of orders, lack of coordination by the senior watchstander, starting or securing machinery without orders, and opening or closing valves without orders to do so.

It is very important to hold the boiler load to a minimum until the main feed pump can be warmed up and is ready to feed the boiler. On ships using an emergency feed pump for feeding the in-port boiler, it is very important to warm up the main feed pump as soon as possible. As additional machinery is started, the load on the emergency feed pump increases. Emergency feed pumps are designed to feed a boiler at low loads only; a main feed pump should take the load as soon as one is warmed up and ready to be put on the line.

Another means of keeping the load on the emergency feed pump to a minimum is to keep the main steam stop bypass valve closed until the main feed pump is feeding the boiler.

When an additional boiler is ready to be brought in on the line, the officer of the watch must carefully coordinate the efforts of the engineroom and fireroom watchstanders to prevent casualties. Putting another boiler into service involves starting additional feed booster pumps, main feed pumps, another deaerating feed tank, and splitting the plant. At this point in the warming up process, a lack of cooperation or a misunderstood order can cause several

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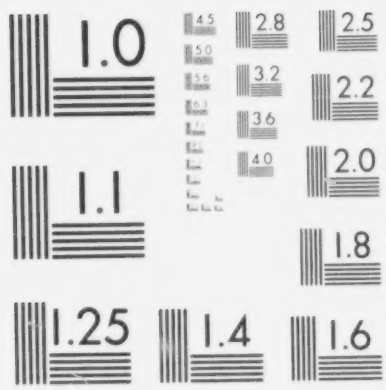

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

different kinds of casualties; an empty deaerating feed tank, loss of main feed pressure, or loss of electrical power are but a few of the casualties that have occurred. Split-plant valves should never be opened or closed without orders from the officer of the watch in main engine control, and when such orders are received the valves should be opened (or closed) as soon as possible.

REPORTING READY TO ANSWER BELLS

During the last few minutes before the ship is scheduled to get underway, the officer of the watch has many duties and responsibilities to carry out. He must be certain that the items listed on the steaming orders are carried out or will be carried out in accordance with the engineer officer's orders. He must know that all required machinery has been warmed up properly, put on the line, and is running normally. He must be sure that the required boilers are on the line, that all main steam lines have been properly drained and lined up as specified by the lighting-off sheets, that the required number of ship's service generators are on the line, and that the electrical load is split. He must also be sure that the Electrician's Mate and I. C. Electricians have tested the engine order telegraph, the shaft revolution indicator, the steering engines, and the anchor windlass. He must know that the plant is split, and that all standby machinery has been tested and is ready for use, if needed.

The main engines must be tested before the engineering plant is ready to get underway. On a small ship, such as a destroyer, the engineering officer of the watch will request permission from the OOD to test main engines, usually about 15 minutes before the ship is scheduled to get underway. On a large ship, such as a CVA, this request may be made one hour or more before the scheduled departure time.

When the OOD is certain that the area around the screws is clear of boats, lines, or other objects that may foul the screws, he will grant permission to test the main engines. When this permission has been granted, the engineering officer of the watch must notify all engineering spaces. When all main engines have been tested satisfactorily, the engineering officer of the watch will report to the OOD that the engineering department is ready to get underway.

After the main engines have been tested, and while you are waiting to answer bells, the main engines must be turned by steam. The engines are spun, astern and then ahead, to prevent putting way on the ship. Spinning the engines not only heats the casings but also prevents the rotors from bowing. The interval of time between testing main engines and getting underway may be prolonged by weather, traffic, casualties, or other conditions; during this time the main engines must be turned by steam at least once every 3 to 5 minutes. However, if the getting underway time is unduly delayed, the commanding officer may grant permission to engage and start turning gear to keep the engines turning.

FIREROOM OPERATIONS

In order for an MMC or MM1 to carry out his duties properly, he must possess some knowledge of basic fireroom procedures. This is especially true of those installations where an MMC is in charge of the control engineroom while underway. The efficient and safe operation of the engineering plant depends to a large degree on close cooperation between the engineroom and fireroom personnel. This close cooperation, will in turn, depend on the MM's knowledge of the fireroom and the BT's knowledge of the engineroom. By the time personnel in either space have become first class or chief petty officers, they should have a good knowledge of the entire engineering plant. This does not mean that they should be able to switch watchstanding jobs, but they should have a good understanding of what is occurring on the other side of the bulkhead or, in some ships, on the other side of the space.

Close cooperation of personnel in both spaces is always important, and is especially important when warming up or securing the plant because this is the time when many casualties occur. As additional machinery is started in the fireroom, the engineroom should be notified. In many instances, the fireroom should be notifed as machinery is started or secured in the engineroom. It should NEVER be taken for granted that personnel in other spaces know which machinery is in operation.

Most combatant ships have either single-furnace or double-furnace boilers. A number of older ships (chiefly auxiliaries) have header-type boilers. A few ships of recent design are equipped with a new type of boiler called a pressurized-furnace or supercharged boiler. The present discussion is limited to pointing out certain operational differences between double-furnace and single-furnace boilers, since these are the

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two most commonly used types at the present time.

The double-furnace boiler with controlled superheat is installed on many combatant ships built up to the end of World War II. The operating pressure of this type boiler is approximately 615 psig with a maximum superheater outlet temperature of 850° F. The superheaters of these boilers cannot safely be fired unless there is a safe minimum flow of steam passing through the superheaters.

On large combatant ships, there is usually sufficient steam flow (even when steaming for auxiliary purposes) to maintain fires under the superheater side. However, in most installations, and particularly in destroyers, it is usually necessary to be underway and making about 12 knots before the fires can be lighted under the superheater side of the boiler. When the superheater is operating and the steam flow drops below a safe minimum, the superheater fires must be secured immediately. On destroyers the superheater fires are usually secured when the speed of the ship drops below 10 knots.

From the standpoint of maintenance and repairs to the steam piping, turbine casings, and superheater handhole plates, it is not feasible to put superheaters into operation until it is expected that the ship's speed will be more than 10 knots for a considerable period of time. Furthermore, continually lighting off and securing the superheater fires will cause extensive steam leaks throughout the system subjected to fast changing temperature conditions. These steam leaks will waste more fuel than could be saved by a few minutes of superheat operation.

The single-furnace boiler without controlled superheat creates a different type of problem. During operation, there is no problem since all steam passes through the superheater and leaves the boiler at superheat temperature. After the boiler is on the line and furnishing steam, there will be sufficient flow because all steam passes through the superheater.

When lighting off and securing this type of boiler, there is no normal flow of steam through the superheater and some means of flow must be established. This means that before a boiler is cut in and after it is removed from the line cooling steam must pass through the superheater.

The following brief discussion on the construction and operation of the single-furnace boiler with uncontrolled superheat will help you to understand the need for protection steam during lighting-off and securing operations.

The superheater is installed within the banks of the generating tubes and receives heat from the same fire as the generating tubes. In operation, the steam is generated but before any of it is used, it is routed through the superheater. The steam used for auxiliary purposes must be desuperheated by passing it through a desuperheater that is submerged below the water level in the steam drum or water drum. When the boiler is steaming for auxiliary or underway purposes, there is a constant flow of steam through the superheater, sufficient to cool the superheater tubes. During the time when the boiler is lighted off, before the stops are opened—and also when the boiler is secured, after the stops are closed—there is no normal flow through the superheater. During this time there is heat in the furnace and the superheater tubes are subjected to this heat. If there is no steam flow through the superheater tubes during this period, the superheater will become overheated and damaged. This problem is overcome by piping steam from the auxiliary steam line (150-psi line), through the superheater tubes and into the auxiliary exhaust line.

When the boiler pressure exceeds 150 psi of the auxiliary steam line, steam flow must be provided through the superheater by the use of high pressure drains, auxiliary machinery, and throttling the steam in the auxiliary exhaust line. The amount of oil fired in the boilers during light off should be very carefully controlled to prevent overheating superheater tubes.

It is sometimes necessary to light off and put additional boilers on the line, when a ship is underway. With noncontrol superheat boilers, the steps are much the same as for putting the first boiler or boilers on the line. With superheat control boilers, additional precautions must be taken.

When the steam lines are carrying superheated steam, it would be dangerous to admit saturated steam to the lines. It is not usually possible to establish enough steam flow to light off the superheaters of the incoming boilers, until they are on the line. It is permissible to bring in the incoming boilers, without their superheaters in operation, if the superheater outlet temperature of the steaming boilers is lowered to 600° F. Lowering of the superheat temperature on the steaming boilers should be started in time so that the cutting-in temperature can be reached before the incoming boilers are up to operating pressure. Except in an

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emergency, the temperature of the superheaters should NOT be lowered or raised at a faster rate than 50° F every 5 minutes.

If the ship is operating at a speed that requires maximum or near maximum superheat temperature and the saturated side is being fired at maximum or near maximum, the officer of the watch must know and inform the bridge that the speed of the ship will have to be reduced in order to cut in additional boilers.

If an emergency exists, it is permissible to attempt to establish flow through the superheaters of the incoming boilers by the following methods: (1) opening the superheater bilge drains, (2) opening the main steam line low pressure drains, (3) opening the main stop bypasses, and (4) steaming the boiler directly to an idle generator (or some installations this cannot be done). If any one or a combination of these measures succeed in establishing sufficient steam flow, the superheaters may be lighted off and the superheat temperature of the incoming boiler brought up to a temperature equal to the temperature of the steaming boilers. None of these measures should be attempted when the speed of the ship can be reduced sufficiently to allow the superheat temperature of the steaming boilers to be lowered to 600° F: these measures may be attempted ONLY in cases of extreme emergency.

The officer of the watch should know the procedure for lighting fires under the superheaters. The casing air pressure is an important factor in lighting these fires. When it is known that superheaters are to be put into use, they should be lighted off before the saturated sides are being fired at a high rate. It is extremely difficult to insert a lighted torch in the superheater furnace when the air casing pressure is high. The torch will almost always be extinguished. Another undesirable result may be flareback which could cause injury to personnel.

OPERATING THE PLANT UNDERWAY

After the ship is clear of the harbor, the commanding officer will order the special sea detail secured. With the ship underway, a considerable amount of attention must be given to the plant. Some of the important factors to be considered are pointed out in the following paragraphs.

OPERATING INSTRUCTIONS

In order to be a good operator, the MM must acquaint himself with all standing orders and operating instructions for his ship. These are made up for each ship and show the various plant arrangements (split plant, cross-connected steaming, cruising arrangement, etc.) for the different speeds. Each watchstander must read and understand the steaming orders and any additional orders issued by the engineer officer.

USING THE CRUISING COMBINATION

A combatant ship operates most of the time at speeds far below maximum. At cruising speeds only a fraction of the turbines' capacity is required. Economy, at lower speeds, is obtained by one of the following methods: (1) by cruising turbines which are designed to operate economically at speeds up to about 18 knots, (2) by cruising stages in the high pressure turbine, and (3) by turbines designed so that they can be operated in series. On turboelectric ships, economy is accomplished by the use of multispeed motors.

On ships that have a cruising turbine, the cruising combination should be used for all underway operations requiring steady speeds of less than 18 knots. The officer of the watch, or petty officer of the watch, should obtain permission from the OOD to operate on cruising combination whenever possible.

To prevent casualties to cruising turbines, the protective devices (sentinel valve, direct-reading thermometer, crossover valve lock, and thermal alarm) should be checked continuously.

MAIN CONDENSER VACUUM

Maintaining a high vacuum in the main condenser makes available more useful work from each pound of steam. This increases the maximum speed of the ship. The vacuum for which the turbine was designed must be maintained. Watchstanders must give careful attention to detect and prevent air leaks into the main condensing system. In order to maintain a high vacuum, the following precautions must be taken:

1. Keep gland packing in good condition.
2. Maintain gland seal steam at the required pressure (usually 1/2 to 2 psig).
3. Eliminate all air leaks into the condensing system.

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4. Maintain adequate water in the reserve feed tank which is in use for makeup feed.

5. Ensure that throttles not in use do not leak. Any leakage of steam past a closed throttle will tend to raise the temperature and pressure within turbines not in use.

If the condenser vacuum is not as high as it should be in relation to the condenser load and the cooling water overboard temperature, some part of the condensing system is not functioning properly. The operator should check for malfunctioning of a condensate pump or air ejectors, and for an air leak in some part of the system under vacuum.

ACCELERATION AND DECELERATION CHART

Acceleration and deceleration charts are posted at each main engine throttle board. These charts give the exact amount of time that the throttleman should use in changing speed. When a speed change is ordered, the throttleman can instantly tell, by checking the chart, the minutes and seconds necessary for him to accelerate or decelerate to the new speed. Main engine control has tachometers indicating the number of rpm each shaft is doing. By checking these tachometers, he can coordinate the rpm of the shafts. If one throttleman accelerates or decelerates too fast or too slow, it can be detected and corrected by the officer of the watch.

Improper acceleration or deceleration wastes fuel oil and in general promotes uneconomical operation of the main plant. Each throttleman should make a revolution-pressure table, which gives the approximate pressure required in the first stage of the high pressure turbine to develop a certain rpm. By using this table and the acceleration and deceleration chart, the throttleman can not only promote efficient operation of the plant but also make his watchstanding much easier. There must always be a complete understanding between the engineroom and the bridge as to how many rpm are to be maintained for one-third, two-thirds, standard, and full speed. The throttleman should never relieve the watch without knowing the rpm for these speeds.

SECURING THE MAIN PLANT

After main engine control has been notified of the time that the ship is expected to enter port, advance preparations can be made for entering port, securing the main plant, and setting the auxiliary watch. Personnel must be informed and given specific instructions. On most ships, especially on small ships, the MMC in charge of the watch will supervise the preparations for entering port and the operations that take place. The MMC and MM1 will also be concerned with the administrative procedures involved in bringing a ship into port, securing the main engines, and setting the auxiliary watch.

PREPARING TO ENTER PORT

While the ship is still out in open sea, main engine control should request permission to pump bilges and blow tubes on all steaming boilers. The officer of the watch must keep in mind that the Oil Pollution Act of 1924 (as amended) and the Oil Pollution Act of 1961 prohibit the overboard discharge of oil and water containing oil in port and in navigable coastal waters. The Oil Pollution Act of 1961 extends the 1924 Act by prohibiting the overboard discharge of oil or oily water within 50 miles of land. In addition, the 1961 Act establishes special prohibited zones which in some areas extend as far as 150 miles from land.

When the bilges have been pumped and tubes blown on all steaming boilers, a report must be made to the bridge. If the ship has fuel oil tanks ballasted with salt water, this oily ballast water will have to be pumped overboard while the ship is well out at sea.

Lowering the Superheat (Controllable Superheat Boilers Only)

It is necessary to lower the temperature of the superheated steam before entering port. Lowering the temperature and securing the superheaters require close cooperation between the bridge, the engineroom and the fireroom. This is especially true on destroyers, where low maneuvering speeds require immediate securing of superheater fires. The fireroom must receive word in sufficient time so that the Boilermen can lower the superheat temperature at the proper rate (superheat should NOT be raised or lowered at a rate greater than 50° F every 5 minutes). When it is desired that the steam temperature be raised or lowered, the fireroom should be notified in sufficient time so that the desired temperature can be reached slowly.

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Auxiliary Machinery

On installations where the turbogenerators exhaust to either the auxiliary or main condensers, the following procedure should be used:

1. Put the required auxiliary condensers in operation, and start the required number of ship's service turbogenerators. After sea detail is set, all turbogenerators should be exhausting into their respective auxiliary condensers.
2. Warm up all auxiliary machinery which is to be used in anchoring or mooring the ship.
3. Shift the low pressure drains to the auxiliary condenser. It is usually not good practice to shift the auxiliary exhaust to the auxiliary condenser until the main plant is at least partially secured. In most installations, the auxiliary exhaust will overload the auxiliary condenser, cause a loss of vacuum, and probably result in loss of one or more ship's service turbogenerators. The auxiliary exhaust should be dumped to the main condensers until it is believed that the auxiliary condenser will not be overheated.

SETTING THE AUXILIARY WATCH

Each ship or class of ships will have its own detailed forms for securing procedures. A procedure used for destroyers is described in Machinist's Mate 3 and 2, NavPers 10524-C.

The officer of the watch must coordinate the securing operations. Although securing sheets are provided for each space, the petty officer in charge of the space must secure in accordance with the orders of the officer of the watch. No split-plant valves should be opened or closed without specific orders from the officer of the watch. No machinery, especially ship's service turbogenerators, should be started or stopped without orders from the officer of the watch. No watchstander should take for granted that he knows what is going on in another space. Usually, only the officer of the watch knows what is going on in all spaces.

When the auxiliary watch is set, the officer of the watch or the MMC in charge of the watch will make a final inspection before reporting to the OOD. The status of all machinery must be known by the officer of the watch. He must be able to report to the engineer officer and the OOD that the auxiliary watch is set, which boiler(s) and ship's service generator(s) are in use, and the time of securing boilers, generators, and engines. The officer of the watch should also inform the OOD that the turning gears are engaged and turning, and approximately when they will be secured. The officer of the deck enters this information in the deck log.

The officer of the watch or MMC in charge of the watch must also know what units of machinery, if any, will require repairs, the extent of the repairs, approximately how long the unit(s) will be out of commission, and the length of time that would be required to get the ship underway. This information should be known to all persons concerned, from the men actually doing the work to the commanding officer of the ship. The commanding officer must know at all times how long it would take to get the ship underway and the maximum speed of which the ship is capable. Transmittal of this information starts with the senior petty officer in each space and goes through the chain of command to the commanding officer.

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Block II - Radio Servicing

Unit 3 - Receiver Construction (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
	Delayed automatic volume control Squelch systems Tuning indicators - meter types Tuning indicators - electron ray type
FM receiver	The front end section Image interference Sensitivity, noise, input loading Oscillator stability Oscillator-voltage injection Requirements of the FM I.F. section Amplitude limiters
	Demodulation in FM receivers: Foster-seeley discriminator Off-tune Ratio detector Lock in oscillator Gated-beam-detector Pre-emphasis and de-emphasis FM tuning indicators FM tuner units
Combination AM-FM receiver	Audio amplifier systems used with FM

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CHAPTER 14

ENGINEERING CASUALTY CONTROL

This chapter presents general information on engineering casualty control—its purpose, the factors involved, and procedures to be followed. Emphasis is placed on the prevention of progressive casualties, the need for correct action to be taken when a casualty occurs, and the importance of cooperation between fireroom and engineroom personnel under casualty conditions.

Engineering casualty control is a phase of damage control. If a review of damage control principles and related information is necessary, see Basic Military Requirements, NavPers 10054-B, Military Requirements for Petty Officer 3&2, NavPers 10056-B, Fireman, NavPers 10520-C, Machinist's Mate 3&2, NavPers 10524-C, and chapter 9880 (88), Naval Ships Technical Manual.

Engineering casualty control is concerned with the prevention, minimization, and correction of the effects of operational and battle casualties to the machinery, electrical, and piping installations. The mission of casualty control is to maintain all engineering services in a state of maximum reliability, under all conditions. The first objective under this mission is the effective maintenance of propulsion machinery, auxiliary and electric power, lighting, interior and exterior communications, fire control, electronic services, ship control, firemain supply, and miscellaneous services (heating, air conditioning, and compressed air). Failure to provide all normal services will affect the ship's ability to function effectively as a fighting unit, either directly (by reducing its power) or indirectly (by reducing habitability) and thereby lowering morale and efficiency of personnel. The second objective—which will contribute to the successful accomplishment of the first—is the minimization of personnel casualties and of secondary damage to vital machinery.

For detailed information you should familiarize yourself with the Engineering Casualty Control Manual, the Damage Control Book, the Ship's Organization Book and the Ship's Repair Party Manual. These publications will vary from ship to ship, but they give the organization and the procedures to be followed in case of engineering casualties to the ship, and other emergency conditions.

FACTORS INFLUENCING CASUALTY CONTROL

The basic factors influencing engineering casualty control are: (1) sound design, (2) inspections, (3) maintenance (including preventive maintenance), and (4) effective organization and training of personnel. Through a combination of these four factors, engineering casualty control reaches a peak of efficiency. CASUALTY PREVENTION is always the most effective form of CASUALTY CONTROL.

Influence of Design

Sound design influences the effectiveness of casualty control in two ways: (1) elimination of weaknesses which may lead to material failure, and (2) installation of alternate or standby means for supplying vital services in the event of a casualty to the primary means.

Both of these factors are employed in the design of naval ships. The second factor is carried out, in the case of individual units, by the installation of duplicate vital auxiliaries; by the use of loop systems and cross connections; and by the installation of complete propulsion plants designed to operate as isolated units (split-plant design).

Inspections and Maintenance

Preventive inspections and maintenance are vital to successful casualty control, since they minimize the occurrence of casualties by material failures. Continuous detailed inspection procedures are necessary not only to discover

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partly damaged parts which may fail at critical times, but also to eliminate the underlying conditions which lead to early failure (improper adjustment, improper lubrication, corrosion, erosion, and other enemies of machinery reliability). Particular attention must be paid to the following external evidences of internal malfunctioning: (1) unusual noises, (2) vibrations, (3) abnormal temperatures, (4) abnormal pressures, and (5) abnormal operating speeds.

Operating personnel should thoroughly familiarize themselves with the temperatures, pressures, and operating speeds of equipment specified for each operating condition, in order that abnormal operating conditions will be more readily apparent. It must not be assumed that an abnormal reading on a pressure gage or a thermometer is caused by an error in the instrument. Each case must be investigated to establish fully the cause of the abnormal reading. Installing a spare instrument, or making a calibration test, will quickly determine if an instrument error exists. All other causes must be traced to their source, if preventive maintenance is to be effective. Some specific examples of advanced warning of ultimate failure are outlined in the following paragraphs.

Because of the safety factor incorporated in pumps, considerable loss of capacity can occur before any external evidence is apparent. Changes in the operating speeds from normal for the existing load in pressure-governor-controlled pumps should be viewed with suspicion. Variations from the normal in chest pressures, lubricating oil temperature, and lubricating oil pressures are indicative of either inefficient operating procedures or poor condition of machinery.

When a material failure occurs in any unit, a prompt inspection should be made of all similar units to determine if there is danger of the same failure. Prompt inspection may eliminate many repeat casualties.

Abnormal wear, fatigue, erosion, or corrosion of a particular part may be indicative of a failure to operate the equipment within its design limits of loading, velocity, and lubrication—or may indicate a design or material deficiency. In the event of a failure of any of the preceding types, a detailed inspection to prevent repeat damage should be undertaken, unless corrective action can be taken which will ensure that such failures will not occur.

Strict attention must be paid to the proper lubrication of all equipment, including frequent inspection and sampling to determine that the correct quantity of the proper lubricant is being used in the unit. It is good practice to make a daily check of samples of lubricating oil in all auxiliary machinery. The samples should be allowed to stand long enough for any water to settle. When units of auxiliary machinery have been idle for several hours, all settled water should be drained from the lowest part of the oil sump, before the unit is started. Replenishment of the oil to the normal working level should be included in this routine. An unusual amount of water in the oil is normally indicative of either poorly fitted or excessively worn carbon packing on turbine-driven pumps.

The presence of salt water in lubricating oil, can be detected by drawing off the settled water and then running a standard chloride test. A sample of sufficient quantity for test purposes can be obtained by adding distilled water to the oil sample. Because of its corrosive effects, salt water in the lubricating oil is far more dangerous to a unit of machinery than is an equal amount of fresh water. Salt water is particularly harmful in the units having ball bearings. Where such units are found to be subject to salt-water contamination of the lubricating oil, it is essential to drain the oil as soon as possible, flush thoroughly, and refill with fresh oil.

Casualty Control Training

Casualty control training must be continuous; it requires step-by-step procedures and constant refresher drills. Drills must be preceded by adequate preparation; then the casualties must be simulated realistically. Supervisory personnel must visualize fully the consequences of any error which may be made in handling simulated casualties originally intended to be of a relatively minor nature. The simulation of major casualties and of battle damage must be preceded by a complete analysis and by careful instruction to all participants. A new crew must be given time to become familiar with the ship's piping systems and equipment prior to simulating any casualty which may have other than local effects.

In the preliminary phase of training, a "dry run" is a useful device for imparting a knowledge of casualty control procedures, without endangering the ship's equipment by too realistic a simulation of a casualty before sufficient experience has been gained. Under this procedure, a casualty is announced, and all individuals are required to report as though action were taken (an indication must be made that the action was simulated). Definite corrective actions can be made, and with careful supervision the timing of individual actions can appear to be very realistic.

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Regardless of the state of training, such dry runs should always be carried out before any actual attempt is made to simulate realistically any involved casualty. Similar rehearsals should precede relatively simple casualties whenever an appreciable proportion of men, new to the ship, are involved, and particularly after an interruption of regularly conducted casualty training, such as a shipyard overhaul.

Correction of Casualties

The speed with which corrective action is applied to an engineering casualty is frequently of paramount importance. This is particularly true when dealing with casualties which affect the propulsion plant, steering, and electrical power generation and distribution. If casualties associated with these functions are allowed to become cumulative, they may lead to serious damage to the engineering plant; this damage often cannot be repaired without temporary loss of the ship's propulsion power. Where possible risk of permanent damage exists, the commanding officer has the responsibility of deciding whether to continue operating the equipment under abnormal conditions; usually this action can be justified only where the risk of even greater damage, or loss of the ship, may be incurred by immediately securing the affected unit(s). For example, an engineering plant with high salinity could be operated long enough to steam clear of an area of possible enemy attack. However, all possible steps must be taken to shorten the period of hazardous operation.

If there is no probability of risk greater than the damage to machinery, the proper procedure is to secure the malfunctioning unit(s) as quickly as possible, even though loss or a partial loss, of the ship's propulsion power may occur.

Although speed in controlling a casualty is essential, action should never be undertaken without accurate information; otherwise the casualty may be mishandled, and further damage to the ship, or even loss of the ship may result. Cross-connecting an intact plant with a damaged plant must be delayed until it is certain that such action will not jeopardize the intact one. Speed in the handling of casualties can be achieved only by a thorough knowledge of the equipment and associated systems, and by thorough and repeated training in the routine required to handle specific casualties.

Split-Plant Operation

One fundamental of engineering casualty control is SPLIT-PLANT OPERATION. Small combatant ships have two engineering plants and the larger combatant ships have four individual engineering plants.

Split-plant operation means dividing boilers, engines, pumps, ship's service generators, and other machinery so that you have either two or four engineering plants—each complete in itself, and each operating its own fuel oil service pumps and source of fuel oil supply. Each turbine installation will operate its own main condenser, air ejectors, lubricating pumps, and other auxiliary machinery when operating split-plant. If one engineering plant (boilers, main engines, or other units of machinery in the specific plant) is put out of commission by explosion, shellfire, or flooding, the other plant(s) can keep the ship underway, though at a reduced speed.

Split-plant operation applies to all piping and electrical systems aboard ship. Split-plant operation is a means of reducing the chance of a casualty that would completely immobilize the entire engineering plant. It prevents a casualty to one plant being transmitted to another plant, or seriously affecting its operation. If a ship were steaming split-plant and a main steam line casualty occurred in one section, main steam would be lost from only one set of boilers; if the plant were cross-connected, steam would be lost from all boilers.

PHASES OF CASUALTY CONTROL

The handling of casualties can be divided into three phases: (1) limitations of the effects of the damage, (2) emergency restoration of services, and (3) complete repair.

The first phase is concerned with immediately controlling the casualty so as to prevent further damage to the unit(s) concerned and to prevent the casualty from spreading through secondary effects.

The second phase consists of restoration, insofar as practicable, of the services which were interrupted as a result of the casualty. When all services are restored, this will, generally, correct all operational difficulties, except for the temporary loss of some standby units. If no damage to, or failure of, machinery has occurred, this phase usually completes the operation.

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The third phase of casualty control consists of making repairs which will completely restore the installation to its original condition.

ENGINEERING CASUALTIES

In the event of a casualty to a major component of the propulsion plant, the first consideration should be the prevention of additional or major casualties. Under normal operating conditions, the safety of personnel and machinery should be given first consideration. Where practicable, the propulsion plant should be kept in operation by the use of standby auxiliary machinery and piping systems. The important thing is to prevent minor casualties from becoming major casualties, even if it means a temporary loss of propulsion power. It is better to stop the main engines for a short time than to put them completely out of commission, so that major repairs will be required to place them back in commission.

When a casualty occurs, the engineering officer of the watch, or the petty officer of the watch, must be notified immediately. Then he notifies the OOD and engineer officer. Main engine control must keep the bridge informed as to the nature of the casualty, the ship's ability to answer bells, the maximum speed available, and probable duration of the casualty.

Engineroom Casualties

For each class of ships, the type commander formulates engineering casualty procedures which are applicable to the specific type of engineering plant. This chapter contains information on typical engineroom casualties and the general procedures recommended by NavShips for the control of each. Consult the ship's Engineering Casualty Control Manual for engineering casualty procedures on your ship.

High Oil Level in Reduction Gear Sump.—If a casualty of this type occurs, the action to be taken is as follows:

1. Obtain permission from the OOD to slow the engine.
2. Pump down the sump tank to the proper level.
3. Determine the source of trouble and correct it.

Locking and Unlocking of Shaft Underway.—In the event a main shaft has to be LOCKED while the ship remains underway, the following procedure is recommended by NavShips:

1. Slow the ship's speed to approximately 1/2 of full power or less, or the designated locking speed.
2. Close the ahead throttle and open the astern throttle until the shaft stops. When the shaft stops, the throttleman must make a note of the astern steam pressure that was required to stop the shaft.
3. As soon as the shaft is stopped, engage the turning gear and immediately set the turning gear motor shaft brake.
4. Close the astern valve slowly. As the astern throttle is being closed, station an observer to check for shaft rotation.
5. If the shaft is to remain locked for an extended period of time, the main condenser vacuum should be broken.

In UNLOCKING the shaft, the following action should be taken:

1. Reduce the temperature of the main steam as much as practicable.
2. Bring the ship to the same speed (rpm) at which the shaft was locked.
3. Open the astern throttle until the same astern steam pressure as was used when the shaft was locked, is obtained.
4. Disengage the turning gear. (It may be necessary to raise or lower the astern steam pressure slightly in order to disengage the turning gear.) The turning gear brake may then be released.
5. Slowly close the astern throttle.
6. Open the ahead throttle sufficiently to start the turbine rotating.

CAUTION: If the shaft has been locked for 5 minutes or more the turbine rotor may have bowed. A bowed rotor can be straighted by following the procedure given in the manufacturer's technical manual or in NavShips Technical Manual.

Piping System Casualties

A rupture in a piping system is another type of casualty that frequently occurs in an engineering space. The corrective action for the particular situation depends on the location and extent of the damage. While all piping system casualties differ in some respects, the following procedures apply to any casualty of this type:

1. Secure the space or isolate damaged sections of system as necessary.

2. Cross-connect systems or plants, where possible, to maintain maximum propulsion power. (CAUTION: Inadvert cross connection may result in flooding or endanger personnel. Before cross connecting an adjacent space, be sure personnel in that space are aware of action to be taken.)

Rupture in Main Steam Piping (Split-Plant). — The rupture of main steam piping may fill the space with steam, making it untenable. This will necessitate abandoning the space and securing it from outside. Entry into the space will be possible after the steam leak has been isolated and the space has cooled. After reentry into the space is possible, the damage can be repaired and the units can be put back into operation.

If main steam piping has carried away in a fireroom, close the main boiler stop valve and close the throttle to the affected main engine. Secure the fuel oil to the boiler(s) by closing the master fuel oil valve or by remote control (tripping the quick-closing valve) and isolate all main steam lines in the fireroom. If practicable, open cross-connecting valves to restore main steam to the main engines, turbo-generators, and vital auxiliary machinery. The space should continue to receive auxiliary steam to maintain lube oil pressure to the main engines. If the lube oil service pumps are electrically driven, and the ship's service generator is lost, the main consideration is to restore electrical power from another generator.

Rupture in Auxiliary Steam Piping System. — A rupture in a section of auxiliary steam piping may cause the space to fill with steam and become untenable. If possible the line should be isolated from within the space, if this is not possible, the steam must be secured from outside the space.

If the casualty occurs in a fireroom and there are no means available for maintaining the lube oil pressure to the main engines, the engine-room personnel should stop and lock the shaft.

If the casualty occurs in an engineroom, it is possible (on some ships) to continue operation of the propulsion plant. The auxiliary steam piping usually consists of a loop in the engineroom. Damage to one section can be isolated so that only half of the vital auxiliary machinery will be affected. The plant can, therefore, continue operating but the maximum speed of the ship will be limited to the rate at which the one remaining main feed pump will feed the boiler(s).

All possible means should be used to maintain lube oil pressure to the main engines.

Rupture in Auxiliary Exhaust Piping. — A rupture in the auxiliary exhaust system can be isolated only if the rupture occurs between a unit of machinery and its exhaust valve. But patches, plugs, and blank flanges may be used in repairing damage to the low pressure exhaust system. When a section of the auxiliary exhaust system is damaged, the first considerations should be to prevent personnel from being burned and to prevent feed water casualties. If the damaged section cannot be isolated, use only the necessary machinery which exhausts into the damaged section.

If a major break occurs in the auxiliary exhaust system, the deaerating feed tank should be kept under continuous observation to prevent a feed water casualty.

Fireroom Casualties

As an MM1 or MMC, you will be concerned with various fireroom casualties. In general, the Boilerman is responsible for taking the necessary steps to control fireroom casualties. However, it will become necessary for the Machinist's Mate to carry out proper procedures to control the casualties which have a direct effect on the operation of the engineroom. Close cooperation between the engineroom and fireroom personnel is necessary for the most efficient handling of engineering casualties.

Under all circumstances, the Boilerman will notify the engineroom of the fireroom casualties. The necessary action that must be taken will be based on the report given by the Boilerman. When a fireroom casualty affects the operation of the engineroom, cooperation and communication between personnel of both the spaces are extremely important. Lack of (or improper) communication or cooperation can be the indirect cause of a casualty getting out of control and resulting in serious damage to machinery and injury to personnel. Main engine control must receive all important information in order to coordinate the handling of the casualty. Main engine control must have all vital information to keep the officer of the deck informed as to the status of the machinery and the maximum speed the ship can make.

For additional information on fireroom casualties, see Machinist's Mate 3 & 2, NavPers 10524-C.

Battle Casualties

As an MM1 or MMC, you will be responsible for knowing how to handle battle casualties. Speed is a critical factor when applying corrective procedures to battle casualties. But speed is not the only factor to be considered, CORRECT ACTION must be taken. Thorough training of all personnel concerned is essential in applying proper procedures in handling battle casualties.

This training course contains information on some of the different types of battle casualties. Battle casualty control procedures are extremely important; and an MM1 or MMC will be expected to know them. You must be familiar with the procedures as presented both in this training course and in other publications that cover them in greater detail. NavShips Technical Manual, chapter 9880 (88), and your own ship's Damage Control Book, Engineering Casualty Control Manual, and Ship Repair Party Manual are publications which contain very important information which you must know.

Shell or torpedo hits in engineering spaces usually result in multiple casualties to machinery and systems. The corrective action for any particular casualty depends on the location and extent of damage. While battle casualties differ in many respects, the following procedures apply to any casualty of this type:

1. Secure the space or isolate damaged sections, as practical.
2. Cross-connect systems or plants when possible.
3. Stop and lock the shaft—in the event of serious damage to the turbine, reduction gear, main steam line, or the main shaft, or in the event of loss of lubricating oil pressure to the main engines.
4. Carry out applicable casualty control procedures in the event of damage to machinery or piping systems.
5. Take all precautions to prevent flooding of the space. Put all available pumps on the bilges of the damaged space; plug all holes and if possible, prevent flooding of other spaces.

(Note: The main condenser circulating pumps are provided with a bilge suction which has the largest potential capacity available for pumping engineroom bilges. If a main circulating pump operates on bilge suction, it should be started the same as for main condenser circulating service, the bilge suction valve should be opened, and the sea suction valve gradually closed. When the pump is operating on a high suction lift, as when pumping bilges, the speed should be reduced to approximately 2/3 of rated speed. Pump noise can be minimized by slowing the pump.)

6. Lube oil lines, fresh water lines, salt water cooling mains, auxiliary exhaust lines and other low pressure lines may be repaired by the use of soft patches, blank flanges, wooden plugs, or other suitable means.
7. If a ruptured steam line prevents entry of repair party personnel into a space, the space may be secured by using remote controls.
8. Fires should be extinguished and damage should be investigated as soon as possible.
9. Make repairs to return machinery or the space back to service, if possible.
10. Keep communication lines open and keep main engine control advised of the existing conditions.

CHAPTER 15

INSPECTIONS AND TRIALS

A naval ship must be inspected from time to time to ensure that her operation, administration, and material are maintained at a high standard of readiness for war. The frequency with which the various types of inspections are held is determined by CNO, the fleet commander, and the type commander. As far as the ship is concerned, the type commander usually designates the type of inspection and when it will be held.

A ship is frequently notified some time in advance when an inspection will take place, but preparation for an inspection should not be postphoned until the notice of inspection is received. It is a mistake to think that a poorly administered division or department can, by a sudden burst of energy, be prepared to meet the inspector's eagle eye. By using proper procedures, and keeping up to date on such items as repair work, maintenance work, operating procedures, training of personnel, engineering casualty control drills, maintenance records, operating records, and other records and reports, you will always be ready for an inspection.

Your ship may be required to furnish the inspecting party that will make an inspection on another ship. Should this occur, you as a CPO or PO1 may be assigned the duty as an assistant inspector. Therefore, you should know something about the different types of inspections and how they are conducted.

ADMINISTRATIVE INSPECTION

Administrative inspections cover administrative methods and procedures normally employed by the ship, and each inspection is divided into two general categories—the general administration of the ship as a whole, and the administration of each department. In this discussion we will consider the engineering department only.

The purpose of the administrative inspection is to determine (1) that the department is being administered in an intelligent, sound, and efficient manner, and (2) that the organizational and administrative methods and procedures are directed toward the objective of every naval ship—namely, being prepared to carry out her intended mission.

INSPECTING PARTY

It is a routine procedure for one ship to conduct an inspection on another ship within the division. General instructions for conducting the inspection are usually given by the division commander; however, the selecting and organizing of the inspecting party is done aboard the ship that has received instructions to conduct the inspection.

The Chief Inspector, usually the commanding officer of the ship, will organize the assisting board. The organization of the assisting board is in general conformance with the departmental organization of the ship. It is divided into appropriate groups, each headed by an inspector with assistant inspectors as necessary. Chief petty officers and petty officers first class may be assigned as assistant inspectors.

The engineering department inspecting group (or party) will be organized and supervised by the engineer officer. The manner in which the inspection will be carried out will depend to a great extent upon the knowledge and ability of the assistant inspectors.

GENERAL INSPECTION OF THE SHIP

One of the two categories of the administrative inspection is that of the general administration of the ship as a whole. Items of this inspection that will have a direct bearing on the engineering department, and for which the report of inspection indicates a grade, are as follows:

1. Appearance, bearing, and smartness of personnel.
2. Cleanliness, sanitation, smartness, and appearance of the ship as a whole.

3. Adequacy and condition of clothing and equipment of personnel.

4. General knowledge of personnel in regard to the ship's organization, ship's orders, and administrative procedures.

5. Dissemination of all necessary information among the personnel.

6. Indoctrination of newly reported personnel.

7. General educational facilities for individuals.

8. Comfort and conveniences of living spaces, including adequacy of light, heat, ventilation, and fresh water, with due regard for economy.

ENGINEERING DEPARTMENT INSPECTION

The administrative inspection is primarily an inspection of the engineering department paper work, which includes numerous publications, bills, files, books, records, and logs. However, the inspection will also include other items with which the chief and first class will be concerned. Some of these items are the cleanliness and preservation of machinery and engineering spaces; training of personnel; assignment of personnel to watches and duties; the proper posting of operating instructions and safety precautions; adequacy of warning signs and guards; the marking and labeling of lines and valves; and the proper maintenance of operating logs.

ADMINISTRATIVE INSPECTION CHECKOFF LISTS

Administrative inspection checkoff lists are usually furnished to the ships by the type commander. These lists are used as an aid for inspecting officers and chiefs, to assist them in ensuring that no important item is overlooked. Inspecting personnel should not accept these lists as being all-inclusive. It usually develops, during an inspection, that there are additional items to be considered or observed.

As a petty officer, you should be familiar with the various checkoff lists used for inspections. The checkoff lists will give you a good understanding of how to prepare for an inspection as well as how to carry out your daily supervisorary duties. You will find it helpful to obtain copies of the various inspection checkoff lists from the log room and to carefully look them over. They will give detailed information for your type of ship.

You can get a better understanding of the scope and purpose of administrative inspections, as compared to other types of inspections, from the following abbreviated sample of an engineering department checkoff list:

1. BILLS FOR BOTH PEACE AND WAR:
   a. Inspect the following, among others, for completeness, correctness, and adequacy:
      (1) Department Organization.
      (2) Watch, Quarter, and Station Bills.
      (3) Engineering Casualty Bill.
      (4) Fueling Bill.

2. ADMINISTRATION AND EFFECTIVENESS OF TRAINING:
   a. Administration and effectiveness of training of personnel for current and prospective duties.
      (1) Are sufficient nonrated men in training to replace anticipated loses?
      (2) BuPers training courses:
         (a) Number of men enrolled.
         (b) Percentage of men in department enrolled.
         (c) Number of men whose courses are completed.
      (3) Are personnel concerned familiar with operating instructions and safety precautions? (Question personnel at random.)
      (4) Are personnel concerned properly instructed and trained to handle casualties to machinery?
      (5) Are personnel properly instructed and trained in damage control?
      (6) Are training films available and used to the maximum extent?
      (7) Are training records of personnel adequate and properly maintained?

3. DISSEMINATION OF INFORMATION WITHIN DEPARTMENT:
   a. Is necessary information disseminated within the department and divisions?
   b. Are the means of familiarizing new men with department routine orders and regulations considered satisfactory?

4. ASSIGNMENT OF PERSONNEL TO STATIONS AND WATCHES:
   a. Are personnel properly assigned to battle stations and watches?

b. Are sufficient personnel aboard at all times to get the ship under way?
c. Are men examined and qualified for important watches?
d. Does it appear that men on watch have been properly instructed? (Question personnel at random.)

5. OPERATING INSTRUCTIONS, SAFETY PRECAUTIONS, AND CHECK-OFF LISTS:

a. Inspect completeness of the following:
(1) Operating instructions posted near machinery.
(2) Posting of necessary safety precautions.
b. Are check-off lists (daily, weekly, monthly, etc.) properly maintained?
c. Are weekly tests and inspections of safety devices properly carried out?
d. Are responsible personnel familiar with current instructions regarding routine testing and inspections?
e. Are lighting-off and securing sheets properly used?

6. PROCEDURES FOR PROCUREMENT, ACCOUNTING, INVENTORY, AND ECONOMY IN USE OF CONSUMABLE SUPPLIES REPAIR PARTS AND EQUIPAGE:

a. Is an adequate procedure in use for replacement of repair parts?
b. Are there adequate measures used to prevent excessive waste of consumable supplies?
c. Is there proper supervision in the proper supply of, care of, and accountability for hand tools?
d. Are inventories taken of repair parts which are in the custody of the engineering department?
e. How well are repair parts preserved and stowed?
f. What type of system is used to locate a repair part carried on board? (Have a chief or first class petty officer explain to you how he would obtain a repair part for a certain piece of machinery.)
g. Are custody cards properly maintained for accountable tools and equipment?

7. MAINTENANCE OF RECORDS AND LOGS:

a. Inspect the following for compliance with pertinent directives, completeness, and proper form:
(1) Engineering Log.
(2) Bell Book.
(3) Operating records.
(4) Maintenance records.
(5) Alteration and Improvement Program.
(6) Daily Oil and Water Records.
(7) Engineering Reports.
(8) Training Logs and Records.
(9) Work Books for Engineering Spaces.

8. AVAILABILITY AND CORRECTNESS OF PUBLICATIONS, DIRECTIVES AND TECHNICAL REFERENCE MATERIAL:

a. Engineering Blueprints Recommended:
(1) Ship's Plan Index (SPI).
(2) Proper indexing of blueprints.
(3) Completeness and condition.
b. Manufacturers' Instruction Books:
(1) Proper indexing.
(2) Completeness and condition.
c. Type Commanders Material Letters.
d. NavShips Technical Manual.
e. General Information Book.
f. Booklet Plans of Machinery.

9. CLEANLINESS AND PRESERVATION:

a. Preservation and cleanliness of space (including bilges).
b. Preservation and cleanliness of machinery and equipment.
c. Neatness of stowage.
d. Condition of ventilation.
e. Condition of lighting.
f. Compliance with standard painting instructions.

OPERATIONAL READINESS INSPECTION

The operational readiness inspection consists of a demonstration on the part of the ship of her readiness and ability to perform the operations which might be required of her in time of war.

The inspection will consist of the conduct of a battle problem and other operational exercises. A great deal of emphasis is placed on AA and surface gunnery, damage control, engineering casualty control and other appropriate exercises. Various drills are held and observed. The ship will be operated at full power for a brief period of time.

The overall criteria of performance includes:

1. Can the ship as a whole carry out her operational functions?

2. Is the ship's company well trained, well instructed, competent, and skillful in all phases of the evolutions?

3. Is the ship's company stationed in accordance with the ship's Battle Bill, and does the Battle Bill meet wartime requirements?

OBSERVING PARTY

The personnel and organization of the operational readiness observing party will be about the same as that of the administrative inspection party. However, more personnel are usually required in the operational readiness observing party, and these additional personnel are very often chiefs and first class petty officers.

The observing party members should be briefed in advance of the scheduled exercises and drills that are to be conducted. The observers must have sufficient training and experience so that they can properly evaluate the exercises and drills that are to be held. Each observer will usually have an assigned station. He should be well qualified in the procedure of conducting drills and exercises for that station. It is highly desirable that each observer be familiar with the type of ship to be inspected.

BATTLE PROBLEMS

In this discussion we will consider the battle problem from the viewpoint of the observer, and present some general information on the requirements and duties of a member of the engineering department observing party. Then, knowing the viewpoint and duties of an observer, you can prepare yourself and your men for a battle problem and other appropriate exercises.

Preparation of a Battle Problem.—The degree of perfection achieved in any battle problem is a direct reflection of the skill and application of those who prepare it. A great deal depends upon the experience of officers and chief petty officers.

The primary purpose of a shipboard battle problem is to provide a medium for testing and evaluating the ability of all divisions of the engineering department to function together as a team in simulated combat operations in order to accomplish the mission assigned by the problem.

Battle problems can be made the most profitable and significant of all peacetime training experience, since they demonstrate how ready a department is for combat. The degree of realism of this test governs its value: the more nearly it approximates actual battle conditions, the more valuable it is.

Conduct of a Battle Problem.—There is one element in conducting a battle problem which increases its value to the ship's company: the element of surprise. Of course, preparations for carrying out a problem can't be kept entirely a secret. Before a battle problem is to be conducted, the ship is furnished information such as:

1. Authority for conducting the inspection.
2. Time of boarding of the inspecting party.
3. Time ship is to get underway.
4. Time for setting the first material readiness condition.
5. Time of conducting inspection for zero problem time conditions.
6. Zero problem time.
7. End of problem time.
8. Time to critique.

Observers should be proficient in the proper methods of introduction of information. In general, information delivered to ship's personnel should be verbal when practicable, and only that information which ship's personnel would logically determine from procedure and adequacy of investigation on search should be furnished by the observer. Should the inadequacy of procedure by ship's personnel result in the nondiscovery of a casualty imposed, observers may resort to coaching, but a notation should be made on the observer's form as to the time allowed before coaching and information were furnished. Special precautions should be taken to give the symptoms of casualty the same degree of realism that they would have if the casualty were actual rather than simulated.

In order to impose casualties, valves may have to be closed, switched opened, or machinery stopped. In each case the observer should inform responsible ship's personnel of the action desired, and the ship's personnel should operate the designated equipment. A casualty should be simulated, or omitted entirely, if there is danger that personnel injury or material damage might result because of lack of preparation or experience of personnel concerned. The supply of lubricating oil to the main engines or the supply of feed water to the boilers MUST NOT be stopped to simulate casualties.

An emergency procedure is set up, by the observing party and ship's company, to take proper action in case actual casualties—as distinguished from simulated or problem casualties—should occur.

The general announcing system (the 1MC circuit) may be used by the ship but observers normally will have priority in its use. The problem

Block II - Radio Servicing

Unit 4 - Receiver Servicing

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Making normal operational tests	General trouble shooting procedure
Isolating defective stage	Characteristic symptoms of troubles in various stages
Isolating defective part	Relationship of common troubles to parts
Replacing parts	Requirements of substitute parts Evaluation of substitute parts
Performing preventative maintenance	How to find potential trouble spots
Servicing AC power supply	Typical circuits Voltage readings Resistance readings Power transformer Filters and rectifiers Load current
Servicing AC-DC power supply	Safety precautions used Normal operation Range of voltage and resistance readings Filament circuit variations Rectifier and filament component defects
Servicing audio frequency amplifiers	Indications of normal operation Tests for performance Normal voltage and resistance readings Defects and their effects on receiver performance
Servicing speakers	Normal operation Tests for normal performance Voltage and resistance readings Speaker fidelity
Servicing IF amplifiers	Indications of normal operation Tests for performance Voltage and resistance readings Defects and the effects on normal receiver operation

time announcer will use the general announcing system to announce the start of the battle problem, the problem time at regular intervals, the conclusions of the problem, and the restoration of casualties. However, the general announcing system is kept available at all times for use in case of actual emergency. All other announcing system circuits and all other means of interior communications are reserved for the use of the ship.

Engineering telephone circuits should be monitored by one or more observers. A check should be made for proper procedure and circuit discipline, and for handling of information or casualties.

An inspection should be made to see that the engineering plant is properly split in accordance with current directives. Any fire hazards such as paint, rags, or oil should be noted. Check for missile hazards such as loose gear, loose floor plates, tool boxes, and repair parts boxes. The condition of fire fighting, damage control, and remote control gears should be carefully inspected.

Analysis of the Battle Problem.—The maximum benefit obtained from conducting a battle problem lies in the determination of existing weaknesses and deficiencies, and the resulting recommendations for improvement in organization and future training. Every effort should be made by observers to determine excellencies as well as deficiencies; a knowledge of existing excellencies by ship's personnel is helpful to morale and indicates those factors that presently, at least, may receive less emphasis in the shipboard training program.

Analysis of the battle problem affords the observers an opportunity to present to the ship their opinion of her performance, and for the ship to comment on the observers' remarks and to consider suggested improvements in doctrine or material. Analysis is conducted in two steps; the critique and the observers' reports.

A critique of the battle problem should be held on board the observed ship before the observing party leaves, in order that a review of the problem and the action taken may be made when both are fresh in the minds of all concerned. The critique is attended by all the ship's officers, appropriate chief and first class petty officers, the Chief Observer, and all Senior Observers. The various points of interest of the battle problem are discussed, and the Chief Observer comments on the overall conduct of the problem after the Senior Observers have completed their analysis of the battle problem as developed from their observers' reports.

The observers' reports will be in the form prescribed by the type commander, and will include any additional instructions given by the Chief Observer. The reports of the observers are collected by the Senior Observer for each department. Senior Observers submit their reports to the Chief Observer. All observers' reports are reviewed by the Senior Observer for the requisite department before the critique is held.

The observers' reports also serve to furnish the inspected ship with detailed observations of the battle problem which may not, because of time limitations, be brought out during the critique. The inspected ship receives a copy of all observers' reports; in this way, each department is given the opportunity to view the detailed comments and to set up a training schedule to cover weak points.

A brief example of an engineering observer's report form is given as follows:

Engineering Observer. . . . . .
Location. . . . . .

1. The engineering department's evaluation is based on: (a) extent of the department's preparation and fulfillment of the ordered conditions of readiness as appropriate to the problem, (b) extent of correct utilization of the engineering damage control features built into the ship, (c) extent to which proper engineering casualty control is accomplished, (d) extent to which on-station personnel take corrective action for control of damage, (e) adequacy of reports and dissemination of information, and (f) the general handling of the plant in accordance with good engineering practice, and the ability of the department to ensure maximum mobility and maneuverability of the ship and to supply all necessary services to other departments in fighting the ship.

2. Hit. . . . . .
   Exercise. . . .
   a. Preparation and status of the plant.
   b. Fulfillment of proper conditions of readiness.
   c. Fire and missile hazards.
   d. Condition of firefighting and damage control gear.
   e. Condition of personnel clothing and protection.
   f. Stationing and readiness of personnel.

g. Investigation and interpretation of casualty.
h. Promptness and effectiveness in taking care of casualty.
i. Were proper doctrine and procedures used?
j. Were prompting and additional information given by observer?
k. Were proper reports made?
l. Readiness of standby units.
m. Readiness of alternate and emergency lighting and power.
n. Were proper safety precautions observed?
o. Material deficiencies.
p. Coordination of personnel.
q. Coordination of engineering spaces.

3. Main Engine Control. Receipt of vital interior communications, origination and transmissions of required reports to Conn, Damage Control Central, and other stations.

4. Action taken by main engine control:
   a. Correct action.
   b. Sound judgement based on good practice.
   c. Assurance.
   d. Speed.
5. Recommendations.

The blank parts of the observers' report forms are filled in as applicable to the individual observer's station. Items that were not observed by him are either left blank or crossed out. Additional information, if required for a certain exercise or condition, may be written on the reverse side of the form. A separate form or sheet is used for each exercise or drill. Remarks or statements made by the observer should be clear and legible.

MATERIAL INSPECTION

The purpose of material inspection is to determine the actual material condition of the ship in regard to the ability to perform all functions for which the items were separately and interrelatedly designed. On the basis of what the inspection discloses, it may be necessary to recommend repairs, alterations, changes, or developments which will ensure the material readiness of the ship to carry out the mission for which she was designed. In addition, the material inspection determines whether or not proper procedures have been carried out in the care and operation of machinery and equipment. Administrative procedures and material records which are inspected include such items as maintenance records and routine tests and inspections.

In brief, the prescribed requirements for material readiness are as follows:

1. Established routines for the conduct of inspections and tests, schedules for preventive maintenance, and a system which will ensure timely and effective repairs.
2. Adequate material maintenance records, that are kept in accordance with current directives and that will give the history and detailed condition of machinery and equipment.
3. Planned and effective utilization of the ship's facilities for preservation, maintenance, and repair.
4. Correct allocation of necessary work to the following categories: (a) the ship's force, (b) the tenders and repair ships, and (c) the naval shipyards or other shore repair activity.

The scope of the inspection will be similar to that of inspections made by the Board of Inspection and Survey. (These inspections are discussed later in this chapter.) The inspection should be thorough and searching, and cover detailed maintenance and repair rather than general appearance. The distinction between administrative inspections and material inspections should be clearly recognized, and there should be as little duplication as possible. An examination of the material maintenance records and reports will be made to obtain data and material history for a proper understanding of the material condition of machinery and equipment. General administrative methods, general appearance, cleanliness of compartments, and cleanliness of machinery are not part of this inspection, except in cases where they have a direct bearing on material condition. Special painting should not be done solely in preparation for material inspection.

The inspecting party for the material inspection is similar to that of the administrative inspection party.

PREPARATION FOR THE INSPECTION

At an appropriate time prior to the date of the inspection the Chief Inspector will furnish the ship with advance instructions, including:

1. List of machinery and major equipment to be opened for inspection. The limit that a unit of machinery or equipment should be opened is that which is necessary to reveal known or

probable defects. The units selected to be opened should be representative and, in a multiple-shaft ship, should not disable more than one-half of the propulsion units. Proper consideration must be given to the ship's operational schedule and safety.

2. List of equipment to be operated. Auxiliary machinery such as the anchor windlass, winches, and steering gear are normally placed on this list.

3. Copies of the condition sheets. This is a form of checkoff list which is used for the material inspection.

4. Any additional instructions considered necessary by the type commander or other higher authority.

Each department will have to prepare WORK LISTS showing the items of work to be accomplished, and recommended means of accomplishment such as by shipyard, tender or repair ship, or ship's force during an overhaul or upkeep period. The items must be arranged in the recommended order of importance and numbered according to current directives. A list of the outstanding alterations is also made up for the inspection. Work lists usually consist of 5 by 8 cards, with one repair or alteration item on each card. The work list should include all maintenance and repair items, because material deficiencies found during the inspection will be checked against the work list. If the item does not appear on the work list, a discrepancy in maintaining the required records is noted by the inspector.

Condition Sheets.—Condition sheets are made up in accordance with different material groups. The engineering department will be primarily concerned with the machinery, the electrical, the damage control, and the hull condition sheets. Condition sheets contain material in form of checkoff sheets and material data sheets, and consist of a large number of pages. Items for data and check-off purposes are listed for all parts of the ship, and for all machinery and equipment on board ship.

In advance of inspection, the ship to be inspected must fill in a preliminary copy of the condition sheets. In order to accomplish this, detailed data must be obtained from the maintenance records and reports.

An entry of any known fault or abnormal condition of machinery or equipment is made in the proper place on the condition sheets. Details and information are given, as necessary, to indicate the material condition to the inspecting party. If corrective work is required in connection with a unit or space, a reference is made to the work list item. Data and information requested in the condition sheets should be furnished whenever possible. The preliminary copy, if properly filled out, will represent the best estimate as to the existing material condition of the ship.

When the condition sheets have been completed, they are turned over to the respective members of the inspecting party upon their arrival on board ship. During the inspection, the inspectors will fill in the various check-off sections of the condition sheets. These sheets are then used in preparing the final inspection report on the condition of the ship.

For more detailed information concerning your ship, you should obtain a copy of the applicable condition sheets from the engineering log room.

Opening Machinery for Inspection.—The ship will open machinery as previously directed by the Chief Inspector, and as considered desirable, in order to obtain the inspector's opinion concerning known or probable defects. The information given in chapter 9004(6) of NavShips Technical Manual should be used as a guide in opening particular machinery units. More detailed information on opening machinery for material inspections will be found in the administrative letters of the type commander.

A list of machinery, tanks, and major equipment opened, and the extent of opening, should be supplied to the inspecting party on its arrival. Test reports on samples of lubricating oil should be furnished to the machinery inspector.

Ship's company should have portable extension lights rigged up and in readiness for the units of machinery opened up for inspection. The lighting of the space should be in good order. The inspectors should be furnished flashlights, chipping hammers, file scrapers, and similar items. Precision measuring instruments should be readily available.

Assembly of Records and Reports.—The material inspection also includes an inspection of various material records and reports. These documents are assembled so that they will be readily available for inspection. Records should be kept up to date at all times; it is a good idea to check over all records to make sure that they ARE up to date and that nothing has been overlooked. The individual records should be filled out and maintained in accordance with current

directives. Where applicable, the petty officer in charge of an engineering space, or other assignment, should check on any records or reports that concern the material or the maintenance procedures of his space or assignment.

CONDUCT OF THE INSPECTION

The inspecting group for the engineering department should conduct a critical and thorough inspection of the machinery and equipment under the cognizance of the department. The condition sheets supplied by the type commander serve as a guide and a check-off list in making the inspection. Appropriate remarks, comments, and recommendations are entered on the condition sheets for the particular unit of machinery or equipment.

The inspectors should conduct the inspection with the ship's personnel. No attempt is made to follow a predetermined inspection schedule, but different units are inspected as they are made available by the ship's company. If the ship is prepared for the inspection there should be no delay between the inspection of the different units of machinery. It is not necessary that all machinery of one type be inspected simultaneously nor is it necessary to complete the inspection of one space before going to another.

Important items to be covered by the inspection are as follows:

1. All opened machinery and equipment should be carefully inspected, especially where the need of repair work is indicated on the work list.
2. An investigation should be made to locate any defects, in addition to those already known, that may exist in material condition or design.
3. Operational tests of machinery and equipment, in accordance with the furnished list, are observed.
4. Ensure that electrical equipment is not endangered by salt water from hatches, doors, or ventilation outlets. Check for possible leaks in piping flanges.
5. Ensure that currently required fire-fighting and damage control equipment in the engineering space is installed and properly maintained in accordance with current directives.
6. Inspect the supports and running gear of heavy suspended material.
7. Inspect hold-down bolts, plates, and other members of machinery foundations. Make free use of hammers for sounding, and of file scrapers for removing paint in order to disclose any condition of metal corrosion.
8. The condition sheets should be checked to see that all the required information has been filled in by the ship being inspected, and that all items have been checked off and filled in by the inspector.
9. Ensure that routine tests of mechanical and electrical safety devices are being conducted according to current directives.
10. The maintenance records and reports should be carefully inspected to see that they are maintained in accordance with prescribed procedures. A check should be made to see that all known repair requirements are listed.

ANALYSIS AND REPORTS

A critique should be held on board the inspected ship, at a convenient time after the completion of the material inspection, in order that the ship may derive the greatest benefit from the inspection. It should be attended by the ship's commanding and executive officers, heads of departments, and such other personnel as may be designated from the inspected ship, the Chief Inspector, and inspectors of each inspection group.

The inspectors, after receiving data from the assistant inspectors, submit reports of their inspections to the Chief Inspector. These reports provide a means of furnishing the inspected ship with those observations that may not be fully discussed during the critique but are of interest to the ship's officers concerned. The inspector's report should include his evaluation and any recommendations for the items inspected or observed. These reports can be used by the ship as a check-off list for corrective action and material improvement.

The Chief Inspector, after receiving the reports from the inspectors, will make up his report, evaluating and grading the inspection. The Chief Inspector should mention, with appropriate comment, the following:

1. Those conditions requiring remedial action which should be brought to the attention of the commanding officer of the ship inspected, and to higher authority.
2. Those conditions of such excellence that their dissemination will be of value in improvements to other ships.
3. Those suggestions or recommendations which merit consideration by higher authority.

The final smooth report is written up in a detailed procedure in accordance with the type commander's directives.

BOARD OF INSPECTION AND SURVEY INSPECTION

The Board of Inspection and Survey is under the administration of CNO. This board consists of a flag officer, as president, and of such other senior officers as may be required to assist him in carrying out the duties of the board. Regional boards and sub-boards are established, as necessary, to assist the Board of Inspection and Survey in the performance of its duties. In this discussion we are considering the shipboard inspections that are made by the sub-boards. These sub-boards consist of the Chief Inspector and about 10 or more members, depending upon the type of ship that is to be inspected.

MATERIAL INSPECTIONS BY BOARD

The inspection made by the Board of Inspection and Survey is in several respects similar to the Material Inspection that has just been discussed. In fact, the Board of Inspection and Survey's inspection procedure, condition sheets, and reports are used as guides in establishing directives for the Material Inspection. The primary difference, in regard to material inspections, is that the Material Inspection is conducted by Forces Afloat, usually a sister ship, and the Board of Inspection and Survey inspection is conducted by a specially appointed board. This distinction, however, refers only to the routine shipboard material inspection. It must be remembered that the Board of Inspection and Survey conducts other types of inspections which are of a different nature.

Inspections of ships are conducted by the Board of Inspection and Survey, when directed by CNO, to determine their material condition. This inspection usually takes place 4 to 6 months prior to regular overhaul. Whenever practicable, such inspections should be held sufficiently in advance of a regular overhaul of the ship to permit accomplishment, during such overhaul, of the authorized work resulting from the Board's recommendations. Upon the completion of its inspection the Board will report the general condition of the ship and its suitability for further naval service, together with a list of the repairs, alterations, and design changes which, in its opinion, should be made.

ACCEPTANCE TRIALS AND INSPECTIONS

Trials and inspections are conducted by the Board of Inspection and Survey on all ships prior to final acceptance for naval service, to determine whether or not the contract and authorized changes thereto have been satisfactorily fulfilled. The builder's trials and preliminary acceptance trials are usually conducted before a new ship is placed in commission. After commissioning, a final acceptance trial is held. Similar inspections are made on ships that have been converted to other types. All material, performance, and design defects and deficiencies found to exist, either during the trials or as a result of examination on completion of trials, are reported by the Board, together with its opinion as to the responsibility for correction of defects and deficiencies. The Board will recommend any changes in design which it believes should be made in the ship or in others of its type. Recommendations as to the acceptance or rejection of the ship is made to the Secretary of the Navy.

Unless war circustances prevent, the preliminary acceptance trial takes place at sea over an established trial course. Tests include full power runs ahead and astern, quick reverse, boiler overload, steering, and anchor engine. During the trial, the builder's personnel usually operate the ship and her machinery. Ship's personnel who are on board to observe the trial should carefully inspect the operation and material condition of machinery and equipment. Any defects or deficiencies should be noted and brought to the attention of division or engineer officer, so that the items can be discussed with the appropriate members of the Board of Inspection and Survey.

SURVEY OF SHIPS

Survey of a ship is conducted by the Board of Inspection and Survey whenever a ship is deemed by CNO to be unfit for further service, because of material condition or obsolescence. The Board will, after a thorough inspection, render an opinion to the Secretary of the Navy as to whether the ship is fit for further naval service, or can be made so without excessive cost.

If the Board believes that the ship is unfit for further naval service, the Board will make appropriate recommendations as to the ship's disposition.

SHIP TRIALS

There are a number of different types of trials which are carried out under specified conditions. To convey a general idea of the different trials, a list comprising most of them is given here:

1. Builder's trials.
2. Preliminary acceptance trials.
3. Final acceptance trials.
4. Post repair trials.
5. Laying up or pre-overhaul trial.
6. Recommissioning trials.
7. Standardization trials.
8. Tactical trials.
9. Full power trials.
10. Economy trials.

The trials that are considered to be routine ship's trials are numbers 4, 9, and 10 of the above list. Post repair, full power, and economy trials are the only ones discussed in this chapter, but information on the other types of trials can be found in chapter 9080(8) of NavShips Technical Manual.

POST REPAIR TRIAL

The post repair trial should be made whenever the machinery of a vessel has undergone extensive overhaul, repair, or alteration which may affect the power or capabilities of the ship or the machinery. A post repair trial is usually made when the ship has completed a routine naval shipyard overhaul period; the trial is OPTIONAL whenever machinery has undergone only partial overhaul or repair. The object of this trial is to ascertain if the work has been satisfactorily completed and efficiently performed, and if all parts of the machinery are in every respect ready for service.

The post repair trial should be held as soon as practicable after the repair work has been completed, the preliminary dock trial made, and the persons responsible for the work are satisfied that the machinery is in all respects ready for a full power trial. The conditions of the trial will be largely determined by the character of the work that has been performed. The trial should be conducted in such manner as the CO and commander of the shipyard may deem necessary. In cases where repairs have been slight and the CO is satisfied that they have been satisfactorily performed and can be sufficiently tested without a full power trial, such trial may be dispensed with.

Any unsatisfactory conditions beyond the capacity of ship's force should be corrected by the naval shipyard. If necessary, machinery should be opened up and carefully inspected to determine the extent of any injury, defect, or maladjustment which may have appeared during the post repair trial.

A certain number of naval shipyard personnel-technicians, inspectors, and repairmen—accompany the ship on a post repair trial. The yard personnel witness the operation of machinery that has been overhauled by the yard. If a unit of machinery is not operating properly, the yard technicians will carefully inspect it and try to determine the cause of unsatisfactory operation.

FULL POWER AND ECONOMY TRIALS

Trials are necessary to test engineering readiness for war. Except while authorized to disable or partially disable, ships are expected to be able to conduct prescribed trials at any time. Ships normally should be allowed approximately a 2-week period after tender overhaul, and a 1-month period after shipyard overhaul, to permit final checks, tests, and adjustments of machinery before being called upon to conduct a competitive trial.

Trials are also held from time to time to determine machinery efficiency under service conditions, the extent of repairs necessary, the sufficiency of repairs, and the most economical rate of performance under various conditions of service.

Inspections and Tests Prior to Trials

The full power and the economy trials, as discussed in this chapter, are considered in the nature of competitive trials. It is assumed that the ship has been in full operational status for sufficient time to be in a good material condition and to have a well-trained crew.

Prior to the full power trial, inspections and tests of machinery and equipment should be made to ensure that no material item will interfere with the successful operation of the ship at full power. The extent of the inspections and the tests will largely depend upon the recent performance of the ship at high speeds, the material condition of the ship, and the time limits imposed by operational commitments.

Not later than one day before a trial, the engineer officer should report to the CO the condition of the machinery installation, stating whether or not it is in proper condition and fit to proceed with the trial, or wherein any part is, in his opinion, not in a safe and proper condition.

General Rules for Trials

During all full power trials, and during other machinery trials to which they may be applicable and consistent with the conditions imposed, the following general rules should be observed:

1. The speed of the engines should be gradually increased to the speed specified for the trial. Prior to commencing a power trial, the machinery should be thoroughly warmed up; this can be accomplished by operating at a high fractional power.
2. The machinery should be operated economically, and designed pressures, temperatures, and number of revolutions must not be exceeded.
3. The full power trial should not be conducted in SHALLOW WATER, which is conductive to excessive vibration, loss of speed, and overloading of the propulsion plant. Detailed information on the proper depth of water for your ship may be obtained from chapter 9080(8) of NavShips Technical Manual.
4. If it is desirable to continue a full power trial beyond the length originally specified, the observations should be continued until the trial is finished. The four hours, or any other predetermined time, of the trial should be continuous and without interruption. If a trial at constant rpm be discontinued for any reason, that trial should be considered unsatisfactory and a new start made. No major changes of the plant set-up or arrangement should be made during economy trials.

Underway Report Data

Reports of trials should include all the attending circumstances, especially draft forward, draft aft, mean draft, and corresponding displacement of the ship at the middle of the trial; the condition of the ship's bottom; the last time drydocked; the average horsepower developed by the main engines; the consumption of fuel per hour, per mile, and per shaft horsepower on indicated horsepower of the main engines per hour; the average speed of the ship through the water; and the average revolutions of the propelling engines. The methods by which the speed and shaft horsepower were determined should also be described.

This report should also include a tabulation of gage and thermometer readings of the machinery in use, and revolutions or strokes of pertinent auxiliaries. The auxiliaries in use during the trial should be stated. The report should state whether the machinery is in a satisfactory condition. If its condition is found to be unsatisfactory, all deficiencies should be fully described and recommendations made for correcting them.

Trial Requirements

Trial requirements for each ship, covering the revolutions per minute for full power at various displacements and injection temperatures, are furnished to commanders and units concerned, by the Chief of Naval Operations (Operations Readiness Division). The rpm for 15, 20, and 25 knots is also furnished for the appropriate ships.

Full power trails are of 4 hours duration, as far as the report data are concerned. The usual procedure is to operate the ship at full power for a sufficient length of time until all readings are constant, before starting the official 4-hour trial period. Economy trials are of 6 hours duration, a different speed being run at each time a trial is made.

Trials once scheduled should be run unless prevented by such circumstances as:

1. Weather conditions which might cause damage to the ship.
2. Material trouble which forces the ship to discontinue the trial, or which might cause damage to the machinery if the trial were continued.
3. Any situation such that running or completing the trial would endanger human life.

If a trial performance is UNSATISFACTORY, the ship concerned will normally be required to hold a retrial of such character as the type commander may consider appropriate to demonstrate satisfactory engineering readiness.

The fact that a ship failed to make the required rpm for any hour during the trial, and the amount by which it failed, should be noted in the trial report.

Observation of Trials

When full power trials are scheduled, observing parties should be appointed from another ship whenever practicable. When a ship is scheduled to conduct a trial while proceeding independently between ports, or under other conditions where it is considered impractical to provide observers from another ship, the ship under trial may be directed to appoint the observers. For economy trials, observers may be appointed from the ship under trial.

The number of personnel assigned to the observing party will vary according to size and

are considered doubtful or defective should be replaced before trials are held. A quartermaster must check and adjust all clocks in the engineering spaces and on the bridge before any trials are held.

It is common procedure of many commanding officers, when making full power trials, to bring the ship up to a speed of one or more knots below the trial run speed of the ship. Then the control of the speed (except in cases of emergency nature) of the ship is turned over to the engineer officer. The control engineroom, under the supervision of the engineer officer, will bring the speed up slowly, depending upon the conditions of the plant, until the specified speed has been reached. In view of the fact that for most ships the designed boiler power is the first factor that establishes the maximum speed that the ship can attain, it is a good policy to check boiler steaming conditions before ringing up additional turns. The boilers should not be loaded down faster than they are capable of taking care of the increased load. The steam pressure and temperature should be kept at full value for the appropriate steaming condition. In other words, the turbines must not get ahead of the boilers. The boilers should be the controlling factor and should be kept ahead of the turbines. If the turbines are allowed to get ahead of the boilers, the main steam pressure and temperature will drop below normal values for that particular steaming condition, or speed of the ship. Then, in order to make up this loss in steam pressure and temperature and to meet additional increases of speed that may be rung up, the boilers must be fired at an extremely high rate. In some ships, this firing rate may exceed the full load rating of the boiler and approach the maximum 120 percent overload capacity rating of the boiler. As far as the engineering plant is concerned, the primary purpose of the acceleration curve or table is to prevent the overloading of boilers. The use of the acceleration curve is of particular importance when accelerating near full speed and full power.

CHAPTER 16

SHIP REPAIR

Ships can operate only a certain length of time without repairs. To keep a ship in prime condition, constant attention should be given to material upkeep and definite intervals of time must be allotted for general overhaul and repair.

Even when regular maintenance procedures are carefully followed, accidents and derangements may necessitate emergency repair work. Defects and deficiencies which can be corrected by ship's force should be dealt with as soon as possible. When repairs are beyond the capacity of ship's force to accomplish, aid must be obtained from a repair activity afloat or ashore.

Repair activities afloat consist of repair ships and tenders; repair activities ashore consist of naval shipyards, private shipyards under contract with the navy, and naval ship repair facilities (usually located outside the continental limits of the United States). The chapter discusses repair, alteration, and upkeep procedures for naval ships by forces afloat and by shore-based repair activities; it does not include information on the use of allowance lists and other sources for determining the repair parts, tools, and supplies carried on board, nor does it include information on the procedures for obtaining replacement parts and supplies. Such information is given in Military Requirements for PO 3 & 2, NavPers 10056-B, and in Military Requirements for PO 1 & C, NavPers 10057-B.

REPAIRS AND ALTERATIONS

Corrective maintenance to ships may be divided into the general categories of (1) repairs, (2) alterations, and (3) alterations equivalent to repairs.

A REPAIR is defined as the work necessary to restore a ship or an article to serviceable condition without change in design, in materials, on in the number, location, or relationship of parts. Repairs may be accomplished by ship's force by repair ships and tenders, or by naval shipyards or other shore-based activities.

An alteration to a naval ship is any change in the hull, machinery, equipment, or fittings that involves a change in design, materials, number, location, or relationship of the component parts of an assembly regardless of whether it is undertaken separately from, incidental to, or in conjunction with, repairs. Requests for alterations may originate with the Naval Ship Systems Command, the forces afloat, or the Chief of Naval Operations (CNO).

A prime responsibility of the Naval Ship Systems Command for ship maintenance is that of administering alterations under its technical cognizance. In its day-to-day relations with the forces afloat, the naval shipyards, private industry, and research centers, the Naval Ship Systems Command keeps informed of techinical developments. In striving to maintain the ships of the fleet in as efficient and modern a state as possible, the Naval Ship Systems Command may determine that a particular ship or class of ships should be altered to encompass desired improvements. These alterations may be changes to the hull, such as changes to bulkheads that will strengthen them or changes to deck arrangements that will provide space for installation of machinery; changes to machinery or the substitution of newer and more efficient machinery; changes to equipment, such as the replacement of an item with a more efficient type; or changes in design, such as the installation of a paint mixing and issue room.

When the commanding officer of a ship considers an alteration necessary for the satisfactory performance of his ship, he addresses a request for the alteration to the Naval Ship Systems Command via the established administrative chain of command. Copies of the request are sent to all ships of the type within the appropriate fleet for comments as to applicability.

Block II - Radio Servicing

Unit 4 - Receiver Servicing (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Servicing detectors	Indications of normal operation Tests for performance Voltage and resistance readings Defects and their effects on normal receiver operation
Servicing mixer section	Indications of normal operation AM signal injection Range of normal voltage and resistance readings Determination of defects Signal tracing
Servicing oscillator section	Normal operation AM signal injection Range of normal voltage and resistance readings Correction of defects Signal tracing
Servicing RF section	Normal operation AM signal injection Range of normal voltage and resistance readings Determination of defects Signal tracing
Radio-phonograph combination servicing	Block diagrams Typical circuits
Portable radio servicing	Special problems of portable radio servicing
Servicing three-way portables	Block diagrams Switching circuits
Servicing short-wave receivers	Frequency and range bands Alignment technique
Servicing multiband receivers	Band-switching techniques Special service problems
Servicing communications receivers	Block diagrams Special service problems

Another source of alterations is the reports of the Board of Inspection and Survey. Upon completion of each material inspection, the Board, in its report of the general condition of the ship and its suitability for further naval service, furnishes a list of repairs, alterations, and design changes, which, in its opinion, should be made. Alterations recommended by the Board of Inspection and Survey normally are not acted upon by the Naval Ship Systems Command until after the receipt of appropriate requests from the commanding officers of the ships inspected and the recommendations of the type commanders.

Alteration requests addressed to the Naval Ship Systems Command are endorsed by the type commanders (or other administrative commanders, as appropriate), with their recommendations as to approval, classification, and applicability to other ships of the type. Copies of the basic request and endorsements are forwarded to other type commanders concerned, who are also requested to comment on them for the information of the Naval Ship Systems Command.

Alterations involving material under the technical cognizance of the Naval Ship Systems Command are known as ShipAlts. ShipAlts can be approved by the Naval Ship Systems Command when the alterations do not affect military characteristics of the ships concerned. A ShipAlt that affects military characteristics requires approval by CNO. Any ShipAlt that requires the approval of CNO is called a NavAlt. Alterations under the technical cognizance of the Naval Ship System Command, regardless of whether or not they affect the military characteristics of ships, are known as ShipAlts. Thus an alteration might be only a ShipAlt or it might be both a ShipAlt and a NavAlt.

When the Naval Ship Systems Command determines that a ShipAlt affects the military characterics of the ship, the alteration is forwarded to CNO. In approving NavAlts, CNO also establishes the relative priority for their accomplishment. The NavAlts are then recorded in the Ship Improvement Guide (SIG) for overall and long-range planning purposes and in the Material Improvement Plan. NavAlts are classified by CNO as follows:

Priority 1—Mandatory for national security.
Priority 2—Essential for combat readiness.
Priority 3—Desirable for naval efficiency.

An ordinary ShipAlt (a ShipAlt that does not affect military characteristics) may be approved by the Naval Ship Systems Command after all factors have been considered, including the effect of the change on weight, stability, space, power, and the possible increased effectiveness of the ship. Following approval, the relative priority of accomplishment of the ShipAlt is established. Priorities assigned to ordinary ShipAlts are:

Priority A—Mandatory.
Priority B—Essential.
Priority C—Desirable.

ShipAlts not affecting military characteristics of a ship are those ShipAlts that, in general, concern matters of safety, efficiency, and economy of operation or maintenance. Annually, the Naval Ship Systems Command compiles and issues a ship-type priority list of all ordinary ShipAlts. The ShipAlts are grouped so that those of approximately equal importance fall into the same priority groups regardless of the type ship. The ShipAlt priority lists are revised and reissued as necessary during the year.

Approval of a ShipAlt is usually evidenced by its issuance, or by a letter, to be followed by issuance of the ShipAlt, to the activities immediately concerned. Type commanders periodically review approved ShipAlts and initiate action to CNO or the Naval Ship Systems Command (as appropriate) for cancellation of those no longer considered necessary.

A ShipAlt may not be accomplished in any ship until its accomplishment has been specifically authorized by the Naval Ship Systems Command. The Naval Ship Systems Command reviews the outstanding ShipAlts for each ship in advance of regular overhauls. ShipAlts to be accomplished are selected from the Material Improvement Plan and the priority lists, with due consideration being given to relative priorities and to current budgetary or fiscal limitations. The ShipAlts to be accomplished are authorized by letters issued not less than 150 days prior to the scheduled commencement of the ship's overhaul.

After study of a request for an alteration, the Naval Ship Systems Command may determine that the alteration is an alteration equivalent to a repair. An alteration that has been designated an alteration equivalent to a repair is forwarded to the appropriate type commander for accomplishment as a repair.

An alteration is considered to be an alteration equivalent to a repair if it meets one or more of the following conditions:

1. The substitution, without other change in design, of materials which have previously been approved for similar use and which are available from standard stock.
2. The replacement of wornout or damaged parts, assemblies, or equipments requiring renewal by those of later and more efficient design previously approved.
3. The strengthening of parts that require repair or replacement in order to improve reliability of the parts and of the unit, provided no other change in design is involved.
4. Minor modifications which involve no significant changes in design or functioning of equipment but which are considered essential to prevent recurrence of unsatifactory conditions.

SHIP AVAILABILITIES

As it applies to work on naval ships, an availability is the period of time assigned a ship by competent authority for the accomplishment of corrective maintenance at a repair activity. During certain availabilities, a ship may be incapable of engaging in fleet operations and the operating schedule is adjusted accordingly. Only the authority granting the availability can alter or extend the period of the availability; however, a repair activity may request that the ship's availability be extended so that work can be completed or it may recommend a completion date to the authority granting the availability. There are several types of ship availabilities.

A REGULAR OVERHAUL is an availability for the accomplishment of general repairs and alterations at a naval shipyard or other shore-based repair activity, normally scheduled in advance and in accordance with an established cycle.

A RESTRICTED AVAILABILITY is an availability for the accomplishment of specific items of work by a repair activity, normally with the ship present, during which period the ship is rendered incapable of fully performing its assigned mission and tasks due to the nature of the repair work. This availability applies to shipyards only.

VOYAGE REPAIRS is emergency work necessary to enable the ship to continue on its mission and which can be accomplished requiring a change in the ship's operating schedule or the general steaming notice in effect. This availability applies to shipyards only.

A TECHNICAL AVAILABILITY is an availability for the accomplishment of specific items of work by a repair activity, normally with the ship not present, during which period the ship's ability of fully performing its assigned mission and tasks is not affected by the nature of the repair work. This availability applies to shipyards only.

A REGULAR TENDER AVAILABILITY is an availability for the accomplishment of general repairs and authorized alterations which are beyond the capacity of the ship's force alongside a tender or repair ship. It is normally scheduled in advance.

AN EMERGENCY TENDER AVAILABILITY is an availability assigned to a ship for the purpose of rendering repairs to specific casualties. Emergency work takes first priority on a tender capacity.

A PARENT TENDER/AUTOMATIC AVAILABILITY is an availability for the accomplishment of items of work usually on ship-to-shop basis. The repairs are normally of a non-operational nature and done by a tender or repair ship on an unscheduled basis.

A CONCURRENT AVAILABILITY is an availability for the accomplishment of ship-to-shop work by the tender or repair ship scheduled to coincide with the regular shipyard overhaul, or restricted availability.

A SUPPORT AVAILABILITY is an availability for the accomplishment of specific items of work for units or commands, other than a ship, such as an afloat staff or shore based activity.

A NRT SHIP AVAILABILITY is an availability for the accomplishment of work for a naval reserve training ship.

A SUPPLY AVAILABILITY is a period of time assigned a ship for the uninterrupted accomplishment of a supply overhaul. A supply overhaul is the work involved in the purification and adjustment of on-board stocks and records to bring them into conformity with prescribed allowances or other stockage objective criteria. A supply availability is normally scheduled to conincide with a regular overhaul.

SHIP'S FORCE MAINTENANCE AND REPAIRS

Each ship should insofar as practicable, be self-sustaining with regard to normal repairs.

Each ship should be well supplied with materials, repair parts, and tools and equipment so that much of its own repair work can be accomplished by ship's force. Repairs should be undertaken under the supervision of the most competent and experienced personnel. Personnel not familiar with specific repairs and tests should be instructed to take advantage of ship or repair ship availabilities or tender assignments to observe how such work is undertaken.

The purpose of preventive maintenance is to maintain satisfactory material conditions and ensure that the equipment or machinery is always ready for service. A regular schedule of cleaning, inspections, operations, and tests is required to ensure trouble-free operation and the detection of incipient faults before they develop sufficiently to be major sources of difficulty.

Most routine inspections and tests are performed by ship's force. Some of these inspections and tests are quite simple; others require planning so that they can be undertaken during upkeep or overhaul periods. Shipyard and repair ship assistance should not be requested unless the test or inspection is actually beyond the capacity of ship's force.

An interdepartment routine request for work requiring assistance by another shipboard department is referred to as a ship's memorandum work request. Such a form enforces proper channeling of a work request between departments, and permits the setting up of priorities of available manpower and facilities. The work request memorandum is a form which is made up by the ship; however, some ships use the Repair Record, or the repair work request for this purpose.

REPAIR SHIP/TENDER REPAIRS

Ships are scheduled for a regular tender availability or an upkeep period alongside repair ships or tenders at certain intervals of time. These time intervals vary with different types of ships. The availability periods are usually planned far in advance and depend upon the quarterly employment schedule of the ship concerned.

When a ship receives its employment schedule, or is otherwise notified, it can begin to prepare the necessary paperwork in advance of the scheduled availability period. The Maintenance Deferred Action Sheet (replacement for the CSMP cards) is used as a basis for advance preparation of a work request. Work Requests (OPNAV 4700-2C) are made out on outstanding work indicated by the Deferred Action Sheet (OPNAV 4700-2D).

The work requests, with the required number of copies, are sent with a forwarding letter to the type commander. The staff officer handling material and maintenance screens the work requests. Most of the ship's availability work list items are approved and authorized. Also, the ship may have to furnish more detailed information on certain work requests. The amount of corrective action taken by the reviewing staff officer will depend upon how well the work requests are written and the extent to which they follow established policies and procedures. Upon the completion of this screening, the ship's work requests are forwarded to the repair ship or tender. This is done well in advance of the assigned period of availability so that the repair department personnel can schedule the work and make any necessary preparations.

ARRIVAL CONFERENCE

When a ship comes alongside for a regular tender availability or an upkeep period, an arrival repair conference is usually held immediately. The conference is attended by representatives of the ship, of the repair department, and (usually) of the type commander. The relative needs of the ship and the urgency of each job are discussed. The arrival repair conference serves to clear up uncertainties for repair department personnel who have received and studied the work requests.

Arrangements are also made for the repair ship to provide the primary services of steam and electricity in sufficient quantity to take care of heating and lighting requirements and to provide limited power for ships alongside. In addition to these services, the repair ship may take over communication watches. Fresh water and fuel requirements are not usually supplied except from barges.

WORK REQUESTS AND JOB ORDERS

Although the terms "work request" and "job order" are sometimes used interchangeably, this is not technically correct because the two terms actually have slightly different meanings. Work requests are made up by the ship and are forwarded through proper channels to the repair activity. When the work request has been approved by the repair activity, it is issued as a job order.

Information on processing a work request is given in chapter 2 of this training course.

As soon as the work requests have been approved at the arrival conference, the jobs that require delivery to the tender should be started. Starting these repair jobs early is very important in getting all necessary jobs completed. Equipment that is not needed for the operation of the ship may be disassembled in advance so that the defective parts can be delivered to the tender as soon as the work requests have been approved.

All material delivered to the tender must be properly tagged and identified. The information on each tag should include the number and name of the ship; the department, division, or space; and the job order number. Additional information should be included if necessary. Reference material such as blueprints and manufacturer's technical manuals should be identified with the ship's name and number.

Ship-to-Shop Jobs

Many repair jobs are designated by the ship or approved by the repair activity as "ship-to-shop" jobs. In a job of this type, ship's force does a large part of the repair work. For example, the repair or renewal of a damaged pump shaft might well be written up as a ship-to-shop job. The pump is disassembled and the shaft is removed by ship's force; the shaft and any necessary blueprints are delivered to the machine shop of the repair activity. The machine shop supervisor checks the job and gives an approximate date of completion. When the shaft has been repaired, or when a new one has been made, it is picked up and brought back to the ship by ship's force. The pump is reassembled, inspected, and tested by ship's force to ascertain that the unit is satisfactory.

Repair jobs on portable equipment such as small gages and valves are almost always written up as ship-to-shop jobs.

Checking Progress of Tender Repair Jobs

The petty officer in charge should know at all times the status of repair work (including ship's force repair work) being done for his space or equipment.

Tender repairs that are being accomplished on your own ship can be checked by discussing them with the petty officer in charge of the repair detail. Checking on the progress of work in the shops on the tender requires planning and coordination between your ship and the tender. Personnel in the tender shops are busy with their repair work, so any method used to check on progress of work must be one which does not interfere with progress.

Some tenders and repair ships have a chief petty officer who acts as ship superintendent. His duties include:

1. Acting as liaison officer between the ships alongside and the tender in regard to repair department jobs.
2. Acting as a coordinator of shop work for assigned ships.
3. Reporting daily to a representative of the ship.
4. Maintaining a daily running progress report or chart which indicates the percentage of completion of each job; the availability of plans, manufacturers' technical manuals, samples, etc.; and the availability of materials required for each job.
5. Notifying the ship when it is time to pick up completed work from the tender.
6. Notifying ship's personnel when it is necessary for them to witness tests needed because work has been performed on machinery, compartments, tanks, etc.
7. Obtaining signatures from officers if job orders are cancelled or changed.

If the tender provides a ship superintendent, it is obviously quite easy for ship's personnel to check on the progress of the work. If the services of a ship superintendent are not provided, the ship alongside the tender should appoint a petty officer to perform similar duties for the division or department.

A progress chart should be kept for all work that is planned for accomplishment during the repair period. The chart should be kept up to date with respect to the status of each job. Keeping a close watch on the progress of the repair work will ensure that jobs, are not unnecessarily delayed, that jobs are not overlooked or forgotten, and that all work undertaken is satisfactorily completed at the end of the repair period.

NAVAL SHIPYARD REPAIRS

The primary purpose of a naval shipyard is to render services to the fleet in the form of efficient and economical building, repair, alteration, overhaul, docking conversion, outfitting, and replenishment and to perform related special manufacturing when required. Naval shipyards

perform many other functions, including research and design, which are not discussed here.

Naval shipyards are designated as home yards and as planning yards. A home yard is the shipyard to which a particular ship is usually assigned for the accomplishment of a regular overhaul. A planning yard is a shipyard which has been designated by Naval Ship Systems Command as the yard which undertakes the design work for the type ship allocated to it.

WORK REQUESTS

The procedures for submitting shipyard work requests prior to a regular overhaul are laid down, in general, in Navy Regulations; they are specified in detail in regulations issued by fleet commanders and type commanders.

Type commanders require that work requests to be accomplished during an overhaul (regular or interim) be submitted (for their inspection, screening, and approval) in sufficient time to allow completion of the type commander's action and arrival of the work requests at the shipyard in advance of commencement of the overhaul; this is necessary in order to permit successful preliminary planning by the shipyard.

Each work request is submitted on the standard work request form. All work requests are screened and assigned a priority for accomplishment at a conference of the heads of department, the executive officer, and the commanding officer. A work list containing brief statements of the work to be accomplished, arranged in the ship's integrated priority sequence, is prepared and submitted along with the work requests to the type commander for his screening action.

ALTERATION REQUESTS

The list of authorized alterations that are to be accomplished at a routine naval shipyard overhaul is prepared by NavShips. NavShips usually provides the type commander with a priority list of the alterations to be accomplished on the ship scheduled for a regular overhaul approximately 150 days prior to the overhaul. The type commander may submit to NavShips recommended changes in this prospective priority list. The type commander usually requests recommendations from the ship concerned in regard to ShipAlts that should be completed during the shipyard overhaul period. Late requests for alteration authorization are discouraged.

For an authorization of a late alteration request to be considered for approval, it must first be determined that the alteration requested is:

1. Strictly confined to items of vital operational requirements which involve late and significant technological developments
2. Feasible of accomplishment from the standpoint of plan development and special material availability within the scheduled overhaul availability of the ship
3. Acceptable to the overhauling shipyard
4. Acceptable from the standpoint of availability of funds

Approximately 90 days in advance of the ship's arrival, NavShips will forward to the shipyard, to the type commander, and to the ship a list of approved alterations (90 day material status letter) in the priority applicable to the individual ship. Any changes in the scope of work authorized in the 150-day letter will be reflected in this letter.

SHIPALTS marked for accomplishment by forces afloat are not, as a rule, undertaken by naval shipyards.

Naval Shipyard Arrival Conference

When the ship arrives at the shipyard for a routine overhaul, an arrival conference is held. The conference is supervised by the planning officer of the shipyard and attended by representatives from the ship, the type commander, and the naval shipyard planning department. The ship's work requests and the individual item costs estimated by the shipyard planning department are reviewed. When necessary, the details of the repair items are discussed, and the work to be done is decided upon.

The limitations of the funds made available by the type commander determine to a great extent the amount of repairs that will be accomplished during a naval shipyard overhaul period. The estimated cost of each repair job, when approved at the conference, is added up to give the total cost. When the total cost reaches approximately the amount of funds appropriated, or the cutoff point, the shipyard will not accept additional repair requests. Under this condition, when there are several additional important jobs that should be accomplished, the type commander must either furnish more funds or rearrange the individual items in question and revise the priority list accordingly.

Establishing the cutoff point enables the shipyard to make certain that the most important repairs and alterations are accomplished during

the availability period. This does not necessarily imply that other items with less urgent priority will be undertaken and accomplished before the end of the overhaul period. After the ship has been placed in drydock, for example, it may be found that anticipated repairs to the shafting and propeller will not be required, and the funds reserved for this work can be used to finance other items. Sometimes a job may be seriously underestimated because of conditions that were not apparent until the job was well underway. If funds were not originally provided to cover the cost of the work, the necessary funds may now be provided by deferring other approved items of less relative importance.

Also established at the arrival conference are tentative dates for drydocking, the operation of the propulsion machinery and associated auxiliary equipment, and dock and sea trials.

When agreement has been reached at the arrival conference on the items of work to be undertaken, the planning department issues job orders authorizing the work to be performed by the production shops. Each job order clearly defines the scope of the work, includes complete specifications, and identifies the necessary plans. Job orders are not issued for all work at the same time. The first to be issued are for those jobs requiring practically the entire availability period. The other orders are issued as soon as possible thereafter. If design plans are required for the accomplishment of any specific item, the issue date of the job order is coordinated with the planned completion date. In any case, job orders for all items approved at the arrival conference are usually issued during the first third of the overhaul period.

The method of numbering job orders differs somewhat in the several naval shipyards. However, the numbering systems are all essentially for the purpose of identifying a particular item of work by a job order number. In addition to the naval shipyard job order number, the ship's work request or work item number is entered on the job order sheets for identification purposes.

Checking on Progress of Work

During a routine shipyard overhaul, the ship must submit shipyard progress reports in accordance with the type commander's instructions. Supervisory personnel of the ship must therefore keep an accurate check on the progress of all work (including ship's force work) at all times. Standard progress charts are available for recording and reporting progress. As a rule, one progress chart is used to record shipyard repairs, another to record alterations, and another to record ship's force work. Copies of the progress charts should be posted outside the log room and kept up to date by assigned ship's personnel.

The shipyard commander holds frequent (usually weekly) conferences with the commanding officer of the ship to review progress. The ship superintendent and other key shipyard personnel also attend these conferences.

In checking on the progress of work, it is of course necessary to know what repair work is planned for accomplishment during the overhaul. This information can be obtained from the job orders issued by the planning department of the yard. The ship receives three or more copies of the job orders. A complete set of job orders is usually kept on file in the log room; a set of the job orders that apply to your division is usually kept by your division officer. Always check the details of the job orders before you start checking on the progress of a repair job.

OBTAINING ADDITIONAL REPAIR JOBS

It may be necessary to prepare supplementary work requests to include items arising after the submission of the original work requests. Additional repairs may be required because of voyage casualties or because of conditions discovered during shipyard tests and inspections. The supplementary work requests must be submitted in accordance with the same procedure used for submitting the original work requests, and the supplementary items must be dovetailed into the ship's priority index.

Supplementary work requests should be made out immediately, as soon as the need becomes evident, and submitted to the yard as soon as possible after they have been prepared.

INSPECTION DUTIES OF SHIP'S FORCE

The inspection of work being done by a repair activity for a ship is the responsibility of both the repair activity and the ship. The repair activity should require such inspections to be made as will ensure the proper execution of the work and adherence to prescribed specifications and methods. Ship's personnel should make such inspections as may be necessary to determine if the work is satisfactory, both during its progress and when completed. The petty

officer in charge should schedule his work in such a manner that he will have time to inspect and check the progress of naval shipyard work going on in his space or being performed on equipment for which he has the responsibility of maintenance and upkeep. A check should be made to see that all required tests are made by the shipyard before the job is considered complete. The naval shipyard job order will list any tests that have to be made by yard personnel.

In case any unsatisfactory work is being performed by shipyard personnel, you should follow the instructions put out by your engineer officer. Talking things over in a friendly manner with the workmen will usually solve your problems; if this is not successful, notify your division officer or the engineer officer, who can take up problems of unsatisfactory work with the ship superintendent. In exceptional cases the CO of your ship can take necessary action in accordance with Navy Regulations.

On many ships the division officer or the engineer officer will check with you before he signs a job order as being completed. By a continuous inspection of shipyard work, and by checking off the jobs that have been satisfactorily completed, you can furnish the required information without unnecessary delays.

DRYDOCKING THE SHIP

The ship is drydocked each time it goes into a naval shipyard for a regular overhaul. Drydocking is usually scheduled as early as possible in the overhaul period, since it is difficult to tell in advance just how much drydock work will be required. Scheduling the drydocking for early in the overhaul permits the accomplishment of all necessary drydock work without interfering with work which must be done later and without interfering with machinery trials, strength tests of structural work, and so forth. As soon as all drydock work has been completed, the ship is removed from drydock.

Before the ship goes into drydock, ship's personnel must have detailed information on the sea valves. When preparing to drylock the ship, the engineer officer is required to furnish the shipyard with a sea valve checkoff list indicating the size, location, and function of each sea valve. He must also furnish the yard with the ship's docking plan and, if the ship was last drydocked in a different shipyard, the last docking report. The shipyard maintains file copies of docking plans for each ship which it is expected to drydock. However, it is necessary to check these plans against the ship's copy to make any corrections reflecting work done elsewhere and to determine the last docking position used.

A ship entering drydock should be without list and without excessive trim. Trim in excess of 1 foot per 100 feet of length is sufficient to make the docking operation hazardous. If practicable, the trim should be brought below this limit before any attempt is made to drydock the ship.

While the ship is in drydock, no fuel oil, water, or other weight should be shifted, added or removed, except as specifically authorized by the docking officer. Water tanks and oil tanks should be either completely full or completely empty, if practicable. When permission is given by the shipyard to shift weight, ship's force must keep accurate records of the amount of weight shifted, the location from which it is shifted, and its new location.

The propellers must not be turned without permission of the docking officer after the ship enters the dock. No fuel oil or other flammable liquid should be drained or pumped into the dock. If the need arises, the shipyard will provide special containers for the disposal of these liquids. During freezing weather, all valves, pipes, and fittings attached to the hull should be drained to prevent freezing and consequent cracking.

Whenever a ship is drydocked, propellers, shaft tubes, outboard portions of the shafting, couplings, bearings, and all sea valves must be examined and the results of the examination must be entered in the engineering log.

Examination of each sea valve should include determination of the condition of the yoke, yoke rods, valve stem, securing bolts, and all internal parts of the valve. At least two of the bolts holding outboard valves to sea stools should be removed from each valve for inspection, and the remaining bolts should be sounded with a hammer. If defects are found in any bolt, all the other bolts for the valve should be removed for inspection. Whenever all bolts are removed, the gasket should be replaced. All repairs required to place the sea valves in good condition should be made while the ship is still in drydock.

While the ship is in drydock, ship's force and shipyard personnel may have occasion to work on sea valves. All openings in the hull must be blank-flanged at the end of working hours; ship's force and shipyard personnel are each responsible for closing the openings which they make in the hull. At the end of each working

day, status of all sea valves must be reported to the engineer officer entered in the engineering log.

Before the drydock is flooded, all sea valves must be carefully inspected to be sure they are properly secured. The results of this inspection should be reported to the engineer officer and entered in the engineering log.

While the drydock is being flooded, there must be continuous inspection of all sea valves until the ship is afloat and all valves are under a normal head of water. Any unsatisfactory condition must be reported at once to the engineer officer so that the docking officer can be notified. A report of leakage must be made in sufficient time so that the docking officer can stop flooding, if necessary, before the ship lifts from the supporting blocks.

Shortly after the undocking of a ship, the shipyard submits the docking report to NavShips with copies to the commanding officer and the type commander. The docking report includes the name and class of ship; the place and date of docking and undocking; the number of days underway, not underway, and waterborne since the last docking; the formula for the paint used and the extent of bottom painting; the shaft and rudder clearances; the docking position used; and details of all other work performed.

DOCK TRIAL

A dock trial is always held after major repairs to propulsion machinery have been made by a naval shipyard. A dock trial is usually held at the completion of a routine naval shipyard overhaul.

At least one day prior to the dock trial, all auxiliary machinery should be tested to prevent delay or interference with the testing of the main engines and associated equipment.

The actual tests of propulsion machinery are made by the ship's engineering personnel, under the direction of the engineer officer. The ship is secured to the pier during this trial. The propulsion machinery and equipment must be tested sufficiently to ensure that it has been properly repaired and is in satisfactory operating condition. Any defect, deficiency, or maladjustment must be corrected either by ship's force or by shipyard personnel. The dock trial is repeated as often as necessary until conditions are satisfactory.

CPO AND PO1 RESPONSIBILITIES

Much of the information just given on Navy repair procedures is of less direct concern to you than it is to ship's officers type commanders, fleet commanders, the Naval Ship Systems Command, and shipyard personnel. You need some general knowledge of these procedures so that you can provide maximum assistance in the overall job of getting the work done. However, such general knowledge is not enough by itself. You must also know what is expected of you as a CPO or PO1 in the engineering department, when your ship goes alongside a tender or repair ship or enters a shipyard for overhaul. Also, if you are assigned to a tender or repair ship, you must know just what is expected of you when other ships come alongside.

If you are on a ship that is coming alongside a tender or repair ship or entering a shipyard, one of your first and most important duties is furnishing information. No one should be in a better position than you to know exactly what is wrong with the equipment or machinery for which you are responsible. The accuracy and completeness of the information you give will have a definite effect on the decisions made by higher authority concerning the repair work. For example, a type commander is not in a position to decide offhand whether reconditioning a valve is more urgent than refacing a flange, or whether repairing a pump is more urgent than patching a bulkhead. Decisions like these can only be made on the basis of full and accurate information. Since literally hundreds of decisions may be required when a ship goes in for overhaul, the importance of furnishing accurate and complete information on all needed repairs must be thoroughly understood by all petty officers.

Keeping records and reports up to date and accurately filled out is the best way to make sure that all information on repairs and alterations will be available when it is needed. You have a definite responsibility for providing information for the required records and reports.

On ship-to-shop jobs, you will probably be required to supervise the dismantling and removal of pumps, gages, valves, electric motors, and other relatively small items from your spaces. Remember that all parts must be tagged and that the identification must be accurate and complete.

When repair personnel come aboard your ship to make repairs, your first responsibility is to make sure that everything is ready so that the work can proceed without delay. After the repair

personnel are on board, you will have to stand by to provide information and at times to assist with the work. If staging is required, it is usually furnished by the deck force of your own ship; again, however, you will be expected to assist when the work is being done in your own spaces. The deck force can erect the staging, but you should keep a close watch to see that it will be suitable for the particular job that must be done.

Fire watches are usually furnished by the ship coming alongside a tender or repair ship. As a CPO or PO1, you may be required to set fire watches and to assign men to the watches.

As a CPO or PO1 on a repair ship or tender, you will have somewhat different responsibilities. If you are in charge of a shop, you will be responsible for seeing that the required materials are available, that all tools and equipment are in good working order, and that the shop work is scheduled according to the established priorities. You will have to keep checking on your men to see that the work moves along according to schedule. If bottlenecks develop, you will have to find a way out of the difficulty.

Repair personnel on the repair ship or tender are usually responsible for furnishing all necessary papers in connection with welding or cutting in dangerous or poorly ventilated spaces. As a rule, certifications that a space is safe for entering or safe for hot work must be signed by the gas-free engineer on the repair ship or tender AND by the gas-free engineer on the ship alongside. One copy of the appropriate certification must be posted at the place where the hot work is to be done.

Repair personnel on the repair ship or tender are responsible for testing all items which they fabricate (valves, piping section, etc.) to make sure that all requirements are met. If a job order is written up in such a way that you are required to reinstall the equipment, you will be responsible for testing it after installation and for seeing that it is operating correctly.

A general rule of responsibility is that repair personnel of tenders, repair ships, and shipyards are responsible for an item or a piece of work until the job order is signed off; after that, the responsibility is with the ship. However, this general rule of responsibility may be modified by particular circumstances.

Whether you are on a repair ship or tender or on the ship coming alongside, you will have a great deal of responsibility for the safety of personnel. Repair work frequently requires the observance of additional precautions, over and above those that must normally be observed aboard ship. The hazards may be particularly great if your men are unfamiliar with the equipment being used by repair personnel.

All repair personnel must share responsibility for seeing that repairs and alterations do not result in unauthorized changes in weight, movement, or stability of the ship. Over the course of years, some naval ships have suffered such weight changes-and particularly such weight additions-that their powers of survival in an emergency are seriously impaired. Although the addition of a small amount of weight here or there or the shifting of a small amount of weight from one place to another may appear to be trivial, the cumulative effect can be extremely serious. Weight changes generally happen a little at a time. The danger is particularly great because the weight changes, being small and unsystematic, tend to be unnoticed and therefore uncompensated. Haphazard weight changes that endanger the safety of the ship can only be controlled if all repair personnel share the responsibility for not allowing unauthorized alterations or weight changes.

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CHAPTER 17

RECORDS AND REPORTS

Engineering records and reports for the administration, maintenance, and repair of naval ships are prescribed by directives from authorities such as the type commander, NavShips and CNO. These records and reports must be accurate and adequate, and must be kept up to date in accordance with current instructions.

As an MM3 and MM2, you have been primarily concerned with operating logs and similar records. As an MM1 and MMC, you will have new supervisory duties which will require that you have a greater knowledge of engineering paperwork and the associated administrative procedures. Supervisory duties and responsibilities require a knowledge of engineering records as well as of such items as inspections, administrative procedures, training, preventive maintenance, and repair procedures.

Information on some of the most common engineering records and reports is given in this chapter. These standard forms are for issue to forces afloat and can be obtained as indicated in the Navy Stock List of Forms and Publications, NavSup 2002. The forms are revised as conditions warrant; personnel ordering forms must be sure that current forms are obtained. When complementary forms are necessary for local use, make certain that an existing standard form will not serve the purpose before having complementary forms prepared and printed. (The records and reports used in connection with the 3-M System are discussed in chapter 2 of this training course.)

LEGAL ENGINEERING RECORDS

The Engineering Log and the Engineer's Bell Book are the only legal records compiled by the engineering department. The Engineering Log is a midnight-to-midnight record of the ship's engineering department. The Engineer's Bell Book is a legal record of any order regarding change in the movement of the propellers.

ENGINEERING LOG

The Engineering Log, NavShips 117, and the Log Continuation Sheet, NavShips 117A, are used to record important daily events and data pertaining to the engineering department and the operation of the engineering plant. A table is provided in the log for recording the hourly average rpm (to the nearest tenth) of all shafts and the resultant speed, in knots. Additional tables and spaces are provided for recording the ship's draft and displacement (upon getting underway and anchoring or mooring); the total engine miles steamed for the day and the distance traveled through water; the number of days out of dock, the amount of fuel, water, and lubricating oil on hand, received, and expended; the name of the ship, the date, and the location or route of the ship; and remarks chronicling important events.

Entries in the Engineering Log must be made in accordance with instructions given (1) on the log sheet (NavShips 117), (2) in chapter 10 of U.S. Navy Regulations, (3) in chapter 9004 (6) of NavShips Technical Manual, and (4) in directives of the type commander.

Remarks written in the Engineering Log must include (1) boilers in use, (2) engine combination in use, (3) major speed changes (such as 1/3, 2/3, standard, and full), (4) all injuries to personnel occurring within the department, (5) casualties occurring to material under the cognizance of the engineering department, and (6) such other matters as may be specified by competent authority. Each entry must be a complete statement and employ standard phraseology. The type commander's directives contain other specific requirements pertaining to the "remarks" section of Engineering Logs for ships of the type; the engineer officer must ensure compliance with these directives.

The original Engineering Log, prepared neatly and legibly in ink or pencil, is the legal record. The remarks should be prepared—and must be signed—by the engineering officer of the watch

Block II - Radio Servicing

Unit 4 - Receiver Servicing (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Servicing auto radios	Block diagrams Special service problems
Using basic troubleshooting methods: preliminary questions, observations and checks	Questioning the receiver owner Interpreting and verifying customer information
Using basic troubleshooting methods: dynamic testing	What it is and how to use it Preparation for dynamic analysis The signal tracing method Instruments required Signal tracing Signal strength and stage gain Signal injection Comparison of the tracing and injection Using the oscilloscope in dynamic analysis
Using special troubleshooting methods with AC/DC portables	Primary differences from AC/DC sets Problems in AC/DC heater connection Plate and screen supply information Actual troubleshooting procedures Portables using selenium rectifiers Portables and receivers using doublers Rechargeable battery portables
Solving special problems in battery-only portables	Battery power distinguished from other arrangements in battery powered sets Tube types used Battery-powered using storage batteries Testing and charging of batteries Wind-driven battery chargers Dry-battery receiver design The car receiver power supply Vibrator troubles in car receivers Input circuits in auto receivers Car receiver troubleshooting procedures
Servicing communication	Performance factors in communication receivers Circuit layouts RF amplifier stages

(underway) or the engineering department duty officer (in port). No erasures are permitted in the log. When a correction is deemed necessary, a single line is drawn through the original entry so that the entry remains legible and the correct entry is inserted in such a manner as to ensure clarity and legibility. Corrections, additions, or changes are made only by the person required to sign the log for the watch and are initialed by him on the margin of the page.

The engineer officer verifies the accuracy and completeness of all entries and signs the log daily. The commanding officer approves the log and signs the log on the last calendar day of each month and on the date he relinquishes. command. The engineer officer should require that the log sheets be submitted to him in sufficient time to allow him to check and sign them prior to noon of the first day following the date of the log sheet(s).

When the commanding officer (or engineer officer) directs a change or addition to the Engineering Log, the person concerned must comply unless he believes the proposed change or addition to be incorrect; in this event the commanding officer (or engineer officer) enters such remarks over his signature as he deems appropriate. After the log has been signed by the commanding officer, no change is permitted without his permission or direction.

Completed Engineering Log sheets are filed in a post-type binder. Pages of the log are numbered consecutively with a new series of page numbers commencing with the first day of each calendar year.

ENGINEER'S BELL BOOK

The Engineer's Bell Book, NavShips 116, is a record of all bells, signals, and other orders received by the throttleman regarding movement of the ship's propellers. Entries are made in the Bell Book by the throttleman (or an assistant) as soon as an order is received. Entries may be make by an assistant when the ship is entering or leaving port, or engaging in any maneuvering which is likely to involve numerous or rapid speed changes. This procedure allows the throttleman to devote his undivided attention to answering the signals.

A separate bell sheet is used for each shaft each day, except where more than one shaft is controlled by the same throttle station, in which case the same bell sheet is used to record the orders for all shafts controlled by the station. All sheets for the same date are filed together as a single record.

Major speed changes (normally received via engine order telegraph) are recorded using the following symbols:

1/3 - ahead 1/3 speed

2/3 - ahead 2/3 speed

I - ahead standard speed

II - ahead full speed

III - ahead flank speed

Z - stop

B1/3 - back 1/3 speed

B2/3 - back 2/3 speed

BF - back full speed

BEM - back emergency speed

Ships and craft equipped with controllable reversible pitch propellers record the propeller pitch in feet and fractions of feet set in response to a signaled speed change, rather than the shaft revolution counter readings. The entries for astern pitch are preceded by the letter B. Each hour on the hour, entries are made of counter readings, thus facilitating the calculation of engine miles steamed during those hours when the propeller pitch remains constant at the last value set in response to a signaled order.

Before going off watch, the engineering officer of the watch signs the Bell Book in the line following the last entry for his watch and the next officer of the watch continues the record immediately thereafter. In machinery spaces where an engineering officer of the watch is not stationed, the bell sheet is signed by the watch supervisor.

The Bell Book is maintained by bridge personnel in ships and craft equipped with controllable reversible pitch propellers, and in which the engines are directly controlled from the bridge. When control is shifted to the engineroom, however, the Bell Book is maintained by the engineroom personnel. The last entry made in the Bell Book on the bridge indicates the time that control is shifted; and the first entry made in the Bell Book in the engineroom indicates the time that control is taken by the

engineroom. Similarly, the last entry made by engineroom personnel indicates when control is shifted to the bridge. When the Bell Book is maintained by bridge personnel, it is signed by the OOD in the same manner as prescribed for the engineering officer of the watch.

Alterations or erasures are not permitted in the Bell Book. An incorrect entry is corrected by drawing a single line through the entry and recording the correct entry on the following line. Deleted entries are initialed by the engineering officer of the watch, the OOD, or watch supervisor, as appropriate.

OPERATING RECORDS AND REPORTS

Engineering operating records are meant to ensure regular inspection of operating machinery and to provide data for performance analysis. Operating records are not intended to replace frequent inspections of operating machinery by supervisory personnel and are not to be trusted implicitly to provide warning of impending casualties. Personnel who maintain operating records must be properly indoctrinated. They must be trained to correctly obtain, interpret, and record data, and to report any abnormal conditions noted.

The type commander's directives specify which engineering operating records will be maintained and prescribe the forms to be used when no standard record forms are provided. The engineer officer may require additional operating records when (all factors considered—including the burden of added paperwork) he deems them necessary.

The operating records discussed in this chapter are generally retained on board for a period of 2 years after which time they may be destroyed in accordance with current disposal regulations. Completed records must be stowed where they will be properly preserved, and in such a manner as to ensure that any one of the records can be easily located.

STEAM TURBINE OPERATING RECORD

The Propulsion Steam Turbine Operating Record, NavShips 3652, is a daily record maintained for each main engine in operation. In ships with more than one main engine in the same engineroom, a separate sheet is maintained for each engine but common entries are omitted from the record for the port engine.

The watch supervisor enters the remarks and signs the record for his watch. The petty officer in charge of the engineroom checks the accuracy of the record and signs his name in the space provided on the back of the record. The main propulsion assistant notes the contents and signs the record. Any unusual conditions noted in the record are immediately reported to the engineer officer.

WARMING-UP AND SECURING SCHEDULES

The warming-up and securing schedules vary from ship to ship, depending on the procedure developed by the type commander. Each Machinist's Mate should become familiar with the type of check-off sheets used on his ship.

The purpose of the check-off sheet is to provide a guide to assist the MM1 and MMC in warming up or securing the main plant. Although experienced Machinist's Mates are capable of warming up and securing main plants, there are times when even the most experienced person will overlook a step in the procedure. Hence these forms simplify matters and provide a convenient method of checking off the various steps in the procedure so that no steps will be overlooked. The check-off list is filled out by the petty officer in charge of warming up or securing the plant.

MONTHLY SUMMARY

The Monthly Summary of Fuel Inventory and Steaming Hours Report, NavShips 3540/1, is shown in figure 17-1. The purpose of this report is to provide the Naval Ship Systems Command with a monthly summary of information on the ship's fuel inventory, the ship's fuel consumption, and on the steaming hours. This report contains all data as of 2400 of the last day of the previous month and shall be forwarded within five (5) days of completion of the reporting period. This report consists of one original copy and three carbon copies. The original copy is sent to the Naval Ship Systems Command, one carbon copy to the type commander, one carbon copy to the squadron commander or division commander, as appropriate, and the last carbon copy is filed aboard ship.

This summary provides current and cumulative data necessary for determining budget and fleet logistic requirements and operational performance. Most engineer officers prefer to compile the necessary data for this summary on a daily basis rather than to wait for the end of

MONTHLY SUMMARY OF FUEL INVENTORY AND STEAMING HOURS REPORT
(Excludes Nuclear Powered Ships)

NAVSHIPS REPORT 3540-1

NAVSHIPS 3540/1 (REV. 11-66) S/N 0105-501-3360

(No letter of transmittal required. Submit by 5th of following month.)

FROM: *(Name, type, hull no.)* USS EXTRA (CAG-33)

DATE *(Month & Year)* May 1968

TO: COMMANDER, NAVAL SHIP SYSTEMS COMMAND (SHIPS - 10134) DEPARTMENT OF THE NAVY WASHINGTON, D. C. 20360

ADMINISTRATIVE CONTROL *(Type Commander)*: CRUDESLANT

OPERATIONAL CONTROL *(Fleet Commander)*: CINCLANTFLT

SUMMARY OF ACTIVITIES: ISE, Norfolk Area

1. DAYS UNDERWAY 28 2. DAYS NOT UNDERWAY 3

TYPE OF PROPULSION FUEL USED: [X] NSFO [ ] DIESEL [ ] JP-5

DATA SUMMARY

1. FUEL OIL INVENTORY (GALLONS)	FUEL OIL INVENTORY (GALLONS) (A) NAVY SPECIAL	(B) DIESEL	(C) JP-5/OTHER
1.1 ON HAND FIRST OF MONTH	712304	2054	
1.2 RECEIPTS DURING MONTH	463398	0	
1.3 DELIVERIES	0	0	
1.4 GAIN BY INVENTORY *(Explain in Item 5)*	0	0	
1.5 FUEL USED UNDERWAY	461724		
1.6 FUEL USED NOT UNDERWAY	1864		
1.7 FUEL USED FOR BOATS, AUX. EQUIP., ETC.		62	
1.8 LOSS BY INVENTORY *(Explain in Item 5)*	0	0	
1.9 ON HAND LAST OF MONTH	712114	1992	

2. STEAMING HOURS	STEAMING HOURS UNDERWAY (A)	STEAMING HOURS NOT UNDERWAY (B)	HOURS NOT STEAMING (C)	TOTAL HOURS (D)
2.1 MAIN PROPULSION POWER	654	90	0	744
2.2 BATTERY SUBMARINE				
2.3 TOTAL	654	90	0	744

3.1 FUEL RECEIPTS

DATE	RECEIVED FROM	FUEL TYPE	GALLONS
5-15-	USS TALUGA (AO-62)	NSFO	260090
5-26-	USS TALUGA (AO-62)	NSFO	203308

3.2 FUEL DELIVERIES

DATE	RECEIVED FROM	FUEL TYPE	GALLONS

147.169

Figure 17-1.—Monthly Summary.

the month to make computations from the various operating records. As a petty officer in the engineering department, you may be required to compile data for the monthly summary.

OPERATING INSTRUCTIONS AND SAFETY PRECAUTIONS

A master list of all the engineering department operating instructions and safety precautions is kept in the log room. When a ship is commissioned, the building yard normally provides a master copy, in addition to posting the individual operating instructions and safety precautions throughout the engineering spaces. If any of the posted operating instructions and safety precautions are damaged or lost, a duplicate copy can be readily made up from the master list.

Where the operating instructions and safety precautions are not provided, they can be made up by the ship's force. The required instructions can be obtained from the manufacturer's technical manuals and from the appropriate chapters in NavShips Technical Manual.

DISPOSAL OF ENGINEERING RECORDS AND REPORTS

Before any engineering department records are destroyed, the Disposal of Navy and Marine Corps Records, USN and USNS Vessels, SecNav P5212.5 (revised) should be studied. This publication informs ships of the Navy of the procedures used for disposing of records. For each department aboard ship, these instructions list permanent records which must be kept, and temporary records which may be disposed of in accordance with an established schedule.

Both the Engineering Log and Engineer's Bell Book must be preserved as permanent records on board ship for a 3-year period unless they are requested by a Naval Court or Board, or by the Navy Department, in which case, a copy (preferable photostatic) of such sheets or parts of these records that are sent away from the ship, is certified by the engineer officer as a true copy for the ship's files.

At regular intervals, such as each quarter, the parts of those records that are over 3 years old are destroyed. When a ship that is less than 3 years old is decommissioned, the current books should be retained. If a ship is scrapped, the current books are forwarded to the nearest Naval Records Management Center.

Any reports forwarded to, and received from NavShips or other superior command may be destroyed when 2 years old, if they are no longer required for any other purpose.

It is important that only those reports which are required, or serve a specified purpose, be maintained on board ship. However, any report or record which will assist personnel in scheduling or making repairs, and which will supply personnel with information which is not contained elsewhere in publications or manuals, should be kept on board ship.

APPENDIX I

TRAINING FILM LIST

Certain training films that are directly related to the information presented in this training course are listed below under appropriate chapter numbers and titles. Unless otherwise specified, all films listed are black and white with sound, and are unclassified. For a description of these and other training films that may be of interest, see the United States Navy Film Catalog, NavWeps 10-1-777, (1966), and Supplement 2, NavAir 10-1-777 (1967).

Chapter 1

ADVANCEMENT

MN-5328B	Shipboard Training—Learning by Doing. (13 min.—1949.)
MN-6929A	Instructor Training—The Trainee. (12 min.—1952.)
MN-6929B	Instructor Training—Subject Matter. (11 min.—1952.)
MC-8709	Production 5118. (30 min.—1957.)
MN-9199A	Duties of the Division Officer—Organization and Administration. (18 min.—1953.)
MN-9199B	Duties of the Division Officer—Training. (21 min.—1954.)
MN-9199C	Duties of the Division Officer—Inspections. (20 min.—1954.)

Chapter 3

TURBINES

MN-6732A	Naval Steam Turbines—The Steam Cycle. (17 min.—1951.)
MN-6732B	Naval Steam Turbines—How Turbines Work. (17 min.—1950.)

MN-6732C Naval Steam Turbines—Turbine Casualties. (18 min.—1950.)

Chapter 6

HEAT EXCHANGERS AND AIR EJECTORS

FN-6733 Maintenance and Repair of Steam Condensers —Circulating Water Side. (23 min.—1952.)

MN-9356A Deaerating Feed Tanks—Theory of Operation. (6 min.—1955.)

MN-9356B Deaerating Feed Tanks—Dissolved Oxygen Test. (10 min.—1955.)

Chapter 7

PUMPS

SN-4057 Centrifugal Pumps Aboard Ship—Care and Repair. (14 min.—1944.)

MN-6741 Ship's Pumps. (16 min.—1951.)

Chapter 8

PIPING AND VALVES

MN-8428 Reseating Steam Valves in Place. (15 min.—1956.)

Chapter 9

DISTILLING PLANTS

MN-3706A Distilling Plants—Low Pressure Type (Griscom-Russell)—How It Works—Part 1. (13 min.—1944.)

MN-3706B Distilling Plants—Low Pressure Type (Griscom-Russell)—How It Works—Part 2. (18 min.—1944.)

SN-3706C Low Pressure Evaporators (Griscom-Russell)— Starting and Securing. (16 min.—1945.)

Chapter 10

AIR CONDITIONING AND REFRIGERATION

MN-2246A	Mechanical Refrigeration—How it Works. (20 min.—1957.)
FN-8158A	Refrigeration—Introduction to Control Mechanisms. (10 min.—1957.)
FN-8158B	Refrigeration—Evaporator Controls. (8 min.—1957.)
FN-8158C	Refrigeration—Compressor Controls. (6 min.—1957.)
FN-8158D	Refrigeration—Condenser Controls. (5 min.—1957.)

Chapter 11

AUXILIARY EQUIPMENT

MN-8208	Electro-Hydraulic Steering Gear. (15 min.—1956.)
MN-8831	The Waterbury Type Hydraulic Transmission—How it Works. (20 min.—1961.)
MN-9343A	High Pressure Air Compressors—Ingersol-Rand. (22 min.—1953.)
MN-9343B	High Pressure Air Compressors—Worthington—Operation. (13 min.—1954.)
MN-9343C	High Pressure Air Compressors—Worthington—Trouble Shooting. (17 min.—1954.)
MN-9498	Prevention of Explosions in Compressed Air and Hydraulic Systems. (20 min.—1962.)

Chapter 12

ADMINISTRATION, SUPERVISION, AND TRAINING

MN-5328A	Shipboard Training—Principles and Procedures. (12 min.—1948.)
MN-9199B	Duties of the Division Officer—Training. (21 min.—1954.)

Chapter 13

PROPULSION PLANT EFFICIENCY

MN-6732A	Naval Steam Turbines—The Steam Cycle. (17 min.—1951.)
MN-6903A	The Engine Room—Steam Cycle. (10 min.—1951.)

MN-6903B	The Engine Room—Getting Underway. (9 min.—1951.)
MN-9223A	Boilers and Their Operation—How Boilers Work. (15 min.—1955.)
MN-9223B	Boilers and Their Operation—Lighting Off Procedures. (13 min.—1956.)
MN-9223C	Boilers and Their Operation—Operation. (14 min.—1956.)
MN-9223D	Boilers and Their Operation—Securing. (5 min.—1956.)

Chapter 14

ENGINEERING CASUALTY CONTROL

MN-6774	Damage Control—Method of Unwatering Flooded Compartments. (18 min.—1950.)
MN-6931	Damage Control—Oxygen Breathing Apparatus. (20 min.—1951.)
MN-6931D	Damage Control—The High Capacity Foam System. (18 min.—1957.)
MN-6931E	Damage Control—Shipboard Fire Protection and Fire Prevention. (16 min.—1960.)
MN-6931F	Damage Control—Shipboard Firefighting Basic. (15 min.—1960.)
MN-7368	Damage Control—Casualty Power System. (22 min.—1952.)

Chapter 16

SHIP REPAIR

MN-9421A	Make the Most of Your Overhaul-Advance Planning. (20 min.—1962.)
MN-9421B	Make the Most of Your Overhaul—The Overhaul. (17 min.—1962.)

Chapter 17

RECORDS AND REPORTS

MN-9199A	Duties of the Division Officer—Organization and Administration. (18 min.—1953.)

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Block II - Radio Servicing

Unit 4 - Receiver Servicing (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
	Oscillators and mixers I.F. amplifier section Automatic volume control Beat frequency oscillator Noise limiters S meters Audio amplifiers Double-detection receivers
Realigning AM receivers	General types of equipment required General rules TRF realignment procedures General factors-superhet alignment Preparation for superheterodyne Realignment of the I.F. amplifiers Oscillator realignment procedure Realignment of the mixer Realignment of short wave receivers Push-button system alignment Realigning AFC circuits Special realignment problems in communication receivers
Replacement of defective resistors	Test characteristics Power rating and derating Replacement of composition resistors Determining the proper wattage RTMA color code for resistors RTMA preferred values Choosing values for wire-wound resistor Taper in volume controls Linear taper Left-hand taper Combination left and right taper Replacement when no value is available Repairing wire-wound controls Repairing carbon controls Repairing volume control switches
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VT 012 786
Machinist's Mate 3 and 2. Navy Training Course.

Department of the Navy, Washington, D.C.
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ABSTRACT - Prepared for enlisted men of the Navy who are studying for advancement to the rates of MM2 and MM3, this training course was developed by the Navy Training Publications Division. Contents are: (1) Advancement, (2) The 3-M System, (3) Steam Turbines, (4) Reduction Gears and Related Equipment, (5) Pumps, (6) Pump Operation and Maintenance, (7) Piping and Valves, (8) Heat Exchangers and Air Ejectors, (9) Lubrication, (10) Engineroom Operating Procedures, (11) Refrigeration, (12) Air Conditioning, (13) Steam Operated Distilling Plants, (14) Distilling Plant Operation and Maintenance, (15) Compressed Air Plants, (16) Additional Auxiliary Equipment, (17) Engineering Casualty Control, and (18) Lathes and Lathe Machinery Operations. A training film list is appended. A related document in this issue is available as VT 012 785. (GB)

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MACHINIST'S MATE 3 & 2

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10524-C

VT012786

PREFACE

This training course has been prepared for men of the Navy and of the Naval Reserve who are studying for advancement to the rates of MM3 and MM2. Combined with the necessary practical experience and a review of other applicable Navy Training Courses, a knowledge of the information in this training course will help the reader meet advancement requirements.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CESSE 12254

CREDITS

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NAVY TRAINING COURSES

Basic Handtools (metalworking skills only), NavPers 10085-A
Blueprint Reading and Sketching (chapters 1-4, 7), NavPers 10077-B

OTHER PUBLICATIONS

Naval Ships Technical Manual, chapter 9220 (22)

USAFI COURSES

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your educational services officer.* A partial list of these courses applicable to your rating follows:

Number	Title
B779	Blueprint Reading
D290	Physics I
D936	Introduction to Refrigeration

*Members of the United States Armed Forces Reserve components when on active duty are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more; or if they have been on active duty for a period of 120 days or more regardless of the time specified in the active duty orders.

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Block III - General Television Servicing

Unit 1 - Television Test Instruments

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Introduction and troubleshooting the TV receiver	Lab layout and procedure; use of isolation transformer
	The seven major sections of a TV receiver: function and signal flow
	Effects of defective operation of each section on picture, sound, and raster
	Basic troubleshooting procedure
Operating the oscilloscope	Why an oscilloscope is used in TV servicing
	Block diagram discussion of how an oscilloscope works; adjustment of oscilloscope controls
	Oscilloscope characteristics desirable in TV servicing Frequence response Sensitivity Input impedance Sweep frequency range Special characteristics
Measuring peak-to-peak waveforms	Measuring peak-to-peak waveform in TV receiver servicing
	Internal voltage calibration of an oscilloscope
	Block diagram discussion of how an external voltage calibrator works and how it is used in calibrating an oscilloscope
	What direct and low-capacitance probes are; why and when they are used in TV servicing; finding the divider factor of a low-capacitance probe

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CHAPTER 1

ADVANCEMENT

This training course has been prepared for men of the Navy and of the Naval Reserve who are studying for advancement to the rates of Machinist's Mate 3 and Machinist's Mate 2. The Machinist's Mate qualification requirements used as a guide in the preparation of this training course are those contained in change 1 (1966), of the Manual of Qualifications for Advancement in Rating, NavPers 18068-B. Change 2 (1967) made no change to the MM qualification requirements.

Chapters 2 through 18 of this training course deal with the technical subject matter of the Machinist's Mate rating. Chapter 2 deals with the 3-M planned maintenance system. Chapter 3 covers classification, operation, and maintenance of main and auxiliary steam turbines. Chapter 4 contains information on main engine and other reduction gear installations found on Navy ships. Chapters 5 and 6 deal with the principles of operation, uses, operation, and maintenance of pumps employed aboard Navy ships. Chapter 7 gives general information on piping, valves, steam traps, packing, and insulation. Heat exchangers and air ejectors are discussed in chapter 8. Chapter 9 deals with fluid friction and lubrication, lubricating systems, and care of lubricating oil. Watchstanding and engineroom operating procedures are covered in chapter 10. Chapters 11 and 12 deal with the principles, types, operation, and maintenance of refrigeration and air conditioning systems. The construction, operation, and maintenance of low pressure, steam-operated distilling plants are discussed in chapters 13 and 14. Chapters 15 and 16 deal with equipment located outside of enginerooms: air compressors, steering gears, anchor windlasses, winches, capstans, elevators, galley and laundry equipment, and industrial gas plants. Chapter 17 contains information dealing with engineering casualty control. Chapter 18 contains selected information on engine lathes and machining operations.

The remainder of this chapter gives information on the enlisted rating structure, the Machinist's Mate rating, requirements and procedures for advancement in rating, and references that will help you both in working for advancement and in performing your duties as a Machinist's Mate. This chapter also gives information on how to make the best use of Navy Training Courses. Therefore, it is strongly recommended that you study this chapter carefully before beginning intensive study of the remainder of this training course.

THE ENLISTED RATING STRUCTURE

The two main types of ratings in the present enlisted rating structure, are general ratings and service ratings.

GENERAL RATINGS identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

SERVICE RATINGS identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

THE MACHINIST'S MATE RATING

The Machinist's Mate rating is a general rating; there are no service ratings.

Machinist's Mates assigned to the "M" division operate and maintain the ship's main engines and associated equipment such as: pumps, distilling plants, compressors, valves,

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oil purifiers, heat exchangers, governors, reduction gears, shafts, and shaft bearings.

Machinist's Mates who are assigned duties other than in enginerooms maintain and repair machinery such as: steering engines, anchor windlasses, cranes, winches, elevators, laundry equipment, galley equipment, and air conditioning and refrigeration equipment. Machinist's Mates also perform duties in the generation, stowage, and transfer of the following gases: oxygen, nitrogen, carbon dioxide, and acetylene.

Machinist's Mates are assigned to all types of steam-driven surface ships. Most Machinist's Mates are assigned to "M" division where they operate and maintain ship propulsion equipment and associated equipment.

Machinist's Mates who are assigned to the generation, transfer, and stowage of industrial gases are graduates of the Navy Compressed Gases School or they work under the direct supervision of Navy Compressed Gases School graduates.

The nature of the Machinist's Mates duties depends largely on the type of ship to which he is assigned. Repair ships and tenders furnish other ships with spare parts, repairs, and other services that are beyond the facilities of the ship's crew. The duties of a Machinist's Mate assigned to a repair ship or tender may consist mainly of repairs and other services to ships assigned to the tender or repair ship. As a Machinist's Mate, you may choose an area of specialization. As you work in your rating and learn more about your job, you may seriously consider the fields of air conditioning and refrigeration, and industrial gases. Almost all Machinist's Mates who work in these two fields are graduates of the appropriate school. You can make a choice when you have reached the rate of MM3. A qualified PO3 can attend the Compressed Gases School or the Air Conditioning and Refrigeration School. Oxygen-nitrogen producing plants are installed aboard all Forrestal-class carriers and aboard some other ships. Almost all new ships are air conditioned. Thus, the rapidly expanding fields of industrial gases and air conditioning and refrigeration have created a demand for men trained to operate and maintain shipboard equipment used in these fields.

One of the responsibilities of an MM2 will be to take charge of a repair detail. The required work process is only one factor involved. It may be necessary to choose the correct materials and tools, and to requisition materials not readily available. You must know how to use allowance lists (RIAL, SAL, and COSAL), the general stores catalog, and you must know the procedures for maintaining inventories and obtaining replacements.

In order to successfully take charge of a repair detail, you must become a LEADER. You must know how to assign and supervise the work of others. This means that you must learn how to handle men. When you set high standards, your men will follow your example. Your personal behavior and attitude toward your job will influence the type of work your men will do.

For a definition of leadership, read General Order No. 21. For information on the practical application of leadership and supervision, study Military Requirements for Petty Officer 3 & 2, NavPers 10056-B.

ADVANCEMENT IN RATING

Some of the rewards of advancement in rating are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

But the advantages of advancing in rating are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating, you increase your value to the Navy in two ways. First, you become more valuable as a specialist in your own rating. And second, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy.

HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement in rating? The requirement may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and occupational training courses.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1. In some cases the Record of Practical Factors may contain the old form number, NavPers 760.

4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.

5. Demonstrate your KNOWLEDGE by passing written examinations on (a) military qualification requirements and (b) occupational qualification requirements.

Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your division officer or training officer to be sure that you know the most recent requirements.

Advancement in rating is not automatic. After you have met all the requirements, you are ELIGIBLE for advancement. You will actually be advanced in rating only if you meet all the requirements (including making a high enough score on the written examination) and if the quotas for your rating permit your advancement.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement in rating? You must study the qualifications for advancement, work on the practical factors, study the required Navy Training Courses, and study other material that is required for advancement in your rating. To prepare for advancement, you will need to be familiar with (1) the Quals Manual, (2) the Record of Practical Factors, NavPers 1414/1, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052, and (4) applicable Navy Training Courses. The following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

The Quals Manual

The Manual of Qualifications for Advancement in Rating, NavPers 18068B (with changes), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals Manual," and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military qualification requirements, and (2) occupational qualification requirements.

MILITARY QUALIFICATION REQUIREMENTS apply to all ratings rather than to any one particular rating. Military qualification requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

OCCUPATIONAL QUALIFICATION REQUIREMENTS are those that are directly related to the work of each rating.

Both the military qualification requirements and the occupational qualification requirements are divided into subject matter groups; then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

In most subject matter areas, you will find both practical factor and knowledge factor qualifications. In some subject matter areas, you may find only practical factors or knowledge factors. It is important to remember that there are some knowledge aspects to all practical factors, and some practical aspects to most knowledge factors. Therefore, even if the Quals Manual indicates that there are no knowledge factors for a given subject matter area, you may still expect to find examination questions dealing with the knowledge aspects of the practical factors listed in that subject matter area.

In summary, then, the written examination for advancement in rating may contain questions relating to the practical factors and to the knowledge factors of both the military qualification requirements and the occupational qualification requirements. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

You are required to pass a Navy-wide military/leadership examination for E-4 or E-5, as appropriate, before participating in the occupational examinations. The military/leadership examinations for both levels are given quarterly. Candidates are required to pass the applicable military/leadership examination only once. Each of these examinations consists of 100 questions based on information

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	# E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service— or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3. AME 3, HM 3			Class B for AGC MUC, MNC.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam	Standard Exam or Rating Training.	Standard Exam required for all PO Advancements.			Standard Exam, Selection Board. Also pass Mil. Leadership Exam for E-4 and E-5.		
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

contained in the Manual of Qualifications for Advancement in Rating, NavPers 18068B and Training Publications for Advancement in Rating, NavPers 10052.

The Navy-wide occupational examinations for pay grades E-4 and E-5 will contain 150 questions related to occupational areas of your rating.

If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

The Quals Manual is kept current by means of changes. The occupational qualification requirements for your rating which are covered in this training course were current at the time the course was printed. By the time you are studying this course, however, the quals for your rating may have been changed. Never trust any set of quals until you checked it against an UP-TO-DATE copy in the Quals Manual.

Record of Practical Factors

Before you can take the servicewide examination for advancement in rating, there must be an entry in your service record to show that you have qualified in the practical factors of both the military qualification requirements and the occupational qualification requirements. A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 1414/1 is used to keep a record of your practical factor qualifications. This form is available for each rating. The form lists all practical factors, both military and occupational. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement in Rating, and revised forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 1414/1 form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

NavPers 10052

Training Publications for Advancement in Rating, NavPers 10052 (revised), is a very important publication for anyone preparing for advancement in rating. This bibliography lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052 for your rating.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Navy Training Courses are marked with an asterisk (*). Any course marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you can be eligible to take the servicewide examination for advancement in rating. Each mandatory course may be completed by (1) passing the appropriate enlisted correspondence course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the training course; or (3) in some cases, successfully completing an appropriate Class A course.

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Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military qualification requirements for advancement. Personnel of ALL ratings must complete the mandatory military qualification requirements training course for the appropriate rate level before they can be eligible to advance in rating.

The references in NavPers 10052 which are recommended but not mandatory should also be studied carefully. All references listed in NavPers 10052 may be used as source material for the written examinations, at the appropriate rate levels.

Navy Training Courses

There are two general types of Navy Training Courses. RATING COURSES (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the occupational qualification requirements of ONE rating. SUBJECT MATTER COURSES or BASIC COURSES give information that applies to more than one rating.

Navy Training Courses are revised from time to time to keep them up to date technically. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether any particular copy of a Navy Training Course is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists all current training courses and correspondence courses; you will find this catalog useful in planning your study program.)

Navy Training Courses are designed to help you prepare for advancement in rating. The following suggestions may help you to make the best use of this course and other Navy training publications when you are preparing for advancement in rating.

1. Study the military qualification requirements and the occupational qualification requirements for your rating before you study the training course, and refer to the quals frequently as you study. Remember, you are studying the training course primarily in order to meet these quals.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training course intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training course in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions:

What do I need to learn about this?
What do I already know about this?
How is this information related to information given in other chapters?
How is this information related to the qualifications for advancement in rating?

5. When you have a general idea of what is in the training course and how it is organized fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not

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answered. Without looking at the training course, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Navy Training Courses or other appropriate texts. As mentioned before, completion of a mandatory Navy Training Course can be accomplished by passing an Enlisted Correspondence Course based on the Navy Training Course. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master the information given in the training course, and also helps you see how much you have learned.

10. Think of your future as you study Navy Training Courses. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCES OF INFORMATION

Besides training courses, NavPers 10052 lists official publications on which you may be examined. You should not only study the sections required, but should become as familiar as possible with all publications you use.

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military qualification requirements for advancement and the occupational qualification requirements of your rating.

Some of the publications described here are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you to do your work or to advance in rating; it is likely to be a waste of time, and may even be seriously misleading.

BUPERS PUBLICATIONS

Some of the BuPers publications that you will need to study or refer to as you prepare for advancement have already been discussed earlier in this chapter. Some additional BuPers publications that you may find useful are Basic Handtools, NavPers 10085-A, Blueprint Reading and Sketching, NavPers 10077-B, and Fireman, NavPers 10520-C.

In addition, you may find it useful to consult the Navy Training Courses prepared for other Group VII (Engineering and Hull) ratings. Reerence to these training courses will add to your knowledge of the duties of other men in the engineering department aboard ship.

NAVSHIPS PUBLICATIONS

A number of publications issued by the Naval Ship Systems Command will be of interest to you. The Naval Ships Technical Manual (formerly Bureau of Ships Technical Manual) is the basic doctrine publication of the Naval Ship System Command. Chapters of particular importance to you include the following:

Chapter 9200 (20)	Winches and Capstans
Chapter 9210 (21)	Hydraulic Speed Gears
Chapter 9220 (22)	Steering Gear
Chapter 9230 (23)	Industrial Gases
Chapter 9410 (41)	Main Propelling Machinery—Turbines—Section 1
Chapter 9420 (42)	Reduction Gears
Chapter 9430 (43)	Bearings and Shafting
Chapter 9450 (45)	Lubricants and Lubrication Systems
Chapter 9460 (46)	Condensers and Air Ejectors
Chapter 9470 (47)	Pumps
Chapter 9480 (48)	Piping Systems
Chapter 9490 (49)	Compressed Air Plants
Chapter 9500 (50)	Auxiliary Steam Turbines
Chapter 9580 (58)	Distilling Plants
Chapter 9830 (83)	Elevators
Chapter 9950 (95)	Gaskets and Packings

The Naval Ship Systems Command Technical News is a monthly publication which contains interesting and useful articles on all aspects of shipboard engineering. This magazine is particularly useful because it presents information which supplements and clarifies information

contained in the Naval Ships Technical Manual and because it presents information on new developments.

The manufacturers' technical manuals that are furnished with most machinery units and many items of equipment are valuable sources of information on operation, maintenance, and repair. The manufacturers' technical manuals that deal with NAVSHIPS machinery and equipment are usually given NAVSHIPS numbers.

BLUEPRINTS AND SHIP DRAWING INDEX

As a Machinist's Mate, you are required to use mechanical drawings and handbooks to obtain data when repairing machinery. You must also be able to read and interpret blueprints, a principal source of information required for repair work, and you must have a knowledge of the Ship Drawing Index. Information on how to read and interpret blueprints is available in Blueprint Reading and Sketching, NavPers 10077-B. Supplementary information is provided in the following paragraphs on the filing of blueprints.

All ships use a standard system of filing drawings by their assigned code number, although the number and type of plans carried will be different on different ships. The number assigned to a drawing for identification and filing purposes is composed of several groups. There are two types of numbering systems in use: (1) the older system, referred to as the S-group numbering system, and (2) the new consolidated index numbering system. All drawings prepared under the cognizance of NavShips after 1 January 1957 utilize the consolidated index numbering system. For example, in NAVSHIPS drawing number CA-139-S5101-525802, which is an S-group numbered drawing, or LST 1173-206-2465214A, which uses the consolidated index numbering system, the group CA 139 and LST 1173 is the class ship designation or the class of ships for which the plan applies. The next group is S5101, which is the subject matter group or material file number, or 206, which is the consolidated index number. In this example, the S-group number identifies a drawing on the automatic combustion controls of a boiler. The index number 206 identifies the drawing on the same subject as the S-group number. The S-group numbers and the consolidated index numbers are cross-referenced in NAVSHIPS Consolidated Index of Materials and Services Related to Construction and Conversion.

In either system, the last group of numbers is the individual drawing number or serial number. Except for multisheet drawings, no two drawings will bear the same serial number. If an alteration or change has been made, the accompanying drawing will have an alteration number or a revision letter. If the drawing is under the S-group numbering system, it will have an alteration number such as CA 139-S5101-525802 Alt. 2; the Alt 2 is the alteration number. If all alterations have been completed, the plan Alt 2 is kept on file. If the drawing is under the consolidated index numbering system, it will have a revision letter. With this system, the original drawing is always designated as REV A. A drawing number of LST 1173-206-2465214C would indicate that the drawing is the second revision of the original drawing. It is standard procedure to throw away all obsolete drawings. Care must be taken to see that you have an up-to-date drawing and not one that is obsolete. This can be done by checking the ALT number or the REV letter.

Each ship has a list of the drawings that are furnished to the ship. This list of plans is called the "Ship Drawing Index." Ships may also have a typewritten copy of the index of the drawings that are carried on board. The use of an index is the best method of finding a drawing on board a ship. Assume that repairs are to be made to a boiler, and that a drawing is needed. The proper procedure would be to go to the engineer's log room and obtain the Ship Drawing Index. If you know the filing number for boilers, you can immediately turn to that group. Here you will see listed the numbers and titles of the various drawings on the boilers. From the listed titles you can usually spot the drawing you want. You should note the number opposite the title, then go to the filing cabinet where the drawings are stowed.

The file drawers are labeled with the numerical sequence of the drawings in the drawer. You should look for the file drawers marked for the numerical sequence that the desired drawing would come under. The individual drawings inside the drawer usually are kept in large manila envelopes with the number and title in the upper left-hand corner; they are filed in numerical sequence.

SAFETY PRECAUTIONS

The Department of the Navy maintains a consistent policy of safety for personnel and equipment. Most accidents which occur in noncombat operations can be prevented if all personnel cooperate in eliminating unsafe conditions and acts.

To assist commanders in the operating forces in carrying out their responsibilities concerning safety, the Chief of Naval Operations issues an index (OPNAVINST 5100.6, revised) of publications, pamphlets, periodicals, and directives, issued by bureaus and offices of the Navy Department to conform with safety precautions applicable to the operating forces. The manual entitled United States Navy Safety Precautions (OPNAV 34P1) is no longer issued for use by the operating forces.

Instructions and procedures pertaining to safety aspects are contained in general and specific manuals such as Naval Ships Technical Manual, NavShips 250-000 (Volumes I, II, and III), and the U. S. Diving Manual, NavShips 250-538. The safety precaution references listed in the index are not intended to replace those in various manuals; the references listed are intended to serve as a supplement when changes in safety precautions have occurred or the new precautions have been implemented. When referenced safety precautions have been included in the appropriate manual, the reference is deleted from the index when it is revised.

Safety precautions related to specific mechinery are included at appropriate points throughout this training course. Other precautions with which you must be familiar are given in this section.

Material Handling

When working on shipboard machinery, there are several things you can do to prevent accidents. Chain hoists are usually provided to lift heavy objects. However, if a heavy object must be moved by hand, there is a proper way of doing it: The lifter should stand close to the load, with feet solidly placed and slightly apart. With knees bent, he should grasp the object firmly, and then lift by straightening the legs, keeping the back as vertical as possible. Never stand on a slippery deck to lift a heavy object, nor reach for it.

Materials should never be thrown from elevated places to the deck. Suitable lowering equipment should always be used.

Lifting or lowering operations being performed by several persons should be done on signal from one person, and then only when all personnel are in the clear.

Never overload a chain hoist, block and tackle, crane or any other lifting device. Defective or broken straps should never be used.

Before any material is handled, it should be examined and personnel should be protected against sharp edges, protruding points, or other factors likely to cause accidents.

Before opening a fitting or piece of equipment, valves which permit entrance of steam, water, air, oil, etc., into the fitting or equipment should be closed, tagged, and secured by locking or wiring in order to prevent accidental opening.

Keep work areas clear of stray gear such as tools, fire hazards, and oil.

Warn others away from any known unsafe condition.

Taking on Fuel

When fueling at sea, an MM will be mostly concerned with properly manning the engineroom. The usual procedure consists of starting an extra ship's service generator, splitting the plant, manning appropriate sound powered telephones and keeping the propellers on the required r.p.m. However an MM may be assigned to a fueling station topside. You may be detailed to bring rags and sand to a fueling station to dispose of spilled oil. You may be responsible for having available spanner wrenches or other tools used in making up fuel hose connections, or in opening or closing valves. The fueling detail shall take every precaution to prevent tanks from overflowing. No leak should be neglected and any oil that may be spilled should be disposed of as soon as possible. During fueling, smoking and open flames are forbidden. Line handlers shall wear life jackets and take every precaution to prevent falling or being washed overboard.

Working with Electrical Equipment

Even though the care and maintenance of electrical equipment is the responsibility of an EM, safety precautions must always be observed by persons working around electrical circuits and equipment, in order that injury caused by contact with an electrically charged unit may be avoided.

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Block III - General Television Servicing

Unit 1 - Television Test Instruments (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
	What a demodulation probe is; why and when it is used in TV servicing
Operating the crosshatch generator	What a crosshatch or dot-and-bar generator is. Why and how it is used in TV receiver servicing
	Output signal characteristics of crosshatch or dot-and-bar generator
Operating the sweep generator	How a sweep frequency generator works; methods by which FM is accomplished
	Characteristics and desirable features of a sweep frequency generator for TV alignment and troubleshooting; operating controls
Operating the marker generator	How a marker generator for TV alignment and trouble-shooting works; operating controls
	Frequency calibration of marker generator
	Self-contained facilities for calibration Use of plug-in crystals and other external calibrating standards
Familiarization with sweep, marker, and AM generators	Hooking up equipment for taking video i-f, r-f and sound i-f response curves.
	Marker injection
	Use of bias box
Operating the AM generator	Setting attenuators for proper output; test for circuit overloading
	Frequency distribution and interpretation of response curve; comparison with manufacturers' published curves

ESSI 1224

Electric shock from contact with an energized circuit can cause serious injury. Even low voltage circuits can cause death upon contact, especially when current passes through the chest. Shipboard conditions are particularly conducive to severe shocks because (1) the body is likely to be in contact with the ship's metal structure, and (2) the body resistance to electricity may be low because of perspiration or damp clothing. Extra care is therefore needed when you are working in the vicinity of electric circuits on board ship.

Care should be exercised to prevent short circuits. A short circuit may be caused by accidently placing or dropping a metal tool, a ruler, a flashlight case, or some other conducting article across an energized line. The arc, and the fire which may result, from even relatively low voltage circuits may cause extensive damage to equipment and serious injury to personnel.

Safety precautions are posted in the vicinity of electrical equipment. If these simple precautions are observed, injury or accident will seldom occur when you are working around electrical equipment. When working in the vicinity of electrical equipment, keep in mind that electricity strikes without warning; that hurrying reduces caution and invites accidents; that taking chances is an invitation to trouble; and that every electrical circuit is a potential source of danger.

Even when safety precautions are carefully observed, accidents may occur. You should be familiar, therefore, with the procedures to be followed when rescue from electrical contact is necessary, and when injuries from electricity have been received. Rescuing a person who is in contact with an electrically charged object is likely to be a difficult and dangerous job. Extreme caution must be used; otherwise, you may be electrocuted yourself. You must not touch the victim's body, the charged object, or any other object which may be conducting electricity.

When rescusing a person from an electric contact you should, first of all, look for the switch. When you find the switch, shut off the current immediately. Do not spend much time hunting for the switch, however; every second counts. If you cannot find the switch rapidly, try to move the victim's body off the electrically charged object. Use anything dry and nonconducting, such as a stick, a pole or an oar, or a board. It may be possible to use dry rope or dry clothing pull the wire away from the victim. You can also break the contact by cutting the wire with a wooden-handled axe, but this is extremely dangerous; the cut ends of the wire are likely to curl and lash back at you before you have time to get out of the way. When you are trying to break an electrical contact, always stand on some nonconducting material, such as a dry board, dry clothing, or a rubber mat.

The passage of electric current over the skin or through the body may result in asphyxiation, burns, or shock. Asphyxiation is the primary danger. Burns are most likely to occur when the skin is dry. Shock (a serious disturbance of the blood flow) accompanies or follows asphyxiation and burns.

When someone receives injuries from electricity, you should proceed as follows:

1. Deenergize the circuit or release the victim from contact. Avoid unnecessary danger to yourself by observing all appropriate precautions.
2. If the victim is not breathing, treat for asphyxiation. Begin artificial respiration immediately. Keep the victim quiet after normal breathing is reestablished. As the victim is recovering, he may go through a period of frenzied violence.
3. Treat the victim for shock. Keep him lying down, with his head slightly lower than his feet. Keep the victim warm, but do not overheat him. (NOTE: Any person who has suffered an interruption of breathing should not be given morphine.) Have some one notify the Medical Department and send a doctor to the scene of the accident.
4. Treat the victim for burns, if necessary. For information on the first aid treatment of burns, methods of artificial respiration, heat exhaustion, and injuries from electricity, refer to Standard First Aid Training Course, NavPers 10081-B.

TRAINING FILMS

Training films available to naval personnel are a valuable source of supplementary information on many technical subjects. A selected list of training films that may be useful to you is given in appendix I of this training course. Other films that may be of interest are listed in the United States Navy Film Catalog, NAVWEPS 10-1-777. This catalog, published in 1966,

supersedes three earlier publications: the former catalog with the same title but numbered NavPers 10000-A; the Supplement, NAVWEPS 10-1-772; and the Navy Classified Film Catalog, NavPers 10001-A.

When selecting a film, note its date of issue listed in the film catalog. As you know, procedures sometimes change rapidly. Thus some films become obsolete rapidly. If a film is obsolete only in part, it may still have sections that are useful, but it is important to note procedures that have changed. If there is any doubt, verify current procedures by looking them up in an applicable source.

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CHAPTER 2

THE 3-M SYSTEM

The Navy Maintenance and Material Management (3-M) System has been implemented in the Navy as an answer to the ever present problem of maintaining a high degree of operational readiness. Although the Standard Navy Maintenance and Material Management (3-M) System is designed to improve the degree of readiness, its effectiveness and reliability are dependent upon you, the individual. The accuracy with which you perform your work, along with the neat and complete recording of required data on the prescribed forms, is one of the keys to the degree of readiness of your ship and therefore is a reflection of your success or failure as a petty officer.

The two basic elements of the 3-M System are the Planned Maintenance System (PMS) and the Maintenance Data Collection System (MDCS). The Planned Maintenance System (PMS) provides a uniform system of planned maintenance. The Maintenance Data Collection System (MDCS) provides a means of collecting necessary maintenance and supply data, in a form suitable for rapid machine processing. A Manhour Accounting System is used aboard repair ships and tenders in conjunction with the Maintenance Data Collection System.

Preventive maintenance should not be confused with corrective maintenance. Preventive maintenance is a scheduled check on select parts of a piece of equipment. Corrective maintenance is the repair of equipment.

As a third or second class petty officer, you will be concerned with both the Planned Maintenance System (PMS) and certain portions of the Maintenance Data Collection System (MDCS) as discussed in this chapter.

THE PLANNED MAINTENANCE SYSTEM

Planned maintenance reduces casualties and saves the cost of major repairs. The PMS is designed to define the minimum planned maintenance required, to schedule and control its performance, to describe the methods and tools to be used, and to aid in the prevention and detection of impending casualties.

In establishing minimum planned maintenance requirements for each piece of equipment, the NavShips Technical Manual, manufacturers' technical manuals, and applicable drawings are critically reviewed. If the planned maintenance requirements are found to be unrealistic or unclear, they are modified or completely revised before being incorporated into the PMS.

It is possible that the planned maintenance prescribed in the PMS may conflict with that prescribed in other documents such as the NavShips Technical Manual. Should this happen, it must be remembered that the PMS supersedes and takes precedence over any and all documentation that may be in conflict with it.

THE PLANNED MAINTENANCE SYSTEM MANUAL

A master Planned Maintenance System Manual is tailored to a specific ship. It contains the minimum planned maintenance requirements for each maintainable component installed in that particular ship. Appropriate sections (engineering, electronics, weapons, etc.) of the master manual are normally kept in the department officers and are primarily used by the department heads in planning and scheduling the maintenance requirements in their departments.

The departmental PMS Manual contains a section for each division or maintenance group within the department. Each divisional section (called the group maintenance manual) contains a table of contents and a Maintenance Index Page (MIP) for each system, subsystem, or component involved.

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Applicable portions of the PMS Manual are kept in the working space for the equipment involved and serve as a ready reference to the planned maintenance required. Each MIP contains a brief description of the maintenance requirements and the frequency with which maintenance is to be effected. The frequency code is: D—daily, W—weekly, M—monthly, Q—quarterly, S—semiannually, A—annually, C—overhaul cycle, and R—situation requirement. The frequency codes for the daily, weekly, monthly, quarterly, semiannual, and annual planned maintenance actions are self-explanatory. Certain planned maintenance actions are performed once each operational cycle between shipyard overhauls, during a specified quarter of the cycle, and are designated by the code C. The code R is used to identify those planned maintenance actions which are to be performed prior to getting underway, after a specified number of hours of operation, or to meet other requirements that only arise during specific situations (prior to overhaul, for example).

Figure 2-1 shows a Maintenance Index Page (MIP) taken from a typical PMS Manual. Information to be found on the MIP includes the system or component involved, a short description of each maintenance requirement, the maintenance frequency code plus a consecutive number starting with "1" for each frequency code assigned, the rate or rates recommended to perform the maintenance, the average time that is required to perform the maintenance, and related maintenance requirements. The related maintenance listed is additional planned maintenance which can be completed prior to, in conjunction with, or immediately after the scheduled maintenance.

Because shipboard application of the PMS will vary slightly from one ship to another, the information found on the MIPs regarding rates recommended to perform the maintenance and the average time required for the task requires certain clarification. The maintenance tasks are actually performed by personnel available and capable, regardless of what rate is listed on the MIP. The average time required, as listed on the MIP, does not take into account the time required to assemble the necessary tools and materials nor the time required to clean the area and put away the tools at the end of the task. It must be remembered that no maintenance is complete until the tools and equipment are put away and the area is cleaned.

SCHEDULING OF PLANNED MAINTENANCE

For each division or maintenance group, a cycle schedule which provides a visual display of the planned maintenance requirements (based on the operational cycle of the ship between shipyard overhauls) is maintained in the departmental office. The information to be found on the cycle schedule for any particular division or maintenance group includes the MIP number from the PMS Manual, a listing of all the equipment within that particular group for which planned maintenance is required, and the specific quarter in which the semiannual, annual, and overhaul cycle planned maintenance actions are to be performed. The cycle schedule also lists the quarterly and the situation requirement planned maintenance actions which must be scheduled, as well as the monthly planned maintenance requirements.

The cycle schedule is used by the department head, in conjunction with his division officers and leading petty officers, to make out the quarterly planned maintenance schedule. The quarterly schedule, displayed adjacent to the cycle schedule in a holder known as the maintenance control board, shows the ship's employment schedule and the planned maintenance to be performed during that particular quarter.

The quarterly schedule has thirteen columns, one for each week in the quarter, for the scheduling of maintenance throughout the 3-month period.

At the end of each week, the leading petty officer of the division or maintenance group will update the quarterly schedule by crossing out (with an X) the preventive maintenance performed. If a planned maintenance action is not completed during the week it is scheduled, the leading petty officer will circle the action on the quarterly schedule. The uncompleted maintenance is then rescheduled for another week within the same quarter.

At the close of each quarter, the quarterly schedule is removed from its holder and retained on board as a record of the planned maintenance completed. This record may be discarded at the beginning of the second quarter after the next shipyard overhaul.

The quarterly schedule is also used by your leading petty officer to make out a weekly planned maintenance schedule which is posted in the space where you work. The weekly schedule of

System, Subsystem, or Component	Reference Publications and/or Maintenance Significant Number
HP Air Compressor	

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
AP	ZZZFCH1	84	4934	D	1. Measure crankcase oil level.	D-1	FN	0.1	None
AP	ZZZFCH1	84	4935	W	1. Operate compressor by power. 2. Blow down all air flasks, separators, and filters. 3. Sample and inspect lube oil.	W-1	MM2	0.5	D-1
AP	ZZPFVA1	84	4936	M	1. Lift relief valves by hand.	M-1	MM3	0.1	None
AP	ZZZFCH1	84	4937	Q	1. Clean suction filter. 2. Test inlet and outlet valves by operation. 3. Test temperature switch by operation. 4. Test automatic start and stop switch by operation.	Q-1	MM2	0.5	None
AP	ZZZFCH1	94	5519	Q	1. Drain and clean crankcase. 2. Clean oil filter 3. Clean crankcase vent.	Q-2	MM2 FN	2.0 2.0	None
AP	ZZZFCH1	84	4938	Q	1. Sound and tighten foundation bolts. 2. Inspect air flasks, separators, and piping for external corrosion.	Q-3	FN	0.2	None
AP	ZZZFCH1	84	5742	S	1. Inspect 4th stage cooler and discharge piping for oil and carbon accumulations.	S-1	MM2	4.0	None
AP	ZZZFCH1	84	4939	A	1. Renew air filter and clean strainers. 2. Test air system under full working pressure. 3. Test 3000-300 psi and 3000-100 psi reducers.	A-1	MM2	3.0	None
AP	ZZZFCH1	84	4940	C	1. Inspect internal parts for wear.	C-1	MM1 FN	30.5 30.5	None
AP	ZZPFVA1	84	4941	C	1. Test relief valves by pressure.	C-2	FN	1.3	None

Bureau Page Control No. A-3/6-B4

98.171

Figure 2-1.—Maintenance Index Page.

SC 2271

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056 238

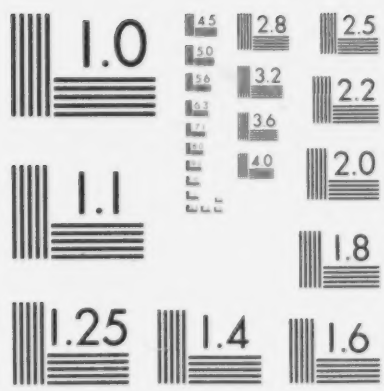

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

planned maintenance should not be considered as the total work for the week. This schedule only covers the scheduled preventive maintenance and is in addition to the other routine work, upkeep, and corrective maintenance to be done.

The weekly schedule provides a list of the components in the working area, the appropriate page number of the PMS Manual, and spaces for the leading petty officer to use in the assignment of planned maintenance tasks to specified personnel. The daily and weekly planned maintenance actions are preprinted on the forms and the other maintenance actions are written in by the leading petty officer as required. When the leading petty officer ascertains that a maintenance task has been completed, he crosses out the maintenance requirement number on the weekly schedule. If for some reason a task cannot be completed on the day scheduled, the leading petty officer will circle the maintenance requirement number and reschedule it for another day. The status of scheduled maintenance can be readily determined by looking at the weekly schedule.

A sample weekly schedule is shown in figure 2-2. In addition to the daily and weekly maintenance actions, the leading petty officer has assigned other maintenance responsibilities as required (see fig. 2-2). In the far right-hand column, it is noted that maintenance requirement A-1 for the H.P. Air Plant is due within the next 4 weeks. In the schedule shown in figure 2-2, all maintenance scheduled for Monday, Tuesday, and Wednesday was completed except W-1 for the L.P. Air Plant. This action has been rescheduled for Thursday of the same week.

THE MAINTENANCE REQUIREMENT CARD

The Maintenance Requirement Card (MRC) is a card, 5 by 8 inches, on which the planned maintenance task is defined in sufficient detail to enable assigned personnel to perform the task (see fig. 2-3). A master set of MRCs is maintained in the departmental office and those applicable to the equipment with which you are concerned are maintained in your working space. If a card in the working space becomes lost or mutilated, a new card can be made from the master set and used until a feedback report is sent in and a new card obtained.

The MRC is one of the primary tools of the PMS with which you will be concerned. Suppose that on a Monday morning you look at the weekly schedule (fig. 2-2) and find that you are assigned the maintenance action for the H.P. Air Plant identified as W-1. The weekly schedule indicates that this particular maintenance action is listed on page A-3 of the PMS Manual. The MRC which describes the task you are assigned is identified by the number combination "A-3 W-1" in the upper right-hand corner. In preparation for performing the assigned task, you would pull MRC number A-3 W-1 (fig. 2-3) from the set of cards in the working space.

The MRC identifies the component involved; gives a brief description of the maintenance requirement; lists the safety precautions to be followed; and lists the tools, parts, and materials needed to accomplish the task. This information is listed to enable you to be completely ready to perform the prescribed maintenance prior to actually working on the equipment involved. The procedure listed on the MRC is standardized and is the best known method of performing that particular task. Any related maintenance requirement listed on the MRC should be done at the same time or in conjunction with the assigned task for the purpose of time conservation.

The 16-digit number on the lower right-hand side of the MRC is the bureau card control number which can also be found on the MIP. Each MRC has a bureau card control number, which must be referred to in any correspondence concerning the card.

On some ships, two or more divisions may have identical equipment. When this occurs, each division will have separate (but identical) MRC cards for the equipment.

FEEDBACK REPORT

The PMS Feedback Report, OPNAV Form 4700-7 (fig. 2-4), is designed to report any discrepancies or suggested improvements in the PMS as installed aboard ship. The report is to be filled out by the man who discovers the discrepancy or suggests an improvement, signed by the commanding officer or his designated representative, and mailed via the type commander to the appropriate field office listed on the reverse side of the originator's copy of the form. Atlantic Fleet ships use the Norfolk address and Pacific Fleet ships use the San Diego address.

When submitting a feedback report, be sure it is filled out completely and legibly. Handwritten

GROUP AUXILIARY WORK SCHEDULE FOR WEEK OF 11 APRIL 1966

COMPONENT	MAINTENANCE RESPONSIBILITY	PAGE	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT/SUN	OUTSTANDING REPAIRS AND P.M. CHECKS DUE IN NEXT 4 WEEKS
STARBOARD STEERING UNIT	ROBERTS	A-1	W-1 D-1	S-1 D-1	S-2 D-1	D-1	D-1	D-1 D-1	
PORT STEERING UNIT	ROBERTS	A-1	W-1 D-1	D-1	D-1	D-1	D-1	D-1 D-1	
FWD. EMERGENCY DIESEL ENGINE	JONES	A-2	W-1						
AFT. EMERGENCY DIESEL ENGINE	JONES	A-2	W-1	M-1	Q-1				
COMPRESSED AIR PLANT (H.P.)	SMITH	A-3	W-1 D-1	D-1	D-1	D-1	D-1	D-1 D-1	A-1
COMPRESSED AIR PLANT (L.P.)	WOODS/SMITH	A-4	W-1	A-1	A-1				
WINDLASS WINCHES	WATERS	A-5	W-1, X						
#1 MAIN REFRIG. UNIT	WOODS/PAYNE	A-6	W-1			C-1			
#2 MAIN REFRIG. UNIT	PAYNE	A-6	W-1 M-1				M-2		
#1 MAIN AIR COND. UNIT	PAYNE	A-6	W-1						
#2 MAIN AIR COND. UNIT	PAYNE	A-6	W-1	M-1		M-2			
BOAT WINCH	WATERS	A-33	W-1						
PORTABLE GAS DRIVEN PUMP P-250		A-34							
PORTABLE GAS DRIVEN PUMP P-60		A-35							
VACUUM PRIMING PUMP	WATSON	A-50	W-1						
AUXILIARY VENTILATION	WATSON	A-53	D-1	D-1	D-1	D-1	D-1 M-1	D-1 D-1	

OPNAV FORM 4700-6

98.175

Figure 2-2.—Weekly Preventive Maintenance Schedule.

SYSTEM	COMPONENT	M.R. NUMBER
Auxiliary	HP Air Compressor MAINT. SIGNIFICANT NO.	A-3 W-1
SUB-SYSTEM	RELATED M.R.	RATES / M/H
Compressed Air	D-1	MM2 / 0.5

M.R. DESCRIPTION
1. Operate compressor by power.
2. Blow down all air flasks, separators, and filters.
3. Sample and inspect lube oil.

TOTAL M/H: 0.5
ELAPSED TIME: 0.5

SAFETY PRECAUTIONS
1. Observe standard safety precautions.
2. Ensure high-pressure air compressor is secured while measuring oil level.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT
1. 6 oz Bottle

PROCEDURE
Preliminary
a. Ensure high-pressure air compressor is secured while measuring oil level.

1. Operate Compressor by Power.
a. Remove dipstick and measure oil level. See card D-1.
b. Operate unit and observe pressure.
c. Observe for unusual noises in unit.

2. Blow Down All Air Flasks, Separators, and Filters.
a. Open drain valves on all air flasks, separators, and filter and drain condensate.

3. Sample and Inspect Lube Oil.
a. Draw lube oil sample in sample bottle.
b. Allow sample to settle for 1/2 hour.
c. Inspect for water and sediment.

AP ZZZF CH1 84 4935

LOCATION W

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Figure 2-3.—Maintenance Requirement Card.

copies are acceptable, but a ballpoint pen must be used to ensure that all copies are legible. Instructions for filling out the feedback report are listed on the back of the form and are discussed here for the purpose of clarification.

You are required to complete the "TO" line with the appropriate (San Diego or Norfolk) address. In the "FROM" line insert the hull number of your ship (DDG 11, DD 789, AD 36, etc.); and in the "VIA" line indicate the type commander. The date will be the day you discover the discrepancy or suggest an improvement. The serial number indicates the number of feedback reports sent in by your ship. If your ship has previously forwarded ten feedback reports, the next report will be numbered 11.

The blocks concerning the system, subsystem, component, M.R. number, and the bureau card control number should be filled in with information from the appropriate MIP and/or MRC. If the MRC or MIP is missing and the bureau card control number is not available, the equipment should be identified by its name and its APL/CID or AN number. The APL/CID number identifies the parts list for the equipment and is found in the index to the Coordinated Shipboard Allowance List (COSAL). The "Technical Publications" block in the "Discrepancy" section of the report is intended to include all Naval Ship Systems Command (formerly Bureau of Ships) and Naval Ordnance Systems Command (formerly part of Bureau of Naval Weapons) publications. In the event that any of these are in error, identify the publication number, volume, revision, date, change number, page, paragraph, and/or figure.

Prior to the distribution of the report (as indicated on the original and each of the four carbon copies), check it for completeness. The discrepancy should always be explained clearly and a suggestion for its correction must always be offered.

THE MAINTENANCE DATA COLLECTION SYSTEM

The Maintenance Data Collection System is designed to provide a means of recording maintenance actions in substantial detail so that a great variety of information may be collected concerning maintenance actions and the performance of equipment involved. In addition, the system provides data concerning the initial discovery of a malfunction, how the equipment malfunctioned, how many manhours were expended, which equipment was involved, what repair parts and materials were used, what delays were incurred, the reasons for delay, and the technical specialty or work center which performed the maintenance.

Codes must be used in recording maintenance actions in order to allow converting the information to a language that can be read by automatic data processing machines. As a third or second class petty officer, you will be required to fill out various maintenance forms, using the codes listed in the Equipment Identification Code Manual (EIC Manual). The forms are sent to a data processing center where the coded information is punched into cards which are

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INSTRUCTIONS ON BACK OF GREEN PAGE

FROM: DDG - 11

SERIAL #: 125

DATE 14 APR 6-

TO: Navy Maintenace
Management Field Office
BOX STATION 604
HAMPTON ROADS BRANCH
NORFOLK, VIRGINIA 23511

VIA: COMCRUDESLANT

SUBJECT: PLANNED MAINTENANCE SYSTEM FEEDBACK REPORT

SYSTEM	COMPONENT
AUXILIARY	H.P. AIR COMPRESSOR
SUB-SYSTEM	M.R. NUMBER A-3 D-1
COMPRESSED AIR	BU. CONTROL NO. AP 22F CH1 84 4934D

DISCREPANCY

- [ ] M. R. Description
- [ ] Equipment Change
- [ ] Typographical
- [ ] Safety Precautions
- [ ] Missing Maintainance Index Page (MIP)
- [ ] Technical Publications
- [ ] Tools, Etc.
- [ ] Technical
- [ ] Miscellaneous
- [x] Missing Maintainance Requirement Card (MRC)
- [ ] Procedure

MUTILATED MAINTENANCE REQUIREMENT CARD

SIGNATURE OF C. O. OR DESIGNATED REPRESENTATIVE

Lt. J. E. Brown, U.S.N.

THIS COPY FOR: ADDRESSEE 1

OPNAV Form 4700/7 (10-65)

40.101

Figure 2-4.—Feedback Report (OPNAV 4700-7).

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Block III - General Television Servicing

Unit 1 - Television Test Instruments (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
	Signal tracing the video section of a TV receiver, using sweep generator with and without demodulation probe
Operating the vacuum tube voltmeter	Operating characteristics of a VTVM; use of zero center scale; use of high-voltage and r-f probes; reading voltage across two points, both above ground potential.
Operating the volt-ohm meter	Operating characteristics of a VOM; ohms/volt rating; circuit loading; use of r-f probe
	Use of VTVM and VOM in servicing a TV receiver; resistance reading. D C and A C readings; checking capacitors for leakage
Tube testing	Use of a tube tester in servicing and preventive maintenance
	Operation and use of CRT tester
Operating the capacitance checker	What a capacitance tester checks, and how it is used
Operating field strength meters	How a field strength meter works; relative field strength measurements; use in antenna installations
Operating wattmeter	How a wattmeter is used to measure power drain and to locate cause of excessive power drain
Operating selenium rectifier tester	Use of a selenium rectifier tester in TV servicing
	Use of an audio oscillator in TV servicing
	Test equipment preventive maintenance; periodic tests to determine performance characteristics of oscilloscope, sweep and marker generator, VTVM, and other test instruments; the service technician's standards in checking his test instruments

machine processed to produce the various reports for use in maintenance and material management.

The reports that are produced by the automatic data processing machines will be accurate and useful only if the information is clearly and accurately entered on the maintenance forms. Therefore it is very important that the codes which you enter on the forms be accurate and clearly written. All inaccurate or incomplete forms will be returned to be corrected and resubmitted.

MAINTENANCE DATA COLLECTION SYSTEM FORMS

The MDCS forms on which you may be required to make coded entries include OPNAV Form 4700-2B (Shipboard Maintenance Action), OPNAV Form 4700-2C (Work Request), and OPNAV Form 4700-2D (Deferred Action). Detailed descriptions of the entries to be made on these forms are listed in the EIC Manual and in chapter 3 of the 3-M Manual (OPNAV 43P2). Brief descriptions of these entries are also listed here to help you become familiar with the forms, which are shown in figures 2-5 through 2-8.

Block A, Ship Name and Hull No./Activity: Enter the name and hull number of your ship—for example, USS Buck (DD 761).

Block 1, Administrative Organization: Enter the 4-letter/number code (from section II of the EIC Manual) to which your ship is assigned (if your ship is assigned to DESRON 32, you would enter D320).

Block 2, Ship Accounting Number (now called Unit Identification Code, UIC): Enter the UIC number for the ship or activity for which the maintenance was performed. This entry is obtained from the NAVCOMPT Manual Volume 2, chapter 5, or the Supply Department.

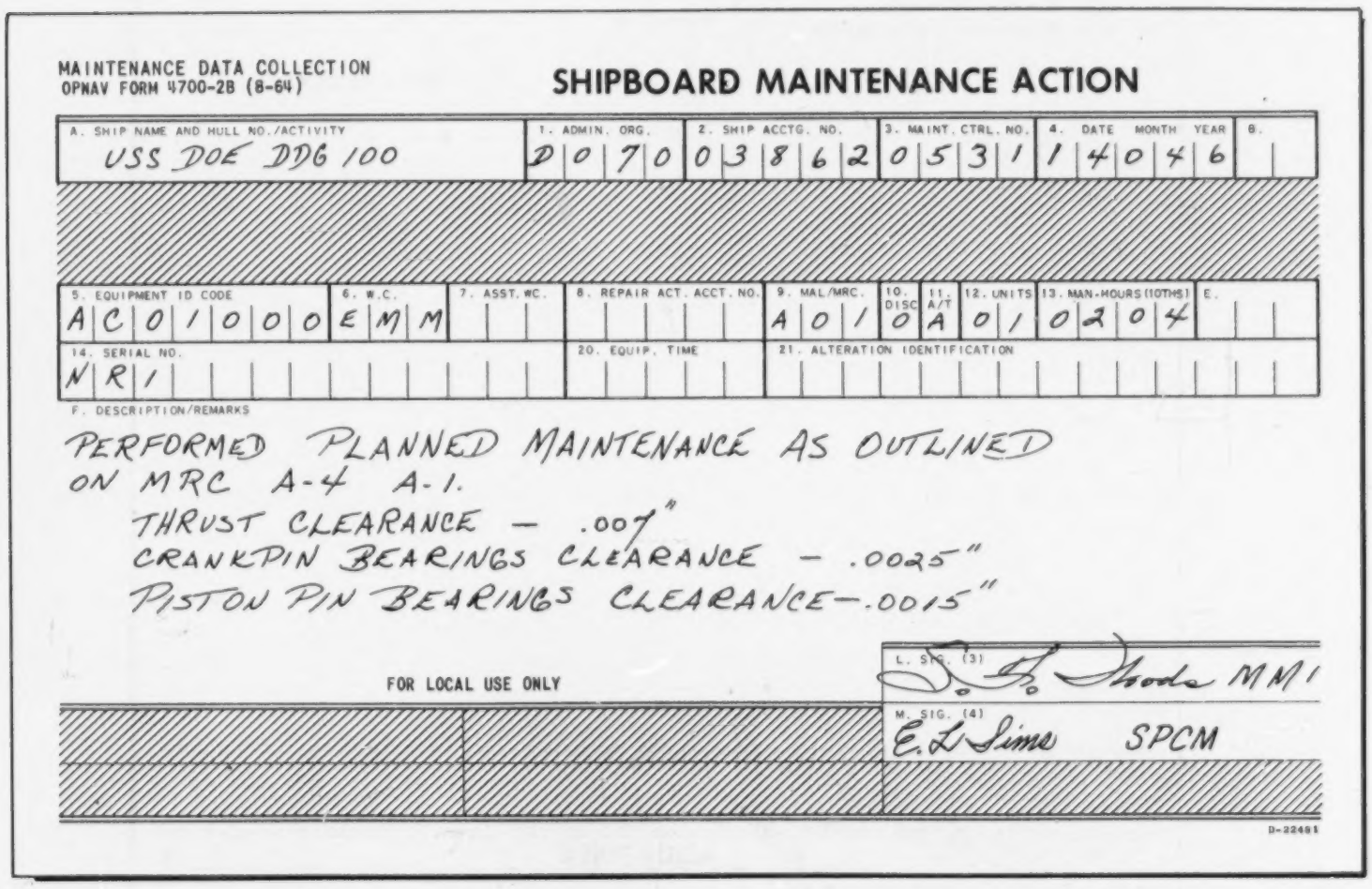

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2B (8-64)

SHIPBOARD MAINTENANCE ACTION

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE MONTH YEAR	B.
USS DOE DDG 100	D070	03862	0531	14046	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. WC.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MAN-HOURS (10THS)	E.
AC0100	EMM			A01	0	A	01	0204	

14. SERIAL NO.	20. EQUIP. TIME	21. ALTERATION IDENTIFICATION
NR1		

F. DESCRIPTION/REMARKS

PERFORMED PLANNED MAINTENANCE AS OUTLINED
ON MRC A-4 A-1.
THRUST CLEARANCE — .007"
CRANKPIN BEARINGS CLEARANCE — .0025"
PISTON PIN BEARINGS CLEARANCE—.0015"

FOR LOCAL USE ONLY

L. SIG. (3) J. J. Shoals MM1

M. SIG. (4) E. L. Sims SPCM

D-22491

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Figure 2-5.—Shipboard Maintenance Action Form (OPNAV 4700-2B).

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS DOE DDG100	D 0 7 0	0 3 8 6 2	0 4 9 9	2 9 0 3 6	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MANHOURS	E.
Z Q 0 1 0 3 0	E M M			0 2 0	G	R	0 1	0 0 0 0	

14. SERIAL NO.	20. EQUIP/TIME	21. ALTERATION IDENTIFICATION
N R 1		

F. DESCRIPTION/REMARKS
SHAFT SLEEVE ON NO. 1 MAIN CONDENSATE PUMP IS WORN EXCESSIVELY. OUTSIDE ASSISTANCE IS REQUIRED FOR REPAIR

FOR LOCAL USE ONLY

L. SIG. (3) J. D. Jones MM2
M. SIG. (4) E. L. Sims SPCM

17.81D

Figure 2-6.—Deferred Action Form, Sheet 1 (OPNAV 4700-2D).

Block 3, Maintenance Control Number: This number is used to relate all documents submitted on a specific job and is filled in by the maintenance control section of your ship before the documents leave the ship. The numbers will be assigned consecutively beginning with 0001 and ending at 9999. Upon reaching 9999 or on 1 July, the series will be started again at 0001.

Block 4, Date: Enter the day, month, and year the maintenance is accomplished; or, for a work request, enter the date the request is submitted.

Block B, Type Availability: This block is left blank on all forms except the Work Request, OPNAV Form 4700-2C. On the work request, this block will be filled in with a single-letter code, taken from section IX of the EIC Manual, to identify the type of availability in which the repair activity will perform the maintenance.

Block 5, Equipment Identification Code: Enter, from section X of the EIC Manual, the appropriate 7-letter/number code which identifies the system, subsystem, component, or part, whichever is the lowest designated assembly on which maintenance is requested or performed. Caution must be exercised to ensure that the EIC number correctly identifies the exact item on which maintenance is requested or performed.

Block 6, Work Center: Enter the 3-letter/number code from section III of the EIC Manual which identifies the department, rating, shop, or group which performs the maintenance actions on the equipment identified in the equipment identification code, block 5.

Block 7, Assisting Work Center: Leave blank. When information is required in this block it will be filled out by your supervisor in accordance with the EIC Manual and chapter 3 of the 3-M Manual.

Block 8, Repair Activity Accounting Number (now called Unit Identification Code, UIC): This

MAINTENANCE DATA COLLECTION
OPNAV 4700-2C (8-64)

WORK REQUEST 1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO	4. DATE	B.
USS DOE DDG 100	D070	03862	0499	290306	

5. EQUIPMENT ID CODE	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	12. UNITS	C.
ZQ0103 0	04638	020	G	01	

14. SERIAL NO.	15. T/A	16. REQ. W.C.	17. DESIRED CMPLN DATE	18. SERV	D.
NR1		EMM	15046	E	

F. DESCRIPTION/REMARKS

NO. 1 MAIN CONDENSATE PUMP - DE LAVAL
CID# 016160192 ALTERATION # N/A
SHAFT SLEEVE WORN EXCESSIVELY - REPLACE SHAFT SLEEVE

FOR LOCAL USE ONLY

G. NO. 1 CONTACT	J. SIG (1)
J. P. Jones MM2	E. L. Sims SPCM
H. NO. 2 CONTACT	**K. SIG (2)**
J. L. Moore MM1	Lt. J. E. Brown U.S.N.

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Figure 2-7.—Work Request (OPNAV 4700-2C).

blank will be filled in by the repair activity designated by the type commander.

Block 9, How Mal/MRC: If the action is a result of a malfunction, list the 3-digit code from section IV of the EIC Manual which best describes the trouble. If the action is a result of planned maintenance (MRC), enter a 3-letter/number combination code which identifies the frequency check on the equipment. For example, if the situation is an M-1 PMS action enter MO1.

Block 10, Discovered: Enter the appropriate code from section V of the EIC Manual which identifies the time the maintenance requirement was discovered.

Block 11, Action Taken: Enter the code from section VI of the EIC Manual which best describes the maintenance action taken. "Not Repairable This Ship" (NRTS) codes will be used only by repair activities.

Block 12, Units: Enter the number of identical items, identified in block 5, on which the same maintenance action was attempted, performed, or requested. If identical alterations or significant maintenance actions are accomplished on identical equipment bearing different serial numbers, each equipment will be reported on a separate document.

Block 13, Manhours: On completion of the maintenance action, enter the total manhours (to the nearest tenth) expended by all shipboard personnel. If the test was completed in 1 1/2 hours, for example, you would enter "0015". Enter a "0" in any space not used.

Block C, Blank: Leave blank.

Block 14, Serial Number: For detailed information on completing this particular block, see chapter 3 of the 3-M Manual. For mechanical/electrical equipment, the serial number is not required; instead, the shipboard numbering identification system will be used, followed by the abbreviated name of the equipment. For example, if block 5 identified a main

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MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 2

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS DOE DDG 100	D 0 7 0	0 3 8 6 2	0 4 9 9	1 5 0 4 6	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MANHOURS	E.
Z Q 0 1 0 3 0	E M M			0 2 0	G	M	0 1	0 1 0 2	

14. SERIAL NO.	20. EQUIP/TIME	21. ALTERATION IDENTIFICATION
N R 1		

F. DESCRIPTION/REMARKS

SHAFT SLEEVE ON NO. 1 MAIN CONDENSATE PUMP IS WORN EXCESSIVELY. OUTSIDE ASSISTANCE IS REQUIRED FOR REPAIR. RECEIVED REBUILT SHAFT FROM USS SIERRA INSTALLED SHAFT ASSEMBLY PACKED PUMP WITH 3 RINGS OF ½" 1433. PACKING BELOW LANTERN RING AND 3 RINGS OF ½" 1433 PACKING ABOVE LANTERN RING. TESTED PUMP, TEST SATISFACTORY.

FOR LOCAL USE ONLY

L. SIG. (3) J. J. Stock MM1

M. SIG. (4) E. L. Sims SPCM

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Figure 2-8.—Deferred Action Form, Sheet 2.

feed pump, and the pump in question is number 1, block 14 should contain the entry "NR 1 MNFDPMP."

Block 15, T/A: Leave blank.

Block 16, Requesting Work Center: Enter the letter/number code that identifies the department, rating, shop, or group that is requesting assistance from the repair activity. Work center codes may be found in section III of the EIC Manual.

Block 17, Desired Completion Date: Enter the 5-number code that identifies the day, month, and year that the outside repair activity must complete maintenance in order for the requesting activity to meet its operational commitments. If this date were 9 March 1966, for example, you would enter 09036.

Block 18, Service: Enter the single-letter code from section VII of the EIC Manual which identifies the type of assistance the requesting ship will furnish the repair activity in completing the requested maintenance.

Block 19, Scheduled Start Date: This entry, which is for repair activities only, is the estimated starting date of the requested maintenance.

Block D, Blank: Leave blank.

Blocks E and 20, Equipment Downtime and Equipment Operating Time: These entries are required only for equipment identified by green pages in the EIC Manual. Detailed instructions for these blocks may be found in section I of the EIC Manual and chapter 3 of the 3-M Manual.

Block 21, Alteration Identification: If an alteration is to be accomplished, this block will contain the alteration identification from the authorization directive.

The Shipboard Maintenance Action Form (OPNAV 4700-2B) is a single-sheet document used to record the completion of planned

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maintenance actions, corrective maintenance actions, and authorized alterations that have been performed at the shipboard level by shipboard personnel. All planned maintenance actions except daily and weekly planned maintenance actions must be recorded on this form in addition to checking them off on the weekly and quarterly schedules. Routine preservation such as chipping, painting, and cleaning should not be reported.

The weekly schedule shown in figure 2-2 reflects that WOODS and SMITH completed maintenance requirement A-4 A-1 on Wednesday. Figure 2-5 shows the Shipboard Maintenance Action form which WOODS completed for this maintenance requirement. Note that, in addition to giving the date (14 Apr 1966), the manhours (20.4), and the proper codes taken from the EIC Manual, WOODS has given a brief description of the maintenance performed (in block F) and has signed the form. His leading petty officer has signed the form to indicate the information is complete and accurate.

Any corrective maintenance actions that are deferred because of the ship's operations, lack of repair parts, or the requirement of outside assistance are reported on the Deferred Action Form (OPNAV 4700-2D). The first sheet of this 2-sheet document is used to record and report the reason for deferral and the second sheet is used to report the completion of the maintenance action. If a corrective maintenance action must be deferred, this form is required at the time a malfunction is noted. A sample sheet 1 of the Deferred Action Form is shown in figure 2-6. The action taken code, block 11, and the manhours expended, block 13, on sheet 1 of the Deferred Action Form apply only to the action taken and manhours involved at the time of the discovery of the malfunction. Some manhours must be expended, if only for investigation.

Figure 2-7 shows a Work Request (OPNAV 4700-2C) to have the part repaired for the deferred corrective maintenance action (fig. 2-6). In completing block F (Description/Remarks) of the work request, note that:

1. The component must be identified by name.
2. The CID number of the component must be listed.
3. The alteration number must be given, if applicable. If not applicable (N/A), it must be so indicated (see fig. 2-7).
4. A description of what is wrong with the equipment and what you desire the repair activity to do must be given.
5. Additional information as requested by the type commander.

The signature blocks G, H, and J are to be signed by three leading petty officers, one from each duty section, who are familiar with the work to be done by the repair activity. Signature block K will be used by the commanding officer or his authorized representative to indicate command approval of the request for repair assistance.

After the repaired part is received from the repair activity and installed, the carbon (sheet 2) of the Deferred Action Form (fig. 2-8) is completed by inserting the date of completion in block 4, a new action taken code in block 11, the additional manhours in block 13, and appropriate remarks in block F. The form is then signed by the man doing the work and by his supervisor, and is then submitted to the data processing center.

The information contained in blocks A, 1 and 2 of OPNAV Forms 4700-2B, 4700-2C, and 4700-2D will be identical on all forms for any particular ship; if desired, this information may be preprinted in by the ship. Each maintenance action is assigned its own unique maintenance control number; if a maintenance task requires more than one form, as in the example using figures 2-6 through 2-8, the numbers will be identical.

MATERIAL USAGE AND COST DATA

The documentation of material usage and cost data on maintenance transactions requires the joint effort of the supply and maintenance personnel on board your ship. Economy of effort and the elimination of duplicate recording are highly desirable.

Any time that repair parts or materials are drawn from the supply department for shipboard maintenance, a NAVSANDA form is used to request the materials from supply. Maintenance personnel are required to furnish the work center code and the EIC taken from the EIC Manual, the CID number, the maintenance control number, the name of the part, the quantity required, and the stock number when submitting this form to the supply department. The supply

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personnel will then complete the form. If the ship does not have data processing equipment aboard, NAVSANDA Form 1250 is used, and cost is documented from that form. If the ship has data processing equipment, a DD Form 1348 is used.

When the material to support a maintenance action is obtained from outside the normal supply channels or from pre-expended material bins, the reverse side of the appropriate OPNAV 4700 is used. The reverse sides of OPNAV 4700 series forms are essentially the same. The reverse side of OPNAV Form 4700-2B is shown in figure 2-9. On this side of the form, when appropriate, you will enter the CID number, the source code taken from section VIII of the EIC Manual, the cognizance symbol taken from supply publications to identify the supply account and the inventory manager of the item used, the Federal Stock Number, the reference symbol taken from circuit diagrams or the name of the part being replaced, the unit of issue of the material used, the quantity used, and the unit cost of the item.

CID/APL/AEL/AN
55376101

SOURCE CODE	COG.	FEDERAL STOCK NO./PART NO.	REFERENCE SYMBOL/NOUN	MATERIAL REQ. UNITS	MATERIAL REQ. QUANTITY	MATERIAL USED UNITS	MATERIAL USED QUANTITY	UNIT PRICE
1	IN	5905-258-0034	R 1445			EA	2	.38

OPNAV FORM 4700-2B (8-64) BACK

17.81 BCD

Figure 2-9.—Reverse side of OPNAV 4700-2B.

CHAPTER 3

STEAM TURBINES

Steam turbines are used for ship propulsion and for driving many of the auxiliary machinery units associated with the propulsion plant, such as lubricating oil pumps, condensate pumps, feed pumps, circulating pumps, fuel oil pumps, forced draft blowers, and ship's service generators.

As an MM3 or MM2, you will need a great deal of general information about propulsion plants and associated auxiliary machinery, and you will need specific information about the operation of the propulsion machinery installed in your ship.

In this chapter we will discuss in detail the main and auxiliary steam turbines from the standpoint of basic design features and operating principles. In addition, we will consider briefly the various unit or component parts, controls, and accessories of turbines used in the Navy. Turbogenerator operation and turbine maintenance are also covered in this chapter.

Additional information dealing with typical propulsion units (geared-turbine drive, turbine electric drive, and diesel engine drive), and the classification and construction of steam turbines can be obtained from Fireman, NavPers 10520-C.

STEAM TURBINE CLASSIFICATIONS

Turbine types, whether used for main propulsion power or to drive auxiliary machinery, may be classified in four ways by the:

1. Manner in which the steam causes the turbine rotor to rotate.
2. Type of staging and compounding of steam pressure and velocity.
3. Division of the steam flow.
4. Direction of the steam flow.

Under each of these classifications, there are several types of turbines, some of which are described briefly in the following paragraphs. After reading these descriptions and studying the accompanying illustrations, you should be able to classify in a number of different ways every turbine used by the Navy. A fifth method of classification, repetition of steam flow (including single entry, single re-entry, and double re-entry type turbines) is also used on some naval ships.

BY IMPULSE AND REACTION PRINCIPLES

The basic distinction made between turbines has to do with the manner in which the steam causes the turbine rotor to move. When the rotor is moved by a push or "impulse" from a high velocity jet of steam that strikes blades mounted on the periphery of a wheel, the turbine is said to be an IMPULSE TURBINE. When the rotor is moved by the force of reaction, the turbine is said to be a REACTION TURBINE.

The angle at which the steam hits the moving blades and the shape of the moving blades are the two main factors which determine whether the rotor is moved by a direct impulse or by reaction to an impulse. Figure 3-1 shows the nozzle and blade arrangement in an impulse turbine. Figure 3-2 shows the fixed blades and the moving blades in a reaction turbine.

Impulse Turbines

In the impulse turbine, the steam expands through stationary nozzles only and so loses pressure but gains velocity. In the moving blades, the steam loses velocity but the pressure remains constant. Actually, an impulse turbine utilizes both the impulse of the steam jet and, to a lesser extent, the reactive force

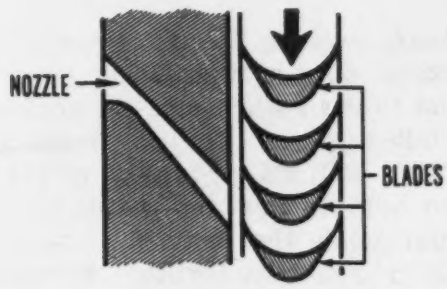

38.77x

Figure 3-1.—Impulse turbine nozzle and blades.

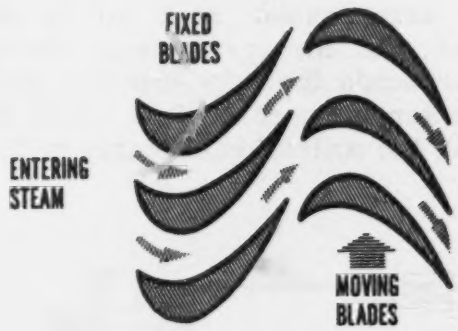

38.77x

Figure 3-2.—Fixed and moving blades in a reaction turbine.

which results from the fact that the curving blades cause the steam to change its direction.

Reaction Turbines

In the reaction turbine, the steam enters through a row of fixed blades which expand and direct the flow of steam to the moving blades. As you can see in figure 3-2, the fixed blades and the moving blades are very similar in shape. Steam expansion takes place in both sets of the blades.

A reaction turbine is moved by (1) the reactive force produced on the moving blades when the steam increases in velocity, and (2) the reactive force produced on the moving blades when the steam changes direction. However, some of the motion of the rotor is actually caused by the impact of the steam on the blades; and, to a certain extent, therefore, the reaction turbine operates on the impulse principle as well as on the reaction principle.

Basic Differences Between Impulse and Reaction Turbines

Now let us take time to compare the basic differences between impulse- and reaction-turbine blading. No matter what the number of fixed and moving blade rows in an impulse turbine, the pressure remains the same throughout the blading of each stage.

In the reaction turbine, the steam pressure decreases in every row of fixed and moving blades. There are no nozzles in the reaction turbine; the fixed blades serve the same purpose as the nozzles of an impulse turbine.

BY STAGING AND COMPOUNDING

The information in this section is supplementary to that given in Fireman, NavPers 10520-C. Simple impulse turbines, which are single stage units, have the advantage of being simple in design and construction. They are often used for small auxiliary units. The simple impulse stage is usually called a RATEAU STAGE.

The velocity-compounded impulse turbine, which has two rows of moving blades, has only one pressure drop and therefore, by definition, only one stage. This type of velocity-compounded impulse stage is usually called a CURTIS STAGE. Many of the auxiliary turbines used for pumps and forced draft blowers consist of one CURTIS STAGE.

(Velocity-compounding can also be achieved when only one row of moving blades is used, provided the steam is directed in such a way that it passes through the blades more than once. This point will be taken up in greater detail in the discussion of types of steam flow.)

A pressure-compounded impulse turbine is often called a RATEAU TURBINE, since it is essentially a series of simple impulse (Rateau) stages arranged in sequence in one casing. Pressure compounded impulse turbines are not commonly used for small auxiliary units.

The COMBINATION IMPULSE AND REACTION TURBINE employs a velocity-compounded impulse (Curtis) stage at the high pressure end of the turbine. This effects large temperature and pressure drops in the first-stage nozzles, as well as a high initial utilization of thermal energy. It also enables the remaining pressure-compounded reaction stages of the turbine to work more efficiently and with less tendency to distortion in the

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turbine parts. Figure 3-3 illustrates diagrammatically the design of this type of turbine, which is often referred to as a MODIFIED PARSONS TURBINE.

BY DIVISION OF STEAM FLOW

The next classification of turbines concerns the number and type of divisions in the steam flow through the several elements which comprise the complete turbine. The turbine types under this classification include single-flow turbines, cross-compounded turbines, and double-flow turbines.

Single-Flow Turbines

In single-flow turbines, the steam enters at the inlet or throttle end, flows once through the blading in a line approximately parallel to the rotor or shaft, and emerges at the exhaust end of the turbine. Figure 3-4 illustrates this type of turbine.

The steam passing through a multistage impulse turbine does not exert any appreciable axial thrust to the rotor since the pressure drop actually takes place in the nozzles. The EQUALIZING HOLES provided in the turbine wheel also help to prevent the development of axial thrust upon the individual wheel of the rotor. In a reaction turbine, however, considerable axial thrust does result from the steam pressure drop since the pressure drop occurs in the moving blades as well as in the stationary blades. In single-flow reaction turbines, this axial thrust is partially counterbalanced by use of a dummy piston and dummy cylinder arrangement such as is shown in figure 3-5. In this arrangement, the space A, which surrounds the inlet end face area of the turbine rotor, is connected to space B, which surrounds the outlet face end area of the rotor,

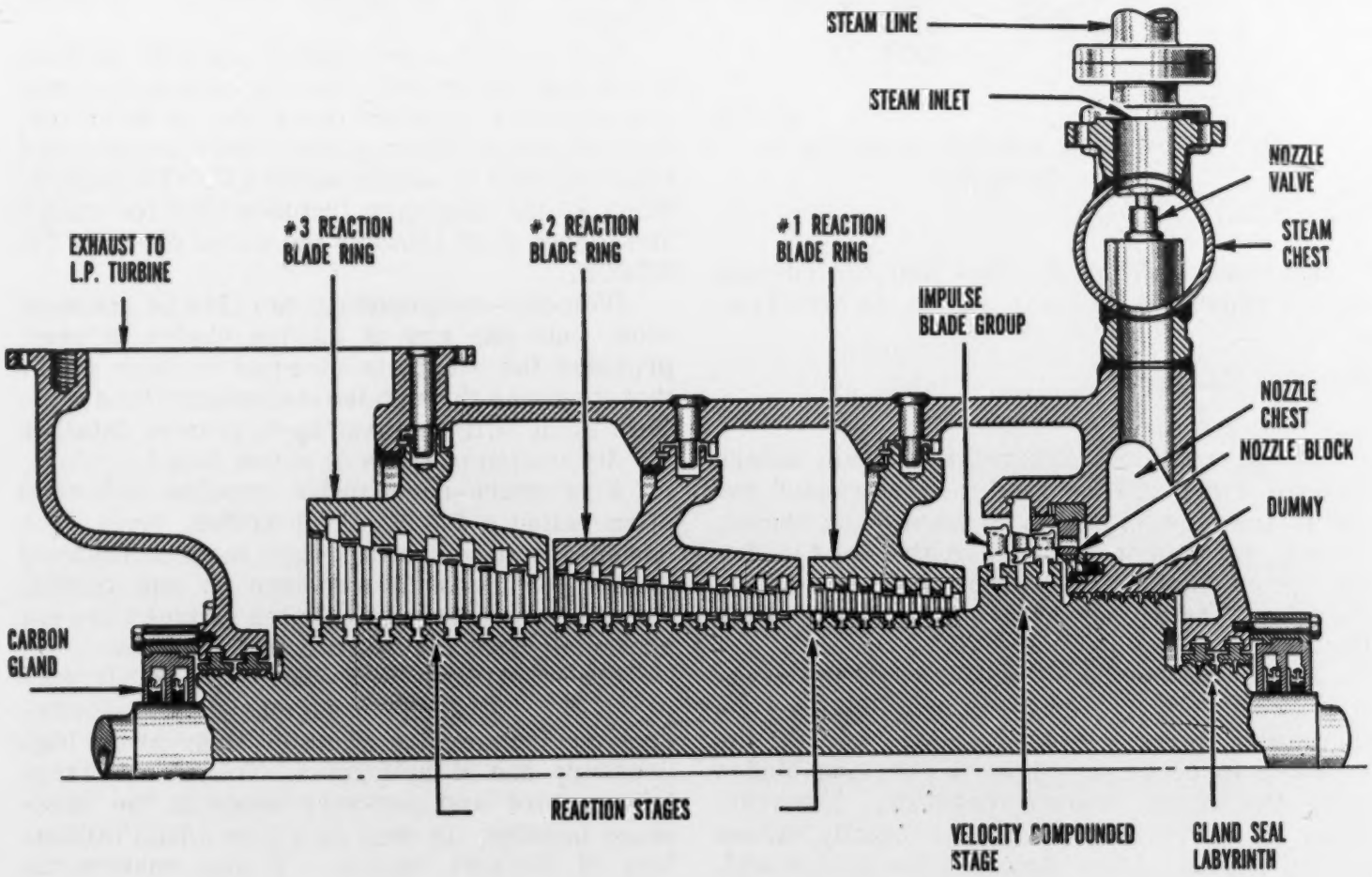

47.3x

Figure 3-3.—Combination impulse and reaction turbine.

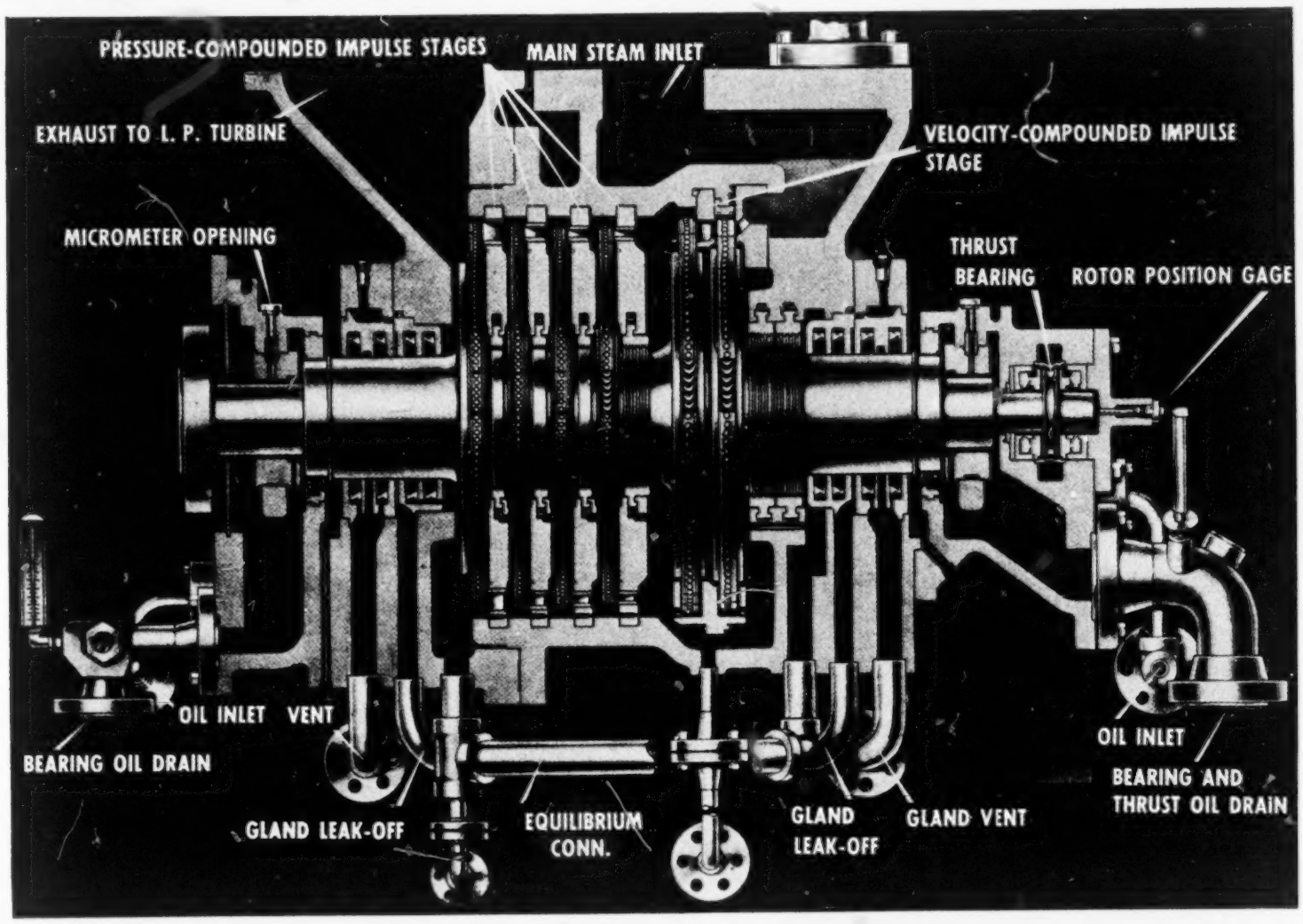

47.4

Figure 3-4.—Single-flow pressure velocity compounded impulse turbine.

by an equalizing pipe. The dummy piston and cylinder which form a close running sealing surface serve to prevent the entry of large amounts of steam from the inlet passage into space A. (The difference in steam pressure across the dummy causes a thrust toward the high pressure end of the turbine, partially counterbalancing the thrust in the opposite direction caused by the pressure drop in the rotor blading.)

In some types of combination impulse and reacting turbines, as for example figure 3-3, a dummy piston and dummy cylinder arrangement similar to the one just described was used to help offset the axial thrust effect caused by the reaction blading of the turbine. In reaction turbines of the double-flow type, which are discussed later in this chapter, the dummy piston and cylinder are not necessary since the axial thrusts developed at each end counterbalance each other.

Compound Turbine Units

In turbine units of small or moderate power, complete expansion of the steam, and resultant utilization of the latent energy, can be provided for in a single casing. For greater power requirements, however, this type of turbine would require casings and rotors of such great size as to create serious difficulties in construction. The weights of these parts would also be so great that required assembly and disassembly for inspection and overhaul would be very difficult.

12285

Block III - General Television Servicing

Unit 2 - Television Circuit Construction and Analysis

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Construction and analysis of:	
RF amplifiers	Comparisons between audio and video RF amplifiers
Straight impedance coupling	Qualities of impedance coupling
Grounded grid circuit	Advantages of grounded grid circuit
Balanced amplifier circuit	Typical balanced amplifier circuits
Mixer circuits	How signals are combined
Oscillator circuits	Uses of oscillator circuits
Picture IF amplifier	The stagger-tuned video IF amplifier
Video detector	Principle of operation of video detectors
Sound IF section and detector	Function of the IF section
Intercarrier system	The elimination of sound IF stage
Video voltage amplifier	Comparison with audio amplifiers, loss response, phase distortion, phase response
Video power amplifier	
Video amplifier section	Gain of video amplifiers
Sync-separator section	Synchronization action
Sweep circuit	Magnetic deflection amplifiers Linearity and size control

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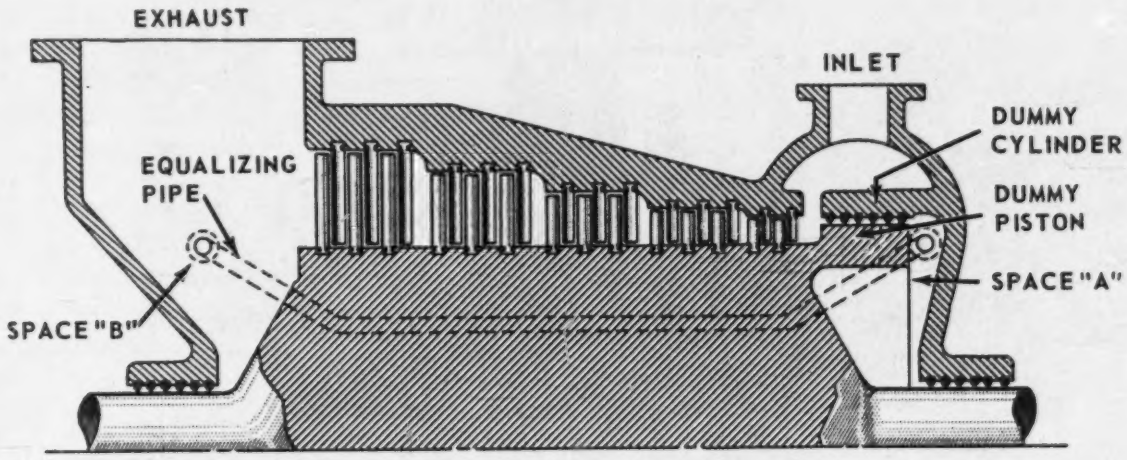

47.5x

Figure 3-5.—Dummy piston and dummy cylinder.

High-power geared turbine installations are, therefore, generally built as compound turbine units. In this type, the steam is partially expanded in a HIGH PRESSURE TURBINE (enclosed in a casing of its own), and then exhausted, through a crossover pipe, to a LOW PRESSURE TURBINE where the expansion is completed. The energy-depleted steam is then exhausted to the main condenser. In some instances, a CRUISING TURBINE precedes the high pressure turbine. This turbine is operated over the cruising range and may be bypassed at higher powers or speeds.

In more recent designs, a series-parallel turbine is being used. It consists of a single high pressure-intermediate pressure rotor and casing, and a conventional low pressure unit. The high pressure-intermediate pressure steam chest and nozzle control valves are arranged so that steam is admitted only to the high pressure element for speeds in the cruising range. The steam then passes through an external pipe to the intermediate pressure element and is exhausted to the low pressure unit. For this condition, the turbine is said to be operating in series. For speeds in excess of the cruising range, main steam is admitted to both the high pressure and intermediate pressure elements, and the turbine is operating in parallel. Both the high pressure and intermediate pressure elements exhaust to the low pressure element.

There were originally two general types of compound turbine units in use—the cross-compound and the tandem-compound—but the cross-compound type is the only one now used in the Navy. In these CROSS-COMPOUND TURBINE installations (fig. 3-6), the high and low pressure units are on separate shafts. The two turbine shafts are connected, through reduction gears, to a common shaft which drives the ship's propeller.

CRUISING TURBINES are similar in design to the high pressure turbines, except that the cruising turbines are smaller in size. When cruising turbines are in use, steam passes first through the cruising turbine before going to the high pressure turbine (part A of fig. 3-7). In this way, the steam is expanded through a greater number of pressure stages. This extracts more energy from the steam than is possible by use of the high pressure and low pressure turbines. When speeds in excess of the cruising turbine's range are desired or anticipated, the steam is led directly to the high pressure turbine, bypassing the cruising turbine, as shown in part B of figure 3-7. Cooling steam is supplied to the cruising turbine from the high pressure turbine to prevent damage from overheating caused by friction of rotation. Reduction gears and shafting are used to connect the high pressure turbine and the cruising turbine.

Steam should not be admitted to the backing or astern turbine while steam is being admitted to the ahead turbines. (See part C of fig. 3-7.) Steam may be admitted to an astern turbine when a ship is going ahead at any time it is desired to slow, stop, or back the ship, providing the ahead throttle is closed. Astern turbines may be either single-flow or double-flow impulse turbines, and they develop about one-fifth to

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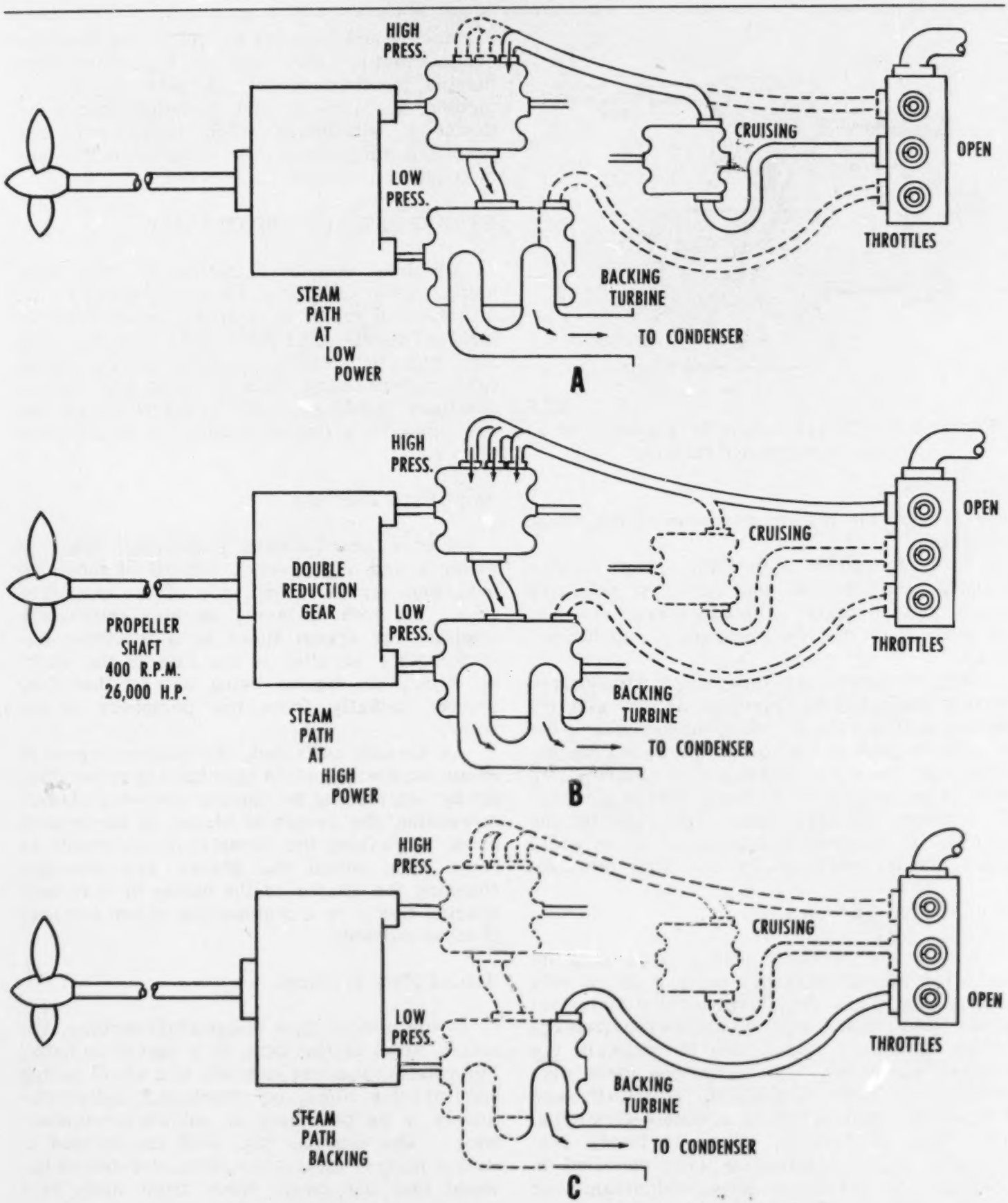

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Figure 3-7.—Schematic diagrams showing steam flow to cruising, high pressure, and astern turbines.

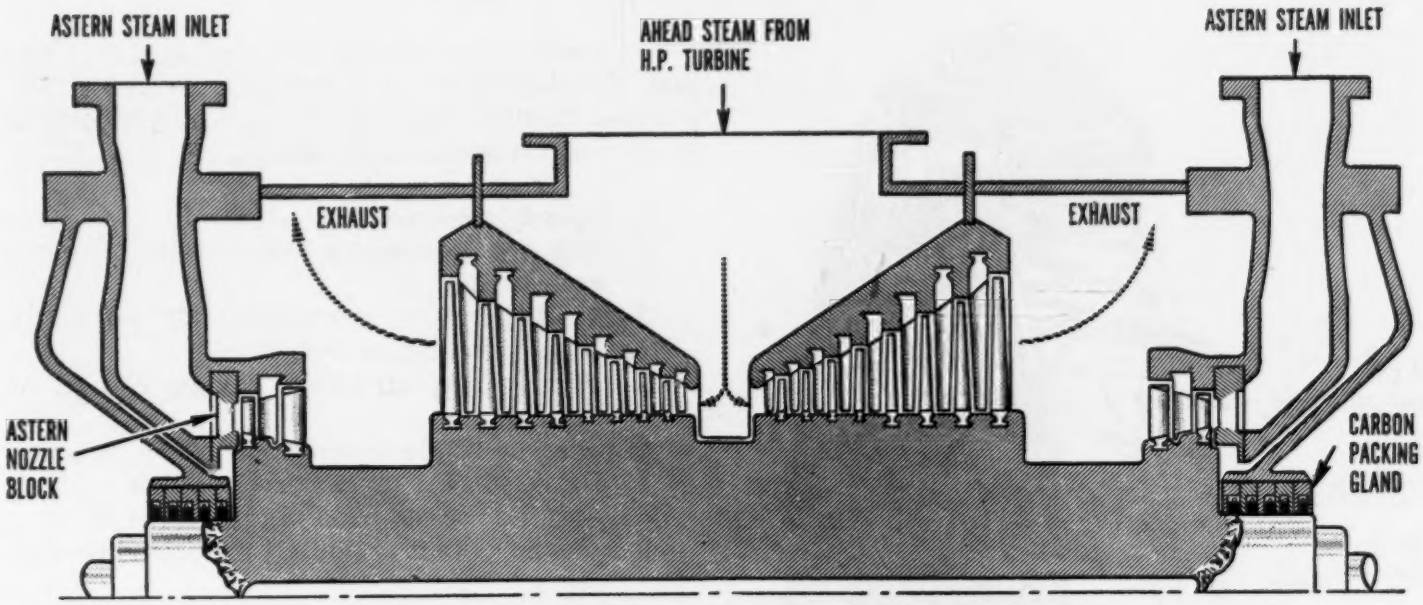

47.8x

Figure 3-8.—Low pressure double-flow reaction turbine.

the wheel. The moving buckets are so shaped that the direction of the steam flow is reversed within them, and the steam is sent back out of the side opposite from where it entered.

The steam coming out of the moving buckets is caught in stationary buckets or REVERSING CHAMBERS, where its direction is again reversed and the steam flows back through the moving buckets. This reversing and redirecting process is repeated several times, after which the steam passes out through the exhaust opening.

A nozzle and the accompanying set of fixed redirecting buckets or reversing chambers are cast or welded in one place. Up to the limit imposed by the circumference of the wheel, any number of these nozzle and bucket sets may be installed. Since the only drop in pressure occurs in the nozzle, this turbine is a single-stage, velocity-compounded, impulse turbine.

This type of turbine is built only in small units, up to a few hundred horsepower, and is used for driving such auxiliary machinery as pumps and forced draft blowers. It has reasonably high efficiency over a wide range of speeds, and is especially adapted to units requiring large speed variations in normal operation.

AUXILIARY STEAM TURBINES

The preceding portions of this chapter have described the general principles and construction features of the various types of turbines in use by the Navy, with particular (though not exclusive) emphasis on the larger types of turbines used for main propulsion. There are, of course, a considerable number of small turbines employed in all naval engineering plants for driving auxiliary machinery such as generators, pumps, air compressors, and forced draft blowers.

Most auxiliary machinery units outside the engineering spaces on modern naval ships, and many units within these spaces, are driven by electric motors. For example, the usual practice is to duplicate some turbine-driven pumps with electrically driven units to be used at cruising speeds and in port. These motor-driven pumps have a comparatively high efficiency, but on some ships their capacity is not great enough to meet the demands of the engineering plant at high speeds.

EFFICIENCY OF AUXILIARY TURBINES

Turbine-driven units (particularly pumps) have a higher capacity than the motor-driven units. Two additional reasons for employing turbines to drive the auxiliary machinery are as follows:

1. Turbines ensure greater reliability than motor-driven units. The possibility of interruption or loss of electric power supply is greater

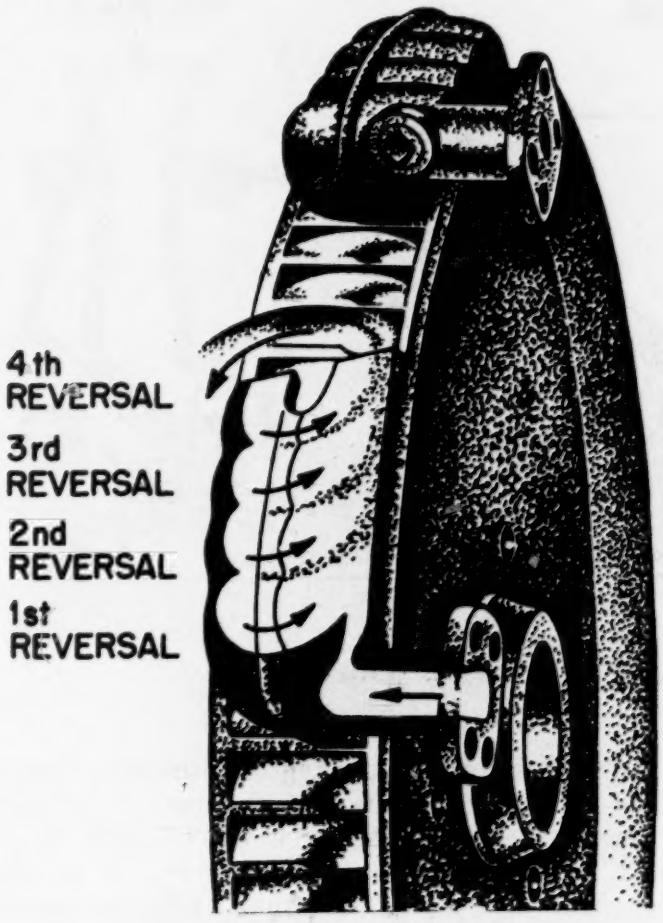

47.18x

Figure 3-9.—Phantom view of steam path in a Sturtevant helical flow turbine.

than the possibility of loss of steam supply—especially during General Quarters and special details.

2. Turbines improve the over-all efficiency of the plant by supplying exhaust steam for such auxiliary machinery units as deaerating feed tanks and evaporators, where low pressure is required.

The efficiency of most auxiliary turbines is increased with the use of reduction gears. Those turbines are designed to have comparatively few stages (sometimes only one), to conserve space. This results in a large pressure drop in each stage, and a high steam velocity. To obtain maximum efficiency, the blade speed must also be high. Hence, the reduction gears reconcile the two conflicting speed requirements, and increase the general efficiency.

AUXILIARY TURBINE CLASSIFICATION

In general, auxiliary turbines in naval use may be classified (in a manner similar to the general turbine type classifications) according to the following characteristics.

1. Speed (constant or variable).
2. Exhaust conditions (condensing or non-condensing).
3. Shaft position (horizontal or vertical).
4. Type (impulse or reaction).
5. Steam flow direction (axial, radial, or helical).
6. Stages (single or multiple).
7. Drive (direct or geared).
8. Service (based upon driven auxiliary).
9. Power output capacity, limiting speeds, etc.

Except for turbine-driven electric generators, the auxiliary turbines are usually impulse turbines of either the helical-flow or axial-flow type. They operate against a back pressure of approximately 15 psig, depending upon the auxiliary exhaust line operating pressure of the ship in which installed. In later ships, this back pressure is 15-17 psi. Turbines for driving the ship's service generators are ordinarily of the impulse, axial-flow, multistage, geared type.

USES OF AUXILIARY TURBINES

Since the various types of turbines were discussed in the earlier part of this chapter, it is unnecessary to explain in detail construction of the various auxiliary turbines utilized to drive the numerous pumps in the engineering spaces of your ship. The principal pumps driven by the auxiliary turbines, however, include the main condensate pumps, main condenser circulating pumps, main feed pumps, main feed booster pumps, main fuel oil service pumps and forced draft blowers.

Main Condensate Pump Turbines

On some ships the turbines driving the main condensate, main feed booster, and the lube oil service pumps are identical. The bucket wheels (turbine wheels) and many other parts such as governors, bearings, and turbine and gear casings are interchangeable. Figure 3-10 shows the wheel and blading diagram of a turbine used to drive the main condensate, main feed

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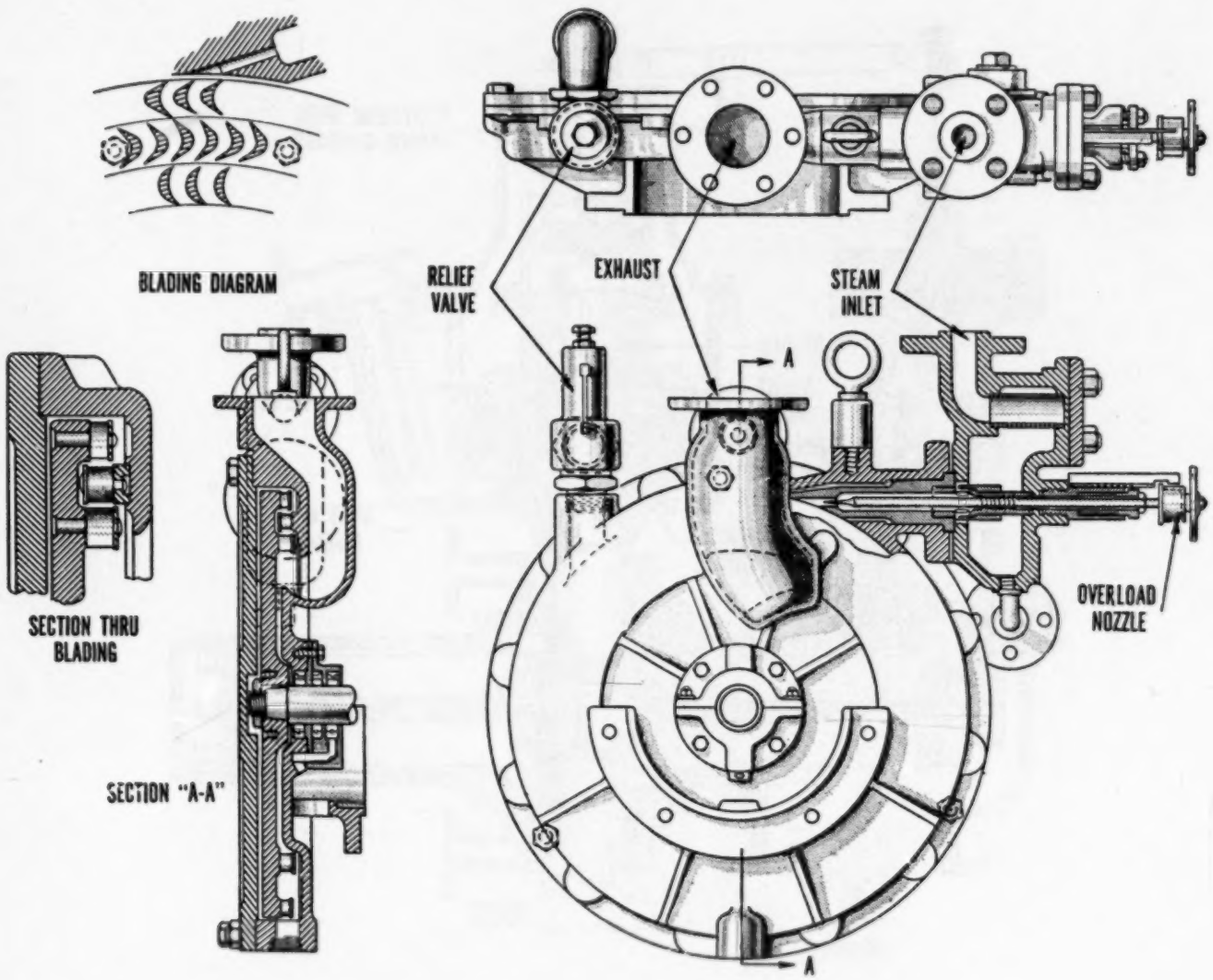

47.9

Figure 3-10.—Main lube oil pump turbine.

booster, and lube oil service pumps on a DD-692 class destroyer. These turbines are single pressure stage, radial flow single entry turbines. Although destroyers and other ships have changed radically since World War II, the basic design of these turbines has changed little. Improved metals are used, however, to withstand the higher pressures and temperatures of steam on modern warships.

Main Condenser Circulating Pump Turbine

Figure 3-11 shows a vertically mounted, single stage, axial flow, velocity compounded, impulse unit. The turbine shaft is coupled to the vertical shaft of the pump. A thrust bearing, mounted integrally with the upper main bearing, carries the weight of the rotating element, and absorbs any unbalanced downward thrust. A throttle valve and a double-seated balanced inlet valve (normally held wide open by governor mechanism) let the steam into the turbine.

Generator Turbines

Figure 3-12 shows a turbine used to drive a 400-kilowatt a-c, 50-kilowatt, d-c, generator. The turbine is an axial flow, pressure compounded, impulse type. It exhausts to a separate auxiliary condenser having its own circulating and condensate pumps and air ejector. Cooling water for the condenser is provided by the auxiliary circulating pump, through separate injection and overboard valves. On some ships

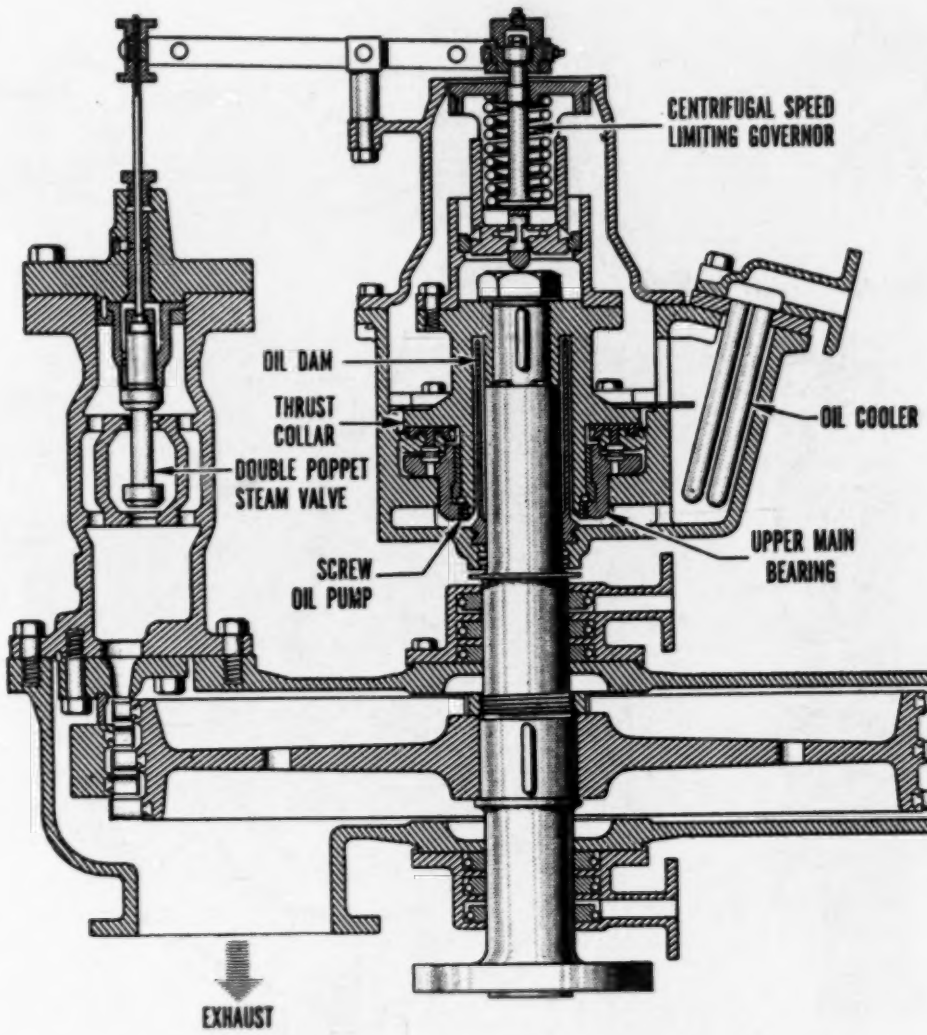

47.10

Figure 3-11.—Main condenser circulating pump turbine.

when a casualty to the auxiliary condenser occurs, the turbine may exhaust to the main condenser, while the main plant is in operation.

A relief valve is always installed on the turbine exhaust casing to relieve excess pressures which would build up within the turbine casing if for some reason the exhaust valve should be inadvertently closed or a loss of vacuum should occur.

The turbine is so designed that it can operate on either saturated or superheated steam at a pressure of 525 psi, and at a maximum temperature of 825° F at the throttle. On most ships provision is made for supplying steam to the turbine from either the main steam line (superheated) while underway, or the auxiliary steam line (saturated) during in-port operation, when the main engines and main steam lines are secured. The steam is admitted to the turbine through a throttle trip valve to the steam chest—the speed being regulated by a number of nozzle control valves under the control of a governor. This type of control is explained in a later section of this chapter.

There are so many variations of generator turbines that it is necessary to consult the manufacturer's technical manual for details of construction, operation, and maintenance of any specific unit.

TURBINE PARTS

Now that you are familiar with the variety and diversity of turbines used in the Navy, the component parts, controls, and accessories of these turbines will be covered briefly in the

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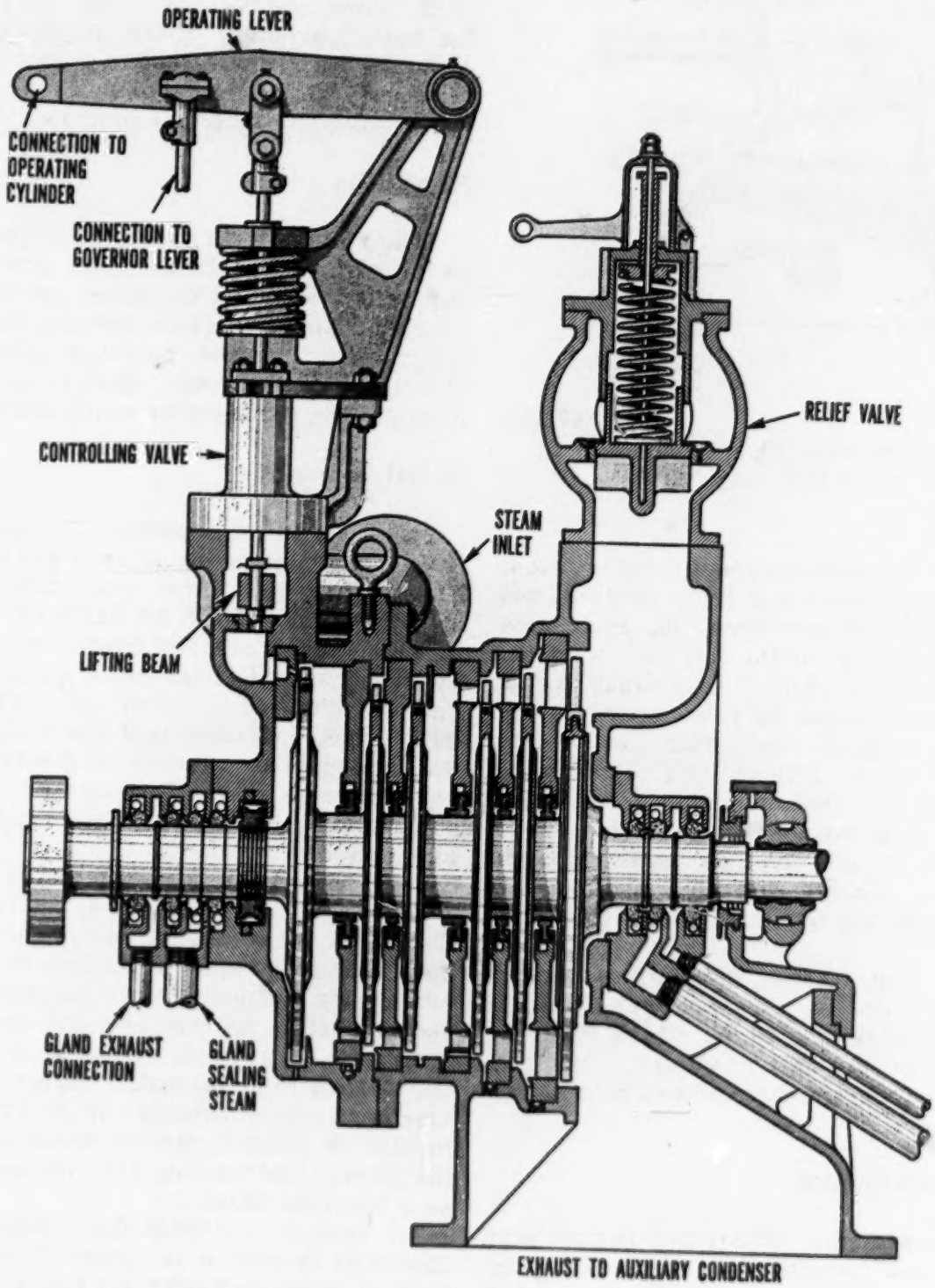

Figure 3-12.—Ship's service generator turbine. 47.11x

sections which follow. At this point, however, it should be noted that the information which follows is supplementary to that given in Fireman, NavPers 10520-C.

Foundations, casings, nozzles, wheels and rotors, blading, bearings, shaft glands, and gland seals are turbine parts common to impulse and reaction turbines.

The forward end of a turbine may be secured to a deep FLEXIBLE I-BEAM (fig. 3-13) installed with its axis lying athwartship. When the turbine is operating at maximum power this

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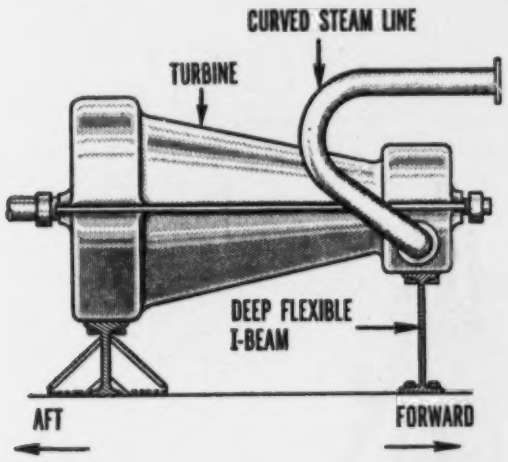

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Figure 3-13.—Turbine foundation, showing flexible I-beam.

I-beam stands in a vertical undeflected position. When the turbine operates at lower powers, and therefore lower temperatures, the I-beam is deflected slightly aft of the vertical position. The fixed end of the turbine is aft, so that motion due to expansion cannot be transmitted to the reduction gears, where distortion and serious damage would result. STEAM LINES connected to the turbines are bent (as shown in fig. 3-13) to allow for expansion of the steam line and to relieve strain on the turbines resulting from thermostress. Corrugated pipe sections or expansion joints are sometimes used for these bends.

On most modern ships, the main condenser is supported by the low pressure turbine which is rigidly mounted on beams which form an integral part of the hull structure. In other ships, the low pressure turbine may be mounted on the condenser.

NOZZLE DIAPHRAGMS

Nozzle diaphragms, illustrated in part A of figure 3-14, are installed ahead of the rotating blades of each stage of a pressure-compounded impulse turbine. These contain the nozzles and admit steam to the rotating blades of each stage in much the same way as the nozzle groups of the first stage. Some nozzle diaphragms, however, have nozzles extending around the entire circle of blades. The pressure drop existing across each diaphragm necessitates the installation of a packing seal to minimize the flow of steam between the diaphragm and the rotor. For this purpose a labyrinth packing ring, similar to the shaft gland packing, is placed in a groove in the inner periphery of the diaphragm. Part B of figure 3-14 illustrates the placement of these rings which are installed in sections and are spring-backed to effect a good seal.

BEARINGS

The rotor of every turbine must be positioned radially and axially by bearings. Radial bearings carry the weight of the rotor, and maintain the correct radial clearance between the rotor and the casing. Thrust bearings limit the axial movement of the rotor. Both types are briefly discussed in the sections which follow.

Radial Bearings

Most turbines, including all main turbines, have a radial bearing at each end of the rotor. These bearings are generally known as JOURNAL BEARINGS or SLEEVE BEARINGS, of which there are two types: cylindrical, and spherical seated. Some small auxiliary turbines employ what are known as ANTIFRICTION BEARINGS, including ball and roller bearings. This discussion, however, is limited to friction type bearings, where two metallic surfaces are separated by and depend upon a fluid oil-film for lubrication.

The effectiveness of this FLUID FILM LUBRICATION, as illustrated and explained in Chapter 9, "Lubrication and Associated Equipment," depends upon a number of factors: the lubricant's properties of cohesion, adhesion, and viscosity; its temperature; as well as the clearance, alignment, and surface condition of the bearing and journal. Except for the momentary metal-to-metal contact at the time the turbine is started, the two metallic surfaces of the journal and bearing are constantly separated by a thin film of oil.

A typical CYLINDRICAL BEARING is illustrated in part A of figure 3-15. The shell is lined with BABBITT METAL (a composition of tin, copper, and antimony), which is characterized by a tendency to quickly dissipate the friction heat and transfer it to the lubricating oil. A dowel keeps the sleeve from turning. The BEARING CAP, or upper half of the bearing housing, is bolted securely to the lower half of the bearing housing. The bolts are not shown.

The ADJUSTABLE SPHERICAL-SEATED SELF-ALIGNING BEARING (part B of fig. 3-15)

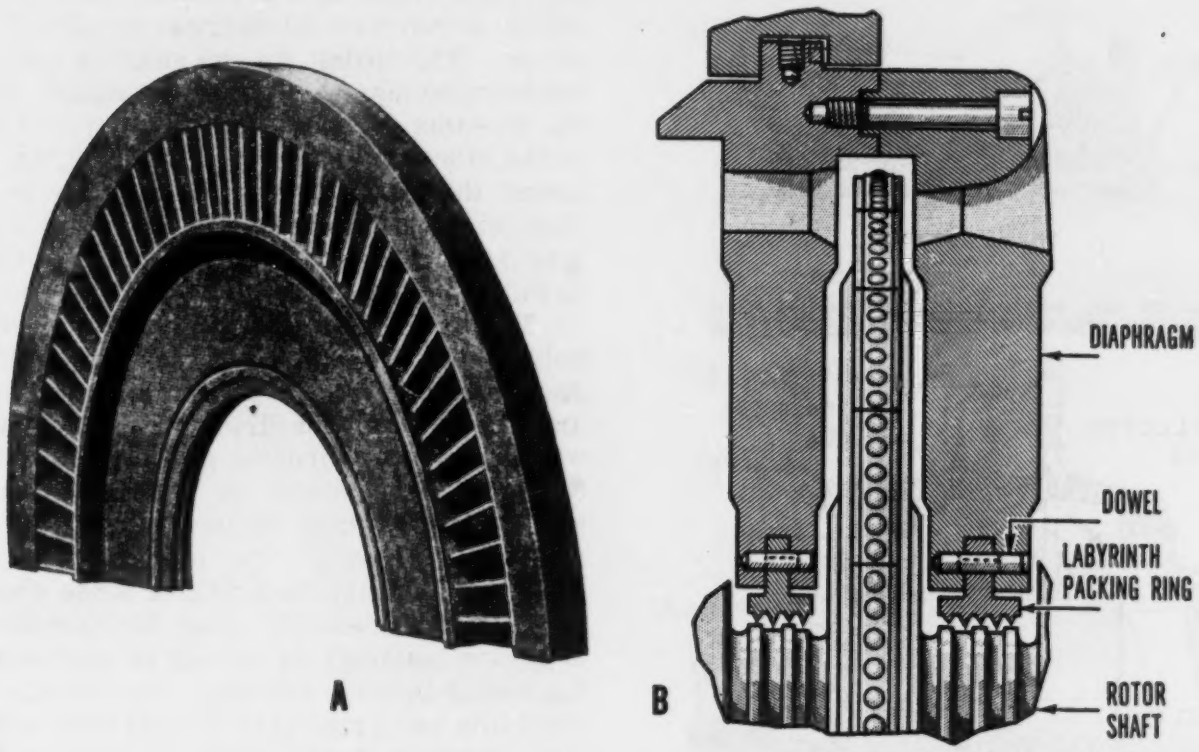

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Figure 3-14.—Turbine nozzle diaphragms. A. Impulse nozzles and nozzle diaphragm. B. Internal construction.

is used in some modern main turbines. The shell assembly consists of upper and lower CYLINDRICAL SHELLS around which are fitted ADJUSTING KEYS with spherically shaped outer surfaces. This spherical surface fits into a similarly shaped BEARING HOUSING—the spherical shape permits a small amount of shell movement to compensate for minor misalignments of the SHAFT. Radial adjustment of the bearing is accomplished either by varying the thickness of the adjusting key or by placing shims between the adjusting keys and the shells. Since the bearings are located close to the shaft glands, OIL DEFLECTOR RINGS (part B of fig. 3-15) are fitted to the housing. This prevents leaking gland steam from contaminating the lubricating oil and also prevents the leakage of oil out of the bearing.

Thrust Bearings

In addition to the radial bearings which serve to support and hold the rotor in correct radial position relative to the casing, a turbine is provided with an axial or thrust bearing. This thrust bearing limits the axial or fore-and-aft travel of the rotor and thereby maintains the necessary clearance between moving and stationary parts within the turbine.

In some auxiliary turbines, thrust bearings of the ball or roller type are used. In others, the radial bearing is designed to present a small axial bearing surface, as well as the radial bearing surface; this type of bearing is actually, therefore, a combination radial and thrust bearing.

In a small thrust bearing, the babbitt-faced thrust plate is rigidly attached to the bearing housing. To facilitate the entry of lubricating oil to the running surface, the babbitt-faced surface is usually provided with radial grooves. This type of bearing works satisfactorily for light thrust loads and slow shaft speeds. But in a thrust bearing of a large, high-speed turbine or propeller shaft, a rigidly mounted thrust plate, even though grooved, would not maintain an adequate oil film between the thrust face of the bearing and the thrust face of the collar. To overcome this difficulty, main turbine and propeller shafts are equipped with

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Block III - General Television Servicing

Unit 3 - Field Servicing

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Installing antennas	Characteristics of TV receiving antennas VHF antennas - structure, selection UHF antennas - structure, selection Positioning and orientation of antennas Indoor antennas
Installing rotators	Purpose, types, theory of operation
Installing boosters	Purpose, types, theory of operation
Installing transmission lines	Unbalanced transmission lines Balanced transmission lines Transmission line attenuation Matching transmission lines to the receiver
Installing receivers	Locating set Setting up the receiver Operating control adjustment Picture tuning
Adjusting ion traps	Functional description of different types of ion traps Maladjustment symptoms Possible damages due to maladjustment Adjustment procedure
Adjusting horizontal and vertical centering controls, deflection yoke, and focus unit	Functional description of centering Controls, deflection yoke and focus unit Adjustment procedure
Adjusting vertical height and linearity controls	Functional description of vertical height and linearity controls Adjustment procedure
Adjusting horizontal frequency, phase, and lock-in range controls	Functional description of horizontal frequency, phase, and lock-in range controls Adjustment procedure
Adjusting oscillator of tuner	Functional description of oscillator of tuner Adjustment procedure

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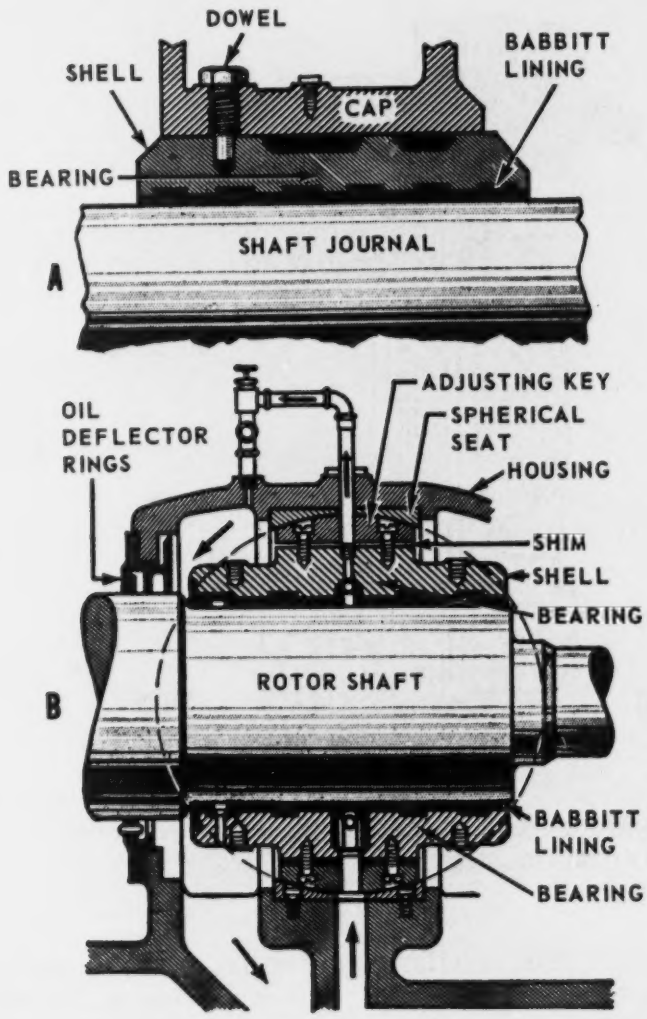

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Figure 3-15.—Turbine rotor bearings. A. Cylindrical bearing. B. Adjustable spherical-seated bearing.

a pivoted shoe (Kingsbury) type thrust bearing. In this type of bearing the thrust plate, instead of being a single, rigidly mounted, babbitt-faced piece, consists of a number of babbitt-faced segments or shoes that are free to assume a slight tilt. This freedom to assume a tilt aids in maintaining an adequate oil film between the shoe faces and the thrust collar.

The Kingsbury type thrust bearing shoes pivot on the upper leveling plates in such a way that they may be tilted very slightly (above 0.001 to 0.002 inches). Because the entire assembly is submerged in oil, the pivoting arrangement allows the formation of a continuous wedge-shaped oil film between the shoes and thrust collar (fig. 3-16). Whenever the shaft rotates, oil is dragged in (between the collar and each shoe) at the leading edge of the shoe which is beveled 30 degrees to allow the oil to enter. The thrust on the shaft or collar has a tendency to squeeze the oil out again. Since the oil streams in at the leading edge and goes out at the sides and at the trailing edge, the oil film under the leading edge of the shoe is thicker than at the trailing edge. In other words, as long as the shaft is rotating, each of the shoes is riding on a wedgeshaped oil film.

Turbine thrust is usually in one direction only. Most Kingsbury type thrust bearings have shoes on both sides of the collar to take care of axial thrust in either direction. In some turbines, where the rotor thrust is always in one direction, or only very slight in the other direction, pivoted shoes may be used on the thrust absorbing side only; the non-thrust side may have a plain babbitted ring or three shoes.

A thrust bearing may be installed in a separate housing, or it may be enclosed within the radial bearing housing. For details on construction and principles of operation of a Kingsbury thrust bearing, refer to chapter 4 of this training course.

SHAFT PACKING GLANDS

When the pressure inside the turbine casing is greater than atmospheric pressure, shaft packing glands are used to prevent the escape of steam from the casing. The packing glands

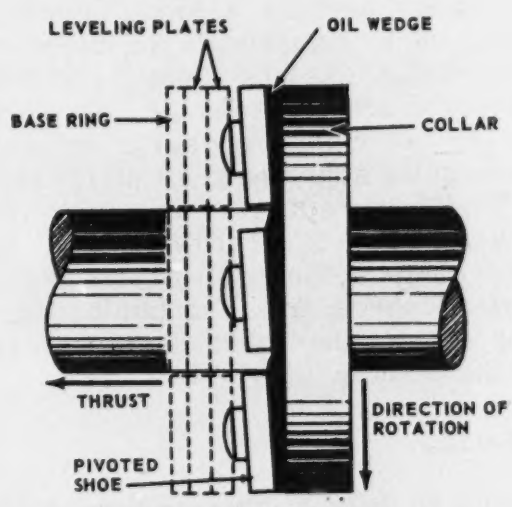

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Figure 3-16.—Diagrammatic arrangement of a Kingsbury thrust bearing, showing oil film.

also prevent air from entering the turbine when the pressure within the casing drops below atmospheric pressure.

There are three types of shaft glands most generally used on naval turbine installations—labyrinth packing glands, carbon packing glands, and a combination of both labyrinth and carbon packing glands. Since labyrinth packing glands are carbon packing glands are discussed and illustrated in Fireman, NavPers 10520-C, the paragraph which follows deals with the combination of labyrinth and carbon packing glands.

A COMBINATION OF LABRYINTH AND CARBON PACKING GLANDS (fig. 3-17) is used in the glands of some modern steam turbines. The labyrinth packings are used at the initial high pressure end of the turbine and for interstage packing. Carbon packing is generally used for shaft sealing at the low pressure ends. Labyrinth packing is used in instances where prevailing high pressures would cause excessive leakage around the carbon packing.

GLAND SEAL

Packing alone will neither stop the flow of steam out of the turbine nor prevent the flow of air into the turbine. Gland sealing steam is used to prevent the entrance of outside air into the turbine, which would reduce or destroy the vacuum in the main condenser. Figure 3-18 shows how gland sealing steam of about 2 psig (17 psi absolute) is led into a space between two sets of gland packing. On most ships, steam is supplied from the auxiliary exhaust steam line through a stop valve. Two weight-loaded valves operate automatically to maintain a pressure of 1/2 to 2 psig on the glands.

During periods of warming-up, low-speed operation, backing-down, and securing, these weight-loaded valves are open. When the turbine is speeded up, and the steam flowing out of the labyrinth gland of the high pressure turbine reaches 2 psig, the valve supplying the high pressure turbine closes automatically—admitting no more gland steam from the auxiliary exhaust line. The high pressure turbine gland is then supplying enough steam leakage to seal the low pressure glands. As the turbine speed is still further increased, and the pressure in the sealing system rises to about 2 1/2 psig, the excess steam is led, by a manually operated or an automatically operated valve, either to the main condenser or to the low pressure turbine (depending on the ship).

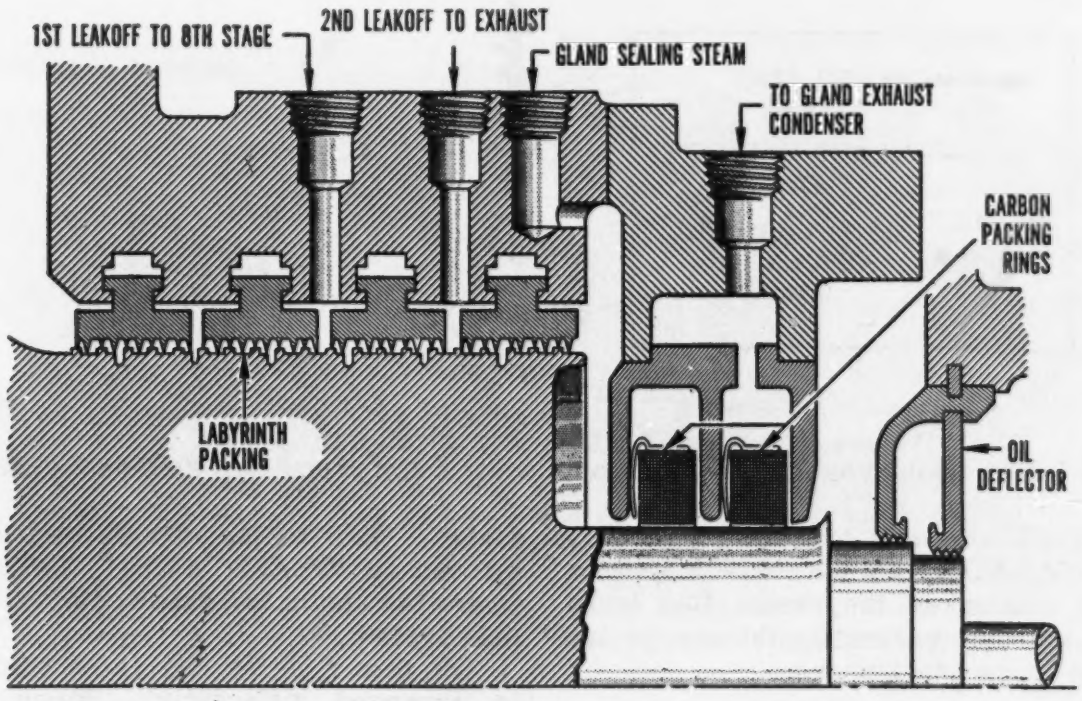

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Figure 3-17.—High pressure turbine gland.

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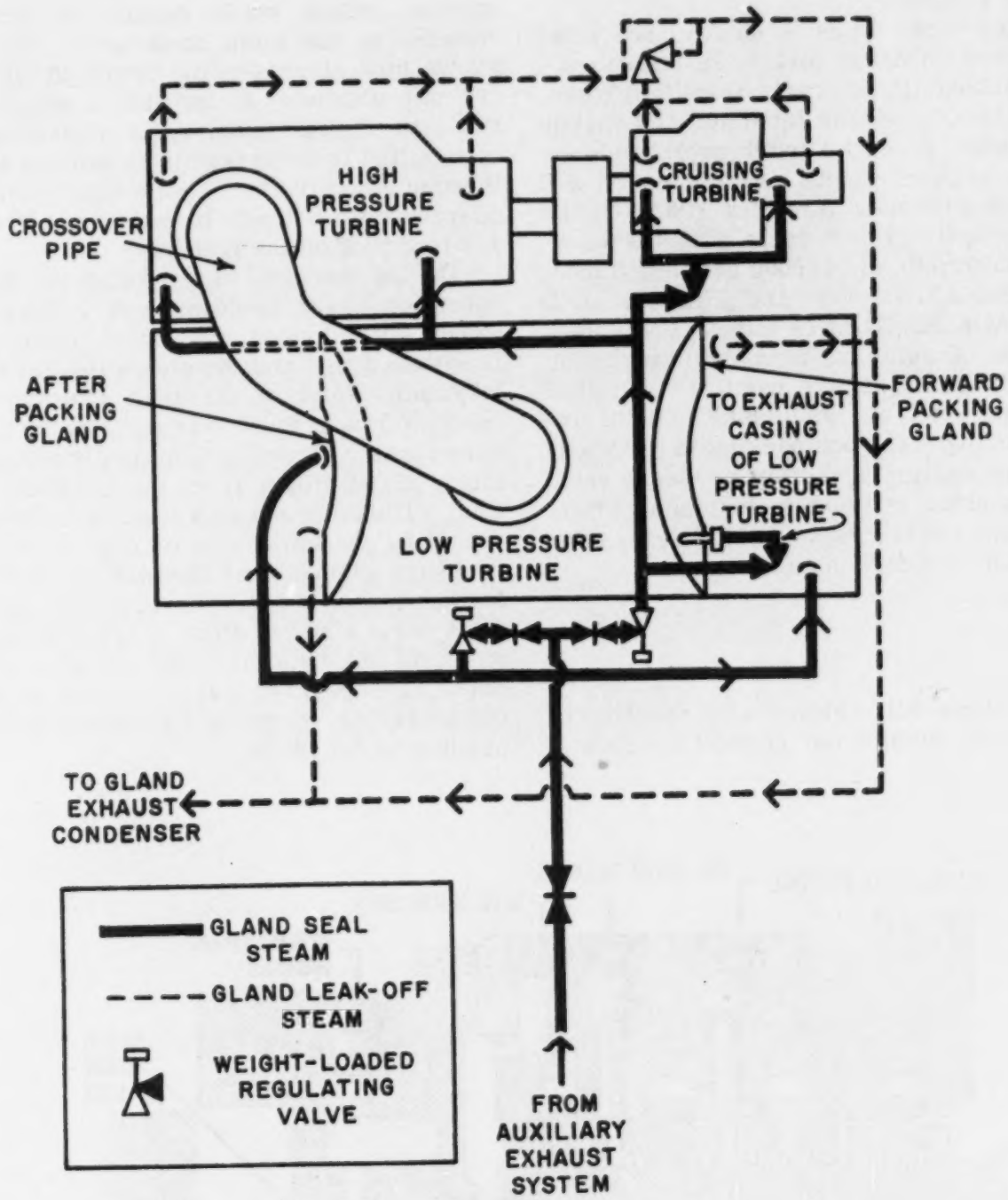

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Figure 3-18.—Gland seal and gland exhaust system for propulsion turbines (destroyer).

The leak-off connections (fig. 3-18) are linked to the GLAND LEAK-OFF PIPING, which collects and condenses the steam that leaks from the gland, thus preventing the escape and loss of steam to the atmosphere.

A fan type GLAND SEAL EXHAUSTER (not shown) puts a slight vacuum on the leak-off piping. This vacuum draws the leak-off steam through a GLAND EXHAUST CONDENSER, where the steam is condensed and returned to the feed system.

On newer ships the gland sealing system is arranged differently. Steam is supplied from the 150 psi steam line. It is reduced to 2 psi through a diaphragm-operated control

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valve, actuated by an air pilot. The pilot is supplied with compressed air at 20 psi through a pressure reducing valve. The system also provides for the recovery of steam leaking from the main turbine valve stems and of excess sealing steam from the inner pockets of the high pressure turbine glands. For standby, astern, and slow ahead speeds, both glands on the high pressure turbine require sealing steam; while at all speeds, the glands on the low pressure turbine require sealing steam. At approximately 20 knots, the pressure in the high pressure turbine becomes high enough so that the forward gland no longer needs sealing steam. The excess steam is then led to a header and helps to seal the low pressure glands. Any excess steam is led to the main condenser by way of a relief or weight-loaded valve. The gland exhaust system removes the air and steam mixture from the four turbine glands. Most of this mixture is condensed in the gland exhaust section of the main air ejector condenser and returns to the condensate system. The air and noncondensable gases are exhausted, by the gland exhauster, to the atmosphere. Ship's service generator turbines are sealed in the same way, but they require an independent sealing system, so that they may be operated in port with the main plant secured.

TURBINE CONTROL UNITS

To start, stop, or reduce the steam flow to the main propulsion turbines, a system of cam-operated NOZZLE CONTROL VALVES is operated by a single handwheel. The amount of steam entering the high pressure or cruising turbine depends upon the degree to which the nozzle control valves (numbers 3 to 7) are opened.

NOZZLE CONTROL VALVES

Since space limitations do not permit a detailed discussion of all ship types, the following description of a DD installation will serve to acquaint you with a typical turbine control system.

Three nozzle control valves admit steam to the cruising turbine via the cruising turbine chest. As speed is increased, operating gear (THROTTLE CONTROL VALVE) leading from the main gage board rotates a cam shaft which causes cams to lift three valves successively. There are five valves which admit steam to the high pressure turbine. These valves are cam-operated the same as those of the cruising turbine. The first two of these valves to open admit steam to the first-stage chest (fig. 3-19) of the turbine.

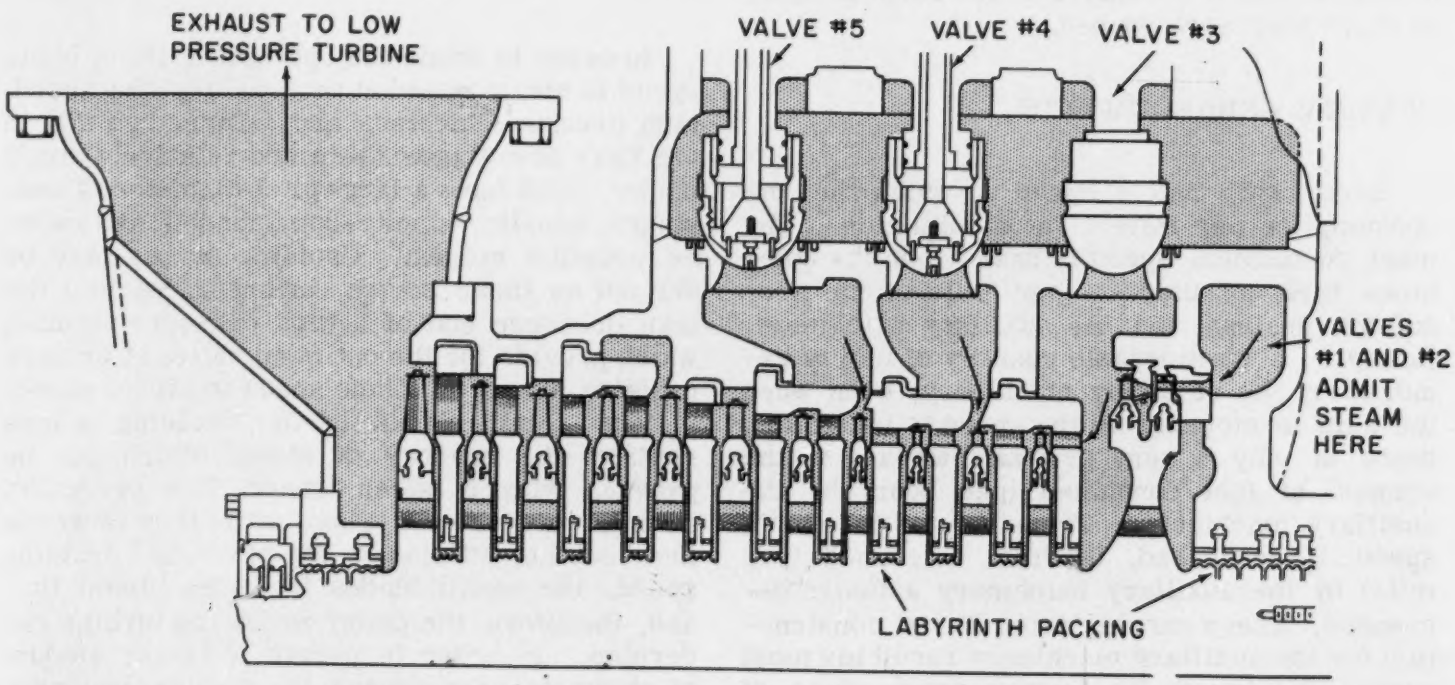

Figure 3-19.—High pressure turbine showing valve arrangement.

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With valves #1 and #2 fully open, the steam pressure in the steam chest is approximately at line pressure. The first-stage nozzles are passing steam to the first stage at the limit of their capacity. To further increase the power and speed of the turbine, it is necessary to increase the amount of steam flowing through the turbine. To do this, valve #3 is opened. This admits steam from the chest through a bypass to the second-stage nozzles. The increased volume and velocity of the steam impinging upon the blading increase the turbine power and speed. With valve #3 wide open, it is necessary to open valve #4 to obtain a further increase in power. This admits steam from the chest through a bypass to the fourth-stage nozzles. With valve #4 wide open, the plant should operate at almost its full power rpm. Valve #5 will, when opened, admit steam to the sixth-stage nozzles. This will permit operation of the turbine at its maximum available speed and power.

On the more modern ships, as the handwheel is rotated, an indicator on the throttle control valve mounting shows which valves are open. Valve #1 begins to open as soon as the indicator moves away from the SHUT position. The other valves open at the points indicated on the indicator as the handwheel is turned counterclockwise. When the indicator reaches the OPEN position, all valves are fully open. Turning the handwheel in the clockwise direction closes the valves in the reverse order in which they were opened.

CRUISING ARRANGEMENTS

Every ship has a speed at which the fuel consumption per mile is at a minimum. The most economical speed is based upon the combined fuel consumption per mile of the propulsion engines and the auxiliary machinery. However, a considerable quantity of fuel is required by the auxiliary machinery, even when the ship is stopped; as the speed is increased, there is only a very gradual increase in the amount of fuel consumed (per hour) by the auxiliary machinery. Therefore, as the ship's speed is increased, the fuel consumed (per mile) by the auxiliary machinery actually decreases. These varying rates of fuel consumption for the auxiliary machinery result in a most economical speed, for turbine-driven ships, of between 12 and 20 knots, depending upon the type of ship.

In order to conserve fuel and thereby increase the ship's cruising radius, a major part of all steaming is done at close to the most economical speed; therefore, the most economical speed is generally designated as cruising speed. Although it is desirable to have the most economical speed as high as possible, there is a practical limit above which this speed cannot be raised (because of the progressively increasing resistance of water to the ship's hull as the speed of the ship is increased). Increasing the efficiency of the main engines will tend to raise the most economical speed.

It is also desirable for combatant ships to be able to steam at or near full power for long periods of time. This requirement makes it necessary for propulsion plants to be designed with a relatively high turbine efficiency at high speeds.

Maximum efficiency in a turbine is obtained when the optimum ratio of blade speed to steam speed exists. Therefore, in order to obtain the lowest possible fuel consumption per mile at cruising speed and at full power, it is necessary that propulsion turbines be designed so that the optimum ratio of blade speed to steam speed will be approached at both these speeds. This is accomplished by the use of (1) cruising stages and (2) cruising turbines.

Cruising Stages

In order to attain the optimum ratio of blade speed to steam speed at or near cruising speed, high pressure turbines are designed so that in the first few stages there are relatively small blades which have a large pitch diameter. These stages, usually velocity-compounded, are known as cruising stages. Cruising stages may be defined as those stages, incorporated into the high pressure end of a high pressure turbine, which provide for the optimum ratio, at or near cruising speed, of blade speed to steam speed.

The small blades in the cruising stages restrict the quantity of steam which can be passed, with a given steam line pressure, through the turbine. Thus, while they increase the turbine efficiency at or near cruising speed, the small blades limit the steam flow and, therefore, the power which the turbine can develop. In order to permit a larger amount of steam to pass through the turbine, bypasses (fig. 3-20) are installed. (These bypass valves allow the steam to be bypassed around the

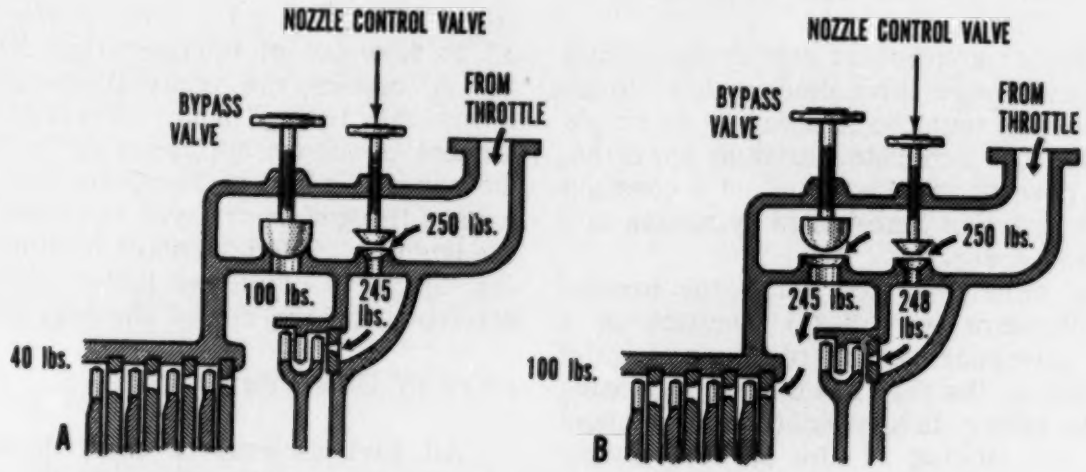

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Figure 3-20.—Diagrammatic arrangements of a bypass valve. A. With valve closed. B. With valve open.

cruising stages when high power is desired. The bypasses allow high pressure steam to work directly on the larger blades of the later stages, thereby developing more power.)

Cruising Turbines

In some installations, the optimum ratio of blade speed to steam speed at cruising speeds is attained by means of a separate, small turbine, known as a cruising turbine. These turbines are similar in design to high pressure turbines, except that they are smaller in size and are not fitted with bypasses. When a cruising turbine is in use, steam passes through the cruising turbine before it goes to the high-pressure turbine. In this way, the steam is expanded through a greater number of pressure stages and more energy is extracted from the steam than would be possible by the use of the high pressure and low pressure turbines. When speeds in excess of the cruising turbine's range are desired or anticipated, the steam is led directly to the high pressure turbine, bypassing the cruising turbine. When cruising turbines are bypassed, cooling steam is supplied to the cruising turbine by means of a crossover valve, installed on the cruising turbine exhaust, between the cruising turbine and the high pressure turbine. Because of their high speed of rotation, cruising turbines are connected to the high pressure turbine shaft through a reduction gear and shafting.

AUXILIARY TURBINE GOVERNORS

You have studied the various types of main propulsion and auxiliary turbines and how they work; and how the cam-operated nozzle control valves regulate the amount of steam entering a high pressure or cruising turbine, thereby controlling turbine speed. However, in auxiliary turbines used to drive generators, forced-draft blowers, pumps, air compressors, and other auxiliary machinery, some speed controlling governor or device must be used.

Types of Governors

Generally speaking there are two types of governors in use: constant speed governors and speed limiting governors. The CONSTANT SPEED GOVERNOR is used on constant speed machines to maintain a constant speed regardless of the load on the turbine up to design limits. Constant speed governors are usually set so that the turbine cannot even momentarily exceed 110 percent of normal operating speed.

The SPEED LIMITING GOVERNOR, used principally on variable speed machines, allows a turbine to operate under all conditions from no-load to over-load, up to the speed for which the governor is set, but it does not allow operation in excess of 105 percent of normal operating speed. Since this type of governor is adjusted to the maximum operating speed of the turbine, it has no control over the admission of steam until

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the upper limit of safe operating speed is reached.

Ship's service generators supply electricity for lighting and power throughout a ship. Since a constant voltage must be maintained on ship's service lines, the generator turbine operates, even under greatly varying loads, at a constant speed. This speed is maintained by means of a constant speed governor.

A typical ship's service generator turbine control mechanism (fig. 3-21) consists of a centrifugal governor which operates a pilot valve controlling the flow of oil to an operating cylinder. The latter, in turn, controls the amount of opening or closing of the turbine nozzle valves.

A gear-type oil pump and the main governor, mounted on the same shaft, are driven through a worm and gear (fig. 3-21). The worm is directly connected to the low speed gear shaft of the turbine reduction gear and thereby drives the governor at a speed that is directly proportional to the turbine speed.

On some installations, the turbine nozzle valves are operated by a lifting beam. The nozzle valve stems, of varying lengths, are designed so that they slide freely through holes in the lifting beam. As the beam is moved up and down, the nozzle valves open and close in a predetermined sequence.

Governor Operation

When a governor tends to slow down, because of an increased load on the generator, the governor weights move inward and cause the pilot valve to move upward. This permits oil to enter the operating cylinder. Thus, the operating piston rises and, through the controlling-valve lever, the lifting beam is raised. The nozzle valves open and admit additional steam to the turbine. This upward motion of the controlling-valve lever causes the governor lever to rise, thus raising the bushing. Upward motion of the bushing tends to close the upper port, shutting off the oil flow to the operating cylinder; this stops the upward motion of the operating piston. The purpose of this follow-up motion of the bushing is to regulate the governing action of the pilot valve. Without this feature the pilot valve would operate, with each slight variation in turbine speed, to alternately fully open and fully close the nozzle valves.

When the turbine tends to speed up because of a decreased load on the generator, the governor weights move outward, moving the pilot valve downward, opening the lower ports, and allowing oil to flow out of the operating cylinder. This action causes the controlling-valve lever to lower the lifting beam, thereby reducing the amount of steam delivered to the turbine. The downward motion of the controlling-valve lever causes the governor lever to lower; this lowers the bushing. The downward motion of the bushing tends to close the lower port, preventing oil from flowing out of the operating cylinder.

SAFETY DEVICES

All turbogenerators have three safety devices: an overspeed trip, a back-pressure trip, and an emergency hand trip. Some turbogenerators have a fourth safety device; a low lube oil pressure trip or alarm.

Safety devices differ from control devices in that they have no control over the turbine under normal operating conditions. It is only during some abnormal condition that safety devices come into use—to either stop the unit or control its speed.

The OVERSPEED TRIP shuts off the steam supply to the turbine after a predetermined speed has been reached, and thus stops the unit. Overspeed trips are set to trip out at about 110 percent of normal operating speed.

The BACK-PRESSURE TRIP is used to close the throttle automatically whenever the back or exhaust pressure reaches a set pressure.

The LOW-OIL-PRESSURE TRIP is used on turbogenerators to close the throttle if the lubricating oil pressure drops below a specified pressure.

The EMERGENCY HAND TRIP is fitted to all turbogenerators to provide for closing the throttle quickly, by hand, in case of damage to either the turbines or generator. The emergency hand trip may also be used to close the throttle valve when the turbogenerator is secured.

STEAM-DRIVEN TURBOGENERATORS AND TURBOGENERATOR OPERATION

Electrical power provided by steam-driven turbogenerators, is a vital part of today's modern Navy. Many factors such as maximum power requirements, safety, and reliability determine the number of generators installed aboard each class of ship. A DD-692 class destroyer has two steam-driven turbogenerator

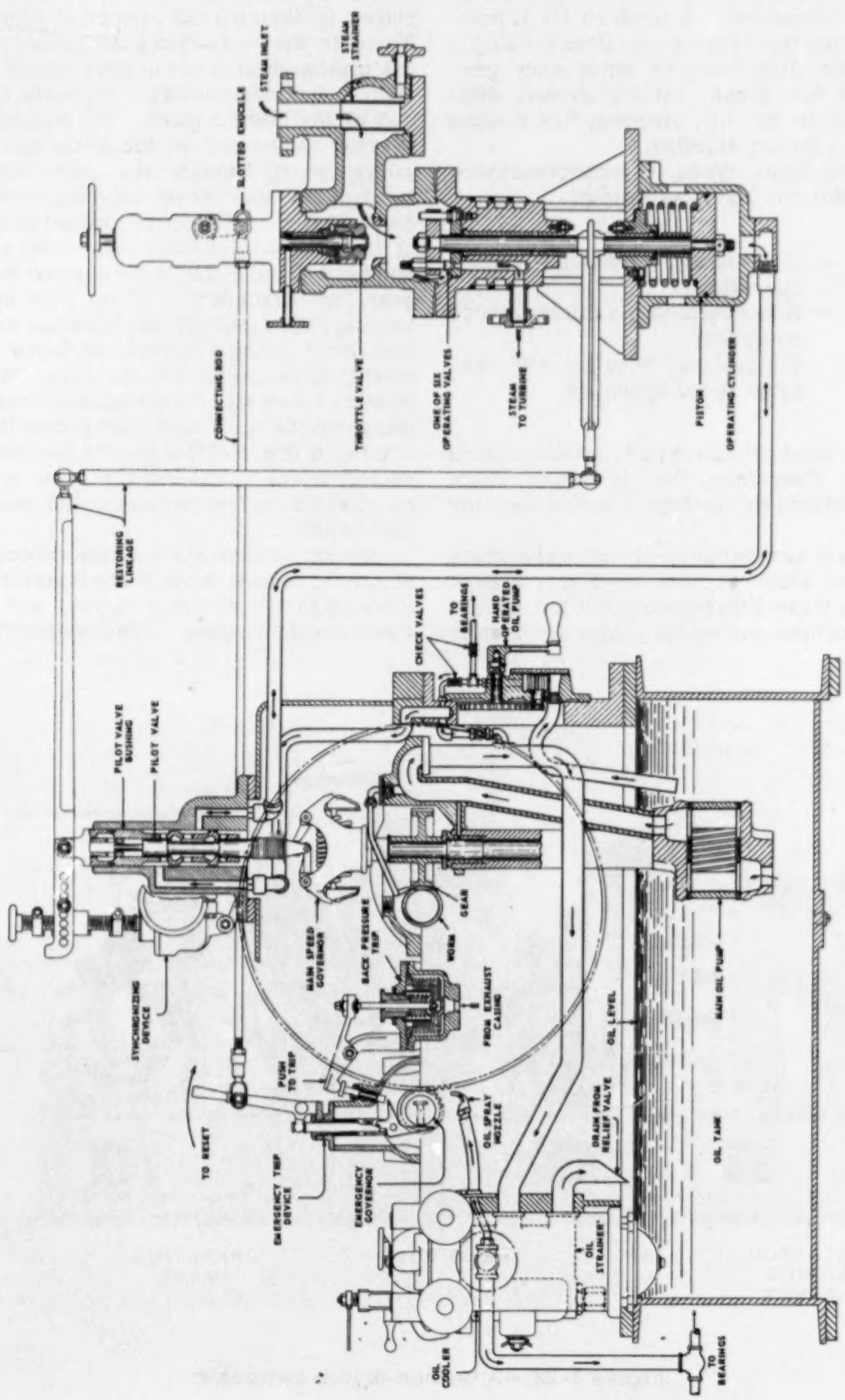

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Figure 3-21.—Ship's service turbine-driven generator governor system.

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sets (turbogenerators) and two diesel-driven emergency generators. A modern CVA, however, has eight steam turbogenerators for ship's service, three diesel-driven emergency generators, and two steam turbine-driven, 400-cycle generators for I.C. circuits, fire control circuits, and aircraft starting.

There are three types of turbogenerators employed within the Navy, as follows:

TYPE I — Condensing, constant speed operation
TYPE II — Noncondensing, variable speed operation
TYPE III — Condensing, constant and variable speed operation.

Type I is the most prevalent installations aboard naval ships. Therefore, the discussion which follows is confined to the Type I turbogenerator installation.

The general arrangement of turbogenerators on all surface ships is very similar. Figure 3-22 shows a typical turbogenerator for a small ship. The turbine and pinion shafts are rigidly connected and supported by three bearings, as shown in figure 3-23. Bearings numbers 2 and 3 are in the reduction gear casing and support the pinion shaft and the gear end of the turbine shaft. Bearing number 1 supports the opposite end of the turbine shaft. The high speed thrust bearing is located on the generator end of the pinion shaft, outside the gear casing. The location of the thrust bearing varies on new construction units but is located predominantly at the steam inlet end of the turbine. Bearings numbers 4 and 5 (fig. 3-23) support the reduction gear and also are part of the slow speed thrust bearing; the faces of these bearings are babbitted and bear against thrust surfaces which are machined on the hubs of the gear. The babbitted bearing faces and the thrust surfaces of the gear hub form the slow speed thrust bearing. Bearing number 6 (fig. 3-23) supports the generator and exciter rotor. The exciter rotor is eliminated on modern turbogenerators that employ static excitation.

Steam enters the turbine through a steam strainer, passes through the throttle valve, then through the controlling valves, and then to the first stage nozzles. The steam then passes

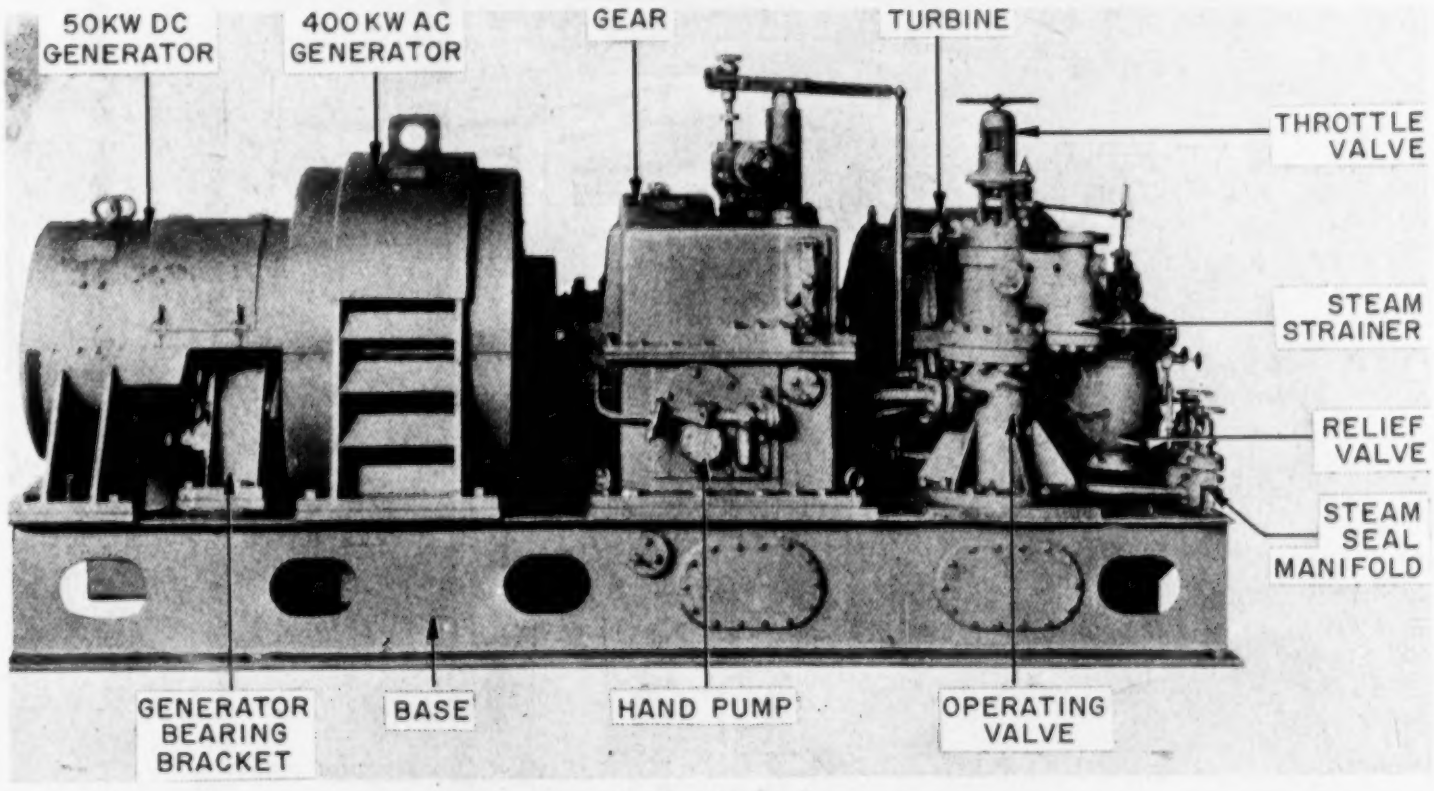

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Figure 3-22.—A turbine-driven generator.

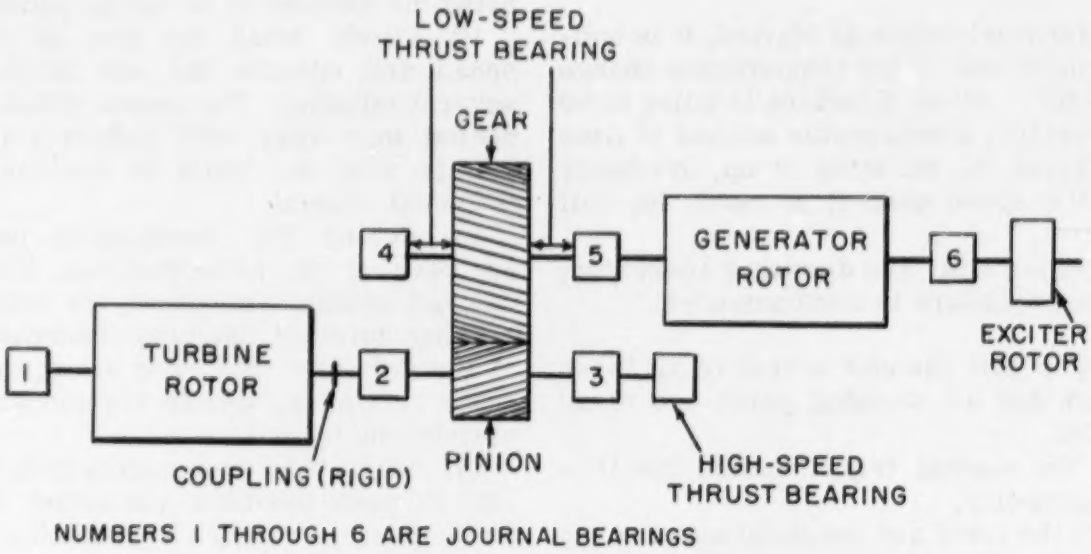

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Figure 3-23.—Positions of bearings in a turbogenerator.

through the turbine stages (usually 5 to 10), from initial pressure to final or condensing pressure.

The speed of the unit is controlled by a constant speed governor which is of the centrifugal type. The governor speed setting can be adjusted electrically or manually to control the speed of the turbine.

The throttle valve is provided with a handwheel for manual control and for resetting the valve after it has been tripped. The throttle valve closed when the overspeed trip or high back pressure trip functions, or when the manual trip lever is pushed.

Submarines use a direct drive turbogenerator which usually has a flexible coupling installed between the turbine and the generator. Direct drive turbogenerators are used on submarines for ship's service because the inlet steam conditions are relatively low and therefore the available energy of the steam to the turbine is low compared with surface ships. This permits the turbine to operate at low speeds and still maintain a satisfactory efficiency. The elimination of the reduction gears considerably reduces the noise level of the turbogenerator.

Surface ships use direct drive turbogenerators to produce 400-cycle power for IC and control circuits and aircraft starting. High speed generators are necessary in order to generate 400-cycle power; therefore, both the generator and the turbine can run at high speeds (normally 12,000 rpm) and thus maintains high turbine efficiency.

The auxiliary air ejectors maintain a vacuum in the auxiliary condenser. They are basically the same as main air ejectors. In order to provide continuous plant operation, two sets of nozzles and diffusers are provided for each air ejector condenser. Only one set is necessary for normal operation of the plant, the other set is for use in case of damage or malfunctioning of the set in use. Both sets may be used when there is excessive air leakage into the auxiliary condenser. On some installations, the second air ejector set has a higher capacity and is used in starting the plant. After the normal condenser vacuum has been established, the smaller set should be started and the larger set secured.

The auxiliary circulating pump is a high capacity, low pressure, centrifugal, motor-driven pump. The pump has separate injection and overboard valves. Some auxiliary circulating pumps supply cooling water to the turbogenerator lube oil cooler. In some installations, cooling water for the auxiliary condenser can be taken from the firemain, in case of failure of the circulating pump.

The auxiliary feed booster pump is a centrifugal, motor-driven pump used to maintain a pressure on the suction line to the emergency feed pump during in-port operation. In case of failure of this pump, a main feed booster pump may be used as a part of the auxiliary plant.

Block III - General Television Servicing

Unit 3 - Field Servicing (Cont'd.)

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Adjusting AGC	Functional description of automatic gain controls Adjustment procedure
Solving combination picture and sound problems	Procedure for locating general troubles Loss of sound and picture Picture distorted-sound defective Contrast abnormal - sound defective Extraneous material in picture - sound defective Picture unstable - sound defective
Solving defective picture problems	Procedure for locating defects in the video section Picture abnormal Abnormal contrast Picture distorted Picture torn and broken Extraneous material in picture Unstable picture
Solving defective sound problems	Comparison between radio receivers and TV sound sections Troubleshooting TV sound sections No sound Weak sound Noisy sound Hum or buzz in sound Sound drifting and distortion

STARTING A TURBOGENERATOR

When a turbogenerator is started, it is subject to expansion due to the temperature change it will undergo. When a turbine is going to be placed in service, a reasonable amount of time should be spent in warming it up, gradually increasing the speed until it is ready for full load.

When starting a turbine driving a generator, the following procedure is recommended:

1. Be sure that the unit is free of all loose material and that all working parts are clean and well oiled.
2. Test the manual trip to ensure that it is functioning properly.
3. Check the level and temperature of oil in the sump tank. The oil level should be at the maximum mark on the gage and the temperature of the oil should be above 60° F.
4. Open the drain ahead of the throttle valve. Leave the drain open until all water is drained out of the line and dry steam is being discharged.
5. Open the root valve slowly so as to warm the line gradually, and drain the water from it.
6. Open the turbine exhaust valve.
7. Open the injection and overboard valves, start the auxiliary circulating pump, and make sure that water is being circulated through the condenser.
8. Start the auxiliary condensate pump. Open the recirculating valve to ensure an adequate amount of cooling water for the auxiliary air ejector condenser.
9. Drain the air ejector steam line and cut steam into the auxiliary air ejectors. Bring the vacuum up to about 15 inches.
10. Start turning the hand oil pump. Keep the hand oil pump turning until the unit has been started and the attached oil pump takes over. Check the oil pressure gages and sight-flow indicators to ensure an oil flow to the bearings.
11. After the controlling valve has been lifted by the oil pressure, open the throttle valve sufficiently to start the turbine rolling. Under no circumstances shall steam be admitted to the turbine, for any appreciable length of time, with the rotor stationary. Uneven heating will distort the rotor and cause vibration when the turbine is started.
12. After the turbine has started, test the manual trip to see that it operates properly.
13. Reset the trip and open the throttle valve just enough to keep the unit turning.
14. Admit steam to the packing glands and bring the vacuum up as far as possible.
15. Slowly bring the unit up to about half speed and operate the unit at that speed for several minutes. The length of this warming-up period may vary with different installations, details may be found in the manufacturer's technical manual.
16. During the warming-up period, watch all bearing oil temperatures, listen for any unusual noises, and check for vibration. If a rubbing noise is detected, decrease the speed of the unit until the noise disappears; or if the noise continues, secure the unit and locate and correct the trouble.
17. When the temperature of the oil reaches 100° F, open the inlet and outlet water valves on the lube oil cooler. Regulate the temperature of the oil by closing down or opening up on the cooling water outlet valve.
18. When the unit is properly warmed up, open the throttle valve until the constant speed governor takes control.
19. Increase the speed until the overspeed trip functions. Close the throttle valve, reset the overspeed trip, and gradually bring the speed of the unit up to operating speed.

When bringing a generator turbine up to speed, you should always accelerate rapidly through the critical speed of the unit. The slight vibration which may occur when going through critical speed will disappear when the unit is up to operating speed. The critical speed of a generator turbine usually is 20 to 25 percent below normal operating speed; for other auxiliary turbines, critical speed is well above operating range.

When the unit is operating normally, open the throttle valve wide; then close the valve about 1/2 turn to prevent the throttle sticking as the metal expands due to temperature increase.

The bearings are designed to ensure proper flow of oil when the oil enters the bearing at normal operating temperature. If the temperature of the oil is far enough below normal operating range, the flow of oil may be reduced to a point where it will not be sufficient to carry away the heat of the bearing. Low starting speeds are, therefore, necessary when oil temperatures are low.

Turbogenerators should never be started until the oil in the sump is at least 60° F. Oil below this temperature can be heated by

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circulating it through the purifier heater, then the unit can be started and operated slowly until the oil entering the bearings is 100° F.

The oil level in the sump should be at the maximum mark on the gage to allow for the drop in oil level due to oil filling the system. On most installations, the generator oil cooler is fitted with a bypass. The oil flow can be diverted around the cooler until the oil temperature reaches approximately 100° F.

To prevent water hammer when warming up the turbogenerator steam line, open the drain ahead of the throttle valve. Do not open the throttle until all condensate is discharged from the line and the drain is discharging dry steam.

OPERATING A TURBOGENERATOR

When the unit is up to speed and the load is applied, the following steps should be observed during operation:

1. See that the oil cooler is receiving an adequate supply of cooling water. If the supply of water is insufficient, the bearings will overheat in a very few minutes.
2. See that the surface cooler is receiving cooling water, or that air is circulating through the generator, whichever is applicable.
3. Adjust the gland sealing steam in accordance with the manufacturer's instructions.
4. See that the oil pump delivers an adequate supply of oil to the bearings. If the oil cooler was bypassed during warming up, ensure that the bypass is closed during normal operation.

Periodically determine the temperature of the oil leaving the bearings. A satisfactory running temperature of the return oil is 140° F to 160° F. The maximum oil temperature should not exceed 180° F. The temperature rise of oil passing through any bearing should not exceed 50° F.

During operation, continuous attention should be given to the following:

1. Cleanliness of the unit.
2. Prevention of leakage of steam, oil or water.
3. Smoothness of operation and freedom from unusual noises or vibration.
4. Correct readings of pressure and vacuum gages.
5. Freedom of movement of the governor parts.

Make sure that all control and safety devices are in proper operating condition. If they are not, the unit should be stopped and the trouble located and corrected before the unit is again started.

SECURING A TURBOGENERATOR

When securing a turbogenerator, the procedure is as follows:

1. After the Electrician's Mates have shifted the electrical load to another generator, trip the throttle valve by pushing the manual trip button at the emergency tripping device.
2. Close the stop valve ahead of the throttle valve and open the drain ahead of the throttle valve.
3. Station a man at the hand lube oil pump, when the lube oil pressure (to the bearings) drops to about 5 psig, start turning the hand oil pump to maintain adequate lube pressure to the bearings and gears.
4. Secure the gland sealing steam.
5. Operate the air ejectors for several minutes to draw out all vapor from the turbine in order to prevent internal corrosion.
6. Secure the auxiliary air ejectors, auxiliary condensate pump, and the auxiliary circulating pump.
7. Close the inlet and outlet cooling water valves to the lube oil cooler.

When the unit is to be secured, even for a short time, take every precaution against steam entering the turbine casing. If the unit is to be restarted, bring it up to speed with the same care used when starting cold.

On older ships, turbogenerator operation can vary greatly. While each generator has its own auxiliary condenser to receive the turbine exhaust, some generator turbines can exhaust to the main condenser when the ship is underway and some can exhaust to the atmosphere. On more recently constructed naval surface ships, generator operation is similar, but each generator turbine exhausts only to its own auxiliary condenser except in submarines, where the turbine exhausts only to the main condenser.

The operation of an auxiliary plant for a turbine-driven generator is explained in the following paragraphs.

The auxiliary plant is basically a small main plant. It consists of an auxiliary condenser, an auxiliary circulating pump, an auxiliary condensate pump, auxiliary air ejectors, and an auxiliary feed booster pump. It uses the main plant deaerating feed tank instead of having an

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auxiliary deaerating feed tank. The operation of each of these units is the same as the operation of the main plant, except that their capacity is far less.

An auxiliary circulating pump circulates sea water through the auxiliary condenser continuously during operation, instead of a scoop injection as in some main plants. The cooling water makes one or two passes through the condenser, the inlet water box on the two pass condenser being divided by a partition into an inlet chamber and outlet chamber.

The auxiliary condensate pump removes the condensate from the auxiliary condenser, discharges it through the auxiliary air ejectors, and into the deaerating feed tank. Auxiliary condensate pumps are small motor-driven centrifugal pumps with a capacity equal to the maximum condensing capacity of the auxiliary condenser. A recirculating line is fitted at the condensate outlet of the air ejector condenser and leads to the auxiliary condenser. When starting up and at low loads, the recirculating valve must be opened to prevent the condenser from being pumped dry. The recirculating line also ensures that sufficient cooling water will at all times be supplied to the air ejector condenser.

TURBINE MAINTENANCE

The maintenance of turbine installations is as important as their proper operation. If proper maintenance procedures are followed, abnormal conditions may be prevented. You will be concerned with major adjustments, as well as measurements, of turbines. In addition, you must know how to fit carbon packing rings to turbines.

MAJOR ADJUSTMENTS OF A TURBINE

In all propulsion turbines installed on ships in the Navy, there are two major adjustments: the fixing of the proper radial and axial positions of the rotor. The radial position of the rotor is maintained by the main bearings, and the axial position by the thrust bearings.

In impulse staging, the radial clearances are large and have no effect on the efficiency of the turbine. The axial clearances also, within the limits permitted by the design of the turbine, will have almost no appreciable effect on the turbine efficiency, because the same pressure exists on both sides of the moving blades; as a result, there is no tendency for the steam to bypass the blades. In impulse staging, axial clearances are kept small in order to reduce the length of the rotor and the casing.

The clearances in all shaft and diaphragm packings are small, and they will be altered if the position of the rotor changes (as a result of wear, either of the journal or of the thrust bearings). This change results in reduced efficiency of the turbine because of the steam leakage from the glands, and repairs will eventually be necessary.

The major reason for maintaining a turbine rotor in its proper position is to prevent damage to the turbine. If the rotor touches the casing at any time, because of failure of the thrust or journal bearings, while the turbine is in operation, damage will result and it will be necessary to lift the turbine casing for repairs. The turbine parts that are particularly subject to damage, because of close clearances involved, are the rotor blading, diaphragm packing rings, shaft packing rings, and oil deflector or oil seal rings.

Radial Position of the Rotor

The quickest means of detecting any change in the radial position of the rotor, resulting from bearing wear, is by using the depth gage micrometer. When the turbines were installed originally, depth gage readings were taken and recorded. Any difference between the original and the new readings will be the amount of bearing wear.

To take new readings (see fig. 3-24) a depth gage spindle is inserted into the depth gage well until the bridge of the gage rests evenly on the reference boss; the knurled handle of the micrometer is then turned until the spindle touches the journal. Read the micrometer and compare the new and the original readings.

Another means of checking bearing wear is by measuring the crown thickness with an outside micrometer. When the turbine bearings were installed originally, the radial position of the turbine rotor was set, and by using a micrometer the combined thickness of the bearing shells and liners (at designated places) was measured and stamped on the bearing shell. To take new readings, the bearing cap must be removed, the top half of the bearing lifted off, and the lower half of the bearing rolled out.

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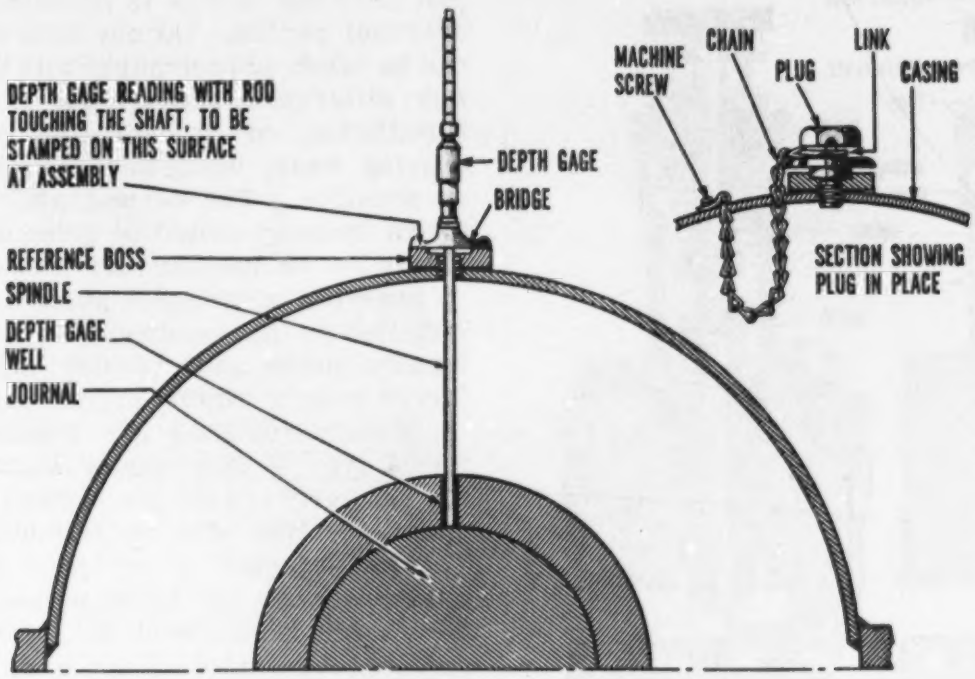

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Figure 3-24.—Bearing wear micrometer depth gage.

Radial lines are scribed on one end of each bearing to indicate the measurement points which are always 1 1/4 inches from the end of the bearing. Any difference between the shipboard and the factory measurements will be the amount of bearing wear.

Another way of measuring bearing wear is by using an inside micrometer to measure the inside diameter of the bearing and an outside micrometer to measure the outside diameter of the journal. The difference between the readings will be the oil clearance. The difference between the old and the new oil clearances will be the amount of bearing wear.

Axial Position of the Rotor

The axial position of a turbine rotor is maintained by means of a thrust bearing, usually of the pivoted segmental or Kingsbury type. With this type bearing, the axial position of the rotor is adjusted by machining from the filler piece, by adding shims, or by installing larger filler pieces.

The axial clearance instruments consist of the rotor position micrometer and the axial clearance micrometer. The rotor position micrometer is shown in figure 3-25. It is used on old type turbines, while they are in operation, to determine the axial position of the rotor and the amount of thrust bearing wear.

The principal parts of the rotor position micrometer are: (1) the spindle, with spindle head attached; (2) the body, attached directly to the turbine casing; (3) the index wheel, which is threaded to the body and graduated to read axial movement in thousandths of an inch; (4) the feeler plate; and (5) the spring. The spindle is cut away at the end, leaving only a half-section.

With the spindle turned as shown in part A of figure 3-25, the protruding half-section rests against the turbine rotor; when it is turned 180°, as shown in part B of figure 3-25, it rests against a projection of the casing. The spindle is kept from turning, when not pulled all the way out, by means of two projecting lugs (on the spindle), a short distance from the spindle head. These lugs slide in slots machined on the inner diameter of the body. When the spindle is not resting against the casing or rotor, the feeler plate is held tightly between the index wheel and the spindle head by the compression of the spring. However, when the index wheel is advanced until the spindle touches the casing or rotor, the spindle head and index wheel separate and allow the feeler plate to become free. The

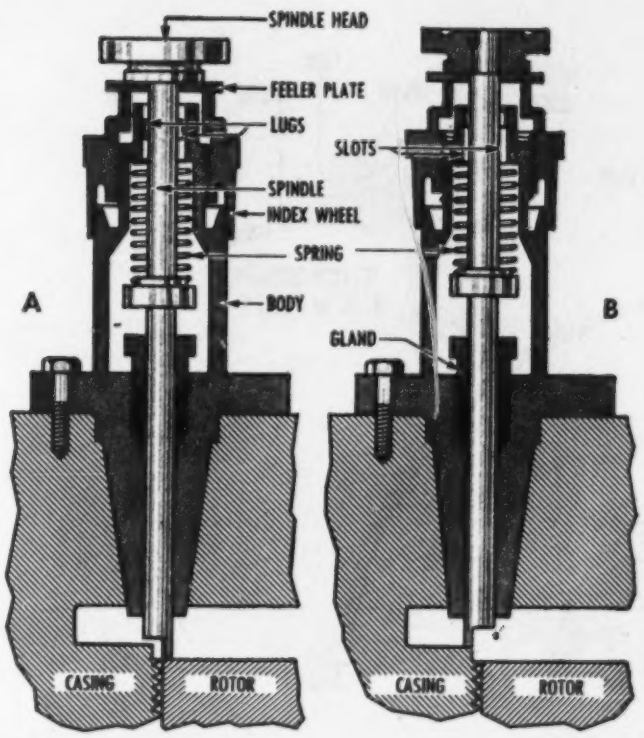

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Figure 3-25.—Rotor position micrometer.

purpose of the feeler plate and spring arrangement is to enable the operator to know when the spindle is just touching the rotor or casing. In addition, the danger of seriously wearing or breaking the spindle end on the rapidly turning rotor is avoided, because the maximum pressure that can be applied to the spindle is that which can be exerted by the spring.

To take a reading, back the index wheel off sufficiently to hold the spindle away from the turbine rotor. Then turn the spindle so that it can rest against the rotor. Then advance the index wheel slowly until the feeler plate is just free (part A of fig. 3-25). With the feeler plate just free, take and record the reading on the micrometer. Next, back the index wheel off, pull out the spindle, and turn it 180° so that it can rest against the casing. Again advance the index wheel until the feeler plate is just free and take another reading (part B of fig. 3-25). The difference between the two readings, taken with the rotor position micrometer, gives the relative position of the turbine rotor and casing. (The reading is taken on the casing as well as on the rotor because a single reading on the rotor would not take into account the wear in the end of the spindle.)

Readings are carefully taken and recorded just after the turbine is installed, and after each overhaul period. (At any future time, readings can be taken and compared with those on record.) Any difference between the readings taken at installation, or at overhauls, indicates thrust bearing wear, which should be checked as soon as possible. The normal oil clearance in the thrust bearing should be given consideration; it should not be mistaken for excessive wear.

Sometimes the rotor position micrometer is installed so that readings can be taken from the dummy piston and cylinder; it may then be referred to as a dummy micrometer.

Modern turbines are equipped with a different type of micrometer which is mounted on the forward end of the turbine shaft, with its spindle in line with the centerline of the shaft. The linear speed of any point on the shaft approaches zero as the point nears the center of the shaft. Thus, when the micrometer spindle touches the center of the shaft, it will suffer negligible wear. Therefore, in taking one reading, instead of two, and comparing that reading with the predetermined safe limits, the axial position of the shaft can be readily determined. This type of rotor position micrometer has an additional advantage in that it does not pass through the casing of the turbine, and therefore does not require a stuffing box and packing gland.

Most modern main turbine installations are equipped with forward and aft clearance indicators. A forward and aft clearance indicator of the type installed on the low pressure turbine of a modern destroyer is shown in figure 3-26. The indicator is located at the forward end of the turbine and provides an easy means of obtaining a check on the forward and aft position of the rotor. When not in use, the lever is held out of contact with the shoulder on the shaft by means of a spring. The indicator is used by moving the stud manually so as to bring the lever in contact with the shaft shoulder. The pointer, at its initial adjustment, indicates rotor center; and the indicator plate is marked to indicate the danger point of deviation (at which point adjustment must be made).

Another means of determining whether the rotor is operating within safe limits is to check the total oil clearance of the thrust bearing. This clearance can be obtained by measuring the end play of the rotor. Methods of taking this measurement for various installations may differ but the basic principle is the

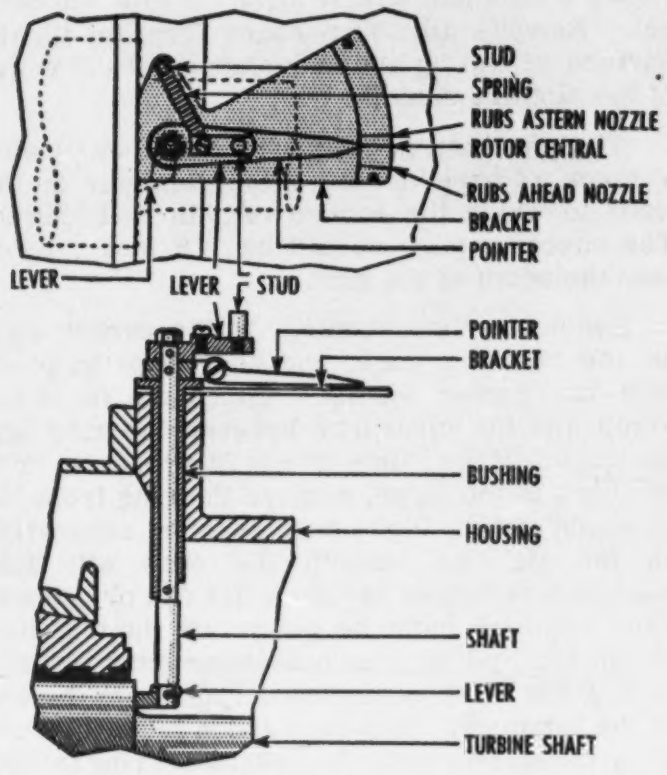

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Figure 3-26.—Axial clearance indicator.

same. With the thrust bearing completely assembled, the rotor is moved (jacked) as far as it will go, first in one direction and then in the opposite direction. The length of travel is measured with a precision instrument, such as a dial indicator.

One method of moving the rotor is as follows: Remove the upper half of the coupling guard and attach the dial indicator to the flanged surface of the bearing cap. To move the rotor forward, apply a bar between the after face of the coupling flange and the face of the adjacent cover. To move the rotor aft, the bar is applied between the forward face of the coupling flange and the face of the bearing cap. In each case a wooden block is used to prevent marring the metal surfaces. The end play (thrust bearing clearance) is obtained from the two readings of the dial indicator. If the end play is within designed limits, the rotor is operating within its allowable limits.

Additional information concerning journal and bearing clearances can be obtained from the manufacturer's technical manual for the specific installation.

MAINTENANCE OF CARBON PACKING RINGS

Carbon packing with an excessive amount of clearance can have adverse effects on turbine operation. If the turbine exhausts to a condenser (under vacuum), a loss of vacuum will occur. If the turbine exhausts to the auxiliary exhaust line, an excessive amount of steam will blow through the packing, eventually causing the shaft to become steam cut. If carbon packing is installed too tight, the shaft will overheat and may become scored. The proper clearance for a specific unit can be obtained by consulting the manufacturer's technical manual.

Care of Carbon Packing Rings

Carbon packing, like all engineroom equipment, requires care and maintenance. You must know how to check and fit carbon rings. When examining packing rings, check all segments carefully for scores, grooves, and general wear. The springs also should be carefully examined and tested. If they are weak or corroded, they must be renewed. Spare packing rings are provided in the ship's allowance of spare parts. The segments of a given packing ring should not be rearranged; always follow the sequence of markings on the ends of the segments. When it becomes necessary to renew or refit carbon packing rings, the detailed specifications and instructions in the manufacturer's technical manual should always be followed for a particular turbine.

If carbon packing rings are in good condition, they will show a uniform glazed surface on the inside diameter. Scoring on the shaft should be carefully removed with an oilstone; be carefully not to reduce the diameter or leave a flat surface on the circumference of the shaft. Carbon packing rings are designed to operate without lubricants other than the natural lubricant contained in them. The presence of even the smallest amount of grease or oil, in any form, will prevent the rings from functioning properly. If the sealing surfaces of a packing housing become scratched or damaged, they should be restored with a very smooth oilstone moistened with kerosene.

Fitting Carbon Packing Rings

Refitting or renewing carbon packing rings is a rather difficult and tedious job. You can

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simplify the work considerably by making up a jig or mandrel, similar to the one shown in figure 3-27, and a checking gage. The jig can be made from a square steel plate or from round bar stock; it should be approximately 3/8 inch thicker than the ring to be fitted, and about 1 1/2 inches greater in diameter (or perimeter, if you are using a square plate) than the inside diameter of the ring. The upper part should be turned down to a diameter which is about 0.001 or 0.002 inch LESS than the final bore required for the carbon ring, and a cutting edge should be raised around the periphery of the turned surface. The cutting edge is made by making diagonal cuts about 0.003 inch deep, with a pitch of about 1/2 inch, on the turned surface. The final diameter of the turned surface, including this raised cutting edge, should be the same as the required inside diameter of the carbon ring.

The width of the turned surface should be about 1/8 inch greater than the width of the carbon ring to be fitted. A small groove should be cut in the shoulder, as an extension of the turned surface; this groove will provide a space in which loose carbon particles can collect, so that they will not interfere with the fitting of the carbon ring.

Cut a 5/16-inch slot through the turned surface, and continue in about 1/8 inch into the shoulder or flange below the turned surface. One edge of the slot must pass EXACTLY through the center, forming a true diameter of the circular face of the jig; the other edge of the slot will therefore be slightly off-center.

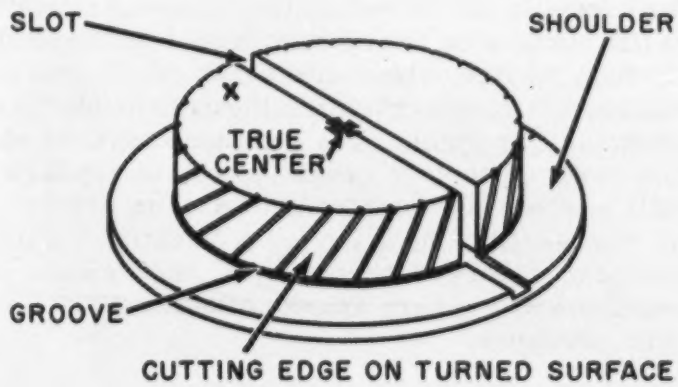

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Figure 3-27.—Jig for fitting carbon packing rings.

Be sure to mark that part of the face which forms a true half-circle after the slot has been cut. Remove all sharp edges from the turned surface of the jig and make sure that the edges of the slot are smooth.

The checking gage can be made by turning a piece of steel to the same diameter as the shaft to which the carbon ring is to be fitted. The checking gage should be 1/8 inch thicker than the width of the ring.

Assemble the segments of the carbon ring on the checking gage, and hold them in place with the garter spring. Check the fit of the joints and the clearance between the ring and the gage. If the joints do not fit properly, or if the bore is too large, remove the ring from the checking gage. Place each segment separately on the jig and smooth the ends with fine sandpaper wrapped around a flat file or a block. Each segment must be placed on the true half of the jig, and the true centerline must be used as a guide when removing carbon from the end of the segment. Remove carbon from the ends of each segment until the assembled ring is TOO SMALL to fit over the checking gage. Then assemble the entire ring, with its garter spring, on the fitting jig. Hold the ring against the bottom of the jig and turn it by hand until the cutting edge on the jig has removed enough carbon to allow the ends of the segments to make proper butt joints.

Remove the carbon ring from the jig and try it on the checking gage. If the ring is too small, put it back on the jig and remove some more carbon from the inner surface of the ring. If the ring is too large, replace each segment on the jig and remove carbon from each end until the ring is the correct size.

When carbon rings are fitted in the manner just described, the ends of the segments will make firm butt joints and there will be a small clearance between the inner surface of the ring and the shaft. On some auxiliary turbines, the carbon rings are designed to rub against the shaft and to have a clearance between the butting ends of the segments. When fitting these rings, make the jig with a diameter which is, including the raised cutting edge, the same as the diameter of the shaft. Rings cut on this jig should make contact with the shaft along the full length of each segment, and the end of the segments should be filed down to make the proper butt clearance.

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CHAPTER 4

REDUCTION GEARS AND RELATED EQUIPMENT

This chapter deals primarily with reduction gears used in geared-turbine drive. It also includes information on related equipment such as bearings and shafting. The information which follows is supplementary to that given in Fireman, NavPers 10520-C.

The REDUCTION GEARS are the mechanisms to which the turbine rotor shafts are coupled, and which, through various arrangements of the gearing wheels, combine, convert, and reduce the high and different speeds of the high pressure and low pressure turbine rotor shafts to a single low speed for the main propulsion shaft and propeller.

A separate individual reduction gear, known as the CRUISING TURBINE REDUCTION GEAR, reduces the speed of the cruising turbine to that of the high pressure turbine shaft—the cruising turbine reduction gear output shaft being coupled to the shaft of the high pressure turbine.

High speed propellers are inefficient, compared to the low speed propellers. They waste much of the horsepower churning up water, instead of using it to move the ship. The turbine speeds are, therefore, geared down to the appropriate speed for the size propeller the ship can carry—hence the term geared-turbine drive.

REDUCTION GEARS

For turbine drives, double reduction gears are normally used. The locked train, or divided power path train gear (fig. 4-1) is used principally for combatant ships. The articulated gear (fig. 4-2) or the nested gear (fig. 4-3) is generally installed on auxiliary ships. The single reduction type (fig. 4-4) is installed on older ships where low turbine speeds permit the use of this gear arrangement.

Propulsion gears, driven by electric motors, are in accordance with figures 4-4 or 4-5. In such installations, either 1, 2, or 4 motors are used.

For diesel engines, where the gear arrangements are also in accordance with figures 4-4 and 4-5, the diesels used (1,2,3, or 4) are generally connected to the propulsion gears by hydraulic clutches, electric clutches, or with a single engine arrangement incorporating an air actuated clutch. Engines which are unidirectional generally have a reversing gear for astern operation. Gas turbines use gear arrangements similar to those for unidirectional diesels.

The construction, operation, and minor maintenance of main reduction gears (used with propulsion turbines) and reduction gears employed on auxiliary turbines, will be discussed in the following paragraphs.

MAIN REDUCTION GEARS

All reduction gearing in current combatant ships has double helical gears. The use of double helical gears produces a smoother action of the reduction gearing and avoids tooth shock. Since the double helical gear has two sets of teeth at complementary angles to each other, axial thrust, such as is developed in single helical gears, is eliminated. One member of a herringbone gear set should be capable of axial float in order to prevent excessive tooth loads due to mismatch of the two halves of the gear. Double helical gears can be made larger due to the absence of axial thrust. Double helical gears which have large helix angles and small teeth tend to run more quietly than those with small helix angles and large teeth.

Reduction gears are classified by the number of steps used to bring about the speed reduction and the arrangement of the gearing. When two gears are run together and the driving gear is larger than the mating gear, the gear is referred to as a speed increaser. When the driving gear is smaller than the mating gear, it is referred to as a speed decreaser. The ratio of the speeds is proportional to the diameters of the pinion

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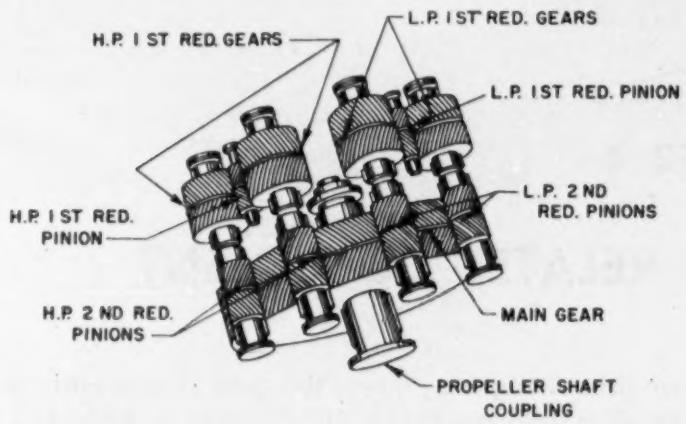

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Figure 4-1.—Locked train, double reduction gear.

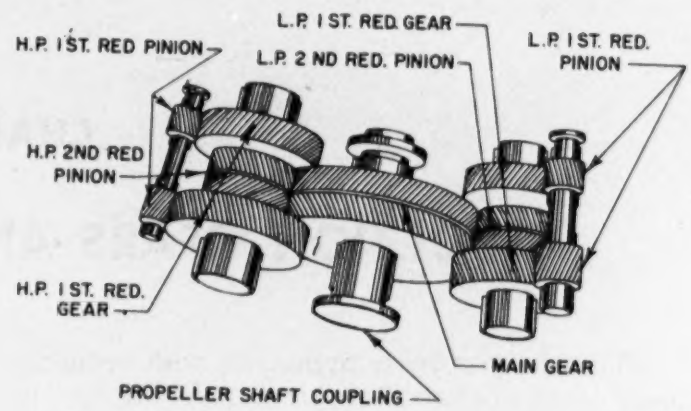

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Figure 4-3.—Nested type, double reduction gear.

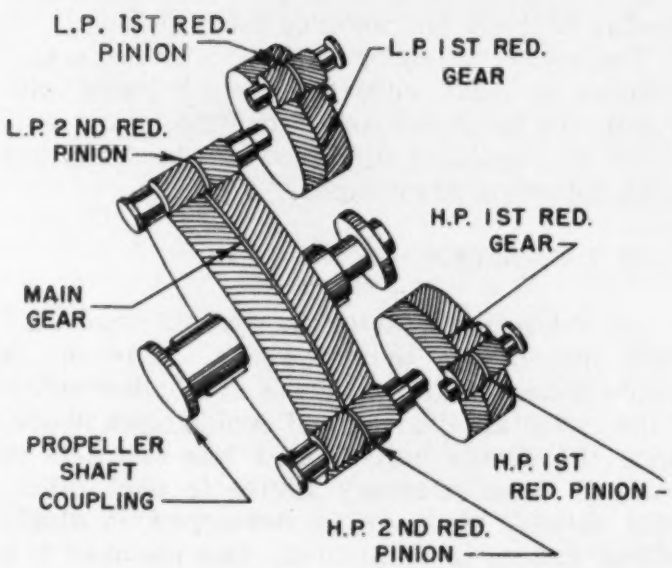

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Figure 4-2.—Articulated, double reduction gear.

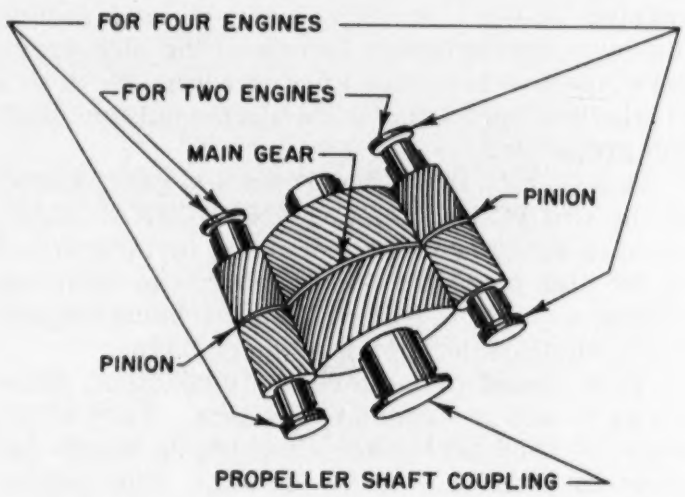

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Figure 4-4.—Two pinion, single reduction gear.

and gear. When there are just two gears, the train is known as a single reduction gear (single speed increaser). Double reduction gears are used to keep the size of the bull (large) gear, attached to the propeller shaft, from becoming too large.

Shipboard Applications

In a double reduction gear, a high speed pinion, connected to the turbine shaft by a flexible coupling, drives an intermediate first reduction gear connected to a shaft having the second reduction pinion fastened to the other end.

When a single first reduction gear and the second reduction pinion each have two bearings and are connected by a quill shaft, the design is called ARTICULATED. This type of design (fig. 4-2) is found on some of the recently built submarines.

When a single high speed pinion is driving two intermediate first reduction gears connected by a quill shaft to two separate second reduction pinions (each gear and pinion mounted in its own

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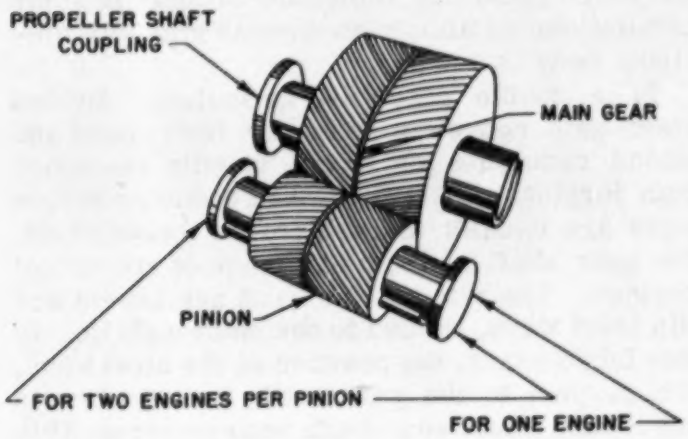

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Figure 4-5.—One pinion, single reduction gear

two bearings), this is known as a LOCKED TRAIN GEAR. This type design is found aboard such ships as DLGs and DD692 destroyers.

In order to obtain an economical use of the fuel, a small turbine is used on the DD692 class destroyer. This turbine, called the cruising turbine, is connected to the high pressure turbine through a single reduction gear. The cruising turbine and the pinion are bolted together and supported on three bearings. The direction of rotation of the cruising turbine is such as to cause the pinion bearing reaction to be in the upper half of the bearing. The HP and LP turbines are connected to the reduction gear by double ended "dental" tooth, or gear, type flexible couplings.

The reduction gear shown in figure 4-2 is a parallel shaft, divided path, articulated reduction gear. The high speed high pressure pinion drives one first reduction gear. The second reduction pinions are coupled to these gears by dental tooth type flexible couplings and a quill shaft. Each gear and each pinion is supported in its own bearings.

In other ships, the economy of operation is accomplished by using a combination HP-IP turbine. For low power, the high power, intermediate pressure (IP) and low pressure turbines operate in series. As speed and power are increased, the high pressure and intermediate pressure turbines operate in parallel and in series with the low pressure turbine. The DDG class destroyers use this turbine arrangement. The reduction gear arrangement driven by the HP-IP turbine is similar to the DD692 reduction gear.

The nested type double reduction gear (fig. 4-3) employs no quill shafts and uses a minimum number of bearings and flexible couplings. This type gear, which is the simplest of all double reduction gears, is used on many auxiliary ships.

Construction of Main Reduction Gears

The gears in a main reduction gear unit (main gears and pinions) operate at high rotational speed and must be capable of transmitting tremendous power loads. Since even very slight unevenness of tooth contour and tooth spacing would cause the gears to operate noisily or even to fail, special precautions are taken to manufacture the gears to very close limits. The gears are cut in rooms in which the temperature and humidity are kept constant. Expansion and contraction of the gear-blank, during machining, are negligible; oxidizing, due to moisture in the air, is virtually eliminated. In addition, all gears are carefully checked for errors.

CASINGS.—Except for some small units, gear casings are of welded construction. Most gears have an upper and a lower casing and gear case covers. These casings are of box-girder construction with integral-bearing blocks. The low speed gear-bearing housing is an integral part of the lower casing. Gear case covers, bolted to the upper casing, are arranged so that their removal provides access to gearing and bearing caps. Inspection plates are provided in covers and gear cases so that the rotating parts may be sighted.

Casings are arranged for access to spray fittings so that fittings may be removed and cleaned. Turning gears, tachometer drives, sight flow and thermometer fittings, and thermocouples or RT junction boxes are attached to gear casings.

GEARS.—In general, pinions are forged steel, as shown in figure 4-6. Where pinions are very large, their construction is similar to gear wheels. For minesweeper applications, pinions are made of aluminum-bronze or non-magnetic steel.

The gear wheel construction and materials depend upon the size. For small gears, the entire gear wheel may be made from a single steel forging. Large gears are generally built

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Block III - General Servicing

Unit 4 - Color Television Receivers

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Analyzing color television circuits	Theory of color The color transmitter The color receiver Antenna Tuner Picture IF section and detector Sound section AGC system Luminance amplifier Sweep section Chroma amplifier and color sync section I and Q demodulator section Color matrix section Color picture tubes
Servicing color receivers	Color tube adjustments Positioning Deflection yoke Converging-coil and magnet assembly Color purifying magnets or coils Blue beam positioning magnet
Adjusting for high voltage	High voltage adjustments
Purifying color	Color purity adjustments
Correcting for size and linearity	Size and linearity adjustments
Adjusting convergence	Convergence adjustments
Correcting black and white defects	Convergence troubles Color purity Color flashes in picture
Correcting defects in color reception	No color Loss of color sync Improper color rendition

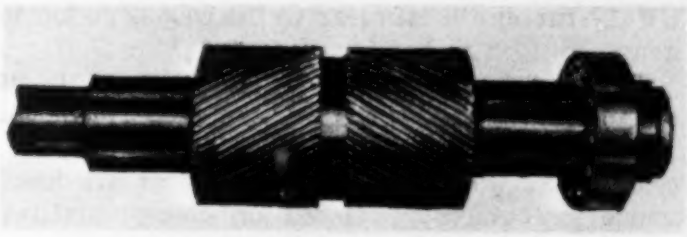

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Figure 4-6.—Forged steel pinion.

up by welding. These sections usually are the shaft, the hub or center (which may be omitted when the webs are welded to the shaft), the webs, and the rim in which teeth are cut. The shaft is always of forged steel. Where propeller-thrust bearings are located within the propulsion gear casing, a removable collar is located at the forward end of the low speed gear shaft, or an integral flange for attachment of thrust bearing facing collars is located on the after-end of the shaft, forward of the flange, for connecting to the line shaft. Other types of construction used consist of a close-grained cast steel body welded to a shaft, with teeth cut directly in the casting or a cast-steel body pressed on a shaft and secured by fore and aft shrink rings and a locknut. Figure 4-7 illustrates a typical first reduction gear. Figure 4-8 shows a bull gear with flange for an after-thrust bearing. For minesweepers, gears are generally aluminum-bronze; in some installations an aluminum-bronze rim with aluminum body is used.

In a double reduction articulated divided power path reduction gear, the high speed and second reduction pinion are usually machined from forgings. The first and second reduction gears are usually of a fabricated construction. The gear shaft and rim are made of good steel forgings. The rim and the shaft are assembled with steel webs, welded to the shaft and rim. In wide faced gears, the position of the steel webs, with respect to the gear teeth, is important in that it may affect gear tooth wear patterns. This assembly is stress relieved and heat treated for desired hardness.

Some gears are rough cut prior to heat treatment and the final finish operation will bring them to the proper size. The journals are then cut slightly oversize to permit a final finishing operation. The teeth are cut in a temperature controlled room. The cutting operation is a continuous operation; this avoids the heat generated in cutting from affecting the roundness of the finished gear. The air temperature control prevents changes in the ambient temperature from affecting the roundness of the gear. When the tooth cutting and the finishing operations are completed, the journals are finished so that they are concentric with the axis. The assembly is then balanced. The bull gear is made in a similar

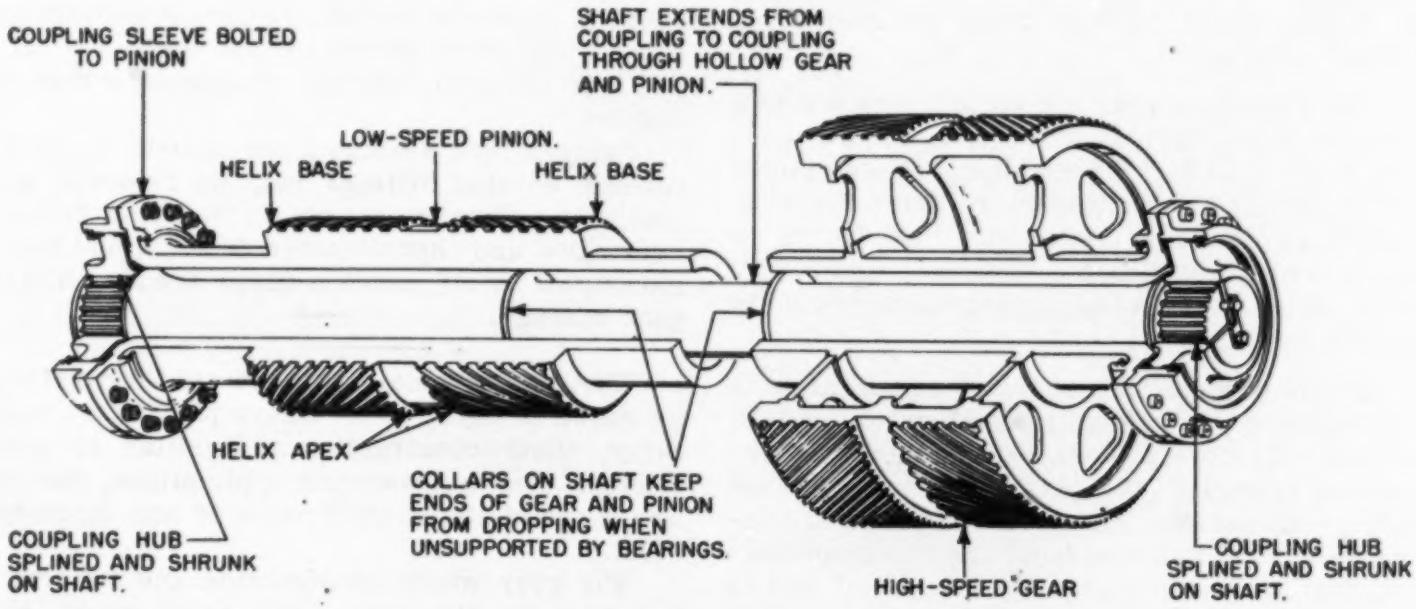

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Figure 4-7.—Cutaway view of intermediate rotor assembly (first reduction gear).

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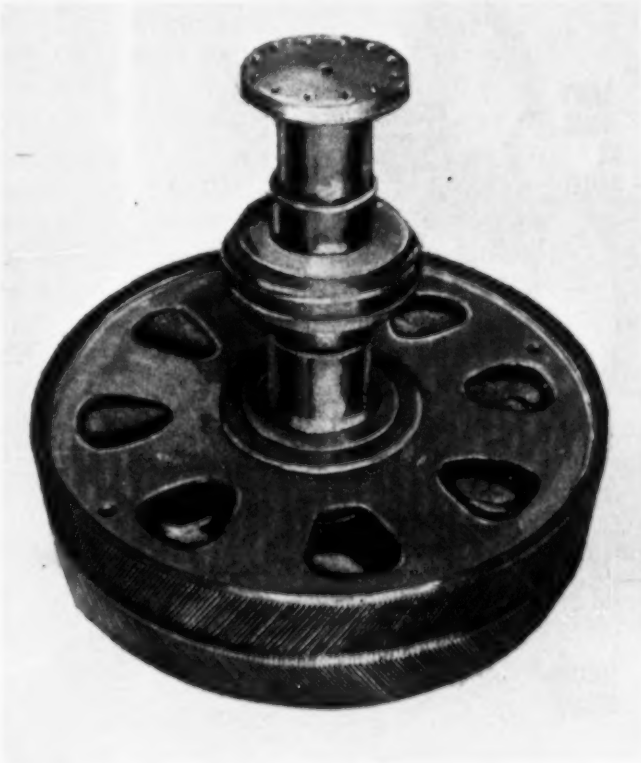

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Figure 4-8.—Bull gear with flange.

fashion. Some first reduction gear and bull gears in naval use are keyed and locked in place with a locking device. When the gears are all completed, the contact is checked in a gear rolling machine before they are assembled in the gear case.

FLEXIBLE COUPLINGS.—Flexible couplings provide longitudinal flexibility between the turbine shaft and the pinion gear shaft. This permits each shaft to be adjusted axially to its proper position.

In most installations the flexible couplings are of the gear type. Power is transmitted through a floating intermediate member with external teeth that mesh with the internal teeth of the shaft rings (sleeve) mounted on the driving and driven shafts.

Figure 4-9 illustrates the design of the gear type flexible couplings that connect the main turbines to the high speed pinions of the main reduction gear. The couplings also allow for expansion of the turbine shafts, and take care of any slight misalignment between the main turbines and the reduction gears.

The design of the flexible couplings, which connect the first reduction gears and the second reduction pinions, is shown in figure 4-10. In this case, a quill shaft of high torsional flexibility is used, as the floating member, to obtain equal distribution of the load among the several elements of the gear train. The quill shaft runs inside the hollow bore of the intermediate speed gear and slow speed pinion. Figure 4-10 illustrates how flexibility is obtained between the first reduction gear and the second reduction pinion.

A flexible coupling is installed in the shaft between the cruising turbine reduction gear and the high pressure turbine. Figure 4-11 shows a flexible coupling such as is used on destroyers. In this coupling, the floating member is the two sleeves which are bolted together; the internal teeth of the sleeves mesh with the external teeth of the hubs mounted on the shaft.

Steady streams of oil from the supply passages of adjacent bearings are directed into the coupling when the reduction gears operate. The oil is caught by projecting lips of the turbine and pinion flanges (see fig. 4-9). Centrifugal action forces oil through the horizontal holes in the flanges to the coupling teeth. Oil is discharged from the teeth into coupling guards and then flows into the oil drain system.

TURNING GEARS.—All geared turbine installations are equipped with an electric motor-driven jacking or turning gear. A typical turning (jacking) mechanism is illustrated in figure 4-12. The unit is used for turning the main engine during warming-up and securing periods so that the turbine rotor may heat or cool evenly. (The rotor of a hot turbine or of one that is in the process of being warmed up, with gland sealing steam cut in, will become bowed or distorted if left stationary even for a few minutes.) The turning gear is used for other routine purposes such as for turning the engine in order to bring the reduction gear teeth into view during routine inspection. In addition, the turning gear is used for the required daily jacking of the main engines.

The turning gear (fig. 4-12) is mounted on top and at the after end of the reduction gear casing. A shaft, extending from the end of the high pressure first reduction pinion over the bull gear to the after end of the reduction gear casing, connects to the turning gear by means of a manually operated jaw clutch. Engaging this clutch connects the pinion to an electric motor, through a train of gears, which usually consist of one or more sets of worm gears and one or more sets of spur or helical gears. Engaging the clutch and

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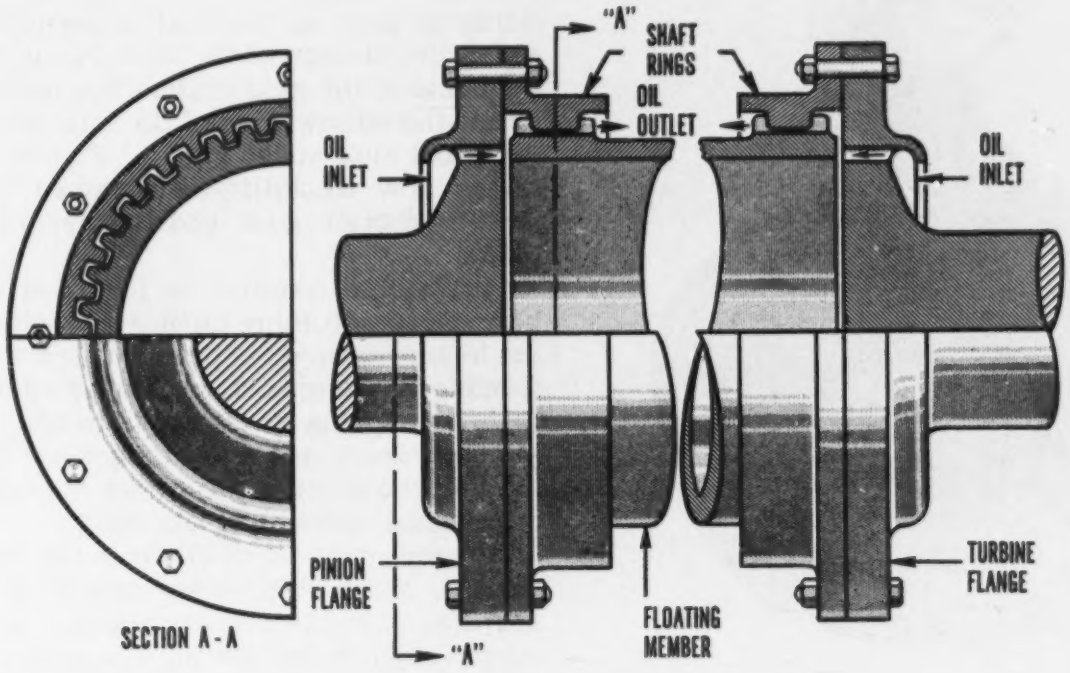

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Figure 4-9.—Gear type flexible coupling.

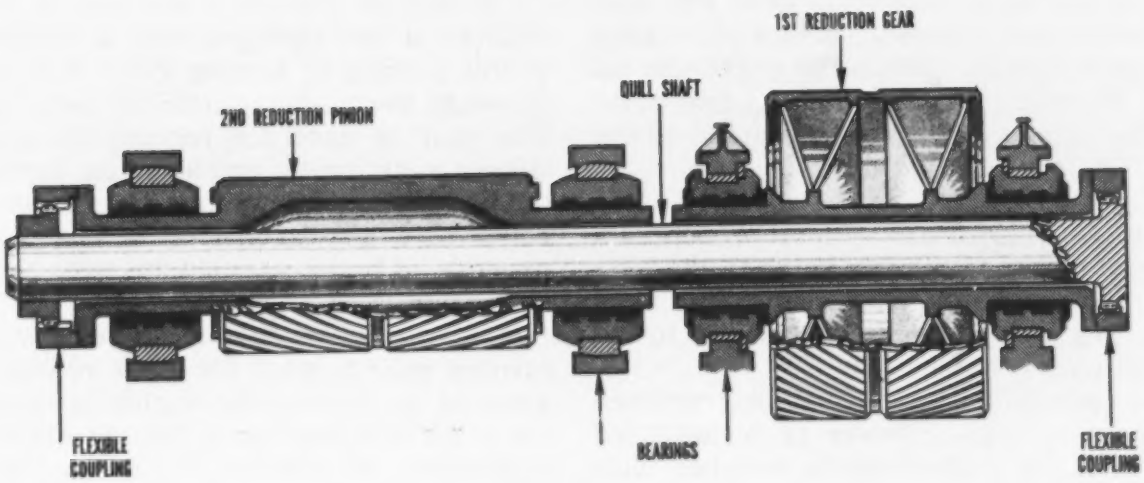

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Figure 4-10.—Quill shaft assembly.

operating the motor will turn the high pressure first reduction pinion, causing the reduction gears, the main engines, and the main (propeller) shaft to turn. On some installations, the reduction ratio between the main shaft and the electric motor may be as high as 17,000 to 1; with the motor turning and the turning gear engaged, the main shaft will make one and one quarter turns in approximately 15 minutes. Because of this high ratio, if the shaft was allowed to turn under steam at 1 rpm, the motor would overspeed and be seriously damaged.

The turning gear is equipped with a shaft locking device (fig. 4-13) which is used when it

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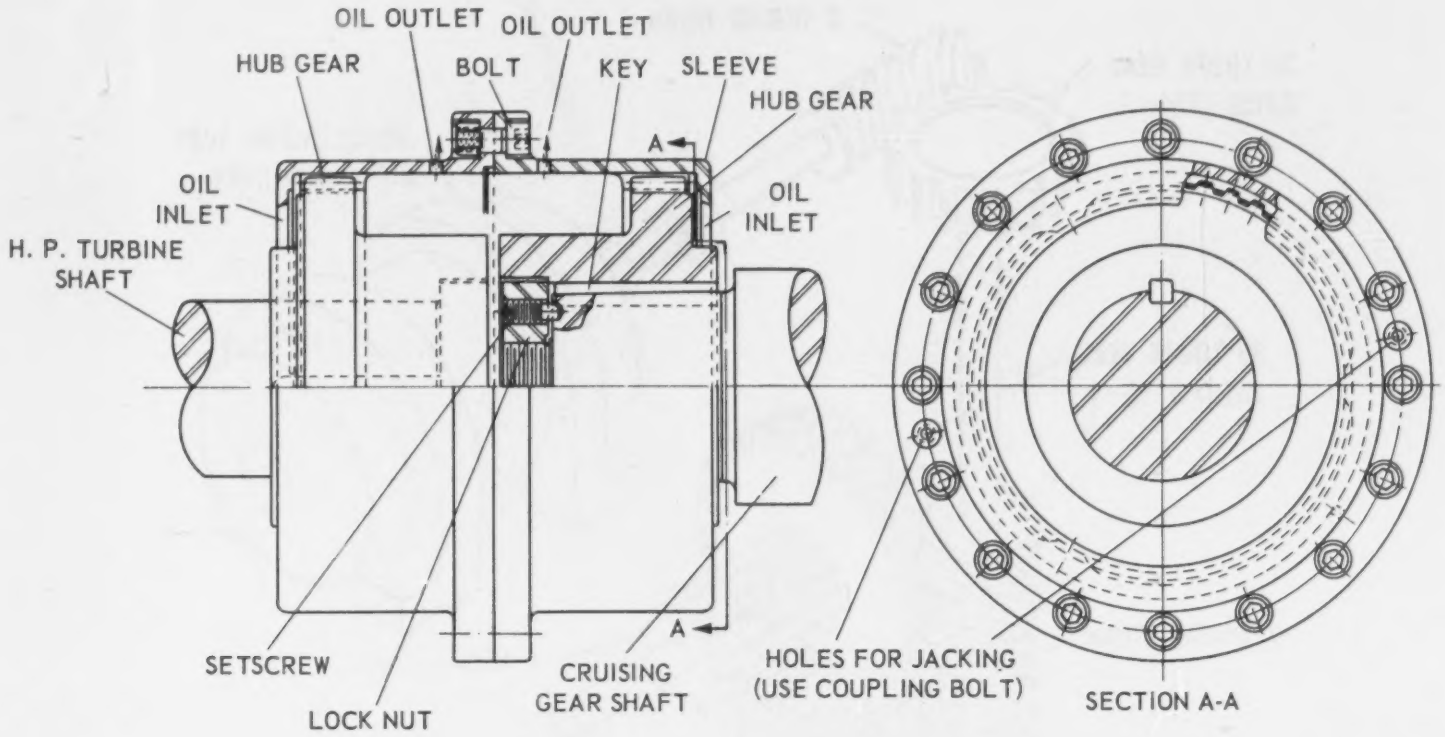

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Figure 4-11.—Flexible coupling between the cruising gear and the high pressure turbine.

becomes necessary to lock a shaft against rotation while underway. A friction brake is installed on the first reduction worm shaft. Either a brake drum is mounted on the worm shaft or the shaft coupling serves as a drum.

With the jacking gear engaged and the brake set, a ship can go ahead on its other engines and the idle shaft will be held stationary. All geared turbine-drive ships have electric motor-driven turning gears similar to that shown in figure 4-14. This figure also illustrates a clamp-type brake used for locking the motor shaft. Some turning gears have positive locking devices which use internal and external gear teeth in engagement. Turning gear operated by air motors or by hand is generally used where continuous turning is not required.

In order to engage the jacking gear clutch it is necessary to first stop the shaft, either by stopping the ship or by using the astern turbine to stop and then hold the shaft stationary. Never, under any circumstances, attempt to engage the jacking gear with the shaft turning. Regardless of how slow the propeller shaft movement may be, damage to the motor or gears, or both, will occur.

REDUCTION GEARS FOR AUXILIARY MACHINERY

In the previous section of this chapter, main reduction gears of the double helix, double reduction type, were discussed. In smaller units of engineroom machinery, such as turbogenerators and turbine-driven pumps, there are different types of reduction gears.

Turbogenerators

On modern combatant ships, ship's service turbogenerators generally use a single reduction, single helix type of reduction gearing. An example of this type is found on the DD-692 class destroyers. A gear ratio of 8.3825 reduces the turbine speed of 10,059 rpm to the generator speed of 1200 rpm. The pinion is forged integral with the shaft. One end of the pinion shaft is flanged and bolted rigidly to the turbine shaft. On the other end, a high speed thrust bearing is mounted to maintain the axial position of the pinion and turbine rotor. The gear wheel is a steel forging, pressed and keyed on its shaft. One end of the shaft is coupled solidly to the

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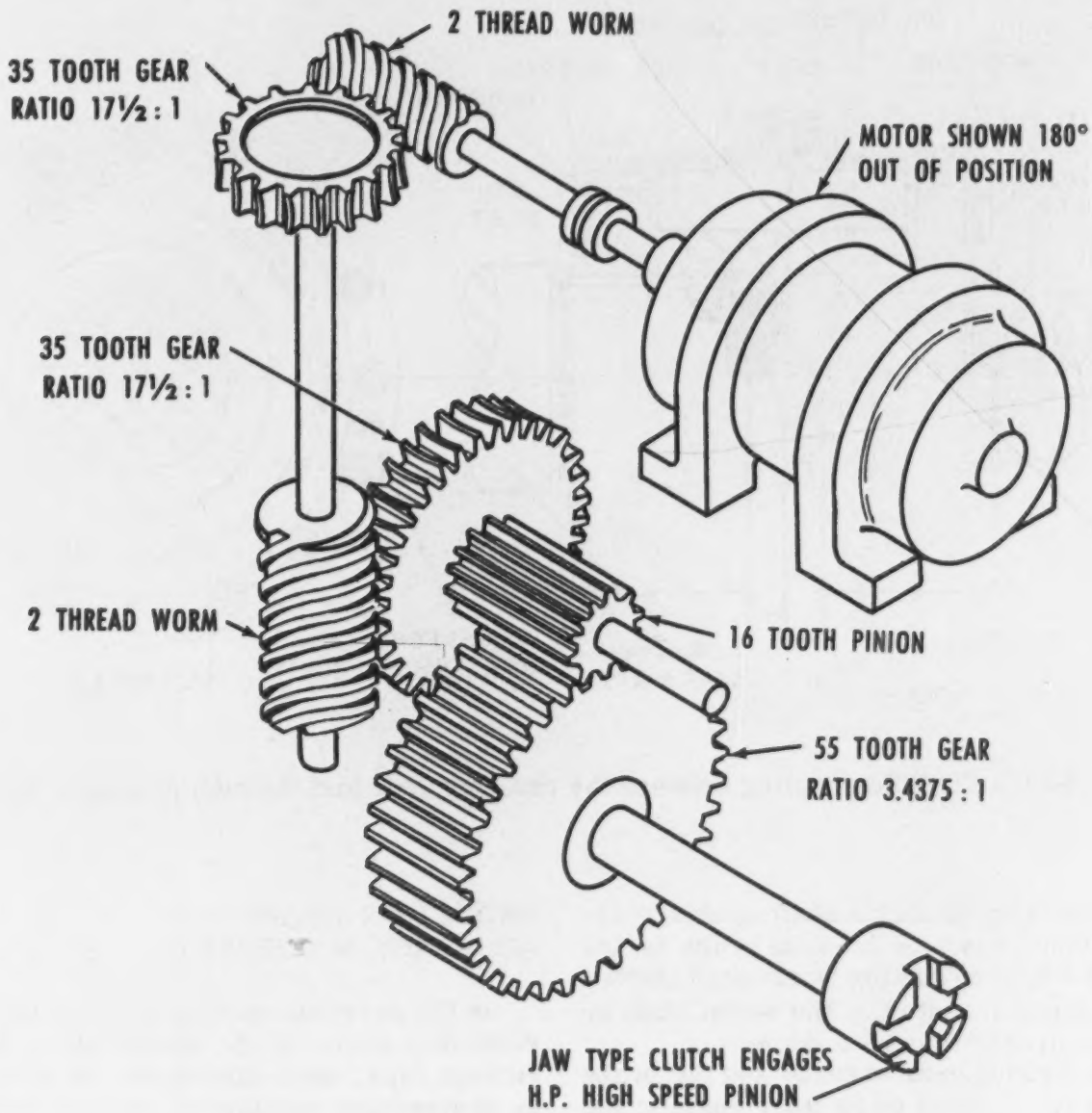

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Figure 4-12.—Jacking gear mechanism.

generator shaft, the turbine end is extended to carry the gear that drives the oil pump and governor.

Main Circulating Pumps

Turbine-driven main circulating pumps employ single reduction, double helical gears with a ratio of about 8 to 1. These gears reduce the turbine speed of approximately 5000 rpm to the pump speed of 600 rpm. Lubrication of the reduction gear is provided by a gear type pump mounted on the lower end of the pinion shaft. Oil is sprayed through an orifice into the space between the gear teeth.

The weight of the combined rotating element of the pump and the driving unit is carried on a Kingsbury-type thrust bearing which supports a collar mounted at the upper end of the reduction gear shaft. The weight of the turbine rotor and pinion shaft is transmitted to the Kingsbury thrust bearing through the teeth of the double helical reduction gear.

The pinion is a solid forging, while the gear is constructed by welding a forged hub, forged rim, and plate sidewalls. The gear hub is bolted to a spider which is keyed to the gear shaft and

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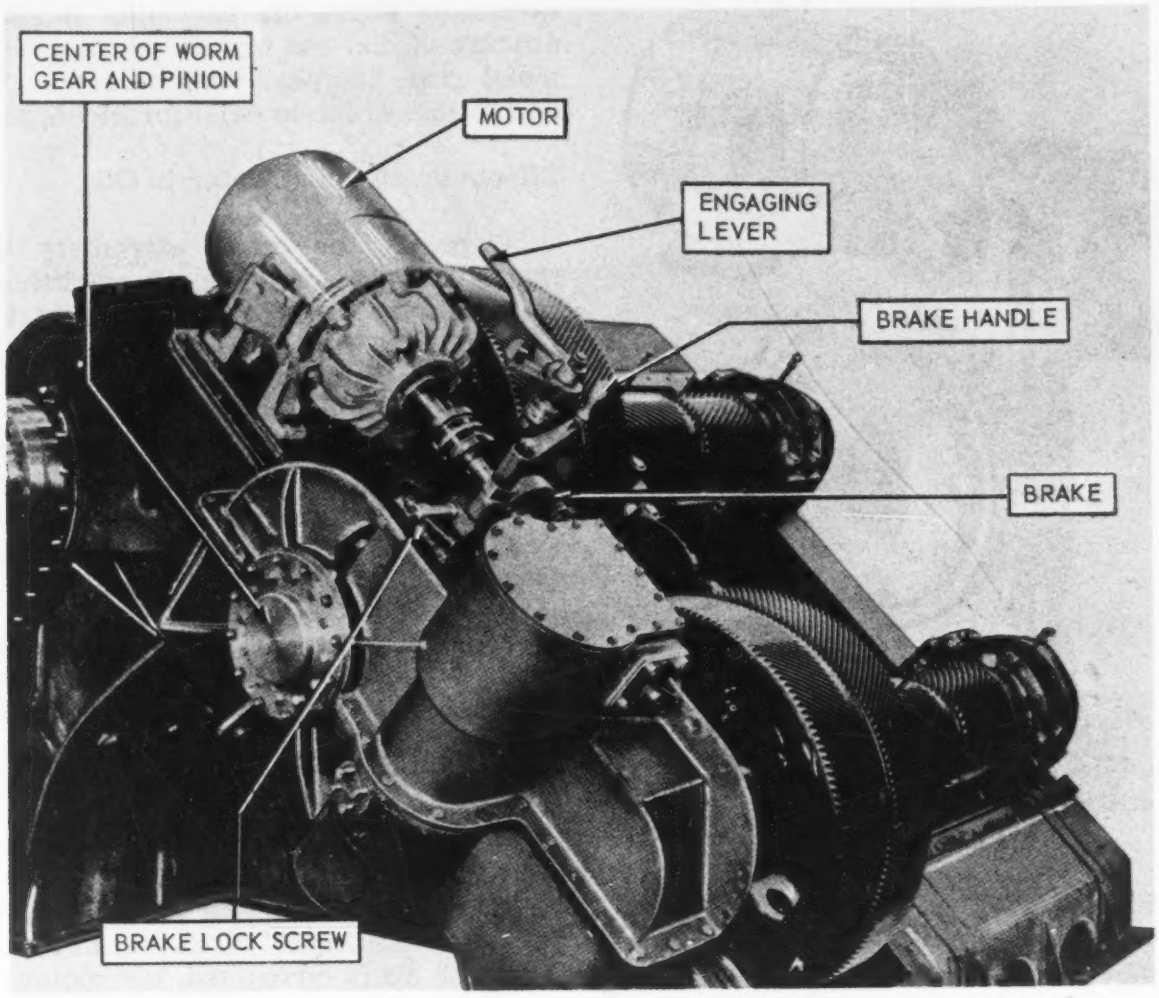

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Figure 4-13.—Main reduction gear after end, high pressure side, showing turning gear and propeller locking mechanism.

held in place by the thrust collar which screws on to the shaft and locks with a setscrew.

Main Condensate Pumps

The condensate pump gear reduction frequently uses the worm type design to obtain good pump efficiencies at lower speed. The worm shaft and worm wheel reduce the turbine speed of 5534 rpm to the pump speed of 1145 rpm. The worm is cut in a solid, low carbon, nickel-steel forging. It is carried in two babbitt-lined split sleeve bearings and is located axially by a collar type thrust element. One end is tapered for mounting the turbine wheel while the other is squared for the application of a turning wrench.

The worm wheel is a solid, nickel-bronze casting; it is pressed on a forged steel shaft which carries the drive pinion for the speed limiting governor and the driving half of the main pump coupling. The gear casing is cast steel, specially designed to form a rigid support for the rotating elements. The gear case is of rugged construction to ensure proper alignment of the driving and driven elements, and is split horizontally to allow assembly and disassembly. The gear unit has a separate, closed pressure oil system; the bottom half of the gear casing serves as the oil sump.

REDUCTION GEAR CARE AND OPERATION

Compared with other units of engineroom machinery, reduction gears require very little

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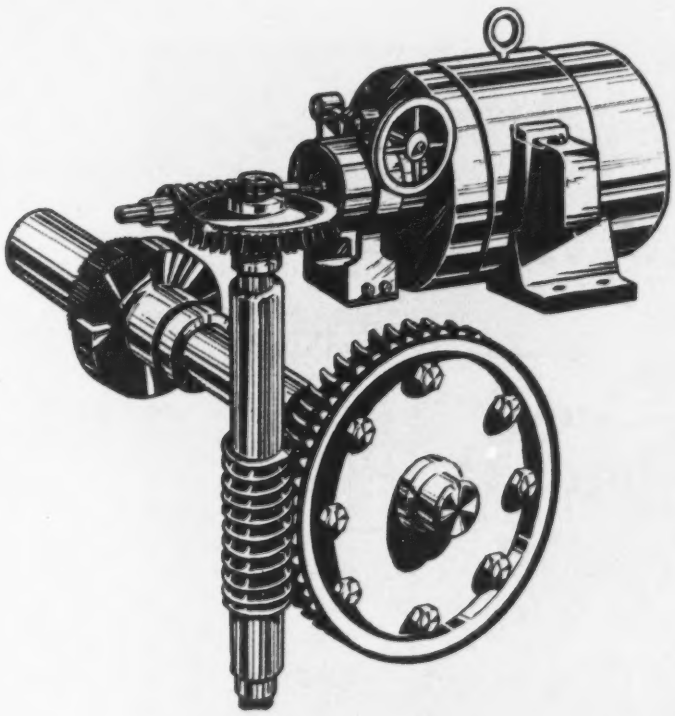

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Figure 4-14.—Rotating parts of electric motor-driven turning gear.

care. With clean, pure oil at the designed pressure and temperature, reduction gears may operate successfully for several years.

Lubrication

Efficient lubrication of reduction gears is of utmost importance. Oil at the designated working pressure and temperature must be supplied to the gears at all times while they are being turned over, either with or without load. Lubricating oil, Navy symbol 2190T or 2190 TEP is used for the main reduction gears as well as for the turbines. Clean, pure oil is essential if long life and successful operation of the gear is desired.

Oil must be free from all impurities—especially such impurities as water, dirt, grit, and metallic particles. Care must be taken to remove metal flakes and fine chips as new gears are being worn into a working fit. Lint or dirt, if allowed to remain in the system, will clog the oil spray nozzles that lubricate the gears. Keep oil spray nozzles open at all times. Never alter the oil spray apparatus without proper authority.

Fine metallic particles which are not picked up by the magnets in the lube oil strainers, or dirt which may get through the strainers, may become embedded in the babbitted bearings and eventually score the journals. In addition, the mixture of dirt and metallic particles may erode metal from the gear teeth surfaces. The solution to this problem calls for clean, purified oil.

Effects of Acid and Water in Oil

Water in the oil is extremely dangerous. Even small amounts soon cause pitting and corrosion of the teeth. Acid is equally dangerous. The oil must be tested frequently for water as well as for acid content.

Corrective measures must be taken when salt water is found in the reduction gear lubricating oil system. Occasionally gross contamination of the oil by salt water occurs when a cooler leaks or when leaks develop in a sump which is integral with the skin of the ship.

Immediate location and sealing of the leak or removal of the source is not enough. Steps must also be taken to remove the contaminated oil from all steel parts and surfaces. Postponement of such treatment may cause badly corroded and pitted gears, journals, and couplings, in addition to burned-out bearings.

When the main engines are secured, the oil should be circulated until the temperature of the oil and of the reduction gear casing approximates the ultimate engineroom temperature. While the oil is circulated, the cooler should be operated and the engine should be jacked continuously. The purifier should also be operated while the oil is being circulated, and after circulation until water is no longer discharged from the purifier. This procedure will eliminate condensation from the interior of the main reduction gear casing.

Sump Oil Level

Since the reduction gears are located directly above the lubricating oil sump tank, positive means should be taken to ensure that the bull gear wheel will not dip into the oil. The proper oil level in the sump is indicated by a liquid level indicator. This oil level indicator registers two indications—normal level and low level. If the bull gear is permitted to rotate in the oil, the churning action will aerate the oil and cause the oil temperature to rise. Oil churning can also prevent full speed operation of the shaft. This condition can be noted by an overflow of foaming oil from the escape vent in the top of the

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gear casing. If this occurs, the engines must be slowed or stopped until the excess oil can be removed and normal conditions restored.

Unusual Sounds

A properly operating reduction gear has a certain definite sound. Any unusual noises from the reduction gears should be investigated. The gears should be operated with caution until the cause is discovered and remedied.

BEARINGS

Although bearings in main propulsion units vary greatly in size, composition and lubrication requirements, their purposes are the same. Bearings are used to guide and support rotating or reciprocating elements and to prevent free axial or radial movement of these elements. Radial or journal bearings are designed to carry loads applied in a plane perpendicular to the axis of the shaft. Thrust bearings are designed to carry loads applied in the same direction as the axis of the shaft and are used to prevent free endwise movement.

Lubrication of bearings differs. For example, babbitt-lined bearings are lubricated by an approved lubricating oil while stern tube and strut bearings, which are lined with hardwood or a rubber composition, are salt water lubricated. Bearings are designed to operate with a small oil clearance (the difference between the outside diameter of the journal and the inside diameter of the bearing is the oil clearance) which must always be maintained. With proper clearances and proper lubrication, bearings may operate successfully for many years. The information given in this training course is of a general nature. Additional information may be obtained from chapter 9430 (43) of Naval Ships Technical Manual. For details concerning a particular unit, consult the manufacturer's technical manual.

MAIN REDUCTION GEAR AND PROPULSION TURBINE BEARINGS

Reduction gear bearings must not only support the weight of the gears and their shafts, but they must also hold the shafts in place against the tremendous forces exerted by the shafts and gears when they are transmitting power from the turbine shaft to the propeller shaft. Like other radial bearings in main engine installations, these bearings are of the babbitt-lined split type; however, instead of being spherically seated and self-aligning, the reduction gear bearings are rigidly mounted, and doweled into the bearing housings. The angular direction of the forces acting upon a main reduction gear bearing changes with the amount of propulsion power being transmitted by the gear. In order to obtain the best bearing performance when load is the greatest, reduction gear bearings must be positioned so that the heavy shaft load is not brought against the area where the bearing halves meet (the split). For this reason most of the bearings in a reduction gear are placed so that the split between the halves is at an angle to the horizontal plane.

Turbine bearings, unlike reduction gear bearings, are self-aligning. This feature is obtained by providing a spherical seat for the bearing shells. Turbine bearings are pressure lubricated by means of the same forced-feed system that lubricates the reduction gear bearings.

MAIN THRUST BEARINGS

The main thrust bearing, which is usually located in the reduction gear casing, serves to absorb the axial thrust transmitted through the shaft from the propeller.

Kingsbury or pivoted segmental shoe thrust bearings of the type shown in figure 4-15 are commonly used for main thrust bearings. This type of bearing consists of pivoted segments or shoes (usually six) against which the thrust collar revolves. Ahead or astern axial motion of the shaft, to which the thrust collar is secured, is thereby restrained by the action of the thrust shoes against the thrust collar. These bearings operate on the principle that a wedge-shaped film of oil is more readily formed and maintained than a flat film and that it can therefore carry a heavier load for any given size.

In a segmental pivoted-shoe thrust bearing, upper leveling plates upon which the shoes rest and lower leveling plates equalize the thrust load among the shoes (fig. 4-16). The base ring, which supports the lower leveling plates, holds the plates in place and transmits the thrust on the plates to the ship's structure. Shoe supports (hardened steel buttons or pivots) located between the shoes and the upper leveling plates enable the shoe segments to assume the angle required to pivot the shoes against the upper

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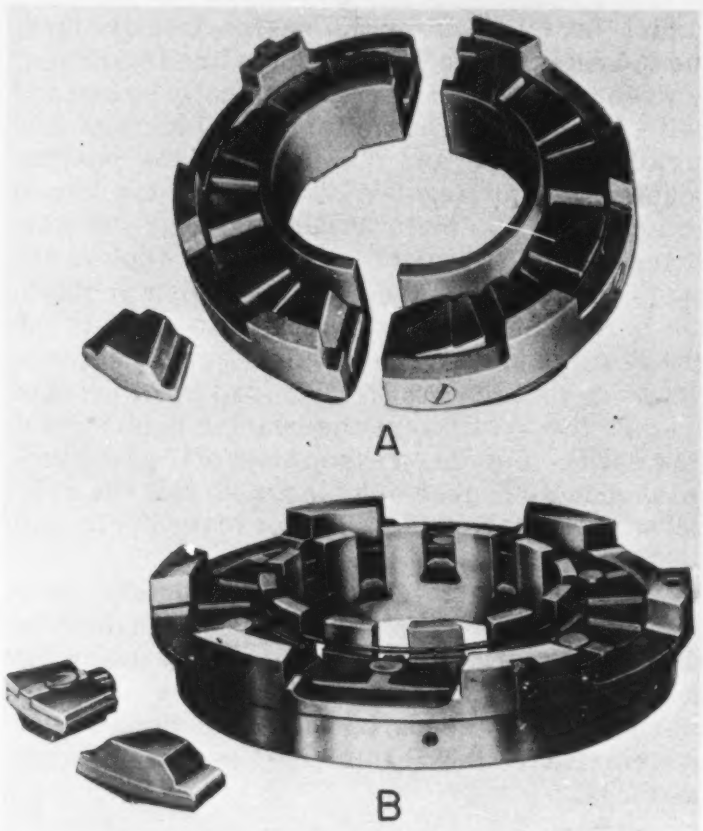

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Figure 4-15.—Kingsbury pivoted-shoe thrust bearing.

leveling plates. Pins and dowels hold the upper and lower leveling plates in position, allowing ample play between the base ring and the plates to ensure freedom of movement (oscillation only) of the leveling plates. The base ring is kept from turning by its notched construction, which secures the ring to its housing.

Lubrication of the main thrust bearing is provided by the same system which furnishes oil to the turbine bearings, reduction gears, and flexible couplings—if located in with the reduction gear casing. While rotating the engines by turning gear, backing down, or by going ahead slowly, oil is supplied by an electric- or a turbine-driven gear pump. When the shaft speed is increased sufficiently, a shaft- or chain-driven gear pump, where fitted, supplies oil to the bearing and the electric- or turbine-driven pump is placed in a standby condition. The shaft speed at which the shaft- or chain-driven pump provides all lubrication will vary with the type of ship. For additional information, consult the manufacturer's technical manual or equipment.

MAIN PROPULSION SHAFT BEARINGS

You will be required to watch and maintain the main propeller shaft bearings. The bearings which support and hold the propulsion shafting in alignment are divided into two general groups; the main line shaft bearings or spring bearings, and the stern tube bearings and the strut bearing.

Main Line Shaft Bearings or Spring Bearings

These bearings are of the ring-oiled, babbitt-faced, spherical seat, shell type. This bearing (see fig. 4-17) is designed primarily to align itself to support the weight of the shafting. In many of the older, low powered ships, the bearing is not of the self-aligning type and consists only of a bottom half. The upper half of the assembly consists only of a cap or cover (not in contact with the shaft) to protect the shaft journal from dirt. The spring bearings of all modern naval ships, however, are provided with both upper and lower self-aligning bearing halves.

The brass oiler rings, shown in figure 4-17, hang loosely over the shaft journal and the lower bearing half, and are slowly dragged around by the rotation of the shaft. As they glide through the reservoir of oil at the bottom the rings carry some of the oil along to the top of the shaft journal. The upper bearing half is grooved or provided with guides to accommodate and align the rings.

Spring bearing temperatures and oil levels should be checked hourly while underway. At least once each year, the bearings should be inspected, clearances taken and defects corrected.

Stern Tube and Stern Tube Bearings

The hole in the hull structure for accommodating the propeller shaft to the outside of the hull is called the stern tube. The propeller shaft is supported in the stern by two bearings—one at the inner end and one at the outer end of the stern tube—called stern tube bearings. At the inner end of the stern tube is a stuffing box packing gland (fig. 4-18) generally referred to as the stern tube gland. The stern tube gland seals the area between the shaft and stern tube and yet allows the shaft to rotate. Construction of the stern tube bearings is similar to that of the strut bearings. (See the next section of this chapter.)

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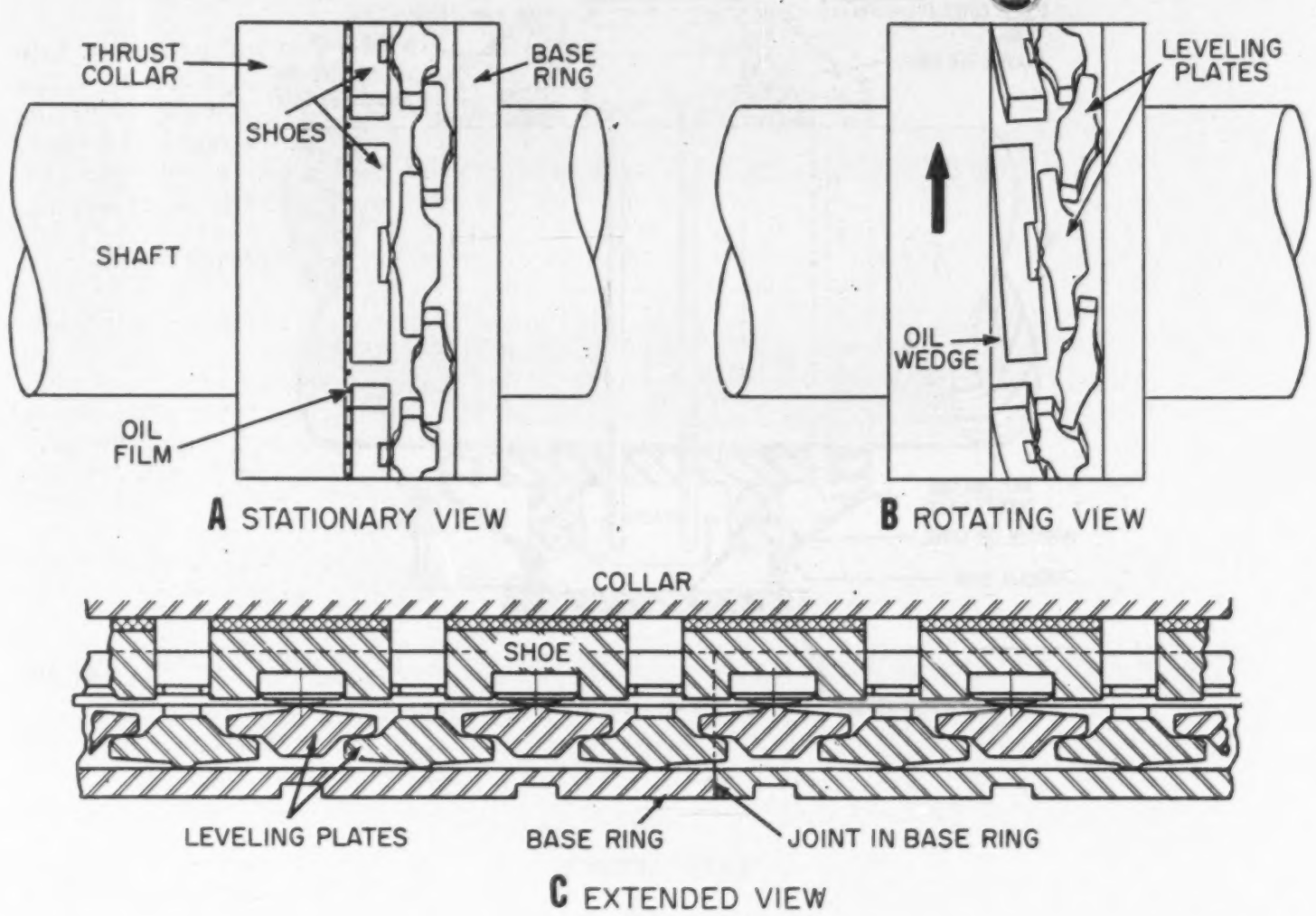

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Figure 4-16.—Diagrammatic arrangement of Kingsbury thrust bearing.

The stuffing box is flanged and bolted to the stern tube. Its casting is divided into two annular compartments—the forward space being the stuffing box proper, the after space being provided with a flushing connection for providing a positive flow of water through the stern tube for lubricating, cooling, and flushing. This flushing connection is supplied by the firemain. A DRAIN CONNECTION is provided both for testing the presence of cooling water in the bearing, and for permitting sea water to flow through the stern tube and cool the bearing when underway, where natural sea water circulation is employed.

The gland for the stuffing box is divided longitudinally into two parts. The gland bolts are long enough to support the gland when it is withdrawn at least 1 inch clear of the stuffing box. This permits the addition of a ring of new packing, when needed, while the ship is waterborne. Either braided flax packing or special semimetallic packing is used (ship's engineering drawings show the proper type of packing). This gland is usually tightened up, and flushing connection closed, to eliminate leakage when the ship is in port, and loosened just enough to permit a slight trickle of water for cooling purposes, when the ship is underway. Whenever packing is added to a stern tube, be sure that the gland is drawn up evenly by using a rule to measure the distance between the gland and stuffing box.

The operation and maintenance of the prime seals should be accomplished in accordance with instructions contained in the manufacturer's manual. Inflatable seals, seal assemblies, and stuffing boxes are mounted concentric with the shaft to accommodate the motions of the shaft during operation. Periodic adjustments must

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Block IV - Television Bench Servicing

Unit 1 - Vertical Sweep Section

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Problems in servicing the vertical sweep section: No voltage sweep Insufficient vertical sweep Poor vertical linearity Poor vertical linearity with foldover Picture rolls vertically Lock-in range of vertical hold control too narrow Vertical jitter Incorrect vertical frequency Picture splits vertically Picture keystones vertically Buzz from the vicinity of vertical sweep section	Function of vertical sweep section Recognition of vertical sweep circuit defects Vertical sweep section electromagnetic deflection systems Vertical sweep section for electrostatic deflection system Vertical oscillators Blocking oscillator Plate coupled multivetrator Cathode coupled multivetrator Vertical output simplifier Component function and effects of component breakdown in these circuits Adjustment of controls General trouble shooting procedure DC and AC test points Waveforms Troubleshooting by signal tracing Interpreting voltage and resistance readings Comparison of vertical oscillator and output circuits used in late model receivers Part replacement requirements Techniques for servicing vertical sections on bench

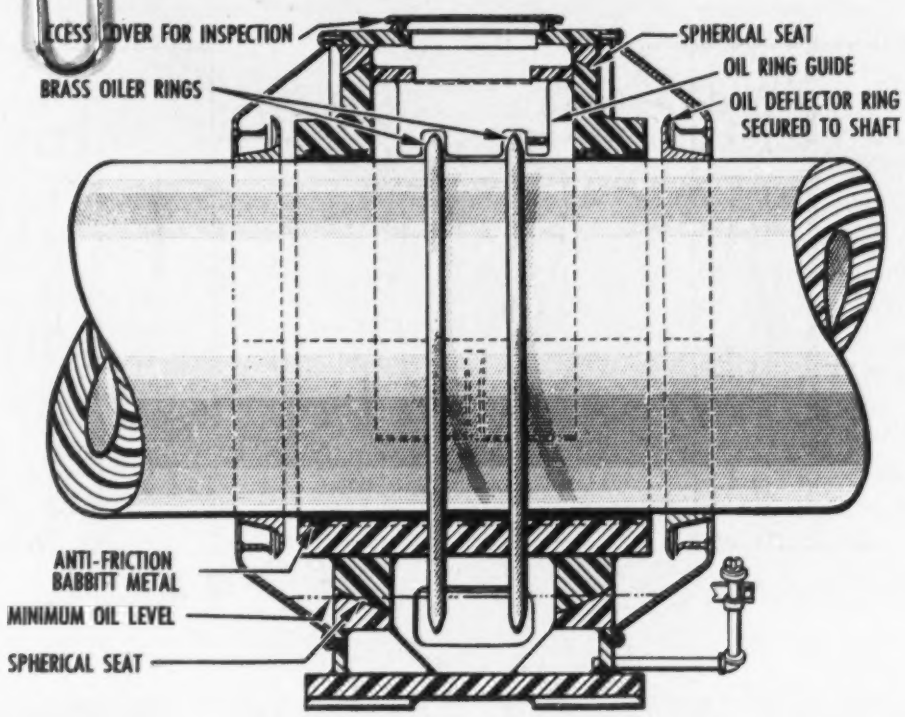

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Figure 4-17.—Main line shaft bearing.

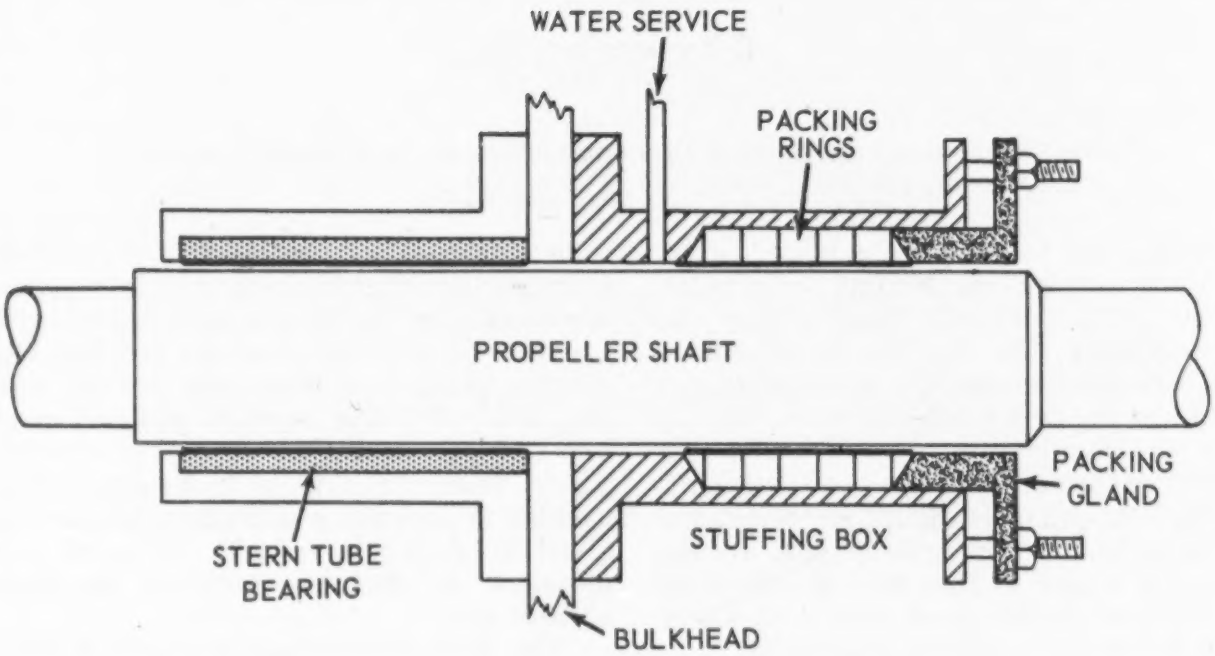

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Figure 4-18.—Stern tube stuffing box and gland.

made to maintain concentricity of the seal assemblies with the shaft axis during the weardown of the stern tube bearings.

For surface ships, a split inflatable seal is installed aft of a stuffing box and gland which is designed for the alternate use of the split face-type seals or conventional packing.

The split inflatable rubber ring seal, installed aft of the prime seal assembly, is used when repairing or replacing the prime sealing elements with the ship waterborne. The following instructions are provided for guidance in operating and testing the split inflatable ring seal:

1. The split inflatable ring seal must not be pressurized except when the ship is waterborne and the shaft is at rest (not rotating).
2. The inflatable seal rings should be tested periodically in accordance with the 3-M planned maintenance system or Naval Ship Systems Command recommendations.
3. For inflating the split inflatable seal ring, the pressure must not exceed 150 psi over sea pressure for surface conditions, and 150 psi over sea pressure for any submerged conditions up to a maximum pressure of 300 psi to avoid rupture of the inflatable seal. The charging air connection for pressurizing these seals should be provided with a needle valve, pressure gage, and a relief valve.

Additional information concerning the pressure gage range and relief valve settings can be obtained from either chapter 9430(43) of the Naval Ships Technical Manual or the manufacturer's technical manual for the specific equipment.

Strut Bearings

These bearings, as well as the stern tube bearings, are equipped with composition bushings which are split longitudinally into two halves. The outer surface of the bushing is machined with steps to bear on matching landings in the bore of the strut. One end is bolted to the strut.

Since it is usually impracticable to use oil or grease as a lubricant for underwater bearings, some other material must be employed for that purpose. There are certain materials that become slippery when wet, including natural or synthetic rubber; lignum vitae, a hard tropical wood with excellent wearing qualities; or laminated phenolic material consisting of layers of cotton fabric impregnated and bonded with phenolic resin. Strips of this material, as shown in figure 4-19, are fitted inside the bearing.

A rubber composition is the type most used in modern installations. These bearings, of course, will never be seen by you while the ship is afloat, and chances are you will have little to do with them when your ship is in drydock, as then the navy yard men will be doing most of the work.

CARE OF BEARINGS AND JOURNALS

Properly operated bearings may give years of satisfactory service but like all units of engineroom machinery, they require periodic tests, inspections, and maintenance. When bearings are originally installed, the manufacturer takes oil clearance readings which are recorded in accordance with the 3-M system. At regular intervals the ship's force must take these readings. Any difference between the old and the new readings will be the amount of bearing wear.

For main engine bearings the readings may be taken by depth gage or crown thickness as described in chapter 3 of this training course. For bearings installed in auxiliary machinery or on main line shafting, leads may be taken. Chapter 6 of this training course gives information on the procedures for taking lead readings.

For another example, a dial indicator may be used to take thrust bearing clearances as explained in chapter 3. In all cases, bearings should be inspected at regular intervals as prescribed in the appropriate chapters of the Naval Ships Technical Manual.

In most cases, the first indication of bearing trouble is a rise in temperature. Within limits, there is no objection to the rise in temperature of a running bearing; in fact it must take place. The rise in temperature is advantageous in that it is accompanied by a decrease in the viscosity of the lubricant. This decreases the internal friction at any given speed. There is no objection to running a bearing warm, provided the temperature reached is not sufficient to do harm, and provided there is no progressive increase in heat, indicating trouble. The thing to guard against is not necessarily a high running temperature of a bearing, but rather a rapid rise in temperature and an increase over the usual operating temperature of the bearing.

If the temperature of a bearing increases above its normal running temperature, the quality and quantity of the lubricant supplied to the bearing should be checked first. If possible

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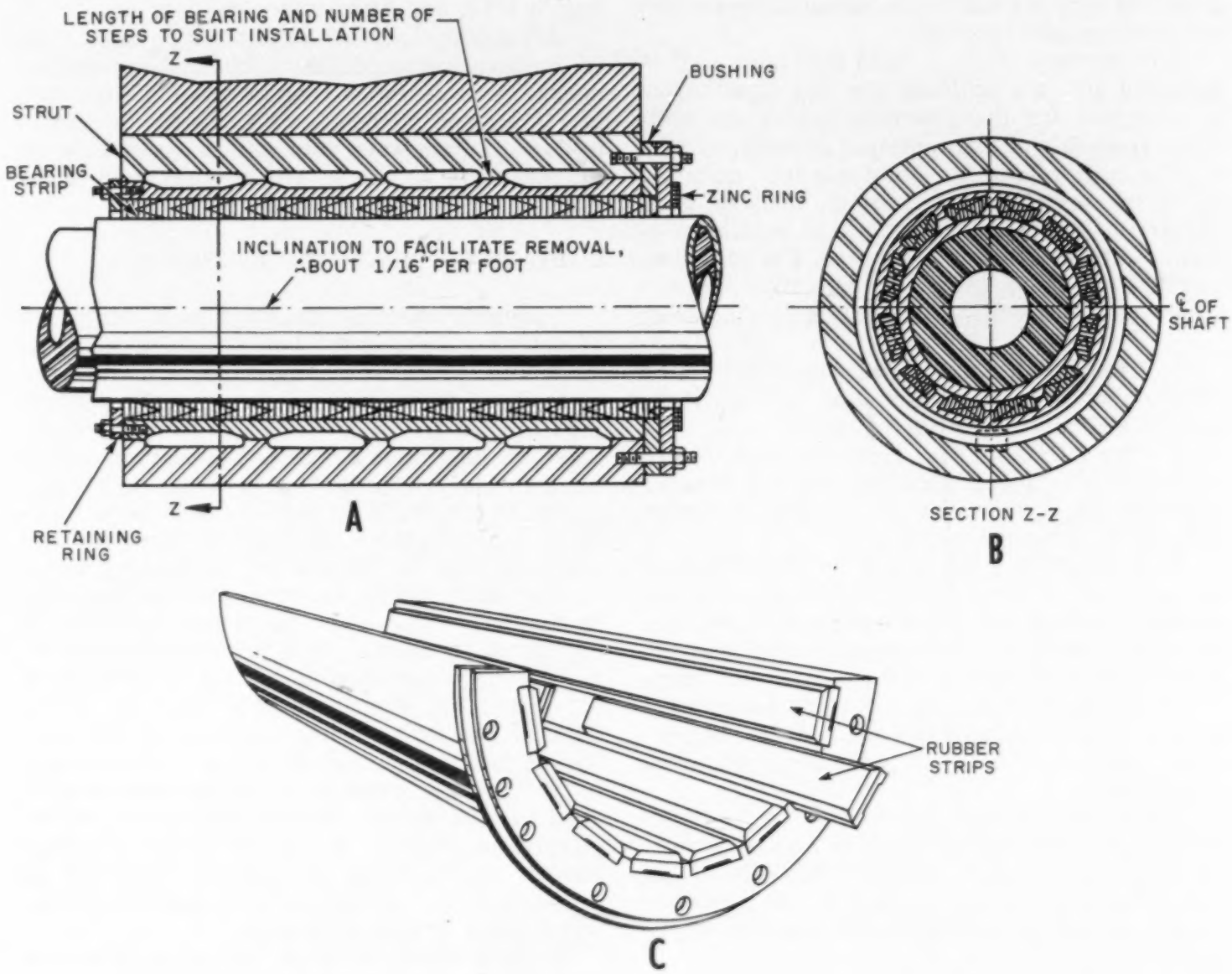

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Figure 4-19.—Details of underwater strut bearing. (A) Longitudinal view. (B) Cross-sectional view. (C) Rubber stripping in the bearing.

increase the supply of lubricant to the bearing. In addition, increase the flow of circulating water to the coolers. If these measures do not reduce the bearing temperature, stop the unit and inspect the bearing. If the bearing has wiped, it should be replaced as soon as possible. However, if the wiping is slight, the bearing can probably be scraped to a good surface and restored to service, provided that readings are taken and the oil clearance is not excessive. For successful operation of bearings, the journal surfaces must be free from rust and be smooth and even at all times. To remove rust, ridges, and sharp edges, the journals should be honed with an oilstone or oilstone powder. Carborundum may be used but in this case great care must be taken to remove all particles. A dial indicator may be used to check the trueness of journal surfaces. First, clamp the indicator to the bearing base, or some other solid, stationary metal, so that the contact point of the spindle rests near the middle of the journal. Slowly rotate the shaft 360° and watch the needle on the dial. If the journal is out of round or has uneven spots, the needle will move. This motion is registered on the dial which is calibrated in

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one-thousandths of an inch. The total travel of the needle (plus and minus) will be the total run-out of the journal.

SAFETY PRECAUTIONS FOR BEARINGS

Because of the similarities in operation of bearings in general, the safety precautions listed here apply to all main engine, main shaft, and auxiliary machinery bearings. If safety precautions are observed, many difficulties and breakdowns may be prevented.

1. Never use a piece of machinery if the bearings are known to be in poor condition.
2. Make certain that bearings have the proper quality and quantity of lube oil before starting the respective machinery.
3. Make certain the operating temperature of each bearing is not above the specified normal for particular load and speed conditions. Investigate and report abnormal temperature immediately.
4. Remember that rapid heating of the bearing is a danger sign. A bearing hot to the hand after an hour's operation may be all right, but the same heat reached in 10 or 15 minutes indicates trouble.
5. Newly installed bearings should, if possible, be given a run-in period with no load applied.
6. Use clean rags (lint free) in cleaning bearings, shafting, and sumps.
7. In assembling and installing bearings with symmetrical halves, take care not to end-to-end one of the halves or to reverse the assembled bearing in its pedestal, as this may cover the lube oil inlet passage.
8. Clean out wells of self-lubricated sliding-surface bearings at frequent intervals, and see that the rings run freely and do not drag.
9. Refit or renew a wiped bearing.
10. When taking leads, make certain that the bearings halves are set up metal to metal.
11. Do not file or machine bearing joints.
12. After spotting-in a bearing, make certain that all shavings and dirt are cleaned from the parts.

PROPELLERS AND MAIN PROPULSION SHAFTING

The turbine and reduction gears convert the thermal energy of steam into usable mechanical energy. This mechanical energy is utilized through the propulsion shafting and the propeller. The MAIN PROPULSION SHAFTING, which ranges in diameter from 18 to 21 inches for small twin-screw destroyers to approximately 30 inches for large four-screw carriers, is divided into four functional sections—the line shaft, the thrust shaft, the stern tube shaft, and the propeller or tail shaft (fig. 4-20).

MAIN PROPULSION SHAFTING

Segments of the line and thrust shaft sections of the shafting are joined together with integral FLANGE TYPE COUPLINGS. The stern tube shaft is joined to the after end of the line shaft with what is known as the INBOARD STERN TUBE COUPLING, with a removable after-sleeve flange. The tail shaft is joined to the stern tube shaft with what is known as a MUFF TYPE OUTBOARD COUPLING. The shaft bearings have already been discussed in a preceding section.

On single-screw ships, that portion of the outboard shaft which turns in the stern tube bearing is normally covered with a SHRUNK-ON COMPOSITION SLEEVE. This is done to protect the shaft from corrosion, and to provide a suitable journal for the water lubricated bearings. On multiple-screw ships, these sleeves normally cover only the bearing areas, and the exposed shafting between the sleeves is covered with synthetic sheet rubber to protect it against sea water corrosion.

For carriers and cruisers, normally the wet shafting (shafting outboard in the sea) is composed of three sections, a tail shaft, an intermediate or dropout section, and a stern tube section. Integral flanged ends of these sections are normally used for joining sections together.

Circular steel or composition shields known as fairwaters are secured to the bearing bushings of the stern tube and strut bearings, and to both the forward and the after ends of the underwater outboard couplings. These are intended primarily to reduce underwater resistance. The coupling fairwaters are secured to both the shaft and coupling flanges and are filled with tallow to protect the coupling from corrosion.

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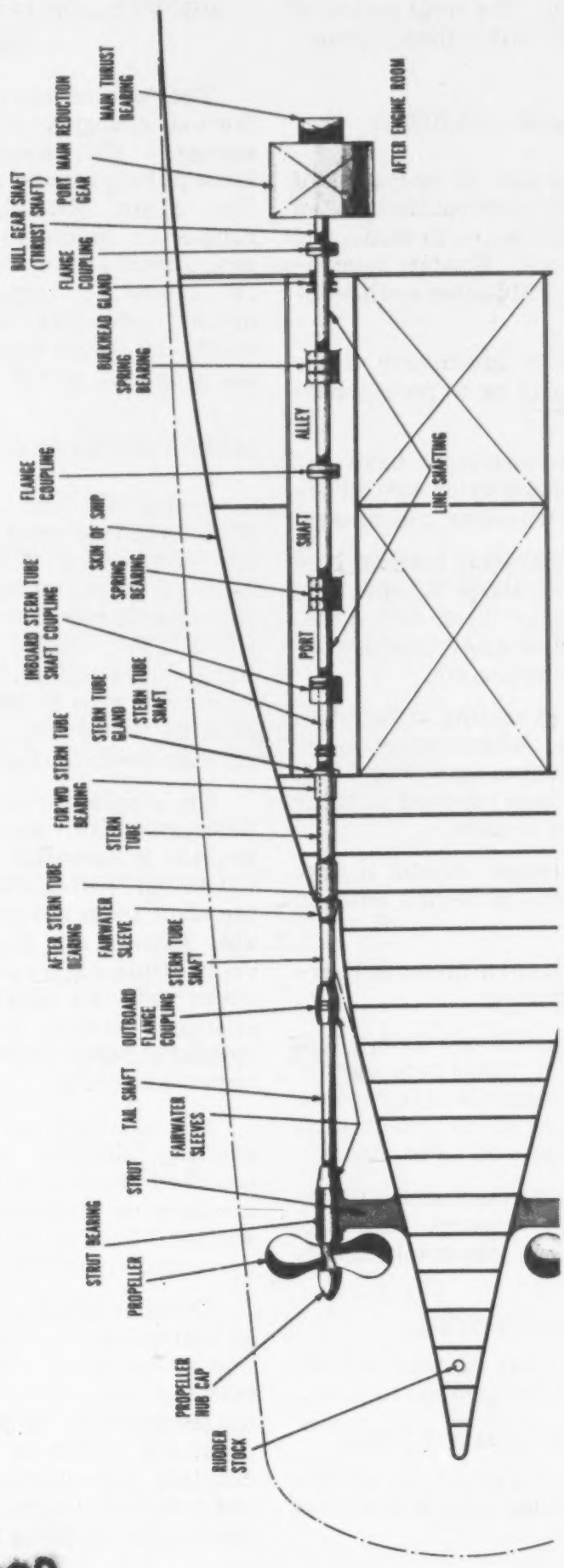

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Figure 4-20.—Diagrammatic arrangement of a main propulsion shafting.

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PROPELLERS

The propellers, where the mechanical energy produced by the main engine is finally utilized, are of various types of construction. They may be left-hand helices, turning counterclockwise in ahead direction when viewed from astern, or right-hand helices, turning clockwise. All starboard and centerline propellers turn clockwise. All port propellers turn counterclockwise. They may be of constant pitch, with pitch of blades identical at all points along the radius; variable pitch, with pitch of blades varying along the radius; or controllable pitch, with blades capable of being rotated within their sockets to change speed and direction of propeller thrust. They may be of solid construction, of single casting, or of built-up construction with individually cast blades bolted to the propeller hub. The number of blades may vary from three to five.

CHAPTER 5

PUMPS

Pumps are vitally important to the functioning of your ship. If they fail, the power plants they serve fail. In an emergency, pump failures can prove disastrous. Maintaining the pumps in efficient working order is, therefore, a very important task of the Machinist's Mate.

The pumps with which you will be concerned are employed for such purposes as:

1. Feeding water to the boilers.
2. Drawing condensate out of the main and auxiliary condensers.
3. Supplying sea water to the firemain.
4. Circulating cooling water for coolers and condensers in the engineering spaces.
5. Pumping out the bilges or ballast water.
6. Circulating lube oil to bearings and gears of the main propulsion plant.
7. Transferring oil fore and aft, or to other ships.

It is not necessary to mention specifically all of the various spots in which pumps are located aboard your ship. You are probably acquainted with the location of most of them already, and in working as a Machinist's Mate you will soon learn the locations and purposes of many more. You should learn to operate, and to make minor adjustments and operational repairs to all the pumps found in the enginerooms and other spaces to which Machinist's Mates are assigned.

PRINCIPLES OF PUMP OPERATION

A pump's PRIMARY PURPOSE is to move liquid from one point and deliver it to another, by pulling, pushing, throwing, or a combination of these methods. Every pump has a POWER END, whether it be a steam turbine, a reciprocating steam engine, a steam jet, or some kind of electric motor. Each pump also has a FLUID END, where the fluid enters (suction) and leaves (discharges) the pump.

The addition of energy to a liquid by a pump usually results in an increase in pressure, which is generally referred to as HEAD. In connection with pump operation, you should know that there are four types of heads: (1) net positive suction head, (2) suction head, (3) discharge head, and (4) head.

The NET POSITIVE SUCTION HEAD, or NPSH, is the suction pressure minus the vapor pressure expressed in feet of liquid at the pump suction. For example, in a feed booster pump with a deaerating feed tank operating at saturated conditions, the NPSH on the pump equals the pressure resulting from the height of the water above the booster pump suction.

THE SUCTION HEAD on a pump means the total pressure of the liquid entering the pump. In a deaerating feed tank operating under saturated conditions, the suction head of the feed booster pump is equal to the NPSH plus the auxiliary exhaust pressure. The DISCHARGE HEAD means the pressure of the liquid leaving the pump, or the level of liquid with respect to the level of the pump on the discharge side. The HEAD is the difference between the suction head and the discharge head. Suction head is usually expressed in feed of water if positive, and in inches of mercury if negative. When a pump operates below the level of a liquid, its suction end receives the liquid under a gravity flow. When it operates above the level of the liquid it must create a vacuum to which the liquid may be raised by atmospheric pressure or by another pump. ATMOSPHERIC PRESSURE has an important bearing on the suction of the pump.

The PRINCIPLE OF SUCTION FORCE, or suction lift, as applied to RECIPROCATING PUMPS is illustrated in figure 5-1. In diagram (a) the piston cylinder is open at both the top and bottom, so the liquid level at A and B is the same. In diagram (b) the cylinder is closed at the

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bottom. A piston has been inserted and partly withdrawn, thus creating a partial vacuum. When a valve at the foot of the cylinder opens, as in diagram (c), as a result of the lower pressure in the cylinder, the liquid at position (A) will lower in the well and rise through the cylinder to the new position (B) which is higher than the original position (B) shown in diagram (a). Assuming the vacuum is complete in diagram (c), and the liquid is water, the atmospheric pressure at point A has pushed the water up into the cylinder to a height of 34 feet at position B.

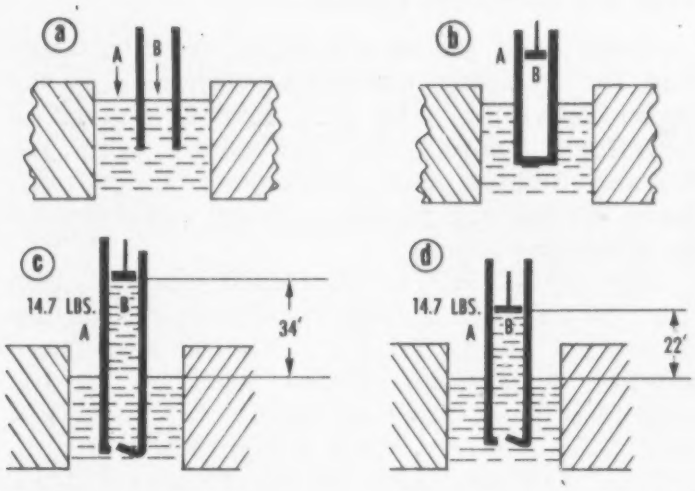

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Figure 5-1.—Diagrams illustrating the principle of suction force.

You understand, of course, that the example is for a theoretical condition. Because of leaks, friction in the pipes, and gases in the liquid, a suction lift of about 22 feet is the maximum pull any shipboard pump can be designed to give; see diagram (d). When a pump is pumping certain liquids such as hot water, oil, or gasoline, some of the liquid will vaporize because of the vacuum on the suction side of the pump. This may cause the pump to become vapor bound; this will definitely reduce the possible suction lift.

The suction force principle applies to other types of pumps, as well as to the reciprocating type, though to a lesser degree and in a somewhat different manner. The CENTRIFUGAL, PROPELLER, and ROTARY pumps all may use suction force to a certain extent. Here a partial vacuum can be produced by the revolving mechanisms, instead of by the reciprocating plunger. An additional characteristic of centrifugal pumps is that they are not self priming because they will not pump air. Their casing must be flooded before they will function. In the JET PUMP, flow is maintained by the suction force created by a jet of water or steam passing through a nozzle at high velocity. These principles are explained in more detail later in the chapter.

TYPES OF PUMPS

Pumps constitute by far the most numerous units of auxiliary machinery aboard ship. Included among the types are centrifugal pumps, propeller pumps, reciprocating pumps, positive displacement rotary pumps, jet pumps such as eductors and air ejectors. The training course Fireman, NavPers 10520-C, gives in clear, simple language and diagrams the basic principles of each of the many different types of pumps, and explains the characteristics of each type which make it adaptable to a particular service in the various engineering systems. Be sure to review that material carefully before studying this chapter.

Brief definitions for each of the general types of pumps and detailed descriptions of these pumps, and their several variations, are given in the following sections.

CENTRIFUGAL PUMPS

The basic principles of operation of the centrifugal pump are discussed in Fireman, NavPers 10520-C. The centrifugal pump utilizes the throwing force of a rapidly revolving IMPELLER. The liquid is pulled in at the center or EYE of the impeller and is discharged at the outer rim of the impeller.

By the time the liquid reaches the outer rim of the impeller, it has acquired a considerable velocity. The liquid is then slowed down by being led through a volute or through a series of diffusing passages. As the velocity of the liquid decreases, its pressure increases; and thus its kinetic energy is transformed into potential energy.

There are many different types of centrifugal pumps, but the two which you are most likely to encounter on board ship are the volute pump and the volute turbine, or diffuser, pump.

In the VOLUTE PUMP shown in figure 5-2, the impeller discharges into a volute (a gradually widening channel in the pump casing). As the

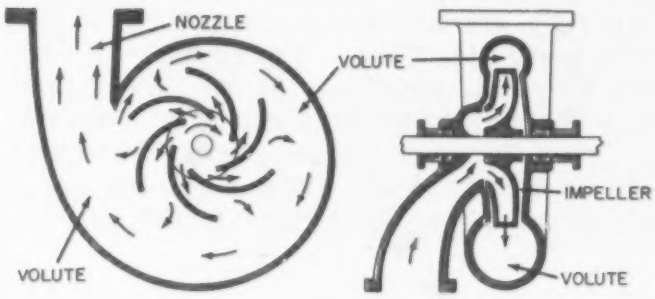

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Figure 5-2.—Simple volute pump.

liquid passes through the volute and into the discharge nozzle, a great part of its kinetic energy is converted into potential energy.

In the DIFFUSER PUMP, shown in figure 5-3, the liquid leaving the impeller is first slowed down by the stationary diffuser vanes which surround the impeller. The liquid is forced through gradually widening passages in the diffuser ring (not shown) and into the volute. Since both the diffuser vanes and the volute reduce the velocity of the liquid, there is an almost complete conversion of kinetic energy to potential energy.

Centrifugal pumps may be classified in several ways. For example, they may be either SINGLE-STAGE or MULTISTAGE. A single-stage pump has only one impeller. A multistage pump has two or more impellers housed together in one casing; as a rule, each impeller acts separately, discharging to the suction of the next stage impeller. Centrifugal pumps are also classified as HORIZONTAL or VERTICAL, depending upon the position of the pump shaft.

The impellers used on centrifugal pumps may be classified as SINGLE SUCTION or DOUBLE SUCTION. The single-suction impeller allows liquid to enter the "eye" from one direction only; the double-suction type allows liquid to enter the "eye" from two directions. Impellers are also classified as CLOSED or OPEN. Closed impellers have side walls which extend from the eye to the outer edge of the vane tips; open impellers do not have these side walls. Most centrifugal pumps used in the Navy have closed impellers.

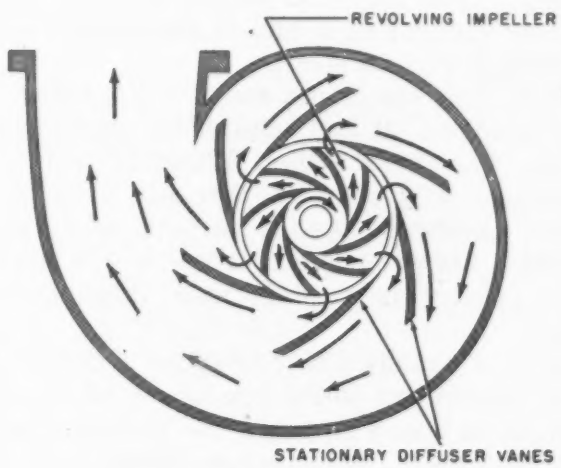

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Figure 5-3.—Volute turbine pump.

Uses of Centrifugal Pumps

Centrifugal pumps are widely used on board ship for pumping nonviscous liquids. In the engineroom you will find several important centrifugal pumps: the feed booster pump, the fire and flushing pump, condensate pumps, auxiliary circulating pumps, and—in some ships—the main feed pump.

The FEED BOOSTER PUMP takes suction from the deaerating tank and discharges into the main feed pump suction. The booster pump provides a positive suction pressure for the main feed pump, and thus enables the main feed pump to handle feed water at high temperatures, without becoming vapor bound and losing suction. Feed booster pumps operate at or near constant speed. In a turbine-driven feed booster pump, the speed is maintained approximately constant by the turbine speed limiting governor.

CONDENSATE PUMPS are vertical, one- or two-stage pumps which are used in closed and open feed systems. These pumps may be turbine driven or electric motor driven. The distinguishing features of condensate pumps are the large suction chambers and the large impeller "eye." The area above the impeller eye is vented to the main condenser to prevent the pump from becoming vapor bound. The condensate pump is always located below the condenser, and consequently has a positive suction head into the impeller eye. In a turbine-driven condensate pump, the speed is maintained approximately constant by a speed limiting governor.

FIRE AND FLUSHING PUMPS are usually single-stage, double-suction, volute type centrifugal pumps, driven either by an electric motor or by a steam turbine. Turbine-driven units are fitted with a constant pressure governor and a speed limiting governor.

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A typical MAIN FEED PUMP is shown in figure 5-4. Main feed pumps are of the high-speed, horizontal, turbine-driven type. Main feed pumps usually operate at a discharge pressure of 100 to 150 psig above the maximum operating steam drum pressure of the boiler, except on ships using 1,200 psig steam pressure. On such ships, the discharge pressure of the main feed pumps is approximately 200 to 300 psig above steam drum pressure. It is necessary for a main feed pump to operate at varying speeds to maintain a constant discharge pressure under all conditions of load. A constant pressure governor automatically regulates the admission of steam to the turbine so as to control the discharge pressure; in addition, a speed limiting governor is installed. However, on some newer ships, feed pumps are provided with a differential pressure governing system that maintains a constant differential pressure across the feed water regulating valve.

Construction of Centrifugal Pumps

As a rule, the casing for the liquid end of a pump with a single-suction impeller is made with an end plate which can be removed for inspection and repair of the pump. A pump with a double-suction impeller is generally made so that one half of the casing may be lifted without disturbing the pump.

Since the impellers rotate at very high speed, they must be carefully machined in order to minimize friction; and they must be balanced in order to avoid vibration. A close radial clearance must be maintained between the outer hub

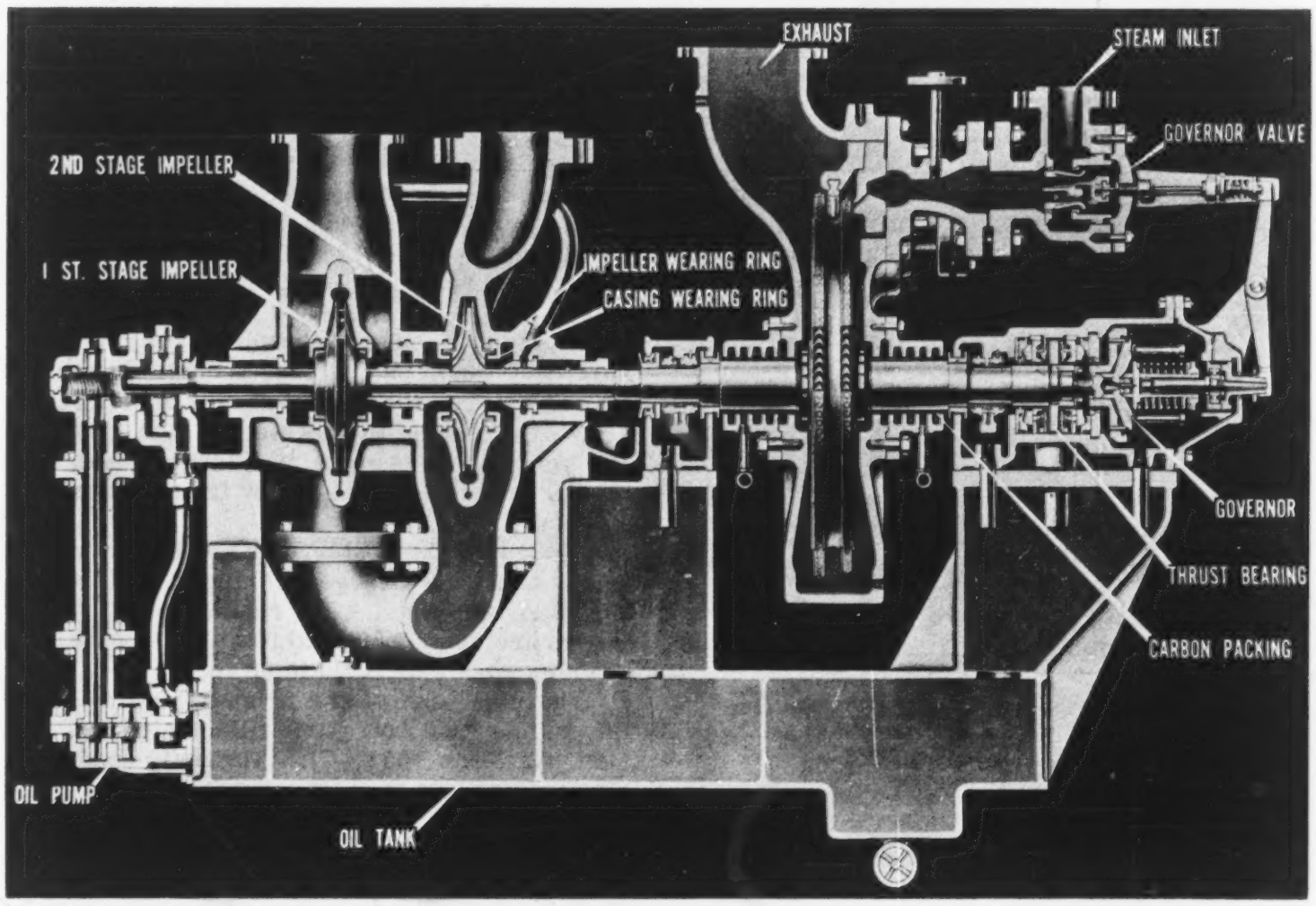

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Figure 5-4.—Two-stage main feed pump.

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Block IV - Television Bench Servicing

Unit 2 - Horizontal Sweep Section

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Problems in servicing the horizontal sweep and high voltage section High voltage section No high voltage Low high voltage Insufficient horizontal sweep Poor damping Arcing, flashing, or corona discharge Picture off-center horizontally Picture keystones No horizontal sweep, though high voltage is present Horizontal hold weak, drifting Incorrect horizontal oscillator frequency	Function of the horizontal sweep circuit Horizontal sweep section for electromagnetic deflection systems Horizontal oscillator, waveshaping and AFC circuits Synchrolock circuit Synchroguide circuit Phase-detector circuit Horizontal output stage and high voltage supply Circuit employing a horizontal output transformer The direct-drive circuit High-voltage supply circuit The direct drive circuit Circuit employing a horizontal output autotransformer Horizontal sweep section and high voltage service Types of high voltage supply Component function and effects of component breakdown in horizontal output circuits Adjusting drive, width and linearity controls General troubleshooting procedures AC - DC test points Waveforms Part replacement requirements Techniques for servicing horizontal sweep circuits on the bench

of the impeller and that part of the pump casing in which the hub rotates in order to minimize leakage from the discharge side of the pump casing to the suction side.

Because of the high rotational speed of the impeller and the necessarily close clearance, the running surfaces of both the impeller hub and the casing at that point are subject to relatively rapid wear. To eliminate the need for renewing an entire impeller and pump casing solely because of wear in this location, centrifugal pumps are designed with replaceable wearing rings. One ring is attached to the hub of the impeller, and rotates with the impeller; a matching ring is attached to the casing, and is therefore stationary. The replaceable ring on the hub of the impeller is called the IMPELLER WEARING RING, and the ring attached to the casing is called the CASING WEARING RING. (Wearing rings are shown on the main feed pump illustrated in fig. 5-4.)

It should be noted that some small pumps with single-suction impellers are made with a casing wearing ring only, and no impeller ring; in this type of pump, the casing wearing ring is fitted into the end plate.

In many centrifugal pumps, the shaft is fitted with replaceable sleeves (fig. 5-5). The advantage of using sleeves is that they can be replaced more economically than the entire shaft.

Recirculating lines are installed on some centrifugal pumps to prevent the pumps from overheating and becoming vapor bound when the discharge is entirely shut off. Seal piping (liquid seal) is also installed to cool the shaft and the packing, to lubricate the packing, and to seal the joint between the shaft and the packing against air leakage. A lantern ring (spacer) is inserted between the rings of the packing in the stuffing box. Seal piping (fig. 5-5) leads liquid from the discharge side of the pump to the annular space within the lantern ring. The web of the ring is perforated so that water can flow in either direction along the shaft, between the shaft and the packing.

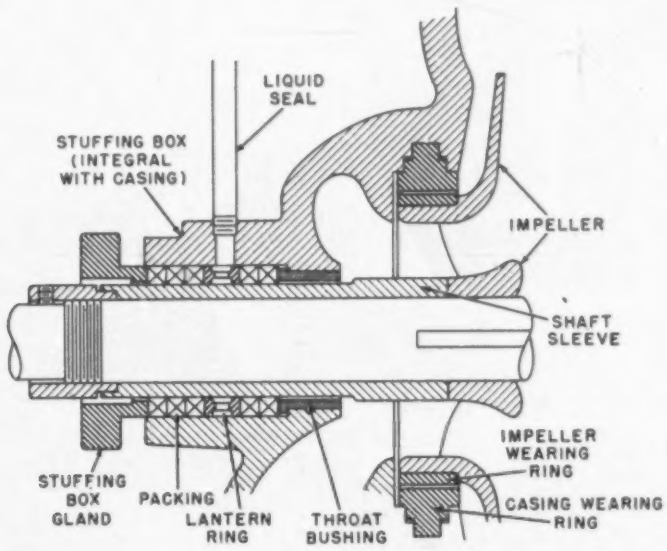

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Figure 5-5.—Stuffing box on centrifugal pump.

Bearings support the weight of the impeller and shaft, and maintain the position of the impeller, both radially and axially. Most centrifugal pumps have a built-in bearing lubrication system, complete with lube oil pump, sump, cooler, strainer, and temperature and flow indicators.

The power end of a centrifugal pump may be either a steam turbine or an electric motor. For most constant-speed applications, the turbine drive has no particular advantage over the motor drive. On naval ships, however, where reliability and flexibility are essential considerations, most large centrifugal pumps are turbine driven. Smaller pumps, such as those used for in-port or cruising operation, are often motor driven.

The turbines used for centrifugal pumps are usually single-stage impulse turbines. As a rule, high-pressure centrifugal pumps are direct drive—that is, the impeller rotates at the same rpm as the turbine. However, some low pressure centrifugal pumps have reduction gears installed between the turbine and the impeller; this allows the turbine to operate at a high speed and the impeller to operate at a lower speed, thus obtaining maximum efficiency from both turbine and pump.

PROPELLER PUMPS are used primarily where there is a large volume of liquid with a relatively low total head requirement. These pumps are usually limited to use where the total head does not exceed 40 to 60 feet.

The chief use of the propeller pump is for the main circulating pump (illustrated in Fireman, NavPers 10520-C). The main condenser circulating pump on most ships has an emergency suction for pumping out the engineroom.

The main condenser circulating pump is of the vertical propeller type. The pump unit consists of three major parts: the propeller, together with its bearings and shaft; the pump casing; and the driving unit.

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The propeller of this pump is a multi-bladed screw propeller having a large pitch; the blades are thick at the roots and flare out toward the tips. The blades and hubs are cast or forged in one piece, and are then machined and balanced. The lower shaft bearing is a water-lubricated sleeve-type bearing; the shaft packing gland prevents excessive leakage of water between the casing and the shaft.

Because of the similarity of the centrifugal and propeller type pumps, the information given concerning care, maintenance, inspection, and precautions for centrifugal pumps is equally applicable for propeller pumps.

VARIABLE STROKE PUMPS

Variable stroke pumps are used in shipboard hydraulic transmission systems. You will be responsible for maintaining and making minor repairs to hydraulic and related equipment outside your ship's engineering spaces. The information which follows is supplementary to that given in Fireman, NavPers 10520-C.

There are two general types of variable stroke pumps in common use: the axial-piston type and the radial-piston type. In the axial-piston type (fig. 5-6), the pistons are arranged parallel to each other and to the pump shaft; in the radial-piston type, the pistons are arranged radially from the shaft.

The VARIABLE STROKE AXIAL-PISTON PUMP usually has either seven or nine single-acting pistons which are evenly spaced around a cylinder barrel. (Note that the term CYLINDER BARREL, as used in this connection, actually refers to a cylinder BLOCK which holds all the cylinders.) The piston rods make a

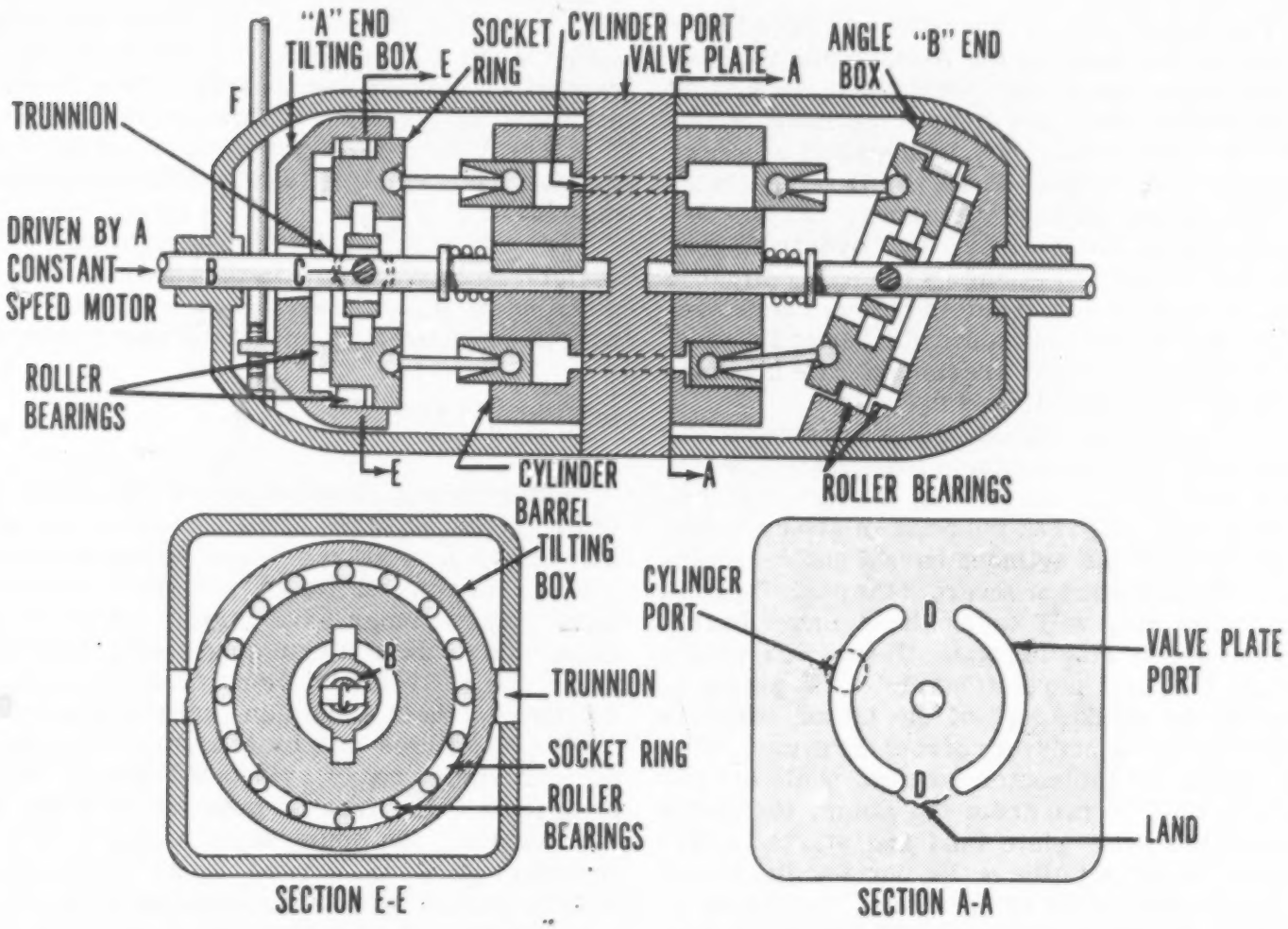

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Figure 5-6.—Axial-piston type hydraulic speed gear.

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ball-and-socket connection with a socket ring. The socket ring rides on a thrust bearing carried by a casting called the TILTING BOX or TILTING BLOCK.

When the tilting box is at a right angle to the shaft, and the pump is rotating, the pistons do not reciprocate; therefore, no pumping takes place. When the box is tilted away from a right angle, however, the pistons reciprocate and the liquid is pumped.

When the variable stroke axial-piston pump is used as a part of a variable speed gear such as in electrohydraulic anchor windlasses, cranes, winches, and the power transmitting unit in electrohydraulic steering engines, the tilting box is so arranged that it may be tilted in either direction. Thus it may be used to transmit power hydraulically to pistons or rams, or it may be used to drive a hydraulic motor. In the latter use, the pump, which is driven by a constant speed electric motor, is called the A-end of the variable speed gear and the hydraulic motor is called the B-end.

The B-end unit of the hydraulic speed gear is exactly the same as the A-end of the variable stroke pump mentioned previously, except that it generally does not have a variable stroke feature. The tilting box is installed at a permanently fixed angle. Thus, the B-end becomes a fixed stroke axial-piston pump. Figure 5-6 illustrates an axial-piston type hydraulic gear with the A-end and B-end as a single unit; it is used in turrets for train and elevation driving units. For electrohydraulic winches and cranes, the A-end and B-end are in separate housings connected by hydraulic piping.

Hydraulic fluid introduced under pressure to a cylinder causes the piston to be pushed out. In being pushed out, the piston, through its connecting rod, will seek the point of greatest distance between the cylinder barrel and the socket ring. The resultant pressure of the piston against the socket ring will cause the cylinder barrel and the socket ring to rotate. This action occurs during the half revolution while the piston is passing the intake port of the motor, which is connected to the pressure port of the pump. After the piston of the motor has taken all the hydraulic fluid it can from the pump, the piston passes the valve plate land and starts to discharge oil through the outlet ports of the motor to the suction inlet of the pump, and thence to suction pistons of the pump. The pump is constantly putting pressure on one side of the motor while it is constantly receiving hydraulic fluid from the other side. The fluid is merely circulated from pump to motor and back again.

The VARIABLE STROKE RADIAL-PISTON PUMP is similar in general principle to the axial-piston type just described, but the arrangement of component parts is different. In the radial-piston pump, the cylinders are arranged radially in a cylinder body which rotates around a nonrotating central cylindrical valve. Each cylinder communicates with horizontal ports in the central cylindrical valve. Plungers or pistons, which extend outward from each cylinder, are pinned at their outer ends to slippers which slide around the inside of a rotating floating ring or housing.

The floating ring is so constructed that it can be shifted off center from the pump shaft. When it is centered, or in the neutral position, the pistons do not reciprocate and the pump does not function, even though the electric motor is still causing the pump to rotate. If the floating ring is forced off center to one side, the pistons reciprocate and the pump operates. If the floating ring is forced off center to the other side of the pump shaft, the pump also operates but the direction of the flow is reversed. Thus it can be seen that the direction of flow and the amount of flow are both determined by the position of the cylinder body relative to the position of the floating ring.

The shipboard application of reversible type variable stroke pumps is in such hydraulic transmission gear as steering mechanisms (discussed in chapter 16 of this training course).

ROTARY PUMPS

Rotary pumps, like reciprocating pumps, operate on the positive displacement principle—that is, each rotation or each stroke delivers a definite quantity of liquid. Positive displacement rotary pumps have largely replaced reciprocating pumps for pumping viscous liquids in naval ships, as they have a greater capacity in relation to their weight and occupy less space.

Rotary pumps are most useful for pumping oil and other heavy, viscous liquids. In the engineroom this type of pump is used for lube oil service. In some ships a rotary fuel oil transfer pump is located in the engineroom. Rotary pumps are sometimes used for nonviscous liquids, such as water or gasoline. The power end of a rotary pump is usually an electric motor or a steam-driven turbine.

Rotary pumps are designed with very small clearances between rotating parts and stationary parts, in order to minimize slippage from the discharge side back to the suction side. Rotary pumps are designed to operate at relatively moderate speeds in order to maintain these clearances; operation at higher speeds causes erosion and excessive wear, which result in increased clearances.

Classification of rotary pumps is generally made according to the type of rotating element. The following paragraphs briefly discuss the main features of gear pumps and screw pumps.

The SIMPLE GEAR PUMP has two spur gears which mesh together and revolve in opposite directions. One is the DRIVING GEAR, and the other is the DRIVEN GEAR. Clearances between the gear teeth (outside diameter of gear) and the casing and between the end face and the casing are only a few thousandths of an inch. As the gears turn, the gears unmesh and liquid flows into the pockets which are vacated by the meshing gear teeth. This creates the suction that draws the liquid into the pump. The liquid is then carried along in the pockets formed by the gear teeth and the casing. On the discharge side, the liquid is displaced by the meshing of the gears, and forced out through the discharge side of the pump.

In the herringbone gear, a modification of the simple gear pump, one discharge phase begins before the previous discharge phase is entirely complete; and this overlapping tends to give a steadier discharge pressure than is found in the simple gear pump. Power-driven pumps of this type are sometimes used for low pressure fuel oil service, lubricating oil service, and diesel oil service.

The HELICAL GEAR PUMP (fig. 5-7) is still another modification of the simple gear pump. Because of the helical gear design, the overlapping of successive discharges from spaces between the teeth is even greater than it is in the herringbone gear pump; and the discharge flow is, accordingly, even smoother. Since the discharge flow is smooth in the helical gear pump, the gears can be designed with a small number of large teeth—thus allowing increased capacity without sacrificing smoothness of flow.

The pumping gears in this type of pump are driven by a set of timing and driving gears, which also function to maintain the required close clearances while preventing actual metallic contact between the pumping gears. Metallic contact between the teeth of the pumping gears would provide a tighter seal against slippage; but it would cause rapid wear of the teeth because foreign matter in the pumped liquid would be present on the contact surfaces.

Roller bearings at both ends of the gear shafts maintain proper alignment, and so minimize the friction loss in the transmission of power. Stuffing boxes are used to prevent leakage at the shafts. The helical gear pump is used to pump nonviscous liquids and light oils at high speed. It can be used to pump heavy, viscous materials at lower speed.

The LOBE TYPE PUMP is still another variation of the simple gear pump. A lobe pump (heliquad type) is illustrated in figure 5-8. The lobes are considerably larger than gear teeth, but there are only two or three lobes on each rotor. The rotors are driven by external spur gears on the rotor shafts. Some lobe pumps are made with replaceable inserts (gibs) at the extremities of the lobes. These inserts take up the wear which would otherwise be sustained by the ends of the lobes; in addition, they maintain a tight seal between the lobe ends and the casing. The inserts are usually seated on a spring, and are thus able to automatically compensate for considerable wear of both the gibs and the casing. Replaceable cover plates (liner plates) are fitted at each end of the casing, where the lobe faces cause heavy wear.

There are several types of SCREW PUMPS. The main points of difference between the various types are the number of intermeshing screws and the pitch of the screws. Figure 5-9 shows a positive displacement, double-screw, low-pitch pump.

In the screw pump, liquid is trapped and forced through the pump by the action of rotating screws. As the rotor turns, the liquid flows in between the threads at the outer end of each pair of screws. The threads carry the liquid along within the housing to the center of the pump where it is discharged.

ROTATING PLUNGER PUMPS are used in the naval service for the following applications: fuel oil and diesel oil service, fuel oil booster and transfer service, fuel oil tank drains, and lubricating oil service.

Figure 5-10 illustrates the main operating parts of the rotating plunger pump (sometimes classified as a "cam-and-plunger" pump). The plunger is shown in three positions, illustrating the pumping process. The main body of the pump is a cylinder with the suction port entering through the side, as shown, in the upper left-hand

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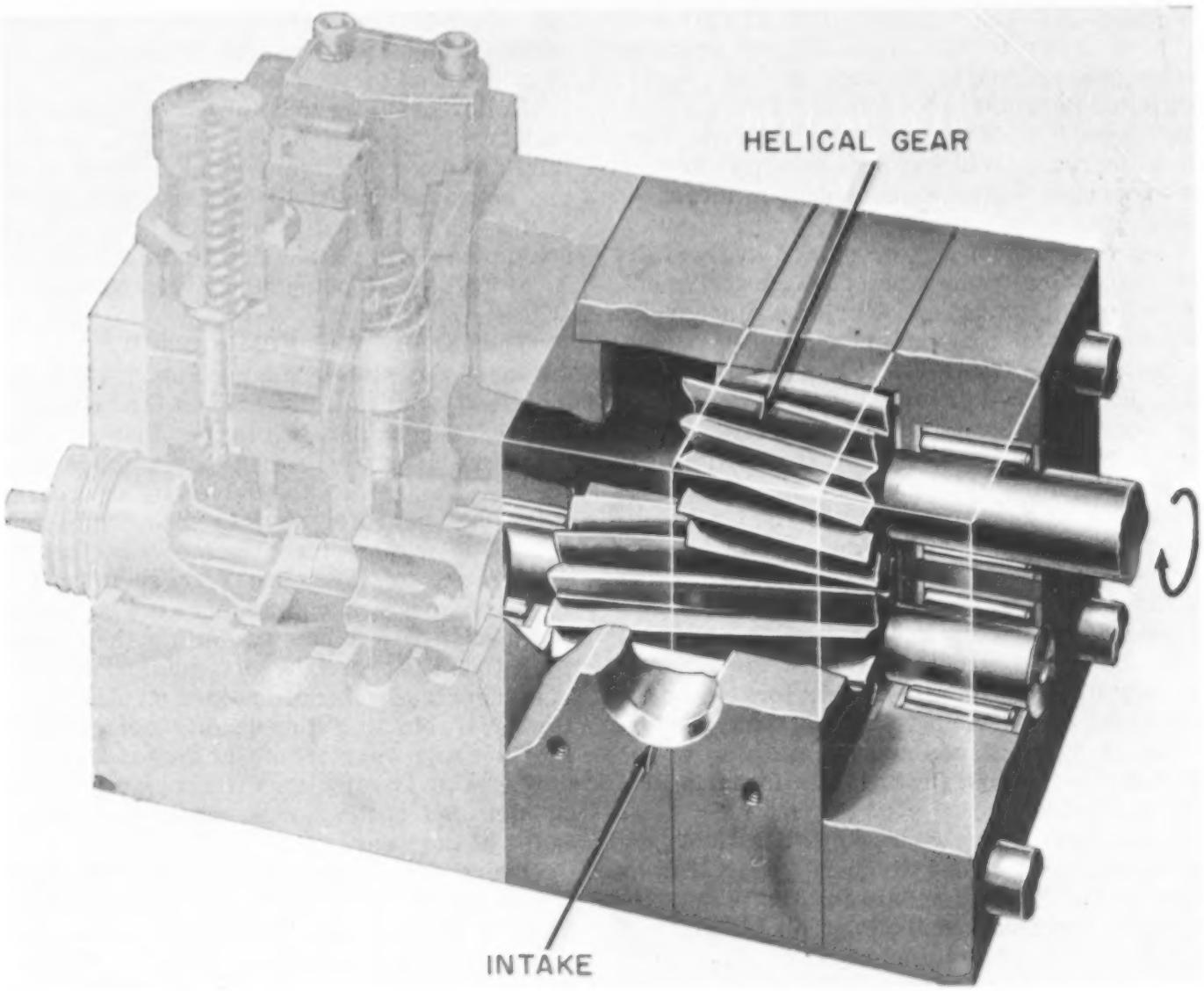

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Figure 5-7.—Helical gear pump.

corner. The drive shaft, concentric with the pump cylinder, carries an eccentric strap which has a slightly smaller diameter than the pump cylinder. The eccentric strap operates as a piston or "plunger." The eccentric arm plus the radius of the plunger is equivalent to the radius of the cylinder less the necessary operating clearances. Therefore, with each revolution of the eccentric, the point of nearest contact of the plunger on the cylinder wall rotates completely around the cylinder. Motion of the plunger about its own center is constrained by a hollow arm, or slide, which extends from the plunger through a slot in the top of the cylinder, and above that point, through a slotted pin carried in a bearing which seals the cy .nder space from the discharge space.

Referring to (1) in figure 5-10, it may be seen that liquid trapped in the right side of the cylinder will be forced through the hollow arm to the discharge line as the eccentric rotates counterclockwise. View (2) shows the next phase with the space on the left side opening, thereby creating a vacuum which causes liquid to flow in from the suction line. The next stage, shown at (3), illustrates the discharge port, at the bottom of the hollow arm, beginning to close. The discharge port is closed by the slide pin, during the suction portion of the stroke. When the eccentric turns slightly further, the point of

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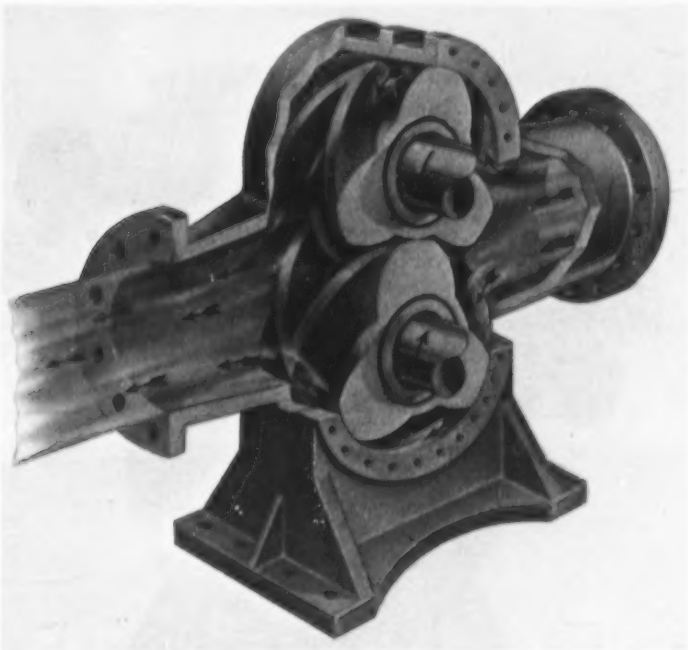

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Figure 5-8.—Lobe pump (heliquad type).

contact of the plunger on the cylinder will pass over the suction port and trap the new charge on the discharge side, as shown in view (1).

In order to reduce the tendency to pulsate, rotating plunger pumps usually employ two plungers whose driving eccentrics are 180° apart on the shaft. The plungers are separated by a diaphragm through which the shaft extends.

The MOVING-VANE TYPE PUMP, illustrated in figure 5-11, consists of a cylindrically bored housing with a suction inlet on one side, and a discharge outlet on the other side. A rotor (smaller in diameter than the cylinder) is driven about an axis so placed above the centerline of the cylinder as to provide minimum clearance between the rotor and cylinder at the top and maximum clearance at the bottom. (NOTE: Aboard some naval ships, the Blackmer vane pump has largely supplanted the pivoted vane, particularly for light hydrocarbon transfer such as JP5. Additional information on such pumps can be obtained from the manufacturer's technical manual for the specific installation.)

The rotor carries vanes which move in and out as it rotates to maintain sealed spaces between the rotor and the cylinder wall. The vanes trap liquid on the suction side and carry it to the discharge side where contraction of the space expels liquid through the discharge line. The vanes may swing on pivots, as shown in the illustration, or they may slide in slots in the rotor. Vane type pumps are used for lubricating oil service and transfer, and in general for handling lighter viscous liquids.

RECIPROCATING PUMPS

The reciprocating pump moves water or other liquid by means of a plunger which reciprocates—that is, goes back and forth or up and down—within a cylinder. Reciprocating pumps are usually classified as:

1. Direct acting or indirect acting.
2. Simplex (single) or duplex (double).
3. Single acting or double acting.
4. High pressure or low pressure.
5. Vertical or horizontal.

The reciprocating pump shown in figure 5-12 is a direct-acting simplex, double-acting, high pressure, vertical pump. Now let's see what all these terms mean, with reference to the pump shown in the illustration.

The pump is DIRECT ACTING because the pump rod is a DIRECT extension of the piston rod; and, therefore, the piston in the power end is DIRECTLY connected to the plunger in the liquid end. Most reciprocating pumps used in the Navy are direct acting.

The pump shown in figure 5-12 is called a SINGLE or SIMPLEX pump because it has only one liquid cylinder. Simplex pumps may be either direct acting or indirect acting. A DOUBLE

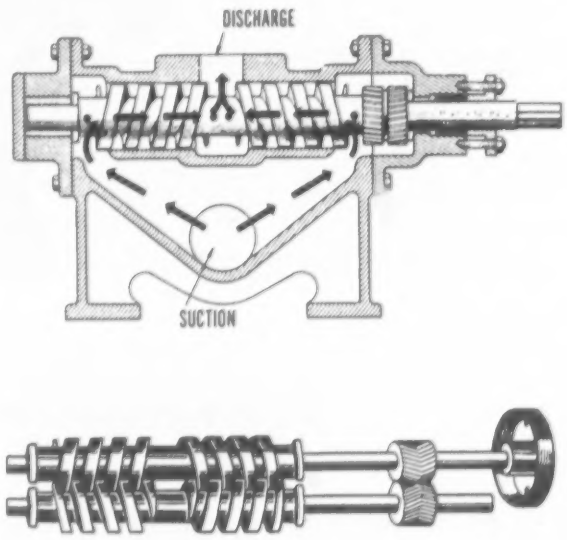

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Figure 5-9.—Positive displacement double-screw low-pitch pump.

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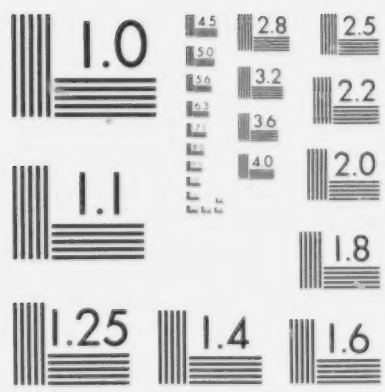

MICROCOPY RESOLUTION TEST CHART

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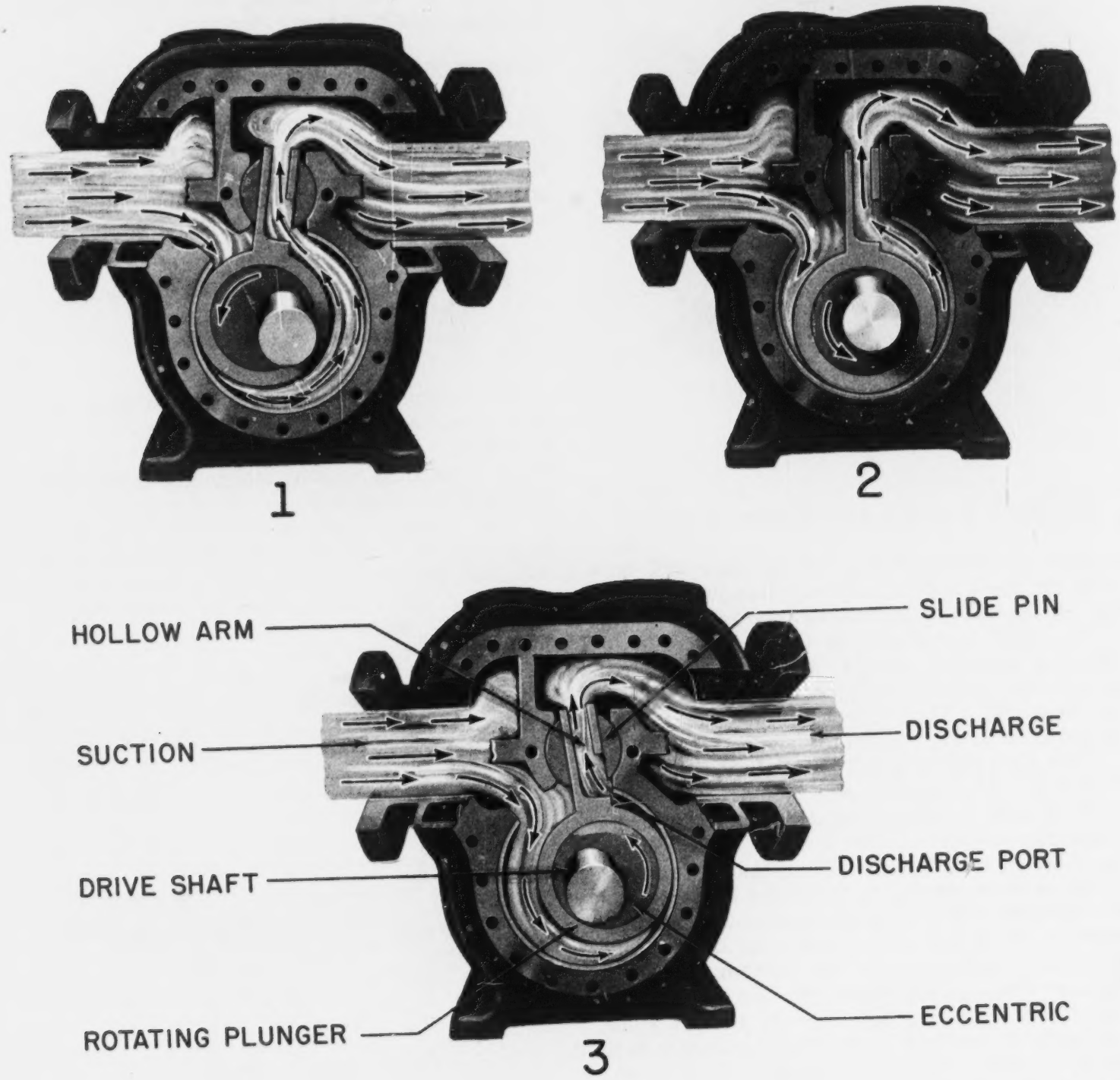

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Figure 5-10.—Operating parts of the rotating plunger pump.

OR DUPLEX pump is an assembly or two single pumps, placed side by side on the same foundation; the two steam cylinders are cast in a single block, and the two liquid cylinders are cast in another block. Duplex reciprocating pumps are seldom found in modern combatant ships, but were commonly used in older ships.

In a SINGLE-ACTING pump, the liquid is drawn into the liquid cylinder on the first or SUCTION STROKE and is forced out of the

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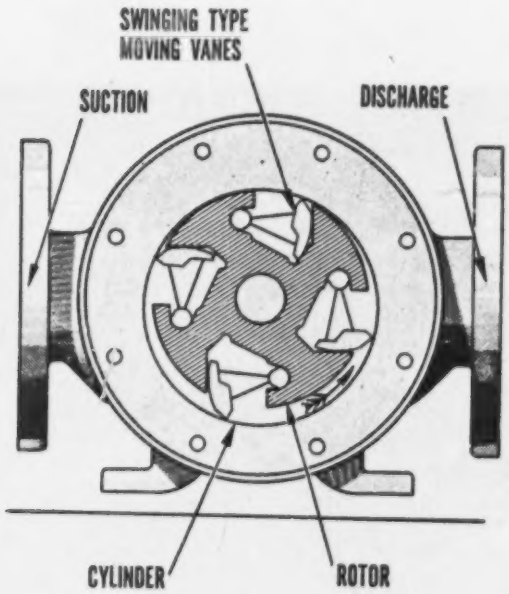

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Figure 5-11.—Moving vane type pump.

cylinder on the return or DISCHARGE STROKE. In a DOUBLE-ACTING pump, each stroke serves both to draw in liquid and to discharge liquid. As one end of the cylinder is filled, the other end is emptied; on the return stroke, the end which was just emptied is filled and the end which was just filled is emptied.

The pump shown in figure 5-12 is double-acting, as are most of the reciprocating pumps used in the Navy. (NOTE: Only one of two sets of valves is shown in fig. 5-12.) The pump illustrated is designed to operate with a discharge pressure which is higher than the pressure of the steam operating the piston in the steam cylinder. In other words, this is a HIGH PRESSURE pump. In a high pressure pump, the steam piston is larger in diameter than the plunger in the liquid cylinder. Since the area of the steam piston is greater than the area of the plunger in the liquid cylinder, the total force exerted by the steam against the steam piston is concentrated on the smaller working area of the plunger in the liquid cylinder; and, therefore, the pressure per square inch is greater in the liquid cylinder than in the steam cylinder. A high pressure pump discharges a comparatively small volume of liquid against a high pressure. A LOW PRESSURE pump, on the other hand, has a comparatively low discharge pressure but a larger volume of discharge. In a low pressure pump, the steam piston is smaller than the plunger in the liquid cylinder.

The standard way of designating the size of a reciprocating pump is by giving three dimensions, in the following order: (1) the diameter of the steam piston; (2) the diameter of the pump plunger; and (3) the length of the stroke. For example, a 12 x 11 x 18 inch reciprocating pump has a steam piston which is 12 inches in diameter, a pump plunger which is 11 inches in diameter, and a stroke of 18 inches. The designation enables you to tell immediately whether the pump is a high pressure or low pressure pump.

Finally, the pump shown in figure 5-12 is classified as VERTICAL because the steam piston and the pump plunger move up and down. Most reciprocating pumps in naval use are vertical; but you may occasionally encounter a HORIZONTAL pump, in which the piston moves back and forth rather than up and down.

The following discussion of reciprocating pumps is generally concerned with direct-acting, simplex, double-acting, vertical pumps, since most reciprocating pumps used in the Navy are of this type.

Construction of Reciprocating Pumps

The power end of a reciprocating pump consists of a bored cylinder in which the steam piston reciprocates. The steam cylinder is fitted with heads at each end; one head has an opening to accommodate the piston rod. Steam inlet and exhaust ports connect each end of the steam cylinder with the steam chest. Drain valves are installed in the steam cylinder, so that water resulting from condensation may be drained off.

Automatic timing of the admission and release of steam to and from each end of the steam cylinder is accomplished by a valve operating assembly which connects the pilot valve operating rod and the pump rod (shown in fig. 5-13). As the crosshead arm (sometimes called the rocker arm) is moved up and down by the movement of the pump rod, the moving tappet slides up and down on the pilot valve rod. The tappet collars are adjusted so that the pump will make the full designed stroke.

The piston type valve gear, commonly used for automatic timing, consists of a piston type slide valve and a pilot slide valve. The position of the pilot slide valve is controlled by the

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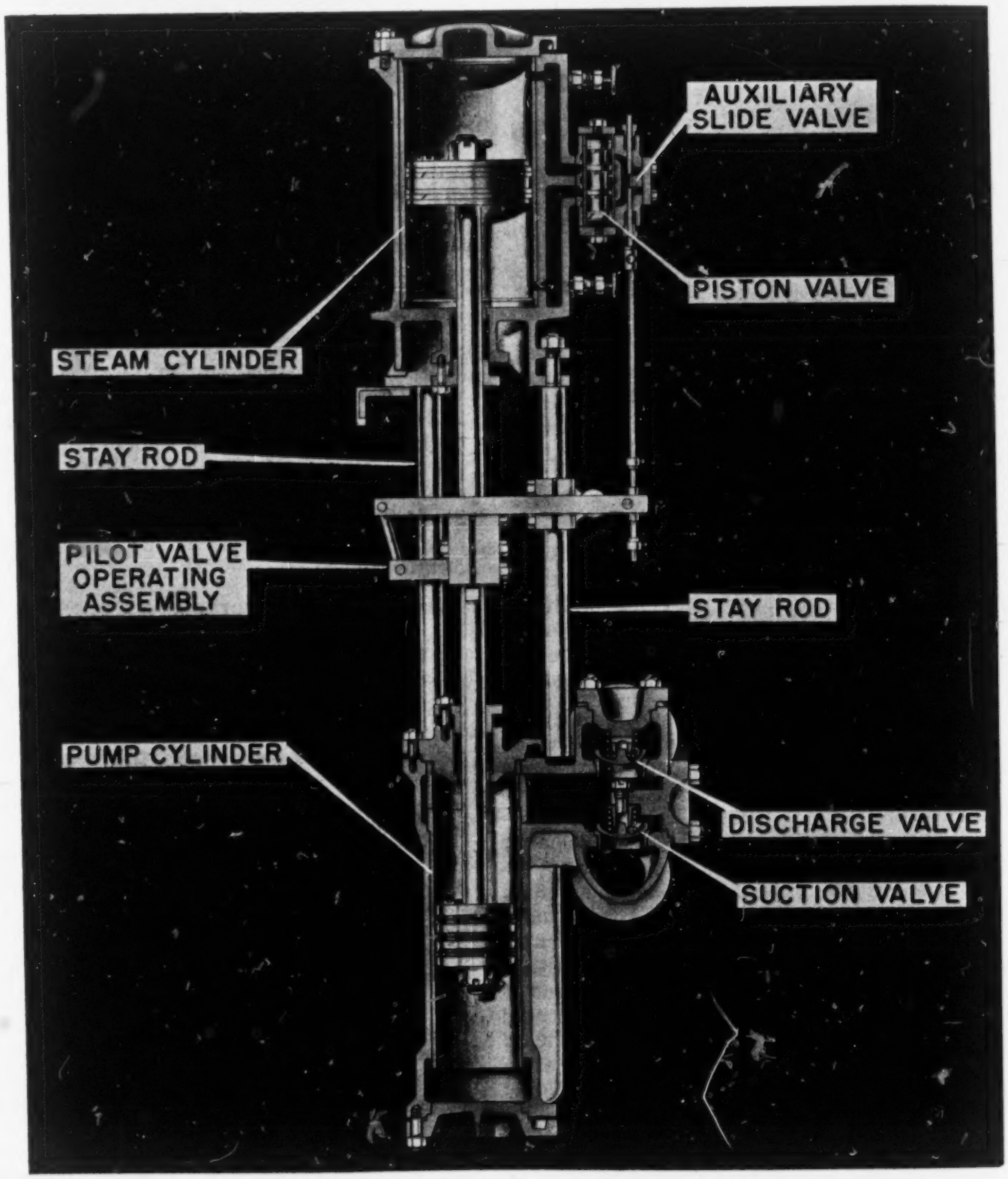

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Figure 5-12.—Reciprocating pump.

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Block IV - Television Bench Servicing

Unit 3 - Synchronization Section

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Problems in servicing the synchronization section: No synchronization Weak sync Video information in sync pulses Hum in sync section Poor vertical hold Poor horizontal hold Vertical jitter	Function of the sync section Question of the sync section Composite video signal Synd separation Sync simplifier Sync noise inverters Pentagrid sync separator and noise clipper Separate vertical and horizontal sync clippers Requirements for synchronization for each type of oscillator Integrator and differentiation circuits Troubles found in the vertical sync circuits Troubleshooting procedures for vertical sync troubles AFC requirements for horizontal oscillators AFC phase-detector types Synchrolock, duo-diode detector tube reactance and sine wave oscillator Triode detector operating with cathode-coupled multivetrator Triode detector, reactance tube and sine wave oscillator Duo-diode detector operating with cathode coupled multivetration Pulse width AFC system Troubles associated with pulse width system Troubleshooting procedure for horizontal AFC circuits

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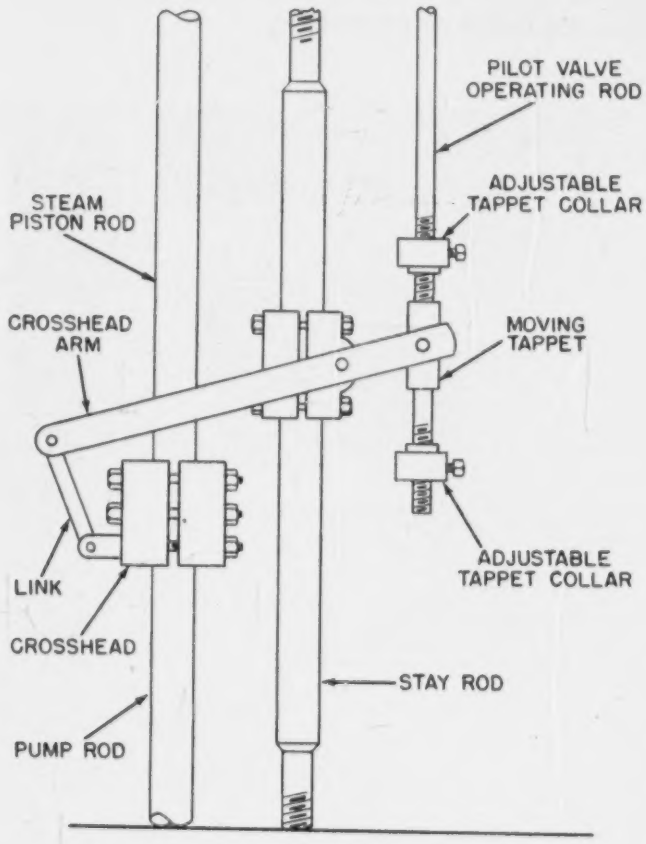

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Figure 5-13.—Valve operating assembly.

position of the main piston in the steam cylinder. At the completion of the down stroke of the pump, the crosshead arm moves the moving tappet against the upper adjustable tappet collar to actuate the pilot slide valve which admits steam to reposition the floating piston. The movement of the floating piston opens ports to admit steam to the underside of the piston in the steam cylinder and exhaust the steam above the piston; thus causing the piston to move upward. Once the pump has completed the upstroke, the cycle repeats itself in reverse.

The liquid end of a reciprocating pump has a piston and cylinder assembly similar to that of the power or steam end. The piston in the liquid end is often called a PLUNGER. A VALVE CHEST, sometimes called a WATER CHEST, is attached to the liquid cylinder; it contains two sets of suction and discharge valves, one set to serve the upper end of the liquid cylinder and one to serve the lower end. The valves are so arranged that the pump takes suction from the suction chamber and discharges through the discharge chamber on both the up and down strokes.

As in all Navy pumps, a relief valve is installed in the discharge piping between the pump and the discharge valve. The relief valve is to protect the pump and the piping against excessive pressure.

Uses of Reciprocating Pumps

Reciprocating pumps are used for two purposes in the main machinery spaces; as fire and bilge pumps and as emergency or auxiliary feed pumps. Reciprocating pumps are very good for emergency use because they are relatively simple, reliable, and easy to start and operate under cold conditions. Special precautions must be taken with the fire and bilge pump to see that the suction strainers are kept clean. Clogged suction strainers and the pressure of foreign matter in the water chest suction and discharge valves are the most frequent causes of trouble in the liquid end of the fire and bilge pump.

The EMERGENCY or AUXILIARY FEED PUMP is a direct-acting, simplex, double-acting, high pressure, vertical pump of the type shown in figure 5-12. The pump is operated from the auxiliary steam line. It is used for filling idle boilers, for transferring reserve feed water, for applying pressure to boilers undergoing hydrostatic test, and in some cases for regular boiler feed service for in-port (auxiliary) steaming. This pump does not have sufficient capacity for high firing rates, and its use is therefore limited to emergency or auxiliary service.

EDUCTORS

The pumps discussed so far in this chapter have been electrical or mechanical driven. Eductors, like other types of jet pumps, have no moving parts. They are actuated by water, under a designed or set pressure, and are used to pump large volumes of water.

On newer ships, eductors have replaced fire and bilge pumps as the primary means of pumping large volumes of water overboard, in applications such as pumping bilges, deballasting, and dewatering compartments. By use of eductors, centrifugal fire pumps can, indirectly, serve as drainage pumps without the risk of becoming fouled with debris from the bilges. The centrifugal pumps pressurize the firemain, and water from the firemain is used to actuate the

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eductors. On newer combatant ships the eductors have a much larger pumping capacity than fire and bilge pumps. They are installed as part of the piping in the drainage system and are flanged to permit easy removal and disassembly when repairs are necessary.

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CHAPTER 6

PUMP OPERATION AND MAINTENANCE

Chapter 5 contained information on types of pumps, their construction, and principles of operation. Most of the information was on the two most common types of pumps, centrifugal and reciprocating. This chapter gives general information on the operation and maintenance of centrifugal and reciprocating pumps and safety precautions applicable to pumps installed on Navy ships. As an MM3 or MM2, you must know a great deal about the operation and maintenance of engineroom pumps. You may find it helpful to review this subject in Fireman, NavPers 10520-C, and chapter 9470 (47) of the Naval Ships Technical Manual.

Pumps are so widely used for various services that it is usually necessary to consult the manufacturer's technical manual for details concerning the operation of a specific unit. Routine maintenance, however, is performed in accordance with the Planned Maintenance System requirements. Figure 6-1 illustrates the planned maintenance requirements for one type of turbine-driven main lube oil pump. Similar requirements are established for all pumps.

CENTRIFUGAL PUMPS

This section contains information about centrifugal pumps that you should know, such as: (1) how they are constructed, (2) how to operate them, (3) how to take care of them, and (4) what precautions must be observed when you operate them.

OPERATING INSTRUCTIONS

The operating instructions for centrifugal pumps vary somewhat from one pump to another. Before attempting to operate any pump, therefore, you should read the posted operating instructions, read the valve labels, and check the piping markings.

The posted instructions for starting and operating a centrifugal pump will probably read something like this:

1. Check the lube oil level in the sump tank or bearing housing. Fill the oil cups or reservoirs, if fitted. Rotate the handle of the lube oil filter before starting the pump, and at least once during each watch.
2. Lubricate the linkage and slides on the speed limiting governor. If a gravity-feed oil cup is provided for the end bearing of the governor spindle, lift the snap tip of the needle valve to a vertical position; and check to be sure that oil is being fed at the proper rate—about 5 to 10 drops per minute, or as recommended by the manufacturer's technical manual.
3. Open the pump suction valve.
4. Check the suction pressure.
5. Make sure that the recirculating valve (if installed) is locked in the OPEN position.
6. Open the vents on the pump end.
7. When the vents on the pump end discharge solid streams of water, close them.
8. Open all drains on the steam end.
9. Open the turbine exhaust valve.
10. Open the bypass around the constant pressure pump governor (if fitted).
11. Crack open the turbine throttle (or start the motor).
12. Close the drains when steam blows through them.
13. Increase the throttle opening and run the pump fast enough so that the lube oil will begin to circulate. Make sure that the packing gland leak-off is adequate.
14. Make sure that the speed limiting governor is free and operable. If an overspeed trip is installed, trip it by hand and reset it.
15. Continue to run the pump at moderate speed until the oil temperature reaches 100° F. Be sure to keep the pump running fast enough to maintain adequate discharge; if the discharge

System, Subsystem, or Component

Turbine Driven Main Lube Oil Pump

Reference Publications

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
MM	ZVVFPJ4	95	4006	W	1. Sample and inspect lube oil. 2. Lubricate speed limiting governor. 3. Turn idle pump by hand; if free, operate by power.	W-1	FN	0.5	None
MM	ZZ1FRP6	95	7768	M	1. Test the speed limiting governor.	M-1	MM2 FN	0.1 0.1	None
MM	ZZ2FPJ4	84	4839	Q	1. Clean sump. 2. Clean lube oil filter. 3. Renew oil.	Q-1	MM2 FN	2.0 2.0	None
MM	ZVVFPJ4	95	4369	Q	1. Sound and tighten foundation bolts. 2. Lubricate flexible coupling.	Q-2	MM3	0.3	None
MM	ZZPFTRO	94	5422	Q	1. Measure turbine thrust clearance.	Q-3	MM2 FN	0.3 0.3	None
MM	ZZFFVA1	84	0851	Q	1. Test combination exhaust and relief valve. 2. Test lube oil relief valve.	Q-4	MM2 FN	0.2 0.2	None
MM	ZZ1FRP5	A5	4854	Q	1. Clean and inspect pump pressure regulator.	Q-5	MM2	2.0	None
MM	ZVVFPJ4	A5	6042	A	1. Inspect shaft journals, thrust collar, and bearings for condition; measure bearing clearance. 2. Inspect and clean steam strainer.	A-1	MM2 FN	3.3 3.3	M-1 Q-1 Q-3
MM	ZXFFCW4	95	4370	A	1. Renew stuffing box packing. 2. Inspect flexible coupling.	A-2	MM2	2.0	Q-2
MM	ZX6FPJ4	84	6044	A	1. By operational test, inspect internal parts for wear.	A-3	MM2	0.3	None
MM	ZZPFTRO	95	6045	C	1. Inspect carbon packing for wear. 2. Inspect turbine exterior.	C-1	MM2 FN	3.0 3.0	None

MAINTENANCE INDEX PAGE
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Figure 6-1.—PMS, Maintenance Index Page.

pressure is too low, the pump packing will not be lubricated properly.

16. When the lube oil temperature reaches 100° F, cut in the cooling water to the oil cooler. Regulate the flow of cooling water to suit operating conditions. Be sure that all air is vented from the waterside of the cooler.

17. When ordered to cut in the pump, close the constant pressure governor bypass valve and open the throttle valve all the way. Bring the discharge pressure up to the required line pressure by putting tension on the constant pressure governor spring, and slowly open the discharge valve.

If the pump fails to build up pressure, notify the petty officer of the engineroom watch. If the pressure goes too high, open bypass and use manual control until another pump has been started, and is on the line. Then secure the malfunctioning pump and correct the trouble.

Instructions for stopping and securing a centrifugal pump will, in general, read something like this:

1. Release tension on the constant pressure governor spring.
2. Close the throttle valve (OR stop the motor).
3. Close the exhaust valve.
4. Open the turbine drains.
5. Close the pump discharge valve.
6. Close the suction valve.
7. Close the drains, after the turbine is completely drained.
8. Secure the cooling water to the lube oil cooler.

OPERATING TROUBLES

Some of the operating troubles which you may have to deal with in centrifugal pumps, together with the probable causes, are given in the following paragraphs.

If a centrifugal pump DOES NOT DELIVER ANY LIQUID, the trouble may be caused by (1) insufficient priming; (2) insufficient speed of the pump; (3) excessive discharge pressure, such as might be caused by a partially closed valve or some other obstruction in the discharge line; (4) excessive suction lift; (5) clogged impeller passages; (6) the wrong direction of rotation; (7) clogged suction screen (if used); (8) ruptured suction line; or (9) loss of suction pressure.

If a centrifugal pump delivers some liquid but operates at INSUFFICIENT CAPACITY, the trouble may be caused by (1) air leakage into the suction line; (2) air leakage into the stuffing boxes, in pumps operating at less than atmospheric pressure; (3) insufficient speed of the pump; (4) excessive suction lift; (5) insufficient liquid on the suction side; (6) clogged impeller passages; (7) excessive discharge pressure; or (8) mechanical defects such as worn wearing rings, impellers, stuffing box packing, or sleeves.

If a pump DOES NOT DEVELOP ENOUGH DISCHARGE PRESSURE, the trouble may be caused by (1) insufficient speed of the pump; (2) air or gas in the liquid being pumped; or (3) mechanical defects such as worn wearing rings, impellers, stuffing box packing, or sleeves.

If a pump WORKS FOR A WHILE AND THEN FAILS TO DELIVER LIQUID, the trouble may be caused by (1) air leakage in the suction line; (2) air leakage in the stuffing boxes; (3) clogged water seal passages; (4) insufficient liquid on the suction side; or (5) excessive heat in the liquid being pumped.

If a motor-driven centrifugal pump TAKES TOO MUCH POWER, the trouble will probably be indicated by overheating of the motor. The basic cause of the difficulty may be (1) operation of the pump at excess capacity and insufficient discharge pressure; (2) excessively high viscosity or specific gravity of the liquid being pumped; or (3) misalignment, a bent shaft, excessively tight stuffing box packing, worn wearing rings, or other mechanical defects.

VIBRATION of a centrifugal pump is often caused by (1) misalignment; (2) a bent shaft; (3) a clogged, eroded, or otherwise unbalanced impeller; or (4) lack of rigidity in the foundation. Insufficient suction pressure may also cause vibration, as well as NOISY OPERATION and FLUCTUATING DISCHARGE PRESSURE, particularly in pumps handling hot or volatile liquids.

If the pump fails to build up pressure when the discharge valve is opened and the pump speed increased, proceed as follows:

1. Secure the pump.
2. See that the pump is primed and that all air is expelled through the air cocks on the pump casing.
3. See that all valves on the pump suction line are open.

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4. Start the pump again. If the discharge pressure is not normal when the pump is up to its proper speed, the suction line may be clogged, or an impeller broken. It is also possible that air is being drawn into the suction line or into the casing. If any of these conditions exist, stop the pump, try to find the source of the trouble, and correct it, if possible.

MAINTENANCE OF CENTRIFUGAL PUMPS

Some of the information which you must have in order to give proper care and maintenance to centrifugal pumps is given in this section. For further details, and for specific information on any one pump, you should consult the Naval Ships Technical Manual and the appropriate manufacturer's technical manuals. Before attempting to repair a pump, you should assemble the pump history and all pertinent drawings and dimensional data.

LUBRICATION is essential for the proper operation of centrifugal pumps, and inadequate lubrication is a primary cause of pump failure. The supply of oil to the bearings must be checked frequently during each watch. Grease cups and bearing housings must be kept filled with lubricant, and free of water or other foreign matter. Lubricating oil should be changed whenever it foams excessively, becomes emulsified, or contains dirt or sludge.

Repacking Pumps

Lubrication of the pump packing is extremely important. The quickest way to wear out the packing is to forget to open the water piping to the seals or stuffing boxes. If the packing is allowed to dry out, it will score the shaft. When you are operating a centrifugal pump, be sure that there is always a slight trickle of water coming out of the stuffing box or seal.

How often the packing in a centrifugal pump should be renewed depends on several factors. The type of pump, condition of the shaft sleeve, and hours in use, are only a few of the factors that determine the length of service of packing. A fresh water service pump may run for several months with no maintenance required, while a brine overboard pump may have to be repacked about once a month in order for it to perform satisfactorily.

To ensure the longest possible service from pump packing, make certain that the shaft or sleeve is smooth when the packing is removed from a gland. Rapid wear of the packing may be caused by roughness of the shaft sleeve or shaft. If the shaft is rough, it should be sent to the shop for a finishing cut to smooth the surface. If it is very rough, or has deep ridges cut in it, it will have to be renewed. It is absolutely necessary to use the correct packing. Navy packing is identified by symbol numbers as explained in chapter 7 of this training course. To find the right packing for a particular pump, check the packing chart, generally prepared by the engineer officer of each ship. The packing chart lists the symbol numbers and the size and number of rings required. When cutting the packing rings make the ends square, not beveled, and cut each ring so that the ends will just touch when installed on the shaft. Insert the packing with the ends staggered at 90° intervals.

When replacing packing, see that there is a uniform thickness around the shaft sleeves. An excess of packing on one side of the shaft will deflect the shaft, and frequently cause it to break.

The box should be packed loosely and the packing gland set up lightly, allowing a liberal leaking for stuffing boxes subjected to pressure above atmospheric. Then, with the pump in operation, the gland should be tightened in small increments, with several hours between tightenings, to compress the packing gradually, thereby avoiding excessive heat and scoring of the shaft or shaft sleeve. Remember that a certain amount of leakage is necessary for lubrication and cooling.

After the packing has been compressed, it will usually be necessary to add more packing. The water supply to the packing seal should be examined frequently during each watch to ensure that it is clear.

Care of Lantern Rings, Sleeves, and Flingers

Where a stuffing box is fitted with a lantern ring, be sure to replace the packing beyond the lantern ring at the bottom of the stuffing box, and see that the sealing water connection to the lantern ring is not blanked off by the packing. (See fig. 5-5.) Sleeves fitted at the packing on the pump shafts must always be tight. These sleeves are usually made secure by shrinking or keying them to the shaft. Care must be taken to see that water does not leak between the shaft and shaft sleeves.

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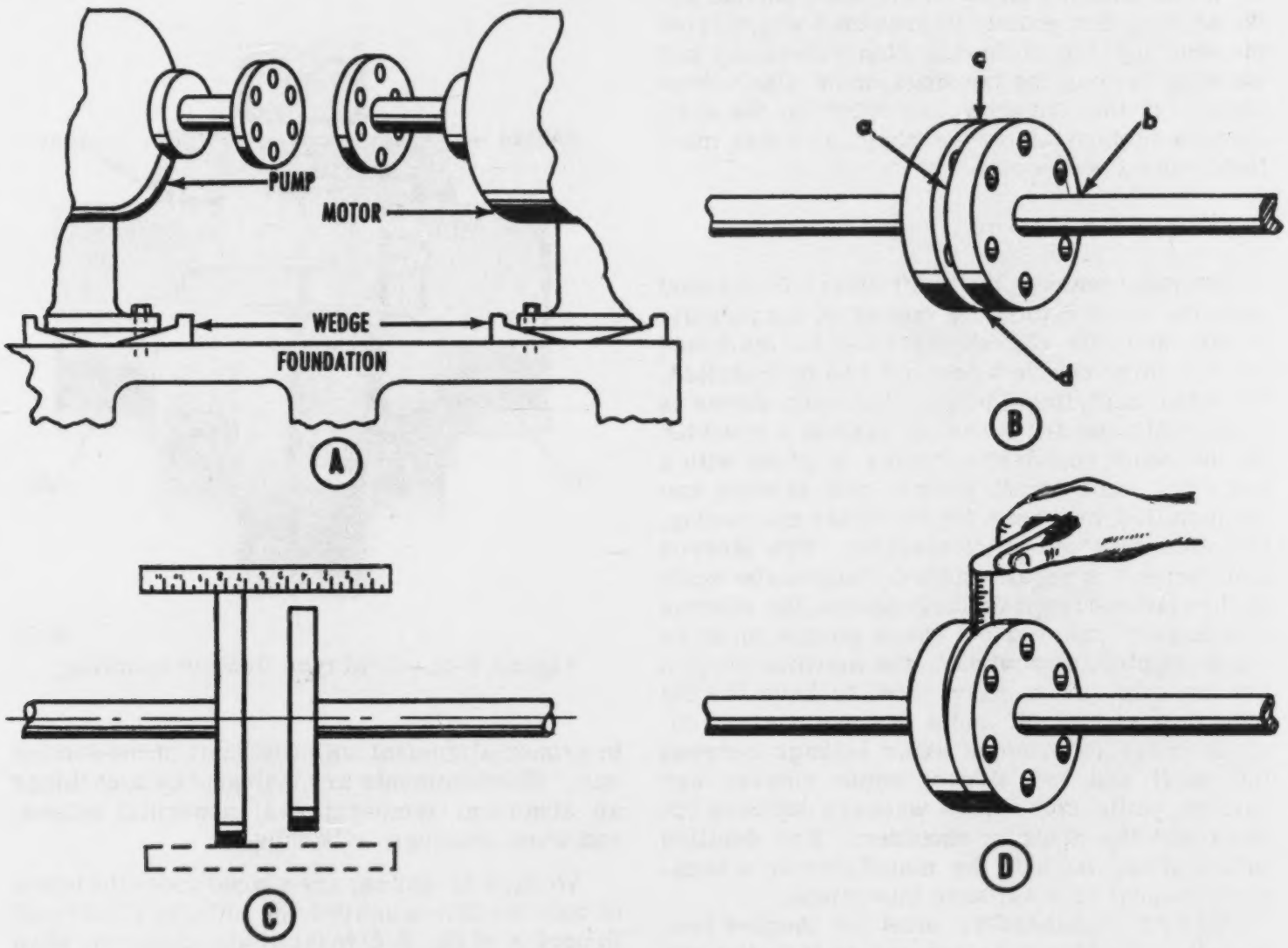

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Figure 6-3.—Alignment of flange couplings: A. Leveling the unit. B. Aligning coupling faces. C. Aligning flange diameters. D. Checking with feelers.

Some types of installations, of course, call for special methods of handling.

When USING A 6-INCH SCALE to check alignments, check the distance between the faces of the coupling flanges at 90° intervals. Find the distances between the faces at point a (part B of fig. 6-3), point b (on the opposite side), point c, and point d (opposite point c). This will indicate whether the coupling faces are parallel with each other. If they are not parallel, adjust the driving unit or the pump, or both, with shims until the couplings check true. While the distances are being measured, the outside diameters of the coupling flanges must be kept in line. To do this, place the scale across the two flanges, as shown in part C of figure 6-3. If the flanges do not line up, raise or lower one of the units with shims. Then, if necessary, shift them sidewise by means of the jacks welded on the foundation. The scale should be used (as shown in part C of fig. 6-3) at intervals of 90°, as was done in checking between the flange faces (part B of fig. 6-3).

When USING A THICKNESS GAGE to check alignments, the procedure followed is similar to that employed with a scale. When the outside diameters of the coupling flanges are not the same, use a scale on the surface of the larger flange, then use "feelers" between the surface of the smaller flange and the edge of the scale. The distance between the coupling flanges may be checked with a thickness gage (as shown in

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part D of fig. 6-3), when the space is narrow. Wider spaces are checked with the use of a piece of square key-stock and a thickness gage. The couplings should be revolved one at a time, and checked at 90° intervals. If the faces are not true, the shaft has been sprung. Many times the shafts must be removed and sent to the ship's machine shop for reworking.

When USING A DIAL INDICATOR to check alignments, clamp the indicator to one coupling flange, then revolve the opposite coupling. If no variation is shown on the indicator, the coupling is running true. By revolving the coupling with an indicator clamped to it, while the opposite coupling remains still, the degree to which the coupling centers are out of line will be shown. An adjustment (necessitating the loosening of bolts at unit bases) must be made, and the alignment checked again. When alignment is true, secure the dowels at the unit bases, and insert and fasten the coupling bolts. Dial indicators should be used wherever possible in aligning a coupling.

Shaft alignment should be checked whenever the pump is opened up, and whenever a noticeable vibration is observed. If it is found that shafts are out of line or inclined at an angle to each other, alignment of the unit should be undertaken in order to avoid shaft breakages and renewal of bearings, pump casing wearing rings, and throat bushings.

Measuring Bearing Clearances

In a centrifugal pump installation, fitted with an internal water-lubricated bearing inside the pump casing (such as condensate pumps), an adequate supply of clean water, for lubricating and cooling, must be supplied to the bearing. Several types of materials which have been used for internal water-lubricated bearings are as follows:

1. Laminated phenolic material grade FBM (fabric base bakelite or Micarta).
2. High lead content bronze.
3. Graphited bronze.
4. Lignum vitae bearings are also satisfactory.

However, because these bearings are hard to install, their use is NOT recommended, except in an emergency.

The condition of all types of internal water-lubricated bearings should be checked frequently to guard against excessive wear which results in misalignment and possibly shaft failure.

As far as oil-lubricated sleeve or shell-type bearings are concerned, the bearing clearances should be measured with leads at least every 6 months. Maintain the clearances, within the limits shown on the manufacturer's plans. If such plans are not available, follow the instructions outlined in chapter 9005 (40) of the Naval Ships Technical Manual.

When measuring the clearance of a bearing by taking leads, the following procedure is used:

1. Remove the upper half of the bearing.
2. Lay several lengths of soft lead wire circumferentially on the journal. Do not use hard fuse wire.
3. Replace the upper half of the bearing and set up on all bearing nuts. Mark the position of each one.
4. Remove the top half of the bearing; examine, and measure the thickness of the leads with a micrometer.

The best method of placing the leads on the journal is shown in figure 6-4. Leads should not be used which are heavier than required for the clearance to be measured. When taking leads, see that all bolts, bolt holes, bearing surfaces, liners (if used), and butting faces of the shells are free from foreign matter. When the leads have been properly placed and the bearing assembled, the nuts should be run down to bring the shells solidly against the liners (if used), or to bring the metal-to-metal butting faces together. (Do not apply an additional force to the nuts because it may result in deforming the threads or straining the metal of the bolts.) When set up, the position of the bearing nuts should be marked so that they may be again tightened the same amount after the leads have been removed.

When the leads are removed from the journal, one end of each lead should be pinned to a piece of paper. The leads should be spaced the same distance apart and arranged in the same order as they were on the journal. If the lead is found to be squeezed out evenly along its entire length, the clearance is uniform. To determine the bearing clearance, measure each lead at, or near its mid-point. The average thickness will indicate the bearing clearance, provided there is no great variation in the thickness of the individual leads. In addition, the thickness of each lead should be carefully measured at several places, with a

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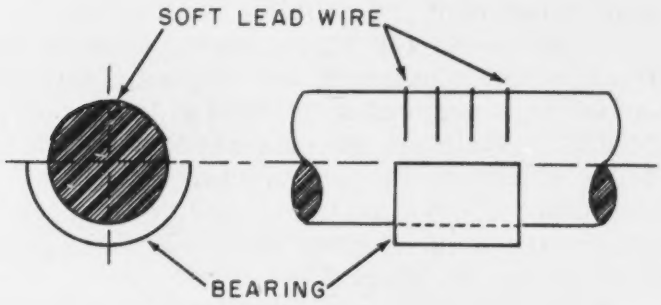

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Figure 6-4.—Taking leads.

micrometer, along the length of the wire. Leads which vary in thickness indicate an uneven bearing surface. Such bearings should be refitted to give uniform clearance.

Fitting and Spotting-In of Bearings

To fit a bearing to its journal, coat the journal with a very thin layer of prussian blue. Lay one of the bearing halves on the journal and rotate it back and forth slightly. Remove the bearing half and examine the surfaces for high spots. The high spots are located in the area where the coloring compound has adhered to the bearing surfaces. These spots must be scraped (do not let tool chatter on bearing surface) to produce a smooth and even contact surface. Continue this process until the prussian blue is uniformly distributed over the bearing surface, and covers such an area that practically all of the surface is in contact with the journal. With large bearings or those that are not easily accessible, use a mandrel the exact size of the journal. During the finishing operations, you should, as a final check, spot the bearing to the journal. After the bearing has been spotted in, take leads to determine if the bearing clearance is satisfactory.

When scraping-in a bearing, care must be taken that the lining is concentric with the shell. (If the concentricity of a bearing is lost, the pump shaft may become misaligned. This will cause unequal loads on the bearings along the shaft, and is also likely to destroy the clearances between the casing wearing rings and the impeller wearing rings.)

With very small bearings the amount of clearance is often determined by "feel." These bearings should be fitted as previously described and assembled on their journals with the bearing nuts set up hard. If the clearance is correct, there will be only the slightest indication of play between the bearing and its journal, and the journal will revolve easily.

Renewal of Wearing Rings

The clearance between the impeller wearing ring and the casing wearing ring (fig. 6-5) must be maintained as shown in the manufacturer's plans. When clearances exceed the specified figures, the wearing rings must be replaced. On most ships, this job can be done by the ship's force but it requires the complete disassembly of the pump. All necessary information on disassembly of the unit, dimensions of the wearing rings, and reassembly of the pump can be found in the manufacturer's technical manual.

In deciding whether the wearing rings need renewing, the capacity of the pump and the discharge pressure of the pump must be taken into consideration. On low pressure pumps, the wearing ring diametral clearance may be 0.015 to 0.030 inch more than the designed amount without any appreciable effect on the pump's capacity. For pumps having a discharge pressure up to 75 psi, a wear of 0.030 to 0.050 inch in permissible.

The percentage of capacity loss, with a 0.030 inch wearing ring clearance in excess of standard, may be large with a small pump, but comparatively small with a large pump. For high pressure boiler feed pumps, the effect of increased wearing ring clearance is readily

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Figure 6-5.—Impeller, impeller wearing ring, and casing wearing ring for a centrifugal pump.

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Block IV - Television Bench Servicing

Unit 4 - Video Section

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Problems in servicing the video section:	Operation and function of the video section
Troubleshooting by signal tracing	The VHF tuner
Troubleshooting by signal substitutes	The RF amplifier
Waveforms at output of video detector	The frequency-conversion section
Circuit comparison of different IF amplifiers	The local oscillator The mixer stage
Check response of video amplifier with square wave generator	UHF converter and tuner
Flashes in picture	
No picture, sound or raster	Single channel converters
Insufficient contrast	
Overloaded picture	All channel converters
Excessively snowy picture	
Sound bars in picture	VHF - UHF tuners
No reception of UHF channels	
Brightness control ineffective	Picture IF amplifier
Picture and sound do not track	Picture detector stage
Smeared picture	IF amplifier stage
	The video amplifier
	Automatic gain control systems
	Simple AGC circuits Delayed AGC circuits Keyed AGC circuits

noticeable in the efficiency and maximum capacity of the pump. For high pressure pumps the wearing rings should be renewed when the clearance shown on the manufacturer's plans is exceeded by 100 percent. It is usually not considered necessary to renew wearing rings unless the wear is at least 0.015 inch. If a pump has to be disassembled because of some internal trouble, the wearing rings should be checked for clearance. Measure the outside diameter of the impeller wearing ring with an outside micrometer, and the inside diameter of the casing wearing ring with an inside micrometer; the difference between the two diameters will be the actual wearing ring diametral clearance. By checking the actual wearing ring clearance with the maximum allowable clearance, it can be decided whether to renew the rings before reassembling the pump.

The amount of work involved in disassembling the pump, the length of time the pump can be out of commission without affecting the ship, and whether or not a repair ship or other repair activity will be involved are some of the factors that have to be taken into consideration when determining whether to renew wearing rings.

For most small pumps, wearing rings are carried aboard as part of the ship's repair parts allowance. These may need only a slight amount of machining before they can be installed. For some pumps, such as main condensate, and main feed booster pumps, spare rotors are carried aboard. The new rotor can be installed and the old rotor sent to a repair activity for overhaul. Overhauling a rotor includes renewing the wearing rings, bearings, and the shaft packing sleeve.

RECIPROCATING PUMPS

As a Machinist's Mate, you will be required to operate and maintain reciprocating pumps. This type of pump was introduced in Fireman, NavPers 10520-C. Additional information is provided in the sections which follow.

OPERATION OF RECIPROCATING PUMPS

Procedures for the operation of the general service pump, are in general, the same as for any other reciprocating pump. With the general service pump, however, special precautions must be taken to see that the suction strainers are kept clean. Clogged suction strainers and the presence of foreign matter in the water chest suction and discharge valves are the most frequent causes of trouble in the liquid end of the general service pump.

Operating and Securing Instructions

1. Check to be sure that the steam cylinder and steam chest drain valves are open. (They should always be opened when the pump is shut down.)
2. Oil the pins and bushings of the valve operating gear.
3. Open the water end suction and discharge valves.
4. Open the steam end exhaust valve.
5. Crack open the throttle valve. Warm up the steam end slowly.
6. When the cylinder and chest are free of water, close the drain valves.
7. Bring the pump up to the desired speed or discharge pressure by slowly opening the throttle valve.

The following steps are generally used in securing a reciprocating pump:

1. Close the throttle valve.
2. Open the steam cylinder and chest drain valves.
3. Close the exhaust valve.
4. Close the water end suction and discharge valves.

Operating Troubles

From time to time you are likely to have some operating troubles with reciprocating pumps. The most common causes of trouble, together with their symptoms and remedies, are described here.

Lack of proper suction will cause jerky or irregular operation of the pump, or it may cause the pump to race without any appreciable increase in discharge pressure. Loss of suction may be caused by a number of different conditions, including:

1. Obstructions in the suction line.
2. Loss of suction head, which causes the pump to become vaporbound.
3. Air in the system, which causes the pump to become airbound.

Obstructions in the suction line frequently cause trouble in fire and bilge pumps. Be sure

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that the suction line is clear and that all stop or check valves in the line are open. Clean the suction line strainer and the bilge strainer.

A pump can lose suction by becoming airbound—that is, having air trapped in the system. The remedy for this condition is to open the aircocks and vents on the liquid end valve chest; leave them open until water flows out.

Insufficient prime often causes loss of suction in pumps which have a considerable suction lift. The fire and bilge pump can be primed from the sea by opening the sea suction valve for a short time.

Worn packing on the plunger or damaged suction or discharge valves in the liquid end may cause the pump to race without an appreciable increase in discharge pressure. It is hard to distinguish this kind of trouble from the troubles caused by loss of suction, since the general symptoms are very similar. However, if you suspect that the plunger packing is worn or that the liquid end valves are damaged, you should stop the pump as soon as possible and locate and correct the trouble.

Groaning in the steam end of the pump may indicate that the piston rod packing is too tight, that the piston or a piston ring is broken, that rust has formed in the cylinder, or that the steam cylinder is out of alignment. The pump should be secured so that the difficulty may be found and corrected.

Groaning in the liquid end of the pump is generally due to excessively tight packing or broken or damaged follower plate or other broken parts. Stop the pump and investigate.

Knocking in the steam end of the pump may be caused by too long a stroke, by water in the steam cylinder, by loose pistons or piston rings, or by some difficulty in the piston-type valve gear. The pump should be stopped at once so that the trouble may be found and corrected.

Proper adjustment of the length of stroke is extremely important. If the stroke is too long, the steam piston will hit against the cylinder heads and make a heavy, metallic knocking sound. When the stroke is too short, the pilot valve may block the ports sufficiently to interfere with the admission of steam into the main valve; and this may cause the pump to stop. In addition, a short stroke causes shoulders to be worn in the cylinder; and when the stroke is lengthened, these shoulders may cause the piston rings to break. Improper length of stroke, whether too short or too long, may cause great damage to the pump. To adjust the pump stroke, throttle down the pump, and adjust the stroke as necessary.

MAINTENANCE OF RECIPROCATING PUMPS

Reciprocating pumps require routine maintenance and repair work. This section covers some factors dealing with maintenance and repair. For additional information, check chapter 9470 (47) Naval Ships Technical Manual, or the manufacturer's technical manual.

Before repairing or examining a pump, assemble the Maintenance Requirement Card, all the pertinent blueprints, drawings, and available data. These drawings and data will give you the required clearances, tools to be used, measurements, information regarding materials to be used, and other important data. In addition, you should have the complete history of the pump being repaired, so that you will know what has been done previously, when repairs were made, and what kind of trouble has been encountered with this particular pump.

Whenever reciprocating pumps are opened for repairs, micrometer or caliper measurements should be taken of the main cylinders and the valve chest cylinders. These measurements are made on the fore and aft and athwartships diameters at the top, middle, and bottom. The results should be recorded with accompanying remarks or a diagrammatic sketch showing the measurements obtained and the date on which they were made.

Remember that the steam end of a reciprocating pump should NOT be dismantled until a thorough check reveals that the water end is satisfactory. Most reciprocating pump troubles, however, result from fouled water cylinders, worn valves, or from faulty conditions in the pipe connections external to the pump.

Adjustment of Stroke

In order for a steam-driven reciprocating pump to operate properly, the steam piston must travel a little beyond counterbore (fig. 6-6); this means that the pump must operate with a full stroke. A full stroke will result in more even wear throughout the cylinder.

The length of the stroke is adjusted by moving the two adjustable tappet collars on the threaded portion of the valve rod link. The

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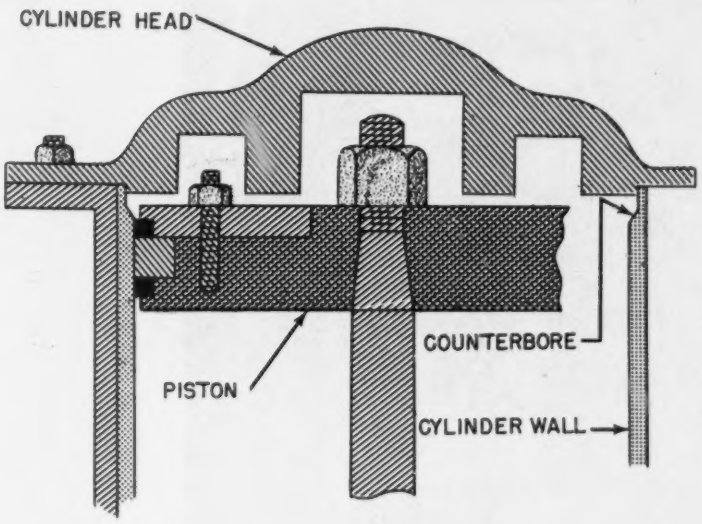

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Figure 6-6.—Steam piston at upper end of stroke.

tappet moves between the tappet collars as the lever is moved by the action of the piston rod.

To shorten the stroke of the pump, turn the tappet collar in the direction that moves it toward the tappet. To lengthen the stroke of the pump, turn the tappet collar in the direction that moves it away from the tappet. Once the tappet collars have been set properly, they should be left alone. If it becomes necessary to adjust the tappet collars frequently while the pump is operating, the pump should be stopped and disassembled as soon as possible. The trouble may be in the operating linkage, the auxiliary piston valve, or the main piston valve.

Properly adjusted tappet collars will ensure a full stroke for the various pump loads and speeds. Refer to manufacturers' drawings and technical manuals for detailed information as to the method to be followed for specific types of valve gear. The following method may be used for a general guide if the appropriate information is not available.

Place the steam piston and auxiliary piston valve on the center or half stroke. Then move each tappet collar so that it will be one-half the width of the steam port away from the tappet. Next start the pump. If the stroke is too short, move the tappet collars further apart. If the stroke is too long, move the tappet collars closer together. Make certain that the tappets are moved an equal amount, or the stroke will be longer on one end than on the other. When final adjustment has been made, lock the tappet collars securely in place.

Run the pump slowly, with the throttle cracked, against little or no pressure, and with the cushioning valves wide open. The piston should be striking on the cylinder heads (if it does not, there is friction at some point). Close down on the cushioning valves until the pump is running at full stroke and with smooth reversal and no striking. If it is impossible to obtain smoothness of reversal, it may be necessary to adjust the tappet collars.

In figure 6-7 the steam piston is shown beginning the up stroke. Both valves are in the upper position, thereby admitting high pressure steam through the lower steam inlet port to the underside of the steam piston, and permitting steam above the piston to escape through the exhaust port.

When the steam piston reaches the top of the stroke the lever and tappet linkage move the pilot (auxiliary piston valve) down, opening port A to the annual exhaust space above the center of the auxiliary and main piston valve. See figure 6-7. Opening port A releases pressure in space B, below the main piston valve, and permits the unbalanced higher pressure in space C to force the main piston valve down. The small size of the equalizing port in the main piston valve prevents the escape of any appreciable amount of high pressure steam into space B. The pilot valve blanks off the upper port, preventing the escape of high pressure steam from space C, even after the downward movement of the main piston valve uncovers port C, and thereby ensures complete movement of the piston valve to its lower position.

At the end of its travel, the main piston valve cushions itself when it blanks off the port to space A, trapping dead steam which cannot readily escape through the small equalizing port in the valve. The initial condition of steam balance is reestablished by means of this equalizing port. The previously described movements are repeated on the opposite end of the stroke.

The force which actuates the main piston valve is determined by the difference in the rate of flow of steam through port A, which is 1/4 inch in diameter, and through the 1/16-inch equalizing port drilled through the outside collars of the main piston valve. Except when the main piston valve is actually in motion, it is in complete balance, both axially and

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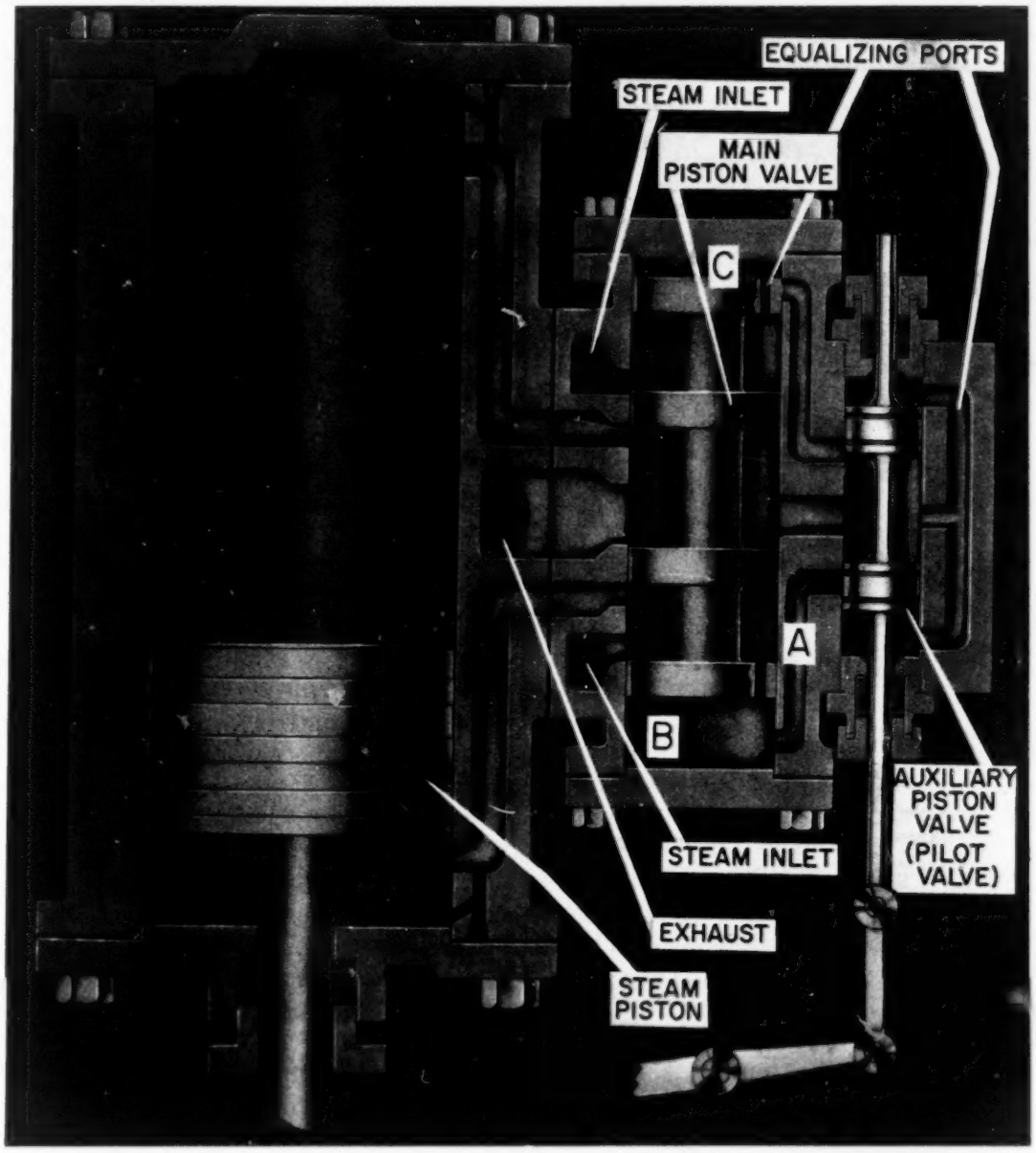

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Figure 6-7.—Steam end assembly for a reciprocating pump.

circumferentially, so that the friction between the sliding surfaces is the only force restricting its travel. The equalizing port, which connects the outer ends of the auxiliary piston valve cylinder, is essential to permit free movement of the auxiliary piston valve. Light packing will suffice for the pilot valve actuating rod, since only auxiliary exhaust pressures must be held.

Care of Pistons and Packing

Pistons in the water end of pumps (fig. 6-8) are generally constructed of bronze and are of the body and follower type. The piston itself is not a tight fit, but depends upon several rings of packing to prevent leakage. These rings of packing are placed between a shoulder at one end of the piston and a follower plate at the other end. To renew this packing, close, wire, and tag the water end suction and discharge valves. Remove the bottom water and cylinder head. Then remove the follower and the old packing. Check the packing chart for the right type and size of packing. If fibrous packing is used, the packing should be soaked in hot water for at least 12 hours before it is cut and installed. The rings should be step-cut, when fitted to the piston.

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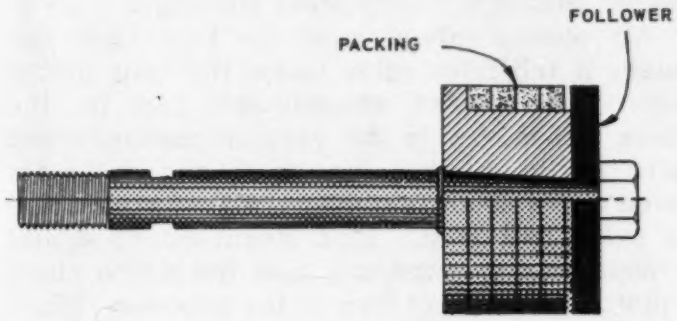

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Figure 6-8.—Liquid end piston, rod, packing, and follower.

Insert the packing, staggering the ring gaps at 90° intervals.

Replace the follower and, by using a bar, jack the pump over. If the new packing does not bind and there is no groaning in the water end, replace the cylinder head. In emergencies fibrous packing can be used without soaking, provided it is cut with sufficient clearance to allow for swelling. Failure to provide ample clearance will cause the pump to groan and may result in a scored cylinder.

Worn or Broken Piston Rings

Troubles in the steam cylinder result mainly from faulty piston rings. Wearing of piston rings can cause a pump to lose power, and even, to stop. If a pump stops, while operating slowly, in the middle of a stroke, the trouble may be due to worn rings; secure the pump and examine the condition of the rings and the cylinder. If necessary, renew the piston rings.

Figure 6-9 shows a steam piston assembly of a reciprocating pump. The piston rings are cast iron. If the piston rings are broken or worn or have been poorly fitted so that there is excessive leakage by the piston, new rings must be installed.

To remove a piston ring, hold the piston rod and piston in a vise, as illustrated in figure 6-9. (When doing this, use soft metal covers on the vise jaws to prevent digging into or otherwise abrading the polished surface of the piston rod.) Pry the end of the old ring by means of a thin, pointed drift tool and a strip of sheet iron or an old piece of hacksaw blade, as shown. Continue the prying and add more strips until the ring is raised out of its groove and can be slipped off the piston.

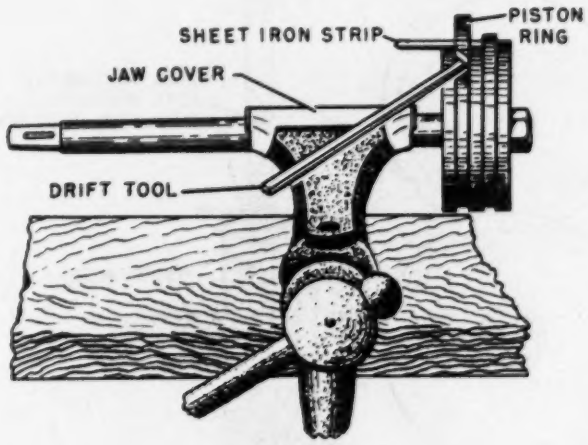

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Figure 6-9.—Removing piston rings.

When the rings have been removed, take micrometer measurements of the cylinder or liner to determine the exact diameter. In addition, measure the width of the ring grooves in the piston to determine the width of the new rings. The inside diameter of the new ring can be determined by checking the applicable blueprint or by measuring the inside diameter of an old ring. To take measurements of an old ring, place a piece of chart paper in the gap where the ring is cut, bind the ring so that the ends butt up snugly, and then measure the inside diameter.

When replacing piston rings, first fit the new rings to the cylinder to check the GAP clearance. If the gap clearance is not specified on the blueprint, allow a clearance slightly less than 0.001 of an inch per inch of cylinder diameter. For example, a clearance of 0.007 to 0.008 inch should be allowed for a piston ring of a 10-inch cylinder. If necessary, file the ends until proper clearance is obtained. Check the width of the rings to make sure that they will fit into the grooves properly. You can fit the piston rings by rolling them around the piston grooves. The rings should fit snugly, yet roll freely (fig. 6-10). If they do not roll freely, polish the sides of the rings lightly on fine emery cloth held against a smooth and even surface. Repeat the process until the rings fit properly in their respective grooves. (The ring gaps must be staggered so that they do not fall in one line.)

Scored Water Cylinder

When a water cylinder becomes scored, it is not always necessary to rebore the cylinder

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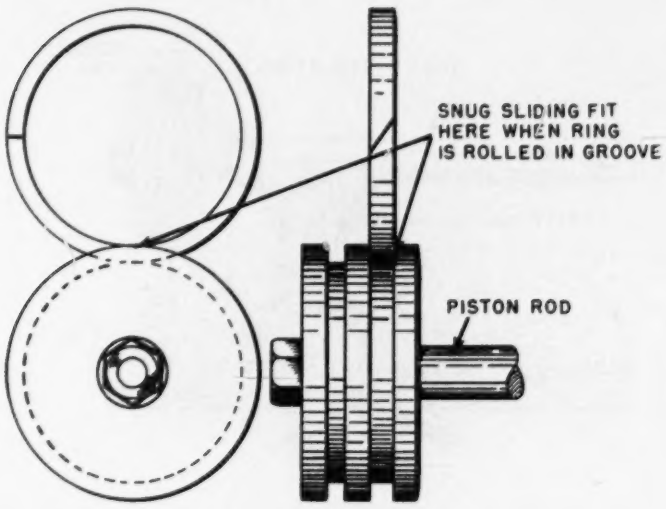

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Figure 6-10.—Fitting piston rings.

or renew the liner. Slight leakage from wear can usually be corrected by stoning the cylinder liner and renewing the packing. If reboring must be done, consult the tolerances allowed in boring cylinders, given in chapter 9005 (40) of the Naval Ships Technical Manual. Reboring or renewal of the liner should be considered only when the scoring is extensive and rapid wearing of the packing takes place.

Scored Steam Cylinder

Scoring in a steam cylinder, even though of a minor nature, necessitates reboring to prevent steam leakage past the piston. The presence of such leakage is indicated by a dullness and discoloration of the cylinder walls. Once leakage has started, steam will gradually cut away cylinder walls until piston leakage becomes so excessive as to interfere with proper operation of the pump.

Care of Steam Valve Mechanism

The same care must be exercised in fitting the steam valve operating mechanism as is used in fitting the steam piston and cylinder. It is most important that all wear be kept out of the steam valve operating mechanism. Failure to do this will cause the pump to operate in a faulty manner, and perhaps to stick. The pins should be rebushed and renewed as often as necessary. If wear of bushings occurs rapidly, despite careful lubrication, the holes may be bushed with tool steel bushings.

All steam valves must be kept tight because, if the pilot valve leaks, the main piston valve will become steambound; that is, the steam pressures in the various passages and parts of the pilot valve chest and the main piston valve chest cylinders will equalize, and the pump will stop. Flat steam valves should be kept true by scraping, and the piston rings of piston valves kept free in the grooves. When scraping flat steam slide valves, the strokes of the scraper should cross, so that the scraper will not chatter on the narrow bridges between the ports; any unevenness will result in steam leakage when the valve is in operation.

As a result of frequent spotting-in of the main piston valve and the pilot valve, the relative size and arrangement of port openings may change owing to irregular coring. A simple method used to check the accuracy of the valve action is to cut paper patterns of the valve and the valve seat faces by laying the paper on the valve and peening with a hammer. Sliding the pattern of the valve over that of the seat will show the exact laps, leads, and port openings, which can be checked with the drawings.

Repairs to Valve Chests, Liners, and Piston Rings

Preventive maintenance of steam valve chests operating under high steam pressures is most important to avoid serious steam cutting and wear. Careful attention to lapping out these early cuts will ensure a tight metal-to-metal fit of the valve chest and steam cylinder.

Prior to making up the metal-to-metal joint, it should be blued and tested for good overall contact. If the joint is not a good metal-to-metal fit, or if scores or leakage are evident, remove the studs from the steam cylinder and lap the steam chest in against the cylinder seat.

In making up the joint, strict cleanliness must be observed so that no particles of dirt or scale will prevent a good metal-to-metal contact of the ground faces. A thin film of copaltite should be applied. The hold-down bolts should be taken up gradually and alternately in a diagonal sequence. After the pump is in operation, the hold-down bolts should be taken up again.

Do not install gaskets on the steam chest joint. Such a gasket tends to blow out around

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the steam passage lands, thus aggravating the cutting action of the steam.

When continued lapping of the valve chest and the steam cylinder have worn them down to the extent that they must be built up to the original dimensions, then both should be overlayed and brought back to the design dimension. When piston valve chest joints, lands, and other parts are badly damaged by wear and steam cutting, the repair procedures given in the following paragraphs are authorized by the Naval Ship Systems Command. (Refer to fig. 6-11 for identification of the areas to be repaired.)

Joint face A (fig. 6-11), between the steam chest and the cylinder, may be built up by overlaying. Both surfaces should be brought back to their design dimensions.

Main liner chest lands B may be built up by welding with a corrosion-resisting steel (25 percent chromium, 20 percent nickel) electrode.

Liners should be replaced, if possible, rather than subjected to extensive repair. However, if spare liners are not available, the individual liner may be chrome plated on the outside area C. In such cases, liners should be shrunk into place. Pressing chrome-plated liners into the chest will result in galling. Chrome plating of the inside or wearing surface of liners (area D of fig. 6-11) is not authorized; such a repair would do away with the graphitic lubrication provided by the original special alloy iron liners.

Main piston valves and the pilot valves should be replaced when worn or steam cut. Building up ring grooves E with chromium-cobalt composition is authorized, if replacement valves cannot be obtained. The original valve material has a hardness of approximately 200 Brinell; the liner, approximately 500 Brinell. Thus, wear will be taken on the pistons rather than on the more expensive liners. Therefore, overlaying of the ring grooves with a harder material than the liner should be avoided to prevent rapid wear of the liner.

The end lands of main piston valves may be found to have insufficient clearance with the liner. The clearance on diameter between end lands F and the liner should range from 0.002 to 0.0025 inch per inch of diameter. Center lands should have approximately half of this clearance.

Replacement piston rings G should be of cast iron (as originally installed) in order to obtain the required finish on the working faces.

If tail rods H are to be replaced, they should be of K-Monel to avoid corrosion and the danger of rust working loose in the valve chest. Chrome plating of the original carbon steel rods is satisfactory as a repair.

Overhauling Water End Valves

All valves in the water end of the pump must be kept tight to ensure satisfactory and economical pump operation. Valves may be faced in a lathe and then ground in on their seats by a simple device which consists of a length of rod slotted to fit a piece of metal which seats across the top of the valve.

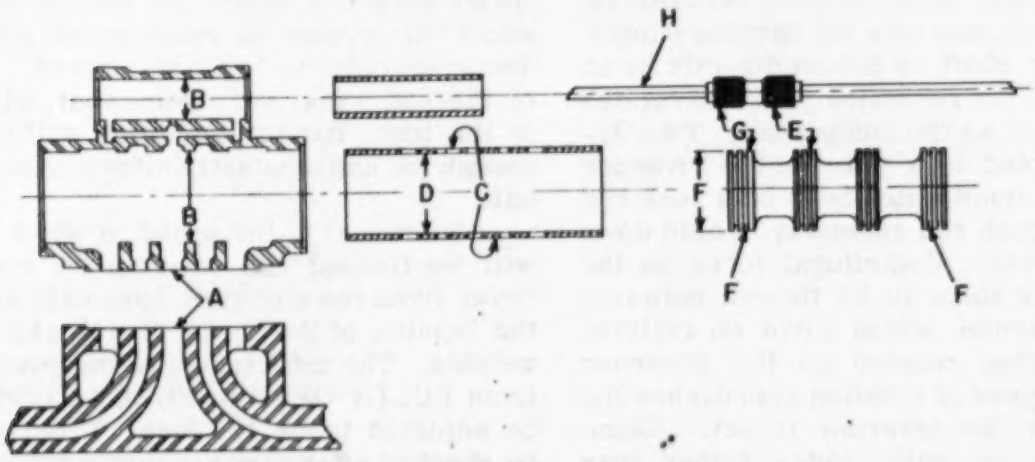

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Figure 6-11.—Repair of valve chests, liners, and piston rings.

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It is sometimes desirable to take a cut off the valve seat without removing it. A simple cutter can be made with an extension for a bitstock, similar to the grinding-in device. When flat valves are fitted, the seats may be trued up by using a small surface plate and spotting-in the section on the surface plate.

Valve disks and seats should be ground in, or replaced if necessary, in accordance with Maintenance Requirement Cards and manufacturer's instructions.

After the valves have been ground in, test the valves by closing the suction valve, opening the discharge valve, starting the pump, and noting the vacuum that the pump is capable of attaining.

PUMP CONTROL AND SAFETY DEVICES

Turbines, used to drive pumps, are fitted with devices to control or limit the speed of the turbine, or to regulate the discharge pressure of the unit.

These devices are seldom found on reciprocating pumps. However, all turbine-driven rotary and centrifugal pumps have some type of governor; where discharge pressure has to be controlled, both a constant pressure governor and a speed limiting governor are installed.

SPEED LIMITING GOVERNOR

The speed of turbine-driven condensate and booster pumps is controlled by a speed limiting governor. This type of governor has no control of the pump speed until it reaches about 95 percent of maximum. Figure 6-12 shows one of the more common types used on main condensate, main feed booster, and lube oil service pumps.

The governor shaft is driven directly by an auxiliary shaft in the reduction gear and rotates at the same speed as the pump shaft. Two flyweights are pivoted to a yoke on the governor shaft and carry arms which bear on a push rod assembly. The push rod assembly is held down by a strong spring. Centrifugal force on the flyweights causes them to be thrown outward. This lifts the arms, which pivot on rollers, against the spring tension on the governor stem when the speed of rotation approaches the speed for which the governor is set. (Some flyweights pivot on knife edges rather than rollers.) If the turbine speed begins to exceed that for which the governor is set, increased

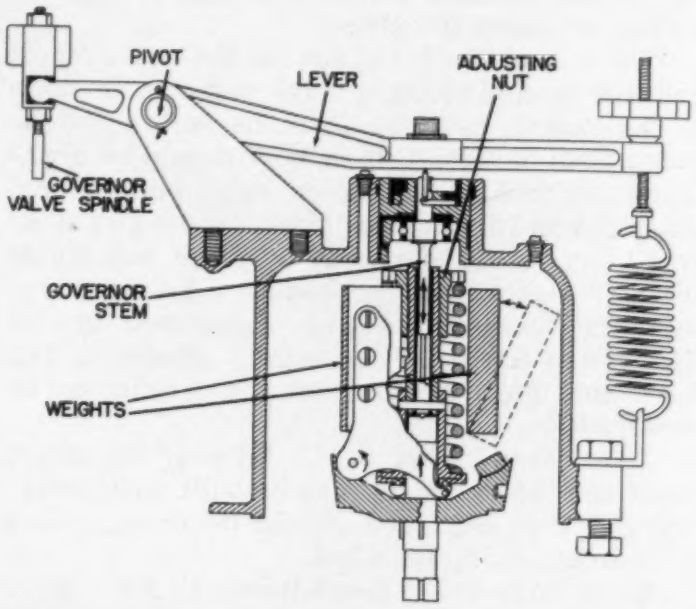

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Figure 6-12.—Speed limiting governor, main condensate pump.

centrifugal force acting on the rotating flyweights will cause them to move farther out, and thereby cause the governor valve to throttle down on the steam. On the other hand, when the turbine slows down, as from an increase in load, the centrifugal force on the flyweights is reduced, and the governor push rod spring acts to pull the flyweights inward. This rotates the lever about its pivot and opens the governor valve, thus admitting more steam with a resultant speedup of the turbine until normal operating speed is reached.

Therefore, the governor acts as a constant speed governor (when the turbine is operating above 95 percent of rated speed) although it is designed only to limit the speed. The speed of the pump may vary somewhat, with a change in the load, but the variation will not be great enough to cause unsatisfactory operation of the unit.

Adjustment of the speed to which the turbine will be limited can be made by removing the cover from the governor assembly and changing the tension of the spring that works against the weights. The total travel of the governor valve, from FULLY OPEN to FULLY CLOSED, should be adjusted to be 1/4 inch. This travel should be checked after each readjustment of the spring. The pump is normally operated with the throttle fully open, passing full steam pressure to the

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governor valve, and thereby allowing the valve to control the speed of the unit.

Figure 6-13 shows a CENTRIFUGAL WEIGHT TYPE of SPEED LIMITING GOVERNOR for a main feed pump. Centrifugal weights are mounted on a hub which rotates with the turbine shaft. As the speed of the turbine increases, centrifugal force causes the free ends of the weights to move outward, compressing the governor spring. This action causes the sleeve to move out against one end of the governor lever. The other end of the lever is thereby moved inward, closing the double-poppet steam governor valve and thus cutting down the amount of steam which is admitted to the turbine. Tension on the spring at the outer end of the double-poppet valve stem tends to open the valve again, as soon as the turbine shaft has slowed down and allowed the centrifugal weights to move inward.

CONSTANT PRESSURE GOVERNOR

Many turbine-driven pumps are fitted with constant pressure pump governors. The function of a constant pressure pump governor is to maintain a constant pump discharge pressure under varying conditions of load. The governor, which is installed in the steam line to the pump, controls the pump discharge pressure by controlling the amount of steam admitted to the driving turbine.

Two types of constant pressure pump governors are used in the Navy—the Leslie governor and the Atlas governor. The two types of governors are very similar in operating principles. The discussion here is based on the Leslie governor, but most of the information applies also to the Atlas governor.

A Leslie constant pressure pump governor for a main feed pump is shown in figure 6-14. The governors used on fuel oil service pumps, lube oil service pumps, fire and flushing pumps, and various other pumps are almost identical. The chief difference between governors used for different services is in the size of the upper diaphragm. A governor used for a pump which operates with a high discharge pressure has a smaller upper diaphragm than one for a pump which operates with a low discharge pressure.

Two opposing forces are involved in the operation of a constant pressure pump governor. Fluid from the pump discharge, at discharge pressure, is led through an actuating line to the space below the upper diaphragm. The pump

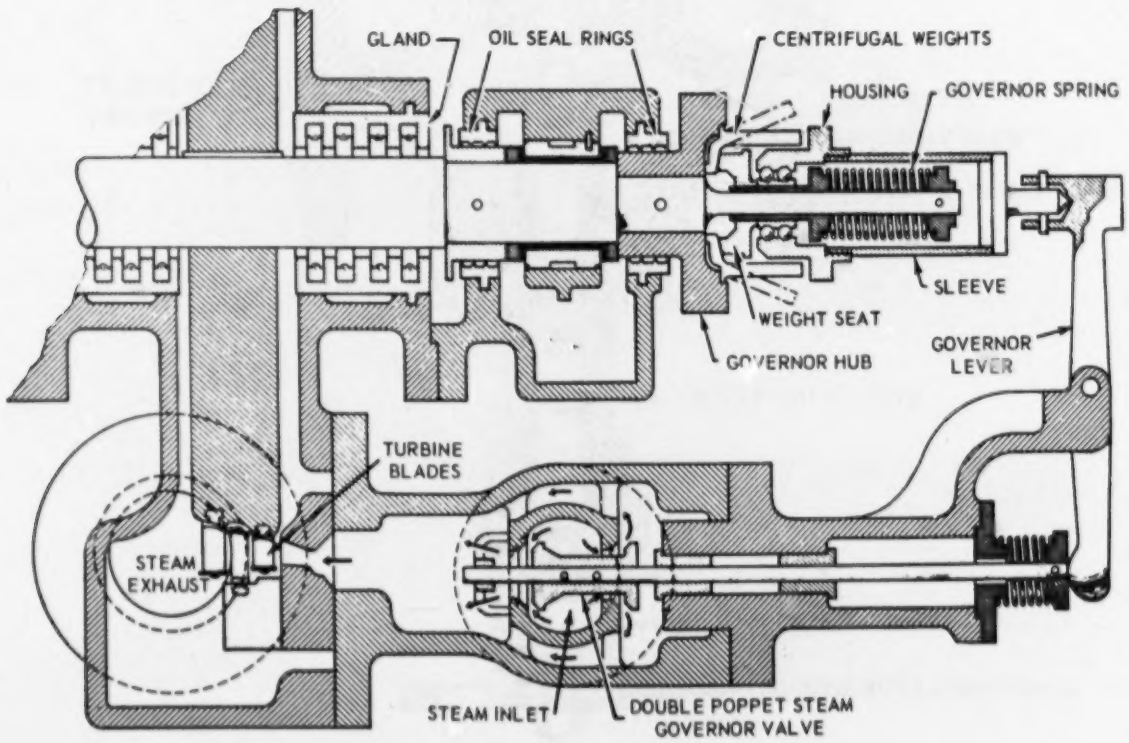

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Figure 6-13.—Speed limiting governor, main feed pump.

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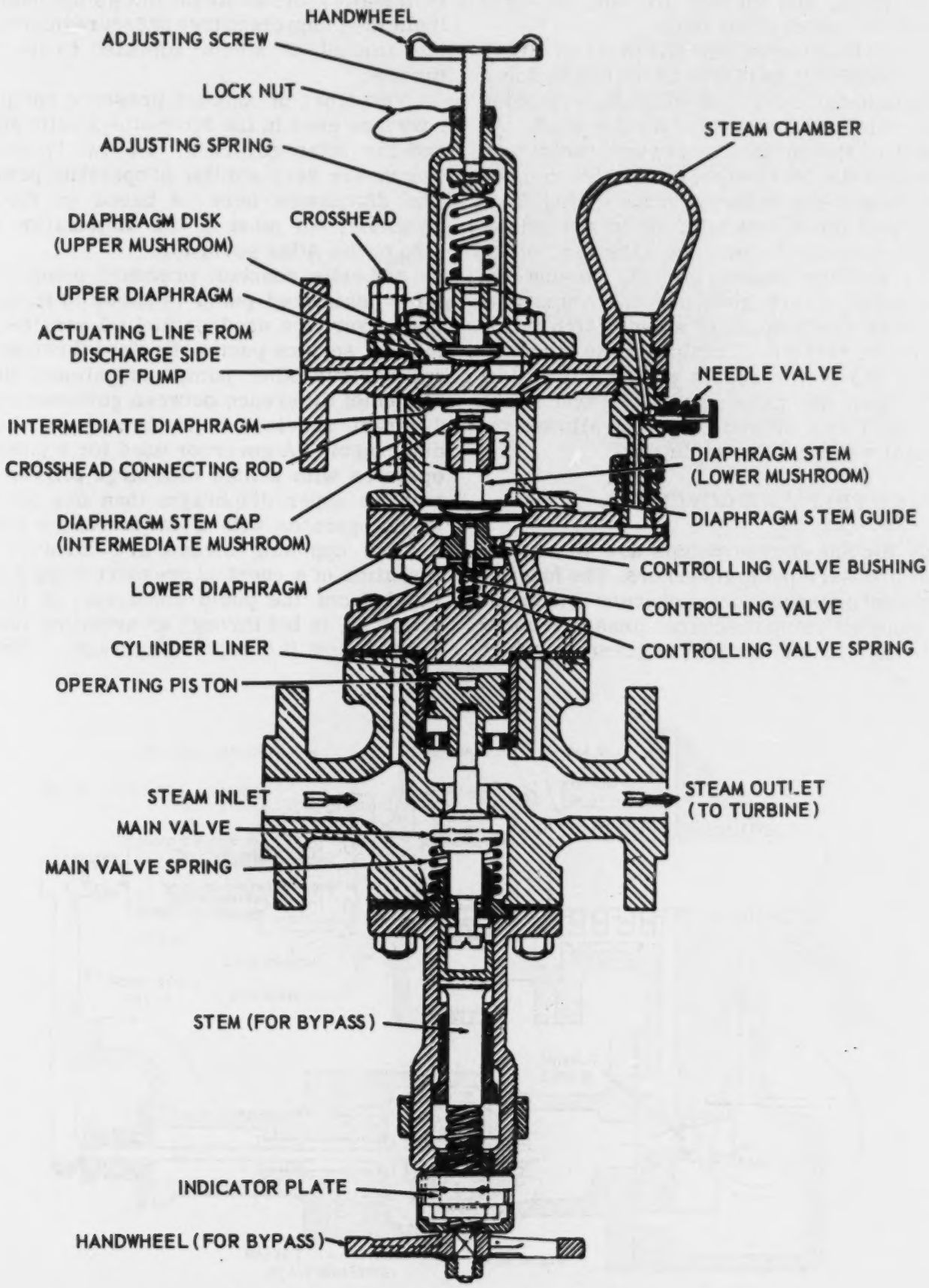

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Figure 6-14.—Constant pressure governor for main feed pump.

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Block IV - Television Bench Servicing

Unit 5 - High Voltage Circuits

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Troubleshooting high voltage circuits	Visual indications of high-voltage section defects
	High-voltage circuit comparison in late model receivers
	Single-tube used as half-wave rectifier Voltage doubler types
	Compound function and effects of component breakdown in high-voltage circuits
	High-voltage DC and AC measurements
	Procedure for servicing high-voltage section

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discharge pressure thus exerts an UPWARD force on the upper diaphragm. Opposing this, an adjusting spring exerts a DOWNWARD force on the upper diaphragm.

When the downward force of the adjusting spring is greater than the upward force of the pump discharge pressure, the spring forces the upper diaphragm and the upper crosshead down. A pair of connecting rods connects the upper crosshead rigidly to the lower crosshead, so the entire assembly of upper and lower crossheads moves together. When the crosshead assembly moves down, it pushes the lower mushroom and the lower diaphragm downward. The lower diaphragm is in contact with the controlling valve. When the lower diaphragm is moved down, the controlling valve is forced down and open.

The controlling valve is supplied with a small amount of steam through a port from the inlet side of the governor. When the controlling valve is open, steam passes to the top of the operating piston. The steam pressure acts on the top of the operating piston, forcing the piston down and opening the main valve. The extent to which the main valve is open controls the amount of steam admitted to the driving turbine. Increasing the opening of the main valve therefore increases the supply of steam to the turbine and so increases the speed of the turbine.

The increased speed of the turbine is reflected in an increased discharge pressure from the pump. This pressure is exerted against the under side of the upper diaphragm. When the pump discharge pressure has increased to the point where the upward force acting on the under side of the upper diaphragm is greater than the downward force exerted by the adjusting spring, the upper diaphragm is moved upward. This action allows a spring to start closing the controlling valve, which in turn allows the main valve spring to start closing the main valve against the now reduced pressure on the operating piston. When the main valve starts to close, the steam supply to the turbine is reduced, the speed of the turbine is reduced, the pump discharge pressure is reduced.

At first glance, it might seem that the controlling valve and the main valve would be constantly opening and closing and that the pump discharge pressure would be continually varying over a wide range. This does not happen, however, because the governor is designed with an arrangement which prevents excessive opening or closing of the controlling valve. An intermediate diaphragm bears against an intermediate mushroom which, in turn, bears against the top of the lower crosshead. Steam is led from the governor outlet to the bottom of the lower diaphragm and also, through a needle valve, to the top of the intermediate diaphragm. A steam chamber is provided to ensure a continuous supply of steam at the required pressure to the top of the intermediate diaphragm.

Any movement of the crosshead assembly, either up or down, is therefore opposed by the force of the steam pressure acting either on the intermediate diaphragm or on the lower diaphragm. The whole arrangement serves to prevent extreme reactions of the controlling valve in response to variations in pump discharge pressure.

Limiting the movement of the controlling valve in the manner just described reduces the amount of hunting the governor must do to find each new position. Under constant-load conditions, the controlling valve takes a position which causes the main valve to remain open by the required amount. A change in load conditions results in momentary hunting by the governor until it finds the new position required to maintain pump discharge pressure at the new load.

A pull-open device, consisting of a valve stem and a handwheel, is fitted to the bottom of the governor. Turning the handwheel to the open position draws the main valve open and allows full steam flow to the turbine. When the main valve is opened by means of this bypass arrangement, the turbine must be controlled manually. Under all normal operating conditions, the bypass remains closed and the pump discharge pressure is raised or lowered, as necessary, by increasing or decreasing the tension on the adjusting spring.

An AUTOMATIC SHUTDOWN DEVICE has been developed by the Leslie Company for use on main feed pumps. The purpose of this device is to shut down the main feed pump and so protect it from damage in the event of loss of feed booster pump pressure. The shutdown device has been tested in service and has shown that it can shut down the main feed pump when the feed booster pump pressure is inadequate.

The Leslie automatic shutdown device consists of an auxiliary pilot valve and a constant pressure pump governor, arranged as shown in

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figure 6-15. The governor is the same as the Leslie governor just described except that it has a special top cap. In the regular Leslie governor, the steam for the operating piston is supplied to the controlling valve through a port in the governor valve body. In the automatic shutdown device, the steam for the operating piston is supplied to the controlling valve through the auxiliary pilot valve. The auxiliary pilot valve (fig. 6-16) is actuated by the feed booster pump discharge pressure. When the booster pump discharge pressure is inadequate, the auxiliary pilot valve will not deliver steam to the controlling valve of the governor. Thus inadequate feed booster pump pressure allows the main valve in the governor to close, shutting off the flow of steam to the main feed pump turbine.

MAINTENANCE AND REPAIR OF GOVERNORS

The maintenance and repair of governors should be accomplished in accordance with the applicable Maintenance Requirement Cards or manufacturer's instructions for the specific equipment. Information which follows is general in nature.

As far as speed limiting governors are concerned, very little wear is experienced. However, the governor must be kept clean. Dirt or other foreign matter can foul the spring, and thus require more force to move the weights, which will allow the pump to overspeed. Rust on the governor lever fulcrum pin will cause the lever to bind and not function properly. All pins in the linkage and the valve stem must be kept free

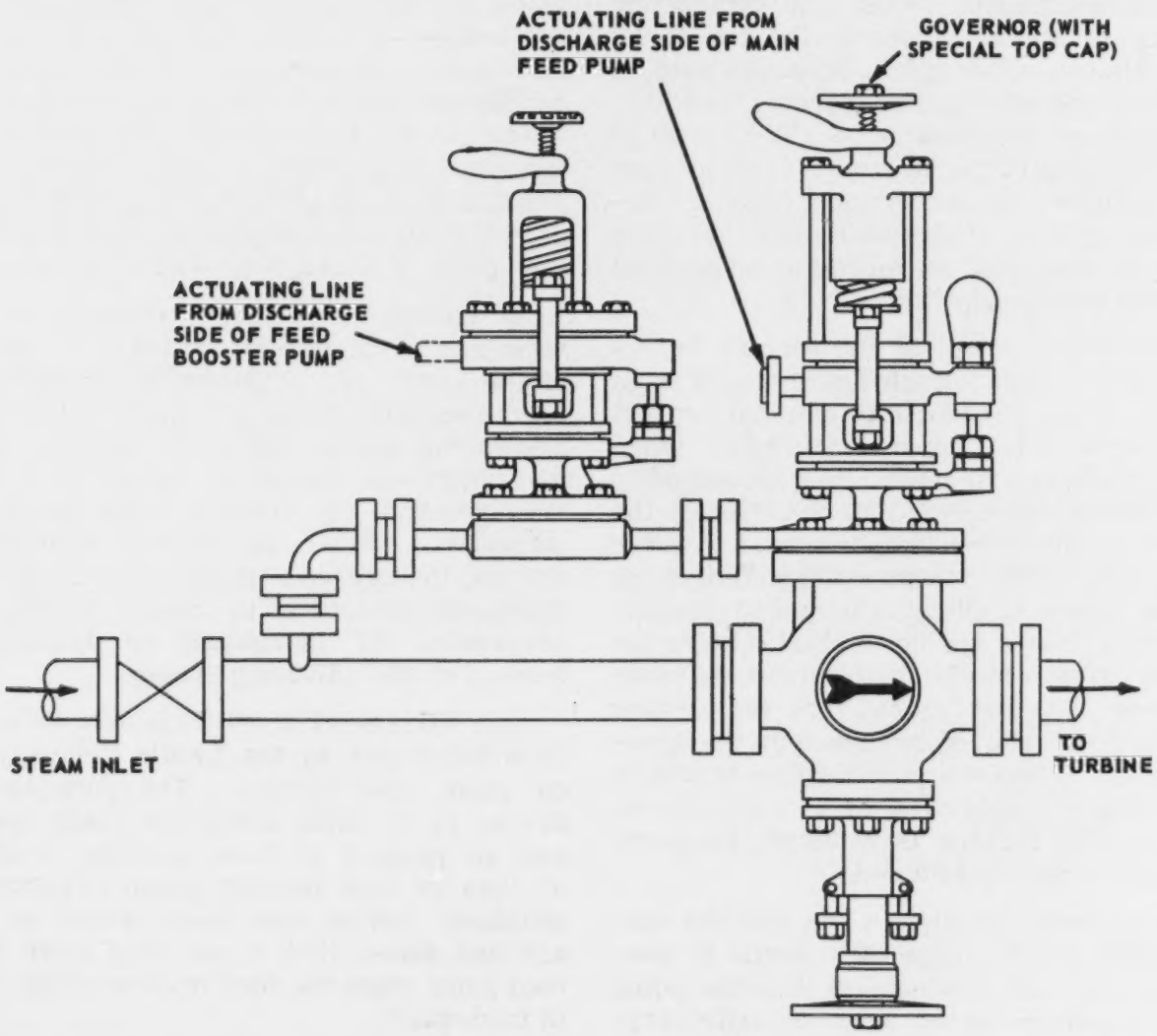

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Figure 6-15.—Automatic shutdown device for main feed pump.

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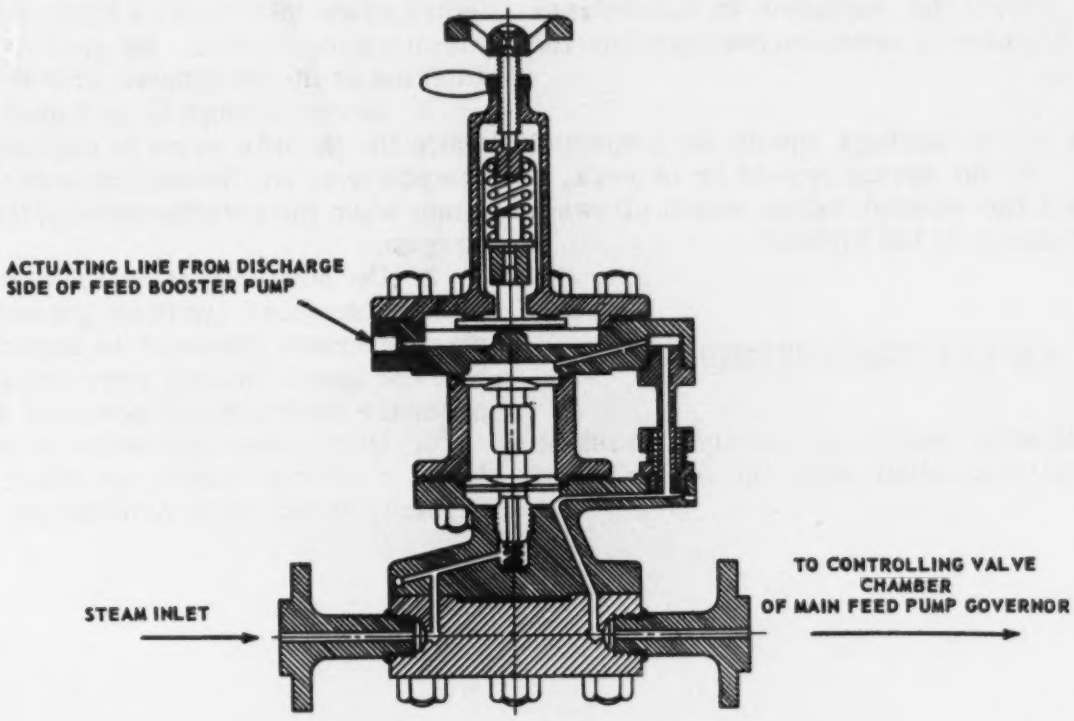

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Figure 6-16.—Auxiliary pilot valve for automatic shutdown device.

of paint, rust, and dirt so that the linkage can move freely. Occasionally, a test should be made to determine whether the poppet valve (fig. 6-13) is leaking. The test may be made by pushing the valve onto its seat by hand. If the valve is leaking the turbine will continue to rotate.

When constant pressure governors are disassembled, all diaphragms should be carefully inspected. If indications of failure are found, the affected part(s) should be renewed. In performing routine overhaul maintenance of Leslie pump governors, however, it may be necessary to replace serviceable diaphragms because of distortion resulting from normal operating pressure. Unless manufacturer-furnished diaphragms are used, reference should be made to finished plans for guidance as to proper dimensions and materials.

Distortion of diaphragms, within the manufacturer's prescribed limits, is normal and has no adverse affect on the operation of governors. Unless distortion beyond the prescribed limits is found, replacement of diaphragms is not necessary.

The control or pilot valve may be a source of trouble, particularly in a Leslie pump governor. Steam, passing through the control valve, is continuously throttled, and the valve is subjected to considerable erosion (wiredrawing). The control valve and valve seat should be inspected frequently. When reassembling the control valve or installing a new one, it is very important to maintain the correct clearance between the control valve stem and the lower diaphragm. If the clearance is excessive, the lower diaphragm cannot fully open the control valve, and the pump capacity is reduced. If there is not enough clearance, the diaphragm will hold the control valve open and the pump cannot be stopped without closing the root steam valve. It is also necessary that there be no steam leakage through the control valve bushing because the leaking steam will hold the main valve open, allowing steam to flow to the turbine.

Faulty governor operation may also result from the wearing of grooves in the cylinder liner. The grooves, which limit the travel of the main valve, become worn when the piston is moved through a short travel; this reduces the capacity of the pump and causes failure of the governor. Whenever a constant pressure governor is disassembled, the liner should be

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carefully checked; and if it is grooved excessively, it should be replaced in accordance with manufacturer's recommendations for the specific unit.

Control valve springs should be inspected frequently. If the spring breaks or is weak, it cannot close the control valve, which allows a full flow of steam to the turbine.

SAFETY PRECAUTIONS

The following safety precautions must be observed in connection with the operation of pumps:

1. See that all relief valves are tested at the appropriate intervals as required by the Planned Maintenance System. Be sure that relief valves function at the designated pressure.
2. Never attempt to jack over a pump by hand while the throttle valve to the turbine is open or the power is on. Never jack over a reciprocating pump when the throttle valve or the exhaust valve is open.
3. Do not attempt to operate a pump while either the speed limiting governor or the constant pressure governor is inoperable. Be sure that the speed limiting governor and the constant pressure governor are properly set.
4. Do not use any boiler feed system pump for any service other than boiler or feed water service, except in an emergency.

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CHAPTER 7

PIPING AND VALVES

As an MM3 or MM2 you will be working with piping, fittings, valves, and insulation. You will be responsible for routine maintenance of this equipment in your spaces. In order for you to qualify for advancement in the Machinist's Mate rating you will have to know how to (1) make minor repairs to insulation, (2) repack high pressure valves, (3) overhaul and adjust regulating and reducing valves, (4) overhaul gate, globe, check, and other valves, (5) select the right packing and gaskets, and (6) make repairs to high and low pressure steam lines. The machinery in your space cannot operate properly unless valves and piping are kept in good working condition. This chapter covers principal difficulties encountered with valves and piping. Additional information can be found in Fireman, NavPers 10520-C, and Naval Ships Technical Manual, chapter 9480(48).

PIPING AND TUBING

The Naval Ship Systems Command defines piping as an assembly of pipe or tubing, valves, fittings, and related components forming a whole or a part of a system for transferring fluids (liquids and gases).

IDENTIFICATION

In commercial usage, there is no clear distinction between pipe and tubing, since the correct designation for each tubular product is established by the manufacturer. If the manufacturer calls a product pipe, it is pipe; if he calls it tubing, it is tubing.

In the Navy, however, a distinction is made between pipe and tubing. This distinction is based on the way the tubular product is identified as to size.

There are three important dimensions of any tubular product: outside diameter (OD), inside diameter (ID), and wall thickness. A tubular product is called TUBING if its size is identified by actual measured outside diameter (OD) and by actual measured wall thickness. A tubular product is called PIPE if its size is identified by a nominal dimension called IRON PIPE SIZE (IPS) and by reference to a wall thickness schedule designation.

The size identification of tubing is simple enough, since it consists of actual measured dimensions; but the terms used for identifying pipe sizes may require some explanation. A NOMINAL dimension such as iron pipe size (IPS) is close to—but not necessarily identical with—an actual measured dimension. For example, a pipe with a nominal pipe size of 3 inches has an actual measured outside diameter of 3.50 inches. A pipe with a nominal pipe size of 2 inches has an actual measured outside diameter of 2.375 inches. In the larger sizes (about 12 inches) the nominal pipe size and the actual measured outside diameter are the same. For example, a pipe with a nominal pipe size of 14 inches has an actual measured outside diameter of 14 inches. Nominal dimensions are used in order to simplify the standardization of pipe fittings and pipe taps and threading dies.

The wall thickness of pipe is identified by reference to wall thickness schedules established by the American Standards Association. For example, a reference to schedule 40 for a steel pipe with a nominal pipe size of 3 inches indicates that the wall thickness of the pipe is 0.216 inch. A reference to schedule 80 for a steel pipe of the same nominal pipe size (3 inches) indicates that the wall thickness of the pipe is 0.300 inch.

A schedule designation does NOT identify any one particular wall thickness unless the nominal pipe size is also specified. For example, we have seen that a schedule 40 steel pipe of nominal pipe size 3 inches has an actual wall thickness of 0.216 inch. But if we look up schedule 40 for a

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steel pipe of nominal pipe 4 inches, we will find that the wall thickness is 0.237 inch. These examples are used merely to illustrate the meaning of wall thickness schedule designations. Many other values can be found in pipe tables given in engineering handbooks.

You have probably seen pipe identified as STANDARD (Std), EXTRA STRONG (XS), and DOUBLE EXTRA STRONG (XXS). These designations, which are still used to some extent, also refer to wall thicknesses. However, pipe is manufactured in a number of different wall thicknesses, and some pipe does not fit into the standard, extra strong, and double extra strong classifications. The wall thickness schedules are being used increasingly to identify the wall thickness of pipe because they provide for the identification of more wall thicknesses than can be identified under the strong, extra strong, and double extra strong classifications.

The standard ways of identifying size and wall thickness of pipe and tubing have been briefly described here. It should be noted, however, that you will sometimes see pipe and tubing identified in other ways. For example, you may see some tubing identified by ID rather than by OD. And you may see some pipe identified by nominal pipe size, by OD, by ID, and by actual measured wall thickness.

PIPING MATERIALS

A great many different kinds of pipe and tubing are used in shipboard piping systems. Some shipboard applications of pipe and tubing that may be of particular interest to MMs are mentioned here.

SEAMLESS CHROMIUM-MOLYBDENUM ALLOY STEEL PIPE is used for some high pressure, high temperature steam systems.

SEAMLESS CARBON STEEL TUBING is used in oil, steam, and feed water lines operating at 775° F and below. Different types of this tubing are available; the type used in any particular system depends on the working pressure of the system.

SEAMLESS CARBON-MOLYBDENUM ALLOY STEEL TUBING is used for feed water discharge piping, boiler pressure superheated steam lines, and boiler pressure saturated steam lines. Several types of this tubing are available; the type used in any particular case depends upon the boiler operating pressure and the superheater outlet temperature. The upper pressure and temperature limits for any class of this tubing are 1500 psi and 875° F.

SEAMLESS CHROMIUM-MOLYBDENUM ALLOY STEEL TUBING is used for high pressure, high temperature steam service on newer ships. This type of alloy steel tubing is available with different percentage of chromium and molybdenum.

WELDED CARBON STEEL TUBING is used in some water, steam, and oil lines where the temperature does not exceed 450° F. There are several types of this tubing; each type is specified for certain services and certain service conditions.

NONFERROUS PIPE and NONFERROUS TUBING are used for many shipboard piping systems and for most shipboard heat exchangers. Nonferrous materials are used chiefly where their special properties of corrosion resistance and high heat conductivity are required. Various types of SEAMLESS COPPER TUBING are used for refrigeration installations, plumbing and heating systems, lubrication systems, and other shipboard systems. COPPER-NICKEL ALLOY TUBING is available in composition 70-30 (70 percent copper and 30 percent nickel) and in composition 90-10 (90 percent copper and 10 percent nickel). The 70-30 composition is generally used in submarine piping systems and heat exchangers. The 90-10 composition is widely used in surface ships.

Many other kinds of pipe and tubing besides the kinds mentioned here are used in shipboard piping systems. It is important to remember that design considerations control the selection of any particular pipe or tubing for any particular system. Although many kinds of pipe and tubing look almost exactly alike from the outside, they may respond very differently to pressures, temperatures, and other service conditions. Therefore, each kind of pipe and tubing can be used ONLY for specified applications.

PIPING SYSTEMS

Aboard ship the various units of machinery and equipment are connected by miles of piping. Each piping system consists of sections of piping or tubing, fittings for joining the sections, and valves for controlling the flow of fluid. Most piping systems also include other fittings and accessories such as vents, drains, traps, strainers, relief valves, and various gages and instruments. In this chapter we will briefly

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discuss some of the engineering piping systems with which Machinist's Mates are concerned.

Main Steam System

The main steam system is one of the shortest and simplest of the engineering piping systems. On many ships, the main steam system includes only the piping which carries superheated or saturated steam to the main propulsion turbines and the turbogenerators. On ships having two main propulsion plants, the forward and after systems can be cross-connected by piping and valves between the forward engineroom and the after fireroom. By means of this piping, any boiler may supply steam to any main engine or any turbogenerator. Thus the propulsion plants may be operated independently (split plant) or by the cross connected plant. On ships having four main propulsion plants, the systems are arranged for forward group and after group operation. The two forward plants may be operated cross connected, and the two after plants may be operated cross connected, or all four plants may be operated independently (split plant).

Auxiliary Steam Systems

Auxiliary steam systems supply saturated steam for the operation of many systems and units of machinery, both inside and outside the engineering spaces. Constant and intermittent service steam systems, steam smothering systems, air compressors, whistles, sirens, air ejectors, and a wide variety of pumps are typical of the systems and machinery that use auxiliary steam. Most ships have a 600 psi auxiliary steam system and a 150 psi system. The 600 psi system serves some machinery directly and also supplies the 150 psi system through reducing valves. The 150 psi system serves some units directly and also provides steam, through reducing valves, for units and systems which require steam at pressures lower than 150 psi. Auxiliary steam systems are normally arranged in loop form, with cross connections at required intervals to provide for split plant or cross connected operation.

Auxiliary Exhaust System

The auxiliary exhaust system receives exhaust steam from machinery which does not exhaust directly to a condenser. Auxiliary exhaust is used in various units such as deaerating feed tanks, distilling plants, and (on most ships) gland sealing systems. The pressure is maintained at 15 psig. If the pressure becomes too high, automatic unloading valves (dumping valves) allow the excess exhaust to go to the main or auxiliary condenser. If the pressure drops too low, makeup steam is supplied from the 150 psi steam system through pressure controlled reducing valves or by manually operated valves.

Condensate and Feed Systems

The condensate and feed systems include all the piping that carries water from the condenser to the boilers and from the feed tanks to the boilers or the condenser. The condensate system includes the main and auxiliary condensers, condensate pumps and piping. The boiler feed system includes the feed booster pumps, the feed pumps, and the piping required to carry water from the deaerating feed tank. Since the condensate and feed systems form one continuous system, the terms feed system and feed water system are quite commonly used to include both the condensate and the boiler feed water systems.

Steam and Fresh Water Drain Systems

Most of the feed water in a shipboard steam plant is recovered so it can be used over and over again for the generation of steam. Steam is condensed in the main and auxiliary condensers and the condensate is returned to the feed system. The auxiliary exhaust is used in the deaerating feed tank and so becomes part of the feed system. But steam is used throughout the ship in equipment and piping which does not exhaust to a condenser or to the auxiliary exhaust system. Therefore, steam and fresh water drain systems are provided so that water can be recovered and put back into the feed system. The systems of piping which carry the water to the feed system, and also the water carried in the systems, are known as drains. On ships built to Navy specifications, there are four steam and fresh water drain systems which recover water from machinery end piping: (1) the high pressure steam drain system, (2) the service steam drain system, (3) the oil heating drain system, and (4) the fresh water or low pressure drain collecting system. A fifth system is provided for collecting contaminated drains which cannot be returned to the feed system.

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These five drain systems are described briefly in the following sections.

High Pressure Drain System

High pressure drains generally include drains from superheater headers, throttle valves, main and auxiliary steam lines and other steam equipment and systems which operate at pressures of 150 psi or above. On most ships, the high pressure drains are led directly to the deaerating feed tank, where the remaining heat is used to heat the feed water. On some new ships, the high pressure drains go into the auxiliary exhaust system, just before the exhaust enters the deaerating feed tank. In either arrangement the high pressure drains end up in the same place—the deaerating feed tank.

SERVICE STEAM DRAIN SYSTEM

The service steam drain system collects drains from low pressure (below 150 psi) steam piping systems and steam equipment outside of machinery spaces. Space heaters and the equipment used in the laundry, tailor shop, and galley are typical sources of drains for the service steam drain system. On some ships these drains are discharged into the fresh water drain collecting system. On some large ships, these drains discharge to special service steam drain collecting tanks located in the machinery spaces. The contents of the service steam drain collecting tanks are discharged to the condensate system. Each tank has gravity drain connections to the bilges.

Oil Heating Drain System

The oil heating drain system collects drains from the steam side of fuel oil heaters, lube oil heaters, and other steam equipment used to heat oil. Since leakage in the heating equipment could cause oil contamination of the drains and eventually oil contamination of the boilers, these drains are collected separately and inspected before they are discharged to the feed system. The oil heating drains are collected in drain mains and then discharged to inspection tanks. The inspection tanks have a glass strip along the side through which the water can be inspected for the presence of oil. Normally, the inspection tanks discharge to the deaerating feed tanks; however, they have connections to the fresh water drain collecting tanks and to the bilges.

Fresh Water Drain Collecting System

The fresh water drain collecting system (often called the low pressure drain collecting system) collects drain from various piping systems, machinery, and equipment which operate at steam pressures less than 150 psi. The fresh water drain collecting system collects gravity drains (open funnel), turbine gland seal drains, auxiliary exhaust drains, air ejector after condenser drains, and other low pressure drains that result from condensation of steam during warming up or the operation of machinery and piping. Fresh water drains are collected in the fresh water drain collecting tank and enter the feed system in two ways: (1) they may be drawn into the main auxiliary condenser by vacuum drag, or (2) in some installations they may be pumped into the condensate line just ahead of the deaerating feed tank.

Contaminated Drain System

A contaminated drain system is installed in each main and auxiliary machinery space. The contaminated drain system collects oil and water from machinery and piping which normally has some leakage and from any other services which may at times be contaminated. These drains are collected in a bilge sump tank and are pumped overboard by the bilge drainage system.

PIPE FITTINGS

Piping sections of the proper size and material are connected by various standard fittings, including several types of threaded, bolted, welded, silver-brazed, and expansion joints.

Threaded Joints

The threaded joints are the simplest type of pipe fittings. Threaded fittings are not widely used aboard modern ships except in low pressure water piping systems. The union fittings are provided in piping systems to allow the piping to be taken down for repairs and alterations. Unions are available in many different materials and designs to withstand a wide range of pressures and temperatures. Figure 7-1 shows some commonly used types of unions. The union is used a great deal for joining piping up to 2 inches in size. The pipe ends connected to the union are threaded, silver-brazed, or welded into the tall pieces; then the two ends

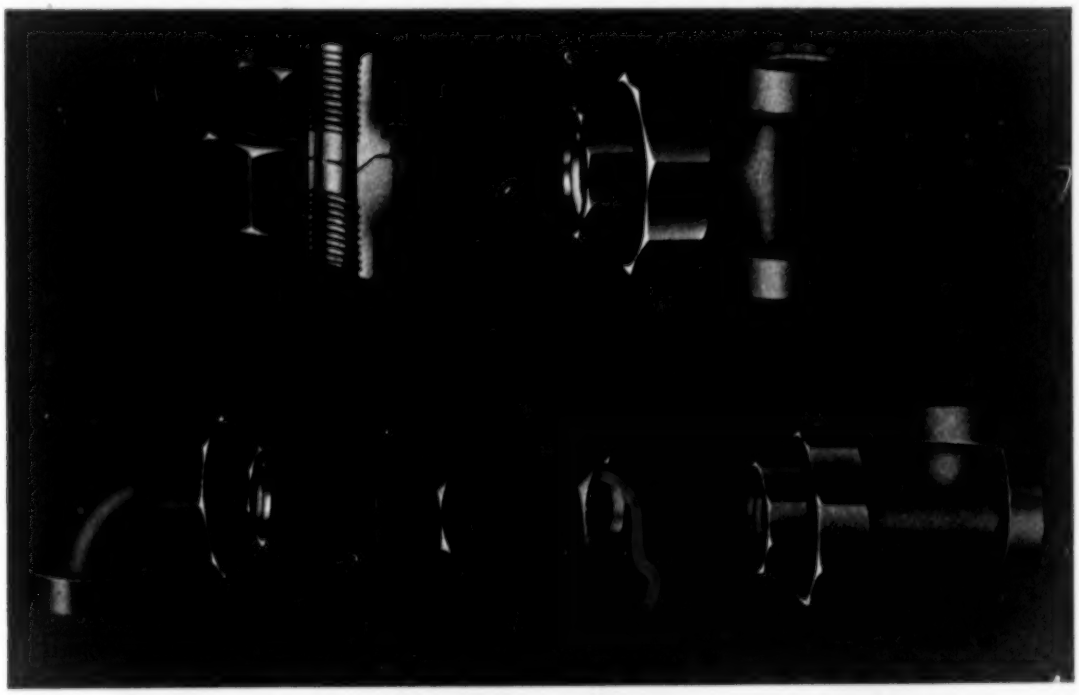

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Figure 7-1.—Unions.

are joined by setting up on the union ring. The male and female connecting ends of the tail pieces are carefully ground to make a tight metal-to-metal fit with each other. Welding or silver-brazing the ends to the tail pieces prevents contact of the carried fluid or gas with the union threading.

Bolted Flange Joints

Bolted flange joints (fig. 7-2) are suitable for all pressures now in use. The FLANGES are attached to the piping by welding, brazing, screw threads (for some low pressure piping), or rolling and bending into recesses. Those illustrated in figure 7-2 are the most common types of flange joints used. The same types of standard fitting shapes (tee, cross, elbow, etc.) are manufactured for flange joints, such as the threaded fittings (illustrated in Fireman, NavPers 10524-C). The Van Stone type and the welding neck-type flange joints are used extensively where piping is subjected to high pressures and heavy expansion strains.

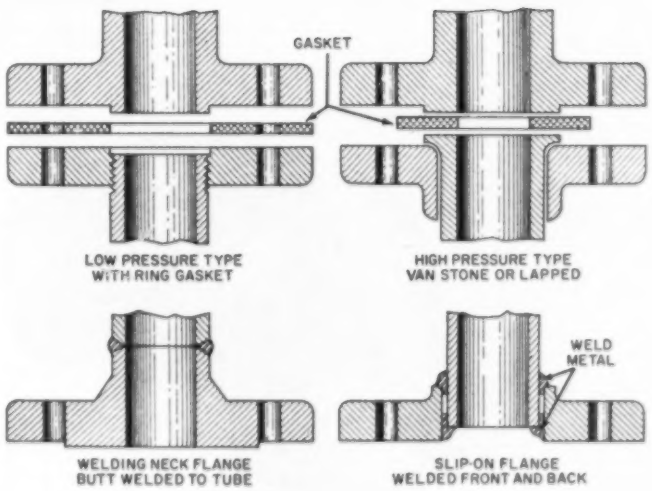

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Figure 7-2.—Four types of bolted flange piping joints.

Welded Joints

The majority of joints found in subassemblies of piping systems are welded joints, especially in high pressure piping. The welding is done according to standard specifications which define the materials and techniques. There are three general classes of welded joints—butt-weld, fillet-weld, and socket-weld (fig. 7-3).

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Figure 7-3.—Various types of welded joints.

Silver-Brazed Joints

Silver-brazed joints (fig. 7-4) are commonly used for joining nonferrous piping in the pressure and temperature range where its use is practicable. These practical factors limit this joint's use to steam lines not exceeding 425° F; for cold lines, these fittings may be used for

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Block IV - Television Bench Servicing

Unit 6 - Automatic Gain Control Section

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Troubleshooting AGC section circuits	Circuit comparison: keyed AGC circuits Visual indications of age defect Troubles associated with AGC circuits Taking response curve of video IF section when alignment is suspected as a source of trouble Video circuit adjustments Procedure for troubleshooting the video section Test points (AC and DC) Symptoms and suggested techniques: No picture, no sound, raster present Hum in picture and/or sound Loss of picture detail or smearing AGC troubles and use of bias box Troubles in CRT circuits Home-servicing techniques Preventive maintenance and parts replacement

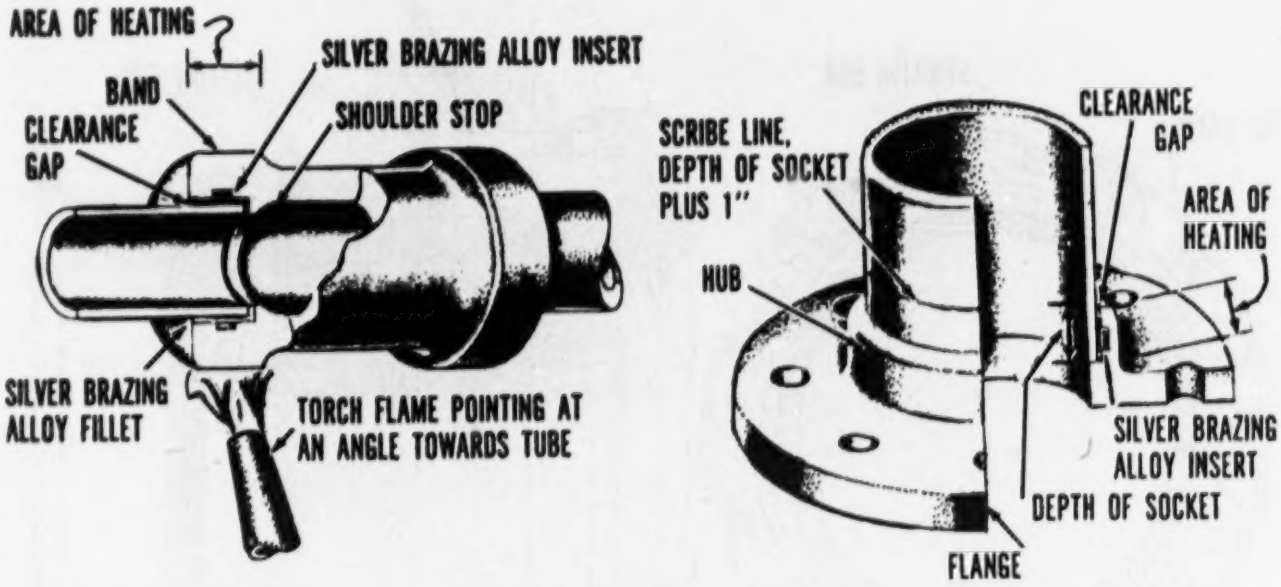

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Figure 7-4.—Silver-brazed joints.

pressures up to 3000 psi. The alloy is melted by heating the joint with an oxyacetylene torch. This causes the molten metal to fill the few thousandths of an inch annular space between the pipe and the fitting.

Expansion Joints

Expansion joints of various types are installed at suitable intervals in long steam lines, because of the expansion and contraction of metal subjected to a wide range of temperature. The types include the slip joint, expansion bends, corrugated joints, and bellows joints.

The SLIP JOINT (fig. 7-5) is used for low pressures, such as auxiliary exhaust piping. A slip joint consists of a stuffing box, packing gland, male sliding tube, female receptacle tube, and stop bolts (to prevent separation of male and female sections of the joint).

EXPANSION BENDS are employed for high pressure and high temperature steam piping in preference to the slip joint. Expansion bends are merely loops of piping of proper length and configuration to take up the changes in pipe length caused by temperature changes. The expansion bends take many shapes—most common are the U-bend, Z-bend and L-bend.

The CORRUGATED and BELLOWS TYPES of expansion joints (fig. 7-6) are used for both medium and high pressures and temperatures. The principle of these joints is obvious: the expansion-contraction movement is absorbed by the changing curvature of the corrugations or bellows (as with an accordion). The internal sleeves, free to slide axially in these joints, serve to prevent excessive turbulence and erosion of the expansion parts. Figure 7-7 illustrates a corrugated BULKHEAD EXPANSION JOINT, which is designed to provide for both radial and axial movement of piping, with respect to the bulkhead.

Pipeline Strainers

Strainers are fitted in all piping lines to prevent the passage of grit, scale, dirt, and other foreign matter. Such matter could obstruct pump or throttle valves, or damage machinery parts. Various types of strainers are used, depending upon the service intended.

The BILGE SUCTION STRAINER is located in the bilge pump suction line between suction manifold and pump. Any debris which enters the piping will collect in the strainer basket. The basket is removed for cleaning by loosening the strong-back screws, removing the cover, and lifting out the basket by its handle. These strainers should be cleaned at least every 24 hours while in port, and every 4 hours while underway. The basket-type strainers, provided in most lube oil systems, are fitted with magnets

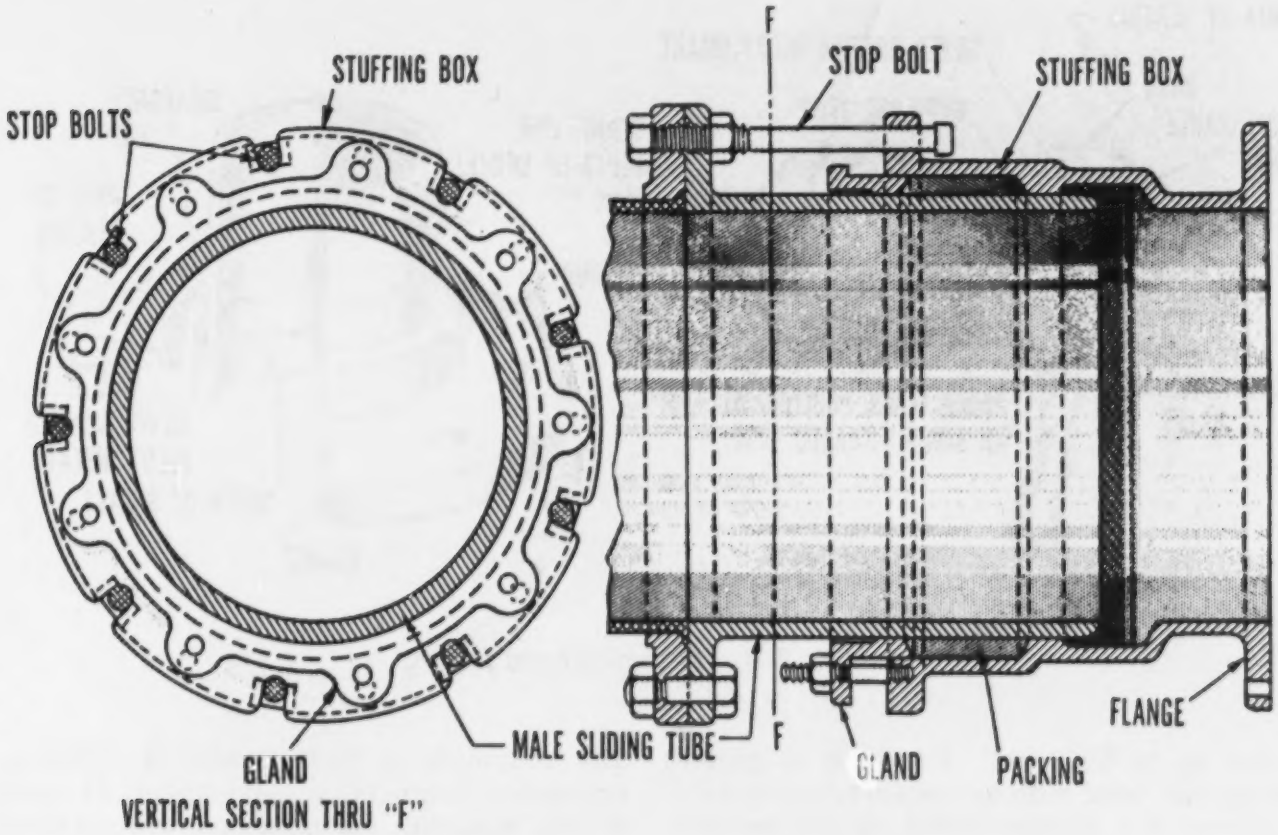

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Figure 7-5.—Slip type expansion joints.

which catch any small metallic particles that may be in the lube oil. When cleaning these strainers, metallic particles that adhere to the magnets should be removed.

DUPLEX OIL STRAINERS are generally used in fuel or lube oil lines, where it is important than an uninterrupted flow be maintained. The flow may be diverted from one strainer basket to the other, while one is being cleaned. The shutoff device works on the principle of a four-way cock.

Before removing a basket for cleaning a duplex strainer, open the drain at the bottom of the casing and drain off all entrapped oil. Back off on the binding screw or head nuts a few turns; if there is no oil seepage around the cover, it is safe to remove the cover. Remove the basket, replace the cover, and close the drain. After the basket has been cleaned and inspected, repeat the above proceduce and test for leaks.

CAUTION: Never start to clean a strainer basket without first shifting to the other basket. Serious fires have occurred when inexperienced personnel have tried to remove a strainer basket while it was still in service. A lot of oil can spray out awfully fast if you open the wrong side of a duplex oil strainer.

A MANIFOLD STEAM STRAINER is desirable where space is limited, since it eliminates the use of separate strainers and their fittings. The cover is located so that the strainer basket can be easily removed for cleaning.

PIPING CARE AND MAINTENANCE

REASONABLE CARE must be given the various piping assemblies, as well as the machinery connected by the piping. All joints, valves, and cocks in the lines must be examined frequently, and kept tight. The piping on any ship should not be subjected to strains by being used for handholds or footholds, by having chain falls secured to them, or by being used for supporting weights.

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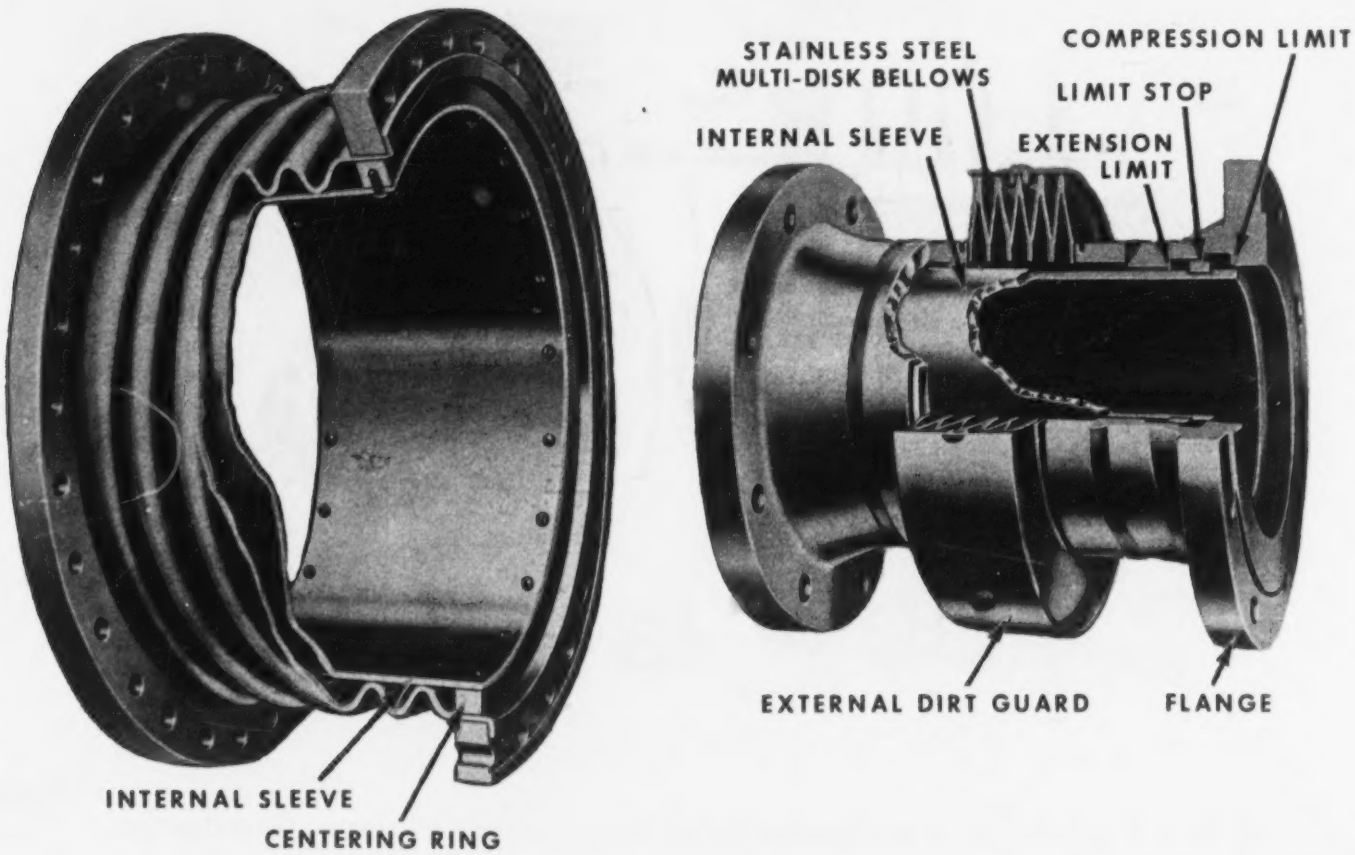

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Figure 7-6.—Corrugated type and bellows type expansion joints.

Where piping passes through decks or bulkheads, and a possibility exists for movement of one with respect to the other, stuffing boxes of flexible bulkhead connections are provided—if expansion bends or other offsets are not provided in the piping—to take up the movement. The external surfaces of uncovered and ungalvanized steel or iron piping should be kept properly painted and free of moisture. Copper and brass piping is seldom painted.

Continual LEAKAGE AT A JOINT where a branch line joins another line is usually due to improper allowance for expansion in one or the other line, or to excessive vibration. A slight alteration in the anchorages, connections, hangers, or leads of the piping, to allow the required expansion and prevent strain, or the fitting of supports which will prevent vibration, will often correct such leaks. Leaky joints may also be due to poor alignment of the piping, or to movement of decks or bulkheads. Realignments should be made so that flanges or screw threads meet properly without forcing. Sometimes the flange joints may have to be refaced, or distance pieces fitted. Small leaks in gaskets should be taken up immediately, before a dangerous blowout results from progressive growth of the leak.

PIPE THREAD LEAKS should be promptly corrected. Leaky screwed joints which cannot be tightened with a reasonable amount of pullup should be taken apart, cleaned, examined for bad thread conditions, recoated with the appropriate compound, and carefully reassembled, to avoid any other thread damage. Poorly cut threads are a constant source of trouble with threaded pipe joints. The proper use and care of pipe cutters will prevent such pipe troubles as shaved thread, wavy thread, and poor shoulders.

PERMANENT OR SEMIPERMANENT REPAIRS of leaky piping sections are generally made by or with the aid of the Shipfitters. Permanent repairs of copper or brass piping may be made by brazing. Small holes may be plugged with a rivet or a screw plug. Semipermanent repairs of leaky piping sections may be made by serving the piping with tightly drawn

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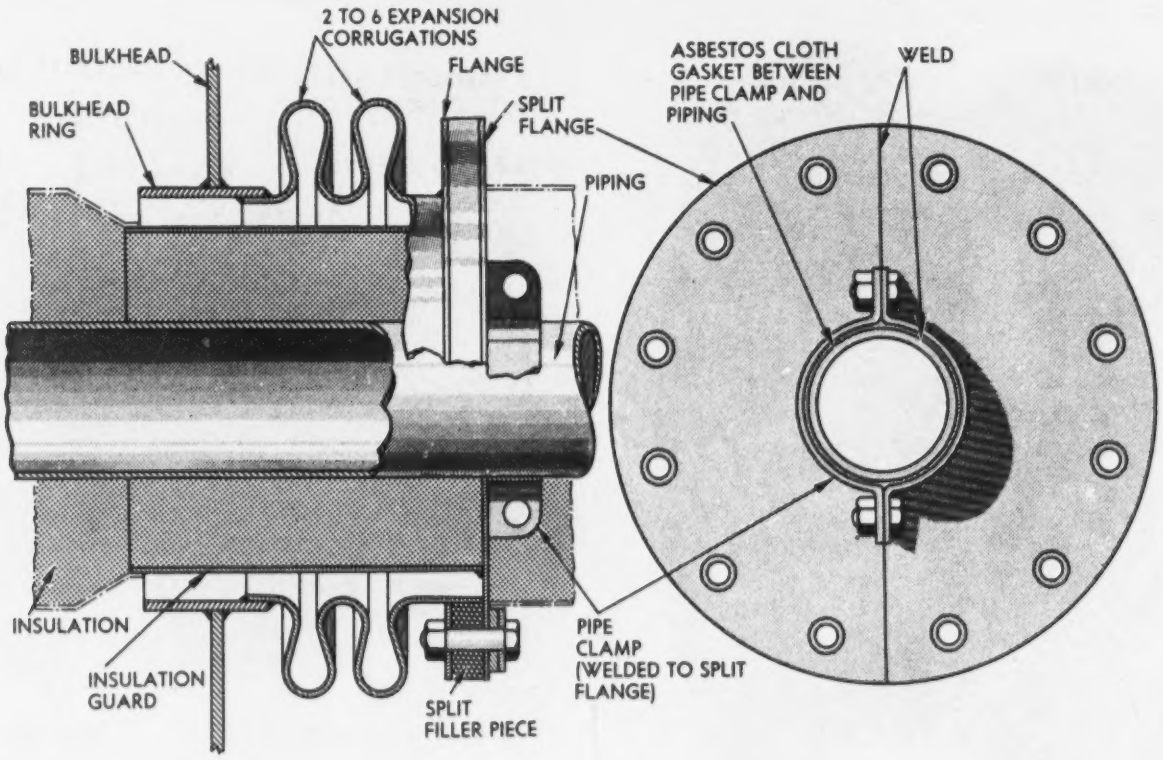

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Figure 7-7.—Corrugated bulkhead expansion joint, showing details of installation.

wire, soldered or brazed as it is applied. Several layers of wire securely bonded given a strong, tight repair.

The life of SALT WATER PIPING may be lengthened by operating the systems with minimum practical water velocities; by eliminating grounds from electrical systems, especially d-c circuits; by eliminating air from the salt water systems; by promptly correcting any leaks; by insulating with sheet rubber the hangers which support piping other than that made of wrought iron or steel; and by eliminating wire-drawing, by fully opening valves where throttling is unnecessary.

PIPING SAFETY PRECAUTIONS

The following safety precautions should be taken whenever you work on steam or hot water lines.

1. To prevent water rams, drain steam piping of water before admitting steam.
2. Before opening large steam valves, open bypasses to warm lines and equalize pressures; if bypasses are lacking, "crack" the valves.
3. Open trap bypasses when admitting steam to piping.
4. When breaking a flange joint, particularly in steam and hot water lines or in those salt water lines which have a possibility of direct connection with the sea, special precautions should be taken to ensure that:

(a) There is no pressure on the line.

(b) The valves cutting pressure off the part of the line undergoing repair are secured in such a manner that they cannot be accidentally opened.

(c) The line is completely drained.

(d) Two of the flange-securing nuts (diametrically opposite if possible) remain in place while the others are being removed. The two remaining nuts should then be slacked sufficiently to allow breaking the joint. If the line is clear, all the nuts may be removed. This precaution is necessary to prevent accidents such as scalding personnel or flooding compartments.

5. After remaking a steam joint, tighten up on the nuts according to prescribed methods.

6. Do not use piping for handholds or footholds.

7. Secure copper and brass piping free from contact with bilges. The brackets should be lined with electrical insulating material to prevent direct contact between piping and any of the ship's structure.

VALVES

Valves are usually made of bronze, brass, cast or malleable iron, or steel. Steel valves are either cast or forged, and are made of either plain steel or alloy steel. Alloy steel valves are used in high pressure, high temperature systems; the disks and seats of these valves are usually surfaced with a chromium-cobalt alloy known as STELLITE. Stellite is extremely hard.

Brass and bronze valves are never used where temperatures exceed 550° F. Steel valves are used for all services above 550° F, and in lower temperature systems where internal or external conditions of high pressure, vibration, or shock would be too severe for valves made of brass or iron. Bronze valves are used almost exclusively in systems carrying salt water. The seats and disks of these valves are usually made of Monel, a metal which has excellent corrosion and erosion resisting qualities.

PRESSURE CONTROL VALVES

In Fireman, NavPers 10520-C, information was given on the common stop valves, (globe, gate, plug, piston, needle, and throttle valves) and check valves. Therefore, this section will deal with pressure control valves.

There are many types of automatic pressure control valves—some of them merely providing an escape for pressures exceeding the normal pressure; some providing only for the reduction of pressure; and some providing for the regulation of pressure. The valves discussed here are known as relief valves, reducing valves, unloading valves, thermostatically controlled valves, sentinel valves, and diaphragm control valves with air operated pilots. The principle of operation of the constant pressure pump governor valves is discussed in this training course in chapter 6, Pump Operation and Maintenance.

Relief Valves

RELIEF VALVES (fig. 7-8) are automatic valves used on steam, water, and oil lines, and on various units of machinery. Relief valves prevent the building up of an excessive pressure due to sudden closing of outlet valves, failure of regulating or reducing valves, or other causes.

Generally speaking, a relief valve consists of a valve body containing a valve disk, the stem of which extends into a spring plate. The compression of the heavy spring (shown in fig. 7-8) tends to hold the valve down on its seat. The desired setting is attained by manipulation of the adjusting nuts. When the total pressure in the valve inlet exceeds the resistance of the spring on top of the valve, the valve is forced open and the pressure relieved until it falls below that for which the valve is set.

Sentinel Valves

Small spring-loaded sentinel valves are sometimes attached to the inlet chamber of

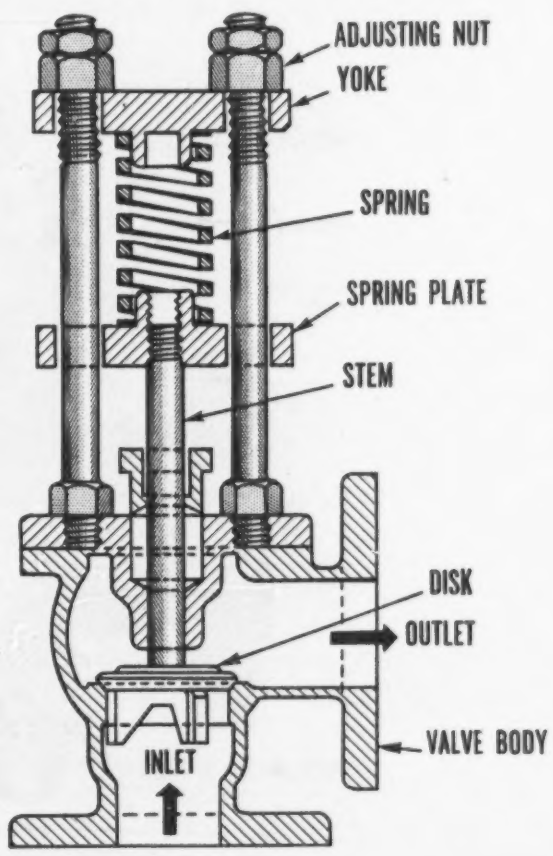

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Figure 7-8.—Relief valve.

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relief valves, to give warning of dangerous pressures. Sentinel valves operate on the same principle as relief valves.

Pressure Reducing Valves

Reducing valves are automatic valves which are used to provide a steady pressure lower than the supply pressure. Reducing valves are used on gland seal lines, galley steam lines, heating steam lines, and on many other reduced pressure lines. A reducing valve can be set for any desired discharge pressure, within the limits of the design of the valve. After the valve is set, the reduced pressure will be maintained regardless of changes in the supply pressure (as long as the supply pressure is at least as high as the desired delivery pressure) and regardless of the amount of reduced pressure steam that is used. Two general types of reducing valves have been in common use: the spring-loaded reducing valve, and the pneumatic pressure controlled (or gas-loaded) reducing valve. On recently built combat ships, a third type is being used, the diaphragm control valve.

SPRING-LOADED REDUCING VALVES.—The principal parts of a spring-loaded reducing valve (fig. 7-9) are: (1) the main valve, an upward-seating valve which has a piston on top of its valve stem; (2) an upward-seating auxiliary (or controlling) valve; (3) a controlling diaphragm; and (4) an adjusting spring.

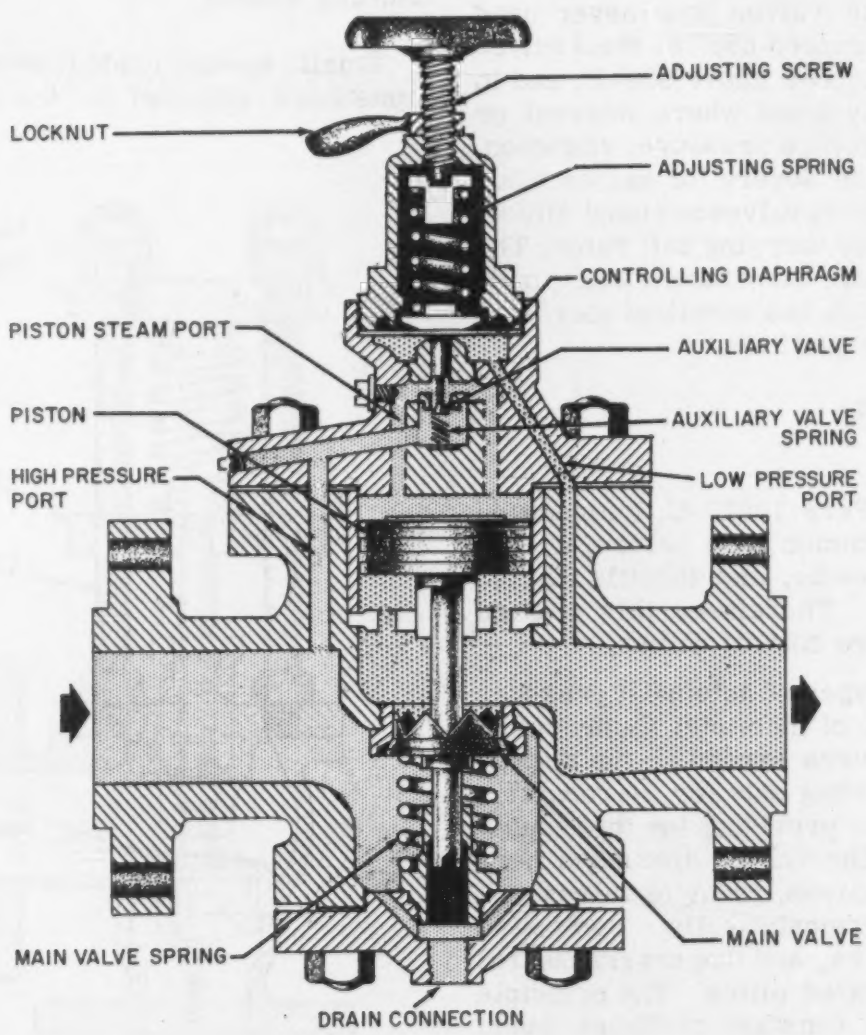

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Figure 7-9.—Spring-loaded reducing valve, showing fluid flow.

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High pressure steam (or other fluid) enters the valve on the inlet side and acts against the main valve disk, tending to close the main valve. However, high pressure steam is also led through ports to the auxiliary valve, which controls the admission of high pressure steam to the top of the main valve piston. The piston has a larger surface area than the main valve disk; therefore, high pressure steam acting on the top of the main valve piston will tend to open the main valve, and so allow steam at reduced pressure to flow out the discharge side.

But what makes the auxiliary valve open to allow high pressure steam to get to the top of the main valve piston? The controlling diaphragm transmits a pressure downward upon the auxiliary valve stem, and this tends to open the valve. However, reduced pressure steam is led back to the chamber beneath the diaphragm; and this steam exerts a pressure upward on the diaphragm, which tends to close the auxiliary valve. The position of the auxiliary valve, therefore, is determined by the position of the controlling diaphragm.

The position of the diaphragm at any given moment is determined by the relative strength of two opposing forces: (1) the downward force exerted by the adjusting spring; and (2) the upward force which is exerted on the underside of the diaphragm by the reduced pressure steam. These two forces are continually seeking to reach a state of balance; and, because of this, the discharge pressure of steam is kept constant as long as the amount of steam used is kept within the capacity of the valve.

Another type of spring-loaded reducing valve found aboard ship, is the type usually installed in the flushing system and in the cooling water main. It is of the single-seated, direct-acting, diaphragm type illustrated in figure 7-10. Control of water passing through this valve is effected by means of a pressure difference on opposite sides of the diaphragm. The diaphragm is secured to the stem. Reduced water pressure from the valve outlet is led through an internal passage to a diaphragm chamber, below the diaphragm. An adjusting spring acts on the upper side of the diaphragm. A leather cup washer or a neoprene O-ring makes the water seal between the valve inlet and the diaphragm chamber. The water seal is located about halfway down the valve stem.

When the outlet (discharge) pressure is greater than the spring pressure, the diaphragm

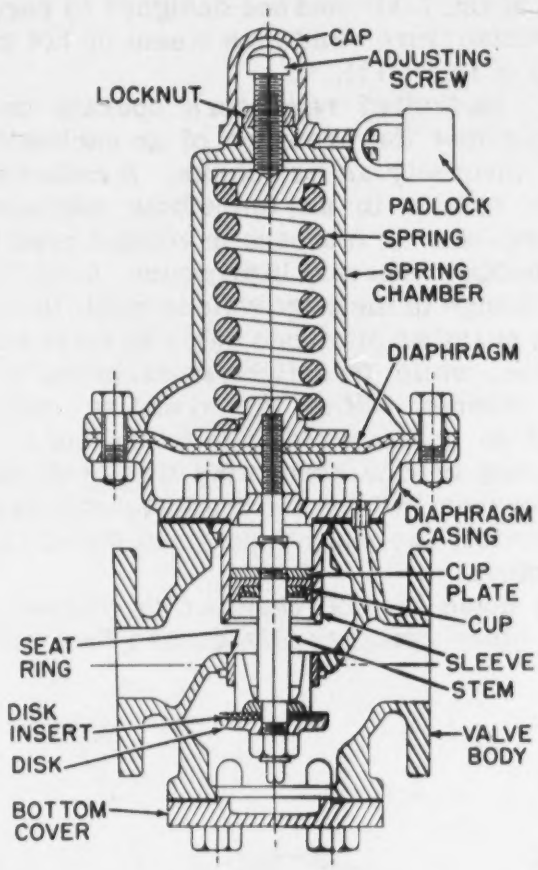

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Figure 7-10.—Spring-loaded reducing valve.

is forced up; because this is an upward seating valve, the upward movement of the stem tends to close the valve, thus decreasing the outlet pressure. When the outlet pressure is less than the spring pressure, the diaphragm and stem are forced down, opening the valve and increasing the outlet pressure.

When the outlet pressure and the spring pressure are equal, the diaphragm and the valve stem remain stationary and the outlet pressure remains constant. The amount of pressure applied by the spring to the top of the diaphragm can be varied by turning the adjusting screw. Turning the adjusting screw clockwise increases the pressure applied by the spring to the top of the diaphragm, thus opening the valve. Turning the adjusting nut counterclockwise decreases the amount of spring pressure on top of the diaphragm.

PNEUMATIC PRESSURE CONTROLLED REDUCING VALVES.—The pneumatic pressure controlled (or gas-loaded) reducing valve exists

in two types—one type designed to regulate low temperature fluids, such as air, water, or oil (part A of fig. 7-11); and one designed to regulate high temperature fluids, as steam or hot water (part B of fig. 7-11).

Air controlled regulators operate on the principle that the pressure of an enclosed gas varies inversely as its volume. A reduction in volume results in an immediate increase in pressure—and an increase in volume results in an immediate decrease in pressure. A relatively small change in the large volume within the dome loading chamber produces only a slight pressure variation, while the slightest variation in the small volume within the actuating chamber creates an enormous change in pressure. The restricting orifice connecting these two chambers governs the rate of pressure equalization by retarding the flow of gas from one chamber to the other.

The dome loading chamber is charged with air or other compressible gases at a pressure equal to the desired reduced pressure. When the chamber is loaded, and the loading valve closed, the dome will retain its charge almost indefinitely. When the regulator is in operation, the trapped pressure within the dome passes into the actuating chamber through the small separation plate orifice and moves the large flexible diaphragm which forces the reverse acting valve off its seat. The pressure entering the regulator is then permitted to flow through the open valve into the reduced pressure line. A large pressure equalizing orifice transmits this pressure directly to the underside of the diaphragm. When the delivered pressure approximates the loading pressure in the dome, and the unbalanced forces are equalized, the valve is closed. With the slightest drop in delivered pressure, the pressure charge in the dome instantly forces the valve open. This allows air to pass through and thereby maintain the outlet pressure relatively constant.

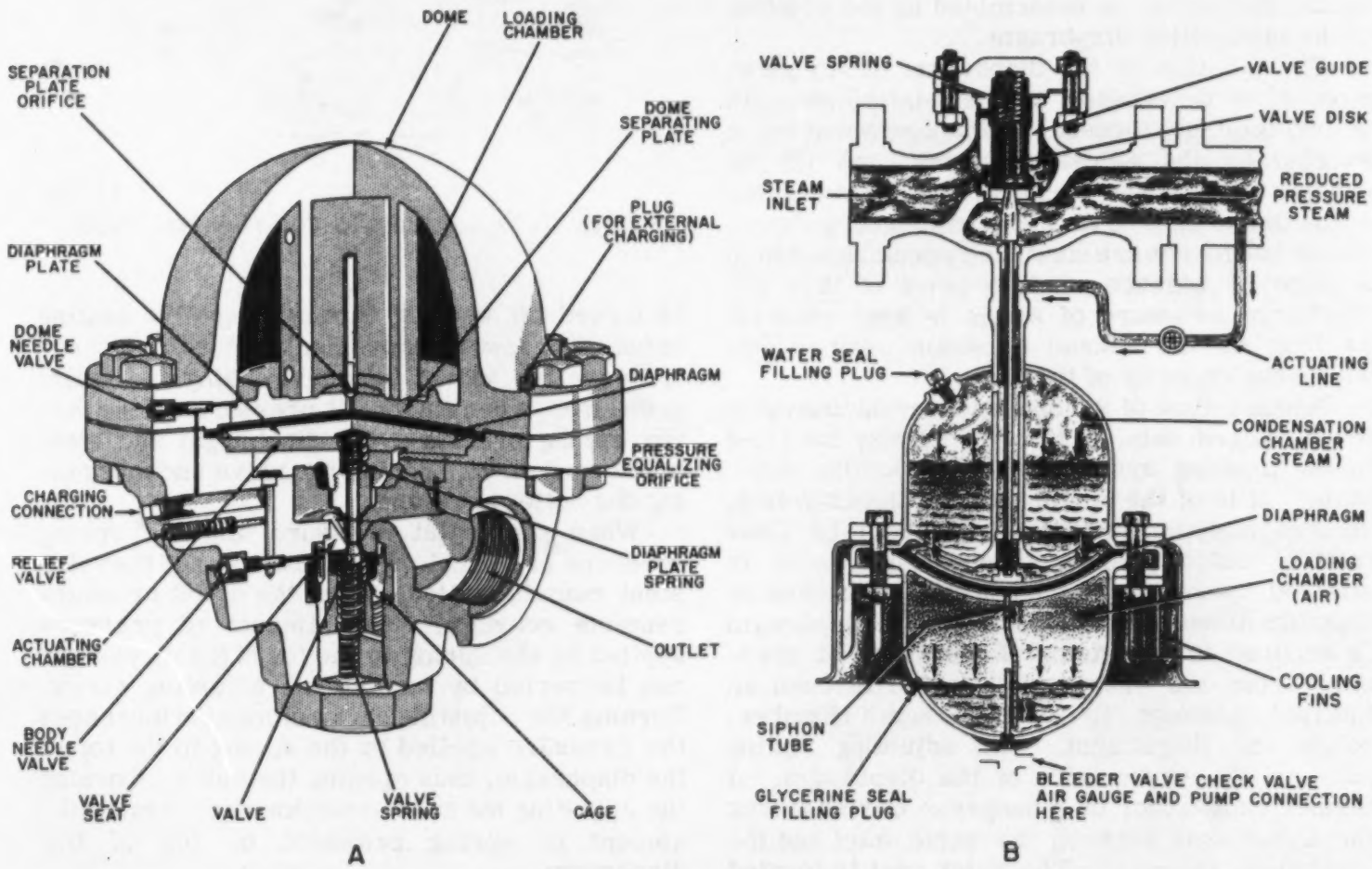

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Figure 7-11.—Pneumatic pressure controlled reducing valves. A. For low temperature fluids. B. For high temperature fluids.

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To charge the loading chamber, remove the dome needle valve, connect up the specially furnished hand pump (either 300 or 600 psi), and fill the dome, depending upon the desired outlet pressure. If the regulator is to handle a gas, charge the dome loading chamber with this gas via the dome needle valve and the body needle valve (part A of fig. 7-11). If the regulator is to handle a liquid, the dome must be charged from an external source. Remove the plug on the dome loading chamber and connect the external source, an air bottle or an air pump. The body needle valve should be kept closed while the dome needle valve should be used to adjust the dome pressure for obtaining the desired outlet pressure.

Part B of figure 7-11 shows the construction and indicates the operating features of a pneumatic pressure controlled (gas-loaded) reducing valve designed to regulate high temperature fluids.

A rubber diaphragm is installed in the middle of the dome. The bottom of the diaphragm is separated from the bottom half of the dome by a fixed steel plate. The area immediately above the diaphragm communicates with the upper part of the dome through holes in the shrouding. The upper half of the dome carries a level of water for sealing; the lower half of the dome carries a level of glycerine for sealing. The area above the glycerine is charged with air, which exerts a downward pressure on the glycerine and forces some of it to go up the tube toward the diaphragm. This pressure causes the diaphragm to move upward; and, since the stem of the valve is in contact with the diaphragm, the upward movement of the diaphragm causes the valve to open. When the valve is open, steam can pass through the valve.

From the outlet connection, an actuating line leads back to the upper part of the dome, in the manner shown in part B of figure 7-11. Steam at the reduced pressure is thus allowed to exert a force on the top of the water seal; this force is transmitted through the water and tends to move the diaphragm downward. When the pressure or steam from the actuating line exceeds the loading air pressure in the lower half of the dome, the diaphragm moves downward sufficiently to close the valve. The closing of the valve reduces the pressure of the steam on the discharge side of the valve. When the pressure on the outlet side of the valve is equal to the air pressure in the lower half of the dome, the valve takes a balanced position which allows the passage of sufficient steam to maintain that pressure.

If the steam load increases, tending to take more steam away from the valve, the outlet pressures will be momentarily reduced. Thus, the pressure of steam on top of the diaphragm becomes less than the pressure of air below the diaphragm, and the valve then opens wider to restore the outlet pressure to normal. If the demand is reduced, this causes a momentary increase in outlet pressure, and this in turn increases the pressure on top of the diaphragm above that of the air pressure below it, causing the diaphragm to be displaced downward. The outlet pressure is again restored to normal.

Thus, theoretically, the valve should deliver a pressure of steam equal to the pressure of air pumped into the lower half of the dome. However, since the valve itself has weight and is equipped with a light spring which tends to close it, it is necessary to introduce slightly more air pressure than is theoretically required. For the higher pressure valves, about 10 psi additional air pressure is required. If air is pumped in when the valve is cold, slightly less air pressure will be needed because the air pressure will increase slightly when the valve is warmed up.

The copper shroud extending outside the dome from the center flange appears only on the high pressure valves. It is installed to allow for transmission of heat from the upper half of the dome to the atmosphere and to keep heat from passing into the lower half, where it may cause an excessive rise in the air pressure.

When the reducing valve is being put into operation, the discharge valve should be opened first. Then, if proper air pressure is in the dome, the inlet valve should be opened slowly, allowing the valve to heat up. The valve in the actuating line must be open. It may be difficult to get these valves on the line unless some steam is being bled away from the discharge side. It is desirable to have some steam leaving the valve when cutting it in. If you are careful to warm up reducing valves properly and to put them on the line slowly, no trouble should be encountered with their operation. Glycerine should always be used for the lower seal. Water should be used for the upper seal; the condensation of steam in the upper part of the dome is usually sufficient to maintain the water seal at the proper level.

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Diaphragm Control Valves with Air-Operated Control Pilots

Diaphragm control valves with air-operated control pilots are being used increasingly on newer combatant ships for various pressure control applications. These valves and pilots are available in several basic designs to meet different requirements. They may be used to reduce pressure, to augment pressure, or to provide continuous regulation of pressure, depending upon the requirements of the system in which they are installed. Valves and pilots of very similar design can also be used for other services such as liquid level control and temperature control. However, the discussion here is limited to the valves and pilots used for pressure control applications.

The air-operated control pilot may be either direct acting or reverse acting. A direct acting air-operated control pilot is shown in figure 7-12. In this type of pilot, the controlled pressure—that is, the pressure from the discharge side of the diaphragm control valve—acts on top of a diaphragm in the control pilot. This pressure is balanced by the pressure exerted by the pilot adjusting spring. If the controlled pressure increases and overcomes the pressure exerted by the pilot adjusting spring, the pilot valve stem is forced down. This action

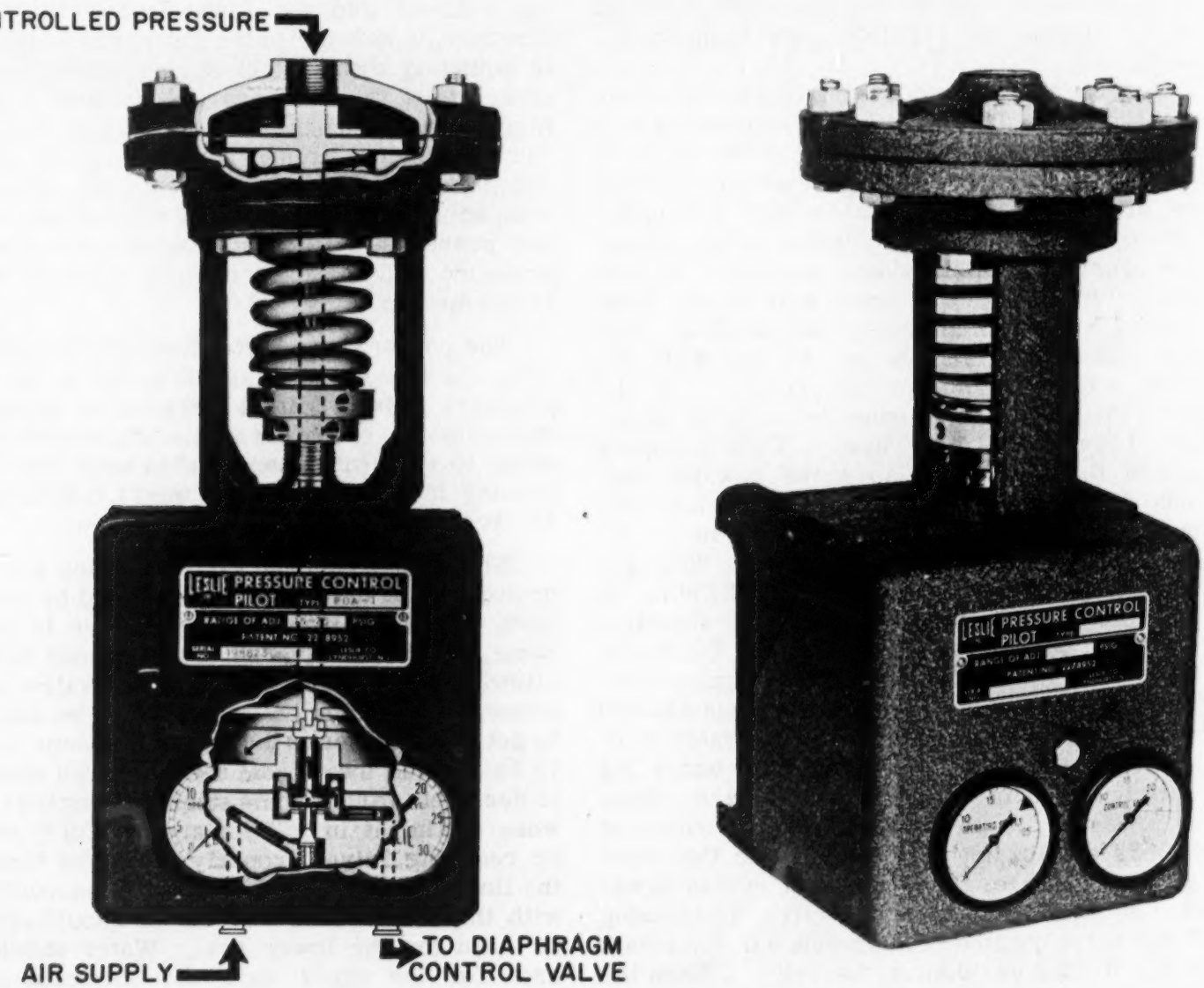

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Figure 7-12.—Air operated control pilot.

Block IV - Television Bench Servicing

Unit 7 - Sound Section

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Troubleshooting sound section circuits	Component stages and functions of sound section
	Circuit comparison of late model receiver:
	FM, IF amplifiers and detector Audio amplifiers
	Identifying characteristics of the three basic FM detectors
	Troubles in FM circuits
	Taking FM, IF and detector response curves when improper alignment is suspected as a source of trouble.
	Troubleshooting procedure for the sound section

Block IV - Television Bench Servicing

Unit 8 - Low Voltage Supplies

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Troubleshooting low voltage supply circuits	Components of the low-voltage supply
	Circuit comparison in late model receivers:
	Transformer type Selenium rectifier types, including voltage doublers
	Troubleshooting procedure for the low-voltage supply
	Preventive maintenance

causes the pilot valve to open and so increases the amount of operating air pressure going from the pilot to the diaphragm control valve. A reverse-acting pilot has a lever which reverses the pilot action. In a reverse acting pilot, therefore, an increase in controlled pressure produces a decrease in operating air pressure.

In the diaphragm control valve, operating air from the pilot acts on the valve diaphragm. The superstructure which contains the diaphragm is direct acting in some valves and reverse acting in others. If the superstructure is direct acting, the operating air pressure from the control pilot is applied to the TOP of the valve diaphragm. If the superstructure is reverse acting, the operating air pressure from the pilot is applied to the UNDERSIDE of the valve diaphragm.

Figure 7-13 shows a very simple type of direct acting diaphragm control valve, with operating air pressure from the control pilot applied to the top of the valve diaphragm. Since this is a downward seating valve, any increase in operating air pressure pushes the valve stem down and tends to close the valve.

Now look at figure 7-14. This is also a direct acting valve, with operating air pressure from the control pilot applied to the top of the valve diaphragm. But the valve shown in figure 7-14 is more complicated than the one shown in figure 7-13. The valve shown in figure 7-14 is an upward seating valve rather than a downward seating valve. Therefore, any increase in operating air pressure from the control pilot tends to OPEN this valve rather than close it.

As we have seen, the air-operated control pilot may be either direct acting or reverse acting. The superstructure of the diaphragm control valve may be either direct acting or reverse acting. And the diaphragm control valve may be either upward seating or downward seating. These three factors, as well as the purpose of the installation, determine how the diaphragm control valve and its air-operated control pilot are installed in relation to each other.

To see how these factors are related, let's consider an installation in which a diaphragm control valve and its air-operated control pilot are to be used to supply reduced steam pressure. Figure 7-15 shows one arrangement that might be used. We will assume that the service requirements indicate the need for a direct acting upward seating diaphragm control valve. Can you figure out what kind of a control pilot—direct acting or reverse acting—would have to be used in this installation?

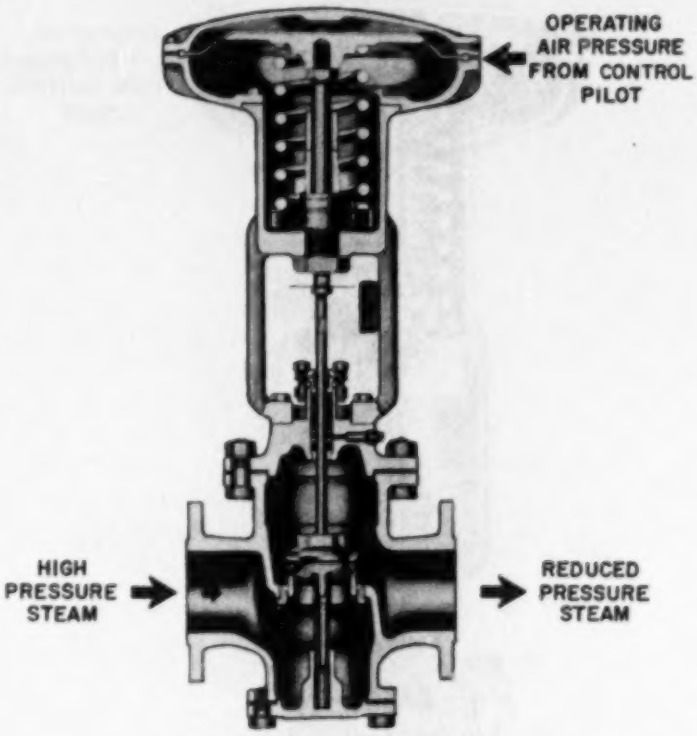

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Figure 7-13.—Diaphragm control valve, downward seating type.

Let's try it first with a direct acting control pilot. As the controlled pressure (discharge pressure from the diaphragm control valve) increases, increased pressure would be applied to the diaphragm of the direct acting control pilot. The valve stem would be pushed down and the valve in the control pilot would be opened, thus sending an increased amount of operating air pressure from the control pilot to the top of the diaphragm control valve. The increased operating air pressure acting on the diaphragm of the valve would push the stem down and—since this is an upward seating valve—this action would OPEN the diaphragm control valve still wider. Obviously, this won't work—for this application, an INCREASE in controlled pressure must result in a DECREASE in operating air pressure. Therefore, we make a mistake in choosing the direct acting control pilot. For this particular pressure-reducing aplication, we should have chosen a REVERSE ACTING control pilot.

It is not likely that you will be required to decide what type of control pilot and diaphragm

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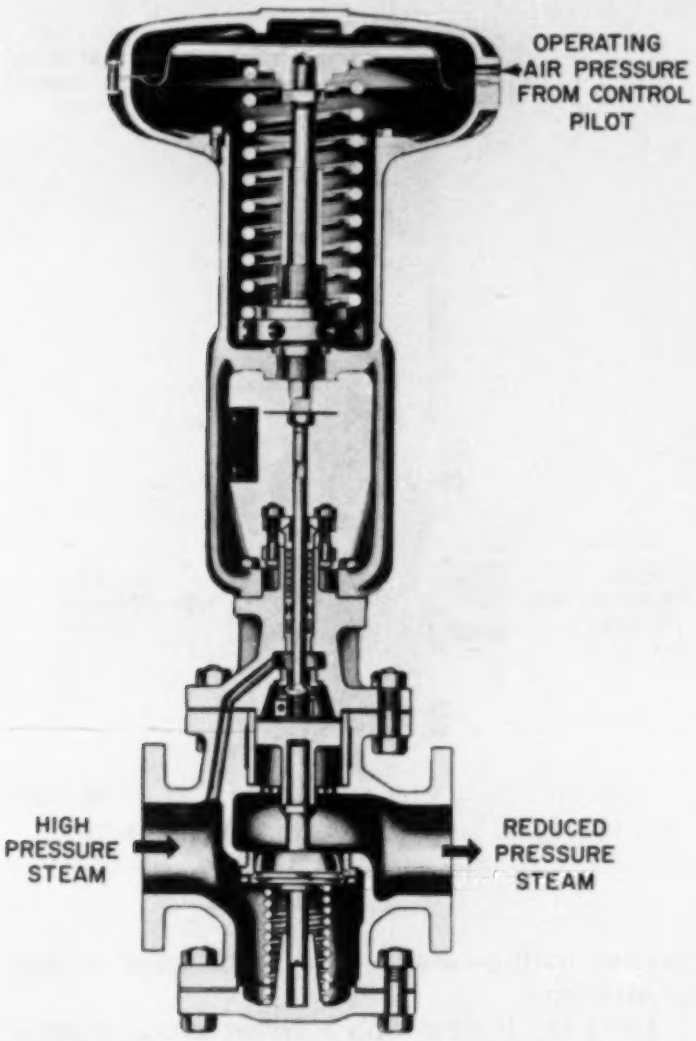

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Figure 7-14.—Diaphragm control valve, upward seating type.

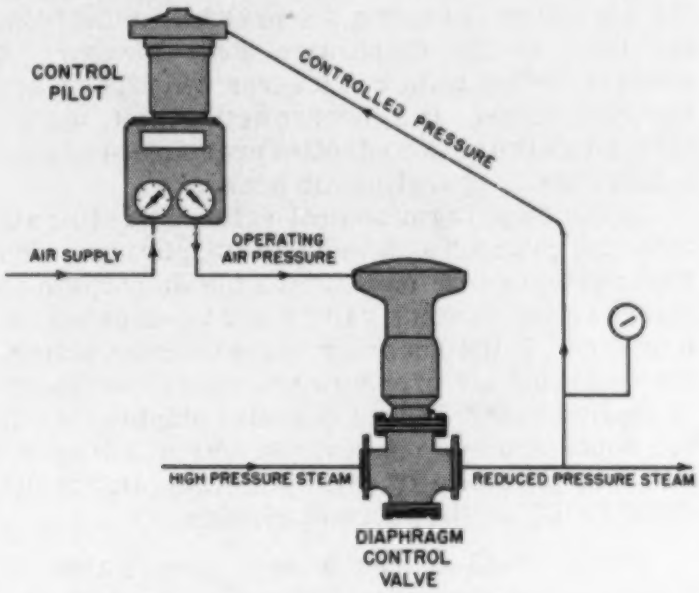

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Figure 7-15.—Arrangement of control pilot and diaphragm control valve for supplying reduced steam pressure.

control valve are needed in any particular installation. But you must know how and why they are selected so that you will not make mistakes in repairing or replacing these units.

Unloading Valves

An AUTOMATIC UNLOADING VALVE (fig. 7-16) or "dumping valve," is installed at each main and auxiliary condenser. The function of these valves is to discharge steam from the auxiliary exhaust line into the condensers whenever the exhaust line pressure exceeds 15 psi.

In figure 7-16, auxiliary exhaust steam is led through valve A to the top of the actuating valve diaphragm. The actuating valve is double-seated, and one side is open while the other is closed. When the auxiliary exhaust line pressure is less than the preset pressure, the upper seat is closed and the lower seat is open. The valve is thus held by the diaphragm spring. Steam passes into the line through valve B and under the unloading valve diaphragm. The pressure acting on this diaphragm holds the unloading valve up and closed. If the auxiliary exhaust pressure exceeds the pressure of the actuating valve diaphragm spring, the diaphragm is forced downward, and the lower seat closes while the upper seat opens. This makes a direct connection between the top and bottom of the unloading valve diaphragm through the actuating valve. The equalized pressure on the diaphragm allows the auxiliary exhaust pressure to force the unloading valve down and steam is unloaded to the condenser. The unloading pressure can be adjusted by turning the adjusting screw and thereby changing the tension against the actuating valve diaphragm.

To operate the valve manually, it is necessary to open the bypass valve. This equalizes the pressure on both sides of the unloading valve diaphragm.

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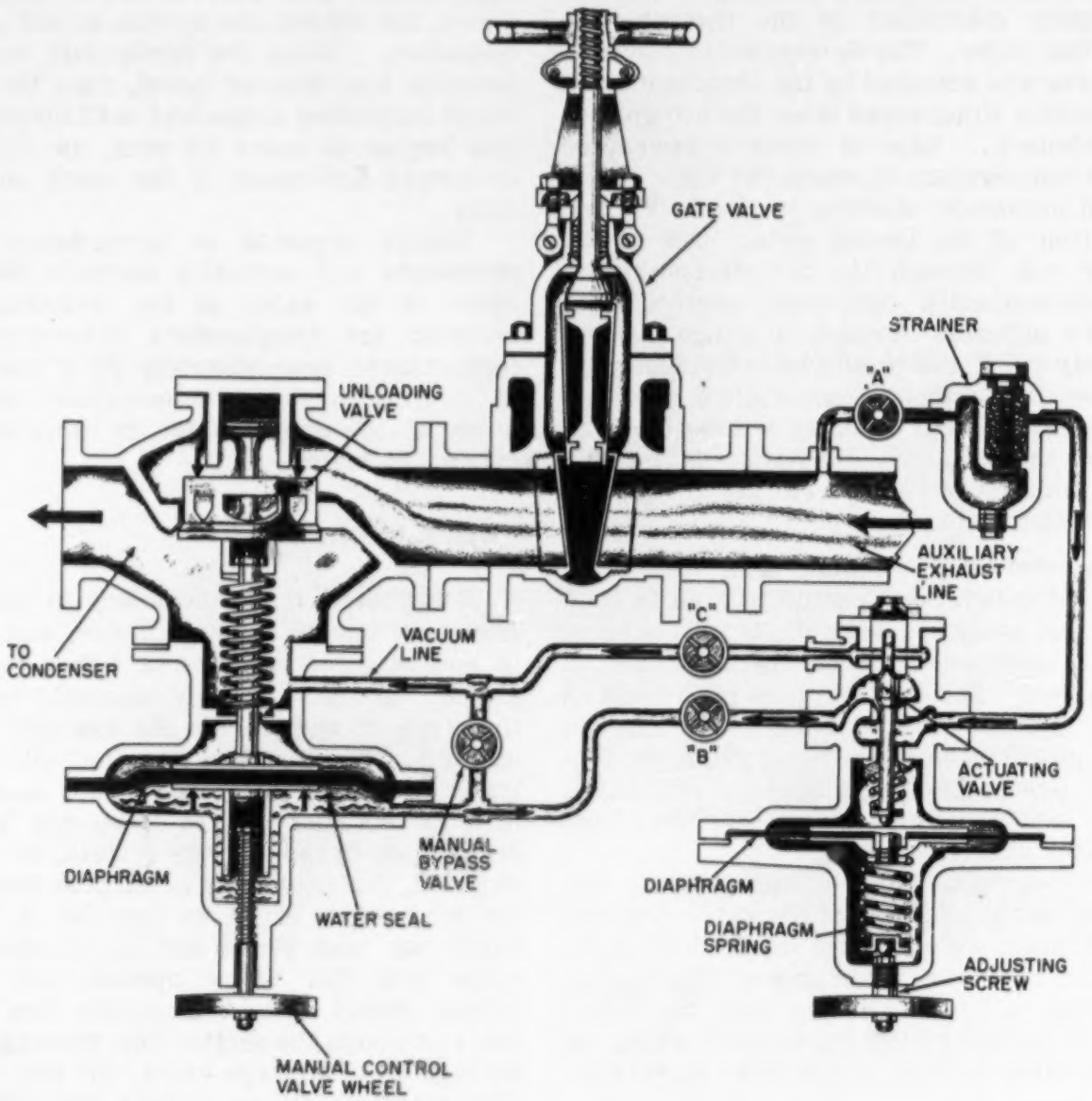

47.61x

Figure 7-16.—Automatic unloading valve.

Thermostatically Controlled Recirculating Valves

At fractional power, or cruising power, recirculating condensate from the discharge sides of the main air ejector condenser to the main condenser is essential. Recirculating presents excessive loss of feed water (as vapor discharged from the air ejector after condenser vent) and ensures proper operation of the air ejectors at fractional power. To make recirculation automatic and to avoid excessive recirculation with attendant excessive loss of heat, most air ejector recirculating lines are fitted with thermostatically controlled valves.

Excessive heat loss can be avoided by recirculating condensate from the discharge side of the main air ejector condenser to the main condenser. The air ejector condensers must be supplied with cooling water (condensate) during their operation. A hand-controlled valve allows bypassing of the thermostatic recirculating valve during the warming-up period. This bypass valve is also used when the thermostatic valve is inoperative.

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Under normal operating conditions, recirculation to the main condenser at light loads is automatically controlled by the thermostatic recirculating valve. The thermostatic recirculating valves are actuated by the temperature of the condensate discharged from the air ejector after condenser. Rise of water temperature above the temperature at which the valve is set results in automatic opening of the valve, and recirculation of the heated water back to the condenser and through the air ejector again. The thermostatically controlled recirculating valves are adjusted through a range of approximately 40° F and should be individually set to open at the highest temperature at which the air ejectors will operate without loss of condenser vacuum, or discharge of an appreciable amount of vapor from the air ejector after condenser vent.

In the interest of economy, the thermostatically controlled valve should be kept in good condition and properly set. Under all normal operating conditions, the manual bypasses should be kept closed. The control bulbs of the valves should be located in the condensate line as close as possible to the after condenser discharge, or preferably (when space is available), within the last pass of the air ejector after condenser water chest.

Figure 7-17 illustrates a thermostatic recirculating valve. Failure of the valve to maintain the cooling water at the desired temperature is an indication of improper adjustment. It may also be an indication that the thermostatic elements of the valve are leaking, or that some other portion of the valve has failed.

The main cause for improper adjustment of the valve is the lack of instructions for the proper adjustment procedure. Operating personnel should become familiar with the procedure for adjustment of this type of valve; it is recommended that they consult the manufacturer's instructions.

Briefly, the adjustment consists of changing the tension of the spring which opposes the action of the thermostatic bellows. An increase in spring tension will require a higher temperature to be reached before the valve will act to direct a greater portion of the condensate to the condenser.

However, when placing a new valve in service, steps must be taken to ensure that the valve will open and close at the recommended temperatures.

When the valve is completely installed in accordance with correct maintenance procedures, the condensate system should be placed in operation. When the condensate temperature reaches the desired level, turn the adjusting wheel (adjusting assembly) until the poppet valve just begins to leave its seat, as shown by the downward movement of the mark on the valve stem.

Valves adjusted in accordance with this procedure will normally maintain the temperature of the water at the thermostatic bulb between the temperature determined and a temperature approximately 20° F higher. This 20° F difference is the temperature rise required to cause the poppet valve to move through the necessary travel.

VALVE MANIFOLDS

Sometimes it is necessary to take suction from any one of many sources, and discharge to another unit or units of either the same or another group. A valve manifold is used for this type of operation. An example of such a manifold (fig. 7-18) is the fuel oil filling and transfer system, where provision must be made for the transfer of oil from any tank to any other tank, to the service system, or to another ship. If, for example, the purpose is to transfer oil from tank No. 1 to tank No. 4, the filling valve for tank No. 4 and the discharge valve from tank No. 1 are opened, and all other valves closed. Fuel oil can now flow from tank No. 1, through the suction line, through the pump, through the discharge valve, and into tank No. 4. The manifold filling valves are often of the stop-check type, to prevent draining of pumps when they are stopped.

REMOTE OPERATED VALVES

Remote operating gear is installed to provide a means of operating certain valves from distant stations. Remote operating gear may be mechanical, hydraulic, pneumatic, or electric.

Some remote operating gear for valves is used in normal operation of valves. For example, the main engine throttle valves are opened and closed by a reach rod or series of reach rods and gears. Reach rods may be used to operate engineroom valves in instances where the valves are difficult to reach from operating stations.

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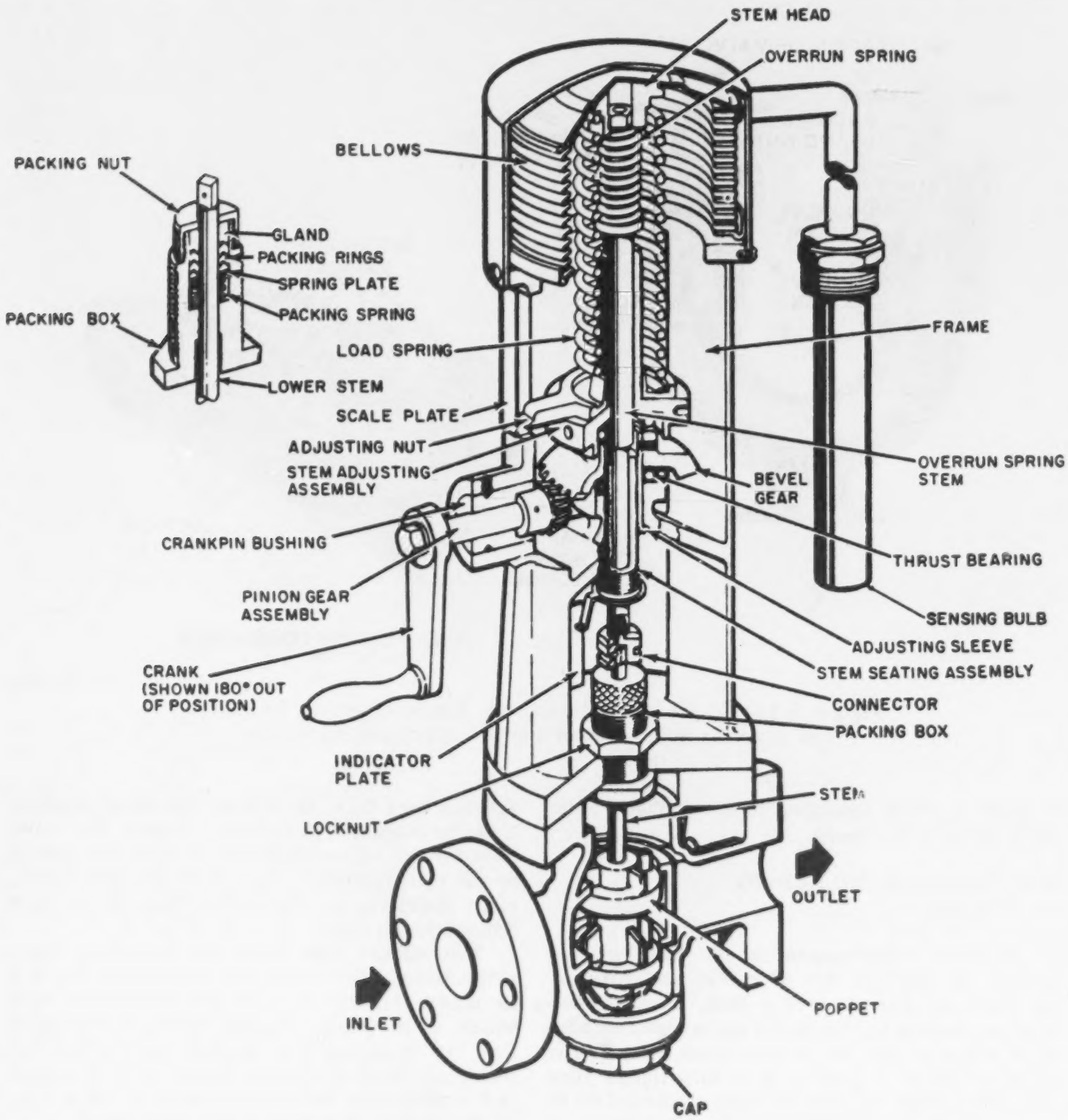

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Figure 7-17.—Thermostatic recirculating valve.

Other remote operating gear is installed as emergency equipment. Some split-plant valves, main drainage valves, and main condenser injection and overboard valves are equipped with remote operating gear. These valves can be operated normally or in an emergency they may be operated from remote stations. Remote operating gear also includes

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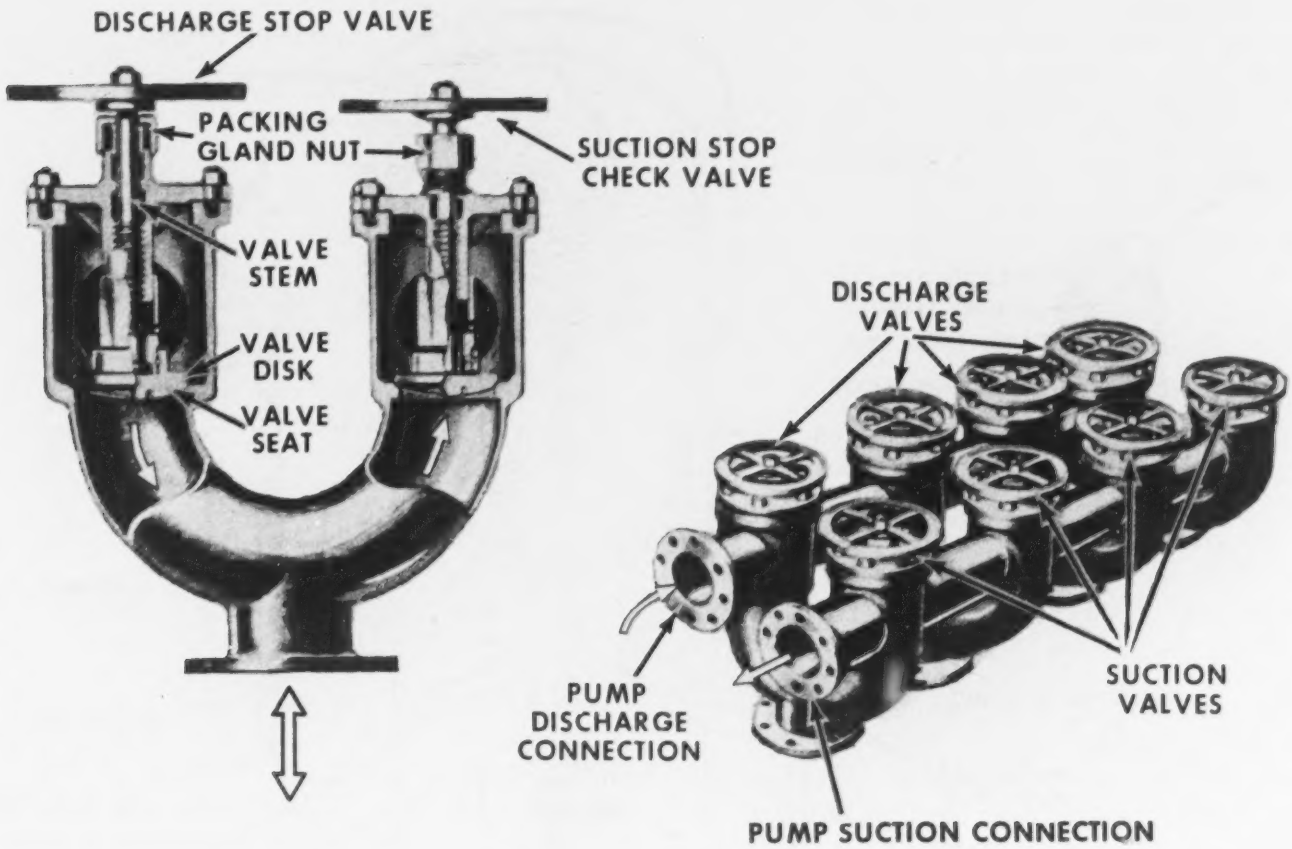

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Figure 7-18.—Valve manifold showing cutaway view of the valves and typical combination of suction and discharge valves.

a valve position indicator to show whether the valve is open or closed.

MAINTENANCE AND REPAIR OF VALVES

Periodic maintenance is the best way to extend the service life of valves and fittings. As soon as you observe a leak, check to see what is causing it; then apply the proper remedy. This remedy may be as simple as tightening a packing nut or a gland. A leaking flange joint may need only to have the bolts tightened or to have a new gasket inserted. Dirt and scale, if allowed to collect, can ultimately cause leakage. Loose hangers permit sections of a line to sag, and the weight of the pipe and the fluid in these sagging sections may strain joints to the point of leakage.

Whenever you are going to install a valve, make sure that you know the function that the valve is to perform—that is, whether it must prevent back flow, start flow, stop flow, regulate flow, or regulate pressure. Inspect the valve body for the information that is stamped upon it by the manufacturer: type of system (oil, water, gas); operating pressure; direction of flow; and other information.

You should also know the operating characteristics of the valve, the metal from which it is made, and the type of end connection with which it is fitted. Operating characteristics and the material are factors that affect the length and kind of service that a valve will give; end connections indicate whether or not a particular valve is suited to the installation.

Valves should be installed in accessible places, and with enough headroom to allow for full operation. Install valves with stems pointing upward, if possible. A stem position between straight up and horizontal is acceptable, but avoid the inverted position (stem pointing downward). When the valve is installed in the latter position, sediment will collect in the bonnet and score the

stem. In a line that is subject to freezing temperatures, liquid that is trapped in the valve bonnet may freeze and rupture it.

Globe valves may be installed with pressure either above the disk or below the disk, depending upon which method will be best for the operation, protection, maintenance, and repair of the machinery served by the system. The question of what would happen if the disk became detached from the stem is a major consideration in determining whether pressure should be above the disk or below it. If you are required to install a globe valve, be SURE to check the blueprints for the system to see which way the valve must be installed. Very serious casualties can result from installing a valve with pressure above the disk when it should be below the disk, or below the disk when it should be above.

Valves which have been in constant service over a long period of time will eventually require gland tightening, repacking, or a complete overhaul of all parts. If it is known that a valve is not doing the job for which it is intended, the valve should be dismantled and all parts inspected. All defective parts must be repaired or replaced.

The repair of globe valves (other than routine renewal of packing) is generally limited to refinishing the seat and disk surfaces. When this work is being done, there are certain precautions that should be observed.

When refinishing the valve seat, no more material should be removed than is necessary. Valves that do not have replaceable valve seats can be refinished only a limited number of times.

Before you do any repair to the seat and disk of a globe valve, check the valve disk to make certain it is secured rigidly to and is square on the valve stem. Also, check to be sure that the stem is straight. If the stem is not straight, the valve disk cannot seat properly. The valve seat and valve disk should be carefully inspected for evidence of wear, for cuts on the seating area, and for improper fit of the disk to the seat. If the disk and the seat appear to be in good condition, they should be spotted-in to find out whether they actually are in good condition.

Spotting-in Valves

The method used to determine visually whether or not the seat and the disk make good contact with each other is called spotting-in. To spot-in a valve seat, first apply a thin coating of prussian blue evenly over the entire machined face surface of the disk. Then insert the disk into the valve and rotate it a quarter turn, using a light downward pressure. The prussian blue will adhere to the valve seat at those points where the disk makes contact. Figure 7-19 shows what a correct seat looks like when it is spotted-in; it also shows what various kinds of imperfect seats look like.

After you have noted the condition of the seat surface, wipe all the prussian blue off the disk face surface. Apply a thin, even coat of blue to the contact face of the seat, and again place the disk on the valve seat and rotate the disk a quarter of a turn. Examine the resulting blue ring on the valve disk. The ring should be unbroken and of uniform width. If the blue ring is broken in any way, the disk is not making a proper fit.

Grinding-in Valves

The manual process used to remove small irregularities by grinding together the contact surfaces of the seat and disk is called grinding-in. Grinding-in should not be confused with refacing processes in which lathes, valve reseating machines, or power grinders are used to recondition the seating surfaces.

To grind-in a valve, first apply a small amount of grinding compound to the face of the

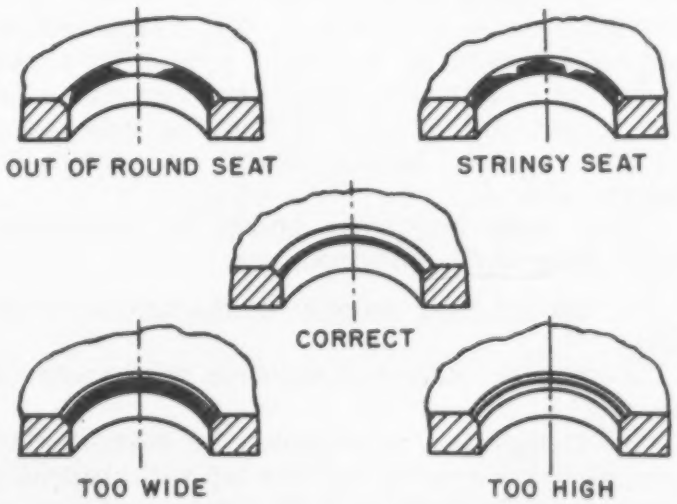

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Figure 7-19.—Examples of spotted-in valve seats.

disk. Then insert the disk into the valve and rotate the disk back and forth about a quarter of a turn; shift the disk-seat relationship from time to time so that the disk will be moved gradually, in increments, through several rotations. During the grinding process, the grinding compound will gradually be displaced from between the seat and disk surfaces; therefore, it is necessary to stop every minute or so to replenish the compound. When you do this, wipe both seat and the disk clean before applying the new compound to the disk face.

When it appears that the irregularities have been removed, spot-in the disk to the seat in the manner previously described.

Grinding-in is also used to follow up all machining work on valve seats or disks. When the valve seat and disk are first spotted-in after they have been machined, the seat contact will be very narrow and will be located close to the bore. Grinding-in, using finer and finer compounds as the work progresses, causes the seat contact to become broader. The contact area should be a perfect ring covering approximately one-third of the seating surface.

Be careful to avoid overgrinding a valve seat or disk. Overgrinding tends to produce a groove in the seating surface of the disk; it also tends to round off the straight, angular surface of the disk. Machining is the only process by which overgrinding can be corrected.

Lapping Valves

When a valve seat contains irregularities that are slightly larger than can be satisfactorily removed by grinding-in, the irregularities can be removed by lapping. A cast-iron tool (LAP) of exactly the same size and shape as the valve disk is used to true the valve seat surface. Two lapping tools are shown in figure 7-20.

The most important points to remember while using the lapping tool are:

1. Do not bear heavily on the handle of the lap.
2. Do not bear sideways on the handle of the lap.
3. Change the relationship between the lap and the valve seat so that the lap will gradually and slowly rotate around the entire seat circle.
4. Keep a check on the working surface of the lap. If a groove develops, have the lap refaced.

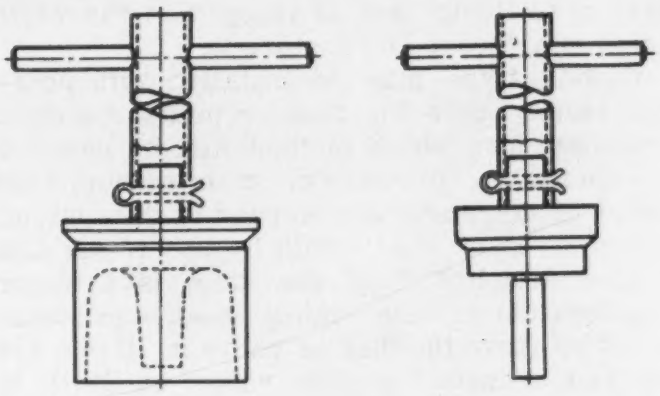

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Figure 7-20.—Lapping tools.

5. Always use clean compound for lapping.
6. Replace the compound often.
7. Spread the compound evenly and lightly.
8. Do not lap more than is necessary to produce a smooth, even seat.
9. Always use a fine grinding compound to finish the lapping job.
10. Upon completion of the lapping job, spot-in and grind-in the disk to the seat.

Only approved abrasive compounds should be used for reconditioning valve seats and disks. Compounds for lapping and grinding valve disks and seats are supplied in various grades. A coarse grade compound is used when extensive corrosion or deep cuts and scratches are found on the disks and seats. A compound of medium grade is used to follow up the coarse grade; it may also be used to start the reconditioning process on valves which are not too severely damaged. A fine grade compound should be used when the reconditioning process nears completion. A microscopic-fine grade is used for finish lapping and for all grinding-in.

Refacing Valves

Badly scored valve seats must be refaced in a lathe, with a power grinder, or with a valve reseating machine. The lathe, rather than the reseating machine, should be used for refacing all valve disks and all hard surfaced valve seats. Work that must be done on a lathe or with a power grinder should be turned over to shop personnel. The discussion here applies only to refacing valve seats with the reseating machine shown in figure 7-21.

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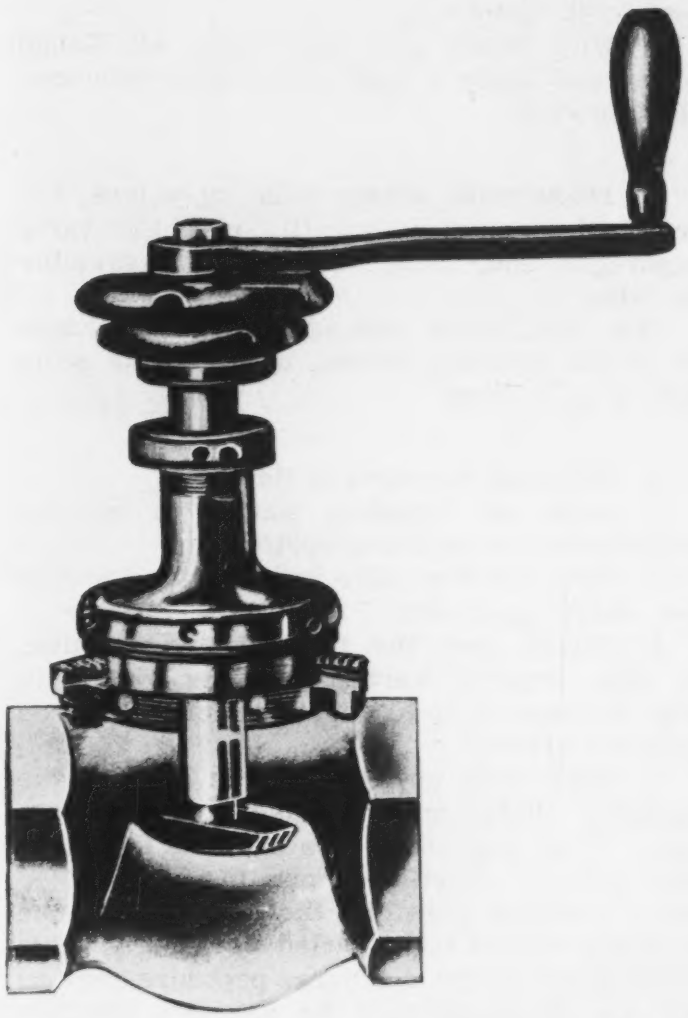

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Figure 7-21.—Valve reseating machine.

To reface a valve seat with a reseating machine, attach the correct 45° facing cutter to the reseating machine. With a fine file, remove all high spots on the surface of the flange upon which the chuck jaws must fit. Note that a valve reseating machine can be used ONLY with a valve in which the inside of the bonnet flange is bored true with the valve seat; if this condition does not exist, the valve must be reseated in a lathe, and the inside flange bored true.

Before placing the chuck in the valve opening, open the jaws of the chuck wide enough to rest on the flange of the opening. Now tighten up on the jaws lightly so that the chuck securely grips the sides of the valve opening, tap the chuck down with a wooden mallet until the jaws reset firmly and squarely on the flange, and then tighten up further on the jaws.

Adjust and lock the machine spindle in the cutting position and start the cutting by turning slowly on the crank. Feed the cutter slowly so that very light shavings are taken. After some experience, you will be able to know by the feel whether or not the tool is cutting evenly all around. Remove the chuck to see if enough metal has been removed.

Be sure that the seat is perfect. Then remove the cutter and face off the top part of the seat with a flat cutter. Dress the seat down to the proper dimensions, as follows:

WIDTH OF SEAT	SIZE OF VALVE
1/16 inch	1/4 to 1 inch
3/32 inch	1 1/4 to 2 inches
1/8 inch	2 1/2 to 4 inches
3/16 inch	4 1/2 to 6 inches

After the refacing, grind-in the seat and disk. Spot-in as necessary to check the work. A rough method of spotting-in that may be used is to place pencil marks at intervals of about 1/2 inch on the bearing surface of the seat or disk; then place the disk on the seat and rotate the disk about a quarter of a turn. If the pencil marks in the seating area rub off, the seating is considered satisfactory.

Repacking Valve Stuffing Boxes

If the stem of a valve (particularly a globe valve) is in good condition, stuffing box leaks can usually be stopped by setting up on the gland. If this does not stop the leakage, repack the stuffing box. The gland must not be set up on or packed so tightly that the stem binds. If the leak persists, a bent or scored valve stem may be the cause of the trouble.

Coils (string) and rings are the common forms of packing used in valves. (Additional information concerning packing is discussed later in this chapter.) The form of packing to be used in repacking a particular valve depends in part on the size of the packing required. In general, rings are used in valves that require packing larger than 1/4 inch. When a smaller size of packing is required, string packing is generally used.

To repack a stuffing box, place successive turns of the packing material around the valve stem. If you are using string packing, coil it around the valve stem and bevel off the ends to make a smooth seating for the bottom of the

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gland. Then put on the gland and set up on the gland nut. To keep string packing from folding back when the gland is tightened, wind the packing in the direction in which the gland nut is to be turned. When using ring packing, be sure that the joints of the successive rings are staggered.

Steam Reducing Valves,
Internal Pilot Actuated

Steam reducing valves, internal pilot actuated, should be isolated, removed, and disassembled in accordance with manufacturer's instructions. When valves are disassembled, the most important preventive maintenance procedures are as follows:

1. Clean the parts with an inflammable solvent. Remove foreign materials with crocus cloth, except for nonmetallic parts. Check the main and pilot valves to ensure that they move freely in their guides and are properly seated.
2. Clean the guide stems and bushings with crocus cloth.
3. Inspect the guide stems at the junction with the valve disk by using dye penetrant for fatigue cracks. Replace if necessary.
4. Inspect the seating surfaces for damage. Fine cracks or small pits can be removed by handlapping the disk to seat with an appropriate, very mild lapping compound. If the seating surfaces are badly wire-drawn, scored, or pitted, replace the disk and seat or reface the seating surfaces.
5. Clean the cylinder liner, where applicable, with crocus or very mild aluminum oxide cloth. Badly scored liners should be rehoned or replaced. In honing, an I.D. variation of 0.005 inch over the standard dimension shown on the drawing is permissible.
6. Inspect the piston seals for damage and if piston rings are used, they should move and expand freely in grooves; replace if damaged or distorted.
7. Hand lap the pilot valve and clean the guiding surfaces with crocus cloth.
8. Run soft copper wire through control ports to clean out dirt, and blow out with compressed air.
9. Inspect all flange seating surfaces for signs of wire drawing. Remachine if necessary.
10. Check the pilot valve stem clearance after tightening the pilot valve seat. Refer to the applicable technical manual for the prescribed procedure. Remember that the pilot valve seat must be tight. Do not loosen to meet depth dimension.
11. Wire brush and wipe clean all flange bolting and apply a light coat of high temperature lubricant.

To reassemble steam reducing valves, internal pilot actuated, install a new pilot valve diaphragm, and, using new gaskets reassemble the valve.

The installation and adjustment procedure for steam reducing valves, internal pilot actuated, is as follows:

1. Reinstall the valve in line.
2. Back off adjusting screw to release compression on adjusting spring.
3. Open the stop valve in the remote impulse line, where applicable.
4. Slowly open the inlet stop valve wide. On high capacity valves, use the bypass to bring the system up to slightly under the desired pressure setting.
5. Fully open any stop valves between the regulator outlet and the discharge pressure gage. (The gage should be ahead of the outlet stop valve.) Partially open the outlet stop valve. Where possible, the flow through the regulator should be throttled by using a valve downstream of the discharge pressure gage so that the regulator may be set at a low flow condition.
6. Slowly turn down on the adjusting screw until the desired downstream pressure is shown on the discharge pressure gage.
7. Secure the bypass valve.
8. Slowly bring the regulator up to full flow and check regulation.
9. To change the outlet pressure, turn the adjusting screw clockwise to increase and counterclockwise to decrease the pressure.

STEAM TRAPS

Steam traps are installed in steam lines to drain condensate from the lines without allowing the escape of steam. There are many different designs of steam traps; some are suitable for high pressure use and others for low pressure use. Some types of steam traps that are used in the Navy are described in this section.

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Block IV - Television Bench Servicing

Unit 9 - Front End Section

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Troubleshooting front end sections	Component stages and functions in the front end Signal frequencies in VHF and UHF Circuit comparison of VHF tuners used in late model receivers: Mechanical and electrical differences Features of cascode tuners Tuners classified as turret, switch wafer, and continuous Troubles found in VHF tuners Circuit comparison of UHF tuners UHF strips for turret tuners UHF converters UHF tuner types Taking response curves of tuners Troubleshooting procedures for the front end Tools requirement and repair practice Characteristics of UHF antennas UHF installation practices Transmission lines for UHF antennas Antenna couplers UHF installation practices Orientation

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MECHANICAL STEAM TRAPS

Mechanical steam traps in common use include ball float traps and bucket type traps. The ball float type of trap is described and illustrated in Fireman, NavPers 10520-C.

The operation of the bucket type steam trap shown in figure 7-22 is controlled by the condensate level in the trap body. The bucket floats as condensate enters the trap body. The valve is connected to the bucket in such a way that the valve closes as the bucket rises. As condensate continues to flow into the trap body, the valve remains closed until the bucket is full. When the bucket is full, it sinks and thus opens the valve. The valve remains open until enough condensate has blown out to allow the bucket to float, thus closing the valve.

THERMOSTATIC STEAM TRAPS

There are several types of thermostatic steam traps. In general, these traps are more compact and have fewer moving parts than most mechanical steam traps. The operation of a bellows type thermostatic trap (illustrated in Fireman, NavPers 10520-C) is controlled by expansion of the vapor of a volatile liquid, enclosed in a bellows type element. Steam enters the trap body and heats the volatile liquid in the sealed bellows, thus causing expansion of the bellows. The valve is attached to the bellows in such a way that the valve closes when the bellows expands. The valve remains closed, trapping steam in the trap body. As the steam cools and condenses, the bellows cools and contracts, thereby opening the valve and allowing the condensate to drain.

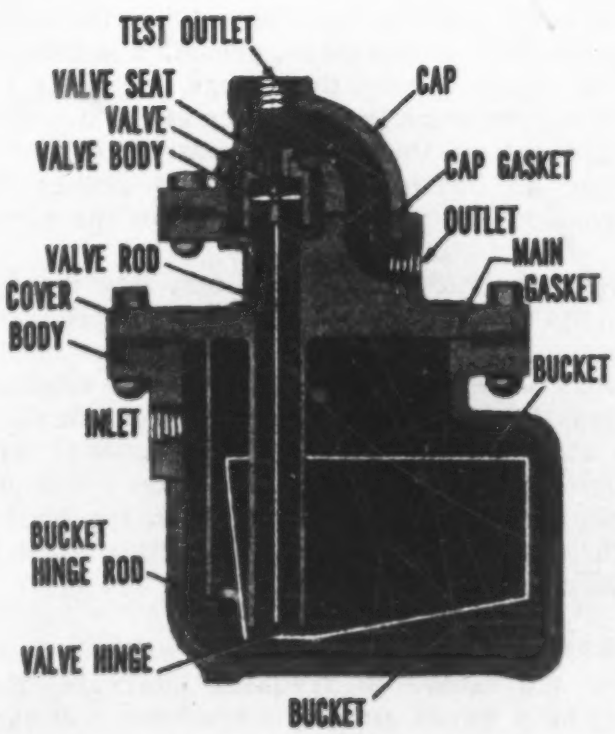

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Figure 7-22.—Bucket type steam trap.

IMPULSE STEAM TRAPS

Impulse steam traps of the type shown in figure 7-23 are commonly used in steam drain collecting systems aboard ship. Steam and condensate pass through a strainer before entering the trap. A circular baffle keeps the entering steam and condensate from impinging on the cylinder or on the disk.

The impulse type of steam trap depends for its operation upon the fact that hot water under pressure tends to flash into steam when the pressure is reduced. In order to understand how this principle is utilized, let's consider the arrangement of parts shown in figure 7-23 and see what happens to the flow of condensate under various conditions.

The only moving part in the steam trap is the disk. This disk is rather unusual in design. Near the top of the disk there is a flange that acts as a piston. As you can see in figure 7-23, the working surface above the flange is larger than the working surface below the flange; the importance of having this larger effective area above the flange is brought out later in this discussion.

A control orifice runs through the disk from top to bottom, being considerably smaller at the top than at the bottom. The bottom part of the disk extends through and beyond the orifice in the seat. The upper part of the disk (including the flange) is inside a cylinder. The cylinder tapers inward, so the amount of clearance between the flange and the cylinder varies according to the position of the valve. When the valve is open, the clearance is greater than when the valve is closed.

When the trap is first cut in, pressure from the inlet (chamber A) acts against the underside of the flange and lifts the disk off the valve seat. Condensate is thus allowed to pass out through the orifice in the seat; and, at the same time, a small amount of condensate (called CONTROL

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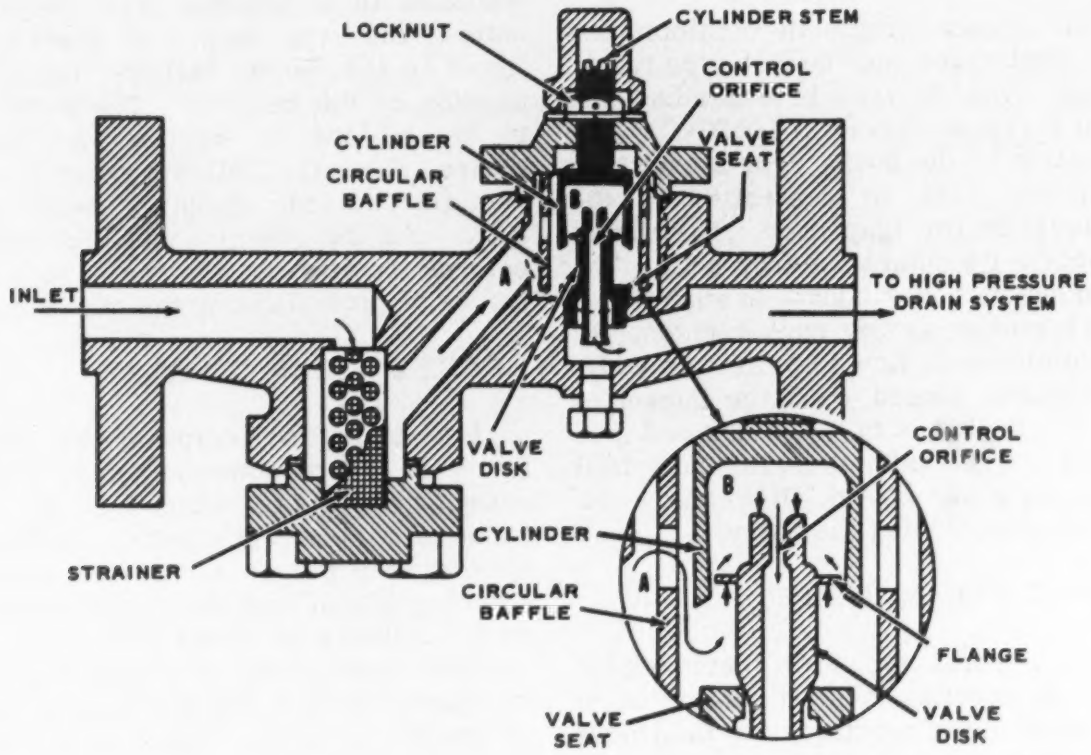

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Figure 7-23.—Impulse steam trap.

FLOW) flows up past the flange and into chamber B. The control flow discharges through the control orifice, into the outlet side of the trap, and the pressure in chamber B remains lower than the pressure in chamber A.

As the line warms up, the temperature of the condensate flowing through the trap increases. The reverse taper of the cylinder varies the amount of flow around the flange until a balanced position is reached in which the total force exerted above the flange is equal to the total force exerted below the flange. It is important to note that there is still a PRESSURE DIFFERENCE between chamber A and chamber B. The FORCE is equalized because the effective area above the flange is larger than the effective area below the flange. The difference in working area is such that the valve maintains an open, balanced position when the pressure in chamber B is 86 percent of the pressure in chamber A.

As the temperature of the condensate approaches its boiling point, some of the control flow going to chamber B flashes into steam as it enters the low pressure area. Since the steam has a much larger volume than the water from which it is generated, pressure is built up in the space above the flange (chamber B). When the pressure in this space is greater than 86 percent of the inlet pressure, the force exerted on the top of the flange pushes the entire disk downward and so closes the valve.

With the valve closed, the only flow through the trap is past the flange and through the control orifice. When the temperature of the condensate entering the trap drops slightly, condensate enters chamber B without flashing into steam. Pressure in chamber B is thus reduced to the point where the valve opens and allows condensate to flow through the orifice in the valve seat. Thus the entire cycle is repeated.

With a normal condensate load, the valve opens and closes at frequent intervals, discharging a small amount of condensate at each opening. With a heavy condensate load, the valve remains wide open and allows a heavy, continuous discharge of condensate.

BIMETALLIC-ELEMENT STEAM TRAPS

On some ships, bimetallic-element steam traps are used to drain condensate from main and auxiliary steam lines. In this type of trap, the bimetallic element responds differentially to the temperature of the fluid in the line, thus causing the trap to close when steam is present and to open when condensate is present.

ORIFICE-TYPE STEAM TRAPS

Aboard ship, continuous-flow steam traps of the orifice type are used in some constant service steam systems, oil heating steam systems, ventilation preheaters, and other systems or services in which condensate forms at a fairly steady rate. Orifice-type steam traps are NOT suitable for services in which the condensate formation is not continuous.

There are several variations of the orifice-type steam trap, but all types have one thing in common—they contain no moving parts. One or more restricted passageways or orifices allow condensate to trickle through but do not allow steam to flow through. In addition to the orifices, some orifice-type steam traps have baffles.

MAINTENANCE AND REPAIR OF STEAM TRAPS

A strainer is installed just ahead of each steam trap. This strainer must be kept clean and in good condition to keep scale and other foreign matter from getting into the trap. Scale and sediment can clog the working parts of a steam trap and seriously interfere with the working of the trap.

Steam traps that are not working properly can waste a large amount of steam and can cause operating troubles in vital systems and machinery. A quarterly check on the operation of all steam traps is required by the Naval Ship Systems Command.

One way to check on the operation of a steam trap is to listen to it. If the trap is leaking, you will probably be able to hear it blowing through the orifice. Another way to check the operation of steam traps is to check the pressure in the drain system. A leaking steam trap causes an unusual increase in pressure in the drain system. When this condition is observed, the defective trap can be located by cutting out traps, one at a time, until the pressure in the drain system returns to normal.

Defective steam traps should be disassembled, cleaned, and inspected. After determining the cause of the trouble, repair or replace parts as required. In some steam traps, the main working parts can be replaced as a unit; in others, you may have to grind in a seating surface, replace a disk, or perform other repairs. Defective trap discharge valves should be reseated. Always install new gaskets when reassembling a steam trap.

STEAM WHISTLES AND SIRENS

Since you will have to maintain, and occasionally repair, the steam whistles and sirens installed on your ship, you should know something about their construction and how they work.

The STEAM WHISTLE illustrated in figure 7-24 is of the diaphragm type, and is typical of the steam whistles used on modern ships. When the operating lever is pulled, the valve opens and admits steam through the orifice. This steam forces the spring-metal diaphragm disks to the left. As the disks attempt to spring back against the nozzle, they vibrate and produce an audible sound. The steam passes out around the nozzle and through the horn. Condensate leaks off through the drain connection. Before the whistle is used, the drain should be opened.

To ensure against damage, a steam separator (located below decks) is installed in the steam line to the whistle. The separator removes condensate from the steam by imparting a whirling motion to the steam when it passes on its way to the whistle. The whirling motion is set up by stationary curved baffles and guide vanes. Water is removed from the steam by the centrifugal motion imparted to the steam by the baffles and guide vanes.

Steam enters the STEAM SIREN (fig. 7-25) through a control valve and fills an annular chamber which surrounds a stationary slotted cylinder. This cylinder is pierced by a series of beveled slots. Inside is a second slotted hollow cylinder. The slots of the fixed cylinder act as steam nozzles which direct steam against the rotating cylinder's vertical slots which act as turbine blades. The alternate covering and uncovering of the slots, as the rotor speeds up with pressure of the steam, sets up violent vibrations of increasing frequency in the column of steam escaping through the megaphone above

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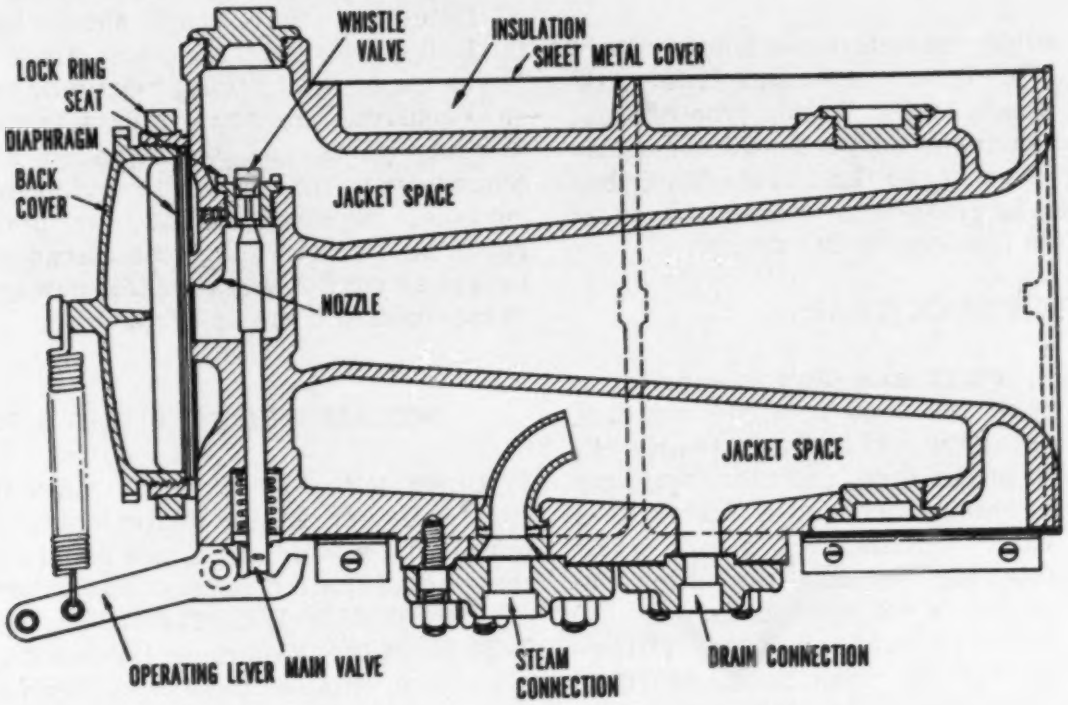

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Figure 7-24.—Sectional view of a diaphragm type steam whistle.

the cylinder. The speed of the inner cylinder rotation determines the pitch of the sound. Brake shoes, attached to the rotating cylinder, prevent overspeeding.

When a ship is in port, the steam lines to the whistle and siren should be secured. About an hour prior to getting underway, the whistle and siren steam lines should be turned on with all drains open and traps in operation for at least 30 minutes to ensure proper heating and removal of condensate. AT NO TIME, while underway, should the whistle and siren steam lines be secured.

PACKING AND GASKET MATERIALS

Packing and gasket materials are required to seal joints in steam, water, gas, air, oil, and other lines and to seal connections which slide or rotate under operating conditions. There are many types and forms of packing and gasket materials available commercially. To simplify the selection of packing and gasket materials commonly used in naval service, the Naval Ship Systems Command has prepared a packing and gasket chart (Mechanical Standard Drawing B-153) showing the symbol numbers and the recommended applications of all types and kinds of packing and gasket materials.

The symbol number used to identify each type of packing and gasket consists of a four-digit number. The first digit indicates the class of service with respect to fixed and moving joints; the numeral 1 indicates a moving joint (moving rods, shafts, valve stems) and the numeral 2 indicates a fixed joint (flanges, bonnets). The second digit indicates the material of which the packing or gasket is primarily composed—asbestos, vegetable fiber, rubber, metal, etc. The third and fourth digits indicate the different styles or forms of the packing or gaskets made from the material.

Practically all shipboard packing and gasket problems can be solved by selecting the correct material from the listings on the packing and gasket chart. The following examples show the kind of information that you can get from the packing and gasket chart.

Suppose you are required to repack and install a valve in a 300-psi saturated steam line. By referring to the packing and gasket

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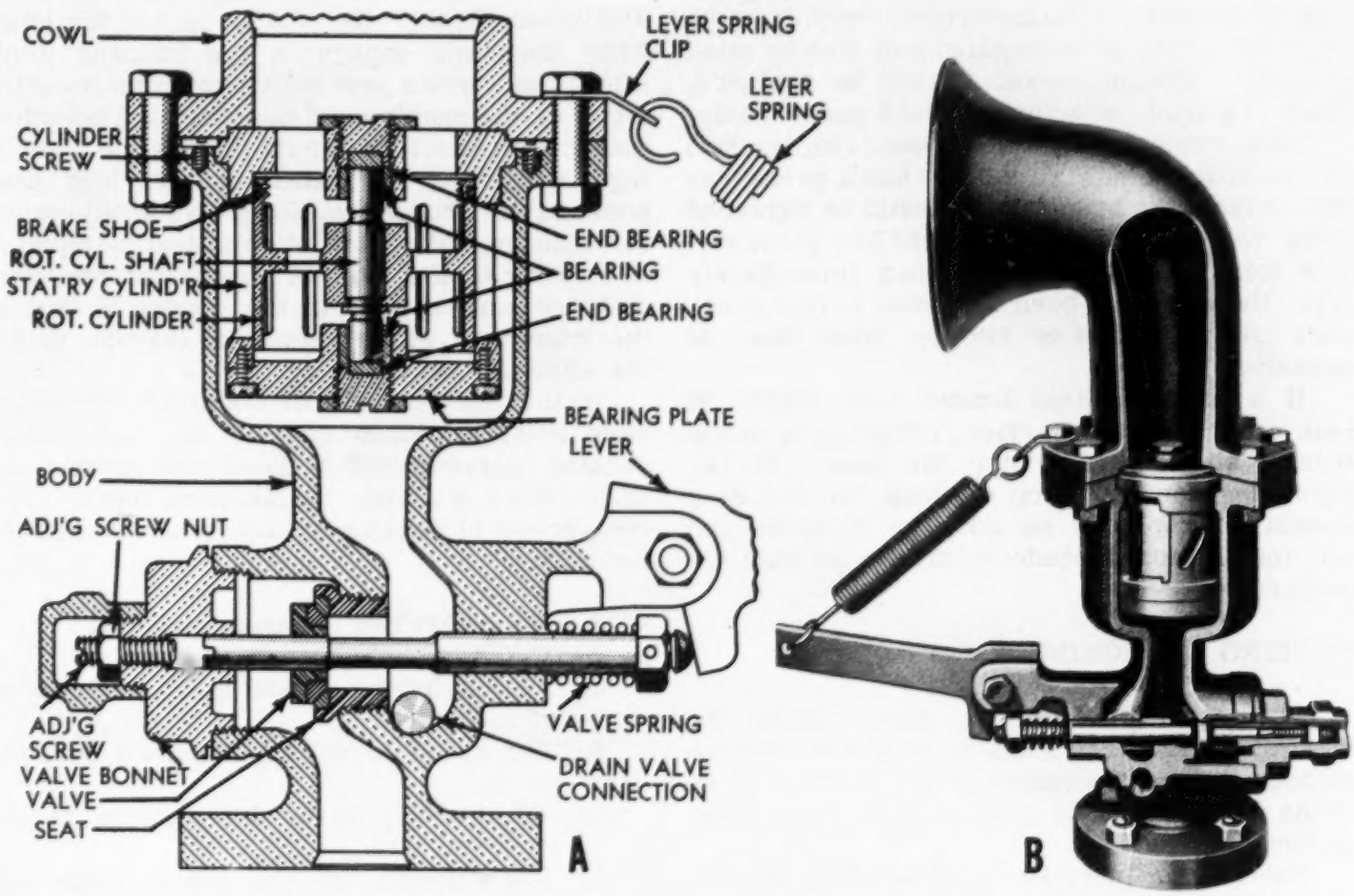

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Figure 7-25.—Steam siren. A. Sectional view. B. Exterior view.

chart, you will find several materials that are suitable for repacking the valve:

Symbol 1100 . . . . . asbestos, rod, high pressure
Symbol 1103 . . . . . asbestos, rod, braided, plain
Symbol 1400 . . . . . semimetallic asbestos jacket
Symbol 1430 . . . . . metallic, flexible

Notice that the first digit is 1 in each case, to indicate that the packing is suitable for a moving joint.

For installing the valve, you will need suitable gaskets. In this case, the first digit will be 2, indicating that the gasket material is suitable for fixed joints. By referring to the packing and gasket chart, you will find that you can use any of the following materials:

Symbol 2150 . . . . . asbestos, sheet, compressed
Symbol 2151 . . . . . asbestos, metallic cloth, sheet
Symbol 2410 . . . . . gaskets, metallic-asbestos, spiral-wound

In addition to the Naval Ship Systems Command chart, most ships have a packing and gasket chart made up specifically for each ship. The shipboard chart shows the symbol numbers and the sizes of packing and gaskets required in the ship's piping system, machinery, and hull fittings.

RENEWING BONNET GASKETS AND SEAL RINGS IN VALVES

Care must be taken in reassembling valves with gaskets under the bonnets to ensure an

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even compression of the gasket, to prevent misalignment. High pressure steam valves may have been originally furnished with Symbols 2410, 2470 flat, or corrugated soft iron or steel gaskets. Bonnet gaskets should be replaced, when required, with Symbol 2410 gaskets only.

When replacing a pressure-seal ring (gasket) or installing a new valve that has a pressure-seal bonnet, the bonnet joint should be tightened prior to subjecting the valve to line pressure. The joint should be retightened immediately after the valve has been subjected to line pressure and again after two or three days of operation.

If a pressure-seal bonnet joint starts to leak after being in service, retightening of the bonnet studs should stop the leak. If retightening does not stop the leak, the seal ring should be replaced as soon as possible and the installation procedure, mentioned earlier, performed.

PACKING OF MOVING JOINTS

The packing of moving joints offers the most difficulty. The seals must prevent leakage without causing excessive friction, undue wear of the moving part, or rapid deterioration of the packing.

Packing is inserted in STUFFING BOXES that consist of annular chambers located around valve stems, rotating shafts, and reciprocating pump rods. The packing material is compressed to the necessary extent and held in place by gland nuts or other devices.

The types of packing used for moving joints (illustrated in Fireman, NavPers 10524-C) depends primarily on whether the seal is for a sliding or rotating joint. The packing of a SLIDING JOINT may be one of a large variety of types. High pressure asbestos rod packing was formerly used exclusively for sealing steam joints (rods, valve stems, etc.). This type has been superseded to a large extent, however, by WIRE-INSERTED SQUARE-BRAIDED ASBESTOS, (for pressures up to 400 psi and temperatures up to 700° F) and by PLASTIC NON-METALLIC ASBESTOS ENCASED IN A BRAIDED WIRE COVERING (for pressures up to 650 psi and temperatures up to 850° F).

The SEALING OF ROTATING JOINTS is a more difficult problem than that of sliding joints. With this type of joint, it is possible for the packing to create enough friction to prevent the machine from operating. In the sliding joint, the heat of friction created by the packing is dissipated through the moving part of the joint. This does not happen in the rotating joint, where the friction heat builds up on the wearing faces of the packing and the shaft, unless other means are provided for its dissipation. Packings composed of materials with high heat conductivity properties, along with an allowance for leakage, take care of this heat dissipation in rotating joints. It is very important, however, that pressure applied to the packing be kept at the minimum which keeps the leakage within the allowable limits.

In the INSTALLATION OF ROD PACKING, care must be taken both to use the proper packing material and to detect and correct any deficiencies existing in the joint itself. The best grade of packing cannot seal a rod effectively if:

1. The rod is bent, scored, or rusty.
2. The gland is cocked.
3. The stuffing box and gland are scored or nicked.
4. The gland is out of alignment with the shaft.
5. All the old, hard, dry packing is not removed.
6. The threads on the gland studs are burred to the extent that the setting up of the gland nuts is prevented.

Whenever a stuffing box is broken down, the box, gland, rod, and studs should be carefully inspected to determine if any of the above conditions exist. The packing of any moving joint should never be jammed tight with a wrench, as this increases the friction and causes wear of both the packing and the rod.

When installing packing rings in stuffing boxes of moving rods, the ends of the rings should be cut square, not beveled. Enough clearance should be left between the ends of the rings to allow for elongation when the packing is set up. After any possible causes of faulty sealing have been corrected, the cut rings should be installed in the box one at a time with the joints staggered. Insert the gland, draw it up with a wrench, and then back it off until it is finger-tight. A slight leakage will occur during the time the packing is adjusting itself to the rod and box. As the packing expands, further backing off on the nuts may be necessary.

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Hydraulic rod packing, such as tuck, and rock hard, must be soaked in water for about 12 hours to allow for swelling, before cutting and fitting in a pump plunger. Step-type joints are best. When it is necessary in an emergency to use this packing dry, be sure to allow enough clearance to provide for the swelling which will occur after the packing has absorbed moisture.

PACKING OF FIXED JOINTS

Fixed steam joints used to be satisfactorily sealed with gaskets of compressed asbestos sheet packing (part A of fig. 7-26), but the 15-percent rubber content of the packing makes it unsatisfactory for modern high temperature steam. Gaskets of corrugated copper or of asbestos and copper are sometimes used on low and medium pressure lines. The following two types of metallic or semi-metallic gaskets are in use in present day high temperature high pressure installations:

1. SERRATED-FACE METAL GASKETS (part B of fig. 7-26), also made of Monel or soft iron, have raised serrations to make a better seal at the piping flange joints. These gaskets have resiliency,

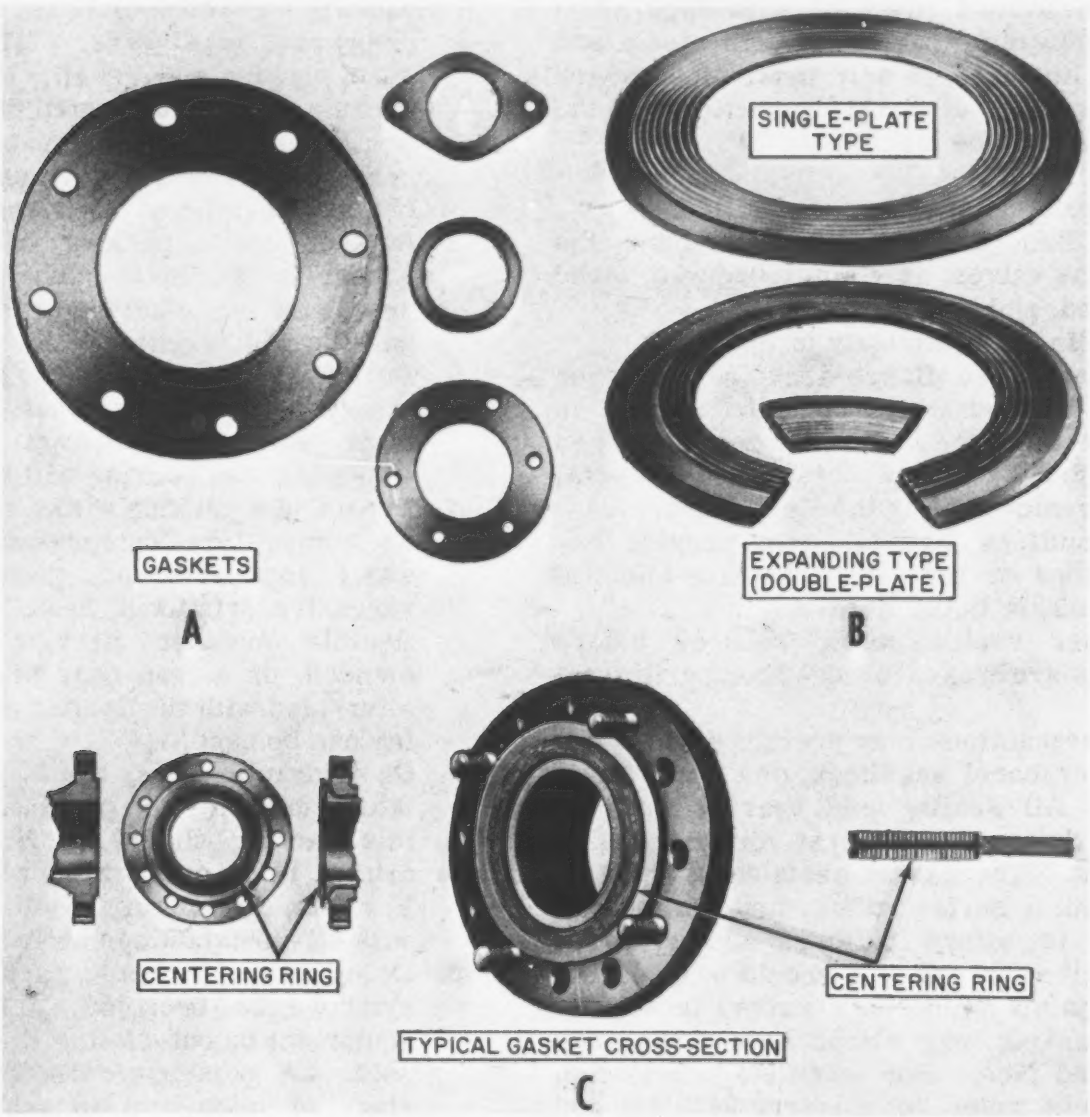

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Figure 7-26.—Fixed joint gaskets. A. Sheet asbestos gaskets. B. Serrated-face metal gaskets. C. Spiral-wound metallic-asbestos baskets.

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and line pressure tends to force the serrated faces tighter against the adjoining flange. The gaskets shown are two variations.

2. SPIRAL-WOUND METALLIC-ASBESTOS GASKETS (part C of fig. 7-26), are composed of alternate layers of dovetailed stainless steel ribbon, and strips of asbestos spirally wound, ply upon ply, to the desired diameter. The gasket is then placed into a retainer or centering ring. The solid steel centering ring also acts as reinforcement to prevent blowouts. The gaskets can be compressed to the thickness of this centering ring.

When renewing a gasket in a flanged joint, special precautions must be exercised when breaking the joint, particularly in steam and hot water lines, or in salt water lines which have a possibility of direct connection with the sea. Care should be taken that:

1. There is no pressure on the line.
2. The line pressure valves including the bypass valves, are firmly secured, wired closed, and tagged.
3. The line is completely drained.
4. At least two flange-securing bolts and nuts diametrically opposite remain in place until the others are removed, then slackened to allow breaking of the joint, and removed after the line is clear.
5. Precautions are taken to prevent explosions or fire when breaking joints of flammable liquid lines.
6. Proper ventilation is ensured before joints are broken in closed compartments.

These precautions may prevent serious explosions, personnel scaldings, or compartment floodings. All sealing and bearing surfaces should be thoroughly cleaned for the gasket replacement. The gasket seats should then be checked with a surface plate, and scraped as necessary, to afford uniform contact. All damaged bolt studs and nuts should be replaced. In flanged joints which have raised faces, the edges of gaskets may extend beyond the edge of the raised face. For complete information about gaskets refer to chapters 9480(48) and 9950(95) in the Naval Ships Technical Manual.

When cutting a PLAIN FULL-FACED GASKET from compressed asbestos sheet, lay an appropriate size piece of the asbestos sheet on the flange. Scribe in the bolt holes and flange circle lines with light blows of a ball-peen hammer. Using a gasket punch, about 1/16 inch larger in diameter than the bolts, cut the bolt holes into the gasket material. Use a piece of hard wood as the supporting and backing surface for the material while punching it. This will prevent damage to the lips of the punch. After the holes have been punched, use shears or a sharp knife to cut the center and outside circles to form the ring.

PACKING PRECAUTIONS

The following general precautions should be observed with regard to the use of packings:

1. Do not use metallic or semimetallic packing on bronze or brass shafts, rods, plungers, or sleeves. Where this is done, scoring may result. Use a braided packing that is lubricated throughout, or a nonmetallic plastic packing in the center of the box, with an end ring of the braided packing at each end of the box.
2. Do not use a packing frictioned with rubber or synthetic rubber of any kind on rotary or centrifugal shafts. Such packing will overheat.
3. Do not use braid-over-braid packing on rotary or centrifugal shafts. The outer layer will wear through quickly, and eventually the packing will become rags.
4. Do not use packing with a rubber binder on rotary type compressors. It will swell and bind and, thereby, develop excessive frictional heat. The use of flexible metallic packing is recommended, or a lead-base plastic packing alternated with the flexible metallic packing can be used.
5. On hydraulic lifts, rams, and accumulators use a V-type packing. For water, this packing should be frictioned with crude, reclaimed, or synthetic rubber. For oils, the packing should be frictioned with oil-resistant synthetic rubber.
6. Do not use a plastic packing, such as symbol 1433 or 1439, alone on worn equipment or out-of-line rods; it will not hold. A combination of 1433 with end rings of plain braided asbestos (1103), or flexible metallic packing (1430), may be satisfactory for temporary service, until defective parts can be repaired or replaced.

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7. Do not use a soft packing against thick or sticky liquids, or against liquids having solid particles. This packing is too soft to hold back such liquids as cold boiler fuel oil, and usually gets torn. Some of the solid particles which may be suspended in these liquids embed themselves in the soft packing, thereafter acting as an abrasive on the rod or shaft. Flexible metallic packing is best for these conditions.

INSULATION

The purpose of insulation is to retard the transfer of heat FROM piping that is hotter than the surrounding atmosphere or TO piping that is cooler than the surrounding atmosphere. The use of insulation helps to maintain the desired temperatures in all systems. In addition, it prevents sweating of piping that carries cool or cold fluids. Insulation also serves to protect personnel from being burned by coming in contact with hot surfaces. Piping insulation represents the composite piping covering which consists of the insulating material, lagging, and fastening. The INSULATING MATERIAL offers resistance to the flow of heat; the LAGGING, usually of painted canvas, is the protective and confining covering placed over the insulating materials; the FASTENING attaches the insulating material to the piping, and to the lagging.

INSULATION TEMPERATURE RANGE

Insulation covers a wide range of temperatures, from the extremely low temperatures of the refrigerating plants, to the very high temperatures of the ship's boilers. No one material could possibly be used to meet all the conditions with the same efficiency. Cork or rock wool, is used for LOW TEMPERATURES. Such basic minerals as asbestos, carbonate of magnesia, diatomaceous earth, aluminum foil, argillaceous (clay-like) limestone, mica, fibrous glass, and diatomaceous silica are employed for HIGH TEMPERATURES. Because of its high degree of refractoriness, diatomaceous silica forms the base of practically every high temperature insulating material.

INSULATION MATERIALS

The following QUALITY REQUIREMENTS for the various insulating materials are taken into consideration by the Navy in the standardization of these materials:

1. Ability to withstand highest or lowest temperature to which it may be subjected without its insulating value being impaired.
2. Sufficient structural strength to withstand handling during its application, and mechanical shocks and vibrations during service, without disintegration, settling, or deformation.
3. Stability in chemical and insulation characteristics.
4. Ease of application and repair.
5. Must not provide a hazard in case of fire.
6. Low heat capacity, when used for boiler wall and furnace insulation, so that starting-up time may be minimized.
7. Must be moisture repellant and vermin proof.

CORK in sheet form is generally limited to refrigeration spaces. MOLDED CORK PIPE COVERING, treated with a fire-retardant compound, is used on refrigerant piping.

MINERAL OR ROCK WOOL is supplied in wire-reinforced pads. This material is suitable for high temperature use, and is particularly useful for insulating large areas (part A of fig. 7-27).

Molded sheets, pads, blankets, or tapes of long ASBESTOS FIBERS are suitable for insulating temperatures up to 850° F. This insulation material is cheaper and lighter than the diatomaceous earth type, and is durable and rugged. The PADS or BLANKETS are used for insulating flanges or valves which must be taken down fairly often, as well as for turbine casings. The pads are molded to fit any shape, and the outer surface is fitted with metal hooks to facilitate installation and removal. The blankets are made in various thicknesses and widths, and are also fitted with hooks. TAPES are used for covering small piping with curves and bends. They can be used for temperatures up to 750° F, and tend to reduce fire hazards, but have poor insulating quality.

MAGNESIA-ASBESTOS PIPE COVERING (part B of fig. 7-27) is most commonly used as insulation on high temperature piping. This

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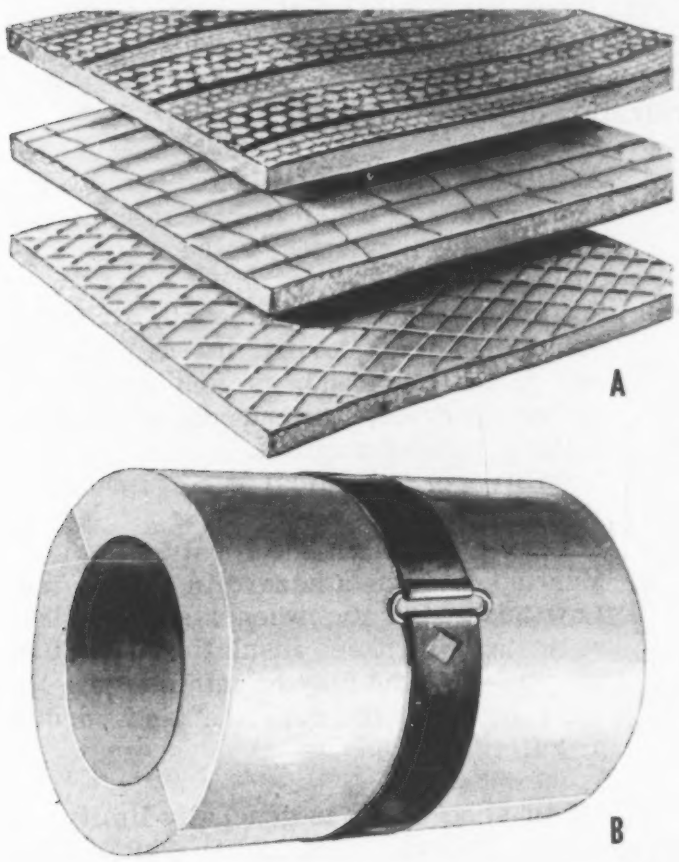

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Figure 7-27.—Piping insulation materials. A. Mineral wool blankets. B. Magnesia-asbestos pipe covering.

material is supplied in molded cylindrical sections which are 3 feet long; each section is split in half lengthwise. Suitable widths are available to fit the various pipe sizes. Magnesia-asbestos pipe covering comes in three grades: Grades I, II, and III are suitable for temperatures up to 500° F, 750° F, and 1050° F respectively.

The DIATOMACEOUS EARTH (formed from skeletons of certain microscopic plants) materials are combinations of the earth and magnesium or calcium carbonates, bonded together with small amounts of asbestos fibers. These materials are heavier, more expensive, and less insulating than others, but their high heat resistance allows their use for temperatures up to 1500° F. When practicable, pipe coverings are made up with this material as an inner layer, and with an outer layer of the magnesia-asbestos material. This lightens the overall weight.

FIBROUS GLASS SLABS AND BATTS are used widely for insulating hull spaces and living quarters. The fibrous glass has a low moisture absorbing quality, and offers no attraction to insects, vermin, fungus growth, or fire. The slabs are first cut to shape, then secured in place by mechanical fasteners (as quilting pins), and covered with glass cloth facing and stripping tape (held in place by fire-resistant adhesive cement).

The INSULATING CEMENTS are composed of many varied materials, differing widely among themselves as to heat conductivity, weight, and other physical characteristics. Typical of these variations are the asbestos cements, diatomaceous cements, and mineral and slag wool cements. These cements are less efficient than other high temperature insulating materials, but they are valuable for patchwork emergency repairs, and for covering small irregular surfaces (valves, flanges, joints, etc.). The cements are also used for a surface finish over block or sheet forms of insulation, to seal joints between the blocks, and to provide a smooth finish over which asbestos or glass cloth lagging may be applied (fig. 7-28).

APPLYING INSULATION

Do not allow the insulating materials to become moist. Moisture impairs the insulating value of the material, and may cause eventual disintegration. Large air pockets in the insulation cause large heat losses, so be sure to fill and seal all cavities or cracks. Hangers or other supports should be insulated so as to prevent loss of heat by conduction.

All sections or segments of the pipe coverings should be TIGHTLY BUTTED AT JOINTS, and secured with wire loops, metal bands, or lacing. Block insulation should be secured with 18 gage steel wire and galvanized mesh wire, or expanded metal lattice. Insulating cement should be used to fill all crevices, to smooth all surfaces, and to coat wire netting before final lagging is applied.

MOISTURE PROOFING is just as important in high temperature insulation as it is in low temperature insulation. In the former case heat is lost because of evaporation, while in the latter case condensed moisture may freeze. In either case, insulating efficiency is impaired and eventually the insulating material disintegrates.

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Block IV - Television Bench Servicing

Unit 10 - Alignment Techniques

Manipulative Skills Jobs or Experiments by Students	Related Technical Knowledge Instruction Sheets or Information Topics
Aligning video IF amplifier	Checks to determine when realignment is needed
Aligning front ends	Techniques in setting up equipment for alignment
Aligning sound IF	Alignment techniques:
	Marking the response curve Checking for response curve Trap alignment Use of bias box
	Video IF amplifier alignment:
	Methods of alignment Overcoming oscillation Identifying spurious markers Response curve tolerances
	Front end alignment:
	Impedance matching RF alignment Oscillator alignment
	Sound IF alignment methods
	Using AM or FM generator Using transmitted signal

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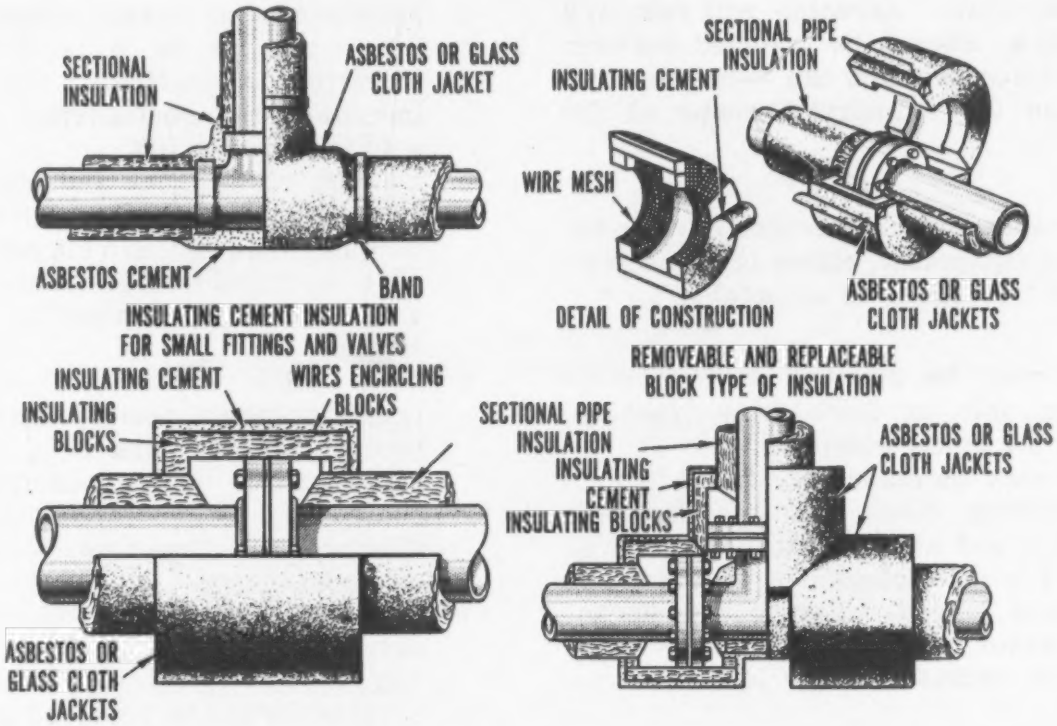

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Figure 7-28.—Permanent type insulation of pipe fittings, flanges, and valves.

While the same insulating material employed on the piping may be used, the insulation of pipe fittings, flanges, and valves requires additional consideration. Figure 7-28 illustrates several types of insulation for flanged pipe joints adjacent to machinery or equipment that must be broken when units are opened for inspection or overhaul.

REMOVABLE TYPE OF INSULATION is usually installed in the following locations:

1. Manhole covers, inspection openings, turbine casing flanges, drain plugs, strainer cleanouts, and spectacle flanges.
2. Flanged pipe joints adjacent to machinery or equipment that must be broken when units are opened for inspection or overhaul.
3. Valve bonnets of valves larger than 2 inches, IPS, that operate at 300 psi and above, or at 240° F and above.
4. All pressure reducing and pressure regulating valves, pump pressure governors, and strainer bonnets.

For a small unit of machinery or equipment such as an auxiliary turbine, where it would be difficult to install both permanent insulation over the casing and removable and replaceable covers over the casing flanges, the entire insulation may be made removable and replaceable. Covers should fit accurately and should project over adjacent permanent insulation.

For piping components any one of the following methods of fabrication is acceptable:

1. Covers may be made in two halves of thermal insulating felt enclosed in asbestos cloth. Each half cover should be sewn and quilted with wire-inserted asbestos yarn, or fastened with mechanical stapling to provide a uniform thickness, strength, and rigidity.
2. Covers for use at temperatures of 850° F and below, should be filled with asbestos felt. Wire-inserted asbestos cloth should be used on the inside surface of the covers.
3. Covers for use at temperatures above 850° F should have filling consisting of inner layers of fiber-glass felt, outer layers of asbestos felt, and should be covered on the inside surface and on the ends with nickel-chromium alloy wire

mesh and on the outside surface with asbestos cloth. Asbestos roll felt, 1/8 inch thick, should be inserted between the absestos felt and the asbestos cloth to retain the cylindrical shape of the cover.

For removable and replaceable covers for machinery and equipment, either of the following methods of fabrication is acceptable:

1. Covers may be similar to the flexible asbestos felt or fiber-glass type described for piping components.
2. Covers may be made in sections formed of insulating block and held together with wire and adhesive cement, covered with 1/2-inch thickness of finishing cement, and lagged. Lacing with hooks, rings, washers, and wire, or brass snap fasteners should be used to secure the covers.

GENERAL INSULATION PRECAUTIONS

The following general precautions should be observed with regard to the application and maintenance of insulation:

1. Fill and seal all air pockets and cracks. Failure to do this will cause large losses in the effectiveness of the insulation.
2. Seal the ends of the insulation and taper off to a smooth, airtight joint. At joint ends or other points where insulation is liable to damage, use sheet-metal lagging. Flanges and joints should be cuffed with 6-inch lagging.
3. Asbestos cloth covering fitted over insulation should be tight and smooth. It may be sewed with asbestos yarn or may be cemented on.
4. Keep moisture out of all insulation work. Moisture is an enemy of heat insulation fully as much as it is in the case of electrical insulation. Any dampness increases the conductivity of all heat-insulating materials.
5. Insulate all hangers and other supports at their point of contact from the pipe or other unit they are supporting, otherwise a considerable quantity of heat will be lost via conduction through the support.
6. Sheet metal covering should be kept bright and not painted unless the protecting surface has been damaged or has worn off. The radiation from bright-bodied and light-colored objects is considerably less than from rough and dark-colored objects.
7. Once installed, heat insulation requires careful inspection, upkeep, and repair. Lagging and insulation removed to make repairs should be replaced just as carefully as when originally installed. When replacing insulation, make certain that the replacement material is of the same type as had been used originally. Old magnesia blocks and sections broken in removal, can be mixed with water and reused in the plastic form for temporary repairs. Save all old magnesia for this use.
8. Insulate all flanges with easily removable forms which can be made up as pads of insulating material wired or bound in place, and the whole covered with sheet-metal casings which are in halves, and easily removable.

The main steam, auxiliary steam, auxiliary exhaust, feed water, and steam heating piping systems are lagged to hold in the heat. The circulating drainage, fire, and sanitary piping systems are lagged to prevent condensation of moisture on the outside of the piping.

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CHAPTER 8

HEAT EXCHANGERS AND AIR EJECTORS

Any device or apparatus designed to allow the transfer of heat from one fluid (liquid or gas) to another fluid is a heat exchanger. Boilers, distilling plants, and deaerating feed tanks are primary examples of heat exchangers; in common usage, however, these large and relatively complex pieces of equipment are seldom referred to as heat exchangers.

In order for heat to be transferred from one substance to another, a temperature difference is required. Heat flow or heat transfer can occur only from a substance that is at a higher temperature to a substance that is at a lower temperature. When two objects at different temperatures are placed in contact with each other, or near each other, heat will flow from the warmer object to the cooler one until both objects are at the same temperature. Heat transfer occurs at a faster rate when there is a large temperature difference than when there is only a slight temperature difference. As the temperature difference approaches zero, the rate of heat flow also approaches zero.

In some heat exchangers it is desired to RAISE THE TEMPERATURE of one fluid. Fuel oil heaters, combustion air preheaters, lube oil heaters, and many other heat exchangers used on board ship serve this function.

In some heat exchangers we want to LOWER THE TEMPERATURE of one fluid. Lube oil coolers, boiler water sample coolers, and desuperheaters are examples of this type of heat exchanger.

In condensers, we want to REMOVE LATENT HEAT from a fluid in order to make it change from a gas to a liquid. Very often, we want to remove the latent heat without removing any sensible heat—that is, we want to change the state of the fluid but do not want to lower its temperature. For example, the purpose of the main condenser is to remove the latent heat from the turbine exhaust steam so that the steam will condense. In this process, however, we do NOT want to lower the temperature of the condensate. Since any heat removed from the condensate must be replaced in the deaerating feed tank or in the boiler, lowering the temperature of the condensate is wasteful of heat and therefore wasteful of fuel.

In some heat exchangers, we want to ADD LATENT HEAT to a fluid in order to make it change from a liquid to a gas. The generating part of a boiler is a good example of this type of heat exchanger. Since it is impossible to raise the temperature of the steam as long as it is in contact with the water from which it is being generated, the steam does not increase in temperature until it has been drawn off into another heat exchanger (the superheater).

This chapter deals with such heat exchangers as you will encounter in the engineroom. These include the main and auxiliary condensers, air ejector condensers, air coolers, lube oil coolers, and deaerating feed tanks. Information concerning other heat exchangers may be obtained from either the manufacturer's technical manual or the Naval Ships Technical Manual.

CLASSIFICATION OF HEAT EXCHANGERS

Heat exchangers may be classified according to the path of heat flow, the relative direction of the flow of the fluids, the number of times that either fluid passes the other fluid, and the general construction features such as the type of surface and the arrangement of component parts. The types of heat exchangers in common use on naval ships are described in the following sections in terms of these basic methods of classification.

PATH OF HEAT FLOW

When classified according to the path of heat flow, heat exchangers are of two basic types. In

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the INDIRECT or SURFACE type of heat exchanger, the heat flows from one fluid to the other through some kind of tube, plate, or other "surface" that separates the two fluids; consequently, there is no mixing of the fluids. In the DIRECT CONTACT type of heat exchanger, the heat is transferred directly from one fluid to another as the two fluids mix. The deaerating feed tank is a direct contact heat exchanger; practically all other heat exchangers used on board ship are of the indirect or surface type.

DIRECTION OF FLUID FLOW

In surface heat exchangers, the fluids may flow parallel to each other, counter to each other, or at right angles to each other (crossflow).

In PARALLEL FLOW, both fluids flow in the same direction. If a parallel flow heat exchanger has a long enough heat transfer surface, the temperatures of the two fluids will be practically equal as the fluids leave the heat exchanger.

In COUNTERFLOW, the two fluids flow in opposite directions. Counterflow heat exchangers are used in many applications where it is necessary to obtain a large temperature change in the cooled or heated fluid.

In CROSSFLOW, one fluid flows at right angles to the other. Crossflow is particularly useful for removing latent heat and thus condensing a vapor to a liquid.

Counterflow and crossflow heat exchangers are more commonly used than the parallel flow type on board ship. Fuel oil heaters, lube oil coolers, and many internal combustion engine coolers are examples of the counterflow type. Crossflow is used for most condensers, including the main and auxiliary condensers. In many heat exchangers, the types of flow are combined in various ways so that it is not always easy to determine whether the flow is basically parallel, counter, or cross.

NUMBER OF PASSES

Surface heat exchangers may be classified as SINGLE-PASS units, if one fluid passes another only once; or as MULTIPASS units, if one fluid passes another more than once. Multipass flow may be obtained either by the arrangement of the tubes and of the fluid inlets and outlets, or by using baffles to guide a fluid so that it passes the other fluid more than once before it leaves the heat exchanger.

TYPE OF SURFACE

Surface heat exchangers are known as PLAIN SURFACE units, if the surface is relatively smooth, or as EXTENDED SURFACE units, if the surface is fitted with rings, fins, studs, or some other kind of extension. The main advantage of the extended surface lies in the fact that the extensions increase the heat transfer area without requiring any substantial increase in the overall size and weight of the unit.

TYPE OF CONSTRUCTION

Surface heat exchangers are often called by names that indicate general features of design and construction. Basically, all surface heat exchangers are of SHELL-AND-TUBE construction. However, the shell-and-tube arrangement is modified in various ways and in some cases it is not easy to recognize the basic design. Shell-and-tube heat exchangers include such types as (1) straight tube, (2) U-tube, (3) helical or spiral tube, (4) double-tube, (5) strut tube, and (6) plate tube heat exchangers.

In STRAIGHT TUBE heat exchangers, the tubes are usually arranged in a bundle and enclosed in a cylindrical shell. The ends of the tubes may be expanded into a tube sheet at each end of the bundle or they may be expanded into one tube sheet and packed and ferruled into the other. The use of ferrules allows the tube to expand and contract slightly with temperature changes.

U-BEND heat exchangers, sometimes called RETURN BEND heat exchangers, consist of a bundle of U-shaped tubes inside a shell. Since the tubes are U-shaped, there is only one tube sheet. The shape of the tubes provides a sufficient allowance for expansion and contraction.

HELICAL TUBE or SPIRAL TUBE heat exchangers have one or more coils of tubing installed inside a shell. The tubes may communicate with headers at each end of the shell; or in the case of relatively simple units such as boiler water sample coolers, the ends of the tubing may pass through the shell and serve as the inlet and the outlet for the fluid that flows through the coil of tubing.

DOUBLE-TUBE heat exchangers have one tube inside another. One fluid flows through the inner tube and the other flows between the outer and the inner tube. The outer tube may thus be regarded as the shell for each inner tube. The shells or outer tubes are usually arranged in

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banks and are connected at one end by a common tube sheet and a partitioned cover that serves to direct the flow. Many double-tube heat exchangers are of U-bend construction to allow for expansion and contraction. The sectional G-fin fuel oil heater commonly used in the Navy is an example of a double-tube heat exchanger.

STRUT TUBE and PLATE TUBE heat exchangers are noticeably different in design from the other shell-and-tube heat exchangers. The tubes in both strut tube and plate tube heat exchangers consist of pairs of flat, oblong strips; one fluid flows inside the tubes and the other flows around the outside. Strut tube and plate tube heat exchangers are used primarily as water coolers and lubricating oil coolers in internal combustion engines; they are also used as lube oil coolers for some small auxiliary turbines.

STEAM CONDENSERS

A condenser is a type of heat exchanger used to remove latent heat from a vapor and thereby change the vapor to a liquid. Since the main condenser of a steam plant is one of the most important units in the plant, the operation of the main condenser is discussed here in some detail.

MAIN CONDENSERS

A typical main condenser system is illustrated in figure 8-1. There are two separate circuits involved in the condensation of steam in a condenser of this type. The first is the vapor-condensate circuit, in which the steam exhausted from the turbine enters the condenser at the top of the shell and comes into contact with the outside surfaces of the condenser tubes. The latent heat of the steam is transferred through the tube walls to the sea water that is flowing inside the tubes. As its latent heat of vaporization is removed, the steam condenses on the tube surfaces. The condensate then falls to the bottom of the condenser and drains into the hot well, from which it is removed by the condensate pump. Air and other noncondensable gases which enter with the exhaust steam are drawn off by the air ejector through an AIR EJECTOR SUCTION OPENING in the shell, above the condensate level. The second circuit in the condenser is the cooling water circuit. During normal ahead operation, sea water flow through the condenser is provided automatically by means of the INJECTION SCOOP. The scoop, located below the waterline, and the forward motion of the ship (5 knots or above) causes sea water to flow through the condenser. STRAINER BARS are installed in the sea chest to strain out

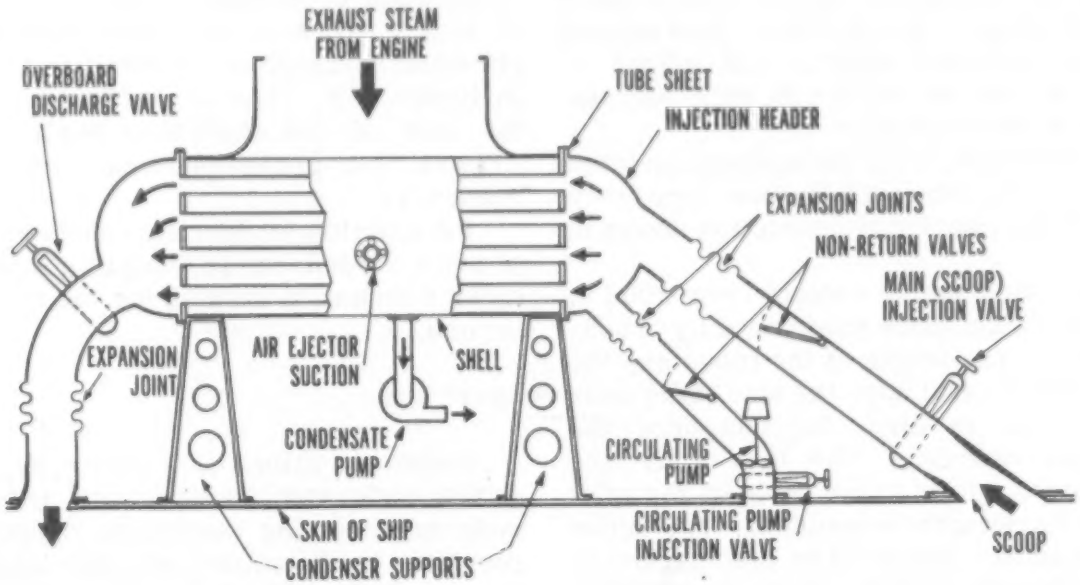

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Figure 8-1.—Schematic arrangement of a main condensing system.

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debris which could foul the piping and the condenser tubes. The injection and overboard discharge lines are provided with expansion joints to prevent undue strains as a result of either change in temperature or working of the hull.

A main CIRCULATING PUMP provides a flow of water through the condenser at times when scoop injection is inadequate—as, for example, when a ship is stopped, backing down, or moving ahead at a very slow speed. A large SWING-CHECK VALVE or NONRETURN VALVE which prevents backflow of water is installed in the main injection line; another one is installed in the main circulating pump discharge line. When water is flowing into the condenser through the main injection line, the nonreturn valve in the main circulating pump discharge line prevents the backflow of water through the pump. When the circulating pump is in operation, the nonreturn valve in the main injection line prevents backflow of water through that line.

In all cases, the main circulating pump must have a large capacity (as high as 40,000 gpm against a very low head). The pump is usually of the propeller type. The main circulating pump is provided with a bilge suction line so that it can be used to pump water overboard in case of serious flooding of the engineroom.

Construction

To ensure proper maintenance of a condenser, there are certain installation and construction features which you should understand. Modern installation practice is to suspend the condenser from the turbine rather than to have the condenser support the turbine. This allows for a greatly reduced weight, and makes it unnecessary to use an expansion joint between the turbine and the condenser.

All main condensers that have scoop injection are of the straight-tube, single-pass type; they are usually of the general construction shown in figure 8-2.

A main condenser may contain from 2000 to 10,000 copper-nickel alloy tubes, usually of 5/8-inch diameter. The length of the tubes and the number of tubes depend upon the size of the condenser; and this, in turn, depends upon the capacity requirements. The tube ends are usually expanded into the tube sheet at the inlet end and are flared after expansion. The outlet tube ends are either expanded or else packed or ferruled into the tube sheet. Condensers having tubes ferruled into each tube sheet are found in some older ships.

The tube sheets serve as partitions between the salt water circuit and the vapor-condensate circuit. Access to the tube sheets is by way of manholes in each water chest. Zinc plates are attached to each manhole cover.

Various methods of construction are used to provide for relative expansion and contraction of the shell and tubes in main condensers. Packing the tubes at the outlet end is sometimes sufficient. Where the tubes are expanded into each tube sheet, the shell may have an expansion joint. In some condensers the tubes are arranged to bow upward about one-half inch at the middle; this provides for expansion and contraction and also makes it easier to drain the salt water side of the condenser. Expansion joints are also provided in the scoop injection line and in the overboard discharge lines as shown in figure 8-1. In recent installations, additional means such as a flexible support foot or lubricated sliding feet are provided to compensate for expansion and contraction differentials between the shell and the condenser supporting structure.

As the steam is condensed on the tubes, the condensate drips down and collects on a receiving tray. Because of the arrangements made for steam flow in a main condenser, some steam flows under the tube bundle and thereby reheats the condensate. From the receiving tray, the condensate drains to the hot well, where the condensate pump takes suction.

Main condensers have various internal baffle arrangements for the purpose of separating air and steam so that the air ejectors will not be overloaded by having to pump large quantities of steam with the air. One arrangement that provides separate air-cooling sections is shown in figure 8-2. The air baffles are extended up the side of the condenser shell. Figure 8-3 illustrates a cross-sectional view of a typical condenser.

Information on specific construction features of main condensers is available in the manufacturer's technical manual for the condenser concerned.

Operation

Under conditions of warming up, standing by, getting underway, cooling down, and securing the main engines, the condenser vacuum should be regulated in accordance with information given in chapter 9460 (46) of the Naval Ships Technical Manual, the manufacturer's technical manual, and any orders issued by the engineer officer.

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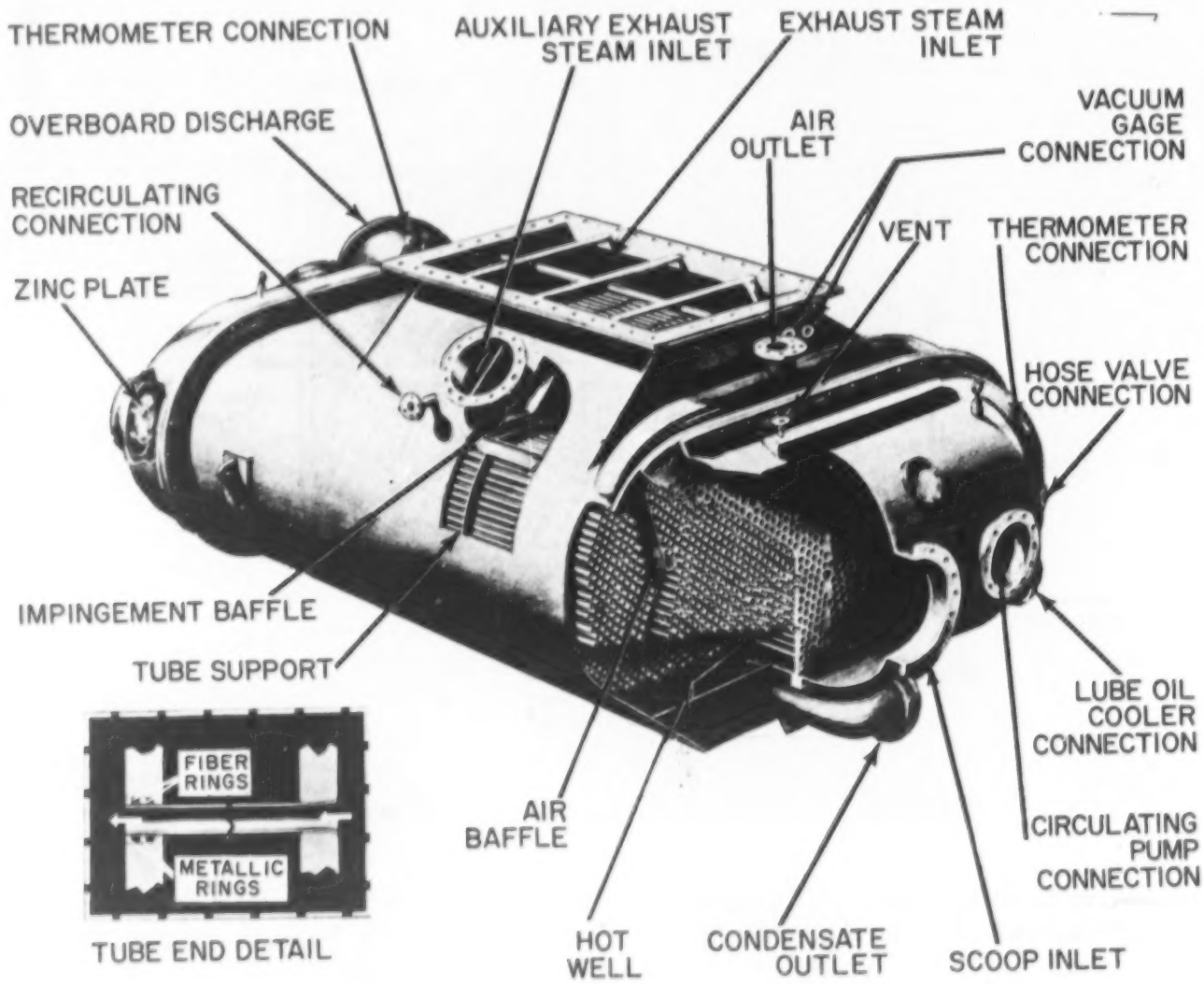

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Figure 8-2.—Cutaway view of a main condenser.

Two basic rules that apply to the operation of single-pass main condensers should be kept in mind. The first is that the OVERBOARD TEMPERATURE should be about 10° higher than the INJECTION TEMPERATURE. The second rule is that the condensate discharge temperature should be within a few degrees of the temperature corresponding to the vacuum in the condenser. The accompanying chart lists vacuums (based on a 30.00-inch barometer) and corresponding temperatures.

Inches of Mercury	Corresponding Temperature (°F)
29.6	53
29.4	64
29.2	72
29.0	79
28.8	85
28.6	90
28.4	94
28.2	98
28.0	101
27.8	104
27.6	107

Scoop injection systems are designed to provide a sufficient amount of cooling water at speeds of 5 knots and above, with the injection and overboard valves wide open. Ordinarily it

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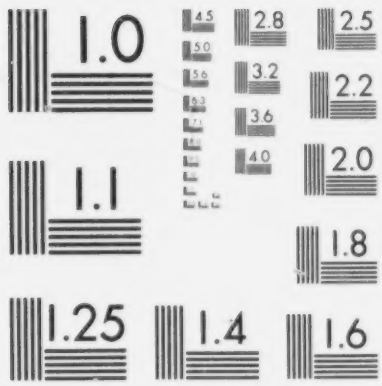

MICROCOPY RESOLUTION TEST CHART

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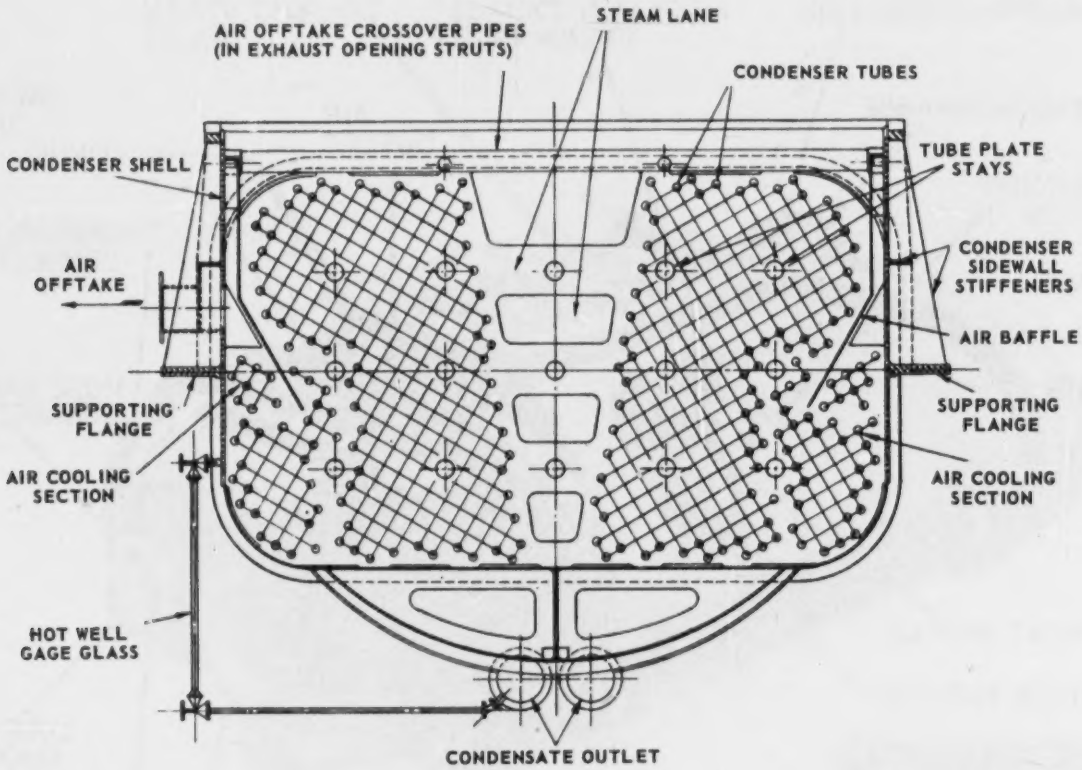

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Figure 8-3.—Cross-sectional view of main condenser.

is not necessary to control the circulating water flow by throttling the valves. If throttling becomes necessary because the ship is in cold waters or because of other unusual operating conditions, the proper valve to use is the overboard valve; the valve should never be more than three-fourths closed. Using the inlet valve to throttle the flow of circulating water would cause turbulence and consequent erosion of the tubes.

If the condenser vacuum is not as high as it should be in relation to the condenser load and the cooling water overboard temperature, some part of the condensing system is not functioning properly. You may find, for example, that the air ejectors are not properly removing air from the condenser, that the condensate pump is not keeping the right condensate level, or that there is an air leak in the condenser or in some other part of the system under vacuum.

The condensate level should be kept as low as possible while maintaining a continuous flow of condensate through the air ejector. It should not rise into the condenser shell. Allowing the level to rise slightly higher than the top of the hot well causes the condensate temperature to be lower than normal because the path for the flow of reheating steam is partially blocked by the condensate. (Reheating steam is the steam which enters the hot well by way of the central steam lane. The central steam lane extends completely through the tube bundle and provides for longitudinal distribution of steam from the exhaust inlet directly to the condenser hot wall.) If the condensate level is allowed to rise to the bottom row of tubes, the flow of reheating steam is further restricted, causing an even greater drop in condensate temperature. At this point, the high condensate level begins interferring with the flow of air toward the air removal areas, thus causing a gradual loss of vacuum. A rapid loss of vacuum, accompanied by a rapid increase in condenser shell temperature and exhaust trunk temperature, results if the condensate level rises to the lower end of the air baffles. This results not only because air removal ceases but also because a large part of the tube bundle is submerged and not available for cooling and condensing the incoming steam. If the condensate level rises and cannot be brought down to normal

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immediately by speeding up the condensate pump or by cutting in an additional pump, the speed of the main engine must be reduced to avoid serious damage to the turbine and condenser.

An adequate flow of circulating water must be provided continuously to an operating condenser. This circulating water cools the steam and causes it to condense. Failure of the circulating water supply causes overheating of the condenser and loss of vacuum. Unless the situation is corrected immediately, steam pressure will build up to the point where it might cause the condenser shell to rupture.

Causes of insufficient circulating water are:

1. Condenser tubes clogged with foreign matter such as fish, seaweed, or mud.
2. Obstruction of injection or discharge sea chests, piping, or valves.
3. Injection or overboard valves not properly adjusted.
4. Inefficient or inoperative circulating pump.
5. Obstructed air vents (condenser vapor bound).
6. Faulty nonreturn valves (flappers) in scoop injection lines or in main circulating pump discharge lines.

Steam or air connections are provided to clear foreign matter from sea chests. Sometimes, however, thick accumulations of marine growth on or around sea valve openings cannot be blown clear. When maximum pressure fails to clear a sea chest, the obstruction must be removed by a diver.

Air vents must be kept open under all operating conditions where air is vented overboard through the hull or where the inlet water chest is vented to the discharge water chest or piping, to minimize air erosion of the tubes and to avoid air-binding. Vents that are piped to the bilges should be kept slightly open at all times when the condenser is in use. As long as a trickle of water escapes, the unit will not become air bound and the circulating water flow will not be obstructed.

Main condenser circulating pumps are provided with a bilge suction which has the largest potential capacity available for pumping engine-room bilges.

If a main circulating pump operates on bilge suction, it should be started the same as for main condenser circulating service, then the main injection valve should be gradually closed and the bilge suction valve opened. When the pump is operating on a high suction lift (as when pumping bilges), the speed should be reduced to approximately 2/3 of rated speed. Pump noise can be minimized by slowing the pump.

AUXILIARY CONDENSERS

Condensers into which turbogenerators exhaust are generally referred to as auxiliary condensers. They operate on the same principle as main condensers. In an auxiliary condenser, however, the cooling water is pumped through the condenser at all times instead of being scoop injected. Also, most auxiliary condensers are of two-pass rather than single-pass construction. Figure 8-4 shows a two-pass auxiliary condenser; the sea water chest is divided into an inlet chamber and a discharge chamber. In other construction features, including the metals used, auxiliary condensers are similar to main condensers.

Auxiliary exhaust steam, beyond that required for units such as the deaerating feed tank and the distilling plants, may be directed either to the auxiliary condenser or to the main condenser. In port, the auxiliary exhaust goes only

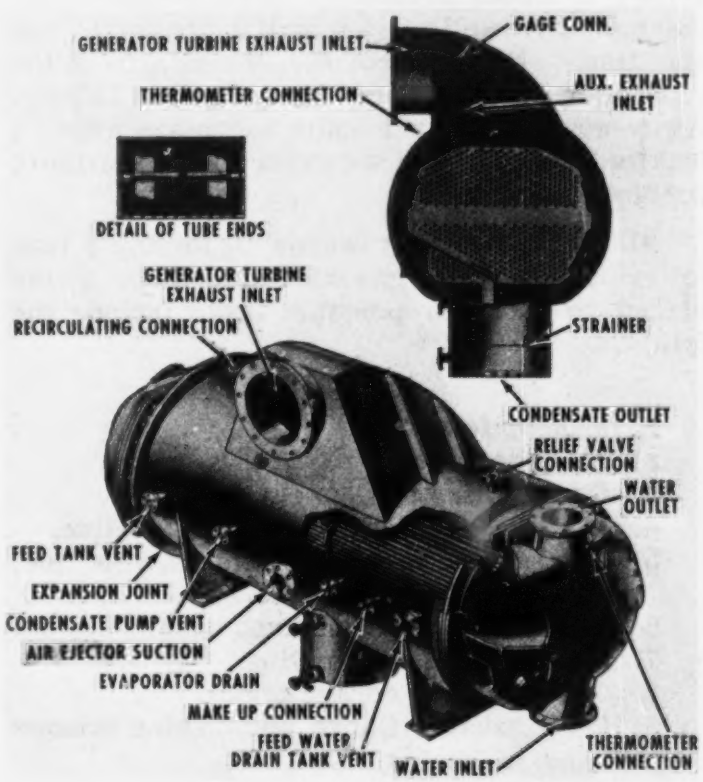

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Figure 8-4.—Auxiliary condenser (turbogenerator).

OUTLINE OF SOCIAL-INDUSTRIAL RELATIONSHIPS

INDUSTRIAL RELATIONSHIPS

Note: The industrial relations, for which every skilled worker must have an understanding and appreciation form a definite part of the instructional program in all of the areas previously outlined.

Some of these are:

Materials of the Trade -- Source, manufacture, distribution, specifications, costs, etc.

Tools -- Operations and processes in this trade that affect the worker and his relationships with other workers.

Working Conditions -- Hours, pay, seasonal employment, health, recreation, morale; workers' responsibility for these conditions.

Health -- Personal and social hygiene; vital facts every worker should know about well-being.

Industrial Development -- Growth of the industry, its scope and trends; other industries that support it; its relationship to other industries; how organized; how supported; importance of time and costs records.

Industrial Organizations -- Trade, labor, and employer; what their functions are on the job; how these affect happiness of the worker.

Shop Relationships -- Those which concern fellow-workers and the "boss" on or off the job; how these affect efficiency and happiness of the worker.

Law and Ordinances -- City, county, or state that affect the worker, his job, trade, and industry; worker's compensation, unemployment, social security, safety.

Public Relations -- Those factors having to do with consumer interests, confidence, honest work, fairness in dealings, loyalty to job.

Personality Characteristics -- Attitudes and habits that should be developed to make a successful craftsman; responsibility as a craftsman and citizen to join with others in promoting better working conditions for all and the civic and social welfare of the community.

Related Occupational Opportunities -- The extent to which this trade opens employment opportunities in related occupations.

inspections and descaling (if necessary) as directed by the engineer officer and by the Naval Ships Technical Manual.

It is absolutely essential that good contact be made between the zincs and the metal of the condenser in order to protect the condenser from galvanic corrosion. Zincs are generally mounted on studs which are welded to manhole plates or water chests. Serrated copper-nickel washers are mounted between the zincs to ensure metallic contact. Split pins are used to prevent the nut from coming loose and damaging the water chest or tubes.

Cleaning Condensers

Foreign matter lodged on the steam side of the condenser tubes interferes with and reduces the rate of the flow of heat from the condensing steam to the circulating water. This, in turn, reduces the maximum vacuum obtainable and lowers the efficiency of the condenser. The lodgment of foreign matter on the sea water side of the tubes is detrimental to the tubes themselves in addition to slowing down the transfer of heat. Frequent visual inspections provide the only safe means of knowing the conditions of condenser fouling.

Grease and dirt on the steam side of a condenser may be boiled out with a strong solution of Navy standard boiler compound. Normally, though, this boiling-out process should not be necessary more than once every 2 or 3 years. (Condensers serving engines may require boiling out operations much more frequently.)

To boil out a condenser, proceed as follows:

1. Drain and clean the sea water side.
2. Close condensate or air pump suction and other valves in the lines connected to the condenser.
3. For each 1,000 gallons of water the steam side of the condenser will hold, make a mixture of 200 gallons of fresh water with 100 pounds of boiler compound. Dissolve the compound thoroughly in hot water and introduce the mixture into the condenser shell.
4. Fill the steam side of the condenser with fresh water to above the top row of tubes unless the water at this height, when brought to the boiling temperature, will enter the turbine exhaust trunk. In such cases the height should be regulated.
5. Introduce live steam into the condenser through the boiling out connection and bring the contents to the boiling point at atmospheric pressure. Care must be taken that the condenser is vented to the atmosphere during this operation and that no pressure is allowed to build up within the condenser shell.
6. Boil out the condenser for about 12 hours at the temperature, or boiling point, mentioned in the previous step.
7. Drain the condenser to the bilges or, preferably, pump the solution overboard if convenient means are available. Care must be exercised that none of the emulsion is admitted to the feed system.
8. Wash out the condenser several times with fresh water, follow by removing an inspection plate near the bottom of the condenser, and hose out all sediment collected in the bottom of the hot well.
9. Test the condenser for leaks.
10. Before and during this boiling out of a condenser, inspection shall be made, by the division officer and the petty officer in charge of the station, of all boiling out and drainage arrangements to provide against accidents, and proper safeguards should be provided for the men engaged in this work. This is of particular importance if it becomes impracticable to drain the solution through regular drainage connections to the bilges, and necessary to drain the hot water and sludge contents by slackening away inspection handhole plates in the hot well. A safer method would be to pump out by using a hose connection.

The SEA WATER SIDE of the tubes should be cleaned as often as necessary; the intervals depending upon the rate at which slime, marine growth, scale, mud, oil, grease, etc., are deposited on the tube walls. The amount of such deposits depends upon existing conditions. Operation in shallow water, for example, may cause this fouling of the tubes. For ordinary cleaning, the tubes can be scrubbed out with a rotating bristle brush, or an air lance may be pushed through them. Another method is to shoot soft rubber plugs (fig. 8-6) through the tubes by means of compressed air or water under pressure.

Care of Idle Condensers

The salt water side of the idle condenser should be kept dry. If the condenser is to be put into active use again in a few days, it may be kept filled and the water should be circulated daily. One exception should be noted: when the ship is anchored in highly polluted waters, the

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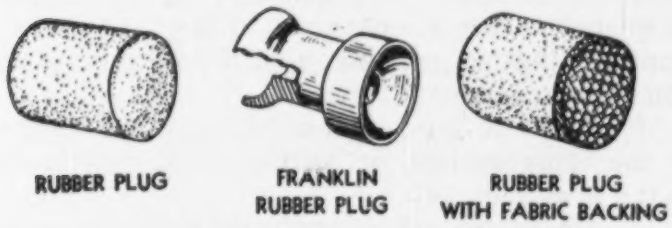

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Figure 8-6.—Types of rubber plugs used for cleaning condenser tubes.

sea water side should be drained and thoroughly washed out whenever the condenser is secured. The steam side of the condenser should always be dry when the condenser is secured.

Whenever the sea water side of a condenser is drained, special care should be taken to ensure that the tubes do not have water anywhere along their lengths. Tubes frequently become sagged and water trapped in these pockets at one or more points along the tube length, if allowed to remain in a drained condenser, will gradually evaporate. The impurities left behind (after the water has evaporated) will corrode the tubes at these points, and in time result in failure. This action is particularly acute when condensers are drained of highly polluted water, generally in harbors. The best method of avoiding this type of tube deterioration, when an ample supply of fresh water is available from a pier, is to water-lance each tube with fresh water in order to wash out the polluted water and remove foreign matter from the tubes. Following the water-lancing operation, the tubes should be air-lanced and left dry until the condenser is again put to service. If the tubes cannot be left completely dry, the sea water side should be left completely filled with fresh water following the cleaning operation.

If sufficient fresh water is not available for water-lancing, each condenser tube should be air-lanced and left completely dry; then the condenser should be inspected daily. If any water tends to collect in the tubes, through condensation from the atmosphere, the air-lancing operation should be repeated, as necessary, to avoid the formation of water pockets at low points along the tubes.

To avoid possible damage to an idle condenser and the associated turbine, see that the valves admitting steam to the condenser, such as the auxiliary exhaust dumping valve, are closed.

Salt Water Leaks

Leakage of sea water into the condensate through even one tube, out of the thousands installed, will contaminate the feed water. Sea water leakage into the system is serious; the entire feed system will salt up and the ship's boilers will become badly damaged as a result.

You may learn that a leak exists by watching the salinity indicator (described in chapter 14 of this training course). The indicator, usually located at a position convenient to the main control station in the engineroom, must be kept in operative condition at all times. Salinity cells must be checked frequently. When the salinity reading goes above normal, action should be taken as soon as practicable to determine the cause.

Objectionable salt water leakage cannot always be detected by the conductivity type salinity indicators installed in the condensate system, because of the large quantity of condensate which generally flows. The first indications of sea water leakage in the active tube length between the tube sheets may be a chloride buildup in the boiler or the steam generator (of newly constructed plants) or, when the plant has been secured, in the hotwell of the idle condenser.

Care must be taken to ensure that the source of chloride contamination is not in the piping connected to the condenser rather than in the condenser tubes. Special attention should be given to these sections of the condensate, drain, or makeup feed piping, normally under vacuum and located in the bilge area. Experience has demonstrated that leakage of bilge water into joints of this piping may occur, and may not be detected until after considerable time and effort have been devoted to a search for a tube leak. Therefore, when a search is instituted for the source of salt water contamination of the condensate, all such piping should be uncovered by lowering the level of water in the bilges, and all joints should be inspected while the condenser and the piping are filled with fresh water under pressure, as described in the paragraphs which follow.

Several test methods designed to locate the source of circulating water leakage into condensers or other heat exchangers are described in the sections which follow and in chapter 9460 (46) of the Naval Ships Technical Manual. The method selected will depend upon the design of the condenser or heat exchanger in question,

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accessibility of its various parts, and availability of the test equipment required. In general, the simplest suitable test should be used first.

Prior to starting any test work, review the "PRECAUTIONS TO BE OBSERVED WHEN TESTING OR CLEANING CONDENSERS." The recommended methods, approved by the Naval Ship Systems Command, used to detect tube leakage, are discussed in the paragraphs which follow.

THE PROCEDURE FOR USING METHOD I IS AS FOLLOWS:

1. Drain the sea water side of the condenser and remove the waterbox inspection plates.
2. Ventilate the sea water side of the condenser.
3. Wash clean the waterbox, tubes, and tube sheets, and dry the tubes and tube sheets by using compressed air.
4. Fill the steam side of the condenser with fresh water of feed water quality, being careful not to flood the low pressure turbine.
5. Inspect the tube ends, since at this point a gross leak may be detected. It is advisable, however, to apply an air pressure, not exceeding 15 psi over the water to ensure that all leaks are located.
6. The sensitivity of this test will be increased by careful drying of the tubes and the tube sheets, and by using warm water to fill the condenser to prevent condensation on the tube sheets and in the tube ends.
7. Additional sensitivity may be obtained by adding an appropriate sea marker dye to the condenser at the rate of 3.0 ounces per 1,000 gallons of water. The dye should be premixed with fresh water to ensure thorough mixing. The tube ends on the circulating water side of the condenser are then inspected by using an ultra violet lamp, or an ordinary flash light, if an ultra violet light is not available.

CAUTION: Sea marker dye contains chlorides. Care should be taken to see that the steam side of the condenser is carefully flushed so that these chlorides do not enter the boiler via the condensate system. In condensers of nuclear power plants, it is preferable to use sodium fluorescein to preclude any possibility of chlorides contaminating the feed system.

If faulty tubes are found, they should be plugged at each end with the tube plugs furnished to the ship. Plugs should be driven firmly into the ends with light hammer blows. If it becomes necessary to plug tube sheet holes after a tube has been removed, it is good practice to install short sections of a capped tube in the tube holes and secure them by expanding prior to inserting tube plugs; this will protect the tube holes from damage. Plugged tubes should be renewed, if possible, at a naval shipyard during the next availability for the ship.

THE PROCEDURE FOR USING METHOD II IS AS FOLLOWS:

1. Drain the condenser circulating water side, and remove the waterbox inspection plates.
2. Place the steam side of the condenser under air pressure not exceeding 15 psi.
3. Slowly fill the circulating water side of the condenser with water. Replace the inspection plates, as the water level nears the openings.
4. Carefully watch the surface of the water adjacent to both tube sheets for air bubbles that will indicate leakage.
5. Gross leakage should be immediately noticeable. Smaller leakage, especially in a tube, requires time and close observation to ensure detection. Note the trim or list of the ship and maintain a close watch of the high end of the tubes. If the drawing of the condenser or heat exchanger indicates that the tubes are bowed, this fact should be considered when inspecting for leakage.

THE PROCEDURE FOR USING METHOD II-A IS AS FOLLOWS:

1. It is often found that there are tubes located above the lower edge of the highest waterbox inspection opening and Method II cannot be used to find a leaking tube in this location. It will be advantageous to install plexiglass or other transparent plates, of 3/8-inch-or-greater thickness, on the upper inspection openings. The plastic plates should be cut to the outside dimensions of the inspection opening flanges and have steel backup flanges conforming to the outside and inside dimensions of the flanges. Soft rubber gaskets should be used.
2. Method II should be followed until the water reaches the lower edge of the upper inspection opening; the plastic plates and backup flanges should be installed, and the circulating water side filled with water. (Fresh water will probably be necessary in harbor areas for good visibility.)
3. If desirable, plastic plates may be installed on all inspection openings instead of only the upper ones; the circulating water side may be filled with water, and the tube ends observed for air bubbles.

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THE PROCEDURE FOR USING METHOD III IS AS FOLLOWS:

1. Drain the circulating water side of the condenser, and remove the waterbox inspection plates.
2. Ventilate the circulating water side of the condenser.
3. Wash clean the waterbox, tubes, and tube sheets, and dry the tubes and tube sheets by using compressed air.
4. Apply a light coat of grease to each tube sheet face. Place pieces of light sheet plastic such as "Saran Wrap" against each tube sheet. Seal the plastic sheet by pressing the material around the tube holes.
5. Using the air ejector equipment associated with the condenser or other available means, obtain the maximum vacuum possible in the steam side of the condenser. For precautions to be observed during this step of the test, consult the applicable technical manual for the equipment served by the condenser.
6. Carefully observe the appearance of the plastic sheet sealing the ends of each tube. A tube leak will be indicated by a star-like puckering or possibly complete failure of the plastic at the ends of the defective tube.
7. If the leak is not detected within the first 30 minutes after a vacuum is obtained in the condenser, a different test method should be used. Continuation of this test for an extended period will usually result in false indications of leakage caused by air pressure changes in the ship.
8. Use extreme care in removing the plastic sheet from the tube sheets. Using a hot water hose, remove as much grease as possible from the tube ends and tube sheets.

METHOD IV is the suggested method to use to detect minute leaks in the condenser which cannot be detected by simpler means. This method is particularly applicable to condensers of recently constructed plants in which chloride contamination of the steam generator cannot be tolerated; therefore, extraordinary means must be taken to eliminate salt water leaks. This method requires much time, labor, and special equipment (a limited amount of which is available upon application to the Naval Ship Systems Command, and certain equipment may be available at naval shipyards and other repair facilities).

Method IV consists of two distinct tests known as Test A and Test B, designed respectively to determine whether the condenser is leaking and, if so, the location of the leak.

The object of Test A is to determine the tightness of the condenser and, depending upon the access available, to inspect the steam side of the condenser to acquire knowledge as to the general location of the leak. This test consists of pressurizing the sea water side of the condenser using fluorescent dye and water mixture while inspecting the steam side of the condenser, using ultra violet light. During this test, the waterbox flanges and the piping in the bilge will also be inspected by using ultra violet light.

The object of Test B is to locate a leaky tube. It consists of pressurizing internally a group of tubes and monitoring the pressure drop in each tube, using nitrogen gas at 500 psig.

Four possible sources of salt water leakage into the condenser are as follows:

1. At a tube end, due to leakage between the external tube wall and the tube sheet, or through the tube packing. This can be discounted in the case of double tube sheet condensers such as are used in condensers in newly constructed ships.
2. Through a small hole in a tube.
3. Via a path under a water box tube sheet-flange gasket, the clearance holes in the flange bolting, and under the tube sheet-shell flange gasket into the condenser shell. In double tube-sheet condensers in which the inner steel-tube sheet is welded to the shell, thus eliminating the gasketed joint, this possibility is eliminated.
4. In the piping, or joints thereof, connected to the condenser and normally under vacuum, and which are sometimes submerged in the bilge.

Additional information concerning Test A and Test B services, materials, and equipment required to perform these tests, can be obtained from chapter 9460 (46) of the Naval Ships Technical Manual.

METHOD V is used for detecting salt water leaks in double tube sheet condensers where joint leakage occurs in the tube to the outer tube sheet. THE PROCEDURE FOR USING METHOD V IS AS FOLLOWS:

1. Close the condenser main injection, the overboard valves, and the main circulating pump suction valve. Take necessary steps to ensure against their unauthorized opening.
2. Open the waterbox drain and vent connections, and drain the sea water side of the condenser.

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3. Attach a pump, capable of developing a head equal to the hydrostatic test pressure for this space, to the double tube sheet drain connection. Fill the double tube sheet space with water of secondary system quality.

4. Plug or cap the vent from the space between the double tube sheet.

5. Pressurize the double tube sheet space to the hydrostatic test pressure.

CAUTION: In some designs this double tube sheet space should NOT be pressurized unless the waterbox is installed. This requirement is based upon the need for the additional strength, in accordance with manufacturer's instructions, offered by the waterbox bolting and the waterbox flange.

6. Carefully dry the face of the outer tube sheet, and inspect the end of each tube for indications of leakage.

7. Reroll any tube to tube-sheet joints found leaking.

CONDENSER SAFETY PRECAUTIONS

The following safety precautions should be observed in relation to all steam condensers in the engineering plant:

1. Make every effort to eliminate air leaks through all parts of the system that operate under vacuum.

2. Do not subject sea water chests to pressures in excess of 15 psig.

3. Lift by hand and examine water chest relief valves whenever condensers are secured.

4. To detect salt water leaks, constantly check the salinity indicator.

5. Keep baffle plates in place under steam inlets to condensers, and keep them in good condition.

6. Keep the required number of zincs in place, and ensure that they always have good metallic contact.

7. Slow down or stop the engine if a loss of vacuum is accompanied by a hot or flooded condenser.

8. Do not allow water to accumulate in the condenser and overflow into the turbine.

9. Keep condensers clean and tight.

10. Before the salt water side of a condenser is opened, close all sea connections tightly and secure them against accidental opening.

11. Bring no open flame (or anything which will cause a spark) close to a newly opened condenser, until after the condenser has been thoroughly blown out with steam or air. Hydrogen or sewer gas may be present.

12. Renew deteriorated tube packing before it reaches such a condition that removal is difficult.

13. When setting-up on ferrule-type tube packing, do not exert so much pressure that the tube end is necked or crimped; however, screw down the ferrules enough to keep them from backing out.

14. Be careful not to damage tube sheets when repairing tube ends or renewing tubes.

15. Keep condenser tubes clear of foreign matter.

16. Keep salt water sides of idle condensers dry, especially when the ship is in polluted waters.

17. Keep the steam side of secured condensers drained.

18. Keep the salt water sides of condensers in use free from air.

19. When boiling out and draining condensers, see that necessary safeguards are provided to protect yourself and others against being scalded.

20. Keep salinity indicator systems in constant operation.

21. Test the main circulating pump bilge suction, when directed by the engineer officer. To conduct this test, it is generally necessary only to start the main circulating pump, open the bilge suction line stop or check valve, and then close down on the sea suction line valve to about 3/4 closed, or until the maximum bilge suction capacity is obtained.

OTHER HEAT EXCHANGERS

Some of the other various heat exchangers in use aboard ship are discussed throughout this training course in relation to the specific systems of which they are a part. Information on some other shipboard heat exchangers is given in the following sections.

DEAERATING FEED TANKS

Deaerating feed tanks serve three purposes: (1) to free the condensate of oxygen and other noncondensable gases, (2) to heat the feed water, and (3) to act as a reservoir in which to store water to take care of fluctuations in feed water demand or condensate supply. Deaerating feed tanks "scrub" the feed water free of air by use of spray nozzles. The feed water is heated by direct contact with auxiliary exhaust steam.

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Deaerating feed tanks generally operate at 15 psi and at approximately 250° F. The water is kept just under its boiling point at the operating pressure so that it will not flash into steam.

A deaerating feed tank is shown in figure 8-7. Condensate enters the tank through the tubes of the vent condenser and then flows to the spray head. It is forced out through multiple spring-loaded spray nozzles in the spray head. The nozzles are designed to open at a very low pressure and to maintain good atomization even at very low loads. The water leaves the spray nozzles in a very fine spray and is discharged throughout the steam-filled upper section of the tank. The water is heated and scrubbed by the steam and releases some oxygen. The water, partially heated and deaerated, then falls into a cone-shaped baffle which conducts it to a central port. Here the steam coming into the deaerating unit picks up the water and throws it radially outward and upward against the lower side of the conical baffle. In this process, the water and

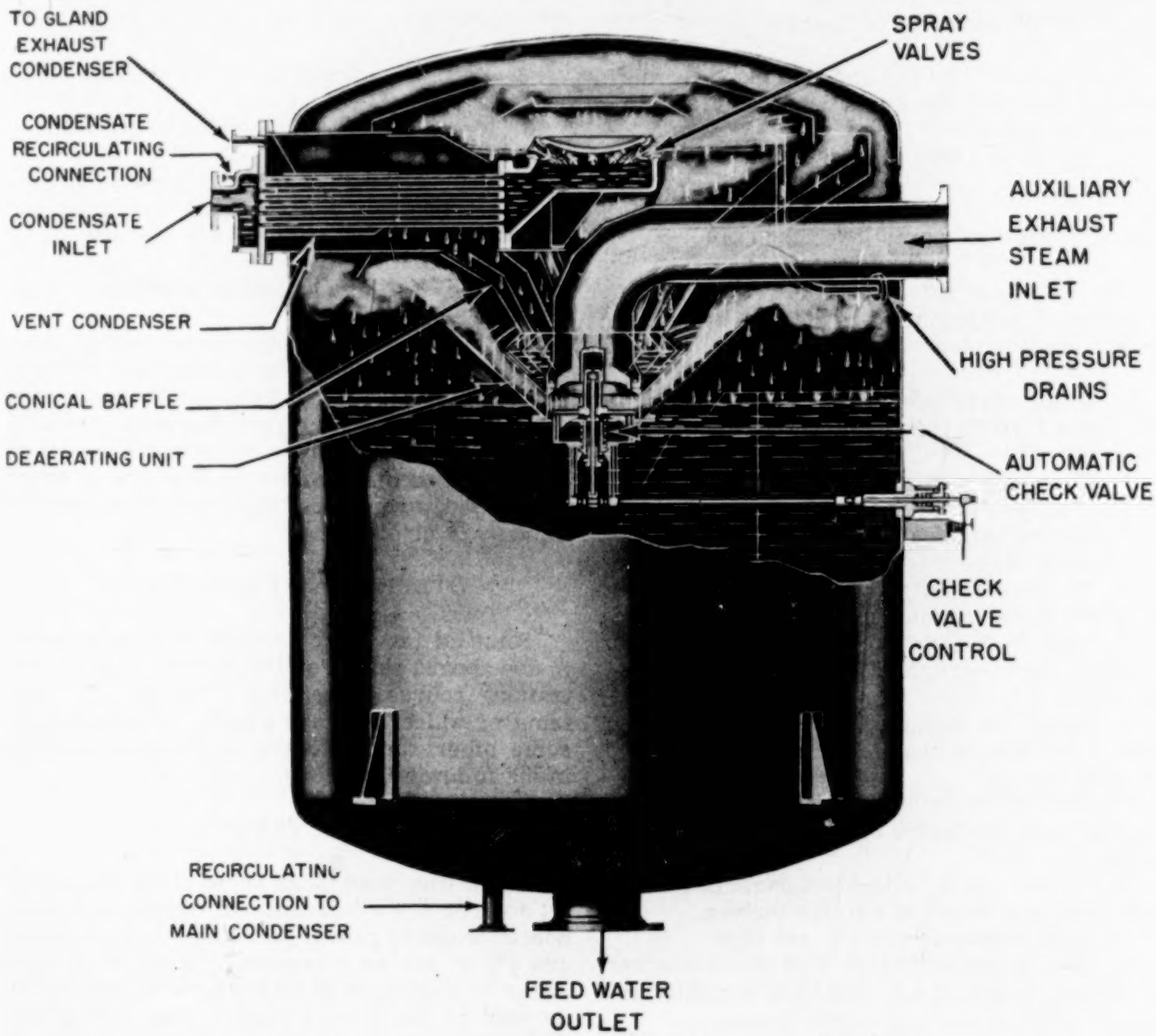

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Figure 8-7.—Elliott type deaerating feed tank.

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steam are so thoroughly mixed that the water is heated to practically the same temperature as the steam, and the dissolved gases in the water are removed. The deaerated water then falls into the storage space at the bottom of the tank, where it remains under a blanket of air-free steam until it is needed for the boilers.

Steam sweeps the air from the deaerating feed tank. The mixture of steam and air travels across the vent condenser tubes, where most of the steam is condensed into water which drops back into the deaerating tank. The air, together with any remaining steam is vented to the gland exhaust condenser.

The steam control valve remains wide open during normal operation and the flow of steam into the tank is controlled by the rate of condensation. Normally the pressure drop between the auxiliary line and the deaerating feed tank will be 1/2 psig or less. At low loads, the water overflowing the cup-shaped recess fills the space within the conical baffles. This causes a cessation of steam flow until the tank pressure has decreased, because of condensation, to a point where the pressure drop is great enough to allow steam to blast through the water in the helical baffles. At high loads, the rate of steam flow is great enough to prevent accumulation of water in the baffles; the steam drives the water out as it overflows the cup-shaped recess.

A shaft extends from the steam valve through the side of the tank; the shaft has a lever attached to it. When the lever is thrown in one direction, it presses a collar against the check valve and forces it to the fully closed position. When the lever is thrown in the opposite direction, another collar forces the check valve to the wide open position. When the lever is in the center position, the check valve is free to operate automatically.

Operation

During normal operation, the only control necessary is maintaining the proper water level. The maximum water level, beyond which the unit should never be operated, is shown in figure 8-8. If the water level is too high, the tank cannot properly remove the air from the feed water. A low water level may endanger the main feed booster pumps, the main feed pumps, and the boilers.

Deaerating feed tanks remove gases from the feed water by using the principle that the solubility of gases in feed water approaches zero when the water temperature approaches the boiling point. During operation, steam and water are mixed by spraying the water so that it comes in contact with steam from the auxiliary exhaust line. The quantity of steam must always be proportional to the quantity of water, otherwise, faulty operation or a casualty will result.

In most deaerating feed tanks, the manhole provides access for the inspection of spray nozzles; other tanks are so designed that the spray nozzle chamber and the vent condenser must be removed in order to inspect the nozzles.

Auxiliary exhaust steam flows directly into the deaerating unit. A check valve either in the deaerating tank, or in the line leading to the tank, allows the steam to flow from the auxiliary exhaust line whenever the pressure inside the deaerating tank is less than the pressure in the exhaust line. The check valve also prevents the return flow of water into the auxiliary exhaust line, in the event that the deaerating tank becomes flooded.

START-UP.—A secured deaerating tank must be kept isolated from the feed water system and its contained water must be deaerated before the tank is put into service. If the tank is empty, it may be filled by means of the emergency feed pump, taking suction from a reserve feed tank and discharging to the condensate line, or in some installations, discharging directly to the deaerating tank. During this operation, the auxiliary exhaust must be cut in to the deaerating tank to heat and deaerate the feed water.

In warming up a deaerating tank, the steam and water supply valves should be opened slowly to avoid sudden temperature changes in the tank. When the tank is filled to the normal operating level, a feed booster pump should be started to recirculate the water from the deaerating tank, through the booster pump and then through the vent condenser, or directly back to the DFT, depending on the class ship. It will take about 10 minutes for this recirculation to heat the water in the tank. The deaerating tank should be operated at normal operating temperature and pressure for a minimum of 10 minutes before it will be ready to be put into service.

When the deaerating tank is fully warmed up, and before it is cut into the feed system, the valve in the warming up line should be closed slowly. The starting line should be closed during all normal operating. The main feed pump recirculating line is relied on to protect the booster pumps and the feed pumps. If the starting up line

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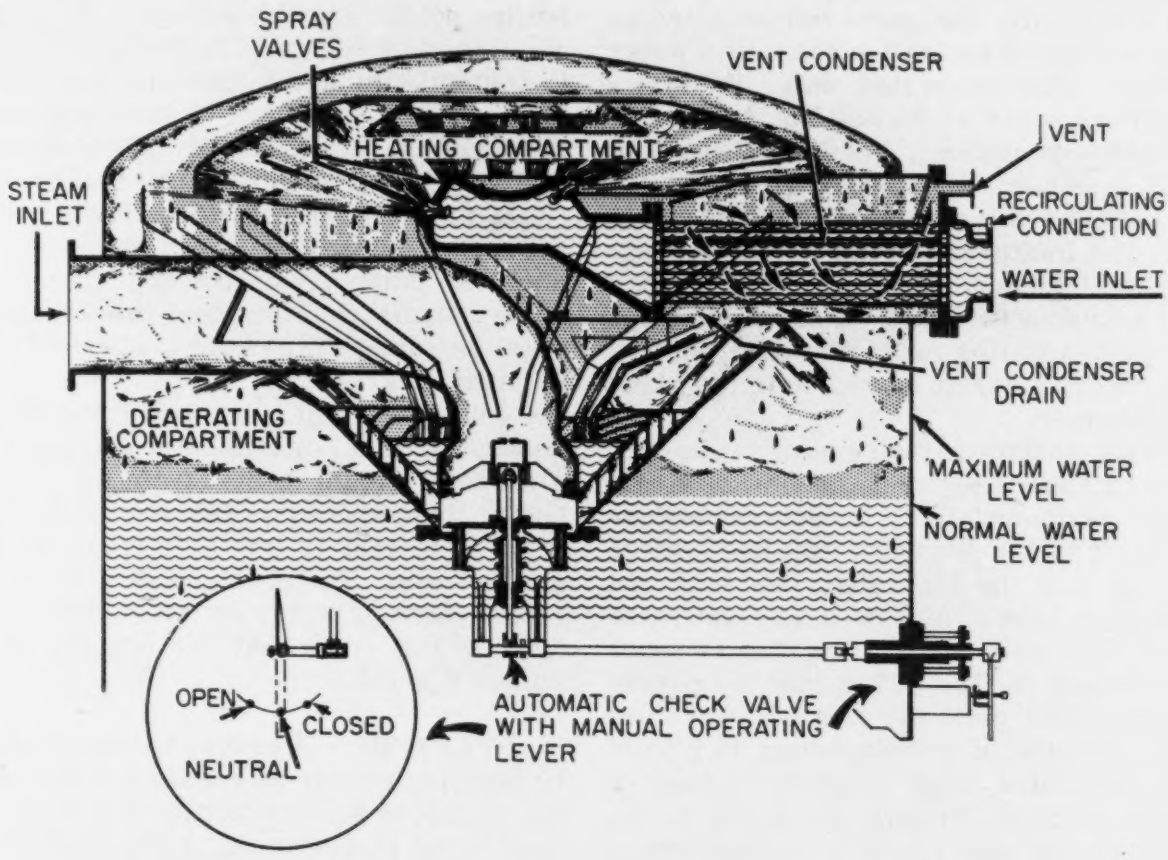

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Figure 8-8.—Deaerating feed tank (diagrammatic arrangement).

is left open during operation, it could reduce the main feed pump suction pressure below that required.

UNDERWAY.—In order to have effective deaeration, it is necessary to vent sufficient steam from the deaerating feed tank to sweep out all air which has been separated from the feed water. This separated air is continuously concentrated in the uncondensed portion of the steam, as the steam passes through the deaerating unit, preheater, and vent condenser. If all the steam were condensed in the vent condenser, the separated air would again mix with the condensate.

The amount of vented steam is controlled by an orifice installed in the vent line of the vent condenser. The vent line orifice must be large enough so that the minimum quantity of steam-air mixture necessary for proper deaeration is discharged when the minimum operating pressure exists in the deaerating tank.

A vent condenser, showing the path of gases into the unit, is shown in figure 8-9.

SHUTDOWN.—In securing the deaerating tank, the vent valve should be opened before the water supply is secured. When securing the water, the pressure in the tank should not be allowed to build up. Should the tank pressure rise too high for normal operation, due to some external means (high pressure drains), a recirculating connection, leading from the base of the tank into the main condenser, provides increased circulation through the tank. This recirculating connection enables the water to be discharged back into the tank, after it has been cooled by the condenser, thereby causing a reduction in pressure and temperature within the tank. Except in an emergency, the steam must not be secured before securing the water, the tank will be filled with cold water that is not deaerated. Under normal securing conditions, the vent should be shifted from the gland seal

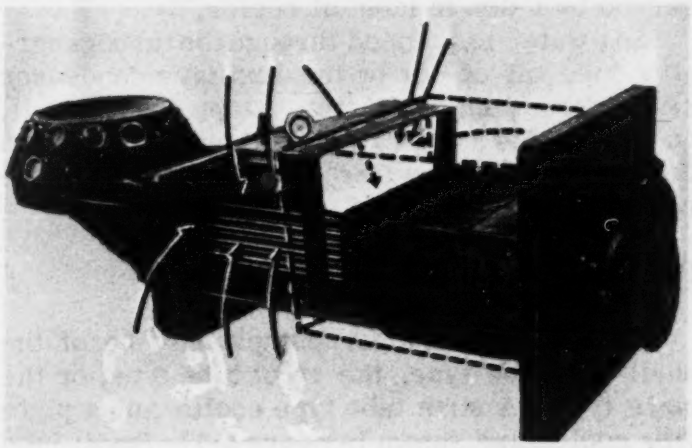

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Figure 8-9.—Vent condenser, showing path of gases.

condenser to the atmosphere; if this is not done, the gland seal condenser will overheat.

MAINTENANCE

Deaerating feed tanks must operate effectively to provide a continuous supply of oxygen-free water for the boilers. Effective operation depends primarily on the operation of the spray valves. The spray valves should be tested at least once each 6 months.

Complete information on constructing and using a test rig for spray valves can be found in chapter 9560 (56) of the Naval Ships Technical Manual. This rig is available at all repair activities ashore and afloat. When testing spray valves with this rig, the following items should be carefully checked:

1. The spray valve must be fully open or completely shut. Any leakage indicates faulty operation which will seriously affect deaeration. If leakage does exist, the valve should be examined for scored or damaged seats or improper spring tension.

2. When the valve opens, the spray should be a complete cone. Any other form of discharge is a positive indication of faulty operation. An incomplete cone indicates cocking of the disk which may be caused by a defective spring.

3. All valves should open at the same pressure to avoid leaving gaps in the spray area. The valves and seats should be free of deposits and should operate freely in any position.

4. When test procedures described in the Naval Ships Technical Manual are used, the results will not be definitive, however, they will indicate MAJOR malfunctioning of the unit. All naval shipyards have the equipment and personnel to perform proper tests for more positive results. For any test results to be of value, all testing should be accomplished with samples taken from an operating deaerating feed tank feeding a steaming boiler.

In the construction of deaerating feed tanks, as many parts as possible are welded together, but some bolts and nuts are used. When parts are assembled, all nuts should be secured with split pins. Split pins must be of a corrosion-resistant metal such as Monel or stainless steel. Ordinary steel will corrode too rapidly to give satisfactory service.

A screen is installed in the bottom of the deaerating feed tank (booster pump suction) so that if an internal part of the tank should come loose, or if metal from the condensate or steam system should enter the tank, the screen will prevent the part from entering the booster pump suction.

A MANHOLE in the shell provides access to the interior of the tank. All removable parts of the tank section are small enough to be taken out through this manhole.

The vent condenser can be removed as a unit by breaking the flanges on the condensate inlet, the vent line, and the recirculating line, then removing the vent condenser flange bolts and pulling the vent condenser out. The spray chamber and spray nozzles are attached to the vent condenser and are removed as a unit.

For safety purposes, all deaerating feed tanks are equipped with two spring-loaded relief valves. One is to prevent a high pressure from accidentally building up inside the tank, and the other, called a vacuum breaker, is to prevent a high vacuum from developing inside the tank. The vacuum breaker allows atmospheric air to enter the tank whenever the vacuum exceeds a predetermined amount.

The steam control valve automatically controls the amount of steam admitted to the deaerating tank. There are many different arrangements of these valves; this publication does not contain information on the repair procedures for each type. For complete information on each type of steam control valve, refer to the manufacturer's technical manual for the specific installation.

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SOCIAL RELATIONSHIPS

Note: The skilled worker also appreciates the contribution which his work can make in the areas of health, effective services, and general social and public relations. Such development forms a definite part of the instructional program.

Some of this instruction is along the following lines:

The individual in relation to special observances and current events

The individual -- a member of varying social groups (home, social, club, church, etc.)

The individual in his leisure time

The individual in his inner life and development of character

The individual worker in a trade or occupation presenting distinctive opportunities

The individual worker in relation to specific jobs, economic issues, and problems

The individual in relation to major civic and social issues

The individual in occasions of special personal government services

The individual in a legally constituted state

The individual worker in relation to specific jobs involving the lives of others

The individual worker in relation to specific jobs involving the safety of fellow workmen

The individual worker in relation to specific jobs involving the happiness and contentment of others

GLAND EXHAUST CONDENSER

In order to recover the steam expelled by the turbine glands and the deaerating feed tank, a gland leak-off and vent and drain system is installed. By means of this system the recovered steam is returned to the feed system in the form of condensate. The gland leak-off steam is led to the GLAND EXHAUST CONDENSER, where the vapors are condensed and led to the fresh water drain collecting tank. Air is drawn off from the gland exhaust condenser by a gland exhaust fan which discharges in the vicinity of an exhaust vent.

MAIN LUBE OIL COOLERS

Main lube oil coolers are usually of the shell-and-straight-tube type and may be of single-pass or multipass construction. In modern naval ships, the main lube oil coolers are installed horizontally, as illustrated in figure 8-10. The size of an oil cooler depends upon the quantity of heat that must be removed per unit of time from the lube oil in order to maintain proper bearing temperature.

The lube oil cooler consists of a cylindrical shell with a header at each end. Inside the shell is a bundle of straight, copper-nickel tubes through which the cooling water flows from one header to the other. Hot lube oil enters at the top of the shell, at the end opposite the water outlet, and flows across the tubes and around the annular jacket. The cooled oil comes out of the top of the cooler at the other end, near the water inlet. The baffles and tube support plates direct the oil flow. Inside each header, a zinc is secured to protect the metal surfaces of the cooler against galvanic corrosion.

On older ships, a bypass valve is installed in the oil inlet line to the cooler. The purpose of this bypass is to isolate the cooler in event of a cooler casualty. On more recent ships, this bypass has been omitted.

On the upper surface of the lube oil cooler is a steam connection used for warming up cold lube oil prior to getting under way.

TURBOGENERATOR LUBE OIL COOLERS

Turbogenerator lube oil coolers are similar to main lube oil coolers in construction. A three-way selector valve is placed in the oil line to route oil through the cooler or to bypass oil around the cooler. Each turbogenerator is served by a single lube oil cooler.

Sea water is pumped through the turbogenerator lube oil cooler by the auxiliary condenser circulating pump. If this pump should fail, cooling water may be taken from the firemain through a cooling water reducer which can be regulated to the desired pressure.

PUMP LUBE OIL COOLERS

Lube oil coolers for pumps may be of the shell-and-tube type, the strut tube type, or the plate type. A strut tube type cooler and a plate type cooler are shown in figure 8-11. Small lube oil pump coolers are usually multitube single-pass coolers. In some, the water flows through the tubes and the lube oil flows through the shell; in others, the water flows through the shell and the lube oil flows through the tube.

Part A of figure 8-11, shows a strut tube type oil cooler in which the water passes through the tubes. In this cooler, heat transfer is accelerated by stamped dimples in the strut tube plates. The strut tube plates are assembled so that the convex sides of the dimples touch.

Part B of figure 8-11 illustrates a plate type oil cooler for a pump. In this type of cooler the lube oil passes through the tubes. The grid distributor strip accelerates the transfer of heat from the tubes.

Strut tube coolers and plate tube coolers have replaceable core assemblies, and several spare core assemblies are usually carried on board ship. In practically all cases of failure of these types of coolers, core replacement is all that is required to correct the trouble. It is seldom necessary to replace the entire cooler.

AIR COOLERS

Air coolers are installed on shipboard propulsion motors and generators to keep them from overheating. The air cooler is connected to the air intake and air discharge openings of the motor or generator by suitable ducts. The only characteristic difference between a lube oil cooler and a propulsion motor or generator air cooler is that the latter is of double-tube construction with the outer tubes having high fins.

The air cooler consists of double-wall fin tubes through which the cooling water flows. The ends of the tubes at the front and rear of the cooler are enclosed by headers. Cooling

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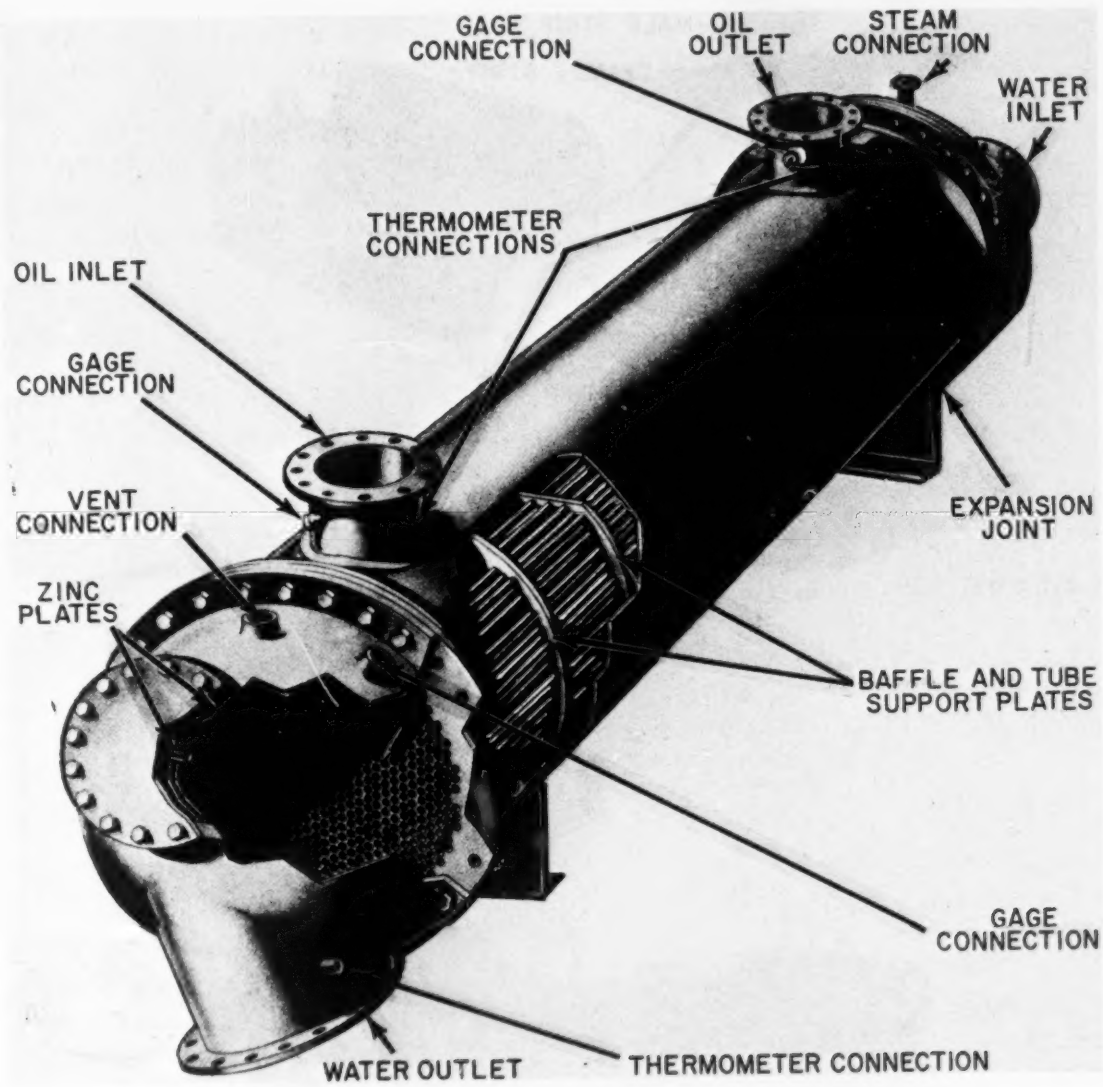

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Figure 8-10.—Main lube oil cooler.

water may make one or more passes through the cooler. Hot air from the motor or generator passes through the air cooler tube bank in a path perpendicular to the tubes (fig. 8-12).

The water tubes are of double-wall construction. The inner tube is of a copper-nickel alloy (5/8-inch OD) and the outer tube is made of brass (3/4-inch OD) or other nonferrous material. The smooth-surfaced inner tube carries the cooling water. The outer tube has internal longitudinal ribs or lands which make contact with the outer surface of the inner tube. The internal ribs of the outer tube and the cooling fins mounted on the outside surface of the outer tube facilitate the transfer of heat to the cooling water.

Failure of an inner tube can be detected by water leaking from the telltale drains in the front and rear headers.

At the bottom of the front header, and to the right of the leakage drain plug, is a connection for draining water from the cooler. At the top of the front and rear header is a vent plug. These air relief plugs should be removed whenever the cooler, after having been drained of water, is to be refilled. The plugs should be removed from the telltale drain system to allow

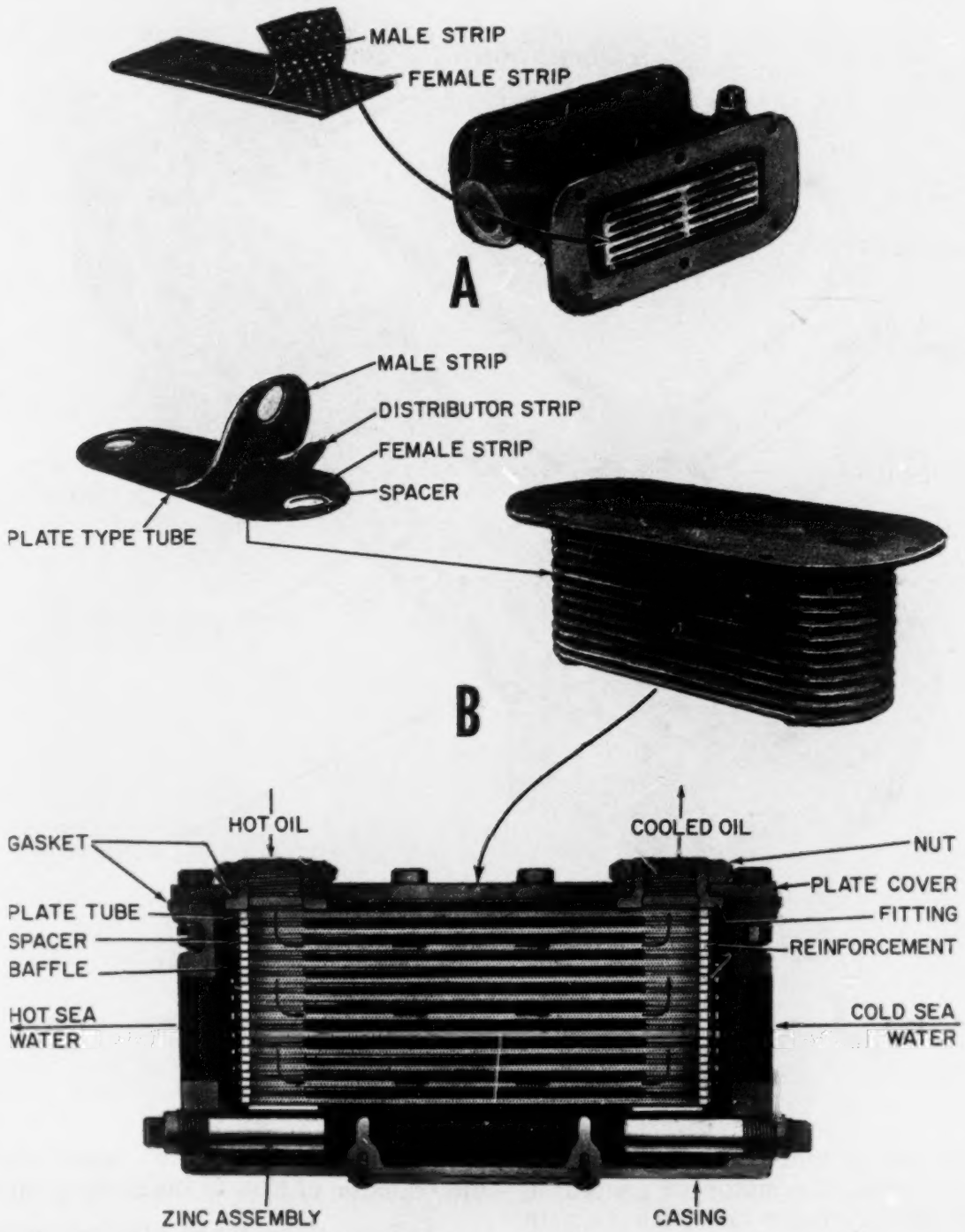

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Figure 8-11.—Oil coolers for pumps. A. Strut tube type oil cooler. B. Plate type oil cooler.

detection of leaks from the tube section of the cooler.

AIR EJECTORS

The function of an air ejector is to remove air and other noncondensable gases from the condenser. An air ejector is a type of jet pump, containing no moving parts. The flow through the air ejector is maintained by a jet of high velocity steam passing through a nozzle (fig. 8-13). The steam is taken from the 600 psi and the 150 psi auxiliary steam systems on most ships.

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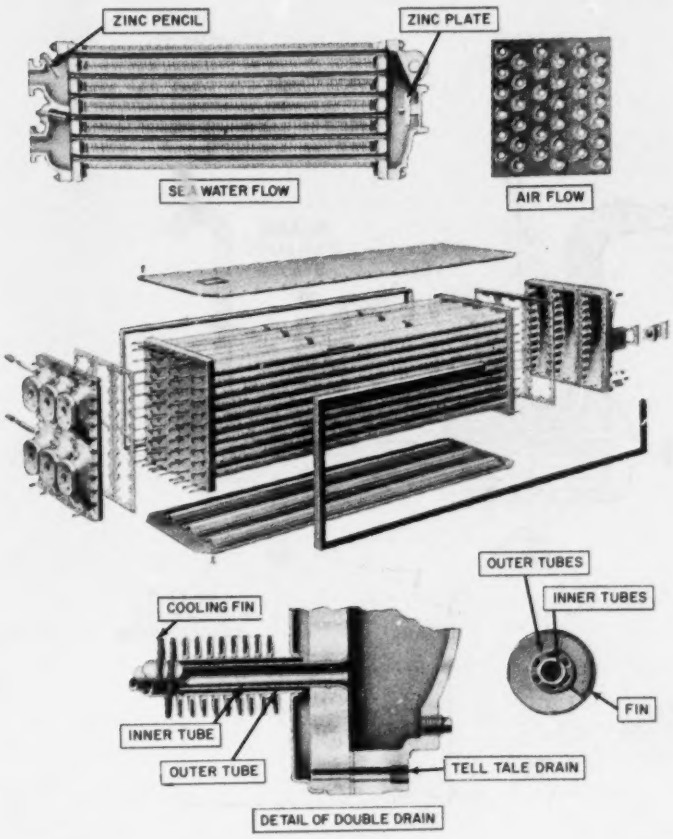

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Figure 8-12.—Air cooler for a motor or generator.

The air ejector assembly used to remove air from the main condenser usually consists of a first-stage air ejector, an inter condenser, a second-stage air ejector, and an after condenser.

In most ships, however, the first and second stages of the air ejectors and their condensers have been combined into one complete assembly, such as is shown in figure 8-14. In many ships, the gland exhaust condenser has been incorporated within the shell of the after condenser. The shell is rectangular, and is divided by a longitudinal plate into the intercondenser and the after-condenser sections. A baffle at the gland vapor inlet deflects the air and vapor downward over the lower bank of tubes in the after-condenser section.

In order to provide for continuous operation, two sets of nozzles and diffusers are furnished for each stage of the air ejectors. Only one set is necessary for operation of the plant; the other set is maintained ready for use in case of damage or unsatisfactory operation of the set in use. The two sets can be used simultaneously when excessive air leakage into the condenser necessitates additional pumping capacity.

An inter stage valve is provided between the discharge of each first-stage ejector and the inter condenser so that the pressure built up by the first-stage jet, in operation, will not be lost back to the condenser through the idle first stage. For a similar reason, a cutout valve is located between each second-stage suction chamber and the inter condenser. By means of diaphragm plates in the inlet and outlet heads, the cooling water (condensate) is forced to make several passes through the unit before being discharged.

The atmospheric vent is usually connected to the suction of a small motor-driven fan (gland exhauster), which provides a positive discharge through piping to the atmosphere above decks. This is necessary to avoid filling the engineroom with steam should the air ejector cooling water supply fail, thereby allowing the steam to pass through the inter condenser and after condenser without being condensed.

PRINCIPLES OF OPERATION

The first-stage air ejector takes suction on the main condenser and discharges the steam-air mixture to the inter condenser, where the steam content of the mixture is condensed. The resulting condensate drops to the bottom of the inter condenser shell, and from there it drains to the main condenser through a U-shaped loop seal line. The air passes to the second-stage air ejector suction.

In the second-stage air ejector, another jet of steam is used. The steam-air mixture is now discharged into the after condenser, where the steam is condensed and the air is vented to the atmosphere. (Normally, the air is vented to the atmosphere by way of the gland exhaust condenser; however, in some installations it is vented directly to the atmosphere from the air ejector after condenser.)

Condensate from the main condenser is used as the cooling water in the air ejector inter and after condensers. The air ejectors remove air only from the condenser, not from the condensate.

The inter condenser is under vacuum of about 26 inches of mercury. The after condenser is at approximately atmospheric pressure.

To assure sufficient cooling water for proper operation of the air ejectors when raising vacuum, standing by, and at fractional power (cruising), a condensate recirculating line and valve are installed at the cooling water outlet

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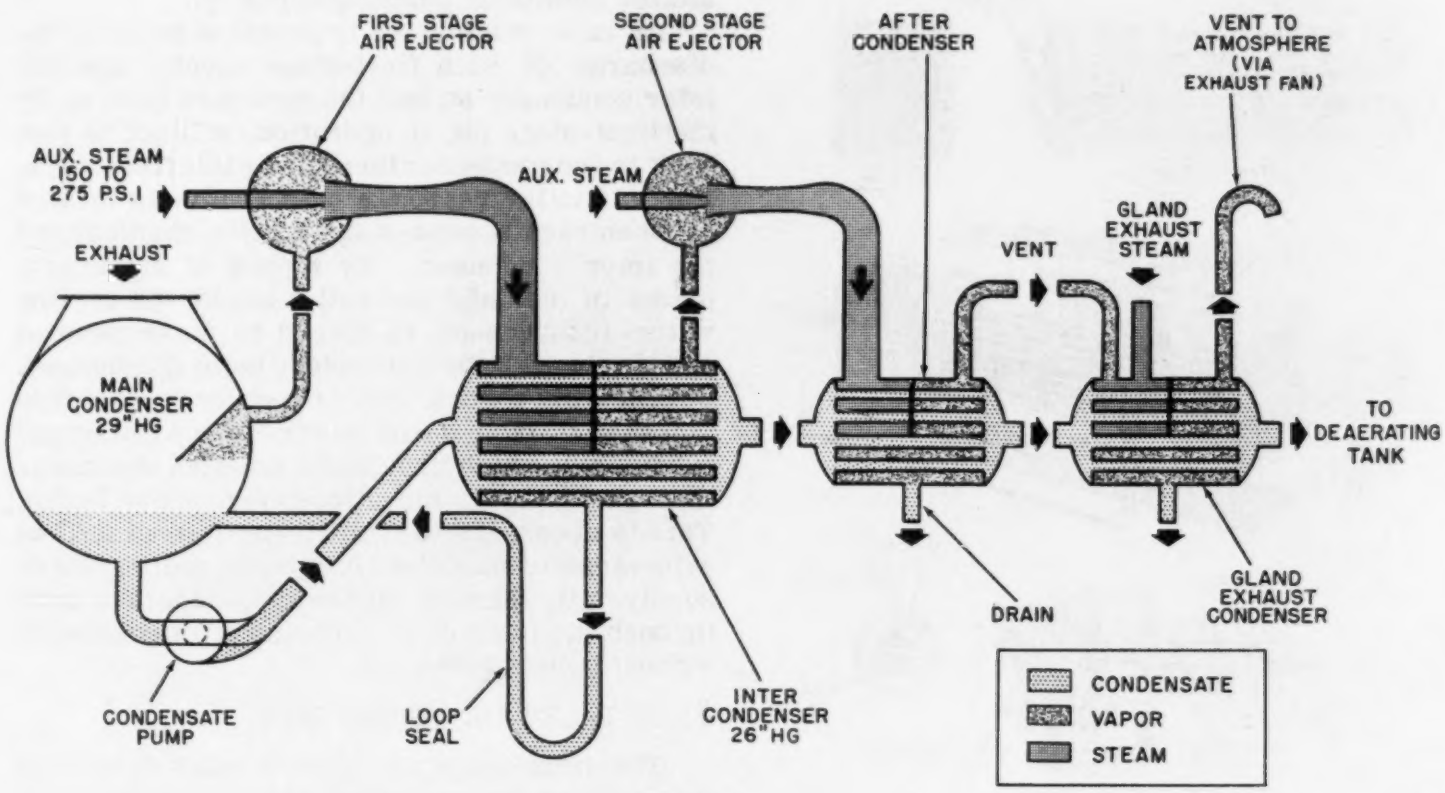

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Figure 8-13.—Flow diagram of a two-stage air ejector.

from the after condenser or on the vent condenser inlet header. To make recirculation automatic, and to avoid overheating of the air ejector condenser, most air ejector recirculating lines are fitted with thermostatically controlled valves, discussed in chapter 7 of this training course.

A manually controlled valve allows bypassing of the thermostatic recirculating valve during the warming-up period. This bypass valve is also used in case the thermostatic valve is inoperative. When the required condenser vacuum is obtained, the manually controlled bypass valve is secured. Under normal operating conditions, recirculation to the main condenser at light loads is automatically controlled by the thermostatic recirculating valve.

As previously noted, the condensate formed in the inter condenser is returned to the main condenser through the loop seal. If there was a direct connection between the inter condenser and the main condenser, the vacuum would be equalized in the two condensers. Since the main condenser carries a higher vacuum than the inter condenser, it is necessary that some form of seal be maintained in this drain line to prevent this equalization of vacuum. A water level in the U-shaped loop seal line provides this seal.

STARTING AIR EJECTORS

Manufacturers' technical manuals are furnished to provide information on the proper operation of all air ejector installations. The procedure for starting the air ejectors is usually as follows:

1. Start circulation of condensate cooling water through the condenser.
2. Open the valves in the drain lines, from the inter and after condensers.
3. Check the valves in the pressure and vacuum gage lines to be sure they are open.
4. Lift relief valves by hand.
5. Open the second-stage discharge valve.
6. Drain the steam supply lines to the air ejector assembly.
7. Cut in the steam to the second stage. (Be sure that the steam is at or slightly above designed pressure.)

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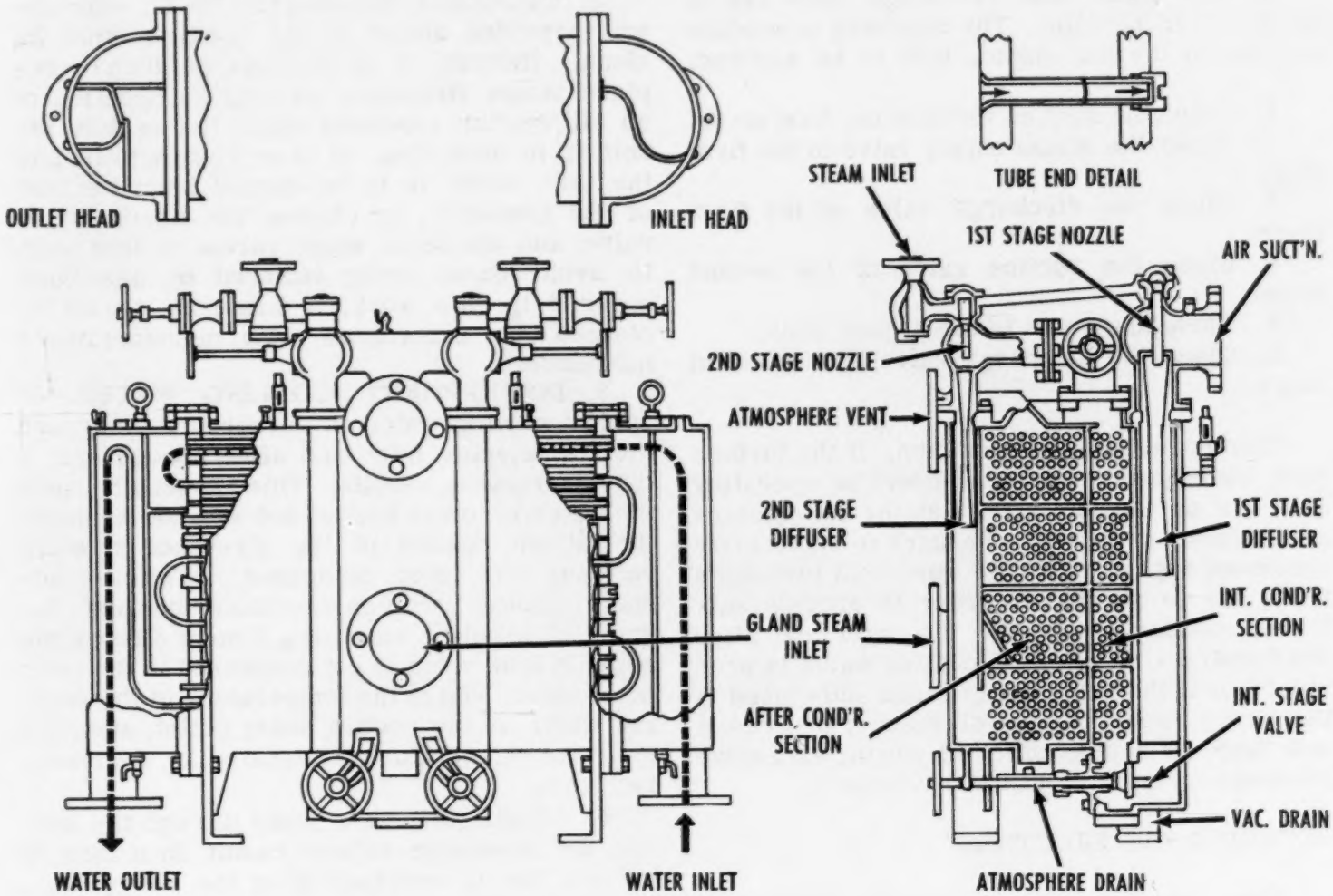

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Figure 8-14.—A main air ejector and condenser assembly.

8. Open the second-stage suction valve.
9. When the main condenser vacuum reaches 20 inches (or when ordered by the officer of the watch), open the first-stage discharge valve.
10. Cut in the steam to the first stage.
11. Open the first-stage suction valve.

Upon completion of the preceding procedure, the ejector should be in full operation and the main condenser vacuum should rapidly rise to that normally obtainable under standby conditions.

Discharge valves should always be opened before steam is admitted to the air ejector nozzles, and the steam supply should always be shut off before the discharge valves are closed.

After an air ejector has been started properly, it requires very little attention. It is necessary to (1) supply dry steam at designed pressure, (2) provide sufficient cooling water through the air ejector condenser tubes, (3) maintain proper drainage of the inter and after condensers, and (4) maintain a proper water level in the loop seal line.

SHIFTING AIR EJECTORS

Should it become necessary or desirable to shift from one two-stage air ejector unit to another while an air ejector unit is in operation, the procedure is as follows:

1. Open the discharge valve of the standby second stage.
2. Open the second-stage steam inlet valve.
3. Open the second-stage suction valve.
4. Open the first-stage discharge valve.
5. Open wide the steam inlet valve to the first-stage nozzle.
6. Open wide the suction valve of the first-stage element.

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At this point both two-stage units are in operation in parallel. The following procedure applies to the air ejector unit to be secured:

1. Close the suction valve of the first stage.
2. Close the steam supply valve to the first stage.
3. Close the discharge valve of the first stage.
4. Close the suction valve of the second stage.
5. Close the steam to the second stage.
6. Close the discharge valve of the second stage.

This completes the operation. If the turbine (and consequently the condenser) is operating at a low or medium rate when the air ejectors are shifted, it may be necessary to recirculate condensate during the time when both two-stage units are in service in order to provide sufficient cooling water for the inter and after condensers. If sufficient cooling water is provided, or if the valves are opened and closed in the wrong order, a loss of vacuum will result and there is a possibility of putting excessive pressure on the air ejector condensers.

SECURING AIR EJECTORS

When securing an air ejector assembly, proceed as follows:

1. Close the first-stage suction valve.
2. Close the first-stage steam inlet valve.
3. Close the first-stage discharge valve.
4. Close the second-stage suction valve.
5. Close the second-stage steam valve.
6. Close the second-stage discharge valve.
7. Close the inter and after condenser drains.

CARE AND MAINTENANCE OF AIR EJECTORS

If an air ejector fails to maintain the proper vacuum, the cause may be traced to one of the following difficulties.

1. FAULTY STEAM PRESSURE.–If the pressure fluctuates and falls below standard, raise it to a point not over 15 psi above the designed pressure. Too high a pressure can also cause a reduced capacity, may overload the condenser units, and will cause an uneconomical quantity of steam to be used.

2. CLOGGED STEAM STRAINERS.—Strainers provided ahead of the nozzles must be clean. (NOTE: It is possible to clean or replace steam strainers, as well as nozzles, of an air ejector assembly while the rest of the unit is in operation. It is necessary to isolate the unit which is to be opened from the rest of the assembly, by closing the steam supply valve and the inter stage valves of this unit, to avoid burns being suffered by personnel engaged in this work.) Strainers should be cleaned in accordance with manufacturer's instructions.

3. INSUFFICIENT COOLING WATER.—If enough cooling water is not circulated through the air ejector inter and after condensers, a loss in vacuum results. This happens because the water becomes heated and will not condense the steam content of the air-vapor mixture entering the inter condenser. The second-stage ejector becomes overloaded because, instead of handling only air, it must also handle some steam which is not condensed in the inter condenser. Watch the temperature of the cooling water at the cooling water outlet, and keep it at the temperature designated by the manufacturer.

4. LEAKAGES.—Air leaks through the suction or discharge valves result in a loss of vacuum due to overloading of the air ejector. Leaks in valve glands, gasketed joints, relief or sentinel valves, etc., will have the same results.

Flooding of the inter or after condenser shell with the condensate, whether caused by leaking tubes in the inter or after condenser or by improper drainage, will interrupt the removal of air and cause loss of vacuum.

Tube joint leakage can be remedied by repacking the tube ends with new packing rings. For detailed information about methods of repairing leaks, refer to the manufacturer's technical manual and to chapter 9460 (46) in the Naval Ships Technical Manual.

5. FOULED NOZZLES.—Erosion or fouling of air ejector nozzles is evidence that wet steam is being admitted to the equipment. The faulty nozzles make it impossible to operate the ejector under a high vacuum. In some instances, the nozzles may be clogged with grease, boiler compound, or some other deposit which will decrease the jet efficiency. If there are grease deposits the nozzles should be cleaned by soaking them in an approved solvent.

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6. UNSTABLE LOOP SEAL.—An air leak in the U-shaped loop seal provided for draining the inter condenser causes an unstable seal. Occasionally a violent roll of the ship may cause the water in the seal to siphon out into the condenser. A connection on the condensate line is provided for filling the loop seal line.

AIR EJECTOR SAFETY PRECAUTIONS

The following safety precautions should be observed for air ejectors:

1. When starting an air ejector, always open the discharge valves before admitting steam to the nozzles. When securing an air ejector, always close tightly the steam supply valves to the nozzles before closing the discharge valves.

2. Before starting an air ejector, always drain the steam supply line, open the drain valves in the inter and after condenser drain lines, and be sure the atmospheric vent line is clear.

3. Should retubing or any other major repairs to an air ejector assembly be necessary, all parts should be hydrostatically tested following reassembly.

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CHAPTER 9

LUBRICATION AND ASSOCIATED EQUIPMENT

Lubrication reduces friction between moving parts by substituting fluid friction for solid friction. Without lubrication, it is difficult to move a hundred-pound weight across a rough surface; with lubrication, and with proper attention to the design of bearing surfaces, it is possible to move a million-pound load with a motor that is small enough to be held in the hand. By reducing friction, lubrication reduces the amount of energy required to perform mechanical actions and also reduces the amount of energy that is dissipated as heat.

Too much emphasis cannot be placed on the importance of proper lubrication of all units in any machinery plant. Moving surfaces must be steadily supplied with the proper kinds of lubricants, these lubricants must be maintained at specified standards of purity, designed pressures, and specified temperatures.

The lubrication requirements of shipboard machinery are met in various ways, depending upon the nature of the machinery. This chapter deals with the basic principles of lubrication, the lubricants used aboard ship, the lubrication systems installed for many shipboard units, and the devices used to maintain lubricating oils in the required condition of purity.

FRICTION

The friction that exists between a body at rest and the surface upon which it rests is called static friction. The friction that exists between moving bodies (or between one moving body and a stationary surface) is called kinetic friction. Static friction, which must be overcome to put any body in motion, is greater than kinetic friction, which must be overcome to keep the body in motion.

There are three types of kinetic friction: sliding friction, rolling friction, and fluid friction. Sliding friction exists when the surface of one solid body is moved across the surface of another solid body. Rolling friction exists when a curved body such as a cylinder or a sphere rolls upon a flat or curved surface. Fluid friction is the resistance to motion exhibited by a fluid.

Fluid friction exists because of the cohesion between particles of the fluid and the adhesion of fluid particles to the object or medium which is tending to move the fluid. If a paddle is used to stir a fluid, for example, the cohesive forces between the molecules of the fluid tend to hold the molecules together and thus prevent motion of the fluid. At the same time, the adhesive forces of the molecules of the fluid cause the fluid to adhere to the paddle and thus create friction between the paddle and the fluid. Cohesion is the molecular attraction between particles that tends to hold a substance or a body together; adhesion is the molecular attraction between particles that tends to cause unlike surfaces to stick together. From the point of view of lubrication, adhesion is the property of a lubricant that causes it to stick (or adhere) to the parts being lubricated; cohesion is the property which holds the lubricant together and enables it to resist breakdown under pressure.

Cohesion and adhesion are possessed by different materials in widely varying degrees. In general, solid bodies are highly cohesive but only slightly adhesive. Most fluids are quite highly adhesive but only slightly cohesive; however, the adhesive and cohesive properties of fluids vary considerably.

FLUID LUBRICATION

Fluid lubrication is based on the actual separation of surfaces so that no metal-to-metal contact occurs. As long as the lubricant film remains unbroken, sliding friction and rolling friction are replaced by fluid friction.

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In any process involving friction, some power is consumed and some heat is produced. Overcoming sliding friction consumes the greatest amount of power and produces the greatest amount of heat. Overcoming rolling friction consumes less power and produces less heat. Overcoming fluid friction consumes the least power and produces the least amount of heat.

LANGMUIR THEORY

A presently accepted theory of lubrication is based on the Langmuir theory of the action of fluid films of oil between two surfaces, one or both of which are in motion. Theoretically, there are three or more layers or films of oil existing between two lubricated bearing surfaces. Two of the films are boundary films (indicated as I and V in part A of fig. 9-1), one of which clings to the surface of the rotating journal and one of which clings to the stationary lining of the bearing. Between these two boundary films are one or more fluid films (indicated as II, III, and IV in part A of fig. 9-1). The number of fluid films shown in the illustration is arbitrarily selected for purposes of explanation.

When the rotating journal is set in motion (part B of fig. 9-1), the relationship of the journal to the bearing lining is such that a wedge of oil is formed. The oil films II, III, and IV begin to slide between the two boundary films, thus continuously preventing contact between the two metal surfaces. The principle is again illustrated in part C of figure 9-1, where the position of the oil wedge W is shown with respect to the position of the journal as it starts and continues in motion.

The views shown in part C of figure 9-1 represent a journal or shaft rotating in a solid bearing. The clearances are exaggerated in the drawing in order to illustrate the formation of the oil film. The shaded portion represents the clearance filled with oil. The film is in the process of being squeezed out while the journal is at rest, as shown in the stationary view. As the journal slowly starts to turn and the speed increases, oil adhering to the surfaces of the journal is carried into the film, increasing the film thickness and tending to lift the journal as shown in the starting view. As the speed increases, the journal takes the position shown in the running view. Changes in temperature, with consequent changes in oil viscosity, cause changes in the film thickness and in the position of the journal.

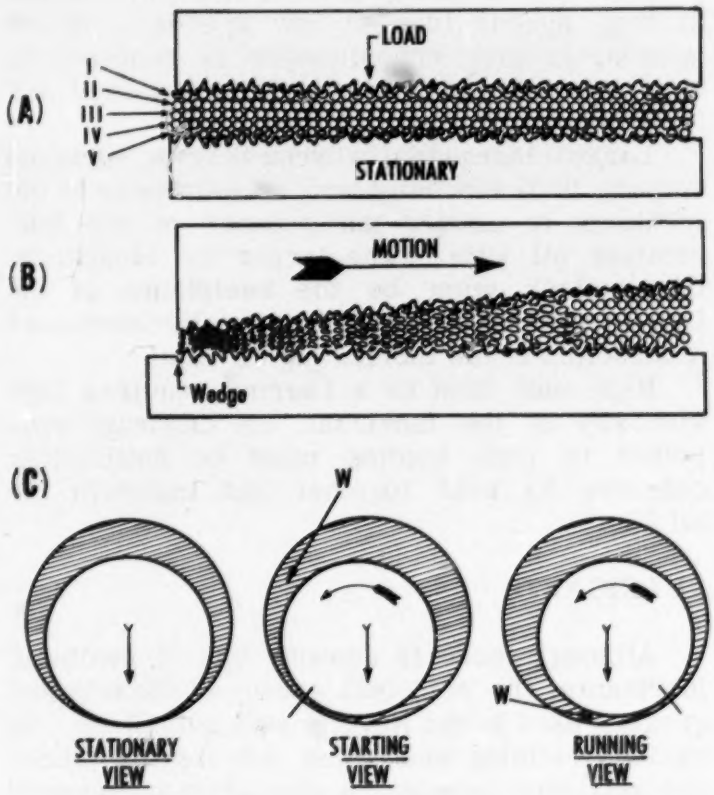

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Figure 9-1.—Oil film lubrication. (A) Stationary position, showing several oil films; (B) surface set in motion, showing principle of oil wedge; (C) principle of (A) and (B) shown in a journal bearing.

If conditions are correct, the two surfaces are effectively separated, except for a possible momentary contact at the time the motion is started.

FACTORS AFFECTING LUBRICATION

A number of factors determine the effectiveness of oil film lubrication, including such things as pressure, temperature, viscosity, speed, alignment, condition of the bearing surfaces, running clearances between the bearing surfaces, starting torque, and the nature and purity of the lubricant. Many of these factors are interrelated and interdependent. For example, the viscosity of any given oil is affected by temperature and the temperature is affected by running speed; hence the viscosity is partially dependent upon the running speed.

A lubricant must be able to stick to the bearing surfaces and support the load at operating speeds. More adhesiveness is required

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IV. SAMPLES OF INSTRUCTION SHEETS

Job
Information

JOB SHEET

Aligning Superheterodyne Receivers

Block II

Objective: To learn the correct procedure of aligning a receiver

Equipment: A.M. Signal Generator, Superheterodyne Receiver

Tools: Small insulated screwdriver, alignment tool for IF transformer

Supplies: .01 600v capacitor

Safety: Use .01 capacitor in hot lead of generator to avoid shock hazard

Alignment Procedure

1. Attach output leads from signal generator to set; outer braid lead to Ground terminal, inner (hot) lead to Antenna terminal. Sets with "hank" antenna, connect hot lead here, and braid lead to set chassis.

2. Turn on receiver and advance volume control to maximum. Turn on signal generator. Set dial to 455 kc. Set attenuator (RF Vol) knob on generator at lowest clearly audible position. Excessive signal to set will create two resonance points making proper alignment impossible.

3. Turn set's tuning dial so capacitor plates are fully open. (16- 1620 kc on dial.) If set has more than one IF transformer, start with the last one (nearest detector tube) and adjust transformer slugs with the plastic screwdriver until the 400-cycle tone from signal generator is loudest.

4. Repeat slug adjustments above on remaining IF transformers (if any). If signal becomes too loud, retard generator's attenuator knob. After adjusting the input IF, start over again as in step No. 3, adjusting slugs for any further minute increase in signal that may result.

5. Now tune the signal generator to 1620 kc. Turn the trimmer screw on the Osc. Section of the tuning capacitor until the 400-cycle tone can be heard. Next turn the trimmer screw on the larger (Antenna) section of the tuning capacitor until signal is loudest. Use plastic screwdriver for these adjustments.

6. Rotate tuning capacitor until plates are fully closed. Set signal generator to 550 kc and adjust slug of oscillator coil or padder capacitor (as case may be) for maximum 400-cycle tone. Use plastic screwdriver except where oscillator slug has brass external adjust screw. Here metal blade may be used.

7. In some instances, adjustment of the low (500 kc) end of the dial may cut off tuning at the high (1600kc) end. In such instances, repeat step No. 5 until the 400-cycle signal can be tuned in at both ends of the radio dial.

8. If above steps have been followed, your set is now correctly aligned.

to make a lubricant adhere to bearing surfaces at high speeds than at low speeds. At low speeds, greater cohesiveness is required to keep the lubricant from being squeezed out from between the bearing surfaces.

Large clearances between bearing surfaces require high viscosity and cohesiveness in the lubricant to ensure maintenance of the lubricating oil film. The larger the clearance, the greater must be the resistance of the lubricant to being pounded out, with consequent destruction of the lubricating oil film.

High unit load on a bearing requires high viscosity of the lubricant. A lubricant subjected to high loading must be sufficiently cohesive to hold together and maintain the oil film.

LUBRICANTS

Although there is growing use of synthetic lubricants, the principal source of the oils and greases used in the Navy is still petroleum. By various refining processes, lubricating stocks are extracted from crude petroleum and blended into a multiplicity of products to meet all lubrication requirements. Various compounds or additives are used in some lubricants (both oils and greases) to provide specific properties required for specific applications.

Types of Lubricating Oils

Lubricating oils approved for shipboard use are limited to those grades and types deemed essential to provide proper lubrication under all anticipated operating conditions.

For diesel engines, it is necessary to use a detergent-dispersant type of additive oil in order to keep the engines clean. In addition, these lubricating oils must be fortified with oxidation inhibitors and corrosion inhibitors to allow long periods between oil changes and to prevent corrosion of bearing materials.

For steam turbines, it is necessary to have an oil of high initial film strength. This oil is then fortified with anti-foaming additives and additives that inhibit oxidation and corrosion. In addition, it is necessary to use extreme pressure (EP) additives to enable the oil to carry the extremely high loading to which it is subjected in the reduction gears.

For the hydraulic systems in which petroleum lubricants are used, and for general lubrication use, the Navy uses a viscosity series of oils reinforced with oxidation and corrosion inhibitors and anti-foam additives. The compounded oils, which are mineral oils to which such products as rape seed, tallow, or lard oil are added, are still used in deck machinery and in the few remaining steam plants that utilize reciprocating steam engines.

A great many special lubricating oils are available for a wide variety of services. These are listed in the Federal Supply Catalog. Among the more important specialty oils are those used for lubricating refrigerant compressors. These oils must have a very low pour point and be maintained with a high degree of freedom from moisture.

The principal synthetic lubricants currently in naval use are (1) a phosphate ester type of fire-resistant hydraulic fluid, used chiefly in the deck-edge elevators of carriers (CVAs); and (2) a water-base glycol hydraulic fluid used chiefly in the catapult retracting gears.

Classification of Lubricating Oils

The Navy identifies lubricating oils by symbols. Each identification number consists of four digits (and, in some cases, appended letters). The first digit indicates the class of oil according to type and use; the last three digits indicate the viscosity of the oil. The viscosity digits are actually the number of seconds required for 60 milliliters of the oil to flow through a standard orifice at a specified temperature. The symbol 3080, for example, indicates that the oil is in the 3000 series and that a 60-ml sample flows through a standard orifice in 80 seconds when the oil is at a specified temperature (210° F, in this instance). To take another example, the symbol 2135 TH indicates that the oil is in the 2000 series and that a 60-ml sample flows through a standard orifice in 135 seconds when the oil is at a specified temperature (130° F, in this case).

The letters H, T, TH, or TEP added to a basic symbol number indicate that the oil contains additives for special purposes.

Additional information on the classification of lubricating oils can be obtained from chapter 9450 (45) of the Naval Ships Technical Manual.

Lubricating Oil Characteristics

Lubricating oils used by the Navy are tested for a number of characteristics, including viscosity, pour point, flash point, fire point,

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auto-ignition point, neutralization number, demulsibility, and precipitation number. Standard test methods are used for making all tests. The characteristics of lube oil are briefly explained in the following paragraphs.

The VISCOSITY of an oil is its tendency resist flow or change of shape. A liquid of high viscosity flows very slowly. In variable climates automobile owners, for example, change oils in accordance with prevailing seasons because heavy oil becomes too sluggish in cold weather, and light oil becomes too fluid in hot weather. The higher the temperature of an oil, the lower its viscosity becomes; lowering the temperature increases the viscosity. The high viscosity or stiffness of the lube oil on a cold morning makes an engine difficult to start.

If an oil of a higher viscosity is used under such conditions, the increased internal friction will raise the temperature and reduce the viscosity of the oil. The viscosity must always be high enough to keep a good oil film between the moving parts—otherwise, there will be increased friction, power loss, and rapid wear on the parts. Oils are graded by their viscosities at a certain temperature—by noting the number of seconds required for a given quantity (60 millilitres) of the oil at the given temperature to flow through a standard orifice. The right grade of oil, therefore, means oil of the proper viscosity.

THE VISCOSITY INDEX of an oil is based on the slope of the temperature-viscosity curve—or on the rate of change in viscosity of a given oil with a change in temperature, with other conditions remaining unchanged. A low index figure denotes a steep slope of the curve, or a great variation of viscosity with a change in temperature; a higher index figure denotes a flatter slope, or lesser variation of viscosity with identical changes in temperatures. If you are using an oil with a high viscosity index, its viscosity or body will change less when the temperature of the engine increases.

The POUR POINT of an oil is the lowest temperature at which the oil will barely flow from a container. At a temperature below the pour point, oil congeals or solidifies. A low pour point is an essential characteristic of lube oils used in cold weather operations. (NOTE: The pour point is closely related to the viscosity of the oil. In general, an oil of high viscosity will have a higher pour point than an oil of low viscosity.)

The FLASH POINT of an oil is the temperature at which enough vapor is given off to flash when a flame or spark is present. The minimum flash points allowed for Navy lube oils are all above 315° F, and the temperatures of the oils are always far below that under normal operating conditions.

The FIRE POINT of an oil is the temperature at which the oil will continue to burn when ignited.

The AUTO-IGNITION POINT of an oil is the temperature at which the flammable vapors given off from the oil will burn without the application of a spark or flame. For most lubricating oils, this temperature is in the range of 465° F to 815° F.

The NEUTRALIZATION NUMBER of an oil is the measure of the acid content and is defined as the number of milligrams of potassium hydroxide (KOH) required to neutralize one gram of the oil. All petroleum products deteriorate (oxidize) in the presence of air and heat; the products of this oxidation include organic acids, which, if present in sufficient concentration, have harmful effects on alloy bearings at high temperatures, galvanized surfaces, and the demulsibility of the oil with respect to fresh and sea water. This last effect, in turbine installations, may result in the formation of sludge and emulsions too stable to be broken by the means available. An increase in acidity is an indication that the lubricating oil is deteriorating.

The DEMULSIBILITY (or emulsion characteristic) of an oil is its ability to separate cleanly from any water present—an important factor is forced-feed systems. It is especially important to keep water (fresh or salt) out of oils.

The PRECIPITATION NUMBER of an oil is a measure of the amount of solids classified as asphalts or carbon residue contained in the oil. The number is reached by diluting a known amount of oil with naphtha and separating the precipitate by centrifuging—the volume of separated solids equals the precipitation number. The test is a quick means of determining the presence of foreign materials in used oils. An oil with a high precipitation number may cause trouble in an engine by leaving deposits or by plugging up valves and pumps.

Lubricating Greases

Some lubricating greases are simple mixtures of soaps and lubricating oils. Others are

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more exotic liquids such as silicones and dibasic acid esters, thickened with metals or inert materials to provide adequate lubrication. Requirements for oxidation inhibition, corrosion prevention, and extreme pressure performance are met by incorporating special additives.

Lubricating greases are supplied in three grades: soft, medium, and hard. The soft greases are used for high speeds and low pressures; the medium greases are used for medium speeds and medium pressures; the hard greases are used for slow speeds and high pressures.

CLASSIFICATION OF GREASES

Navy specifications have been drawn to cover the several grades of lubricating greases, the grades most common in engineroom use are as follows:

Ball and roller bearing grease, MIL-G-18709.
For general use in ball and roller bearings operating at medium speeds and over a temperature range of 125° F to 200° F and for a short intermittent service at 225° F.

Extreme pressure grease, MIL-G-17740.
Has antirust properties and is suitable for the lubrication of semienclosed gears, or any sliding or rolling metal surfaces where loads may be high and where the equipment may be exposed to salt spray or moisture. It is intended for use through a temperature range of 0° F to 140° F.

Graphite Grease, VV-G-671.
Graphite grease is intended for use in compression grease cups for bearings operating at temperatures not to exceed 150° F.

Grade 1	Soft	For light pressures and high speeds
Grade 2	Medium	For medium pressures and medium speeds
Grade 3	Medium Hard	For high pressures and slow speeds

LUBRICATING SYSTEMS

Main lubricating oil systems on steam-driven ships provide lubrication for the turbine bearing and the reduction gears. The main lubricating oil system generally includes a filling and transfer system, a purifying system, and separate service systems for each propulsion plant. On most ships, each lubricating oil service system includes three positive-displacement lube oil service pumps: (1) a shaft-driven pump, (2) a turbine-driven pump, and (3) a motor-driven pump. The shaft-driven pump, attached to and driven by either the propulsion shaft or the quill shaft of the reduction gear, is used as the main lube oil service pump when the shaft is turning fast enough so that the pump can supply the required lube oil pressure. The turbine-driven pump is used while the ship is getting underway and is then used as standby at normal speeds. The motor-driven pump serves as an emergency pump standby for the other two lube oil service pumps.

Figure 9-2 illustrates the lube oil supply and lube oil drain piping of the service system on the frigates DLG14 and DLG15.

FORCED-FEED LUBRICATION SYSTEMS

The forced-feed lubricating oil systems are used for the lubrication of main engine turbines and reduction gears, turbogenerators, feed pumps and other auxiliary machinery. and in most internal-combustion engines. Each engineroom lube oil system is arranged for independent operation, and generally there is no service connection provided between enginerooms. The main engine lubricating systems include a purifier; whereas the other auxiliary systems must be periodically drained (as the crankcase of an automobile is drained) and replenished with new or purified oil.

The essential parts of a forced lubrication system are as follows:

1. Pumps for delivering the oil to the various parts of the system. If the pump is driven from the unit it serves, additional pumps are provided, where necessary, for supplying oil to the system before the unit is started, during warming up and low speed operation.
2. Oil relief valves are intended primarily to protect the system from excessive pressures that may occur because of a malfunction of an operating part.
3. Oil strainers and filters for removing foreign matter from the oil before it enters the bearings and oil sprays.

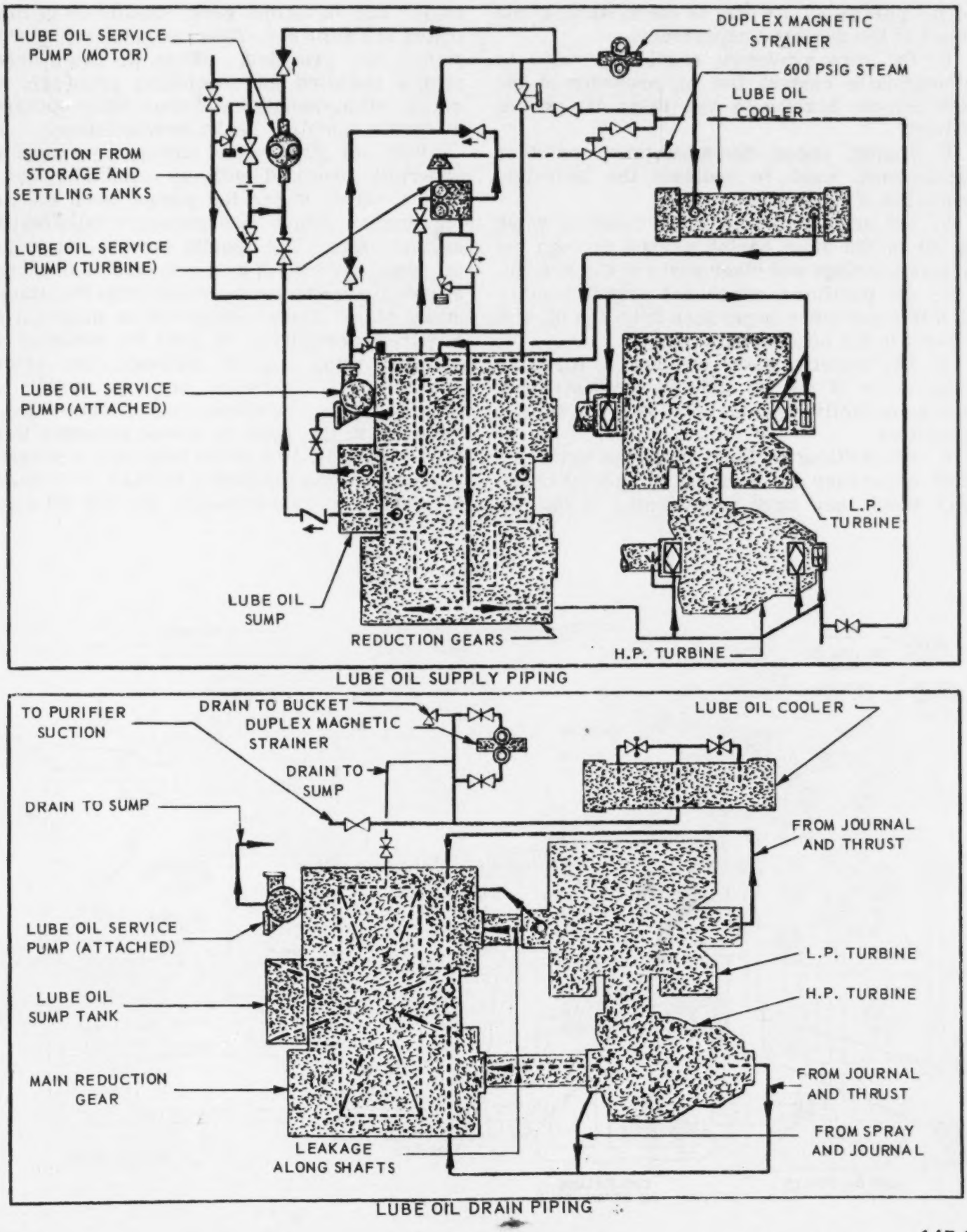

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Figure 9-2.—Lubricating oil service system, DLG 14 and DLG 15.

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4. Integral oil cooler heater, through which the oil passes on its way to the system, keeps the oil at the desired temperature.

5. Oil back pressure regulating valve to automatically control the oil pressure at the most remote bearing by bypassing all excess oil back.

6. Piping, gages, thermometers, and other instruments, used to indicate the operating conditions of the system.

7. Oil drain tanks or sump tanks to which the oil is led after having passed through the various bearings and other parts of the system.

8. Oil purifiers, which are used to remove all water and other impurities from the oil that collects in the oil on a daily basis.

9. Oil heaters, which are used to raise the temperature of the oil entering the centrifugal purifier to facilitate removal of water, and other impurities.

10. Oil-settling tanks in which the water and other impurities are removed by special treatment when they have accumulated in the oil.

A forced-feed lubrication system for a main engine and reduction gear installation is illustrated in figure 9-3. Three main lube oil service pumps are provided. Shaft or chain driven pumps installed and operating properly, will supply oil at designed pressure while operating at speeds specified by the manufacturer.

Lube oil standby and emergency pumps are generally provided with an automatic cut in device which starts the pumps when the lubricating oil supply line pressure falls below a certain value. The standby turbine-driven lube oil pump, controlled by a governor, assumes or shares the load when the supply from the attached pump is no longer sufficient to maintain the required pressure. If both the attached and standby pump cannot maintain the system pressure, a pressure sensing switch will then start the emergency motor-driven pump. Usually, at the point of lowest pressure in the lube oil supply line to the bearings, a pressure operated switch WARNING SIGNAL is installed. It is set to operate whenever the lube oil supply

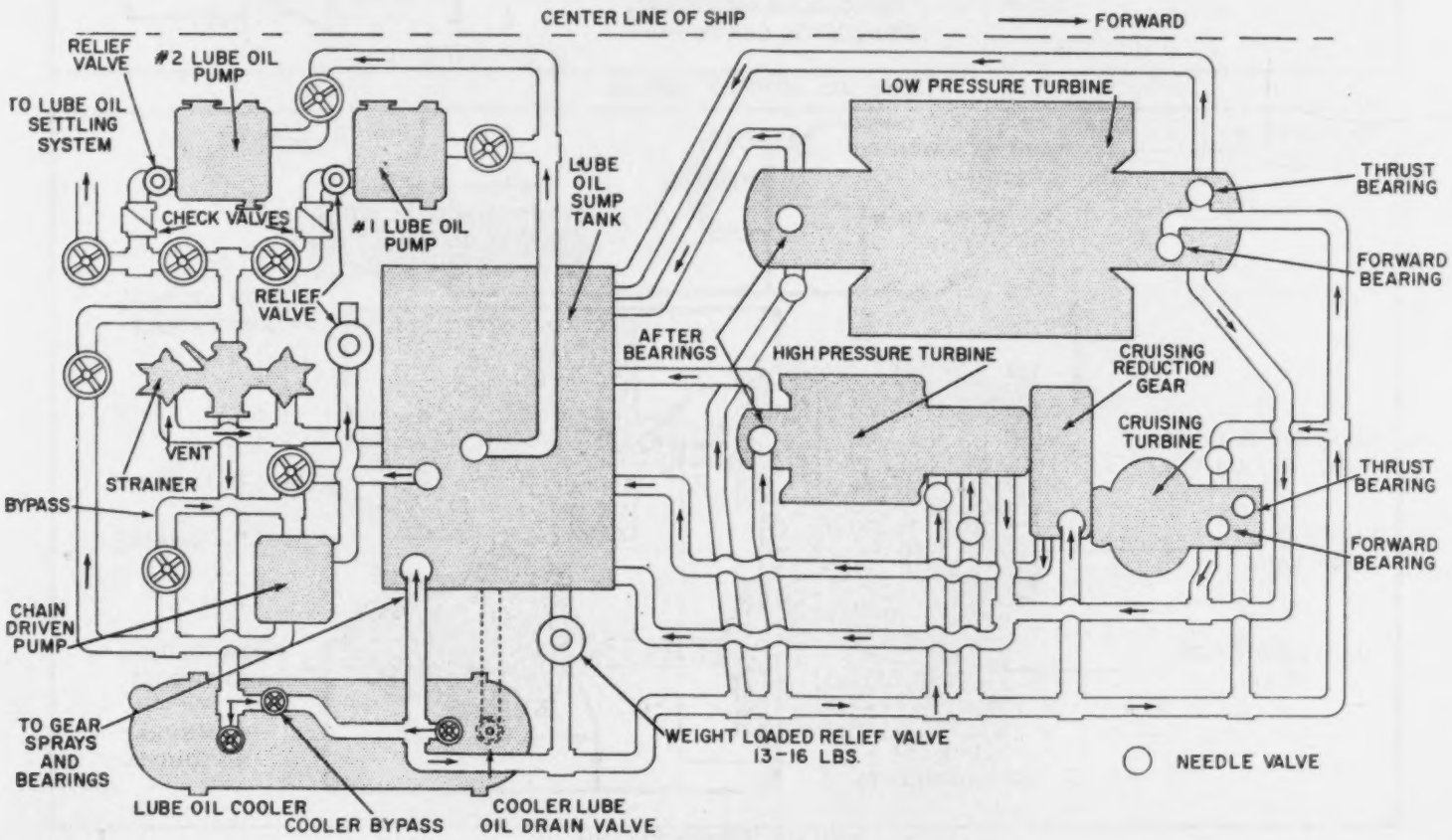

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Figure 9-3.—Diagram of a DD-692 class destroyer forced-feed lubricating system.

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falls below a predetermined pressure, thereby giving the throttleman (or operators of other machinery) instant warning of low oil pressure.

The OIL COOLER, through which the oil passes on its way to the lubricated parts, is fitted with thermometers and a bypass (bypasses are not fitted on some new ships). Thermometers register the inlet and outlet oil temperatures; the bypass may be used to bypass the cooler in case of tube failure. Valves are also provided in the cooling water supply and discharge lines to and from the cooler to provide for varying the rate of flow of cooling water, which controls the temperature of the lube oil leaving the cooler. From the cooler, the oil passes to individual bearings through NEEDLE VALVES or, on some ships, internal fixed orifices. These valves regulate the oil flow to the individual bearings. From the bearings, the oil is drained back to the main engine sump. Oil is supplied to the teeth of the reduction gears through SPRAY NOZZLES, after which the oil drains to the main engine sump. A FLOAT GAGE on the sump indicates the oil level. As additional oil is required for the system, it is drained or pumped into the sump from the STORAGE TANK.

Figure 9-4 illustrates a typical main turbine bearing which is lubricated by a forced-feed lube oil service system. Since these bearings are located close to the shaft glands, OIL DEFLECTORS are fitted to prevent leaking gland steam from contaminating the lube oil, and to prevent the oil from escaping.

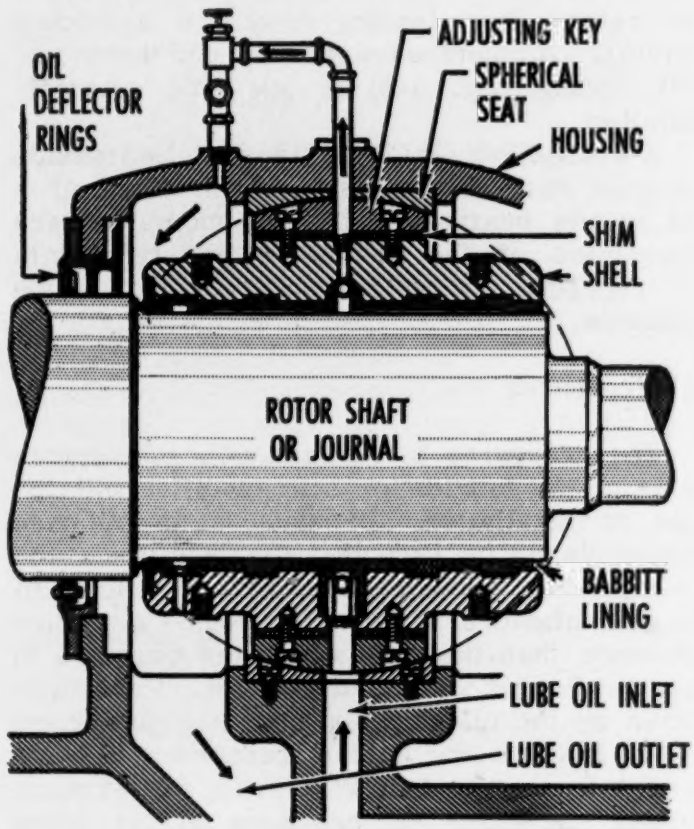

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Figure 9-4.—Adjustable spherical-seated bearing lubricated by forced feed.

Oil Purifying and Settling System

The oil purifying and settling functions of the forced-feed system include a centrifugal OIL PURIFIER (discussed later in the chapter), an OIL HEATER for raising the temperature of the oil entering the purifier (to facilitate removal of water), and SETTLING TANKS fitted with steam heating coils.

The oil is normally purified, while the lubricating system is in operation. The purifier takes oil from the main sump tank; after it is purified, the oil is discharged back to the same sump. Oil from the smaller forced-feed systems is drained and put into a settling tank, from which the purifier may take a suction when it is not employed in purifying oil of the main system. The purifier is normally operated 12 hours a day for the main system, while underway.

If the oil becomes badly contaminated by water or other impurities, or if it becomes emulsified, the mixture is pumped up to the SETTLING TANKS. Here the oil is heated by the steam-heated coils. After several hours of heating, the impurities will have settled and can be drawn off through the drains at the bottom of the tanks. The remaining oil is then passed through the purifier and discharged back to the sump. Purification of the main sump oil, by heating and settling, can be done only in port, because all the oil must be pumped out of the main engine sump. This should be done as soon as possible after securing. The reason for this action is to take advantage of the heat accumulated by normal engine operation.

Oil Check Fittings

Various means are provided for maintaining a continuous check on the supply of oil to bearings and on the temperature of oil flowing from the bearings. In modern turbines and reduction gears, a THERMOMETER, and a

bull's-eye SIGHT-FLOW fitting are installed in the return line leading from the individual bearing. A combined sight-flow and thermometer fitting (fig. 9-5) is one type normally installed.

A PRESSURE GAGE is also installed outside the gear case—on the header from which oil is fed to the bearings. The thermometers are sometimes of the distant-reading type—with the recording bulbs connected to a dial-type indicator.

Oil Pressures

The pressures to be carried at the various parts of the lubrication system differ with the type of installation. Pressure at the service pumps should be such that the pressure at the most remote bearing will be in accordance with the manufacturer's specification. A higher pressure than this will cause the bearings to become flooded and the oil to foam. Pressures shown by the oil gages on the main gage board should indicate the actual pressure at the low pressure alarm connections to the system. Sudden increases in pressure at the pump (usually due to a clogged strainer or pipeline) should prompt immediate checking of oil flow at the bearings. The trouble should be located and corrected at once.

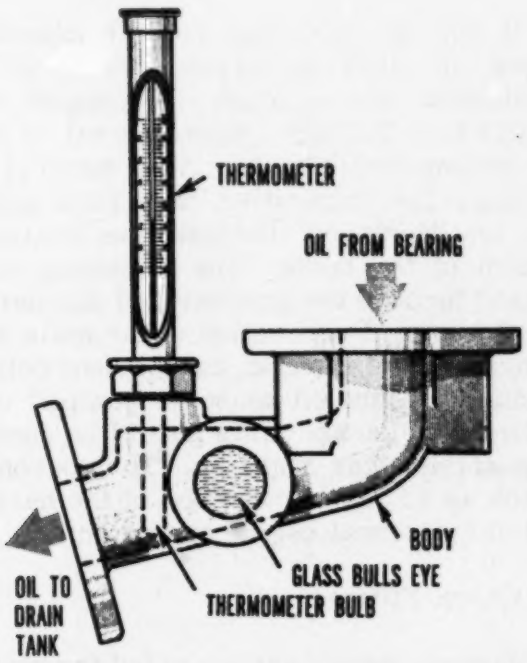

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Figure 9-5.—Combined lube oil sight-flow and thermometer.

Oil Flow

The flow of oil at the bearing, as seen through the sight-flow glass, must be uniform. Frequent inspections should be made during each watch. If the oil supply is interrupted at any time, the main shaft should be stopped and locked. If the oil temperature rises beyond allowable limits, reduce the shaft speed and notify the bridge.

Oil Temperatures

Bearing temperatures depend on the viscosity of the oil being used, design of the bearing, rpm, and clearances. The manufacturer's technical manual for a unit gives the correct temperatures of lube oil flowing from the bearings. The temperature rise of oil passing through the bearings should not exceed 50° F (difference between discharge of lube oil cooler and the temperature leaving the bearing), even through the maximum allowable temperature is not exceeded. Investigate the cause of any rising temperature that fails to level off, no matter how slowly it is rising.

Since friction loss in a journal bearing is directly proportional to the oil viscosity, and the viscosity depends upon the temperature, the oil leaving the cooler should be between 120° and 130° F. The efficiency of double reduction gears, for example, will be decreased appreciably at cruising speeds, if operated at temperatures lower than those prescribed.

Take PRECAUTIONS WITH THE THERMOMETERS. Make certain that the bulbs are sufficiently immersed in the oil streams to give an accurate reading. In many cases, the thermometers give only the average temperature in the bearing reservoir. Checks on temperature should, therefore, be periodically made by feeling the cap and by inspecting the sight glasses to ensure that there is a flow of oil.

The OIL COOLERS should be put into operation when the temperature of the oil from the cooler reaches 120° F. The temperature from the cooler should be carried at 120° to 130° F. When the system has more than one cooler, the coolers should be used alternately. (The operating principles of the lube oil cooler are discussed in the preceding chapter.)

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Oil Purity

The purity of the lube oil is very important for efficient lubrication, and careful attention should be given to keeping the oil free of both metallic particles and water.

The oil strainers should be removed and cleaned during each watch. All residue found in the strainers should be carefully examined. If pieces of metal are found, determine the character of the metal. Later ships have strainer magnets installed to remove ferrous (iron) particles from the oil. Bits of brass or babbitt metal indicate that there is a damaged, or wiped, bearing in the system, or that the bearing metal is breaking up. If the metal has the appearance of rust, it indicates that corrosion is occurring in the system. Pieces of metal rust will scratch the bearing or mar a thrust shoe. A sudden rise in bearing temperature, followed by a return to normal, usually indicates that some foreign substance reached the bearing, scratched it, and was then washed out by the oil supply.

Every effort should be made to prevent the entry or to effect the IMMEDIATE REMOVAL OF WATER FROM THE OIL. Water not only increases the frictional resistance, and causes the oil film to break down prematurely, but also corrodes the bearing journals. Water may actually cause corrosion in the entire system, particularly in those parts which are not covered with oil at all times. Condensation of moisture, which promotes rusting on exposed surfaces such as gear casings, upper portions of drain tanks, etc. should be prevented by eliminating factors which tend to reduce the temperature of the surfaces. All unprotected escape hatches in the vicinity of gear casings must be kept secured at all times when the temperature of the outside air is less than 70° F, except when engines are secured. Air from ventilation ducts should never blow directly or indirectly on the gear casing. When coming to anchor, or securing main propulsion machinery, circulate oil through the system for at least an hour to minimize the effects of an unavoidable amount of fresh-water condensation.

Water enters the lubrication system at the following principal points:

1. Leaky tubes or joints in the oil coolers.
2. Steam-sealed glands of turbines (sometimes because of clogged drain).
3. Vents on tanks and gear casings (as atmospheric moisture, subsequently condensed).
4. Leaks in drain or sump tanks located in bilges.

Lube oil may lose its lubricating qualities if it is contaminated, but if the impurities and water are removed as soon as their presence is noted, the oil can be used over and over indefinitely. To ensure that the oil is kept free of all foreign matter, a sample of lube oil should be drawn from the auxiliary machinery sumps about once a week. Allow this sample to settle and examine for contamination. If the lube oil shows any contamination, drain the oil system of the particular piece of auxiliary machinery, and replenish the system with clean lube oil. The contaminated oil should be placed into one of the settling tanks and purified at some later date.

CENTRIFUGAL PURIFIERS (centrifuges) are used to purify the lube oils. Because of the importance of this purifier, and because it is employed for the purification of lube oil used in other than forced-feed systems, it is treated somewhat fully further on in this chapter. Generally, the oil must be heated to higher than operating temperature before being run through the centrifuge. This results in a greater degree of purification.

GRAVITY-FEED LUBRICATION SYSTEMS

There are two types of gravity-feed lubricating systems—the gravity force feed and the straight gravity feed. The straight gravity-feed system is further differentiated as being either a DRIP-FEED or a WICK-FEED system. None of these systems will be found to any great extent on the modern naval ships. They are described in chapter 9450 (45) of the Naval Ships Technical Manual.

SELF-OILING SPRING BEARINGS

Main shaft spring bearings on the propulsion shaft are lubricated by a self-oiling system. Most of these bearings are ring-oiled, though some are chain-oiled. You must know how to ensure continuous correct lubrication of these important units.

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Ring-Oiled Spring Bearings

The lubrication system for the ring-oiled bearings consists of an OIL SUMP below the bearing journal, and brass OILER RINGS which are hung loosely over the journal and lower half of the bearing. These rings are immersed in the oil and carry a continuous supply of oil over the journal as the rings are dragged around by the rotation of the shaft. The rings must be finished smoothly and fit properly in the guides in the upper half of the bearing shell to prevent hanging and failure to rotate evenly. The upper half of the bearing is cut away in the middle to accommodate the oiler rings. A hinged ACCESS COVER in the upper half of the bearing housing permits inspection of the journal and oiler rings. The OIL DEFLECTOR RINGS, secured to the shaft, keep the oil within the bearing space.

Care of Spring Bearing Oil

The frequency of changing the oil and cleaning the oil sumps depends upon the service and the mechanism. If the oil doesn't become contaminated by impurities, it can be used for an extended period before the lubricating qualities are reduced. Regardless of condition, the oil should be drained once a quarter and run through the purifier. Whenever the oil is renewed, the sump should be thoroughly cleaned. Be sure to keep inspection openings in operating condition, and closed when not in use.

Samples of the oil in the sump should be examined after each extended run, and after 10 days of periodic service. If the oil shows an increase in viscosity, discoloration, or formation of sludge deposits in the reservoir, immediate renewal is necessary. When underway, the oil level and bearing operations must be inspected and logged hourly.

GREASE LUBRICATION SYSTEMS

Grease lubrication is employed in many locations where the retention of lube oil at the bearing surface would otherwise be difficult. The grease is applied either through the use of grease cups or through pressure fittings, such as the Zerk type.

Grease Cup Lubrication

Whereas dirt in lube oil will generally settle out, dirt in grease remains mixed with grease and becomes abrasive. For this reason, particular care must be taken to prevent contamination, especially where grease cups are used. Before opening the container, all dirt should be carefully removed from the exterior. No dirt must be allowed to enter either the opening or the grease cups. The cups should be frequently emptied, cleaned, and refilled with fresh grease.

Pressure Greasing

Pressure fittings form a convenient means of lubricating numerous low-speed, lightly loaded, or widely separated bearings. They are not, however, satisfactory for use on electric generators and motors because of the danger of forcing grease out of the bearing and onto windings. These fittings are similar to those on an automobile, where grease guns are employed for lubrication.

Before applying the grease gun, the pressure fittings should be wiped clean. The gun tip, too, must be clean. The pressure should be applied until grease comes out around the edges of the bearing. In bearings fitted with felt or other seals, care must be taken to avoid breaking the seals by overpressure. Excessive pressure in the lubrication of needle-type roller bearings may unseat the needles.

Ball And Roller
Bearing Lubrication

The oil or grease employed for the lubrication of ball and roller bearings (known jointly as ROLLING CONTACT BEARINGS) provides a lubricating film between the balls and rollers and the retainers, and between ends of the rollers and the races; dissipates heat caused by friction; prevents corrosion of the highly polished parts; and aids in excluding dirt, water, and other foreign matter. The lubricant specified for each machine should be used, and excessive lubrication should be avoided.

OIL LUBRICATION

Where ball or roller bearings are oil lubricated, the lube oil, as speeds increase, begins churning and produces heat. The quantity of oil must, therefore, be reduced accordingly, until at very high speeds only a mist of oil is desirable. It is common practice to fill the bearing housing to a point between the center of the lower ball and the lowest point of the

inner ring, depending upon the speed of operation. DRAINS are generally installed to prevent the oil from rising above this point; SIGHT INDICATORS are also provided. For extremely high speeds, the drip-feed or wick-feed gravity lubrication is sometimes used.

Grease Lubrication

To apply grease to ball and roller bearings, proceed as follows:

1. Remove the relief plug at the bottom of the bearing closure and free a hole through the cavity.
2. With the mechanism running, turn down the grease cup slowly until grease begins to push through the relief plug hole.
3. Leave the hole open for 10 to 15 minutes, then free the hole again with a clean rod or knife, and replace the plug.
4. If excessive grease appears when the plug is removed, remove the cover and clean out excessive grease. Add sufficient grease, if necessary, to the bearing closure to make it about 1/3 to 1/2 full. This procedure should be followed after new bearings are installed.

Where a relief pipe is fitted to the bearing closure or grease sump, and the closure is not accessible, the relief pipe should be removed (if possible) and thoroughly cleaned. A stiff, clean wire should be inserted through the pipe, to free an opening through the grease in the sump, before attempting to replenish the lubricant in the bearing.

After relubricating with the relief plug off the relief pipe, and with the motor running, leave the plug open for 10 to 15 minutes, occasionally loosening the excess grease in the pipe with the stiff wire. Then remove the relief pipe and free it of excess grease, attach it to the closure, and place the plug in the end of the relief pipe.

LUBE OIL PURIFICATION

In the forced-feed lubrication systems on modern naval ships, if the purity of the oil remains intact, the oil may be kept in service for a long period of time. LUBE OIL DOES NOT WEAR OUT; it is merely robbed of its lubricating properties by foreign substances. In other words, improper performance of a correct oil is not due to internal change, but to contamination or to the formation of sludge. No one would ever willfully pour into the lubrication system of his machine a mixture of oil, water, sand, fine metallic particles, sludge, and acid. Yet lubricating systems do contain mixtures of this nature, when preventive measures are not taken. The centrifugal oil purifier is employed on all naval ships to remove the water and other foreign matter from the lube oil. Water is the greatest source of contamination.

Contamination must be removed or the oil will not meet lubrication requirements. Dirt, sludge, and other contaminants will act as abrasives to score and scratch the rubbing metal surfaces within engines, generators, pumps, and blowers. Contaminants interfere with the ability of the oil to maintain a good lubricating film between metal surfaces.

Several different devices are used to keep the oil as clean as possible. Each device is designed to remove certain kinds of contamination and it takes several types of devices in a lubricating system to keep oil in a usable condition. Strainers, filters, settling tanks, and centrifugal purifiers are the devices used to free oil of contamination. Strainers and filters will not be discussed in this chapter—settling tanks and purifiers will be discussed, with emphasis on purifiers.

SETTLING TANKS

Shipboard lubricating systems include settling tanks which permit used oil to stand while water and other impurities settle out. Settling is due to force of gravity. A number of layers of contamination may form, the number of layers formed depending upon the difference in specific gravity of the various substances. For example, there might be a layer of metal particles on the bottom, then a layer of sludge, then a layer of water, and then the clean oil.

Lubricating oil piping is generally arranged to permit two methods of purification: batch purification and continuous purification. In the batch process, usually done while the ship is in port, the lubricating oil is transferred from the sump to a settling tank by means of a purifier or a transfer pump. (After the oil is heated and allowed to settle for several hours, water as well as other impurities are removed from the settling tanks. The oil is then centrifuged and returned to the sump from which it was taken.)

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INFORMATION SHEET

Tube Testers

Block III - General Television Servicing
Unit 1 - Television Test Instruments
Job 11 - Tube Testing

General

The tube tester provides a rapid check on the condition of vacuum tubes. No tube tester, however, allows a check on every tube type that is manufactured. They are generally confined to tube types likely to be found in receiving equipment, control equipment, or other electronic devices in which relatively small size tubes are used.

All tube testers have certain characteristics in common. Electrically, they all incorporate the same basic circuits, and consequently it may be assumed that in general appearance all testers are much alike.

Testing Methods

There are three accepted methods of testing tubes:

1. By measuring the electron emission of the tube.
2. By measuring the transconductance of the tube.
3. By measuring the power output of the tube.

The measurement obtained by any of these methods is compared to a standard measurement for any given tube type. The standard measurement for comparison is usually obtained by employing a meter as part of the tester and marking a part of its scale as "good" and another part as "bad" or "replace". If the tube being tested causes a meter deflection to the "good" section of the scale it is classed as a good tube and, conversely for the scale section marked "bad."

Testing Procedure

An actual test of a tube is made by setting the tester controls to the positions indicated on a chart which accompanies the tester. It should be pointed out here that a tube tester is useless without such a chart, to give the correct control settings for each tube type. Obviously, then, the charts must be handled with care.

To test a particular tube it is necessary to: first, locate the tube type on the chart provided; second, set the tester controls to the positions indicated by the chart; third, place the tube in the appropriate socket on the tester; and fourth, press the appropriate test button on switch (as given also by the chart) and read the meter indication to determine the condition of the tube.

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CENTRIFUGAL PURIFICATION

While a ship is at sea or when time does not permit batch purification in the settling tanks the continuous purification process is used. Centrifugal purifiers are also used in this process. The purifier takes the oil from the main sump in a continuous cycle. Before entering the purifier, the oil is heated to facilitate easier removal of the impurities.

Detailed instructions on construction, operation, and maintenance of purifiers are furnished by the manufacturers. The instructions should be carefully studied and followed by the personnel who are responsible for operation and maintenance of purifiers. The following general information is provided to familiarize you with the methods of purification and the purposes and principles of operation of purifiers.

PRINCIPLES OF PURIFIER OPERATION

In the purification process, a purifier may be used to remove water and sediment from oil or to remove sediment only. When water is involved in the purification process, the purifier is called a SEPARATOR. When the principal item of contamination is sediment, the purifier is used as a CLARIFIER. When used to purify lubricating oil, a purifier may be used as either a separator or a clarifier. Whether a purifier is used as a separator or a clarifier depends upon the moisture content of the oil to be purified.

If an oil contains no moisture, it needs only to be clarified, since the solids will be deposited in the bowl, and the oil will be discharged in a pure state. If, however, the oil contains some moisture, the continued feeding of "wet" oil to the bowl results eventually in a bowl filled with water, and from then on the centrifuge is not separating any water from the oil. Even before the bowl is completely filled with water, the presence of a layer of water in the bowl reduces the depth of the oil layer. As a result, the incoming oil passes through the bowl at a very high velocity.

This higher velocity means that the liquid is under centrifugal force for a shorter time, and the separation of water from the oil is, therefore, not so complete as it would be if the bowl were without the water layer, or if the water layer were a shallow one. Because of this, the centrifuge should not be operated as a clarifier unless the oil contains very little or no water. A small amount of water can be satisfactorily accumulated, together with the solids, to be drained out when the bowl is stopped for cleaning. However, if there is any appreciable amount of water in the oil, the bowl should be operated as a separator.

TYPES OF CENTRIFUGAL PURIFIERS

There are two types of purifiers used in Navy installations. Both types operate on the same principle. The principal difference in the two types of purifiers is in the design of the rotating units. In one type the rotating element is a bowl-like container which encases a stack of disks and in the other type the rotating element is a hollow, tubular rotor; thus, they are known as the DISK-TYPE PURIFIER and the TUBULAR-TYPE PURIFIER.

A sectional view of a disk type centrifugal purifier is shown in figure 9-6. The bowl is mounted on the upper end of the vertical bowl spindle, which is driven by means of a worm wheel and friction clutch assembly. A radial thrust bearing is provided at the lower end of the bowl spindle to carry the weight of the bowl spindle and to absorb any thrust created by the driving action.

The parts of a disk-type bowl are shown in figure 9-7. The flow of oil, through the bowl and additional parts, is shown in figure 9-8.

Contaminated oil enters the top of the revolving bowl through the regulating tube. The oil then passes down the inside of the tubular shaft and out at the bottom into the stack of disks. As the dirty oil flows up through the distribution holes in the disks, the high centrifugal force exerted by the revolving bowl causes the dirt, sludge, and water to move outward and the purified oil inward toward the tubular shaft. The disks divide the space within the bowl into many separate narrow passages or spaces. The liquid confined within each passage is restricted so that it can only flow along that passage. This arrangement prevents excess agitation of the liquid as it passes through the bowl and creates shallow settling distances between the disks.

Most of the dirt and sludge remains in the bowl and collects in a more or less uniform layer on the inside vertical surface of the bowl shell. Any water, along with some dirt and sludge, separated from the oil, is discharged

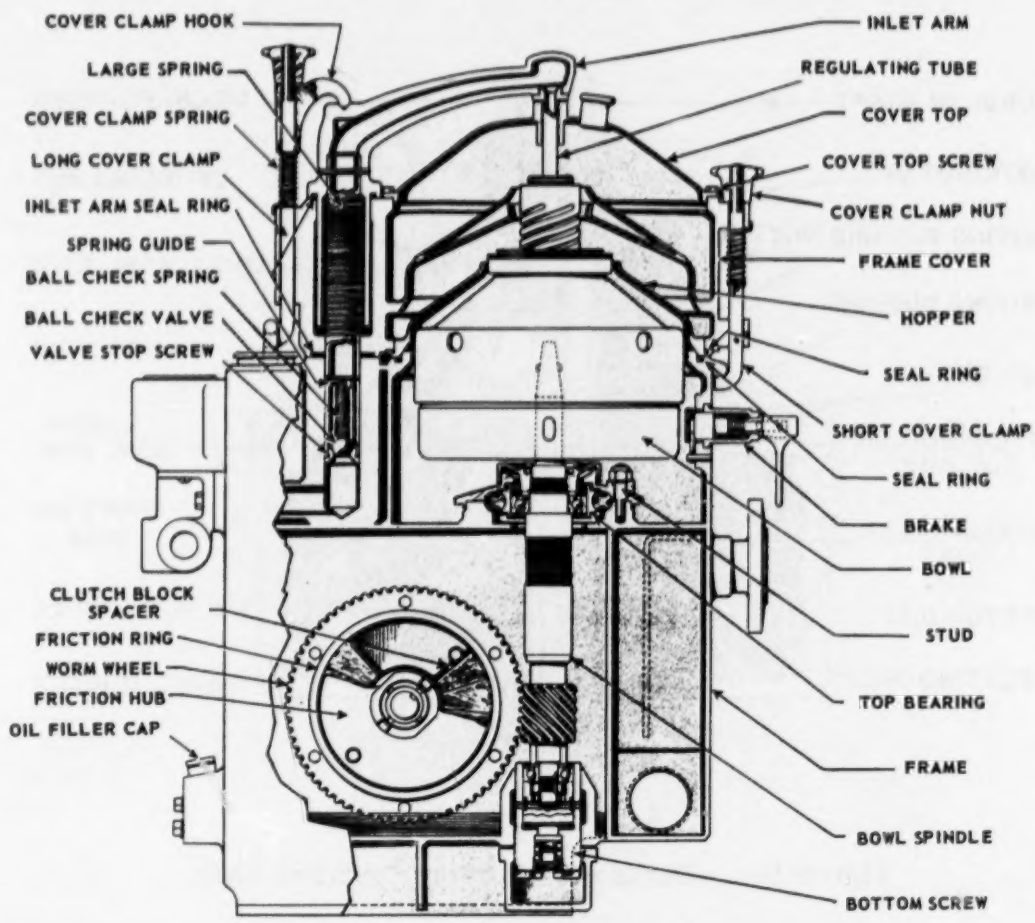

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Figure 9-6.—Disk-type centrifugal purifier.

through the discharge ring at the top of the bowl. The purified oil flows inward and upward through the disks, discharging from the neck of the top disk (fig. 9-8.)

A cross section of a tubular-type centrifugal purifier is shown in figure 9-9. This type of purifier consists essentially of a hollow rotor or bowl which rotates at high speeds. The rotor has an opening in the bottom to allow the dirty lube oil to enter and two sets of openings at the top to allow the oil and water (separator) or the oil by itself (clarifier) to discharge (see insert, fig. 9-9). The bowl, or hollow rotor, of the purifier is connected by a coupling unit to a spindle which is suspended from a ball bearing assembly. The bowl is belt-driven by an electric motor mounted on the frame of the purifier.

The lower end of the bowl extends into a flexibly mounted guide bushing. The assembly, of which the bushing is a part, restrains movement of the bottom of the bowl, but allows sufficient movement so that the bowl can center itself about its center of rotation when the purifier is in operation. Inside the bowl is a device consisting essentially of three flat plates equally spaced radially. This device is commonly referred to as the three-wing device, or just the three-wing. The three-wing rotates with the bowl and forces the liquid in the bowl to rotate at the same speed as the bowl. The liquid to be centrifuged is fed into the bottom of the bowl through the feed nozzle, under pressure, so that the liquid jets into the bowl in a stream.

When the purifier is used as a lube oil clarifier, the three-wing has a cone on the bottom, against which the feed jet strikes in order to bring the liquid up to bowl speed smoothly without making an emulsion. Both types of three-wing devices are shown in figure 9-10.

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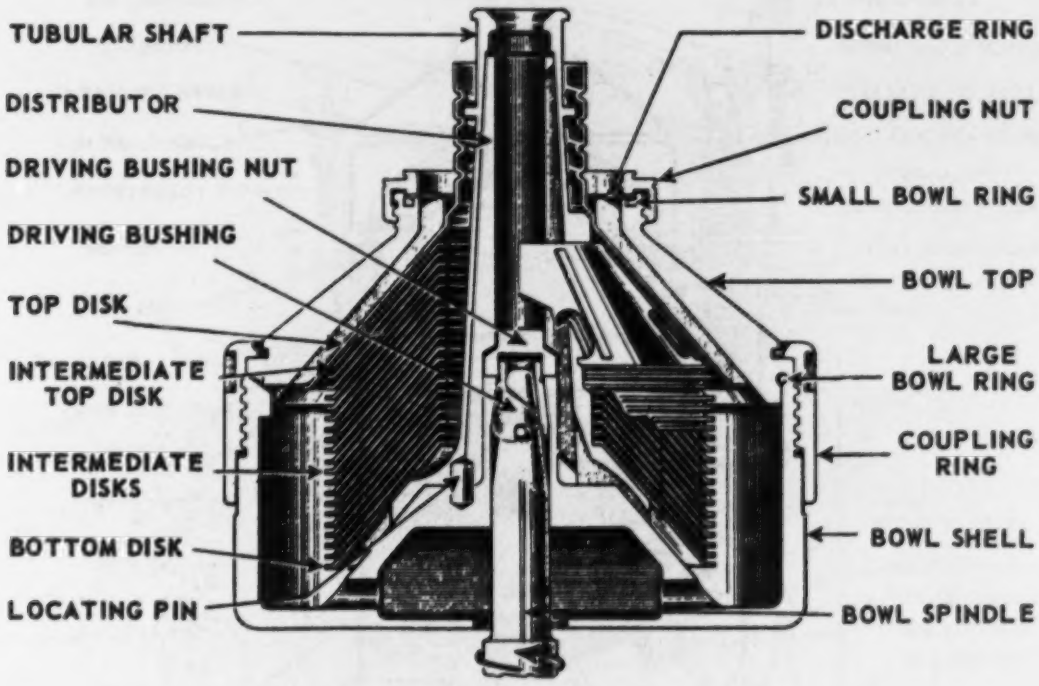

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Figure 9-7.—Parts of a disk-type purifier bowl.

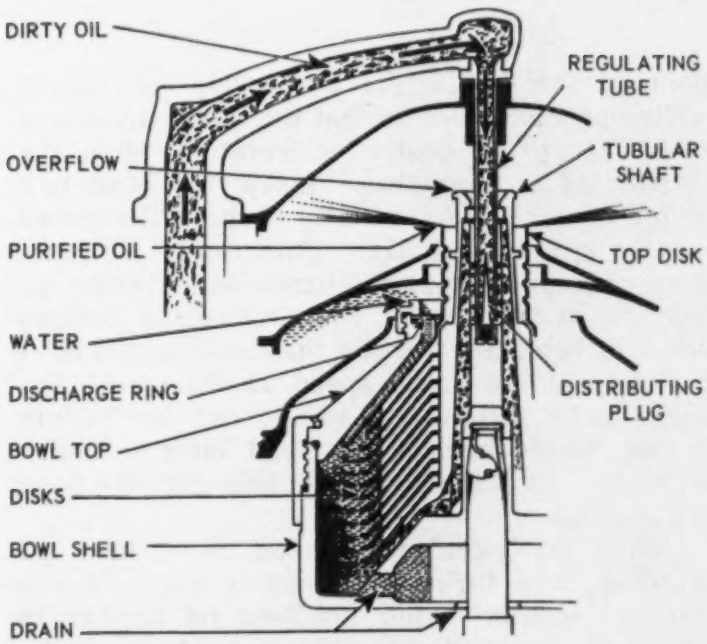

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Figure 9-8.—Path of contaminated oil through disk-type purifier bowl (De Laval).

The process of separation is basically the same in the tubular-type purifier as in the disk-type purifier. In both types, the separated oil assumes the innermost position and the separated water moves outward. Both liquids are discharged separately from the bowls, and the solids separated from the liquid are retained in the bowl (fig. 9-11).

GENERAL NOTES ON PURIFIER OPERATIONS

The specific details for operating a given purifier should be obtained from the appropriate instructions provided with the unit. Information provided here is, in general, applicable to both types of purifiers.

For maximum efficiency, purifiers should be operated at maximum designed speed and rated capacity. Since turbine oils are always contaminated with water of condensation, the purifier bowls should be operated as separators and not as clarifiers. An exception to operating a purifier at designed rated capacity is when a unit is used as a separator of 9000 series (compounded or additive-type-heavy-duty lube

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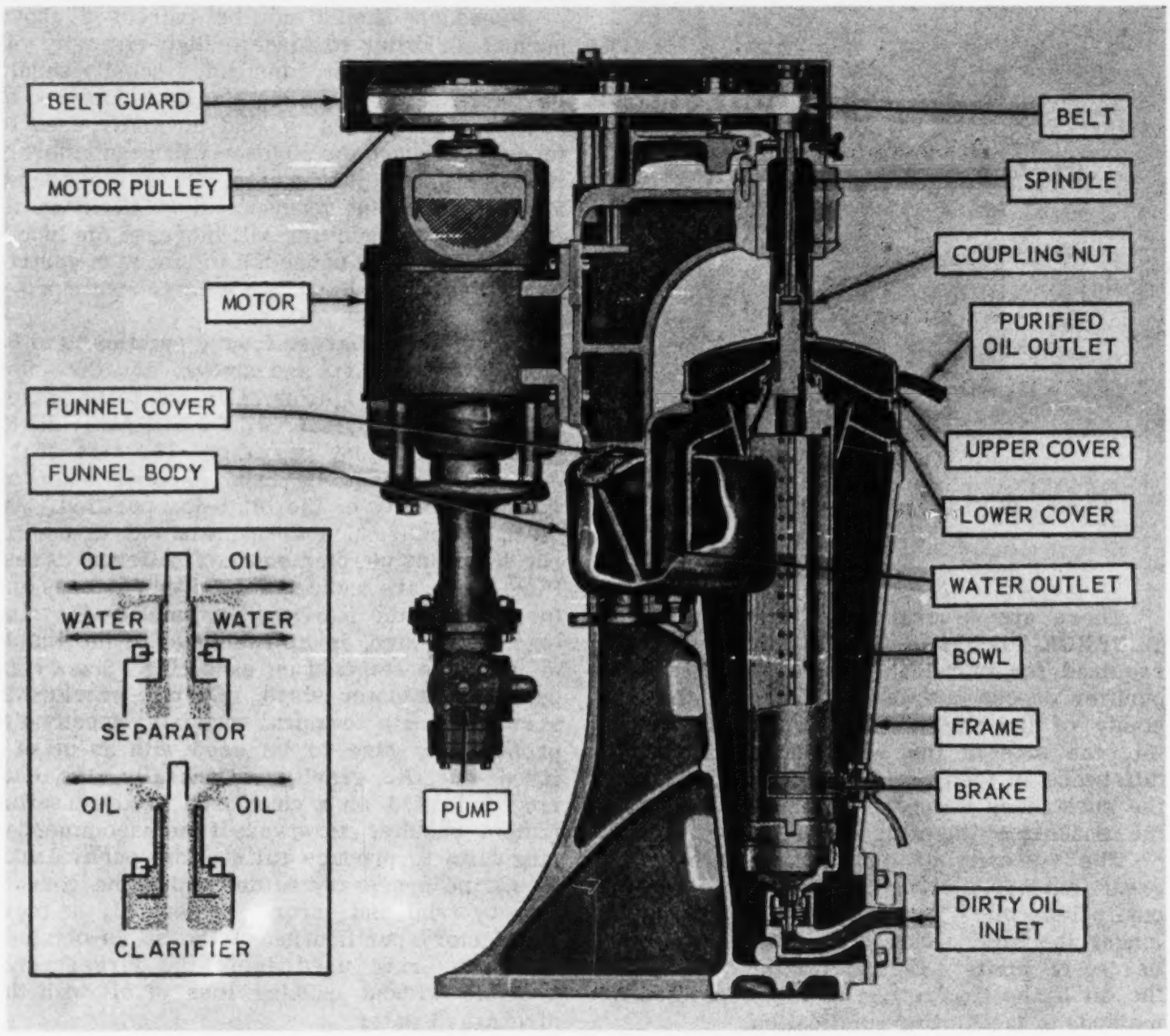

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Figure 9-9.—Tubular-type centrifugal purifier.

oils) detergent oil. Some engine installations using oils of the 9000 series are exposed to large quantities of water. If the oil becomes contaminated with water, the oil has a tendency to emulsify. The tendency to emulsify is most pronounced when the oil is new, and gradually decreases during the first 50 to 75 hours of engine operation. When an emulsion appears, the purifier should be reduced to approximately 80 per cent of the rated capacity and operation continued as long as an appreciable amount of free water discharges along with the emulsion.

When a purifier is operated as a separator, PRIMING OF THE BOWL with fresh water is essential before any oil is admitted to the purifier. The water serves to seal the bowl and to create an initial equilibrium of liquid layers. If the bowl is not primed, the oil will be lost through the water discharge ports.

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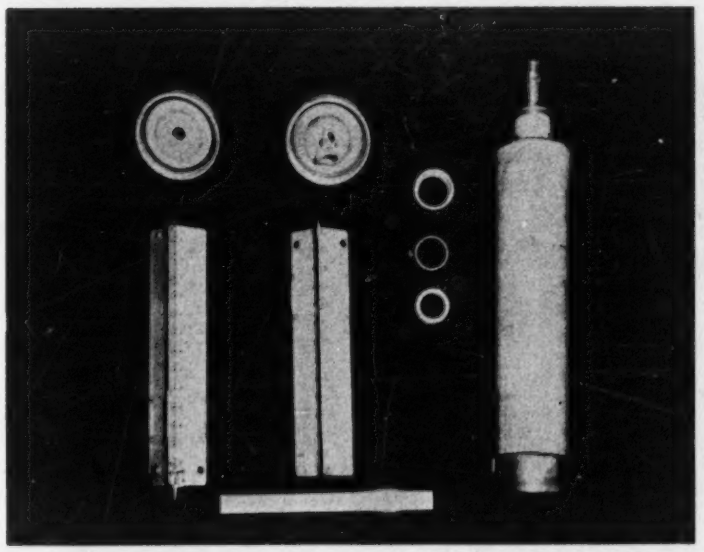

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Figure 9-10.—Parts of a tubular-type purifier bowl.

There are several FACTORS WHICH INFLUENCE PURIFIER OPERATION. The time required for purification and the output of a purifier depend upon such factors as the viscosity of the oil, the pressure applied to the oil, the size of the sediment particles, the difference in the specific gravity of the oil and the substances which contaminate the oil, and the tendency of the oil to emulsify.

The viscosity of the oil determines to a great extent the length of time required to purify lube oil. The more viscous the oil, the longer the time required to purify it to a given degree of purity. Decreasing the viscosity of the oil by heating is one of the most effective methods of facilitating purification.

Even though certain oils may be satisfactorily purified at operating temperatures, a greater degree of purification will generally result by heating the oil to a higher temperature. To accomplish this, the oil is passed through a heater where the proper temperature is obtained before the oil enters the purifier bowl.

Oils used in Naval installations may be heated to temperatures specified in chapter 9450 (45) of the Naval Ships Technical Manual without adverse effects, but prolonged heating at higher temperatures is not recommended because of the tendency of such oils to oxidize. Oxidation results in rapid deterioration. In general, oil should be heated sufficiently to produce a viscosity of approximately 90 seconds, Saybolt Universal (90 SSU).

Pressure should not be increased above normal in order to force a high-viscosity oil through the purifier. Instead, viscosity should be decreased by heating the oil. The use of pressure in excess of that normally used to force oil through the purifier will result merely in less efficient purification. On the other hand, a reduction in the pressure at which the oil is forced into the purifier will increase the length of time the oil is under the influence of centrifugal force, and therefore will tend to improve results.

If the oil discharged from a purifier is to be free of water, dirt, and sludge, and the water discharged from the bowl is not to be mixed with oil, the PROPER SIZE DISCHARGE RING (RING DAM) must be used. The size of the discharge ring to be used depends upon the specific gravity of the oil being purified. All discharge rings have the same outside diameter, but have inside diameters of different sizes. Ring sizes are indicated by even numbers and the smaller the number, the smaller the ring size. The size, in millimeters, of the inside diameter is stamped on each ring. Sizes vary by two-millimeter steps. Charts, provided in manufacturer's technical manuals, specify the proper ring size to be used with an oil of a given specific gravity. Generally, the size ring indicated on a chart will produce satisfactory results. However, if the recommended ring fails to produce satisfactory purification, it will be necessary to determine the correct size by trial and error. In general, the most satisfactory purification of the oil is obtained when the ring used is of the largest size possible without causing loss of oil with the discharged water.

MAINTENANCE OF PURIFIERS

Proper care of an oil purifier requires that the bowl be cleaned frequently and all sediment carefully removed. The frequency of cleaning depends upon the amount of foreign matter in the oil to be purified. If the amount of foreign matter in an oil is not known, the machine should be shut down for examination and cleaning once during each watch, or more often if necessary. The amount of sediment found in the bowl at this time will give an indication as to how long the purifier may be operated between cleanings. The bowl should be thoroughly

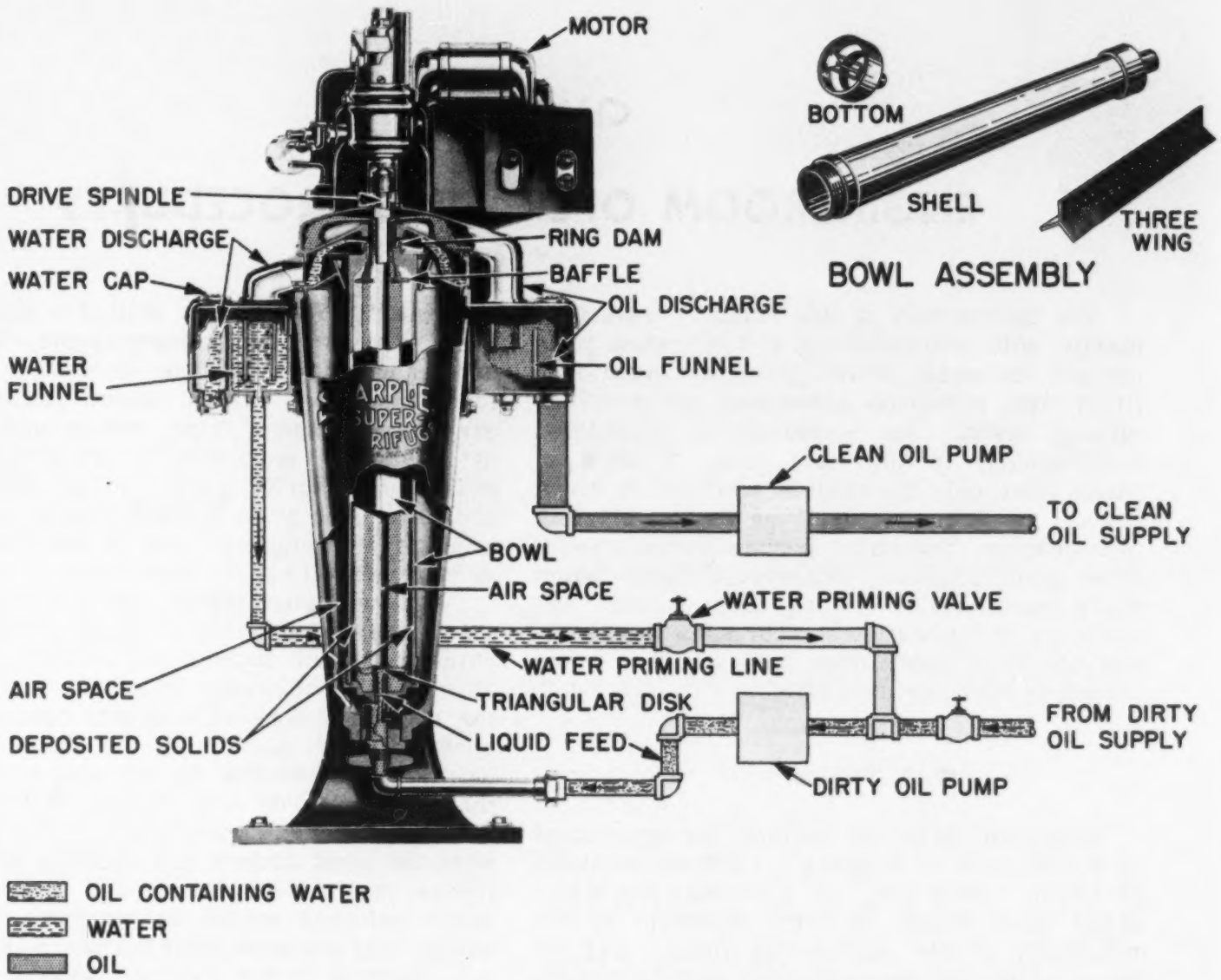

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Figure 9-11.—Path of contaminated oil through a bowl type purifier (Sharples).

cleaned each time lube oil is run through for batch purification from the settling tank.

Periodic tests should be made to ensure that the purifier is working properly. Tests should be made at intervals of about 30 minutes when the oil in the system is being purified by the batch process. When the continuous process of purification is used, tests should be made once a watch. If these tests show oil free of water and sediment, the purifier may be operated at the rate of 12 hours per day and cleaned once a watch.

The general efficiency of the purifier may be determined by observing the clarity of the purified oil and the amount of oil in the separated water.

Purifiers should be tested and inspected in accordance with the 3-M planned maintenance system requirements.

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CHAPTER 10

ENGINEROOM OPERATING PROCEDURES

The information in this chapter deals primarily with watchstanding and operating procedures for steam-driven propulsion machinery fitted with reduction gears and motor-driven turning gear. The steam-driven propulsion installations, in the Navy, vary to such an extent that only general information is given here. In addition to studying the material in this chapter, you must become familiar with those manufacturers' technical manuals which apply specifically to each main turbine and auxiliary unit installed on your ship, the standard operating procedures, and specific orders issued by your engineer officer.

WATCHSTANDING

Every watch in the engineering department is a vital part of an operation and maintenance program. How you, as a Machinist's Mate, stand your watch is very important to the reliability of the engineering plant. Certain types of machinery casualties may be caused by radical maneuvering of the ship or prolonged high speeds but there are times when such casualties reflect inadequate training, improper watchstanding, and too little preventive maintenance. Proper watchstanding and preventive maintenance always pay; you will spend less time tearing down machinery for overhaul. To properly stand an engineroom watch, you must be skilled in detecting unusual noises, vibrations, or odors which may indicate faulty machinery operation, as well as in taking appropriate and prompt corrective measures. You must be ready, in emergencies, to act quickly and independently; you must know the ship's piping systems and HOW, WHERE, and WHY they are controlled. You must know each piece of machinery: How it is constructed, how it operates, how it fits into the engineering plant, and where its related equipment is controlled. You must be skilled in reading and interpreting measuring instruments. You must understand how and why protective devices function (relief valves, speed limiting governors, overspeed trips, cut-in and cut out devices). You must remove fire hazards, stow gear that is adrift, and keep floor plates clean and dry. You must NEVER attempt to operate a piece of equipment that is defective. You must report all unsafe conditions.

Whatever your watch, you are responsible for knowing the status of every piece of machinery at your station, for promptly handling any necessary change in speed or setup, and for recording correctly all data concerning the operation and maintenance of the machinery. You must be sure that the log is up to date, that the status boards are correct, that you know what machinery is operating, and that you know what the night orders and standing orders are before you relieve the watch. Reporting the watch relieved means to the petty officer in charge that you know what the score is and have the situation under control. DON'T TRY TO RELIEVE THE WATCH FIRST AND FIND OUT THE SCORE LATER.

Your duties while on watch include not only the proper operation, care, and emergency repair of machinery in your charge, but also the recording of pertinent data on standard or ship forms provided for the purpose. It is essential, therefore, that you know what logs and records are kept, how to take the readings, when to take readings, and what should be immediately entered on the bell sheet or reported to the officer of the watch (OOW) for recording in his log.

The duties of the various watches vary in accordance with the size and type of ship, the layout of the ship, and the type of machinery installed. In general, Machinist's Mates stand watches at the main engine control station, at telephones, or miscellaneous engineroom

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machinery, on pumps and condensers, on compressors, on evaporators, on refrigeration machinery, in the steering engineroom, and in repair parties. Wherever you are on watch, you must know how to set various conditions of material readiness, and how to arrange split-plant and cross-connected operations at your station. Before standing any watch in the machinery spaces, familiarize yourself with the posted operating instructions and safety precautions for the particular pieces of machinery and equipment at your watch station.

As an MM3 or MM2, you must be able to stand the main engine control watch. This duty requires a thorough knowledge of control valve operating procedures and their use in conjunction with steam pressure and temperature, and ship's speed; a thorough knowledge of correct readings for control board gages, to detect instantly any abnormality; a knowledge of acceleration and deceleration tables; advanced knowledge of safety precautions pertaining to the main engines and associated auxiliaries, and the steps to be taken in cases of material casualty; and a general knowledge of fireroom operations insofar as they concern the engineroom operation.

Orders from the bridge relative to movement of the propellers must be complied with immediately. To make correct adjustments for the required speed you must keep a close watch on the rpm indicator on the control board and open and close the control valves as required to attain or maintain the necessary rpm. In addition to handling the controls, you may also have to operate various associated valves, accurately log all speed changes in the Engineer's Bell Book (fig. 10-1), visually check all gages (pressure, temperature, vacuum, etc.) installed on the control board, and keep the petty officer in charge informed of any abnormal gage readings.

The Engineer's Bell Book, NavShips 116, shown in figure 10-1, is a record of all bells, signals, and other orders received by the throttleman regarding movement of the ship's propellers. Entries are made in the Bell Book by the throttleman (or an assistant) as soon as an order is received. Entries may be made by an assistant when the ship is entering or leaving port, or engaging in any maneuver which is likely to involve numerous or rapid speed changes. This procedure allows the throttleman to devote his undivided attention to answering the signals.

The Bell Book is maintained in the following manner:

1. A separate bell sheet is used for each shaft each day, except that where more than one shaft is controlled by the same control station, the same bell sheet is used to record the orders for all shafts controlled by the station. All sheets for the same date are filed together as a single record.

2. The time of receipt of the order is recorded in column number 1 (fig. 10-1).

3. The order received is recorded in column number 2. Minor speed changes (generally received via revolution telegraph) are recorded by entering the number of rpm ordered. Major speed changes (normally received via engine order telegraph) are recorded using the following symbols:

1/3—ahead 1/3 speed
2/3—ahead 2/3 speed
I—ahead standard speed
II—ahead full speed
III—ahead flank speed
Z—stop
B1/3—back 1/3 speed
B2/3—back 2/3 speed
BF—back full speed
BEM—back emergency speed

4. The number of revolutions corresponding to the major speed change ordered is entered in column 3. When the order received is recorded as rpm in column 2 (minor speed changes), no entry is made in column 3.

5. The shaft revolution counter reading (total rpm) at the time of the speed change is recorded in column 4. The shaft revolution counter reading—as taken hourly on the hour, while underway—also is entered in column 4.

Ships and craft equipped with controllable reversible pitch propellers record in column 4 the propeller pitch in feet and fractions of feet set in response to a signaled speed change, rather than the shaft revolution counter readings. The entries for astern pitch are preceded by the letter B.

Before going off watch, the engineering officer of the watch signs the Bell Book in the line following the last entry for his watch and the next officer of the watch continues the record immediately thereafter. In machinery spaces where an engineering officer of the watch is not stationed, the bell sheet is signed

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ENGINEER'S BELL BOOK—ALL VESSELS
NavShips 116 (Rev 11-56)

ENGINEER'S BELL BOOK

(SEE INSTRUCTIONS ON COVER)

U. S. S. SAMPLE (DRT-1) SHAFT NO(S). ONE (1) DATE 6 JUNE 19--

En route from NORFOLK, VIRGINIA to CADIZ, SPAIN

Record of all "BELLS," SIGNALS, and ORDERS received regarding movement of propellers this date

TIME ZONE DESCRIPTION +5 QUEBEC AND +4 PAPA Clocks set ~~back~~ ahead 1 hrs. 0 min., at 2300

(1) TIME	(2) SIGNAL	(3) R. P. M.	(4) COUNTER OR PITCH SET	(1) TIME	(2) SIGNAL	(3) R. P. M.	(4) COUNTER OR PITCH SET	(1) TIME	(2) SIGNAL	(3) R. P. M.	(4) COUNTER OR PITCH SET
16	ENGAGED TURNING GEAR		214622								
16	MECHANICAL COUNTER		999210								
1742	DISENGAGED TURNING GEAR		214631								
1744	TESTED MN. ENGINE		214634								
1758	UNDERWAY		214651								
1800	COUNTER		214660								
1801	1/3	32	214660								
1803	2/3	70	214730								
1804	Z		214738								
1805	B2/3		214870								
1805	Z		214883								
1805	BF		214891								
~~1810~~	~~Z~~	~~B.J.M.~~	~~214891~~								
1808	Z		214999								
1810	1/3	32	215030								
1814	2/3	70	215151								
~~1900~~	~~B.J.M.~~										
19	COUNTER		218343								
1902	I	110	218500								
1920	122		220480								
B. J. Manteen LT USN											
20	COUNTER		225360								
2009	110		226352								
21	COUNTER		232952								
22	COUNTER		239552								
J. M. Houke LTJG USN											
24	COUNTER		246150								
J. Morrow Ens, USN											

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Figure 10-1.—Engineer's Bell Book.

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by the watch supervisor. The Bell Book is a legal record and alterations or erasures are not permitted. An incorrect entry is corrected by drawing a single line through the entry and recording the correct entry on the following line. Deleted entries are initialed by the engineering officer of the watch or watch supervisor, as appropriate.

PROCEDURE FOR PLACING PLANT IN READINESS FOR GETTING UNDERWAY

The engineroom operating procedures which follow, include the steps usually taken in operating geared turbine installations on ships with two enginerooms.

A general checkoff sheet or table of instructions to be followed in getting a turbine installation ready for getting underway is usually provided on each ship. These instructions and the specified times of accomplishment of various items will differ from ship to ship in accordance with the type of installation, the particulars of machinery design, the particulars of machinery arrangement, and with the instructions issued by the engineer officer. The steps included in the following list are representative of those to be taken in placing a particular steam-driven propulsion plant in readiness for getting underway.

1. Take and record turbine rotor positions, enter in log specifying cold readings.
2. Back off throttle valves and reseat lightly.
3. Operate hand nozzle control valves.
4. Open all funnel drains on main steam line and turbine valve chest. (When steam blows through, close funnel drains and cut in high pressure drain traps.)
5. Have Electrician's Mates energize and test all power and I.C. circuits.
6. Check oil levels in sump, pumps, and main shaft bearings.
7. Check cooling main, ensure adequate cooling water to all auxiliary machinery.
8. Assure proper temperature of oil and start a lube oil service pump. Check oil delivery to all bearings and check lube oil system for leaks.
9. Energize and test low pressure lube oil alarm. Warm up standby lube oil service pump and test automatic cut-in devices.
10. Cut in cooling water to stern tubes, allow a small amount of water to leak through gland.
11. With permission from the officer of the deck (OOD), engage turning gear (jacking gear) and start turning main engines.
12. Open main injection and overboard discharge valves, vent main condenser.
13. Start main circulating pump. Do not operate with less than 125 to 150 psi steam chest pressure.
14. Start a main condensate pump, recirculate condensate through the air ejector condenser back to the main condenser.
15. Cut in steam to main turbine gland seal and start gland exhaust fan.
16. Cut in steam slowly to second stage of main air ejectors.
17. Warm up one main feed booster pump and one main feed pump.
18. Shift from emergency feed pump to main feed pump. (Secure emergency feed pump in standby condition.)
19. Open wide the bypasses on the main steam bulkhead stop and main engine guarding valve.
20. Start warming up the main steam line by cracking open the main steam boiler stop valve bypass.
21. Open the drains from the whistle and cut in steam to the whistle slowly.
22. When main condenser vacuum reaches 20 inches, shift auxiliary exhaust and low pressure drains to main condenser.
23. Have Electrician's Mates test steering engines and anchor windlass. Report results of tests to main control.
24. Warm up and test standby auxiliary machinery: condensate pump, main feed booster pump, and main feed pump.
25. Warm up an additional ship's service turbogenerator.
26. When the required number of boilers are on the line, split the following systems: main steam (if applicable), auxiliary steam, 150 psi steam, auxiliary exhaust, high pressure drains, low pressure drains, main condensate, makeup feed, fireman, inspection tank (fuel oil heater) drains, and (if applicable) turbogenerator steam. Parallel and then split the electrical load.
27. Man the 1JV and 2JV phones in all main propulsion spaces.
28. Request permission from the OOD to test main engines.

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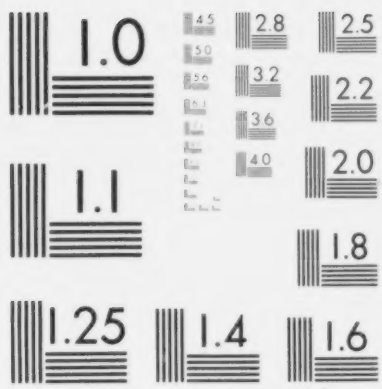

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

29. Stop and disengage the turning gear, open wide the main steam bulkhead stop and the main engine guarding valve 3 turns.
30. Test the main engines by spinning astern and then ahead.
31. When main engines have been tested satisfactorily, open wide the main engine guarding valve and bulkhead stops. Report engineering department readiness for getting underway to the OOD and to the engineer officer. Then cut steam into the first stage of the main air ejectors.
32. Request permission from the OOD to spin main engines every 3 to 5 minutes, and record for entry in the smooth log.
33. Take and log main engine "hot rotor position" readings.
34. Get underway when ordered.
35. Close main turbine drains.

NOTE: Information related to some of the preceding steps in the procedures for warming up the main plant is identified as step 1, step 2, etc., and is given for cross-reference.

For details on taking turbine rotor position readings (step 1), refer to chapter 3 of this training course.

Steps 6, 8, and 9 deal with lubrication and the main plant lubrication system. A review of chapter 9 of this training course before studying the information in the following paragraphs will be helpful at this point.

When preparing to get underway, the first step in connection with lubrication is to check the amount of oil available. A float gage indicates the oil level (in gallons) in the main engine sump. Dip sticks are used to check the oil level in auxiliary machinery sumps and main shaft bearings. The need for cleanliness, at all times, in the operation of lubricating systems must be constantly kept in mind. Lubricating oil will lose its lubricating qualities if it is contaminated; if the impurities (water or other foreign matter) are removed, the oil can be used over and over. The entire lubrication system must be given constant careful attention to ensure that the oil is kept free of foreign matter.

Each time a lubrication system is put into operation, all parts of the system must be in satisfactory operating condition; to ensure that it is, proceed as follows:

a. Take and record the oil level.
b. Inspect and clean strainers.
c. Start a lube oil service pump and maintain the designed pressure throughout the system. Automatic cut-in devices for all lube oil service pumps should be tested. Motor-driven pumps should be tested on alternate sources of power. Turbine-driven pumps should be operated satisfactorily on their constant pressure governors.
d. The temperature of the oil supplied to the main engines and reduction gears must be at least 90° F before the unit is turned over. If the oil is below this temperature, it can be heated by use of the purifier heater, by use of sump heaters, or by use of the auxiliary exhaust connection to the lube oil cooler, depending upon the arrangement.
e. An adequate supply of cooling water must, at all times, be available to the lube oil cooler. When the cooler is put into use, open wide the cooling water inlet valve, open the cooling water vent valves until all air is expelled, then close the vent valves. After the oil leaving the cooler reaches 120° F, regulate the temperature of the oil by opening or closing down on the overboard valve.
f. Observe pressure gages to determine that oil pressure is correct, and pour into sight flow fittings to ascertain that oil is flowing through the bearings. Inspect the lubricating system for leaks. Any trouble found must be corrected.
g. Test the emergency cooling connections, if fitted.
h. Test the low lube oil pressure alarm by decreasing the oil pressure until the alarm sounds. If the alarm does not sound at the proper pressure, remedy the defect at once.
i. While underway, draw a sample of oil at least once each watch, from the sump or from the strainer in use. Compare the sample with previous samples to determine whether any water has collected in the system. To test the operation of the purifier, draw a sample of oil from the purifier test cock. Check for water or other impurities by comparing sample with previous samples.

Step 11. Never turn the main engines over without permission of the officer of the deck. A screw may hit a boat, barge or some other floating object or a mooring line or wire may

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be in a position to foul the screw. The officer of the deck will ensure that the area near the screws is clear before granting permission to turn the main engines.

Step 13. When operating in cold water, standing by, or steaming at slow speeds, the cooling water requirements for the main condenser are greatly reduced. However, the main circulating pump MUST NOT be operated with less than 125 to 150 psi steam chest pressure. At a steam pressure less than 125 to 150 psi the speed of the pinion-driven oil pump will not be high enough for the pump to deliver an adequate supply of oil to the lubrication system of the driving unit.

Steps 15 and 16. Never cut in gland sealing steam until the turning gear is engaged and started. The gland exhauster and the second stage of the main air ejector should be placed in operation just prior to, or simultaneously with, the admission of gland sealing steam. The first stage of the main air ejectors should not be placed in operation until after the turning gear has been disengaged.

Steps 18-20. When the steaming boiler is receiving feed water from the main feed pump, the auxiliary or emergency feed pump may be secured in a standby condition. In the event of a main feed casualty, the emergency feed pump is ready for immediate use and can prevent a loss of ship's electrical power or a boiler casualty.

Under normal warming-up conditions, the main steam stop bypass valve should not be opened until the main feed pump is feeding the boiler. This reduces the load that would otherwise be put on the emergency feed pump.

The procedure for warming the main steam line will vary from ship to ship. On most combatant ships the procedure is as follows:

a. Open (1 to 1 1/2 turns) the low pressure (funnel) drain valves.
b. Open the bypass valves on the main engine guarding valve, the bulkhead or line stop valve(s), and the main steam split-plant valve.
c. Crack open the bypass valve on the main steam boiler stop valve.
d. When the pressure in the main steam line reaches 50 psi, cut in the high pressure drain traps and secure the low pressure (funnel) drains.
e. When the plant is split, secure the bypass on the main steam split-plant valve.
f. When permission has been granted to test main engines, open the main steam boiler stop valve and the line or bulkhead stop or stops. The turning gear must be stopped and disengaged before the main engine guarding valve is opened. Open the guarding valve and bulkhead stop ONLY 3 TURNS; this serves as a safety measure in the event that a casualty occurs. For example, if a nozzle control valve or astern throttle sticks open while the main engines are being tested, the main engine guarding valve or bulkhead stop can be closed very quickly, from the 3-turn position. When engines have been tested satisfactorily, open bulkhead stop and guarding valve wide.

WARMING UP THE MAIN TURBINES

In warming up a turbine it is well to remember that the rotor and the casing must be evenly heated; otherwise, unequal expansion will take place and will produce distortion of the rotor or the casing or both. The results of such distortion are not as noticeable in small turbine installations as in large installations; however, the cumulative effect of distortions due to temperature change and unequal expansion is very noticeable, and unless extreme care is taken, serious damage, such as rubbing of blades or packing, will result.

When you are standing watch in the engineroom you should be able to detect any unusual rubbing or grinding sounds and be able to locate the trouble quickly. At any time that an unusual noise is detected, the turbine should be stopped immediately in order to prevent damage to the installation. No unusual sound is so trivial that it can be neglected. A listening rod will be helpful in detecting faint or indistinct sounds.

Two procedures are used in the warming up of a turbine: turning the turbine; and spinning the turbine. The turning procedure is used during a normal warming up; the spinning procedure is used when the ship is standing by to get underway and the turning gear has been disengaged.

Turning the Main Engines

During warming up or cooling-off of the turbine, the rotor must not be permitted to remain at rest for any appreciable time while

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steam (including gland steam) is being admitted to the turbine. The turning gear should be put into operation to turn the turbine rotor before steam is admitted to the turbine glands.

Spinning the Main Engines

After the main engines have been tested satisfactorily and while you are waiting to answer bells, the main engines must be turned by steam. The engines are spun astern and then ahead, to prevent putting way on the ship. Spinning the engines by steam not only heats the turbines and their casings, but also prevents the rotors from becoming bowed. When the turbine is ready to be rolled, open the throttle wide enough to admit sufficient steam to start the rotors turning. If the rotor does not turn, steam will hit only a small portion of the blading and cause uneven heating.

PROCEDURES FOR STANDING BY

When orders are received to stand by, the procedure to be followed will depend on the length of time that the ship is to remain in "stand by" condition.

Standing By Indefinitely

When a ship is standing by for an indefinite period of time, the condition of the main propulsion plant will depend upon how much time has been allowed to change from "stand by" condition to "ready to answer bells" condition. The principal variations will be in the number of boilers left on the line, the number of auxiliaries in use, and whether or not the plant will be cross-connected. If the ship is standing by for an hour or more the following steps may be taken:

1. Close the main engine guarding valve.
2. Secure the first stage of the main air ejectors.
3. Engage and start the turning gear.
4. Cross-connect the main plant and secure all boilers that are not necessary. (On a large ship having four screws, a two-plant setup may be used, the two forward plants cross-connected with one boiler steaming and the two after plants cross-connected with one boiler steaming. In this setup, the systems will remain split between the two forward plants and the two after plants. On a destroyer, or other small ship, only one boiler is necessary.)
5. Use one lube oil service pump in each engineroom, maintain the required lube oil pressure to the bearings and reduction gears.
6. Maintain the required lube oil temperature.
7. Maintain the gland sealing steam at 1/2 to 2 psi.
8. Run the main circulating pump, using 125 to 150 psi steam chest pressure.
9. Use one main feed booster pump and one main feed pump to feed the steaming boiler.
10. Close the main steam boiler stop valve on the steaming boiler; open the main steam bypass valve. (If the turbo-generators receive steam from the main steam line, the main steam boiler stop valve will remain open.) Every effort should be made to operate the plant economically, the main feed pump discharge pressure can be lowered to about 75 psi higher than boiler operating pressure. Drain valves from the main steam line and main engines should be cracked open; however do not open low pressure funnel drains an excessive amount, because this wastes feed water, causes high fuel oil consumption, and raises the temperature of the engineroom.

Standing By On
Thirty-Minute Notice

When a ship is standing by with orders to get underway in thirty minutes, the following steps may be taken:

1. Close the main engine guarding valve.
2. Engage and start the turning gear.
3. Secure the first stage of the main air ejectors.

NOTES ON TURBINE OPERATION

Underway procedures must be carried out in a manner that enables the ship to accomplish its mission with the greatest operating economy possible. Economical and efficient operation of a propulsion plant, under varying conditions and speeds, necessitates the maintenance of a

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high vacuum and the proper use of the cruising and maneuvering combinations.

IMPORTANCE OF HIGH VACUUM

In order to attain the greatest operating economy, the vacuum for which the turbine was designed must be maintained. Therefore, you should realize the necessity for the prevention and detection of air leaks in the vacuum system.

When the steam pressure within the turbine is greater than atmospheric pressure, steam tends to leak out of the turbine to the surrounding atmosphere. On the other hand, when the pressure in the turbine is less than that of the atmosphere, air tends to leak into the turbine and impair the vacuum. To prevent air leakage into the turbine and steam leakage from the turbine, steam is led to the glands and the pressure on the glands is maintained slightly greater than that of the atmosphere, generally 1/2 to 2 psi.

To ensure that the optimum vacuum will be maintained, care must be taken that the astern throttles do not leak; any leakage of steam past a closed throttle tends to raise the temperature and to increase the pressure within the turbine.

If the following precautions are observed, there will be little difficulty in maintaining the prescribed vacuum:

1. Gland packing must be kept in good condition.
2. A steam pressure between 1/2 and 2 psi must be maintained on the glands when the turbines are in operation.
3. There must be no air leaks in the condenser, exhaust trunks, throttles, lines to air ejectors, gage lines, idle condensate pump packing and valves, makeup feed lines, etc.
4. Adequate water must be maintained in the feed tank on which the vacuum drag is being taken.

CRUISING COMBINATIONS

A combatant ship operates most of the time at speeds far below the maximum; at cruising speeds, therefore, there is required only a fraction of the power for which the main turbines are designed. Operating economy at these lower speeds is attained (1) by the use of cruising turbines, which are specially designed to operate at reduced speeds, or (2) by the use of cruising stages in the high pressure turbines, and (3) by arranging the turbines so that they can be run in series. The cruising combinations should be used whenever the standard speed is such that the combination can furnish the required number of revolutions.

PROTECTION OF CRUISING TURBINES

Protective devices and indicating instruments are required to prevent casualties to cruising turbines. Devices and instruments installed on cruising turbines for this purpose include sentinel valves, relief valves, retard-compound gages, direct reading thermometers, and thermal alarms.

When a ship is operating on cruising turbine combination, the following precautionary measures should be taken at frequent intervals to prevent casualties to the cruising turbine.

1. Be sure that the crossover valve is fully shifted to the proper combination.
2. Check the retard-compound gage to be sure that the safe operating pressure is not exceeded.
3. Check the sentinel valve frequently. If there is steam blowing from the sentinel valve, the safe operating pressure is being exceeded.

TURBINE VIBRATION

If a turbine begins to vibrate as its speed is increased, the turbine should be slowed down immediately. If the vibration ceases at a lower speed, maintain that speed for several minutes; then attempt to build up the speed again. If no further vibration is noted, it may be assumed that the trouble was probably due to unequal heating of the rotor or to an accumulation of water in the turbine. If the vibration does not cease at a lower speed the turbine must not be used, except in an emergency; and steps must be taken immediately to locate and remedy the trouble. If, after the turbine has been running at a reduced speed for some time, the vibration again occurs at the higher speed, a speed limit lower than that at which vibration occurs must be set; and this reduced speed must not be exceeded until the trouble has been eliminated.

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USE OF NOZZLES

In all modern installations, the flow of steam to the cruising and high pressure turbines is controlled by cam-operated nozzles or lifting-beam valves. These valves are mechanically connected so as to open and close in the proper sequence. In some older installations, however, steam flow to the nozzles is controlled by the manual operation of individual control valves.

It is essential that the pressure in the steam chest be kept as high as practicable. High pressure here allows for greater steam expansion and a resulting increase in the useful work obtained from the steam. The fewer the nozzles in use, the higher will be the chest pressure; therefore, it is essential that installations which are fitted with individually operated nozzle valves be operated (at either low or high speeds) with the minimum number of nozzles required to obtain the desired speed. Adjacent nozzles should be used to ensure uniform stresses in the turbine blades, and the nozzle valves in use must be opened wide. The nozzle valves not in use must be tightly closed; otherwise, the resulting steam leakage will reduce turbine efficiency.

TURBINE BLADE CLEARANCE

In an impulse turbine, the axial distance of the moving blades from the casing or the stationary blades is known as the axial (fore-and-aft) blade clearance. This clearance may be determined by means of a finger piece, a rotor-position micrometer, or a clearance indicator.

A ready visual check on the fore-and-aft position of the turbine rotor may be obtained from the FINGER PIECE. Most finger pieces consist of an indicator which extends almost to the shaft, fastened to a plate which is secured to the turbine case. Usually three lines are scribed on the shaft to show the normal position and the maximum positions. In some finger pieces, the indicator extends into a groove in the shaft and the distance from the indicator to the shaft shoulder may be measured with feelers to determine fore-and-aft clearance.

The axial position of a turbine rotor may be determined with a ROTOR-POSITION MICROMETER. This instrument can be used when the rotor is either revolving or at rest. The micrometer is mounted at the forward end of the turbine shaft, with the spindle in line with the centerline of the shaft. When the micrometer is being used, the spindle contacts the end of the shaft at the center. The reading obtained is compared with established limits to determine if the position of the shaft is satisfactory. Care must be exercised to prevent the end of the micrometer spindle from becoming worn by long or hard contact with the rotating shaft.

In some installations, the axial blade position of a turbine rotor is determined with a ROTOR-POSITION INDICATOR. The indicator may be used when the turbine is in operation. The instrument consists of a scale plate and an indicator, mounted within a bracket which is bolted to the turbine casing. The scale plate has scribed lines showing the normal position (midposition) and the maximum and minimum (forward and aft) positions. One end of the indicator is made in the shape of a pointer, and a roller or contact surface is mounted on the other end. The indicator operates on a pivot. To take a reading, it is only necessary to press the arm of the indicator so that contact is made between the shaft and the roller, and then note the position of the pointer on the scale.

ROUTINE UNDERWAY INSPECTIONS

Periodic inspections of the propulsion plant must be made if the plant is to be kept operating efficiently. When a ship is underway, the following items should be checked or inspected at very short intervals during each watch:

1. Check all main engine and reduction gear bearing thermometers to detect signs of overheating.
2. Check oil sight-flow indicators for proper oil flow.
3. Check clearance indicators for proper rotor position.
4. Check all thermometers, pressure gages, and vacuum gages.
5. Check the oil level in the main sump.
6. Maintain the proper water level in the deaerating feed tank.
7. Keep a constant check on salinity indicators.
8. Check the lube oil temperature from the lube oil cooler, maintain oil temperature at 120° to 130° F.

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9. Check the cooling water main for proper pressure.

10. Constantly be on the alert for unusual sounds and vibrations.

11. Each watch, clean lube oil and bilge strainers.

Usually, the first indication of bearing trouble will be a rise in temperature. There is no objection to a bearing running warm, provided the temperature reached is not sufficient to harm the bearing. What must be guarded against is a rapid rise in temperature and an increase over the normal operating temperature. If the bearing temperature increases above normal, the quality and quantity of lubricating oil must be checked. If possible, increase the supply of oil to the bearing and increase the flow of cooling water through the oil cooler. If these measures do not reduce the bearing temperature, the unit must be slowed or stopped.

A sight-flow indicator is fitted in the lube oil line of each main engine bearing and each reduction gear bearing on most units. When a lube oil service pump is in operation, each indicator should show a steady flow of lube oil. Frequent inspections of the sight-flow indicators should be made in order to detect any interruption to the flow of lube oil.

Each hour, the rotor-position indicator for each turbine is checked and the rotor position logged to help determine the position of the rotor in respect to the casing. Any abnormal reading must be thoroughly investigated. Should the rotor move sufficiently for the moving blades to strike the stationary blades or nozzles, great damage would result.

One of the first indications of engineroom trouble is an abnormal reading on a thermometer or gage. All thermometers and gages must be checked frequently to detect and prevent casualties. It should never be taken for granted that an abnormal reading is due to the fault of the gage or thermometer. The accuracy of a gage or thermometer may be easily checked by replacing it with one that has been calibrated.

Each hour, the oil level in the main engine sump is to be checked and logged in the main engine operating record. However, more frequent checks should be made. An increase in the oil level generally means that water is entering the lube oil system or that the system is gaining oil in some improper manner. The lube oil purifier may be lined up wrong. A decrease in the oil level of the main engine sump usually indicates a leak in the lube oil system or that the lube oil purifier is discharging oil through the impurity discharge. An increase or a decrease in the main sump oil level should NEVER be neglected. It could result in a temporary loss of a main engine, or even costly repairs to main engine bearings and reduction gears.

For safe efficient operation, the water level in a steaming deaerating feed tank should be kept within the normal operating range. If the water level is allowed to go above the maximum level, the deaerating effect is lost. Admitting large quantities of comparatively cold water to the deaerating feed tank will reduce the pressure in the tank. This reduces the main feed booster pressure, which may result in casualties to the main feed pump and boiler.

If the water level is below minimum, a sudden demand for feed water for the boilers may empty the deaerating feed tank. This may well result in casualties to the boiler, the main feed booster pump, and the main feed pump.

A salinity indicator meter is located on or near the throttle board in each engineroom, to detect the entrance of salt water into the condensate system. The meter must be constantly checked as a small amount of salt in the condensate system will contaminate a steaming boiler beyond allowable limits. An abnormal reading (0.1 epm or above) must be checked and the source of contamination eliminated. More information on salinity indicators may be found in chapter 9580 (58) of the Naval Ships Technical Manual, chapter 14 of this training course, and the appropriate manufacturer's technical manuals.

A properly operating main engine and reduction gear installation has a definite sound which trained personnel can recognize. Any abnormal sound should be investigated and the unit operated with caution until the cause is found and remedied.

PREPARATIONS FOR ANCHORING AND SECURING

After the control engineroom has been notified as to the time the ship will enter port, the necessary preparations must be made to secure the main engines. Personnel should be notified and given specific instructions for setting up the in-port auxiliary watch. The auxiliary

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machinery to be used in port must be placed in operation, the deck machinery used in anchoring must be tested and numerous other tasks must be accomplished.

SETTING SEA DETAIL

On installations where the turbogenerators exhaust to either the auxiliary or the main condenser, the following procedure should be followed in setting sea detail:

1. Man the 1JV and 2JV sound-powered telephone.
2. Put the auxiliary condenser in operation, shift the turbogenerator exhaust from the main condenser to the auxiliary condenser.
3. Start the standby turbogenerator, parallel with generators in use, and then split the electrical load.
4. Warm up the main circulator. (Open the turbine exhaust valve, close the turbine casing drain when steam blows through, and drain the steam supply line.)
5. If not already done, split the plant as ordered by the engineer officer. Start the main circulating pump (when necessary).
6. Open turbine drains on the first stop bell.

SECURING MAIN ENGINES

Each ship has its own detailed form for securing main engines. The following procedure (enginerroom only) is given as an example.

1. Secure and lock closed the throttle valves and close the main engine guarding valve. Close the main steam boiler stop valve and drain the main steam line and turbines.
2. Secure the first stage of the main air ejector.
3. Engage and start the turning gear.
4. Cross-connect the plant.
5. Shift the electrical load to the generator designated for in-port use and secure the standby generator.
6. Shift the high pressure drains, low pressure drains, and the auxiliary exhaust to the steaming engineroom.
7. Secure the following pumps:

   a. Lube oil service pump.
   b. Main feed pump.
   c. Main feed booster pumps.

8. Start the auxiliary feed booster pump (if installed) and the emergency feed pump.
9. Secure the main feed pump and then the main feed booster pump.
10. Shift the auxiliary exhaust and low pressure drains to the auxiliary condenser.
11. Secure the second stage of the main air ejectors.
12. Secure gland sealing steam (when main condenser vacuum drops to 10 inches of mercury).
13. Secure main circulating pump when the exhaust trunk temperature drops to near room temperature. Close the main injection and overboard valves.
14. Close all throttle, root, exhaust, and drain valves not in use. Secure all unnecessary vents.
15. Stop and disengage turning gear. (Time will depend on type of ship.)
16. When oil has cooled to room temperature, secure lube oil service pump and drain waterside of oil cooler.
17. Report main engines secured to duty officer and OOD.
18. Twenty-four hours after securing, close turbine and steam line drains.

As previously stated, operating procedures vary from ship to ship. The information given in this chapter is general. For example, in step 14 of the securing schedule, no specific time can be given for securing the main circulating pump. On a World War II destroyer, the time may be one hour; while on a Forrestal class carrier, the main circulating pump may be run 18 to 24 hours after the main engines are secured. For any particular ship the best sources of information are the ship's warming-up schedule, operating instructions, securing schedule, and specific instructions issued by the engineer officer.

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CHAPTER 11

REFRIGERATION

As a Machinist's Mate, you should have a knowledge of refrigeration and air conditioning systems. From practical experience, you will probably learn how to start, operate, stand watch on, and secure these systems. To do your job properly, you must have a thorough understanding of the operating principles of refrigeration systems. This understanding can be attained through study.

The refrigeration systems most commonly used in the Navy, utilize R-12 as a refrigerant. The information given in this chapter is, therefore, primarily concerned with R-12 systems. It should be noted that the cycle of operation and the main components of R-12 systems are basically the same for refrigeration and air conditioning plants.

FUNDAMENTALS OF REFRIGERATION

Refrigeration is a general term used to describe the process of removing heat from an area or a substance. The term is usually applied to an artificial means of lowering the temperature. Mechanical refrigeration may be defined as a mechanical system or apparatus so designed and constructed that, through its function, heat is transferred from one substance to another.

Refrigeration is more readily understood if you know the relationships among temperature, pressure, and volume, and how pressure affects liquids and gases.

HEAT

The purpose of refrigeration is to maintain spaces at low temperatures. Remember, however, that you can't cool anything by adding coolness to it; you have to REMOVE HEAT from it. Refrigeration, therefore, is a process of cooling by removing heat.

Heat and Temperature

It is important to distinguish between heat and temperature. HEAT is a form of energy. TEMPERATURE is the intensity of heat. The quantity or amount of heat is measured in terms of a standard unit called a BRITISH THERMAL UNIT (Btu). Temperature, as you know, is measured in degrees, which indicate the intensity of the heat in a given substance; it does not indicate the number of Btus in the substance. For example, let's consider a spoonful of very hot water and a bucketful of warm water. Which has the higher temperature? Which has more heat? The heat in the spoonful of hot water is more intense; therefore, its temperature is higher. The bucketful of warm water has more Btu (more heat energy), but its heat is less intense.

Sensible Heat and Latent Heat

In the study of refrigeration, it is necessary to distinguish between sensible heat and latent heat. SENSIBLE HEAT is the term applied to the heat that is absorbed or given off by a substance that is NOT in the process of changing its physical state. When a substance is not in the process of changing its state, the addition or removal of heat always causes a change in the temperature of the substance. Sensible heat can be sensed, or measured with a thermometer.

LATENT HEAT is the term used to describe the heat that is absorbed or given off by a substance while it is changing its physical state. When a substance is in process of changing its physical state, the heat absorbed or given off does NOT cause a temperature change in the substance—the heat is latent or hidden. In other words, sensible heat is the term used to describe heat that affects the temperature of things; latent heat is the term used to describe

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heat that affects the physical state of things. Additional information on sensible heat and latent heat is given in chapter 3 of Fireman, NavPers 10520-C.

Specific Heat

Substances vary with respect to their ability to absorb heat or to lose heat. The ability of a substance to absorb heat or to lose it is known as the SPECIFIC HEAT of the substance. The specific heat of water is taken to be 1.0, and the specific heat of each other substance is measured by comparison with this standard. Thus, if it takes only 1/2 Btu to raise the temperature of 1 pound of a substance 1° F, the specific heat of that substance is 0.5, or one-half the specific heat of water. If you look up the specific heat of ice in a table, you will find it to be about 0.5.

Heat Flow

Heat flows only from objects of higher temperature to objects of lower temperature. When two objects at different temperatures are placed near each other, heat will flow from the warmer object to the cooler one until both objects are at the same temperature. Heat flow takes place at a greater rate when there is a large temperature difference than when there is only a slight temperature difference. As the temperature difference approaches zero, the rate of heat flow also approaches zero. Heat flow may take place by radiation, by conduction, by convection, or by some combination of these methods.

Refrigeration Ton

The unit which measures the amount of heat removal and thereby indicates the capacity of a refrigeration system is known as the REFRIGERATION TON. The refrigeration ton is based on the cooling effect of 1 ton (2000 pounds) of ice at 32° F melting in 24 hours. The latent heat of fusion of ice (or water) is 144 Btu. Therefore, the number of Btu required to melt 1 ton of ice is 144 x 2000, or 288,000. The standard refrigeration ton is defined as the transfer of 288,000 Btu in 24 hours. On an hourly basis, the refrigeration ton is 12,000 Btu per hour (288,000 divided by 24).

It should be emphasized that the refrigeration ton is the standard unit of measure used to designate the heat-removal capacity of a refrigeration unit. It is not necessarily a measure of the amount of ice the unit can make in a given length of time.

PRESSURE, TEMPERATURE, AND VOLUME

In studying refrigeration, it is important to understand some of the ways in which pressure affects liquids and gases, and some of the relationships between pressure, temperature, and volume in gases.

The boiling point of any liquid varies according to the pressure on the liquid—the higher the pressure, the higher the boiling point. It is well to remember that condensing a gas to a liquid is just the reverse process of boiling a liquid until it vaporizes, and that the same pressure and temperature relationship is required to produce either change of state.

Water boils at 80° F under a vacuum of 29 inches of mercury; at 212° F at atmospheric pressure; and at 489° F at a pressure of 600 psig. Refrigerants used in vapor compressor cycle equipment usually have much lower boiling points than water, under any given pressure, but these boiling points also vary according to pressure. R-12, for example, boils at -21° F at atmospheric pressure; at 0° F at 9.17 psig; at 50° F at 46.69 psig; and at 100° F at 116.9 psig. From these figures, you can see that R-12 cannot exist as a liquid at ordinary temperatures unless it is confined and put under pressure.

If the temperature of a liquid is raised to the boiling point corresponding to its pressure, and if the application of heat is continued, the liquid begins to boil and vaporize. The vapor which is formed remains at the same temperature as the boiling liquid, as long as it is in contact with the liquid. A vapor CANNOT be superheated as long as it is in contact with the liquid from which it is being generated.

The pressure-temperature-volume relationships of gases are expressed by Boyle's law, Charles' law, and the general gas law or equation.

BOYLE'S LAW states that the volume of any dry gas varies inversely with its absolute pressure, provided the temperature remains constant. This law may also be expressed as an equation:

$$V_1P_1 = V_2P_2$$

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where V_1 is the original volume of the gas, P_1 its original absolute pressure, V_2 its new volume, and P_2 its new absolute pressure.

CHARLES' LAW states that the volume of a gas is directly proportional to its absolute temperature, provided the pressure is kept constant. The equation for this law is:

$$V_1T_2 = V_2T_1$$

THE GENERAL GAS EQUATION combines Boyle's law and Charles' law, and expresses the relationship between the volume, the absolute pressure, and the absolute temperature of gases. The general gas law is expressed by the equation:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

These equations indicate the nature of the relationship between the pressure, the volume, and the temperature of any gas. You will probably not find it necessary to use the equations themselves, but you should have a thorough understanding of the principles which they express. Let's summarize them:

1. When temperature is held constant, increasing the pressure on a gas causes a proportional decrease in volume; decreasing the pressure causes a proportional increase in volume.
2. When pressure is held constant, increasing the temperature of a gas causes a proportional increase in volume; decreasing the temperature causes a proportional decrease in volume.
3. When the volume is held constant, increasing the temperature of a gas causes a proportional increase in pressure; decreasing the temperature causes a proportional decrease in pressure.

In this discussion of the effects of pressure on a gas, we have noted that the volume and the temperature of the gas are different AFTER the pressure has been changed. It is important to note, however, that a temperature change normally occurs in a gas WHILE the pressure is being changed. Compressing a gas raises its temperature; allowing a gas to expand lowers its temperature. As we will see, this fact is of importance in the refrigeration cycle.

MECHANICAL REFRIGERATION SYSTEMS

Various types of refrigerating systems are used for naval shipboard refrigeration and air conditioning. The most generally employed is the vapor compression cycle with reciprocating compressors. Vapor compression cycle refrigerating systems with centrifugal compressors as described in chapter 12 are sometimes used for air conditioning. Centrifugal units are generally used to cool a secondary refrigerant; brine for cargo refrigeration and fresh water for air conditioning application.

The STEAM-JET REFRIGERATION SYSTEM is used on some naval ships for air conditioning purposes. As shown in figure 11-1, the steam-jet plant consists of a flash tank, a booster ejector, a condenser, air ejectors, and the necessary pumps and piping. The flash tank (sometimes called the evaporator) is maintained under exceptionally high vacuum by a steam-jet booster ejector. As water is sprayed into the flash tank, part of each drop flashes into vapor and thereby cools the unvaporized portion of each drop to about 50° F or lower, depending upon the capacity of the unit. The cooled water falls to the bottom of the shell; it is then pumped to the cooling coils, and returned to the flash tank at a temperature of about 55° F.

The vapor compression cycle with reciprocating compressors using R-12 is used for most naval refrigeration plants. Figure 11-2 gives a general idea of this type of refrigeration cycle. As you study this system, try to understand what happens to the refrigerant as it passes through each part of the cycle. In particular, be sure that you understand why the refrigerant changes from liquid to vapor and from vapor to liquid, and what happens in terms of heat because of these changes of state. It will be helpful to trace the refrigerant through its entire cycle, beginning with the thermostatic expansion valve.

Liquid refrigerant enters the expansion valve from the high pressure side of the system and passes through an orifice, which reduces the pressure of the refrigerant. Due to the reduction in pressure, the liquid refrigerant begins to boil and to flash into vapor.

From the thermostatic expansion valve, the refrigerant passes into the cooling coil (or evaporator). The boiling point of the refrigerant under the low pressure in the evaporator is about 20° F lower than the temperature of the space in which the cooling coil is installed. As

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V. SAMPLES OF TESTS

RADIO I

(SAMPLE)

Student's Name _____ Date _____

Please complete the following statements by supplying the missing word or words.

1. When two separate windings or coils are wound on one form with no connections between them, the resulting coil is called as _____.

2. R is the symbol for _____.

3. I is the symbol for _____.

4. The unit used as a measure of inductance in a radio is called a _____.

5. Increasing the number of plates in a condenser increases its _____.

6. When the grid is made less negative, its repelling action on electrons flowing toward the plate is _____.

7. The primary of the output transformer as a rule is connected to B+ and to the plate of the _____ _____.

8. A transformer that has more turns of wire on the secondary than it has on its primary is known as a _____ _____ transformer.

9. An ohmmeter is used to measure _____ in a circuit.

10. When you step up the voltage you step down the _____.

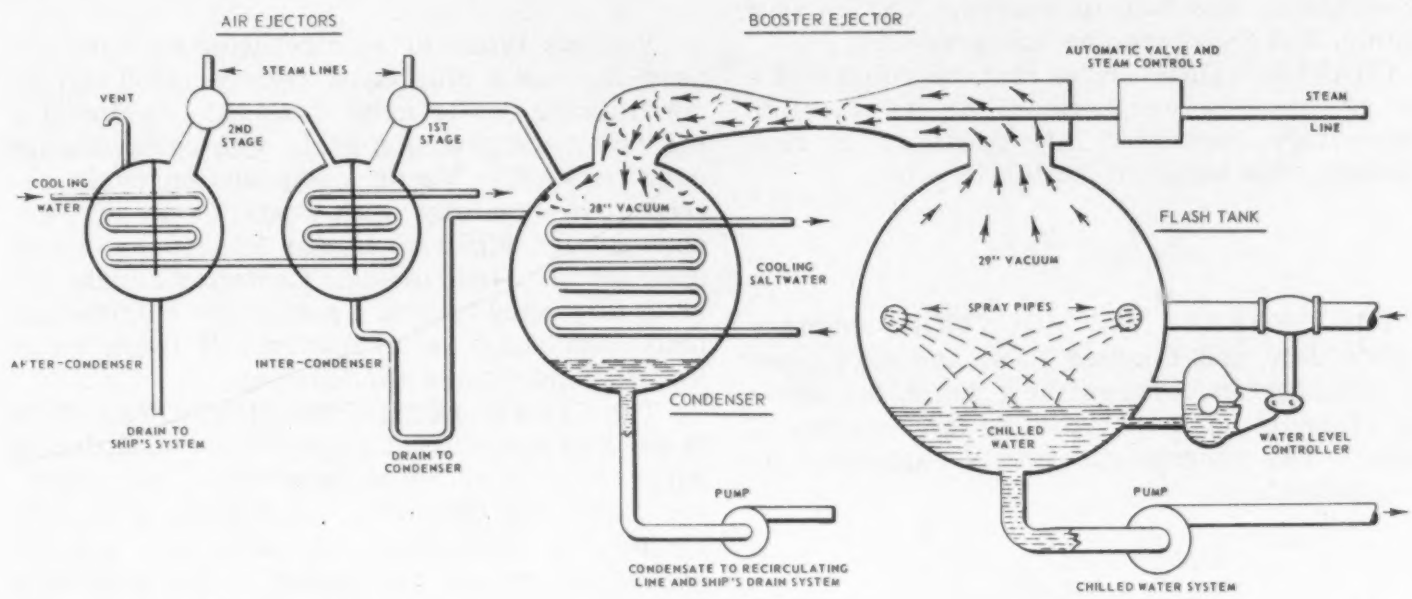

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Figure 11-1.—Steam-jet refrigeration system.

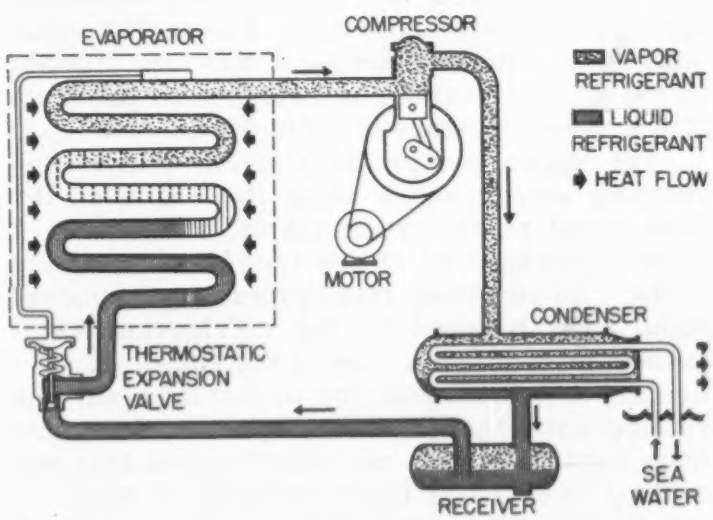

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Figure 11-2.—R-12 refrigeration cycle.

the liquid boils and vaporizes, it picks up its latent heat of vaporization from the surroundings, thereby removing heat from the space. The refrigerant continues to absorb latent heat of vaporization until all the liquid has been vaporized. By the time the refrigerant is ready to leave the cooling coil, it has not only absorbed this latent heat of vaporization, but has also picked up some additional heat—that is, the vapor has become superheated. As a rule, the amount of superheat is 4° F to 12° F.

The refrigerant leaves the evaporator as a low pressure superheated vapor, having absorbed heat and thus cooled the space to the desired temperature. The remainder of the cycle is concerned with disposing of this heat and converting the refrigerant back into a liquid state so that it can again vaporize in the evaporator and thus again absorb the heat.

The low pressure superheated vapor is drawn out of the evaporator by the compressor, which also keeps the refrigerant circulating through the system. In the compressor cylinders, the refrigerant is compressed from a low pressure, low temperature vapor to a high pressure vapor, and its temperature rises accordingly.

The high pressure R-12 vapor is discharged from the compressor into the condenser. Here the refrigerant condenses, giving up its superheat (sensible heat) and its latent heat of vaporization to the ambient air in an air-cooled condenser or the cooling water in a water-cooled condenser. The refrigerant, still at high pressure, is now a liquid again.

From the condenser, the refrigerant flows into a receiver, which serves as a storage place for the liquid refrigerant in the system. From the receiver, the refrigerant goes to the thermostatic expansion valve, and the cycle begins again.

As you can see from this description of the compression cycle, this type of refrigeration

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system has two pressure sides. The LOW PRESSURE SIDE extends from the orifice of the thermostatic expansion valve up to and including the intake side of the compressor cylinders. The HIGH PRESSURE SIDE extends from the discharge valve of the compressor to the thermostatic expansion valve.

MAIN PARTS OF THE R-12 SYSTEM

The main parts of an R-12 refrigeration system are shown diagrammatically in figure 11-3. The primary components of the system are the thermostatic expansion valve, the evaporator, the compressor, the condenser, and the receiver. Additional equipment required to complete the plant includes piping, pressure gages, thermometers, various types of control switches and control valves, strainers, relief valves, sight-flow indicators, dehydrators, and charging connections. Figure 11-4 shows most of the components on the high pressure side of an R-12 system, as actually installed on board ship. Additional information concerning refrigerant components can be obtained from chapter 9590 (59) of Naval Ships Technical Manual.

In the following discussion, we will deal with the R-12 system as though it had only one evaporator, one compressor, and one condenser. As you will see from figure 11-3 however, a refrigeration system may (and usually does) include more than one evaporator; and it may include additional compressor and condenser units.

Thermostatic Expansion Valve

The thermostatic expansion valve is essentially a reducing valve between the high pressure side and the low pressure side of the system. The valve is designed to regulate the rate at which the refrigerant enters the cooling coil in proportion to the rate of evaporation of the liquid refrigerant in the coil; the amount depends of course, on the amount of heat being removed from the refrigerated space.

A thermal control bulb for the thermostatic expansion valve is clamped to the cooling coil, near the outlet. The bulb contains R-12. Control tubing connects the bulb with the area above the diaphragm in the thermostatic expansion valve. When the temperature at the control bulb rises, the R-12 expands and transmits a pressure to the diaphragm; this causes the diaphragm to be moved downward, thus opening the valve and allowing more refrigerant to enter the cooling coil. When the temperature at the control bulb falls, the pressure above the diaphragm is decreased and the valve tends to close. Thus, the temperature near the evaporator outlet controls the operation of the thermostatic expansion valve.

Evaporator

The evaporator consists of a coil of copper tubing installed in the space to be refrigerated. Figure 11-5 illustrates some of this tubing. As mentioned before, the liquid R-12 enters the tubing at a very much reduced pressure and with, therefore, a very much lowered boiling point. In passing through the expansion valve, part of the refrigerant boils and vaporizes, due to the reduced pressure, and the remaining liquid refrigerant is cooled to its boiling point. Then, as the refrigerant passes through the evaporator, the heat flowing to the coil from the surrounding air causes the rest of the liquid refrigerant to boil and vaporize. After the refrigerant has absorbed its latent heat of vaporization (that is, after it is entirely vaporized), the refrigerant continues to absorb heat until it becomes superheated by about 10° F. The amount of superheat is determined by the amount of liquid refrigerant admitted to the evaporator; and this, in turn, is controlled by the spring adjustment of the thermostatic expansion valve. A temperature range of 4° to 12° F of superheat is considered desirable because it increases the efficiency of the plant and because it evaporates all of the liquid, thus preventing liquid carryover into the compressor.

Compressor

The compressor in a refrigeration system is essentially a pump. It is used to pump heat "uphill" from the cold side to the hot side of the system.

The heat absorbed by the refrigerant in the evaporator must be removed before the refrigerant can again absorb latent heat. The only way in which the vaporized refrigerant can be made to give up the latent heat of vaporization that it absorbed in the evaporator is by cooling and condensing it. In view of the relatively high temperature of the available cooling medium,

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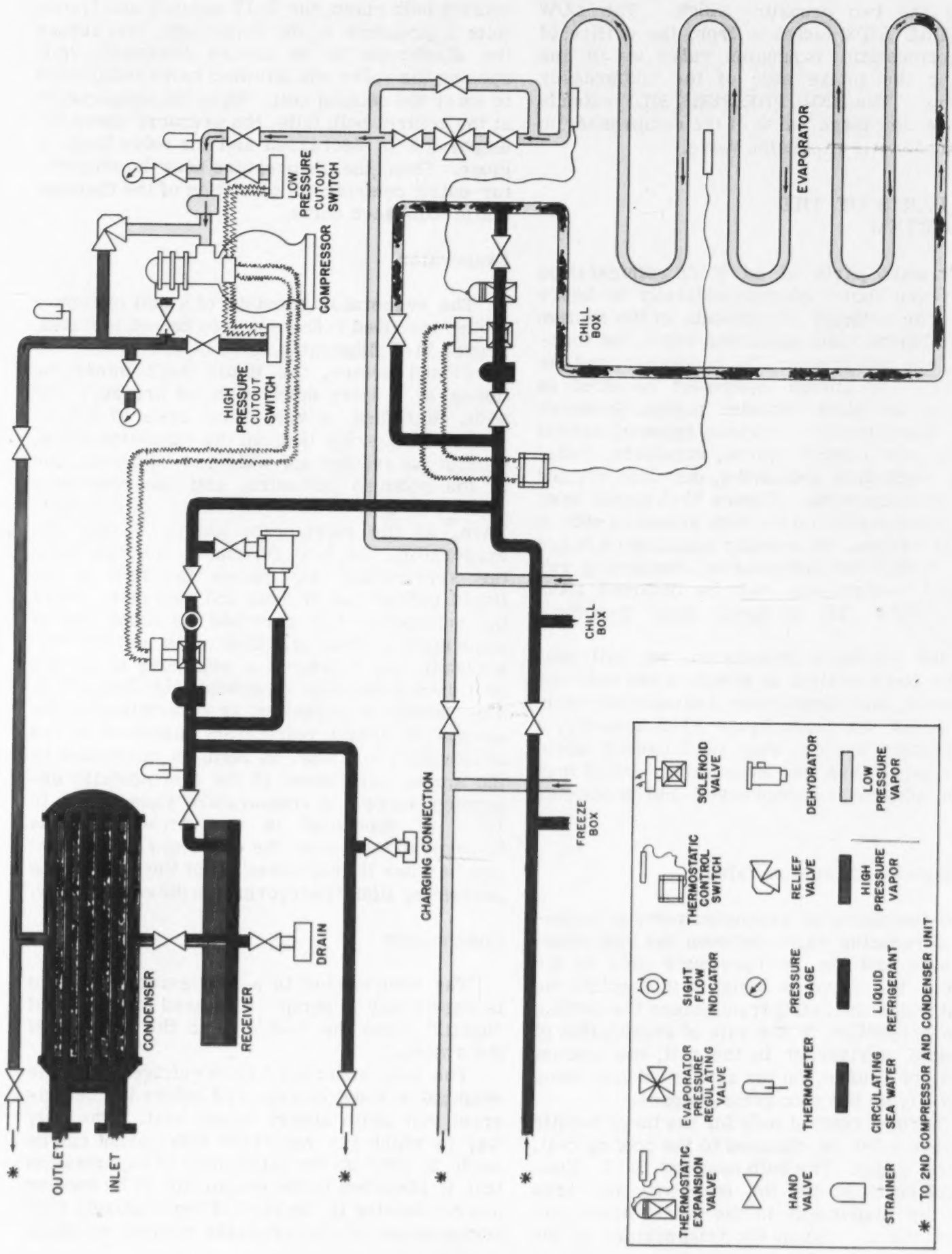

Figure 11-3.—Diagram of an R-12 refrigeration system.

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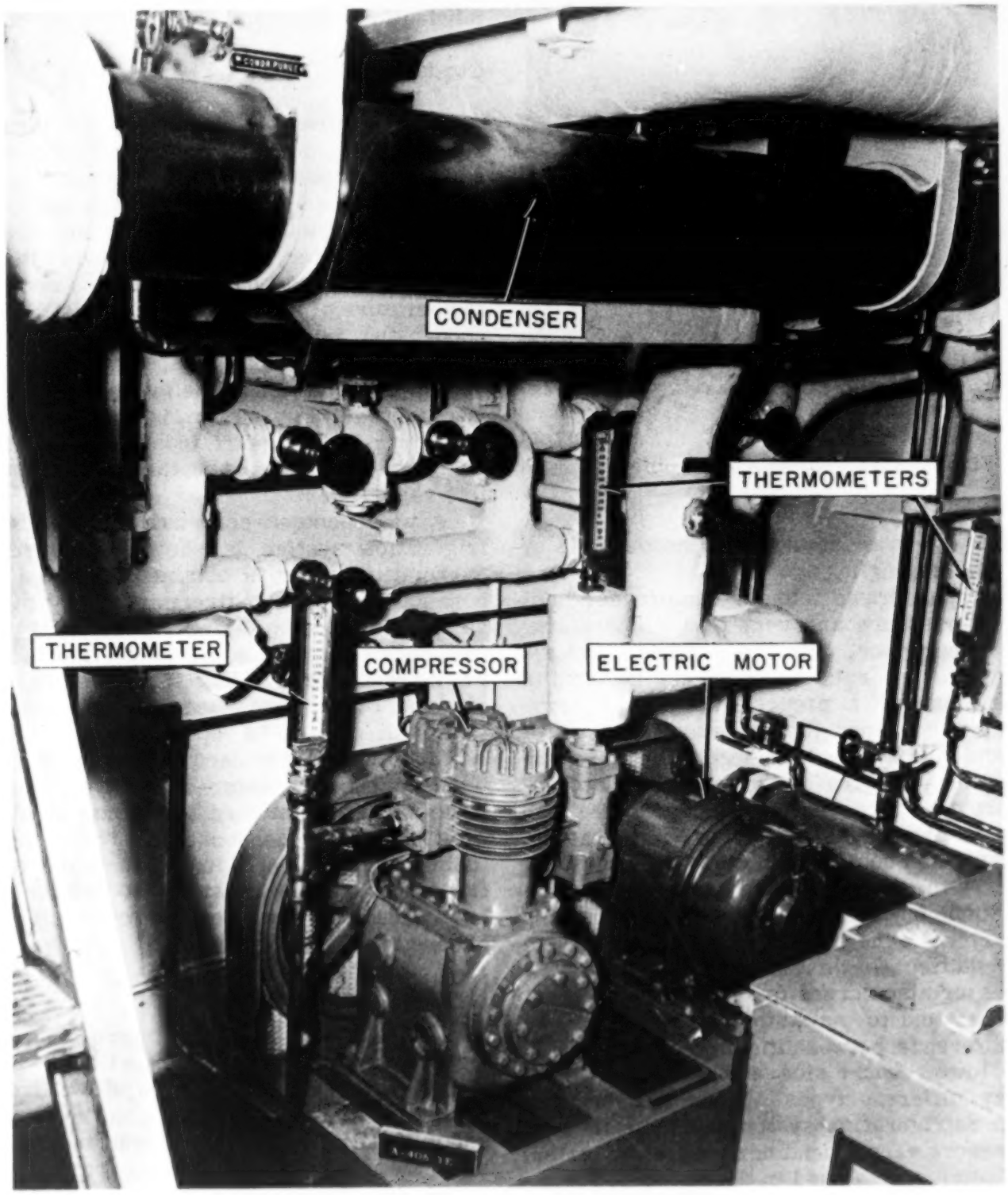

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Figure 11-4.—R-12 installation.

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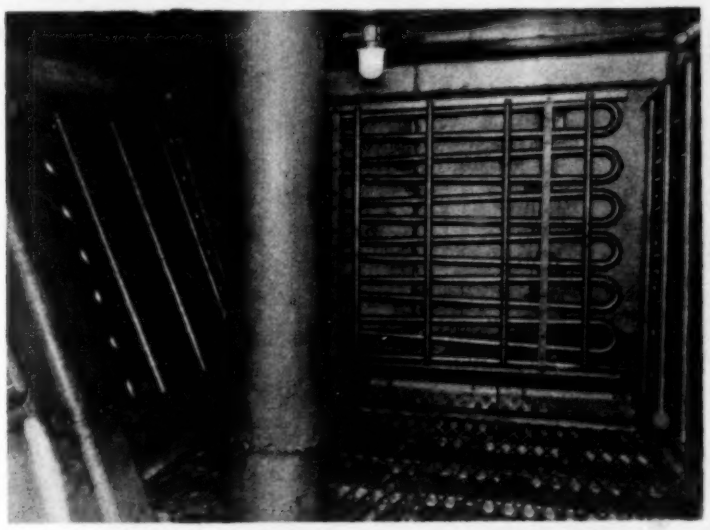

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Figure 11-5.—Evaporator tubing.

the only way to make the vapor condense is by first compressing it.

The vapor drawn into the compressor is at very low pressure and very low temperature. In the compressor, both the pressure and the temperature are raised. Since an increase in pressure causes a proportional rise in temperature, and since the condensation point of any vapor is dependent upon the pressure, raising the pressure of the vaporized refrigerant provides a condensation temperature high enough to permit the use of sea water as the condensing and cooling medium. The compressor raises the pressure of the vaporized refrigerant sufficiently high to permit condensation to take place in the condenser.

In addition to this primary function, the compressor also serves to keep the refrigerant circulating and to maintain the required pressure difference between the high pressure side and the low pressure side of the system.

Many different types of compressors are used in refrigeration systems. The designs of compressors vary depending upon the application of the refrigerants used in the system. Figure 11-6 shows a motor-driven, single acting, two-cylinder, reciprocating compressor such as is commonly used in naval refrigeration plants.

Compressors used in R-12 systems may be lubricated either by pressure lubrication or by splash lubrication. Splash lubrication, which depends upon maintaining a fairly high oil level in the compressor crankcase, is usually satisfactory for smaller compressors. High speed, or large capacity, compressors use pressure lubrication systems.

Condenser

The compressor discharges the high pressure, high temperature refrigerant vapor to the condenser, where it flows around the tubes through which sea water is being pumped. As the vapor gives up its superheat (sensible heat) to the sea water, the temperature of the vapor drops to the condensation point. As soon as the temperature of the vapor drops to its boiling or condensing temperature at the existing pressure, the vapor condenses, giving off its latent heat of vaporization in the process. The refrigerant, now in liquid form, is subcooled slightly below its boiling point (condensation point) at this pressure to ensure that it will not flash into vapor.

A water-cooled condenser for an R-12 refrigeration system is shown in figure 11-7. Circulating water is obtained through a branch connection from the firemain, or by means of an individual pump taking suction from the sea. The purge connection shown in figure 11-7 is on the refrigerant side; it is used to remove air and other noncondensable gases that are lighter than the R-12 vapor.

Most condensers used for naval refrigeration plants are of the water-cooled type. However, it should be mentioned that some small units have air-cooled condensers. These consist of tubing with external fins to increase the heat transfer surface. Most air-cooled condensers have fans to ensure positive circulation of air around the condenser tubes.

Receiver

The receiver, shown in figure 11-8, acts as a temporary storage space and surge tank for the liquid refrigerant which flows from the condenser. The receiver also serves as a vapor seal, to prevent the entrance of vapor into the liquid line to the expansion valve. Receivers may be constructed for either horizontal or vertical installation.

Accessories

In addition to the five main components just described, a refrigeration system requires a number of controls and accessories. The most important of these will be described briefly.

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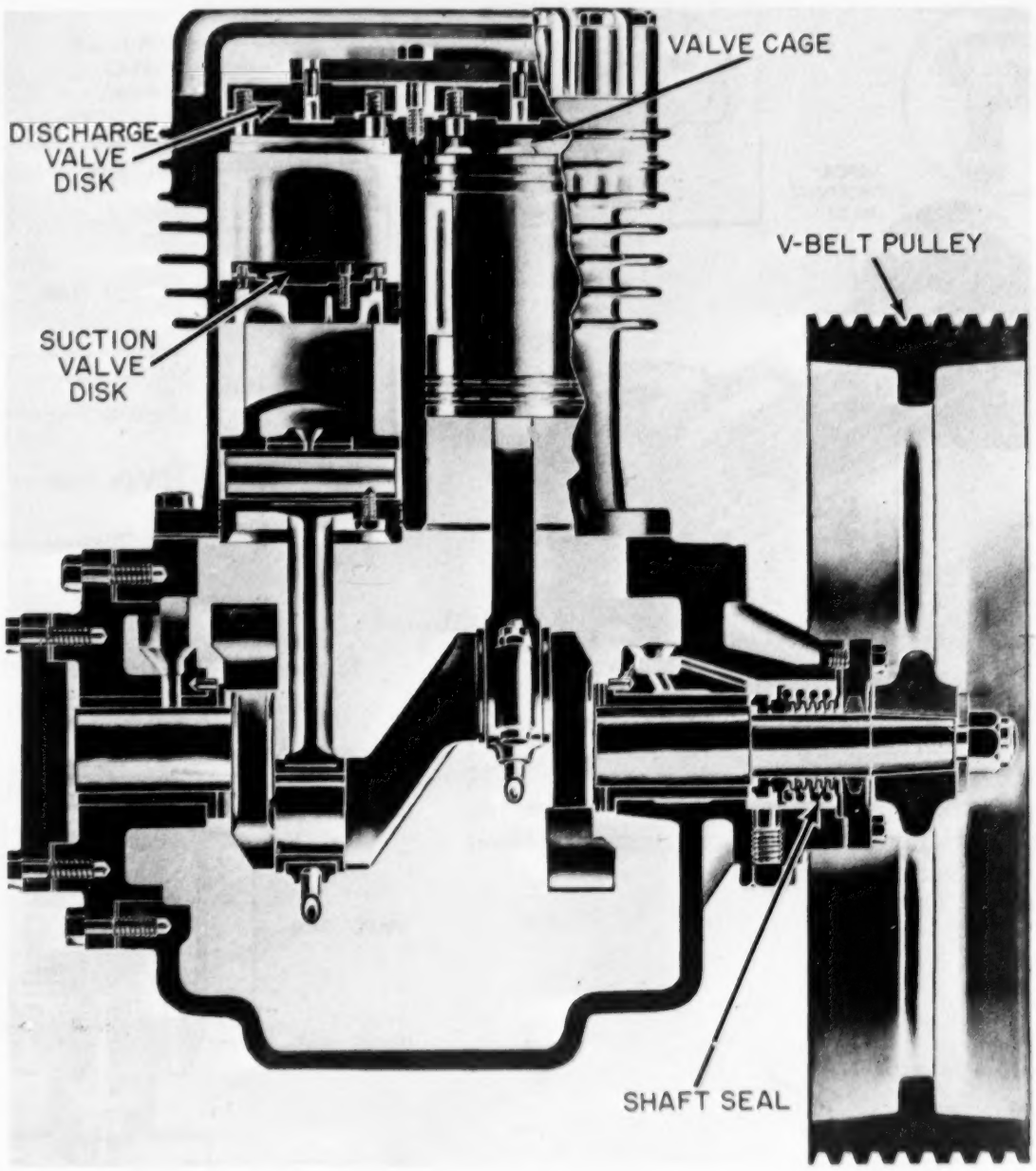

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Figure 11-6.—Reciprocating compressor.

A DEHYDRATOR, or dryer, is placed in the liquid refrigerant line between the receiver and the thermostatic expansion valve. In older installations, bypass valves allow the dehydrator to be cut in or out of the system. In newer installations, the dehydrator is installed in the liquid refrigerant line without any bypass arrangement. A MOISTURE INDICATOR is either located in the liquid refrigerant line or built into the dehydrator. A dehydrator is shown in figure 11-9.

A SOLENOID VALVE is installed in the liquid line leading to each evaporator. Figure 11-10 shows a solenoid valve and the thermostatic control switch that operates it. The thermostatic control switch is connected by long flexible tubing to a thermal control bulb which is located in the refrigerated space. When the temperature in the refrigerated space drops to the desired point, the thermal control bulb causes the thermostatic control switch to open, thereby closing the solenoid valve and

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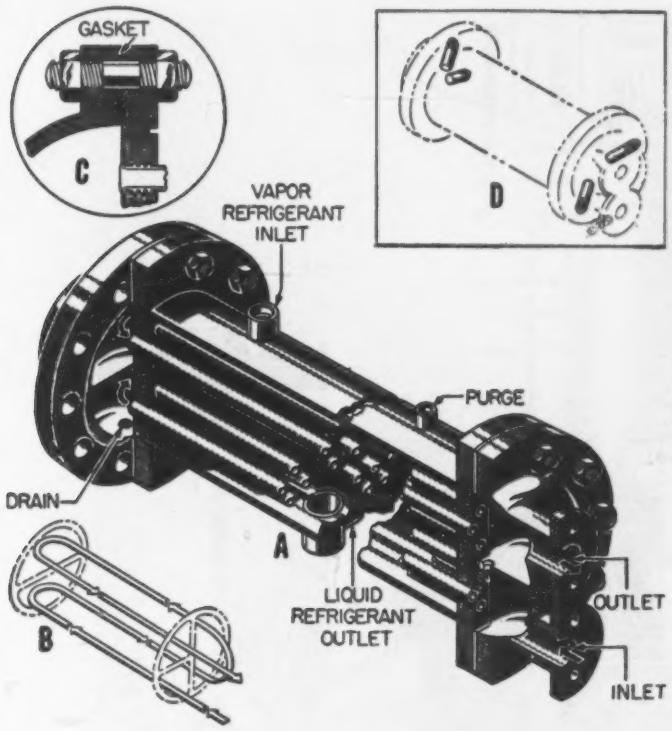

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Figure 11-7.—Water-cooled condenser for R-12 refrigeration system. A. Cutaway view. B. Water-flow diagram. C. Arrangement of heat joint. D. Position of zincs.

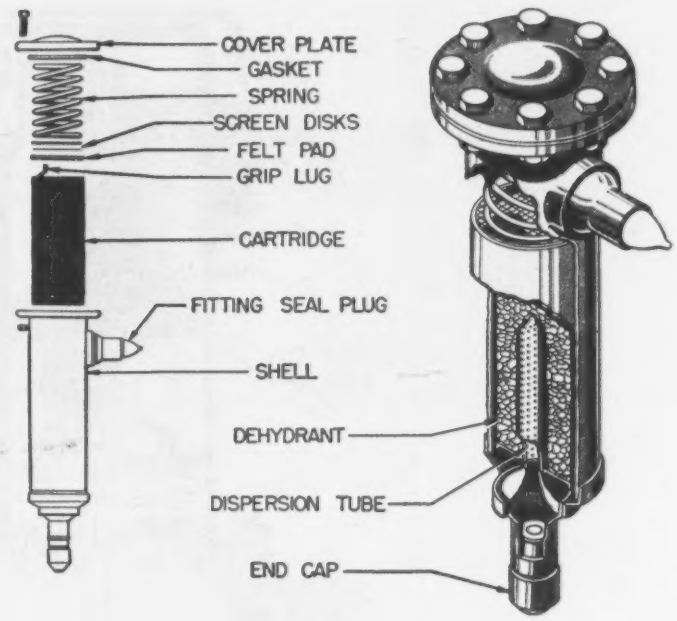

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Figure 11-9.—Refrigerant dehydrator.

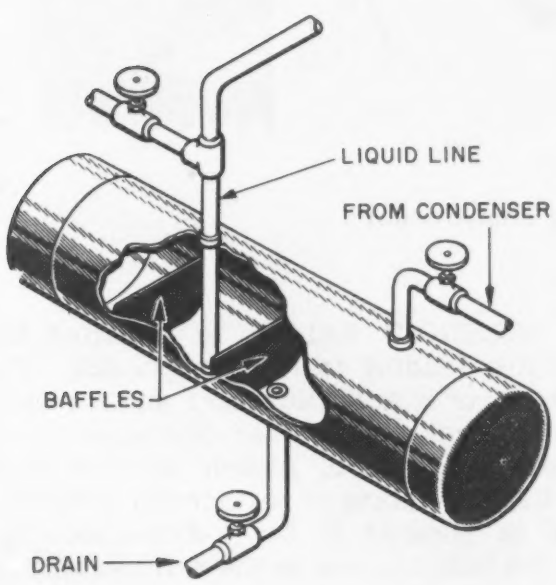

47.96

Figure 11-8.—Receiver.

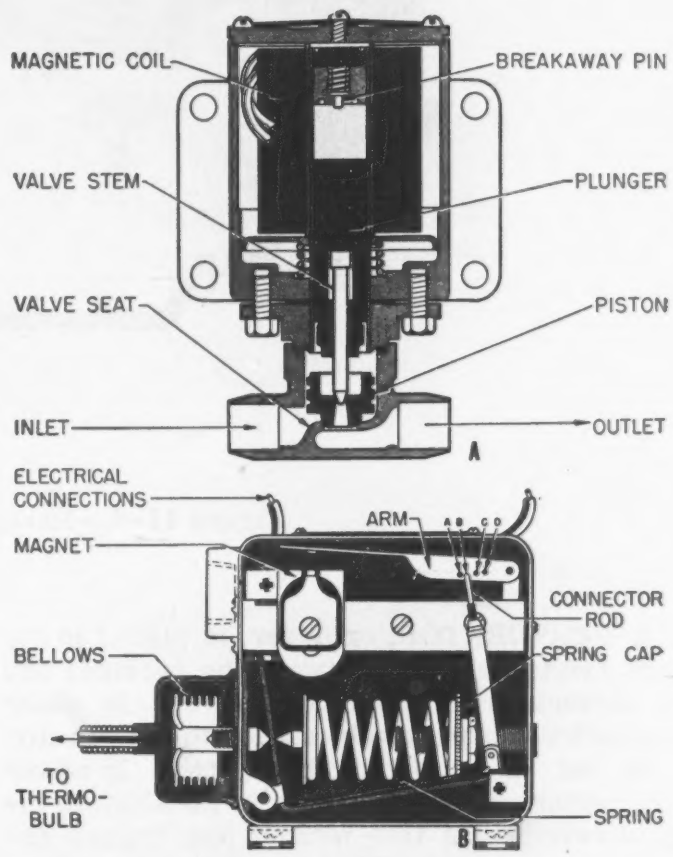

47.98

Figure 11-10.—Solenoid valve and thermostatic control switch.

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shutting off all flow of liquid refrigerant to the thermostatic expansion valve. When the temperature in the refrigerated space rises above the desired point, the thermostatic control switch closes, the solenoid valve opens, and liquid refrigerant once again flows to the thermostatic expansion valve.

The solenoid valve and its related thermostatic control switch serve to maintain the proper temperature in the refrigerated space. If the thermostatic expansion valve controls the amount of refrigerant admitted to the evaporator, why is the solenoid valve necessary? Actually, the solenoid valve is not necessary on units having only one evaporator. In systems having more than one evaporator, where there is wide variation in load, the solenoid valve provides the additional control required to prevent the spaces from becoming too cold at light loads.

In addition to the solenoid valve installed in the line to each evaporator, a large refrigeration plant usually has a main liquid line solenoid valve installed just after the receiver. If the compressor stops for any reason except normal suction pressure control, the main liquid solenoid valve closes and prevents liquid refrigerant from flooding the evaporator and flowing to the compressor suction. Extensive damage to the compressor can result if liquid is allowed to enter the compressor suction.

Whenever several refrigerated spaces of varying temperatures are to be maintained by one compressor, an EVAPORATOR PRESSURE REGULATING VALVE is installed at the outlet of each evaporator EXCEPT the evaporator in the space in which the lowest temperature is to be maintained. The evaporator pressure regulating valve is set to keep the pressure in the coil from falling below the pressure corresponding to the lowest temperature desired in that space.

Suction pressure regulating valves may be installed in the suction line at the outlet of the evaporator where minimum temperature must be maintained as in certain types of water cooler applications or where high humidities are desired, as in fruit and vegetable rooms or where two or more spaces are maintained at different temperature levels from a single compressor unit. (Pressure regulating valves are designed to maintain a substantially constant pressure within the cooling coil higher than the suction pressure downstream and independent of suction pressure fluctuations.) Valve adjustment is obtained by compression of the adjusting spring to a point where a predetermined coil pressure is established. The automatic operation is maintained by diaphragm balance resulting from small fluctuation in coil pressures permitting positioning of the valve seat to adjust the refrigerant flow.

Suction pressure regulating valves function to decrease the temperature difference which would otherwise exist between the compartment temperature and the surface of the cooling coils. Since the amount of heat which can be transferred into the evaporating refrigerant is directly proportional to the temperature difference, the employment of suction pressure regulating valves requires the provision of more coil surface in a given compartment than would be otherwise necessary. It is, therefore, not generally practicable to install a suction pressure regulating valve in the suction line from an existing cooling coil installation unless additional coil surface is provided.

Suction pressure regulating valves are ADJUSTED by changing the pressure exerted by an auxiliary spring against the valve disk.

For a given setting the valve maintains a substantially constant pressure in the cooling coil regardless of changes in the compressor suction pressure, provided that the suction pressure is about 4 psi or more lower than that which the regulator is set to maintain in the coil. Adjustment to increase the spring pressure tending to close the valve increases the evaporating pressure and vice versa. A test gage is temporarily connected to the cooling coil side of the valve when adjustment is to be made.

The pressure setting for any individual application is dependent on coil design and the amount of coil surface available. In general, settings are not critical where the same refrigerant circuit is also controlled by a solenoid valve except that the pressure setting must be maintained sufficiently low to provide a temperature differential between the refrigerant evaporating temperature and the compartment temperature. Where temperature and humidity control depend on the pressure regulating valve, the setting must be sufficiently high to permit the control desired, keeping in mind the temperature differential required for satisfactory coil operation. Where the medium being cooled is water, as in process and drinking-water coolers, the setting of the suction pressure regulating valve is VERY CRITICAL and, if improperly or hastily adjusted, may cause

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derangement. A change in pressure setting of 1 pound will appreciably change the temperature of the delivered water. Too low a pressure setting will result in an almost immediate freezing of the water in the cooler with possible rupture. Consequently, adjustment of this valve in a water-cooler application should be very carefully made. Turn the adjusting screw only one-eighth turn at a time and take frequent samples of delivered water to check the temperature.

Figure 11-11 shows an exploded view of a typical valve which demonstrates the ease of disassembly for repair or replacement of the parts without disturbing soldered piping joints. Dirt or foreign matter under the seat or in moving parts can cause erratic operation.

The LOW PRESSURE CUTOUT SWITCH, or suction pressure control switch, is the control that causes the compressor to go on or off, as required for normal operation of the refrigeration plant. This switch is located on the suction side of the compressor, and is actuated by pressure changes in the suction line. When the solenoid valves in the lines to the various evaporators are closed, so that the flow of refrigerant to the evaporators is stopped, the pressure of the vapor in the compressor suction line drops quickly. When the suction pressure has dropped to the desired pressure, the low pressure cutout switch causes the compressor motor to stop. When the temperature in the refrigerated spaces has risen enough to operate one or more of the solenoid valves, refrigerant is again admitted to the cooling coils, and the compressor suction pressure builds up again. At the desired pressure, the low pressure cutout switch closes, starting the compressor again and repeating the cycle.

A HIGH PRESSURE CUTOUT SWITCH is connected to the compressor discharge line to protect the high pressure side of the system against excessive pressures. The design of this switch is essentially the same as that of the low pressure cutout switch, however, the low pressure cutout switch is made to CLOSE when the suction pressure reaches its upper normal limit, whereas the high pressure cutout switch is made to OPEN when the discharge pressure is too high. The high pressure switch is normally set to stop the compressor when the pressure reaches 160 psi and to start it again when the pressure drops to 140 psi. As mentioned before, the low pressure cutout switch is the compressor control for normal operation of the plant; the high pressure cutout switch, on the other hand, is a safety device only and does not have control of compressor operation under normal conditions.

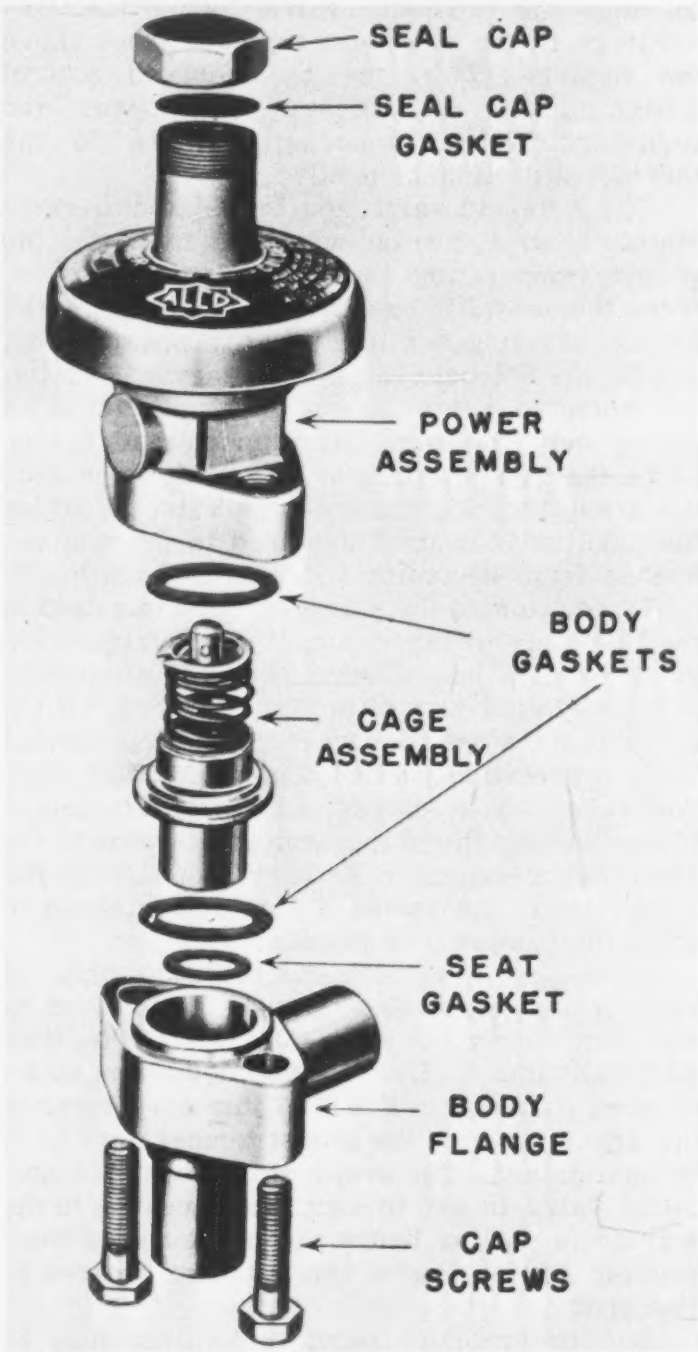

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Figure 11-11.—Exploded view of typical suction pressure regulating valve.

A SPRING LOADED RELIEF VALVE is installed in the compressor discharge line as an additional precaution against excessive

pressures. The relief valve is set to open at about 225 psi; therefore, it functions only in case of failure or improper setting of the high pressure cutout switch. If the relief valve opens, it discharges high pressure vapor to the suction side of the compressor.

A WATER REGULATING VALVE is installed to control the quantity of circulating water flowing from the firemain to the refrigerant condenser. The water regulating valve is actuated by the refrigerant pressure in the compressor discharge line; this pressure acts upon a diaphragm (or, in some valves, a bellows arrangement) which transmits motion to the valve stem. As the temperature of the circulating water increases, the temperature of the refrigerant vapor increases; this causes the pressure of the refrigerant to increase, and thereby raises the condensation point. When this occurs, the increased pressure of the refrigerant causes the water regulating valve to open wider, thus automatically permitting more circulating water to flow through the condenser. When the condenser is cooler than necessary, the water regulating valve allows less water to flow through the condenser. Thus, the flow of cooling water through the condenser is automatically maintained at the rate actually required to condense the refrigerant under varying conditions of load and temperature.

A WATER FAILURE SWITCH is provided to stop the compressor in the event of failure of the circulating water supply. This is a pressure-actuated switch, generally similar to the low pressure cutout switch and the high pressure cutout switch previously described. If the water failure cutout switch should fail to function, the refrigerant pressure in the condenser would quickly build up to the point where the high pressure switch would function.

Because of the solvent action of R-12, any particles of grit, scale, dirt, and metal that the system may contain are very readily circulated through the refrigerant lines. To avoid damage to the compressor from such foreign matter, a STRAINER is installed in the compressor suction connection.

In addition, a LIQUID STRAINER of the type shown in figure 11-12 is installed in the liquid line leading to each evaporator; these strainers serve to protect the solenoid valves and the thermostatic expansion valves.

A number of PRESSURE GAGES and THERMOMETERS are used in refrigeration systems. Figure 11-13 shows a compound refrigerant gage. The temperature markings on this gage show the boiling point (or condensing point) of the refrigerant at each pressure; the gage cannot measure temperature directly. The short pointer (red in color) is a stationary pointer

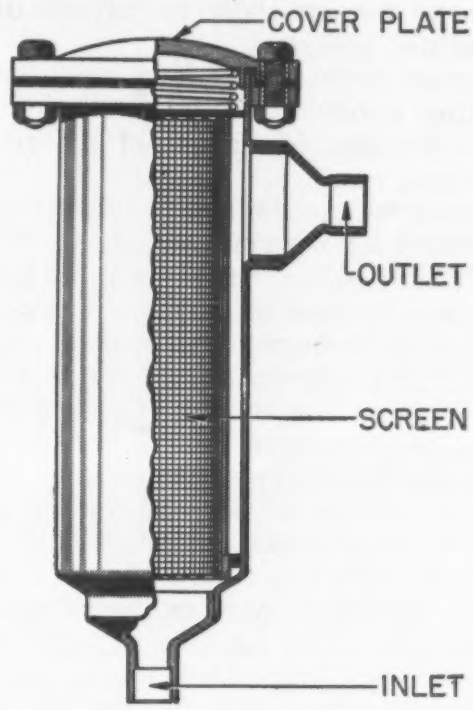

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Figure 11-12.—Strainer for liquid refrigerant.

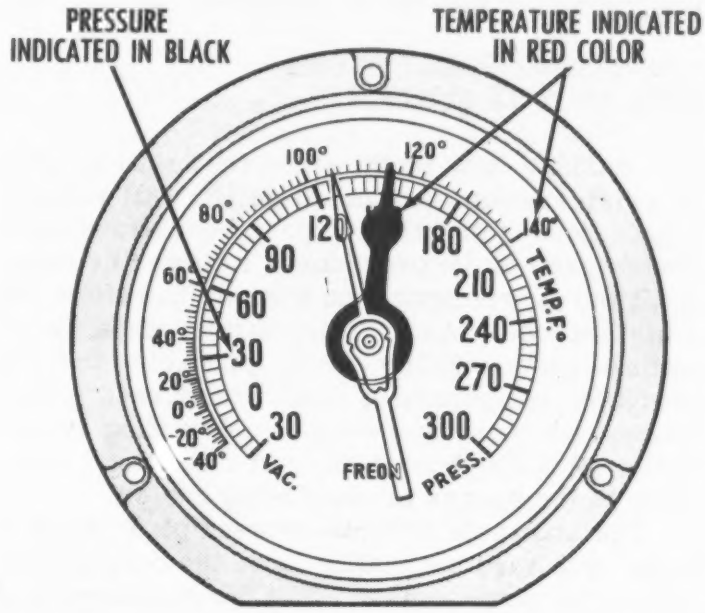

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Figure 11-13.—Compound R-12 pressure gage.

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RADIO I

(SAMPLE)

Name _____ Date _____

Instructions: Place a circle around the letter "T" if the statement is True or around the letter "F" if the statement is False.

1. T F A wavelength is the number of cycles in a given rate of time.

2. T F The speed with which the wave travels depends upon the nature of the medium.

3. T F Electrical pressure will cause an electric current to move in a circuit.

4. T F Conductors consist of any substances through which a current of electricity can flow freely.

5. T F A capacitor consists of two plates separated by an insulator or dielectric material.

6. T F In a series circuit the current is decreased and the voltage remains the same.

7. T F A direct current does not fluctuate.

8. T F Tube checkers are used to evaluate the true condition of tubes.

9. T F AC current does not reverse its direction of flow but DC current does.

10. T F A series circuit has but one complete path for electric to flow through.

that can be set manually to indicate the maximum working pressure.

A water pressure gage is installed in the circulating water line to the condenser, to give visual indication of failure of the circulating water supply.

Standard thermometers of appropriate range are provided for the refrigerant system.

REFRIGERANT PIPING in modern naval installations is made of copper. Copper is good for this purpose because (1) it does not become corroded by refrigerants; (2) the internal surface of the tubing is smooth enough to minimize friction; and (3) copper tubing is easily shaped to meet installation requirements.

Nearly all hand-operated valves in large refrigeration systems are PACKLESS VALVES of the type shown in figure 11-14. In this type of valve, the upper part of the valve is sealed off from the lower part by a diaphragm. An upward-seating ball check in the lower valve stem makes it possible for the spring to lift the lower stem regardless of pressure differences developed while the valve was closed. Thus, the valve will operate properly regardless of direction of flow. By backseating the valve, the diaphragm can be changed without placing the system or unit out of operation.

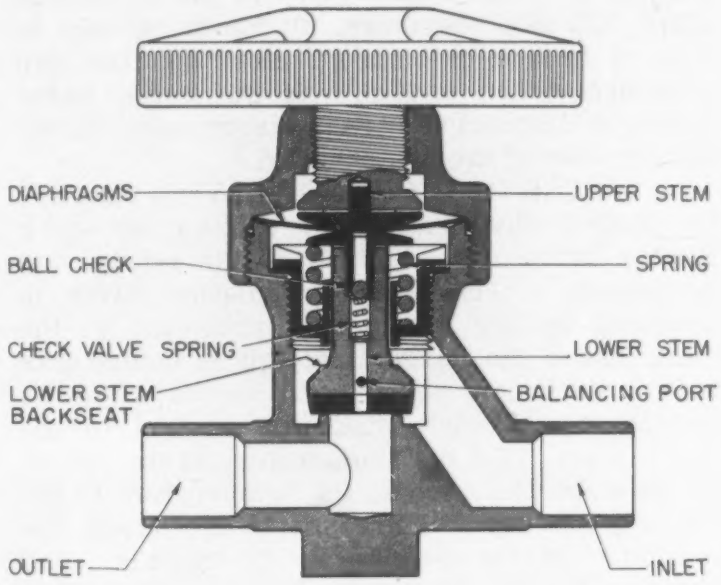

47.103

Figure 11-14.—Packless valve for refrigeration system.

OPERATING PROCEDURES FOR AN R-12 SYSTEM

Learning how to do all of the tasks related to refrigeration system operation will require a good deal of practical experience and attentive observation of the procedures followed by those qualified in refrigeration system operation and maintenance. As a Machinist's Mate, your initial responsibility will probably include checking temperatures and pressures, maintaining the plant operating log, detecting symptoms of faulty operation, and checking conditions in the spaces or units being cooled.

The intervals of time between plant inspections will vary depending upon the purpose for which the plant is used. The temperatures and pressures throughout the system and the oil level in the compressor crankcase are checked and the results recorded every two hours unless watchstanding instructions specify otherwise. The results of these checks can be used to determine whether the plant is operating properly. One of the best methods for checking plant operation is to compare the existing temperatures and pressures with those recorded during a period when the plant was known to be operating properly, under conditions similar to the present conditions.

The following information on operating procedures applies to refrigeration systems in general.

1. Open the compressor discharge valve; open all stop valves in the circulating water supply and in the discharge lines for the condenser.
2. Open the condenser refrigerant outlet valve; open the evaporator pressure regulating valves, stop valves, and the freeze box tail coil outlet valve, and open the thermal expansion stop valves on the chill and freeze boxes.
3. Start all air circulating fans on water cooling applications (soda fountains, drinking water coolers, and air conditioning water chillers), admit the water to be cooled, and purge the water circuit of air.
4. If water is taken from the firemain, make certain that the pressure-reducing valve ahead of the water regulating valve is adjusted to provide a water pressure of 35 psi or less ahead of the water regulating valve.

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5. When no pressure-reducing valve is installed, regulate the firemain connection stop valve manually so that the required water pressure ahead of the water regulating valve is maintained.
6. When an individual circulating pump is used to supply condenser circulating water, be sure that any valves which permit transmission of pump discharge pressure to the water failure switch are open.
7. If the compressor unit is equipped with an air-cooled condenser, make certain that the air flow passages to the condenser are unobstructed, and that the air circulating fans are clear.
8. Open the compressor discharge-line valve, the stop valve in the line connecting the condenser and the liquid receiver, and the main liquid-line valve.

Starting the Compressor

Too much stress cannot be placed on the need for thoroughness and care at the time the compressor is started. Bent crankshafts, distorted valves, and blown gaskets are a few of the casualties which may occur if proper procedures and applicable precautions are not followed. After accomplishing or checking the items listed under the posted prestarting instructions, proceed as follows:

1. Set the AUTOMATIC-MANUAL selector switch in the MANUAL position.
2. Close the maintaining-contact START button in the pump control circuit to prepare the pump motor for starting.
3. Close the momentary-contact START switch in the compressor control circuit to start the pump motor which also energizes the main line solenoid valve circuit.

   As the pump circulates the water, the water failure switch closes automatically and completes the circuit of the compressor-motor contactor coil. When this circuit is closed, the compressor motor starts. In installations where a pump motor and a pump control circuit are not installed, closing the momentary-contact START switch energizes the compressor control circuit and starts the compressor motor.
4. Start and stop the motor and compressor several times by manual control, to check their operating condition; then, stop the compressor and check the oil level.
5. After it has been determined that the motor and the compressor are in operating condition, crack the suction stop valve and set the controls on AUTOMATIC. This arrangement will eliminate the possibility of the pressure in the system from decreasing below that of the atmosphere and drawing air into the compressor.

   Open the compressor suction valve slowly, with the compressor running, so as to limit the quantity of suction gas handled by the compressor.

   The suction gage should be watched as the compressor suction valve is opened to ensure that the suction pressure is within the limits of the automatic control low pressure suction setting. The valve should be opened gradually, at a rate so that there will be neither a rapid fluctuation in suction pressure nor a rapid drop of pressure in the compressor crankcase. This will prevent the rapid boiling off of refrigerant from the oil and the carrying of oil into the system. Unusual noise or knocking in the compressor and frosting of crankcase or suction valve are indications of liquid refrigerant being drawn into the compressor.
6. If lubrication of the compressor is by forced feed, check the pressure on the oil pressure gage.

   Unless specific instructions indicate otherwise, the oil pressure should be between 15 and 30 psi above the compressor suction pressure within a few seconds after the compressor is started. If the compressor is designed for automatic capacity control, oil pressure of 50 to 60 psi above suction pressure is required.
7. Make certain that the proper quantity of circulating water is flowing through the condenser before the compressor discharge pressure reaches 125 psi.
8. Open the receiver outlet valve and the main solenoid outlet valve.

In systems not equipped with water regulating valves, normal operating conditions generally produce condensing pressures of less than 125 psi, since the condensing water temperature is usually less than 85° F. In systems

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equipped with water regulating valves, the valves should be adjusted to maintain the condensing pressure at 125 psi. When the valves are so adjusted, the quantity of cooling water required decreases rapidly with decreasing circulating water temperatures. In systems equipped with air-cooled condensers, condensing pressures may exceed 125 psi when the temperature of the surrounding air is higher than normal.

Operating An R-12 Plant In Automatic

After the prescribed operating pressures and temperatures have been established with the selector switch set in the AUTOMATIC position, the suction-pressure control is so connected by electrical means, that it starts and stops the compressor automatically, on the basis of load conditions. If the automatic control valves and switches are in proper adjustment, the operation of the plant, after proper starting, will be entirely automatic.

When the selector switch is set for automatic operation, the closing of the water failure switch, the high pressure switch, or the low pressure switch through automatic operation will energize their respective circuits. Other control devices require the intervention of an operator before the compressor can be restarted. Some high pressure switches are provided with manual reset devices which must be reset by the operator after the switches have been opened by excessive pressure.

Some installations are designed so that the supply of condenser cooling water is available either from a centrifugal pump or from the fire and flushing main directly. If cooling water is obtained from the fire and flushing main instead of from the pump, the pump controller switch is opened manually. The water failure switch remains closed regardless of the source of condenser cooling water.

Securing The Compressor

If a compressor is to be secured for only a short period, it is not necessary to pump down the system. The compressor however, must be pumped down. To do this, first close the compressor suction valve slowly, to prevent too rapid a reduction in crankcase pressure. Then allow the compressor to run until it is stopped by the low pressure control switch; push the STOP button on the motor-control panel. Next, close the compressor discharge shutoff valve; shut off the water supply to the condensers. Finally, close the main liquid valve after the receiver.

If a refrigeration system is to be secured for an extended period, the system must be pumped down. The pumping-down procedure involves pumping most of the R-12 out of the coils of the evaporator, and storing the refrigerant in the receiver. If the quantity of liquid refrigerant contained in the system is in excess of the capacity of the receiver, the surplus liquid must be drawn off into refrigerant drums.

Notes On Compressor Operation

An R-12 compressor should not remain idle for an extended period of time. When two or more compressors are installed for a particular plant, the compressors should be operated alternately so that the total operating time on each of the compressors is approximately the same. An idle compressor should be operated at least once a week.

Except in an emergency, only one compressor should serve a cooling coil circuit. When compressors are operated in parallel on a common cooling coil circuit, lubricating oil may be transferred from one compressor to another. Such transfer of oil may result in serious damage to all compressors on the circuit.

Operating Log

The operating record of a refrigeration system must be maintained by the men on watch. The information recorded in the operating log serves as a guide to the condition of the plant. Figure 11-15 shows a daily operating log for a refrigeration system.

MAINTENANCE OF R-12 SYSTEMS

As a Machinist's Mate, you will do some of the maintenance jobs required to keep a refrigerating plant operating efficiently. In order for you to perform your share of the required maintenance on a refrigerating system, you must be familiar with the proper procedures for the following jobs: defrosting the cooling cools, pumping down a system and checking for noncondensable gases, purging a system of noncondensable gases, using a halide torch to

NAVSHIPS 4731 (6-57) (Front)

REFRIGERATION/AIR CONDITIONING EQUIPMENT OPERATING RECORD

INSTRUCTIONS

1. Take readings every two hours. Take compressor and condenser readings ONLY WHEN COMPRESSOR IS OPERATING.
2. Code for "Bull's-Eye" level: H=High, L=Low, N=Normal.
3. Code for condition of liquid line sight flow indicator: C=Clear, B=Bubbles.
4. Code for condition of liquid line moisture: W=Wet, D=Dry.
5. For compartment normal range, enter the normal temperature range (NTR) of the refrigerated space (do not include comfort air-conditioned compartments).

DATE 5 SEPT 19

MAKE	SIZE/MODEL	REFRIGERANT	APPLICATION	PLANT NO.	LOCATION
CARRIER	2 TONS 7H5	R-12	MAIN PLANT	2	3-15-2-A

TIME	MACH. SPACE AMB. TEMP. °F	COMPRESSOR						CONDENSER (Water cooled)			LIQUID LINE			INITIALS
		SUCTION		DISCHARGE		LUBRICATING OIL		WATER SUPPLY		DISCH.				
		PRESS. PSIG	TEMP. °F	PRESS. PSIG	TEMP. °F	PRESS. PSIG	BULL'S-EYE LEVEL	PRESS. PSIG	TEMP. °F	TEMP. °F	TEMP. °F	CONDITION AT SIGHT FLOW INDICATOR	CONDITION AT MOISTURE INDICATOR	
0200	89	13	18	98	152	48	N	35	78	82	80	C	D	J.E.B
0400	89	7	14	96	148	48	L	35	78	80	80	C	D	J.E.B.
0600														
0800														
2200														
2400														

(OVER)

A

NAVSHIPS 4731 (6-57) (Back)

REFRIGERATION/AIR CONDITIONING EQUIPMENT OPERATING RECORD

TIME	WATER CHILLER				COMPARTMENT								REMARKS
	SUPPLY		RETURN		NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	
	PRESS. PSIG	TEMP °F	PRESS. PSIG	TEMP. °F	Meat Room	Fruit & Veg.	Butter Egg	Vesti-bule	Freeze Room	Chill Room			
					NTR	NTR	NTR	NTR	NTR	NTR	NTR	NTR	
					15 18	40 43	32 35	45 48	0 3	33 36			
0200					15	42	32	48	2	34			
0400					14	40	32	46	1	33			0400 added 1 pint of oil to No. 2 Compressor.
0600													
0800													
1000													
2200													
2400													

GENERAL REMARKS

B

47.104

Figure 11-15.—Refrigeration/Air Conditioning Equipment Operating Record, NavShips 4731. A. Front. B. Back.

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test for refrigerant leaks, checking compressor oil, taking care of V-belts, and setting and adjusting refrigeration system controls and safety devices. Most of these maintenance items are covered by the Planned Maintenance System and will be scheduled accordingly. Figure 11-16 is an example of a CVA's maintenance schedule for refrigeration and air conditioning plants.

Defrosting of Cooling Coils

The cooling coils should be defrosted as often as necessary to maintain the effectiveness of the cooling surface. Excessive accumulations of frost on the coils will result in reduced cooling capacity, low compressor-suction pressure, and a tendency for the compressor to short cycle. The maximum permissible time interval between defrosting operations depends on many factors, such as refrigerant evaporating temperature, free-moisture content of supplies placed in the refrigerated space, temperature of refrigerated spaces, frequency of opening of cold-storage compartment doors, and atmospheric humidity. In the average cold-storage refrigeration installation it is good practice to defrost cooling coils before the average frost thickness reaches 3/16 inch. This is not a hard and fast rule, however; sometimes the frost layer may become appreciably thicker without seriously interfering with plant operation. At other times it may be necessary to defrost more often to maintain satisfactory operation of the plant and proper compartment temperature.

The most COMMON METHOD OF DEFROSTING a cooling coil in the average refrigeration installation is (1) to shut off the supply of R-12 to the coil to be defrosted, by closing the liquid-line stop valve ahead of the expansion valve; and (2) to permit the temperature in the compartment to rise above 32° F, by leaving the entrance door open. The frost will melt off the coils or may be easily brushed off. Since the cooling coils are made of tinned copper or galvanized steel tubing, care should be taken not to damage the evaporator coil if a scraper is used to remove frost.

Most installations now in use are provided with HOT-GAS DEFROSTING lines to facilitate defrosting where compartment temperatures are maintained at 32° F or less. The principal advantage of hot-gas defrosting is that this process permits defrosting of the freeze room coils while the rest of the plant operates normally.

In the following paragraphs, defrosting procedures will refer only to freeze room coils.

A hot-gas defrosting line leads from the compressor discharge piping to the tail-coil of the freeze room cooling coil. The hot-gas line joins the suction line, between the freeze room and the suction valve; therefore, hot gas admitted to the freeze room cooling coil flows "backwards" through the coil—that is, the hot gas flows in a direction opposite to the flow of refrigerant under normal operating conditions.

When it is desired to defrost the coils of the freeze room, the normal refrigerant-liquid supply and suction return-line valves of the freeze room cooling coil are closed. The valve in the hot-gas supply line is then opened; compressed refrigerant-gas is admitted to the coil. As the frost melts on the exterior coil surfaces, the gas is condensed in the coils and becomes a liquid. The liquid is led, from the inlet end of the freeze room cooling coil, to the main liquid supply line and is utilized in the other compartments.

Upon completion of the defrosting process, the system is returned to its normal operating condition by closing the defrosting valves and opening the valves in the refrigerant-liquid supply line to the freeze room coil, and the suction return valve from the freeze room coil. Care must be taken that all liquid refrigerant has been discharged from the freeze room coil before the suction line valve from the compartment is opened. Proceed as previously outlined in step 5 for starting the compressor using the tail coil suction valve, vice the compressor suction valve, as the control valve. If all the liquid has not been discharged, liquid slugs may be returned to the compressor.

Pumping Down A Refrigerant System

The pumping-down procedure to be followed will depend on the maintenance to be done. In some cases, the necessary maintenance can be performed on the charged system after a part to be repaired or replaced has been isolated. Generally, it is possible to pump down any part of a charged system except the condenser, the liquid receiver, and the compressor discharge line. When repairs are to be made to a major portion of the system, the refrigerant system must be pumped down to return all refrigerant to the receiver. If repairs are to be made to the receiver, the condenser, or the compressor discharge line, the entire system must be

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drained into spare refrigerant drums. However, in systems having valves to isolate the compressor discharge line and condenser, and where it is not objectionable to release refrigerant (which may still be trapped in the condenser after the system has been pumped down to the receiver) to the atmosphere, repairs to the compressor discharge line and condenser may be made with this section isolated.

Whenever it is necessary to open a charged system in order to make repairs or replacements or to clean strainers, the refrigerant pressure within the part of the system to be opened should be pumped down to a pressure slightly above atmospheric (1/2 to 2 psig) before any connections are broken. It is generally possible to pump down any part of the system (except the condenser, the liquid receiver, and the compressor discharge line) by proper manipulation of cutout valves. As a part of the system which contains liquid R-12 is pumped down, its temperature will decrease as a result of the evaporation of the liquid refrigerant. When the temperature of such a part of the system begins to rise to normal again, while the low pressure in the part is maintained, it is reasonably certain that all R-12 liquid within the part has been evaporated.

If, in the final evacuation of a part of the system, a pressure of less than 0 psig is reached, sufficient refrigerant should be immediately bled into the evacuated part of the system to raise the pressure to between 1/2 and 2 psig. Connections may then be opened; and repairs, replacements of parts, or other necessary service operations may be accomplished.

When a refrigerant system is opened, the free ends of the refrigerant lines should be temporarily plugged in order to prevent the entrance of air and dirt. When the connections are remade, one connection is made tight while the other connection is left loose, temporarily, so that the air or other foreign gases in the section of the system which is serviced can be swept out through the free end as this section of the system is slowly purged with refrigerant-gas bled from the charge in the system. The other connection (or connections) is then quickly tightened. Refrigerant, oil-charging, gage, and control lines, although generally of small size and short length, should be purged with refrigerant-gas immediately before they are connected to the system. Where connecting lines which have been removed are to be used again, the ends of the lines should be capped to protect the connecting fitting and to ensure that the tube will be clean when it is used again.

When MAJOR REPAIRS are to be made to a major portion of the system or when the system is to be secured for an extended period, the refrigerant system must be pumped down to return all refrigerant to the receiver. Sufficient refrigerant-gas should be retained within the system to create a positive pressure of approximately 2 psig throughout the circuit, except within the compressor-discharge line and the condenser, and between the receiver and the main liquid-line shutoff valve. To pump down the system, close the main liquid-line shutoff valve and the dehydrator-bypass valve (if installed), and open the cooling-coil solenoid valves. Allow the compressor to operate on manual control until the suction pressure reaches approximately 1/2 to 2 psig; then stop the compressor. Repeat the operation until the liquid refrigerant in the circuit has evaporated and the suction pressure remains relatively constant at 1/2 to 2 psig. During the pump-down period, the evaporation of liquid refrigerant can be traced on the liquid line back to the main liquid-line shutoff valve by the formation of frost and its subsequent melting as the liquid refrigerant is evaporated and superheated. Open the power-supply switch to the compressor; close the compressor suction and discharge shutoff valves. Shut off the water supply to the condenser and drain the condenser water. Where the amount of liquid refrigerant contained in the system is in excess of the capacity of the receiver, the surplus liquid refrigerant must be drawn off into separate refrigerant drums.

To drain the refrigerant charge from the system when it is necessary to make repairs to the condenser, the liquid receiver, or the compressor discharge line, or for any other reason, proceed as follows:

1. Start the compressor and pump down the cooling coil and suction-line pressure, with the liquid-line valve at the receiver outlet closed, to the point at which the low pressure control switch stops the unit.
2. When the compressor is stopped by the low pressure cutout switch, restart the unit manually and continue the pumping-down procedure until the suction pressure reaches approximately 2 psig and

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stop the compressor. Repeat the operation in periodic cycles until the liquid refrigerant in the circuit has evaporated and the suction pressure remains relatively constant between 1/2 and 5 psig.

3. Close the compressor discharge line valve; close all liquid valves at the cooling coils.
4. Connect an empty R-12 service drum to the refrigerant drain valve. (Before connecting the drum to the R-12 system, cool the drum thoroughly and thus permit rapid draining of the refrigerant into the drum.) Always use a clean R-12 service drum containing no air or water so that the drained R-12 may be kept in suitable condition for future use.
5. Purge the air out of the line connecting the drain valve and the drum by leaving the connection at the drum valve open as you slowly flush refrigerant through the line and out at the connection; then close the connection. The R-12 may now be drained into the cooled drum by opening the drain valve and the service drum valve.
6. When the service drum is full, close the drain valve and permit the R-12 liquid in the drain line to evaporate; then close the service drum valve and disconnect the drum from the system.
7. Weigh the drum while filling, to be certain that it is not overcharged. The net and gross weights are stamped on the drum. (These weights include that of the cast iron protector cap which fits over the cylinder valve.)

CAUTION: Never fill a service drum beyond its rated capacity; drum rupture may result from hydraulic pressure upon rise in temperature.

8. Discharge the R-12 vapor, which remains in the condenser and receiver to the atmosphere through the purge valve.

Testing for Refrigerant Leaks

Refrigerant leaks mean the loss of refrigerating effect and loss of refrigerant. Various tests are used to determine the existence of leaks in refrigerant systems. Pressure tests are used after the installation of a system and after extensive repairs or replacement of parts have been made. Pressure tests are made before the system is charged with refrigerant. Charged systems are tested for leakage either with a halide leak detector or with soapsuds; which of the two methods is to be used will depend largely upon the size of the leak, and upon the type of space in which the test is to be performed.

As an MM, you will be required to know how to use the detector and how to use soapsuds to check for refrigerant leakage.

In addition to those tests for leaks which are made at periodic intervals, tests should be made before the compressors are started and at any other time that a shortage of refrigerant in the system is suspected. Unusual operating conditions which indicate a shortage of refrigerant in the system are:

1. High suction-line temperatures.
2. Relatively high crankcase and cylinder temperatures.
3. Excessively high refrigerant temperature in the liquid line.
4. Bubbles in the refrigerant sight-flow indicator.
5. Liquid refrigerant carrying partially through the coil, with considerable superheat at the thermal element.
6. Short cycle or compressor running continuously.
7. Excessive oil seepage at shaft seal connection.
8. Oil seepage at refrigerant-system piping and compressor connections.

A shortage of refrigerant in the system nearly always indicates the presence of leaks. When a shortage of refrigerant is found the entire system should be tested for leaks by one of the following methods.

The use of a HALIDE LEAK DETECTOR is the most positive method of detecting leaks in a refrigerant system. Such a detector consists essentially of a torch burner, a copper reactor plate, and an exploring hose. (See fig. 11-17.)

Most detectors use either acetylene gas or alcohol as a fuel. Pressure for detectors which use alcohol is supplied by a pump. If a pump-pressure type of alcohol-burning detector is used, be sure that the air pumped into the fuel tank is pure.

Atmosphere suspected of containing R-12 vapor is drawn, by injector action, through the exploring hose into the torch burner of the detector. Here the air passes over the copper reactor plate, which is heated to incandescence.

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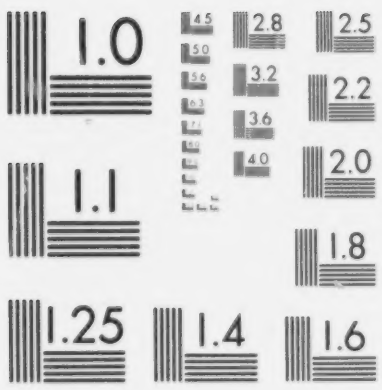

MICROCOPY RESOLUTION TEST CHART
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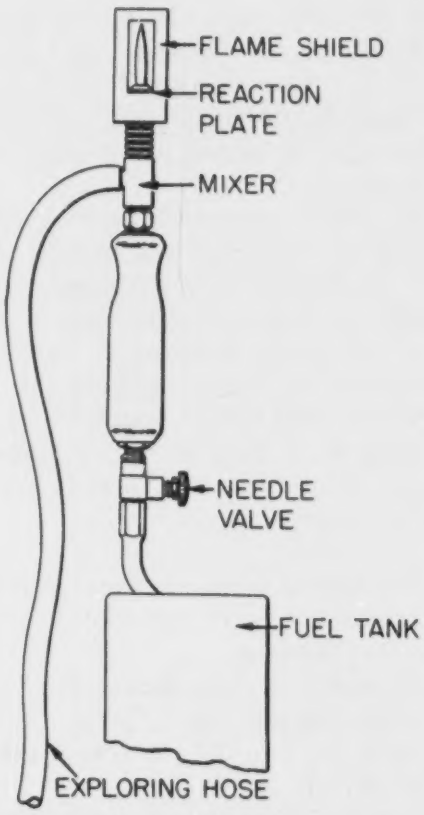

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Figure 11-17.—Halide leak detector.

If there is a minute trace of R-12 present, the color of the torch flame will change from a blue (neutral) to green as the R-12 comes in contact with the reactor plate. The shade of green will depend upon the relative amount of R-12 present; a pale green indicates small concentrations and a darker green shows heavier concentrations. Excessive quantities of R-12 will cause the flame to burn with a vivid purple color. Extreme concentrations of R-12 may extinguish the flame by crowding out the oxygen available from the air.

When a leak detector is used, best results are obtained if the following precautions are observed:

1. Be sure that the reactor plate is properly in place.
2. Adjust the flame so that it does not extend beyond the end of the burner. (A small flame is much more sensitive than a large flame. If difficulty is experienced in lighting the torch when it is adjusted to produce the necessary small flame, block the end of the exploring hose until the fuel ignites; this will reduce the amount of oxygen drawn in. Then gradually open the hose.)
3. Clean out the exploring tube if the flame continues to have a white or yellow color. (A white or yellow flame indicates that the exploring tube is partially blocked with dirt.)
4. Check to see that air is being drawn into the exploring tube; this check can be made, from time to time, by holding the end of the tube to your ear.
5. Hold the end of the exploring tube close joint being tested; this prevents dilution of the sample by stray air currents.
6. Move the end of the exploring hose tube slowly and completely around each joint being tested. (Leak testing cannot be safely hurried. There is a definite time lag between the moment when air enters the exploring tube and the moment it reaches the reactor plate; permit sufficient time for the sample to reach the reactor plate.)
7. If a greenish flame is noted at any time, repeat the test in the same vicinity until the source of the refrigerant is determined.

A halide torch is so sensitive that it is useless if the atmosphere is contaminated by excessive leakage of R-12. This is most likely to happen in a small or poorly ventilated compartment. If a compartment is contaminated by R-12 and cannot be ventilated, the SOAPSUDS TEST must be used.

In using the soapsuds test, prepare the soap-and-water solution so that it has the consistency of liquid hand soap, and will work up a lather on a brush. (The lather will remain wet for a longer period if a few drops of glycerin are added to the solution.)

Apply the lather all the way around the joint; then look carefully for bubbles. If a joint is so located that a part of it is not visible, use a small mirror when inspecting that part.

Remember that it sometimes takes a minute or more for bubbles to appear, if the leak is small. Doubtful spots should be lathered and examined a second time.

Always follow a definite procedure in testing for refrigerant leaks, so that no joints will be missed. The extra time spent in testing all joints will be justified. Even the smallest leak is not to be considered negligible. However insignificant the leak may seem, it eventually

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PERFORMANCE TEST: Pupil's Answer and Rating Sheet

1. Procedure - Number the steps in the order which should be followed to make RC amplifier

Layout and Fabrication of Amplifier Chassis

( ) Transfer the paper patterns to metal
( ) Select correct chassis
( ) Cut out paper patterns
( ) Lay out the pattern
( ) Punch the screw holes
( ) Check the layout for accuracy

Mount Parts on Chassis

( ) Place screws on chassis
( ) Put tube sockets in place
( ) Mount transformer, power, and output
( ) Place controls on set

Total Points _____

2. Pattern Layout

Points

Starting time _____
Finishing time _____
Time for layout _____
Accuracy _____

Total Points _____

3. Technique and Housekeeping

Points

Use of Tools
Care of Tools
Use of Material
Care of Material

Total Points _____

4. Quality of Job

Points

Accuracy
Neatness and finish

Total Points _____

5. Speed of Fabrication and Assembly

Points

Starting time
Finishing time
Time to do Job

Total Points _____

GRADE _____

empties the system of its charge to the point of faulty plant operation. Because R-12 is practically odorless, the first indication that leakage exists is the loss of refrigerating effect. A refrigerant system should never be recharged until all leaks are discovered and definitely repaired.

Never use oil to test for R-12 leaks. Oil is not reliable because of the capacity of the oil for absorbing R-12. If a small leak should exist where oil has been applied, the R-12, will be absorbed by the oil and will show no indication (bubbles) of the leak until the oil is saturated with R-12. Furthermore, if a halide torch is used to test a joint that has been tested previously with oil, the torch will give a false indication because of the R-12 released from the oil.

Testing For Air and Noncondensable Gases

It is essential that every reasonable precaution be taken to keep air and noncondensable gases out of a refrigerant system. When air enters the system the condenser must be purged, with a resultant loss of refrigerant. Atmospheric air always contains some moisture, which will enter the system when air does. A refrigerant system must be kept as moisture-free as possible to eliminate such troubles as the freezing of water at the expansion valves, internal oxidation or corrosion of parts, and emulsification or sludging of lubricating oils.

Air and noncondensable gases in a refrigerant system are pumped through the system and are discharged by the compressor into the condenser. These gases are trapped in the condenser by the liquid seal maintained over the receiver outlet. These gases are, in general, lighter than the relatively dense R-12 vapor; they tend to collect, therefore, in the upper part of the condenser when the compressor is stopped. The purge valve for discharging these gases to the atmosphere is located either in the upper part of the condenser shell or in the compressor discharge line above the condenser. While the compressor is in operation, any noncondensable gases in the system are thoroughly mixed with the R-12 vapor. This mixing is caused by the turbulence produced by the rapidly pulsating discharge of refrigerant into the condenser. Therefore, it is not advisable to attempt to purge noncondensable gases from the system while the compressor is in operation. Noncondensable gases in a condenser cause excessive condensing pressures with a resultant loss in plant efficiency.

The best time to check an R-12 system for noncondensable gases is immediately before the compressor starts after a shutdown period. When a condenser is to be checked for noncondensable gases, it is essential that the gages and thermometers used be accurate and that the system have sufficient refrigerant charge so that the liquid refrigerant present in the receiver will seal the liquid-line connection.

The following procedure should be followed when checking a refrigerant system for noncondensable gases:

1. Close the liquid-line valve.
2. Shut off the compressor and close the suction-line valves.
3. Determine the actual condensing temperature of the refrigerant.

   A service gage should be installed in the compressor discharge connection if a discharge-pressure gage is not already provided. An approximation of the actual condensing temperature of the refrigerant will be reached when no further decrease is noted in the discharge pressure. (On water-cooled condensers, the reduction in pressure can be accelerated by permitting circulation of condenser water until discharge pressure is reduced.) The thermometer provided on most ships in the liquid line at the receiver will indicate the actual condensing temperature. If a thermometer is not installed in an air-cooled condenser application, one should be placed near the condenser to record the ambient temperature at that location. When the temperature of an air-cooled condenser has dropped to the ambient temperature, the reading of the thermometer will approximate the actual condensing temperature.
4. On the compound pressure gage, read the condensing temperature which corresponds to the condensing pressure registered by the high pressure gage; the temperature indicated on the temperature scale is the condensing temperature of pure R-12 at the pressure indicated by the gage.
5. Subtract the existing condensing temperature from the condensing temperature of pure R-12 at the existing condenser

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pressure. If the difference between these two temperatures is more than 5° F, it will be necessary to purge the condenser of noncondensable gases.

If the above test indicates the need for PURGING, slowly release the noncondensable gases. When a purge valve is not provided, purge the gases by opening the discharge pressure gage connection.

The proportion of R-12 gas that will mix with the noncondensable gases and escape while the condenser is being purged will depend upon the rate of purging and upon the concentration of the noncondensable gases in the condenser. No practical test is available aboard ship to determine definitely when an excessively high proportion of R-12 gas is being purged with the noncondensable gases. To keep the R-12 loss to a minimum when the condenser is being purged, purge slowly; and frequently check the condenser for noncondensable gases. R-12 is odorless in concentrations of less than 20 percent by volume in air; in heavier concentrations, however, it resembles carbon tetrachloride in odor. If you can get close to the purge-valve discharge, you may be able to determine by the odor of the purged gases when purging should be discontinued and when the check for noncondensable gases should be repeated. Protect your eyes with goggles when you are checking the odor of purged gases.

Checking Compressor Oil

If the apparent oil level observed immediately after a prolonged shutdown period is lower than normal, it is almost certain that the actual working oil level is far too low. After a sufficient quantity of oil has been added to raise the apparent oil level to the center of the bull's-eye sight-glass, the actual oil level should be checked as follows:

1. Operate the compressor on MANUAL control for at least one hour. If the compressor is operating on a water cooler or other coil which is apt to freeze, observe the temperature and interrupt compressor operation as necessary to prevent freezing. Repeat cycling until the total running time (one hour) is obtained. Then slowly close the suction line stop valve.

2. Stop the compressor. If the compressor is force lubricated, immediately observe the oil level in the sight-glass. If the compressor is splash lubricated, turn the flywheel until the crankshaft and connecting rod ends are immersed in the lubricating oil, then check the oil level.

To check the oil level when the compressor has been running on its normal cycle, with no abnormal shutdown period, proceed as follows:

1. Wait until the end of a period of operation; if the operation is continuous, wait until the compressor has been in operation at least 1/2 hour, then stop the compressor.

2. As soon as the compressor stops, observe the oil level in the sight-glass on force-lubricated compressors. If the compressor is splash lubricated, turn the flywheel until the crankshaft and connecting rod ends are satisfactorily immersed in the lubricating oil; then check the oil level.

Do not remove oil from the crankcase because of an apparent high level unless too much oil has been previously added, or unless it is apparent that oil from the crankcase of one compressor of the plant has been inadvertently deposited in the crankcase of another.

However, if the oil level is lower than its recommended height on the glass, a sufficient quantity of oil should be added to obtain the desired level. Do not add more oil than is necessary; too much oil can result in excessive oil transfer to the cooling coils.

ADDING OIL.—There are two common methods of adding oil to a compressor. In one type of installation, a small oil-charging pump is furnished for adding oil to the compressor crankcase. In another type, oil is placed in the compressor by means of a clean, well-dried funnel. In either installation, care must be taken to prevent the entrance of air or foreign matter into the compressor.

When performing hourly checks of the compressors, you may observe no oil in the crankcase, or a very low oil level on the sight-glass. This indicates that the oil has left the compressor and is circulating in the system; and it will be necessary to add oil and operate the system. After the compressor has reclaimed the excessive oil in the system, the excess oil should be drained.

REMOVING OIL.—To remove oil from the compressor crankcase, reduce the pressure in

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the crankcase to approximately 1 psi by gradually closing the suction line stop valve. Then stop the compressor, and close the suction and discharge line valves, loosen the lubricating oil drain plug near the bottom of the compressor crankcase, and allow the required amount of oil to drain out. Since the compressor crankcase is under a slight pressure, do not fully remove the drain plug from the compressor, but allow the oil to seep out around the threads of the loosened plug. When the desired amount of oil has been removed, tighten the drain plug, open the suction and discharge line valves, and start the compressor. If an oil drain valve is provided in lieu of a plug, the required amount of oil may be drained without pumping down the compressor.

RENEWING THE LUBRICATING OIL.—When clean copper tubing is used for R-12 systems, and reasonable care has been taken to prevent the entrance of foreign matter and moisture during installation, the oil in the compressor crankcase will probably not become so contaminated that it requires renewal more than once a year. When iron or steel pipe and fittings are used in the R-12 system, a sample of oil from the compressor crankcase should be withdrawn into a clean glass container every 3 months. If the sample shows contamination, all the lubricating oil should be renewed. It is good practice to check the cleanliness of the lubricating oil after each cleaning of the compressor suction scale trap.

Care of V-Belts

Excessive looseness will cause slippage, rapid wear, and deterioration of V-belts. On the other hand, a belt that is too tight will cause excessive wear of both the belt and the main bearing of the compressor. In extreme cases it may cause a bad seal leak. When properly tightened, a belt can be depressed 1/2 to 3/4 inch, by the pressure of one finger, at a point midway between the flywheel and the motor pulleys.

When replacement of one belt of a multiple V-belt drive is necessary, a complete new set of matched belts should be installed. Belts stretch considerably during the first few hours of operation. Replacement of a single belt will upset the load balance between the new and old belts and will be a potential source of trouble. It is better practice to run the unit temporarily with a defective belt removed than to attempt to operate a new belt in conjunction with two or more seasoned belts.

V-belts, motor pulleys, and compressor flywheels should be kept dry and free of oil. Belt dressing should never be used.

Setting Control and Safety Devices

A refrigeration plant cannot operate EFFICIENTLY and SAFELY unless the control and safety devices are in good working order and set properly. When a new control or safety device is installed in a refrigeration system, it must be adjusted or set to function at pressures or temperatures in accordance with the plant design. Periodic tests and inspections may indicate faulty plant operation that is due to improperly adjusted control or safety devices. As a Machinist's Mate, you must know how these devices operate and how to adjust them.

This section contains information on some of the more common types of control and safety devices used by the Navy.

The methods of setting the low pressure switch, the water failure switch, and the thermostatic switch are similar; however, these switches differ as to operating range, purpose, and setting. Also, the high pressure switch and the water failure switch are safety devices while the low pressure switch and the thermostatic switches are control devices.

For detailed information, consult Naval Ships Technical Manual and the manufacturer's technical manuals.

The HIGH PRESSURE SWITCH has an operating range of 60 to 350 psig and an adjustable differential (difference between the cut-in point and cutout point). As mentioned earlier in the chapter, the switch should be set to cut out at 160 psig and to cut in at 140 psig. To set the switch, first remove the cover plate. Then the two adjusting screws; one labeled differential, the other labeled range, are easily accessible. Turning the range adjusting screw to the right raises both the cut-in point and cutout point. Turning it to the left lowers these points. The differential adjustment affects only the cutout point. Turning it to the right raises the cutout point and turning it to the left lowers the cutout point. Start the compressor and control the discharge pressure by throttling the circulating water through the condenser. Turn the differential screw all the way to the left and turn the range screw all the way to the

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right. Raise the compressor discharge to 150 psig. Turn the range screw to the left until the contactor in the switch opens, thereby stopping the compressor. When the discharge pressure drops to 140 psig, turn the range screw to the right until the contacts close, starting the compressor. The cut-in point is now set. With the compressor running, turn the differential screw all the way to the right, then raise the discharge pressure to 160 psig. Turn the differential screw to the left until the contacts open, stopping the compressor. The cutout point is now set.

The LOW PRESSURE SWITCH has an operating range of 20 inches of vacuum to 80 psig and an operating differential of 9 psig to 30 psig.

To set the low pressure switch, start the compressor and control the suction pressure by throttling the compressor suction valve. Turn the range and differential adjustment screws to the left. Lower the suction pressure to about 10 psig below the desired cut-in pressure and turn the range screw to the right until the switch contacts open, stopping the compressor. Allow the suction pressure to rise to the desired cut-in pressure and turn the range screw to the left until the switch contacts close, starting the compressor. The cut-in point is now set. Turn the differential screw all the way to the right, throttle the suction valve to lower the suction pressure to the desired cutout pressure. Turn the differential screw to the left until the switch contacts open, stopping the compressor. The cutout point is now set.

The WATER FAILURE SWITCH should be set to cut in at 15 psig and to cut out at 5 psig. To set the water failure switch, turn the differential screw to the left limit for minimum differential since the required differential (difference between cut-in and cutout points) is 10 psig. Throttle water overboard valve until a pressure of 15 psig is maintained at the condenser inlet. Turn the range screw clockwise until the switch contacts open, then turn counterclockwise slowly until contacts close. Slowly shut off water supply, decreasing the pressure. The contacts should open at 5 psig.

The THERMAL EXPANSION VALVE is generally factory set and seldom needs adjustment. The design and construction of expansion valves vary greatly. Figure 11-18 shows a cross sectional assembly view of a type which is generally used aboard ship. Other designs may have different arrangements for adjustment, sealing, and control.

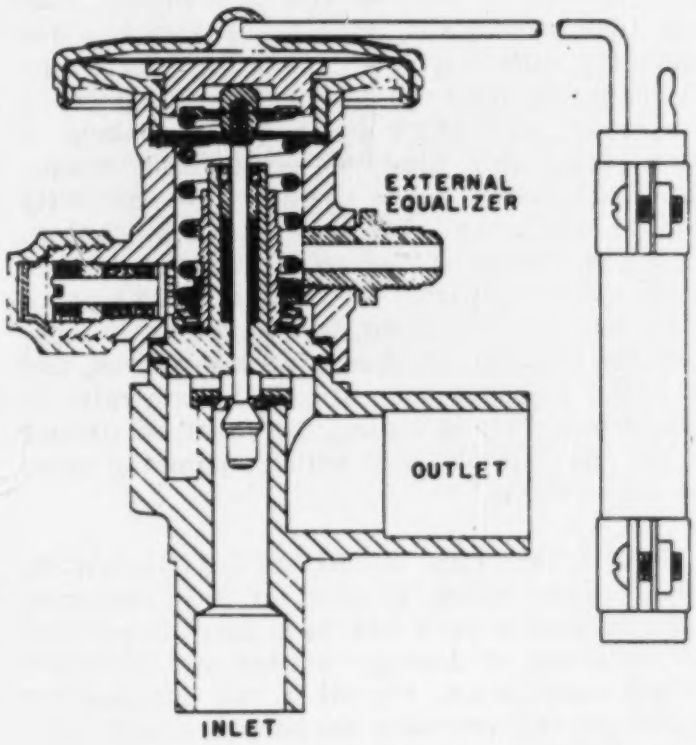

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Figure 11-18.—Single outlet thermal expansion valve.

Figure 11-19 shows a sketch of a thermal expansion valve and a cooling coil operating under assumed conditions of 40° evaporating temperatures with a valve adjusted to operate with a 10° superheat and with negligible pressure loss in the cooling coil. The 40° has a corresponding pressure of approximately 37 psig. As long as any liquid exists in the coil at this pressure the refrigerant temperature will remain at 40°. As the liquid approaches point B on the cooling coil, it becomes evaporated due to the rate of liquid feed by the valve and due to the absorption of heat equal to the latent heat of vaporization of the refrigerant from the surrounding atmosphere. The refrigerant as a gas continues along the coil at a pressure of 37 pounds until at point C its temperature has increased to 50° due to the continued absorption of heat from outside the coil. This then represents the 10° superheat (50°-40°). The amount of the superheat is dependent upon the amount of refrigerant fed by the expansion valve and the load to which the cooling coil is exposed.

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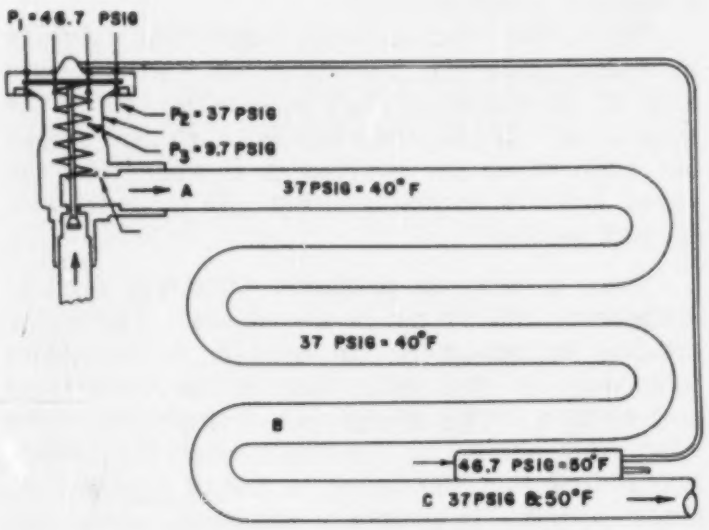

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Figure 11-19.—Thermal expansion valve with internal equalizer on evaporator with no pressure drop.

Since the cooling coil temperature at C is 50°, the thermal bulb strapped to the coil at this point also will be 50°. The temperature of the thermal bulb affects the pressure of the refrigerant within the bulb so that it has an internal pressure equal to 46.7 psig. This pressure, shown as P_1, is the pressure exerted on top of the diaphragm. The pressure, P_2, exerted on the underside of the diaphragm is a result of the pressure of 37 psig at point A (expansion valve has an internal equalizer). The pressure, P_3, is that exerted by the spring under compression.

The movement of the diaphragm in response to pressure operates the valve stem to modulate the valve opening and to control flow. When the cooling load decreases, the rate of refrigerant feed would extend beyond point B resulting in a temperature lower than 50° at point C with a smaller superheat condition. The thermal bulb, in turn, would have lower temperature with a correspondingly lower pressure so that the reduced pressure exerted on top of the diaphragm would cause the valve to start to close until a balancing point was reached reducing the flow of refrigerant. On the other hand if the cooling load is increased, liquid refrigerant would be vaporized before it reached point B, resulting in more superheat by the time the gas passed point C. This in turn would raise the temperature of the thermal element increasing the pressure on top of the diaphragm causing the valve to open to admit more refrigerant. It will be noted in the example that the valve attempted to maintain a predetermined superheat represented by the spring pressure, P_3. The pressure is adjustable to increase or decrease the superheat setting and is usually maintained from 5° to 10° depending on the application.

An external equalizing connection, shown in figure 11-18 is required where the refrigerant pressure loss through the cooling coil is of any consequence: such as, above 2 1/2 pounds for air conditioning, 1 1/2 pounds for middle range refrigeration and 1/2 pound for frozen food applications. The need for an external equalizing port can be described by using figure 11-20. Assume the pressure loss through the coil is 10 pounds. This would result in a pressure at point B of 37 psig minus 10 psig or 27 psig which is equivalent to an evaporating temperature of approximately 28°. Pressure at point A would still be 37 psig and the pressure at the underside of the diaphragm would still be 37 psig plus 9.7 psig or 46.7 psig. The required pressure above the diaphragm for equalization purposes would be 46.7 psig equivalent to a thermal bulb temperature of 50°. However, the difference between the superheated temperature

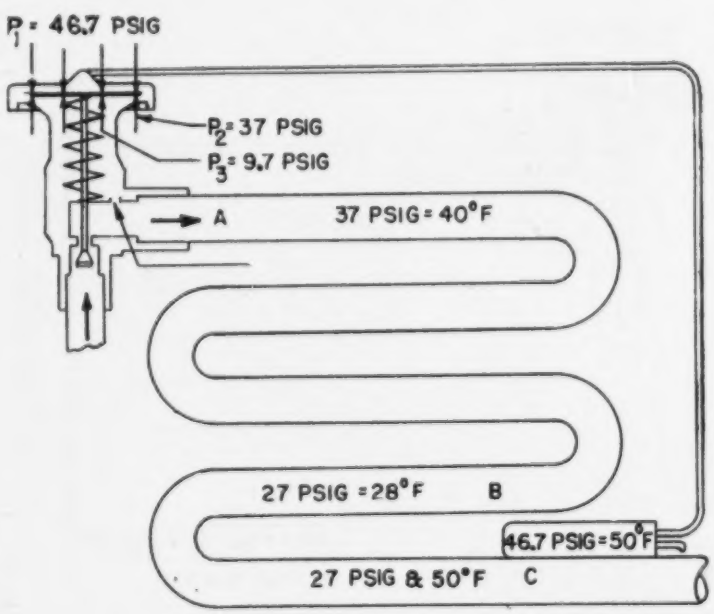

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Figure 11-20.—Thermal expansion valve with internal equalizer on evaporator with 10 psi drop.

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at 50° at point C and 28° evaporating temperature at point B results in a 22° superheat. This increase in superheat from 10° to 22° makes it necessary to use more of the cooling coil surface for superheating the vapor rather than for absorption of latent heat by the liquid and so the cooling coil is not fully utilized. The thermal expansion valve provided with an external equalizer must be used where such a condition exists. Figure 11-21 shows the connection with external equalizer, resulting in using the pressure of 27 psig at C and applying it directly to the underside of the diaphragm P_2 for a true response to superheat temperature.

Thermal expansion valves are rated by the manufacturer in tons of refrigeration for various refrigerant evaporating temperatures and pressure differentials across the valve. These ratings are based generally on an assumed 1° sub-cooling of the liquid refrigerant at the entrance to the valve. This requires that each valve be selected not only for the tonnage needed for the cooling coil it serves but also for the conditions of pressure and temperature of the refrigerant at the inlet and downstream of the valve for its specific location in the refrigerating piping system. Thus, it becomes necessary to determine pressure losses including vertical rise of liquid and anticipate realistic operating conditions in order to properly select a valve of adequate size.

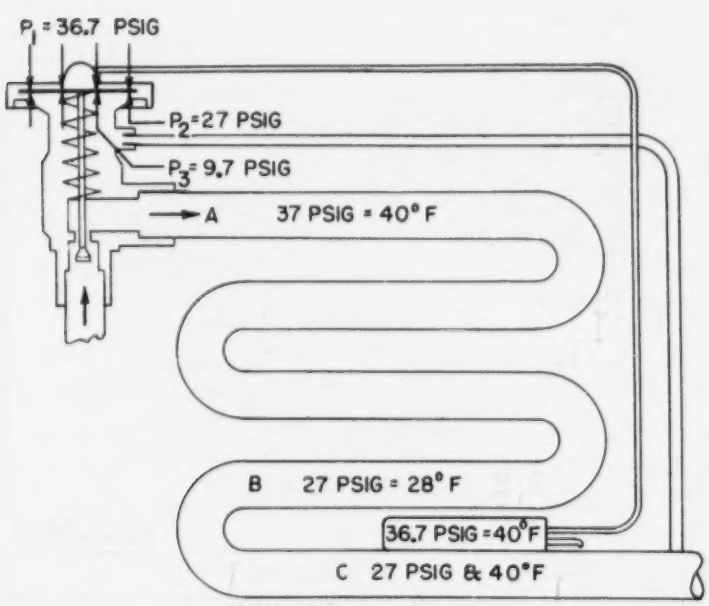

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Figure 11-21.—Thermal expansion valve with external equalizer on evaporator with 10 psi pressure drop.

When the thermostatic expansion valve is operating properly, the temperature at the outlet side of the valve is much lower than that at the inlet side. If this temperature difference does not exist when the system is in operation, the valve seat is probably dirty and clogged with foreign matter.

Once a valve is properly adjusted, further adjustment should not be necessary. The major trouble encountered can usually be traced to moisture or dirt collecting at the valve seat and orifice. The symptoms of improper valve operation should be carefully analyzed before concluding that the valve is out of adjustment. Once a valve is properly adjusted, additional adjustment should not be necessary unless changes are made to the cooling coil arrangement or thermal element location.

By means of a gear and screw arrangement, the thermostatic expansion valve is adjusted to maintain a superheat ranging approximately from 4° F to 12° F at the cooling coil outlet. The proper superheat adjustment varies with the design and service operating conditions of the valve, and the design of the particular plant. Increased spring pressure increases the degree of superheat at the coil outlet and decreased pressure has the opposite effect. Many thermostatic expansion valves are initially adjusted by the manufacturer to maintain a predetermined degree of superheat, and no provision is made for further adjustments in service.

If expansion valves are adjusted to give a high degree of superheat at the coil outlet, or if the valve is stuck shut, the amount of refrigerant admitted to the cooling coil will be reduced. With an insufficient amount of refrigerant, the coil will be "starved" and will operate at a reduced capacity. Compressor lubricating oil carried with the refrigerant may tend to collect at the bottom of the cooling coils, thus robbing the compressor crankcase, and providing a condition whereby slugs of lubricating oil may be drawn back to the compressor. If the expansion valve is adjusted for too low a degree of superheat, or if the valve is stuck open, liquid refrigerant may flood from the cooling coils back to the compressor. Should the liquid collect at a low point in the suction line or coil, and be drawn back to the compressor intermittently in slugs, there is danger of injury to the moving parts of the compressor.

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In general, the expansion valves for air conditioning and water cooling plants (high temperature installations) must be adjusted for higher superheat than are the expansion valves for cold storage refrigeration and ship's service store equipment (low temperature installations).

If it is impossible to adjust expansion valves to the desired settings, or if it is suspected that the expansion valve assembly is defective and requires replacement, appropriate tests must be made. (First be sure that the liquid strainers are clean, that the solenoid valves are operative, and that the system is sufficiently charged with refrigerant.)

The major equipment required for expansion valve tests is as follows:

1. A service drum of R-12, or a supply of clean dry air at 70 to 100 psig. The service drum is used to supply gas under pressure. The gas used does not have to be the same as that employed in the thermal element of the valve being tested.

2. A high pressure and a low pressure gage. The low pressure gage should be accurate and in good condition so that the pointer does not have any appreciable lost motion. The high pressure gage, while not absolutely necessary, will be useful in showing the pressure on the inlet side of the valve. Refrigeration plants are provided with suitable spare and test pressure gages.

The procedure for testing is as follows:

1. Connect the valve inlet to the gas supply with the high pressure gage attached so as to indicate the gas pressure to the valve, and with the low pressure gage loosely connected to the expansion valve outlet. The low pressure gage is connected up loosely so as to provide a small amount of leakage through the connection.

2. Insert the expansion valve thermal element in a bath of crushed ice. Do not attempt to perform this test with a container full of water in which a small amount of crushed ice is floating.

3. Open the valve on the service drum or in the air supply line. Make certain that the gas supply is sufficient to build up the pressure to at least 70 psi on the high pressure gage connected in the line to the valve inlet.

4. The expansion valve can now be adjusted. If it is desired to adjust for 10° F superheat, the pressure on the outlet gage should be 22.5 psig. This is equivalent to an R-12 evaporating temperature of 22° F, and since the ice maintains the bulb at 32° F, the valve adjustment is for 10° superheat (difference between 32 and 22). For a 5° superheat adjustment, the valve should be adjusted to give a pressure of approximately 26.1 psig. There must be a small amount of leakage through the low pressure gage connection while this adjustment is being made.

5. To determine if the valve operates smoothly, tap the valve body lightly with a small weight. The low pressure gage needle should not jump more than 1 psi.

6. Now tighten the low pressure gage connection so as to stop the leakage at the joint, and determine if the expansion valve seats tightly. With the valve in good condition, the pressure will increase a few pounds and then either stop or build up very slowly. With a leaking valve, the pressure will build up rapidly until it equals the inlet pressure.

7. Again loosen the gage so as to permit leakage at the gage connection; remove the thermal element, or control bulb, from the crushed ice, and warm it with the hand or place it in water that is at room temperature. When this is done, the pressure should increase rapidly, showing that the power element has not lost its charge. If there is no increase in pressure, the power element is dead.

8. With high pressure showing on both gages as outlined above, the valve can be tested to determine if the body joints or the bellows leak. This can be done by using a halide leak detector. When performing this test, it is important that the body of the valve have a fairly high pressure applied to it. In addition, the gages and other fittings should be made up tightly at the joints so as to eliminate leakage at these points.

If it is evident that the expansion valve is defective, it must be replaced. Often it is possible to replace a faulty power element or other part of the valve without having to replace the entire assembly. When replacement of an expansion valve is necessary, it is important to replace the unit with a valve of the same capacity and type, designed for R-12 systems.

The WATER REGULATING VALVE should be adjusted to maintain a compressor discharge pressure of approximately 125 psig. To raise the valve opening point, turn the adjusting nuts clockwise, increasing tension on the main springs. Increasing main spring tension increases the amount of pressure required to open the valve. Turning the adjusting nuts counterclockwise decreases the main spring

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tension, therefore decreasing the amount of pressure required to open the valve. If the ambient temperature is high, pressure (gas) in the compressor discharge line and condenser may remain high and cause the water regulating valve to partly open when the compressor is idle. In such instances, the point of valve opening should be raised just enough to cause the valve to close during compressor shutdown.

The valve may be flushed by opening it with an outside force, a screwdriver or similar tool may be used to force the spring yoke.

The THERMOSTATIC SWITCH which operates the solenoid valve is similar to the low pressure switch. Tubing connects a bellows in the thermostatic switch to a thermal bulb in the compartment being cooled. The thermal bulb and tubing are charged with R-12 or some other volatile liquid. Temperature changes in the refrigerated compartment cause corresponding pressure changes of the actuating medium in the thermal bulb. These pressure changes are transmitted to the thermostatic switch, through the connecting tubing. To set or adjust the cut-in and cutout points of the thermostatic switch, the same procedure is used as in setting and adjusting the low pressure switch.

When condenser circulating water is obtained from the firemain, the pressure must be reduced. For this pressure reduction, an AUTOMATIC REDUCING VALVE is installed in the branch line leading from the firemain to the condenser. The reducing valve is installed just ahead of the regulating valve. While maintenance of the reducing valve is usually a responsibility of the Shipfitter, the Machinist's Mate may have to adjust the reducing valve to raise or lower the outlet pressure. The outlet pressure can be varied by turning the adjusting screw, which is located under the cap. Turning the adjusting screw clockwise increases the pressure applied by the spring to the top of the diaphragm, thus opening the valve wider and increasing the outlet pressure. Turning the adjusting screw counterclockwise decreases the spring pressure on the top of the diaphragm, thus tending to decrease the discharge pressure.

CHARACTERISTICS OF REFRIGERANTS

Pure R-12 (CCl_2F_2) is colorless. In concentrations of less than 20 percent by volume in air, R-12 is odorless; in higher concentrations, its odor resembles that of carbon tetrachloride. It has a boiling point of -21° F at atmospheric pressure. At ordinary temperatures R-12 is a liquid when under a pressure of about 70 to 75 psig.

Mixtures of R-12 vapor and air, in all proportions, are nonirritating to the eyes, nose, throat, and lungs. The refrigerant will not contaminate or poison foods or other supplies with which it may come in contact. The vapor is nonpoisonous; it will not support respiration, however, and it produces mild anesthesia when it is inhaled in sufficient quantities. In view of its low boiling point at atmospheric pressure, care must be taken to prevent liquid R-12 from coming in contact with the eyes; the liquid will freeze the tissues of the eyes. Always wear goggles if you are to be exposed to R-12.

R-12 in either a liquid or vapor state is nonflammable and nonexplosive. R-12 will not corrode the metals commonly used in refrigerating systems.

One hazard which may be introduced through the use of R-12 as a refrigerant is the very remote health hazard which may be presented should leakage of a large amount of the vapor come in direct contact with an open flame of high temperature (about 1,000° F.) and be decomposed. In order to be a health hazard, the leakage of R-12 must be within a confined and poorly ventilated space and the vapor must come in direct contact with a high temperature flame. When these conditions exist, however, the products of decomposition are pungent and irritating, rendering them noticeable even when they are present only in minute quantities; ample warning is available before concentrations dangerous to health are reached.

R-12 is a stable compound capable of undergoing without decomposition, the physical changes required of it in refrigeration service. It is an excellent solvent and has the ability to loosen and remove all particles of dirt, scale, and oil with which it comes in contact within a refrigerating system.

R-22 ($CHClF_2$) and R-11 (CCl_3F) are colorless, nonexplosive, nonpoisonous refrigerants with many properties similar to those of R-12.

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SAFETY PRECAUTIONS

Refrigerants are furnished in cylinders for use in shipboard refrigeration systems. The following precautions must be observed in the handling, use, and storage of these cylinders:

1. Never drop cylinders nor permit them to strike each other violently.
2. Never use a lifting magnet or a sling (rope or chain) when handling cylinders. A crane may be used if a safe cradle or platform is provided to hold the cylinders.
3. Caps provided for valve protection must be kept on cylinders except when the cylinders are being used.
4. Whenever refrigerant is discharged from a cylinder, the cylinder should be weighed immediately and the weight of the refrigerant remaining in the cylinder should be recorded.
5. Never attempt to mix gases in a cylinder.
6. NEVER put the wrong refrigerant into a refrigeration system! No refrigerant except the one for which the system was designed should ever be introduced into the system. Check the equipment nameplate or the manufacturer's technical manual to determine the proper refrigerant type and charge. Putting the wrong refrigerant into a system may cause a violent explosion.
7. When a cylinder has been emptied, close the cylinder valve immediately to prevent the entrance of air, moisture, or dirt. Also, be sure to replace the valve protection cap.
8. Never use cylinders for any purpose other than their intended purpose. DO NOT use them as rollers, supports, etc.
9. DO NOT tamper with the safety devices in the valves or cylinders.
10. Open cylinder valves slowly. Never use wrenches or other tools except those provided by the manufacturer.
11. Make sure that the threads on regulators or other connections are the same as those on the cylinder valve outlets. Never force connections that do not fit.
12. Regulators and pressure gages provided for use with a particular gas must NOT be used on cylinders containing other gases.
13. Never attempt to repair or alter cylinders or valves.
14. Never fill R-12 cylinders beyond 80 percent of capacity.
15. Store cylinders in a cool, dry place, in an upright position. If the cylinders are exposed to excessive heat, a dangerous increase in pressure will occur. If cylinders must be stored in the open, take care that they are protected against extremes of weather. NEVER allow a cylinder to be subjected to a temperature above 125° F.
16. NEVER allow R-12 to come in contact with a flame or red-hot metal! When exposed to excessively high temperatures, R-12 breaks down into PHOSGENE gas, an extremely poisonous substance.

Because R-12 is such a powerful freezing agent that even a very small amount can freeze the delicate tissues of the eye, causing permanent damage; it is essential that goggles be worn by all personnel who may be exposed to a refrigerant, particularly in its liquid form. If refrigerant does get in the eyes, the person suffering the injury should receive medical treatment immediately in order to avoid permanent damage to the eyes. In the meantime, put drops of clean olive oil, mineral oil, or other nonirritating oil in the eyes, and MAKE SURE that the person does not rub his eyes. CAUTION: DO NOT use anything except clean, nonirritating oil for this type of eye injury.

If R-12 comes in contact with the skin, it may cause frostbite. This injury should be treated as any other case of frostbite. Immerse the affected part in a warm bath for about 10 minutes, then dry carefully. Do NOT rub or massage the affected area.

Although R-12 is generally classed as nontoxic, it IS poisonous in high concentrations such as might occur from excessive R-12 leakage in a confined or poorly ventilated space. If a person should be overcome by R-12 remove him IMMEDIATELY to a well-ventilated place and get medical attention at the earliest opportunity. Watch his breathing. If the person is not breathing, begin artificial respiration.

Additional information on first-aid treatment for exposure to refrigerants is given in the Standard First Aid Training Course, NavPers 10081-B.

CHAPTER 12

AIR CONDITIONING

Air conditioning is a field of engineering dealing with the design, construction, and operation of equipment used in establishing and maintaining desirable indoor air conditions. It is the science of maintaining the atmosphere of an enclosure at any required temperature, humidity, and purity. As such, air conditioning involves the cooling, heating, dehumidifying, ventilating, and purifying of air.

This chapter covers the principal factors involved in the conditioning of air, the type of equipment used in ventilating, cooling, and heating the air, and general information concerning the maintenance of air conditioning equipment. Additional information may be obtained from chapter 9380 (38) of the Naval Ships Technical Manual.

PURPOSES OF AIR CONDITIONING AND RELATED FACTORS

One of the chief purposes of air conditioning is to keep the ship's crew comfortable, alert, and physically fit. The air of various compartments must be of the right temperature, have the proper moisture content, have contamination held within an acceptable level, be circulated properly, and have the correct proportion of oxygen. The human body cannot long maintain a high level of efficiency under adverse conditions.

The comfort and fitness of the crew is not the only immediate purpose of air conditioning. Mechanical cooling or ventilation must also be provided for AMMUNITION SPACES, to prevent deterioration of ammunition components; for GAS STORAGE SPACES, to prevent excessive pressure buildup in containers and contamination from leakage in the space; and for ELECTRICAL/ELECTRONIC EQUIPMENT SPACES, to limit ambient (encompassing) temperature to that specified for the equipment.

The principal factors which must be considered in connection with achieving the objectives of air conditioning are discussed in this chapter.

HUMIDITY

Vapor content of the atmosphere called HUMIDITY, has a great influence on human comfort. The common expression, "It isn't the heat, it's the humidity," indicates the recognition of the discomfort producing effects of moisture-laden air in hot weather. Extremely low moisture content also has undesirable effects on the human body. The measurement and control of the moisture content of the air is an important phase of air conditioning engineering. In order to understand this phase of air conditioning engineering, you should become familiar with the information given in the following paragraphs.

Saturated Air

The air holds varying amounts of water vapor, and, as temperature rises, the amount of moisture that the air can hold increases. But for every temperature there is a definite limit as to the amount of moisture that the air is capable of holding. When air attains the maximum amount of moisture which it can hold at a specific temperature, it is said to be saturated.

The saturation point is usually called the dew point. If the temperature of saturated air falls below its dew point, some of the water vapor in the air must condense to water. The dew that appears on foliage in the early morning when there is a drop in temperature in such a condensation. The "sweating" of cold water pipes is the result of water vapor from the air condensing on the cold surface of the pipes.

Absolute and Specific Humidity

The amount of water vapor in the air is expressed in terms of the weight of the moisture.

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Practices in Animal Sanitation. Service Bulletin Number Seven.

Arizona Univ., Tucson. Dept. of Agricultural Education.
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ABSTRACT - Written by a graduate assistant in agricultural education, this bulletin is intended to serve as a reference for vocational agriculture teachers and students studying units on livestock sanitation and disease. Section I covers such general sanitation practices as: (1) Sanitation in Housing Facilities, (2) Methods of Disinfection and Sterilization, (3) Chemical Disinfectant Chart, (4) Control of Disease Transport through Application of Sanitation, (5) Isolation as Part of the Sanitation Program, (6) Carcass Disposal, and (7) Care of Animals Immediately Before and After Birth. The second section is concerned with specific practices for specific kinds of animals, including swine, beef, sheep, dairy cattle, horses, and dogs and cats. Information on wounds and their treatment is also given. The bulletin also provides a glossary and a list of selected references. Three related documents are available as VT 001 012 and VT 001 013 (both in AIM Winter 1968) and VT 010 397 (also in this issue). (AW)

VT 010 369

The weight is usually given in grains (7000 grains equal 1 pound). Absolute humidity is the weight in grains of water vapor per cubic foot of air. Specific humidity is the weight in grains of water vapor per pound of air. (The weight of water vapor refers only to moisture in the vapor state, and not in any way to the moisture that may be present in the liquid state, such as rain, or dew.)

Relative Humidity

Relative humidity is the ratio of the weight of water vapor in a sample of air to the weight of water vapor that same sample of air would contain if saturated, at the existing temperature. This ratio is usually stated as a percentage. For example, when air is fully saturated, its relative humidity is 100 percent. When air contains no moisture at all, its relative humidity is zero percent. If air is half saturated, its relative humidity is 50 percent.

As far as comfort and discomfort resulting from humidity are concerned it is the relative humidity and not the absolute or specific humidity that is the important factor. This can be easily understood from the discussion that follows.

Moisture always travels from regions of greater wetness to regions of less wetness, just as heat travels from regions of higher temperature to regions of lower temperature. If the air above a liquid is saturated, the two are in equilibrium and no moisture can travel from the liquid to the air; that is, the liquid cannot evaporate. If the air is only partially saturated, some moisture can travel to the air; that is, some evaporation can take place.

If the specific humidity of the air is 120 grains per pound, it is the actual weight of the water vapor in the air. When the temperature of the air is 76° F, the relative humidity is then nearly 90 percent—that is, the air is nearly saturated. At such a relative humidity, the body may perspire freely but the perspiration does not evaporate rapidly; thus a general feeling of discomfort results.

However, if the temperature for the air were 86° F, the relative humidity would then be only 64 percent. That is, although the absolute amount of moisture in the air is the same, the relative humidity is lower, because at 86° F the air is capable of holding more water vapor than it can hold at 76° F. The body is now able to evaporate its excess moisture and the general feeling is much more agreeable, even though the temperature of the air is 10° higher. (The cooling effect is brought about by the absorption of latent heat during the evaporating process.)

In both examples, the specific humidity is the same, but the ability of the air to evaporate liquid moisture is quite different at the two temperatures. This ability to evaporate moisture is directly indicated by the relative humidity. It is for this reason that the control of relative humidity is of extreme importance in air conditioning.

HEAT OF THE AIR

The heat of the air is considered from three standpoints—differentiated as sensible, latent, and total heat.

SENSIBLE HEAT is the heat that changes the temperature of a substance (air) when added to or removed from it. Sensible heat changes can be measured by the household, or dry-bulb thermometer.

Air always contains more or less water vapor. Any water vapor in the air contains the LATENT HEAT OF VAPORIZATION. (Remember that the amount of latent heat present has no effect upon the temperature of the air, as read on a dry-bulb thermometer.)

Any mixture of dry air and water vapor contains both sensible and latent heat. The sum of the sensible heat and the latent heat in any sample of air is called the TOTAL HEAT of the air.

TEMPERATURES

When testing the effectiveness of air conditioning equipment and when checking the humidity of a space, two different temperatures are generally considered. These are the dry-bulb and wet-bulb temperatures.

Measurement of Temperatures

The DRY-BULB TEMPERATURE is the temperature of the sensible heat of the air, as measured by an ordinary thermometer. Such a thermometer in air conditioning engineering is referred to as a dry-bulb thermometer because its bulb is dry, in contrast with the wet-bulb type next described.

The WET-BULB TEMPERATURE is best explained by a description of a wet-bulb thermometer. It is an ordinary thermometer, with a loosely woven cloth sleeve or wick placed

around its bulb and then wet with water. The water in the sleeve or wick is caused to evaporate by a current of air at high velocity. This evaporation withdraws heat from the thermometer bulb, lowering the temperature a number of degrees. The difference between the dry-bulb and the wet-bulb temperature is called the wet-bulb depression. The wet-bulb temperature is the same as the dry-bulb when the air is saturated (that is, when evaporation cannot take place). The condition of saturation, however, is unusual, and a wet-bulb depression is normally expected.

The wet-bulb and dry-bulb thermometers are usually mounted side by side on a frame, to which a handle or short chain is attached so that the thermometers may be whirled in the air, thus providing a high-velocity air current that promotes evaporation. Such a device is known as a SLING PSYCHROMETER. When using the sling psychrometer, whirl it rapidly, at least four times per second. Observe the wet-bulb temperature at intervals. The point at which there is no further drop in temperature is the wet-bulb temperature for that space.

MOTORIZED PSYCHROMETERS are provided with a small motor-driven fan and dry cell batteries. Motorized psychrometers are generally preferred and are gradually replacing sling psychrometers.

Relationships Between the Temperatures

The definite relationships between the three temperatures should be clearly understood. These relationships are:

1. When the air contains some moisture but is not saturated, the dew-point temperature is lower than the dry-bulb temperature, and the wet-bulb temperature lies between them.
2. As the amount of moisture in the air increases, the differences between the dry-bulb temperature and wet-bulb temperature become less.
3. When the air is saturated, all three temperatures are the same.

BODY HEAT BALANCE

Ordinarily the body remains at a fairly constant temperature of 98.6° F. It is very important that this body temperature be maintained, and since there is a continuous heat gain from interior processes, there must also be a continuous outgo to maintain a balance. Excess heat must be absorbed by the surrounding air or lost by radiation. As the temperature and humidity of environment vary, the body automatically regulates the amount of heat which it gives off. However, this ability to adjust to varying environmental conditions is limited. Furthermore, although the body may adjust to certain atmospheric conditions, it may do so with a distinct feeling of discomfort. The discussion which follows will help you understand how atmospheric conditions affect the body's ability to maintain a heat balance.

Body Heat Gains

The body gains heat (1) by radiation, (2) by convection, (3) by conduction, and (4) as a by-product of physiological processes that take place within the body.

The heat gain by radiation comes from our surroundings, but since heat always travels from regions of higher temperature to regions of lower temperature, the body receives heat from those surroundings that have a temperature higher than body surface temperature. The greatest source of heat radiation is the sun. Indoor heat radiation is gained from heating devices, operating machinery, hot steam piping, etc.

The heat gain by convection comes from currents of heated air only. Such currents of air may come from a galley stove or an engine.

The heat gain by conduction comes from objects with which the body, from time to time, is in contact.

Most of the body heat comes from within the body itself. Heat is being continuously produced inside the body by the oxidation of foodstuffs and by other chemical processes, by friction and tension within the muscle tissues, and by other causes as yet not completely identified.

Body Heat Losses

There are two types of body heat losses: loss of sensible heat, and loss of latent heat. Sensible heat is given off by three methods: (1) radiation, (2) convection, and (3) conduction. Latent heat is given off in the breath and by evaporation of perspiration.

The body is usually at a higher temperature than that of its surroundings, and therefore radiates heat to bulkheads, decks, and equipment. This action is called heat radiation loss. The temperature of the air does not influence this radiation, except as it may alter the temperature of such surroundings.

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The heat loss by convection occurs when the heat is carried away from the body by convection currents, both by the air coming out of the lungs and by exterior air currents.

The heat loss by conduction is caused by bodily contact with colder objects or substances. Since the body is usually at a higher temperature than that of its surroundings, it gives up heat by conduction through physical contact with its surroundings.

When the air temperature and relative humidity are not too high and when the body is not too active, the body gets rid of its excess heat by radiation, convection, conduction, and a slight amount of perspiration. When engaged in work or exercise, the body develops much more internal heat, and perspiration increases. If the relative humidity is low, perspiration rapidly evaporates. As the perspiration evaporates, the body loses additional heat (latent heat of vaporization). However, if the relative humidity of the air is high, the moisture cannot evaporate, or it does so at a slow rate; hence the excess heat cannot be removed by evaporation, and discomfort follows.

The amount of heat given off by the body varies according to the body's activity. When seated at rest, the average adult male gives off about 380 Btu per hour. Doing routine work on a ship, a man gives off an average of 500 to 600 Btu per hour.

For light work on a ship, particularly on a submarine, research has shown that the total amount of body heat loss is divided as follows: About 45 percent by radiation, 30 percent by convection and conduction, and 25 percent by evaporation.

EFFECT OF AIR MOTION

In perfectly still air, a layer of air adjacent to the body absorbs the sensible heat given off by the body and increases in temperature. The layer of air also takes up the water vapor given off by the body, and thus increases in relative humidity. The body is thus surrounded by an envelope of air which is at a higher temperature and relative humidity than the ambient air, and the amount of heat which the body can lose to this envelope is less than that amount it can lose to the ambient air. If the air is set in motion past the body, the envelope is continually broken up and replaced by the ambient air, and the heat loss from the body is increased. When the increased heat loss improves the heat balance, the sensation of a "breeze" is felt; when the increase is excessive, the sensation of a "draft" is felt.

SENSATION OF COMFORT

From the foregoing discussion, it is evident that the three factors—temperature, humidity, and air motion—are closely interrelated in their effects upon comfort and health. In fact, a given combination of temperature, humidity, and air motion will produce the same feeling of warmth or coolness as a higher or lower temperature in conjunction with a compensating humidity, and air motion. The term given to the net effect of these factors is known as the EFFECTIVE TEMPERATURE. This temperature cannot be measured by any instrument, but may be found on a special psychrometric chart when the dry-bulb and wet-bulb temperatures and air velocity are known.

Though all of the combinations of temperature, relative humidity, and air motion of a particular effective temperature may produce the same feeling of warmth or coolness, they are not all equally comfortable. It has been found that a relative humidity below 15 percent produces a parched condition of the mucous membranes of the mouth, nose, and lungs, and increases susceptibility to disease germs. A relative humidity above 70 percent causes an accumulation of moisture in clothing. For best health conditions, a relative humidity ranging from 40 to 50 percent for cold weather, and from 50 to 60 percent for warm weather, is desirable. An overall range from 30 to 70 percent is acceptable.

VENTILATION EQUIPMENT

Since proper circulation is the basis for all ventilating and air conditioning systems and of related processes, information dealing with the means of circulating air will be considered first. The sections which follow contain information on equipment used to supply, circulate, and distribute fresh air, and to remove used, polluted, and overheated air.

Fans used on Navy ships in conjunction with supply and exhaust systems may be divided into two general classes; axial flow and centrifugal. Most fans in duct systems are of the axial flow type because axial flow fans generally require less space for installation.

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Centrifugal fans are generally preferred for exhaust systems handling explosive or hot gases. The motors of these fans, being outside the air stream, cannot ignite the explosive gases. The motors are subject to overheating to a lesser degree than are motors of vane-axial fans. If the temperature of the gases being handled is very high, the heat transmitted to the motor, through the shaft, may cause trouble.

VANE-AXIAL FANS (fig. 12-1) are high pressure fans and are generally installed in duct systems. They are provided with vanes at the discharge end to straighten out rotational air motion caused by the impeller. The motors for these fans are cooled by the air in the duct. They will overheat if operated with all air over the fan shut off.

TUBE-AXIAL FANS are low pressure fans and are usually installed without duct work. However, they do have sufficient pressure for a short length of duct.

CENTRIFUGAL FANS (part A of fig. 12-2) are used primarily for exhausting explosive or hot gases. However, they may be used in lieu of axial flow fans if they work in better with the arrangement or if their pressure-volume characteristics suit the installation better than an axial flow fan. Centrifugal fans are also used in the standard fan coil assemblies.

The PORTABLE FANS (part B of fig. 12-2) with flexible airhoses, are used aboard ship to ventilate compartments after painting, to exhaust flammable or toxic gases from closed spaces and tanks, and to cool hot spots around machinery during repairs.

Most of the portable fans are of the axial flow type, driven by electric, "explosion-proof" motors. On ships carrying gasoline, a few air turbine-driven centrifugal fans are normally provided. Greater confidence is placed in the explosion-proof characteristics of these fans.

The WATERPROOF VENTILATOR, shown in figure 12-3 consists of an outer housing, an inner ventilator shaft extending up to the outer housing, and a bucket-type closure supported over the ventilator shaft by a compression spring. The bucket is provided with drain tubes extending into a sump between the ventilator shaft and the outer housing. The sump is provided with scupper valves, which drain onto the weather deck.

The ventilator operates automatically, and is normally open. Small quantities of water which enter the ventilator fall into the bucket and drain out through the drain tubes and scuppers. In heavy seas, when water enters the bucket faster than it drains out, the weight of water forces the bucket down against the top of the ventilator shaft. Thus, a watertight seal is formed and maintained until sufficient water drains out to permit the force of the spring to raise the bucket to the open position. Operating gear is generally provided, also, to permit a manual closing of the ventilator. With slight variations in construction, this ventilator is used for both the supply and exhaust of air.

BRACKET FANS are used in hot weather to provide local circulation. These fans are usually installed in living, hospital, office, commissary, issuance, and berthing spaces. Where mechanical cooling is employed, bracket fans are sometimes used to facilitate proper circulation and direction of cold air.

EXHAUSTS are used to remove heat and objectionable odors at their source. Machinery spaces, laundries, and galleys are but a few of the spaces aboard ship where exhausts are used.

Most exhausts on Navy ships are mechanical although natural exhaust is sometimes provided on small craft and in ships' structures.

MECHANICAL COOLING EQUIPMENT

On the latest combatant ships, practically all parts of the ship, except machinery spaces, are air conditioned. To determine what equipment will most effectively dehumidify and lower the temperature of compartment air, the Navy has tested several types of air cooling systems. Basically, these systems are refrigerant systems, their design and construction depending on the characteristics of the cooling element circulated through the system and on the principle of operation utilized.

There are, in general, three types of mechanical air-cooling systems used aboard Navy ships: the refrigerant circulating system, the chilled water circulating system, and the self-contained air conditioners.

REFRIGERANT CIRCULATING SYSTEMS

The refrigerant circulating system (fig. 12-4) is essentially a shipboard refrigerating plant, consisting of a compressor, condenser, cooling coils, fan, air filter, and the necessary controls. (R-12 is used as the refrigerant and cooling agent in systems of this type.)

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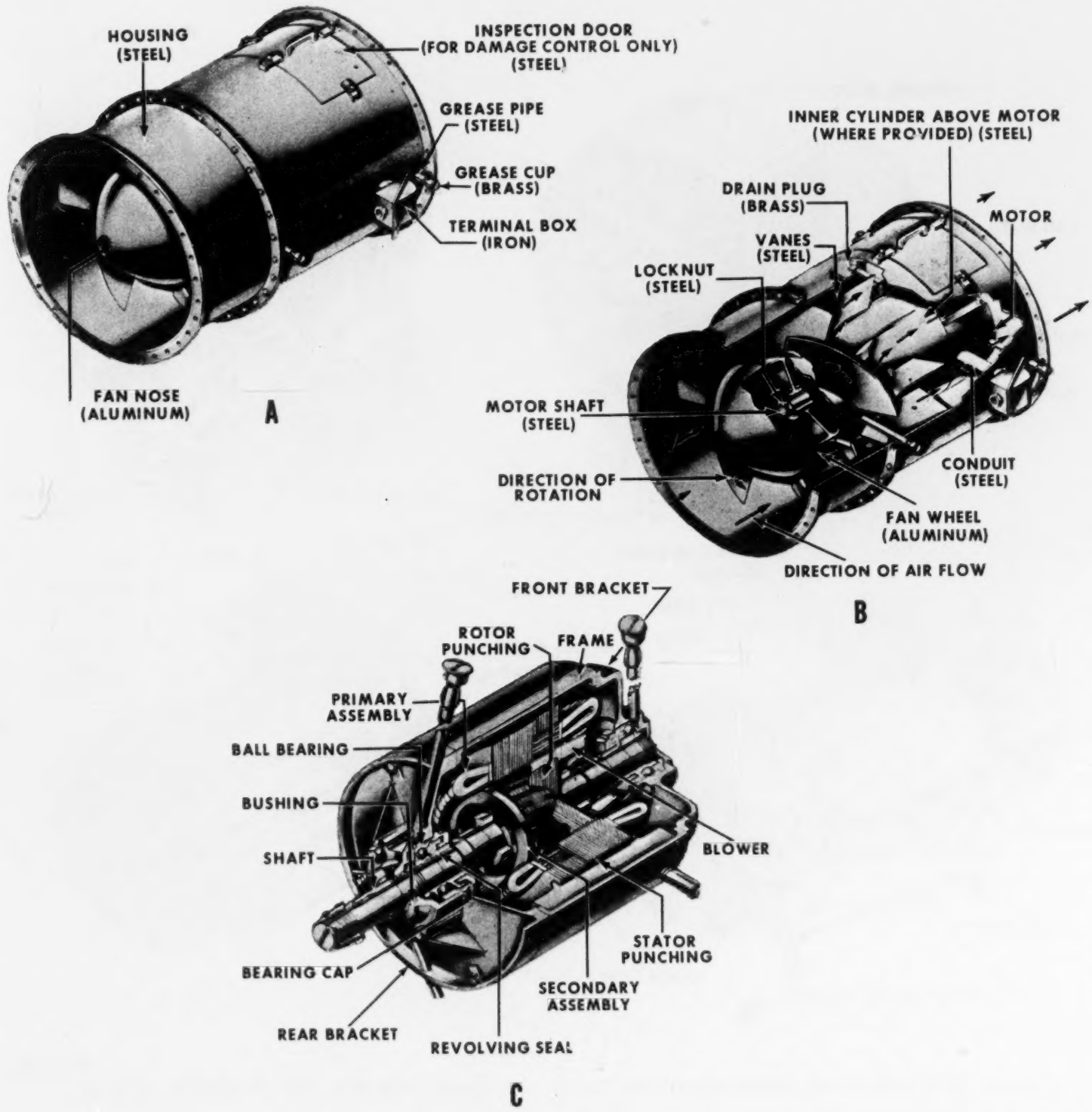

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Figure 12-1.—Vane-axial ventilating fan: A. Exterior view. B. Cutaway view. C. Cutaway view of the fan motor.

Starting from the space to be cooled, the air conditioning cycle is as follows: The hot, moist air from the space is drawn through a duct, or passageway, where it mixes with fresh air drawn in from the outside. The fan may be so located as to blow air over the cooling coil; the refrigerant inside the coil cools the coil surface. The cold surface absorbs the heat from the air passing over it and condenses the excess moisture. The moisture drips off into a pan

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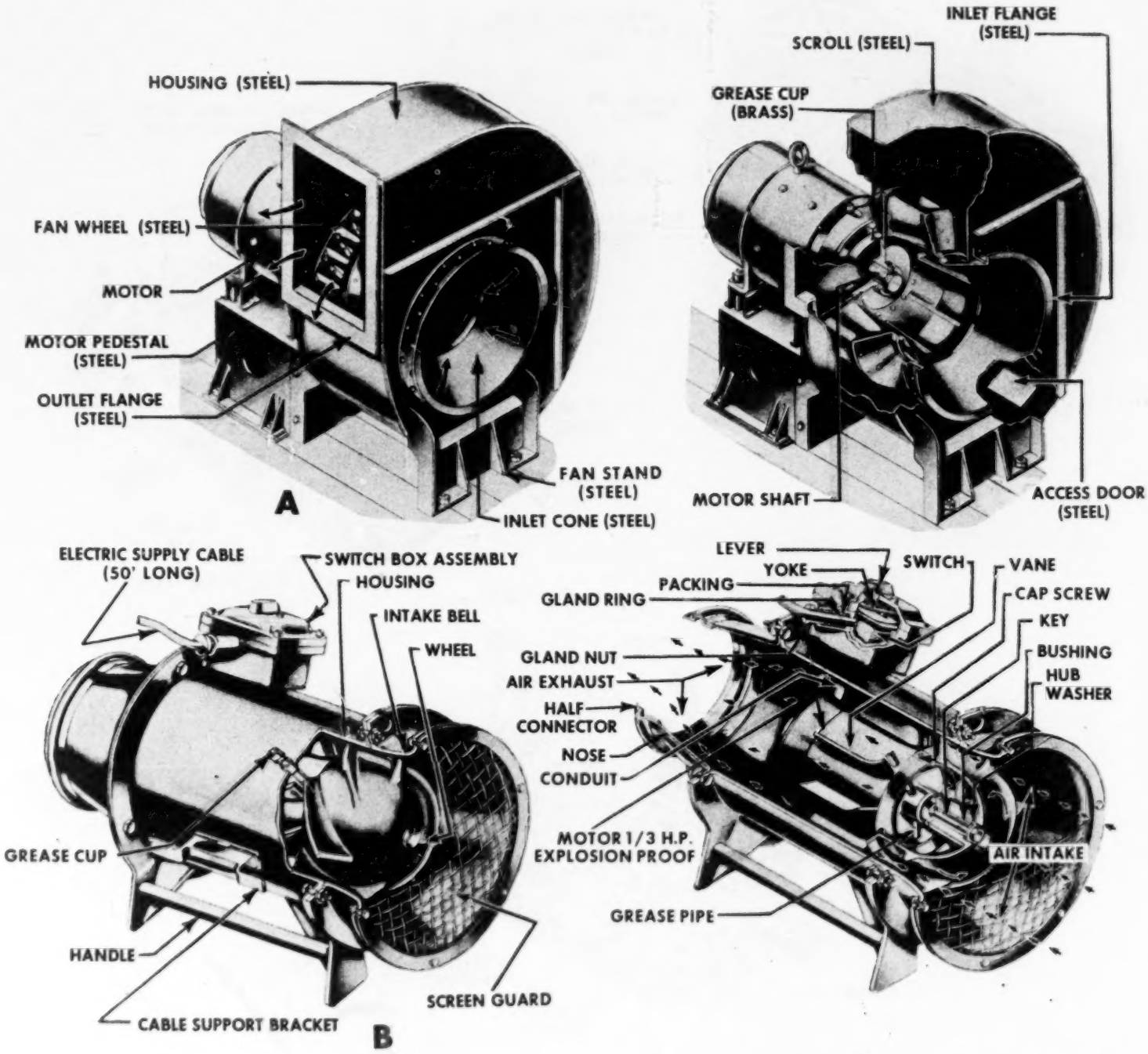

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Figure 12-2.—Miscellaneous ventilating fans: A. Centrifugal fan. B. Portable axial fan.

below the coil and is carried away by drain piping. The cool, dry air leaving the coil is blown into the compartment to be air conditioned, where it absorbs the excess heat and moisture in the space, and is then returned to the cooling coil. Air is exhausted from the space to allow for fresh air being drawn into the space. The cooling coils are installed in the ventilation ducts leading to the spaces to be air conditioned. Automatic and manual controls are added to regulate the operations of the air conditioning equipment.

In general, the machinery and piping arrangements of the ship's refrigeration system and of the R-12 air conditioning system are similar.

Operating suction pressures and evaporator temperatures used in air conditioning systems

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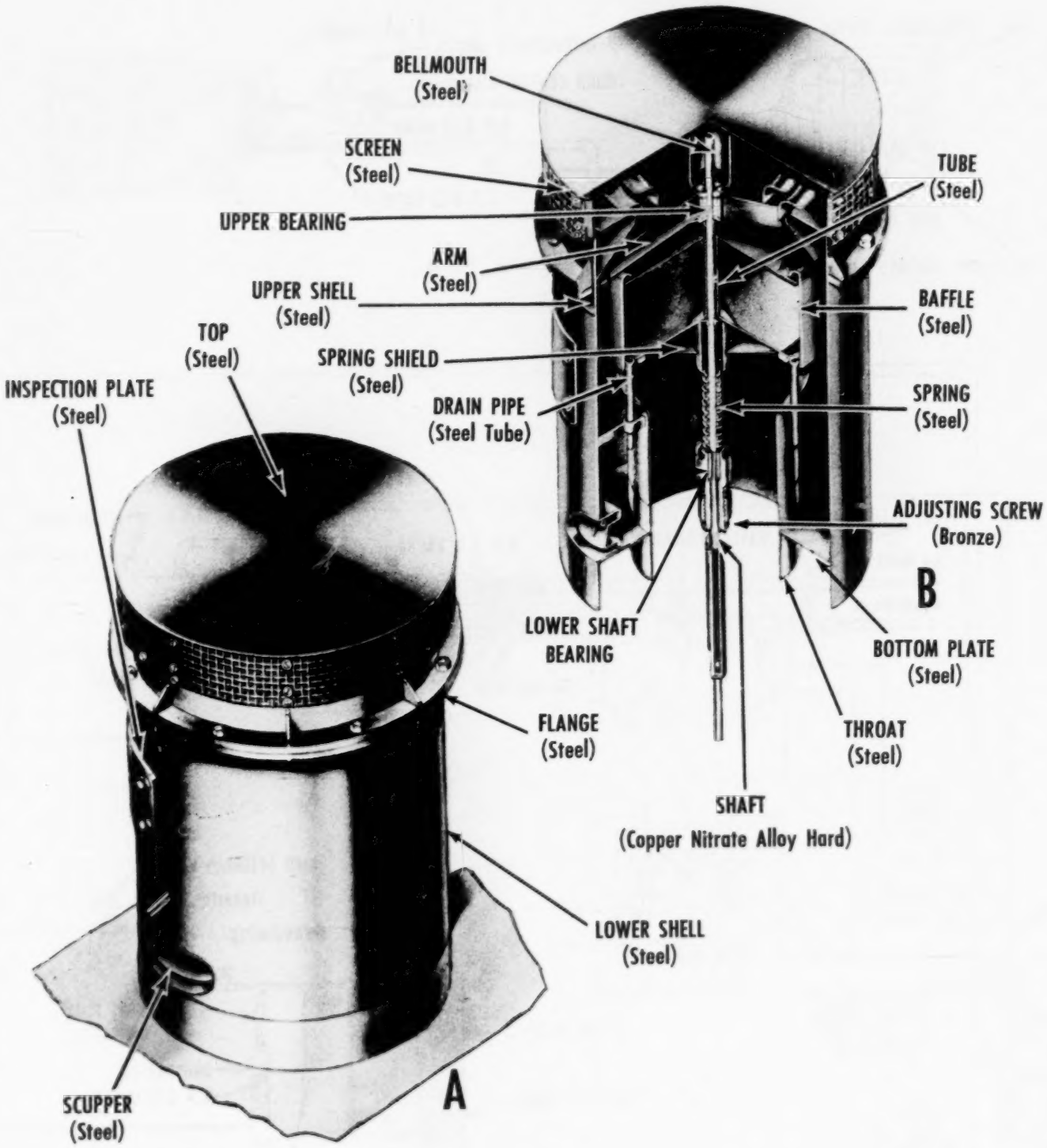

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Figure 12-3.—Waterproof ventilators: A. Exterior view. B. Cutaway view.

are higher than those in refrigeration systems. The difference in suction pressure results in a corresponding effect on the rated capacity of the compressor.

In refrigerant-circulating air conditioning plants the thermostatic expansion valves are normally of the external equalizing type. The internal equalizing port between the valve outlet

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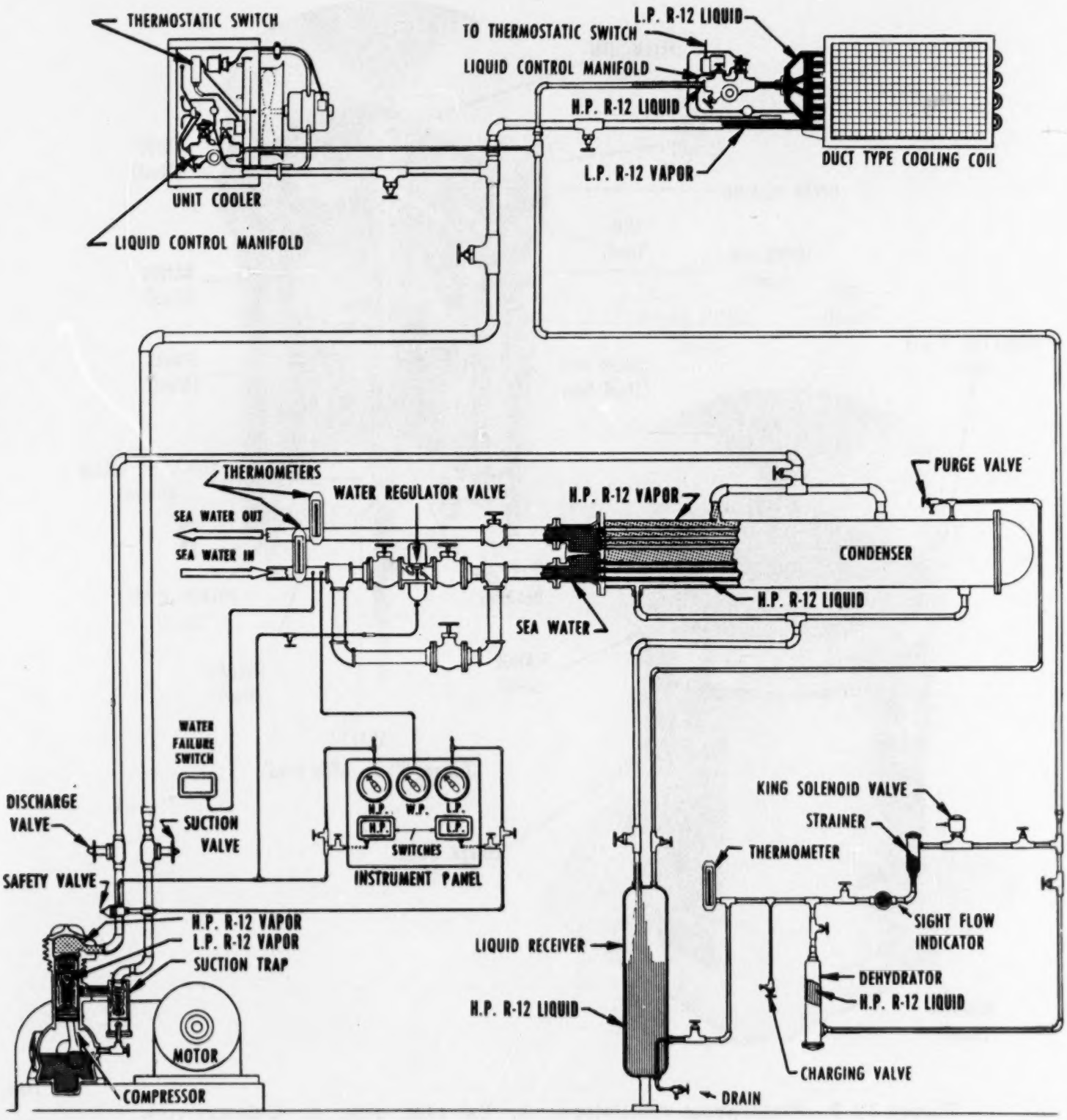

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Figure 12-4.—Typical shipboard refrigerant-circulating air conditioning system.

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and the spring chamber is eliminated; instead there is an opening, through the valve, directly into the spring chamber. By means of copper tubing the spring chamber is connected to the cooling coil, beyond the point of greatest pressure drop. In air conditioning plants, the external equalizer is required in instances where the pressure drop through the cooling coils is 2-1/2 psi or more, or when multicircuit coils are used.

CHILLED WATER CIRCULATING SYSTEMS

There are two air conditioning systems currently in use, which circulate chilled water to the spaces to be cooled. One type operates on the vapor compression cycle and R-11 or R-12 is used as the primary refrigerant; the type of primary refrigerant used will depend on the size of the unit and the type of compressor installed. The other type of system, used on some ships, operates on the absorption cycle and uses water as the primary and secondary refrigerants; lithium bromide is used as an absorbent.

The discussion which follows deals with the vapor compression chilled water circulating systems, used on most ships. Detailed information concerning absorption cycle operating systems can be obtained from the manufacturer's technical manual for the specific system.

The vapor compression chilled water circulating system differs from a direct expansion air conditioning system in that the air conditioning is accomplished by a secondary refrigerant (chilled water) which is circulated to the various cooling coils. Heat from the air conditioned space is absorbed by the chilled water and is removed from the water by the primary refrigerent system in the water chiller. In larger capacity air conditioning systems, the compressor may be a centrifugal type that uses R-11 as the primary refrigerant rather than a reciprocating type that uses R-12 as the primary refrigerant.

The operating cycle of the centrifugal refrigerating machine (fig. 12-5) is basically the same as most refrigerating machines except for the method of compression. The refrigerant vapor coming from the cooler goes into an opening around the hub of the first impeller wheel. The blades in the rapidly rotating wheel impart velocity and compress the vapor. In a multistage compressor the vapor is then directed to the hub of the second wheel, where it is compressed to about 12 psi and discharged to the condenser.

Between the condenser and the cooler, the liquid refrigerant passes through an economizer. A float in the upper chamber of the economizer allows the passage of refrigerant into the lower chamber. By connecting the economizer to the second stage of the compressor—the pressure in the lower chamber is greatly reduced. This reduction of pressure causes some of the liquid refrigerant to flash into vapor and cools the remainder of the refrigerant. Thus the economizer acts as an interstage flash cooler and increases the efficiency of the plant. A float in the lower chamber of the economizer allows the passage of the refrigerant into the cooler. In the cooler, the liquid refrigerant changes its state to a vapor and in so doing absorbs heat from the water.

Water is pumped through the cooler (fig. 12-5) where it loses heat to the refrigerant. The water leaves the cooler at 45° F to 50° F and is directed to the compartments to be cooled.

The centrifugal compressor (fig. 12-5) is of the two-stage type and consists of the casing, rotor, bearings, shaft, impellers, and shaft seal. Centrifugal compressors are usually motor driven through a speed increasing gear which ensures proper compressor speed with a standard speed motor. The speed increasing gear is of the double-helical type, pressure lubricated by a gear type oil pump, which is driven from the compressor shaft.

Some centrifugal compressors are turbine driven; in this case a speed increasing gear is not necessary. The majority of centrifugal air conditioning compressors recently installed on U.S. Navy ships are single stage. The multistage economizer functions described are not applicable to centrifugal air conditioning units having single-stage compressors.

The chilled water cooler is of the shell and tube type. A gas baffle is installed above the tubes to prevent the carryover of liquid refrigerant into the compressor suction. When the plant is shut down, the normal refrigerant charge covers about 50 percent of the tubes, however, when the plant is in operation, the boiling refrigerant covers all of the tubes.

The following controls and safety devices are typical of those installed on a refrigerating system, using a centrifugal compressor: (Control settings are approximate since they will vary with differences in design.)

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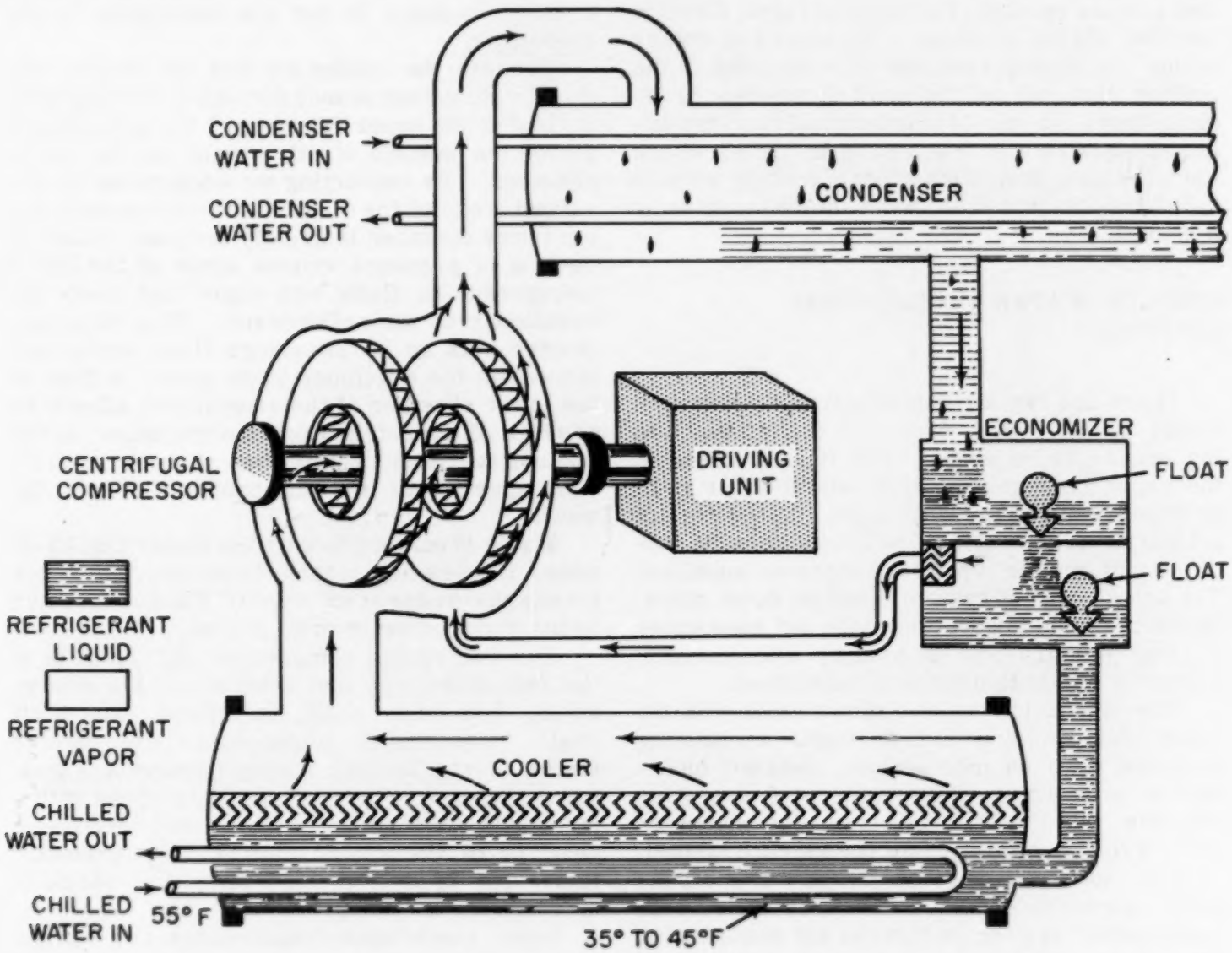

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Figure 12-5.—Chilled water circulating system, with two-stage centrifugal compressor.

1. The CONDENSER GAGE indicates the pressure corresponding to the condensing temperature.

2. The COOLER GAGE indicates the pressure corresponding to the evaporator temperature.

3. The OIL GAGE indicates the lube oil pressure within the lubricating system.

4. The HIGH PRESSURE SWITCH is actuated by the condenser pressure and is set to cut in at 5 psig and to cut out at 15 psig.

5. The COMPRESSOR LOW LUBE OIL PRESSURE SWITCH is actuated by the compressor oil pressure and is set to cut in at 12 psig and to cut out at 6 psig.

6. The GEAR LOW LUBE OIL PRESSURE SWITCH is actuated by the gear oil pressure and is set to cut in at 15 psig and to cut out at 6 psig.

7. The CONDENSER WATER PRESSURE FAILURE SWITCH is actuated by the sea water pressure and is set to cut in at 15 psig and to cut out at 5 psig.

8. The CHILLED WATER DIFFERENTIAL PRESSURE FAILURE SWITCH is actuated by the chilled water pressure and is set to cut in at 20 psig and to cut out at 16 psig.

9. The REFRIGERANT TEMPERATURE CONTROL SWITCH has its thermal bulb located in the cooler. It is set to cut out at 30° F and to cut in at 40° F.

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Practices in Animal Sanitation

Department of Agricultural Education
The University of Arizona Tucson

Service Bulletin
Number Seven

1247

10. The CHILLED WATER TEMPERATURE CONTROL SWITCH has its thermal bulb located in one of the tubes in the chilled water cooler. It is set to cut out at 42° F and to cut in at 50° F.

11. The OIL HEATER START AND STOP BUTTON controls the electric heater located in the oil pump chamber of the compressor. The oil heater limits the amount of refrigerant absorption during shutdown. The heater should be turned on when the compressor is not running and turned off when the plant is operating.

The contacts of all safety devices are closed when normal conditions exist. Opening the contacts of any safety device stops the compressor. After the cause of the abnormal condition has been determined and corrected, the compressor must be started in the usual way.

The centrifugal refrigerating unit operates on the usual compression cycle. The cycle, starting at the cooler, is as follows:

The water flowing through the cooler tubes is warmer than the refrigerant on the outside of the tubes. The heat transfer is from the water to the refrigerant. The heat evaporates the refrigerant. The evaporated refrigerant (vapor) is drawn into the compressor by the first-stage impeller. The first-stage impeller compresses the vapor and discharges it to the second-stage impeller. Here it joins a stream of vapor coming from the economizer. Compression of the two streams is completed by the second stage and the compressed vapor is discharged to the condenser.

In the condenser, the vapor condenses to a liquid and drains into the condenser float chamber. The rising refrigerant level opens the float valve and allows the liquid refrigerant to pass into the economizer chamber which has a connection to the second stage of the compressor. Enough of the liquid evaporates to cool the remainder to the temperature corresponding to the pressure in the economizer. As the liquid collects in the economizer float chamber, the rising level opens the float valve to pass to the cooler.

SELF-CONTAINED AIR CONDITIONERS

Self-contained air conditioners are now being installed on some ships that were built without air conditioning. This type air conditioner is built with the entire unit in one metal cabinet. Installation is simple; only the mounting brackets, electrical leads, and the cooling water lines are necessary for complete installation.

Compressing elements in the self-contained air conditioners are usually of the hermetic type (motor and compressor are contained in a welded steel shell). Repairing the compressor or motor aboard ship is impractical; the assembly should be replaced as a unit.

Compressor discharge pressures vary from 120 psig to 200 psig, suction pressures vary from 30 psig to 65 psig. The temperature DROP of the air across the cooling coil is usually 16° F to 18° F.

Self-contained air conditioners use a thermal expansion valve, similar to the type used on the ship's refrigeration plant. However, these expansion valves are non-adjusting type valves, built with a fixed setting by the manufacturer. If an expansion valve does not function properly, it should be removed and replaced with a similar valve.

The high pressure and low pressure switches are set and sealed at the factory. The only adjustable controls are the water regulating valve and the thermostat. The principle of operation and the adjustment of the water regulating valve are the same as for the one used on the ship's refrigerating plant.

To set the thermostat, the following procedure may be used:

1. In the air conditioned compartment, place a thermometer at a point where the desired room temperature is of most importance.
2. Turn thermostat control to the coldest position.
3. When the desired temperature is reached, slowly turn the thermostat control toward the "warmer" position until the compressor stops.

FAN-COIL ASSEMBLIES

The fan-coil assembly is a new piece of equipment presently (1966) being specified for new construction and for some ships in the fleet that are scheduled for the installation of central air conditioning units. Fan-coil assemblies are prefabricated air conditioners, consisting of a fan and motor, air filters, coil bypass damper, thermal and acoustical insulation, and a chilled water coil enclosed in a metal cabinet, used in conjunction with a chilled water system for air conditioning spaces on all types of ships.

The fan-coil assembly may be used in lieu of a fan room aboard ship. The assembly may be installed with or without ductwork. The assembly has outlets on the top, front, and ends of

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the cabinet. The outlets may be used singly or in multiples for zone air distribution with ductwork or for free air delivery without ductwork. A cooling coil bypass is also provided. When the air conditioner is installed outside the space being served, ductwork between the air conditioned space and the cooling coil bypass inlet is provided by the installing activity. This is to ensure that return air is used for bypass and not replenishment air.

The fan used in the assembly is a belt-driven centrifugal fan. The belt drive permits a varying capacity to fit the application depending on the use or extent of ductwork.

The cooling coil has copper tubes, fins, and headers. The coil is eight rows deep in direction of air flow and is provided with vent and drain cocks. The vent and drain are accessible through a removable access panel.

The assembly is provided with a fixed bypass manual locking type damper mounted as an integral part of a removable end panel. All working mechanisms of the damper are enclosed inside the cabinet to prevent adjustment of the damper from the exterior of the cabinet without the panel being removed.

Provision is made to permit access to and removal of the fan, fan drive, motor, and cooling coil through removable end panels. The removable end panels are interchangeable on each assembly. A front access opening is also provided to permit servicing, adjustment, and removal of the motor, fan bearings, pulleys, and belts from the front of the cabinet. The removable panels and access openings are gasketed and airtight under normal operating conditions.

For servicing the air filters, access openings are provided on each end of the cabinet.

AIR CONDITIONING EQUIPMENT OPERATING RECORD

A daily operating record is maintained for all air conditioning equipment except self-contained air conditioners. Figure 12-6 shows the back side of the form, used to record compartment temperatures and chilled water pressures and temperatures. The front side of the operating record is the same as that shown in figure 11-16-A. The main difference in filling in the front side of the form is that compressor suction and discharge temperatures and pressures will be higher for air conditioning plants than for refrigeration plants.

HEATING EQUIPMENT

VENTILATION HEATERS (fig. 12-7) are installed in duct systems and are used wherever practical because of savings in weight, space, and piping. These heaters are built to withstand considerable shock and have standard connections to simplify piping. The copper tubes, through which the steam flows, are arranged in a single row.

Two different types of coil arrangements are employed. Part B of figure 12-7 shows the "S" arrangement with the tubing serpentined. The S-type is used in small size heaters. For large size heaters the S-type is not efficient; a small amount of uncondensed steam is left in the drain end portion of the tube.

Part C of figure 12-7 shows a "T" arrangement which has a copper tube within a tube (a 3/8-inch distributing tube inside a 5/8-inch outer tube). Steam pressures up to 150 psi may be used in these heaters.

Large ventilation supply systems, excepting those serving machinery spaces, are provided with a PREHEATER at or near the weather intake. By locating the heater near the intake, the duct temperature is kept high enough to avoid condensation during cold weather operation.

If the system serves spaces that are maintained at a specified temperature (generally 65° F) a REHEATER (or reheaters) is also provided. In recirculating cooling systems reheaters are usually provided to maintain specified space temperatures during cold weather operation.

The preheater has a thermostatic control arranged to prevent freezing of the coil and to maintain a certain duct air temperature (usually between 45° F and 65° F). Steam is supplied through two regulating valves, either in a single body or as separate valves. One valve is orificed to pass 25 percent of the required steam and is controlled by a thermostat in the duct on the weather side of the heater. It is factory set at 35° F. The other valve is orificed to pass 75 percent of the required steam and is controlled by a thermostat in the duct on the discharge side of the heater.

Reheaters supply either single spaces or zones. Zones are made up of spaces that are expected to have similar heat loads. Reheaters are generally controlled by room thermostats. In a few installations, reheaters are controlled by duct type thermostats. In recirculating cooling systems on the newer ships, the reheaters

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NAVSHIPS 4731 (6-57) (Back)

REFRIGERATION/AIR CONDITIONING EQUIPMENT OPERATING RECORD

TIME	WATER CHILLER				COMPARTMENT								REMARKS
	SUPPLY		RETURN		NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	
	PRESS. PSIG	TEMP. °F	PRESS. PSIG	TEMP. °F	2-41-2-C	2-43-3-C	2-51-1-C	1-52-0-L	1-57-2-L	2-58-2-L	1-59-1-C	1-61-2-C	
					HTR 78-82	HTR 78-82	HTR 78-82	HTR 78-82	HTR 78-82	HTR 78-82	HTR 78-82	HTR 78-82	
0200	45	47	45	56	80	80	80	79	78	79	84	80	0030 Readjusted
0400	45	46	45	55	78	79	79	79	78	79	80	79	thermostatic
0600													switch in
0800													compartment 1-59-1-C
1000													
1200													
2200													
2400													

GENERAL REMARKS

0045 Started No. 1 Compressor
0115 Secured No. 2 Compressor

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Figure 12-6.—Air conditioning equipment operating record (back), NavShips 4731.

utilize a constant supply of steam to reheat air to any zone which would be overcooled.

In small ventilation systems employing short duct runs where one heater will produce the required temperature rise, the COMBINATION HEATER is used alone. Combination heaters may also be used with reheaters where it is desired that the system supply more than one space but where the combination heater is sufficient to maintain the required temperature rise in one of the spaces.

CONVECTOR HEATERS (fig. 12-8) are installed in small spaces or in spaces which are not fitted with mechanical supply ventilation. These heaters have a high heating capacity for their size and weight, are considerably smaller than radiators or pipe-coils of the same capacity, and will withstand severe shock. A steam pressure up to 150 psi may be used in the heaters, or a forced hot water system may be employed. When convector heaters are used with steam pressure between 25 and 50 psi, temperature differentials at different levels in the room are reduced. The heating is regulated with the air bypass damper in the front part of the heater. The cabinets are generally of steel, though they may be (if desired) of copper of a nonmagnetic construction.

UNIT HEATERS, illustrated in figure 12-9, are actually ventilation heaters installed separately with their own fans. They are used in special cases such as when the amount of supply ventilation is too small to provide sufficient heat through ventilation heaters, or where there is no mechanical ventilation supply and the heat requirements exceed the capacity of convector heaters. They can be used with either steam pressure up to 150 psi or with forced hot water

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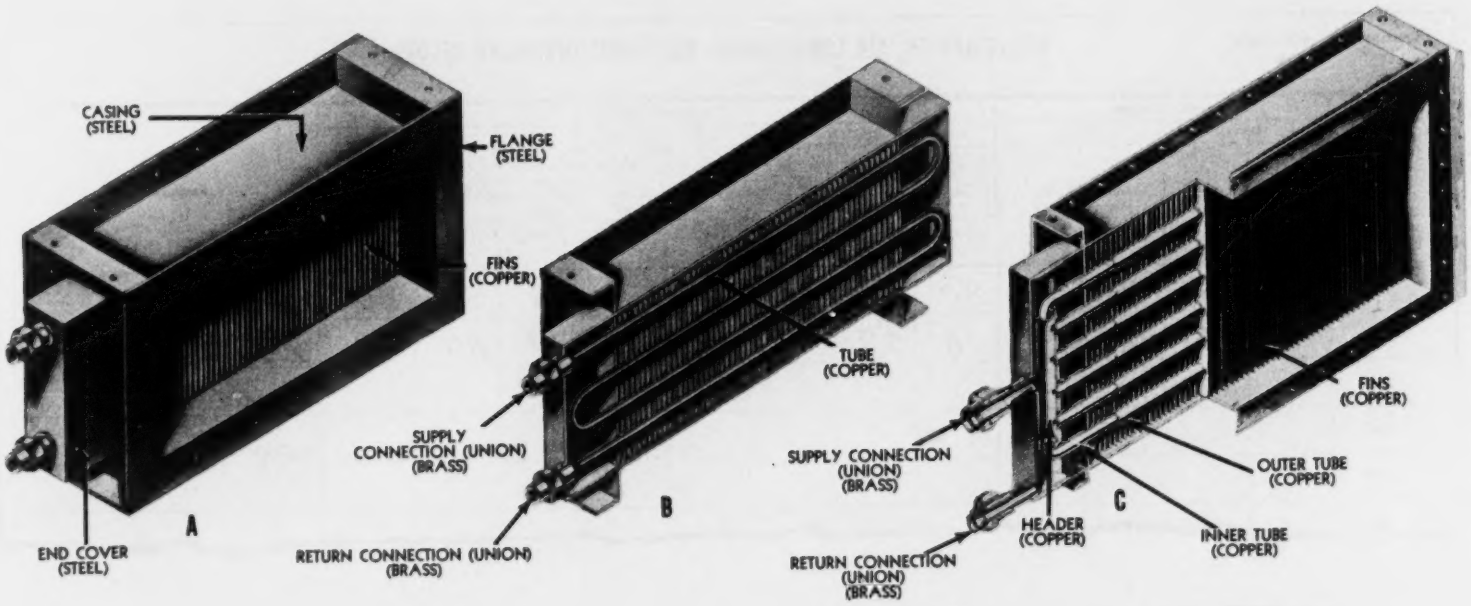

47.111

Figure 12-7.—Ventilation heater: A. Exterior view of S-type heater. B. Tube arrangement of S-type heater. C. Tube arrangement of T-type heater.

systems. Composite parts of the heaters include the heat transfer surface (fins and tubes), fan, thermostatic control valve, strainer, trap, and directional louvers.

ELECTRICAL HEATERS are used for spaces located at a considerable distance from the steam piping system. They are built in many types and designs.

MAINTENANCE OF AIR CONDITIONING EQUIPMENT

To ensure proper operation of any air conditioning system, periodic inspection and maintenance is absolutely necessary. Each ship should have an organization responsible for the maintenance of ventilating, heating, and cooling equipment.

MAINTENANCE OF VENTILATION EQUIPMENT

Shipboard ventilation must serve not only to supply, circulate, and distribute fresh air, but also to remove the used, contaminated, and overheated air from the various spaces. If the ventilation equipment fails to perform its functions properly, conditions may be created which will jeopardize the health or life of crew members. Therefore, the individuals responsible for inspection and maintenance must be thoroughly familiar with the ventilation equipment.

A shipboard ventilation system and its constituent parts cannot be isolated and separated from other component systems in a complete air conditioning system. For example, the air duct distribution system of a ship may be utilized for other systems used in cooling, heating, and dehumidifying the ship's atmospheric air. In addition to ducts, a ventilation system may include weather openings, screens, filters, fans, gratings, closures, heaters, cooling coils, venturi tubes, dampers, and terminals. Obviously, if a ventilation system is to function effectively, it is essential that all of its various units be kept clean and in satisfactory operating condition. To maintain a ventilating system in the best condition requires the observance of applicable precautionary measures, and the adherence to prescribed maintenance procedures.

Guarding Against Obstructions to Ventilation

Such items as swabs, deck gear, and trash stowed in fan rooms or ventilation trunks not only restrict air flow but also increase dirt and odors taken inboard. Ventilation terminals must never be used for stowage. Wet clothing

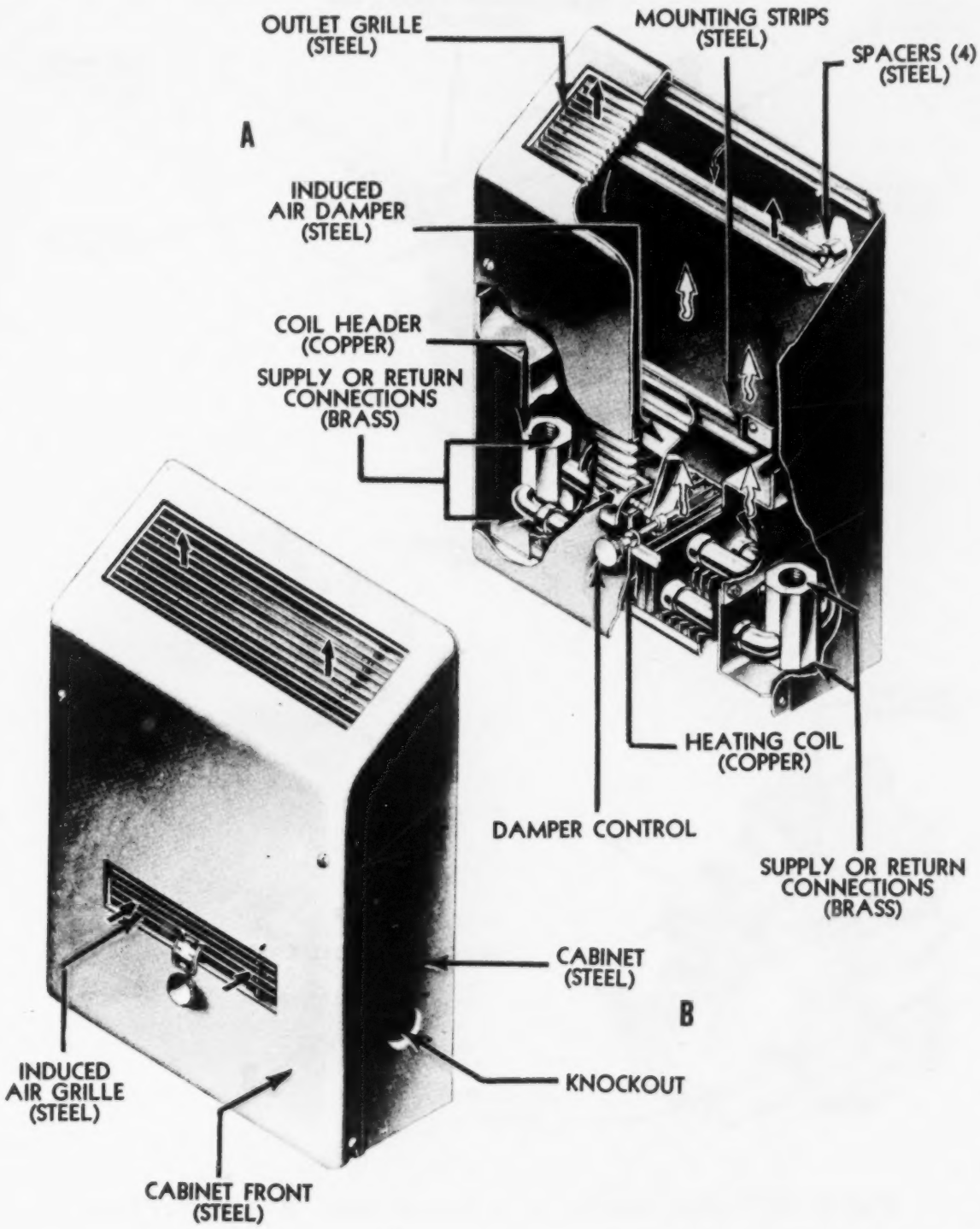

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Figure 12-8.—Convector heater: A. Cutaway view. B. Exterior view.

secured to ventilation terminals increases the moisture content of the compartment air, and restricts the air flow. Stowage arrangements should be such that ventilation weather openings and forced draft blowers are never restricted.

Do not use gauze or similar material as a filter over an air supply terminal. Gauze may aid in preventing the passage of dirt but it also serves an obstruction to the passage of air. The fact that filtering is necessary indicates that the

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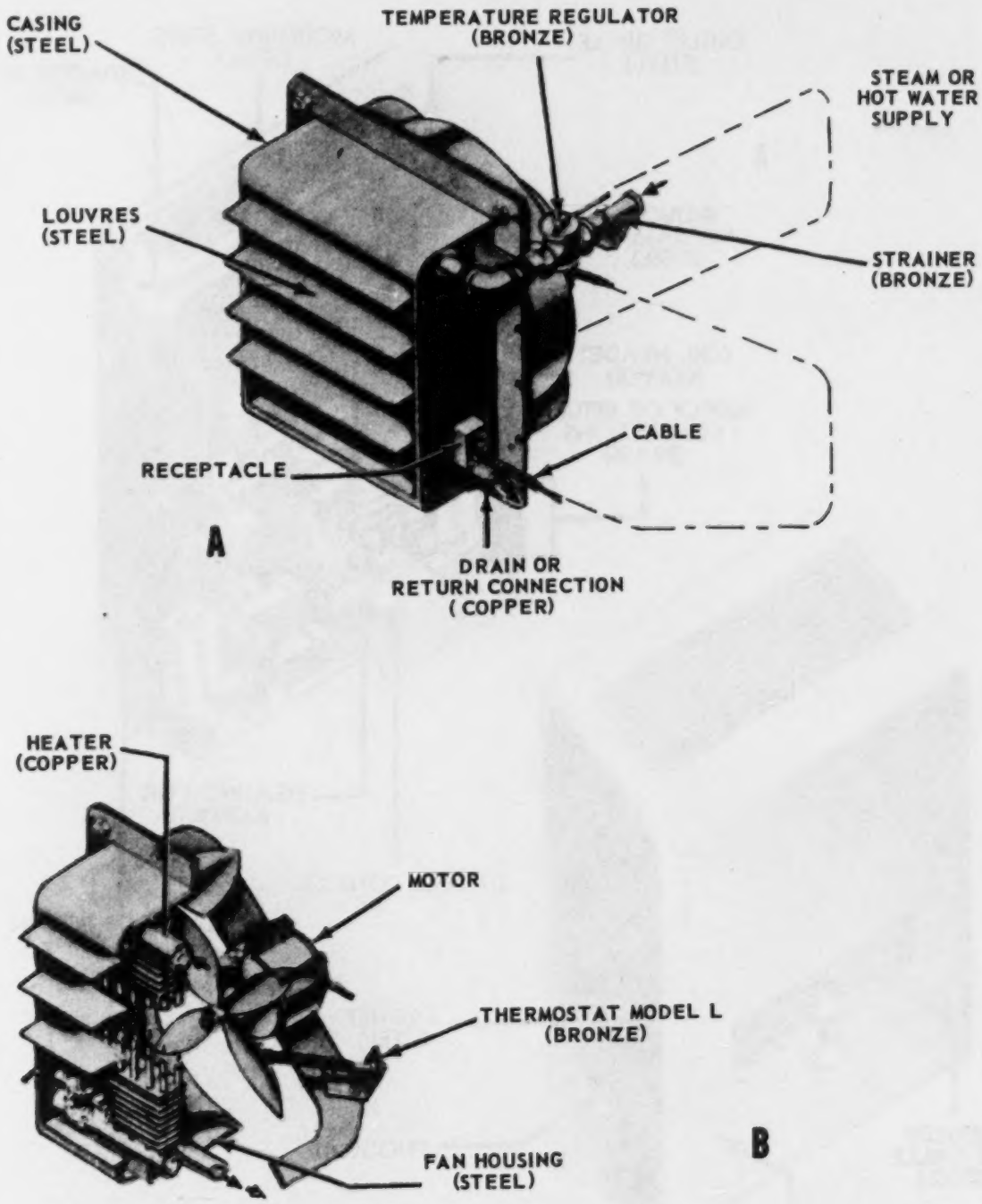

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Figure 12-9.—Unit heater: A. Exterior view. B. Cutaway view.

system needs cleaning. The amount of dirt entering a space from the ventilation system can be most effectively reduced by keeping the ducts clean. If it becomes necessary to place a filter in an air supply system, place the filter at the intake rather than supply terminals.

Keeping the System Clean

Dirt accumulations in a ventilation system not only restrict the flow of air but also create a serious fire hazard. In a clean duct the cooling effect of the metal tends to act as a flame arrester, but an accumulation of foreign matter within a duct becomes a potential source of combustion. One method of reducing the amount of dirt and combustible matter which may be carried into a ventilation system is to wet down the areas in the vicinity of the air intakes before sweeping.

Since a great volume of air passes through or over the elements of a ventilation system,

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dirt will collect in the various units in spite of precautionary measures. The greatest accumulations of dirt will be within trunks and ducts where it is not readily noticeable. Therefore, periodic inspections and a definite service procedure are necessary to keep the system clean.

Cleaning Filters

Navy standard air filters have pressure taps on each side of the filter bank. By use of a portable differential pressure gage, the pressure drop across the filter may be quickly read. When the pressure drop increases to three times that of a clean filter, the filter must be cleaned. Ships are provided with spare filters so that a clean one may be substituted for the dirty one. A systematic procedure may be set up for cleaning all filters on the ship.

Where there are only a few filters aboard ship, they may be cleaned in the galley dishwashing machine. Ships having a sufficient number of filters to justify the space, expense, and weight are supplied with special cleaning sinks. In either case, filters are washed with dishwashing compound, used in accordance with the current dishwashing instructions.

If a special cleaning sink is used, proceed as follows:

1. Place filters in the wire basket, one filter deep, with the dirty side up.
2. Fill sink with fresh water, cut steam into sink to heat and agitate the water. (Most of the lint and dirt will rise to the top and pass off with the overflow.)
3. When filters are clean, cut off the steam and drain the sink.
4. Refill sink with fresh water, cut steam into sink, and rinse filters.
5. Reoil filters.

Navy standard air filters have a thin film of oil applied to the wires. The oil film retains fine particles of dirt and lint. After each washing, the filters may be reoiled by spraying with 2075 oil. Spray guns furnished for oiling air filters must not be used for any other purpose, to avoid the possibility of contaminating the filters with toxic, flammable, or odor laden materials.

Flame arresters and grease filters may be cleaned in the manner prescribed for air filters, however, special care must be taken in rinsing. Flame arresters and grease filters SHOULD NEVER BE OILED.

MAINTENANCE OF COOLING EQUIPMENT

Since air conditioning systems are in many ways similar to refrigeration plants, much of the information concerning refrigeration, given in this training course, is equally applicable to air conditioning equipment. To ensure proper operation of any R-12 air conditioning plant, periodic inspections must be made of compressors, valves, motors, cooling coils, air filters, and other installed equipment. Most of these maintenance items are covered by the Planned Maintenance System and will be scheduled accordingly (refer to figure 11-17).

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CHAPTER 13

STEAM OPERATED DISTILLING PLANTS

This chapter deals with the general description and operation of steam operated naval distilling plants. Evaporation followed by condensation is the means used to produce distilled water from raw sea or river water. This distilled water is sufficiently free of impurities, that it can be and is used for boiler feed water. Boiler feed water must be of high purity to maintain high heat transfer and prevent excessive scaling and corrosion. Distilled water is also used aboard ship for drinking, cooking, and washing.

Basically all distilling plants operate on the same principle, although designs differ. Each plant has a heating section to produce water vapor, a condenser to condense the vapors from the evaporators, a preheater to preheat the feed water, and a cooler to cool the distillate. This chapter provides information on steam operated plants of the submerged tube, vertical basket, and flash types.

SUBMERGED TUBE DISTILLING PLANTS

Submerged tube distilling plants are divided into three types: Soloshell double effect (fig. 13-1), triple effect, (fig. 13-2), and two-shell double effect (fig. 13-3).

A brief discussion of the differences between the three principal types of low-pressure distilling plants will give you a general idea of the plants you may work with. These three types are the Soloshell double-effect, the two-shell double-effect, and the three-shell triple-effect plants.

SOLOSHELL DOUBLE-EFFECT PLANTS

Virtually all low-pressure distilling plants up to and including the 12,000 gpd capacity plant are of the Soloshell double-effect type. This type consists of a single cylindrical shell mounted with the axis horizontal. A vertical partition plate, parallel to the axis, divides the shell into two evaporator chambers. Each of these chambers has a separate removable tube bundle bolted to the front head of the shell (the first- and second-effect evaporator tube bundles). The first-effect vapor feed heater is built into the upper part of the first-effect shell, and also has a removable tube bundle bolted to the front head.

The distilling condenser (condensing and feed-heating sections) is built into the upper part of the second-effect shell. This unit does not have a removable tube bundle that the tube sheets project beyond the front and rear heads of the shell, providing access for cleaning or replacing tubes. The air ejector condenser is a separate unit, mounted on brackets on the evaporator shell. The distillate cooler is also in a separate shell and may be located wherever convenient for the necessary piping connections.

One type of 20,000 gpd capacity Soloshell double-effect plant was installed on light and heavy cruisers. Two such plants are installed when it is necessary to furnish an overall capacity of 40,000 gpd. In such plants, the vertical partition separating the first and second effects is at right angles to the axis of the cylinder. The first-effect vapor feed heater is in the upper part of the first-effect shell; the distilling condenser is in the upper part of the second-effect shell, and the air ejector condenser is mounted on the main evaporator shell. The distillate cooler is mounted similarly to that in the smaller Soloshell plants.

The distilling plant's steam is obtained from the auxiliary exhaust line through a weight-loaded or an air controlled regulating valve. This valve is set to maintain a constant steam pressure of 1 to 5 psi to the tube nest of the first-effect evaporator. A pressure gage is installed ahead of the regulating valve. A

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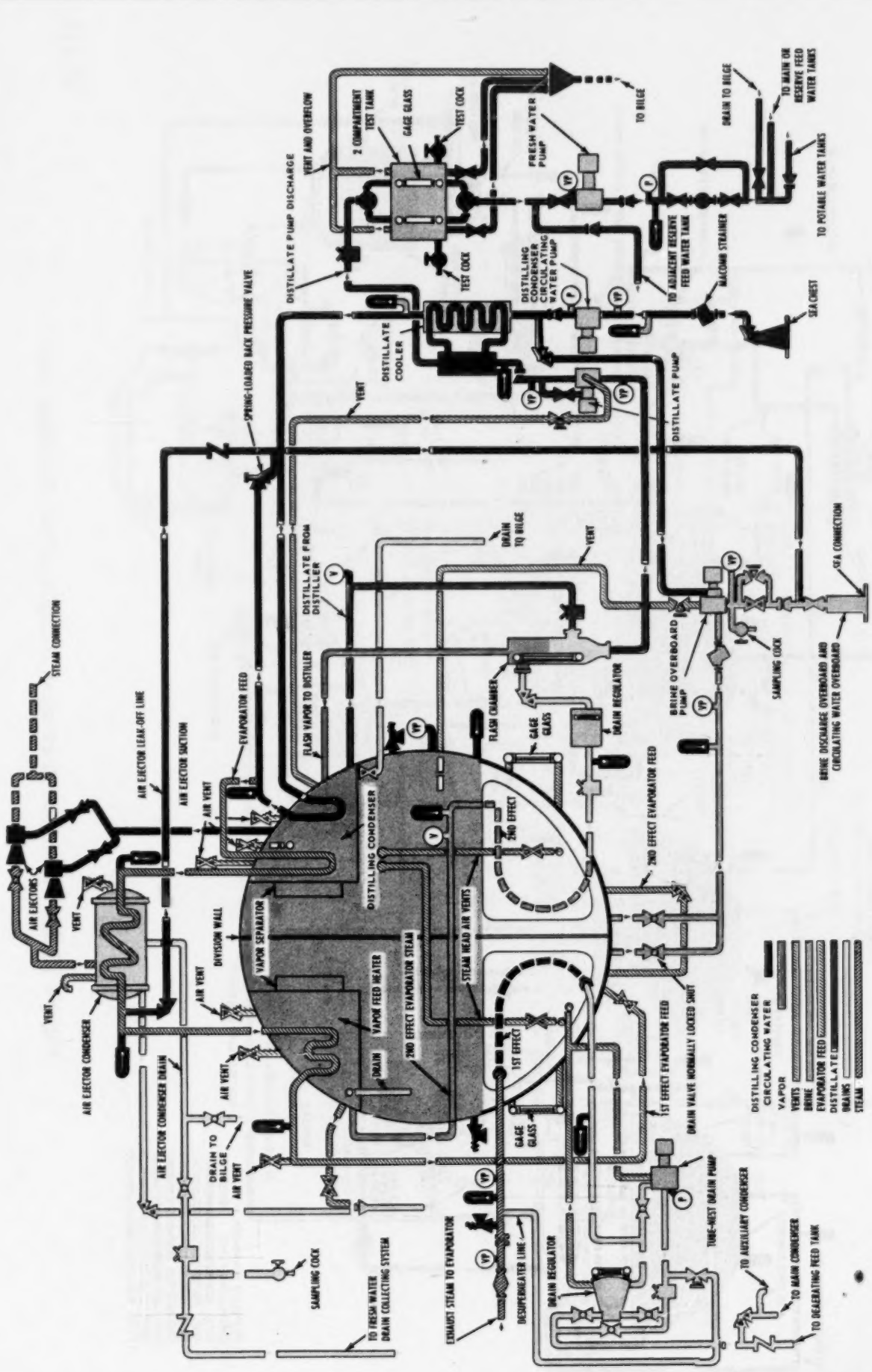

Figure 13-1.—Schematic drawing of a double-effect distilling plant.

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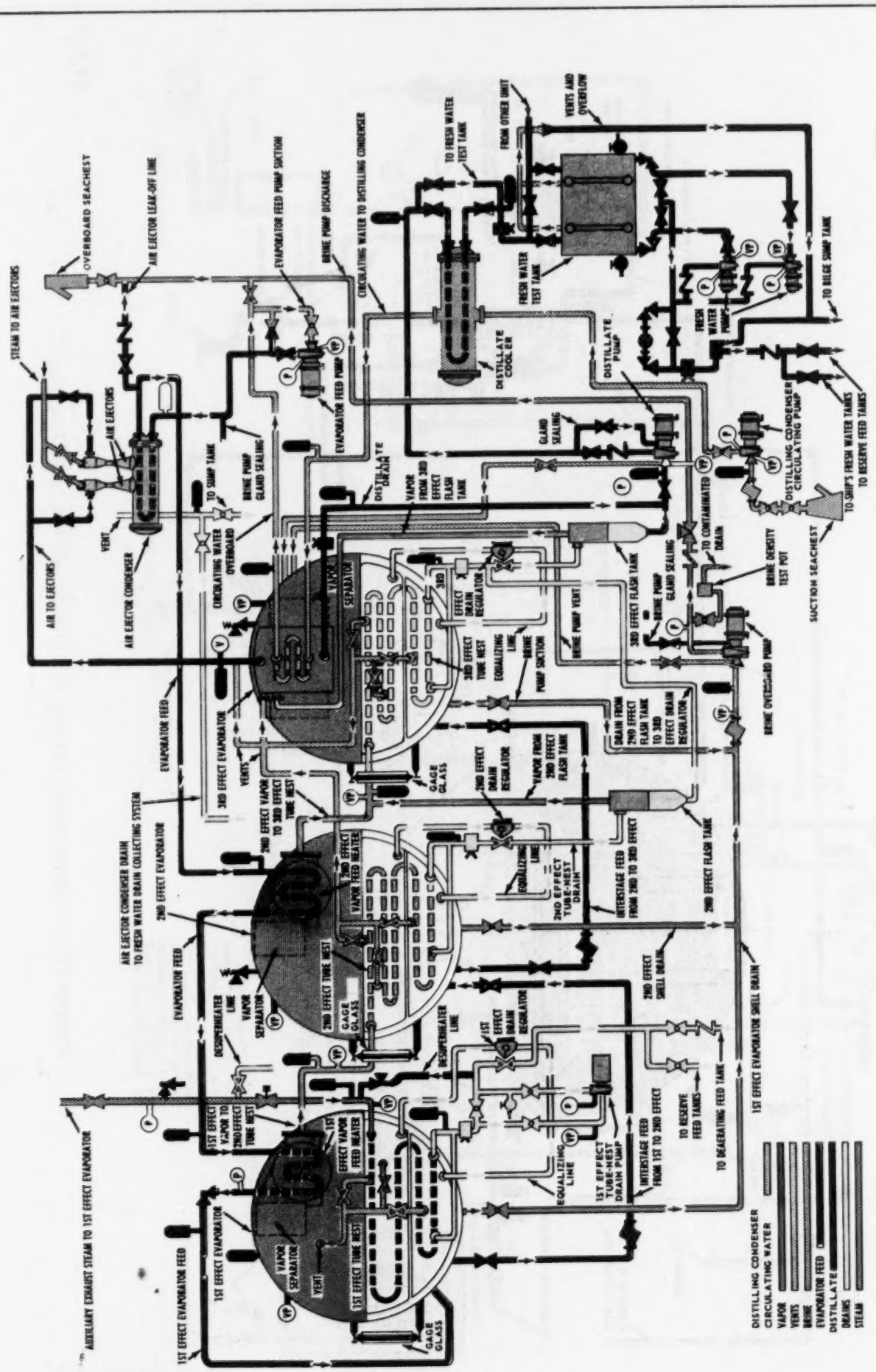

Figure 13-2.—Schematic drawing of a triple-effect distilling plant.

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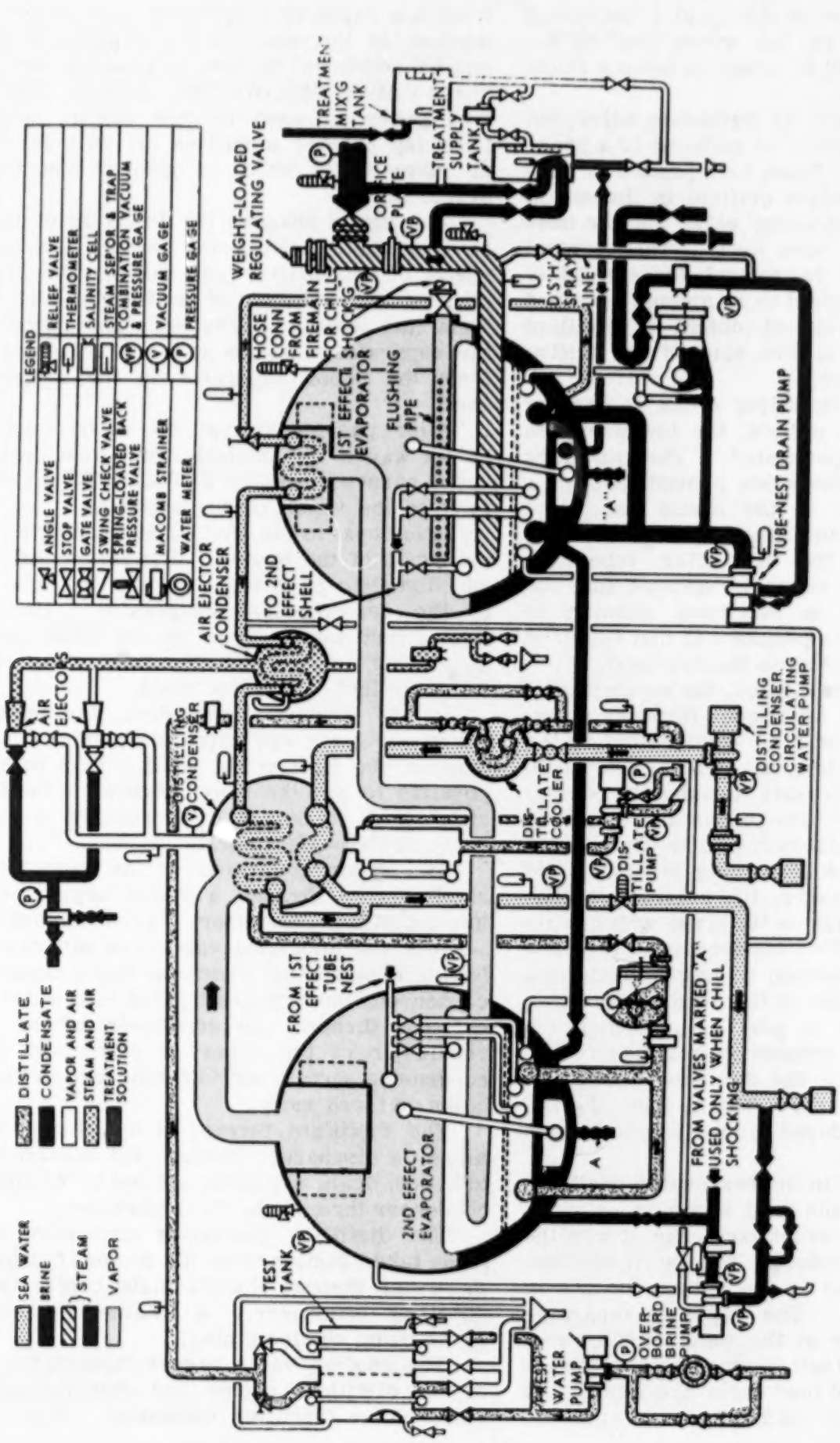

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Figure 13-3.—Schematic drawing of a two-unit double-effect distilling plant.

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relief valve, a thermometer, and a compound gage are installed on the steam head of the evaporator tube nest in order to keep a check on the steam supply.

In passing through the regulating valve, the auxiliary exhaust steam is reduced to a pressure of 5 psi. The steam then passes through an orifice plate (control orifice) in the steam line between the regulating valve and the inlet to the first-effect tube nest. This central orifice is designed to control the amount of steam entering the plant to an amount required for the plant's designed output of distilled water. A change in the size of the orifice alters the plant output.

Because of the throttling effect in passing through the control orifice, the low-pressure steam becomes superheated. The auxiliary exhaust steam is therefore passed through a desuperheating area in the steam line. Desuperheating is accomplished by a spray of hot water piped from the first-effect tube nest drain pump. This water is sprayed into the steam supply line in sufficient quantity to reduce the steam temperature to that required for the pressure existing in the tube nest.

After being desuperheated, the steam passes into the first-effect tube nest. Here the steam gives up its latent heat of vaporization to the feed water surrounding the first-effect tubes. The resulting condensate (condensed steam) from the first-effect tube nest is discharged by the pump to the deaerating feed tank. In an emergency, the condensate may be discharged to the main condensers, the auxiliary turbogenerator condensers, or the fresh water drain collecting system. This condensate is returned to the boiler feed system to help maintain the heat and water content of that system constant.

When a ship is in port or at anchor, the supply of auxiliary exhaust steam may not be sufficient to operate the distilling plant. To overcome this deficiency, steam from the 150 psi system is introduced to the system through an augmenting valve.

Steam generated in the evaporator shells by the evaporation of the feed water is referred to as VAPOR, to prevent confusing it with the steam which is introduced into the first-effect evaporator tubes and is the outside source of heat for the plant. The vapor is separated from the feed water at the water surface and, although the vapor itself is pure, small particles of raw, unevaporated feed water are mixed with it. The particles of feed water are removed from the vapor by a series of baffles above the surface of the water in the evaporator shell, and by additional baffles or vanes in the first-effect VAPOR SEPARATOR. (NOTE: The term feed water as used in this chapter and the following chapter identifies the raw sea water or river water which is used as feed for the evaporator.)

The vapor changes its direction of motion several times in passing around the hooked edges of the baffles and vanes. The hooked edges trap particles of feed water and drain them into pipelines. These pipelines discharge the separated moisture as far away as possible from the vapor separator in the evaporator shell.

After passing through the vapor separator on its way to the second-effect tube nest, the vapor passes through a VAPOR FEED HEATER. Part of the vapor is condensed as it gives up its latent heat to the feed water passing through the tubes of the heater. The remaining vapor and distillate pass together into the tube nest of the second-effect evaporator. Here the first-effect vapor gives up its latent heat in generating vapor from the feed water in the second-effect evaporator shell.

In the second-effect shell, the pressure surrounding the sea water is considerably less than in the first-effect shell. This makes it possible to use the vapor formed in the first-effect shell to boil and vaporize the sea water in the second-effect shell.

The vapor generated in the second-effect shell passes through a vapor separator and into a distiller condenser. The condensing tubes nearest the incoming vapor are utilized as a feed heating section where the vapor is partially condensed; thereby heating the feed water circulating through the condenser tubes. The remainder of the vapor is condensed in the condensing section and is discharged to the test tanks as fresh water.

The distillate formed in the second-effect tubes is discharged through the second-effect tube nest drain regulator and led to the distiller condenser through the flash chamber.

The distilling condenser circulating water pump takes suction from the sea and discharges the water through the distillate cooler and the distilling condenser. A strainer is installed in the pump suction piping.

The cooling water passes through the shell of the distillate cooler and then through the tubes of the distilling condenser. The cooling

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water is then discharged overboard through a spring-loaded back-pressure valve set to maintain a back pressure of about 5 psig.

A portion of the sea water discharged from the cooling water circuit is used as feed to the first-effect evaporator. A 5 psi back pressure provides sufficient head to force water through the distilling condenser, air ejector condenser, vapor feed heater, and to the first-effect shell where it enters through perforated internal feed distributing pipes located well below the working water level in the shell.

A portion of the feed water is evaporated after entering the first-effect shell. This increases the density, or salinity, of the remaining portion. This denser or saltier water, commonly referred to as BRINE to distinguish it from sea water, is led into the second-effect shell.

The brine is transferred to the second-effect shell through a pipeline having a manually controlled feed regulating valve installed in it. The higher pressure in the first-effect shell is utilized to force the brine into the second effect, where it is distributed by means of perforated internal feed pipes. (In a triple-effect plant, the brine then passes to the third-effect shell through a pipeline and is distributed in a manner similar to that in the second-effect shell of a double-effect plant.)

A brine overboard pump takes suction from the second-effect shell through a Macomb-type strainer, and discharges the brine into the distilling condenser circulating pump overboard discharge line. To permit rapid draining of the first- and second-effect shells as when chill shocking, they have suction connections leading directly to the brine overboard pump. Since these connections are not used in normal operations, they are provided with valves that can be locked closed to prevent accidental opening, which would upset proper operations of the plant.

TWO-SHELL DOUBLE-EFFECT PLANTS

The most commonly used 20,000 gpd double-effect plant is built with two horizontal cylindrical evaporator shells (fig. 13-3), one for each effect, and usually mounted with the axes of the shells parallel. Tube nests for both shells may be removed from the front head. The first-effect vapor feed heater is built into the upper part of the first-effect shell. In this design, the distilling condenser and the distillate cooler are built into separate shells, and usually mounted between the two evaporator shells. The air ejector condenser is also an independent unit and is mounted on one of the two shells.

TRIPLE-EFFECT PLANTS

The triple-effect distilling plant is similar to the double-effect plant except that the triple effect has an intermediate evaporating stage. A standard 20,000 gpd triple-effect plant consists of three horizontal, cylindrical shells set side by side with their axes parallel. The tube bundles can be withdrawn from the front cover of each shell. The first- and second-effect vapor feed heaters are built into the front end of the second- and third-effect evaporator shells. The distilling condenser is contained within the third-effect shell. The air ejector condenser and the distillate cooler are in separate shells and are mounted on the third-effect shell. Figure 13-4 illustrates the internal arrangement of a first-effect evaporator shell of a triple-effect plant.

Another 20,000 gpd triple-effect design consists essentially of three horizontal shells bolted together end to end, with vertical partition plates between each section (shell) to form the three effects. The tube bundles can be withdrawn horizontally through one side of the cylinder. Vapor separators in independent shells are installed in the vapor piping between effects and between the third effect and the distilling condenser. The first- and second-effect vapor feed heaters are in separate shells and are mounted in the piping at the inlet to the second- and third-effect tube bundles, respectively. The two sections of the distilling condenser and the distillate cooler are built into a single shell and independently mounted as space and piping arrangements may permit. The air ejector condenser is also a separately mounted unit.

The standard 30,000 gpd triple-effect plant is similar to the standard 20,000 gpd plant, except for the increased size of the units.

There are two types of 40,000 gpd triple-effect plants which may be considered as standard, due to their wide use in naval ships. The first type uses exactly the same arrangement as the standard 20,000 gpd triple-effect plant, with the size of the units and parts increased as necessary for the greater capacity. The second type consists of three horizontal

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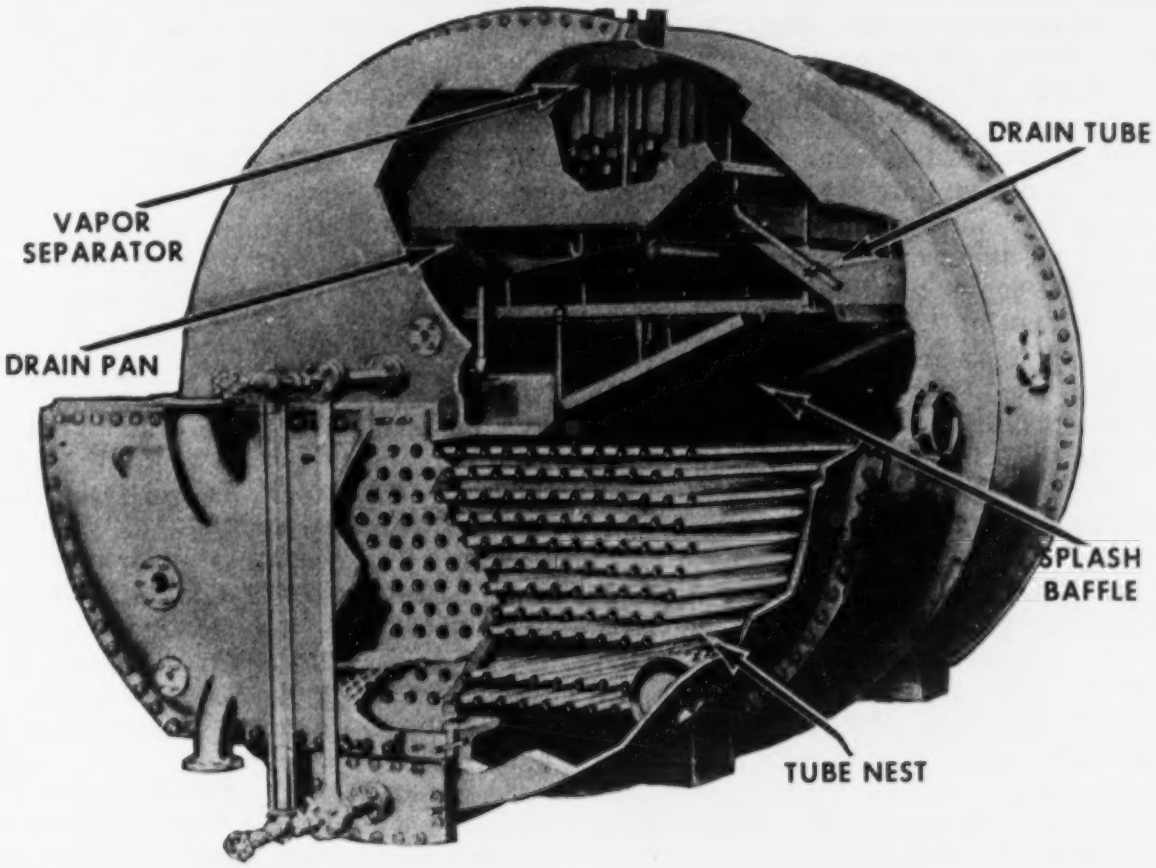

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Figure 13-4.—Internal arrangement of the first-effect shell of a triple-effect distilling plant.

shells, usually mounted side by side with axes parallel. The tube bundles can be withdrawn through the front end of the shells as in the 20,000 gpd two-shell double-effect plant. In this design, both vapor feed heaters and the distilling condenser are built as three independent units, each mounted separately outside the evaporator shells. The air ejector condenser and the distillate cooler are also in independent shells and are separately mounted outside the evaporator shells.

When you compare a low-pressure triple-effect distilling plant with a low-pressure double-effect plant, you will find that:

1. UNITS ADDED to the triple-effect plant include one evaporator shell, one vapor separator, one feed water heater, one feed pump, and several salinity cells. The evaporator feed pump takes suction from the distilling condenser cooling water circuit at a point between the outlet of the condensing section of the distilling condenser and the spring-loaded back-pressure valve.
2. The SALT WATER FEED is piped successively from the first-effect shell to the second- and third-effect shells. The water decreases in heat and increases in density as it progresses from the first to the third effects.
3. The BRINE DISCHARGE is made from the third-effect shell instead of from the second-effect shell.
4. The GENERATING HEAT in the tube nests of the second- and third-effect shells is derived from the vapor created in the preceding shell.
5. The VACUUM is increasingly higher in each successive evaporator shell and in the plant as a whole, as the distance from the air ejector and the distilling

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condenser is decreased. This higher vacuum, lowering the boiling point, makes it possible to generate vapor with the lower overall temperatures of the sea water or brine and the vapor filled tubes.

The principal parts of a modern low-pressure triple-effect distilling plant include the tube nests, distiller condenser, vapor feed heaters, level controllers, air ejector, flash chamber, air ejector condenser, distillate cooler, and tube-nest drain regulator.

Evaporator Tubes

The evaporator tubes are made of either copper-nickel alloy or copper-zinc-tin alloy (admiralty metal). The tube bundle consists of two sets of tubes—an upper set of either eight or nine rows of horizontal tubing, and a lower set of two or three rows of similar tubing. Tube ends are inserted into and expanded to fit tightly in holes in the front and rear tube sheets (fig. 13-4). Both front and rear tube sheets are provided with flanged heads or cover plates. The internal areas of the tubes and heads thus form the evaporator heating section (tube bundle). The front head and tube sheet are flanged to the front head of the shell cylinder. The rear tube sheet and head, and an intermediate tube supporting plate are supported inside the shell cylinder by rollers which are mounted on rails. This "floating head" design permits unrestricted expansion and contraction of the tube bundles. In addition, this type of construction permits removal of the tube bundles for cleaning.

Distilling Condenser

This condenser consists mainly of a bank of tubes through which the cooling sea water flows, a baffle plate which deflects the water vapor away from the air precooling section, a section of tubes known as the inner heating section, and an outside shell.

On the feed inlet end of the condenser there is a zinc pencil, and at the outlet end a zinc plate is installed. In standard designs, the condensing unit is generally built into the third-effect shell. The distilling condenser of the Soloshell double-effect plant is built into the upper part of the second-effect shell (fig. 13-1). However, in some distilling plants the condenser is a separate unit, such as that illustrated in figure 13-5.

Vapor Feed Heaters

The number of vapor feed heaters in a distilling plant varies, depending upon the number of effects and the design of the plant. The feed water passes through the tubes in these heaters on its way to the first-effect shell. Vapor from one of the evaporator shells passes into each heater and flows around the heater tubes, thus heating the feed water. A typical vapor feed heater is shown in figure 13-6.

Level Controllers

In practically all of the distilling plants built prior to 1950, the water level in the shell of each effect is controlled by manually regulating the individual feed inlet valves. Many of the plants built since that date, however, are provided with automatic feed-level control devices. These adjustable weir type level controllers (fig. 13-7) are located in the brine discharge from each effect. The feed from each effect to the next is only the amount of brine that spills over the weir and is the excess of feed over evaporation in that effect.

The weir proper is carried on an adjusting screw which permits the height to be adjusted to any desired operating level. The bottom of the weir chamber is water-sealed to prevent equalizing shell pressures.

The level controllers consist of a chamber in parallel with the evaporator shell. A weir pipe within each evaporator shell discharges into a weir well. Feed water in excess of that which is evaporated spills over the weir pipe and into the weir well.

The internal weir pipe may be raised or lowered by the external handwheel. The weir well vents into the weir chamber by a pipe which also serves as a guide for the weir pipe. A gage glass is installed on the weir well.

Flowrator

A few distilling plants may be equipped with a flowrator or some other visual flow indicator in the evaporator feed line. Flowrators are calibrated in gallons per minute (gpm) and it is possible to set the rate-of-feed by adjusting a hand valve in the feed line. In order to maintain the proper density (1.5/32) in the last-effect shell, 3 gallons of sea water feed must be fed into the distilling plant for each gallon of distilled water produced. The remaining 2

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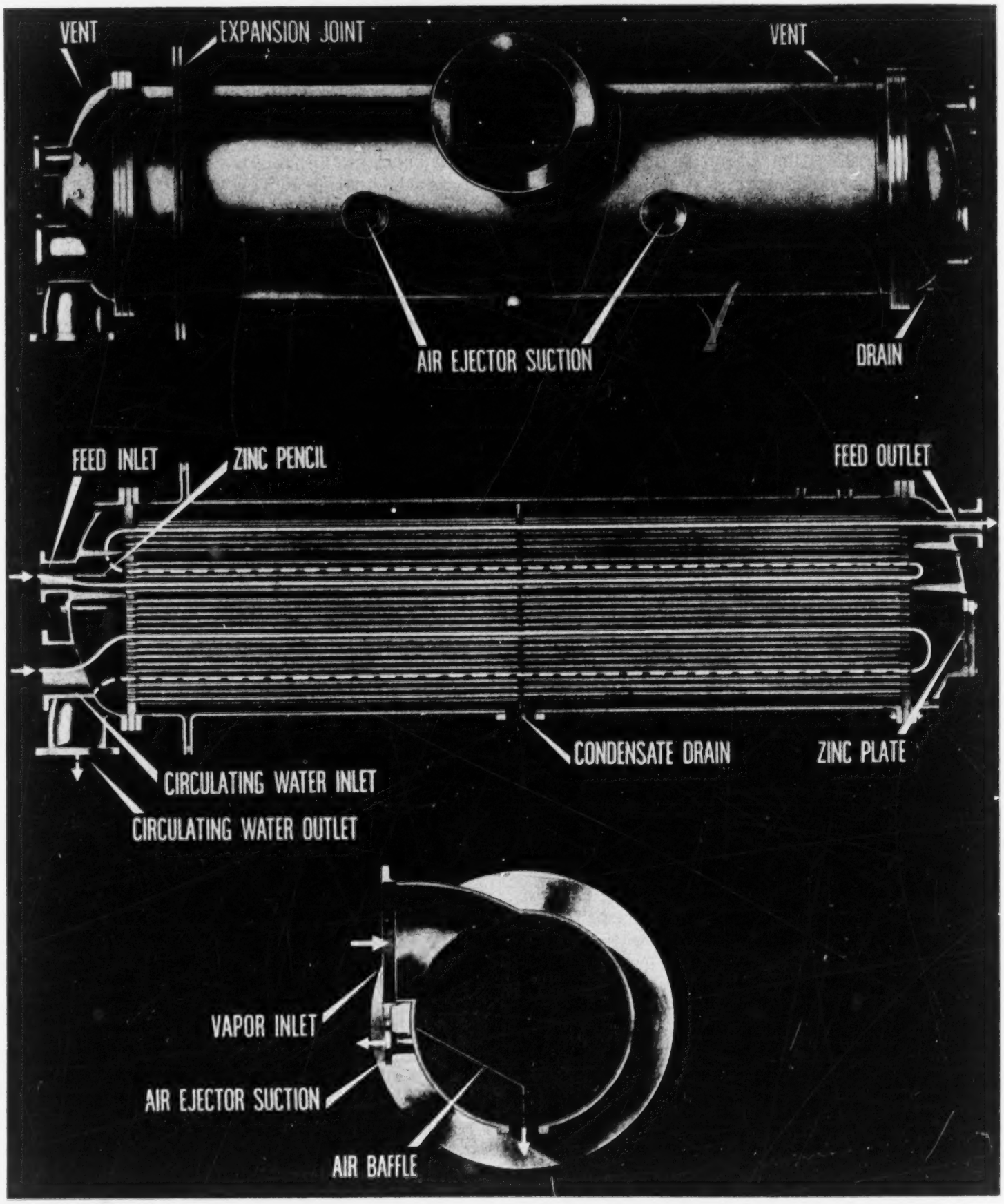

Figure 13-5.—Distilling condenser. 47.119

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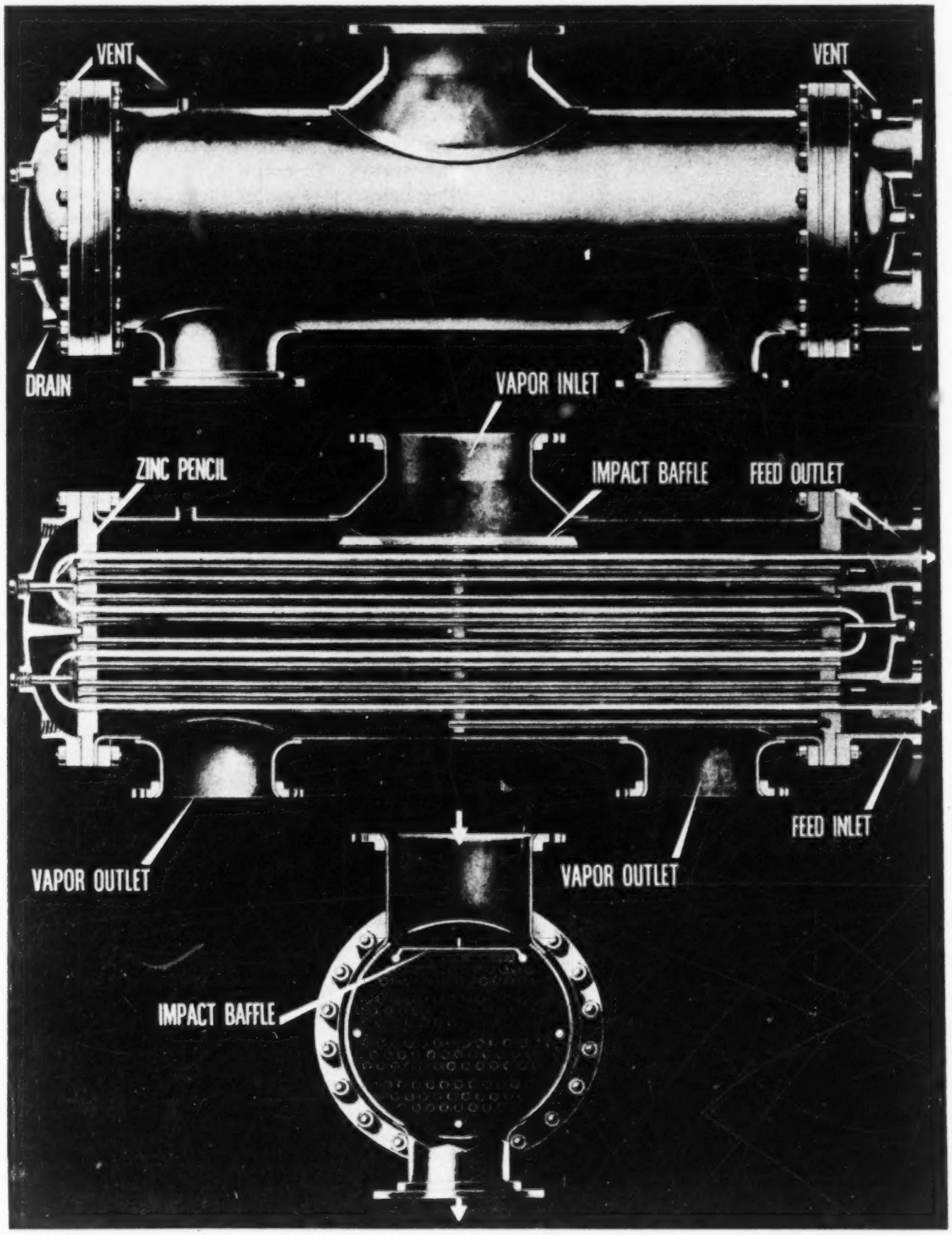

Figure 13-6.—Vapor feed heater. 47.120

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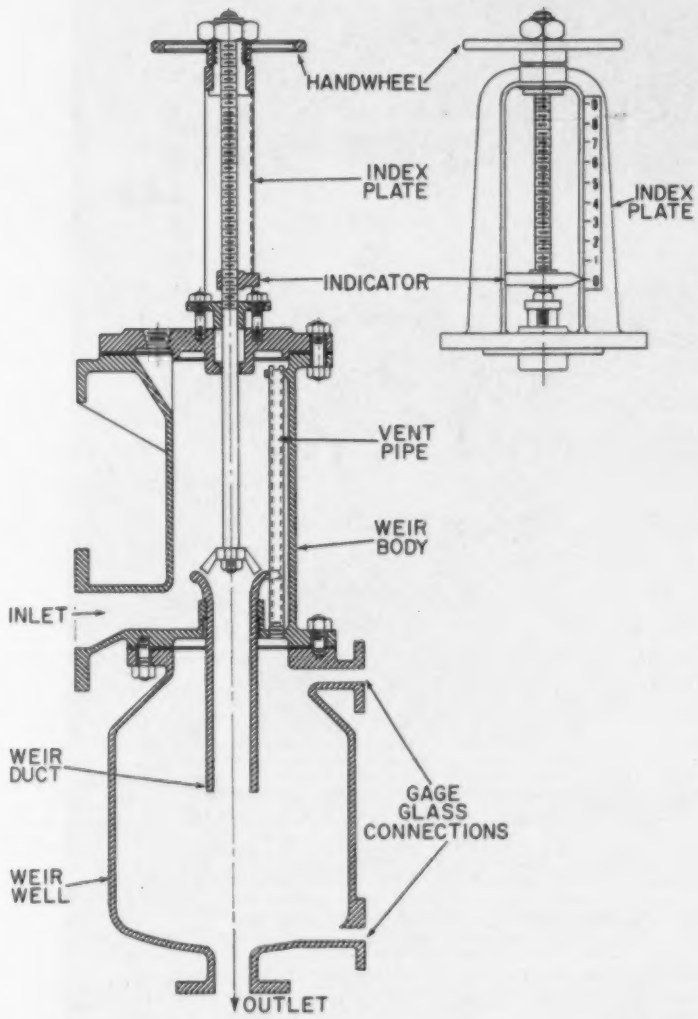

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Figure 13-7.—Weir type level controller.

gallons of concentrated sea water (brine) are pumped overboard. The flowrator compares the amount of incoming feed against the amount of brine leaving the last effect, thus making it simple to keep the feed rate adjusted correctly.

Solenoid-Operated Distillate Bypass Valve

In later installations, a three-way solenoid trip valve is usually provided to divert the output to the bilge whenever the purity is unsatisfactory. The solenoid valve is tripped automatically whenever the salt content at the distillate cooler outlet exceeds 0.25 grains per gallon (gpg) or 0.065 equivalent parts per million (epm). When this occurs, the distillate continues to flow to the bilge and an alarm is sounded on the conductivity meter panel.

The solenoid valve is so wired that flow can be directed to the ship's tanks only when the solenoid is energized. An increase in salinity to more than 0.25 gpg (0.065 epm) deenergizes the solenoid and trips the valve to the bilge. This arrangement makes it impossible to reset the valve to discharge to the ship's tanks until the salinity is below 0.25 gpg (0.065 epm) and the solenoid is again energized. In the event of a power failure at the panel, the solenoid valve will trip and discharge to the bilge.

Air Ejector

The function of air ejectors is to remove the noncondensable gases, mainly air, which may leak or be discharged into condensers operating under a vacuum. The air ejector (fig. 13-8) is a comparatively simple mechanism consisting of a steam inlet and nozzle, an inlet for the saturated air from the condenser, and a diffuser tube. Steam (125 to 150 pounds) is led to the air ejector and passes through the nozzle. The steam attains a high velocity as it passes from the nozzle. The high-velocity steam jet issuing from the nozzle creates a suction and draws in the saturated air from the distilling condenser. Two air ejectors are usually provided for each distilling plant; however, one unit is usually sufficient to operate the plant.

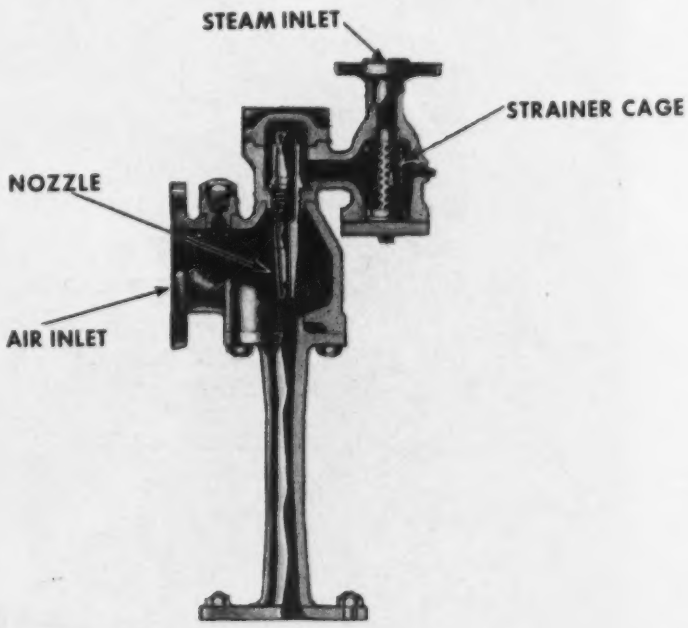

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Figure 13-8.—Air ejector.

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Air Ejector Condenser

The steam-air mixture discharged from the air ejector is normally condensed in a shell and tube type air ejector condenser (fig. 13-9). This is nothing more than a bank of tubes divided by a series of baffles and enclosed in a shell. The baffles ensure that the steam-air mixture passes over the entire cooling surface of the tubes before reaching the air vent. The steam is condensed and the resulting condensate is led into the low pressure drain system.

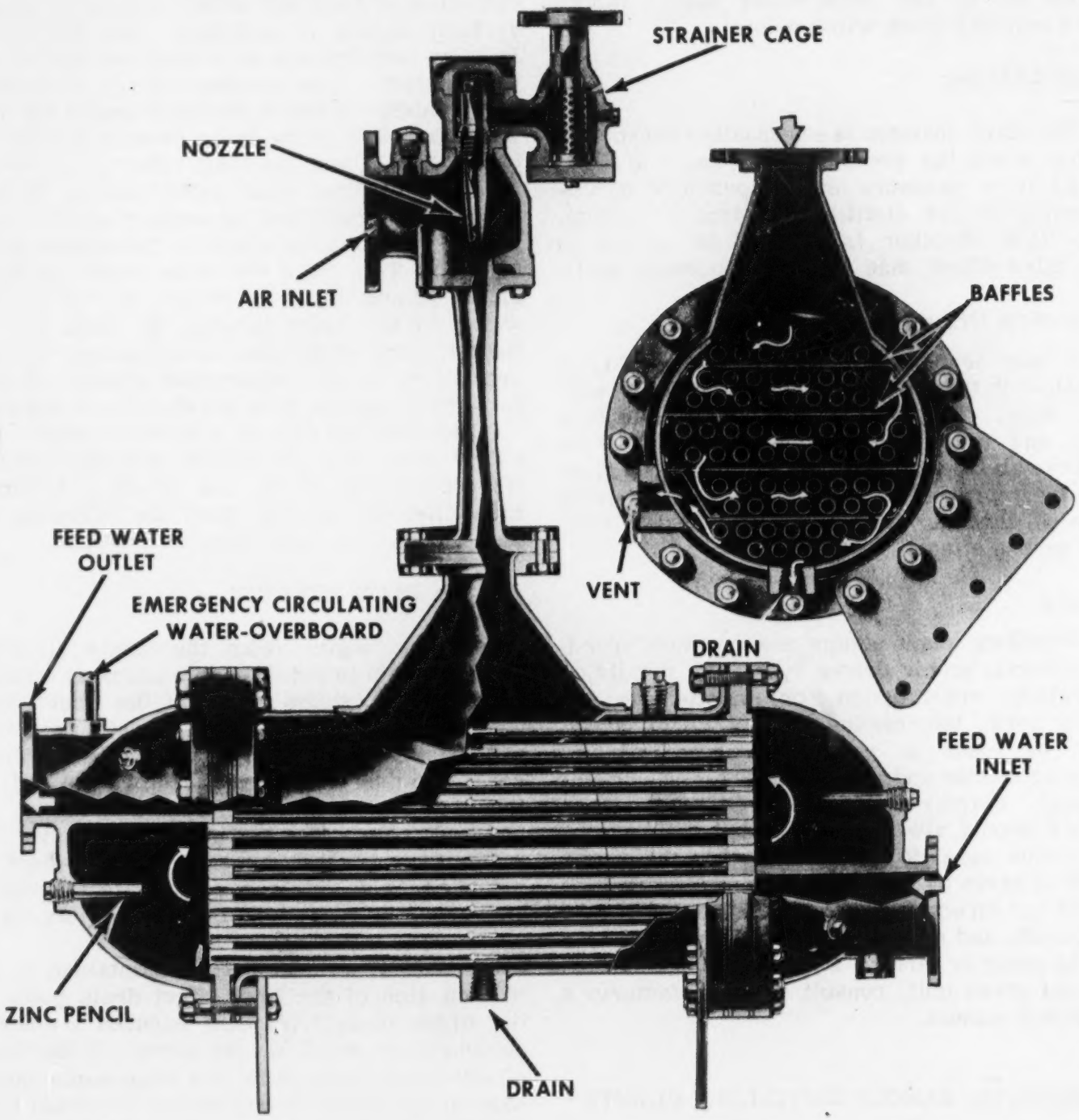

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Figure 13-9.—Air ejector condenser.

Distillate Cooler

The distillate cooler (fig. 13-10) is a tubular surface multipass heat exchanger. The fresh water (distillate) from the distilling condenser is drawn out by the distillate pump and discharged through the tubes of the distillate cooler. (Later units circulate the sea water through the tubes and the distillate around the tubes.) From here the distillate is further drawn out by the fresh water pump. (Later units omit the fresh water pump.)

Flash Chamber

The flash chamber is essentially a receptacle within which the second-effect drains are reduced to a pressure and temperature corresponding to the distilling condenser vacuum. The flash chamber is attached or located on the third-effect side of the evaporator shell.

Tube-Nest Drain Regulator

A tube-nest drain regulator (fig. 13-11) is installed in the drain line from each evaporator tube nest. The drain regulator consists of a body and cover enclosing a balanced cage or rotary valve operated by a ball float. The drain regulator prevents the generating steam from blowing through the tube bundle in the first and second effects.

Pumps

Distilling plant pumps are constant speed, centrifugal, motor driven type. No details on operation, construction, or maintenance are given here; information on centrifugal pumps may be found in chapters 5 and 6 of this training course and in the Naval Ships Technical Manual, chapter 9470 (47). Distilling plant pumps should always be installed with a submergence equal to that specified on the nameplate or given by the manufacturer. The pump's speed and direction of rotation should be checked frequently and rechecked after any work is done on the pump or motor. For detailed information on any given unit, consult the manufacturer's technical manual.

VERTICAL BASKET DISTILLING PLANTS

Some of the newer ships are being equipped with distilling plants that differ somewhat from the submerged tube type. One such type is the vertical basket plant.

The low pressure vertical-basket type distilling plant (fig. 13-12) consists of two-effect (or more) evaporators with a distiller condenser, vapor feed heaters, air ejectors and after condensers, and a distillate cooler. The only difference between this type of distilling plant and the conventional submerged-tube type is in the evaporators. Each evaporator consists of a vertical shell into which a deeply corrugated vertical basket is installed. See fig. 13-13. In some installations more than one basket may be installed. Low pressure steam is admitted to the inside of the first-effect basket and feed water is boiled in the space between the outside of the basket and the shell. The vapor formed from the boiling feed water passes through centrifugal-type vapor separators and the vapor feed heater into the inside of the second-effect basket. This boils the brine from the first-effect in addition to a certain amount of feed water in the space between the shell and the basket. The vapor thus formed passes through separators to the subsequent effects, or in a two-effect basket, into the distiller condenser.

The flow circuits of a vertical basket distilling unit are illustrated schematically in figures 13-14, 13-15, and 13-16. Refer to these figures as you study the following descriptions of the flow circuits of the unit.

STEAM FLOW CIRCUIT

Heating steam from the ship's auxiliary exhaust main is fed through a pressure-control valve to the steam chest of the first effect. The pressure-control valve is set to maintain a constant steam-supply pressure; it should be set for 5 psig steam on the upstream side of the orifice plate for rated output, and lower for reduced output. The heating steam is condensed within the corrugated basket; the condensate is returned to the ship's condensate system or reserve feed tanks by the first-effect drain pump. (See fig. 13-14.)

A steady water level is maintained in the suction line of the first-effect drain pump by the drain controller; this ensures a positive submergence head for the pump. If the first-effect drain pump fails, the evaporator can be kept in operation by bypassing the drain controller and manually controlling the condensate discharge to the low pressure drain mains; at least 1 psig pressure in the steam chest is

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PREFACE

One of the services most frequently requested by teachers of agriculture is a supply of publications containing up-to-date teaching content on timely subjects, organized and written for student use. In response to this need a new series of bulletins was introduced in 1963. Publications in this group were designed to provide basic information and fundamental principles pertaining to large comprehensive units of instruction. To date, three numbers in this series have been prepared as follows: Introduction to Animal Diseases, Harmful Parasites of Domestic Animals, and Introduction to Plant Diseases. These have been well received by both students and teachers.

There is demand for a second type of reference composed mainly of procedures or "how" information for performing various types of farm and ranch jobs according to the best known practices. This type of bulletin was formerly published by this department on most of the major farm enterprises of Arizona, under the title of Jobs and Practices.

It is suggested that the unit, Livestock Sanitation and Its Relation to Disease Control, which served as the basis for this bulletin, be taught along with the units on animal parasites and animal diseases. Since the content of the bulletin is quite limited it should be supplemented with more extensive references. Some selected references are listed at the end of this publication.

This work represents the cooperative effort of a number of people including staff members in agricultural education, animal pathology and teachers of vocational agriculture. The publication was written by Howard N. Acott, Graduate Assistant in Agricultural Education. A preliminary copy was used on a trial basis by selected teachers of vocational agriculture. Throughout the preparation of the manuscript the content was checked for completeness and accuracy by staff members of the Department of Animal Pathology of the University of Arizona.

If this bulletin proves to be useful, similar publications may be prepared for other major areas of content in the course guides for vocational agriculture in Arizona.

R. W. Cline, Head of
The Department of
Agricultural Education
University of Arizona
Tucson

July 1966

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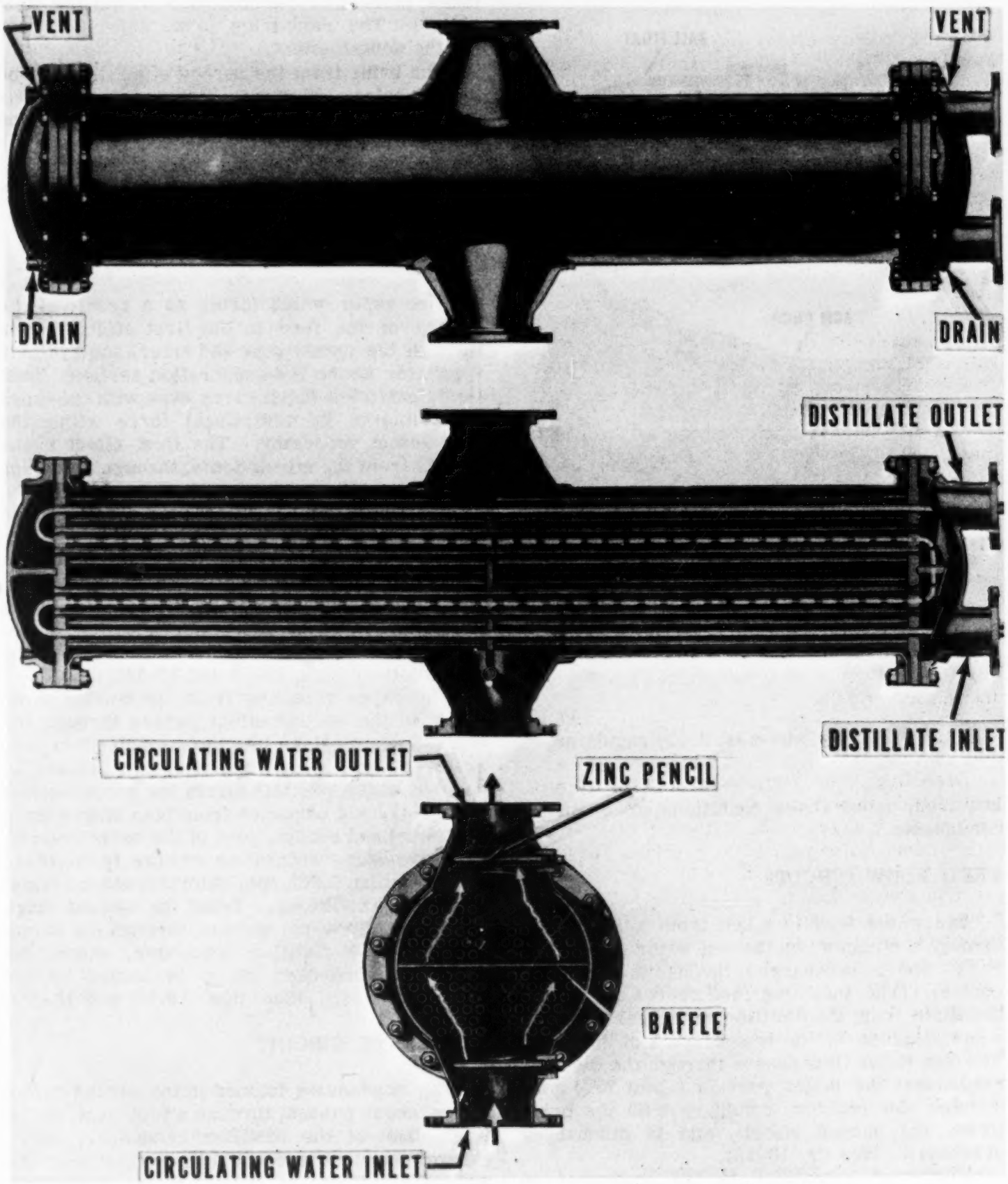

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Figure 13-10.—Distillate cooler.

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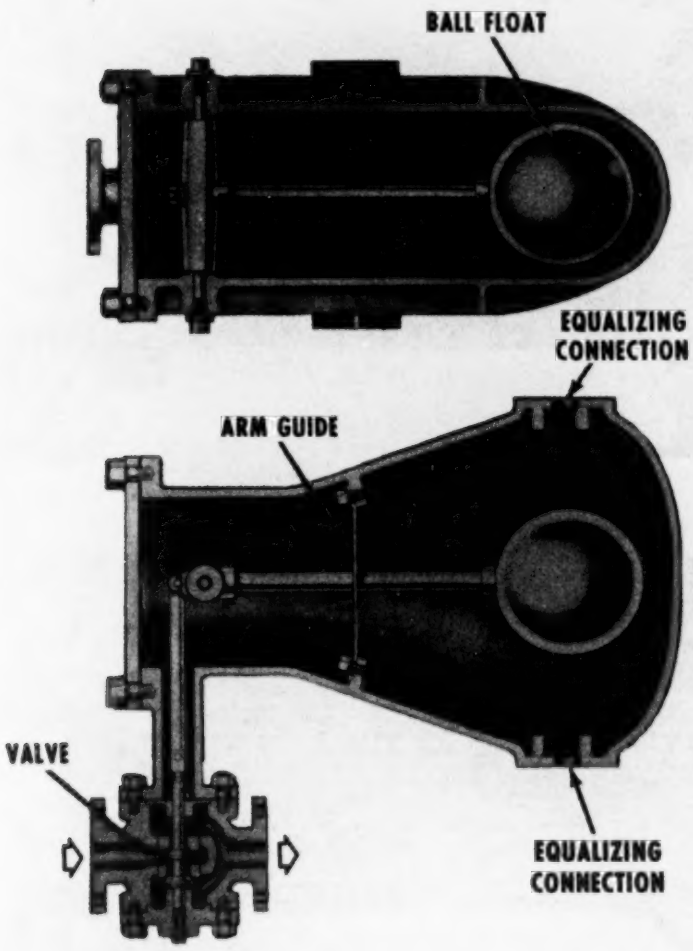

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Figure 13-11.—Tube-nest drain regulator.

required, under these conditions, to drain the condensate.

FEED FLOW CIRCUIT

Sea water feed is taken from a sea chest, through a strainer, by the sea water circulating pump, and is discharged, through the distillate cooler. (The incoming feed serves to cool the distillate from the distiller condenser to within a few degrees of the temperature of the feed.) The sea water then passes through the distiller condenser; the major portion (about 75%) goes through the eductor, combines with the brine (from the second effect), and is discharged overboard. (See fig. 13-16).

The feed remaining in the condenser is directed through the after condenser and the vapor feed water heater to the first effect, where it surrounds the basket. Violent boiling takes place and vapor forms within the first effect. The remaining brine serves as feed for the second effect.

The brine from the second effect is removed by the brine overboard-discharge pump; it is discharged overboard, through the eductor and control valve, after it has been combined (in the eductor) with the sea water overboard discharge from the distiller condenser (figs. 13-14 and 13-15).

VAPOR CIRCUIT

The vapor which forms as a result of the boiling of the feed in the first effect passes through the uptake pipe and enters the cyclonic separator above the evaporation section. Most liquid particles which carry over with the vapor are removed by centrifugal force within the first-effect separator. The first-effect vapor passes from the steam dome, through the vapor feed water heater, to the steam chest and the evaporator basket of the second effect. Some of the vapor, in passing from the first effect to the second effect, condenses as it heats the feed water passing through the vapor feed water heater. The major portion of the first-effect vapor, however, enters the second-effect steam chest and condenses as it heats the brine in the second effect (figs. 13-14 and 13-15).

The vapor resulting from the boiling of the brine in the second effect passes through the second-effect uptake into the second-effect separator, where centrifugal force is utilized to remove water particles from the second-effect vapor. (Liquid particles from both stages drain downward and become part of the brine drains.) This two-stage separation results in distillate with less than 0.065 epm chloride, under normal operating conditions. From the second-stage separator, the vapor passes, through the steam dome, to the distiller condenser, where the vapor is condensed as it is cooled by the incoming feed. (See figs. 13-15 and 13-16).

DISTILLATE CIRCUIT

The condensate formed in the second-effect steam chest passes, through a loop seal, to the flash tank of the distiller condenser, under the pressure differential existing between the second-effect steam chest and the flash tank. The loop seal permits only condensate to pass.

The vapor from the second-effect steam dome condenses in the distiller condenser and

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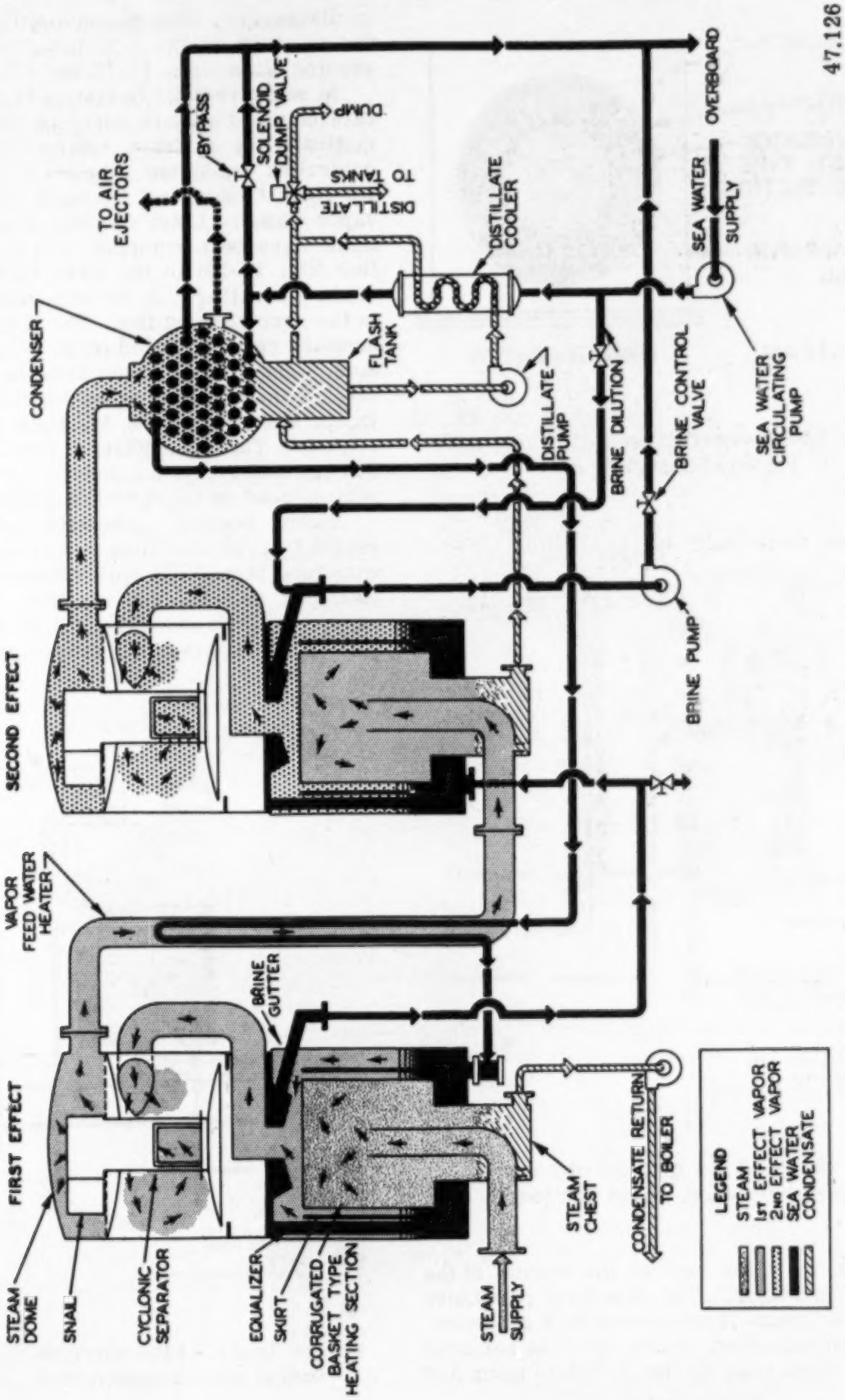

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Figure 13-12.—Low pressure double-effect distilling plant (vertical basket type).

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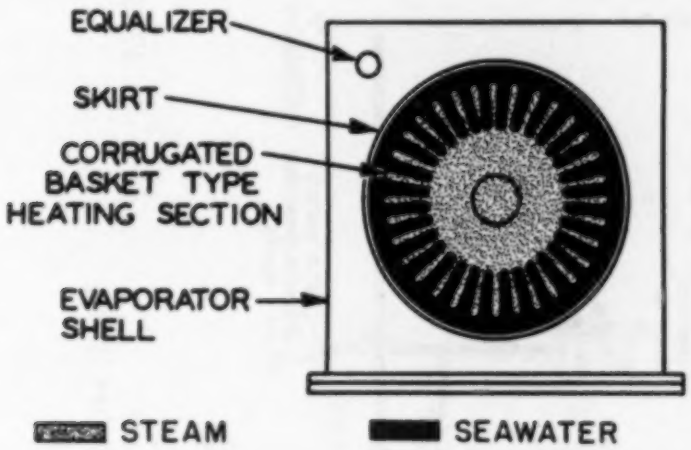

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Figure 13-13.—Section view of evaporator (vertical basket type).

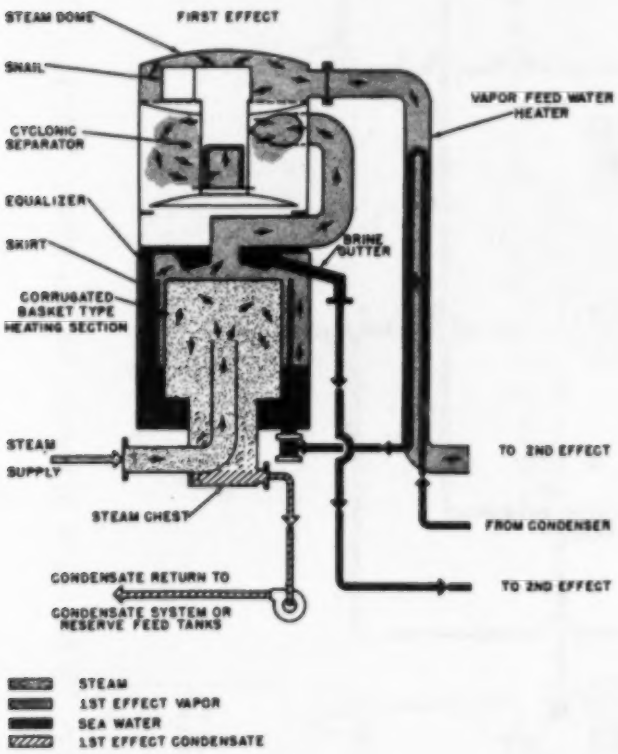

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Figure 13-14.—Flow circuits of a vertical basket unit—first-effect section.

collects in the flash tank at the bottom of the distiller condenser. The distillate (combined condensate drains from the distiller condenser and the second-effect steam chest) is removed from the flash tank by the distillate pump and is discharged, through the distillate cooler and the solenoid-operated dump valve, to the ship's service tanks (figs. 13-15 and 13-16).

In some vertical basket units, the discharge rate of the distillate pump is controlled automatically by a drain controller. The drain controller maintains a positive water level in the flash tank so that the pump will not become vapor bound. Later models of vertical basket units have been equipped with a recirculating line (fig. 13-16) to the flash tank, instead of a drain controller. A throttle valve is included in the recirculating line. The recirculating line supplies relatively cold fresh water to the flash tank. The cooling water reduces the temperature of the distillate below the flash point; thus vapor lock within the distillate pump is prevented. The recirculating line also ensures, through control of the throttle valve, a positive suction head on the distillate pump.

Under normal operating conditions, the vertical basket distilling unit produces distillate with less than 0.065 epm chloride (0.25 grains salt per gallon). If the unit is to produce relatively pure distillate, it is essential that salt water be prevented from entering the vapor

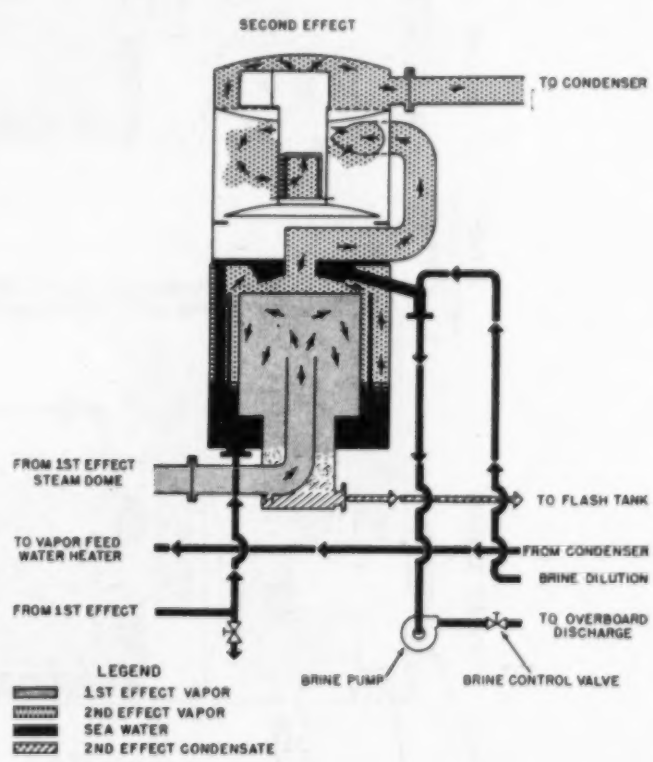

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Figure 13-15.—Flow circuits of a vertical basket unit—second-effect section.

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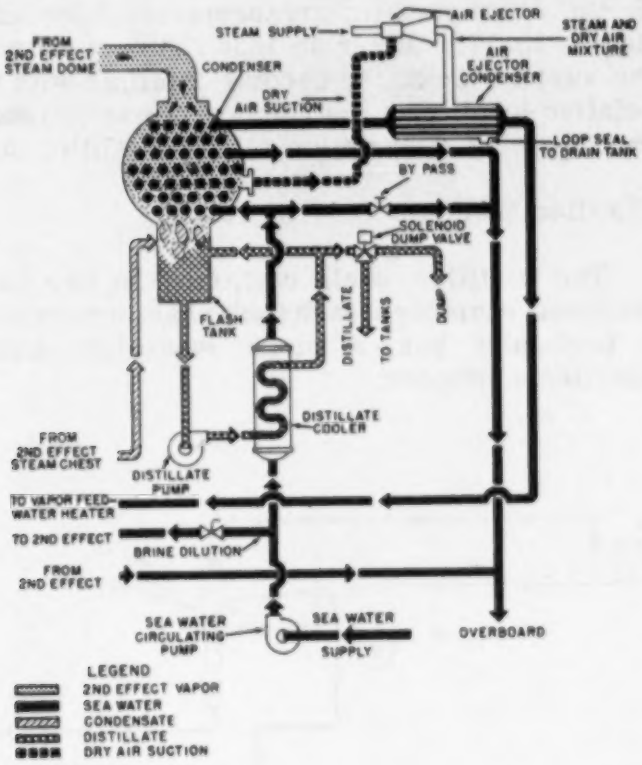

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Figure 13-16.—Flow circuits of a vertical basket unit—condenser section.

and condensate systems. To prevent salt water contamination of the ship's fresh water supply, a salinity cell is provided in each of the unit's fresh water lines. If a salt water leak should develop in the distillate circuit, the salinity indicator actuates the solenoid dump valve, which diverts the contaminated water to the bilge until the unit can be secured and the leakage stopped.

NONCONDENSABLE GASES

Air and other noncondensable vapors in the distiller condenser are removed and vacuum is maintained throughout the evaporator units by an air ejector. The ejector is of the single-nozzle, single-stage, steam jet type. The ejector is mounted on the side of the distiller condenser, and takes its suction from a specially baffled section within the distiller condenser. Vent lines and interconnecting vapor-piping connect components in which vacuum must be maintained.

The air ejector removes the air and other noncondensable vapors from the distiller condenser by utilizing the energy in steam at 150 psi. The gases entering the suction of the ejector are entrained by the steam jet from the nozzle and are carried through the diffuser, where the pressure is raised to that of the atmosphere. The ejector discharges into a surface after-condenser, where the steam is condensed and the noncondensable gases are vented to the atmosphere.

FLASH TYPE DISTILLING PLANTS

Some of the later ships are being equipped with flash type distilling plants. These plants use low pressure steam and operate on the principle of evaporation followed by condensation. The flash type unit may have two or more stages. For example, CVA-62 is equipped with five-stage units, each having a capacity of 50,000 gallons per day. Two-stage units of 12,000 gallons per day are being installed on new destroyer type ships.

PRINCIPLES OF OPERATION

Each stage of a flash unit has a flash chamber, a feed box, a vapor separator, and a distilling condenser. There is also a two-or three-stage air ejector, a distillate cooler, and a feed water heater. Feed water passes through the tubes of the distillate cooler, the stage distilling condensers, and the air ejector condenser. In each of these heat exchangers the feed water picks up heat and the final heating is done by low pressure steam admitted to the shell of the feed water heater. From this heater the feed water enters the first-stage feed box and comes out through orifices into the flash chamber. As the heated feed water enters the chamber, a portion flashes or vaporizes because the pressure in the chamber is lower than the saturation pressure corresponding to the temperature of the hot feed. This vapor condenses on the tubes of the first-stage distilling condenser. The feed which does not vaporize in the first chamber passes to the second chamber. The process is repeated in each stage and the brine remaining in the last stage is removed by the brine overboard pump. Vapor formed in each stage passes through a vapor separator and into the stage condenser where it is condensed to distillate. The distillate passes through a loop seal on its way to the distilling condenser of the next stage. The distillate pump removes the distillate from the last stage.

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BASIC PARTS OF A TWO-STAGE FLASH UNIT

The basic component of the unit is the distiller shell. The shell is divided to form the two stages (flash or vacuum chambers) of the unit. Most accessories for the unit are mounted directly on the shell. The piping system of the unit includes the essential pumps and strainers and an electrical salinity-indicator system. The relative location of these components and the flow circuits of the unit are shown in the diagrammatic arrangement of the unit, figure 13-17. Refer to that figure and trace the various circuits; become familiar with the relative location of the components as you study the following description of the distilling unit.

Distiller Shell and Internal Parts

The distiller shell contains the two flash (vacuum) chambers; each flash chamber contains a feed-inlet box, a vapor separator, and a distiller condenser.

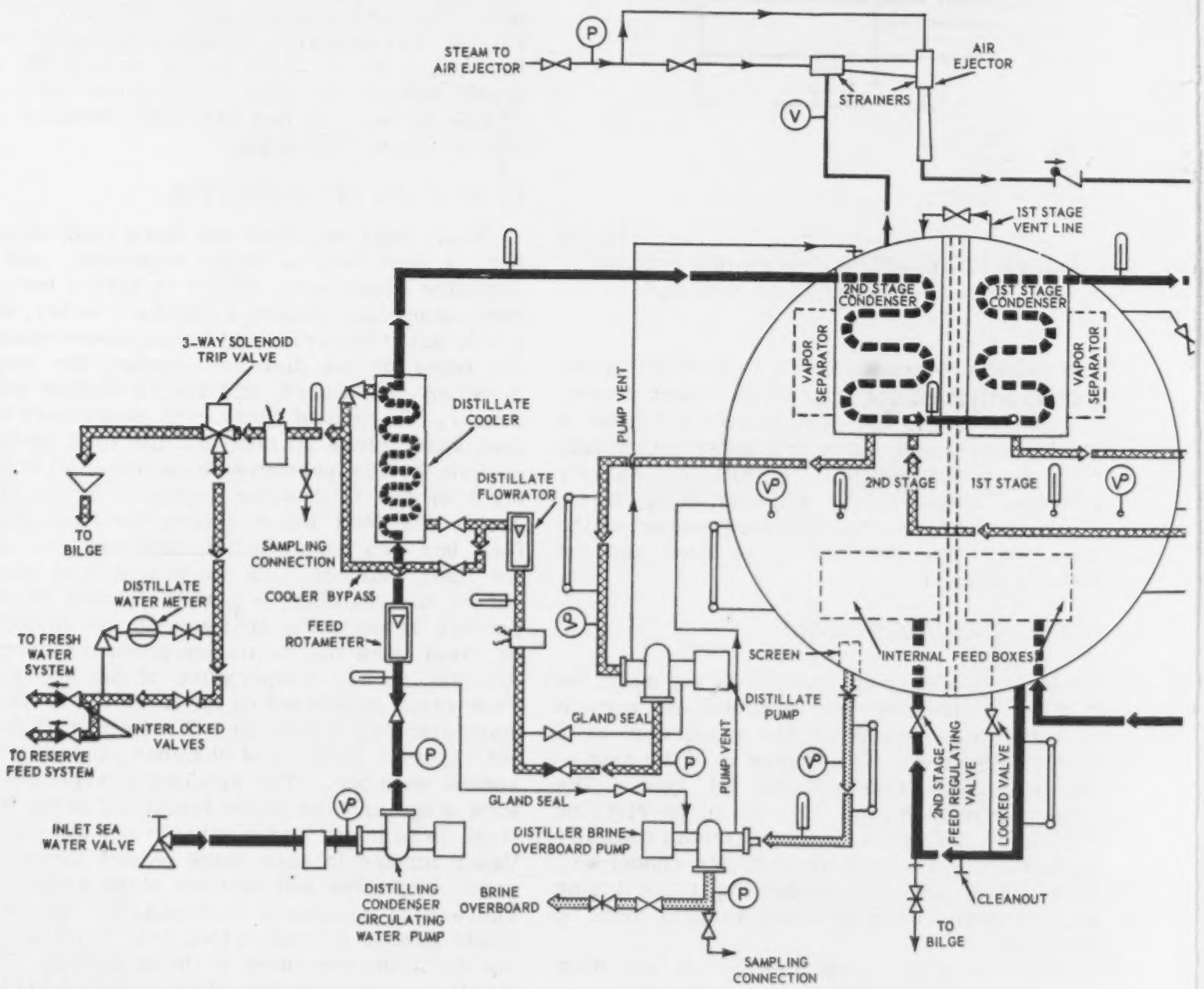

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The first- and second-stage FLASH CHAMBERS are separated from each other by a vertical wall through the center of the distiller shell. In each chamber, the vapor separator and the distilling condenser are located at the top and the feed-inlet box is located at the bottom.

Access openings to each flash chamber are provided through the front of the distiller shell. Sight glasses are provided on the side of each flash chamber for observing the conditions within the flash chamber during operation. Gage glasses mounted on the access covers indicate the level of the water within each flash chamber. A screen is fitted over the suction connection to the brine-overboard pump to prevent scale, which may form on and flake off the distiller shell, from passing into the brine pump.

Hot feed enters the distiller shell through the FEED-INLET BOXES. The construction of a feed-inlet box is illustrated in figure 13-18.

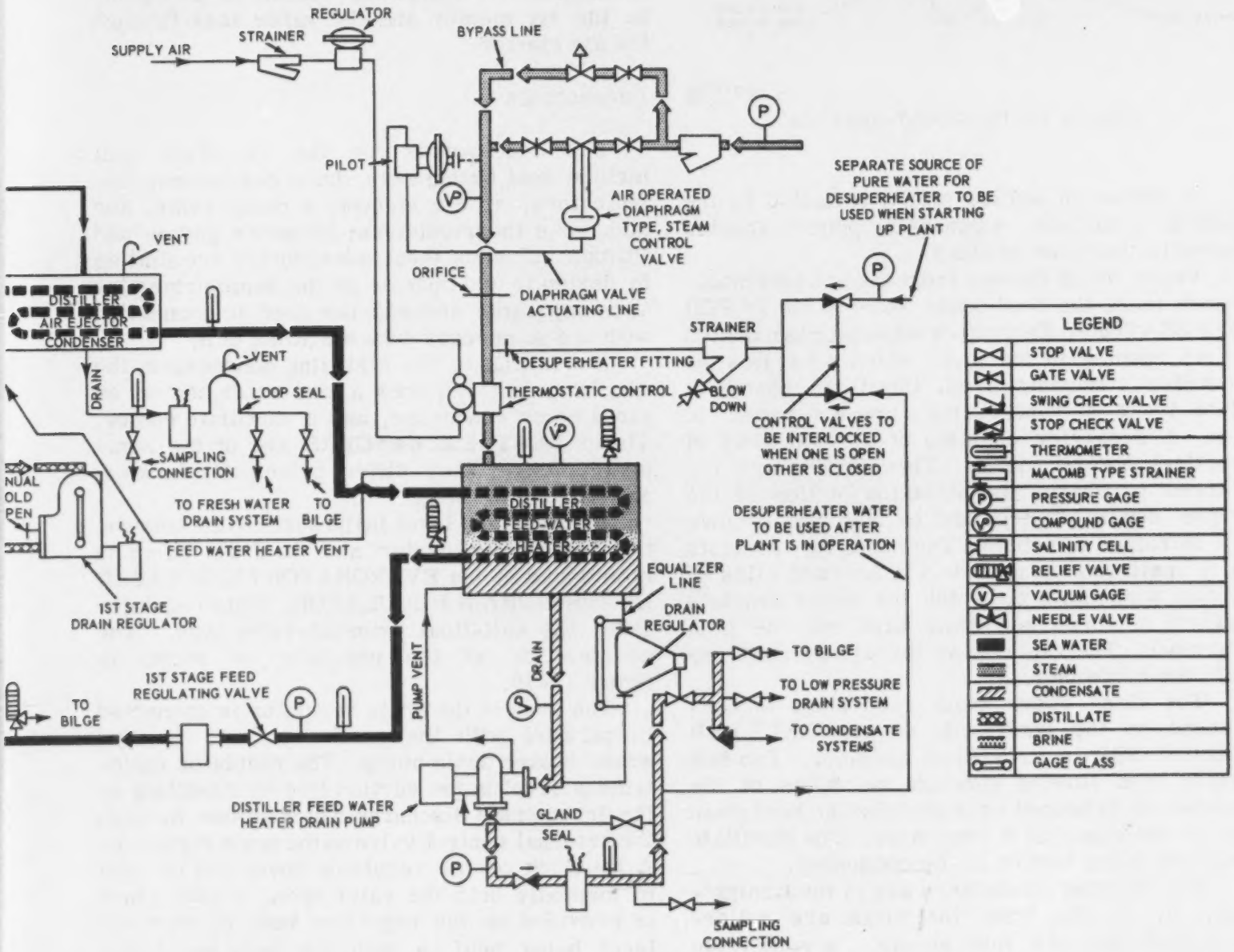

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Figure 13-17.—Diagrammatic arrangement of a two-stage flash unit (Griscom-Russell).

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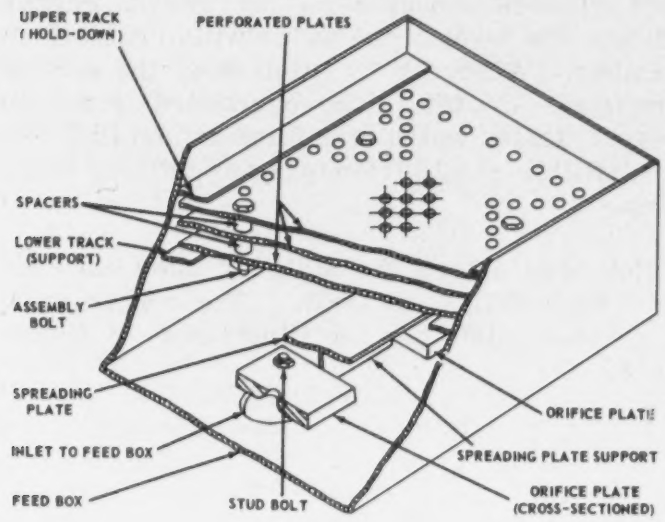

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Figure 13-18.—Feed-inlet box.

A series of orifice plates is bolted to the bottom of the box. A spreading plate is located directly above the orifices.

Vapor which flashes from the hot feed introduced from the feed boxes flows to the VAPOR SEPARATORS. Each vapor separator is mounted in an opening in the plate which separates the distiller condenser from the flash chamber. Two types of vapor separators are used. In one, a separator consists of several rows of vertical hooked vanes. These vanes are arranged to change the direction of flow of the vapor several times, and to trap and remove all entrained moisture. The other type consists of a mattress composed of numerous plies of woven wire cloth on which the water droplets collect or form, and drain back into the flash chamber. The vapor flows through the mattress into the condenser.

The flash vapor from each stage is condensed on the shell side of the DISTILLER CONDENSER in each flash chamber. The salt water feed flowing through the tubes of the condenser is heated as it absorbs the heat given off by the vapor as it condenses. The distillate collects in the bottom of the condenser.

The distiller condensers are of the straight-tube or U-tube type; the tubes are roller-expanded into the tube sheets. A removable head provides access to the inside of the tubes. Each head is designed to direct the flow of the water through the tubes in several passes. The heads are fitted with vents, drains, and pencil zincs. A plate welded to the shell provides support at the middle of the tube bundle. A diaphragm-type expansion joint between the rear shell head and the rear tube sheet allows for differential expansion of the tubes when straight tubes are used. Several baffles are arranged within the shell to direct the flow of the vapor through the shell from the warmest pass to the coolest pass. A separate baffle around the vent connection on each condenser forms an air cooling section; in this section the air and other noncondensable gases are forced to travel across a portion of the coolest pass of the condenser before they are released. This arrangement reduces the volume of gas going to the air ejector and the vapor loss through the air ejector.

Accessories

The accessories for the two-stage unit include heat exchangers, drain regulators, flow indicators, an air ejector, a dump valve, and numerous thermometers, pressure gages, and fittings. Many of these accessories are similar in design to and operate on the same principles as comparable accessories used in connection with the submerged-tube distilling unit.

In addition to the distilling condensers, the distilling unit requires a feed water heater, an air ejector condenser, and a distillate cooler. These HEAT EXCHANGERS are of the same basic design; they differ principally in size, and number of tubes.

The required level in the suction line between the feed water heater and its drain pump is maintained by the EVAPORATOR FEED WATER HEATER DRAIN REGULATOR. This regulator is of the ball-float external-valve type. The construction of the regulator is shown in figure 13-19.

The body of the drain regulator is connected in parallel with the suction line to the feed water heater drain pump. The regulator maintains a level in the suction line by throttling on the drain-pump discharge which passes through the external control valve on the drain regulator. A handjack on the regulator cover can be used to manually hold the valve open. A gage glass is provided on the regulator body to show the level being held in both the body and in the suction line to the feed water heater drain pump.

The flow of distillate from the first-stage distilling condenser to the second-stage distilling condenser is controlled via a loop seal

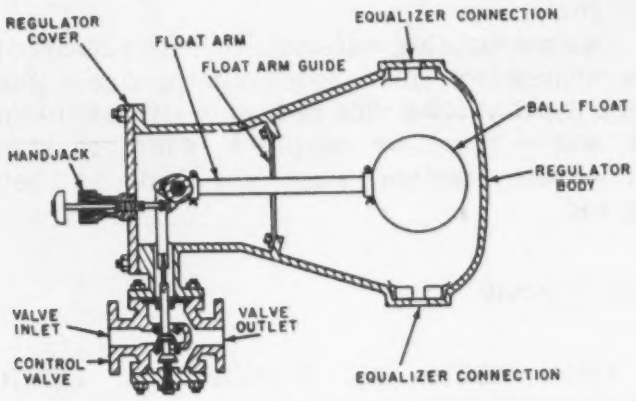

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Figure 13-19.—Evaporator feed water heater drain regulator.

or by the FIRST-STAGE DISTILLATE DRAIN REGULATOR. This regulator is of the ball-float internal-valve type. The construction of the regulator is shown in figure 13-20.

The distillate from the bottom of the first-stage distilling condenser enters the top of the drain regulator, passes through the body, and is discharged through the piston-type valve into the bottom of the second-stage distilling condenser. A gage glass is provided on the regulator body to indicate the level within the body. A handjack on the regulator cover can be used to hold the valve open manually. The regulator is self-venting.

The salinity of the distillate at various points within the distillate circuit is indicated by an electrical SALINITY INDICATING SYSTEM. The system includes five cells. One cell is installed in each of the following locations: distillate outlet from the distillate cooler; distillate inlet to the distillate cooler; distillate drains from the first-stage distilling condenser feed; water heater drain pump discharge; and air ejector condenser drain line (fig. 13-18). An alarm sounds whenever the salinity at any cell exceeds 0.065 epm. All cells register on the salinity indicating panel. The arrangement is such that when the salinity of the distillate

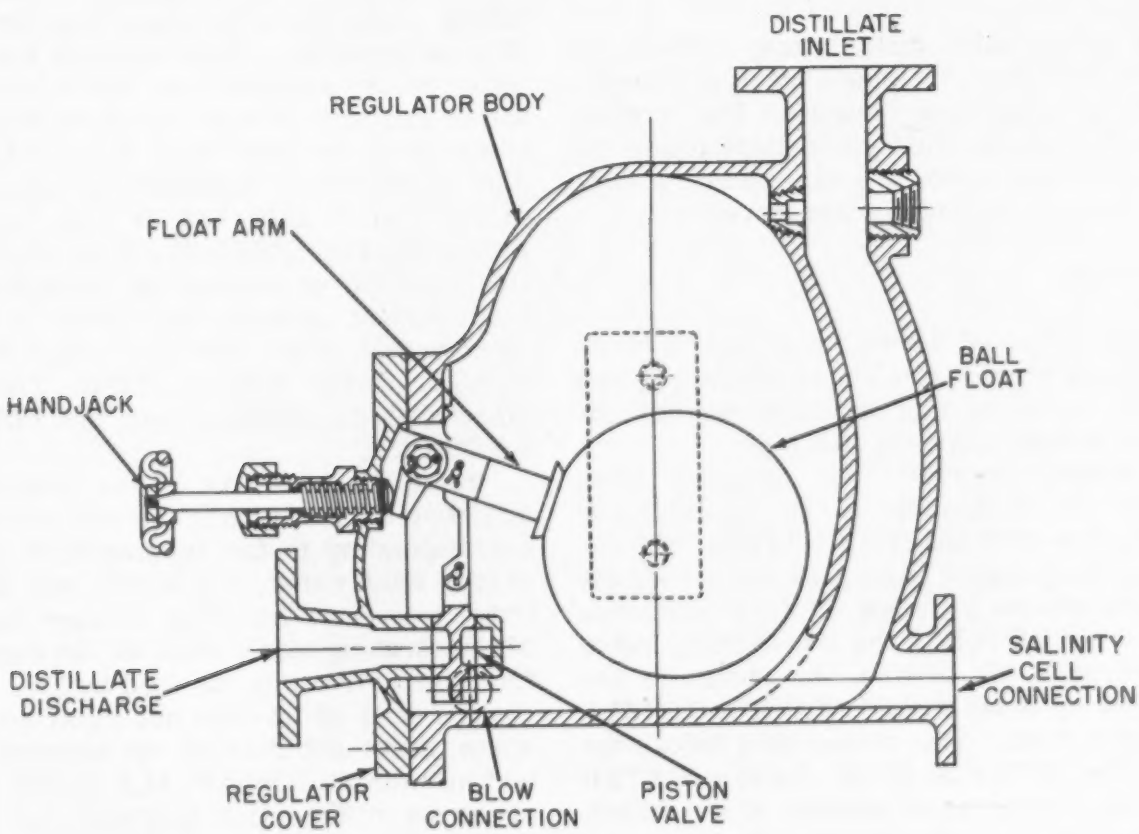

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Figure 13-20.—First-stage distillate drain regulator.

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exceeds 0.065 epm the cell in the outlet of the distillate cooler causes the solenoid of the THREE-WAY TRIP VALVE to be de-energized. This causes the valve to trip, and the contaminated distillate is discharged to the bilge. Once the valve has been tripped, the distillate will continue to flow to the bilge until the valve is reset manually.

The distilling unit is provided with VENTS at numerous points (see fig. 13-18). The feed water heater shell is vented, through a line with a control valve, to the shell of the first-stage distilling condenser. The first-stage distilling condenser is vented, through a line with a control valve to the second-stage condenser. The second-stage condenser is vented to the atmosphere through the air ejector and air ejector condenser.

The feed water heater drain pump is vented to the feed water heater shell. The brine-overboard pump is vented to the second-stage flash chamber. The distillate pump is vented to the second-stage condenser.

CIRCUITS OF A TWO-STAGE FLASH UNIT

While flash units differ from submerged tube units in design, the same types of circuits are found in both types of units. The circuits of the flash unit are described here under the headings of steam, feed, and vapor and distillate circuits, and the air ejector systems.

Steam Circuit

The heat required for the distillation process is provided by steam from the auxiliary exhaust main. The steam is supplied to the evaporator feed water heater. (See fig. 13-17.)

The steam pressure is reduced from 15 pounds to 5 pounds by an air-operated diaphragm-type STEAM REGULATING VALVE. This valve is operated from a 20 psi air supply line, and maintains 5 pounds of steam pressure ahead of the ORIFICE in the steam line. After passing through the orifice, the steam is desuperheated by a DESUPERHEATER NOZZLE in the steam line. The steam then enters the shell of the EVAPORATOR FEED WATER HEATER and condenses outside of the tubes. The condensate is removed from the heater by the evaporator feed water heater drain pump and is discharged through a salinity cell and a drain regulator to the bilge, to the steam-drain collecting system, or to the ship's condensate system.

Desuperheating water may be furnished from the evaporator feed water heater drain pump when the distilling unit is in operation; however, the water must be supplied from the ship's condensate system when the unit is being started.

Feed Circuit

THE DISTILLING CONDENSER CIRCULATING WATER PUMP takes feed, through a strainer, from a sea chest. The evaporator feed water is discharged through the FEED ROTAMETER and through the tubes of the DISTILLATE COOLER in a single pass. From the distillate cooler, the feed flows through the tubes of the SECOND-STAGE DISTILLING CONDENSER where the feed condenses the vapor released in the second stage. The feed then passes through the tubes of the FIRST-STAGE DISTILLING CONDENSER where it performs a similar function. (The evaporator feed water is heated as it passes through the distilling condensers by absorbing the latent heat of condensation. This reduces the amount of heat to be absorbed in the evaporator feed water heater.) From the first-stage distilling condenser, the feed flows through the distillate AIR EJECTOR CONDENSER where a little more heat is absorbed; it then flows into the EVAPORATOR FEED WATER HEATER. The final heating of the feed is accomplished as the feed passes through the tubes of the heater. The heated feed passes through the FIRST-STAGE FEED REGULATING VALVE and a Macomb-type strainer into the FIRST-STAGE FEED BOX.

Since the pressure in the first-stage flash chamber is lower than the saturation pressure corresponding to the temperature of the evaporator feed water, the water will flash to the lower pressure and thus release vapor. Most of the flashing takes place as the water emerges from the orifices in the feed box.

The feed which does not vaporize in the first stage flows out through an external loop seal and into the SECOND-STAGE FEED BOX. (The pressure differential between the two stages causes the feed to flow through the loop seal.) Since the second stage is at a lower pressure (higher vacuum) than the first stage, an additional portion of the feed vaporizes in the

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SECTION I - GENERAL PRACTICES

THE IMPORTANCE OF SANITATION IN LIVESTOCK PRODUCTION

Diseases of animals cost farmers and ranchers about one billion dollars every year. An effective sanitation program on the home farm and ranch could save hundreds of millions of dollars each year. Certainly well planned and carefully conducted sanitation practices would be the least expensive and most effective way to fight animal diseases.

While most people include some sanitation practices in their herd management, they often overlook some elementary practices which perhaps nullify most of the other things they are doing.

Just what is sanitation? The dictionary defines sanitation, in part, as anything done to improve health. In this bulletin, however, sanitation will be discussed as a program of disease prevention by maintaining sanitary buildings, grounds, and animals. Absolute cleanliness is the major theme in this attempt to offer some complete sanitation programs for general livestock production, with current recommendations for disease prevention through sanitary practices.

Sanitary practices vary considerably from one farm or ranch to another. This is because many people do not realize the necessity of planned programs of cleanliness. Farmers and ranchers often come to the erroneous belief that they can save money by slighting good management practices. Most people realize that complete sanitation can be accomplished only be destroying all disease organisms and means of transmitting them. Such a program, of course, might cost more than would be economical. The opposite of this "perfect" situation is a farm or ranch which practices no sanitation at all. This is also a quick method of wasting money.

Somewhere between these two extremes is the right sanitation program for most livestock owners. Overcrowding and poor sanitation in pens puts undue stress upon the natural resistance of animals. Proper sanitation can relieve this overstressing and prevent disastrous disease outbreaks. In fact, sanitation will save and earn greater income, by helping to produce larger, healthier animals in a shorter length of time.

To understand how to prevent disease best, one must understand how diseases are spread. Most diseases are spread by direct animal to animal contact, contaminated food and water containers, insect vectors, or through the air. Isolation of new animals prior to introducing them into the herd, isolation of diseased animals in a herd, vector control, and recommended sanitation on the premises can prevent many disease problems.

Following approved practices and the recommendations of the local veterinarian will result in healthier animals and higher profits from livestock enterprises.

SANITATION IN HOUSING FACILITIES

Sanitary housing is of primary importance in developing a regular program of herd hygiene. Buildings with concrete floors are easier to keep clean and sanitary. It is almost impossible to thoroughly disinfect dirt floors.

Factors in Farm Building Construction

Farm building construction includes many factors, many of which must be considered in planning the sanitation program. Some of the factors to consider are:

1. Animals should be protected from weather, as changes in weather put a stress upon the animals' natural resistance to disease. Cold, rainy weather often causes respiratory diseases, and hot weather keeps animals from gaining weight because of lower feed consumption.

second-stage flash chamber. The brine remaining in the second stage after flashing occurs flows out of the distiller shell, through a strainer, and is discharged overboard by the BRINE-OVERBOARD PUMP.

Vapor and Distillate Circuits

The vapor flashed from the evaporator feed water in the first-stage flash chamber rises and passes through the FIRST-STAGE VAPOR SEPARATOR into the FIRST-STAGE DISTILLING CONDENSER. The vapor condenses on the outside of the tubes and transfers its latent heat to the incoming feed. The distillate flows through the external FIRST-STAGE DRAIN REGULATOR, or a loop seal and into the bottom of the second-stage distilling condenser where a portion of it flashes to the lower pressure in the second-stage distilling condenser.

The vapor flashed from the feed in the second-stage feed box rises and passes through the SECOND-STAGE VAPOR SEPARATOR into the SECOND-STAGE DISTILLING CONDENSER. After condensing on the outside of the tubes, the distillate mixes with that from the first-stage condenser and is removed from the second-stage condenser shell by the DISTILLATE PUMP.

The discharge from the distillate pump passes through a salinity cell and the DISTILLATE FLOWRATOR into the distillate cooler where the distillate is cooled by the incoming evaporator feed water. From the cooler, the distillate passes through the salinity cell which controls the THREE-WAY SOLENOID TRIP VALVE. Depending on the purity of the distillate as it passes through the last salinity cell, the three-way valve will direct the distillate to the bilge or to the ship's fresh water system or reserve feed system.

Air Ejector System

Air and other noncondensable vapor may enter the system dissolved in the feed water, and possibly by leakage at the various vacuum joints. These noncondensable gases are removed and the required vacuum is maintained at the second-stage distilling condenser by a TWO-STAGE AIR EJECTOR. The construction of the air ejector is shown in figure 13-21.

Steam for both stages of the ejector is supplied from a 150 psig steam line. The first stage of the ejector takes its suction from the coolest portion of the second-stage distilling condenser. The gases enter the inlet of the first-stage nozzle at the mixing chamber and are entrained by the steam flowing from the nozzle. The gases are carried through the diffuser and are discharged into the mixing chamber of the second-stage nozzle. The gases are again entrained by the steam flowing from the second-stage nozzle and are carried through the second-stage diffuser. From the second-stage diffuser the gases and steam are discharged into the AIR EJECTOR AFTER-CONDENSER. The steam is condensed by the evaporator feed water which flows through the condenser tubes. The condensate is discharged from the condenser shell, through a salinity cell, to the drain collecting system or to the bilge. The noncondensable gases are discharged to the atmosphere through the vent in the top of the condenser shell.

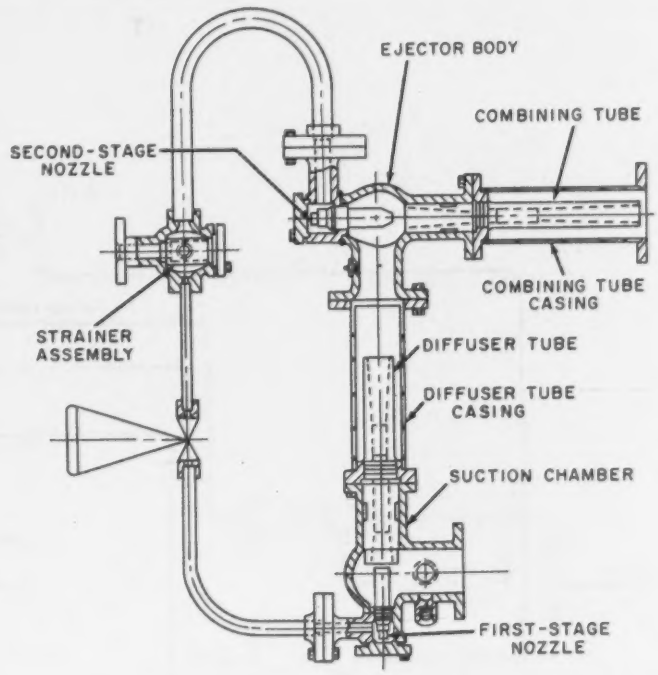

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Figure 13-21.—Two-stage air ejector.

FIVE-STAGE FLASH UNIT

The five-stage flash unit consists of five evaporator-condenser stages in a single shell. Passages and loop seals, between the stages, permit the flow of feed water and distillate, while preserving a different vacuum in each stage.

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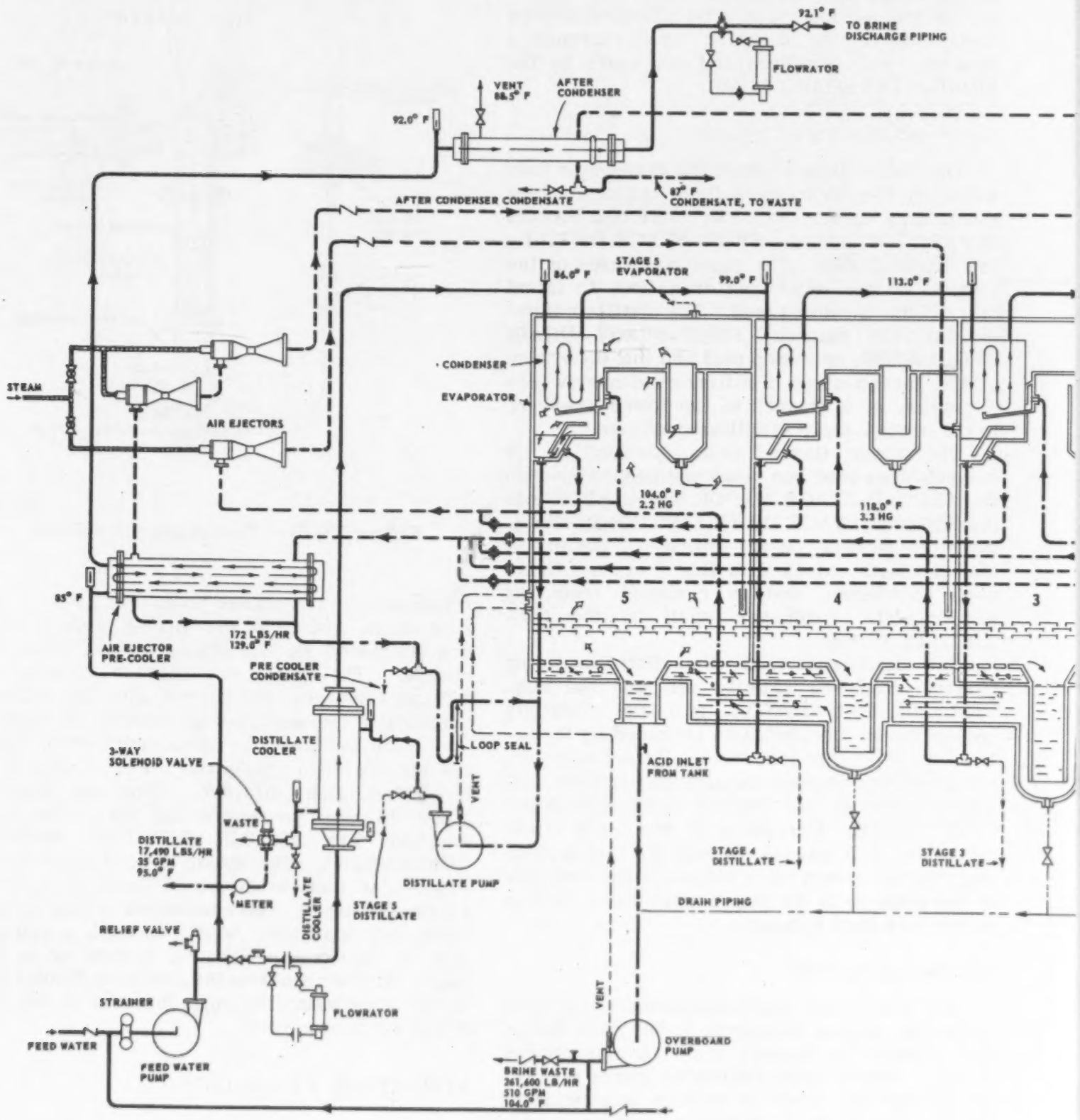
92.1° F
TO BRINE DISCHARGE PIPING
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VENT 88.5° F
AFTER CONDENSER
92.0° F
AFTER CONDENSER CONDENSATE
87° F
CONDENSATE, TO WASTE
STAGE 5 EVAPORATOR
86.0° F
99.0° F
113.0° F
CONDENSER
EVAPORATOR
STEAM
AIR EJECTORS
104.0° F
2.2 HG
118.0° F
3.3 HG
5
4
3
85° F
AIR EJECTOR PRE-COOLER
172 LBS/HR
129.0° F
PRE COOLER CONDENSATE
DISTILLATE COOLER
LOOP SEAL
VENT
3-WAY SOLENOID VALVE
ACID INLET FROM TANK
WASTE
DISTILLATE
17,490 LBS/HR
35 GPM
95.0° F
METER
DISTILLATE COOLER
STAGE 5 DISTILLATE
DISTILLATE PUMP
STAGE 4 DISTILLATE
STAGE 3 DISTILLATE
DRAIN PIPING
RELIEF VALVE
STRAINER
FLOWRATOR
FEED WATER
FEED WATER PUMP
VENT
OVERBOARD PUMP
BRINE WASTE
261,600 LB/HR
510 GPM
104.0° F

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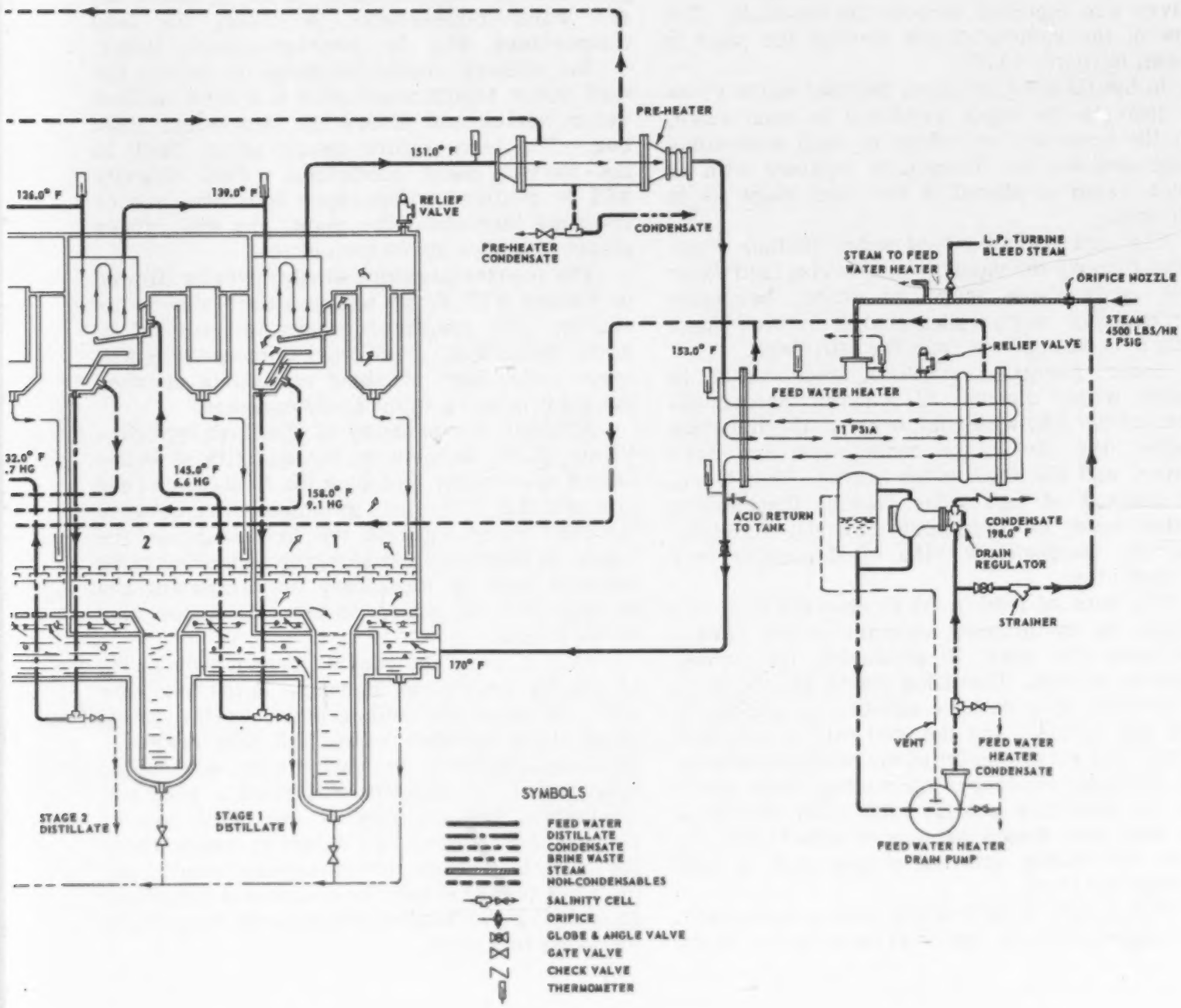

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Figure 13-22.—Flow diagram for a five-stage flash type distilling unit.

In most instances, the feed water heater, drain regulators, air ejectors, air ejector condensers, condensate coolers, interstage distillate drain regulators, feed and distillate flow regulators, and three-way solenoid dump valves are mounted directly on the shell. The flow of the various fluids through the plant is shown in figure 13-22.

In the flashing process, the feed water gives up heat to the vapor produced in each stage, but the pressure reduction in each succeeding stage enables the flashing to continue with as much vapor produced in the final stage as in the first.

The concentrated feed water (brine) overflows through the vacuum-preserving feed water loop seals from stage to stage, becoming increasingly more concentrated in each stage until it is pumped out from the fifth stage.

Under normal conditions, feed water is heated within the unit as it flows through the tubes of the following components: the distillate cooler, the five-stage condensers, the preheater, and the feed water heater. Therefore, the amount of feed water flowing through the heater must be regulated manually in order that the temperature rise of the water may be controlled.

The rate of feed to the first-stage inlet box should be maintained constant at all times, providing the plant is producing its normal capacity or less. Distilling plants are designed to operate at a definite number of gallons of feed per minute, and the feed rate is indicated by the feed rotameter(s) in the feed line between the distilling condenser circulating water pump and the distillate cooler. All other valves in the feed line should be opened wide to prevent their interfering with the proper flow of feed through the plant.

With proper feed flow and with a clean plant, the temperature of the feed entering the first-stage feed inlet box will be 175° or less, depending on the temperature of the sea water. Plants are designed to operate with a feed temperature of 175° maximum when the temperature of the sea water is 85° F; when the sea water temperature is lower, the feed temperature will be correspondingly lower.

No attempt should be made to control the feed water temperature after it leaves the feed water heater and enters the first-stage flash box. The temperature should adjust itself to the varying plant conditions. Full capacity will be realized with proper feed flow, proper vacuums throughout the plant, and with proper steam pressure above the orifice.

The feed temperature should never be allowed to exceed 175° F, as temperatures above this amount will greatly increase the amount of scale formation. Such high temperatures will occur under high overload conditions or when the plant is being improperly operated.

Although the capacity of the flash type distilling plant depends on the quantity of evaporator feed water entering the first-stage feed box and the difference in temperature between the feed water entering the first stage and the vapor in succeeding stages, the capacity can be changed only by increasing or decreasing the amount of heat added to the evaporator feed water heater.

With a constant steam pressure of 5 psig above the orifice, an increase in the feed flow will decrease the temperature in the first-stage flash chamber which will also decrease the temperature of the vapor in the succeeding stages and the capacity will remain constant. Therefore, the capacity of the plant can be changed by changing the steam pressure above the orifice. Except for emergency conditions, the plant should always be operated at its normal capacity as overload conditions tend to increase the scale formation.

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CHAPTER 14

DISTILLING PLANT OPERATION AND MAINTENANCE

Information dealing with the construction and principles of operation of distilling plants used by the Navy is given in chapter 13. This chapter deals with the operation and maintenance of distilling plants; these are important responsibilities of Machinist's Mates. The large quantities of pure fresh water required aboard ship make it impossible to store sufficient water for more than a few days' supply. With proper operation and maintenance, distilling plants can make adequate fresh water to supply the needs of the ship.

OPERATION

Careful starting, operating, and securing of distilling plants will, to a great extent, ensure trouble-free operation. Operating procedures, tests, inspections, and maintenance are discussed in the sections which follow.

STARTING A MANUALLY CONTROLLED PLANT

To start a low pressure submerged-tube distilling plant, when the evaporators are empty and all pumps are secured, proceed as follows:

1. Open the valves in the drain lines from the first-effect heat exchanger and from the air ejector condenser. Close the valves in the tube next drains on succeeding effects.

2. Open all valves in the circulating water suction and discharge lines, and start the distilling condenser circulating water pump. Open all air vents on the distilling condenser head and bleed out any entrapped air, closing these vent valves as soon as the air pockets are cleared. If the distillate cooler is fitted with vents on the sea water side, open these valves until all trapped air is freed.

3. Adjust the spring-loaded back-pressure valve in the circulating water overboard lines to maintain a pressure of approximately 5 psig in the feed system.

4. Open all valves in the evaporator feed system, except the valve in the leakoff line from the outlet of the air ejector condenser. Bypass valves around any heat exchangers should remain closed. If weir level controls are provided, raise the overflow weir pipes to the highest position.

5. Fill each evaporator shell up to the top of the heat exchanger. Start the evaporator feed pump, if installed. Open all vents provided at high points in the circulating water and evaporator feed lines until all entrapped air is bled out.

6. Secure the feed valves to the first effect and between effects to prevent water from siphoning into the last effect as the vacuum is obtained.

7. Open the valve in the emergency outboard line at the feed outlet from the air ejector condenser. See that the valves in the vent lines from the first-effect steam chest are closed tightly. (The steam chest vent lines on succeeding effects should be opened wide.)

8. Close all valves in the distillate pump discharge line and in the discharge line from the brine pump. In addition, close the gland sealing line to the brine pump.

9. Start the air ejector and see that the air vent from the shell of the air ejector condenser to the atmosphere is free from obstruction. Open the gate valve in the air suction line to the air ejector to be used. If a valve is provided at the discharge side of the air ejector, see that it is open. Admit high pressure steam to the air ejector nozzle, opening the steam valve wide. See that the steam line to the air ejector nozzle is properly drained. The pressure at the nozzle must be at least that specified on the air ejector nameplate, and the steam must be dry for satisfactory operation. The air valve to the air ejector not in use should be tightly closed.

10. Check the salinity of the distillate drains from the air ejector condenser. When less than 0.25 gpg (0.065 epm), shift drains from the bilges to the boiler feed system. A full vacuum of at least 26 inches Hg should exist in all evaporator shells. A failure to obtain this vacuum indicates possible air leaks which must be eliminated.

11. When certain that the system is tight, open the first-effect steam supply valve and adjust the regulating valve to provide the required pressure (5 psig) above the orifice plate, which should be installed between the regulating valve and the tube nest. (Weight-loaded valves are adjusted by adding or removing metal disks which are provided with the valve.)

12. If a first-effect heat exchanger drain pump is installed, proceed as follows:

a. Unlock the drain valve mechanism to give float operation, or close the bypass around the drain regulator.

b. When a distillate level appears in the drain regulator gage glass, open the valve (if installed) in the suction line to the drain pump and start the pump. See that the pump vent and gland sealing lines are open. If the drains to the bilges are installed ahead of the drain regulator, a water level may not appear in the drainer gage glass unless the valve in the bilge line is hand-regulated to obtain and hold a water level. If the water level continues to rise to the top of the drainer gage glass, check the speed of the pump, and check for air leakage, especially at the pump glands. Check the salinity of the tube nest drains, and when tests indicate that the drains are pure, open the drain pump discharge line to the low pressure drain main, and secure the line to the bilge.

c. Open the valve(s) venting the tube nest to the first-effect shell about one turn.

13. When a distillate level appears in the drain regulator gages on succeeding effects, open the discharge valve from each drainer so that the distilled water drains will be carried to the flash chamber.

14. When distillate appears in the last-effect flash chamber, start the distillate pump and open all valves in the discharge line from this pump to the test tank or solenoid operated bypass valve. The distillate pump vent and sealing water line valves should be open. If weir overflow pipes are provided, lower them to their operating positions.

15. When vapor starts passing into the distilling condenser, check the relative temperatures of the circulating water in and out of the distilling condenser. The difference should not exceed 20° F. If the difference is greater than 20° F, adjust the overboard discharge valve to increase the flow of cooling water.

16. When water appears in the gage glass on the test tank, open the valve draining the test tank to the bilge. If a solenoid bypass valve is installed, trip the valve lever so that the valve discharges to the bilge.

17. Open all valves in the brine overboard line except the brine pump discharge valve. Open the valve in the vent line between the brine pump suction and the last-effect shell, and the valve in the brine pump sealing line from the circulating or feed pump to the brine pump gland seal. Start the brine pump and open the bypass valve around the pump discharge valve about 1 1/2 turns. The brine overboard valve at the sea chest or at the connection to the circulating water overboard line should always be wide open during plant operation.

18. As the output of the plant increases, water levels in all shells will drop, the feed valves or weir level controls to each shell should be adjusted to the desired position, and all valves in the steam chest vent lines adjusted to their normal operating position (approximately one turn open). The valve in the emergency overboard line from the feed outlet of the air ejector condenser should be closed, and only opened when the first effect feed is shut off, or reduced in warm waters for decreased output. Opening this valve slightly, under these conditions, is necessary to obtain sufficient water through the condenser to condense the air ejector steam and prevent it from blowing through the open vent to the evaporator room.

19. Check the density of the brine pump discharge with the salinometer set and adjust the control valve until the density is less than 1.5 thirty-seconds. (Higher density tends to cause scaling and salting up of brine lines. Lower densities tend to decrease the plant capacity because of excess heat pumped overboard with the brine.)

20. After steady levels have been reached in each of the evaporator shells and the brine density is constant at 1.5 thirty-seconds, the quality of distilled water may be checked. First see that the salinity indicator electrical system is energized; the meter pointer should indicate zero on the scale with the selector switch in the OFF position. Select the specific cell location where a measurement is desired and turn the selector switch to the number of that cell given

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in the table of cell locations. Take the temperature of the water at that point, and turn the temperature compensator so that the dial indicates (to the nearest 5°) the temperature of the water passing over the salinity cell. (The meter indicates the salt content in epm of chloride or gpg of sea salt.)

21. When the purity of the distillate is satisfactory, open the valves to the fresh water pump and at the water meter. Start the fresh water pump and secure the valve in the line draining the test tank to the bilge. When, for any reason, the salinity indicator indicates higher than 0.25 gpg (.065 epm), immediately shift the distillate to the bilges.

Additional information concerning starting procedures for low pressure distilling plants can be obtained from either chapter 9580 (58) of the Naval Ships Technical Manual or the technical manual for the specific installation.

SECURING A MANUALLY CONTROLLED PLANT

The correct procedure for securing a manually controlled low pressure distilling plant begins by notifying the engineer officer of the watch that the evaporator plant is ready to be secured. In addition, it should be requested that the auxiliary exhaust and the air ejector steam supply lines, and the first-effect evaporator tube nest and the air ejector condenser drain lines be secured in the engineroom. When permission to secure has been received, proceed as follows:

1. Secure the valve in the steam line supplying the first-effect tube nest.
2. Secure the steam supply to the air ejector and close the air suction valve between the distilling condenser and the air ejector.
3. Secure the first-effect tube nest drain pump (when provided), and close the valves in the drain lines from the first-effect tube nest and from the air ejector condenser.
4. Secure the distillate pump, the fresh water pump, and the suction and discharge valves at these pumps.
5. Secure the valves around the water meter.
6. Open all valves, in the steam chest vent lines, wide to equalize the pressure in all the units of the distilling plant.
7. Allow the distilling condenser circulating water pump, the evaporator feed pump (when supplied), and the brine overboard pump to continue operating for approximately 15 minutes to cool the distilling plant.
8. Fill each evaporator shell until the water level is just above the top row of evaporator tubes, and secure the brine pump, the circulating water pump, and the evaporator feed pump (when supplied).
9. Close the suction and discharge valves for all pumps except the adjusting valve for the brine overboard density control.
10. Close all suction and overboard sea chest valves, and (if supplied) the valve in the brine line discharge into the circulating water overboard line.
11. Secure the feed valves to each evaporator shell.
12. Open the drain lines to the bilge, from the first-effect tube nest and from the air ejector condenser.
13. Secure the inlet and outlet valves to the drain regulators, and all valves in the vent lines into the shells from the tube nests and from the distillate, the brine, and the tube nest drain pumps.

STARTING AN AUTOMATICALLY CONTROLLED PLANT

To start an automatically controlled low pressure distilling plant, when the evaporators are empty and all pumps have been secured, proceed as follows:

1. Open wide all valves in the circulating water circuit from the sea suction to the overboard discharge.
2. Start the circulating pump. Pumps must not be run dry. Before starting any pump, make certain that the suction, vent, and gland seal valves (where provided) are open, and that the pump casing is full of water. On centrifugal pumps, leave the discharge valve closed until after the pump has been started.
3. See that the spring-loaded back-pressure valve is properly adjusted to maintain 5 psi in the discharge line from the distilling condenser.
4. Open all air vent cocks on the distilling condenser, vapor feed heater, and air ejector condenser heads until the air is expelled, then close the vent cocks.
5. If evaporator bundles are submerged, be sure that the first-effect feed valve is closed and that the overflow weir pipes are set at their highest position. If the bundles are not submerged, see that the weirs are at their highest position, open the feed valves until the tube nests are fully covered, and then close the feed valves.

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6. Open the valve in the emergency circulating water line from the air ejector condenser.

7. Open wide the second-effect evaporator tube-nest vent valve. The first-effect tube-nest vent valve should remain closed.

8. See that the first-effect tube nest and the air ejector condenser drains are directed only to the bilge, and not to the ship's tanks.

9. Open the air suction to the ejector. Open the steam supply to the ejector, making sure that the full pressure required (stamped on the nameplate) is available at the nozzle, and that the steam supply is properly drained.

10. Test the salinity of the air ejector condenser drain. When less than 0.25 gpg (0.065 epm), close the bilge drain and open the drain to the tank.

11. When the second-effect shell vacuum is about 16 inches, gradually open wide the first-effect tube-nest steam supply valve. Adjust the regulating valve to maintain a steady pressure of 5 psig. The last-effect shell vacuum should continue to increase to 26 inches or more.

12. When the distillate discharges from the first-effect drain line to the bilge, test for salinity. When satisfactory, close the bilge drain valve, set the drain valves to discharge the distillate to the return system, and open the first-effect tube-nest valve one full turn.

13. When distillate appears in the second-effect drain, see that the drain discharge valve is open, and then adjust the second-effect tube-nest vent valve to operating position (approximately one turn open).

14. When distillate appears in the flash chamber, be sure the distillate cooler discharge is directed to the bilge by manually tripping the solenoid-actuated valve. Then start the distillate pump. (The same point applies here as was given in step 2, with reference to starting a pump.)

15. The following steps should now be performed in fairly rapid sequence:

(a) Lower the overflow weir pipes to their operating positions.

(b) Start the brine pump and open all valves in its discharge line.

(c) If a loop seal of at least 8 feet has been provided in the feed line between effects, open wide the second-effect feed valve. Otherwise open it partially.

(d) Close the emergency circulating water overboard line from the air ejector condenser and open the first-effect feed valve.

16. When the salinity of the distillate leaving the distillate cooler is less than 0.25 gpg (0.065 epm), set the solenoid valve to discharge to the ship's tanks.

17. Open and adjust the feed-treatment injection valve or pump, if feed treatment is to be done.

18. After the plant is in operation about half an hour, check the density of the brine. If the density is more than 1.5 thirty-seconds, open wider the first-effect feed valves; if less than 1.5 thirty-seconds, close down on the valve. Repeat every half hour until two successive readings of 1.5 thirty-seconds are obtained. Then test at hourly intervals.

SECURING AN AUTOMATICALLY CONTROLLED PLANT

The correct procedure for securing an automatically controlled low pressure distilling plant begins by notifying the engineer officer of the watch that the evaporator plant is ready to be secured. When permission to secure has been received, proceed as follows:

1. Shut off the steam supply to the first-effect tube nest.

2. Close the first-effect tube-nest drain line to the return system, and open the drains to the bilge.

3. Close the first-effect tube-nest vent valve.

4. Close the air suction and steam supply valves to the air ejector.

5. Open wide the second-effect tube-nest vent valve.

6. Secure the distillate pump.

7. Raise the weir pipes, on both effects, to their highest positions and continue operation of the distilling condenser circulating water pump and brine overboard pump for 10 minutes or longer to cool off the distilling plants.

8. Secure the brine overboard pump.

9. When both tube nests are fully covered with water, secure the circulating pump.

10. Secure the suction and overboard sea chests.

11. Secure the feed valve to the first effect.

12. Close the air ejector and condenser drain lines to the return system and open the drains to the bilge.

13. Trip the solenoid valve in the distillate line to discharge to the bilge.

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WATCHSTANDING

Proper watchstanding requires the operator to constantly check pressures, temperatures, vacuum, and salinity. Installing automatic controls does not relieve the operator of the responsibility of attentive watchstanding. The most important tests and inspections performed by the MM3 or MM2 standing distilling plant watches are discussed in the section which follows.

DISTILLATE TESTING

The fresh water (distillate) produced must meet specified standards of chloride content and purity. To ensure that those standards are met, the distillate must be tested continuously. Chloride content and purity tests are accomplished by two methods: the electrical salinity test and the periodic chemical tests.

The results of distillate tests are expressed in terms of a unit called EQUIVALENTS PER MILLION (epm). However, before explaining epm, it will be easier if you understand a unit called PARTS PER MILLION (ppm).

PARTS PER MILLION is a weight-per-weight unit denoting the number of parts of a specified substance in a million parts of water. For example, 58.5 pounds of salt in 1 million pounds of water represents a concentration of 58.5 parts per million (ppm). Note, also, that 58.5 OUNCES of salt dissolved in 1 million OUNCES of water, or 58.5 TONS of salt dissolved in 1 million TONS of water represent the same concentration—58.5 ppm.

EQUIVALENTS PER MILLION can be defined as the number of equivalent parts of a substance per million parts of water. (The word "equivalent" refers to the chemical equivalent weight of a substance.) The chemical equivalent weight is different for each element or compound. The chemical equivalent weight of sodium chloride (common table salt) is 58.5. A solution containing 58.5 PARTS PER MILLION of this salt is said to contain 1 EQUIVALENT PER MILLION. If a substance has a chemical equivalent of 35.5, a solution of that substance containing 35.5 ppm is described as having a concentration of 1 epm.

Electrical Salinity Testing

Electrical salinity cells are installed throughout the distilling plant to maintain a constant check on the distilled water. An electrical salinity indicator consists of a number of electric salinity cells in various points in the plant—in the fresh water pump discharge, distillate pump discharge, tube-nest drain, and air ejector condenser drain—connected to a salinity indicator panel on a bulkhead near the plant.

Since the electrical resistance of a solution varies according to the amount of ionized salts in solution, it is possible to measure salinity by measuring the electrical resistance. The salinity indicator panel is equipped with an ammeter calibrated to read directly in either epm or grains per gallon (gpg). Since resistance also varies with temperature, a temperature-compensator must be set at a valve corresponding to the temperature of the solution.

When reading the dial of an electrical salinity indicator, be sure that you know what you are reading. Some salinity indicators are still calibrated in grains of sea salt per gallon (gpg). This unit is no longer used for reporting water analyses, so any reading taken in gpg must be converted to epm. Multiply the gpg (meter reading) by 0.261 to get the epm. For example, a meter reading of 0.75 grains of sea salt per gallon is equal to 0.75 X 0.261, or 0.196 epm.

To check an electrical salinity indicator for operation, proceed as follows:

1. Turn on the power to the indicator.
2. Set the temperature-compensator at 110° F.
3. Depress the test button and hold it down until the reading is taken.
4. Read the indicator. The reading should be approximately 1 grain. If the salinity indicator does not give a reading of 1 grain, the instrument is not correctly calibrated and should be checked by an I. C. Electrician.

Chemical Salinity Testing

A chemical salinity testing procedure must also be followed for every 50 gallons of distillate pumped into the measuring and testing tanks of the plant. This test is applied to samples of water drawn out through the test cocks of the tanks. Specific instructions for making the tests are generally posted on or near the water testing equipment cabinet provided in each evaporator space. The instructions may also be found in chapter 9560 (56) of the Naval Ships

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Technical Manual. The general procedure is as follows:

1. Rinse a 100-ml graduated cylinder with some of the water to be tested. Then fill the graduate to the 100-ml mark with distillate from the test tank, and pour it into a clean, dry casserole.
2. Add 5 drops of chloride indicator to the sample. The water should turn blue-violet or red, depending upon its alkalinity.
3. Using the nitric acid burette, add reagent nitric acid, one drop at a time, stirring continuously, until the violet or red color just disappears. (The water will probably be pale yellow.)
4. Now add exactly 1 ml more of reagent nitric acid.
5. Fill the mercuric nitrate burette and let it drain down to zero. Drain some to fill the burette to the tip. Then refill the burette.
6. Place the casserole under the mercuric nitrate burette and add reagent mercuric nitrate to the contents of the casserole. Stir continuously until a pale blue-violet color persists throughout the solution. (Add the mercuric nitrate at a fairly rapid rate at first, but add it very slowly—drop by drop—as the end point is approached.)
7. Read the burette. Take the reading from the BOTTOM of the MENISCUS (the curved surface of the liquid column). Since the sample size was 100 ml, and the burette factor is 0.25 epm of chloride per milliliter of mercuric nitrate solution, multiply the burette reading by the factor 0.25. For example, if the 100 ml water sample requires 1.75 ml of mercuric nitrate, the chloride concentration is 1.75 X 0.25, or 0.44 epm.

Test Periods And Chloride Limits

Chloride content can be determined either with the electrical salinity indicator or by the chemical method. Electrical salinity indicator readings should be checked frequently by the chemical method. Test periods and chloride limits for the various feed water constituents are as follows:

1. Distilling plant discharge to reserve feed tanks: each measuring tank is to be tested before it is discharged to the reserve feed tanks; the limit is 0.065 epm.
2. Condensate: main condensers, every 15 minutes while underway and every 30 minutes while standing by; auxiliary condensers, every 30 minutes; chloride limit is 0.05 epm.
3. Deaerating feed tanks and surge tanks in use: once each watch; chloride limit is 0.15 epm.
4. Reserve feed tanks: daily and for each tank just prior to being put in use; chloride limit is 0.25 epm.

The test periods and chloride limits mentioned are in accordance with chapter 9560 (56) of the Naval Ships Technical Manual.

CONTROL ORIFICE

Capacity control is maintained by means of an orifice in the steam supply line. The orifice controls the flow of steam to the first-effect tube nest. By maintaining a constant pressure (5 psig) above the orifice, the flow of steam into the tubes is kept constant. This results in a relatively constant distilling plant output. First-effect tube-nest vacuum automatically adjusts itself to provide the temperature difference required to condense the steam as fast as it enters.

Constant capacity is desirable because it helps to provide a uniformly pure product, and ease in control of water levels and brine density.

WEIGHT-LOADED REGULATING VALVE

A weight-loaded regulating valve is installed in the steam supply line to the first-effect evaporator. The purpose of this valve is to maintain the inlet steam pressure at approximately 5 psig above the orifice. To permit free movement of the valve piston, a vent is installed at the top of the valve body. During operation, this vent must be open at all times. On some new ships, the weight-loaded regulating valve is replaced by a diaphragm-operated control valve, actuated by an air pilot.

FEED LEVELS

The water level in each evaporator shell is controlled by hand-regulated feed valves or by overflow weirs. At the side of each evaporator shell you can check the level in the shell by examining the gage glass or looking through the sight glass. For most efficient evaporator operation, the tube bundles should be barely covered by the boiling brine.

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DESUPERHEATING OF STEAM SUPPLY

If the steam temperature below the orifice is less than 245° F, desuperheating is unnecessary. However, if the steam temperature below the orifice is above 245° F, desuperheating will be required. Desuperheating is accomplished by taking water from the first-effect tube-nest drain pump discharge and discharging through a nozzle in the steam line between the orifice and the first-effect tube nest. The desuperheating water should never be taken from the distilling plant distillate or the fresh water pump. It is likely that the entire boiler feed system will be contaminated if the distillate from the distilling plant becomes salty, since the first-effect coil drains are usually discharged into the deaerating feed tank.

The desuperheating water lowers the steam temperature to the temperature corresponding to the pressure that exists in the first-effect tube bundle.

FIRST-EFFECT TUBE-NEST VACUUM

There should be no perceptible change in the first-effect tube-nest vacuum in any one day's operation because of scale deposits on evaporator tubes. A sudden drop, or failure to obtain 14 to 16 inches of vacuum when the tubes are clean and the plant is operated at rated capacity is due to some other cause which can and must be eliminated. Do not assume, because the distilling plant output is not immediately affected, that the loss of first-effect tube-nest vacuum is not serious. No matter what the condition of the evaporator tubes, the first-effect tube-nest vacuum should be kept as high as possible. Otherwise more scale will form and the plant will have to be operated at higher temperatures. In addition, frequent cleaning will be required in order to maintain capacity.

LAST-EFFECT SHELL VACUUM

In operating the plant, it is necessary to maintain a constant last-effect shell vacuum, as a rapid fluctuation in this vacuum has a strong tendency to cause priming. It also is necessary to maintain the highest vacuum possible at all times to keep scale formation at a minimum and thus maintain capacity production for long periods without cleaning.

Obtaining maximum vacuum depends upon elimination of air leaks, proper operation of air ejectors, sufficient flow of circulating water, and the effectiveness of the heat transfer surfaces in the distilling condensers.

AIR EJECTORS

The air ejectors require very little attention during distilling plant operation. In a tight plant, only one air ejector is required to maintain a vacuum of at least 26.5 inches at the air ejector suction.

The air ejector operating pressure, stamped on the nameplate, is the minimum pressure required at the nozzle. Allowance must be made for a pressure drop in the line, through the strainer, when setting the air ejector steam reducing valve. A pressure at the nozzle, slightly higher than the minimum specified, is not objectionable unless it causes overheating of the air ejector condenser.

A low vacuum may be due to faulty operation of the ejector, but is more often due to air leakage. An unsteady vacuum, however, almost invariably indicates difficulty at the ejector. The most frequent causes are insufficient steam pressure and wet steam. A clogged strainer or nozzle may also be responsible.

VENTING EVAPORATOR TUBE NESTS

Proper venting of evaporator tube nests is very important. During normal operation of a low pressure plant, all vents leading from the steam heads to the evaporator shell should be open. When all systems of a distilling plant are operating at approximately normal temperatures and pressures, the vent valves should be adjusted so that they are open about one turn. The amount of valve opening may vary from plant to plant; therefore, the actual setting must be determined by operating experience with a particular plant.

The result of improper venting of the evaporator tube nests may be either an accumulation of air in the tubes, with a resultant loss of capacity, or an excessive loss of tube nest steam to the distilling condenser, with a loss of efficiency.

BRINE CONCENTRATION

Although the salt concentration of sea water is not always the same, the average is generally

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accepted as being 1 part in 32—that is, 1 pound of dissolved salts is contained in 32 pounds of sea water. As sea water is vaporized in the distilling plant, the proportion of dissolved salts becomes greater in the remaining solution. The brine concentration in the last-effect shell should be kept at 1.5 thirty-seconds—that is, there are 1.5 pounds of dissolved salts in 32 pounds of brine.

The concentration (density) of brine in the evaporator, within limits, has a direct bearing on the quality of the fresh water distilled by the plant. Since the varying quantities of brine that are discharged overboard affect the operating conditions of the plant, it is desirable to keep the quantity of brine discharged and the brine concentration in the last-effect shell as constant as possible. If the brine concentration is too low, there will be a loss in capacity and economy, and it will be difficult to obtain proper feeding. If the brine concentration is too high, there will be an increase in the rate of scaling of the evaporator tubes, and the quality of the distillate may be impaired. The brine concentration depends mainly on the quantity of brine pumped overboard and the quantity of fresh water being produced. The brine concentration should be checked frequently during each watch (usually at intervals of 1 hour).

The brine density is measured by a SALINOMETER (fig. 14-1), calibrated to read directly in thirty-seconds. The salinometer has four separate scales which indicate the salinity of the brine at four different temperatures—110°, 115°, 120°, and 125° F.

Samples of the brine are usually obtained through a sampling cock at the brine overboard pump discharge. It is important to obtain a sample truly representative of the brine in the last-effect shell. The temperature of the sample drawn into the sampling pot should agree closely with the reading of the thermometer on the last-effect shell. A difference of more than 3° or 4° F usually indicates faulty operation of the brine overboard pump, or dilution of the brine between the last-effect shell and the sampling cock.

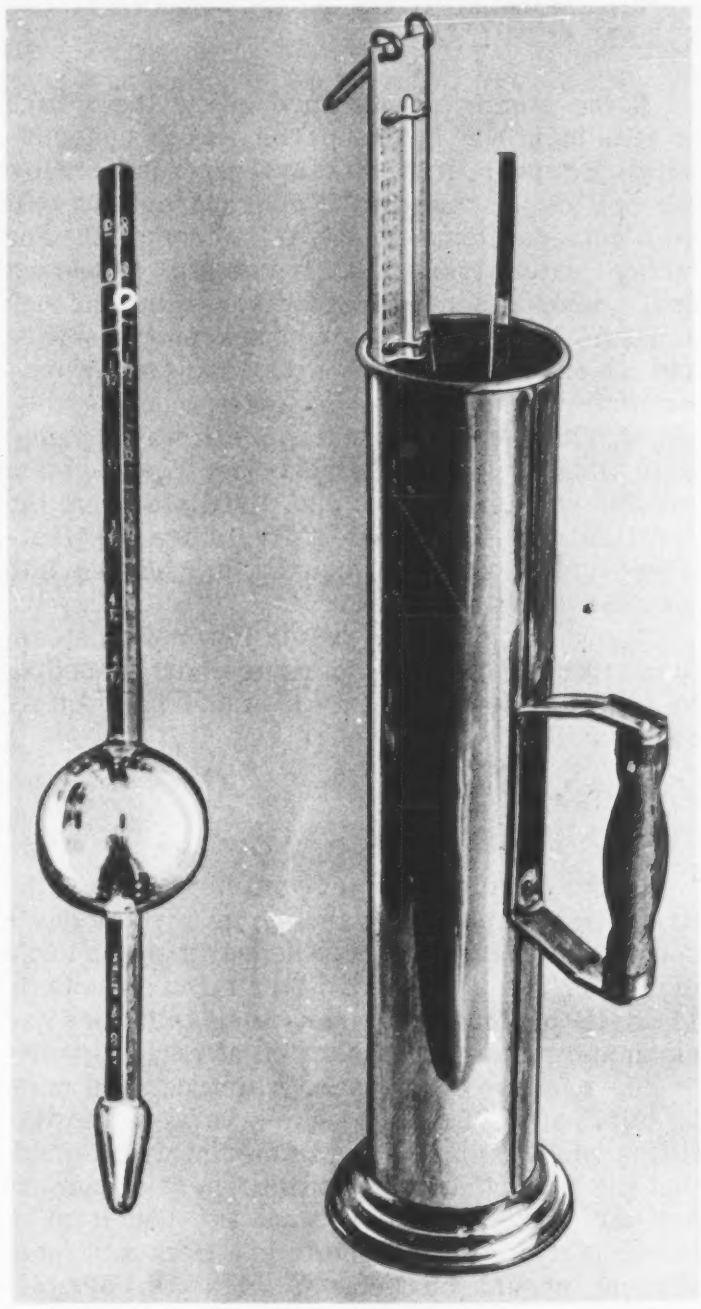

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Figure 14-1.—Salinometer and sampling pot.

OPERATING RECORD

The Distilling Plant Operating Record (figs. 14-2 and 14-3) is a daily record of the operation of the ship's evaporators and their auxiliaries. Entries are made for each hour of the watch while the distilling plants are in operation. Different ships have different types of distilling plants, but all of the daily distilling plant operating records require practically the same data. The record form illustrated is used primarily for single shell evaporators on destroyers and destroyer escorts.

The information required by this record consists of the following:

1. Feed water injection temperature.
2. Auxiliary exhaust steam pressure to the reducing valve or orifice.

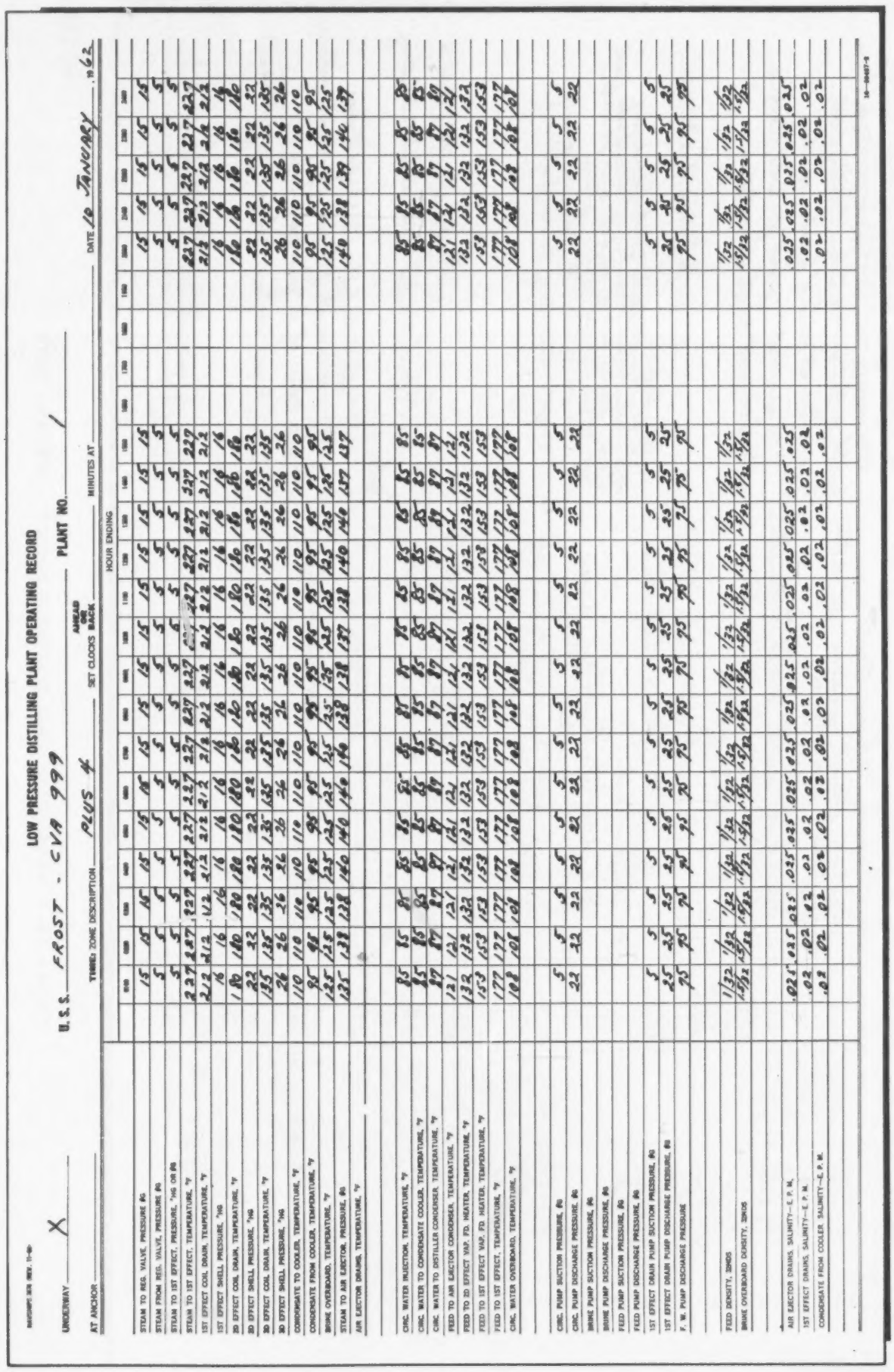

LOW PRESSURE DISTILLING PLANT OPERATING RECORD

UNDERWAY X U.S.S. FROST - CVA 999 PLANT NO. 1

AT ANCHOR

TIME ZONE DESCRIPTION PLUS 4 SET CLOCKS AHEAD OR BACK

MINUTES AT 1 DATE 10 JANUARY 1962

HOUR ENDING

	000	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300
STEAM TO REG. VALVE, PRESSURE #G	15	15	15	15	15	15	15	15	15	15	15	15	15	15
STEAM FROM REG. VALVE, PRESSURE #G	5	5	5	5	5	5	5	5	5	5	5	5	5	5
STEAM TO 1ST EFFECT, PRESSURE, "HG OR #G	5	5	5	5	5	5	5	5	5	5	5	5	5	5
STEAM TO 1ST EFFECT, TEMPERATURE, °F	227	227	227	227	227	227	227	227	227	227	227	227	227	227
1ST EFFECT COIL DRAIN, TEMPERATURE, °F	212	212	212	212	212	212	212	212	212	212	212	212	212	212
1ST EFFECT SHELL PRESSURE, "HG	16	16	16	16	16	16	16	16	16	16	16	16	16	16
2D EFFECT COIL DRAIN, TEMPERATURE, °F	180	180	180	180	180	180	180	180	180	180	180	180	180	180
2D EFFECT SHELL PRESSURE, "HG	22	22	22	22	22	22	22	22	22	22	22	22	22	22
3D EFFECT COIL DRAIN, TEMPERATURE, °F	135	135	135	135	135	135	135	135	135	135	135	135	135	135
3D EFFECT SHELL PRESSURE, "HG	26	26	26	26	26	26	26	26	26	26	26	26	26	26
CONDENSATE TO COOLER, TEMPERATURE, °F	110	110	110	110	110	110	110	110	110	110	110	110	110	110
CONDENSATE FROM COOLER, TEMPERATURE, °F	85	85	85	85	85	85	85	85	85	85	85	85	85	85
BRINE OVERBOARD, TEMPERATURE, °F	125	125	125	125	125	125	125	125	125	125	125	125	125	125
STEAM TO AIR EJECTOR, PRESSURE, #G	135	138	138	140	140	140	140	138	138	137	138	140	140	137
AIR EJECTOR DRAINS, TEMPERATURE, °F														
CIRC. WATER INJECTION, TEMPERATURE, °F	85	85	85	85	85	85	85	85	85	85	85	85	85	85
CIRC. WATER TO CONDENSATE COOLER, TEMPERATURE, °F	85	85	85	85	85	85	85	85	85	85	85	85	85	85
CIRC. WATER TO DISTILLER CONDENSER, TEMPERATURE, °F	87	87	87	87	87	87	87	87	87	87	87	87	87	87
FEED TO AIR EJECTOR CONDENSER, TEMPERATURE, °F	121	121	121	121	121	121	121	121	121	121	121	121	121	121
FEED TO 2D EFFECT VAP. FD. HEATER, TEMPERATURE, °F	132	132	132	132	132	132	132	132	132	132	132	132	132	132
FEED TO 1ST EFFECT VAP. FD. HEATER, TEMPERATURE, °F	153	153	153	153	153	153	153	153	153	153	153	153	153	153
FEED TO 1ST EFFECT, TEMPERATURE, °F	177	177	177	177	177	177	177	177	177	177	177	177	177	177
CIRC. WATER OVERBOARD, TEMPERATURE, °F	108	108	108	108	108	108	108	108	108	108	108	108	108	108
CIRC. PUMP SUCTION PRESSURE, #G	5	5	5	5	5	5	5	5	5	5	5	5	5	5
CIRC. PUMP DISCHARGE PRESSURE, #G	22	22	22	22	22	22	22	22	22	22	22	22	22	22
BRINE PUMP SUCTION PRESSURE, #G														
BRINE PUMP DISCHARGE PRESSURE, #G														
FEED PUMP SUCTION PRESSURE, #G														
FEED PUMP DISCHARGE PRESSURE, #G														
1ST EFFECT DRAIN PUMP SUCTION PRESSURE, #G	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1ST EFFECT DRAIN PUMP DISCHARGE PRESSURE, #G	25	25	25	25	25	25	25	25	25	25	25	25	25	25
F. W. PUMP DISCHARGE PRESSURE	75	75	75	75	75	75	75	75	75	75	75	75	75	75
FEED DENSITY, 32MS	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
BRINE OVERBOARD DENSITY, 32MS	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32
AIR EJECTOR DRAINS, SALINITY—E. P. M.	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025
1ST EFFECT DRAINS, SALINITY—E. P. M.	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
CONDENSATE FROM COOLER, SALINITY—E. P. M.	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
STEAM TO REG. VALVE, PRESSURE #G	15	15	15	15	15	15	15	15	15	15
STEAM FROM REG. VALVE, PRESSURE #G	5	5	5	5	5	5	5	5	5	5
STEAM TO 1ST EFFECT, PRESSURE, "HG OR #G	5	5	5	5	5	5	5	5	5	5
STEAM TO 1ST EFFECT, TEMPERATURE, °F	227	227	227	227	227	227	227	227	227	227
1ST EFFECT COIL DRAIN, TEMPERATURE, °F	212	212	212	212	212	212	212	212	212	212
1ST EFFECT SHELL PRESSURE, "HG	16	16	16	16	16	16	16	16	16	16
2D EFFECT COIL DRAIN, TEMPERATURE, °F	180	180	180	180	180	180	180	180	180	180
2D EFFECT SHELL PRESSURE, "HG	22	22	22	22	22	22	22	22	22	22
3D EFFECT COIL DRAIN, TEMPERATURE, °F	135	135	135	135	135	135	135	135	135	135
3D EFFECT SHELL PRESSURE, "HG	26	26	26	26	26	26	26	26	26	26
CONDENSATE TO COOLER, TEMPERATURE, °F	110	110	110	110	110	110	110	110	110	110
CONDENSATE FROM COOLER, TEMPERATURE, °F	85	85	85	85	85	85	85	85	85	85
BRINE OVERBOARD, TEMPERATURE, °F	125	125	125	125	125	125	125	125	125	125
STEAM TO AIR EJECTOR, PRESSURE, #G	137	137	140	140	138	139	138	140	140	139
AIR EJECTOR DRAINS, TEMPERATURE, °F										
CIRC. WATER INJECTION, TEMPERATURE, °F	85	85	85	85	85	85	85	85	85	85
CIRC. WATER TO CONDENSATE COOLER, TEMPERATURE, °F	85	85	85	85	85	85	85	85	85	85
CIRC. WATER TO DISTILLER CONDENSER, TEMPERATURE, °F	87	87	87	87	87	87	87	87	87	87
FEED TO AIR EJECTOR CONDENSER, TEMPERATURE, °F	121	121	121	121	121	121	121	121	121	121
FEED TO 2D EFFECT VAP. FD. HEATER, TEMPERATURE, °F	132	132	132	132	132	132	132	132	132	132
FEED TO 1ST EFFECT VAP. FD. HEATER, TEMPERATURE, °F	153	153	153	153	153	153	153	153	153	153
FEED TO 1ST EFFECT, TEMPERATURE, °F	177	177	177	177	177	177	177	177	177	177
CIRC. WATER OVERBOARD, TEMPERATURE, °F	108	108	108	108	108	108	108	108	108	108
CIRC. PUMP SUCTION PRESSURE, #G	5	5	5	5	5	5	5	5	5	5
CIRC. PUMP DISCHARGE PRESSURE, #G	22	22	22	22	22	22	22	22	22	22
BRINE PUMP SUCTION PRESSURE, #G										
BRINE PUMP DISCHARGE PRESSURE, #G										
FEED PUMP SUCTION PRESSURE, #G										
FEED PUMP DISCHARGE PRESSURE, #G										
1ST EFFECT DRAIN PUMP SUCTION PRESSURE, #G	5	5	5	5	5	5	5	5	5	5
1ST EFFECT DRAIN PUMP DISCHARGE PRESSURE, #G	25	25	25	25	25	25	25	25	25	25
F. W. PUMP DISCHARGE PRESSURE	75	75	75	75	75	75	75	75	75	75
FEED DENSITY, 32MS	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
BRINE OVERBOARD DENSITY, 32MS	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32	1-5/32
AIR EJECTOR DRAINS, SALINITY—E. P. M.	.025	.025	.025	.025	.025	.025	.025	.025	.025	.025
1ST EFFECT DRAINS, SALINITY—E. P. M.	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
CONDENSATE FROM COOLER, SALINITY—E. P. M.	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

47.137.1

Figure 14-2.—Distilling plant operating record: data page.

APD2545

DISTILLED WATER RECORD

HOUR ENDING	METER READING	GALLONS: SHIPS TANKS*	GALLONS: FEED TANKS*
0000	1254000		
0100	1256050	2050	
0200	1258100	2050	
0300	1260200	2100	
0400	1262250	2050	
0500	1264350	2100	
0600	1266450	2100	
0700	1268500		2050
0800	1270600		2100
0900	1272650		2050
1000	1274700		2050
1100	1276800		
1200	1278850		
1300	1280900		
1400	1282940		
1500	1284970		
1600			
1700			
1800			
1900			
2000	1287070	2100	
2100	1289170	2100	
2200	1291250	2080	
2300	1293350	2100	
2400	1295430	2080	

* Indicate under REMARKS number of tanks being filled.

SCALING RECORD

	EFFECT NO. 1	EFFECT NO. 2	EFFECT NO. 3
DATE LAST SCALED	6 Jan '56	7 Jan '56	8 Jan '56
HOURS BROUGHT FORWARD	175	175	175
HOURS THIS DATE	20	20	20
HOURS TO DATE	195	195	195
GALLONS BROUGHT FORWARD	123,850	123,850	123,850
GALLONS THIS DATE	42,430	42,430	42,430
GALLONS TO DATE	166,280	166,280	166,280

CHECKED (Signature) Irving Birnbaum, LT, USN

APPROVED Harold Witala LCDR, USN
(Engineer Officer, U. S. N.)

REMARKS

0000-0800

#1 distilling plant in operation, distilling to ships tanks.
Feeding starch mixture at rate of 2 gals. per hour.
0200 mixed new batch in accordance with posted instructions.
Carried out routine distilling plant watch.

SIGNED Sargent, M., MM3

0800-1200

As before #1 plant distilling to ships tanks.
1400 mixed new batch of starch in accordance with posted instructions. Feeding starch mixture at rate of 2 gals per hr.
1500 secured #1 plant for cold shocking.
Carried out routine watch

SIGNED Johnson, L. MM2

1200-1600

As before #1 plant distilling to ships tanks.
0700 shifted distilling from ships tanks to feed tanks.
Carried out routine tests of inspections.

SIGNED Bowers, H., MM2

1600-2000

As before.
1630 completed cold shocking.
Removed hand hole plate from first effect scale trap, raked out scale. Replaced hand hole plate.
1730 started #1 distilling plant.
1800 #1 distilling to ships tanks.

SIGNED Lineberger, M., MM3

2000-2400

As before #1 plant distilling to feed tanks.
1100 shifted distilling from feed tanks to ships tanks.
Made routine test and inspections.

SIGNED Wilson, H., MM3

2000-2400

As before except 2000 started #1 distilling plant.
2030 #1 plant distilling to ships tanks.
2100 commenced feeding corn starch mixture at the rate of 2 gals per hours.
Carried out routine test and inspections.

SIGNED McMurray, J., MM2

NAVSHIPS 3576 (REV. 11-50) BACK — U. S. GOVERNMENT PRINTING OFFICE 30—00007-1 — Stocked in CDS — For disposal of this record see current Records Disposal Instructions for Vessels of the U. S. Navy.

47.137.2

Figure 14-3.—Distilling plant operating record: remarks page.

GPO 125546

3. Coil pressure, coil drain temperature, shell vacuum, and feed water temperature for each evaporator effect unit.

4. Steam inlet pressure, suction temperature, and suction vacuum of the air ejector for each evaporator unit.

5. Distillate circulating pump discharge pressure and temperature for each evaporator unit.

6. Brine temperature and density (measured in thirty-seconds) through the brine pump of each evaporator unit.

7. Meter reading for flow of fresh water distillate, quantity of distilled water produced, both chemical and electrical salinity measurement of the distilled water, and whether the water was piped to the ship's tanks or the feed bottoms.

8. Scaling record for each evaporator unit, which includes the date of last scaling, and the hours operated and the quantity of distilled water produced since the last scaling to the day of record, on the day of record, and since the last scaling to the end of the day of record.

9. Time of starting and securing and the total operating time for the day for each evaporator and each unit of auxiliary machinery, including air ejectors, distillate circulating pumps, brine pumps, feed water pumps, fresh water pumps, and coil drain pumps.

10. Remarks (fig. 14-3) concerning the distilling plant operation and maintenance for each watch of the day.

It is absolutely essential that you make accurate entries in the Distilling Plant Operating Record. Accurate entries not only help predict troubles but, should abnormal operating conditions suddenly develop, checking previous entries will aid in locating the sources of trouble.

MAINTENANCE OF LOW PRESSURE DISTILLING PLANTS

The full output of a distilling plant can be maintained for relatively long periods without interruption only if every part of the plant is kept in proper operating condition. This can be accomplished by periodic tests, inspections, cleaning, and maintenance. No strict schedule can be set up but experience with a particular installation may indicate the frequency of testing, inspecting, cleaning, and maintenance required for the unit. The following are some of these maintenance procedures and the approximate frequency required.

CARE OF HEAT EXCHANGER SURFACES

The output of the low pressure submerged tube distilling plant is not reduced appreciably by scale deposits on the evaporator tubes until the deposits have caused a reduction in first-effect tube-nest vacuum to 1 or 2 inches of mercury. When the first-effect tube-nest vacuum is lost entirely, the reduction in output becomes very great. Assuming the reduction in vacuum is due to scale, and is not the result of improper operating conditions, the evaporator tubes MUST be cleaned when the tube nest vacuum approaches zero. To maintain adequate output the tubes SHOULD be cleaned when the first-effect tube-nest vacuum falls below 3 inches of mercury.

When the plant is properly operated, and when the evaporator feed is treated, the interval between cleanings should be 6 months or more.

Salt water flows inside the distilling condenser tubes, air ejector condenser, and vapor feed heaters. Under some operating conditions, scale deposits may accumulate inside these tubes, particularly in the air ejector condenser and the first-effect feed heater. Every 6 months, or whenever the plant is secured for descaling evaporator tubes, the inside surfaces of these heat exchanger tubes should be inspected and cleaned if necessary. Neglect can lead to thick scale deposits which will be difficult to remove.

Scale Formation and Prevention

Very little hard scale should form in a distilling plant using sea water for feed if: feed water distribution is proper, steam pressure above the orifice is not more than 5 psi, a high vacuum is maintained, and the density of the brine overboard is not over 1.5 thirty-seconds.

During normal operating conditions, scale deposits will form at a certain rate on the distilling plant evaporator tubes. The rate of scaling depends upon the concentration of suspended matter and carbonates present in the sea or fresh water used to feed the distilling plant. However, the important point to remember is that excessive scaling of the evaporator tubes can be caused by improper operation of the distilling plant.

The scale deposits increase as the density of the brine in the last-effect shell increases. The brine concentration is dependent mainly upon the quantity of brine pumped overboard

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and upon the amount of fresh water produced. If the brine concentration is too high, there will be an increase in the rate of scaling of the evaporator tubes, and the quality of the distillate may be impaired.

To retard the formation of scale on evaporator tubes and to minimize priming, solutions are continuously injected into the evaporators.

A chemical compound known as HAGEVAP replaces cornstarch and boiler compound for the treatment of evaporator feed water and has been accepted as the Navy standard feed treatment compound. Hagevap has proved to be superior because of its ability to prevent the formation of scale. The use of Hagevap increases the production of distilled water by decreasing the amount of time that plants must be shut down for cold shocking and scale removal.

Hagevap is composed of polyphosphates, lignins, and antifoam agents. The polyphosphates combine with the scale-forming particles in sea water, while the lignins keep the resulting solids dispersed and suspended. The antifoaming agents prevent foaming and help prevent scale.

Proportioning pump and tank assemblies, available from ship's parts supply segment of the naval supply system, consist of a 30-gallon mixing tank having a capacity of 24 gallons from top to bottom of the gage glass and a simplex or duplex proportioning pump having a maximum capacity of 2.5 gallons per hour per pump. Assemblies obtained directly from a shipyard may differ in the capacity of tank and/or pump. Installation instructions in the form of SHIPALTS have been issued for all classes of ships having low pressure submerged tube or vertical basket type distilling plants installed. The required amount of Hagevap should be dissolved, by stirring, in a bucket of warm water at a temperature not to exceed 100° F. This concentrated solution is dumped into the 30-gallon mixing tank, enough cold water is added to dilute the solution to a total of 24 gallons, then the mixture should be stirred thoroughly to ensure a uniform solution. This mixing and dilution can be carried out while the pump continues to deliver Hagevap to the operating evaporator.

The simplex pump consists of one pump and one motor. The duplex pump consists of two pumps, driven by one motor, served by the same mixing tank. Duplex pumps may serve two distilling plants ONLY when the two plants have the same design distillate capacity and when these two distilling plants are located in the same compartment. In all other cases simplex pumps must be installed.

With either the simplex or duplex pump, the length of the stroke determines the pump capacity. The stroke is adjusted but is never set at less than 20 percent, as accuracy of the injection rate and lubrication of the pump plunger will be affected. If possible, the pump stroke (or strokes on a duplex pump) should be set to empty the mixing tank, from the top to the bottom of the gage glass, in exactly 24 hours. If this rate of injection should require a pump stroke of less than 20 percent, then the stroke should be set to empty the tank in less than 24 hours, preferably in 12 or 8 hours to enable easy establishment of a routine for refilling. However, if the time is 12 hours the solution will contain only half the amount of Hagevap required for a 24-hour period, and the tank must be filled twice a day. If the period of time for emptying the mixing tank is 8 hours, the solution will contain only 1/2 the required daily amount, and the tank must be filled three times each day.

If the pump stroke must be changed, the setting can be made from the indicator scale mounted on the crank arm, and verified by checking the amount of time required to empty the mixing tank. The indicator scale is calibrated from 0 to 10. If the pump has a maximum capacity of 7 gph, setting the indicator pointer on 5 will result in a delivery of 3 1/2 gph. To change the stroke, stop the pump and loosen the crankpin locknut. Watch the pointer on the indicator scale and turn the adjusting screw the required amount. Tighten the crankpin locknut and restart the pump. Check the time required to empty the tank and reset the pump stroke if necessary.

A vacuum drag injection line, used when the proportioner pump fails, runs from the mixing tank to a point downstream (vacuum side) of the feed control valve. A needle valve is installed in the line to allow the operator to make relatively fine adjustments in the amount of solution allowed to flow into the evaporator.

For submerged tube and basket type distilling plants, Hagevap should be injected into the evaporator feed system at a rate not to exceed 1 pound per 10,000 gallons per day distilling plant output. This rate of injection is required during the entire time the plant is in operation. A 4,000-gpd plant requires 4/10 of a pound for a 24-hour period. Two 12,000-gpd plants require the same quantity as a 24,000-gpd plant, or 2.4 pounds per day.

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The injection rate of 1 pound per 10,000 gallons per day is a maximum figure; the most effective figure will probably be closer to 3/4 pound. The best figure can be arrived at by reducing the amount of Hagevap for each batch. Each mixture should be tried for a week and if no scale is found on the evaporator tubes the amount of Hagevap can be reduced further. If scale forms during this trial, it will gradually crack off when the proper injection rate is established. The brine overboard density should always remain at 1.5 thirty-seconds as the density will influence the effectiveness of the Hagevap.

Hagevap feed treatment is not necessary for scale prevention in 2-stage flash type distilling plants, but the treatment has proven beneficial for units with more than two stages. In a 50,000-gpd flash type distilling plant, 6.0 pounds of Hagevap should be injected per 24-hour period.

The effectiveness of the Hagevap treatment can be checked by observing the shell temperature in the feed water heater. Changes in the shell temperature, with the same rate of flow, indicates changes in the resistance in the heat path between the steam and the feed water. Increases in the shell temperature indicate a buildup of either scale or Hagevap sludge.

In accordance with the Planned Maintenance System, the mixing tank should be drained to the bilges and flushed out with fresh water at least once each week, or more often if necessary, to prevent sludge from accumulating in the tank.

Scale Removal

As previously stated in this chapter, the evaporator tubes of a submerged tube type unit MUST be cleaned when the first-effect tube-nest vacuum approaches zero. The vertical basket type unit should be cleaned when it becomes necessary to use a steam pressure of 4 psig, or more, in the first-effect steam chest, to produce rated capacity. The flash type unit will require cleaning when it becomes necessary to use a steam pressure of 4 psig in the evaporator feed water heater. Assuming these reductions in capacity are due to scale and not the results of improper operation, an approved cleaning method should be used to remove the scale. The following are some of the approved scale removal methods:

CHILL SHOCKING.—The first-effect tube nest, in which the temperature of the tube nest is near that of the steam supply, tends to scale up more quickly than other parts of the plant. To combat this scale, some method of CHILL SHOCKING (COLD SHOCKING) the tubes is generally provided. This is done by draining the brine from all shells, then reflooding them by means of a hose line connected to a flushing pipe or flooding connection on the shell. This reflooding chills the tube nest bundles. Steam is then quickly admitted into the tubes, causing differential expansion and contraction to take place, which breaks the scale loose from the tubes.

If a feed treatment is not used, the distilling plant should be chill shocked daily. If the Navy standard feed treatment is used, daily chill shocking may be desirable; however, longer intervals are satisfactory.

Submerged Tube Type.—Chill shocking on a submerged tube type evaporator is performed as follows:

1. Secure the steam supply to the first-effect tube nest, the tube-nest drain pump and its discharge valve, the distillate pump, and the fresh water pump.
2. Open the emergency circulating water overboard valve at the outlet from the air ejector condenser and secure the first-effect feed valve.
3. Open wide all interstage feed valves. In plants which have shell drain or pump-out lines connected to the brine pump suction, unlock and open wide the valves in these lines.
4. Pump out the brine from all evaporator shells.
5. Connect a hose line to the flushing pipe or flooding connection.
6. Open the hose (water supply) valve to spray or flood the evaporator shells until the tubes in all evaporator shells are fully submerged.
7. Secure the hose valve and again pump out all evaporator shells.
8. Flood all shells again until the tubes in all shells are submerged. This second flooding is to lower the tube bundle temperature as much as possible. When the tubes are fully submerged, secure the hose valve and open quickly the steam supply valve to the first-effect tube nest. The flow of steam will be restricted somewhat by the orifice, if installed, and should be increased by loading the weight-loaded regulating valve to produce not more than 10 psig pressure above the orifice. After the plant has warmed up, the pressure should be cut back to normal.

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9. Start the pumps and regulate the water levels as necessary to put the plant in steady operation.

10. If the plant is one of the earlier installations which have chill shocking and spraying water supply from the fire and flushing main, disconnect the hose line from the flooding or flushing connection to protect the evaporator shells from possible excessive pressure. Such installations should be changed to utilize the distilling condenser circulating pump discharge at the earliest opportunity.

Handhole plates are provided on the bottom of the evaporator shells for the removal of scale which has flaked off the tubes.

Vertical Basket Type.—Scale forms on the outside of the corrugations of the vertical basket-type evaporator. The scale can be removed by cold shocking. Drain the shell and admit low pressure steam into the basket. This expands the corrugations and also dries the scale, thus making the scale brittle. Turn off the steam and admit sea water into the shell until the basket is covered by the sea water. Condensation of the steam in the basket creates a vacuum and the differential pressure causes the corrugations to contract. This loosens the scale which drops to the bottom of the shell. Clean-out holes near the bottom of the shell can be opened for removal of the scale particles.

The first effect, which has the most scale formation, is usually cold shocked about every 75 hours. Subsequent effects should be cold shocked at double this interval or more. In the case of a quadruple-effect unit, the fourth effect will probably require cold shocking only once or twice a year.

MECHANICAL CLEANING.—The capacity of a distilling plant is not appreciably reduced by scale deposits on the EVAPORATOR TUBES until the deposits have caused the first-effect vacuum to be reduced to 1 or 2 inches of mercury. When scale deposits cause the vacuum to approach zero, the tubes MUST be cleaned to keep the plant operating at its maximum efficiency. When the plant is properly operated and the feed water is treated, the interval between cleanings should be about 6 months. The evaporator tube nest must be withdrawn from the shell for the cleaning. Lifting gear suitable to the type of installation is usually provided to facilitate removing the tube nest.

Submerged Tube Type.—Some evaporators or distilling plants are provided with an overhead trolley from which the tube nest may be suspended for cleaning. Another type is provided with tracks and roller brackets which bolt to the front head of the tube nest. Chain falls can be used to handle the tube nest in small installations.

When the tube nest is withdrawn beyond the support plate, the tube-nest stop should be bolted in place to prevent accidental dropping of the rear head. The tubes are cleaned with a light scaling tool operated by a light air hammer. It should be held against the tube with moderate pressure, and moved over the entire length of the tube. Every tube in the nest must be cleaned, as missing one will impair the output of the plant and also make cleaning more difficult in the future.

A torch should never be used for descaling a tube nest made up of straight tubes. The expansion and contraction caused by the heat may cause the tubes to loosen at their joints.

After cleaning the tubes, a hydrostatic test of 50 psi should be applied to the bundle before replacing it within the shell.

When the evaporator tubes are pulled for cleaning, the DISTILLING CONDENSER, AIR EJECTOR CONDENSER, and the VAPOR FEED HEATERS should be inspected and cleaned, if necessary. Under some operating conditions, scale deposits may accumulate in these tubes, particularly in the air ejector condenser and the first-effect feed heater.

The distilling condenser on soloshell plants must be removed for inspection and cleaning. On other types of plants the distilling condenser can be inspected and cleaned by removing the heads at both ends. The air ejector condensers on all plants can be cleaned by removing both heads. The vapor feed heater tubes on practically all designs must be removed for cleaning.

The cleaning of these tube nests is accomplished by means of an extended shank drill, driven by a reversible motor at 250 or 300 rpm, or by standard tube cleaning equipment adapted for use with 5/8-inch outside diameter condenser tubes.

Flash Type.—In the flash type distilling plant, scale formation is reduced to a minimum because the feed is heated under pressure, which prevents boiling, and vapor is formed by free flushing under vacuum. The heat exchanger tubes require periodic cleaning. The tube sheet outer surfaces and tube interiors of the distilling

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condensers, air ejector condensers, evaporator feed water heater, and distillate cooler are accessible when the front and rear water boxes are removed. An electric or air-driven cleaning tool may then be pushed through the tubes to remove scale deposits.

CHEMICAL CLEANING.—Chemical cleaning has proven to be faster, more economical, more effective, and less detrimental to evaporator parts than mechanical cleaning. In chemical cleaning, a heated, diluted acid solution is circulated through the salt water circuits of the system. The two acids most commonly used are hydrochloric and sulfamic. In using these acids which may be harmful to personnel, observe the safety precautions and follow the procedures listed in chapter 9580 (58) of the Naval Ships Technical Manual.

Hydrochloric acid comes in liquid form and presents hazards in handling and storing. The use of hydrochloric acid is authorized ONLY when properly supervised by qualified naval shipyard personnel, never by ship's force alone.

Sulfamic acid comes in powdered form and is safe for storage aboard ship, when stored in the original containers. The use of sulfamic acid is authorized under the supervision of qualified tender or naval shipyard personnel. At the discretion of type commanders, individual ships may be authorized to carry sulfamic acid, and cleaning may be performed by qualified personnel in the ship's crew. Cleaning can be accomplished by passing 50-gallon slugs of solution through the feed and brine systems. This should be done while the plant is in operation and distilling to the bilge. A solution containing 100 gallons of sea or fresh water and 50 pounds of sulfamic acid powder can be injected into the distilling plant in two ways; by taking feed pump suction through a hose-valve assembly directly from a container of acid solution, or by using the plant vacuum to draw in the solution. Regardless of the method of injection used, the solution should be injected as rapidly as possible. The distilling plant should remain in operation so the solution will be heated as it passes through. The plant may be unbalanced by interruptions in flow but will settle down quickly when the feed water flow is again constant.

Careless handling of the acid solution can result in injury to personnel and equipment. The chemicals are harmful to the eyes and skin. If possible the chemicals should be handled by mechanical means rather than manually; protective clothing should be worn at all times during cleaning operations.

Chapter 9580 (58) of the Naval Ships Technical Manual has a complete list of safety precautions and procedures which must be carefully followed when chemically cleaning distilling plants.

CARE OF STRAINERS

Quick-opening, flanged, basket type strainers are installed in the suction lines of the brine and circulating pumps, to prevent foreign matter from entering the pumps and piping systems of the distilling plant. The brine pump suction strainer should be inspected and cleaned when the plant is secured, and after any repairs that might cause scale to fall into the brine suction line.

The clogging of this strainer interferes with the operation of the pump, and, in a submerged-tube type plant, makes it impossible to maintain the brine density at 1.5 thirty-seconds. A clogged strainer in a flash type plant will cause the last flash stage to flood.

The circulating pump suction strainer should be inspected about once a week when at sea, and more frequently when in port. Even partial clogging of this strainer will result in a reduction in the flow of circulating water, which in turn causes a reduced vacuum. Scale will then form more rapidly on the evaporator tubes and inside the vapor feed heater and air ejector condenser tubes.

AIR EJECTOR CLEANING

The AIR EJECTOR STEAM STRAINER should be inspected regularly and cleaned whenever necessary. When a new plant is put into operation, the strainer may require cleaning daily or even more frequently, due to the foreign material in the new lines. Once the steam lines have been thoroughly flushed out, a monthly check should be sufficient. Failure to keep the strainer clean will cause a reduced or fluctuating vacuum.

Clogging or scoring of the air ejector NOZZLE can also cause a reduced or fluctuating vacuum. The nozzle can be cleaned with a piece of wood or soft wire. Do not use hard material; it will score the nozzle. A scored nozzle must be replaced with a new one.

MISCELLANEOUS CLEANING

When the distilling plant is dismantled for cleaning evaporator tubes, a number of other

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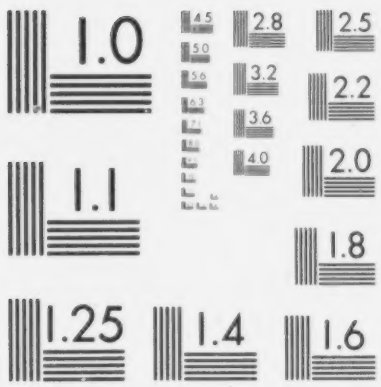

MICROCOPY RESOLUTION TEST CHART
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As sunlight and dry conditions cannot do all the work; cleaning, scrubbing, and chemical disinfecting must do the rest.

Physical Methods of Cleaning

The first step in sanitation is cleaning. Organic debris or deposits can inhibit the disinfectant process, so cleaning must come first. All manure and bedding must first be removed from the building to be treated. If the manure is thought to be contaminated in any way, it should be disposed of where animals will not come in contact with it.

1. Buildings. The surface of the building which animals may contact must be scrubbed with brushes and water with detergent added until clean. Steam generators may be used to make cleaning more effective. Steam under pressure penetrates more deeply into any surface than just brushing or rinsing.

When the building has been cleaned of all organic matter, scalding (140°F) water and lye may be used as a cheap disinfectant. (1 pound of lye in 15 gallons of water makes a good, economical disinfectant.)

Laundry bleach may also be used as a good, cheap method of disinfecting, (1 gallon of bleach plus 250 gallons water) although it is not as effective as lye when any dirt is present.

After using either of the above methods, the buildings must be thoroughly air dried, and then the places where animals are fed should be rinsed again. All metal surfaces must be rinsed after drying to keep the metal from corroding.

2. Corrals and dirt floors. When a veterinarian has established the fact that an infectious disease is present in the herd, certain steps must be taken. In addition to disinfecting buildings where animals are located, all corrals and other places where animals are kept must be sanitized. Thorough cleaning and disinfecting of corrals and pens is important. First, about three inches of earth should be removed from the corrals and placed in a waste area where animals are not allowed access. Then all fence posts, feed bunks, and other objects left in the yards must be disinfected. Chlorinated lime or saponated cresol (see chart, page 7) can be used to disinfect these objects.

Corrals may be covered lightly with oil, burned, and then plowed up. It is best to let the corral stay idle for a period of time to allow the sun to kill germs prior to burning and plowing. It must be remembered that infectious diseases can easily reestablish themselves if any item is overlooked in a sanitation program following a disease outbreak. The final step is recovering the floors of pens with fresh earth, sand or gravel and clean bedding.

Chemical Means of Disinfecting

The standard measure of the strength of a disinfectant is its "phenol coefficient." This comparison of the germicidal action of other disinfectants with the action of carbolic acid provides a measure of the relative effectiveness of disinfectants on microscopic organisms. A disinfectant with a phenol coefficient of 4 would be approximately 4 times as strong as phenol under laboratory conditions. While phenol (carbolic acid) is the oldest commercial disinfectant there are now many other available. Some of these may be cheaper and more effective on certain disease organisms (see chart, page 4).

parts should be inspected, and cleaned if necessary. The feed water distributing pipes, flushing pipes, and separate drain lines should be removed and any scale deposits cleaned out. The hooks and troughs on the baffles should be cleaned to ensure proper drainage. The upper and lower gage glass equalizer lines, gage glass fittings, gage and sight glasses, feed lines between effects, brine lines, and brine pump impeller should all be inspected, and cleaned if necessary.

INSPECTION OF ZINCS

Zinc rods or plates are usually provided in all salt water units of a plant (except the evaporator shell) to reduce the effects of galvanic action on structural parts. Zincs installed in the salt water circuit of condensers and other heat exchangers should be inspected and cleaned (or renewed) in accordance with the Planned Maintenance System. When the salt water side of a condenser is opened, inspecting and cleaning the zincs should be one of the first considerations. When a zinc is more than half corroded, a new one should be installed.

A casual inspection of a badly scaled zinc, especially while it is still wet, may lead personnel to believe that zinc metal instead of scale is exposed. The zinc, even though it appears to be in good condition, should be tested with a chipping hammer to learn the true condition of zinc metal. Whenever zincs are inspected or cleaned, the condition of the metallic contact between the zinc and its support should be checked.

A new type of high-purity zinc, known as ANODE ZINC, is being installed on naval ships. Zinc protectors made of this material have the ability to slough off corrosion products as rapidly as they are formed. This characteristic allows the zinc to give continuous protection against galvanic action, since the zinc does not become encrusted with corrosion products.

CHAPTER 15

COMPRESSED AIR PLANTS

As an MM3 or MM2, you should have a thorough knowledge of air compressors, their construction, and care. You will find compressed air outlets in all engineering spaces. It would be difficult to mention all the uses for compressed air aboard a modern Navy ship, but some of the more common uses include: operating pneumatic tools, cleaning, ejecting gas from ships' guns, starting diesel engines, charging and firing torpedos, operating gun counter recoil mechanisms, and operating automatic combustion control systems. Compressed air is supplied to the various systems by high pressure, medium pressure, or low pressure air compressors, as appropriate. Reducing valves reduce a higher pressure to a lower pressure for a specific system.

AIR COMPRESSORS

There are a number of variations in the design and construction of air compressors. The construction and principles of operation of some of the most common types of air compressors, used on Navy ships, will be discussed in this chapter.

COMPRESSOR CLASSIFICATIONS

Air compressors are classified in various ways. A compressor may be single acting or double acting, single stage or multistage, and horizontal, angle, or vertical, as shown in figure 15-1. A compressor may be designed so that ONLY one stage of compression takes place within one compressing element, or so that more than one stage takes place within one compressing element. In general, compressors are classified according to the type of compressing element, the source of driving power, the method by which the driving unit is connected to the compressor, and the pressure developed.

1. Types of Compressing Elements.—Air compressor elements may be of the centrifugal, rotary, or reciprocating types. The reciprocating type is generally selected for capacities below 1,000 cfm and for pressures of 100 psi or above, the rotary type for capacities up to 10,000 cfm and for pressures below 100 psi, and the centrifugal type for 10,000 cfm or greater capacities and for up to 100 psi pressures.

Most of the compressors used in the Navy have reciprocating elements (fig. 15-2). In this type of compressor the air is compressed in one or more cylinders, very much like the compression which takes place in an internal combustion engine.

2. Sources of Power.—Compressors are driven by electric motors, internal combustion engines, steam turbines, or reciprocating steam engines. Most of the air compressors in naval service are driven by electric motors.

3. Drive Connections.—The driving unit may be connected to the compressor by one of several methods. When the compressor and the driving unit are mounted on the same shaft, they are close coupled. Close coupling is often used for small capacity compressors that are driven by electric motors. Flexible couplings are used to join the driving unit to the compressor where the speed of the compressor and the speed of the driving unit can be the same.

V-belt drives are commonly used with small, low pressure, motor-driven compressors, and with some medium pressure compressors. In a few installations, a rigid coupling is used between the compressor and the electric motor of a motor-driven compressor. In a steam turbine drive, compressors are usually driven through reduction gears.

4. Pressure Classification.—In accordance with General Specifications for Ships of the United States Navy, compressors are classified as low pressure, medium pressure, or high

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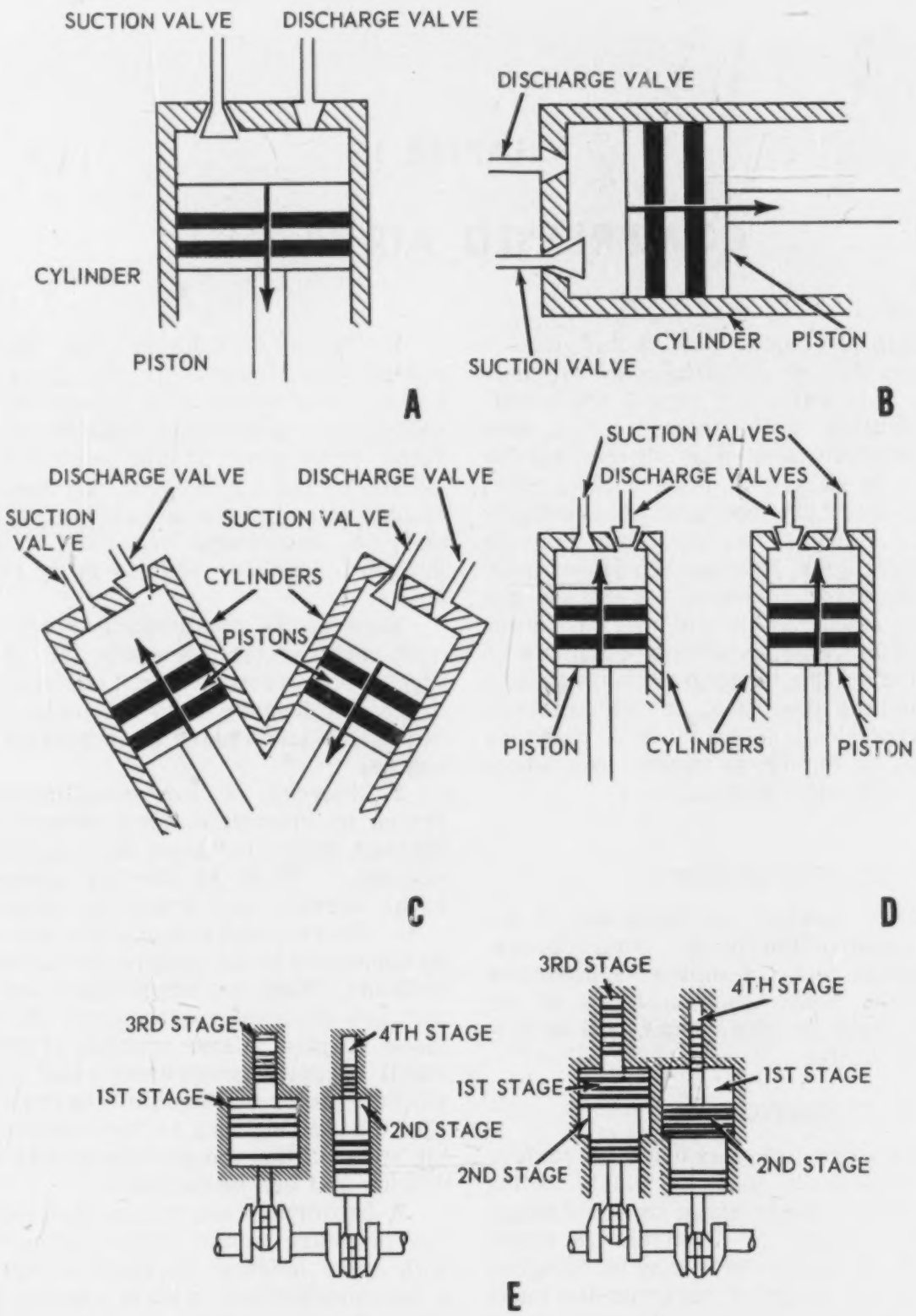

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Figure 15-1.—Types of air compressors.: A. Vertical. B. Horizontal. C. Angle. D. Duplex. E. Multistage.

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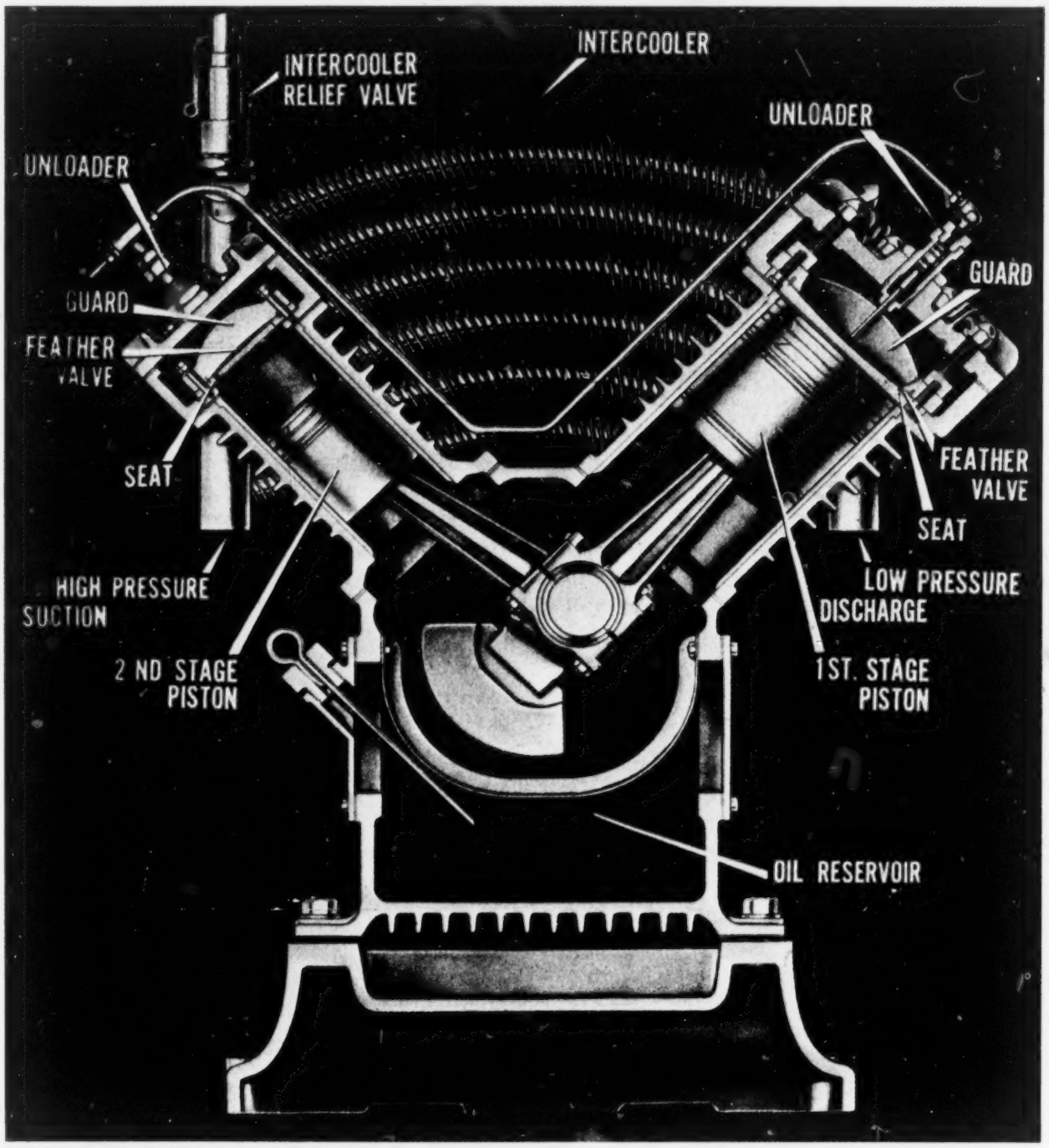

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Figure 15-2.—A simple two-stage reciprocating low pressure air compressor.

pressure. Low pressure compressors are those which have a discharge pressure of 150 psi or less. Medium pressure compressors are those which have a discharge pressure of 151 psi to 1,000 psi. Compressors which have a discharge pressure above 1,000 psi are classified as high pressure.

Most low pressure air compressors are of the two-stage type with either a vertical V (see fig. 15-2) or a vertical W arrangement of cylinders. Two-stage, V-type low pressure compressors usually have one cylinder for the first (lower pressure) stage of compression, and one cylinder for the second (higher pressure)

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stage of compression. W-type compressors have two cylinders for the first stage of compression, and one cylinder for the second stage. This arrangement is shown in the two-stage, three-cylinder, radial arrangement in part A of fig. 15-3.

Compressors may be classified according to a number of other design features or operating characteristics.

Medium pressure air compressors are of the two-stage, vertical, duplex, single-acting type. Many medium pressure compressors have differential pistons; this type of piston has more than one stage of compression during each stroke of the piston. (See fig. 15-3,A.)

Modern air compressors are generally motor-driven (direct or geared), liquid-cooled, four-stage, single-acting units with vertical or horizontal cylinders. Cylinder arrangements for high pressure air compressors installed on Navy ships are illustrated in part B of figure 15-3. Small capacity high pressure air systems may have three-stage compressors. Large capacity, high pressure, air systems may be equipped with five- or six-stage compressors.

OPERATING CYCLE OF RECIPROCATING AIR COMPRESSORS

Reciprocating air compressors are usually similar in design and operation. The following discussion relates to the operating cycle during one stage of compression in a single-stage, single-acting compressor.

The cycle of operation, or compression cycle within an air compressor cylinder includes two strokes of the piston: a suction stroke and a compression stroke. The suction stroke begins when the piston moves away from top dead center (TDC). The air under pressure in the clearance space (above the piston) expands rapidly until the pressure falls below the pressure on the opposite side of the inlet valve. At this point, the difference in pressure causes the inlet valve to open and air is admitted to the cylinder. Air continues to flow into the cylinder until the piston reaches bottom dead center (BDC).

The compression stroke starts as the piston moves away from BDC; compression of the air begins. When the pressure in the cylinder equals the pressure on the opposite side of the

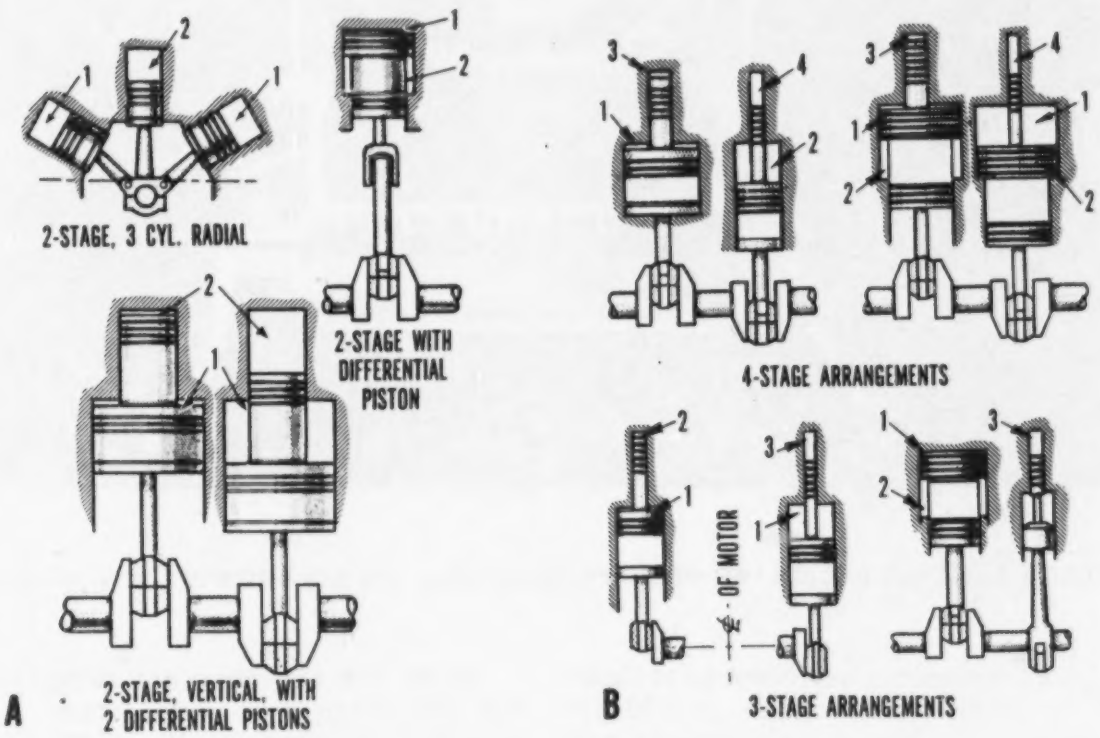

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Figure 15-3.—Air compressor cylinder arrangements. A. Low and medium pressure cylinders. B. High pressure cylinders.

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air inlet valve, the inlet valve closes. Air is increasingly compressed as the piston moves toward TDC, until the pressure in the cylinder becomes great enough to force the discharge valve open against the discharge line pressure and the pressure of the valve springs. (The discharge valve opens a few degrees before the piston reaches TDC.) During the balance of the compression stroke, the air which has been compressed in the cylinder is discharged, at almost constant pressure, through the open discharge valve.

The basic operating cycle just described is repeated a number of times in double-acting compressors and in other stages of multistage compressors. In a double-acting compressor, each stroke of the piston is a suction stroke in relation to one end of the cylinder, and a compression stroke in relation to the other end of the cylinder. In a double-acting compressor, therefore, two basic compression cycles are always in process when the compressor is operating; but each cycle, considered separately, is simply one suction stroke and one compression stroke.

In multistage compressors, the basic compression cycle must occur at least once for each stage of compression. If the compressor is designed with two compressing elements for the first (low pressure) stage, two compression cycles will be in process in the first stage at the same time. If the compressor is designed so that two stages of compression occur at the same time in one compressing element, the two basic compression cycles (one for each stage) will occur at the same time. In each stage, air is compressed to the designed working pressure of that particular stage and is then discharged to the stage having the next highest working pressure, with the last stage discharging to the receiver.

COMPONENT PARTS OF RECIPROCATING AIR COMPRESSORS

Reciprocating air compressors consist of a system of connecting rods, crankshafts, and flywheels used to transmit the power developed by the driving unit to the pistons; and also consist of compressing elements, lubrication systems, cooling systems, control systems, and unloading systems.

Compressing Element

The compressing element of a reciprocating compressor consists of the air valves, the cylinder, and the piston.

The VALVES of modern compressors (except for some high pressure compressors aboard submarines) are of the automatic type. The opening and closing of these valves is caused solely by the difference between (1) the pressure of the air in the cylinder and (2) the pressure of the external air on the intake valve or the pressure of the discharged air on the discharge valve. On most compressors, a thin plate, low lift type of valve is used (fig. 15-4).

Various designs of CYLINDERS and PISTONS are used, depending primarily upon the number of stages of compression which take place within a cylinder. The three most common cylinder arrangements for low and medium pressure air compressors are shown in part A of figure 15-3. High pressure compressors with four-stage arrangements and three-stage arrangements are shown in part B of figure 15-3. The numbers 1 through 4 in figure 15-3 represent the stages of compression. Five- and six-stage compressors have the same basic stage arrangements.

The PISTONS may be of two types, trunk pistons and differential pistons. TRUNK PISTONS (fig. 15-5,A) are driven directly by the connecting rods. Since the upper end of a connecting rod is fitted directly to the piston wrist pin, there is a tendency for a piston to develop a side pressure against the cylinder walls. To distribute the side pressure over a wide area of the cylinder walls or liners, trunk pistons with long skirts are used. This type of piston minimizes cylinder wall wear. DIFFERENTIAL PISTONS (fig. 15-5,B) are modified trunk pistons having two or more different diameters. These pistons are fitted into special cylinders which are arranged so that more than one stage of compression is served by one piston. The compression for one stage takes place over the piston crown; compression for the other stage(s) takes place in the annular space between the large and small diameters of the piston.

Lubrication System

Lubrication of high pressure air compressor cylinders is generally accomplished by means

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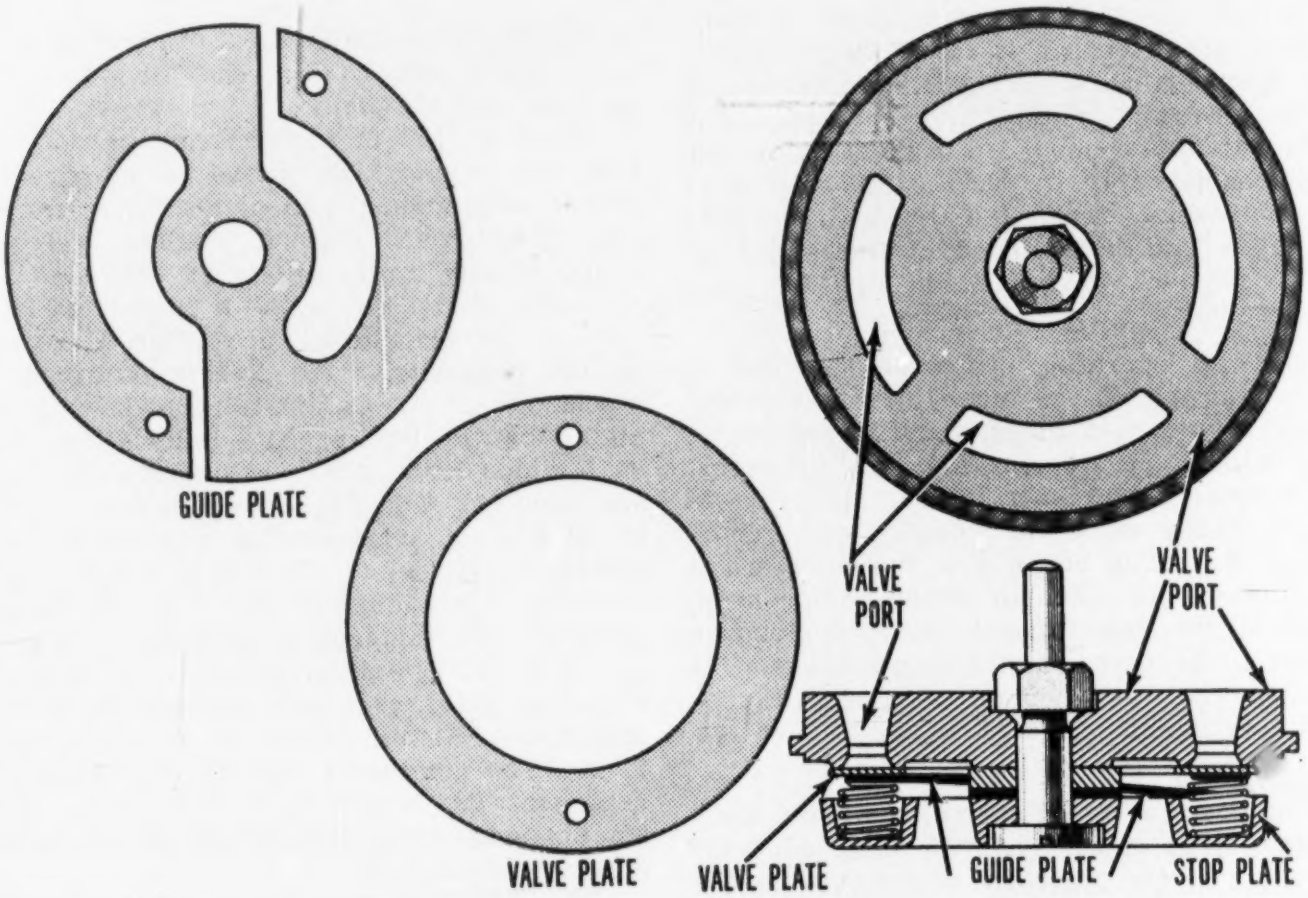

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Figure 15-4.—Diagram of a thin plate air compressor valve.

of an adjustable mechanical force-feed lubricator, which is driven from a reciprocating or a rotary part of the compressor. Oil is fed from the cylinder lubricator, by separate feed lines, to each cylinder. A check valve is installed at the end of each feed line to keep the compressed air from forcing the oil back into the lubricator. Each feed line is equipped with a sight-glass oil flow indicator. Lubrication begins automatically as the compressor starts up. The amount of oil that must be fed to the cylinder depends upon the cylinder diameter, the cylinder wall temperature, and the viscosity of the oil.

In most low pressure and medium pressure compressors, the cylinders are lubricated by the splash method, from dippers on the ends of the connecting rods or by the forced feed method whereby oil under pressure is generally forced up through a drilled passage in the connecting rod.

Lubrication of the running gear of a modern compressor is accomplished by an oil pump, which is attached to the compressor and is driven from the compressor shaft. This pump (usually of the gear type) draws oil from the reservoir (oil sump, shown in fig. 15-6) in the compressor base and delivers it, through a filter, to an oil cooler (fig. 15-6). From the cooler, the oil is distributed to the top of each main bearing, to spray nozzles for reduction gears, and to outboard bearings. The crankshaft is drilled so that oil fed to the main bearings is picked up at the main bearing journals and carried to the crank journals. The connecting rods contain passages which conduct lubricating oil from the crank bearings up to the wrist pin bushings. As oil leaks out from the various bearings, it drips back to the oil sump (in the base of the compressor) and is recirculated. Oil from the outboard bearings is carried back to the sump by the drain lines.

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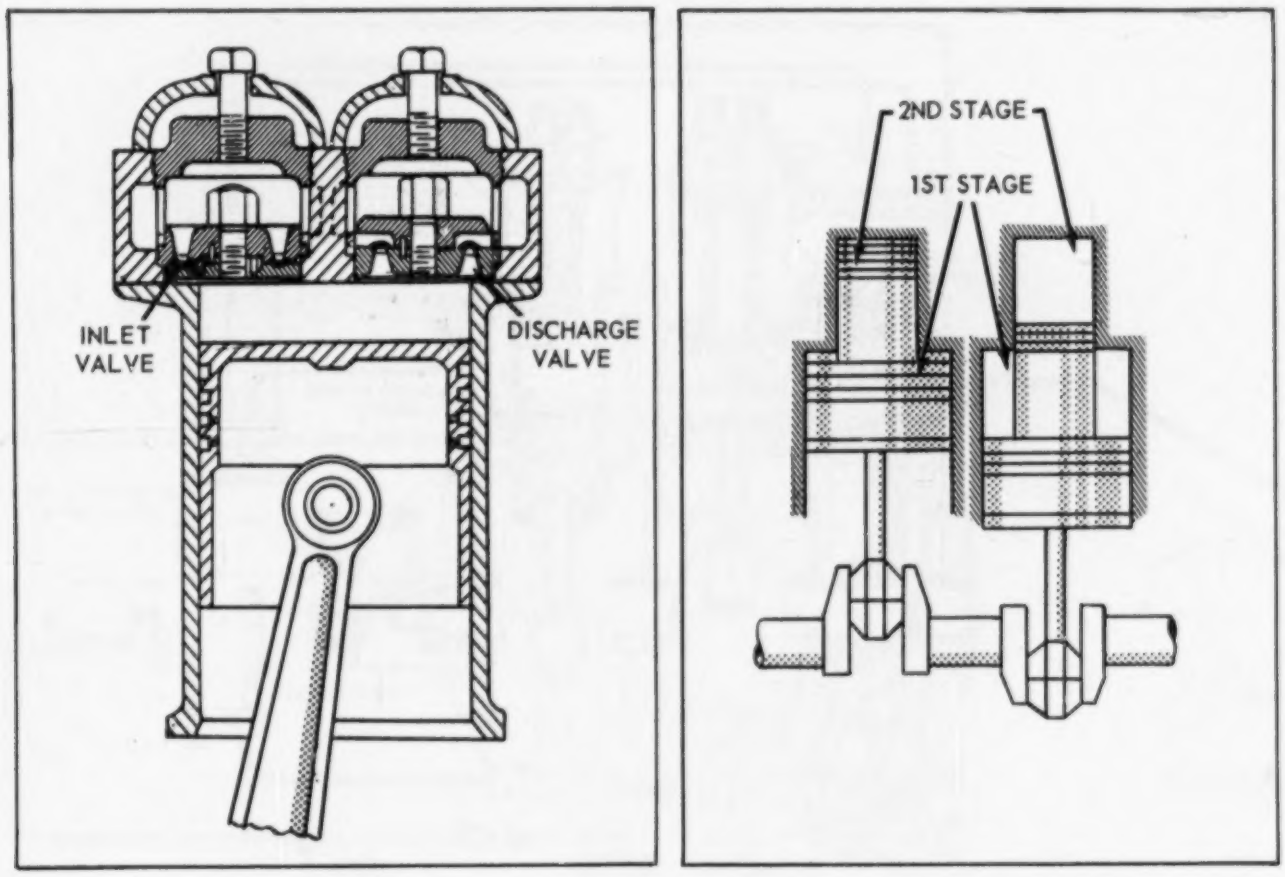

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Figure 15-5.—Air compressor pistons. A. Trunk type. B. Differential type.

The discharge pressure of lubricating oil pumps varies with different pump designs. A relief valve, fitted to each pump, functions when the discharge pressure exceeds the pressure for which the valve is set. When the relief valve lifts, excess oil is returned to the sump.

Cooling Systems

Most high pressure and medium pressure compressors are cooled by sea water supplied from the ship's fire, flushing, or cooling water service mains. The cooling water is generally available to each unit through at least two sources. Compressors located outside the larger machinery spaces are generally equipped with an attached circulating water pump as a standby source of cooling water. Small low pressure compressors for ship's service and diesel engine starting, and some small capacity high pressure air compressors, are air cooled by a fan mounted on, or driven from, a compressor shaft.

The path of water in the cooling water system of a typical four-stage compressor is illustrated in figure 15-7. Not all cooling water systems have identical paths of water flow, but in systems equipped with oil coolers it is important that the coldest water be available for circulation through the cooler. Valves are usually provided so that the water to the cooler can be controlled independently of the rest of the system. Thus oil temperature may be controlled without harmfully affecting other parts of the compressor. Next in importance are the inter coolers and after coolers, then come the cylinder jackets and heads. The high pressure air compressors require from 6 to 25 gallons of cooling water per minute, while medium pressure air compressors require from 10 to 20 gallons per minute.

When sea water is used as the cooling agent, all parts of the circulating system must be of corrosion-resisting materials. The cylinders and heads are therefore composed of

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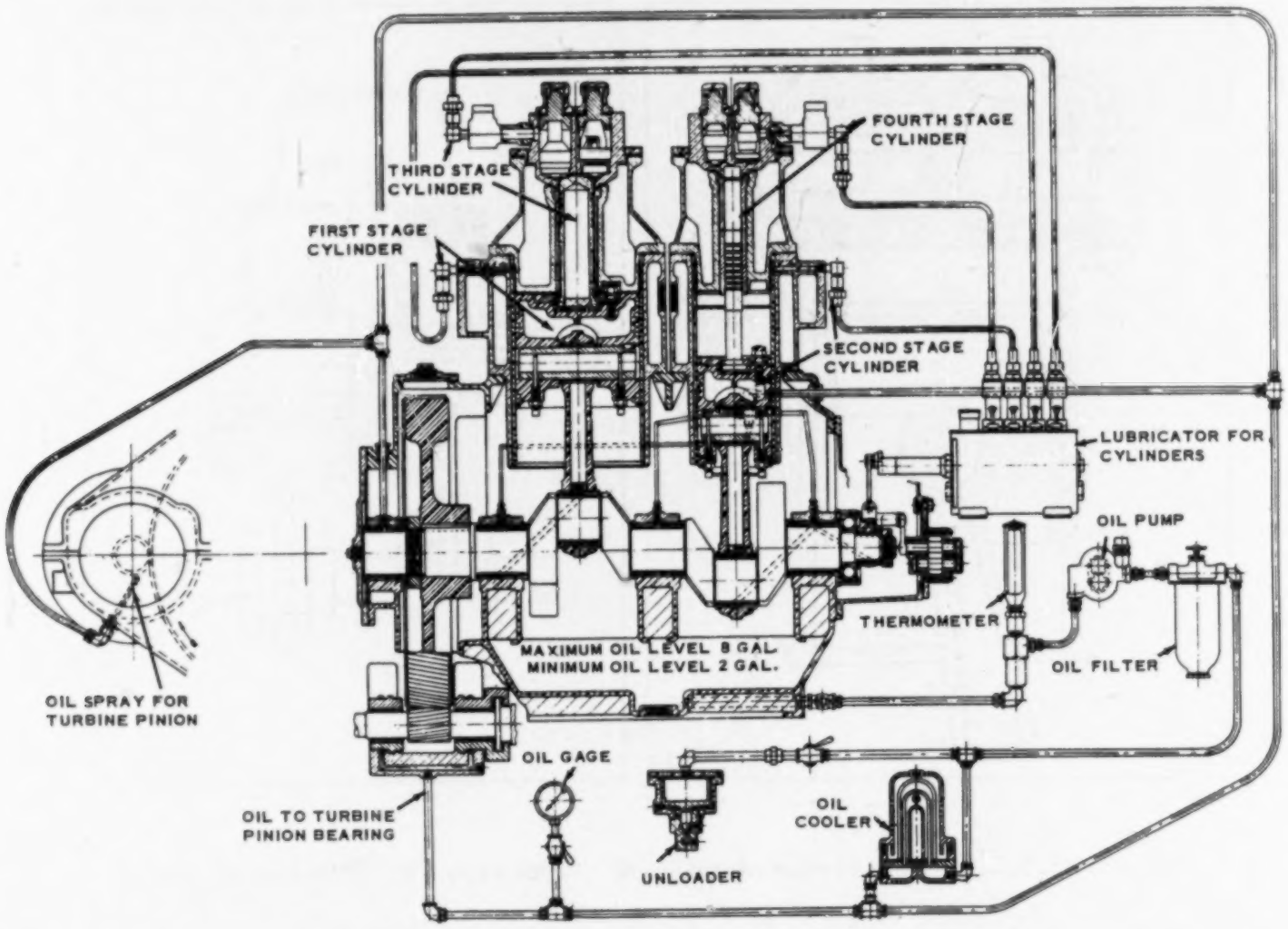

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Figure 15-6.—Lube oil system of a typical multistage turbine-driven high pressure air compressor.

gun metal or valve bronze composition, with water jackets cast integral with the cylinders. Each cylinder is generally fitted with a liner of special cast iron or steel to withstand the wear of the piston. Wherever practicable, cylinder jackets are fitted with handholes and covers so that the water spaces may be inspected and cleaned. Jumpers are generally used to make water connections between the cylinders and heads, since these prevent any possibility of leakage into the compression spaces. In some compressors, however, the water passes directly through the joint between the cylinder and the head. With this latter type, extreme care must be taken to ensure that the joint is properly gasketed to prevent leakage which, if allowed to continue, would ruin both the cylinder liner and the piston rings.

The INTER COOLERS and AFTER COOLERS remove the heat generated during compression and cause the condensation of any vapor that may be present. It is important that this condensate be drained at regular intervals to prevent carryover into the next stage, accumulation at low points, water hammer, freezing or bursting of pipes in exposed locations, faulty operation of pneumatic tools, and possible damage to electrical apparatus where air is used for cleaning. The removal of heat is also required for economical compression. During compression the temperature of the air is increased, thus causing the air to expand to a larger volume which, in turn, requires a corresponding increase of work to compress it. Multistaging, therefore, with interstage cooling of the air, reduces the power requirement for

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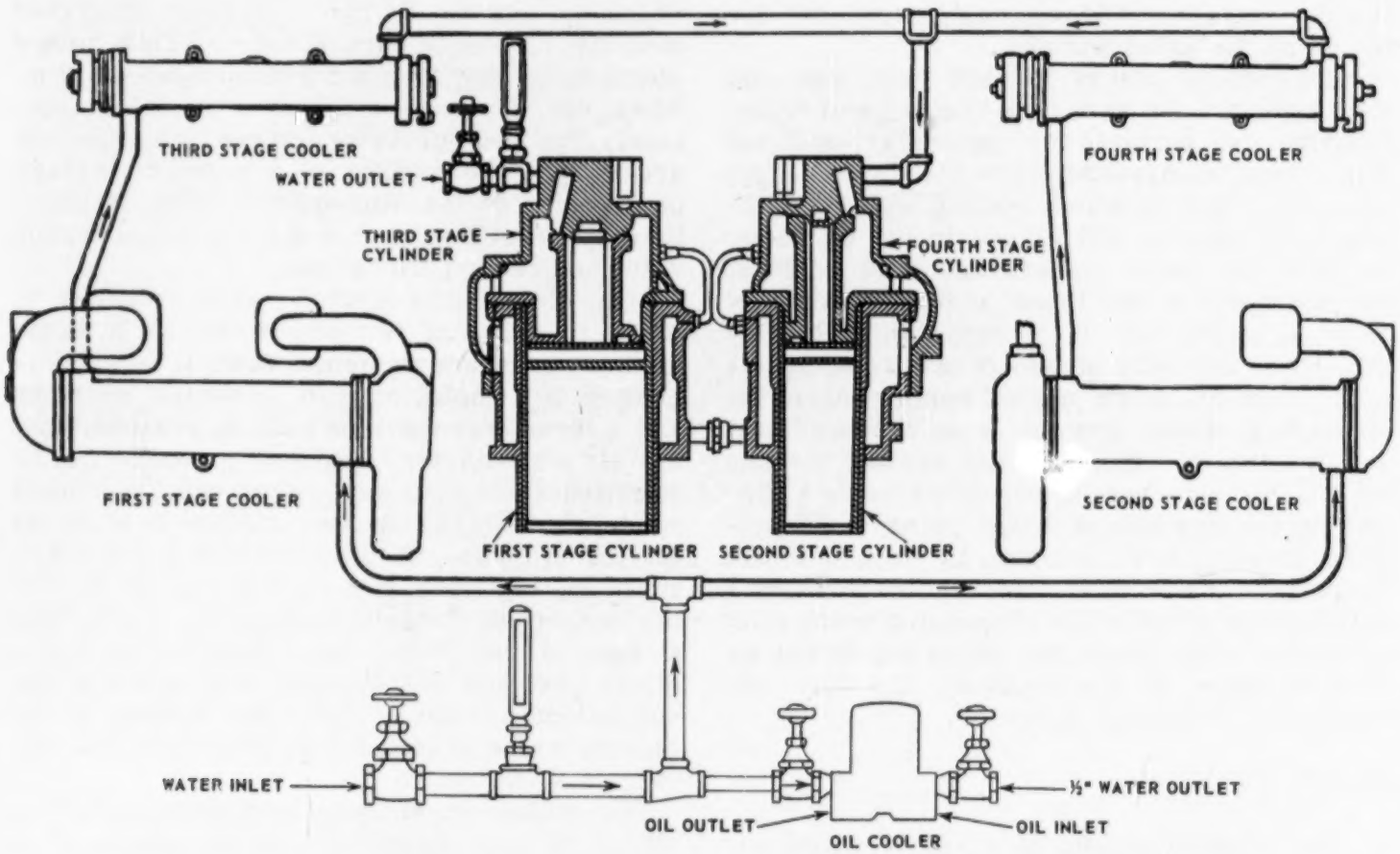

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Figure 15-7.—Cooling water system in a typical multistage air compressor.

a given capacity. The interstage cooling reduces the maximum temperature in each cylinder and thereby reduces the amount of heat which must be removed by the water jacket at the cylinder. Also, the resulting lower temperature in the cylinder ensures better lubrication of the piston and the valves. Both the inter coolers and the after cooler are of the same general construction except that the after cooler is designed to withstand a higher working pressure than the inter coolers.

Water-cooled inter coolers may be of the straight tube and shell type or, if size dictates, may be of the coil type. In coolers where air pressure is below 250 psi, the air generally flows either through the tubes or over and around them. In coolers where air pressure exceeds 250 psi, the air generally flows through the tubes. Suitable baffles are provided in tubular coolers to deflect the air or water in its course through the cooler. In coil-type coolers the air passes through the coil, with the water flowing around the coils. Suitable provision is made for the expansion of the tube nest.

Air-cooled inter coolers and after coolers may be of the radiator type or may consist of a bank of finned copper tubes located in the path of blast air supplied by the compressor fan.

Each inter cooler and after cooler is generally fitted with relief valves on both the air and water sides. Water relief valves are generally set at 5 psi in excess of the maximum working pressure which may be applied to the system. The air relief valves must be kept set in accordance with directions given in the particular manufacturer's technical manual, or in the Naval Ships Technical Manual.

Inter coolers and after coolers are generally fitted with moisture separators on the discharge side to remove the condensed moisture and oil from the air stream. The separators are of a variety of designs. The removal of liquid is accomplished by centrifugal force, impact, or

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There are certain compounds that are used more than others for chemical disinfecting: (a) Lye. Lye is a very effective disinfectant and is used more often than most other disinfectants. It is made of sodium hydroxide (NaOH) and potassium hydroxide (KOH). Lye is very destructive to most germs and is effective in helping to clean organic matter from buildings. (b) Sodium hypochlorite (laundry bleach) is used for most dairy equipment. While its effectiveness is reduced by the presence of organic matter, it nevertheless is a very good, cheap disinfectant. (c) Cresols. Saponated cresols are effective germ killers, and are recommended for general use. Cresols may be used anywhere except where milk is produced, as the milk becomes tainted when exposed to the cresols.

When looking for an ideal disinfectant, the following points should be considered:

1. It should have good germ-killing power.
2. It remains chemically active over a long period of time.
3. It is active in the presence of organic matter.
4. It is inexpensive to use.
5. It has low toxicity to man and animals.
6. It is non-corrosive to equipment.

The chart below lists several of the more commonly used disinfectants, provides directions on how to mix and use them and gives some suggestions and precautions on their use.

CHEMICAL DISINFECTANT CHART

Disinfectant	Mixture	Application	Remarks
Alkalies			
Lye	1 lb. to 15 gals. of scalding (140°) water.	General sanitation (May help control footrot when mixed with 5% $CuSO_4$ and placed where cattle gather)	Very caustic, will burn skin and permanently damage eyes. Keep away from children.
	(2% mixture) 13-1/2 oz. to 5 gals. water.	Maternity quarters and general building sanitation	
	(5% mixture) 13-1/2 oz. to 2 gals. water.	Hog cholera, erysipelas, vascular exanthema, anthrax, blackleg, malignant edema	
Lime	Unslaked	Used when burying dead animals	Same precautions as for lye.
Coal-tar derivatives			
Phenol	(4% mixture) 1 cup to 2 gals. water	Footbaths, buildings, pens Will be most effective after organic debris has been removed	Penetrates skin easily. Very toxic. Disagreeable odor.
Lysol	(.5 to 1% mixture) Follow directions on label for different strengths.	Footsoak for footrot Often used diluted for castrating, dehorning, tattooing, etc.	Disagreeable odor, will burn eyes.

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sudden changes in velocity of the air stream. Drains are provided on each separator for removing the water and oil.

Oil coolers are of the coil type, tube and shell type, or of a variety of commercial types. External oil coolers are generally used but some naval compressors are fitted with a base type oil cooler in which cooling water is circulated through a coil placed in the oil sump. As with the inter coolers and after coolers, the materials of the tubes, coils, or cores of these coolers, are of a copper-nickel alloy with shell and tube sheets of bronze composition. On all later model compressors the circulating water system is so arranged that the quantity of cooling water passing through the oil cooler may be regulated without disturbing the quantity of water going to the cylinder jackets, inter coolers, or after coolers. Thermometers or other temperature measuring devices are fitted to the circulating water inlet and outlet connections, the intake and discharge of each stage of compression, the final air discharge, and the oil sump.

Control Systems

The control system of a reciprocating air compressor may include one or more devices such as automatic high temperature shutdown devices, start-stop controls, constant speed controls, and speed-pressure governors.

AUTOMATIC HIGH TEMPERATURE SHUTDOWN DEVICES are fitted on all recent designs of high pressure air compressors. Thus, if the cooling water temperature rises above a safe limit, the compressor will stop and will not restart automatically. Some compressors are fitted with a device that will shut down the compressor if the temperature of the air leaving any stage exceeds a preset value.

Control or regulating systems for naval air compressors are mainly of the start-stop type, in which the compressor starts and stops automatically as the receiver pressure falls or rises within predetermined limits. On electrically driven compressors the system is very simple—the receiver pressure operates against a pressure switch that opens when the pressure upon it reaches a given limit, and closes when the pressure drops a predetermined amount.

On steam-driven compressors the receiver pressure is piped to a control valve (also known as a pilot, trigger, or auxiliary valve) which, when the designed cutoff pressure is reached, admits air to a plunger connected with the turbine governor valve. This causes steam to be shut off and the compressor to stop. When the pressure falls to a predetermined level, the control valve closes, and the air acting upon the plunger is released by leakage or bleeding to the atmosphere. The steam is thereby permitted to flow through the governor valve and restart the turbine.

On electrically driven units required to start at either of two pressures, as in some medium pressure systems, control is accomplished by employing two pressure switches and a three-way valve or cock so arranged that the air accumulator (receiver) pressure can be admitted to the pressure switch with the desired range of settings. Another method is to direct the air from the receiver through a three-way valve to either of two control valves set for the respective range of pressures. To do this, a line is run from each control valve to a single pressure switch which may be set at any convenient pressure since the setting of the control valve selected will determine the operation of the switch.

On steam-driven units required to start at either of two pressures, the arrangement is similar to that of the electrically driven units except that the air from the control valve selected is directed to the plunger which operates the turbine governor valve.

The CONSTANT SPEED CONTROL is a method of controlling the pressure in the air receiver by controlling the output of the compressor without stopping or changing the speed of the unit. This control is used to prevent frequent starting and stopping of compressors when there is a fairly constant but light demand for air. Control is provided by directing air to unloading devices through a control valve set to operate at a predetermined pressure.

Combined SPEED AND PRESSURE GOVERNORS are usually furnished for reciprocating steam-driven compressors, where neither the start-stop nor the constant speed control is very satisfactory.

Unloading Systems

Air compressor unloading systems are installed for the removal of all but the friction loads on the compressors; that is, they automatically remove the compression load from the compressor while the unit is starting, and

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automatically apply the load after the unit is up to operating speed. For units having the start-stop control, the unloading system is separate from the control system. For compressors equipped with the constant speed control, however, the unloading and control systems are integral parts of each other.

A detailed explanation cannot be given here for every type of unloading device used to unload air compressor cylinders, but you should know something about several of the unloading methods which you will probably encounter. These include closing or throttling the compressor intake, holding intake valves off their seats, relieving inter coolers to the atmosphere, relieving the final discharge to the atmosphere (or opening a bypass from the discharge to the intake), opening up cylinder clearance pockets, using miscellaneous constant speed unloading devices, and the employment of various combinations of these methods.

As an example of a typical compressor unloading device, consider the MAGNETIC TYPE UNLOADER. Figure 15-8 illustrates the unloader valve arrangement. This type of unloader consists of a solenoid-operated valve connected with the motor starter. When the compressor is at rest, the solenoid valve is deenergized, admitting air from the receiver to the unloading mechanism. When the compressor approximates normal speed, the solenoid valve is energized, releasing the pressure from the unloading mechanism and loading the compressor again.

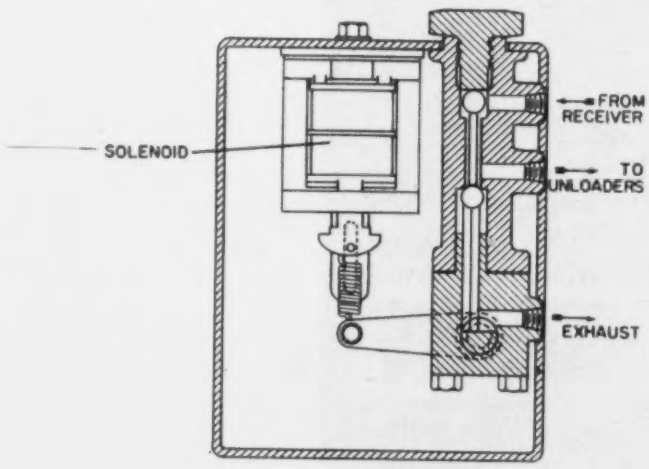

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Figure 15-8.—Magnetic type unloader.

For detailed information on the various unloading devices, refer to the pertinent manufacturers' technical manuals for compressors installed on your ship.

COMPRESSED AIR RECEIVERS

An air receiver is installed in each space housing air compressors. The receiver acts as a supply tank and a storage tank. If demand is in excess of compression capacity, some of the stored air goes into the system. If demand is less than the compressor capacity, the excess is stored in the receiver or accumulator. Thus, in a compressed air system, the receiver functions to minimize pressure variations in the system. This will thereby minimize start-stop cycling of air compressors equipped with pressure sensing controls. The receivers may be horizontal or vertical. The vertically mounted ones have convex bottoms to permit proper draining of accumulated moisture, oil, and foreign matter. All receivers include such fittings as inlet and outlet connections, drain connections and valves, connections for operating a line to compressor regulators, pressure gages, relief valves (set at 10 percent above normal working pressure of the receiver), and handhole or manhole plates (depending upon the size of the receiver). The discharge line between the compressors and the receiver is as short and straight as possible to eliminate vibration due to pulsations of the air and to reduce pressure losses due to friction.

TYPICAL LOW PRESSURE AIR COMPRESSORS

Having considered the various parts which make up an air compressor, you may now follow the path of air through a typical compressor. Figure 15-9, as an example, illustrates various views of a radial, single-acting, three-cylinder, two-stage, motor-driven, low pressure air compressor with a V-belt connected flywheel, air-cooled cylinders, and air-cooled inter coolers and after coolers.

Atmospheric air is drawn in through the two air inlet filters and then through the inlet or suction valves of the two first-stage cylinders as the two first-stage pistons are on their downward or suction stroke. As the first-stage pistons are sent on their upward or compression stroke, by action of the crankshaft, the air is

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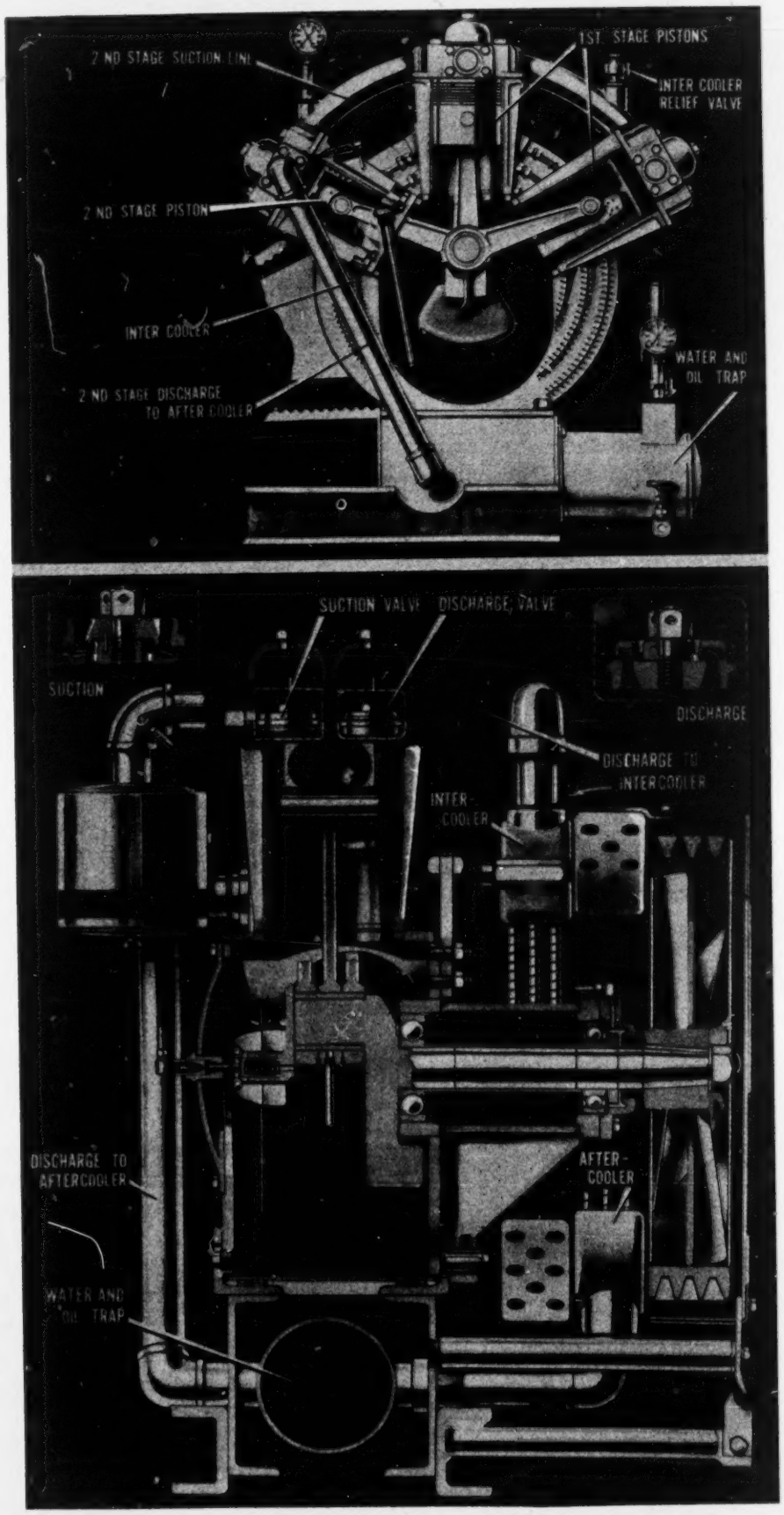

Figure 15-9.—Typical, radial, single-acting, three-cylinder, two-stage, motor-driven, air-cooled, low pressure, air compressor. 47.159

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compressed in the two cylinders and forced out of the discharge valves. The fins on the outside of the cylinders distribute the compression heat over a larger area, and therefore facilitate the removal of heat by the cooler air directed on them by the flywheel fan.

The discharged compressed air is directed from the discharge valves on the first-stage cylinders, through the first-stage discharge line, to the air-cooled inter cooler. In the inter cooler, the first-stage compressed air loses most of its heat by passing through coils surrounded by cooler air. From the inter cooler, the compressed air is discharged, through the second-stage suction line, into the suction valve of the second-stage cylinder. Here the air is further compressed to the designed pressure, and then forced through the discharge valve, the second-stage discharge line, and the water and oil trap, to the after cooler, where the second-stage compression heat is removed. From the after cooler, the compressed air is discharged into the air receiver.

OPERATING AN AIR COMPRESSOR

Before attempting to operate any air compressor for the first time, be sure that you are thoroughly familiar with the machine. Study the manufacturer's technical manual. There are numerous varieties of compressors in naval use, so that it would be impossible in the limited space of this training course to present the operating procedures for each type of compressor. The following operating procedure is of a general nature.

STARTING A COMPRESSOR

In starting a compressor:

1. Inspect and clean the compressor exterior. Tighten any loose nuts, including foundation bolts. Remove any loose equipment that may be lying around.
2. Check the oil sump and (if necessary) fill to the proper level with the correct grade of oil. Prime the oil pump and lubricator.
3. Set the overspeed tripping device (if provided).
4. Jack the compressor over by hand. (Be sure the power is off and the jacking bar is removed.)
5. Turn on cooling water to the cooling system. Vent the system.
6. Open all air system stop valves.
7. Open all separator drains and remove all accumulations of moisture or oil from the separators. These should remain open until the compressor is running.
8. When the compressor is up to normal speed, gradually put a load on the compressor by closing the separator drains and indicator cocks, taking care to close those connected with the first stage, and then those connected with the second stage. If the compressor is fitted with additional stages, continue progressively through those stages.

OPERATING A COMPRESSOR

In operating a compressor:

1. After the compressor has been in operation a few minutes, recheck the oil level in the sump; if it has fallen appreciably, add sufficient oil to bring the level to normal.
2. Drain the receivers and accumulators at least once each watch.
3. Adjust the flow of cooling water so as to cool the air properly between stages. For compressors using salt water for cooling, the air leaving the after cooler should not exceed the temperature of the cooling water inlet by more than 20° F. When operating a HP air compressor, the temperature of the air leaving any stage should not exceed 400° F., for most installations, however, the temperature will not exceed 300° F.
4. Drain the inter cooler and the after cooler separators frequently.
5. Check the amount of oil being fed to the air cylinders, and adjust in accordance with manufacturer's instructions. If no information is available, 1 to 10 drops of oil per minute may be considered satisfactory for naval compressors having cylinder diameters up to 10 inches.
6. Check the operation of all relief valves regularly—use the hand levers; when provided.
7. Observe the pressure gages and thermometers frequently while the compressor is in operation.

CARE OF AIR COMPRESSORS

To keep the ship's air compressors operating efficiently at all times, you must know

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what common troubles may be expected and their causes; how to care for the air intakes; how to maintain and replace air valves; how to take care of the air cylinders and pistons; how to adjust bearings, wrist pins, couplings, etc.; and how to take care of the lubrication, cooling, control, and air systems.

AIR INTAKES

A supply of clean, cool, dry air is essential to the satisfactory operation of compressors. To ensure this, the AIR INTAKE FILTERS must be regularly inspected and cleaned; otherwise, the filter becomes clogged and causes loss of capacity. To clean, remove the filter element and subject it to a jet of hot water or steam, or plunge it into a strong solution of sal soda. The filter body should be drained and replaced. If the filter is the oil-wetted type, dip it in clean, medium grade oil and allow it to drain thoroughly before replacing the filter in the intake. Do not use gasoline or kerosene for cleaning filters; fumes may collect and explode in the compressor or receiver.

Care must also be taken to prevent entrance of rain or spray into INTAKE PIPES, and means should be provided for draining the intake pipe of any water which may collect. The lines should be as short and direct as possible.

AIR VALVES

Air inlet and discharge valves must be kept clean and in good working order. Leaky valves are generally dirty valves, and cause capacity loss and excessive temperatures. The valves are removed by first loosening their setscrews or clamps, and then removing their cover plates. Each valve and valve unloader, if fitted, may then be lifted out. Each valve should be marked, to make certain that it is returned to the same port from which it was removed.

Valves removed for inspection should not be taken apart for cleaning unless their condition makes it necessary. Dirt or carbon in valve ports can usually be removed without taking the valve apart. This is done by soaking the valves in kerosene, and then giving them a stiff brushing or a light scraping. Valve action should be tested by inserting a screwdriver through the seat ports; the valve should lift and close freely.

If it becomes necessary to disassemble the valve, note the arrangement of the various parts so that the proper relationship will be kept when the valve is reassembled. (There are periodic shipboard reports of damage to pistons and associated valve parts resulting from improperly assembled valves which protruded in the way of the oncoming piston.)

Before replacing air valves in a cylinder, inspect the gaskets and replace any which are damaged. Copper-covered asbestos or plain, thin copper gaskets should be used. If these are not available, 1/16-inch compressed-asbestos sheet gaskets may be used temporarily. Each valve assembly should be inserted in the same hole from which it was removed. Since it may be difficult, in many cases, to distinguish between suction or discharge valves, extreme care must be taken when the valves are being inserted in the cylinder. Make certain that suction valves open TOWARD, and the discharge valves AWAY FROM, the center of the cylinder; otherwise serious damage or loss of capacity will result. Then place the valve cover on the cylinder, making certain that its gasket is squarely in place; draw down on cover nuts evenly, and in turn, so as not to tilt the cover. Tighten down the valve setscrew or clamping bolt, drawing it tight to hold the valve on its seat. If special locknuts are not provided to seal against leakage at the threads of the valve setscrew, a turn of solder or fuse wire should be placed around the screw and set down into a recess by the locking nut.

CYLINDERS AND PISTONS

The cylinders and pistons should be inspected only after the manufacturer's technical manual has been consulted. Care should be taken when removing heads, particularly where metal-to-metal joints are involved, to prevent damage to the joint. Where joints are fitted with a gasket, the gaskets can occasionally be saved by running a knife blade in between the gasket and head, after the head has been lifted not over 1/4 inch.

If REPLACEMENT OF PISTON RINGS is required because they are worn or broken, accurate measurements of the cylinder liners should be taken. Standard size rings may be used in oversize cylinders if the oversize does not exceed 0.003 inch per inch of cylinder diameter. The liner may also need to be replaced if it is badly worn or out of round.

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When replacing piston rings, first fit them to the cylinder to check for proper end clearance. File the ends, if necessary, to make them fit. The side clearance of the rings should be such that the rings will fall easily into the piston grooves, which should be deep enough for the ring thickness. Ring splits should be staggered. After assembly of the piston, wire the rings tight with a soft copper wire, so that they will enter the bore easily. The wire can be removed through the valve ports after the ring has started into the cylinder bore.

When reassembling the air cylinders and heads, be sure they are all drawn down evenly, especially on multistage compressors where the heads contain cylinders for third and fourth stages. Otherwise, excess wear on the cylinders and pistons will result.

When a compressor piston has been replaced, the piston end clearance must be checked. This is done by inserting a lead wire through a valve port or indicator connection. Jack the compressor over. When the piston has moved to the end of its stroke, the lead will be flattened to the exact amount of clearance. The wire should be long enough to permit a reading near the center of the piston. These readings should also be taken after any adjustment or replacement of these bearings: main, crank, wrist pin, or crosshead. Methods of adjusting the clearances vary in accordance with compressor design; consult the manufacturer's technical manual for this adjustment.

LUBRICATION SYSTEM

Proper care of a compressor lubrication system includes the following procedures:

1. Keeping the oil at a normal level in the sump at all times, in order to maintain proper oil temperature.
2. Changing crankcase oil periodically, and at the same time cleaning and flushing the crankcase and cleaning the oil filter.
3. Maintaining proper lube oil pressure, by keeping the oil in good working order and adjusting the bypass relief valve.
4. Keeping the oil cooler free from leaks (since pressure on water side exceeds that of the oil), to prevent oil contamination and emulsification.
5. Occasionally replenishing transparent liquid (glycerine and water) in lubricator sight-feeds.
6. Properly adjusting the lubricator for the specified quantity of oil feed.

COOLING SYSTEM

Proper care of a compressor cooling system includes the following inspections and maintenance procedures:

1. Periodically inspecting the inter coolers and after coolers.
2. Removing collections of gummy oils or tarry substances from the cooler tubes by washing tube nests with a suitable solvent. See that they are thoroughly dry before reassembling.
3. Correcting any leakage in tube nests, to prevent leaks of water into the compressor while secured, or leaks of air into water side during operation.
4. Inspecting and cleaning cylinder water jackets periodically with a cleaning nozzle.

When FILLING THE COOLING WATER SYSTEM after the compressor has been drained, open the water inlet valve slightly to allow the water to rise slowly in the cooler shells and water jackets. Vent valves fitted to the water spaces should be opened to permit entrapped air to escape, and to remove any air pockets.

CONTROL DEVICES

Because of the great variety of REGULATING AND UNLOADING DEVICES employed on compressors, consult the manufacturer's technical manual for information regarding the adjustment of these devices on particular compressors.

If a control valve fails to work properly, it should be taken apart and cleaned. Some valves are fitted with a filter filled with a sponge or woolen yarn to prevent particles of dust or grit from being carried into the valve chamber, and to remove gummy deposits from oil used in compressor cylinders. When repacking, use only genuine wool. Cotton will pack and stop the air flow.

Relief valves, very important for safe compressor operation, should be set as specified by the manufacturer, test-lifted by hand each time the compressor is placed in operation, and periodically tested by raising the pressure in the system to which they are attached (to check the setting).

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MISCELLANEOUS ADJUSTMENTS

Miscellaneous adjustments required from time to time on compressors include those pertaining to wrist pins, crosshead shoes, reduction gears, couplings, and V-belt drives. The manufacturer's technical manual will give specific information for the care, adjustment, and replacement of all fitted bearings. Refer to the manufacturer's technical manual for detailed and specific information regarding when and how to make these adjustments.

WRIST PIN BUSHINGS are replaced when necessary, such as when maximum recommended tolerances have been exceeded. In making a replacement, be sure the oil hole in the bushing is properly lined up with the oil hole in the connecting rod. After being pressed into the rod, the new bushing must be reamed.

CROSSHEAD SHOES are provided with shim or wedge adjustment. Wear should be slight, but adjustment should be made when the travel of the piston rod causes a movement in the stuffing boxes.

Alignments of REDUCTION GEARS AND PINIONS should be checked periodically, especially on a new compressor. Misalignment may be caused later by settling, straining, or springing of foundations; pipe strains on turbine-driven compressors; bearing wear; or springing due to heat from a turbine.

FLEXIBLE COUPLINGS require very little maintenance when properly lined up. Some types require occasional lubrication to prevent excessive wear of springs or bushings. A noisy coupling is an indication that the bushing is worn and requires replacement.

V-BELT DRIVES require adjustment for belt tension. Belts generally stretch slightly during the first few months of use. A loose belt will slip on the motor pulley and cause undue heating and wear on the belt. A tight belt will overload the bearings. Belts should be protected against oil and excessive temperatures, to prevent rapid deterioration. V-belts are usually installed in sets of two or three. If a single belt is worn or deteriorated, then the complete set should be replaced to ensure that each belt will carry its share of the load.

PLANNED MAINTENANCE

The Maintenance Index Page (MIP) shown in figure 15-10 lists the planned maintenance for a low pressure air compressor, that is typical of the maintenance required on most air compressors. These maintenance requirements are in addition to those previously discussed under Care of Air Compressors.

SAFETY PRECAUTIONS

1. Explosions may be caused by dust laden air, presence of oil vapor in the compressor or receiver, and by leaky or dirty valves resulting in abnormally high temperatures.
2. Every effort must be made to have only clean, dry air at the compressor intake.
3. Never use benzine, kerosene, or other light oils to clean compressor intake filters, cylinders, or air passages. These oils vaporize easily and will form a highly explosive mixture with the air under compression.
4. Secure a compressor immediately if it is observed that the temperature of the air discharged from any stage rises unduly or exceeds the maximum temperature recommended.
5. Never leave the compressor station after starting the compressor unless you are sure that the control, unloading, and governing devices are operating properly.
6. To prevent damage due to overheating, compressors must not be run at excessive speeds. Proper cooling water circulation must be maintained.
7. If the compressor is to remain idle for any length of time, and is in an exposed position in freezing weather, the compressor circulating water system should be thoroughly drained.
8. Before working on a compressor make sure that the compressor is secured and cannot start automatically or accidentally. The compressor should be blown down completely, all valves (including control or unloading valves) between the compressor and the receiver should be secured. Leave the pressure gages open at all times.
9. When cutting air into the whistle, siren, or piece of machinery, be sure the supply line to the equipment has been properly drained of moisture. When securing the supply of air to the affected equipment, be sure all drains are left open.
10. Prior to disconnecting any part of an air system be sure that it is not under pressure. Pressure gages should always be left open to the sections to which they are attached.

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System, Subsystem, or Component	Reference Publications
Low-Pressure Compressed Air Plant	

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
AP	ZZZFCH5	85	2398	W	1. Inspect oil level. 2. Run unit by power, check automatic starting, and stop. 3. Blow down receivers and separators.	W-1	MM3	0.2	None
AP	ZZZFCH5	75	5927	M	1. Lift relief valves by hand. 2. Sample and inspect lube oil.	M-1	MM3	0.3	None
AP	ZZZFCH5	75	2840	M	1. Clean the air cooler fins. 2. Clean the air filter.	M-2	MM3	0.5	None
AP	ZZZFCH5	75	5369	Q	1. Inspect "V" belts for wear or stretching.	Q-1	MM3	0.5	None
AP	ZZZFCH5	85	2841	Q	1. Sound and tighten foundation bolts. 2. Inspect the air receiver and piping for external corrosion. 3. Drain and clean the compressor crankcase. 4. Inspect and clean the suction and discharge valves.	Q-2	MM3	2.5	None
AP	ZZZFCH5	C5	4803	A	1. Test all parts of air system under full working pressure.	A-1	MM3	1.5	None
AP	ZZQFVA1	75	2843	C	1. Test relief valves for proper lifting pressure.	C-1	MM3	0.5	None
AP	ZZ2FRG7	75	7203	C	1. Inspect interior of air receivers.	C-2	MM3 FN	0.5 0.5	None
AP	ZZ2FRG6	75	6542	C	1. Hydrostatically test air receiver.	C-3	MM3 FN	1.0 1.0	None
AP	ZZZFCH5	85	7082	C	1. Disassemble the compressor and inspect internal parts for wear.	C-4	MM2 MM3	12.0 12.0	Q-2

MAINTENANCE INDEX PAGE
OPNAV FORM 4700-3 (4-64)

BUREAU PAGE CONTROL NUMBER A-4/30-65

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Figure 15-10.—Planned maintenance for a low pressure air compressor.

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CHAPTER 16

ADDITIONAL AUXILIARY EQUIPMENT

There are a number of AUXILIARY UNITS OUTSIDE THE REGULAR ENGINEERING SPACES which you will be expected to know something about. This machinery includes the steering gear, anchor windlasses, deckwinches, capstans, cranes, elevators, pumps, and miscellaneous remote controlled valves. You may or may not be responsible for the operation of this equipment, but you must know how to maintain the units in good operating condition. Most of this auxiliary equipment operates hydraulically.

It may be helpful for you at this point to review the chapter on hydraulic principles and machinery in Basic Machines, NavPers 10624-A, and Fluid Power, NavPers 16193-A.

Some pieces of the auxiliary machinery, such as anchor windlasses, are required to operate at variable speeds over a considerable range. In addition, there must be close control of speed between maximum and minimum limits. A common requirement of this auxiliary machinery is high starting torque and ability to accelerate to maximum speed quickly. To meet these requirements in modern Navy ships, the electrohydraulic drive has been adopted. Because some of the older ships are still being used, we will also discuss electromechanical and steam-driven auxiliary machinery.

As a Machinist's Mate, you are also responsible for maintaining and repairing galley and laundry equipment, when required. This equipment is maintained in operating condition through the joint efforts of operating personnel and maintenance personnel. In general, the operator will keep the equipment clean, make minor adjustments related to the operation of the machine, and, in some installations, accomplish routine maintenance. When trouble occurs, the operator must determine whether electrical or mechanical equipment is involved. If mechanical equipment needs maintenance, it is the responsibility of the Machinist's Mate to make the necessary repairs, replacements, or adjustments. Therefore, a section dealing with the maintenance of galley and laundry equipment is included in this chapter.

Inasmuch as Machinist's Mates are required to handle one or all of the several compressed gases used aboard ship, you should have a general understanding of the characteristics and uses of these gases. Therefore, this chapter has a section dealing with industrial gases.

ELECTROHYDRAULIC SPEED GEAR

Rotary motion, transmitted by hydraulic equipment, is accomplished by use of a combination of an electrically driven hydraulic pump (A-end) and a hydraulic motor (B-end). See figure 16-1. For a discussion of the operation of this pump (axial piston variable-stroke pump) refer back to chapter 5 of this training course.

Since the B-end is already on stroke, it will be made to rotate by the hydraulic force of the oil acting on the pistons. Movement of the pistons' A-end is controlled by a tilt box in which the socket ring is mounted.

By moving the tilt box one way or another, and by the amount of angle at which the tilt box is placed, the length of piston movement is controlled. This in turn controls the amount of fluid flow. The A-end is always in motion, but with the tilt box in a neutral or vertical position no oil is pumped to the B-end. Any movement of the tilt box, regardless of how slight, causes pumping action to start, and

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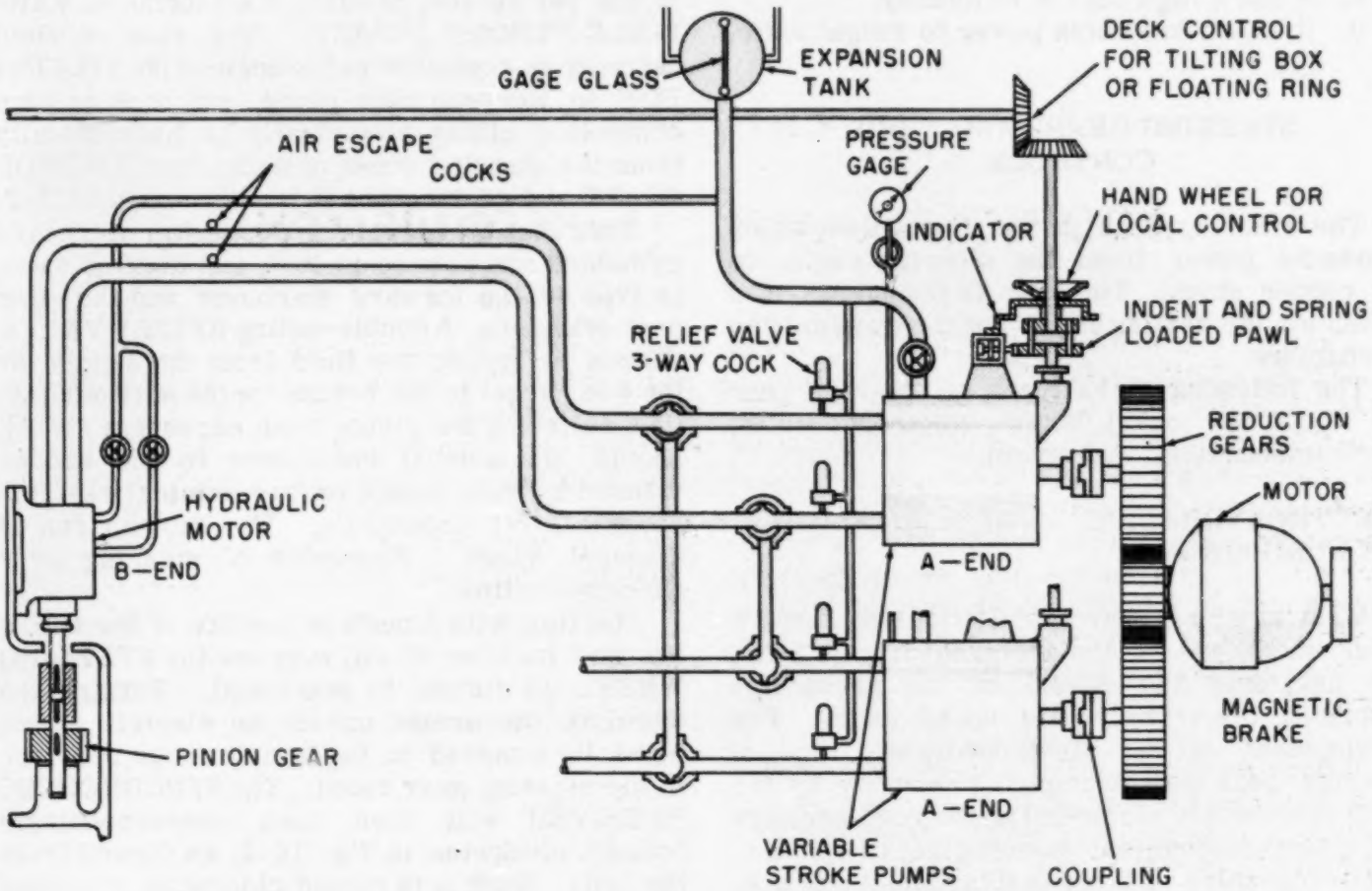

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Figure 16-1.—Typical hydraulic power transmission.

therefore causes immediate action in the B-end.

When reciprocating motion is desired, such as in a steering gear, the B-end is replaced by a piston or ram. The force of the hydraulic fluid causes the movement of the piston or ram. The tilt box in the A-end can be controlled either locally (as on the anchor windlass) or by remote control (as on the steering gear).

USES OF ELECTROHYDRAULIC SPEED GEAR

Hydraulic units are used for driving or controlling steering gears, windlasses, winches, capstans, airplane cranes, ammunition hoists, and distant control valves. This chapter contains information on hydraulic units with which Machinist's Mates are concerned.

ADVANTAGES OF ELECTROHYDRAULIC MACHINERY

The electrohydraulic type of drive very efficiently meets the operating requirements of modern naval machinery. Some of the major advantages of electrohydraulic machinery are that:

1. Tubing, which can readily transmit fluids around corners, is used to conduct the liquid which transmits the force.
2. Very little space is required for tubing.
3. It allows flexibility in location of components.
4. Operation at variable speeds is possible.
5. Close control of speeds from minimum to maximum limits is allowed.
6. It can be shifted from no load to full load rapidly without damage to machinery.

CHEMICAL DISINFECTANT CHART (Continued)

Disinfectant	Mixture	Application	Remarks
Halogens			
Iodine	(2% tincture) purchase as 2%	Navel and skin disinfectant Effective against ringworm and warts.	Good skin disinfectant, but destroys skin tissues on contact.
Chlorine (sodium hypochlorite	1 gal. of laundry chlorine bleach to 250 gals. of water.	Dairy utensils and metals An effective udder wash	Presence of organic matter decreases effectiveness.
Detergents			
Anionic Phisodex Triton or other laundry detergents	Liberal amount in warm water.	Skin cleaning Feed and water containers	Removes dirt and some infectious agents. Low toxicity Low antiseptic action.
Cationic Benzalknonium Chloride-zephiran	1:1000 to 1:1200	Dairy utensils and metals An effective udder wash May be used for ringworm	Non-irritating Low toxicity Will be of some benefit even when organic matter is present.
Alcohol	Buy 50% ethyl alcohol.	Skin disinfectant Storage for needles, etc.	
Formaldehyde	37% gas	Fumigation Used with heat (150°F) and moisture (high humidity)	A highly poisonous gas Very toxic to all animals.
	Use 4% solution (add 1 part formalin to 10 parts water)	A powerful germicide, can be used to penetrate cracks in floors and walls	Very toxic to all animals.

CONTROL OF DISEASE TRANSPORT THROUGH APPLICATION OF SANITATION

There are many means of introducing disease into a herd and spreading the disease on a farm. When a diseased animal must be isolated there are certain conditions that must be met for real isolation. Insects, rodents, and birds often act as vectors in spreading disease. These are called biological or live vectors (bearers, carriers).

If all live vectors can be controlled, there is still the possibility of transmission of disease from sick animals to healthy animals through the herdsman himself. In addition to discussing the control of rodents and birds, this section presents a general sanitation program to prevent the mechanical transmission of disease.

7. It accelerates quickly.
8. It has a high rate of efficiency.
9. It has a favorable power to weight ratio.

STEERING GEARS AND THEIR CONTROLS

The steering gear is the mechanism which transmits power from the steering engine to the rudder stock. The term is frequently used to include the driving engine and the transmitting mechanism.

The following three types of steering gear are found on naval ships: electrohydraulic, electromechanical, and steam.

ELECTROHYDRAULIC STEERING GEAR

Most steering gear installations on modern naval ships are of the electrohydraulic type, and use only the A-end of the previously described electrohydraulic speed gear. The development of the electrohydraulic type of steering gear was prompted primarily by the large momentary electrical power requirements for electromechanical steering gears—particularly for ships of large displacement and high speed. Also the elimination of d-c power from ships made switching and speed control of electric motors more difficult.

Types of Steering Gears

There are various types of electrohydraulic steering gear layouts in use, but their operating principles are about the same. Some ships have double hydraulic rams and cylinders mounted fore and aft; others have double-cylinder single rams mounted athwartships. Some systems use axial piston variable-stroke pumps; others use radial piston pumps.

Information on components of a hydraulic system is provided in Fluid Power, NavPers 16193-A.

How the Steering Gear Operates

Figure 16-2 shows a simple diagrammatic arrangement of a double-ram type electrohydraulic steering gear. Here the RUDDER YOKE is connected to two hydraulic PLUNGERS or RAMS, each ram is equipped with CYLINDERS at both ends. The pressure of the hydraulic fluid in the closed system is maintained by one of the two rotary, positive displacement, VARIABLE-STROKE PUMPS. The rate of fluid delivery is regulated by the angle of the TILTING BOX in the hydraulic pump, which is in turn controlled either electrically or hydraulically from the steering wheel on deck. The CONTROL SHAFT and gearing are indicated in figure 16-2.

Note that the forward port and after starboard cylinders are interconnected, and that the same is true of the forward starboard and the after port cylinders. A double-acting RELIEF VALVE serves to bypass the fluid from the supply (or the discharge) to the return (or the suction) line, thus relieving the piping from excessive strain, should an unusual resistance to the rudder (caused by wave action or by jamming) result in abnormal oil pressures. The motors run at constant speed. Examples of steering gear operation follow.

Starting with a neutral position of the tilting box and no flow of oil, suppose the STEERING WHEEL is turned to starboard. Turning the wheel on the bridge causes an electric signal to be transmitted to the synchronous receiver in the steering gear room. The SYNCHRONOUS RECEIVER will then turn correspondingly (counterclockwise in fig. 16-2, as viewed from the left). Shaft A is turned clockwise, carrying gear B with it. The gears C, meshing with gear B and internal gear teeth on E, turn counterclockwise. Then E turns counterclockwise and turns the CONTROL SHAFT, which operates the TILTING BOXES on the PUMPS. A quantity of oil now flows to the forward port and after starboard cylinders, the rams move as indicated in figure 16-2, the rudder is thereby caused to move to the right, and an equal portion of oil is returned to the pumps from the opposite cylinders.

When the steering wheel and synchronous receiver stop moving, the starboard ram, in moving forward, operates the RACK AND PINION and turns gear D clockwise. Gear B and shaft A are held by the now motionless synchronous receiver, and gear C and casing E turn clockwise, thus returning the tilting boxes to the neutral position and stopping the flow of oil. The PLANETARY DIFFERENTIAL GEAR thereby, operates as a followup mechanism. If the steering wheel is turned to port, the actions described are the opposite in direction.

In actual installations, two sets of synchronous receivers, two sets of electric motors and pumps, are provided for reliability and

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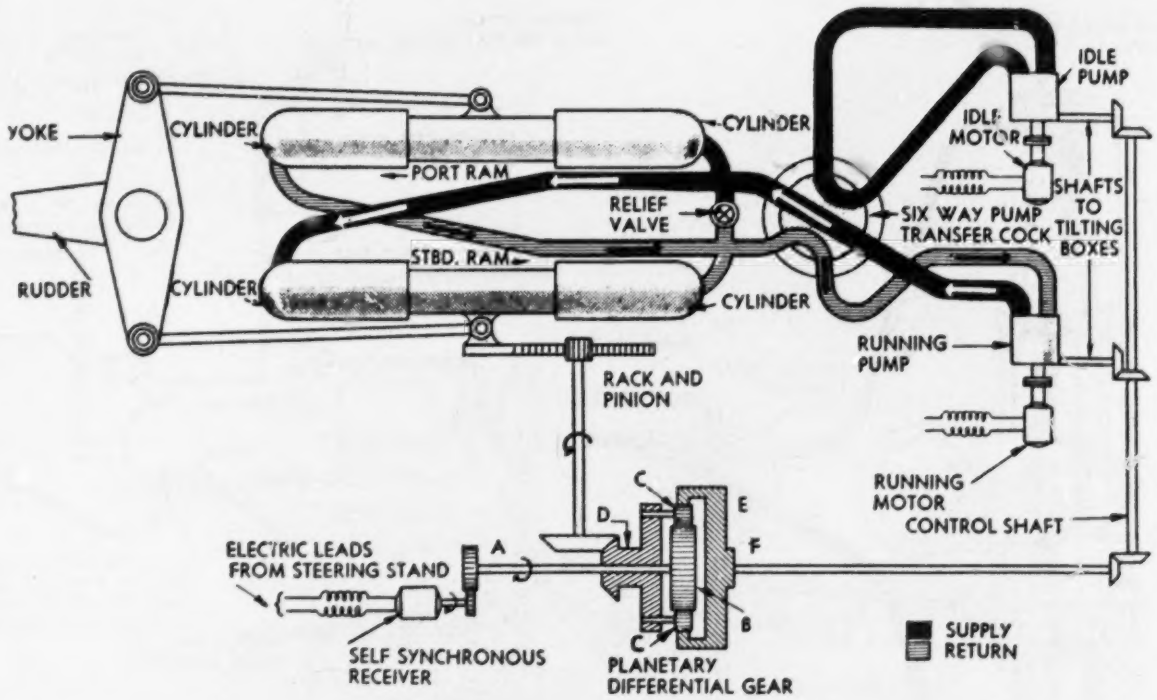

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Figure 16-2.—Simple diagrammatic arrangement of a double-ram electrohydraulic steering gear.

flexibility. The SIX-WAY PLUG COCK makes it possible to transfer quickly from the operating pumps to the standby pump.

The single-ram type of electrohydraulic steering gear, illustrated in figure 16-3, operates on the same principle as the double-ram type. The only difference is that there is but one ram, with port and starboard cylinders, mounted athwarthship. As the port plunger is forced to move by the pressure of oil against it, the starboard plunger moves correspondingly and forces the same amount of oil out of the starboard cylinder.

STEAM-DRIVEN STEERING GEAR

There are several types of steam steering gears still in use, however, but all of them operate on the same general principle. You should understand this general principle, as well as what inspections should be made, and how to maintain the mechanism in good working order.

Principles of Operation

Figure 16-4 illustrates a right- and left-screw steering gear used on a few auxiliary ships. Turning effort is through a gear train comprised of a spur gear on the power input shaft, which drives the right-threaded and left-threaded screw shaft. The driven nuts on the screw shaft move forward and aft as the shaft turns and the links transmit the movement to the rudder yoke which is keyed to the stock of the rudder. In the worm gear and quadrant type steering gear (illustrated in Fireman, NavPers 10520-C), two or more cylinders are used on this steering gear (each acting as a simple reciprocating steam engine), driving a common crankshaft. The cranks are placed at right angles when two cylinders are used, to provide for a continuous even torque, and to keep the engine from ever being at a dead center position. To reduce the height of the installation, the cylinders are sometimes placed in a horizontal or an inclined position.

Except for use on some auxiliary ships, steam-driven steering engines have been

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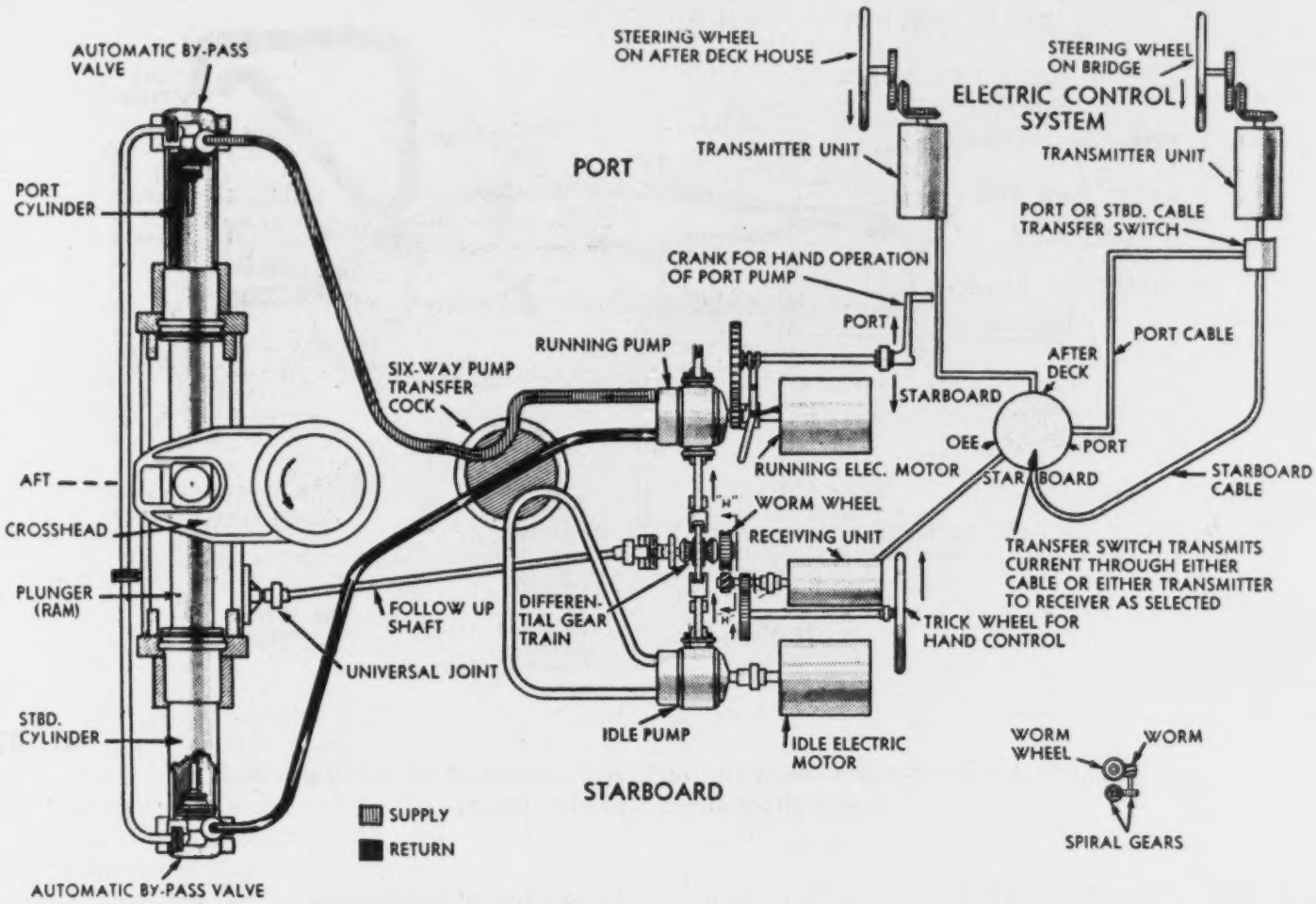

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Figure 16-3.—Diagrammatic arrangement of a single-ram electrohydraulic steering gear.

abandoned because of vulnerability of the steam piping, lost heat, poor economy, excessive maintenance, excessive space and weight, and lack of flexibility.

Inspection and Care of Steam-Driven Steering Gear

All bearings in the steering engine must be well lubricated. Bearings that are difficult to reach or those located in hot places should be given special attention.

Emery, emery cloth, or any other gritty substance should never be used for cleaning the bright surface of the steering engine or its associated gear. The spaces adjacent to gears must be kept clean, and not used as storage places for clothing or other articles. Such material might become entangled with the transmission gears.

WHEN NOT UNDERWAY, and the steering gear is not in use, the steering engine should be turned over at least twice a week to preserve the pistons, valve stems, and other working parts. During freezing weather, steam-driven steering engines not in use should be drained of water, and the drain valves left open so that condensate of any leaking exhaust steam may drain. Be sure the drain holes are kept clear; otherwise, the cylinders or jackets may freeze.

ELECTROMECHANICAL STEERING GEAR

Electric motors were first introduced as prime movers of steering gears on combat

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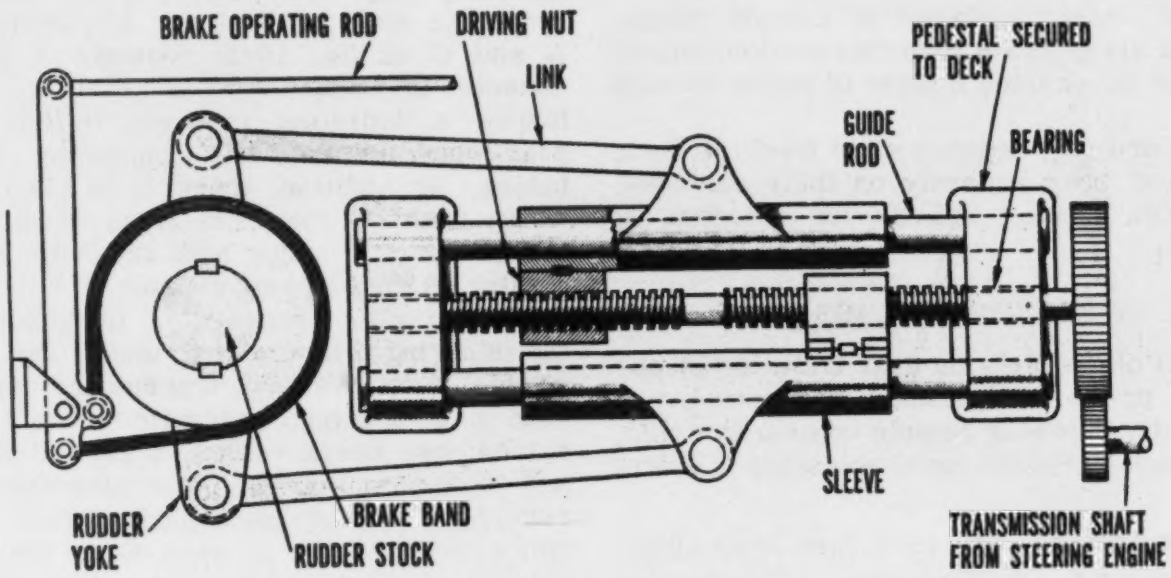

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Figure 16-4.—Right-and-left screw steering gear.

ships to serve in case of failure of the steam steering engines. Later on, however, they were used as the primary source of power, with steam as a reserve. This type of steering equipment may be found on naval auxiliary ships which have been converted from maritime type ships.

Principles of Operation

The principles of operation are practically the same for all designs of electromechanical steering gear. Any differences that exist are mainly in the manner in which the driving motor is connected to the rudder stock, and the method by which the motor is controlled. The electric motor drives a right-and-left screw (fig. 16-4), or worm gear and quadrant, as with the steam-driven gears or it may drive a winch drum connected to a quadrant on the rudder stock with wire rope. The steering motor control may be either followup or non-followup. In the non-followup type, the motor is controlled by a master controller at the steering station and continues to turn as long as the control is held over unless power is interrupted by a limit switch.

When the master controller is brought to neutral, dynamic braking action takes place to slow down the motor; the motor is finally brought to rest and held by a magnetic brake. The followup type of control usually uses a roller and ring type contact in the steering engine stand. The rollers are geared to the helm and rotating the wheel brings a roller in contact with a contact ring. The ring is connected to the motor control panel and when the circuit is closed, the motor turns in the proper direction. When the ring has rotated to the required position, the electrical circuit is broken and the motor stops.

Most wire rope and chain drive steering gears use a followup control system. The followup motion is transmitted from the steering gear to the steering stand by means of shafting, bevel gears, and flexible couplings.

In most electromechanical installations, the shafting connecting the steering engine to the wheel is utilized not only to provide followup control to the steering stand, but also to provide a means for steering by hand from the pilot house if power is lost.

Maintenance of Electromechanical Steering Gear

The following instructions are for the care and inspection of electromechanical steering gear. The frequency of inspection usually depends on the amount of operation and operating conditions. Inspections should be conducted at least once each month.

1. Gears and bearings should be lubricated in accordance with instructions in the manufacturer's technical manual.

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2. Crocus cloth should be used to clean the inner and outer surfaces of contact rings.

3. The air gaps between ring sections should be cleaned by passing a piece of paper through the gaps.

4. Ensure that brushes slide freely in their holders and bear squarely on their surfaces.

5. Check contact rollers for freedom of movement.

CONTROL OF STEERING GEARS

Control of the steering gear from the steering wheel on the bridge may be accomplished by any of the following remote control systems, although most modern naval ships use the first one:

1. ELECTRICALLY, by means of an alternating current synchronous transmission system.
2. HYDRAULICALLY, by means of a hydraulic telemotor system.
3. ELECTRICALLY, by means of a direct-current pilot motor and its controller.
4. MECHANICALLY, by means of a shafting or wire rope from the steering station.

Alternating-Current Synchronous Transmission

The alternating current synchronous transmission type of remote control consists of receiving and transmitting units which are similar to small motors; these are connected to the same alternating-current supply. When the transmitter rotor is turned, the receiver motor turns at the same speed and in the same direction.

The transmitters are located in steering stands, at remote control stations and are mechanically connected through gearing to the wheels. A transmitter at one of the remote stations is electrically connected to a receiver in the steering room. The receiver is connected to the control shaft of the variable displacement hydraulic pump through a differential. Where more than one remote steering station is provided, a switch is provided for selecting the desired control station. Indicating lights are provided on the steering stands and at the selector switch to indicate the selected circuit and that power is available.

Hydraulic Telemotor Control

The hydraulic telemotor type of remote control (fig. 16-5) is found on many Navy auxiliary ships that are equipped with electro-hydraulic steering engines. The system (parts A and C of fig. 16-5) consists of a steering console (hydraulic transmitter) in the pilot house; a hydraulic receiver in the steering gear compartment, and connecting hydraulic tubing. In addition, there is an electric cable which connects the helm angle transmitter on the receiver housing with the helm angle indicator on the steering console.

A hydraulic transmitter is located inside the steering console and under the steering wheel. The hydraulic transmitter components consist of a pump, hydraulic tubing, two relief valves, two check valves, a replenishing tank, and a bypass valve. The remotely located receiver is a hydraulic plunger-type unit with two cylinders—one on each end of the receiver housing—in axial alignment. A double-acting plunger operates in the cylinders. On the middle portion of this plunger a crosshead is connected for mechanical linkage to the steering gear control mechanism.

The direction of the hydraulic fluid movement depends upon the direction of rotation of the steering wheel. Rotation of the steering wheel actuates bevel and spur gears which in turn operate a reversible, hydraulic, axial piston type pump. The operating principles of this pump are similar to those of the axial piston variable-stroke pump.

In the reversible axial piston pump, however, the socket ring is set permanently at a fixed angle so that the pistons are always on stroke. When the pump shaft and cylinder barrel are rotated by means of the steering wheel, the pistons draw fluid in from one hydraulic fluid line and discharge it to the other hydraulic fluid line. Reversing the rotation of the steering wheel reverses the direction of fluid flow through the pump. The pump has external check valves and piping for replenishing the hydraulic system from the tank. Relief valves and a bypass valve (part B of fig. 16-5) are also included, as well as vents for purging the system.

When the hydraulic pump shaft is rotated in one direction, the fluid output is discharged from one side of the pump to one of the receiver cylinders. In the other cylinder, hydraulic fluid is displaced to the hydraulic pump. Thus the hydraulic fluid under pressure moves the receiver plungers and produces a linear movement of the crosshead. This motion is, in turn, transmitted to the connected steering gear

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control mechanism. Travel of the crosshead and plungers is limited by adjustable stops on the receiver housing. In part C of figure 16-5, the solid arrows show direction of action for right rudder while the broken arrows show the flow of hydraulic fluid for right rudder.

Air cocks and filling or charging connections are provided on the receiver cylinders for venting, filling, or purging the hydraulic system.

FILLING THE TELEMOTOR SYSTEM from the charging tank is done by opening the air cocks at the forward telemotor and starting the charging pump. After the oil has appeared at the air cocks, the pumping is continued until the oil is free of bubbles. The air cocks are then closed and the oil allowed to fill the replenishing tank. While the pump is still operating, the valve leading to the replenishing tank is closed and the system is subjected to a slight pressure.

The effective operation of the telemotor system depends upon the PURGING OF ALL ENTRAINED AIR and the elimination of leaks. Purging the system of air, under normal operating conditions, is done by opening the valve leading from the replenishing tank, and the air cocks at the forward telemotor. Because the replenishing tank is located above the highest point of the telemotor system, the air is forced out of the air cocks by the gravity flow of oil. The cocks are closed when the oil flows smoothly without bubbles.

To detect and eliminate leaks in the system, the valves and joints should be inspected frequently. To correct a leaky piston in the internally packed telemotor, see that the leathers are in good condition, and that the springs (if used) keep the leather in contact with the inside wall of the telemotor cylinders. To stop leaks in the externally packed telemotor, tighten the glands just enough to cause the packing to be compressed about the rams, until the leak is stopped.

The HYDRAULIC FLUID CHARACTERISTICS are especially important when the telemotor system is exposed to low ambient temperatures. Under such conditions, a high grade mineral oil having a cold pour point of -24°F to -40°F should be used. Where low temperatures are not involved or where special oil with the designated cold pour point cannot be readily obtained, the symbol 2075H oil may be used satisfactorily. The oil should have a low rate of expansion and be sufficiently viscous at 150° F to remain a good hydraulic fluid.

When FILLING THE CHARGING TANK with hydraulic fluid, strain the oil into the tank through a funnel which has in it a fine mesh screen. This prevents the entry of foreign matter and at the same time prevents the entry of air bubbles into the hydraulic system. The oil should never be allowed to become contaminated with water.

Direct-Current Pilot Motor Control

The direct-current pilot motor type of remote control is used with some early electrohydraulic steering gears. It consists of a small, reversible direct-current motor, which is connected, through a differential gear, to the control shaft of a variable-stroke pump. The pilot motor is controlled by means of a magnetic control panel located next to the motor, and with a master controller located at the steering wheel. (The motor has a magnetic brake which stops and holds the motor when the master controller is returned to the neutral position.)

Auxiliary Hand Operation

Auxiliary hand gear is provided for most ships that have electrohydraulic steering gears. This auxiliary hand gear usually consists of a hand-operated hydraulic pump supplemented by chain hoists.

The hydraulic emergency steering system consist of a relief valve, shuttle valve, hand-operated dual hydraulic pump, associated piping, valves and fittings. The piping from the emergency pump to the main hydraulic system is arranged so that the high-pressure stop valves may be closed to prevent leakage through the main hydraulic units from the pressure developed by the hand pumps. The emergency pump is usually connected to the main hydraulic system, permitting the use of all four ram cylinders. If the emergency pump is not connected in this manner, it is necessary to reduce the speed of the ship in order to limit the ram pressure to that permitted by the pump design. Since it is necessary to block off the emergency system under normal steering gear operation, the emergency lines are generally connected to the drain valves; this eliminates the necessity of additional high pressure valves.

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As the emergency steering system, described in this section, depends upon an intact hydraulic system for operation, rudder positioning equipment to permit steering with the propellers (after all other means of steering have been rendered inoperable) is also furnished. This equipment consists of some type of mechanical device for moving the rudder with the ship dead in the water.

Steering Engineroom Watch

As a Machinist's Mate, you may be required to stand watch in the steering engineroom. The duties of the steering engineroom watch include operation, care, and emergency repair of the machinery in your charge. Operating instructions and system diagrams are posted in the steering gear room. The diagrams describe the various methods of operating the steering gear under normal as well as emergency conditions. The diagrams show the position of the valves for setting the gear for each method of operation.

During your watch in the steering engineroom make sure that the standby equipment is ready for instant use in case of an emergency.

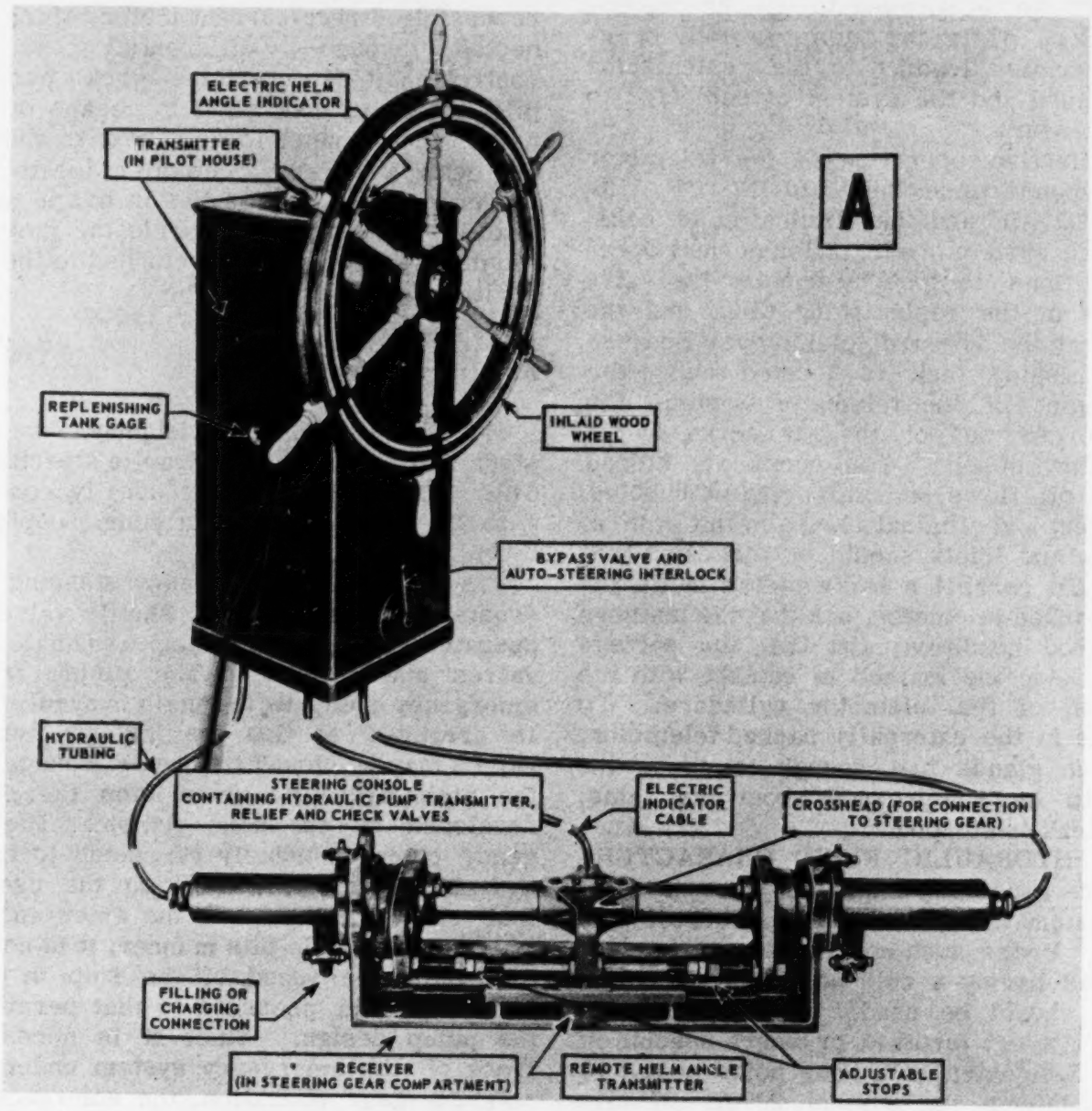

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Figure 16-5.—Hydraulic telemotor control. A. Telemotor components.

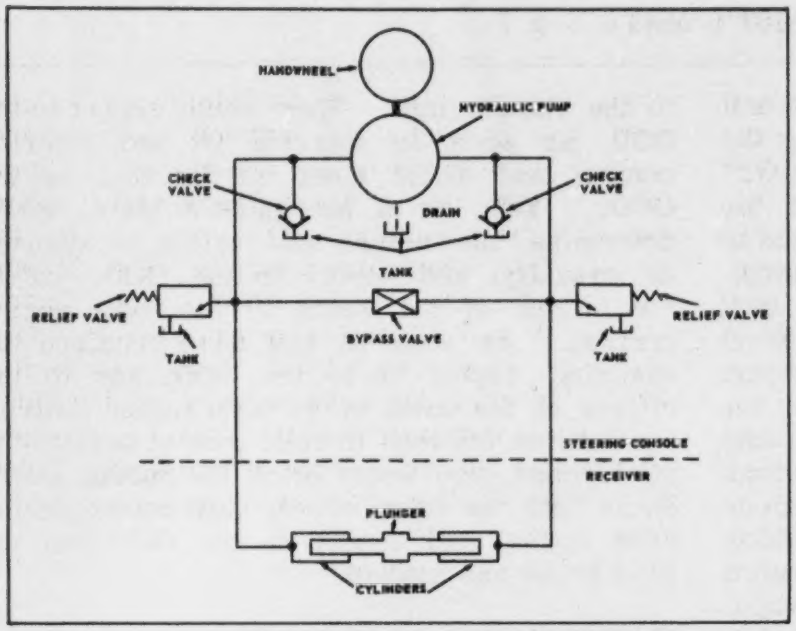

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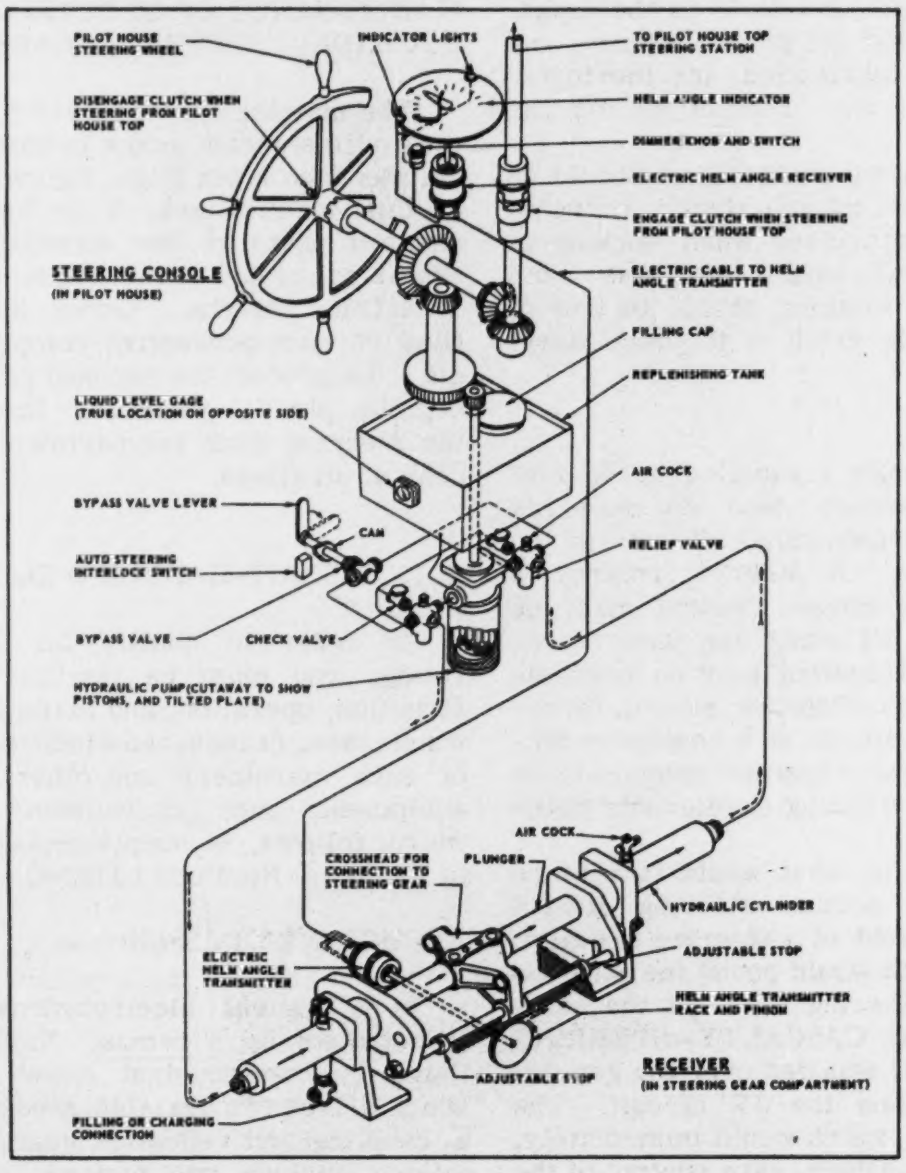

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Figure 16-5.—Hydraulic telemotor control—Continued. B. Hydraulic circuit diagram. C. Schematic diagram of telemotor components.

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Inspect the steering gear thoroughly. The unit in operation should be checked by feeling the various parts. Any part that feels "HOT" to the bare hand should be reported to the officer of the deck (OOD) on the bridge and to the officer of the watch in main engine control. Investigate for binding, overloading, and lack of lubrication. Listen for new or unusual sounds which indicate loose parts or wear. Bleed all air out of the system. Check for leaks in the lines and fittings. Piping leaks usually occur following unusual strain (rough seas). Most leaks can be corrected by tightening the flange bolts. Small leaks at ram packing glands are not objectionable since the small flow of hydraulic fluid provides lubrication. Always maintain sufficient fluid in the tanks. Check and ensure that all grease fittings and surfaces requiring lubrication are lubricated in accordance with the instructions on the lubrication chart.

All applicable safety precautions should be observed. Keep oil off the deck. Extreme caution should be exercised when working in the confined spaces around the rams and actuating gear. All clothing should be free of loose ends that might catch in the machinery.

Steering Casualty

Steering is normally controlled in the pilot house by the helmsman, who receives his orders from the commanding officer via the officer of the deck. If steering control is lost from the pilot house, control must be shifted to steering aft using emergency procedures. Shifting of control may be necessitated by damage to the telemotor system or remote control apparatus, or as a routine underway training measure to test the preparedness and efficiency of the steering engineroom watch party.

In general, this is what would take place when shifting from normal steering control to steering aft in event of a steering casualty. The pilot house watch would sound the steering alarm located in steering aft. At the same moment "STEERING CASUALTY—STEERING CASUALTY" would be sounded over the general announcing system and the JV circuit. The steering engineroom watch would immediately, and without further orders, take control of the trick wheel. They would match the trick wheel to the actual rudder position. If necessary, the steering engineroom watch party would shift to the standby unit. They would report to the OOD as soon as steering aft had steering control and would steer as directed by the OOD. You, as a Machinist's Mate, would determine the nature and extent of damage or casualty, and report to the OOD, and to the officer of the watch in the main engine control. As soon as you have repaired the casualty, report it to the OOD, and to the officer of the watch in the main engine control. Upon being ordered to shift control back to the pilot house, you would bring the rudder amidships with the trick wheel, shift control to the pilot house, and report to the OOD that the pilot house has control.

MAINTENANCE OF ELECTRO-HYDRAULIC STEERING GEARS

The maintenance required for most electrohydraulic steering gears is shown on the Planned Maintenance Index Page, figure 16-6. In addition to this maintenance, it is important that the exposed parts of the steering gear rams be protected against water and damage from rolling or falling objects. Cover them with a thin film of rust-preventive compound or a heavy oil. To protect the exposed parts from rolling objects, place a guard over the parts, and keep the steering gear compartment clear of loose gear at all times.

WEIGHT-HANDLING EQUIPMENT

In order to qualify for advancement in rating, you must be familiar with the construction, operation, and maintenance of anchor windlasses, cranes, and winches. The discussion of such machinery and other weight-handling equipment, such as capstans and elevators, which follows, is supplementary to that given in Fireman, NavPers 10520-C.

ANCHOR WINDLASSES

In a typical electrohydraulic mechanism (illustrated in Fireman, NavPers 10520-C), there is one constant speed electric motor which drives two variable-stroke pumps through a coupling and reduction gear. Other installations include two motors, one for driving each of the pumps. Each pump normally drives one wildcat, though (with the use of 3-way plug cock type valves) either pump

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System, Subsystem, or Component	Reference Publications
Steering Gear	

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
AU	ZZZESRO	75	4065	W	1. Inspect all pins, couplings, and shafts. 2. Inspect agreement of helm angle indicator with mechanical rudder indicators. 3. Inspect ram packing glands for correct tightness. 4. Inspect system for excessive oil leaks.	W-1	MM3 FN	0.5 0.5	None
AU	ZZZESRO	65	A627	W	1. Lubricate ram room machinery. 2. Lubricate pump room machinery. 3. Inspect oil levels.	W-2	MM3	1.0	None
AU	ZZZESRO	25	2383	M	1. Inspect rudder stock packing. 2. Clean packing gland.	M-1	FN	0.5	None
AU	ZZZESRO	65	A628	M	1. Lubricate pump room machinery.	M-2	MM3	0.5	None
AU	ZZZESRO	72	6669	Q	1. Sound and tighten foundation bolts.	Q-1	FN	0.6	None
AU	ZZZESRO	45	9347	Q	1. Drain hydraulic oil filter on fill and drain pump.	Q-2	FN	0.2	None
AU	ZZZESRO	45	8150	Q	1. Provide hydraulic oil sample for chemical analysis.	Q-3	FN	0.1	None
AU	ZZZESRF	65	A629	Q	1. Inspect oil level and lubricate emergency steering gear. 2. Test operate unit.	Q-4	MM2 FN	0.5 0.5	None
AU	ZZ1ECW4	84	4915	S	1. Lubricate flexible couplings.	S-1	MM3	0.8	None
AU	ZZZESRO	65	A630	S	1. Lubricate follow-up gears.	S-2	FN	0.1	None
AU	ZZZESRO	65	A631	S	1. Filter oil in hydraulic system.	S-3	MM3 FN	3.0 3.0	Q-2
AU	ZZZESRO	25	7756	A	1. Renew oil in speed reducers.	A-1	MM3	1.0	None
AU	ZZZESRF	85	6368	A	1. Inspect motor brake and lubricate linkage.	A-2	MM3	0.3	None
AU	ZZZESRO	65	4919	A	1. Conduct operational test of steering gear.	A-3	MM1	0.3	None

(Page 1 of 2)

MAINTENANCE INDEX PAGE
OPNAV FORM 4700-3 (4 64)

BUREAU PAGE CONTROL NUMBER A-1/56-65

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Figure 16-6.—Planned Maintenance Index Page, steering gear.

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Controlling the Spread of Disease by Animal Pests

The most common animal pests in the United States are rats, mice, English sparrows, starlings, and pigeons. Any sanitation program must provide for control of these pests.

1. Rodents are wasteful because they eat and ruin grain feeds by consumption and littering. They are also harmful as carriers of some of the worst diseases known to mankind.

Rodents are rather easy to control if buildings and grounds are neat and clean. A thorough clean-up of facilities and the poisoning of rodents are two absolutely necessary steps in initiating a sanitation program on your home farm. The cheapest and best way of controlling rodents is by poison. There are many forms of poison on the market, but anticoagulants are the best for general use.

Anticoagulants disturb the blood processes and when properly administered will cause the rodents to die from internal bleeding. Since these poisons are tasteless and odorless when they are mixed with tasty feed animals keep coming back for continued doses until they die. This usually takes from 5 to 14 days. Warfarin, pival, and fumarin are examples of the different kinds of anticoagulants. There is also a poison on the market named "Raticate," which is specific in that it kills only rats.

a. Using anticoagulants - the safest and surest way of using anticoagulants is to buy them ready-mixed. Several companies have ready-mixed anticoagulants for sale. Five to ten pounds of mixed bait will control rodents on most farms.

b. Directions for use - place one to two cups of mixed bait in shallow pans in areas where rats are most frequently found. Make certain that children and pets do not have access to the bait station. Bait stations can be constructed from boards 4 feet long and 10 to 12 inches wide, either nailed or hinged at a 45° angle from a building wall. A wooden box turned upside down with entry holes in either end can be used where the first method is impractical. Tile pipe and hollow logs have also been used with good results. A pan of water near the bait station will increase the kill because rodents are very thirsty when eating the poisoned material.

Examine the bait station every day for the first week and then every other day for several weeks after. Never allow the bait station to be empty more than 48 hours. Always bait for at least two weeks. Replace all moldy or sour bait. A good way to find out if rodents are visiting the bait station is to sift white flour on the floor or ground where the entry to the bait station is and check for tracks. If no tracks are found in 72 hours, move the bait station.

c. Precautions - (1) Never let children, pets, or other farm animals eat the coagulant bait or come in contact with it. A doctor must be consulted if children should accidentally eat some. (2) Burn or bury all dead rodents to prevent disease spreading. (3) Handle the anticoagulant as if it were deadly poison (because it is).

During and after baiting the rodents, the premises must be thoroughly cleaned. All rubbish must be picked up and disposed of where it can no longer harbor rats. All buildings and other structures should be rat proofed. Rats like to burrow under granaries, water tanks, and feed bunks, close to feed. An L shaped 18" concrete

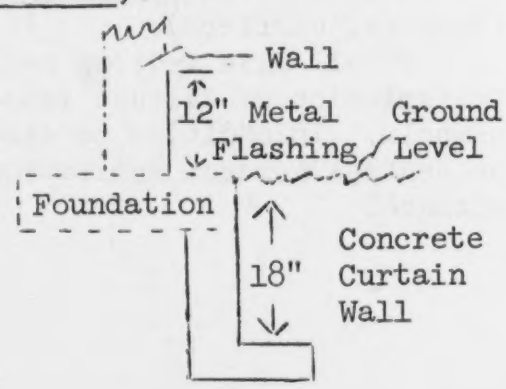

may drive either of the two wildcats. The hydraulic motors drive the wildcat shafts by means of multiple spur gearing and a locking head. The locking head permits disconnecting of the wildcat shaft thus permitting free operation of the wildcat as when dropping anchor.

Each windlass pump is controlled either from the weather deck or locally with handwheels on shafting leading to the pump control. The hydraulic system will require your attention. Make certain that the hydraulic system is always serviced with the specified type of clean oil.

The types of windlasses which a Machinist's Mate will probably have to maintain are the electric, electrohydraulic, and the hand-driven windlasses. Hand-driven windlasses are only used on small ships where the weight of the anchor gear is such that it can be handled without excessive effort by operating personnel.

In maintaining a hand windlass, the major factor is to keep the linkage, friction shoes, locking head, and brake in proper adjustment and in satisfactory operating condition at all times. In maintaining an electrohydraulic windlass, your principal concern will be the hydraulic system. Since hydraulic systems are basically the same, the information given under "Maintenance of Hydraulic Systems," later in the chapter, is applicable to steering gear, windlasses, winches, cranes, and elevators.

Even though used intermittently and only for relatively short periods of time, a windlass must be capable of handling the required load under extremely severe conditions. To prevent deterioration and to provide dependable operation wherever required, maintenance and adjustment must be continued during the periods when the machinery is not in use.

Windlass brakes must be maintained in satisfactory condition if they are to perform their function properly. Because of wear and compression of brake linings, the clearance between the brake drum and band will increase after a windlass has been in operation. Brake linings and clearances should be inspected frequently. Means of adjustment are provided on all windlass brakes. Adjustments should be made in accordance with the manufacturer's instructions.

Lubrication instructions furnished by the manufacturer should be followed carefully. If a windlass has been idle for some time, lubrication of the equipment should be accomplished before operation is attempted. After a windlass has been used, the equipment should be lubricated to protect finished surfaces from corrosion, and to prevent freezing of adjacent parts.

The hydraulic transmissions of electrohydraulic windlasses and other auxiliaries are manufactured with close tolerances between moving and stationary parts. If these tolerances are to be maintained and unnecessary wear prevented, every possible precaution must be taken to prevent the entry of dirt and other abrasive material. When the system is replenished or refilled, only clean oil should be used and the oil should be strained as it is poured into the tank. If a hydraulic transmission has been disassembled, all parts should be thoroughly cleaned before reassembly. Before piping or valves are installed, their interiors should be cleaned to remove any scale, sand, or other foreign matter.

WINCHES AND CAPSTANS

Winches are used for heaving in on mooring lines, hoisting boats, topping lifts on jumbo booms of large auxiliary ships, and for handling cargo. Power for operating shipboard winches is usually furnished by steam or electricity. Where delicate control and high acceleration without jerking are required, such as for handling aircraft, electrohydraulic winches are usually installed. Most modern auxiliary ships are equipped with either electrohydraulic or electric winches, while the other auxiliary ships are equipped with either steam or electric winches.

Cargo Winches

Among the various types of winches for general cargo handling are: double-drum, double-gypsy, and single-drum single-gypsy units. Four-drum two-gypsy machines are generally used for mine sweeping.

STEAM WINCHES.—The steam-operated deck winch (fig. 16-7) is driven by a two-cylinder, single expansion, double-acting reciprocating engine. The drive is by means of a train of spur gears in which a gear shift is provided to give two drive speeds.

Illustrated in figure 16-7 (part A) is a plan view of a winch with two gypsy heads (1), one mounted at each end of the main

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drive shaft. The speed and direction of rotation of the engine is controlled by a hand lever (14). Steam is admitted through the steam line connections (6) and (8). With the winch in "compound gear", the drum turns to lift a load when the hand lever (14) is raised. With the lever in this position, a spool-type valve passes steam from the reverse valve (9) through the two top horizontal pipelines (5) to the cylinders where it drives the engine.

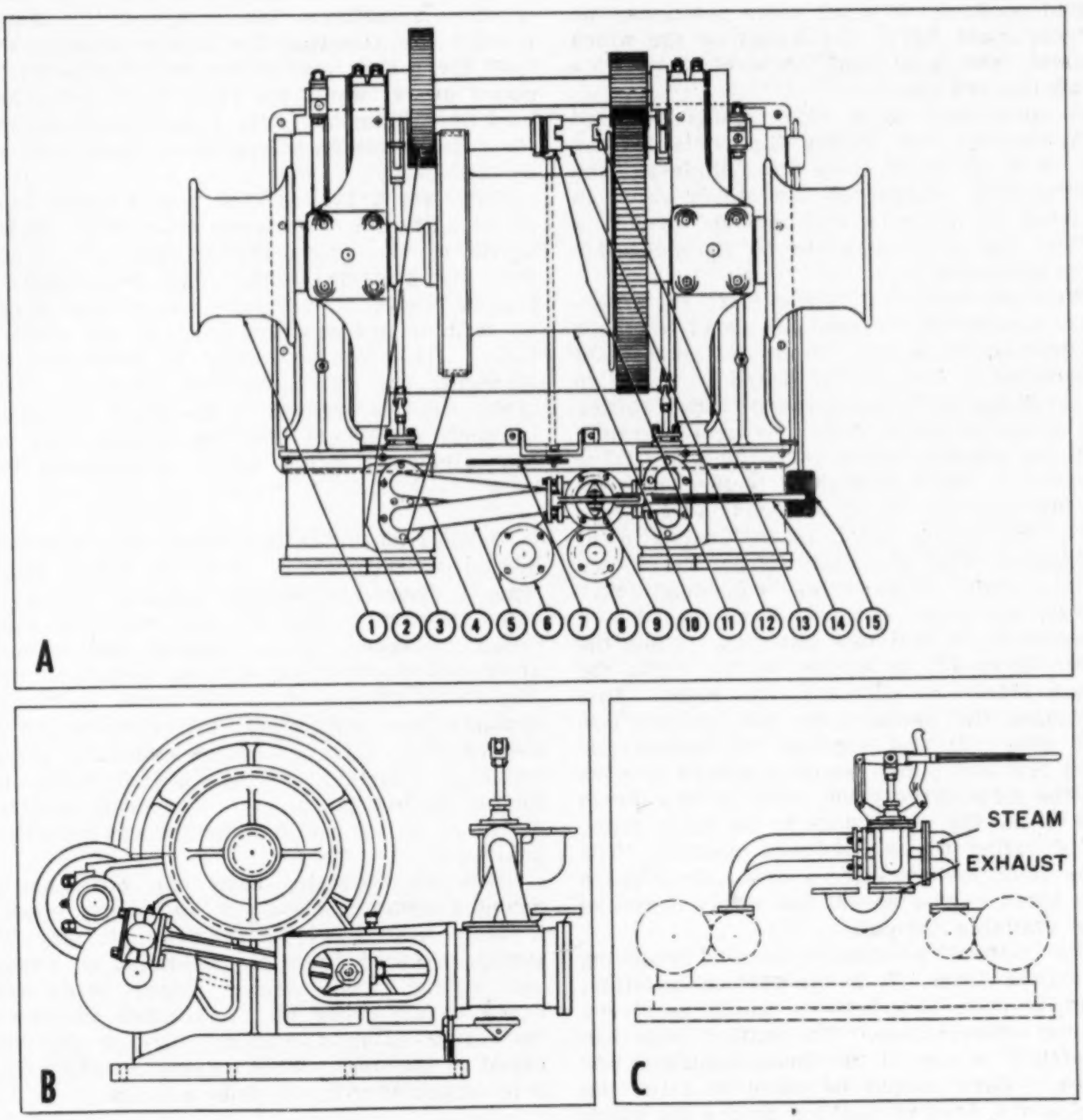

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Figure 16-7.—Steam-operated winch. A. Plan view. B. Side view. C. Reversing throttle valve.

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(Also see parts B and C of fig. 16-7.) The two lower pipes (4) are exhaust lines. When the lever is lowered below the horizontal position, the direction of steam flow is reversed in these pipes and the engine turns in the opposite direction,thus lowering the load. Some levers are provided with an automatic latch for holding them in the horizontal, or neutral position. For all other positions, the controls must be in the hands of the winch operator who must hold the lever in position for the desired speed.

A spool-type steam valve slides back and forth, opening and closing the ports for the flow of steam to or from the cylinders. The reciprocating motion of the steam valve is imparted to it by a rod moving through a stuffing box and connected to the eccentric on the main shaft.

With the winch in "single gear" the direction of rotation is reversed and a load is raised by lowering the lever. The clutch mechanism consists of a sleeve (11) which is keyed to the crankshaft (12) and provided with a shifter yoke which is operated by a lever (7) located near the reverse valve (9). (See part C of fig. 16-7.) When this lever is thrown to the left (the position shown in part A of figure 16-7), the pinion which is integral with it, is engaged with the gear (2) on the intermediate shaft. This is the "compound gear" position and gives a slower-drum speed with an increase in available line pull. When the shifter lever (7) is thrown to the right, the driving sleeve is shifted to the right. This disengages the pinion from the intermediate shaft gear (2) and engages the square jaw clutch (13) and pinion which is always in mesh with the main drive gear. This gives a direct drive from the crankshaft to the main shaft, and is called the single gear position. The single gear position gives a higher drum speed for a given engine speed, but with a decrease in the available line pull.

The "neutral" position is obtained by placing the shifter lever (7) in the vertical position, leaving no connection between the driving sleeve (11) and either pinion. The shifter lever can be latched in any of the three described positions. Care should be taken to latch the lever in the desired position before the winch is operated.

When the winch is under heavy load, there is a high pressure between clutch faces, or gear teeth. This makes it impossible to shift the sleeve and change the gear ratio. To make a change, it is necessary to remove the load from the winch and then turn the engine over very slowly while making the shift.

With the engine running in a given direction, the shifting from compound gear to single gear, or vice versa, reverses the direction of drum rotation. The design of the winch is such that lowering the load by lowering the hand lever (14), applies for heavy loads (compound gear), while the reverse, lowering the load by raising the lever (single gear) applies for higher speeds where heavy loads are not encountered.

The winch is provided with a gypsy head (1) at each end of the main drive shaft. Being keyed to the shaft, the gypsies are turned with the hoisting drum. The drum (10) is provided with a standard type of band brake (3) with a foot-operated control and ratchet lock. The locking device is controlled by springing the foot pedal (15) laterally. The brake band is secured to the winch bed plate in such a manner that the brakes may be convenieniently taken up to compensate for wear.

ELECTROHYDRAULIC WINCHES.—Electrohydraulic winches (fig. 16-8) are always drum type. They are usually installed on ships with alternating current and where a wide range of speed, close control, and smooth acceleration are required, as in cargo handling. The drive equipment is like most hydraulic systems; a constant speed electric motor drives the (A-end) variable-stroke hydraulic pump which is connected to the (B-end) hydraulic motor, by suitable piping. The drum shaft is driven by the hydraulic motor through reduction gearing.

Winches normally have one horizontally mounted drum and one or two gypsy heads. If only one gypsy is required, it may be easily removed from or assembled on either end of the drum shaft. Gypsy heads are keyed to the drum shaft and rotate whenever the winch is in operation. Drums are not keyed to the shaft. When a drum is to be used, it is connected to the shaft by a clutch.

Capstans

The terms "capstans" and "winches" should not be confused. The primary differences

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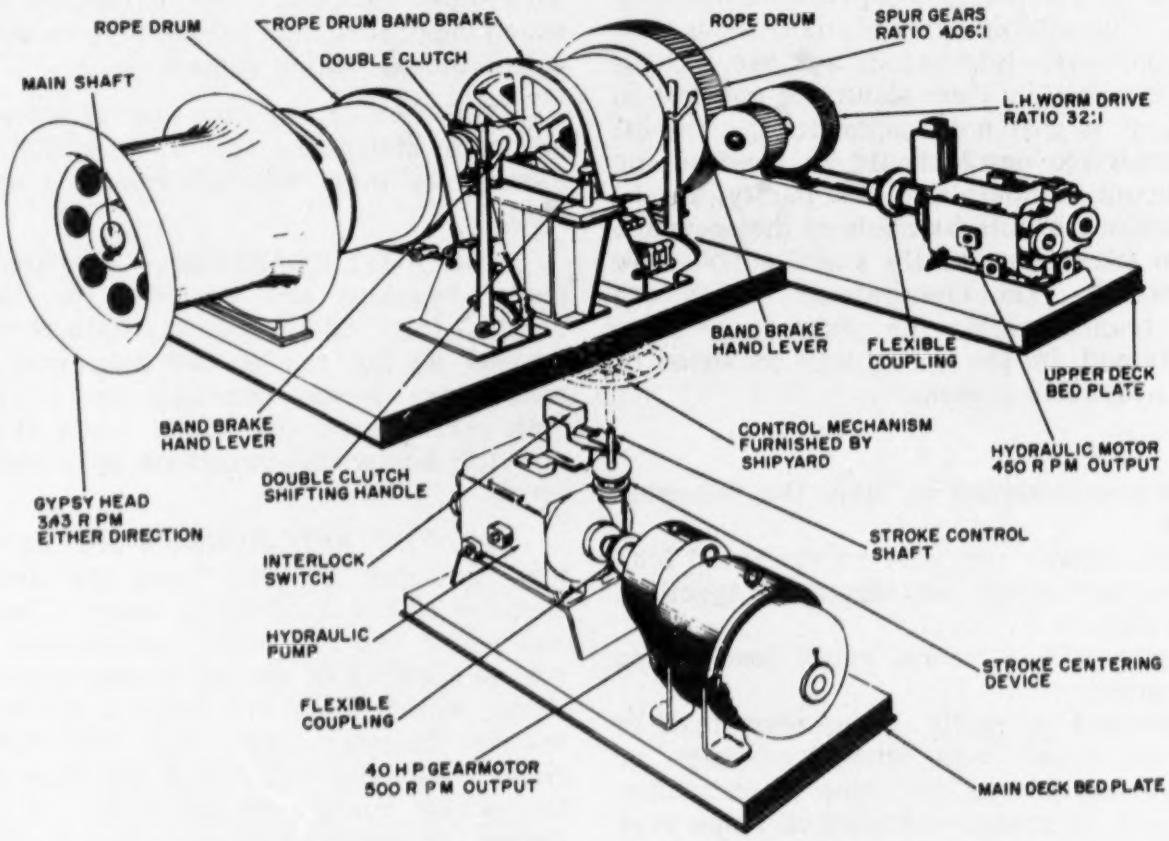

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Figure 16-8.—Electrohydraulic winch units.

between a winch and a capstan is that a winch has a horizontal shaft and a capstan has a vertical shaft. The type of capstan installed aboard ship depends on the load requirements and type of power available. In general, a capstan consists of a single head mounted on a VERTICAL shaft, reduction gearing, and a power source. The types, classified according to power source, are electric and steam.

ELECTRIC CAPSTANS.—Electric capstans are usually of the reversible type and develop the same speed and power in either direction. Capstans driven by alternating-current motors have two speeds, full speed and one-half speed. Capstans driven by direct-current motors usually have from three to five speeds in either direction of rotation.

STEAM CAPSTANS.—Steam capstans were formerly used extensively on Navy ships, but they are now used only occasionally where the electric power is insufficient.

Steam capstans are driven by twin cylinder, reciprocating, reversible steam engines. A hand-operated control valve reverses and controls the speed of the capstan. Steam-driven capstans generally do not operate on full boiler pressure, usually a reducing valve is used to reduce the steam supply between 100 psi and 135 psi.

Maintenance of Winches and Capstans

In several respects, the maintenance of a winch or a capstan is similar to that of a windlass. Where band brakes are used on the drums, the friction linings should be inspected regularly and replaced when necessary. Steps should be taken to prevent oil or grease from accumulating on the brake drums. The operation of brake-actuating mechanisms, latches, and pawls should be checked periodically.

Winch drums driven by friction clutches should be inspected frequently to determine if

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deterioration has occurred in the friction material, or if oil and grease are preventing proper operation. The sliding parts of positive clutches must be properly lubricated, and the locking device on the shifting gear should be checked to determine if it will hold under load. The oil of gear reduction units should be checked for proper amount, temperature, and purity. Periodic inspections should be made of the pressure lubrication fittings normally installed on slow moving parts. On installations which use hydraulic transmission, the pumps and lines are maintained in the same way as those of any other hydraulic system.

Cranes

Cranes are designed to meet the following conditions:

1. Hoist, lower top, and rotate rated load at the specified speed, and against a specified list of the ship.
2. Handle 150 percent rated load at no specified speed.
3. Withstand a static, suspended load of 200 percent rated load without damage or distortion to any part of the crane or structure.

The types of cranes installed on ships vary in accordance with the equipment handled. Cranes are classified as general type and type of drive as follows:

1. General Type
   a. Rotating king post.
   b. Stationary king post.
   c. Fixed topping lift.
   d. Variable topping lift.
   e. Jib.
2. Type of Drive
   a. Electrohydraulic.
   b. Straight electric.
   c. Gasoline engine.
   d. Diesel engine.
   e. Hand operated.

Components of Cranes

The crane equipment generally includes the boom, king post, king post bearings, sheaves, hook and rope, machinery platforms, rotating gear, drums, hoisting, topping and rotating drives, and controls. The important components are described in the paragraphs which follow.

BOOMS.—A boom, used as a mechanical shipboard appliance, is a structural member utilized for lifting, transferring, or supporting heavy weights. A boom is used in conjunction with other structure or structural members which support it, and various ropes and pulleys, called blocks, which control it.

KING POSTS.—A king post of either the rotating or stationary type is provided, as necessary, to meet the lift requirements of the ship.

KING POST BEARINGS.—On stationary king posts, bearings are provided for taking both vertical load and horizontal strain at the collar, located at the top of the king post. On rotating king posts, bearings are provided for both vertical and horizontal loads at the base, and for horizontal reactions at a higher deck level.

SHEAVES AND ROPES.—The hoisting and topping ropes are led from the drums over sheaves to the head of the boom. The sheaves and ropes are designed in accordance with recommendations by the Naval Ship Systems Command, which gives the criteria for selection of sheave diameter, size, and flexibility of the rope. Sufficient fair-lead sheaves are fitted to prevent fouling of the rope. A shock absorber is installed in the line, hoisting block or sheave at the head of the boom, to take care of shock stresses.

MACHINERY PLATFORMS.—Machinery platforms are provided for carrying the power equipment and operator's station. These platforms are mounted on the king post above the deck.

ROTATING GEAR AND PINIONS.—Rotation of the crane is accomplished by means of vertical shafts with pinions engaging a large rotating gear.

DRUMS.—The drums of the hoisting and topping winches are generally grooved for the proper size wire rope. The drums in the latest designs are arranged to stow the rope in one layer in order to facilitate spooling and to prevent crushing of the rope. The hoisting system is arranged for use with single or multiple part lines as required. The topping system is arranged for use with a multiple purchase as required.

Operation and Maintenance of Cranes

The hoisting whips and topping lifts of cranes are usually driven by hydraulic variable-speed

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gears, through gearing of various types. This provides the wide range of speed and delicate control required for load handling. The cranes are usually rotated by an electric motor connected to worm and spur gearing, or by an electric motor and hydraulic variable-speed gear connected to appropriate reduction gearing.

Some of the electrohydraulic cranes are also provided with automatic slack line takeup equipment, consisting of an electric torque motor geared to the drum. When these cranes are used for lifting boats, aircraft or other loads from the water, the torque motor assists the hydraulic motor drive to reel in the cable in case the load is lifted faster by the water than it is being hoisted by the crane.

Electrohydraulic equipment for the crane consists of one or more electric motors, running at constant speed. Each motor drives one or more A-end variable displacement hydraulic pumps whose strokes are controlled through operating handwheels. START, STOP, and EMERGENCY RUN pushbuttons are located at the operator's station for the control of the electric motors. Interlocks are provided to prevent starting the electric motors when the hydraulic pumps are on stroke. B-end hydraulic motors are connected to the A-end pumps by piping, and drive the drums of the hoisting and topping units or the rotating machinery.

Reduction gears are provided between the electric motor and the A-end pump and between the B-end hydraulic motor and the rotating pinion. Each hoisting, topping, and rotating drive is provided with an electric brake on the hydraulic motor output shaft. The electric brake is so interlocked with the hydraulic pump control that the brake will set when the hydraulic control is on neutral or when electric power is lost. A centering device is provided for accurately finding and retaining the neutral position of the hydraulic pump.

Relief valves are installed for the protection of the hydraulic system. These relief valves are normally set at 150 percent of the normal working pressure.

A rapid slack-takeup device consisting of an electric torque motor, which is connected to the hoist drum through reduction gearing, is usually provided on cranes. This device works in conjunction with the pressure stroke control on the hydraulic pump, and provides for fast acceleration of the hook in the hoisting direction under light hook conditions. Thus, slack is prevented from forming in the cable when hoisting is started.

Some cranes are provided with a light-hook paying-out device. This device is mounted on the end of the boom to pay out the hoisting cables when the weight of the hook and cable beyond the boom head sheave is insufficient to overhaul the cable as fast as it is unreeled from the hoisting drum.

When the mechanical hoist control is in neutral, the torque motor is not energized and the cable is gripped lightly by the action of a spring. Moving the hoist control to LOWER energizes the torque motor, and the sheaves clamp and pay out the cable as it is unreeled from the hoist drum. When the hoist control is moved to HOIST, the torque motor is reversed and operates to unclamp the sheaves. A limit switch opens and automatically de-energizes the paying-out device. Figure 16-9 shows the light-hook pay-out device with the torque motor paying out the cable.

Maintenance of cranes should be accomplished in accordance with the planned maintenance system requirements or the manufacturers' instructions. In general, the maintenance of electrohydraulic cranes requires that the oil in the replenishing tanks be kept at the prescribed levels, and that the system be kept clean and free of air. The limit stop and other mechanical safety devices must be checked regularly for proper operation. When cranes are not in use, they should be secured in their stowed positions and all electric power to the crane controllers disconnected at the power distribution panel.

ELEVATORS

Some of the hydraulic equipment which you may be required to maintain will be found in electrohydraulic elevator installations. Elevators of this type are in use on modern carriers. The elevators described in this chapter are of the type now in service on some of the more recent ships of the CVA class. These ships are equipped with four deck-edge airplane elevators which have a maximum lifting capacity of 79,000 pounds to 105,000 pounds. The cable lift platform of each elevator projects over the side of the ship and is operated by an electrohydraulic power plant.

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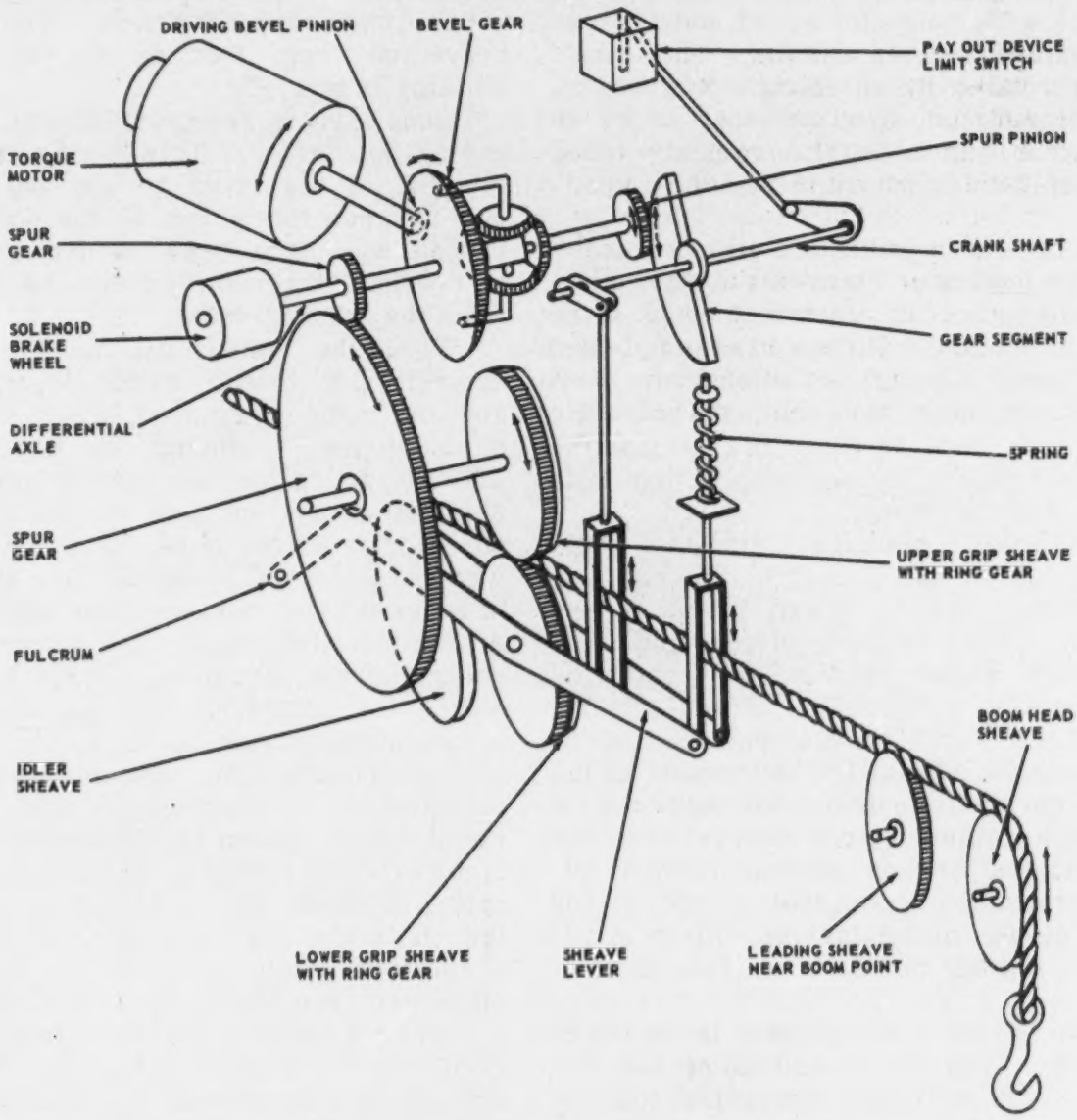

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Figure 16-9.—Light hook pay-out device.

POWER PLANT

The electrohydraulic power plant consists of the following:

1. A horizontal plunger type hydraulic engine.
2. Multiple variable delivery parallel piston type pumps.
3. Two high pressure tanks.
4. One low pressure tank.
5. Sump tank system.
6. Two constant delivery vane type pumps (sump pumps).
7. Oil storage tank.
8. Piping system and valves.
9. Nitrogen supply.

The hydraulic engine is operated by pressure developed in a closed hydraulic system. Oil is supplied to the system in sufficient quantity to cover the baffle plates in the high pressure tanks and allow for piston displacement. Nitrogen makes up the rest of the volume. Nitrogen is used because air and oil in contact under high pressure form an explosive mixture. Air should not be used except in an emergency; nitrogen, when used, should be maintained at 97 percent purity.

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Principles of Operation

The hydraulic engine is fitted with a balanced piston type valve with control orifices and a differential control unit. This control assembly is actuated by an electric motor and can be operated by hand. To raise the elevator, the valve is moved off center, allowing high pressure oil to enter the cylinder. High pressure oil entering the cylinder, moves the ram, which, through a system of cables and sheaves, moves the platform upward. The speed of the elevator is controlled by the amount of pressure in the high pressure tank and the control valve.

When the elevator starts upward, the pressure in the high pressure tank drops. This pressure drop automatically starts the main pumps which transfer oil from the low pressure tank to the high pressure system until the pressure is restored. An electrical stopping device automatically limits the stroke of the ram and stops the platform at the proper position at the flight deck level.

To lower the elevator, the control valve is moved in the opposite direction, which permits the oil in the cylinder to flow into the exhaust tank. As the platform descends, oil is discharged to the low pressure tank and the original oil levels and pressures, except for leakages, are reestablished. The speed of lowering is controlled by the control valve and the cushioning effect of the pressure in the exhaust tank. Leakage is drained to the sump tanks and is automatically transferred to the pressure system by the sump pumps. An electrically operated stopping device automatically slows down the ram and stops the platform at its lower level (hangar deck).

SAFETY FEATURES

Some of the major safety features incorporated into modern deck edge elevators include the following:

1. If the electrical power fails while the platform is at the hangar deck, there will be enough pressure in the system to move the platform to the flight deck one time without the pumps running.

2. Some platforms are fitted with serrated safety shoes. Should all hoisting cable break on one side, the shoes will wedge the platform between the guide rails and stop the platform with a minimum of damage.

3. Some main pumps are fitted with (1) pressure actuated switches which stop the pump motors when the discharge pressure reaches 1140 psi, and (2) a relief valve set to lift at 1270 psi.

4. The sump pump system has a capacity sufficient to return the unloaded platform from the hangar deck to the flight deck.

5. The oil filter system may be used continuously while the engine is running, thus part of the oil may be cleaned with each operation of the elevator.

MAINTENANCE OF HYDRAULIC SYSTEMS

As an MM, you must know how to renew packing on hydraulic engines and how to change seals and gaskets on hydraulic equipment. Details concerning any specific unit can be found in the Planned Maintenance System Manual or the appropriate manufacturer's technical manual. The information which follows will also be helpful. While the following section applies specifically to hydraulic elevators, the information is also applicable in general to most shipboard hydraulic systems.

REPLACING HYDRAULIC ENGINE CYLINDER PACKING

As the plunger moves in and out of the cylinder, the cylinder packing confines the pressure in the cylinder and prevents leakage of oil. The packing is made up of several split rings. To prevent leakage, the cylinder gland nuts must be tightened periodically. If the gland nuts have been tightened and the packing continues to leak excessively, the packing is worn or damaged and must be renewed.

To renew the packing, proceed as follows:

1. Lock the platform at the flight deck.
2. Set the stroke of the main pumps at zero and close all pressure tank, exhaust tank, and strainer valves.
3. Drain the oil from the cylinder, through the engine drain line. When oil stops draining, close the drain line.

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4. Remove the gland nuts and the gland.
5. Remove the old packing rings.
6. Insert new packing rings in the packing gland. Stagger the splits in the rings at 90° intervals. It may be necessary to support the ram in order to insert new packing on the underside of the ram.
7. Replace the gland and nuts. Care must be taken to pull the nuts up evenly and only to the point where they are snug.
8. Open all valves to the exhaust and pressure tank and open the engine air cocks.
9. Check to be certain that the main pump handwheels are set at zero stroke. Start the main pump motors and set the pumps on automatic control.
10. Open the control valve slightly, by rotating the hand control valve counterclockwise, until the oil flows from the engine air cocks.
11. Close the control valves.
12. Tighten the packing gland nuts one turn at a time until oil leakage, through the packing gland, is a few drops per second. (Nuts should be tightened so that the gland is drawn up evenly.) Some oil leakage is necessary for proper lubrication of the packing.
13. Loosen each nut one-half turn and lock with jam nut.

CAUTION: If the packing is too tight the plunger will not operate at proper speed and may also damage the packing.

14. Bleed all the air from the cylinder and pressure line.
15. Check the oil levels and pressures before placing the elevator in service. An oil seal is provided for wiping the plunger of foreign material on the in-stroke. It is split and can be removed after sliding off the plate.

REPLACING MAIN SHAFT OIL SEALS

When the main shaft oil seals become worn or damaged and cause excessive oil leakage, replace the seals as follows:

1. Disconnect the universal joint from the main shaft by removing the bolt.
2. Shove the main shaft toward the motors.
3. Remove the fork and the plate (part A of fig. 16-10).
4. Remove the old seal and replace it with a new seal (part B of fig. 16-10).
5. Reassemble the seals with the plate, fork, and universal joint (part C of fig. 16-10).

REPLACING MOTOR SHAFT OIL SEALS

To determine the condition of the motor pinion assembly and associated oil seals, make periodic inspections for excessive leakage. If it becomes necessary to replace the motor shaft oil seals, proceed as follows:

1. While supporting the motors, remove the bolts fastening the motor blocking to the mounting bracket.
2. Pull the motors horizontally away from the gear box until the pinion on the motor shaft is clear of the gear box (part A of fig. 16-11).
3. Remove the old seals and replace them with new seals (part B of fig. 16-11).
4. Return the motor pinion into the gear box, and bolt the motor blocking, or frames, into place (part C of fig. 16-11).

CLEANING MAIN AND SUMP PUMP OIL STRAINERS

The main pump oil strainers should be cleaned shortly after the hydraulic system has been filled with oil, or after repair work has been completed. (It is possible that foreign matter, such as dirt, metal chips, and filings may have entered the system.) To clean a main pump oil strainer, proceed as follows:

1. Close the strainer intake (inlet) valve and the main pump suction valve.
2. Open the air cock, at the top of the strainer, and the drain valve, at the bottom of the strainer. This will drain the oil from the strainer into the sump tank.
3. Close the drain valve.
4. Loosen the bolts and remove the cover from the strainer (part A of fig. 16-12).
5. Lift the basket out of the strainer (part B of fig. 16-12).
6. Blow out all dirt and foreign matter from the strainer basket. Then clean the strainer basket thoroughly (part C of fig. 16-12).
7. Insert the basket into the strainer, place the cover on the strainer (using a new gasket), replace and tighten the bolts.
8. Open the strainer intake valve and refill the strainer with oil from the system while bleeding off the air.
9. Close the air cock and open the main pump section valves.

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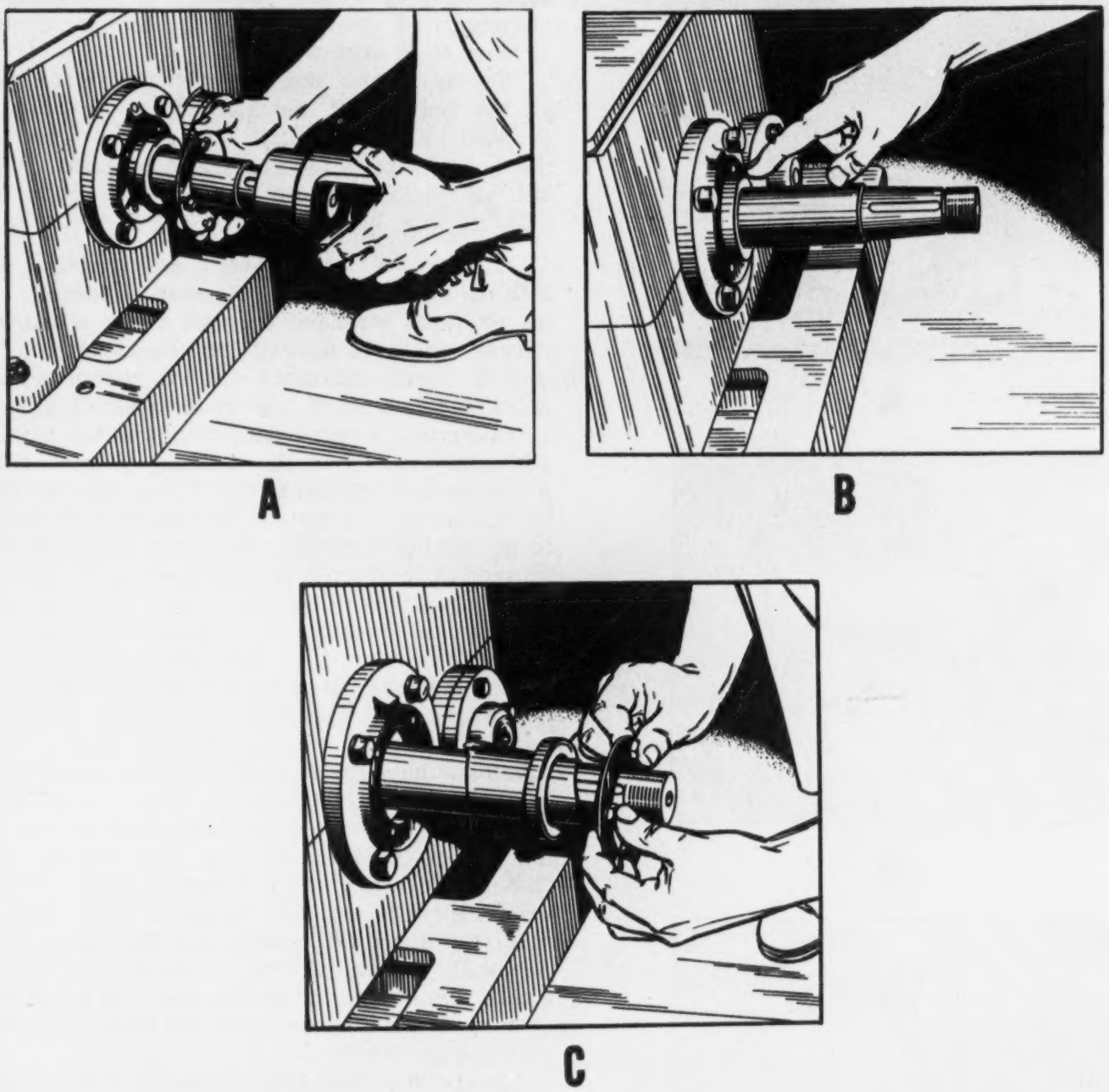

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Figure 16-10.—Replacing main shaft oil seals. A. Removing fork and plate. B. Removing oil seal. C. Reassembling oil seal and plate.

The sump pump oil strainers should be cleaned at the same time as the main pump oil strainers. They are cleaned by the following procedure:

1. Close the storage tank stop valve, the exhaust tank stop check valve, the engine stop check valve, and the sump pump stop check valve.

2. Open the air cock and the drain valve. Then continue the procedure as outlined under main pump strainers, and remember to open the check valves before refilling the strainer with oil.

CARE OF MAIN HYDRAULIC PUMPS

Maintenance of the main pump consists mainly of draining and refilling with oil, when

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curtain wall around the foundation can eliminate burrowing. All exposed wooden parts should be protected with metal flashing 12" wide.

Windows and doors should be in good repair to prevent entry. Mice can be controlled with the same methods, except that there should be less bait used per station, move the stations more often, and feed for a longer time, as mice are less susceptible to the bait than rats.

2. Bird Control. If bird pests become a problem, especially around buildings where livestock are fed, shooting is often the best control method. An air rifle (B-B gun) and a flashlight after dark can be very effective in eliminating English sparrows from semi-open buildings. Birds may be trapped in areas where shooting and poisoning are not possible, but this is not as effective as the prior methods. Poisoning birds is very effective, although care must be exercised not to kill songbirds and other harmless animals. Remember that poisoned grain left for 2 or 3 days will attract harmless birds and animals even after the objectionable birds have been poisoned.

A platform 4-6 feet high kept baited with strychnine poisoned grain will control the birds. Keep all livestock away from the platform.

3. Insect and other Arthropod Vectors. Insects and other arthropods, such as spiders, lice and fleas, in addition to being parasitical, are often the means of diseases being transmitted from one animal to another. A sanitation program can only be considered complete if all insect vectors are controlled. There is no use in keeping sick animals in isolation if flies can move from sick animals to well ones. (Agricultural Education Department Service Bulletin Number 1, Harmful Parasites of Domestic Animals, for control of parasites of animals.)

General Sanitation Practices to Follow to Prevent the Spread of Disease in the Home Herd.

Many people follow just part of a sanitation program. This could mean that the practices neglected might completely cancel out those that are followed. The program should be complete and thorough. Key points in sanitation:

1. Leave a pair of overshoes at the sick barn. They are more easily disinfected than other footwear and can readily be slipped off and left there to avoid taking germs back to healthy livestock. (Try to set a pattern of taking care of chores for healthy animals before tending sick ones. To do the reverse increases the risk of disease.)
2. Clean and disinfect your hands before and after handling sick animals. Most veterinarians now use disposable plastic arm gloves to keep completely sanitary.
3. Keep clean cattle handling equipment on hand and disinfect equipment before storage.
4. Before operating on animals for any reason, make sure that your tools and equipment are disinfected. Use disinfectant to clean the animal's hide before actually cutting into it.
5. Always use different feed and water containers for well and sick animals.
6. Never allow people to wander about your premises without disinfecting their footwear.
7. Livestock trucks should be disinfected before and after hauling any livestock.

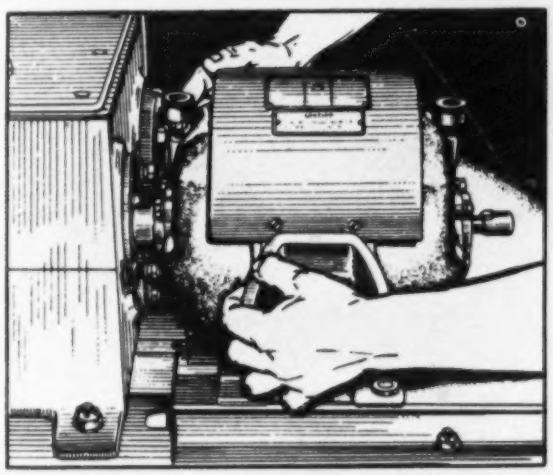

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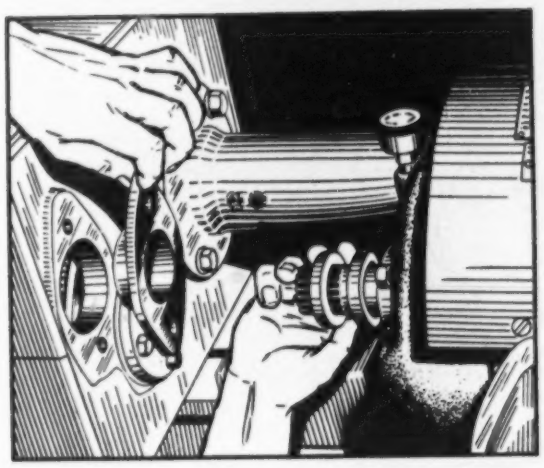

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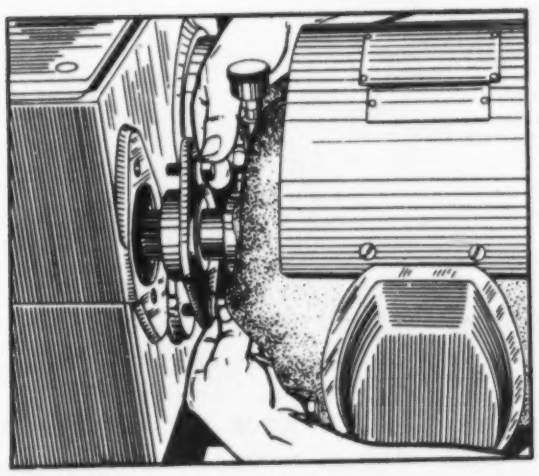

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Figure 16-11.—Replacing motor shaft oil seals. A. Pulling motors. B. Replacing oil seals. C. Returning motor pinion into gear box.

the oil in the hydraulic system has become dirty or mixed with water. In addition, the compensator control filter should be cleaned at least once each week.

To drain the pump, open the drain valve at the bottom of the unit. When the pump is drained, clean out dirt and sludge, and flush the pump with acid-free cleaning fluid. Wash out all cleaning fluid and blow the pump dry with an air hose before refilling with fluid.

Use fire resistant, or safety, fluid MIL-H-19457 in the hydraulic system. All oil must be strained through a fine mesh wire screen as it is poured into the system. The use of cloth strainers is not recommended, since the continued use of such material tends to cause an accumulation of lint in the system. This may result in the sticking of the pistons. A convenient accessory for filling may be made by soldering a piece of fine mesh wire screen to an ordinary funnel. In some cases the usefulness of the funnel is increased by the addition of a pipe thread at the lower end. By connecting this funnel to a length of pipe, the funnel may be used for filling purposes in places that are not otherwise accessible.

See that all containers used for filling the system, or for storing oil, are clean. They must not have been used previously for acids, lyes, or other chemicals. When the pump is drained after having been in service, all dirt and sludge must be cleaned out, and the pump flushed with acid-free cleaning fluid. Before refilling with oil, all cleaning fluid must be removed from the pump, and the pump blown out with air until dry. Unless this is done, either the chemical or the physical properties of the oil may be impaired by small quantities of cleaning fluids.

In elevator hydraulic systems, water seeping into the pump will usually settle in low points. If the drain plugs are removed, the water will come out.

Hydraulic equipment which has been standing idle at extremely low temperatures should be started with care. (Before operating the equipment the entrapped air should be bled from the cylinders, control valves, strainer, and piping.) While the oil is pumpable at low temperatures, it does not lubricate properly. A short time is required to force the oil between closely fitted parts so as to provide lubrication. Two or three minutes' operation at low pressures will provide ample time for penetration. During

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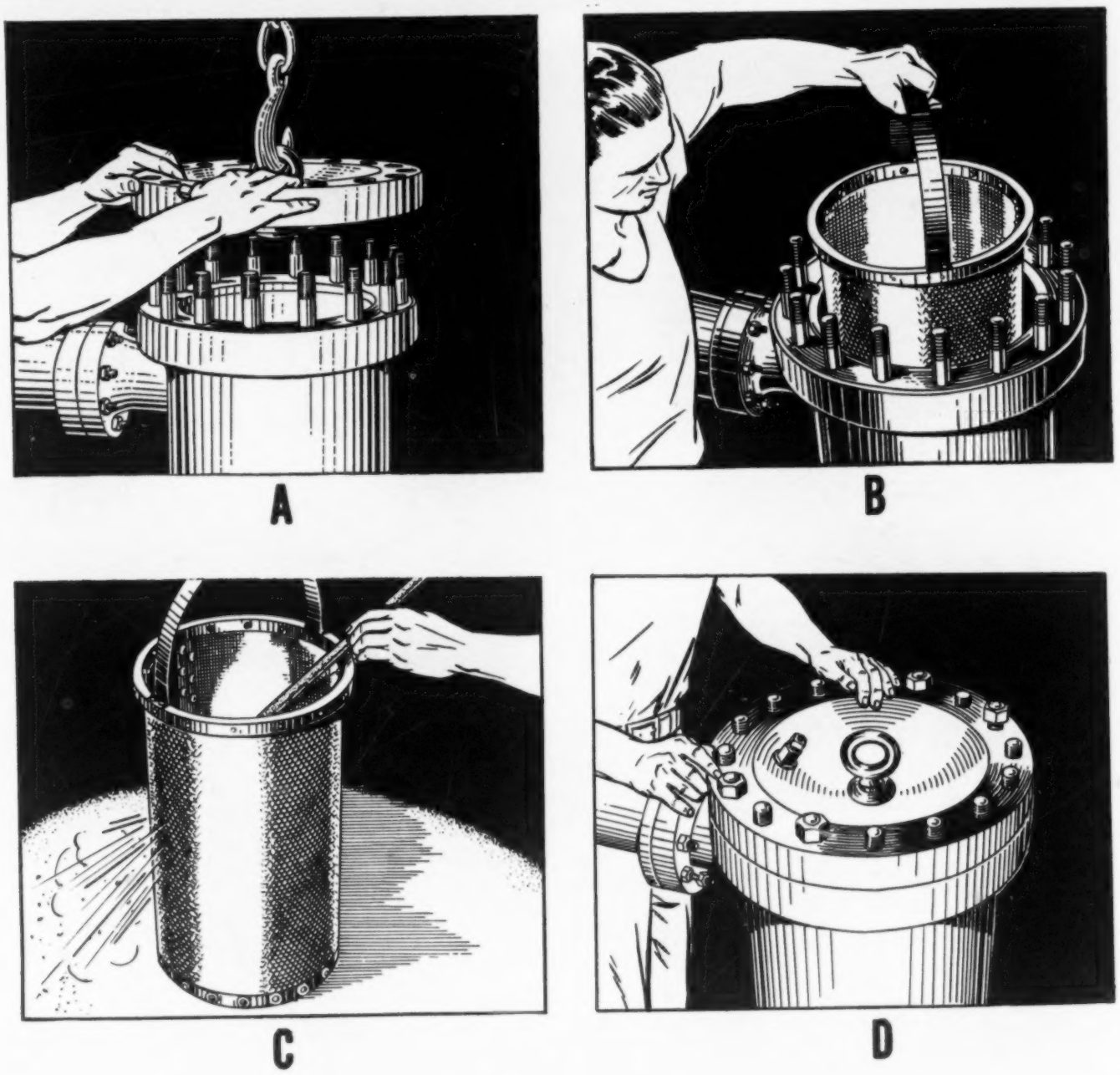

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Figure 16-12.—Cleaning main and pump oil strainers. A. Removing strainer cover. B. Lifting strainer basket. C. Cleaning strainer basket. D. Replacing strainer cover.

this time the oil will warm up and the viscosity will be greatly reduced.

Grit and abrasive particles in the oil will cause wear which destroys the seal between the pistons and the cylinder. This results in the leakage losses which reduce the efficiency beyond allowable limits. If the wear becomes excessive, the worn part should be replaced.

CLEANING AND REPLACING FILTER ELEMENTS

Each elevator has a micronic oil filter (fig. 16-13) installed in its power system. The filter is generally designed to handle approximately 140 gpm of hydraulic oil, at a working pressure of 350 psi. The quantity of oil passing through the unit is controlled

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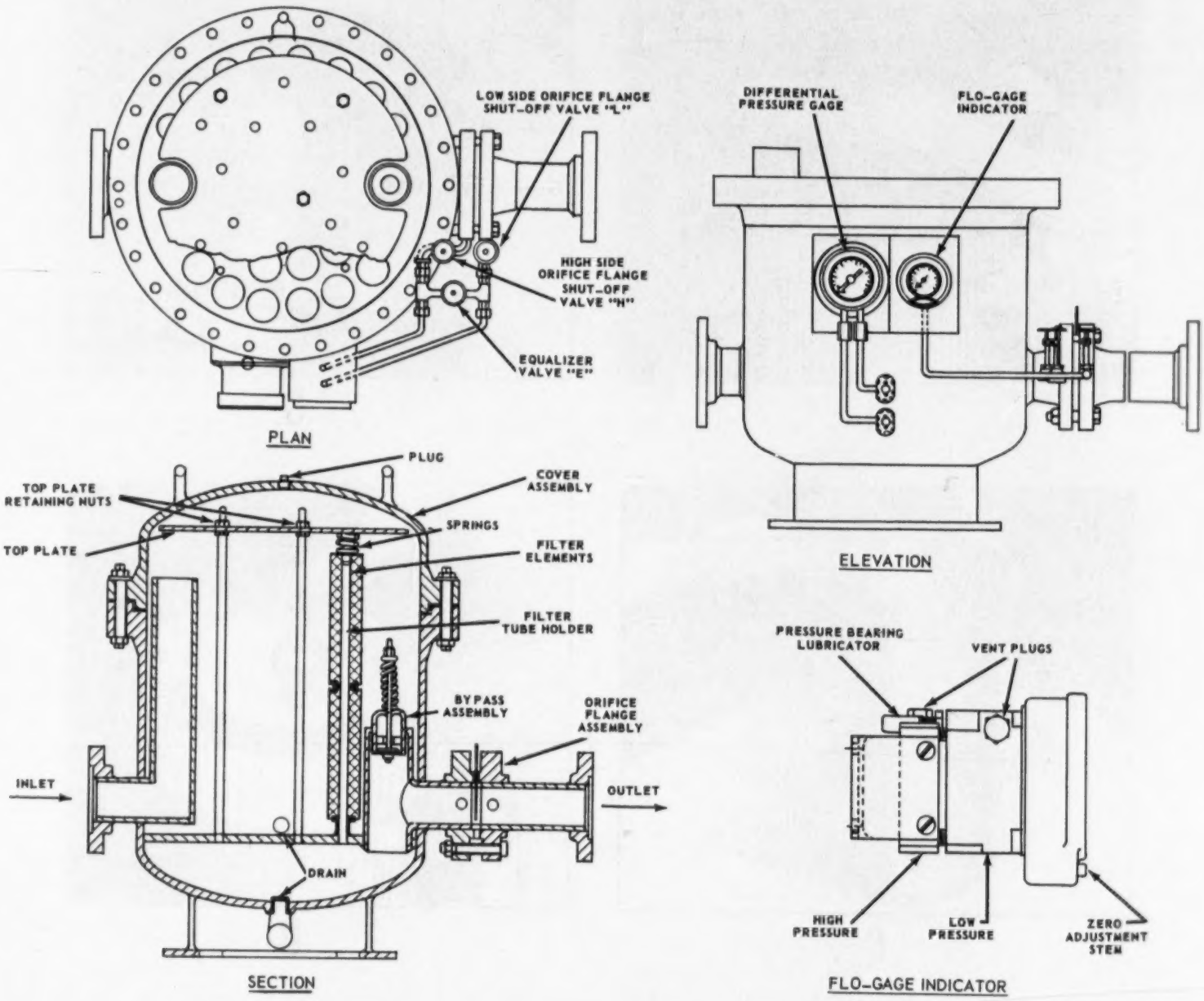

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Figure 16-13.—Micronic oil filter.

by an orifice installed between the flanges located on the discharge side of the filter. The quantity of oil will be indicated on the Flo-Gage and the pressure gage. An internal bypass valve is installed and set to open at 20 psi above the working pressure. Stop valves are installed on the inlet and outlet sides of the filter to facilitate cleaning and/or replacement of the filter elements. The piping to the filter is arranged to take oil from the exhaust tank and discharge to the suction sides of the main pumps.

To clean all the oil in the enclosed pressure system, operate the elevator on a cycle once "up" and "down"; this takes approximately 3-1/2 minutes. Use at least one of the main pumps to circulate the oil. Shorten the strokes of the pumps to reduce delivery so that the pumps are not automatically shut down between runs of the elevator. Close the inlet and the

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outlet valves of the main strainers; this will cause all the oil being pumped to pass through the filter. Watch the Flo-Gage and adjust the strokes of the pumps so that the flow does not exceed 140 gpm. Operate the elevator as frequently as necessary to keep the pumps operating, i.e., run the elevator up and down before the oil level and pressure are completely restored in the high pressure tank which would shut off the pumps. Maintain this operation for about 30 minutes—in which time, all of the oil should have passed through the filter. Observe the differential pressure gage and if the indication is above 5 psi, stop filtering and clean the filter. After the complete cleaning of the oil, the filter can be used in parallel with the main strainer. This condition will allow about 10 percent of the oil to flow through for continuous filtering during the normal operation of the elevator.

To clean the filter, proceed as follows:

1. Place the Flo-Gage in the inoperative position.
2. Close the inlet and the outlet gate valves.
3. Slowly open the globe valve in the drain line from the bottom of the filter.
4. Open the gate valve in the drain line from the side of the filter body.
5. Close the globe valve in the drain line from the bottom of the filter.
6. Attach the air hose (25 psi) to the 1/4-inch size needle valve and allow air to blow back through the filter elements, through the open gate valve to the blow-down tank.
7. Close the drain and air valve, and allow the oil to settle in the blow-down tank after which a check for the cleavage point can be made by using the try cocks on the tank. Impurities in the oil can be disposed of through the 1/2-inch valve installed below the blow-down tank.
8. When refilling with oil, or fluid, open the plug on top of the filter to bleed the air.
9. Open the outlet valve, and the inlet valve. Close the plug when all the air is out.
10. Place the Flo-Gage in operation.

If the filter cannot satisfactorily be cleaned, replace the filter as follows:

1. Proceed as for cleaning the filter elements; steps 1 through 4.
2. Remove the filter cover assembly, the top plate retaining nuts, the top plate, and the filter elements.
3. Before replacing the elements, wipe out any sediment on the bottom of the chamber.
4. Replace the filter elements on the filter tube holder and springs.
5. Before replacing the top plate, see that the element holders and springs are all evenly in place. Replace the top plate, the top plate retaining nuts, and the cover assembly.
6. Place the filter in operation by proceeding as in steps 8, 9, and 10 of the cleaning procedure.

CLEANLINESS OF HYDRAULIC SYSTEMS

Dirt or foreign matter in hydraulic systems can disable pumps, cause valves to stick, ruin packing, and damage control systems. Hydraulic systems should never be opened except for good cause and then only by qualified personnel. When it is necessary to open a hydraulic system, extreme care should be taken to keep out dirt; all parts should be carefully cleaned before being reinstalled. Oil filters should be cleaned or changed in accordance with the 3-M planned maintenance system requirements. Any oil added to the system should be filtered. Only clean oil of an approved type should be added to a hydraulic system. Use only approved packing and gasket materials and never allow water to enter a hydraulic system.

Complete maintenance of all types of hydraulic systems cannot be given in this training course. Maintenance instructions for a particular unit may be found in the Planned Maintenance System Manual or in the technical manual furnished by the manufacturer. Additional information concerning hydraulic elevator machinery, operating precautions and maintenance can be found in chapter 9830 (83) of the Naval Ships Technical Manual.

MAINTENANCE OF GALLEY AND LAUNDRY EQUIPMENT

Most of the equipment used in the preparation of food and in the sanitizing of cooking utensils utilizes electrical power. The electrical components of such equipment are usually maintained by the Electrician's Mate. The mechanical components of the smaller machines used in the galley require very little maintenance and that required will generally be

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performed by operating personnel. The Machinist's Mate will most likely be called upon to maintain larger items of galley equipment, many of which utilize steam as a source of heat. Such equipment includes steam-heated cooling equipment and dishwashing machines.

Each piece of laundry equipment (washing machines, extractors, driers, ironers, and laundry presses) should be inspected and maintained in accordance with the 3-M planned maintenance system or applicable procedures outlined in the manufacturer's technical manual for the specific equipment. Adjustments, repairs, and replacements should be made as soon as possible after the need for maintenance is revealed by an inspection.

Before proceeding with the maintenance and repair of galley and laundry equipment, you should be familiar with the type of equipment you'll have to maintain.

DISHWASHING MACHINES

The Navy uses dishwashers of the single-tank and the double-tank types. Both types are available in manual and automatic models. One model of an automatic single-tank dishwashing machine is shown in figure 16-14.

Single Tank Machines

In single tank machines the temperature of the wash water in the tank should be between 140°F. and 160°F. Rinsing is accomplished by means of hot water which is sprayed on the dishes from an outside source. The rinse water is controlled by an adjustable automatic STEAM-MIXING VALVE which maintains the temperature of the rinse water between 180° and 195°F. Washing and rinse sprays are controlled separately by automatic valves in the automatic machine, and by handles in the manually operated machine.

Double Tank Machines

Double tank machines of several sizes are in use. Machines of the double tank type are generally used when the utensils for more than 150 persons are to be washed. These machines are provided with separate wash and rinse tanks and a final rinse of hot water is sprayed on the dishes from an outside source. The final rinse is controlled by a self-closing valve which is opened by the baskets as they pass through the machine. The final rinse is fitted with an adjustable automatic steam-mixing valve which maintains the temperature of the rinse between 180° and 195°F. Double-tank machines are equipped with a thermostatically operated switch in the rinse tank which prevents operation of the machine when the temperature of the rinse water is lower than 180°F. Dish baskets pass through the machine automatically by means of conveyor chains.

Maintenance of Dishwashing Machines

If high health standards are to be maintained on board ship, it is essential that dishwashing machines be maintained in satisfactory operating condition. The following inspection should be made in accordance with the planned maintenance system requirements.

1. Check the tension on the conveyor chains of machines so equipped; make adjustments if necessary. If both chains are equipped with lugs, see that these lugs are directly opposite each other.
2. Check to see that guide sprockets are located on their shaft so that the conveyor chain rides properly on the track assembly.
3. On single-tank machines, inspect the operation of the doors; be sure that all counterweights are properly attached and that they hold the doors open when the doors are raised.
4. After the machine has been placed in operation in accordance with prescribed operating instructions, check the operation of all thermometers, pressure gages, and thermostats, and of the automatic mixing valve or booster heater.

The thermostat on the rinse tank of a double-tank machine should be adjusted so that the machine cannot be started unless the temperature in the rinse tank is 180°F or higher.

The automatic mixing valve should be adjusted to maintain the temperature of the water at or above 190°F when the rinse valve is open.

5. Inspect the pump packing and adjust it as necessary to stop leakage around the pump shaft.
6. Check the force of the recirculating wash spray.

Hold a tray inside the machine to deflect the spray from the upper spray assembly

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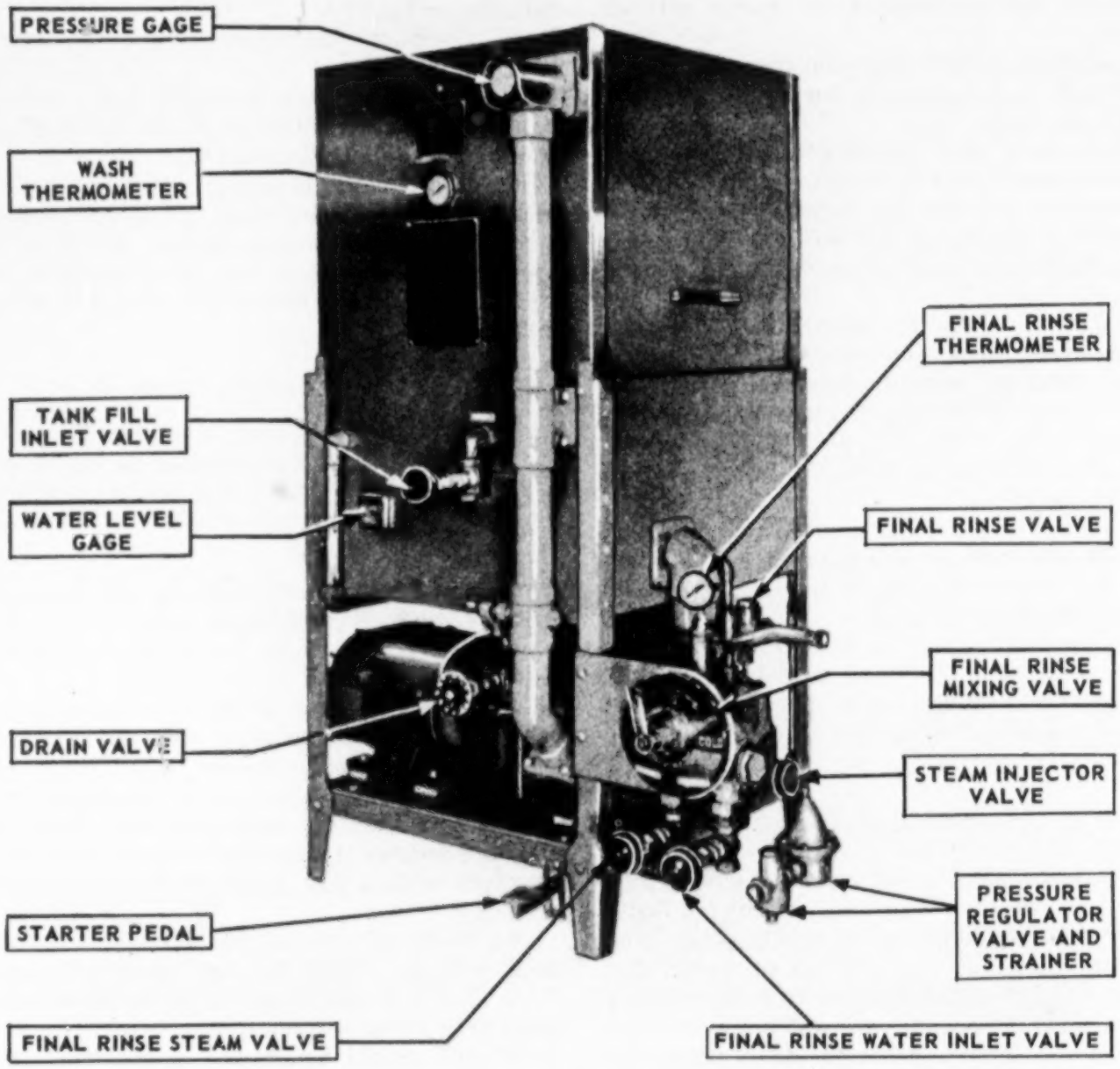

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Figure 16-14.—Automatic single-tank dishwashing machine (model 50SA-7).

further into the machine; the lower spray, when not meeting the upper spray, should rise approximately to the top of the machine. If this is not occurring, there is insufficient spray velocity to produce satisfactory results. The cause of the trouble should be determined and corrected. The trouble may be caused by:

a. Pump-suction line blocked.
b. Spray-tube cap missing.
c. Spray-tube missing
d. Jet orifices excessively worn.
e. Pump running backward.
f. Pump impeller corroded.

7. Ascertain whether the conveyor on a conveyor-type machine is functioning in the proper manner.

8. Determine whether the final-rinse valve on a double-tank machine is functioning in a satisfactory manner; and whether, when the valve

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is opened, a uniform spray is coming from each of the orifices.

9. Clean the orifices of the spray valve if necessary.

10. Lubricate motor and pump bearings.

11. Check and lubricate, as necessary, the gear reducer unit.

12. Lubricate the conveyor-shaft bearings, drive mechanism, and sprocket chains.

13. Replace any missing lubrication fittings.

14. Inspect all steam and water valves.

15. Adjust gland nuts as necessary to prevent leakage.

16. Fill the tanks to the normal operating level, but do not open any steam valve; observe the water for a period of 5 minutes to determine whether there is an appreciable reduction in the water level. When there is an excessive reduction in the water level, check the drain valves for leakage.

17. Fill the tanks to the overflow opening and determine whether the overflow drain is functioning to prevent the water level from rising above the overflow opening.

18. Clean the drains and the overflow if necessary. The pumps should be dissassembled and inspected at least once a year. Inspect the pump rotors to determine whether they are excessively eroded or corroded.

Descaling of Dishwashing Machines

Excessive scale deposit on the inside of piping and pumps clogs them and interferes with the efficient performance of dishwashing machines by reducing the volume of water that comes in contact with the utensils in the washing and sanitizing process. In addition, deposits within the machine provide an ideal place for dangerous bacteria to collect. Dishwashing machines should be descaled as often as necessary to prevent scale from interfering with the operation of the machine. The following method of descaling dishwashing machines may be used:

1. Fill the tanks half way to the overflow level with hot clean water.

2. To prepare the cleaning solution, add to the water in each tank 7 fluid ounces of orthophosphoric acid 85 percent and 1/2 fluid ounce of wetting agent for each gallon of water the tank will hold when it is filled to the overflow level. (When the capacity of a tank is not known, the inside dimensions (inches) of each tank may be used in the following formula to calculate the capacity in gallons; length times width times depth (to the water line) divided by 231 equals capacity in gallons.)

3. Complete the filling of the tanks to the overflow level.

4. With scrap trays, spray arms, and curtains in place, operate the machine for 30 minutes at the highest temperature possible.

5. Remove the cleaning solution completely by draining the tanks; rinse the tanks thoroughly by refilling them with fresh hot water and then operating the machine for five minutes. The rinsing procedure should be repeated several times.

Lubrication of Dishwashing Machines

The points of lubrication and the schedule to be followed will vary depending on the type and design of each machine. The following schedule for one type of automatic double-tank dishwashing machine is typical:

1. Turn the grease cups on the pump-shaft bearings one or two turns each week. (If oil cups are installed, keep the cups near the overflow level.)

2. Check the level of oil in the speedreducer case every three months. Oil should be added when the oil level is below the oil-level plug.

3. Turn the grease cups on the drive-end of the conveyor once a week and refill them when they are empty; if cups are not provided, oil the bearings with a few drops of recommended oil each day.

4. Turn the grease cup on the rinse lever once a week; refill the cup when it is empty.

5. Apply a few drops of oil to the revolving wash arm whenever the motor is oiled.

6. Oil should be placed in the cups on the motor once each week unless the bearings are of the ball type; some ball bearings need greasing once a year, others need no periodic lubrication. Check to be sure of the type of bearing in use.

CAUTION: A dishwashing machine must not be lubricated or repaired when the machine is in operation.

Repair of Dishwashing Machines

To the extent that they are applicable, these general instructions should be followed when dishwashing machines need adjustment or repair:

1. Repair strainer pans as soon as they are damaged or become defective; if pans are

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warped, straighten them so they lie flat in the machine.

2. Adjust the speed of the conveyor in automatic machines so that the washing and rinsing intervals are as recommended by the manufacturer.

3. Repair torn or worn curtains; replace them when they are beyond repair.

4. When the pump does not deliver enough water to the spray nozzles, remove the inspection plate and clean the pump housing. Impellers which are worn or damaged beyond repair should be replaced. Be sure the replacements have the correct dimensions and design.

5. When the packing around the pump shaft leaks, tighten the packing nut lightly; excessive tightening causes the packing to bind the shaft, which in turn overloads the motor and causes scoring of the shaft and the packing to wear excessively.

6. Replace worn gland packing. Do not put more packing than necessary in a packing gland; excess packing will bind the shaft when the packing nut is tightened.

7. Replace damaged thermometers.

8. Make necessary adjustments and replacements on conveyors to ensure satisfactory operation.

On some machines, the speed reducer for the conveyor is driven by a V-belt from the pump shaft. This belt will often stretch after the machine has been in operation for some time. To tighten the belt, first loosen the set screw on the outside portion of the belt pulley; then turn the outside half of the pulley so that the pitch diameter is changed sufficiently to tighten the belt. After the proper tension has been obtained, tighten the pulley set-screw.

9. Keep inspection doors on wash and rinse compartments watertight at all times. Leaks may result from a bent door; in such cases, straighten the door to make a tight fit. If the door still fits improperly, check the grooves in which the door slides and remove any accumulation of rust or other obstructions.

10. Check chains and pulleys of counterbalanced doors for defects. Oil moving parts and joints regularly to ensure smooth operation.

11. Repair dish racks as soon as defects are noted.

12. Adjust or repair steam coils, traps, and thermostats.

STEAM-HEATED COOKING EQUIPMENT

Some of the galley equipment which you will inspect and maintain utilizes steam as a source of heat. Some of this equipment, such as steam cookers, steam-jacketed kettles, and proofing cabinets, has few, if any, moving parts which require maintenance. In equipment of this type, your primary concern will be the maintenance of the valves and the piping which supply steam to the unit.

Steam Cookers (Steamers)

Some large galleys are equipped with a steamer that is used for cooking vegetables. Steam cookers are made of cast iron or steel, and have three or more compartments equipped with heavy doors operated by handwheels. Live steam that heats the steamer is controlled by a PRESSURE-REDUCING VALVE. Steam which does not condense escapes through the BLOW-OFF VALVE, and, in case of excess pressure, through the SAFETY VALVE. (See figure 16-15.)

The doors of a steam cooker are of the full-floating type; that is, they are suspended on supporting arms which are hinged to the side of the cooker. The doors are closed by wheel-operated ball-bearing pressure screws on the door arms; the door arms apply equalized pressure at the center of the doors. When the doors are closed, a seal is maintained by endless gaskets of special rubber composition.

Each compartment is supplied with steam through a quick-closing safety THROTTLE VALVE which is so arranged that the compartment doors cannot be opened until steam is shut off. Each compartment is provided with a separate outlet and valve arrangement to prevent the intermingling of odors from various compartments.

An evaporating compartment is located under the steam compartments. The evaporating compartment is equipped with a STEAM COIL and STEAM-CONTROL VALVE, HAND WATER-FEED CONTROL VALVE, DRAIN VALVE, SAFETY VALVE and WATER-LEVEL GAGE. An access door is provided to facilitate cleaning of the evaporating compartment.

Steam cookers require a minimum of maintenance. The following repairs, replacements, and adjustments should be made on steam cookers whenever necessary.

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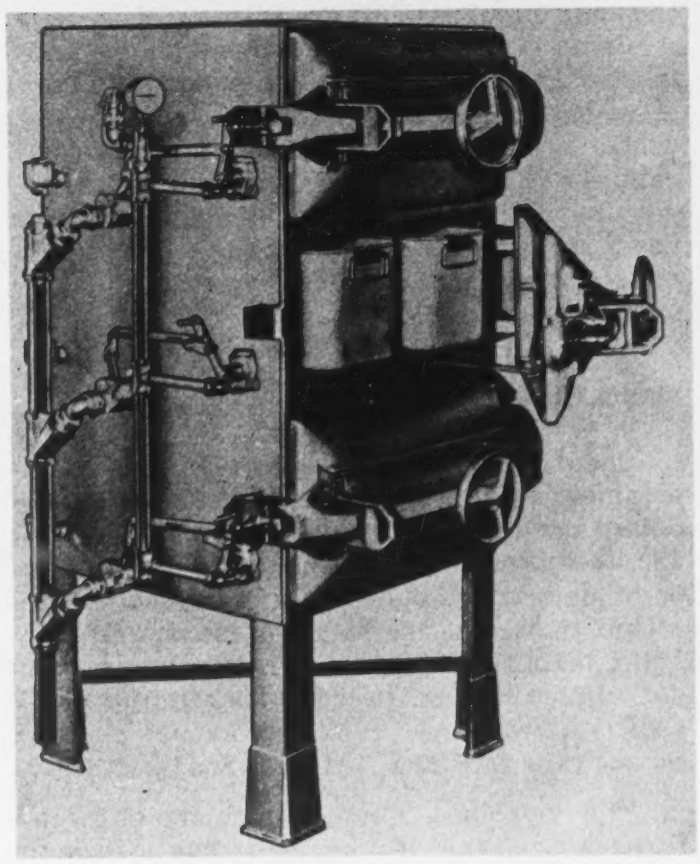

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Figure 16-15.—Steam cooker.

1. GASKET REPLACEMENT. Remove the door and place it on a work bench. Remove the old gasket and clean the channel thoroughly; take care not to chip or damage the channel.

Apply the recommended gasket cement, and insert the new gasket. Force the gasket into the channel at the corners and then work it toward the center of each end and side.

Rehang the door and close it lightly. Before closing the door tightly, place paper over the door opening to keep excess gasket cement from adhering to the mating surfaces of the door and cookers.

Leave the door closed until the cement sets. Clean off surplus cement.

2. DOOR-FIT ADJUSTMENT. Some full-floating doors are adjustable, others are not. When adjustment is possible, the doors and gaskets may be adjusted by turning the hexagon-head bolts which extend through the door, near each corner. When a replacement gasket is installed, adjust the bolts so the closed door touches the body of the steamer evenly and does not bind at any corner. If the door is not adjusted properly, the gasket will be cut by the corners of the door.

3. LOCKING DEVICE ADJUSTMENT. If a plunger-type valve is used in conjunction with the locking device, adjust the plunger so that the valve is fully open when the door is closed and allows the full amount of steam to enter the compartment. Adjust the valve so it stops the steam supply completely when the steam door is opened.

4. STEAM VALVE REPAIR. When repacking a steam valve, install packing which fits, enters easily, and draws up evenly. When winding coil packing around the valve stem, force the packing to the outer edge of the stuffing box instead of wrapping it tightly around the valve stem; after adding the maximum number of packing rings, draw up packing gland evenly and make the nut handtight.

5. PIN AND BUSHING REPLACEMENT. The hinge pins and bushings of compartment doors should be replaced when they are excessively worn.

Steam Jacketed Kettles

Kettles were originally made of copper; they are now made of aluminum or corrosion-resistant steel. Kettles used by the Navy range in size from 10 to 80 gallons and are of the stationary type. (See figure 16-16.)

The kettle illustrated is typical of most steam-jacketed kettles used by the Navy. The lower two thirds of the kettle is surrounded by a JACKET, which is set off from the main body of the kettle to provide space for steam to circulate and thus heat the contents of the kettle. Stationary kettles are generally mounted on three legs, have a HINGED COVER and a tube at the bottom of the body of the kettle with a DRAW-OFF FAUCET. A SAFETY VALVE is provided to release pressure from the jacket when the pressure exceeds the design limit. Most kettles are designed to operate on a maximum steam pressure of 50 pounds per square inch.

WASHING MACHINES

The following inspections and adjustments of washing machines should be made in accordance with planned maintenance systems requirements:

1. Check all gear-casing gaskets and stuffing boxes; they must be tight to keep water from entering the gear casing.

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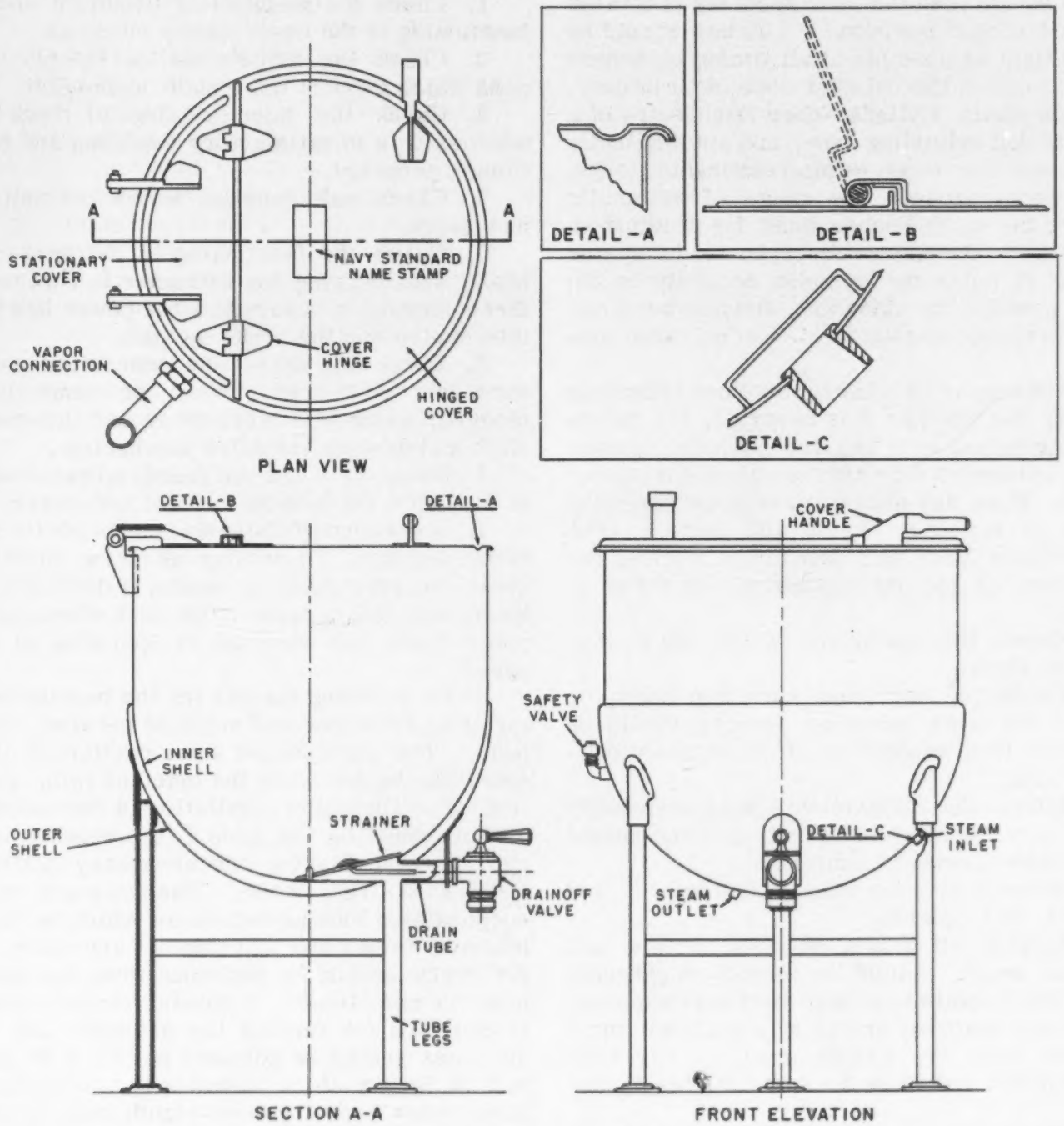

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Figure 16-16.—Steam-jacketed kettle.

2. Check the mechanical condition and functioning of thermometers, water-level indicator, and timer, if fitted.

3. Check the tightness of steam valves and water-filling valves.

4. Check the tightness of the dump valve by filling the machine with water to the 6-inch level and determining whether, with all filling valves closed, water level drops more than one inch in ten minutes. An excessive rate of drop in water level indicates the need for valve repair or replacement.

5. Inspect the trunnion packing; adjust or replace as necessary.

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ISOLATION AS A PART OF THE SANITATION PROGRAM

General Practices

1. Isolation of Newly Acquired Animals. The addition of new animals to the breeding herd is necessary from time to time. The best herd health history possible should be secured before purchasing any animal. A buyer should have a veterinarian check animals for brucellosis, tuberculosis, and any other local problems before taking delivery. Never buy an animal without knowledge of its background of health.

When new animals are added to the herd, certain health checks must be made. After examination by a veterinarian, the animal may be shipped in, unloaded and placed in isolation. It should be isolated where no other animals can come in contact. Keeping animals in separate pastures may not be enough precaution, because of the tendency of animals to congregate along fence lines.

The isolation period should be for at least three weeks to allow for the passage of any incubation period and for disease symptoms to show themselves. If no disease symptoms appear and the animal seems normal, it can then be introduced into the herd. The barn or stall in which the animals were temporarily isolated should then be cleaned thoroughly and disinfected.

2. Isolation of Sick and Recovering Animals. All sick animals should be isolated in some type of confinement conducive to their possible recovery. If these animals recover, they may be kept in pasture or lots separate from the rest of the herd for a short time to make sure that all disease is gone and complete recovery is apparent. After the recovery of the animals, the pens where the animals were confined during sickness must be thoroughly cleaned and disinfected. Even after animals have recovered from some diseases, they will have to be marked and sold for slaughter for controlled purposes, as they may remain carriers of the disease. A veterinarian should be consulted about treating any infectious disease, including the sale of animals having recovered from infectious diseases.

3. Grouping Animals as to Size, Weight, and Origin. Animals should be kept separate on the basis of size, weight, and origin. Larger animals can cause undue stress upon the smaller ones by preventing smaller ones from getting adequate amounts of food and water. Running young animals with older ones exposes the younger ones to the diseases and parasites infecting the larger ones.

Mixing different kinds of livestock is not recommended because some diseases can be transmitted between classes. (Chicken might carry blackhead disease without showing any symptoms, but if allowed into an area with turkeys, could cause an outbreak of this disease.)

If a number of animals are purchased from different sources, and placed in the same pen on delivery, there is great risk of exposing the whole group to diseases.

CARCASS DISPOSAL

The importance of proper carcass disposal cannot be over-emphasized. Death, even if not caused by an infectious disease, can cause contamination of lots, pens or pastures because of putrefaction and the release of organisms by the dead animals. Disease vectors, such as flies and maggots, may accumulate and spread from a carcass left rotting in the open. A carcass left where drainage

6. Check the cylinder-door latches to determine whether they are functioning properly; latches should hold the door securely in both the open and closed positions. Latches should be kept as tight as possible at all times; looseness hastens wear of the cylinder door, door latches, and latch parts. Cylinder-door latches are of a tapered, self-adjusting type, and automatically compensate for wear within reasonable limits. When wear exceeds the range of automatic take-up, the latch-keeper must be readjusted.

7. Check the magnetic brake to determine whether it holds the cylinder securely in the proper position for unloading, and whether it releases properly when power is applied to the controller.

8. Determine whether the machine is running smoothly and whether it is reversing the direction of rotation in a regular periodic manner without excessive vibration or shock during reversals. Make any necessary adjustments in the tension of sprocket chains and belts. (The Electrician's Mate will determine whether the adjustment of the timing-motor controller is correct.)

9. Check the operation of the shell-door interlock switch.

10. Check for any loose nuts, tap bolts, or screws; all such fastening devices should be fitted with lock washers or other suitable locking devices.

11. Inform the Electrician's Mate when faulty operation of the machine is believed to be caused by defective electrical equipment.

12. Remove all gear guards, belt guards, and sprocket-chain guards.

13. Inspect all gears, sprocket chains, and belts for wear. Adjust the tension of sprocket chains and V-belts to ensure best performance. On a large machine driven by a sprocket chain on each end, the chains must be carefully synchronized and have the same degree of tension.

14. Check the trunnion bearings on each end of the shaft and all intermediate bearings for excessive wear; lubricate the bearings as necessary.

15. Clean all parts of the machine.

16. Replace the guards and make sure that all nuts, tap bolts, and screws are fitted with lock washers or other locking devices.

LAUNDRY EXTRACTORS

The following inspections and adjustments of laundry extractors (fig. 16-17) should be made in accordance with planned maintenance system requirements:

1. Check the mechanical condition and the functioning of the cover safety interlock.

2. Check the adjustment on the pressure pads which support the spindle and basket.

3. Check the bumper ring to determine whether it is in satisfactory condition and functioning properly.

4. Check belt tension; adjust the belts as necessary.

5. Check the functioning of the brake; the brake should bring the extractor to rest within three-fourths of a minute after power has been interrupted and the brake applied.

6. Check the drain-like connection and be sure that it is open. When the connection is clogged, water will overflow around the spindle shaft and damage the drive mechanism.

7. Removal of the belt guard and examination of the belts; replace the belts if necessary.

8. Inspection of the basket and bands for possible defects. Particular attention should be given the strengthening bands; if defective, the bands may fail because of the high stresses imposed when the machine is operating at high speed.

The supporting flanges for the bearing housing of an extractor are mounted between rubber pads. The pads permit some oscillation of the extractor basket when the machine is in operation. The amount of oscillation is controlled by the pressure on the pads. A pressure nut is provided for making the necessary ADJUSTMENTS TO THE PADS. The pressure nut incorporates a locking set-screw which should be loosened before any adjustments are made. The set screw should be tightened when the adjustment is completed. A special spanner wrench is provided for turning the pressure nut. The pressure should be adjusted so that a 20-pound pull at the top of the basket will cause a movement of not more than one-eighth inch. In order to prevent excessive oscillation when the ship rolls the pressure must be maintained considerably higher than on extractors installed ashore.

Particular attention must be given to the INSPECTION OF BASKET BANDS. Rust may accumulate between the bands on the basket in such a way as to give the appearance of a double band in good condition; actually the metal may be greatly reduced in effective area and strength by corrosion. Special care is necessary to detect the true condition of the bands. Prod, scale, or take such other steps as are practicable to

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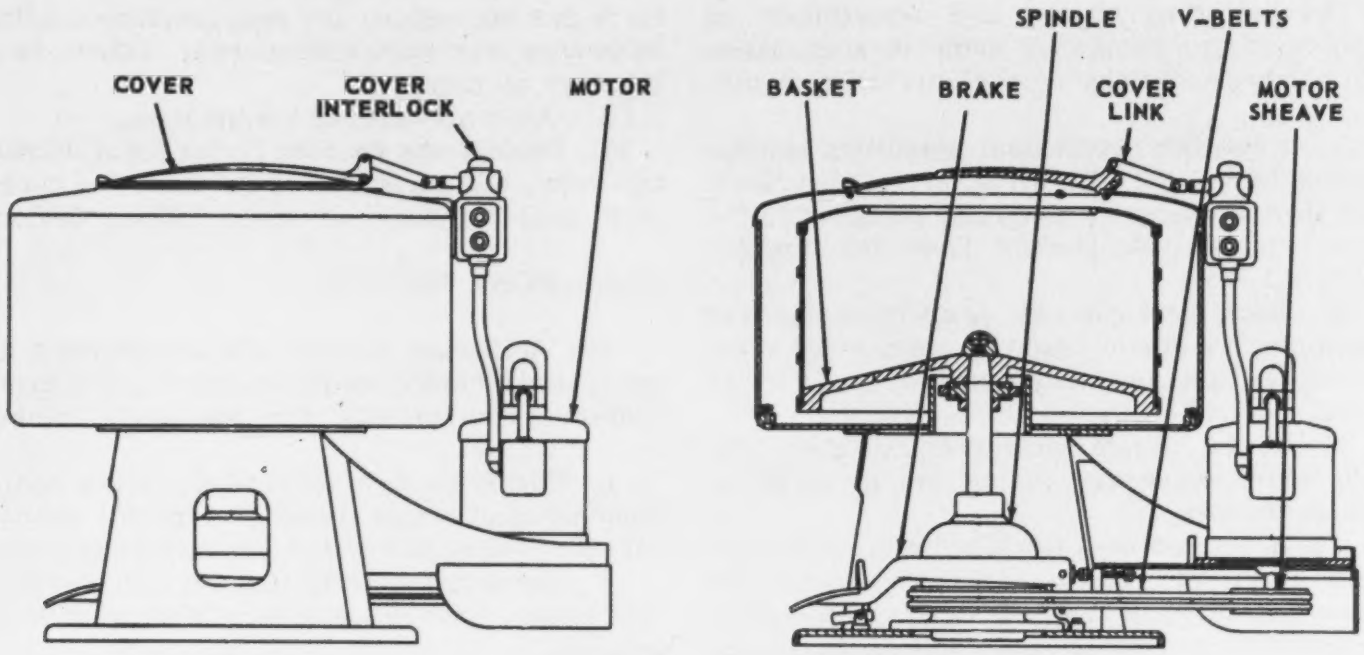

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Figure 16-17.—Laundry extractor.

determine the condition of the strengthening bands. Should doubt arise as to the condition of the basket and the strengthening bands, steps should be taken to obtain a new basket. On recent extractors the baskets and reenforcing bands are made of corrosion-resistant metal.

COMBINATION WASHER-EXTRACTOR MACHINES

Periodic inspections of combination washer-extractor machines should be made to ensure that:

1. Hold-down bolts are tight.
2. V-belts are adjusted properly.
3. Nuts, bolts, and screws are tight.
4. Seals and gaskets are tight.
5. Surfaces are clean and free of dirt.
6. Moving parts are properly lubricated.

A properly adjusted V-belt can be depressed 1/4 inch, midway between the pulleys. A V-belt that is tightened excessively will wear rapidly. A V-belt that is adjusted too loosely will slip. V-belts may be tightened by loosening the lower nuts on the motor-plate adjusting screws and tightening the upper nuts, then adjusting nuts equally.

The supply door must seal to prevent leaking. Occasionally the supply door locking assembly must be adjusted to compensate for gasket wear. To adjust, regulate the adjustment nuts on the lock lever loop to increase tension on the supply door lid hook.

The clutch must be kept in proper adjustment. A slipping clutch will overheat and wear out quickly.

The brake wears to some extent even under the best operating conditions. As the brake bands wear, adjustment should be made to keep the braking time constant (35 seconds). To adjust the brake, proceed as follows:

1. Remove belt guard.
2. Turn notched wheel on brake cylinder until brake drum is handtight.
3. Back off notched wheel 5 notches (adjust each shoe in the same manner).
4. Replace belt guard.
5. Make certain that the machine is bolted tightly to the foundation, steel to steel, no gaskets to minimize vibration.

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TUMBLER DRIERS

The following checks and adjustments of tumbler driers should be made in accordance with planned maintenance system requirements:

1. Check the mechanical condition, and the functioning of the thermometer, if installed. (The thermometer is generally installed in the air-discharge duct leading from the tumbler cylinder.)

2. Check the tightness of all valves and the functioning of steam traps to ensure that when the valves are open, the coils are uniformly heated.

3. Inspect steam heater-coils; clean the coils when necessary, using an air hose or vacuum cleaner.

The heater coils of tumbler driers are generally arranged in two banks with separate steam connections to each bank. In most cases valves are provided on both the inlet and the drain side of each bank.

4. Remove the covers from all clean-out openings and clean all lint and dust from the machine and from the air-discharge ducts.

5. On end-loading tumblers, check the cylinder-door latches and determine whether the door is held firmly when it is in the closed position. On side-loading tumblers, check the cylinder-door latches and determine whether the latches hold the door securely in both the open and closed positions.

6. On side-loading tumblers, check the magnetic brake to determine whether it securely holds the cylinder in the proper position for unloading, and whether the brake releases properly when power is applied to the controller.

7. On side-loading tumblers, determine whether the machine is running smoothly and is reversing its direction of rotation in a regular periodic manner without excessive vibration or shock during reversals. Make any necessary adjustments in the tension of sprocket chains and belts.

8. On all side-loading tumblers check to determine whether all dampers are set so that there is no recirculation of air within the drier.

9. On side-loading tumblers, check the operation of the shell-door interlock.

10. Remove the guards and inspect all gears, sprocket chains, and belts for wear. Adjust the tension of sprocket chains and V-belts to ensure best performance. Replace parts which are worn excessively.

11. Check the trunnion bearings and all intermediate shaft bearings to determine whether there has been excessive wear; replace bearings when they are worn excessively. Lubricate all bearings as required.

12. Clean all parts of the machine.

13. Replace the guards; be sure that all nuts, tap bolts, and screws are fitted with the necessary lock washers or other locking devices.

FLAT-WORK IRONERS

The following checks and adjustments are generally included in the planned maintenance system requirements for flat-work ironers:

1. Check the tightness of all valves and the functioning of steam traps; be sure that when the valves are open, the cylinder is uniformly heated.

2. Check the packing of the cylinder steam-joints and adjust as necessary to prevent steam leakage.

The packing is held in place by a spring. If a joint shows more than a reasonable amount of leakage, check the packing for excessive wear. If the packing is not worn excessively, the packing spring may be broken.

3. Check the operation of the safety guard and the interlock switch.

All gear guards, belt guards, and sprocket-chain guards should be removed periodically from flat-work ironers. In addition, periodic inspections, checks, and adjustments outlined in the applicable technical manual, should be included as follows:

1. Inspect all gears, sprocket chains, and belts for wear. Adjust tension of sprocket chains and V-belts to ensure best performance.

2. Check the trunnion and roller bearings and all intermediate bearings to determine whether there has been any excess wear; lubricate the bearings as required.

3. Clean all parts of the machine.

4. Replace all guards; make sure that all nuts, tap bolts, and screws are fitted with the necessary locking devices.

5. The steam cylinder of a flat-work ironer should be given a HYDROSTATIC TEST at the pressure recommended by the manufacturer.

LAUNDRY PRESSES

Manual presses are used extensively in shipboard installations; many ships, however, are

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equipped with air-operated presses. In general, inspection of laundry presses will include the following checks and adjustments.

1. Check the mechanical condition of the machine to determine whether the head, when released, returns smoothly and without shock to the fully-open position; adjust counterbalance springs, shock-absorber cylinder, and air vent as necessary.
2. Fill the shock-absorber cylinder (if so equipped).
3. Inspect all valves to determine whether they are functioning without leakage.
4. Inspect the steam traps. If they are not functioning properly the head and buck will not be heated uniformly and there will be an excessive loss of steam.
5. On air-operated presses, make sure that neither of the air-control valves has been bypassed and that they are so adjusted as to require the use of both hands to close the press and apply pressure.
6. Check to determine whether excessive pressure is required on the foot pedal to lock the head in the pressing position. If excessive pressure is required, check for an excessive amount of padding; if the padding is satisfactory, check the linkage of the head pressure-mechanism.
7. Removal and cleaning of all air filters.
8. Examination of the cups on the closing cylinders and pressure cylinders; replace the cups if they are badly worn.

All press-heads and bucks should be given an ANNUAL HYDROSTATIC TEST at the pressure recommended by the manufacturer.

LUBRICATION OF LAUNDRY EQUIPMENT

Lubrication is an important part of the inspection of each piece of laundry equipment. The lubrication charts furnished with each piece of equipment should be checked for the location of lubrication fittings for the lubricants to be used. The location of the fittings as they appear on the chart for one type of flat-work ironer are shown in figure 16-18.

In general, all bearings and sliding surfaces of each piece of laundry equipment must be checked at least once a week and lubricated as recommended by the manufacturer of the machine. Oil and grease cups should be filled to the recommended level and grease should be added through all pressure grease fittings. All lubrication fittings should be checked; any fittings that are missing, damaged, or broken should be replaced. The sprocket chains of tumbler driers and washing machines are generally lubricated through drip type oil cups; these cups should be kept full.

SAFETY DEVICES ON LAUNDRY EQUIPMENT

Each piece of laundry equipment is provided with one or more safety devices. Since they are designed to protect the operator of the machine, safety devices must be maintained in proper working condition at all times. The inspection of safety devices is included as a part of the periodic inspections of laundry equipment. If a safety device is removed from a machine for any reason, the device must be replaced and be in satisfactory operating condition before the machine is again put in operation. Some of the safety devices which you may be required to adjust and maintain are described in the following paragraphs.

Safety Interlocks

The covers of laundry extractors are fitted with safety interlocks. The interlock is designed to keep the cover of an extractor from being opened while the basket is rotating, and to keep the machine from being started when the cover is open. On some recent extractors, there is an interlock between the brake and the safety switch; this interlock keeps the brake from being applied while the motor is energized, and keeps the machine from being started when the brake is set. In all cases, the STOP button should be operated to deenergize the motor before the foot brake is applied; and the foot brake must be released before the START button is used.

The cover safety-lock mechanism on laundry extractors includes a connecting rod which connects the portion of the interlock mechanism mounted on the top of the curb with the portion of the mechanism that is mounted underneath the curb. Generally, the components of interlock mechanisms will function reliably. The connecting rod between the portions of the interlock mechanisms may become bent, however, if considerable force is applied in opening the door of the extractor.

The connecting rod of an interlock mechanism should be checked regularly and frequently. If the rod is found to be bent or if there is an

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to fit the presently installed clevises. If a larger rod is indicated but is not available, the existing rod should be straightened and a piece of close-fitting steel tubing or iron pipe should be slipped over the rod to increase its stiffness.

The hinge pins and clevis pins of many safety-interlock mechanisms are held in place by cotter pins which can be removed readily. In order to make it more difficult for unauthorized personnel to disconnect the safety-interlock mechanism, upset or rivet as many of the pins as practicable.

Washing machines and tumbler driers of the side-loading type also are equipped with safety interlocks. On these machines the interlocks prevent starting the machine while the door in the outer shell is open; and, when the cylinder is in motion, they either stop the machine automatically when the door in the outer shell is opened or prevent the door being opened.

Safety Guards

Flat-work ironers are always equipped with a safety guard or bar which extends along the front of the machine. The arrangement is such that the operator's hands will push the guard before they can enter the rolls of the machine. When the guard is pushed, a safety switch which stops the motor is activated. Some return-apron flat-work ironers have an added safety device which either applies a brake or declutches the motor when the safety guard is pushed. Safety guards should be inspected regularly and frequently; you must be sure that they are properly in place and performing their function. Safety guards which do not stop the motor when the guard is pushed must be adjusted or replaced before the machine is again operated.

All exposed gears, chains, and belts on laundry equipment are fitted with guards or shields. These guards must be in place and in satisfactory condition when equipment is put in operation.

Pushbutton Valves

The two operating valves of air-operated laundry presses are of the pushbutton type. The arrangement of the valves is such that both hands of the operator must be used to operate the press; the hands of the operator, therefore, cannot be caught in the press when it closes. The pushbutton valves must not be bypassed or left permanently open.

INDUSTRIAL GASES

Historically, the first gas to be put to large-scale commercial use was coal gas, obtained by distilling coal in retorts. In this process, coal is heated in containers which shield it from air, and thereby prevent combustion, thus driving off gas from the coal, leaving coke. The city gas industry developed so rapidly in the last century, especially in England, that to most people the word "gas" became synonymous with the cooking, heating, and lighting gas mixture supplied by the gas companies. Coal gas is known as "producer gas"; oil is known as "natural gas"; their chief components are METHANE and other HYDROCARBONS. Hydrocarbons, as the word itself signifies, are components formed of carbon and hydrogen. Similar gases are developed in the process of "cracking" oil to produce gasoline, and those gases are known as "cracker gases."

Air consists mostly of oxygen and nitrogen, plus small percentages of the inert gases, argon, neon, krypton, and xenon. Methods of separating the constitutents of the atmosphere have been developed and many important industrial uses for these components have been found.

Only a few Machinist's Mates are engaged with the actual generation or compression of industrial gases, and then only after special training. All men of this rating, however, are required to handle one or all of the several compressed gases used aboard ship. It is important, therefore, that you have a general understanding of the characteristics as well as the uses of these gases.

GENERAL NATURE OF GASES

Before discussing the physical properties and characteristics of specific gases, let us briefly summarize the general nature of gases.

ALL GASES ARE COMPRESSIBLE; that is, they can be forced into spaces of lesser volume than they occupy under normal conditions. You are probably familiar with the two GAS LAWS (discussed in Fireman, NavPers 10520-C) which express the relationship of the gas pressure with its volume and temperature; BOYLE'S LAW and CHARLES' LAW.

The TEMPERATURE FACTOR is important in handling gases, for when the temperature of a gas in a container is increased, the pressure increases on all parts of the container. Consider an automobile tire, for example. The air in the revolving tire gains heat from the warm

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pavement, and from friction. This added heat energy increases the molecular activity of the air within the tire. The tire appears to have accumulated more air, as indicated by the increased pressure against the tire walls (the tire actually expands due to the increased pressure). Let the tire cool, however, and the pressure returns to normal.

Gas cylinders are not elastic and do not expand from the pressure of the gas within them. Cylinders are, therefore, filled with compressed gases only to the maximum safe pressures at normal atmospheric temperatures. Storage of the cylinders in hot spaces will increase the pressure of the confined gases to a dangerously high point, where the cylinders will explode. The boiling points for the various liquefied gases are important. Various gases have to be separated from each other. Their different boiling points make this possible. As an illustration of this principle, take a mixture of water and alcohol in an automobile radiator: Alcohol boils at 172° F, but water boils at 212° F; the alcohol therefore begins to evaporate and separate from the water before the water nears the boiling point. As the water is never allowed to reach 212° F, the alcohol content grows less and less as the temperature rises above 172° F. The same process is employed in separating and purifying gases.

GAS CHARACTERISTICS

In addition to knowing the general nature of gases, you should know some of the distinguishing features of the gases utilized by the Navy, and the special precautions to be exercised in handling industrial gases. From a standpoint of volume used by the Navy, the gases oxygen, carbon dioxide, acetylene, and nitrogen together with various refrigerants, lead all others by far. Figure 16-19 shows the characteristics of gases. However, the discussion which follows deals with the characteristics of acetylene, carbon dioxide, oxygen, and nitrogen, and the safety precautions to be followed when handling each of the industrial gases.

Acetylene

Acetylene is a chemically produced gas which is not found in the natural state. In 1892, a method for the commercial production of the chemical CALCIUM CARBIDE was discovered. It is from calcium carbide and water that acetylene is produced. In 1895, it was discovered that acetylene, combined with oxygen and burned, has the ability to produce high temperatures.

By the turn of the century, acetylene was being used for lighting, both commercially and domestically. Even today acetylene is used in lighthouses and buoys because of its exceptional brilliance while burning.

Acetylene (C_2H_2) is a colorless gas. When pure it has a sweet odor, but when impure, usually with HYDROGEN SULPHIDE as an impurity, it has a disagreeable odor. Hydrogen sulphide is the gas that produces the well known "rotten eggs" smell. Acetylene is shipped dissolved in ACETONE in cylinders that contain a MONOLITHIC (the cylinder is filled throughout with the same mixture of asbestos, charcoal, cement, and diatomaceous earth. Diatomaceous means composed of the skeletons of various forms of sea life) filler. Acetone is a liquid ORGANIC compound which is used as a solvent for many other organic compounds. Roughly, an organic compound is any one that contains carbon (C); note that acetylene (C_2H_2) is an organic compound formed by combining two atoms of carbon with two atoms of hydrogen.

Acetylene is stable and safe to handle as charged in Navy standard acetylene cylinders. But in the free gaseous state, or if compressed in cylinders not designed for acetylene, the gas is very unstable and likely to decompose violently. In large volumes, at pressures exceeding 15 psi, acetylene is dangerously explosive. This means that acetylene can "explode of its own accord" (spontaneous ignition) when improperly stored or handled. It does not always need air, or oxygen, or a spark to help it explode. Any shock or heat may be enough to set acetylene off if it is stored at pressures higher than 15 psi.

When mixed with air or oxygen, the chances of violent explosion are doubled. The explosive limits of acetylene in air range from 3 to 82 percent acetylene with maximum effect at approximately 7.8 percent. Acetylene in copper piping systems, or in piping systems with silver-brazed joints, may form acetylides by combining with copper or silver. Acetylides so formed are violently explosive and are capable of being detonated by shock or heat.

Acetylene mixed in controlled proportions with oxygen in the acetylene torch produces an intensely hot flame. Its uses in welding and cutting are well known.

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Name	Symbol	Odor	Explosive limits percent by volume in air		Auto-ignition temperature of	Density relative to air Air = 1	Vapor pressure at 68°F. p.s.i.	Weight in pounds of 1 cubic foot at standard atmospheric pressure and 68°F.	Physical state when shipped	Remarks
			Lower	Upper	(of)					
Acetylene	C_2H_2	Garlic	2.5	80	635	0.90	663.57	0.06754	Dissolved	Shipped dissolved in acetone 250 psi at 70°F.
Air	------	None	----	--	-----	1.00	(a)	.07528	Gas	Critical point below 68°F.
Ammonia	NH_2	Pungent	16	27	1,436	.59	124.34	.04420	Liquid	
Argon	A	None	----	--	-----	1.38	(a)	.10389	Gas	Inert gas
Carbon dioxide	CO_2	do.	----	--	-----	1.52	830.47	.1142	Liquid	do.
Chlorine	Cl_2	Pungent	----	--	-----	2.44	96.58	.1839	do.	Reacts with hydrogen
Refrigerant 12	CCl_2F_2	None	----	--	-----	4.17	67.54	.3136	do.	Inert
Refrigerant 22	$CHClF_2$	do.	----	--	-----	2.99	122.00	.2243	do.	do.
Ethyl chloride	C_2H_5Cl	Sweet	3.6	14.8	-----	2.22	19.55	.1664	do.	
Ethylene oxide	C_2H40	do.	3	80	804	1.52	------	.1142	do.	
Helium	He	None	----	--	-----	.14	(a)	.01039	Gas	Critical point below 68°F.
Hydrogen	H_2	do.	4.1	74.2	1,076	.07	(a)	.00523	do.	do.
Inert gas	------	None	----	--	-----	1.05 (approx).	(a)	.079	--------	Inert
Methyl chloride	CH3Cl	Ether	8.2	19.7	------	1.74	69.82	.1309	Liquid	
Nitrogen	N_2	None	----	--	------	.97	(a)	.07274	Gas	do.
Nitrous oxide	N_2O	Ether	----	--	------	1.52	739.41	.1143	Liquid	
Oxygen	O_2	None	----	--	------	1.10	(a)	.08305	Gas	do.
Propane	C_3H8 b/	Rotten cabage c/	2.37	9.5	871	1.55	129.36	.1143	Liquid	
Sulfur dioxide	SO_2	Pungent	----	--	------	2.21	47.78	.1663	do.	
Butane	$C4H_{10}$ b/	Rotten cabage c/	1.6	8.5	806	2.04	30.6	.1507	do.	

a/ Infinite

b/ Fuels of which the major constituent has the indicated chemical symbol.

c/ Fuels which generally are odorless in the natural state, and are artifically odorized as an aid for detecting leaks.

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Figure 16-19.—Characteristics of gases.

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The SAFETY PRECAUTIONS for acetylene should be emphasized again and again. You will be held strictly accountable for knowing and observing these rules yourself, and you should make every effort to see that others handling acetylene know and observe them.

The safety rules for acetylene are as follows:

1. Acetylene should never be discharged into hose lines and manifolds at a pressure greater than 15 psi. A suitable pressure-reducing regulator should be employed on all occasions.
2. Acetylene cylinders should be used or stored only in an upright position, valve end up, to avoid the possibility of withdrawing acetone when the cylinders are being discharged. Do not open the cylinder valve more than 1 1/2 turns of the spindle.
3. Do not recharge acetylene cylinders or transfer acetylene from one cylinder to another without specific approval from the Naval Ship Systems Command. It is possible to charge or refill acetylene cylinders safely only with special equipment. Acetylene cylinders contain a porous material with minute cellular spaces, so that no pockets of appreciable size remain where free acetylene in the gaseous state may collect. In addition, acetone partially fills the cellular spaces and acts as a solvent for the acetylene. While in the dissolved state, acetylene is stable. It should be clear by now that NO OTHER TYPE cylinder should be used to store acetylene gas.
4. Keep sparks and flames away from acetylene cylinders, and under no circumstances allow a flame to come in contact with the safety devices. Never allow the cylinders to contact electric welding apparatus or electrical circuits.
5. Where it is necessary to test for leaks, use soapy water.
6. Do not interchange acetylene regulators, hose, or other appliances with similar equipment intended for other gases.
7. Do not use acetylene manifolds which are not approved by the Naval Ship Systems Command.
8. Use no wrench other than the one designed for opening the cylinder, and keep the wrench on the cylinder while it is in use.
9. Should a cylinder catch fire, use a wet blanket to extinguish the fire; if this fails, spray a stream of water on the cylinder.

Carbon Dioxide

Carbon dioxide (CO_2) is a colorless, odorless gas and 1.52 times as heavy as air. It can be condensed into a colorless liquid and stored in this state, under pressure, in cylinders. When the cylinder valve is opened, gaseous CO_2 escapes and, due to the rapid drop in pressure and temperature, forms carbon dioxide snow. This snow, when compressed into blocks or cubes, is what we know as "dry ice." Dry ice, in solid form and at atmospheric pressure, volatilizes, remaining at -109° F until it has disappeared. It is excellent for certain refrigeration uses.

Because it will neither support combustion nor form explosive mixtures, CO_2 is one of the chief fire extinguishing agents in use today. It is also used for inflatable gear such as life rafts and vests, and as a propellant or expelling agent.

Carbonated soft drinks contain carbon dioxide dissolved in water and kept under pressure in the container. When this pressure is relieved, CO_2 bubbles will rise to the surface.

Small percentages of carbon dioxide will cause tiredness and perhaps headaches. Three percent in the air doubles breathing effort, and 5 percent causes panting. Eight percent causes marked distress and 10 percent causes unconsciousness very quickly.

Since CO_2, in addition to being heavier than air, is both invisible and odorless, it presents a particular hazard. It will tend to collect in low, unventilated places which might well be below decks on shipboard for instance. The fact is obvious that the more of any other gas, poisonous or not, that is present, the less breathable oxygen there will be present. Men going into these conditions or places, or left there, run the risk of suffocating to death.

Treatment of personnel exposed to CO_2 includes removal from the CO_2-laden atmosphere, artificial respiration (if necessary), administering oxygen, and keeping the patient warm and quiet.

The safety precautions to observe when entering spaces containing carbon dioxide gas are as follows:

1. Do not enter an area or compartment containing hazardous amounts of carbon dioxide without being equipped with a breathing mask and an independent supply of oxygen.
2. If this is not practicable, and the case is urgent, enter only when equipped with a life line and with an assistant standing by outside the area or compartment.

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Oxygen

Oxygen is a colorless, odorless, tasteless gas that makes up about 21 percent of the atmosphere. Although oxygen is found in many compounds such as, water, limestone, sand, and iron ore, it occurs as free oxygen only in the atmosphere.

Probably to humans, the most important property of oxygen is that it is the element in the air that supports life. If the required amount of oxygen is not present in the atmosphere, it is not possible for people to live. In high altitude flying, or in confined spaces, it is necessary to supply air for breathing from some outside source. One of the important uses of oxygen, therefore, is to furnish a supply to persons who would otherwise face a lack of oxygen.

Another shipboard use for oxygen is for oxyacetylene welding. When mixtures of oxygen and acetylene burn, they furnish a very high heat which is easily controlled. This type of heat is also used to heat treat metals.

Oxygen is normally shipped in a gaseous state in cylinders and is one of two types, (1) aviators' breathing oxygen (99.5 percent pure oxygen) and (2) technical or industrial oxygen. The Navy buys only aviators' breathing oxygen. This not only simplifies the supply system but eliminates the possibility of industrial oxygen being charged into aviators' breathing apparatus. Industrial oxygen may have a small moisture content which would freeze at high altitudes.

While oxygen is itself nonflammable, it gives intensive support to combustion. If it should become mixed with hydrogen or with grease, it becomes highly explosive. No combustible material should ever be allowed to come into contact with compressed oxygen.

Oxygen plants are installed on all CVA's and in some other type ships. The method of producing oxygen will be discussed later in this chapter.

Detailed information concerning safety precautions to be observed with oxygen can be obtained from chapter 9230(23) of the Naval Ships Technical Manual.

Nitrogen

Nitrogen (N_2) is considered to be an inert gas. It is not completely inert like helium or argon, for there are many nitrogen compounds such as the nitrates used in fertilizers and explosives. However, nitrogen is very slow to combine chemically with other elements under normal conditions. This is clearly seen when you consider that four-fifths of the atmosphere is nitrogen. Unlike oxygen, nitrogen, as a gas, does not support life or combustion, and causes no decomposition of most of the things with which it comes in contact. By chemical and electrical processes it can, and is, taken from the air and combined with other substances. Such processes are known as "nitrogen-fixation."

In the Navy, nitrogen is used for pressure-operated mechanisms such as recoil systems, as an expellent in flame throwers, in optical instrument applications, for testing pipelines, and as a gas-blanket if required (as in atmospheric controlled furnaces), and for preservation packing. Nitrogen for naval use is pumped by a water-lubricated compressor and is specially dried. Nitrogen cannot be used for inert-gas shielded metal arc welding because the high temperatures involved can cause nitrogen to combine with other substances.

Nitrogen is slightly lighter than air, and, as indicated, is neither flammable nor explosive. It is not poisonous, but unless oxygen is mixed with it, it is an asphyxiant. Nitrogen gas is obtained by the fractional distillation of air. On aircraft carriers, nitrogen is a byproduct of the oxygen plant. The nitrogen is utilized extensively on these ships for maintaining an inert blanket over aviation fuel and other special fuels in their respective storage tanks.

The safety precautions for nitrogen are similar to those for liquid oxygen. However, since nitrogen (liquid or gas) does not support combustion, the precautions regarding exposure to sparks, open flame, and combustible materials do not apply.

Safety rules relative to the use of gaseous nitrogen are similar to those cited for other non-flammable, non-oxidizing, and non-toxic compressed gases. Nitrogen should not be discharged, in large quantities, into closed compartments unless adequate protection is provided.

CYLINDER DESIGN AND IDENTIFICATION

Gas cylinders are made of high quality steel. For high pressure gases, such as oxygen and hydrogen, cylinders are of seamless construction. For low pressure gases, such as acetylene, the cylinders may be welded or brazed.

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is a factor might spread disease organisms over a large area. Never allow animals to lie in pens or lots and just rot away.

If a post-mortem examination is indicated (that is, if it is suspected that the animal died from a communicable disease) a veterinarian should be consulted as soon as the animal dies.

Methods of Carcass Disposal

There are three recommended methods of carcass disposal:

1. Burning is the best method, but expensive and time consuming. It is also very difficult to burn large carcasses. Burning should take place, when possible, at the site of death. The advantage of burning is that all disease organisms perish with the carcass.
2. Burial is a very common and cheap method of disposal. If this method is adopted the carcass will usually have to be transported some distance. The carcass must be buried at least four feet deep and away from any possible water supply. The dead animal should be buried in lime. Remember to carefully disinfect all equipment used to transport and to bury the animal after disposal.
3. Rendering plants will normally take dead animals if one is located near enough to serve your area. Remember that the truck from the rendering plant is a possible source of infection. It may be best to transport the animal near to a place of easy access for the truck so that the truck does not have to enter the yards or lots.

CARE OF ANIMALS IMMEDIATELY BEFORE AND AFTER BIRTH

The proper care of animals before and after birth many times is the key to whether the livestock operation will be profitable or not. Lack of proper sanitation at birth is the cause of much disease and loss of life.

Care of Sow and Litter at Farrowing

1. Disinfect farrowing quarters by a recommended method.
2. Control internal and external parasites according to recommended practices.
3. Wash sow thoroughly before moving her to a farrowing stall. This is done about 48 hours before farrowing.
4. Burn or bury all afterbirth.
5. Treat navel cords of newborn pigs with tincture of iodine (2%).
6. Clip needle teeth and ear notch for identification.
7. Add iron to diet of pigs born on concrete, following recommended practices.

Care of Cow and Calf at Calving

1. Beef cows should calve in clean pastures whenever possible.
2. Disinfect maternity quarters with lye if inclement weather makes indoor calving advisable.
3. Disinfect navels with tincture of iodine (2%) when calves are born in confinement.
4. Burn or bury all afterbirth.
5. Keep calves' stalls clean and dry as long as calves are in them.
6. Prevent young weaning calves from sucking each other.
7. Keep all calf feeder buckets clean.

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All cylinders are carefully tested at pressures above the maximum permissible charging pressure. Figure 16-20 shows the characteristics of commonly used cylinders.

Gas cylinders are substantially the same, except those for acetylene. Acetylene cylinders are completely filled with a porous material impregnated with acetone, which acts as a solvent; and are stubby, rather than slender, as shown in figure 16-21. All gas cylinders have safety devices either in the valve or in the shoulder or bottom of the cylinder, or in a combination of these places.

One type of safety device is the fusible plug, which may be described as a threaded hex head plug, having a center filled with a fusible metal. If the cylinder should be subjected to high temperatures, the fusible metal will melt, allowing the gas to vent to the atmosphere.

Unbacked safety devices with rupture disks consist of a perforated safety cap covering a safety port. The cap retains a frangible disk firmly over the safety port. Under excessive pressure, the safety disk ruptures, allowing the gas to escape through the ports.

Backed safety devices with rupture disks have a frangible disk supported by fusible metal (contained in the safety cap) blocking off escape ports. If the cylinder becomes heated above the melting point of the fusible metal, the pressure in the cylinder will increase and the frangible disk will rupture, venting the gas to the atmosphere.

To protect the valve, a threaded valve protection cap screws onto the cylinder neck ring.

Gas cylinders used by the Navy, Army, and Air Force carry certain standard identifying features in addition to markings required by the Interstate Commerce Commission. So much injury and damage can be, and has been caused by mistaking one gas cylinder for another, that a national program has been established to make it almost impossible to confuse cylinders. Under this program, the identifying features used by the Armed Forces consist of a color code for painting the cylinders, stenciling the name of the gas along two sides of the cylinder, and affixing two decalcomanias to the shoulder of each cylinder. The official color code for marking compressed gas cylinders is given in the current MIL-STD-101. The color coding is revised from time to time. In checking the cylinder color code, always be certain you have the latest revision including ALL page changes.

Navy-owned gas cylinders are identified by indented serial numbers, proceeded and followed by the letters USN. Navy serial numbers are augmented by a designated letter preceeding the numerals. This letter identifies the cylinder in respect to the specific gas contained in that specific cylinder. The following are examples of serial numbers:

1. For an oxygen cylinder

```
U       U
SX618793S
N       N
```

2. For an acetylene cylinder

```
U       U
SA54687S
N       N
```

In the first example, the letter "X" identifies the cylinder as one containing oxygen. In the second example, the letter "A" identifies the cylinder as an acetylene cylinder. The LETTERS assigned to gases are for identification purposes only, they have no consistent connection with spelling of a gas name or CHEMICAL SYMBOLS for gases. The acetylene symbol is C_2H_2, and for oxygen the correct chemical symbol is O_2.

If the camouflage scheme of a ship is adversely affected by the cylinder colors, canvas covers painted with the camouflage colors shall be put over the cylinders.

Shatterproof cylinders shall be stenciled in two locations with the phrase "Non-Shat" placed longitudinally and at a 90° angle from titles. Letters shall be black or white and approximately 1 inch in size.

OXYGEN-NITROGEN PRODUCING PLANTS

Oxygen and nitrogen are produced aboard some ships, mostly CVA's. Only graduates of the Compressed Gases School (or men working under their direct supervision) are allowed to operate the oxygen-nitrogen plants. This training course does not go into detail concerning oxygen-nitrogen plants, but merely explains the basic process of generating oxygen and nitrogen.

Oxygen can be produced by chemical or physical processes. Chemically, oxygen can be produced in a number of ways by releasing it from

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Service	Capacity at N. P. T. 1/	Working pressure	ICC spec.	Dimensions (approximate) Diameter	Dimensions (approximate) Length (add 6 inches for cap)	Empty weight (approximate)	Periodic test required	Outlet connection
		p. s. i.		Inches	Inches	Pounds		Inches
Acetylene	10 cu. ft.	250	ICC8	4	14	11 2/	NO	3/8
	40 cu. ft.	250	ICC8	6	25		NO	3/8
	50 cu. ft.	250	ICC8	7	26 - 1/4	40 2/	NO	1
	225 cu. ft.	250	ICC8	12	36	130 - 134 2/	NO	1
Air	200 cu. ft.	1,800	ICC3A	9	51	110 - 115	Yes	3/4
Ammonia	100 lbs.	480	ICC3A	10 - 13	50 - 68	130 - 140	Yes	3/4 and 1
Argon	197 cu. ft.	1,800	ICC3A	9	51	110 - 115	Yes	3/4
Butane	100 lbs.	240 - 300	ICC4B	13 - 16	45 - 55	100 - 125	Yes	3/4
Carbon dioxide (storage)	50 lbs.	1,800 - 2,015	ICC3A	8 - 1/2	51	110 - 115	Yes	3/4
Carbon dioxide (fire extinguisher) 3/	do.	2,015	ICC3A	8 - 1/2	51	3/ 110	Yes	1
	35 lbs.	2,015	ICC3A	8 - 1/2	34	90	Yes	1
	15 lbs.	2,015	ICC3A	6 - 1/4	26	35	Yes	1
Carboxide	30 lbs.	1,800 - 2,015	ICC3A	8 - 1/2	26	65 - 70	Yes	3/4
	60 lbs.	1,800 - 2,015	ICC3A	8 - 1/2	51	100 - 115	Yes	3/4
Chlorine	30 lbs.	480	ICC3A	6 - 8	27 - 30	30 - 35	Yes	3/4
	120 lbs.	480	ICC3A	9 - 12	34 - 44	85 - 90	Yes	3/4
	150 lbs.	480	ICC3A	10 - 13	50 - 68	130 - 135	Yes	3/4
Helium	200 cu. ft.	2015	ICC3A	9	51	110 - 115	Yes	3/4
Nitrogen	184 cu. ft.	1800	ICC3A	9	51	110 - 115	Yes	3/4
Oxygen	200 cu. ft.	1800	ICC3A	9	51	110 - 115	Yes	3/4
	23.3 cu. ft.	2015	ICC3A	5 - 3/8	18	19	Yes	3/4
	38.4 cu. ft.	2015	ICC3A	7	19	31	Yes	3/4
Refrigerants 122, etc.	10 lbs.	300	ICC4B	4-1/2-5-1/2	14 - 16	13 - 15	Yes	3/4
	50 lbs.	300	ICC4B	7-1/2-8-1/2	27 - 29	27 - 30	Yes	3/4

1/ N. P. T. - Normal temperature and pressure, 68-70° F. and atmospheric pressure.

2/ Tare weight stamped on cylinder.

3/ For complete information on fire extinguisher carbon dioxide cylinders, see chapter 9930. Actual weights, charged and empty, will be found stamped on cylinder valve.

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Figure 16-20.—Characteristics of commonly used cylinders.

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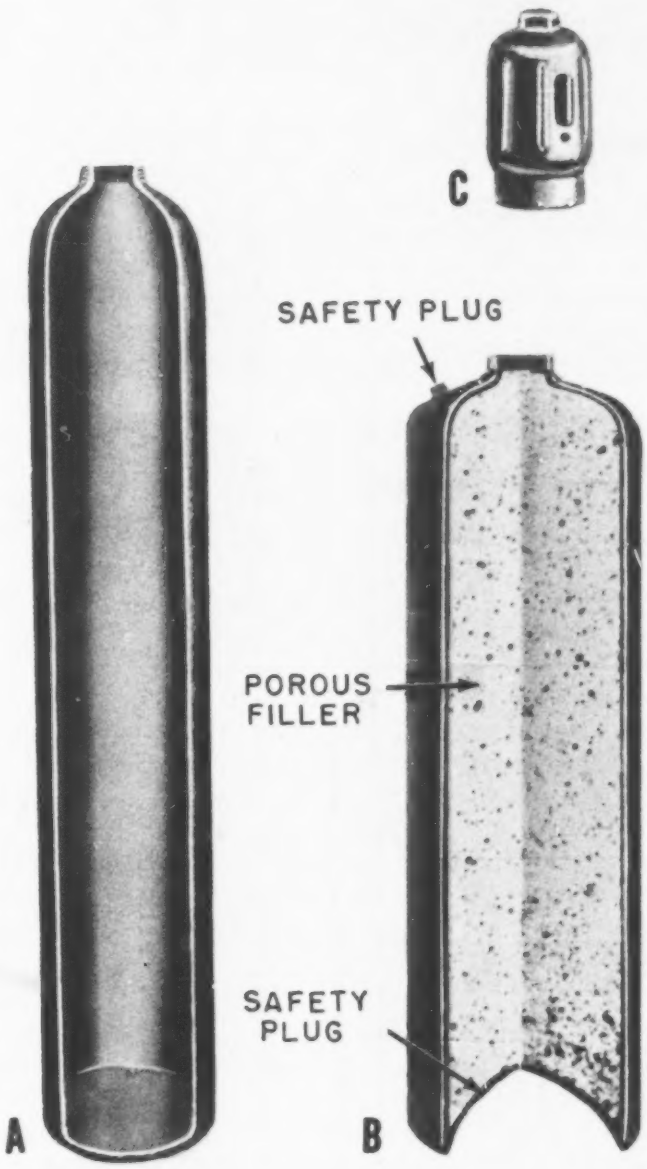

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Figure 16-21.—Cutaway view of compressed gas cylinders. A. Oxygen cylinder. B. Acetylene. C. Valve protection cap.

different compounds. For large-scale production, however, oxygen is produced by the physical process of distilling liquid air.

Atmospheric air is a mixture of oxygen and nitrogen and is therefore a convenient and inexhaustable source of both of these gases. The problem is to separate them simply and economically.

Liquid mixtures can be separated by heating. The component having the lowest boiling point leaves the mixture before the components with higher boiling points are heated enough to boil off. This process is known as DISTILLATION. By first liquefying air, the process of distillation can be used to separate oxygen from nitrogen. Nitrogen has a lower boiling point than oxygen, and therefore will leave the mixture first.

In the liquid air process for producing oxygen, air is cooled until it becomes a liquid. The liquid is then distilled—that is, the nitrogen is boiled off as a gas, while the oxygen remains as a liquid.

The liquid oxygen can then be drained off to a storage tank and, when ready for use, converted to a gas.

LIQUEFYING AIR

At atmosphere pressure, the boiling point of oxygen is -297° F, and that of nitrogen is -321° F. You can readily see that a great amount of heat must be removed from air in order to liquefy it.

A temperature of -297° F may be hard to imagine. Ice feels very cold to the touch; it melts at 32° F. The North Pole is very cold, yet the air there is rarely below -70° F or -80° F. You can see how much colder air must be in order to liquefy.

There is a natural tendency to think of a boiling point as applied only to water. The boiling point of a substance is the temperature at which it turns from a liquid to a gas. At a given pressure the boiling point is a fixed temperature for any one material. Pressure always affects the boiling point. A good example of this temperature-pressure relationship is that water or any other liquid will boil at lower temperatures on high mountains than at sea level.

Since we make use of differences in boiling points to separate oxygen from the other constituents of air, it follows that the big job, outside of the actual distillation itself, is to liquefy air. To do this, heat must be removed from the air. You will remember that a change in the pressure of a gas is directly proportional to a change in temperature. Therefore, it follows that if you expand a gas, or lower its pressure, the temperature of the gas will drop. This fact is made use of in lowering the temperature of air in order to liquefy it. Air is compressed in stages, cooled, and then suddenly expanded. This drops the temperature below the boiling point of air.

Atmospheric air, at sea level, is composed of nine gases. For practical purposes, let us assume air to be a mixture of two gases: nitrogen, 78 percent, and oxygen, 21 percent. The

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remaining gases we will refer to as rare gases. These gases, with the exception of carbon dioxide (CO_2) will cause little trouble in the operation of an oxygen-nitrogen plant. CO_2 has to be removed from the air stream as it will solidify at -109° F. When CO_2 becomes a solid, it can block the passage of air and reduce or stop the plant production. Solid particles of CO_2, if allowed to carry over into the oxygen, would lower the purity of the oxygen below the required 99.5 percent.

Figure 16-22 shows a simple, high pressure liquid air plant. The temperatures and pressures are only approximate values and are for purposes of explanation only. The main components of the high pressure liquid air plant are: (1) high pressure air compressor, (2) counterflow heat exchanger, (3) air expansion valve, and (4) liquid air receiver or flash tank. The expansion valve plays a major role in the liquefaction process. To understand the function of this valve, you have only to know that air is cooled when allowed to expand from a high pressure area to a low pressure area. In figure 16-22, air is expanded from 3000 psi down to 22 psi and the temperature drops from 70° F to -317° F. The expansion valve provides the fundamental source of cooling.

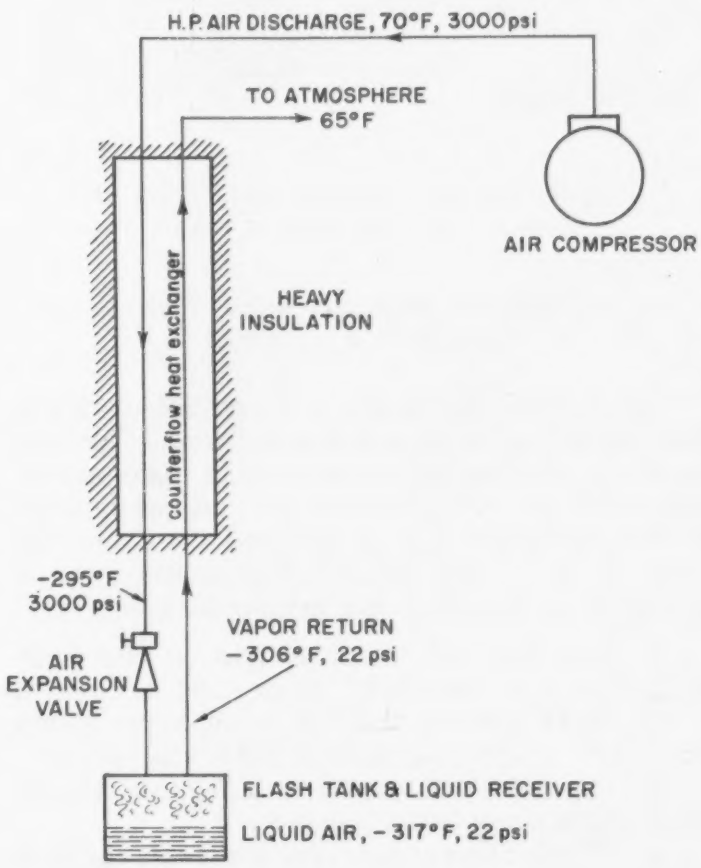

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Figure 16-22.—Simple oxygen plant.

The flow of air must be continuous, but for simplicity of explanation we will consider the air flow as the first, second, and third pounds of air entering the plant. The air is discharged from the compressor at 3000 psi. Trace the air flow on figure 16-22. The first pound of air enters the high pressure side of the counterflow heat exchanger at about 70° F. It leaves the heat exchanger at the same temperature, for there is no return flow in the low pressure side of the heat exchanger with which it can exchange heat. The first pound of air blows through the expansion valve and its pressure is reduced to 22 psi and its temperature drops a small amount. The air continues down into the flash tank, out, and back through the low pressure side of the heat exchanger.

Suppose now that the second pound of air, at high pressure, is just starting down the high pressure side of the heat exchanger, as the first pound is passing up the low pressure side. The two pounds of air will be at different temperatures, so a heat transfer will take place. The first pound of air, being cooler than the second pound, will cool the second pound. Thus the second pound of air will arrive at the expansion valve cooler than the first pound. The second pound of air will pass through the expansion valve and be cooled to a lower temperature than was the first pound.

The second pound of air will pass through the flash tank and up through the low pressure side of the heat exchanger, where it will cool the third pound of air which is now entering the heat exchanger. The third pound of air will pass through the expansion valve and be cooled to a lower temperature than the second pound because it arrived at the expansion valve at a lower temperature and went through the same pressure drop.

This process goes on and on until the plant reaches a temperature low enough for the air to liquefy as it blows through the expansion valve (approximately -317° F).

With this process, about 9 percent of the air entering the plant will become useable liquid oxygen. The oxygen yield can be increased to 21 percent by the use of mechanical refrigeration. As previously explained, the lower the temperature of the air entering the expansion

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valve the lower will be the temperature of the air leaving the expansion valve. The mechanical refrigeration is not essential, but is used only to increase the yield of the plant.

SEPARATING OXYGEN AND NITROGEN

To more fully understand the distillation process which separates the oxygen from the nitrogen, we will first consider a container of water being heated. In time vapor (steam) will rise from the container. The vapor will be of the same composition as the water remaining in the container. The vapor is the gaseous phase and the water is the liquid phase.

Let us now consider a container of liquid air instead of water. As heat is applied, a vapor is driven off. The vapor will have a composition of 5 percent oxygen and 95 percent nitrogen. If the boiling is continued, the remaining liquid will become richer and richer in oxygen.

At the present time, all liquid oxygen plants used aboard ship operate by the distillation process. The liquid air leaves the expansion valve and enters at the top of a distilling column (fig. 16-23) and begins to fall down through a series of trays. The column is a towerlike affair with a coil in the bottom. Above the coil are tiers of porous trays (fig. 16-24). The liquid air comes into contact with the warmer vapor rising off the liquid product collected in the bottom of the column. This rising vapor gets richer in nitrogen, because the nitrogen, having a lower boiling point, will boil off first. The downflowing liquid will become richer in oxygen as the nitrogen continues to boil off. The liquid entering the top of the column is a mixture of oxygen and nitrogen and one part of the mixture (nitrogen) is being released by boiling. The part of the mixture remaining in the bottom of the column is oxygen. This is the process going on inside a simple column. In a plant of this type, liquid oxygen (LOX) can be drawn off from the bottom of the column and gaseous nitrogen released (through the heat exchanger) to the atmosphere.

Some plants are designed to produce pure (99.5%) liquid oxygen and pure gaseous nitrogen. In this type of plant, two columns are used. The two products, LOX and gaseous nitrogen, are drawn off and stored until ready for use. Details of this type of plant will not be given in this training course.

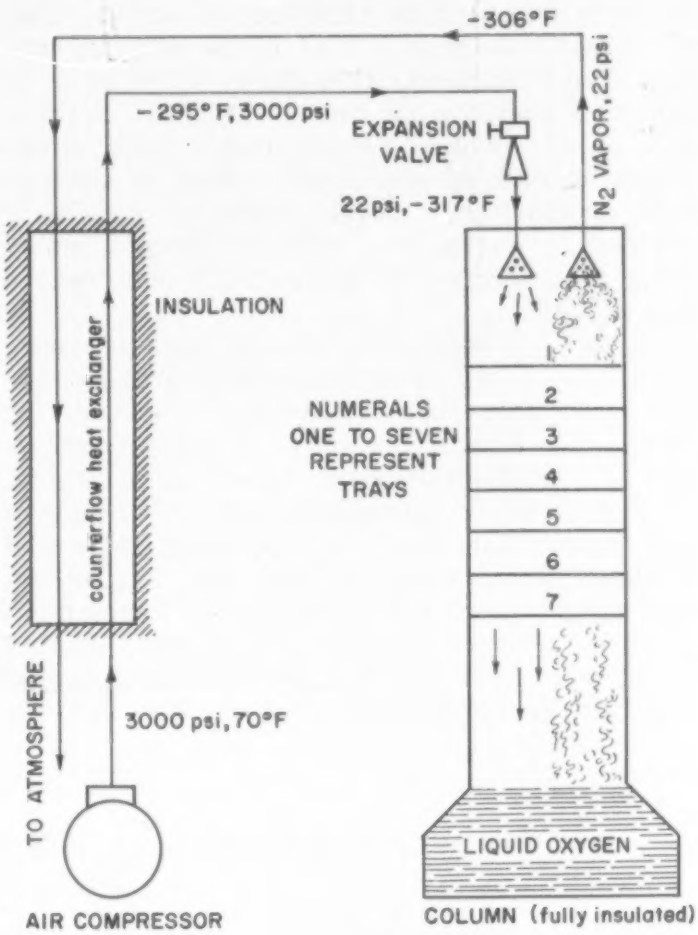

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Figure 16-23.—Oxygen plant showing column and position of trays.

SAFETY PRECAUTIONS FOR INDUSTRIAL GASES

All compressed gases are hazardous. Many detailed precautions could be set down regarding handling, storing, and transporting these gases. Make certain that all special precautions relative to the particular gas being used are observed. Some of the more important precautions to be observed in handling all industrial gases are:

1. See that all required gas or chemical analyses are carefully made and recorded.
2. Make certain that all plant adjustments are made in accordance with these analyses.
3. Constantly inspect for leaks, and repair immediately any leaks located.
4. Watch all pressure and temperature gages with extreme care.
5. Never permit any flames, sparks, or flammable material in the plant.

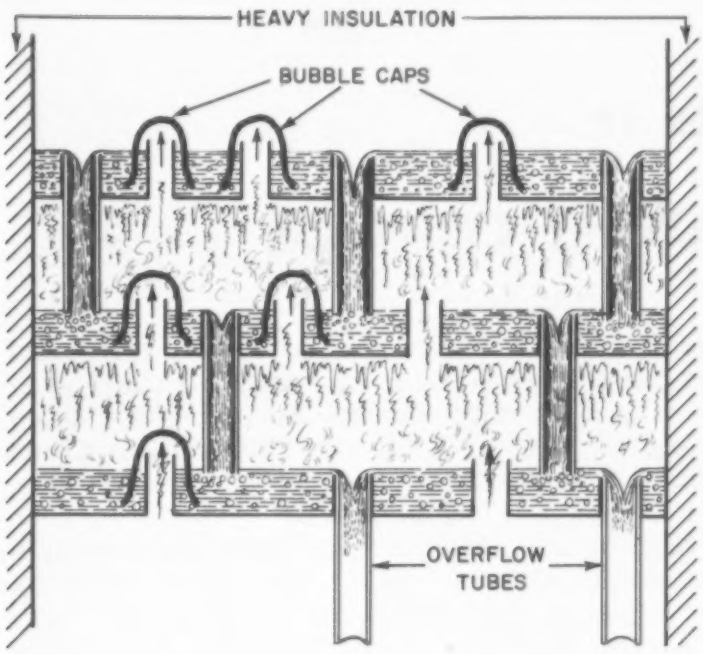

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Figure 16-24.—Porous bubbler trays.

In HANDLING THE COMPRESSED GASES, never use gas from a cylinder except through a pressure regulator with its adjustment screw properly set.

1. Open the cylinders by hand, never with hammers or wrenches.
2. Crack open the valve 1/4 turn and close, before connecting the pressure regulator; do not open the valve near sparks or other sources of ignition.
3. Do not let gas enter pressure regulators suddenly.
4. Open valves full when cylinder is in use (only 1 1/4 turns for acetylene valves).
5. Never tamper with safety devices; never force-fit any of the connections.
6. Close valves which leak at the stem; release gas to outdoor atmosphere if safety device leaks.
7. When referring to a particular gas always use its identifying name—never refer to it as just "gas."
8. Make sure hoses and fittings are always tight; do not interchange fittings or hoses with similar equipment for other gases.
9. Never tighten an adjustment nut to stop a leak before first closing the valve and releasing any pressure in the system.
10. Close the valves and replace outlet caps when cylinders are not in use.
11. Before removing pressure regulators, close the valve and release all gas from the regulator.

In HANDLING THE GAS CYLINDERS, use the cylinders only for the gas for which they are intended.

1. Never remove numbers or any other markings from cylinders.

2. Do not use cylinders for rollers or any other nonstandard purpose.

3. Never handle cylinders roughly or use them where they can be damaged by falling objects, etc.; always handle all cylinders as though full (unknown pressure remaining may otherwise cause accidents).

4. Do not lift cylinders by valve caps but provide carrying devices—never drag or slide.

5. In promoting more rapid discharge, never immerse more than 20 percent of the cylinder surface area, and never immerse in water over 125° F (fusible plugs will otherwise soften or melt).

6. Never store near flammable material (oil, gasoline, waste, etc.), in damp locations, near live wires, near corrosive chemicals or fumes, near heaters, or near any other gas.

7. Erect fire-resistant partitions between flammable and nonflammable gas cylinders.

8. Store gas cylinders (except ammonia) upright.

9. Make sure storage rooms are ventilated to prevent accumulation of an explosive or otherwise harmful concentration of gas.

10. Mark empty cylinders "empty" or "MT," and segregate them from full cylinders.

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CHAPTER 17

ENGINEERING CASUALTY CONTROL

Upon the effectiveness of casualty control may depend the ship's ability to fulfill its prescribed mission. Regardless of the ship's inherent resistance to damage, her survival depends upon prompt and correct control action being taken when casualties occur. It is of vital importance, therefore, that you be fully aware of and trained for whatever action you may be called upon to perform in any possible casualty situation.

CONTROL OF CASUALTIES

Engineering casualty control is concerned with the prevention, minimization, and correction of the effects of operational and battle casualties to engineroom machinery, related machinery outside of engineroom spaces, and the piping installations relative to the various pieces of machinery. The mission of engineering department personnel is the maintenance of all engineering services in a state of maximum reliability under all conditions. Failure to provide all normal services will affect a ship's ability to function effectively as a fighting unit, either directly by reducing its military function, or indirectly by reducing habitability and efficiency.

Work involved in the HANDLING OF ENGINEERING CASUALTIES can be divided into three general phases:

1. Immediate action to prevent further damage.
2. Emergency restoration of service(s) interrupted by the casualty.
3. Repairs which completely restore damaged machinery, plants, or systems to their original condition.

To perform your casualty control job well, you must master the operation of the equipment at your normal duty station and at your battle station. The Engineering Operation and Casualty Control Manual, your ship's Damage Control Book, the Ship's Organization Book, the manufacturer's emergency instructions for the equipment or systems on your GENERAL QUARTERS STATION, and the ship's Damage Control Bills are your primary sources of instruction for handling any engineering casualty in addition to maintaining the over-all damage resistance of your ship. These publications may vary on different ships, but in all instances they present the organization and procedures to be followed in event of engineering casualties, damage to the ship, or other emergency conditions.

PREVENTIVE MAINTENANCE

Casualty prevention is the most effective form of casualty control. One of the principal factors which influence the effectiveness of casualty control is preventive maintenance. Inspections and preventive maintenance are vital to successful casualty control, since these activities minimize casualties caused by material failures.

Detailed inspection procedures are necessary to discover damaged parts which may fail at a critical time. Inspections at frequent intervals make it possible to locate and eliminate conditions which may lead to early failure of a machine. Early failure may result from maladjustment, improper lubrication, corrosion, erosion, or other enemies of machinery reliability.

SYMPTOMS OF OPERATIONAL CASUALTIES

You must be on the alert at all times to detect even the most minor sign of faulty operation of machinery. Particular and

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continuous attention must be paid to the following symptoms of malfunctioning of machinery:

1. Unusual noises.
2. Vibrations.
3. Abnormal temperatures.
4. Abnormal pressures.
5. Abnormal operating speeds.

You should become thoroughly familiar with the normal temperatures, pressures, and speeds of equipment specified for each condition of operation; departures from normal will then be readily apparent. It must not be assumed that an abnormal reading on a gage, or on any other instrument indicating operating conditions of machinery, is caused by an error in the instrument. Each such case should be investigated to establish fully the cause of the abnormal reading. Either the substitution of a spare instrument or a calibration test will quickly show whether an instrument error exists. Abnormal readings which are not caused by faulty instruments must be traced to their source, if preventive maintenance is to be effective. Some specific examples of advance warning of ultimate failure are outlined in the following paragraphs.

Because of the safety factor commonly incorporated in pumps and similar equipment, considerable loss of capacity can occur before any external evidence of trouble is readily apparent. In pressure governor controlled equipment, changes in operating speeds from normal for the existing load should be viewed with suspicion. Variations from normal in chest pressures, lubricating oil temperatures, and system pressures indicate either inefficient operation or poor condition of the machinery. Where a material failure occurs in any unit, a prompt inspection should be made of all similar units to determine whether they are subject to the same type of failure. Prompt inspection may eliminate a wave of similar casualties.

Abnormal wear, fatigue, erosion, or corrosion of a part may indicate a failure to operate the equipment within its designed limits of loading, velocity, and lubrication; or it may indicate a design or material deficiency. If any of these symptoms have appeared, special inspections to detect damage should be undertaken as a routine matter, unless action can be taken which will ensure that such a condition will not recur.

Strict attention must be paid to the proper lubrication of all equipment; this will include frequent inspection and sampling to determine that the correct quantity of the proper lubricant is in each unit. It is good practice to take daily samples of lubricating oil from all auxiliaries. Such samples should be allowed to stand long enough for any water to settle. Where auxiliaries have been idle for several hours, particularly overnight, a sample should be drained from the lowest part of the oil sump. All settled water must be drained from the sump and the oil level must be brought back to normal by adding fresh oil. An unusual quantity of fresh water in the oil is normally indicative of either poorly fitted or worn carbon packing on the turbine-driven pumps.

Salt water may enter the oil from the salt water pump glands, from the salt water cooled oil coolers, or from salt water dripping or spraying on the unit. The presence of salt water in the oil can be detected by drawing off a sample of oil and allowing it to settle. Because of its corrosive effects, salt water in the lubricating oil is far more dangerous to a unit than an equal quantity of fresh water. Salt water is particularly harmful to units with oil-lubricated ball bearings. When units with oil-lubricated ball bearings are found to be subject to salt water contamination of the lubricating oil, it is essential that the oil be drained as soon as possible, that the bearings and sump be flushed thoroughly, and that the unit be refilled with fresh oil.

GENERAL PROCEDURES FOR CONTROL OF ENGINEERING CASUALTIES

The importance of engineering casualty control cannot be taken lightly. Failure of any of the ship's normal services immediately reduces the ship's resistance to damage, and impairs its ability to function effectively as either a fighting or auxiliary unit. The effects of engineering casualties are both direct and indirect. Directly, the casualties reduce the ship's mobility, offensive power, defensive power, its ability to control fire, flooding, hull, and armament damage. Indirectly, the casualties reduce the ship's habitability and, thereby, lower the morale and efficiency of personnel.

It is quite easy for a single damaged unit in a machinery plant to disable the entire

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plant. A leaking condenser, for example, may disable both the boilers and the turbines. A damaged lube oil line or pump, and the resulting loss of pressure, can also quickly damage the turbine bearings and reduction gear bearings. Prompt remedial action must always be taken as soon as the casualty occurs.

The speed with which corrective action is undertaken in an engineering casualty is frequently of paramount importance. This is particularly true when such casualties affect propulsion power, steering, and electrical power generation and distribution. If casualties associated with these functions are allowed to become cumulative, they may lead to serious damage to the engineering installation—damage which often cannot be repaired without loss of the ship's operating ability. Where the risk of developing permanent damage exists, the commanding officer has the responsibility of deciding whether to continue operation of the equipment under casualty conditions; such action can be justified only where the risk of greater damage, or even loss of the ship, might be incurred as a result of immediately securing the affected unit. For example, an entire plant might be operated with abnormal salinity present if such operation were necessary to enable the ship to steam clear of an area of possible enemy attack. However, all possible steps must be taken to shorten such a period of hazardous operation. It is reemphasized that whenever there is no probability of greater risk, the proper procedure is to secure the malfunctioning unit as quickly as possible, even though considerable disturbance to the ship's operations may result.

Although speed in controlling a casualty is essential, action should never be taken without accurate information; otherwise the casualty may be mishandled, and further damage to the machinery may result. Cross-connecting an intact plant with a partly damaged one must be delayed until it is certain that such action will not jeopardize the intact one.

The discussion of engineroom casualties in this chapter is intended to give you a general idea of how casualties should be handled. For further information on casualty control, study the Naval Ships Technical Manual, chapter 9880(88), and the casualty control instructions issued by the engineer officer on your own ship.

Most of the casualties discussed in this chapter are treated in a step-by-step way. In handling actual casualties, the steps may have to be modified. Different circumstances may require a different sequence of steps for control of a casualty. Also, in handling a real casualty you may have to see that several steps are performed at the same time. You should learn the steps for controlling casualties in the order in which they are given, but do not overlook the fact that steps may have to be performed simultaneously.

ENGINEROOM CASUALTIES

For each class of ship, the type commander formulates engineering casualty procedures which are applicable to the specific type of engineering plant. However, the Naval Ship Systems Command recommends general procedures for the control of typical engineroom casualties. As a Machinist's Mate, you are required to have a thorough knowledge of the action to be taken for a specific casualty.

LUBRICATING OIL CASUALTIES

Even a momentary loss of flow of lubricating oil to the bearings of a machine will result in localized overheating and probably in slight wiping of one or more bearings. Damage can be prevented or minimized by stopping the shaft and quickly restoring the flow of lubricating oil. Continued operation with wiped bearings will cause serious derangement to the entire unit. The important lubricating oil casualties that may arise are discussed in the paragraphs which follow.

Loss of or Low Lubricating Oil Pressure

The loss of lubricating oil pressure may be caused by: (1) The failure of the system itself, including the main lubricating oil pumps; or (2) the failure of steam or electrical power supply to the main lubricating oil pumps.

Component parts of the lube oil system may fail because of the presence in these parts of dirt, rags, or other foreign matter. Failure of the system may be caused by a piping failure, by a failure of the operating pump, or by failure of the standby pump to

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start. Standby pumps should be maintained ready to start the moment the pressure drops below the prescribed operating range. If automatic-starting devices are not available on steam-driven pumps, the pumps must be lined up so that opening the throttle is the only action required to start the pumps. Steam supply lines to standby pumps should be drained continuously. Where electrical pumps are installed, personnel must be thoroughly familiar with alternate sources of power.

The general procedure to be followed when lube oil pressure is lost is as follows:

1. Sing out, "Loss of lube oil pressure."
2. Close the ahead throttle.
3. Open the astern throttle until the shaft stops.
   a. Simultaneously with steps 1 and 2, attempt to regain lube oil pressure.
   b. Slow the ship's speed to 1/2 power or less, if ship has more than one screw.
4. When the shaft is completely stopped, engage the turning gear and apply the brake. Secure gland sealing steam and main air ejectors.
5. Close the astern throttle slowly. If ship has two or more screws, speed may now be increased to the limit for locked shaft operation.
6. Every effort should be made to regain lube oil pressure.
   a. Check the lube oil pump in use. (If motor-driven, check normal and alternate power supplies; if turbine-driven, check the throttle valve and constant pressure governor.)
   b. Shift and inspect the duplex strainers, check for flakes of babbitt and other metal.
   c. Any oil leaks should be found and repaired. If there is an oil leak, bilges should be flushed and pumped.
7. If, during split-plant operation, a lube oil casualty is due to a loss of steam pressure, take WAY off the ship by backing the other engine(s). If cross-connecting will not cause a loss of steam to the other plant, open the main steam and auxiliary steam cross-connecting valves. If cross-connecting would affect the other plant, isolate the damage and then cross-connect the main and auxiliary steam systems.
8. Inspect all bearings to see if any have overheated.
9. Start the purifier if it is not in use.

Following a machinery derangement caused by the failure of the lubricating oil supply, a thorough examination of the main reduction gear bearings may be impracticable; however, the following information should be considered when such a casualty is being investigated:

1. The oil-strainer basket in use should be examined for the presence of babbitt flakes.
2. All turbine and cruising reduction gear bearings should be thoroughly inspected. (In the event of loss of oil pressure, the cruising reduction gear bearings are the first to be damaged.)
3. The main reduction gear bearings can be divided into three groups, in accordance with the rotational speed of the journals and the probability of the bearings becoming wiped. The rotational speed of the two high-speed pinions is the same as that of the respective turbine rotors. The speed of the bull-gear shaft is the same as that of the propeller shaft. The speed of the four intermediate-speed gear and pinion assemblies is approximately one-half the speed of the low pressure turbine rotor.
4. The high-speed pinion and the intermediate-speed pinion bearings of the main reduction gear should be examined, through the inspection openings, for possible flow of babbitt from the bearings.
5. Check for oil flow through the reduction gear bearing sight flow indicators. An absence of flow or a reduced flow through a sight flow indicator indicates that the bearing has been wiped to the extent that the oil passage is blocked or partially blocked. When such a condition exists, a below normal reading may be shown on the thermometer.
6. If the turbine bearings are found to be in good condition, it can be assumed that the main reduction gear bearings are also in good condition.
7. If a partial examination of the main reduction gear bearings shows no indication of wiping and only one of the turbine and cruising gear bearings is

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Care of Mare and Foal at Foaling

1. If mares are foaled outside, clean pastures away from any other livestock are recommended.
2. If mares are to be foaled indoors, the stalls should be disinfected, lighted with natural light when possible, dry, and with good ventilation.
3. All afterbirth should be burned or buried in lime.
4. Treat navel with tincture of iodine (2%).
5. If unsanitary conditions are found, antibiotics may be administered.
6. Be present at foaling time.

Care of Ewe and Lamb at Lambing

1. Clean and disinfect lambing quarters according to recommendation.
2. Trim ewes so no tags are present.
3. Burn or bury all afterbirth.
4. Treat navel with tincture of iodine (2%).
5. Vaccinate according to recommended local practice.
6. Before putting an ewe in any quarter to lamb, the quarters should be cleaned and disinfected thoroughly.

SECTION II - SPECIFIC PRACTICES FOR THE DIFFERENT KINDS OF ANIMALS

Swine

Hogs are normally very sanitary animals. This is due both to their habits and the fact that they have little body hair. Unfortunately, swine producers many times tend to keep their hogs in filthy quarters, thus leading to disease and parasitism.

A general sanitation program should include the following points:

1. Satisfactory, well ventilated housing. Because swine are very sensitive to extremes in heat, they must always have shade, particularly if they are of the light-skinned breeds.
2. Clean bedding should always be placed in hog houses after cleaning and disinfecting.
3. Always keep hogs separated according to size, age and sex.
4. Keeping hogs cool: Good results have been obtained by spraying with cool water under shade. Provisions must be made for proper drainage in the lots to avoid unsanitary puddles of water.
5. If roundworms are found, the McLean County system of swine sanitation is recommended where practical. Other parasites may be controlled by different methods. (See Agricultural Education Department Service Bulletin #1, Harmful Parasites of Domestic Animals.)
6. Isolate all new animals added to the breeding herd for at least three weeks before adding them to the herd. Before adding these animals to the herd, inspect for external and internal parasites.
7. Spread manure in fields where hogs have no access.
8. Use waterers and feeders of a type in which hogs cannot stand or wallow.
9. Footwear should always be disinfected when entering and leaving the hog house.
10. Make certain that animals get plenty of exercise.

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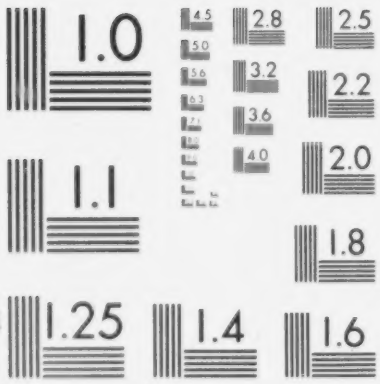

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found to be wiped, the shaft may be operated at the minimum speed which the tactical situation will permit until such time as a thorough examination of the main reduction gear bearings can be made by a repair activity.

8. If several of the bearings for the high pressure turbine, and especially those for the low pressure turbine, are found to be wiped, it is likely that the high-speed pinion bearings for the main reduction gear are also wiped. In this case, the shaft should not be operated until the high-speed pinion bearings have been thoroughly examined. If these bearings are wiped, the intermediate-speed gear and pinion bearing should be inspected. Whenever possible, these inspections and repairs should be made at a naval shipyard.

The previous procedure applies when the lubricating oil pressure of the entire system is lost. However, if it is noted that a turbine bearing is overheated because of a local loss of oil or because of the presence of foreign matter, and it becomes necessary to shut down the turbine, it should be slowed down, and kept operating at a slow speed, until the bearing and journal have cooled to a safe temperature. If the shaft is stopped quickly, the bearing metal may freeze to the shaft and thereby make repairs much more difficult.

Cooler Tube Carries Away

When a tube of the lubricating oil cooler carries away, the action to be taken is as follows:

1. If it is permissible to reduce the speed of the ship, bypass the cooler; and strike down oil from the storage tank to the sump to restore the working level.
2. If it is not permissible to reduce the speed of the ship sufficiently, or if the oil leak is not serious and there is an adequate supply of oil on board, increase the lubricating oil pressure so that oil will leak into the waterside of the cooler; and pump make-up oil into the sump tank.

Lubricating Oil Leak Into Engineroom

When lubricating oil leaks into the engineroom, the action to be taken is as follows:

1. If permissible, stop the engine.
2. If it is not permissible to secure the engine, plug or patch the leak so as to stop oil loss and prevent the creation of a fire hazard.
3. Inspect the oil level in the sump; strike down purified make-up oil as necessary.

Excessive Oil Pump Discharge Pressure

If the discharge pressure of the oil pump becomes excessive, the action to be taken is as follows:

1. Inspect the constant-pressure pump governor for proper operation.
2. Inspect the strainer and all parts of the lubricating oil system for restrictions of oil flow.
3. Check all bearing and reduction gear temperatures. A clogged strainer or a pipeline restriction may greatly reduce the amount of oil being delivered to the lubrication system, thus causing overheating of the bearings and gears.

LOSS OF VACUUM

The major causes of a loss of vacuum are: excessive air leakage into the vacuum system, improper functioning of the air-removal equipment, improper drainage of condensate from the condenser, insufficient flow of circulating water, and high injection temperature.

1. EXCESSIVE AIR LEAKAGE INTO THE VACUUM SYSTEM may be caused by:
   a. Insufficient gland sealing steam.
   b. Vent valve on idle condensate pump open.
   c. Loop-seal filling valve open.
   d. Bypass valve on drain tank open.
   e. Drain tank float valve stuck open.
   f. Leakage of flanges, fittings, or valve stem packings under vacuum.
   g. Taking make-up feed from empty feed bottom. The following actions should be taken with an empty feed bottom in use for make-up feed:
      (1) Shift to another reserve feed bottom for make-up feed.
      (2) Refill the empty feed bottom either by distilling to the empty feed tank, or by using the emergency feed pump to transfer

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feed water from the opposite feed tank to the empty feed tank.

2. IMPROPER FUNCTIONING OF THE AIR-REMOVAL EQUIPMENT may be due to:
   a. Insufficient steam to the air ejectors.
   b. Foreign matter lodged in the air ejector nozzle(s).
   c. Erosion of the air ejector nozzle, over a period of time.
3. IMPROPER DRAINAGE OF CONDENSATE FROM THE CONDENSER may be caused by:
   a. Low speed of condensate pump, indicating malfunctioning of the pump's speed-limiting governor.
   b. Condensate pump air-bound because of the vent connection from the first stage being closed or not opened wide.
4. INSUFFICIENT FLOW OF CIRCULATING WATER may be caused by:
   a. Improper adjustment of the overboard discharge valve (the main injection valve being wide open whenever the condenser is under vacuum).
   b. Inadequate speed of the main circulating pump.
   c. Plugged tubes, resulting from mud, shells, small fish, or kelp being trapped against the injection strainer bars or in the inlet water chest.
   d. Air trapped in condenser.
5. HIGH INJECTION TEMPERATURE

Basically, the injection temperature limits the maximum vacuum (minimum absolute pressure) obtainable in a specific plant, assuming the condenser, associated equipment, and piping under vacuum to be clean and properly operated.

Whenever there is a loss of vacuum, the first step in correcting the trouble is to locate the cause of the casualty. The major possible causes are so numerous that no attempt will be made to list the proper action required for each one. The required action may be very simple, such as closing the loop seal filling valve, or it may be much more complicated, such as cleaning the main condenser or replacing air ejector nozzles.

LOSS OF STEAM PRESSURE IN THE ENGINEROOM

In the event of a loss of steam pressure, the following action should be taken:

1. Close the main throttle and trip the turbogenerator to prevent the main steam pressure from dropping below the designated minimum operating pressure, normally about 85 percent of the rated pressure. If the electrical load is split, the bus tie between the two main switchboards must be closed immediately, pending supply of steam to the turbogenerator from the other plant.
2. Open auxiliary steam cross-connection valves.
3. Open the main steam cross-connections and the turbogenerator steam cross-connections.
4. Shift to electrical auxiliaries if installed.

LOSS OF MAIN FEED PRESSURE

The MAJOR CAUSES for loss of main feed pressure are as follows:

1. Constant pressure governor not functioning properly.
2. Feed pump vapor-bound.
3. Feed booster pump pressure low.
4. Speed limiting governor set too low or sticking.

The following ACTION should be taken to correct the trouble:

1. Feed boiler(s) with emergency feed pump.
2. Check discharge pressure of main feed pump and main feed booster pumps.
3. Check water level in deaerating feed tank.
4. Check auxiliary exhaust pressure and pressure in deaerating feed tank.
5. Check feed check valves on idle boiler(s) (if applicable).
6. Check operation of constant pressure governor and speed limiting governor.
7. Open vents on main feed pump water casing.

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NOTE: If the deaerating feed tank water level and the feed booster pressure are normal, the standby main feed pump may be started before checking other causes of loss of main feed pressure.

LEAK IN CONDENSER

If a condenser salinity indicator shows a rise in the chloride content, the source of the contamination must be determined immediately. To locate these sources, test the fresh water from different units in the system by checking the proper salinity indicators (if installed) and by making chemical chloride tests. There are five major causes of a salty condenser:

1. Leaky tube(s) in the condenser.
2. Make-up feed tank salted up.
3. Low pressure drain tank salted up.
4. Heating system drains salted up.
5. Leaky feed suction and drain lines which run through the bilges.

Each of the aforementioned possibilities must be investigated to determine the source of the contamination and its elimination.

If there is a minor leak in the condenser and the ship's prospective arrival time is less than 24 hours, the affected plant will probably be continued in operation. Isolate the condensate system, and limit the number of boilers on the engine involved. When operating under these conditions it will be necessary to blow down the boiler(s) as required, to keep the boiler salinity within the specified limit.

However, if the leak is serious, the following action should be taken:

1. Stop the engine.
2. Shift drains, auxiliary exhaust, and turbogenerator exhaust to the auxiliary condenser.
3. Retain the main lubrication oil system in operation, and proceed on the other engine(s).
4. Test the condenser and plug the leaking tube(s).

For the procedure in locating and plugging leaking condenser tubes, refer to chapter 8 of this training course.

LOSS OF CIRCULATING WATER

In the event of a loss of circulating water through a main condenser, the main engine that the condenser serves must be secured. Any further action will depend on the type ship and the type of damage. If the injection or overboard piping is ruptured, the main engine cannot be used until the damage is repaired. On a combatant ship, a damaged main circulating pump means that the main engine can be used only when the ship is going ahead at a speed of 5 knots or more. On some auxiliary ships the main injection piping has a cross-connecting line which allows either main circulating pump to circulate sea water through both main condensers.

DEAERATING FEED TANK CASUALTIES

During normal operation, the only control necessary for operating a deaerating feed tank is maintaining the proper water level. Overfilling the deaerating feed tank may upset the steam-water balance and cool the water to such an extent that ineffective deaeration will occur. Overfilling the deaerating feed tank also wastes heat and fuel.

The deaerating feed tank casualties which are of importance to you, as a Machinist's Mate, are discussed in the paragraphs which follow.

Deaerating Feed Tank Water Level Drops During Steady Steaming

If the deaerating feed tank water level drops during steady steaming, ACTION to be taken is as follows:

1. Check operation of main condensate pump.
2. Check recirculating valves on main condensate line. (Close valves if they are open.)
3. Check water level in main condenser and start standby main condensate pump if water level is too high.
   CAUTION: This is to be done gradually, keeping close watch on auxiliary exhaust pressure.
4. Check other engineroom(s) for excess feed water conditions.
5. If all these conditions are normal, take on make-up feed.

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Deaerating Feed Tank Too Full

If the deaerating feed tank is too full, the ACTION to be taken is as follows:

1. Check feed booster pump operation.
2. Check make-up feed valve, ensure it is closed.
3. Open excess feed valve, deaerating feed tank to feed bottom, or if other engineroom can take the excess feed, open condensate crossover and secure condensate to deaerating feed tank.

Casualty to Deaerating Feed Tank (DFT) Split-Plant

In the event of a casualty to a deaerating feed tank when steaming split-plant with all deaerating feed tanks in use, the following action should be taken:

1. Open to the unaffected plant the crossover valves in the condensate system, the main feed system, the auxiliary exhaust steam line, the high pressure drains, and the fuel oil heater drains.
2. Secure the main feed pump(s) and the booster pump(s).
3. Secure the exhaust steam to the damaged DFT.
4. Secure the high pressure drains to the damaged DFT.
5. Secure the fuel oil heater drains to the damaged DFT.
6. Secure the condensate discharge valve to the damaged DFT.
7. Secure the recirculating system and all the vent valves on the damaged DFT.

Casualty to Deaerating Feed Tank (Cross-Connected Plant)

If a casualty to the DFT occurs when the ship is steaming with a cross-connected plant and has one deaerating feed tank in use, the following action should be taken:

1. Start the standby main feed pump and the booster pumps(s) in the opposite engineroom.
2. Secure the main feed pump(s) and the booster pump(s) in the engineroom having the casualty to the DFT.
3. Secure the exhaust steam to the damaged DFT and route it to the opposite DFT.
4. Secure the high pressure drains to the damaged DFT, and route them to the opposite DFT.
5. Secure the fuel oil heater drains to the damaged DFT, and route them to the opposite DFT.
6. Secure all the vent valves and the recirculating valves on the damaged DFT.
7. Secure the condensate discharge to the damaged DFT, and discharge it into the opposite DFT.
8. Open the vent on the DFT being placed in service, and shift make-up feed to the opposite engineroom.

COOLING WATER TO AUXILIARIES FAILS

If the cooling water to the auxiliaries fails, proceed as follows:

1. Take cooling water from the firemain or (a) cross-connect cooling main, (b) start pump(s) as necessary.
2. A portable gas-driven pump and hose may be used if other means fail.

EXCESSIVE VIBRATION AND UNUSUAL NOISES

Engineroom casualties concerning excessive vibration and unusual noises are discussed in the sections which follow.

Shaft Vibrates Excessively

If the shaft vibrates excessively, the following action should be taken:

1. Slow the engine, speed up the other engine(s) to maintain speed.
2. If vibration continues at reduced speed, slow all engines until the cause of trouble is determined.
3. Inspect the main shaft bearings and the bulkhead stuffing glands.
4. If possible, inspect the propellers, the fairwaters, and the rope guards.
5. If vibration continues to be excessive, stop the shaft and lock it.

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Turbine Vibration

If the turbine begins to vibrate, the following action should be taken:

1. Slow the turbine and reduce the superheat temperature. A rumbling noise probably indicates the presence of water in the casing, either from boiler priming or from inadequate casing drainage.
2. If the turbine has been standing more than 5 minutes without being spun, it is probable that the rotor has bowed temporarily. Usually a brief slowing of the turbine will allow the shaft to straighten.

Unusual Noise in Reduction Gear

In the event of an unusual noise in the reduction gear (when tooth failure is not probable), the following action should be taken:

1. Slow the engine immediately, and stop it if the noise persists.
2. Check the oil pressure discharge, the temperature of the bearings, and the operation of oil sprays; check the strainers for the presence of babbitt or foreign matter.
3. If a loud or roaring noise is heard, stop the engine and check the shaft immediately. Lock the shaft and to the extent that the ship's operations permit, make a preliminary investigation.

Metallic Noise Emanating from Turbine

In the event of a metallic noise in the turbine, the turbine should be stopped, the shaft locked, and the turbine placed out of commission until the cause of the noise has been located and corrected.

CRUISING TURBINE OUT OF COMMISSION

In the event of damage to the cruising turbine or the cruising turbine reduction gear, the following procedure should be carried out:

1. Disconnect the flexible coupling between the cruising reduction gear and the high pressure turbine.
2. Lock the cruising turbine and gear against rotation.
3. Secure the appropriate valves (gland seal, gland leak-off, drains, and cooling steam) applicable to the cruising turbine.

OVERHEATED BEARINGS AND THEIR TREATMENT

An overheated bearing is a typical propulsion plant casualty. The bearings of turbines, line shafts, and reduction gears are possible points of trouble. As a Machinist's Mate, you should have a knowledge of the action to be taken when any of these bearings become overheated.

When the temperature of a TURBINE or MAIN SHAFT BEARING exceeds its normal operating range, the following action should be taken:

1. Check to see that the proper amount of oil is being discharged from the cooler, and that an adequate supply of oil is being discharged to the bearings.

   The supply of oil may be increased by opening the needle valve, if a needle valve is provided; or by increasing the delivery pressure of the oil pumps, where this is practicable. The oil may be further cooled by increasing the flow of circulating water to the coolers. Only in an emergency may water be sprayed on an overheated bearing for the purpose of cooling it.
2. If these measures are not effective in reducing the bearing temperature, the speed of the unit should be reduced; in some cases, it may be necessary to stop the unit.
3. If overheating has not caused damage to shaft packings, overheated bearings may be operated at moderate speeds; however, the bearing should be replaced as soon as possible.
4. If bearing damage is believed to be excessive, turn the shaft at a slow speed until the bearing has cooled sufficiently to keep the bearing from freezing; then stop and lock the shaft. Continue the operation of the forced-lubrication system.
5. Operate the lubricating oil purifier continuously to remove any flakes of babbitt or other foreign matter, which may be in the oil system.

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6. Shift, inspect, and clean the lubricating oil strainer.

When REDUCTION GEAR BEARINGS become overheated, do not operate the gear, except in an emergency, until the bearings have been examined. Wiped bearings would permit pinion or shaft misalignment which, in turn, would result in uneven gear wear.

JAMMED THROTTLE

If the head throttle valve jams open, proceed as follows:

1. Close the guarding valve or main line stop valve.
2. Use astern throttle to stop the shaft in an extreme emergency.

If the astern throttle valve jams open, proceed as follows:

1. Close the line stop valve.
2. Use ahead throttle to stop the shaft in an extreme emergency.

NOTE: On some new combatant ships, the guarding valve controls the steam to both the ahead and astern throttles. In such cases, should either throttle jam, the casualty is controlled by closing the guarding valve. The shaft CANNOT be stopped by using the opposite throttle.

GAGE GLASS ON
EVAPORATOR BREAKS

If a gage glass breaks on an evaporator, proceed as follows:

1. Secure the valve at top and bottom of the gage glass.
2. Check the water level by looking through the glass port on the side of the evaporator shell.
3. Remove any broken glass from the gage glass rubber gaskets. Obtain a replacement gage glass or cut replacement from glass tube stock.
4. Install the new gage glass.
5. Open the valves at top and bottom of the gage glass.

FIREROOM CASUALTIES

As an MM3 or MM2, you will be concerned with various fireroom casualties. In general, the Boilerman is responsible for taking the necessary steps to control fireroom casualties. However, it will become necessary for the Machinist's Mate to carry out proper procedures to control the casualties which have a direct effect on the operation of the engineroom. Close cooperation between the engineroom and fireroom personnel is necessary for the most efficient handling of engineering casualties.

Under all circumstances, the Boilerman will notify the engineroom of the fireroom casualties. The necessary action that must be taken will be based on the report given by the Boilerman. When a fireroom casualty affects the operation of the engineroom, cooperation and communication between personnel of both the spaces are extremely important. Lack of (or improper) communication or cooperation can be the indirect cause of a casualty getting out of control and resulting in serious damage to machinery and injury to personnel. Main engine control must receive all important information in order to coordinate the handling of the casualty. Main engine control must have all vital information to keep the officer of the deck informed as to the status of the machinery and the maximum speed the ship can make.

Some of the fireroom casualties that affect the engineroom, and the procedures for controlling them, are listed in the following paragraphs.

If the fireroom notifies the engineroom that there is oil in the fuel oil heater drains, the Machinist's Mate should immediately check the inspection tank to see if oil has carried through to the engineroom. The inspection tank drains should be shifted to the bilges to prevent the oil entering the feed system. The Boilerman will shift his fuel oil heater drains to the bilges and then shift to another fuel oil heater. When the drains have cleared up, the Boilerman will shift the drains to the drain system and any oil left in the drain system will be carried to the engineroom. When the fuel oil heater drain inspection tank has cleared up, the Machinist's Mate will shift the inspection drain tank drains back to the drain system.

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If the fireroom informs the engineroom that the salinity of the boilers is excessively high and that the boilers may be receiving feed water which has a high salinity content, the Machinist's Mate should check all sources of feed water contamination that are his responsibility.

One very common source of feed water contamination is the leakage of salt water into the feed water system. Leakage may occur in any of the following parts of the system:

1. Main and auxiliary condensers.
2. Distilling plants.
3. Leaky feed water and drain lines that run through the bilges.
4. Open funnel drains.
5. Steam heating lines to lube oil coolers.

If the Boilerman notifies the engineroom that it is necessary to blow down the boiler to reduce the salinity, the Machinist's Mate must take on makeup feed to replace the water that will be lost due to blowing down the boiler. The water must be taken on slowly to maintain the deaerating feed tank temperature and the auxiliary exhaust line pressure. The Boilerman must take on water slowly and the Machinist's Mate must watch the deaerating feed tank closely to avoid lowering the water level to a dangerously low level. If the water level of the tank gets too low, the Machinist's Mate must notify the fireroom to cease blowing down the boiler. The amount of reserve feed water that is available for blowdown purposes should be estimated, and when this water has been used, the blowdown should be discontinued.

If it is impossible to maintain the salinity content of the boiler within the allowable limits, the boiler will have to be secured, or the firing rate will have to be reduced in order to prevent carryover.

In the event of the fireroom casualty, HIGH WATER IN THE BOILER, the Machinist's Mate should close the main engine throttle and trip the ship's service turbogenerator. Open all steam line drains and all turbine drains to ensure that all water is drained from the steam lines and turbines before the cross-connection valve is opened. The plant will then be cross-connected to receive steam from another boiler. These procedures should be carried out simultaneously. The Boilerman will close the feed check valve, secure the burners, and stop the blowers. The Boilerman will also close the main, the turbogenerator, and the auxiliary boiler steam stop valves. After the boiler is secured, the Boilerman will run down the water to the steaming level, relight fires, and bring the boiler on the line.

Priming has resulted in many failures of turbogenerator thrust bearings, due to slugs of water entering the turbine.

FAILURE OF A FORCED DRAFT BLOWER can be serious, depending on the existing conditions. If two blowers are in use and the speed of the ship is high, the ship will have to be slowed. If only one blower is in use, its failure will necessitate the securing of the boiler until another blower can be started. If there is only one boiler furnishing steam to a space the Machinist's Mate will have to cross-connect the space and take steam from another boiler. This will necessitate securing the deaerating feed tank and sending condensate to the space furnishing steam.

When there is a LOSS OF FUEL OIL SUCTION to the steaming boilers, the steps necessary to correct this casualty depend on the existing conditions (whether steaming split-plant or cross-connected). If the plant is split, the Boilerman will secure the boilers if the steam pressure drops below 85 percent of operating pressure. Should it become necessary to secure the boilers, the Machinist's Mate will have the plant cross-connected in order to provide steam for the vital auxiliaries. The Boilerman will need steam from another plant in order to operate the forced draft blowers and fuel oil service pumps. When fuel oil suction has been regained, the Boilerman will light off the boilers and bring them back on the line. If an engineering plant is being steamed cross-connected, the loss of fuel oil suction is more serious. All main throttles must be secured immediately. The Boilerman must see that at least one boiler is cut in on the auxiliary line. This is necessary in order to obtain steam for the forced draft blowers, the fuel oil service pumps, and the lube oil service pumps. If proper procedures are not followed by engineroom and fireroom personnel, the ship will soon be without steam or power. Normal operation can be resumed as soon as fuel oil suction has been regained, fires have been lighted, and the boilers are back on the line.

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Any fireroom casualty affecting the engineroom-or engineroom casualty affecting the fireroom-requires complete cooperation between the personnel of all spaces concerned, plus close coordination of the corrective procedures by the officer of the watch. A minor casualty can quickly become a major casualty if improper procedures are used. Thorough training of all engineering department watchstanders can be the difference between effective and ineffective action taken to control casualties. All personnel, not just a few KEY men, should know the engineering plant-each piece of machinery, the piping systems, how each unit is used in conjunction with other units, and how each casualty affects the operation of another space or other spaces.

BATTLE DAMAGE CASUALTIES

As an MM3 or MM2, you will also be responsible for knowing how to handle battle casualties. Speed is a critical factor when applying corrective procedures to battle casualties. But speed is not the only factor to be considered, CORRECT ACTION must be taken. Thorough training of all personnel concerned is essential in applying proper procedures in handling battle casualties.

This section contains information on some of the different types of battle casualties. You must be familiar with the procedures as presented both in this section and in other publications that cover them in greater detail. Naval Ships Technical Manual (chapter 9880), and your own ship's Damage Control Book, Engineering Casualty Control Manual, and Ship Repair Party Manual are publications which contain very important information which you must know.

RUPTURE IN FIREMAIN PIPING BETWEEN PUMP AND FIREMAIN

When a rupture occurs in the firemain piping between the pump and the firemain, the following action should be taken:

1. Close the cutout valves located where the pump-discharge line joins the firemain.
2. Close the pump discharge valve.
3. Stop the pump.
4. When another pump is available, place it on the line.
5. If another pump is not available, a jumper can be run between broken sections of the firemain; or a hose can be run between fireplugs on either side of a damaged section. A portable gasoline-driven fire pump or electric submersible pump can be connected to discharge to the firemain.

RUPTURE IN MAIN FEED PIPING

If damage occurs to the main feed piping system, secure the main pump and feed the boiler with the emergency feed pump. If the proper water level cannot be maintained in the steaming boiler(s), secure the boiler(s) before a low water casualty occurs. Isolate the damaged sections of the feed system, repair the rupture, and restore main feed service; or cross-connect the main feed system, if applicable.

RUPTURE IN HIGH PRESSURE DRAIN PIPING

If damage occurs to a section of the high pressure drain piping, the first corrective step is to isolate the damaged section, by closing the bulkhead stop(s). If escaping vapor hinders operations in the space, close off all high pressure drain traps and crack the funnel drains, or the bilge drains, as applicable.

To conserve water, crack open drains only at points where condensate tends to form, and use as few bilge drains as possible. If a rupture occurs at the deaerating feed tank, the drain valve at the entrance of the deaerating feed tank must be closed.

Whenever the high pressure drainage system cannot be used, drain various units to the funnel drains as often as needed. In some instances, all but the vital high pressure drain traps can be cut out and the high pressure drain system can be cross-connected.

RUPTURE IN FUEL OIL HEATING DRAIN PIPING

If there is a rupture in the fuel oil heating drain piping, proceed as follows:

1. Isolate the damaged section from the drain system by securing the bulkhead stops.

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2. Let drains from the section isolated go to the bilge.
3. Plug the drain piping and recover as much of the water as possible.

RUPTURE IN SALT WATER COOLING SERVICE PIPING

When this type of casualty occurs, jumpers of hose can be rigged in the system; and hoses can be run directly from undamaged sections of the system to units which require cooling water. Damaged sections of piping should be isolated and patched or plugged.

RUPTURE IN FUEL OIL TRANSFER LINE

When this casualty occurs, the following action should be taken:

1. Stop the transfer pump.
2. Isolate the damaged section of the line.
3. Use the transfer line on the opposite side of the ship, if fitted; if the ship is not fitted with an additional transfer line, patch rupture.
4. Restart the transfer pump.

STEERING GEAR AND PROPELLER CASUALTY—NEAR MISS

In the event of a steering gear and propeller casualty, the engine(s) should be stopped and the type of damage determined. The action to be taken will depend upon the type of damage:

1. If the electric power supply to the steering gear is damaged, a casualty power cable must be rigged.
2. If steering motors are damaged, shift to the emergency steering unit or steer with main engines.
3. If oil lines are ruptured, patch them; or replace them, if possible.
4. If a propeller is beyond repair, lock the shaft and proceed on the other engine.

ELECTRICAL CASUALTIES IN BATTLE

Every effort has been made in designing the electric plant to obtain the greatest reliability and continuity of service under practicable casualty conditions. However, full realization of the design features can be attained only by proper use of the equipment and systems provided.

Damage control books contain diagrams of the various systems, and other valuable information for electrical casualty control. Damage Control Instructions (USF 82) require that an engineering casualty control book be prepared for use in the engineer department. These instructions specify the type of information that the casualty control book should contain.

In any casualty involving damage to electrical cable and equipment, electrical circuits may be a hazard if they remain energized. The individual circumstances concerned with each type of damage will dictate the action to be taken.

When serious damage occurs, it is generally necessary to remove electrical power from all cables in the damaged area to prevent the ignition of combustible liquids and gases. Continued operations, however, may require the reestablishment of power to undamaged circuits, particularly those which extend through the damaged area. The facility with which this can be accomplished will largely depend on the familiarity with the available information on the ship's electric plant.

Since electrical casualties affect the normal operation of a ship, it is beneficial to have a general knowledge of electrical equipment installed on board to provide the maximum uninterrupted supply of electrical power and lighting. When all electric power, ventilation, and lights go out, it is too late to ask an Electrician's Mate what can be done to restore power. The Electrician's Mate will be too busy to stop and give any detailed information as to what happened, what can be done to restore electrical services, and how long it will take to get things back to normal conditions. Therefore, it is best to have a general knowledge of the purpose of electric generating plants and their operation under various conditions, and of the types of casualties that will interfere or disrupt the normal operation of an engineering plant.

THE ELECTRIC PLANT

The ship's power and lighting plant comprises the generators, switchboards, power panels, cables, circuit breakers, and other appurtenances necessary for the generation, distribution, and control of power supplies to

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Beef

1. A beef sanitation program is built on healthy animals. All animals in a breeding herd should be of the optimum weight for their size and age. Animals in good condition not only breed more easily, but raise larger, healthier calves.
2. Any bulls kept off the range should have about two acres of land so that they get plenty of exercise.
3. Swampy areas and mudholes must be fenced off or drained, to prevent possible exposure to leptospirosis and footrot.
4. Avoid overgrazing land, as increased parasite population increase may be the result.
5. Never mix different classes of livestock.
6. Isolate new and sick animals from the herd.
7. Never bring home diseases from other cattle. Boots and shoes may be contaminated after a visit to other herds or the sale barn.

Suggested sanitation practices for introducing new stock in the herd:

a. Isolate for three weeks.
b. Make appropriate tests prior to shipment to your farm for:
   (1) Brucellosis
   (2) Tuberculosis
c. Check for general health during isolation.
d. Obtain a clean bill of health on new bulls. The veterinarian should examine them before you take delivery.
e. Clean and disinfect the stall after the animal is placed in other quarters or with the breeding herd.

Sheep

A suggested sanitation program to insure sheep health is as follows:

1. Keep all yards and lots well drained.
2. Follow recommended parasite and disease control practices.
3. Feed balanced rations.
4. Vaccinate to prevent diseases.
5. Treat open wounds with recommended disinfectants.
6. Avoid crowding
7. Constant observation is necessary for early detection of disease and parasites.

Dairy Cattle

A suggested sanitation program for the dairy herd is as follows:

1. Bring only brucellosis and tuberculosis free animals into the herd.
2. Isolate all new animals for at least three weeks before introducing them into the home herd.
3. Build housing where lots will drain readily. Never allow water to stand and become stagnant.
4. Isolate all sick animals.
5. Follow recommended vaccination program for common diseases.
6. Follow a sanitation program that includes fly control, wound treatment, regular cleaning, disinfection of premises, manure elimination, and proper housing.
7. Cattle on pastures should follow rotation grazing to control certain parasites. (See Agricultural Education Department Service Bulletin #1, Harmful Parasites of Domestic Animals.)
8. Eliminate any hazards which could result in injury to cattle especially to mammary glands.

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electrically driven auxiliaries, lighting, interior communication, electronics equipment, and other electrically powered devices. In designing the electric plant, every effort has been made to obtain the greatest reliability and continuity of service practicable under casualty conditions.

The distribution system forms the vital connection between the generators and the equipment which uses electric power. The distribution of electrical power is through the ship's service or the emergency switchboards, and may be through a casualty power circuit rigged from either of these switchboards.

The general arrangement of the ship's service system is such that a faulty circuit will be cut out automatically, without interruption of power supply to other circuits, through the operation of protective devices. If the ship's service generators fail, the emergency generator is automatically placed in operation for battle functions. The emergency switchboard can supply power to the vital circuits of the ship.

Protection against loss of power on a ship with ship's service, emergency, and casualty power distribution systems can be summarized as follows:

1. FAILURE OF ONE SHIP'S SERVICE GENERATING PLANT. The load can be transferred, by the Electrician's Mate, to the other ship's service generating plant. Care must be taken to prevent overloading the generating plant that takes over the load.

2. CIRCUIT OR SWITCHBOARD FAILURE. Vital loads can be transferred to an alternate feeder and source of ship's service power by means of a manual or automatic bus transfer panel.

3. FAILURE OF BOTH NORMAL AND ALTERNATE POWER SUPPLY. In cases of this nature, certain vital equipment can be shifted to an emergency feeder which receives power from the emergency switchboard.

4. FAILURE OF SHIP'S SERVICE AND EMERGENCY CIRCUITS. Temporary circuits can be rigged with the casualty power cables from any live switchboard to supply power to vital circuits.

EMERGENCY POWER SYSTEM

The emergency power system is provided to furnish an immediate, automatic source of electric power to a limited number of selected vital circuits. It includes one or more diesel-driven emergency generators, emergency switchboards, and a distribution system which is separate from the ship's service electric plant and distribution system. Emergency feeders run from the emergency switchboards to at least one and usually to two different ship's service switchboards. Emergency power feeders for certain vital auxiliaries are also run to control panels. The emergency power system, with the use of transformers, is also used for furnishing emergency lighting.

Whenever practicable, emergency generators and switchboards are installed above the waterline, to minimize danger from flooding. Also, the emergency plant is installed as far away as possible from the ship's service plant, to avoid both plants being put out of action by battle damage.

On most ships, the emergency generators do not have the same capacity as the ship's service plants. Therefore, care must be taken to prevent overloading the emergency generator.

CASUALTY POWER SYSTEM

The scope of this system is limited to the bare minimum of facilities which are required, in the event of damage, to keep the ship afloat and to get it out of a danger area, so that temporary electrical repairs of a more extensive and time-consuming nature can be accomplished. Thus, the application of casualty power is limited to the most vital equipment on board ship. The casualty power system receives its electrical power from the following sources: the ship's service generating plant; the diesel-driven emergency power plant.

Additional information on casualty power systems can be obtained from chapter 9880 (88) of the Naval Ships Technical Manual.

EMERGENCY FIRE PUMPS

Most ships have electric-driven fire pumps located outside the engineering spaces. These pumps furnish water under pressure to their own piping system or to the ship's firemain. Provisions are made for different sources of electrical power to these pumps: Normal and

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alternate supply from the ship's service generators, emergency supply from the diesel-driven emergency generators, and the casualty power system.

Many ships, such as carriers, tankers, and tugs, have independent diesel-driven fire pumps. In case of damage to the ship's pumps and firemain, these diesel-driven pumps can furnish large amounts of water for fire-fighting purposes. Many of the tugs have diesel-driven pumps and other facilities installed for fighting fire on other ships, piers, and docks.

LIGHTING SYSTEM

On ships using a-c generators, the ship's service and emergency lighting systems are energized from the generator and distribution switchboards through a bank of transformers. These transformers supply power to the lighting system through the lighting distribution panels.

Lighting throughout the machinery spaces is supplied from the normal switchboard for the compartments involved, with some lights in each space supplied from the alternate switchboard. A few lights in each compartment are supplied through automatic bus transfer equipment from circuits originating at the emergency switchboards.

In the event of complete failure of the ship's service and emergency lighting systems, automatic type hand lanterns are provided to supply an instantaneous source of illumination. These relay-operated hand lanterns are installed at vital stations. In addition, non-automatic type hand lanterns are installed at strategic locations. Although the Electrician's Mates have the responsibility for the maintenance of the hand battle lanterns, it is the duty of the petty officer in charge of the space to see that his men do not remove the lanterns or use them for unauthorized purposes. If the Electrician's Mates do not properly maintain the battle lanterns, the petty officer in charge should report the fact to the appropriate Electrician's Mate or take any other action that may be necessary.

RADIOLOGICAL MONITORING

Radiological monitoring teams, aboard ship, are made up of personnel from the damage control parties and the medical department. You, as an MM, will be required to use radiac instruments and perform monitoring operations on salt water intake lines and engineering ventilation systems.

The instruments used for surveying radiological contamination are known as RADIACS. Various types of radiacs are used aboard ship, since no single type of radiac can make all the measurements that may be required. The radiacs that you may use aboard ship include (1) survey meters for measuring gamma radiation, (2) survey meters for measuring gamma and beta radiation, (3) survey meters for measuring alpha radiation, and (4) dosimeters for measuring accumulated doses of radiation received by individuals.

The radiac instruments and methods of radiation detection are discussed in Military Requirements for Petty Officer 3 & 2, NavPers 10056-B. Additional information can be obtained from chapter 9900(90) of the Naval Ships Technical Manual.

MONITORING SURVEYS

The purpose of a radiological monitoring survey is to determine the location, type, and intensity of radiological contamination. The type of monitoring survey made at any time depends on the radiological situation and on the tactical situation. GROSS or RAPID SURVEYS are made as soon as possible after a nuclear weapon has been exploded, to get a general idea of the extent of contamination. DETAILED SURVEYS, made later, give a more complete picture of the radiological situation.

On board ship, two main types of radiological surveys would be required after a nuclear attack. SHIP SURVEYS (first gross, then detailed) include surveys of all weather decks, interior spaces, machinery spaces, circulating water and air systems. An MM monitoring in a machinery space would be primarily concerned with surveying contamination in systems using sea water; main and auxiliary condensers, distilling plants, fire pumps and cooling water pumps. Later and more detailed surveys are made by personnel from damage control parties. The medical department makes clinical tests, maintains dosage records, and makes specific recommendations concerning monitoring of food, water, and air.

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Detailed instructions for making monitoring surveys cannot be specified for all situations, since a great many factors must be considered before monitoring procedures can be decided on. Monitors must be thoroughly trained before the need for monitoring arises. Simulated practice will teach something about the general movements made by a monitor, but it will not prepare him to actually use the radiac instruments. All personnel who may be required to perform monitoring operations should be given instructions and practice in the use of all types of radiacs available on board ship.

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CHAPTER 18

LATHES AND LATHE MACHINING OPERATIONS

Although machine shop work is generally done by men in other ratings, there may be times when you will find the lathe essential to complete a repair job, and you are required to know the purpose and principles of operation of lathes. There are a number of different types of lathes installed in the machine shops of various Navy ships, including the engine lathe, horizontal turret lathe, vertical turrent lathe, and several variations of the basic engine lathe, such as bench, toolroom, and gap lathes. All lathes, except the vertical turret type, have one thing in common in that for all usual machining operations the workpiece is held and rotated about a horizontal axis, while being formed to size and shape by a cutting tool. In the vertical turret lathe, the workpiece is rotated about a vertical axis. Of the various types of lathes, the type you are most likely to use is the engine lathe; therefore, this chapter deals only with lathes of that type and the machining operations you may be required to perform.

THE ENGINE LATHE

An engine lathe similar to the one shown in figure 18-1 is found in every machine shop, however small. It is used principally for turning, boring, facing, and screw cutting, but it may also be used for drilling, reaming, knurling, grinding, spinning, and spring winding. The work held in the engine lathe can be revolved at any one of a number of different speeds, and the cutting tool can be accurately controlled by hand or power for longitudinal feed and crossfeed. (Longitudinal feed is the movement of the cutting tool parallel to the axis of the lathe; crossfeed is the movement of the cutting tool perpendicular to the axis of the lathe.)

Lathe size is determined by two measurements: (1) the diameter of work it will swing over the bed and (2) the length of the bed. For example, a 14-inch x 6-foot lathe will swing work up to 14 inches in diameter, and has a bed that is 6 feet long.

Engine lathes are built in various sizes ranging from small bench lathes having a swing of 9 inches to very large lathes for turning work of large diameter such as low pressure turbine rotors. The 16-inch lathe is the average size for general purposes, and is the size usually installed on ships having only one lathe.

PRINCIPAL PARTS

To learn the operation of a lathe, you must first become familiar with the names and functions of the principal parts. Lathes of different manufacture differ somewhat in details of construction, but all are built to perform the same general functions. As you read the description of each part, find its location on the lathe by referring to figure 18-1 and the figures which follow. (For specific details on the features of construction and operating techniques, refer to the manufacturer's technical manual for the machine you are using.)

Bed and Ways

The bed is the base or foundation of the working parts of the lathe. The main features of its construction are the ways which are formed on its upper surface and run the full length of the bed. They provide the means for maintaining the tailstock and carriage, which slide on them, in alignment with the headstock, which is permanently secured by bolts at one end (at operator's left).

Headstock

The headstock carries the headstock spindle and the mechanism for driving it. In the belt-driven type, shown in figure 18-2, the driving

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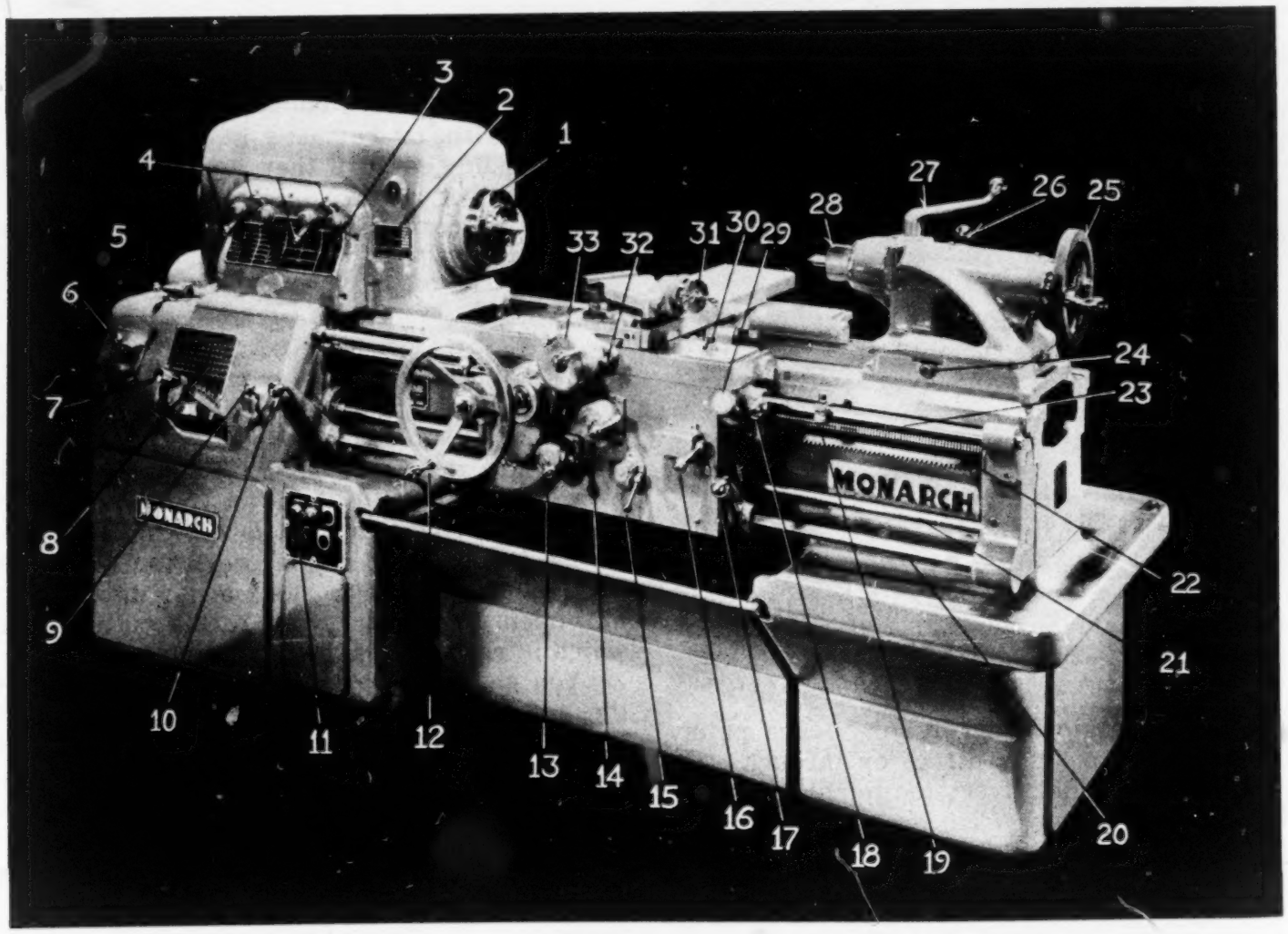

1. Headstock spindle
2. Identification plate
3. Spindle speed index plate
4. Headstock spindle speed change levers
5. Upper compound lever
6. Lower compound lever
7. Tumbler lever
8. Feed-thread index plate
9. Feed-thread lever
10. Spindle control lever
11. Electrical switch grouping
12. Apron handwheel
13. Longitudinal friction lever
14. Cross-feed friction lever
15. Feed directional control lever
16. Half nut closure lever
17. Spindle control lever
18. Leadscrew reverse lever
19. Reverse rod stop dog
20. Control rod
21. Feed rod
22. Lead screw
23. Reverse rod
24. Tailstock setcver screw
25. Tailstock handwheel
26. Tailstock clamping lever
27. Tailstock spindle binder lever
28. Tailstock spindle
29. Chasing dial
30. Carriage binder clamp
31. Compound rest dial and handle
32. Thread chasing stop
33. Cross-feed dial and handle

28.69x

Figure 18-1.—An engine lathe.

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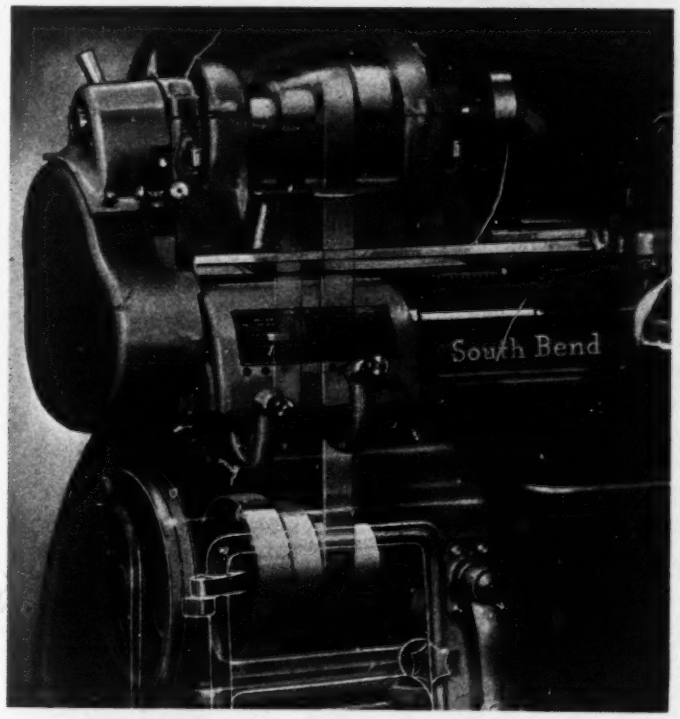

28.71x
Figure 18-2.—Belt-driven type headstock.

mechanism consists merely of a cone pulley that drives the spindle direct or through back gears. When driving direct, the spindle revolves with the cone pulley; when driving through the back gears, the spindle revolves more slowly than the cone pulley, which, in this case, turns freely on the spindle. Thus two speeds are obtainable with each position of the belt on the cone; if the cone pulley has four steps as illustrated, eight spindle speeds can be obtained.

The geared headstock shown in figure 18-3 is more complicated but more convenient to operate, because speed changes are accomplished by the mere shifting of gears. It is similar to an automobile transmission except that it has more gear-shift combinations and therefore a greater number of speed changes. A speed index plate attached to the headstock indicates the lever positions for obtaining the different spindle speeds.

Tailstock

The primary purpose of the tailstock is to hold the DEAD center to support one end of work being machined on centers. However, it can also be used to hold tapered shank drills, reamers, and drill chucks. It is movable on the ways along the length of the bed to accommodate work of varying lengths and can be clamped in the desired position by means of the tailstock clamping nut.

Before inserting a dead center, drill, or reamer, carefully clean the tapered shank and wipe out the tapered hole of the spindle. When holding drills or reamers in the tapered hole of a spindle, be sure they are tight enough so they will not revolve. If allowed to revolve, they will score the tapered hole and destroy its accuracy.

Carriage

The function of the carriage is to carry the compound rest, which in turn carries the cutting tool in the tool post. Figure 18-4 shows how the carriage travels along the bed over which it slides on the outboard ways.

The carriage is provided with T-slots or tapped holes for clamping work for boring or milling. When used in this manner the carriage movement feeds the work to the cutting tool, which is revolved by the headstock spindle.

You can lock the carriage in any position on the bed by tightening up on the carriage clamp screw. This is done only when doing such work as facing or cutting-off, for which longitudinal feed is not required. Normally the carriage clamp should be kept in the released position. Always move the carriage by hand to be sure it is free before applying the automatic feed.

Apron

The apron is attached to the front of the carriage and contains the mechanism for controlling the movement of the carriage for

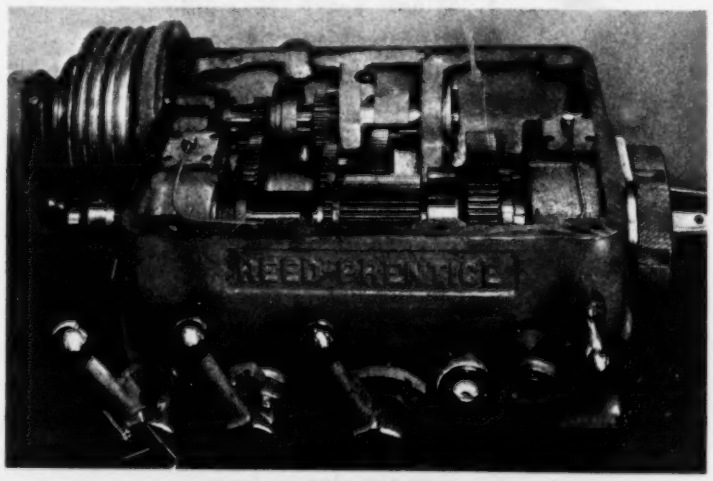

28.72x
Figure 18-3.—Sliding gear type headstock.

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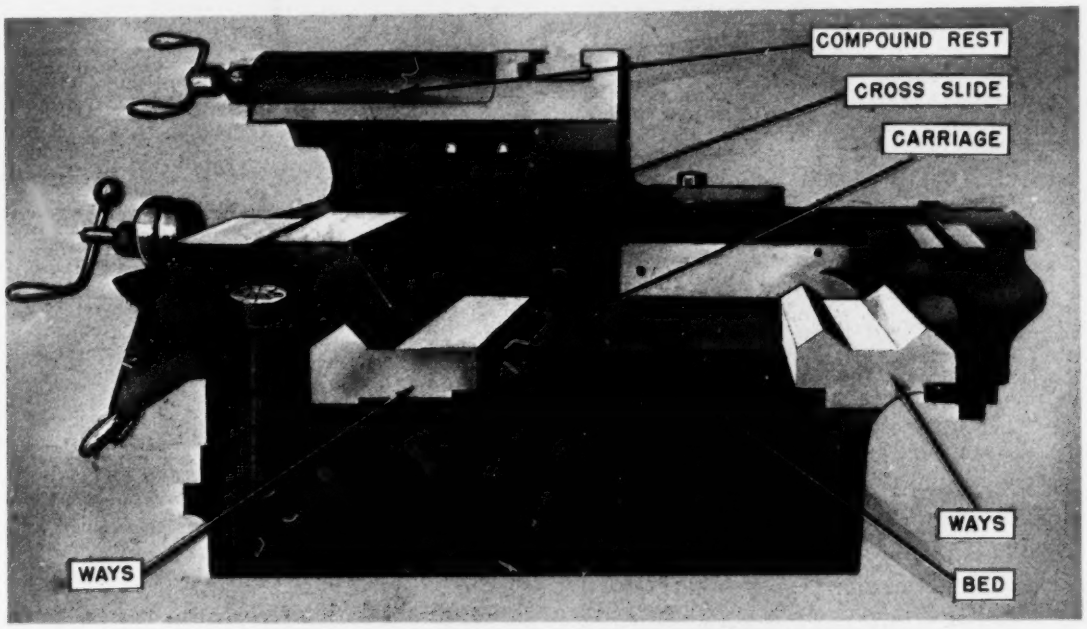

28.76x

Figure 18-4.—Side view of a carriage mounted on bed.

longitudinal feed and thread cutting, and the lateral movement of the cross-slide.

Feed Rod

The feed rod transmits power to the apron to drive the longitudinal feed and crossfeed mechanisms. The feed rod is driven by the spindle through a train of gears, and the ratio of its speed to that of the spindle can be varied by means of change gears to produce various rates of feed. The rotating feed rod drives gears in the apron, and these gears in turn drive the longitudinal feed and crossfeed mechanisms through friction clutches.

Lead Screw

The lead screw is used for thread cutting. Along its length, it has accurately cut Acme threads, which engage the threads of the half-nuts in the apron when the half-nuts are clamped over it. When the lead screw turns in the closed half-nuts, the carriage moves along the ways a distance equal to the lead of the thread in each revolution of the lead screw. Since the lead screw is driven by the spindle through a gear train (fig. 18-5), the rotation of the lead screw bears a direct relation to the rotation of the spindle. Therefore, it may be seen that when the half-nuts are engaged, the longitudinal movement of the carriage is directly controlled by the spindle rotation, and consequently the cutting tool is moved a definite distance along the work for each revolution that it makes.

Compound Rest

The compound rest provides a rigid adjustable mounting for the cutting tool. The compound rest assembly has the following principal parts:

1. The compound rest SWIVEL, which can be swung around to any desired angle and clamped in position. It is graduated over an arc of 90° on each side of its center position to facilitate setting to the angle selected. This feature is used when machining short, steep tapers such as the angle on bevel gears, valve disks, and lathe centers.

2. The compound rest TOP or TOP SLIDE, is mounted on the swivel section of a dovetailed slide. It is moved by means of the compound rest feed screw.

This arrangement permits feeding at any angle (determined by the angular setting of the swivel section), while the cross-slide feed provides only for feeding at right angles to the axis of the lathe. The graduated collars on the cross-feed and compound rest feed screws read in thousandths of an inch for fine adjustment in regulating the depth of cut.

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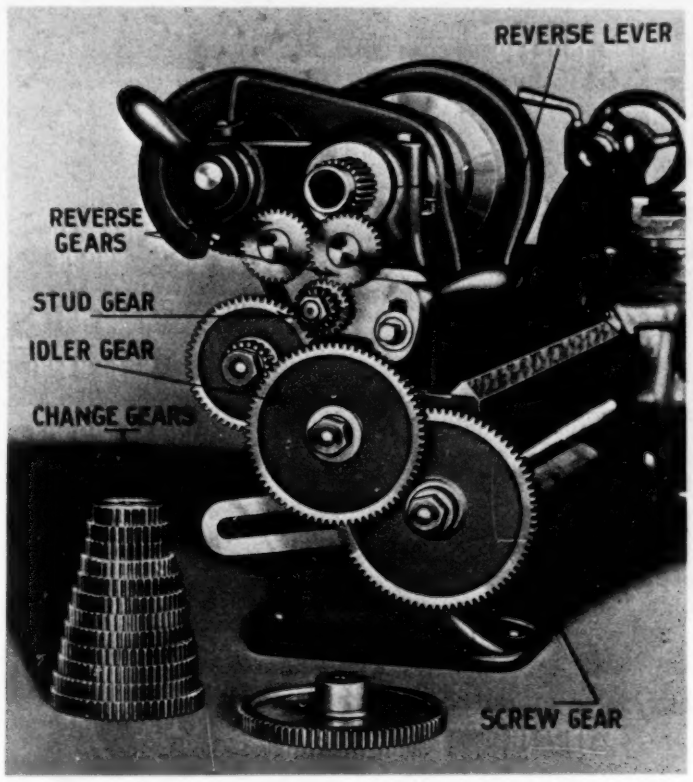

28.80x

Figure 18-5.—Lead screw gear train.

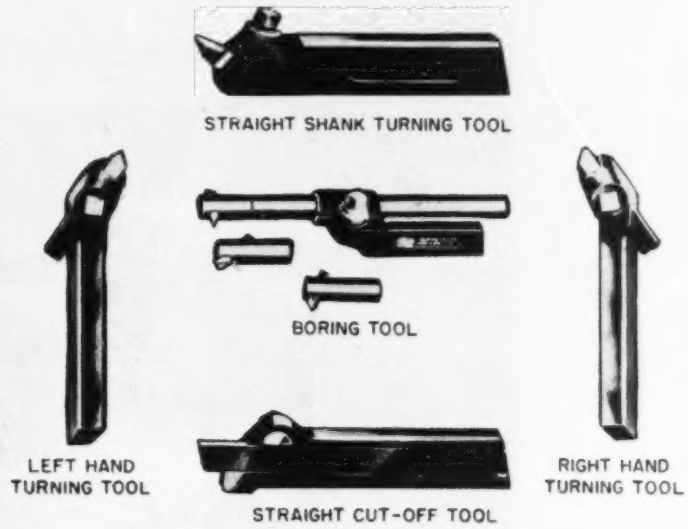

28.67

Figure 18-6.—Common types of toolholders.

ATTACHMENTS AND ACCESSORIES

Accessories are the tools and equipment used in routine lathe machining operations. Attachments are special fixtures which may be secured to the lathe to extend the versatility of the lathe to include taper cutting, milling, and grinding. Some of the common accessories and attachments used on lathes are described in the following paragraphs.

Tool Post

The sole purpose of the tool post is to provide a rigid support for the tool. It is mounted in the T-slot of the compound rest top. A forged tool or a toolholder is inserted in the slot in the tool post. By tightening a setscrew, the whole unit is firmly clamped in place with the tool in the desired position.

Toolholders

Some of the common toolholders used in lathe work are illustrated in figure 18-6. Notice the angles at which the tool bits set in the various holders. These angles must be considered with respect to the angles ground in the tools and the angle that the toolholder is set with respect to the axis of the work.

Engine Lathe Tools

Figure 18-7 shows the most popular shapes of ground lathe tool cutter bits and their application. In the following paragraphs each of the types shown is described.

LEFT-HAND TURNING TOOL.—This tool is ground for machining work when fed from left to right, as indicated in A, figure 18-7. The cutting edge is on the right side of the tool and the top of the tool slopes down away from the cutting edge.

ROUND-NOSED TURNING TOOL.—This tool is for general all-round machine work and is used for taking light roughing cuts and finishing cuts. Usually, the top of the cutter bit is ground with side rake so that the tool may be fed from right to left. Sometimes this cutter bit is ground flat on top so that the tool may be fed in either direction (B, fig. 18-7).

RIGHT-HAND TURNING TOOL.—This is just the opposite of the left-hand turning tool and is designed to cut when fed from right to left (C, fig. 18-7). The cutting edge is on the left side. This is an ideal tool for taking roughing cuts and for general all-round machine work.

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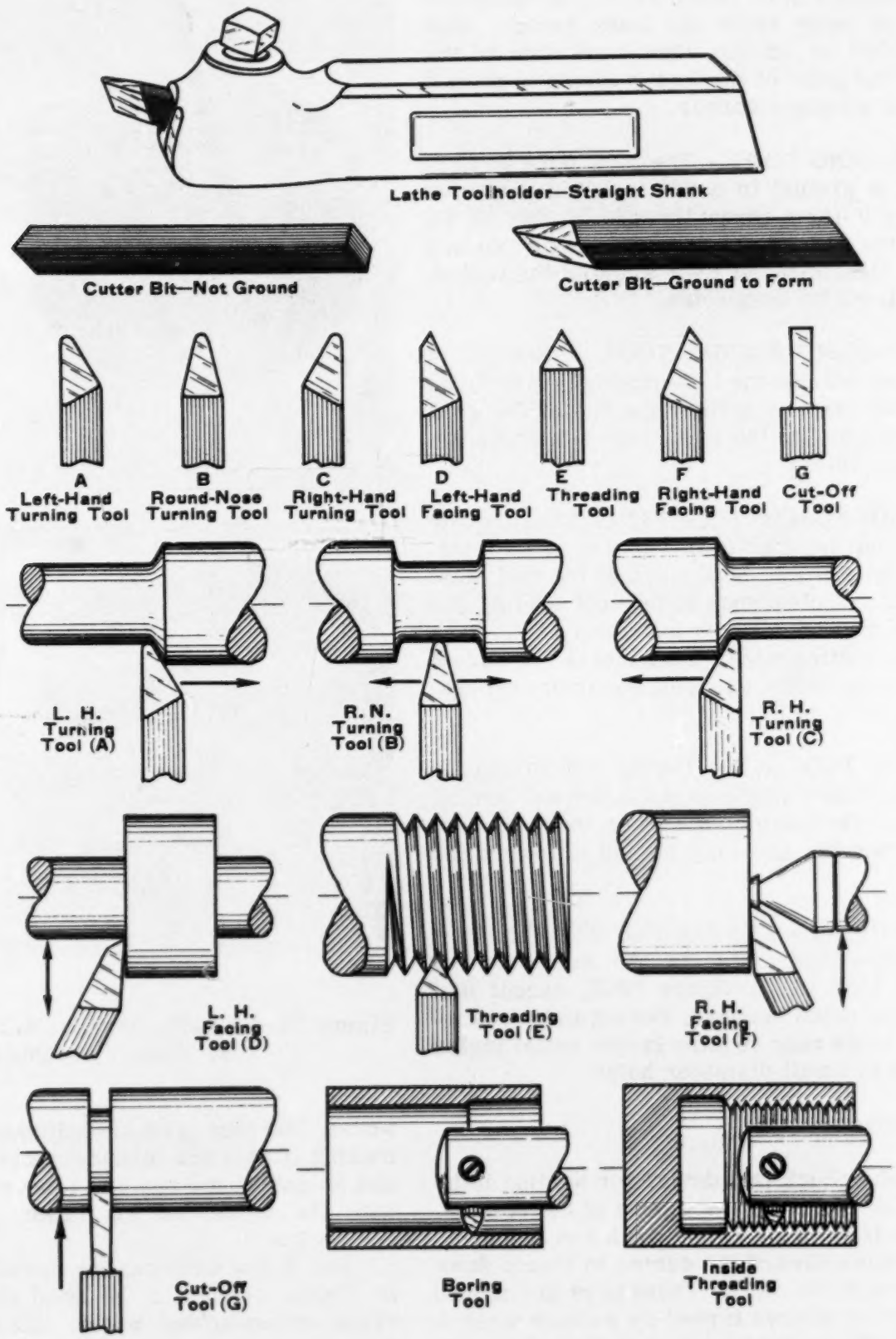

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Figure 18-7.—Lathe tools and their application.

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LEFT-HAND FACING TOOL.—This tool is intended for facing on the left-hand side of the work, as shown in D, figure 18-7. The direction of feed is away from the lathe center. The cutting edge is on the right-hand side of the tool and the point of the tool is sharp to permit machining a square corner.

THREADING TOOL.—The point of the threading tool is ground to a 60° included angle for machining V-form screw threads (E, fig. 18-7). Usually the top of the tool is ground flat and there is clearance on both sides of the tool so that it will cut on both sides.

RIGHT-HAND FACING TOOL.—This tool is just the opposite of the left-hand facing tool and is intended for facing the right end of the work and for machining the right side of a shoulder. (See F, fig. 18-7.)

SQUARE-NOSED PARTING TOOL.—The principal cutting edge of this tool is on the front. (See G, fig. 18-7.) Both sides of the tool must have sufficient clearance to prevent binding and should be ground slightly narrower at the back than at the cutting edge. This tool is convenient for machining necks, grooves, squaring corners, and for cutting off.

BORING TOOL.—The boring tool is usually ground the same shape as the left-hand turning tool so that the cutting edge is on the front side of the cutter bit and may be fed in toward the headstock.

INTERNAL—THREADING TOOL.—The internal-threading tool is the same as the threading tool in E, figure 18-7, except that it is usually much smaller. Boring and internal-threading tools may require larger relief angles when used in small diameter holes.

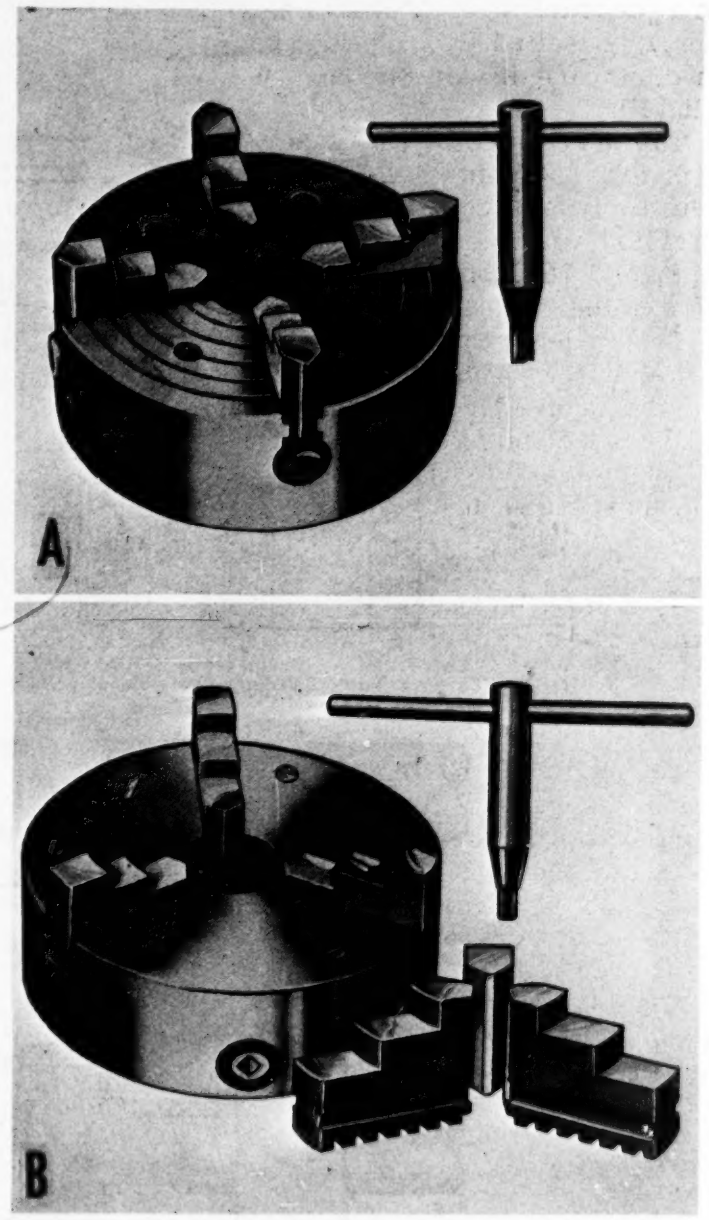

28.90x

Figure 18-8.—Lathe chucks. A. Four-jaw chuck. B. Three-jaw chuck.

Lathe Chucks

The lathe chuck is a device for holding lathe work. It is mounted on the nose of the spindle. The work is held by jaws which can be moved in radial slots toward the center to clamp down on the sides of the work. These jaws are moved in and out by screws turned by a chuck wrench applied to the sockets located at the outer ends of the slots.

The 4-jaw independent lathe chuck, part A in figure 18-8, is the most practical for general work. The four jaws are adjusted one at a time, making it possible to hold work of various shapes and to adjust the center of the work to coincide with the center of the lathe. The jaws are reversible.

The 3-jaw universal or scroll chuck, part B in figure 18-8, can be used only for holding round or hexagonal work. All three jaws are moved in and out together in one operation. They move universally to bring the work on center automatically. This chuck is easier to operate than the 4-jaw type, but when its

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Horses

1. When transporting horses, remember to take along all feed and water containers. Never allow them to use public feed and water facilities.
2. Graze animals on clean pastures.
3. Never spread horse manure on pasture grazed by horses.
4. Clean stalls daily when keeping horses in confinement.
5. Isolate all new animals for at least three weeks. Make sure the veterinarian certifies the health of the animal prior to time of purchase or exhibition.

Dogs and Cats

This section includes some suggested sanitation practices for the care of dogs and cats as pets. Many of the diseases that affect other animals are infective to dogs and cats, though the symptoms may differ.

Cats generally live longer than dogs. However, they have a more delicate constitution. Both dogs and cats may vomit more often than other farm animals, probably due to the fact that they bolt their food, rather than chew it. If any symptoms of disease are present, isolation and treatment will be necessary.

Points to Remember about Cats

1. Cats can be protected from external parasites by use of 1% rotenone powder.
2. Never use carbolic acid (phenol) on cats, as they are highly susceptible to phenol toxicity.
3. Never use DDT or other chlorinated hydrocarbons on cats.
4. A simple way of drenching a cat is to put a small amount of vaseline on its paws and let it lick the vaseline off.
5. Cat beds should be cleaned often and disinfected. It may be best to rinse out strong disinfectants with warm water to lessen the chance for toxic reaction.
6. Cats should be washed only when absolutely necessary, as they clean themselves by licking. If a cat must be washed, set a window screen at an angle to the floor and place the cat on the screen. The cat will dig its claws into the screen and can then be washed. Be sure to use a mild soap and rinse thoroughly after washing.
7. Cats are subject to hairballs of the stomach, caused by licking themselves continuously. Brushing cats that are kept in confinement will help control this. Vegetable oils help remove the hairballs, but never give over 1-2 teaspoonsful at a time.
8. Cats like to roam, especially at night. It is better to let cats do this as they need exercise. Periodical inspection for parasites is necessary.
9. When a cat shows visible signs of disease, consult a veterinarian.

Key Points in Dog Sanitation

1. Dogs like to be in clean places and stay much healthier if they are permitted to do so. Balanced diet, exercise and sunlight will keep most dogs healthy except for contagious diseases.
2. Dogs have very sensitive noses. A strong smell of disinfectant will keep a dog out of his quarters. Rinsing with warm water after disinfecting can overcome this.

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parts become worn, its accuracy in centering cannot be relied upon. Proper lubrication and constant care in use are necessary to ensure reliability.

The draw-in collet chuck is used to hold small work for machining in the lathe. It is the most accurate type of chuck made and is intended for precision work.

Figure 18-9 shows the parts assembled in place in the lathe spindle.

The collet chuck which holds the work is a split-cylinder with an outside taper that fits into the tapered closing sleeve and screws into the threaded end of the hollow drawbar. Screwing up on the drawbar by turning the handwheel pulls the collet back into the tapered sleeve, thereby closing it firmly over the work, and centering it accurately and quickly. The size of the hole in the collet determines the diameter of the work it can accommodate.

Faceplates

You will use the faceplate for holding work of such shape and dimensions that it cannot be swung on centers or in a chuck. The T-slots and other openings on its surface provide convenient anchors for bolts and clamps used in securing the work to it. The faceplate is mounted on the nose of the spindle.

The driving plate is similar to a small faceplate and is used principally for driving work that is held between centers. The radial slot receives the bent tail of a lathe dog clamped to the work and thereby transmits rotary motion to the work.

Lathe Centers

The function of the 60° lathe centers shown in figure 18-10 is to provide a means for holding the work between points so it can be turned accurately on its axis. The head spindle center is called the LIVE center because it revolves with the work. The tailstock center is called the DEAD center because it does not turn. Both live and dead centers have shanks turned to a Morse taper to fit the tapered holes in the spindles; both have points finished to an angle of 60°. They differ only in that the dead center is hardened and tempered to resist the wearing effect of the work revolving on it. The live center revolves with the work, and it is usually left soft. The dead center and live center must NEVER be interchanged. (There is a groove around the hardened dead center to distinguish it from the live center.)

The centers fit snugly in the tapered holes of the headstock and tailstock spindles. If chips, dirt, or burrs prevent a perfect fit in the spindles, the centers will not run true.

To remove the headstock center, insert a brass rod through the spindle hole and tap the center to jar it loose; it can then be picked out with the hand. To remove the tailstock center, run the spindle back as far as it will go by turning the handwheel to the left. When the end of the tailstock screw bumps the back of center, it will force it out of the tapered hole.

Lathe Dogs

Lathe dogs are used in conjunction with a driving plate or faceplate to drive work being machined on centers, the frictional contact alone between the live center and the work not being sufficient to drive it.

The common lathe dog, shown at the left in figure 18-11, is used for round work or work having a regular section (square, hexagon, octagon). The piece to be turned is held firmly in hole A by setscrew B. The bent tail C projects through a slot or hole in the driving plate or faceplate, so that when the latter revolves with the spindle it turns the work with it. The clamp dog, illustrated in figure 18-11, may be used for rectangular or irregular shaped work. Such work is clamped between the jaws.

Center Rest

The center rest, also called the steady rest, is used for the following purposes:

1. To provide an intermediate support or rest for long slender bars or shafts being machined between centers. It prevents them from springing under cut, or sagging as a result of their otherwise unsupported weight.

2. To support and provide a center bearing for one end of work, such as a spindle, being bored or drilled from the end when it is too long to be supported by a chuck alone. The center rest is clamped in the desired position on the bed, on which it is properly aligned by the ways, as illustrated in figure 18-12. It is important that the jaws (A) be carefully adjusted to allow the work (B) to turn freely and at the same time keep it accurately centered on the axis of the lathe. The top half of the frame

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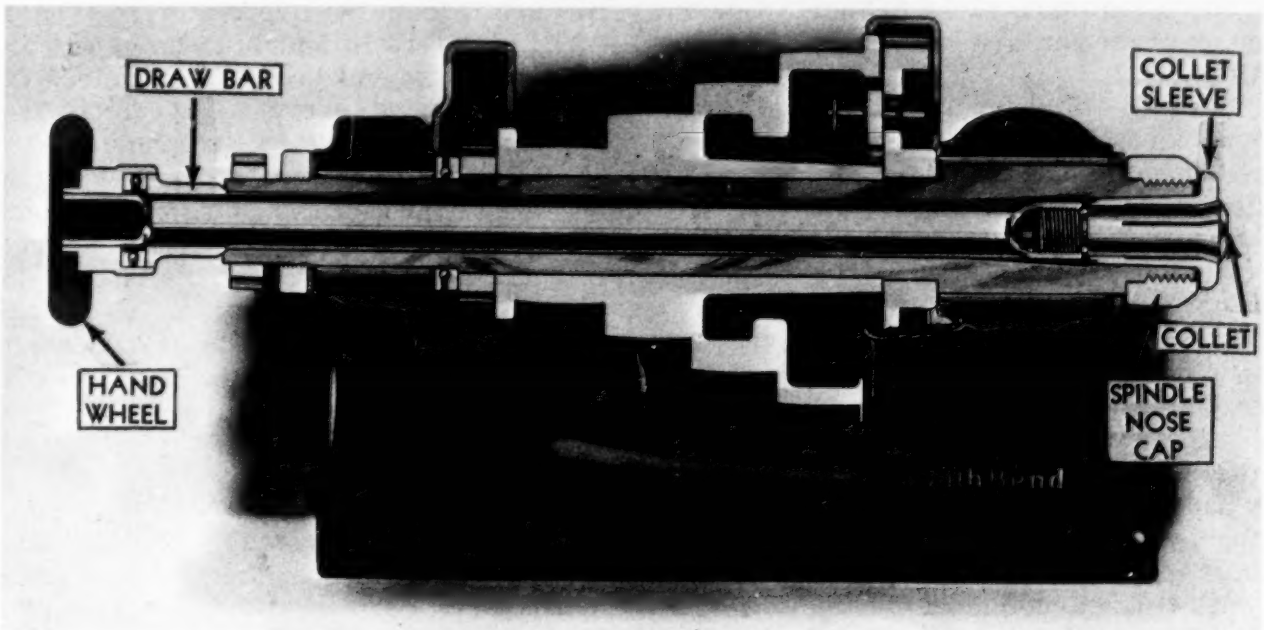

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Figure 18-9.—Draw-in collet chick.

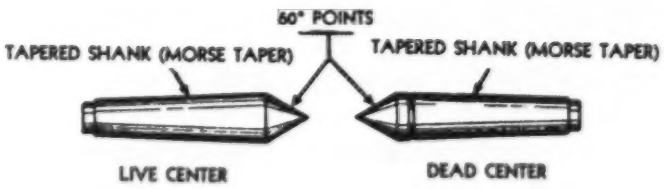

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Figure 18-10.—Sixty-degree lathe centers.

is hinged at C to facilitate placing it in position without removing the work from the centers or changing the position of the jaws.

Follower Rest

The follower rest is used to back up work of small diameter to keep it from springing under the stress of cutting. It gets its name from the fact it follows the cutting tool along the work. As shown in figure 18-13, it is attached directly to the saddle by bolts (B). The adjustable jaws bear directly on the finished diameter of the work opposite the cutting tool.

Taper Attachment

The taper attachment, illustrated in figure 18-14, is used for turning and boring tapers. It is bolted to the back of the carriage saddle. In operation, it is so connected to the cross-slide that it moves the cross-slide laterally as the carriage moves longitudinally, thereby causing the cutting tool to move at an angle to the axis of the work to produce a taper.

The angle of the taper it is desired to cut is set on the guide bar of the attachment. The guide bar support is clamped to the lathe bed.

Since the cross-slide is connected to a shoe that slides on this guide bar, the tool follows along a line that is parallel to the guide bar and hence at an angle to the work axis corresponding to the desired taper.

The operation and application of the taper attachment will be further explained under the subject of taper work.

Thread Dial Indicator

The thread dial indicator, shown in figure 18-15, eliminates the necessity of reversing the lathe to return the carriage to the starting point to catch the thread at the beginning of each successive cut that is taken. The dial, which

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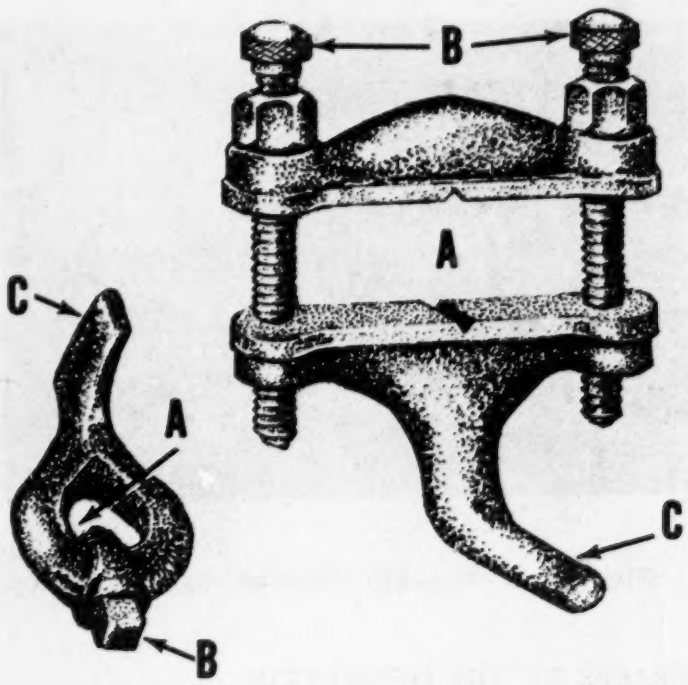

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Figure 18-11.—Lathe dogs.

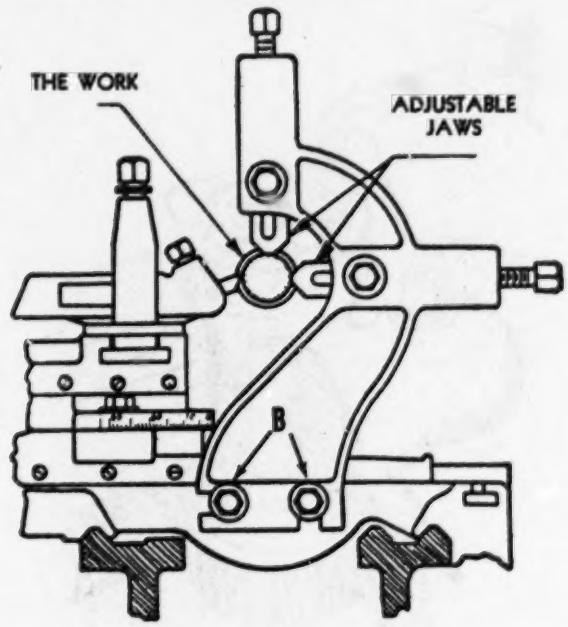

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Figure 18-13.—Follower rest.

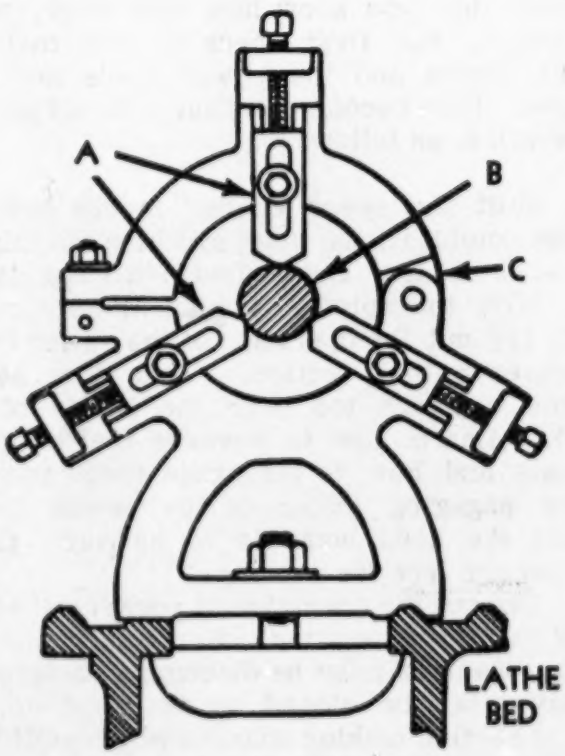

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Figure 18-12.—Center rest.

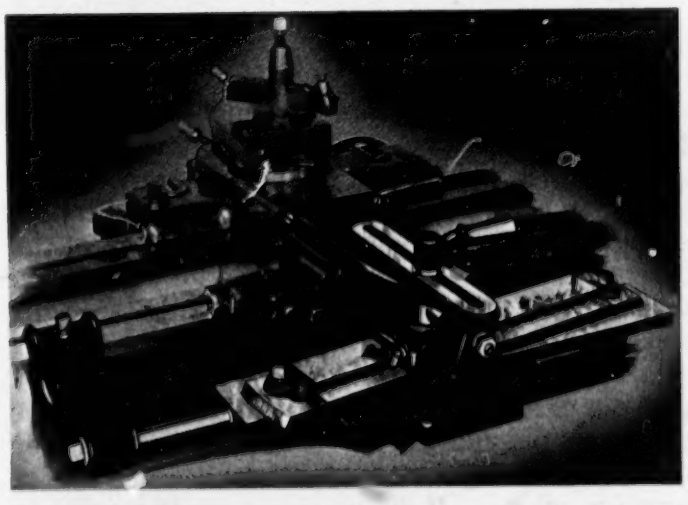

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Figure 18-14.—A taper attachment.

is geared to the lead screw, indicates when to clamp the half-nuts on the lead screw for the next cut.

The threading dial consists of a worm wheel which is attached to the lower end of a shaft and meshed with the lead screw. On the upper end of the shaft is the dial. As the lead screw revolves, the dial is turned and the graduations on the dial indicate points at which the half-nuts may be engaged.

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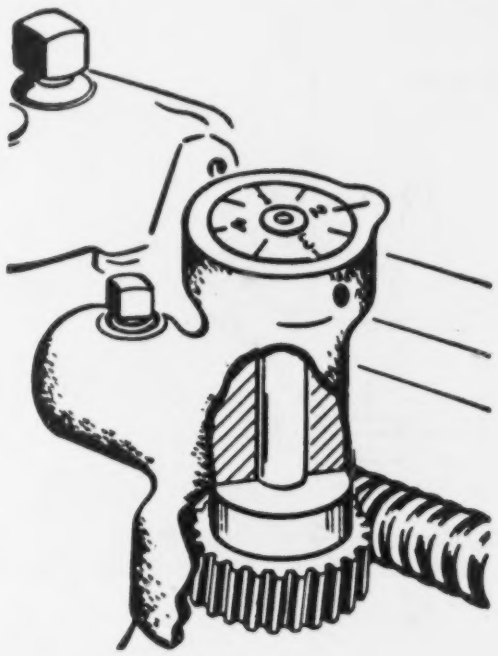

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Figure 18-15.—Thread dial indicator.

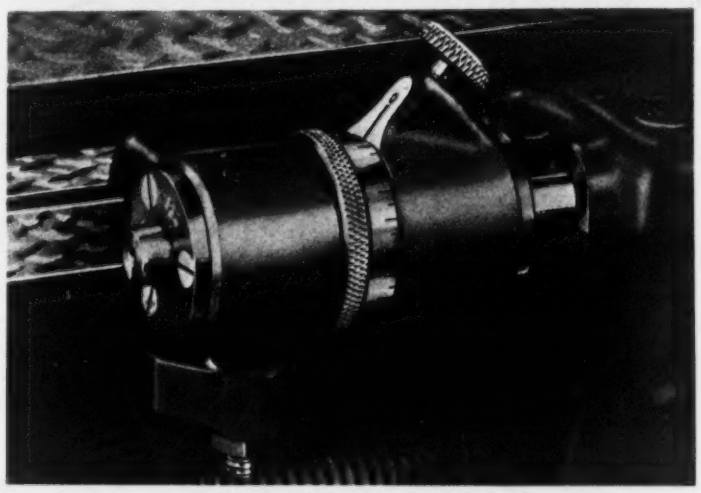

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Figure 18-16.—Micrometer carriage stop.

Carriage Stop

The carriage stop can be attached to the bed at any point where it is desired to stop the carriage. It is used principally when turning, facing, or boring duplicate parts, as it eliminates the necessity of repeated measurements of the same dimension. In operation, the stop is set at the point where it is desired to stop the feed. Just before reaching this point, the operator shuts off the automatic feed and carefully runs the carriage up against the stop. Carriage stops are provided with or without micrometer adjustment. Figure 18-16 shows a micrometer carriage stop. It is clamped on the ways in the approximate position required and then adjusted to the exact setting by means of the micrometer adjustment. (Do not confuse this stop with the automatic carriage stop that automatically stops the carriage by disengaging the feed or stopping the lathe.)

FACTORS RELATED TO MACHINING OPERATIONS

A knowledge of many factors is required if you are to be proficient in performing machine work with a lathe. Some of these factors are considered in the following sections.

PHASES OF THE OPERATION

Before attempting the operation of any lathe, make sure you know how to run it. Read all operating instructions supplied with the machine. Ascertain the location of the various controls and how to operate them. When you are satisfied that you know how they work, start the motor, but first check to see that the spindle clutch and the power feeds are disengaged. Then become familiar with all phases of operation, as follows:

1. Shift the speed change levers into the various combinations; start and stop the spindle after each change. Get the feel of this operation.
2. With the spindle running at its slowest speed, try out the operation of the power feeds and observe their action. Take care not to run the carriage too near the limits of its travel. Learn how to reverse the direction of feeds and how to disengage them quickly. Before engaging either of the power feeds, operate the hand controls to be sure parts involved are free for running.
3. Try out the operation of engaging the lead screw for thread cutting. Remember that the feed mechanism must be disengaged before the half-nuts can be closed on the lead screw.
4. Practice making changes with the QUICK-CHANGE GEAR MECHANISM by referring to thread and feed index plate on the lathe you intend to operate. Remember that changes in the gear box are done with the lathe running

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slowly, but the lathe must be stopped for large changes made by shifting gears in the main gear train.

MAINTENANCE

Maintenance is an important part of operational procedure for lathes. The first requisite is PROPER LUBRICATION. Make it a point to oil your lathe daily where oil holes are provided. Oil the ways daily—not only for lubrication but to protect their scraped surfaces. Oil the lead screw often while in use; this is necessary to preserve its accuracy, for a worn lead screw lacks precision in thread cutting. Make sure the headstock is filled up to the oil level; drain it out and replace it when the oil becomes dirty or gummy. If your lathe is equipped with an automatic oiling system for some parts, make sure all those parts are getting oil. Make it a habit to CHECK frequently for lubrication of all moving parts.

Don't treat your machine roughly. When you shift gears for changing speed or feed, remember that you are putting solid gear teeth into mesh with each other; feel the gears into engagement. Disengage the clutch and stop the lathe before shifting.

Before engaging the longitudinal feed, be certain that the carriage CLAMP SCREW is loose and that the CARRIAGE can be moved by hand. Avoid running the carriage against the headstock or tailstock while under power feed; it puts an unnecessary strain on the lathe and may jam the gears.

Do not neglect the motor just because it may be out of sight; check its LUBRICATION. If it does not run properly, notify the Electrician's Mate whose duty it is to care for it. He will cooperate with you to keep it in good condition. On lathes with a belt drive from the motor to the lathe, avoid getting oil or grease on the belt when oiling the lathe or motor.

Keep your lathe CLEAN. A clean and orderly machine is an indication of a good mechanic. Dirt and chips on the ways, on the lead screw, and on the crossfeed screws will cause serious wear and impair the accuracy of the machine.

Never put wrenches, files, or other tools on the ways. If you must keep tools on the bed, a board should be provided to protect the finished surfaces of the ways.

Never use the bed or carriage as an anvil; remember that the lathe is a precision machine and nothing must be allowed to destroy its accuracy.

CUTTING SPEEDS AND FEEDS

CUTTING SPEED is the rate at which the surface of the work passes the point of the cutting tool. It is expressed in feet per minute.

To find the cutting speed, multiply the circumference of the work (in inches) by the number of revolutions it makes per minute (rpm) and divide by 12. (Circumference = diameter x 3.1416.) The result is the peripheral or cutting speed in feet per minute (fpm). For example, a 2-inch diameter piece turning at 100 rpm will produce a cutting speed of

$$\frac{(2 \times 3.1416) \times 100}{12} = 52.36 \text{ fpm}$$

Conversely, the rpm required to obtain a given cutting speed is found by dividing the product of the given cutting speed and 12 by the circumference of the work (in inches).

FEED is the amount the tool advances in each revolution of the work. It is usually expressed in thousandths of an inch per revolution of the spindle. The index plate on the quick-change gear box indicates the setup for obtaining the feed desired. The amount of feed to use is best determined from experience.

Cutting speeds and tool feeds are determined by various considerations: the hardness and toughness of the metal being cut; the quality, shape, and sharpness of the cutting tool; the depth of the cut; the tendency of the work to spring away from the tool, and the strength and power of the lathe. Since conditions vary, it is good practice to find out what the tool and work will stand, and then select the most practicable and efficient speed and feed consistent with the finish desired.

If the cutting speed is too slow, the job takes longer than necessary and often the work produced is unsatisfactory. On the other hand, if the speed is too great, the tool edge will dull quickly, and frequent grinding will be necessary. The cutting speeds possible are greatly affected by the use of a suitable cutting lubricant. For example, steel which can be rough turned dry at 60 rpm can be turned at about 80 rmp when flooded with a good cutting lubricant.

Table 18-1 gives the approximate recommended cutting speeds for different metals, using high-speed steel tool bits. Figures indicate feet per minute (fpm).

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Table 18-1.—Cutting Speeds with High Speed Steel Tool Bits. 28.292

Type of metal	Roughing cut	Finishing cut	Thread-cutting
	Feet per minute (fpm)		
Cast iron	60	80	25
Machine steel	90	125	35
Tool steel	50	75	20
Brass	150	200	50
Bronze	90	100	25
Aluminum	200	300	50

When ROUGHING parts down to size, use the greatest depth of cut and feed per revolution that the work, the machine, and the tool will stand at the highest practicable speed. On many pieces where tool failure is the limiting factor in the size of roughing cut, it is usually possible to reduce the speed slightly and increase the feed to a point where the metal removed is much greater. This will prolong tool life. Consider an example where the depth of cut is 1/4 inch, the feed 20 thousandths of an inch per revolution, and the speed 80 fpm. If the tool will not permit additional feed at this speed, it is usually possible to drop the speed to 60 fpm and increase the feed to about 40 thousandths of an inch per revolution without having tool trouble. The speed is, therefore, reduced 25 percent but the feed increased 100 percent, so that the actual time required to complete the work is less with the second setup.

On the FINISH TURNING OPERATION a very light cut is taken, since most of the stock has been removed on the roughing cut. A fine feed can usually be used, making it possible to run at a high surface speed. A 50-percent increase in speed over the roughing speed is commonly used. In particular cases the finishing speed may be twice the roughing speed. In any event, the work should be run as fast as the tool will withstand to obtain the maximum speed in this operation. A sharp tool should be used when finish turning.

COOLANTS

A cutting lubricant serves two main purposes—it cools the tool by absorbing a portion of the heat and reduces the friction between the tool and the metal being cut. A secondary purpose is to keep the cutting edge of the tool flushed clean.

The best lubricants to use for cutting metal must often be determined by experiment. Ordinary oil is often used, but soapy water or soda water is better for iron and steel shafting and if used in conjunction with a sharp tool and light finish cut, the work will be smooth enough to polish without filing. Other cutting lubricants are mineral lard oil, kerosene, and turpentine. Special cutting compounds containing such ingredients as tallow, graphite, and white lead, marketed under various names, are also used, but these are expensive and used mainly in manufacturing where high cutting speeds are the rule.

The usual lubricants for turning the following metals are:

Metal	Lubricant
Cast iron	Usually worked dry.
Mild steel	Oil or soapy water.
Hard steel	Mineral lard oil.
Monel metal	Dry (or mineral lard oil).
Bronze	Dry (or mineral lard oil).
Brass	Dry (kerosene or turpentine sometimes used on the hard compositions).
Copper	Dry (or mixture of lard oil and turpentine).

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Metal	Lubricant
Babbitt.	Dry (or mixture of lard oil and kerosene).
Aluminum.	Dry (or kerosene or mixture of lard oil and kerosene).

For threading, a lubricant is more important than for straight turning. Mineral lard oil is recommended for threading in all steels and cast iron, kerosene mixed with oil for aluminum, white lead mixed with oil (to the consistency of glue) for Monel metal, and kerosene or turpentine for brass compositions.

CHATTER

If you are unaware of the meaning of the word "chatter," you will learn all too soon while working with a machine tool of any description.

Briefly, chatter is vibration in either the tool or the work. The finished work surface appears to have a grooved or lined finish instead of the smooth surface that is to be expected. The vibration is set up by a weakness in the work, work support, tool, or tool support, and is about the most elusive thing to find in the entire field of machine work. As a general rule, strengthening the various parts of the tool support train will help. It is also advisable to support the work by a center rest or follower rest.

Possibly the fault may be in the machine adjustments. Gibs may be too loose; bearings may, after a long period of heavy service, be worn; the tool may be sharpened improperly, etc. If the machine is in excellent condition, the fault may be in the tool or tool setup. Grind the tool with a point or as near a point as the finish specified will permit; avoid a wide round leading edge on the tool. Reduce the overhang of the tool as much as possible and be sure that all the gib and bearing adjustments are properly made. See that the work receives proper support for the cut, and, above all, do not try to turn at a surface speed that is too high. Excessive speed is probably the greatest cause of chatter, and the first thing you should do when chatter occurs is to reduce the speed.

DIRECTION OF FEED

Regardless of how the work is held in the lathe, the tool should feed toward the headstock. This results in most of the pressure of the cut being exerted on the workholding device and spindle thrust bearings. When it is necessary to feed the cutting tool toward the tailstock, take lighter cuts at reduced feeds. In facing, the general practice is to feed the tool from the center of the workpiece out toward the periphery.

PRELIMINARY PROCEDURES

Before starting a lathe machining operation, always ensure that the machine is set up for the job you are doing. If the work is mounted between centers, check the alignment of the dead center with the live center and make any changes required. Ensure that the toolholder and cutting tool are set at the proper height and angle. Check the workholding accessory to ensure that the workpiece is held securely. Use the center rest or follower rest for support of long workpieces.

PREPARING THE CENTERS

The first step in preparing the centers is to see that they are accurately mounted in the headstock and tailstock spindles. The centers and the tapered holes in which they are fitted must be perfectly clean. Chips and dirt left on the contact surfaces will impair accuracy by preventing a perfect fit of the bearing surfaces. Make sure that there are no burrs in the spindle hole. If burrs are found they should be removed by careful scraping or reaming with a Morse taper reamer. Burrs will produce the same inaccuracies as chips or dirt.

Center points must be accurately finished to an angle of 60°. Figure 18-17 shows the method of checking this angle with a center gage. The large notch of the center gage is intended for this particular purpose. If this test shows that the point is not perfect it must be trued in the lathe by taking a cut over the point with the compound rest set at 30°. The hardened tail center must be annealed before it can be machined in this manner, or it can be ground if a grinding attachment is available.

CHECKING ALIGNMENT

To turn a shaft straight and true between centers, it is necessary that the centers be in a plane parallel to the ways of the lathe. The tailstock may be moved laterally to accomplish

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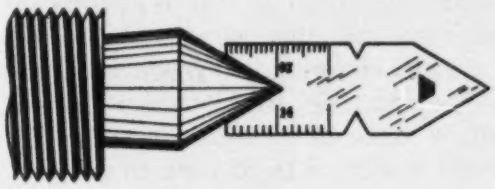

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Figure 18-17.—Checking center point with center gage.

this alignment by means of two adjusting screws after it has been released from the ways. At the rear of the tailstock are two zero lines, and the centers are approximately aligned when these lines coincide. This approximate alignment may be checked by moving the tailstock up until the centers almost touch, and observing their relative positions as shown in figure 18-18. For very accurate work, especially if it is long, the following test is necessary to correct small errors in alignment not otherwise detected.

The work to be turned, or a piece of stock of similar length, is mounted on the centers. With a turning tool in the tool post, take a small cut to a depth of a few thousandths of an inch at the headstock end of the work. Then remove the work from the centers to allow the carriage to be run back to the tailstock without withdrawing the tool. Do not touch the tool setting. Replace the work in the centers, and with the tool set at the previous depth take another cut coming in from the tailstock end. Compare the diameters over these cuts with a micrometer. If the diameters are exactly the same, the centers are in perfect alignment. If they are different, the tailstock must be adjusted in the direction required by means of the set-over adjusting screws.

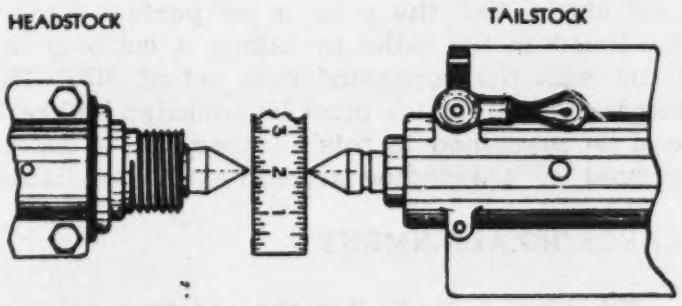

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Figure 18-18.—Aligning lathe centers.

Repeat the above test and adjustments until a cut at each end produces equal diameter.

Positive alignment of centers may also be checked by placing a test bar between centers and bringing both ends of the bar to a zero reading as indicated by a dial indicator clamped in the tool post. The tailstock must be clamped to the ways and the test bar properly adjusted between centers when taking the indicator readings.

Another method that may be used for positive alignment of lathe centers is to take a light cut over the work held between centers. Then measure the work at each end with a micrometer, and if the readings are found to differ, adjust the tailstock accordingly. Repeat the procedure until alignment is obtained.

SETTING THE TOOLHOLDER AND CUTTING TOOL

The first requirement for setting the tool is to have it rigid. Make sure the tool sets squarely in the tool post and that the setscrew is tight. Reduce overhang as much as possible to prevent springing when cutting. If the tool has too much spring, the point of the tool will catch in the work, causing chatter and damaging both the tool and the work. The distances represented by A and B in figure 18-19 show the correct overhang for the tool bit and the holder.

The point of the tool must be correctly positioned on the work. The cutting edge is placed slightly above the center for straight

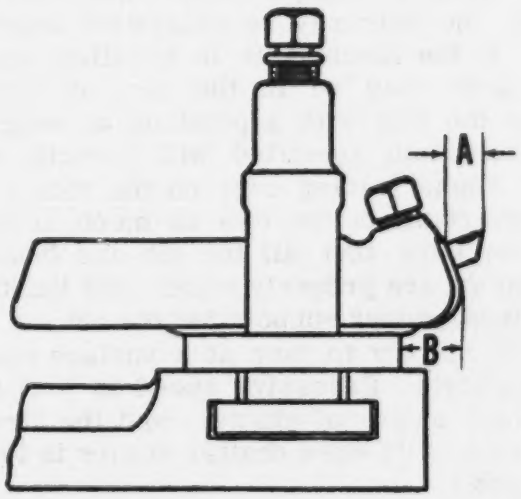

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Figure 18-19.—Tool overhang.

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turning of steel and cast iron, and exactly on the center for all other work. To set the tool at the height desired, raise or lower the point of the tool by moving the wedge in or out of the tool post ring. By placing the point opposite the tail center point, the setting can be accurately adjusted.

HOLDING THE WORK

Accurate work cannot be performed if work is improperly mounted. Requirements for proper mounting are:

1. The work center line must be accurately centered with the axis of the lathe spindle.
2. The work must be rigidly held while being turned.
3. The work must not be sprung out of shape by the holding device.
4. The work must be adequately supported against any sagging caused by its own weight and against springing caused by the action of the cutting tool.

There are four general methods of holding work in the lathe: (1) between centers, (2) on a mandrel, (3) in a chuck, and (4) on a faceplate. Work may also be clamped to the carriage for boring and milling, in which case the boring bar or milling cutter is held and driven by the headstock spindle.

Other methods of holding work to suit special conditions are: (1) one end on the live center or in a chuck and the other end supported in a center rest, and (2) one end in a chuck and the other end on the dead center.

Holding Work Between Centers

To machine a workpiece between centers, center holes must be drilled in each end to receive the lathe centers. A lathe dog is then secured to the workpiece and then the work is mounted between the live and dead centers of the lathe.

CENTERING THE WORK.—To center finished round stock such as drill rod or cold-rolled steel, where the ends are to be turned and must be concentric with the unturned body, the work can be held on the head spindle in a universal chuck or a draw-in collet chuck. If the work is long and too large to be passed through the spindle, a center rest must be used to support one end. The centering tool is held in a drill chuck in the tail spindle and is fed to the work by the tailstock handwheel (fig. 18-20).

If a piece must be centered very accurately, the tapered center hole should be bored after center drilling to correct any run-out of the drill. This is done by grinding a tool bit to a center gage at a 60° angle. Then with the toolholder held in the tool post, set the compound rest at 30° with the line of center as shown in figure 18-21. Set the tool exactly on the center for height and adjust to the proper angle with the center gage as shown at A. By feeding the tool as shown at B, any run-out of the center is corrected. The tool bit should be relieved under the cutting edge as shown at C to prevent the tool from dragging or rubbing in the hole.

For centerdrilling a workpiece, the combined drill and countersink is the most practical tool. These combined drills and countersinks vary in size and the drill points also vary. Sometimes a drill point on one end will be 1/8 inch in diameter, the drill point on the opposite end 3/16 inch in diameter. The angle of the centerdrill is always 60° so that the countersunk hole will fit the angle of the lathe center point.

If a centerdrill is not available, the work may be centered with a small twist drill. Let the drill enter the work a sufficient length on each end; then follow with a special countersink, the point of which is 60°.

In centerdrilling, a drop or two of oil should be used on the drill. The drill should be fed slowly and carefully so as not to break the tip. Extreme care is needed when the work is heavy, because it is then more difficult to "feel" the proper feed of the work on the center drill.

If the center drill breaks while countersinking and part of the broken drill remains in the work, this part must be removed. Sometimes it can be driven out by a chisel or jarred loose, but it may stick so hard that it cannot be removed.

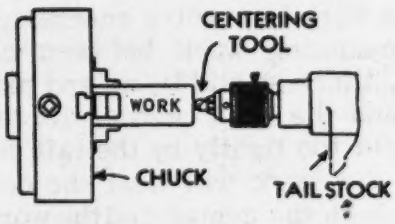

28.111

Figure 18-20.—Drilling center hole.

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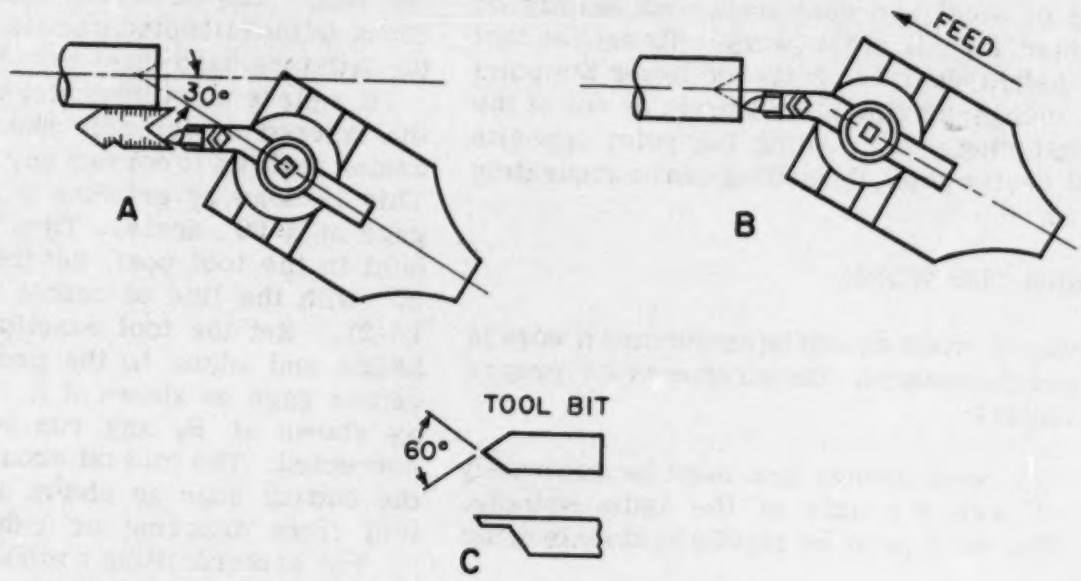

Figure 18-21.—Boring center hole. 28.112

Then the broken part of the drill should be annealed and drilled out.

The importance of proper center holes in the work and a correct angle on the point of the lathe centers cannot be overemphasized. To do an accurate job between centers on the lathe, countersunk holes must be of the proper size and depth, and the points of the lathe centers must be true and accurate.

MOUNTING THE WORK.—Figure 18-22 shows correct and incorrect methods of mounting work between centers. In the correct example, the driving dog is attached to the work and rigidly held by the setscrew. The tail of the dog rests in the slot of the faceplate and extends beyond the base of the slot so that the work rests firmly on both the headstock center and tailstock center.

In the incorrect example, note that the tail of the dog rests on the bottom of the slot on the faceplate at A, thereby pulling the work away from the center points, as shown at B and C, and causing the work to revolve eccentrically.

When mounting work between centers for machining, there should be no end play between the work and the dead center. However, if the work is held too tightly by the tail center when revolving, the work will heat the center point, destroying both the center and the work. To help prevent overheating, the tail center must be lubricating with a heavy mixture of white lead and oil.

Holding Work on a Mandrel

Many parts, such as bushings, gears, collars, and pulleys, require all the finished external surfaces to run true with the hole which extends through them. That is, the outside diameter must be true with the inside diameter or bore.

General practice is to finish the hole to a standard size, within the limit of the accuracy desired. Thus a 3/4-inch standard hole would ordinarily be held from 0.7505 inch or a tolerance of one-half thousandth of an inch above or below the true standard size of exactly 0.750 inch.

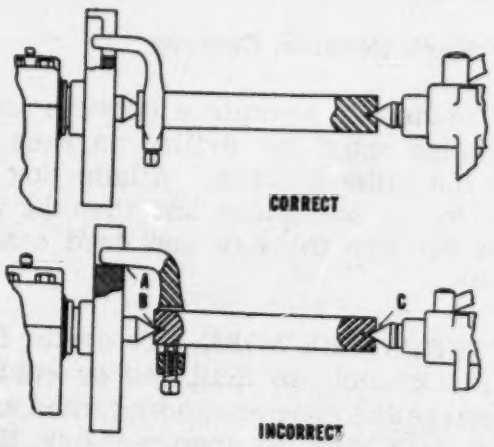

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Figure 18-22.—Examples of work mounted between centers.

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3. Excessive washing removes oil from skin and hair and can result in skin eruptions. A good rinsing after washing will help to lessen this problem.
4. Worming may be necessary to control specific parasites in dogs (See Service Bulletin Number One, pp. 41-27).
5. Dogs must be vaccinated for rabies, infectious hepatitis, distemper and leptospirosis.

WOUNDS AND WOUND THERAPY

Many wounds of animals go untreated through neglect and ignorance. Wounds, aside from being a means of entry for many infectious diseases, often result in unthrifty livestock. The animals are too busy fighting infection to grow properly. Many untreated wounds have resulted in secondary infections, or even systemic poisoning.

Most small wounds of animals may be treated very quickly. A wound may be washed out with soap and clean water, followed by a rinse with clean water. The wound may be covered with gauze or cotton, taped in place and left for 72 hours, after which the bandage should be removed.

There are many different types of wounds, and different treatments are necessary for each type. The two most common kinds of wounds are lacerations (cuts) and punctures. Because the puncture is often unnoticed and does not usually bleed much, it is the more dangerous of the two general types of wounds. Tetanus (lockjaw) and systemic poisoning often accompany the untreated puncture wound.

Treating the Puncture Wound

Puncture wounds may be treated by sterile probing to remove all foreign matter and to establish drainage. Packing the puncture with gauze will help the wound to heal from the inside out. When the wound has started to heal the gauze may be removed.

Treating the Laceration

1. Control bleeding, if necessary.
   a. Bleeding normally stops when clots develop.
   b. If bleeding continues, the following methods may be used to stop it.
      (1) A pressure bandage over the wound to keep blood flow restricted until clots develop.
      (2) Small vessels may be clamped or tied off. Forceps or tweezers will help you to get hold of the vessel ends.
      (3) A pressure bandage may be applied over a wound that is bleeding profusely. The bandage may allow more blood to escape than a tourniquet, but is normally better than a tourniquet because it can be left in place.
2. Clean the wound to prevent infection. In wounds that exhibit little bleeding, flushing must be done. Clean water and soap are very good for this purpose.
3. A deep wound will have to be sutured, or "stitched." A veterinarian or an experienced person should perform this operation with proper equipment and supplies. Deep wounds also require drainage. Rubber tubes or strips of gauze are often used for this purpose. Shallow wounds may be sutured binding only the skin. The sutures should be 1/2 to 3/4 inches apart and about 3/4 of an inch long. Be careful not to pull the sutures too tight.

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First drill or bore the hole to within a few thousandths of an inch of the finished size; then remove the remainder of the material with a machine reamer, following with a hand reamer if the limits are extremely close.

The piece is then pressed on a mandrel tight enough so the work will not slip while being machined. A dog is clamped on the mandrel, which is mounted between centers. Since the mandrel surface runs true with respect to the lathe axis, the turned surfaces of the work on the mandrel will be true with respect to the hole in the piece.

A mandrel is simply a round piece of steel of convenient length which has been centered and turned true with the centers. Commercial mandrels are made of tool steel, hardened and ground with a slight taper (usually 0.0005 inch per inch). On sizes up to 1 inch the small end is usually one-half thousandth of an inch under the standard size of the mandrel, while on larger sizes this dimension is usually one thousandth of an inch under standard. This taper allows the standard hole in the work to vary according to the usual shop practice, and still provides a drive to the work when the mandrel is pressed into the hole. The taper is not great enough to distort the hole in the work. The countersunk centers of the mandrel are lapped for accuracy. The ends are turned smaller than the body of the mandrel and provided with flats which give a driving surface for the lathe dog.

Holding Work in Chucks

The independent chuck and universal chuck are more often used than other workholding devices in performing lathe operations. The universal chuck is used for holding relatively true cylindrical work when accurate concentricity of the machined surface and holding power of the chuck is secondary to time required to do the job. When the work is irregular in shape, must be accurately centered, and must be held securely for heavy feeds and depth of cuts, the independent chuck should be used.

FOUR-JAW INDEPENDENT CHUCK.—Figure 18-23 shows a rough casting mounted in a four-jaw independent lathe chuck on the spindle of the lathe. Before truing the work, determine which part you wish to have turn true. To mount this casting in the chuck, proceed as follows:

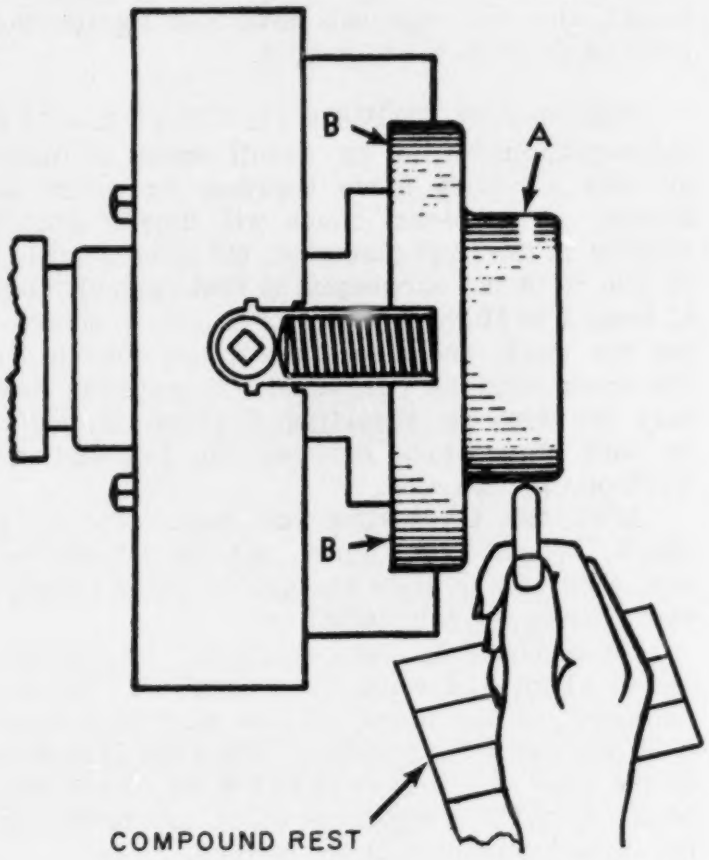

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Figure 18-23.—Work mounted in a Four-jaw chuck.

1. Adjust the chuck jaws to receive the casting. Each jaw should be concentric with the ring marks indicated on the face of the chuck. If there are no ring marks, be guided by the circumference of the body of the chuck.

2. Fasten the work in the chuck by turning the adjusting screw on jaw No. 1 and jaw No. 3, a pair of jaws which are opposite each other. Next tighten jaws No. 2 and No. 4.

3. At this stage the work should be held in the jaws just tight enough so it will not fall out of the chuck while being trued.

4. Revolve the spindle slowly and, with a piece of chalk, mark the high spot (A in fig. 18-23) on the work while it is revolving. Steady your hand on the tool post while holding the chalk.

5. Stop the spindle. Locate the high spot on the work and adjust the jaws in the proper direction to true the work by releasing the jaw opposite the chalk mark and tightening the mark.

6. Sometimes the high spot on the work will be located between adjacent jaws. In that case,

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loosen the two opposite jaws and tighten the jaws adjacent to the high spot.

THREE-JAW UNIVERSAL CHUCK.—The three-jaw universal or scroll chuck is made so that all jaws move together or apart in unison. A universal chuck will center almost exactly at the first clamping, but after a period of use it is not uncommon to find inaccuracies of from 2 to 10 thousandths of an inch in centering the work, and consequently the run-out of the work must be corrected. Sometimes this may be done by inserting a piece of paper or thin shim stock between the jaw and the work on the high side.

After the positioning has been done in a chuck, be sure to tighten all the screws so that each jaw is tight against the piece to prevent it from slipping under cut.

When chucking thin sections, be careful not to clamp the work too tightly, as then the diameter of the piece will be machined when it is in a distorted position. When the pressure of the jaws is released after the cut, there will be as many high spots as there are jaws, and the turned surface will not be true.

CARE OF CHUCKS.—To preserve a chuck's accuracy, handle it carefully and keep it clean and free from grit. Never force a chuck jaw by using a pipe as an extension on the chuck wrench.

Before mounting a chuck, remove the live center and fill the hole with a rag to prevent chips and dirt from getting into the taper hole of the spindle. Removal of the center is necessary to prevent the possibility of its being ruined when drilling work held in the chuck (the operator may inadvertently drill right through the center).

Clean and oil the threads of the chuck and the spindle nose.—Dirt or chips on the threads will not allow the chuck to run true when it is screwed up to the shoulder. Screw the chuck on carefully. Avoid bringing it up against the shoulder so fast that the chuck comes up with a shock since this will strain the spindle and the threads and make removal difficult. Never use mechanical power in screwing on the chuck. Rotate the spindle with the left hand while holding the chuck in the hollow of the right arm.

To remove a small chuck, place an adjustable jaw wrench on one of the jaws and start it by a smart blow with the hand on the handle of the wrench. To remove a heavy chuck, rotate it against a block of wood held between a jaw and the lathe bed. When mounting or removing a heavy chuck, lay a board across the bed ways to protect them; the board will serve as a support for the chuck as it is put on or taken off.

The above comments on mounting and removing chucks also apply to faceplates.

Holding Work on a Faceplate

A faceplate is used for mounting work which cannot be chucked or turned between centers. This may occur because of the peculiar shape of the work. A faceplate may be used when holes are to be accurately machined in flat work, or when large and irregularly shaped work is to be faced on the lathe.

Work is secured to the faceplate by bolts, clamps, or any suitable clamping means. The holes and slots in the faceplate are used for anchoring the holding bolts. Angle plates may be used to present the work at the desired angle, as shown in figure 18-24.

Note the counterweight added for balance.

For work to be mounted accurately on a faceplate, the surface of the work in contact with

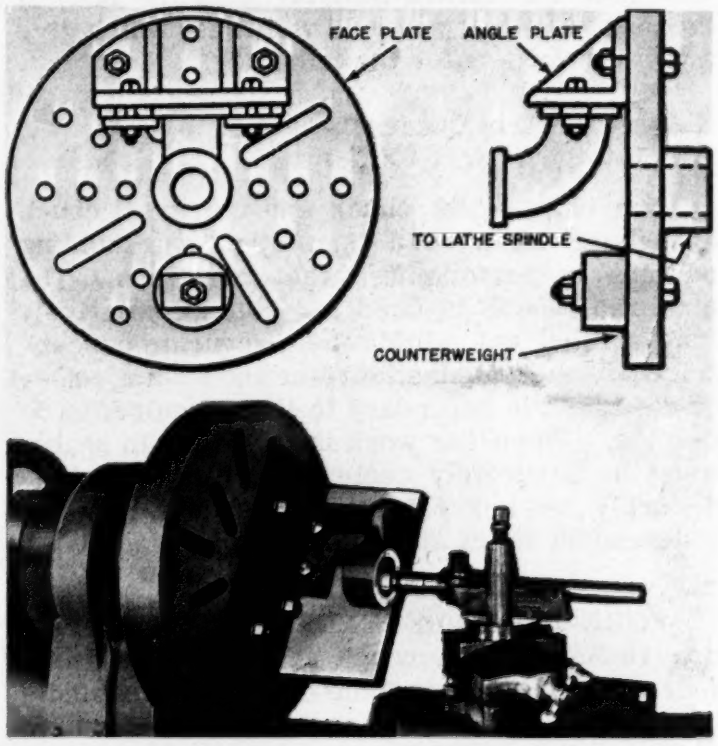

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Figure 18-24.—Work clamped to an angle plate.

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the faceplate must be accurately faced. For very accurate work, the faceplate itself should be refaced by taking a light cut over its surface. It is good practice to place a piece of paper between the work and the faceplate to prevent slipping.

Before securely clamping the work, it must be moved about on the surface of the faceplate until the point to be machined is centered accurately over the axis of the lathe. Suppose you wish to bore a hole, the center of which has been laid out and marked with a prick punch. First clamp the work to the approximate position on the faceplate. Then prepare a rod with a countersunk center hole to fit the tailstock center at one end, and with an accurate center point on the other end. Slide the tailstock up and place the rod with the point in the prick-punch mark on the work and the other end on the tail center. Then revolve the work slowly. If the punch mark is off center, the point of the rod will describe a small circle (appear to wobble); if it is right on center the rod will remain stationary. For very accurate centering, a dial indicator held in the tool post and applied to the rod will indicate a very small movement of the rod (to a thousandth of an inch).

Using the Center Rest and Follower Rest

In addition to being supported at the ends by the lathe centers, long slender work often requires support between ends while being turned; otherwise the work would spring away from the tool and chatter. The center rest is used to support such work so it can be accurately turned with a faster feed and cutting speed than would be possible without it.

The center rest should be placed where it will give the greatest support to the piece to be turned. This is usually at about the middle of its length.

Ensure that the center point between the jaws of the center rest coincides exactly with the axis of the lathe spindle. To do this, place a short piece of stock in a chuck and machine it to the diameter of the workpiece to be supported. Without removing the stock from the chuck, clamp the center rest on the ways of the lathe and adjust the jaws to the machined surface. Without changing the jaw settings, slide the center rest into position for supporting the workpiece. Remove the stock used for setting the center rest and set the workpiece in place. Use a dial indicator to true the workpiece at the chuck. Figure 18-25 shows how a chuck and center rest are used when machining the end of a workpiece.

The follower rest differs from the center rest in that it moves with the carriage and provides support against the forces of the cut only. The tool should be set to the diameter selected and a "spot" turned about 5/8 to 3/4 inch wide. Then the follower rest jaws should be adjusted to the finished diameter to follow the tool along the entire length to be turned.

Use a thick mixture of white lead and oil on the jaws of the center rest and follower rest to prevent "seizing" and scoring the workpiece. Check the jaws frequently to see that they do not become hot. The jaws may expand slightly if they get hot thus pushing the work out of alignment (when using the follower rest) or binding (when using the center rest).

Holding Work in a Draw-In Collet Chuck

The draw-in collet chuck is used for very fine accurate work of small diameter. Long work can be passed through the hollow drawbar, and short work can be placed directly into the collet from the front. The collet is tightened on the work by rotating the drawbar to the right; this draws the collet into the tapered closing sleeve. The opposite operation releases the collet.

Accurate results are obtained when the diameter of the work is exactly the same size as the dimension stamped on the collet. In some cases, the diameter may vary as much as 0.002 inch; that is, the work may be 0.001 inch smaller or larger than the collet size. If the work diameter varies more than this, it will impair the accuracy and efficiency of the collet. That is why a separate collet should be used for each small variation of work diameter, especially if precision is desired.

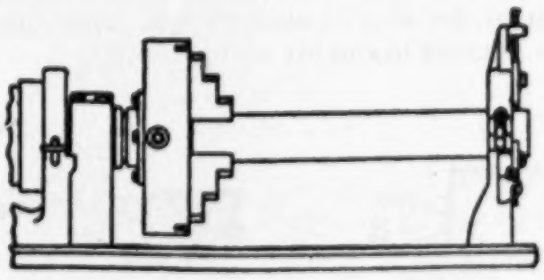

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Figure 18-25.—Work mounted in a chuck and center rest.

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MACHINING OPERATIONS

Up to this point you have studied the preliminary steps leading up to the performance of machine work in the lathe. You have learned how to mount the work and the tool, and which tools are used for various purposes. Now, to be considered is the method of using the proper tools in combination with the lathe to perform various machining operations.

FACING

Facing is the machining of the end surfaces and shoulders of a workpiece. In addition to squaring the ends of the work, facing provides a means of accurately cutting the work to length. Generally in facing the workpiece, only light cuts are required as the work will have been cut to approximate length or rough machined to the shoulder.

Figure 18-26 shows the method of facing a cylindrical piece. The work is placed on centers and driven by a dog. A right-hand side tool is used as shown, and a light cut is taken on the end of the work, feeding the tool (by hand crossfeed) from the center toward the outside. One or two chips are taken to remove sufficient stock to true the work. Then the dog is placed on the other end of the work and faced to the proper length. A steel rule is used to measure off the length. Another rule or straightedge held on the end that has just been faced provides an accurate base from which to measure. Be sure there is no fin or burr on the edge to keep the straightedge from bearing accurately on the finished end. Use a sharp scriber to mark off the dimension desired.

Figure 18-27 shows the application of a turning tool in finishing a shouldered job having a fillet corner. A finish cut is taken on the small diameter. The fillet is machined with a light cut; then the tool is used to face from the fillet to the outside diameter of the work.

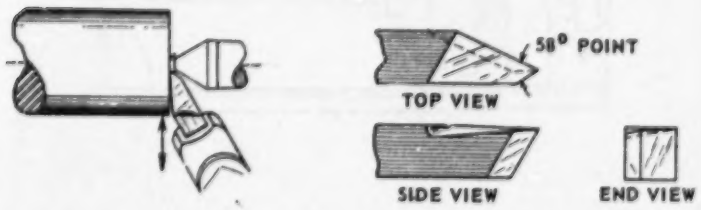

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Figure 18-26.—Facing a cylindrical piece.

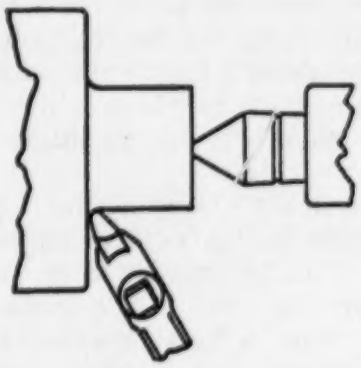

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Figure 18-27.—Facing a shoulder.

In facing large surfaces the carriage should be locked in position, since only crossfeed is required to traverse the tool across the work. With the compound rest set at 90° (parallel to the axis of the lathe), the micrometer collar can be used to feed the tool to the proper depth of cut in the face. For greater accuracy in obtaining a given size in finishing a face, the compound rest may be set at 30°. In this position, one-thousandth of an inch movement of the compound rest will move the tool exactly one-half thousandth of an inch in a direction parallel to the axis of the lathe. (In a 30°-60°-90° right triangle, the length of the side opposite the 30° angle is equal to one-half the length of the hypotenuse.)

TURNING

Turning is the machining of excess stock from the periphery of the workpiece to reduce the diameter. In most lathe machining requiring removal of large amounts of stock, a series of roughing cuts is taken to remove most of the excess stock; then a finishing cut is taken to accurately "size" the workpiece.

Rough Turning

When a great deal of stock is to be removed, heavy cuts should be taken in order to complete the job in the least possible time. This is called rough turning.

The proper tool should be selected for taking a heavy chip. The speed of the work, and the amount of feed of the tool should be as great as the tool will stand.

When taking a roughing cut on steel, cast iron, or any other metal that has a scale upon

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its surface, be sure to set the tool deep enough to get under the scale in the first cut. Unless you do, the scale on the metal will dull the point of the tool.

The work should be rough machined to almost the finished size; then care in measuring is required.

Bear in mind the fact that the diameter of the work being turned is reduced by an amount equal to twice the depth of the cut; thus, if you desire to reduce the diameter of a piece by one-fourth of an inch, one-eighth of an inch of metal must be removed from the surface.

Figure 18-28 shows the position of the tool for taking a heavy chip on large work. The tool should be set so that if anything occurs while machining to change the position of the tool, it will not dig into the work, but rather it will move in the direction of the arrow-away from the work.

Finish Turning

When the work has been rough turned to within about 1/32 inch of the finished size, take a finishing cut. A fine feed, the proper lubricant, and above all a keen-edged tool are necessary to produce a smooth finish. Caliper carefully to be sure that you are machining the work to the proper dimension. Stop the lathe when measuring with calipers.

Where very close limits are to be held, it is advisable to see that the work is not hot when the finish cut is taken. Cooling of the piece will leave it undersized if it has been turned to the exact size.

On work that is to be finished by a cylindrical grinder, a limited amount of stock is usually left for grinding to the finished dimensions.

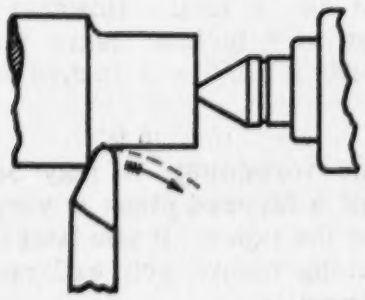

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Figure 18-28.—Position of tool for heavy cut.

Perhaps the most difficult operation for a beginner in machine work is to make accurate measurements. So much depends on the accuracy of the work that you should make every effort to become proficient in the use of measuring instruments. A certain "feel" in the application of calipers is developed through experience alone; do not be discouraged if your first efforts produce imperfect results. Practice taking caliper measurements on pieces of known dimensions. You will acquire skill if you are persistent.

Turning to a Shoulder

Machining to a shoulder is often done by locating the shoulder with a parting tool. The parting tool is inserted about 1/32 inch back of the shoulder line, and enters the work within 1/32 inch of the smaller diameter of the work. Then the stock may be machined by taking heavy chips up to the shoulder thus made. Shouldering eliminates detailed measuring and speeds up production.

Figure 18-29 illustrates the method of shouldering. A parting tool has been used at P and the turning tool is taking a chip. It will be unnecessary to waste any time in taking measurements. You can devote your time to rough machining until the necessary stock is removed. Then you can take a finishing cut to accurate measurement.

BORING

Boring is the machining of holes or any interior cylindrical surface. The piece to be bored must have a drilled or cored hole, and the hole must be large enough to insert the tool. The boring process merely enlarges the hole to

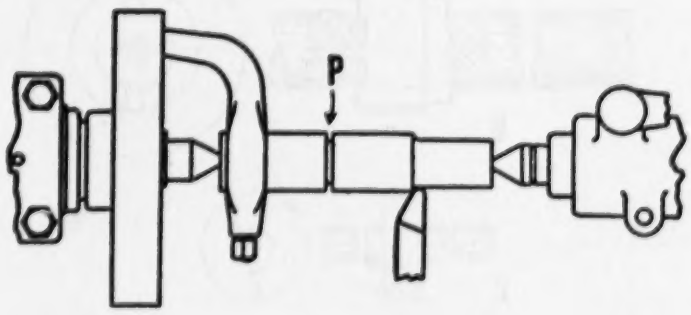

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Figure 18-29.—Machining to a shoulder.

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the desired size or shape. The advantage of boring is that a perfectly true round hole is obtained, and two or more holes of the same or different diameters may be bored at one setting, thus ensuring absolute alignment of the axis of the holes.

It is the usual practice to bore a hole to within a few thousandths of an inch of the desired size and then finish it with a reamer to the exact size.

Work to be bored may be held in a chuck, bolted to the faceplate, or bolted to the carriage. Long pieces must be supported at the free end in a center rest.

When the boring tool is fed into the hole in work being rotated on a chuck or faceplate, the process is called single point boring. It is the same as turning except that the cutting chip is taken from the inside. The cutting edge of the boring tool resembles that of a turning tool. Boring tools may be of the solid forged type or the inserted cutter bit type.

When the work to be bored is clamped to the top of the carriage, a boring bar is held between centers and driven by a dog. The work is fed to the tool by the automatic longitudinal feed of the carriage. Three types of boring bars are shown in figure 18-30.

Note the countersunk center holes at the ends to fit the lathe centers.

Figure 18-30(A) shows a boring bar fitted with a fly cutter held by a headless setscrew. The other setscrew, bearing on the end of the cutter, is for adjusting the cutter to the work.

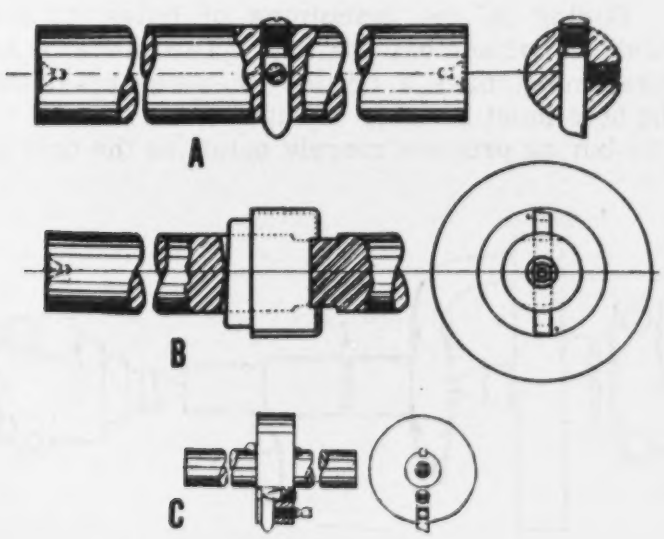

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Figure 18-30.—Boring bars.

Figure 18-30(B) shows a boring bar fitted with a two-edged cutter held by a taper key. This is more of a finishing or sizing cutter, as it cuts on both sides and is used for production work.

The boring bar shown in figure 18-30(C) is fitted with a cast-iron head to adapt it for boring work of large diameter. The head is fitted with a fly cutter similar to the one shown in part A of figure 18-30. The setscrew with the tapered point adjusts the cutter to the work.

TAPERS

The term "taper" may be defined as the gradual lessening of the diameter or thickness of a piece of work toward one end. The amount of taper in any given length of work is found by subtracting the size of the small end from the size of the large end. Taper is usually expressed as the amount of taper per foot of length, or as an angle.

We will take two examples as an illustration.

EXAMPLE 1.—Find the taper per foot of a piece of work 2 inches long: Diameter of small end is 1 inch; diameter of the large end is 2 inches.

The amount of the taper is 2 inches minus 1 inch, which equals 1 inch. The length of the taper is given as 2 inches. Therefore, the taper is 1 inch in 2 inches of length. In 12 inches of length it would be 6 inches. (See fig. 18-31.)

EXAMPLE 2.—Find the taper per foot of a piece 6 inches long. Diameter of small end is 1 inch; diameter of large end is 2 inches.

The amount of taper is the same as problem 1, that is, 1 inch. However, the length of this taper is 6 inches; hence the taper per foot is 1 inch x 12/6 = 2 inches per foot (fig. 18-31).

From the foregoing, it may be seen that the length of a tapered piece is very important in computing the taper. If you bear this in mind when machining tapers you will not go wrong. Using the formula:

$$\text{Taper per foot} = T \times \frac{12}{L},$$

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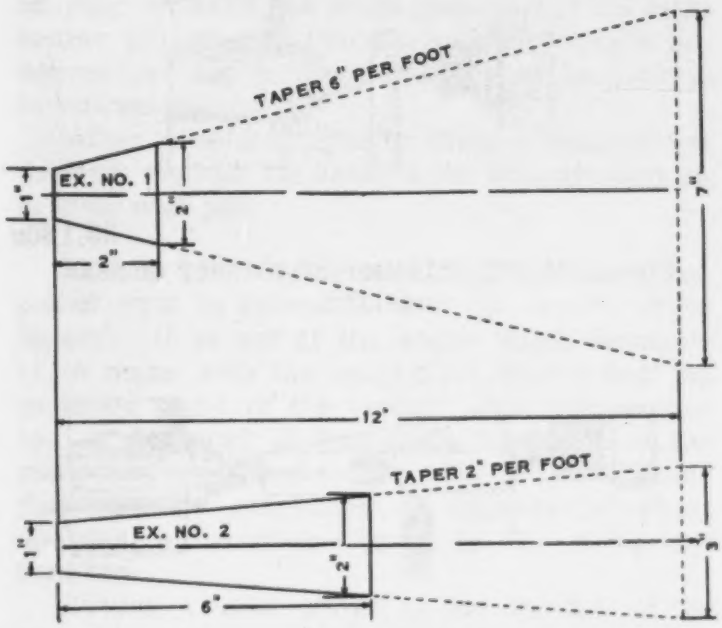

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Figure 18-31.—Tapers.

where T represents the amount of taper in length L, both expressed in inches.

Now let us consider the angle of the taper. In a round piece of work, the included angle of the taper is twice the angle that the surface makes with the axis or centerline. In straight turning, it will be recalled that the diameter of a piece is reduced by twice the depth of the cut taken from its surface. For the same reason, the included angle of the taper is twice the angle that the path of the cutting tool makes with the axis or centerline of the piece being turned. There are tables or charts in all machinist's handbooks that give the angles for different amounts of taper per foot.

There are several well-known tapers that are recognized as standards for machines in which they are used. These standards make it possible to make or obtain parts to fit the machine in question without the necessity of detailed measuring and fitting. By designating the name and number of the standard taper being used, the length, the diameter of the small and large ends, the taper per foot, and all other pertinent measurements are immediately obtainable by reference to appropriate tables found in machinist's handbooks.

There are three standard tapers with which you should be familiar: (1) the MORSE TAPER (approximately 5/8 inch per foot) used for the taper holes in lathe and drill press spindles and the attachments that fit them, such as lathe centers, drill shanks, etc.; (2) the BROWN & SHARPE TAPER (1/2 inch per foot except No. 10 which is 0.5161 inch per foot) used for milling machine spindle shanks; and (3) the JARNO TAPER (0.6 inch per foot) used by some manufacturers because of its simplicity, it being the only taper that is constant and does not require a table to find the various dimensions pertaining to its parts; e.g.

$$\text{Diameter of large end} = \frac{\text{taper number}}{8}$$

$$\text{Diameter of small end} = \frac{\text{taper number}}{10}$$

$$\text{Length of taper} = \frac{\text{taper number}}{2}$$

The taper for pipe ends, 3/4 inch per foot, is also considered a standard.

Turning Tapers

In ordinary straight turning, the cutting tool moves along a line parallel to the axis of the work, causing the finished job to be the same diameter throughout. If, however, in cutting, the tool moves at an angle to the axis of the work, a taper will be produced. Therefore, to turn a taper, it is necessary either to mount the work in the lathe so the axis upon which it turns is at an angle to the axis of the lathe, or to cause the cutting tool to move at an angle to the axis of the lathe.

There are three methods in common use for turning tapers:

1. SETTING OVER THE TAILSTOCK, which moves the dead center away from the axis of the lathe and hence causes work supported between centers to be at an angle with the axis of the lathe.
2. USING THE COMPOUND REST set at an angle and causing the cutting tool to be fed at the desired angle to the axis of the lathe.
3. USING THE TAPER ATTACHMENT, which also causes the cutting tool to move at an angle to the axis of the lathe.

In the first method, the cutting tool is fed by the longitudinal feed parallel to the lathe axis, but a taper is produced because the work axis is at an angle. In the second and third

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methods, the work axis coincides with the lathe axis, but a taper is produced because the cutting tool moves at an angle.

SETTING OVER THE TAILSTOCK.—The tailstock top may be moved laterally on its base by means of adjusting screws. In straight turning, you will recall that these adjusting screws were used to align the dead center with the tail center by moving the tailstock to bring it on the centerline. For taper turning, we deliberately move the tailstock off-center, and the amount we move it determines the taper produced. The amount of setover can be approximately set by means of the zero lines inscribed on the base and top of the tailstock as shown in figure 18-32. Then for final adjustment, the setover is measured with a scale between center points as illustrated in figure 18-33.

In turning a taper by this method, the distance between centers is of utmost importance. To illustrate, figure 18-34 shows two very different tapers produced by the same amount of setover of the tailstock, because in one case the length of the work between centers is greater than in the other. THE CLOSER THE DEAD CENTER IS TO THE LIVE CENTER, THE STEEPER THE TAPER PRODUCED.

Suppose it is desired to turn a taper on the full length of a piece 12 inches long with one end having a diameter of 3 inches, and the other end a diameter of 2 inches. The small end is to be 1 inch smaller than the large end; so we set the tailstock over one-half this amount or 1/2 inch. Thus, at one end the cutting tool will be 1/2 inch closer to the center of the work than at the other end; so the diameter of the finished job will be 2 x 1/2 or 1 inch less at

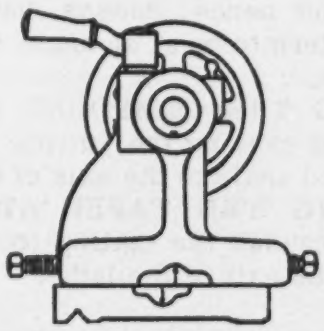

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Figure 18-32.—Tailstock setover for taper turning.

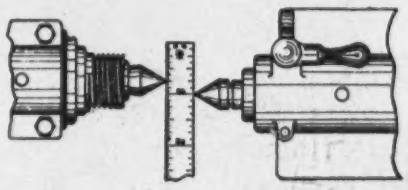

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Figure 18-33.—Measuring setover of dead center.

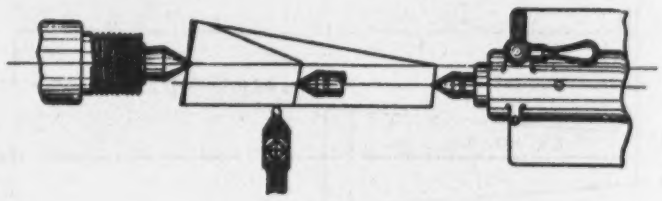

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Figure 18-34.—Setover of tailstock showing importance of considering length of work.

the small end. Since the piece is 12 inches long, we have produced a taper of 1 inch per foot. Now, if you wish to produce a taper of 1 inch per foot on a piece only 6 inches long, the small end would be only 1/2 inch less in diameter than the large end, so the tailstock would be set over 1/4 inch or one-half of the distance used for the 12-inch length.

From the foregoing, it is seen that the setover is proportional to the length between centers and may be computed by the following formula:

$$S = \frac{T}{2} \times \frac{L}{12}$$

Where: S = setover in inches
T = taper per foot in inches
$\frac{L}{12}$ = length in feet

Remember that L is length of work, in inches, from live center to dead center. If the work is on a mandrel, L is the length of the mandrel between centers.

The setover tailstock method cannot be used for steep tapers because the setover necessary would be too great and the work would not be properly supported by the lathe centers. It is obvious that with setover there is not a true

bearing between the work centers and the lathe center points, and that the bearing surface becomes less and less satisfactory as the setover is increased.

After turning a taper by the tailstock setover method, realign the centers for straight turning of your next job.

USING THE COMPOUND REST.—The compound rest is generally used for short, steep tapers. It is set at the angle which the taper is to make with the centerline (that is half the included angle of the taper). The tool is then fed to the work at this angle by means of the compound rest feed screw. The length of taper that can be machined is necessarily short because of limited travel of the compound rest top.

Truing a lathe center is one example of the use of the compound rest for taper work. Other examples are the refacing of an angle type valve disk, the machining of the face of a bevel gear, and similar work. Such jobs are often referred to as working to an angle rather than as taper work.

The graduations marked on the compound rest provide a quick means for setting to the angle desired. When set at zero, the compound rest is perpendicular to the lathe axis. When set at 90° on either side, the compound rest is parallel to the lathe axis.

However, when the angle to be cut is measured from the centerline, the setting of the compound rest corresponds to the complement of that angle—(the complement of an angle is that angle which added to it makes a right angle; that is, angle plus complement = 90°). For example, to machine a 50° included angle (25° angle with centerline), the compound rest is set at 90°-25° or 65°.

When a very accurate setting of the compound rest is to be made to a fraction of a degree, for example, run the carriage up to the faceplate and set the compound rest with a vernier bevel protractor set to the required angle. The blade of the protractor is held on the flat surface of the faceplate, and the stock is held against the finished side of the compound rest.

USING THE TAPER ATTACHMENT.—For turning and boring long tapers with accuracy, the taper attachment is indispensable. It is especially useful in duplicating work; identical tapers can be turned and bored with one setting of the taper guide bar.

The guide bar is set at an angle to the lathe axis corresponding to the taper desired. By means of a shoe which slides on the guide bar as the carriage moves longitudinally, the tool cross-slide is moved laterally. The resultant movement of the cutting tool is along a line that is parallel to the guide bar, and therefore a taper is produced whose angular measurement is the same as that set on the guide bar. The guide bar is graduated in degrees at one end, and in inches per foot of taper at the other end to facilitate rapid setting.

When preparing to use the taper attachment, run the carriage up to the approximate position of the work to be turned. Set the tool on line with the centers of the lathe. Then bolt or clamp the holding bracket to the ways of the bed (the attachment itself is bolted to the back of the carriage saddle) and tighten clamp C, figure 18-35. The taper guide bar now controls the lateral movement of the cross-slide. Set the guide bar for the taper desired and the attachment is ready for operation. The final adjustment of the tool for size must be made by means of the compound rest feed screw, since the crossfeed screw is inoperative.

Taper Boring

Taper boring may be accomplished only by the use of the compound rest or the taper attachment.

The rules that are applicable to outside taper turning also apply to the boring of tapered holes. The cutting point of the tool is placed on center and, if the taper attachment is used, care must be exercised to eliminate the backlash of the slide fittings so that the hole will not be bored straight at the start. Measurement of the size and taper of the hole is generally made with a taper plug gage by the cut and try method. After a cut or two has been taken, the bore is cleaned, the gage rubbed lightly with chalk, inserted in the hole and twisted slightly to cause the chalk to show where the gage is bearing. Any necessary corrections may then be made and the boring continued until the taper is brought to size. A very light application of prussian blue to the gage will give better results than chalk for accurate work.

When making a blind tapered hole, such as may be required in drill sockets, it is best to drill the hole carefully to the correct depth with a drill of the same size as specified for the small end of the hole. This gives the

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advantage of boring to the right size without the removal of metal at the extreme bottom of the bore, which is rather difficult, particularly in small, deep holes.

For turning and boring tapers the tool cutting edge should be set exactly at the center of the work. That is, set the point of the cutting edge even with the height of the lathe centers.

In testing the taper on a piece of work that is to fit a spindle and is nearly finished, make a chalk mark along the element or side of the taper piece. Place the work in the taper hole it is to fit and turn carefully by hand. Then remove the work, and the chalk mark will show where the taper is bearing. If it is a perfect fit, it will indicate along the entire line of the chalk mark. If it is not, it will show where the adjustment is needed. Make the adjustment, take another light chip, and test again. Be sure the taper is correct before turning to the finished diameter.

Figure 18-36 shows a Morse standard taper plug and a taper plug and a taper socket gage. They not only give the proper taper, but also show the proper distance that the taper should enter the spindle.

SCREW THREADS

The thread forms you will be working with most are V-form threads, Acme threads, and square threads. Each of these thread forms is used for specific applications. V-form threads are commonly used on fastening devices such as bolts and nuts as well as on machine parts. Acme screw threads are generally used for transmitting motion such as that between the lead screw and lathe carriage. Square threads

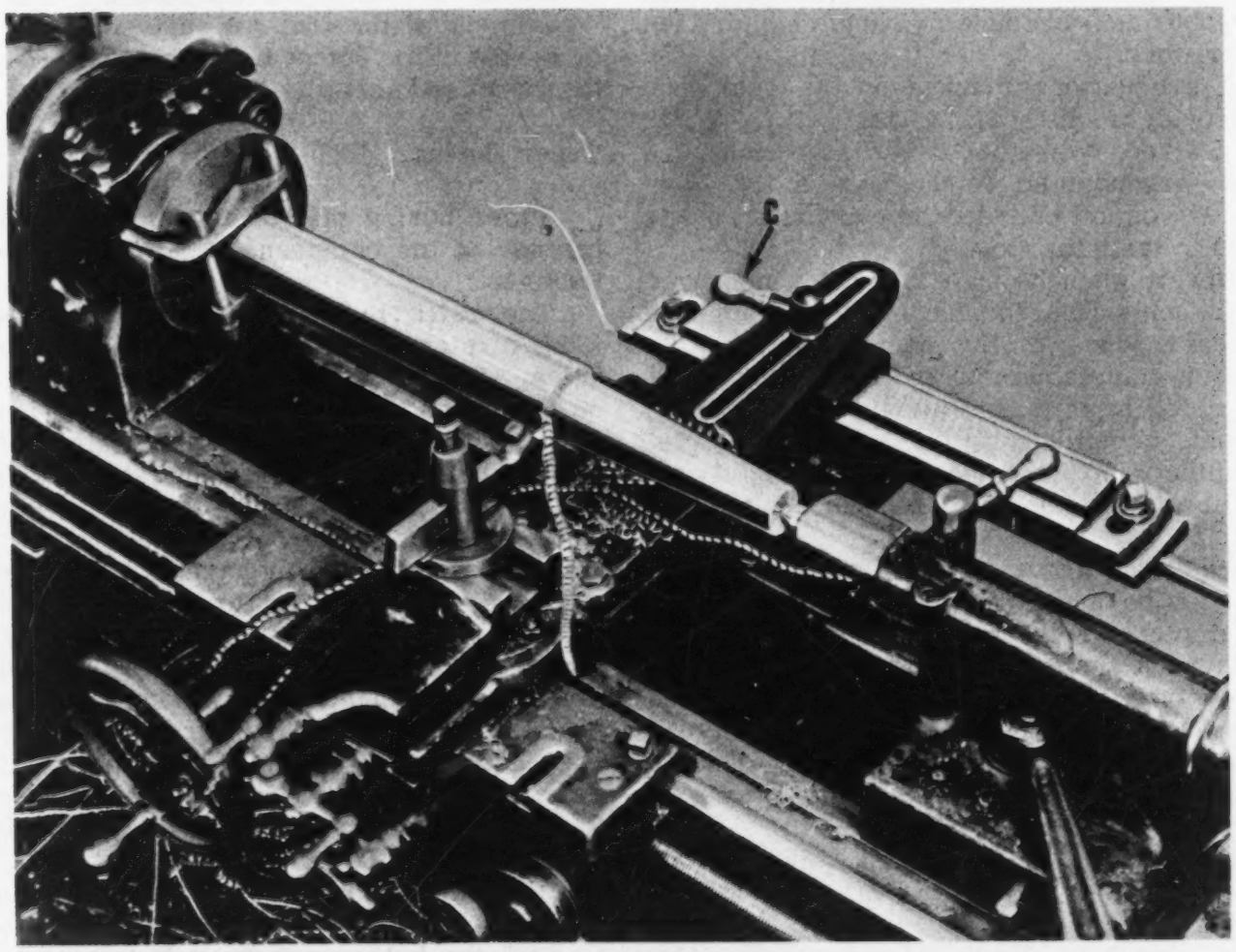

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Figure 18-35.—Turning a taper using taper attachment.

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Wounds more than skin deep should be closed by a veterinarian. When a wound is on a knee joint or some place where sutures may tear, use loose sutures and change the bandage daily.

4. In fly season, EQ 235 or a similar insect repellent may be applied around the wound to discourage flies.

5. Apply a dressing to protect the wound.

6. Check frequently while keeping the animal in isolation to see that the wound is healing properly.

GLOSSARY

ANTICOAGULANT (an′tī kō ag′ū lant) a substance which prevents clotting of blood and other liquids.

ARTHROPOD (ar′thrōw pod) a member of the Arthropoda phylum, which consists of animals with articulated bodies and limbs (insects and crustaceans).

BACTERIA (băk tēr′i a) a large, widely distributed group of typically one-celled organisms.

BRUCELLOSIS (brew′sell ōsis′) a specific contagious disease primarily affecting cattle, swine, and goats. It is characterized by abortions.

CONTAGIOUS (kŏn ta′ jus) spreading from one to another by direct or indirect contact with the disease.

CRESOL (krē′sōl) a substance derived from coal and wood tar, used as a disinfectant.

CARBOLIC ACID (kär bŏl′ ik) a weak acid derived from coal tar; also called phenol.

DEBRIS (de brē′) rubbish, waste material, dirt.

DIAGNOSIS (di′ăg nō′ sĭs) the process of identifying a disease by examination and study of its symptoms.

DISINFECTANT (dis′ in fekt′ ant) an agent, as carbolic acid or lime, used to destroy pathogens.

DISTEMPER (dis temp′ er) a highly contagious disease of dogs.

FORMALDEHYDE (for mal′ dĕ hīd) a colorless gas with a sharp odor, formed by partly burning methanol.

HEMORRHAGE (hem′ ō rij) any escape or discharge of blood from the blood vessels.

HEPATITIS (hep′ a tīt′ is) an acute infectious contagious disease of dogs, affecting primarily the liver.

HYPOCHLORITE (hīp ō clŏr′ īt) a salt of hypochlorus acid, used as an oxidizing agent. (Commercial bleaches are hypochlorites.)

INFECTIOUS DISEASE (in fek′ shŭs) any disease caused by the entrance and growth of pathogens in the body.

INSECT (ĭn′ sekt) any of a class of small animals whose bodies appear to have three distinct regions (head, thorax, abdomen), with three pairs of legs and usually winged.

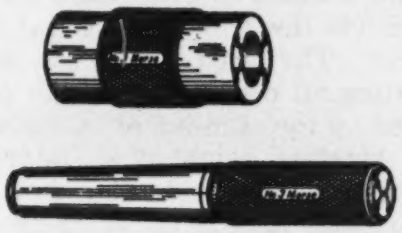

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Figure 18-36.—Morse taper socket gage and plug gage.

are used to increase mechanical advantage and to provide good clamping ability as in the screw jack or vise screw.

Terminology

There are several terms used in describing screw threads and screw thread systems which you must know before you can calculate and machine screw threads. Figure 18-37 illustrates the application of some of the following terms:

External Thread.—A thread on the external surface of a cylinder.

Internal Thread.—A thread on the internal surface of a hollow cylinder.

Right-Hand Thread.—A thread which, when viewed axially, winds in a clockwise and receding direction.

Left-Hand Thread.—A thread which, when viewed axially, winds in a counterclockwise and receding direction.

Lead.—The distance a threaded part moves axially in a fixed mating part in one complete revolution.

Pitch.—The distance between corresponding points on adjacent threads.

Single Thread.—A single (single start) thread having the lead equal to the pitch.

Multiple Thread.—A multiple (multiple start) thread has a lead which is equal to the pitch multiplied by the number of starts.

Class of Threads.—Classes of threads are distinguished from each other by the amount of tolerance or tolerance and allowance specified.

Thread Form.—The axial plane profile of a thread for a length of one pitch.

Flank.—The side of the thread.

Crest.—The top of the thread (bounded by the major diameter on external threads; by the minor diameter on internal threads).

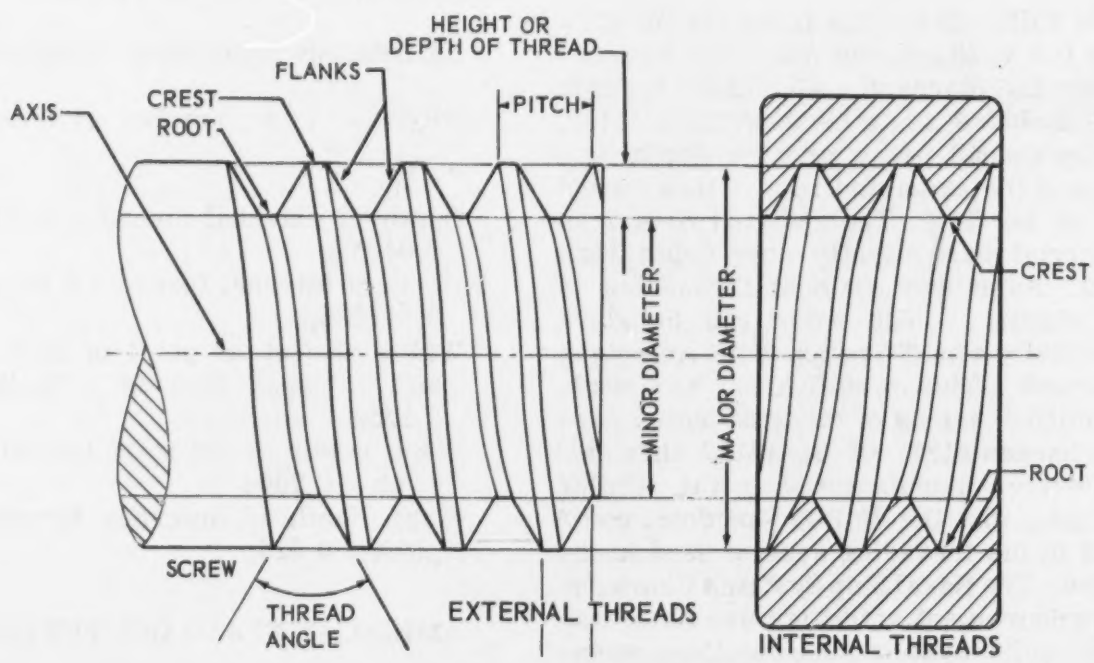

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Figure 18-37.—Screw thread nomenclature.

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Root.—The bottom of the thread (bounded by the minor diameter on external threads; by the major diameter on internal threads).

Thread Angle.—The angle formed by adjacent flanks of a thread.

Major Diameter.—The diameter of a cylinder that bounds the crest of an external thread or the root of an internal thread.

Minor Diameter.—The diameter of a cylinder that bounds the root of an external thread or the crest of an internal thread.

Height of Thread.—The distance from the crest to the root of a thread measured perpendicular to the axis of the threaded piece (also called depth of thread).

Slant Depth.—The distance from the crest to the root of a thread measured along the angle forming the side of the thread.

Thread Series.—Groups of diameter pitch combinations which are distinguished from each other by the number of threads per inch to a specific diameter. The common thread series are the coarse series and the fine series.

Forms of Threads

V-FORM THREADS.—The three forms of V-threads are the V-sharp, the American National and the American Standard. All of these threads have a 60° included angle between their sides. The V-sharp thread has a greater depth than the others and the crest and root of this thread have little or no flat. The external American Standard thread has slightly less depth than the external American National thread but is otherwise similar. The American Standard thread is actually a modification of the American National thread. This modification was made so that a unified series of threads, which permits interchangeability of standard threaded fastening devices manufactured in the United States, Canada, and the United Kingdom, could be included in the threading system used in the United States. The Naval Ship Systems Command and naval procurement activities use American Standard threading system specifications whenever possible; this system is recommended for use by all naval activities.

To cut a V-form screw thread, you need to know (1) the pitch of the thread, (2) the straight depth of the thread, (3) the slant depth of the thread, and (4) the width of the flat at the root of the thread. The pitch of a thread is the basis for calculating all other dimensions and is equal to 1 divided by the number of threads per inch. Twice the straight depth of an internal thread subtracted from the outside diameter of the externally threaded part is the basis for determining the bore diameter of a mating part to be threaded internally. When the thread cutting tool is fed into the workpiece at one-half of the included angle of the thread, the slant depth is the dimension necessary to determine how far to feed the tool into the work. The point of the threading tool must have a flat equal to the width of the flat at the root of the thread (external or internal thread, as applicable). If the flat at the point of the tool is too wide, the resulting thread will be too thin if the cutting tool is fed in the correct amount. If the flat is too narrow, the thread will be too thick.

The following formulas will provide you with the information you need to know for cutting V-form threads:

V-SHARP THREAD.

Pitch $= \frac{1}{n} = 1 \div$ number of threads per inch

Depth of thread = 0.866 x pitch = 0.866p

Slant depth of thread = pitch

AMERICAN NATIONAL THREAD.

Pitch = 1 ÷ number of threads per inch $= \frac{1}{n}$

Depth of external thread = 0.64952 x pitch = 0.64952p

Depth of internal thread = 0.541266 x pitch = 0.541266p

Width of flat at point of tool for external and internal threads = 0.125 x pitch = 0.125p

Slant depth of external thread = 0.750 x pitch = 0.750p

Slant depth of internal thread = 0.625 x pitch = 0.625p

AMERICAN STANDARD THREAD.

Pitch = 1 ÷ number of threads per inch $= \frac{1}{n}$

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Depth of external thread = 0.61343 x pitch = 0.61343p
Depth of internal thread = 0.541266 x pitch = 0.541266p
Width of flat at point of tool for external threads = 0.166 x pitch = 0.166p
Width of flat at point of tool for internal threads = 0.125 x pitch = 0.125p
Slant depth of external thread = 0.708 x pitch = 0.708p
Slant depth of internal thread = 0.625 x pitch = 0.625p

To produce the correct thread profile, the cutting tool must be accurately ground to the correct angle and contour. Also the cutting tool must be set in the correct position. Figure 18-38 shows how a tool must be ground and set.

The point of the tool must be ground to an angle of 60°, as shown in A of figure 18-38. A center gage or a thread-tool gage is used for grinding the tool to the exact angle required. The top of the tool is usually ground flat, with no side rake or back rake. However, for cutting threads in steel, side rake is sometimes used.

The threading tool must be set square with the work, as shown in B and C of figure 18-38. The center gage is used to adjust the point of the threading tool and if the tool is carefully set, a perfect thread will result. Of course, if the threading tool is not set perfectly square with the work, the angle of the thread will be incorrect.

For cutting external threads, the top of the threading tool should be placed exactly on center as shown in D of figure 18-38. Note that the top of the tool is ground flat and is in exact alignment with the lathe center. This is necessary to obtain the correct angle of the thread.

Size of the threading tool for cutting an internal thread is important. The tool head must be small enough to be backed out of the thread and still leave enough clearance to be drawn from the threaded hole without injuring the thread. However, the boring bar which holds the threading tool for internal threading should be as large in diameter and as short as possible to prevent springing.

THE ACME SCREW THREAD.—The Acme screw thread is used on valve stems, the lead screw of a lathe, and other places where a strong thread is required. The top and bottom of the threads are similar to a square thread

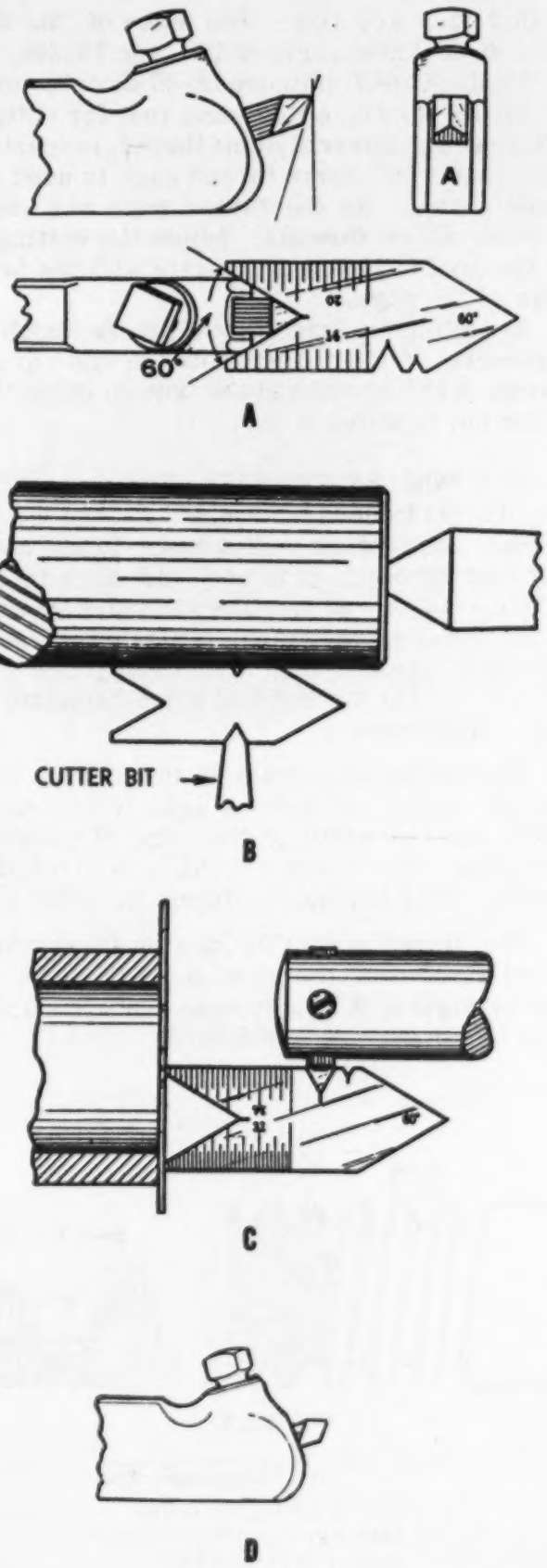

28.146x

Figure 18-38.—Threading tool setup for V-form threads.

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in that they are flat. The sides of the thread have an included angle of 29° (fig. 18-39).

Parts A and B of figure 18-40 show the method of setting an Acme threading tool for cutting an external and internal Acme thread, respectively. Note that a 29° Acme thread gage is used in the same manner as the center gage was used for V-form screw threads. Adjust the cutting edge of the tool to line it up exactly with the beveled edge of the gage.

In cutting an Acme thread, there should be a clearance of 0.010 inch between the top of the thread of the screw and the bottom of the thread of the nut in which it fits.

THE SQUARE THREAD.—The square thread (fig. 18-41) is used where heavy threads are required, such as in jack screws, press screws, and feed screws. It is used for much the same purpose as the Acme thread, which is used in many places where the square thread was formerly used. The disadvantage of square threads is that the straight sides eliminate side-play adjustment.

The cutting edge width of the tool for cutting square screw threads is exactly one-half the pitch, but the width of the edge of the tool for threading nuts is from 0.001 inch to 0.003 inch larger. This permits a sliding fit on the screw.

The threading tool for cutting square threads is set square with the work. Since the edge of the tool is square, it is only necessary to adjust the edge to the surface of the work.

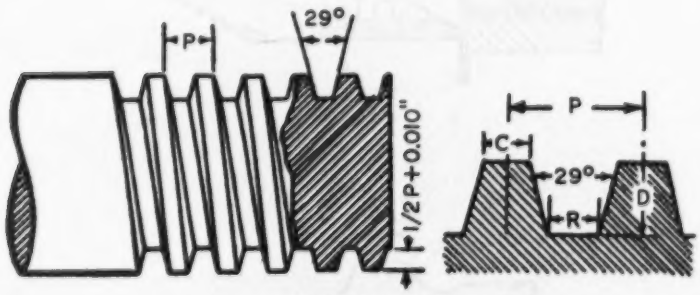

FORMULAS

$$\text{PITCH (P)} = \frac{1}{\text{No. Threads per inch}}$$

DEPTH (D) = 1/2 P + 0.010"
SLANT DEPTH = 0.516 P + 0.010"
CREST (C) = 0.3707 P
ROOT (R) = 0.3707 P − 0.0052"

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Figure 18-39.—Acme thread and formulas.

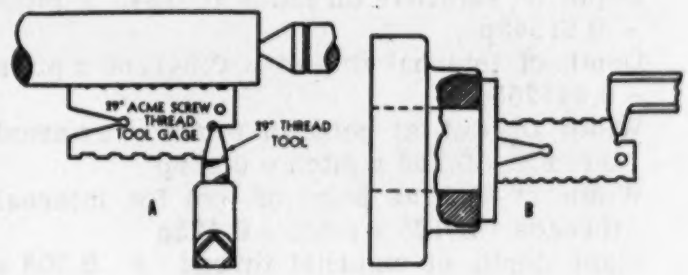

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Figure 18-40.—Use of Acme thread tool gage.

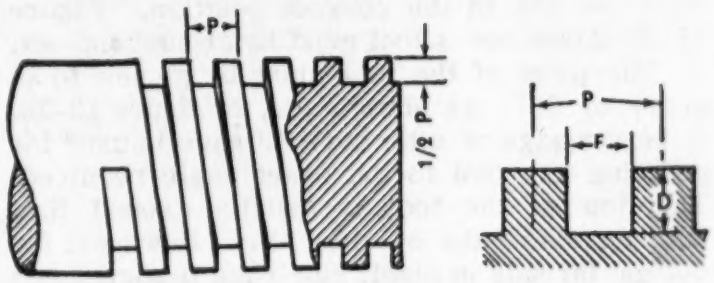

FORMULAS

$$\text{PITCH (P)} = \frac{1}{\text{No. Threads per inch}}$$

DEPTH (D) = P x 0.500"
SPACE (F) = P x 0.500"

28.149x

Figure 18-41.—Square thread and formulas.

The clearance between the top of the thread of the screw and that of the bottom of the thread of the nut should be about 0.005 inch to 0.006 inch for each inch of thread diameter.

Cutting Screw Threads

Cutting screw threads on the lathe is accomplished by connecting the headstock spindle of the lathe with the lead screw by a series of gears so that a positive carriage feed is obtained, and the lead screw is driven at the required speed with relation to the headstock spindle. The gearing between the headstock spindle and lead screw may be arranged so that any desired pitch of the thread may be cut. For example, if the lead screw has 8 threads per inch and the gears are arranged so that the headstock spindle revolves four times while the lead screw revolves once, the thread cut will be four times as fine

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as the thread on the lead screw, or 32 threads per inch. By means of the quick-change gear box, the proper gearing arrangement can be made quickly and easily by placing the levers as indicated on the index plate for the thread desired.

When the lathe is set up to control the carriage movement for cutting the desired thread pitch, the next consideration is shaping the thread. The cutting tool is ground to the shape required for the form of the thread to be cut, that is V, Acme, square, etc. The depth of the thread is obtained by adjusting the cross slide.

MOUNTING WORK IN THE LATHE.—When mounting work between lathe centers for cutting screw threads, be sure the lathe dog is securely attached before starting to cut the thread. If the dog should slip, the thread will be ruined. Never remove the lathe dog from the work until the thread has been completed. If it is necessary to remove work from the lathe before the thread is completed, be sure that the lathe dog is replaced in the same slot of the driving plate.

When threading work in the lathe chuck, be sure the chuck jaws are tight and the work is well supported. The chuck must be tight enough on the spindle to prevent unscrewing when the lathe is reversed. Never remove the work from the chuck until the thread is finished.

When threading long slender shafts, use a follower rest. The center rest must be used for supporting one end of long work that is to be threaded on the inside.

POSITION OF COMPOUND REST FOR CUTTING SCREW THREADS.—Ordinarily on threads of fine lead, the tool is fed straight into the work on successive cuts. For coarse threads, it is better to set the compound rest at one-half of the included angle of the thread and feed in along the side of the thread. For the last few finishing cuts, the tool should be fed straight in with the crossfeed of the lathe to make a smooth, even finish on both sides of the thread.

When cutting V-form threads and when maximum production is desired, it is customary to place the compound rest of the lathe at an angle of 29°, as shown in part A of figure 18-42. When the compound rest is set in this position, and the compound-rest screw is used for adjusting the depth of cut, most of the metal is removed by the left side of the threading tool

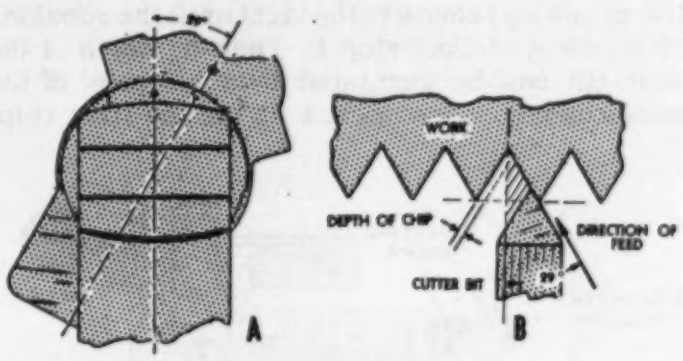

28.150x

Figure 18-42.—Compound rest set at 29°.

(part B of fig. 18-42). This permits the chip to curl out of the way better than if the tool is fed straight in, and prevents tearing the thread. Since the angle on the side of the threading tool is 30°, the right side of the tool will shave the thread smooth and produce a better finish; although it does not remove enough metal to interfere with the main chip, which is taken by the left side of the tool.

USING THE THREAD-CUTTING STOP.—On account of the lost motion caused by the play necessary for smooth operation of the change gears, lead screw, half-nuts, etc., the thread-cutting tool must be withdrawn quickly at the end of each cut. If this is not done, the point of the tool will dig into the thread and may be broken off.

To reset the tool accurately for each successive cut, and to regulate the depth of the chip, the thread-cutting stop is useful.

First, set the point of the tool so that it just touches the work, then lock the thread-cutting stop and turn the thread-cutting stop screw A (fig. 18-43) until the shoulder is tight against stop B (fig. 18-43). When ready to take the first chip, run the tool rest back by turning the crossfeed screw to the left several times and move the tool to the point where the thread is to start. Then turn the crossfeed screw to the right until the thread-cutting stop screw strikes the thread-cutting stop. The tool is now in the original position, and turning the compound-rest feed screw in 0.002 inch or 0.003 inch will place the tool in a position to take the first cut (fig. 18-43).

For each successive cut after the carriage is returned to its starting point, the tool can be reset accurately to its previous position. Turn

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the crossfeed screw to the right until the shoulder of screw A strikes stop B. Then the depth of the next cut can be regulated by adjustment of the compound rest feed screw as for the first chip.

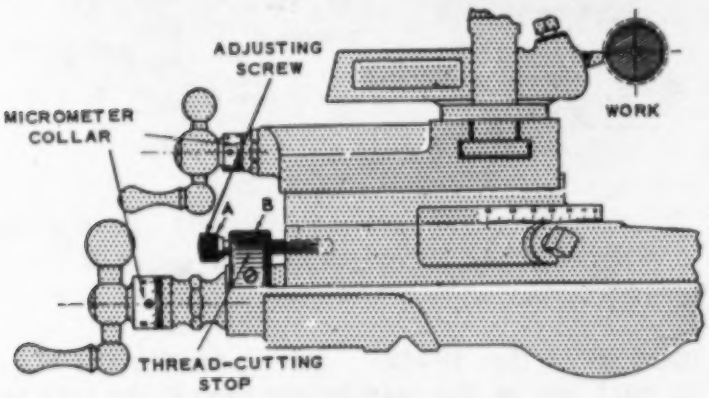

28.151x

Figure 18-43.—Adjustable thread-cutting stop mounted on carriage saddle (clamped to dovetail).

For cutting an internal thread, the adjustable thread-cutting stop should be set with the head of the adjusting screw on the inside of the stop. In this case, the tool is withdrawn by moving it toward the center or axis of the lathe.

The micrometer collar on the crossfeed screw may be used in place of the thread-cutting stop, if desired.

To do this, first bring the point of the threading tool up so that it just touches the work; then adjust the micrometer collar on the crossfeed screw to zero. All adjustments for obtaining the desired depth of cut should be made with the compound-rest screw. Withdraw the tool at the end of each cut by turning the crossfeed screw to the left one complete turn; return the tool to the starting point and turn the crossfeed screw to the right one turn, stopping at zero. The compound rest feed screw may then be adjusted for any desired depth.

ENGAGING THE THREAD FEED MECHANISM.—When threads are being cut on a lathe, the half-nuts are clamped over the lead screw to engage the threading feed and released at the end of the cut by means of the threading lever. The threading dial (illustrated in fig. 18-15) provides a means for determining the time to engage the half-nuts so that the cutting tool follows the same path during each cut. When an index mark on the threading dial is aligned with the witness mark on its housing, the half-nuts may be engaged. For some thread pitches however, the half-nuts may be engaged only when certain index marks are aligned with the witness mark. On most lathes the half-nuts can be engaged as follows:

For all even-numbered threads per inch, close the half-nuts at any line on the dial.

For all odd-numbered threads per inch, close the half-nuts at any numbered line on the dial.

For all threads involving one-half of a thread in each inch, such as 11 1/2, close the half-nuts at any odd-numbered line.

CUTTING THE THREAD.—After setting up the lathe, as explained previously, take a very light trial cut just deep enough to scribe a line on the surface of the work, as shown in part A of figure 18-44. The purpose of this trial cut is to be sure that the lathe is arranged for cutting the desired pitch of thread.

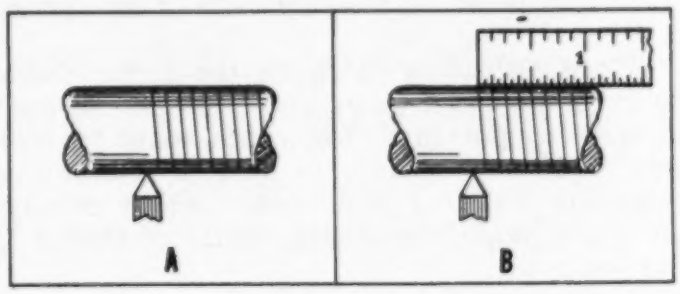

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Figure 18-44.—The first cut.

To check the number of threads per inch, place a rule against the work, as shown in part B of figure 18-44, so that the end of the rule rests on the point of a thread or on one of the scribed lines. Count the scribed lines between the end of the rule and the first inch mark, and this will give the number of threads per inch.

It is quite difficult to count accurately fine pitches of screw threads, as described above. A screw pitch gage used as illustrated in figure 18-45 is very convenient for checking the finer screw threads. This gage consists of a number of sheet metal plates in which are cut the exact form of threads of the various pitches and each plate is stamped with a number indicating the number of threads per inch for which it is to be used.

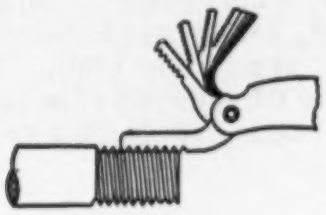

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Figure 18-45.—Screw pitch gage.

Final check for both diameter and pitch of the thread may be made with the nut that is to be used or with a ring thread gage, if one is available. The nut should fit snugly without play or shake but should not bind on the thread at any point.

RESETTING THE TOOL.—If the thread-cutting tool needs resharpening or gets out of alignment, or if you are chasing the threads on a previously threaded piece, you must reset the tool so that it will follow the original thread groove. This may be done by using the compound-rest feed screw and crossfeed screw to jockey the tool to the proper position, by disengaging the change gears and turning the spindle until the tool is positioned properly, or by loosening the lathe dog (if used) and turning the work until the tool is in proper position with the thread groove. In either case the micrometer collars on the crossfeed screw and compound rest screw will usually have to be reset.

Before adjusting the tool in the groove, use the appropriate thread gage to set the tool square with the workpiece. Then with the tool a few thousandths of an inch away from the workpiece, start the machine and engage the threading mechanism. When the tool has moved to a position such as is shown in figure 18-46, stop the lathe without disengaging the thread mechanism.

The most practical and commonly used method for resetting a threading tool for machining angular form threads is the compound rest and crossfeed positioning method. By adjusting the compound rest slide forward or backward the tool is moved parallel to the axis of the work as well as toward or away from the work. When the point of the tool coincides with the original thread groove (see alternate view of tool in fig. 18-46), the crossfeed screw is used to bring the tool point directly into the groove. When a good fit between the cutting tool and thread groove is obtained, the micrometer collar on the crossfeed screw is set on zero and the micrometer collar on the compound rest feed screw is set to the depth of cut previously taken or to zero as required. (Note: Be sure that the thread mechanism is engaged and the tool is set square with the work before adjusting the position of the tool along the axis of the workpiece.)

If it is inconvenient to use the compound rest for readjusting the threading tool, the lathe dog (if used) may be loosened; turn the work so that threading tool will match the groove, and tighten the lathe dog. If possible, however, avoid the necessity of doing this.

Another method that is sometimes used, is to disengage the reverse gears or the change gears; turn the headstock spindle until the point of the threading tool enters the groove in the work, and then engage the gears.

FINISHING THE END OF A THREADED PIECE.—The end of a thread may be finished by any one of several methods. The 45° chamfer on the end of a thread, as shown in part A of figure 18-47, is commonly used for bolts, and cap screws. For machined parts and special screws,

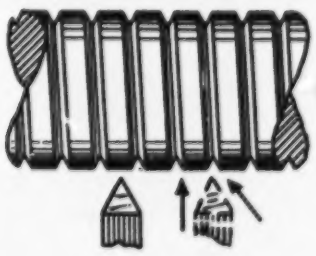

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Figure 18-46.—Tool must reset to original groove.

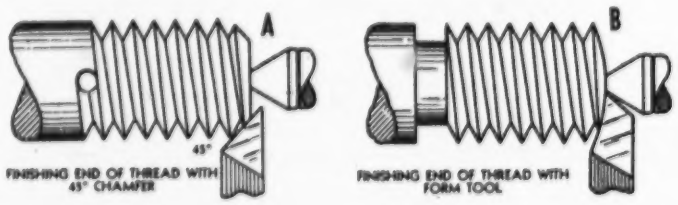

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Figure 18-47.—Finishing the end of a threaded piece.

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the end is often finished by rounding with a forming tool, as shown in part B of figure 18-47.

It is difficult to stop the threading tool abruptly, so some provision is usually made for clearance at the end of the cut. In part A of figure 18-47, a hole has been drilled at the end of the thread, and in part B, a neck or groove has been cut around the shaft. The groove is preferable, as the lathe must be run very slowly in order to obtain satisfactory results with the drilled hole.

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APPENDIX I

TRAINING FILM LIST

Certain training films that are directly related to the information presented in this training course are listed below under appropriate chapter numbers and titles. Unless otherwise specified, all films listed are black and white with sound, and are unclassified. For a description of these and other training films that may be of interest, see the United States Navy Film Catalog, NavWeps 10-1-777.

Chapter 1

ADVANCEMENT

MN-06798D Your Job in the Navy—Part 4. (31 min.—1950.)

Chapter 2

THE 3-M SYSTEM

MN-10043A The Planned Maintenance System—Introduction. (20 min.—Color—1965.)

MN-10043B Shipboard Maintenance Data Collection System—Standard Navy Maintenance and Material Management. (20 min.—Color—1965.)

Chapter 3

STEAM TURBINES

MN-2385B Turbine-Electric AC Drive (Destroyer Escort) Operation—Part 1. (23 min.—1944.)

MN-2385C Turbine-Electric AC Drive (Destroyer Escort) Operation—Part 2. (23 min.—1944.)

MN-2385D Turbine-Electric AC Drive (Destroyer Escort) Operating Notes. (15 min.—1944.)

MC-2451 Lubrication of Turbine Systems. (27 min.—1946.)

MN-6732A Naval Steam Turbines—The Steam Cycle. (17 min.—1951.)

MN-6732B Naval Steam Turbines—How Turbines Work. (17 min.—1951.)

MN-6732C Naval Steam Turbines—Turbine Casualties. (18 min.—1950.)

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ISOLATION (ī sōl′ā′shun) act of isolating, i.e., keeping an animal separate from the herd.

LETHAL (lē′thal) deadly, fatal.

LEPTOSPIROSIS (lep′tō spī rō′sis) an acute infectious disease caused by a spyrochete. Man, dogs, cattle, pigs, and horses are susceptible.

LYE (lī) a strong alkali substance composed chiefly of potassium carbonate. Used as a disinfectant.

MALNUTRITION (mal′nu trĭsh′un) an unhealthy condition resulting either from poor feed or lack of feed.

ORGANISM (ōrg′an ĭzm) any living being.

PARASITIC (par′a sĭt′ik) referring to a disease caused by a parasite; designating a carrier of such disease.

PATHOGEN (păth′og jen) an organism capable of producing disease.

PHENOL (fēn′ol) see carbolic acid.

PUTREFACTION (pūt rē făk′shun) the decomposition of organic matter.

QUARANTINE (kwär′an tēn) a condition of isolation. The isolation of an animal with a contagious disease.

RABIES (rā′bees) an acute infectious disease of the central nervous system.

RODENT (rō′dent) pertains to the order of (rodentia) gnawing mammals, such as rats, mice and squirrels.

SANITATION (săn ĭ tā′shŭn) pertaining to health, the preservation or restoration of health.

STRESS (strĕs) unusual strain due to unfavorable conditions.

SUSCEPTIBLE (sŭ sep′ti bl) such in constitution or temperament to be unresistant; liable through weakness.

SYMPTOM (sĭmp′tum) any perceptible change in the body or its functions indicating disease.

TOXICITY (tŏks ĭs′ĭ tĭ) quality, state, or degree of being toxic or poisonous.

TRANSMISSIBLE (trans mĭs′i bl) capable of being transmitted, as through inheritance, contact, etc.

TRAUMATISM (trô′ma tĭs m) the morbid condition of the system due to wounds, injury or shock.

TUBERCULOSIS (tū bŭr′kū lō sis) an infectious disease caused by certain bacteria. Commonly found in the lungs.

VACCINATE (văk′si nāt) to innoculate with any vaccine as a preventive measure.

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Chapter 12

AIR CONDITIONING

MN-06941 Shipboard Heating ,Ventilation and Mechanical Cooling—Introduction. (17 min.—1952.)

Chapter 13

STEAM OPERATED DISTILLING PLANTS

MN-03706A Distilling Plants—Low Pressure Type (Griscom-Russell)—How it Works—Part 1. (13 min.—1944.)

MN-03706B Distilling Plants—Low Pressure Type (Griscom-Russell)—How it Works—Part 2. (18 min.—1944.)

Chapter 14

DISTILLING PLANT OPERATION AND MAINTENANCE

SN-03706C Low Pressure Evaporators (Griscom-Russell)—Starting and Securing. (16 min.—107 frames—Color—1945.)

SN-03706D Low Pressure Evaporators (Griscom-Russell)—Operational Notes. (27 min.—102 frames—Color—1945.)

Chapter 15

COMPRESSED AIR PLANTS

MN-09343A High Pressure Air Compressors—Ingersol-Rand (22 min.—1953.)

MN-09343B High Pressure Air Compressors—Worthington—Operation. (13 min.—1954.)

MN-09343C High Pressure Air Compressors—Worthington—Trouble Shooting. (17 min.—1954.)

Chapter 16

ADDITIONAL AUXILIARY EQUIPMENT

MA-08541 Hydraulic System—Principles of Operation. (14 min.—1956.)

MA-09354 Introduction to Electric Winch. (7 min.—1953.)

MN-01730B Elementary Hydraulics—Part 2—Derivation of Pascal's Law. (16 min.—1943.)

MN-08076A Crane Operations—Floating Cranes. (16 min.—1955.)

MN-08076B Crane Operations—Safety Precautions. (14 min.—1955).

MN-08208 Electro-Hydrauling Steering Gear. (15 min.—1956.)

MN-08210A Shipboard Oxygen-Nitrogen Generating Plant—Introduction and Air Separator. (16 min.—1957.)

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MN-08210C Shipboard Oxygen-Nitrogen Generating Plant—Liquid Oxygen Storage Tank and Pumping Equipment. (10 min.—1957.)

MN-08774A Submarine Hydraulic Systems—Main Hydraulic Plant—600 PSI System. (11 min.—1959.)

MN-08774B Submarine Hydraulic Systems—Hydraulic Plant—3000 PSI System. (12 min.—1959.)

MN-08831 Waterbury Type Hydraulic Transmission—How It Works. (20 min.—Color—1961.)

SC-08620B Hydraulic Steering System (International Harvester). 71 Fr—1956.

Chapter 17

ENGINEERING CASUALTY CONTROL

MN-4920D2 Damage Control—Investigation of Damage. (16 min.—1961.)

MN-6931 Damage Control—Oxygen Breathing Apparatus. (20 min.—1951.)

MN-6931D Damage Control—The High Capacity Foam System. (18 min.—1957.)

MN-6931E Damage Control—Shipboard Fire Protection and Fire Prevention. (16 min.—1960.)

MN-6931F Damage Control—Shipboard Fire Fighting—Basic. (15 min.—1960.)

MN-6931G Damage Control—Fire Fighting Aboard Aircraft Carriers. (13 Min.—1960.)

MN-6949A Industrial Radiological Decontamination of Ships—Introduction. (20 min.—1951.)

MN-7368 Damage Control—Casualty Power System. (22 min.—1952.)

Chapter 18

LATHES AND LATHE MACHINING OPERATIONS

ME-00243A The Engine Lathe—Rough Turning Between Centers. (15 min.—1942.)

ME-00243B The Engine Lathe—Turning Work of Two Diameters. (11 min.—1942.)

ME-00243C The Engine Lathe—Cutting a Taper with a Compound Rest. (11 min—1942.)

ME-00243D The Engine Lathe—Drilling, Boring, and Reaming Work Held in a Chuck. (11 min.—1942.)

ME-00243E The Engine Lathe—Cutting an External National Fine Thread. (12 min.—1942.)

ME-00243F Operation on the Lathe—Turning a Taper with the Tailstock Set Over. (17 min.—1942.)

MC-00365B How to Run a Lathe—Plain Turning. (20 min.—Color—1942.)

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Transistors and Printed Circuits.
Instructor's Guide for Maintenance Technician Training.

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ABSTRACT - To assist the instructor in teaching the course, transistors and printed circuits, this teaching guide was developed by the Department of the Navy. Contents are: (1) Introduction to Transistors, (2) Semiconductor Basic Circuits, (3) Transistor Circuit Applications, (4) Printed Circuits, and (5) Description of Training Device Circuits. Also included are suggestions for the instructor, a training aid list, and a master materials list. (GB)

VT 012 787

VECTOR (vĕk′tōr) an organism, usually an insect, which transmits disease causing microorganisms.

VIRUS (vī′rŭs) any of a group of submicroscopic infective agents.

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*Essential references used in developing this bulletin.

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DEPARTMENT OF THE NAVY
BUREAU OF NAVAL PERSONNEL
WASHINGTON 25, D.C.

TRANSISTORS AND PRINTED CIRCUITS
INSTRUCTOR'S GUIDE, NAVPERS 92386A

1. This publication has been prepared to assist the instructor in teaching the course, Transistors and Printed Circuits. The Trainee's Guide, NavPers 92387A, the complementing text for this course, is designed for student use.

2. Corrections and recommended changes to this publication are invited. Commanding Officer, Service School Command, Great Lakes, Illinois, is hereby assigned clearing house responsibility for evaluating and compiling recommended improvements, and for submitting them to the Chief of Naval Personnel in the form of a proposed change to the publication. Users of this course material are requested to submit their recommendations directly to the Commanding Officer, Service School Command, Great Lakes, Illinois, with a copy to the Chief of Naval Personnel (Attn: Pers-C1).

3. This publication supersedes Transistors and Printed Circuits, Instructor's Guide, NavPers 92386 (1960).

P. S. Smith

P. S. SMITH
Captain, USN
Director, Instructional Standards
and Materials Division

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SAFETY

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The attention of officers and opera
Section V, Chapter 67 of Bureau of
superseding instructions on the sub

Equipments using transistors and printed circuits employ voltages whi
Extreme caution should be exercised when working with such equipmen
equipments, the following rules must be strictly observed.

KEEP AWAY FROM LIVE CIRCUITS:

Operating personnel must at all times observe all safety regulatio
high-voltage supply on. Under certain conditions dangerous potentials
charges retained by capacitors. To avoid casualties always remove po

DON'T SERVICE OR ADJUST ALONE:

Under no circumstances should any person reach within or enter t
ment without immediate presence or assistance of another person capa

DON'T TAMPER WITH INTERLOCKS:

Do not depend upon equipment door switches or interlocks for prot
Under no circumstances should any access gate, door, or safety interl
way, by other than authorized maintenance personnel, nor should relia
from the equipment.

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SAFETY NOTICE

WARNING

The attention of officers and operating personnel is directed to Section V, Chapter 67 of Bureau of Ships Technical Manual or superseding instructions on the subject of safety.

g transistors and printed circuits employ voltages which are dangerous and may be fatal if contacted by operating personnel. should be exercised when working with such equipments. While every practical precaution has been incorporated in Navy following rules must be strictly observed.

OM LIVE CIRCUITS:

ersonnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with ply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to by capacitors. To avoid casualties always remove power, and discharge and ground circuits prior to touching them.

OR ADJUST ALONE:

rcumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equip- mediate presence or assistance of another person capable of rendering aid.

WITH INTERLOCKS:

nd upon equipment door switches or interlocks for protection but always shut down motor generators or other equipment. stances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with in any n authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages ent.

(Continued)

RULES REGARDING CIRCUITS EMPLOYING 300 V

Voltages in excess of 300 volts shall not be measured by probing or holding the tes are necessary on equipment employing potentials in excess of 300 volts or where rubbe and procedures shall be observed:

1. The equipment shall first be de-energized.
2. High-voltage capacitors shall be discharged with a suitable insulated shorting- or g
3. The technician shall ascertain that test equipment controls are set correctly for tes
4. Test leads capable of carrying high voltage shall be secured on the desired test poi
5. The technician shall withdraw the equipment under test, making sure that he is also making correct meter readings.
6. The equipment shall be energized by an assistant standing by the switch.
7. After the necessary reading is made, the equipment shall be de-energized and high
8. The foregoing steps shall be repeated as necessary for each measurement.

GENERAL NOTES (WHICH CAN SAVE YOU

A. Make certain that you are not grounded whenever you are adjusting equipment or us
B. In general, use only one hand when servicing live equipment.
C. If test meter must be held or adjusted while voltage is applied, ground the case of t not touch the live equipment while you are holding the meter. Some moving vane ty should not be held during measurements.
D. Do not forget that high voltages may be present across terminals that are nominall breakdown. Be careful even when measuring low voltages.
E. Do not use test equipment known to be in poor condition.
F. High-voltage, high-capacity capacitors should be discharged with an insulated short in series with the grounded line. Where neither terminal of a capacitor is groundec
G. Take time to be safe.

RESUSCITATION

An approved poster illustrating the rules for re by the Holger-Nielsen method shall be displayec in each radio, radar or sonar enclosure. Poste obtained by request to the Bureau of Medicine a

RULES REGARDING CIRCUITS EMPLOYING 300 VOLTS OR MORE:

volts shall not be measured by probing or holding the test probe in the hands. Whenever measurements
mploying potentials in excess of 300 volts or where rubber gloves cannot be worn, the following precautions
ved:

e de-energized.
all be discharged with a suitable insulated shorting- or grounding-bar.
tain that test equipment controls are set correctly for testing high voltage.
ying high voltage shall be secured on the desired test point by the technician.
raw the equipment under test, making sure that he is also free from leads and in a good position for
lings.
rgized by an assistant standing by the switch.
g is made, the equipment shall be de-energized and high voltage capacitors shall be discharged.
e repeated as necessary for each measurement.

GENERAL NOTES (WHICH CAN SAVE YOUR LIFE):

not grounded whenever you are adjusting equipment or using measuring equipment.
nd when servicing live equipment.
or adjusted while voltage is applied, ground the case of the meter before starting measurement, and do
t while you are holding the meter. Some moving vane type meters should not be grounded; thus they
measurements.
ages may be present across terminals that are nominally low voltage due to equipment malfunction or
en when measuring low voltages.
known to be in poor condition.
y capacitors should be discharged with an insulated shorting- or grounding-bar with approximately 10 ohms
d line. Where neither terminal of a capacitor is grounded, short the capacitor terminals together.

RESUSCITATION

An approved poster illustrating the rules for resuscitation by the Holger-Nielsen method shall be displayed prominently in each radio, radar or sonar enclosure. Posters may be obtained by request to the Bureau of Medicine and Surgery.

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HOW TO USE THIS INSTR

TECHNICAL TRAINING

This Instructor's Guide has been prepared to place emphasis on the practical training of the technician in the operation, adjustment, and maintenance of equipment which contains either transistors or printed circuits. All Navy Technicians are craftsmen - not engineers or designers - and they will learn their skill by doing.

PRACTICAL WORK

All theory discussions must be tied to practical work. The design theory of transistors and printed circuits may be interesting to you, but the trainee must primarily learn how to service transistors and printed circuits. The trainee must concentrate on learning to perform the necessary adjustment and maintenance techniques required by transistors and printed circuits. Any activity that does not contribute directly to training in the servicing of transistors and printed circuits is wasted effort, regardless of how interesting it may seem to be. The reason for having theory is to assist the trainee in doing practical work.

TRAINING GOALS

The trainee must understand the training goals for each topic. These goals and the skills to be acquired are stated in his Trainee's Guide. The mere statement is not sufficient. You must be certain that he understands the goals, so that he will know when he has attained them. The topic will have been completed when each trainee has attained every goal.

STUDY ASSIGNMENTS

Study assignments are provided in your Instructor's Guide and in the Trainee's Guide. Study assignments covering the

VT 010 397
Introduction to Plant Diseases.

Arizona Univ., Tucson. Dept. of Agricultural Education.
Arizona State Dept. of Vocational Education, Phoenix.
MF AVAILABLE IN VT-ERIC SET.
Service Bulletin Number Three
PUB DATE - Aug69 54p.

DESCRIPTORS - *SUPPLEMENTARY TEXTBOOKS; *VOCATIONAL AGRICULTURE; *PLANT SCIENCE; *PLANT PATHOLOGY; *RESOURCE MATERIALS

ABSTRACT - One of a series of service bulletins prepared to aid vocational agriculture teachers in presenting introductory material on specific areas of agricultural science, this booklet provides basic instruction on plant diseases. The unit is recommended for use in the second year of vocational agriculture, with major emphasis upon helping students to develop an understanding of basic principles and terminology related to plant pathology. Contents include: (1) Importance of Plant Diseases, (2) The Nature and Classification of Plant Diseases, (3) Growth and Reproduction of Plant Pathogens, (4) Dissemination of Plant Pathogens, (5) Infection by Plant Pathogens, and (6) Principles of Plant Pathology in Exercises and Experiments. A section giving descriptions and information on specific plant diseases, including various photographs and charts, is also provided, as well as a glossary, selected references for teachers and students, teaching aids and materials, films and slides, and suggested resource people. Other bulletins in the series are available as VT 001 012 and VT 001 013 (AIM Winter 1968) and VT 010 369, also in this issue. An instructor's guide for teaching this unit may be obtained from the Department of Agricultural Education, University of Arizona, Tucson. (AW)

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HOW TO USE THIS INSTRUCTOR'S GUIDE

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S

e provided in your Instructor's Guide
. Study assignments covering the

material to be discussed the following day should normally be made at the end of the preceding school day.

DISCUSSION TOPICS AND TRAINING AIDS

After the trainee has studied the assigned material he is ready to engage in a discussion of the stated topics. It is your responsibility to guide the discussion so as to accomplish the learning goals. The use of training aids and demonstration of the equipment will facilitate learning. Where a skill is to be acquired, actual work on the equipment is necessary. You will demonstrate the correct techniques and the trainee will learn by doing. The transistor circuit training device will be the most important training aid used.

PRECAUTIONS FOR USE OF TRAINEE'S GUIDE

The Trainee's Guide is provided for the trainee's use while learning the theory, operation, and application of transistors and printed circuits, and is intended for his retention at the end of this course. A quantity of blank pages have been provided in the Trainee's Guide, and note-taking is to be encouraged by the instructor.

DIVISION OF COURSE MATERIAL INTO FUNCTIONAL SYSTEMS

The course material in the Instructor's Guide has been sectionalized according to the functional applications of the components to be studied. This arrangement is better adapted to teaching for understanding of the transistors and printed circuits to be used. Since the Trainee's Guide has been organized with the same progression and sequence of units, the study assignments will follow in an orderly manner.

183 OF 327

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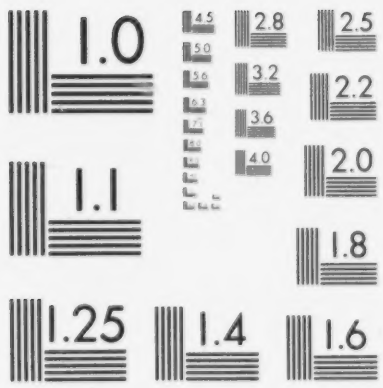

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PREPARATION OF THE INSTRUCTOR'S GUIDE

This material, a standardized curriculum, was prepared for the Bureau of Naval Personnel. The Instructor's Guide and the Trainee's Guide have been prepared along parallel lines and are to be used together to achieve maximum desired results in this training program.

CLEARING HOUSE OPERATION

A "clearing house" operation has been established for the purpose of improving these publications. It is each

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ion has been established for
publications. It is each instructor's responsibility to become familiar with this operation. You are to submit all of your suggestions for improvement through "clearing house." These suggestions should include discrepancies found, or any comments that you feel will improve training in this course.

SAFETY PRECAUTIONS

Voltages present in the equipments using transistors and printed circuits are dangerous. Safety must be stressed daily to develop safe working habits in the trainee. Practice and teach SAFETY.

INSTRUCTOR'S GUIDE
FOR
TRANSISTORS AND PRINTED CIRCU

NAME _____

SCHOOL _____

CLASSES
TAUGHT _____

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INSTRUCTOR'S NAME PAGE

INSTRUCTOR'S GUIDE
FOR
TRANSISTORS AND PRINTED CIRCUITS TRAINING

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RECORD OF CHANGES AND CORRECTIONS

Number or Description of Change	Made b

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RECORD OF CHANGES AND CORRECTIONS

ption of Change	Made by	Date

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The following training aids are available fo
NavPers 92386A, Instructor's Guide for Tr
Printed Circuits:

NavPers 309671.2T Series Transparencies

NavPers 309671.2C Series Wall Charts
Films MN 8479A throu

TRAINING AIDS ANNOUNCEMENT

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The following training aids are available for use with NavPers 92386A, Instructor's Guide for Transistors and Printed Circuits:

NavPers 309671.2T Series Transparencies

NavPers 309671.2C Series Wall Charts
Films MN 8479A through MN8479G

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An Introduction to

Plant Diseases

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OFFICE OF EDUCATION
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Department of Agricultural Education
The University of Arizona Tucson

Service Bulletin

Number Three

1267

SECTION 1: INTRODUCTION TO TRAN

Topic No.	Topic Title
1	Development of the Transistor
2	Transistor Description
3	Transistor Theory
4	Operation of the Semiconductor Diode
5	Operation of the Transistor
6	Typical Operating Characteristics of Junction Transistor
7	Precautions for Transistors

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TSAOS

SECTION 1: INTRODUCTION TO TRANSISTORS

Topic Title	Instructor's Guide Pages	Trainee's Guide Pages
of the Transistor	1-5	1-3
escription	6-7	4-7
heory	8-11	8-19
he Semiconductor Diode	12-13	20-23
he Transistor	14-17	24-33
ting Characteristics of Junction Transistors	18-21	34-45
or Transistors	22-24	46-50

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15300

TOPIC 1: DEVELOPMENT OF THE

Training Goals:

A. Each trainee will learn:

1. Early history of the audion tube and the transistor.
2. Advantages and disadvantages of early transistors.
3. Printed circuits as a natural partner of transistors.
4. A few applications of transistors and printed circuits.

Trainee P

A. Trainee'

1. Stud

Instructor

A. Review a

TOPIC 1: DEVELOPMENT OF THE TRANSISTOR

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the audion tube and the

disadvantages of early

as a natural partner of

ns of transistors and

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 1, Topic 1.

Instructor Preparation:

A. Review assigned trainee materials.

DISCUSSION - DEMONSTRATION - ACTIVI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Development of the transistor.	
a. Dr. Lee De Forest's discovery of the audion tube.	
b. Dr. William Shockley and associates' discovery of the transistor.	
2. The early transistor.	
a. Advantages of the early transistor: (1) Amplification. (2) Oscillation. (3) Simplicity. (4) Small size and weight. (5) Low current consumption.	
b. Disadvantages of the early transistor: (1) Low voltage gain. (2) Oscillation at low frequencies only. (3) Noisy. (4) Low power.	
3. Development of printed circuits as a natural partner of transistors.	

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DISCUSSION-DEMONSTRATION-ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
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DISCUSSION-DEMONSTRATION-A

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
4. Use of transistor-printed circuits in:	
a. Invisible hearing aid.	
b. Miniature portable radios.	
c. Long distance telephone dialing.	
d. Vanguard and later satellites.	
e. Medicine. (Electrical shocks for heart stimulation.)	
5. Review and summary.	

DISCUSSION-DEMONSTRATION-ACTIVITIES

Procedures:

OINT	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
nsistor-printed circuits		
ible hearing aid.		
ture portable radios.		
distance telephone dialing.		
uard and later satellites.		
cine. (Electrical shocks for heart stimulation.)		
nd summary.		

12708

TOPIC 2: TRANSISTOR DESCRIPTIO

Training Goals:

A. Each trainee will learn:

1. Definition of a semiconductor.
2. Definition and derivation of the term "transistor."
3. Physical description of a transistor.
4. Where transistors are used.
5. The advantages of transistors.

Trainee Preparati

A. Trainee's Guide:

1. Study Section 1,

Instructor Prepar

A. Review assigned trai

B. Training aids require

1. Transparencies:

a. 1-2-1, Milit

TIME_____Hrs.

TOPIC 2: TRANSISTOR DESCRIPTION

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Trainee Preparation:

A. Trainee's Guide:

1. Study Section 1, Topic 2.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training aids required:

1. Transparencies:

a. 1-2-1, Military Uses of Transistors.

INTRODUCTION

TO

PLANT DISEASES

Service Bulletin
Number Three

Prepared by
Department of
Agricultural Education
University of Arizona
Tucson

Published by
State Department of
Vocational Education
Phoenix, Arizona

1268

DISCUSSION - DEMONSTRATION - ACTIV

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. How to recognize a semiconductor.	
2. Definition and derivation of the term "transistor."	
3. Physical description of transistors.	
4. Where transistors are used.	4. Project transparency.
a. Commercial.	
b. Military.	b. 1-2-1.
5. Comparison of a transistor with a vacuum tube.	
6. Review and summary.	

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DISCUSSION-DEMONSTRATION-ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
tor.	
4. Project transparency.	
b. 1-2-1.	
h	

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TOPIC 3: TRANSISTO

Training Goals:

A. Each trainee will learn:

1. Structure of matter.
2. Structure of the atom.
3. Covalence bonding.
4. Crystal structure.
5. N- and P-type semiconductors.
6. Donor and Acceptor atoms.

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TOPIC 3: TRANSISTOR THEORY

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Trainee Preparation:

A. Trainee's Guide:

1. Study Section 1, Topic 3.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training aids required:

1. Transparencies:

a. 1-3-1, Atom Structure.

b. 1-3-2, The Periodic Chart (Partial).

c. 1-3-3, Germanium Atom.

d. 1-3-4, Germanium and Silicon Atoms Showing Subshells.

e. 1-3-5, Crystal Lattice of Germanium Atom.

f. 1-3-6, "N" and "P" Type Germanium.

DISCUSSION-DEMONSTRATION-ACTI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Review of the structure of matter.	
2. Structure of the atom.	2. Project transparencies:
a. Components.	a. 1-3-1.
b. Atomic weight.	
c. Atomic number.	
d. Nature of electricity.	
e. Periodic Chart.	e. 1-3-2.
3. Definition of covalence bonding.	
4. Crystal structure.	4. Project transparencies:
a. Germanium structure.	a. 1-3-3.
b. Silicon structure.	b. 1-3-4.
c. Orbital electrons.	c. 1-3-5.
5. Non-intrinsic Crystals.	5. Project transparency 1-3-6.
a. N-type.	
b. P-type.	

(Continued)

SCUSSION - DEMONSTRATION - ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
2. Project transparencies:	
a. 1-3-1.	
e. 1-3-2.	
4. Project transparencies:	
a. 1-3-3.	
b. 1-3-4.	
c. 1-3-5.	
5. Project transparency 1-3-6.	

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DISCUSSION - DEMONSTRATION -

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
6. Donor and Acceptor Atoms.	
a. The effects of adding impurities.	
b. Description of "holes."	
7. Review and Summary.	

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DISCUSSION - DEMONSTRATION - ACTIVITIES

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RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
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TOPIC 4: OPERATION OF THE SEMIC

Training Goals:

A. Each trainee will learn:

1. The P-N junction.
2. Forward Bias.
3. Reverse Bias.
4. The Zener diode.

B. Each trainee will acquire skill in:

1. Soldering connections for semiconductor diodes and circuit components.
2. Obtaining and observing forward and reverse current readings.

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A. Review n

B. Training

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TIME_____Hrs.

4: OPERATION OF THE SEMICONDUCTOR DIODE

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 1, Topic 4.

Instructor Preparation:

A. Review materials to be presented.

B. Training aids required:

1. Film:

   a. MN-8479A, Transistors - P-N Junction

2. Materials:

   a. Germanium or Silicon diodes.

   b. Appropriate voltage supply.

   c. Test equipment.

   d. Soldering iron (50 watts or less).

   e. Solder.

   f. Resistors.

   g. Heat shunt.

3. Transparencies:

   a. 1-4-1, Forward and Reverse Bias.

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STATE DEPARTMENT OF VOCATIONAL EDUCATION
412 Arizona State Building
Phoenix, Arizona 85007

Mrs. Sarah Folsom, Executive Officer, State Board for Vocational Education and Superintendent of Public Instruction

J. R. Cullison, Director, Vocational-Technical Education

Carlos H. Moore, State Supervisor, Agricultural Education

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DISCUSSION - DEMONSTRATION

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVIT
1. Operation of the P-N junction.	1. Show Film MN 8479A.
a. Effects of bonding together N- and P-type material.	
b. Potential barrier.	
c. Formation of Germanium diode.	
2. Obtaining forward bias.	2. Demonstrate forward current using a Germanium or Silico diode. Use transparency 1-4-1.
a. Effects of connecting battery.	
3. Description of reverse bias.	3. Demonstrate reverse current using a Germanium or Silicon diode. Use transparency 1-4-1.
a. Current flow.	
b. Use as a rectifier.	
c. Description of Zener voltage.	
4. Description of Zener diode.	
a. Use as a voltage regulator.	
5. Review and summary.	

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DISCUSSION-DEMONSTRATION-ACTIVITIES

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	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
ion.	1. Show Film MN 8479A.	
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um diode.		
attery.	2. Demonstrate forward current, using a Germanium or Silicon diode. Use transparency 1-4-1.	2. Connect Germanium or Silicon diode to obtain and observe forward current readings.
s.	3. Demonstrate reverse current using a Germanium or Silicon diode. Use transparency 1-4-1.	3. Connect Germanium or Silicon diode to obtain and observe reverse current readings.
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TOPIC 5: OPERATION OF T

Training Goals:

A. Each trainee will learn:

1. The transistor compared with a vacuum tube triode.
2. Junction transistors.
3. Manufacturing methods for junction transistors.
4. Point-contact transistors.
5. Tetrode transistors.
6. Surface barrier transistors.
7. Operation of junction transistors as amplifiers.

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TOPIC 5: OPERATION OF THE TRANSISTOR

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 1, Topic 5.

Instructor Preparation:

A. Review materials to be presented.

B. Training aids required:

1. Film:

   a. MN 8479B, Transistors - Triode Fundamentals

2. Transparencies:

   a. 1-5-1, Vacuum Tube Triode and Transistor.

   b. 1-5-2, NPN Junction Transistor with Input Signal.

DISCUSSION-DEMONSTRATION-

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Comparison of transistor and vacuum tube.	1. Project transparency 1-5-1.
a. Functions of emitter and cathode.	
b. Functions of base and grid.	
c. Functions of collector and plate.	
2. Types of junction transistors.	2. Show Film MN 8479B.
a. PNP junction transistor.	
b. NPN junction transistor.	
3. How junction transistors are manufactured.	
a. The alloy-junction transistor.	
b. The grown-junction transistor.	
4. Description of point-contact transistor.	
5. Tetrode transistors used for additional frequency response.	

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DISCUSSION-DEMONSTRATION-ACTIVITIES

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RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Project transparency 1-5-1.	
2. Show Film MN 8479B.	

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(Continued)

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DISCUSSION-DEMONSTRATION-

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
6. Surface barrier transistors.	
a. Use for high frequency response.	
b. Manufacturing methods.	
7. The junction transistor as an amplifier.	7. Project transparency 1-5-2.
a. Emitter-base circuit bias.	
b. Base-collector circuit bias.	
c. Transistor and VT triode compared as amplifiers.	
8. Review and summary.	

DISCUSSION-DEMONSTRATION-ACTIVITIES

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	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
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triode fiers.		

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TOPIC 6: TYPICAL OPERA
JUNCTION T

Training Goals:

A. Each trainee will learn:

1. Forward and reverse bias.
2. Methods of biasing.
3. Use of the terms "Common" and "Ground."
4. Comparable transistor and vacuum tube amplifiers.
5. The grounded-emitter amplifier.
6. The grounded-collector amplifier.
7. The grounded-base amplifier.
8. Parameters.
9. Special terms.

TOPIC 6: TYPICAL OPERATING CHARACTERISTICS OF JUNCTION TRANSISTORS

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ube amplifiers.

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nded-collector amplifier.

nded-base amplifier.

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Trainee Preparation:

A. Trainee's Guide:

1. Study Section 1, Topic 6.

Instructor Preparation:

A. Review materials to be presented.

B. Training aids required:

1. Film:

   a. MN 8479C, Minority Carriers.

2. Transparencies:

   a. 1-6-1, Grounded Cathode and Grounded Emitter.

   b. 1-6-2, The Grounded-Collector Amplifier and the Cathode Follower.

   c. 1-6-3, Grounded-Base and Grounded-Grid Amplifiers.

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IMPORTANCE OF PLANT DISEASES 1
Importance of Plants
1. Economic importance of plant diseases 1
2. Developments in the study of plant diseases 2

THE NATURE AND CLASSIFICATION OF PLANT DISEASES 2
Classification of Plant Diseases Based on Symptoms
1. Superficial diseases 2
2. Necrosis 2
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4. Hypertrophy or abnormal overgrowth 3
5. Wilts 3

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2. Animate or parasitic 4

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2. Environmental factors affecting growth 7
3. Reproduction of bacteria and fungi 7

DISSEMINATION OF PLANT PATHOGENS 7
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Methods of Plant Disease Control
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3. Protection 10
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DISCUSSION - DEMONSTRATION

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVIT
1. Forward and reverse bias.	
a. Effects on resistance.	
b. Effects on current.	
c. Effects on voltage.	
2. Methods of biasing.	
a. Common base, fixed bias.	
b. Common emitter, fixed bias.	
c. Self bias.	
d. Combination bias.	
3. Use of the terms "Common" and "Ground."	
4. Comparable transistor and vacuum tube amplifiers.	
5. The grounded-emitter amplifier.	5. Project transparency 1-6-1.
a. Reasons for popularity.	

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DISCUSSION - DEMONSTRATION - ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY

5. Project transparency 1-6-1.

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DISCUSSION-DEMONSTRATION-ACTIVIT

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
6. The grounded-collector amplifier.	6. Project transparency 1-6-2.
a. Compared with the cathode follower.	
7. Gain characteristics of the grounded-base amplifier.	7. Project transparency 1-6-3.
8. Definition of a parameter.	
a. Transistor parameters.	
b. Use of manufacturer's characteristic sheets.	
c. Similiarity between vacuum tube and transistor characteristic sheets.	
9. Definition of special terms contained in this course.	9. Show Film MN 8479C.
a. Obtaining ratio of current gain.	
b. Obtaining gain factor.	
c. Obtaining Beta amplification factor.	
10. Review and summary.	

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TOPIC 7: PRECAUTIONS FOR TR

Training Goals:

A. Each trainee will learn:

1. Effect of increased temperature on operation.
2. Importance of proper polarity.
3. Avoidance of sudden voltage surges.
4. Damaging effect of stray currents.
5. Transistor connections.

B. Each trainee will acquire skill in:

1. Proper method of making circuit connections to avoid damaging transistors.

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TOPIC 7: PRECAUTIONS FOR TRANSISTORS

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ransistors.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 1, Topic 7.

Instructor Preparation:

A. Review assigned trainee material.

B. Training materials required:

1. Demonstration materials.

a. Soldering iron (50 watts or less).

b. Solder.

c. Transistor.

d. Resistor.

e. Heat shunt.

DISCUSSION - DEMONSTRATION

Suggested Procedures:

DISCUSSION POINT

1. Effect of heat on a transistor.
   a. Intrinsic conductivity.
   b. Effects of using a heat sink in mounting transistors.
   c. Heat effect on DC resistance.
   d. Use of a heat shunt when soldering transistors.
2. Importance of checking polarity.
   a. Methods of checking polarity of transistors.
3. Methods of avoiding sudden voltage surges.
4. Why stray currents must be avoided.
   a. Effect of punch-through voltage on a transistor.
   b. Methods of reducing damage from stray current.

RELATED INSTRUCTOR ACTIVITY

1. Demonstration of soldering a resistor to the base of a transi without applying excessive heat the transistor.

   Caution: A heat shunt must be between the transistor and the being soldered to conduct heat from the transistor.

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DISCUSSION-DEMONSTRATION-ACTIVITIES

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RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Demonstration of soldering a resistor to the base of a transistor without applying excessive heat to the transistor. Caution: A heat shunt must be held between the transistor and the joint being soldered to conduct heat away from the transistor.	1. Solder a resistor to a transistor base.

(Continued)

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DISCUSSION-DEMONSTRATION-ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
5. **Manufacturer's methods of marking transistor leads.**	
6. **Review and summary.**	

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SCUSSION - DEMONSTRATION - ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY

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2. Diversity and ubiquity of microorganisms 15
3. Relation of wounds to decay of citrus fruit 16
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5. Relation of age of seedlings to susceptibility to pythium damping-off 18
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2	Transistor Amplifier Circuits	2
3	Power Amplifier Circuits	3
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Topic Title	Instructor's Guide Pages	Trainee's Guide Pages
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Transistor Amplifier Circuits	28-31	58-67
Power Amplifier Circuits	32-33	68-73
Miscellaneous Transistor Circuits	34-38	74-90

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TOPIC 1: SEMICONDUCTOR DIODE CIR

Training Goals:

A. Each trainee will learn:

1. General classification of diodes.

   a. Junction diode.

   b. Point-contact diode.

   c. Selenium diode.

2. Use of Zener diode as a voltage regulator.

3. Use of diodes in a temperature sensing device.

Trainee Preparati

A. Trainee's Guide:

1. Study Section 2,

Instructor Prepar

A. Review assigned trai

B. Training aids require

a. 2-1-1, Zener Dio

TIME_____Hrs.

TOPIC 1: SEMICONDUCTOR DIODE CIRCUITS

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ication of diodes.

ode.

act diode.

iode.

as a voltage regulator.

emperature sensing device.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 2, Topic 1.

Instructor Preparation:

A. Review assigned trainee material.

B. Training aids required:

a. 2-1-1, Zener Diode Characteristic Curve.

DISCUSSION-DEMONSTRATION-ACTIV

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Introduction to the general classes of diodes.	
a. The junction diode.	
b. The point-contact diode.	
c. The Selenium diode.	
d. The Zener diode.	
2. How the Zener diode is used as a voltage regulator.	2. Project transparency 2-1-1.
a. Use as a contact protection.	
b. Germanium junction diode used for intentional time delay.	
c. Advantages of the Silicon diode as a voltage regulator.	
d. Uses of double anode Zener diodes in AC regulation.	
3. Circuit configuration of a temperature sensing device using two diodes.	
4. Review and summary.	

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DISCUSSION-DEMONSTRATION-ACTIVITIES

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	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
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Silicon diode ator.		
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f a temperature wo diodes.		

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TOPIC 2: TRANSISTOR AMPLIFIER CIR

Training Goals:

A. Each trainee will learn:

1. The operating characteristics of the three basic transistor amplifier circuits.
2. The basic components of the three types of transistor amplifiers.
3. The coupling considerations essential in the construction of cascaded-stage transistor amplifiers.

B. Each trainee will acquire skill in:

1. Testing transistor circuits.

Trainee Preparatio

A. Trainee's Guide:

1. Study Section 2, T

Instructor Preparc

A. Review assigned train

B. Training aids require

1. Films:

a. MN 8479D, L
b. MN 8479E, H

2. Transparencies:

a. 2-2-1, Comp of Co Comm
b. 2-2-2, Comm
c. 2-2-3, Comm
d. 2-2-4, Comm
e. 2-2-5, Comm
f. 2-2-6, Vario Stage
g. 2-2-7, Casca
h. 2-2-8, Imped
i. 2-2-9, Direc

TIME_____Hrs.

TOPIC 2: TRANSISTOR AMPLIFIER CIRCUITS

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amplifier circuits.

of the three types
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ations essential
cascaded-stage

skill in:

cuits.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 2, Topic 2.

Instructor Preparation:

A. Review assigned trainee material.

B. Training aids required:

1. Films:

   a. MN 8479D, Low Frequency Amplifiers.
   b. MN 8479E, High Frequency Amplifiers.

2. Transparencies:

   a. 2-2-1, Comparison of Operating Characteristics of Common-base, Common-emitter, and Common-collector Amplifier Circuits.
   b. 2-2-2, Common-base Amplifier with Two Batteries.
   c. 2-2-3, Common-base Amplifier with One Battery.
   d. 2-2-4, Common-emitter Amplifier.
   e. 2-2-5, Common-collector Amplifier.
   f. 2-2-6, Various Methods of Coupling Transistor Stages.
   g. 2-2-7, Cascaded Amplifier Stages.
   h. 2-2-8, Impedance-coupled Amplifier.
   i. 2-2-9, Direct-coupled Amplifier.

DISCUSSION - DEMONSTRATION - ACTIV

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Introduction to transistor amplifiers and the three basic types:	1.
a. Common-base.	a. Project transparency 2-2-1.
b. Common-emitter.	b. Show Film MN 8479D.
c. Common-collector.	c. Show Film MN 8479E.
2. Common-base amplifiers.	2. Project Transparency 2-2-2, and 2-2-3.
a. Function of components.	
b. Theory of operation.	
c. Representative circuit.	
3. Common-emitter amplifiers.	3. Project transparency 2-2-4.
a. Function of components.	
b. Theory of operation.	
c. Representative circuit.	
4. Common-collector amplifiers.	4. Project transparency 2-2-5.
a. Function of components.	
b. Theory of operation.	

(Continued)

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DISCUSSION-DEMONSTRATION-ACTIVITIES

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
ifiers	1.	
	a. Project transparency 2-2-1.	
	b. Show Film MN 8479D.	
	c. Show Film MN 8479E.	
	2. Project Transparency 2-2-2, and 2-2-3.	
	3. Project transparency 2-2-4.	
	4. Project transparency 2-2-5.	

(Continued)

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PREFACE

This publication is the third in a series of service bulletins prepared by the Department of Agricultural Education to attempt to meet the requests of Arizona vocational agriculture instructors for materials to teach introductory content on specific areas of agricultural science. The enthusiastic response to the first two publications, Harmful Parasites of Domestic Animals and An Introduction to Animal Diseases encouraged the preparation of this booklet on plant diseases.

The primary purpose of this publication is to provide basic general information on plant pathology and to guide students through experiences in the laboratory that will lead toward a better understanding of the various types of plant diseases and how those diseases affect plants. Information about specific plant diseases is included only to serve as examples of the various types of diseases that affect crops in Arizona. Additional references will be needed to supplement this publication when teaching units on the cause, symptoms, prevention and treatment of specific diseases.

It is suggested that this unit be taught in the second year of vocational agriculture and emphasis be given to developing an understanding of basic principles and terminology. The identification and control of specific plant diseases of commercial crops may be taught as a follow-up to this unit or integrated with the content on various crop production units. An instructor's guide for teaching this unit is available from the Department of Agricultural Education.

This publication is the product of the cooperative effort of many people, including Wayne Mortenson and Phil Neilson, graduate students in Agricultural Education, Phillip R. Zurbrick, Graduate Research Assistant in Agricultural Education and Dr. John R. Williams, Associate Professor of Agricultural Education. Dr. Alice M. Boyle and Dr. Arlen D. Davison of the Department of Plant Pathology evaluated and checked all content for accuracy and helped in preparing the laboratory exercises. Most of the descriptive sheets on specific diseases were prepared by Dr. Davison and Dr. Shields and made available through the Arizona Agricultural Extension Service. A preliminary edition of this publication was used on a trial basis in several departments of agriculture during the school year 1964-65 and was then further evaluated by members of the State Committee on Course Construction, composed of Carlos H. Moore, State Supervisor of Agricultural Education, Frank Adams, Page Bakarich, R. Clair Decker, Gordon G. Hall, Cy Henry, Richard Meder and Ronald Wolhart, all teachers of agriculture.

Department of
AGRICULTURAL EDUCATION
UNIVERSITY OF ARIZONA
TUCSON
August 1965

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DISCUSSION-DEMONSTRATION-ACTIVIT

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
c. Representative circuit.	
5. Cascaded-stage amplifiers.	5. Project transparencies:
a. Introduction.	
b. Methods of coupling.	b. 2-2-6.
(1) Resistance capacitance coupling.	(1)-(2) 2-2-7.
(2) Transformer coupling.	
(3) Impedance coupling.	(3) 2-2-8.
(4) Direct coupling.	(4) 2-2-9.
6. Review and summary.	

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DISCUSSION-DEMONSTRATION-ACTIVITIES

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	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
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rs.	5. Project transparencies:	
citance	b. 2-2-6. (1)-(2) 2-2-7.	
upling. ing.	(3) 2-2-8. (4) 2-2-9.	

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TOPIC 3: POWER AMPLIFIER

Training Goals:

A. Each trainee will learn:

1. The purpose and nature of transistorized power amplifiers.
2. The comparison and contrast between Class A and Class B power amplifiers.
3. Some of the methods used with transistors in attaining push-pull operation in amplifier circuits.
4. The purpose and construction of phase-inverter circuits.

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A. Trainee's

1. Study

Instructor

A. Review as

B. Training a

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TIME_____Hrs.

TOPIC 3: POWER AMPLIFIER CIRCUITS

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pull operation in amplifier

nd construction of phase-
ts.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 2, Topic 3.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training aids required:

1. Transparencies:

a. 2-3-1, Class A and Class B Power Amplifiers.

b. 2-3-2, Single-ended Class A Power Amplifier.

c. 2-3-3, Class B Transistor Power Amplifier.

d. 2-3-4, Class B Complementary Push-pull Power Amplifier.

e. 2-3-5, Phase Inverter Circuit.

DISCUSSION-DEMONSTRATION

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVIT
1. Transistorized power amplifiers.	
a. Where and how they are used.	
b. Classification.	
2. Class A, B, and C power amplifiers.	2. Project transparencies:
a. Basic components.	a. 2-3-1.
b. Operating characteristics.	b. 2-3-2.
c. Representative diagrams.	c. 2-3-3.
3. The nature of push-pull amplifier circuits and the methods used to obtain this operation with transistors.	3. Project transparency 2-3-4.
a. Conventional systems.	
b. Complementary symmetry.	
4. Phase-inverter circuits.	4. Project transparency 2-3-5.
a. Purpose.	
b. Diagram of a simple phase-inverter circuit.	
5. Review and summary.	

POWER AMPLIFIER CIRCUITS

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DISCUSSION-DEMONSTRATION-ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
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sed.	
ifiers.	2. Project transparencies: a. 2-3-1. b. 2-3-2. c. 2-3-3.
fier to sistors.	3. Project transparency 2-3-4.
y.	4. Project transparency 2-3-5.
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TOPIC 4: MISCELLANEOUS TRANSISTOR CIRC

Training Goals:

A. Each trainee will learn:

1. The nature and purpose of transistorized oscillator circuits.

2. The nature, construction, and operating characteristics of resonant circuits.

3. The nature and purpose of positive feedback circuits.

4. The construction, purpose of various components, and operation of some transistorized external feedback oscillators and their comparison with vacuum tube equivalents:

   a. The Armstrong Oscillator.

   b. The Hartley Oscillator.

   c. The Colpitts Oscillator.

5. The principle of negative resistance as it applies to the construction and operation of internal feedback oscillators.

6. The use of complementary symmetry transistor multivibrators.

7. The construction and operating characteristics of multivibrator circuits as compared with the vacuum tube equivalent.

Trainee Preparation:

A. Trainee's Guide:

   1. Study Section 2, Topic 4

B. Reference Publications:

   1. Review Section IV of Na

   2. Review Pages 138 to 143

Instructor Preparation:

A. Review assigned trainee mat

B. Training materials required:

   1. References:

      a. NavPers 91885

      b. NavPers 92213

C. Training aids required:

   1. Transparencies:

      a. 2-4-1, RC Network

      b. 2-4-2, The Armstro Transistor C

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TIME_____Hrs.

4: MISCELLANEOUS TRANSISTOR CIRCUITS

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circuits.

positive feedback

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e equivalents:

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Trainee Preparation:

A. Trainee's Guide:

1. Study Section 2, Topic 4.

B. Reference Publications:

1. Review Section IV of NavPers 91885.

2. Review Pages 138 to 143 of NavPers 92213.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. References:

a. NavPers 91885

b. NavPers 92213

C. Training aids required:

1. Transparencies:

a. 2-4-1, RC Network or Phase-shift Oscillator.

b. 2-4-2, The Armstrong Oscillator and a Comparable Transistor Oscillator.

Training Goals:

8. The uses of a blocking oscillator.
9. The nature and uses of photosensitive transistors.
10. The use of drift transistors at high frequencies.

Instructor

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oscillator.

photosensitive transistors.

stors at high frequencies.

Instructor Preparation:

c. 2-4-3, The Hartley Oscillator and a Comparable Transistor Oscillator.

d. 2-4-4, The Colpitts Oscillator and a Comparable Transistor Oscillator.

e. 2-4-5, Internal Feedback Circuits.

f. 2-4-6, How a Multivibrator Operates.

g. 2-4-7, Analysis of the Operation of a Free-running Multivibrator-First Time Interval.

h. 2-4-8, Analysis of the Operation of a Free-running Multivibrator-Second Time Interval.

i. 2-4-9, Transistor Free-running Blocking Oscillator.

j. 2-4-10, Photosensitive Transistor Using NPN-type Construction.

k. 2-4-11, Block Diagram of a Drift Transistor.

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IMPORTANCE OF PLANT DISEASES

Importance of Plants

Man is completely dependent upon the plant kingdom. His food, clothing, shelter and much of his fuel comes from plants. Plants alone are capable of synthesizing elementary substances into organic compounds necessary for animal metabolism and growth. Bacteria, fungi, mosses, ferns, and seed plants are included in the plant kingdom, the most important being the seed plants. Of the more than 200,000 species of plants, about 3,000 are used for food, only 300 are widely cultivated and of these some dozen plants supply 95 per cent of the world's annual food crop.

1. Economic Importance of Plant Diseases. Diseases may make plant products unfit for human or animal food. During the Middle Ages thousands of people died from eating rye bread made from grain infested with ergot, *Claviceps purpurea*. Scabby barley caused by *Gibberella zeae* makes pigs violently sick. Stinking smut of wheat caused by *Tilletia triticic* may require special washing of the grain before milling. Transportation and storage diseases cause losses in succulent fruits and vegetables. Even less perishable food such as rice, millet, and beans may be damaged by storage diseases. Wood products such as pulpwood, posts, poles, and timber are subject to fungus stains and structural weakness.

It is impossible to give accurate data on financial losses from plant diseases. The magnitude of such losses can be shown, however. A stem rust epidemic destroyed almost 300 million bushels of wheat in the United States and Canada in 1916. Not only was it ruinous to the crop, but it forced thousands of farmers from their farms through despair or bankruptcy. The reduction in the quality and price of the wheat harvested and marketed increased the loss still more. Moreover, the loss in purchasing power of farmers affected business in the entire spring-wheat region and far beyond. Each year cotton yields in Arizona are reduced by diseases. The estimated loss in dollars due to plant diseases in Arizona alone in 1963 was set at over $38,000,000. This estimate is considered conservative because not all crops were figured in the estimate. Cotton was the hardest hit with a total loss of over $21,000,000.

Plant diseases often force the substitution of low-value crops for high-value crops, the substitution of inferior varieties for superior ones, the limiting of land where a crop can be grown, and the loss of capital investment in processing plants and other equipment through non-use. One of the practical obligations of the plant pathologist is to attempt to control these devastating epidemics which can cause violent fluctuations in the production of the world's food crops. The price for this work is not low. The cost of capital investment in spray machinery, chemicals for treatment, labor, and the cost of large-scale eradication campaigns amount to millions of dollars each year. Another expense in the control of disease is the cost involved in developing new disease resistant crops.

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DISCUSSION-DEMONSTRATION-ACTIV

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. The nature and purpose of oscillators: a. Resonant circuits. b. Feedback circuits.	
2. The nature and operation of external feedback oscillators.	2. Project transparency 2-4-1.
3. The Armstrong Oscillator employing transistors compared with the vacuum tube equivalent.	3. Project transparency 2-4-2.
4. The Hartley Oscillator employing transistors compared with the vacuum tube equivalent.	4. Project transparency 2-4-3.
5. The Colpitts Oscillator employing transistors compared with the vacuum tube equivalent.	5. Project transparency 2-4-4.
6. The principle of negative resistance and its application to the construction of transistorized internal feedback oscillators.	6. Project transparency 2-4-5.
7. Comparison of transistor and vacuum tube multivibrator waveforms.	

DISCUSSION-DEMONSTRATION-ACTIVITIES

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	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
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ation of ex- illators.	2. Project transparency 2-4-1.	
illator rs compared e equivalent.	3. Project transparency 2-4-2.	
tor employing ed with the lent.	4. Project transparency 2-4-3.	
tor employing ed with the lent.	5. Project transparency 2-4-4.	
gative resistance o the construc- ed internal feedback	6. Project transparency 2-4-5.	
sistor and ibrator waveforms.		

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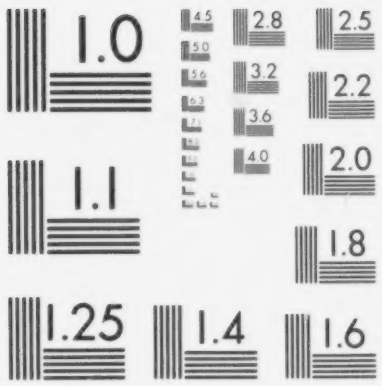

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

DISCUSSION-DEMONSTRATION-AC

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
8. The construction and operating characteristics of multivibrator circuits employing transistors as compared with vacuum tube equivalents.	8. Project transparency 2-4-6, 2-4-7, and 2-4-8.
9. The nature, purpose, and construction of a blocking oscillator.	9. Project transparency 2-4-9.
10. The construction and operation of photosensitive transistors.	10. Project transparency 2-4-10.
11. Drift transistor applications.	11. Project transparency 2-4-11.
12. Review and summary.	

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DISCUSSION - DEMONSTRATION - ACTIVITIES

ures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
l operating ultivibrator ransistors as m tube equi-	8. Project transparency 2-4-6, 2-4-7, and 2-4-8.	
, and con- ng oscillator.	9. Project transparency 2-4-9.	
l operation of istors.	10. Project transparency 2-4-10.	
ications.	11. Project transparency 2-4-11.	

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SECTION 3: TRANSISTOR CIR

Topic No.	Topic
1	Transistor Amplifiers
2	Transistor Generating Circuits

SECTION 3: TRANSISTOR CIRCUIT APPLICATIONS

Topic	Instructor's Guide Pages	Trainee's Guide Pages
Transistor Amplifiers	39-43	91-99
Transistor Generating Circuits	44-46	100-108

TOPIC 1: TRANSISTOR AMPLIFI

Training Goals:

A. Each trainee will learn:

1. The classification of transistor amplifier circuits according to frequency output.
2. The purpose of components included in radio frequency amplifiers.
3. The purpose of components included in intermediate frequency amplifiers.
4. Audio and video amplifiers.
5. How transistors are used in hearing aids.
6. The use of transistors in remote controls.
7. Battery operated transistorized tape recorder.

Trainee Prepar

A. Trainee's Guide:

1. Study Sectio

Instructor Prep

A. Review assigned

B. Training aids re

1. Films:

a. MN 847

b. MN 847

2. Transparen

a. 3-1-1,

b. 3-1-2,

c. 3-1-3,

d. 3-1-4,

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TIME_____Hrs.

TOPIC 1: TRANSISTOR AMPLIFIERS

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n of transistor amplifier
g to frequency output.

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mplifiers.

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quency amplifiers.

mplifiers.

are used in hearing aids.

stors in remote controls.

transistorized tape recorder.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 3, Topic 1.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training aids required:

1. Films:

   a. MN 8479D, Transistors, Low Frequency Amplifiers.

   b. MN 8479E, Transistors, High Frequency Operations.

2. Transparencies:

   a. 3-1-1, RF and Mixer Stage of a Transistor Radio Receiver.

   b. 3-1-2, A Two-stage Transistor IF Amplifier.

   c. 3-1-3, A Two-stage Transistor Audio Amplifier.

   d. 3-1-4, A Two-stage Video Amplifier.

DISCUSSION-DEMONSTRATION-ACT

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Brief review of material covered in Basic Electronics course.	1. Show films: a. MN 8479D. b. MN 8479E.
2. Radio frequency amplifiers: a. How transistors are used in this circuit. b. Important considerations which affect the use of transistors in this circuit.	2. Project transparency 3-1-1.
3. Intermediate frequency amplifiers: a. How transistors are used in this circuit. b. Important considerations which affect the use of transistors in this circuit.	3. Project transparency 3-1-2.
4. Audio and video amplifiers: a. Function of audio amplifiers and explanation of representative circuit. b. Function of video amplifiers and explanation of a representative circuit.	4. Project transparencies: a. 3-1-3. b. 3-1-4.

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IMPORTANCE OF PLANT DISEASES

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Man is completely dependent upon the plant kingdom. His food, clothing, shelter and much of his fuel comes from plants. Plants alone are capable of synthesizing elementary substances into organic compounds necessary for animal metabolism and growth. Bacteria, fungi, mosses, ferns, and seed plants are included in the plant kingdom, the most important being the seed plants. Of the more than 200,000 species of plants, about 3,000 are used for food, only 300 are widely cultivated and of these some dozen plants supply 95 per cent of the world's annual food crop.

1. Economic Importance of Plant Diseases. Diseases may make plant products unfit for human or animal food. During the Middle Ages thousands of people died from eating rye bread made from grain infested with ergot, *Claviceps purpurea*. Scabby barley caused by *Gibberella zeae* makes pigs violently sick. Stinking smut of wheat caused by *Tilletia triticic* may require special washing of the grain before milling. Transportation and storage diseases cause losses in succulent fruits and vegetables. Even less perishable food such as rice, millet, and beans may be damaged by storage diseases. Wood products such as pulpwood, posts, poles, and timber are subject to fungus stains and structural weakness.

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DISCUSSION-DEMONSTRATION-ACTIVITIES

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
ered in	1. Show films: a. MN 8479D. b. MN 8479E.	
d in	2. Project transparency 3-1-1.	
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fiers:	3. Project transparency 3-1-2.	
d in this		
s which ors in		
	4. Project transparencies:	
ers and ative circuit.	a. 3-1-3.	
ers and ntative circuit.	b. 3-1-4.	

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DISCUSSION-DEMONSTRATION-ACT

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
5. Gain control.	
6. Hearing aid circuit.	
7. Review and summary.	

DISCUSSION-DEMONSTRATION-ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY

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TOPIC 2: TRANSISTOR GENERATING CIRC

Training Goals:

A. Each trainee will learn:

1. Review of the nature and use of audio oscillators.
2. The difference in principles of operation of external and internal feedback supply in audio oscillators.
3. The three basic circuits of internal feedback oscillators using transistors.
4. A one transistor transmitter circuit.
5. Memory circuits in computing machines.
6. The power supply for Geiger counter.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 3, Topic 2.

B. Reference Publications:

1. Review NavPers 91887, Section 4, Topic 1 and Topic 3.
2. Review NavPers 92213, Topic 8 and Topic 9.

Instructor Preparatio

A. Review assigned trainee m

B. Training materials require

1. References:
   a. NavPers 91887.
   b. NavPers 92213.

C. Training aids required:

1. Film:
   a. MN 8479F, Switc
2. Transparencies:
   a. 3-2-1, The Hartl Using Tra
   b. 3-2-2, Wireless
   c. 3-2-3, Base-cont Oscillator
   d. 3-2-4, Negative
   e. 3-2-5, RF Oscill
   f. 3-2-6, Flip-flop

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TIME_____Hrs.

TOPIC 2: TRANSISTOR GENERATING CIRCUITS

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l learn:

e nature and use of audio oscillators.

ce in principles of operation of
l internal feedback supply in audio

asic circuits of internal feedback
using transistors.

istor transmitter circuit.

cuits in computing machines.

supply for Geiger counter.

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n 3, Topic 2.

cations:

Pers 91887, Section 4, Topic 1 and Topic 3.

Pers 92213, Topic 8 and Topic 9.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. References:

   a. NavPers 91887.

   b. NavPers 92213.

C. Training aids required:

1. Film:

   a. MN 8479F, Switching.

2. Transparencies:

   a. 3-2-1, The Hartley and Colpitts Oscillators Using Transistors.

   b. 3-2-2, Wireless Microphone Circuit.

   c. 3-2-3, Base-controlled Negative Resistance Oscillator.

   d. 3-2-4, Negative Resistance Oscillators.

   e. 3-2-5, RF Oscillator Power Supply.

   f. 3-2-6, Flip-flop Circuit.

DISCUSSION - DEMONSTRATION - A

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Review of the nature and use of audio oscillators from Basic Electronics and Fire Control Radar Special Circuits courses.	
2. The nature of positive feedback and methods which may be used to achieve this condition:	2. Project transparencies:
a. External feedback circuits.	a. 3-2-1.
3. How a transistor can be used in a circuit to transmit into your radio.	3. Project transparency 3-2-2.
4. Internal feedback oscillators using transistors.	4. Project transparencies:
a. Parallel resonant circuit connected to a base lead.	a. 3-2-3.
b. Series resonant circuit connected to an emitter lead.	b-c. 3-2-4.
c. Series resonant circuit connected to a collector lead.	
5. The Geiger counter reduced in weight by transistors.	5. Project transparency 3-2-5.

(Continued)

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DISCUSSION-DEMONSTRATION-ACTIVITIES

rocedures:

NT	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
e nature and use of audio rom Basic Electronics trol Radar Special Cir- s.		
f positive feedback and ch may be used to achieve n:	2. Project transparencies:	
l feedback circuits.	a. 3-2-1.	
stor can be used in a nsmit into your radio.	3. Project transparency 3-2-2.	
back oscillators using	4. Project transparencies:	
resonant circuit connected e lead.	a. 3-2-3.	
esonant circuit connected itter lead.	b-c. 3-2-4.	
esonant circuit connected ector lead.		
ounter reduced in weight s.	5. Project transparency 3-2-5.	

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DISCUSSION - DEMONSTRATION - ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	REL
6. **The transistor flip-flop in memory circuits.**	6. **Project transparency 3-2-6. Show Film MN 8479F.**	
7. **Review and summary.**		

DISCUSSION-DEMONSTRATION-ACTIVITIES

es:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
in memory	6. Project transparency 3-2-6. Show Film MN 8479F.	

SECTION 4: PRINTED CIRCUITS

Topic No.	Topic Title	Instructor Guide Page
1	Introduction to Printed Circuits	47-51
2	Repairing Modular Assemblies	52-55
3	Troubleshooting Modular Assemblies	56-58

2. Developments in the Study of Plant Diseases. Farmers have always been beset with hazards in their struggles to feed others. Plant diseases, insect pests, weeds, and unfavorable weather are among the greatest hazards. Frequent references in the Bible tell of famines caused by plant diseases and insects. The ancient Greeks thought that the occurrence of disease was due to unfavorable soil or weather and to the displeasure of the gods. Many of the ancient rites of the pagan religions were to gain favor of the gods in order to spare their crops from destruction. The first known attempt to control a plant disease was a law passed in Rouen, France in 1660, requiring the eradication of barberry bushes because of their apparent connection with the destructive rust on cereals. Similar laws were passed in Connecticut (1726), Massachusetts (1753), Rhode Island (1766-1772).

With the invention of the compound microscope about 1590, micro-organisms were first seen, but it took centuries before man began to understand them. The terrible potato blight that struck Ireland between 1830 and 1840 with the resultant migration of many millions to the United States added increased impetus to the study of plant diseases. De Bary, "the father of modern plant pathology," is usually credited with the discovery in 1850 that fungi can cause plant disease. Discovery that bacteria and viruses also cause plant diseases followed within a few decades. The improvement in materials and methods for disease control by chemicals, cultural practices, storage facilities and resistant varieties has come within the past thirty to fifty years. Plant diseases still take a heavy toll in all important agricultural areas, because known satisfactory control measures are not used as frequently as they should be and feasible methods for controlling some diseases have not been worked out.

THE NATURE AND CLASSIFICATION OF PLANT DISEASES

A plant disease may be defined as any alteration of a plant that interferes with its normal structure or function and renders it unfit for its normal use. Plant diseases are often classified by symptoms and causal agents.

Classification of Plant Diseases Based on Symptoms

One method of classification of plant disease is that based on symptoms. A symptom is a visible reaction of the plant to disease. Five common symptoms of plant disease are superficial, necrosis, hypoplasia, hypertrophy, and wilt.

1. Superficial diseases are those in which the organism lives on the surface of the plant tissue. They invade the epidermal cells of the plant with a haustoria (foot like organ) and cause reduction in thriftness in the whole plant which is reflected in reduced yield. Powdery mildew is an example of a superficial disease.

2. Necrosis is the destruction of tissue. It may be general when due to species of micro-organisms that grow as long as there is susceptible tissue. Necrosis is manifest as either dry rots or soft rots. An example of soft rot is lettuce watery brown rot. Commonly affected plant parts include fleshy organs such as fruits and bulbs. Timber, railroad ties, posts and poles may also be rotted. Dry rots may be

SECTION 4: PRINTED CIRCUITS

Topic Title	Instructor's Guide Pages	Trainee's Guide Pages
Introduction to Printed Circuits	47-51	109-113
Repairing Modular Assemblies	52-55	114-123
Troubleshooting Modular Assemblies	56-58	124-130

TOPIC 1: INTRODUCTION TO PRINTED CIRCUITS

Training Goals:

A. Each trainee will learn:

1. The advantages, disadvantages and the nature of modular construction.
2. The necessity of special tools and their description.
3. The rules of proper solder selection and its use.
4. The precautions relating to repair of printed circuitry.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 4, Topic 1.

Instructor Preparation:

A. Review assigned trainee material

B. Training materials required:

1. Tools.
2. Printed Circuit Board.
3. Components.

C. Training Aids required:

1. Transparencies.
2. Film.

TIME_____Hrs.

IC 1: INTRODUCTION TO PRINTED CIRCUITS

tages and the nature of

tools and their description.

r selection and its use.

to repair of printed

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 4, Topic 1.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Tools.
2. Printed Circuit Board.
3. Components.

C. Training Aids required:

1. Transparencies.
2. Film.

DISCUSSION-DEMONSTRATION-ACTI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Advantages and disadvantages of Modular Construction.	
a. Size, weight, heat dissipation, voltages, and such.	
2. Definition of terms:	2. Clarify terminology.
a. Subminiaturized.	
b. Module.	
c. Unitized Construction.	
d. Modular Assemblies.	
3. Special Tools:	3. Show special tools and demonstrate correct use.
a. Ungar universal handle.	
b. Interchangeable soldering tips.	
c. Interchangeable DE-soldering tips.	
d. Magnifying glass.	

(Continued)

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DISCUSSION-DEMONSTRATION-ACTIVITIES

res:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
ntages of		
dissipation,		
	2. Clarify terminology.	
ion.		
es.		
	3. Show special tools and demonstrate correct use.	
ndle.		
ldering tips.		
E-soldering		

(Continued)

DISCUSSION-DEMONSTRATION-ACTIVITI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
e. Needle-point probe.	e. Explain construction.
f. Seizers.	f. Can be obtained from Med. Dept., Mk 1A computer kit, and such.
4. Soldering techniques and precautions.	4.
a. Soldering iron wattage.	a. Emphasize 40-watt choice.
b. Heat transfer; Tinning.	b. Demonstrate tinning.
c. Ideal solder; tin-to-lead ratio (60/40).	
d. Acid-core solder; corrosion, leaks, shorts, and such.	
e. Improvised soldering tip.	e. Demonstrate construction.
f. Heat sinks.	f. Demonstrate construction of improvised heat sink.
5. Review and summary.	

DISCUSSION-DEMONSTRATION-ACTIVITIES

dures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
obe.	e. Explain construction.	
	f. Can be obtained from Med. Dept., Mk 1A computer kit, and such.	
and pre-	4.	
vattage.	a. Emphasize 40-watt choice.	
Tinning.	b. Demonstrate tinning.	
n-to-lead ratio		
er; corrosion, and such.		
dering tip.	e. Demonstrate construction.	
	f. Demonstrate construction of improvised heat sink.	
y.		

TOPIC 2: REPAIRING MODULAR ASSEMBI

Training Goals:

A. Each trainee will learn:

1. Correct techniques for removal and replacement of printed circuit components.
2. Related soldering techniques.
3. How to repair printed wiring.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 4, Topic

Instructor Preparatior

A. Review assigned trainee ma

B. Training materials require

1. Ungar universal handle
2. Printed circuit board.
3. Components.

TIME_____ Hrs.

OPIC 2: REPAIRING MODULAR ASSEMBLIES

r removal and replacement of
nents.

niques.

wiring.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 4, Topic 2.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Ungar universal handle and assorted tiplets.
2. Printed circuit board.
3. Components.

DISCUSSION-DEMONSTRATION-ACTIVI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. False concepts regarding Fleet maintenance of modular assemblies.	
a. Canned and potted components.	
b. Improved accessibility over conventional assemblies.	
2. Replacing defective, short-lead, parallel components.	2. Demonstrate replacement.
a. Cutting.	
b. Crushing.	
c. Lead looping.	
d. Soldering.	
3. Removing soldered components.	3. Demonstrate techniques.
a. Chassis position.	
b. No force.	
c. Bent leads, tabs, and such.	
d. Straight-line multiple terminals.	

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root rots, leaf spots, blights, cankers, scabs, or anthracnose. It is local in the case of leaf spots and fruit spots where the extent of the lesion is limited. Often the lesions are characteristic in shape, size, pattern and color. For example, necrosis occurring in the disease, angular leaf spot of cotton, is limited by veins of the leaf, thus being limited in shape and size.

3. Hypoplasia or underdevelopment is the stunting or dwarfing of a plant. It may be caused by a virus such as sugar beet yellows and mosaic dwarf of potatoes or it may be caused by a fungus such as dwarf bunt of wheat. Underdevelopment of above ground parts of plants may also result from destruction of roots, an excess of a deficiency of soil moisture and/or nutrients.

4. Hypertrophy or abnormal overgrowth, may be caused by some viruses, fungi, nematodes, bacteria, or insects. These may cause distortions, deformations and galls. Some chemicals including the "growth hormones," the growth modifiers, and the weed killer 2,4-D may also cause abnormal overgrowth. Some examples are corn smut galls, potato wart and cabbage club root.

5. Wilts are a loss of freshness and drooping of leaves of plants due to inadequate water supply through the vascular system. Plants with wilt symptoms usually show discoloration of the root and/or stem vascular system. Verticillium wilt of cotton is an example of a wilt disease.

Classification of Plant Diseases Based on Causal Agents

The two broad categories of causes or combination of causes of plant diseases are: inanimate or non-parasitic and animate or parasitic.

1. Inanimate or non-parasitic causal agent are terms used interchangeably to describe the cause of any unhealthy condition not brought about by a living organism. Many cases of weakened or unthrifty plants are due to soil conditions. Deficiency of soil moisture causes stunting, premature ripening and death in case of severe drought. Extensive and pronounced drought injury is clearly recognizable, but milder forms are sometimes difficult to diagnose, especially if plants are affected by parasitic diseases. Excess soil moisture causes indirect injury; the water itself is not usually injurious, but it can reduce the amount of oxygen to the danger point or even beyond. The physical structure of the soil may have a direct effect on plants if it is so hard and compact as to prevent normal penetration and development of roots. A hard pan near the soil surface prevents normal root growth. Heavy clay soils may prevent proper drainage; sandy or gravelly soils have poor water holding capacity. Both deficiency or an excess of a major or minor plant nutrient can cause disease symptoms. For example, a deficiency of nitrogen causes yellowish, reddish or purplish tints, subnormal growth and poor seed or fruit production. An excess of nitrogen causes succulent growth, delayed ripening and consequent increased susceptibility to diseases, heat and drought injury. Soil pH. has a decided effect upon plant growth. Most agriculture plants grow well in soils with a pH.

DISCUSSION-DEMONSTRATION-ACTIVITIES

dures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
arding Fleet dular assemblies.		
tted components.		
ssibility over ssemblies.		
e, short-lead, ts.	2. Demonstrate replacement.	
d components.	3. Demonstrate techniques.	
on.		
bs, and such.		
multiple terminals.		

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[redacted]

DISCUSSION-DEMONSTRATION-A

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
e. Circular multiple terminals.	
f. Improvised tiplets.	
4. Soldering techniques.	4. Demonstrate, using spare printe circuit board.
a. Cleaning and tinning of part.	
b. Cleaning printed ribbon.	
c. Toxic hazards.	
d. Pre-forming leads.	
e. Soldering components.	
f. Excess or splashed solder.	
5. Repairing printed wire.	5. Demonstrate, using spare printe circuit board.
a. Causes of damage.	
b. Repairing short breaks.	
c. Capacitance distribution.	
d. Repairing long breaks.	

DISCUSSION - DEMONSTRATION - ACTIVITIES

dures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
ble terminals.		
ets.		
s.	4. Demonstrate, using spare printed circuit board.	
nning of part.		
d ribbon.		
ads.		
onents.		
shed solder.		
ire.	5. Demonstrate, using spare printed circuit board.	
ge.		
t breaks.		
stribution.		
breaks.		

DISCUSSION-DEMONSTRATION-ACTI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
6. Transistors and semiconductors.	
a. Pigtail leads.	
b. Heat sinks.	
c. High transients.	
7. Review and summary.	

DISCUSSION-DEMONSTRATION-ACTIVITIES

edures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
semiconductors.		
.		
nts.		
nary.		

TOPIC 3: TROUBLESHOOTING MODULAR A

Training Goals:

A. Each trainee will learn:

1. Methods of printed circuit casualty analysis.
2. Precautions related to troubleshooting modular assemblies.

Trainee Preparatio

A. Trainee's Guide:

1. Study Section 4, To

Instructor Preparat

A. Review assigned traine

B. Training materials req

1. Tools.
2. VTVM and needle-
3. Magnifying glass.
4. Printed circuit boa
5. Spare components.

TIME_____Hrs.

OPIC 3: TROUBLESHOOTING MODULAR ASSEMBLIES

s:

earn:

nted circuit casualty analysis.

elated to troubleshooting modular

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 4, Topic 3.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Tools.
2. VTVM and needle-point probe.
3. Magnifying glass.
4. Printed circuit board.
5. Spare components.

DISCUSSION-DEMONSTRATION-ACTIVIT

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Identification of components.	1. Clarify methods of quick identification.
a. Comparison with conventional assemblies.	
2. Resistance and continuity measurements.	2. Demonstrate proper techniques.
a. Light bulb.	
b. VTVM with needle-point probe.	b. Explain construction and use.
3. Translucent boards.	
a. Light bulb.	
b. Magnifying glass.	
4. Opaque boards.	
a. VTVM.	
5. General precautions.	
a. Polarities.	
b. High transients.	
c. Isolation transformer.	
d. Test signal levels.	

(Continued)

DISCUSSION-DEMONSTRATION-ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
6. Construction of chassis - holding jig.	6. Explain. (This is included only for trainee's use when on board ship. DO NOT SPEND MUCH TIME ON THIS POINT.)
7. Review and summary.	

ranging from about 4 to 8. Excessive salt in the soil may also cause plants to become weakened or even die.

The presence of lime, as calcium carbonate may bring about an excess of hydroxyions around soil particles. Under these conditions in the soil, the elemental iron in soil solution is precipitated (become unavailable) and the roots fail to pick it up. Since iron is essential to the formation of chlorophyll, this lack causes the plant to become chloratic (yellow).

Many meteorologic conditions cause diseases directly and can also effect the development of parasitic diseases. All higher plants require sunlight for photosynthesis. Light deficiency causes etiolation, weak, spindly growth and general under-development. Alfalfa and oats require long days; soybeans need short days; other crops are indifferent. Certain varieties of a crop mature many weeks later than others, thus they are longer in jeopardy of damage from unfavorable weather and attack by diseases. Summer heat, winter cold and unseasonable frosts can injure or destroy a high percentage of crop plants even in areas where they are adapted. Tropical and sub-tropical plants are easily injured by frost, while crops in temperate climates are more resistant. Tomatoes are often "cooked on the vine" when high temperatures follow moist, cloudy weather. "Smudge pots" protect citrus against frost; heated greenhouses protect plants against winter cold.

Relative humidity of the air obviously has an effect on the rate of transpiration of plants. The combination of heat, wind and low relative humidity can cause extensive injury or death to plants. Wind, heavy rain, sleet, hail or lightening may cause direct or indirect injuries which reduce the vigor of the plant and provide avenues of entrance for parasitic organisms.

A farmer's cultural practices may injure plants. Too deep or too close cultivation may cause injury. Fungicides when improperly used may cause russeting of leaves and fruit, leaf and fruit drop and scorch. Insecticides may accumulate in the soil to cause injury to fruit trees. Herbicides such as 2,4-D may cause severe injury to plants at a susceptible stage.

Industrial contaminants such as dust from cement plants may settle on the floral parts and prevent fertilization and fruit formation. Smelter fumes, gas leaking from mains and even smog in large cities have caused extensive injury to plants. Volitile compounds given off by apples in storage may cause fruit scald.

2. Animate or parasitic causal agent are terms used to describe the cause of any unhealthy condition brought about by a living organism. Higher animals occasionally cause an unhealthy condition of plants that satisfies the definition of plant disease. For example, a farmer mowing a field of alfalfa does interfere with the normal structure and function of the alfalfa, but does not render it unfit for its normal use and so would not be called a disease. However, a cow that gets into the field of corn and tramps down or eats the corn plants does interfere with the normal structure and function of the corn and does

DISCUSSION - DEMONSTRATION - ACTIVITIES

res:

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
6. Explain. (This is included only for trainee's use when on board ship. DO NOT SPEND MUCH TIME ON THIS POINT.)	

SECTION 5: DESCRIPTION OF TRAINING DEVICE CIRCUITS

Topic No.	Topic Title	Instructor Guide Pag
1	Introduction to the Training Device	59-61
2	Power Supply	62-63
3	Transistor Tester	64-65
4	Wien Bridge Oscillator	66-67
5	Transistor Amplifier	68-69
6	Biased Diode Limiter	70-71
7	Differentiating and Limiting Circuit	72-73
8	One-shot Multivibrator	74-75
9	Sawtooth Generator	76-77
10	Phase Inverter	78-79
11	Flip-flop Multivibrator	80-81
12	Blocking Oscillator	82-83
13	Coincidence Circuit	84-85

SECTION 5: DESCRIPTION OF TRAINING DEVICE CIRCUITS

Topic Title	Instructor's Guide Pages	Trainee's Guide Pages
Introduction to the Training Device	59-61	131-135
Power Supply	62-63	136-139
Transistor Tester	64-65	140-141
Wien Bridge Oscillator	66-67	142-147
Transistor Amplifier	68-69	148-151
Biased Diode Limiter	70-71	152-153
Differentiating and Limiting Circuit	72-73	154-155
One-shot Multivibrator	74-75	156-159
Sawtooth Generator	76-77	160-161
Phase Inverter	78-79	162-163
Flip-flop Multivibrator	80-81	164-167
Blocking Oscillator	82-83	168-171
Coincidence Circuit	84-85	172-173

TOPIC 1: INTRODUCTION

Training Goals:

A. **Each trainee will learn:**

1. **The types and sequence of the circuits used in the Training Device.**
2. **Signal flow between the circuits of the Training Device.**

B. **Each trainee will acquire skill in:**

1. **Tracing signal flow on the Training Device block diagram.**

TIME_____Hrs.

TOPIC 1: INTRODUCTION TO THE TRAINING DEVICE.

ls:

learn:

d sequence of the circuits used in Device.

etween the circuits of the Training

acquire skill in:

al flow on the Training Device m.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 1.

B. Reference publications:

1. Review pages 15-16, 73-81, 94, 97-98, 121-123, 145-146, 151, 182, 191-192, 198, and 218-219 in NAVPERS 92213.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. References:

a. NAVPERS 92213.

C. Training aids required:

1. Wall charts:

a. 5-1-1, Training Device Block Diagram.

2. Films:

a. MN 8479G, Transistor Servicing.

DISCUSSION-DEMONSTRATION-ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	RE
1. Introduction to Training Device.	1. Point out that the device is being designed and circuits will be the same as those following, but are not available for practical work.	
2. Types of circuits used in the Training Device.	2-4. Show wall chart 5-1-1, and relate to Fire Control Special Circuits Chassis.	
3. Sequence of circuits.		
4. Signal flow between circuits.		
5. Review and summary.	5. Show Film MN 8479G.	5.

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SCUSSION - DEMONSTRATION - ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Point out that the device is being designed and circuits will be the same as those following, but are not available for practical work.	
2-4. Show wall chart 5-1-1, and relate to Fire Control Special Circuits Chassis.	
5. Show Film MN 8479G.	5. Trace signal flow through Training Device block diagram.

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TOPIC 2: POWER SUPPLY

Training Goals:

A. Each trainee will learn:

1. The functional operation of the power supply.
2. How to trace a signal from the AC input to the DC output.

B. Each trainee will acquire skill in:

1. Measuring the input and output voltages of the power supply.

Trainee Preparati

A. Trainee's Guide:

1. Study Section 5,

Instructor Prepar

A. Review assigned trai

B. Training materials r

1. Test equipment:

a. Multimeter

C. Training aids require

1. Transparencies:

a. 5-2-1, Powe

TIME_____Hrs.

TOPIC 2: POWER SUPPLY

s:

earn:

operation of the power supply.

signal from the AC input to the

cquire skill in:

input and output voltages of the

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 2.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Multimeter AN/PSM-4.

C. Training aids required:

1. Transparencies:

a. 5-2-1, Power Supply.

DISCUSSION-DEMONSTRATION-ACTI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Components of the power supply and their function.	1. Project transparency 5-2-1.
a. Transformers.	
b. Diodes.	
c. Filter.	
d. Transistors.	
2. Rectification of AC to DC.	2. Trace input AC through supply for one complete cycle of negative supply. Use transparency 5-2-1.
3. Regulation of the DC output voltage.	3. Use transparency 5-2-1.
4. Review and summary.	4. Supervise trainees.

render it unfit for its intended use and would therefore be called an animate causal agent.

Insects such as leafhoppers, while feeding on a plant, secrete toxic substances which cause a diseased appearance, e.g. hopperburn of potatoes. Other insects cause overgrowths such as witchesbroom or plant galls.

Most animate causal agents are parasites, living organisms that obtain their nutrients wholly or in part from other living organisms, and so the term parasitic causal agent is often used interchangeably with animate causal agent.

Nematodes are very small roundworms, varying in size from 1/8 inch to so small they cannot be seen except through a microscope. Many are free living; others are parasitic on animals and plants. Nematodes may attack any part of a plant, including the roots, stems, leaves, flowers and fruit. Examples of diseases caused by nematodes are stem nematodes of alfalfa and rootknot nematode of cotton (See the individual disease section of this publication).

The majority of known plant parasites are bacteria or fungi. Bacterial plant pathogens are small, rod-shaped, single-celled micro-organisms 2 to 4 microns long (a micron is one-thousandth of a millimeter). Bacteria are the simplest form of plants. They are so tiny that if 8,000 to 12,000 were placed side by side they would not exceed an inch. (See colonies of bacteria collected in exercise two.) Even though bacteria are small and consist of only one cell, they multiply at an enormous rate. This increase in number is carried out by division. Redivision may vary from 20 minutes to several hours. In some of the faster multiplying types, a single bacterium could produce over 47,000,000,000 descendants in a 12 hour period. Fortunately, most bacteria are beneficial to mankind. Some cause human disease, however, and 170 different kinds of bacteria are capable of feeding on green plants and producing a disease condition. Bacteria cannot penetrate directly into plants. They must make entry through the breathing pores, wounds or be deposited by a feeding insect.

An example of a bacterium entering a plant by a wound is Agrobacterium tumefaciens which causes Crown Gall. An example of a bacterium that enters a plant by insects is Ervinia arnylovora, the cause of Fire Blight. (See individual disease section of this publication.)

Fungi are tiny, thread-like microscopic plants, commonly called molds. Fungi are living plants. They require a source of energy but, unlike green plants, cannot use energy from the sun to make their food. They must get food from external sources such as other plants. When these plant-feeding fungi become numerous, a disease epidemic develops. (See colonies of fungi collected in exercise two.) Many fungi reproduce by the formation of spores. These spores are produced on the tips of the filaments in or on specialized structures. Spores are produced in fantastic numbers,sometimes millions, on a single plant. Many never find lodging on a desirable host, but because spores are in such large numbers, reproduction continues. Under favorable conditions, a spore

DISCUSSION-DEMONSTRATION-ACTIVITIES

res:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
ver supply	1. Project transparency 5-2-1.	
DC.	2. Trace input AC through supply for one complete cycle of negative supply. Use transparency 5-2-1.	2. Trace signal through the positive portion of the supply.
utput voltage.	3. Use transparency 5-2-1.	
	4. Supervise trainees.	4. Perform the operations in the Trainee's Guide.

TOPIC 3: TRANSISTOR TES

Training Goals:

A. Each trainee will learn:

1. The operation of the transistor tester.
2. Precautions to be observed when testing transistors.
3. How PNP and NPN transistors are tested.

B. Each trainee will acquire skill in:

1. Testing PNP and NPN transistors.

Trainee Prep

A. Trainee's Gu

1. Study Se

Instructor P

A. Review assig

B. Training ma

1. Test equ

a. Osc

b. Spa

C. Training aid

1. Transpa

a. 5-3

2. Wall cha

a. 5-1

TIME_____Hrs.

TOPIC 3: TRANSISTOR TESTER

ls:

l learn:

n of the transistor tester.

to be observed when testing transistors.

d NPN transistors are tested.

acquire skill in:

and NPN transistors.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 3.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

b. Spare transistors (NPN and PNP).

C. Training aids required:

1. Transparencies:

a. 5-3-1, Transistor Tester.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION - DEMONSTRATION - ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	RELATED
1. Inputs and outputs of the transistor tester.	1. Show wall charts 5-1-1.	
2. Operation of the transistor tester using:	2. Project transparency 5-3-1.	
a. PNP transistor.		
b. NPN transistor.		
3. Types of inputs to the transistor tester.		
a. Wien bridge oscillator.		
b. Signal generator.		
4. Precautions when using the transistor tester.	4. Project transparency 5-3-1.	4. Tra PNP
a. Switch position.		
b. Polarity.		
5. Review and summary.	5. Supervise trainees.	5. Per Tra

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DISCUSSION-DEMONSTRATION-ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Show wall charts 5-1-1.	
2. Project transparency 5-3-1.	
4. Project transparency 5-3-1.	4. Trace signal through circuit for PNP and NPN transistors.
5. Supervise trainees.	5. Perform the operations in the Trainee's Guide.

TOPIC 4: WIEN BRIDGE OSCILL

Training Goals:

A. Each trainee will learn:

1. About the use of audio oscillators.
2. The functional operation of the Wien bridge oscillator.
3. How the frequency of operation is determined.

B. Each trainee will acquire skill in:

1. Tracing a signal through the Wien bridge oscillator.
2. Observing waveforms in the oscillator circuit.
3. Checking voltages in the oscillator circuit.

Trainee Prepa

A. Trainee's Guid

1. Study Secti

Instructor Pre

A. Review assigne

B. Training mater

1. Test equipr

a. Oscillo

b. Multim

C. Training aids re

1. Transparen

a. 5-4-1,

b. 5-4-2,

2. Wall charts

a. 5-1-1,

TOPIC 4: WIEN BRIDGE OSCILLATOR

TIME_____Hrs.

ls:

learn:

of audio oscillators.

l operation of the Wien bridge

ency of operation is determined.

acquire skill in:

nal through the Wien bridge

veforms in the oscillator

ges in the oscillator circuit.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 4.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

b. Multimeter AN/PSM-4.

C. Training aids required:

1. Transparencies:

a. 5-4-1, Wien Bridge Oscillator.

b. 5-4-2, The Wien Bridge.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION-DEMONSTRATION-

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Output of the Wien bridge oscillator.	1. Show wall chart 5-1-1.
2. Use of audio oscillators.	
3. Operation of the Wien bridge oscillator.	3. Project transparency 5-4-1.
4. Selection of regenerative feedback.	4. Project transparency 5-4-2.
5. Determining frequency of operation.	5. Assign values to the components of the Wien bridge. Use Transparency 5-4-2.
6. Review and summary.	6. Supervise trainees.

DISCUSSION-DEMONSTRATION-ACTIVITIES

d Procedures:

POINT	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
the Wien bridge oscillator.	1. Show wall chart 5-1-1.	
udio oscillators.		
n of the Wien bridge r.	3. Project transparency 5-4-1.	
of regenerative .	4. Project transparency 5-4-2.	4. Trace a cycle of oscillation through the circuit.
ning frequency of n.	5. Assign values to the components of the Wien bridge. Use Transparency 5-4-2.	5. Using formula, work out frequency of output.
nd summary.	6. Supervise trainees.	6. Perform the operations in the Trainee's Guide.

TOPIC 5: TRANSISTO

Training Goals:

A. Each trainee will learn:

1. Uses of transistor amplifiers in Navy equipment.
2. Operation of the transistor amplifier.

B. Each trainee will acquire skill in:

1. Tracing a signal through the transistor amplifier.
2. Observing amplifier gain and waveforms.
3. Checking voltages in amplifier circuit.

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B.

C.

landing on a susceptible plant can produce a new infection center. Plant disease fungi may be obligate parasites; that means they can live only on living plants. Those that can grow on dead organic matter as well as living plants are known as facultative saprophytes. Facultative parasites grow mosly on non-living matter but can attack plants. Examples of fungus diseases are Verticillium wilt, damping-off, powdery mildew, Texas root-rot, smuts and rusts.

Other forms of plant life, in addition to bacteria and fungi, may cause plant disease. Algae rarely cause disease, but in Asia, a green alga causes severe injury to tea and coffee. Parasitic seed-bearing plants such as dodder, broomrope and mistletoe cause economic damage to crop plants.

Viruses are pathogenic entities which attack many forms of life, including bacteria and plants. Virus particles, rod or spherical in shape, are so tiny that only an electron microscope makes them visible. Virus particles may enter plants by mechanical inoculations, insect feeding or vegetative propagation. Cigarette smokers are common carriers of tobacco mosaic virus and transmit it to tomato and related plants. Viruses also are carried in seed, tubers and bulbs. Viruses can cause leaf spotting, stunted growth and death of the plant. In some plants, however, viruses are present but fail to show symptoms. Examples of virus diseases are yellow dwarf of barley and cucurbit viruses (See individual disease section of this publication).

GROWTH AND REPRODUCTION OF PLANT PATHOGENS

The ideal characteristics of a successful plant pathogen are: 1) Virulence; the relative strength of a pathogen's ability to cause a destructive disease. 2) Rapid growth; it can multiply rapidly both as a saprophyte and parasite. 3) Wide host range; it can multiply on many kinds of wild and cultivated plants. 4) Dissemination; propagative bodies are produced abundantly and widely disseminated by wind, water, animals, insects and man.

General Requirements for Growth

Nutrient requirements for pathogenic bacteria and fungi are essentially the same as those of green plants. Since they do not possess chlorophyll, they cannot carry on photosynthesis and must get their food from living or non-living organisms or their products. That is, they must live as parasites or saprophytes. In addition, some require growth factors or vitamins, others can synthesize their needs.

1. Host Range. Obligate parasites can grow and produce only on living host. The rusts and powdery mildews, for example, have not been grown on non-living substrates. Most other plant pathogens can also grow on dead plants or plant parts and on artificial media. They are known as facultative saprophytes. The range of hosts for different pathogens varies widely; some are restricted to single species, others to a single family and others to a wide variety of plants. They differ in their ability to attack different tissues. Rhizoctonia may kill seedlings and rot roots, but cannot attack the woody cells of mature trees, while others can only attack the woody cells. Some pathogens affect

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TIME_____Hrs.

TOPIC 5: TRANSISTOR AMPLIFIER

Goals:

inee will learn:

s of transistor amplifiers in Navy equipment.

ration of the transistor amplifier.

inee will acquire skill in:

cing a signal through the transistor
lifier.

erving amplifier gain and waveforms.

cking voltages in amplifier circuit.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 5.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test Equipment:

a. Oscilloscope OS-8U.

b. Multimeter AN/PSM-4.

C. Training aids required:

1. Transparencies:

a. 5-5-1, Transistor Amplifier.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

3. Films:

a. MN 8479D, Low Frequency Amplifiers.

b. MN 8479E, High Frequency Amplifiers.

DISCUSSION - DEMONSTRATION - ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	REL
1. Inputs and outputs of the transistor amplifier.	1. Show wall chart 5-1-1.	
2. Uses of transistor amplifiers in Navy equipments.	2. Show Films MN 8479D and MN 8479E.	
3. Operation of the transistor amplifier.	3. Project transparency 5-5-1.	3.
4. Review and summary.	4. Supervise trainees.	4.

DISCUSSION-DEMONSTRATION-ACTIVITIES

edures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
of the transistor	1. Show wall chart 5-1-1.	
amplifiers in	2. Show Films MN 8479D and MN 8479E.	
ransistor	3. Project transparency 5-5-1.	3. Trace signal through the circuit.
ary.	4. Supervise trainees.	4. Perform the operations in the Trainee's Guide.

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TOPIC 6: BIASED DIODE L

Training Goals:

A. Each trainee will learn:

1. The function and operation of the biased diode limiter.

B. Each trainee will acquire skill in:

1. Tracing a signal through the biased diode limiter.
2. Observing the waveforms in the limiter circuit.
3. Measuring the bias on the diode limiter.

Trainee P

A. Trainee's

1. Stud

Instructor

A. Review a

B. Training

1. Test

a.

b.

C. Training

1. Tra

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2. Wall

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TOPIC 6: BIASED DIODE LIMITER

TIME_____Hrs.

ls:

learn:

and operation of the biased
.

acquire skill in:

gnal through the biased diode

e waveforms in the limiter

e bias on the diode limiter.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 6.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

b. Multimeter AN/PSM-4.

C. Training aids required:

1. Transparencies:

a. 5-6-1, Biased Diode Limiter.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION-DEMONSTRATION-ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	REL
1. Inputs and outputs of the biased diode limiter.	1. Show wall chart 5-1-1.	
2. Function of the biased diode limiter.		
3. Operation of the biased diode limiter.	3. Project transparency 5-6-1.	3.
4. Review and summary.	4. Supervise trainees.	4.

DISCUSSION-DEMONSTRATION-ACTIVITIES

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Show wall chart 5-1-1.	
3. Project transparency 5-6-1.	3. Trace signal through the biased diode limiter.
4. Supervise trainees.	4. Perform the operations in the Trainee's Guide.

TOPIC 7: DIFFERENTIATING AND LIM

Training Goals

A. Each trainee will learn:

1. The function and operation of the differentiating and limiting circuit.

B. Each trainee will acquire skill in:

1. Tracing a signal through the circuit.

2. Observing waveforms in the differentiating and limiting circuit.

Trainee Pre

A. Trainee's C

1. Study S

Instructor

A. Review ass

B. Training m

1. Test e

a. Os

C. Training ai

1. Transp

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2. Wall c

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TOPIC 7: DIFFERENTIATING AND LIMITING CIRCUIT

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ill learn:

on and operation of the differentiating
ng circuit.

ill acquire skill in:

signal through the circuit.

waveforms in the differentiating and
rcuit.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 7.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

C. Training aids required:

1. Transparencies:

a. 5-7-1, Differentiating and Limiting Circuit.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION-DEMONSTRATION-ACTIVI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Inputs and outputs of the differentiating and limiting circuit.	1. Show wall chart 5-1-1.
2. The function of the circuit.	
3. The operation of the circuit.	3. Project transparency 5-7-1.
a. Differentiating.	
b. Limiting.	
4. Review and summary.	4. Supervise trainees.

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all parts of the host plant but produce different effects on each part.

Some pathogens require two taxonomically distinct kinds of hosts, either for persistance or for developing their complete life cycle. One stage develops on one host and the other stage on the second host. Some of these stages cannot infect the host on which they were produced.

2. Environmental Factors Affecting Growth. Many environmental factors affect the growth of pathogens. In some cases, pH may be a limiting factor in the growth of some pathogens. The pathogen that causes club-root of cabbage is inhibited in alkaline soils, while potato scab, caused by *Streptomyces scabies* is generally inhibited in acid soils.

Temperature is another environmental factor of importance to the growth of certain pathogens. The cardinal temperatures (minimum, optimum, and maximum) differ widely with the pathogen.

A third factor that affects pathogens is the biotic environment. The pathogen must compete with other organisms that are antibiotic to it. Thus, the hay bacillus, *Bacillus subtilus*, inhibits the growth of *Helminthosporium sativum*, the cause of root rot of cereals.

3. Reproduction of Bacteria and Fungi. Reproduction in bacteria is by simple fission. The conditions that favor their growth, also favor their reproduction. Fungi produce many special reproductive structures called spores on which their classification is based. Many reproduce both asexually (usually rapid) and sexually (survives unfavorable growing conditions). Generally, growth continues as long as nutritional and other factors are favorable. When checked, sporulation occurs. The incubation period varies considerably. The range of incubation periods will vary from 4-5 days in the case of the potato late blight fungus to almost a year for the fungus that causes loose smut of wheat.

THE DISSEMINATION OF PLANT PATHOGENS

The Requirements for Successful Dissemination

The requirements for a successful plant pathogen are rapid multiplication, efficient spore liberation, long-lived inoculum and abundant, timely and widespread dissemination. The principle agents of dissemination are wind, water, insects, animals other than insects, and man.

1. Principle Agents of Dissemination. Little is known about wind dissemination of bacteria or viruses. Wind, however, is very instrumental in the case of fungi. Spores have been caught 14,000 feet above infected fields and others have been caught over the Caribbean 600 miles from their nearest possible source. Some fungi are only disseminated locally by the wind, others such as *Puccinia graminis tritic* are spread over a large area by the wind. The repeating stage of this fungus survives the winter in Texas and in Mexico, but not the hot, dry summer. In the spring, mass air movements occur from south to north carrying the spores hundreds of miles in a few hours. In 1923, five successive waves carried the fungus 2,000 miles from Texas to the Canadian border in two months. In 1953 (early June) it was estimated

DISCUSSION-DEMONSTRATION-ACTIVITIES

s:

RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Show wall chart 5-1-1.	
3. Project transparency 5-7-1.	3. Trace signal through the circuit.
4. Supervise trainees.	4. Perform the operations in the Trainee's Guide.

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TOPIC 8: ONE-SHOT M

Training Goals:

A. Each trainee will learn:

1. The function and operation of the one-shot multivibrator.

B. Each trainee will acquire skill in:

1. Tracing a signal through the one-shot multivibrator.

2. Observing the waveforms and checking the voltages in the one-shot multivibrator circuit.

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TIME_____Hrs.

TOPIC 8: ONE-SHOT MULTIVIBRATOR

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peration of the one-shot

re skill in:

rough the one-shot

eforms and checking the
-shot multivibrator circuit.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 8.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment.

a. Oscilloscope OS-8U.

b. Multimeter AN/PSM-4.

C. Training aids required:

1. Transparencies:

a. 5-8-1, One-shot Multivibrator.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

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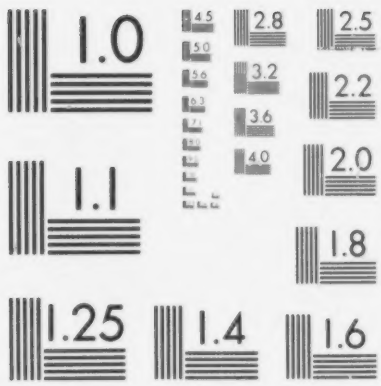

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

DISCUSSION-DEMONSTRATION-ACTI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Inputs and outputs of the one-shot multivibrator.	1. Show wall chart 5-1-1.
2. Function of the one-shot multivibrator.	
3. Operation of the one-shot multivibrator.	3. Project transparency 5-8-1.
4. Review and summary.	4. Supervise trainees.

DISCUSSION-DEMONSTRATION-ACTIVITIES

edures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
s of the one-shot	1. Show wall chart 5-1-1.	
ne-shot multi-		
one-shot multi-	3. Project transparency 5-8-1.	3. Trace signal through the circuit.
nary.	4. Supervise trainees.	4. Perform the operation in the Trainee's Guide.

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TOPIC 9: SAWTOOTH GENERA

Training Goals:

A. Each trainee will learn:

1. The function and operation of the sawtooth generator.

B. Each trainee will acquire skill in:

1. Tracing a signal through the sawtooth generator.
2. Observing waveforms in the sawtooth generator circuit.

Trainee Prepar

A. Trainee's Guide:

1. Study Sectio

Instructor Prep

A. Review assigned

B. Training materia

1. Test equipm

a. Oscillos

C. Training aids re

1. Transparen

a. 5-9-1,

2. Wall charts

a. 5-1-1,

TOPIC 9: SAWTOOTH GENERATOR

rn:

operation of the sawtooth

uire skill in:

through the sawtooth generator.

orms in the sawtooth generator

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 9.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

C. Training aids required:

1. Transparencies:

a. 5-9-1, Sawtooth Generator.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION-DEMONSTRATION-ACTI

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Inputs and outputs of the sawtooth generator.	1. Show wall chart 5-1-1.
2. Function of the sawtooth generator.	
3. Operation of the sawtooth generator.	3. Project transparency 5-9-1.
4. Review and summary.	4. Supervise trainees.

DISCUSSION-DEMONSTRATION-ACTIVITIES

ures:

the saw-

oth

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RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Show wall chart 5-1-1.	
3. Project transparency 5-9-1.	3. Trace signal through the circuit.
4. Supervise trainees.	4. Perform the operations in the Trainee's Guide.

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that 4,000 tons of spores, 150 billion to the pound, were produced on 4 million acres of wheat in northern Oklahoma and south-central Kansas. The winds carried the spores northward and deposited them at the rate of 3.5 million per acre over 40,000 square miles in the Dakotas and Minnesota. In the fall, the air masses move southward, carrying inoculum back to Texas and Mexico for overwintering. Bacteria and fungi spores extruded in gelatinous masses or spore-horns can be dispersed and washed away by water. Splashing and splattering rain water may distribute them to other parts of the same plants or to neighboring plants. Some pathogens have been observed to be disseminated by surface water.

Insects may be responsible for or aid in the direct production of disease without the aid of a pathogen, usually by the injection of a toxic substance in the tissues of the plant, e.g. hopperburn of potatoes. Insects may also disseminate pathogens through their feeding habits. They may inoculate the host with a pathogen. They may aid in the entry of the pathogen into the plant by providing openings in the host. Insects may preserve the pathogen by providing for its overwintering in the body of the insect or they may transfer the pathogen from a weed host to the crop plants. Some insects can transmit a virus to their progeny through eggs.

It is not known how important animals other than insects are for the dissemination of plant pathogens. Birds have been noted to be carrying fungus spores, but their effectiveness as carriers has not been established.

In transporting plant and plant products, man has also carried pests, pathogens and weed seeds. Plant pathogens may also be transmitted from field to field on farm implements. A pathogen may become far more destructive in an area where it is introduced than in the region of its origin, either because the new environmental conditions are most favorable or because the species or varieties of the new host plant are more susceptible. There are cases where pathogens, relatively harmless to native plants, have become extremely virulent when introduced to different varieties of the host plant.

INFECTION BY PLANT PATHOGEN

Sequence of Events for Growth

For a fungus disease to be produced, the following sequence of events must take place: 1) The spore must land on a susceptible surface of the host plant (inoculation). 2) The spore must germinate (germination). 3) The germ tube must grow and enter into the host tissue (penetration). 4) The hyphae must obtain nutrients for production on mycelium (establishment of fungus in the host).

The disease inoculum may consist of spores, vegetative mycelium, seeds (as in the case of dodder) or eggs (as in the case of nematodes). There is a great variation in the time required for germination; some germinate in 40 minutes while other may take 40 hours. Some spores can germinate immediately after liberation, others require a rest period. Moister is required for the germination of most spores and temperature requirements vary greatly.

TOPIC 10: PHASE

Training Goals:

A. Each trainee will learn:

1. The function and operation of the phase inverter.

B. Each trainee will acquire skill in:

1. Tracing a signal through the phase inverter.
2. Observing the waveforms in the phase inverter circuit.

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TIME_____Hrs.

TOPIC 10: PHASE INVERTER [redacted]

g Goals:

ainee will learn:

e function and operation of the phase inverter.

ainee will acquire skill in:

acing a signal through the phase inverter.

serving the waveforms in the phase
erter circuit.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 10.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

C. Training aids required:

1. Transparencies:

a. 5-10-1, Phase Inverter.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION - DEMONSTRATION - ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	RELATED T
1. Inputs and outputs of the phase inverter.	1. Show wall chart 5-1-1.	
2. Function of the phase inverter.		
3. Operation of the phase inverter.	3. Project transparency 5-10-1.	3. Trace circuit
4. Review and summary.	4. Supervise trainees.	4. Perfor Traine

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DISCUSSION-DEMONSTRATION-ACTIVITIES

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inverter.

e inverter.

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RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
1. Show wall chart 5-1-1.	
3. Project transparency 5-10-1.	3. Trace a signal through the circuit.
4. Supervise trainees.	4. Perform the operations in the Trainee's Guide.

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TOPIC 11: FLIP-FLOP MULTIVIBRATO

Training Goals:

A. Each trainee will learn:

1. Uses of the flip-flop multivibrator.
2. The function and operation of the flip-flop multivibrator.

B. Each trainee will acquire skill in:

1. Tracing a signal through the flip-flop multivibrator.
2. Observing waveforms and checking the voltages in the flip-flop multivibrator circuit.

Trainee Preparatio

A. Trainee's Guide:

1. Study Section 5, T

Instructor Prepara

A. Review assigned traine

B. Training materials re

1. Test equipment:
   a. Oscillator O
   b. Multimeter

C. Training aids required

1. Transparencies:
   a. 5-11-1, Flip
2. Wall charts:
   a. 5-1-1, Trai

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TIME_____Hrs.

TOPIC 11: FLIP-FLOP MULTIVIBRATOR

oals:

will learn:

he flip-flop multivibrator.

tion and operation of the flip-flop rator.

will acquire skill in:

a signal through the flip-flop multivibrator.

g waveforms and checking the voltages p-flop multivibrator circuit.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 11.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscillator OS-8U.

b. Multimeter AN/PSM-4.

C. Training aids required:

1. Transparencies:

a. 5-11-1, Flip-flop Multivibrator.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION-DEMONSTRATION-ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	REL
1. Uses of the flip-flop multivibrator.		
2. Inputs and outputs of the flip-flop multivibrator.	2. Show wall chart 5-1-1.	
3. Function of the flip-flop multivibrator.		
4. Operation of the flip-flop multivibrator.	4. Project transparency 5-11-1.	4.
5. Review and summary.	5. Supervise trainees.	5.

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DISCUSSION-DEMONSTRATION-ACTIVITIES

dures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
p multivibrator.		
of the flip-flop	2. Show wall chart 5-1-1.	
-flop multi-		
ip-flop	4. Project transparency 5-11-1.	4. Trace a signal through the circuit.
ary.	5. Supervise trainees.	5. Perform the operation in the Trainee's Guide.

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TOPIC 12: BLOCKING OSCILLATO

Training Goals:

A. Each trainee will learn:

1. The use of a blocking oscillator as a "count down" circuit.

2. The operation of the blocking oscillator.

B. Each trainee will acquire skill in:

1. Tracing a signal through the blocking oscillator.

2. Observing the waveforms and checking the voltages in the blocking oscillator circuits.

Trainee Preparati

A. Trainee's Guide:

1. Study Section 5,

Instructor Prepar

A. Review assigned tra

B. Training materials r

1. Test equipment:

a. Oscillosco

b. Multimete

C. Training aids requir

1. Transparencies:

a. 5-12-1, B

2. Wall charts:

a. 5-1-1, Tr

TIME_____Hrs.

TOPIC 12: BLOCKING OSCILLATOR

als:

l learn:

blocking oscillator as a
' circuit.

on of the blocking oscillator.

l acquire skill in:

ignal through the blocking

he waveforms and checking the
the blocking oscillator circuits.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 12.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

b. Multimeter AN/PSM-4.

C. Training aids required:

1. Transparencies:

a. 5-12-1, Blocking Oscillator.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

Pathogens may enter plants in one or more of the following ways: through wounds, through natural openings, or directly through plant surfaces. Often pathogens do not discriminate as to what plants they penetrate. They may or may not grow after entrance; thus host reactions range from immunity to susceptibility. In the establishment of disease, the genetic nature of both the host and the pathogen must be considered. Is the host susceptible or resistant? Is the pathogen virulent or non-virulent? This host-parasite relationship is affected by environment. Thus temperature extremes may inhibit the establishment of a virulent pathogen in a susceptible host. Pathogens may be divided according to their means of establishment in the host; those that kill cells and disorganize tissue as the pathogen advances, (an example would be the bacterium Erwinia amylovera which causes fire blight) and those that obtain their nutrients from living cells, often without killing them (an example would be Erysiphe spp which causes powdery mildew).

PRINCIPLES OF PLANT DISEASE CONTROL

By control of a plant disease, we mean the reduction in the amount of injury it may cause. There are four main methods of plant disease control: exclusion, eradication, protection and use of resistant varieties.

Methods of Plant Disease Control

1. Exclusion refers to measures designed to keep pathogens from entering the area or sphere in which the host is growing or to reduce to a minimum the extent to which the pathogen is introduced. The sphere may include flats, greenhouses, gardens, fields, regions, countries, and continents. These measures include compulsory quarantines and inspection; embargoes; voluntary inspection and certification of planting stocks, together with their production in areas where the pathogen is minimized or excluded by unfavorable environment and inspection of perishable fruits and vegetables at shipping points. Exclusion will not control pathogens that produce wind blown spores that can easily cross barriers.

Major plant pests and plant diseases cause billions of dollars of damage each year in the United States alone. Over half of these pests and diseases were introduced from other countries. Plant quarantine refers to legal restrictions on the movement of commodities for the purpose of preventing or delaying the establishment of plant pests and diseases in areas where they are not known to occur. Great economic loss may be sustained by the introduction and establishment of pests and pathogens into areas where a biological balance between host and pathogen has not been reached. When the environment for the development of the introduced pathogen is especially favorable and the number of susceptible hosts is large, a severe epidemic may result. Thus, it is necessary to regulate the movement of plant materials that might be infested with pests or pathogens. Some important introductions of foreign pathogens into the United States are white-pine blister rust, chestnut blight, citrus canker, potato black wart, and Dutch Elm disease. Today over 150 countries or political units have established quarantines to control the movement of plant and animal materials from one geographic area to another. In addition, hundreds of domestic quarantines have been established. In the United States, the first

DISCUSSION-DEMONSTRATION-ACTIVITIES

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY	RELA
1. Inputs and outputs of the blocking oscillator.	1. Show wall chart 5-1-1.	
2. How the blocking oscillator works as a "count down" circuit.		
a. Free running frequency.		
b. Triggered frequency.		
3. Purpose of the emitter follower.	3-4. Project transparency 5-12-1.	
4. Operation of the blocking oscillator.		4.
5. Review and summary.	5. Supervise trainees.	5.

DISCUSSION-DEMONSTRATION-ACTIVITIES

ures:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
the	1. Show wall chart 5-1-1.	
llator wn" circuit.		
quency.		
ncy.		
r follower.	3-4. Project transparency 5-12-1.	
king oscillator.		4. Trace a signal through the circuit.
.	5. Supervise trainees.	5. Perform the operation in the Trainee's Guide.

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TOPIC 13: COINCIDENCE CIR

Training Goals:

A. Each trainee will learn:

1. The function and operation of the coincidence circuit.

B. Each trainee will acquire skill in:

1. Tracing a signal through the coincidence circuit.
2. Observing the waveforms in the coincidence circuit.

Trainee Prepa

A. Trainee's Guid

1. Study Sect

Instructor Pr

A. Review assign

B. Training mate

1. Test equip

a. Osc

C. Training aids

1. Transpar

a. 5-1

2. Wall char

a. 5-1

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TIME_____Hrs.

TOPIC 13: COINCIDENCE CIRCUIT

ls:

l learn:

and operation of the coincidence

l acquire skill in:

gnal through the coincidence circuit.

he waveforms in the coincidence circuit.

Trainee Preparation:

A. Trainee's Guide:

1. Study Section 5, Topic 13.

Instructor Preparation:

A. Review assigned trainee materials.

B. Training materials required:

1. Test equipment:

a. Oscilloscope OS-8U.

C. Training aids required:

1. Transparencies:

a. 5-13-1, Coincidence Circuit.

2. Wall charts:

a. 5-1-1, Training Device Block Diagram.

DISCUSSION-DEMONSTRATION-ACTIVIT

Suggested Procedures:

DISCUSSION POINT	RELATED INSTRUCTOR ACTIVITY
1. Inputs and outputs of the coincidence circuit.	1. Show wall chart 5-1-1.
2. Function of the coincidence circuit.	
3. Operation of the coincidence circuit.	3. Project transparency 5-13-1.
a. DC restorer.	
4. Review and summary.	4. Supervise trainees.

DISCUSSION-DEMONSTRATION-ACTIVITIES

es:

	RELATED INSTRUCTOR ACTIVITY	RELATED TRAINEE ACTIVITY
	1. Show wall chart 5-1-1.	
nce		
ence	3. Project transparency 5-13-1.	3. Trace a signal through the circuit.
	4. Supervise trainees.	4. Perform the operation in the Trainee's Guide.

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MASTER MATERIALS LIST

Course: Transistors and Printed Circuits

Date:

Class Size:

A. Texts

Item No.	Navy No.	Description
1.	NavPers 92386A	Transistors and Printed Circuits, Instructor's Guide. Prepared by Bureau of Naval Personnel, 1962.
2.	NavPers 92387A	Transistors and Printed Circuits, Trainee's Guide. Prepared by Bureau of Naval Personnel, 1962.

B. References

1.	NavPers 91885	Basic Electronics, Vol. 4.
2.	NavPers 92213	Fire Control Radar Special Circuits.
3.	NavPers 91887	Basic Electronics, Vol. 6.

C. Films

The source of all film is the cognizant district training aids office. Listed in "Catalog of Tra

Item No.	Navy No.	Title
1.	MN 8479A	Transistors - P-N Junction.
2.	MN 8479B	Transistors - Triode Fundamentals.
3.	MN 8479C	Minority Carriers.

MASTER MATERIALS LIST

rs and Printed Circuits

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	Description	Per Man	Per Inst	Per Cl
A	Transistors and Printed Circuits, Instructor's Guide. Prepared by Bureau of Naval Personnel, 1962.		1	2
A	Transistors and Printed Circuits, Trainee's Guide. Prepared by Bureau of Naval Personnel, 1962.	1	1	12
	Basic Electronics, Vol. 4.	1	1	12
	Fire Control Radar Special Circuits.	1	1	12
	Basic Electronics, Vol. 6.	1	1	12

all film is the cognizant district training aids office. Listed in "Catalog of Training Films," NavPers 230058.

Title	Running Time	Per Cl
Transistors - P-N Junction.		1
Transistors - Triode Fundamentals.		1
Minority Carriers.		1

C. Films (Continued)

Item No.	Navy No.	Title
4.	MN 8479D	Low Frequency Amplifiers.
5.	MN 8479E	High Frequency Amplifiers.
6.	MN 8479F	Switching.
7.	MN 8479G	Transistor Servicing.

D. Graphics

Wall charts (one each per classroom)

Source of charts is the cognizant district training aids office. Reference source is Training A

NAVPERS Number	Course Number	T
309671.2C-1	5-1-1	Training Device Bl

Transparencies (one each per classroom)

NAVPERS Number	Course Number	T
309671.2T-1	1-2-1	Military Uses of Tr
309671.2T-2	1-3-1	Atom Structure
309671.2T-3	1-3-2	The Periodic Chart
309671.2T-4	1-3-3	Germanium Atom
309671.2T-5	1-3-4	Germanium and Sili
309671.2T-6	1-3-5	Crystal Lattice of G
309671.2T-7	1-3-6	"N" and "P" Type G
309671.2T-8	1-4-1	Forward and Rever

d)

Title	Running Time	Per Cl
Low Frequency Amplifiers.		1
High Frequency Amplifiers.		1
Switching.		1
Transistor Servicing.		1

each per classroom)

is the cognizant district training aids office. Reference source is Training Aids Catalog NavPers, 2300056.

Number	Course Number	Title
2C-1	5-1-1	Training Device Block Diagram

(one each per classroom)

Number	Course Number	Title
2T-1	1-2-1	Military Uses of Transistors
2T-2	1-3-1	Atom Structure
2T-3	1-3-2	The Periodic Chart (Partial)
2T-4	1-3-3	Germanium Atom
2T-5	1-3-4	Germanium and Silicon Atoms Showing Subshells
2T-6	1-3-5	Crystal Lattice of Germanium Atom
2T-7	1-3-6	"N" and "P" Type Germanium
2T-8	1-4-1	Forward and Reverse Bias

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quarantine law was passed in Connecticut in 1726 to prevent the movement of the common barberry which was suspected of being responsible for stem rust epidemics. In 1881 the United States passed a domestic quarantine law to prevent the spread of the grape-gall louse. Finally, in 1912 the Federal Plant Quarantine Law was passed to prevent the importation of pests and diseases from abroad. An example of a quarantine in effect is the quarantine of citrus nursery stock which prohibits citrus plants from Europe, Asia, Africa, South America or Central America from entering the United States. Quarantine enforcement is difficult. Both laxness and excessive strictness is criticized. To be successful, quarantine regulations must be scientifically sound and administratively feasible. Thus, before a quarantine is established, a great deal of information is needed. The nature of the pathogen, the mode of dissemination, the mode of action, the host range and its natural barriers must all be taken into consideration. Quarantine regulations are classified as exclusive or regulatory. Regulatory conditions include inspection to see if plants are disease free, routine fumigation, and the holding of propagative stock under quarantine for a stated period of time. Exclusive quarantines prohibit the importation of plant materials. Exclusive quarantines are established when it is impossible to make certain that virulent pathogens are not accompanying plant materials.

2. Eradication consists of measures which are concerned with the elimination of the pathogen after it has become established in the sphere where the host is growing. These measures include: (a) eradication of alternate host such as currents in white pine blister rust or cedars in cedar-apple rust; (b) eradication of wild or overwintering host such as certain weed host of plant viruses (this practice often is too expensive and eradication of the insect vector that spreads the virus is more feasible); (c) eradication of overwintering debris as sources of primary inoculum by crop rotation such as in cotton-angular leaf spot (the organism that causes this disease must live on cotton residue); (d) sterilization, and/or sanitation as in the case of soil sterilization for nematodes or washing of fruit at the packing shed before shipping; (e) eradication of the pathogen from propagative parts of the host such as seeds, tubers, and bulbs as in the case of hot water treatment of barley seed for loose smut; (f) eradication from growing parts of the host by surgery as the removal of cankers from pear and apple trees with fire blight; (g) eradication of host and pathogen as in the removal and destruction of citrus trees with citrus canker; (h) eradication of established pathogens by means of a chemical as in the case of fungicide application for powdery mildew.

3. Protection refers to measures in which it is assumed that the host will be exposed to the pathogen and that infection will occur unless protection procedures are undertaken. Measures taken to regulate environment include; 1) selection of growing areas, as in the case of growing certified seed potatoes in northern states where there are "disease-proof" areas or the growing of bean and crucifer seed in the west, 2) protection by regulation of storage and transportation environment as in cooling, moisture control and air movement control for fruits and vegetables on their way to the consumer and 3) regulation of greenhouse environment as to humidity and temperature.

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D. Graphics (Continued)

Transparencies (one each per classroom)

NAVPERS Number	Course Number	T
309671.2T-9	1-5-1	Vacuum Tube Triode
309671.2T-10	1-5-2	NPN Junction Transis
309671.2T-11	1-6-1	Grounded Cathode and
309671.2T-12	1-6-2	The Grounded-Collec
309671.2T-13	1-6-3	Grounded-Base and G
309671.2T-14	2-1-1	Zener Diode Characte
309671.2T-15	2-2-1	Comparison of Opera Common-emitter, a Circuits
309671.2T-16	2-2-2	Common-base Amplif
309671.2T-17	2-2-3	Common-base Amplif
309671.2T-18	2-2-4	Common-emitter Amp
309671.2T-19	2-2-5	Common-collector Ar
309671.2T-20	2-2-6	Various Methods of C
309671.2T-21	2-2-7	Cascaded Amplifier S
309671.2T-22	2-2-8	Impedance-coupled A
309671.2T-23	2-2-9	Direct Coupled Ampli
309671.2T-24	2-3-1	Class A and Class B
309671.2T-25	2-3-2	Single-ended Class A
309671.2T-26	2-3-3	Class B Transistor P
309671.2T-27	2-3-4	Class B Complementa
309671.2T-28	2-3-5	Phase Inverter Circui
309671.2T-29	2-4-2	The Armstrong Oscill Oscillator
309671.2T-30	2-4-3	The Hartley Oscillato Oscillator
309671.2T-31	2-4-4	The Colpitts Oscillat Oscillator

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Course Number	Title
1-5-1	Vacuum Tube Triode and Transistor
1-5-2	NPN Junction Transistor with Input Signal
1-6-1	Grounded Cathode and Grounded Emitter
1-6-2	The Grounded-Collector Amplifier and the Cathode Follower
1-6-3	Grounded-Base and Grounded-Grid Amplifiers
2-1-1	Zener Diode Characteristic Curve
2-2-1	Comparison of Operating Characteristics of Common-base, Common-emitter, and Common-collector Amplifier Circuits
2-2-2	Common-base Amplifier with Two Batteries
2-2-3	Common-base Amplifier with One Battery
2-2-4	Common-emitter Amplifier
2-2-5	Common-collector Amplifier
2-2-6	Various Methods of Coupling Transistor Stages
2-2-7	Cascaded Amplifier Stages
2-2-8	Impedance-coupled Amplifier
2-2-9	Direct Coupled Amplifier
2-3-1	Class A and Class B Power Amplifiers
2-3-2	Single-ended Class A Power Amplifier
2-3-3	Class B Transistor Power Amplifier
2-3-4	Class B Complementary Push-pull Power Amplifier
2-3-5	Phase Inverter Circuit
2-4-2	The Armstrong Oscillator and a Comparable Transistor Oscillator
2-4-3	The Hartley Oscillator and a Comparable Transistor Oscillator
2-4-4	The Colpitts Oscillator and a Comparable Transistor Oscillator

ach per classroom)

er	Course Number	Title
	2-4-5	Internal Feedback Circuits
	2-4-6	How a Multivibrator Operates
	2-4-7	Analysis of the Operation of a Free-running Multivibrator-First Time Interval
	2-4-8	Analysis of the Operation of a Free-running Multivibrator-Second Time Interval
	2-4-9	Transistor Free-running Blocking Oscillator
	2-4-10	Photosensitive Transistor Using NPN-type Construction
	2-4-11	Block Diagram of a Drift Transistor
	3-1-1	RF and Mixer Stage of a Transistor Radio Receiver
	3-1-2	A Two-stage Transistor IF Amplifier
	3-1-3	A Two-stage Transistor Audio Amplifier
	3-1-4	A Two-stage Video Amplifier
	3-2-1	The Hartley and Colpitts Oscillators Using Transistors
	3-2-2	Wireless Microphone Circuit
	3-2-3	Base-controlled Negative Resistance Oscillator
	3-2-4	Negative Resistance Oscillators
	3-2-5	RF Oscillator Power Supply
	3-2-6	Flip-flop Circuit
	5-2-1	Power Supply
	5-3-1	Transistor Tester
	5-4-1	Wien Bridge Oscillator
	5-4-2	The Wien Bridge
	5-5-1	Transistor Amplifier

(Continued)

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D. Graphics (Continued)

Transparencies (one each per classroom)

NAVPERS Number	Course Number	Tit
309671.2T-60	5-6-1	Biased Diode Limiter
309671.2T-61	5-7-1	Differentiating and Li
309671.2T-62	5-8-1	One-shot Multivibrato
309671.2T-63	5-9-1	Sawtooth Generator
309671.2T-64	5-10-1	Phase Inverter
309671.2T-65	5-11-1	Flip-flop Multivibrato
309671.2T-66	5-12-1	Blocking Oscillator
309671.2T-67	5-13-1	Coincidence Circuit
309671.2T-68	2-4-1	RC Network or Phase-

E. Test Equipment

Item No.	Description
1.	Oscilloscope OS-8U
2.	Multimeter AN/PSM-4

tinued)

es (one each per classroom)

S Number	Course Number	Title
1.2T-60	5-6-1	Biased Diode Limiter
1.2T-61	5-7-1	Differentiating and Limiting Circuit
1.2T-62	5-8-1	One-shot Multivibrator
1.2T-63	5-9-1	Sawtooth Generator
1.2T-64	5-10-1	Phase Inverter
.2T-65	5-11-1	Flip-flop Multivibrator
.2T-66	5-12-1	Blocking Oscillator
.2T-67	5-13-1	Coincidence Circuit
.2T-68	2-4-1	RC Network or Phase-shift Oscillator

t

Description	Per Cl
Oscilloscope OS-8U	12
Multimeter AN/PSM-4	4

F. Transistor Training Device, Navpers 17534 - Spare Parts

TB-1 Parts and Layout

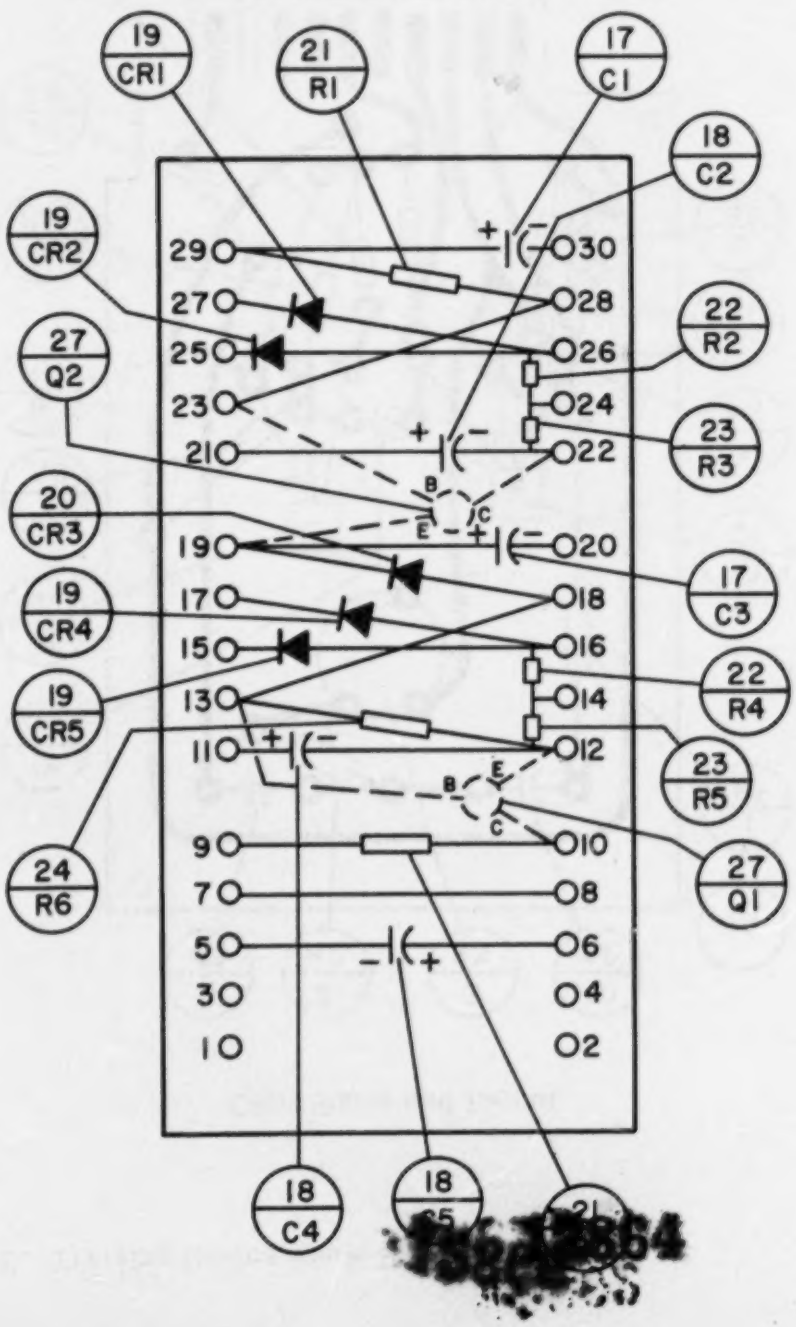

Item	Circuit Symbol	Manufac
1		Burtek,
2		Burtek,
3	T1&T2	Triad
4	TB1	USECO
5	TB2	USECO
6		Cornish
7		Littlefu
8	F1	Amphen
9		Grayhil
10		E. F. Jo
11		Amphen
12	S1	SPEMC
13	S2	SPEMC
14	S3	SPEMC
15	CB1 thru CB11	ELCO
16	PL1	Dialco
17	C1&C3	CD
18	C2,C4&C5	CD
19	CR1,CR2, CR4&CR5	Int. Rec
20	CR3	Int. Rec
21	R1&R7	AB (or
22	R2&R4	AB (or
23	R3&R5	AB (or
24	R6	AB (or
25	R8	AB (or
26	R9	Central
27	Q1&Q2	Texas I

MAIN

Note: Only the layout fo
all the components of th
contained in the Trainee
other components.

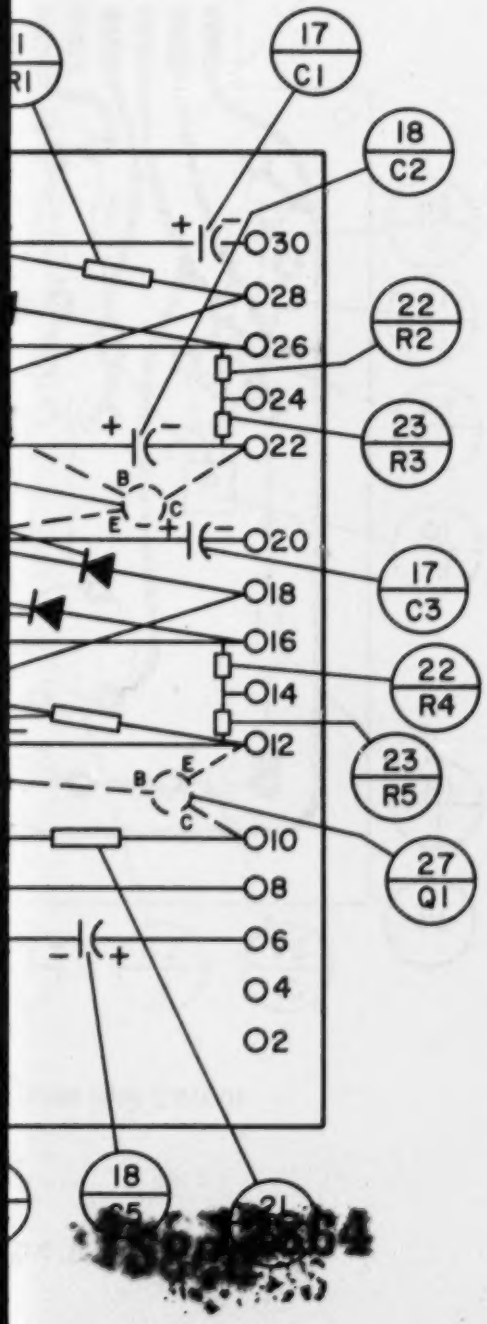

MAIN CHASSIS UNIT PARTS

Item	Circuit Symbol	Manufacturer	Description
1		Burtek, Inc.	Chassis
2		Burtek, Inc.	Bracket
3	T1&T2	Triad	Transformer #F40X
4	TB1	USECO	Terminal Board #C1100D
5	TB2	USECO	Terminal Board #C1100
6		Cornish	Line Cord #3552
7		Littlefuse	Fuseholder #342012
8	F1	Amphenol	Fuse 1/3 Amp. #3AG
9		Grayhill	Spring-Loaded Post #29-104-B
10		E. F. Johnson	Test Jack Type 105 (56 places)
11		Amphenol	Receptable #61M10
12	S1	SPEMCO	Switch #1137
13	S2	SPEMCO	Switch #1195
14	S3	SPEMCO	Switch #1135
15	CB1 thru CB11	ELCO	Printed Ckt. Brd. Socket #6007-10-6-S-5
16	PL1	Dialco	Indicator #521308 H991
17	C1&C3	CD	Cap. 50 MFD 25 VDC #50-25
18	C2,C4&C5	CD	Cap. 100 MFD 25 VDC #100-25
19	CR1,CR2, CR4&CR5	Int. Rect. Corp.	Rectifier #SD91
20	CR3	Int. Rect. Corp.	Zener Diode #1N1513
21	R1&R7	AB (or equal)	Resistor 500 ohm 1 watt
22	R2&R4	AB (or equal)	Resistor 10 ohm 1/2 watt
23	R3&R5	AB (or equal)	Resistor 20 ohm 1/2 watt
24	R6	AB (or equal)	Resistor 390 ohm 1/2 watt
25	R8	AB (or equal)	Resistor 470 ohm 1/2 watt
26	R9	Centralab	Potentiometer 10K Type B-15
27	Q1&Q2	Texas Instrument	Transistor 2N250

Note: Only the layout for TB1 is illustrated. This contains all the components of the power supply. The wiring diagram contained in the Trainee's Guide should be used for locating other components.

CB-1 Parts and Layout

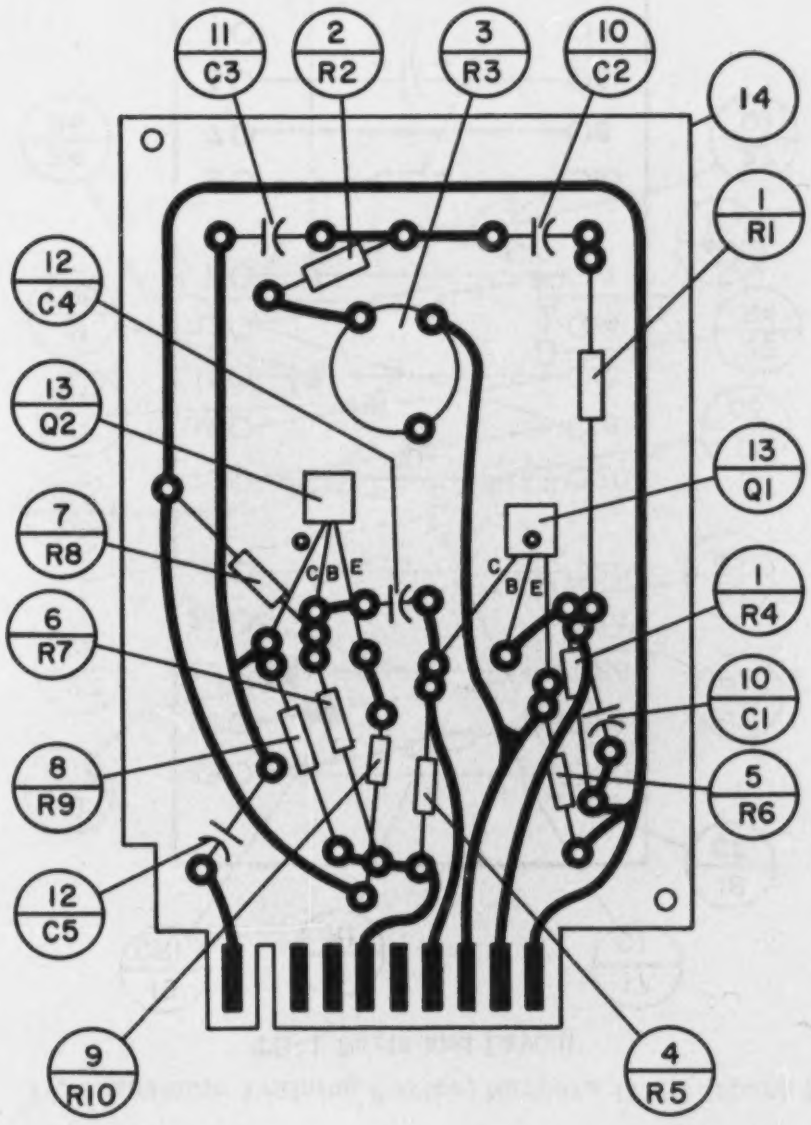

Item	Circuit Symbol	Manufacturer
1	R1&R4	AB (or equal)
2	R2	AB (or equal)
3	R3	Continental
4	R5	AB (or equal)
5	R6	AB (or equal)
6	R7	AB (or equal)
7	R8	AB (or equal)
8	R9	AB (or equal)
9	R10	AB (or equal)
10	C1&C2	CD
11	C3	Centralab
12	C4&C5	Centralab
13	Q1&Q2	G.E.
14	CB-1	Burtek, Inc.

Note: The illustration shows the location looking at the epoxy side of the board.

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Layout

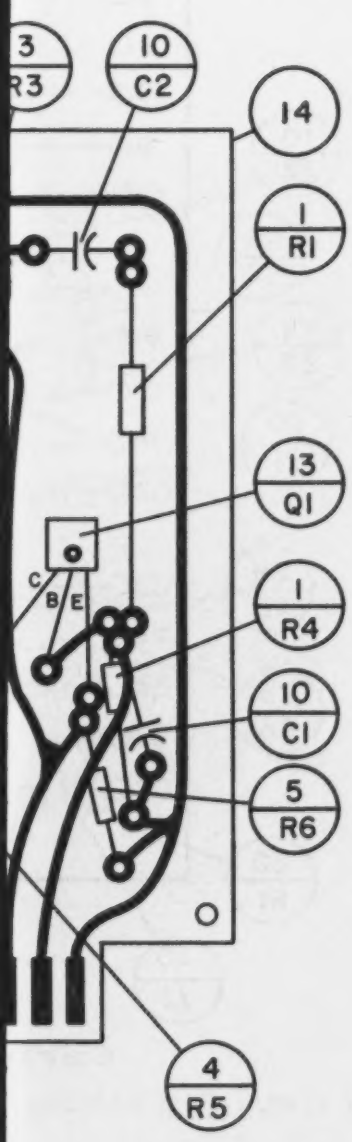

Item	Circuit Symbol	Manufacturer	Description
1	R1&R4	AB (or equal)	Resistor 15K 1/4 watt ±1%
2	R2	AB (or equal)	Resistor 1K 1/4 watt
3	R3	Continental	Rheostat 1K #WC816B
4	R5	AB (or equal)	Resistor 51K 1/4 watt
5	R6	AB (or equal)	Resistor 470 ohm 1/4 watt
6	R7	AB (or equal)	Resistor 1 Meg 1/4 watt
7	R8	AB (or equal)	Resistor 27K 1/4 watt
8	R9	AB (or equal)	Resistor 10K 1/4 watt
9	R10	AB (or equal)	Resistor 47 ohm 1/4 watt
10	C1&C2	CD	Cap. .01MFD #CD-1A551
11	C3	Centralab	Cap. .22MFD #UK-10-204
12	C4&C5	Centralab	Cap. .1MFD #UK-10-104
13	Q1&Q2	G.E.	Transistor 2N322
14	CB-1	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows the location of components looking at the epoxy side of the board.

Cultural practices followed to protect hosts include; 1) time of planting, as in planting cotton when the soil temperature will prohibit damping-off of seedlings; 2) regulation of soil moisture; 3) adjustment of soil pH as is the case of lowering the pH to protect against potato scab and 4) regulation of fertility level and balance as in limiting nitrogen fertilizer on pear trees as protection against fire blight or addition of chelated iron to prevent cholorosis.

Proper handling practices assist in the prevention of bruises caused by handling fruit and vegetables.

Chemicals are used to protect plant parts before the pathogen invades the plant, as in the application of a fungicide to protect against late blight of potatoes and tomatoes. Another example of the use of chemicals for host protection is pre-plant seed treatment to control pre-emergence damping-off.

Tubers, bulbs and other propogative plant parts are treated with an antibiotic dip to protect from crowngall. Bare root stock may also be treated in this way.

Row fumigation is used to treat soil for protection against nematodes.

4. Resistant varieties are used to control many of the serious plant diseases which cannot be controlled by seed treatment, chemical sprays or cultural methods. In these cases, the use of resistant varieties is the cheapest way to control diseases. In breeding for disease resistance the plant breeder is dealing with two series of heritable variations; (1) those of the host plant and (2) those of the pathogen.

The plant breeder tests the progenies by exposing them to the species of bio-types of the pathogen with which he is working. Environmental conditions ideally suited for the best development of the disease are maintained. Plants which are resistant to the pathogen are selected from the hybrids and later generations with close attention to other desirable characteristics such as yield. Having obtained suitable parental materials, the breeder attempts to combine disease resistance from one plant with the desirable commercial or cultural characteristics of the other.

Examples of diseases that can be controlled through the use of resistant varieties include flax wilt, cabbage yellows and stem and crown rusts of oats. An example of a way resistant varieties were developed, it was noted that when flax was grown on the same land for several years, serious losses from wilt often resulted. Hirotsuka in Japan (1896) and Bolley in North Dakota (1901) found that a Fusarium was responsible. Previously Bolley had noticed that a few plants survived each year in his "disease garden." He selected these, sowing the seed in the same plot and by repeated selection obtained wilt resistant varieties.

5. Kinds of disease resistance. There are two kinds of disease resistance: 1) Resistance to entrance; the epidermis of some plants is so resistant that the germ tube cannot penetrate; 2) Resistance after

F. Training Device Spare Parts (Continued)

CB-2 Parts and Layout

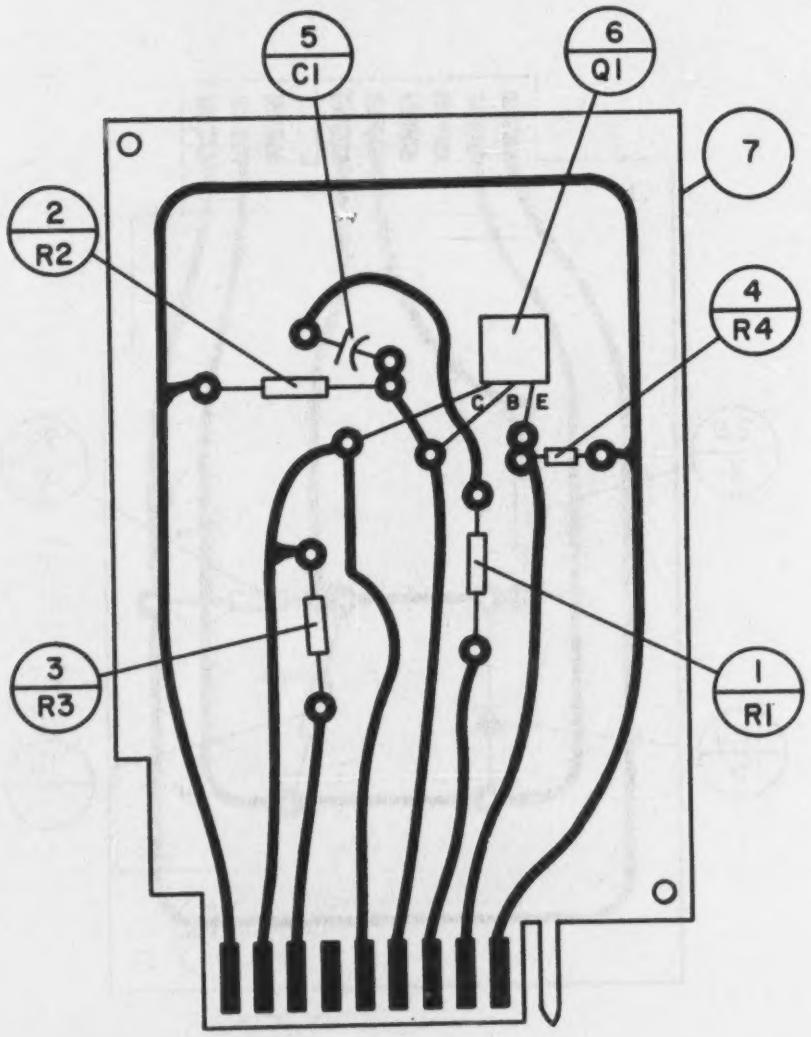

Item	Circuit Symbol	M
1	R1	A
2	R2	A
3	R3	A
4	R4	A
5	C1	C
6	Q1	G
7	CB-2	B

Note: The illustra
looking at the epox

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ıre Parts (Continued)

Parts and Layout

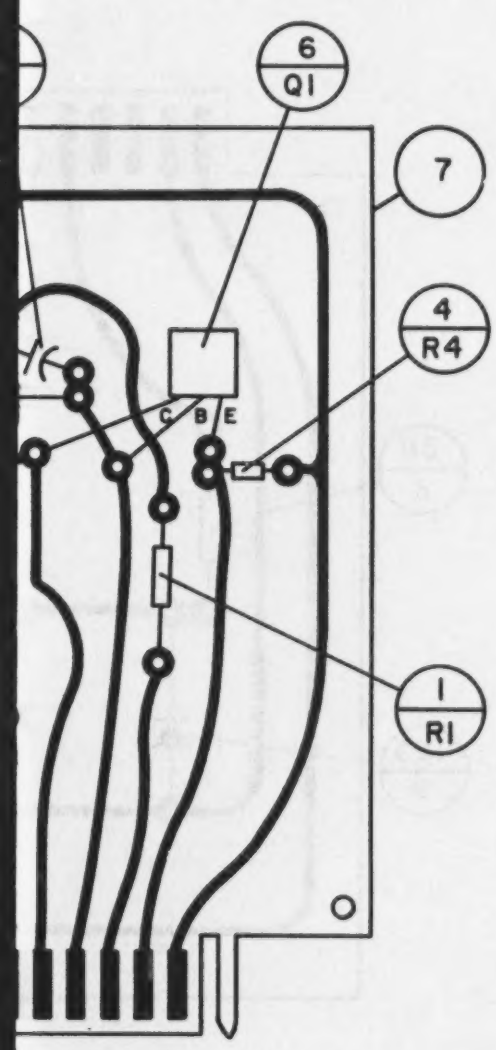

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 6.8K 1/4 watt
2	R2	AB (or equal)	Resistor 4.7K 1/4 watt
3	R3	AB (or equal)	Resistor 47 ohm 1/4 watt
4	R4	AB (or equal)	Resistor 100 ohm 1/4 watt
5	C1	Centralab	Cap. 1MFD #UK-10-104
6	Q1	G.E.	Transistor 2N322
7	CB-2	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows the location of components looking at the epoxy side of the board.

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F. Training Device Spare P[redacted]ued)

CB-3 Parts and Layout

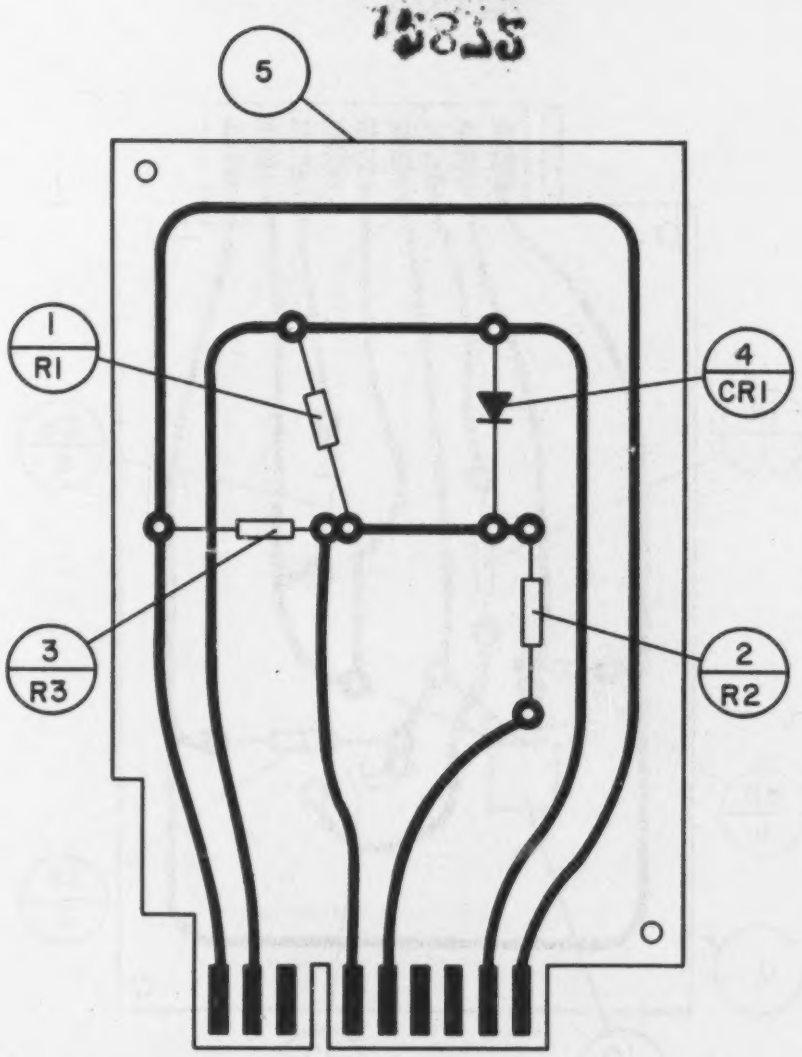

Item	Circuit Symbol	Manufactur[redacted]
1	R1	AB (or equa
2	R2	AB (or equa
3	R3	AB (or equa
4	CR1	Int. Rect. C
5	CB-3	Burtek, Inc

Note: The illustration show
looking at the epoxy side of

3 Parts and Layout

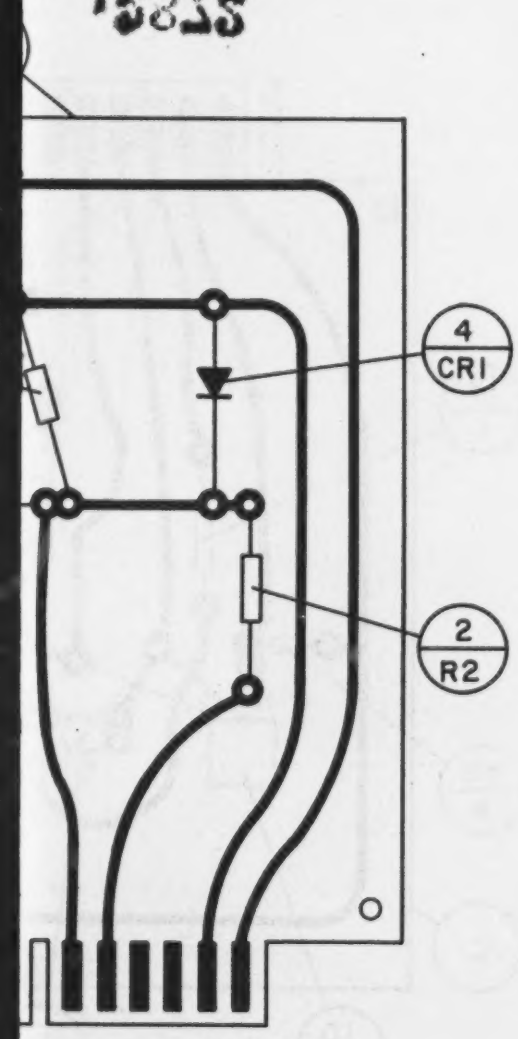

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 15K 1/4 watt
2	R2	AB (or equal)	Resistor 680 ohm 1/4 watt
3	R3	AB (or equal)	Resistor 1K 1/4 watt
4	CR1	Int. Rect. Corp.	Diode 1N34A
5	CB-3	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows the location of components looking at the epoxy side of the board.

F. Training Device Spare Parts (Continued)

CB-4 Parts and Layout

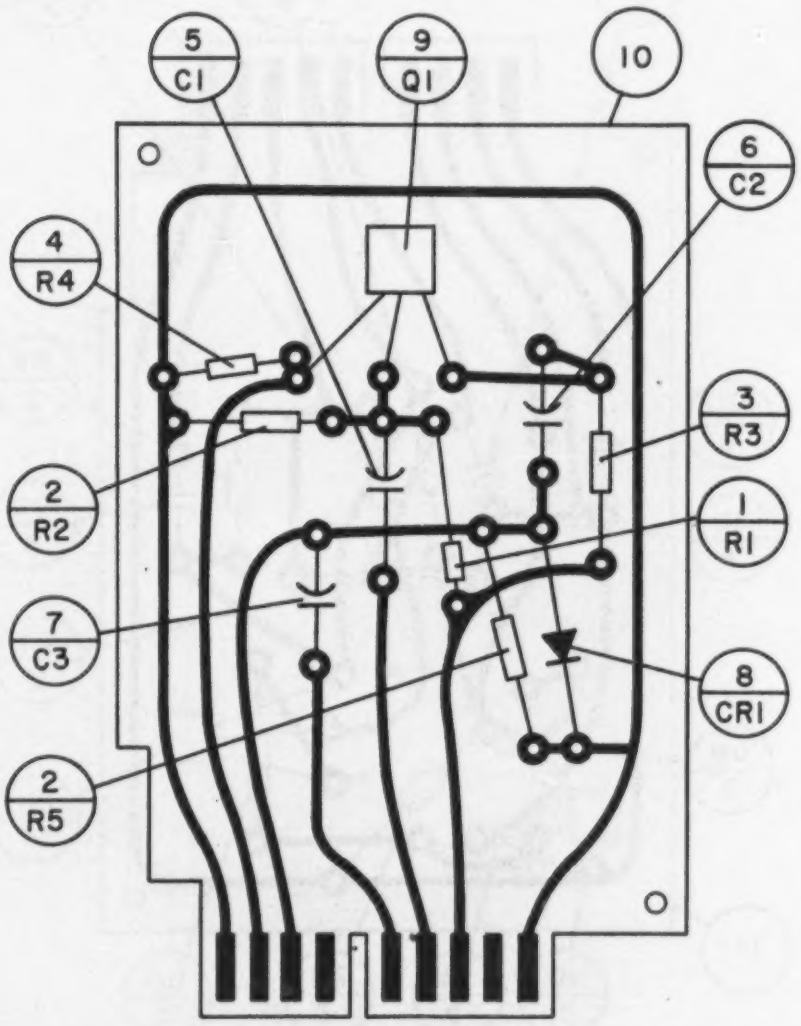

Item	Circuit Symbol	M
1	R1	A
2	R2&R5	A
3	R3	A
4	R4	A
5	C1	C
6	C2	C
7	C3	C
8	CR1	In
9	Q1	G
10	CB-4	B

Note: The illustra
looking at the epo

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ce Spare Parts (Continued)

CB-4 Parts and Layout

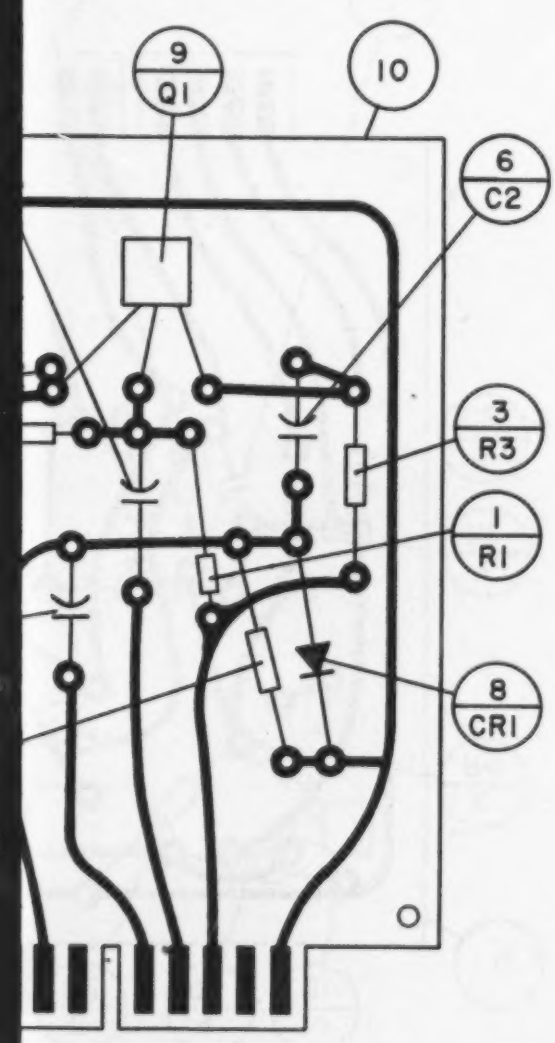

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 470K 1/4 watt
2	R2&R5	AB (or equal)	Resistor 68K 1/4 watt
3	R3	AB (or equal)	Resistor 27K 1/4 watt
4	R4	AB (or equal)	Resistor 27 ohm 1/4 watt
5	C1	Centralab	Cap. .1MFD #UK-10-104
6	C2	Centralab	Cap. .001MFD #DM-102
7	C3	Centralab	Cap. .005MFD #DM-502
8	CR1	Int. Rect. Corp.	Diode 1N34A
9	Q1	G. E.	Transistor 2N322
10	CB-4	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows the location of components looking at the epoxy side of the board.

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F. Training Device Spare Parts (Continued)

CB-5 Parts and Layout

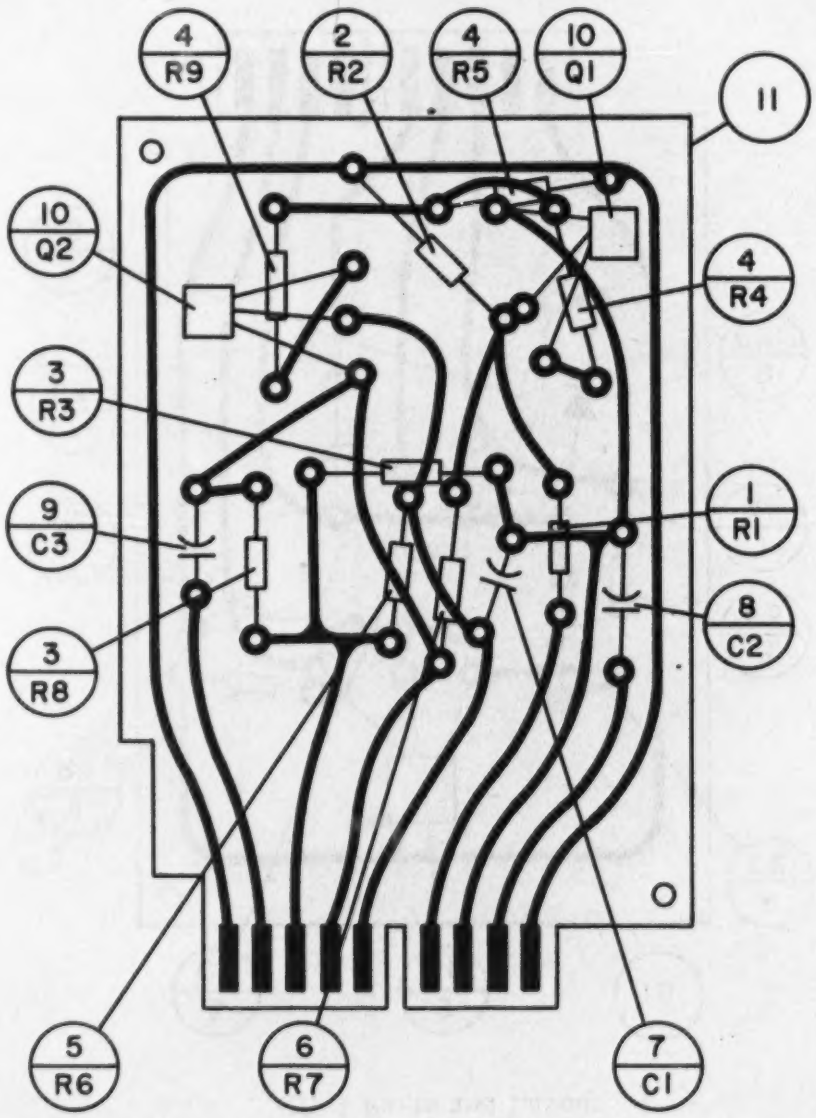

Item	Circuit Symbol	Manufacturer
1	R1	AB (or equal)
2	R2	AB (or equal)
3	R3&R8	AB (or equal)
4	R4,R5&R9	AB (or equal)
5	R6	AB (or equal)
6	R7	AB (or equal)
7	C1	Centralab
8	C2	Centralab
9	C3	Centralab
10	Q1&Q2	G. E.
11	CB-5	Burtek, Inc.

Note: The illustration shows the location looking at the epoxy side of the board.

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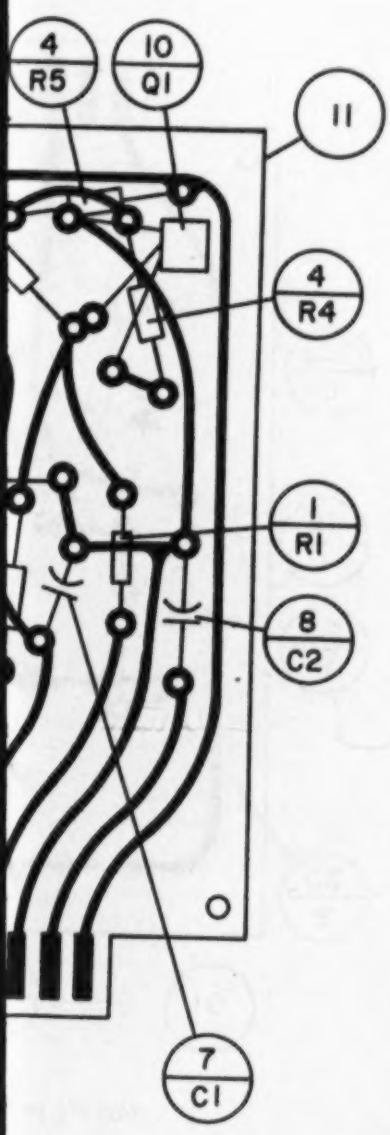

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 12K 1/4 watt
2	R2	AB (or equal)	Resistor 22K 1/4 watt
3	R3&R8	AB (or equal)	Resistor 15K 1/4 watt
4	R4,R5&R9	AB (or equal)	Resistor 1K 1/4 watt
5	R6	AB (or equal)	Resistor 1 Meg 1/4 watt
6	R7	AB (or equal)	Resistor 68K 1/4 watt
7	C1	Centralab	Cap. .003MFD #DM-302
8	C2	Centralab	Cap. .1MFD #UK-10-104
9	C3	Centralab	Cap. .001MFD #DM-102
10	Q1&Q2	G. E.	Transistor 2N322
11	CB-5	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows the location of components looking at the epoxy side of the board.

F. Training Device Spare Parts (Continued)

CB-6 Parts and Layout

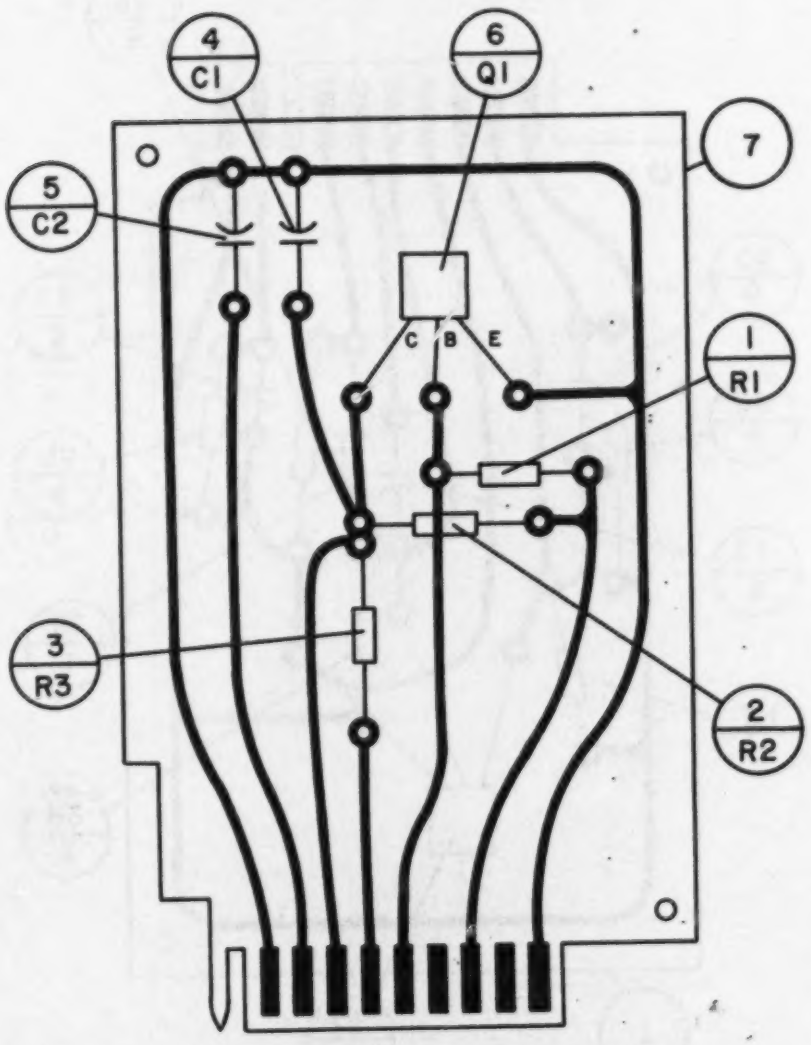

Item	Circuit Symbol	Manufac
1	R1	AB (or
2	R2	AB (or
3	R3	AB (or
4	C1	Centrala
5	C2	Centrala
6	Q1	G. E.
7	CB-6	Burtek,

Note: The illustration s
looking at the epoxy side

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Parts (Continued)

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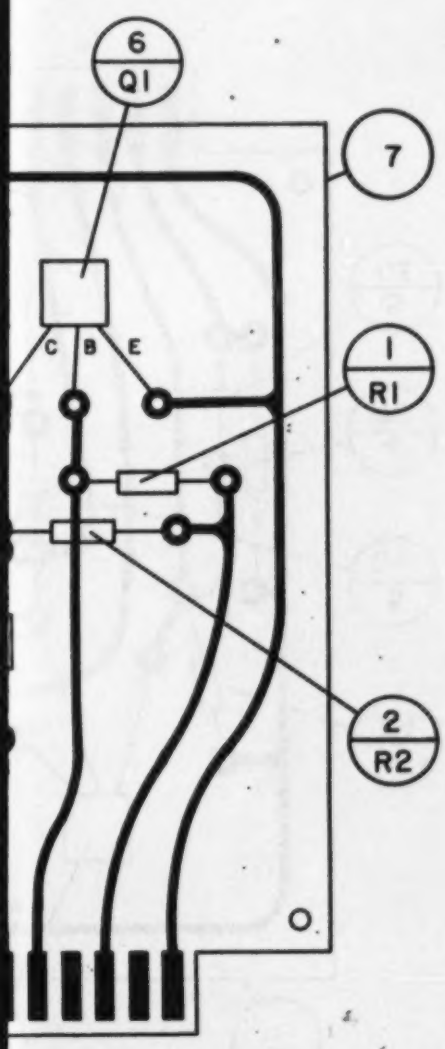

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 220K 1/4 watt
2	R2	AB (or equal)	Resistor 15K 1/4 watt
3	R3	AB (or equal)	Resistor 68K 1/4 watt
4	C1	Centralab	Cap. .01MFD #DM-103
5	C2	Centralab	Cap. .005MFD #DM-502
6	Q1	G. E.	Transistor 2N1086
7	CB-6	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows the location of components looking at the epoxy side of the board.

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entrance; the germ tube quickly kills a few host cells and in turn is killed by substances from the host cell.

In addition to the above, plant diseases may be avoided or minimized by: 1) Escape; where rapid growth and early maturity enables plants to escape attack of plant pathogens; 2) Disease tolerance; in disease tolerance the plant can live with the pathogens or else overcome their adverse effects by compensating growth. An example would be where new roots are sent out quickly when some have been killed by root rot organisms.

SUMMARY

Man depends upon plants for food, shelter and clothing. The cost of these items has increased millions of dollars each year because plant diseases render unfit for consumption or reduce the yield of much of the farmer's production. Additional millions of dollars are spent in attempts to control or learning how to control plant diseases.

Plant disease may be classified as to symptoms or causal agents. Symptoms or signs are manifest as superficial, tissue death, underdevelopment, abnormal overgrowth or wilt. Agents which cause disease are classified as inanimate or animate. The inanimate causal agents may be unfavorable soil conditions or weather, improper cultural practices, industrial contaminants or the results of uncontrolled plant metabolism. Animate causal agents consist of higher animals, insects, nematodes, baceteria, fungi, algae, parasitic seed plants and viruses.

Plant pathogens may obtain their food from either dead or living matter and may be selective or have a wide range of hosts. Environment influences their growth and reproduction. Plant pathogens are spread by wind, water, insects, animals and man. Normally, for a plant to become infected by a pathogen, it must be inoculated. The pathogen must germinate and penetrate the host to become established. Plant diseases are controlled by excluding the pathogen from the host, eradicating the pathogen from the host, protecting the host from the pathogen or by using varieties resistant to the pathogen. Further research is needed to learn new and more effective ways of controlling plant diseases.

F. Training Device Spare Parts (Continued)

CB-7 Parts and Layout

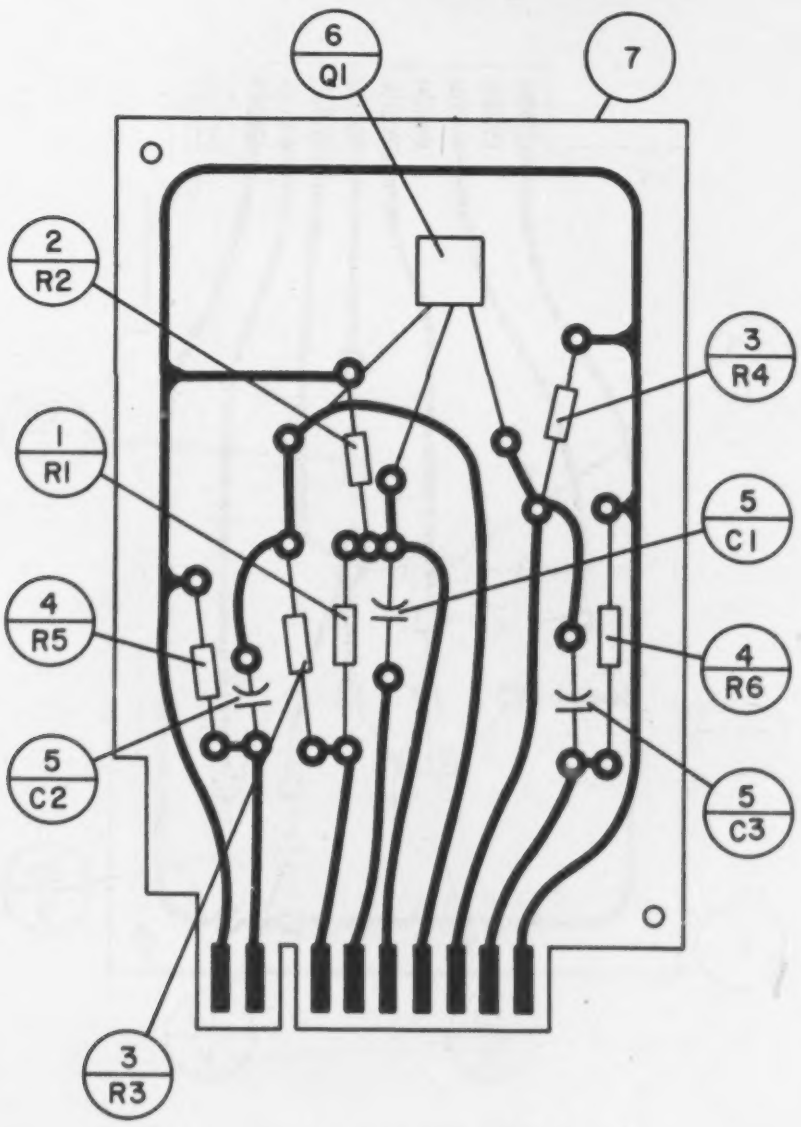

Item	Circuit Symbol	Manufacturer	Desc
1	R1	AB (or equal)	Resis
2	R2	AB (or equal)	Resis
3	R3&R4	AB (or equal)	Resis
4	R5&R6	AB (or equal)	Resis
5	C1,C2&C3	Centralab	Cap.
6	Q1	G. E.	Trans
7	CB-7	Burtek, Inc.	Print

Note: The illustration shows the location of c
looking at the epoxy side of the board.

e Parts (Continued)
ts and Layout

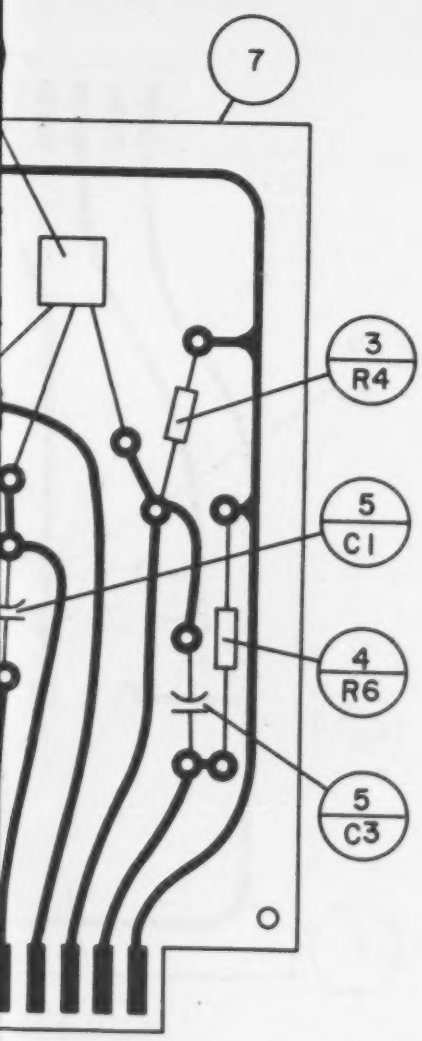

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 150K 1/4 watt
2	R2	AB (or equal)	Resistor 470K 1/4 watt
3	R3&R4	AB (or equal)	Resistor 10K 1/4 watt
4	R5&R6	AB (or equal)	Resistor 47K 1/4 watt
5	C1,C2&C3	Centralab	Cap. .1MFD #UK-10-104
6	Q1	G. E.	Transistor 2N322
7	CB-7	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows the location of components looking at the epoxy side of the board.

F. Training Device Spare Parts (Continued)

CB-8 Parts and Layout

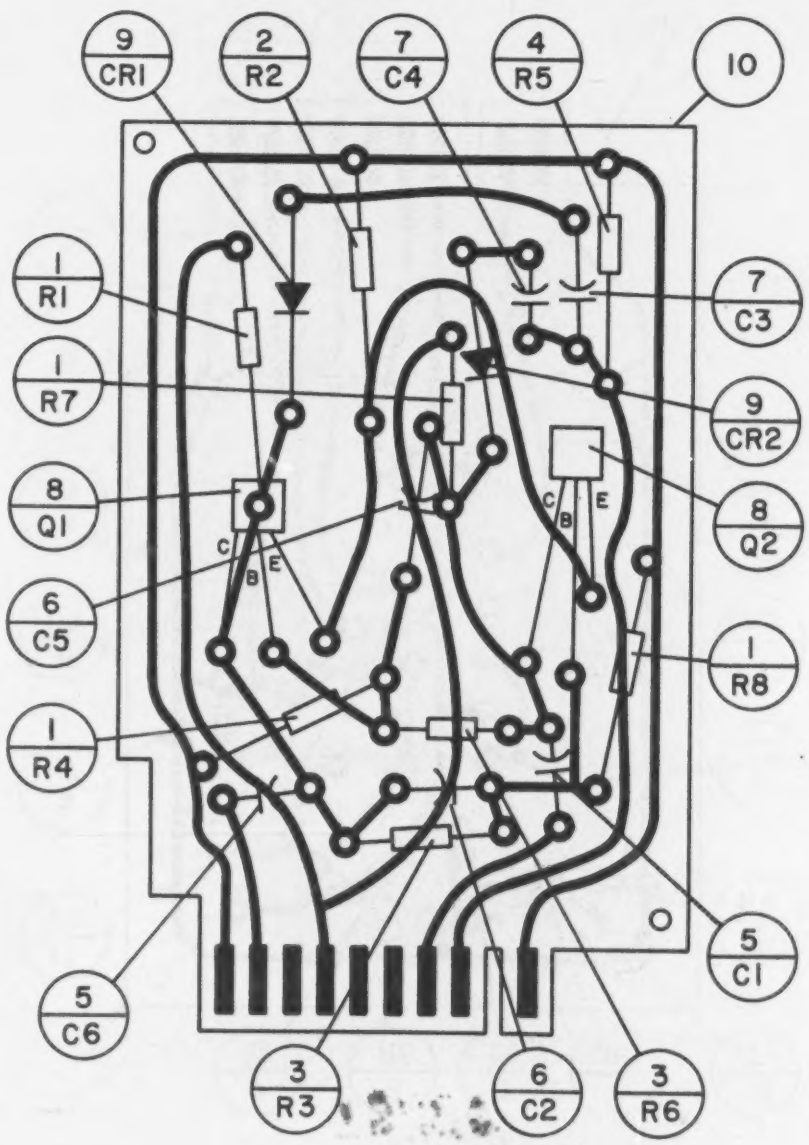

Item	Circuit Symbol	Manufacturer
1	R1,R4,R7 &R8	AB (or equal)
2	R2	AB (or equal)
3	R3&R6	AB (or equal)
4	R5	AB (or equal)
5	C1&C6	Centralab
6	C2&C5	Centralab
7	C3&C4	Centralab
8	Q1&Q2	G. E.
9	CR1&CR2	Int. Rect. Corp
10	CB-8	Burtek, Inc.

Note: The Illustration shows th
looking at the epoxy side of the

e Spare Parts (Continued)

3-8 Parts and Layout

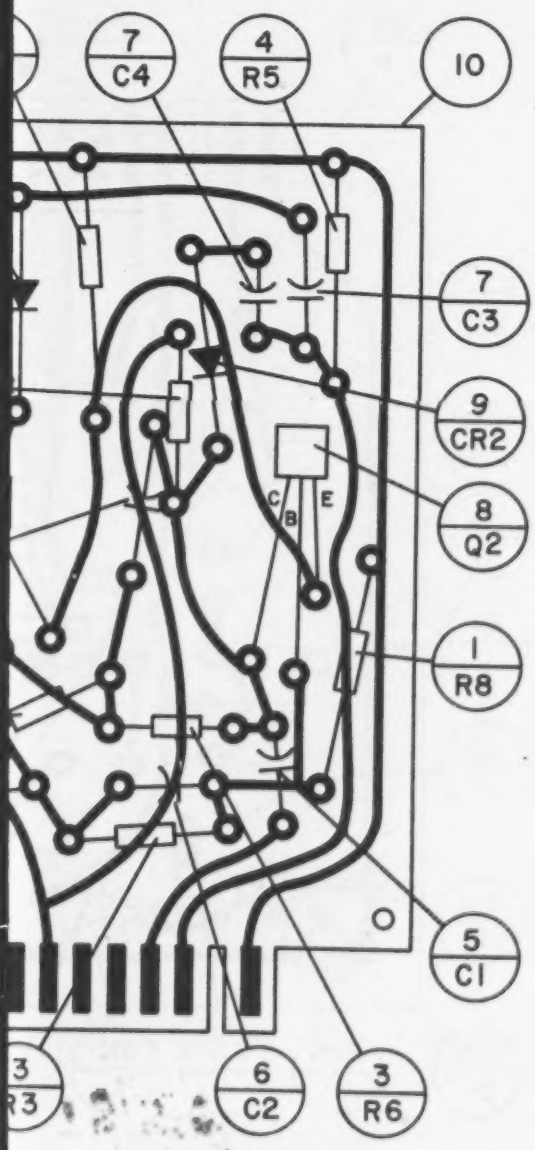

Item	Circuit Symbol	Manufacturer	Description
1	R1,R4,R7 &R8	AB (or equal)	Resistor 15K 1/4 watt
2	R2	AB (or equal)	Resistor 470 ohm 1/4 watt
3	R3&R6	AB (or equal)	Resistor 120K 1/4 watt
4	R5	AB (or equal)	Resistor 22K 1/4 watt
5	C1&C6	Centralab	Cap. .1MFD #UK-10-104
6	C2&C5	Centralab	Cap. .005MFD #DM-502
7	C3&C4	Centralab	Cap. .001MFD #DM-102
8	Q1&Q2	G. E.	Transistor 2N322
9	CR1&CR2	Int. Rect. Corp.	Diode 1N34A
10	CB-8	Burtek, Inc.	Printed Circuit Board

Note: The Illustration shows the location of the components looking at the epoxy side of the board.

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F. Training Device Spare Parts 12882

CB-9 Parts and Layout

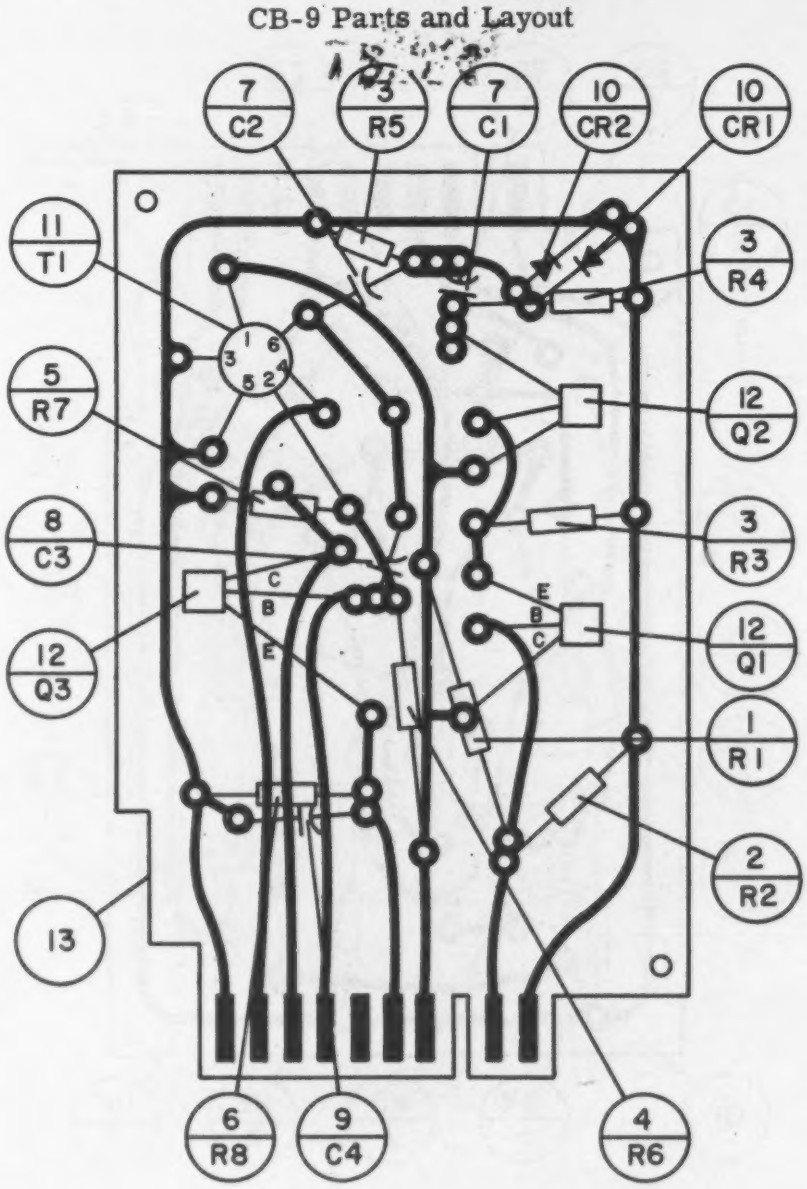

Item	Circuit Symbol	Manufacturer
1	R1	AB (or equal)
2	R2	AB (or equal)
3	R3,R4&R5	AB (or equal)
4	R6	AB (or equal)
5	R7	AB (or equal)
6	R8	AB (or equal)
7	C1&C2	Centralab
8	C3	Centralab
9	C4	Centralab
10	CR1&CR2	Int. Rect. Corp.
11	T1	UTC
12	Q1,Q2&Q3	G. E.
13	CB-9	Burtek, Inc.

Note: The illustration shows loca
looking at the epoxy side of the bo

Layout

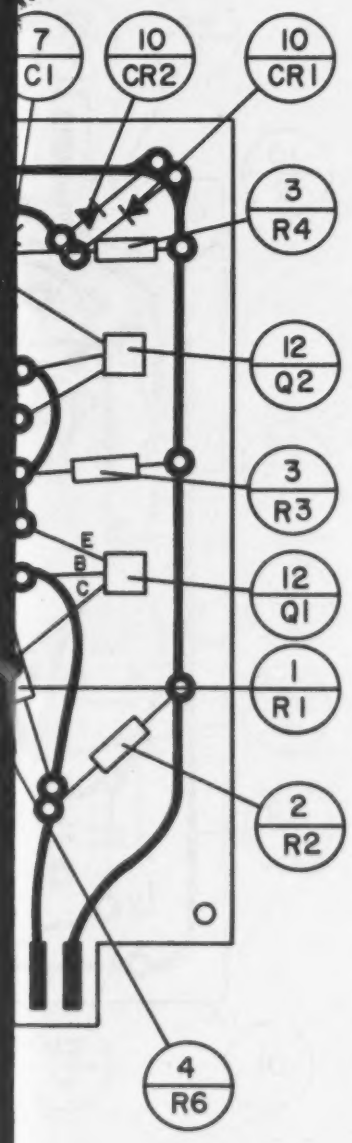

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 680K 1/4 watt
2	R2	AB (or equal)	Resistor 270K 1/4 watt
3	R3,R4&R5	AB (or equal)	Resistor 22K 1/4 watt
4	R6	AB (or equal)	Resistor 470K 1/4 watt
5	R7	AB (or equal)	Resistor 39K 1/4 watt
6	R8	AB (or equal)	Resistor 300 ohm 1/4 watt
7	C1&C2	Centralab	Cap. .1MFD #UK-10-104
8	C3	Centralab	Cap. .05MFD #UK-10-503
9	C4	Centralab	Cap. 1.0MFD #UK-10-105
10	CR1&CR2	Int. Rect. Corp.	Diode 1N34A
11	T1	UTC	Transformer #H-51
12	Q1,Q2&Q3	G. E.	Transistor 2N322
13	CB-9	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows location of components looking at the epoxy side of the board.

F. Training Device Spare Parts (Continued)

CB-10 Parts and Layout

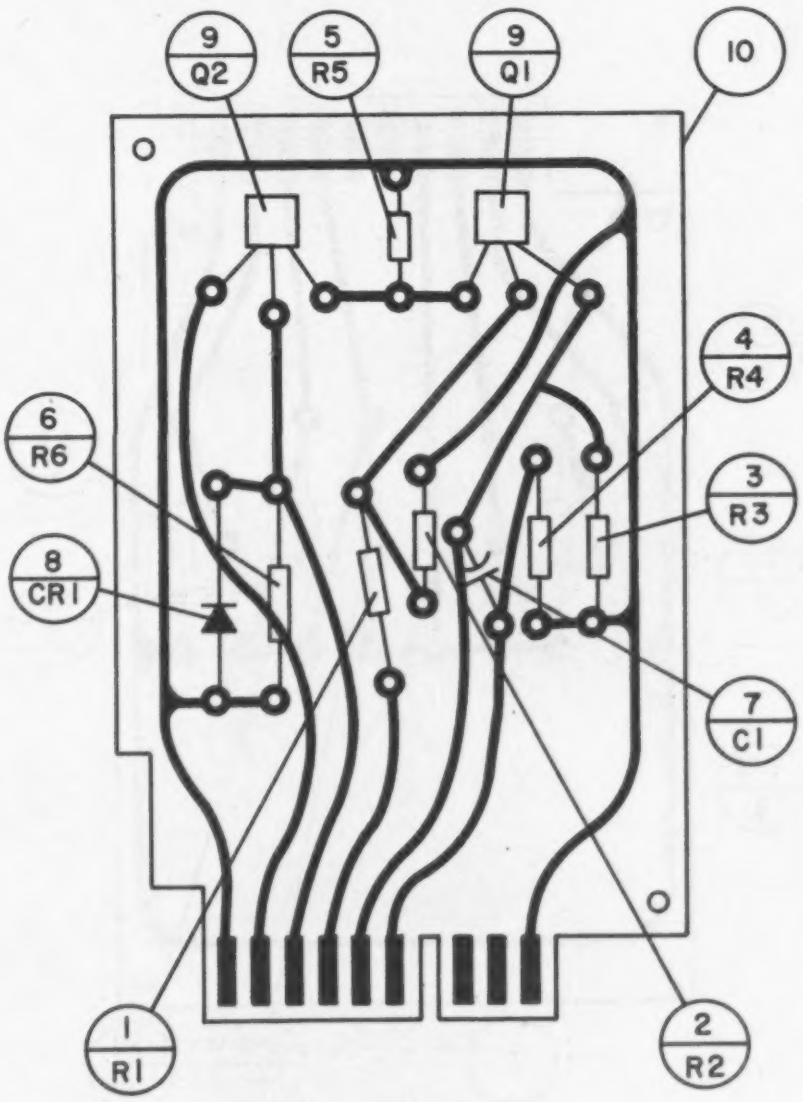

Item	Circuit Symbol	Manufacturer
1	R1	AB (or equal)
2	R2	AB (or equal)
3	R3	AB (or equal)
4	R4	AB (or equal)
5	R5	AB (or equal)
6	R6	AB (or equal)
7	C1	Centralab
8	CR1	Int. Rect. Co
9	Q1&Q2	G. E.
10	CB-10	Burtek, Inc.

Note: The illustration shows
from epoxy side of the board.

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ce Spare Parts (Continued)

B-10 Parts and Layout

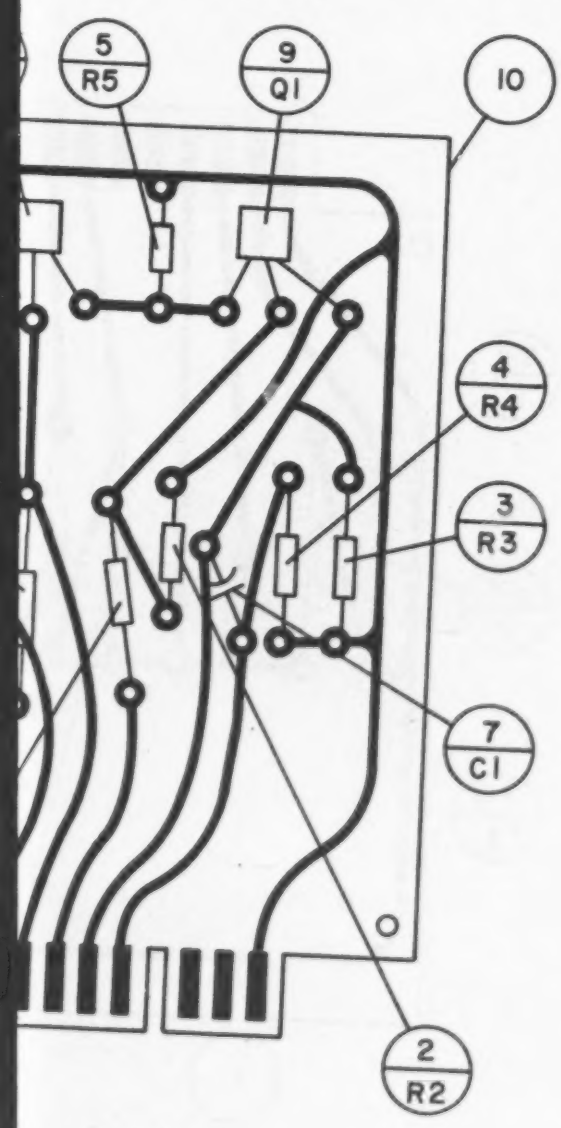

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 51K 1/4 watt
2	R2	AB (or equal)	Resistor 27K 1/4 watt
3	R3	AB (or equal)	Resistor 22K 1/4 watt
4	R4	AB (or equal)	Resistor 47K 1/4 watt
5	R5	AB (or equal)	Resistor 1K 1/4 watt
6	R6	AB (or equal)	Resistor 82K 1/4 watt
7	C1	Centralab	Cap. .01MFD #DM-103
8	CR1	Int. Rect. Corp.	Diode 1N34A
9	Q1&Q2	G. E.	Transistor 2N1086
10	CB-10	Burtek, Inc.	Printed Circuit Board

Note: The illustration shows location of components from epoxy side of the board.

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F. Training Device Spa[illegible]ontinued)

CB-1[illegible] Layout

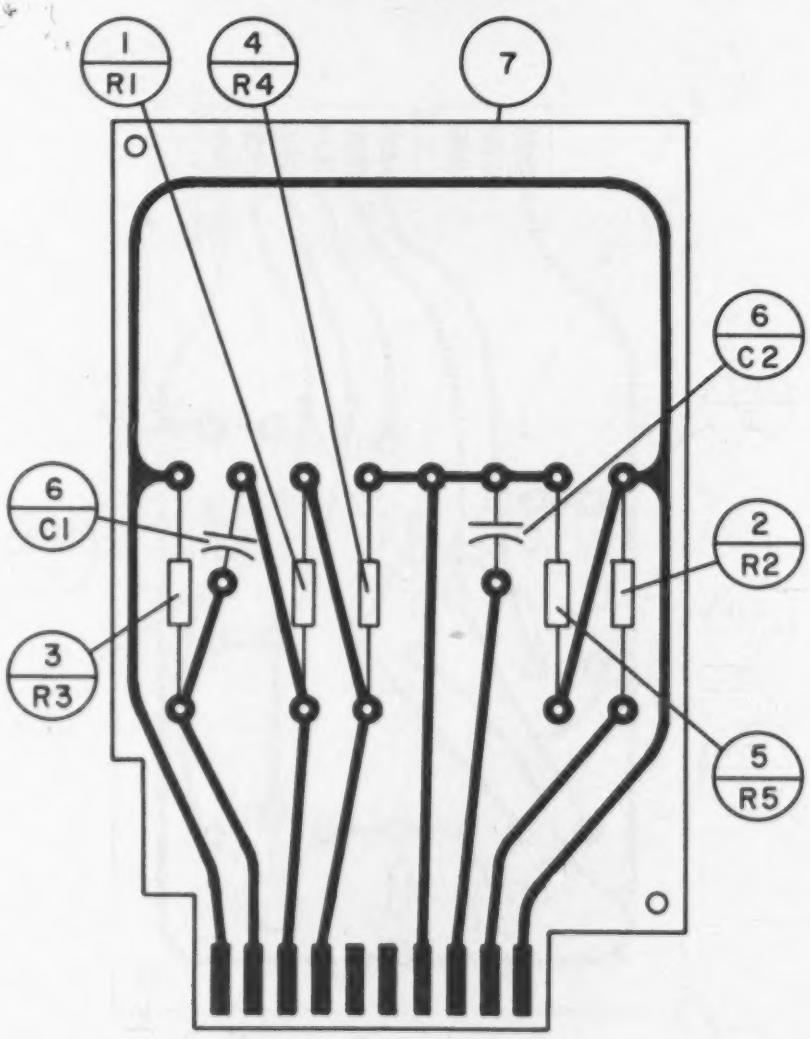

Item	Circuit Symbol	Manufacturer
1	R1	AB (or equal)
2	R2	AB (or equal)
3	R3	AB (or equal)
4	R4	AB (or equal)
5	R5	AB (or equal)
6	C1&C2	Centralab
7	CB-11	Burtek, Inc.

Note: The Illustration shows loc
looking at the epoxy side of the b

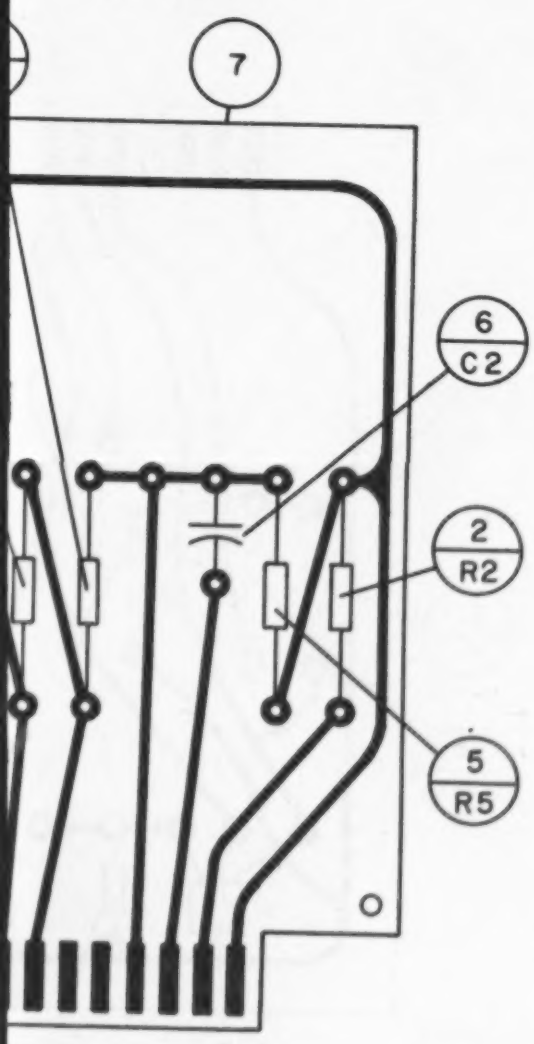

Item	Circuit Symbol	Manufacturer	Description
1	R1	AB (or equal)	Resistor 10K 1/4 watt
2	R2	AB (or equal)	Resistor 1K 1/4 watt
3	R3	AB (or equal)	Resistor 47K 1/4 watt
4	R4	AB (or equal)	Resistor 1Meg 1/4 watt
5	R5	AB (or equal)	Resistor 27K 1/4 watt
6	C1&C2	Centralab	Cap. .1MFD #UK-10-104
7	CB-11	Burtek, Inc.	Printed Circuit Board

Note: The Illustration shows location of components looking at the epoxy side of the board.

* U.S. GOVERNMENT PRINTING OFFICE : 1962 O—625815

PRINCIPLES OF PLANT PATHOLOGY

IN

EXERCISES AND EXPERIMENTS

The exercises included in this section are designed to be performed by individual students or students working in teams. Most of the exercises require a period of time before the final results can be recorded. It is desirable that the experiments be carefully planned ahead of time in order that results will be available at the appropriate time that the material or principle it demonstrates is being discussed.

Listed below are seven vital functions in the life of plants involving food production and growth.

1. Food stored in seed, roots or modified stems maintain respiration of a bud or embryo and supports growth after dormancy.

2. The stored foods are hydrolized into simple sugars and amino acids and transferred to the expanding bud or embryo in the spring.

3. The new plant sends out roots with limited food reserves. Roots acquire water and nutrients from the soil.

4. Food reserves from seed and solutes from the soil are used to inaugurate meristimatic activity in the young plant. Food source is transferred from seed to the new leaves.

5. As the seedling enlarges water must be transferred from the roots to the leaves to sustain photosynthesis.

6. In the leaves carbon dioxide and water are combined to form sugars.

7. Foods are transferred from leaves to meristems and storage organs where they promote growth, are used in reproduction, or are stored.

The exercises included in this section are designed to demonstrate types of parasitism which interfere with the vital functions listed above. The purpose or function interfered with is listed below followed by the number or numbers denoting the exercises which are designed to demonstrate how this happens. There is more than one exercise for several of the functions. The instructor may wish to use all of the exercises or select a lesser number.

1. Introductory. Exercises 1, 2

2. Destruction of stored foods or storage organs. Soft rots and seedling decay. Exercises 3, 4, 5

3. Destruction of seedlings, damping-off diseases. Exercise 5

4. Diseases resulting from interference with uptake of water and solutes from the soil. Root rot diseases. Exercise 6

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DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *STUDY GUIDES; *ENLISTED MEN; *HYDRAULICS; *FLUID POWER EDUCATION; GLOSSARIES; FILMS; MILITARY TRAINING; POWER MECHANICS

ABSTRACT - This training course was developed by the Navy Training Publications Center to provide coverage of the hydraulic and pneumatic knowledge factors for enlisted men who desire to advance to Petty Officer Third Class. Contents are: (1) Introduction, (2) Physics of Fluids, (3) Hydraulic and Pneumatic Fluids, (4) Basic Systems and Circuit Diagrams, (5) Circulatory System Components, (6) Reservoirs, Strainers, Filters, and Accumulators, (7) Pumps and Compressors, (8) Types of Packing Material, (9) Control and Measurement of Flow, (10) Measurement and Control of Pressure, (11) Directional Control Valves, (12) Actuators, and (13) Hydraulic and Pneumatic Systems. A glossary and a film list are appended. (GB)

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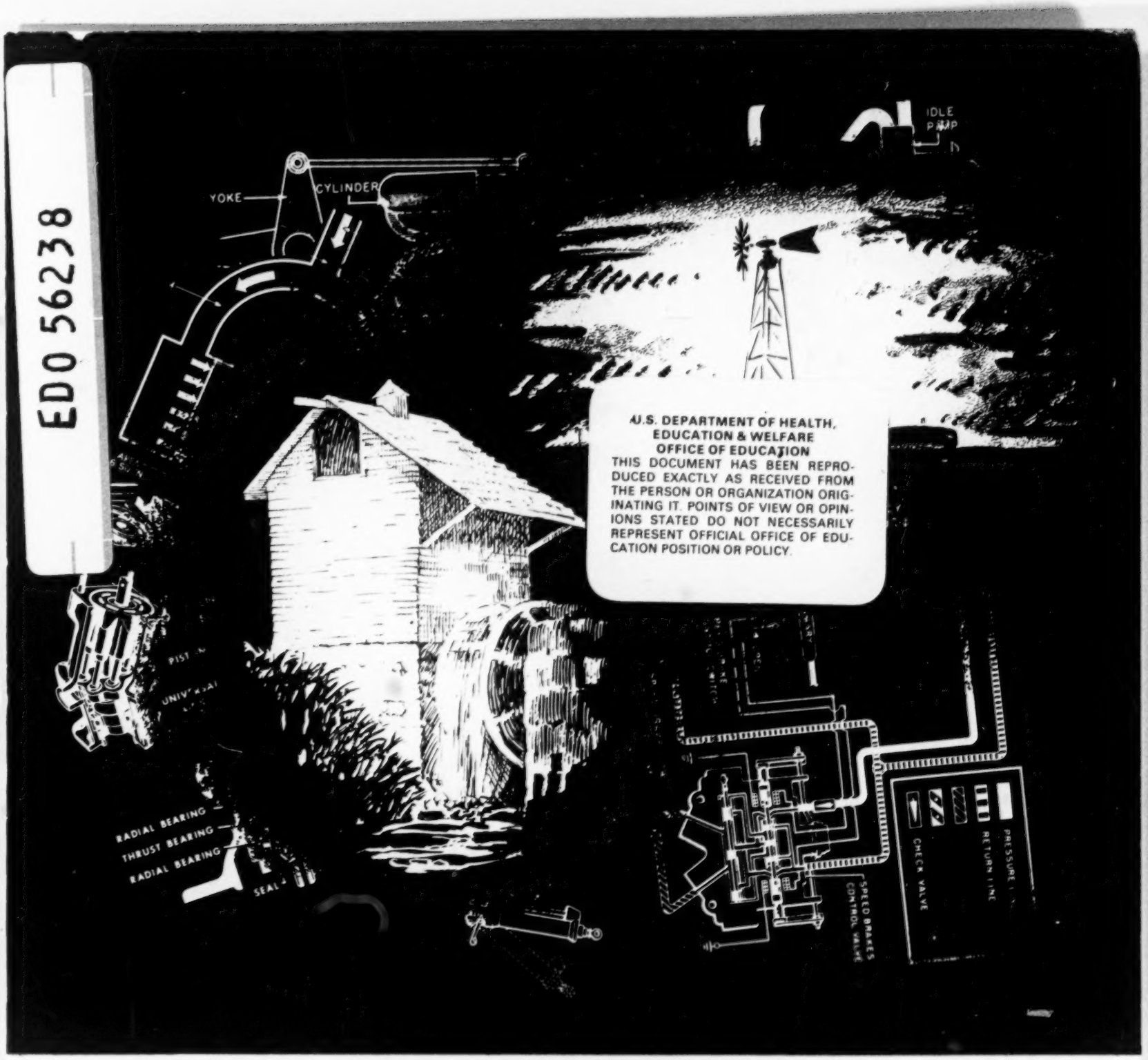

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BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 16193-A

PREFACE

Fluid Power is written primarily to provide coverage of the hydraulic and pneumatic knowledge factors required of men of the U. S. Navy and Naval Reserve who desire to advance in certain ratings. The subject matter covers a broad area of Qualifications for Advancement in Rating, all of which are common to several rates and ratings.

Combined with the necessary practical experience, this training course will assist nonrated men in preparing for advancement to Petty Officer Third Class in the specific ratings requiring a knowledge of fluid power. This training course should also be valuable as a review and reference source for personnel of more senior rates.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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CHAPTER 1

INTRODUCTION

Fluid Power, NavPers 16193-A, presents in logical sequence many of the fundamental concepts in the fields of hydraulics and pneumatics. Emphasis is placed primarily on the theory of operation of typical fluid power components and systems that have applications in naval equipment.

This training course is intended as a basic reference for all personnel of the Navy whose duties require them to have a knowledge of the fundamentals of fluid power. Individual rating courses should be consulted for information concerning the application of fluid power to specific equipments.

A brief summary of the contents of this training course is given in the following paragraphs:

Chapter 2 describes the physical properties and characteristics of fluids, both at rest and in motion. This description includes the similarities and differences of liquids and gases.

Chapter 3 discusses the qualities of satisfactory fluids for fluid power systems and the types of fluid used. Included is a section on liquid contamination concerning the types and effects of contaminants and control of the contamination problem. Also included are some of the potential hazards involved with the handling of compressed gases.

Chapter 4 gives brief descriptions of the components which are contained in basic and simple fluid power systems, including examples of simple systems in common applications. This chapter also includes the types of diagrams and the different symbols used in the illustration of fluid power systems.

Chapter 5 deals with the lines—pipes, tubing, and flexible hose—used to convey fluid under pressure, and the various connectors employed to join the components of fluid power systems.

Chapter 6 describes the functions and types of reservoirs, strainers, filters, and accumulators, and their application in fluid power systems.

The power supply for fluid power systems is covered in chapter 7. This includes the classifications, types, and operation of the pumps used in hydraulic systems and the compressors used in pneumatic systems.

Chapter 8 discusses the purposes and types of seals and packings used in fluid power systems, including the different materials used in their construction.

Chapter 9 describes the operation of the different valves used to control the flow of fluid and the meters used to measure the quantity and rate of flow.

Chapter 10 covers the types and operation of gages used for measuring fluid pressure and the valves used for the control of fluid pressure.

The types and operation of directional control valves are described in chapter 11.

Chapter 12 deals with the actuators used in fluid power systems. This includes the operation of actuating cylinders, motors, and turbines which are used to convert fluid power to mechanical force and motion.

Chapter 13 briefly describes various systems which illustrate some of the applications of fluid power in the Navy.

A glossary of terms commonly used in the field of fluid power is provided in appendix I. Reference to the glossary is directed at various places throughout the course whenever immediate reference to the glossary will serve to clarify the text. Appendix II provides a film list of selected films which may be used in conjunction with this course to clarify or expand coverage of certain areas in the field of fluid power.

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The remainder of chapter 1 is devoted to the introduction to fluid power, including brief sections on the history, development, and applications of hydraulics and pneumatics, and concludes with a discussion on the advantages and problems of fluid power applications.

FLUID POWER

The term fluid power has recently been established to include the generation, control, and application of smooth, effective power of pumped or compressed fluids (either liquids or gases) when this power is used to provide force and motion to mechanisms. This force and motion may be in the form of pushing, pulling, rotating, regulating, or driving. Fluid power includes hydraulics, which involves liquids, and pneumatics, which involves gases. Liquids and gases are similar in many respects and therefore are described as fluids in most sections of this course. The differences are pointed out in the appropriate areas. In these areas they are described separately as liquids and gases, or, as in the following sections, as hydraulics and pneumatics.

HYDRAULICS

The word hydraulics is a derivative of the Greek word hydro (meaning water) and aulis (meaning tube or pipe). Originally, the study of hydraulics covered the physical behavior of water at rest and in motion. Use has broadened its meaning to include the physical behavior of all liquids, including the media used in present day hydraulic systems.

The science includes, for example, the manner in which liquids act in tanks and pipes, dealing with their properties and with ways of utilizing these properties. It includes the laws of floating bodies and the behavior of liquids on the submerged surfaces of dams and sluice gates. It treats the flow of liquids under various conditions, and ways of directing this flow to useful ends, as well as many other related subjects.

Development

Although the modern development of hydraulics is of comparatively recent date, the ancients were familiar with many hydraulic principles and their applications. The Egyptians and the ancient peoples of Persia, India, and China conveyed water along channels for irrigation and domestic purposes, using dams and sluice gates to control the flow. The ancient Cretans had an elaborate plumbing system. Archimedes studied the laws of floating and submerged bodies. The Romans constructed aqueducts to carry water to their cities.

After the breakup of the ancient world, there were few new developments for many centuries. Then, over a comparatively short period, beginning not more than three or four hundred years ago, the physical sciences began to flourish, thanks to the discovery of principles basic to all of them, and to the invention of many new mechanical devices. Thus, the fundamental law underlying the entire science of hydraulics was discovered by Pascal in the 17th century.

Pascal's theorem was as follows: "If a vessel full of water, and closed on all sides, has two openings, the one a hundred times as large as the other, and if each is supplied with a piston that 'fits it exactly', then a man pushing the small piston will exert a force that will equilibrate that of one hundred men pushing the large piston and will overcome that of ninety-nine men." (This is the basic principle of hydraulics and is covered in detail in chapter 2.)

For Pascal's law to be made effective for practical applications, it was necessary to have a piston that "fit exactly." It was not until the latter part of the 18th century that methods were found to make these snugly fitted parts required in hydraulic systems. This was accomplished by the invention of machines which were used to cut and shape the necessary closely fitted parts and, particularly, by the development of seals and packings. Since this time, such components as valves, pumps, and motors have been developed and refined to make hydraulics one of the leading methods of transmitting power.

Application

As previously stated, the control of flow of water for irrigation and domestic use depends upon the application of hydraulic principles. Today, however, the term hydraulic commonly refers to power hydraulics in which liquid is used under controlled pressure to do work. This course deals primarily with this phase of hydraulics.

Today, hydraulic power is used to operate many different tools and mechanisms. In a

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garage, a mechanic raises the end of an automobile with a hydraulic jack. Dentists and barbers use hydraulic power to lift their chairs to a convenient working height by a few strokes of a lever. Hydraulic doorstops keep heavy doors from slamming. Hydraulic brakes have been standard equipment on automobiles for approximately 30 years. Most automobiles are equipped with automatic transmissions which are hydraulically operated. Power steering is another application of hydraulic power. Construction men depend upon hydraulic power for the operation of various components of their equipment. For example, the blade of a bulldozer is operated by fluid power.

During the period preceding World War II, the Navy began to apply hydraulics to naval mechanisms extensively. Since then, naval applications have increased to the point where many ingenious hydraulic devices are used in the solution of problems of gunnery, aeronautics, and navigation. Aboard ship, hydraulic power is utilized to operate such equipment as anchor windlasses, power cranes, steering gear, remote control devices, power drives for elevating and training guns and rocket launchers, and elevators on aircraft carriers to transfer aircraft from the hangar deck to the flight deck and vice versa.

Most naval aircraft contain a network of hydraulic lines and components. Hydraulic power is used to operate such units as wheel brakes, landing flaps, antennas, speed brakes, control surfaces, and the retraction and extension of the landing gear. Many types of guided missiles contain hydraulic systems for the operation of flight control devices.

PNEUMATICS

Pneumatics is that branch of physics that deals with properties such as pressure, density, etc., of air and other gases. Pneumatics is a derivative of the Greek word pneuma, which means air, wind, or breath.

Development

There is no record of man's first use of air to do work. Probably the first were fans used to separate the chaff from grain and sails used to move ships. One of the first pneumatic devices was the blow gun used by primitive man. In the latter part of the 18th century, heated air was used to carry the first balloon aloft. The heated air was allowed to expand in the balloon, and therefore it became lighter than the surrounding air and caused the balloon to rise.

Every age of man has witnessed the development of devices to utilize air to do work. However, it can be seen that man used air for work long before he understood it.

Many of the principles of hydraulics apply to pneumatics. For example, Pascal's law applies to gases as well as liquids. Also, like hydraulics, the development of pneumatics depended upon closely fitted parts and the development of seals and packings. Since the invention of the air compressor, pneumatics has become a very reliable source for the transmission of power.

Application

In this course, pneumatics is considered as power transmitted and controlled through the use of compressed gas, usually air or nitrogen. Probably one of the greatest uses of pneumatic power is in the operation of the various types of pneumatic tools. Pneumatic drills, screwdrivers, and nut setters are operated by air motors. Riveting guns and chipping hammers are usually operated by air pressure. Compression tools such as rivet squeezers and punches are operated by pneumatic power. Trains, buses, and large trucks are normally equipped with air brakes.

Most models of aircraft contain pneumatic systems as an emergency means of operating those units which are normally operated hydraulically. Guided missiles utilize compressed gas as a power source for electric generators and hydraulic pumps. In some missiles, pneumatic power is utilized to operate flight control devices.

Pneumatics and hydraulics are combined for some applications. The lift used in garages and service stations is one example. Air pressure is applied to the surface of hydraulic fluid in a reservoir. The air pressure forces the hydraulic fluid to raise the lift. The accumulator, described in chapter 6, is another example of this combination.

ADVANTAGES OF FLUID POWER

The common use of fluid power is due to the fact that properly constructed fluid power systems possess a number of favorable characteristics. They eliminate the need for complicated

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systems of gears, cams, and levers. Motion can be transmitted without the slack inherent in the use of all solid machine parts. The fluids used are not subject to breakage as are mechanical parts, and the mechanism is not subject to great wear.

The different parts of a fluid power system can be conveniently located at widely separated points, and the forces generated are rapidly transmitted over considerable distances with small loss. These forces can be conveyed up and down or around corners with small losses in efficiency and no complicated mechanisms. Very large forces can be controlled by much smaller ones, and can be transmitted through comparatively small lines and orifices.

If the system is well adapted to the work it is required to perform, and if it is not misused, it can provide smooth, flexible, uniform action without vibration, and unaffected by variation of load. In case of overload, an automatic release of pressure can be guaranteed, so that the system is protected against breakdown or strain. Fluid power systems can provide widely variable motions in both rotary and straight-line transmission of power. Need for control by hand can be minimized. Finally, fluid power systems are economical to operate.

SPECIAL PROBLEMS

The extreme flexibility of fluid power elements gives rise to a number of problems. Since fluids have no shape of their own, they must be positively confined throughout the entire system. Special consideration must be given to the structural organization and the relation of parts of a fluid power system. Strong pipes and containers must be provided. Leaks must be prevented. This problem is acute with the high pressure obtained in many fluid power installations.

The pressures required in fluid power systems must be controlled and likewise the movement of the component fluids. This movement causes friction, within the fluid itself and against the containing surfaces, which if excessive, can lead to serious losses in efficiency. Foreign matter must not be allowed to accumulate in the system, where it will clog small passages or score closely fitted parts. Chemical action may cause corrosion. Above all, it is necessary to know how a fluid power system works, both in terms of the general principles common to all physical mechanisms and the peculiarities of the particular arrangement at hand.

Although solids differ in certain ways from liquids and gases, and although each substance—lead, tin, water, oil, nitrogen, etc.—has its own special properties, all kinds of matter show the same fundamental pattern of action and reaction. When the principles common to all physical science became clarified in early modern times, new possibilities of understanding and action were opened up for mankind. Thus, today when a person thoroughly grasps these principles, he is in a position to enlarge his power to understand and control the natural world.

Although solids are rigid and fluids are not, the knowledge of levers can be applied to fluid power situations. Just as a child weighing say 50 pounds can balance one weighing 100 pounds by sitting twice as far away from the balancing point, so in fluid power a force of 50 pounds applied over a certain area can balance a force of 100 pounds acting over twice that area.

The inventor or engineer who wants to move something is therefore always faced with a number of possibilities. The object to be moved could be pushed with a stick or pulled with a chain. A jet of water or a stream of air might be directed against it, or something could be thrown against it. If a weight is to be lifted, levers, gears, ropes and pulleys, chain hoists, screw jacks, hydraulic jacks, or the force of floatation might be used. Part of the system could make use of electricity, heat, or even light, as in the case of doors that open automatically when people approach.

Each method of accomplishing mechanical movements has its good points and its bad, its special capabilities, and its limitations. Ropes and chains, for example, can pull but they cannot push; fluid power elements can push but they cannot pull; solid rods can both push and pull but cannot go around corners like chains, ropes, or fluid power elements. Gears can operate continuously in a rotary motion, whereas a lever usually operates so that the arms of the lever move back and forth. And so it goes for every machine element. Though each obeys the same general physical laws, each also possesses special properties that must be taken into account.

CHAPTER 2

PHYSICS OF FLUIDS

Physics is the term applied to that area of knowledge in which the attempt is made to understand the basic and fundamental nature of matter and energy. It does not attempt to determine why matter and energy behave as they do in their relation to physical phenomena, but rather how they behave.

The personnel who operate fluid power systems should have a knowledge of the physics of fluids. The personnel who service and maintain fluid power systems must have a thorough understanding of the properties of fluids and the behavior of fluids under different circumstances.

STATES OF MATTER

Matter is any substance that occupies space and has weight. There are three states of matter—solids, liquids, and gases. Solids have a definite volume and a definite shape; liquids have a definite volume, but they take the shape of the containing vessel; gases have neither a definite volume nor a definite shape. Gases not only take the shape of the containing vessel, but they expand and fill the vessel, no matter what its volume.

Matter can change from one state to another. Water is a good example. At high temperature it has the gaseous state known as steam. At moderate temperatures it is a liquid, and at low temperatures it becomes ice, which is definitely a solid state. In this example, the temperature is the dominant factor in determining the state that the substance assumes. Pressure is another important factor that will effect changes in the state of matter. At pressures lower than atmosperic, water will boil and thus change into steam at temperatures lower than 212° Fahrenheit (F). Pressure is a critical factor in changing some gases to liquids or solids. Normally, when pressure and chilling are both applied to a gas, it assumes a liquid state. Liquid air, which is a mixture of oxygen and nitrogen, is produced in this manner.

FLUIDS

Both liquids and gases flow freely; for that reason both are called fluids, from the Latin word "fluidus" meaning to flow. A fluid is defined as a substance which changes its shape easily and takes the shape of its container. This applies to both liquids and gases. The characteristics of liquids and gases may be grouped under similarities and differences.

Similar characteristics are listed as follows:

1. Each has no definite shape but conforms to the shape of the container.
2. Both readily transmit pressures.

Differential characteristics are listed as follows:

1. Gases fill their containers completely, while liquids may not.
2. Gases are lighter than equal volumes of liquids.
3. Gases are highly compressible, while liquids are only slightly so.

These differences are described in the appropriate areas of the following discussion concerning the properties and characteristics of fluids at rest. Also included are some of the outside factors which affect fluids in different situations.

DENSITY AND SPECIFIC GRAVITY

The density of a substance is its weight per unit volume. The unit volume selected for use in the English system of measurement is 1 cubic foot. In the metric system it is 1 cubic centimeter. Therefore, density is expressed in pounds per cubic foot or in grams per cubic centimeter.

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5. Disease resulting from abnormal growth. Crown Galls. Club Root. Exercise 7

1. How to Use the Microscope

The microscope will be used frequently in studying the details of host cells and the structures of the pathogen which are not large enough to be seen clearly with the unaided eye. The microscope and the mount may be ruined if precautions are not observed. The following procedure will minimize this hazard and assist in quickly bringing the object into focus.

A. The microscope should be placed near the chest so the eye is brought directly over the ocular. The microscope should not be tilted; if it is tilted the liquid on the slides will flow off and it will also be difficult to obtain adequate light.

B. The correct amount of light may be attained by adjusting the substage mirror in the direction of the light source, so that a large amount of light will be reflected through the slide or mount to the ocular. An adjustable diaphragm beneath the microscope stage controls the amount of light. Various amounts of light will be required by different mounts. Adjust the amount of light until the greatest detail is obtained.

C. Use the following technique when focusing the microscope:

1. Turn the coarse adjustment to raise the tube, then place the slide on the stage.

2. Place the slide directly over the opening in the stage and hold the slide with the spring clamps on either side.

3. Lower the tube until the low power objective is within 1/8 inch of the slide or mount.
   DO NOT focus downward while looking through the microscope.

4. Slowly raise the tube with the coarse adjustment while watching through the microscope. Use the fine adjustment when the object is nearly in focus.

5. Move the slide to center the desired part in the field.

6. When higher magnification is needed, rotate the nosepiece until the highpower objective moves in place under the tube. This should be done gently. Never force the objective into position.

7. Move the fine adjustment up or down gently to bring the object into clear focus. Under highpower magnifications only certain areas of the field will be in focus at the same time. Small adjustments in focus will be necessary as various parts of the field are studied.

To find the density of a substance, its weight and volume must be known. Its weight is then divided by its volume to find the weight per unit volume.

EXAMPLE: The liquid which fills a certain container weighs 1497.6 pounds. The container is 4 feet long, 3 feet wide, and 2 feet deep. Its volume is 24 cubic feet (4 ft x 3 ft x 2 ft). If 24 cubic feet of liquid weighs 1497.6 pounds, then 1 cubic foot weighs $\frac{1497.6}{24}$ or 62.4 pounds. Therefore, the density of the liquid is 62.4 pounds per cubic foot.

This is the density of water at 4° centigrade (C) and is usually used as the standard for comparing densities of other substances. (In the metric system the density of water is 1 gram per cubic centimeter.) The standard temperature of 4° C is used when measuring the density of liquids and solids. Changes in temperature will not change the weight of a substance, but will change the volume of the substance by expansion or contraction thus changing its weight per unit volume.

The procedure for finding density applies to all substances; however, it is necessary to take pressure into consideration when finding the density of gases. Temperature is more critical when measuring the density of gases than it is for other substances. The density of a gas increases in direct proportion to the pressure exerted on it. Standard conditions for the measurement of the densities of gases have been established at 0° C for temperature and 76 centimeters of mercury. (This is the average pressure of the atmosphere at sea level.) Density is computed on these conditions for all gases.

It is often necessary to compare the density of one substance with that of another. For this purpose a standard is needed. Water is the standard that physicists have chosen with which to compare the densities of all liquids and solids. For gases, air is most commonly used. Hydrogen is sometimes used as a standard for gases. In physics, the word specific implies a ratio. Thus, the ratio of the weight of a unit volume of some standard substance, measured under the standard pressure and temperature conditions, is called specific gravity. The terms specific weight or specific density are sometimes used to express this ratio.

The following formulas are used to find the specific gravity (sp gr) of liquids and solids.

$$\text{sp gr} = \frac{\text{Weight of the substance}}{\text{Weight of an equal volume of water}}$$

or,

$$\text{sp gr} = \frac{\text{Density of the substance}}{\text{Density of water}}$$

The same formulas are used to find the density of gases by substituting air or hydrogen for water.

Specific gravity is not expressed in units, but as pure numbers. For example, if a certain hydraulic liquid has a specific gravity of 0.8, 1 cubic foot of the liquid weighs 0.8 times as much as a cubic foot of water—62.4 times 0.8 or 49.92 pounds. In the metric system, 1 cubic centimeter of a substance with a specific gravity of 0.8 weighs 1 times 0.8 or 0.8 gram. (Note that in the metric system the specific gravity of a liquid or solid has the same numerical value as its density. Since air weighs 1.293 grams per liter, the specific gravity of gases does not equal the metric densities.)

Specific gravity and density are independent of the size of the sample under consideration and depend only upon the substance of which it is made. See table 2-1 for typical values of specific gravity for various substances.

A device called a hydrometer is used for measuring specific gravity of liquids. This device consists of a tubular shaped glass float which is contained within a larger glass tube. (See fig. 2-1.) The larger glass tube provides the container for the liquid. A rubber suction bulb draws the liquid up into the container. There must be enough liquid to raise the float and prevent it from touching the bottom. The float is weighted and has a vertically graduated scale. To determine specific gravity the scale is read at the surface of the liquid in which the float is immersed. An indication of 1000 is read when immersed in pure water. When immersed in a liquid of greater density the float rises, indicating a greater specific gravity. For liquids of lesser density the float sinks, indicating a lower specific gravity.

An example of the use of the hydrometer is when used to determine the specific gravity of the electrolyte (battery liquid) in an automobile battery. When a battery is discharged, the calibrated float immersed in the electrolyte will indicate 1150. The indication of a fully charged battery is 1270.

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A body submerged in a liquid or a gas weighs less than when weighed in free space.

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Table 2-1.—Typical values of specific gravity

Solids	sp gr	Liquids (Room temperatures)	sp gr	Gases (Air standard at 0°C and 76.0 centimeters of mercury)	sp gr
Aluminum	2.7	Alcohol, ethyl	0.789	Air	1.000
Bronze	8.8	Gasoline	0.68-0.72	Hydrogen	0.0695
Copper	8.9	Oil (paraffin)	0.8	Nitrogen	0.967
Ice	0.917	Water	1.00	Oxygen	1.105

This is due to the upward force that the fluid exerts on the submerged body. An object will float if this upward force of the fluid is greater than the weight of the object. Objects denser than the fluid, even though they sink readily, appear to lose a part of their weight when submerged. An individual can lift a larger weight under water than he can possibly lift in the air. The upward force which any fluid exerts upon a body placed in it is called buoyant force.

The following experiment is illustrated in figure 2-2. The overflow can is filled up to the spout with water. The heavy metal cylinder is first weighed in still air and then is weighed while completely submerged in the water. The difference between the two weights is the buoyant force of the water. As the cylinder is lowered into the overflow can, the water is caught in the catch bucket. The volume of water which overflows equals the volume of the cylinder. (The volume of irregular shaped objects may be measured by this method.) If this experiment is performed carefully, the weight of the water displaced by the metal cylinder exactly equals the buoyant force of the water.

Experiments similar to this were performed by Archimedes (287-212 B.C.) As a result of his experiments he discovered that the buoyant force which a fluid exerts upon a submerged body is equal to the weight of the fluid the body displaces. This statement is referred to as Archimedes' principle. This principle applies to all fluids, gases as well as liquids. Just as water exerts a buoyant force on submerged objects, air exerts a buoyant force on objects submerged in it.

TEMPERATURE

As indicated in the following paragraphs, temperature is a dominant factor affecting the physical properties of fluids. It is of particular concern when calculating changes in the state of gases.

The three temperature scales used extensively are the centigrade, the Fahrenheit, and the absolute or Kelvin scales. The centigrade scale is constructed by using the freezing and boiling points of water, under standard conditions, as fixed points of zero and 100, respectively, with 100 equal divisions between. The Fahrenheit scale uses 32° as the freezing point of water and 212° as the boiling point, and has 180 equal divisions between. The absolute or Kelvin scale is constructed with its zero point established as 273° C, or 459.4° F below the freezing point of water. The relations of the other fixed points of the scale are shown in figure 2-3.

Absolute zero, one of the fundamental constants of physics, is commonly used in the study of gases. It is usually expressed in terms of the centigrade scale. If the heat energy of a given gas sample could be progressively reduced, some temperature should be reached at which the motions of the molecules would cease entirely. If accurately determined, this temperature could then be taken as a natural reference, or as a true "absolute zero" value.

Experiments with hydrogen indicated that if a gas were cooled to -273.16° C (used as -273 for most calculations), all molecular motion would cease and no additional heat could be extracted from the substance.

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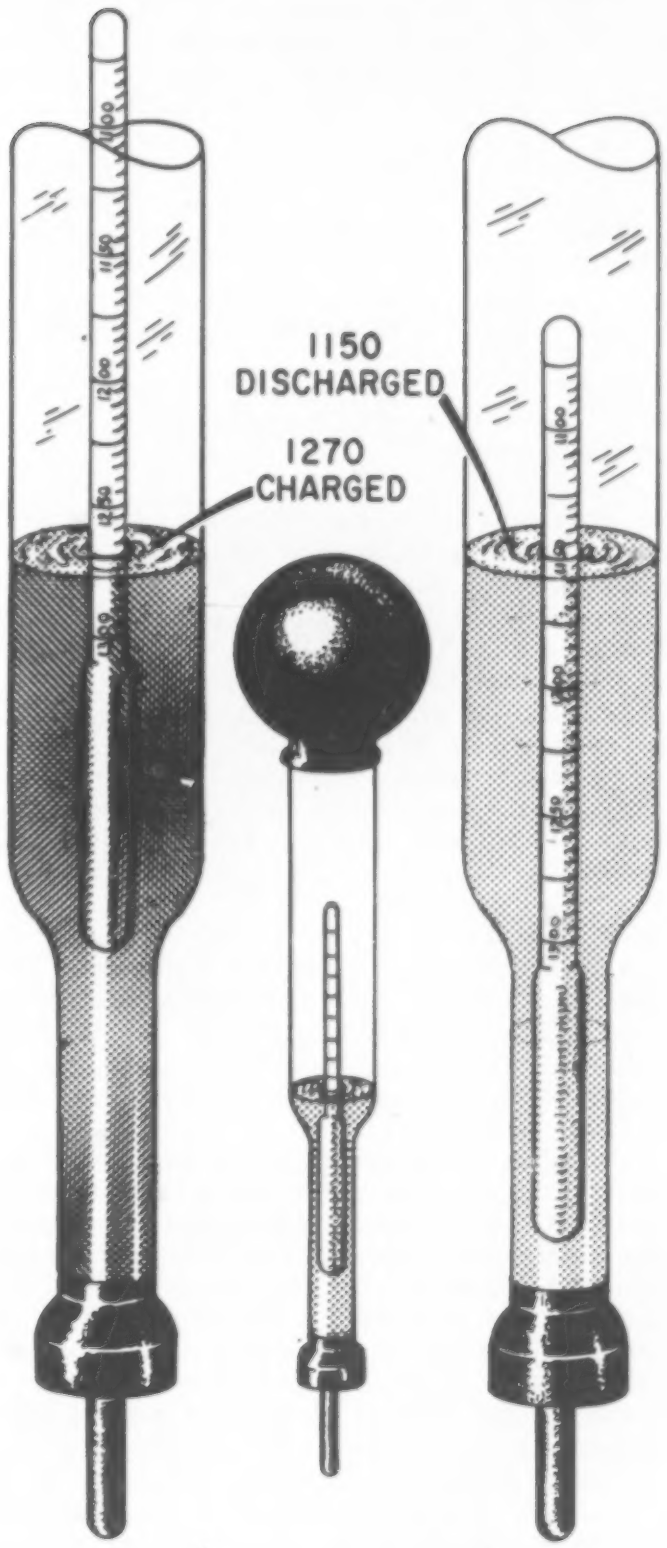

Figure 2-1.—A hydrometer.

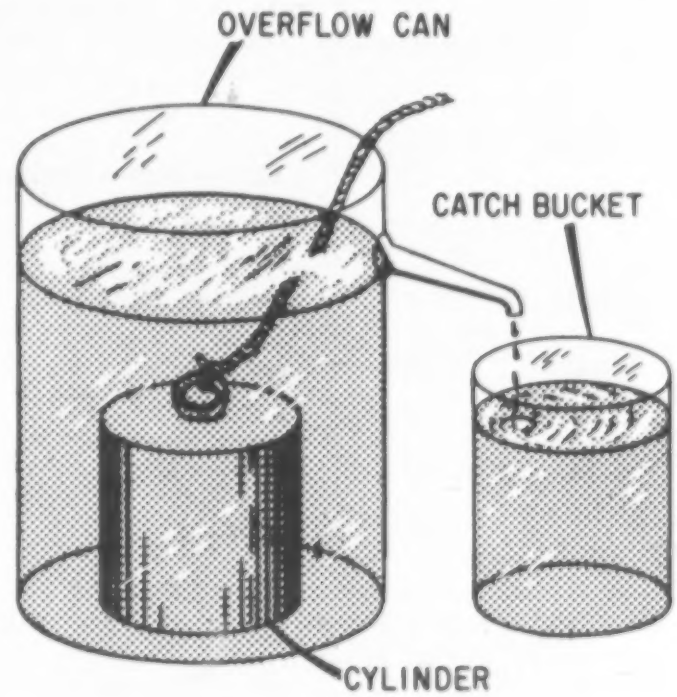

Figure 2-2.—Measurement of buoyant force.

When temperatures are measured with respect to the absolute zero reference, they are expressed as zero in the absolute or Kelvin scale. Thus, absolute zero may be expressed as 0° K, as -273° C, or as -459.4° F (used as -460 for most calculations).

Personnel working with temperatures must always make sure which system of measurement is being used and how to convert from one to another. The conversion formulas are shown in figures 2-3. For purposes of calculations, the Rankine scale illustrated in figure 2-4 is commonly used to convert Fahrenheit to absolute. For Fahrenheit readings above zero, 460° is added. Thus, 72° F equals 460° plus 72° or 532° absolute. If the Fahrenheit reading is below zero, it is subtracted from 460°. Thus -40° F equals 460° minus 40° or 420° absolute. It should be stressed that the Rankine scale does not indicate absolute temperature readings in accordance with the Kelvin scale but these conversions may be used for the calculations of changes in the state of gases.

The Kelvin and centigrade scales are used more extensively in scientific work and, therefore, some technical manuals may use these scales in giving directions and operating instructions. The Fahrenheit scale is commonly used in the United States and most people are

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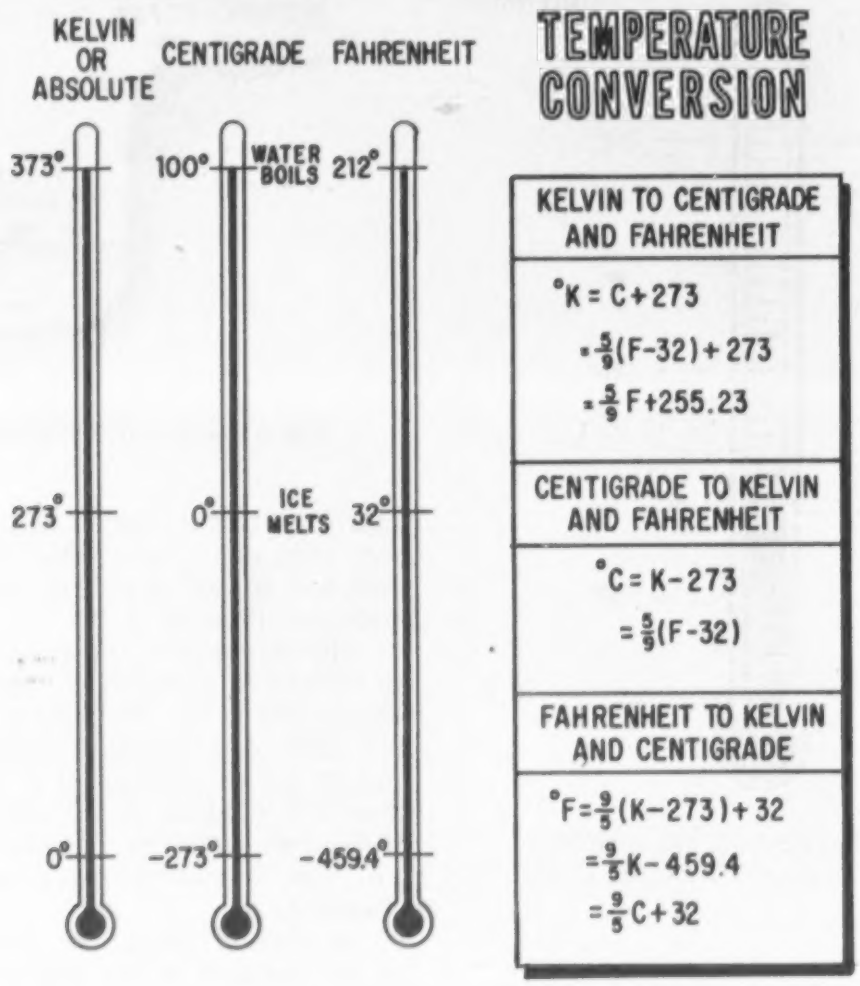

Figure 2-3.—Comparison of Fahrenheit, centigrade, and Kelvin temperature.

familiar with it. Therefore, the Fahrenheit scale is used in most areas of this course.

PRESSURE

The term pressure as used throughout this course, is defined as a force per unit area. It is further defined in relation to other factors later in this chapter. Pressure is usually measured in pounds per square inch (psi). Sometimes pressure is measured in inches of mercury, or for very low pressure, inches of water.

Pressure may be in one direction, several directions, or in all directions. (See fig. 2-5.) The ice (a solid) exerts pressure downward only. Water (a fluid) exerts pressure on all surfaces with which it comes in contact. Gas (a fluid) exerts pressure in all directions. Gas exerts pressure on all sides because it completely fills the container.

Atmospheric Pressure

The atmosphere is the whole mass of air surrounding the earth. While it extends upward for about 500 miles, the section which is of primary interest is that portion of the air which rests on the earth's surface and extends upward for about 7 1/2 miles. This layer is called the troposphere and the higher above the earth the lower the pressure. This is because air has weight. If a column of air 1-inch square extending all the way to the "top" of the atmosphere could be weighed, this column of air would weigh approximately 14.7 pounds at sea level. Thus, atmospheric pressure at sea level is approximately 14.7 pounds per square inch

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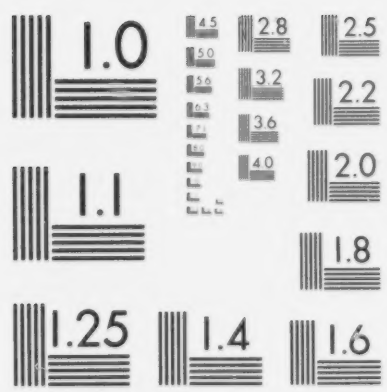

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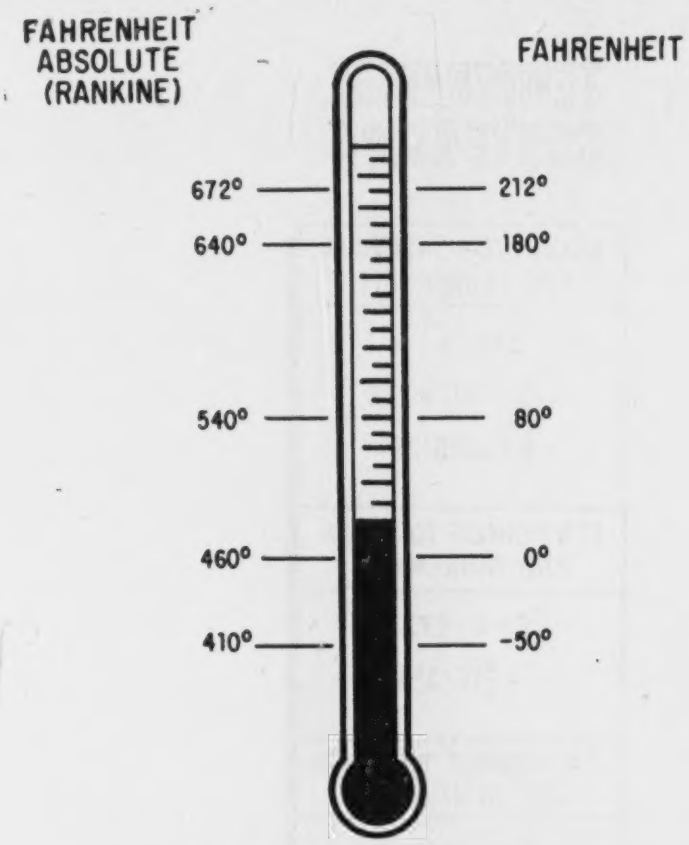

Figure 2-4.—Fahrenheit and absolute temperature compared (Rankine scale).

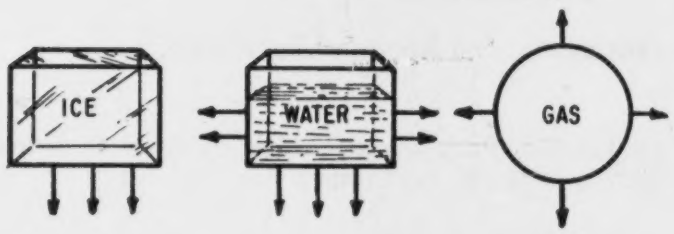

Figure 2-5.—Exertion of pressure.

(psi). (See fig. 2-6.) As one ascends, the atmospheric pressure decreases approximately 1.0 psi for every 2,343 feet. However, below sea level, in excavations and depressions, atmospheric pressure increases. Pressures under water differ from those under air only because the weight of the water must be added to the pressure of the air.

Atmospheric pressure can be measured by any of several methods. The common laboratory method employs the mercury column barometer. A mercury column consists of a glass tube

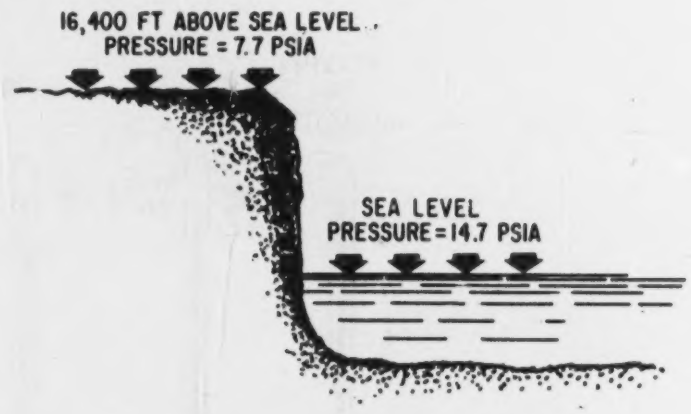

Figure 2-6.—Atmospheric pressure.

approximately 34 inches in length, sealed at one end, then completely filled with mercury, and inverted in an open cup partially filled with mercury. (See fig. 2-7.)

The mercury in the tube settles down, leaving an evacuated space in the upper end of the tube. The height of the mercury column serves as an indicator of atmospheric pressure. At sea level and at a temperature of 0° C, the height of the mercury column is 76 cm or approximately 30 inches, which represents a pressure of 14.7 psi. The 30-inch column is used as a reference standard.

At higher levels, the atmospheric pressure on the surface of the mercury in the open cup is less than at sea level; hence, the column of mercury in the tube settles lower. These variations in the height of the mercury column represent changes in atmospheric pressure which may be calibrated in terms of altitude with reference to sea level.

Another device used to measure atmospheric pressure is the aneroid barometer. (See fig. 2-8.) This barometer consists of a small sealed metal drum that has been partially evacuated and which has one side or end made of corrugated metal. This thin metal moves in or out with the variation of pressure on its external surface. This movement is transmitted through a system of levers to a pointer. The pointer is pivoted so that it sweeps across a graduated scale calibrated either in psi or in feet to designate an altitude corresponding to the indicated pressure.

The atmospheric pressure does not vary uniformly with altitude. It changes more rapidly at lower altitudes because of the compressibility of the air which causes the air layers close

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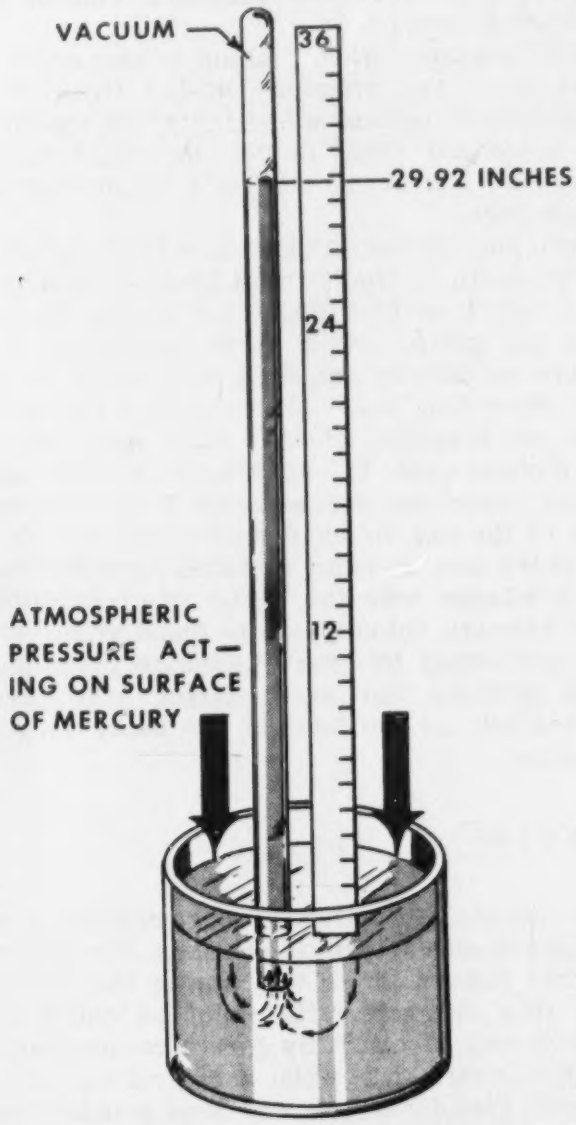

Figure 2-7.—Measurement of atmospheric pressure—mercury barometer.

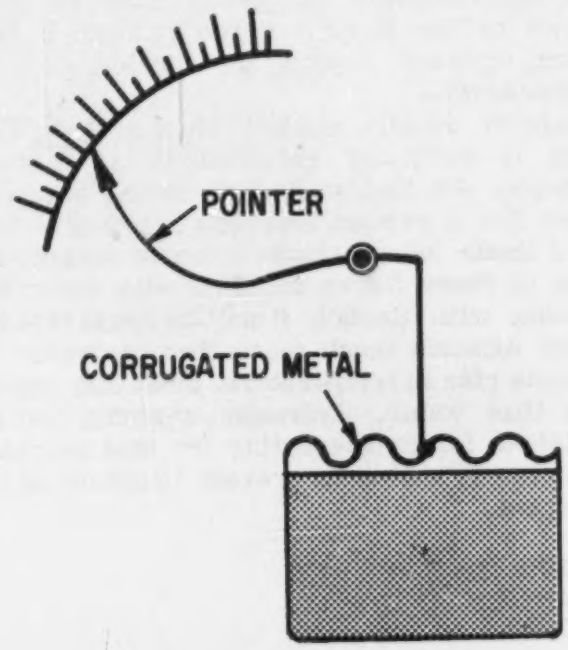

Figure 2-8.—Aneroid barometer.

to the earth's surface to be compressed by the air masses above them. This effect, however, is partially counteracted by contraction of the upper layers due to cooling. The cooling tends to increase the density of the air.

Atmospheric pressures are quite large, but in most instances practically the same pressure is present on all sides of objects so that no single surface is subjected to a great load.

Absolute Pressure

As stated previously, absolute temperature is used in the calculation of changes in the state of gas. It is also necessary to use absolute pressure for these calculations.

Absolute pressure is measured from absolute zero pressure rather than from normal or atmospheric pressure (approximately 14.7 psi). Gage pressure is used on all ordinary gages, and indicates pressure in excess of atmospheric. Therefore, absolute pressure is equal to atmospheric pressure plus gage pressure. For example, 100 psi gage pressure (psig--meaning pounds per square inch gage) equals 100 psi plus 14.7 psi or 114.7 psi absolute pressure (psia--meaning pounds per square inch absolute).

INCOMPRESSIBILITY AND EXPANSION OF LIQUIDS

Liquids can be only slightly compressed; that is, the reduction of the volume which they occupy, even under extreme pressure, is very small. If a pressure of 100 psi is applied to a body of water, the volume will decrease only 3/10,000 of its original volume. It would take a force of 32 tons to reduce its volume 10 percent. Since other liquids behave in about the same manner, liquids are usually considered incompressible.

NOTE: In some applications of hydraulics where extremely close tolerances are required,

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the compressibility of liquids must be considered in the design of the system. In this course, however, liquids are considered to be incompressible.

Liquids usually expand when heated. This action is normally referred to as thermal expansion. All liquids do not expand the same amount for a certain increase in temperature. If two flasks are placed in a heated vessel, and if one of these flasks is filled with water and the other with alcohol, it will be found that the alcohol expands much more than the water for the same rise in temperature. Most oils expand more than water. Hydraulic systems contain provisions for compensating for this increase of volume in order to prevent breakage of the equipment.

COMPRESSIBILITY AND EXPANSION OF GASES

The two major differences between gases and liquids are in respect to compressibility and expansion. While liquids are practically incompressible, gases are highly compressible. Gases tend to completely fill any closed vessel in which they are contained, while liquids fill a container only to the extent of their normal volume.

Kinetic Theory of Gases

The simple structure of gases makes them readily adaptable to mathematical analysis from which has evolved a detailed theory of the behavior of gases. This is called the kinetic theory of gases. The theory assumes that a body of gas is composed of identical molecules which behave like minute elastic spheres, spaced relatively far apart and continuously in motion.

The degree of molecular motion is dependent upon the temperature of the gas. Since the molecules are continuously striking against each other and against the walls of the container, an increase in temperature with the resulting increase in molecular motion causes a corresponding increase in the number of collisions between the molecules. The increased number of collisions results in an increase in pressure because a greater number of molecules strike against the walls of the container in a given unit of time.

If the container were an open vessel, the gas would tend to expand and overflow from the container. However, if the container is sealed and possesses elasticity (such as a rubber balloon), the increased pressure causes the container to expand.

For instance, when making a long drive on a hot day, the pressure in the tires of an automobile increases and a tire which appeared to be somewhat "soft" in cool morning temperature may appear normal at a higher midday temperature.

Such phenomena as these have been explained and set forth in the form of laws pertaining to gases and tend to support the kinetic theory.

At any given instant, some molecules of a gas are moving in one direction, some in another direction; some are traveling fast while some are traveling slowly; some may even be in a state of rest. The combined effect of these varying velocities corresponds to the temperature of the gas. In any considerable amount of gas, there are so many molecules present that in accordance with the "laws of probability" some average velocity can be found which, if it were possessed by every molecule in the gas, would produce the same effect at a given temperature as the total of the many varying velocities.

Boyle's Law

As previously stated, compressibility is an outstanding characteristic of gases. The English scientist Robert Boyle was among the first to study this characteristic which he called the "springiness of air." By direct measurement he discovered that when temperature of an enclosed sample of gas was kept constant and the pressure doubled, the volume was reduced to half the former value; as the applied pressure was decreased, the resulting volume increased. From these observations, he concluded that for a constant temperature the product of the volume and pressure of an enclosed gas remains constant. Boyle's law is normally stated: "The volume of an enclosed dry gas varies inversely with its pressure, provided the temperature remains constant."

This law can be demonstrated by confining a quantity of gas in a cylinder which has a tightly fitted piston. A force is then applied to the piston so as to compress the gas in the cylinder to some specific volume. When the force applied to the piston is doubled, the gas is compressed to one-half its original volume, as indicated in figure 2-9.

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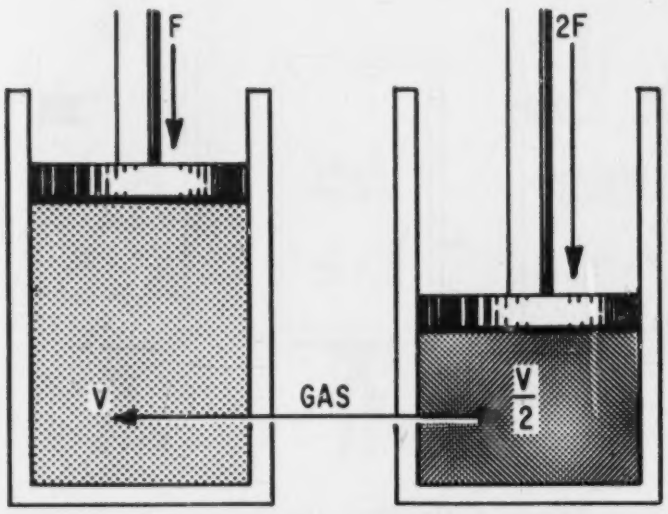

Figure 2-9.—Gas compressed to half its original volume by a double force.

In equation form, this relationship may be expressed either

$$V_1 P_1 = V_2 P_2$$

$$\text{or } \frac{V_1}{V_2} = \frac{P_2}{P_1}$$

when V_1 and P_1 are the original volume and pressure, and V_2 and P_2 are the revised volume and pressure.

Example of Boyle's law: 4 cubic feet of nitrogen are under a pressure of 100 psi (gage). The nitrogen is allowed to expand to a volume of 6 cubic feet. What is the new gage pressure? Remember to convert gage pressure to absolute pressure by adding 14.7.

Formula or equation:

$$V_1 P_1 = V_2 P_2$$

Substituting:

$$4 \times (100 + 14.7) = 6 \times P_2$$

$$P_2 = \frac{4 \times 114.7}{6}$$

$$P_2 = 76.47 \text{ psi absolute}$$

Converting absolute pressure to gage pressure:

76.47
-14.7
61.77 psi gage pressure—Answer.

A gas which conforms to Boyle's law is termed an ideal gas. When pressure is increased upon such a gas, its volume decreases proportionally and its density is increased. So it follows that the density of a gas varies directly as the pressure, if the temperature remains constant as in the case of an ideal gas. Density also varies with temperature, since gases expand when heated and contract when cooled.

Charles' Law

The French scientist Jacques Charles provided much of the foundation for the modern kinetic theory of gases. He found that all gases expand and contract in direct proportion to the change in the absolute temperature, provided the pressure is held constant. Expressed in equation form, this part of the law may be expressed.

$$V_1 T_2 = V_2 T_1,$$

$$\text{or } \frac{V_1}{V_2} = \frac{T_1}{T_2}$$

where V_1 and V_2 refer to the original and final volumes, and T_1 and T_2 indicate the corresponding absolute temperatures.

Since any change in the temperature of a gas causes a corresponding change in volume, it is reasonable to expect that if a given sample of a gas were heated while confined within a given volume, the pressure should increase. By actual experiment, it was found that the increase in pressure was approximately 1/273 of the 0° C pressure for each 1° C increase. Because of this fact, it is normal practice to state this relationship in terms of absolute temperature. In equation form, this part of the law becomes

$$P_1 T_2 = P_2 T_1,$$

$$\text{or } \frac{P_1}{P_2} = \frac{T_1}{T_2}$$

In words, this equation states that with a constant volume, the absolute pressure of a gas varies directly with the absolute temperature.

Examples of Charles' Law: A cylinder of gas under a pressure of 1,800 psig at 70° F is left out in the sun in the tropics and heats up to a

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temperature of 130° F. What is the new pressure within the cylinder? The pressure and temperature must be converted to absolute pressure and temperature.

Formula or equation:

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

Using the Rankine system:

$$70°F = 530° \text{ absolute}$$
$$130° F = 590° \text{ absolute}$$

Substituting:

$$\frac{1{,}800 + 14.7}{P_2} = \frac{530}{590}$$

Then:

$$P_2 = \frac{(590)\ (1{,}814.7)}{530}$$

$$P_2 = 2{,}020 \text{ psia}$$

Converting absolute pressure to gage pressure:

$$\begin{array}{r} 2{,}020.0 \\ -14.7 \\ \hline 2{,}005.3 \end{array} \text{ psig—Answer.}$$

General Gas Law

The facts concerning gases discussed in the preceding sections are summed up and illustrated in figure 2-10. Boyle's law is expressed in (A) of the figure, while the effects of temperature changes on pressure and volume (Charles' law) are illustrated in (B) and (C), respectively.

By combining Boyle's and Charles' law, a single expression can be derived which states all the information contained in both. This expression is called the GENERAL GAS LAW, a very useful form of which is given in the following equation. (NOTE: The capital P and T signify absolute pressure and temperature, respectively.)

$$\frac{P_1\ V_1}{T_1} = \frac{P_2\ V_2}{T_2}$$

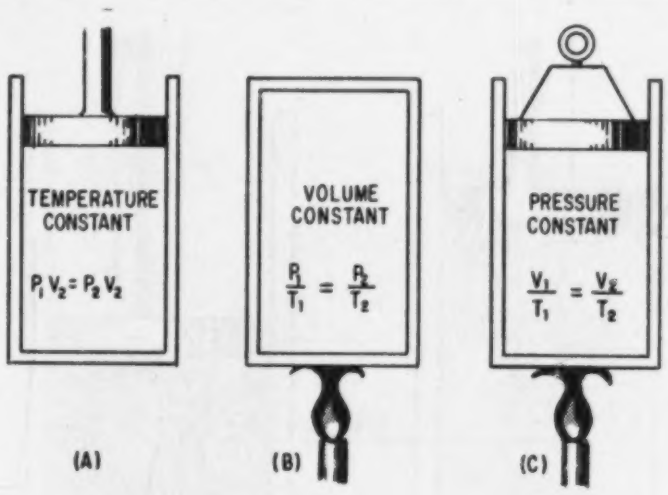

Figure 2-10.—The general gas law.

It can be seen by examination of figure 2-10 that the three equations are special cases of the general equation. Thus, if the temperature remains constant, T_1 equals T_2 and both can be eliminated from the general formula, which then reduces to the form shown in (A). When the volume remains constant, V_1 equals V_2, thereby reducing the general equation to the form given in (B). Similarly P_1 is equated to P_2 for constant pressure, and the equation then takes the form given in (C).

The general gas law applies with exactness only to "ideal" gases in which the molecules are assumed to be perfectly elastic. However, it describes the behavior of actual gases with sufficient accuracy for most practical purposes.

Two examples of the general equation follow:

1. Two cubic feet of a gas at 75 psig and 80° F are compressed to a volume of 1 cubic foot and then heated to a temperature of 300° F. What is the new gage pressure?

Formula or equation:

$$\frac{P_1\ V_1}{T_1} = \frac{P_2\ V_2}{T_2}$$

Using the Rankine system:

$$80° F = 540° \text{ absolute}$$
$$300° F = 760° \text{ absolute}$$

Substituting:

$$\frac{(75 + 14.7)\ (2)}{540} = \frac{P_2\ (1)}{760}$$

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D. Eyestrain. Both eyes should be kept open when looking through the microscope. If one eye is kept closed while using the other to look through the microscope, the eye muscles will tire. Imperfect focusing will also cause eye strain.

E. Cleaning the lenses. Always use lens paper to clean the lens. Hold the lens paper against the lens and twist slightly. You should NEVER rub heavily, it may scratch the lens. Do not use cloth or tissue paper to clean the lens, they may contain grit that would damage the lens.

2. Diversity and Ubiquity of Microorganisms

OBJECTIVES: To show (1) that the atmosphere, under most circumstances, contains an abundance and diversity of microorganisms; (2) that the population varies from time to time, and from situation to situation; and (3) that microorganisms in the air may be isolated by suitable culture techniques.

MATERIALS: PDA; nutrient agar; water agar; petri dishes; nitrient broth; flasks; transfer needles.

PROCEDURES: Depending on the time available, solid and liquid media can be prepared as a part of the exercise or provided at the outset. If the media are prepared, the instructor can, as he wishes, demonstrate the use of the hot-air sterilizer, autoclave, etc. As an added feature of this particular exercise, if time permits, any one or more of the routine steps may be omitted purposely and the effect thereof on the end result noted; i.e., sterilization of the media or of the petri dishes might be omitted.

Select a number of petri dishes of PDA (favoring growth of filamentous fungi) and of nutrient agar (favoring growth of bacteria). The number used will depend on facilities available, number of persons involved, and the number of situations to be tested.

Expose plates of each medium for varying lengths of time not only in the laboratory, but in sites that are as diverse as practicable, such as garden, grocery store, kitchen, outdoors in shelter of shrubs, etc. If at all possible, expose plates at different times of day at the same situation, such as early morning and afternoon; or expose plates under very different weather conditions outdoors, such as on a windy day in the afternoon and early the following morning, if still and foggy.

Details of the experiment will vary greatly, but the main objective will be achieved if sufficiently diverse samples are made and if careful records are kept so that the exposed dishes may be identified during the period of incubation. In each situation there should be at least one dish not exposed and held as a control.

Incubate exposed dishes at room temperature and examine at intervals of 3-4 days. Make records of the number and diversity of bacteria and fungi which appear. If desired, these examinations may include microscopic examination and preliminary or provisional identifications can be made by reference to Barnett (1960).

Then:

$$\frac{179.4}{540} = \frac{P_2}{760}$$

$$P_2 = \frac{(179.4)\ (760)}{540}$$

$$P_2 = 252.5 \text{ psia}$$

Converting absolute pressure to gage pressure:

$$\begin{array}{r} 252.5 \\ -14.7 \\ \hline 237.8 \end{array} \text{ psig --Answer.}$$

2. Four cubic feet of a gas at 75 psig and 80° F are compressed to 237.8 psig and heated to a temperature of 300° F. What is the volume of the gas resulting from these changes?

Formula or equation:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Using the Rankine system:

$$80° \text{ F} = 540° \text{ absolute}$$

$$300° \text{ F} = 760° \text{ absolute}$$

Substituting:

$$\frac{(75 + 14.7)\ (4)}{540} = \frac{(237.8 + 14.7)\ V_2}{760}$$

Then:

$$\frac{(89.7)\ (4)}{540} = \frac{(252.5)\ v_2}{760}$$

$$V_2 = \frac{358.8 \times 760}{540 \times 252.5}$$

$$V_2 = 2 \text{ cubic feet--Answer.}$$

Avogadro's Law

An Italian physicist, Avogardo, conceived the theory that "at the same temperature and pressure, equal volumes of different gases contain equal numbers of molecules." This theory was proven by experiment and found to agree with the kinetic theory, so it has come to be known as Avogadro's law.

Dalton's Law

If a mixture of two or more gases which do not combine chemically is placed in a container, each gas expands throughout the total space and the absolute pressure of each gas is reduced to a lower value, called its partial pressure. This reduction is in accordance with Boyle's law. The pressure of the mixed gases is equal to the sum of the partial pressures. This fact was discovered by Dalton, an English physicist, and is set forth in Dalton's law which states that "a mixture of several gases which do not react chemically exerts a pressure equal to the sum of the pressures which the several gases would exert separately if each were allowed to occupy the entire space alone at the given temperature."

TRANSMISSION OF FORCES THROUGH FLUIDS

When the end of a bar is struck, the main force of the blow is carried straight through the bar to the other end. (See fig. 2-11 (A).) This happens because the bar is rigid. The direction of the blow almost entirely determines the direction of the transmitted force. The more rigid the bar, the less force is lost inside the bar or transmitted outward at right angles to the direction of the flow.

When a force is applied to the end of a column of confined liquid (fig. 2-11 (B)) it is transmitted straight through to the other end and also equally and undiminished in every direction throughout the column--forward, backward, and sideways--so that the containing vessel is literally filled with pressure.

If a gas is used instead of a liquid, the force is transmitted in the same manner. The one difference is that gas, being compressible, provides a much less rigid force than the liquid which is incompressible. (This is the main difference in the action of liquids and gases in fluid power systems.)

An example of this distribution of force is illustrated in figure 2-12. The flat hose takes on a circular cross section when it is filled

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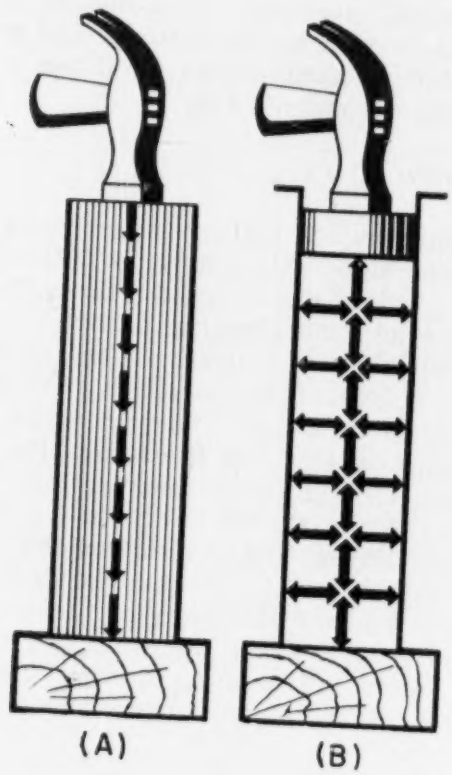

Figure 2-11.—Transmission of force; (A) Solid; (B) fluid.

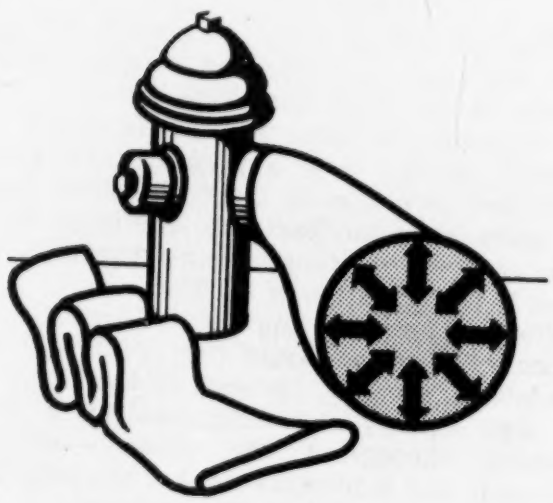

Figure 2-12.—Distribution of force.

with water under pressure. The outward push of the water is equal in every direction. The automobile tire and the toy balloon are examples of this distribution of force through the use of gases.

PASCAL'S LAW

The foundations of modern hydraulics, and pneumatics, were established in 1653 when Pascal discovered that pressure set up in a fluid acts equally in all directions. This pressure acts at right angles to containing surfaces. Thus in figure 2-13, if the liquid standing on a square inch (A) at the bottom of the tank weighs 8 pounds, a pressure of 8 psi is exerted in every direction at (A). The liquid resting on (A) pushes equally downward and outward. The liquid on every square inch of the bottom surface is pushing downward and outward in the same way, so that the pressures on different areas are in balance. At the edge of the bottom the pressures act against the wall of the tank, which must be strong enough to resist them with a force exactly equal to the push. Every square inch of the bottom of the tank must also be strong enough to resist the downward pressure of the liquid resting on it. The same balance of pressures exists at every other level in the tank, though of lesser pressures as one approaches the surface. Therefore, the liquid remains at rest--it does not leak out and the tank does not collapse.

One of the consequences of Pascal's law is that the shape of the container in no way alters pressure relations. Thus in figure 2-14, if the pressure due to the weight of the liquid at one point on the horizontal line (H) is 8 psi, the pressure is 8 psi everywhere at level (H) in the system.

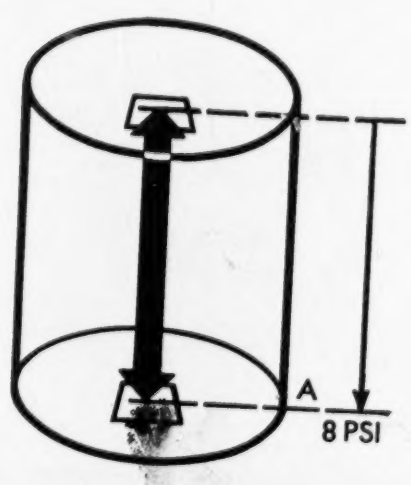

Figure 2-13.—Pressure acting on a container.

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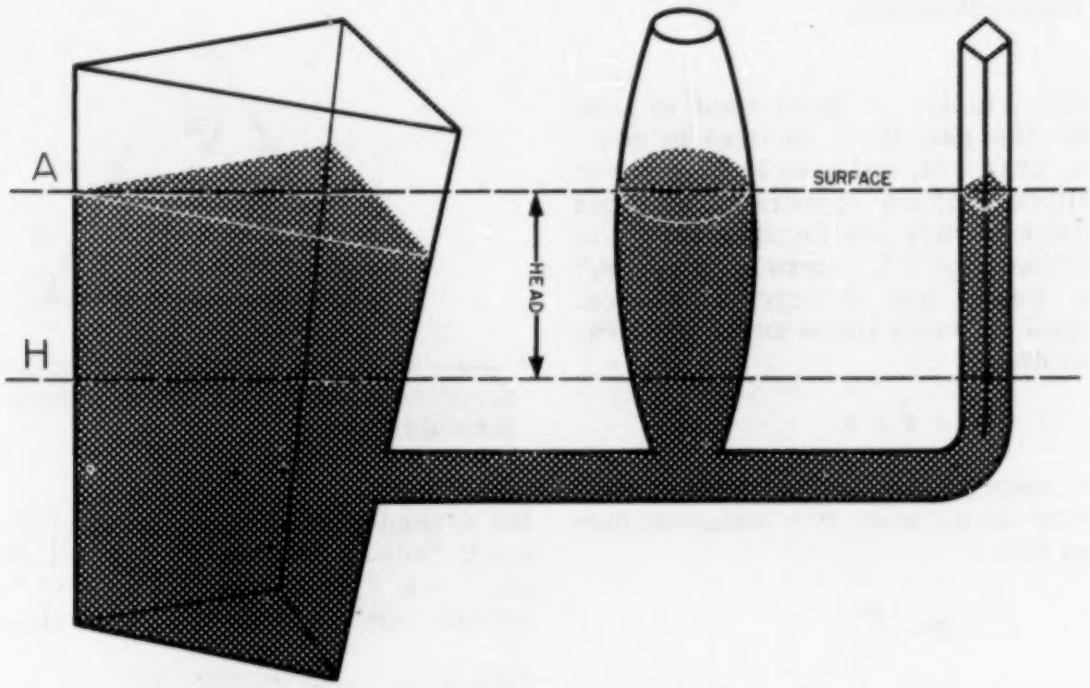

Figure 2-14.—Pressure relationship with shape.

Pressure due to the weight of a fluid depends, at any level, upon the vertical height of the fluid from the level to the surface of the fluid. The vertical distance between two horizontal levels in a fluid is known as the head of the fluid. In figure 2-14, the liquid head of all points on level (H) with respect to the surface is indicated.

Pressure due to fluid head also depends upon the density of the fluid. Water, for example, weighs 62.4 pounds per cubic foot or 0.036 pound per cubic inch, while certain oil might weigh 55 pounds per cubic foot, or 0.032 pound per cubic inch. It would take 222 inches of head, using water, to produce a pressure of 8 psi and 252 inches using the oil. (See fig. 2-15.)

This pressure head also exists with the use of gases. However, a cubic foot of air at 70° F and under a pressure of 100 psi produces a pressure head which is less than 1 percent of that produced by a cubic foot of water.

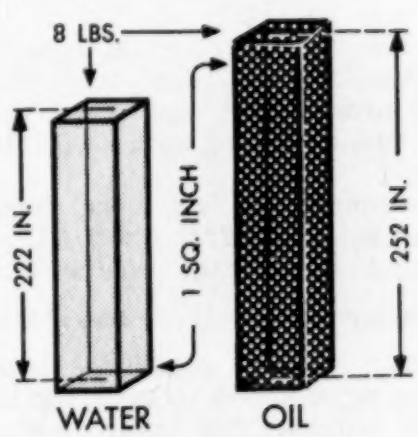

Figure 2-15.—Pressure and density relationship.

FORCE AND PRESSURE

In order to understand how Pascal's principle is applied to fluid power, a distinction must be made between the terms force and pressure. Force may be defined as a push or pull. It is the push or pull exerted against the total area of a particular surface and is expressed in pounds. As previously stated, pressure is the amount of force on a unit area of the surface acted upon. In hydraulics and pneumatics, this unit area is expressed in pounds per square inch. Thus, pressure is the amount of force acting upon 1 square inch of area.

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Computing Force, Pressure, and Area

A formula, similar to those used in conjunction with the gas laws, is used in computing force, pressure, and area in fluid power systems. Although there appears to be three formulas, there is only one formula written in three variations where P refers to pressure, F indicates force, and A represents area.

Force equal pressure times area. Thus, the formula is written

$$F = P \times A$$

Pressure equals force divided by the area. By rearranging the formula, this statement may be condensed into

$$P = \frac{F}{A}$$

Since area equals force divided by pressure, the formula is written

$$A = \frac{F}{P}$$

Figure 2-16 illustrates a device for recalling these formulas. Any letter in the triangle may be expressed as the product or quotient of the other two, depending upon its position within the triangle.

For example, to find area, consider the letter A as being set off to itself, followed by an equal sign. Now look at the other two letters. The letter F is above the letter P; therefore, $A = \frac{F}{P}$.

In order to find pressure, consider the letter P as being set off to itself, and look at the other two letters. The letter F is above the letter A; therefore, $P = \frac{F}{A}$.

Likewise, to find force, consider the letter F as being set off to itself. The letters P and A are side by side, therefore, $F = P \times A$.

NOTE: Sometimes the area may not be expressed in square inches. If it is a rectangular surface, the area may be found by multiplying the length (in inches) by the width (in inches). The majority of areas to be considered in these calculations are circular in shape. Either the radius or the diameter may be given. The radius in inches must be known to find the area. The radius is one-half the diameter. Then,

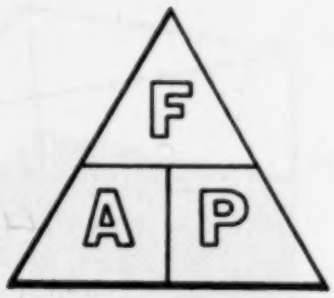

Figure 2-16.—Device for determining the arrangement of the force, pressure, and area formula.

the formula for finding the area of a circle is used. This is written $A = \pi r^2$, where, A is the area, π is 3.1416 (3.14 or 3 1/7 for most calculations), and r^2 indicates radius squared.

PRESSURE AND FORCE IN FLUID POWER SYSTEMS

In accordance with Pascal's law, any force applied to a confined fluid is transmitted equally in all directions throughout the fluid regardless of the shape of the container. Consider the effect of this in the system shown in figure 2-17. This is in reality a modification of figure 2-11 (B) in which the column of fluid is curved back upward to its original level, with a second piston at this point. It is clear that when the input piston (1) is pushed downward, a pressure is created through the fluid, which acts equally at right angles to surfaces in all parts of the container.

Referring to figure 2-17, if the force (1) is 100 pounds and the area of the piston is 10 square inches, then the pressure in the fluid is 10 psi $\left(\frac{100}{10}\right)$. This pressure acts on piston (2), so that for each square inch of its area it is pushed upward with a force of 10 pounds. In this case, a fluid column of uniform cross section is considered so that the area of the output piston (2) is the same as the input piston (1), or 10 square inches. Therefore, the upward force on the output piston (2) is 100 pounds, the same as was applied to the input piston (1). All that has been accomplished in this system was to transmit the 100-pound force around a bend. However, this principle underlies practically all mechanical applications of fluid power.

At this point it should be noted that since Pascal's law is independent of the shape of the

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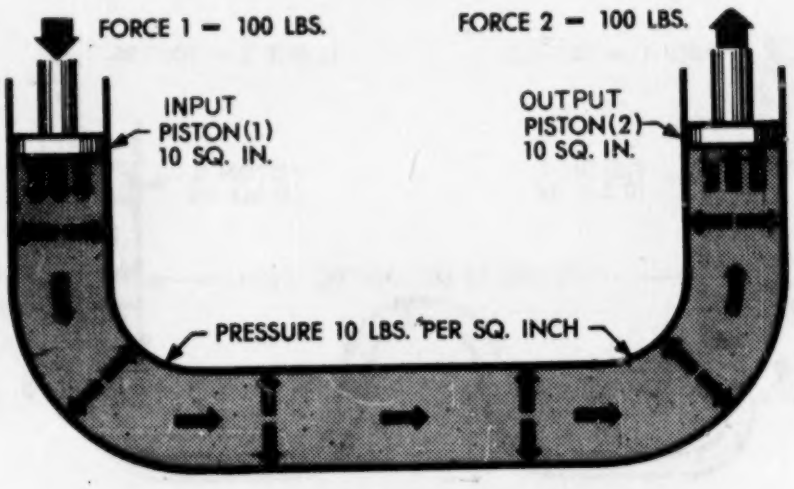

Figure 2-17.—Force transmitted through fluid.

container, it is not necessary that the tube connecting the two pistons should be the full area of the pistons. A connection of any size, shape, or length will do, so long as an unobstructed passage is provided. Therefore, the system shown in figure 2-18, wherein a relatively small, bent pipe connects two cylinders, will act exactly the same as that shown in figure 2-17.

Multiplication of Forces

In figures 2-17 and 2-18 the systems contain pistons of equal area wherein the output force is equal to the input force. Consider the situation in figure 2-19, where the input piston is much smaller than the output piston. Assume that the area of the input piston (1) is 2 square inches. Pushing down on the input piston (1) with a force of 20 pounds creates 10 psi $\left(\frac{20}{2}\right)$ in the fluid. Although this force is much smaller than the applied force in figures 2-17 and 2-18, the pressure is the same. This is because the force is concentrated on a relatively small area.

This pressure of 10 psi acts on all parts of the fluid container, including the bottom of the output piston (2). The upward force on the output piston (2) is therefore 10 pounds for each of its 20 square inches of area, or 200 pounds (10 x 20). In this case, the original force has been multiplied tenfold while using the same pressure in the fluid as before. Obviously, the system would work just the same for any other forces and pressures, so that the ratio of output force to input force is always ten to one.

The system works the same in reverse. Consider piston (2) as the input and piston (1) as the output. Then the output force will always be one-tenth the input force. Sometimes such results are desired.

Therefore, if two pistons are used in a fluid power system, the force acting on each is directly proportional to its area, and the magnitude of each force is the product of the pressure and its area.

Differential Areas

Consider the special situation shown in figure 2-20. Here, a single piston (1) in a cylinder (2) has a piston rod (3) attached to one side of the piston which extends out of the cylinder at one end. Fluid under pressure is admitted to both ends of the cylinder equally through the pipes (4, 5, and 6). The opposed faces of the piston (1) behave like two pistons acting against each other. The area of one face is the full area of the cylinder, say 6 square inches, while the area of the other face is the area of the cylinder minus the area of the piston rod, which is 2 square inches, leaving an effective area of 4 square inches on the right face of the piston. The pressure on both faces is the same, in this case, 20 psi. Applying the rule just stated, the force pushing the piston to the right is its area times the pressure, or 120 pounds (20 x 6). Likewise, the force pushing it to the left is its area times the pressure, or 80 pounds. Therefore, there is a net unbalanced force of 40 pounds acting to the right, and the piston will move in that direction. The net effect is the same as if the piston and cylinder

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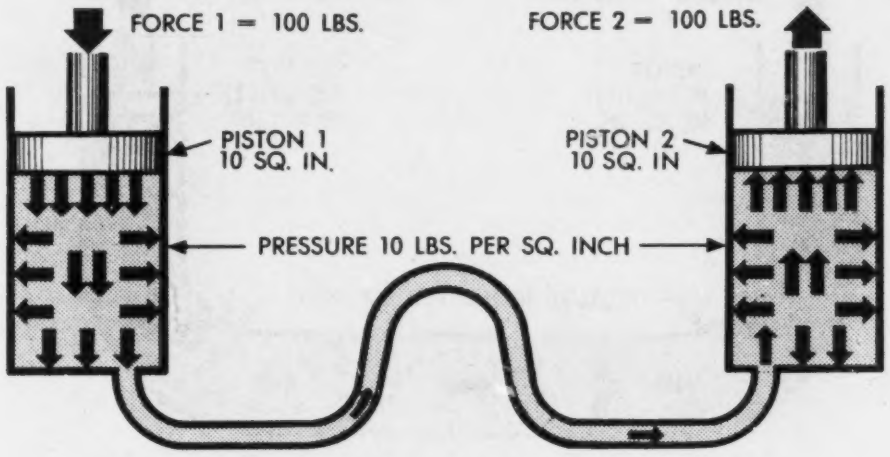

Figure 2-18.—Transmitting force through small pipe.

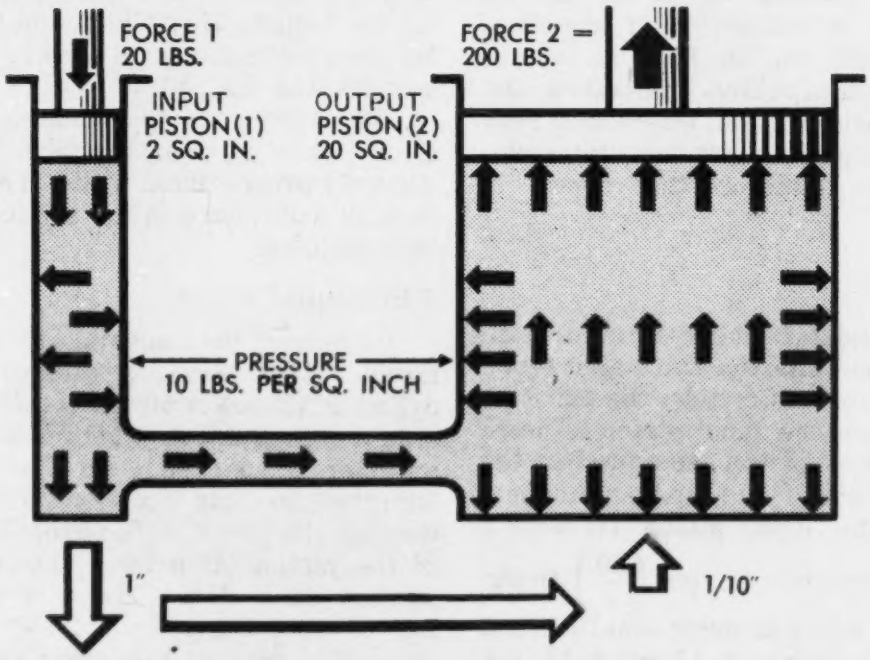

Figure 2-19.—Multiplication of forces.

were just the size of the piston rod, since all other forces are in balance.

Volume and Distance Factors

In the systems illustrated in figures 2-17 and 2-18, the pistons have areas of 10 square inches each. Therefore, if one of these pistons is pushed down 1 inch, 10 cubic inches of fluid is displaced. Since liquid is practically incompressible, this volume must go some place. In the case of a gas, it will compress momentarily, but will eventually expand to its original volume. Thus, this volume moves the other piston. Since the area of this piston is likewise 10 square inches it will move 1 inch in order to accommodate the 10 cubic inches of fluid. The pistons are of equal areas, and will therefore

move equal distances, though in opposite directions.

Applying this reasoning to the system in figure 2-19, it is obvious that if the input piston (1) is pushed down 1 inch, only 2 cubic inches of fluid is displaced. In order to accommodate these 2 cubic inches of fluid the output piston (2) will have to move only one-tenth of an inch, because its area is 10 times that of the input piston (1). This leads to the second basic rule for two pistons in the same fluid power system, which is that the distances moved are inversely proportional to their areas.

Effects of Atmospheric Pressure

Atmospheric pressure, described previously, obeys Pascal's law the same as pressure set up in fluids. As illustrated in figure 2-13, pressures, due to liquid head, are distributed equally in all directions. This is also true of atmospheric pressures. The situation is the same if these pressures act on opposite sides of any surface, or through fluids. In figure 2-21 (A) the suspended sheet of paper is not torn by atmospheric pressure, as it would be by an unbalanced force of 14.7 psi, because atmospheric pressure acts equally on both sides of the paper. In figure 2-21 (B), atmospheric pressure acting on the surface of the liquid is transmitted equally throughout the liquid to the walls of the container, but is balanced by the same pressure acting directly on the outer walls of the container. In figure 2-21 (C), atmospheric pressure acting on the surface of one piston is balanced by the same pressure acting on the surface of the other. The different areas of the two surfaces make no difference, since for a unit of area, pressures are in balance.

Vacuum and Partial Vacuum

When an individual drinks soda through a straw, he removes some of the air from the straw. This disturbs the balance of pressures which was prevailing between the liquid in the glass and the liquid in the straw. This results in an unbalance of pressures, and atmospheric pressure on the liquid in the glass pushes the soda up into the straw until a new balance is reached. The soda can be held at a certain level in the straw. This level will always be where the pressure of the head of liquid exactly equals the difference between the pressure in the straw and that on the surface on the liquid in the glass. (See fig. 2-22.) When the straw is removed from the person's mouth, the soda in the straw is subject to the same pressure as that on the surface of the liquid in the glass. This causes the liquid in the straw to return to its original level which is the same as that in the glass.

A partial vacuum is produced in the straw--that is, a pressure less than the prevailing atmospheric pressure. The theoretical limit of this process would be a condition of zero pressure--a complete vacuum. In actual practice, however, it is impossible to produce a complete vacuum.

This action takes place in the power supply for fluid power systems. As the pump or compressor moves the fluid into the system, a low pressure area (partial vacuum) is developed at the inlet port. This allows atmospheric pressure to push fluid into the inlet port of the pump or compressor. This action is discussed in greater detail in chapter 4.

INPUT AND OUTPUT RELATIONS

As illustrated in figure 2-19, an increase in output force over input force is accompanied by a decrease in the distance moved in exactly the same ratio. An increase in force can be obtained only by a proportional decrease in distance moved. This is also true if the system is operated in the reverse direction—a distance increase can be obtained, but only at the expense of a force decrease in the same ratio. This leads to the basic statement: Neglecting friction, in any fluid power system (or any other mechanical system for that matter), the input force multiplied by the distance through which it moves, is always exactly equal to the output force multiplied by the distance through which it moves.

Work and Energy

Work is defined as a force moving through some distance, and the amount of work done is the product of the force multiplied by the distance through which it moves. Therefore, when friction is neglected, the work output is always equal to the work input. Energy is a similar but broader term. Energy includes work and in addition, all the forms into which work can be converted or which can be converted into work. Work always involves actual movement,

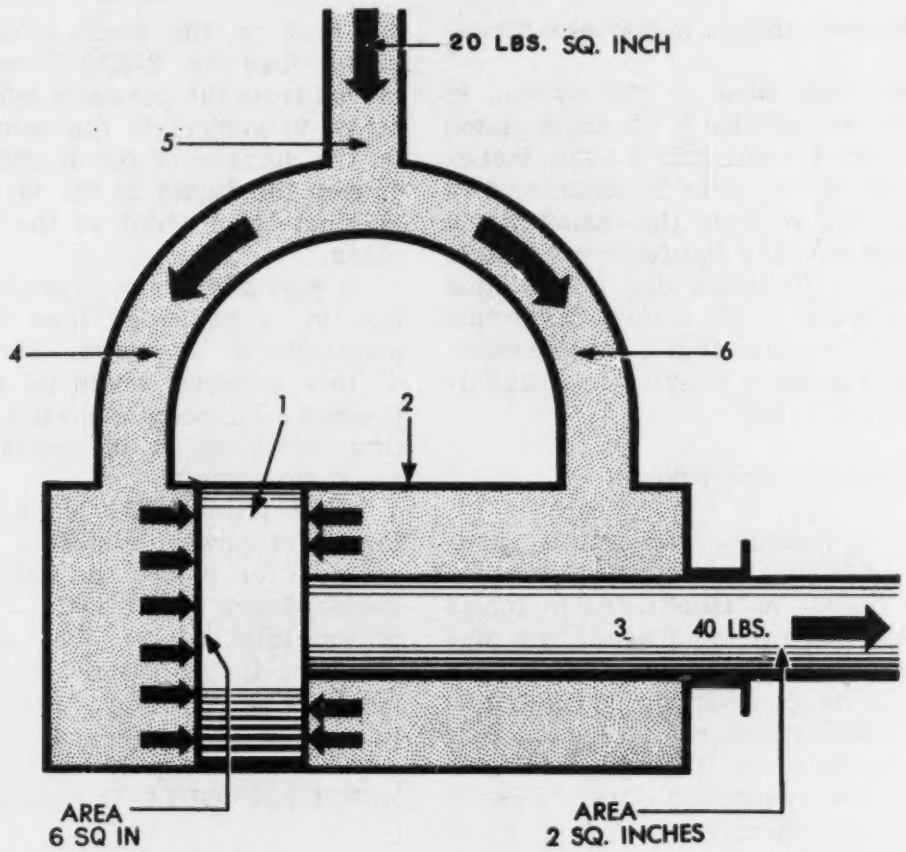

1. Piston.
2. Cylinder.
3. Piston rod.
4. Pipe.
5. Pipe.
6. Pipe.

Figure 2-20 .—Differential areas on a piston.

but energy can be at rest and still exist as energy, so long as it is capable of doing work.

Energy can exist in a great many different forms, but they all have one thing in common; they are all interchangeable with each other and with work. The many forms which energy can take and their interchangeability are illustrated by a hydroelectric plant. (See fig. 2-23.) Here, a body of water is held back by a dam. In this case the water represents potential energy, because it is not doing work at the moment, but is capable of doing work if it is released. If an opening is provided, water will rush out in a high velocity jet representing energy of motion or kinetic energy. If this jet is directed against the blades of a water wheel it will push them around producing a continuous rotary motion. This is work in its true sense because a force is moving through a distance.

The water wheel can, in turn, be connected to an electric generator which converts the work into electricity. This electricity can, in turn, be converted back into work by the use of an electric motor; or it can be converted into light by the use of an electric bulb or into heat in an electric iron. By means of a motor and a pump, the energy can be transformed back into its original form of potential energy existing as a body of water at an elevation. Thus, all of these forms of energy are interchangeable with each other. In actual mechanisms, there is always some loss in the form of friction producing heat at every exchange, but the total energy, useful and wasted, will always add up to the original input energy.

For simplicity, friction was disregarded in the preceding discussions. However, it is well known that there is always some friction in actual machines. It is also known that heat is produced whenever work is accomplished against friction. Therefore, heat is a form of energy because it can be produced from work. Likewise heat in the form of fire under a boiler can be converted into work through the medium of a steam engine. Friction represents a loss of efficiency, but this does not

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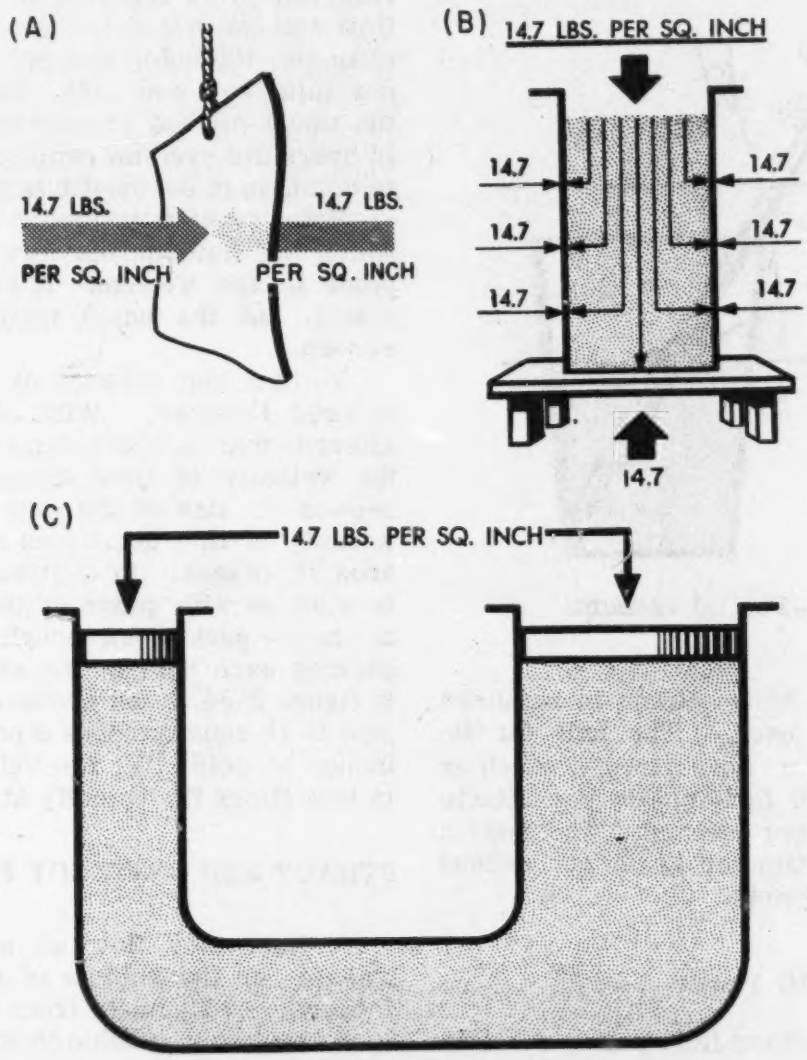

Figure 2-21. Effects of atmospheric pressure.

mean an annihilation of energy itself. It means only that some of the energy put into the system has been converted into another form which is not useful for the particular problem in hand. The energy is not usable or available, but it still exists as dissipated heat.

In agreement with this fact, any work or energy added to the system must in turn come from somewhere else, for it is not possible to create or destroy energy. All that can be done is to change it from one form into other forms, so as to make it more or less applicable to the purposes at hand. In the case of a hydraulic jack, since there is always some friction both within the liquid and between adjacent parts, the useful work output will not exactly equal the work input, but the difference will always exist somewhere in some other form of energy. In this case it will appear as heat which must escape from the system somewhere at some time. In other words, while the usable work output does not equal the input, the total energy output in all forms will always exactly equal the total energy input. This is known as the law of the conservation of energy.

Work and Power

Work and energy are measured in the same units, the foot-pound in the English system and the gram-centimeter in the metric system. Power is the rate of doing work. The same amount of work may be accomplished in two instances but less time is used in one case

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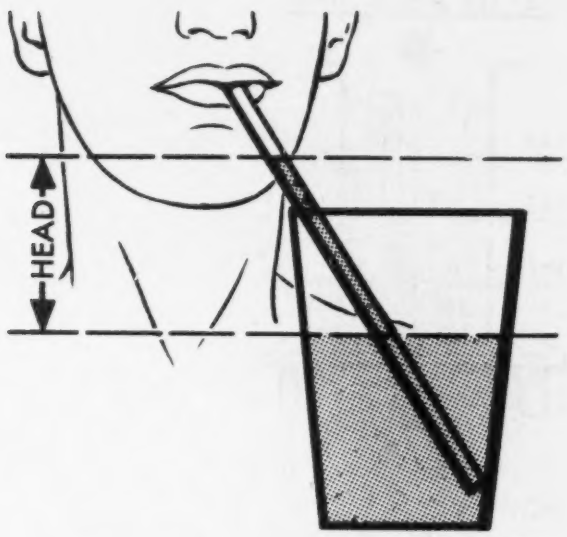

Figure 2-22.—Partial vacuum.

than in the other. More power is required where less time is used. The unit for the English system is the horsepower, which is at the rate of 33,000 foot-pounds per minute or 550 foot-pounds per second. The metric system uses the centimeter-gram per second as its unit of measurement.

FLUID FLOW

In order to understand fluid power systems in action, it is necessary to become acquainted with some of the elementary characteristics of fluids in motion. Among these are volume and velocity of flow, steady and unsteady flow, streamline and turbulent flow, and, even more important, the force and energy changes that occur in flow and the relations of different kinds of energy to each other in fluid power systems.

Under normal working conditions the fluid in a fluid power system is under pressure and completely fills the pipes of the system. This pressure is due in part to the force of gravity or weight of the fluid, and in part to externally applied forces such as might result from the action of a pump or compressor, which, in turn, might have energy supplied to it by an electric motor.

VOLUME AND VELOCITY OF FLOW

The quantity of fluid that passes a given point in a fluid power system in a unit of time is referred to as the volume of flow. Volume of flow can be stated in a number of ways; as for example, 100 cubic feet per minute, 100 gallons per minute or hour, etc. Gallons per minute is the usual method of expressing volume of flow in hydraulic systems, while cubic feet per minute is common in pneumatic systems.

Velocity of flow means the rate or speed at which the fluid moves forward at a particular point in the system. It too can be variously stated, but the usual method is in feet per second.

Volume and velocity of flow are often considered together. With other conditions unaltered—that is, with volume of input unchanged—the velocity of flow increases as the cross section or size of the pipe decreases, and the velocity of flow decreases as the cross section area increases. In a stream, velocity of flow is slow at wide parts of the stream and rapid at narrow parts even though the volume of water passing each part of the stream is the same. In figure 2-24, if the cross-sectional area of the pipe is 16 square inches at point (A) and 4 square inches at point (B), the velocity of flow at (B) is four times the velocity at (A).

STEADY AND UNSTEADY FLOW

A fluid may flow as a single continuous stream, or the volume of flow may increase, decrease, or fluctuate from moment to moment. Such changes in volume constitute unsteady flow. For example, when a faucet is first opened, the initial flow is unsteady during the short time that the rate of flow of the water is increasing from the initial zero rate to the full rate of flow. The flow then becomes steady and is maintained if the pressure remains constant. If the pressure changes, the rate of flow once more becomes unsteady until a new balance is reached.

STREAMLINE AND TURBULENT FLOW

At quite low velocities or in tubes of small diameter, flow is streamline, meaning that a given particle of fluid moves straight forward without crossing the paths followed by other particles, and without bumping into them. Streamline flow is often referred to as laminar flow which is defined as a flow situation in which fluid moves in parallel lamina or layers. As an example of streamline flow, consider figure 2-25, which illustrates an open stream flowing at

Comparison should be made on the basis of the samples taken and between media used. If desired, water agar can be used, in addition to the PDA and nutrient agars, as a demonstration that the presence of organisms can be detected easily only if conditions are favorable for their development into visible colonies. Also, by substituting broth for a solid medium, it can be shown that the diversity of organisms is demonstrable only if the medium selected permits growth of isolated colonies rather than a heterogeneous mixture. It can also be pointed out that only a solid medium permits any estimate of the relative numbers or organisms in the test sites.

TIME REQUIRED: Depending on variable included, 2-3 hours for exposure; 3 to 4 days for growth of colonies of bacteria and fungi.

RESULTS: If any of the initial steps in preparation of media are intentionally omitted, contamination will develop in the eventual plates without their being exposed.

If exposure sites are well chosen, this experiment will show: (1) the abundance of organisms in the environment; (2) variations in numbers and types from one place to another and from one time to another in the same site; (3) diversity of both bacterial and fungal organisms; and (4) the efficiency of solid media as a means of sampling the microflora of the atmosphere.

3. Relation of Wounds to Decay of Citrus Fruit by *Penicillium* sp.

OBJECTIVE: To demonstrate essentiality of wounds for infection of plant tissues with *Penicillium* sp.

MATERIALS: Oranges with blue mold; culture of *Penicillium* sp., healthy oranges; moist chambers.

PROCEDURES: Inoculate healthy orange with *Penicillium* by transferring discernible amounts of culture material (1) to intact surfaces, (2) into cuts in the rind but not down into the juice sacs, and (3) into cuts made down into the juice sacs. Repeat 1, 2, and 3 using scraping from obviously molded portions of rotted citrus fruit.

One fruit may serve for more than one inoculation by using marked portions of the fruit. Place inoculated fruit in moist chambers and observe for decay.

TIME REQUIRED: 1 hour to prepare material and make inoculations, 4 to 5 days to observe results.

RESULTS: Decay will occur only in those fruits in which wounds have been made. This exercise illustrates that wounded tissue is essential for a weak pathogen such as Penicillium to initiate infection and cause decay of citrus fruit.

4. Effect of Temperature on Fungi and Effect of Injury on Fruit Rots

OBJECTIVE: Demonstrate the effect of temperature on fungus growth and the effect of injury on invasion by fungi.

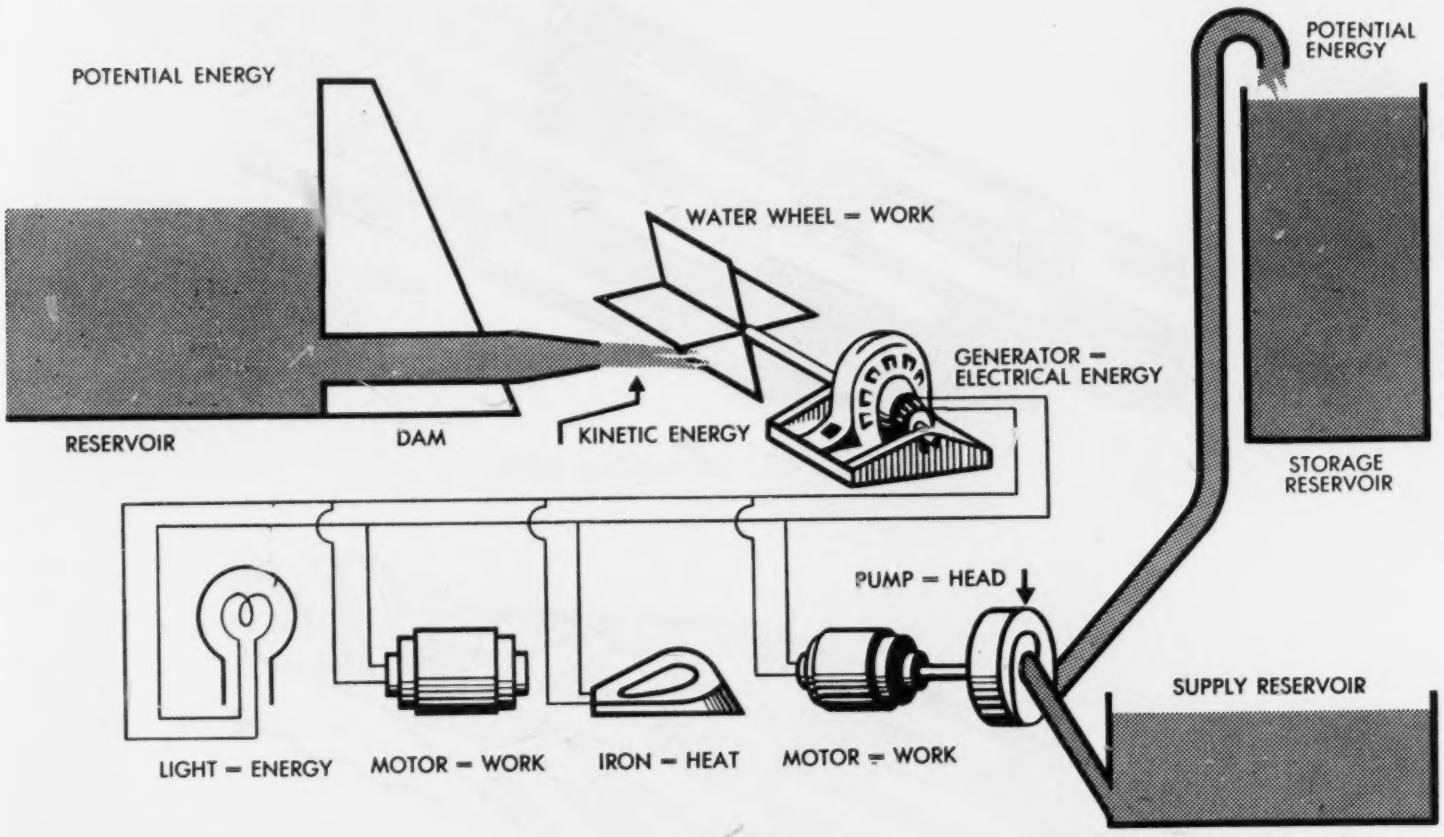

Figure 2-23.—Potential and kinetic energy.

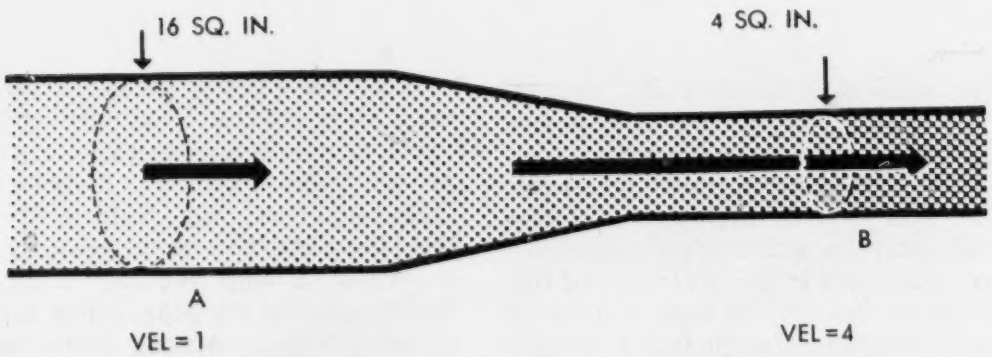

Figure 2-24.—Volume and velocity of flow.

a slow uniform rate with logs floating on its surface. The logs represent particles of fluid. So long as the stream flows along at a slow uniform rate, each log floats downstream in its own path, without crossing or bumping into the other.

If the stream narrows, however, and the volume of flow remains the same, the velocity of flow increases. If the velocity increases sufficiently, the water becomes turbulent. (See fig. 2-26.) Swirls, eddies, and cross-motions are set up in the water. As this happens, the

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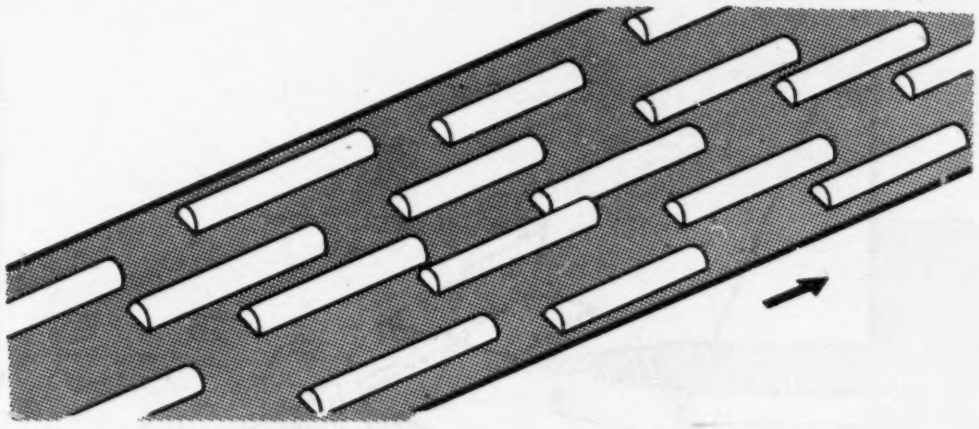

Figure 2-25.—Streamline flow.

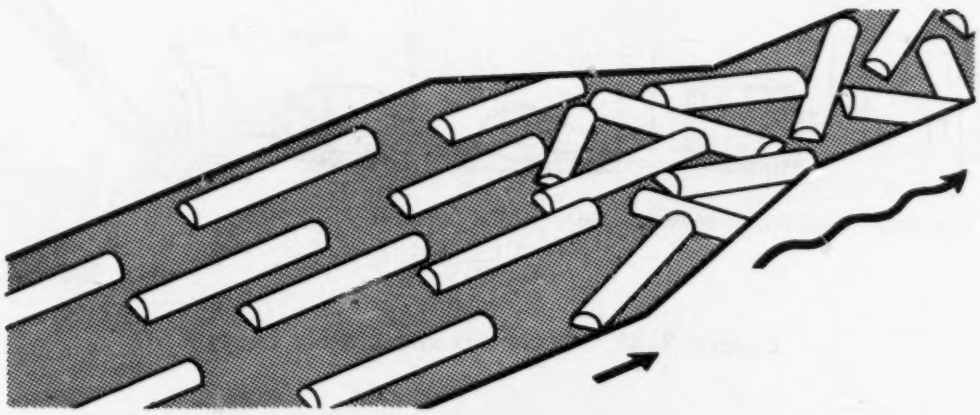

Figure 2-26.—Turbulent flow.

logs are thrown against each other and against the banks of the stream, and the paths followed by different logs will cross and recross.

Particles of fluid flowing in pipes act in the same manner. The flow is streamline if the fluid flows slowly enough, and remains streamline at greater velocities if the diameter of the pipe is small. If the velocity of flow or size of the pipe increases sufficiently, the flow becomes turbulent.

One effect of turbulent flow is illustrated in figure 2-27, where the length of the horizontal arrows indicates the relative velocities of flow at different places in the pipe, from the center to the edge, when the flow is streamline and when the flow is turbulent. In both instances the rate of flow varies from the center of the pipe to the edge, but streamline flow varies more in velocity than turbulent flow. For streamline flow the average velocity is about one-half the maximum velocity, while for turbulent flow it is about four-fifths. Velocity of flow varies both vertically and horizontally, or from the center of the pipe outward. In both streamline and turbulent flow, the fluid next to the wall of the pipe has little or no velocity.

While a high velocity of flow will produce turbulence in any pipe, other factors contribute to turbulence. Among them are the roughness of pipe, obstructions, and the degree of curvation of bends and the number of bends in the pipe. In setting up or maintaining fluid power systems, care should be taken to eliminate or minimize as many causes of turbulence as possible, since the energy consumed by turbulence is wasted. Limitations as to the degree and number of bends of pipe are discussed in chapter 5.

While designers of fluid power equipment do what they can to minimize turbulence, to a very considerable extent it cannot be avoided.

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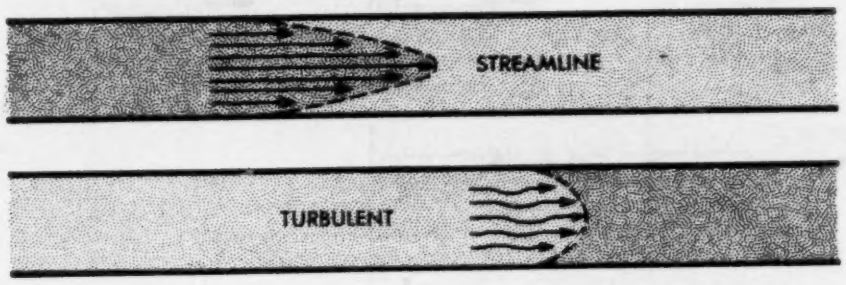

Figure 2-27.—Streamline versus turbulent flow.

Thus, in a 4-inch pipe at 68° F, flow becomes turbulent at velocities over approximately 6 inches per second or about 3 inches per second for a 6-inch pipe. These velocities are far below those commonly encountered in fluid power systems, where velocities of 5 feet per second and above are frequent. In streamline flow, losses due to friction increase directly with velocity, while with turbulent flow these losses increase much more rapidly.

FACTORS INVOLVED IN FLOW

An understanding of the behavior of fluids in motion, or solids for that matter, requires an understanding of the term "inertia." Inertia is the term used by scientists to describe that property possessed by all forms of matter which makes the matter resist being moved if it is at rest, and likewise, resist any change in its rate of motion if it is moving.

The basic statement covering the action of inertia is: "A body at rest tends to remain at rest, and a body in motion tends to continue in motion with the same velocity and in the same direction." This is simply saying in more scientific terms what everyone has learned by experience—that one must push an object to start it moving and offer an opposition to stop it again.

A familiar illustration is the effort a pitcher must exert to make a fast pitch and the opposition the catcher must put forth to stop the ball. Similarly, considerable work must be performed by the engine to make an automobile begin to roll; although, after it has attained a certain velocity, it will roll along the road at uniform speed if just enough effort is expended to overcome friction, while brakes are necessary to stop its motion. Inertia also explains the kick or recoil of guns and the tremendous striking force of projectiles.

Inertia and Force

In order to overcome this tendency to resist any change in its state of rest or motion, some force which is not otherwise canceled or unbalanced must act upon the object. Some unbalanced force must be applied whenever fluids are set in motion or increased in velocity; while conversely, forces are made to do work elsewhere whenever fluids in motion are retarded or stopped.

Ignoring friction, if the force (A) in figure 2-28 produces a velocity of 10 miles per hour (mph) when it is applied to a body for 5 seconds, it will produce a velocity of 20 mph when it is applied for 10 seconds. The same result of 20 mph would be obtained if a force (B) equal to twice (A) was applied to the body for 5 seconds. Again ignoring friction, the body would be returned to rest from a velocity of 20 mph if force (C), equal to (A) but acting in the opposite direction, was applied to it for 10 seconds, or if a force (D) equal to twice (C) was applied to it for 5 seconds.

There is a direct relationship between the magnitude of the force exerted and the inertia against which it acts. This force is dependent on two factors—on the mass of the object (which is proportional to its weight), and on the rate at which the velocity of the object is changed. The rule is that the force in pounds required to overcome inertia is equal to the weight of the object, multiplied by the change in velocity measured in feet per second, and divided by 32.2 times the time in seconds required to accomplish the change. Thus, the rate of change in

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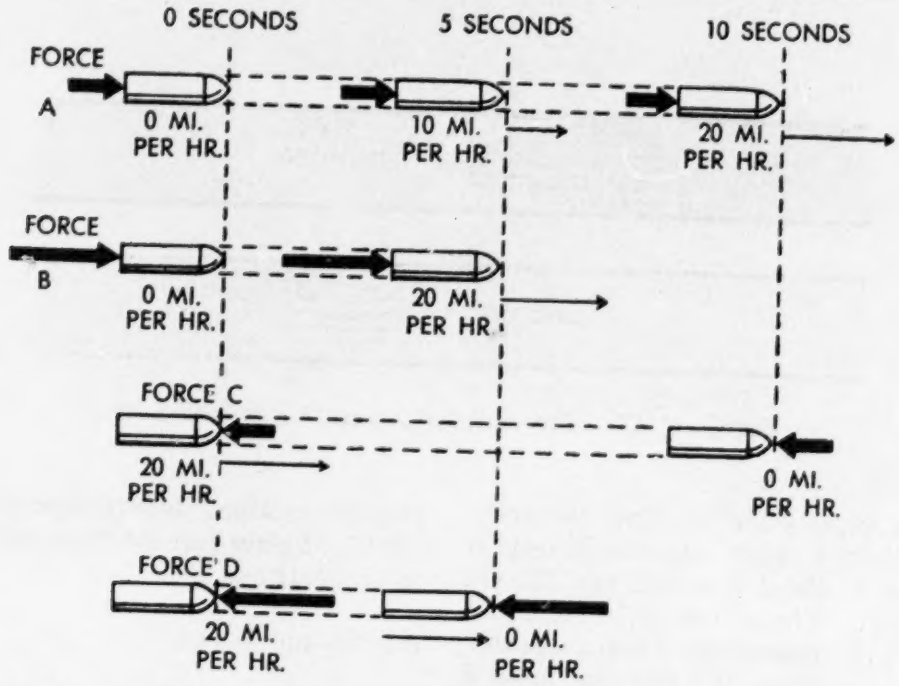

Figure 2-28.—Force and velocity.

velocity of an object is proportional to the force applied. The number 32.2 appears because it is the conversion factor between weight and mass.

As discussed previously, fluids are always acted upon by the force of gravity, or in other words, by their own weight. Also previously explained, is the fact that fluids are acted upon by atmospheric pressure, or the weight of air over the system, if they are exposed to it—if, that is, the system is not completely enclosed. The action of specific applied force was also explained, and, in addition, it was brought out that whenever there is movement there is always some friction. Inertia, just described, completes the list of forces which control the action of fluids in motion.

There are five physical factors which can act upon a fluid to affect its behavior. All of the physical actions of fluids in all possible systems are determined by the relationships of these five factors to each other. Summarizing, these five factors are as follows:

1. Gravity, which acts at all times upon all bodies, regardless of other forces.
2. Atmospheric pressure, which acts when any part of a system is exposed to the open air.
3. Specific applied forces, which may or may not be present, but which, in any event, are entirely independent of the presence or absence of motion.
4. Inertia, which comes into play whenever there is a change from rest to motion or the opposite, or whenever there is a change in direction or in rate of motion.
5. Friction, which is always present whenever there is motion.

Figure 2-29 illustrates a possible relationship of these factors with respect to a particle of fluid (P) in a system. The different forces are shown in terms of head, or in other words, in terms of vertical columns of fluid required to provide the forces. At the particular moment under consideration, a particle of water (P) is being acted upon by an applied force equivalent to a head (A), by atmospheric pressure to a head (B), and by gravity head (C) produced by the weight of the fluid standing over it. The particle possesses sufficient inertia or velocity head to rise to level (P1), since head equivalent to (F) was lost in friction as (P) passed through the system. Since atmospheric pressure (B) acts downward on the system on both sides, what was gained on one side was lost on the other.

If all the pressure acting on (P) to force it through the nozzle could be recovered in the form of elevation head, it would rise to level (Y).

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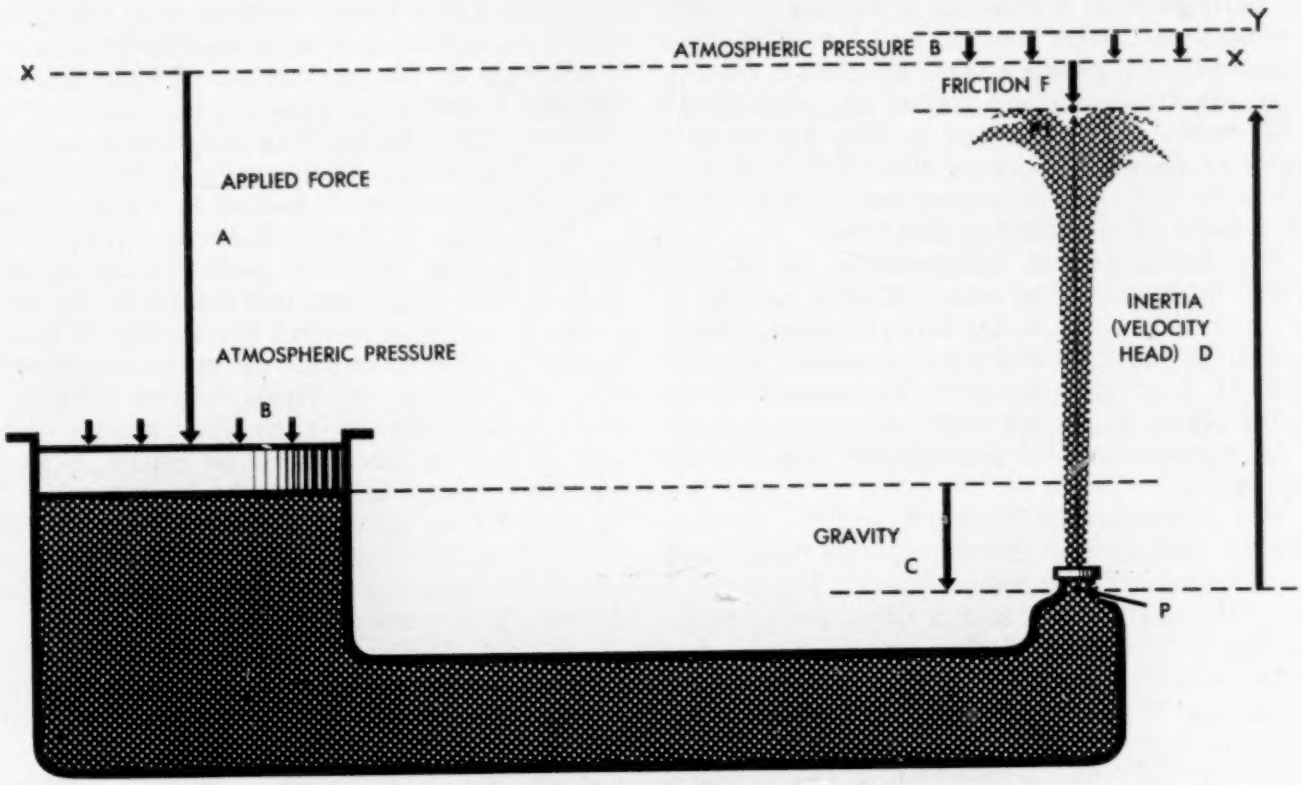

Figure 2-29.—Physical factors governing fluid flow.

If account is taken of the balance in atmospheric pressure, in a frictionless system, (P) would rise to level (X), or precisely as high as the sum of the gravity head and the head equivalent to the applied force.

Kinetic Energy

It was previously pointed out that a force must be applied to an object in order to impart velocity to it or to increase the velocity it already has. Of necessity the force must act while the object is moving over some distance. It was also previously stated that a force acting over a distance is work, and that work and all forms into which it can be changed are classified as energy. Obviously, then, energy is required to give an object velocity. The greater the energy used, the greater the velocity will be.

Likewise, disregarding friction, for an object to be brought to rest or its motion slowed down, a force opposed to its motion must be applied to it. This force also acts over some distance. In this way energy is given up by the object and delivered in some form to whatever opposes its continued motion. The moving object is therefore a means of receiving energy at one place (where its motion is increased) and delivering it to another point (where it is stopped or retarded). While it is in motion it is said to contain this energy as energy of motion or kinetic energy.

Since energy can never be destroyed, it follows that if friction is disregarded the energy delivered to stop the object will exactly equal the energy which was required to increase its speed. At all times the amount of kinetic energy possessed by an object depends upon its weight and the velocity at which it is moving.

Thus, in figure 2-30, the force (F) is applied to the body (A), which is at rest. Disregarding friction, after it has moved 1 foot it will possess kinetic energy equivalent to 1. During each

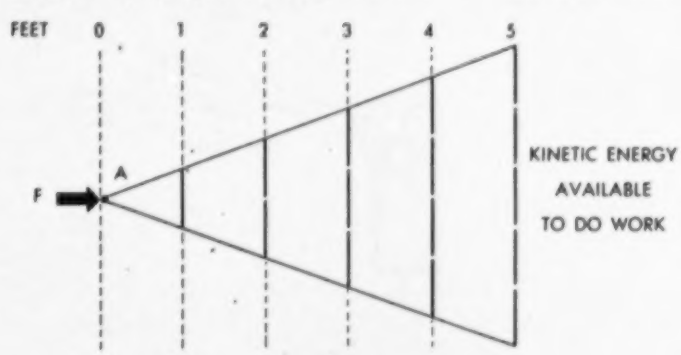

Figure 2-30.—Kinetic energy.

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succeeding foot of movement it will gain an equal increment of kinetic energy, so long as the force is applied. If it meets a resistance after moving 5 feet, kinetic energy equivalent to 5 is available to do work. Accelerated motion has been a means of receiving energy while force (F) was applied to (A), and of delivering it to do work at the place (A) reached at that time.

The mathematical relationship for kinetic energy is stated in the rule: "Kinetic energy in foot-pounds is equal to the force in pounds which created it, multiplied by the distance through which it was applied, or to the weight of the moving object in pounds, multiplied by the square of its velocity in feet per second, and divided by 64.4."

The relationship between inertia forces, velocity, and kinetic energy can be illustrated by analyzing what happens when a gun fires a projectile against the armor of an enemy ship. (See fig. 2-31.) The explosive force of the powder in the breach pushes the projectile out of the gun, giving it a high velocity. Because of its inertia the projectile offers opposition to this sudden velocity and a reaction is set up which pushes the gun backward (kick or recoil). The force of the explosion acts on the projectile throughout its movement in the gun. This is force acting through a distance producing work. This work appears as kinetic energy in the speeding projectile. The resistance of the air produces friction, which uses some of the energy and slows down the projectile. Eventually, however, the projectile hits its target and because of the inertia tries to continue moving. The target, being relatively stationary, tends to remain stationary because of its inertia. The result is that a tremendous force is set up which either leads to the penetration of the armor or the shattering of the projectile. The projectile is simply a means of transferring energy, in this instance for a destructive purpose, from the gun to the enemy ship. This energy is transmitted in the form of energy of motion or kinetic energy.

Referring to figure 2-31, the projectile is shown in four different positions: at (A) where it is at rest in the gun, just before firing; at (B), a short distance beyond the muzzle of the gun, when its kinetic energy is at the maximum; at (C), midway in its flight, where friction has used up a portion of its original kinetic energy; and at (D), at the moment of impact, where its kinetic energy is suddenly transformed into work by its inertia and the opposed inertia offered by the target. Energy imparted to the projectile at (A) has been transferred in the form of kinetic energy to do work at (D).

In this diagram no effort has been made to exhibit the magnitude of the force of gravity acting on the projectile. It enters, of course, into the path the projectile takes. This situation differs from that shown in figure 2-30 in which the propelling force was continuously applied throughout the period covered by the diagram, whereas in figure 2-31, the force was applied only while the projectile was moving from (A) to (B).

RELATIONSHIP OF FORCE, PRESSURE, AND HEAD

In dealing with fluids, forces are usually considered in relation to the areas over which they are applied. As previously discussed, a

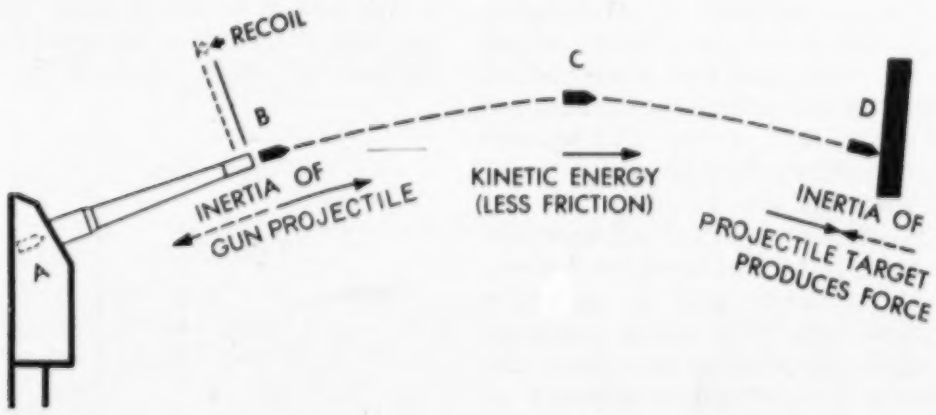

Figure 2-31.—Relationship of inertia, velocity, and kinetic energy.

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force acting over a unit area is a pressure, and pressures can alternatively be stated in psi or in terms of head, which is the vertical height of the column of fluid whose weight would produce that pressure.

In most of the applications of fluid power in the Navy, applied forces greatly outweigh all other forces, and in most systems the fluid is entirely confined. Under these circumstances it is customary to think of the forces involved in terms of pressures. Since the term head is encountered frequently in the study of fluid power, it is necessary to understand what it means and how it is related to pressure and force.

All five of the factors which control the actions of fluids can, of course, be expressed either as force, or in terms alternatively of equivalent pressures or heads. In each situation, however, the different factors are commonly referred to in the same terms, since on this common basis they can be added and subtracted to study their relationship to each other.

At this point some terms in general use should be reviewed. Gravity head, when it is of sufficient importance to be considered, is sometimes referred to as head. The effect of atmospheric pressure is referred to simply as atmospheric pressure (Atmospheric pressure is frequently and improperly referred to as suction.) Inertia effect, because it is always directly related to velocity, is usually called velocity head, and friction, because it represents a loss of pressure or head, is usually referred to as friction head.

STATIC AND DYNAMIC FACTORS

The first three factors—gravity, applied force, and atmospheric pressure—apply equally to fluids at rest or in motion, while the latter two—inertia and friction—apply only to fluids in motion. The first three are the static factors and the latter two the dynamic factors. The mathematical sum of the first three—gravity, applied force, and atmospheric pressure—is the static pressure obtained at any one point in a fluid at any given time. Static pressure exists in addition to any dynamic factors which may also be present at the same point and time.

Remember, Pascal's law states that a pressure set up in a fluid acts equally in all directions and at right angles to the containing surfaces. This covers the situation only for fluids at rest, or practically at rest. It is true only for the factors making up static head. Obviously, when velocity becomes a factor it must have a direction, and, as previously explained, the force related to the velocity must also have a direction, so that Pascal's law alone does not apply to the dynamic factors of fluid power.

The dynamic factors of inertia and friction are related to the static factors. Velocity head and friction head are obtained at the expense of static head. However, a portion of velocity head can always be reconverted to static head. Force, which can be produced by pressure or head when dealing with fluids, is necessary to start a body moving if it is at rest, and is present in some form when the motion of the body is arrested. Therefore, whenever a fluid is given a velocity, some part of its original static head is used to impart this velocity, which then exists as velocity head.

BERNOULLI'S PRINCIPLE

Consider the system illustrated in figure 2-32. Chamber (A) is under pressure and is connected by a tube to chamber (B), which is also under pressure. The pressure in chamber (A) is static pressure of 100 psi. The pressure at some point (X) along the connecting tube consists of a velocity pressure of 10 psi exerted in a direction parallel to the line of flow, plus the unused static pressure of 90 psi, which still obeys Pascal's law and operates equally in all directions. As the fluid enters chamber (B) it is slowed down, and, in so doing, its velocity head is changed back into pressure head. The force required to absorb its inertia equals the force required to start the fluid moving originally, so that the static pressure in chamber (B) is again equal to that in chamber (A), although it was lower at an intermediate point.

This situation (fig. 2-32) disregards friction, and would therefore not be encountered in actual practice. Force or head is also required to overcome friction, but, unlike inertia effect, this force cannot be recovered again, although the energy represented still exists somewhere as heat. Therefore, in an actual system the pressure in chamber (B) would be less than that in chamber (A) by the amount of pressure used in overcoming friction along the way.

At all points in a system, therefore, the static pressure is always the original static pressure less any velocity head at the point in question, and less the friction head consumed in reaching that point. Since both velocity head

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dimensions for the particular conditions is used, and it is installed along as direct a route as possible. Sharp bends and sudden changes in cross sectional area are avoided. Valves, gages, and other components are designed so as to interrupt the flow as little as possible. Careful thought is given to the size and shape of openings. The systems are designed so they can be kept clean inside and so variations from normal operation can easily be detected and remedied.

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CHAPTER 3

HYDRAULIC AND PNEUMATIC FLUIDS

During the design of equipment that requires fluid power, many factors must be considered in the selection of the type of system to be used—hydraulic, pneumatic, or a combination of the two. Some of the factors that must be considered are as follows: Required speed and accuracy of operation, surrounding atmospheric conditions, heat, economic conditions, availability of replacement fluid, required pressure level, temperature range, contamination possibilities, cost of transmission lines, limitations of the equipment, lubricity, safety to operators, and expected service life of the equipment.

After the type of system has been selected, many of these same factors must be considered in selecting the fluid for the system, particularly in the selection of a liquid for a hydraulic system.

HYDRAULIC LIQUIDS

Liquids are used in hydraulic systems primarily to transmit and distribute forces to the various units to be actuated. As was pointed out in chapter 2, liquids are able to do this because they are almost incompressible. Pascal's law states that a force applied on any area of an enclosed liquid is transmitted equally and undiminished to all equal areas throughout the enclosure. Thus, if a number of passages exist in a system, pressure can be distributed through all of them by means of the liquid.

Commercial manufacturers of hydraulic devices usually specify the type of liquid best suited for use with their equipment, in view of the working conditions, the service required, temperatures expected inside the systems and out, pressures the liquid must withstand, the possibilities of corrosion, etc. In Navy hydraulic systems, proper specifications are determined by various bureaus on the basis of experiments, tests, and trials. The bureaus experienced many difficulties; for example, in the search for hydraulic liquids adapted to both the subzero Arctic climate and the high temperatures of the Tropics.

PROPERTIES

If incompressibility and fluidity were the only qualities required, any liquid not too thick might be used in a hydraulic system. But a satisfactory liquid for a particular installation must possess a number of other properties. Some of the properties and characteristics that must be considered when selecting a satisfactory liquid for a particular system are discussed in the following paragraphs.

Viscosity

One of the most important properties of the liquid to be used in hydraulic equipment is its viscosity. Viscosity is the internal resistance of a fluid which tends to prevent it from flowing. A liquid, such as gasoline, which flows easily has a low viscosity; and a liquid, such as tar, which flows slowly has a high viscosity. Viscosity increases with decreases in temperature, since liquids flow less easily when cold than when hot.

A satisfactory liquid for a given hydraulic system must have enough body to give a good seal at pumps, valves, and pistons; but must not be so thick that it offers resistance to flow, leading to power loss and higher operating temperatures. These factors will add to the load and to excessive wear of the parts. A fluid that is too thin will also lead to rapid wear of moving parts, or of parts which have heavy loads.

MEASUREMENT OF VISCOSITY.—The viscosity of a liquid is measured with an instrument called a viscosimeter or viscometer. There are several types, but the instrument most often used by American engineers is the Saybolt Universal

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MATERIALS: An orange with blue or green mold on it or a mold culture, eight oranges without bruises or soft spots, tweezers, cellophane tape and refrigeration.

PROCEDURES: Divide the good oranges into two groups, "I" and "II". Divide each group into two sub groups, "A" and "B", and from each orange in the "A" sub group cut a 1/4" piece out of the rind with the tweezers and very carefully place some inoculum from the molded orange or the culture into the wound and cover with cellophane tape. The oranges in sub groups "B" are to be inoculated also, being very careful not to injure the surface of the oranges. Cover the spot inoculated with cellophane tape. Then place the 4 oranges in group I in a refrigerator. Put the 4 oranges in group II in a dish and put them in a safe place in your room.

Compare the growth of mold under the different conditions.

TIME REQUIRED: 1 hour to prepare materials and make inoculations, 7 days to observe results.

RESULTS: Compare mold growth according to temperature and to injury of the oranges. This shows that the proper storing temperature and care in handling are both necessary to prevent fruit rots.

RECORD SHEET

1. Answer the following questions:

a) Did mold grow on all 8 oranges?_____ If not, on which ones did it grow? _____

b) Was the fungus growth better on those stored in the refrigerator or those kept in your room? _____

_____

c) What do you think is the reason for these results? _____

_____

_____

d) Was there more fungus growth on the oranges that were injured than on those that were uninjured?_____ Why? _____

_____

_____

_____

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Viscosimeter (fig. 3-1). This instrument measures the number of seconds it takes for a fixed quantity of liquid (60 cubic centimeters) to flow through a small orifice of standard length and diameter at a specific temperature. This time of flow is taken in seconds, and the viscosity reading is expressed as Second, Saybolt Universal (SSU). For example, a certain liquid might have a viscosity of 80 SSU at 130° F.

The Saybolt Viscosimeter consists of a reservoir for the liquid surrounded by a bath heated by heating coils to bring the liquid to the temperature at which the viscosity is to be measured. The bottom of the reservoir issues into the standard viscosimeter orifice. Passage through the orifice is blocked by a cork. The reservoir is filled to a marked level with the liquid to be tested and a container marked at the 60-cubic centimeter (cc) level is placed under the opening. When the liquid is at the desired test temperature, the cork is removed, and the number of seconds it takes for the liquid to reach the 60-cc level gives the SSU reading.

VISCOSITY INDEX.—One of the properties of an ideal hydraulic liquid would be that of retaining the same viscosity under all temperature and pressure conditions to which it is subjected. Many liquids, particularly petroleum base oils, do not have this characteristic. As the temperature increases, the oil becomes thinner—the viscosity decreases; as the temperature decreases, the oil thickens—the viscosity increases. The variation is greater for some liquids than for others. Pennsylvania crude oils (paraffinic) vary comparatively little in viscosity with changes in temperature; while with Gulf Coast crudes (naphthenic or asphaltic), the variation is considerably greater.

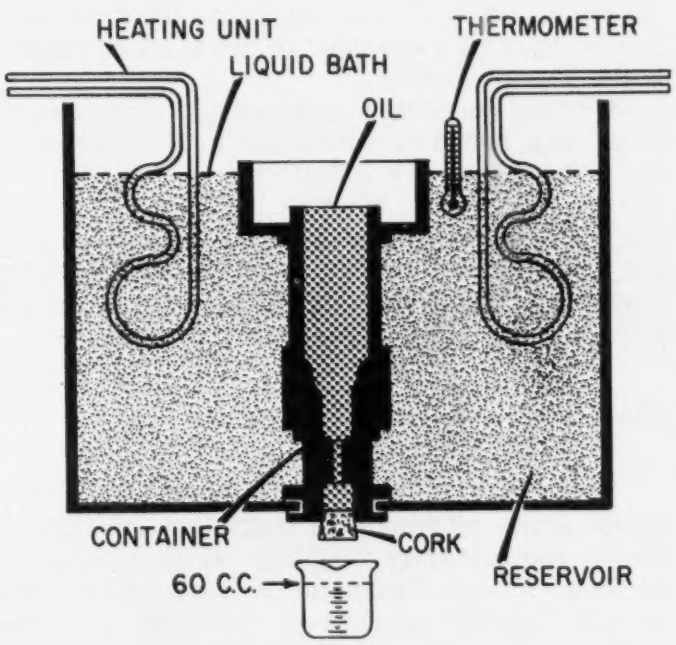

Figure 3-1.—Saybolt Viscosimeter.

In order to obtain a numerical indication of the degree to which viscosity changes with change in temperatures, these two oils are taken as the basis for a scale. The change in viscosity of a specific paraffinic oil between 100° F and 210° F is assigned a viscosity index (V.I.) value of 100, while the change in viscosity of a specific naphthenic oil over the same temperature range is assigned a value of 0. Other liquids are then assigned a viscosity index in terms of the degree to which their viscosity changes over this range, as compared to the standard oils.

The greater the variation in viscosity with changes in temperature, the lower the V.I. The V.I. figures may range above 100 or below 0, if the liquids being measured vary less or more widely in viscosity than the standard oils. Thus, a liquid with a viscosity index of -10 would vary in viscosity with changes in temperature to an even greater degree than naphthenic oils; while an oil with a viscosity index of 120 would show even less change in viscosity with changes in temperature than paraffinic oils.

Since naval hydraulic systems must work satisfactorily under wide temperature extremes, from Arctic regions to the Tropics and from below sea level to many miles into space, the liquids used should have as high a viscosity index as possible, consistent with the other properties the liquid must possess. The viscosity of a liquid is often increased through the use of chemical additives.

Lubricating Power

If motion takes place between surfaces in contact, friction tends to oppose the motion. When pressure forces the liquid of a hydraulic system between the moving surfaces, the liquid spreads out into a thin film which enables the parts to move more freely. This lubricates the area. Different liquids, including oils vary greatly not only in their lubricating ability, but also in film strength which is the capacity of a liquid to resist being wiped or squeezed out from between the surfaces when spread out in an extremely thin layer. A liquid will no longer lubricate if

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the film breaks down, since the motion of part against part wipes the metal clean of liquid. Since lubricating power varies with temperature, climatic and working conditions must enter into the determination of the lubricating qualities of a liquid. Unlike viscosity, which is a physical property, the lubricating power and film strength of a liquid is directly related to its chemical nature. Lubricating qualities and film strength can be improved by the addition of certain chemical agents.

Chemical Stability

Chemical stability is another property which is exceedingly important in the selection of a hydraulic liquid. It is defined as the liquid's ability to resist oxidation and deterioration for long periods. All liquids tend to undergo unfavorable chemical changes under severe operating conditions. This is the case, for example, when a system operates for a considerable period of time at high temperatures.

Excessive temperatures have a great effect on the life of a liquid. It should be noted that the temperature of the liquid in the reservoir of an operating hydraulic system does not always represent a true state of operating conditions. Localized hot spots occur on bearings, gear teeth, or at the point where liquid under pressure is forced through a small orifice. Continuous passage of a liquid through these points may produce local temperatures high enough to carbonize or sludge the liquid, yet the liquid in the reservoir may not indicate an excessively high temperature. Liquids with a high viscosity have a greater resistance to heat than light or low viscosity liquids which have been derived from the same source. The average hydraulic liquid has a low viscosity. Fortunately, there is a wide choice of liquids available for use in the viscosity range required of hydraulic liquids.

Liquids may break down if exposed to air, water, salt, or other impurities, especially if they are in constant motion or subjected to heat. Some metals, such as zinc, lead, brass, and copper, have an undesirable chemical reaction on certain liquids.

These chemical processes result in the formation of sludge, gums, and carbon or other deposits which clog openings, cause valves and pistons to stick or leak, and give poor lubrication to moving parts. As soon as a small amount of sludge or other deposits are formed, the rate of formation generally increases more rapidly. As they are formed, certain changes in the physical and chemical properties of the liquid take place. The liquid usually becomes darker in color, higher in viscosity, and acids are formed.

The extent to which changes occur in different liquids depends on the type of liquid, type of refining, and whether it has been treated to provide further resistance to oxidation. The stability of liquids can be improved by the addition of oxidation inhibitors. Laboratory tests must be conducted to select the type and quantity of the inhibitor most effective against oxidation of a particular liquid. However, inhibitors must also be compatible with the other required properties of the liquid.

Freedom from Acidity

An ideal hydraulic liquid should be free from acids which cause corrosion of the metals in the system. Most liquids cannot be expected to remain completely noncorrosive under severe operating conditions. The degree of acidity of a liquid, when new, may be satisfactory; but after use, the liquid may tend to develop corrosive tendencies as it begins to deteriorate. The liquid must be carefully processed with the specific aim of inhibiting harmful acid formation which would attack metal surfaces in the system.

Many systems are idle for long periods after operating at high temperatures. This permits moisture to be condensed in the system, resulting in rust formation.

Certain corrosion- and rust-preventive additives are added to hydraulic liquids. Some of these additives are effective only for a limited period. Therefore, the best procedure is to use the liquid specified for the system, and to protect the liquid and the system as far as possible from contamination by foreign matter, from abnormal temperatures, and misuse.

Flashpoint

Flashpoint is the temperature at which a liquid gives off vapor in sufficient quantity to ignite momentarily or flash when a flame is applied. A high flashpoint is desirable for hydraulic liquids because it indicates good resistance to combustion and a low degree of evaporation at normal temperatures.

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Fire Point

Fire point is the temperature at which a substance gives off vapor in sufficient quantity to ignite and continue to burn when exposed to a spark or flame. Like flashpoint, a high fire point is required of desirable hydraulic liquids.

Minimum Toxicity

Toxicity is defined as the quality, state, or degree of being toxic or poisonous. Some liquids contain chemicals that are a serious toxic hazard. These toxic or poisonous chemicals may enter the body through inhalation, by absorption through the skin, through the eyes, or through the mouth. The result is sickness and in many cases death. Manufacturers of hydraulic liquids strive to produce suitable liquids that contain no toxic chemicals and, as a result, most hydraulic liquids are free of harmful chemicals. Some fire-resistant liquids are toxic, and suitable protection and care in handling must be provided. Containers for toxic liquids must be properly labeled.

NOTE: MIL-STD-755 establishes a uniform design for symbols to warn users of potential hazards involved with the use of materials in containers. The toxic symbol consists of a brown edged square inside of which is a brown circular patch on a white background. A skull and the following lettering appears in white on the brown patch: DANGER, TOXIC, CONTAINS (name of substance) AVOID INHALING, SWALLOWING, OR CONTACT WITH THE SKIN. Additional information concerning the identification of compressed-gas cylinders and pipelines containing hazardous substances is contained in MIL-STD-101A and MIL-STD-1247A.

TYPES OF HYDRAULIC LIQUIDS

Many different liquids have been tested for use in hydraulic systems. The liquids that are presently in use include mineral oil, vegetable oil, water, phosphate esters, ethylene glycol compounds, and oil in water. Hydraulic liquids are usually classified according to their type of base. The three most common types of hydraulic liquids are water base, petroleum base, and synthetic base.

Water Base Liquids

Water was used as a fluid medium in the first hydraulic systems. It is still suitable for certain large commercial hydraulic installations that require high pressures and low operating speeds, but it does not meet all the requirements for general hydraulic equipment use. As a hydraulic liquid, water presents many problems, such as rust and corrosion, ineffective lubrication, temperature variations, and the hazard of foreign matter in the water itself which might cause an abrasive action on the smooth interior surfaces of the system components. All of these act as factors detrimental to the operating efficiency and long service life of the equipment.

Water has ideal fire resistance. When water is used as a hydraulic liquid, it is usually combined with certain oils, ethylene glycol, and other substances. When combined with oil, the combination is fire resistant until the water evaporates. Then the oil may burn. Other combinations can eliminate ignition problems but may have mechanical or economic limitations. During the early 1950's, the Navy used Hydrolube, a mixture of water and polyethylene glycol (antifreeze compound) in approximately 80 percent of their aircraft. This liquid contained 35 to 40 percent water together with polyethylene glycol, rust inhibitors, thickeners, and lubricating agents. After a few years of use, problems were encountered with thin film corrosion in the aircraft systems using Hydrolube, resulting in the Navy discontinuing its use in aircraft systems. Water base liquids are used by the Navy in the catapult systems on aircraft carriers. This was approved following explosions attributed to petroleum base liquids.

Petroleum Base Liquids

One of the first oils used as a hydraulic liquid was a petroleum base automotive brake fluid. Its use was limited due to the natural rubber seals and packings in use not being compatible with petroleum base oils. As a result, a vegetable base oil containing 50 percent castor oil and 50 percent alcohol was used in some applications. This solved the problems with seals and packings, as natural rubber is compatible with vegetable base oils. However, this liquid was unsatisfactory due to oxidation of the castor oil. Also, liquid is an excellent conductor of electricity, resulting in a high degree of electrolysis (the chemical disintegration of a substance accomplished by an electric current passing through it). Vegetable base liquids also have a very poor temperature stability.

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During the middle 1930's, a light petroleum base oil was developed and, when used with asbestos seals, proved quite successful. By the late 1930's, advancement in packing materials, such as synthetic rubber seals, permitted extensive use of petroleum base liquids in hydraulic systems. As a result, a petroleum base oil was developed about 1940 that proved very satisfactory and, with certain refinements, is in use today. This liquid was improved through the use of a number of additives, such as oxidation and corrosion inhibitors, viscosity index improvers, pour depressants, etc. These additives not only permit liquid operation at greater temperature extremes, but add to their lubricating qualities and life characteristics.

Petroleum base liquids are the most widely used media for hydraulic systems. Certain petroleum base oils are used in a number of different applications. For example, MIL-H-5606A is the specification number of the petroleum base hydraulic oil presently used in most Navy aircraft hydraulic systems. Another example is MIL-F-1711 which is the specification number of the petroleum base oil generally approved for ordnance equipment, except guided missiles. Many special petroleum base oils are required for specific applications.

Synthetic Base Liquids

Petroleum base oils contain most of the desired properties required of a hydraulic liquid. However, they are flammable under normal conditions and can become explosively dangerous when subjected to high pressures and a source of flame or high temperatures. Water base liquids are fire resistant, but do not have the high lubricity of petroleum base oils. Some water base liquids cause corrosion of components in the hydraulic system.

In recent years, nonflammable synthetic liquids have been developed for use in hydraulic systems where fire hazards exist. A synthetic material is a complex chemical compound that has been artifically formed by the combining of two or more simpler compounds or elements. Some of the synthetic liquids currently used as a hydraulic medium are chemically described as phosphate esters, chlorinated biphenyls, or blends of each. Certain synthetic liquids have been found to attack packings used in hydraulic systems; therefore, special packings are normally required when these fluids are used.

CONTAMINATION

Experience has shown that trouble in a hydraulic system is inevitable whenever the liquid is allowed to become contaminated. The nature of the trouble—whether a simple malfunction, or the complete destruction of a component—depends to some extent on the type of contaminant.

Classes of Contamination

The two general contamination classes can be distinguished as follows:

1. Abrasives, including such particles as core sand, weld spatter, machining chips, and rust.
2. Nonabrasives, including those resulting from oil oxidation, and soft particles worn or shredded from seals and other organic components.

The mechanics of the destructive action by abrasive contaminants is clear. When the size of the particles circulating in the hydraulic system is greater than the clearance between moving parts, the clearance openings act as filters and retain such particles. Hydraulic pressure then embeds these particles into the softer materials, and the reciprocating or rotating motion of component parts develop scratches on finely finished surfaces. Such scratches result in internal component leakage and decreased efficiency.

Oil-oxidation products, usually called sludge, have no abrasive properties. Nevertheless, sludge may prevent proper functioning of a hydraulic system by clogging valves, orifices, and filters. Frequent changing of hydraulic system liquid is not a satisfactory solution to the contamination problem. Abrasive particles contained in the system are not usually flushed out, and new particles are continually created as friction products. Furthermore, every minute remnant of sludge acts as an effective catalyst to speed up oxidation of the fresh fluid. (A catalyst is a substance which, when added to another substance, speeds up or slows down chemical reaction, but is itself unchanged at the end of the reaction.)

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Origin of Contaminants

The origin of contaminants in hydraulic systems can be traced to four major areas as follows:

1. Particles originally contained in the system. These particles originate during fabrication of welded system components, especially in reservoirs and pipe assemblies. The presence is minimized by proper design. For example, seam-welded overlapping joints are preferred, and arc welding of open sections is usually avoided. Hidden passages in valve bodies, inaccessible to sand blasting, are the main source of introduction of core sand. Even the most carefully designed and cleaned casting will almost invariably free some sand particles under the action of hydraulic pressure. Rubber hose assemblies always contain some loose particles, most of which can be removed by flushing, while others withstand cleaning and are freed later by the action of hydraulic pressure.

Particles of lint from cleaning rags can cause abrasive damage in hydraulic systems, especially to closely fitted moving parts. In addition, lint in a hydraulic system packs easily into clearances between packings and contacting surfaces, leading to component leakage and decreased efficiency. Lint also helps clog filters prematurely. Rust or corrosion initially present in a hydraulic system can usually be traced to improper storage of materials and component parts. Particles can range in size from large flakes to abrasives of microscopic dimensions. Proper preservation of stored parts is helpful in eliminating corrosion.

2. Particles introduced from outside forces. Particles can be introduced into hydraulic systems at points where either the liquid or certain working parts of the system (e.g., piston rods) are at least in temporary contact with the atmosphere. The most common danger areas are at the refill and breather openings and at cylinder rod packings. Contamination arising from carelessness during servicing operations is minimized by the use of filters in the system fill lines and finger strainers in the filter adapters of hydraulic reservoirs. Hydraulic cylinder piston rods incorporate wiper rings and dust seals to prevent the dust that settles on the piston rod during its outward stroke from being drawn into the system when the piston rod retracts.

3. Particles created within the system during operation. Contaminants created during system operation are of two general types—mechanical and chemical. Particles of a mechanical nature are formed by wearing of parts in frictional contact, such as pumps, cylinders, and packing gland components. These wear particles can vary from large chunks of packings down to steel shavings of microscopic dimensions which are beyond the retention potential of system filters.

The chief source of chemical contaminants in hydraulic liquid is oxidation. These contaminants are formed under high pressure and temperatures, and are promoted by the catalytic action of water and air and of metals like copper or iron oxides. Oil-oxidation products appear initially as organic acids, asphaltines, gums, and varnishes—sometimes combined with dust particles as sludge. Liquid soluble oxidation products tend to increase liquid viscosity, while insoluble types form sediments and precipitates, especially on colder elements such as heat exchanger coils.

Liquids containing antioxidants have little tendency to form gums under normal operating conditions. However, as the temperature increases, resistance to oxidation diminishes. Hydraulic liquids which have been subjected to excessively high temperatures (above 250° F) will break down in substance, leaving minute particles of asphaltine suspended in the liquids. The liquid changes to brown in color and is referred to as decomposed liquid. This explains the importance of keeping the hydraulic liquid temperature below specified levels.

The second contaminant producing chemical action in hydraulic liquids is one which permits these liquids to establish a tendency to react with certain types of rubber, causing structural changes in the rubber, turning it brittle, and finally causing its complete disintegration. For this reason, the compatibility of system liquid with seals and hose material is a very important factor.

4. Particles introduced by foreign liquids. One of the most common foreign-fluid contaminants is water, especially in hydraulic systems which require petroleum base oils. Water, which enters even the most carefully designed systems by condensation of atmospheric moisture, normally settles to the reservoir bottom. Oil movement in the reservoir disperses the water into fine droplets, and agitation of the liquid in the pump and in high speed passages forms an oil-water-air emulsion. Such an emulsion normally

separates out during the rest period in the system reservoir; but when fine dust and corrosion particles are present, the emulsion is catalyzed by high pressures into sludge. The damaging action of sludge explains the need for effective filtration, as well as the need for water separating qualities in hydraulic liquids.

Contamination Control

Filters (discussed in chapter 6) provides adequate control of the contamination problem during all normal hydraulic system operations. Control of the size and amount of contamination entering the system from any other source must be the responsibility of the personnel who service and maintain the equipment. Therefore, precautions must be taken to insure that contamination is held to a minimum during maintenance repair and service operations. Should the system become excessively contaminated, the filter element should be removed and cleaned or replaced.

As an aid to exercising contamination control, the following maintenance and servicing procedures should be adhered to at all times:

1. Maintain all tools and the work area (workbenches and test equipment) in a clean, dirt-free condition.

2. A suitable container should always be provided to receive the hydraulic liquid which is spilled during component removal or disassembly procedures.

NOTE: The reuse of drained hydraulic liquid is prohibited in some hydraulic systems; for example, aircraft hydraulic systems. In some large capacity systems the reuse of liquid is permitted. When liquid is drained from the latter systems, it must be stored in a clean and suitable container. This liquid must be strained and/or filtered as it is returned to the system reservoir.

3. Before disconnecting hydraulic lines or fittings, clean the affected area with drycleaning solvent.

4. All hydraulic lines and fittings should be capped or plugged immediately after disconnecting.

5. Before assembly of any hydraulic components, wash all parts in an approved drycleaning solvent.

6. After cleaning parts in drycleaning solution, dry the parts thoroughly and lubricate with the recommended preservative or hydraulic liquid before assembly.

NOTE: Use only clean, lint-free cloths to wipe or dry component parts.

7. All seals and gaskets should be replaced during the reassembly procedure.

8. All parts should be connected with care to avoid stripping metal slivers from threaded areas. All fittings and lines should be installed and torqued in accordance with applicable technical instructions.

9. All hydraulic servicing equipment should be kept clean and in good operating condition.

Contamination Checks

FLUID SAMPLING.—Whenever it is suspected that a hydraulic system has become excessively contaminated, or the system has been operated at temperatures in excess of the specified maximum, a check of the system should be made. The filters in most hydraulic systems are designed to remove most foreign particles that are visible to the naked eye. Hydraulic liquid which appears clean to the naked eye may be contaminated to the point that it is unfit for use.

Thus, visual inspection of the hydraulic liquid does not determine the total amount of contamination in the system. Large particles of impurities in the hydraulic system are indications that one or more components in the system are being subjected to excessive wear. Isolating the defective component requires a systematic process of elimination. Liquid returned to the reservoir may contain impurities from any part of the system. In order to determine which component is defective, liquid samples should be taken from the reservoir and various other locations in the system.

Liquid samples should be taken in accordance with the instructions contained in the applicable technical publication for the particular hydraulic system and the contamination test kit. Some hydraulic systems are provided with permanently installed bleed valves for taking liquid samples; while on other systems, lines must be disconnected to provide a place to take a sample. In either case, while the liquid is being taken, a small amount of pressure should be applied to the system. This insures that the liquid will flow out of the sampling point and thus prevent dirt from entering the hydraulic system. Hypodermic syringes are provided with some contamination test kits for the purpose of taking samples.

CONTAMINATION TESTING.—Various test procedures are recommended to determine the contamination level in hydraulic liquids. The filter patch test provides a reasonable idea of the condition of the fluid. This test consists

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basically of filtration of a sample of hydraulic system liquid through a special filter paper. This filter paper darkens in degree in relation to the amount of contamination present in the sample, and is compared to a series of standardized filter disks which, by degree of darkening, indicate the various contamination levels. The equipment provided with one type of contamination test kit is illustrated in figure 3-2.

When using this liquid contamination test kit, the liquid samples should be poured through the filter disk (shown in fig. 3-2), and the test filter patches should be compared with the test patches supplied with the test kit. A microscope is provided with the more expensive test kits for the purpose of making this comparison. Figure 3-3 shows test patches similar to those supplied with the testing kit.

To check liquid for decomposition, pour new hydraulic liquid into a sample bottle of the same size and color as the bottle containing the liquid to be checked. Visually compare the color of the two bottles. Liquid which is decomposed will be darker in color.

At the same time the contamination check is made, it may be necessary to make a chemical test. This test consists of a viscosity check, a moisture check, and a flashpoint check. However, since special equipment is required for these checks, the liquid samples must be sent to a laboratory, where a technician will perform the test.

System Flushing

Whenever a contamination check indicates impurities in the system or indicates

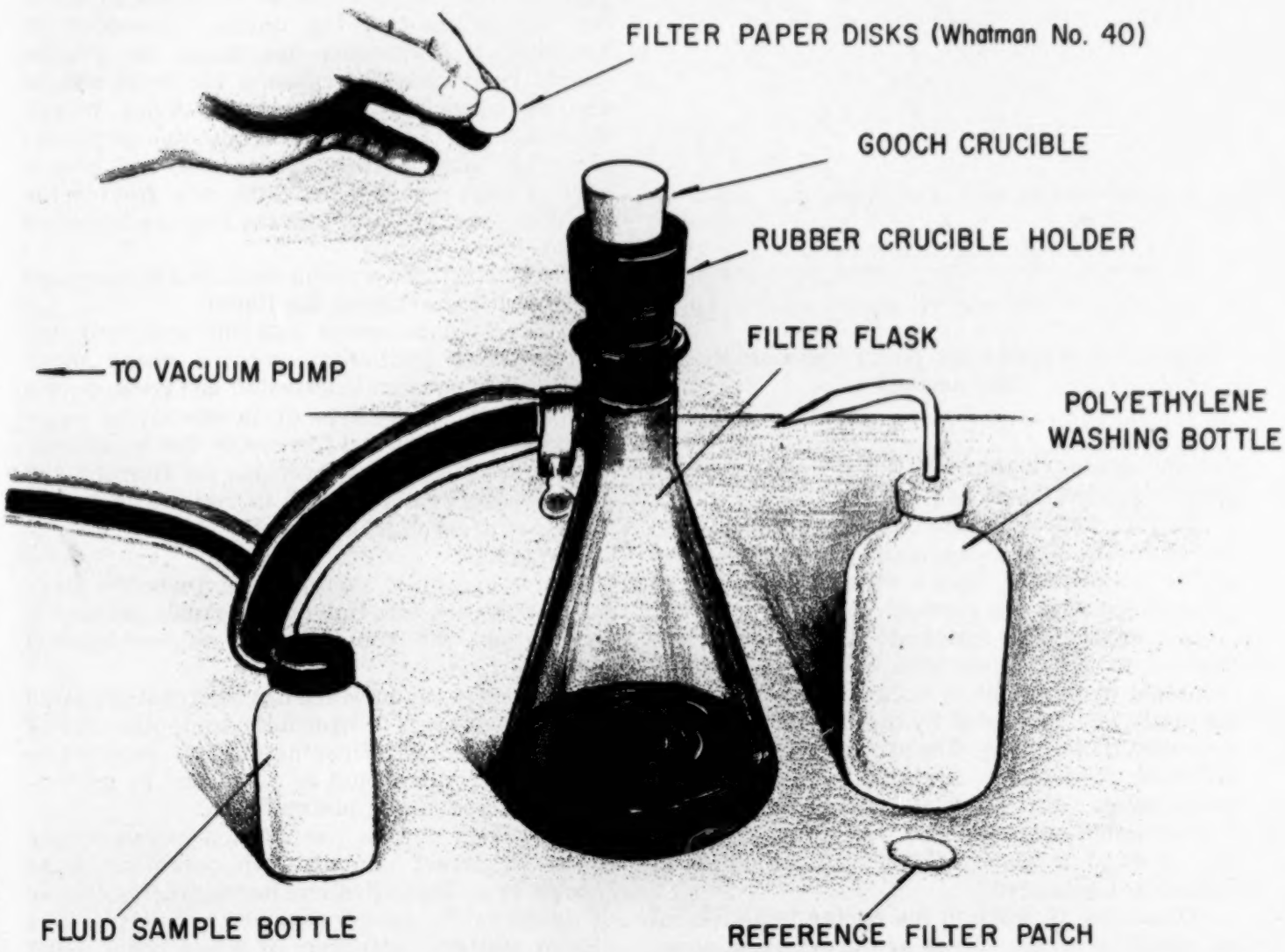

Figure 3-2.—Liquid contamination test kit.

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FILTER BOWL SAMPLE

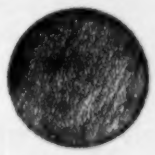

1. Discoloration as dark as or darker than reference disk.
2. More than 2 metal chips larger than 0.01 inch in diameter. (About size of sharp pencil dot.)
3. More than 25 very fine but visible metal particles.

DOWNSTREAM SAMPLE

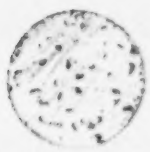

1. Discoloration as dark as or darker than reference disk.
2. More than 1 metal chip larger than 0.01 inch in diameter. (About size of sharp pencil dot.)
3. More than 10 very fine but visible metal particles.

Figure 3-3.—Hydraulic liquid contamination test patches.

decomposition of the hydraulic liquid, the hydraulic system must be flushed.

NOTE: The presence of foreign particles in the hydraulic system indicates a possible component malfunction, which should be corrected prior to flushing the system.

A contaminated hydraulic system should be flushed in accordance with current applicable technical instructions. Flushing procedures are normally recommended by the manufacturer and approved by the Navy. The procedure varies with different hydraulic systems. The following procedures for flushing hydraulic power-transmission systems used with naval ordnance are covered in NavOrd OD 3000, Lubrication of Ordnance Equipment.

Drain out as much of the contaminated liquid as possible. Drain valves are provided in some systems for this purpose; while on other systems, lines and fittings must be disconnected at the low points of the system to remove any trapped liquid in the lines and components. Close all the connections and fill the system with the applicable flushing medium. Any of the hydraulic liquids approved for use in power-transmission systems may be used for flushing purposes. In the interest of economy, however, either used or reclaimed liquids should be used for flushing, provided they are clean and free from water and insoluble contaminants and do not contain acid resulting from oxidation of the liquids.

CAUTION: Diesel fuel oil must not be used for flushing hydraulic systems in active service, owing to its poor lubricating qualities and its contaminating effect on the subsequent fill or hydraulic liquid.

While being flushed with an approved hydraulic liquid, power-transmission hydraulic systems can be operated at full load to raise the temperature of the liquid. Immediately following the warming operation, the system should be drained by opening all drain outlets and disconnecting the hydraulic lines to remove as much of the flushing medium as possible. All filter elements, screens, and chambers should be cleaned with new fluid prior to filling the system with the required service liquid.

CAUTION: The system should not be operated while or after draining the liquid.

Power-transmission systems and their interconnected hydraulic controls whose inner surfaces have been inactivated and treated with a corrosion preventive or preservation compound must be flushed to remove the compound. The latest current instructions for flushing and other operations required to reactivate a particular system must be strictly followed to prevent damage.

Some hydraulic systems are flushed by forcing new liquid into the system under pressure, forcing out the contaminated or decomposed liquid.

Hydraulic liquid which has been contaminated by continuous use in hydraulic equipment or has been expended as a flushing medium must not be used again, but should be discarded in accordance with prevailing instructions.

CAUTION: Never permit high-pressure air to be in direct contact with petroleum base liquids in a closed system, because of the danger of ignition. If gas pressure is needed, in a closed system, nitrogen or some other inert gas should be used.

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PNEUMATIC GASES

Gases serve the same purpose in pneumatic systems as liquids serve in hydraulic systems. Therefore, many of the same qualities that are considered when selecting a liquid for a hydraulic system must be considered when selecting a gas for a pneumatic system.

QUALITIES

The ideal fluid medium for a pneumatic system must be a readily available gas that is nonpoisonous, chemically stable, free from any acids that cause corrosion of system components, and nonflammable. It should be a gas that will not support combustion of other elements.

The viscosity of gases is not a critical quality to consider in the selection of a medium for pneumatic systems. However, it should be noted that, unlike liquids, the viscosity of gases increases as the temperature rises and decreases as the temperature decreases.

Gases that have these desired qualities do not have the required lubricating power. Therefore, lubrication of the components of a pneumatic system must be arranged by other means. For example, air compressors have their own lubricating system, and components are either lubricated by external sources or upon installation.

TYPICAL GASES USED

The two most common gases used in pneumatic systems are compressed air and nitrogen.

NOTE: Compressed air is a mixture of all the gases contained in the atmosphere. However, in this course it is referred to as one of the gases used as a fluid medium for pneumatic systems.

Compressed Air

The unlimited supply of air and the ease of compression make compressed air the most widely used fluid for pneumatic systems. Some pneumatic systems contain air compressors as the source of supply, while other systems receive their supply from cylinders which are charged (filled to the required pressure) at a centrally located air compressor. Compressed air has most of the desired characteristics of a gas for pneumatic systems. It is nonpoisonous and nonflammable but does contain gases, such as oxygen, which support combustion. Changes in temperature will cause condensation of moisture in the lines; and if the weather becomes extremely cold, this condensation will freeze and make the system inoperative.

Nitrogen

For all practical purposes, nitrogen is considered to be an inert gas. (Inert is defined as chemically inactive; not combining with other chemicals.) It is not completely inert like helium or argon, for there are many nitrogen compounds, such as nitrate used in fertilizers and explosives. However, nitrogen is very slow to combine chemically with other elements under normal conditions. Nitrogen, as a gas, supports no fires, no living things, and causes no rust or decay of most of the things with which it comes in contact. Due to these qualities, its use is preferred over compressed air in many pneumatic systems, especially aircraft and missile systems.

Nitrogen is obtained by the fractional distillation of air. On some ships, particularly aircraft carriers, nitrogen is obtained as a byproduct of the oxygen plant. The nitrogen is compressed into cylinders which are used to fill the pneumatic system to the required pressure.

A combination of nitrogen and compressed air is used in some pneumatic systems. Compressed nitrogen is supplied from cylinders, while a compressor provides compressed air to replenish any expended nitrogen and maintain the pneumatic system at the required pressure.

POTENTIAL HAZARDS

All compressed gases are hazardous. Compressed air and nitrogen are neither poisonous nor flammable, but should not be handled carelessly. Some pneumatic systems operate at pressures exceeding 3,000 psi. Lines and fittings have exploded, injuring personnel and property. Literally thousands of careless men have blown dust or harmful specks into their eyes by the careless handling of compressed air outlets.

Nitrogen gas will not support life, and when released in a confined space will cause asphyxia (the loss of consciousness as a result of too little oxygen and too much carbon dioxide in the blood). Because compressed air and nitrogen seem so safe in comparison with other gases, do not let overconfidence lead to personal injury.

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CONTAMINATION CONTROL

Pneumatic systems should be purged periodically to remove contamination, moisture, and oil from the components and lines. Purging of the pneumatic system is accomplished by pressurizing the system and removing plumbing from various components throughout the system. Removal of the pressurized lines will cause a high rate of airflow through the system. This airflow will cause the foreign matter to be exhausted from the system.

NOTE: If an excessive amount of foreign matter, particularly oil, is exhausted from any one system, the lines and components should be removed and cleaned or replaced.

Upon the completion of pneumatic system purging and after reconnecting all the system components, the system drain valves should be opened to exhaust any moisture or impurities which may have accumulated. After all drain valves are closed, the system should be serviced with the approved gas, usually nitrogen or compressed air. The system should then be given a thorough operational check and an inspection for leaks and security.

History has indicated that the development of fluid power and its mechanical equipment goes hand in hand with the development of specific fluids for each intended application. Past breakthroughs in high-temperature fluids have shown that, when future equipment requires fluid power, satisfactory systems and fluids will be available. For example, hot gas fluid power systems are under study and development for use in space vehicles. The hot gases are obtained by bleeding off the main rocket engine or using a solid or liquid propellent gas generator.

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e) Draw pictures of the oranges and describe in your own words how each one appears. Then describe the conclusions you have reached.

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5. Relation of Age of Seedlings to Susceptibility to Pythium Damping-Off

OBJECTIVE: To demonstrate that seedlings become more resistant to *Pythium debaryanum* with age.

MATERIALS: A pathogenic isolate of *P. debaryanum*; potato-dextrose broth; 15 sterile 4 or 6 in. pots; enough sterile white quartz sand to fill pots to within 1 inch of top; about 10 sq. ft. of greenhouse space or lighted laboratory space (24°C); about 1500 fungus-free seeds of alfalfa, sweet clover, red clover, or Ladino white clover (seed produced in the more arid regions of western U. S. is best for this purpose; it is most likely to be free of infection); and a small volume of half-strength Hoagland's solution.

PROCEDURES: Grow *P. debaryanum* in potato-dextrose broth in eight 4-liter Erlenmeyer flasks (1200 ml of broth/flask) on shaker for 7 days. Inoculum will develop as small mycelial balls which should be separated from the broth and washed with sterile water before using. The pathogen may be increased on 10 PDA plates for 5 days and the mycelial mats (with agar) broken up. Five sterile agar plates should be included for controls.

Surface disinfect seed in 95% ethyl alcohol and 1% solution of sodium hydrochlorite, dry seed, and count out 15 lots of 100 seeds each. Sow 3 pots with 100 seeds each on each of 5 seedling dates so seedlings will be 6, 3, 2, 1, and zero days old at time of inoculation. Cover seeds with 0.25 in. of sand and add sterile water until all sand in pot is wet. Add inoculum to 2 of the 3 pots of each age group at the rate of 1 heaping tsp/pot. The third pot of each group is the control. Inoculum may be added to surface of sand and washed in with sterile water. Keep sand moist at all times. Sterile water may be used until the seedlings emerge; after emergence, Hoagland's nutrient solution should be used. Pots should have holes in bottoms for drainage.

Compare total emergence, amount of postemergence damping-off, and

CHAPTER 4

BASIC SYSTEMS AND CIRCUIT DIAGRAMS

As with most technical skills, a knowledge of the basic components, systems, and circuits is a prerequisite for understanding and being able to troubleshoot and maintain fluid power equipment. A knowledge of the fundamentals of fluid power requires that the individual begin with the basic skills and progress to the more complex skills. This will require a high proficiency in studying, understanding, and analyzing the basic systems and the circuits which comprise these systems.

COMPONENTS OF A BASIC FLUID SYSTEM

The basic components of a fluid power system are essentially the same, regardless of whether the system employs a hydraulic or pneumatic medium. There are five basic components used in a system. These basic components are as follows:

1. Reservoir.
2. Pump or compressor.
3. Tubing or piping (circulatory system).
4. Control valve or selector valve.
5. Actuating unit.

The primary purpose of a RESERVOIR is to provide storage space for the fluid used in the system. A well designed reservoir can also be used as a heat exchanger to control the temperature of the fluid and may also be used as a place to filter and clean the fluid. Reservoirs are discussed in detail in chapter 6 of this course.

The primary purpose of a PUMP OR COMPRESSOR is to move fluid from one point to another in a fluid system. To do this, the pump or compressor must convert mechanical energy into fluid energy. The basic principles on which a pump or compressor operate are slightly different. Therefore, for more details on pumps and compressors consult chapter 7 of this course.

The CIRCULATORY SYSTEM (TUBING OR PIPING) is the medium for transmitting fluid from one component to another. This is normally accomplished by using either tubing, piping, or flexible hose for interconnecting pumps to cylinders, valves to pumps, reservoirs to valves, etc.

Tubing is used in aircraft where weight is a prime factor, and piping is generally used where weight is not a factor. Flexible hose is generally employed in connection with moving parts or where it is necessary to install a line that is subject to considerable vibration. Circulatory systems are discussed in detail in chapter 5 of this course.

The CONTROL VALVE (also referred to as a selector valve) is a device for directing and controlling the flow or pressure of fluids. Various types of valves are used in fluid systems. A few of the more common valves and their applications are discussed in chapter 11 of this course.

The ACTUATING UNIT of a fluid power system is that device which converts the fluid pressure into useful work. Actuators perform the opposite function of hydraulic pumps and compressors in that they convert fluid energy into mechanical energy.

These five components when combined into one unit are the basis for a fluid power system. An example of a basic fluid power system is shown in figure 4-1.

The flow of fluid can be traced readily from the reservoir through the pump to the control valve. With the control valve in the position shown, the flow of fluid created by the pump flows through the valve to the right-hand end of the actuating cylinder. Fluid pressure then forces the piston to the left and at the same time the fluid which is on the left of the piston is forced out, up through the control valve, and back to the reservoir through the return line.

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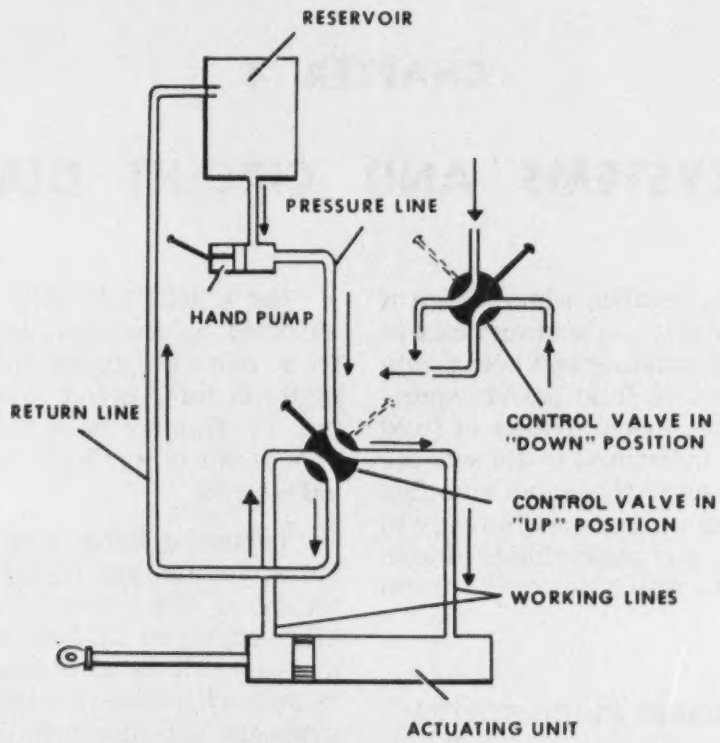

Figure 4-1.—Basic system, hand pump operated.

When the control valve is moved to the position indicated by the dotted lines, the fluid from the pump then flows to the left side of the actuating cylinder, thus reversing the process. Movement of the piston can be stopped at any time simply by moving the control valve to neutral. In this position, all four ports are closed and pressure is trapped in both working lines. This basic system is one from which any system can be derived. Additions may be made to it for the purpose of providing additional sources of power, operating additional cylinders, making operation more automatic, or increasing the reliability; but these additions are all made on the framework of the basic system diagramed in figure 4-1.

COMPONENTS OF A SIMPLE SYSTEM

With the addition of a few simple components, a basic system can be improved into a more workable system. Figure 4-2 shows a basic system with the addition of a power-driven pump and the following essential components: Filter, pressure regulator, accumulator, pressure gage, relief valve, and two check valves. The function of each of these components is explained in the following paragraphs. Construction, operating features, and maintenance of these components are described later in this course.

The FILTER removes foreign particles from the fluid, preventing dust, grit, and other undesirable matter from entering the system.

The purpose of the PRESSURE REGULATOR is to unload or relieve the power-driven pump when the desired pressure in the system is reached. It is therefore often referred to as an unloading valve.

When one of the actuating units is being operated, and pressure in the line between the pump and control valve builds up to the desired point, a valve in the pressure regulator automatically opens and fluid is bypassed back to the reservoir. This bypass line is shown in figure 4-2 leading from the pressure regulator to the return line.

Many fluid power systems do not use a pressure regulator, but have other means of

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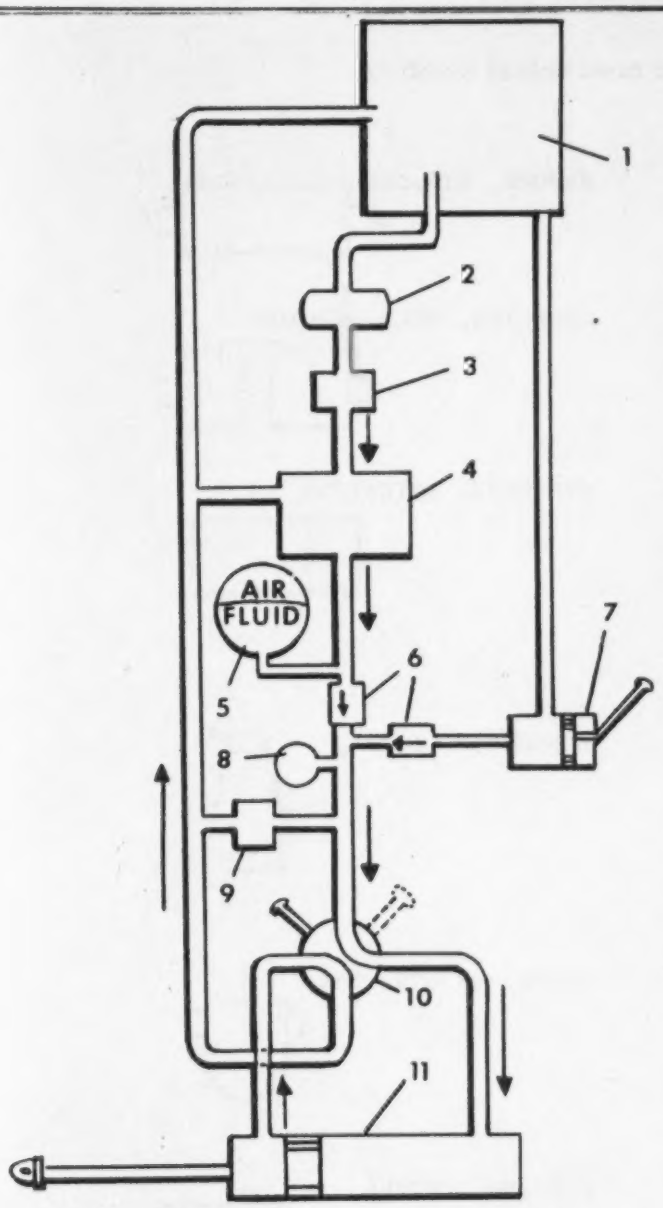

1. Reservoir.
2. Power pump.
3. Filter.
4. Pressure regulator.
5. Accumulator.
6. Check valves.
7. Hand pump.
8. Pressure gage.
9. Relief valve.
10. Control valve.
11. Actuating unit.

Figure 4-2.—Basic system with addition of power pump.

unloading the pump and maintaining the desired pressure in the system.

The ACCUMULATOR serves a twofold purpose. It serves as a cushion or shock absorber by maintaining an even pressure in the system, and it stores enough fluid under pressure to provide for emergency operation of certain actuating units. It is designed with a compressed-air chamber separated from the fluid by a flexible diaphragm, synthetic rubber bladder, or a movable piston.

The PRESSURE GAGE indicates the amount of pressure in the system.

The RELIEF VALVE is a safety valve installed in the system so that fluid is bypassed through the valve back to the reservoir in case excessive pressure is built up in the system.

CHECK VALVES allow the flow of fluid in one direction only. There are numerous check valves installed at various points in the lines of most fluid power systems. A careful study of figure 4-2 will reveal why the two check valves are necessary in this system. One check valve prevents power pump pressure from entering the hand-pump line; the other prevents hand-pump pressure from being directed to the accumulator.

CIRCUIT DIAGRAMS AND SYMBOLS OF A SIMPLE SYSTEM

A thorough knowledge of symbols and how to read diagrams are basic requirements for understanding fluid power systems. To understand the diagrams of a system, first requires a knowledge of the symbols used in the schematic diagrams.

Many manufacturers use their own symbols to represent the various components in a system. However, the Navy uses two Military Standards in identifying and using symbols in fluid power systems. These two Military Standards are as follows:

1. Military Standard, Mechanical Symbols (Other than Aeronautical, Aerospacecraft, and Spacecraft Use), Part I, MIL-STD-17B-1.

2. Military Standard, Mechanical Symbols for Aeronautical, Aerospacecraft, and Spacecraft Use, Part 2, MIL-STD-17B-2.

Some of the more pertinent symbols used in fluid power systems have been selected from these two standards and are depicted in tables 4-1 and 4-2 of this chapter.

While the symbols illustrated in this chapter are not all encompassing, they do provide a basis for the man working with fluid power systems to build upon. For greater details on the symbols used in fluid power systems, the reader should consult the above mentioned Military Standards. Also, for additional information on symbols and the reading of diagrams, consult Blueprint Reading and Sketching, NavPers 10077-B.

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Table 4-1.—Aeronautical mechanical symbols.

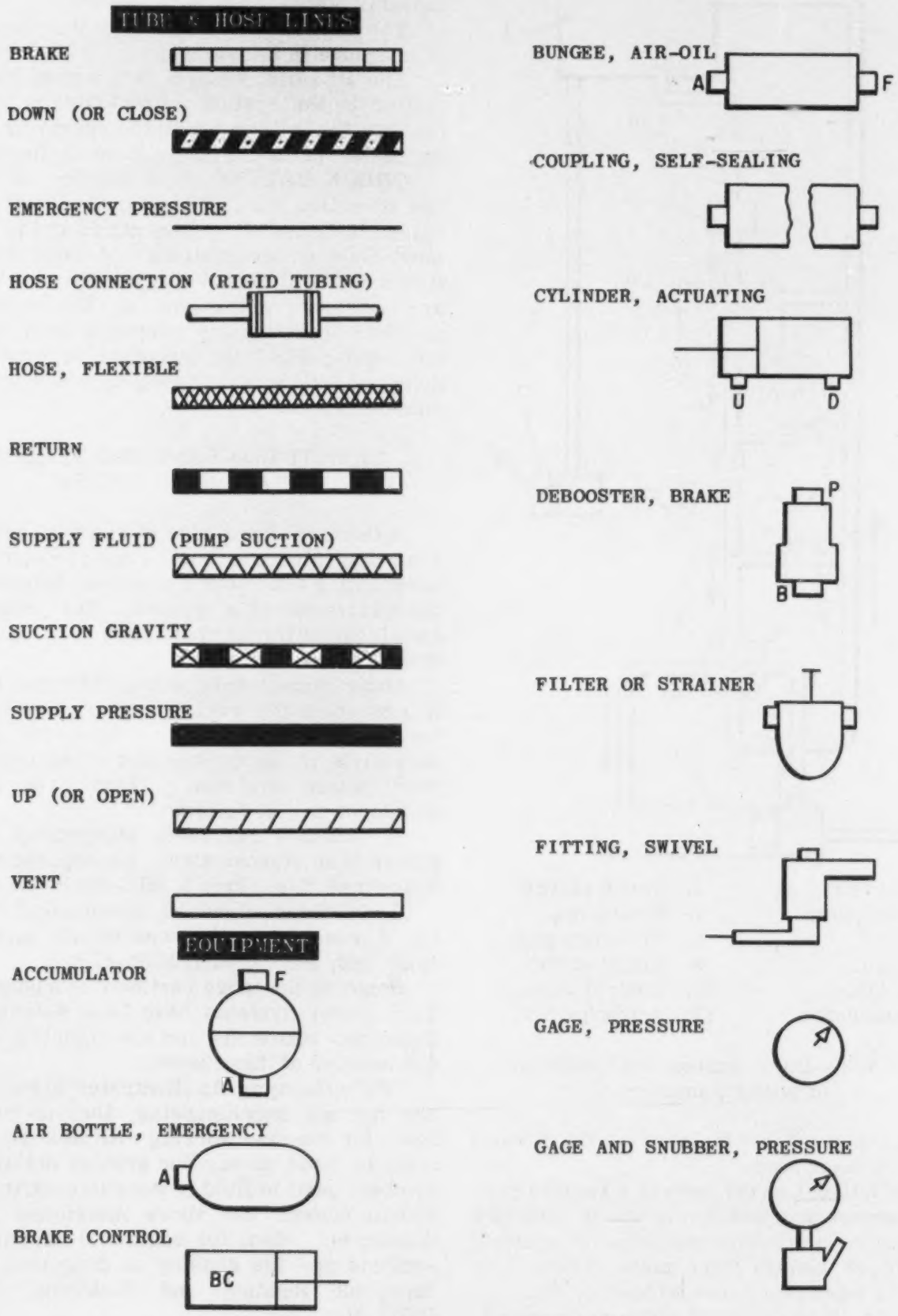

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Table 4-1.—Aeronautical mechanical symbols—Continued.

PUMP, HAND

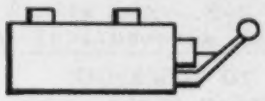

PUMP, POWER DRIVEN

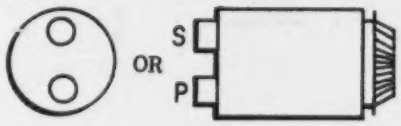

RESERVOIR

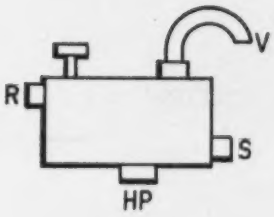

VALVE, CHECK, AUTOMATIC

VALVE, CHECK, MANUAL

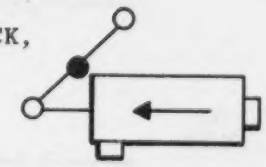

VALVE, BRAKE CONTROL

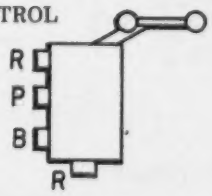

VALVE, GUN CHARGER CONTROL

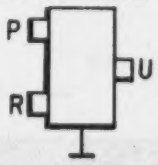

VALVE, PRESSURE REGULATING (UNLOADING) AUTOMATIC

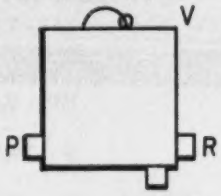

VALVE, PRESSURE REGULATING (UNLOADING) MANUAL

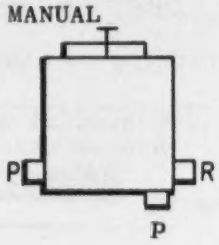

VALVE, RELIEF

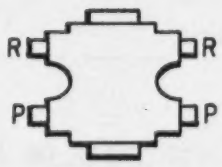

VALVE, RESTRICTOR, BOTH WAYS

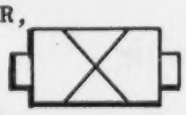

VALVE, RESTRICTOR, PARTIAL ONE-WAY

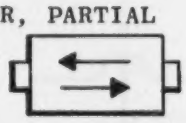

VALVE, SHUTTLE

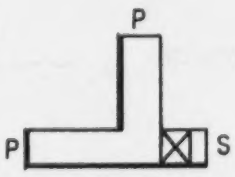

VALVE OR SELECTOR, DIRECTIONAL CONTROL

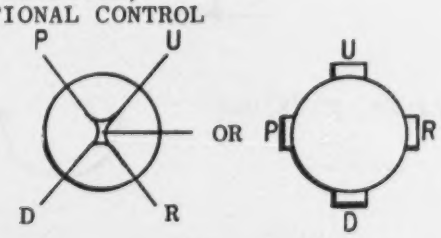

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Table 4-1.—Aeronautical mechanical symbols—Continued.

Table 4-1.--Aeronautical mechanical symbols--Continued.

ALPHABETIC CODE

A - AIR	HP - HANDPUMP
B - BRAKE	P - PRESSURE
BC - BRAKE CONTROL	R - RETURN
D - DOWN (OR CLOSE)	S - SUCTION (OR SUPPLY)
F - FLUID (LIQUID)	U - UP (OR OPEN)

Table 4-2.--Mechanical symbols other than aeronautical.

FLOW LINES

LINES, WORKING

LINES, PILOT

LINES, LIQUID DRAIN OR AIR EXHAUST

LINES, CROSSING

LINES, JOINING

LINES, FLEXIBLE

FLOW, DIRECTION OF

Table 4-2.—Mechanical symbols other than aeronautical—Continued.

Table 4-2.--Mechanical symbols other than aeronautical--Continued.

LINES TO RESERVOIR

BELOW FLUID LEVEL

ABOVE FLUID LEVEL

PLUG OR PLUGGED CONNECTION

TESTING STATION

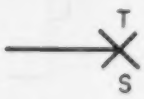

FLUID POWER TAKE-OFF STATION

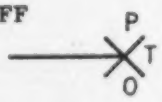

RESTRICTION, FIXED

QUICK DISCONNECT WITHOUT CHECKS

WITH CHECKS DISCONNECTED

WITH ONE CHECK

WITH TWO CHECKS

PUMPS, COMPRESSORS & ROTARY MOTORS

BASIC SYMBOL ENVELOPE

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Table 4-2.—Mechanical symbols other than aeronautical—Continued.

PORTS

LINES OUTSIDE ENVELOPE ARE NOT PART OF SYMBOL, BUT REPRESENT FLOW LINES CONNECTED THERETO.

SHAFTS, ROTATING

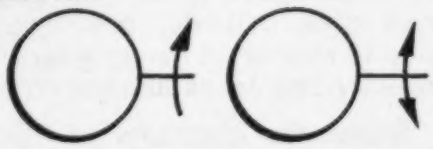

ARROW INDICATES DIRECTION OF ROTATION BY ASSUMING IT IS ON NEAR SIDE OF SHAFT.

PUMPS, HYDRAULIC

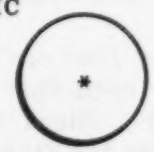

APPROPRIATE SYMBOLS SHALL BE ADDED TO INDICATE SHAFTS, CONNECTING LINES, AND METHOD OF CONTROL.
*TYPE OF PUMP SHALL BE INDICATED WITHIN BASIC SYMBOL BY APPROPRIATE LETTERS LISTED BELOW.

PF FIXED DISPLACEMENT
PK KINETIC - CENTRIFUGAL
PV VARIABLE DISPLACEMENT

COMPRESSORS, AIR

APPROPRIATE SYMBOLS SHALL BE ADDED TO INDICATE SHAFTS, CONNECTING LINES, AND METHOD OF CONTROL.
*TYPE OF COMPRESSOR SHALL BE INDICATED WITHIN BASIC SYMBOL BY APPROPRIATE LETTERS LISTED BELOW.

CF FIXED DISPLACEMENT
CK KINETIC

FLUID MOTORS, ROTARY

APPROPRIATE SYMBOLS SHALL BE ADDED TO INDICATE SHAFTS, CONNECTING LINES, AND METHOD OF CONTROL.
*TYPE OF MOTOR SHALL BE INDICATED WITHIN BASIC SYMBOL BY APPROPRIATE LETTERS LISTED BELOW.

MF FIXED DISPLACEMENT
MO OSCILLATING
MV VARIABLE DISPLACEMENT

CYLINDERS

SINGLE ACTING

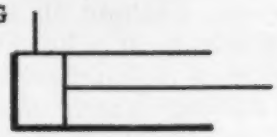

DOUBLE ACTING
SINGLE END ROD

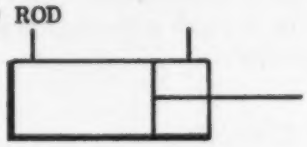

DOUBLE END ROD

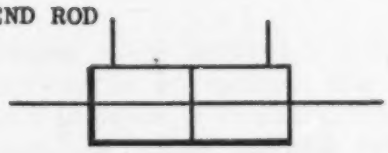

RESERVOIRS

FOR LIQUID, VENTED

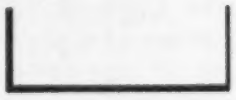

PRESSURIZED,
RECEIVER FOR AIR OR OTHER GASES

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USES OF DIAGRAMS

In order to troubleshoot fluid power systems intelligently, the mechanic or technician must be familiar with the system at hand. He must know the function of each component in the system and have a mental picture of its location in relation to other components in the system. These can best be achieved by studying the diagrams of the system.

There are many types of diagrams; however, those which are the most pertinent to fluid power systems may be divided into two classes. These diagrams are usually referred to as pictorial or schematic diagrams and are provided by the manufacturer to aid the maintenance man in understanding and troubleshooting the equipment. There may be instances where a schematic diagram will be shown as a pictorial diagram, or the diagram may consist of a combination of the two.

A diagram, whether it is a pictorial or schematic diagram, may be defined as a graphic representation of an assembly or system, indicating the various parts and expressing the methods or principles of operation. As a general rule, the various components are indicated by symbols in schematic diagrams, while drawings of the actual components are used in pictorial diagrams.

Pictorial Diagrams

Pictorial diagrams show general location, function, and appearance of parts and assemblies. An example of a pictorial diagram is the installation diagram shown in figure 4-3. This is a diagram of the liquid oxygen system of a Navy aircraft. It shows the location of each of the components within the aircraft on the principal view. Each letter (A, B, C, etc.) on the principal view refers to a detail view located elsewhere on the diagram. Each detail view is an enlarged drawing of a portion of the system, identifying each of the principal components.

Diagrams of this type are invaluable to maintenance personnel in identifying and locating components, and understanding the principle of operation of various systems.

Schematic Diagrams

The primary purpose of a schematic diagram is to enable the maintenance man to trace the flow of fluid, component by component. This type of diagram does not necessarily indicate the physical location of the various components, but does show the relation of each component to other components within the system.

Figure 4-4 is an example of a schematic diagram of a speed brake system used in a current aircraft. This diagram does not indicate the physical location of the individual components within the aircraft, but does locate components with respect to each other within the system. For example, the check valve in figure 4-4 is not necessarily located immediately above the speed brake control valve. The diagram does indicate, however, that the check valve is located in the pressure line and that the pressure line leads into the control valve.

Schematic diagrams of this type are used mainly in troubleshooting. Note that each line (pressure, return, brakes open, and brakes closed) is coded for ease of reading and tracing the flow. Each component is identified by name, and its location within the system can be ascertained by noting which lines lead into and out of the unit.

In tracing the flow of fluid through the system, it can be seen that the first unit in the pressure line is a check valve. The arrow on the valve indicates the direction of flow through the valve. It is obvious that this check valve is located in the pressure line for the purpose of preventing speed brake pressure from dropping when main system pressure drops momentarily, as when another actuating system is operated.

The next unit in the pressure line is the speed brake control valve. It can be seen that the control valve is a four-port unit, being connected to pressure, return, and to each actuating line.

When the control valve is placed in brakes open position, fluid under pressure is ported through the brakes open line to the actuating cylinders, opening the speed brakes. Also in the brakes open line is a blow-back relief valve. It can be seen that the relief valve is also connected to the return line. It is obvious that its purpose is to protect the speed brakes against excessive wind blasts. For example, if the pilot opened the speed brakes at an airspeed greater than that for which the speed brakes are designed, the blow-back relief valve would open, allowing the excess fluid pressure to return to the reservoir. Thus, the speed brakes would be blown back to the closed position.

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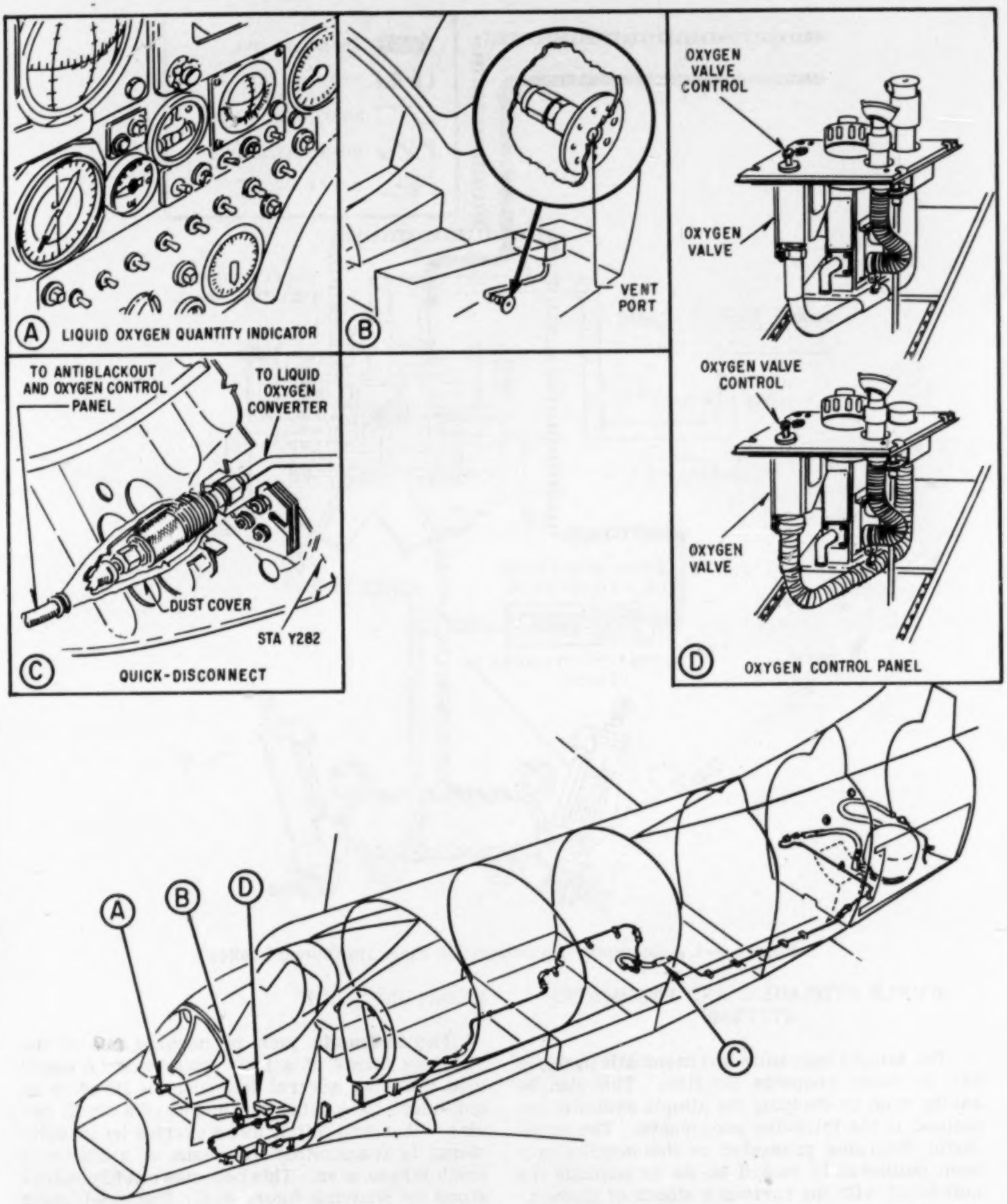

Figure 4-3.—Example of a pictorial diagram.

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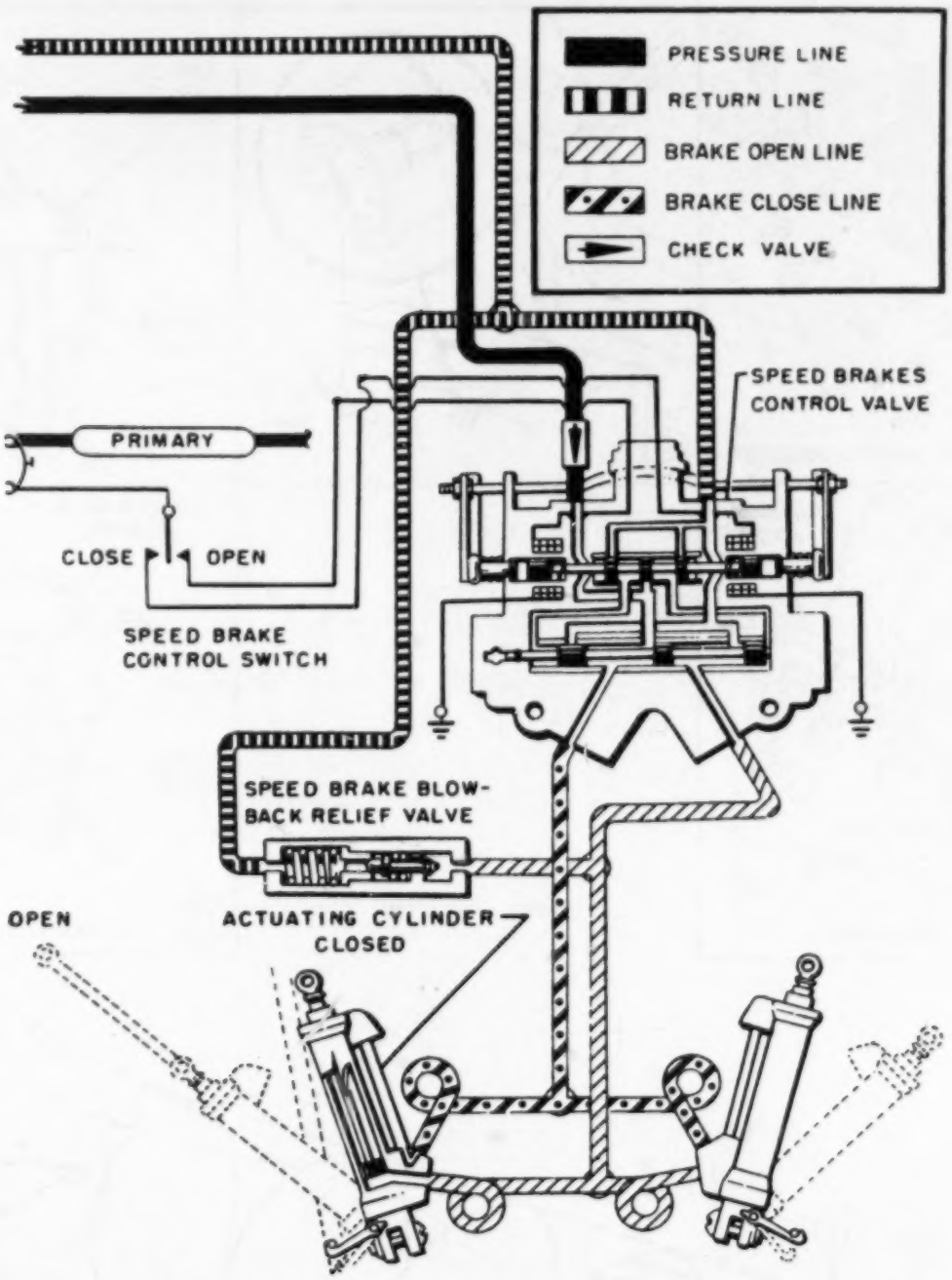

Figure 4-4.—Example of a schematic diagram (speed brakes).

SIMPLE HYDRAULIC AND PNEUMATIC SYSTEMS

The simple hydraulic and pneumatic systems are in many respects similar. This can be easily seen by studying the simple systems explained in the following paragraphs. The schematic diagrams presented in this section have been deliberately varied so as to acquaint the individual with the various methods of presenting schematic diagrams.

HYDRAULIC JACK

The hydraulic jack is perhaps one of the simplest forms of a fluid power unit. A heavy load weighing several tons may be lifted by an individual by moving the handle of a small device. A small initial force exerted by an individual is transmitted by means of a fluid to a much larger area. This becomes readily understood by studying figure 4-5. The small input piston has an area of 5 square inches and is

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general conditions of inoculated and uninoculated seedlings of different ages.

TIME REQUIRED: About 22 days -- 7 days to increase inoculum and establish seedlings + 15 days from inoculation to final observation.

RESULTS: Disease severity decreased as age of plant at time of inoculation increases.

6. Isolating *Phytophthora* spp. From Soil

OBJECTIVE: To isolate *Phytophthora cinnamomi* or certain other *Phytophthora* spp. from soil or from plant tissue.

MATERIALS: Avocado fruits, firm apples, or green or partially ripe watermelons; cork borers; Scotch tape; corn meal agar; petri dishes.

PROCEDURES: Partially embed apple or avocado in soil in the field or in containers and flood with water or thoroughly moisten soil and place in holes bored into apple or watermelon, using a 0.5 in. cork borer. Cover holes with Scotch tape or masking tape and incubate at room temperature for 5-10 days. Transfer any firm brown rot from margin of rotted area to corn meal agar and examine after 4-5 days or transfer thin slices of the firm rot to water in a petri dish and examine in 4-8 days.

TIME REQUIRED: 5-10 days, depending on temperatures.

RESULTS: *P. cinnamomi* will grow from the soil into buried avocado fruits, *P. cinnamomi* will do the same in apples. However, if soil is placed in holes in apples, other species of *Phytophthora* may be isolated. The technique has also been used to isolate *Pythium ultimum* from soil. Watermelons may exude considerable moisture and should be placed in waterproof containers.

Fruit tissue rotted by *P. cinnamomi* will be firm and only moderately discolored. Any soft rot present is usually caused by other organisms. For positive identification, all rot suspected of being caused by *P. cinnamomi* should be checked in corn meal agar. *P. cinnamomi* may be isolated from avocado, pine, and other roots by placing unsterilized root pieces in apples and placing the resulting rot in corn meal agar.

7. Proof of Pathogenicity of *Agrobacterium tumefaciens* in the Crown Gall Disease

OBJECTIVE: To demonstrate Koch's postulates using the crown gall disease caused by *Agrobacterium tumefaciens* as the example.

Proof of pathogenicity of an organism is obtained by following the general rules first outlined by Robert Koch: (1) A specific organism must always be associated with the disease. (2) This organism must be isolated in pure culture from the diseased host. (3) When inoculated into a healthy susceptible host, under favorable conditions, the organism must produce the characteristic symptoms of the disease in the host. (4) The organism must be reisolated from the artificially inoculated host, obtained in pure culture, and identified as that first isolated.

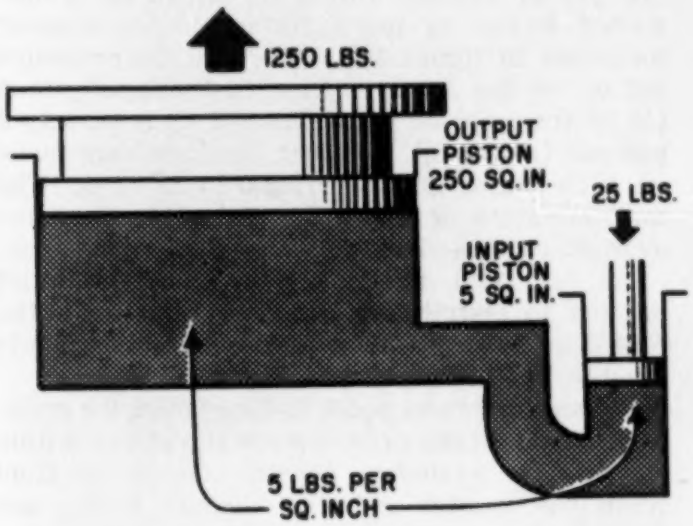

Figure 4-5.—Hydraulic jack.

directly connected to a large cylinder with an output piston having an area of 250 square inches. The top of this piston forms a lift platform.

If a force of 25 pounds is applied to the input piston, it produces a pressure of 5 pounds per square inch in the fluid. This pressure acting on the 250 square inch area of the output piston will make a force of 1,250 pounds available to raise the lift. An input force of 25 pounds has been transformed into a working force of more than half a ton. However, for this to be true requires that the distance traveled by the input piston be 50 times as great as that traveled by the output piston. Thus, for every inch that the input piston moves the output piston will move only one-fiftieth of an inch.

This would be ideal if the output piston needed to move only a short distance. However, in most instances, the output piston would have to be capable of moving a greater distance to serve a practical application. The device shown in figure 4-5 is not capable of moving the output piston farther than that shown. Therefore, some other means must be employed to raise the output piston to a greater height.

The output piston can be raised higher and maintained at this height if valves are installed as shown in figure 4-6. In this illustration the jack is designed so that it may be raised, lowered, or held at a constant height. These results are attained by introducing a number of valves, and also a reserve supply of fluid to be used in the system.

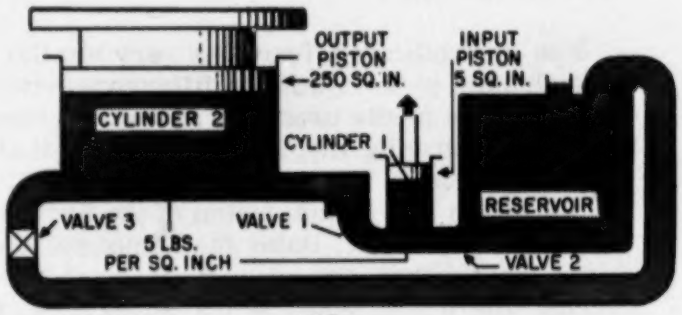

(A)

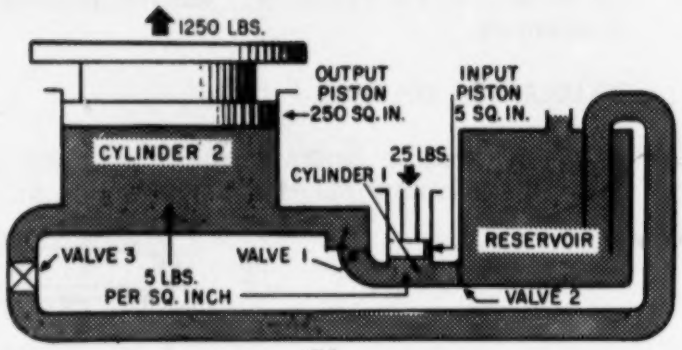

(B)

Figure 4-6.—Hydraulic jack; (A) Up stroke; (B) downstroke.

As the input piston is raised (fig. 4-6 (A)), valve 1 is closed by the back pressure from the weight on the output piston. At the same time, valve 2 is opened by the head of fluid in the reservoir. This forces fluid into cylinder 1. When the input piston is lowered (fig. 4-6 (B)), a pressure is developed in cylinder 1. When this pressure exceeds the head in the reservoir, it closes valve 2 and when it exceeds the back pressure from the output piston, it opens valve 1, forcing fluid into the pipeline. The pressure from cylinder 1 is thus transmitted into cylinder 2, where it acts to raise the output piston with its attached lift platform. When the input piston is again raised (fig. 4-6 (A)), so that the pressure in cylinder 1 falls below that in cylinder 2, valve 1 will close, preventing return of the fluid and holding the output piston with its attached lift platform at its new level. Thus, by repeated strokes of the input piston, the lift platform can be progressively raised. To lower the lift platform, valve 3 is opened, and the fluid from cylinder 2 is returned to the reservoir.

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HYDRAULIC LIFT

The hydraulic lift functions very similar to the hydraulic jack. The basic difference between the two is the media used to transmit the force.

In the hydraulic lift, air pressure applied to the surface of oil in a reservoir is transmitted by the oil to the output piston of the hydraulic lift. (See fig. 4-7.) Using the compressed air as the input piston, the oil as a means of transferring the force, and the lift attached to the output piston, a means is provided for lifting a heavy automobile. When the release valve is opened, the compressed air pressure drops, the oil returns to the reservoir, and the automobile is lowered.

HYDRAULIC BRAKES

The hydraulic brake system used in the automobile is a multiple piston system. A multiple piston system allows forces to be transmitted to two or more pistons in the manner indicated in figure 4-8. Note that the pressure set up by the force applied to the input piston (1) is transmitted undiminished to both output pistons (2 and 3), and that the resultant force on each piston is proportional to its area. The multiplication of the output pistons is the same as that explained in the preceding paragraphs.

A practical application of multiple outlet pistons to distribute forces can be found in the four-wheel hydraulic brake system commonly used on automobiles. (See fig. 4-9.)

When the brake pedal is depressed, the pressure on the brake pedal moves the piston within the master cylinder, forcing the brake fluid from the master cylinder through tubing and flexible hose into the wheel cylinders. The wheel cylinders contain two opposed output pistons, each of which is attached to a brakeshoe fitted inside the brakedrum. Each output

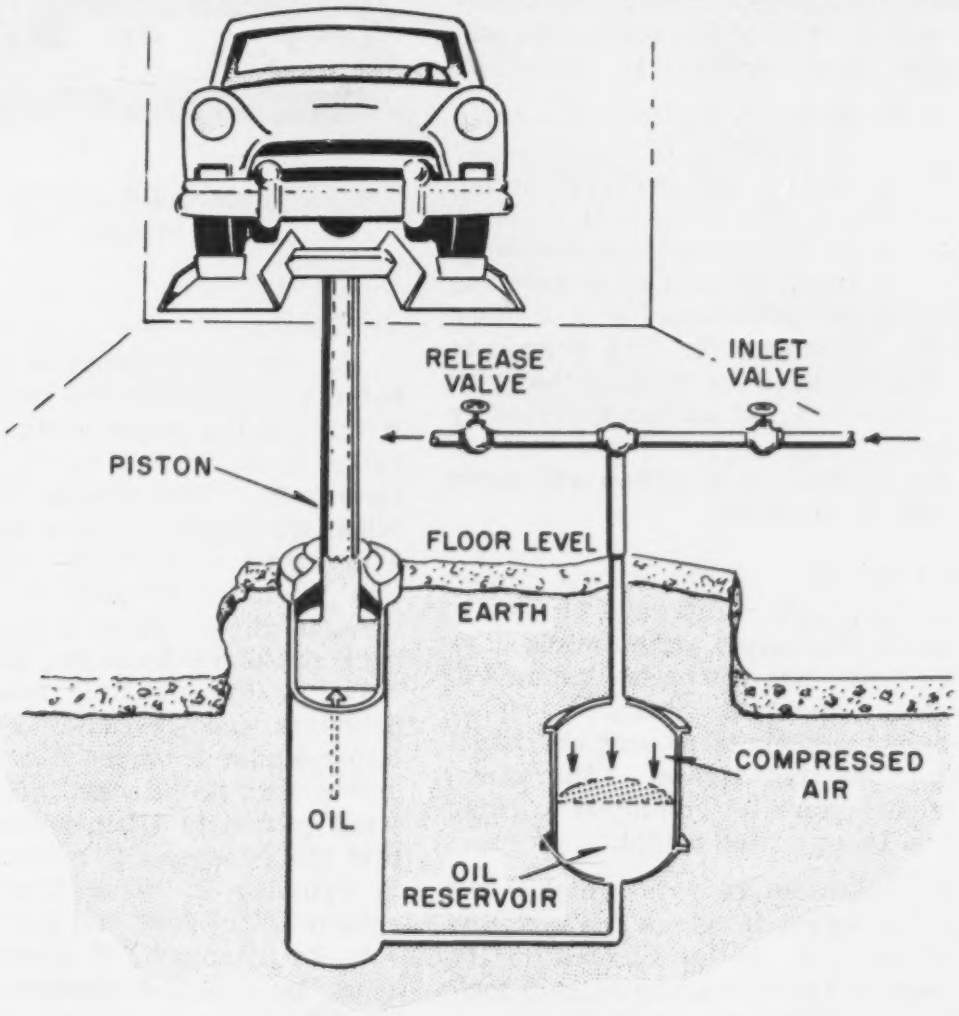

Figure 4-7.—Hydraulic lift.

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piston pushes its brakeshoe against the wall of the brakedrums, thus retarding the rotation of the wheel. When pressure on the pedal is released, the springs on the brakeshoes return the wheel cylinder pistons to their released positions. This action forces the brake fluid back through the flexible hose and tubing to the master cylinder. There is also a return spring in each brake cylinder and one at the brake pedal.

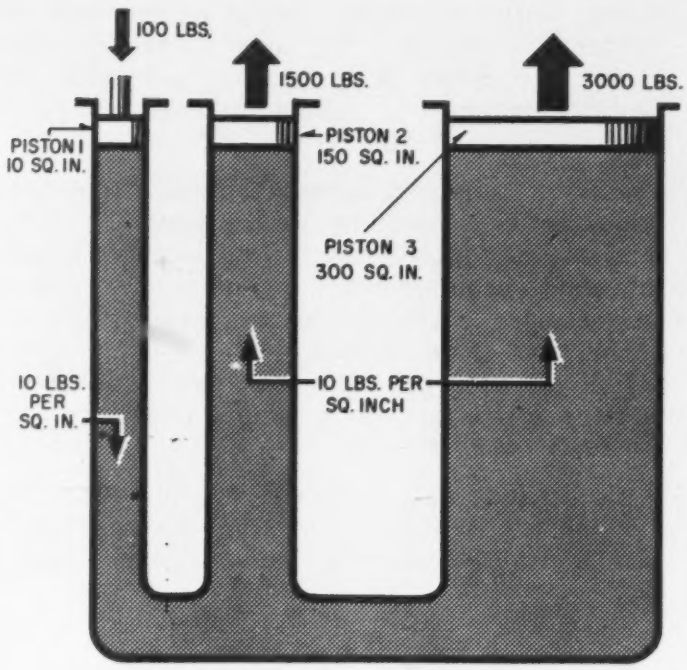

Figure 4-8.—Multiple piston.

The force applied to the brake pedal produces a proportional force on each of the output pistons, which in turn apply the brakeshoes frictionally to the turning wheels to retard rotation. If all eight output pistons were of the same size, the force exerted on each brakeshoe would be exactly the same, provided frictional losses from the master cylinder to each wheel were equal. Likewise, if the brakeshoes were identical, each wheel would be equally retarded.

In actual brake designs, it is customary to use a greater piston area for the rear wheels than for the front. This produces a greater braking action at the rear in a constant and predetermined ratio, and helps to keep the vehicle under control when stopping suddenly on slippery pavements.

HAND WATER PUMP

A pump is a mechanism that uses an external source of power to apply force to a fluid. All pumps in open hydraulic systems take advantage of the fact that the earth's atmosphere, a gaseous fluid, exerts a static pressure, the existence of which becomes noticeable whenever a partial vacuum is created.

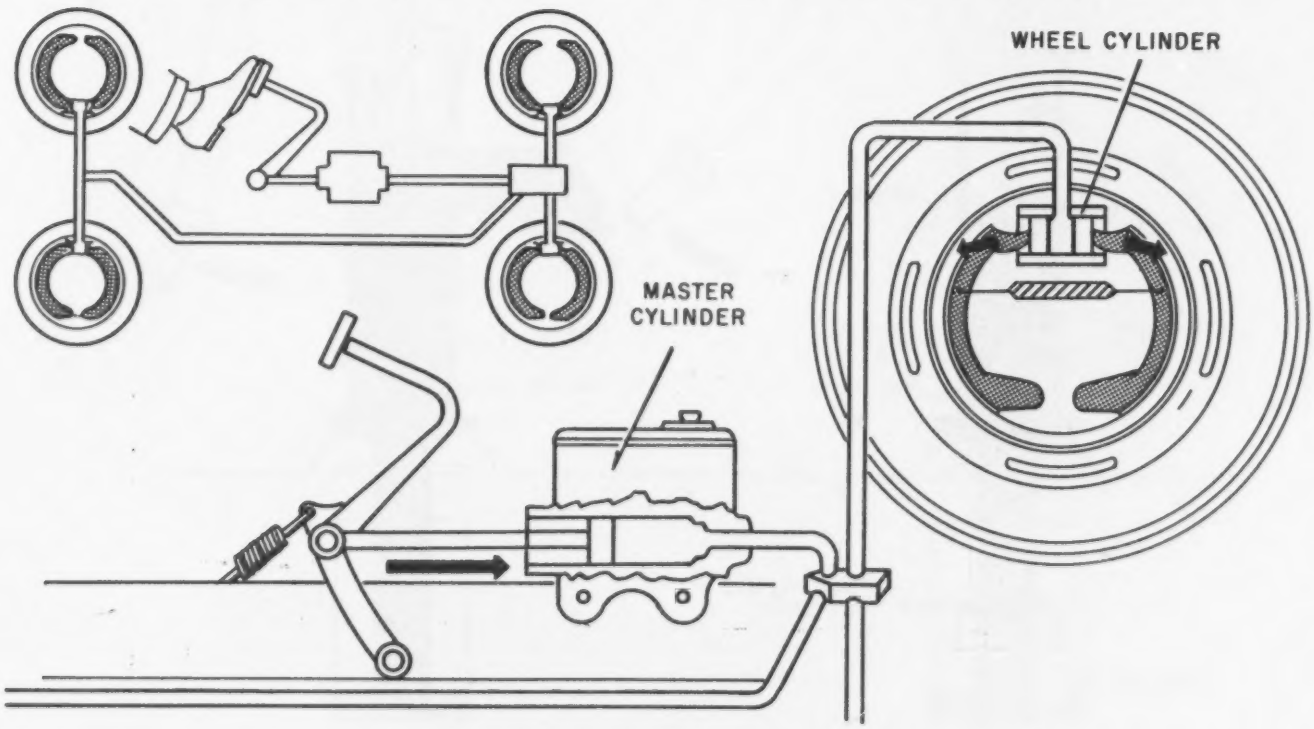

Figure 4-9.—An automobile brake system.

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Anybody who drinks through a straw is making use of this phenomenon. By sucking on the straw, a partial vacuum is created. Atmospheric pressure, acting on the fluid in the tumbler, forces enough of it up the straw to dispel the partial vacuum.

In the hand pump shown in figure 4-10, the lever type pump handle is joined to a piston rod with a simple upward-opening check valve (1) in the piston. The downstroke of the piston applies pressure to the water in the pump, opening the check valve (1) and closing another check valve (2) at the base of the pump.

On the up stroke of the piston, pressure is reduced, and a partial vacuum is created in the area between the two valves. When the check valve (1) closes, atmospheric pressure in the well forces water up the pipe. The upward thrust of the water opens the other check valve (2), but is not strong enough to open the first check valve (1) as long as the piston continues to rise. The excess water thus drawn into the pump flows from the spout.

DOORSTOP

A doorstop is a mechanism for reducing the speed of a closing door. Doorstops vary in size, shape, design, media, and the principle used to control the door's movement. Hydraulic doorstops are normally used in controlling heavy doors, while pneumatic doorstops are used for lighter type doors. The most commonly used doorstop consists of a cylinder and piston especially designed to cushion or buffer the quick motions of the closing door.

In a pneumatic doorstop, the cushion or buffer effect is attained by the transmission of the motion to the piston rod, which thereupon forces the piston head against the volume of air within the cylinder. The air is compressed and absorbs most of the motion, while graduated holes in the cylinder permit the air to escape slowly and the piston and door behind it are brought gradually to rest.

In the hydraulic type, a liquid (oil) is used to cushion the motion of the door. Two cylinders are generally interconnected by an orifice

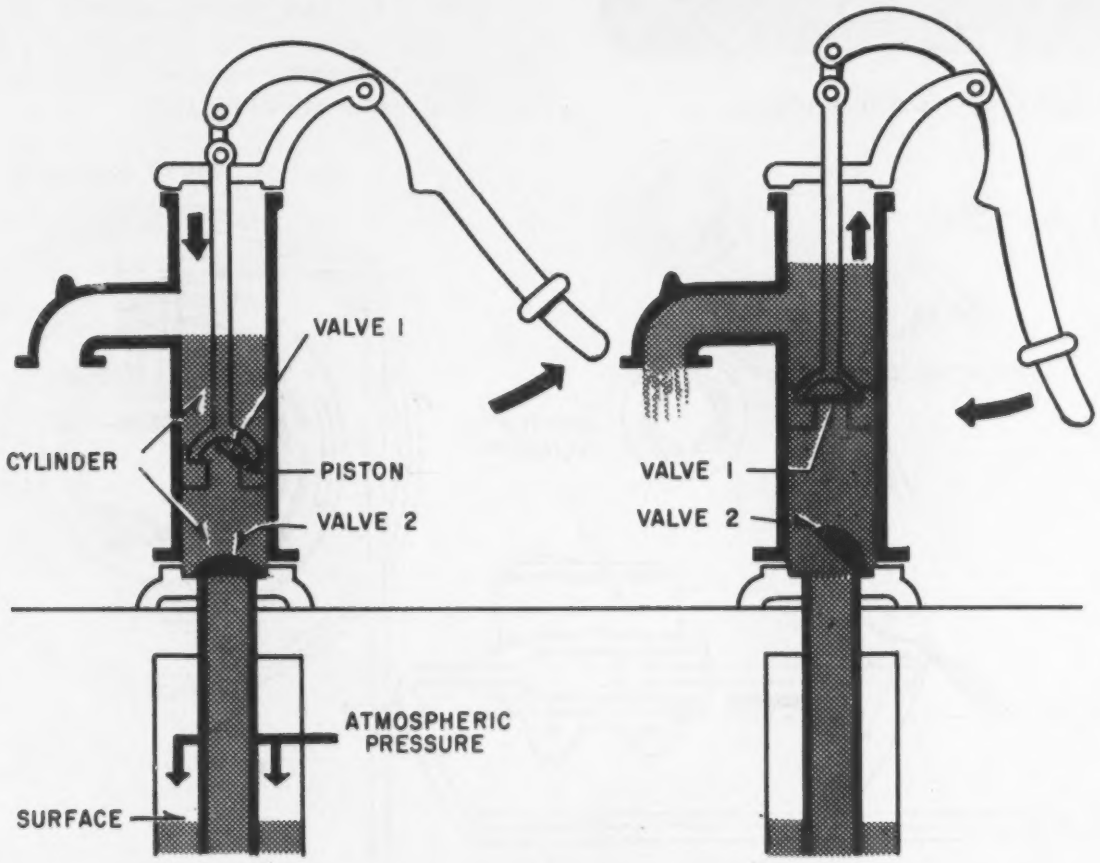

Figure 4-10.—Hand water pump.

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through which the liquid is forced as the door is opened or closed. The door can thus close only as rapidly as the liquid can be moved through the orifice.

AIRBRAKES

Airbrakes were developed to enable the driver to apply sufficient braking action to the wheels of high-speed, heavily-loaded vehicles. With modern airbrake systems, the brake pedal is merely a controlling device for the braking force, which is compressed air. On a vehicle that tows trailers provided with airbrakes, an additional hand controller is provided, which may be operated separately or in conjunction with the pedal. Airbrakes are a form of power brakes. Being more powerful than the hydraulic brakes previously described, they must be larger so that the individual brake will have a greater braking area.

In an airbrake system (fig. 4-11), an engine-driven air pump or compressor is used to compress air and force it into a reservoir, where it is stored under pressure and made available for operating the brakes. Air under pressure in the reservoir is released to the brake lines by an air valve operated by the brake pedal. This released air goes to brake chambers located close to the wheel brakes, which contain a flexible diaphragm and plate. The force of the compressed air admitted to the chamber causes the diaphragm to move the plate, and operates the

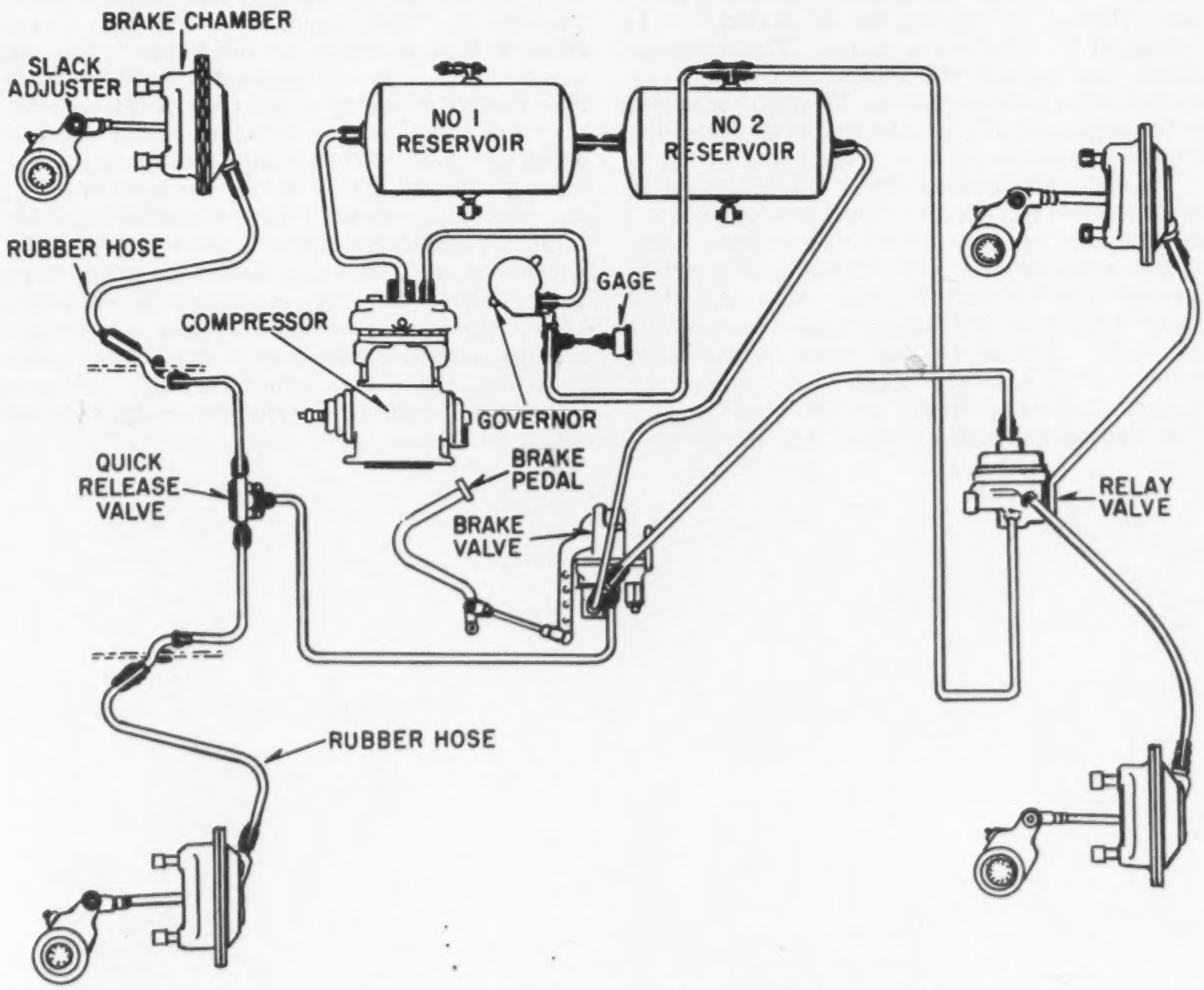

Figure 4-11.—Typical airbrake system.

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brakeshoes through a mechanical linkage. Considerable force is available for braking since the operating air pressure may be as high as 100 pounds per square inch. All brakes on a vehicle, and on a trailer when one is used, are operated by means of special regulating valves.

AIR-OVER-HYDRAULIC BRAKE SYSTEM

The air-over-hydraulic brake system uses the principle of the hydraulic brake to operate the wheel brake cylinders and produce braking action. However, the hydraulic pressure for the wheel brake cylinders is not supplied from the master cylinder. Instead, there are two circuits. The first leads from the air-hydraulic cylinder and admits air pressure which actuates this cylinder by moving an air piston that is connected to a hydraulic piston. The hydraulic piston then applies the hydraulic pressure that produces the braking action. The air is admitted by the action of valves controlled by the hydraulic pressure from the master cylinder.

An air-over-hydraulic brake system is shown in figure 4-12. Air pressure is supplied by a compressor and stored in reservoirs. The master cylinder is similar to the master cylinders used in hydraulic brakes. Also, the wheel brake cylinders and wheel brake construction are very similar to that used in hydraulic brakes. The essential difference between the straight hydraulic brake system and the air-over-hydraulic brake system lies in the air-hydraulic cylinder. This cylinder consists of three essentials: a large diameter air piston; a small diameter hydraulic piston in tandem with it, both on the same rod; and a set of valves controlled by hydraulic pressure from the master cylinder for admitting air into the air cylinder section of the air-hydraulic cylinder.

The air-hydraulic cylinder embodies an air cylinder and a hydraulic cylinder in tandem, each fitted with a piston with a common piston rod between. The air piston is of greater diameter than the hydraulic piston. This difference in areas of the two pistons gives a resultant hydraulic pressure much greater than the air pressure admitted to the air cylinder. Automatic valves, actuated by fluid pressure from the master cylinder, control the air admitted to the air cylinder. Thus, the fluid pressure in the brake lines is always in a direct ratio to foot pressure on the brake pedal. An air line from the air-hydraulic cylinder leads to a trailer coupling at the rear of the vehicle.

Valve action varies with the amount of brake pedal pressure. When heavy brake pedal pressure is applied by the driver for hard braking, the hydraulic pressure in the master cylinder (which operates the valves) causes greater valve movement, and therefore the valves admit more air pressure into the air-hydraulic cylinder. This higher air pressure causes a stronger braking action. With only a light brake pedal pressure, the valves admit less air pressure into the air-hydraulic cylinder and the braking action is lighter.

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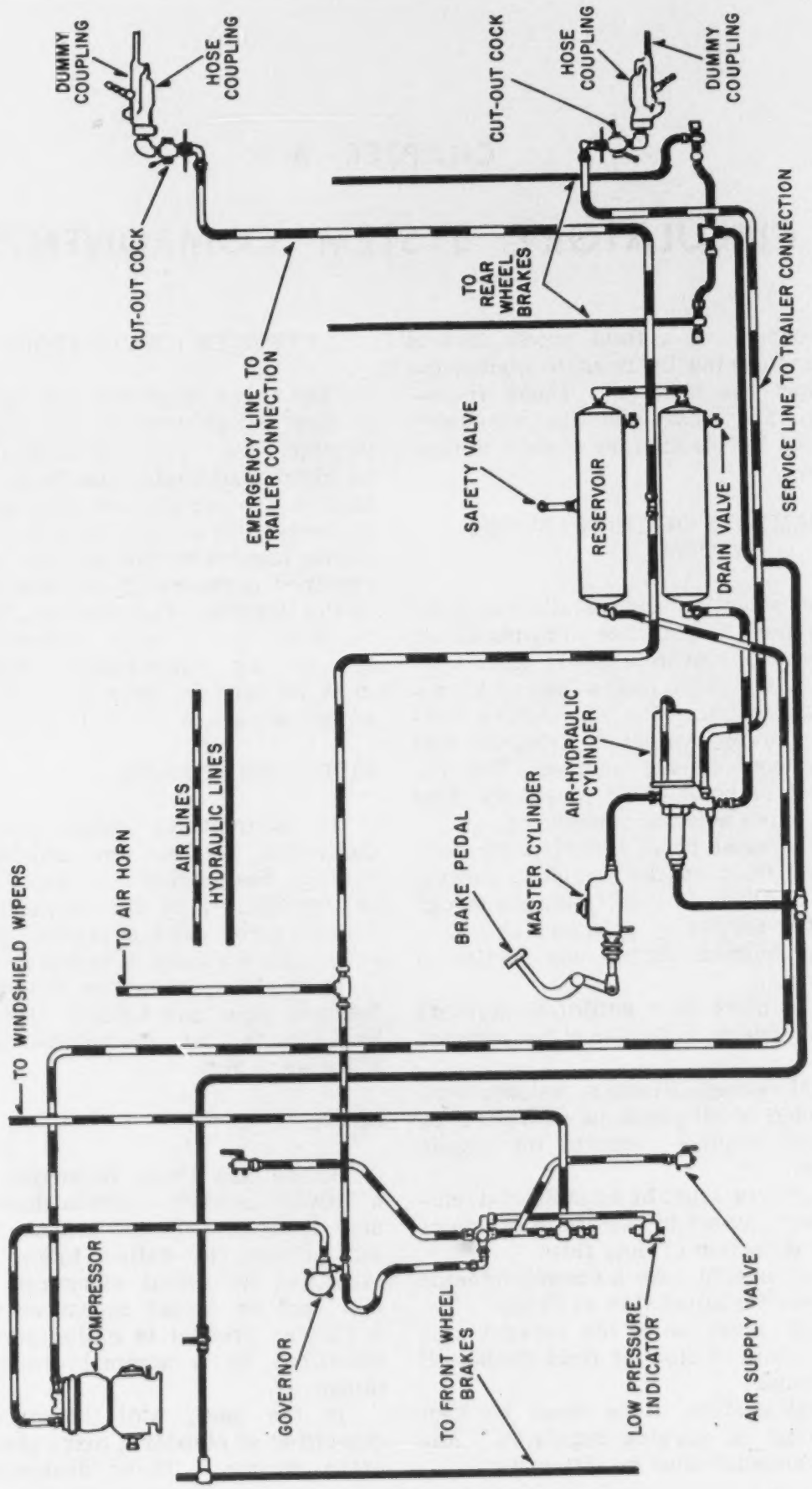

Figure 4-12.—Air-hydraulic brake system.

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CHAPTER 5

CIRCULATORY SYSTEM COMPONENTS

The components of a fluid power system must be interconnected by lines to convey the fluid throughout the system. These lines—pipes, tubing, and hose—and the necessary fittings make up the circulatory system of fluid power systems.

REQUIREMENTS OF CIRCULATORY SYSTEMS

The proper selection and installation of the lines are of utmost importance in hydraulic or pneumatic systems. An improperly piped system can lead to a serious power loss or harmful fluid contamination. The circulatory system of a fluid power system is designed with several basic requirements in mind. The following is a list of some of the most important requirements which must be considered:

1. The lines must be of sufficient strength to contain the fluid at the desired working pressure and, in addition, must be strong enough to withstand the surges of pressure that may develop in the system during any portion of the operating cycle.
2. The lines must have sufficient strength to support components which may be mounted in or on them.
3. Terminal fittings (flanges, unions, etc.) must be provided at all junctions with parts or components that require removal for repair or replacement.
4. Line supports must be capable of damping shock waves caused by surges of pressure and changes in direction of fluid flow.
5. The lines should have a smooth interior surface to reduce turbulent flow of fluid.
6. The lines must be of the correct size to insure the required flow of fluid during all system operations.
7. After installation, lines must be kept clean by flushing or purging regularly. Any source of contaminant must be eliminated.

TYPES OF CIRCULATORY SYSTEMS

The three most common types of lines used in fluid power systems are pipes, tubing, and flexible hose. They are sometimes referred to as rigid, semirigid, and flexible. A number of factors are considered when selecting the type of circulatory system for a fluid power system. These factors include the type of fluid medium, required pressure of the system, and location of the system. For example, heavy pipe might be used for a large stationary fluid power system, but comparatively lightweight tubing must be used in aircraft and missiles because weight and space are critical factors.

PIPING AND TUBING

In commercial usage, there is no clear distinction between pipe and tubing, since the correct designation for each tubular product is established by the manufacturer. If the manufacturer calls a product pipe, it is pipe; if he calls it tubing, it is tubing.

In the Navy, however, a distinction is made between pipe and tubing. This distinction is based on the way the tubular product is identified as to size.

Sizes

There are three important dimensions of a tubular product—outside diameter (OD), inside diameter (ID), and wall thickness. A tubular product is called tubing if its size is identified by actual measured outside diameter and by actual measured wall thickness. A tubular product is called pipe if its size is identified by a nominal dimension and wall thickness.

In the past, wall thickness of pipe was classified as standard, extra strong, and double extra strong. These designations are still

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used to some extent. However, pipe is manufactured in a number of different wall thicknesses and does not always fit into the standard, extra strong, or double extra strong classifications. In recent years, a trend has developed toward the use of scheduled numbers to classify the wall thickness of pipe and pipe fittings. These schedule numbers, established by the American Standards Association, range from 10 to 160 and cover 10 distinct sets of wall thickness. (See table 5-1.) Schedules 40 and 80 are comparable in thickness for most nominal pipe sizes to the standard and extra strong classes, respectively. Schedule 160 covers pipes with the greatest wall thicknesses in this classification, but are slightly thinner than the double extra strong class. The table includes only pipe sizes up through 12-inch nominal size, although larger sizes are available. Schedule 10 is for nominal pipe sizes larger than 12 inches.

A nominal dimension is close to—but not necessarily identical with—an actual measured dimension. As indicated in table 5-1, a pipe with a nominal size of 3 inches has an actual measured outside diameter of 3.500 inches. A pipe with a nominal size of 2 inches has an actual measured outside diameter of 2.375 inches. In the larger size (above 12 inches) the nominal pipe size and the actual measured outside diameter are the same. For example, a pipe with a nominal pipe size of 14 inches

Table 5-1. —Wall thickness schedule designations for pipe.

Nominal size	Pipe OD	Inside diameter									
		Sched. 10	Sched. 20	Sched. 30	Sched. 40	Sched. 60	Sched. 80	Sched. 100	Sched. 120	Sched. 140	Sched. 160
1/8	0.405				0.269		0.215				
1/4	.540				.364		.302				
3/8	.675				.493		.423				
1/2	.840				.622		.546				0.466
3/4	1.050				.824		.742				.614
1	1.315				1.049		.957				.815
1 1/4	1.660				1.380		1.278				1.160
1 1/2	1.900				1.610		1.500				1.338
2	2.375				2.067		1.939				1.689
2 1/2	2.875				2.469		2.323				2.125
3	3.500				3.068		2.900				2.624
3 1/2	4.000				3.548		3.364				
4	4.500				4.026		3.826		3.624		3.438
5	5.563				5.047		4.813		4.563		4.313
6	6.625				6.065		5.761		5.501		5.189
8	8.625		8.125	8.071	7.981	7.813	7.625	7.439	7.189	7.001	6.813
10	10.750		10.250	10.136	10.020	9.750	9.564	9.314	9.064	8.750	8.500
12	12.750		12.250	12.090	11.934	11.626	11.376	11.064	10.750	10.500	10.126

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has an actual measured outside diameter of 14 inches. Nominal dimensions are used in order to simplify the standardization of pipe fittings, pipe taps, and threading dies.

Tubing differs from pipe in its size classification. Tubing is designated by its actual outside diameter. (See table 5-2.) Thus, 5/8-inch tubing has an outside diameter of 5/8 inch. As indicated in the table, tubing is available in a variety of wall thicknesses. The diameter of tubing is often measured and indicated in 16ths. Thus, No. 6 tubing is 6/16 or 3/8 inch, No. 8 tubing is 8/16 or 1/2, etc.

The foregoing is a brief description of the standard ways to identify the size and wall thickness of pipe and tubing. It should be noted, however, that pipe and tubing are sometimes identified in other ways. For example, some tubing is identified by ID rather than by OD and some pipe is identified by nominal pipe size, by OD, by ID, and by actual measured wall thickness.

Table 5-2. —Tubing size designation.

Tube OD	Wall thickness	Tube ID
1/8	0.028	0.069
	.032	.061
	.035	.055
3/16	0.032	0.1235
	.035	.1175
1/4	0.035	0.180
	.042	.166
	.049	.152
	.058	.134
	.065	.120
5/16	0.035	0.2425
	.042	.2285
	.049	.2145
	.058	.1965
	.065	.1825
3/8	0.035	0.305
	.042	.291
	.049	.277
	.058	.259
	.065	.245
1/2	0.035	0.430
	.042	.416
	.049	.402
	.058	.384
	.065	.370
	.072	.356
	.083	.334
	.095	.310
5/8	0.035	0.555
	.042	.541
	.049	.527
	.058	.509
	.065	.495
	.072	.481
	.083	.459
	.095	.435
3/4	0.049	0.652
	.058	.634
	.065	.620
	.072	.606
	.083	.584
	.095	.560
	.109	.532
7/8	0.049	0.777
	.058	.759
	.065	.745
	.072	.731
	.083	.709
	.095	.685
	.109	.657
1	0.049	0.902
	.058	.884
	.065	.870
	.072	.856
	.083	.834
	.095	.810
	.109	.782
	.120	.760
1 1/4	0.049	1.152
	.058	1.134
	.065	1.120
	.072	1.106
	.083	1.084
	.095	1.060
	.109	1.032
	.120	1.010
1 1/2	0.065	1.370
	.072	1.356
	.083	1.334
	.095	1.310
	.109	1.282
	.120	1.260
	.134	1.232
1 3/4	0.065	1.620
	.072	1.606
	.083	1.584
	.095	1.560
	.109	1.532
	.120	1.510
	.134	1.482
2	0.065	1.870
	.072	1.856
	.083	1.834
	.095	1.810
	.109	1.782
	.120	1.760
	.134	1.732

MATERIALS: A tomato plant (10-11 wk. old) that has been inoculated with A tumefaciens and has young (10-20 day old) gall formations; young potted tomato plants (6-8 wk. old); saturated solution of calcium hypochlorite; saturated solution of sodium thiosulfate; inoculating needles (Dissecting needles may be used) and a platinum loop; several test-tube slants and petri dishes of nutrient agar; test tubes of nutrient broth and sterile water blanks; forceps; scalpel; razor blade; mortar and pestle.

PROCEDURE: (1) Isolation of Agrobacterium tumefaciens: Select galls on an inoculated tomato plant that are still young (10-20 days old). Cut 1 of the galls from the stem of the plant using a sterile scalpel and sterile forceps. Immerse the gall in a vial of saturated calcium hypochlorite for 5 seconds and neutralize immediately in a saturated solution of sodium thiosulfate. Triturate the surface-sterilized gall in 20 ml of sterile distilled water using a sterile mortar and pestle.

Dip a sterile platinum loop in the ground gall suspension and make serial streaks on 2 nutrient agar petri dishes. Incubate these plates (in an inverted position) for 48 hours at 30°C. Check the streak plates for presence of colonies at 24 hr. intervals. Colonies may not be visible until the second or third day, but in 4-5 days convex, pearly lustered colonies 1.5-2 mm in diameter should be visible. Colonies appearing earlier and attaining a diameter of 4-5 mm in 4-5 days can be discarded since they are probably saprophytes. Comparisons should be made with valid cultures of the crown gall bacterium.

With a sterile platinum loop, transfer a portion of a typical colony (small, white, circular, glistening, translucent) from 1 of the petri dishes to nutrient agar slants and nutrient broth tubes.

(2) Observations of colonies isolated from tomato gall: Observations can be made using a hanging-drop preparation, the relief staining technique and the standard Gram staining procedure. Characteristics which should be determined are motility, general morphology, and reaction to Gram's stain (negative or positive).

(3) Inoculation of tomato plants with Agrobacterium tumefaciens: Puncture 2 tomato plants through a stem internode with a sterile inoculating needle and repeat the procedure at another internode. These tomato plants will serve as controls.

Dip a sterile inoculating needle into the bacterial growth on 1 of the nutrient agar slants and inoculate immediately 1 of the tomato plants by puncturing the needle through a stem internode. Repeat this procedure at 2 other internodes and inoculate several other plants in the same manner.

For the next several weeks maintain the inoculated plants under favorable conditions of watering and light at 16° - 24°C. During this period, observe the tomato plants for the development of tumorlike swellings characteristic of crown gall at inoculation points.

(4) Reisolation of the bacterium: While the galls are still young (10-20 days old), repeat procedures described in (1) and (2).

Materials

Pipes and tubing are commonly made from case iron, steel, copper, brass, aluminum, and stainless steel. All of these have their own distinct advantages or disadvantages in certain applications.

Steel pipe and tubing are relatively inexpensive, and are used in many hydraulic and pneumatic systems. Steel is used because of its strength, its suitability for bending and flanging, and its adaptability to high pressures and temperatures. Its chief disadvantage is its comparatively low resistance to corrosion.

Copper piping and tubing are sometimes used for fluid power circulatory systems. Copper has high resistance to corrosion and is easily drawn or bent. It is unsatisfactory for high temperatures and has a tendency to harden and break due to stress and vibration.

Since weight elimination is vital in aircraft design, the majority of circulatory systems in naval aircraft fluid power systems contain aluminum alloy tubing. Two aluminum alloys are in common use—alloy 5052 may be used for lines carrying pressures up to 1,500 psi, and alloy 6061 for pressures up to 3,000 psi. Stainless steel tubing is used in certain parts of many aircraft fluid power systems. As a general rule, exposed lines and lines subject to abrasion or intense heat are made of stainless steel.

Application

The material, the inside diameter, and the wall thickness are the three primary considerations in the selection of lines for the circulatory system of a particular fluid power system. Most of the advantages and disadvantages of the metals used for the manufacture of fluid power lines were covered in the preceding paragraphs.

The inside diameter of a line is important, since it determines the rate of flow that can be passed through the line without loss of power due to excessive friction and heat. Velocity of a given flow is less through a large opening than through a small opening. If the inside diameter of the line is too small for the amount of flow, excessive turbulence and friction heat cause unnecessary power loss and overheated fluid.

The wall thickness, the material used, and the inside diameter determine the bursting pressure of a line or fitting. The greater the wall thickness in relation to the inside diameter and the stronger the metal, the higher the bursting pressure. However, the greater the inside diameter for a given wall thickness, the lower the bursting pressure, because force is the product of area and pressure. Industrial activities recommend that rigid lines should have a bursting pressure which provides a safety factor of at least eight; that is the rated bursting pressure should be at least eight times greater than the maximum working pressure in the system.

The manufacturers of tubing and pipe usually supply charts, graphs, or tables which aid in the selection of the proper lines for fluid power systems. These tables and charts use different methods for deriving the correct sizes of pipe and tubing. Regardless of the method, some provision must be made for correlating the strength of the line in terms of bursting pressure with the inside diameter in terms of flow capacity at recommended velocity.

The units of fluid power systems are designed as compactly as is practicable, in order to keep the connecting lines short. Every section of line should be anchored securely in one or more places so that neither the weight of the line nor the effects of vibration are carried on the joints. The aim should be to minimize stress throughout.

Lines should normally be kept as short and free of bends as possible. However, tubing should not be assembled in a straight line, because a bend tends to eliminate strain by absorbing vibration and compensates for thermal expansion and contraction. Bends are preferred to elbows, because bends cause less of a power loss. A few of the incorrect and correct methods of installing tubing are illustrated in figure 5-1.

Bends are described in terms of the ratio of the radius of the bend to the inside diameter of the tubing or pipe. The ideal bend radius is 2 1/2 to 3 times the inside diameter, as shown in figure 5-2. If the inside diameter of a line is 2 inches, the radius of the bend should be between 5 and 6 inches.

While friction head increases markedly for sharper curves than this, it also tends to increase up to a certain point for gentler curves. The increases in friction in a bend with a radius of more than about 3 pipe diameters result from increased turbulence on the outside edges of the flow. (See glossary.) Particles of fluid must travel a longer distance in making the change

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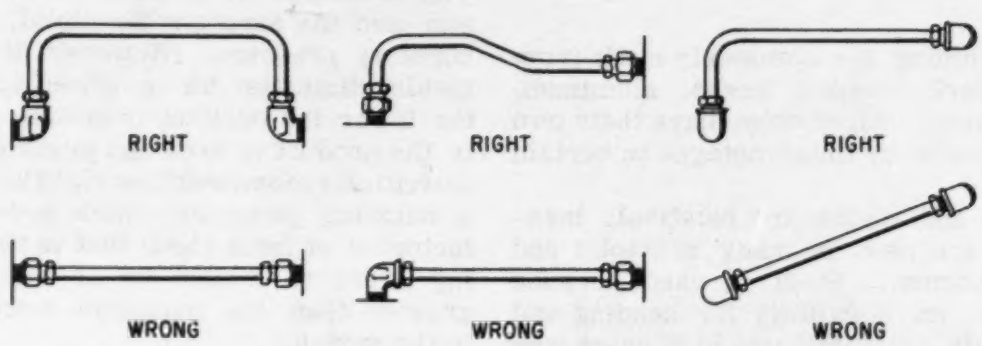

Figure 5-1.—Correct and incorrect methods of installing tubing.

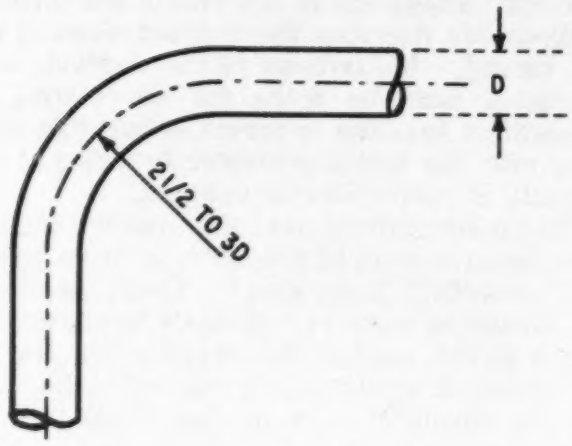

Figure 5-2.—Ideal bend radious.

in direction. When the radius of the bend is less than about 2 1/2 pipe diameters, the increased pressure loss is due to the abrupt change in direction of flow, especially for particles on the inside edge of the flow.

Cutting and bending of pipe and tubing are covered in Basic Handtools, NavPers 10085-A, in other applicable Navy Training Courses, and in applicable technical publications.

FLEXIBLE HOSE

Hose is used in fluid power systems where there is a necessity for flexibility, such as connections to units that move while in operation, or to units attached to a hinged portion of the equipment. It is also used in locations that are subjected to severe vibration. Flexible hose is usually used to connect the pump to the system. The vibration that is set up by an operating pump would ultimately cause rigid tubing to fail.

Sizes

Flexible hose is designated by a dash number, according to its size. The dash number is stenciled on the side of the hose and will indicate the size which refers to the equivalent tubing size. It does not denote the inside or outside diameter of the hose. For example, a hose with -8 stenciled on it is used with No. 8 tubing. The No. 8 tubing has an outside diameter of 1/2 inch (8/16). The inside diameter of the hose will not be 1/2 inch; it will be slightly smaller to allow for wall thickness. The actual inside diameter of both the hose and tubing is the same. As long as the dash number of the hose corresponds with the number of the tubing, the proper size is being used.

The following is a complete breakdown for a hose designation:

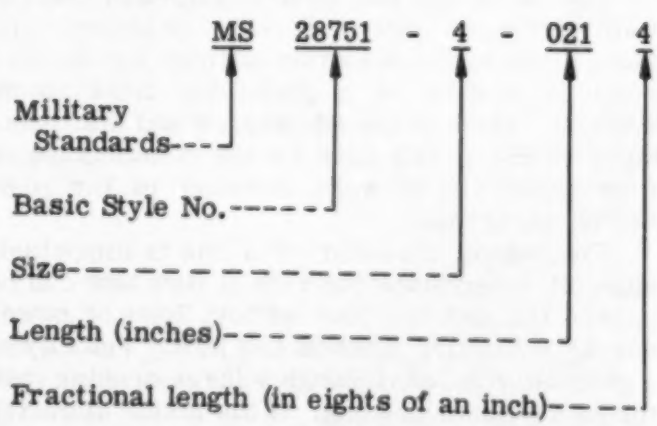

This information and the date of manufacture are usually stenciled on the outside of the hose. On some of the newer type flexible hose, the information is placed on a metal tag and attached to the hose.

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Materials

RUBBER.—Flexible rubber hose consists of a seamless synthetic rubber tube covered with layers of cotton braid and wire braid, and an outer layer of rubber-impregnated cotton braid. The inner tube is designed to withstand the attack of the material which pass through it. The braid, which may consist of several layers, is the determining factor in the strength of the hose. The cover is designed to withstand external abuse.

TEFLON.—Teflon hose is a flexible hose designed to meet the requirements of higher operating pressures and temperatures in present fluid power systems. Teflon hose consists of a chemical resin, which is processed and extruded into tube shape to a desired size. It is covered with stainless steel wire which is braided over the tube for strength and protection.

Teflon hose is unaffected by all fluids presently used in fluid power systems. It is inert to acids, both concentrated and diluted. Certain Teflon hose may be used in systems where operating temperatures range from -100° F to + 500° F. Teflon is nonflammable; however, where the possibility of open flame exists, a special asbestos fire sleeve should be used.

Teflon hose will not absorb moisture. This, together with its chemical inertness and anti-adhesive characteristics, make it ideal for missile fluid power systems where noncontamination and cleanliness are so essential.

Application

Flexible hose is provided in four pressure ranges. Low-pressure hose is used in low-pressure fluid power systems and for exhaust lines of high-pressure systems. Medium-pressure hose is used in fluid power systems with pressures up to 1,200 psi; high-pressure hose is used in systems with pressures up to 3,000 psi; and extra-high-pressure hose in systems with pressures up to 5,000 psi. High-pressure and extra-high-pressure hose are available only in complete assemblies with factory installed end fittings. Medium-pressure and low-pressure hose are available in bulk and are usually fabricated locally. The fabrication of hose assemblies is covered in applicable Navy Training Courses and technical publications.

Flexible hose must not be twisted on installation, since this reduces the life of the hose considerably and may cause the fittings to loosen as well. Twisting of the hose can be determined from the identification stripe running along its length. This stripe should not tend to spiral around the hose. (See fig. 5-3.)

Flexible hose should be protected from chafing by wrapping lightly with tape, but only where necessary.

The minimum bend radius for flexible hose varies according to size and construction of the hose, and the pressure under which the system will operate. Current applicable technical publications contain tables and graphs showing minimum bend radii for the different types of installations. Bends which are too sharp will reduce the bursting pressure of flexible hose considerably below its rated value.

Flexible hose should be installed so that it will be subjected to a minimum of flexing during operation. Support clamps are not necessary with short installations, but with hose of

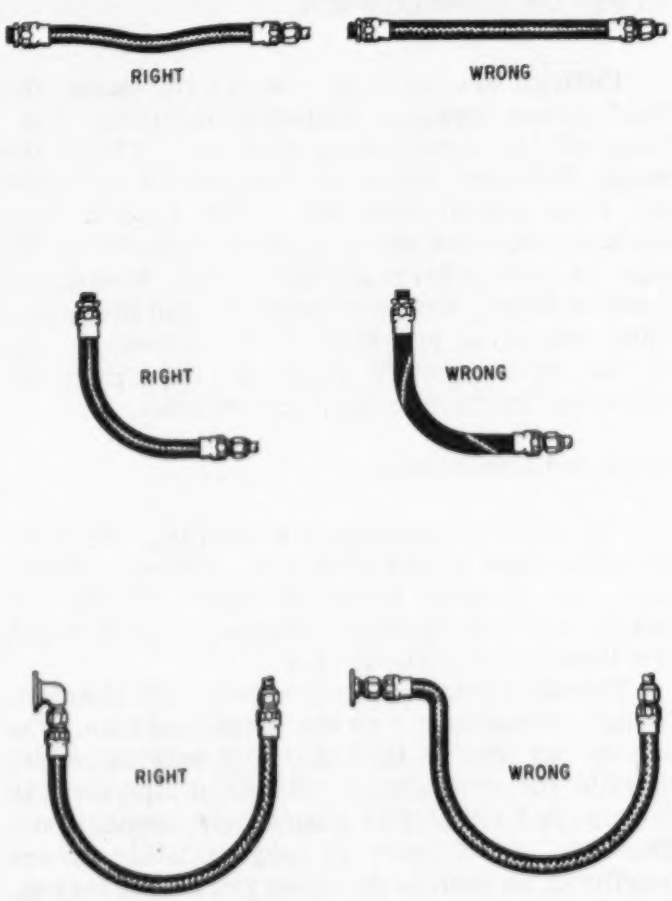

Figure 5-3.—Correct and incorrect installation of flexible hose.

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considerable length (48 inches for example), clamps should be placed not more than 24 inches apart. Closer supports are desirable and in some cases needed.

A flexible hose must never be stretched tight between two fittings. About 5 to 8 percent of the total length must be allowed as slack to provide freedom of movement under pressure. When under pressure, flexible hose contracts in length and expands in diameter. Examples of correct and incorrect installations of flexible hose are illustrated in figure 5-3.

All Teflon hose should be handled carefully during removal or installation. Sharp or excessive bending will kink or damage the hose. Teflon flexible hose tends to form itself to the installed position in the circulatory system. Some Teflon hose is performed during fabrication. Upon removal of such hose, the preformed section must be handled carefully to prevent straightening or kinking.

TYPES OF CONNECTORS

Fittings are used to connect the units of a fluid power system, including individual sections of the circulatory system. There are many different types of connectors provided for fluid power systems. The type of connectors required for a system depends on the type of circulatory system (pipe, tubing, or flexible hose), the fluid medium, and the maximum operating pressure of the system. Some of the most common types of connectors are described in the following paragraphs.

Threaded Connectors

Threaded connectors are used in some low-pressure fluid power systems. In Navy systems they are usually made of steel, copper, or brass, and in a variety of designs, some of which are illustrated in figure 5-4.

Threaded connectors are made with standard female threading cut on the inside surface. The end of the pipe is threaded with outside (male) threads for connecting. Standard pipe threads are tapered slightly to insure tight connections. The amount of taper is approximately three-fourths of an inch in diameter per foot of thread. (See fig 5-5.)

Metal is removed when a pipe is threaded, thinning the pipe and exposing new and rough surfaces for chemical action. Corrosion agents work more quickly at such points than elsewhere. If pipes are assembled with no protective compound on the threads, corrosion sets in at once and the two sections stick together so that the threads seize when disassembly is attempted. The result is damaged threads and pipes.

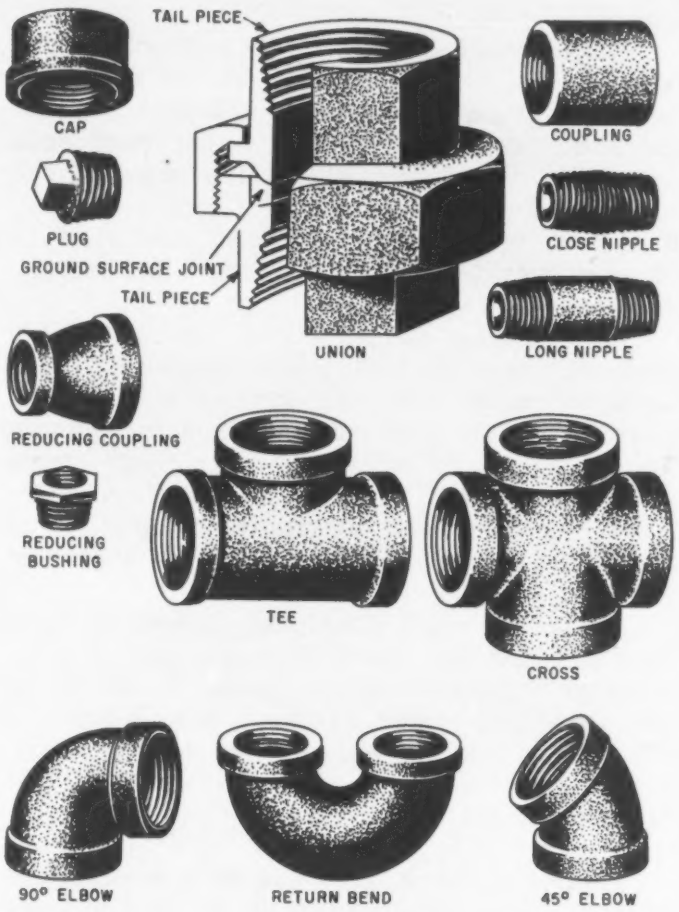

Figure 5-4.—Threaded pipe connectors.

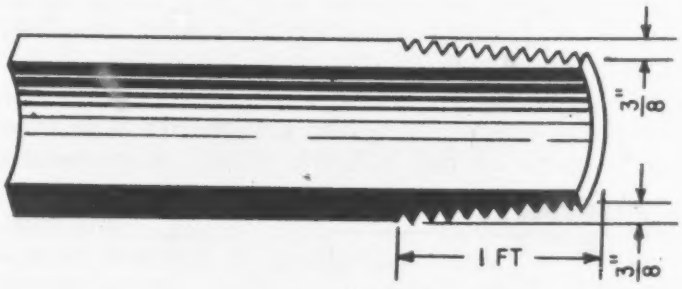

Figure 5-5.—Standard taper for pipe threads.

To prevent seizing, a suitable pipe thread compound is sometimes applied to the threads as illustrated in figure 5-6. The two end threads are kept free of compound so that it will not contaminate the fluid. Pipe compound, when improperly applied, may get inside the lines and harm pumps and control equipment. This has been such a problem that many manufacturers forbid the use of any compound when fabricating the piping for fluid power systems.

Flanged Connectors

Bolted flange joints (fig. 5-7) are suitable for most pressures now in use. The flanges are attached to the piping by welding, brazing, tapered threads (for some low-pressure piping), or rolling and bending into recesses. Those illustrated are the most common types of flange joints used. The same types of standard fitting shapes (tee, cross, elbow, etc.) are manufactured for flange joints, such as the threaded fittings illustrated in figure 5-4.

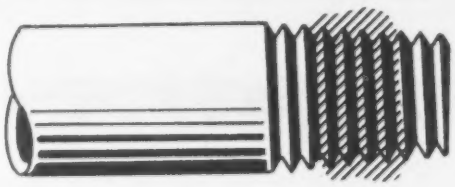

Figure 5-6.—Application of protective compound to pipe threads.

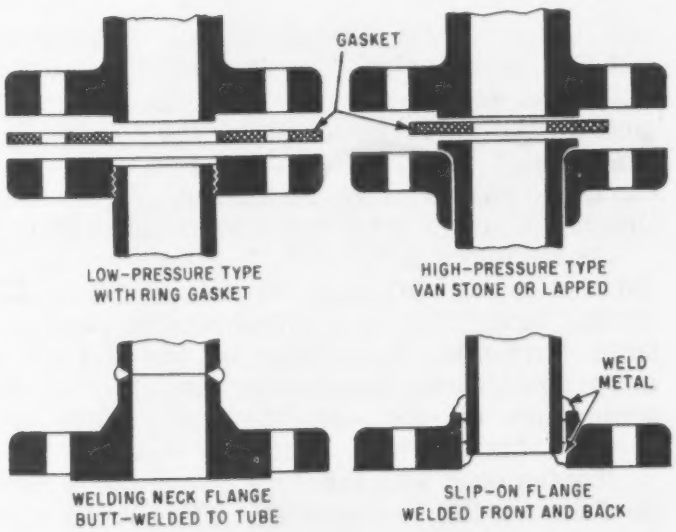

Figure 5-7.—Four types of bolted flange connectors.

Welded Connectors

The subassemblies of some circulatory systems are connected by welded joints, especially in high-pressure piping systems. The welding is accomplished according to standard specifications which define the materials and techniques. There are three general classes of welded joints—butt-weld, fillet-weld, and socket-weld (fig. 5-8).

Brazed Connectors

Silver-brazed connectors (fig. 5-9) are commonly used for joining nonferrous (copper, brass, etc.) piping in the pressure and temperature range where their use is practical. These practical factors limit the use of this type of connector to lines not exceeding 425° F; for cold lines, these fittings may be used for pressures up to 3,000 psi. The alloy is melted

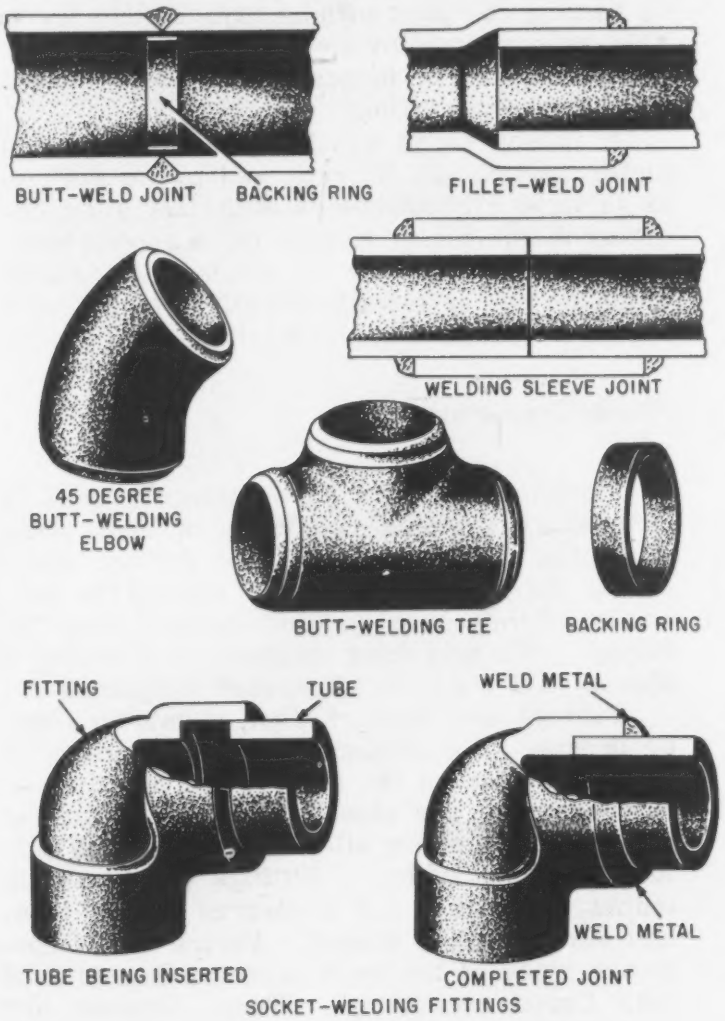

Figure 5-8.—Various types of welded joints.

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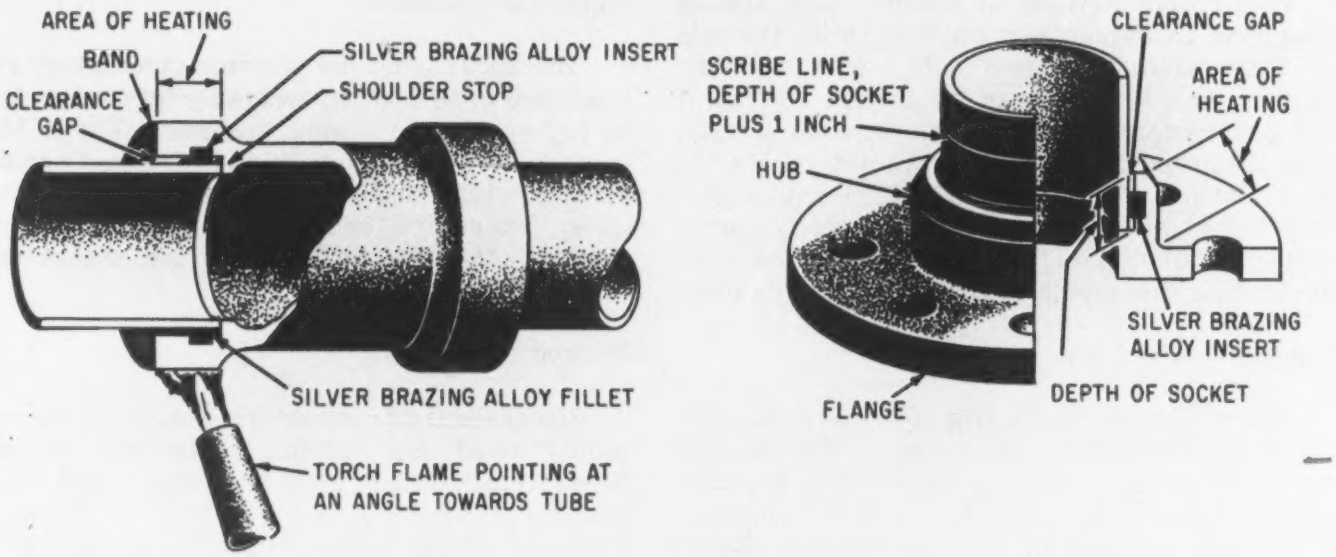

Figure 5-9.—Silver-brazed connectors.

by heating the joint with an oxyacetylene torch. This causes the alloy insert to melt and fill the few thousandths of an inch annular space between the pipe and the fitting.

A fitting which has been removed from a piping system can be rebrazed into a system, as in most circumstances sufficient alloy remains in the insert groove for a second joint. New alloy inserts may be obtained for fittings which do not have sufficient alloy remaining in the insert for making a new joint.

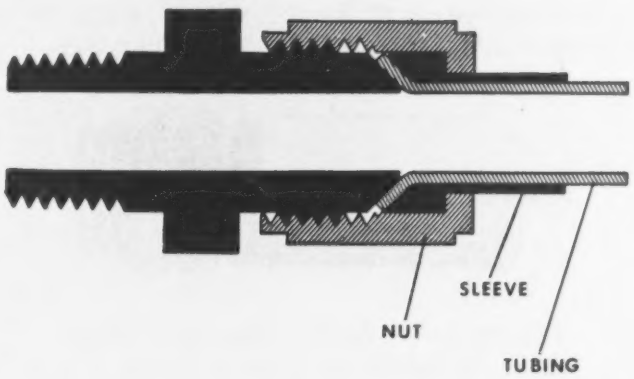

Figure 5-10.—Flared-tube connector.

Flared Connectors

Flared connectors are commonly used in circulatory systems consisting of lines made of tubing. These connectors provide safe, strong, dependable connections without the necessity of threading, welding, or soldering the tubing. The connector consists of a fitting, a sleeve, and a nut, as illustrated in figure 5-10.

Fittings are made of steel, aluminum alloy, or bronze. The fittings should be of material similar to that of the sleeve, nut, and tubing. For example, use steel connectors with steel tubing and aluminum alloy connectors with aluminum alloy tubing. Fittings are made in unions, 45-degree and 90-degree elbows, tees, and various other shapes. Figure 5-11 illustrates some of the most common fittings used with flared connectors. Tees, crosses, and elbows are self-explanatory. Universal and bulkhead fittings can be mounted solidly with one outlet of the fitting through a bulkhead and the other outlet(s) positioned at any angle. Universal denotes the fact that the fitting can assume the angle required for the specific installation. Bulkhead denotes that it is long enough to pass through a bulkhead. Figure 5-12 illustrates a universal bulkhead-mounted fitting.

As indicated in figure 5-11, fittings are available in many different thread combinations. Unions have tube connections on each end; elbows have tube connections on one end and a male pipe thread, female pipe thread, or a tube connection on the opposite end. Tees and crosses have several different combinations.

Tubing used with this type of connector must be flared prior to assembly. The nut fits over the sleeve and when tightened, draws the sleeve and tubing flare tightly against the male fitting to form a seal.

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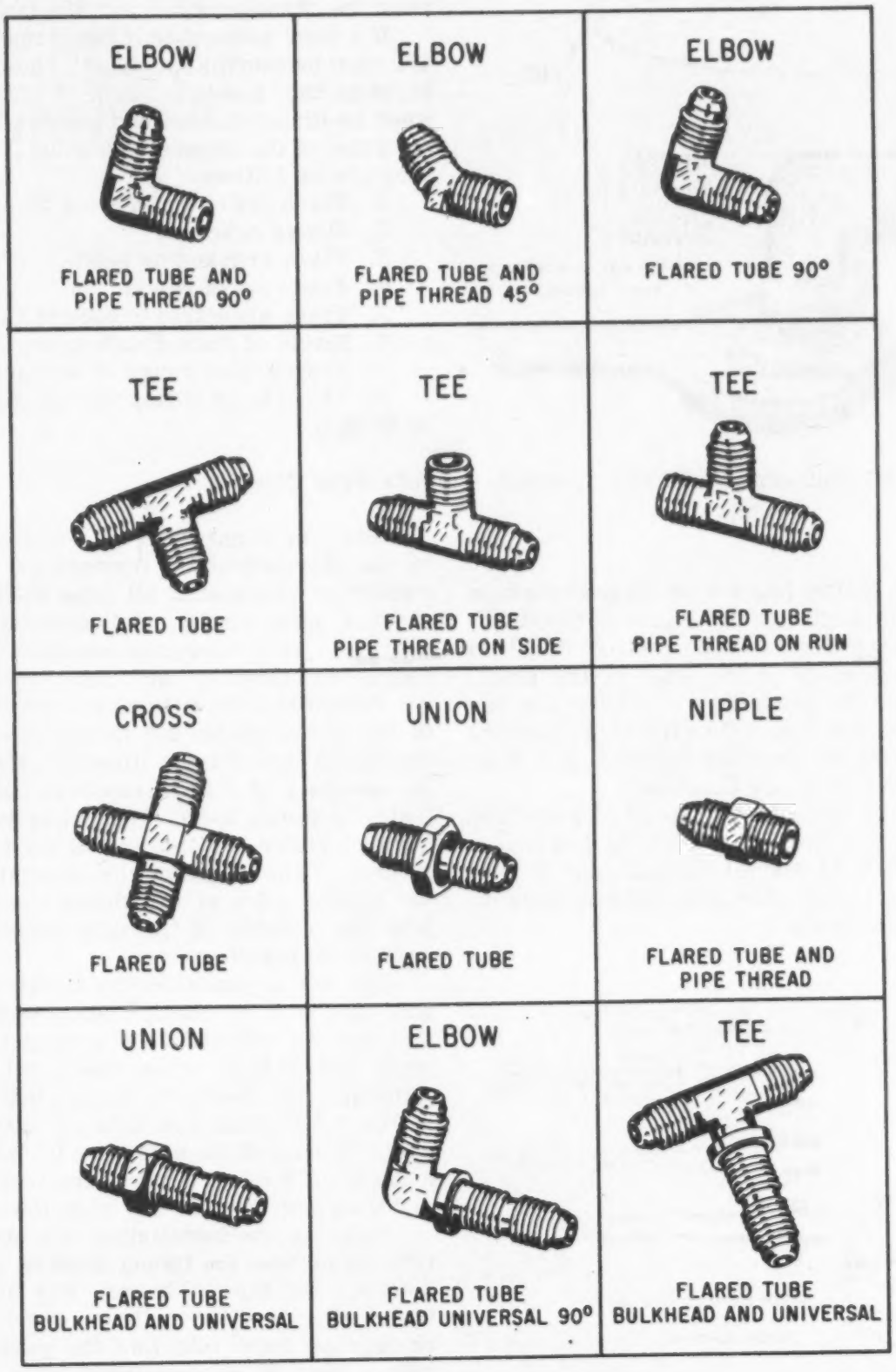

Figure 5-11.—Flared-tube fittings.

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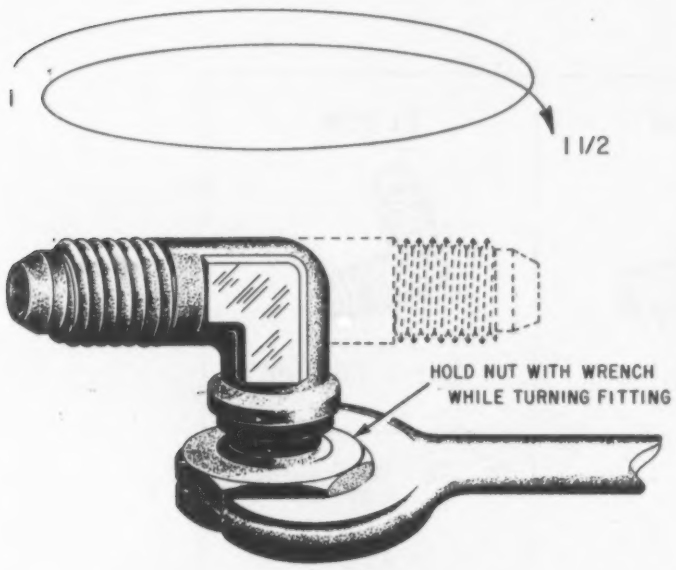

Figure 5-12.—Universal bulkhead-mounted fitting.

The male fitting has a cone-shaped surface with the same angle as the inside of the flare. The sleeve supports the tube so that vibration does not concentrate at the edge of the flare, and distributes the shearing action over a wider area for added strength. Tube flaring is covered in Basic Handtools, NavPers 10085-A, and other applicable Navy Training Courses.

Correct and incorrect methods of installing flared-tube connectors are illustrated in figure 5-13. Tubing nuts should be tightened with a torque wrench to the value specified in applicable technical publications.

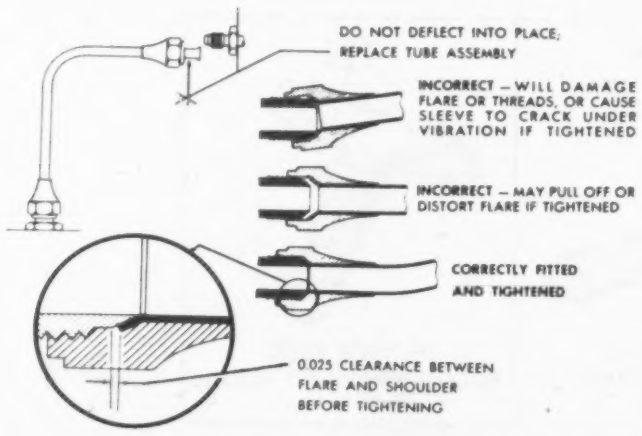

Figure 5-13.—Correct and incorrect methods of tightening flared connectors.

If an aluminum alloy flared connector leaks after tightening to the specified torque, it must not be tightened further. The leaking connector must be disassembled and the fault corrected.

If a steel connector leaks, it may be tightened 1/6 turn beyond the specified torque in an attempt to stop the leakage; then, if unsuccessful, it must be disassembled and repaired.

Some of the causes of leaking flared connectors are as follows:

1. Flare distorted into nut threads.
2. Sleeve cracked.
3. Flare cracked or split.
4. Flare out of round.
5. Flare eccentric to tube OD.
6. Inside of flare rough or scratched.
7. Fitting cone rough or scratched.
8. Threads of fitting or nut dirty, damage, or broken.

Bite Type Connectors

Bite type connectors are commonly referred to as flareless-tube connectors. This type connector eliminates all tube flaring, yet provides a safe, strong, and dependable tube connection. This connector consists of a fitting, a sleeve or ferrule, and nut. (See fig. 5-14.)

Flareless-tube fittings are available in many of the same shape and thread combinations as the flared type fittings illustrated in figure 5-11. An example of a flareless-tube fitting is illustrated in figure 5-15. The fitting has a counterbore shoulder for the end of the tubing to rest against. The angle of the counterbore causes the cutting edge of the sleeve or ferrule to cut into the outside of the tube when the two are assembled together.

The nut presses on the bevel of the sleeve and causes it to clamp tightly to the tube. Resistance to vibration is concentrated at this point rather than at the sleeve cut. When fully tightened, the sleeve or ferrule is bowed slightly at the midsection and acts as a spring. This spring action of the sleeve or ferrule maintains a constant tension between the body and the nut and thus prevents the nut from loosening.

Prior to the installation of a new flareless-tube connector, the tubing must be square, concentric, and free of burrs. For the connection to be effective, the cutting edge of the sleeve or ferrule must bite into the periphery of the tube. This is accomplished by presetting the sleeve or ferrule on the tube using a presetting tool which has the same dimensions as the

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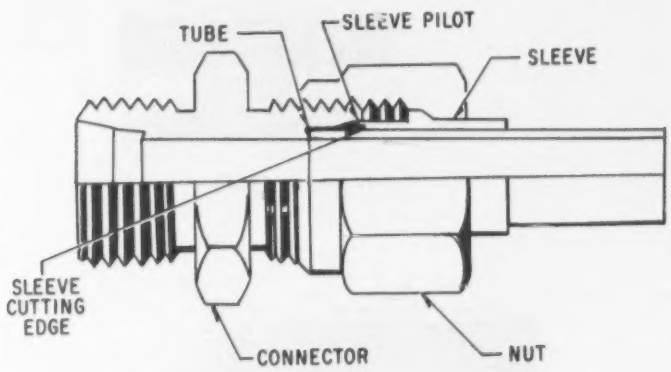

Figure 5-14.—Flareless-tube connector.

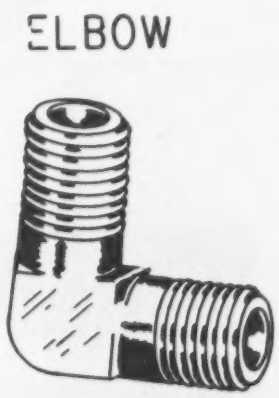

Figure 5-15.—Flareless-tube fitting.

fitting body, and which can be obtained from the fitting manufacturer. If a presetting tool is not available, a suitable male-thread fitting may be used. Steel fittings are preferred for this operation. If an aluminum fitting is used as a preset tool it should not be reused in the system.

Applicable Navy Training Courses, technical publications, or specifications may be consulted for the proper procedure to be followed for presetting flareless-tube connectors.

After presetting, the connector is disassembled for inspection. If the sleeve or ferrule is satisfactorily installed, the connector is ready for final assembly in the system. When making the final assembly in the system, the following installation procedure should be followed.

1. Lubricate all threads with a liquid that is compatible with the fluid that is to be used in the system.

2. Place the tube assembly in position and check for alignment.

3. Tighten the nut by hand until the increase in resistance to turning is encountered. This indicates that the sleeve pilot has contacted the fitting.

4. With a wrench, turn the nut 1/6 turn (one hex side). Use a wrench on the hex of the fitting to prevent it from turning while tightening the nut.

CAUTION: Overtightening will yield and damage the fitting. If the connection leaks after tightening to the foregoing instructions, it may be tightened an additional 1/6 turn. If this does not stop leakage, the connector must be disassembled and repaired. Always remember, DO NOT OVERTIGHTEN FLARELESS-TUBE CONNECTORS.

Connectors for Flexible Hose

Most of the flexible hose used in Navy fluid power systems must be drawn from supply as an assembly and is equipped with end fittings that are applicable to the particular system. The end fittings most commonly used on flexible hose used in fluid power systems are either for the flared or flareless type connectors. Hose is also available with fittings adaptable to flange type connectors. Examples of end fittings for flexible hose are illustrated in figure 5-16.

Quick-Disconnect Couplings

Quick-disconnect couplings of the self-sealing type are used at various points in many fluid power systems. These couplings are installed at locations where frequent uncoupling of the lines is required for inspection, test, and maintenance.

Quick-disconnect couplings provide a means of quickly disconnecting a line without the loss of fluid from the system or entrance of foreign matter into the system. Several types of quick-disconnect couplings have been designed for use in fluid power systems. Figure 5-17 illustrates a coupling that is used with portable pneumatic tools. The male section is connected to the tool or to the line leading from the tool. The female section, which contains the shutoff valve, is installed in the pneumatic line leading from the power source. These connectors can be separated or connected by very little effort on the part of the operator.

The most common quick-disconnect coupling for hydraulic systems consists of two parts,

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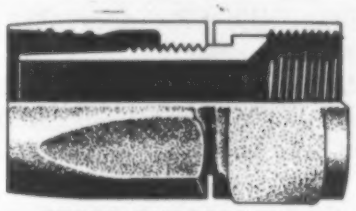
SWIVEL NUT FITTING

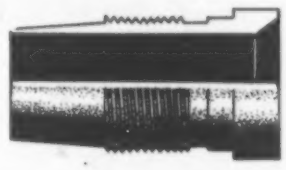
SWIVEL NUT FITTING NIPPLE

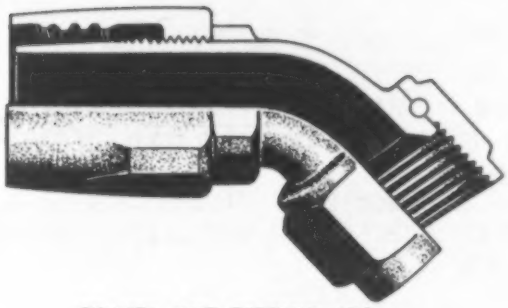
SWIVEL NUT FITTING 45°

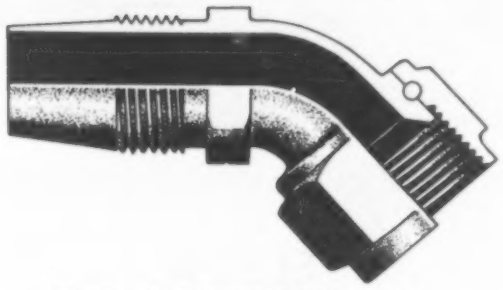
SWIVEL NUT FITTING NIPPLE 45°

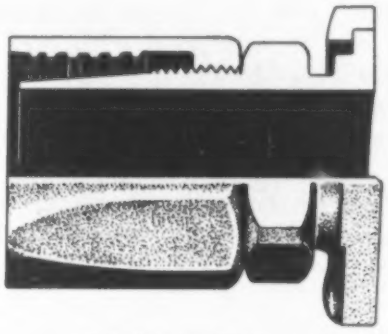
FLANGE FITTING

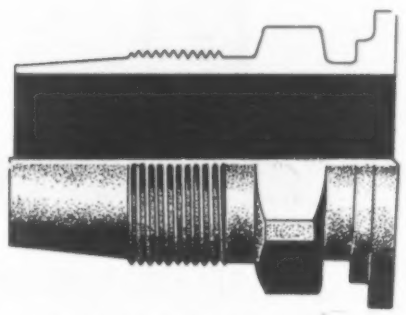
FLANGE FITTING NIPPLE

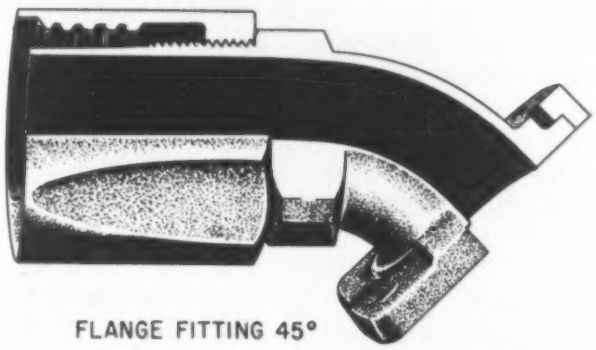
FLANGE FITTING 45°

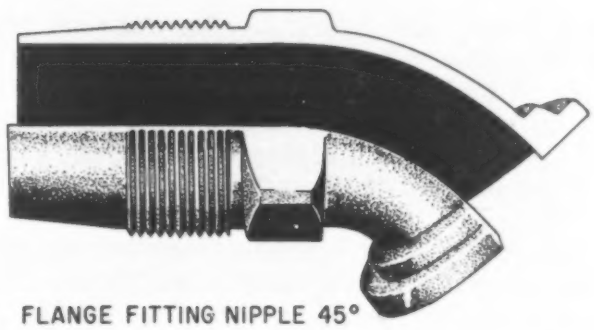
FLANGE FITTING NIPPLE 45°

Figure 5-16.—Flexible hose end fittings.

held together by a union nut. Each part contains a valve which is held open when the coupling is connected, allowing fluid to flow in either direction through the coupling. When the coupling is disconnected, a spring in each part closes the valve, preventing the loss of fluid and entrance of foreign matter.

The union nut has a quick-lead thread which permits connecting or disconnecting the coupling by turning the nut. The amount the nut must be turned varies with different styles of couplings. For one style, a quarter turn of the union nut locks or unlocks the coupling. For another style, a full turn is required. Some couplings require wrench tightening; others are connected and disconnected by hand. Some installations require

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PRECAUTIONS: Aseptic technique must be maintained at all times. In inoculating the tomato plants it is recommended that the inoculating needle be pushed completely through the stem internode. Be careful that the inoculating needle is not excessively hot after flaming and prior to picking up the bacteria from the slant for inoculation.

TIME REQUIRED: 3-4 weeks.

RESULTS: Using the above procedures, colonies of *Agrobacterium tumefaciens* should be isolated readily from the streak plates with little contamination. The bacteria from the nutrient broth should exhibit motility in a hanging-drop preparation, although some strains of *A tumefaciens* are not motile. Gram staining should reveal the bacteria to be Gram-negative. Characteristic galls usually appear on the inoculated tomato plants about 2 weeks after inoculation. The bacteria isolated from these galls should have the same characteristics as the original isolate fulfilling Koch's postulates.

8. Inoculation with Sclerotinia sclerotiorum

OBJECTIVES: To demonstrate techniques required for successful inoculation with sclerotia of *Sclerotinia sclerotiorum* and to illustrate disease symptoms caused by the fungus.

MATERIALS: (Suggest that the experiment be carried out by the instructor as a demonstration.)
Two heads of lettuce; 20-25 sclerotia of *S. sclerotiorum*; 2 glass or plastic containers large enough to accommodate a head of lettuce; 1-1000 mercuric chloride solution or 1-20 chlorox solution; sterile water; paper towels; forceps.

PROCEDURE: Wipe out the plastic or glass containers with mercuric chloride or chlorox solution. Place several paper towels dampened with sterile water in the bottom of each container. Place lettuce head on top of damp paper towels. Place sclerotia in mercuric chloride solution or chlorox solution for five minutes and rinse in sterile water. With a flamed forceps, place sclerotia on one lettuce head in various positions in relation to the lettuce head and to individual leaves.

Keep second lettuce head uninoculated as a control.

Sterile water should be added to both containers every few days.

TIME REQUIRED: For severe symptoms to develop, two weeks are required.

RESULTS: Observations should be made daily and notes taken on (1) changes in appearance of the sclerotia; (2) changes in inoculated lettuce head; (3) any difference in appearance of the control.

When the inoculated lettuce head has completely broken down, the fungus will form new sclerotia. These may be collected, dried, placed in a jar to store and used in future experiments.

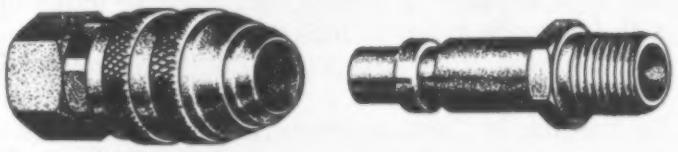

Figure 5-17.—Quick-disconnect coupling for air lines.

that the coupling be safetied with safety wire, others do not require any form of safetying. Because of these individual differences, all quick disconnects should be installed in accordance with the instructions in the applicable technical publication.

A typical quick disconnect coupling for hydraulic systems is illustrated in figure 5-18. Each coupling consists of two halves, referred to as the S1 half and the S4 half. When disconnected, the union nut remains with the S1 half. The S4 half has a mounting flange (9) for attaching to a bulkhead or other structural member.

All parts referred to in the following paragraph are identified in figure 5-18. The two halves of the coupling may be connected by placing the tubular valve (1) within the protruding nose (6) of the mating half and rotating the union nut in a clockwise direction. The union nut must be rotated until the teeth (5) fully engage the lock spring (8). A properly tightened coupling will have compressed the lock spring until a 1/16-inch minimum gap exists between the inside lip of the spring retainer fingers and the spring plate. Figure 5-19 shows the coupling both properly tightened and improperly tightened.

The locking action may be followed by referring to figure 5-18. Positive locking is assured by the locking spring (8) with teeth which engage ratchet teeth on the union nut (5) when the coupling is fully connected. The lock

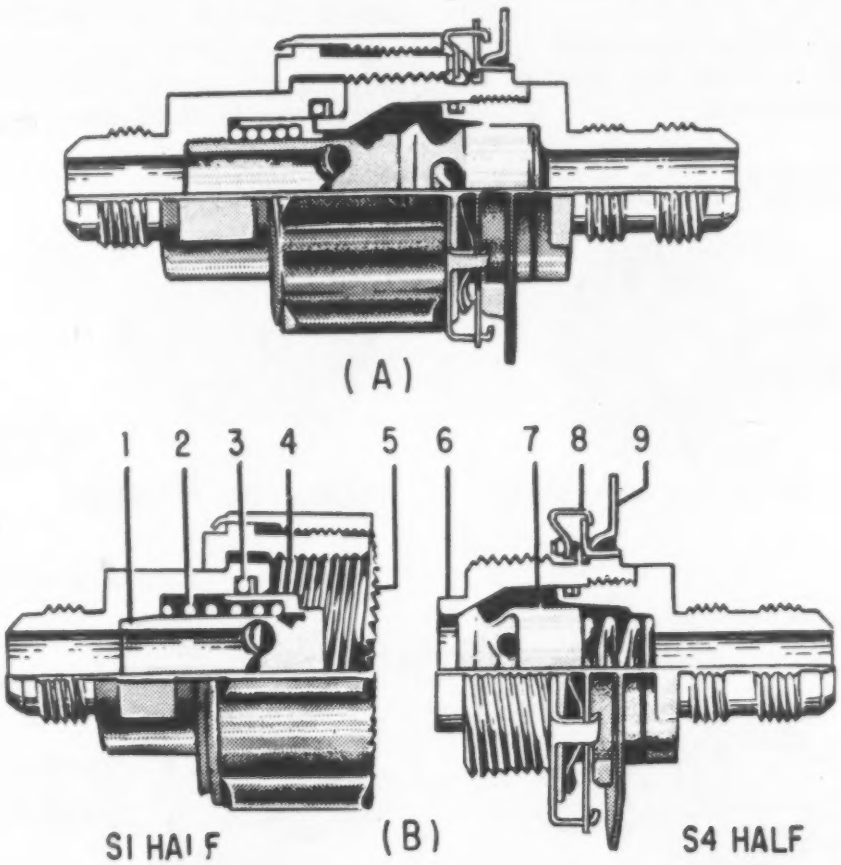

1. Tubular valve.
2. Valve spring.
3. O-ring packing.
4. Sleeve.
5. Union nut teeth.
6. Protruding nose.
7. Poppet valve.
8. Lock spring.
9. Mounting flange.

Figure 5-18.—Typical quick-disconnect coupling.

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spring automatically disengages when the union nut is unscrewed. An O-ring packing (3) seals against leakage as the coupling halves are joined. Positive opening of the valves occurs as the halves are connected.

When the coupling halves are joined, the protruding nose (6) of the S4 half contacts the sleeve (4) of the S1 half. Simultaneously, the head of the tubular valve (1) contacts the face of the poppet valve (7), thus preventing foreign matter from entering the system.

Tightening the union pulls the coupling halves together. This causes the nose of the S4 half to push the sleeve into the S1 half, uncovering the ports of the tubular valve. At the same time, the head of the tubular valve depresses the poppet valve.

When the coupling halves are fully connected, the sleeve and poppet valve have reached the positions shown in the left-hand view of figure 5-19. The nose of the S4 half has engaged the O-ring packing of the S1 half, providing a positive sleeve.

Dust caps are usually provided with quick-disconnect couplings to cover the ends of the coupling when it is separated.

It should be emphasized that regardless of the type of lines or connectors used to make up a fluid power system, make certain that they are the correct size and strength, and perfectly clean on the inside. Circulatory systems must be absolutely clean and free from scale and other foreign matter. Iron or steel pipes, tubing, and fittings can be cleaned with boiler tube wire brush or with commercial pipe cleaning apparatus. Rust and scale can be removed from short straight pieces by sandblasting, provided there is not danger that sand particles will remain lodged in blind holes or pockets after the piece is flushed. In the case of long pieces or pieces bent to complex shapes, rust and scale can be removed by pickling (cleaning metal in a chemical bath). Parts must be degreased prior to pickling. The manufacturer of the parts should provide complete pickling instructions.

Open ends of pipes, tubing, hose, and fittings should be capped or plugged when they are to be stored for any considerable period. Rags or waste must not be used for this purpose, because they deposit harmful lint which can cause severe damage to the fluid power system.

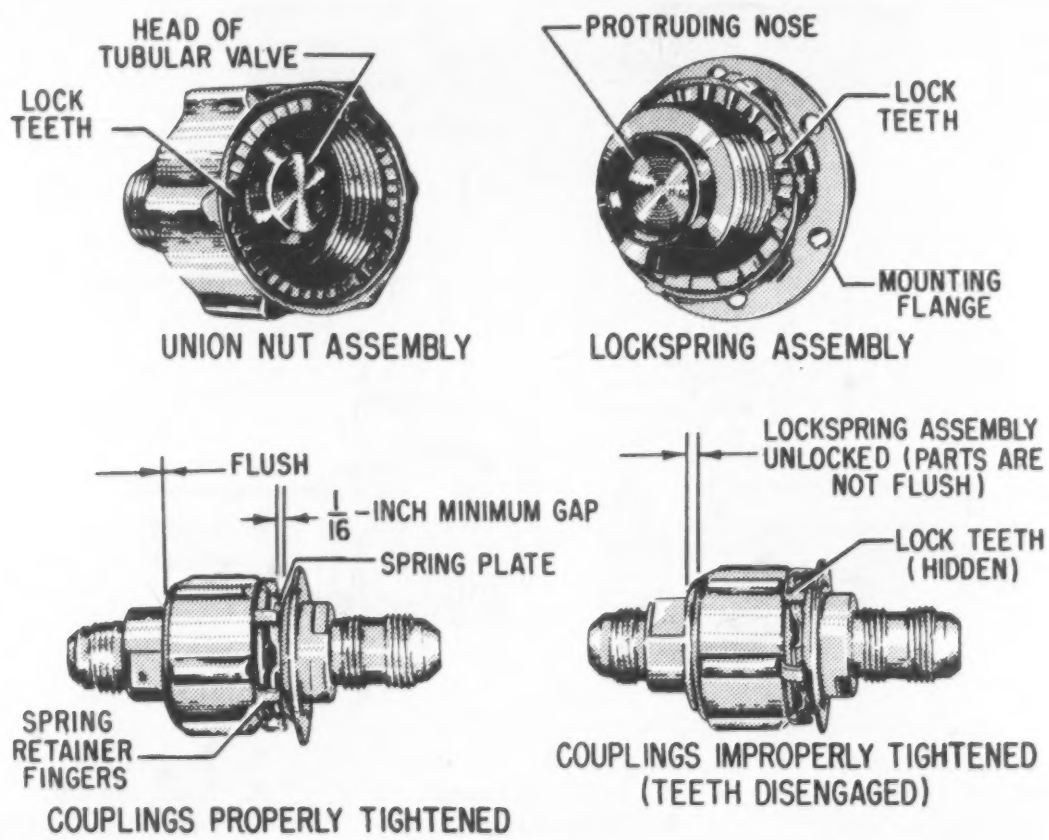

Figure 5-19.—Quick-disconnect coupling properly and improperly tightened.

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CHAPTER 6

RESERVOIRS, STRAINERS, FILTERS, AND ACCUMULATORS

Fluid power systems must have a sufficient supply of noncontaminated fluid for the efficient operation of the systems. The components which provide these requirements for hydraulic systems differ to some extent from the similar components of pneumatic systems. Because of these differences, it is necessary to cover the components separately under each system.

HYDRAULIC SYSTEM COMPONENTS

An adequate supply of the recommended liquid is a very important requirement for the efficient operation of a hydraulic system. The liquid must be kept clean and free of air. The components used to accomplish these requirements are described in the following paragraphs.

RESERVOIRS

The reservoir is a basic component of any hydraulic system. Although its primary function is to provide a storage space for the hydraulic liquid required by the system, a well constructed reservoir provides a number of additional functions. Among these functions are dissipation of heat, trapping of foreign matter, and the separation of air from the system. In most systems the reservoir is a separate component of the system, while in other systems, for example an automatic transmission of an automobile, the reservoir also serves as the housing for the complete system.

Reservoirs dissipate heat by radiation from the external walls or by use of internal or external radiating devices such as cooling coils or fins. The trapping of foreign matter usually requires the use of filters and strainers which are discussed later in this chapter. The separation of air from the system is accomplished by the design of the reservoir which includes the incorporation of baffles to slow the liquid as it returns to the reservoir. The air bubbles have a greater chance of escaping to the surface of the liquid if the liquid moves at a slow velocity.

Many factors are considered when selecting the size and configuration of a hydraulic reservoir. The reservoir must be large enough to store more than the anticipated volume of liquid that the system will require. The recommended reservoir volume is usually based on the gallon-per-minute flow demanded by the system. A reservoir capacity equal to two or three times the maximum rate of flow required by the system is usually sufficient. A higher ratio is desirable for fixed installations, and a somewhat lower ratio may be required for mobile equipment. Adequate space must be allowed to accommodate thermal expansion of the hydraulic liquid and changes in liquid level due to system operation.

Reservoirs are of two general types—nonpressurized and pressurized. Nonpressurized reservoirs are vented to the atmosphere to prevent a vacuum from being formed as the liquid level in the reservoir is lowered. The vent also makes it possible for any air that has entered the system to find a means of escape.

Aircraft and missiles which are designed for high-altitude operation require pressurized reservoirs. Pressurizing assures a positive flow of liquid to the pump at altitudes where low atmospheric pressure is encountered.

Nonpressurized Reservoirs

Hydraulic systems used to operate equipment which is located at or near sea level are normally equipped with nonpressurized reservoirs. This includes the hydraulic systems of ground and ship installations and some aircraft which are limited to low altitude operations.

A typical reservoir for use with ground and ship installations is illustrated in figure 6-1. This type reservoir is made of hot rolled steel

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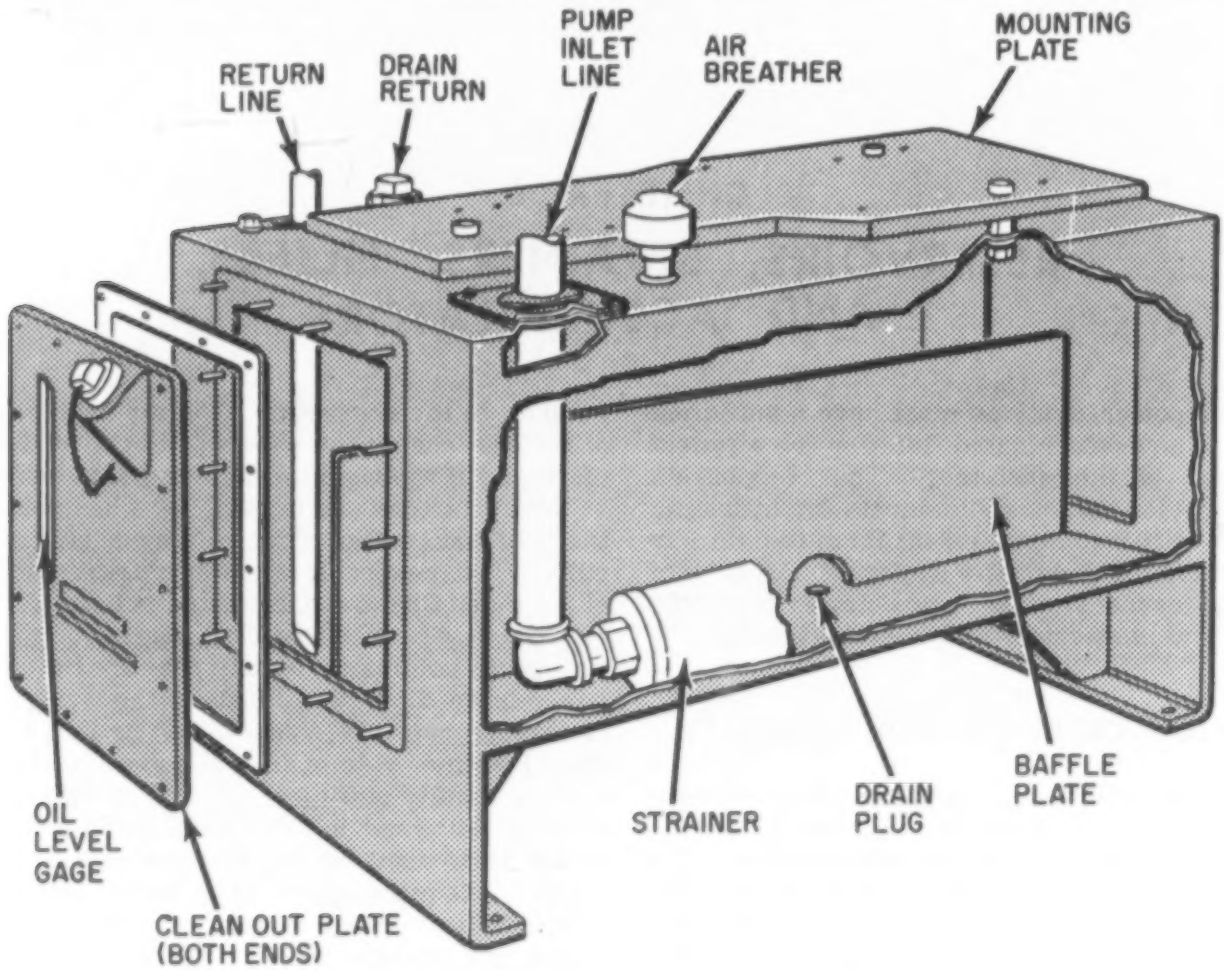

Figure 6-1.—Nonpressurized reservoir (ground or ship installation).

plates and welded joints. The ends of the tank extend below the bottom of the reservoir and serve as the support. The bottom of the reservoir is concave and a drain plug is incorporated at the lowest point.

Large removable covers are installed on each end of the reservoir to provide easy access for cleaning. One of the covers contains a liquid level indicator and a filler opening with a chained cap. Since the liquid level must be checked frequently, the indicator is located in a position where it can easily be read. A strainer is installed in the filler neck to keep foreign matter from entering the reservoir when new liquid is added.

In this type reservoir a baffle plate extends lengthwise through the center of the tank and separates the pump supply line from the system return. The baffle usually extends from the bottom of the tank to approximately two-thirds the height of the normal liquid level. The purpose of the baffle is not to completely divide the reservoir into separate compartments, but rather to reduce turbulence created by return flow and prevent the continuous recirculation of the same liquid. It also allows foreign matter to settle to the bottom of the compartment and air bubbles to escape through the surface of the liquid before the liquid is recirculated.

The vent (air breather) line contains a filter to purify the air. Some vent assemblies contain a bypass check valve. The vent assembly functions to allow the pressure in the reservoir to balance with atmospheric pressure and to filter the air which is drawn in when the liquid level is lowered due to system operation. The check valve allows air to be expelled from the reservoir at a greater rate than normal when large volumes of liquid are returned to the reservoir, and it also prevents unfiltered air from being drawn into the reservoir.

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The pump supply line enters the reservoir at the top and extends to within a few inches of the reservoir bottom. Return lines must be well below the liquid surface level to prevent foaming. The end of the return line is usually cut at an angle of approximately 45 degrees and positioned so that the flow is directed toward the walls of the tank and away from the pump intake line. This provides for maximum heat dissipation.

The inside of the reservoir is painted with a sealer to minimize oxidation which can be caused by condensation. The sealer must be of a composition which will not react chemically with the liquid specified for the system.

Because of the design of this type reservoir, a large portion of the harmful contaminants in the system will accumulate in the reservoir. Therefore, the reservoir should be periodically drained and flushed with a solvent compatible with the liquid being used in the system. After cleaning, the reservoir should be filled to the proper level with clean hydraulic liquid of the type that conforms to the specification to be used in the system. The system must be operated for a few minutes to allow the liquid to displace the air in the system. The liquid level must then be rechecked and more liquid added if necessary. In some systems it is necessary to have air bleed valves to provide a means for trapped air to escape from the system. The automobile brake system is a good example of the use of these bleed valves.

As mentioned earlier in this chapter, some aircraft hydraulic systems are equipped with nonpressurized reservoirs. Figure 6-2 is a typical example of the nonpressurized reservoirs used in aircraft systems. Because of weight limitations required in aircraft construction, the reservoirs are made of welded aluminum alloy. There are two pump supply line outlets—one supplies the main power pump, while the other outlet supplies the emergency pump. The outlet which supplies the main power pump is located a considerable distance above the outlet which supplies the emergency pump. If leakage, such as the result of a ruptured line, occurs during normal operation, a reserve supply of liquid will remain in the reservoir to supply the emergency pump. The reserve supply of liquid should be of sufficient volume to operate the subsystems necessary for a safe landing of the aircraft. This includes such operations as the extension of the landing gear and lowering the landing flaps.

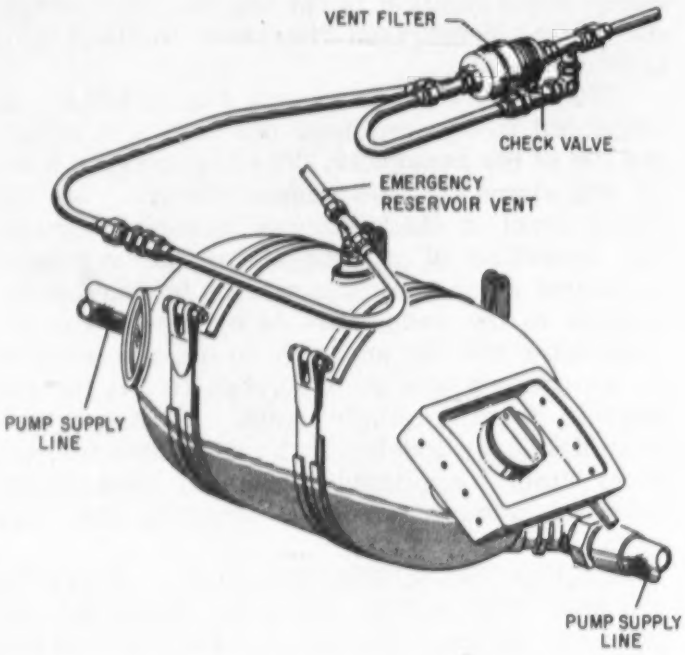

Figure 6-2.—Nonpressurized reservoir (aircraft system).

Maintenance of this reservoir consists mainly of cleaning the filler neck strainer and replacement of the vent filter. The filler neck strainer should be cleaned with a cleaning fluid that is compatible with the liquid used in the system. When cleaning the strainer, inspect for broken mesh (sometimes the result of servicing with a funnel).

The vent filter element should be replaced in accordance with applicable technical publications. Additional information on strainers and filters is presented later in this chapter.

The cleanliness of the reservoir is maintained by periodic flushing similar to the procedures described in chapter 3.

Pressurized Reservoirs

Many of the Navy's aircraft and missile hydraulic systems are equipped with pressurized reservoirs. This assures a positive flow of liquid to the pump at high altitudes where low atmospheric pressures are encountered. There are two common types of pressurized reservoirs—air-pressurized and liquid-pressurized.

AIR-PRESSURIZED.—In the air-pressurized reservoir, air pressure is introduced into the top of the reservoir. The air pressure is

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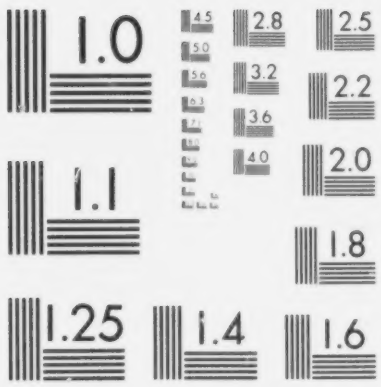

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usually provided by bleed air taken from the compressor section of the engine. An example of an air-pressurized reservoir is illustrated in figure 6-3.

The air is filtered and the pressure is regulated to the required psi before it enters the top of the reservoir. The required pressure is stipulated by the manufacturer. As the liquid level in the reservoir changes (through the operation of a subsystem) the regulator maintains a constant pressure by increasing the airflow to the reservoir, or by venting the excess reservoir air pressure to the atmosphere.

Provisions are incorporated to fill the reservoir from a single point. Filling is accomplished by forcing hydraulic liquid into the filler line. Applicable technical instructions must be adhered to when servicing this type reservoir.

LIQUID-PRESSURIZED.—Some hydraulic systems use system hydraulic pressure for pressurizing the reservoir. A reservoir of this type is shown in figure 6-4. This type reservoir is divided into two compartments by a floating piston. The floating piston is forced downward in the reservoir by a spring and by a pressure probe which fits into the piston.

The pressure probe is connected to the pump pressure line so that when the system is pressurized, pressure enters the probe and aids the springs in pressurizing the liquid in the lower compartment. This pressurizes the pump supply line and the reservoir return line to the same pressure. This pressure prevents pump starvation at all altitudes.

This type reservoir has five ports—pump supply, return, pump pressure, reservoir drain, and overboard drain. Liquid is supplied to the pump through the pump supply port. Liquid returns to the reservoir from the system through the return port. Pressure from the system enters the pressure probe in the top of the reservoir through the pump pressure port. The reservoir drain port is for the purpose of draining the reservoir, when draining is necessary. The overboard drain port is equipped with a sight gage which is used in determining when the reservoir is full. When servicing the reservoir, a container should be placed under the overboard drain port, and liquid should be pumped into the reservoir until air-free liquid flows through the sight gage. (Air-free liquid is liquid containing no air bubbles.)

An indicator rod that protrudes through the top of the reservoir housing is used in determining when the reservoir needs servicing. The word REFILL is stamped on the rod guide. When the reservoir is full, the rod is extended and the word REFILL is hidden; when the rod is retracted, the word REFILL is exposed and the reservoir needs servicing.

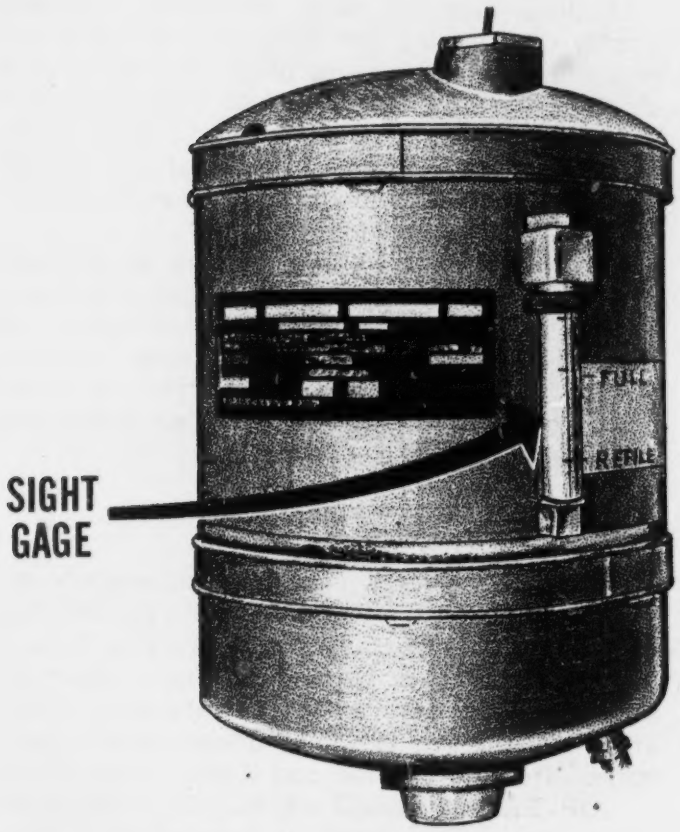

Figure 6-3.—Air-pressurized reservoir.

FILTRATION OF HYDRAULIC LIQUIDS

The importance of keeping hydraulic liquid clean and free of contaminants cannot be overemphasized. Foreign matter in the system can cause excessive wear, increase power loss, clog control valves, and substantially increase maintenance and replacement costs. Although great care is taken while servicing, maintaining, and operating hydraulic systems, it is impossible to prevent some foreign matter from entering the system. Also, tiny particles of metal are deposited in the liquid during the normal wear of valves, pumps, and other system components. Filtering devices are incorporated in hydraulic systems to remove as much of this foreign matter as possible.

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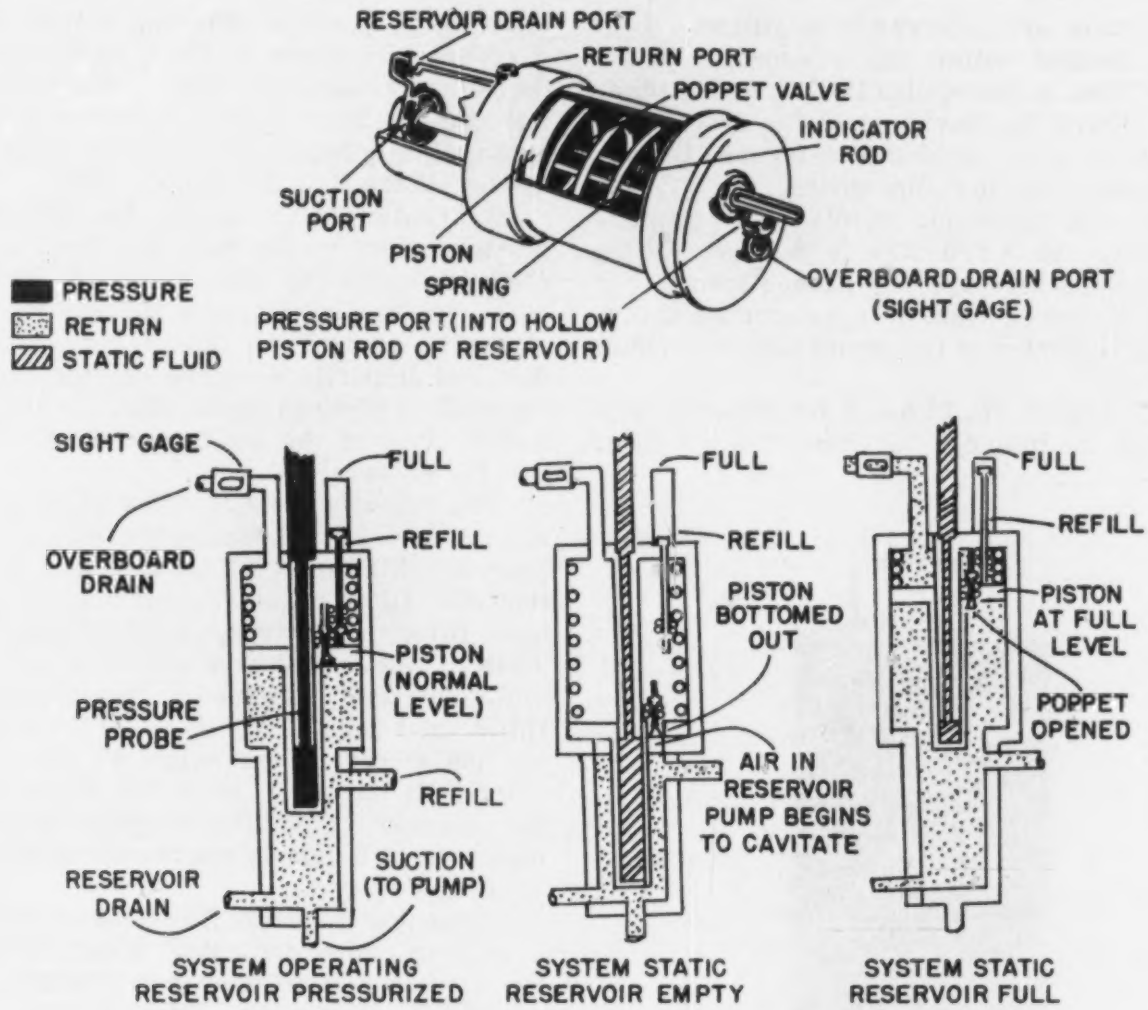

Figure 6-4.—Liquid-pressurized reservoir.

The filtering devices used in hydraulic systems are most commonly referred to as strainers and filters. Since they share a common function, the terms strainer and filter are often used interchangeably. Devices used to remove large particles of foreign matter from hydraulic liquids are normally referred to as strainers, while those used to remove the smallest particles are referred to as filters.

Strainers

Strainers usually consist of a metal frame wrapped with a fine mesh wire screen, or a screening element made up of varying thickness of specially processed wire. A typical strainer is illustrated in figure 6-5.

Strainers do not provide as fine a screening action as filters, but offer less resistance to flow. Therefore, strainers are usually used in pump inlet lines where restriction of flow would result in starvation of the pump. Strainers are also used in the filler necks of some hydraulic reservoirs.

Various arrangements for using strainers in a pump supply line are illustrated in figure 6-6. If one strainer causes excessive restriction of flow to the pump, two or more may be used in parallel as shown. Since strainers must be removed frequently for cleaning, they need only be hand tightened during installation, provided the fittings will remain submerged during the operation of the system. Pump inlet fittings exposed to air must be airtight.

Filters

The most common devices incorporated in hydraulic systems to prevent foreign particles and contaminating substances from remaining

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in the system are referred to as filters. They may be located within the reservoir, in the pressure line, in the return line, or in any other location where the designer of the system decides that they are needed to safeguard the hydraulic system against impurities.

Filters are classified as full flow or proportional flow. In a full flow type filter, all the liquid which enters the unit passes through the filtering element, while in a proportional flow type, only a portion of the liquid passes through the element.

FULL FLOW FILTER.—A full flow filter is illustrated in figure 6-7. This type of filter provides a positive filtering action; however, it offers resistance to flow, particularly when the element becomes dirty. For this reason a full flow filter usually contains a valve to automatically bypass the element when it cannot handle all the flow through the unit.

Figure 6-5.—Typical hydraulic system strainer.

Hydraulic liquid enters the filter through the inlet port in the body and flows around the element inside the filter bowl. Filtering takes place as the liquid passes through the filtering element and into the hollow core, leaving the dirt and impurities on the outside of the filter element. Filtered liquid then flows from the hollow core to the outlet port in the body and into the system.

The bypass pressure relief valve in the body allows the liquid to bypass the filter element and pass directly through the outlet port in the event that the filter element becomes clogged. In most filters of this type, the relief valve will open when a differential pressure of 50 psi has been built up. For example, if the pressure at the filter inlet port is 90 psi, and the pressure at the outlet port drops below 40 psi, the relief valve will open and allow the liquid to bypass the element. Additional information on the operation of relief valves is presented in chapter 10 of this course.

Some nonbypassing filters are equipped with a contamination indicator which works under the principle of difference in pressure between the fluid entering the filter and the pressure after it leaves the element. As contaminating particles collect on the filter element, the differential pressure across the element increases. When the increase in pressure reaches a specific value, an indicator (usually in the filter head) pops out, signifying that the element

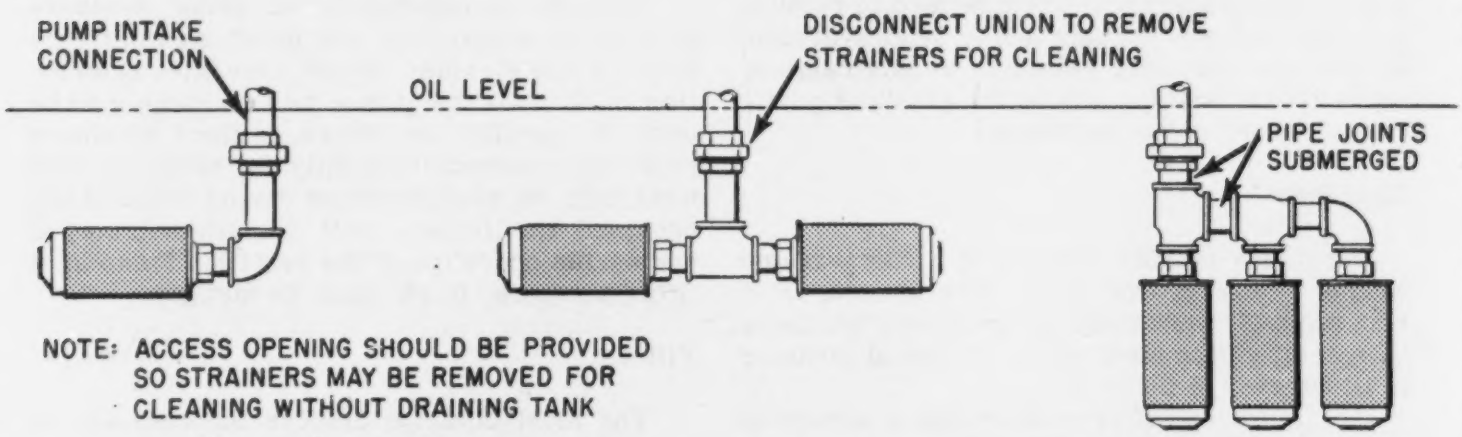

Figure 6-6.—Various arrangements of hydraulic system strainers.

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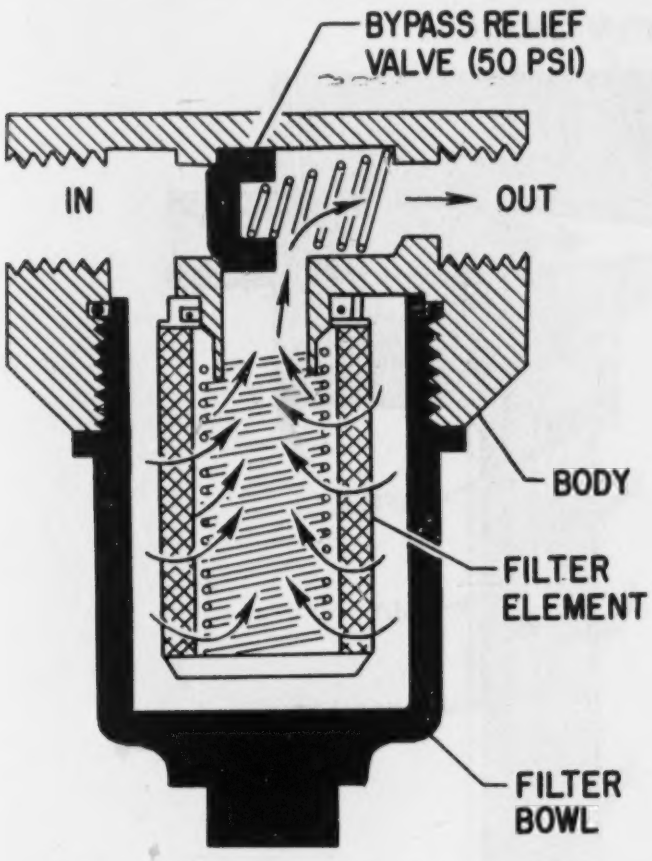

Figure 6-7.—Full flow hydraulic filter.

must be cleaned or replaced. A low temperature lockout feature is incorporated in some types of contamination indicators to prevent actuation below 20° F, and thus eliminate the possibility of false indications due to cold weather.

The use of the nonbypassing type filter eliminates the possibility of contaminated liquid passing the filter element and contaminating the entire system. This type filter will minimize the necessity for flushing the entire system and lessen the possibility of other components in the system to fail.

PROPORTIONAL FLOW FILTER.—Figure 6-8 illustrates a proportional flow type filter. This type of filter operates on the venturi principle. (See glossary.) As the liquid passes through the venturi throat a drop in pressure is created at the narrowest point. This decrease in pressure causes a siphoning action which draws a portion of the liquid down around the cartridge through the filter element and up into the venturi throat. Filtering is provided for either direction of flow. Although only a portion of the liquid is filtered during each cycle, constant recirculation through the system will eventually cause all the liquid to pass through the filter element.

Filter Elements

The effectiveness of any filter is measured by the degree of filtration it produces. Degree of filtration means that a specific filter element will, when new and clean, stop a certain percentage of the particles which measure a certain size or larger, while the liquid is operating under its designed flow conditions.

The unit of measurement used in expressing the degree of filtration is the micron. A micron equals one-millionth of a meter, or 0.00004 inch. For comparison value, consider that the normal lower level of visibility to the naked eye is about 40 microns. (A grain of table salt is about 100 microns in size; the thickness of a human hair is about 70 microns; and a grain of talcum powder is about 10 microns in size.)

Some hydraulic systems require a much finer degree of cleanliness than other systems. This is due to closer tolerances required in some systems, such as the precisely mated parts in the servomechanisms of missiles. Some systems only require that 98 percent of the particles over 100 microns in size are removed, while other systems require that 100 percent of the particles measuring 2 or more microns are removed. The degree of filtration of a filter depends on the material and design of the filter element.

Filter elements are made of various materials, such as cellulose paper (micronic), plastic, porous metal, clay, and fuller's earth. Some of the different types of filter elements are described in the following paragraphs.

FULLER'S EARTH.—Fuller's earth is a clay-like material consisting of very fine particles and is used in the purification of mineral or vegetable base oils. It produces a fine degree of filtration; however, its use as a filtering element in present day hydraulic systems is limited. Filters employing fuller's earth or activated clay should not be used with hydraulic liquids containing additives, because such filters may remove the additives as well as the impurities.

MICRONIC.—Micronic, a term derived from the word micron, could be used to describe any filter element. Through usage, this term has become associated with a specific type filter with a filtering element made of a specially treated cellulose paper. The paper is formed

GLOSSARY

ANTIBIOTIC - a substance produced by a living organism which is antagonistic to another organism.

ASEXUALLY - producing new individuals without sex.

BACTERIA - small rod-shaped, usually single-celled plants micro-organisms 2-4 microns long (a micron is one-thousandth of a millimeter).

BIOTIC - relating to life.

CAUSAL ORGANISM - produces a given disease under a certain set of circumstances.

CHLOROSIS - a yellowing of normally green tissue due to partial failure of chlorophyll to develop.

DEBILITATING - to impair the strength of, to enfeeble.

DELETERIOUS - hurtful, noxious.

DISEASE CYCLE - all the events involved in disease development, including various stages in development of the pathogen and the effect of the disease on the host.

DISSEMINATION - the spread of infectious material.

EPIDEMIC - common to, or affecting at the same time, many in a plant community.

EPIDERMIS - the outermost layer of cells of a leaf or other plant part.

EPIPHYTE - a plant that grows upon another plant which it uses as a mechanical support but not as a source of food.

ETIOLATION - yellowing of plants due to lack of light.

EXUDATE - any material or substance formed inside a plant and discharged through a natural opening or an injury.

FACULTATIVE PARASITE - an organism that can grow either on living or dead organic matter.

FACULTATIVE SAPROPHYTE - an organism which is ordinarily a parasite, but under certain conditions may live saprophytically.

FISSION - a spontaneous division of the body into two or more parts, each of which grows into a complete organism, as in bacteria.

FUMIGANT - a liquid or solid substance that forms vapors which destroy pathogens, insects, etc.

FUNGICIDE - a chemical that kills or inhibits fungi.

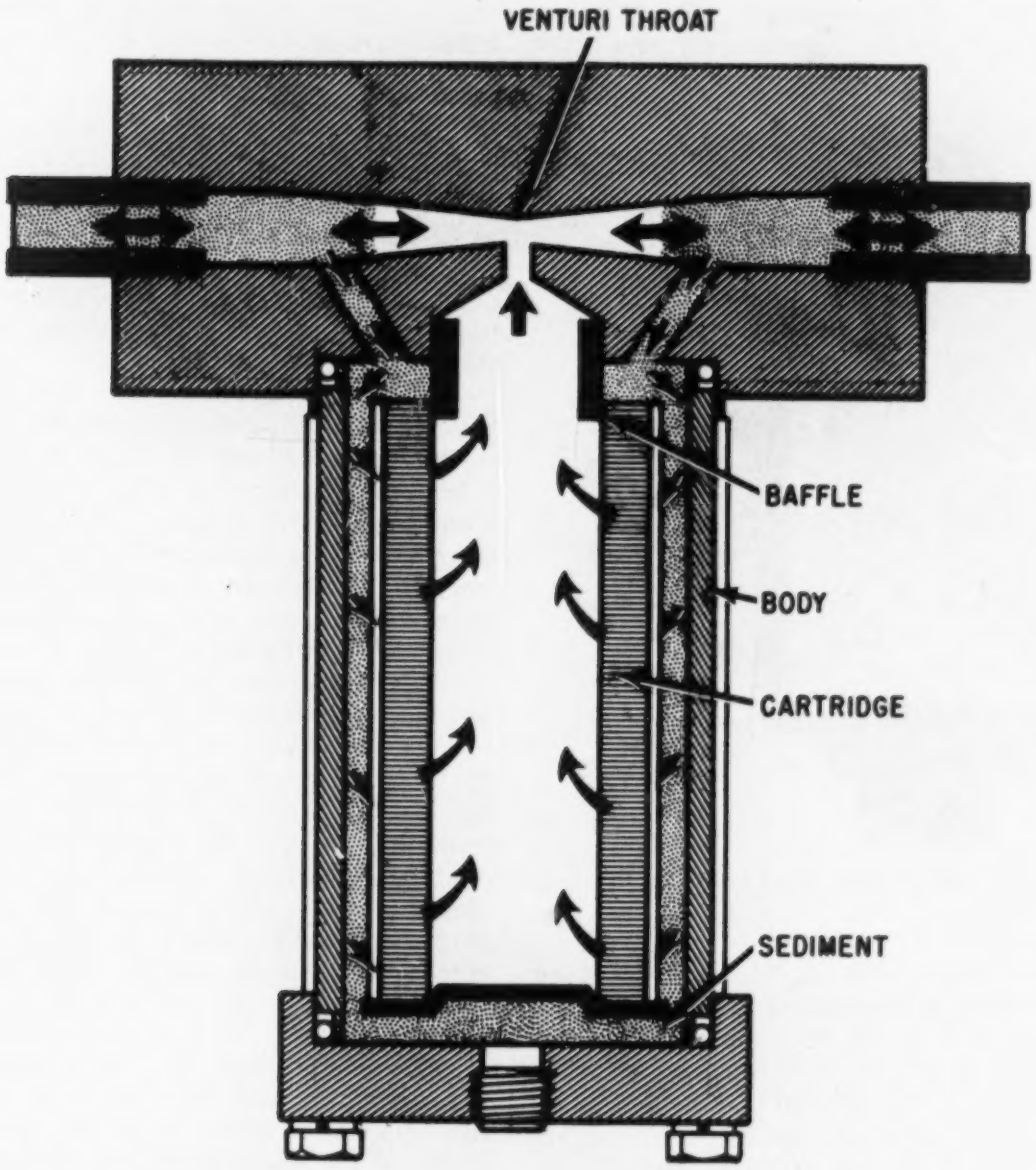

Figure 6-8.—Proportional flow hydraulic filter.

in vertical convolutions (wrinkles) and is made in a cylindrical pattern. (See fig. 6-9.) An internal spring holds the element in shape.

This type element is designed to prevent the passage of 99 percent of solids greater than 10 microns (0.000394 inch) in size. The element in the full flow filter illustrated in figure 6-7 is of this design.

The element is normally thrown away when removed. It is replaced at periodic intervals in accordance with the applicable technical instructions. The element is replaced in the following manner:

1. Relieve system pressure.

2. Remove the bowl from the filter body. In some systems, such as aircraft hydraulic systems, the bowl is safetywired to the body and the wire must be cut for removal.

3. Remove the filter element from the filter body with a slight rocking motion. Do not twist the element.

4. Replace the element with a new one whenever possible. If a new element is not available, the old element may be cleaned, inspected, and reinstalled.

NOTE: A used micronic filter element may be cleaned by masking the element outlet and

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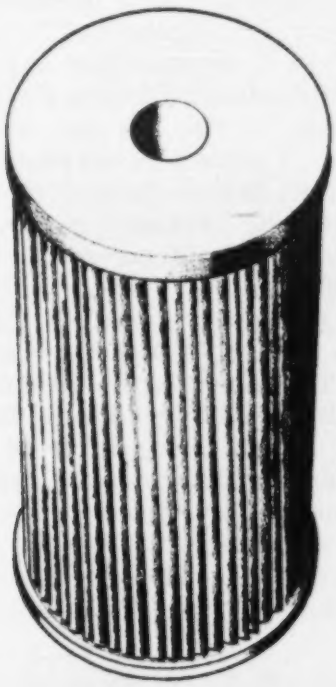

Figure 6-9.—Micronic filter element.

rinsing it with a cleaning solvent which is compatible with the liquid used in the system. After cleaning, inspect carefully to insure that there are no holes in the paper walls of the element.

5. Replace all old O-ring packings and backup washers with new ones.

6. Reinstall the bowl on the head assembly. Do not tighten bowl excessively; handtight is usually sufficient.

7. Pressurize the system and check the filter assembly for leaks. Safetywire if required.

POROUS METAL.—The porous metal element consists of minute metal balls joined together as one solid piece, but still remaining porous. The process of joining the balls is known as the sintered process. The metal used for this element is usually bronze or stainless steel. The element is capable of filtering particles greater than 5 microns, or approximately 0.0002 inch in size.

The design and operation of the porous metal filter is very similar to the micronic filter. Most porous metal filters are equipped with either the bypass relief valve or the contamination indicator described earlier in this chapter.

The porous metal element may be cleaned, tested, and reused. Cleaning is usually accomplished by backflushing clean liquid through the element. Special equipment is used for cleaning and inspection. Current applicable technical instructions must be consulted whenever cleaning and inspection of a porous metal filter element is necessary.

Some hydraulic systems have magnetic filters installed at strategic points. Filters of this type are designed primarily to trap any magnetic metal particles that may be in the system.

ACCUMULATORS

Hydraulic accumulators are incorporated in hydraulic systems to store a volume of liquid under pressure for subsequent conversion into useful work. This potential energy may be in the form of gravitation, the elasticity of springs, or the compressibility of gases.

Dead-Weight Accumulator

The dead-weight or gravity type accumulator represents the earliest form of accumulators and is generally used as a single unit to operate a multiple battery of hydraulic machines.

This accumulator consists of a vertical cylinder with a smoothly ground bore into which is fitted a piston with suitable packing. (See fig. 6-10.) A platform is mounted on top of the piston on which is placed a high density material, such as concrete blocks, metal, or stone. The force of gravity provides energy to force the liquid from the cylinder to the hydraulic system. The main advantage of this type accumulator is the pressure is constant regardless of the amount of liquid in the cylinder as the weight of the material on top of the cylinder remains constant. The main disadvantage of the dead-weight accumulator is its cumbersome size and weight.

Spring-Operated Accumulator

The spring-operated accumulator is similar in principle and design to the dead-weight type, except that spring compression supplies the weight pressure. Figure 6-11 depicts two examples of spring-operated accumulators.

The load characteristics of a spring are such that the energy storage depends on the force required to compress the spring. The uncompressed length of the spring represents zero energy storage.

In this type accumulator the compression resulting from the maximum installed length of the spring or springs should provide the

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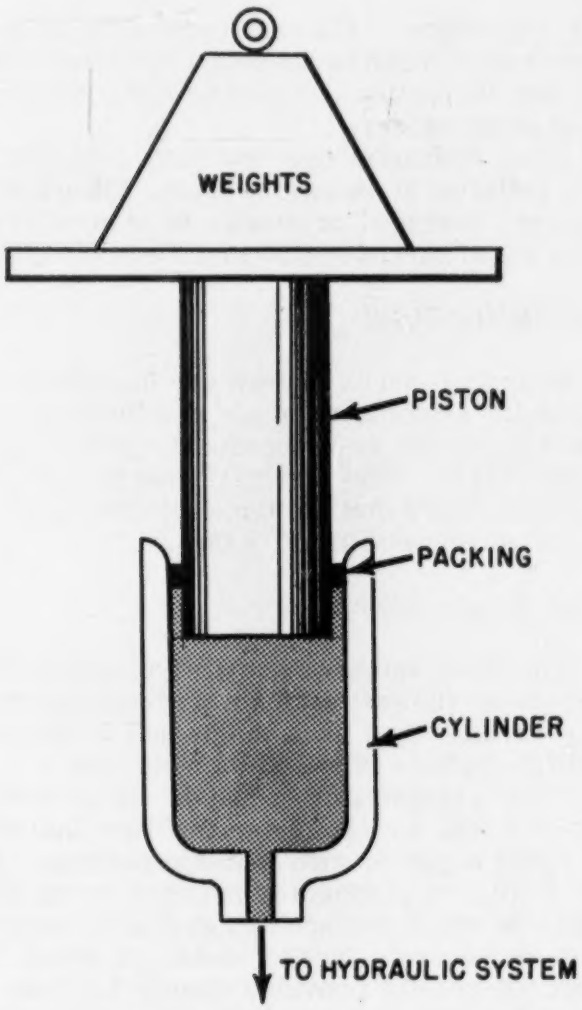

Figure 6-10.—Dead-weight accumulator.

minimum pressure required of the liquid in the cylinder assembly. As liquid is pumped into the cylinder, the piston is forced up and the spring or springs are further compressed, thus providing a reservoir of potential energy for later use.

Air-Operated Accumulators

The air-operated accumulator is often referred to as pneumatic or hydropneumatic accumulator. This type accumulator utilizes compressed gas (usually air or nitrogen) to apply force to the stored liquid. Air-operated accumulators are classified as either separator or nonseparator types.

In the nonseparator type, no means are provided for separating the gas from the liquid. It consists of a fully enclosed cylinder, mounted in a vertical position, containing a liquid inlet port on the bottom and a pneumatic charging port at the top. Figure 6-12 depicts a nonseparator type of air-operated accumulator.

There must be some hydraulic liquid trapped in the bottom of the cylinder when this type accumulator is placed in service. Nitrogen or compressed air is then charged into the top of the cylinder until the pressure is equivalent to the minimum system requirements. As the system forces liquid into the bottom of the cylinder, the gas is further compressed and this compressed gas is then used as the energy medium. Only about 70 percent of the accumulator liquid volume is used in the system, as the remaining space must act as a separator to prevent the gas from entering the hydraulic system.

In the separator type of air-operated accumulator, a means is provided to separate the gas from the liquid. Three types of separators are bladder or bag, diaphragm, and piston (cylinder).

BLADDER OR BAG.—Figure 6-13 illustrates one version of an air-operated accumulator of the bladder type. This accumulator derives its name from the shape of the synthetic rubber bladder or bag which separates the liquid and gas within the accumulator. The accumulator consists of a seamless high-pressure shell, cylindrical in shape with domed ends. The bladder is fully enclosed in the shell and is molded to an air stem in the upper end of the shell. The air stem contains a high-pressure air valve. The bottom end of the shell is sealed with a special plug assembly containing the liquid port and usually a safety feature which makes it impossible to disassemble the accumulator with pressure on the system.

The bladder is larger in diameter at the top and gradually tapers to a smaller diameter at the bottom. The synthetic rubber is thinner at the top of the bladder than at the bottom. The operation of the accumulator is based on Barlow's formula for hoop stress which states: the stress in a circle is directly proportional to its diameter and wall thickness. This means that for a certain wall thickness, a large diameter circle will stretch faster than a small diameter circle; or for a certain diameter, a thin wall hoop will stretch faster than a thick wall hoop. Thus, the bladder will stretch around the top at its largest diameter and thinnest wall thickness, and will gradually stretch downward and push itself outward against the side walls of the shell. As a result it will squeeze out all the

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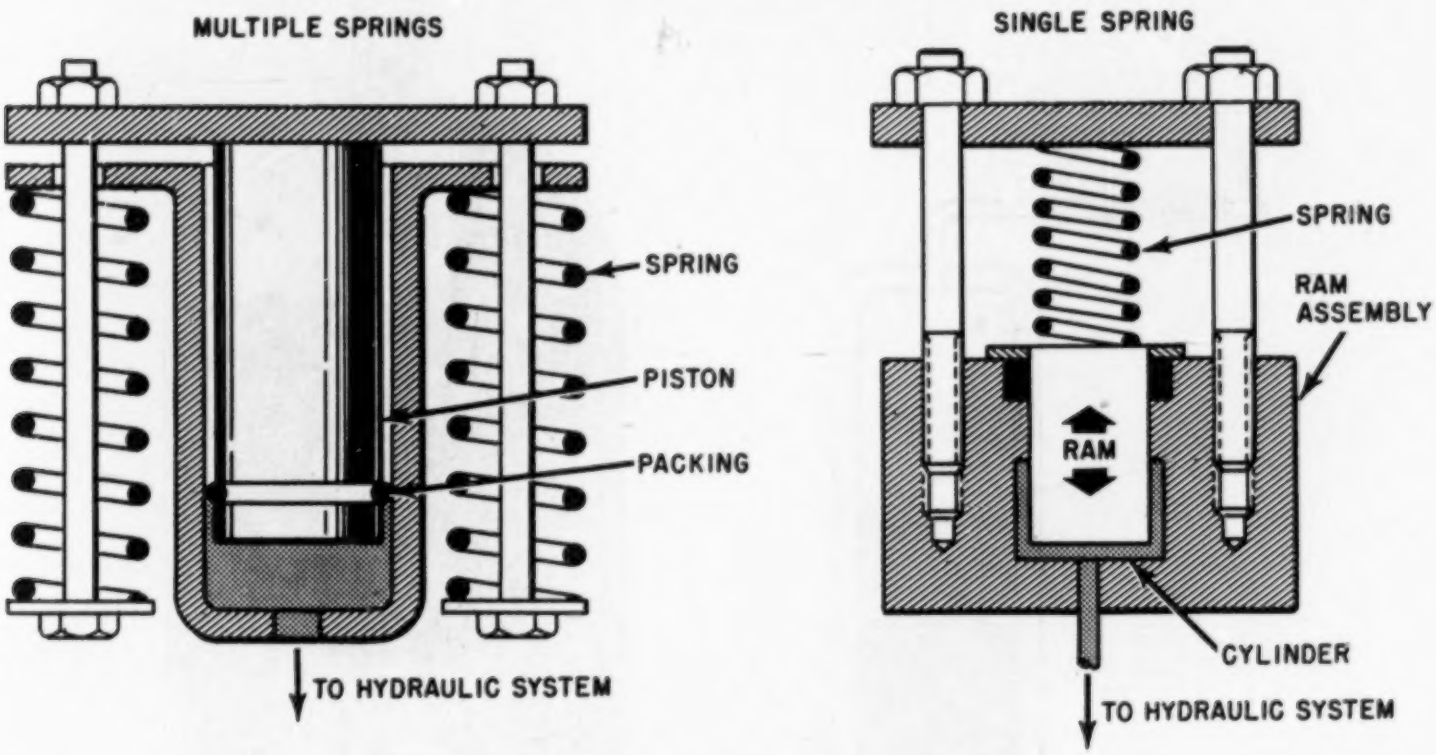

Figure 6-11.—Spring-operated accumulators.

liquid from the accumulator and consequently the bladder accumulator has very high volumetric efficiency. (A high volumetric efficiency is the ability to utilize a large percentage of the stored liquid to do work.)

DIAPHRAGM.—Although there are various modifications of this type accumulator, it is usually spherical in shape. Figure 6-14 illustrates an example of this type. The shell is constructed of two metal hemispheres which are either screwed or bolted together. The fluid and gas chambers are separated by a synthetic rubber diaphragm. An air valve to pressurize the accumulator is located in the gas chamber end of the sphere, and the liquid port to the hydraulic system is located on the other end of the sphere. This accumulator operates very similar to the bladder type.

CYLINDER.—The cylindrical accumulator contains a free-floating piston (fig. 6-15) which separates the air and hydraulic liquid chambers. The cylindrical accumulator consists of a barrel assembly, a piston assembly, and two end cap assemblies. The barrel assembly houses the piston and incorporates provisions for securing the end caps. The piston contains two packings. (See chapter 8 for information about packings.) A drilled passage in the piston provides for lubrication of the seal on the air chamber side.

In operation of the pneumatic type accumulators, the compressed air chamber is inflated with air or nitrogen to a predetermined pressure which is somewhat lower than system pressure. This pressure is stipulated by the system manufacturer. This initial charge of gas is referred to as accumulator preload.

As an example of accumulator operation, assume that an accumulator is designed for a preload of 600 psi in a 1,500 psi system.

The hydraulic system pressure should be zero when the initial charge of 600 psi preload is introduced into the air chamber of the accumulator. Some accumulators are equipped with air pressure gages for checking the preload. When the accumulator is not so equipped, a suitable high-pressure air gage must be installed at the air preload fitting for this purpose. As air pressure is applied through the air pressure port, it moves the separator (bladder, diaphragm, or piston) toward the opposite end. After the accumulator has been preloaded to 600 psi the hydraulic system is operated and the pump will force liquid into the accumulator until the pressure is 1,500 psi (system operating pressure). This compresses the gas until it occupies less than one-half the space that it did at 600 psi.

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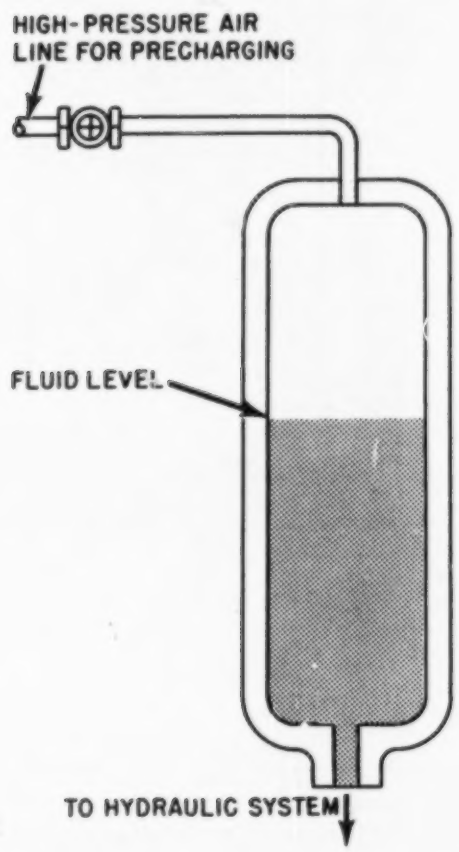

Figure 6-12.—Air-operated accumulator (nonseparator type).

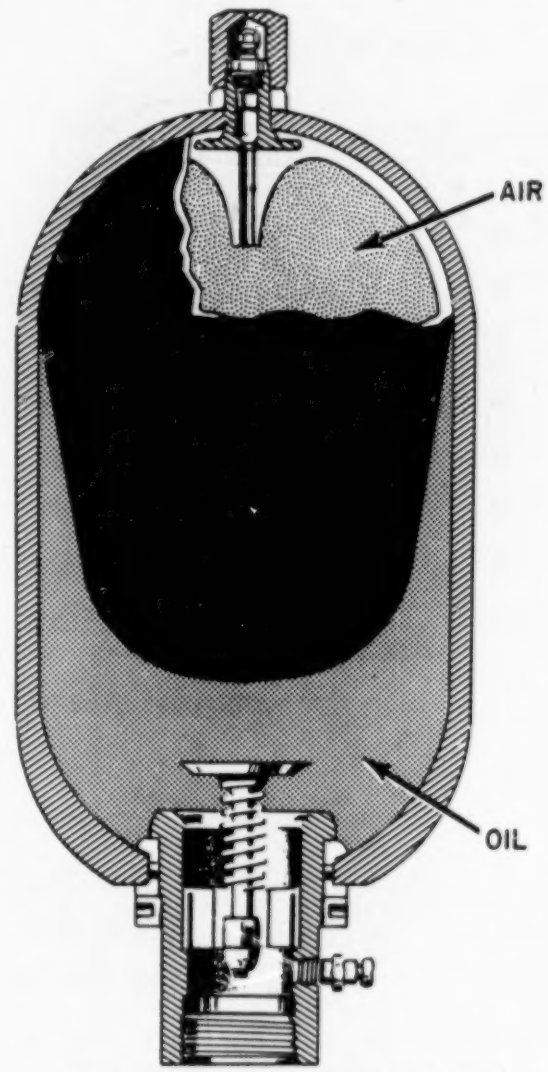

Figure 6-13.—Air-operated bladder type accumulator.

When actuation of hydraulic circuits lowers system pressure, it is evident that the compressed gas will expand against the separator, forcing hydraulic liquid from the accumulator, thus supplying an instantaneous supply of liquid to the hydraulic system.

Pneumatic accumulators should be visually examined for indications of external hydraulic leaks periodically. They should then be examined for external air leaks by brushing the exterior with soapy water, which will form bubbles where the air leaks occur.

The air valve assembly should be loosened to examine the accumulator for internal leaks. If hydraulic liquid comes out of the air valve, it indicates a leak in the separator. This is caused by a ruptured bladder or diaphragm, or by faulty packing on the piston type. As a result the accumulator must be removed, repaired, and reinstalled.

Before removing an accumulator from the system for repairs, all internal pressure must be relieved. The pumps must be turned off and system pressure relieved by actuating some part of the system until all pressure is dissipated. The preload is released by unscrewing the air valve fitting very slowly for approximately two revolutions so that the air or gas will escape gradually.

Applications

Many of the present day hydraulic systems are equipped with one or more accumulators. This storage of liquid under pressure serves several purposes in hydraulic systems, some of which are described briefly in the following

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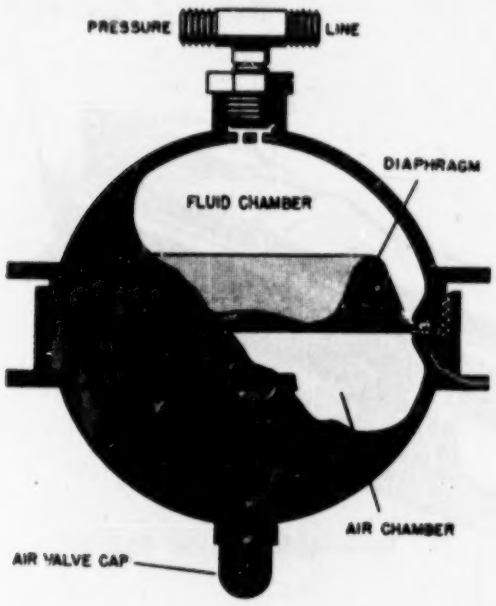

Figure 6-14.—Diaphragm accumulator.

paragraphs. Some of the hydraulic systems illustrated and described in chapter 13 of this course show the applications of accumulators and their relationship to other components of the system.

LEAKAGE COMPENSATOR.—In some operations it is necessary to maintain the hydraulic system under a controlled pressure for a long period of time. It is very difficult to maintain a closed system without some leakage, either external or internal. Even a small leak can decrease the required pressure. By the proper use of an accumulator, this leakage can be compensated for and the pressure maintained within an acceptable range for long periods of time. In the same manner, the accumulator can compensate for thermal expansion and contraction of the liquid due to variations of temperature.

SHOCK ABSORBER.—A liquid, flowing at a high velocity in a pipe, will create a backward surge when stopped suddenly by the closing of a valve and thus develop instantaneous pressures two and three times the operating pressure of the system. This shock will result in objectional noise and vibration which can cause considerable damage to piping, fittings, and components. The incorporation of an accumulator will enable such shock and surges to be absorbed or cushioned by the entrapped gas, thereby reducing their effects. The accumulator will also dampen pressure surges which are caused by the pulsating fluid delivery from the pump.

AID TO PUMP.—There are times when most hydraulic systems require large volumes of liquid for short periods of time. This is due to large cylinders or the necessity of operating two or more circuits simultaneously. It is not economical to incorporate a pump of such capacity in the system for only intermittent usage to supply these applications, particularly if there are sufficient intervals during the working cycle for an accumulator to store up a volume of liquid to aid the pump during these peak demands.

EMERGENCY POWER SUPPLY.—The energy stored in an accumulator may be used to actuate a unit in the event of normal hydraulic system failure. For example, in an aircraft hydraulic system, sufficient energy can be stored in the accumulator for several applications of the wheel brakes.

PNEUMATIC SYSTEM COMPONENTS

Like hydraulic systems, pneumatic systems require an adequate supply of clean fluid for the efficient operation of the system. In addition, the gas used in pneumatic systems must be as free of moisture as possible.

RECEIVERS

Receiver, storage cylinder, air bottle, and air cylinder are all terms used to describe the component of a pneumatic system which provides the functions similar to those provided by the reservoir of a hydraulic system. As described earlier in this chapter, the hydraulic reservoir supplies the liquid to the pump and provides a place for the return liquid from the system. In pneumatic systems the receiver stores a volume of gas under the maximum pressure required by the system and supplies it to the system as needed. In many systems air is forced into the receiver by an air compressor which is part of the system. (See chapter 7 for detailed information about air compressors.) In other systems the receiver is a storage cylinder or bottle which is charged from some outside source.

Receiver is the term usually associated with ground and shipboard pneumatic systems which employ a compressor as part of the system.

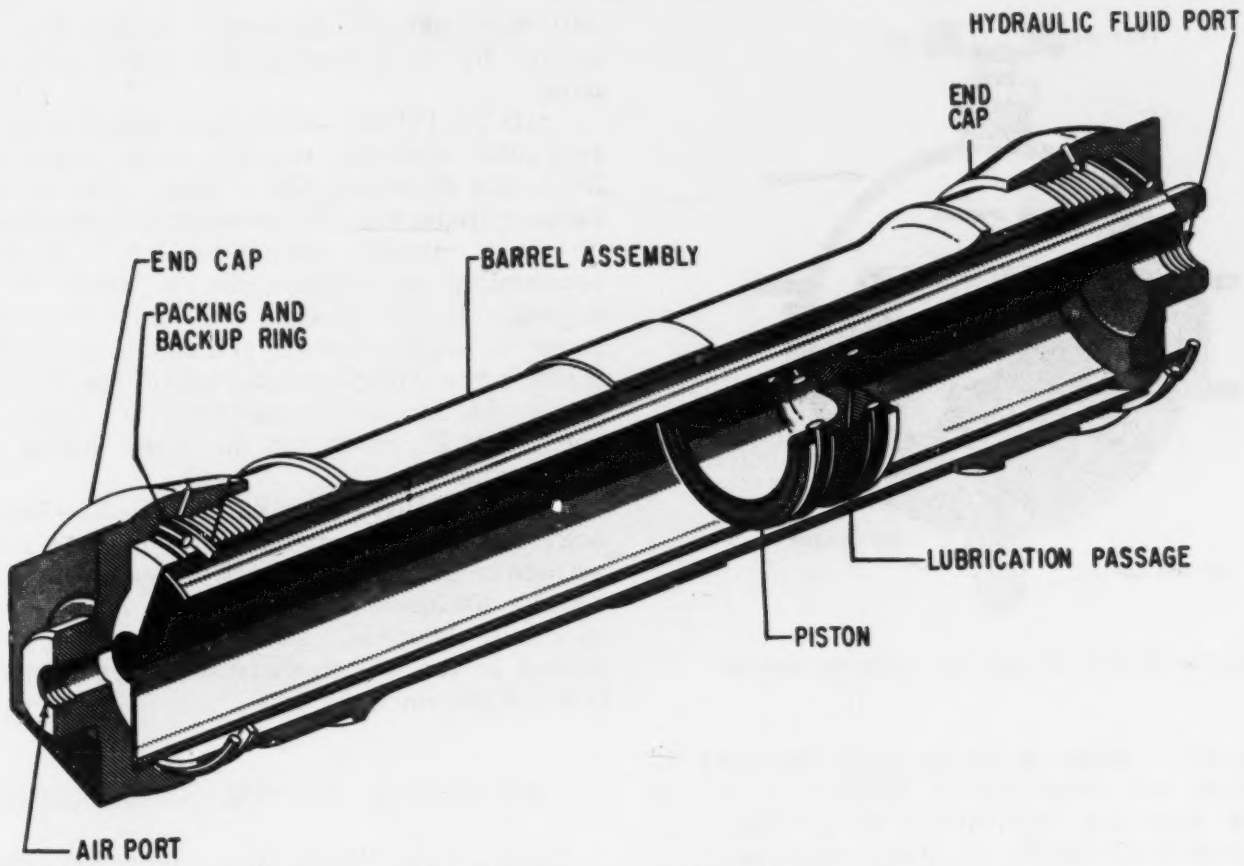

Figure 6-15.—Cylinder (piston) accumulator.

The receiver is located near the compressor and is often considered as part of the compressor.

The receiver acts as a storage tank and also as a supply tank. When the demand for air pressure is in excess of the compressor capacity, some of the air from the receiver enters the system. When the demand is less than the compressor capacity, the excess air enters the receiver. Thus, in a pneumatic system, the receiver functions to maintain the system at a constant pressure and thereby retards the length of the start-stop-start cycles of the compressor.

The size and construction of the receiver depend on the maximum pressure and volume of air required to efficiently operate the complete system. The receiver is cylindrical in shape and may be mounted either horizontally or vertically, the position and location being dependent on the space available for installation. Vertically mounted receivers should have bottom heads of convex shape to permit proper draining of accumulations of moisture, oil, and foreign matter. Each receiver should be fitted with the following accessories and connections:

1. Inlet and outlet connections.
2. Drain connections and valve.
3. Connection for operating line to compressor regulator.
4. Pressure gage.
5. Relief valve.
6. Manhole or handhole plate, depending on size of receiver.

The inlet connection should be located near the top of the receiver and the outlet line to the system taken from a point above the bottom of the receiver. The line between the compressor and receiver should be kept as short and as free from bends as possible in order to eliminate excessive vibration due to the pulsations of air and to reduce loss of pressure due to friction.

The receivers in aircraft pneumatic systems are referred to as storage cylinders or bottles. The compressed air or nitrogen is stored in these cylinders until required by actuating the system. The cylinders are initially charged with compressed air or nitrogen from an external source. Most systems contain air compressors which replace the pressure and volume

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lost through leakage, thermal expansion, and system operation.

The storage cylinders are either spherical or cylindrical in shape. The cylinders are nonshatterable and each is equipped with a manual moisture drain valve for periodic draining of the moisture or bleeding air from the cylinder. Cylinders are provided in different sizes the selection of which depends on the requirements of the system. The required size is stipulated by the manufacturer of the system. The unit of measurement to indicate the volume of cylinders is the cubic inch. The pressure normally required in aircraft pneumatic systems is 3,000 psi. Figure 6-16 illustrates an example of a storage cylinder used in an aircraft pneumatic system.

FILTRATION OF PNEUMATIC GASES

Clean, dry gas is required for the efficient operation of pneumatic systems. Free air, satisfying these requirements adequately, is seldom found. The atmosphere contains dust and impurities in various amounts, depending on the locality. Also, the atmosphere generally contains a substantial amount of moisture in vapor form.

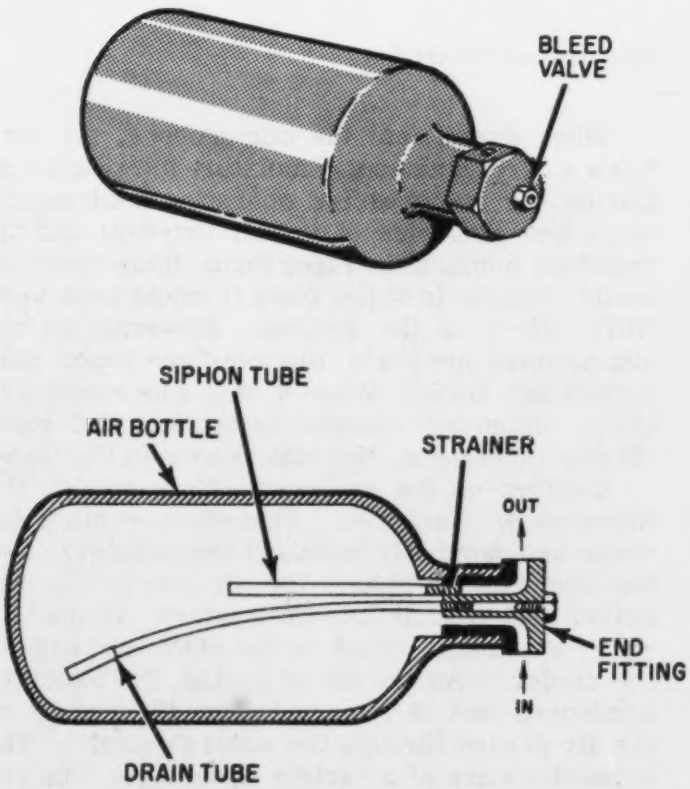

Figure 6-16.—Storage cylinder for an aircraft pneumatic system.

Solids, such as dust, rust, or pipe scale in pneumatic systems may lead to excessive wear, failure of components, or in some cases prevent the pneumatic devices from operating. Moisture is also very harmful to the system. It washes lubrication from moving parts, thereby aiding corrosion and causing excessive wear of components. Moisture will also settle in low spots in the system and freeze during cold weather, causing stoppages of the system or rupture of transmission lines.

As discussed in chapter 3, the use of nitrogen decreases these hazards to some extent. However, it is not economically feasible to use nitrogen, except in small systems.

An ideal filter would remove all dirt and moisture from a pneumatic system without causing a pressure drop in the process. Obviously, such a condition can only be approached; it cannot be attained.

Removal of Solids

Air filters are similar in design and operation to the hydraulic filters discussed earlier in this chapter. Some materials used in the manufacture of elements for air filters are woven screen wire, steel wool, fiber glass, and felt fabrics. Elements made of these materials are often used in the units that filter the air as it enters the compressors. They are used in the same manner as carburetor filters on automobiles. These filters must be checked frequently for the accumulation of foreign matter and the elements cleaned and replaced as necessary. If the filter element becomes clogged, the compressor is reduced in efficiency or, in extreme cases, becomes inoperative. Filters of this type are usually designed to remove particles as small as 25 microns.

Porous metals and ceramic elements are used in filters which are installed in the compressed air supply lines. These filters also use a controlled airpath to provide some filtration. Internal design causes the air to flow in a centrifugal path within the bowl. (See fig. 6-17.) Heavy particles and water droplets are thrown out from the airstream and drop to the bottom

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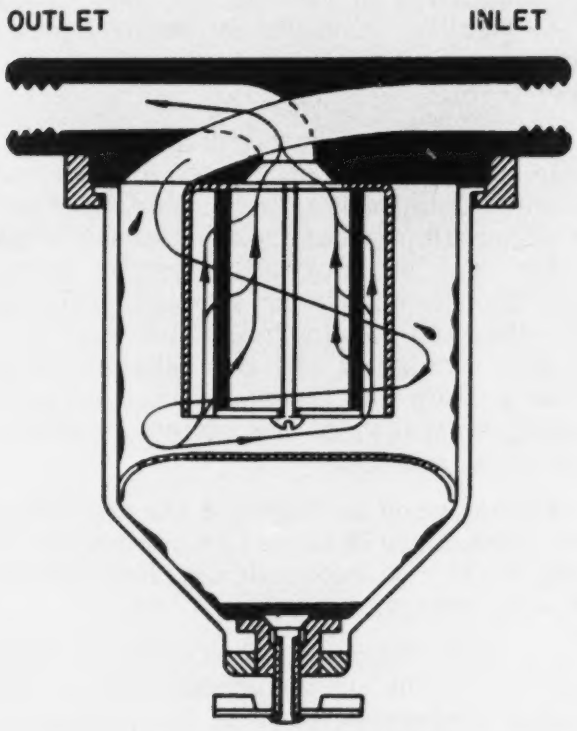

Figure 6-17.—Air filter.

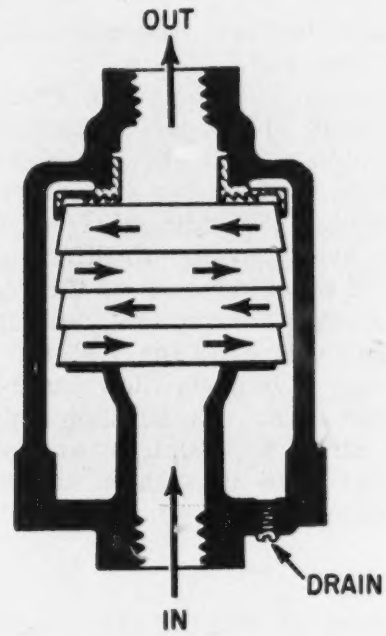

Figure 6-18.—Air filter using rotating blades as element.

of the bowl. The air then flows through the filter element, which filters out most of the smaller particles. The filter is designed with a drain valve at the bottom of the bowl. When the valve is opened with air pressure on the system, the accumulation of solids and water will be blown out of the bowl. Many air filters have transparent bowls so that accumulation of impurities can be seen. Some units provide for automatic drainage.

An air filter which employs moving mechanical devices as an element is illustrated in figure 6-18. As the compressed air passes through the filter the force revolves a number of multiblade rotors at high speed. Moisture and dirt are caught on the blades of the rotors. The whirling blades hurl the impurities by centrifugal force to the outer rims of the rotors and to the inner walls of the filter housing. Here, contaminating matter is out of the airstream and falls to the bottom of the bowl where it must be drained at periodic intervals.

The removal of solids from pneumatic systems is generally accomplished either by screening, centrifugal force, or a combination of the two. Design features of these filters may vary, but the principles of operation remain the same. To maintain their efficiency, filters must be cleaned or replaced as often as operating conditions require.

Removal of Moisture

When drawn into the compressor, air contains a certain amount of moisture in vapor form. During the compression operation the temperature and pressure of the air increase and the moisture remains in vapor form. If the moisture would remain in vapor form it would have very little effect on the system. However, as the compressed air cools, the moisture vapor condenses into water. When it is in this condensed state, moisture causes corrosion and rust, dilutes lubricants, and may freeze in the lines.

Cooling of the compressed air causes the moisture to condense. Therefore, cooling devices are normally installed immediately after the compressor before the air enters the receiver and goes on into the system. There is a water separator fitted on the discharge side of the cooler. As the air is cooled, the moisture condenses and is removed from the system as the air passes through the water separator. The separators are of a variety of designs. The removal of liquid is accomplished by centrifugal force, impact, or sudden changes in velocity of the air-stream. Many water separators are

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similar in design and operation to the air filter illustrated in figure 6-18.

Chemical driers are incorporated in some pneumatic systems. Their purpose is to absorb any moisture that may collect in the lines after the moisture separator. Each drier contains a cartridge of an absorbent chemical such as silica-gel. The cartridge should be blue in color. If otherwise noted, the cartridge is to be considered contaminated with moisture and should be replaced.

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FUNGUS - a group of plants lacking chlorophyll, reproducing by sexual or asexual spores, and consisting primarily of mycelium.

GALL - a pronounced localized swelling; an outgrowth, often more or less spherical, consisting of unorganized cells.

GERM TUBE - the thread-like filament (hypha) produced by a fungus spore when it begins to grow.

GERMICIDE - a substance that kills micro-organisms.

GERMINATION - the beginning of growth.

HERBICIDE - a chemical that kills or inhibits green plants.

HOST - the plant which is invaded or parasitized by a disease-producing agent from which the parasite obtains its sustenance.

HOST RANGE - the various kinds of plants that a particular parasite may affect.

HYBRIDIZATION - to produce or cause to produce hybrids.

HYPERPLASIA - abnormal increase in the number of cells resulting in the formation of galls or tumors.

HYPERTROPHY - abnormal increase in the size of an organ or tissue brought about by the enlargement of the cells or by an increased cell division or both.

HYPHA - one of the thread-like strands, or filaments, that constitute the body (mycelium) of a fungus.

HYPOPLASIA - undergrowth, stunting or dwarfing.

IMMUNITY - the ability of a plant to remain free from a disease by virtue of inherent properties of the plant.

IMMUNIZATION - to render immune.

INCUBATION PERIOD - the period of time between the inoculation of a plant by a disease producing agent and the appearance of symptoms.

INFECTION - to become established in a parasitic relationship with a host plant.

INFESTATION - the presence of disease in a population of plants or of pathogens where they can produce a disease.

INGRESS - to gain entrance into plant tissue.

INOCULATE - to bring infectious material (the inoculum) in contact with a host plant.

INOCULUM - infectious material, disease producing substance.

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CHAPTER 7

PUMPS AND COMPRESSORS

The heart of any fluid power system is the component which generates the force required by the fluid to move the actuating devices. Pumps are utilized to provide this requirement in hydraulic systems; while compressors are used in pneumatic systems. Although pumps and compressors serve a similar purpose, the principles of operation and the design differ to some extent. Due to these differences, the two components are discussed separately in this chapter.

PUMPS

Pumps are used for a number of essential services in the Navy. Pumps supply water to the boilers, draw condensation from condensers, supply sea water to the firemain, circulate cooling water for coolers and condensers, pump out bilges, transfer fuel oil, supply water to the distilling plants, and serve many other purposes. Although the pumps discussed in this chapter are those used in hydraulic systems, the principles of operation of the different types apply to the pumps used in other systems.

PURPOSE

Hydraulic pumps are devices for converting mechanical energy into hydraulic energy. Many different sources are used to provide the mechanical energy to the pumps. Electric motors, air motors, and gasoline engines are all used as a source of power to operate hydraulic pumps. Some pumps are manually operated. Many of the pumps in aircraft hydraulic systems are attached to and driven by the engine.

The purpose of a hydraulic pump is to supply a flow of liquid to the hydraulic system. A pump does not create pressure. As it provides flow, the pump transmits a force to the liquid. Although the force is generated by the pump, it is not controlled by the pump. Pressure can be created only by a restriction to the flow of liquid from the pump. The pressure is controlled by the load imposed on the system or the action of a pressure regulating device.

In order for a pump to create a flow of liquid to the outlet port and into the system it must have a continuous supply of liquid available to the inlet port. Atmospheric pressure (discussed in chapter 2) plays an important role in the supply of liquid to the inlet port. If the pump is located below the reservoir, the force of gravity supplements atmospheric pressure. However, in most systems the pump is located above the reservoir. Aircraft and missiles which operate at high altitudes are equipped with pressurized hydraulic reservoirs (see chapter 6) to compensate for low atmospheric pressure encountered at high altitudes.

As the pump forces liquid through the outlet port, a suction is created at the inlet port. Suction is defined as a partial vacuum or low-pressure area. This low-pressure area contains a pressure lower than the atmospheric pressure (approximately 14.7 psi at sea level). When the pressure at the inlet port of the pump is lower than the local atmospheric pressure, the atmospheric pressure acting on the liquid in the reservoir forces the liquid into the pump.

PUMP PERFORMANCE

Pumps are normally rated in terms of volumetric output and pressure. The volumetric output is the amount of liquid the pump can deliver to its outlet port in a certain period of time at a given speed. Volumetric output is usually expressed in gallons per minute (gpm). Changes in pump speed affect volumetric output. Therefore, some pumps are rated according to displacement at a certain pressure. Pump displacement is the amount of liquid a pump can

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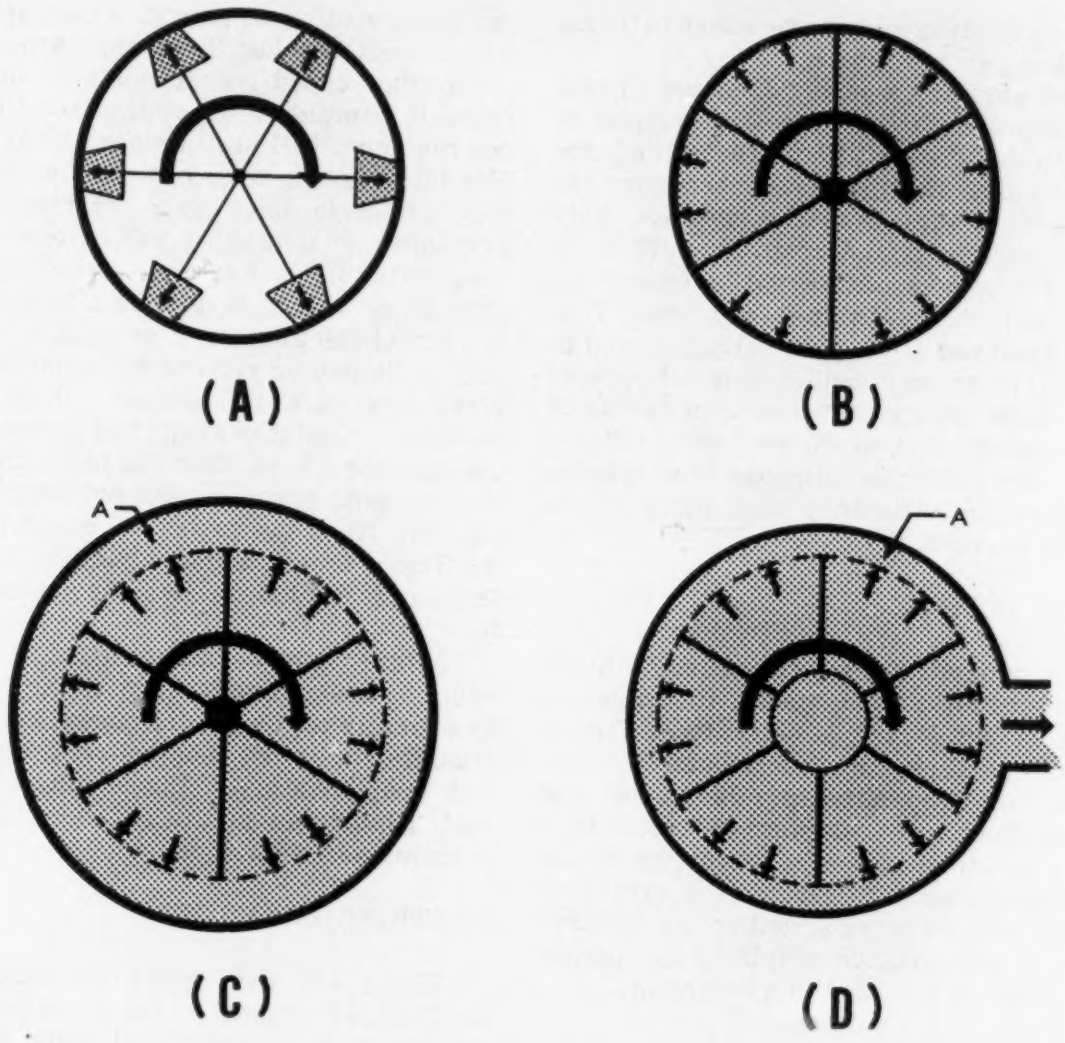

Figure 7-1.—Centrifugal force.

If the buckets are shaped like pieces of pie, and they completely fill the circle, as shown in figure 7-1 (B), then the buckets will act as a paddle wheel revolving in a drum-shaped container. The result is a continuous liquid pressure due to the centrifugal force over all circumference of the container. The pressure is the result of the restriction to the flow of the liquid caused by the walls of the container.

By enlarging the diameter of the container (fig. 7-1 (C)), a space (A) is created for liquid between the ends of the paddles and the drum. The rotation of the liquid in the buckets, because of centrifugal force, pushes outward against the liquid bottom and thereby imparts a pressure to the liquid in space (A). If the liquid remains stationary—which would not actually be the case in practice—then it would be subjected to a true static pressure the magnitude of which would be dependent upon the centrifugal force of the liquid between the paddles.

If an opening were provided in the containing drum, this force would cause the liquid in space (A) to be discharged. If the liquid in space (A) were stationary, this discharge could take any direction because, according to Pascal's law, static pressure in a fluid is transmitted equally in all directions. In practice, however, another factor must be considered which determines the direction of discharge. This factor is explained shortly.

If a means for continuously filling the bucket is provided, such as a central opening in the container, and a source of power to rotate the paddles is provided, then a continuous flow, as shown in figure 7-1 (D), exists. This demonstrates one of the principles which applies to the operation of the centrifugal pump.

When a force which is compelling an object to move in a curved path is removed, the object will travel in a straight line with the speed and direction it had at the instant the force is removed. This is illustrated in figure 7-2. An object is attached to a line (R) and swung around in a circular path. Assume that the line breaks when it reaches the vertical position shown. The object will then fly off horizontally (at right angles to the line) with the velocity it had at that moment. This horizontal path will be tangent to the circular path the object was following up to this moment, so this action is commonly called "going off on a tangent", while the velocity is called tangential velocity.

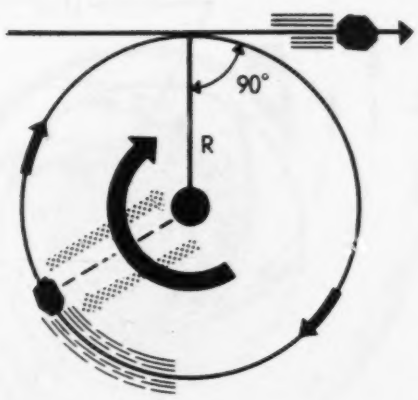

Figure 7-2.—Tangential velocity.

This is the principle of the old fashioned sling shot, in which a man placed a stone in a leather holder to which two strings were attached, swung it around his head to impart velocity, and then let go one of the strings. This principle is utilized in the centrifugal pump in addition to the outward action of centrifugal force previously described.

Referring to figure 7-1 (D), it is clear that as soon as some of the liquid in space (A) is permitted to escape, a continuous suction or low-pressure area will be set up in the center opening. (This center opening is commonly referred to as the eye.) Atmospheric pressure or gravity force acting on the liquid in the reservoir will force liquid to the eye of the container. The blades or paddles will then start rotating the liquid. As the liquid in space (A) flows out of the container, the liquid between the blades will move out to a greater and greater radius. In so doing it will acquire an increasing tangential velocity, because the angular velocity of the blades is constant, and as the radius of the path circle increases, the liquid must travel a greater distance per revolution. Eventually, it will reach the tip of the blades and enter space (A), which is equivalent to "going off on a tangent" as described earlier. The liquid will also tend to continue moving directly outward from the center of the circle because of its inertia. (See glossary.) The two actions—centrifugal and tangential—are then combined.

This liquid which is thrown off the tips of the blades has a velocity equal to the tangential velocity it had the instant it left them. The two actions—centrifugal force and tangential velocity—cause the liquid to flow out of the discharge port.

Since it is part of the meaning of velocity that it have direction (see chapter 2), the direction in which the discharge takes place becomes important. In order to make the most use of the velocity, the discharge is generally in an approximately tangential direction.

The liquid is thrown off the paddles, or impeller blades, as they are called in the pump, all around the circle. Therefore, liquid is being added to the space (A) at all points, but is escaping from it at only one point. In order to compensate for this, it is customary to increase the area of space (A) as the outlet is approached. By this means it is also possible to slow down the tangential velocity at a more gradual rate, and thereby obtain more efficient conversion of the velocity in the pump into flow to the system. Therefore, it is customary to give space (A) a shape like that shown in figure 7-3. This shape—called a volute—continuously expands in a definite ratio. The details of the size and shape of the volute used are very important to the efficiency of the pump, as are likewise the exact shape, size, and speed of rotation of the impeller. In general, it is true that impeller blades that curve backward with respect to their direction of rotation give better results than straight blades, but the reasons for this and for other details of construction are matters which concern the designer primarily, and are outside, the scope of this course.

Types

The two most common types of centrifugal pumps used in hydraulic systems are the volute

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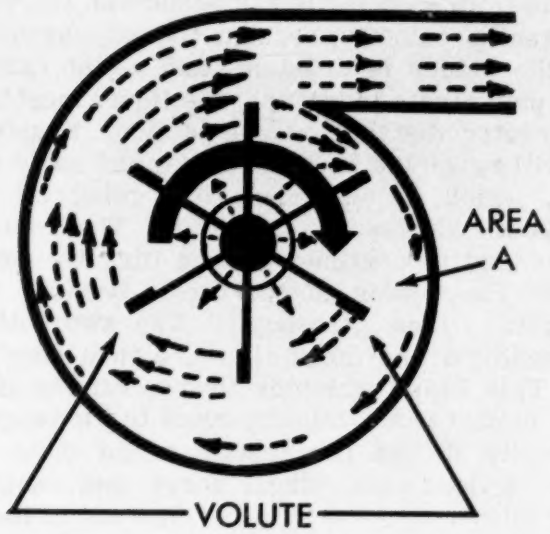

Figure 7-3.—Basic elements of a centrifugal pump.

and diffuser types. In both types flow is provided by the action of centrifugal force. At the same time the rotation of the impeller produces the greater part of the velocity which drives the liquid out through the discharge. The major differences between these two types are described in the following paragraphs.

VOLUTE TYPE.—Figure 7-4 illustrates the principles of operation of a volute type centrifugal pump. The impeller discharges the liquid at a high velocity into a progressively expanding casing. This contour of the casing directs the movement of the liquid through the outlet port and into the system.

DIFFUSER TYPE.—Figure 7-5 illustrates the diffuser type pump. It is similar in design to the volute pump, with the addition of a series of stationary blades incorporated around the outside circumference of the impeller blades. These stationary blades are termed the diffuser. The diffuser blades are curved in the opposite direction from the rotating impeller blades. The diffuser reduces the velocity of the liquid and decreases slippage (previously described), which increases the efficiency of the pump.

Classification

Centrifugal pumps are classified in several ways. For example, they may be either single-stage or multistage. A single-stage pump has only one impeller. A multistage pump has two or more impellers housed together in one casing.

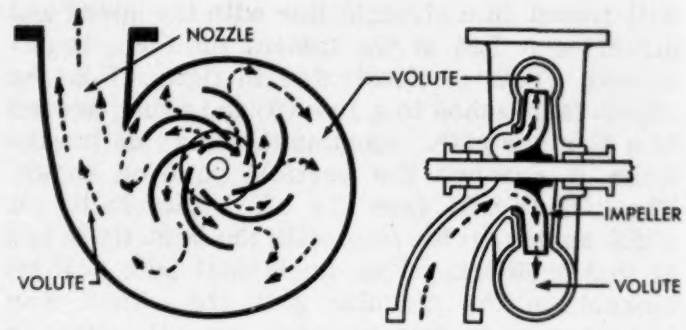

Figure 7-4.—Volute type centrifugal pump.

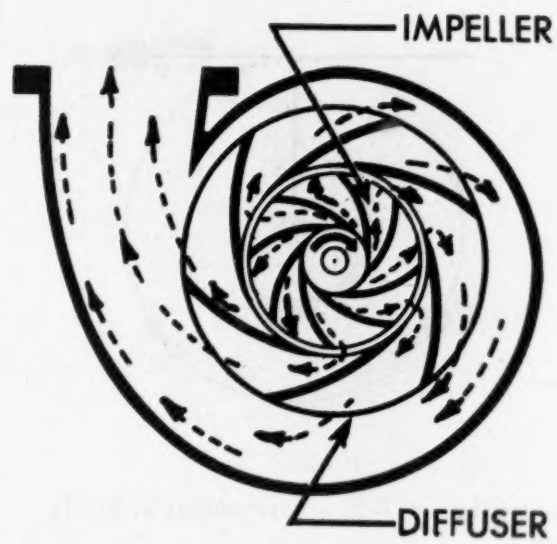

Figure 7-5.—Diffuser type centrifugal pump.

As a rule, each impeller acts separately, discharging to the suction of the next stage impeller. For the sake of compactness the several impellers of multistage pumps are almost invariably placed on one shaft. Figure 7-6 shows a possible flow diagram for a four-stage pump.

Centrifugal pumps are also classified as horizontal or vertical, depending upon the position of the pump shaft.

The impellers used on centrifugal pumps may be classified as single-suction or double-suction. The single-suction impeller allows liquid to enter the eye from one direction only; the double-suction type allows liquid to enter the eye from two directions. Impellers are also classified as CLOSED or OPEN. Closed

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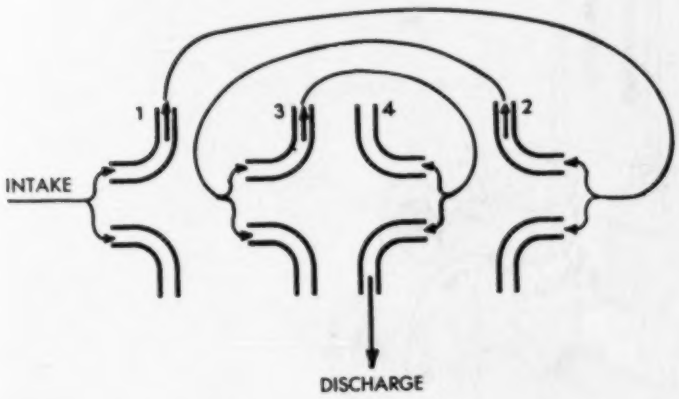

Figure 7-6.—Flow diagram of a four-stage centrifugal pump.

impellers have side walls which extend from the eye to the outer edge of the blade tips; open impellers do not have these side walls.

Manufacturers sometimes classify centrifugal pumps according to the size and shape of the casing, arrangement of the discharge nozzle in relation to the pumping chamber, and the type of material used in the construction of the pump.

Centrifugal pumps may be driven by any of the sources mentioned previously in this chapter. Many of the pumps aboard ship are driven by steam turbines. As a rule, high-pressure centrifugal pumps are direct-drive—that is, the impeller rotates at the same rpm as the power source. However, some low-pressure centrifugal pumps have reduction gears installed between the power source and the impeller. This allows the power source to operate at a high speed and the impeller to operate at a lower speed, thus obtaining maximum efficiency from both the power source and the pump.

Applications

Centrigual pumps are nonpositive displacement pumps. They are used in hydraulic systems which require a large volume of flow and operate at relatively low pressures. Some hydraulic systems require variations of flow and pressure. A centrifugal pump is sometimes used in combination with a positive displacement pump to supply the demands of such systems. The positive displacement pump maintains the system during periods requiring low volume and high pressure. The centrifugal pump aids the positive displacement pump when the system requires large volumes and low pressure.

In some hydraulic systems a centrifugal pump is used with a variable displacement pump. Both pumps are driven by the same electric motor. The motor is fully enclosed and is cooled by a flow of liquid from the centrifugal pump. The centrifugal pump also provides a supply of liquid to the inlet port of the variable displacement pump. This insures an adequate supply of liquid to the main system pump (variable displacement) for all demands of the system.

ROTARY PUMPS

All rotary pumps work by means of rotating parts which trap the fluid at the suction side and force it through the discharge outlet. Gears, screws, lobes, vanes, and cam-and-plunger arrangements are commonly used as elements in rotary pumps. Rotary pumps operate on the positive displacement principle—that is, each rotation or each stroke delivers a definite quantity of liquid.

Rotary pumps are designed with very small clearances between rotating parts and between rotating parts and stationary parts, in order to minimize slippage from the discharge side back to the suction side. Rotary pumps are designed to operate at relatively moderate speeds in order to maintain these clearances. Operation at higher speeds causes erosion and excessive wear, resulting in increased clearances.

Classification

Like centrifugal pumps, there are numerous types of rotary pumps and various methods of classification. They may be classified as to shaft positions—either vertically or horizontally mounted; the type of drive—electric motor, gasoline engine, etc.; manufacturer's name; or service application. However, classification of rotary pumps is generally made according to the type of rotating element. A few of the most common types of rotary pumps are discussed in the following paragraphs.

GEAR.—The simple gear pump (fig. 7-7) consists of two meshed gears which revolve in a housing. The drive gear in the illustration is turned by a drive shaft which engages the power source. The clearances between the gear teeth as they mesh and between the teeth and the pump housing are very small.

The inlet port is connected to the reservoir supply line, and the outlet port is connected to

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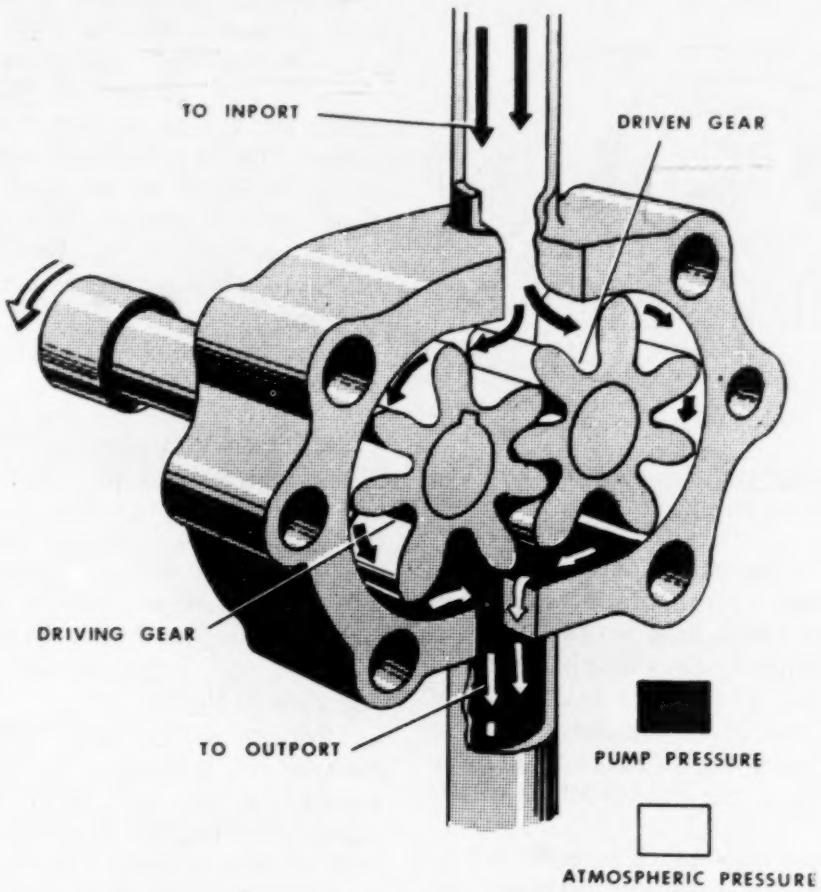

Figure 7-7.—Gear type rotary pump.

the pressure line. In the illustration, the drive gear is turning in a counterclockwise direction, and the driven (idle) gear is turning in a clockwise direction. As the teeth pass the inlet port, liquid is trapped between the teeth and the housing. This liquid is carried around the housing to the outlet port. As the teeth mesh again, the liquid between the teeth is displaced into the outlet port. This action produces a positive flow of liquid into the pressure lines. A shearpin or shear section that will break under excessive loads is incorporated in the drive shaft. This is to protect the power source or reduction gears if the pump fails because of excessive load or jamming of parts.

The gears of the pump illustrated in figure 7-7 are referred to as spur gears. Herringbone and helical gears are also used in the construction of gear pumps.

The herringbone gear pump (fig. 7-8) is a modification of the simple gear pump. The liquid is pumped in the same manner as in the simple spur gear pump. In this type pump, one discharge phase begins before the previous discharge phase is entirely complete. This overlapping and the relatively larger space at the center of the gears tend to minimize pulsations and give a steadier flow than is found in the spur gear pump.

The helical gear pump is still another modification of the simple gear pump. Because of the helical gear design, the overlapping of successive discharges from spaces between the teeth is even greater than it is in the herringbone gear pump; and the discharge flow is, accordingly, even smoother. Since the discharge flow is smooth in the helical gear pump, the gears can be designed with a small number of large teeth—thus allowing increased capacity without sacrificing smoothness of flow.

Figure 7-9 shows a helical gear pump. The pumping gears in this type of pump are driven by a set of timing and driving gears, which also function to maintain the required close clearances while preventing actual metallic contact

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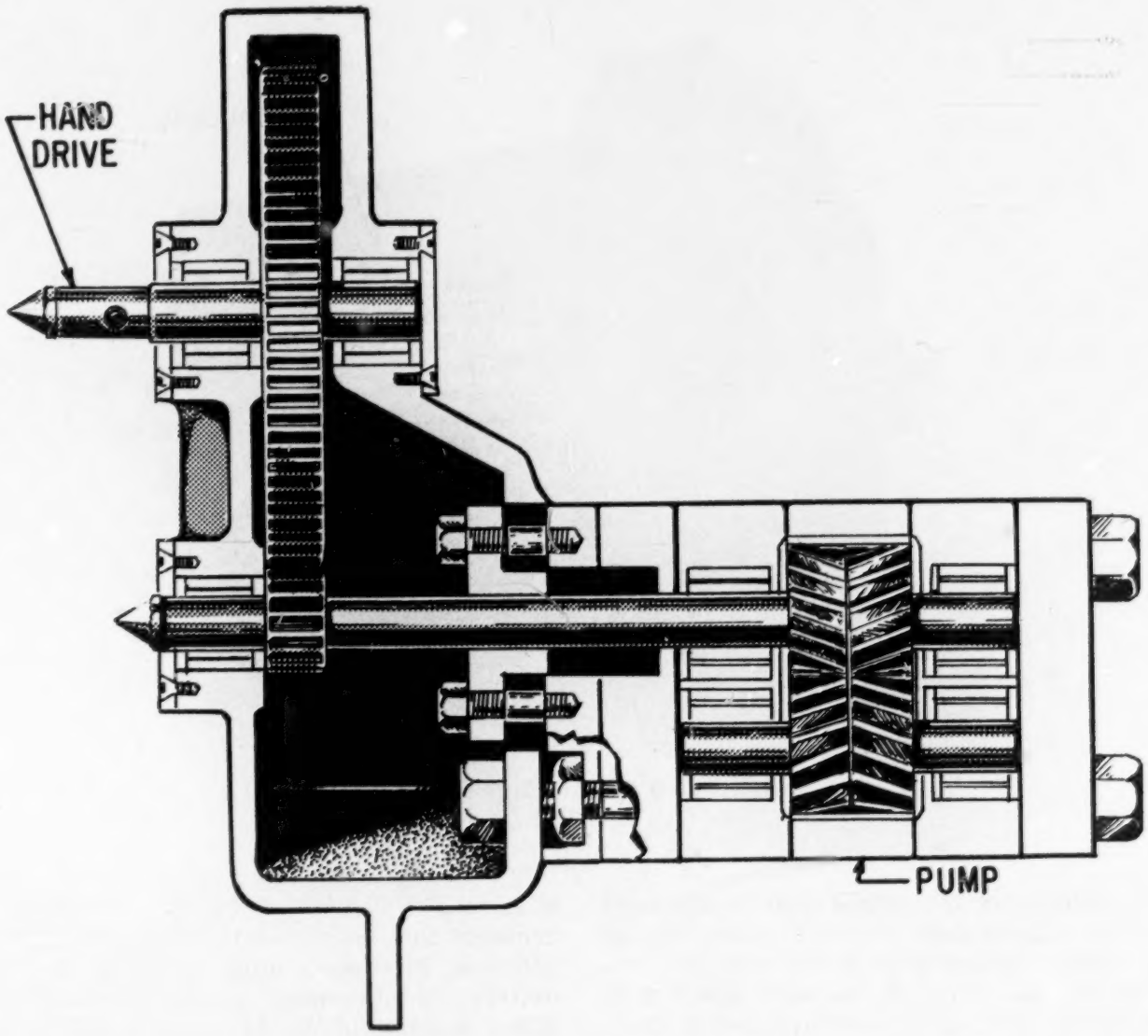

Figure 7-8.—Herringbone gear pump.

between the pumping gears. (Metallic contact between the teeth of the pumping gears would provide a tighter seal against slippage; but it would cause rapid wear of the teeth, because foreign matter in the liquid would be present on the contact surfaces.)

Roller bearings at both ends of the gear shafts maintain proper alignment and minimize the friction loss in the transmission of power. Packings are used to prevent leakage around the shaft.

The spur, herringbone, and helical are all classed as external gear pumps. This is because both sets of teeth project outward from the center of the gears. In an internal gear pump, the teeth of one gear project outward, but the teeth of the other gear project inward toward the center of the pump, as shown in figure 7-10 (A). One gear wheel stands inside the other in an internal gear pump. A gear of this kind can rotate, or be rotated by, a suitably constructed companion gear.

One type of internal gear pump is illustrated in figure 7-10 (B). The external gear is directly attached to the drive shaft of the pump and is placed off-center in relation to the internal gear. The two gears mesh on one side of the pump chamber, between the suction and the discharge. On the opposite side of the chamber a crescent-shaped form stands in the space between the two gears in such a way as to provide a close tolerance with them.

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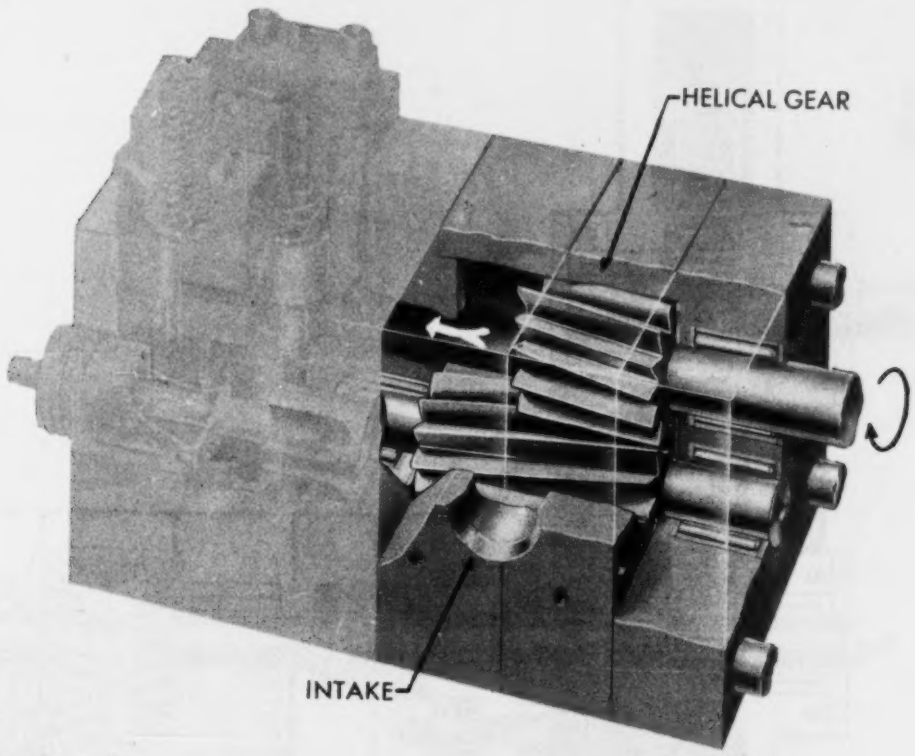

Figure 7-9.—Helical gear pump.

The rotation of the center gear by the shaft causes the outside gear to rotate, since the two are in mesh. Everything in the chamber rotates except the crescent, causing liquid to be trapped in the gear spaces as they pass the crescent. The liquid is carried from the suction to the discharge, where it is forced out of the pump by the meshing of the gears. As the liquid is carried away from the intake side of the pump, the pressure is diminished, and liquid is forced in from the source of supply. The size of the crescent that separates the internal and external gears is the determining factor in the volume delivery of this pump. A small crescent allows more volume of liquid per revolution than a larger crescent.

An internal gear pump of quite another construction is illustrated in figures 7-11 and 7-12. This pump consists of a pair of gear-shaped elements, one within the other, mounted in the pump chamber. The inner gear is directly connected to the drive shaft of the source of power.

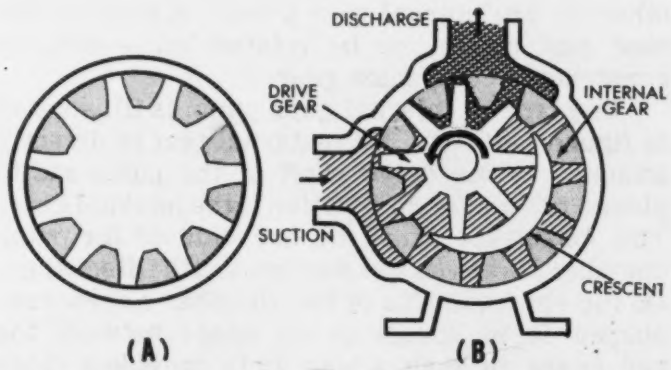

Figure 7-10.—Off-centered, internal gear pump.

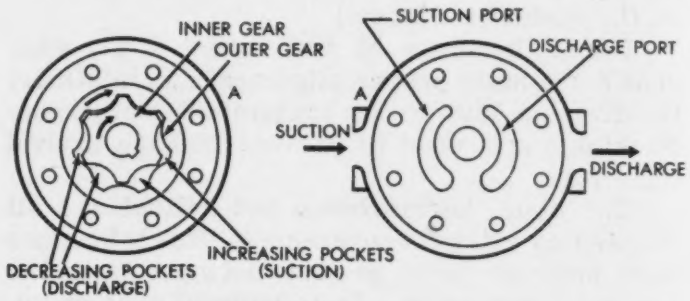

Figure 7-11.—Centered internal gear pump.

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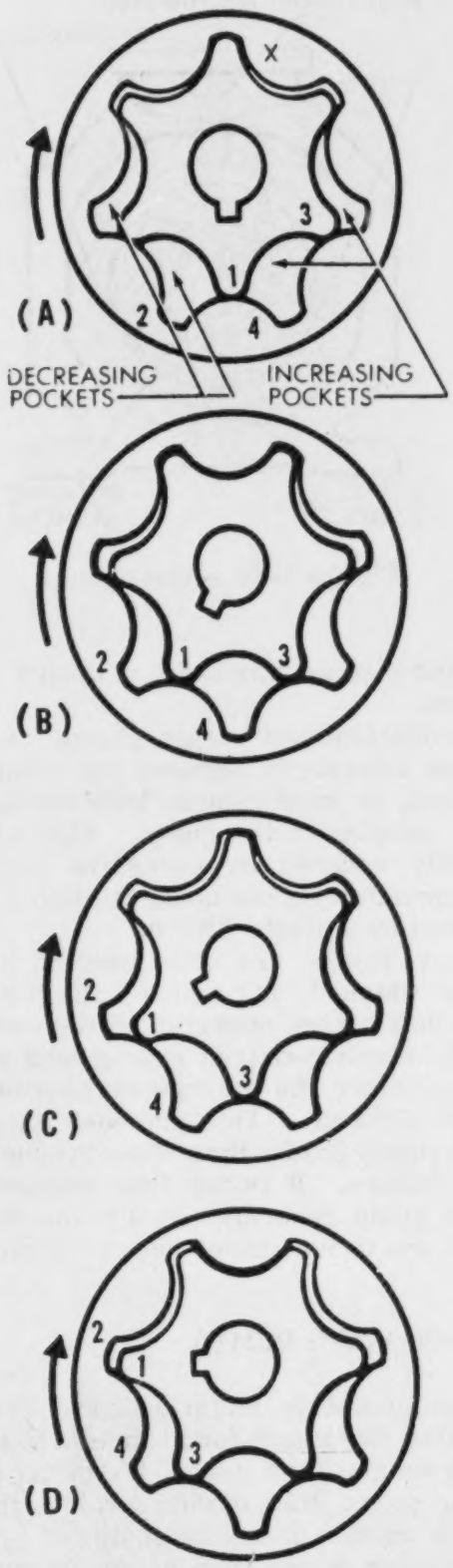

Figure 7-12.—Principles of operation of the internal gear pump.

How the gears operate to give a pumping action is shown in figure 7-12. The inner gear has one fewer teeth than the outer gear. The tooth form of each gear is related to that of the other in such a way that each tooth of the inner gear is always in sliding contact with the surface of the outer gear. Each meshing pair of teeth of the two gears definitely engages at just one place in the pump. In the illustration this place is at the top (X) so that tooth 1 will be in mesh with tooth 2, tooth 3 in mesh with tooth 4, and so on, when each pair reaches position (X).

At one side of the point of mesh, pockets of increasing size are formed as the gears rotate, while on the other side the pockets decrease in size. The pockets of increasing size are suction pockets, while those of decreasing size are discharging pockets. In figure 7-12 the pockets on the right-hand side of the drawings are increasing in size as one moves down the illustration, while those on the left-hand side are decreasing in size. The intake side of the pump would therefore be to the right and the discharge to the left. In figure 7-11, since the right-hand side of the drawing was turned over to show the ports, the intake and discharge appear reversed. Actually, A in one drawing covers A in the other.

LOBE.—The principle of operation of a lobe pump is exactly the same as for the external gear pump already described. The lobes are considerably larger than gear teeth, but there are only two or three lobes on each rotor. Figure 7-13 illustrates a three-lobe pump. The two elements are rotated, one being directly driven by the source of power, and the other through timing gears. As the elements rotate, liquid is caught between each lobe and the wall of the pump chamber, and carried around from the suction side to the discharge side of the pump. As each volume of liquid leaves the intake chamber, the

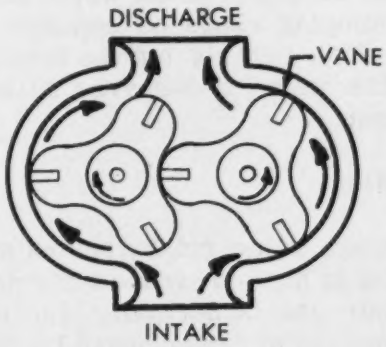

Figure 7-13.—Lobe pump.

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INVASION - growth or movement of an infectious agent into a plant and its establishment in it.

INNOCUOUS - harmless, producing no ill effect or injury.

LESION - a localized spot of diseased tissue.

LIFE CYCLE, LIFE HISTORY - the complete succession of events in the life of an organism.

LOCAL INFECTION - infection involving only a limited part of a plant.

MACRO - a combining form meaning large.

MICRO - a combining form meaning small.

MOSAIC - a plant disease caused by a virus and generally characterized by irregular light and dark green areas in the leaves.

MOTTLE - an irregular pattern of light and dark areas.

MUMMY - a dried, shriveled fruit, the result of some fungus disease.

MYCELIUM - the vegative body of the fungus, an aggregate of many hyphae.

NECROSIS - death, dead plant tissue.

NEMATOCIDE - a chemical that kills nematodes.

NEMATODE - a small invertebrate animal (often called roundworm) that seldom exceeds one-eighth inch in length. Nematodes may feed on plant parts.

NODULE - a lump, knot, or tubercle.

OBLIGATE PARASITE - an organism that must complete its active growth and reproduction upon or in its respective host.

PARASITE - an organism that obtains its nutrients wholly or in part from another living organism.

PATHOGEN - any organism capable of causing disease.

PATHOGENESIS - the part of the life of a disease-producing organism when it is directly associated with a living host.

PATHOLOGIST - one who studies diseases.

PENETRATION - same as invasion.

PESTICIDE - any agent that destroys pests, such as a fungicide, insecticide, etc.

pH - a symbol of a scale used to designate the relative acidity of a solution.

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pressure in the intake chamber is lowered, and additional liquid is forced into the chamber from the source of supply.

The lobes are so constructed that there is a continuous seal at the point of juncture at the center of the pump. The lobes of the pump illustrated in figure 7-13 are fitted with small vanes at the outer edge to improve the seal of the pump. Although these vanes are mechanically held in their slots, they are, to some extent, free to move outward. Centrifugal force keeps the vanes snug against the chamber and the other rotating members.

VANE.—Figure 7-14 illustrates a vane pump of the unbalance design. The rotor of this pump is slotted and is rotated by the drive shaft. Each slot of the rotor is fitted with a rectangular vane. These vanes are, to some extent, free to move outward in the slot. The rotor and vanes are enclosed in a housing, the inner surface of which is offset with the drive shaft axis. As the rotor turns, centrifugal force keeps the vanes snug against the wall of the housing. The vanes divide the area between the rotor and housing into a series of chambers. The chambers vary in size according to their respective positions around the shaft. The inlet port is located in that part of the pump where the chambers are expanding in size so that the partial vacuum formed by this expansion draws the liquid into the pump. The liquid is trapped between the vanes and is carried to the outlet side of the pump. The chambers contract in size on the outlet side, and this action forces the liquid through the outlet port and into the system.

The pump is figure 7-14 is referred to as unbalanced because all of the pumping action takes place on one side of the shaft and rotor. This causes a side load on the shaft and rotor. Some vane pumps are constructed with an elliptical shaped housing which forms two separate pumping areas on opposite sides of the rotor. This cancels out the side loads; therefore, this pump is referred to as a balanced vane pump.

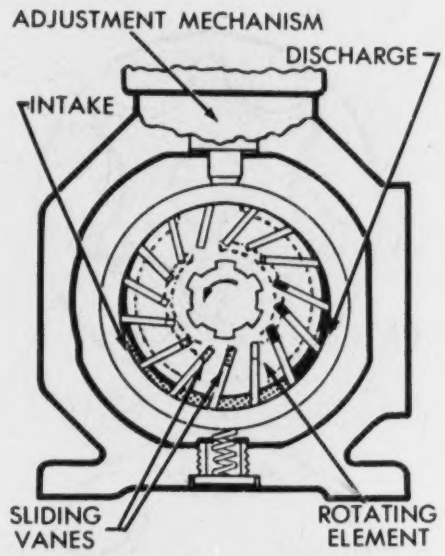

Figure 7-14.—Vane pump.

Application

Although some rotary pumps are capable of operating in high-pressure systems (above 1,500 psi), their use is normally limited to systems which operate at pressures of 1,500 psi or below. As compared to other hydraulic pumps, rotary pumps are less expensive, have fewer moving parts, and feature simplicity in design and construction.

The efficiency of rotary pumps depends on the close tolerances between the rotating elements and, in most pumps, between the rotors and the housing of the pump. This efficiency is quickly reduced by excessive wear. For this reason dirt picked up by the liquid must be eliminated by suitable filters.

Rotary pumps are often used in hydraulic systems which do not require the continuous, or near continuous, operation of the pump. For example, electric-driven gear pumps are often used to operate the emergency hydraulic systems in aircraft. This provides an efficient pump to supply fluid to the system in case of main system failure. It is far less expensive than the type pump generally used in the main system and due to its limited use, maintains efficiency.

RECIPROCATING PUMPS

A reciprocating pump depends upon a reciprocating (back-and-forth) motion to transmit liquid from the inlet port to the outlet port. In this type pump, this motion involves the back-and-forth motion of pistons inside of cylinders. Reciprocating pumps, like rotary pumps, operate on the positive displacement principle—that is, each stroke delivers a definite volume of liquid to the system.

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Classification

The master cylinder of the automobile brake system and the hand water pump, both of which are described and illustrated in chapter 4, are examples of simple reciprocating pumps. Reciprocating pumps of this type are usually classified as:

1. Direct- or indirect-acting.
2. Simplex (single) or duplex (double).
3. Single- or double-action.
4. Vertical or horizontal.

Figure 7-15 illustrates a manually operated reciprocating pump. This type pump is often used as an emergency pump in a hydraulic system. It is a direct-acting pump, because the pump rod is a direct extension of the piston.

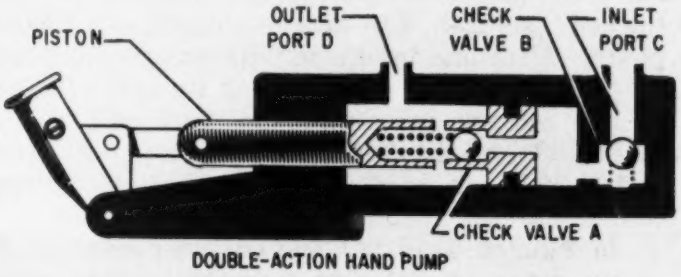

Figure 7-15.—Hydraulic hand pump.

This pump is referred to as a simplex because it has only one cylinder. A double or duplex pump is an assembly of two single pumps placed side by side on the same foundation. Duplex pumps are seldom used with modern equipment.

In a single-action pump the liquid is drawn into the cylinder on the first or suction stroke and is forced out of the cylinder on the return or discharge stroke. The pump illustrated in figure 7-15 is a double-action pump. When the piston is moved to the left, the force of the liquid in the outlet chamber and spring tension causes check valve (A) to close. This movement causes the piston to force the liquid in the outlet chamber through the outlet port (D) and into the system. This same movement of the piston causes a low-pressure area in the inlet chamber. Atmospheric pressure acting on the liquid in the reservoir transmits this pressure to the liquid at the inlet port (C). This differential of pressures acting on the ball of check valve (B) causes the spring to compress and open the check valve. This allows liquid to enter the inlet chamber.

When the piston completes this stroke to the left, the inlet chamber is full of liquid. This liquid eliminates the low pressure area in the inlet chamber thereby allowing spring tension to close check valve (B).

When the piston is moved to the right, the force of the confined liquid in the inlet chamber acts on the ball of check valve (A). This action compresses the spring and opens check valve (A), allowing the liquid to flow from the intake chamber to the outlet chamber. Because of the area occupied by the piston rod, the outlet chamber cannot contain all the liquid discharged from the inlet chamber. Liquid will not compress; therefore, the extra liquid is forced out port (D) into the system. Because each stroke of the pump forces liquid into the system, this type pump is referred to as a double-action pump.

This pump is classified as horizontal because the piston moves back and forth on a horizontal plane. If the piston moves up and down, the pump is classified as a vertical pump.

Two other classes of reciprocating pumps are the radial-piston and the axial-piston. These pumps are often classified as rotary-piston pumps, because a rotary motion is imparted to the pumps by the source of power. However, the actual pumping is performed by sets of pistons reciprocating inside sets of cylinders.

RADIAL-PISTON PUMPS.—Figure 7-16 illustrates the operation of the radial-piston pump. The pump consists of a pintle which remains stationary and acts as a valve; a cylinder block which revolves around the pintle and contains the cylinders in which the pistons operate; a rotor which houses the reaction ring of hardened steel against which the piston heads press; and a slide block which is used to control the length of the piston strokes. The slide block does not revolve but houses and supports the rotor, which does revolve due to the friction set up by the sliding action between the piston heads and the reaction ring. A drive shaft is secured to the cylinder block.

In figure 7-16 (A) assume liquid is in space (X) in one of the cylinders of the cylinder block when the piston is at position (1). If the cylinder block and piston are rotated in a clockwise direction, the piston is forced into its cylinder as it approaches position (2). This action reduces the volumetric size of the cylinder and forces a quantity of liquid out of the cylinder and into the outlet port above the pintle. The

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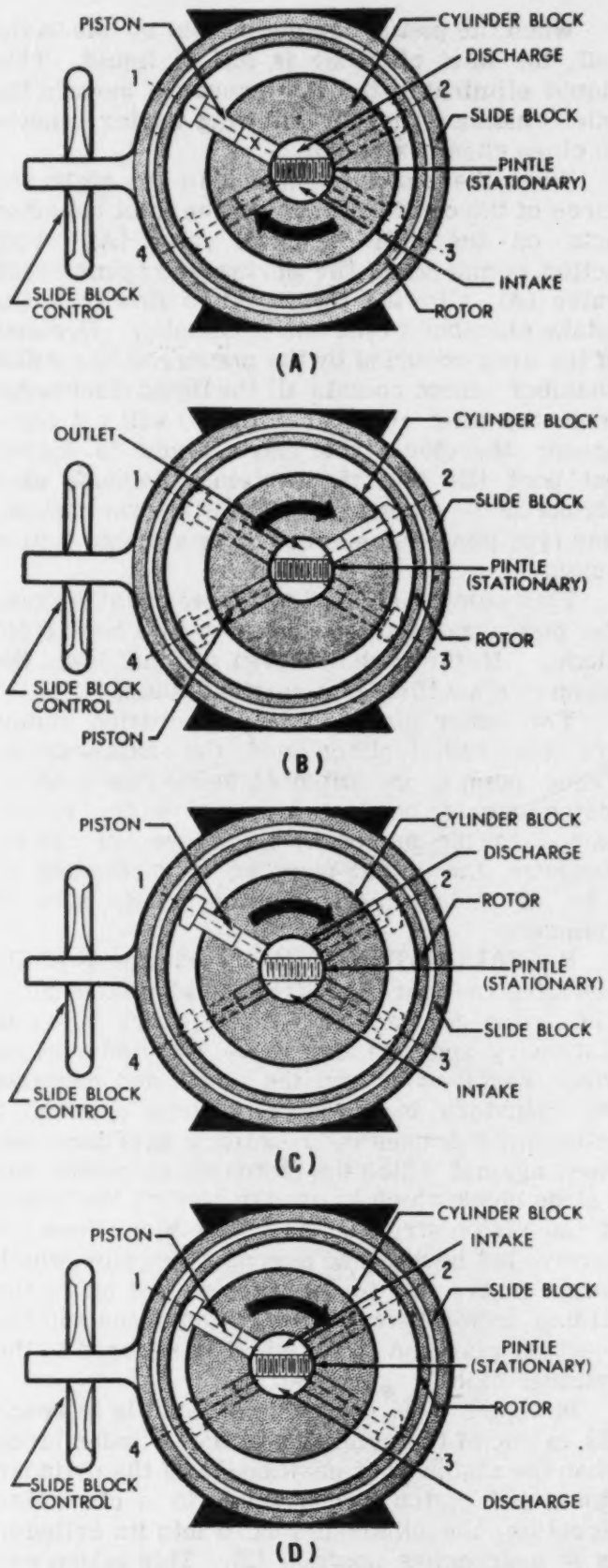

Figure 7-16.—Principles of operation of the radial-piston pump.

pumping action is due to the fact that the rotor, in the slide block, is offcentered in relation to the center of the cylinder block.

In figure 7-16 (B) the piston has reached position (2) and has pushed the liquid through the outlet port. The cylinder outlet is blocked as the piston moves from position (2) to (3). No pumping or suction will occur while the piston and cylinder are passing over the solid part of the pintle. After the piston moves to position (3), however, it starts drawing liquid into the cylinder as the rotation of the cylinder block moves the piston to position (4). At this point the cylinder has taken on a full charge of liquid. The pistons are driven out of the cylinder block by centrifugal force as the cylinder block is revolved. As the piston moves across the pintle, no intake or discharge of liquid occurs. After the piston has passed the pintle and starts toward position (2) another discharge takes place. Alternate intake and discharge continues as the rotor is revolved about its axis—intake on one side of the pintle and discharge on the other side, as the piston slides in and out. The piston head is held against the reaction ring of the rotor by centrifugal force.

In figures 7-16 (A) and (B) the center point of the rotor is different from the center point of the cylinder block. It is the difference of these centers that produces the pumping action. If the rotor is moved so that its center point is the same as that of the cylinder block, as shown in figure 7-16 (C), there is no pumping action, since the piston does not move back and forth in the cylinder as it rotates with the cylinder block.

The flow in this pump can be reversed by moving the slide block, and therefore the rotor, to the right so that the relation of the centers of the rotor and the cylinder block are reversed from the position shown in figures 7-16 (A) and (B). Figure 7-16 (D) shows this arrangement. The piston draws liquid in as it travels from position (1) to position (2) and pumps liquid out as it travels from (3) to (4).

In the illustrations the rotor is shown in the center, the extreme right, or the extreme left in relation to the cylinder block. The amount of adjustment in distance between the two centers determines the amount of liquid pumped. This difference determines the length of the piston stroke, which controls the amount of liquid flow in or out of the cylinders. This adjustment may be controlled in different ways. Manual control by means of a handwheel is the

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simplest. The pump illustrated in figure 7-16 is controlled in this way. For automatic control of delivery to accommodate varying volume requirements during the operating cycle, a hydraulically controlled cylinder may be used to position the slide block. A gear-motor controlled by a push-button or limit switch is sometimes used for this purpose.

A pump of this type with only one piston would not be practical. Therefore, the cylinder contains several pistons. Note that the pump illustrated in figure 7-17 contains an odd number of pistons. This is because no more than one piston is completely blocked by the pintle at any one time. If there were an even number of pistons spaced evenly around the cylinder block; for example, eight, there would be occasions when two of the pistons would be blocked by the pintle, while at other times none would be blocked. This would cause three pistons to discharge at one time and four at one time, causing pulsation in flow. With an odd number of pistons spaced evenly around the cylinder block, only one piston is completely blocked by the pintle at any one time. This reduces pulsations of flow.

Some of the principal parts of the radial-piston pump are described in more detail in the following paragraphs.

Pintle.—In figure 7-16 the pintle is shown, for the sake of simplicity, as a flat bar around which the rotor turns. Actually, the pintle is a

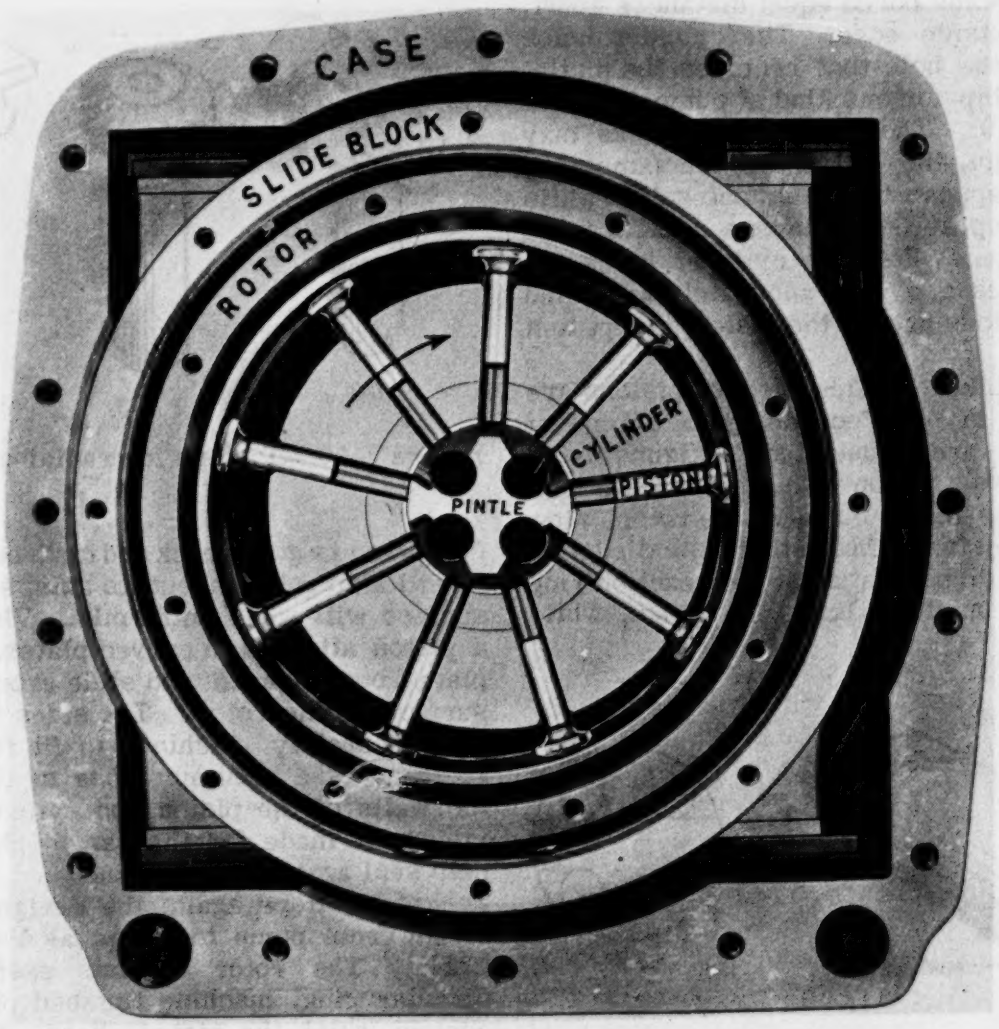

Figure 7-17.—Nine piston radial-piston pump.

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round bar which serves as a stationary shaft around which the cylinder block turns. The pintle shaft, as shown in figure 7-18, has four holes bored from one end lengthwise through part of its length. Two holes serve as the intake and the remaining two as the discharge. Two slots are cut in the side of the shaft so that each slot connects two of the lengthwise holes. The two slots are in line with the pistons when the cylinder block is assembled on the pintle. One of these slots provides the path for the liquid to pass from the pistons to the discharge holes bored in the pintle. The other slot connects the two inlet holes to the pistons when they are drawing in liquid. The discharge holes are connected through appropriate fittings to a discharge line so that the liquid can be directed into the system. The other pair of holes are connected to the inlet line.

Cylinder Block.—This is a block of metal with a hole bored through its center to fit the pintle and cylinder holes bored equal distances apart, around its outside edge. The cylinder holes connect with the hole that receives the pintle. The relationship for one kind of pump is shown in figure 7-19. Though cylinder blocks may differ in design, they all serve the same purpose. Some appear to be almost solid, while others have spokelike cylinders radiating out from the center. Both the cylinder holes and the pintle holes are very accurately machined so that liquid loss around the piston is kept to a minimum.

Pistons.—Like cylinder blocks, pistons are manufactured in different designs. Some of these designs are illustrated in figure 7-20. View (A) shows a piston with small wheels that roll around the inside curve of the rotor. View (B) shows a piston in which the conical edge of the top bears directly against the reaction ring of the rotor. In this particular design, while the piston is going back and forth in the cylinder, it will also rotate about its axis, so that the top surface will wear uniformly. View (C) shows a piston attached to curved plates. The curved plates bear against and slide around the inside surface of the rotor. The sides of the pistons are accurately machined to fit the cylinders, so there is a minimum loss of liquid between the walls of the piston and cylinder. No provision is made for the use of piston rings to help seal against piston leakage.

Rotor.—Here again, the design may be different from pump to pump, as shown in figure 7-21. The rotor consists essentially of a circular ring, machine finished on the inside, against which the pistons bear. The rotor rotates within the slide block which can be shifted

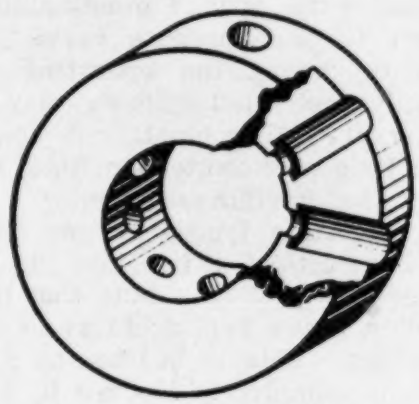

Figure 7-19.—Cylinder block for radial-piston pump.

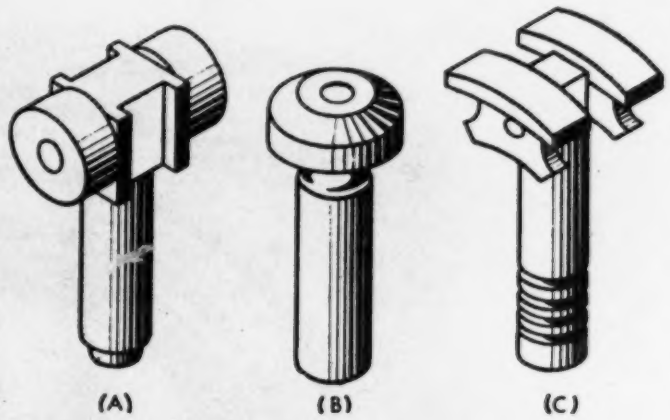

Figure 7-20.—Pistons for radial-piston pumps.

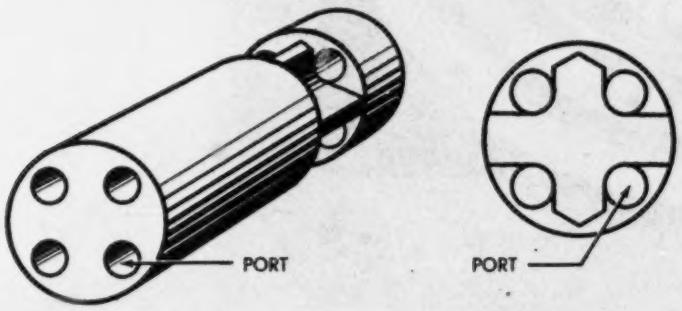

Figure 7-18.—Pintle for radial-piston pump.

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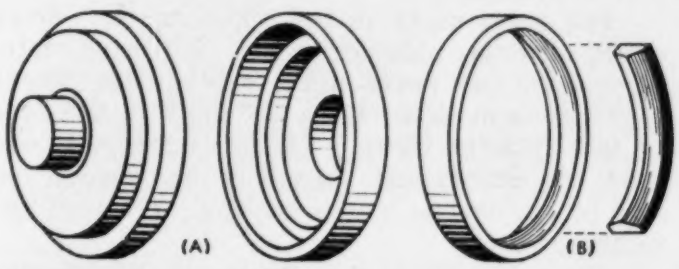

Figure 7-21.—Rotors for radial-piston pumps.

from side to side in order to control the length of stroke of the pistons. The slide block has two pairs of machined surfaces on the exterior so that it can slide in tracks in the pump case. The sliding motion is controlled by any of the means covered earlier in this chapter.

These parts, together with the drive shaft, constitute the main working parts of the pump. The drive shaft is connected to the cylinder block and is driven by an outside force such as an electric motor.

AXIAL-PISTON PUMPS.—Axial piston pumps have the same general characteristics as radial-piston pumps. However, in the axial-piston pump, the block with its pistons rotate on a shaft in such a way that the pistons reciprocate in their cylinders along lines parallel to the axis of the shaft. This is called axial motion.

The pumping action of this type pump is made possible by a universal joint or link. Figure 7-22 is a series of drawings which illustrate how the universal joint is used in the operation of the axial-piston pump.

First, a rocker arm is installed on a horizontal shaft. (See fig. 7-22 (A).) The arm is joined to the shaft by a pin in such a way that it can be swung back and forth. Next, a ring is placed around the shaft and secured to the rocker arm so that the ring can turn from left to right as shown in figure 7-22 (B). This makes it possible to get two rotary motions in different planes at the same time, and in varying proportions as may be desired. The rocker arm can swing back and forth in one arc, and the ring can simultaneously move from left to right in another arc, in a plane at right angles to the plane in which the rocker arm moves.

Next, a tilting plate is added to the assembly. The tilting plate is placed at a slant to the axis of the shaft, as depicted in figure 7-22 (C). In

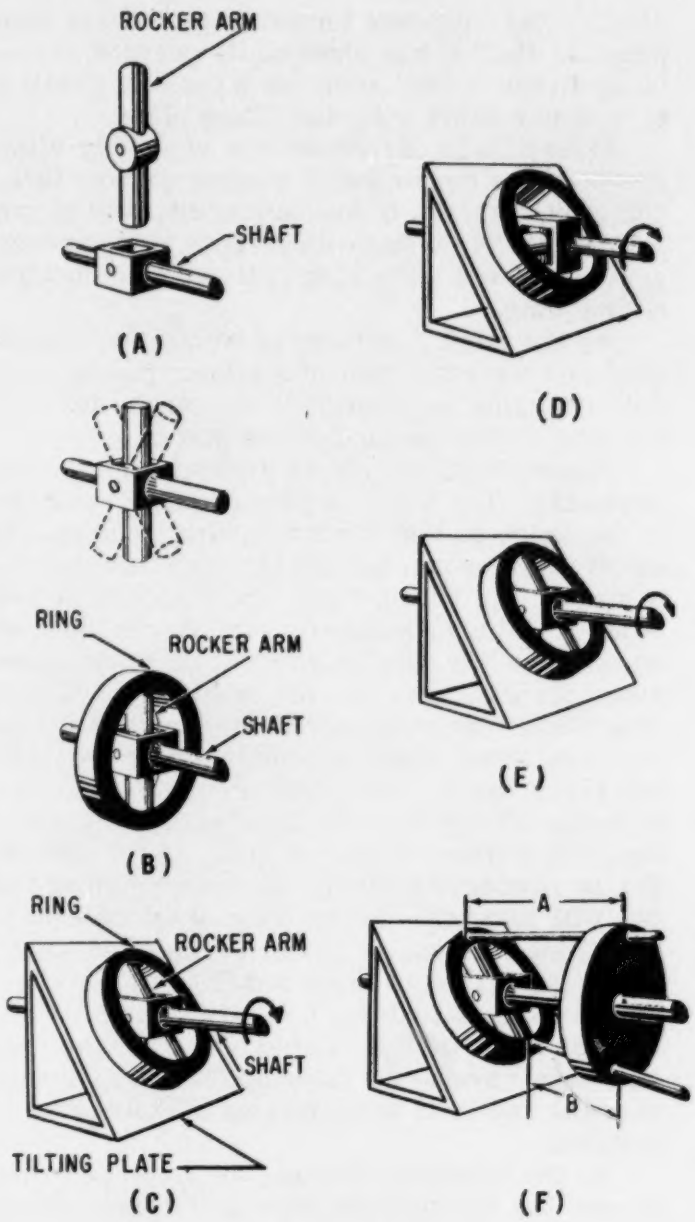

Figure 7-22.—Relationship of the universal joint in the operation of the axial-piston pump.

this position the rocker arm is slanted back at the same angle as the tilting plate, so that it lies parallel to the tilting plate. The ring is also parallel to the tilting plate and in contact with it. Its position in relation to the rocker arm is unchanged from that shown in figure 7-22 (B).

Figure 7-22 (D) shows the assembly after the shaft, still in a horizontal position, has been rotated a quarter turn. The rocker arm is still in the same plane as the tilting plate, and is now perpendicular to the axis of the

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shaft. The ring has turned on the rocker arm pins, so that it has changed its position in relation to the rocker arm, but it remains parallel to, and in contact with, the tilting plate.

Figure 7-22 (E) shows the assembly after the shaft has been rotated another quarter turn. The parts are now in the same position as shown in figure 7-22 (C), but with the ends of the rocker arms reversed. The ring still bears against the tilting plate.

As the shaft continues to rotate, the rocker arm and the ring turn about their pivots, with each changing its relation to the other, and with the ring always bearing on the plate.

Figure 7-22 (F) shows a wheel added to the assembly. The wheel is placed upright and fixed to the shaft, so that it rotates with the shaft. In addition, two rods, (A) and (B), are loosely connected to the tilting ring, and run through two holes standing opposite to each other in the fixed wheel. As the shaft is rotated, the fixed wheel runs perpendicular to the shaft at all times. The tilting ring rotates with the shaft and always remains tilted, since it remains in contact with the tilting plate. The distance along rod (A), from the tilting ring to the fixed wheel, is greater than the distance along rod (B). As the assembly is rotated, however, the distance along rod (A) will decrease as its point of attachment to the tilting ring comes closer to the fixed wheel, while the distance along rod (B) will increase. These changes continue until after a half revolution, at which time the initial position of the rods has been reversed. After another half revolution the two rods will again be in their original position.

As the assembly rotates, the rods are moved in and out through the holes in the fixed wheel. This is the way the axial-piston pump works. To get a pumping action, it is only necessary to place pistons at the ends of the rods, beyond the fixed wheel, and insert them in cylinders. The rods must be connected to the pistons and to the wheel by ball and socket joints. As the assembly rotates, each piston moves back and forth in its cylinder. Intake and discharge lines can be arranged so that liquid enters the cylinders while the spaces between the piston heads and the bases of the cylinders are increasing, and leaves the cylinders during the other half of each revolution, when the piston heads are moving in the opposite direction.

Figure 7-23 is an example of an axial-piston pump which illustrates the application of these operating principles. This type pump usually consists of a circular cylinder block with either 7 or 9 equally spaced pistons.

The main parts of the pump are the drive shaft, pistons, cylinder block, and valve plate. There are two ports in the valve plate. These ports connect directly to openings in the face of the cylinder block. Liquid is forced in one port by atmospheric pressure and forced out the other by the reciprocating action of the pistons.

There is a fill port in the top of the cylinder housing. This opening is normally kept plugged, but it can be opened for testing the pressure in the housing or case. When installing a new pump or newly repaired one, this plug must be removed and the housing filled with the recommended liquid before the pump is operated. There is a drain port in the mounting flange to drain away any leakage from the drive shaft oil seal.

When the drive shaft is rotated, it rotates the pistons and cylinder block with it. The offset position of the cylinder block causes the pistons to move back and forth in the cylinder block while the shaft, pistons, and cylinder block rotate together. As the pistons reciprocate in the cylinder block, they draw the liquid in one port and force it out the other.

In figure 7-24, piston (A) is shown at the bottom of the stroke. When piston (A) has rotated to the position held by piston (B), it will have moved upward in its cylinder, forcing liquid through the outlet port during the entire distance. During the remainder of the rotation back to its original position, the piston will be traveling downward in its cylinder, drawing the liquid through the inlet port. Since each one of the pistons will be performing the same operation in succession, liquid is constantly being taken into the cylinder bores through the inlet port and expelled from the cylinder bores into the pressure line of the system. This action creates a steady, nonpulsating flow of liquid.

As shown in figure 7-22 (F), the distance the pistons move back and forth in their cylinders depends on the tilt or angle given to the tilting plate. In the pump illustrated in figures 7-23 and 7-24, this tilt or angle is fixed by the shape of the housing and therefore is referred to as a fixed or constant displacement pump. Pump output is determined by the angle and can be changed only by varying the pump speed.

With no tilt at all, no pumping action would occur since the pistons would not move back and forth. The distances (A) and (B) in figure

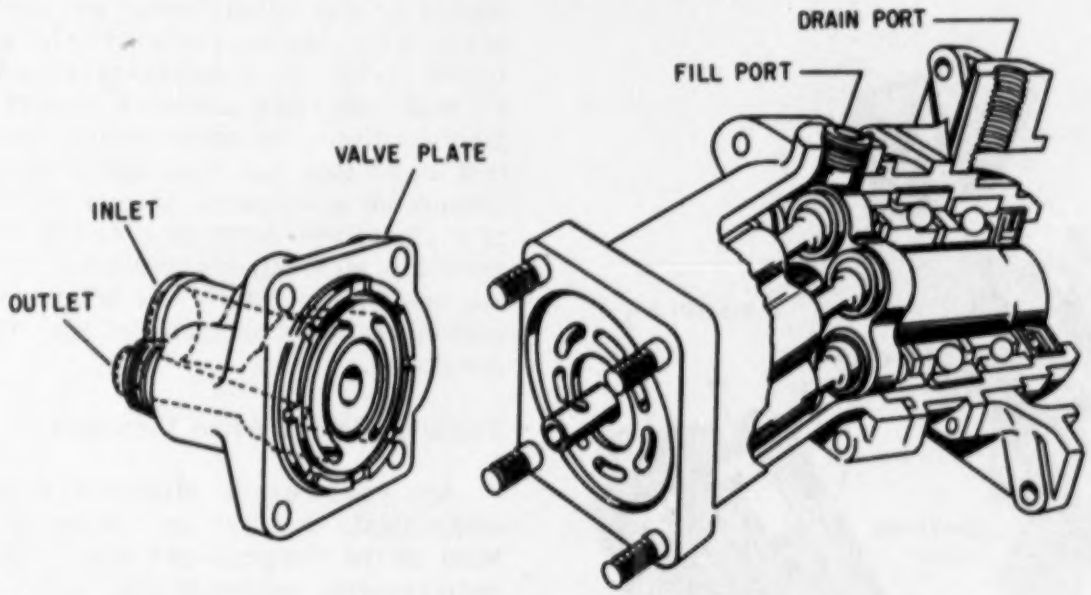

Figure 7-23.—Partial cutaway view of axial-piston pump.

7-22 (F) would be equal, and would remain equal as the assembly rotates. If the angle of tilt given to the tilting plate were reversed, making distance (A) less than distance (B), the pumping action would be reversed. What had been the discharge would now become the intake and vice versa. By adding a mechanism to control the angle at which the tilting plate stands, any variation in delivery can be obtained, from a maximum in one direction through zero delivery, to a maximum in the opposite direction, although the drive shaft continues to rotate at a constant speed.

The variable displacement (stroke) axial-piston pump, shown in figure 7-25, usually has either seven or nine single-acting pistons which are evenly spaced around a cylinder barrel. (Note that the term cylinder barrel, as used in this connection, actually refers to a cylinder block which holds all the cylinders.) The piston rods make a ball-and-socket connection with a socket ring. The socket ring rides on a thrust bearing carried by a casting—the tilting box or plate.

When the tilting box is at a right angle to the shaft, and the pump is rotating, the pistons do not reciprocate; therefore, no pumping action takes place. When the tilting box is tilted away from a right angle, however, the pistons reciprocate and the liquid is pumped.

Displacement of this type pump can be varied by changing the angle of the tilting box. Various methods are used to control the movement of the tilting box—manual, electric, pneumatic, or hydraulic. The operation of a hydraulically controlled variable displacement pump is included in the hydraulic power drive system in chapter 13.

Application

As stated previously, the manually operated reciprocating pump is used for emergency operation of hydraulic systems. They are commonly used in aircraft hydraulic systems for ground checking the hydraulic system in addition to their use for emergency operation.

Radial- and axial-piston pumps are commonly used for applications requiring high pressures and accurate control of the volume discharge. They are the most common type pump used in Navy hydraulic systems. Some piston pumps are designed to operate in systems requiring pressures of over 10,000 psi. However, most of the hydraulic systems in the Navy operate at pressures of 3,000 psi or less.

Variable displacement piston pumps are used in electro-hydraulic anchor windlasses, cranes and winches, the power transmitting unit in electro-hydraulic steering systems, and many other systems aboard ship.

Variable displacement axial-piston pumps are used in most aircraft hydraulic systems. Due to weight and space limitations, the design

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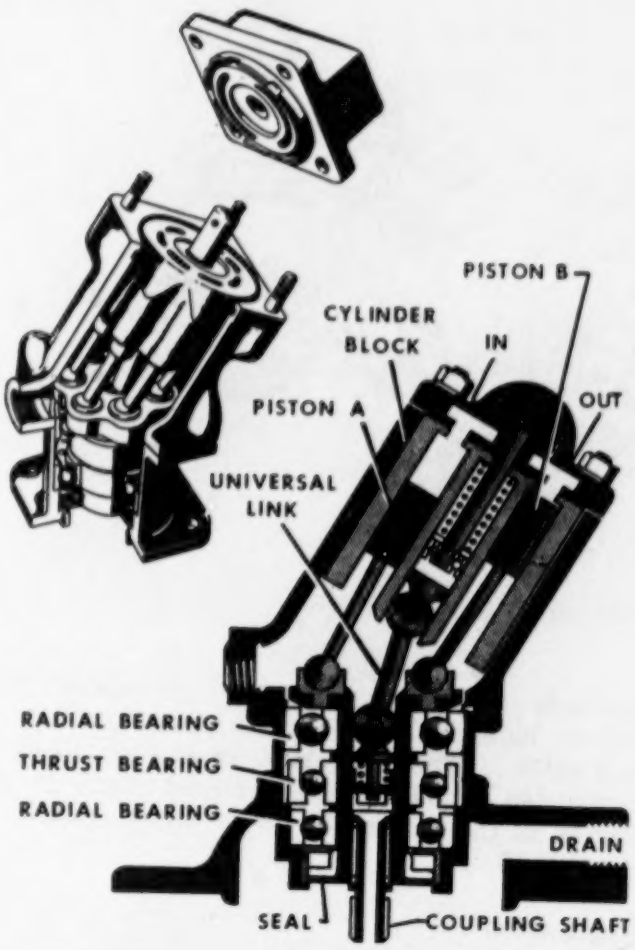

Figure 7-24.—Schematic diagram of axial-piston pump.

of these pumps differs to some extent as compared to the variable displacement pump previously described. The current edition of Navy Training Course, Aviation Structural Mechanic H 3 & 2, NavPers 10310 (Series), and applicable technical publications should be consulted for the description of these pumps.

AIR COMPRESSORS

Compressors are used in pneumatic systems to provide requirements similar to those required by pumps in hydraulic systems. They furnish compressed air as required to operate the units of pneumatic systems.

COMPRESSOR CLASSIFICATIONS

Air compressors are classified in various ways. A compressor may be single-acting or double-acting, single stage or multistage, and horizontal, angle, or vertical, as shown in figure 7-26. A compressor may be designed so that only one stage of compression takes place within one compressing element, or so that more than one stage takes place within one compressing element. In general, compressors are classified according to the type of compressing element, the source of driving power, the method by which the driving unit is connected to the compressor, and the pressure developed.

Types of Compressing Elements

Air compressor elements may be of the centrifugal, rotary, or reciprocating types. Most of the compressors used in the Navy have reciprocating elements (fig. 7-27). In this type compressor the air is compressed in one or more cylinders very much like the compression which takes place in an internal combustion engine.

Sources of Power

Compressors are driven by electric motors, internal combustion engines, steam turbines, reciprocating steam engines, or hydraulic motors. A majority of the air compressors in naval service are driven by electric motors.

Drive Connections

The driving unit may be connected to the compressor by one of several methods. When the compressor and the driving unit are mounted on the same shaft, they are close coupled. Close coupling is often used for small capacity compressors that are driven by electric motors. Flexible couplings are used to join the driving unit to the compressor where the speed of the compressor and the speed of the driving unit can be the same.

V-belt drives are commonly used with small, low-pressure, motor-driven compressors, and some medium-pressure compressors. In a few installations, a rigid coupling is used between the compressor and the motor. In a steam turbine drive, compressors are usually driven through reduction gears.

Pressure Classification

Compressors are classified as low-pressure, medium-pressure, or high-pressure.

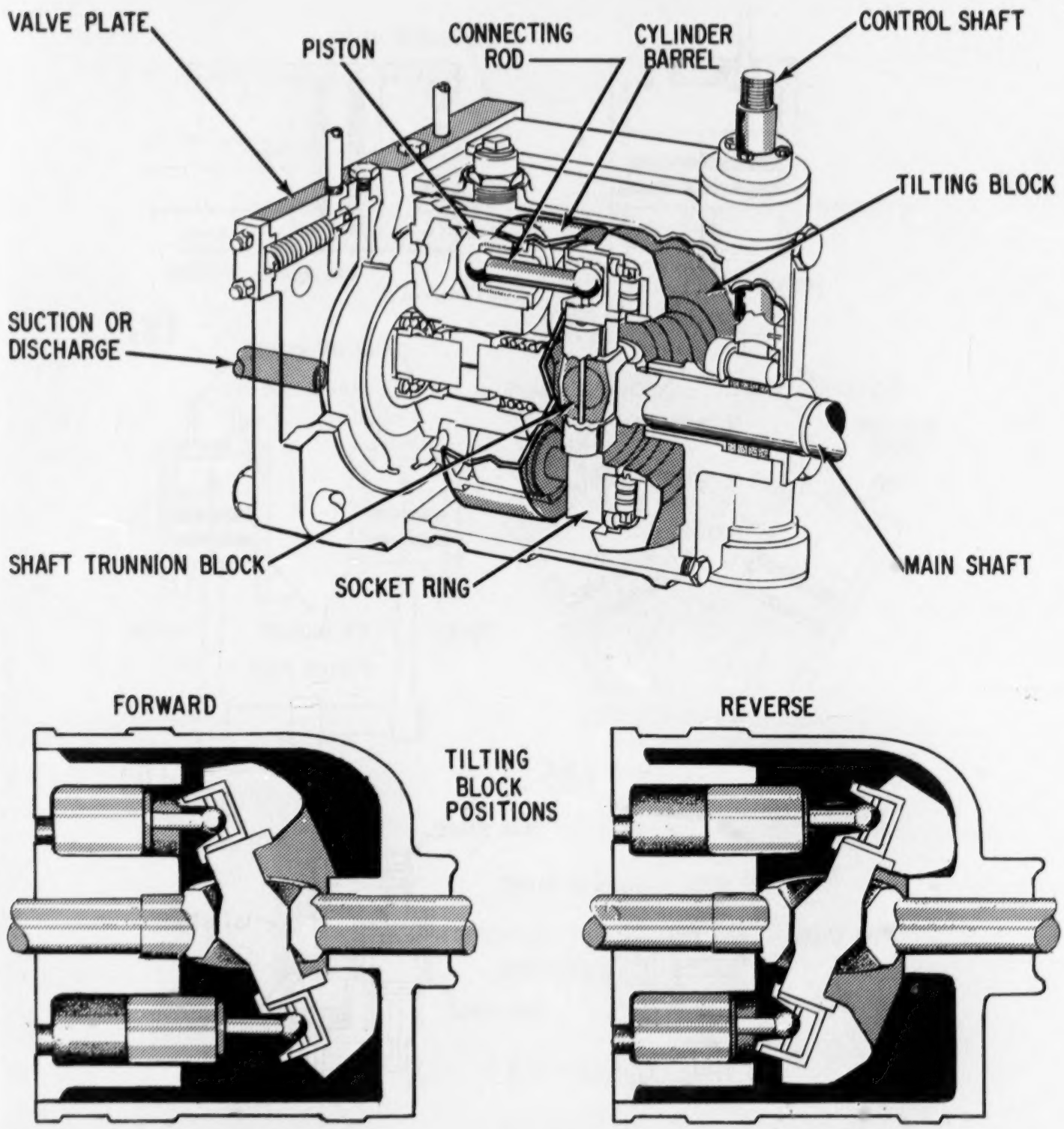

Figure 7-25.—Variable displacement (stroke) axial-piston pump.

PHOTOSYNTHESIS - the complicated process by which green plants make organic substances from water and carbon dioxide of the air through the energy of sunlight.

PLANT DISEASE - any alteration of a plant that interferes with its normal structure, or function and renders the plant unfit for its normal use.

PLANT PATHOLOGY - the study of plant diseases.

PROGENY - offspring.

PUSTULE - a pimple-like or blister-like structure.

QUARANTINE - to isolate; to keep from normal relations due to contagious diseases or infections.

RESISTANCE - ability of a plant to remain relatively unaffected by a disease because of inherent properties it possesses.

SAPROPHYTE - an organism that feeds on dead organic matter.

SHOT HOLE - a symptom of disease in which small roundish fragments drop out of the leaves so that the leaves look as though they had been riddled by shot.

SOIL STERILIZATION - the process of treating soil so as to kill living things in it.

SPORE - the one-to-many celled reproductive unit of a fungus which corresponds to a seed in plants.

SPORULATION - the process of producing spores.

SPOT - a definite diseased area.

STOMA - a minute opening in a leaf or stem; a pore.

SUSCEPT - any plant liable to infection by a given disease-producing agent.

SUSCEPTIBILITY - lacking inherent ability to resist disease.

SYMBIOSIS - a mutually beneficial association of two or more organisms.

SYMPTOM - any reaction of the host plant to disease. Usually it refers to visible reactions.

SYSTEMIC - pertaining to a disease in which an infection leads to a general spread throughout the plant body. Could refer to the spread of a chemical.

TOLERANCE - the degree of endurance of a plant to the effects of adverse conditions, chemicals, or parasites. A tolerant plant is capable of sustaining a disease without serious injury or crop loss.

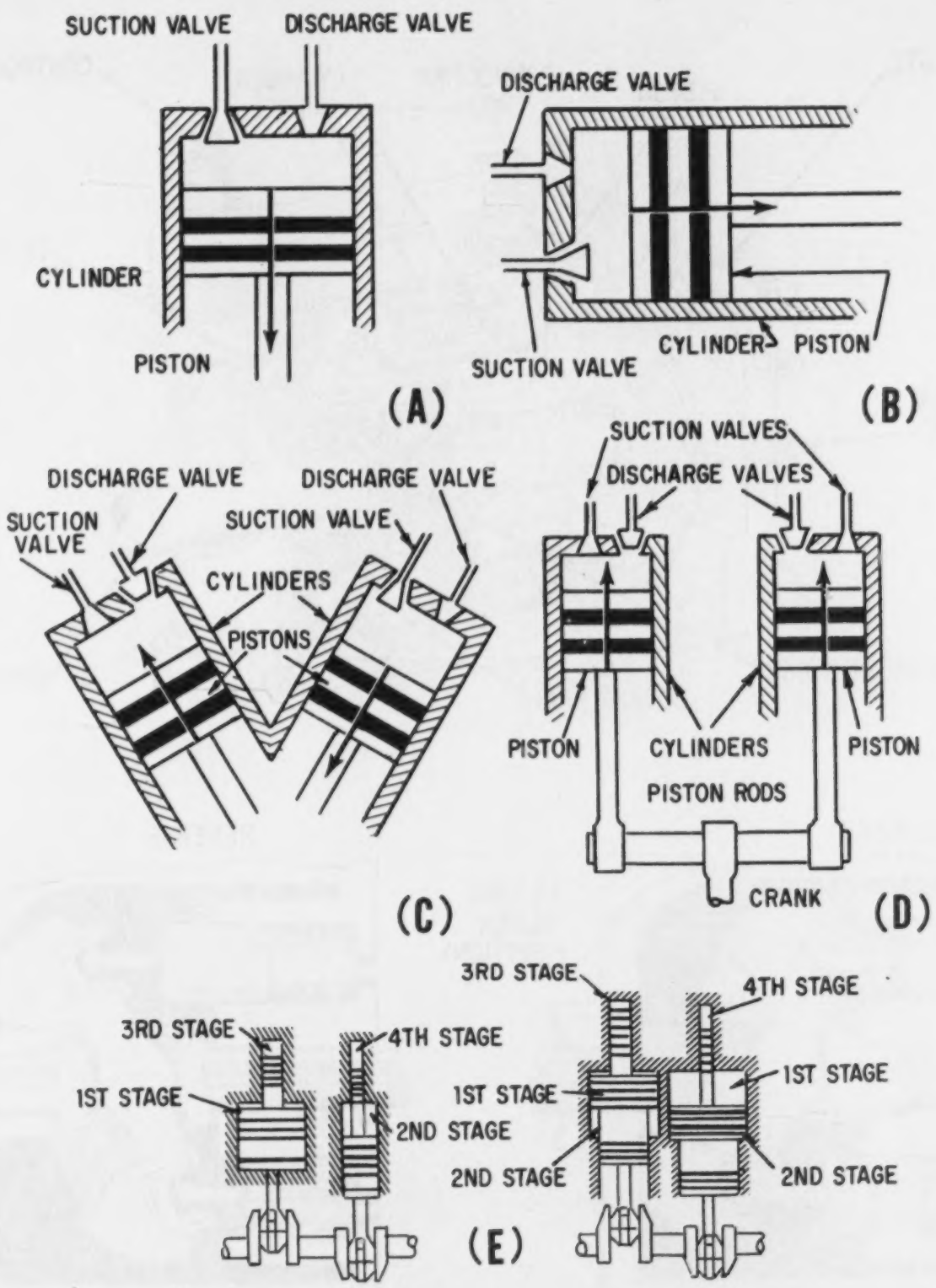

Figure 7-26.—Types of air compressors:
(A) Vertical; (B) horizontal; (C) angle; (D) duplex; (E) multistage.

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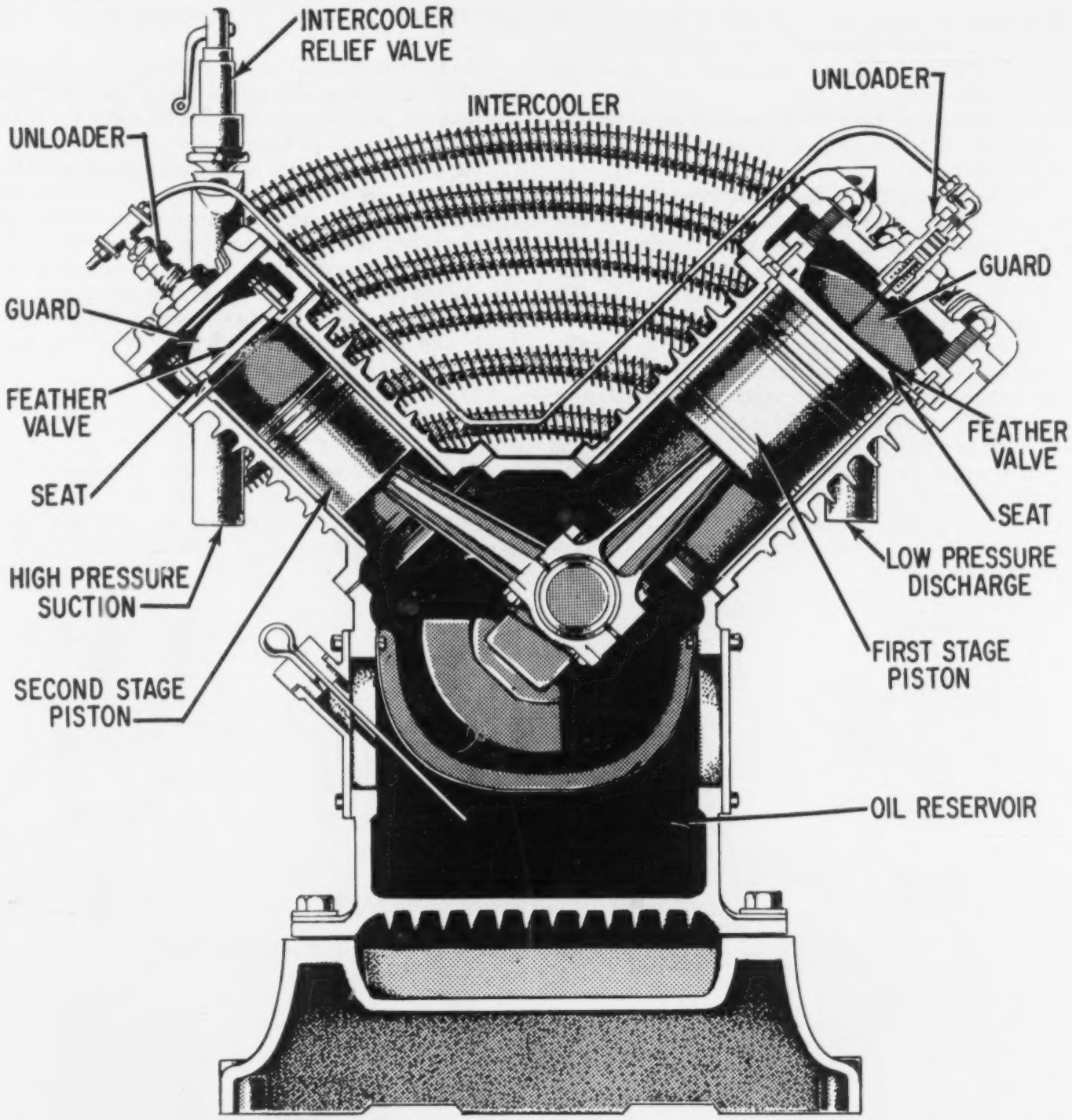

Figure 7-27.—A simple two-stage reciprocating low-pressure air compressor.

Low-pressure compressors are those which have a discharge pressure of 150 psi or less. Medium-pressure compressors are those which have a discharge pressure of 151 psi to 1,000 psi. Compressors which have a discharge pressure above 1,000 psi are classified as high-pressure.

Most low-pressure air compressors are of the two-stage type with either a vertical V (fig. 7-27) or a vertical W arrangement of cylinders. Two-stage, V-type, low-pressure compressors usually have one cylinder for the first (low-pressure) stage of compression, and one cylinder for the second (high-pressure) stage. W-type

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compressors have two cylinders for the first stage of compression and one cylinder for the second stage. This arrangement is shown in figure 7-28 (A).

Compressors may be classified according to a number of other design features or operating characteristics.

Medium-pressure air compressors are of the two-stage, vertical, duplex, single-acting type. Many medium-pressure compressors have differential pistons; this type of piston has more than one stage of compression on each piston. (See fig. 7-28 (A).)

Modern air compressors are generally motor-driven (direct or geared), liquid-cooled, four-stage, single-acting units with vertical or horizontal cylinders. Cylinder arrangements for high-pressure air compressors utilized in naval service are illustrated in figure 7-28 (B). Small capacity high-pressure air systems may have three-stage compressors. High capacity air systems may be equipped with five- or six-stage compressors.

RECIPROCATING AIR COMPRESSOR

Reciprocating air compressors are usually similar in design and operation. The following discussion relates to the radial, three-stage, piston type, high-pressure air compressor.

An air compressor assembly includes all the associated equipment required for delivering filtered, oil and moisture free compressed air as required for the operation of various units. The complete assembly normally includes the compressor, filter and separator assembly, an adjustable relief valve assembly, a control system, and an air receiver with a pressure gage attached. (See fig. 7-29.)

Principles of Operation

The air compressor consists of three piston type air pumps connected in series. Therefore, the process of compressing ambient air (see glossary) to a relatively high pressure is accomplished in three stages. Each compressor

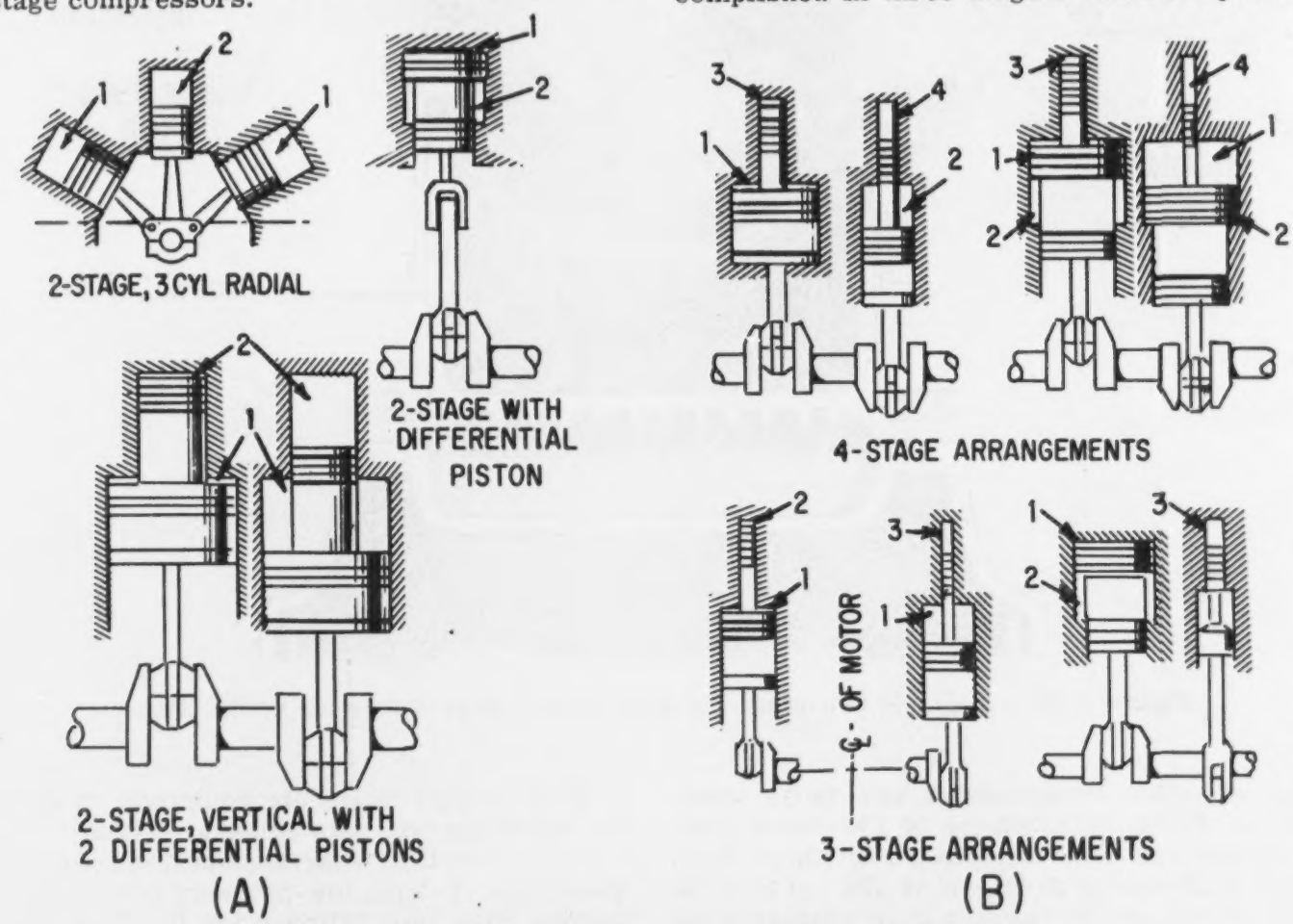

Figure 7-28.—Air compressor cylinder arrangements:
(A) Low- and medium-pressure cylinders; (B) high-pressure cylinders.

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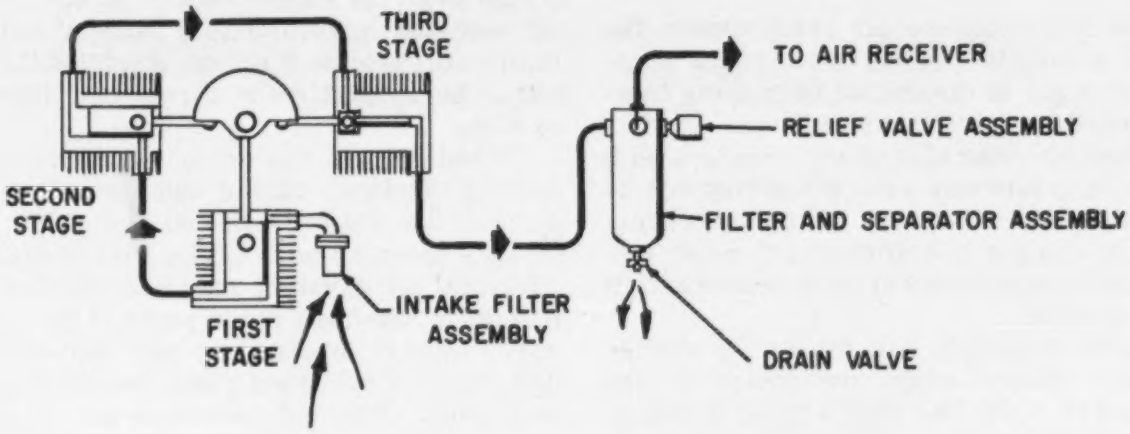

Figure 7-29.—Air compressor assembly.

stage consists of a cylinder, a reciprocating piston, and intake valve mechanism, and an exhaust valve mechanism. The reciprocating pistons are connected to, and actuated by, a master rod assembly attached to a shaft that is coupled to the power source by a flexible coupling. The intake and exhaust valve are usually hardened steel discs, carefully ground and lapped to seat snugly against a shoulder at the end of the cylinder bore (chamber). The valves are held against the valve seat by a tempered steel spring. As the piston travels downward, the cylinder bore forward of the piston is at a reduced pressure and the intake valve lifts from its seat and allows air to enter the area. As the piston travels upward, the intake valve closes and the air is compressed until the pressure overcomes the resistance of the exhaust valve spring. The exhaust valve is then lifted from its seat and the compressed air in the cylinder escapes through the outlet fitting into the interstage tubing.

To compensate for the volumetric decrease of the air as it is compressed, the cylinder bores and piston displacement of the three stages are progressively decreased. The first-stage cylinder is the largest, receiving a relatively large volume of ambient air and compressing it into a smaller volume for delivery to the medium sized second-stage cylinder. Here, the compression cycle is repeated, the supercharged inlet air being raised to a higher pressure and applied to the third-stage cylinder. The compression cycle is completed and the air is raised to its ultimate delivery pressure in the third-stage cylinder. (This is an application of Boyle's law discussed in chapter 2.)

NOTE: These cycles compare with the number of stages of a particular compressor. For example, a six-stage compressor has six such cycles.

Compressor Lubrication

Unlike hydraulic pumps, which are lubricated by the liquid of the system passing through the moving parts, the pneumatic compressor requires a lubrication system for its moving parts.

Most compressors are lubricated by a simple but effective combination of pressure, splash, and mist principles. Normally the compressor base is used as the oil sump and oil pump housing. The oil level can be measured by a dip stick, or an oil level sight gage may be mounted on the outside of the base.

During compressor operation, sump oil enters the pump cylinders through ports in the cylinder walls on the up stroke of the piston. On the downstroke, the piston descends past the ports, preventing the escape of oil. The oil trapped in the cylinder is forced through a spray tube and is directed against the rapidly moving master rod. The impact forms a fine oil mist which fills the interior of the crankcase and provides lubrication of the master rod, bearing, pistons, connecting links, and other internal parts. Internal lubrication of the cylinders and valve mechanisms is aided by the small quantity of vapor drawn into the first-stage cylinder from the crankcase and passed on to the second and third stages through the interstage connecting tubes.

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Cooling

In some low-pressure air compressors the heat which normally results from rapid compression of a gas is dissipated before the temperature attains a troublesome level. This is accomplished by using aluminum cylinders with integral cooling fins and a fan which blows cooling air past the cylinders and interstage tubing. This type of cooling is sufficient for most low-pressure air compressors being operated in well ventilated spaces.

Most high-pressure and medium-pressure compressors aboard ships are cooled by sea water supplied from the ship's fire, flushing, or water service mains. The cooling water is generally available to each unit through at least two sources. Compressors located outside the larger machinery spaces are generally equipped with an attached circulating water pump as a standby source of cooling water.

The cooling water is circulated through the compressor in much the same manner as an automobile engine. The path of water in the cooling water system of a typical four-stage compressor is illustrated in figure 7-30. Not all systems have identical paths of water flow, but in all systems it is important that the coldest water be available for circulation through the system.

When an oil cooler is incorporated in the cooling system, valves are usually provided so that the water to the oil cooler can be controlled independently of the rest of the system. Thus, oil temperature may be controlled without harmfully affecting other parts of the compressor. Next in importance are the intercoolers and aftercoolers, then come the cylinder jackets and heads. The high-pressure air compressors require from 6 to 25 gallons of cooling water per minute, while medium-pressure air compressors require from 10 to 20 gallons per minute.

Since sea water is used as the cooling agent, all parts of the circulating system must be of corrosion-resisting materials. The cylinders and heads are therefore composed of gun metal or valve bronze composition, with water jackets

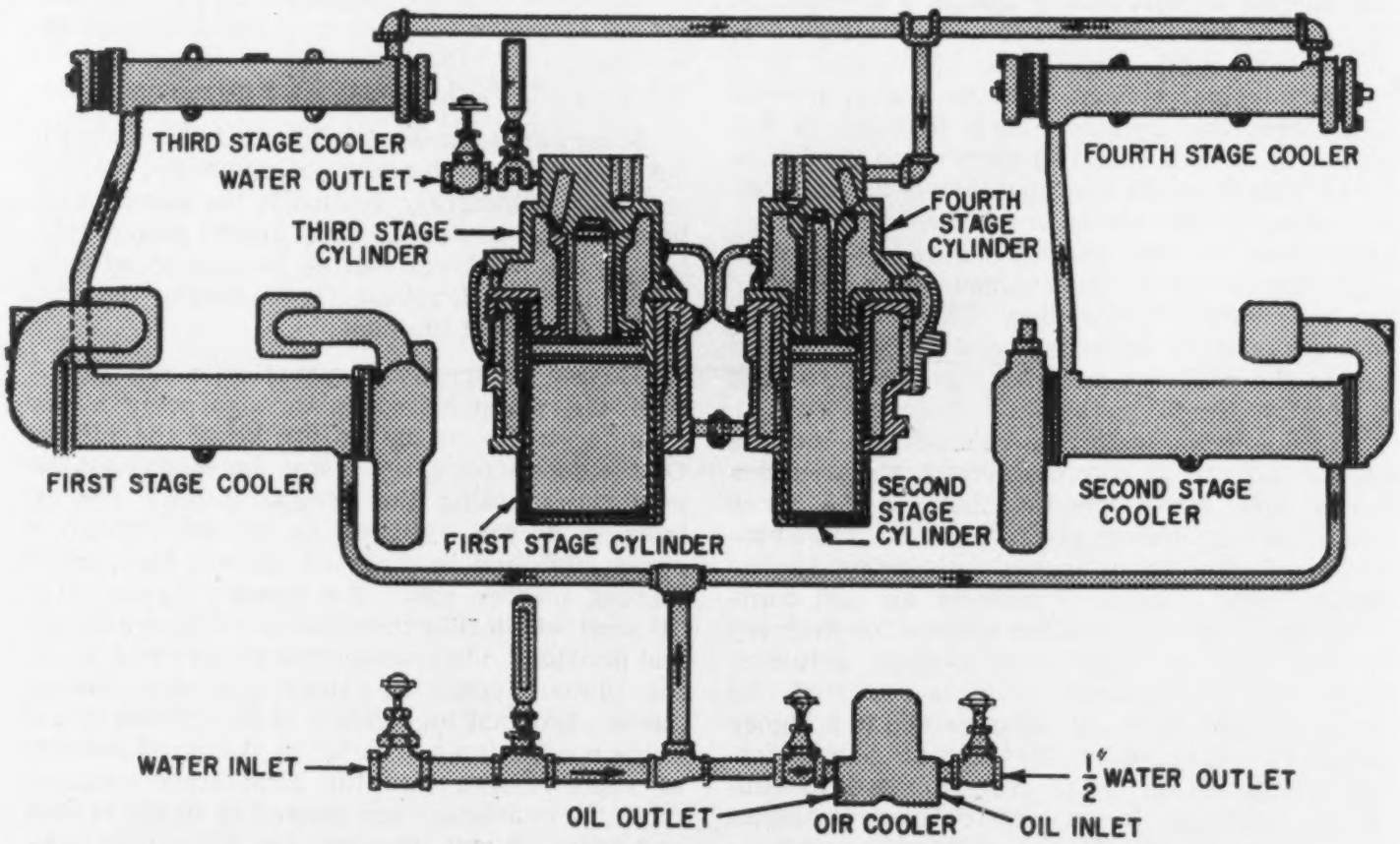

Figure 7-30.—Cooling water system in a typical multistage air compressor.

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cast integral with the cylinders. Each cylinder is fitted with a liner of special cast iron or steel to withstand the wear of the piston. The cylinder jackets are fitted with handholes and covers so that water spaces may be inspected and cleaned. Jumper lines are generally used to make water connections between the cylinders and heads, since these prevent any possibility of leakage into the compression spaces. In some compressors, however, the water passes directly though the joint between the cylinder and the head. With this latter type, extreme care must be taken to insure that the joint is properly sealed to prevent leakage which, if allowed to continue, would ruin both the cylinder liner and the piston.

The intercoolers and aftercoolers remove the heat generated during compression and cause the condensation of any vapor that may be present. This prevents unwanted accumulations at low points, water hammer, freezing or bursting of pipes in exposed locations, faulty operation of pneumatic tools and equipment, and possible damage to electric apparatus where air is used for cleaning. The removal of heat is also required for economical compression. During compression the temperature of the air is increased, thus causing the air to expand to a larger volume which, in turn, requires a corresponding increase of work to compress it. (The effect of changes in temperature on compressed gas is discussed in chapter 2.) Multistaging and cooling of the air between stages reduce the power requirement for a given capacity. The intercooling reduces the maximum temperature in each cylinder and thereby reduces the amount of heat which must be removed by the water jacket at the cylinder. Also, the resulting lower temperature in the cylinder insures good lubrication of the piston and the valves. Both the intercoolers and the aftercoolers are of the same general construction, except that the aftercoolers are designed to withstand a higher working pressure than the intercoolers.

Water-cooled intercoolers may be of the straight tube and shell type or, if size permits, may be of the coil type. In coolers with air pressure above 250 psi, the air flows through the tubes. Suitable baffles are provided in tubular coolers to deflect the air or water in its course through the cooler. In coil type coolers the air passes through the coil, with the water flowing around the outside.

Air-cooled intercoolers and aftercoolers may be of the radiator type or may consist of a bank of finned copper tubes located in the path of blast air provided by the air compressor.

Automatic temperature shutdown devices are fitted on all recent designs of high-pressure air compressors. Thus, if the cooling water temperature rises above a safe limit, the compressor will stop and will not restart automatically. Some compressors are fitted with a device that will shut down the compressor if the temperature of the air leaving any stage exceeds a preset value.

Compressor Assembly Components

As previously stated, certain other components are often considered as part of the compressor assembly. A brief description of these components is given in the following paragraphs. They are described in detail in other sections of this course, as indicated.

A filter and a moisture separator are incorporated in the line between the compressor and the receiver tank. Their purpose is to remove as much dirt and moisture as possible before the air enters the system. Filters and separators are discussed in chapter 6.

An air receiver or reservoir is installed in or near each space housing air compressors. The receiver acts as a supply tank and a storage tank for the pneumatic system. Air receivers are explained in chapter 6.

An unloading system that removes the compression load from the compressor while the unit is starting and automatically applies the load after the unit reaches operating speed is installed on most systems. Unloading valves are covered in more detail in chapter 10.

A pressure relief valve is installed in the assembly. It exhausts compressor discharge air to the atmosphere when the air pressure in the equipment being charged exceeds a predetermined maximum value. Pressure relief valves are described in chapter 10.

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CHAPTER 8

TYPES OF PACKING MATERIAL

One of the major problems that has always been present in fluid power systems is that of finding suitable packing materials for the various types of systems. These packing materials are commonly referred to as seals.

The seals used in fluid power systems and component units are of two general classes. One is the packing, which is used to provide a seal between two parts of a unit which move in relation to each other. The other class is the gasket, which is a seal between two stationary parts. This classification will apply in most cases; however, deviations may be found in some technical publications.

Seals are made from several different types of materials. The type of material used depends upon several factors. Pressure, temperature, type of fluid, and type of motion are a few of the factors that determine the type of material from which the seals must be made. Leather, synthetic rubber, natural rubber, cork, asbestos, Teflon, and metal are a few of the materials most commonly used. Synthetic rubber, cork, and leather seals are designed primarily for use with petroleum-base fluids; natural rubber seals are used with nonpetroleum-base fluids; and Teflon and metal seals may be used with either type of fluid. Asbestos material is used where heat is a problem.

The selection of the correct packings and gaskets and their proper installation are important factors in maintaining an efficient fluid power system. Manufacturers specify the type of packings and gaskets to be used in their equipment, and their instructions should be followed in replacing these items. If the proper part is not available, careful consideration should be given to the selection of a suitable substitute. The Bureau of Ships Technical Manual and other applicable technical manuals should be consulted if doubt exists in selecting the proper packing.

GASKETS

In selecting a gasket, the manufacturer has two major objectives. These objectives are to successfully prevent the escape of fluid and to prevent the entry of foreign matter into an assembly or component.

Effective seals are best obtained when the joint and the gasket are considered as a unit in the design stage. The best gasket will not seal a poorly designed joint, nor will a superbly engineered joint be sealed by a poor quality or improperly selected gasket.

To meet all the various sealing requirements, manufacturers have developed many types of gaskets. A few of the more common types are discussed in the following paragraphs.

NEOPRENE GASKETS

One of the materials most widely used in making gaskets for fluid power systems is neoprene (sometimes referred to as chloroprene), a synthetic rubber and fiber composition which comes in sheet form to be used between flat surfaces and in molded packing rings to be used around movable shafts and rods. Since neoprene is flexible, it is often used in sheet form at points where a gasket must expand enough to allow air to accumulate, as with cover plates on supply tanks, etc.

Over a period of time, oil tends to deteriorate the material used in making neoprene gaskets. For this or mechanical reasons, small particles of the material may be cast free in the system, and may restrict passage of the fluid. The condition of the gasket must therefore be checked whenever the unit is disassembled.

Since neoprene gasket material is soft and flexible, it may become misshapen, scratched, or torn. Great care is therefore necessary in working with neoprene gaskets. Shellac, gasket

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sealing compounds, or "pipe dope" should never be used with sheet neoprene.

CORK GASKETS

The physical properties of cork composition gaskets make them among the most versatile and widely used gaskets. Cork gaskets have several features which make them ideally suited as a sealing material. A few of the more common properties are discussed in the following paragraphs.

The compressibility of cork composition gaskets makes them well suited for confined applications where no relief for side flow can be provided. The compressibility of the cork also makes a good seal which can be used under various pressures and allows the gasket to be cut to any desired thickness to fit any surface, while still forming an excellent seal.

Cork is generally recommended for use where sustained temperature at the gasket line does not exceed 275° F.

Cork requires the same care in disassembly as any other soft gasket material. The condition of the cork gasket should be checked for defects when a unit is disassembled, so that small particles will not be cast off into the system during use.

SYNTHETIC RUBBER GASKETS

The materials used in synthetic rubber gaskets are either of a neoprene or nitrile-butadiene base. These gaskets are available in wide ranges of density, tensile strength, and elongations.

Many factors contribute to make synthetic rubber gaskets ideal for seals. The elasticity of the material makes the use of the gaskets easier in many applications. Since synthetic rubber gaskets are virtually impermeable (prevent passage of fluid) in their uncompressed state, they require less sealing load than many other types of gaskets. Synthetic rubber gaskets are used in a wide variety of applications and are capable of functioning in temperature ranges as wide as -65° F to +300° F.

CORK AND RUBBER GASKETS

Cork and rubber gaskets are made by combining synthetic rubber and cork. This combination allows a sealing material which has the properties of either of the two materials. This means that gaskets can be made with the compressibility of cork, but with a resistance to fluids comparable to the specific synthetic rubber on which they are based. At the same time gaskets can also be made with the noncompressibility of rubber, but with many of the sealing properties of cork. This allows many variations in the designing of a suitable material for a seal.

Cork and rubber gaskets are generally recommended for use in the temperature range of -20° F to +275° F.

METAL GASKETS

One of the most common metal gaskets used in Navy equipment is the copper gasket. Therefore, copper gaskets are discussed in this chapter in lieu of other metal gaskets.

Copper gaskets are used extensively in naval ordnance systems, both in the form of flat copper rings used under adjusting screws, etc., to give oil seals, and as molded copper rings to be used with speed gears, etc., operating under high pressures. Either type is easily bent and requires careful handling. In addition, copper becomes hard when used over long periods or if subjected to compression. Whenever a unit or component is disassembled, the copper gasket rings should be replaced. However, if a new gasket is not available and the part must be repaired, then the gasket should be softened by annealing. (Annealing is the process of heating a metal, then cooling, so as to make the metal more pliable and less brittle.)

PACKINGS

Packings are made of synthetic or natural rubber, asbestos, plastics, hemp, flax, leather, lead, carbon, and other metallic substances. They are generally used as running seals; that is, in units that contain moving parts, such as actuating cylinders, pumps, valves, etc. Packings are made in the form of O-rings, Quad-rings, V-rings, and U-rings, each designed for a specific purpose. Figure 8-1 illustrates some of these packings. A section is cut out of each packing to show its cross-sectional shape. A few of the more common packings used in Navy equipment are discussed in the following paragraphs.

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O-RINGS

An O-ring, as shown in figure 8-1, is round in cross section. O-rings are made of resilient and elastic rubber or a synthetic rubber compound. All O-rings are molded and trimmed to extremely close tolerances in cross-sectional area, inside diameter, and outside diameter. The O-ring is generally fitted into a rectangular groove machined in the mechanism to be sealed.

O-ring seals are used for preventing both internal and external leakage. An O-ring seals by distortion of its resilient, elastic compound to fill the leakage path.

Figure 8-2 shows the proper installation of an O-ring seal. The clearance for the O-ring is less than its free outer diameter, and the O-ring is squeezed diametrically out-of-round even before the application of pressure (fig. 8-2 (A)).

When pressure is applied to the O-ring, the seal moves away from the pressure into the path of the leakage (fig. 8-2 (B)). The O-ring seal is designed so that the seal flows up to the passage, thus completely sealing it against leakage. The greater the pressure applied, the tighter the seal becomes. When the pressure is decreased, the resiliency and elasticity of the seal results in the O-ring returning to its natural shape.

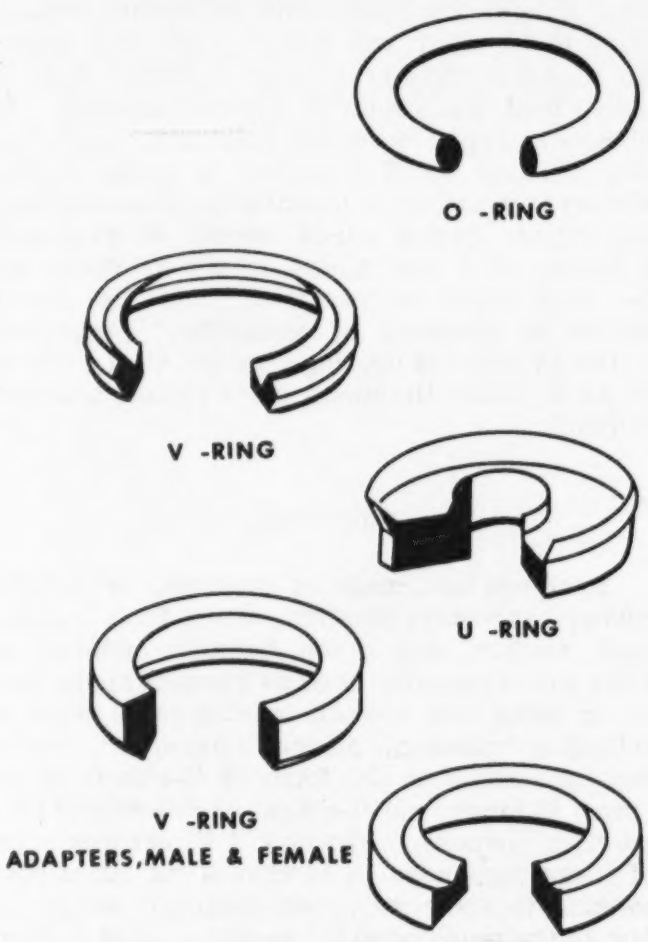

Figure 8-1.—Packing rings.

O-ring seals have been used in aircraft hydraulic system components for several years and are now used in all types of fluid power systems.

Figure 8-3 shows a typical O-ring installation. Some of the precautions that must be observed at installation are discussed in the following paragraphs.

The first step in replacing an O-ring is to identify it both as to size and material. The size is indicated by a dash number, which always follows the part number of the O-ring. For example, in the part number MS28778-6, the -6 indicates the size.

After determining that the replacement seal is made of the correct material and is of the proper size, the seal should be inspected visually for cuts, nicks, or flaws and discarded if any defects appear. NOTE: More information on identification and inspection of O-rings is presented later in this section.

Prior to installation, the O-ring must be properly lubricated to insure good service life. The O-ring, grooves, and all surfaces over which the O-ring must slide should be lubricated with the fluid in which it will operate, if applicable; otherwise, petrolatum or other specified lubricant should be used.

O-rings will wear out very rapidly when they are not properly lubricated. In pneumatic systems, the O-rings must be coated with a lubricant which has a high melting point. Barium and lithium soap grease is recommended for use in low-pressure pneumatic systems, while a silicone lubricant is recommended for pneumatic systems which have pressures of 1,000 psi or more.

Another method of lubricating O-rings is to install felt washers on both sides of the O-ring. These washers will retain the lubricant for a fairly long time. Installations and fittings can also be provided so that the washers can be lubricated periodically.

When installing an O-ring, use extreme care to prevent scratching or cutting the seal on threads or sharp corners. Also make certain that it is not installed in a twisted condition, for it will not function correctly if twisted.

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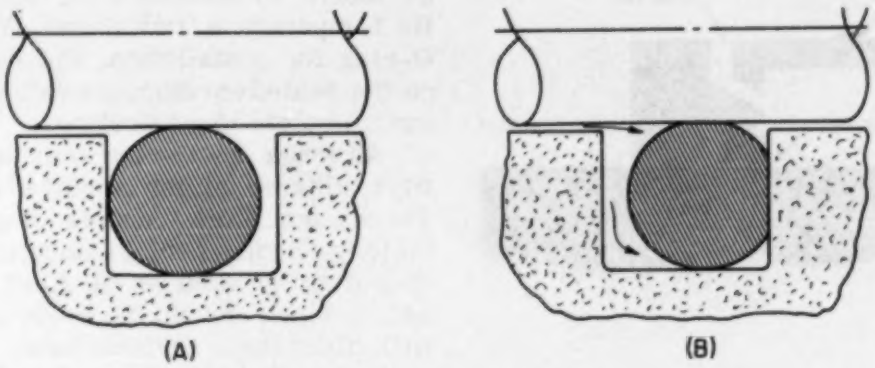

Figure 8-2.—Properly installed O-ring.

To facilitate removing an O-ring seal, a special tool may be made of soft iron, aluminum, or brass rod. (See fig. 8-4.) Be sure that the edges are flattened and that the burrs and rough surfaces have been removed by polishing.

The O-ring seal, when used alone, is limited to systems having a maximum operating pressure of 1,500 psi or less. This is particularly true when it is used as a "running seal." In the event the seal is subjected to high pressure (3,000 psi, for example), it may become pinched. Figure 8-5 shows a set of O-ring seals being pinched because of high pressure. This condition may be prevented by using leather nonextrusion devices. By definition, an extrusion is a shape formed by passing material through a die. A nonextrusion device is commonly referred to as a "backup washer." Backup washers are discussed later in this chapter.

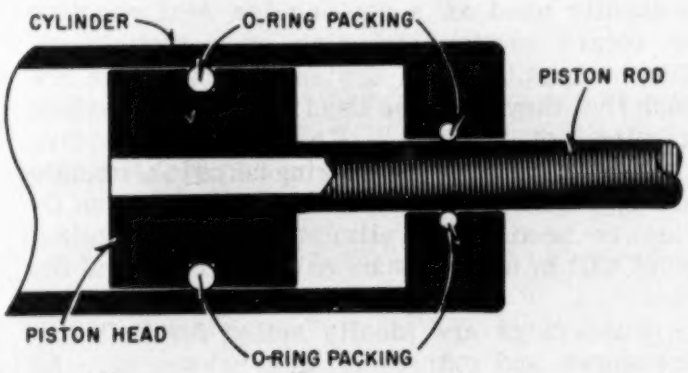

Figure 8-3.—Typical O-ring installation.

Identification and Inspection

Individuals working with fluid power systems must be able to positively identify, inspect, and install the correct size and type O-ring for every application in order to insure the best possible service.

The task of procuring and positively identifying the correct seal can be difficult since part numbers cannot be put directly on the seals. This situation is further confused by the fact that there is a continual introduction of new types of seals and the obsolescence of others.

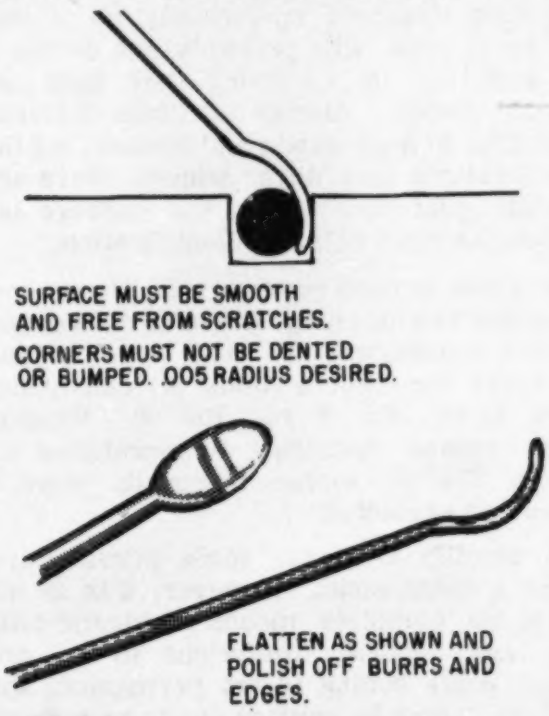

Figure 8-4.—O-ring removal tool.

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TOXIN - a poison formed by an organism.

VASCULAR - pertaining to the tissues of plants that conduct fluids.

VECTOR - an agent that transmits disease.

VIRULENCE - relative strength or ability to cause disease.

VIRUS - a pathogenic entity which is not visible by any optical microscope.

WILT - a vascular disease which interferes with uptake of water and nutrients by a plant.

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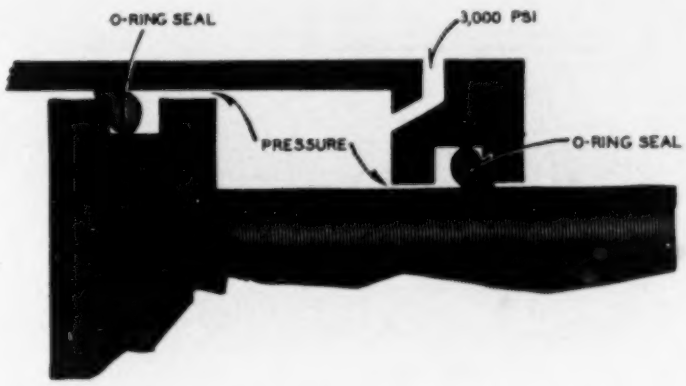

Figure 8-5.—O-ring seals—pinched condition.

Because of the difficulties with color coding, O-rings are made available in individual hermetically sealed envelopes, labeled with all pertinent data. (See fig. 8-6.) It is recommended that they be procured and stocked in these envelopes.

When selecting an O-ring for installation, information printed on the envelope should be carefully observed. If an O-ring cannot be positively identified, it should be discarded.

The components from which O-rings are manufactured have been formulated for various operating conditions, temperatures, and fluids. An O-ring designed specifically as a static (stationary) seal will probably not do the job when installed on a moving part such as a hydraulic piston. Almost all kinds of O-rings are similar in appearance and texture, but their characteristics may differ widely. Here again the basic part number on the package label provides the most reliable identification.

Advances in fluid power systems have necessitated new O-ring compositions to meet changed operating conditions. O-rings were originally established for use in fluids at temperatures ranging from -65° F to +160° F. When new designs raised operating temperatures to a possible 275° F, more compounds were developed and perfected.

To identify O-rings, some manufacturers provide a color code. However, this is not a reliable or complete means of identification. There are several limitations to the color coding. Some coding is not permanent, while on others it may be omitted due to manufacturing difficulties or interference with operation. Furthermore, the color coding system provides no means to establish the age of the O-ring or its temperature limitations. When selecting an O-ring for installation, the basic part number on the sealed envelope provides the most reliable and complete identification.

Although an O-ring may appear perfect at first glance, slight surface flaws may exist. These are often capable of preventing satisfactory O-ring performance under the variable operating pressures of fluid power systems, and O-rings should be rejected for flaws that will affect their performance.

By rolling the ring on an inspection cone or dowel, the inner diameter surface can be checked for small cracks, particles of foreign material, and other irregularities that will cause leakage or shorten the life of O-rings. The slight stretching of the ring when it is rolled inside out will help to reveal some defects not otherwise visible. A further check of each O-ring should be made by stretching it between the fingers, but care must be taken not to exceed the elastic limits of the rubber. Following these inspection practices will prove to be a maintenance economy. It is far more desirable to take care identifying and inspecting O-rings than to repeatedly overhaul components because of faulty seals.

QUAD-RINGS

The Quad-ring is very similar to the O-ring discussed previously, the major difference being that the Quad-ring has a modified square type of cross section, as shown in figure 8-7. Quad-rings are molded and trimmed to extremely close tolerances in cross-sectional area, inside diameter, and outside diameter.

The Quad-ring is relatively new and is presently used as a packing for reciprocating or rotary motion and also as a static seal. The composition and design of Quad-rings are such that they could be used in most applications in place of O-rings. The relatively square cross section of the Quad-ring helps to eliminate the spiral twist that is encountered when an O-ring is used. The elimination of this spiral twist will in many instances extend the life of the seal.

Quad-rings are ideally suited for both low pressures and extremely high pressures. An example of a Quad-ring used as a cover gasket is depicted in figure 8-8.

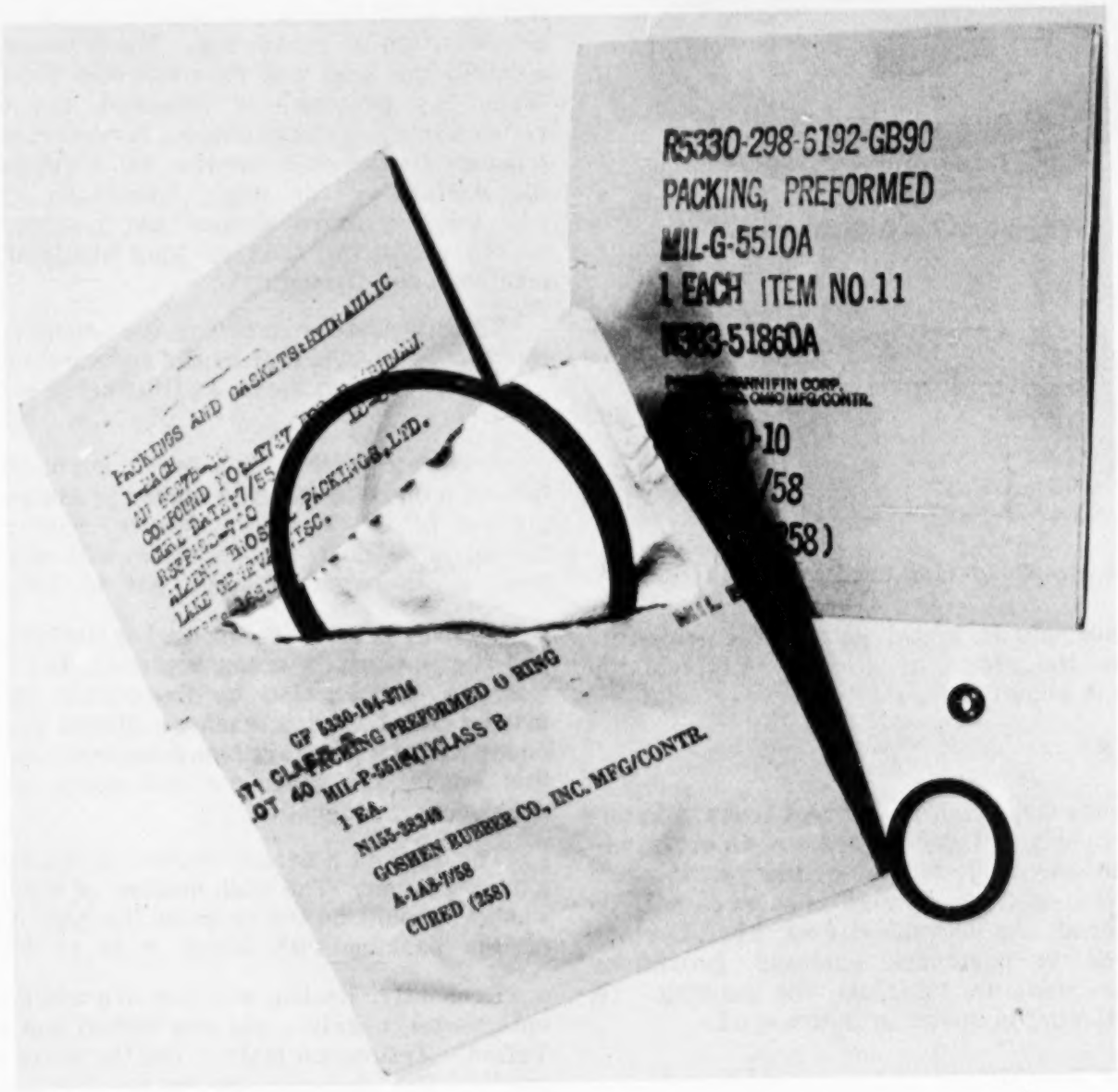

Figure 8-6.—O-ring in sealed envelope as drawn from supply.

V-RINGS

A V-ring seal will provide a seal in only one direction. Therefore if a piston is to move in two directions under fluid pressure, two sets of V-rings must be used. V-rings are always installed with the open end of the V facing the pressure. Male and female adapters are used in conjunction with V-rings for reinforcement. (See fig. 8-9.)

Installation of the V-ring is slightly different from that of O-ring seals. The rings are placed in their respective grooves, one at a time. Make sure that they are seated properly; then tighten the adjusting nut (fig. 8-9). The adjusting nut should be tightened enough to hold the seals securely. If possible, the unit should be operated by hand to check the adjustment.

CUP PACKING

Cup packings are predominantly used as piston seals in fluid power systems. A cup packing is generally made of synthetic rubber

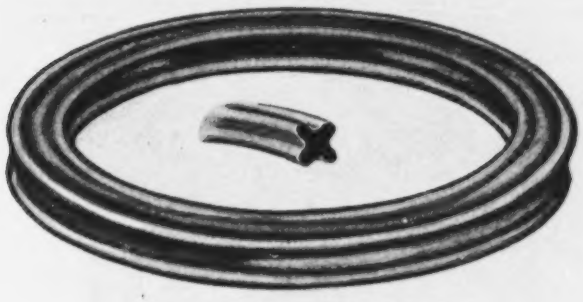

Figure 8-7.—A Quad-ring.

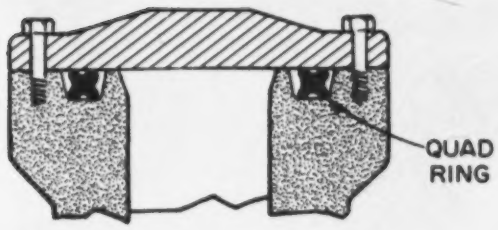

Figure 8-8.—Quad-ring used as a cover gasket.

or leather and is made, just as the name implies, in the shape of a cup. A typical cup packing is shown in figure 8-10.

U-RINGS

U-rings are used to prevent leakage in one direction only. Typical uses are in brake assemblies and brake master cylinders. U-rings are never used where high pressures will be encountered. As with the O-ring, when U-rings are used in pneumatic systems, provisions must be made to lubricate the packing. A typical U-ring is shown in figure 8-11.

FLANGE PACKINGS

Flange packings are recommended for use only in low-pressure applications. Flange packings are the least desirable of the previously mentioned types of packings. They are normally used only where there is not sufficient space for either a V-ring packing or a U-ring packing. Flange packings are sometimes referred to as "hat packings." A typical flange packing is shown in figure 8-12.

BACKUP WASHERS

One of the major problems in using seals is the problem of extrusion. Extrusion may be defined as distortion, under pressure, of portions of a seal into the clearance between mating metal parts. Figure 8-13 illustrates an extrusion of an O-ring. When pressure is applied, the seal will flow into the clearance. When the pressure is released, the O-ring returns to its original shape. However, the extrusion groove will appear as a cut beneath the surface of the ring. Eventually, the cut will become more severe and a section will be cut out of the O-ring. This will lead to the failure of the O-ring.

To eliminate extrusion, the manufacturer must use either harder seals, reduce clearance, or use backup washers as illustrated in figure 8-14.

A backup washer is a device normally used behind a seal to allow a higher pressure to be applied to the seal. A backup washer used behind an O-ring, for example, will extend the seal pressure from 1,500 psi to 3,000 psi.

When a part or component is disassembled and the packing is being replaced, the backup washers should also be thoroughly checked. Inspection of backup washers should include a check that surfaces are free from irregularities, that edges are clean-cut and sharp, and that scarf cuts are parallel.

The size of a backup washer is indicated by a dash number. The dash number of the backup washer should be the same as the dash number of the packing with which it is to be used.

Presently, backup washers are made of thin split metal, bakelite, chrome tanned leather, or Teflon. Teflon and leather are the most widely used. The material the backup washers are made of determines the shelf life limitations, and the manufacturers' recommendations, along with the standards established by the Navy, should normally be followed.

LEATHER BACKUP WASHERS

The chrome tanned leather backup washer is made of leather with hair on the outer side of the leather. The outer side of the leather is called the grain side while the cut or inside of the leather is called the flesh side. The backup washer is always installed in the gland (groove). The flesh side of the backup washer is always next to the gland. This positions the grain side to the seal. (In this case, the seal is an O-ring.)

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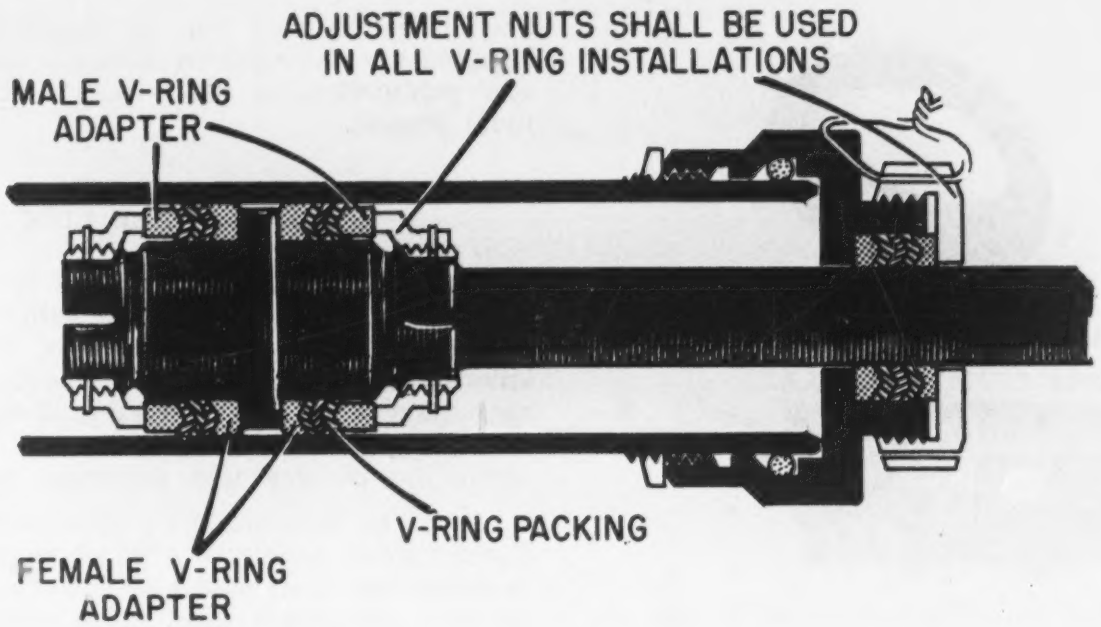

Figure 8-9.—V-ring installation.

If pressure is exerted on the seal in one direction only, place the backup washer away from the pressure. If pressure is applied alternately from both directions, one backup washer must be placed on each side of the O-ring.

NOTE: Leather backup washers should never be cut, as results have shown that when pressure is applied, this will be the section most likely to fail.

TEFLON WASHERS

Backup washers made of Teflon do not deteriorate with age, are unaffected by any system fluid or vapor, and tolerate temperature extremes in excess of those encountered in high-pressure fluid power systems. They are procurable under a number of basic part numbers and are normally interchangeable; that is, any Teflon backup washer may be used to replace any other Teflon backup washer if it is of proper overall dimension to support the applicable packing.

NOTE: In checking the Teflon spiral backup washers, make sure that the coils do not separate more than one-fourth inch when unrestrained.

Figure 8-10.—Typical cup packing.

INSTALLATION

Unfortunately, the length of time that a seal will function properly depends on many factors; many of them unpredictable. Therefore, it is almost impossible to say that a seal will wear out in a specified time.

Figure 8-11.—Typical U-ring.

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Figure 8-12.—Flange packing.

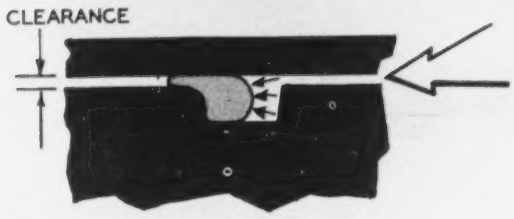

Figure 8-13.—Extrusion of an O-ring.

Each time a component or unit is disassembled the seals should be carefully inspected. If there is any doubt as to their condition, they should be replaced. In most cases, automatic replacement of the seal is standard procedure. The manufacturers' recommendations along with the previous experience of the personnel repairing the unit or component should be the main criteria for determining when to replace a specific seal. Installation of seals should be carried out as specified in the Maintenance Instructions Manual, manufacturers' publication, or the Bureau of Ships Technical Manual.

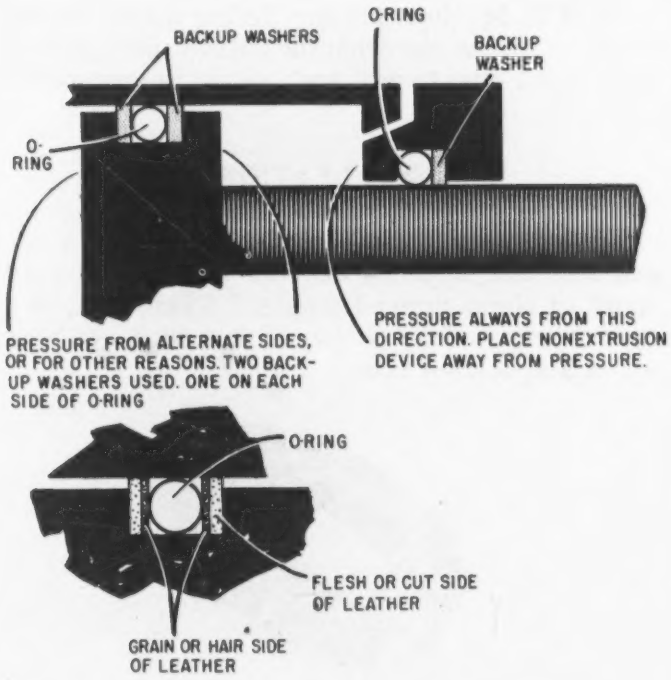

Figure 8-14.—O-ring with backup washers.

PACKING SHELF LIFE

Packing shelf life goes hand in hand with inventories. It has been found with experience that packings deteriorate with age. Therefore, knowing and understanding packing shelf life will save many hours of unnecessary toil experienced in repacking a unit and having it still leak because the packing was defective due to age.

Prior to the installation of natural and synthetic rubber packings, a check must be made to determine whether these parts are acceptable for use. All natural and synthetic rubber packing containers are marked to facilitate an age control program. This information is available for all packings used, regardless of whether the packing is stocked on shipboard at stock distribution points, or furnished as an integral part of a component. Positive identification, indicating the source, "cure date," and "expiration date" must be made of packings.

The age control of all natural packings is based upon the cure date stamped on the manufacturer's unit package, intermediate package, and shipping container. Shelf life control of all packings is governed by the expiration date stamped beside the manufacturer's cure date on each package.

Expiration date is the date after which a packing CANNOT be used in service, and time of delivery means the date of acceptance by the purchaser. All packing is scrapped if not put into use by the time of the expiration date.

Cure date means the time the packing was manufactured and is designated by the quarter of the year and the year of manufacture. Packings manufactured during any given quarter are considered one-quarter old at the end of the succeeding quarter. For purposes of explaining the coding used by manufacturers to designate the cure date, each year is divided into quarters as follows:

1. First Quarter: January, February, and March.
2. Second Quarter: April, May, and June.
3. Third Quarter: July, August and September.

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4. Fourth Quarter: October, November, and December.

Tables 8-1 and 8-2 establish shelf life limitations of natural and synthetic rubber for Supply Points and Repair Activities and Fleet Service Vessels.

In order to maintain components in an RFI (ready for issue) state, all packing assembled in a component must be removed and scrapped on its expiration date. The component must then be reassembled with new packing, not to exceed 4 quarters (1 year) in age. After repacking, the component must be redated to show the expiration date of the packing just installed. It should be returned to storage until it is required for service, or reexamination, whichever occurs first.

To identify the age of natural or synthetic rubber packing, use the following procedure:

1. On the manufacturer's containers, stamp the cure date by quarter of the year and the year in accordance with Specification MIL-STD-129. The quarter of the year should be separated by the letter "Q" to indicate whether first, second, third, or fourth quarter. Containers of packings from manufacturers marked with an illegible cure date are cause for rejection of delivery.

2. An expiration date should also appear on the manufacturer's unit package to facilitate scrapping. The date should be specified by month and year, 2 years after the manufacturer's cure date, using the last month of the quarter.

EXAMPLE: 1Q66 Expiration Date: March 1968.

1Q66 means a cure date of the first quarter of the calendar year 1966. Expiration Date: March 1968 indicates the time when the usefulness of the packing expires.

Table 8-1.—Supply points and repair activities.

From: Cure Date	Maximum age in quarters
To: (1) Time of Delivery from manufacturer or his agent.	2 (6 months)
(2) Time of Delivery from source other than manufacturer or his agent.	4 (1 year)
(3) Time limit of shelf storage.	8 (2 years)

Table 8-2.—Fleet service vessels.

From: Cure Date for Service Installation	Maximum age in quarters
To: (1) Time of Installation for service use on equipment.	8 (2 years)
(2) Time for Replacement of packing in stored equipment.	8 (2 years)

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Natural or synthetic rubber packing must not be removed from the manufacturer's unit package until ready for use, and should be stored in an area protected from sunlight and drafts. The storage temperatures, also applicable to components in which these packings are installed, should normally range from 60° F to 100° F, and must not exceed 125° F.

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CHAPTER 9

CONTROL AND MEASUREMENT OF FLOW

It is all but impossible to develop a practical fluid power system without using valves, as it is equally difficult to manage a fluid power system without knowing how to control its valves and insure their efficient operation. The first part of this chapter includes a brief introduction and classification of the different valves used in fluid power systems. This is followed by detailed descriptions of those valves which control fluid flow.

Some fluid power systems require devices for measuring the quantity or rate of flow through the system. The latter part of this chapter is devoted to various types of flowmeters used for measuring flow.

INTRODUCTION TO VALVES

A valve is defined as any device by which the flow of fluid may be started, stopped, or regulated by a movable part which opens or obstructs passage. As applied to fluid power systems, valves are used for controlling the flow of the fluid, the pressure of the fluid, or the direction of the fluid flow. Fluid power system valves may be controlled manually, electrically, pneumatically, mechanically, hydraulically, or by combinations of two or more of these means.

Valves must be accurate in the control of fluid pressure and flow. Usually, no packing is used between the valving element and the valve seat since fluid leakage is reduced to a negligible quantity by precision machined surfaces, resulting in carefully controlled clearances. (Packing is required around valve stems, between lands of spool valves, etc.) This is another very important reason for using only the recommended fluid in the system and for keeping the fluid clean. Oxidation, rust particles, and other foreign materials such as dust, dirt, lint, etc., can cause considerable damage to precision valves. This contamination will cause valves to stick, may plug small orifices, or cause abrasion of the valving surfaces resulting in leakage through the valve. Any one of these can result in inefficient operation or complete stoppage of the equipment.

CLASSIFICATION OF VALVES

All the types of valves available for fluid power systems are too numerous to mention in this course. Most valves, however, are variations of three fundamental classes described in the following paragraphs.

Valves are sometimes classified as simple, compound, or direction valves, according to their method of operation. A simple valve requires only a single internal motion for its operation. Fluid acting on one side of the valve, for example, opens it against the resistance of gravity or a spring; or the valve is opened and closed manually by turning a screw so that a passage for the fluid is opened or closed. A compound valve involves a combination of internal motions for its operation. Directional valves are used to control the direction of flow of fluids along two or more paths.

As a general rule, simple valves include those which control the flow of fluid; while compound valves include those which control the pressure. Flow control valves are described in this chapter. Pressure control valves are discussed in chapter 10, while directional valves are described in chapter 11.

APPLICATIONS

Each type of valve used in fluid power systems has a specific purpose or, in some applications, a combination of different purposes. These applications and purposes are discussed in more detail as the different valves are described in this chapter and in chapters 10 and

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11. In general, however, the applications of valves according to their classifications, are briefly covered in the following paragraphs.

Flow control valves are used in fluid power systems to open and close a line to flow or to control the rate of flow through the lines. They are sometimes used as ON and OFF valves to isolate circuits of the system during certain operations.

The uses of pressure control valves include the regulation of system pressure, the protection of the system and components from pressure overload, and the control of the sequence of operation of certain components in some systems.

Among other applications, directional control valves are used to control the path of the fluid to operating components. For example, these valves are used to control the direction of rotation of actuating motors, and the direction of movement of actuating cylinders.

FLOW CONTROL VALVES

A typical example of a valve used to control flow is the ordinary water faucet. It is normally in the closed position allowing no flow. It can be fully opened allowing a full flow. The rate of flow is varied by turning the faucet handle clockwise or counterclockwise which changes the size of the opening of the faucet. Many of the flow control valves used in fluid power systems are similar in design and operation to the water faucet. Some of the different types of flow control valves used in fluid power systems are described in the following paragraphs.

PLUG VALVES

A plug valve, sometimes referred to as a cock, consists of a hollow cylindrical body into which is fitted a tapered cylindrical plug. Figure 9-1 is an exploded view of a plug valve, including a cross sectional view of the body. The top of the plug extends up through the gland, and can be turned with a wrench. In many plug valves, the plug terminates in a handle for manual control of the valve.

The body of the valve is permanently fixed in the line with holes or ports in the wall of the cylindrical body aligned with the flow of the fluid through the line. The plug, which also contains holes or ports, fits snugly into the valve body. When the plug is open the ports of the plug are in line with the ports of the body and allows the fluid to flow through the valve. (See fig. 9-2.) Flow is stopped by a quarter turn of the plug, which aligns the solid areas of the plug with the ports in the body. The handle of the plug is marked by some method to indicate whether the valve is open or closed.

Although the inside surfaces of plug valves are machined to give close contact, the meeting of metal with metal offers dangers of seizing. When plug valves stand normally in an open position the parts of the plug which provide the seal are not directly in contact with the fluid;

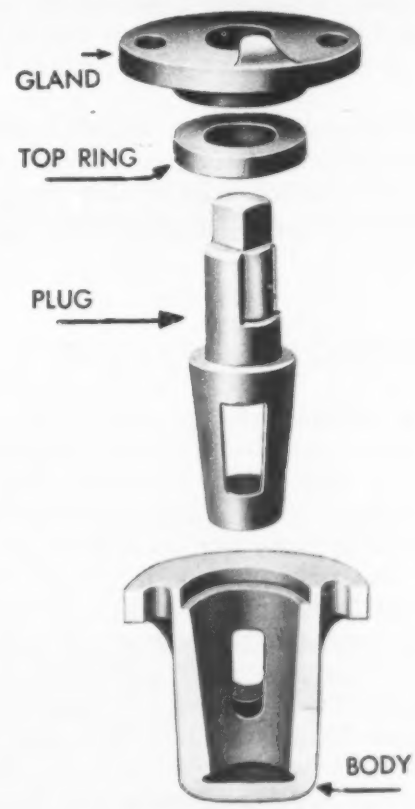

Figure 9-1.—Plug valve.

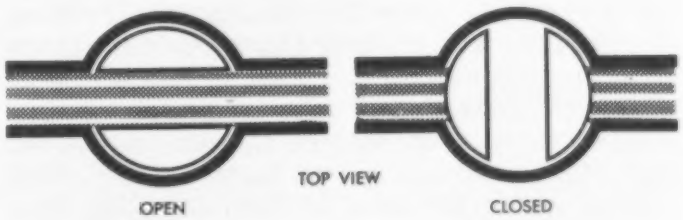

Figure 9-2.—Operation of the plug valve.

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but when the valve is normally closed the fluid will act on one of the sealing surfaces. Under ordinary conditions, however, plug valves can be easily opened or closed.

Plug valves are used as fully ON or fully OFF valves. They are not designed to be used in a semiopen position; that is, to throttle or vary the volume of flow. This is especially true if grooves in the wall of the body are filled with packing to separate metal from metal. In a partly open position, this packing would eventually wear away. In any event, unequal wear is encouraged if the valve remains in the partly open position. Small plug valves are sometimes used in systems containing liquids to free the system of accumulated air. The valve is opened so that the air can escape. When the liquid begins to flow continuously the valve is closed.

GATE VALVES

In this type of valve, flow is controlled by means of a wedge or gate, which can be moved up and down across the line of flow by a handwheel, to open and close the passage. The principal elements of this type valve are shown in cross section in figure 9-3. Part (A) shows the line connection and the outside structure of the valve; while (B) shows the wedge or gate inside the valve and the stem to which the gate and the handwheel are attached. When the valve is open, the gate stands up inside the bonnet, its bottom flush with the wall of the line. While the valve is closed, the gate blocks flow by standing straight across the line, where it rests firmly against two seats extending completely around the line.

Gate valves permit straight flow and offer little or no resistance to the flow of fluid when the valve is completely open. Although they are sometimes placed in the partly open position to restrict the rate of flow, gate valves are intended for use as fully open or fully closed valves. If the valve is left partly open, the face of the valve stands in the flow of fluid. This flow of fluid will act on the face of the valve causing it to erode.

Two different types of gates are used in the construction of gate valves. One type is a solid or hollow wedge. This type is satisfactory for small valves in low pressure systems. However, wedges are sometimes difficult to tighten and will leak when slightly worn. The other type consists

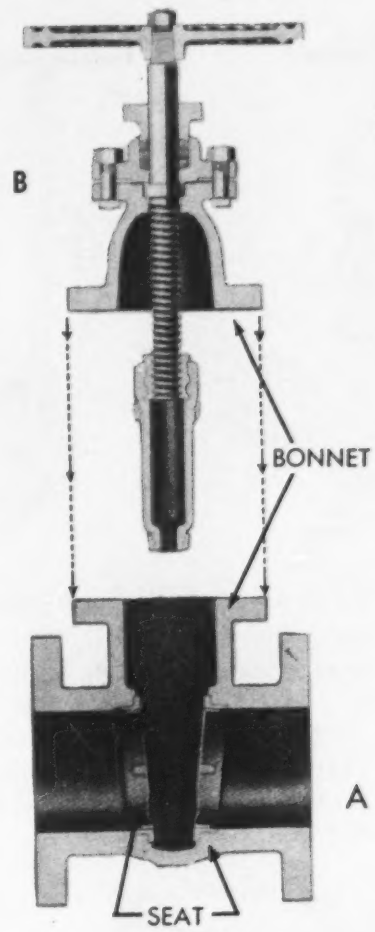

Figure 9-3.—Cross sectional view of a gate valve.

of two facing discs. By using discs a better closure is provided, since the discs are forced apart, snug against the valve seats, as they are moved into position. One arrangement for accomplishing this is shown in figure 9-4. One of the two facing discs, composing the valve, has been removed to show how the valve is constructed. Two cams with arms extending outward stand opposite each other on slanting surfaces in the space between the discs. As the discs move into the closed position the arm of each cam engages a lug on the body of the valve and is turned on the slanting cam bearing surface, forcing the discs against the valve gates during closure.

Gate valves are available in different types of stem connections. Figure 9-5 illustrates three different types. In figure 9-5(A), the stem screws down into the valve gate as the valve is opened. In this type the stem does not rise or fall outside the body of the valve as the valve is opened or closed. In figure 9-5(B), the stem

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Student References:

1. Cotton Disease Council and National Cotton Council, Cotton Diseases and Their Control.
2. Krebs, Alfred H., Agriculture in Our Lives, 2nd Edition; The Interstate Printers and Publishers, Inc., 1964.
3. U.S.D.A., Home and Garden Bulletin 46, Insects and Diseases in the Home Garden, 1961.
4. U.S.D.A., Home and Garden Bulletin 61, Lawn Diseases - How to Control Them, 1964.
5. University of Arizona Agricultural Extension Service Bulletin A-16, Alfalfa for Forage Production in Arizona, 1961.
6. University of Arizona, Department of Agricultural Education, Service Bulletin Number 3, An Introduction to Plant Diseases.

Teacher References:

1. Anderson, H. W., Diseases of Fruit Crops, McGraw-Hill, 1952.
2. Dickson, J. G., Diseases of Field Crops, McGraw-Hill, 1956.
3. Klotz, Leo J., Color Handbook of Citrus Diseases, Agricultural Publications, University of California, Berkeley, 1961.
4. U.S.D.A. Yearbook of Agriculture, 1953, Plant Disease.
5. Walker, J. C., Diseases of Vegetable Crops, McGraw-Hill, 1952.
6. Walker, J. C., Plant Pathology, McGraw-Hill, 1957.

Teaching Aids and Materials:

1. For cultures of pathogens:
   a. American Type Culture Collection, 12301 Parklawn Drive, Rockville, Md. (Catalog sent on request for $1.00 each)
   b. Department of Plant Pathology, University of Arizona
2. Glassware such as flasks, test tubes, petri dishes, culture media and other laboratory supplies obtainable from: General Biological Supply House, Inc. (Turtox) 8220 South Hoyne Ave., Chicago, Illinois.
3. Local grocery store or diseased area for inoculum.

Films and Slides:

1. University of Arizona, Bureau of Audiovisual Service, Design for Abundance.
2. University of Arizona, Department of Agricultural Education, Plant Diseases in Arizona, (Color slides and reference).

Resource People:

1. Extension plant pathologist
2. Local county agricultural agent

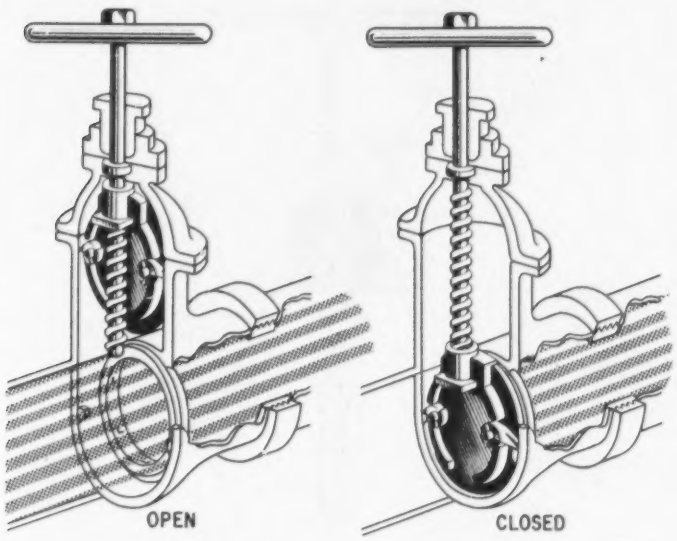

Figure 9-4.—Operation of gate valve.

rises outside the valve as the valve is opened, but the stem screw operates inside the body of the valve. In figure 9-5(C), the stem screw operates at the level of the handwheel, so that the stem rises independently of the wheel as the valve is opened. This is called the outside-screw-and-yoke type valve.

Valves with rising stems are used when it is important to know by immediate inspection whether a valve is open or closed. The non-rising stem type is least likely to leak, and requires less space. Gate valves are difficult to open or close if the pressure is high. Open and close valves slowly. Do not force the disc against the seat. If a valve fails to seat properly, open it slightly so that the sediment on the seat will flush away. If it still fails to seat, the system must be shut down and the valve disassembled to locate and correct the trouble.

GLOBE VALVES

Globe valves derive their name from their body shape. (It should be noted, however, that other types of valves may also have globular bodies; hence, the name may tend to be misleading.)

The controlling member of the globe valve, called the disc, is screwed directly on the end of the stem. The valve is closed by lowering the disc into the valve seat. Since the fluid flows equally on all sides of the center of support when the valve is open, there is no unbalanced

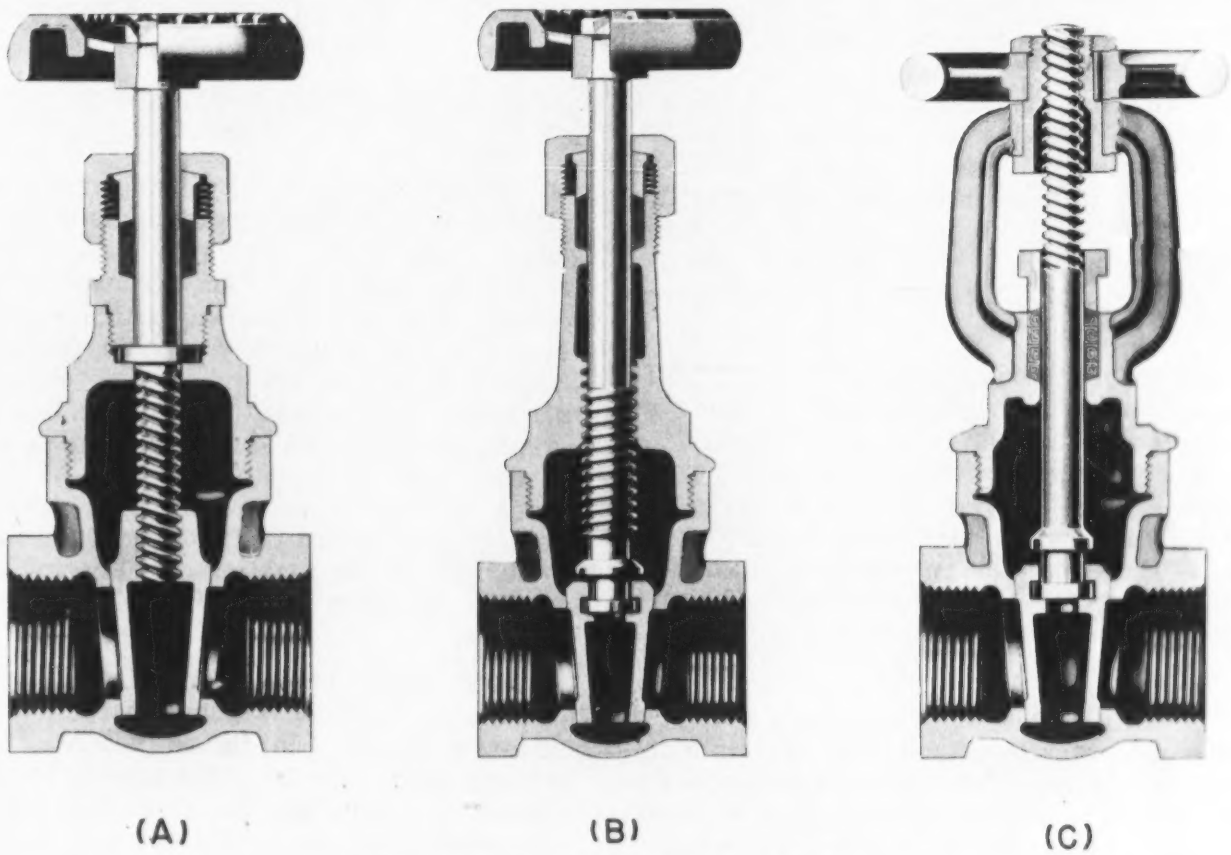

Figure 9-5.—Types of gate valves.

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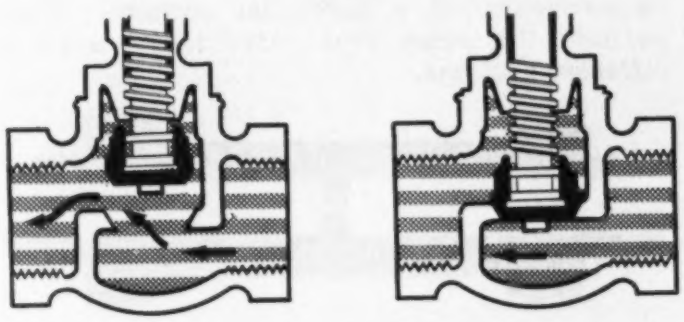

Figure 9-6.—Operation of a globe valve.

pressure on the disc to cause uneven wear. The operation of the globe valve is illustrated in figure 9-6.

The moving parts of a globe valve consist of a disc, valve stem, and a handwheel. Figure 9-7 (A) is an exploded view of a globe valve. The stem, which connects the handwheel and the disc, is threaded and fits into the threads in the valve bonnet. Discs are available in various designs. (See fig. 9-7 (B).)

When the valve is closed, the valve disc rests against the port, which is referred to as the valve seat. The edge of the disc and the seat are very accurately machined so that they form a tight seal when the valve is in the closed position. When the valve is open, the fluid flows through the space between the edge of the disc and the seat. The rate at which the fluid flows through the valve is regulated by the position of the disc. The valve must always be installed *with the pressure* against the face of the disc.

Although globe valves are sometimes used to throttle (vary) the rate of flow, they are most commonly used as fully open or fully closed valves.

NEEDLE VALVES

Needle valves are similar in design and operation to globe valves. Instead of a disc, a needle valve has a long tapered point at the end of the valve stem. Figure 9-8 is a sectional view of a needle valve. The long taper permits the needle valve to be opened or closed gradually. Needle valves are used to control flow into delicate gages which might be damaged if fluid under pressure were suddenly delivered to them. Needle valves are also used to control end operation of a work cycle, where it is desirable that a work motion be brought slowly to a halt; and at other points where precise adjustments of flow are necessary and where a small rate of flow is desired.

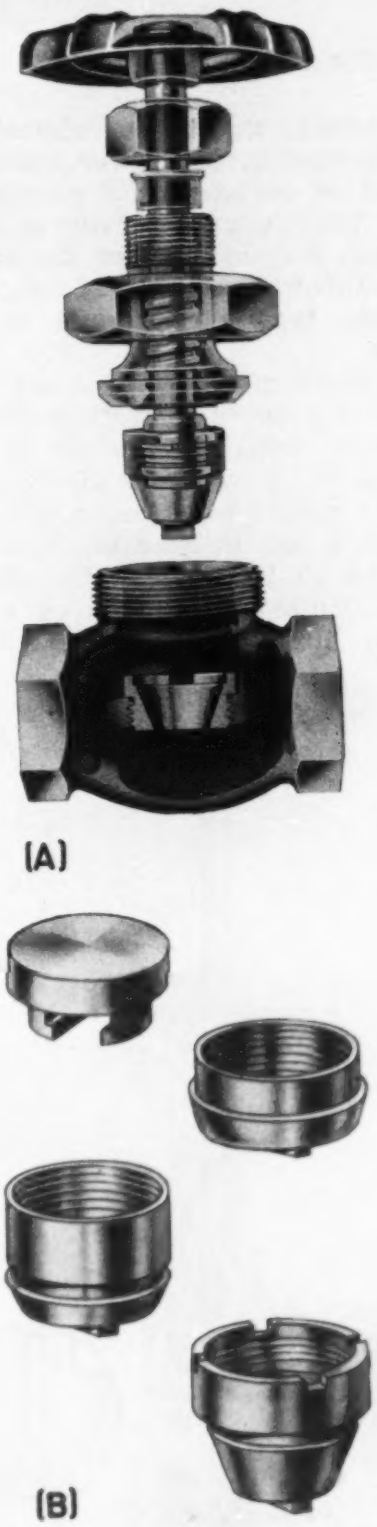

Figure 9-7.—Globe valve with various types of discs.

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Although many of the needle valves are of the manually operated type illustrated in figure 9-8, modifications of this valve are often used as variable restrictors, described in the next section.

RESTRICTORS

Restrictors, sometimes referred to as orifices, are used in fluid power systems to limit the speed of movement of certain actuating devices. They do so by serving as restrictions in the line, thereby limiting the rate of flow. Figure 9-9 shows an example of a typical restrictor. This type is referred to as a fixed restrictor.

Some types of restrictors are constructed so that the amount of restriction can be varied. One type of variable restrictor is illustrated in figure 9-10. This type is simply a modification of the needle valve previously described. Instead of a handwheel control, this valve is constructed so that it can be preadjusted to alter the time of operation of a particular subsystem. It can be adjusted to conform to the requirements of a particular system. This permits the same type valve to be used in different systems.

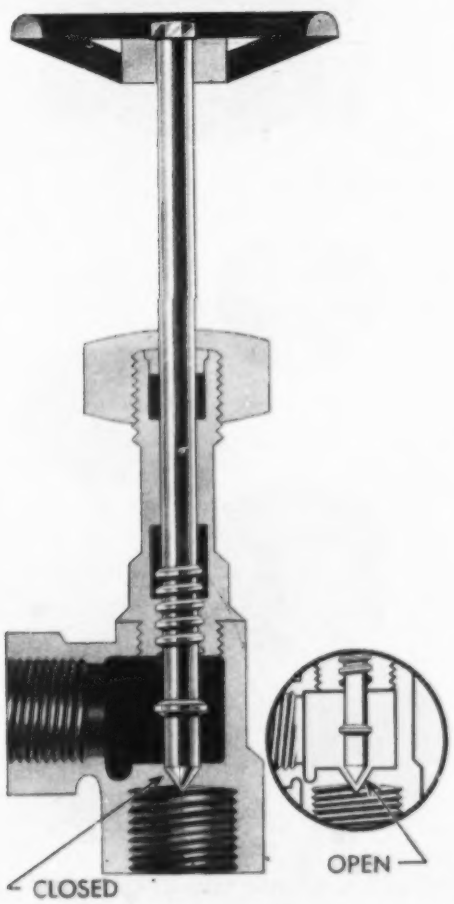

Figure 9-8.—Sectional view of needle valve.

Figure 9-9.—Fixed restrictor.

ORIFICE CHECK VALVES

Check valves are described in more detail in chapter 11, since their purpose is to control the direction of flow. However, they are used in conjunction with some types of flow control valves. The orifice check valve is an example, and is used in fluid power systems to allow normal speed of operation in one direction and a limited speed in the other. Some typical examples of orifice check valves are illustrated in figure 9-11.

Figure 9-11 (A) illustrates a cone-type orifice check valve. The cone (2) is moved off its seat whenever sufficient fluid pressure is applied at port (4), thus allowing free flow of fluid through the valve. Flow through the valve in the opposite direction is restricted by the size of the orifice (3) located in the center of the cone. Figure 9-11 (B) shows a ball-type orifice check valve. Fluid flow through the valve from left to right is normal, whereas fluid flow through the valve in the opposite direction is restricted by the size of the orifice (5) located in the housing of the valve.

An orifice check valve is often installed in the alternating line that carries fluid from the actuating device (for example, an actuating cylinder) as it is operated in the direction in which slower movement is desired. (The line which delivers fluid under pressure to the actuating device for one direction of operation becomes the line which carries the return flow from the actuating device during the opposite direction of operation. Hence, the term alternating line.) This causes the piston speed to be retarded, since fluid cannot escape from the other end of the cylinder any faster than the orifice will allow the fluid to enter the return line.

This type valve is frequently used in aircraft hydraulic systems in the subsystem which

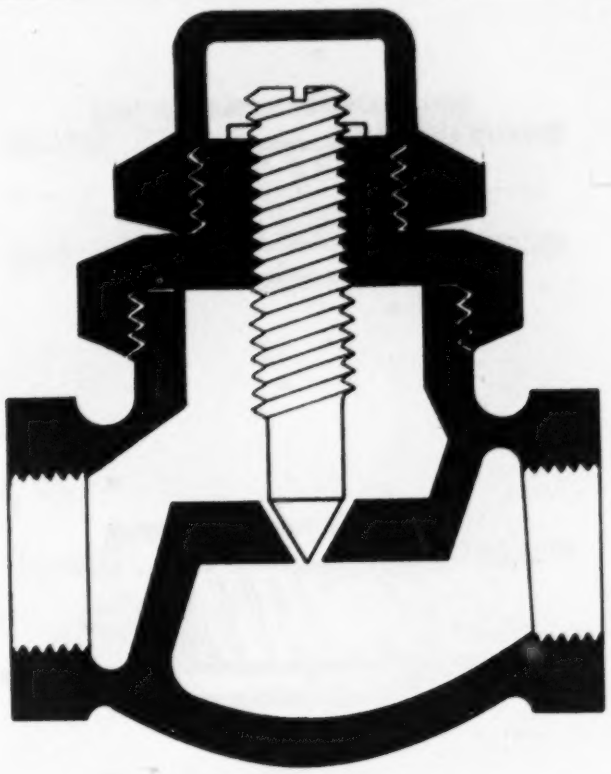

Figure 9-10.—Variable restrictor.

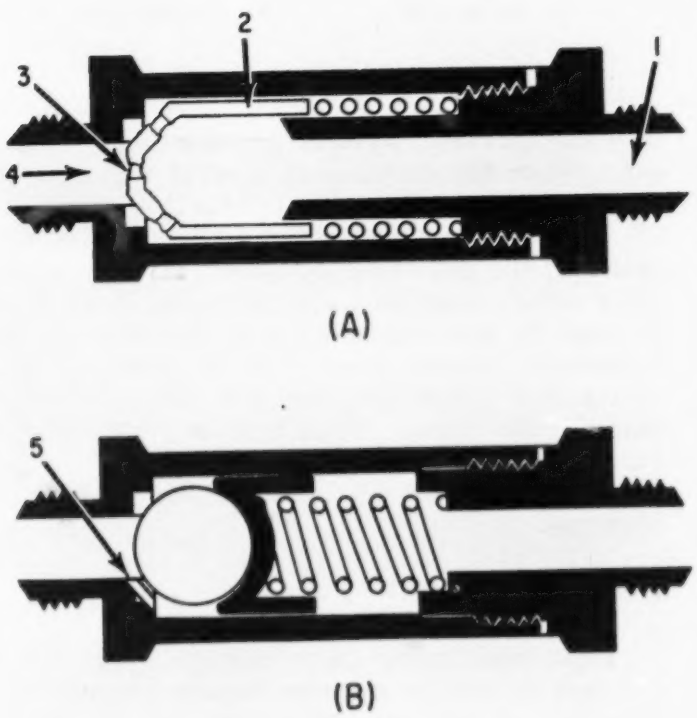

1. Outlet port.
2. Cone.
3. Orifice.
4. Inlet port.
5. Orifice.

Figure 9-11.—Orifice check valves.

retracts and extends the landing gear. The orifice check valve is installed in the UP line (pressure line for the retraction of the landing gear) and allows the fluid to flow freely into the cylinder for rapid retraction of the landing gear. As the gear is extended, fluid leaving the cylinder returns through the UP line and must pass through the orifice. Thus, a cushioning effect results and the gear falls slowly, thereby preventing structural damage. If the restriction were placed in the DOWN line, it would limit the quantity of fluid entering the cylinder and have no effect on the fluid leaving. This would not correct the situation because the heavy gear tends to fall freely, causing a partial vacuum in the cylinder. This would cause the gear to fall too rapidly, resulting in structural damage to the aircraft.

Circuits in which the flow is restricted as the fluid leaves the actuating device, such as the landing gear circuit just described, are often referred to as meter-out circuits. The fluid is metered out of the actuating device. Some circuits require the flow of fluid to be controlled as it enters the actuating device. These circuits are referred to as meter-in circuits.

COMPENSATED VALVES

The flow control valves previously discussed in the chapter are not compensated for changes in fluid temperature or pressure, and are referred to as noncompensating valves. The rate of flow through these valves can vary at a fixed setting if either the pressure or temperature of the fluid changes. Viscosity (discussed in chapter 3) changes, which are often the result of temperature changes, can also cause flow variations through a valve. These valves are satisfactory for use in fluid power systems where slight variations of flow are not a critical factor to be considered. However, some systems require extremely accurate control of the actuating device. Compensated flow control valves are used for this purpose. They automatically change the valve adjustment or pressure drop across the restriction to provide a constant flow at a given setting.

Figure 9-12 illustrates an example of a compensated flow control valve. This type valve meters a constant flow regardless of variation in system pressure. Although it is usually used to meter fluid into a circuit, it can be used to meter fluid as it leaves the circuit. Flow

control, flow regulator, and constant flow valve are all terms used to describe this valve. In this course it is referred to as a flow regulator.

The flow regulator has only one moving part, the piston (5), as illustrated in figure 9-12. The valve will regulate flow from left to right only, since this type flow regulator controls the rate of flow in only one direction. The body of the valve is marked with an arrow to indicate the direction of regulated flow.

Operation of the flow regulator can be seen in figure 9-12. Figure 9-12 (A) shows the valve in the free flow condition. Fluid enters port (3), passes through the orifice in the head of piston (5), through slots (2) in the side of piston (5), and out port (6). If fluid tries to increase its flow through the orifice in the head of the piston, there is more resistance and a greater pressure differential between the fluid entering the orifice and the fluid leaving it. This pressure differential, caused by a momentary increase in flow, causes the piston to move to the right and compresses the spring. When the piston moves to the right, the slots (2) in the piston no longer line up with the holes in the regulator body (fig. 9-12 (B)), and an additional restriction is placed on the fluid which decreases the rate of flow. The piston cannot move to the right far enough to completely block the ports in the side of the regulator body because the pressure on the right side of the piston will build up to a value equal to the pressure in port (3) and against the left side of the piston.

An increase of pressure normally increases fluid flow through an orifice, but this is not the case with the flow regulator. As the pressure increases, the size of the orifice or opening for the fluid decreases, thus maintaining a constant flow. If the resistance to movement of the actuating unit decreases, the fluid flow starts to increase. An increase of fluid flow to the actuating unit causes a decrease in pressure against the piston (5), allowing the piston to move to the right and thereby decreasing the size of the slot opening (2). This allows less fluid to flow to the actuating unit. Thus, the flow regulator maintains a constant rate of flow regardless of variations in system pressure and regardless of the resistance to movement of the actuating unit.

An example of a typical flow regulator installation is shown in figure 9-13. This installation provides for the fluid to be metered

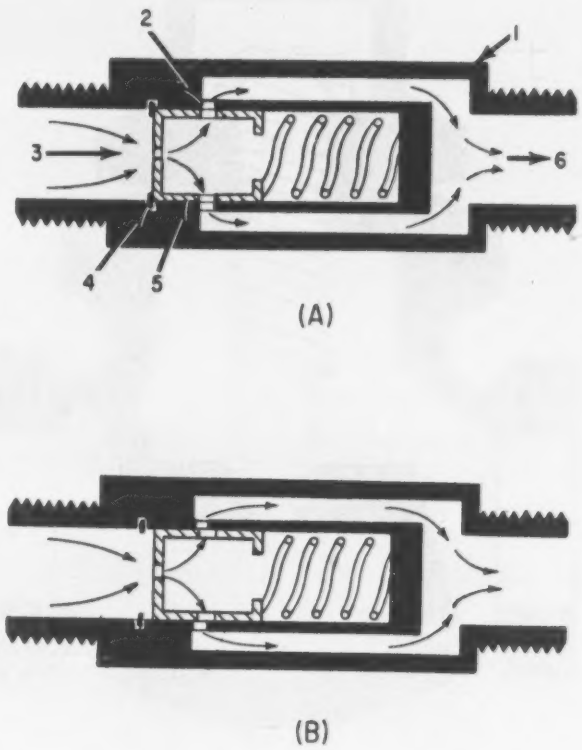

1. Body.
2. Slots.
3. Input port.
4. Retainer.
5. Piston.
6. Output port.

Figure 9-12.—Flow regulator.

into the circuit. System pressure enters port (5). When the directional control valve (3) is positioned, fluid flows through the flow regulator (4). Thus, regardless of the direction of movement of the actuating cylinder (1), one of the alternating lines (2) will have regulated flow through it, insuring a smooth operation of the actuator. These valves are available in different flow capacities, and are rated in gallons per minute (gpm). This type of compensated valve is nonadjustable. Adjustable valves are required and are available for some fluid power systems.

FLOW EQUALIZER

Flow equalizers (flow dividers) are used in some hydraulic systems to synchronize the operation of two actuating units. To do this, it divides a single stream of fluid from the directional control valve into two equal streams. Thus, each actuating unit receives the same rate of flow, and both move in unison. During operation in the opposite direction, the flow

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equalizer combines the two streams of return fluid at an equal rate. Therefore, the flow equalizer synchronizes the movement of the actuating units during both directions of operation. Since the unit equally divides the combined flow, it is said to be dual acting.

One type of flow equalizer is illustrated in figure 9-14. Figure 9-14 (A) shows the valve in the splitting (divided flow) position. Fluid under pressure from the directional control valve enters port (3). This pressure overcomes spring tension and forces the plug (4) down and uncovers the two orifices in the sleeve (2). The fluid then splits and tends to flow equally through the two side passages (1) and (5). The fluid flows through the two splitting checks valves (7) and (15), through the metering grooves (10) and (14), through ports (9) and (13), and through the connecting lines to the actuating cylinders. Any difference in the rate of flow between the two passages results in a pressure differential between these two passages. Then the free-floating metering piston (11) shifts to equalize the internal pressure, and the flow equalizes.

To illustrate this equalizing action, assume that the actuating unit attached to a line from port (9) meets less resistance than the one attached to a line from port (13). The rate of flow through port (9) tends to increase, but in doing so, the flow also increases through passage (5). Fluid leaving port (13) meets with more resistance; so the flow through passage (1) decreases, and the pressure becomes greater than the pressure in passage (5). This momentary pressure differential forces the free-floating metering piston (11) to the left. This causes the space between the piston land (8) and the metering groove (10) to become smaller, which restricts the flow of fluid out of port (9). Thus, the flow equalizer imposes a restriction on the fluid that has a tendency to increase in rate of flow, and the two streams equalize.

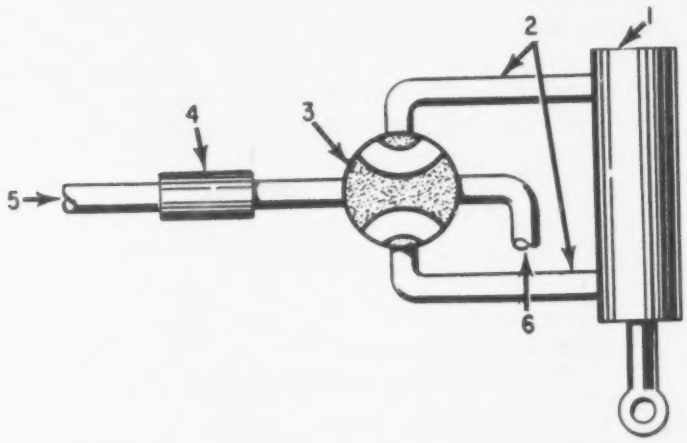

1. Actuating cylinder.
2. Alternating lines.
3. Directional control valve.
4. Flow regulator.
5. Pressure line.
6. Return line.

Figure 9-13.—Flow regulator installation.

The combining position of the flow equalizer is illustrated in figure 9-14 (B). This shows the unit joining the two streams of fluid as it flows from the actuating units. Here, the fluid enters ports (9) and (13) of the valve. The fluid cannot flow through the splitting check valves. Therefore, it takes the path of least resistance, which is around the cylindrical shaped metering piston, and enters the combining check valves (6) and (16) as indicated by the arrows. The pressure of the fluid opens the check valves and then the fluid flows through passages (1) and (5) to the orifice sleeve (2). The fluid pressure will then force the orifice sleeve upward, which opens the orifices and allows the fluid to flow out port (3).

Again for purposes of illustration, assume that the actuating unit attached to a line from port (9) moves with less resistance than the unit attached to a line from port (13). Fluid entering port (9) attempts to flow faster, but as it leaves the check valve and flows up passageway (5) it is restricted by the orifice. Therefore, if the flow momentarily increases, the orifice will cause an increase in pressure in passage (5), which forces the metering piston (11) to the right. This results in a restriction between the metering groove (10) and the piston land (8), and the stream of fluid which tends to flow at a greater rate is restricted and equalizes with the other stream.

PRIORITY VALVES

In systems with two or more circuits, it is sometimes necessary to have some means of supplying all available fluid to one particular circuit in case of a pressure drop in the system. A priority valve is often incorporated in the system to insure a supply of fluid to the critical circuit. The components of the system are arranged so that the fluid to operate each circuit, except the one critical circuit, must pass through the priority valve.

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One type of priority valve is illustrated in figure 9-15. Figure 9-15 (A) shows the valve in the priority flow position. Fluid passes around the poppet and forces the piston to the right which compresses the piston spring. The poppet follows the piston and keeps the valve closed until the preset pressure is reached. (NOTE: The preset pressure depends on the requirements of the system and is set by the manufacturer. For example, assume that the critical system requires 1,500 psi for efficient operation.) When the pressure reaches 1,500 psi, the poppet reaches the end of its travel. As the pressure increases, the piston continues to move to the right, which unseats the poppet and allows a flow through the valve. If the pressure drops below 1,500 psi, the compressed spring moves the piston to the left, the poppet seats, and flow through the valve stops.

Figure 9-15 (B) shows the priority valve in the free flow position. The flow of fluid moves the poppet to the left, the poppet spring compresses, and the poppet unseats. This allows free flow of fluid through the valve.

FLOWMETERS

Although flowmeters are normally associated with systems in which fluids are consumed, such as fuel oil, gasoline, water, etc., they are sometimes required in fluid power systems. Flowmeters are incorporated in test stands which are used to test and adjust fluid power systems and/or components. For example, pumps are rated in gallons per minute (chapter 7) and can be tested for their rated capacity by the use of a test stand which has a flowmeter incorporated.

Measurement of flow may be expressed in units of rate, such as gallons per minute, pounds per hour, cubic feet per second, or in terms of total quantity, such as gallons, pounds, or cubic feet. (This is similar to the speedometer of an automobile. The needle indicates the speed of the automobile in miles per hour which compares with the rate-of-flow type flowmeter. The other indicator, called the odometer, indicates total miles and compares to the quantity type flowmeter.)

A reciprocating pump which displaces a uniform volume of fluid for each stroke of its piston could be used as a meter by installing a device for counting the piston strokes. But the pump would have to be designed to minimize leakage and guarantee uniform displacement. Measurement of flow is accomplished by a variety of means, depending upon the quantities, flow rates, and types of fluid involved. All fluid meters are made to measure fluids of definite specific gravities and characteristics, and must be used only for the purpose for which they were made. Each meter is tested and calibrated before it is shipped from the factory. Several types of flowmeters are described in the following paragraphs.

NUTATING PISTON DISC FLOWMETER

In this type flowmeter the fluid passes through a fixed volume measuring chamber divided into upper and lower compartments by a disc. During operation, one or the other compartment is continually being filled while the other is being emptied. As it passes through these compartments, the pressure of the fluid causes the disc to roll around in the chamber, in a

NOMENCLATURE FOR FIGURE 9-14.

1. Side passage.
2. Sleeve.
3. Entrance port.
4. Plug.
5. Side passage.
6. Combining check valve.
7. Splitting check valve.
8. Piston land.
9. Exit port.
10. Metering groove.
11. Free-floating metering piston.
12. Piston land.
13. Exit port.
14. Metering groove.
15. Splitting check valve.
16. Combining check valve.

Figure 9-14.—Flow equalizer.

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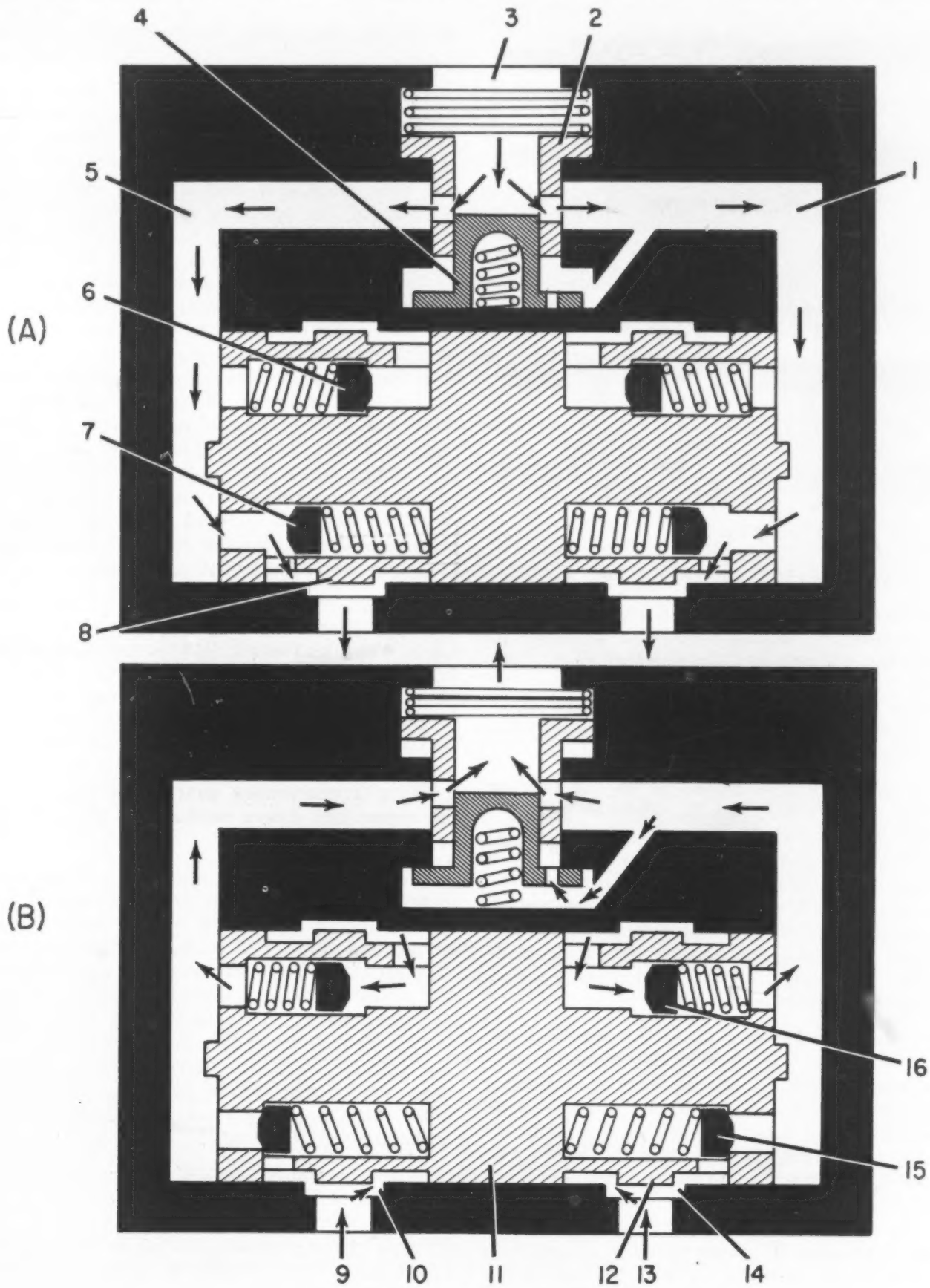

Figure 9-14.—Flow equalizer.

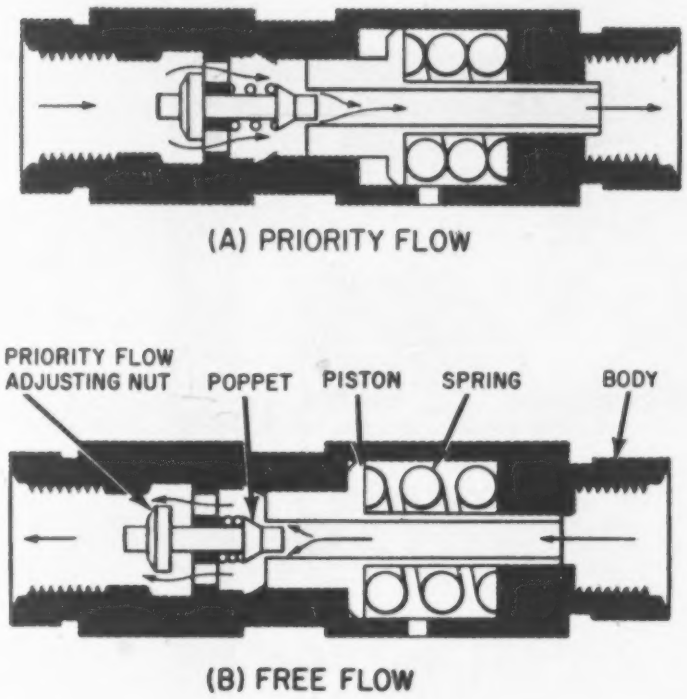

Figure 9-15.—Priority valve.

manner described later, and its movements operate a counter, through suitable gearing, to indicate the volume of fluid passed through the meter. The counter somewhat resembles the odometer of an automobile, previously mentioned, except that the flowmeter usually registers in gallons.

The heart of the meter is the measuring chamber and the disc piston. Figures 9-16 (A) and (B) show how the disc is located in the measuring chamber. Figure 9-16 (C) is a sectional view illustrating one-half of the measuring chamber. It is bound at the top and bottom by conical surfaces (1) and (2), which are joined at their outer edges by spherical surface (3). A sectional view of the entire meter is illustrated in figure 9-17.

Referring to figures 9-16 (A) and (B), the upper and lower surfaces of the chamber converge towards the center to form a spherical cavity for the ball (4), through which passes the spindle (5), which is connected with the counting gears (fig. 9-17). Disc (6) is attached to the ball. Both the ball and disc are machined to fit closely in the chamber. There is a slot (8) in the disc at one point, through which passes the thin partition (7) which cuts the chamber in two. There are openings in the outer wall of the chamber on each side of the partition. Opening (9) is the fluid inlet, while opening (10) is the outlet.

When the ball carrying the disc and the spindle is tilted as far as it can go, the bottom of the disc makes a close contact with the bottom conical surface of the chamber, while the top of the disc similarly contacts the upper conical surface of the opposite end of the disc. Since the disc is flat while the contacting surfaces are conical, contact takes place along a straight line on each surface. The lines of contact produce seals, which when taken in connection with the partition (7), divide both the upper and lower compartments into two parts. The net effect is that the disc and partition produce four separate compartments in the measuring chamber, two above the disc and two below. The top and bottom compartments are separated from each other by the disc, while the pairs of compartments respectively above and below the disc are separated by the seal formed at the line of contact between the disc and the conical top and bottom surfaces, and also by the partition.

Spindle (5) rises from ball (4) and passes through wheel (11) at a point near its outside edge. Vertical shaft (12) is attached to wheel (11) and rotates with it. This shaft is connected at its upper end to the measuring gears, and is mounted directly over ball (4). When wheel (11) turns on its axis, the position of the shaft keeps the spindle inclined at just the angle to produce a continuous seal between disc (6) and the upper and lower surfaces of the measuring chamber.

For the purpose of simplicity, consider the meter as a pump driven by some outside force. The action of the meter can be understood by imagining wheel (11) to be revolved by means of shaft (12). The spindle would revolve with it, and would trace a conical path in space, as shown in figure 9-18. This movement of the spindle would control the positioning of the disc. When the spindle is in position (A), for example, the disc would also be in position (A), while the positions (B) and (C) for the spindle and disc would also correspond.

The disc cannot rotate, because partition (7) stands in slot (8). The disc, therefore, wobbles up and down (nutates), while the seal lines, formed by the disc and the top and bottom walls of the measuring chambers, are made to revolve around the chamber.

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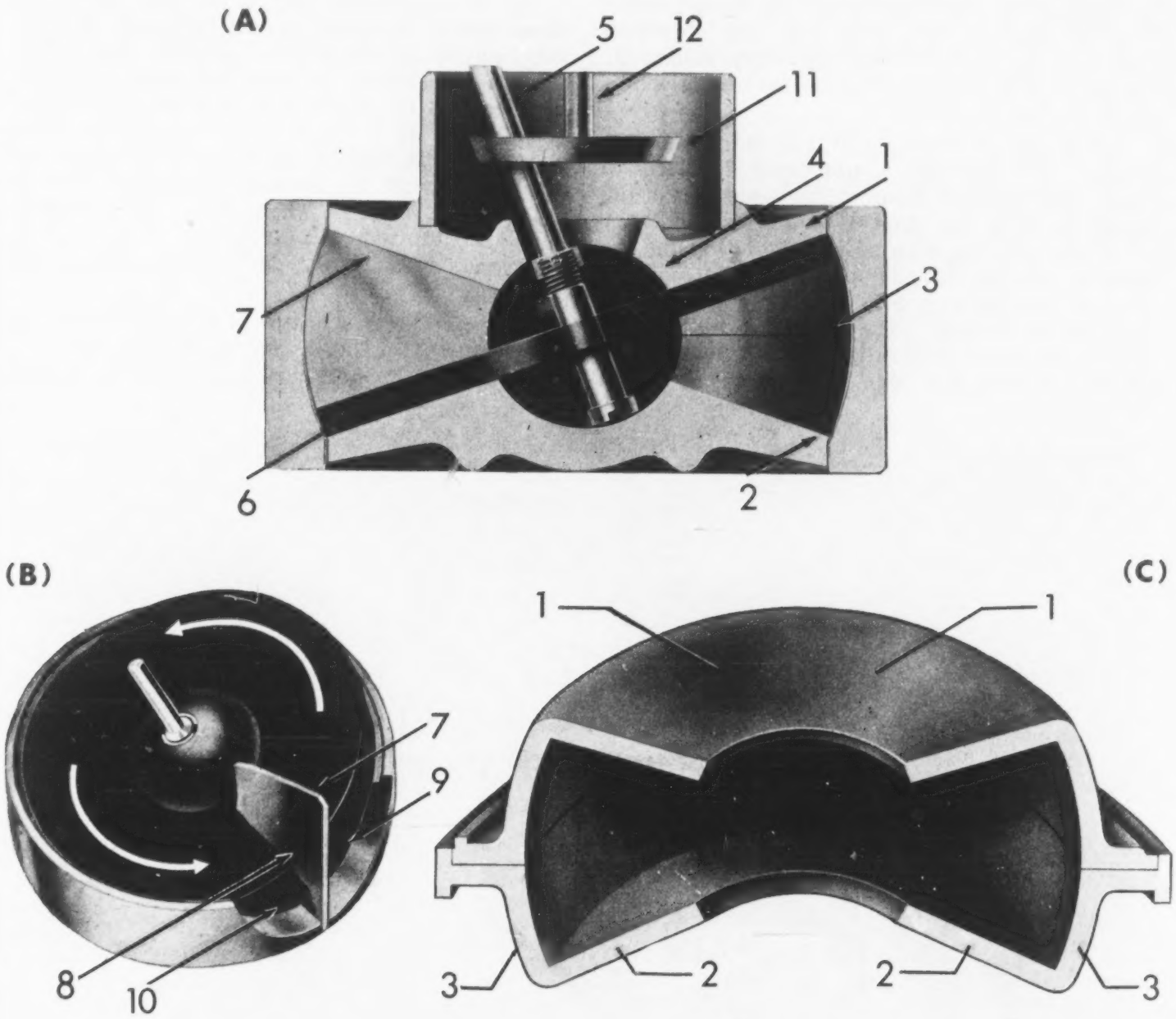

1. Measuring chamber (top surface).
2. Measuring chamber (bottom surface).
3. Measuring chamber (outer edge).
4. Ball.
5. Spindle.
6. Disc.
7. Chamber partition.
8. Slot.
9. Inlet opening.
10. Outlet opening.
11. Wheel.
12. Shaft.

Figure 9-16.—Nutating piston disc flowmeter (sectional views).

For simplicity, consider only the lower partion of the chamber. The seal will always belong the line which has the greatest inclination. As this seal line moves in the direction shown by the arrows in figure 9-17, it will sweep the fluid before it and cause it to be discharged through the opening (10). At the same time it will be opening up an increasing volume in the compartment behind the moving line of the seal. Since this space is open to the inlet (9), it is filled with fresh fluid. When the line of seal passes the partition (7), all the liquid formerly

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DESCRIPTION AND INFORMATION ON INDIVIDUAL DISEASES

Examples of Diseases Caused by Bacteria

Crown gall
Fire blight

Examples of Diseases Caused by Fungi

Cotton verticillium wilt
Southwestern cotton rust
Texas root rot of alfalfa
Euonymus powdery mildew

Examples of Diseases Caused by Viruses

Barley yellow dwarf
Cucurbit viruses

Examples of Diseases Caused by Nematodes

Cotton rootknot nematode
Alfalfa stem nematode

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in front of the seal will have been forced out of the discharge. The seal line then starts to push the fluid, which was formerly behind it, forward. The line of flow of the fluid is as shown in figure 9-17.

Obviously, if the wheel (11) were continuously rotated, the disc (6), would move a volume of fluid equal to the volume of the lower half of the chamber from the inlet to the outlet, for every rotation. During this same revolution the top section is doing the same, except that its seal is always directly opposite the lower seal in the measuring chamber. Therefore, for every revolution, the piston will displace the volume of the entire chamber just once.

In the previous discussion, the meter is described as though it were a pump operated by the rotation of wheel (11). Actually the operation of the meter is just the reverse. It is operated by the slightly greater fluid pressure at the inlet as compared with the outlet. This pressure differential causes the seal line to advance around the measuring chamber, and in doing so it rotates wheel (11). This in turn revolves the indicating register of the meter by means of shaft (12) and suitable reduction gearing.

Standard meters of this type are suitable for temperatures to 200° F, and for pressures to 150 psi, although models are available for higher

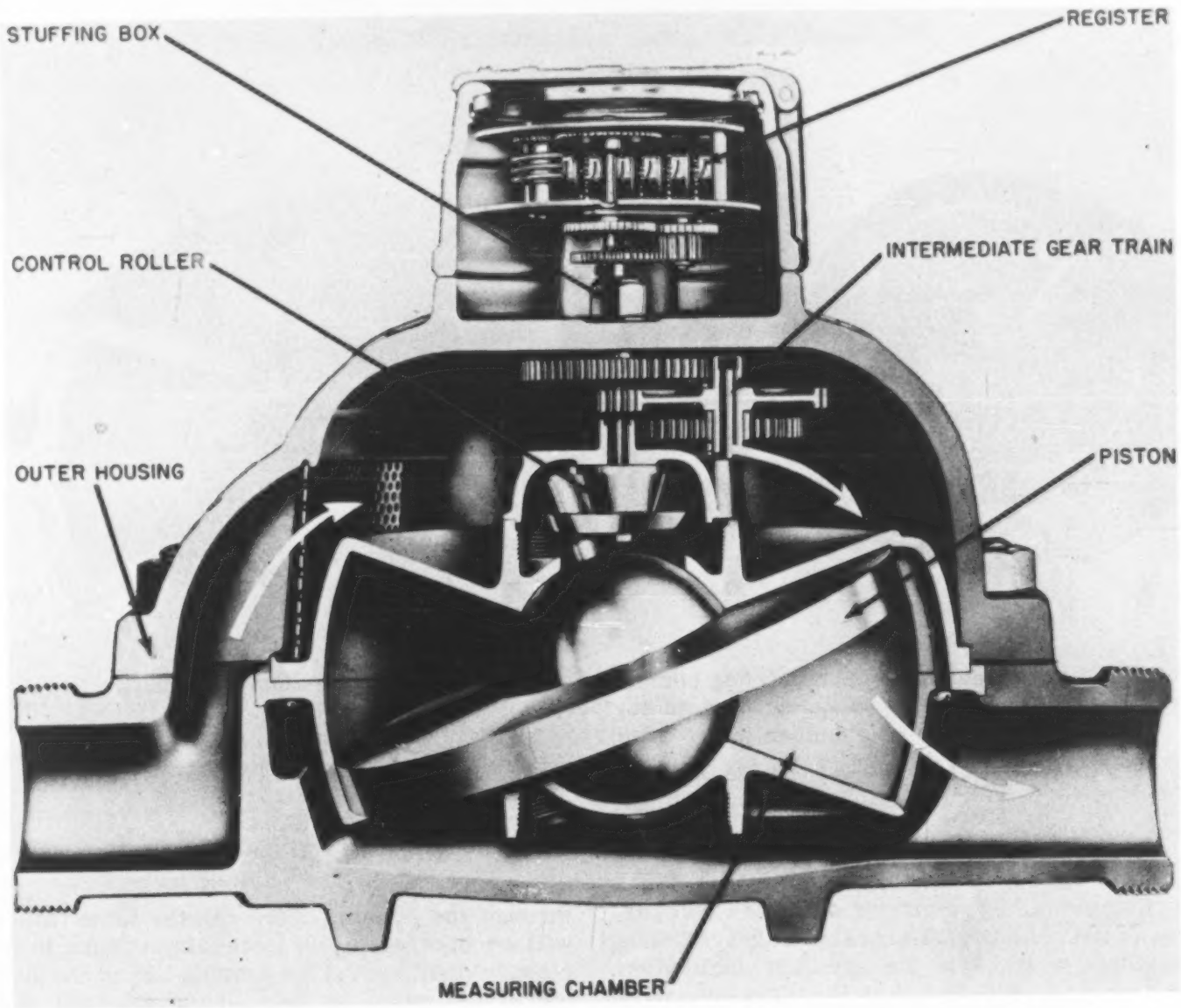

Figure 9-17.—Nutating piston disc flowmeter (indicating fluid flow).

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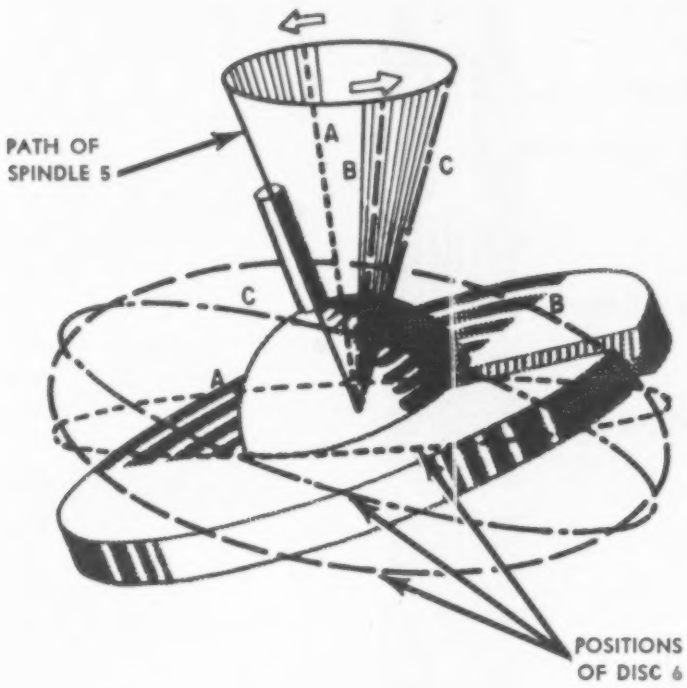

Figure 9-18.—Operation of disc and spindle of nutating piston disc flowmeter.

temperatures and pressure. The meters are accurate to about 1 percent or less. The accuracy of the meter is not affected by pressure variations.

PROPELLER TYPE FLOWMETER

Figure 9-19 illustrates a propeller type flowmeter. The propeller is located in the line of flow and is connected by suitable gearing to the indicator or counter. The propeller rotates at a speed relative to the velocity of the flow through the line. The revolutions are registered through the gearing to the counter, the rate of rotation being volume rate of flow. This type meter is calibrated by the manufacturer for a specific fluid. The accuracy of this meter depends, to varying degrees, on the temperature, pressure, and characteristics of the fluid.

TURBINE TYPE FLOWMETER

The turbine type flowmeter is similar to the propeller type just described. Figure 9-20 illustrates an installation of a turbine type flowmeter. The fluid flows through the helical (spiral) impeller. The flow causes the impeller to rotate. The impeller is connected through suitable gearing to the counter. The revolutions of the impeller, which changes as the velocity of the flow changes, are counted through the gearing to the counter. The rate of rotation of the impeller indicates the volume flow rate. Like the propeller type flowmeter, the accuracy depends on the temperature, pressure, and characteristics of the fluid. This type flowmeter is calibrated by the manufacturer for a specific type fluid.

ROTAMETER

The rotameter is a device for measuring the rate of flow of a fluid. Figure 9-21 illustrates the operation of a rotameter.

The rotameter is an upright glass tube through which the fluid flows. A metal casing with a Plexiglas window protects the glass tube. The tube is tapered, with the small end at the bottom. Inside, a small metal rotor with a central hole slides up and down on a guide rod, and is caused to spin for free sliding by small vanes cut in its sides. Since the tube is tapered, the space between the rotor and the tube wall

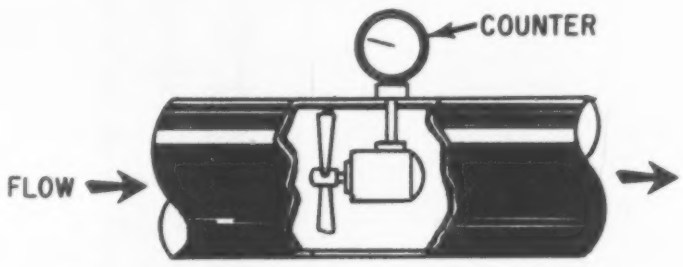

Figure 9-19.—Propeller type flowmeter.

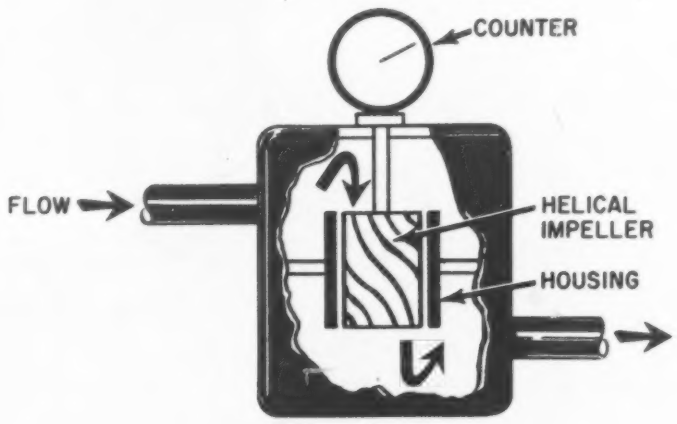

Figure 9-20.—Turbine type flowmeter.

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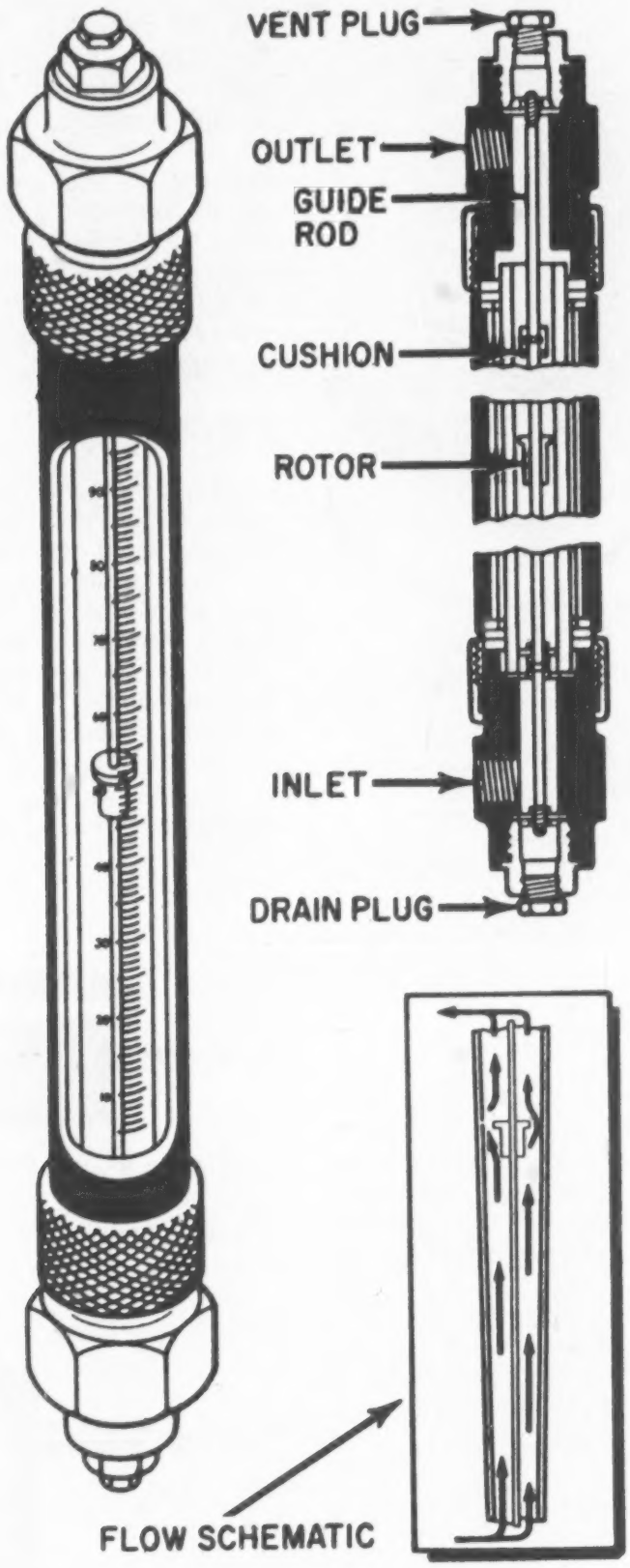

Figure 9-21.—Rotameter.

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increases as the rotor rises, permitting more fluid to flow through that space. Therefore, the rotor always rises to a height corresponding to the rate of flow at any particular time. A scale on the tube is calibrated to indicate the rate of flow in the desired measurement—gallons per hour, gallons per minute, pounds per hour, etc.

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CHAPTER 10

MEASUREMENT AND CONTROL OF PRESSURE

In any fluid power system a means must be provided for measuring the pressure in the system. Likewise, a means must be provided for controlling this pressure. In fluid power systems the pressure is measured by various types of pressure gages and is controlled by various types of valves, pressure regulators, pressure switches, or similar mechanisms.

In the first part of this chapter, the various types of pressure gages commonly used in fluid power systems are described. The latter part of the chapter is devoted to the valves and other units commonly used in controlling pressure.

PRESSURE GAGES

Pressure gages are used in fluid power systems to measure pressure so that the operators of fluid power equipment can maintain pressures at safe and efficient operating levels. Any excess or deficiency of pressure should be immediately investigated with a view of locating and removing the cause of the trouble.

Pressure is generally measured in pounds per square inch, as discussed in chapter 2. Gages used in fluid power systems are therefore calibrated in pounds per square inch (psi). Gage readings indicate the fluid pressure set up by the opposition of forces within the system. Atmospheric pressure also acts on the system, but it can be ignored in practical operation because its action at one place is balanced by its equal and opposite action at another place. When it is taken into account in scientific calculations, the pressure of the system is referred to as absolute pressure. In this course, however, only gage pressures are discussed. (Absolute and gage pressures are defined in chapter 2.)

BOURDON TUBE GAGES

Bourdon tube gages are commonly used for measuring pressure in fluid power systems. The amount of pressure in a system is indicated on a gage scale calibrated for the system. By observing the pressure indicated on the gage scale, personnel operating the system can determine if the pressure is within the desirable operating range. Recorded gage readings are used as a means of insuring proper operating procedures, and also for determining the operating efficiency of the system.

The indicating element of a Bourdon tube pressure gage may be made in any one of a number of shapes. The most common shapes are the C tube, the spiral, and the helical. These three types of Bourdon tube gages are described in the following paragraphs.

C-Shaped Tube

A simple Bourdon tube pressure gage consists of a Bourdon tube, a gear-and-pinion mechanism, a dial, and a pointer. A Bourdon tube and a gear-and-pinion assembly are shown in figure 10-1. The curved hollow Bourdon tube (C-shaped) is closed at one end and connected to the fluid pressure at the other end. When pressure is applied the tube will try to straighten out, like a garden hose when the water is first turned on. Pressure acts equally on every square inch of area in the tube; but since the surface area on the outside of the curve is greater than the surface area on the shorter radius, the force acting on the outer surface will be greater than the force acting on the inner surface. When the pressure is applied the tube straightens out until the difference in force is balanced by the elastic resistance of the material composing the tube. As the movable end of the tube tries to straighten, it turns the gear on the pivot. This gear meshes with the gear fastened to the indicator needle shaft, and causes a reading on the pressure gage. The dial, which is not shown, is properly calibrated so that the needle points to the number which corresponds to the exact pressure. The

tube acts like a spring. When the pressure is removed, it returns to its normal position.

Simplex, vacuum, compound, duplex, hydraulic, differential, electric alarm, and depth are all types of Bourdon tube gages containing the C-shaped tube. A few of the more pertinent ones used in fluid power systems are discussed in the following paragraphs.

SIMPLEX.—A simplex Bourdon tube pressure gage is illustrated in figure 10-2. Gage cases are made of metal or plastic materials, which do not rust and are not affected by ammonia and other substances which injure some types of metal. One hand is connected to the pinion which protrudes up through the dial face. This pointer indicates pressure registered on the dial. The other hand, normally painted red, is always set to the normal working pressure of the system to which the gage is connected. This hand pivots on the dial and is manually positioned. On some gages, red lines are painted on the dial to indicate the minimum and maximum pressures which should be carried for the system to which the gage is connected. These lines should be properly labeled.

A simplex Bourdon tube gage may be used for measuring the pressure of steam, air, water, oil, and similar liquids or gases.

DUPLEX GAGE.—A duplex Bourdon tube gage has two separate tube mechanisms within the same case, each acting independently of the other. A pointer is connected to the gear mechansim of each tube, and each pointer moves over the face of the dial without interfering with the other pointer. (See fig. 10-3.)

Figure 10-2.—Simplex Bourdon tube pressure gage.

Figure 10-1.—Bourdon tube and gear-and-pinion mechanism.

One pointer on the face of the gage illustrated in figure 10-3 points to 0, indicating that no pressure is being exerted on the Bourdon tube to which it is attached. The other pointer of this gage, however, indicates that a pressure of 85 psi is being exerted on the tube to which it is attached.

Figure 10-4 shows a duplex Bourdon tube gage with the face removed. Note the position of the pointers, and also the separate connections to different pressure sources at the base of the case.

Duplex Bourdon tube gages are used for such purposes as showing the pressure drop between the inlet and outlet side of a strainer. The reading by each pointer indicates whether the strainer is clean or dirty; that is, if the pressure is much greater on the inlet side of the strainer, it indicates that foreign matter on the

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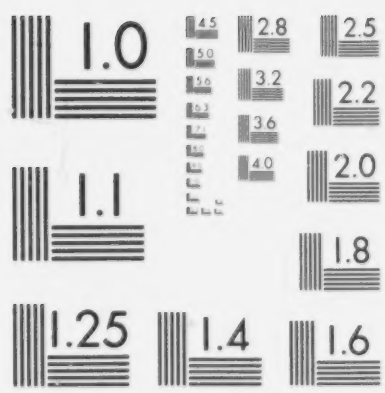

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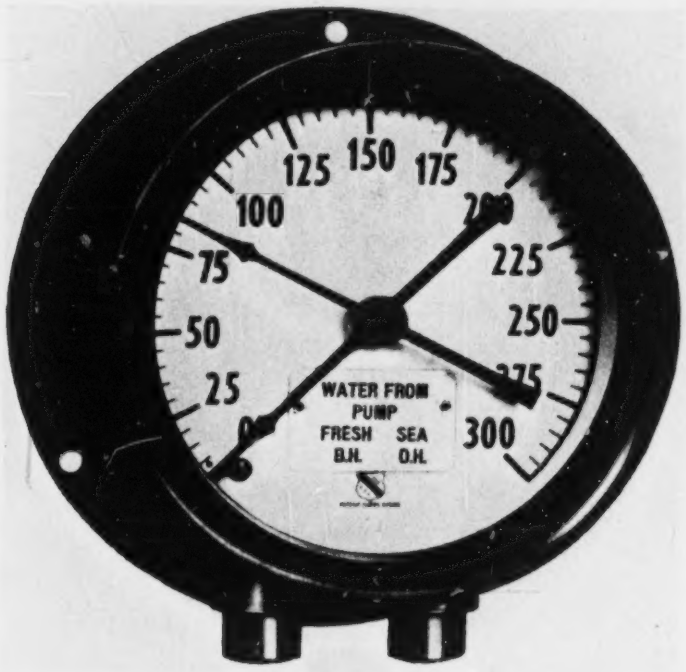

Figure 10-3.—Duplex Bourdon tube gage.

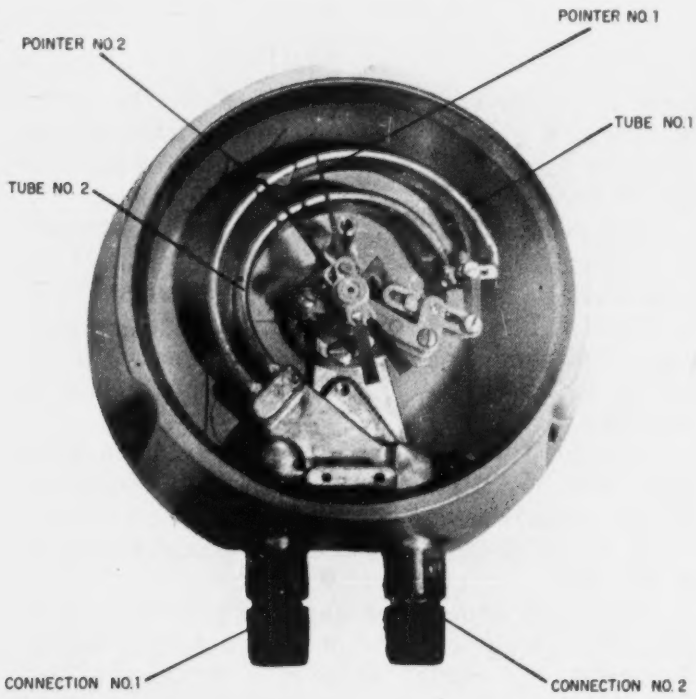

Figure 10-4.—Mechanism of duplex Bourdon tube gage in the operating position.

strainer is very likely responsible for the higher pressure. A duplex gage serves many useful purposes in indicating the operating condition of certain parts or types of equipment.

HYDRAULIC BOURDON TUBE GAGE.—Hydraulic Bourdon tube gages are used to indicate high pressures, as on hydraulic rams (cylinders) used on the ship's steering gear and anchor windlasses. Because the pressure on these gages is so high, they are equipped with a slotted connecting link between the segment gear and the link adjustment to the tube to prevent the pointer from slamming back to 0 when the pressure on the gage is suddenly released. Without such a slotted link, the pointer or the gage mechanism could be damaged by a sudden release of pressure in the tube. Note the slotted link adjustment shown in the gear mechanism of the hydraulic gage illustrated in figure 10-5. Many systems which employ this type gage are equipped with gage snubbers (discussed later in this chapter) to prevent pressure surges from damaging the gage.

Many of the hydraulic gages used by the Navy have dials which indicate both the psi pressure and the corresponding tons of load on the ram. (See fig. 10-6.) The main pointer of this gage rests on 0, but the maximum pointer registers between 3800 and 3900. This means that during the operation the highest pressure reached was

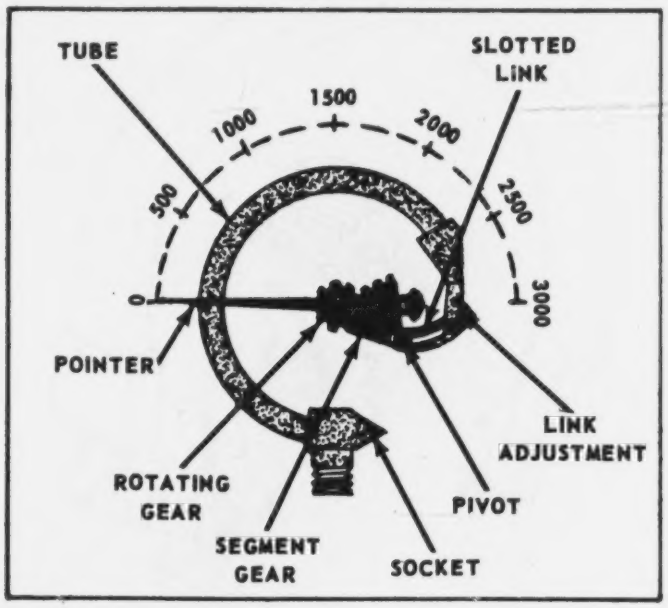

Figure 10-5.—Slotted link in hydraulic Bourdon tube gage.

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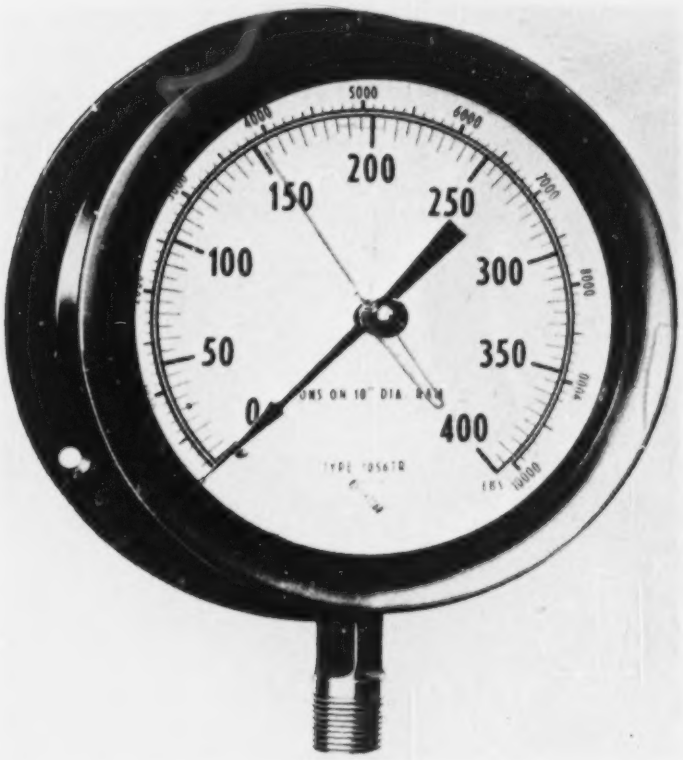

Figure 10-6.—Hydraulic Bourdon tube gage.

slightly less than 3900 tons of load on the ram. At one point during the operation, the highest psi registered by the pointer was over 150, and while it was registering this pressure it carried the maximum pointer up with it. If the pointer had registered 200, for example, the maximum pointer would be pointing to 5100, the tons of load on the ram.

The spindle of the maximum pointer extends up through a small hole in the gage face and has a small knob which screws into the spindle. By turning this knob, the operator can set the maximum pointer. Always check, therefore, to see if the main pointer carries the maximum pointer along with it.

DIFFERENTIAL PRESSURE GAGE.—A differential pressure Bourdon tube gage is used to measure the difference in pressure between two pressures lines. (See fig. 10-7 (A).) It employs two Bourdon tubes in the same case. When the pressure exerted on the right tube is greater than that exerted on the left, the pointer moves to the right, and vice versa.

Tubes in a gage of this type are connected in a definite manner so as to be able to record differences in pressure from two sources. The small Bourdon tube (fig. 10-7 (B)) is connected to a stationary base. Through a system of levers, it is attached to the large Bourdon tube. The base of the large tube works on a pivot, so that the base can move either to the right or to the left at any time. The gage has one pointer, which is connected by linkage to the free end of the Bourdon tube.

The dial of the gage shown in figure 10-7 (A) has the 0 at the bottom-left. A differential pressure Bourdon tube gage with the 0 at this position should be used when the pressure from one source will always be greater than that at the other; but when the pressure from either source may be the greater, a gage with a 0 at the top of the dial should be used. If the 0 is at this position, the gage pointer has freedom for moving to the right or to the left.

CAUTION: When a gage with 0 at the bottom-left is used, turn on the valve to the high pressure source first, and then the valve to the low pressure source. Upon admittance to the line, pressure from the low pressure source will cause the pointer on the gage to retard toward zero.

Spiral and Helical Tubes

Two variations of the C-type Bourdon tube pressure gage are the spiral and the helical. The helical is sometimes referred to as helix. Both are made from tubing with a flattened cross section; both were designed to provide more travel of the tube tip, primarily for moving the recording pen of pressure recorders.

SPIRAL BOURDON TUBE.—The spiral form of Bourdon tube (fig. 10-8) is made by winding the ordinary Bourdon tube in the form of a spiral, having several turns, instead of the approximately 250-degree arc of the conventional Bourdon tube. This arrangement does not change the operating principle of the Bourdon tube, but simply has the effect of producing a tip movement equal to the sum of the individual movements that would result from each part of the spiral considered as a simple Bourdon tube. A given pressure, therefore, causes greater tip travel than the C-shaped Bourdon type.

HELICAL BOURDON TUBE.—The helical (or helix) form of element (fig. 10-9) has the Bourdon tube wound in the form of a helix, as illustrated. This arrangement increases the tip travel considerably. A center shaft is usually installed within the helix, and the pointer linkage is arranged so as to be driven from this shaft. The shaft, in turn, is rotated by the tip of the helix. This design transmits only the circular

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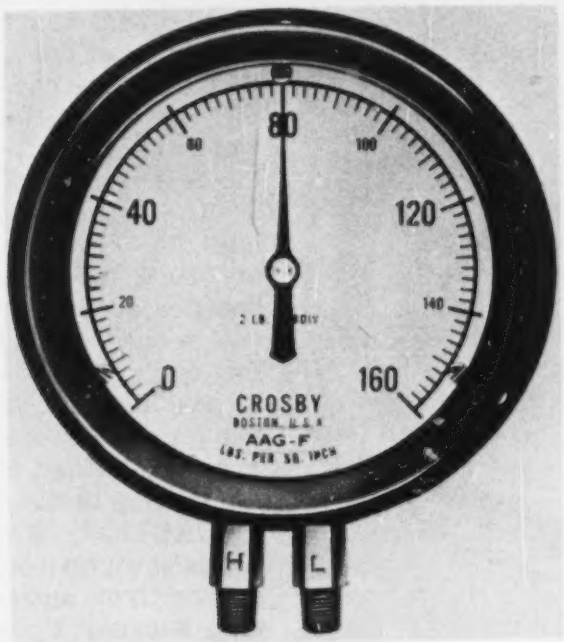

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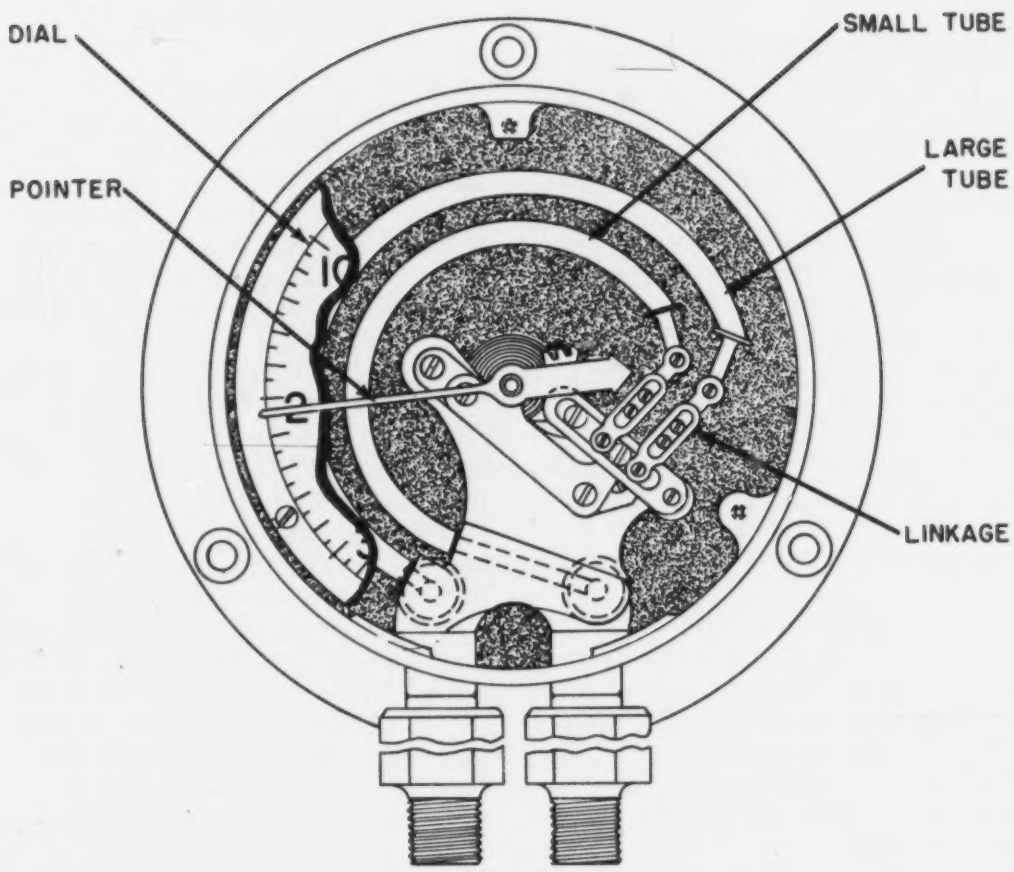

(B)

Figure 10-7.—Differential pressure Bourdon tube gage.

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CROWN GALL

Crown gall is one of the most prevalent and destructive diseases of shrubs and trees, particularly roses, pyracantha and stone fruits. The cause of the disease is a bacterium (Agrobacterium tumefaciens).

Symptoms - Infection of the host by the bacterium results in the development of overgrowths varying from the size of a pea to galls which weigh 50 lbs. or more. Galls occur commonly on roots but may also appear on crown, stems and even leaves of some plants. Gall development results in a gradual decline of the plant similar to that caused by nutrient deficiency.

Disease Cycle - Introduction of the crown gall bacterium into an area is most often by way of infected or contaminated nursery stock. The bacterium is

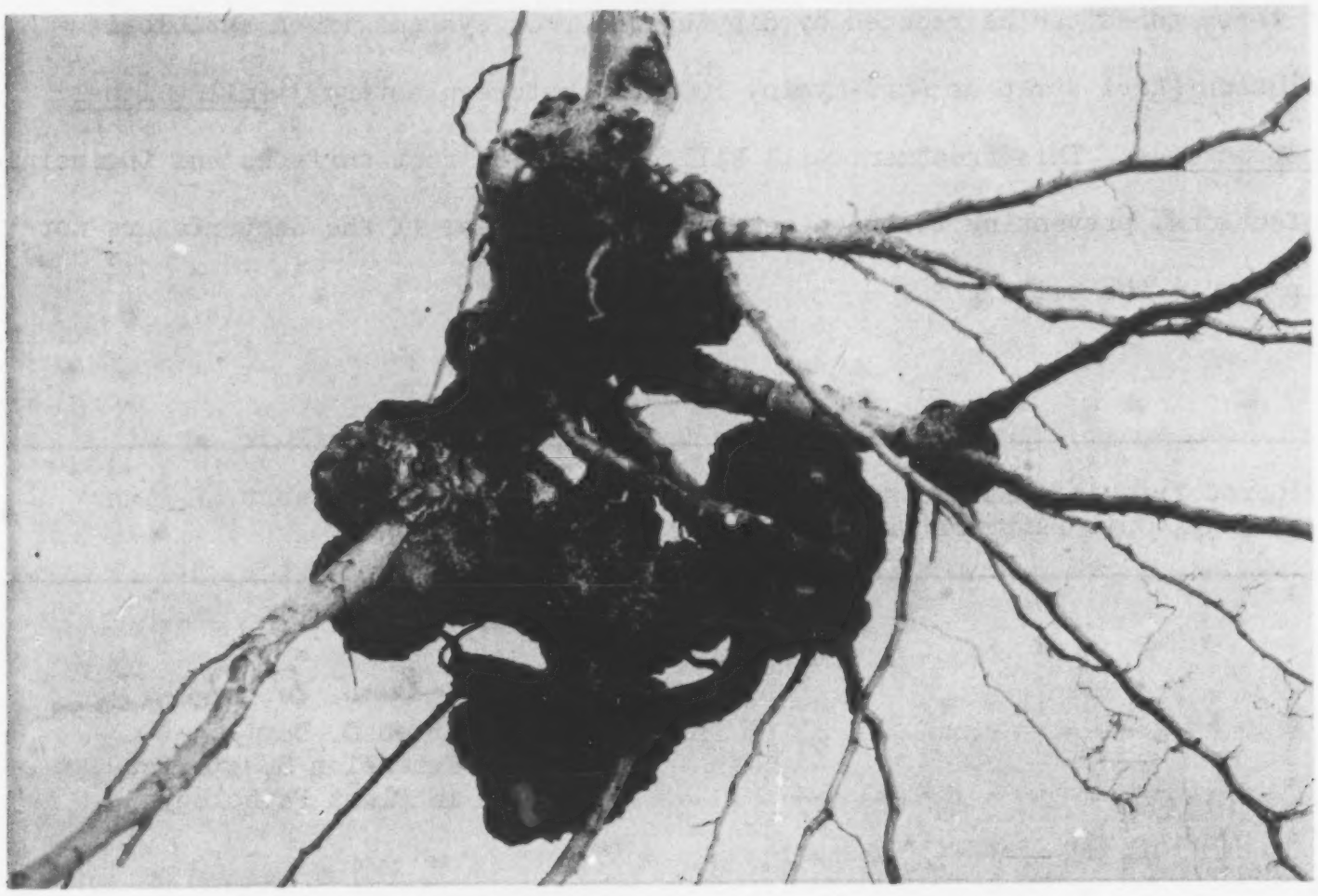

Fig. 1. Overgrowths on roots interfere with food and water supply causing gradual decline of the plant.

part of the tip movement to the pointer; this is the movement that is directly related to the change in pressure. Helical gages are generally confined to measurement of pressures in the range of 5 to 5,000 psi.

DIAPHRAGM GAGES

A diaphragm gage gives sensitive and reliable indications of small differences in pressure. It is often used to measure air pressure. This type of gage is usually designed by the manufacturer in accordance with specifications for a specific purpose and is calibrated accordingly. This does not mean, of course, that further adjustments may not be required when the gage is installed on a piece of equipment.

The indicating mechanism of a diaphragm gage consists of a tough, pliable, leather or neophrene rubber membrane connected to a metal spring which is attached by a simple linkage system to the gage pointer. Study the diaphragm gage illustrated in figure 10-10. Note the installation of the diaphragm in the gage frame and the positions of all parts of the gage. The size of the diaphragm affects its sensitivity

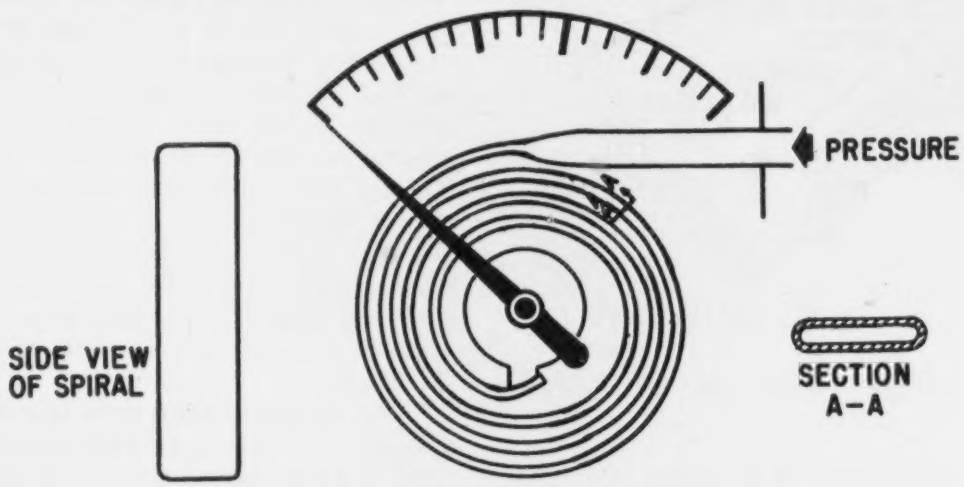

Figure 10-8.—Spiral Bourdon tube.

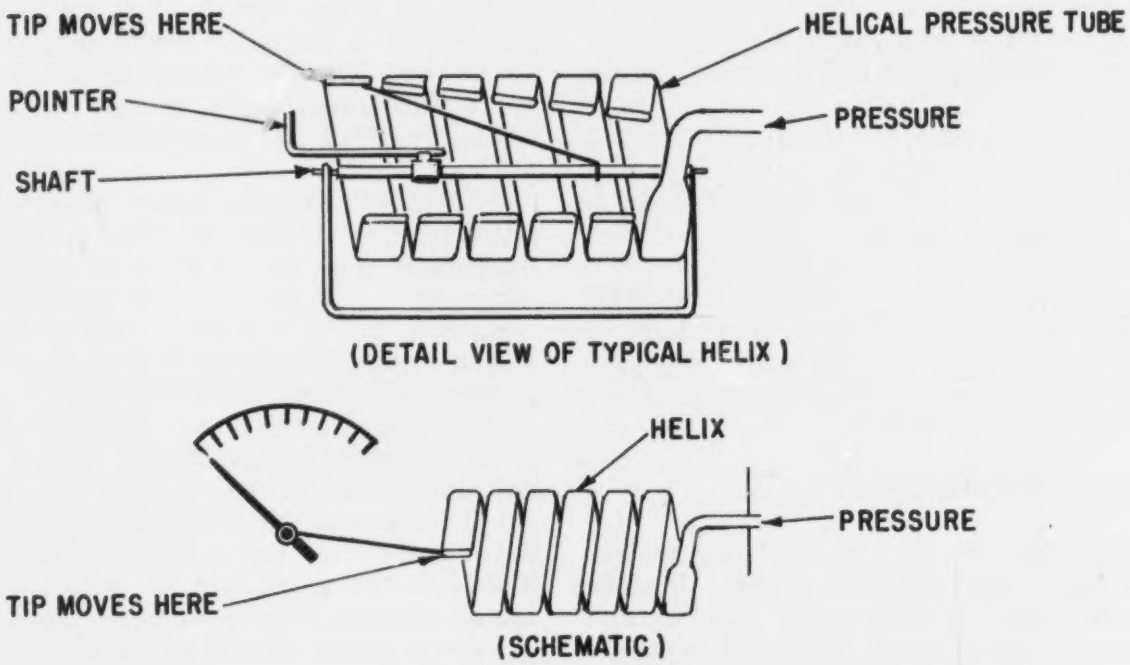

Figure 10-9.—Helical Bourdon tube.

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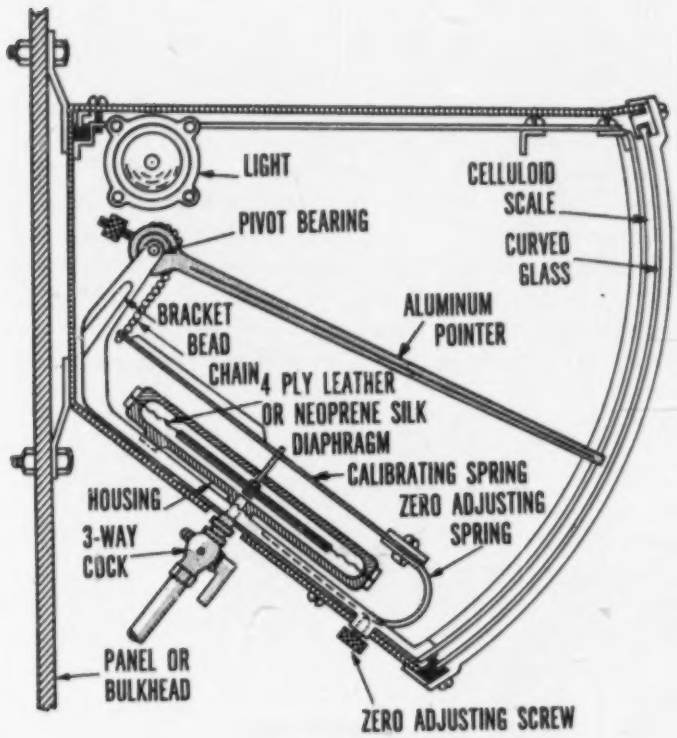

Figure 10-10.—Diaphragm air pressure gage.

in registering pressure—the larger the diaphragm the greater the sensitivity.

One side of the diaphragm is exposed to the pressure being measured; the other side is exposed to the atmosphere. When no pressure is exerted against the diaphragm, both it and the metal spring attached are in a neutral position. When pressure is applied to the diaphragm, it moves upward and pushes the metal spring ahead. As the spring is pushed up, it moves the pointer connected to it with the kinkless bead chain, to a higher reading on the dial. When pressure against the diaphragm decreases, it returns toward its neutral position and pulls the spring and pointer back with it. Thus, the reading on the scale of a diaphragm gage is directly proportional to the amount of pressure exerted on it by the force being measured.

SPRING-LOADED PRESSURE GAGE

The Bourdon tube gage is a delicate instrument and can be damaged very easily. In addition, as the range of fluid power applications widened to include systems where the pressure fluctuates rapidly, the gage sometimes causes trouble. The spring-loaded direct action gage was therefore developed, and since its introduction, has been increasingly accepted.

In the spring-loaded gage a piston is directly actuated by the fluid pressure to be measured and moves up a cylinder against the resistance of a spring, carrying a bar or indicator with it over a calibrated scale. In this manner all levers, gears, cams, and bearings are eliminated, and a sturdy instrument can be constructed.

Figure 10-11 shows the construction of the gage and the manner in which it operates. The parts up through the middle of the gage, from the needle at the bottom on through the packing piston and rod to the button at the top, form a unit which transmits fluid pressure to the sleeve against which the button rests. This sleeve surrounds the inner barrel of the gage. The sleeve is flanged at its base to provide a seat for a spring coiled around the barrel and for a cup to which the pressure indicator is attached. Fluid pressure compresses the spring, and the barrel rises out of the body, carrying the indicator up with it. The indicator moves against a pressure scale on the face of the gage. (See fig. 10-12.)

The spring-loaded gage is calibrated by comparing gage readings with known pressures. A small error can be corrected by loosening four screws on the face of the gage and sliding the scale up or down under the pointer. For larger errors, the adjustment screw which holds the spring in place can be tightened if the gage reading is to high, or loosened if the reading is too low. Turning the adjustment screw varies the compression of the spring. A sealing strip is provided to lock the adjustment screw in place after calibration.

While the spring-loaded pressure gage is satisfactory for ordinary fluid pressure measurements, it is not as accurate as the Bourdon tube gage. It is not a laboratory gage for exact readings, but a sturdily constructed working unit suitable for practical use. It is especially recommended for fluctuating loads.

The gage should be protected against vibration, excessive temperatures, corrosive fluids, and sudden high pressure. A petcock (plug valve) should be installed between the gage and the pressure system so that pressure can be applied slowly to the gage, and so that it will be protected against strain when not in actual use.

These gages should not be used in a system in which maximum pressure may exceed the maximum designated gage reading. Dropping a

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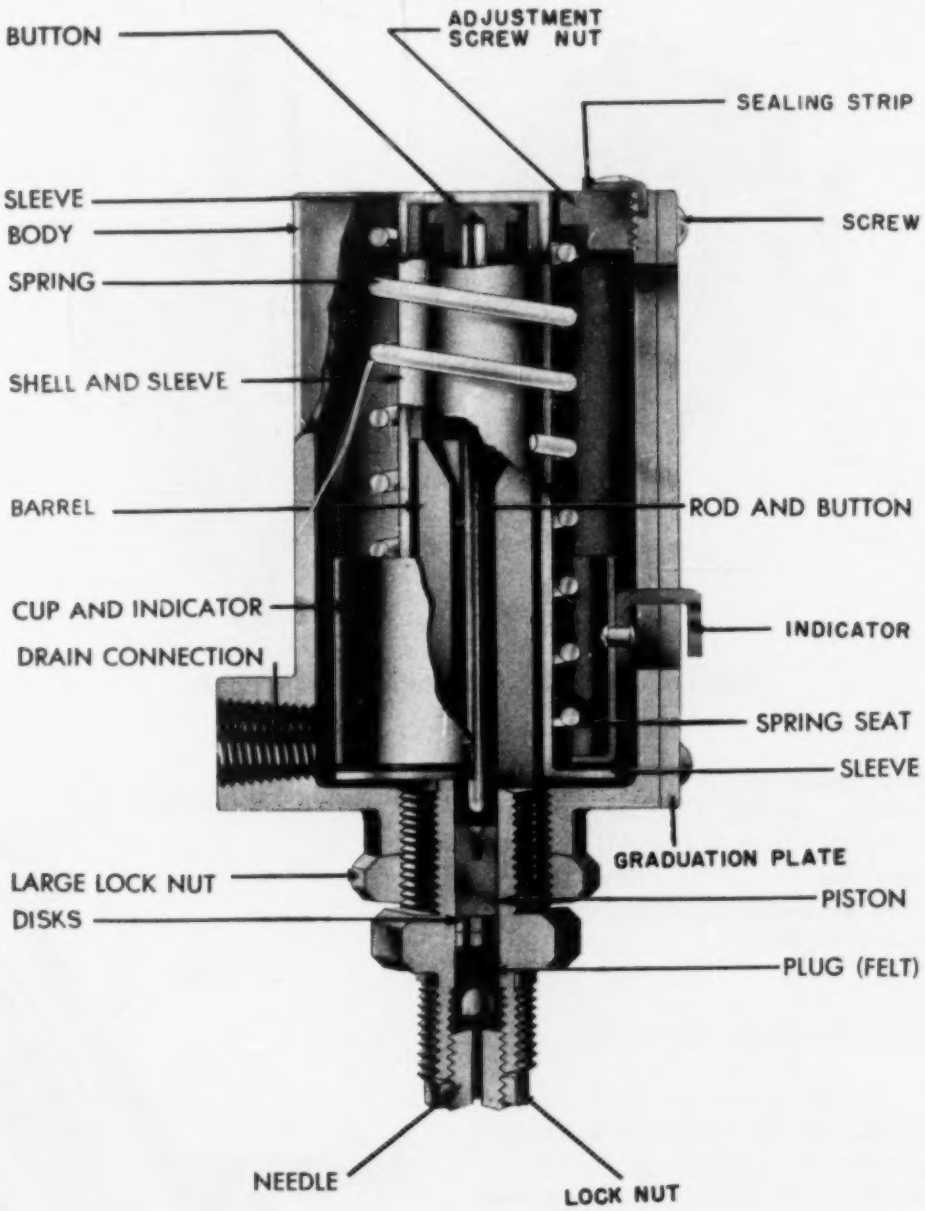

Figure 10-11.—Spring-loaded gage.

gage may permanently damage the calibrated units. When gages are not in use they should be stowed in a dry place.

GAGE SNUBBERS

The irregularity of impulses applied to the fluid power system by some power pumps/compressors causes the pressure gage pointer to oscillate violently. This makes reading of the gage not only difficult but often impossible. Pressure oscillations and other sudden pressure changes existing in fluid power system will also affect the delicate internal mechanism of gages and cause either complete destruction of the gage or, often worse, partial damage, resulting in false readings. A pressure gage snubber is therefore installed in the line to the pressure gage.

The purpose of this unit is to dampen the oscillations and thus provide a steady reading and a protection for the gage. The pressure gage snubber shown in figure 10-13 consists of a two-port housing containing an orifice into which a floating plunger is inserted. The plunger tends to reduce the area of this orifice, thus

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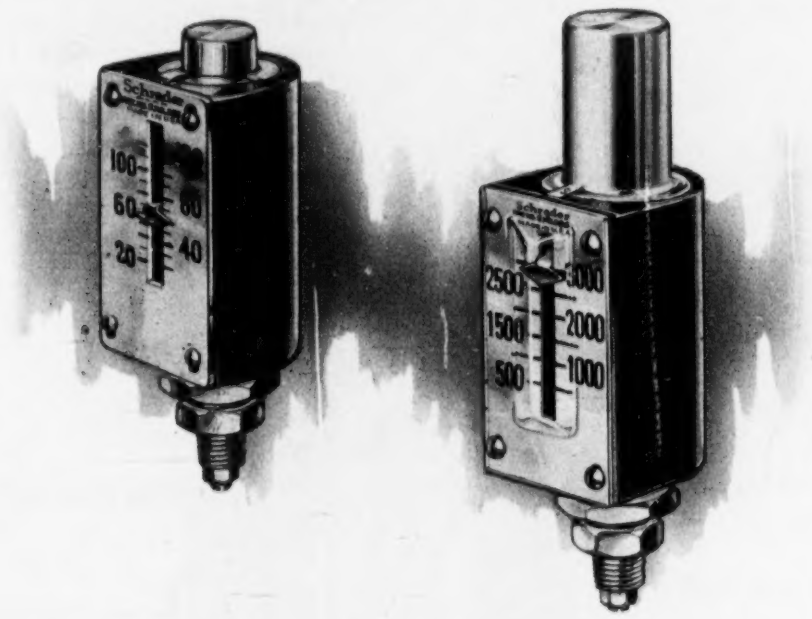

Figure 10-12.—Spring-loaded gage scale.

increasing the dampening effect. The floating action of this plunger causes it to move back and forth in the orifice, thus making the small opening "self-cleaning." This reduction in surges results in a steadier pointer indication and a more accurate reading.

PRESSURE CONTROL DEVICES

Safe and efficient operation of fluid power systems, system components, and related equipment requires a means of controlling pressure. Different types of pressure control devices are utilized in fluid power systems to maintain the desired pressures in the systems and/or subsystems. For example, a system with a number of subsystems may require 3,000 psi to operate all subsystems except one, which requires only 1,500 psi. A pressure control valve is used to maintain the 3,000 psi in the main system and a pressure reducing valve is used to reduce the pressure to 1,500 psi before it enters the one subsystem.

Most pressure control valves are of the type which contains two systems of movable parts whose joint action is responsible for the operation of the valve. As stated in chapter 9, this type is classified as compound rather than simple. Some of the reasons compound valves are used for the control of pressure are explained in the next section of this chapter under relief valves.

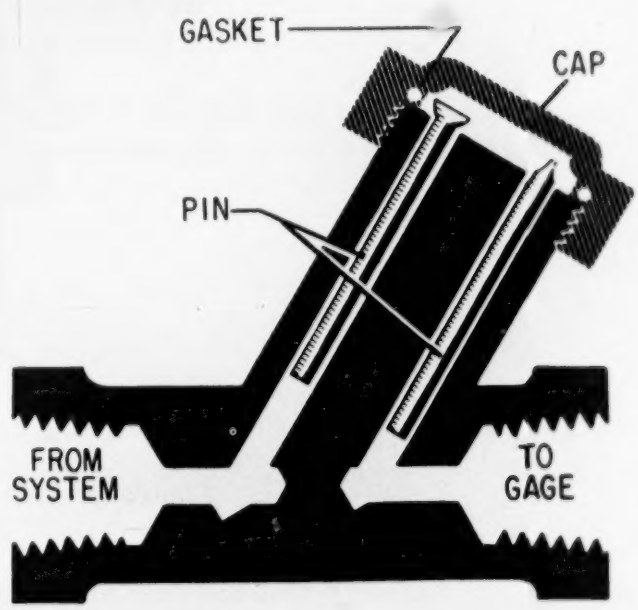

Figure 10-13.—Pressure gage snubber.

The manner in which the most complicated pressure control valve operates will always conform to the hydraulic principles outlined in chapter 2. The valve will open or close because pressures are different over equal areas, because pressures are acting over unequal areas, or a combination of both reasons. In each

instance, inequality of opposed forces causes the valve to open or close. The forces may be set up by the opposition of fluid pressures, or by fluid pressure acting against a mechanical resistance, for example, the resistance set up by a spring.

Like all forces, the force exerted in a certain direction on the face of a valve is always exerted on an area standing exactly at a right angle to that direction. Thus in figure 10-14, if the fluid is under a pressure of 400 psi and the slanting surface (A) has an area of 10 square inches, the force acting in a slanting direction, at right angles to that surface, is 4,000 pounds. The force acting directly downward on surface (A), however, will depend on the horizontal area (B) which is directly beneath (A). If (B) has an area of 8 square inches, the downward force acting on surface (A) is 3,200 pounds (400 X 8).

RELIEF VALVES

A relief valve is simply a pressure limiting device. It is commonly used to prevent the pressure of a confined fluid from building up to a point at which the container would burst. The "pop-off" valve on a steam boiler, the weights on a pressure cooker, and the safety valve on a hot water tank are all relief valves. The pressure cap on an automobile radiator is a relief valve, used to prevent pressure from building up too high and bursting the radiator. Fluid power systems, even when operating normally, may temporarily develop dangerous excess pressures; for example, when an unusually strong work resistance is encountered. Relief valves are used to control this excess pressure. Their purpose is not to maintain flow or pressure at a given amount, but to keep pressure from rising above a definite level when the system is temporarily overloaded.

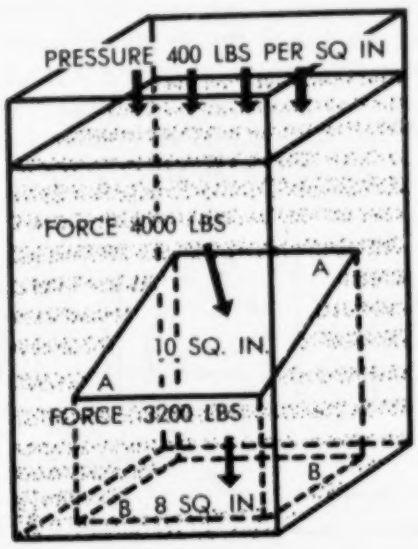

Figure 10-14.—Pressure acting on a slanted surface.

The main system relief valve must be large enough to allow the full output of the hydraulic pump to be delivered back to the reservoir. In the case of a pneumatic system, the relief valve controls excess pressure by discharging the excess fluid into the atmosphere.

Smaller relief valves, which are of the same design as the main system relief valves, are often used in isolated parts of fluid power systems. These smaller relief valves are used in parts of the system where a check valve or a directional control valve prevents pressure from being relieved through the main system relief valve.

These small relief valves are also used to relieve the pressure caused by thermal expansion (see glossary) of the fluids. Since the amount of fluid to be relieved is small, the valve can be small and still do its job.

All relief valves have an adjustment for increasing or decreasing the pressure at which they will relieve. The adjusting screw is usually covered by a cap, which must be removed before the adjustment can be made. Some relief valves are equipped with a handwheel and may be adjusted manually for different operations. To increase pressure at which the valve relieves, turn the adjusting screw or handwheel clockwise.

A simple two-port relief valve is shown in figure 10-15. The pressure from the system enters port (6) and pushes upward on the ball (5). If this pressure is high enough to overcome the force of spring (3), the ball will be pushed off its seat, and the fluid from the system can flow out port (4) to return, or to the atmosphere in pneumatic systems. The adjusting screw (1) increases or decreases the force of the spring, taking more or less pressure to unseat the ball.

Various modifications of the simple relief valve are used and efficiently serve the requirements of some fluid power systems. However, most systems require a compound relief valve. For a better understanding of the operation of relief valves, some of the undesirable characteristics of the simple relief valve are discussed in the following paragraphs.

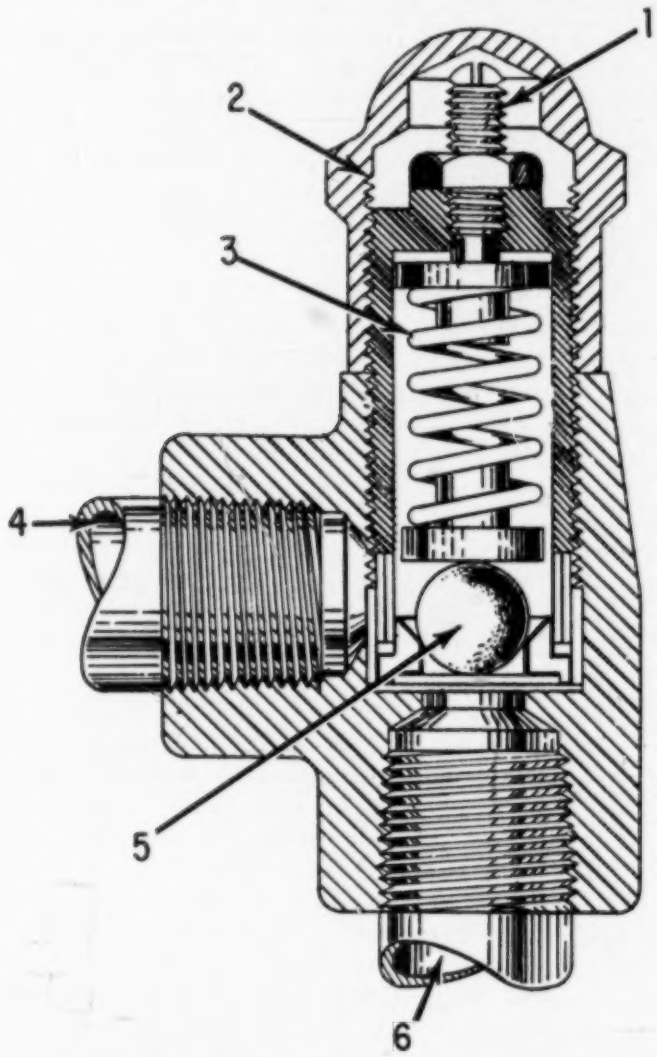

1. Pressure adjusting screw.
2. Adjusting screwcap.
3. Compression spring.
4. Return port.
5. Ball.
6. Pressure port.

Figure 10-15.—Simple two-port relief valve.

It is because simple relief valves are unsatisfactory for some applications thatcompound relief valves were developed. A simple relief valve, such as the one illustrated in figure 10-15, with a suitable spring adjustment can be set so that it will open when the system pressure rises to say 500 psi. When it does open, however, the volume of flow to be handled may be greater than the capacity of the valve, so that pressure in the system may rise as much as several hundred pounds above the set figure before the valve spring brings the pressure under control. A simple relief valve would be effective under these conditions only if it were very large. In that case, however, it would work stiffly and would chatter back and forth.

In addition, when the system pressure is reduced, the valve will close at a pressure below the set figure. As indicated in figure 10-16, the seating surface of the valve must be wider than the pressure opening if the valve is to seat satisfactorily. The pressure in the system acts on the area of the valve open to it. In each case in figure 10-16, the force exerted directly upward by this pressure when the valve is closed depends on the horizontal area across the valve at (A). The moment the valve opens, however, the upward force exerted by the pressure will depend on the horizontal area of the valve at (B), which is necessarily greater than the area at (A). This leads to an upward jump in the action of the valve immediately after it opens, and it also sets up a greater force opposed to the closing of the valve than was needed to open it. As a result, the valve will close at a lower pressure than the pressure at which it opened. The same pressure acting over different areas produces forces proportional to the areas.

For example, assume a valve is set to open at 500 psi. (Refer to fig. 10-16.) When the valve is closed, the pressure acts on the area at (A). If this area is 0.5 square inch, an upward force of 250 pounds (500 X 0.5) will be exerted on the valve at the moment of opening. With the valve open, however, the pressure acts on the area at (B). If the area at (B) is 1 square inch, the upward force is 500 pounds, or double the force at which the valve actually opened. For the valve to close, pressure in the system would have to fall well below the figure at which the valve opened. The exact pressure at which the valve would close depends upon certain relations of the particular shapes of the valve element.

In some hydraulic systems the pressure in the return line must be overcome. This "back pressure" is caused by restriction in the return line. This pressure acting on top of the valve

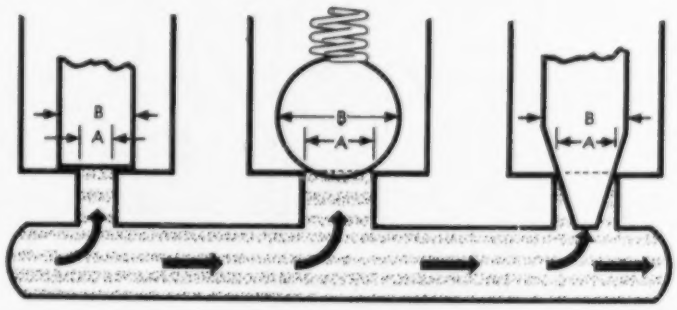

Figure 10-16.—Pressure acting on different areas.

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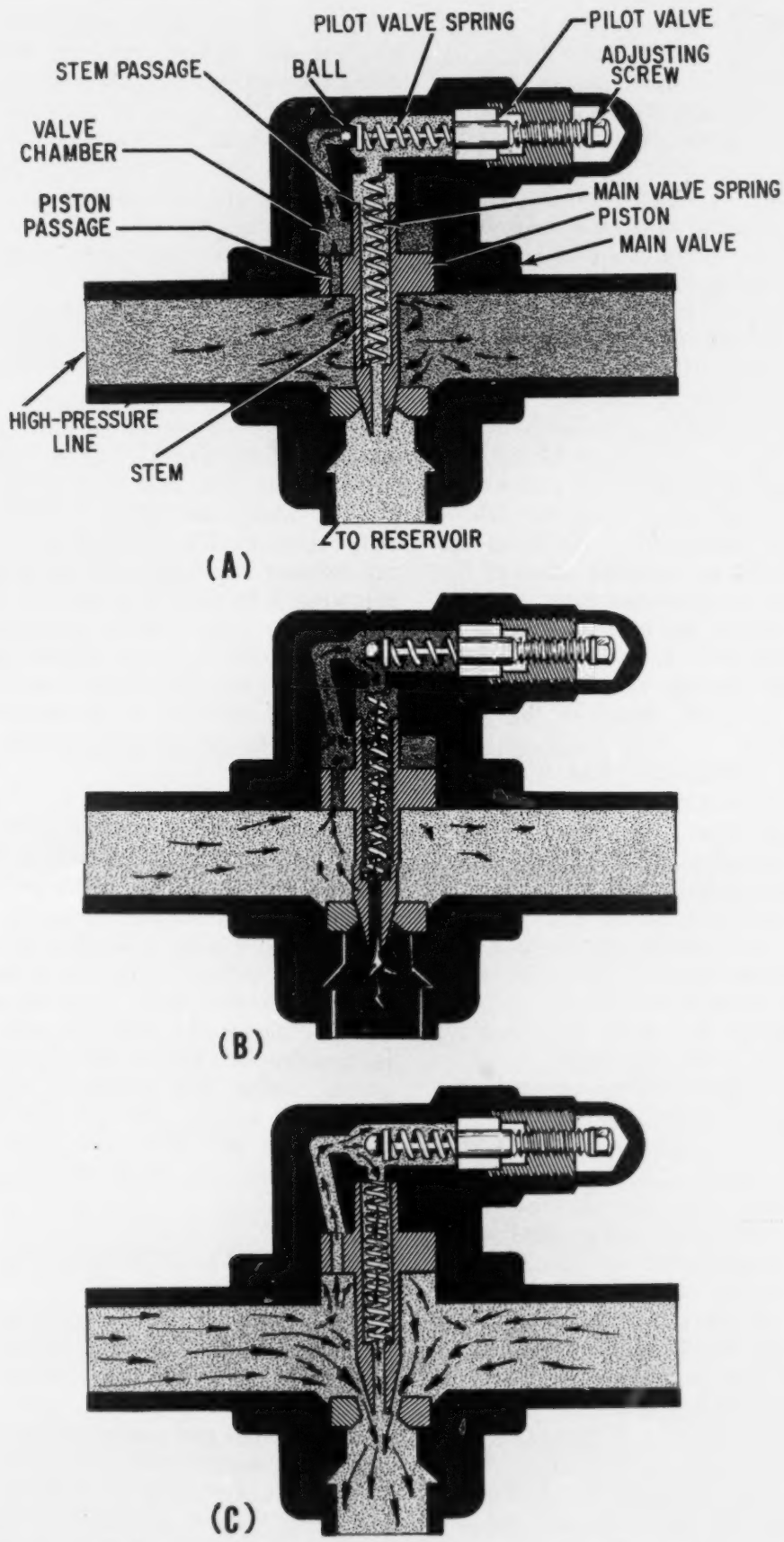

Figure 10-17.—Operation of compound relief valve.

13052

cylinder. For example, counterbalance valves are used in some hydraulically operated fork lifts. The valve offers a resistance to the flow from the actuating cylinder when the fork is lowered. It also helps to support the fork in the UP position.

A counterbalance valve is illustrated in figure 10-18. The valve element is a balanced spool valve (4). The spool valve consists of two pistons permanently fixed on either end of a shaft. The inner piston areas of the pistons are equal; therefore, pressure acts equally on both areas regardless of the position of the valve, and has no effect on the movement of the valve—hence, the term balanced. A small pilot piston is attached to the bottom of the spool valve.

When the valve is in the closed position, the top piston of the spool valve blocks the discharge port (8). With the valve in this position, fluid, flowing from the actuating unit, enters the inlet port (5). The fluid cannot flow through the valve because the discharge port (8) is blocked. However, fluid will flow through the pilot passage (6) to the small pilot piston. As the pressure increases, it acts on the pilot piston until it overcomes the preset pressure of spring (3). This forces the spool up and allows the fluid to flow around the shaft of the spool valve and out the discharge port (8). Figure 10-18 shows the valve in this position.

During reverse flow, the fluid enters port (8). The spring (3) forces the spool valve (4) to the closed position. The fluid pressure overcomes the spring tension of check valve (7). The check valve opens and allows free flow around the shaft of the spool valve and out port (5).

The operating pressure of the valve can be adjusted by turning the adjustment screw (1), which increases or decreases the tension of the spring. This adjustment depends on the weight that the valve must support.

It is normal for small amounts of fluid to leak around the top piston of the spool valve and into the area around the spring (3). An accumulation would cause additional pressure on the top of the spool valve. This would require additional pressure to open the valve. The drain (2) provides a passage for this fluid to flow to port (8).

SEQUENCE VALVES

A sequence valve is used to control a sequence of operations; that is, enable one unit to automatically set another unit into motion. An example of the use of a sequence valve is in an aircraft landing gear actuating system.

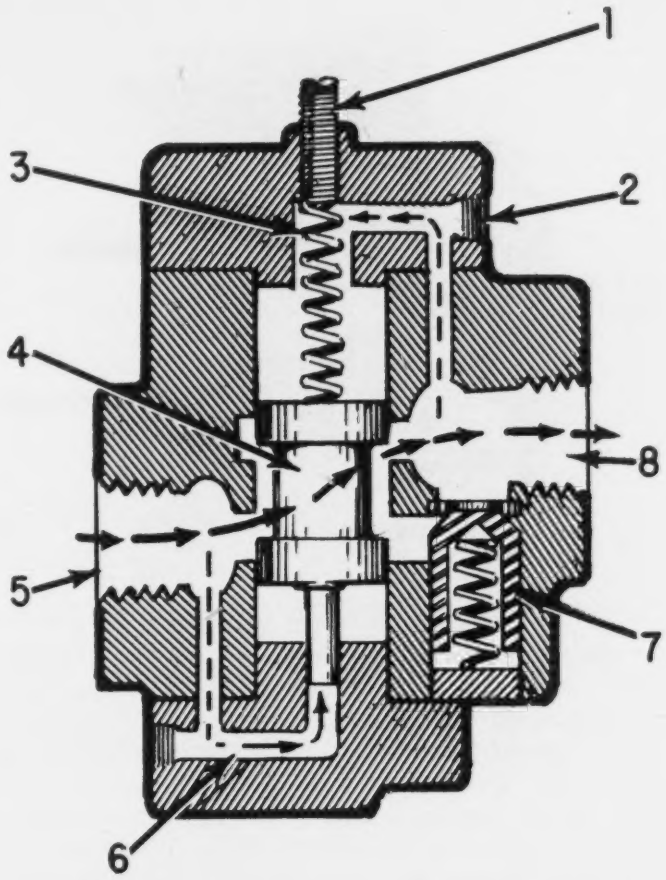

1. Adjustment screw.
2. Internal drain.
3. Spring.
4. Spool.
5. Pressure inlet or reverse free flow outlet.
6. Pilot passage.
7. Check valve.
8. Discharge outlet or reverse free flow inlet.

Figure 10-18.—Counterbalance valve.

In a landing gear actuating system the landing gear doors must be open before the landing gear starts to extend. Conversely, the landing gear must be retracted before the doors close. A sequence valve installed in each landing gear actuating line performs this function.

Figure 10-19 shows an installation of two sequence valves which control the sequence of operation of three actuating cylinders. Fluid from the directional control valve is free to flow into cylinder (A). The first sequence valve (1) blocks the passage of fluid until the piston in cylinder (A) moves to the end of its stroke. At this time, sequence valve (1) opens, allowing fluid to enter cylinder (B). This action continues in sequence until all three pistons move to the right.

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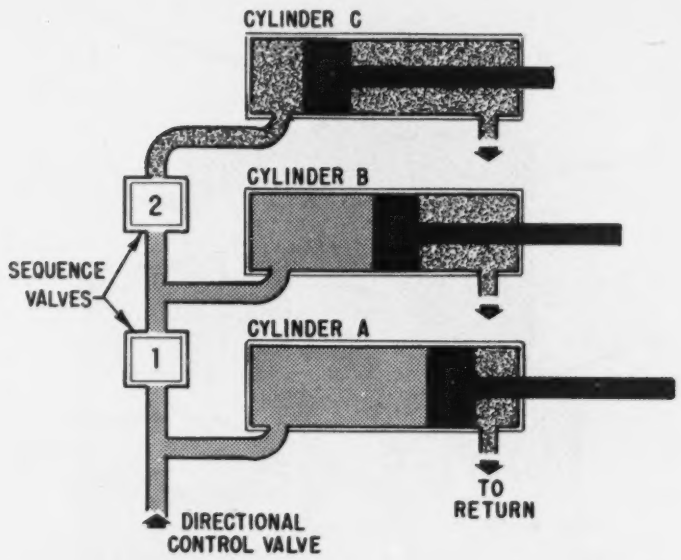

Figure 10-19.—Installation of sequence valves.

There are various types of sequence valves. Some are pressure controlled and some are mechanically controlled. One type of sequence valve operates similar to the counterbalance valve just described. In fact, valves are available which can be utilized as either a counterbalance valve or sequence valve. Two types of sequence valves are described in the following paragraphs. The first is pressure controlled and the second is mechanically controlled.

Pressure Controlled Sequence Valve

The operation of a typical pressure controlled sequence valve is illustrated in figure 10-20. The desired pressure is obtained by adjusting the tension of spring (2), which holds piston (1) in the closed position. Fluid from the directional control valve enters port (3), flows past piston (1) and enters the outlet port (4) to the first (primary) unit to be operated. When the pressure of the fluid flowing through the valve is below the adjusted setting, the force acting upward on piston (1) is less than the downward force of the spring (2). This holds the piston down and the valve is in the closed position as shown in figure 10-20 (A).

When the primary actuating unit completes its operation, the pressure increases in the valve. When the pressure increases sufficiently to overcome the force of spring (2), piston (1) rises. The valve is then in the open position, as shown in figure 10-20 (B). The fluid entering the valve takes the path of least resistance and flows through port (5) to the secondary unit. These valves usually contain a check valve to

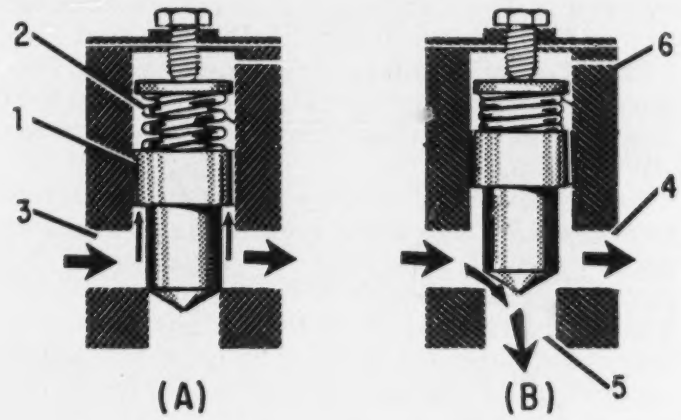

1. Piston.
2. Spring.
3. Entrance port.
4. Outlet port to primary unit.
5. Outlet port to secondary unit.
6. Drain.

Figure 10-20.—Operation of pressure controlled sequence valve.

allow free reverse flow from the secondary actuating unit to the primary unit. However, the sequencing action is provided only in one direction of flow.

Mechanically Operated Sequence Valves

Figure 10-21 illustrates a mechanically operated sequence valve. This valve is operated by the in and out movement of the plunger which extends from the body of the valve. The plunger is held in the extended position by a spring. The valve is mounted so that the plunger will be depressed by the primary unit.

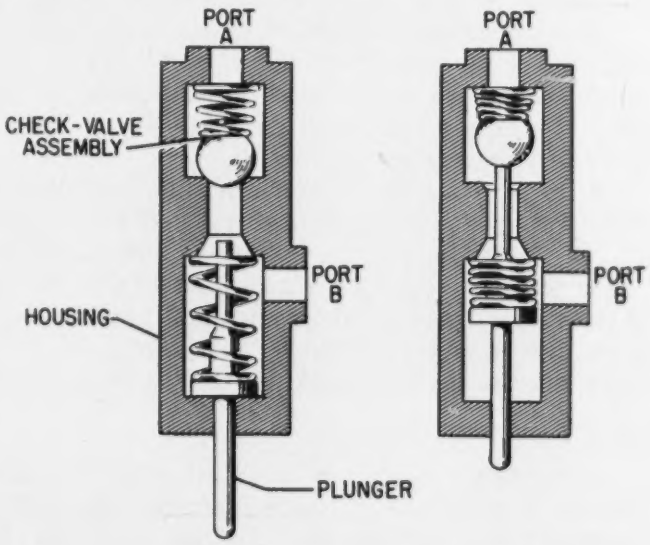

Figure 10-21.—Mechanically operated sequence valve.

1305

a successful soil inhabitant and as such may persist in the soil for several years. Infection takes place through wounds only, as far as is known. When the organism is established in the soil, chewing insects play an important part in the infection process. If sanitary practices in grafting and pruning are not followed, infection may result and gall tissue may be mistaken for wound overgrowth due to imperfect grafting. A third means of entry of the bacterium is probably through natural wounds associated with development of lateral roots.

Control - The most satisfactory approach to crown gall control is through production of clean nursery stock. Choice of a growing area free of crown gall bacteria and chewing insects is important. Sanitary practices (dipping tools in a sterilizing solution) in grafting and storage are essential.

Plants purchased by the home gardener as bare root nursery stock often develop crown gall two or three years after planting. The incidence of infection in these cases can be reduced by dipping the root systems in an antibiotic solution (Agri-strep or Agri-mycin, 100 ppm) before planting. Follow label instructions. This treatment will kill bacteria on root surfaces and in incipient infections, preventing the development of the disease if the bacteria are not already in the soil.

Prepared from information supplied by Dr. Alice Boyle, Department of Plant Pathology, University of Arizona.

Arlen D. Davison
Arlen D. Davison
Extension Specialist
in Plant Pathology

Note: The information given herein is supplied with the understanding that no discrimination is intended and no indorsement by the Arizona Extension Service is implied.

A check valve is incorporated between the fluid ports in the body. The check valve, either a ball or a poppet, is held against the seat by a spring. When seated, the check valve prevents a fluid flow through the valve. The check valve is unseated by the plunger as it is depressed into the valve by the primary unit.

Port (A) and the actuator of the primary unit are connected with a common line from the directional control valve. Port (B) is connected with a line to the actuator of the secondary unit. Fluid under pressure flows from the directional control valve to the primary unit and through port (A) to the seated check valve in the sequence valve. In order to operate the secondary unit, the fluid must pass through the sequence valve. The valve is located in such a position that the primary unit, as it completes its operation, will depress the plunger. The plunger unseats the check valve and allows the fluid to flow through the valve to the secondary unit.

This type sequence valve permits flow in the opposite direction. Fluid enters port (B), flows through the valve, and with a slight amount of pressure, unseats the check valve and flows through port (A).

PRESSURE REGULATORS

As the term implies, pressure regulators are used in fluid power systems to regulate the pressure. In pneumatic systems, the valve commonly referred to as a pressure regulator serves to reduce pressure. This type valve is described under pressure reducing valves in the next section. The pressure switch, described later, is often used in pneumatic systems to regulate systems pressure. The pressure regulator described in the following paragraphs is utilized in hydraulic systems.

Pressure regulators, often referred to as unloading valves, are used in hydraulic systems to unload the pump and to maintain and regulate system pressure between the maximum and the minimum. All hydraulic systems do not require pressure regulators. Many systems are equipped with variable displacement pumps, which contain a pressure regulating device, as described in chapter 7.

Pressure regulators are made in a variety of types by various manufacturers; however, the basic operating principles of all regulators are similar to the one shown in figure 10-22. The schematic diagram shows the regulator in both the cut-in and cutout positions.

A regulator is said to be in the cut-in position when it is directing fluid under pressure into the system. In the cutout position, fluid is bypassed into the return line and back to the reservoir. The difference between cut-in and cutout pressure is known as differential or operating range. For example, assume that a pressure regulator is set to cut in when the system pressure drops below 600 psi, and cut out when the pressure rises above 800 psi. The differential or operating range is 200 psi. Figure 10-22 (A) illustrates the regulator in the cut-in position and figure 10-22 (B) in the cutout position.

Notice that as the fluid is delivered from the pump, it goes to both the top and the bottom of the regulator. The construction of this regulator includes a piston 1 square inch in area, a piston rod, a steel ball one-fourth square inch in area, and a piston spring of 600 pounds force pushing the piston down. Until the pressure is great enough to push the piston up and unseat the ball, the fluid is directed to the system.

When the pressure on the piston builds up to 600 psi, the force applied on the piston face will be 600 pounds. (Force equals pressure times area—F = P x A.) In this case, the pressure is 600 and the area of the piston is 1 square inch; therefore, the force is 600 pounds. Since the spring pushes the piston down with a force of 600 pounds, the two forces on either side of the piston are balanced. However, the force holding the ball in place must be considered. This force, 600 x 1/4 square inch (area of the steel ball), equals 150 pounds. This force allows the fluid to continue to build up pressure in the system.

In figure 10-22 (B) the pressure has built up to 800 psi, or 800 pounds of force, pushing up on the piston. The spring pressure is constant (600 pounds); therefore, the resultant force is 200 pounds pushing the piston up. The force applied to the steel ball will also be 200 pounds (800 x 1/4). At this point the regulator is in the balanced state as both the upward and downward forces are equal. Any pressure in excess of 800 psi will move the piston up and push the ball off its seat. Since the fluid will always follow the path of least resistance, it will pass through the regulator and back to the reservoir. (See fig. 10-22 (B).)

The pump continues to operate, although it does not have to push the fluid out against the pressure. Therefore, it is not constantly under a load and the pump will operate under trouble-free conditions for a longer period.

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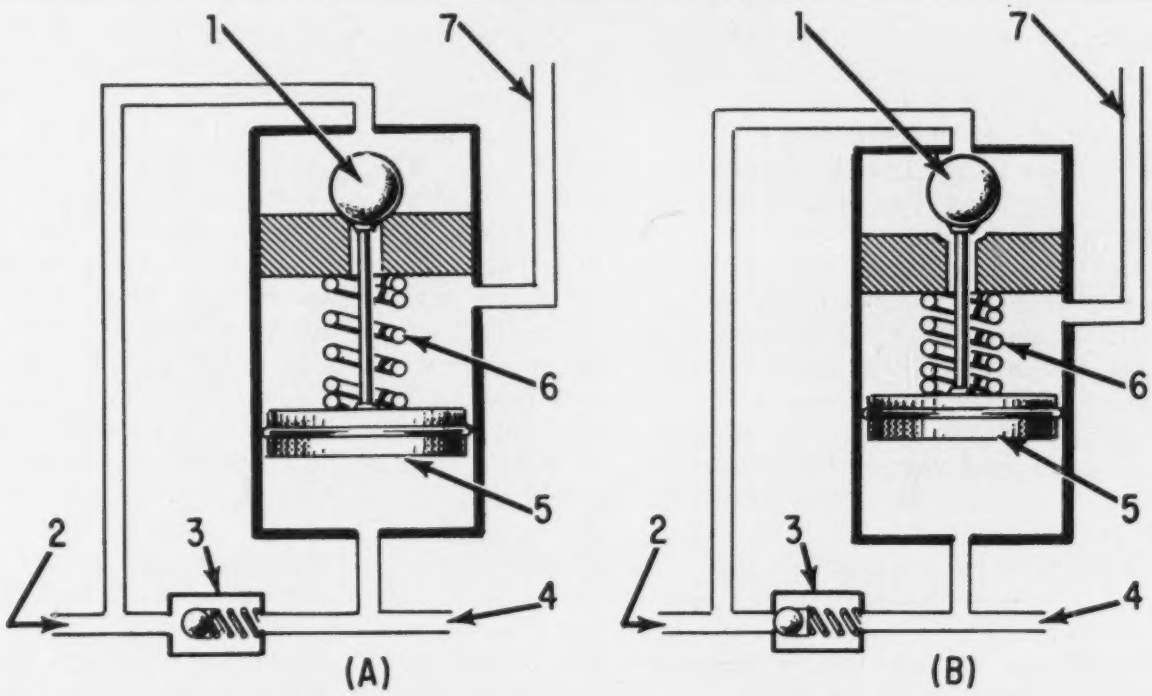

1. Bypass valve.
2. Pressure input.
3. Check valve.
4. System connection.
5. Piston.
6. Spring.
7. Line to reservoir.

Figure 10-22.—Hydraulic pressure regulator.

When the fluid from the pump is suddenly allowed a free path of return, the fluid in the system also tries to escape through the bypass. The check valve (3) will not allow this, however. The fluid in the system is trapped under pressure. The regulator is now in the cutout position. This fluid will remain pressurized until a unit is actuated, or until pressure is slowly lost through normal leakage within the system.

When the system pressure drops to a point where a further decrease in pressure might not provide sufficient force to operate one of the actuating units in the system, the spring (6) forces the piston (5) down, allowing the bypass (1) to close. When the bypass is closed, the fluid cannot flow directly to return. This causes the pressure to increase in the line between the pump and the regulator. This pressure will open check valve (3), and fluid will re-enter the system and build up the pressure to the desired maximum.

Therefore, when the system pressure lowers a certain amount, the pressure regulator will cut in, thus sending fluid into the system. When the pressure increases sufficiently the regulator will cut out allowing the fluid to flow through the bypass and back to the reservoir. As stated previously, the difference between the regulator cut-in pressure and cutout pressure is the differential or operating range. This prevents the regulator from cutting in or out with small changes in pressure. The pressure regulator serves to take the load off the pump and to regulate system pressure.

PRESSURE REDUCING VALVES

In some fluid power systems it is desirable, and often necessary, to operate a subsystem at a lower pressure than the main system. Pressure reducing valves are used for this purpose. For example, assume the operating pressure of a system is 1,500 psi. This pressure is required for all subsystems, except one which must be limited to 800 psi. A relief valve, adjusted to 1,500 psi, installed in the main system would allow system pressure to rise to the required 1,500 psi; however, the relief valve would not limit the subsystem pressure to 800 psi. A relief valve, adjusted to 800 psi, would protect the subsystem, but would also prevent the main system from developing the required 1,500 psi. Therefore, a system such as this requires a relief valve, adjusted to a setting just about 1,500 psi, installed in the main system and a pressure reducing valve, adjusted to 800

13056

psi, installed in the subsystem. In addition to reducing the pressure, a reducing valve regulates the pressure. That is, it maintains the reduced pressure at a constant level during operation of the subsystem.

Like all other valves, there are various designs and types of pressure reducing valves. Two types—the diaphragm-controlled and the pilot-controlled—are described in the following paragraphs.

Diaphragm-Controlled

A diaphragm-controlled pressure reducing valve is illustrated in figure 10-23. This type valve is commonly used in pneumatic systems. Because it serves to regulate reduced pressure to a subsystem, it is often referred to as a pressure regulator.

Control of fluid passing through this valve is effected by means of a pressure difference on

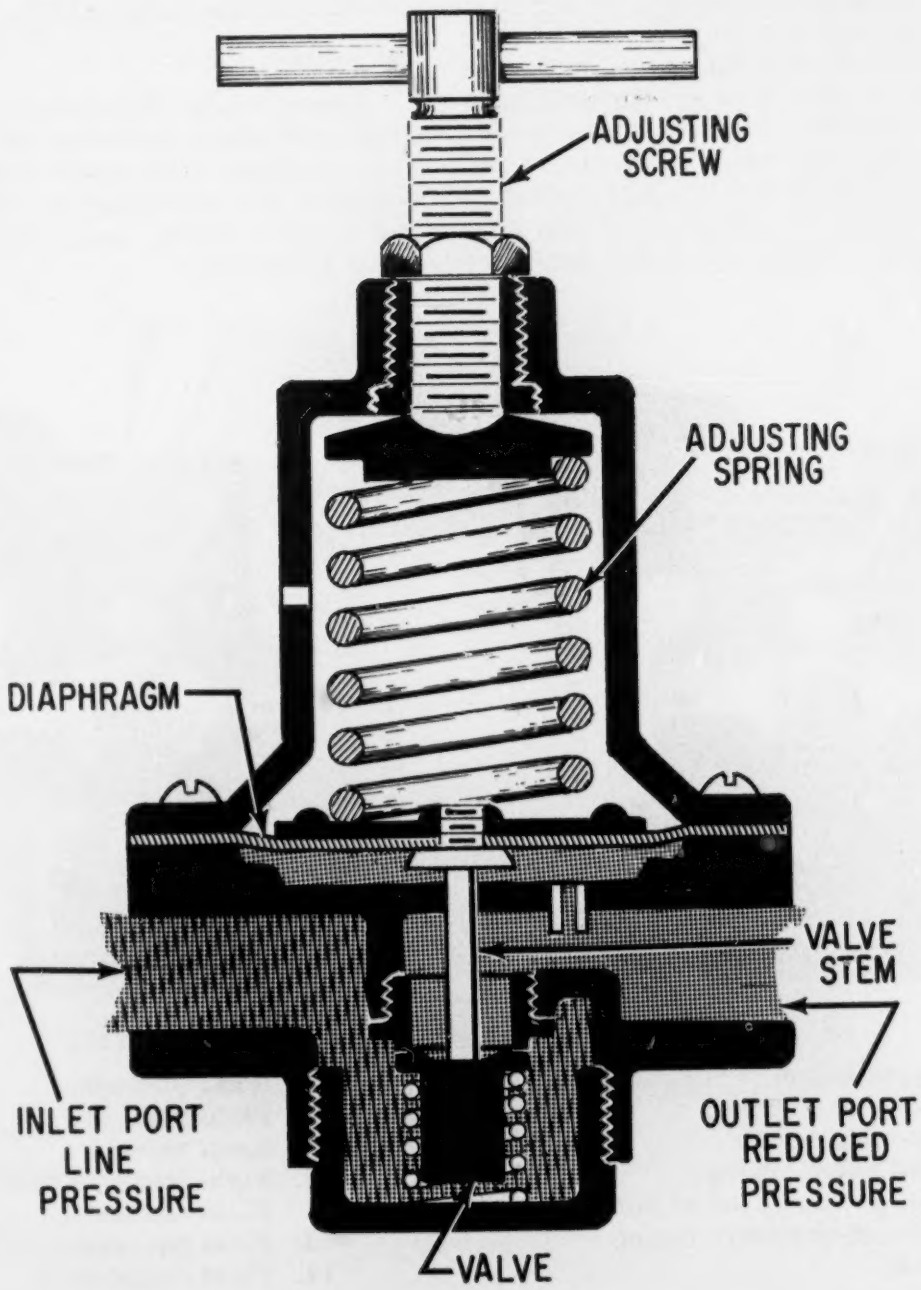

Figure 10-23.—Diaphragm-controlled pressure reducing valve.

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opposite sides of the diaphragm. The diaphragm is secured to the valve stem. Reduced fluid pressure from the valve outlet port flows through an internal passage to a diaphragm chamber below the diaphragm. An adjusting spring acts on the upper side of the diaphragm.

The amount of pressure applied by the fluid to the undersurface of the diaphragm varies according to the pressure in the outlet (reduced pressure) port. When the outlet pressure is greater than the spring pressure, the diaphragm is forced upward. Since this is an upward-seating valve, the upward movement of the stem tends to close the valve or at least to decrease the amount of flow through the valve. When the outlet pressure is less than spring pressure, the diaphragm and the valve stem are forced downward, opening the valve accordingly and increasing the amount of flow through the valve. This flow increases the pressure of the fluid in the outlet port. When the outlet pressure is equal to the spring pressure, the valve stem remains stationary and there is no flow of fluid through the valve.

The amount of pressure applied by the spring to the top of the diaphragm can be varied by turning the adjusting screw. Turning the adjusting screw clockwise increases the pressure applied by the spring to the top of the diaphragm, thus tending to open the valve. Turning the adjusting screw counterclockwise decreases the amount of spring pressure on the top of the diaphragm, thus tending to decrease the amount of pressure in the outlet port.

Pilot-Controlled

Figure 10-24 illustrates the operation of a pilot-controlled pressure reducing valve. This valve consists of an adjustable pilot valve, which controls the operating pressure of the valve, and a spool valve, which reacts to the action of the pilot valve.

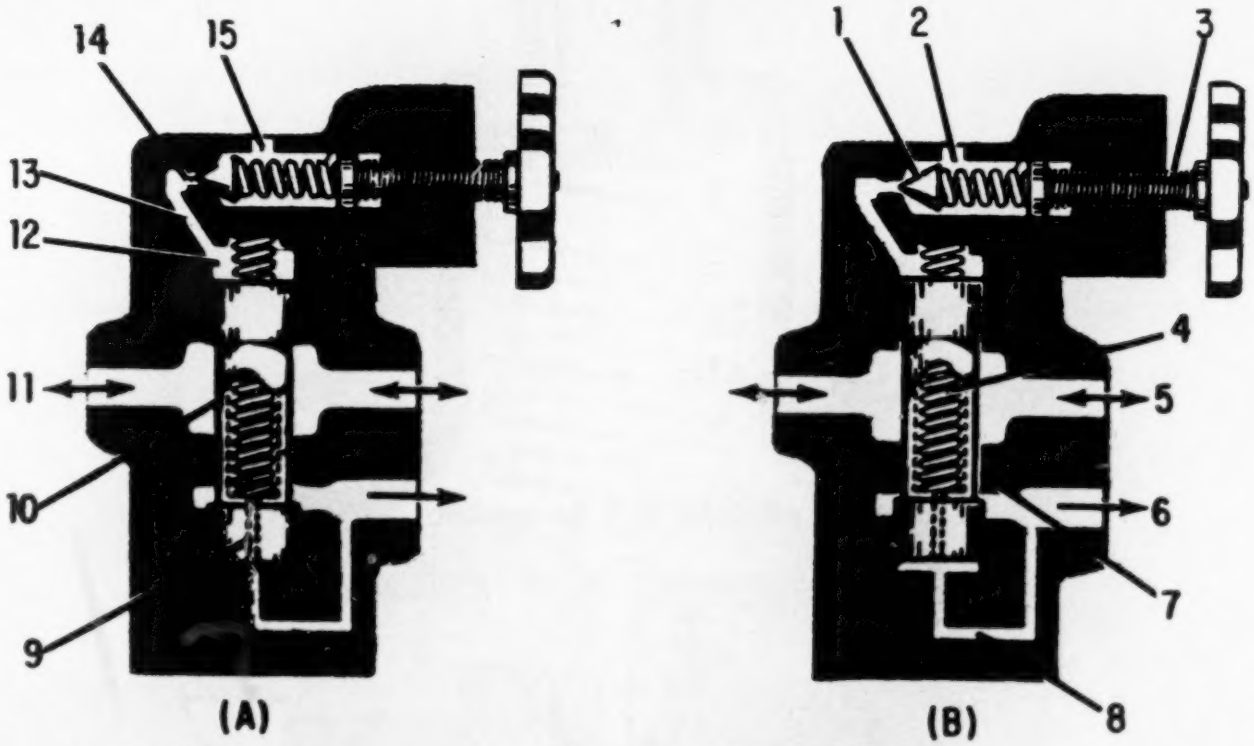

1. Poppet valve.
2. Pilot valve spring.
3. Adjusting screw.
4. Spool valve spring.
5. High-pressure outlet port.
6. Reduced-pressure outlet port.
7. Opening.
8. Fluid passage.
9. Fluid passage.
10. Spool valve.
11. High-pressure inlet port.
12. Fluid chamber.
13. Fluid passage.
14. Fluid chamber.
15. Drain.

Figure 10-24.—Pilot-controlled pressure reducing valve.

13058

The pilot valve consists of a poppet (1), spring (2), and adjusting screw (3). The spool valve assembly consists of a spool valve (10) and spring (4).

Fluid under main system pressure enters the inlet port (11) and, under all conditions, is free to flow through the valve and out port (5). (Either port (5) or port (11) may be utilized as the high-pressure inlet port.)

Figure 10-24 (A) shows the valve in the open position. In this position, the pressure in the reduced-pressure outlet port (6) has not reached the preset operating pressure of the valve. The fluid flows through opening (7) and out through the reduced pressure port (6). The fluid also flows through passage (8), through the smaller passage (9) in the center of the spool valve, and into chamber (12). The fluid pressure at the outlet port (6) is therefore distributed to both ends of the spool. When these pressures are equal the spool is hydraulically balanced. Spring (4) is a low-tension spring and applies a slight downward force on the spool. Its purpose is to position the spool and to maintain opening (7) at its maximum size.

As the pressure increases in outlet port (7), this pressure is transmitted through passages (8) and (9) to chamber (12). This pressure also acts on the pilot valve poppet (1). When the pressure increases above the preset operating pressure of the valve, it overcomes the force of the pilot valve spring (2) and unseats the poppet (1). This allows the fluid to flow through the drain port (usually connected to the reservoir return line) and reduces the pressure in chamber (12).

Because the small size passage (9) restricts the flow to chamber (12), any additional pressure in the outlet port (6) will act on the bottom of the spool valve. This pressure overcomes the downward force of spring (4) and forces the spool up. As the spool moves upward, it restricts the flow through opening (7) and therefore causes the pressure to decrease in the reduced-pressure outlet port (6), (See fig. 10-24 (B).)

When the pressure decreases in outlet (6), the spool valve moves downward, allowing more flow through opening (7).

Reverse free flow from the reduced-pressure port (6) through the valve is possible only if pressure at port (6) is lower than the valve setting. If the pressure exceeds the valve setting, the valve will close, making reverse flow impossible. To insure reverse free flow, this type valve is often equipped with a check valve. The check valve is located between the high-pressure port (5) and the reduced-pressure port (6). Reverse flow will unseat the check valve and flow directly from port (6) to port (5).

PRESSURE SWITCHES

A pressure switch is actuated by a rise or drop in fluid pressure. The switch converts this pressure signal into an electric signal by closing the contacts in an electric circuit. The electric circuit is then used to perform some function in the fluid power system, such as opening and closing a valve, or stopping and starting a pump or compressor. Since fluid pressure is closely related to other system variables, pressure switches can detect fluid level, flow, and velocity. (In some instances, temperature changes can also be detected.)

The pressure signal, which can be either a rise or fall of fluid pressure, is converted into switch actuation by the pressure sensing element. This sensing element can be a piston, Bourdon tube, or diaphragm.

A pressure switch which utilizes a piston type element is illustrated in figure 10-25. The housing of this pressure switch has three external ports. Two of these ports (A and B) are connected to the main pressure line. Port (C) is connected to the return line. Within the housing are two pistons (D and E) and a hollow poppet valve (F). Piston (D) is held down by a spring, but is so placed that the end of its rod will move the ball upward and close the passage in the hollow poppet when pressure becomes great enough to overcome spring tension. Piston (E) is attached to an electrical switch by a piston rod. Pressure on this piston controls the switch. Upward movement of piston (E) turns the switch ON, and downward motion turns the switch OFF.

In figure 10-25, the switch is shown in the OFF position. System pressure, acting through port (B) and the internal passage, holds piston (D) up. When piston (D) is in this position, the opening in the hollow poppet is closed by the ball, and the poppet valve is held up off its seat. When the poppet valve is off its seat, the upper chamber is connected to system pressure, and the pressure acting on the top of piston (E) is the same as the pressure acting on the bottom. Since the area of the top of piston (E) is greater than the area of the bottom (because of the area of the piston rod), the force holding it down is greater than the force holding it up. The switch will therefore remain in the OFF position until

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system pressure is reduced. As the system pressure drops, the large spring forces piston (D) down and allows the poppet valve to seat. Any further decrease in pressure will allow the ball to move away from the opening in the hollow poppet. This action will connect the upper chamber to the return lines through the hollow poppet and the pressure in the upper chamber will drop to zero. The instant this occurs, the force holding piston (E) down will drop to zero and system pressure acting on the bottom of piston (E) will move it up and snap the switch ON.

The piston type sensing element is best suited for high pressure. The major disadvantages of the piston sensing element is that the piston is relatively insensitive to small pressure changes.

The Bourdon tube sensing element is similar in operation to the Bourdon tube pressure gage, previously described. Instead of moving a pointer, as in the pressure gage, the movable end of the tube turns the switch ON and OFF. The Bourdon tube sensing element is capable of operating over a wide range of pressures. It is an accurate pressure switch and is capable of operating at pressures as high as 12,000 psi. Its major disadvantages are cost and its inability to withstand surge pressures.

The diaphragm sensing element is ideally suited for low pressures (up to 400 psi). The diaphragm sensing element is similar in design and operation to the diaphragm pressure gage described earlier in this chapter. It is highly accurate where the diameter of the element is from 2 to 4 inches. The diaphragm sensing

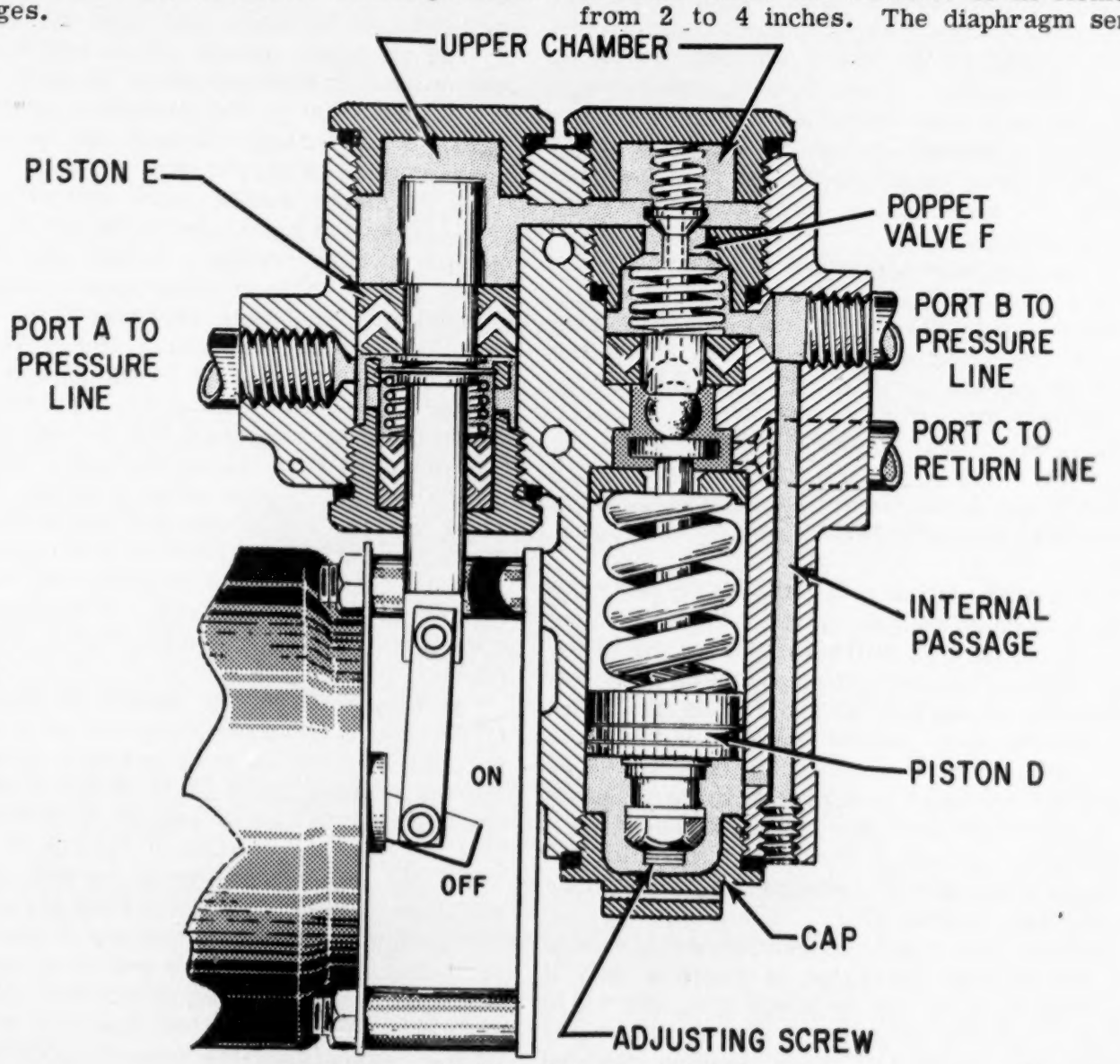

Figure 10-25.—Pressure switch.

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element offers fast response to fluid pressure changes.

HYDRAULIC FUSES

A hydraulic fuse is a protective device designed to assure that all of the fluid in a system does not leak out in case some section of the system develops a leak. When hydraulic fuses are used in a hydraulic system, they are installed at various appropriate locations in the system so that the system is divided into sections. When a leak occurs in a section, the hydraulic fuse limits the fluid loss to the amount contained in the small section of the system that is isolated. Fuses are commonly used in aircraft hydraulic systems. If a leak develops in a subsystem while the aircraft is flying, or a hydraulic line is shot away during combat, a fuse prevents excessive loss of fluid, thus permitting operation of the remaining subsystems.

As its name implies, the hydraulic fuse is very similar to the electric fuse. When too much current flows, the electric fuse blows and opens the circuit. The hydraulic fuse stops the flow when too much fluid has passed through it. It actually measures the quantity of fluid that is flowing, and is sometimes referred to as a quantity measuring fuse.

Figure 10-26 shows a schematic of a hydraulic fuse in the static position. This is the position the valve assumes whenever the subsystem it protects is not in operation, under normal conditions, and there is no flow in either direction. The valve (fig. 10-26) can function as a fuse only when the fluid flows from left to right. It cannot measure the quantity of fluid if the flow is in the opposite direction. For this reason, the hydraulic fuse must be connected to the pressure line leading to the directional control valve of the subsystem, or a fuse must be located in each alternating line. Figure 10-27 shows these two methods of installation.

Figure 10-28 (A) depicts a hydraulic fuse in the flow position. The fluid enters the entrance port (1) where it divides, flowing along the side passages and on to the center of the valve through the drilled holes. Here, it forces the sleeve (5) back, allowing the fluid to flow out the other drilled holes, around the outside passages, and out the exit port (6). As the fluid flows through the valve, some of the fluid entering the entrance port (1) flows through the orifice (2). This fluid slowly forces the piston (3) to the right because, due to fluid flow, there is less pressure on the right side of the piston than on the left. If more fluid flows than is normally required, the piston will finally move to the right until it reaches sleeve (5). The piston blocks the holes drilled through from the outer passages and thus stops fluid flow. In this position, the valve is fused, as is shown in figure 10-28 (B). There is a continual flow of fluid through the fuse until the piston moves far enough to block the holes. Thus, the quantity of fluid allowed to flow before the valve fuses is dependent upon the time it takes the piston to move to the right. A large orifice causes the piston to move faster, allowing less fluid to flow through the outer passages of the valve before it fuses. A small orifice causes the piston to move slower, thereby allowing a greater volume of fluid to flow before the valve fuses.

The size of the orifice used is dependent upon the quantity of fluid needed to move the actuating unit to its extreme travel. For example, an actuating cylinder that requires 40 cubic inches of fluid to extend fully, requires a fuse of slightly larger capacity than the actuating cylinder to insure, under normal operating contions, that the valve will not fuse before the cylinder has reached its full limit of travel. Since the orifice cannot be removed from a fuse, fuses are available with different sized

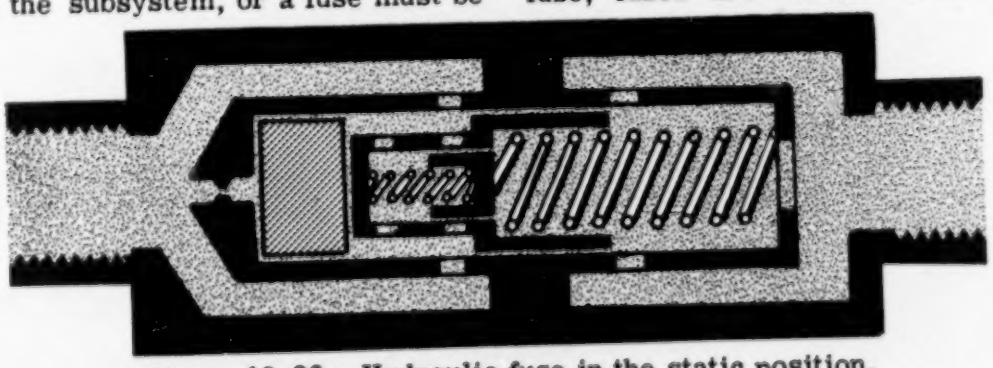

Figure 10-26.—Hydraulic fuse in the static position.

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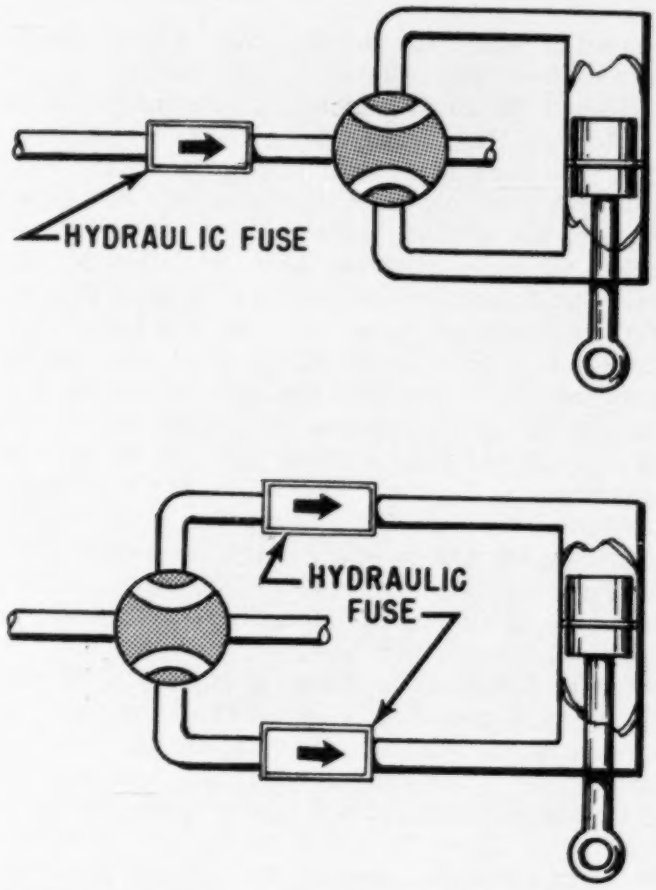

Figure 10-27.—Hydraulic fuse installations.

orifices. Each fuse has the flow capacity clearly marked on its body.

The check valve (4) is incorporated in the fuse to allow for reverse flow, should the fuse be connected in an alternating line. Figure 10-28 (C) shows the reverse flow position with the check valve open. The sleeve (5) and piston (3) are forced to the left, the flow of fluid opens the check valve (4) and allows free reverse flow.

During normal operation the valve nearly fuses each time the full actuator capacity flows through it. When the actuator completes the full travel, the flow of fluid stops, pressure equalizes in all parts of the fuse, and the large spring forces the sleeve and piston to the static position. The fuse also resets to the static position when the fluid pressure is relieved in the line containing the fuse.

If an alternating line should burst, or a seal in an actuating unit ruptures, the fuse allows some its normal flow capacity to escape. At that time it fuses, preventing further fluid loss from the system. Although the hydraulic fuse allows of the fluid to escape from the system, enough fluid remains for normal operation of the other subsystems.

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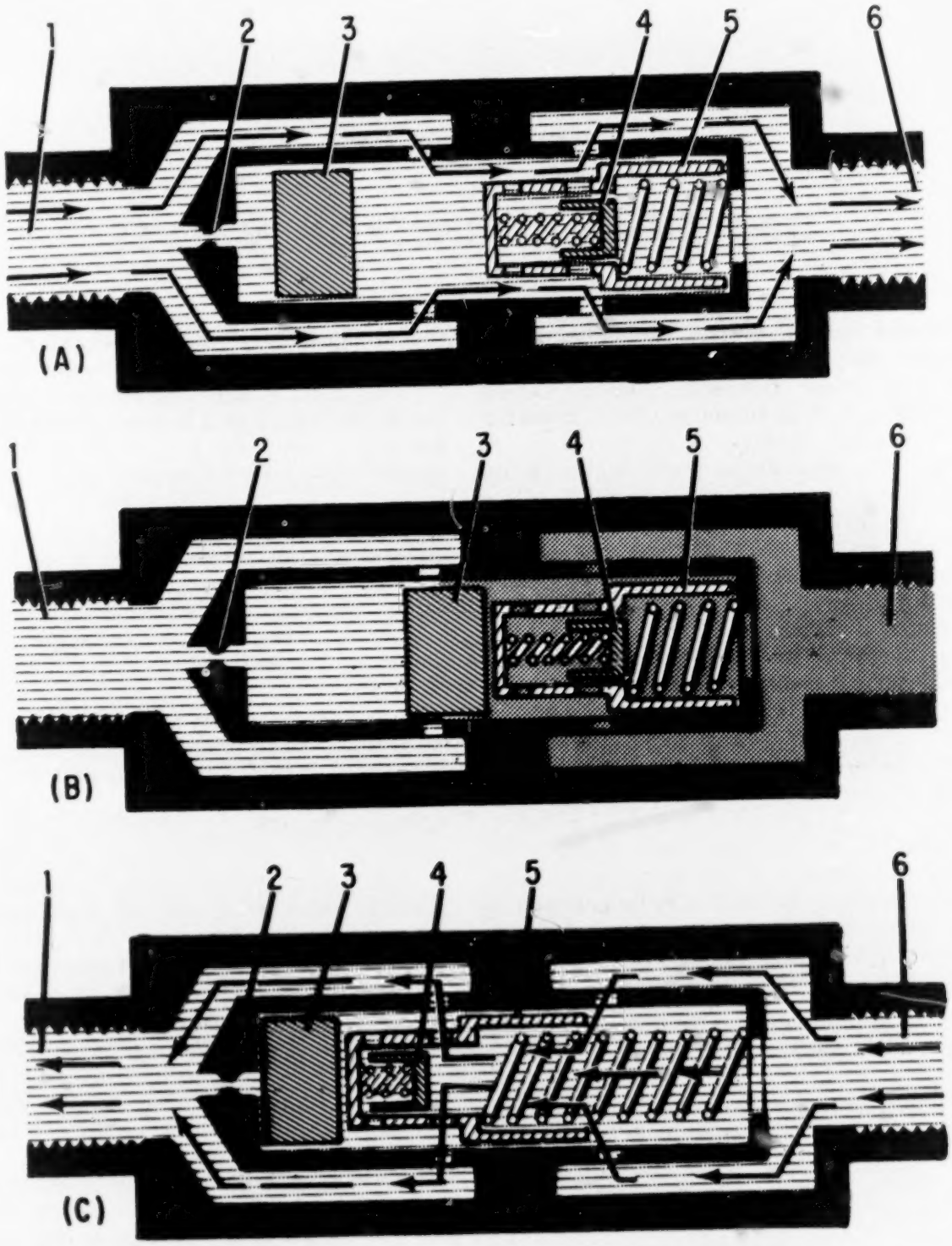

1. Entrance port.
2. Orifice.
3. Piston.
4. Check valve.
5. Sleeve.
6. Exit port.

Figure 10-28.—Hydraulic fuse.

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CHAPTER 11

DIRECTIONAL CONTROL VALVES

Directional control valves are designed for the specific purpose of directing the flow of fluids in fluid power systems. (These valves are also referred to as selector valves, transfer valves, or control valves.) It may be desired, for example, to perform a work operation by driving a piston or ram back and forth in its cylinder. A directional control valve, which functions alternately to admit fluid to and from each end of the cylinder, is used to make this operation possible.

Directional control valves for hydraulic and pneumatic systems are similar in design and operation. One major difference—the return port of a hydraulic valve is ported through a return line to the reservoir; while the similar port of a pneumatic valve is ported to the atmosphere and is commonly referred to as an exhaust port.

Directional control valves may operate by differences of pressure acting on opposite sides of the movable parts, or they may be positioned manually, mechanically, or electrically. Often two or more methods of operating the same valve will be utilized in different phases of its action.

CLASSIFICATION

Directional control valves may be classified in numerous ways. One way is by the type of valving element. Some of the most common types of valve elements are described in the following paragraphs.

POPPET

Figure 11-1 illustrates the operation of a simple poppet valve. The valve consists primarily of a movable poppet which closes against a valve seat. In the closed position, fluid pressure from the inlet tends to hold the valve tightly closed. A small amount of movement from a force applied to the poppet stem opens the poppet and allows fluid to flow through the valve.

The steel poppet fits into the center bore of the seat. There is a lapped or closely machined surface between the poppet and seat, so that the center bore will be sealed when the poppet is seated. This action is similar to the valves of an automobile. An O-ring seal is usually installed on the stem of the poppet to prevent leakage past this portion of the poppet. In some valves the poppets are held in the seated position by springs. The number of poppets in a particular valve depends on the design and purpose of the valve.

There are various methods used for shifting the poppets from one position to another. Some of the most common methods are described later.

ROTARY SPOOL

The rotary type directional control valve has a round core with one or more passages or recesses in it. The core is mounted within a sleeve. (See fig. 11-2.) As the core is rotated (generally by a hand lever or a knob) within the stationary sleeve, the passages or recesses connect or block the ports in the sleeve.

SLIDING SPOOL

Figure 11-3 shows a sliding spool valve. The valve element is so named because of its shape, and it slides back and forth to block and uncover ports in the housing. Some manufacturers refer to this element as a piston type. The inner piston (lands) areas are equal. Thus, pressure within the valve from the inlet ports acts equally on both inner piston areas regardless of the position of the spool. Sealing is usually accomplished by a machined fit between the spool and the valve body or sleeve. For valves with more ports, the spool is designed with more pistons or lands on a common shaft.

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FIREBLIGHT

by

Alice M. Boyle & A. D. Davison[1]

Fireblight is a common and often destructive disease of some members of the rose family (Rosaceae). Pears, apple, and quince are the most susceptible hosts. In Arizona, the disease is often very destructive in the stone fruits and causes severe damage in such ornamentals as hawthorn, pyracantha, cotoneaster, and loquat. Fireblight is caused by a bacterium, *Erwinia amylovora*.

Symptoms - Bacteria that have overwintered in "hold-over" cankers constitute the chief source of inoculum for spring infection. Bacterial ooze from these cankers is carried by ants and flies to the blossoms, causing initial infection. Bacteria may then by spread from blossom to blossom by honeybees. Rain may also be a major factor in spread of the pathogen from hold-over cankers to blossoms.

Control - Blossom sprays are suggested to protect the susceptible blooms from infection. Bordeaux 1/2-1/2-100 or Agrimycin 100, 50 to 100 parts per million are satisfactory. Agrimycin 100 is suggested when maximum temperature is above 65° F. For severe disease situations use 100 ppm, for light blight problems use 50 ppm. Bordeaux 1/2-1/2-100 should be applied during quick drying conditions to avoid possible fruit russet. Fog the trees rather than drenching them.

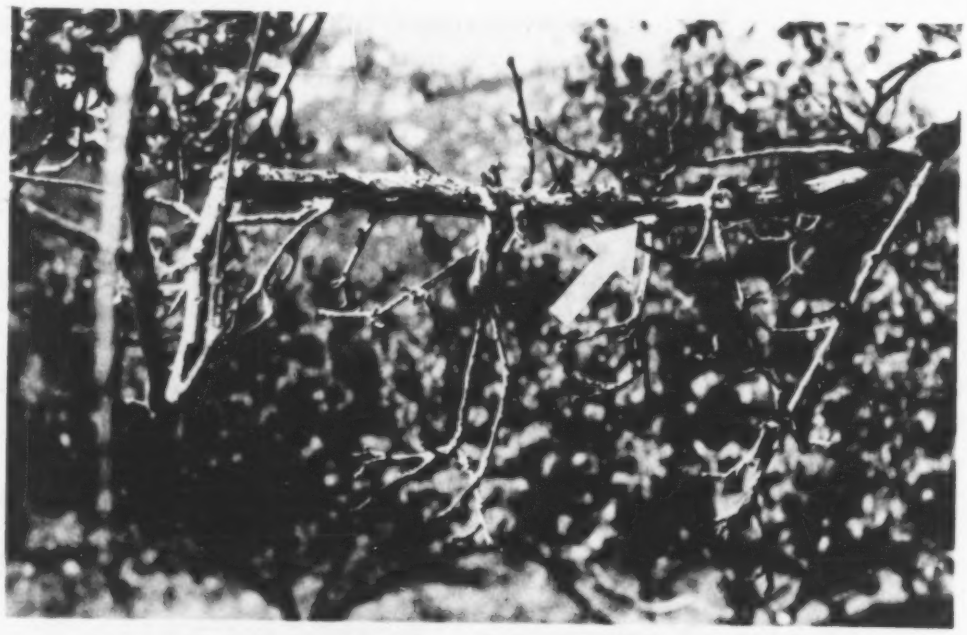

Fig. 1. Thin layers of bark often peel from small infected limbs and twigs.

(1) Plant Pathologist and Extension Specialist in Plant Pathology, respectively.

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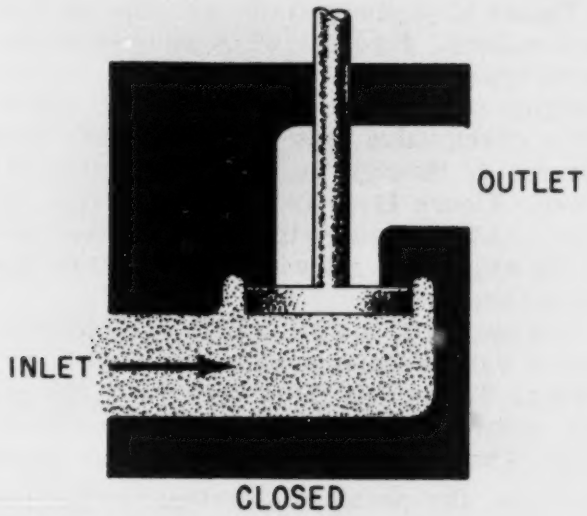

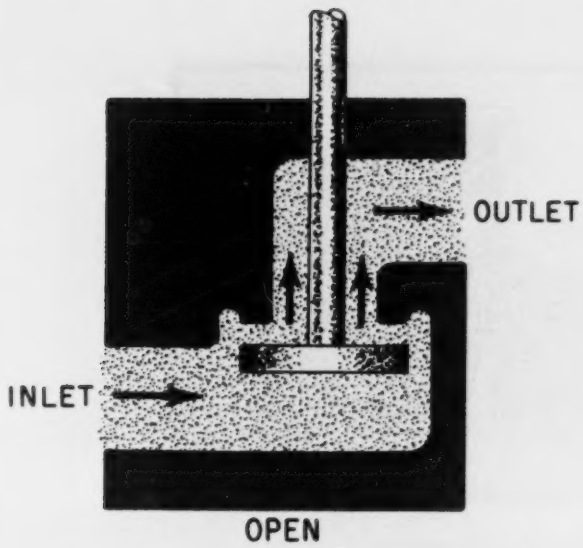

Figure 11-1.—Operation of a simple poppet valve.

Like all classes of directional control valves, various methods are utilized for positioning the sliding spool valve. Some of the most common methods are described under the different types of valves later in this chapter.

Balls, cones, and sleeves are also types of valving elements used in directional control valves. Their use is usually limited to check valves, which are described in the next section.

CHECK VALVES

Check valves are the most commonly used valves in fluid power systems. Although not always classified as such, check valves permit flow in one direction and prevent flow in the other, and can be considered as one-way directional control valves.

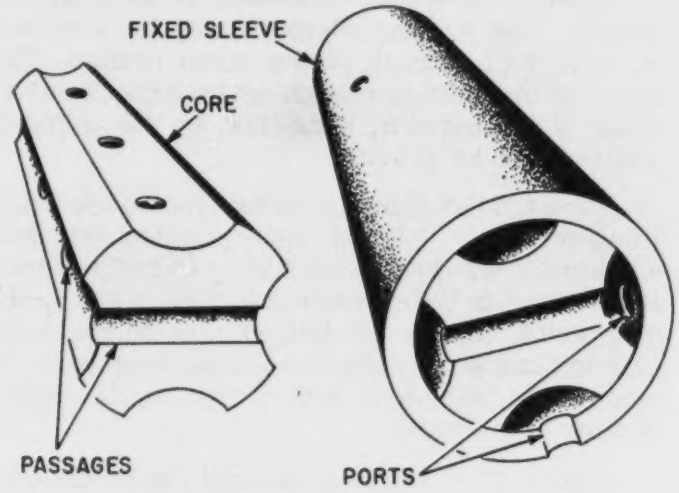

Figure 11-2.—Parts of a rotary directional control valve.

Check valves may be installed independently in a line to allow flow in one direction only. This is indicated in the simple system described in chapter 4. Check valves are also incorporated as an integral part of some other valve, such as the sequence valve, counterbalance valve, and pressure reducing valve described in chapter 10. A modification of the check valve—the orifice check valve (described in chapter 9)—allows full flow in one direction and a limited or restricted flow in the opposite direction.

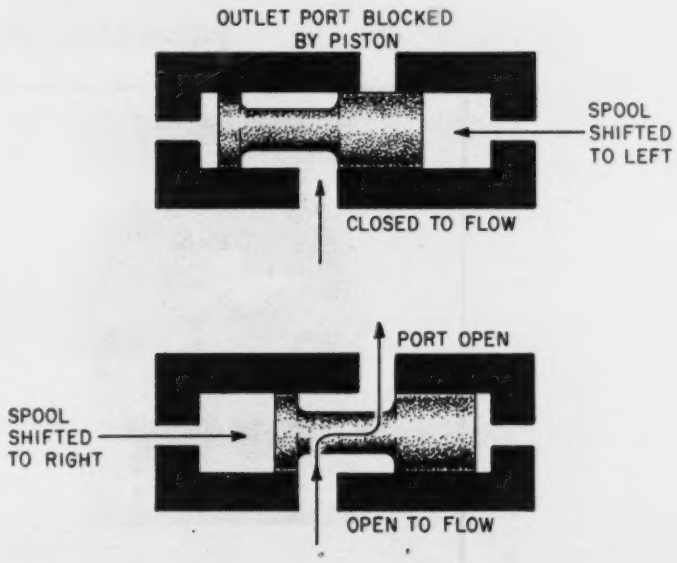

Figure 11-3.—Operation of a sliding spool directional control valve.

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Check valves are available in various designs. The valving element may be a sleeve or cone, ball, poppet, piston, spool, or disc. The force of the fluid in motion opens a check valve, while it is closed by back flow, by the action of a spring, or by gravity.

Figure 11-4 shows a swing type check valve (flapper valve). In the open position the flow of fluid forces the hinged disc up and allows free flow. Flow in the opposite direction, with the aid of gravity, forces the hinged disc to close the passage and blocks the flow. This type valve is sometimes designed with a spring to assist closing of the valve.

Figure 11-5 shows a vertical check valve in which the closing of the valve is influenced considerably by the force of gravity.

Figure 11-6 shows examples of spring-loaded check valves. Figure 11-6 (A) shows the cone or sleeve type. As fluid pressure is applied in the direction of the arrow, the sleeve (2) is forced off the check valve seat (3). This allows fluid to pass freely through the drilled openings of the sleeve. Figure 11-6 (B) shows a ball type check valve. As the pressure is applied, the ball moves off its seat, thus allowing fluid to flow freely through the valve.

The spring is installed in the valve to hold the cone or ball on its seat whenever the fluid is not flowing. The spring (1) is very weak; the pressure differential with full flow is usually about 8 psi. When fluid attempts to flow in the opposite direction, the pressure developed helps to hold the ball or cone on its seat and creates a tighter seal. Since this type valve is not influenced by

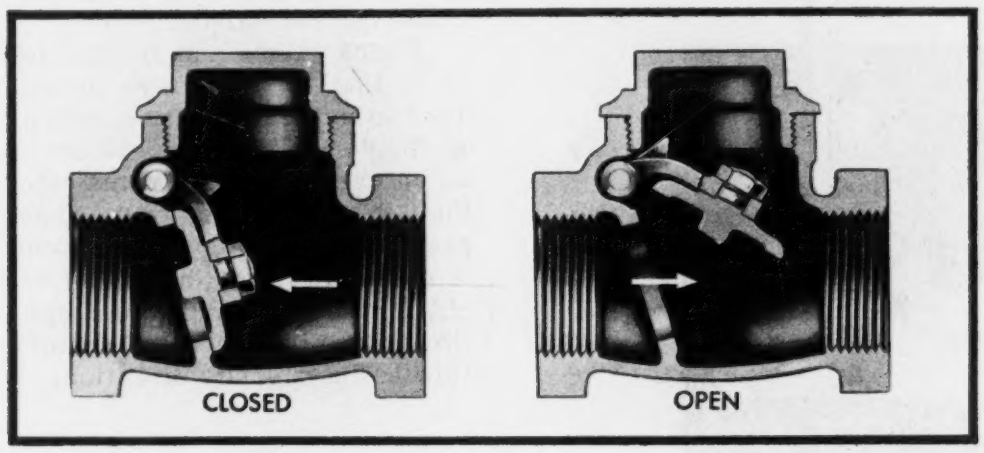

Figure 11-4.—Swing type check valve.

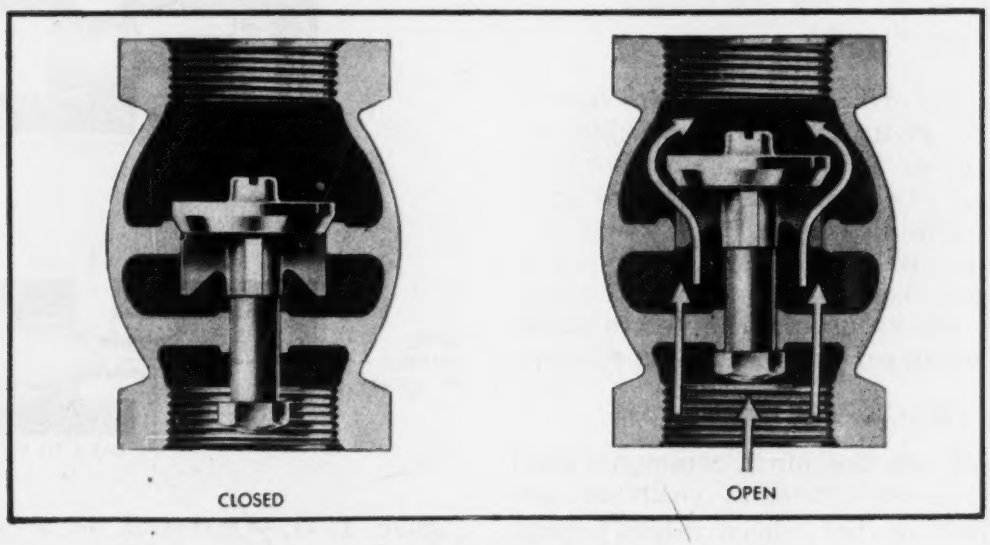

Figure 11-5.—Vertical check valve.

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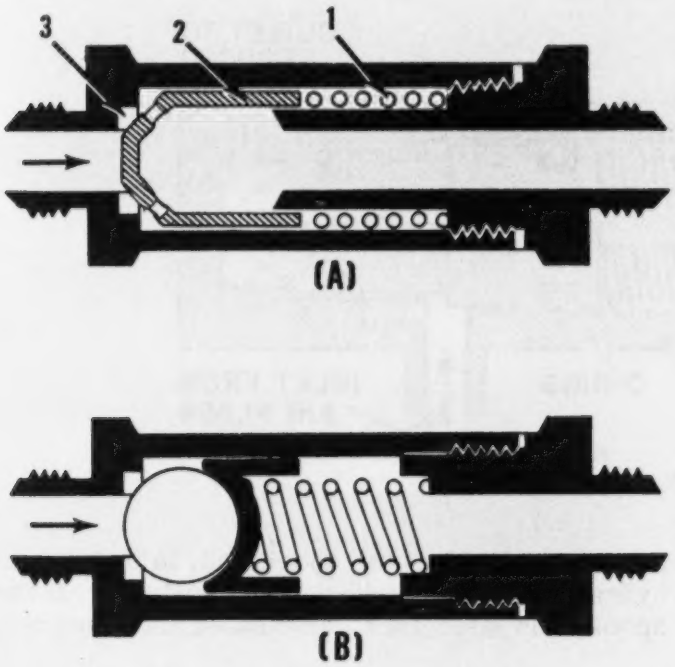

1. Spring. 2. Cone or sleeve. 3. Valve seat.

Figure 11-6.—Spring-loaded check valves.

gravity, it is used in many applications in the fluid power systems of aircraft and missiles.

STARTING VALVES

Starting valves are commonly used in pneumatic systems of missiles. These valves provide a positive block in the discharge (output) side of the air supply (flask). Many of these are designed to be opened by retracting a pin, either manually or electrically. Retraction of the pin permits gas to pass from the flask, thus starting operation of the pneumatic system. Figure 11-7 shows the operation of a starting valve. When the pin is released, inlet pressure acting on the valve shoulder causes piston movement to the left. The function of the spring is merely to absorb the shock of the rapid piston movement.

SHUTTLE VALVES

In certain types of fluid power systems, the supply of fluid to a subsystem must be from more than one point of origin in order to meet system requirements. In some systems an emergency system is provided as a source of pressure in the event of normal system failure. For example, in aircraft hydraulic systems the emergency source of pressure may be compressed air. The emergency system will usually actuate only those units essential in getting the aircraft safely on the ground and stopping it. When using the emergency system, the pressure must be directed to the unit concerned; and yet, emergency pressure must not enter the normal system. To allow operating pressure to reach the actuating unit and still not enter the other system, a shuttle valve is installed in the working line to the actuating unit. The shuttle valve is small and simple, but is a very important component.

The main purpose then of a shuttle valve is to isolate the normal system from an alternate or emergency system.

A typical shuttle valve is shown in figure 11-8. The body contains three ports—normal system inlet port, alternate or emergency system inlet port, and the outlet port. A shuttle valve used to operate more than one actuating unit may contain additional unit outlet ports.

Enclosed in the body is a sliding part called the shuttle. It is used to seal one of the two inlet ports. A shuttle seat is installed at each inlet port; and during operation, the shuttle is held against one of these seats, sealing off that port. These parts are held in the body by end caps. External leakage is prevented by an O-ring gasket at each end cap.

The shuttle may be one of four types—a sliding plunger, a spring-loaded piston, a spring-loaded ball, or a spring-loaded poppet. In shuttle valves employing a shuttle spring, the shuttle is normally held against the alternate system inlet port by the spring.

When a shuttle valve is in the normal operation position, fluid has a free flow from the normal system inlet port to the unit outlet port. The shuttle is seated against the alternate system inlet port, and held there by normal system pressure and by the shuttle spring. The shuttle remains in this position until the alternate system is operated. This action directs fluid under pressure from the alternate system to the shuttle valve and forces the shuttle from the alternate system inlet port to the normal inlet port. Fluid from the alternate system then has a free flow to the unit outlet port, but is prevented from entering the normal system by the shuttle.

TWO-WAY VALVES

A two-way, sliding spool directional control valve is shown in the open and closed positions in figure 11-9. As the spool is moved back and

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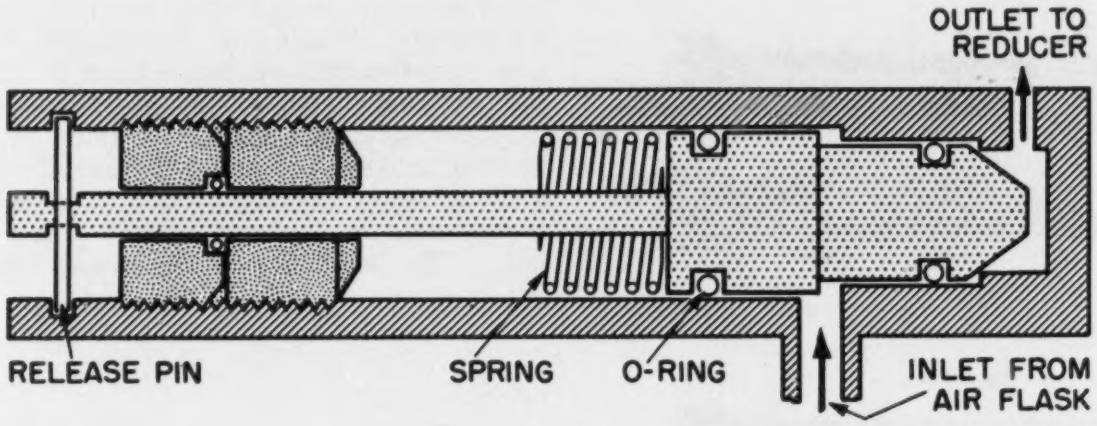

Figure 11-7.—Starting valve.

forth, it either allows fluid to flow through the valve or prevents flow. The spool cannot move back and forth by differences in pressure set up within the cylinder, since the forces there are balanced. As indicated by the arrows against the piston heads, the same pressure acts on equal areas on their inside surfaces; and when the input passage is blocked, the piston blocking it is acted on all around its circumference by the same pressure.

A number of features common to most spool type valves can be noted in figure 11-9. The drain openings at either end of the spool are needed so that back pressure will not be built up and hinder movement of the spool. When spool valves become warn, they may lose balance because of greater leakage on one side of the spool than on the other. In that event the spool would tend to stick in moving back and forth. Small grooves are therefore machined around the sliding surfaces of the spool; and, in the case of hydraulic valves, leaking liquid will encircle the spools and keep them lubricated and centered.

THREE-WAY VALVES

The three-way directional control valve is designed to operate an actuating unit in one direction; it permits either the load on the actuating unit or a spring to return the unit to its original position. Two different designs of poppet type, three-way directional control valves are discussed in the following paragraphs.

CAM-OPERATED

Figure 11-10 illustrates the operation of a cam-operated, three-way, poppet type directional control valve. Figure 11-10 (A) shows fluid pressure forcing the piston outward against

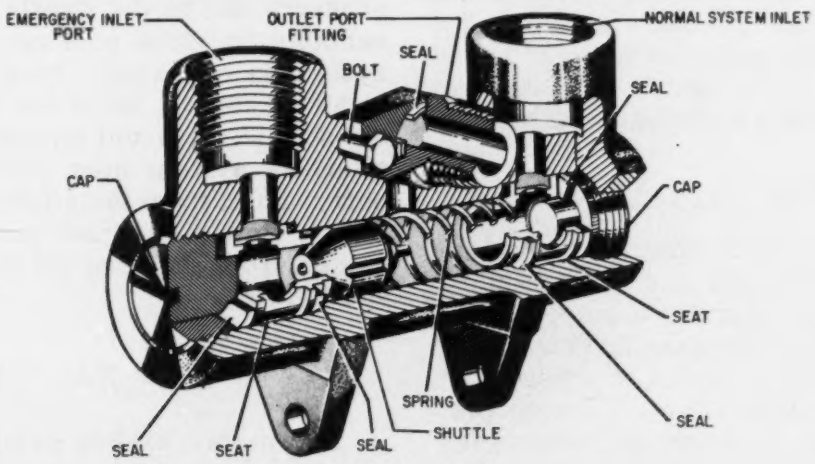

Figure 11-8.—Shuttle valve.

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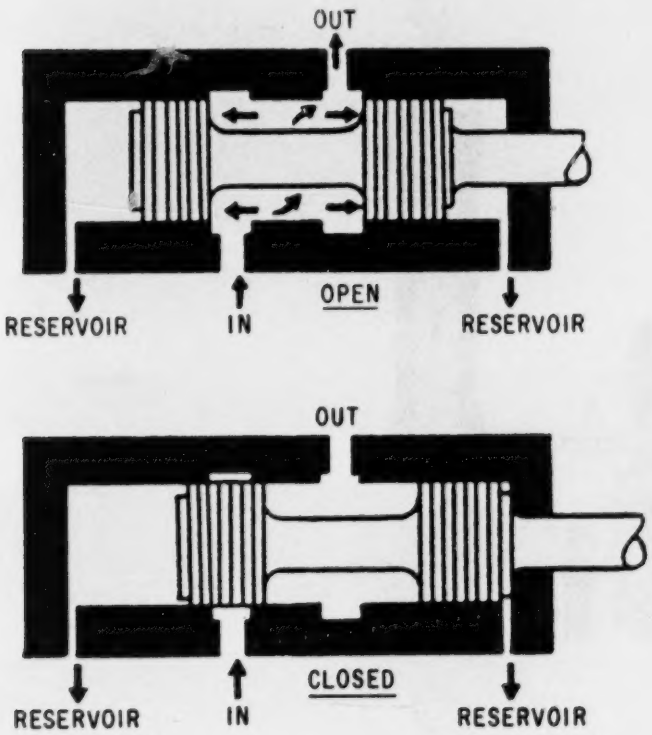

Figure 11-9.—Two-way, sliding spool directional control valve.

a load. The upper poppet (2) is unseated by the inside cam (5), permitting fluid to flow from line (3) into the cylinder to actuate the piston. The lower poppet (1) is seated, sealing off the flow to the return line (4).

In figure 11-10 (B) the control valve has been turned to the opposite setting, and the upper poppet (2) is seated, sealing the fluid from the pressure line (3). The lower poppet (1) is unseated by the outside cam (6) so that the fluid forced from the cylinder can flow through the control valve and out the return port (4). In pneumatic valves, the return port (4) is open to the atmosphere.

PILOT-OPERATED

A pilot-operated, poppet type, three-way directional control valve is illustrated in figure 11-11. Valves of this design are often used in pneumatic systems. This is a normally closed valve and is forced to the open position by fluid pressure entering the pilot chamber. The valve contains two poppets connected to each other by a stem. The poppets are integral with diaphragms which hold them in a centered position. When the pilot chamber is not pressurized, the lower poppet is seated against the lower valve seat. Fluid can flow from the supply line through the inlet port and through the holes in the lower diaphragm to fill the bottom chamber. This pressure holds the lower poppet tightly against its seat and blocks flow from the inlet port through the valve. At the same time, due to the common stem, the upper poppet is forced off its seat. Fluid from the actuating unit flows through the open passage, around the stem, and through the exhaust port to the atmosphere.

When the pilot chamber is pressurized, the force acting against the diaphragm forces the poppets down. The upper poppet closes against its seat. The lower poppet opens, and the passage from the supply inlet port to the cylinder port is open so that fluid can flow to the actuating unit.

The normally open valve is similar in design to the normally closed valve. (See fig. 11-12.) When no pressure is applied to the pilot chamber, the upper poppet is forced off its seat and the lower poppet is closed. Fluid is free to flow from the inlet port through the cylinder port to the actuating unit. When pilot pressure is applied, the poppets are forced downward, closing the upper poppet and opening the lower poppet. Fluid can now flow from the cylinder through the valve and out the exhaust port to the atmosphere.

FOUR-WAY VALVES

Four-way directional control valves are commonly used to control cylinders, motors, or other valves. The typical four-way directional control valve has four ports—a pressure port, a return or exhaust port, and two working ports. The pressure port is connected to the main pressure line, the return port is connected to the reservoir. In the valves used in pneumatic systems, this port is usually vented to the atmosphere. The two working ports are connected by lines to the actuating unit. Some of the different types of four-way directional control valves are described in the following paragraphs.

POPPET TYPE

Figure 11-13 illustrates a typical four-way poppet type directional control valve. This is a manually operated valve and consists of a group of conventional spring-loaded poppets. The poppets are enclosed in a common housing and

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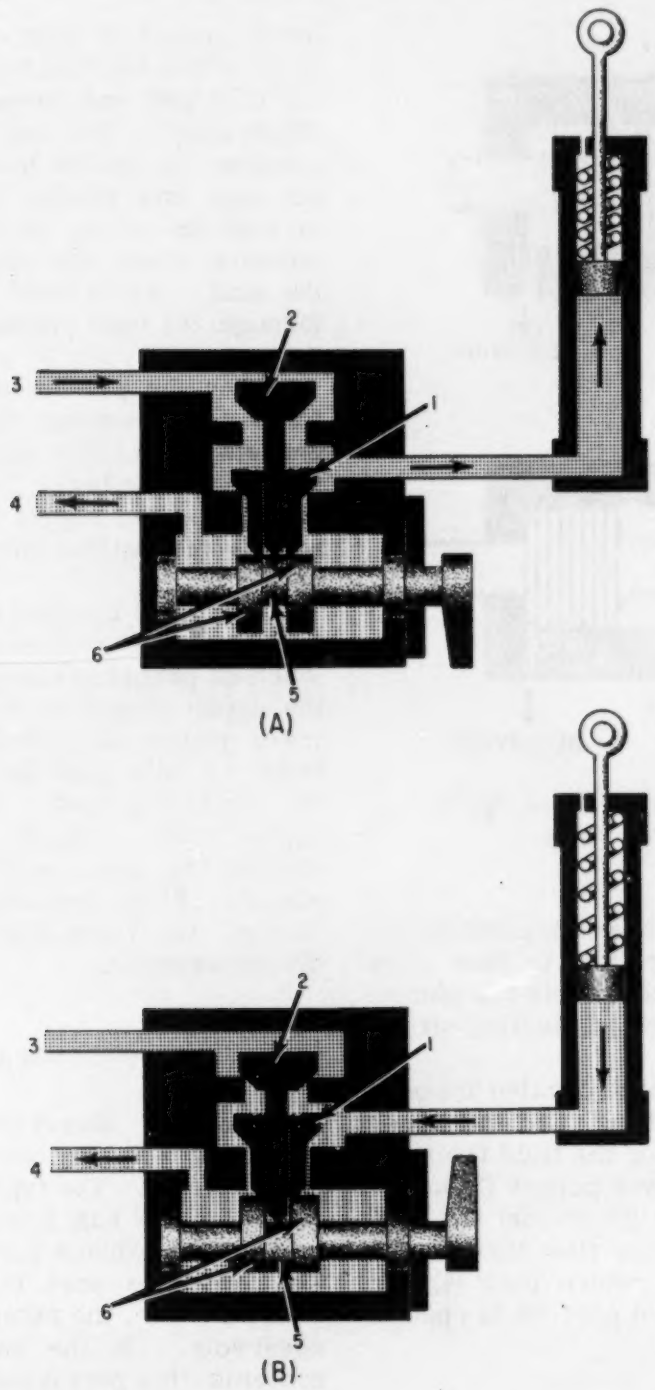

1. Lower (return or exhaust) poppet.
2. Upper (pressure) poppet.
3. Pressure line.
4. Return or exhaust port.
5. Inside cam.
6. Outside cam.

Figure 11-10.—Three-way, poppet type directional control valve (cam-operated).

are interconnected by ducts so as to direct the flow of fluid in the desired direction.

The poppets are actuated by cams on a camshaft, as shown in figure 11-14. They are arranged so that rotation of the shaft by its controlling lever will open the proper combinations of poppets to direct the flow of fluid through the desired line to the actuating unit. At the same time, fluid will be directed from the opposite line of the actuating unit through the valve and back to the reservoir or exhausted to the atmosphere.

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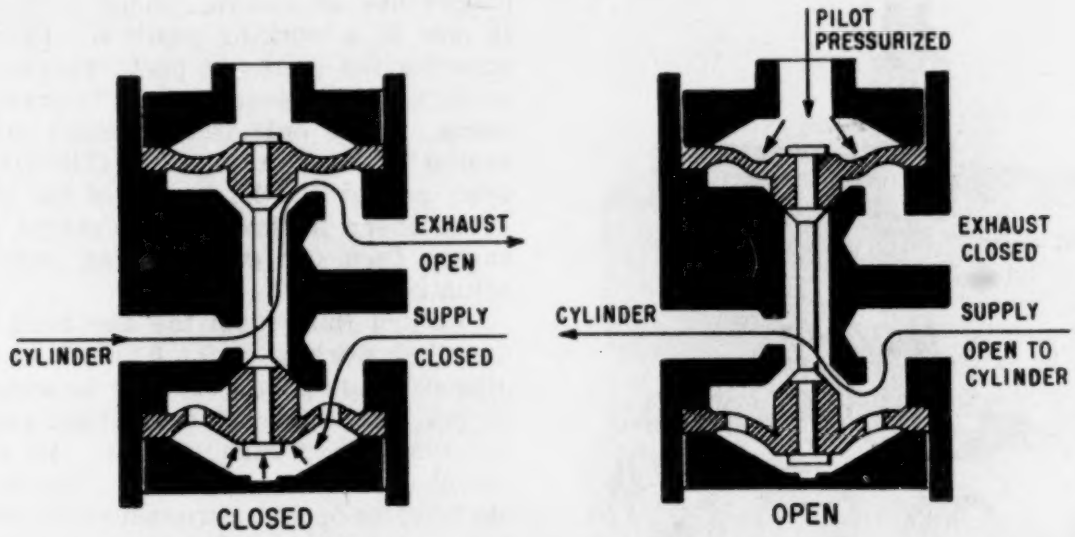

Figure 11-11.—Three-way, poppet type, normally closed directional control valve (pilot-operated)

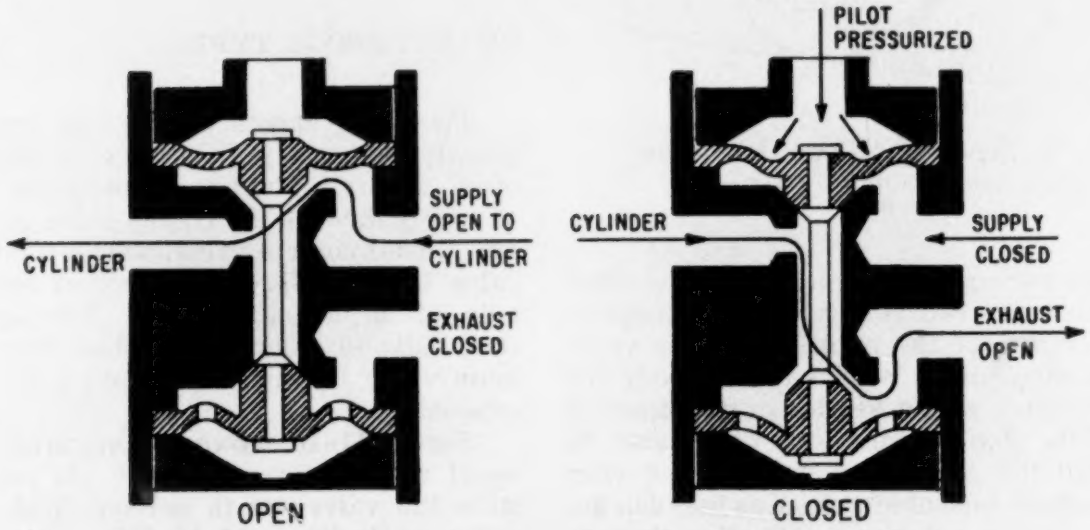

Figure 11-12.—Three-way, poppet type, normally open directional control valve (pilot-operated).

This type valve is provided with a stop for the camshaft. This is an integral part of the shaft and strikes against a stop pin in the body to prevent overrunning.

The poppets are held to their seats by springs, and a camshaft is used to unseat them and allow a flow of fluid through the valve. The camshaft is controlled by the movement of the handle. The valve may be operated by manually moving the handle, or the handle may be connected by mechanical linkage to a control handle located at a convenient place some distance from the valve. The camshaft has a raised flange on the control handle end to prevent it from moving through the housing. A nut screws on the opposite end to secure it to the housing. There are three O-ring packings on the camshaft to prevent internal and external leakage. The camshaft has two lobes, or raised portions. The contour, or shape, of these lobes is such that when the shaft is placed in the neutral position the camming lobes will not be contacting any of the poppets.

When the camshaft is rotated, either clockwise or counterclockwise from neutral, the cam lobes unseat the desired poppets and allow a flow of fluid through the valve. One cam lobe

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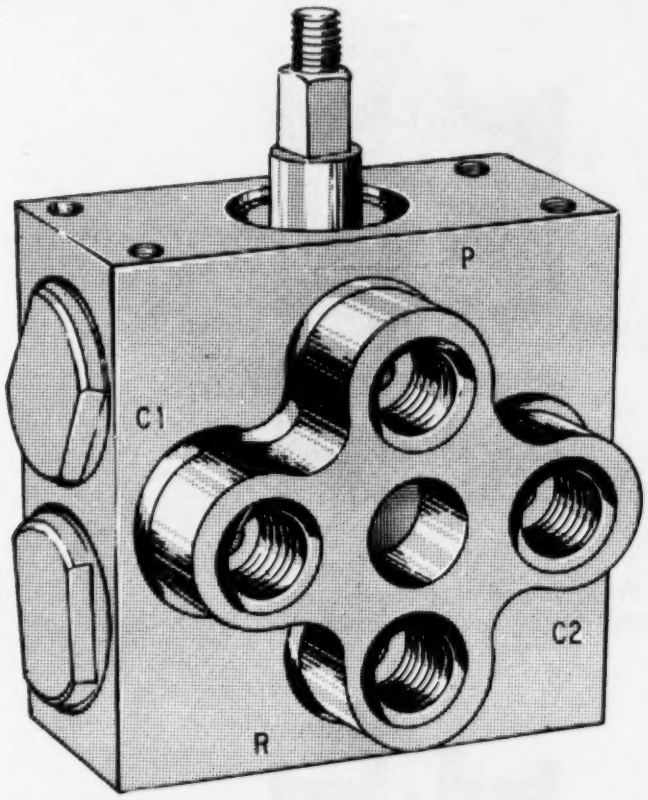

Figure 11-13.—Poppet type, four-way, directional control valve.

operates the two pressure poppets, and the other lobe operates the two return/exhaust poppets. To stop rotation of the camshaft at the exact position, a stop pin is secured to the body and extends through a cutout section of the camshaft flange. This stop pin prevents overtravel by insuring that the cam lobes stop rotating when the poppets have unseated as high as they can go, where any further rotation would allow them to return to their seats.

This directional control valve has three positions—neutral and two working positions. In the neutral position, the camshaft lobes are not contacting any of the poppets. This assures that the poppet springs will hold all four poppets firmly seated. With all poppets seated, there is no fluid flow through the valve. This also blocks the two working ports; so when this valve is in neutral, the fluid in the actuating unit is trapped. To allow for thermal expansion buildup, thermal relief valves must be installed in both working lines.

By moving the control handle either direction from neutral, the camshaft is rotated. This rotates the lobes, which unseat one pressure poppet and one return/exhaust poppet. The valve is now in a working position. Pressure fluid, entering the pressure port, travels through the vertical fluid passages in both pressure poppet seats. Since only one pressure poppet is unseated by the cam lobe, the fluid flows past the open poppet to the inside of the poppet seat. From there it flows out the diagonal fluid passages, then out one working port and to the actuating unit.

Return fluid from the actuating unit enters the other working port. It then flows through the diagonal fluid passages, past the unseated return poppet, through the vertical fluid passages, and out the return/exhaust port. By rotating the camshaft in the opposite direction until the stop pin hits, the opposite pressure and return poppets are unseated, and the fluid flow is reversed. This causes the actuating unit to move in the opposite direction. This action can be observed by studying figure 11-15.

ROTARY SPOOL TYPE

Four-way valves of this type are most frequently used as pilot valves to direct flow to other valves. Fluid is passed from one source of supply through the rotary valve on to another directional control valve, where it positions the valve to direct flow from another source to one side of an actuating unit. Through a return line, fluid is carried from the other end of the main valve through the rotary valve to return/exhaust.

Figure 11-16 shows the operation of a rotary spool valve. Figures 11-16 (A) and 11-16 (C) show the valve set to deliver fluid to another valve, while figure 11-16 (B) shows the valve in neutral position, with all passages through the valve blocked.

Rotary spool valves can be operated manually, mechanically, electrically, or by fluid pressure.

SLIDING SPOOL TYPE

The sliding spool four-way directional control valve is similar in operation to the two-way valve previously described. It is simple in principle of operation and is probably the most durable and trouble free of all four-way directional control valves in current use. Some manufacturers refer to this type valve as a piston type.

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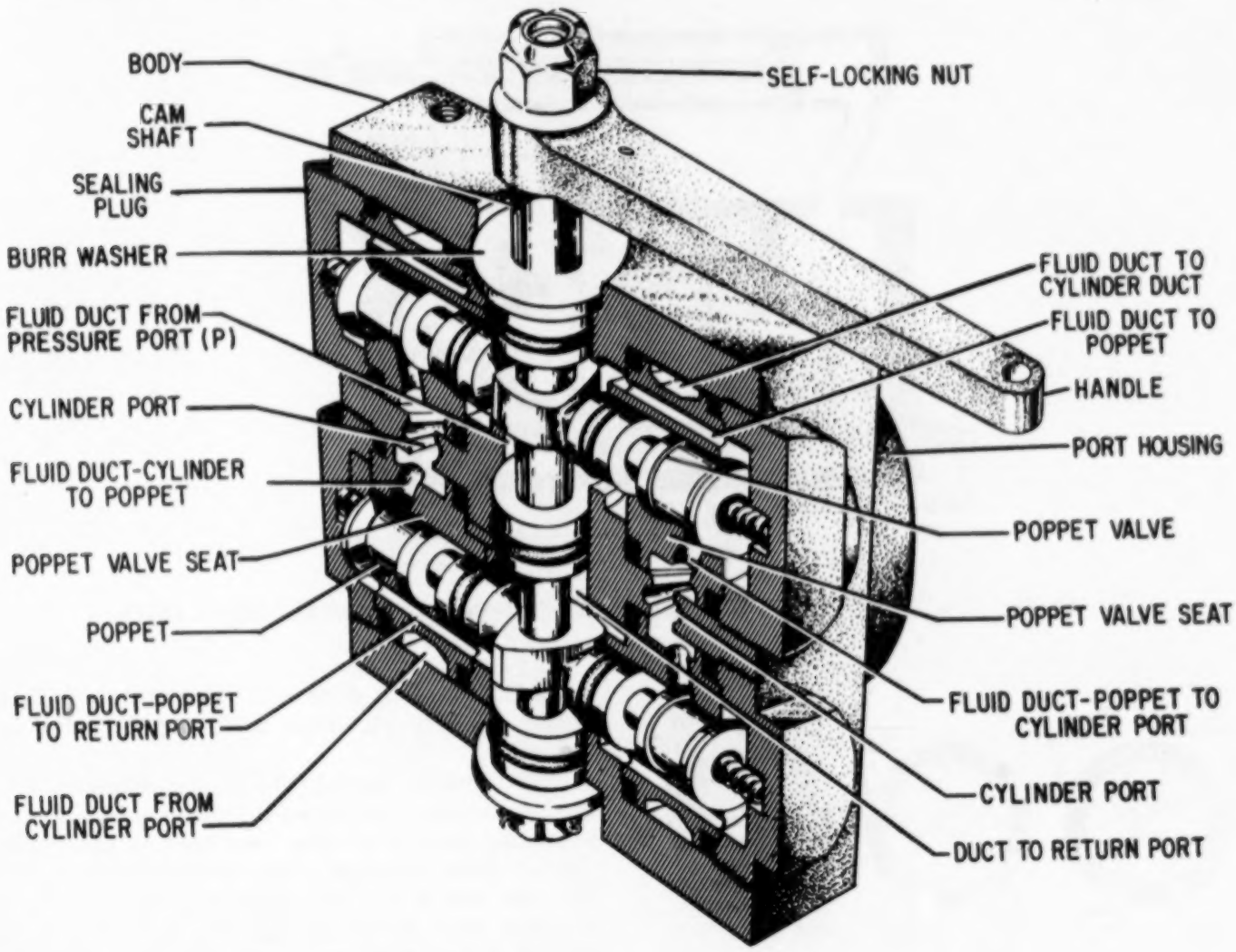

Figure 11-14.—Cutaway view of directional control valve.

Although the first valve described here is a manually operated type, the same principle is used in many remotely controlled directional control valves. An understanding of the operation of this valve will therefore aid in understanding the more complicated solenoid-operated valve discussed later.

Figure 11-17 is a cutaway view of a typical four-way sliding spool directional control valve. The valve body contains four fluid ports—pressure, return/exhaust, and two working ports. (The working ports are referred to as cylinder ports in this discussion; however, this type valve may be used to control other types of actuating units.) A large bore has been drilled lengthwise through the body, and all four fluid ports connect into this main bore at intervals along its length. There is also a drilled passageway in the body that runs along the main bore. This passageway is used to connect one of the cylinder ports to the return/exhaust port.

A hollow steel sleeve (3) fits into the main bore of the body. Around the outside diameter of the sleeve are six O-ring gaskets. As the sleeve is inserted into the main bore, these O-rings form a seal between the sleeve and the body. This creates five chambers around the sleeve, each chamber being formed by two of the O-ring gaskets. Each one of these chambers is lined up with one of the fluid ports in the body. The drilled passageway in the body accounts for the fifth chamber which results in having the two outboard chambers connected to the return/exhaust port. The sleeve has a pattern of holes drilled through it to allow fluid to flow from one port to another. Between each O-ring gasket a series of holes are drilled into the hollow center of the sleeve.

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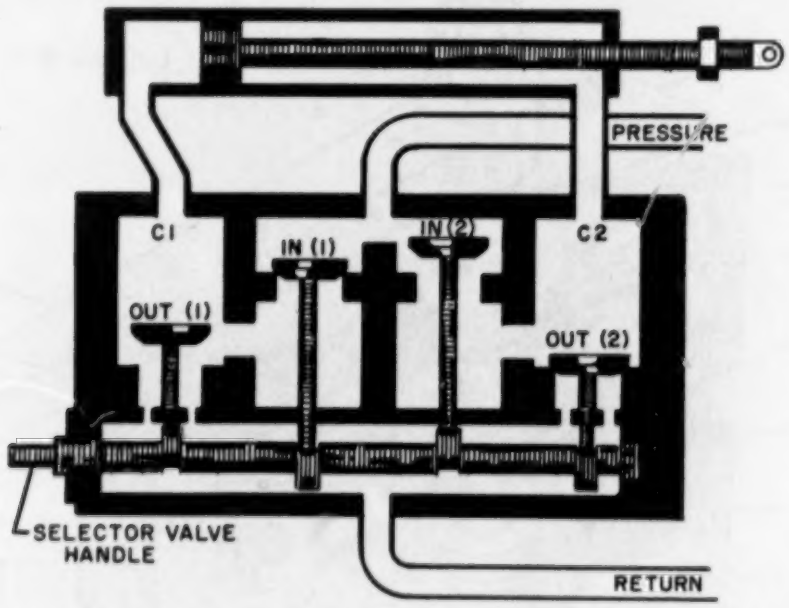

Figure 11-15.—Working view of poppet type, four-way directional control valve.

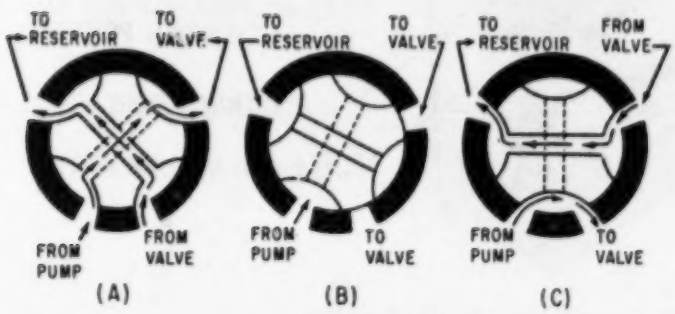

Figure 11-16.—Operation of rotary spool, four-way, directional control valve.

To prevent the sleeve from moving, a sleeve retainer bolt or pin secures it to the body. When this bolt is inserted into the body, it protrudes slightly into the main body bore. A slot around the sleeve lines up with this bolt. In this manner, the sleeve is keyed to the body.

The sliding spool (5) fits into the hollow center of the sleeve. This spool is similar to the spool in the two-way valve, except this spool has three pistons or lands. These lands are lapped or machine fit to the inside of the sleeve.

One end of the sliding spool is connected to a control handle either directly or by mechanical linkage to a more desirable location. When the control handle is moved, it will then position the spool within the sleeve. The lands of the spool then line up different combinations of fluid ports, thereby directing a flow of fluid through the valve.

The detent spring (6) is a clothespin type spring, secured to the end of the body by a spring retaining bolt (7). The two legs of the spring extend down through slots in the sleeve and fit into the detents. The spool is gripped between the two legs of the spring. To move the spool, enough force must be applied to spread the two spring legs and allow them to snap back into the next detent, which would be another position.

Figure 11-18 illustrates the operation of the manually operated sliding spool directional control valve. In the upper view (A), the valve is in the neutral position, with the detent spring clamped in the center detent of the sliding spool. The center land is lined up with the pressure port, preventing fluid from flowing into the valve through this port. The return/exhaust port is also blocked, so there is no flow through that port. With both pressure and return ports blocked, fluid in the actuating lines is trapped. For this reason, a thermal relief valve is usually installed in each actuating line when this type valve is used.

Figure 11-18 (B) shows the valve in one working position with the sliding spool retracted. The detent spring is in the outboard detent, locking the sliding spool in this position. The lands have shifted inside the sleeve, and the ports are opened. Pressure fluid now enters

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Usually three applications are needed for effective fireblight control (full bloom petal fall and late secondary bloom). Copper-lime dust (10-90) and fixed copper may be used following manufacturer's directions.

Canker Removal and Summer Pruning - Winter is the best time to remove blighted twigs and branches. Cut back 4 or more inches from the canker; remove all dead and discolored bark down to the wood. The ends of the cut should be brought to a point to encourage rapid healing. Paint the area with a disinfectant*. When removing blighted twigs and branches in the summer remember that the bacteria are in a very active stage.

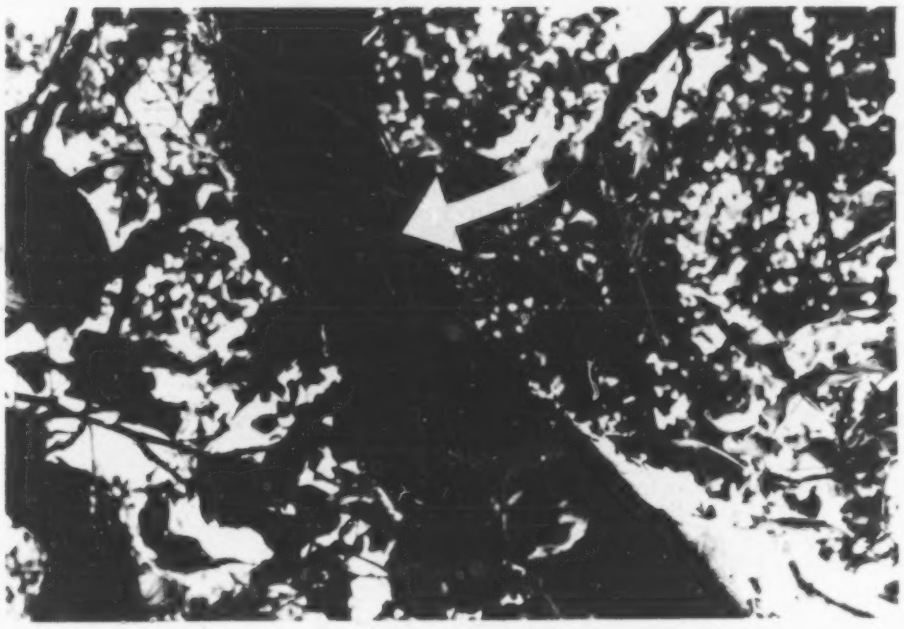

Fig. 2. Large hold-over cankers are sources of bacteria for new infections in the spring.

Therefore, prune at least 12 to 14 inches below the last signs of infection. Disinfect* tools after each cut to avoid mechanical spread by tools. Since damage by fireblight is more severe in succulent tissues, regulation of soil fertility to minimize such growth is an important part of control.

*Disinfectant - For home and garden, use a 10% solution of household bleach; in commercial orchards prepare the disinfectant by dissolving 8 half-gram tablets of cyanide of mercury and 8 half-gram tablets of bichloride of mercury in 1 pint of warm water. To this add 3 pints of commercial glycerine. Be careful when using the material as it is very poisonous and can be absorbed through the skin.

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Extension Specialist
in Plant Pathology

*Note: The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by the Arizona Extension Service is implied.

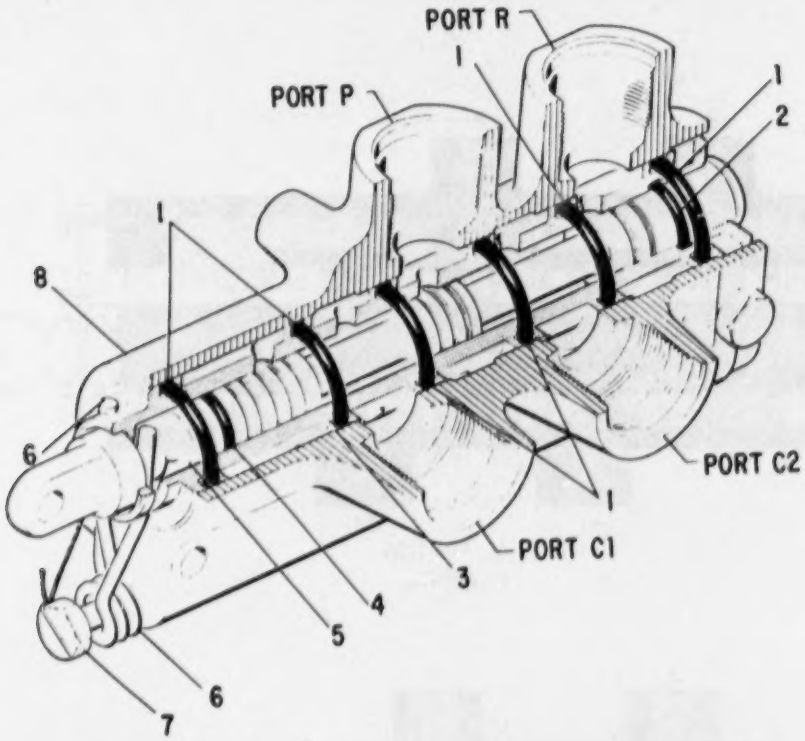

1. O-ring gaskets.
2. O-ring packing.
3. Sleeve.
4. O-ring packing.
5. Sliding spool.
6. Detent spring.
7. Spring retaining bolt.
8. Body.

Figure 11-17.—Cutaway view of sliding spool four-way directional control valve.

the sleeve, passes through it by way of the drilled holes, and leaves through cylinder port (C2). Return fluid, coming from the actuator, enters port (C1), flows through the sleeve, and is directed out the return port back to the reservoir or exhausted to the atmosphere. Fluid cannot flow past the spool lands because of the lapped surfaces.

Figure 11-18 (C) shows the valve in the opposite working position with the sliding spool extended. The detent spring is in the inboard detent. The center land of the sliding spool is now on the other side of the pressure port, and now the pressure fluid is directed through the sleeve and out port (C1). Return flow coming in the other cylinder port is directed to the drilled passageway in the body. It flows along this to the other end of the sleeve where it is directed out of the return/exhaust port.

There are many variations of the sliding spool directional control valve. For example, many valves of this type have two return/exhaust ports. In the case of hydraulic systems, the two ports are connected to a common return line to the reservoir. There are also many different methods of controlling the sliding spool valve.

Figure 11-19 shows a schematic view of a rotary directional control valve used as a pilot valve to control flow to the sliding spool valve. Fluid pressure can be directed to either end of the sliding spool valve which positions the spool and directs flow to and from the actuating unit.

The sliding spool valve, like other types of directional control valves, may be operated electrically. This is usually accomplished through the use of one or more solenoids.

A solenoid may be defined as a hollow or tubular shaped electric coil, made up of many turns of fine insulated wire, and possessing the same properties as an electromagnet. The hollow coil imparts linear motion to a movable iron core (or plunger) placed within the hollow coil of the solenoid.

Figure 11-20 shows a solenoid-operated directional control valve. This valve is sometimes referred to as a transfer valve. The

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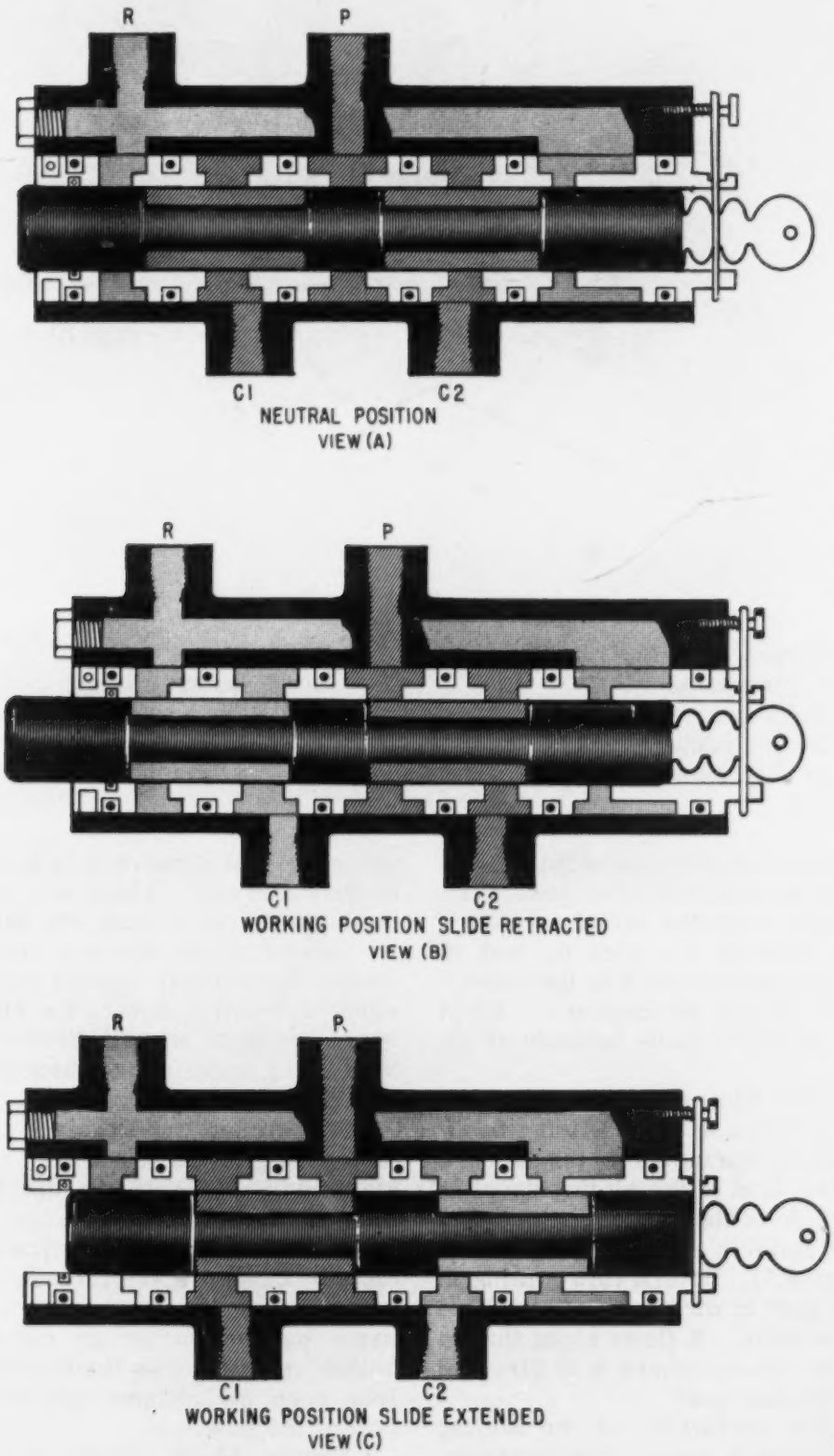

Figure 11-18.—Operation of sliding spool four-way directional control valve.

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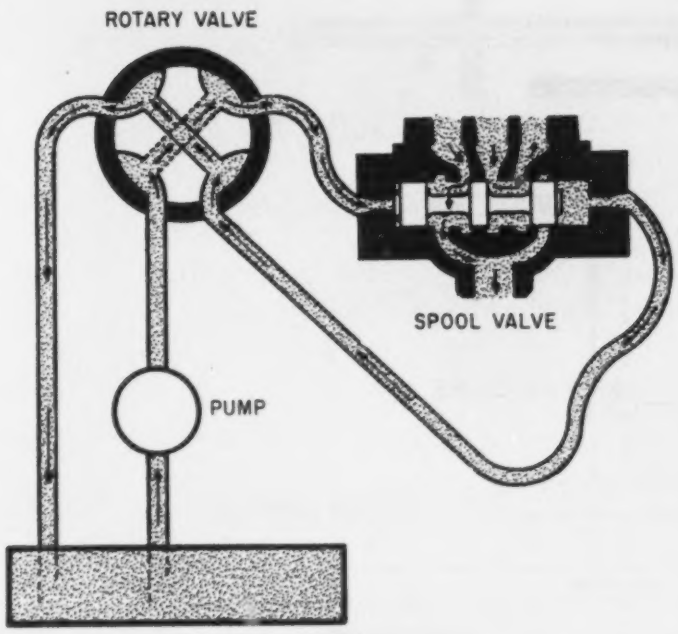

Figure 11-19.—Sliding spool valve controlled by rotary valve.

valve is illustrated in the neutral position with no flow through the valve. The valve is operated by energizing either of the solenoids. This may be accomplished by a manually operated electric switch or, for example in missile systems, automatically by the response of the solenoids to electric signals generated by the missile computer network.

The object is to move the actuator, which is mechanically linked to the device to be operated.

If solenoid (1) in the figure is energized, it will cause the valve spool to move to the left. This will permit pressurized fluid to be ported to the right-hand side of the actuator and cause it to move to the left. If solenoid (2) is energized, the valve spool will move to the right, causing actuator movement to the right in the same manner. In either position, fluid can flow from the opposite side of the actuator through the valve and out the corresponding return/exhaust port.

Solenoids are often used to control a small pilot valve which directs flow to either end of a sliding spool valve. The fluid pressure acting

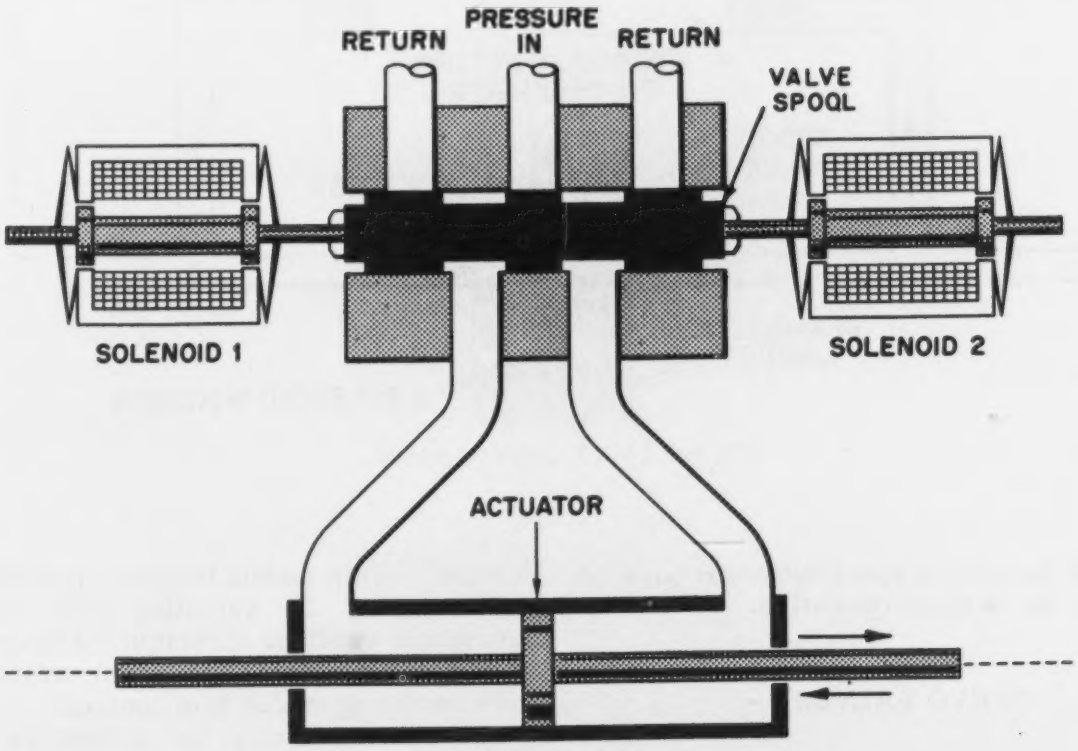

Figure 11-20.—Solenoid-operated sliding spool directional control valve.

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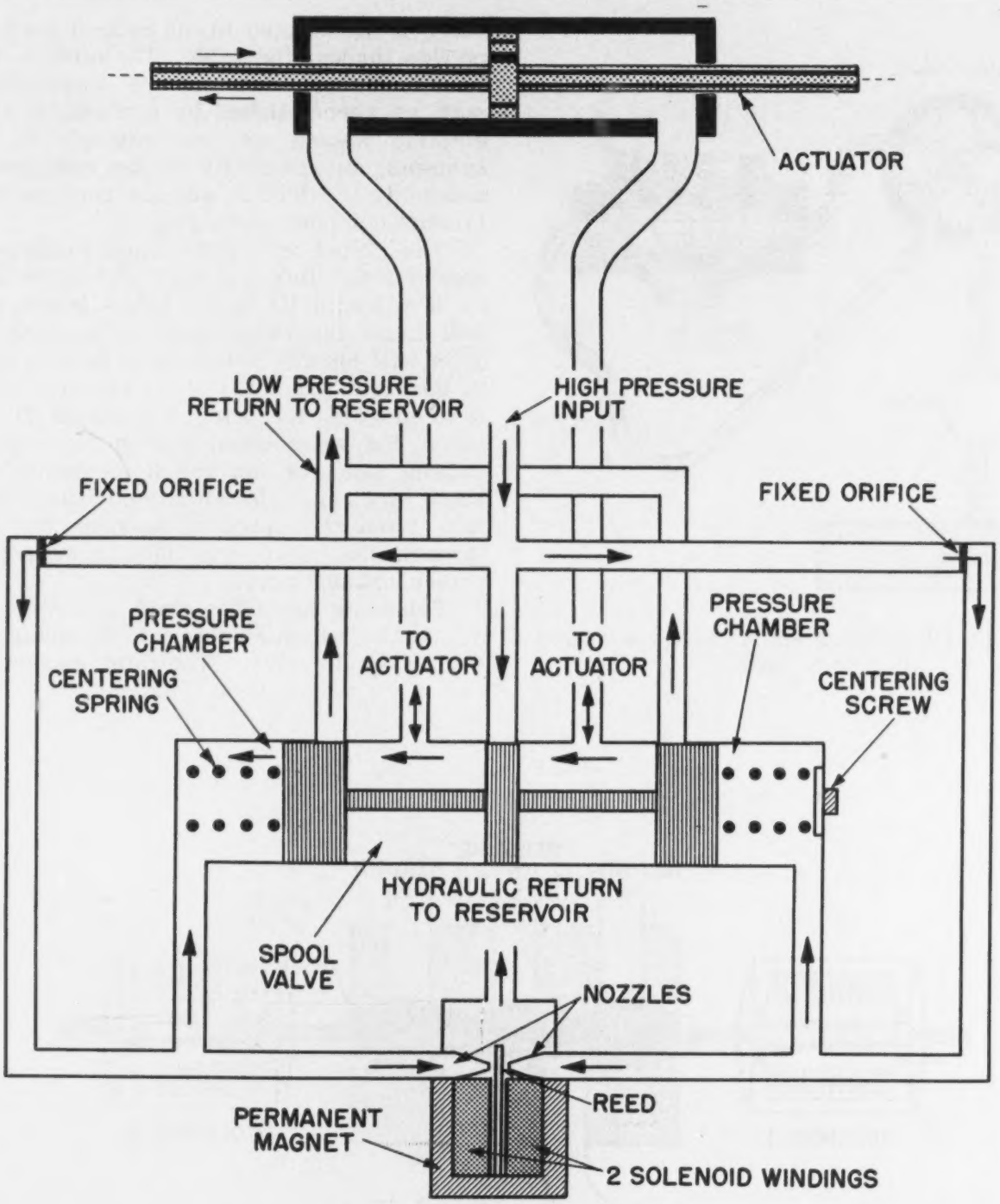

Figure 11-21.—Servo valve.

on the end of the sliding spool valve will position the spool for the desired operation.

SERVO VALVES

The four-way valves just described have one disadvantage in that they operate in an on-off manner. This means that they provide positive movement of the actuating unit; that is, full movement in either direction. A finer control is desirable in many fluid power systems. The servo valve provides this control.

Servocontrol may be defined as a control actuated by a feedback system which compares the output with the reference signal and makes

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corrections to reduce the differences. The feedback signal may be provided by fluid pressure, mechanical linkage, electrical signals, or a combination of the three.

One type of hydraulic servo valve is illustrated in figure 11-21. The valve is controlled by the two solenoids, which receive the electric feedback signals through a followup system from the actuated unit. With neither of the windings energized (or a balanced current flowing through both), the magnetic reed is centered as shown in figure 11-21. In this condition, high-pressure fluid from the input line cannot pass to the actuator, since the center land of the spool valve blocks the input port. The pressurized fluid flows through the alternate routes, through the two restrictors (labeled fixed orifices), passes through the two nozzles, and returns to the reservoir without causing any movement of the actuator.

If the right-hand solenoid is energized, the magnetic reed will move to the right, blocking off the flow of high-pressure fluid through the right-hand nozzle. Pressure will build up in the right-hand pressure chamber. This will move the valve to the left. In moving left, the center land will open the high-pressure inlet and permit fluid flow directly to the right-hand side of the actuator. At the same time, the left-hand land of the spool will open the low-pressure return line and permit flow through the return to the reservoir from the left-hand side of the actuator. This process will cause actuator movement to the left. By energizing the left-hand solenoid, the magnetic reed will move to the left, and the entire process will be reversed, the actuator then being moved to the right.

Note that the servo valve is basically a sliding spool valve. The servomechanism is just another method of control. This type valve has many applications in fluid power systems. For example, servo valves are used in the guidance systems of missiles and control systems of aircraft.

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CHAPTER 12

ACTUATORS

One of the outstanding features of fluid power systems is that force, generated by the power supply, controlled and directed by suitable valving, and transported by lines, can be converted with ease to almost any kind of mechanical motion desired at the very place it is needed. Linear or rotary motion can be obtained by using a suitable actuating device.

An actuator is a device which converts fluid power into mechanical force and motion. Cylinders, motors, and turbines are the most common types of actuating devices used in fluid power systems.

The first part of this chapter is devoted to the various types of actuating cylinders and their applications in fluid power systems. The next part of the chapter covers the different types of fluid motors used in fluid power systems. The remainder of the chapter covers air turbines and turbine governors.

CYLINDERS

An actuating cylinder is a device which converts fluid power to linear or straight line force and motion. The cylinder consists of a movable element, such as a ram or piston, operating within a cylindrical bore. Actuating cylinders are normally installed in such a manner that the movable element is attached to the mechanism to be operated and the cylinder is anchored to a stationary structure. However, in some applications, the piston or ram is anchored to the stationary structure, and the cylinder is attached to the mechanism to be operated and becomes the movable part of the actuator.

Leakage of fluid out of the ends of the cylinders and around the circumference of the piston or ram is controlled by suitably designed seals and packings.

Actuating cylinders for pneumatic and hydraulic systems are similar in design and operation. Some of the variations of ram and piston type actuating cylinders are described in the following paragraphs.

RAM TYPE CYLINDERS

Although the terms ram and piston are often used interchangeably, a ram type cylinder is usually considered one in which the cross-sectional area of the piston rod is more than one-half the cross-sectional area of the movable element. In many cylinders of this type, the rod and movable element have equal areas. The ram type actuating cylinder is used primarily for push functions rather than pull.

Some applications of the ram type cylinder require simply a flat surface on the external part of the ram for pushing or lifting the unit to be operated. Other applications require some mechanical means of attachment, such as a clevis or eyebolt.

Single-Acting Ram

The single-acting ram applies force in only one direction. (See fig. 12-1.) Fluid directed into the cylinder displaces the ram and forces it outward. Since there is no provision for retracting the ram by the use of fluid power, the retracting force can be gravity, or some mechanical means, such as a spring. This type actuating cylinder is often used in the hydraulic jack. Fluid pressure is used to force the ram outward and lift an object. When fluid pressure is released, the weight of the object (gravity) forces the ram down, which, in turn, forces the fluid back to the reservoir.

Double-Acting Ram

A double-acting ram type cylinder is illustrated in figure 12-2. In this type cylinder both

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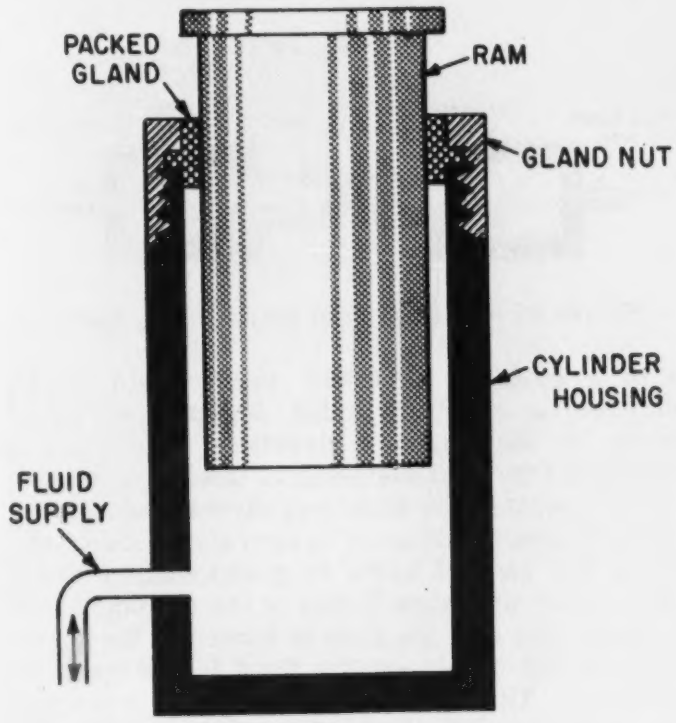

Figure 12-1.—Single-acting ram type actuating cylinder.

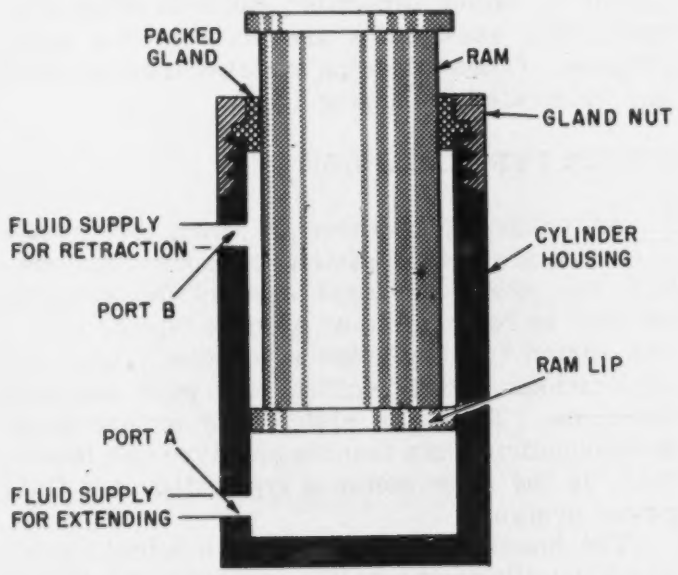

Figure 12-2.—Double-acting ram type actuating cylinder.

strokes of the ram are produced by pressurized fluid. Fluid under pressure is directed to the bottom of the cylinder which extends the ram and applies force. To retract the ram and reduce force, fluid is directed to the top of the cylinder.

A four-way directional control valve is normally utilized to control the double-acting ram. When the valve is positioned to extend the ram, pressurized fluid enters port (A), acts on the bottom surface of the ram, and forces the ram outward. Fluid above the ram lip is free to flow out of port (B), through the control valve and to return/exhaust.

When the directional control valve is positioned to retract the ram, pressurized fluid enters port (B) and acts on the top surface of the ram lip, forcing the ram down. The fluid from the bottom of the cylinder is free to flow out of port (A) and through the directional control valve to return/exhaust.

Normally, the pressure of the fluid is the same for either stroke of the ram. However, note the difference of the areas upon which the pressure acts. The pressure acts against the large surface area on the bottom of the ram during the extension stroke, at which time the ram applies force. Since the ram does not apply force during the retraction stroke, pressure acting on the small area on the top surface of the ram lip provides the necessary force to retract the ram.

Telescoping Cylinders

Figure 12-3 shows a telescoping ram type actuating cylinder. A series of rams is nested in the telescoping assembly. With the exception of the smallest ram, each ram is hollow and serves as the cylinder housing for the next smaller ram. The ram assembly is contained in the main cylinder housing which also provides the fluid ports. Although the assembly requires a small space with all of the rams retracted, the telescoping action of the assembly provides a relatively long stroke when the rams are extended.

An excellent example of the application of this type cylinder is in the dump truck. It is used to lift the forward end of the truck bed and dump the load. A greater force is required for the initial lifting of the load. As the load is lifted and begins to dump, the required force becomes less and less until the load is completely dumped. In the raise position, pressurized fluid enters the cylinder through port (A) and acts on the bottom surfaces of all three rams. (See fig. 12-3.) Ram (1) has the largest surface area, and therefore, provides the greater force for the initial load. As ram (1) reaches the end of its stroke and the required force decreases,

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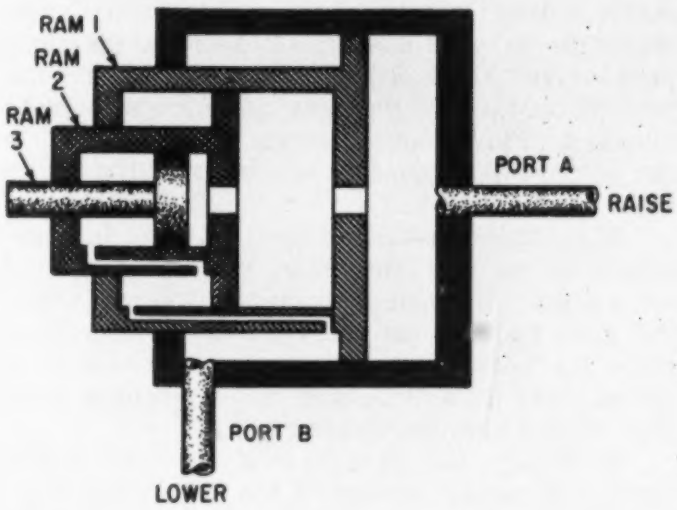

Figure 12-3.-Telescoping ram type actuating cylinder.

ram (2) moves, providing the lesser force needed to continue raising the load. When ram (2) completes its stroke, a still lesser force is required. Ram (3) then moves outward to finish raising and dumping the load.

Some telescoping cylinders are of the single-acting type. In this type the rams are retracted by gravity or mechanical force. Others, like the one illustrated in figure 12-3, are of the double-acting type. In this type, fluid pressure is utilized for both the extension and retraction strokes. A four-way directional control valve is commonly used to control the operation of the double-acting type. Note the small passages in the walls of rams (1) and (2). They provide a path for the fluid to flow to and from the chambers above the lips of rams (2) and (3). During the extension stroke, return fluid flows through these passages and out of the cylinder through port (B). It then flows through the directional control valve to return/exhaust.

To retract the rams, fluid under pressure is directed into the cylinder through port (B) and acts against the top surface areas of all three ram lips. This forces the rams to the retracted position. The displaced fluid from the opposite side of the rams flows out of the cylinder through port (A), through the directional control valve to return/exhaust.

Dual Rams

A dual ram assembly is illustrated in figure 12-4. This assembly consists of a single ram

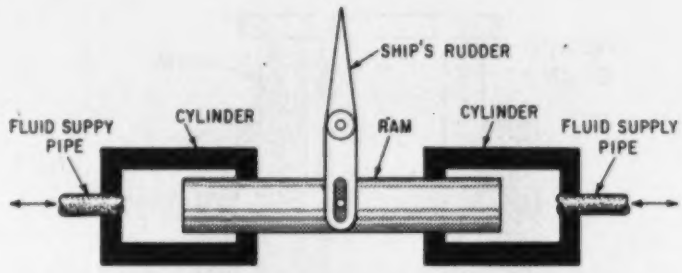

Figure 12-4.—Dual ram actuating cylinder.

with a cylinder at either end. Fluid can be directed to either cylinder, forcing the ram to move in the opposite direction. The ram is connected through mechanical linkage to the unit to be operated. A four-way directional control valve is commonly used to operate the dual ram. When the control valve is positioned to direct fluid under pressure to one of the cylinders, for example the left, the ram is forced to the right. This action displaces the fluid in the opposite cylinder. This displaced fluid flows back through the directional control valve to return/exhaust.

Dual ram actuating cylinders are used in the steering systems of most ships. In some systems one assembly is utilized to actuate the rudder in either direction; while in other systems, two assemblies are used for the same purpose. (These steering systems are described and illustrated in chapter 13.)

PISTON TYPE CYLINDER

An actuating cylinder in which the cross-sectional area of the piston rod is less than one-half the cross-sectional area of the movable element is referred to as a piston type cylinder. The piston type cylinder is normally used for applications which require both push and pull functions. Thus, the piston type serves many more requirements than the ram type and, therefore, is the most common type utilized in fluid power systems.

The housing consists of a cylindrical barrel which usually contains either external or internal threads on both ends. End caps with mating threads are attached to the ends of the cylinder. The end caps usually contain the fluid ports. The end cap on the rod end contains a hole for the piston rod to pass through. Suitable packing must be used between the hole and the piston rod to prevent external leakage. The opposite end cap of most cylinders is provided with a fitting for securing the actuating cylinder to

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some structure. For obvious reasons, this end cap is referred to as the anchor end cap.

The piston rod may extend through either or both ends of the cylinder. The end of the rod is normally threaded for the attachment of some type of mechanical connector, such as an eyebolt or a clevis, and a locknut. This threaded connection of the rod and clevis provides for adjustment between the rod and the unit to be actuated. After correct adjustment is obtained, the locknut is tightened against the clevis to prevent it from turning. The other end of the clevis or eyebolt is connected, either directly or through additional mechanical linkage, to the unit to be actuated.

In order to satisfy the many different requirements of fluid power systems, piston type cylinders are available in various designs. Some of the most common designs are described in the following paragraphs.

Single-Acting

The single-acting piston type cylinder utilizes fluid pressure to apply force in only one direction. In some designs of this type, the force of gravity moves the piston in the opposite direction. However, most cylinders of this type apply force in both directions. Fluid pressure provides the force in one direction and spring tension provides the force in the opposite direction.

Figure 12-5 illustrates a single-acting, spring-loaded piston type actuating cylinder. In this cylinder the spring is located on the rod side of the piston. In some spring-loaded cylinders the spring is located on the blank side and the fluid port is on the rod end of the cylinder.

A three-way directional control valve is normally used to control the operation of this cylinder. To extend the piston rod, fluid under pressure is directed through the port and into the cylinder. (See fig. 12-5.) This pressure acts on the surface area of the blank side of the piston, extending the rod to the right through the end of the cylinder. At the same time, the spring is compressed between the rod side of the piston and the end of the cylinder. Within limits of the cylinder, the length of the stroke depends on the desired movement of the actuated unit.

To retract the piston rod, the directional control valve is moved to the opposite working position which releases the pressure in the cylinder. The spring tension forces the piston to the left, retracting the piston rod. The fluid is

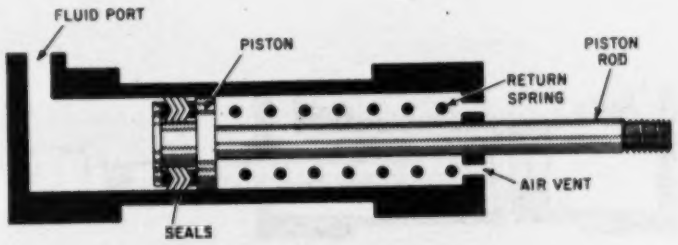

Figure 12-5.—Single-acting, spring-loaded piston type actuating cylinder.

free to flow from the cylinder through the port, back through the control valve to return/exhaust.

The side of the piston opposite the fluid port is vented to the atmosphere. This prevents air from being trapped in this area. Any trapped air would compress during the extension stroke, creating excess pressure on the rod side of the piston. This would cause sluggish movement of the piston and could eventually cause a complete lock, preventing the fluid pressure from moving the piston.

Leakage between the cylinder wall and the piston is prevented by adequate seals. The piston in figure 12-5 contains V-ring seals. (Note that the V's of the seals are placed toward the fluid pressure.) V-rings are used in some cylinders; however, O-rings are utilized in most piston type cylinders.

The spring-loaded cylinder is often used to actuate the arresting hook on carrier aircraft. Raising the arresting hook occurs when fluid pressure is applied through the arresting hook control valve to the fluid side of the piston. This force moves the piston, which through the rod and mechanical linkage, raises the hook. This same force compresses the spring. The arresting hook extends when fluid pressure is relieved and the spring expands.

Double-Acting

Most piston type actuating cylinders are double-acting which means that fluid under pressure can be applied to either side of the piston to provide movement and apply force in the corresponding direction.

One design of the double-acting piston type cylinder is illustrated in figure 12-6. This cylinder operates under the influence of fluid flow in either direction. The cylinder contains one piston and piston rod assembly. The two fluid ports, one near each end of the cylinder, alternate as inlet and outlet, depending on the

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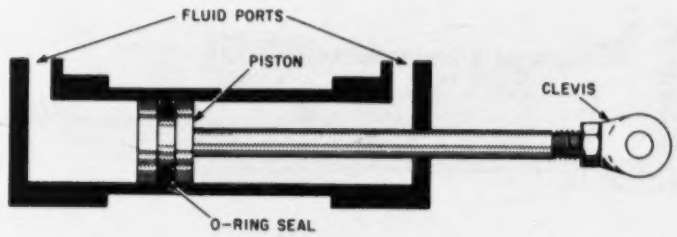

Figure 12-6.—Double-acting piston type actuating cylinder.

direction of flow from the directional control valve.

This is an unbalanced actuating cylinder; that is, there is a difference in the effective working areas on the two sides of the piston. Assume that the cross-sectional area of the piston is 3 square inches and the cross-sectional area of the rod is 1 square inch. In 2,000-psi systems, pressure acting against the blank side of the piston creates a force of 6,000 pounds (2,000 x 3). The 2,000 psi acting against the rod side of the piston creates a force of 4,000 pounds (2,000 x 2). For this reason, this type cylinder is normally installed in such a manner that the blank side of the piston carries the greater load; that is, the cylinder carries the greater load during the piston rod extension stroke.

A four-way directional control valve is normally used to control the operation of this type cylinder. The valve can be positioned to direct fluid under pressure to either end of the cylinder and allow the displaced fluid to flow from the opposite end of the cylinder through the control valve to return/exhaust.

The piston of the cylinder illustrated in figure 12-6 is equipped with an O-ring to prevent internal leakage of fluid from one side of the piston to the other. Some cylinders of this type have a felt wiper-ring attached to the inside of the end cap and fitted around the piston rod to guard against the entrance of dirt into the cylinder. In some localities the atmosphere contains a large amount of dust and abrasive particles. These particles are very harmful to the smooth surface of the piston rod. To prevent damage from these particles, cylinders used in such localities are often equipped with flexible, synthetic rubber, protective coverings around the exposed end of the rod. This covering is referred to as a boot.

Figure 12-7 illustrates a three-port, double-acting piston type actuating cylinder. This type is used in applications where it is necessary to move two mechanisms at the same time. This cylinder contains two pistons and piston rod assemblies.

Fluid under pressure is directed through port (A) by a four-way directional control valve and moves the pistons outward, thus moving the mechanisms attached to the two piston rods. The fluid on the rod side of each piston is forced out of the cylinder through ports (B) and (C) which are connected by a common line to the directional control valve. The displaced fluid then flows through the control valve to return/exhaust.

When fluid under pressure is directed into the cylinder through ports (B) and (C), the two pistons move inward, and the mechanisms to which the piston rods are attached are moved accordingly. Fluid between the two pistons is free to flow through port (A) and through the control valve to return/exhaust.

The actuating cylinder illustrated in figure 12-8 is a double-acting balanced type. The piston rod extends through the piston and out through both ends of the cylinder. One or both of these rods may be attached to a mechanism. In either case, the cylinder provides equal areas on each side of the piston so that the amount of fluid and force required to move the piston a

Figure 12-7.—Three port, double-acting actuating cylinder.

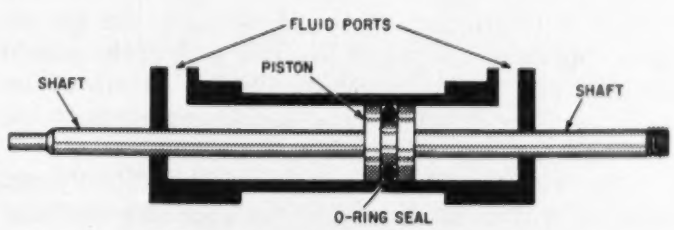

Figure 12-8.—Balanced, double-acting piston type actuating cylinder.

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Cotton Verticillium Wilt

By Ivan J. Shields
Extension Plant Pathologist

The severity of Verticillium wilt has varied from season to season and from soil to soil in Arizona cotton fields. All cotton areas in Arizona have this disease. The greatest losses are being experienced in the Tucson, Safford, Elfrida and Duncan areas. Rapid increase in cotton losses have occurred in the Marana, Casa Grande, Eloy, Florence and Phoenix areas. Once the disease is present, it is soon scattered over the field. (See Figure 1)

Figure 1. Scattered Verticillium wilt infected cotton is evident in a field near Beardsley, Arizona. Infected plants and gin trash carry the fungus over to next season.

WHAT'S YOUR LOSS?

Look for this disease in your cotton fields. Verticillium wilt causes a definite mottling of leaves with pale yellowish areas on the margins and between the veins. As the disease progresses, the yellow areas in the leaf turn brown. The lower leaves are the first to fall. When cotton plants are infected early they may be stunted or killed. (See Figure 2)

Figure 2. Stunted or dead cotton plants result from early infection by this soil-borne fungus. Healthy and diseased plants are of the variety Delta Pine.

CHECK THE STEM

Shortly after infection, the cotton plants will show brownish streaks in the stem. (See Figure 3) Later these streaks

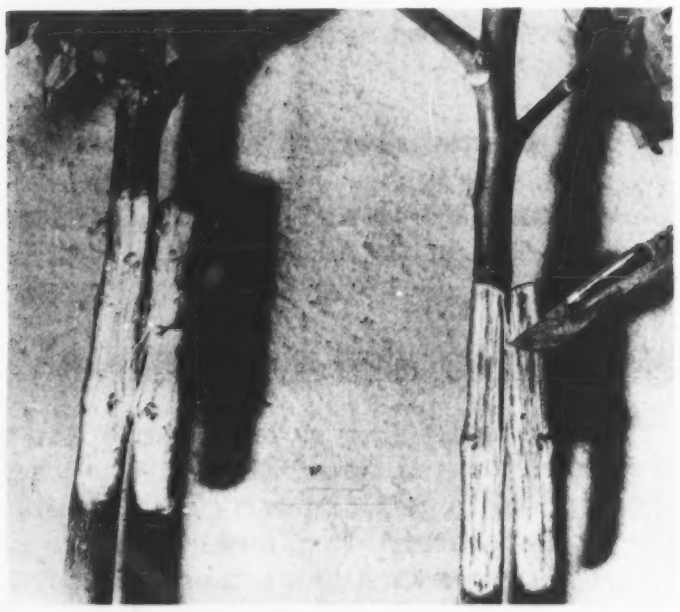

Figure 3. Streaked, brown discolored stems are evident in cotton infected with Verticillium wilt.

Cooperative Extension Service and Department of Plant Pathology of the Agricultural Experiment Station, The University of Arizona, Tucson

certain distance in one direction is exactly the same as the amount required to move it an equal distance in the opposite direction. This type cylinder is commonly used in servomechanisms.

Like the unbalanced, double-acting cylinders, both the three-port and balanced cylinders require suitable seals around the pistons and suitable packing around the piston rods. These cylinders may also be equipped with protective boots around the exposed piston rod.

Cushioned Cylinders

In order to slow the action and prevent shock at the end of the piston stroke, some actuating cylinders are constructed with a cushioning device at either or both ends of the cylinder. This cushion is usually a metering device built into the cylinder to restrict flow at the outlet port, thereby slowing down the motion of the piston. There are various designs used to provide this cushioning effect. One such design is shown in the actuating cylinder illustrated in figure 12-9.

In the cylinder illustrated in figure 12-9, the piston movement is cushioned near the end of the extension stroke. As fluid under pressure flows into port (A), it acts against the blank side of the piston, forcing the piston and rod to the right. Fluid from the rod side of the piston is free to flow between the center hole of the cushioning element and out port (B). Some fluid flows through the metering orifice, but spring tension and fluid pressure cause the check valve to seat, blocking flow through this point. This action continues until the raised portion of the piston rod reaches the center hole of the cushioning element. The close tolerance between this portion of the rod and the center hole results in near stoppage of flow around the piston rod. The remainder of the fluid must flow through the metering orifice. This reduced volume of flow offers resistance to the moving piston, thus cushioning the end of the piston stroke.

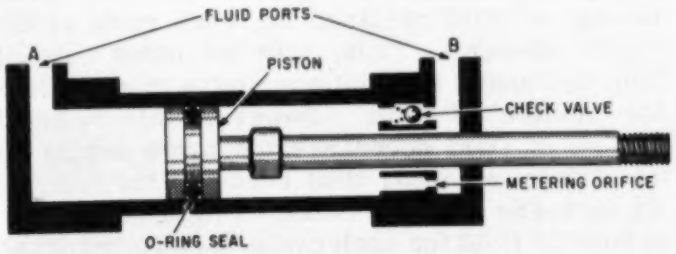

Figure 12-9.—Cushioned actuating cylinder.

To actuate the cylinder in the opposite direction, fluid under pressure is directed into the cylinder through port (B). This pressure overcomes spring tension and unseats the check valve. This allows an unrestricted flow into the cylinder and forces the piston to move to the left.

LIMITED ROTATION CYLINDERS

Rotary actuation of fluid power equipment is normally provided by fluid power motors. However, certain actuating cylinders are designed to provide limited rotary actuation. The rotation is normally limited to approximately 280 degrees. Like all fluid power components, there are many different designs of limited rotation cylinders. One design of this type cylinder is illustrated in the hydraulic windshield wiper system shown in figure 12-10. The design is often referred to as the rack and pinion actuator.

The windshield wiper must move back and forth in an arc of approximately 180 degrees. The rack and pinion actuator provides this limited rotation. The wiper has a mechanical oscillating device which changes the fluid flow to opposite ends of the rack and pinion actuator. The piston rod contains a piston on either end. Motion is caused by the movement of the piston rod which has teeth (serrations) machined along one side. These serrations (the rack) mesh with a gear (the pinion) which has teeth around only a portion of its circumference. As the piston moves back and forth, it causes the rotary motion of the shaft to which the gear is attached. The windshield wiper is attached to the opposite end of the gear shaft.

Only a few of the many applications of actuating cylinders are discussed in the preceding paragraphs. Figure 12-11 illustrates additional types of force and motion applications obtainable. To meet the various requirements of fluid power systems, actuating cylinders are available in many different shapes and sizes.

In addition to its versatility, the cylinder type actuator is probably the most trouble-free component of fluid power systems. It is very important that the cylinder and the mechanical members of the unit to be actuated are correctly aligned. Any misalignment will cause excessive wear of the piston, piston rod, and seals. Also, proper adjustment between the piston rod and the

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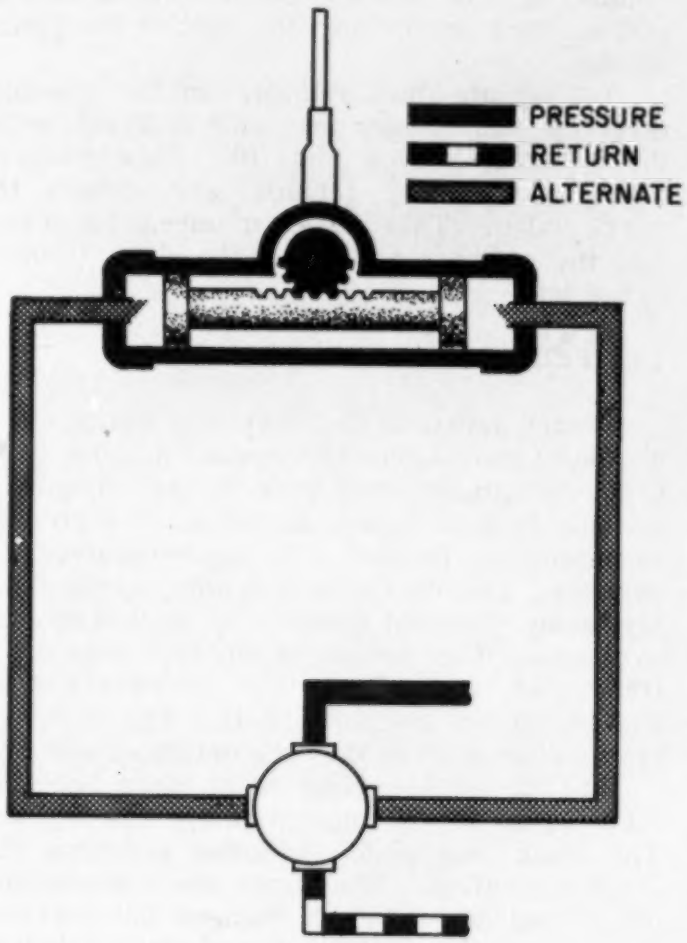

Figure 12-10.—Application of limited rotation actuating cylinder.

actuating unit must be maintained. The exposed ends of the piston rods must be cleaned as required to guard against the entrance of foreign matter into the cylinder.

MOTORS

A fluid power motor is a device which converts fluid power energy to rotary motion and force. Basically, the function of a motor is just the opposite as that of a pump. However, the design and operation of fluid power motors are very similar to pumps. In fact, many hydraulic pumps can be used as motors with little or no modifications. Therefore, a thorough knowledge of the pumps described in chapter 7 will be extremely helpful for understanding the operation of fluid power motors.

Motors serve many applications in fluid power systems. In hydraulic power drives, pumps and motors are combined with suitable lines and valves to form hydraulic transmissions. The pump, commonly referred to as the A-end, is driven by some outside source, such as an electric motor. The pump delivers fluid to the fluid motor. The motor, referred to as the B-end, is actuated by this flow, and through mechanical linkage, conveys rotary motion and force to the work. This type power drive is used to operate (train and elevate) many of the Navy's guns and rocket launchers. Air motors are used in missiles to convert the potential energy of compressed air into electric power, or to drive the pump of the hydraulic system. These are only a few of applications of fluid power motors.

Fluid motors are generally rated in terms of displacement and torque. Displacement refers to the amount of fluid necessary to force the motor through one complete cycle. Displacement is expressed in cubic inches or gallons per minute. The torque (twisting or rotating force) is expressed in inch-pounds at a certain pressure.

The output speed and torque of the motor depends on the power input in terms of pressure and rate of flow. The output speed is proportional to the input volume. The ratio between these two factors depends on the displacement of the motor. The pressure difference between the inlet and outlet ports and the mechanical efficiency of the motor determine the output torque.

The speed and torque requirements vary in different applications. In some applications the unit must be actuated at a high speed, while very little torque is required for the operation. In other applications, low speed and high torque are required to operate a particular unit. The requirements of most applications vary between these two extremes. The ratio of these two factors—speed and torque—depends on the displacement of the motor. With input flow and pressure remaining constant, a decrease in displacement increases the speed of the motor but reduces the torque proportionally. In other words, the decrease in displacement reduces the amount of fluid required for each cycle of the motor element. Thus, with the same rate of flow, the motor element completes more cycles per volume of fluid. However, this reduced volume of fluid decreases the force acting on the motor element, thus reducing the torque. An increase in displacement requires a larger volume of fluid for each cycle, thus reducing the

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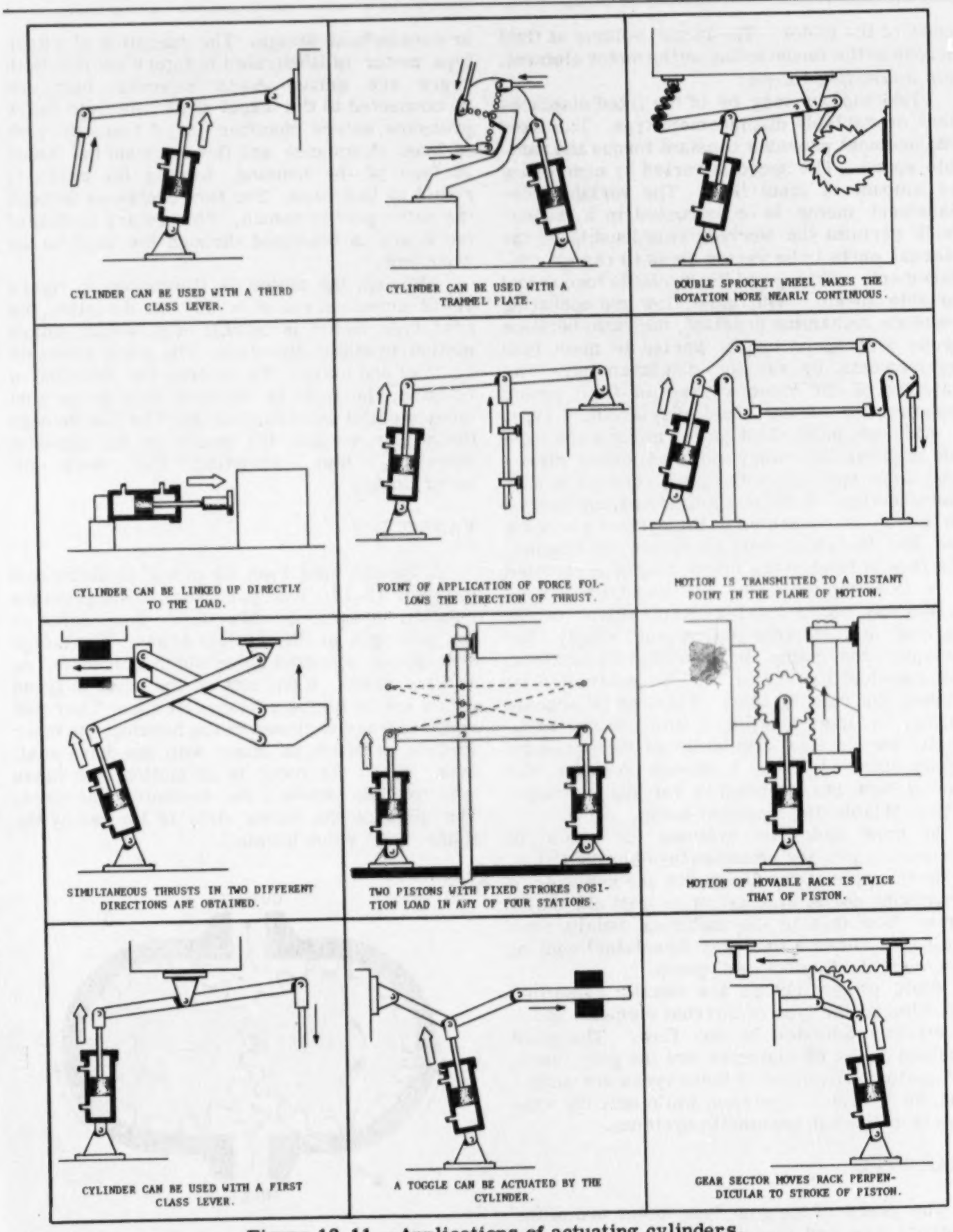

Figure 12-11.—Applications of actuating cylinders.

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speed of the motor. The larger volume of fluid increases the force acting on the motor element, thus increasing torque.

Fluid motors may be of the fixed displacement or variable displacement type. The fixed displacement provides constant torque and variable speed. The speed is varied by controlling the amount of input flow. The variable displacement motor is constructed in a manner which permits the working relationship of the internal parts to be varied so as to change displacement. This provides variable torque and variable speed. With input flow and operating pressure remaining constant, the ratio between torque and speed can be varied to meet load requirements by varying displacement. The majority of the motors used in fluid power systems are of the fixed displacement type.

Although most fluid power motors are capable of providing rotary motion in either direction, some applications require rotation in only one direction. In these applications one port of the motor is connected to the system pressure line and the other port to return or exhaust. The flow of fluid to the motor may be controlled by a flow control valve (ON and OFF valve), a two-way directional control valve, or by starting and stopping the power supply; for example, the pump in a hydraulic system. The speed of the motor may be controlled by varying the rate of flow. This can be accomplished by incorporating a flow control valve (restrictor or flow regulator) in the pressure supply line. In many hydraulic systems, the rate of flow is controlled by varying the output of the variable displacement pump.

In most hydraulic systems the motor is required to provide actuation in either direction. In these applications the ports are referred to as working ports, alternating as inlet and outlet ports. The flow to the motor is usually controlled by either a four-way directional control or a variable displacement pump.

Fluid power motors are usually classified according to the type of internal element, which is directly actuated by the flow. The most common types of elements are the gear, vane, and piston. All three of these types are adaptable for hydraulic systems, while only the vane type is utilized in pneumatic systems.

GEAR TYPE

The gears of the gear type motor are of the external type and may be of the spur, helical, or herringbone design. The operation of a gear type motor is illustrated in figure 12-12. Both gears are driven gears; however, only one is connected to the output shaft. As fluid under pressure enters chamber (A), it takes the path of least resistance and flows around the inside surface of the housing, forcing the gears to rotate as indicated. The flow continues through the outlet port to return. This rotary motion of the gears is conveyed through the shaft to the work unit.

Although the motor is illustrated in figure 12-12 shows operation in only one direction, the gear type motor is capable of providing rotary motion in either direction. The ports alternate as inlet and outlet. To reverse the direction of rotation, the fluid is directed through the port labeled outlet into chamber (B). The flow through the motor rotates the gears in the opposite direction, thus actuating the work unit accordingly.

VANE TYPE

A typical vane type air motor is illustrated in figure 12-13. This particular motor provides rotation in only one direction. It operates on the principle of differential areas. The motor consists of a slotted rotor which is mounted on a drive shaft. Each slot of the rotor is fitted with a freely sliding rectangular vane. The rotor and vanes are enclosed in the housing, the inner surface of which is offset with the drive shaft axis. When the rotor is in motion, the vanes tend to slide outward due to centrifugal force. The distance the vanes slide is limited by the shape of the rotor housing.

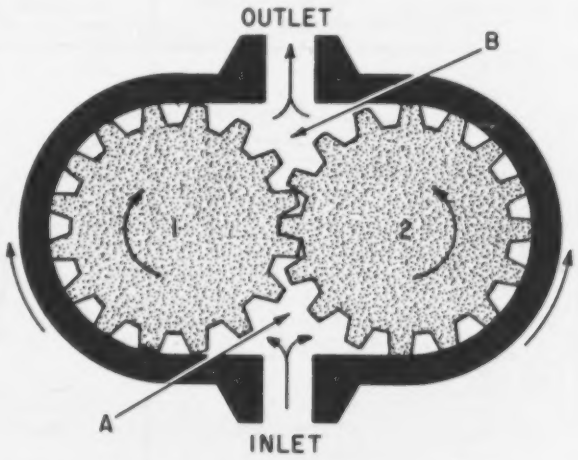

Figure 12-12.—Gear type motor.

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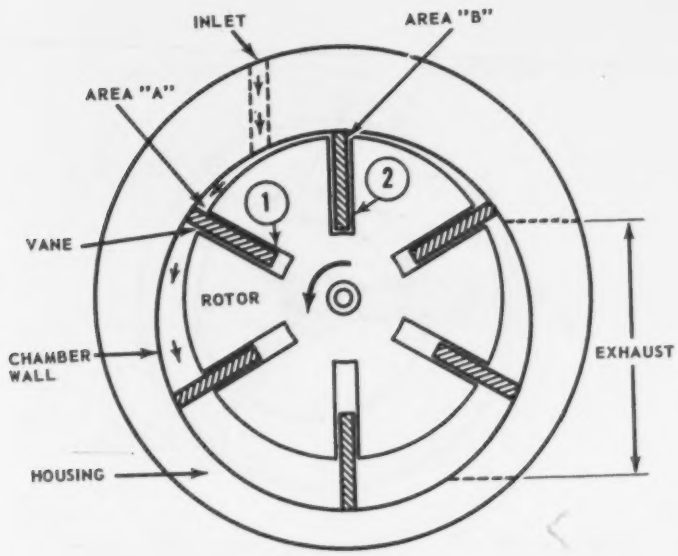

Figure 12-13.—Vane type air motor.

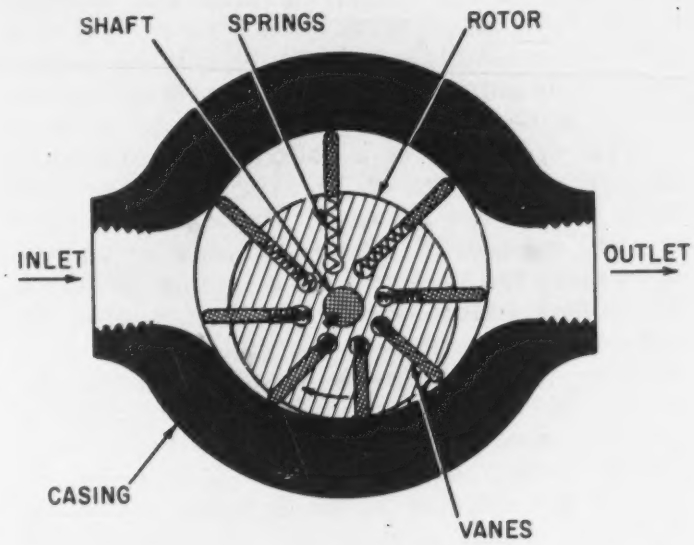

Figure 12-14.—Vane type motor.

When compressed air is ported into the inlet port, its pressure is exerted equally in all directions. Since area (A) is greater than area (B), the rotor will turn counterclockwise. Each vane in turn assumes the No. 1 and No. 2 position and the rotor turns continuously. The potential energy of the compressed air is thus converted into kinetic energy in the form of rotary motion and force. The air at reduced pressure is exhausted to the atmosphere. The shaft of the motor is connected to the unit to be actuated.

Many vane type motors are capable of providing rotation in either direction. A motor of this design is illustrated in figure 12-14. The principle of operation is the same as the vane type motor previously described. The two ports may be alternately used as inlet and outlet, thus providing rotation in either direction. Note the springs in the slots of the rotor. Their purpose is to hold the vanes against the housing during the initial starting of the motor, since no centrifugal force exists until the rotor begins to rotate. Springs are not required in vane type pumps because the drive shaft provides the initial centrifugal force.

PISTON TYPE

Like piston (reciprocating) type pumps, the most common designs of piston type motors are the radial and axial. As previously stated, piston type motors are adaptable only to hydraulic systems.

Although some piston type motors are controlled by directional control valves, they are often used in combination with variable displacement pumps. This pump-motor combination (hydraulic transmission) is used to provide a transfer of power between a driving element, for example an electric motor, and a driven element. Some of the applications for which hydraulic transmissions may be used are speed reducer, variable speed drive, constant speed or constant torque drive, and torque converter. Some advantages of hydraulic transmission over mechanical transmission of power are as follows:

1. Quick, easy speed adjustment over a wide range while the power source is operating at constant (most efficient) speed. Rapid, smooth acceleration or deceleration.
2. Control over maximum torque and power.
3. Cushioning effect to reduce shock loads.
4. Smooth reversal of motion.

(While studying the description of piston type motors in the following paragraphs, it may be necessary to refer to chapter 7 for a review of the operation and particularly the parts of the radial and axial piston pumps.)

Radial

Figure 7-17 in chapter 7 shows a view of the radial piston pump or motor and identifies the parts. In the radial piston pump, as the cylinder block revolves, the pistons press against the rotor and are forced in and out of the

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cylinder, thereby receiving fluid and pushing it out into the system. The motor operates in reverse--fluid forced into the cylinder drives the pistons outward. The pistons pushing against the rotor cause the cylinder block to revolve.

The operation of a radial piston motor is illustrated in figure 12-15. For simplicity, only three pistons are shown. If liquid is introduced into the cylinder (1), the piston must move outward since the liquid cannot be compressed and two bodies cannot occupy the same space. To allow for this movement the cylinder block must revolve in a clockwise direction, since the piston, in moving out, will seek the point of greatest distance between the cylinder block and the rotor. As the force acting on piston (1) causes the cylinder block to move, piston (2) starts to change position and will approach the position of piston (3). It should be noted that the distance between the cylinder block and the reaction ring of the rotor gets progressively shorter on the top half of the rotor as is shown in figure 12-15. As piston (2) moves, it is forced inward and in turn forces the liquid out of the cylinder. Since there is little or no pressure on this side of the pintle valve, the piston is easily moved in by the contact with the reaction ring of the rotor. The liquid is easily forced out of the cylinder and back to a reservoir or to the inlet side of the pump. As piston (3) moves past the midpoint, or past the shortest distance between the cylinder block and rotor, it enters the pressure side of the pintle valve and liquid is forced into the cylinder. Piston (3) then becomes the pushing piston and in turn rotates the cylinder block. This action continues as long as liquid under pressure enters the cylinders. The rate at which the liquid flows into the cylinders determines the speed at which the cylinder block turns.

As a hydraulic transmission, the two ports of the motor are connected to the two ports of the pump. To control the motor speed, it is necessary to control the output capacity of the pump. This is accomplished by controlling the degree to which the slide block of the pump is offcenter in relation to the center of the cylinder block. Pressure in the system is practically independent of the volume output of the pump, and thus the speed of the motor, but varies with the load on the output shaft of the motor.

Assume that in a pump-motor combination of this type, in which both units are the same size, the rotor is set offcenter in the pump a distance that is just equal to the offset of the rotor in the motor. For each full discharge of one cylinder in the pump, a piston in the motor must move an equal distance, as it receives the same amount of liquid that the pump discharges. The cylinder block of the motor revolves at the same speed as the cylinder block of the pump. Now assume that the offset distance in the pump is shortened, so that it requires the discharge of two cylinders in the pump to fill one cylinder in the motor. Under this condition the cylinder block of the pump completes two revolutions for each revolution of the cylinder block in the motor. Thus, the motor rotates at just half the speed of the pump.

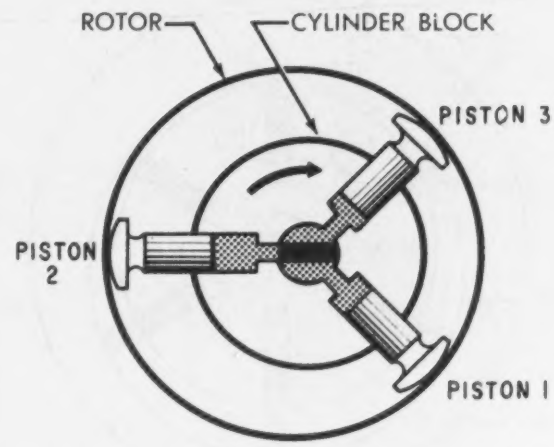

Figure 12-15.—Operation of radial piston motor.

Since the operator has a wide control over the pump end, he has an equal control over the motor end—a control achieved by regulating the amount of flow from the pump. If, in the pump, the rotor and cylinder block are centered, no pumping action will take place, consequently no liquid will be delivered to the motor end, and therefore the output shaft of the motor will not rotate.

In the pump, the direction of flow is reversed by moving the rotor from one side of the neutral position to the other. In the motor, the position of the rotor is fixed. Action of the motor is reversed, however, by reversing the output of the pump. Thus, liquid enters the motor on the top side of the pintle valve, which causes cylinder (3) (fig. 12-15) to become the cylinder into which liquid enters under pressure. This forces the cylinder block to rotate in the opposite direction.

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Variable displacement radial piston motors are available for applications where variable torque is required. If constant speed is required in these applications, a constant displacement pump is used. If control of both speed and torque is required, both the pump and the motor are of the variable displacement type.

Axial Piston

One design of the axial piston type motor is illustrated in figure 12-16. This motor is identical in design to the constant displacement axial piston pump. The operation of this type motor is similar to the operation of the radial piston motor. Fluid under pressure flows through one of the ports in the valve plate and enters the bores of the cylinder block that are open to the port. (For example, in a nine piston motor, four cylinder bores are receiving fluid while four are discharging.) The fluid acting on the pistons in these bores forces the pistons to move away from the valve plate. Since the pistons are held by connecting rods at a fixed distance from the output shaft flange, they can move away from the valve plate only by moving in a rotary direction. The pistons move in this direction to a point around the shaft axis which is the greatest distance from the valve plate. Therefore, driving the pistons axially causes them to rotate the drive shaft and cylinder block. While some of the pistons are being driven by liquid flow from the system, the remaining ones are discharging flow from the outlet port.

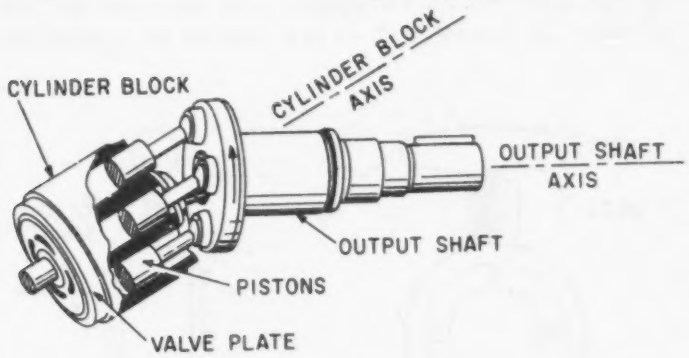

Figure 12-16.—Axial piston hydraulic motor.

This type motor may be operated in either direction of rotation, the rotation being controlled by the direction of flow to the valve plate ports. The direction of flow may be instantly reversed without damage to the motor.

This design of axial piston motors is commonly used in aircraft hydraulic systems to operate such components as landing flaps and radar equipment. In these applications the direction of flow is controlled by four-way directional control valves.

Figure 12-17 shows a hydraulic transmission consisting of an axial piston pump and motor

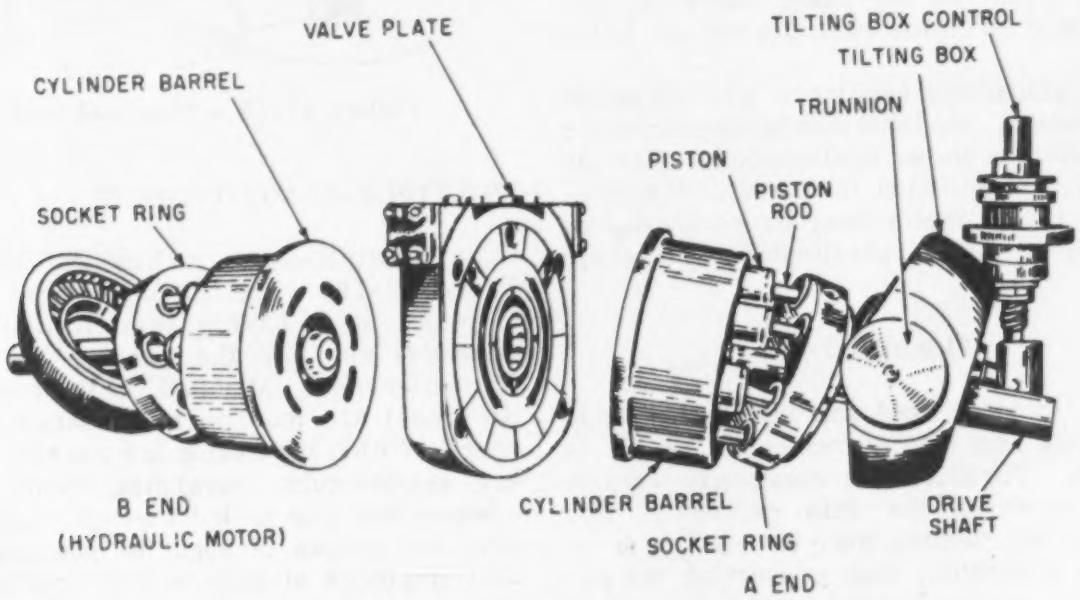

Figure 12-17.—Hydraulic transmission.

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combination. The A-end is a variable displacement axial piston pump. The motor (B-end) is identical to the pump except that it is of the fixed displacement type. Although of slightly different design, the operation of the motor is very similar to the axial piston motor just described.

The hydraulic motor or B-end can be directly connected hydraulically to the pump as illustrated in figure 12-17, or the motor can be installed at a distance from the pump with the two mechanisms connected by piping.

The speed of rotation of this unit is controlled in the same manner as the radial piston unit. With each full stroke of a pump piston, a motor piston must move an equal distance. Thus, speed of output equals speed of input. If the tilting plate (box) of the pump is changed so that the piston stroke of the pump is only one-half as long as the stroke of the motor, it will require the discharge from two pump cylinders to fill one motor cylinder. The motor will then revolve just one-half as fast as the pump. If there is no tilt on the tilting plate, the pumping pistons will not move axially, and no liquid will be delivered to the motor. Therefore, the motor will deliver no power.

If the tilting plate of the pump is reversed, the direction of flow is reversed. Liquid enters the motor through the port by which it formerly was discharged. This reverses the direction of rotation of the motor. The motor rotates in the same direction as the pump when the two tilting plates are tilted in the same direction, and in the opposite direction when the two are tilted oppositely.

Some applications require a wide range of torque variation. Variable displacement motors are available for these applications. Like the radial piston combination, the variable displacement axial piston motor may be controlled by either a fixed or a variable displacement pump.

TURBINES

Another device used for converting fluid power energy into rotary force and motion is the turbine. Turbines are commonly used in pneumatic systems for this purpose. For example, an air turbine may be used to drive an electric generator, thus converting the potential energy of compressed gas into electrical power. A turbine may also be used to drive the pump and supply fluid flow in a hydraulic system. Some of the most common types of air turbines are described in the following paragraphs.

PINWHEEL TURBINE

One type of air turbine is the pinwheel turbine shown in figure 12-18. This turbine is a mechanical jet, similar in principle to a garden sprinkler. Compressed gas is led into the pinwheel hub through the hollow shaft. It eventually passes through the diametrically opposed nozzles where its velocity is increased. (See Bernoulli's principle in chapter 2.) The reaction to the exhaust causes rotation of the pinwheel. The amount of reaction (thrust) is equal to the force of the escaping gas. This force can be determined by measuring the volume and velocity of the gas which escapes. The shaft of the air turbine is connected to the unit to be operated.

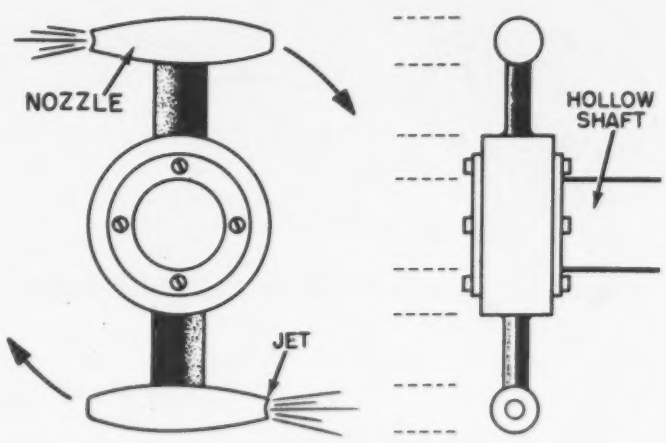

Figure 12-18.—Pinwheel turbine.

MULTIPLE-STAGE TURBINE

A multiple-stage turbine is illustrated in figure 12-19. The turbine wheel is a solid piece of steel having semicircular recesses (buckets) cut into the surface of its outside circumference. Mounted on the casing around the wheel are four nozzles spaced 90 degrees apart. Within the casing are a series of stationary semicircular reversing chambers. The compressed gas is led through a gas manifold ring and passes through the nozzles. The gas then impinges at high velocity on the buckets. In passing through the buckets the direction of flow is reversed 180 degrees. The gas is then caught by a semicircular reversing chamber

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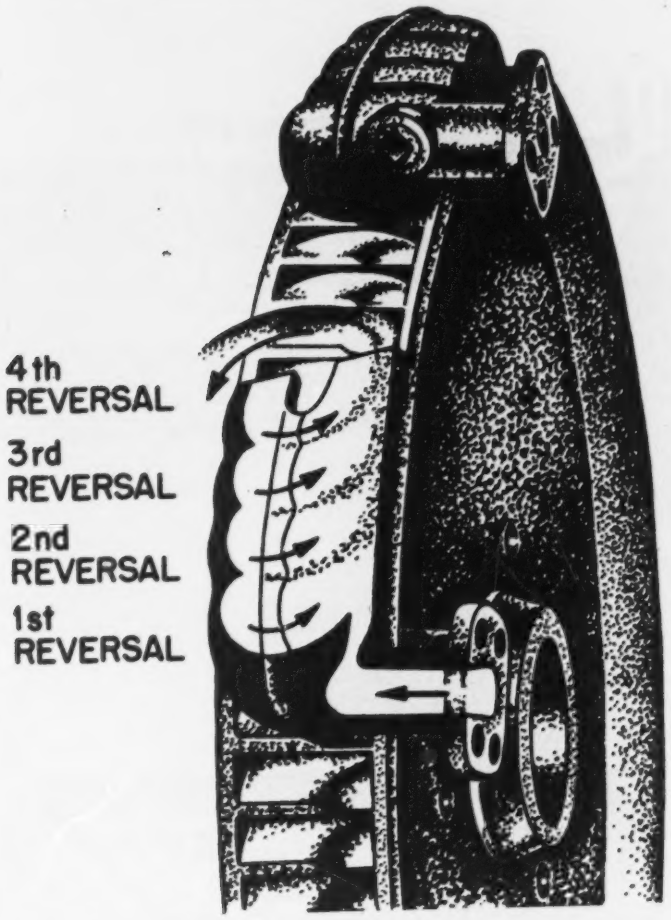

Figure 12-19.—Multiple-stage turbine.

in the casing where it is again reversed 180 degrees and returned to the wheel. The process is repeated five times through a 90-degree arc of the turbine housing after which the gas is exhausted. Reversing the flow of gas several times gives a multiple-stage effect, thereby using more of the potential energy in the gas.

SINGLE-STAGE TURBINE

Another type of turbine is the single-stage turbine shown in figure 12-20. In this turbine the gas expelled through the nozzles is not reversed in direction, but makes only one pass through the turbine.

TURBINE GOVERNORS

As mentioned previously, turbines are often coupled to electric generators. To provide a constant electric output, a governor is commonly used to control turbine speed within very close tolerances. Several types of turbine governors are described in the following paragraphs.

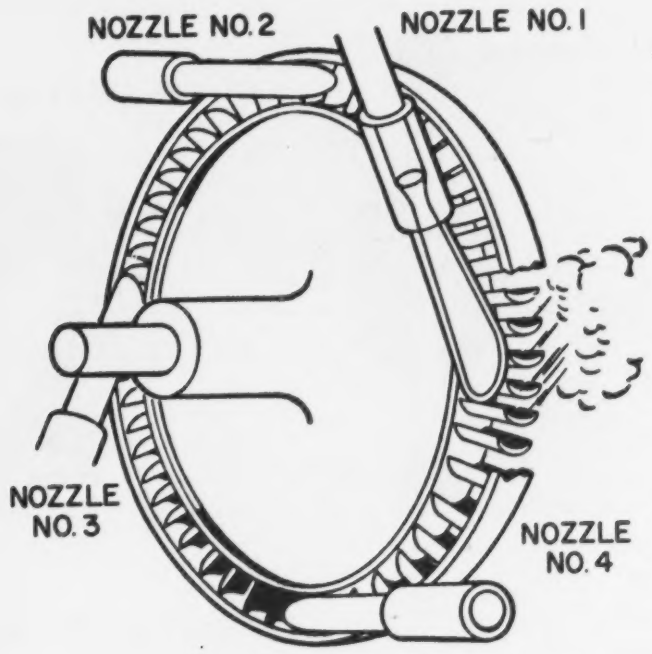

Figure 12-20.—Single-stage turbine.

Moving Shutter Governor

The moving shutter governor is used to control the speed of the pinwheel turbine. It is mounted in the hub of the pinwheel, as shown in figures 12-21 (A) and 12-21 (B). Compressed gas entering the turbine through the follow shaft must pass through the governor before it can pass through the jet nozzles. The governor consists of a shutter secured to a torsion bar. (See fig. 12-21 (C).) As the turbine rotates, centrifugal force causes the shutter to attempt to align itself in the plane of turbine rotation. In figure 12-21 (B) the shutter tends to turn clockwise and block the flow of gas to the nozzles. The torsion bar restrains the shutter from blocking the outlets. As turbine speed approaches a specified limit, the force on the shutter begins to overcome the resistance of the torsion bar, thus permitting the shutter to turn clockwise and partially block the outlets to maintain speed at the specified limit. If turbine speed decreases, the torsion bar overcomes the centrifugal force, and the shutter moves counterclockwise to uncover the outlets. Thus, the moving shutter governor continuously controls turbine speed by metering the flow of gas to the nozzles.

Flyball Governor

A very common type of turbine governor is the flyball governor illustrated in figure 12-22.

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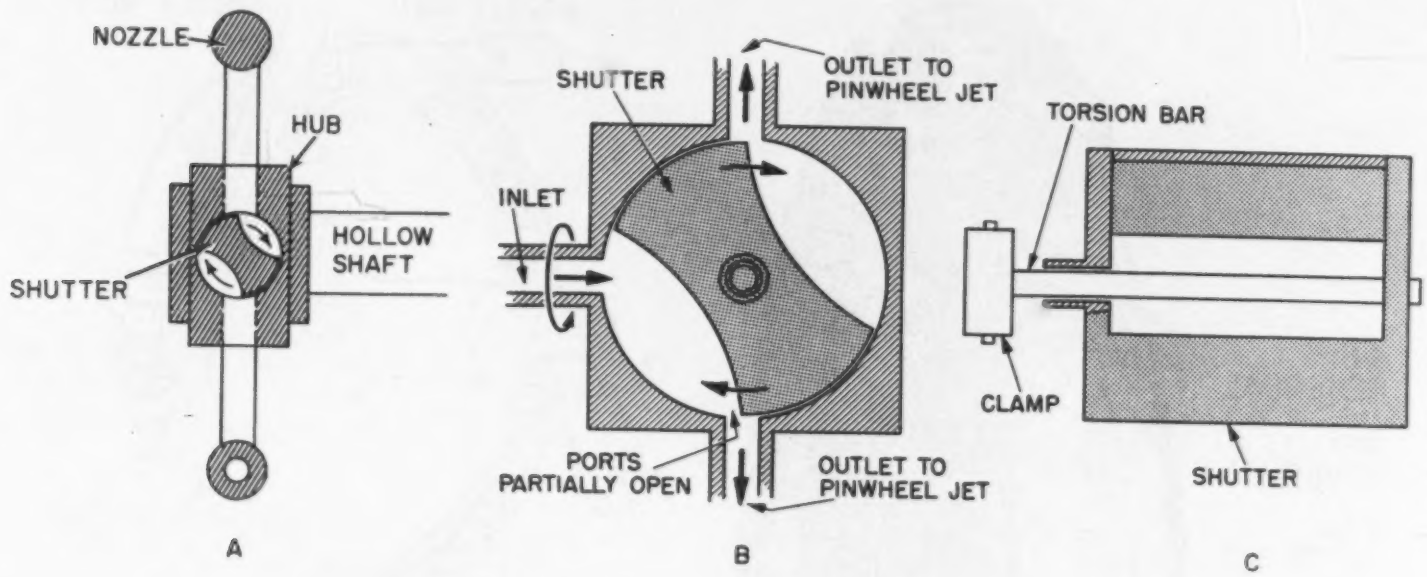

Figure 12-21.—Moving shutter governor.

The coiled springs provide a restraining force on a pair of pivoted counterweights mounted on the turbine shaft. When shaft speed reaches design speed, centrifugal force overcomes spring tension. The counterweights pivot, causing the brake shoes to bear on the brake drum. When design speed is exceeded, the centrifugal force and the braking action increase. At decreasing speeds, the centrifugal force lessens, and the braking action decreases. Thus, a constant turbine speed is maintained.

Another type of flyball governor controls turbine speed by metering the flow of gas to the turbine. Its springs and counterweights are coupled to a valve on the input side of the turbine. Centrifugal force causes the weights to open and close the valve, thereby controlling turbine speed.

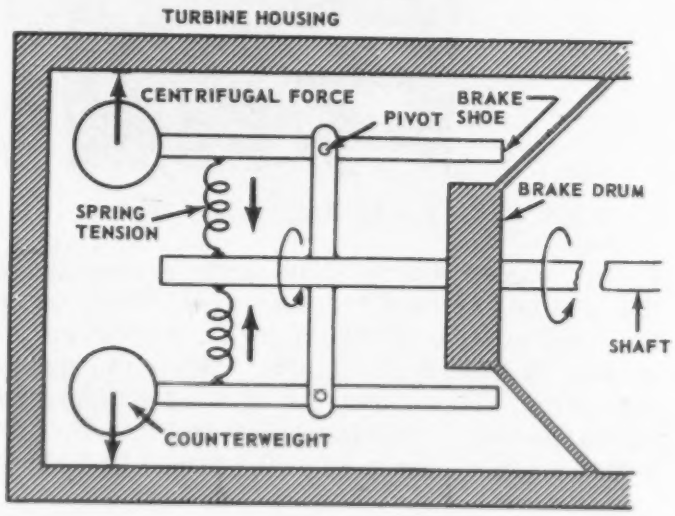

Figure 12-22.—Flyball governor.

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may completely darken the wood. The progress of the disease will slow down during high summer temperatures and the plant will return to normal growth. During this period, no symptoms will show on the leaves and new wood of the stem will be normal. The disease becomes active again in the fall with the return of cooler temperatures.

PREVENT THE SPREAD

Disease readily spreads as diseased plant parts are scattered. Certain practices of precaution should be exercised.

1. Plant seed free of trash, as diseased leaf and stem parts will carry the fungus. Verticillium may be carried on but not in cotton seed.

2. Plow under crop residues immediately after harvest.

3. Refrain from spreading gin trash on fields as most gin trash in Arizona will be infested with Verticillium wilt.

REDUCE LOSSES BY

1. Follow a crop rotation.

Other crops not susceptible to Verticillium wilt will slow the build-up of the disease. Potato, tomato, cantaloup, sugar beet, safflower and flax are susceptible and should not be used in rotation.

2. Do not over-irrigate.

Use no more water than necessary for cotton production, since water lowers the soil temperature thus favors the wilt fungus.

3. Try dry summer fallow.

Tests in wilt areas have shown this to be beneficial in reducing the disease.

4. Control Weeds.

Ten weeds commonly found in Arizona cotton fields have been found as hosts for wilt.

5. Plant tolerant varieties.

Arizona WR-44 and California 442 are tolerant to Verticillium wilt. Delta Pine and A-44 are quite susceptible. The long staple cottons are more tolerant than short staple types.

RESEARCH IN PROGRESS IN ARIZONA

Selections from cotton varieties which were highly tolerant to Verticillium wilt were made several years ago. These selections have been screened and some are now being grown in preliminary yield test. Most of the tests are at The University of Arizona Experiment Farm near Marana. Research workers from U of A and A.R.S. are working cooperatively on these tests.

CHAPTER 13

HYDRAULIC AND PNEUMATIC SYSTEMS

Some of the different applications of fluid power are mentioned throughout this course. These examples indicate, to some extent, that many different designs of systems are necessary to satisfy the requirements of fluid power applications. The type, quantity, and combination of components vary in fluid power systems. Systems range from the simple hydraulic jack described in chapter 4 to extremely complex systems, some of which combine the use of pneumatics and hydraulics.

A few typical systems are described in this chapter to show some of the different applications of fluid power in the Navy. It must be stressed that these are representative systems and not specific systems. Applicable technical publications should be consulted for the operation, servicing, and maintenance of specific systems used in actual applications.

The systems are covered in the following order:

1. Hydraulic power drive.
2. Electrohydraulic steering.
3. Missile fluid power systems.
4. Aircraft fluid power systems.

HYDRAULIC POWER DRIVE SYSTEM

The hydraulic power drive has been used in the Navy for many years. Proof of its effectiveness is the fact that it has been used to train (provide horizontal movement) and elevate (provide vertical movement) nearly all calibers of guns, from the 40-mm to the 16-inch turret. Modifications of these drives are currently being used for the operation of rocket launchers.

Although the power drive system described in this section is of the type used to operate gun mounts and rocket launchers, similar electrohydraulic drive units are used for driving and controlling such equipment as windlasses, capstands, and winches.

In its simplest form the hydraulic power drive consists of the following:

1. A prime mover. This is an electric motor which drives a hydraulic pump.

2. The A-end (hydraulic pump), driven by the electric motor. Its fluid output drives a hydraulic motor called the B-end.

3. The B-end. The output of the B-end is directly connected to the mount by mechanical gearing and shafting. While the A-end is driven at a constant speed by the electric motor, its output is variable. By controlling the output of the A-end, the direction and speed of the B-end, and, hence the direction and speed of the motion of the mount, can be controlled.

4. A means of introducing a signal to the A-end to control its output.

5. The mechanical shafting and gearing that transmits the B-end output to the train and elevation drive pinions.

The 5"/38 twin mounts are driven in train and elevation by separate hydraulic systems. As the systems differ only in size and minor details, only the train power drive is described in the following paragraphs.

The basic components of the train power drive are shown in figure 13-1. The electric drive motor is constructed with drive shafts at both ends. The forward shaft drives the A-end pump through reduction gears. The after shaft is coupled through reduction gears to the auxiliary pumps.

The ports in the A-end valve plate are connected to like ports in the B-end valve plate by large copper pipes. Fluid pumped by the A-end causes rotation of the B-end. Output of the B-end is connected by shafts and gears to the training circle of the gun mount. The function of each major component is described in the following paragraphs.

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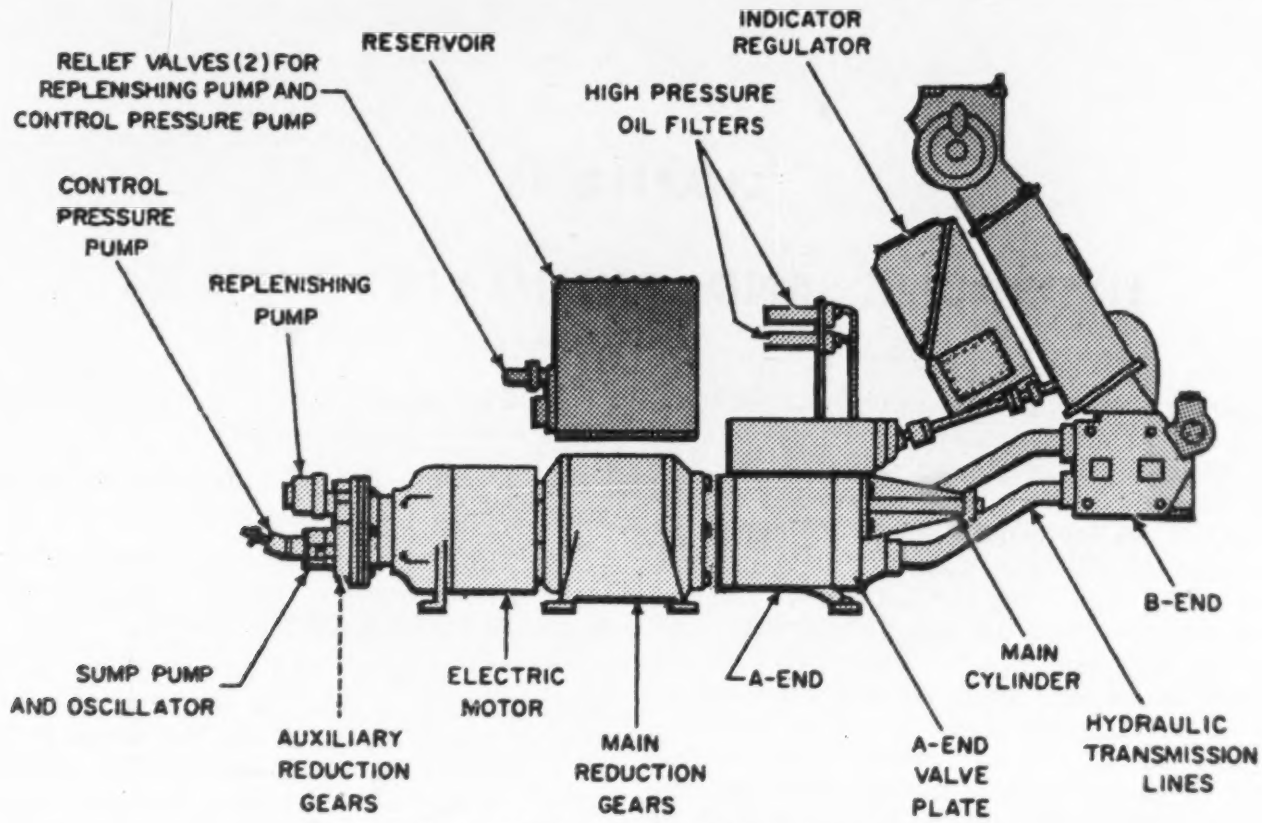

Figure 13-1.—Train power drive-components.

ELECTRIC MOTOR

The prime mover, or electric drive motor, drives the A-end of the hydraulic power transmission. Through reduction gears, it also drives the replenishing pump, control pressure pump, and the sump pump and oscillator. A motor controller with associated pushbutton stations starts and stops the electric motor and gives protection against overload and overvoltage.

MAIN REDUCTION GEAR

The A-end pump is designed to operate at a speed of approximately 900 revolutions per minute. Since this speed is much lower than that of the electric motor, it is necessary to reduce the speed of rotation between the A-end and the electric motor. This speed reduction is accomplished through a gear reduction mechanism. The reduction gears are contained in a housing which is flange-mounted between the electric motor and the B-end. Also mounted on the motor drive shaft is a heavy flywheel, which tends to prevent any sudden change in the speed of reduction gear output.

HYDRAULIC TRANSMISSION

The hydraulic transmission system includes the following components:

1. A-end, an electrically driven variable displacement hydraulic pump.
2. Main cylinder, containing the stroke control shaft. (This assembly is used in controlling the tilt of the A-end.)
3. B-end, a fixed displacement hydraulic motor.
4. Auxiliary pumps.

A-End

The train A-end is an axial piston, variable displacement pump. The direction and speed of its output controls the direction and speed of rotation of the B-end. It is driven at a constant speed by the electric motor through the main reduction gears. The output is controlled by the tilt of the tilting box. Movement of the tilting box is directly controlled by the stroke control shaft.

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B-End

The B-end is similar in construction to the A-end except that the tilt of the tilting box is fixed; that is, the B-end is a fixed displacement motor. As the B-end pistons must each make a full stroke for every revolution of the output shaft, speed of the B-end and hence the speed at which the guns are trained (or elevated), is directly proportional to the angular displacement of the A-end tilting box from its neutral position.

The output shaft of the B-end motor is connected to the training pinions through a mechanical system of gearing and shafting. To compensate for misalignment of the B-end shaft and the final drive gearing, they are connected by flexible or self-aligning type couplings.

Auxiliary Pump Cluster

The auxiliary reduction gears are flange-mounted at the rear of the electric power motor. Three important pumps are driven by the motor through these gears. (See fig. 13-1.)

REPLENISHING PUMP.—This pump is a spur gear pump, driven at a constant speed by the electric motor through the auxiliary reduction gears. Its purpose is to replenish fluid to the active system of the power drive.

The pump draws fluid from the reservoir and discharges it at regulated pressure to the B-end valve plate. The discharge of the pump is held at a constant pressure (normally between 25 and 50 psi) by the action of a pressure relief valve. Normally, because the capacity of the pump exceeds replenishing demands, the relief valve is continuously dumping some of the fluid to return.

SUMP PUMP AND OSCILLATOR.—This pump is also driven by the electric motor through the auxiliary reduction gears. Its purpose is twofold. It pumps leakage, which collects in the sump of the indicator regulator, to the expansion tank.

Its other function is to transmit a pulsating effect to the fluid in the response pressure system. Oscillations in the hydraulic response system help eliminate static friction of valves to cause the hydraulic control to respond faster.

CONTROL PRESSURE PUMP.—The remaining pump driven through the auxiliary reduction gears is the control pressure pump. Its function is to supply high-pressure fluid for the hydraulic control system, brake pistons, lock piston, and the hand-controlled clutch operating piston.

The control pressure pump is an axial piston pump. It is similar to the A-end pump except that the angle of tilt is permanently fixed. Consequently, the pump produces a constant volume output.

To limit the pressure of the pump output to operating pressures, an adjustable relief valve, identical with that of the replenishing pump relief valve, is used. Fluid pressure can be measured by inserting a gage in the plughole located in the relief valve block.

RESERVOIR

The reservoir is used to hold the reserve fluid of the system. It also provides a large cooling surface for the fluid. The reservoir is a bronze tank of considerable surface area which is mounted on shock-absorbing pads on top of the reduction gear housing. External piping connects the reservoir to the hydraulic transmission, control devices, and the expansion tank.

EXPANSION TANK

The expansion tank (not shown in fig. 13-1), as the name indicates, provides space to allow for expansion of the volume of fluid in the hydraulic system due to changes in temperature. The expansion tank is mounted at the highest point in the hydraulic system and has a gage window in its side indicating the safe fluid level for operation of the equipment. A removable cap on the top of the tank serves as a fluid entry point for introducing fluid into the hydraulic system. A removable strainer is located at the fluid entry point to minimize the possiblity of particles of foreign matter entering the hydraulic system.

Since the expansion tank is at the highest point in the hydraulic system, the fluid in this tank serves to provide a positive pressure throughout the system and to prevent the entry of air into the transmission and valve blocks.

CONTROL

Control, as it pertains to the indicator regulator and the handwheel, is beyond the scope of this course. For the purposes of this course, control constitutes the relationship between the stroke control shaft and the tilting box. The

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stroke control shaft is physically located in the main cylinder. (See fig. 13-2.) It is the link between the hydraulic followup system and the power drive itself.

In hand control, the tilting box is mechanically positioned by gearing from the handwheel through the A-end control unit. In local and automatic control, the tilting box is positioned by the stroke control shaft. This shaft is connected at one end of the tilting box. On the other end, operating in the main cylinder, is the main piston. Intermediate high pressure (IHP) is transmitted to one side of the piston. The other side of the main piston is connected to high pressure (HPC), which is held constant at 1,000 psi. Since the area upon which HPC acts is exactly one-half the area upon which IHP acts, the main piston is held fixed in one position when IHP is one-half of HPC. Whenever IHP varies from normal value of one-half HPC, because of action of various control valves, the main piston will move, and thus cause movement of the tilting box.

BRAKE VALVES

An assembly consisting of two brake valves (pistons) acts to force the tilting box to its zero position whenever control pressure is released. (See fig. 13-3.) These spring loaded pistons are normally held back against the spring tension to allow the tilting box free movement. This is done by fluid pumped at high pressure from the control pressure pump. When fluid pressure drops, the pistons are moved by their springs to center the tilting box.

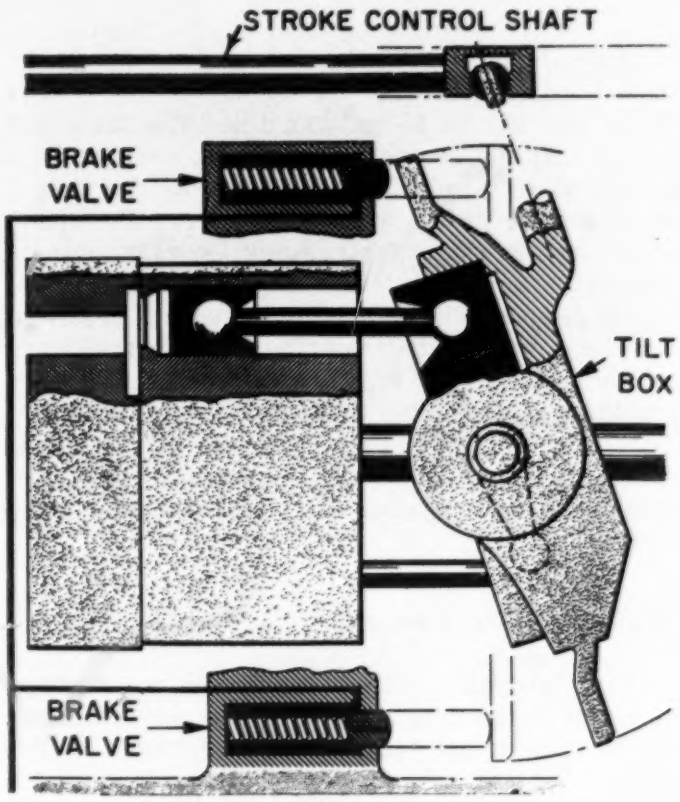

Figure 13-3.—Brake valves.

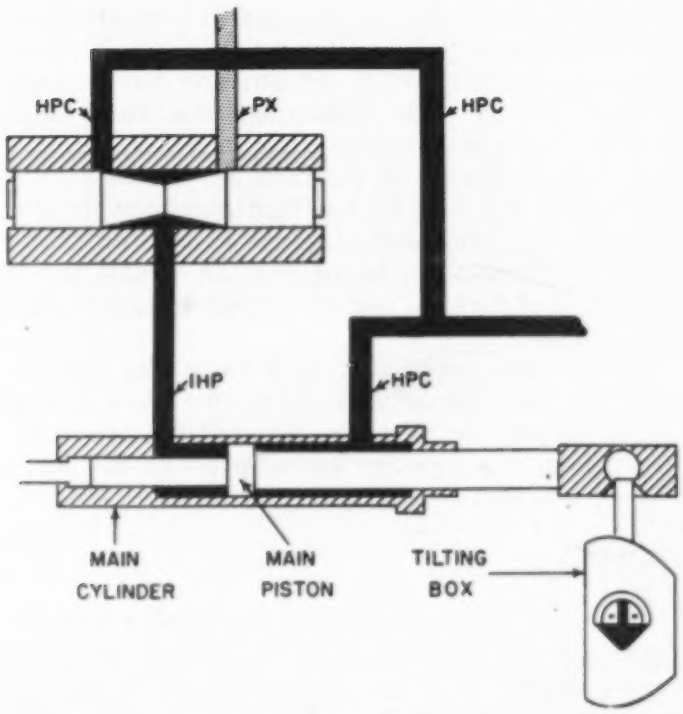

Figure 13-2.—Main cylinder assembly.

OPERATION

Figure 13-4 is a simplified block diagram showing the main elements of the hydraulic power drive system under automatic control for clockwise and counterclockwise rotation.

There are two principal problems in positioning a gun for fire. One is to get an accurate gun-order signal. This problem is solved by the gun director-computer combination. The other problem is to transmit the director signal promptly to the gun, and in such a manner that the position and movements of the gun will be synchronized with signals from the director. This problem is complicated by the fact that movements of the gun tend to fall behind or to overrun director signals, due in part to the lag inherent in transmitting the signals, but mainly

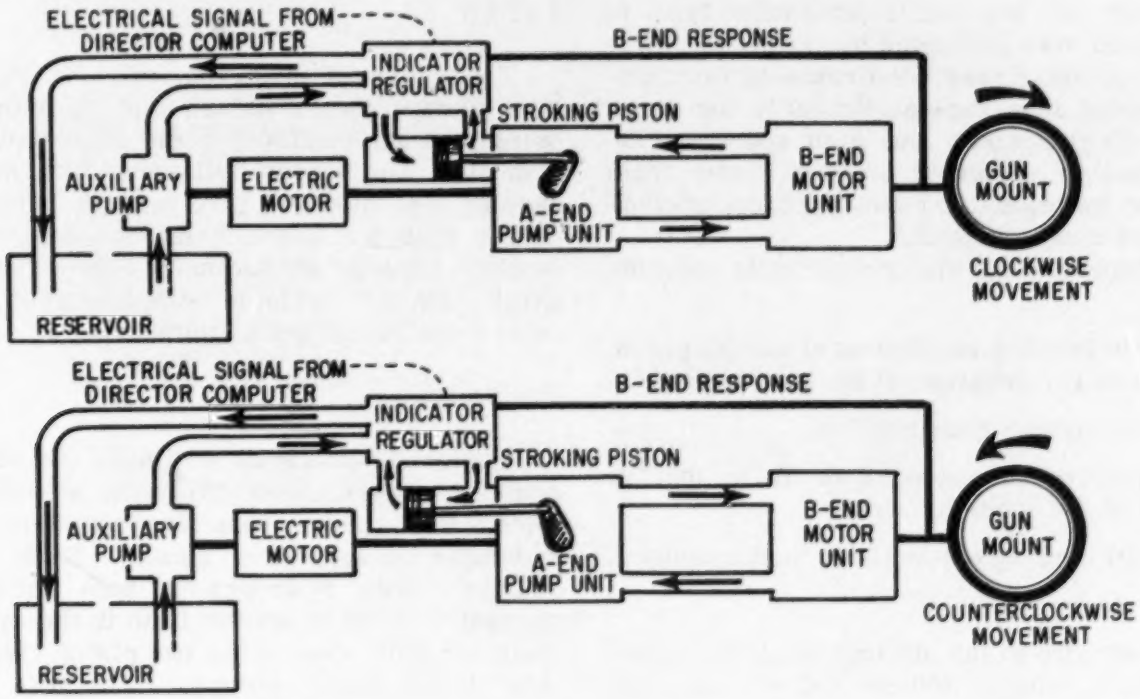

Figure 13-4.—Operation of the hydraulic power drive.

to the inertia of the gun. This inertia tends to keep the gun in movement if it is moving, and at rest if it is at rest, whereas the gun-order signal depends primarily on changes in the location of the target. These signals are always changing, not only because of changes in the relative position of the target and the ship, but also because of the roll and pitch of the ship.

The problem of transforming gun-order signals to mount movements is solved by the power drive and its control, the indicator regulator. The indicator regulator controls the power drive, and this in turn controls the movement of the gun.

The indicator regulator receives an initial electrical gun-order from the director-computer, compares it to the existing mount position, and sends an error signal to the hydraulic control mechanism in the regulator. The hydraulic control mechanism controls the flow to the stroke control shaft which positions the tilting box in the A-end of the transmission. Its tilt controls the volume and direction of fluid pumped to the B-end, and therefore the speed and direction of the drive shaft of the B-end. Through mechanical linkage the B-end output shaft moves the gun by an amount and in a direction determined by the signal.

At the same time, B-end response is transmitted to the indicator regulator, and continuously combines with incoming gun-order signals to give the error between the two. This error is modified hydraulically, according to the rate at which the error is changing, by a system of mechanical linkages and valves in the regulator. When the gun is lagging behind the signal, its movement is accelerated by this means, and, when it begins to catch up, its movement is slowed down so that it will not overrun excessively.

ELECTROHYDRAULIC STEERING

Electrohydraulic transmissions, similar to the one previously described, are utilized in many applications in the Navy. The pump-motor combinations may be either of the radial or axial piston type, and, as previously stated, are used to operate such equipment as capstans and winches aboard ship.

Most steering gear installations on modern naval ships are of the electrohydraulic type, but use only the A-end of the previously described hydraulic power drive. As the steering gear requires reciprocating motion, the B-end is replaced by a ram type actuating cylinder. The

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development of the electrohydraulic type of steering gear was prompted by the large momentary electrical power requirements for electromechanical steering—particularly for ships of large displacement and high speed. Also the elimination of direct current power from ships made switching and speed control of electric motors more difficult.

Advantages of the electrohydraulic steering gear are:

1. Little friction and inertia of moving parts, such as in heavy differential screws and gears.

2. Lower power consumption.

3. Sensitive response, with little lag, to movement of the steering wheel.

4. Small deck space and headroom required.

5. Saving in weight.

6. Flexibility in the arrangement of hydraulic cylinders, pumps, and control mechanisms.

7. Dependability.

TYPES

There are various types of electrohydraulic gear arrangements in use, but their operating principles are similar. Some ships have double hydraulic rams and cylinders (two dual ram assemblies) mounted fore and aft; others have double cylinder single ram (one dual ram assembly) mounted athwartship. Some systems use axial piston, variable displacement pumps; others use radial piston pumps.

Double Ram

Figure 13-5 shows a simple diagram of a double ram type electrohydraulic steering gear. Here, the rudder yoke is connected to two hydraulic plungers or rams. Each ram is equipped with cylinders at both ends. The pressure of the hydraulic fluid in the system is maintained by one of the two piston type, variable displacement pumps. The rate of fluid delivery is regulated by the angle of the tilting

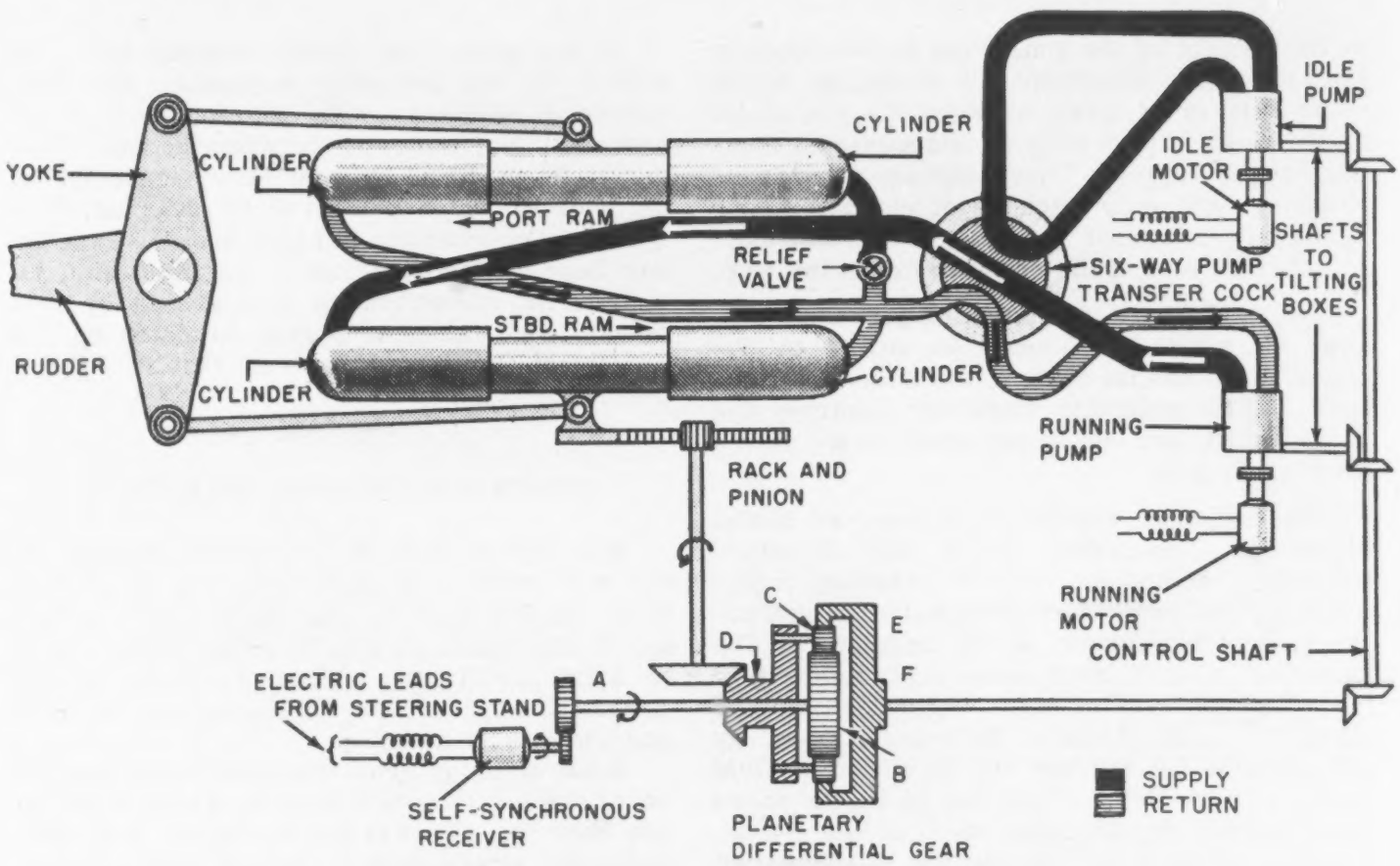

Figure 13-5.—Double ram electrohydraulic steering gear.

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box in the hydraulic pump, which is controlled electrically or hydraulically from the steering wheel on deck. The control shaft and gear are indicated in figure 13-5.

Note that the after cylinder of the port ram is connected to the forward cylinder of the starboard ram and that the after cylinder of the starboard ram is connected to the forward cylinder of the port ram. A double-acting pressure relief valve serves to pass fluid from one working line to the other, thus relieving the piping from excessive strain, should unusual resistance to the rudder result in abnormal pressures.

Starting with a neutral position of the tilting box and no fluid flow, assume that the steering wheel is turned to starboard. Turning the wheel on the bridge causes an electric signal to be transmitted to the synchronous receiver in the steering gear room. (The synchronous receiver is part of the electrical steering gear control and is described later in this chapter.) The synchronous receiver will then turn correspondingly (counterclockwise in fig. 13-5 as viewed from the left). Shaft (A) is turned clockwise, carrying gear (B) with it. The gears (C), meshing with gear (B) and the internal gear teeth on (E), turn counterclockwise. Then (E) turns counterclockwise and turns the control shaft, which operates the tilting boxes on the pumps. A quantity of fluid now flows to the forward port and after starboard cylinders. The rudder is thereby caused to move to the right.

When the steering wheel and the synchronous receiver stop moving, the starboard ram, in moving forward, operates the rack and pinion and turns gear (D) clockwise. Gear (B) and shaft (A) are held by the now motionless receiver. Gear (C) and casing (E) turn clockwise, thus returning the tilting boxes to the neutral position and stopping the flow of fluid. The planetary differential gear, thereby operates as a followup mechanism. When the steering wheel is turned to port, the actions described are in the opposite direction.

In actual installations, two sets of synchronous receivers and two sets of electric motors and hydraulic pumps are provided for reliability and flexibility. The six-way plug valve makes it possible to transfer quickly from the operating pump to the standby pump.

Single Ram

The single ram type electrohydraulic steering gear, illustrated in figure 13-6, operates on the same principle as the double ram type. There is but one ram, with port and starboard cylinders, mounted athwartship. When the steering wheel is turned to starboard, fluid is directed to the port cylinder, forcing the ram to move to the right. The displaced fluid in the starboard cylinder returns to the pump. This movement of the ram causes the rudder to move to starboard.

CONTROL OF STEERING GEARS

Control of the steering gear from the steering wheel on the bridge may be accomplished by any of the following remote control systems:

1. Electrically, by means of an alternating-current synchronous transmission system.
2. Hydraulically, by means of a telemotor system.
3. Electrically, by means of a direct-current pilot motor and its controller.
4. Mechanically, by means of shafting or wire rope from the steering station.

The first two systems are most commonly used and therefore are described in the following paragraphs.

Alternating-Current Synchronous Transmission

The alternating-current synchronous transmission type of remote control consists of receiving and transmitting units which are similar to small motors. These units are connected to the same alternating-current supply. When the transmitter motor is turned, the receiver motor turns at the same speed and in the same direction.

The transmitters are located in steering stands at remote control stations and are mechanically connected through gearing to the steering wheels. A transmitter at each of the remote stations is electrically connected to a receiver in the steering room. The receiver is connected to the control shaft of the variable displacement hydraulic pump through a differential. Where more than one remote steering station is provided, a switch is provided on the steering stands and at the selector switch to indicate the selected circuit and that power is available.

Hydraulic Telemotor Control

The hydraulic telemotor type of remote control (fig. 13-7) is found on many Navy auxiliary

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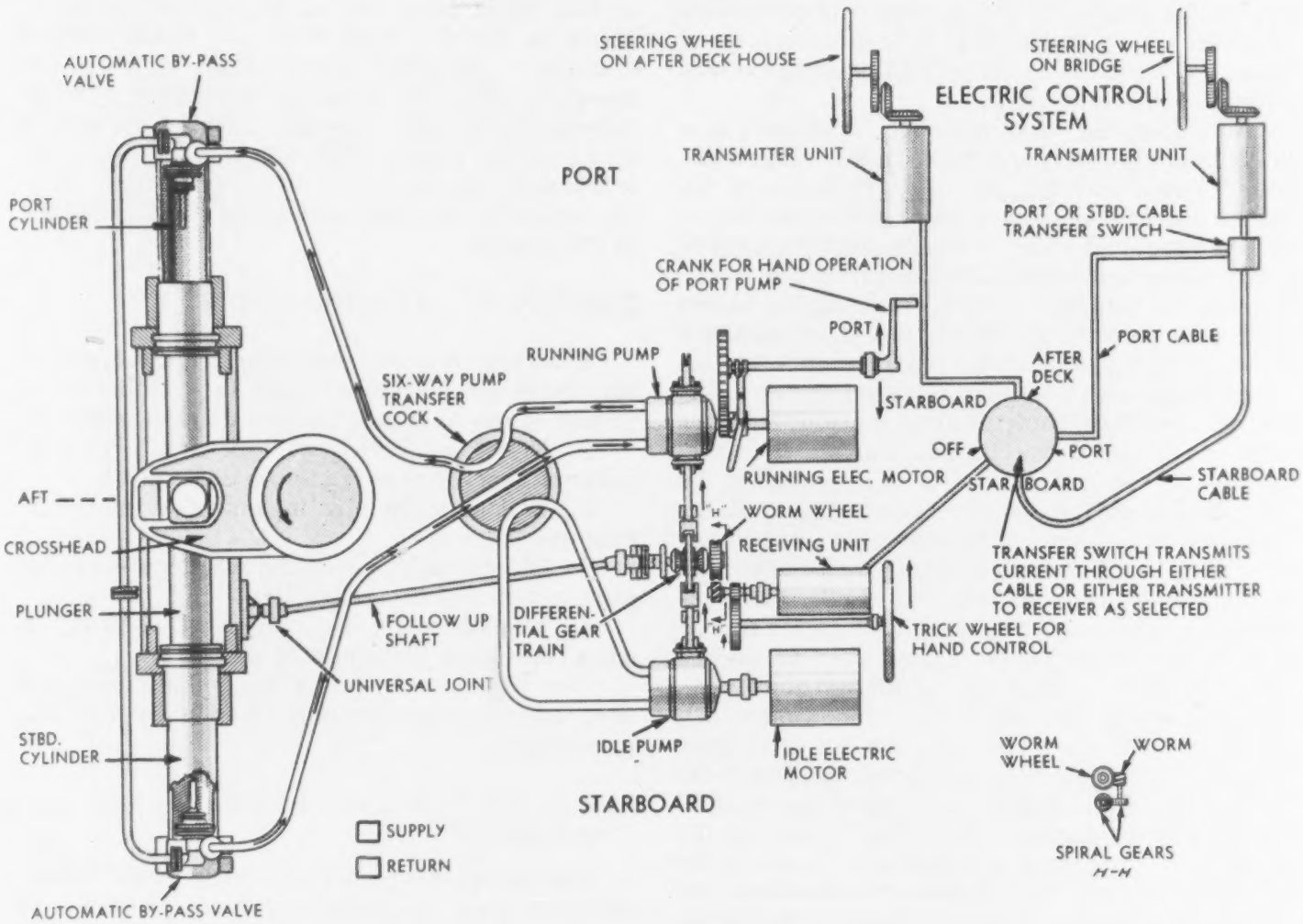

Figure 13-6.—Single ram electrohydraulic steering gear.

ships that are equipped with electrohydraulic steering gear. The control system consists of a steering console (hydraulic transmitter) in the pilot house, a hydraulic receiver in the steering gear compartment, and connecting hydraulic tubing. In addition, there is an electric cable which connects the helm angle transmitter on the receiver housing with the helm angle indicator on the steering console.

A hydraulic transmitter is located inside the steering console and under the steering wheel. The hydraulic transmitter components consist of a pump, hydraulic tubing, two relief valves, two check valves, a replenishing tank, and a bypass valve. The remotely located receiver is a hydraulic ram type unit with two cylinders—one on each end of the receiver housing—in axial alignment. A double acting plunger (ram) operates in the cylinders. On the middle portion of this plunger a crosshead is connected for mechanical linkage to the steering gear control mechanism.

The direction of the hydraulic fluid movement depends upon the direction of rotation of the steering wheel. Rotating the steering wheel actuates bevel and spur gears which in turn operate a fixed displacement axial hydraulic pump. When the pump shaft and cylinder barrel are rotated by means of the steering wheel, the pistons draw fluid in from one fluid line and discharge it to the other fluid line. Reversing the rotation of the steering wheel reverses the direction of fluid flow through the pump. The pump has external check valves and piping for replenishing the hydraulic system from the reservoir. Relief valves and a bypass valve are also included, as well as vents for purging air from the system.

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When the hydraulic pump shaft is rotated in one direction, the fluid output is discharged from one side of the pump to one side of the receiver cylinder. In the other cylinder, hydraulic fluid is displaced to the pump. Thus, the hydraulic fluid under pressure moves the receiver plunger and produces a linear movement of the crosshead. This motion, in turn, is transmitted to the connected steering gear control mechanism. Travel of the crosshead and plunger is limited by adjustable stops on the receiver housing. In figure 13-7 (C), the solid arrows show direction of action for right rudder, while the broken arrows show the flow of hydraulic fluid for right rudder.

Air valves and filling or charging connections are provided on the receiver cylinders for venting, filling, or purging the hydraulic system. Specific filling and purging instructions for telemotor systems should be obtained from applicable steering gear or telemotor manuals, as these instructions vary, depending upon the type of unit and the specific installations. Care should be exercised, however, to insure that the replenishing tank for all types of systems be kept at least three-quarters full at all times.

MISSILE FLUID POWER SYSTEMS

All missiles must contain auxiliary power supply (APS) systems in addition to the main engine required for thrust. The APS systems

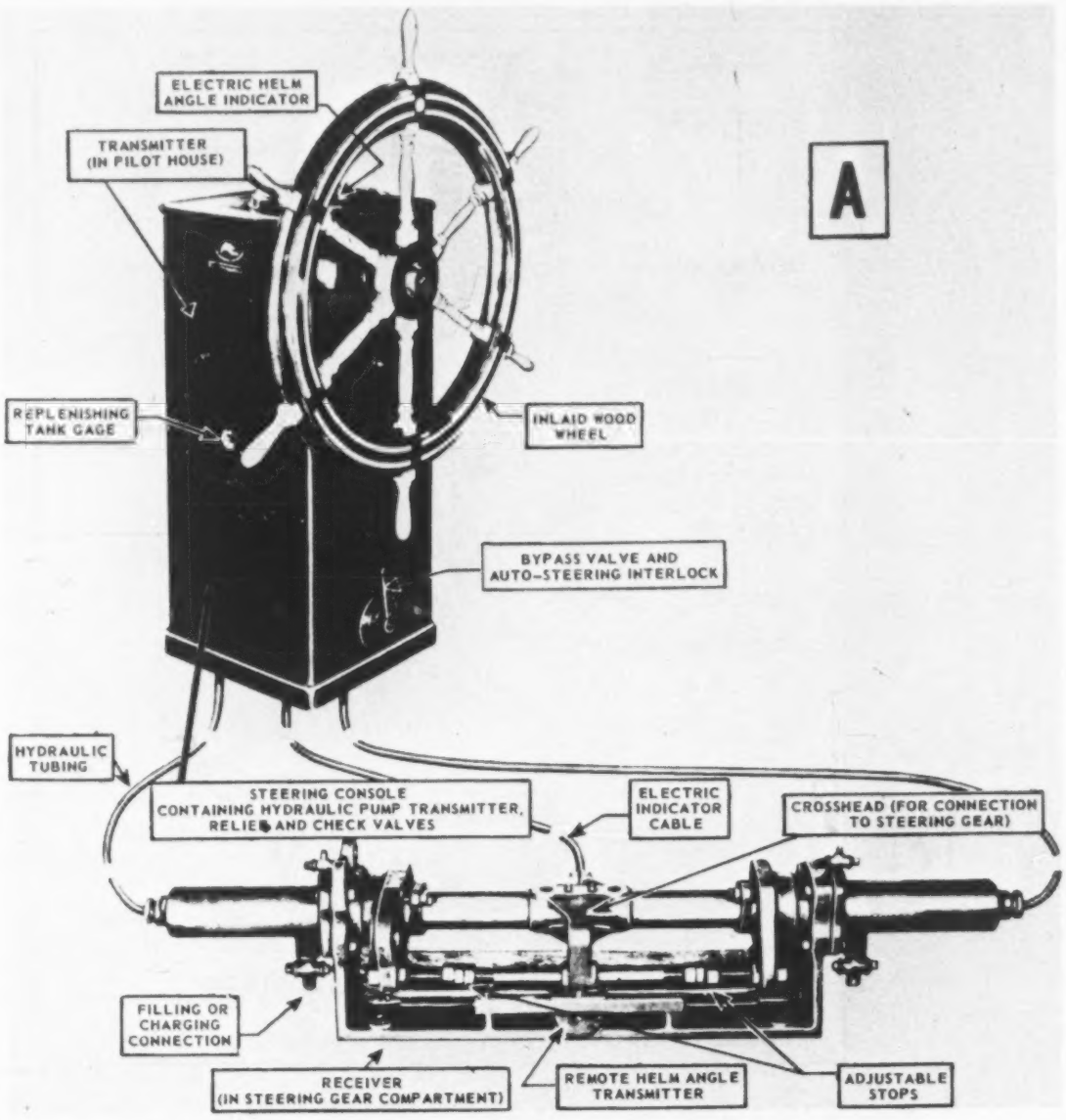

Figure 13-7.—Hydraulic telemotor control. (A) Telemotor components.

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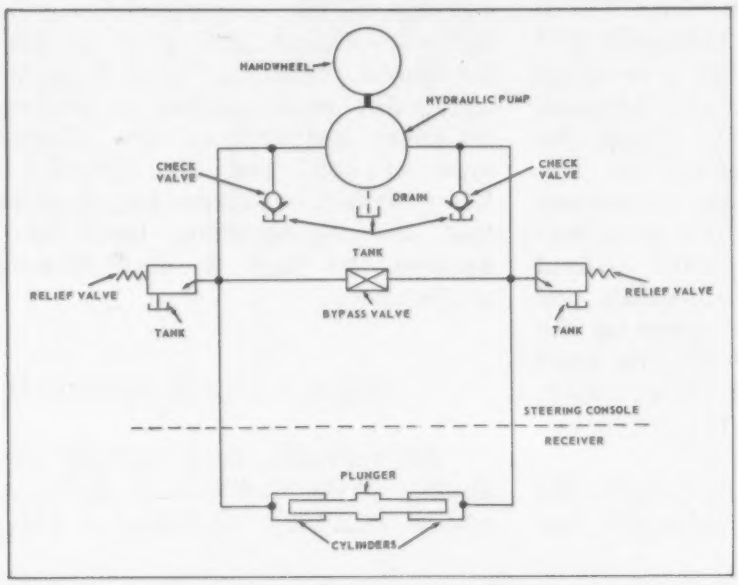

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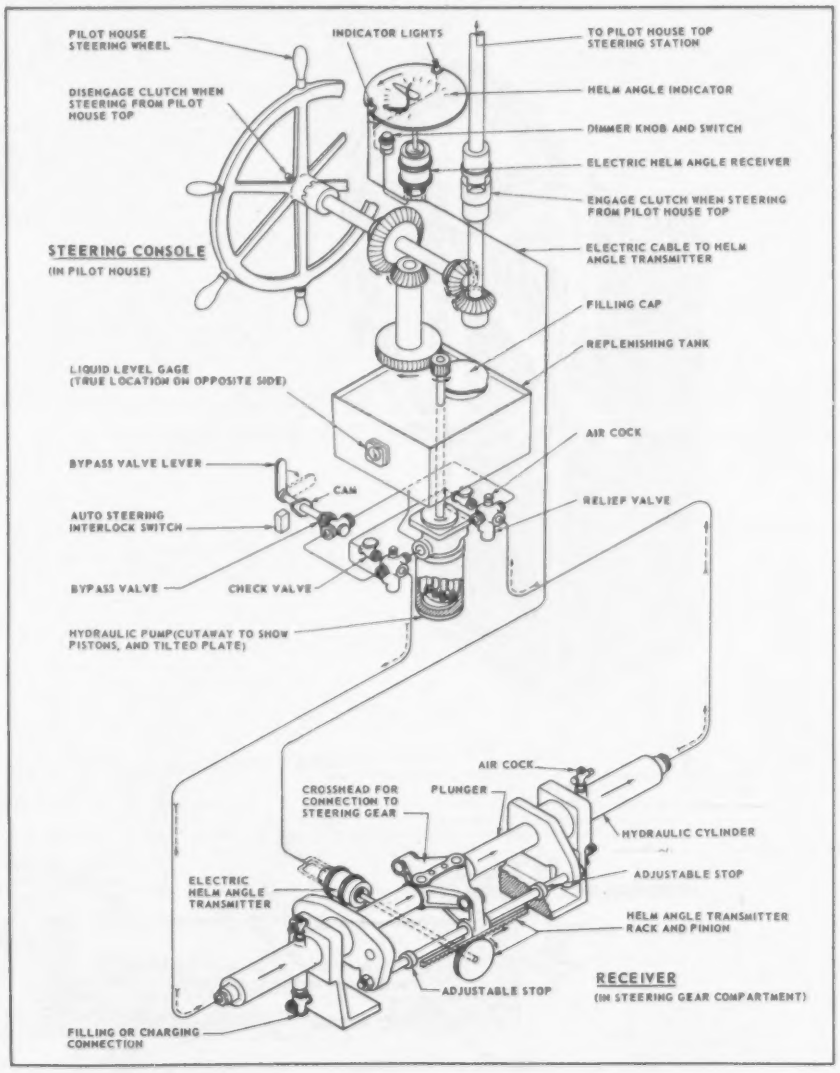

Figure 13-7.—Hydraulic telemotor control—Continued.
(B) Hydraulic circuit diagram; (C) schematic.

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COOPERATIVE EXTENSION WORK IN AGRICULTURE & HOME ECONOMICS STATE OF ARIZONA

The University of Arizona, College of Agriculture, and U. S. Department of Agriculture cooperating

SOUTHWESTERN COTTON RUST

Cause

Southwestern cotton rust, Puccinia stakmanii, has been known in Arizona since 1922. Relatively mild in most years, it has caused considerable damage in certain years. Severe attacks occurred in Cochise County in 1959 and 1960. During these years yields were reduced one-quarter to one-half bale per acre on many farms as a result of leaf shed and boll damage. Serious outbreaks have also occurred in Pima and Santa Cruz Counties.

Look for rusted grama grass

The cotton rust fungus overwinters on grama grass (Fig. 1) and when favorable conditions are present, spores are produced which can be carried in the air to cotton. Severity of rust on cotton is related to the nearness and amount of rusted grama grass around cotton fields. Since there are thousands of spores on each rusted grass stem, heavy stands of infected grama may not be needed if weather conditions are favorable.

Fig. 1. Overwintering spores are found on grama grass.

Rust on cotton follows rain

Rainfall, followed by a period of high humidity, is needed to spread the fungus from grama grass to cotton. The first light showers, which may occur late in June or early July, are not effective in spreading the rust, but do prepare the spores for germination. Normally a rainfall of 1/2 inch or more followed by 12 - 18 hours of high humidity is needed for any sizeable amount of rust to develop.

Small yellow spots about the size of a pinhead will begin to appear on the upper surface of cotton leaves about one week after a large rainfall. These spots enlarge and soon yellow spores begin to appear on the bottom of the leaf (Fig. 2). The boll may also be infected (Fig. 3).

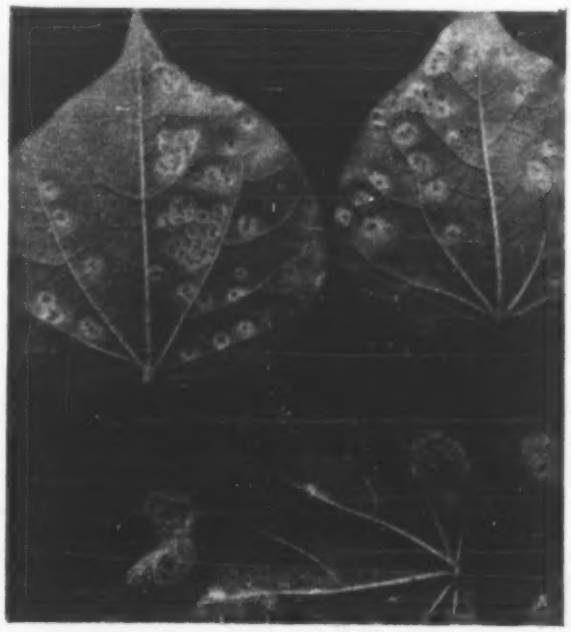

Fig. 2. Yellow spore masses on bottom of leaves.

Control of rust

Zineb is very effective in controlling Southwestern cotton rust, but it must be applied before the cotton becomes infected with the rust. This means that the spray schedule must start before the rains begin in July. The first spray should be applied in early July. Two additional sprays should be applied at 12 to 15 day intervals.

provide a source of power for the many devices required for successful missile flight. Some of the APS systems rely on the main combustion chamber as the initial source of power. Others have their own energy sources completely separate from the main propulsion unit. Whatever the initial source of energy, APS systems may be broken down in two broad categories—static and dynamic. In the static systems, energy is used in the same form in which it is stored. In the dynamic systems, energy is changed from one form to another by a conversion unit.

There are several general requirements for an APS system. First, the system must be able to deliver the necessary power during all conditions of missile flight. Second, the system must be able to respond quickly and accurately to demands made on it. Third, the system must be of minimum size and weight consistent with the requirements it must meet. Fourth, the system must be durable enough to withstand long storage under severe conditions.

BASIC SYSTEMS

As previously mentioned, the static APS systems use energy in the same form in which it is stored. Compressed air may be used directly to operate control system components. Static systems require no rotating machinery for energy conversion.

In dynamic systems, energy is changed from one form to another. For example, the potential energy of compressed air may be changed to electrical energy through an air-driven turbine and electric generator. Air motors or air turbines may be used to drive hydraulic energy transfer units. Figure 13-8 shows a basic pneumatic APS system. The air is led from the air flask through a pressure reducer and then to the air motor or air turbine.

Hydraulic fluid is also used extensively in guided missiles to transfer energy. An example is shown in figure 13-9. Compressed air or hot gas is used to exert pressure against a piston, and hydraulic fluid is then used to operate loads such as the control surfaces.

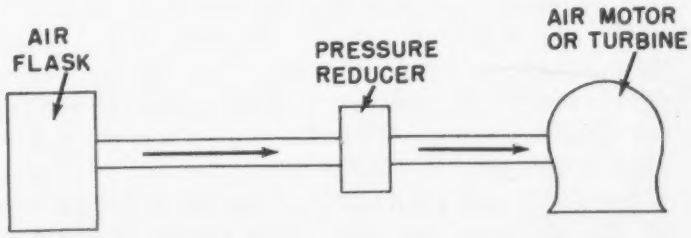

Figure 13-8.—Basic pneumatic system.

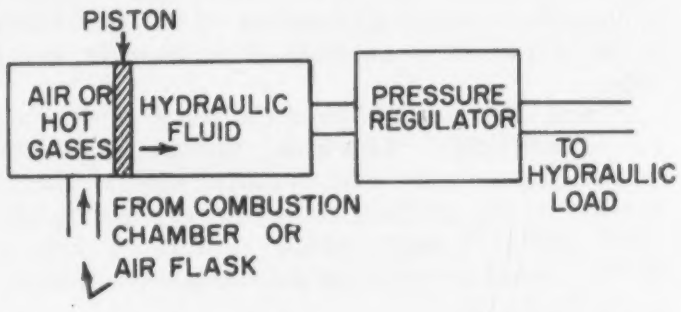

Figure 13-9.—Air or hot gases working against hydraulic piston.

The hydraulic fluid contains no energy in itself, but merely provides a means of transferring energy within a mechanism. Since, for all practical purposes, hydraulic fluid is noncompressible, it can be used to transfer energy with negligible losses. In addition to the air or hot gas method previously mentioned, axial and radial piston pumps, driven by turbines, are commonly used in guided missiles.

MISSILE CONTROL

A missile guidance system keeps the missile on the proper flightpath from launcher to target, in accordance with signals received from control points, from the target, or from other sources of information. The missile control system keeps the missile in the proper flight attitude.

Like an aircraft, whenever a missile changes its attitude in flight, it must turn about one or more of three axes. These axes are imaginary lines passing through the missile. The axes of a missile can be considered as imaginary axles around which the missile turns like a wheel. At the center, where all three axes intersect, each is perpendicular to the other two. The axis which extends lengthwise through the missile from the nose to the tail is called the longitudinal axis. The axis which extends crosswise, from one side to the other is called the lateral axis. The axis which passes through the center, from top to bottom is called the vertical axis.

Motion about the longitudinal axis resembles the roll of a ship from side to side. In fact, the names used in describing the motion about

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the three axes of a missile were originally nautical terms. They have been adapted to aeronautical terminology because of the similarity of motion between an aircraft or missile, and a ship.

Thus, the motion about the longitudinal axis is called roll. Likewise, motion along the lateral (crosswise) axis is called pitch. This is similar to the pitching motion of an ocean vessel as it plows in heavy seas. Finally, a missile moves about its vertical axis in a motion which is termed yaw.

The missile control system keeps the missile in the proper flight attitude by controlling the movements—roll, pitch, and yaw—around the corresponding axes—longitudinal, lateral, and vertical.

Methods of Control

Some missiles are controlled by control surfaces similar to aircraft. The ailerons control roll about the longitudinal axis; the elevator controls pitch around the lateral axis; and the rudder controls yaw about the vertical axis. Jet vanes, movable jets, and fixed steering jets, are also commonly used for control of missiles. The control surface method is presented here because it illustrates the basic principles of control functions.

Types of Control Systems

Regardless of which method is used in controlling the attitude of the missile in flight, the latent power is drawn from one of the auxiliary power systems previously described. The power is transmitted from the supply sources to the movable controls by pneumatic means, by electrical means, by mechanical means, or by using a hydraulic transfer system in conjunction with the other sources. Pneumatic and hydraulic systems are described in the following paragraphs.

PNEUMATIC.—In a pneumatic system, air from a pressurized source passes through lines, valves, and pressure regulators to the transfer (directional control) valve where it is directed to the actuator. The pressurized source generally consists of high pressure air, or nitrogen stored in flasks or bottles.

The pneumatic system does not re-use its transfer medium after it has performed work. For that reason, the air must be stored at a pressure much higher than that necessary for actuating the load in order to maintain adequate system pressure as the stored air supply diminishes.

Figure 13-10 illustrates two double-acting piston type pneumatic actuators used for rudder and elevator control. The air transfer valve is mechanically linked to an air relay (not shown) which receives the air error signal produced by deviations in yaw of the missile. The relay action is such that both force and sense of the error signal are transmitted to the air valve. Thus, the initial direction of displacement of the air transfer valve is determined by the sense of the error signal. Assume that a yaw deviation has occurred, and that the error signal from the air relay has caused the air transfer valve to move toward the right, thus opening the right port of the actuating cylinder. Air from the high-pressure inlet passes through this port and causes the actuator piston rod to move toward the left. Simultaneously, air is forced from the left-hand section of the actuator cylinder through the port located in that section. This displaced air is exhausted into the atmosphere through the air transfer valve exhaust port located at the left end of the air transfer valve.

The actuator piston motion is transmitted through the mechanical linkage to the rudder, which applies corrective control in the proper direction to bring the missile back to the desired yaw position. As the piston moves, it exerts a force on the followup spring. The followup spring is a calibrated coil spring connected between the piston rod and the air transfer valve. Movement of the piston puts the spring in a state of tension or compression, depending upon the direction of piston displacement. In either state, the followup spring exerts a force on the air transfer valve which opposes the force exerted by the air relay. Thus, the air transfer valve movement is the difference of two forces and is in the direction of the resultant force. Movement of the actuator piston continues until the force exerted by the followup spring is equal, but opposite in direction, to the force exerted on the air transfer valve by the air relay. When this condition is established, the air transfer valve spool is centered, and actuator piston movement stops. With the air transfer valve thus balanced, air leaks past the air transfer valve spool and puts equal pressure on both sides of the actuator piston. This action holds the piston, and the rudder to which it is linked, in

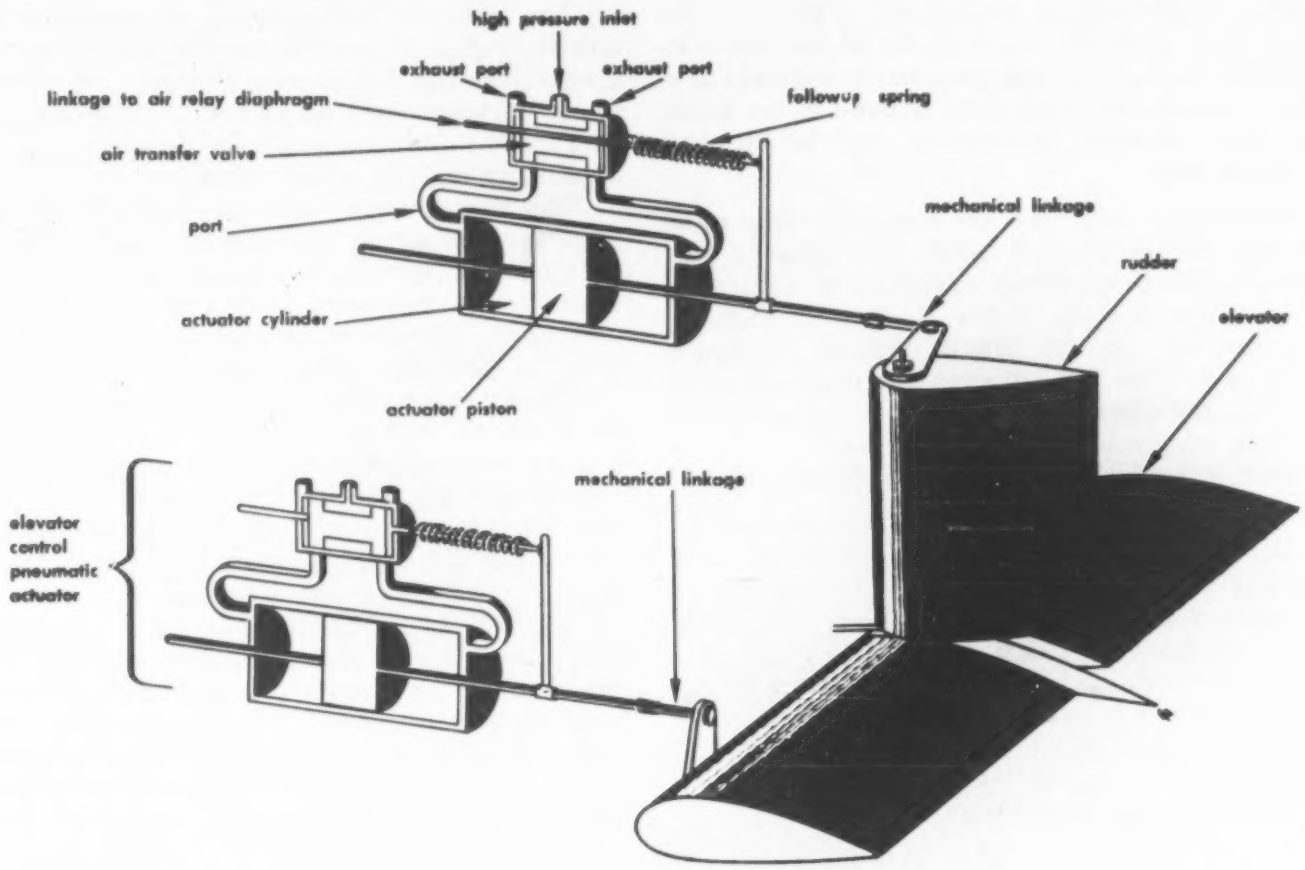

Figure 13-10.—Pneumatic control system.

the corrective position ordered by the air error signal.

The force applied to the rudder causes the missile to turn toward the desired flight attitude. Since the missile is now moving in a direction which is opposite to that during off course displacement, an opposing air rate signal is applied to the air relay. This air signal reduces the force that the air relay is exerting against the air transfer valve. As the missile approaches normal attitude in yaw, the force exerted by the followup spring is greater than that exerted by the air relay. Now the air transfer valve moves to the left and air from the high-pressure inlet forces the actuator piston toward its neutral position; that is, the direction of motion of the piston is now from left to right. This action results in partial removal of the control force applied to the rudder. As the amount of control is reduced, the force exerted by the followup spring is reduced. Therefore, the rate of turn and consequently the rate signal are also reduced. Thus, all forces are continually being reduced as the missile approaches normal attitude. When normal attitude is regained, the air signal is zero, the followup spring force is zero, and the actuator piston and rudder are again centered. All movement ceases until the missile again deviates in yaw due to air gusts or its own flight characteristics.

The elevator control actuator, shown in figure 13-10, operates exactly the same as the rudder except for the manner in which the mechanical linkage is connected to the elevator. The elevator provides pitch control. A similar arrangement is used to operate ailerons for roll control.

PNEUMATIC-ELECTRIC.—The pneumatic control system just described can be combined with other systems to refine the control action. Electric signal pickoffs are accurate and dependable. They can provide a signal voltage that is proportional to displacement. They have a decided advantage over pneumatic systems in transporting information over wires, instead of through tubing.

It is difficult to design a small electric motor with sufficient speed and power to actuate

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missile flight control surfaces. Figure 13-11 illustrates a control system in which the best features of electric and pneumatic systems are used. Electrical equipment is used in the front end and actuates pneumatic servos at the actuating end.

Pneumatic controls are comparatively slow because air is compressible, and time is required to build up enough pressure in a cylinder to move the piston. Since the piston is linked mechanically to the flight control surfaces, there is a time lag between the control signal and the movement of the control surface. But the slow response can be speeded up by adding a booster cylinder, as shown in figure 13-11.

The increase in response speed is obtained by allowing air to escape, through ports, into a relief valve after the servo valve has moved a certain distance from midposition. The relief valve lets high-pressure air into the boost cylinder, which then acts in parallel with the actuator cylinder to move the flight control surfaces. The additional force provided by the boost cylinder makes it possible to obtain large control surface deflections in either direction.

The sensors for a pneumatic-electric system are electric pickoffs that detect gyro displacement and produce a voltage proportional to the heading deviation angle. This voltage is small and must be amplified before it can operate a solenoid and air servo valve.

The change from electric to pneumatic operation takes place at the air servo valve. The air servo motor rotates the torque tubes which are connected to the control surfaces and extend into the center section of the missile. This system may be used for either pitch or yaw control.

The servoamplifier receives a followup signal from the control surface through mechanical linkage and electrical voltage. The feedback voltage cancels the input voltage when the control surfaces have deflected a certain amount. The deflection of the control surfaces is therefore proportional to the input signal.

HYDRAULIC-ELECTRIC.—This combination is similar to the pneumatic-electric, except that the actuators are moved by hydraulic fluid pressure instead of air pressure. This removes some of the disadvantages of a pneumatic system, since the fluid is not compressible. The hydraulic-electric method of control

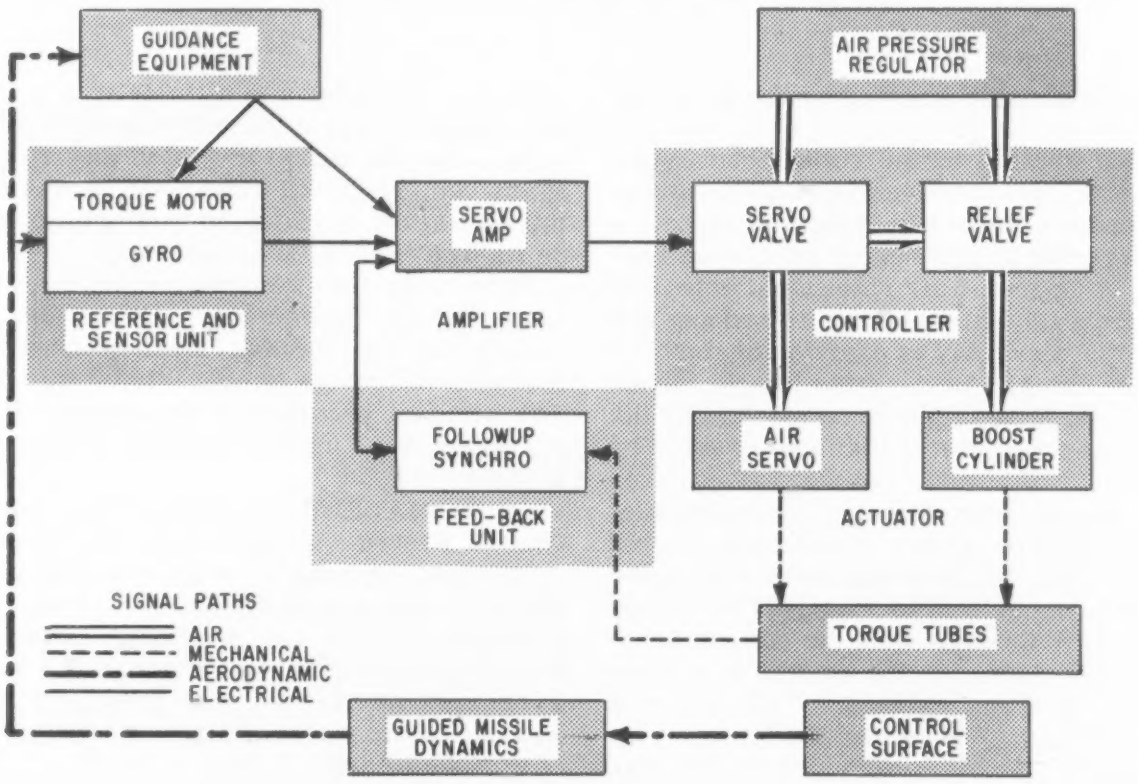

Figure 13-11.—Pneumatic-electric control system.

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is used more than any other types of system. The most important advantages of this type system are the high speed of response and the large forces available when using hydraulic actuators.

Figure 13-12 illustrates a simplified block diagram of a hydraulic-electric controller. This system is composed of the following components:

1. A reservoir, which contains the supply of hydraulic fluid.
2. A motor, as a source of power for the pump. It may be either an electric or air motor.

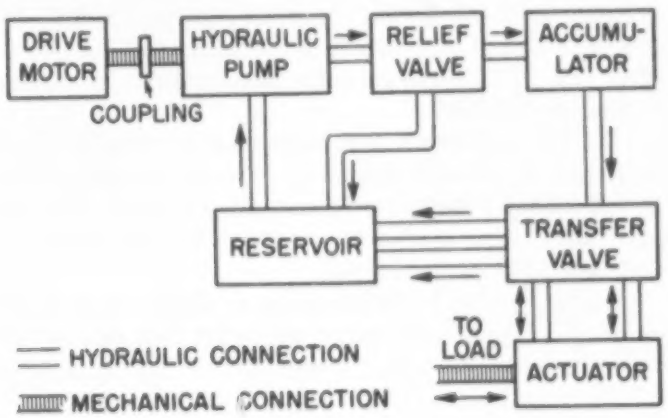

Figure 13-12.—Basic hydraulic controller.

3. A pump, to move the fluid through the system.
4. A relief valve, to prevent excessive pressure in the system.
5. An accumulator, which acts as an auxiliary storage space for fluid under pressure, and as a dampening mechanism which smoothes out pressure surges within the system.
6. A transfer (directional control) valve, which controls the flow of fluid to the actuator. In some systems of this type a servo valve is used instead of a transfer valve. The servo valve provides finer control.

Variations in pitch, roll, and yaw are sensed by gyro reference units with electrical pickoffs. The pickoff voltages are fed to amplifiers and computers and are then used to operate a controller. The controller, a hydraulic transfer or servo valve regulates the amount and direction of flow to the actuator.

Figure 13-13 shows a hydraulic-electric system for roll control. The system uses proportional control only, which means that the controls react to information that shows the deviation of the missile axis from the desired flightpath. The displacement signal is proportional to the deviation.

Should roll develop, the gyro will detect it and cause the synchro to produce an error signal. The correction signal to the servoamplifier is

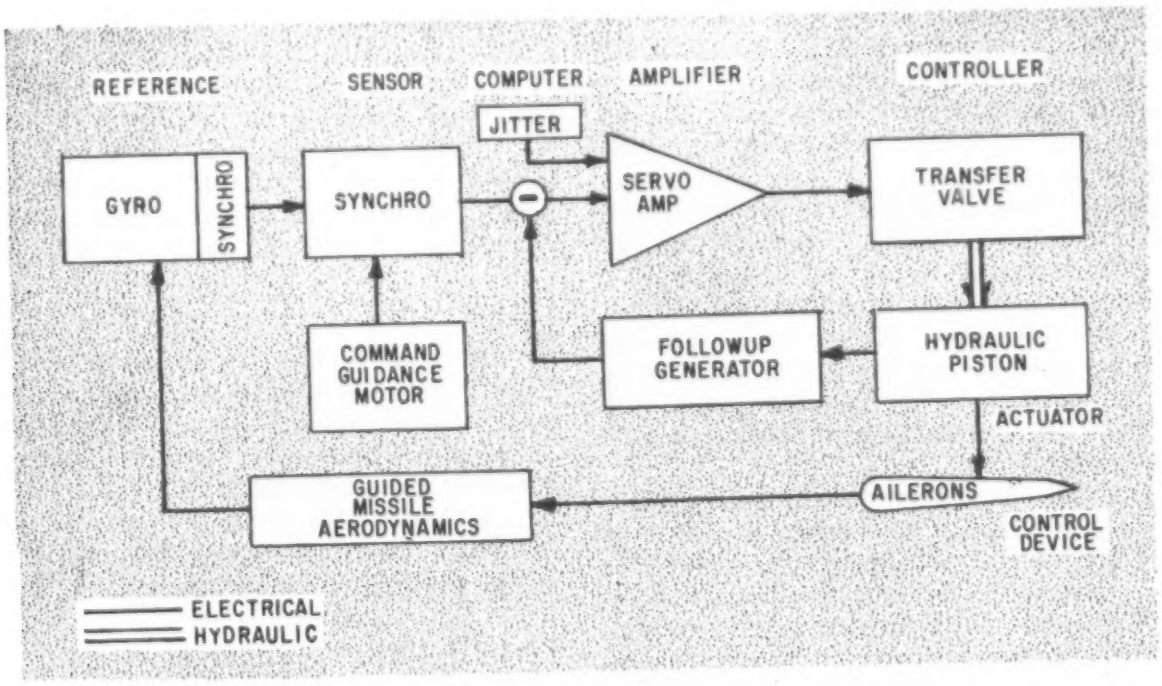

Figure 13-13.—Hydraulic-electric system for roll control.

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the difference between the followup signal and the gyro signal, as indicated by the minus sign in the circle between the synchro block and the servoamplifier triangle.

The difference signal is amplified and used to operate the transfer valve and regulates the flow of fluid to the actuator. This piston in this actuator operates the ailerons (or other roll devices) through mechanical linkage.

The equipment represented by the block labeled "jitter" provides an a-c voltage with a frequency of about 25 cycles per second. This is applied to the transfer valve and other equipment, to keep them in constant vibration and prevent the friction that may develop when the parts are not moving.

AIRCRAFT FLUID POWER SYSTEMS

All modern naval aircraft contain hydraulic systems for the operation of various mechanisms. The number of hydraulically operated units depends upon the model of aircraft. At the present time, the average operational aircraft has a dozen or more hydraulically operated units. Many aircraft are equipped with pneumatic systems for the operation of certain mechanisms. The pneumatic system is also utilized as an emergency system in case of hydraulic system failure.

A complete aircraft hydraulic or pneumatic system consists of a power system and any number of actuating systems (subsystems), the number of actuating systems depending upon the design of the aircraft.

The power system is generally considered to include the fluid supply (reservoir or air bottles), power supply (pump or compressor), and all other components leading up to, but not including, the selector (directional control) valves. The selector valves direct the flow of fluid to the various actuating units, and each selector valve is considered a part of its related actuating system.

The hydraulic and pneumatic systems of a modern fighter aircraft are described in this section. Only the power systems are described in detail. Most of the actuating systems, which are indicated in the illustrations, are controlled by solenoid operated four-way selector valves. The actuators are piston type actuating cylinders or, in some subsystems, fluid motors.

HYDRAULIC SYSTEMS

Current aircraft hydraulic system specifications require two separate systems for operating the flight controls. All aircraft which utilize hydraulically actuated flight controls have at least two hydraulic power systems, one of which supplies fluid pressure to the utility or normal system in addition to the flight controls. The utility system operates the landing gear, wing fold, wheel brakes, and other such units. Most manufacturers refer to the systems supplying pressure only for the flight control surfaces as the power control systems. If there are three hydraulic power systems, they are generally referred to as power control system 1 (PC-1), power control system 2 (PC-2), and utility system. Each system has its own reservoir, power pump, and lines.

Power systems are designed to produce and maintain a given pressure. The pressure output of the Navy's high performance aircraft is 3,000 psi. However, some aircraft hydraulic systems operate at only 1,500 psi.

Figure 13-14 illustrates a utility hydraulic system. This particular aircraft has two other independent hydraulic systems for the operation of the flight controls. All three systems operate at 3,000 psi. A description of the utility power system components and their functions follows.

Reservoir

The reservoir is the source from which the hydraulic pumps draw their supply of fluid, and a storage container for the return fluid displaced by the actuating components. The reservoir is liquid-pressurized. This insures a supply of fluid to the pumps at all times.

Pumps

The flow of fluid to the system is provided by two variable displacement axial piston pumps, one mounted on each engine. Each pump has an integral compensator that regulates volume delivery in accordance with system flow demands. The flow from the pump is ported to a manifold line from which branch lines lead off to the various actuating systems.

Check Valves

Check valves near the pump pressure ports prevent any backfeed of system pressure against

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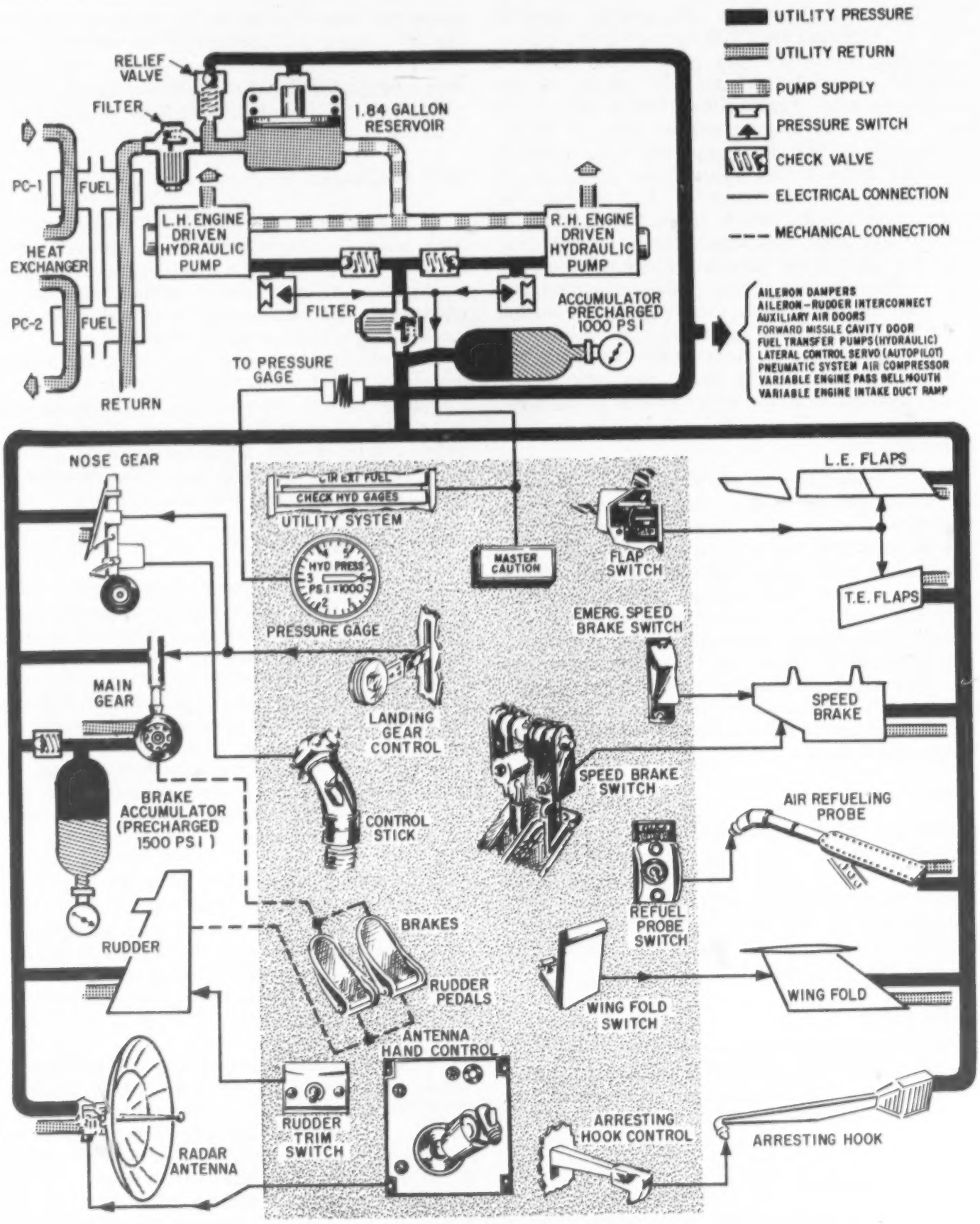

Figure 13-14.—Aircraft hydraulic system.

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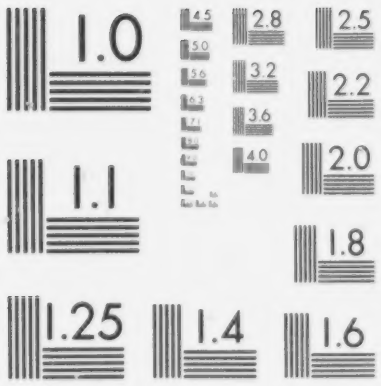

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the pump output and prevent pressure supplied from an external hydraulic power source from attempting to motor the pump (rotating it in reverse), possibly shearing or damaging the pump-to-engine drive spline. Check valves are installed in the system return lines to direct return flow back to the reservoir and to prevent pressure from acting against the return ports of other system components. A check valve is incorporated in the line to the brake system. In normal operating conditions, the check valve allows free flow from the system to the brake system. When system pressure drops below 1,500 psi, the check valve is forced closed from the 1,500 psi accumulator pressure. This maintains a limited amount of fluid under pressure for brake operation during peak demands of the utility system or in the event of system failure.

Accumulators

An accumulator is installed in the manifold line to dampen pump pulsations, which maintains smoothness of system operation. In addition, this accumulator assists the pumps by providing the system with a limited amount of fluid and pressure during peak system power demands. (The function of the accumulator in the brake system was described under check valves.)

Accumulator servicing is accomplished via the connecting air charge valve. The attached pressure gage is used to check the accumulator air charge and to determine the degree of system pressurization.

Filters

Filters are installed in both the system pressure and return lines. The filter elements are of the micronic type. A filter bypass valve allows fluid to flow through the top of the filter instead of the filter element should the element become clogged. Filters are also installed in various actuating systems.

Relief Valve

A system relief valve is installed in the system to protect it from detrimental pressure surges and to limit system pressure buildup in excess of 3,850 psi, by dumping the fluid to return.

Pressure Switches

There are two pressure switches installed in the utility system. They are installed in the pressure lines leading from the pumps and are isolated from one another by the check valves. When the pressure from one or the other pump drops below 1,500 psi the pressure switch completes an electrical circuit that illuminates a warning light in the cockpit.

Heat Exchanger

The heat exchangers are honeycomb radiators, similar to an automobile radiator, located in the fuel tanks. The hydraulic fluid returning to the reservoir is routed through the heat exchangers. The heat energy is transferred from the hydraulic fluid to the cooler fuel.

The utility power system provides fluid under pressure for those actuating systems indicated in figure 13-14. The number of actuating systems vary in different types of aircraft. The PC-1 and PC-2 systems are similar to the utility system and provide fluid under pressure for the operation of the flight control systems.

PNEUMATIC SYSTEMS

The pneumatic power system supplies compressed air for various normal and emergency pneumatic actuating systems. The compressed air is stored in storage bottles in the actuating systems until required by actuation of the system. These bottles and the power system manifold lines are initially charged with compressed air or nitrogen from an external source through a single air charge valve. In flight, the air compressor replaces the air pressure and volume lost through leakage, thermal contraction, and system operation.

The pneumatic system provides power for the normal operation of the cockpit enclosures and emergency operation of such components as landing gear extension and the brake system. The number of normal and emergency systems operated by the pneumatic systems vary in different model aircraft.

The emergency operation is controlled by a three-way spool type selector valve. Usually, the valve is manually operated from the cockpit through mechanical linkage. The compressed air flows into the shuttle valve which is in the working line of the hydraulic system. The air pressure forces the shuttle valve to close the hydraulic inlet port. The air then flows to the actuator.

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The air compressor is supplied with supercharged air from the engine air system. This insures an adequate supply of air to the compressor at all altitudes.

The air compressor may be driven by an electric motor or a hydraulic motor. The system described in this section is hydraulically driven. (See fig. 13-15.)

Power Supply

The aircraft utility hydraulic system provides power to operate the hydraulic motor driven compressor. The air compressor hydraulic actuating system consists of a solenoid-operated selector valve, flow regulator, hydraulic motor, and check valve. When energized,

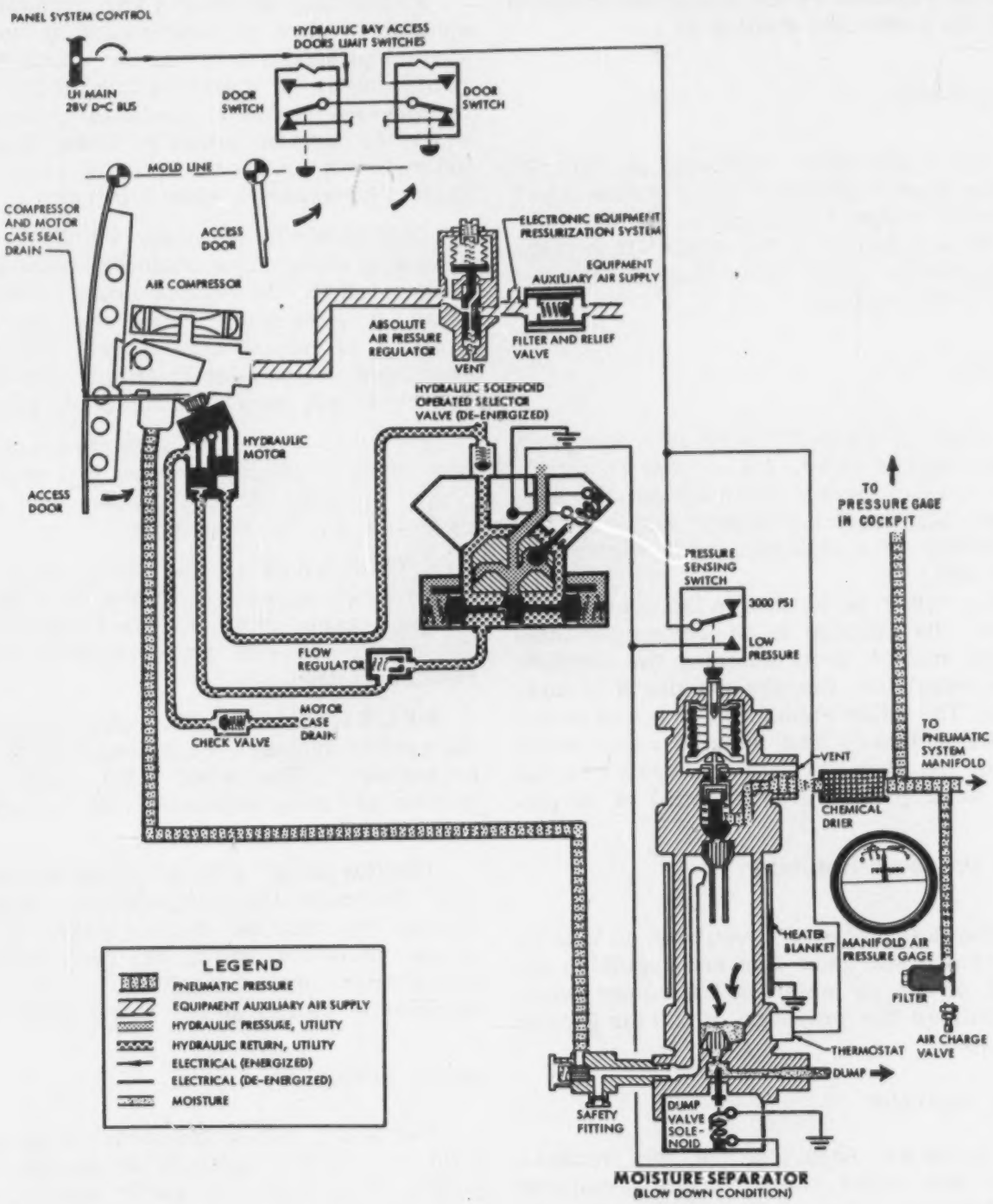

Figure 13-15.—Pneumatic power system.

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Zineb may be obtained in three different forms; less plugging of spray nozzles occurs when the wettable powder form (Dithane Z-78) is used. If the wettable powder is used, two pounds of the material plus a suitable sticker spreader in 40 gallons of water should be applied per acre.

Compatibility charts indicate zineb may be mixed with most insecticides; however, this should be checked with your insecticide salesman. If insecticides are mixed with zineb, they should be added to the tank mixture last.

Application should be made with a ground sprayer having three to five nozzles per row for thorough coverage. Side nozzles should be placed at 45° forward in line of travel and angled up or down depending on location.

Fig. 3.

None of the fungicides tested thus far will eradicate the fungus or alter its normal development once the fungus is established in the tissues of the cotton plant. Therefore, for successful control of cotton rust it is necessary to have the protecting fungicide on the plant before the infective spores come in contact with the cotton plant.

Prepared from information supplied by Dr. Lester M. Blank, Agri. Research Service, U.S.D.A., and Mr. Emroy Shannon, Research Associate, Dept. of Plant Pathology, University of Arizona.

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flames or hot particles, which could result in an explosion, and to relieve excessive pressure buildups.

The flame arrester, a cylindrical shaped fine mesh steel screen, is placed immediately inside of the safety fitting inlet port. Its purpose is to prevent the passage of flame or hot carbon particles, emanating from a buildup of carbon deposits in the air compressor. The stainless steel rupture disc is designed to burst and relieve excessive pressures (4,750 psi), to prevent a shrapnel-like explosion of the moisture separator.

Chemical Drier

A chemical drier further reduces the moisture content of the air emerging from the moisture separator.

Air Charge Valve

The air charge valve provides the entire pneumatic system with a single external servicing point. An air pressure gage, located near the air charge valve, is used in servicing the system. This gage indicates the system pressure.

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APPENDIX I

GLOSSARY

ABSOLUTE PRESSURE.—Actual pressure (includes atmospheric pressure).

ABSOLUTE TEMPERATURE.—The temperature measured using absolute zero as a reference. Absolute zero is -273.16° C or -459.69° F.

ACCELERATION.—Time rate of change of velocity.

ACCUMULATOR.—A device for storing liquid under pressure, usually consisting of a chamber separated into a gas compartment and a liquid compartment by a piston or diaphragm. An accumulator also serves to smooth out pressure surges in a hydraulic system.

ACTUATING CYLINDER.—An actuator which converts fluid power into linear mechanical force and motion.

ACTUATOR.—A device which converts fluid power into mechanical force and motion.

ADDITIVE.—A chemical compound added to a fluid to change its properties.

AFTERCOOLER.—A device which cools a gas after it has been compressed.

AIR BLEEDER.—A device used to remove air from a hydraulic system. It may be a needle valve, capillary tubing to the reservoir, or a bleed plug.

AMBIENT.—Surrounding, such as ambient air meaning surrounding air.

ANEROID.—Containing no liquid, as an aneroid barometer.

BACK PRESSURE.—A pressure exerted contrary to the pressure producing the main flow.

BAROMETER.—An instrument which measures atmospheric pressure.

BERNOULLI'S PRINCIPLE.—If a fluid flowing through a tube reaches a constriction, or narrowing of the tube, the velocity of fluid flowing through the constriction increases and the pressure decreases.

BOYLE'S LAW.—The volume of any dry gas varies inversely with the applied pressure, provided the temperature remains constant.

BUOYANCY.—The upward or lifting force exerted on a body by a fluid.

CALIBRATE.—To make adjustments to a meter or other instrument so that it will indicate correctly with respect to its inputs.

CATALYST.—A substance used to speed up or slow down a chemical reaction, but is itself unchanged at the end of the reaction.

CENTIGRADE.—The temperature scale using the freezing point as zero and the boiling point as 100, with 100 equal divisions between, called degrees.

CENTRIFUGAL FORCE.—A force exerted on a rotating object in a direction outward from the center of rotation.

CHARLES' LAW.—If the pressure is constant, the volume of a dry gas varies directly with the absolute temperature.

CHECK VALVE.—A valve which permits fluid flow in one direction, but prevents flow in the reverse direction.

CHEMICAL CHANGE.—A change which alters the composition of the molecules of a substance. New substances with new properties are produced.

COMPRESSED AIR.—Considered as air at any pressure in excess of the local atmospheric pressure.

COMPRESSIBILITY.—The property of a substance, such as air, by virtue of which its density increases with increase in pressure.

COMPRESSOR.—A mechanical device used for increasing the pressure of a fluid; for example, an air compressor.

CONDENSATION.—The change from a gaseous (or vapor) state to a liquid state.

CONTAMINATION.—Harmful foreign matter in a fluid.

CONTROL.—A means or device used to regulate the function of a unit. For example, valves

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may be controlled hydraulically, manually, mechanically, electrically, or pneumatically. In turn, the valve controls the function of some unit.

CONVERGENT.—That which inclines and approaches nearer together, as the inner walls of a tube that is constricted.

CORROSION.—The slow destruction of materials by chemical agents and electromechanical reactions.

COUNTERBALANCE VALVE.—A valve which permits free flow in one direction, but maintains a resistance to flow in the other direction to prevent a load from falling

DENSITY.—The weight per unit volume of a substance.

DIAPHRAGM.—A dividing membrane or thin partition.

DIFFUSER.—A duct of varying cross section designed to convert a high-speed gas flow into low-speed flow at an increased pressure.

DIRECTIONAL CONTROL VALVE.—A valve which selectively directs or prevents flow to or from desired channels. Also referred to as selector valve, control valve, or transfer valve.

DISPLACEMENT.—The volume of fluid which can pass through a pump, motor, or cylinder in a single revolution or stroke.

DIVERGENT.—Moving away from each other, as the inner walls of a tube that flares outward.

DOUBLE-ACTING CYLINDER.—An actuating cylinder in which both strokes are produced by pressurized fluid.

DYNAMIC PRESSURE.—The pressure of a fluid resulting from its motion, equal to one-half the fluid density times the fluid velocity squared. In incompressible flow, dynamic pressure is the difference between total pressure and static pressure.

EFFICIENCY.—The ratio of output power to input power, generally expressed as a percentage.

ENERGY.—The ability or capacity to do work.

EQUILIBRIUM.—A state of balance between opposing forces or actions.

FAHRENHEIT.—The temperature scale using the freezing point as 32 and the boiling point as 212, with 180 equal divisions between, called degrees.

FEEDBACK.—A transfer of energy from the output of a device back to its input.

FIXED DISPLACEMENT.—The type of pump or motor in which the volume of fluid per cycle cannot be varied.

FLASH POINT.—The temperature at which a substance, such as a fluid, will give off a vapor that will flash or burn momentarily when ignited.

FLOW CONTROL VALVE.—A valve which is used to control the flow rate of fluid in a fluid power system.

FLOWMETER.—An instrument used to measure quantity or the flow rate of a fluid in motion.

FLUID.—Any liquid, gas, or mixture thereof.

FLUID FLOW.—The stream or movement of a fluid, or the rate of its movement.

FLUID POWER.—Power transmitted and controlled through the use of fluids, either liquids or gases, under pressure.

FOOT-POUND.—The amount of work accomplished when a force of 1 pound produces a displacement of 1 foot.

FORCE.—The action of one body on another tending to change the state of motion of the body acted upon. Force is usually expressed in pounds.

FREE FLOW.—Flow which encounters negligible resistance.

FRICTION.—The action of one body or substance rubbing against another, such as fluid flowing against the walls or a pipe; the resistance to motion caused by this rubbing.

FRICTION PRESSURE DROP.—The decrease in the pressure of a fluid flowing through a passage attributable to the friction between the fluid and the passage walls.

GAGE PRESSURE.—Pressure above atmospheric pressure.

GAGE SNUBBER.—A device installed in the line to the pressure gage used to dampen pressure surges and thus provide a steady reading and a protection for the gage.

GAS.—The form of matter which has neither a definite shape nor a definite volume.

GASKET.—A class of seal which provides a seal between two stationary parts.

GRAVITY.—The force which tends to draw all bodies toward the center of the earth. The weight of a body is the resultant of all gravitational forces acting on the body.

HEAD.—A measure of fluid pressure as the height of a fluid column necessary to cause that pressure at its base. The pressure of a fluid owing to its elevation.

HORSEPOWER.—A unit for measuring the power of motors or engines, equal to a rate of 33,000 foot-pounds per minute. The force required to raise 33,000 pounds at the rate of 1 foot per minute.

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HYDRAULICS.—That branch of mechanics or engineering that deals with the action or use of liquids forced through tubes and orifices under pressure to operate various mechanisms.

HYDROMETER.—An instrument for determining the specific gravities of liquids.

IMPACT PRESSURE.—That pressure of a moving fluid brought to rest which is in excess of the pressure the fluid has when it does not flow; that is, total pressure less static pressure. Impact pressure is equal to dynamic pressure in incompressible flow; but in compressible flow, impact pressure includes the pressure change owing to the compressibility effect.

IMPINGEMENT.—The striking or dashing upon with a clash or sharp collision, as air impinging upon the rotor of a turbine or motor.

IMPULSE TURBINE.—A turbine driven by a fluid at high velocity under relatively low pressure.

INERTIA.—The tendency of a body at rest to remain at rest, and a body in motion to continue to move at a constant speed along a straight line, unless the body is acted upon in either case by an unbalanced force.

INHIBITOR.—Any substance which retards or prevents such chemical reactions as corrosion or oxidation.

INTEGRAL.—Essential to completeness, as an integral part. (The valve stem is an integral part of the valve.)

INTERCOOLER.—A device which cools a gas between the compression stages of a multiple stage compressor.

INVERSE PROPORTION.—The relation that exists between two quantities when an increase in one of them produces a corresponding decrease in the other.

KELVIN SCALE.—The temperature scale using absolute zero as the zero point and divisions that are the same size as centigrade degrees.

KINETIC ENERGY.—The energy which a substance has while it is in motion.

KINETIC THEORY.—A theory of matter which assumes that the molecules of matter are in constant motion.

LAMINA.—A layer of fluid.

LAMINAR FLOW.—A smooth flow in which no cross flow of fluid particles occurs.

LINE.—A tube, pipe, or hose which is used as a conductor of fluid.

LIQUID.—A form of matter which has a definite volume but takes the shape of its container.

LOAD.—The power that is being delivered by any power-producing device. The equipment that uses the power from the power-producing device.

MATTER.—Any substance which occupies space and has weight. The three forms of matter are solids, liquids, and gases.

MECHANICAL ADVANTAGE.—The ratio of the resisting weight to the acting force. The ratio of the distance through which the force is exerted divided by the distance the weight is raised.

METER-IN.—To regulate the amount of fluid into a system or an actuator.

METER-OUT.—To regulate the flow of fluid from a system or actuator.

MICRON.—A millionth of a meter or about 0.00004 inch.

MOLECULE.—A small natural particle of matter composed of two or more atoms.

MOTOR.—An actuator which converts fluid power to rotary mechanical force and motion.

NEOPRENE.—A synthetic rubber highly resistant to oil, light, heat, and oxidation.

OSCILLATION.—A backward and forward motion, a vibration.

OXIDATION.—That process by which oxygen unites with some other substance, causing rust or corrosion.

PACKING.—A class of seal which is used to provide a seal between two parts or a unit which move in relation to each other.

PASCAL'S LAW.—Whenever an external pressure is applied to any confined fluid at rest, the pressure is increased at every point in the fluid by the amount of the external pressure.

PERIPHERY.—The outside surface, especially that of a rounded object or body.

PHYSICAL CHANGE.—A change which does not alter the composition of the molecules of a substance.

PILOT VALVE.—A valve used to control the operation of another valve.

PIPE.—That type of fluid line the dimensions of which are designated by nominal (approximate) outside diameter (OD) and wall thickness. (See also TUBING.)

PISTON TYPE CYLINDER.—An actuating cylinder in which the cross-sectional area of the piston rod is less than one-half the cross-sectional area of the movable element.

PLUNGER.—(See RAM TYPE CYLINDER.)

PNEUMATICS.—That branch of physics pertaining to the pressure and flow of gases.

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PORT.—An opening for the intake or exhaust of a fluid.

POTENTIAL ENERGY.—The energy a substance has because of its position, its condition, or its chemical composition.

POWER.—The rate of doing work or the rate of expanding energy.

PRESSURE.—The amount of force distributed over each unit of area. Pressure is expressed in pounds per square inch (psi).

PRESSURE DIFFERENTIAL.—The difference in pressure between any two points of a system or a component.

PRESSURE SWITCH.—An electrical switch operated by the increase and decrease of fluid pressure.

PRIME MOVER.—The source of mechanical power used to drive the pump or compressor.

PUMP.—A device which converts mechanical energy into fluid energy.

RAM TYPE CYLINDER.—An actuating cylinder in which the cross-sectional area of the piston rod is more than one-half the cross-sectional area of the movable element. Also referred to as plunger.

RANKINE SCALE.—A thermometer scale based on absolute zero of the Fahrenheit scale, in which the freezing point of water is approximately 492° R.

RATIO.—The value obtained by dividing one number by another, indicating their relative proportions.

RECEIVER.—A container in which gas is stored under pressure as a supply source for pneumatic power.

RECIPROCATING.—Moving back and forth, as a piston reciprocating in a cylinder.

RELIEF VALVE.—A pressure control valve used to limit system pressure.

RESERVOIR.—A container which serves primarily as a supply source of the liquid for a hydraulic system.

RESTRICTION.—A reduced cross-sectional area in a line or passage which reduces the rate of flow.

RETURN LINE.—A line used for returning fluid back into the reservoir or atmosphere.

SEQUENCE VALVE.—An automatic valve in a fluid power system that causes one actuation to follow another in definite order.

SERVO.—A device used to convert a small movement into a greater movement or force.

SERVOCONTROL.—A control actuated by a feedback system which compares the output with a reference signal and makes corrections to reduce the differences.

SHUTOFF VALVE.—A valve which operates fully open or fully closed.

SHUTTLE VALVE.—A valve which is used to direct fluid automatically from either the normal source or an alternate source to the actuator.

SINGLE-ACTING CYLINDER.—An actuating cylinder in which one stroke is produced by pressurized fluid, and the other stroke is produced by some other force, such as gravity or spring tension.

SOLID.—The form of matter which has a definite shape and a definite volume.

SPECIFIC GRAVITY.—The ratio of the weight of a given volume of a substance to the weight of an equal volume of some standard substance.

STABILITY.—The resistance of a fluid to permanent change in properties due to chemical reaction, temperature changes, etc.

STEADY FLOW.—A flow in which the velocity components at any point in the fluid do not vary with time.

STREAMLINE FLOW.—A smooth, nonturbulent flow, essentially fixed in pattern.

STUFFING BOX.—A chamber and closure with manual adjustment for a sealing device.

SUPPLY LINE.—A line that conveys fluid from the reservoir to the pump.

SURGE.—A momentary rise of pressure in a system.

SYNCHRONIZE.—To make two or more events or operations occur at the proper time with respect to each other.

SYNCHRONOUS.—Happening at the same time.

SYNTHETIC MATERIAL.—A complex chemical compound which is artificially formed by the combining of two or more simpler compounds or elements.

THEORY.—A scientific explanation, tested by observations and experiments.

THERMAL EXPANSION.—The increase in volume of a substance due to temperature change.

TORQUE.—A force or combination of forces that produces or tends to produce a twisting or rotary motion.

TUBING.—That type of fluid line the dimensions of which are designated by actual measured outside (OD) and by actual measured wall thickness.

TURBINE.—A rotary motor actuated by the reaction, impulse, or both, of a flow of

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pressurized fluid. A turbine usually consists of a series of curved vanes on a centrally rotating shaft.

TURBULENCE.—A state of flow in which the fluid particles move in a random manner.

VACUUM.—Pressure less than atmospheric pressure.

VARIABLE DISPLACEMENT.—The type of pump or motor in which the volume of fluid per cycle can be varied.

VELOCITY.—The rate of motion in a particular direction. The velocity of fluid flow is usually measured in feet per second.

VENTURI.—A tube having a narrowing throat or constriction to increase the velocity of fluid flowing through it. The flow through the venturi causes a pressure drop in the smallest section, the amount being a function of the velocity of flow.

VISCOSITY.—The internal resistance of a fluid which tends to prevent it from flowing.

VOLUME OF FLOW.—The quantity of fluid that passes a certain point in a unit of time. The volume of flow is usually expressed in gallons per minute for liquids and cubic feet per minute for gases.

WORK.—The transference of energy from one body or system to another. That which is accomplished by a force acting through a distance.

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APPENDIX II

FILM LIST

MN 1730A Elementary Hydraulics, Part 1—Derivation of Pascal's Law. (16 min.) Applicable to chapter 2.

MN 1730B Elementary Hydraulics, Part 2—Derivation of Pascal's Law. (16 min.) Applicable to chapter 2.

MN 1730C Elementary Hydraulics, Part 1—Application of Pascal's Law. (12 min.) Applicable to chapter 2.

MN 1730D Elementary Hydraulics, Part 2—Application of Pascal's Law. (14 min.) Applicable to chapters 2 and 4.

MN 1730E Elementary Hydraulics—Liquids in motion. (13 min.) Applicable to chapter 2.

MN 1730F Elementary Hydraulics—Characteristics of Hydraulic Fluids. (10 min.) Applicable to chapter 3.

MN 1730G Elementary Hydraulics—Simple Hydraulic Systems. (17 min.) Applicable to chapter 4.

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The University of Arizona, College of Agriculture, and U. S. Department of Agriculture cooperating

TEXAS ROOT ROT OF ALFALFA

Alfalfa is very susceptible to Texas root rot caused by the fungus Phymatotrichum omnivorum. Control of the disease in a perennial crop such as alfalfa is difficult.

Alfalfa, with a tap root penetrating many feet into the soil, is perhaps the best test plant for determining the presence or absence of the root rot fungus. A good, young stand of alfalfa will average several plants per square foot and these penetrate the soil mass so thoroughly that roots will come in contact with any root rot fungus present and infection will take place.

Symptoms

Alfalfa is normally seeded in October in Southern Arizona but usually no trace of root rot, even on heavily infested soil, is seen until the latter part of June of the next year when a few individual plants die suddenly. Adjacent plants soon die in a circular pattern and the circles become larger with each cutting (Fig. 1).

The root rot infection advances from 6 to 15 feet during the growing season. Individual spots are circular initially, but as they enlarge and intersect other spots, the pattern becomes irregular. If root rot is general in the field, the stand may be badly depleted in one year, although occasionally the stand survives for two or three years, but hay yield is

Fig. 1. Plants die in circular pattern. The dead areas enlarge from 6 to 15 feet during a growing season.

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ABSTRACT - Prepared by the Navy Training Publications Center, this training manual is one in a series prepared for enlisted personnel of the Navy who are preparing for advancement to AT3 and AT2. Contents are: (1) Aviation Electronics Technician Rating, (2) Aircraft Maintenance, (3) Safety, (4) Publications, Drawings, and Schematics, (5) Elementary Physics, (6) Electric Power and Cooling Systems, (7) Handtools, (8) Electronic Test Equipment, (9) Electronic Principles, (10) Electronic Circuits, (11) Special Circuits and Components, (12) Servosystems, (13) Electronic Maintenance, (14) Digital Computers, (15) Communication Facilities, (16) Airborne Navigation Equipment, (17) Airborne Radar, (18) Principles of IFF, (19) Electronic Countermeasures, and (20) Infrared Detection. Formulas, Symbols, Greek Alphabet, and laws of exponents are appended. A related document is available as VT 008 298, also in this issue. (GB)

VT 012 789

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AVIATION

ELECTRONICS TECHNICIAN 3 & 2

VT012789

BUREAU OF NAVAL PERSONNEL

RATE TRAINING MANUAL NAVPERS 10317-D

PREFACE

This Rate Training Manual is one of a series of training manuals prepared especially for enlisted personnel of the U.S. Navy and Naval Reserve who are preparing for advancement to AT3 and AT2. Since all personnel seeking advancement to these levels are not held responsible for the entire contents of this training manual, a study guide is included.

The Manual of Qualifications for Advancement, NavPers 18068 (Series), has been used as a guide in the selection of content for this training manual. Trainees should become familiar with the qualifications for advancement prior to starting work on this manual.

Of the 21 chapters in this training manual, 20 are concerned with the technical aspects of the AT rating. Chapter 1 contains introductory information with which the trainee should familiarize himself before studying the other chapters.

Basic Electricity, NavPers 10086 (current edition), and Basic Electronics, NavPers 10087 (current edition), contain essential background information for the AT rating. Some U.S. Armed Forces Institute courses, the content of which are closely related to the AT rating, are listed in the Reading List.

This Rate Training Manual has been prepared by the Navy Training Publications Center, NAS Memphis, Millington, Tennessee, for the Bureau of Naval Personnel. Credit is given to the Naval Air Technical Training Center, located at NAS Memphis, Millington, Tennessee, the Naval Examining Center, Great Lakes, Illinois, and the Naval Air Systems Command for technical reviews.

1969 Edition

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

For trainees that have not had high school algebra and trigonometry.

E 164 Beginning Algebra I
E 165 Beginning Algebra II

or

PA 164-165 Beginning Algebra I - II
(Programed)

For trainees that have had high school algebra and trigonometry.

D 166 Advanced Algebra
D 188 Trigonometry
E 290 Physics I
E 291 Physics II
C 781 Fundamentals of Electricity
B 788 Introduction to Electronics I
B 789 Introduction to Electronics II

"Members of the United States Armed Forces Reserve Components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified in the active-duty orders."

131[illegible]

STUDY GUIDE

The table below indicates the chapters of this manual which particularly apply to your rate.

Chapter	ATN	ATR
1	3	3
2	3	3
3	3	3
4	3	3
5	3	3
6	3	3
7	3	3
8	3	3
9	3	3
10	3	3
11	3	3
12	3	3
13	3	3
14	3	3
15	2	2
16	3	3
17	3	2
18		3
19	3	3
20		3
21	2	2

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greatly reduced. Such fields should not be planted to cotton or other susceptible summer crops without special treatment.

Fig. 2. The tap root rots leaving part of the fibrous center.

Control

If, as is often the case, the root rot infestation is concentrated in one part of the field, and the affected area is large enough to permit the use of farm machinery, the area can be replanted in October. This will not eliminate the root rot organism, but will result in good hay yields until midsummer of the following year. First, apply a two inch layer of manure, straw, spoiled hay or other organic matter to the root rot area. Then sprinkle the organic matter with ammonium sulphate and soil sulphur at the rate of one pound of each to ten square feet. Mix the applied material with the surface soil with a renovator or disc and reseed in October.

If infestation is slight or widely scattered, the above method is impractical. When the yield of hay and/or pasture is no longer profitable, plow up the alfalfa and consider alternative uses of the land. Two possibilities are:

(a) Cotton following a winter manure crop of papago peas as outlined in Root Rot Circular No. 4 which can be supplied by your county agent.

(b) At least a three year rotation with non-susceptible crops such as small grains, sorghums, or Sudan grass or winter crops such as flax, safflower, or winter vegetables. These winter crops are not resistant, but escape the disease which is relatively inactive during winter.

Prepared from information supplied by Dr. R. B. Streets, Department of Plant Pathology, University of Arizona.

Arlen D. Davison

Arlen D. Davison
Extension Specialist
in Plant Pathology

Note: The information given herein is supplied with the understanding that no discrimination is intended and no indorsement by the Arizona Extension Service is implied.

CHAPTER 1

AVIATION ELECTRONICS TECHNICIAN RATING

This Rate Training Manual is designed as an aid in preparing for advancement to Petty Officer Third and Second Class Aviation Electronics Technician. It is based primarily on the professional requirements as specified in the Manual of Qualifications for Advancement, NavPers 18068 (Series), through change No. 4. Therefore, subsequent changes in the qualifications may not be reflected in the information given in this training manual.

Most of the contents of this training manual involves the technical subject matter which the Aviation Electronics Technician must become proficient. Other areas covered include maintenance organization, safety, and publications.

ENLISTED RATING STRUCTURE

The present enlisted rating structure consists of general ratings and service ratings.

General ratings identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Service ratings identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

AVIATION ELECTRONICS TECHNICIAN RATING

The Aviation Electronics Technician rating, at pay grades E-4 and E-5, comprises the two service ratings ATN and ATR. At pay grades E-6 through E-8, there is a single general rating, AT. At pay grade E-9 the Aviation Electronics Technician rating loses its identify; personnel of pay grade E-8 in this rating, along with AECS, AQCS, and AXCS, advance to Master Chief Avionics Technician, AVCM. Figure 1-1 illustrates all paths of advancement for an Airman Recruit to Master Chief Avionics Technician (AVCM), Chief Warrant Officer (W-4), or to Limited Duty Officer (LDO). The advancement paths through the AT ratings are emphasized in the figure. Shaded areas indicate career stages where qualified enlisted men may advance to Warrant Officer (W-1), or selected commissioned Warrant Officers may advance to Limited Duty Officer. Additional information concerning promotion to Warrant or Commissioned Officer is presented later in this chapter.

Aviation Electronics Technicians inspect and maintain aviation electronic equipment except ASW and fire control equipment, including the following: detection, reconnaissance, identification, communication, navigation, display, and special purpose equipment; target drone and pilotless aircraft equipment; and related equipment and test equipment; and operate airborne CIC equipment.

Aviation Electronics Technician N (Radio and Radio Navigation Equipment) inspect and maintain aviation electronic identification, radio communication, and radio navigation equipment including: radio transmitting, receiving, relaying, and direction finding equipment; radio and radar altimeters; electronic interrogating and transponding equipment; distance and time difference measuring equipment; and related equipment and test equipment.

Aviation Electronics Technicians R (Radar and Radar Navigation Equipment) inspect and

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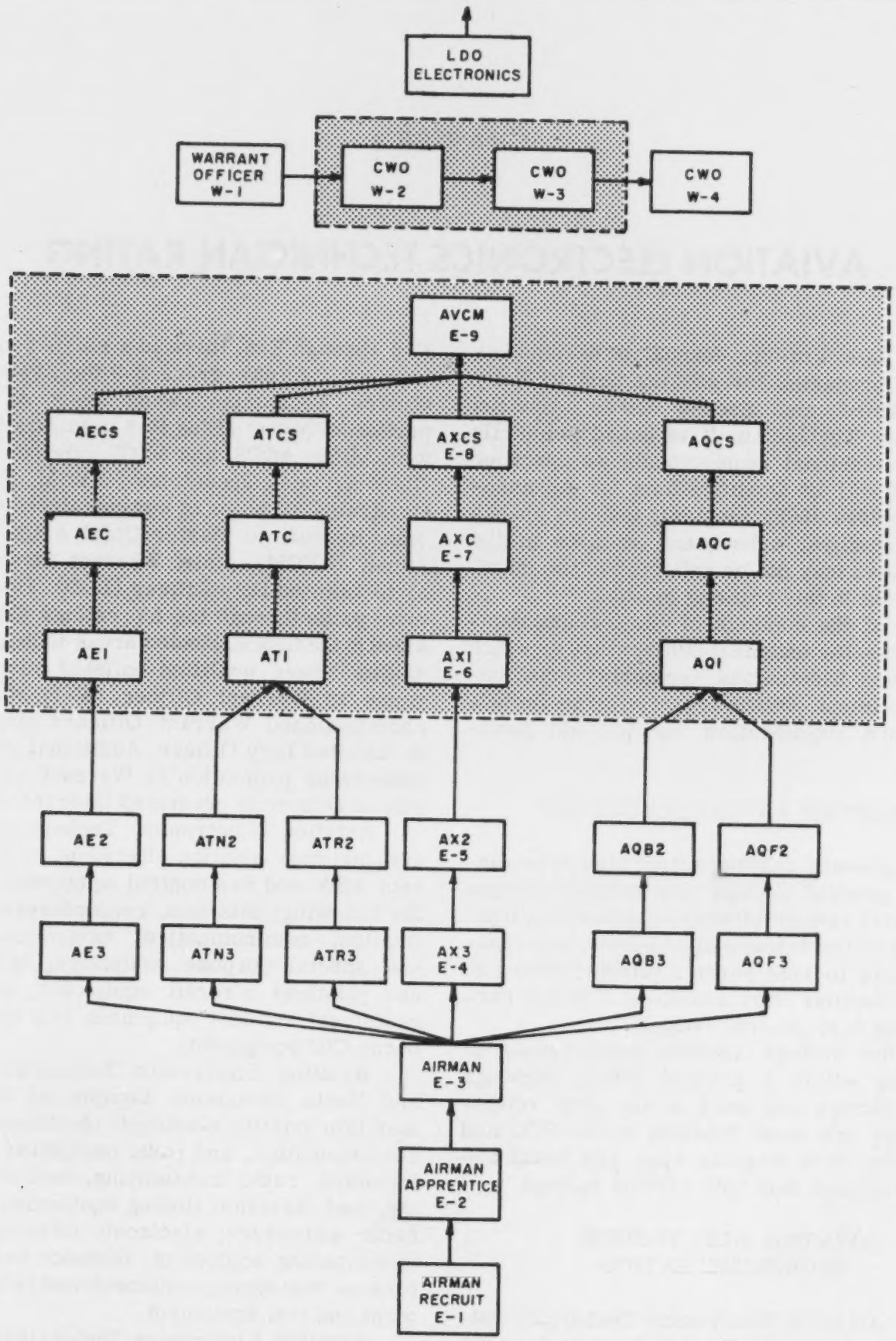

Figure 1-1.–Paths of advancement.

AE.1

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maintain aviation radar and electronic identification equipment, including: radar; radar display and relay equipment; electronic interrogating and transponding equipment; and related equipment and test equipment.

As an Aviation Electronics Technician (N or R) Third Class or Second Class, your assignment possibilities cover a wide range of duties and responsibilities. Your specific duties will depend to a large extent upon the type of organization to which you are assigned. It is probable that you will be assigned to billets which are concerned with the maintenance of electronic and associated equipment within the responsibility of your service rating. As either an ATN or an ATR you may be assigned to any of the several types of aircraft maintenance activities.

In an aircraft squadron, your duties are concerned primarily with the avionics division of the maintenance department. You will work under the supervision of the avionics division chief on all routine maintenance functions and on minor repair of electronic and associated equipments. You will also perform such other duties as may be assigned to you by the avionics officer or his representative. In some squadrons you may be assigned in the capacity of plane captain.

In the aircraft maintenance department (AMD) of a naval air station, you may be assigned duties similar to those in a squadron. You may be assigned to a check crew or to a troubleshooting crew. You may be assigned to a shop for more detailed maintenance than is normally performed by the squadron level activity.

On aircraft carriers you may be assigned to a crew which aids in the incorporation of required changes and modifications in squadron aircraft or electronic equipment. You may be required to perform work involving shop tools and services. You may perform more extensive maintenance than that normally performed by the squadron.

One of the billets available to the ATN2 or ATR2 may be assignments as an instructor in a training activity. Instructor duty may be performed either as a shore duty or as a sea duty assignment. Shore duty instructor assignments in your rate and rating are normally to the Aviation Electronics Technician School at the Naval Air Technical Training Center, Millington, Tennessee. Fleet instructor billets are available at various FAETU (Fleet Airborne Electronics Training Unit) NAMTG (Naval Air Maintenance Training Group), and RCVW (Readiness Air Wing) activities.

FAETU courses are usually concerned with a specific equipment or procedure. NAMTG courses may involve specific procedures, specific equipment, or specific aircraft. RCVW courses are normally concerned with the training of personnel in the operation and maintenance of equipment in new or unfamiliar types of aircraft.

LEADERSHIP

Since you have been in pay grade E-3 or E-4 for some time, you realize that more leadership is required of the higher rates. Not only are you required to have superior knowledge, but you are also required to have the ability to handle personnel. This ability increases in importance as you advance through the various rates as a petty officer.

In General Order No. 21, the Secretary of the Navy outlined some of the most important aspects of naval leadership. By naval leadership is meant the art of accomplishing the Navy's mission through people. It is the sum of those qualities of intellect, of human understanding, and of moral character that enable a man to inspire and to manage a group of people successfully. Effective leadership, therefore, is based on personal example, good management practices, and moral responsibility. The term leadership includes all three of these elements.

The current Navy Leadership Program is designed to keep the spirit of General Order No. 21 ever before you. If the threefold objective is carried out effectively in every command, the program will make you a better leader of men in your present billet and in your future assignments. As you advance up the leadership ladder, more and more of your worth to the Navy will be judged on the basis of the amount of efficient work you obtain from your subordinates rather than how much of the actual work you do yourself.

For information on the practical application of leadership and supervision, study Military Requirements for Petty Officer 3 & 2, NavPers 10056-B.

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ADVANCEMENT

Some of the rewards of advancement are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

The advantages of advancement are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy; and second, you become more valuable as a technical specialist in your own rating.

HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and professional training manuals.
3. Demonstrate your ability to perform all the practical requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Successfully complete the applicable military/leadership examination which is required prior to participating in the advancement (professional) examination.

Some of these general requirements may be modified in certain ways. Figure 1-2 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-3 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

Advancement is not automatic. After you have met all the requirements, you are eligible for advancement. You will actually be advanced only if you meet all the requirements (including making a high enough score on the written examination) and if quotas permit.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement? Advancement is not an overnight affair. One does not take the advancement examination and wake up in the morning in the next pay grade. There is a path or sequence of events which one must pursue. Certain things must be done or accomplished before one is admitted to the advancement in rate examination. To prepare for advancement, you will, need to be familiar with the "Quals" Manual, the Record of Practical Factors, NavPers 1414/1. Training Publications for Advancement, NavPers 10052 (Series), and applicable Rate Training Manuals. The following sections describe them and give you some practical suggestions on how to use them in studying and preparing for the advancement in rate examination.

"Quals" Manual

The Manual of Qualifications for Advancement, NavPers 18068 (Series), gives the minimum requirements for advancement. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: military requirements, and professional (or technical) qualifications.

Military requirements apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all other ratings.

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	# E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3. AME 3, HM 3			Class B for AGC MUC, MNC.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.	Counts toward performance factor credit in advancement multiple.						
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
\# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

Figure 1-2.–Active duty advancement requirements.

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INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam	Standard Exam or Rating Training.	Standard Exam required for all PO Advancements.		Standard Exam, Selection Board. Also pass Mil. Leadership Exam for E-4 and E-5.			
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center		Bureau of Naval Personnel			

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-3.–Inactive duty advancement requirements.

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Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into practical factors and knowledge factors. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rate.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. Study these qualifications and the military requirements carefully. The written examination for advancement will contain questions relating to the knowledge factors and the knowledge aspects of the practical factors of both the military requirements and the professional qualifications. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

The "Quals" Manual is kept current by means of changes which occur from time to time. Never trust any set of "quals" until you have checked the change number against an up-to-date copy of the "Quals" Manual. Be sure you have the latest revision.

Record of Practical Factors

Before you can take the Navy-wide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional qualifications. A special form known as the Record of Practical Factors, NavPers 1414/1 is used to keep a record of your practical factor qualifications. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement and revised forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rate but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, NavPers 1414/1 should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-2 through E-8 for his personal record and guidance.

NAVPERS 10052

Training Publications for Advancement, NavPers 10052 (Series), is a very important publication for anyone preparing for advancement. This bibliography lists required and recommended Rate Training Manuals and other reference material to be used by personnel working for advancement. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be sure that you have the most recent edition.

If extensive changes in qualifications occur between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class. Remember that you are also responsible for the references listed at the third class level.

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In using NavPers 10052, you will notice that some Rate Training Manuals are marked with an asterisk (*). Any manual marked in this way is MANDATORY–that is, it must be completed at the indicated rate level before you are eligible to take the Navy-wide examination for advancement. Each mandatory manual may be completed by passing the appropriate enlisted correspondence course that is based on the mandatory training manual; passing locally prepared tests based on the information given in the training manual, or in some cases, successfully completing an appropriate Class A school.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military requirements for advancement. All personnel must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance.

The references in NavPers 10052 which are recommended, but not mandatory, should also be studied carefully. All references listed in NavPers 10052 may be used as source material for the written examinations at the appropriate rate levels.

Rate Training Manuals

There are two general types of Rate Training Manuals. Rating manuals (such as this one) are prepared for most enlisted rates, giving information that is directly related to the professional qualifications. Basic manuals give information that applies to more than one rate and rating.

Rate Training Manuals are revised from time to time to keep them up to date technically. The revision of a Rate Training Manual is identified by a letter following the NavPers number. You can tell whether any particular copy of a Rate Training Manual is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists current training manuals and correspondence courses; you will find this catalog useful in planning your study program.)

Rate Training Manuals are designed to help you prepare for advancement. The following suggestions may help you to make the best use of this manual and other Navy training publications when you are preparing for advancement.

1. Study the military requirements and the professional qualifications for your rate before you study the training manual, and refer to the "quals" frequently as you study. Remember, you are studying the training manual in order to meet these "quals."

2. Set up a regular study plan. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training manual intensively, become familiar with the entire manual. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the manual without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training manual in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a clear picture of the scope and content of the manual. As you look through the manual in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the qualifications for advancement?

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit–it may be a chapter, a section of a chapter, or a subsection. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit–chapter, section or subsection–write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

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8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without referring to the training manual, write down the main ideas that you have learned from studying this unit. Do not quote the manual. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Rate Training Manuals or on other appropriate texts. As mentioned before, completion of a mandatory Rate Training Manual can be accomplished by passing an Enlisted Correspondence Course based on the Rate Training Manual. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training manuals. Taking a correspondence course helps you to master the information given in the training manual, and also helps you see how much you have learned.

10. Think of your future as you study Rate Training Manuals. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCE OF INFORMATION

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional qualifications of your rating.

Some of the publications described in this manual are subject to change or revision from time to time–some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you perform efficiently or to advance; it is likely to be a waste of time, and may even be seriously misleading.

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CHAPTER 2

AIRCRAFT MAINTENANCE ORGANIZATION

In order to maintain increasingly complex aircraft in their prime operating condition various aircraft maintenance organizations and procedures have been employed throughout the Navy. Prior to and during World War II, it was a general practice for every operating activity to have its own maintenance spaces, equipment, and a complement of maintenance personnel to accomplish all maintenance except overhaul. Due to variance in workload between squadrons, some shops were idle at times and could have been used by maintenance personnel from other squadrons on the same station to accomplish their work.

A combining of talents, efforts, facilities, and equipments for the accomplishment of common tasks was indicated. Through the process of evolution, combining of naval aircraft maintenance personnel and consolidation of maintenance facilities were effected on a Navy-wide basis when the Naval Aircraft Maintenance Program (NAMP) was established.

NAVAL AIRCRAFT MAINTENANCE PROGRAM

The Naval Aircraft Maintenance Program was designed to insure maximum utilization of manpower, material, and equipment and establish standard maintenance procedures and organizations for the accomplishment of maintenance on naval aircraft and associated equipment. The adoption of standard organizations and procedures promotes a high degree of uniformity among all activities in the methods that are used to manage and utilize maintenance personnel, material, and facilities. It results in a decrease in time required to indoctrinate recently assigned personnel.

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The improvement of aircraft readiness is of utmost importance; costly, complex weapons systems and spares demand maximum command attention to the repair of critical items to enable aircraft to be in a ready status. It is therefore mandatory that all maintenance personnel have a thorough knowledge of and abide by the established procedures.

LEVELS OF MAINTENANCE

The task of maintaining naval aircraft in an operationally ready condition ranges from a few minutes of squadron servicing to months of overhaul in a depot level maintenance activity. To more efficiently accomplish maintenance on military aircraft the present concept is to divide the maintenance functions into three distinct levels–depot, intermediate, and organizational. The determination of what maintenance will be performed at each level is governed primarily by the availability and distribution of maintenance equipment and facilities.

Each command and support agency is responsible for continually reviewing the distribution of equipment and facilities to insure that the amount of maintenance performed at the lowest levels is consistent with available skills and personnel.

Organizational Maintenance

Organizational maintenance is the type of work performed by the operating squadron or unit on a day-to-day basis in support of its own operations. Maintenance performed at this level includes (1) inspection, (2) servicing, (3) handling, (4) "on-aircraft" corrective maintenance, including removal and installation of parts and

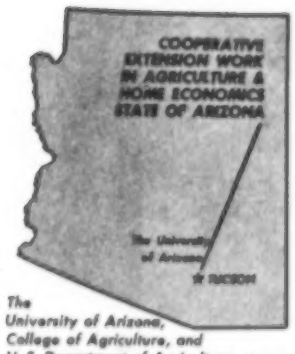

The
University of Arizona,
College of Agriculture, and
U. S. Department of Agriculture cooperating

EUONYMUS POWDERY MILDEW

Powdery mildew on evergreen Euonymus is an unsightly pest and is prevalent in many plantings in Arizona. The disease is caused by the fungus Erysiphe euonymus. Spores which are carried by the wind spread the organism from planting to planting.

Symptoms - The fungus infects leaves of Euonymus and forms a thick white to gray felt on the leaf surface. Some yellowing and defoliation may result.

Control - Sprays of Actidione PM give good control and may be used in hot weather. Follow the label directions. Sulphur dust is also effective, but will burn the foliage when temperatures are above 90°F.

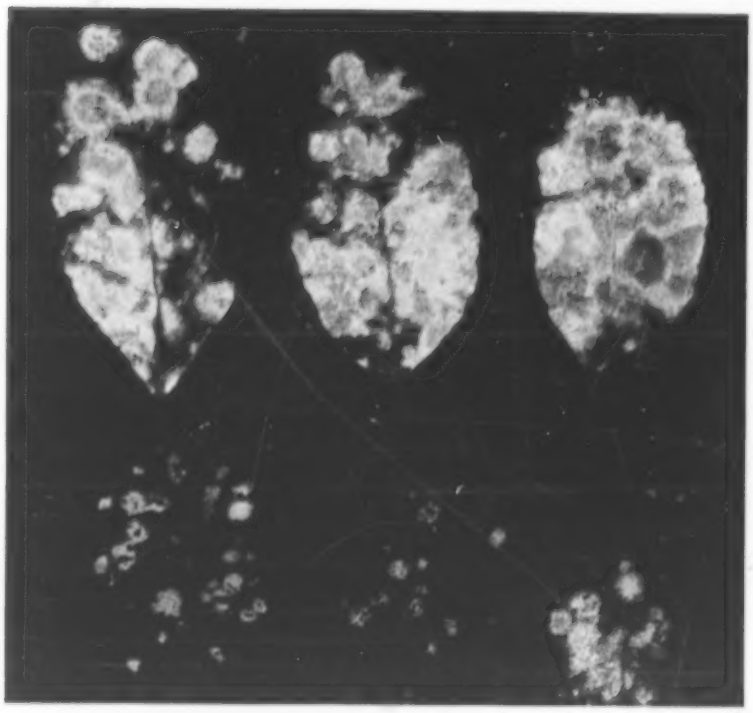

Fig. 1. Mildew may be in scattered spots or covering nearly the entire leaf surface.

Fig. 2. New growth may be severely attacked.

Arlen D. Davison
Arlen D. Davison
Extension Specialist
in Plant Pathology

Note: The information given herein is supplied with the understanding that no discrimination is intended and no indorsement by the Arizona Extension Service is implied.

components, (5) complying with technical directives (when prescribed), and (6) the necessary recordkeeping and reports peculiar to organizational maintenance.

Organizational maintenance in an operating activity is performed by permanently assigned personnel who are not responsible for intermediate maintenance. Organizational maintenance at shore stations (on aircraft assigned to the station) normally is a function of the Operations Maintenance Division (OMD). The OMD also provides organizational maintenance and such other assistance to transiting aircraft as may be directed by higher authority.

Intermediate Maintenance

Intermediate maintenance is that type of work performed in centrally located facilities for the support of operating activities within a designated geographical area, at a particular base or station, or aboard aviation ships. This level of maintenance is assigned for performance to such units as Station or Ships Aircraft Intermediate Maintenance Departments (AIMD), Marine Headquarters and Maintenance Squadrons, etc. Typical of the work performed at this level is shop type repair and test work on aircraft components and equipment from the supported units. Technical assistance, when required, is furnished by personnel of the intermediate maintenance facility to the supported operating activities.

Intermediate maintenance activities are normally manned by a nucleus of permanently assigned personnel and certain designated intermediate maintenance personnel temporarily assigned from the on-board tenant squadrons. When these squadrons deploy from their home stations, their intermediate maintenance personnel accompany them, and are then temporarily assigned to the AIMD if afloat or at their new station.

Depot Maintenance

Depot maintenance is that type of work normally accomplished in an industrial type facility (Naval Air Rework Facilities or contractors' plants.) This level includes overhaul and major repair or modification of aircraft, components, and equipments. It also includes the manufacture of specified aeronautical parts to be stocked as spares and the manufacture of kits for the accomplishment of aircraft and equipment modification. Installation of these spare-parts kits may be done at this or a specific lower level of maintenance.

Navy Depot maintenance activities are manned primarily by civilians. However, some military personnel are usually assigned and assist with the intermediate and organizational type work necessarily connected with the depot facility.

It can be seen from the foregoing that the three aircraft maintenance levels or categories provide for an orderly separation of the various maintenance tasks. The bases for the separation are complexity of the task, equipment and space requirements, the skill level of assigned personnel, and the scope of support responsibility.

AIRCRAFT MAINTENANCE DEPARTMENT ORGANIZATION

The organization for Aircraft Maintenance Departments provide firm lines of authority from the maintenance officer to personnel accomplishing the work for which the department is responsible. The term "department" used in this training manual is used as a general term which applies fully to all maintenance activities having a department head. In cases of maintenance activities assigned as divisions to other departments, the next echelon (division) is used in place of department. Branches become sections, and sections become units.

Major segments of the department are called divisions. Divisions are subdivided into branches and branches are subdivided into sections if necessary. The aircraft maintenance officer manages the department and is responsible to the commanding officer for the accomplishment of the department's mission.

The Aircraft Maintenance Department supports naval operations by the upkeep of assigned and supported aircraft and associated support equipments to the level and depth of maintenance assigned. Specific functions include the following:

1. Periodic maintenance and routine inspection and servicing of aircraft, associated

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support equipment, and aeronautical material and components including the necessary disassembly, cleaning, examination, repair, modification test, inspection, assembly, and preservation.

2. Special work in compliance with technical directives or local instructions.

3. Correction of discrepancies.

4. Assurance of high quality of all work.

5. Maintenance of records and technical publications.

6. Maintenance and custody of tools and other organizational equipment.

7. Training of assigned personnel.

8. Conduct maintenance and ground handling safety programs.

INTERMEDIATE LEVEL ACTIVITY

The primary purpose of intermediate level maintenance is to support and supplement the work of organizational maintenance activities. These functions are normally performed in centrally located areas for the support of operating aircraft on a shore station, aboard a ship, or within a designated area.

The responsibility for intermediate level maintenance is assigned to station aircraft maintenance departments ashore and aircraft intermediate maintenance departments afloat and encompasses the following:

1. Repair and test of aircraft components requiring shop facilities not available in a lower level maintenance activity.

2. Aircraft changes and modifications.

3. Reporting and keeping of records.

Figure 2-1 illustrates an intermediate level maintenance department afloat with their respective work center code numbers.

Figure 2-2 illustrates an intermediate level maintenance department (shore), including work center code numbers. As can be seen in the figure, the activity is composed of staff and production divisions.

Maintenance/Material Control Officer

The Maintenance Material Control Officer is directly responsible to the Maintenance Officer for the management of the overall productive effort of the department. His general responsibilities include but are not limited to the following:

1. Scheduling, coordinating, and monitoring the workload of the department.

2. Maintaining liaison with supported/supporting activities and the local supply department to insure material requirements are fulfilled in order to keep productive capacity compatible with workload requirements.

3. Coordinating the order, receipt, and delivery of material, the administrative screening, scheduling, and control of processed components, and the control and usage of funds provided the department.

In discharging the duties of production control, the Maintenance/Material Control Officer will perform the following:

1. Plan and schedule the workload so as to insure maximum utilization of personnel, material, and resources.

2. Coordinate the actions of the production divisions to insure prompt movement of components through the department.

3. Assign production control numbers, work priorities, due-in and due out dates to the various work centers, and establish maintenance control procedures in order to effectively monitor the daily workload requirements.

4. Maintain technical directive control procedures for the department.

5. Review and approve work requests from supported activities.

6. Maintain files of completed maintenance action forms and work requests (6 months).

7. Maintain the Intermediate Maintenance Control Register.

8. Recommend and control cannibalization in accordance with applicable directives.

9. Submit reports as applicable.

10. Analyze daily and monthly maintenance data reports to ascertain effective utilization of personnel resources.

An assistant to the Maintenance/Material Control Officer will discharge the duties of material control by performing the following:

1. Plan, requisition, and expedite materials to enable the department to perform its mission quickly and effectively.

2. Pass all requirements for material for support of weapons system maintenance to the supporting SSC (Supply Support Center), and maintain a material control register for these items.

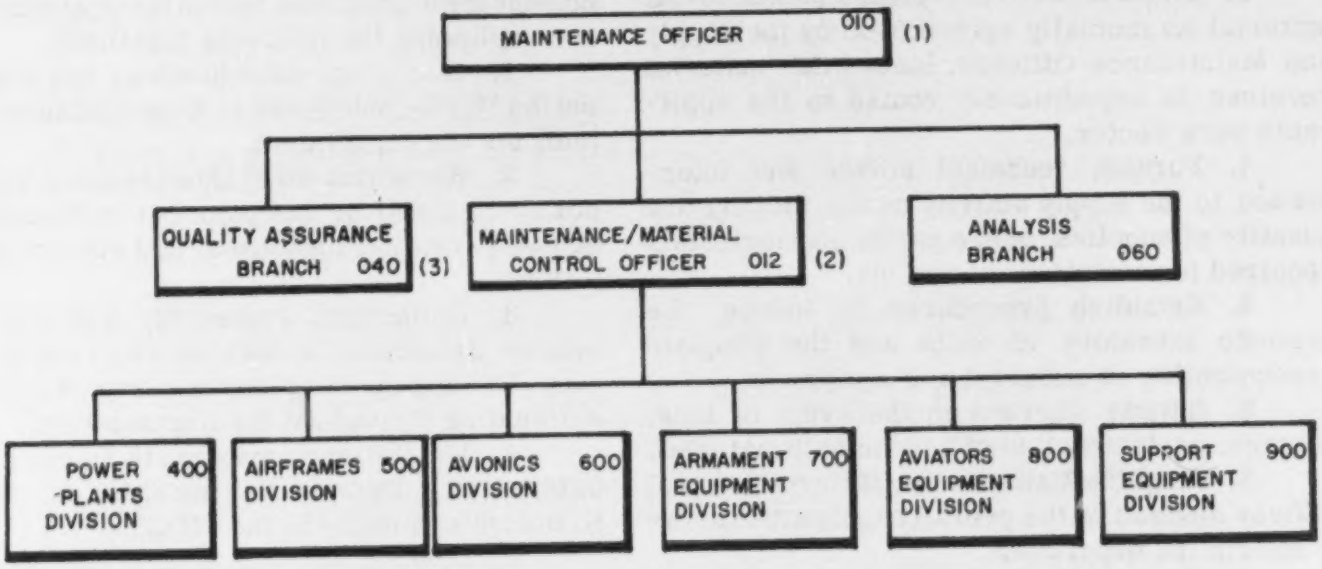

NOTES:

(1) AND (2) THE AIRCRAFT MAINTENANCE DEPARTMENT OFFICER (AFLOAT), DEPENDENT UPON HIS SENIORITY, WILL BE ASSIGNED AS EITHER THE INTERMEDIATE MAINTENANCE OFFICER OR MAINTENANCE/MATERIAL CONTROL OFFICER FOR CUSTODY/CONTINUITY PURPOSE UPON DEBARKATION OF THE AIR WING.

(3) BRANCH OFFICERS WILL BE TAD FROM AIR WING/GROUP TO THE IMA FOR MANAGEMENT RESPONSIBILITIES.

AT.1

Figure 2-1.–Intermediate level maintenance department organization, afloat.

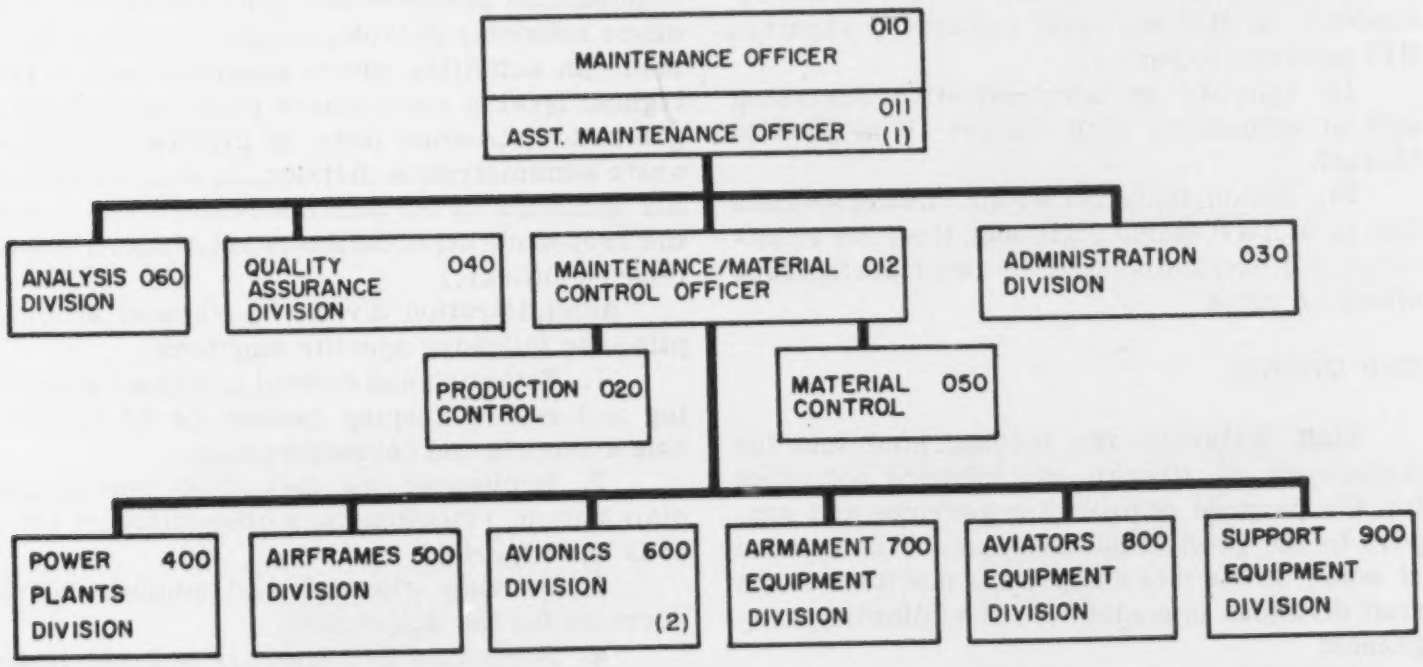

NOTES: (1) WHEN ASSIGNED

(2) QUALIFICATION WILL BE PERFORMED BY THE TEST EQUIPMENT BRANCH OF THE AVIONICS DIVISION

AT.2

Figure 2-2.–Intermediate maintenance department, shore.

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3. Establish delivery-pickup points for all material as mutually agreed upon by the Supply and Maintenance Officers. Insure that material received is expeditiously routed to the applicable work center.

4. Furnish technical advice and information to the supply activity on the identity and quantity of supplies, spare parts, and materials required for maintenance actions.

5. Establish procedures to insure the periodic inventory of tools and the adequate accountability of material and equipment.

6. Initiate surveys in the event of loss, damage, or destruction of accountable material.

7. Keep the Maintenance/Material Control Officer advised of the overall supply situation as it affects the department.

8. Verify Aircraft on Work Stoppage (AOWS) requisitions and prepare necessary reports in accordance with chapter IV of the 3-M Manual.

9. Perform cost and allotment record accounting, charting, and budgeting of costs applicable to the department.

10. Monitor the operation of toolrooms and maintain an updated IMRL (Individual Material Readiness List).

11. Arrange for return of prospective F condition of R/S material and locally repaired RFI material to supply.

12. Operate an administrative screening unit in accordance with chapter IV of the 3-M Manual.

13. Retain material within the department that is in AWP status until such time the requisition is filled and continually ascertain followup status on same.

Staff Division

Staff divisions are incorporated into the framework of aircraft maintenance activities for the purpose of providing services and support to the production divisions. A discussion of some of the more important functions of the staff divisions is contained in the following paragraphs:

ANALYSIS DIVISION.–The Analysis Division provides qualitative and quantitative analysis information to the Maintenance Officer in order to enable him to continually review the management practices within his organization by accomplishing the following functions:

1. Managing, coordinating, and monitoring the MDCS (Maintenance Data Collection System) for the department.

2. Reviewing MDR (Maintenance Data Reports) to discover and point out workload inequities, personnel inequities, and resource inequities.

3. Collecting, reviewing, and delivering source documents to data services for processing. Picking up complete data reports and disseminating throughout the organization.

4. Maintaining an adequate supply of manuals, source documents, registers, etc., on hand to insure continuity in the MDCS.

5. Developing an analytical plan which encompasses all maintenance functions to provide periodic audits of work center performance.

6. Developing charts, graphs, and displays for command presentations.

7. Maintaining an updated master roster for the department.

8. Coordinating and insuring that 3-M training services are provided to assigned personnel.

ADMINISTRATION DIVISION.–The standard organization structure for intermediate maintenance activities provides an administration division. (In activities where organizational is the highest level of maintenance performed, the organization structure does not provide for a separate administration division. In such activities the functions of the administration division are the responsibility of the Assistant Aircraft Maintenance Officer.)

Administration division personnel accomplish the following specific functions:

1. Establish and control a central reporting and record keeping system for all maintenance reports and correspondence.

2. Implement all directives concerning distribution, retention, and disposition of records and reports.

3. Provide clerical and administrative services for the department.

4. Reproduce as necessary and distribute incoming messages and other data.

5. Supervise and coordinate department administrative responsibilities with other departments/divisions as required.

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6. Conduct liason with the Activity's Administration Department regarding department personnel matters.

7. Safeguard and distribute personal mail to department personnel, when appropriate.

8. Make proper distribution of all non-technical information and publications.

9. Distribute approved locally issued maintenance instructions, reports, and studies.

10. Control classified material (excluding technical manuals and letter type directives) required by the department.

11. Establish and coordinate the department training requirements. Obtain necessary school quotas to support these requirements.

12. Determine requirements for and insure establishment of proper transportation and communication systems to provide complete support of the workload.

13. Assign spaces to the various divisions and establish the responsibility for security and cleanliness of such spaces.

14. Assume responsibility for the cleanliness and security of vacant or unassigned aircraft maintenance spaces.

15. Arrange department participation in joint inspections of facilities assigned to tenant activities especially incident to the departure of a tenant activity.

QUALITY ASSURANCE DIVISION.–The Quality assurance division provides the department head with the quality status of work accomplished, points up areas that need particular attention, and develops more realistic inspection requirements. Primary functions performed by this division are as follows:

1. Review all incoming technical publications and directives affecting the department to determine their application to quality assurance.

2. Prepare or assist in the preparation of maintenance instructions to insure that proper direction and emphasis is given to implementing quality assurance.

3. Maintain the master technical library for the department, including letter type technical directives and control classified technical publications for the department. Insure that each division/branch receives all publications applicable to its work areas and that these are kept current and complete. Where applicable, maintain the Reader-Printer and associated equipment for aircraft models supported.

4. Establish qualification requirements for Quality Assurance Representatives and Collateral Duty Inspectors. Review the qualifications of personnel nominated for these positions and endorse nominations to the Commanding Officer via the department head. Maintain a current record of all designated inspectors. Periodically promulgate a list of all designated inspectors by TIMI or command notice.

5. Obtain and utilize appropriate inspection equipment such as lights, mirrors, magnifying glasses, dye penetrant kits, pressure gages, etc. Insure that productive personnel have such equipment available and in use.

6. Periodically accompany Collateral Duty Inspectors on assigned inspections and recheck their qualifications.

7. Insure all work guides, checkoff lists, checksheets, maintenance requirement cards, etc., used to define or control maintenance operations are completed and current prior to issuing to crews/individuals.

8. Review all UR entries, explanations and descriptions to insure they are accurate, clear, concise and comprehensive prior to mailing. Additionally, the technician preparing the UR and either the Quality Assurance or Maintenance Officer must sign the completed UR.

9. Cause to be inspected all equipment received for use, returned for repair, or held awaiting repair to insure its material condition, identification, packaging, preservation, and configuration are satisfactory and, when applicable, that shelf life limits are not exceeded.

10. Perform inspections of maintenance equipment and precision measuring equipment to insure compliance with calibration and safety instructions.

11. Perform technical inspections of all maintenance equipment and facilities.

12. Provide for the continuous on-the-job training of all inspectors in the techniques and procedures pertaining to the conduct of inspections.

13. When directed or required, provide technical task forces to study trouble areas and submit recommendations for corrective action.

14. Maintain adequate records and data on discrepancies to enable establishment of trends

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with the specific objective of determining when discrepancies in any area are ascending.

15. Maintain liaison with contractor, NAESU, NavAirSysComRep's, and other available field technical services. Establish and maintain liaison with other maintenance activities and rework points in order to obtain information on ways for improving maintenance techniques, quality of workmanship and quality assurance procedures.

16. Review maintenance data reports and note unnecessary and/or recurring discrepancies requiring special action.

17. Insure that established standard procedures are observed by production personnel when conducting bench checks, tests, and repairs of components including engines. Periodically check the performance of this work to insure the desired quality level is obtained.

18. Insure the configuration of aircraft components and support equipment is such that all essential/applicable modifications have been incorporated. This necessitates the review of appropriate records.

Production Divisions (Intermediate Level)

Maintenance of naval aircraft involves the actual performance of maintenance tasks by ordnancemen, mechanics, and technicians. The production divisions are manned by such personnel. Although each production division is broken down into work centers, which, on an organizational chart, are shown as the lowest element, this is not in keeping with their importance. If it were not for the production divisions and work centers, there would be no reason for the existence of any other part of the organization.

Intermediate maintenance level production divisions, such as are in AIMD's, are generally manned by personnel of the same rating. In organizational maintenance activities, some divisions are made up of personnel from several ratings. The type of work usually performed by an individual is the same regardless of the maintenance level at which he is working; ie., AD's work on engines, AQ's work on fire control equipment, ordnancemen work on armament equipment, etc. The difference between the work performed in production elements at various levels lies in the depth of maintenance performed.

The standard organization framework for intermediate level maintenance activities provides for six production divisions. (See fig. 2-1 or fig.2-2). The production divisions provide intermediate level maintenance on aircraft components and equipment for the supported activities. Some of the more important responsibilities and functions of these divisions are described in the following paragraphs.

POWERPLANTS.–The powerplants division is manned by Aviation Machinist's Mates who perform maintenance on powerplants, powerplant components, and associated systems.

AIRFRAMES.–Aviation Structural Mechanics are assigned to work centers in the airframes division. This division is responsible for the specified level of maintenance of the airframe and structural components; movable structures and surface including their hydraulic and pneumatic control and actuating systems and mechanisms; air-conditioning, pressurization, visual improvement, oxygen, and other utility systems; and seat and canopy ejection systems and components.

AVIONICS.–The avionics division is manned with the necessary combination of the following ratings of avionics equipment for the supported activities.

The Aviation Electrician's Mates maintain aircraft electrical and instrument systems.

The Aviation Electronics Technicians maintain and test aviation electronic equipment including detection, reconnaissance, identification, communication, navigation, display, and special purpose equipment.

The Aviation Antisubmarine Warfare Technicians maintain and test aircraft antisubmarine warfare (ASW) systems and equipment, including those related to magnetic anomaly detection, long and short-range underwater detection, nuclei detection, integrated displays, and associated ASW equipments.

Aviation Fire Control Technicians maintain and test aircraft armament control systems, including fire control, and bomb director systems.

AVIATORS' EQUIPMENT.–Aircrew Survival Equipmentmen are assigned to the aviators' equipment division. This division is responsible

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for intermediate level maintenance as required in connection with parachutes, liferafts, life-vests, pressure suits, oxygen masks, emergency equipment kits, flight clothing, oxygen regulators, automatic parachute actuators, aviators' protective helmets, etc. AME's may also be assigned to this division for the upkeep and support of the oxygen system, pressurization and air-conditioning systems, and other emergency equipment as assigned within the scope of that rating.

ARMAMENT EQUIPMENT.–Aviation Ordnancemen are assigned to the armament equipment division and are responsible for the maintenance of aircraft armament equipment and aviation ordnance equipment.

SUPPORT EQUIPMENT.–The Aircraft Support Equipment Technician (AS) performs the necessary maintenance on the support equipment assigned to the maintenance department and supported activities. Support equipment includes, but it not limited to, such items as test stands, workstands, mobile electric powerplants, pneumatic and hydraulic servicing equipment.

ORGANIZATIONAL LEVEL ACTIVITY

The responsibility for organizational level maintenance is assigned to operating units on a day-to-day basis–to support their own operations. Maintenance performed at this level includes aircraft servicing, aircraft inspections, minor adjustments, removal and replacement of defective parts and components, limited aircraft changes and modifications, recordkeeping, and reports. Figure 2-3 illustrates an organizational level maintenance department, including work center code numbers.

Maintenance/Material Control Officer

The Maintenance/Material Control Officer performs the following functions:

1. Scheduling, coordinating, and monitoring the workload of the department.
2. Maintaining liaison with the supporting activities and the local supply department to insure material requirements are fulfilled in order to keep productive capacity compatible with workload requirements.
3. Coordinating the ordering, receipt, and delivery of material, the administrative screening, scheduling, and control of processed components, and the control and usage of funds provided the department.

In discharging the duties of production control the Maintenance/Material Control Officer will:

1. Plan and schedule the workload so as to insure maximum utilization of personnel, material, and resources.
2. Assign job control numbers for each reported discrepancy.
3. Maintain the organizational maintenance control register (3 months).
4. Maintain an up-to-date status board.
5. Provide the Operations Department with required aircraft status and configuration information.
6. Maintain technical directive control procedures.
7. Relay discrepancies to work centers with complete information as to status, by the fastest method (i.e., telephone, intercommunications, etc).
8. Review and approve work requests to the supporting activity. (Maintain completed files.)
9. Recommend and control cannibalization in accordance with applicable directives.
10. Submit reports as required.
11. Receive certain completed source documents from work centers and:
    a. Update aircraft and equipment logs, accessory record cards, configuration forms, and associated documents.
    b. Forward complete forms to data analysis.
12. Receive complete source documents from data analysis after processing and file for historical records.
13. Conduct monthly maintenance meetings and publish a monthly maintenance plan.
14. Schedule all periodic and special inspections and insure maintenance test flights are conducted in accordance with applicable instructions.

In discharging the duties of material control, he will perform those applicable functions specified previously under intermediate level maintenance as well as the following:

1. Prepare documents for material required for operational support of weapon sys-

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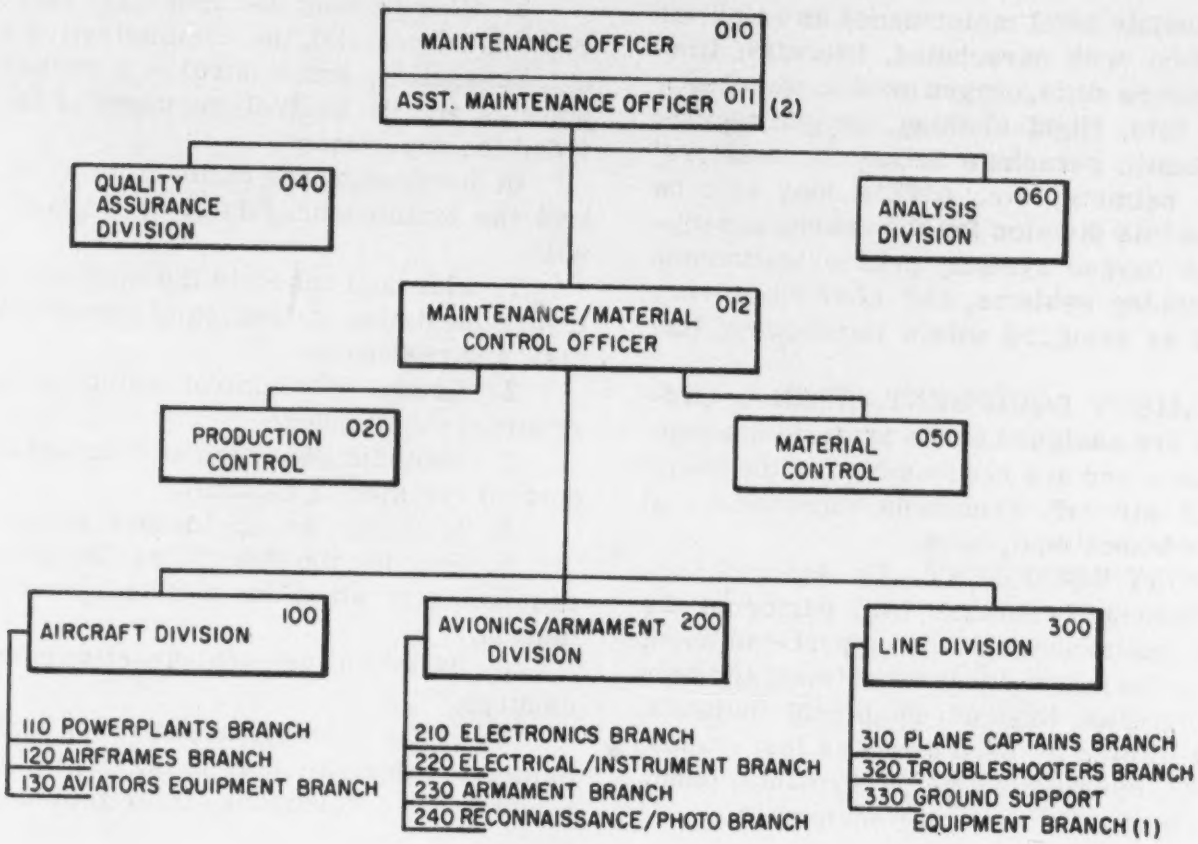

NOTE:

(1) When responsibilities relative to operation and maintenance of ground support equipment are extensive, the Commanding Officer will establish a Ground Support Equipment Branch under the Line Division to coordinate and/or carryout organizational maintenance functions on assigned support equipment.

(2) When assigned.

Figure 2-3.–Organizational maintenance department.

AT.3

tems (i.e., material chargeable to BRAVO funds such as fuel, oil, and flight clothing, etc.) and material carried in SERVMART/JETMART outlets.

2. Verify NORSAIR (Not Operationally Ready Supply Aviation Item Report) requisitions and maintain (by BUNO) current NORSAIR status records.

3. Inventory aircraft upon receipt and transfer. Insure inventory logs entries are updated, authenticated and corrected.

Staff Divisions

The organizational level activity has only two staff divisions, having no administration division as explained under the intermediate level. The analysis division is the same for both activities; therefore, it is not discussed here. The Quality Assurance Division is the same as discussed for the intermediate level with the following additions:

1. Review "yellow sheets", maintenance data reports, periodic inspection records and note unnecessary and/or recurring discrepancies that may require special action.

2. Insure that standard established practices are observed for conducting ground tests, preflight, postflight, and daily inspections. Periodically accompany check crews, plane captains, or pilots during inspection (minimum, once a quarter).

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3. Insure that pilots/crew are briefed prior to each test flight so that purpose and objectives are clearly understood.

4. Maintain current the Type Commander Maintenance Index Record.

Production Divisions

The organizational level activity provides three production divisions, which are subdivided into branches. Each of these branches/divisions performs many maintenance tasks in order for the operating unit to accomplish its assigned mission.

AIRCRAFT DIVISION.–The Aircraft Division is responsible for the accomplishment of the following functions:

1. Supervise, coordinate, and complete periodic maintenance and inspections. (Check crew leaders and such other personnel authorized by the Maintenance Officer will be permanently assigned.) Additional personnel required to perform periodic maintenance and inspections will be made available as required from other production divisions. The Maintenance/Material Control Officer is responsible for insuring that divisions assign qualified personnel for the completion of scheduled maintenance and inspections.

2. As directed by the Maintenance Officer and in conjunction with other production divisions, perform those applicable organizational maintenance functions in those areas relative to assigned branches; i.e., Airframes, Power Plants and Aviators Equipment.

3. Continuously advise the Maintenance/Material Control Officer of the status of work in progress.

4. Insure cleanliness of hangar and assigned spaces.

5. Nominate personnel for assignment as collateral duty inspectors.

6. Initiate requests for maintenance material.

7. Assume custody for tools and support equipment assigned to the Aircraft Division.

8. Interpret applicable directives and prepare, in draft form, maintenance instructions to implement such directives.

9. Recommend changes in techniques to promote maximum ground safety, safety of flight, and operational readiness of aircraft.

10. Carry out an active program for FOD (foreign object damage) control, as established by the Line Division Officer.

11. Initiate requests to maintenance/material control for job control numbers.

12. Provide troubleshooters and aircrew members, as required, and exercise technical supervision over such personnel.

13. Expedite the accomplishment of assigned work through the continuous evaluation of methods and procedures, and incorporate new techniques as appropriate.

AVIONICS/ARMAMENT DIVISION.–The Avionics/Armament Division is responsible for the accomplishment of the following functions:

1. Assign personnel required to accomplish scheduled periodic maintenance and inspections of assigned aircraft. (The Aircraft Division is responsible for the supervision, coordination, and completion of periodic maintenance and inspections.)

2. As directed by the Maintenance Officer and in conjunction with other production divisions, perform those applicable organizational maintenance functions in those areas relative to assigned branches, i.e., Electronics, Electrical/Instrument, Armament, and Reconnaissance/Photographic.

3. Continuously advise the Maintenance/Material Control Officer of the status of work in progress.

4. Insure cleanliness of assigned spaces.

5. Assume custody and accountability for assigned tools and support equipment.

6. Initiate requests for maintenance material.

7. Nominate qualified individuals for assignment as collateral duty inspectors.

8. Interpret applicable directives and prepare, in draft form, maintenance instructions to implement such directives.

9. Recommend changes in methods and techniques to promote maximum ground safety, safety of flight, and operational readiness of aircraft.

10. Initiate requests to maintenance/material control for job control numbers.

11. Provide troubleshooters and aircrew members, as required, and exercise technical supervision over such personnel.

12. Expedite the accomplishment of assigned work by continuous evaluation of methods

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procedures and incorporate new techniques as appropriate.

LINE DIVISION.–The Line Division is responsible for the accomplishment of the following functions:

1. Assign personnel, as required, to accomplish periodic maintenance and inspections of assigned aircraft. (The Aircraft Division is responsible for the supervision, coordination, and completion of periodic maintenance and inspections.)

2. As directed by the Maintenance Officer and in conjunction with other production divisions, perform those applicable organizational maintenance functions in those areas relative to assigned branches; i.e., plane captains, troubleshooters, and ground support equipment (when established).

3. Coordination and direction of troubleshooters. Although troubleshooters will normally be assigned from other division on a daily basis, the Maintenance Officer may assign personnel permanently to a Troubleshooter Branch of the Line Division. A troubleshooter should accomplish correction of minor discrepancies.

4. Initiate requests to maintenance/material for job control numbers.

5. Provide to pilots/aircrews records of aircraft discrepancies and corrective actions for the preceding 10 flights of the aircraft.

6. Administer the plane captain program.

7. Nominate qualified personnel as collateral duty inspectors.

8. Participate in an active FOD (foreign object damage) prevention program.

9. Initiate requests for maintenance material.

10. Insure the cleanliness of assigned aircraft and spaces.

11. Assume custody and accountability for tools and aircraft maintenance support equipment assigned to the division/branch.

12. Insure the security and proper ground handling of aircraft and associated support equipment.

13. Recommend changes in methods and techniques to promote maximum ground safety, safety of flight, and operational readiness of assigned aircraft and associated support equipment.

NAVY MAINTENANCE AND MATERIAL MANAGEMENT (3-M) SYSTEM

The 3-M system is a program to insure the highest state of aircraft readiness and reliability at the lowest cost in men, money, and material. In accomplishing this, it must insure that maintenance personnel, equipment, and facilities are utilized to the fullest extent in the performance of maintenance and not wasted in other functions not requiring highly trained maintenance skills nor specialized and expensive maintenance equipment and facilities.

All aircraft weapon systems must be maintained to the maximum extent possible to perform 100 percent of the functions for which they were designed and to accomplish the assigned mission. Anything short of this goal is considered a compromise to readiness which cannot be afforded.

By analyzing maintenance costs and devising techniques to reduce cost wherever and whenever possible, many procedures and unnecessary actions can be minimized or eliminated entirely. Therefore, by doing away with the unnecessary, effort can be concentrated on increased readiness. The 3-M system embraces two broad areas–a Planned Maintenance System, and a Maintenance Data Collection System.

PLANNED MAINTENANCE SYSTEM

The Planned Maintenance System (PMS) is a system of maintenance planning and control that provides for the uniform accomplishment of planned preventive, rather than corrective, maintenance in all aircraft squadrons. A set of Maintenance Requirement Cards (MRC's) is provided for each type of aircraft, based on information in the Periodic Maintenance Requirements Manual (PMRM). The MRC's tell what inspections are to be performed, when and how they are to be performed, the skills, tools and equipment needed, the safety precautions to be observed, and the inspection sequence.

Many separate but interrelated functions and tasks combine to make up the maintenance workload that is required for support of modern aircraft. The times allocated and available for the accomplishment of this maintenance does not

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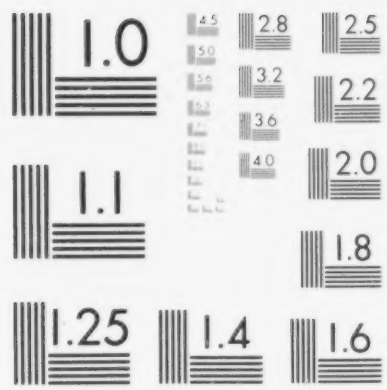

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

allow for all of these tasks to be considered, planned, and performed on an individual basis; therefore, it is necessary that they be combined, sequenced, and phased in the proper order if the overall task is to be accomplished in the most efficient manner. The best possible use of allocated time, manpower, materials, and funds is mandatory if the maximum potential weapons system availability and utilization are to be realized.

Operating aircraft are subject to a variety of stresses, strains, vibrations, and environments. If not inspected regularly for all defects, the aircraft would soon become inoperable. The correcting of discrepancies and timely lubrication are performed in conjunction with inspections and enable the aircraft to be flown safely until the next inspection.

The most frequent types of inspections which are performed by activities responsible for the maintenance of naval aircraft are described in the following paragraphs.

Daily Inspection

Daily inspections are accomplished between the last flight of the day and the next scheduled flight, if no more than 72 hours elapse between the inspection and the next scheduled flight. If more than 72 hours elapse between the inspection and the next flight, the inspection must be repeated. This inspection is basically a combination of requirements for checking equipment that requires a daily verification of satisfactory functioning, plus requirements that prescribe searching for and correction of relatively minor problems to prevent their progress to a state that would require major work to remedy. Other items which require inspection at intervals more frequent than prescribed for calendar inspections are also included on the daily inspection and are accomplished along with the daily inspection on the day they become due.

Preflight Inspection

A preflight inspection is performed prior to each flight. This inspection consists of checking the aircraft for flight readiness by performing visual examinations and operational tests to discover defects and maladjustments that, if not corrected, would cause accidents or aborted missions. It also includes a check to determine that the aircraft has been properly serviced for the next flight.

Postflight Inspection

A postflight inspection is performed on aircraft at the termination of the flight. This inspection includes the following:

1. Inspecting critical areas of the aircraft for obvious damage.
2. Servicing the aircraft with fuel, oil, oxygen, etc., to help maintain the aircraft in a ready-for-flight condition.
3. Installing of safety devices such as ejection seats and canopy safety pins, landing gear safety pins, and jury struts to maintain the aircraft in a safe condition.
4. Securing the aircraft after the last flight of the day. This includes installing all protective covers and plugs such as intake and exhaust covers, refrigeration and pressurization plugs, pitot covers, static vent plugs, etc.

NOTE: This inspection is no longer accomplished except where locally authorized to satisfy specific requirements.

Calendar Inspection

The calendar inspection is a thorough and searching inspection of the aircraft. It consists of visual and operational checks of sufficient depth to uncover discrepancies or progressive deterioration within the aircraft that could affect safety of mission accomplishment. This type of inspection is divided into two categories–an ODD calendar and an EVEN calendar inspection–and consists of basic requirements plus additional items scheduled for compliance at less frequent intervals.

Most of the items to be inspected at less frequent intervals are divided evenly so that approximately half of the items are checked on the first (ODD) calendar inspection and the remainder are checked at the second (EVEN) inspection. Subsequent inspections repeat the same ODD–EVEN cycle.

Under this system, the appropriate inspection is conducted at the expiration of a specified number of calendar weeks. Figure 2-4 illustrates a squadron inspection interval.

13154

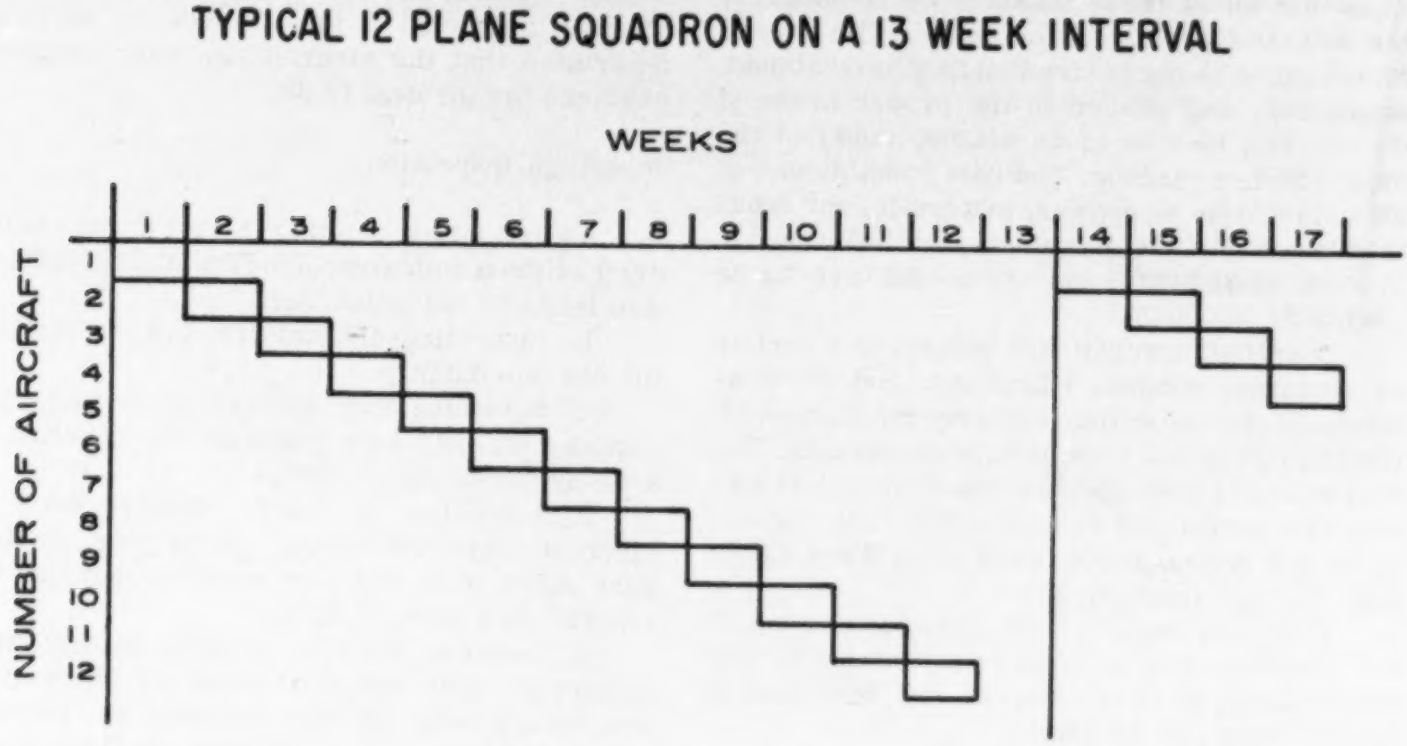

Figure 2-4.–Squadron inspection interval.

The Calendar Inspection System is an efficient system from a maintenance management standpoint. When aircraft are inspected under this system, the workload planning operation is simplified and the schedule maintenance in process is automatically stabilized.

The first inspection interval subsequent to Navy acceptance of a new aircraft under this inspection system commences on the date or at the time of the acceptance test flight. The first calendar inspection is performed at the completion of this first interval with subsequent inspections performed in sequence as previously mentioned.

The first inspection interval subsequent to standard rework commences on the date entered in the Aircraft Logbook by the rework activity certifying accomplishment of the equivalent calendar inspection. The next calendar inspection due is performed at the completion of this first interval and subsequent inspections are in sequence.

During special rework, the rework activity accomplishes all inspections falling due while the aircraft is in custody of the rework activity. Calendar inspections subsequent to special rework, therefore, continue in sequence. All calendar inspections accomplished by rework are noted in the Aircraft Logbook and the Aeronautical Equipment Service Record.

Acceptance Inspection

A minimum acceptance inspection consists of an inventory of installed material and loose gear, configuration verification, functional test of appropriate emergency systems, and a thorough daily inspection. Accepting activities may elect to increase the depth of inspection if the aircraft conditions warrant.

Conditional Inspection

A conditional inspection is an inspection which does not have a prescribed interval and depends upon certain circumstances or conditions (i.e., hard landings, engine overspeed/overtemp, one time inspections directed by higher authority but not issued as a technical directive).

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Maintenance requirements for every model aircraft are promulgated by the Naval Air Systems Command. With every activity using the inspection criteria prescribed for their assigned aircraft models, it follows that any given aircraft model is subject to a standardized program of periodic maintenance wherever it is being operated.

Standardization of planned maintenance procedures is accomplished by use of a Periodic Maintenance Requirements Manual (PMRM), various sets of Maintenance Requirements Cards (MRC's), Sequence Control Charts, and related forms and reports. These publications and forms and their uses are described in the following sections.

PERIODIC MAINTENANCE REQUIREMENTS MANUAL

The Periodic Maintenance Requirements Manual contains all the planned periodic maintenance requirements for the applicable aircraft model for its entire anticipated service life. The maintenance requirements contained in the manual are set forth in a manner to specify the equipment to be inspected or examined and the condition to be sought in each case. Since defects that are discovered during inspections result in unplanned maintenance, and this maintenance cannot be accurately predicted or planned, this type of maintenance requirement is not included in the manual. Maintenance personnel must refer to the proper publications and directives for assembly, disassembly, check, test and repair procedures. The PMRM publication identification code is identical with the other manuals pertaining to the same aircraft model except for part 3. Aircraft manuals are described in chapter 4 of this manual.

Where conflict exists between the information contained in the PMRM and other maintenance directives, the manual–with one exception–takes precedence. This exception is the information given on any Maintenance Requirements Card with a later date than the latest change date given in the PMRM. Although the information given in both these directives should be identical, the cards can be and usually are, changed before the manual.

MAINTENANCE REQUIREMENTS CARDS (MRC'S)

The Maintenance Requirements Cards are the working documents for squadron inspections and preventive maintenance actions. These are 5 x 8 cards arranged by rating and work area to provide the most efficient sequence of accomplishment. Assembled into sets and numbered in sequence, the cards contain pertinent information required by each maintenance man to complete each task. Data for each task includes a description; the time required to perform the task; the power, tool, equipment, and material requirements; and detailed information on such items as adjustments, pressures, and torque values. Also, included, when necessary, is a diagram of the specific area of the aircraft in which the work is to be performed.

Individual sets of MRC's are parepared for preflight, postflight, daily, and calendar inspections. For aircraft models having odd and even calendar intervals, the calendar MRC set is further divided into three groups–calendar, odd calendar, and even calendar. The calendar group contains requirements that must be checked at every calendar inspection, while the other two groups are used alternately with the calendar MRC's. Therefore, at each calendar inspection, two, and only two, of the foregoing groups in the calendar set are used.

The work plan, or order of performing the requirements, specified on the Maintenance Requirements Cards is prearranged in two manners. The preflight, postflight, and daily work is performed item by item in sequential order arranged on consecutively numbered cards. The calendar inspection work is controlled by the order of arrangement of the items on the MRC's and, in addition, employs a sequence chart for scheduling of the MRC's. The calendar MRC's are not necessarily scheduled in numerical card number sequence.

NOTE: No part of any scheduled maintenance is certified (signed off) on the Maintenance Requirements Cards. Therefore, the MRC's may be used as many times as their condition permits.

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SEQUENCE CONTROL CHARTS

Sequence Control Charts (SCC's) are used as a guide for the preparation of the actual calendar maintenance work schedule and as a means of controlling the assignment of work and personnel. These charts indicate what MRC's are to be complied with, the number and speciality of the personnel required, the times during which the separate jobs are scheduled to be performed, and the electric and hydraulic power conditions ("power on" or "power off") required during the work.

The SCC's are planned so as to effectively integrate all periodic maintenance work in a manner which will reduce the total out-of-service time required for the complete periodic maintenance job. The SCC's may consist of one, two, or three sheets, according to the requirements of the aircraft model. Generally, small aircraft not requiring engine removal during the calendar inspection will have only one chart containing both airframe and engine requirements to be accomplished on each calendar inspection. If engine removal is required for accomplishment of the calendar inspection, an engine SCC is provided for use by the shop performing the engine inspection.

Three charts are provided for aircraft models having inspection requirements divided between odd and even calendar intervals and requiring engine removal for inspection by shop personnel.

Calendar Sequence Control Charts have no application to the preflight, postflight, daily, or progressive aircraft rework requirements.

A plastic cover is placed over the chart when in use to facilitate marking of progress by the supervisor. The chart and the plastic cover are therefore reusable for as long as their condition warrants.

A portable workstand is used by the calendar maintenance supervisor to provide a local work control center for the accomplishment of calendar maintenance. This stand consists of four stowable legs, a deck tiedown assembly, a plastic chart holder, and a partitioned carrying case for MRC control and storage. A center storage section is provided for reference maintenance manuals. This stand, with the Sequence Control Charts, becomes the control center for the entire calendar inspection.

MAINTENANCE RECORD FORMS

Maintenance record forms are used to enable aircraft maintenance activities to schedule daily maintenance requirements, assign work in a preplanned manner, establish responsibility for work performed, record component replacement and discrepancies discovered, as well as the corrective action taken. The following sections describe the forms provided.

Daily Schedule Maintenance Planning Record

The Daily Schedule Maintenance Planning Record is used to plan and project the daily scheduled maintenance requirements for each individual aircraft between calendar periodic maintenance periods. It aids in assuring that required maintenance is scheduled on time and enables supervisory personnel to plan workloads accordingly. The form provides a number of spaces for each day in which to enter MRC numbers that require compliance on a basis other than every day (7 days, 14 days, conditional, etc.) It also provides a means for writing in all other scheduled maintenance due during the calendar maintenance period designated for the aircraft. This form is filled out to cover the calendar period. This is accomplished while the aircraft is undergoing calendar periodic maintenance so that all scheduled maintenance for the subsequent operating period is known at the time the aircraft is returned to an operational status.

Preflight/Daily/In-Flight Maintenance Record

This record form is used in conjunction with the Daily Schedule Maintenance Planning Record to enable scheduled work to be assigned in a preplanned manner between calendar inspections. This form controls and assigns responsibility for preflight, postflight, and daily scheduled maintenance including the special and conditional work that may be required. These forms can be prepared daily or made up in numbers sufficient to cover a desired period of time. Local conditions provide the best indication of the method to be employed.

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INSPECTION PROCEDURES

Under the direction of the activity maintenance officer, Maintenance Control holds a planning conference several days in advance of the calendar inspection due date with representatives of Quality Assurance, Material Control, Production Divisions, designated calendar maintenance supervisor (CMS), and key members of the forthcoming calendar inspection team.

The purpose of the conference is to prepare the SCC by adding on any existing additional requirements. Representative items added on at this time are recent local or command maintenance items, discrepancies, component replacements, change incorporations, and other like items which either cannot be anticipated or cannot be programmed into all inspections on a fixed basis.

After the preinspection planning conference, the marked copy of the SCC is forwarded to quality assurance whose personnel certify that local inspection procedures are incorporated and that necessary MRC's, publications, and required maintenance personnel are available and alerted. The SCC is then forwarded to the CMS who prepares the forms required for the inspection.

To initiate the calendar inspection, the supervisor issues MRC's, in the sequence prescribed by the Sequence Control Chart, to personnel of each rating who make up the inspection crew. A single copy Maintenance Action Form (discussed later in this chapter) is issued to inspection crew personnel each time a segment of the card set is issued for accomplishment. When the inspection or servicing requirements specified on the cards are fulfilled, the Maintenance Action Form (MAF) is completed by the person accomplishing the work or his crew leader and returned with the MRC's to the supervisor. Figure 2-5 illustrates the cycle of paperwork for MAF's and MRC's from the supervisor to the worker and back again.

The supervisor marks the SCC to indicate which MRC's have been issued. Return of completed cards to the supervisor is also reflected on the chart. Even though the workstand provides a physical accounting, by separation, of the completed and uncompleted MRC's, the supervisor doublechecks the return of each MRC by noting it on the chart. A mark should exist on the chart for each completed card, each card not in possession of the supervisor, and each card that could not be completed due to NORS (not operational ready-supply.)

Accomplishment and completion of each issued MRC are the responsibility of the appropriate specialist of the inspection crew. Each card must be completed by the specialist and returned to the supervisor. Uncompleted MRC's are returned to the supervisor and the Maintenance Action Form must contain entries listing the number of cards and items completed, and a notation in detail of which items were not completed and why.

The control of the status and the scheduling of the calendar inspection are the responsibility of the supervisor. It is essential that all discrepancies that are discovered are cleared through him. The supervisor (CMS) notifies the appropriate work centers for the correction of discrepancies which cannot be corrected by the calendar maintenance crew.

A set of Preflight, Postlight, and Daily Maintenance Requirements Cards is maintained in the line shack for each aircraft assigned. Prior to each flight, those preflight, postflight, and daily checks, as required, are performed by the applicable personnel and signed off on the appropriate card.

The Preflight/Daily/In-Flight Maintenance Record (fig. 2-6) should be filled in completely. Inasmuch as several inspections may be in progress at the same time, it becomes especially important that the BUNO and MODEX (or side number) spaces be accurately filled in. In some cases these records may be locally preprinted with the necessary basic information (applicable card number and rating), and the person performing the work need only complete the necessary spaces in longhand. Figure 2-6 illustrates this case.

Daily inspections are accomplished in the same manner as the preflight inspections. The accomplishment of the items on the daily inspection cards is also reported on the Preflight/Daily/In-Flight Maintenance Record. The daily inspection card sets contain the minimum daily, and conditional maintenance requirements for the applicable aircraft. Those card requirements that are to be performed on every daily inspection are titled "Daily." Those card requirements that are titled "Conditional" are

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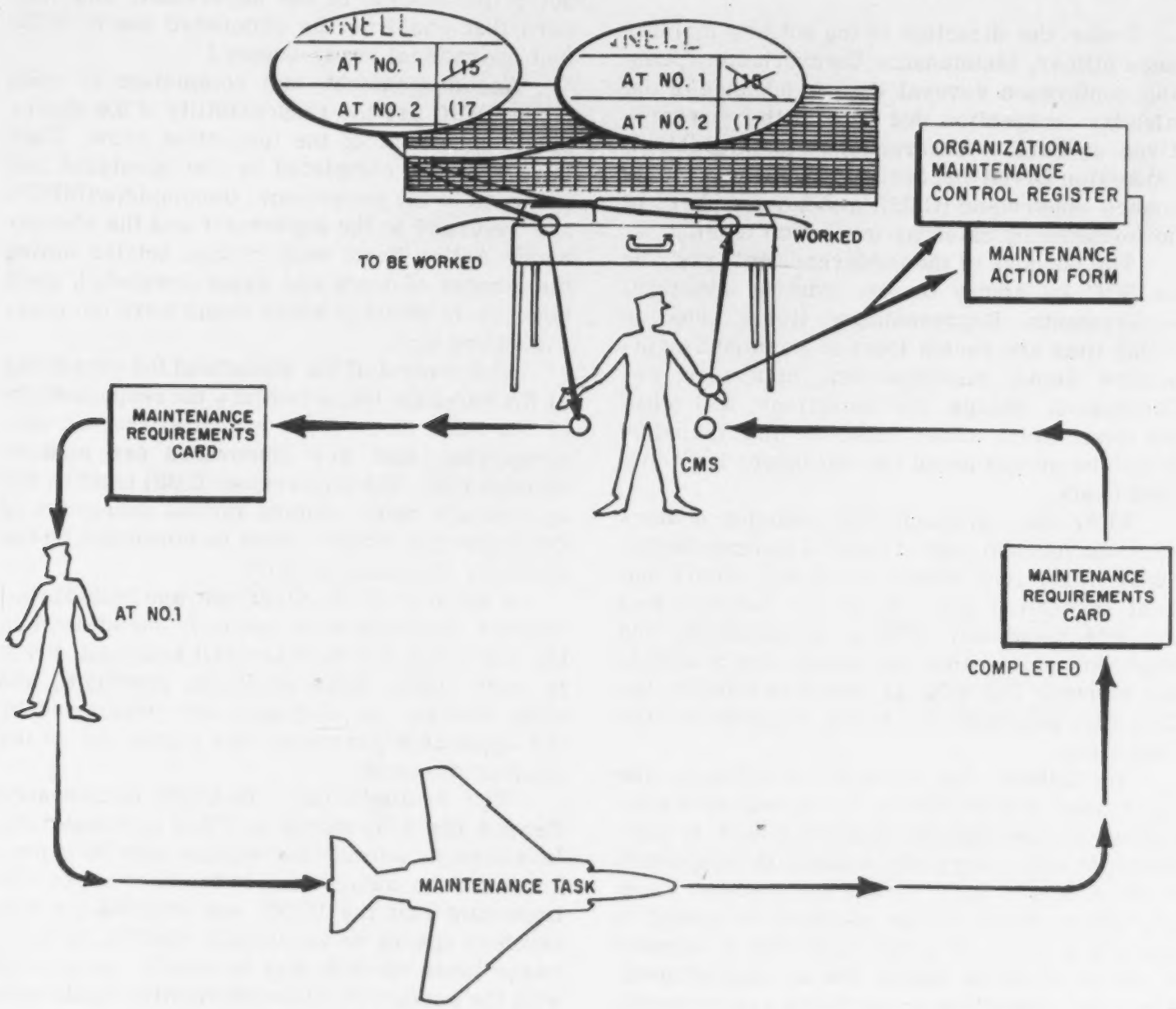

AT.5

Figure 2-5.–Normal MAF and MRC cycle.

items required on other than daily basis; for example, 72 hours, 7 days, 10 days, 30 days, etc. Whenever these special or conditional items are to be included in the daily inspection, the appropriate cards are issued to the persons concerned as part of the daily card set.

FORMS, RECORDS, AND REPORTS

In order that all commands and offices concerned with naval aviation be kept fully informed of the operational and maintenance experiences of naval aviation operating activities, a large variety of records must be maintained and many reports made. Some of the reports provide purely historical information, some furnish statistical data for analyzing efficiency and economy of maintenance and operation, and others have a bearing on the supply support furnished the activity. These records and reports are not limited to aircraft. Support equipment, manhours, and personnel training are representative of other areas of recordkeeping and reporting.

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PREFLIGHT/POSTFLIGHT/DAILY/IN-FLIGHT MAINTENANCE RECORD
NAVAIR FORM 4730/2

PREFLIGHT ~~POSTFLIGHT~~ ~~DAILY~~ ~~IN-FLIGHT~~	MODEL	BUNO	MODEX	ACTIVITY
	S2D	153490	490	VS 36

CARD NO.	RATE	DISCREPANCIES DISCOVERED YES	DISCREPANCIES DISCOVERED NO	WORK ORDER NO.	CORRECTIVE ACTION YES	CORRECTIVE ACTION NO	INITIAL
5	AE		✓	NONE		✓	SRG
9	AT		✓			✓	CHS
13	AX		✓			✓	[illegible]

I certify that the above entries are correct and that the work represented by them has been accomplished for the following date 1-20-69

MONDAY	✓
TUESDAY	
WEDNESDAY	
THURSDAY	
FRIDAY	
SATURDAY	
SUNDAY	

SIGNATURE AND RATE [illegible] AT-1

TIME STARTED 0530
TIME COMPLETED 0600

AT.6

Figure 2-6.–Preflight/Daily/In-flight Maintenance Record.

Through analyses of the data provided, the commands and offices, for whose use the records and reports are submitted, are enabled to better control overall operations. Standardization of maintenance and material areas is improved, unsafe or uneconomical trends are spotted and corrected earlier, and through feedback information, the service experience of other similar activities is made available to all who would find it helpful.

For each record that has to be kept and for every report that has to be made a governing instruction has been issued. These instructions usually give detailed instructions for the preparation of the record or report, prescribe the form and frequency of submission, and indicate the office to which they are to be forwarded. For purely local records such as training records, local instructions are provided to guide the recordkeeping.

The remaining portion of this chapter is devoted to a discussion of a few of the records and reports which are of main concern to the technician.

MAINTENANCE INSTRUCTIONS

Certain basic forms and procedures are set forth in NavAir Instruction 4700.2 (Series) as guidelines for the standardization of maintenance practices. It is essential that each maintenance man become familiar with the purposes and applications of these forms.

When the occasion arises for the aircraft maintenance officer to pass technical information to the mechanics and technicians, a Maintenance Instruction (Form NavAir 4710/7) is issued. This instruction is used for interpreting, amplifying, or clarifying technical directives and maintenance directives received from higher authority. It is also used to promulgate local instructions as necessary.

The instruction is normally prepared by the cognizant division, but it may be prepared by any division designated by the maintenance officer. The rough draft should be reviewed by the quality assurance officer and by the maintenance/material control officer before being submitted to the aircraft maintenance officer for approval.

The Maintenance Instruction (fig.2-7) must be prepared carefully, since this is the instrument by which the division officer directs his men. Command directives received in the form of messages are often so brief that they require considerable amplification and background information in order to be understandable at the working level. On the other hand, directives received in letter form may have been prepared for all aviation activities, and may be excessively lengthy and detailed. Only parts of such directives may apply locally, so they need condensation and selection to adapt them to local conditions.

The same form is used to promulgate instruction of three types: (1) Single Action Main-

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MAINTENANCE INSTRUCTION
NAVAIR FORM 4710/7 (7-67)
S/N-0104-644-7170

☐ TECHNICAL INFORMATION ☒ SINGLE ACTION ☐ CONTINUING ACTION

ORIGINATING ACTIVITY	DATE	MAINTENANCE INSTRUCTION NO.
VF-41	20 Nov, 1969	SAMI 62-53

SUBJECT
Replacement of Dielectric Lens to the AN/APN-22 Radar Altimeter

REFERENCE
F-4B Airframe Change (F4H Aircraft Service Change) No. 96

APPLICATION
Applicable to F-4B aircraft in custody of VF-41

ACTION

1. Install F-4B Airframe Change in accordance with instructions contained in F4H Aircraft Service Change No. 96.

2. Man-hours: 1 man, 2 hours.

WHEN TO BE DONE
Routine action - next intermediate inspection or as directed.

MATERIAL REQUIRED	MATERIAL ORDERED ON REQUISITION NO.
Kit 1, F4H-ASC-96, Stock No. R1510-1-F4H-C96 (1 per A/C)	

WORK RESPONSIBILITY	LOG BOOK ENTRY (ENTRIES) REQUIRED	
Electronics Shop	☒ YES (State entry required) ☐ NO	In Aircraft Log (NAVAIR 418-13, ASC page): "Replacement of Dielectric Lens AN/APN-22."

SUBMITTED BY (Signature of Division Officer)	APPROVED BY (Signature of Maintenance Officer)
D.F. GREIN, LT, USN	C.H. SARVIS, CDR, USNR

(A)

(See instructions on reverse)

AT.7

Figure 2-7.–Maintenance Instruction; Form NavAir 4710/7. (A) Front page.

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This section to be used in case of single action	
BUNO OR SERIAL NO.	DATE COMPLETED
151084	
151085	
151088	
152001	
152002	
153456	
153457	
153459	
153461	

INSTRUCTIONS

Check appropriate box for Technical Information, Single Action or Continuing Action Maintenance Instruction.

Enter name of the squadron or activity preparing Instruction.

Enter date Instruction is prepared.

Enter number for identification and filing purposes. Separate sets of annual consecutive numbers shall be established for Technical Information, Single Action and Continuing Action Maintenance Instructions.

Enter brief, accurate description of the general action required.

Enter identification number and title of the directive that is the basis for this Instruction.

Enter models of aircraft or nomenclature of equipment affected.

Enter a complete, concise set of instructions for the performance of the action required. If the instructions are lengthy and involved, reference may be made to the requiring directive for information, in which case it must be attached to and made a part of the Instruction.

Enter when the specified action is to be taken; in what situation; following what occurrence; in connection with what other work; or a calendar deadline, as appropriate.

Identify material required to comply with this Instruction by part number and nomenclature.

If material must be ordered, enter the requisition number. If material request is not necessary, so indicate.

Enter division or divisions responsible for performance of the required action.

Check appropriate box. If a log book entry is required, a verbatim entry shall be provided for the guidance of the person making the entry. The SAMI or CAMI shall show location in log book of such entry.

Enter signature of the division officer who prepared the Instruction.

Enter signature of the Maintenance Officer or his assistant signifying his approval of the content and preparation of the Instruction.

"BuNo or Serial No." and "Date Completed" columns are used only in the case of Single Action Maintenance Instructions. The former will indicate each individual aircraft or piece of equipment subject to the required action, and the Records and Reports Division will use the latter for entering the date of completion of the action to provide a control for planning and record purposes.

NAVAIR FORM 4710/7 (7-67) (BACK)

(B)

C-2180

Figure 2-7.—Maintenance Instruction; Form NavAir 4710/7. (B) Back Page.

AT.8

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tenance Instruction–SAMI, (2) Continuing Action Maintenance Instruction–CAMI, (3) Technical Information Maintenance Instruction–TIMI. A separate numbering sequence is set up for each type. This facilitates file control and serves as a cross-reference on work orders and inspection records. Each supporting work order merely carries the serial number of the Maintenance Instruction, rather than a repetition of the description of the work to be accomplished.

Single Action Maintenance Instruction

When work ordered is such that it will be completed on one aircraft or piece of equipment by carrying out the instructions set forth, and will not require further action at any time or in any situation on that aircraft or piece of equipment, it is properly the subject of a SAMI; for example, an Airframe Change on all bureau numbers of a certain model of aircraft.

Continuing Action Maintenance Instruction

A CAMI is issued when the work ordered may be required to be repeated at intervals on the same aircraft or piece of equipment due to elapsed time or as a result of the peculiarities of some particular piece of equipment.

Technical Information Maintenance Instruction

A TIMI may be prepared when a directive or situation dictates that technical information be promulgated within the activity. When it is necessary to disseminate information, such as techniques and local policy, which does not direct the accomplishment of specific work at defined intervals but which is sustaining in nature, a TIMI may properly be issued; for example, procedures and techniques for aircraft fueling.

WORK REQUEST

NavAir Form 4710/6 (fig.2-8) has been provided for use as a work request form. The work request is originated by a maintenance activity. The supporting activity reviews the request and either approves or disapproves. If the request is approved, a work order is issued and the requesting activity is notified when the work is completed. If the request is disapproved, the reason for disapproval is entered on the work request and it is returned to the originator. Detailed instructions for preparing the work request are printed on the back of the form.

MAINTENANCE DATA COLLECTION FORMS

This section outlines the procedure for documenting maintenance actions and actions taken in support of maintenance. These actions consume manhours or material or both. Therefore, manhour accounting is also discussed as part of maintenance data collection. The forms used to record this maintenance data are known as source documents. These source documents furnish the input information for the Maintenance Data Collection System. Each source document provided is used for recording and reporting specific maintenance information and much of this information is recorded in code form. The selection of which form to use depends on the type of work to be accomplished.

The forms selected for discussion are listed as follows:

1. Maintenance Action Form (MAF)–used to record actual maintenance actions (work).
2. Support Action Form (SAF)–a record of tasks performed in support of maintenance.
3. Manhour Accounting Form–a record of manhours expended is essential if efficiency is to be maintained.
4. Technical Directives Compliance Form–used to record actions taken in compliance with technical directives.
5. Configuration Control Form–a record of the configuration of repairable items as a result of compliance with a technical directive.
6. Unsatisfactory Material/Condition Report (UR)–used to report specific information concerning material failure and/or defects and other special situations.

Of the six forms listed, the MAF, SAF, and Manhour Accounting Card are discussed in detail because of the frequency with which the worker comes into contact with them. The remaining forms are described only briefly.

13163

Barley Yellow Dwarf

By Ivan J. Shields
Extension Plant Pathologist

Yellow dwarf, a virus disease of barley and other small grains, has caused reduction of grain yields in many parts of Arizona. This disease, first reported in Arizona in 1953, has been in evidence each growing season since that time. In 1954 and 1956, yellow dwarf caused serious damage to barley and oats grown at lower elevations.

FIGURE 1

FIELD SYMPTOMS

A barley field, infested with yellow dwarf will show very uneven growth (Figure 1). This is because more stunting takes place in plants infected in early stages of growth.

In the seedling stage, leaves will yellow at the tips 12 to 15 days after they are infected. The yellowing progresses downward along the blade; the leaf margins yellowing earlier than the center portions. In some cases yellow blotches develop followed by the entire leaf blade turning a golden to orange yellow. In addition to yellowing an extreme stunting occurs. Tillering may be stimulated, but no heads and hence no seeds are produced.

If infection takes place in later stages, only the uppermost leaves will turn a golden yellow (see arrows, Figure 2). Some heading occurs but the grain is light in weight. Yields may be reduced 50 percent to 60 percent. If the plant reaches the boot stage, before infestation, only the flag leaf will turn a bright yellow following an infection, and the yield will only be slightly reduced.

FIGURE 2

HOW IS IT SPREAD?

Yellow dwarf is transmitted from diseased to healthy plants by several grain-infesting aphids. In Arizona, the corn leaf aphid, the English grain aphid, the apple-grain aphid, and the grass aphid are active vectors of this disease.

During the winter growing season these aphids carry the virus from wild grasses along ditch banks and fence rows into the barley. An infective aphid may infest many plants. Later generations become carriers by feeding first on infected barley and then spreading it to neighboring plants.

HOW IS IT CONTROLLED?

No positive controls are known. The following suggestions should decrease losses.

1. Plant barley to avoid heavy aphid populations during the seedling stage. Barley planted before October 15 or after February 15 usually suffers the greatest losses from yellow dwarf. Aphid populations are usually higher in early fall and late spring.

(Over)

Cooperative Extension Service and Department of Plant Pathology of the
Agricultural Experiment Station, The University of Arizona, Tucson

WORK REQUEST
NAVAIR FORM 4710/6 0102-607-4360

TO (Supporting Activity) AMD NORFOLK	DATE PREPARED 6 Jan 1969
ORIGINATING ACTIVITY (Supported Activity) VS-36	WORK REQUEST NO. 10-69

JUSTIFICATION FOR WORK REQUESTED

Beyond capability of Organizational Maintenance, S2 Avionics Change 444 Specifies assistance from Intermediate Maintenance.

LOCATION OF JOB (at originating activity or at supporting activity to which job will be delivered)

Will be delivered to Station AMD hangar.

FOR FURTHER INFORMATION CONTACT (Name and telephone number) AVCM C. H. SARVIS Ext. 365	REQUESTED COMPLETION DATE 15 Jan 1969

WORK REQUEST
(Give complete, accurate and detailed description of desired work. Attach sketch if necessary.)

Incorporate Avionics Change 444 in S2D Buno. 151662.

(Copy of Change attached.)

SUPPORTED ACTIVITY

REQUESTING ACTIVITY WILL FURNISH MATERIAL AS FOLLOWS: (Show stock number and nomenclature) R83-E-S2-444 Change Kit	REQUESTING ACTIVITY WILL FURNISH ASSISTANCE AS FOLLOWS: 1 man (AX2)

SIGNATURE (Maintenance Officer of Supported Activity) H.O. Davison
H.O. DAVISON, LCDR, USNR

SUPPORTING ACTIVITY

[X] APPROVED [ ] DISAPPROVED	REASON (If work is disapproved)	SIGNATURE (Maintenance Officer of Supporting Activity) D. F. Grein D. F. GREIN, CDR, USN

DATE WORK STARTED	DATE WORK COMPLETED	DATE REQUESTING ACTIVITY NOTIFIED THAT WORK HAS BEEN COMPLETED	WORK ORDER NUMBER ASSIGNED
13 Jan 1969	14 Jan 1969	14 Jan 1969	105

AT.9

Figure 2-8.–Work Request, NavAir Form 4710/6

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MAINTENANCE ACTION FORM (MAF)

There are two maintenance action forms, but the format of both is identical. (See fig. 2-9.) The difference is that one is a multiplecopy form and the other is a single copy form. Whether the worker uses the single copy or the multiple copy depends upon whether a repairable item is removed from the aircraft.

A single copy MAF (blue) is used to document the following actions:

1. Repair work on the equipment which does not involve removal of defective or suspected defective repairable components.
2. That portion of calendar, conditional, periodic, acceptance, and transfer inspections which involve the search for (not repair of) defects, sometimes called the "look phase."
3. Removal of components for check, test, inspect, and service actions.
4. Item removal and replacement for cannibalization.
5. Fix-in-place actions discovered during inspections.
6. Recording manhours accumulated during work stoppage for parts or maintenance.
7. Recording accumulated maintenance manhours at the end of a reporting period for a job not completed.
8. To report assistance from work centers in support of a basic work center.
9. In support of a repairable item processing through an Intermediate maintenance activity.

The multiple copy MAF is a set (original and three copies) which is used when processing a defective or suspected defective repairable component through the Intermediate maintenance activity. It is also used to induct a component (including engines) into an Intermediate maintenance activity for compliance with technical directives. However, the multicopy MAF is not used for the accomplishment of test, inspect, and service actions. Instead, see 9, under single copy MAF.

Each copy of the multicopy MAF is used as follows:

Copy 1 (white)–Used for removal/replacement of repairable components from aircraft, engines, or support equipment.

Copy 2 (yellow)–Used to provide status control and suspense information to the Component Control Section of the Supply Support Center for items undergoing processing in the Intermediate maintenance activity.

Copy 3 (green)–Used to document the action taken by the Intermediate maintenance activity on repairable components. Such actions include a determination that the part was beyond the capability of maintenance (BCM), repaired, checked O.K., etc.

Copy 4 (hard back)–Used to provide status control to the component control section of the Supply Support Center and serves as an information copy for all off-station shipment of material requiring rework.

The maintenance action form is originated in the work center. When the work center supervisor is notified of required work, he enters this information in a work center register and assigns men to the job. Upon completion of the work the worker or crew leader fills out the MAF, using information from the supervisor's work center register and verifies completion of the work, manhours expended, materials used, etc. Referring to figure 2-9, completion of the numbered and lettered spaces is as described in the following paragraphs.

Job Control Number (JCN). The job control number is a 10- or 11-character "number" that serves as a base for maintenance data reporting and maintenance control procedures. The JCN provides separate identification of each maintenance action, when necessary. It also identifies the maintenance actions accomplished by Intermediate maintenance activities in support of organizations or an organizational discrepancy. The four parts of the JCN are organization code, date code, sequence number, and suffix and are thus explained.

The organization code is a 3-character code composed of letters and numerals (alphanumeric) which identifies an organization. This part of the JCN is published by higher authority for each individual activity performing or responsible for aircraft maintenance and always remains constant within the activity.

The date code identifies the date of which the JCN was initiated or assigned to a job. Therefore, this is not necessarily the date on which the work was actually started. NOTE: The date code, known as the Julian date, identifies the year and the numerical day of the year and consists of four numbers. The first number indi-

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MAINTENANCE ACTION FORM
MMMPC TEST FORM #4 (Rev. 11/64)

1. JOB CONTROL NUMBER ORG.	DATE	SER	SUF	2. TYPE EQUIP	3. BU/SER NO.	4. ACTION ORG.	5. WORK CENTER	6. MAINT LEVEL	7. ACTION DATE
AQ2	9007	005		A5AA	151658	AQ2	210	[X] 1 ORG [ ] 2 INT [ ] 3 DEP	9007

8. WORK UNIT CODE	9. WHEN DISCD	10. TYPE MAINT	11. ACTION TAKEN	12. MAL	13. ITEMS PROC	14. MAN HRS	15. EMT	16.
69910	D	B	B	135	1	05	05	

20. REMOVED ITEM
.1 RIC/MFGR | .2 SERIAL NUMBER | .3 PART NUMBER | .4 METER READING

21. INSTALLED ITEM
.1 RIC/MFGR | .2 SERIAL NUMBER | .3 PART NUMBER | .4 METER READING

B. DISCREPANCY
TAPE RECORDER INOPERATIVE

C. CORRECTIVE ACTION
ADJUSTED TAKE UP REEL

D. ENTRIES REQUIRED — SIGNATURE
CONFIGURATION [ ] YES [✓] NO
LOG [ ] YES [✓] NO
ACCESS RECORD [ ] YES [✓] NO
C. Davis

E. CORRECTED BY: H. O. Davison AX3
F. INSPECTED BY: [illegible] AMS
G. SUPERVISOR: R. Kennon AVC

30. REPAIR CYCLE DATA

	DATE		DATE
1. REMOVED		5. TO AWP	
2. RECEIVED MATL. CONTROL		6. OFF AWP	
3. WORK STARTED		7. TO AWP	
4. COMPLETED		8. OFF AWP	
RFI [ ] B COND [ ] R/S [ ]		9.	
		0.	

H. PCN | PRIORITY | DATE DUE IN | OUT

40. FAILED MATERIAL

.1 ACT TKN	.2 MAL	.3 QTY	.4 MFGR	.5 PART NUMBER

J. ACCUMULATED HOURS

NAME/SHIFT	DATE	MAN HRS.	EMT
TOTAL			

K. REQUIRED MATERIAL

REQ. NO.	MFGR	PART NUMBER	QTY	PRI	DATE/TIME ORD	DATE/TIME REC	AWP

AT.10

Figure 2-9.–Maintenance action form (MAF).

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cates the last digit of the calendar year, the next three numbers specify the number of days in the calendar year which have elapsed since January 1 of that year; for example, the Julian date 8350 identifies the 350th day of 1968 or, in more familiar terms, 15 December 1968; 9006 is the 6th day of 1969 or January 6, 1969. All dates used in the maintenance data reporting program are reported in Julian dates since any date in any 10-year period can be shown in just four digits. Encoding the date in this manner simplifies recordkeeping the data reduction by machine methods.

The sequence number part of the JCN (identified SER on the form) is either a 3-digit number that runs consecutively from 001 to 999 or a 3-character alphanumeric code with an alphabetic first character and two numbers which run from 00 to 99. The sequence number is normally assigned in sequence as new jobs come up. When the number 999 (or alphanumerically, 99) has been assigned, the next number in sequence is again 001. The alphanumerical sequence numbers are used only when documenting calendar inspection maintenance actions.

The JCN suffix is a single alphabetic character which is added to the basic JCN (those parts just discussed) to identify a subcomponent repair job which was done separately from the major repair job. This code applies to Intermediate maintenance only. An example of this is when a defective item is replaced with a good one during the course of a major job. The MAF job control number used to process the removed part through repair (Intermediate) maintenance would be the same basic code as the major job but the suffix A would be added to identify the subcomponent repair.

Type Equipment. The type equipment code is a 4-character code consisting entirely of letters. The type equipment code on the MAF shown in figure 2-9 is the code for the S-2A aircraft. These codes are listed in official directives and are mandatory for use.

Bu/Ser No. A bureau number or serial number is a number that identifies a specific end item or component, including aircraft and their components. The number is usually assigned by the manufacturer (serial numbers) or the Navy (bureau numbers), and is used to differentiate between a given end item and others of the same type, model, series, design, etc.

Action Org. Entered here is the organization code number of the organization performing the work. In case the same organization that assigned the JCN is performing the work, the code entered is the same as the organization code in the JCN.

Work Center. Entered here is the work center code of the work center accomplishing the maintenance action described on the MAF. This is either (1) the code of the worker's assigned work center, or (2) if temporarily assigned, the code of the work center to which he is temporarily assigned.

Maintenance Level. Entered here is a checkmark in the block which describes the level of maintenance being performed. This information should not be confused with organizational assignment of personnel. For instance, a man assigned to an Intermediate maintenance activity may actually work on an aircraft. Such a job would normally be considered as Organizational level work. As a general rule, all work performed on aircraft or missiles is considered as Organizational level maintenance and work performed off the aircraft or missile as Intermediate level maintenance.

Action Date. Entered here is the Julian date on which (1) the action is completed, or (2) the MAF is turned in to account for manhours accumulated against a job, or (3) the job is turned over to another work center, or (4) a job is interrupted due to the fact that supply must go off station for parts, or (5) a reporting period ends.

Work Unit. The work unit code is usually a 5- or 7-character alphanumeric code which normally identifies the system, subsystem, component and part of the item being worked on. (The look phase of calendar inspections is documented on single copy MAF's by entering "030" in block 8, "0" in blocks 9 and 11, and "000" in block 12.) Work unit codes are published in Work Unit Code Manuals for end items in two major categories; Type/model/series for aircraft, drones, and missiles; and aircraft maintenance support equipment. Five-character work unit codes from these manuals are used to code all work on an end item and its components. The sixth and seventh characters are used in benchwork (off equipment) to allow identification of repairable subassemblies of major components.

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When Discd. When discovered codes are single alphabetic characters which identify when the need for maintenance was discovered. These codes are applicable to the MAF only. There are two sets of when discovered codes, covering the following equipment categories: Aircraft and engines and aircraft maintenance support equipment.

When discovered codes relate primarily to conditions under which the malfunction or discrepancy was discovered rather than to the time in days or hours. For instance, code F (aircraft and engines) identifies a discrepancy or other need for maintenance that was discovered during the pilot's weekly inspection, while code F (aircraft maintenance support equipment) indicates that a need for additional maintenance was discovered during a period of unscheduled maintenance on the support equipment.

Type Maint. The type maintenance code is 1-character alphabetic code used to describe the type of work being accomplished (i.e., scheduled, unscheduled, supply support, etc.). Definitions and explanations of all these codes are contained in an appendix to the Standard Navy Maintenance and Material Management Program Manual.

Action Taken. The action taken code is a 1-character alphabetic or numeric code which describes the action that has been taken to correct the discrepancy. The action taken code "A" (Discrepancy Checked, No Repair Required) is used only in those cases where an inspection or operational check has been performed and the reported trouble cannot be duplicated or does not exist. In these cases the malfunction description code is "799" (No Defect) rather than a code that describes the reported discrepancy.

MAL. (Malfunction Description). The malfunction description code is a 3-character numeric code used to describe the malfunction occurring on or in the item identified by the work unit code on the maintenance data reporting forms. These codes are listed in alphabetical and numerical sequence in all Work Unit Code Manuals.

Items Proc. (Items Processed). Items processed, for the purposes of maintenance data reporting, is defined as the number of times that an action indicated by an action taken code is applied to the item identified by the work unit code recorded on an MDR form, or the number of times a support action is accomplished. EXAMPLE: Since the fuel nozzle of a jet engine is a coded item, replacement of five fuel nozzles would be documented as five items processed. In contrast to this, replacement of several tubes in an electronic assembly would be documented as one item processed with the work unit code identifying the electronic assembly being repaired, and the action taken code indicating repair.

Manhours. Entries in the manhours block of the MAF's represent all manhours expended by assigned personnel in completion of the work described on the source document. Hours and/or tenths worked multiplied by the number of men working equals total manhours. Time expended in exceptions of three-tenths of an hour or less is included in the total labor hours for the job. Exceptions which exceed three-tenths of an hour are not accounted for on maintenance action forms. These exceptions are charged to the proper labor distribution codes described later in this chapter. Entries in the manhour block of the maintenance data reporting (MDR) forms do not include labor hours for any work center other than the one submitting the document. For example, if two work centers jointly correct a discrepancy (same JCN) on the same aircraft or equipment, workers from each work center submit a source document with that particular work center's labor hours in the manhour block.

EMT. (Elapsed Maintenance Time). Elapsed maintenance time is defined as the actual clock time, in hours and tenths, that maintenance was being performed on a job. Although the EMT is directly related to job manhours, it is not to be confused with total manhours required to complete a job.

Block 16. Left blank. Use of this block is not currently prescribed.

Removed Item. This block will be completed on the four part MAF when a reparable component/part is removed from the equipment on which work is being accomplished. Enter the Reparable Item Code (RIC) and component serial number of the removed item in this block. If a RIC is not assigned, enter the manufacturer's code, serial number, part number (if more than fifteen (15) characters enter the last 15), and the meter reading to the nearest whole number. All

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meter readings will be prefixed with the letter "M." If no meter is installed, enter the time since new on the type equipment identified in block two (2) of the MAF.

Installed Item. Enter the Reparable Item Code (RIC) and component serial number of the installed item in this block. If a RIC is not assigned, enter the manufacturer's code, serial number, and part number (if more than fifteen (15) characters enter the last (15) of the installed item). Enter the meter readings in block 21.4 (blank block following the part number). All meter readings will be prefixed with the letter "M." If no meter is installed, enter the time since new on the type equipment identified in block two (2) of the MAF.

NOTE: The Removed/Installed item blocks on the single copy MAF shall be completed when recording cannibalization actions, and when reparable items are removed or re-installed to facilitate other maintenance and recorded as separate maintenance actions. No entries will be made in these blocks on the single copy MAF when the Action Taken Code is L, M, N, S, or when removing items for test, inspection, or service and their subsequent installation.

Discrepancy. A narrative description of the reported discrepancy or work to be performed is entered in this space. The appropriate arrow below the word DISCREPANCY is circled to indicate the flying status of the aircraft.

Corrective Action. A narrative description of the work accomplished in compliance with the discrepancy block is entered here by the person accomplishing the job.

Entries Required. Applicable checkmarks in the entries required space are made when the action or discrepancy requires logbook or accessory record card entries. Maintenance control enters a checkmark in the configuration block when configuration of the equipment is affected. The person making the entries signs his name and rate in the adjacent signature block.

Corrected By. The worker or crewleader who accomplishes or supervises the repair signs his name and rate in this block.

Inspected By. The Quality Assurance Representative or Collateral Duty inspector who inspects the job for proper standards signs his name and rate in this block.

Supervisor. The work center supervisor or his assistant signs his name and rate in this block to indicate that screening and other appropriate action has been accomplished.

Repair Cycle Data. Enter the Julian dates for the following: 1. Removed; 2. Received material control; 3. Work started; and 4. Completed. Check the appropriate block to indicate if the item is ready for issue (RFI), requires rework (B COND), or is recommended for survey or salvage (R/S).

During the actual repair, if the job is interrupted for one or more days due to a lack of parts, enter the Julian date that the job goes AWP (Awaiting Parts) adjacent to block 5 or 7. Enter the Julian date that the parts are received adjacent to block 6 or 8. Blocks 5 and 6 are used the first time the job status is AWP and blocks 7 and 8 are used the second time the status is AWP. If the job status is AWP more than twice, dummy dates within the actual repair time are entered adjacent to blocks 7 and 8 to reflect the actual number of days lost due to the second and subsequent AWP status.

Failed Material. On the single copy MAF, enter the action taken code, malfunction description code, quantity, manufacturer's code, and part number of failed material in this block if the parts replaced during repair are parts, bits, and pieces that have failed in a major component. If the failed item is removed and replaced, enter action taken code "R" (removed and replaced). If the removed item is removed, repaired, and reinstalled, at the Organizational level of maintenance, enter action taken code "C" (repaired). It is intended that this block be utilized to record only primary items that have failed. It is not intended to be used for recording all items replaced (i.e., common hardware, nuts, screws, safety wire, etc.), nor is it to be used to record routine replacement of seals, gaskets, washers, fittings, etc., that are installed during overhaul or repair.

Accumulated Hours. The work centers use this block to record manhours and elapsed maintenance time (EMT) accumulated against a job. Whenever (1) completing a repair action, (2) turning in a supplementing document in support of the job, (3) making a work center change, (4) a reporting period ends, or (5) going

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AWP, manhours and EMT are totaled in this section and entered in blocks 14 and 15 (near the top of the MAF) of the submitted document, after which the entries in the accumulated hours block are lined through to indicate they have already been documented.

Required Material. Whenever material is required to complete a maintenance action, it is requisitioned. In this section a line for each item ordered is filled in. Entered are the requisition number, manufacturer's code, part number, quantity, priority, date and time the material was ordered, and the date and time the material was received.

SUPPORT ACTION FORM (SAF)

The separate reporting of support type data is designed so that time expended in the accomplishment of repetitious type tasks that consume many manhours (but do not involve malfunctions, repairs, or condemnation action) may be easily identified, reported, and monitored. Manhours expended in support duties (such as aircraft refueling, engine or tire buildup, parachute packing, etc.) are documented on the support action form (SAF).

The SAF is a standard electric accounting machine (EAM) card which may be either handscribed or prepunched and preprinted, depending upon the desires and requirements of local maintenance managers. In either case, all support action forms are signed by the work center supervisor to indicate that screening has been accomplished. Figure 2-10 illustrates a handscribed support action form.

In order to identify manhours expended in specific categories of support type work, 3-character codes known as support action codes are used. Nine basic categories of support type work and the related code for each are listed on the back of the SAF form together with type maintenance codes.

Support codes may be further broken down within basic categories if deemed appropriate by local command; i.e., 011, 012, etc. In the event such a breakdown is desired, its use is controlled by the maintenance officer and managed by the analysis section. The areas of support work covered by each basic category are defined in detail in an appendix to the Maintenance and Material Management Manual (3M Manual).

Support action forms are filled out in the following manner:

Type Equipment Code. Enter a 4-character code that identifies the equipment on which support work is being accomplished; i.e., aircraft, engines, ground support equipment, etc. This code is found in appendix H of the 3-M Manual.

Action Organization. If the SAF is not preprinted and prepunched, enter the 3-character code that identifies the organization accomplishing the support action. This is the same alphanumeric organization code that was explained in connection with the maintenance action form.

Work Center Code. This, too, is the same numeric code series that is used with the MAF.

Maintenance Level. If the card is not prepunched and preprinted, enter the 1-character numeric code that identifies the maintenance level of the support action being performed. These codes are provided on the front of the SAF.

Action Date. The action date is the Julian date of the day the support action was completed.

Support Code. Enter the 3-character numeric code that identifies the category of work in which the support action was accomplished. These codes are listed on the back of the SAF.

Type Maintenance Code. This is a 1-character alphabetic code that identified the type of support maintenance that was accomplished.

Items Processed. Entered here is the number of items processed, or the number of times that the support action identified in the support code block has been accomplished (i.e., 4 aircraft refueled, 3 preflight inspections accomplished, etc.).

Manhours. Enter the total number of manhours (in hours and tenths of hours) spent in the accomplishment of the support action documented on the same line of the card. A maximum of 999.9 manhours may be reported on one line entry.

Local Control. Provided for local use, if desired.

Signature. Enter the signature of the person documenting the support action.

Replenish. If preprinted, prepunched cards are used, enter a checkmark in the REPL block when more cards are needed. The maintenance officer controls and analysis section coordinates the production, volume, and distribution of preprinted prepunched cards.

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MMMPC TEST FORM NO. 10 REVISED NOVEMBER 1964

1	2	3	4	5	6	7	8	9	A	B
TYPE EQUIP.	ACT. ORG.	WORK CENTER	MAINT. LEVEL *	ACTION DATE	SUPPORT CODE	TYPE MAINT.	ITEMS PROC.	MAN HOURS	LOCAL CONTROL	SIGNATURE
A.S.A.A	A.Q.2	2.1.0	1	9.0.0.4	0.1.0	C	0.1	.15		[illegible]
A.S.A.A	A.Q.2	2.1.0	1	9.0.0.4	0.1.0	C	0.1	.15		[illegible]

* MAINT. LEVEL
1 - ORG.
2 - INT.
3 - DER

10 ☐ REPL.

C.H. Davis
SUPERVISOR

SUPPORT ACTION FORM

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

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SUPPORT CODES

010 OPERATIONAL SUPPORT
020 CLEANING / PRESERVATION / DEPRESERVATION
030 INSPECTION
040 CORROSION CONTROL
050 GENERAL FUNCTIONS
060 BUILD UP AND TEAR DOWN / ENGINE TEST STAND OPERATION
070 MISSION SHOP SUPPORT
080 INSPECTION OF AVIATORS EQUIPMENT, SAFETY AND SURVIVAL EQUIPMENT
090 NON - AERONAUTICAL WORK

TYPE MAINTENANCE CODES

A GENERAL SUPPORT
C PREFLIGHT INSPECTION
D POSTFLIGHT / DAILY INSPECTION
E ACCEPTANCE / TRANSFER INSPECTION
F TRANSIENT MAINTENANCE
L LOCAL MANUFACTURE
T SUPPLY SUPPORT
U RECLAMATION AND SALVAGE

DNP057379

AT.11

Figure 2-10.–Support action form (SAF).

The support action form is designed so that documentation may be completed by either the work center supervisor or the individual worker. Additionally, the card provides a multiple entry feature so that several different entries may be made on the same form.

MANHOUR ACCOUNTING AND FORMS

The effective use of available manpower is an important function of maintenance management. Manhour accounting is an important part of the maintenance data collection system. The purpose of collecting manhour data is to provide management with essential information necessary to plan and direct more efficiently the distribution of assigned personnel.

The Manhour Accounting System is based upon the "exception" principle; that is, only the deviations or exceptions from normal are reported. Through the use of master rosters, electric accounting machine cards, and machine processed reports, the system provides sum-

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maries of the hours expended by maintenance personnel during the normal working day or in an overtime status. Basically, the system is designed so that the normal working hours for each person assigned to the maintenance activity are allotted or assigned to work centers by types of labor at the beginning of each reporting period. Exceptions from these normal working hours, or labor types, are reported by use of manhour accounting cards. Data processing machines add or subtract the exceptions reported on the manhour accounting cards from the initial manhour allotment. These exceptions and the working hours allotted at the beginning of the period serve as the basis for the daily and monthly manhour accounting reports mentioned in the foregoing. These reports are forwarded to the maintenance officers and supervisors for validation and utilization. Each supervisor and worker must thoroughly understand the importance of the system, its operation, and the need for continual accuracy. Detailed instructions pertinent to the content and use of manhour accounting reports are contained in the following paragraphs.

At the beginning of each reporting period, generally the first of the calendar month, manhours are assigned to every work center to which personnel are assigned. These manhours are based on an 8-hour work day 5 days per week for every person assigned. Not included in these (original assigned manhours) are any hours for work on Saturdays, Sundays, or holidays during the month. If every person assigned to the work center could be continuously employed throughout the month during all the time available for work, there would be no need for manhour reporting, as the time would be accounted for on the maintenance action form. Since continuous employment is not possible, each worker must report what he did when he was not working during any period in excess of 20 minutes, or approximately three-tenths of an hour.

To simplify reporting of hours spent in a labor category other than that for which assigned, a group of prepunched, preprinted manhour accounting cards is provided for every worker assigned. A card is initiated each time a person excepts from normal for a period in excess of three-tenths of an hour and is completed at the end of the exception. The most frequent exceptions requiring the submission of manhour accounting cards are (1) each time a person is assigned to, or transferred from, a work center or organization, (2) each time a person performs work in other than his regularly assigned labor code, (3) each time a person is absent from his work center for nonmaintenance purposes such as watches, leave, sick, special liberty, etc., and (4) each time a person works overtime during a single work day or on his day off (holiday, Sunday, etc.).

Manhour accounting cards are, for the most part, prepunched and preprinted. However, handscribed cards have a place in the system. A handscribed card is illustrated in figure 2-11.

Handscribed manhour accounting cards are normally used to report (1) newly assigned personnel, (2) temporarily assigned personnel, (3) composite manhours involving more than one person, and (4) whenever prepunched, preprinted cards are not available.

The use of the blocks and spaces on the manhour accounting card is discussed in the following paragraphs.

Block 1–Organization Code. The organization code is the same 3-character alphanumeric code described for use with the maintenance action form. Use of the code simplifies the identification of the unit to which a person or persons is/are attached or temporarily assigned. For example, TO1 is the code for NAS, Pensacola, Florida, and is much easier and faster to write in than the name of the activity.

Block 2–Work Center Code. The work center code identifies the functional area to which a person is assigned or temporarily assigned. A standard system of work center codes is prescribed. Therefore, a technician assigned to the avionics division at the Intermediate level of maintenance anywhere in the world will use the same work center code. Those technicians attached to the electronics branch at the organizational level of maintenance all use the same work center code.

Block 3–Name and Initials. This block is self-explanatory, except in the case of composite cards (used for two or more persons) enter the applicable number of men; i.e., "2 men," "4 men,", etc.

Block 4–Grade Code. This code is a 3-character numeric or alphanumeric code used to designate the grade and status of the individual

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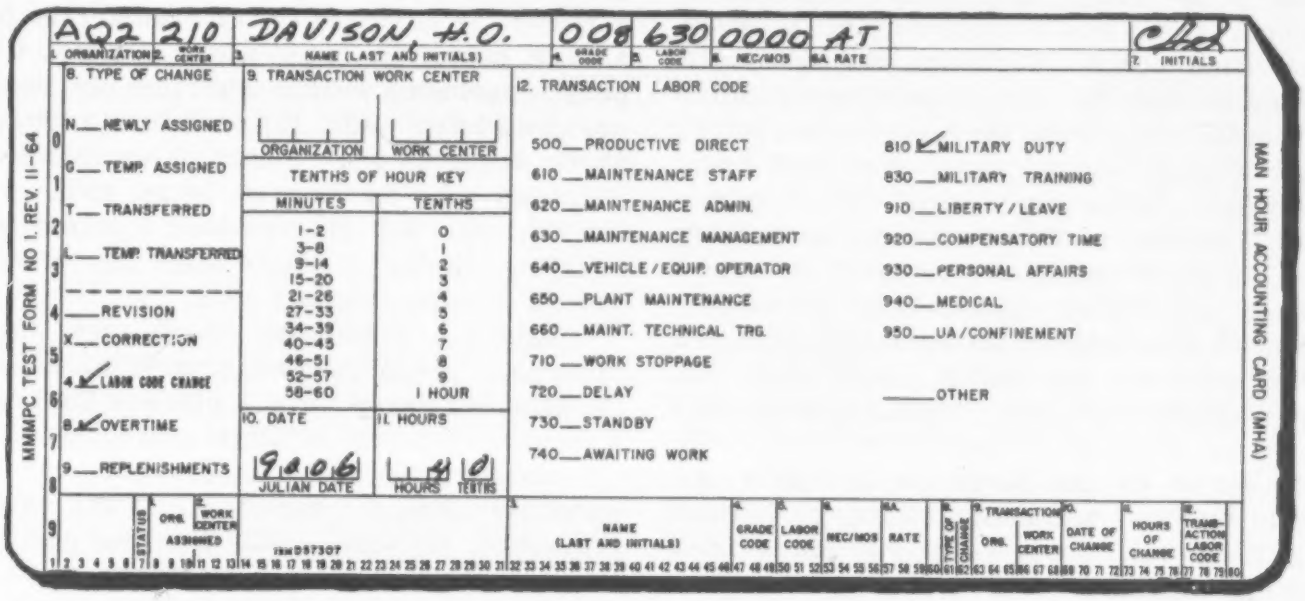

Figure 2-11.–Manhour accounting card. AT.12

being reported. All military grade codes start with 0 and range upward from 001 (recruit) to 019 (captain/colonel). All civil service codes start with G and correspond to their pay status. For example, a GS-1 code is G01 and the top is G14 for a GS-14. Grade codes C01 through C04 are special civilian codes and are provided for use where necessary as directed by the major command.

Block 5–Labor Code. Labor codes in five major categories are prescribed for use here. Manhour expenditures are charged to the labor code which best describes the type of labor performed or how a worker's time was spent. The five major categories are as follows: Direct Labor (500), Productive Indirect (600), Nonproductive (700), Duty Absence (800), and Nonduty Absence (900). All of these code groups except Direct Labor employ digits other than 00 to more precisely picture what was done. For example, Duty Absence (800) is further divided into Military Duty (810) and Military Training (830).

Block 6–NEC/MOS. In this block is entered the primary Navy Enlisted Classification Code or Marine Corps Military Occupation Specialty Code for newly assigned personnel only. Naval Officer Billet Codes (NOBC) or designators may be used for officers. If desired, a person's rating may be entered in block 6a.

Block 7–Initials. The initials of the work center supervisor are entered here to indicate that screening has been accomplished. Every worker assigned to a work center is responsible for submitting his own cards, except when he is absent at the end of a reporting period. In such cases, the supervisor submits the necessary cards. It is the responsibility of the work center supervisor to see that every card submitted by everyone is correct in every detail.

Block 8–Type of Change. It must be kept in mind that maintenance manhours are not reported on manhour accounting cards. Whenever the normal routine (which is set up on the electric accounting machines) varies or changes for any of the reasons listed in block 8, a card must be submitted AFTER the change occurs. For instance, after being temporarily assigned or transferred or immediately after working overtime. A check (✓) in a block 8 space is nearly always accompanied by an entry in block 9, 10, 11, and/or 12. An exception to this is "Replenishments." A preprinted, prepunched card, checked in the "Replenishments" space, is submitted by the man concerned when the number of preprinted, prepunched cards remaining in his personal stack is less than 10. The data center will forward him a new supply the next day. The relationship of block 8 spaces to blocks 9, 10, 11, and 12 will be discussed in conjunction with the coverage of the latter group of blocks.

Block 9–Transaction Work Center. Block 9 is used in conjunction with the "Temporarily

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2. Use tolerant or resistant varieties when available. The Rojo variety is tolerant to yellow dwarf. In variety trials in the Salt River Valley, Rojo yielded as well as Arivat.

3. Control grasses on borders of fields and along ditch banks to reduce areas for aphid build-up.

4. Aphid control by use of insecticides has not proven effective in stopping the spread of yellow dwarf. Additional aphids move in after insecticide application and build up quickly due to absence of predators.

RESEARCH IN PROGRESS IN ARIZONA

Resistance to yellow dwarf has been found in a number of breeding lines. The resistance from four of these lines is being bred into several high-yielding varieties for Arizona.

Assigned" and "Temporarily Transferred" categories in block 8. When a man is temporarily transferred to another work center, the change requires the initiation of two cards, because it involves two work centers. At his permanent work center he initiates a card checked "Temporarily Transferred" in block 8, and his temporary work center code is entered in block 9. When he arrives at his temporary work center he initiates the second card. On this card, "Temporarily Assigned" is checked in block 8, and the code number for his permanent work center is entered in block 9.

Block 10–Date. Block 10 is not filled in until the temporary work assignment is completed. At that time the Julian date is entered in this block, identifying the day the exception was completed.

Block 11–Hours. Upon completion of the exception, the number of hours and tenths of hours involved in the exception are entered here. Space is provided for 999.9 hours to be reported on a single card. When "Newly Assigned" (block 8) is checked, the number of hours reported is the number of hours of normal working time remaining in the reporting period. If "Temporarily Assigned" is the reason for submitting the card, the total elapsed number of working hours while so assigned is reported. The exception to this is when a temporary assignment extends into the next reporting period. In such cases a temporarily assigned card is submitted at the end of the month with that month's hours reported and, when the exception ends during the next reporting period, another temporarily assigned card is submitted to report only the number of temporarily assigned hours elapsed in that reporting period.

If "Transferred" (block 8) is the reason for submitting a manhour accounting card, the number of working hours remaining in the reporting period is reported. It will be recalled that the total number of working hours available for a reporting period for a work center is obtained by multiplying the number of men assigned by 5 days per week and 8 hours per day. When a person is transferred during the reporting period, all the working hours that he would have worked had he remained must be subtracted from the work center's total manhours available. The same reasoning holds true for "Temporarily Assigned" where the number of hours in this category is added to the temporary work center's totals and "Temporarily Transferred" where the number of hours away is also deducted from the permanent work center's totals.

Block 12–Transaction Code. An entry in this block is mandatory if "Labor Code Change" or "Overtime" has been checked in Block 8. A checkmark is entered to identify the labor code in which manhours were expended. If the "Other" line is checked, the appropriate subcode promulgated by the analysis section is entered in the space provided. The majority of manhour accounting cards submitted are "Labor Code Change."

TECHNICAL DIRECTIVES COMPLIANCE FORM

The Technical Directive Compliance Form (TDCF) is a single page form that is also used to document all technical directive maintenance actions. The TDCF is used by reporting custodians for preplanning workload and material requirements and for configuration accounting. Data obtained from these forms allows identification of all direct manhours expended complying with technical directives.

Unlike the MAF and SAF, the TDCF is originated by maintenance or production control. It is normally initiated upon receipt of each approved applicable technical directive.

There are several factors which must be considered in determining the number of copies required. In all cases, an original and one copy must be originated. If parts or kits are required for compliance, one copy is forwarded to material control. The original is forwarded to the primary work center when required material is available and the directive is scheduled for completion. If more than one work center is involved, one copy is forwarded to each assisting work center. One copy is held in suspense by maintenance control until the completed original is received from the work center.

CONFIGURATION CONTROL FORM

The Configuration Control Form (CCF) is a single page multiple entry document which is used to report the part number change of reparable items as a result of technical directive compliance on an aircraft, engine, or other

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selected item of equipment. This form is also used to report the removal and the installation of all items listed on the respective type equipment Configured Item List. A CCF is not required to report the removal and reinstallation of the same part number and serial numbered item on the same equipment when both actions take place as a single maintenance action. The CCF is normally initiated by maintenance control and completed by the primary work center or maintenance control.

NOTE: Configured items are selected items which require configuration status accounting. Items selected normally affect mission capability and can be interchanged with a similar item that results in a different mission capability, or are management attention or time compliance items. Many of the data blocks on the CCF are transcribed directly from the corresponding blocks on the TDCF or the MAF.

UNSATISFACTORY MATERIAL CONDITION REPORT (UR)

The Unsatisfactory Material/Condition Report, hereafter called UR, is a four-part, carbon interleafed, snap-out form. All activities concerned with maintenance of naval aircraft should use the UR's to report SAFETY, URGENT, and SPECIAL SITUATIONS.

The UR provides a system for submittal of specific information concerning failures, material defects, and other critical situations affecting naval aeronautical equipment which require prompt attention and corrective action. The UR is used for special situations as follows:

1. Report hazards to flight safety. The report in such instances serves as a followup to a Flight Safety Message in accordance with NavAir 4700.2 Series Instructions.

2. Report errors or omissions in aircraft and equipment manuals.

3. Report aeronautical equipment found in an unsatisfactory condition as a result of design deficiency, faulty manufacture, faulty overhaul, or faulty preservation and packaging.

4. Make special reports on any weapons system or equipment specifically requested by the Naval Air Systems Command for special reliability studies.

The front page of the UR contains instructions for the completion of the form. Using a typewriter or ball point pen, fill out the required spaces. The second page of the completed form is forwarded to the Naval Technical Services Facility, and the third page is retained by the originating activity for record purposes. The tag copy (fourth page) is attached to the material being turned in to supply or released for investigation. In the event that the material is not turned in to supply or released for investigation, the tag copy is discarded.

VISUAL INFORMATION DISPLAY SYSTEM (VIDS)

The Visual Information Display System (VIDS) is a time charting management tool which provides a graphic display of vital, up-to-date information on a continuing basis. The system correlates all aircraft status information, particularly awaiting parts and flyable discrepancies, and assigns a relative importance to each item. Additionally, the system displays the amount of time required to perform any maintenance and the number of personnel available and engaged in work. The ability to review the overall situation and determine what resources are available enables the maintenance officer and maintenance control officer or supervisor to more effectively and efficiently carry out his duties. This information is displayed on specially configured cardex type display boards.

DISPLAY BOARDS

VIDS boards consist of enlarged cardex type pockets scaled horizontally to represent hourly time periods. Each pocket is overlapped by the one above so that approximately a 3/8-inch strip is visible at the bottom of the pocket. Boards are available in three sizes–100 pocket (40" x 40"), 50 pocket (40" x 26"), 25 pocket (40" x 14"), and in three standard configurations. The configurations are as follows:

1. Organizational, flight maintenance board. This board provides current status of each aircraft plus displaying scheduled/unscheduled maintenance, including outstanding flyable discrepancies, parts on order, scheduled flights, and aircraft configuration. The current and projected workload of each work center and the number of labor code 500 personnel available for work are also displayed on this board.

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2. Material control status board. Outstanding material requisitions are displayed on this board by aircraft modex, work center, and document number.

3. Work center board. The work center board displays the work assignments by name in the work center plus providing space for individual technical qualifications record. Space is also provided for pending assignments, not assigned tasks, and those in an AWP (aircraft awaiting parts) status. The top pocket is configured to show the status of special support equipment (SSE) required by the particular work center.

IMPLEMENTATION PROCEDURES

To make the implementation phase as smooth as possible, a thorough indoctrination of the maintenance/material control personnel and work center supervisors is necessary. All problems concerning operating procedures, information flow, and communication procedures should be resolved prior to the implementation date. Certain steps are necessary if the transition is to be made in an orderly manner with minimum disruption of the maintenance effort.

Information Display Requirements

Efficient management of the maintenance effort requires certain information concerning the resources of the activity be available. The range and depth of information requirements are determined by such factors as mission, size, and physical layout of facilities. For purposes of standardization and to insure that the minimum information requirements are displayed, the following guidelines should apply:

1. Maintenance control.
   a. Inventory of aircraft.
   b. Aircraft configuration.
   c. Aircraft airframe / engine / component/time.
   d. Aircraft / equipment discrepancy status.
   e. Work center loading.
   f. Projected flight and maintenance requirements.
2. Material control.
   a. Outstanding requisitions by aircraft and priority.
   b. Outstanding requisitions not identified to a specific aircraft.
   c. Master register listing by supply document number.
3. Work center.
   a. Personnel status.
   b. Training/qualification record.
   c. IN WORK discrepancies and personnel assigned.
   d. AWP and pending discrepancies.

OPERATING PROCEDURES

There are two approved methods of operation for the Organizational Maintenance Control VIDS. Both methods are in consonance with current OpNav directives and are adaptable to any type activity. With either method, the primary consideration is placing maintenance control in CONTROL OF MAINTENANCE.

Time Charting Method

This method is a 3-day projection–title columns with Julian date; i. e., 9060, 9061, and 9062, and continue sequence as workdays progress. At the beginning of each shift, the maintenance control supervisor will verify his status board(s) with the various work centers. Each work center supervisor will inform him of the number of labor code 500 personnel available for work. These numbers will be indicated by the use of manpower indicators on the work center sections of the board.

Each discrepancy will be transcribed on an appropriate colored maintenance control register along with other pertinent information available at that time. Red registers will be used for discrepancies that place the aircraft in a nonflyable status. Blue registers are used for flyable discrepancies that do not place the aircraft in a reduced material condition (RMC), and an orange register for discrepancies that cause the aircraft to be placed in a reduced material condition.

The maintenance control supervisor will determine whether the affected work center(s) has the capability to handle the discrepancy at the present time. In making this decision he should utilize the manpower information displayed on the work center section, the present workload, and priority of the IN WORK and

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PENDING discrepancies. Based on his decision, the following procedures will be used.

1. Work center has capability. Maintenance control will transmit pertinent information to the affected work center(s). At this time, the work center supervisor will provide maintenance control with the estimated time of completion (ETC), work unit code, and number of personnel that will be assigned to the task. This information is entered in the appropriate spaces of the register. An Equipment Statistical Data (ESD) card will be initiated to indicate a change in the aircraft condition. The colored tabs at the bottom of the register, in excess of the ETC, are folded under. Copy 1, along with the ESD card, is placed in the aircraft pocket or pockets under the appropriate day and time frames. Copy 2 is placed in the appropriate work center pocket in the same manner, and the "men assigned" sliding tab is adjusted to indicate number of personnel assigned. Copy 3 will be forwarded to Quality Assurance for information purposes.

2. Work center does not have capability at present time. Maintenance control will indicate on the register that the discrepancy is in an AWM (aircraft waiting maintenance) status and will schedule the work at a later date and/or time. Copy 1 will be placed in the aircraft pocket, and copies 2 and 3 in the work center pocket under the appropriate date and time frame. An ESD card will be initiated and placed in the aircraft pocket. When the discrepancy is scheduled IN WORK, procedures described above will be utilized.

The register will remain on the board in an IN WORK status until the discrepancy is completed or unless the aircraft goes AWP or AWM. AWP and AWM status are described as follows:

AWP. The existing ESD card is closed out and a new one initiated to show current status. A black tab is placed in front of the register to provide visual recognition of the AWP status. Copy 2 of the register is moved to the AWP section of the work center board. When material is received, discrepancy is rescheduled for work.

AWM. When maintenance control determines that a work center must go AWM on a discrepancy, the pertinent information will be entered. The discrepancy will be rescheduled at a later date and/or time and register copies 1 and 2 will be moved on the board to the appropriate time frame. These registers can be flagged with an appropriate color for easy identification.

When maintenance control is notified that a discrepancy has been corrected, the registers (copies 1 and 2) will be removed from the board and copy 2 destroyed. Pertinent information will be entered in the appropriate blocks of copy 1.

Copy 1 should be retained in a temporary file until the MDR document passes through maintenance control. At that time, all necessary information is verified and then the register is filed in accordance with existing instructions. Insure that the ESD card reflects the current status of the aircraft.

Current Discrepancy
Status Display Method

This method utilizes three columns–PENDING, IN WORK, and AWP–each encompassing one 24-hour period. At the beginning of each shift, the maintenance control supervisor will verify his status board(s) with the various work centers. The supervisor will then determine which work centers have capability to handle incoming discrepancies. In making this decision, he should utilize the manpower information displayed on the work center section, the present workload, and priority of the IN WORK and PENDING discrepancies. Based on his decision, the following procedures will be used:

1. Work center has capability. Maintenance control will transmit pertinent information to the affected work center(s). At this time, the work center supervisor will provide maintenance control with the estimated time of completion (ETC), work unit code, and number of personnel that will be assigned to the task. This information is entered in the appropriate spaces of the register. An Equipment Statistical Data (ESD) card will be initiated to indicate a change in the aircraft condition. The colored tabs at the bottom of the register, in excess of the ETC, are folded under. Copy 1, along with the ESD card, is placed in the aircraft pocket under the heading IN WORK and time frames. Copy 2 is placed in the appropriate work center pocket in the same manner (column and time frame),

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and the "men assigned" sliding tab is adjusted to indicate number of personnel assigned. Copy 3 will be forwarded to Quality Assurance.

2. Work center does not have capability at present time. Maintenance control will indicate on the register that the discrepancy is in an AWM status and will schedule the work at a later date and/or time. Copy 1 will be placed in the aircraft pocket under the heading PENDING. Copies 2 and 3 are placed in the appropriate work center pocket under the same heading.

An ESD card will be initiated and placed in the aircraft pocket. When the discrepancy is scheduled INWORK, procedures described under work center capability will be utilized.

When a discrepancy has been scheduled IN WORK, the register will remain on the board under the heading IN WORK until the discrepancy has been completed or it is necessary to go AWP or AWM.

AWP. When maintenance control determines that a work center must go AWP on a discrepancy, copy 1 is placed in the aircraft pocket under the heading AWP. Copy 2 is placed in the appropriate work center pocket under the same heading. When the material is received, the discrepancy is rescheduled for work. Insure that the ESD card reflects the current status of the aircraft.

AWM. When maintenance control determines that a work center must go AWM on a discrepancy, the pertinent information will be entered in the appropriate block of copy 1. Both copy 1 and the ESD card are then placed in the aircraft pocket under the heading PENDING. Copy 2 is placed in the appropriate work center pocket under the same heading. The discrepancy will be rescheduled at a later date and/or time and the registers (copies 1 and 2) will be moved to the appropriate pockets under the heading IN WORK. Copy 1 will be updated by entering the IN WORK time in the appropriate blocks.

When maintenance control is notified that the discrepancy has been corrected, the registers (copies 1 and 2) will be removed from the board and copy 2 destroyed. Pertinent information will be entered in the appropriate blocks of copy 1.

Copy 1 should be retained in a temporary file until the source document is received in maintenance control. At that time, all necessary information is verified and then the register is filed in accordance with existing instructions. Insure that the ESD card reflects current status of the aircraft.

Maintenance Control Information

The number of the assisting work center(s) is written in the appropriate block when a discrepancy is transcribed on a maintenance control register. A copy 2 register of the same color as the primary register is made out for each assisting work center and placed in the appropriate work center section. As each assisting work center completes their portion of the discrepancy, the source document that is submitted will be verified with the copy 1 register and that particular work center will be crossed out. The initials of the person calling in the completion will be written above the work center number.

ESD cards can be placed on the VIDS board by either placing the card behind copy 1 of the register or inserting the card in the pocket on the extreme left side of the board. In this manner, the status block of the card is visible.

Work Center Information

When a discrepancy is received by the work center supervisor, pertinent data is recorded on the work center register. The supervisor informs maintenance control of the ETC, WUC, and the number of men that will be assigned to the task. The register is then placed in the pocket under the heading IN WORK and parallel to the name of the person given responsibility for the task. A distinguishing tab (or number) can be placed in any corresponding pocket(s) of other personnel assigned to the repair action. The register remains on the board until the discrepancy has been completed or it is necessary to go AWP or PENDING. If either of these two conditions occur, the register is removed from the IN WORK section, annotated with the proper information, and maintenance control is notified of the work status change. The register is then placed either in the AWP or in the PENDING section of the work center board. When the material has been

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CHAPTER 3

SAFETY

In the performance of his normal duties, the naval avionics technician is exposed to many potentially dangerous conditions and situations. No training manual, no set of rules or regulations, no listing of hazards can make working conditions completely safe. However, it is possible for the technician to complete a full naval career without serious accident or injury. Attainment of this goal requires that he be aware of the main sources of danger, and that he remain constantly alert to those dangers. He must take the proper precautions and practice the basic rules of safety. He must be safety conscious at all times, and this safety consciousness must become second nature to him.

Much pertinent safety information is contained in Rate Training Manuals. Of particular worth among these manuals are Airman, NavPers 10307-C, and Standard First Aid Training Manual, NavPers 10081-B. In addition, directives concerning safety are published by all major commands on those specific hazards and procedures falling under the cognizance of those commands. The Chief of Naval Operations has recently issued a listing of specific safety precautions compiled by the Navy Department. This publication cross references safety directives by subject matter and by the identifying designation.

The purpose of this chapter is to indicate some of the major hazards encountered in the normal working conditions of the technician, and to indicate some of the basic precautions that must be observed. Although many of these hazards and precautions are general and apply to all personnel, some of them are peculiar or especially applicable to avionics maintenance personnel.

SAFETY PRECAUTIONS

Most accidents which occur in noncombat operations can be prevented if the full cooperation of personnel is gained, and if care is exercised to eliminate unsafe acts and conditions. In the following paragraphs, some general safety rules are listed. These rules apply to personnel in all types of activities, and each individual should strictly observe the following precautions as applicable to his work or duty:

1. Report any unsafe condition or any equipment or material which he considers to be unsafe.
2. Warn others whom he believes to be endangered by known hazards or by failure to observe safety precautions.
3. Wear or use available protective clothing or equipment of the type approved for safe performance of his work or duty.
4. Report any injury or evidence of impaired health occurring in the course of work or duty.
5. Exercise, in the event of any unforseen hazardous occurrence, such reasonable caution as is appropriate to the situation.

Safety precautions in this chapter are not intended to replace information given in instructions or maintenance manuals. If at any time there is doubt as to what steps and procedures to follow, consult the leading petty officer.

AVIATION SAFETY

For purposes of this discussion, the term AVIATION SAFETY is used in connection with all functions and operations having to do with aircraft and with materials and equipment used in connection with aircraft, hangars, parking areas and ramps, and flight lines and taxiways.

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Hazards

Among the major hazards present in aviation activities are the following:

1. Fire or explosion caused by the application of external or internal power to an aircraft which is in some state of malfunction or disrepair, or undergoing maintenance or modification; or which create explosive vapors; or which have electrical short circuits.

2. Personal injuries sustained in falling from aircraft or workstands, being burned or blown about by jet blast or prop wash, being struck by objects blown about by jet blast or prop wash, being sucked into jet intakes, or being struck by propeller or rotor blades.

3. Being run down or over, due to lack of alertness to the movement of taxiing aircraft or ground equipment vehicles.

4. Explosion of aircraft batteries due to improper charging methods or to current overloading on ground tests within an aircraft.

5. Injuries (especially common during the hours of darkness) caused by encounter with tiedown lines, padeyes, chocks, protruding parts of aircraft or other equipment, or other such items about a deck or ramp.

6. Canopy, ejection seat, ordnance, and other "wrong switch at the wrong time" type accidents.

7. Misuse of, and abuse to, flight safety equipment, parachutes, "Mae Wests," liferafts, etc.

8. Accidents caused by careless workmanship, such as leaving tools or other extraneous materials in aircraft bilges, engine nacelles, intake or exhaust ducts, or movable parts of aircraft structures.

Precautions

Many safety precautions are of general nature and apply to all types of aircraft; however, others vary in specific details between specific models. It is imperative that all personnel whose duties take them into the vicinity of aircraft be familiar with both general safety precautions and with the specific precautions for the model with which they are associated. The following partial list of safety precautions is not intended to represent a complete listing. It is intended to serve merely as a guide to illustrate the general types of safety items which must be included in the safety education and training programs of all aviation activities.

1. Appropriate warning signs must be placed in or around aircraft or work areas whenever and wherever an unsafe condition is known or thought to exist. Strict attention and adherence to the signs must be enforced.

2. Smoking regulations and prohibitions must be observed and strictly enforced. Since explosive vapors may be ignited from any source of open flame or from electrical arcing, these conditions are subject to the same restrictions as smoking.

3. Radio and radar transmitters should not be trained on potentially explosive areas or on personnel, nor should they be operated in close proximity to flammable or explosive materials or vapors. This hazard is discussed in considerable detail in a later portion of this chapter.

4. Storage batteries or electric cables should not be disconnected or removed from their circuits in any enclosed space immediately following flight or fueling operations without first ventilating the space to remove accumulated vapors. All switches should be opened and all electric power disabled prior to disconnecting batteries or electric cables.

5. Combustible materials such as rags and clean waste should be stowed in covered metal containers. Used waste and rags should never be discarded near aircraft; they should be put into plainly marked metal containers.

6. Aircraft should be parked with parking brakes set, chocks in place, and tiedowns installed. If manila rope is used for tiedowns, some slack must be allowed; manila rope will shrink when wet, and may result in undue strain on the aircraft.

7. During jet engine runup, foreign objects may be drawn into the intake ducts, causing damage to the engine compressor section and the danger of flying debris from the exhaust section. During maintenance procedures involving engine operation, a careful inspection of the intake ducts and surrounding areas must be performed to insure the absence of foreign objects; and engine air intake safety screens must be properly installed. Parking areas, turnup areas, taxiways, and runways

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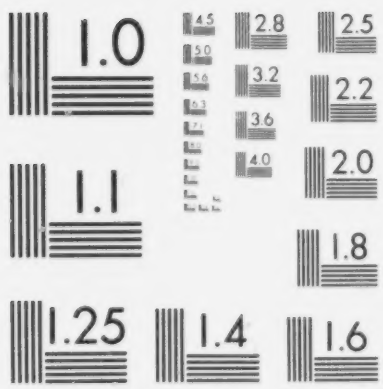

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

must be kept clean and free of stones, hardware, and other foreign objects.

MACHINERY

When working with, on, or around machinery, be constantly alert to moving parts. Never reach into the path of moving parts of a machine, either with the hands or with any other item. Always follow prescribed procedures in making adjustments on machinery while in operation; if at all possible, make the adjustments with the machinery shut down. Never wear loose, baggy, or ill-fitting clothing in the immediate vicinity of machinery. Remove rags, papers, etc., from pockets; remove ties, wristwatches, rings, etc.; button shirt sleeves; make sure dogtags are inside the undershirt or removed completely.

ELECTRICAL EQUIPMENT

The safety precautions and considerations listed above for machinery apply also to electrical equipment. In addition to the danger of being grabbed or struck by moving parts, electrical equipments also present the dangers of fire, explosion, electrical shock, and burns.

Electrical equipment should never be operated in areas where explosive vapors are present or suspected, unless the equipment is of the special explosion-proof designs made expressly for use in such areas.

When working with, on, or around electrical equipment, avoid contact with power circuits. If it is necessary to work on energized circuits or on electrical equipment while in operation, use adequate protective materials (rubber gloves, insulated tools, insulating matting, etc.) and extreme care. Never work on electrical equipment when standing in water, when perspiring heavily, or when in contact with metal decks or other metallic structures or equipment. When preparing to work on deenergized electrical circuits, make sure the power switch is off, and then use a grounding probe to eliminate any residual charge that may exist in the circuit.

These precautions apply to low voltage equipments as well as to high voltage equipments. It must be remembered, in connection with electrical shock and burns, that it is the current that does the damage, not the voltage.

VOLATILE FLUIDS

Volatile fluids are liquids which evaporate rapidly at relatively low temperatures. In this discussion, the term will be used to include pressurized gases escaping from their containers. In safety considerations, two main types of fluids must be considered: First, those which result in explosive vapors; and second, those which are toxic.

Explosive Vapors

Aviation fuels, alcohol, painting materials and supplies, insulating varnish, certain cleaning supplies, and many industrial gases produce potentially explosive vapors when allowed to accumulate in closed spaces. The hazards relating to these materials are associated with the FLASHPOINT of the liquid. This is the lowest temperature at which the liquid gives off vapor which accumulates near the surface in sufficient quantity to form a combustible mixture with air. Although liquid oxygen does not have a flashpoint, the explosive effect is the same. Almost any material that will oxidize becomes highly explosive when in the presence of liquid oxygen.

The flashpoint varies with specific materials. Personnel working with volatile materials should become familiar with the characteristics of the particular materials with which they are associated. They should know the flashpoint and also the concentration which constitutes a combustible mixture.

A general safety rule regarding explosive vapors is to always provide adequate ventilation so as to prevent accumulation of vapors, or to dispel accumulated vapors prior to operating electrical equipment in that space. The presence of an odor of gasoline or other flammable or explosive vapors is not a reliable indicator of flammability, since the ability to detect odors varies between observers.

Toxic Vapors

Some liquids, upon evaporating, produce vapors which are harmful to personnel. Carbon

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The University of Arizona, College of Agriculture, and U. S. Department of Agriculture cooperating

CHARACTERISTICS OF CUCURBIT VIRUSES

Virus	Distribution	Importance in Arizona	Transmission	SYMPTOMS		
				Squash & Cucumber	Cantaloupe	Watermelon
Cucumber Mosaic Virus CMV	Restricted to areas near towns, dooryard gardens or sugar beet fields.	Very important when present.	Aphids	Severe stunt, chlorosis, mosaic. Fruit distorted, discolored.	Severe stunt, mosaic, chlorotic mottle in leaves, fruit size reduced.	Infection rare
Watermelon mosaic virus WMV	Most widespread of cucurbit viruses.	Most important in state as a whole.	Aphids	Mild stunt mosaic in leaves, fruit distorted, discolored.	Mild stunt mosaic and severe leaf distortion. Fruit size reduced.	Mild stunt, mosaic and occasionally severe leaf distortion, fruit size may be reduced.
Curly Top virus CTV	Sporadic in central Arizona. Rare in Yuma area.	Very important when present.	Leafhopper	Severe stunt. Late infections produce less damage.	Severe stunt. Late infections cause less damage.	Severe stunt when infected early.
Squash mosaic virus SMV	Very limited in Arizona.	On squash only, when present.	Cucumber beetles, seed.	Stunt, severe leaf distortion, fruit distorted, discolored.	Mild mottle, little damage.	No infection.
Watermelon Stunt Strain of SMV WSV	Very limited except in fall months.	On squash and watermelon only, when present.	Cucumber beetles, seed.	Relatively mild leaf mosaic, fruit distorted, discolored.	Green vein banding, initial symptoms later fade away.	Very severe stunt, chlorosis and necrosis.
Cucurbit latent virus CLV	Very widespread.	Not known but seems to be of little importance.	Aphids	No visible symptoms, infection does occur.	No visible symptoms, infection does occur.	No visible symptoms, infection does occur.

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tetrachloride is an effective solvent, an excellent cleaning material, and an excellent fire extinguisher—but it produces vapors so toxic that its use for any purpose is specifically prohibited by Navy directives. Many other materials are either prohibited or very rigidly limited for use. In most instances, the precautions are listed on the container. These precautions must at all times be rigidly adhered to and enforced. Safe substitutable materials should be used whenever permissible.

Safety considerations require that all personnel make themselves familiar with the hazards involved in the use of all materials. Toxic materials and vapors may be easily detectable, or they may be almost completely undetectable; they may act very slowly, or they may act almost instantly; they may cause discomfort, temporary damage, permanent injury, or even death; they may or may not be explosive in addition to being toxic. Toxic vapors may produce headache, dizziness, nausea, and a general feeling of illness. They may cause a gradual loss of interest, energy, or awareness. They may result in unconsciousness. They may cause temporary or permanent damage to the respiratory system, eyes, or skin. They may cause paralysis or death. Avoid prolonged exposure to vapors not known to be safe.

CONFINED SPACES

When personnel are working in confined spaces, adequate ventilation must be provided. This includes oxygen for normal breathing, cooling to prevent heat exhaustion, air movement and exchange to prevent hazardous accumulations of vapors, and an additional or alternate source of ventilation for use in the event of emergency. Whenever a worker is sent into a confined space for any reason, provisions should be made in advance for his rescue in the event of accident or emergency. These provisions include the use of safety lines for locating the worker and for retrieving him from the space. Some means of communication must be established so that the conditions existing inside and outside the space may be made known to personnel concerned. A safety man must be provided to keep a constant check on the condition of the space and the worker, and he must be prepared to sound the alarm for additional help or to render assistance to the worker in the confined space, as required.

Fumes tend to collect in confined spaces, so the condition of the space should be checked prior to entry. The worker should also check conditions as he enters and monitor them during his stay. He should maintain constant communication with his safety man and inform him of any abnormal conditions that may exist.

Equipment used by personnel working in confined spaces is a matter of considerable importance. Enough light should be provided so that he can see clearly what he is doing. The light provided should be insulated so that it does not present a shock hazard (confined spaces are usually quite warm, and a safety light produces additional heat, so perspiration may become a serious problem). When possible, explosion-proof equipment should be used in confined spaces, and protective clothing should be used if toxic fumes are known or suspected to exist within the space.

TOOLS

To prevent tragic and unnecessary damage to aircraft or equipment, loss of human life, or personal injury, it is necessary to develop and to practice careful, safe, and clean work habits. All tools and equipment used should conform to Navy standards as to quality and type, and should be used only in the manner and for the purpose intended. All tools in active use should be maintained in good repair, and all damaged or nonworking tools should be replaced through supply channels. When a job is completed, or when work is interrupted, all tools should be counted and returned to the toolboxes or to the tool issue room. This should be done as carefully as a surgeon accounts for all his instruments following a major operation.

Handtools

Detailed information on the use, care, and selection of general tools is contained in the Rate Training Manual, Basic Handtools, NavPers 10085-A. Chapter 7 of this course presents information on specific tools used by avionics technicians. Appropriate study and frequent review of these sources are recommended for all personnel using or supervising

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the use of tools. The following paragraphs point out a few malpractices sometimes found among maintenance personnel.

Care should be taken in selecting the proper type pliers or cutters for the specific job. Pliers or cutters should not be used on nuts or pipe fittings–wrenches are made for this purpose. When cutting short pieces of wire, rivets, or other materials, take precautions that the clippings do not fly and cause eye injury; wear goggles and be careful.

A screwdriver used for electrical work should have a nonconducting handle. Screwdrivers should never be used as a substitute for a punch, chisel, or prybar. The screwdriver selected should be of the proper type and size for the screw on which it is to be used. The tip of the screwdriver should be kept in the proper shape and condition–broken or defective screwdrivers should be discarded and replaced.

Wrenches should be used only if they are in good condition and if they are right for the job. Never use a wrench as a hammer, and never put an extension on the handle to increase torque. An adjustable wrench should be used so that the movable jaw is forward in the direction of turning. When working in close spaces, use a grip that will not endanger the fingers and knuckles if the wrench should slip.

Portable Power Tools

All portable power tools should be carefully inspected prior to use to insure that they are clean and in the proper state of repair. Switches should operate in a normal manner, cords should be free of defects, and the casings of all electrically driven tools should be properly grounded. When using or preparing to use any portable power tools, the cords, hoses, or cables should not be allowed to kink, nor should they be left where they may be run over or constitute a tripping hazard. They should not be allowed to come into contact with oil, grease, hot surfaces, chemicals, or sharp objects. When damaged, they should be replaced, never patched with tape.

Sparking electric power tools or equipment should never be used in any space where flammable vapors, gases, liquids, or explosives are suspected. When unplugging electrical tools or equipment from receptacles, first turn the equipment off, then grasp the plug (not the cord) to remove the plug from the receptacle. Stow the tool in its proper place.

ELECTRIC DRILL.–When using a portable power drill, grasp it firmly during operation to prevent bucking or breaking loose with possible injury to the user or damage to the tool or material. Use only straight, undamaged, and properly sharpened drill bits. Tighten the bit securely in the chuck, using the key provided (never tighten the chuck with wrench or pliers). The bit should be set straight and true in the chuck and the work firmly clamped. When drilling metal, the work should be marked with a center punch before beginning the drilling operation.

SOLDERING IRON.–The soldering iron is a fire hazard and a potential source of burns. Always assume that a soldering iron is hot; never rest the iron anywhere but on a metal surface or rack provided for that purpose. Keep the iron holder in the open to minimize the danger of fire from accumulated heat. Do not swing or flip the iron to dispose of excess molten solder–a drop may strike someone, or strike the equipment and cause a short circuit. Keep the head and hands away from the hot end of the iron; hold small soldering jobs with pliers or clamps. Position the ends of wires and cables so that they do not endanger the face or the eyes; never flip the wires to remove excess solder. When cleaning the iron, place the cleaning rag on a suitable surface and wipe the iron across it–do not hold the rag in the hand. Disconnect the iron when leaving the work, even for a short time–the delay may be longer than planned.

GROUNDING.–A poor safety ground, or one that is wired incorrectly, is more dangerous than no ground at all. The poor ground is dangerous because it does not offer full protection, while the user is lulled into a false sense of security. The incorrectly wired ground is a hazard because one of the line wires and the safety ground are transposed, making the shell of the tool "hot" the instant the plug is connected. Thus the unwary user is trapped, unless by pure chance the safety ground is connected to the grounded side of the line on a single-phase grounded system, or no grounds are present on an ungrounded system. In this instance the user again goes blithely along using the tool until he encounters a receptacle which has its wires transposed or a ground appears on

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the system. Because there is no absolutely foolproof method of insuring that all tools are safely grounded (and because of the tendency of the average sailor to ignore the use of the grounding wire), the old method of using a separate external grounding wire has been discontinued. Instead, a 3-wire, standard, color-coded cord with a polarized plug and a ground pin is required. In this manner, the safety ground is made a part of the connecting cord and plug. Since the polarized plug can be connected only to a mating receptacle, the user has no choice but to use the safety ground.

All new tools, properly connected, use the green wire as the safety ground. This wire is attached to the metal case of the tool at one end and to the polarized grounding pin in the connector at the other end. It normally carries no current, but is used only when the tool insulation fails, in which case it short circuits the electricity around the user to ground and protects him from shock. The green lead must never be mixed with the black or white leads which are the true current-carrying conductors.

Check the resistance of the grounding system with a low reading ohmmeter to be certain that the grounding is adequate (less than 0.1 ohm is acceptable). If the resistance indicates greater than 0.1 ohm, use a separate ground strap.

Some old installations are not equipped with receptacles that will accept the grounding plug. In this event, use one of the following methods:

1. Use an adapter fitting.
2. Use the old type plug and bring the green ground wire out separately.
3. Connect an independent safety ground line.

When using the adapter, be sure to connect the ground lead extension to a good ground. (Do not use the center screw which holds the cover plate on the receptacle). Where the separate safety ground leads are externally connected to a ground, be certain to first connect the ground and then plug in the tool. Likewise, when disconnecting the tool, first remove the line plug and then disconnect the safety ground. The safety ground is always connected first and removed last.

GENERAL HAZARDS

In addition to the specific hazards encountered in electronic maintenance and the obvious dangers involved in falling, tripping, slipping, colliding, etc., the technician is concerned with other general classes of hazards. The following paragraphs, although by no means a complete coverage, will present some pertinent details and general information concerning a few of the most important ones.

FIRE AND EXPLOSION

Although fire and explosion are frequently associated with one another, they may also exist separately. Considerable detail on these subjects is included in Basic Military Requirements, NavPers 10054-B. Study and review of this material will provide a foundation for the specific information presented in this part of this chapter. Information is available in other Navy Training Courses, including the following: Seaman, NavPers 10120-E; Airman, NavPers 10307-C; Military Requirements for Petty Officer 3 & 2, NavPers 10056-B; and Standard First Aid Training Course, NavPers 10081-B.

Fire

A general discussion of the nature of fire, the classes of fires, firefighting systems and equipment, protective clothing and equipment, and fire prevention is contained in chapter 14 of the Rate Training Manual, Basic Military Requirements, NavPers 10054-B. General information concerning aircraft crash rescue and firefighting is found in chapter 15 of Airman, NavPers 10307-C. Specific details relating to firefighting and rescue procedures for a particular model aircraft may be found in the technical manuals published for that model aircraft. Standard First Aid Training Course, NavPers 10081-B, contains general procedures for the rescue of personnel from fire and first aid treatment for fire victims. A thorough study and a review of these references are an obligation of all personnel. Since this material is found in publications which are generally available to

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naval aviation personnel, it is not presented in detail in this course. However, some details of special interest are summarized in the following paragraphs.

In the case of electrical fires, the following steps should be taken:

1. Deenergize the electrical circuit involved, and any other electrical circuits that may interfere with the proper control or extinguishing of the fire, or which may constitute a hazard to the firefighters.

2. Call the fire department. This should be done even if it is a "small fire" that can be "easily" controlled or extinguished. This is a precautionary measure to be taken in the event of unforeseen complications or miscalculation.

3. Attempt to control or extinguish the fire if possible, using the appropriate fire extinguisher and firefighting procedure.

4. Make a full report on the fire to the appropriate authority. The fire marshal has complete information as to the proper forms and reports, and should be contacted for assistance if needed. However, this does not relieve the person discovering the fire from his responsibility in this matter.

For combating electrical fires, a CO_2 (carbon dioxide) fire extinguisher is best. The carbon dioxide should be directed to the base of the flame, where it will serve two purposes: It cools the area, and it decreases the percentage of oxygen present at the fire. However, for major fires of any type in confined spaces, the excessive use of carbon dioxide may be dangerous, due to the decreasing of oxygen content.

Carbon tetrachloride should not be used for firefighting, because it is converted into phosgene gas (a deadly poisonous gas) upon contact with hot metals. Even in open spaces this gas creates a serious hazard, and the use of carbon tetrachloride is specifically prohibited.

Application of water to electrical fires may be dangerous to personnel and injurious to equipment, because of the electrical conductivity of water and the corrosive properties of water when used on metallic substances.

Foam type fire extinguishers should not be used on electrical fires because the foam is electrically conductive.

Avoid inhaling flames or smoke from fires, as these may cause serious injury or death if breathed to excess.

Special precautions must be taken if the fire is in an enclosed or confined space. Local regulations will detail the appropriate procedure to be followed in this event.

In the case of cable fires in which the inner layers of insulation (or insulation covered by armored or shielded cable) are burning, the only positive method of preventing the fire from running the length of the cable is to cut the cable and separate the ends.

Fumes of an explosive, toxic, or corrosive nature are generated in the combustion of certain substances. This will be discussed in a later portion of this chapter.

Explosion

Explosion may be caused by fire or may be the cause of a fire—or the two may be unrelated. It may be the result of a chemical action, heat, mechanical malfunction, or other causes. An explosion is generally accompanied by a loud noise and a sudden buildup pressure. Several types of explosions are of interest to the technician in the performance of his normal duties.

The accumulation of combustible fumes or vapors from fire or from evaporating liquids represents a potential hazard. A spark or increase in heat from any cause or certain chemical combinations, may trigger the explosion.

An explosion in the presence of fire may result in the rapid spread of that fire. An explosion in the presence of combustible materials may cause a fire to start.

An explosion may result in flying debris which will act as shrapnel and may cause severe personnel injuries. In the event of severe explosion, nearby personnel may suffer from the concussion effect of the blast.

In addition to the fire-caused accumulation of combustible vapors and the accumulation of combustible gases in the vicinity of fire or electric sparking, there are several other explosion hazards. A few of these are discussed in the following paragraphs.

Some equipments are pressurized and are susceptible to explosion in the event of excessive pressurization or mechanical failure of any part of the pressurized system. In this event, the major hazard of the explosion is the creation of shrapnel, or the increased danger of arcing in the absence of the pressurization. Implosion,

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like explosion, results in creation of shrapnel, frequently with toxic materials coating the splinters. The rapid collapse of glass vacuum tubes is an example of implosion which is of prime importance to electronics personnel.

Explosive ordnance devices are sometimes installed on aircraft or placed adjacent to the aircraft preparatory to loading. Accidental operation of switches may result in the firing of these devices. The technician, when operating any equipment in the aircraft, must keep himself constantly aware of any electrically initiated ordnance devices in the vicinity of his aircraft, and must observe all precautions which apply to the situation. When missiles or weapons are installed, only fully qualified personnel should be permitted to operate any electronic equipment in the aircraft. A definite possibility of detonation of ordnance devices by radiated RF energy is also known to exist. This hazard is discussed later in the chapter under RF radiation hazards.

FUMES

The term FUMES refers to vapors, gases, or smoke, especially those that are strong or dangerous, or which have a potent odor. For purposes of this discussion, fumes may be classified as toxic, explosive, corrosive, poisonous, suffocating, or irritating. They may result from fire, evaporating liquids or solids, chemical action, or overcrowding in confined or poorly ventilated spaces. They may be easily detectable, or almost impossible to detect. They may represent a single hazard, or they may represent a combination of several distinct hazards.

Fuels

The vapors from nearly all hydrocarbon fuels present hazards of fire and explosion as previously discussed; in addition, they are toxic. When breathed in heavy concentration, or for prolonged periods, they may result in permanent damage to the respiratory system, loss of consciousness, paralysis, and/or death. For these reasons, numerous safety regulations and detailed procedures have been issued regarding fuels and fueling operations. In general, the most important of these regulations require rigid enforcement of the NO SMOKING rules, adequate ventilation, restrictions on the use of electrical equipment, use of special equipment, and the presence of manned firefighting equipment.

Painting Supplies and Materials

Most paints and thinners, and many other painting supplies, emit vapors which are both flammable and toxic. Regulations require these items to be stored in closed containers in a noncombustible enclosure isolated from living, working, or ordinary storage spaces. Use of the material is restricted to well-ventilated areas, and in many cases, special equipment and clothing are made available for use.

Battery Fumes

In the standard lead-acid storage battery, explosive fumes are generated by chemical action. In the charging operation, hydrogen is released. Hydrogen is a highly combustible gas, which is violently explosive when in strong concentration. The newer nickle-cadmium batteries do not present this hazard, but do present other hazards as covered in a later discussion. Battery lockers are subject to very strict safety regulations with special emphasis on smoking restrictions and ventilation requirements.

Smoke

Smoke, a byproduct of fire, represents a toxic and suffocating hazard. In addition, there are other fumes frequently present in smoke. These fumes, products of combustion or of increased evaporation, may be poisonous, corrosive, or explosive. It has been previously mentioned that carbon tetrachloride, upon coming into contact with hot metals, is converted into deadly phosgene gas. There are many other materials which are converted by heat or combustion from relatively harmless substances into lethal fumes.

Carbon monoxide is present in nearly all smoke, and is the most common cause of "smoke poisoning" among firefighters and fire victims. Unless the victim is removed from the smoke and administered artificial respiration and/or oxygen, death may result.

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The use of gas masks, breathing apparatus, and safety lines is prescribed under certain firefighting situations.

Miscellaneous Materials

Many other general classes of materials contain substances which produce hazardous fumes. These materials should be used only according to specified procedures. Some of these material classes are cleaning materials, insecticides, preservatives, solvents, adhesives, and finishes.

Although not technically classified as fumes, dust and small particles from grinding operations present similar hazards and require precautions similar to those taken for fumes.

CHEMICALS

The subject of chemical warfare (and its agents, treatments, and preventive measures) is treated in detail in Navy Training Manuals for which the prospective PO 3 or 2 is responsible. Among these manuals are Basic Military Requirements, NavPers 10054-B; Military Requirements for Petty Officer 3 & 2, NavPers 10056-B; and Standard First Aid Training Course, NavPers 10081-B.

RADIOACTIVITY

Radioactive materials are in common usage throughout the Navy, and particularly in the electronics field. Common radioactive materials familiar to most technicians include the luminous dials on watches and various instruments, and the luminescent markings on equipment. Radioactive material is intentionally added to many special purpose electron tubes to produce a continuous supply of ionized particles to insure that the tube will always ionize at the same voltage. The principal radioactive materials contained in these tubes include certain isotopes of carbon (C^{14}), cesium (Cs^{137}), cobalt (Co^{60}), nickel (Ni^{63}), and radium (Ra^{226}). These tubes are usually the TR and ATR tubes, glowlamp and cold cathode type tubes, and certain spark gap tubes. With proper precautions and procedures, these materials present no serious hazard; with careless or improper treatment, however, the hazard may become very serious.

Radioactive materials emit rays which may cause changes in living tissue with subsequent injury to the body. The amount of change, and therefore the seriousness of the injury, increases with the amount of radiation absorbed. The absorption of radiation is cumulative, and the repair of damaged tissue is slow; therefore, the hazard level is based on the total amount of radiation absorbed as well as on the rate of absorption.

The primary hazard considered in this discussion is injection of radioactive substances into the bloodstream through a cut or an abrasion, or through penetration of the skin by glass slivers from broken tubes. This type injury may be quite serious, even with minute quantities of radioactive materials injected. The materials injected are carried throughout the body by the bloodstream, and tend to accumulate in certain organs or parts of the body. In addition to the radiation effects, they also cause a type of poisoning similar to chemical poisoning.

A wound caused by a radioactive particle requires treatment by a medical officer as soon as possible, regardless of the size of the wound. The hazard of radioactive particles being left in a wound CANNOT BE IGNORED.

There are no known antidotes for poisoning from radioactive particles which remain in the body. Treatment of radiation sickness is complicated and lengthy. Even with the best medical attention, the results are often inconclusive. However, progress continues in this field and close liaison with the medical department will insure that the latest first aid procedures and medical treatment are used.

Inhalation of minute particles of radioactive dust can cause coating of the mucous membranes, with resultant poisoning and increased radiation effects. Once lodged in the nasal passages or throat, these particles are very difficult to remove–in the lungs they are even more difficult.

Contamination of the skin by radioactive materials may produce radiation burns resembling the temporary redness of a mild sunburn (or in severe cases, a serious flame burn which destroys the skin). All such cases should be reported to the medical authorities immediately; with proper medical care, complete recovery may be expected except in extreme

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cases involving severe burns over an extensive area. This type injury is rare.

Detection

Radioactive radiation is completely undetectable through use of the human senses; detection relies upon the use of special equipment. The methods of detection and the types of radioactivity detectors are discussed in chapter 15 of the Rate Training Manual, Basic Military Requirements, NavPers 10054-B. Coverage of the subject in this course is limited to a brief discussion of the various conditions and places which require monitoring.

Storage areas containing instruments, equipments, or tubes with radioactive materials should be monitored periodically to insure that the radiation level does not exceed allowable limits. Specifically, the air intake and exhaust screens or filters should be monitored prior to cleaning. All areas surrounding the breakage of any tube containing radioactive material, or the flaking of radioactive paint or markings, should be monitored to help locate all the radioactive material. These areas should be monitored again following decontamination to determine the effectiveness of the procedures used. Personnel should be monitored whenever contact with radioactive materials is suspected, or following participation in decontamination activities.

Precautions

The following safety practices should be observed to minimize the hazard present by radioactive materials:

1. Tubes or instruments should not be removed from cartons until immediately prior to actual installation. This serves two purposes—to prevent accidental breakage, and to avoid the possibility of concentrating several radioactive sources in a small volume (which would increase the effective intensity of radiation).

2. When a radioactive component is removed from equipment, it should be placed in an appropriate carton to prevent possible breakage.

3. Items containing radioactive materials should never be carried in a pocket or elsewhere about the person in a manner that flaking or breakage can occur.

4. Extreme care should be exercised in the handling of these items while installing or removing them from equipment.

5. Tubes should never be broken intentionally; however, if breakage does occur, material contaminated by radioactivity should not be allowed to come in contact with any part of the body at any time. Take care to avoid breathing any dust or vapor (such as radon gas, a highly radioactive substance) which may be released by such breakage. Immediately locate all broken pieces, and isolate the area until the broken pieces have been removed or declared nonradioactive by test with an adequate radiation-sensitive device.

6. No food or drink should be brought into the contaminated area or near any radioactive material.

7. Immediately after leaving a contaminated area, personnel who have handled radioactive material in any way should remove contaminated clothing. They should wash their hands and arms thoroughly with soap and water, especially before eating, drinking, or smoking.

8. When a wound caused by a sharp radioactive object is sustained, report to medical authorities for treatment as soon as possible.

Decontamination and Disposal

When cleaning a contaminated area, rubber or plastic gloves should be worn. Large fragments of a broken tube should be removed with the aid of some tool such as forceps, if they are available. The remaining particles can be removed with a vacuum cleaner, using a disposable collecting bag, or by wiping a wet cloth across the area. (If the breaking of tubes is a frequent occurrence, care should be given to selecting the best type of collecting bags.)

If a wet cloth is used, make one stroke at a time, and fold the cloth in half after each stroke, always using a clean side. When the cloth becomes too small, discard it and continue with a clean piece. Be careful not to rub the radioactive particles into the surface by using a back-and-forth motion. All debris, cloths, and bags used for cleaning should be sealed in a container such as a plastic bag, heavy waxed paper, or a glass jar, and placed in a steel can for disposal.

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Radioactive waste materials and sweeper bags should not be disposed of individually. They should be collected in a designated steel container with a tight-fitting lid and suitable marking until a reasonable quantity for disposal has been gathered. Containers for radioactive materials should be marked with the radiation symbol. (See fig. 3-1.) The symbol is printed in magenta (purplish shade of red) color on a yellow background.

Radioactive waste can be disposed of by burying in soil or by sinking in the ocean. Detailed information concerning the disposal of radioactive materials is contained in BuShips Instruction 5100.15.

ELECTRICAL HAZARDS

Every person who works with electronic equipment should be constantly alert to the hazards of the equipment to which he may be exposed, and also be capable of rendering first aid to injured personnel. The installation, operation, and maintenance of electronic equipment requires enforcement of a stern safety code. Carelessness on the part of the operator or the maintenance technician can result in serious injury or death due to electric shock, falls, burns, flying objects, etc. After an accident has happened, investigation almost invariably shows that it could have been prevented by the exercising of simple safety precautions and procedures with which the personnel should have been familiar.

Each man concerned with electronic equipment should make it his personal responsibility to read and become thoroughly familiar with the safety practices and procedures contained in applicable safety directives, manuals, and other publications, and in equipment technical manuals prior to performing work on electronic equipment. It is the individual's responsibility to identify and eliminate unsafe conditions and unsafe acts which cause accidents.

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Figure 3-1.—Radiation symbol.

INJURIES FROM ELECTRICITY

Damage to the body may be caused by the passage of electric current over the skin or through the body. In any case, it is important to remember that it is the current, not the voltage, that causes the damage. This current, if of sufficient magnitude, may cause asphyxiation, burns, and/or shock. Because individuals differ in susceptibility to electrical shock and its associated hazards, exact figures are hard to determine.

However, the current magnitude resulting from application of any voltage varies inversely with resistance. When dry, the body has a comparatively high resistance. When moist, however, body resistance is greatly reduced. Even "low voltage" can be extremely hazardous under conditions of heavy perspiration or damp surroundings.

Symptoms of electric shock, and procedures for rescue of electric shock victims are discussed in Standard First Aid Training Course, NavPers 10081-B. Since this topic is of such great importance to all personnel involved in electronics, that material should be studied with great care.

GENERAL PRECAUTIONS

Take time to be safe when working on electronic circuits and equipment. Carefully study the schematics and wiring diagrams of the entire system, noting what circuits must be deenergized in addition to the main power supply. Remember that electronic equipments frequently have more than one source of power. Be certain that ALL power sources are deenergized before servicing the equipment. Do not service any equipment with the power on unless it is necessary.

It must be borne in mind that deenergizing main supply circuits by opening supply switches will not necessarily "kill" all circuits in a given piece of equipment. A source of danger that has often been neglected or ignored—sometimes with tragic results—is the inputs

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to electronic equipment from other sources, such as synchros, remote control circuits, etc. For example, turning off the antenna safety switches will disable the antenna, but it may not turn off the antenna synchro voltages from other sources. Moreover, the rescue of a victim shocked by the power input from a remote source is often hampered because of the time required to determine the source of power and turn it off. Therefore, turn off ALL power inputs before working on equipment.

Remember that the 115-volt power supply voltage is not low, relatively harmless voltage, but is the voltage that has caused more deaths in the Navy than any other.

Do NOT work with high voltage circuits by yourself; have another person (safety observer), who is qualified in first aid for electrical shock, present at all times. The man stationed nearby should also know the circuits and switches controlling the equipment, and should be given instructions to pull the switch immediately if anything unforeseen happens.

Always be aware of the nearness of high voltage lines or circuits. Use rubber gloves where applicable, and stand on approved rubber matting (MIL-M-15562). Not all so-called rubber mats are good insulators.

Equipment containing metal parts, such as brushes and brooms, should not be used in an area within 4 feet of high voltage circuits or any electric wiring having exposed surfaces.

Inform remote stations as to the circuit on which work is being performed.

Keep clothing, hands, and feet dry if at all possible. When it is necessary to work in wet or damp locations, use a dry platform or wooden stool to sit or stand on, and place a rubber mat or other nonconductive material on top of the wood. Use insulated tools and insulated flashlights of the molded type when required to work on exposed parts.

Do not wear loose or flapping clothing. The use of thin-soled shoes with metal plates or hobnails is prohibited. Safety shoes with nonconducting soles should be worn if available. Flammable articles, such as celluloid cap visors, should not be worn.

When working on electronic or electrical apparatus, technicians should first remove all rings, wristwatches, bracelets, ID chains and tags, and similar metal items. Care should be taken that the clothing does not contain exposed zippers, metal buttons, or any type of metal fastener.

Do NOT work on energized circuits unless absolutely necessary. Be sure to take time to lock out (or block out) the switch and tag it. Locks for this purpose should be readily available; if a lock cannot be obtained, remove the fuse and tag it.

Use one hand when turning switches on or off. Keep the doors to switch and fuse boxes closed except when working inside or replacing fuses. Use a fuse puller to remove cartridge fuses after first making certain that the circuit is dead.

All supply switches or cutout switches from which power could possibly be fed should be secured in the OPEN (safety) position and tagged. The tag should read "THIS CIRCUIT WAS ORDERED OPEN FOR REPAIRS AND SHALL NOT BE CLOSED EXCEPT BY DIRECT ORDER OF _____" (the person making, or directly in charge of, repairs).

Never short out, tamper with, or block open an interlock switch. Keep clear of exposed equipment; when it is necessary to work on it, use one hand only as much as possible.

Warning signs and suitable guards should be provided to prevent personnel from coming into accidental contact with high voltages.

Avoid reaching into enclosures except when absolutely necessary; when reaching into an enclosure, use rubber blankets to prevent accidental contact with the enclosure.

Do not use bare hands to remove hot tubes from their sockets. Use asbestos gloves or a tube puller.

Use a shorting stick, similar to the one shown in figure 3-2, to discharge all high voltage charges. Before a worker touches a capacitor or any part of a circuit which is known or likely to be connected to a capacitor (whether the circuit is deenergized or disconnected entirely), he should short circuit the terminals to make sure that the capacitor is completely discharged. Grounded shorting sticks should be permanently attached to workbenches where radar equipment and other types of electronic devices using high voltages are regularly serviced.

Make certain that the equipment is properly grounded. Ground all test equipment to the equipment under test.

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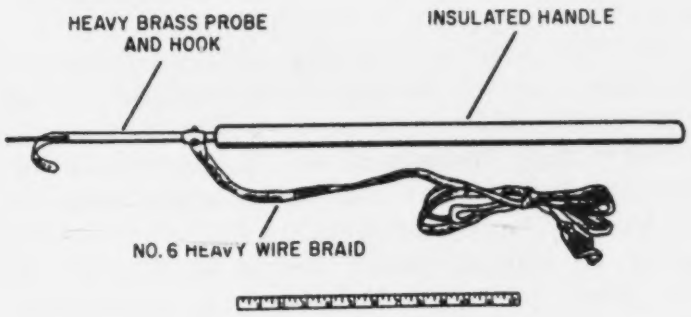

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Figure 3-2.—Shorting stick.

Turn off the power before connecting alligator clips to any circuit.

When measuring circuits over 300 volts, do not hold the test prods.

Transmitter adjustments should not be made while the equipment is energized unless the adjustments can be accomplished from the front control panel. Similar precautions should be taken with oscilloscope circuits, which employ voltages comparable to those used in transmitting equipment.

Avoid exposure to high concentration of RF radiation. When operating high power RF transmitters or radar equipment, make sure that the beam is not directed at personnel, fuel, or ordnance areas. Hazards involved in RF radiation are discussed in a later section of this chapter.

Use only rubber or insulating hose on airlines for blowing out equipment. Use no more than 10 pounds of pressure to avoid damage to the insulation and injury to personnel. Be sure the air is free from water. Never turn compressed air on yourself or others, since it can cause serious injury.

DEGREE OF SHOCK

The amount of current that may pass through the body without danger depends on the individual and the current quantity, the type, path, and length of contact time.

Body resistance varies from 1,000 to 500,000 ohms for unbroken, dry skin. Resistance is lowered by moisture and is highest with dry skin. Breaks, cuts, or burns may lower body resistance to 200 ohms. A current of 1 milliampere can be felt and will cause a person to avoid it. Five milliamperes is about the highest current safe for the average body. If the palm of the hand makes contact with the conductor, a current of about 12 milliamperes will tend to cause the hand muscles to contract, freezing the body to the conductor. Such a shock may or may not cause serious damage, depending on the contact time and your physical condition, particularly the condition of your heart. A current of only 25 milliamperes has been known to be fatal.

Generally, currents between 100 and 200 milliamperes are lethal. Ventricular fibrillation of the heart occurs when the current through the body approaches 100 milliamperes. Ventricular fibrillation is the uncoordinated actions of the walls of the heart's ventricles. This in turn causes the loss of the pumping action of the heart. Fibrillation is difficult to stop by ordinary means; therefore, it is usually fatal.

If currents of 200 milliamperes or higher pass through the body severe burns and unconsciousness result. Generally, in these cases the heart will not fibrillate but will be stopped. The victim will usually respond if by some means the heart is caused to start again. The heart may respond if resuscitation in the form of artificial respiration is given to the victim.

When a person is rendered unconscious by a current passing through the body, it is impossible to tell how much current caused the unconsciousness. Artificial respiration must be applied immediately if breathing has stopped and continued until otherwise directed by medical authority.

SPECIAL COMPONENTS

In addition to the general hazards and precautions listed previously, several components common to aviation electronic maintenance present hazards or potential hazards. The following paragraphs present a brief summary of some of the more important of these components and their hazards.

Selenium Rectifiers

When selenium rectifiers burn out, fumes of selenium dioxide are liberated, causing an overpowering stench. The fumes are poisonous

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Prepared from information supplied by Dr. Merritt R. Nelson, Department of Plant Pathology, University of Arizona.

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and should not be breathed. If a rectifier burns out, deenergize the equipment immediately and ventilate the compartment. Allow the damaged rectifier to cool before attempting any repairs. If possible, move the equipment containing it out of doors. Do not touch or handle the defective rectifier while it is hot, since a skin burn might result, permitting some of the selenium compound to be absorbed.

Batteries

Battery hazards are most common during the charging process and during the installation and removal process. The weight and clumsiness of the battery contribue to the strain hazard; commonsense and routine attention to detail minimize this hazard. All rechargeable storage batteries should be charged in strict accordance with the manufacturer's recommendations.

LEAD-ACID.–Lead-acid storage batteries present hazards of acid burn, explosion, and strain. Burns may be prevented by the proper use of eyeshields, rubber gloves, rubber aprons, and rubber boots with nonslip soles. This protective clothing should be worn whenever refilling, checking, transporting, or charging batteries. Explosion may result from accumulation of hydrogen gas during charging operation. Proper ventilation and strict enforcement of the no smoking rules are mandatory.

NICKEL-CADMIUM.–The electrolyte used in nickel-cadmium (NiCad) batteries is potassium hydroxide (KOH), a highly corrosive alkaline solution which should be handled with the same degree of caution as sulfuric acid. If KOH is sprayed on any material, wash it immediately with liberal quantities of water and neutralize the affected area with vinegar or a weak solution of acetic acid.

An extremely violent explosion would occur if KOH were added to a lead-acid battery or if sulfuric acid were added to a NiCad battery. Although there is no valid excuse for such an occurrence, inattention to detail can make it possible. All battery electrolytes should be kept in clearly marked containers and should, if possible, be kept in different storage areas when not in use.

MERCURY CELL.–Under certain conditions, mercury dry cells or batteries may explode. The most common cause of explosion is overloading the battery (with the subsequent heating and ignition of hydrogen gas within the cell). The loading capacity of the battery is decreased as the battery is discharged. When a mercury cell (or any cell within a mercury battery) has discharged to 70 percent of its nominal voltage, the cell or battery should be replaced. Discharged mercury batteries should never be stored; holes should be punched in the steel jacket and the battery discarded.

Cathode-Ray Tubes

Extreme caution should be exercised in handling a cathode-ray tube (CRT). The glass envelope encloses a high vacuum; and because of the large surface area, the envelope is subjected to considerable total force due to atmospheric pressure. (See chapter 5 of this manual for a discussion of total force and pressure.)

The trend toward the use of larger CRT's has increased the hazard of IMPLOSION (collapse of the glass tubes as a result of atmospheric pressure). The tubes are not considered hazardous if handled properly; but if they are struck, scratched, dropped, or handled improperly in any way, they may become an instrument of severe injury or death.

When handling, installing, or removing a CRT, use extreme care to avoid contact between the tube and any sharp or hard object. Wear suitable gloves to protect the hands. Wear goggles to protect the eyes from flying glass particles in the event of implosion. The goggles should provide both side and front protection, and should have clear lenses that can withstand a rigid impact. Insert the tube carefully into the socket, using only moderate pressure. Do not jiggle the tube. Never hold it by the narrow neck. Do not stand directly in front of the face of the tube; accidental implosion may cause the electron gun or other parts to be propelled directly forward with sufficient velocity to cause severe injury. When the tube must be set down, it is important that the face be placed gently on a thick, clean, soft padding.

In addition to the hazard of implosion, rough handling may also result in displacement of the electrodes within the tube and result in

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faulty operation or nonoperation of the tube.

The chemical coating material on the face of the tube may be extremely toxic. When disposing of a broken tube, use protective devices and procedures to insure that none of this compound gets on the hands or into the skin.

Before a CRT is discarded, the danger of implosion must be eliminated. Place the defective tube face down in an empty CRT carton, carefully break off the locating pin from the tube base, and (using a small screwdriver, pliers, or a probe) break off the tip of the glass vacuum seal. (See fig. 3-3.) With the vacuum seal broken, pressure inside and outside the tube becomes equalized, and the danger of implosion is removed. However, all other hazards still remain.

Dielectric Materials

The increasing use of microwave energy and the accompanying increase in power levels have given rise to several significant problems. Among the problems which have arisen are those resulting from the use of certain dielectric materials in new environments without previous application experience. In several cases situations have developed in which personnel were exposed to potentially toxic agents as a direct result of the introduction of new substances about which little toxicological information was available.

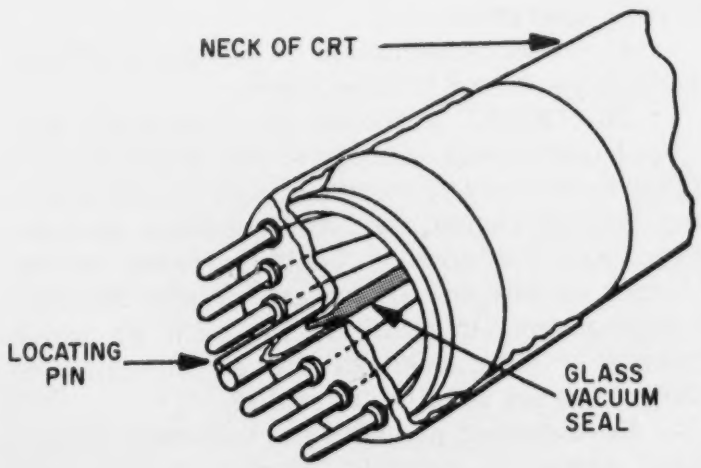

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Figure 3-3.— Constuction of cathode-ray tube base.

One example is the use of sulfur hexafluoride (SF_4) as a gas dielectric to increase power handling capability of waveguides. In its pure state, this gas is essentially inert and nontoxic. However, when arc-over occurs in a waveguide filled with the gas, decomposition products constitute a toxic gas hazard. These toxic gases, which include fluorine, may not irritate the skin, are colorless, and cannot be detected by odor. However, they may cause extreme lung irritation and hemorrhaging.

Arcing may take place periodically in the waveguide until the system fails completely, or at least until system performance drops below an acceptable minimum level. If a maintenance technician should open the waveguide while effecting repairs on the system, he may release these highly toxic agents.

When opening a waveguide pressurized with sulfur hexafluoride, personnel should use approved respiratory protective devices. All such work should be accomplished in a well-ventilated space, and the area should be cleared of all toxic hazard before allowing other personnel to enter the area.

As toxicological or other information regarding safety matters becomes available, precautionary measures and protective devices are developed, distributed, and promulgated. Until it has been ascertained that a new material or substance is completely safe, precautionary measures should be used as if definite hazards were known to exist.

RF RADIATION

Electromagnetic radiation is not visible; its presence must be detected and measured by instruments or approximated by theoretical calculations. Radiated beams of high power RF energy present a health and safety hazard. In general, health and safety factors fall into the ordnance, personnel, fuel, and miscellaneous aspects. The establishment of health and safety precautions regarding electromagnetic radiation is a joint responsibility of the Bureau of Medicine and Surgery, the Naval Air Systems Command, and the Naval Ship Systems Command. Publications which may prove valuable for further reference include Radio-Frequency Hazards Manual, NavOrd OP 3565 (a Confidential manual), and Electronics Instal-

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lation and Maintenance Book - Test Methods and Practices, NavShips 100,000.103.

The energy striking an object in an electromagnetic field may be reflected, transmitted, or absorbed; only the absorbed energy constitutes a hazard. The hazard resulting from focused concentration of such energy, like any hazard, can be rendered relatively harmless by understanding and precaution.

ORDNANCE HAZARDS

The hazards of electromagnetic radiation to ordnance (HERO) problem has become acute. The number and variety of electrically initiated explosive devices are increasing rapidly. For example, some currently operational weapons contain more than 75 electroexplosive devices. Continuing development efforts are directed toward reducing weight and space requirements, lowering power requirements, assuring positive response, and increasing safety and reliability. However, these goals are not always complementary.

At the same time, the power of communications and radar transmitting equipment is constantly being increased and the frequency spectrum broadened. The radiofrequency spectrum now used by the airborne Navy extends from 10 kHz to about 20,000 MHz. Transmitter power outputs extend to 10 kw at communications frequencies, and peak power outputs extend to approximately 5 megawatts at radar frequencies.

These trends produce situations which are in direct conflict with each other. On the one hand, transmitters and their antennas have only one purpose–to radiate electromagnetic energy. The initiating elements of ordnance devices need only to be supplied with the proper amount of electrical energy for an explosion to take place. Therefore, with many explosive ordnance items, certain precautions are required for safety and to insure reliable performance.

To meet the growing need for new procedures to reduce the hazard to ordnance equipment from RF radiation, the Naval Air Systems Command has sponsored tests which, coordinated with studies made by other agencies, have provided new guidelines and restrictions for handling electrically initiated ordnance equipment.

The basic problem in determining an ordnance system's susceptibility to RF radiation lies in the evaluation of the antennalike couplings that exist between illuminating fields and the electroexplosive devices in the system. RF energy may enter a weapon as a wave radiated through a hole or crack in the weapon skin, or it may be conducted into the weapon by the firing leads or other wires leading into the weapon.

The exact chances of electroexplosive device firing are quite unpredictable, being dependent upon such variables as frequency, field strength, positional and directional orientation, environment, and metallic or personnel contacts with the ordnance or aircraft.

The most susceptible period is during assembly, disassembly, loading, unloading, or testing in electromagnetic fields. The most likely effects of premature actuation are dudding, reduction of the reliability of the device, or propellant ignition. In extreme cases, there is a definite possibility of warhead detonation.

Some specific safety precautions which the technician must observe with respect to these weapons and ordnance devices include the following:

1. Turn off all RF transmitters during weapon handling operations in the area.
2. Observe all local and general safety and HERO restrictions.
3. Maintain radio and radar silence during assembly, disassembly, loading, unloading, or testing operations.
4. Avoid illumination of ordnance devices by high power RF transmitters.

The HERO problem is a complex one. The hazard, and therefore the solution, is a function not only of frequency and field strength, but also of geometrical configuration, orientation, and the antenna characteristics of the weapon or weapon-aircraft and weapon-launcher combinations. In general, the path by which energy is introduced to the electroexplosive devices is not readily defineable.

Development projects are underway in several areas to provide special devices and material which will have general application as HERO remedies. It is expected that some

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of these devices, and some developed by other agencies, will be valuable in the design of new weapons as well as modifications for existing weapons. Many possibilities have been and are being explored. These include shielding, filters, RF dissipating attenuators, less sensitive electroexplosive devices, exploding wires, conductive film igniters, spark gap primers, inductive firing devices, and modifications to aircraft armament circuits.

PERSONNEL HAZARDS

Development of RF systems with high power transmitting tubes and high gain antennas has increased the hazard to personnel in the vicinity of these elements. Harmful effects of overexposure to RF radiation are associated with the average power of the absorbed radiation. They are thermal in nature, and are observed as an increase in overall body temperature or as a temperature rise in certain sensitive organs of the body. The only known nonthermal effects on personnel are due to power density values considerably greater than the power densities normally associated with present RF transmitting systems.

The Bureau of Medicine and Surgery has established safe limits based on the power density of the radiation beam and the exposure time of the human body in the radiation field. All areas in which the RF levels exceed the safe limits are considered hazardous. The Naval Ship Systems Command is responsible for determining hazardous shipboard areas and for decreasing the hazard to personnel from RF radiation. Theoretical calculations and power density measurements are used to establish the distances from radar antennas within which it is not biologically safe for personnel to enter. This information is then used to determine if and where hazardous areas exist. All hazardous areas subject to entry by personnel are posted with warning signs, and the ship's intercommunication system is used to warn personnel when the radars are operating.

Personnel Safety Precautions

While every effort must be made to protect personnel from harmful exposure to RF radiation, it is not considered necessary or desirable, in general, that blanket restrictions on antenna radiation be imposed to achieve this end. The existence of such a policy would tend to restrict maintenance and checkout procedures which could otherwise be carried out in safety, provided proper precautions are taken to keep personnel clear of hazardous intensity levels. These precautions include the following:

1. Visual inspection of feed horns, open ends of waveguides, and openings emitting RF electromagnetic energy must not be made unless the equipment is definitely secured for the purpose of such an inspection.
2. Aircraft employing high power radar should be parked, or their antennas should be oriented, so that the beam is directed away from personnel working areas.
3. All personnel must observe RF hazard warning signs which point out the existence of RF radiation hazards in a specific location or area.
4. Those radar antennas which normally rotate are to be rotated continuously while radiating, or trained to a known safe bearing.
5. Nonrotating antennas must be trained and elevated away from inhabited areas, hangars, shop spaces, ships, piers, etc., while radiating.
6. Where a possibility of accidental overexposure might still exist, have a man stationed within view of the antenna (but well out of the beam and in communication with the operator while the antenna is radiating) to warn personnel of the hazard.
7. Radiation hazard warning signs should be available and must be used, not only where they are required to be permanently posted, but also where they may temporarily restrict access to hazardous areas.

FUEL HAZARDS

The increase in radiated RF energy from higher powered communications and radar equipments in recent years has increased the pontential hazard of RF-induced ignition of volatile fuel-air mixtures. This flammable condition is normally present only close to aircraft fuel vents, open fuel inlets, or spilled fuel, or during over-the-wing fueling operations. Ignition of fuel vapors in air has actually occurred; however, the probability of ignition with normal refueling conditions is remote.

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Ignition of gasoline vapors caused by RF-induced arcs is rare because ALL the following conditions must exist:

1. A flammable fuel-air mixture must be present within the range of the induced arcing.
2. The arc must contain a sufficient amount of energy to cause ignition.
3. The gap across which the arc occurs must be a certain minimum distance, and must contain a sufficient amount of the flammable mixture to ignite. The possibility of these conditions occurring simultaneously is probably statistically remote; but since the possibility does exist, care must be exercised.

MISCELLANEOUS ASPECTS

The firing of photoflash bulbs, fluorescent lamps, and neon glowlamps by electromagnetic energy from radar sets is a fairly well known phenomenon. Although this type occurrence is normally of little consequence, burns can result. Photographic personnel should be warned of the presence of any high power radar operating in the area and of the hazards involved.

In a similar manner, steel wool may be set afire, or metallic chips may produce sparks when exposed to radiation. With some high power radar sets, steel wool is ignited with a violent explosion. The presence of oil and spilled fuels in the vicinity of aircraft constitutes a serious hazard. This makes good housekeeping procedures essential.

PERSONNEL INJURIES AND SAFETY EDUCATION

The primary purpose of any safety education program is the PREVENTION of personnel injuries or material damage. For any safety program to be effective, all personnel must be aware of the potential hazards present, and they must observe all necessary precautions at all times. This part of the overall safety education program may be best directed by specially qualified personnel in each aspect of safety, or by a safety engineer if one is available.

A second, but vital, aspect of the safety education program is FIRST AID. This part of the program is usually under the direction of Medical Department personnel.

Since a complete training course of this type is quite time consuming, the most immediate requirement is to instill into all personnel a constant awareness of their actions and their surroundings. This awareness, and commonsense, are absolute essentials–without them no safety education program can be effective. The instilling and maintaining of these characteristics is best promoted by co-worker and immediate supervisory personnel.

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CHAPTER 4

PUBLICATIONS, DRAWINGS, AND SCHEMATICS

At the beginning of World War II, the field of airborne electronics was still quite small. With a little study and some experience, the technician could become quite familiar with all the electronics equipment in the type aircraft employed or supported by his unit. The equipments were comparatively simple, similar in operation and physically large enough for ease of inspection and repair. It was possible for the technician to service, maintain, and repair this equipment with perhaps only an occasional reference to a manual or a schematic.

In the present state of the art, however, this practice is no longer possible. Even a mere listing of the electronics equipment carried on some of the more modern aircraft would be quite lengthy. It is impossible for any one person to be thoroughly familiar with all the various types of electronics equipment in present use; but with a good general background of electronic principles and circuit theory, a little study will enable the technician to rapidly familiarize himself with any specific equipment.

The purpose of this chapter is to discuss some of the sources of information available to the technician, how to use these references, and how to locate details on items of information the technician needs in the performance of his duties. Included in this chapter are discussions of publications, both general and specific; drawings and schematics, including illustrations, block diagrams, and wiring and cabling diagrams; charts and tables; and a brief coverage of procedures for the handling of classified materials and information.

PUBLICATIONS

Naval publications are important sources of information for guiding personnel of the naval aeronautic organization. Generally, these publications fall into two broad groups–those dealing with operational and administrative matters, and those dealing with technical and material matters.

The Secretary of Defense approved a reorganization of the Department of the Navy, which was effective 1 May 1966. This reorganization increases the breadth of authority and responsibility of the Chief of Naval Operations under the continuing direction of the Secretary of the Navy.

The Chief of Naval Operations has three major commands under him–BuPers, BuMed, and Chief of Naval Material.

The Chief of Naval Material heads the Naval Material Command which consists of the following six commands:

1. Naval Air Systems Command.
2. Naval Electronic Systems Command.
3. Naval Ship Systems Command.
4. Naval Ordnance Systems Command.
5. Naval Supply Systems Command.
6. Naval Facilities Engineering Command.

Each of the above commands is headed by a Commander; i.e., Commander, Naval Air Systems Command.

Concurrent with the establishment of the Naval Material Command, the following office and bureaus were abolished:

1. Office of Chief of Naval Material.
2. Bureau of Naval Weapons.
3. Bureau of Ships.
4. Bureau of Supplies and Accounts.
5. Bureau of Yards and Docks.

For example, the Naval Air Systems Command is issuing its own directives and incorporating into its directives pertinent material now in BuWeps directives. Therefore, BuWeps directives and instructions will continue to be

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used and referred to in training courses for sometime to come even though the Bureau of Naval Weapons has been replaced by the Naval Air Systems Command.

Publications dealing primarily with the operation and maintenance of aircraft and related equipment within the Naval Establishment originating from the Naval Air Systems Command are issued by authority of the Commander, Naval Air Systems Command.

Publications concerned mainly with the training of flight personnel and air operations emanate from the Office of the Deputy Chief of Naval Operations (AIR).

The Naval Air Technical Services Facility functions as the sponsor of both types of publications and controls the initial distribution, distribution lists, printing, and retention of reproducible copy.

The Forms and Publications Supply Office functions as inventory manager for residual stocks of both types of publications, including the supporting distribution system and numerical cataloging.

The basic sources of technical aeronautic information are the technical manuals (formerly called handbooks) issued by the Naval Air Systems Command. Letter publications usually supplement the information contained in aeronautic technical manuals.

Technicians at the E-4 and E-5 levels are primarily concerned with technical publications; therefore, this discussion is directed mainly toward them. However, it includes some coverage of general and administrative type publications of importance to all naval personnel.

Good technical manuals are vital to the maintenance of modern weapons systems. Our Navy's combat readiness depends, to an increasing degree, on the information and knowledge possessed by maintenance personnel. If these men are to maintain increasingly complex weapons systems, incorporating the latest devices and systems, they must be able to obtain the required information from technical manuals.

The Department of Defense, the Department of the Navy, and the Naval Air Systems Command are working together to improve the standardization and quality of aeronautic maintenance manuals. The purpose of the following discussion is to present some detailed information concerning the contents and uses of these manuals.

PUBLICATIONS LISTS

Aeronautic publications originated by the Naval Air Systems Command and distributed by the Naval Air Technical Services Facility are covered by separate lists and indexes as listed below:

1. Navy Stock List of Forms and Publications, NavSup Publication 2002, Cognizance Symbol I, Section VIII, Part C. This stock list contains a numerical listing by code numbers and latest issue date of available aeronautic technical manual type publications. The date indicates the date of the basic book, latest change, or revision.

2. Navy Stock List of Forms and Publications, NavSup Publication 2002, Cognizance Symbol I, Section VIII, Part D. This stock list contains a listing of latest issue dates of aeronautic letter type publications.

NOTE: These stock lists are prepared by the Forms and Publications Supply Office, Byron, Georgia, and distributed to the mailing list maintained by the Naval Air Technical Services Facility, 700 Robbins Avenue, Philadelphia, Pa., 19111.

3. The Naval Aeronautic Publications Index, NavAir 00-500 (Series), is prepared in three volumes. It is prepared and distributed by the Naval Air Technical Services Facility. Parts A and B are issued in March and September, with supplements quarterly; Part C is issued in July and January, with no supplements.

The Equipment Applicability List, NavAir 00-500A, lists aircraft components and related equipment by model, type, and part number in alphabetical and numerical sequence with the applicable publications shown in appropriate columns. The Aircraft Application List, NavAir 00-500B, lists aeronautic manual publications with respect to their application to specific aircraft. It lists technical manuals dealing with electronics, armament, instruments, accessories, powerplants, aircraft, and certain general publications. It does not list letter type publications. The Directives Application List, NavAir 00-500C, lists active letter type publications and technical directives with respect to their applicability to specific aircraft.

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NUMBERING SYSTEM FOR MANUALS

Publications issued by the Naval Air Systems Command are designated according to a numbering system based on the type publication and its material content. The system cannot be described fully in this course because of its complex nature and many exceptions.

Coded designations assigned to technical manuals consist of a prefix and an alphanumeric sequence of three or four parts. The example shown below will be used to explain the system for designation of technical manuals:

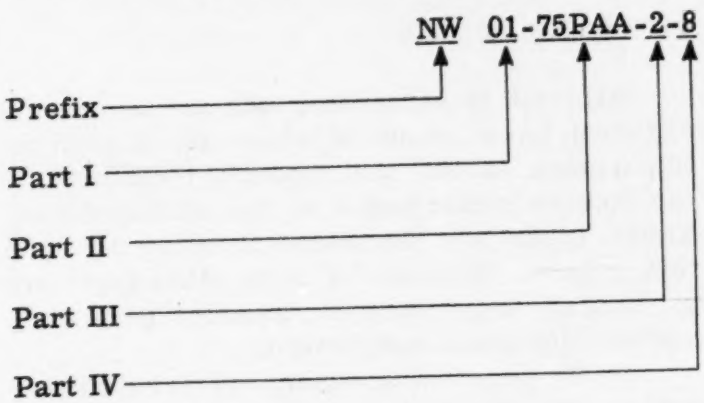

Prefix

The prefix may consist of the letters NavAir (NA), NavAer (NA), NavWeps (NW), AN, TO, or CO. NavAer and NavWeps publications were issued by the Bureau of Aeronautics and Bureau of Naval Weapons, respectively. All new publications are designated with the NavAir (NA) prefix.

The prefix AN was previously assigned for technical manuals used jointly by the Navy and the Air Force; they were prepared to coordinate military specifications.

TO was the prefix assigned to technical manuals originated by the Air Force.

CO was previously used to designate a technical manual with a Confidential security classification.

These prefixes, while no longer assigned for new material, will remain in effect for existing assignments until superseded.

Part I

Part I consists of numbers to identify the general subject classification with the basic subject to which they pertain. These numbers usually have two digits; however, when an additional classification breakdown is necessary, Part I consists of two digits followed by a letter. An example of this is found in the 02 (Powerplants) series. A typical entry in this series has the number 02B immediately following the prefix NW. In this example, the B identifies the powerplant as a jet propulsion type.

Table 4-1 lists the general subject categories and their numerical equivalent. In some instances, it will be noted that an equipment category has more than one numerical equivalent. In the case of electronics, which carries the codes 08 and 16, the equipment category is in the process of subdivision or change.

Part II

Part II of the publication number consists of numbers (or numbers and letters) and indicates the specific class, group, type, or model and manufacturer of the equipment. The subject breakdowns are listed at the beginning of each separate major division within NavSup Publication 2002, Cognizance Symbol I, Section VIII, Part C.

For aircraft manuals and equipment manuals, this part will be explained in more detail later.

Part III

Part III consists of a number or numbers which designate a specific manual. For airframes and engines, this part designates a specific type manual. For other types of equipment, this part is assigned in numerical sequence and has no direct reference to the type of manual.

Part IV

Part IV pertains only to certain specific classes of manuals (such as the Maintenance Instructions Manuals for aircraft), and designates a particular manual of a set. Numbering is not completely standardized, and may have decimal or even double decimal suffixes. The exact volume desired may be determined from the lists or indexes of publications.

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Table 4-1. —Subject categories and code numbers for aeronautic manuals.

General	00
Allowance lists	00-35Q
Training publications (aviation)	00-80
Aircraft	01
Powerplants	02
Accessories	03
Hardware and rubber	04
Instruments	05
Fuels, lubricants, and gases	06
Dopes and paints	07
Ground servicing and automotive equipment	08-20, 14 & 19
Photography	10
Armament	11
Fuel and oil handling equipment	12
Parachute and personal equipment	13
Standard preservation and packaging instructions	15
Electronics	08 & 16
Machinery, tools, and test equipment	17 & 18
Descriptive data for aviation support equipment	20
Chemical equipment	24 & 39
Instructional equipment and training aids	09 & 28
Meteorology (aerology)	50
Ships installations	51

AIRCRAFT MANUALS

Aircraft manuals are prepared by the manufacturer and published for each aircraft model in naval use. The manual for a particular aircraft model consists of a series of individual publications, each dealing with a definite phase of the overall operation or maintenance program. As indicated in the preceding discussion, aircraft manuals fall into the 01 - series category, and manuals pertaining to a particular model may be identified by an alphanumeric designator immediately following the 01 -.

01 - Series Manuals

Aircraft technical manuals are of several different types, some of which are of extreme importance to the maintenance technician in the routine performance of his normal duties. These types are discussed in some detail in this chapter. Manuals of some other types are of limited importance to avionics personnel, and are discussed only briefly.

Using the previous example of manual designation, the aircraft model to which a manual applies may be determined from Part II of the designator. The numbers are coded to indicate the specific manufacturer, and the letters indicate the particular aircraft model.

GENERAL AIRCRAFT MANUALS.–The 01-1 series manuals do not apply to specific aircraft, but present some aspect of construction, operation, maintenance, repair, or inspection applicable to many models of aircraft. Some important examples of this type manual are NavAer 01-1A-505 (Installation Practices: Aircraft Electric and Electronics Wiring); NavWeps 01-1A-509 (Handbook Aircraft Maintenance Cleaning); and NavWeps 01-1A-509 (Handbook Corrosion Control for aircraft).

FLIGHT MANUALS.–Manuals of this class are identified by the number 1 in Part III of the standard nomenclature. For a given model aircraft, the complete flight manual usually comprises the standard NATOPS manual, pocket checklist, and classified supplements. Although this series is of primary interest to the pilot and aircrew, much of the information is of general interest to all personnel concerned in any manner with that aircraft. One section of special interest to avionics personnel is the func-

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tional operation of the electronics equipment installed.

STRUCTURAL REPAIR.–Structural Repair Manuals (identified by the number 3 in Part III of the standard nomenclature) usually comprise two manuals. The -3-1 manual is for use by organizational and intermediate level maintenance activities, while the -3-2 manual is for use by depot level maintenance activities. These manuals prescribe procedures and methods for making repairs to structural components of the aircraft.

MISCELLANEOUS MANUALS.–Although the contents of most other aircraft manuals are standardized, the numbering system is not. Some typical examples are the Special Weapons Check List, Special Stores, Assembly Procedures (for guided missile and target aircraft), Source Coded Data, Component and Shop Repair Data, etc. Some aircraft have only a few manuals of this type; others have many.

Maintenance Instructions Manual (MIM)

For this type manual, Part III of the standard designator is the number 2. The MIM comprises a variable number of individual publications, each dealing with some portion of the overall maintenance effort for the applicable model aircraft. The MIM (formerly called Handbooks of Maintenance Instructions) provides information concerning the location, function, operation, removal, installation, testing, adjusting, and troubleshooting of components. Maintenance methods recommended are concerned with procedures such as those which can be performed by an operating squadron.

These manuals provide the technician with an invaluable aid in locating equipment components and interconnecting cables in the aircraft, and for inspection purposes as well as troubleshooting

Before attempting any new task on an aircraft, the Maintenance Instructions Manual for that particular aircraft should be consulted. By proper use of this manual, possible damage may be prevented and much time may be saved. Recommended maintenance methods are concerned with procedures which can be accomplished by operating units, and include a Quality Assurance Summary, which indicates the minimum quality control inspection requirements for each maintenance task.

In the past, these manuals were issued as a single complete unit. They were arranged so that the pertinent sections could be removed and kept available in the shop. At present, the separate sections of these manuals are being issued as separate publications under individual identifying numbers. This facilitates procurement, storage, filing, and use of specific parts of the manual by maintenance personnel.

Avionics maintenance personnel are concerned most often with the sections covering electrical and electronic systems, radio and radar, and wiring data.

NUMBER BREAKDOWN.–Part IV of the standard designator for an aircraft Maintenance Instructions Manual indicates the subject content of the manual. This designator may consist of a single number, a number and decimal, or even a number with double decimals, as required to break down the information sufficiently. Due to the differences in operational usage of various models of aircraft, this system cannot be standardized completely. However, the following partial listing is typical for many of the new aircraft:

-2–Airframe Maintenance Instructions Manual
- -0–Maintenance Planning Data (For some models of aircraft, this data is contained in a -100 publication rather than in -2-0.)
- -1.1–General Information and Servicing
- -1.2–Corrosion Control and Decontamination
- -2–Airframe Systems
- -3–Powerplant and Related Systems
- -4–Instrument Systems
- -5–Electrical Systems
- -5.1–Electrical Power Supply System
- -5.2–Lighting System
- -6–Electronic Systems
- -7–Armanent and Related Systems
- -8–Airborne Missile Control Systems
- -9–Systems Integration
- -10–Wiring Diagrams
- -10.1–Wiring Data Diagrams
- -10.2–Wiring Data Repair

Each category may be broken down into single or double decimal subdivisions as the occasion requires.

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The
University of Arizona,
College of Agriculture, and
U. S. Department of Agriculture cooperating

COTTON ROOTKNOT NEMATODE

Rootknot nematode (Meloidogyne incognita acrita) of cotton is a serious pest in sandy soils throughout many areas of Arizona. Annual losses are estimated to exceed 2% of the total crop or approximately 17,500 bales. Losses in individual fields may be as high as 50%. Both short and long staple varieties are susceptible. Damping-off or soreshin is increased in nematode infested fields.

Detecting cotton plants attacked by rootknot

Stunted plants growing in soils containing 40% or more sand may be infested with rootknot nematode. Excess wilting may occur, especially during the hotter part of the day. Little or no response from irrigation or fertilizer is common. By carefully digging up the plants, the infected roots are found to be retarded. The taproot is frequently missing or greatly reduced and the lateral roots contain numerous galls or knots. The infestations can also be detected by root examination following harvest and at the time of plowing.

Control of the rootknot nematode in cotton

There are three effective and practical means of controlling the cotton rootknot nematode: crop rotation, summer fallow, and soil fumigation. Rotation of cotton with one of the varieties of alfalfa highly resistant to the rootknot nematode, such as African, Moapa, and Sonora for two or more years reduces the rootknot population for the following cotton crop. In addition, this rotation helps maintain soil fertility at a high enough level for good cotton yields. A one-year rotation of small grains grown during the cool months, followed by grain sorghum in the summer will also reduce the rootknot nematode population for the cotton crop the following year. This also adds crop residue to the soil, thereby increasing cotton yield. Weeds and grass must be eliminated as many serve as host plants to the nematode.

Where it is not practical for growers to rotate crops regularly or to practice summer fallow, soil fumigation is a very effective control method on land planted to cotton year after year.

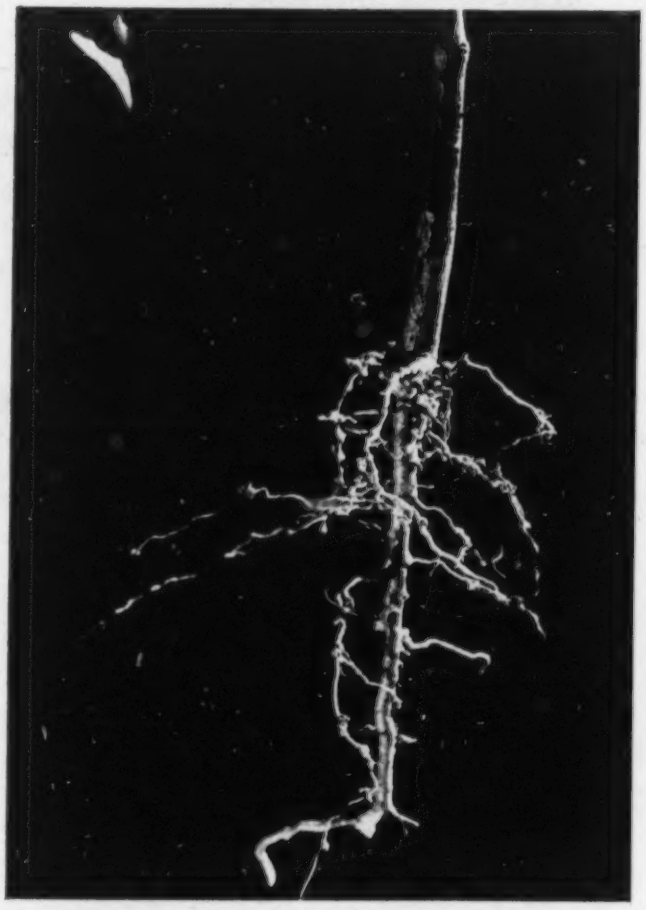

Fig. 1. Numerous knots form on stunted, twisted roots.

MANUAL BREAKDOWN.–The typical volume of the MIM contains six sections as follows:

Section I–Introduction. Provides a general description of the manual, including the scope of coverage, format, and arrangement of the included information. It contains listings of applicable publications and technical directives required by operating activities pertaining to the specific model aircraft or equipment covered in the manual.

Section II–Description and Operation. Includes a physical description of the aircraft or equipment covered by the manual. It includes a detailed listing of components, with separate tables for equipment components, tube and transistor complements, and fuses and circuit breakers. For equipments, this section also incorporates detailed information regarding input and output characteristics and requirements and operating instructions. Also included is a brief discussion on the theory of operation, definition of terms, explanation of terms and symbols, simplified and partial functional diagrams, and built-in test features.

Section III–Organization Maintenance (Line and Hangar). Presents information on testing and operational checks on the various systems or components covered in the manual. It includes such information as a tools and equipment list, manpower requirements, and test procedures (with pertinent notes, warnings, and cautions). In addition, this section includes system troubleshooting charts for installed equipment, and instructions for removal and installation of the equipment.

Sections IV and V–Intermediate Maintenance (Component Repair) (Section V is not always included.) Some manuals combine all functions of maintenance into a single publication; others have various breakdowns. When this level of maintenance is included, the detailed contents parallel those of Section IV, except that the procedures for individual components (rather than the complete unit), are discussed.

Section VI–Diagrams. Contains the complete set of wiring and schematic diagrams for those units covered in the manual.

Illustrated Parts Breakdown (IPB)

The Illustrated Parts Breakdown normally consists of several individual manuals: one for each major functional element of the aircraft, and a final volume which is an index. It is identified by the -4 following the aircraft designation in the standardized publication identification system. It is useful in the procurement, requisitioning, storing, issuing, and identification of new or reclaimed parts.

It can also be used to determine the exact part or item required for replacement in a repair situation. It can also be used as a guide in reassembly of units which have been disassembled for testing, cleaning, or repair.

The separation of the IPB into its separate manuals does not necessarily follow the same order as the MIM breakdown; however, the type information available is consistent for nearly all IPB's.

MANUAL BREAKDOWN.–With the exception of the Index volume, each volume of the IPB follows generally the same format. It is divided into two sections–Introduction and Group Assembly Parts List.

Section I–Introduction. Contains specific detailed instructions for use of the particular IPB and the set to which it belongs.

Section II–Group Assembly Parts List. Provides reference and identification data for the various assemblies and subassemblies within the scope of the manual. For each assembly and subassembly, the data consists of a diagram and table. (See figs. 4-1 and 4-2.) The diagram indicates the location and general appearance of the item and provides clues for assembling.

Inserts A, B, C, and D illustrate items which are furnished as subassemblies of the major item. In the "description" column of the table, note the progressive indentations. The first entry is the complete assembly, and is begun flush at the left. Index numbers 1 through 15 refer to individual items of material which are parts of the assembly, and are indented one space. Index numbers 16 through 30 are bits and pieces of subassembly D and are indented two spaces. Further disassembly would be indicated by additional breakdown of one of

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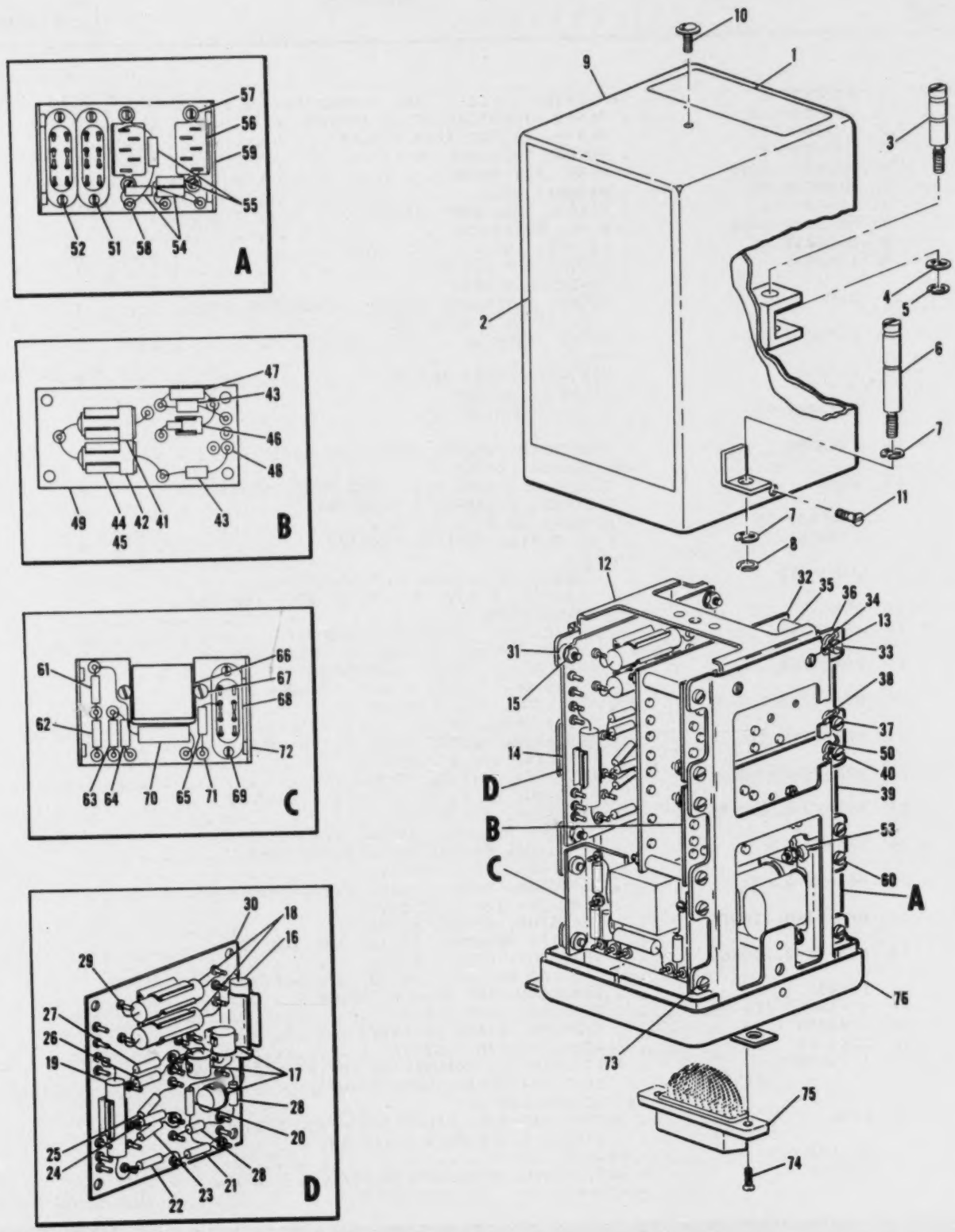

Figure 4-1.–IPB, sample figure.

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FIGURE AND INDEX NUMBER	PART NUMBER	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE
15- 16	1784019-1	AMPLIFIER /07187/ /SEE FIGURE 15-4-6 FOR NHA/ . .	REF	
- 1	1784534-16	. PLATE, IDENTIFICATION /07187/	1	
- 2	1719808-14	. PLATE, INSTRUCTION /07187/.	1	
- 3	1754504-2	. SCREW, SHOULDER /07187/	1	
- 4	MS16633-2018	. RING, RETAINING	1	
- 5	MS35338-80	. WASHER, LOCK.	1	
- 6	1754504-1	. SCREW, SHOULDER /07187/	2	
- 7	MS16633-2018	. RING, RETAINING	4	
- 8	MS35338-80	. WASHER, LOCK.	2	
- 9	1782440	. COVER, TOP /07187/.	1	
		/ATTACHING PARTS/		
- 10	COML	. SCREW, ASSEMBLED WASHER, STAINLESS STEEL, . . . 0.112-40 X 5/16 IN.	1	
- 11	MS35249-21	. SCREW, MACHINE.	2	
		---•---		
- 12	1782439	. BRACKET, COVER /07187/.	1	
		/ATTACHING PARTS/		
- 13	MS35249-10	. SCREW, MACHINE.	4	
		---•---		
- 14	1783290	. AMPLIFIER, RELAY, SENSITIVE /07187/	1	
		/ATTACHING PARTS/		
- 15	COML	. SCREW, MACHINE, FILLISTER HEAD, STAINLESS . . . STEEL, 0.138-32 X 5/16 IN.	4	
	MS35338-79	. WASHER, LOCK.	4	
	278146	. NUT, PLAIN, HEXAGON /56232/	4	
		---•---		
- 16	29F743G2	. . CAPACITOR, FIXED, ELECTROLYTIC, ... 10 UF, P 55%, M 15%, 30 VDCW /06001/	1	
- 17	2N343	. . TRANSISTOR.	3	
- 18	29F783G2	. . CAPACITOR, FIXED, ELECTROLYTIC, ... 4 UF, P 55%, M 15%, 65 VDCW /06001/	2	
- 19	29F742G2	. . CAPACITOR, FIXED, ELECTROLYTIC, ... 2.5 UF, P 55%, M 15%, 30 VDCW /06001/	1	
- 20	MEA-T2-511 OHMS	. . RESISTOR, FIXED, FILM,. . . . . 511 OHMS, PM 1%, 1/8 W /75042/	1	
- 21	MEA-T2-5.11K	. . RESISTOR, FIXED, FILM, 5,110 OHMS,. . . . . PM 1%, 1/8 W /75042/	1	
- 22	MEA-T2-60.4K	. . RESISTOR, FIXED, FILM,. . . . . 60,400 OHMS, PM 1%, 1/8 W /75042/	1	
- 23	MEA-T2-0.100MEG	. . RESISTOR, FIXED, FILM,. . . . . 0.100 MEGOHMS, PM 1%, 1/8 W /75042/	1	
- 24	MEA-T2-2.K	. . RESISTOR, FIXED, FILM, 2,000 OHMS,. . . . . PM 1%, 1/8 W /75042/	1	
- 25	MEA-T2-2.67K	. . RESISTOR, FIXED, FILM, 2,670 OHMS,. . . . . PM 1%, 1/8 W /75042/	1	
- 26	MEA-T2-0.110MEG	. . RESISTOR, FIXED, FILM,. . . . . 0.110 MEGOHMS, PM 1%, 1/8 W /75042/	1	
- 27	MEA-T2-0.100MEG	. . RESISTOR, FIXED, FILM,. . . . . 0.100 MEGOHMS, PM 1%, 1/8 W /75042/	1	
- 28	1N645	. . SEMICONDUCTOR DEVICE, DIODE	2	
- 29	ST-SM-16-P16-YEL	. . TERMINAL STUD /98291/	33	
- 30	1783289	. . TERMINAL BOARD /07187/.	1	
- 31	0361-12	. SPACER, SLEEVE /56232/.	4	
- 32	1779038-2	. PREAMPLIFIER, TRANSISTOR /07187/ /SEE FIGURE. . 15-7 FOR DETAIL BREAKDOWN/	1	
		/ATTACHING PARTS/		
- 33	COML	. SCREW, MACHINE, FILLISTER HEAD, STAINLESS . . . STEEL, 0.138-32 X 1-1/8 IN.	4	
	MS35338-79	. WASHER, LOCK.	4	
	278146	. NUT, PLAIN, HEXAGON /56232/	4	
		---•---		

AT.17

Figure 4-2.—IPB, corresponding table.

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the subassemblies, and the parts descriptions would be progressively indented in the table.

Note also the system used to identify attaching parts. Index number 9 is a cover, and the attaching parts are indexed as 10 and 11. This shows that these two items are used separately to attach 9 to the assembly. Sometimes a screw, washer, and nut (set) will be listed as a single item having a single index number. In these cases, the individual parts are still identified and described in the table. An example of this is index number 15. In each case, the words "attaching parts" preceded and followed by slant marks are inserted in the table immediately following the item they are used to attach.

The table furnishes the details regarding the bits and pieces which make up the unit. It is divided into five columns.

Column 1 gives the figure and index number. This number is a three-part sequence with hyphens separating the parts. The first part references the volume or major subdivision of the IPB. The second part indicates the number of the figure referenced. The third part indicates the callout number of the specific piece to which the other information pertains. The first entry always indicates the complete subassembly, and does not normally include the third part of the sequence.

Column 2 gives the part number for the specific item. This part number is used in conjunction with the Index volume of the IPB for stock number identification.

Column 3–Description. Provides the item name, manufacturer's code number (identifiable in the vendor's listing included in Section I), specification drawings, additional breakdown reference figures, and other pertinent data.

Column 4–Units Per Assembly. Specifies the total number of a given item in a single assembly.

Column 5–Usable on Code. When a specific item is used on certain aircraft of a given model, and a different item is used on other aircraft of the same model, this column is used. When all models use the same item, this column is left blank. The coding is explained in the Introduction, Section I.

The first figure of each volume is normally of the aircraft, showing the location of the major items of the aircraft. The callout numbers are referenced in the accompanying table, and are crossindexed with the applicable IPB figure number; this table gives no details except the title of the item or assembly. This figure and table are actually included in the Introduction, Section I.

INDEX BREAKDOWN.–The Index volume of the IPB comprises three sections–Introduction, Numerical Index, and Reference Designation INDEX.

Section I–Introduction. Contains details on the contents and arrangement of the volume.

Section II–Numerical Index. Consists of a numerical index containing all items listed in the Group Assembly Parts Lists of the preceding volumes. It is divided into two parts: The first part lists all the contractor part numbers, and the second part lists all the standard and vendor part numbers. Each part of the section is divided into five columns: Part Number, Federal Stock Number, Volume Figure and Index Number, Source Code, and Accountability/Recovery Code.

Section III–Reference Designation Index. Provides a cross reference between the Reference Designation Number assigned to each item of electrical, electronics, or mechanical equipment and the part number for each such item. Reference designation numbers for each of the items of equipment are determined from the applicable section of the MIM.

USING THE IPB.–In order to derive maximum benefit from maintenance functions, certain records and reports must be compiled. The requirements for these vary somewhat in different type squadrons and in different areas. The reports and records required in each activity are determined by the maintenance supervisor as one of his administrative duties. One type report that is universally required is the Unsatisfactory Material/Condition Report (discussed in chapter 2 of this manual). This and other reports and records require details concerning parts that have failed or that have been replaced for any reason. These details are available from the IPB. The procedures for locating the information depends on what is known about the part and what data is required, as shown in the following discussion:

1. When the part number is not known, determine the function and application of the part. Turn to the Table of Contents of the IPB volume

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containing the affected equipment or system and select the title that seems most appropriate. Note the illustration page number. Turn to the page indicated and locate the desired part on the illustration. From the illustration, obtain the index (callout) number assigned to the part. Refer to the accompanying description for specific information regarding the part. (If the Federal Stock Number is desired, next refer to the Index volume of the IPB. Locate the part number and note the FSN.)

2. When only the part number is known, refer to the Numerical Index. Locate the part number and note the figure and index number assigned to the part. Turn to the figure indicated, and locate the referenced index number. If a pictorial representation of the part or its location is desired, refer to the same index number on the accompanying illustration. If the FSN is desired, it may be determined directly from the Index volume by locating the part number.

3. When only the reference designation is known, refer to the Reference Designation Index. Locate the reference designation and note the figure and index number and the part number assigned. Turn to the figure indicated and locate the index number. If a pictorial representation of the part, or its location is desired, refer to the index number shown on the accompanying illustration.

Periodic Maintenance Requirements Manual (PMRM)

Periodic maintenance requirements for a particular model aircraft are contained in the -6 series of publications for that model aircraft. The series includes (in addition to the Periodic Maintenance Requirements Manual) the cards and charts used to plan and control the progress of work in scheduled maintenance actions. They provide step by step procedures for performing the minimum inspections required for each type of scheduled maintenance action.

EQUIPMENT MANUALS

Most items of electronics equipment or test equipment commonly used in naval aviation are covered by a manual or a series of manuals. These manuals are usually prepared by the contractor and distributed by the Naval Air Systems Command. Standardization has not progressed to the same extent as it has in the aircraft manuals; however, some generalizations hold true for most manuals of this group.

08 - Series

Manuals of this category usually apply to older equipments which are still in use. (One very important exception is the NAESU Digest, NavAir 08-1-503, discussed later in this chapter.) The 08- series is at present undergoing a complete reorganization and is being combined with the 16- series for electronics equipment. In the issue of the NavSup Publication 2002 used in preparing this course, the 08- entry refers the user to the 16- entry. In the 16- listing, the 08- manuals are listed preceding the 16- manuals.

16- Series

Manuals of this series are identified by a numbering system similar to that used with the aircraft manuals, consisting of a three-part designation following a prefix. The prefix and the Part I serve the same purpose and follow the same rules as outlined in the preceding section. Parts II and III are not completely standardized except for subsections 30 and 35. The subdivisions of the 16- series are listed in table 4-2.

GENERAL.–The 16-1 Series manuals include several publications of many types, the contents of which do not permit inclusion in any other subseries. They include manuals pertaining to general maintenance practices, training manuals, design guidance data, etc. Some of these manuals have been individually referenced in this chapter; some others are referenced in the current indexes of publications.

RADIO AND RADAR.–Manuals of the 5Q and 5S subseries pertain to older equipments and the manuals do not conform to present standardization format. They include miscellaneous operation and maintenance data for radio and radar equipments.

JOINT NOMENCLATURE RADIO EQUIPMENT.–Manuals of this subseries normally appear in the standard format. Part II of the identifying designator specifies the equipment to

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Table 4-2. — 16- Series breakdown.

Subseries	Classification
1	General
5Q	Radio
5S	Radar
30	Joint Nomenclature Radio Equipment
35	Joint Nomenclature Radio Components
40	Signal Corps Nomenclature Equipment
45	Commercial British and Navy Radio Equipment
50	Automatic & Semiautomatic Electronic Checkout Equipment
55	Radio, Radar, Electronic, and Spare Parts Lists

which the manual applies; Part III specifies the type manual. Although Part III is not completely standardized, the number refers to the following type manuals:

Operation Instructions
Service Instructions
Overhaul Instructions
Illustrated Parts Breakdown

Many smaller and less complicated equipments combine two or more of these manuals into one volume, but each of the above manuals will be discussed separately in a later section of this chapter.

OTHER SUBSERIES.–Manuals of the 35 subseries are basically the same as those of the 30 subseries, except that they deal with components rather than complete equipments. Manuals of the 40, 45, 50, and 55 subseries cannot be readily identified as to equipment applicability.

Equipment Nomenclature System.

The Joint Communication–Electronic Nomenclature System ("AN" System), formerly known as the Joint Army-Navy Nomenclature System, is designed so that its indicators will tell at a glance many things pertinent to the item. For example, it tells whether the item is a set or a component, and such other information as where it is used, the kind of equipment, and its purpose.

An indicator for a complete set begins with the letters AN. This is followed by a slant bar and a three-letter group. The three letters of the second group give the general nature of the installation, the type of equipment, and the purpose of the equipment, respectively. Following the three-letter group is a number which indicates the specific model of the equipment. An example of the basic designation is AN/ARC-38. As can be seen in table 4-3, the letters following the slant bar mean airborne radio communications.

When the system just described is applied to a unit of the complete set, the designation is formed by replacing the letters AN with a letter-number group which indicates the type and model of the unit in question. For example, a control unit used with the AN/ARC-38 is designated C-1398/ARC-38. The letter C is an indicator letter which in this case means control. The number following C indicates the specific model of control box. Table 4-4 presents commonly used unit indicator letters that are used in the letter-number group.

Operation Instruction Manual

Operation Instruction Manuals cover the operation of specific equipments and the necessary checks and adjustments required for optimum performance. These instructions are written from the equipment operator's viewpoint and do not include all data vital to the maintenance technician.

Service Instruction Manual

The Service Instruction Manual contains information on maintenance and usage of specific equipment. It provides instructions for alining, maintaining, troubleshooting, and repairing the equipment, as well as concise tabular data on fuses, power drain, number of units, etc. Because of the quantity and complexity of the material involved, the manual is divided into several sections.

Section I, Description and Leading Particulars, gives a description of the equipment and the general principles of its operation. Included in the section is information on the interchangeability of components and any special electrical

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Table 4-3–Set indicator letters.

First letter (Designed installation classes)	Second letter (Type of equipment)	Third letter (Purpose)
A - Piloted aircraft	A - Invisible light, heat radiation	A - Auxiliary assemblies (not complete operating sets used with or part of two or more sets or sets series)
B - Underwater mobile, submarine	B - Pigeon (do not use)	B - Bombing
C - Air transportable (inactivated, do not use)	C - Carrier	C - Communications (receiving and transmitting
D - Pilotless carrier	D - Radiac	D - Direction finder, reconnaissance, and/or surveillance
F - Fixed ground	E - Nupac	E - Ejection and/or release
G - General ground use	*F - Photographic	G - Fire-control, or searchlight directing
K - Amphibious	G - Telegraph or teletype	H - Recording and/or reproducing (graphic, meteorological and sound)
M - Ground, mobile	I - Interphone and public address	K - Computing
P - Portable	J - Electromechanical or Inertial wire covered	L - Searchlight control (inactivated, use G)
S - Water surface	K - Telemetering	M - Maintenance and/or test assemblies (including tools)
T - Ground, transportable	L - Countermeasures	N - Navigational aids (including altimeters, beacons, compasses, racons, depth, sounding, approach, and landing)
U - General utility	M - Meteorological	P - Reproducing (inactivated, use H)
V - Ground, vehicular	N - Sound in air	Q - Special, or combination of purposes
W - Water surface and underwater combination	P - Radar	R - Receiving, passive detecting
	Q - Sonar and underwater sound	S - Detecting and/or range and bearing, search
	R - Radio	T - Transmitting
	S - Special types, magnetic, etc., or combinations of types	W - Automatic Flight or remote control
	T - Telephone (wire)	X - Identification and recognition
	V - Visual and visible light	
	W - Armament (peculiar to armament, not otherwise covered)	
	X - Facsimile or television	
	Y - Data processing	

*NOTE: Not for U.S. use except for assigning modification letters to previously type-designated items.

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Table 4-4.—Unit indicators letters.

Comp Ind	Family Name	Example of use (Not to be construed as limiting the application of the unit indicator)
AB	Supports, antenna	Antenna mounts, mast bases, most sections, towers, etc.
AM	Amplifiers	Power, audio, interphone, radio frequency, video, electronic control, etc.
AS	Antennae, simple and complex	Arrays, parabolic type, masthead, whip or telescopic loop, dipole, reflector, etc.
*AT	Antennae, simple	For new assignments use AS.
BA	Battery, primary type	B batteries, battery packs, etc.
BB	Battery, secondary type	Storage batteries, battery packs, etc.
BZ	Signal devices, audible	Buzzers, gongs, horns, etc.
C	Controls	Control box, remote tuning control, etc.
CA	Commutator assemblies, sonar	Peculiar to sonar equipment.
CB	Capacitor bank	Used as a power supply.
CG	Cable assemblies, R-F	R-F cables, waveguides, transmission lines, etc., with terminals.
CH	Chassis, drawer, door	A framework designed to accept plug-in modules. May include circuitry and/or receptacles. Does not include the plug-in module(s). It is not a storage facility or blank chassis.
CK	Crystal kits	A kit of crystals with holders.
CM	Comparators	Compares two or more input signals.
CN	Compensators	Electrical and/or mechanical compensating regulating or attenuating apparatus.
CP	Computers	A mechanical and/or electronic mathematical calculating device.
CR	Crystals	Crystal in crystal holder.
CU	Couplers	Impedance coupling devices, directional couplers, etc.
CV	Converters (electronic)	Electronic apparatus for changing the phase, frequency, or from "one" medium to "another."
CW	Covers	Cover, bag, roll, cap, radome, nacelle, etc.
CX	Cable assemblies, non-R-F	Non-R-F cables with terminals, test leads, also composite cables of R-F and non-R-F conductors.
CY	Cases and cabinets	Rigid and semirigid structure for enclosing or carrying equipment.
D	Dispensers	Chaff, leaflet, flare, napalm, bomblet, etc.
DA	Load, dummy	R-F and non-R-F test loads.
DT	Detecting heads	Magnetic pickup device, search coil, hydrophone, etc. (see R-F).
DY	Dynamotors	Dynamotor power supply.
E	Hoists	Sonar hoist assembly, etc.
F	Filters	Bandpass, noise, telephone, wave traps, etc.
FN	Furniture	Chairs, desks, tables, etc.
FR	Frequency measuring device	Frequency meters, tuned cavity, etc.
G	Generators, power	Electrical power generators without prime movers, (see PU and PD).
GO	Goniometers	Goniometers of all types.
GP	Ground rods	Ground rods, stakes, etc.

Table 4-4.—Unit indicators letters—Continued.

Comp Ind	Family Name	Example of use (Not to be construed as limiting the application of the unit indicator)
H	Head, hand, and chest sets	Includes earphone.
HC	Crystal holder	Crystal holder less crystal
HD	Environmental apparatus	Heating, cooling, dehumidifying, pressure, vacuum devices, etc.
ID	Indicators, noncathode-ray tube	Calibrated dials and meters, indicating lights, etc. (see IP).
IL	Insulators	Strain, standoff, feed-through, etc.
IM	Intensity measuring devices	Includes SWR gear, field intensity and noise meters, slotted lines, etc.
IP	Indicators, cathode-ray tube	Azimuth, elevation, panoramic, etc.
J	Junction devices	Junction, jack and terminal boxes, etc.
KY	Keying devices	Mechanical, electrical and electronic keyers, coders, interrupters, etc.
LC	Tools, line construction	Includes special apparatus such as cable plows, etc.
LS	Loudspeakers	Separately housed loudspeakers, intercommunication station.
M	Microphones	Radio, telephone, throat, hand, etc.
MA	Magazines	Magnetic tape or wire, etc.
MD	Modulators, demodulators, discriminators	Device for varying amplitude, frequency or phase.
ME	Meters	Multimeters, volt-ohm-milliammeters, vacuum tube voltmeters, power meters, etc.
MF	Magnets or magnetic field generators	Magnetic tape or wire eraser, electromagnet, permanent magnet, etc.
MK	Miscellaneous kits	Maintenance, modification, etc., except tool and crystal (see CK, TK).
ML	Meteorological devices	Barometer, hygrometer, themometer, scales, etc.
MT	Mountings	Mountings, racks, frames, stands, etc.
MX	Miscellaneous	Equipment not otherwise classified, includes subassemblies. Do not use if better indicator is available.
MU	Memory units	Memory units.
O	Oscillators	Master frequency, blocking, multivibrators, etc. (for test oscillators, see SG).
**OA	Miscellaneous groups	Groups not otherwise classified. Do not use if a more specific indicator, such as OD, OE, OG, etc., applies.
**OB	Multiplexer and/or demultiplexer groups	Multiplexer groups, demultiplexer groups, composites thereof.
OC	Ocenographic devices	Bathythemographs, etc.
**OD	Indicator groups	All types.
**OE	Antenna groups	All types.
**OF	Adapter groups	All types.
**OG	Amplifier groups	All types.
**OH	Simulator groups	All types.
**OJ	Consoles and console groups	All types.
**OK	Control groups	All types.
**OL	Data analysis and data processing groups	All types.

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Table 4-4.—Unit indicators letters–Continued.

Comp Ind	Family Name	Example of use (Not to be construed as limiting the application of the unit indicator)
**OM	Modulator and/or demodulator groups	Modulator groups, demodulator groups, composites thereof.
**ON	Interconnecting groups	All types.
**OP	Power Supply groups	All types.
**OQ	Test Set groups	All types.
**OR	Receiver groups	All types.
OS	Oscilloscope, test	Test oscilloscopes for general test purposes.
**OT	Transmitter groups	All types.
**OU	Converter groups	All types.
**OV	Generator groups	All types excluding power generating equipment.
**OW	Terminal groups	Telegraph, telephone, radio, etc.
**OX	Coder, decoder, interrogator, transponder groups	All types.
**OY	Radar Set groups	Do not use if a more specific indicator, such as OE, OR, OT, etc., applies.
**OZ	Radio Set groups	Do not use if a more specific indicator, such as OE, OR, OT, etc., applies.
PD	Prime drivers	Gasoline engines, electric motors, synchros, diesel motors, etc.
PF	Fittings, pole	Cable hanger, clamp, protectors, etc.
*PG	Pigeon articles	Container, loft, vest, etc.
*PH	Photograghic articles	Camera, projector, sensitometer, etc.
PL	Plug-in modules	Plug-in modules not otherwise classified. Do not use if more specific indicators, such as AM, R, T, apply.
PP	Power supplies	Nonrotating machine type such as vibrator pack rectifier, thermoelectric, etc.
PT	Plotting equipments	Except meteorological. Boards, maps, transparent maps, plotting table, etc.
PU	Power equipments	Rotating power equipment except dynamotors, motor-generator, etc.
R	Receivers	Receivers, all types except telephone.
RC	Reels	All types (see RL).
RD	Recorder-reproducers	Sound, graphic, tape, wire, film, disc, facsimile, magnetic, mechanical, etc.
RE	Relay assemblies	Electrical, electronic, etc.
RF	Radio frequency component	Composite component of R-F circuits. Do not use if better indicator is available.
RG	Cables, R-F, Bulk	R-F cable, waveguides, transmission lines, etc. without terminals.
RL	Reeling machines	Mechanisms for dispensing and rewinding antenna or field wire, recording wire or tape, etc.,
RO	Recorders	Sound, graphic, tape, wire, film, disc, facsimile, magnetic, mechanical, etc.
RP	Reproducers	Sound, graphic, tape, wire, film, disc, facsimile, magnetic, mechanical etc.
RR	Reflectors	Target, confusion, etc., except antenna reflectors (see AS).

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(1) DBCP (sold commercially as Nemagon or Fumazone) may be injected into the soil at the time the seed beds are layed-up or after they are completed, with either two shanks per row, each 6" from center, or with one shank about 2" from center. Always inject 8" to 10" below area of seed placement. Seal all cracks left by injector shanks by reshaping beds with plow sweeps or pull a ringroller or cultipacker behind the toolbar. The soil should be in good tilth, the temperature 60° F. or above and the moisture about 20% of its moisture holding capacity. The nematocides may be mixed with water following recommendations on the label. However, no advantage has been found in this practice. Adjust delivery rate to give 1/2 gallon of technical DBCP per acre (8.6 lbs. technical/acre). Higher rates have not proven economically superior to that quantity recommended.

(2) DBCP can also be added effectively to the pre-plant irrigation water where the total quantity of water does not exceed 5 to 7 acre inches. Since the entire field must be treated, the dosage must be increased to 3/4 gallon of technical/acre.

Meter the material into the irrigation ditch at a point where the material will be thoroughly mixed with the water. If water tubulence is satisfactory there is no advantage in using a centrifugal pump to meter the nematocide. Good mixing results in the material remaining in suspension even though the water must travel long distances before entering the field. When the bottom of the irrigation ditch becomes white during application, it is evidence that the mixing process is inadequate.

For assistance in determining if soil fumigation is necessary, it's recommended that your county agent be consulted. He will also have useful suggestions for the best method of nematocide applications based on the grower's equipment and farming operation.

Prepared from information supplied by Dr. Ed Nigh, Dept. of Plant Pathology, University of Arizona, and Dr. Harold Reynolds, A. R.S., Tempe, Arizona

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Arlen D. Davison

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Extension Specialist
in Plant Pathology

Note: The information given herein is supplied with the understanding that no discrimination is intended and no indorsement by the Arizona Extension Service is implied.

Table 4-4.—Unit indicators letters—Continued.

Comp Ind	Family Name	Example of use (Not to be construed as limiting the application of the unit indicator)
RT	Receiver and transmitter	Radio and radar transceivers, composite transmitter and receiver, etc.
S	Shelters	House, tent, protective shelter, etc.
SA	Switching devices	Manual, impact, motor driven, pressure operated, etc.
SB	Switchboards	Telephone, fire control, power, panel, etc.
SG	Generators, signal	Test oscillators, noise generators, etc. (see O)
SM	Simulators	Flight, aircraft, target, signal, etc.
SN	Synchronizers	Equipment to coordinate two or more functions.
ST	Straps	Harness, straps, etc.
SU	Optical device	Telescopes, periscopes, projectors, and boresighting scopes.
T	Transmitters	Transmitters, all types, except telephone.
TA	Telephone apparatus	Miscellaneous telephone equipment.
TB	Towed body	Buoy, fish, paravane, target, etc.
TC	Towed cable	Articulated towing strut, faired cable, etc.
TD	Timing devices	Mechanical and electronic timing devices, range device, multiplexers, electronic gates, etc.
TF	Transformers	Transformers when used as separate items.
TG	Positioning devices	Tilt and/or train assemblies.
TH	Telegraph apparatus	Miscellaneous telegraph apparatus.
TK	Tool kits	Miscellaneous tool assemblies.
TL	Tools	All types except line construction (see LC).
TN	Tuning units	Receiver, Transmitter, antenna, tuning units, etc.
TR	Transducers	Magnetic heads, phonopickups, sonar transducers, vibration pickups, etc. (see H, LS, and M).
TS	Test items	Test and measuring equipment not otherwise included; boresighting and alignment equipment.
TT	Teletypewriter and facsimile apparatus	Miscellaneous tape, teletype, facsimile equipment, etc.
TV	Tester, tube	Electronic tube tester.
TW	Tapes and recording wires	Recording tape and wire, splicing, electrical insulating tape, etc.
U	Connectors, audio and power	Unions, plugs, sockets, adapters, etc.
UG	Connectors, R-F	Unions, plugs, sockets, choke couplings, adapters, elbows, flanges, etc.
V	Vehicles	Carts, dollies, trucks, trailers, etc.
VS	Signaling equipment, visual	Flag sets, serial panels, signal lamp equipment, etc.
WD	Cables, two-conductor	Non-R-F wire, cable and cordage in bulk (see RG).
WF	Cables, four-conductor	Non-R-F wire, cable and cordage in bulk (see RG).
WM	Cables, multiple-conductor	Non-R-F wire, cable and cordage in bulk (see RG).
WS	Cables, single-conductor	Non-R-F wire, cable and cordage in bulk (see RG).
WT	Cables, three-conductor	Non-R-F wire, cable and cordage in bulk (see RG).
ZM	Impedance measuring devices	Used for measuring Q, C, L, R, or PF, etc.

*NOTE: Inactivated for U S. use except for assigning modifcation letters to previously type-designated items

**NOTE: Collection of items part of or used with one set or set series.

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or mechanical characteristics of the system or components.

Section II, Special Test Equipment and Special Tools, lists all necessary special test equipment and tools (including test racks) which are used for complete bench testing of the system or the components. Any instructions necessary for modifying the test equipment for special use or for the fabrication of a special test harness are also found in this section.

Section III, Preparation for Use and Reshipment, is divided systematically, showing the method by which the equipment should be handled from the time it is received until it is ready for use by the operator. The section contains general information on uncrating and assembling the equipment on the test bench or in the aircraft, removing it from the aircraft, and recrating it for shipment. Detailed descriptions of cable fabrication and the connections of cables to the components are also included. Applicable data on any checks and adjustments required during installation of the equipment is found in this section.

Section IV, Theory of Operation, presents a general description of the equipment first, and this is followed by the detailed explanations of the individual circuits. The general description is usually given from the viewpoint of circuit development (see the discussion later in this chapter concerning drawings and schematics), and block diagrams are used to trace the development path. The function of each unit is explained, as well as its relationship to other units in the equipment.

Section V, Organizational and Operational Maintenance, provides the instructions essential for the maintenance of the equipment by organizational maintenance personnel, and indicates the level of maintenance activities designated to perform it. Included are the preoperational and daily inspections and tests, the bench-test procedures, and the troubleshooting methods to be used by these activities. Each performance procedure in this section includes instructions essential for the proper use of test equipment in diagnosing a trouble within a specific equipment.

Section VI, Field Maintenance, includes the instructions required for servicing the equipment at the field maintenance levels. In addition to alinement and parts removal procedures, information is given for checking component functions by means of performance checks. Also contained in this section are systematic trouble isolation procedures which assist in localizing a defective part or component to a circuit or group of circuits, depending upon the nature of the equipment. Each performance procedure in this section includes instructions essential for the proper use of the test equipment in diagnosing a trouble within a specific equipment.

Section VII, Diagrams, is described later in this chapter, under the heading, "Drawings and Schematics."

Section VIII, Difference Data Sheets, may be added (when required) to provide information on improved or modified models of the original equipment.

Overhaul Instruction Manual

The Overhaul Instruction Manual provides detailed information for overhauling the electronics equipment and/or component. This includes such procedures as disassembly, cleaning, repair, recalibration, testing, and any other steps necessary for complete overhaul. The manual also includes a tabulated list of test equipment recommended for overhaul. It is issued primarily to overhaul activities because the nature of the work described is usually beyond the capacities and facilities of field maintenance activities.

Illustrated Parts Breakdown

The Illustrated Parts Breakdown for equipments is similar in format, purpose, and usage to the IPB for aircraft as previously discussed.

Combined Manuals

Frequently, especially for components and small items of electronics test equipment, two or more of the above manuals are combined into a single publication. In most of these cases, the general material content may be determined from the title, but the arrangement of sections within the manual will vary with the individual publication.

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REVISIONS

In an effort to provide maintenance activities with the latest and most accurate information possible, the Naval Air Systems Command has instituted a program of continuous review and frequent revision of technical publications and manuals. These revisions are classed as formal or informal.

FORMAL revisions are printed, and are distributed as a new manual or as a partial replacement on a page-by-page basis. Formal revisions are reflected in the cumulative supplement to the BuSandA publications index. INFORMAL revisions include changes authorized by other means such as messages, notices, letters, or periodicals. They are normally "pen-and-ink" type changes.

Incorporation of Revised Material

When making a pen-and-ink change to any official publication or directive, be sure to record the source of the corrected material or the authority for the change. In this manner, subsequent users of the document will know that the change is official and also where to look for additional details. Eliminating the confusion which results from too much information, some of which may be incorrect, will make the document much more valuable as a tool for maintenance.

When making a substitute page type revision to a manual, be sure to double check that all instructions forwarded with the change copy are complied with. These instructions normally include the removal of certain pages, and substitution of other pages in their place. Be sure that all canceled pages are removed and disposed of in the proper manner, and that all pages not canceled are retained in their proper sequence.

When making a revision of any type to any official document, record the data concerning the number of the change, authority, date of the incorporation of the revision, and the name or initials of the person making the incorporation. In most technical manuals, a special page is included for this purpose.

Reporting of Errors in Manuals

As a part of the program to improve the quality and accuracy of its technical manuals, the Naval Air Systems Command has initiated a program for encouraging users to report errors and discrepancies. At the time of writing, the program applies only to certain specified types of manuals, but it is planned to expand the program to include all technical manuals. The basic reporting document is the Unsatisfactory Material/Condition Report (UR), as described in chapter 2 of this manual.

SPECIFICATIONS

A specification is a minutely detailed description or designation of the characteristics, particulars, values, or tolerances which must be met by a product or process.

The technician is concerned with specifications every time he performs an inspection, calibration, adjustment, operation, or repair on any unit of electronic equipment. In order for the equipment to fulfill its purpose, it must operate in a specified manner–it must meet definite requirements of sensitivity, power output, timing, phase, frequency, signal characteristics, etc. Specifications for a particular unit are found in the operation and inspection manuals and procedures for the applicable aircraft or equipment.

Failure of an item of electronics equipment to meet its specifications will prevent the aircraft from performing at its maximum capability. This condition calls for the removal, adjustment, repair, or calibration of the defective unit. To insure that all equipments are operating within the tolerances allowed in the specifications, operational inspections must be performed at frequent intervals, and in a precise and thorough manner.

Federal Specifications

Federal specifications are prepared under the direction of and promulgated by the Administrator of General Services, and apply to items in general usage by governmental agencies.

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Military Specifications

Military specifications cover materials, products, or services used predominantly by military activities, but which may be used by other federal agencies. These specifications are issued and promulgated by the Office of Standardization, Defense Supply Agencies.

Standards

A standard is a reference or a sample set up or established by competent authority to be used as a guide for comparison or evaluation.

The technician is constantly involved with standards. Every time he measures voltages in a circuit, he is comparing the potentials in that particular circuit with the standard volt. Every time he reads a schematic or block diagram, he recognizes the standard symbols used in the drawing. Every time he reads an explanation of the theory of operation for a circuit, he recognizes and understands the meaning of standard terms. When he replaces a defective resistor or capacitor, he installs a standard item.

Standards make possible the rapid, clear, and concise communication of facts, ideas, and information; without standards, modern technology would be impossible.

FEDERAL STANDARDS.–Federal standards are documents that establish engineering and technical limitations for items, materials, processes, methods, designs, and engineering practices. These documents are for general use by governmental agencies.

MILITARY STANDARDS.–Military standards are documents that establish engineering and technical limitations and applications for items, materials, processes, methods, designs, and engineering practices. These documents are intended primarily for use by agencies of the Department of Defense.

INSTRUCTIONS AND NOTICES

The Navy Directives System is used throughout the Navy for the issuance of directive type releases. Some of these prescribe policy, organization and methods, or procedures; others contain general information. The directives system provides a uniform plan for issuing and maintaining directives; conformance is required of all bureaus, offices, activities, and commands of the Navy. Two types of releases are authorized under the plan–Instructions and Notices.

Information pertaining to action of a continuing nature is contained in Instructions. An Instruction has permanent reference value and remains in effect until the originator supersedes or cancels it. Notices contain information pertaining to action of a onetime nature. A Notice does not have permanent reference value and contains provisions for its own cancellation.

For purposes of identification and accurate filing, all directives can be recognized by the originator's authorized abbreviation; the type of release (whether an Instruction or Notice); a subject classification number; and, in the case of Instructions only, a consecutive number. (Because of their temporary nature, the consecutive number is not assigned to Notices.) This information is assigned by the originator and is placed on each page of the release.

The manner of numbering and identifying directives can be better understood by considering a typical identifier:

SECNAV	INST	5215.1A	
(a)	(b)	(c)	(d)

(a) The authorized abbreviation of the originator of the directive.

(b) The type of release (in this case an Instruction).

(c) The subject number of the directive (obtained from the Table of Subject Classification Numbers).

(d) The consecutive number (found only on Instructions). An originator would assign consecutive numbers to those consecutive instructions with the same subject classification number. In the example above, the subject classification number 5215 concerns "Issuance Systems." If the originator, SecNav, issued additional Instructions dealing with issuance systems, they would be assigned the numbers 5215.2, 5215.3, 5215.4, etc. The letter A indicates that this is the first reissue of the same basic directive.

Subject classification numbers are listed in the Table of Subject Classification Numbers

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found in SecNav Instruction P5210.11. This table contains a numerical and alphabetical listing of numbers with their related subjects, and has reference value when information or instructions of a particular nature are desired. This Instruction contains all necessary information concerning the use and procedures of the Navy Directives System.

LETTER TYPE TECHNICAL DIRECTIVES (CHANGES AND BULLETINS)

BuWeps Instruction 5215.8 established a system to promote uniformity in technical directives. This system is limited to instructions of a technical nature which are not contained in technical manuals and which cannot be satisfactorily incorporated as revisions to the manuals. NavSup Publication 2002, Cognizance Symbol I, Section VIII, Part D, together with its latest cumulative supplement, provides a checkoff list for all current technical aeronautic letter publications.

A CHANGE is a technical directive containing instructions and directions to accomplish a material change, modification, repositioning, or alteration in the physical appearance of an aircraft or equipment or the installation of different parts in subassemblies, assemblies, or components in aircraft or equipment.

A BULLETIN is a technical directive containing instructions and directions to accomplish inspections, calibrations, tests and adjustments, or additional instructions on standard rework, methods, limitations, and procedures which do not fall within the change definition.

A GENERAL BULLETIN may be used in instances where the instructions and directions apply to a number of different powerplants, airframes, etc.

An INTERIM CHANGE or an INTERIM BULLETIN is a change or bulletin directive in message form which defines the action to be taken to correct a safety or operational condition which embodies risks considered to be in need of immediate correction. Interim directives may or may not contain the final solution to the problem. Interim directives are issued only when the action classification (discussed below) is Immediate or Urgent.

Action Classification

The action classification and compliance requirements for completing the directed action are of major concern and importance. In establishing time limits, the originator has considered the type and seriousness of the deficiency, operational employment and environmental conditions affecting the deficiency, prior to accomplishment of other changes, and special tools or facilities required.

IMMEDIATE ACTION.–This type directive is concerned with problems involving safety, which would probably result in fatal or serious injury to personnel, or destruction of (or extensive damage to) property, unless corrected within extremely narrow time limits. Immediate Action directives involve the immediate discontinued use of the aircraft, engine, or equipment in the operational employment under which the adverse safety condition exists. If continued use will not involve the affected component or system in either normal or emergency situations, compliance may be deferred until (but no later than) the next periodic inspection for aircraft and engines, and no later than 6 months from date of issue for equipments.

URGENT ACTION.–A directive of this type also indicates a problem in safety conditions which could result in personnel injury or property damage unless corrected. The major difference is that time limits are not quite so close as with Immediate Action directives, but are still narrow. Operating restrictions may or may not be imposed. (This classification may also be used for mission capability changes when operational and deployment commitments are considered of overriding importance.)

Interim directives classified Urgent Action require incorporation within 60 days from date of issue in those aircraft, engines, or equipments employed under conditions in which the hazard exists. If continued operation will not involve use of the affected component under either normal or emergency situations, action may be deferred up to 180 days from date of issue.

Formal directives classified Urgent Action require incorporation not later than the next Progressive Aircraft Rework (PAR) period or

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overhaul for aircraft and engines, and 18 months from date of issue for equipments.

ROUTINE ACTION.–These directives indicate conditions which, if uncorrected, could eventually result in personnel injury or property damage, or could have an adverse effect on operation, maintenance, or support functions. Although a hazard may exist, the situation is not considered to be critical; therefore, action may be deferred not more than one PAR or overhaul for aircraft and engines, and 18 months from date of issue for equipments.

Noncritical changes requiring the facilities of a Naval Industrial Activity could seriously interfere with operational or deployment commitments. In this event, the change may be deferred by the controlling custodian until the next succeeding PAR or overhaul.

Title

Changes and bulletins are issued under title subjects–Airframe, Powerplant, Avionics, Accessory, Support Equipment, Aviation Armament, Air Crew System, Photographic, Clothing & Survival Equipment, and Propeller.

Numbering

The number is assigned separately for each type directive and for each title subject, in numerical sequence by date of approval (not necessarily the date of issue). Interim changes and bulletings are numbered in sequence along with formal directives; formal directives issued to supersede interims retain the same sequence number.

Occasionally directives require amendment or revision. A REVISION is a completely new edition of an existing publication, and bears the words "Rev. A" or "Rev. B" as appropriate. An AMENDMENT makes a minor change or addition to the basic directive, and is indicated by "Amendment 1" following the basic title.

Some changes are intended to be installed in stages, or by different level maintenance activities. These changes are issued as "Part I" and "Part II" of the basic directive.

Format

Although there are some slight variations in detail, all letter type technical publications conform generally to a standardized format. Only a few of the topics covered in the directive warrant discussion in this course. They are as follows:

1. Publications affected. Lists the publications which should be revised as a result of incorporation of the directive.
2. Application. Identifies the specific aircraft, engines, or equipment to which the directive applies.
3. Supply Data. Presents detailed information concerning all material and supply transactions involved in support of the directed action.
4. Detailed instructions. For the maintenance technician, this is the most important part of the directive. It presents the detailed step by step procedures to be followed in accomplishing the directed action.
5. Identification. Gives instructions for marking the unit upon completion of the action, for easy identification of those units which have undergone modification.
6. Log entry. Indicates the entry, if any, to be made on the applicable logbook.

Obsolescent Types

Many directives which were issued prior to the standardization of the directives system are still effective. These include Aviation Circular Letters, Technical Orders, Technical Notes, Aircraft Changes and Bulletins, Electronic Material Changes, and Electronic Material Bulletins. Although these directives are no longer being issued, those which have not been canceled or superseded are included in the latest edition of the NavSup 2002.

Local Action

Upon receipt of a letter type technical directive, either formal or interim, the directive must be screened by the maintenance activity to determine its applicability to units or aircraft maintained by that activity. If local compliance is required, a local maintenance instruction (discussed in chapter 2) of this manual is prepared to direct compliance by shop personnel. This local instruction provides a ready reference to determine the status of action based on that directive in the activity,

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and provides a record of which units have been processed.

PERIODICALS

Many periodicals of interest to the technician are published and issued by naval activities and commands. A few of the most important are discussed in the following paragraphs.

NAESU Digest

Each month the Naval Aviation Engineering Service Unit (NAESU) prepares and publishes the Digest of U.S. Naval Aviation Electronics. The Digest contains information on electrical and electronics equipment relative to operation, maintenance, installation, and supply. This is an excellent source of information dealing with new equipment and new ideas for the older equipment. It gives the latest procedures (developed by NAESU and other activities) for speeding the testing, calibration, and alinement of equipment. In general, it is as the name suggests–a "digest" of all the latest information pertaining to work in electronics. It should be on the "must read" list for all hands, and always available for ready reference.

Approach

Approach, The Naval Aviation Safety Review, is published monthly by the U.S. Naval Aviation Safety Center. It is distributed to naval aeronautical organizations on the basis of one copy for each ten personnel assigned. It presents the most accurate information currently available on the subject of aviation accident prevention. It is an unofficial publication, and its contents are not to be considered as regulations, orders, or directives. It should, however, be read each month by all aviation personnel.

Naval Aviation News

Naval Aviation News is published monthly by the Chief of Naval Operations and the Naval Air Systems Command. Its purpose is to disseminate information on aircraft, aviation training and operations, and other aeronautical matters.

This publication should be read each month by all naval aviation personnel.

All Hands

ALL HANDS, Nav-Pers-0 Series, the Bureau of Naval Personnel Career Publication, is published monthly by the Bureau of Naval Personnel for the information and interest of the naval service as a whole. It is not an official publication in the sense of constituting authority for action based on information contained therein; nor is it a statement of official policy. However, it is an important publication in that it contains information vital to naval personnel.

Distribution of All Hands is automatic to each activity, and is based on one copy for each ten personnel assigned. It should be read every month by all personnel.

Naval Ordnance BULLETIN

The Naval Ordnance BULLETIN is a CONFIDENTIAL magazine issued quarterly by the Naval Ordnance Systems Command. This Bulletin contains information concerning aviation and ordnance projects of special and general interest, including new developments. The information ranges from suggestions which should help in using present equipment to furnishing a background of information on advanced developments and concepts.

DRAWINGS AND SCHEMATICS

Nearly all technical manuals make extensive use of drawings and diagrams. The technician uses these figures in nearly every phase of his work–the location and identification of units and components, troubleshooting, signal and/or circuit tracing, installation, calibration and adjustment, testing, operation, and evaluation. He uses figures in the study of operating principles of circuits and equipments.

No one particular type illustration is suitable for all applications; therefore, many different types are required. Several of the different types are discussed in the following paragraphs. Each type has its own advantages and disadvantages.

NOTE: Blueprint Reading and Sketching, NavPers 10077-C provides many details con-

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cerning the construction of illustrations and drawings. Review of that manual should be made prior to continuing the study of this chapter.

ILLUSTRATIONS

Illustrations are commonly used to present visually the idea of a text. To this end, illustrations are used in many forms. A few of these are the photograph, line drawing, shaded sketch, cutaway view, blueprint, etc. Some of the more common illustrations are discussed briefly in this chapter.

Pictorial

Pictorial illustrations normally indicate physical appearance. They may present details concerning the location, size, construction, physical relationships of size and location, or parts arrangement. They appear throughout manuals of all types, and are useful for locating and identifying systems, equipments, components, or parts. They are used in connection with installation, inspection, servicing, operation, adjustment, calibration, troubleshooting, and repair functions.

Pictorial illustrations may be accurately detailed representations, or they may be merely generalized indications, depending on their purpose. They may be photographs, halftone or shaded sketches, or line drawings.

Cutaway View

A cutaway view is an illustration used to show some detail of construction which would be extremely difficult or impossible to show by conventional pictorial views. It is often used in connection with discussions of physical construction and the operation of mechanical devices. It is frequently used in assembly diagrams and in construction details.

Location and Dimension

Location diagrams are used to show physical position relationships, and may or may not be sufficiently detailed to show physical appearance. They are primarily useful for familiarization, and are commonly used in Flight Manuals, in the General Information and Servicing section of the Maintenance Instructions Manuals (MIM's), in the Illustrated Parts Breakdown Manual, (IPB) and in the Operation and Maintenance Instructions for equipments.

Dimension diagrams denote physical size and distance. They are useful in planning the layout of bench stations, making equipment installations, or packing materials for reshipment. They are frequently used in the general information sections of technical manuals, and in those sections devoted to familiarization, installation, and shipment. They are also frequently found in change type technical directives.

Location and/or dimension diagrams may be combined with other type illustrations, thus providing additional details without increasing the number of illustrations.

Assembly Diagrams

Assembly diagrams, as the name implies, provide details of construction which are useful in assembling parts into a unit. They are also useful in explaining the operation of mechanical or electromechanical devices.

BLOCK DIAGRAMS

Block diagrams are not used to show physical shape, size, or location; they are used to present a generalized explanation of overall functional operation. They range from very simple to very complex, depending on the type equipment, the quantity and quality of details to be covered, and the purpose for which the information is included. They are found in nearly all manuals dealing with basic or detailed theory of operation, whether of relatively simple subassemblies or of very large and complex systems. The more complex the equipment, the more probable the need for block diagrams.

Many block diagrams are used in connection with electromechanical devices, as well as with electrical or mechanical systems. Proper use of this type diagram helps increase understanding of functional relationships and operation.

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Symbols

Since block diagrams are used mainly to provide a general analysis of functional operation, symbols are generally used to represent individual circuits or functional components. In order to make maximum use of block diagrams, it is essential to recognize the symbols, and to understand their meanings and limitations. Appendix II of this manual contains many of the common symbols found on block diagrams. Numerous block diagrams are included in this manual.

Signal Flow

One special type of block diagram is called the signal flow diagram or signal flow chart. It is usually used in connection with overall operation of complicated systems such as fire control computers, ASW systems, aircraft control or power distribution systems, or search or navigation radar systems. It includes all features normally associated with block diagrams, and in addition it includes considerable detail regarding signal paths, signal wave-shape, timing sequence and relationships, magnitudes of potentials or signals, frequencies, etc.

WIRING DIAGRAMS

The wiring diagram presents detailed circuitry information concerning electrical and electronics systems. A master wiring diagram is a single diagram that shows all the wiring in a complete system or in an aircraft. In most cases, this diagram would prove to be too large to be usable; it is normally broken down into logical functional sections, each of which may be further subdivided into circuit diagrams. By breaking a system into individual circuit diagrams, each individual circuit may be presented in greater detail. The increased detail provides for easier circuit tracing, testing, and maintenance.

Wiring diagrams fall into two basic classes–chassis wiring and interconnecting diagrams–each with specific purposes and many variations in appearance (depending on application). Wiring diagrams are not generally used for discussions of theory of operation of specific circuits.

Figure 4-3(A) is an example of one type chassis wiring diagram commonly used. This drawing shows the physical layout of the unit, and all component parts and interconnecting tie points are shown. Each indicated part is identified by reference designation number, thus facilitating use of the IPB to determine values and other data. (The values of resistors, capacitors, or other components are normally not indicated on wiring diagrams.) The polarity of semiconductor diodes and of the polarized capacitor is shown. Since this specific diagram shows physical layout and dimensioning details for mounting holes, it could be used as an assembly drawing and also as an installation drawing.

Figure 4-3 (B) shows the reverse side of the same mounting board, together with the wiring interconnections to other components. Actual positioning of circuit components is not indicated, and wire bundles are represented as single lines with the separate wires entering at an angle. (The angle indicates the direction to follow in tracing the circuit to locate the other end of the wire.)

The wire identification coding on this diagram consists of a three-part designation. The first part is a number representing the color code of the wire in accordance with Military Specification MIL-W-76A. (Many other chassis wiring diagrams designate color coding by abbreviations of the actual colors.) The second is the reference part designation number of the item to which the wire is connected. The last is the designation of the specific terminal to which connection is made.

Figure 4-3 (C), while not a wiring diagram, illustrates a method commonly used to show some functional aspect of sealed or special components.

Figure 4-3 (D) illustrates several methods used to indicate connections at terminal strips. The details of wire identification coding used are discussed below.

Wiring diagrams are normally the major content of the last volume of an MIM set, or the last section of most other maintenance manuals. This volume or section contains wiring diagrams for all electrical and electronic systems of the aircraft. The diagrams are prepared separately for each circuit and provide all data necessary to understand the construction of

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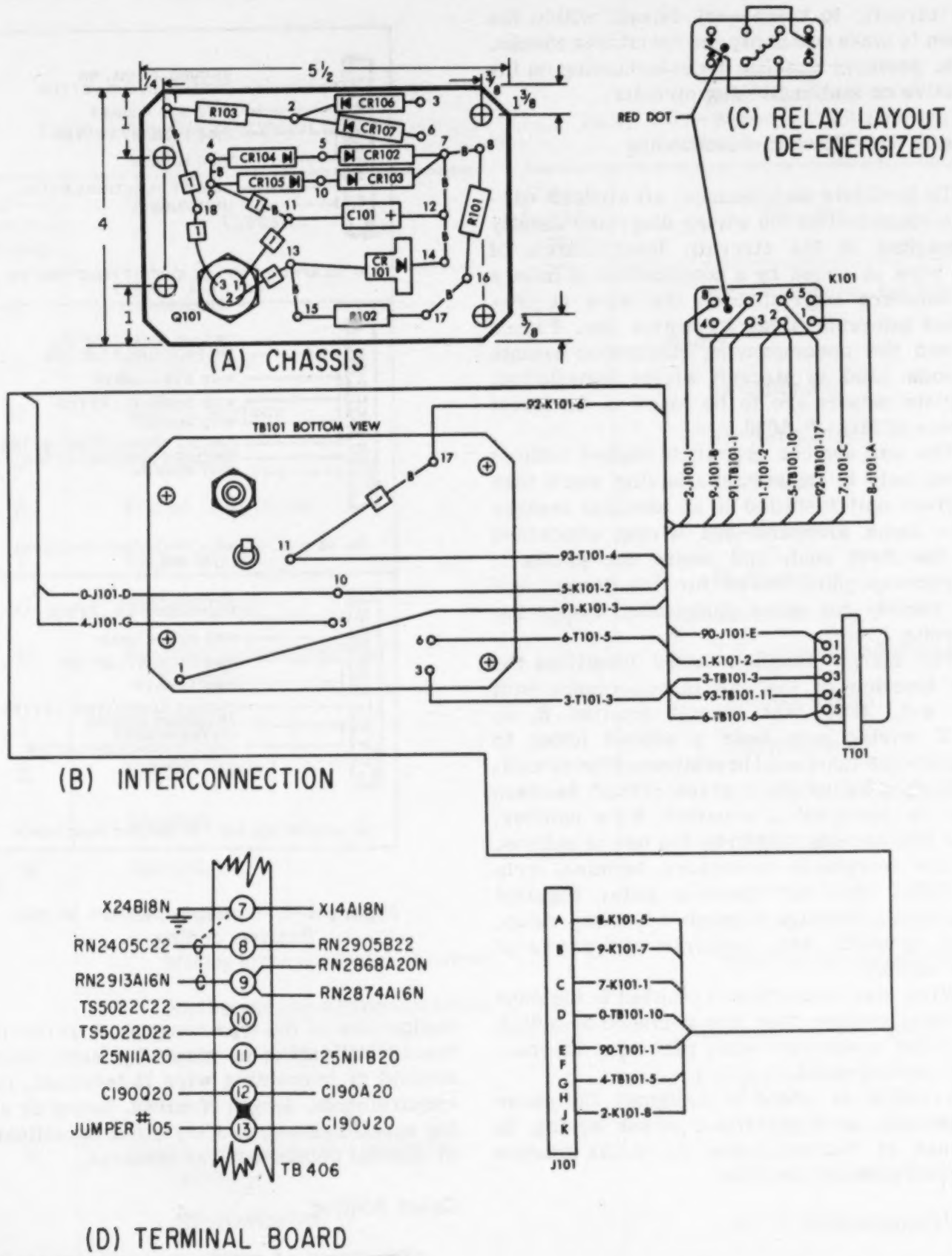

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Figure 4-3.—Wiring diagrams. (A) Chassis wiring; (B) interconnection wiring; (C) sealed component parts layout; (D) terminal board connections.

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Alfalfa Stem Nematode

By Ivan J. Shields
Extension Plant Pathologist

FIGURE 1

Each spring, a number of alfalfa fields in Arizona show damage from the stem nematode. Since it was first reported near Safford about 25 years ago, the stem nematode has been found in many parts of the state. It has never been really serious but heavy infestations of the stem nematode Ditylenchus dipsaci have killed plants and reduced stands in small to large areas of fields. Most alfalfa varieties are susceptible.

CHECK BUDS AND STEMS

Heavily-infested plants will fail to produce stems long enough for harvest. This striking symptom is only exhibited during active growing stages of the plant (Figure 1). The stems will be greatly shortened, thickened and club-like (Figure 2). Crown buds, infested with nematodes, become swollen and distorted, and will break off easily. Alfalfa seedlings will also be affected, especially if seeded into nematode-infested stands.

WHEN TO LOOK

The stem nematode is most active under cool, moist conditions, especially after irrigations. In the lower elevations the nematodes are most active through parts of the winter and early spring; at the higher elevations, they are active in spring and summer. Later in the season the higher temperatures and dry conditions stop nematode activity, so the surviving plants return to normal growth. Many of these weakened plants later succumb to infections by soil-borne fungi and bacteria.

HOW IT SPREADS

Once present in a field, these tiny eel-worms are readily spread to other parts of the field or to other fields. They are easily carried down along the borders in irrigation water. The damage is often greatest next to these borders. Tail water from infested fields can carry the nematodes to new fields. They also may stick to feet of grazing animals or be carried by machinery.

Stem nematodes can live many months in infested alfalfa stems, even after it is cut and thus can be spread over many miles when alfalfa hay is shipped from one part of the state to another.

FIGURE 2

WHAT ARE THE CONTROLS?

1. Prevent stem nematode infestations by avoiding use of tail water from old alfalfa fields.

2. Protect healthy alfalfa by harvesting or grazing infested fields last.

3. Keep alfalfa fields in a rotation with crops other than alfalfa.

4. Plow up infested fields and plant to non-susceptible crops such as cotton, barley, wheat, oats, sorghum, lettuce and beans. Do not replant to alfalfa for at least three years.

5. Plant Lahontan if it is adapted to your area. It is resistant to the stem nematode.

Cooperative Extension Service and Department of Plant Pathology of the
Agricultural Experiment Station, The University of Arizona, Tucson

each circuit, to trace each circuit within the system to make continuity and resistance checks, and to perform specific troubleshooting on inoperative or malfunctioning circuits.

Aircraft Wire Identification Coding

To facilitate maintenance, all aircraft wiring is identified on the wiring diagrams exactly as marked in the aircraft. Identification of each wire is coded by a combination of letters and numbers imprinted on the wire at prescribed intervals along its entire run. Figure 4-4 and the accompanying discussion explain the code used in aircraft wiring installation. Complete details are to be found in the latest revision of MIL-W-5088.

The unit number (shown in dashed outline) is used only in those cases having more than one given unit installed in an identical manner in the same aircraft. The wiring concerned with the first such unit bears the prefix 1, and corresponding wires for the second unit have exactly the same designation except for the prefix 2, etc.

The circuit function letter identifies the basic function of the unit in accordance with table 4-5. Note that circuit function R, S, and T wiring may bear a second letter to designate the functional breakdown of the circuit.

Each wire within a given circuit function group is assigned a separate wire number. Wires that are segmented by the use of splices, plug and receptacle connectors, terminal strip tie points, etc., are given a letter segment designation. Passage through a switch, relay, circuit breaker, etc., requires assignment of a new number.

Wire size numbers are omitted in the case of coaxial cables; they are replaced by a dash and coded designator when part of a thermocouple arrangement.

A suffix is added to designate the phase (or ground) in 3-phase a-c power wiring. In the case of thermocouples the suffix denotes the metal element involved.

Cable Construction

Cable construction diagrams present details concerning the fabrication and construction of cables. These details usually include designation of the type connectors or terminals, the identification of wires for each terminal, method of connecting wire to terminal, potting requirements, length of wires, lacing or sleeving specifications, and any other specifications, or special considerations involved.

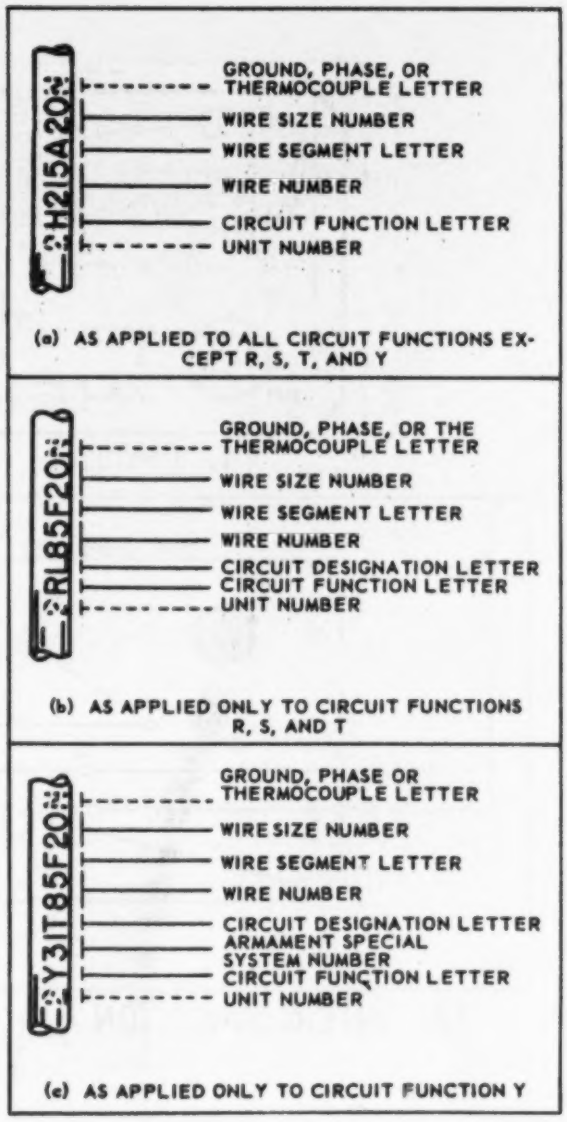

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Figure 4-4.–Example of wire Identification coding.

Cable Routing

Diagrams of major systems generally include an isometric shadow outline of the aircraft showing the approximate location of equipment components, and the physical routing of inter-

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Table 4-5.—Wiring circuit function code.

Circuit function letter	Circuits
A	Armament
B	Photographic
C	Control surface
D	Instrument
E	Engine instrument
F	Flight instrument
G	Landing gear
H	Heating, ventilating, and de-icing
J	Ignition
K	Engine control
L	Lighting
M	Miscellaneous
P	D-c power Wiring in the d-c power or power control system will be identified by the circuit function letter P.
Q	Fuel and oil
R	Radio (navigation and communication) RN-Navigation RP-Intercommunications RZ-Interphone, headphone
S	Radar SA-Altimeter SN-Navigation SQ-Track SR-Recorder SS-Search
T	Special electronic TE - Countermeasures TN-Navigation TR-Receivers TX-Television transmitters TZ-Computer
V	D-c power and d-c control wires for a-c systems will be identified by the circuit function letter V.
W	Warning and emergency
X	A-c power Wiring in the a-c power system will be identified by the circuit function letter X.
Y	Armament special systems

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connecting cables. A cable, regardless of the number of conductors, is represented on an isometric wiring diagram as a single line; no attempt is made to show individual connections at equipment units or in connection boxes. An isometric type drawing thus shows at a glance a picture of the layout of the entire system.

SCHEMATICS

The major purpose of the schematic diagram is to establish the electrical operation of a particular system. It is not drawn to scale, and it shows none of the actual construction details of the system (such as a physical location within the aircraft, physical layout of components, wire routing, or any other physical detail) not essential to understanding circuit operation.

Schematic drawings differ from block diagrams (discussed earlier) by presenting more detail concerning each circuit. Whereas the block diagram deals with functional units of the system, the schematic diagram indicates each individual part which contributes to the functional operation of the circuit.

NOTE: The National Bureau of Standards is now using in all its publications the term hertz, abbreviated Hz, as the term applied to a unit of frequency, one hertz being one cycle per second. Table 4-6 will give you a quick rundown of a few applications of the term to show you how it works.

Simplified Schematics

In large or complex equipments, a complete schematic drawing may be too large for practical use. For this reason, most technical manuals present partial or simplified schematics for individual circuits or units.

Simplified schematics normally omit parts and connections which are not essential to understanding circuit operation. In studying or troubleshooting equipment, the technician frequently must make his own simplified drawings. In these cases he should include only those items that contribute to the purpose of the drawing, but he should take care to include all such items. In using the schematic drawings throughout this manual (and those in technical manuals, textbooks, and other publications), many techniques for simplifying schematics will become apparent. Special attention should be paid to those techniques found useful by the individual maintenance man–they can be extremely important tools in his work.

Electromechanical Drawings

Electromechanical devices such as synchros, gyros, accelerometers, autotune systems, analog computing elements, etc., are quite common in avionics systems. For a complete understanding of these units, neither an electrical drawing nor a mechanical drawing would be adequate–and confusion could result from the use of two drawings. Therefore a com-

Table 4-6.–Hertz table.

Unit/quantity	Old term	Old abbrev.	New term	New abbrev.
Frequency	Cycles Per Second	cps	hertz	Hz
10^{-3} Cycles Per Second	Millicycles Per Second	mc	Millihertz	mHz
10^{3} Cycles Per Second	Kilocycles Per Second	kc	Kilohertz	kHz
10^{6} Cycles Per Second	Megacycles Per Second	Mc	Megahertz	MHz
10^{9} Cycles Per Second	Gigacycles Per Second	Gc	Gigahertz	GHz

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bination type drawing, using some aspects of each component type, is used. These drawings are usually simplified both electrically and mechanically, and only those items essential to the operation are indicated on the drawing.

CHARTS AND TABLES

Charts and tables of many types are used throughout all types of technical publications to present factual data in a clear and concise form. As the terms are used in this discussion, a chart is used to present information in lists, pictures, tables, or diagrams; a table is one type of chart, and is used to present or list information in a very condensed form.

Tables prove valuable in instances when the same general type information is to be presented with respect to numerous items. The corresponding details for the items may be listed in columns, arranged so that reading across will present details regarding a specific item, while reading down will present a comparison of items with respect to a certain detail. One very common and useful table of this type is represented by the IPB listings discussed earlier in this chapter.

SECURITY OF CLASSIFIED MATERIAL

It is important that all personnel in the Naval Establishment be aware of (and comply with) regulations governing the use and safeguarding of classified material and information. The basic policy governing security is established and detailed in the Department of the Navy Security Manual for Classified Material, OpNav Instruction 5510.1 (Series). This manual is to be used as a guide by all naval personnel in the handling of classified material. Many of the electronics equipments installed in modern aircraft (and their applicable technical publications) bear security classification, so it is especially important that all personnel in the avionics ratings become thoroughly familiar with security procedures.

It is the personal responsibility of each individual to safeguard all classified material in his possession so as to prevent loss or compromise. It is also his responsibility to avoid unauthorized disclosure of classified information. Material of a classified nature should not be passed on to any person not having the proper security clearance and the need to know.

In contacts with other persons, do not assume that they have the proper security clearance; be SURE before revealing classified information. In conversations and in writing, avoid compromising security. Do not pass any information to unknown personnel until it is sure that the information is not classified.

Remember that notes jotted down concerning classified material may contain classified information, and must be handled accordingly.

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CHAPTER 5

ELEMENTARY PHYSICS

The Navy technician is associated with some very complex machines and equipment. He is expected to understand, operate, service, and maintain these machines and equipment, and to instruct new men so that they can also perform these functions. No matter how complex a machine or item of equipment is, its action can be satisfactorily explained as an application of a few basic principles of physics. In order to understand, maintain, and repair the equipment and machinery necessary to the operation of the ships and aircraft of the fleet, an understanding of these basic principles is essential. There can be no question that the technician who possesses this understanding is better equipped to meet the demands placed upon him in his everyday tasks.

Physics is devoted to finding and defining problems, as well as to searching for their solutions. It not only teaches a person to be curious about the physical world, but also provides a means of satisfying that curiosity. The distinction between physics and other sciences cannot be well defined, because the principles of physics also pertain to the other sciences. Physics is a basic branch of science and deals with matter, motion, force, and energy. It deals with the phenomena which arise because matter moves, exerts force, and possesses energy. It is the foundation for the laws governing these phenomena, as expressed in the study of mechanics, hydraulics, magnetism, electricity, heat, light, sound, and nuclear physics. It is closely associated with chemistry and depends heavily upon mathematics for many of its theories and explanations.

BASIC CONCEPTS

In any study of physics, it soon becomes obvious that specific words and terms have specific meanings which must be mastered from the very start. Without an understanding of the exact meaning of the term, there can be no real understanding of the principles involved in the use of that term. Once the term is correctly understood, however, many principles may be discussed briefly to illustrate or to emphasize the particular aspects of interest. The first part of this chapter is devoted to definitions of some physical terms and a brief general discussion of certain particular principles of vital interest to all technical personnel.

MEASUREMENT

In all branches of science, measurement is a very important consideration. In order to evaluate results, it is often essential to know how much, how far, how many, how often, or in what direction. As scientific investigations become more complex, measurements must become more accurate, and new methods must be developed to measure new things.

Measurements may be classed in three broad categories–magnitude, direction, and time. These categories are broken down into several types, each with its own standard units. Measurements of direction and time have become fairly well standardized and have comparatively few subdivisions. Magnitude, on the other hand, is an extremely complex category with many classes and subdivisions involved.

To illustrate the complexity of the magnitude category, consider only a few common examples of measurement dealing with magnitude: weight, distance, temperature, voltage, size, loudness, brightness, etc.; then consider measurements based on combinations of magnitude: density (weight per unit volume), pressure (force per unit are), thermal expansion (increase in size per degree change in temperature), etc. In addition, measurements combine categories: The flow of liquids is measured in volume per unit of time, speed is measured in distance per unit of time, rotation is measured in revolutions per minute, frequency is expressed in cycles per second, (hertz) and so on indefinitely.

The importance of measurement and the necessity of selecting the proper measurement cannot be overemphasized. Several systems of measurement further complicate matters. For example, distance may be measured in feet or in meters; weight in pounds or in kilograms; capacity in quarts or in liters; temperature in degrees Fahrenheit, centigrade, or Kelvin; density in pounds per cubic foot or in grams per cubic centimeter; angles in degrees or in radians; etc.

In this manual, as in many other texts, specific measurements will be described when and as necessary for clarity.

MATTER AND ENERGY

MATTER may be defined basically as "anything that occupies space and has weight or mass." It exists naturally in three states–solid, liquid, or gas. All matter is composed of small particles called molecules. Matter may be changed or combined by various methods–physical, chemical, or nuclear. Matter has many properties; properties possessed by all forms of matter are called general properties, while those properties possessed only by certain classes of matter are referred to as special properties.

ENERGY may be defined basically as "the capacity for doing work." It may be classified in many ways; but for this discussion, energy will be classified as mechanical, chemical, radiant, heat, light, sound, electrical, or magnetic. Energy is constantly being exchanged from one object to another and from one form to another. Physics is primarily the study of matter and energy in their various forms and of the relationships that exist between them.

Law of Conservation

Matter may be converted from one form to another with no change in the total amount of matter. Energy may also be changed in form with no resultant change in the total quantity of energy. In addition, a third statement has been added within the past half century: "Although the total amount of matter and energy remains constant, matter can be converted into energy or energy into matter." This statement is known as the law of conservation for energy and matter. The basic mathematical equation which shows the relationship between matter and energy is as follows:

$$E = mc^2$$

where E represents the amount of energy, m represents the amount of matter (mass), and c represents the velocity of light.

From the equation it may be seen that the destruction of matter creates energy, and that the creation of matter requires expenditure of energy. From this observation it may be implied that a given quantity of matter is the equivalent of some amount of energy. In common usage it is usually stated that matter "possesses" energy.

General Properties of Matter

Matter in all forms possesses certain properties. In the basic definition it has been stated that matter occupies space and has mass. Those two ideas contain most, if not all, of the general properties of matter.

SPACE.–The amount of space occupied by, or enclosed within, the bounding surfaces of a body is called volume. In the study of physics, this concept must be somewhat modified in order to be completely accurate. As stated previously, matter may appear as a solid, as a liquid, or as a gas–each having special properties. In a later section of this chapter it will be shown that for even a specific substance the volume may vary with changes in circumstances. It will also be shown that

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liquids and solids tend to retain their volume when physically moved from one container to another; gases tend to assume the volume of the container.

It will be discussed at some length later that all matter is composed of atoms and molecules. In order to clarify our concept of "occupying space," we must deal with these minute particles of matter, which are in turn composed of still smaller particles separated from each other by empty space (which contains no matter). This idea is used to explain two general properties of matter–impenetrability and porosity.

Two objects cannot occupy the same space at the same time; this is known as the "impenetrability of matter." The actual space occupied by the individual subatomic particles cannot be occupied by any other matter. The impenetrability of matter may, at first glance, seem invalid when a cup of salt is poured into a cup of water–the result is considerably less than two cups of salt water. However, matter has an additional general property called "porosity" which explains this apparent loss of volume: The water simply occupies space between particles of salt. Porosity is present in all material–but to an extremely wide range of degree. Generally, gases are extremely porous, liquids only slightly so; solids vary over a wide range, from the sponge to the steel ball.

WEIGHT.–The concept of weight is also quite complicated and involves two general properties of matter–inertia and gravitational attraction. Before discussing weight, these two general properties and the concepts of motion and force must be discussed.

MOTION may be defined as the "act or process of changing place or position." The "state of motion" refers to the amount and the type of motion possessed by a body at some definite instant (or during some interval) of time. A body at rest is not changing in place or position; it is said to have zero motion, or to be motionless.

The natural tendency of any body at rest is to remain at rest; a moving body tends to continue moving in a straight line with no change in speed or direction. A body which obeys this natural tendency is said to be in uniform motion.

Every object tends to maintain a uniform state of motion. A body at rest never starts to move by itself; a body in motion will maintain its speed and direction unless it is caused to change. In order to cause a body to deviate from its condition of uniform motion, a push or a pull must be exerted on it. This requirement is due to that general property of all matter known as INERTIA.

The greater the tendency of a body to maintain uniform motion, the greater its inertia. To assign a numerical value to the inertia of a body, it is compared with some standard which is assigned the inertia value of 1. The quantitative measure of inertia is called the MASS of the body; therefore, since all matter possesses inertia, all matter must also possess mass.

Any change in the state of motion of a body is known as ACCELERATION, and the cause which produces it is called an accelerating force. Acceleration represents the rate of change in the motion of a body, and may represent either an increase or a decrease in speed and/or a change in direction of motion.

FORCE is the action or effect on a body which tends to change the state of motion of the body acted upon. A force may tend to move a body at rest; it may tend to increase or decrease the speed of a moving body; or it may tend to change the direction of motion. The application of a force to a body does not necessarily result in a change in the state of motion; it may only TEND to cause such a change.

A force is any push or pull which acts on a body. Water in a can exerts a force on the sides and bottom of the can. A tug exerts a push or a pull (force) on a barge. A man leaning against a bulkhead exerts a force on the bulkhead.

In the above examples, a physical object is exerting the force and is in direct contact with the body upon which the force is being exerted. Forces of this type are called contact forces. There are other forces which act through empty space without contact–in some cases without even seeming to have any mass associated with them. The force of gravity exerted on a body by the earth–known as the weight of the body–is an example of a force that acts on a body through empty space and without contact. Such a force is known as an

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action-at-a-distance force. Electric and magnetic forces are other examples of these action-at-a-distance forces. The space through which these action-at-a-distance forces are effective is called a force field.

Force is a VECTOR quantity; that is, it has both direction and magnitude. A force is completely described when its magnitude, direction, and point of application are given. In a force vector diagram, the starting point of the line represents the point of application of the force. (The topic of vectors–properties, functions, uses, and methods of calculation–is discussed in detail in Rate Training Manual, Mathematics Vol. 2, NavPers 10071-B.)

Any given body, at any given time, is subjected to many forces. In many cases, all these forces may be combined into a single RESULTANT force, which may then be used to determine the total effect on the body. Combination of all individual forces into a single resultant involves the use of trigonometry, which is also covered in NavPers 10071-B.

Each body of matter in the universe attracts every other body with a force which is proportional to the mass of the bodies and inverse to the square of the distance between them. This force is called the UNIVERSAL FORCE OF GRAVITATIONAL ATTRACTION. Since every body exerts this force on every other body, when considering the forces acting on a single body, it is an almost universal practice to resolve all gravitational forces into a single resultant. At or near the surface of the earth, this becomes a fairly simple process–due to its extremely large mass, the earth exerts such a large gravitational attraction that it is entirely practical to ignore all other such attractions and merely use the earth's gravitational attraction as the resultant.

Although gravitational attraction is exerted by each body on the other, in those cases where there is a great difference in the mass of two bodies, it is usually more convenient to consider the force as being exerted by the larger mass on the smaller mass. Thus, it is commonly stated that the earth exerts a gravitational force of attraction on a body. The gravitational attraction exerted by the earth on a body is called GRAVITY.

The gravitational force exerted by the earth on a body is called the WEIGHT of that body, and is expressed in force units. In the English system, force is expressed in pounds. If a body is attracted by a gravitational force of 160 pounds, the body is said to weigh 160 pounds. The gravitational force between two bodies decreases as the distance between them increases; therefore, a body weighs less a mile above the surface of the ocean than it weighs at sea level; it weighs more a mile below sea level.

Conversion of Mass and Weight

The relationship of mass, weight, and gravity may be expressed mathematically by the formula

$$\text{mass} = \frac{\text{weight}}{\text{acceleration due to gravity}}$$

This relationship is valid for any system of measurement, provided only that all measurements are taken in the same system.

In the English system of measurement, the mass is normally measured in slugs, weight in pounds, and acceleration (due to gravity) in feet per second per second. Therefore, the equation in English terms is

$$m = \frac{w(\text{lb})}{g(\text{ft/sec}^2)}$$

(A slug is frequently defined in terms of force and acceleration: A slug is that mass, which, when acted upon by a force of 1 pound, will be accelerated by 32 ft/sec^2.)

In problems involving the use of mass, it is usually convenient to substitute w/32 for m and the weight of the body for w in the equation. (The 32 comes from the fact that the acceleration due to gravity is 32 ft/sec^2.)

Example 1: If a body has a mass of 5 slugs, its weight (in pounds) at sea level (as measured with a spring balance) may be determined from the formula

$$m = \frac{w}{g}$$

Rearranged to solve for the necessary quantity, this formula becomes

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$$w = mg$$

Substituting the numerical values,

$$w = 5 \times 32$$

$$w = 160 \text{ lb}$$

The spring-balance weight of the object is 160 lb at sea level.

Example 2: At an altitude where the acceleration due to gravity is only 31.5 ft/sec^2, what is the weight of the 5-slug mass? By using the same equation and substituting numerical values

$$w = mg$$

$$w = 5 \times 31.5$$

$$w = 157.5 \text{ lb}$$

These examples illustrate how weight varies as a result of a change in the force of gravity due to a change in altitude. The value of 32 feet per second per second usually assigned g is only an approximation used when measurements are made at or near sea level. Altitude affects the weight of an object, but its mass remains constant everywhere.

It is interesting to note that spring weighing machines are not legal for trade in most states of the U.S. A spring scale registers the force necessary to overcome the pull which gravitational force exerts on the object being weighed. This gravitational force varies with the altitude of the object on the earth. A balancing scale, usually called a BALANCE, measures mass rather than weight, although the dial is marked in pounds. On a balance, the object to be weighed is compared with a standard unit of mass. The variation due to altitude is canceled because it affects both the standard unit and the object to be weighed. Therefore, the standard mass serves as an accurate unit of measure for all locations on the surface of the earth.

Density and Specific Gravity

The DENSITY of a substance is its weight per unit volume. A cubic foot of water weighs 62.4 pounds; the density of water is 62.4 pounds per cubic foot. (In the metric system the density of water is 1 gram per cubic centimeter.)

The SPECIFIC GRAVITY (S.G.) of a substance is the ratio of the density of the substance to the density of water–

$$\text{S.G.} = \frac{\text{weight of substance}}{\text{weight of equal volume of water}}$$

Specific gravity is not expressed in units but as a pure number. For example, if a substance has a specific gravity of 4, 1 cubic foot of the substance weighs 4 times as much as a cubic foot of water–62.4 times 4 or 249.6 pounds. In metric units, 1 cubic centimeter of a substance with a specific gravity of 4 weighs 1 times 4 or 4 grams. (Note that in the metric system of units, the specific gravity of a substance has the same numerical value as its density.)

Specific gravity and density are independent of the size of the sample under consideration, and depend only upon the substance of which the sample is made. See table 5-1 for typical values of specific gravity for various substances.

A great deal of ingenuity is often needed to measure the volume of irregularly shaped bodies. Sometimes it is practical to divide a body into a series of regularly shaped parts and then apply the rule that the total volume is equal to the sum of the volumes of all individual parts.

Table 5-1.—Typical values of specific gravity.

Substance	Specific gravity
Aluminum	2.7
Brass	8.6
Copper	8.9
Gold	19.3
Ice	0.92
Iron	7.8
Lead	11.3
Platinum	21.3
Silver	10.5
Steel	7.8
Mercury	13.6
Ethyl alcohol	0.81
Water	1.00

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Figure 5-1 demonstrates another method of measuring the volume of small irregular bodies The volume of water displaced by a body submerged in water is equal to the volume of the body.

A somewhat similar consideration is possible for floating bodies. A floating body displaces its own weight of liquid. This may be proved by filling a container to the brim with liquid, then gently lowering the body to the surface of the liquid and catching the liquid that flows over the brim. Weighing the liquid displaced and the original body will prove the truth of the statement.

Pressure and Total Force

Pressure and force, while closely related topics, are not the same thing. A weight of 10 pounds resting on a table exerts a force of 10 pounds. However, the shape of the weight must be taken into consideration to determine the effect of the weight. If the weight consists of a thin sheet of steel resting on a flat surface, the effect is quite different than if the same sheet of steel were resting on a sharp corner.

Pressure is concerned with the distribution of a force with respect to the area over which that force is distributed. Pressure is defined as the force per unit of area, or $P = F/A$. A flat pan of water with a bottom area of 24 square inches and a total weight of 72 pounds exerts a total force of 72 pounds, or a pressure of 72/24 or 3 pounds per square inch, on the flat table. If the pan is balanced on a block with a surface area of 1 square inch, the pressure is 72/1 or 72 pounds per square inch. An aluminum pan with a thin bottom is suitable for use on a flat surface, but may be damaged if placed on the small block.

This concept explains why a sharp knife cuts more easily than a dull one. The smaller area concentrates the applied force (increases the pressure) and penetrates more easily. For hydraulic applications, the relationship between pressure and force is the basic principle of operation. In enclosed liquids under pressure, the pressure is equal at every point on the surfaces of the enclosing container, and therefore the force on a given surface is dependent on the area. In a system consisting of two cylinders connected by a tube, the force on the pistons is proportional to the area.

Kinetic Energy

Moving bodies possess energy because, by virtue of their mass in motion, they are capable of doing work. The energy of mass in motion is called KINETIC energy, and may be expressed by the equation

$$\text{Kinetic energy} = 1/2\ mv^2$$

where m represents the mass of the body, and v is the velocity of its motion. When the moving

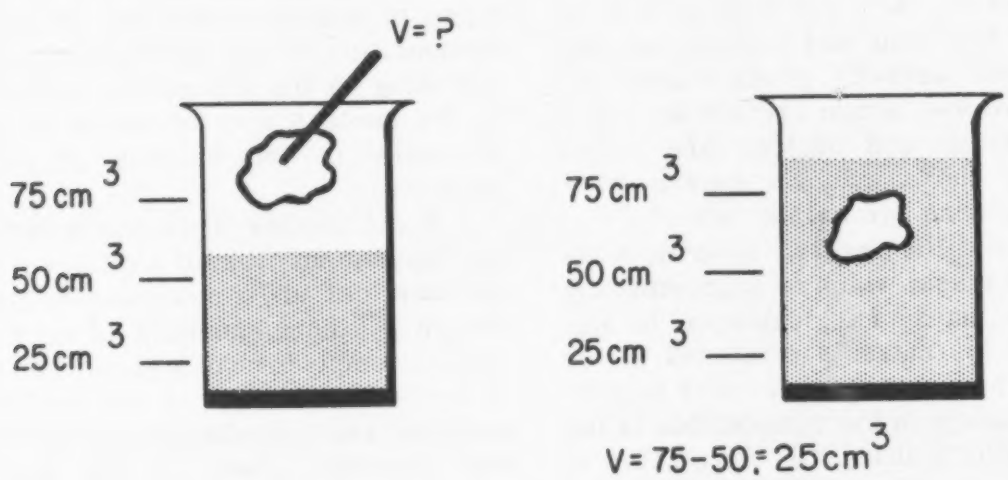

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Figure 5-1.–Measuring the volume of an irregular object.

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Machine Drafting, Volume 1.

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Vocational-Technical Curriculum Laboratory,
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DESCRIPTORS - *VOCATIONAL EDUCATION;
*DRAFTING; ORTHOGONAL PROJECTION; *LABORATORY
MANUALS; *TEACHING GUIDES; TEACHING
PROCEDURES; LESSON PLANS

ABSTRACT - This text, the first of three
proposed volumes on Machine Drafting, is
organized into a series of drawing plates to
teach the elements of drafting and drafting
skills along with the making of typical shop
drawings. Brief information is given relative
to instruments and equipment, lines,
lettering and constructions. The eight units
of instruction include: (1) Introduction,
four lessons, (2) Use of Drawing Instruments,
five lessons, (3) Drawing Geometric
Construction, six lessons, (4) Orthographic
Projection, three lessons, (5) Tracing, three
lessons, (6) Dimensioning, four lessons, (7)
Working Drawings, six lessons, and (8)
Sectional Drawings. The lesson plan contains
the lesson objective, related information,
and some times questions or assignments.
Achievement tests for each unit are included.
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body is stopped, it loses its kinetic energy. The energy is not destroyed, but is merely converted into other forms of energy, such as heat and POTENTIAL energy. It is important to remember that bodies at rest also possess energy by virtue of their position.

COMPOSITION OF MATTER

Many basic facts concerning the structure and composition of matter are presented in Basic Electricity, NavPers 10086-B, and in Basic Electronics, NavPers 10087-B (in connection with the study of transistors). Study of these basic manuals indicates that all matter is composed of atoms, and that these atoms are, in turn, composed of smaller subatomic particles.

The subatomic particles of major interest in elementary physics are the electron, the proton, and the neutron. They may be considered electrical in nature, with the proton representing a positive charge, the electron representing a negative charge, and the neutron being neutral (neither positive nor negative). Although in general the composition of matter follows a consistent pattern for all atoms, the detailed arrangement of subatomic particles is different for each distinct substance. It is the combination and arrangement of the subatomic particles which imparts the distinguishing chemical and physical characteristics to a substance.

The protons and the neutrons of an atom are closely packed together in a nucleus (core), with the electrons revolving around the nucleus. Atoms are normally considered to be electrically neutral–that is, they normally contain an equal number of electrons and protons; but this condition does not actually prevail under all circumstances. Atoms which contain an equal number of electrons and protons are called balanced atoms; those with an excess or a deficiency of electrons are called "ions."

The proton and the neutron have approximately the same mass, which is approximately 1,836 times the mass of an electron. In any atom, nearly all the mass is contained in the nucleus. It may be assumed that under normal conditions any change in the composition of the atom would involve a change in the number of arrangement of the electrons (due to the smaller mass, they are more easily repositioned). This assumption is generally correct–the most notable exception being in the field of nuclear physics, or nucleonics. In chemistry and in general physics, (including electricity and electronics), it is the electron complement that is of major concern.

ELEMENT

The word element is used to denote any one of about 100 substances which comprise the basic substance of all matter. Two or more elements may combine chemically to form a compound; any combination which does not result in a chemical reaction between the different elements is called a mixture. The atom represents the smallest particle of an element. An atom of any one element differs from an atom of any other element in the number of protons in the nucleus; all atoms of a given element contain the same number of protons. Thus, it may be seen that the number of protons in the nucleus determines the type of matter.

The various elements are frequently tabulated according to the number of protons. The number of protons in the nucleus of the atom is referred to as the atomic number of the element.

Nucleus

The study of the nucleus of the atom, known as nucleonics or nuclear physics, is the subject of extensive modern investigation. Experiments on nuclei usually involve the bombardment of the nucleus of an atom, using various types of nuclear particles. By this method the composition of the nucleus is changed, usually resulting in the release of energy. The change to the nucleus may occur as an increase or a decrease in the number of protons and/or neutrons.

If the number of protons is changed, the atom has become an atom of a different element. This process, called "transmutation," is the process sought by the alchemists of the middle ages in their attempts to change various metals into gold. Scientists of that period believed transmutation could be accomplished by chemical means–hence the impetus given to the development of chemistry.

If, on the other hand, only the number of neutrons in the nucleus is changed, the atom

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remains an atom of the same element. Although all the atoms of any particular element have the same number of protons (atomic number), atoms of certain elements may contain various numbers of neutrons. Hydrogen (the sole exception to the rule that all atoms are composed of three kinds of subatomic particles) normally contains a single proton and a single electron–and no neutrons. However, some hydrogen atoms do contain a neutron. Such atoms (although they are atoms of hydrogen) are known as deuterium, or "heavy hydrogen." (They are called "heavy" because the addition of the neutron has approximately doubled the weight of the atom. Deuterium figured prominently in the research which led to the development of nuclear energy and the atomic bomb.) The atomic weight of an atom is an indication of the total number of protons and neutrons in the atomic nucleus.

Atoms of the same element but which have different atomic weights are called isotopes. Nearly all elements have several isotopes; some are very common, and some are very rare. A few of the isotopes occuring naturally and most of those produced by nuclear bombardment are radioactive or have unstable nuclei. These unstable isotopes undergo a spontaneous nuclear bombardment which eventually results in either a new element or a different isotope of the same element. The rate of spontaneous radioactive decay is measured by "half-life" which is the time required for one-half of a sample of radioactive material to change (by spontaneous radioactive decay) into a different substance.

Electron Shells

The physical and chemical characteristics of an element are determined by the number and distribution of electrons in the atoms of that element. The electrons are arranged in successive groups of electron shells of rotation around the nucleus; each shell can contain no more than a specific number of electrons, as described in chapter 2 of Basic Electronics, NavPers 10087-B. An INERT element (that is, an element which does not combine chemically with any other element) is a substance in which the outer electron shell of each atom is completely filled. In an element that is not chemically inert, one or more electrons are missing from the outer shell. An atom with only one or two electrons in its outer shell can be made to give up those electrons; an atom whose outer shell needs only one or two electrons to be completely filled can accept electrons from another element which has one or two "extras."

The concept of "needed" or "extra" electrons arises from the basic fact that all atoms have a tendency toward completion (filling) of the outer shell. An atom whose outer shell has only two electrons would have to collect six additional ones (no easy task, from an energy standpoint) in order to have the eight required for a full shell. A much easier way to achieve the same objective is to give up the two electrons in the outer shell and let the full shell next to it serve as the new outer shell. In chemical terminology, this concept is called valence, and is the prime determining factor in predicting chemical combinations.

COMPOUNDS AND MIXTURES

Under certain conditions, two or more elements can be brought together in such a way that they unite chemically to form a COMPOUND. The resulting substance may differ widely from any of its component elements; for example, ordinary drinking water is formed by the chemical union of two gases–hydrogen and oxygen. When a compound is produced, two or more atoms of the combining elements join chemically to form the MOLECULE that is typical of the new compound. The molecule is the smallest unit that exhibits the distinguishing characteristics of a compound.

The combination of sodium and chlorine to form the chemical compound sodium chloride (common table salt) is a typical example of the formation of molecules. Sodium is a highly caustic poisonous metal containing eleven electrons; its outer shell consists of a single electron, which may be considered "extra" (a valence of + 1). Chlorine, a highly poisonous gas with seventeen electrons, "lacks" a single electron (has a valence of -1) to fill its outer shell. When the atom of sodium gives up its extra electron, it becomes a positively charged ion. (It has lost a unit of negative charge.) The chlorine, having taken on this extra unit of negative change (electron) to fill its outer shell, becomes a negative ion. Since opposite electric charges attract, the ions stick together to form a molecule of the compound sodium chloride.

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The attracting force which holds the ions together in the molecular form is known as the "valence bond," a term which is frequently encountered in the study of transistors.

Note that in the chemical combination, there has been no change in the nucleus of either atom; the only change has occured in the distribution of electrons between the outer shells of the atoms. Also note that the total number of electrons has not changed–there are still the twenty-eight of the original two atoms–although there has been a slight redistribution. Therefore, the molecule is electrically neutral, and has no resultant electrical charge.

Not all chemical combinations of atoms are on a one-for-one basis. In the case of drinking water, two atoms of hydrogen (valence of + 1) are required to combine with a single atom of oxygen (valence of -2) to form a single molecule of water. Some of the more complex chemical compounds consist of many elements with various numbers of atoms of each. All molecules, like all atoms, are normally considered to be electrically neutral. There are some exceptions to this rule, however, with specific cases of interest being the chemical activity in batteries.

Elements or compounds may be physically combined without necessarily undergoing any chemical change. Grains of finely powered iron and sulfur stirred and shaken together retain their own identity as iron or sulfur. Salt dissolved in water is not a compound; it is merely salt dissolved in water. Each chemical substance retains its chemical identity, even though it may undergo a physical change. This is the typical characteristic of a MIXTURE.

STATES OF MATTER

In their natural condition, forms of matter are classified and grouped in many different ways. One such classification is in accordance to their natural state–solid, liquid, or gas. This classification is important because of the common characteristics possessed by substances in one group which distinguish them from substances in the other groups. However, the usefulness of the classification is limited by the fact that most substances can be made to assume any of the three forms.

In all matter, the molecules are assumed to be in constant motion, and it is the extent of this motion that determines the state of matter. The moving molecular particles in all matter possess kinetic energy of motion. The total of this kinetic energy is considered to be the equivalent of the quantity of heat in a sample of the substance. When heat is added, the energy level is increased, and molecular agitation (motion) is increased. When heat is removed, the energy level decreases, and molecular motion diminishes.

In solids, the motion of the molecules is greatly restricted by the rigidity of the crystalline structure of the material. In liquids, the molecular motion is somewhat less restricted, and the substance as a whole is permitted to "flow." In gases, molecular motion is almost entirely random–the molecules are free to move in any direction and are almost constantly in collision both among themselves and with the surfaces of the container.

This topic and some of its more important implications are discussed in detail under the heading "Heat" in a later section of this chapter.

Solids

The outstanding characteristic of a solid is the tendency to retain its size and shape. Any change in these values require the exchange of energy. The common properties of a solid are cohesion and adhesion, tensile strength, ductility, malleability, hardness, brittleness, and elasticity. Ductility is a measure of the ease with which the material can be drawn into a wire. Malleability refers to the ability of some materials to assume a new shape when pounded. Hardness and brittleness are self-explanatory terms. The remaining properties are discussed in more detail in the following paragraphs.

COHESION AND ADHESION.–Cohesion is the molecular attraction between like particles throughout a body, or the force that holds any substance or body together. Adhesion is the molecular attraction existing between surfaces of bodies in contact, or the force which causes unlike materials to stick together.

Cohesion and adhesion are possessed by different materials in widely varying degree. In general, solid bodies are highly cohesive but only slightly adhesive. Fluids (liquids and gases), on the other hand, are usually quite highly ad-

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hesive but only slightly cohesive. Generally a material having one of these properties to a high degree will possess the other property to a relatively low degree.

TENSILE STRENGTH.–The cohesion between the molecules of a solid explains the property called tensile strength. This is a measure of the resistance of a solid from being pulled apart. Steel possesses this property to a high degree, and is thus very useful in structural work. When a break does occur, the pieces of the solid cannot be stuck back together because merely pressing them together does not bring the molecules into close enough contact to restore the molecular force of cohesion. However, melting the edges of the break (welding) allows the molecules on both sides of the break to flow together, thus bringing them once again into the close contact required for cohesion.

ELASTICITY.–If a substance will spring back to its original form after being deformed, it has the property of elasticity. This property is desirable in materials to be used as springs. Steel and bronze are examples of materials which exhibit this property.

Elasticity of compression is exhibited to some degree by all solids, liquids, and gases; the closeness of the molecules in solids and liquids makes them hard to compress, but gases are easily compressed because the molecules are farther apart.

Liquids

The outstanding characteristic of a liquid is its tendency to retain its own volume while assuming the shape of its container; thus a liquid is considered almost completely flexible and highly fluid.

Liquids are practically incompressible; applied pressure is transmitted through them instantaneously, equally, and undiminished to all points on the enclosing surfaces. Hydraulic apparatus can be used to increase or to decrease input forces, thus providing an action similar to that of mechanical advantage in mechanical systems. Because of these properties, hydraulic servomechanisms have advantages as well as disadvantages and limitations when compared with other systems.

The fluidity of hydraulic liquids permits the component parts of the system to be placed conveniently at widely separated points when necessary. Hydraulic power units can transmit energy around corners and bends without the use of complicated gears and levers. They operate with a minimum of slack and friction, which are often excessive in mechanical linkages. Uniform action is obtained without vibration, and the operation of the system remains largely unaffected by variations in load. The accumulator (which provides the necessary pressurization of the system to furnish practically instantaneous response) can be pressurized during periods of nonaction, thus eliminating the "buildup time" characteristic of electric servos.

However, the hydraulic hoses which transmit the fluid from unit to unit are bulky and heavy compared to electric wiring. Many of the hydraulic fluids in common usage are messy and constitute safety hazards. They contribute to the danger of slipping, they cause deterioration of the insulation on electric wiring, they conduct electricity and thus increase the hazards of short circuiting, and they are flammable.

Rate Training Manual, Fluid Power, NavPers 16193-A, contains considerable detail on the basic theory of hydraulic systems and units.

Gases

The most notable characteristics of a gas are its tendency to assume not only the shape but also the volume of its containers, and the definite relationship that exists between the volume, pressure, and temperature of a confined gas.

The ability of a gas to assume the shape and volume of its container is the result of its extremely active molecular particles, which are free to move in any direction. Cohesion between molecules of a gas is extremely small, so the molecules tend to separate and distribute themselves uniformly throughout the volume of the container. In an unpressurized container of liquid, pressure is exerted on the bottom and the sides of the container up to the level of the liquid. In a gas, however, the pressure is also exerted against the top surface, and the pressure is equal at all points on the enclosing surfaces.

The relationship of volume, pressure, and temperature of a confined gas are explained by Boyle's law, Charles' law, and the general law for gases.

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Many laboratory experiments based on these laws make use of the ideas of "standard pressure" and "standard temperature." These are not natural standards, but are standard values selected for convenience in laboratory usage. Standard values are generally used at the beginning of an experiment, or when a temperature or a pressure is to be held constant. Standard temperature is 0° C, the temperature at which pure ice melts. Standard pressure is the pressure exerted by a column of mercury 760 millimeters high. In many practical uses these standards must be changed to other systems of measurement.

All calculations based on the laws of gases make use of "absolute" temperature and pressure. These topics require a somewhat more detailed explanation.

GAS PRESSURE.–Gas pressure may be indicated in either of two ways–absolute pressure or gage pressure. Since the pressure of an absolute vacuum is zero, any pressure measured with respect to this reference is referred to as "absolute pressure." In the present discussion, this value represents the actual pressure exerted by the confined gas.

At sea level the average atmospheric pressure is approximately 14.7 pounds per square inch (psi). This pressure would, in a mercuirial barometer, support a column of mercury 760 millimeters in height. Thus, normal atmospheric pressure is the standard pressure mentioned previously.

However, the actual pressure at sea level varies considerably; and the pressure at any given altitude may differ from that at sea level. Therefore, it is necessary to take into consideration the actual atmospheric pressure when converting absolute pressure to gage pressure (or vice versa).

When a pressure is expressed as the difference between its absolute value and that of the local atmospheric pressure, the measurement is designated "gage" pressure, and is usually expressed in "pounds per square inch gage" (psig). Gage pressure may be converted to absolute pressure by adding the local atmospheric pressure to the gage pressure.

ABSOLUTE ZERO.–Absolute zero, one of the fundamental constants of physics, is usually expressed in terms of the centigrade scale. Its most predominant use is in the study of the kinetic theory of gases. In accordance with the kinetic theory, if the heat energy of a given gas sample could be progressively reduced, some temperature should be reached at which the motions of the molecules would cease entirely. If accurately determined, this temperature could then be taken as a natural reference, or a true "absolute zero" value.

Experiments with hydrogen (making use of the proven correlation with the volume, temperature, and pressure of gases and by calculations based on this correlation) indicated that if a gas were cooled to -273.16° C (used as -273° for most calculations), all molecular motion would cease and no additional heat could be extracted from the substance. At this point both the volume and the pressure would shrink to zero.

When temperatures are measured with respect to the absolute zero reference, they are said to be expressed in the absolute, or Kelvin, scale. Thus, absolute zero may be expressed either as 0° K or as -273° C.

BOYLE'S LAW.–The English scientist Robert Boyle was among the first to study what he called the "springiness of air." By direct measurement he discovered that when the temperature of an enclosed sample of gas was kept constant and the pressure doubled, the volume was reduced to half the former value; as the applied pressure was decreased, the resulting volume increased. From these observations, he concluded that for a constant temperature the product of the volume and pressure of an enclosed gas remains constant. Boyle's law is normally stated: "The volume of an enclosed dry gas varies inversely with its pressure, provided the temperature remains constant."

In equation form, this relationship may be expressed either

$$V_1P_1 = V_2P_2, \text{ or}$$

$$\frac{V_1}{V_2} = \frac{P_2}{P_1}$$

where V_1 and P_1 are the original volume and pressure, and V_2 and P_2 are the revised volume and pressure.

CHARLES' LAW.–The French scientist Jacques Charles provided much of the founda-

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tion for the modern kinetic theory of gases. He found that all gases expand and contract in direct proportion to the change in the absolute temperature, provided the pressure is held constant. Expressed in equation form, this part of the law may be expressed

$$V_1T_2 = V_2T_1, \text{ or}$$

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

where V_1 and V_2 refer to the original and final volumes, and T_1 and T_2 indicate the corresponding absolute temperatures.

Since any change in the temperature of a gas causes a corresponding change in volume, it is reasonable to expect that if a given sample of a gas were heated while confined within a given volume, the pressure should increase. By actual experiment, it was found that the increase in pressure was approximately 1/273 of the 0° C pressure for each 1° C increase. Because of this fact, it is normal practice to state this relationship in terms of absolute temperature. In equation form, this part of the law becomes

$$P_1T_2 = P_2T_1, \text{ or}$$

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

In words, this equation states that with a constant volume, the absolute pressure of a gas varies directly with the absolute temperature.

GENERAL GAS LAW.–The facts concerning gases discussed in the preceding sections are summed up and illustrated in figure 5-2. Boyle's law is expressed in (A) of the figure; while the effects of temperature changes on pressure and volume (Charles' law) are illustrated in (B) and (C), respectively.

By combining Boyle's and Charles' laws, a single expression can be derived which states all the information contained in both. This expression is called the GENERAL GAS EQUATION, a very useful form of which is given by the following equation. (NOTE: The capital P and T signify absolute pressure and temperature, respectively.)

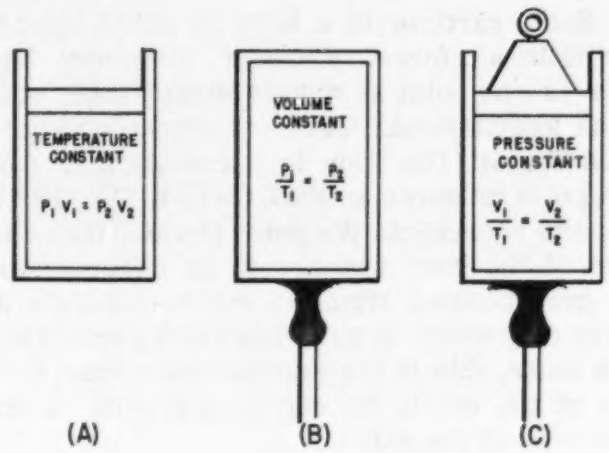

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Figure 5-2.–The general gas law.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

It can be seen by examination of figure 5-2 that the three equations are special cases of the general equation. Thus, if the temperature remains constant, T_1 equals T_2 and both can be eliminated from the general formula, which then reduces to the form shown in (A). When the volume remains constant, V_1 equals V_2, thereby reducing the general equation to the form given in (B). Similarly, P_1 is equated to P_2 for constant pressure, and the equation then takes the form given in (C).

The general gas law applies with exactness only to "ideal" gases in which the molecules are assumed to be perfectly elastic. However, it describes the behavior of actual gases with sufficient accuracy for most practical purposes.

MECHANICS

Mechanics is that branch of physics which deals primarily with the ideas of force, mass, and motion. Normally considered the fundamental branch of physics, it deals with matter. Many of its principles and ideas may be seen, measured, and tested. Since all other branches of physics are also concerned (to some extent at least) with force, mass, and motion, a thorough understanding of this section will aid in the understanding of later sections of this chapter.

FORCE, MASS, AND MOTION

Each particle in a body is acted upon by gravitational force. However, in every body there is one point at which a single force, equal to the gravitational force and directed upward, would sustain the body in a condition of rest. This point is known as the CENTER OF GRAVITY, and represents the point at which the entire mass of the body appears to be concentrated. The gravitational effect is measured from the center of gravity. In symmetrical objects of uniform mass, this is the geometrical center. In the case of the earth, the center of gravity is near the center of the earth.

When considering the motion of a body, it is usually convenient to describe the path followed by the center of gravity. The natural tendency of a moving body is to move in a manner so that the center of gravity travels in a straight line. Movement of this type is called LINEAR motion.

Some moving bodies, however, do not move in a straight line, but describe an arc or a circular path. Circular motion falls into two general classes–rotation and revolution.

Since objects come in many different shapes and in order to discuss rotary and revolutionary motion, it becomes necessary to consider the location of the center of gravity with respect to the body. (Refer to figure 5-3 for the following discussion.)

In (A), the center of gravity of a ball coincides with the physical center of the ball. However, in the flat washer (B), the center of gravity does not coincide with any part of the object, but is located at the center of the hollow space inside the ring. In irregularly shaped bodies, the center of gravity may be difficult to locate exactly.

If the body is completely free to rotate, the center of rotation coincides with the center of gravity. On the other hand, the body may be restricted in such a manner that rotation is about some point other than the center of gravity. In this event, the center of gravity revolves around the center of rotation. This condition is illustrated in figure 5-4.

In general usage, the gyro rotor (A) is said to ROTATE about its axis, and the ball (B) is said to REVOLVE about a point at the center of its path.

MASSES IN MOTION

Any change in the speed or direction of motion of a body is known as acceleration and requires the application of some force. The acceleration of a body is directly proportional to the force causing that acceleration; acceleration depends also upon the mass of the body. The greater mass of a lead ball makes it harder to move than a wood ball of the same diameter. The wood ball moves farther with the same push.

These observations point to a connection between force, mass, and acceleration, and indicate that the acceleration of a body is directly proportional to the force exerted on that body and inversely proportional to the mass of that body. In mathematical form, this relationship may be expressed as

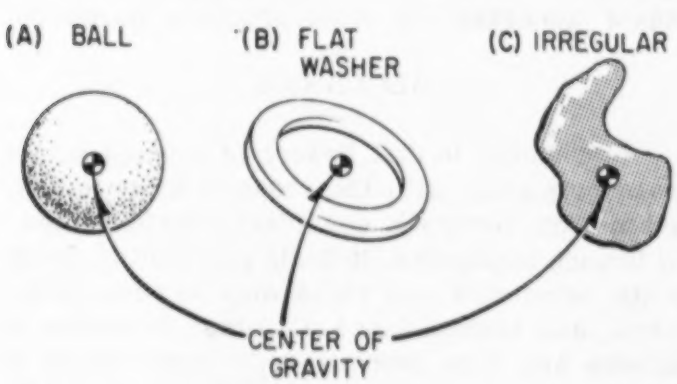

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Figure 5-3.–Center of gravity in various bodies.

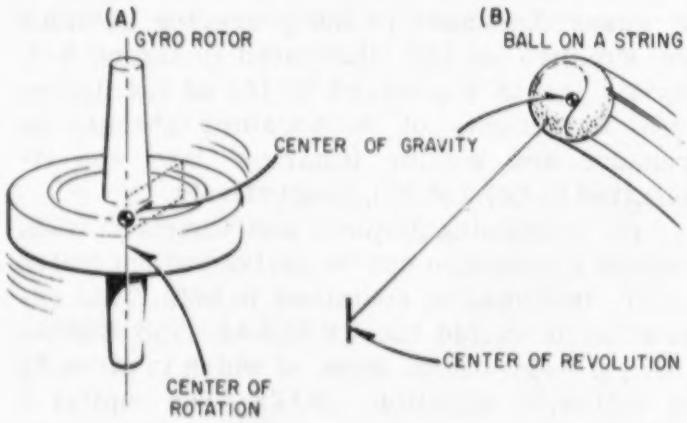

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Figure 5-4.–Center of gravity of rotation.

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$$a = \frac{F}{m}$$

or, as it is more commonly stated: Force is equal to the product of the mass and acceleration ($F = ma$).

If the accelerating force is applied to the center of gravity in such a manner as to accelerate the body with no rotation, it is called a TRANSLATIONAL force. A force applied in such a manner as to cause the body to rotate about a point is called a TORQUE force.

Laws of Motion

Among the most important discoveries in theoretical physics are the three fundamental laws of motion attributed to Newton. Although some of these laws have been used in explanations of various topics earlier in this chapter, they are restated and consolidated at this point to clarify and summarize much of the discussion regarding mechanical physics. This restatement and consolidation are also used to introduce additional aspects involving the applications of basic mechanical principles.

1. Every body tends to maintain a state of uniform motion unless a force is applied to change the speed or direction of motion.
2. The acceleration of a body is directly proportional to the magnitude of the applied force and inversely proportional to the mass of the body; acceleration is in the direction of the applied force.
3. For every force applied to a body, the body exerts an equal force in the opposite direction.

Momentum

Every moving body tends to maintain uniform motion. Quantitative measurement of this tendency is proportional to the mass of the body, and also to its velocity.
(Momentum = mass x velocity.) This explains why heavy objects in motion at a given speed are harder to stop than lighter objects, and also why it is easier to stop a given body moving at low speed than it is to stop the same body moving at high speed.

WORK, POWER, AND ENERGY

As defined earlier, energy is the capacity for doing work. In mechanical physics, WORK involves the idea of a mass in motion, and is usually regarded as the product of the applied force and the distance through which the mass is moved (work = force x distance). Thus, if a man raises a weight of 100 pounds to a height of 10 feet he accomplishes 1,000 foot-pounds of work. The amount of work accomplished is the same regardless of the time involved. However, the RATE of doing the work may vary greatly.

The rate of doing work (called POWER) is defined as the work accomplished per unit of time (power = work/time). In the example cited above, if the work is accomplished in 10 seconds, power is being expended at the rate of 100 foot-pounds per second; if it takes 5 minutes (300 seconds), the rate is approximately 3.3 foot-pounds per second.

In the English system of measurements, the unit of mechanical power is called the HORSEPOWER and is the equivalent of 33,000 foot-pounds per minute, or 550 foot-pounds per second. Since energy is readily convertible from one form to another, the work and power measurements based on the conversion of energy must also be readily convertible. As an example, the electrical unit of power is the watt. Electrical energy may be converted into mechanical energy; therefore, electrical power must be convertible into mechanical power. One horsepower is the mechanical equivalent of 746 watts of electrical power, and is capable of doing the same amount of work in the same time.

The accomplishment of work always involves a change in the type of energy, but does not normally change the total quantity of energy. Thus, energy applied to an object may produce work, changing the composition of the energy possessed by the object. When the work stops, energy is no longer being "expended," so energy must once again be converted in form–but not necessarily into its original form.

Efficiency

Provided there is no change in the quantity of matter, energy is convertible with no gain or loss. However, the energy resulting from a given

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action may not be in the desired form–it may not even be usable in its resultant form. In all branches of physics, this concept is known as EFFICIENCY.

The energy expended is always greater than the energy recovered. An automobile in motion possesses a quantity of kinetic energy dependent on its mass and velocity. In order to stop the car, this energy must be converted into potential energy. When the car is at rest, its potential energy is considerably less than the kinetic energy it possessed while in motion. The difference, or the "energy lost" is converted into heat by the brakes. The heat serves no useful purpose, so the recovered energy is less than the expended energy–the system is less than 100 percent efficient in converting kinetic to potential energy.

The term efficiency is normally used in connection with work and power considerations to denote the ratio of the input to the output work, power, or energy. It is always expressed as a decimal or as a percent less than unity.

Friction

In mechanical physics, the most common cause for the loss of efficiency is FRICTION. Whenever one object is slid or rolled over another, irregularities in the contacting surfaces interlock and cause an opposition to the force being exerted. Even rubbing two smooth pieces of ice together produces friction, although of a much smaller magnitude than in the case of two rough stones. Friction also exists in the contact of air with all exposed parts of an aircraft in flight, as well as in the brakes of the automobile mentioned above.

When a nail is struck with a hammer, the energy of the hammer is transferred to the nail, and the nail is driven into a board. The depth of penetration depends on the momentum of the hammer, the size and shape of the nail, and the hardness of the wood. The larger or duller the nail and the harder the wood, the greater the friction, and therefore the lower the efficiency and less depth of penetration–but the greater the heating of the nail.

Friction is always present in moving machinery, and accounts in part for the fact that the useful work accomplished by the machine is never as great as the energy applied. Work accomplished in overcoming friction is usually not recoverable. Friction can be minimized by decreasing the number of contacting points, by making the contacting areas as small and as smooth as possible, by the use of bearings, or by the use of lubricants.

There are two kinds of friction–sliding and rolling, with rolling friction usually of lower magnitude. Therefore, most machines are constructed so that rolling friction is present rather than sliding friction. The ball bearing and the roller bearing are used to convert sliding friction to rolling friction. A third type, the common (or friction) bearing, utilizes lubricants applied to surfaces which have been made as smooth as possible. Many new types of machines utilize self-lubricating bearings to minimize friction and thus maximize efficiency.

Mechanical Advantage

The concept of mechanical advantage has proved to be one of the great discoveries of science. It permits an increase in force or distance and represents the basic principle involved in levers, block and tackle systems, screws, hydraulic mechanisms, and other work saving devices. However, in the true sense, these devices do not save work, they merely enable humans to accomplish tasks which might otherwise be beyond their capability. For example, a human would normally be considered incapable of lifting the rear end of a truck in order to change a tire; but with a jack, a block and tackle, or a lever, the job can be made comparatively easy.

Mechanical advantage is usually considered with respect to work. Work represents the application of a force through a distance in order to move an object through a distance. Thus, it may be seen that there are two forces involved, each with an appropriate distance. This is illustrated by the simple lever in figure 5-5.

Assuming perfect efficiency, the work input (F_1D_1) is equal to the work output (F_2D_2). Assuming equal distances D_1 and D_2, a force of 10 pounds must be applied at the source in order to counteract a weight of 10 pounds at the load.

By moving the fulcrum nearer the load, less force is required to balance the same load. This is a mechanical advantage of force. If the force is applied in such a manner as to raise the

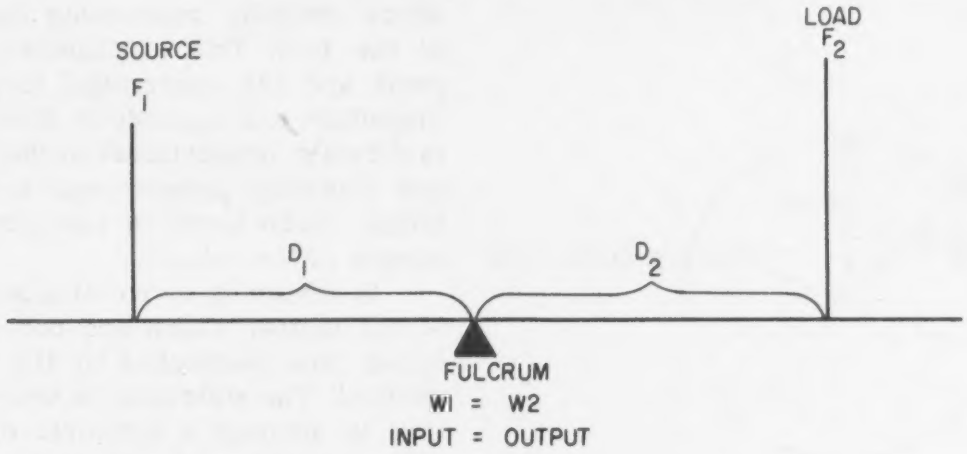

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Figure 5-5.–Mechanical advantage.

load 1 foot, the source must be moved through a distance greater than 1 foot. Thus, mechanical advantage of force represents a mechanical disadvantage of distance. By moving the fulcrum nearer the source, these conditions are reversed.

Since the input work equals the output work (assuming no losses), the mechanical advantage may be stated as a ratio of the force or of the distances. In actual situations, friction results in energy loss and decreased efficiency, thereby requiring an even greater input to accomplish the same work.

A more detailed discussion of mechanical advantages and the characteristics of the six basic mechanical devices (the lever, the screw, the inclined plane or wedge, the block and tackle, the wheel and axle, and the gear) is found in the Rate Training Manual, Basic Machines, NavPers 10624-A.

REVOLVING BODIES

Revolving bodies represent masses in motion; therefore, they possess all the characteristics (and obey all the laws) associated with moving bodies. In addition, since they possess a specific type of motion, they have special properties and factors which must be taken into consideration.

Revolving bodies travel in a constantly changing direction, so they must be constantly subjected to an accelerating force. Momentum tends to produce linear motion, but this is prevented by application of a force which restrains the object. This restraining force prevents the object from continuing in a straight line, and is known as CENTRIPETAL force. According to Newton's third law of motion, the centripetal force must be opposed by an equal force which tends to produce linear motion. This second force is known as CENTRIFUGAL force. The two forces, their relationships, and their effects are illustrated in figure 5-6 and the following explanatory example.

The various forces involved in revolving bodies may be illustrated by use of a ball and string. A slip knot is tied in the center of a 10-foot length of twine so as to shorten the line to 5 feet; a rubber ball is attached to one end of the string. Holding the other end of the line, whirl the ball slowly in a circle. Note that the ball exerts a force against the hand (through the string); and that in order to restrain the ball in its circular path, the hand must exert a force (through the string) on the ball. As the ball is revolved at higher speed, the forces increase, and the ball continues in a circular path. As the rotational velocity of the ball is gradually increased, note the increasing forces.

At some rotational speed, the forces involved become great enough to overcome inertial friction, and the knot slips. At this time, allow the velocity of the rotation to stabilize (stop increasing in rotational velocity, but not slowing down, either), so that the existing conditions may be analyzed. When the knot slips, the ball is temporarily unrestrained and is free to assume linear motion in the direction of travel at that instant (tangent to the circle at the instantaneous position). The ball travels in a straight line until the string reaches its full length;

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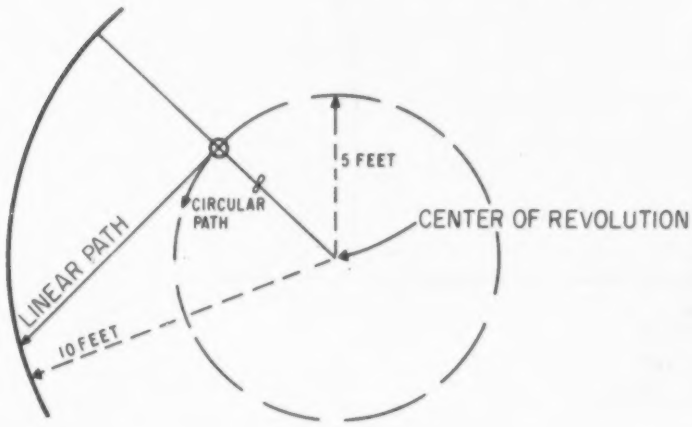

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Figure 5-6.–Forces on revolving bodies.

during this time, no force is exerted on or by the hand. As soon as all the slack is taken up, there is a sharp jerk–an accelerating force is exerted in order to change the direction of motion from its linear path into a circular rotation. The ball again assumes rotational motion, but with an increase in radius.

The ball does not make as many revolutions in the same time (rotational velocity is decreased), but it does maintain its former linear velocity. (The kinetic energy and the momentum of the ball have not changed.) Since the change in direction is less abrupt with a large radius than with a small one, less accelerating force is required, and the hand will feel less force. If the ball is then accelerated to the same rotational velocity as immediately prior to the slipping of the knot, the linear velocity of the ball becomes much greater than before; the centripetal and centrifugal forces are much greater, also.

In this example, it has been assumed that the hand is fixed at a point which represents the center of rotation. This assumption, while somewhat erroneous, does not affect the general conclusions. For practical purposes, the two forces are equal at all points along the string at any given time, and the magnitude of each force is equal at all points along the string.

In summarizing the conclusions reached by the above example and explanation, consider the following relationship:

$$\text{force} = \frac{\text{mass x velocity}^2}{\text{radius}}$$

where velocity represents the linear velocity of the ball. This emphasizes that the centripetal and the centrifugal forces are equal in magnitude and opposite in direction. Each force is directly proportional to the mass of the body and inversely proportional to the radius of rotation. Each force is also proportional to the square of the velocity.

In revolving or rotating bodies, all particles of the matter which are not on the axis of rotation are subjected to the forces just described. The statement is true whether the motion is through a complete circle, or merely around a curve: An aircraft tends to skid when changing course; an automobile tends to take curves on two wheels. The sharper the curve (smaller radius) or the higher the velocity, the greater the tendency to skid.

WAVE MOTION

Wave motion and radiated energy may be compared with the wave motion of water. When a pebble is dropped into a calm pool of water, a series of circular waves travel away from the disturbance. These waves radiate in all directions on the surface of the water until they are absorbed or until they are diverted by coming into contact with an obstruction of some sort. Water waves are a succession of crests and troughs; the distance from the crest of one wave to the crest of the next is called the wavelength. A cork floating on the surface of the water bobs up and down with the waves, but moves very little in the direction of wave travel. Water waves are called transverse waves because the motion of the water particles is up and down, or at right angles (transverse) to the direction in which the wave is traveling.

A second form of wave motion, also involving the motion of particles of matter, may be produced by the physical vibration of a body. An example of this type wave is the sound wave which is produced by striking the tine of a tuning fork. When struck, the tuning fork sets up a vibratory motion. As the tine moves in an outward direction, the air immediately in front of the tine is compressed so that its momentary pressure is raised above that at other points in the surrounding medium. Because air is elastic, this disturbance is transmitted progressively in an outward direction as a compression wave.

When the tine returns and moves in the inward direction, the air in front of the tine is rarefied so that its momentary pressure is reduced below that at other points in the surrounding medium. This disturbance is also propagated, but in the form of a rarefaction (expansion) wave, and follows the compression wave through the medium.

The compression and expansion waves are also called longitudinal waves, because the particles of matter which comprise the medium move back and forth longitudinally in the direction of wave travel. Figure 5-7 is a simplified representation of the use of a tuning fork to produce a longitudinal wave. The transverse wave shown below the longitudinal wave is merely a convenient device to indicate the relative density of the particles in the medium, and does not reflect the movement of the particles.

The progress of any wave requiring movement of particles in the transmission medium involves two distinct motions: the wave itself moves forward with constant speed, and simultaneously the particles within the medium vibrate. The period of a vibrating particle is the time (t, in seconds) required for the particle to complete one full vibration or cycle. The frequency (f) is the number of vibrations completed per unit of time and is usually expressed in Hertz. The period is the reciprocal of the frequency ($t = 1/f$). The amplitude of vibration is the maximum variation of particle density from the equilibrium density.

A body vibrating at a definite rate produces a disturbance that moves away as a wave in the surrounding medium. The velocity of this wave is equal to the wavelength divided by the period. Since the period is the reciprocal of the frequency, the velocity may be expressed as

$$v = f\lambda$$

where v is the velocity of propagation of the wave in the given medium, f is the frequency in Hertz, and λ is the wavelength in compatible units of measure. The velocity of propagation may also be described as representing the distance that a wave travels during one period.

Two particles are in phase when they are vibrating with the same frequency, and continually pass through corresponding points of their paths at the same time. For any other condition, the particles are out of phase. Two particles are in phase opposition when they reach their maximum displacements in opposite directions at the same time.

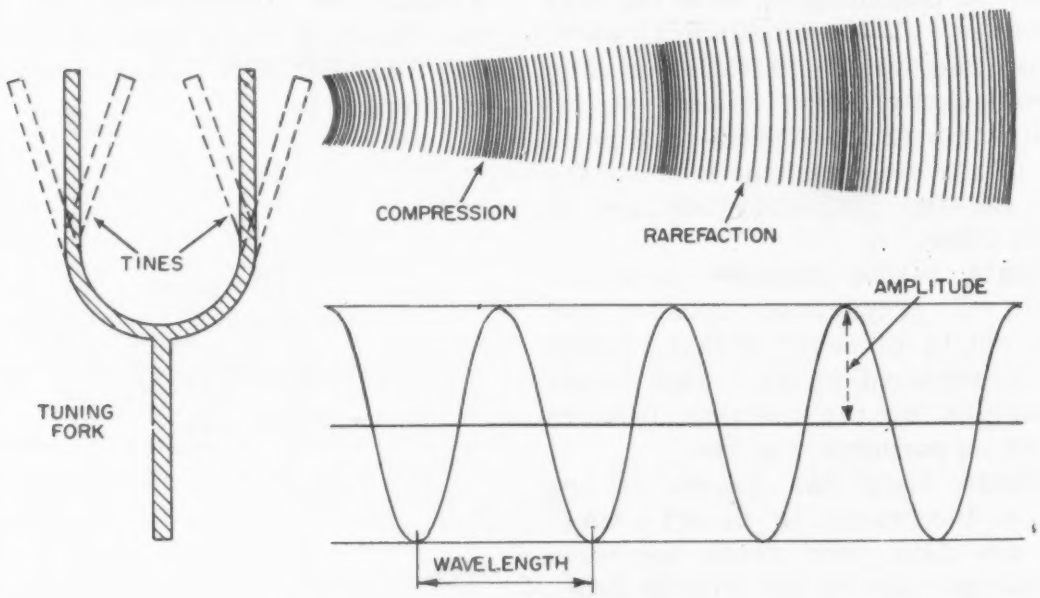

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Figure 5-7.–Compression and expansion wave propagation.

A third type of wave, the electromagnetic wave, does not involve moving particles of matter, but rely on electric and magnetic force fields. The waves previously discussed cannot be propagated in the absence of a conducting medium–electromagnetic waves are propagated most efficiently in the absence of matter. In the electromagnetic wave, two components are required–an electric field and a magnetic field. These two fields are mutually perpendicular to each other and to the direction of propagation. In the particle waves, the velocity of propagation varies with the particular medium, and is comparatively very slow; in the electromagnetic wave, the velocity of propagation is the speed of light (approximately 186,300 miles per second). Examples of electromagnetic waves include heat, light, radio waves, X-rays, cosmic radiations, ultraviolet rays, etc.

All three types of wave motion obey certain common laws and have certain common characteristics: All are periodic; that is, they all constantly repeat the same pattern so that each succeeding wave is the same as the previous one. Each wave displays the same relationships of wavelength, frequency, period, velocity of propagation, amplitude, and phase; and each is subject to the same conditions of reflection and refraction. In the electromagnetic wave, the maxima and minima are correlated with field intensity rather than with particle density or displacement as in the case of the other waves. In the longitudinal wave, the density is related to particle density; in the electromagnetic wave, density is related to the strength of the electric and magnetic fields. In the electromagnetic wave, the electric field and the magnetic field are in phase with each other.

A wavelength is the distance measured along the axis of propagation between two corresponding points of equal intensity which are in phase on adjacent waves. This length can be represented by the distance between maximum points on successive waves.

A line drawn from the source to any point on one of the waves is called a RAY, and indicates the path over which the wave progresses. Although rays do not actually exist, they are frequently used in illustrations as a convenient method of denoting wave propagation. A wavefront is a surface on which all points are in phase. Wavefronts near the source are sharply curved, while those at a distance are almost flat; individual rays from a distant source are considered to be parallel.

REFLECTION

Within a uniform medium, a ray travels in a straight line. Only at the boundary of two media or in an area where the density of the medium changes do the rays change their direction. When an advancing wavefront encounters a medium of different characteristics, some of its energy is reflected back into the initial medium, and some is transmitted into the second medium. When a wavefront encounters a medium which it cannot penetrate, the wave is reflected from the surface.

REFLECTED waves are simply those waves that are neither transmitted nor absorbed, but are thrown back from the surface of the medium they encounter. If a ray is directed against a reflecting surface, the ray striking the surface is called the INCIDENT ray, and the one that bounces back is the REFLECTED ray. An imaginary line perpendicular to the reflecting surface at the point of impact of the incident ray is called the NORMAL. The angle between the incident ray and the normal is called the ANGLE OF INCIDENCE; the angle between the reflected ray and the normal is the ANGLE OF REFLECTION. These terms are illustrated in figure 5-8.

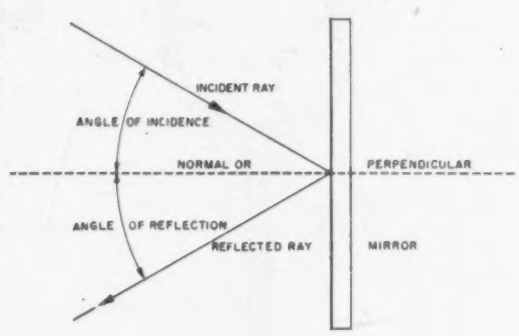

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Figure 5-8.–Terms used to describe the reflection of waves.

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If the surface of the medium contacted by the incident ray is smooth and polished (as a mirror), each reflected ray will be thrown back at the same angle as the incident ray. The path of the ray reflected from the surface forms an angle exactly equal to the one formed by its path in reaching the medium. This conforms to the law of reflection which states: The angle of incidence is equal to the angle of reflection.

Diffusion

Reflection from a relatively smooth surface presents few problems. As shown in figure 5-9 (A), rays are reflected from a flat smooth surface in an orderly manner with all rays at the same angle and all rays parallel to each order. This is called regular or specular reflection. It is a different matter, however, with a rough surface. The law of reflection is still valid; but due to the rough surface, the angle of incidence is somewhat different for each ray. The reflected rays scatter in all directions, as shown in figure 5-9 (B). This form of reflection is called irregular or diffused reflection.

Focusing

In addition to reflection from a flat surface and diffusion from a rough one, waves may also be focused by reflection from a curved surface. If the reflecting surface is concave, the parallel rays striking its surface are reflected, as shown in figure 5-10 (A). The normal is perpendicular to the surface; therefore, the normals on a curved surface are not parallel to one another. The rays come together, or converge, at some point called the focal point. The location of the focal point depends on the rate of curvature of the reflecting surface.

Illumination

If a point source of waves is located at the focal point of the concave reflector, the reflected rays are formed into a narrow beam, with all reflected rays parallel to one another.

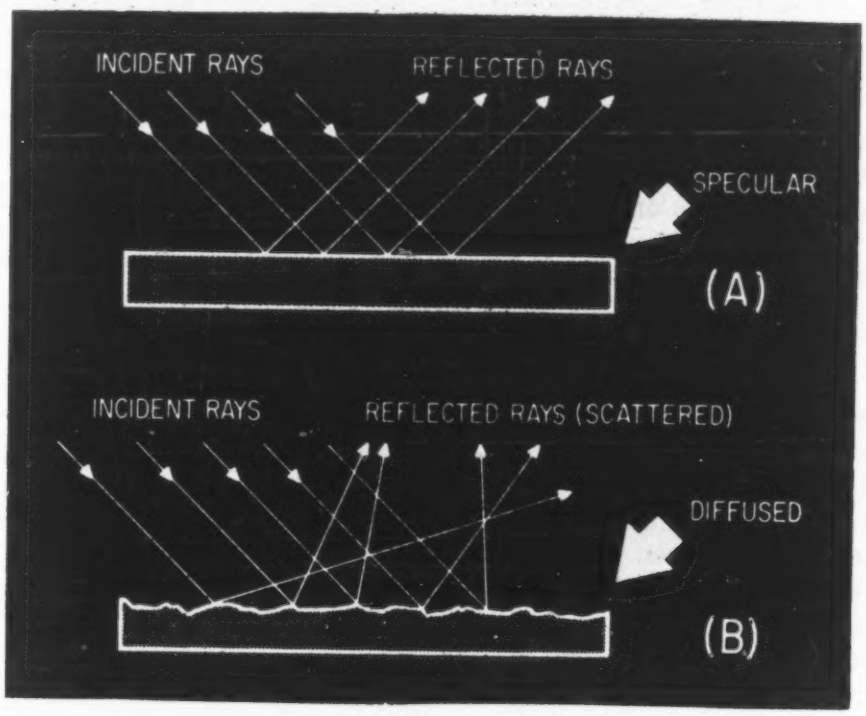

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Figure 5-9.–Reflection from a plane surface.
(A) Regular (specular); (B) irregular (diffused).

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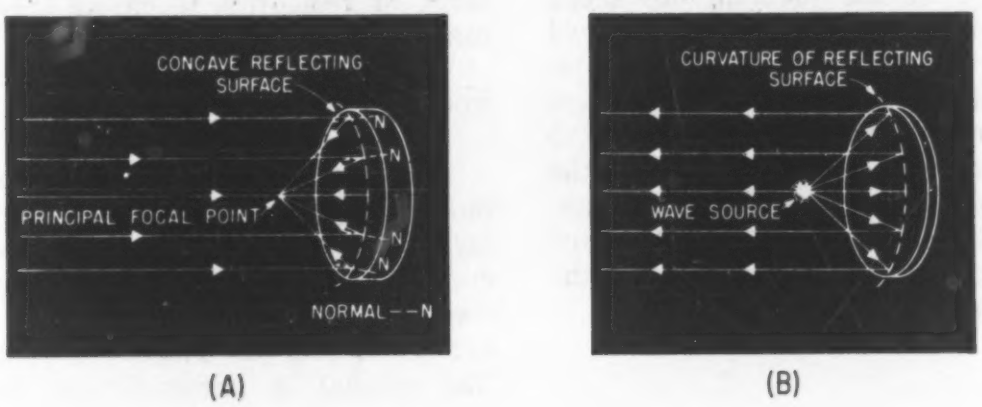

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Figure 5-10.–Reflection from a concave surface.
(A) Focusing; (B) illumination.

This condition is illustrated in figure 5-10 (B). In this manner, the intensity is increased (or the area is "illuminated"), because rays that would normally be lost are directed into the beam along with the direct rays.

REFRACTION

The change of direction which occurs when a ray passes from one medium into another of different density is called REFRACTION. It is due to the fact that waves travel at various speeds in different transmission media. Refraction always follows a general rule: When a ray passes from one medium into another of greater density, refraction is toward the normal; when passing into a medium of lesser density, refraction is away from the normal. This is illustrated in figure 5-11.

DOPPLER EFFECT

When there is relative motion between the source of a wave and a detector of that wave, the apparent frequency at the terminal position differs from the frequency at the source. If the distance between the source and the detector is decreasing, more wavefronts are encountered per second than when the distance is constant. This results in an apparent increase in frequency. Conversely, if the separation is increasing, fewer waves are encountered, with an apparent decrease in frequency.

These apparent changes in frequency are called the Doppler effect, and affect the operation of equipment used to detect and measure wave energy. The amount of change in the apparent frequency depends on the relative velocity of the source and detector and on the velocity of propagation of the wave. The Doppler effect is important in dealing with sound wave propagation as applicable to sonar equipment operation, and in dealing with electromagnetic wave propagation as applicable to radar search, target detection, fire control,

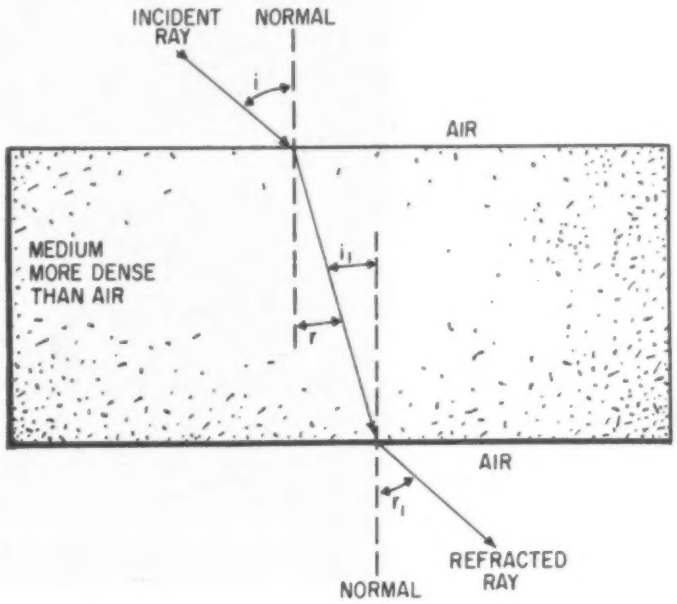

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Figure 5-11.–Refraction of a wave.

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navigation, etc. Specific applications of the Doppler effect are not discussed in detail in this chapter.

HEAT

Heat represents a form of energy; therefore, it must be readily exchangeable with or convertible into, other forms of energy. The conversion of mechanical energy into heat through friction has been mentioned previously. When a piece of lead is struck a sharp blow with a hammer, part of the kinetic energy of the hammer is converted into heat. In the core of a transformer, electrical and magnetic energy are exchanged; but due to hysteresis and eddy currents, some of the energy is lost as heat. These are some examples of the unwanted conversions, but there are many instances when the production of heat is desirable. Many devices are used almost exclusively to produce heat.

Regardless of how or why it is produced, heat possesses certain characteristics which make it important to the technician. A knowledge of the nature and behavior of heat may prove helpful in understanding the operation of some types of electronics equipment or in determining the cause of nonoperation or faulty operation of others.

NATURE OF HEAT

There are several theories regarding the nature of heat, none of which satisfactorily explain all the characteristics and properties exhibited by heat. The two theories most commonly included in discussions regarding the nature of heat are the kinetic theory and the radiant energy theory.

In the kinetic theory (mentioned earlier in this chapter), it is assumed that the quantity of heat contained by a body is represented by the total kinetic energy possessed by the molecules of the body.

The radiation theory treats radio waves, heat, and light as the same general form of energy, differing primarily in frequency. Heat is considered as a form of electromagnetic energy involving a specific band of frequencies falling between the radio spectrum and light.

A common method used to produce heat energy is the burning process. Burning is a chemical process in which the fuel unites with oxygen, and a flame is usually produced. The amount of heat liberated per unit mass or per unit volume during complete burning is known as the heat of combustion of a substance. By experiment, scientists have found that each fuel produces a given amount of heat per unit quantity burned.

TRANSFER

There are three methods of heat transfer-conduction, convection, and radiation. In addition to these, a phenomenon called absorption is related to the radiation method.

Conduction

The metal handle of a hot pot may burn the hand; a plastic or wooden handle, however, remains relatively cool even though it is in direct contact with the pot. This phenomenon is due to a property of matter known as thermal conductivity. All materials conduct heat–some very readily, some to an almost negligible extent. When heat is applied to a body, the molecules at the point of application become violently agitated, strike the molecules next to them, and cause increased agitation. The process continues until the heat energy is distributed evenly throughout the material. Aluminum and copper are used for cooking pots because they conduct heat very readily to the food being cooked. Wood and plastic are used as handles because they are very poor conductors of heat. As a general rule metals are the best conductors of heat, although some metals are considerably better than others.

Among solids, there is an extreme range of thermal conductivity. In the original example, the metal handle transmits heat from the pot to the hand, with the possibility of burns. The wooden or plastic handle does not conduct heat very well, so the hand is given some protection. Materials that are extremely poor conductors are called "insulators" and are used to prevent heat transfer. Some examples are the wood handle of soldering irons, the finely spun glass or rock wool insulation in

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houses, or the asbestos tape or ribbon wrapping used on steam pipes.

Liquids are generally poorer conductors than metals. In figure 5-12, note that the ice in the bottom of the test tube has not yet melted, although the water at the top is boiling. Water is such a poor conductor that the rate of heating of the water at the top of the tube is not sufficient to cause rapid melting of the ice at the bottom.

Since thermal conduction is a process by which molecular energy is passed on by actual contact, gases are generally even poorer conductors than liquids because the molecules are farther apart and molecular contact is not so pronounced.

Convection

Convection is the process in which heat is transferred by movement of a hot fluid. For example, an electron tube gets hotter and hotter until the air surrounding it begins to move. The motion of the air is upward because heated air expands in volume and is forced upward by the denser cool air surrounding it. The upward motion of the heated air carries the heat away from the hot tube by convection. Transfer of heat by convection may be hastened by using a ventilating fan to move the air surrounding a hot object. The rate of cooling of a hot vacuum tube can also be increased by providing copper fins to conduct heat away from the hot tube. The fins provide large surfaces against which cool air can be blown.

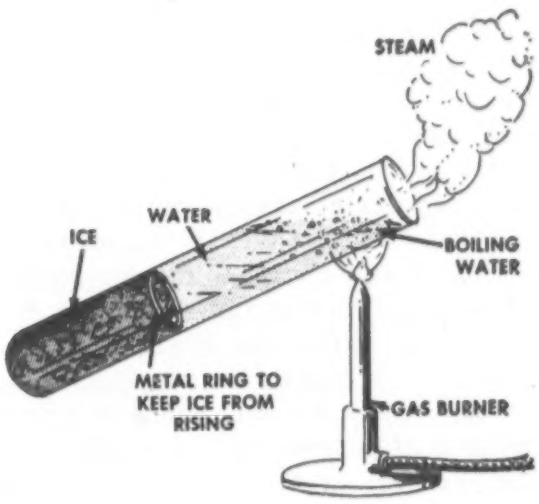

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Figure 5-12.—Water is a poor conductor of heat.

A convection process may take place in a liquid as well as in a gas. One example is a transformer in an oil bath. The hot oil is less dense (has less weight per unit volume) and rises, while the cool oil falls, is heated, and rises in turn.

When the circulation of gas or liquid is not rapid enough to remove sufficient heat, fans or pumps may be used to accelerate the motion of the cooling material. In some installations, pumps are used to circulate water or oil to help cool large equipment. In airborne installations electric fans and blowers are used to aid convection.

Radiation

Conduction and convection cannot wholly account for some of the phenomena that are associated with heat transfer. For example, heating through convection cannot occur in front of an open fire because the air currents are moving toward the fire. It cannot occur through conduction because the conductivity of the air is very low, and the cooler currents of air moving toward the fire would more than overcome the transfer of heat outward. Therefore, heat must travel across space by some means other than conduction and convection.

The existence of another process of heat transfer is still more evident when the heat from the sun is considered. Since conduction and convection take place only through molecular contact within some medium, heat from the sun must reach the earth by some other method. (Outer space is an almost perfect vacuum.) Radiation is the name given to this third method by which heat travels from one place to another.

The term radiation refers to the continual emission of energy from the surface of all bodies. This energy is known as radiant energy. It is in the form of electromagnetic waves and is identical in nature with light waves, radio waves, and X-rays, except for a difference in wavelength. Sunlight is a form of radiant heat energy which travels great distances through cold, empty space to reach the earth. These electromagnetic heat waves are absorbed when they come in contact with nontransparent bodies.

The net result is that the motion of the molecules in the body is increased, as indicated by an increase in the temperature of the body.

The differences in conduction, convection, and radiation are as follows:

1. Although conduction and convection are extremely slow, radiation takes place with the speed of light. This fact is evident at the time of an eclipse of the sun when the shutting off of the heat from the sun takes place at the same time as the shutting off of the light.

2. Radiant heat may pass through a medium without heating it. For example, the air inside a greenhouse may be much warmer than the glass through which the sun's rays pass.

3. Although conducted or convected heat may travel in roundabout routes, radiant heat always travels in a straight line. For example, radiation can be cut off with a screen placed between the source of heat and the body to be protected.

Absorption

The sun, a fire, and an electric light bulb all radiate energy, but a body need not glow to give off heat. A kettle of hot water or a hot soldering iron radiates heat. If the surface is polished or light in color, less heat is radiated. Bodies which do not reflect are good radiators and good absorbers, and bodies that reflect are poor radiators and poor absorbers. This is the reason white clothing is worn in the summer. A practical example of the control of heat is the Thermos bottle. The flask itself is made of two walls of "silvered" glass with a vacuum between them. The vacuum prevents the loss of heat by conduction and convection and the "silver" coating prevents the loss of heat by radiation.

The silver-colored bronze paint on the "radiators" in heating systems is used only for decoration and decreases the efficiency of heat transfer. The most effective color for heat transfer is dull black; dull black is the ideal absorber and also the best radiator.

MEASUREMENT OF HEAT

A unit of heat must be defined as the heat necessary to produce some agreed-on standard of change. There are three such units in common use as follows:

1. One British thermal unit (Btu) is the quantity of heat necessary to raise the temperature of 1 pound of water 1° F.

2. One gram-calorie (small calorie) is the quantity of heat necessary to raise 1 gram of water 1° C.

3. One kilogram-calorie (large calorie) is the quantity of heat necessary to raise 1 kilogram of water 1° C. (One kilogram-calorie equals 1,000 gram-calories.) The gram-calorie or small calorie is much more widely used than the kilogram-calorie or large calorie. The large calorie is used in relation to food energy and for measuring comparatively large amounts of heat. Throughout this discussion, unless otherwise stated, the term calorie means gram-calorie. For purposes of conversion, one Btu equals 252 gram-calories or 0.252 kilogram-calories.

The terms quantity of heat and temperature are commonly misused. The distinction between them should be understood clearly. For example, suppose that two identical pans, containing different amounts of water of the same temperature, are placed over identical gas burner flames for the same length of time. At the end of that time, the smaller amount of water will have reached a higher temperature. Equal amounts of heat have been supplied, but the increase in temperatures is not equal. As another example, suppose that the water in both pans is at the same temperature, say 80° F, and both are to be heated to the boiling point. It is obvious that more heat must be supplied to the larger amount of water. The temperature rise is the same for both pans, but the quantities of heat necessary are different.

Mechanical Equivalent

Mechanical energy is usually expressed in ergs, joules, or foot-pounds. Energy in the form of heat is expressed in calories or in Btu's. In a precise experiment in which electric energy is converted into heat in a resistance wire immersed in water, the results show that 4.186 joules equals 1 gram-calorie, or that 778 foot-pounds equals 1 Btu. The following equation is used when converting from the English system to the metric system·

$$1 \text{ Btu} = 252 \text{ calories}$$

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Specific Heat

One important way in which substances differ from one another is that they require different quantities of heat to produce the same temperature change in a given mass of substance. The specific heat capacity of a substance is the quantity of heat needed, per unit mass, to increase the temperature 1°C. The specific heat of a substance is the ratio of its specific heat capacity to the specific heat capacity of water. Specific heat is expressed as a number which, because it is a ratio, has no units and applies to both the English and the metric systems.

Water has a high specific heat capacity. Large bodies of water on the earth keep the air and the surface of the earth at a fairly constant temperature. A great quantity of heat is required to change the temperature of a large lake or river. Therefore, when the temperature of the air falls below that of such bodies of water, they give off large quantities of heat to the air. This process keeps the atmospheric temperature at the surface of the earth from changing very rapidly.

TEMPERATURE

If an object is hot to the touch, it is said to have a "high" temperature; if it is cold to the touch, it has a "low" temperature. In other words, temperature is used as a measure of the hotness or coldness of an object being described. However, hotness and coldness are only relative. For example, on a cold day, metals seem colder to the touch than nonmetals because they conduct heat away from the body more rapidly. Also, upon leaving a warm room the outside air seems cooler than it really is. Going from the outside cold into a warm room, the room seems warmer than it really is. In other words, the temperature a person feels depends upon the state of his body.

Thermometers

The measurement of temperature is known as THERMOMETRY. Many modern thermometers use liquids in sealed containers. Water was the first liquid used, but because it freezes at 0° C it could not measure temperatures below that point. After much experimentation, scientists decided that the best liquids to use in the construction of thermometers are alcohol and mercury because of the low freezing points of these liquids.

LIQUID THERMOMETERS.–The construction of the common laboratory thermometer gives some idea as to the meaning of a change of 1° in temperature. A bulb is blown at one end of a piece of glass tubing of small bore. The tube and bulb are then filled with the liquid to be used. The temperature of both the liquid and the tube during this process are kept at a point higher than the thermometer will reach in normal usage. The glass tube is then sealed and the thermometer is allowed to cool. During the cooling process, the liquid falls away from the top of the tube and creates a vacuum within the thermometer.

For marking, the thermometer is placed in melting ice. The height of the liquid column is marked as the 0°C. point. Next, the thermometer is placed in steam at a pressure of 76 centimeters of mercury and a mark is made at that point to which the liquid inside rises. That is the boiling point or the 100° C, mark. The space between these two marks is then divided into 100 equal parts. These spacings are known as DEGREES. It is this type of thermometer that is used almost exclusively in laboratory work and in testing electrical equipment. It is known as the CENTIGRADE thermometer.

NOTE: Centigrade scale or thermometer may be referred to as Celsius after the inventor.

In English-speaking countries, the FAHRENHEIT thermometer is commonly used for other than physical or chemical laboratory purposes. The freezing point is marked 32° and the boiling point is marked 212°. The space between these marks is divided into 180 equal parts. These divisions are degrees Fahrenheit, named after the scientist who made the first thermometer of this type. In the U.S., weather reports and room temperatures are given in degrees Fahrenheit.

TEMPERATURE CONVERSION.–There are two systems of temperature measurement; it is frequently necessary to convert from one to the other. The range on the centigrade thermometer from the freezing point to the boiling point is 100° C, and the same range on the Fahrenheit thermometer is 180° F. Thus, over the same

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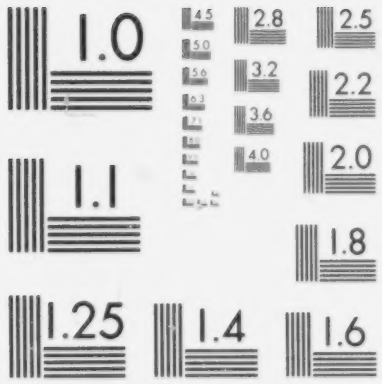

MICROCOPY RESOLUTION TEST CHART

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Department of Vocational-Technical Education
Graduate School of Education
Rutgers · The State University

MACHINE DRAFTING, VOLUME I

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NOVEMBER, 1964

temperature range, the liquid moves 180 divisions on the Fahrenheit scale for every 100 divisions on the centigrade scale. A change of 5 on the centigrade scale, therefore, is equal to a change of 9° on the Fahrenheit scale. (The ratio 100/180 reduces to 5/9.) Because zero on the centigrade scale corresponds to 32° on the Fahrenheit scale, a difference in reference points exists between the two scales. (See fig. 5-13.)

To convert from the Fahrenheit scale to the centigrade scale, subtract the 32° difference and multiply the result by 5/9. As an example, convert 68° Fahrenheit to centigrade–

$$\frac{5}{9}(68 - 32)$$

$$\frac{5}{9} \times 36 = 20° \text{ C}$$

To convert centigrade to Fahrenheit, the reverse procedure is necessary. First multiply the reading on the centigrade thermometer by 9/5 and then add 32 to the result–

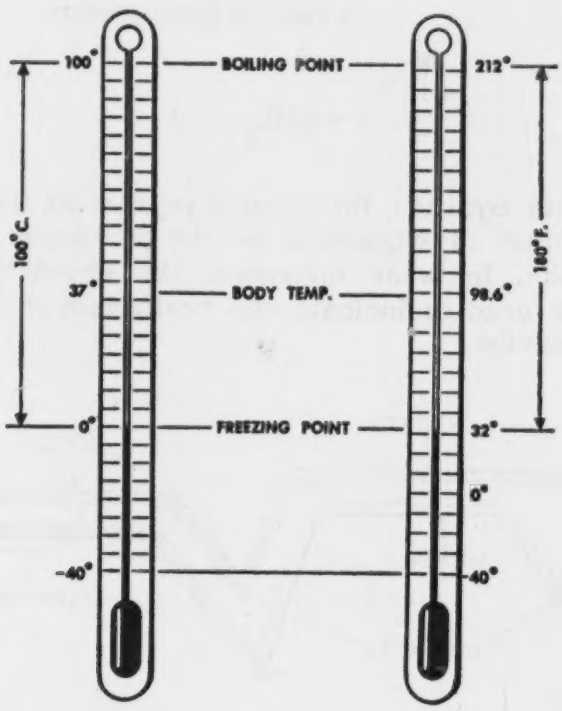

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Figure 5-13.–Fahrenheit and centigrade thermometers.

$$\frac{9}{5}(20) + 32$$

$$36 + 32 = 68° \text{ F}$$

One way to remember when to use 9/5 and when to use 5/9 is to keep in mind that the Fahrenheit scale has more divisions than the centigrade scale. In going from centigrade to Fahrenheit, multiply by the ratio that is larger; in going from Fahrenheit to centigrade, use the smaller ratio.

Another method of temperature conversion which uses these same ratios is based on the fact that the Fahrenheit and centigrade scales both register the same temperature at -40°; that is, -40°F equals -40°C. This method of conversion, sometimes called the "40 rule," proceeds as follows:

1. Add 40 to the temperature which is to be converted. Do this whether the given temperature is Fahrenheit or centigrade.
2. Multiply by 9/5 when changing centigrade to Fahrenheit; by 5/9 when changing Fahrenheit to centigrade.
3. Subtract 40 from the result of step 2. This is the answer.

As an example to show how the 40 rule is used, convert 100° C to the equivalent Fahrenheit temperature:

$$100 + 40 = 140$$

$$140 \times 9/5 = 252$$

$$252 - 40 = 212$$

Therefore, 100° C = 212° F. Remember that the multiplying ratio for converting F to C is 5/9, rather than 9/5. Also remember to always ADD 40 first, then multiply, then SUBSTRACT 40, regardless of the direction of the conversion.

It is important that all technicians be able to read thermometers and to convert from one scale to the other. In some types of electronic equipment, thermometers are provided as a check on operating temperatures. Thermometers are also used to check the temperature of a charging battery.

SOLID THERMOMETERS.–Because the range of all liquid thermometers is extremely limited, other methods of thermometry are necessary. Most liquids freeze at temperatures

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between 0° and -200° centigrade. At the upper end of the temperature range where high heat levels are encountered, the use of liquid thermometers is limited by the high vapor pressures of those liquids. Among the most widely used types of thermometers other than the standard liquid thermometers are the resistance thermometer, and the thermocouple.

The RESISTANCE THERMOMETER makes use of the fact that the resistance of metals changes as the temperature changes. (See chapter 6 of Basic Electricity, NavPers 10086-B.) This type thermometer is usually constructed of platinum wire wound on a mica form and enclosed in a thin-walled silver tube. It is extremely accurate from the lowest temperature to the melting point of the unit.

The THERMOCOUPLE shown in figure 5-14 is essentially an electric circuit. Its operation is based on the principle that when two unlike metals are joined and the junction is at a different temperature than the remainder of the circuit, an electromotive force is produced. This electromotive force can be measured with great accuracy by a galvanometer. Thermocouples can be located whereever measurement of the temperature is important and wires run to a galvanometer located at any convenient point. By means of a rotary selector switch, one galvanometer can read the temperatures at any of a number of widely separated points.

Thermal Expansion

Nearly all substances expand or increase in size when their temperature increases. Railroad tracks are laid with small gaps between the sections to prevent buckling when the temperature increases in summer. Concrete pavement has strips of soft material inserted at intervals to prevent buckling when the sun heats the roadway. A steel building or bridge is put together with red-hot rivets so that when the rivets cool they will shrink and the separate pieces will be pulled together very tightly.

As a substance is expanded by heat, the weight per unit volume decreases. This is because the weight of the substance remains the same while the volume is increased by the application of heat. Thus the density decreases with an increase in temperature.

Experiments show that for a given change in temperature, the change in length or volume is different for each substance. For example, a given change in temperature causes a piece of copper to expand nearly twice as much as a piece of glass of the same size and shape. For this reason, the lead wires into an electronic tube cannot be made of copper but must be made of a metal that expands at the same rate as glass. If the metal does not expand at the same rate as the glass, the vacuum in the tube is broken by air leaking past the wires in the glass stem. The metal usually used for this purpose is an alloy called "Covar."

The amount that a unit length of any substance expands for a 1° rise in temperature is known as the coefficient of linear expansion for that substance.

COEFFICIENTS OF EXPANSION.–To estimate the expansion of any object, such as a steel rail, it is necessary to know three things about it–its length, the rise in temperature to which it is subjected, and its rate or coefficient of expansion. The amount of expansion is expressed by the following equation:

expansion = coefficient x length

x rise in temperature

or

$$e = kl(t_2 - t_1)$$

In this equation, the letter k represents the coefficient of expansion for the particular substance. In some instances, the Greek letter α is used to indicate the coefficient of linear expansion.

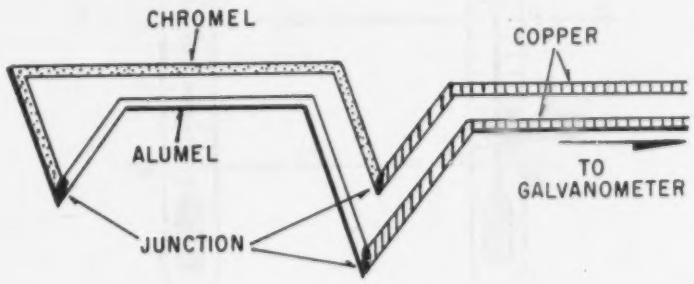

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Figure 5-14.–Thermocouple.

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PROBLEM: If a steel rod measures exactly 9 feet at 21° C, what is its length at 55° C? (The coefficient of linear expansion for steel is 11×10^{-6}.) If the equation $e = kl\ (t_2 - t_1)$ is used, then

$$e = (11 \times 10^{-6}) \times 9 \times (55 - 21)$$

$$e = 0.000011 \times 9 \times 34$$

$$e = 0.003366$$

This amount, when added to the original length of the rod, makes the rod 9.003366 feet long. (Since the temperature has increased, the rod is longer by the amount of e. If the temperature had been lowered, the rod would have become shorter by a corresponding amount.)

The increase in the length of the rod is relatively small; but if the rod were placed where it could not expand freely, there would be a tremendous force exerted due to thermal expansion. Thus, thermal expansion must be taken into consideration when designing ships, buildings, and all forms of machinery.

Table 5-2 is a list of the coefficients of linear expansion of some substances.

Table 5-2.–Expansion coefficients.

Substance	Coefficient of linear expansion
Aluminum	24×10^{-6}
Brass	19×10^{-6}
Copper	17×10^{-6}
Glass	4 to 9×10^{-6}
Covar	4 to 9×10^{-6}
Steel	11×10^{-6}
Quartz	0.4×10^{-6}
Zinc	26×10^{-6}

A practical application for the differences in the coefficients of linear expansion is the thermostat. This instrument comprises two strips of dissimilar metal fastened together. When the temperature changes, a bending takes place due to the unequal expansion of the metals (fig. 5-15). Thermostats are used in overload relays for motors, in temperature sensitive switches, and in electric ovens. (See fig. 5-16.)

The coefficient of surface or area expansion is approximately twice the coefficient of linear expansion. The coefficient of volume expansion is approximately three times the coefficient of linear expansion. It is interesting to note that in a plate containing a hole, the area of the holes expands at the same rate as the surrounding material. In the case of a volume enclosed by a thin solid wall, the volume expands at the same rate as would a solid body of the material of which the walls are made.

CHANGE OF STATE

A thermometer placed in melting snow behaves in a strange manner. The temperature of the snow rises slowly until it reaches 0°C. Provided that the mixture is stirred constantly, it remains at that point until all the snow has changed to water; when all the snow has melted, the temperature again begins to rise. A definite amount of heat is required to change the snow to water at the same temperature. This heat is required to change the water from crystal form to liquid form.

Heat of Fusion

Eighty gram-calories of heat are required to change 1 gram of ice at 0°C to water at

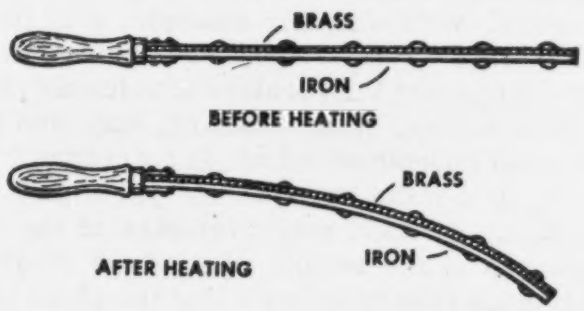

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Figure 5-15.–Compound bar.

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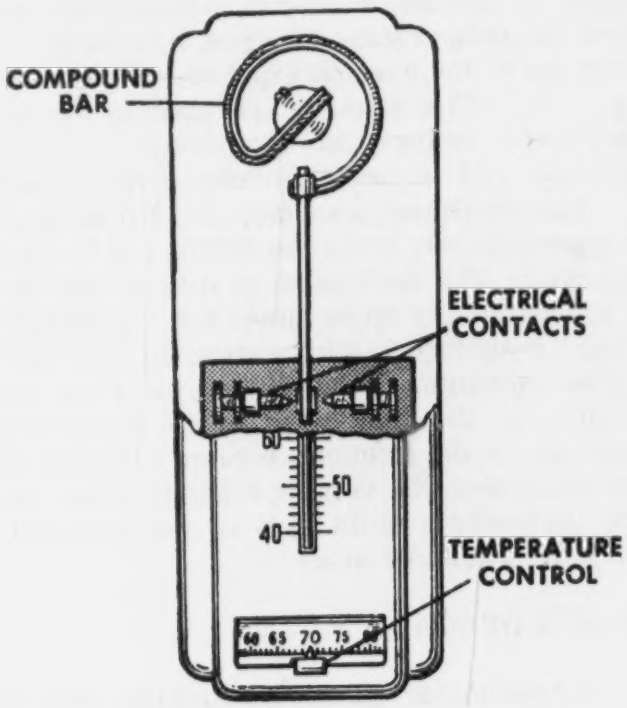

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Figure 5-16.–Thermostat.

0° C. In English units, the heat required to change 1 pound of ice at 32° F to water at 32° F is 144 Btu's. These values are called the HEAT OF FUSION of water. The heat used while the ice is melting represents the work done to produce the change of state. Since 80 calories are required to change a gram of ice to water at 0° C, when a gram of water is frozen it gives up 80 calories.

Many substances behave very much like water. At a given pressure, they have a definite heat of fusion and an exact melting point. There are many materials, however, which do not change from a liquid to a solid state at one temperature. Molasses, for example, gets thicker and thicker as the temperature decreases; but there is no exact temperature at which the change of state occurs. Wax, celluloid, clay, and glass are other substances which do not change from a liquid to a solid state at any particular temperature. In fact, measurements of the glass thickness at the bottom of windows in ancient cathedrals tend to indicate that the glass is still flowing at an extremely slow rate. Most types of solder used in electronics maintenance also tend to become mushy before melting.

Heat of Vaporization

Damp clothing dries rapidly under a hot flatiron but not under a cold one. A pool of water evaporates more rapidly in the sun than in the shade. Thus, it may be concluded that heat has something to do with evaporation. The process of changing a liquid to a vapor is similar to that which occurs when a solid melts.

If a given quantity of water is heated until it evaporates–that is, changes to a gas (vapor)–a much greater amount of heat is used than that which is necessary to raise the same amount of water to the boiling point. For example, several hundred calories are required to change 1 gram of water to vapor at a given temperature. It takes 972 Btu's to change 1 pound of water at 212° F to water vapor (steam) at 212° F. The amount of heat necessary for this change is called the HEAT OF VAPORIZATION of water. Over five times as much heat is required to change a given amount of water to vapor than to raise the same amount of water from the freezing to the boiling point.

BOILING.–When water is heated, some vapor forms before the boiling point is reached. The change from water to vapor occurs as follows: As the water molecules take up more and more energy from the heating source, their kinetic energy increases. The motion resulting from the high kinetic energy of the water molecules causes a pressure which is called the vapor pressure. As the velocity of the molecules increases, the vapor pressure increases. At sea level, atmospheric pressure is normally 29.92 inches of mercury. The boiling point of a liquid is that temperature at which the vapor pressure equals the external or atmospheric pressure. At normal atmospheric pressure at sea level, the boiling point of water is 100° C or 212° F.

While the water is below the boiling point, a number of molecules acquire enough kinetic energy to break away from the liquid state into a vapor. For this reason some evaporation slowly takes place below the boiling point. At the boiling point or above, large numbers of molecules have enough energy to change from liquid to vapor and the evaporation takes place much more rapidly.

If the molecules of water are changing to water vapor in an open space, the air currents carry them away quickly. In a closed container,

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they rapidly become crowded and some of them bounce back into the liquid as a result of collisions. When as many molecules are returning to the liquid state as are leaving it, the vapor is said to be saturated. Experiments have shown that saturated vapor in a closed container exerts a pressure and has a given density at every temperature.

LIGHT

The exact nature of light is not fully understood, although men have been studying the subject for many centuries. Some experiments seems to show that light is composed of tiny particles, and some indicate that it is made up of waves.

First one theory and then the other attracted the approval and acceptance of the physicists. Today there are scientific phenomena which can be explained only by the wave theory and another large group of occurrences which can be made clear by the particle or corpuscular theory. Physicists, constantly searching for some new discovery which would bring these contradictory theories into agreement, gradually have come to accept a theory concerning light which is a combination of these two views.

According to the view now generally accepted, light is a form of electromagnetic radiation; that is, light and similar forms of radiation are made up of moving electric and magnetic forces.

CHARACTERISTICS

When light waves, which travel in straight lines, encounter any substance, they are transmitted, reflected, or absorbed. (See fig. 5-17.) Those substances which permit clear vision through them, and which transmit almost all the light falling upon them, are said to be transparent. Those substances which allow the passage of part of the light, but appear clouded and impair vision substantially, are called translucent. Those substances which transmit no light are called opaque.

Objects which are not light sources are visible only because they reflect all or part of the light reaching them from some luminous source. If light is neither transmitted nor reflected, it is absorbed or taken up by the medium.

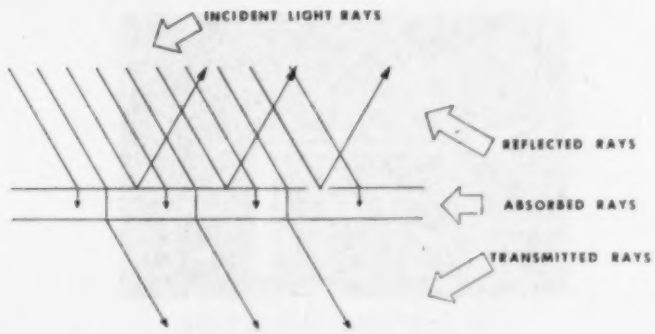

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Figure 5-17.—Light rays reflected, absorbed, and transmitted.

When light strikes a substance, some absorption and reflection always take place. No substance completely transmits, reflects, or absorbs all the light which reaches its surface. Figure 5-17 shows how glass transmits, absorbs, and reflects light.

Reflection

Light waves obey the law of reflection in the same manner as other types of waves. Optical devices incorporated specifically for the purpose of reflecting light are generally classed as mirrors. They may be of a polished opaque surface, or they may be a specially coated glass. In the case of the glass mirror, there is some refraction as well as reflection; however, if the glass is of good quality and not excessively thick, the refraction will cause no trouble. The following discussion is based on the polished surface type mirror.

Several classes of mirrors are illustrated in figure 5-18. All the devices work on the basis of the previously discussed law of reflection, and the applications are only briefly summarized here. Basically, the reflector is used to change the direction of a light beam (A), to focus a beam of light (B), or to intensify the illumination of an area (C).

In figure 5-18 (A), the angle of the reflected light may be changed to a greater or lesser degree by merely changing the angle at which the incident light impinges upon the mirror. In figure 5-18 (B), the focusing action of a concave mirror is indicated. The point of focus may be made any convenient distance from the reflector by proper selection of the arc of curvature of the mirror–the sharper the curvature, the shorter

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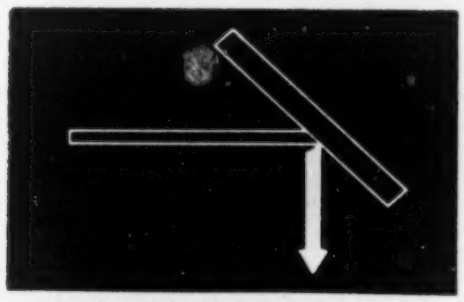

(A) CHANGING DIRECTION

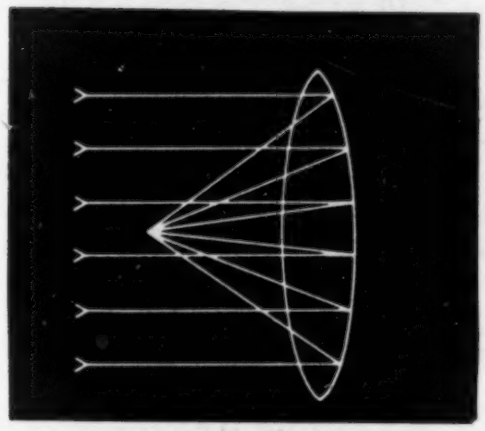

(B) FOCUSING A BEAM

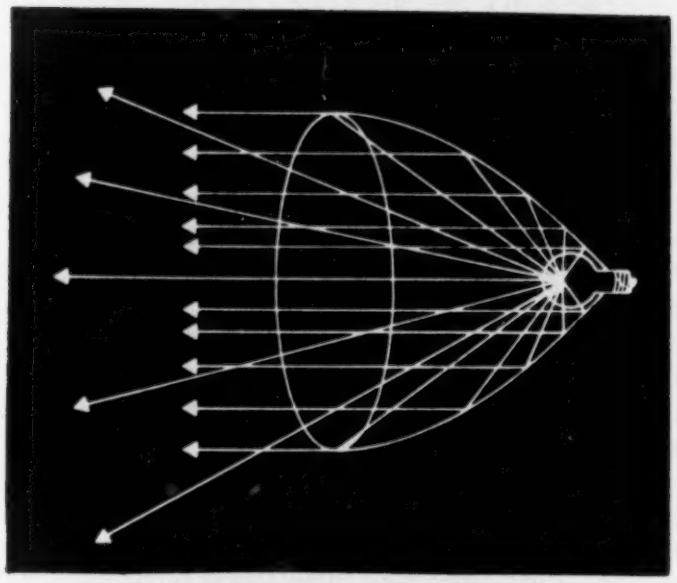

(C) ILLUMINATING AN AREA

Figure 5-18.—Reflectors of light. (A) Changing direction; (B) focusing a beam; (C) illuminating an area. AT.37

the focal length. In figure 5-18 (C), the principal of intensification of illumination for a specific area is illustrated. The flashlight is an example of this application. In the system shown, note that the light source (bulb) is located approximately at the principal focus point, and that all rays reflected from the surface are parallel. Also note that the reflector alone does not concentrate all the rays—some are transmitted without being reflected and are not included in the principal beam.

Refraction

As light passes through a transparent substance, it travels in a straight line. However, as it passes into or out of that substance, it is refracted in the same manner as other waves which were discussed earlier. Refraction of light waves results from the fact that light travels at slightly different velocity in different transparent mediums. In order to simplify the problem of understanding the action of light reflection and to make it possible to predict the outcome of specific applications, many transparent substances have been tested for refractive effectiveness. The ratio of the speed of light in air to its speed in each transparent substance is called the "index of refraction" for that substance. For example, light travels about one and one-half times as fast in air as it does in glass, so the index of refraction of glass is about 1.5. When using the law of refraction in connection with light, a "denser" medium refers to a medium with a higher index of refraction.

Refraction through a piece of plate glass is shown in figure 5-19. The ray of light strikes the glass plate at an oblique angle. If it were to continue in a straight line, it would emerge from the plate at point A; but in accordance with the law of refraction, it is bent toward the normal and emerges from the glass at point B. Upon entering the air, the ray does not continue on its path but is bent away from the normal and along the path BC in the air. If the two surfaces of the glass are parallel, the ray leaving the glass is parallel to the ray entering the glass. The displacement depends upon the thickness of the glass plate, the angle of entry into it, and the index of refraction for the glass.

All rays striking the glass at any angle other than perpendicular are refracted in the same manner. In the case of a perpendicular ray, no

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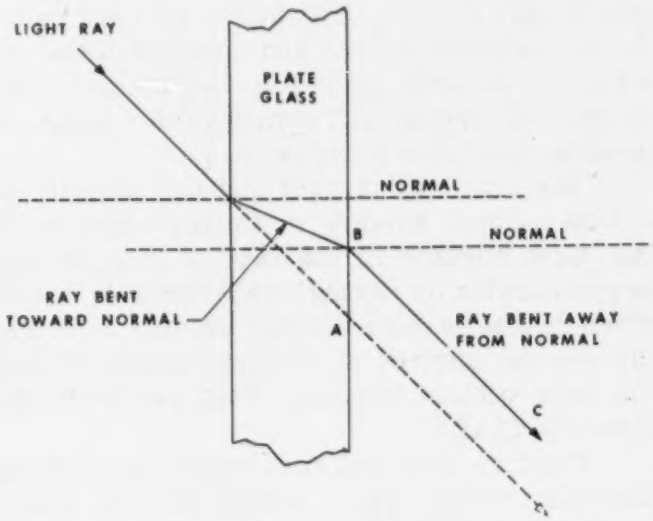

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Figure 5-19.–Refraction through a piece of plate glass.

refraction takes place, and the ray continues through the glass and into the air in a straight line.

PRISMS.–When a ray of light passes through a flat sheet of glass, it emerges parallel to the incident ray. This holds true only when the two surfaces of the glass are parallel. When the two surfaces are not parallel, as in a prism, the ray is refracted differently at each surface of the glass and does not emerge parallel to the incident ray.

Figure 5-20 (A) shows that both refractions are in the same direction, and that the ray coming out of the prism is not parallel to the ray going into it. The law of refraction explains what has happened. When the ray entered the prism, it was bent toward the normal; and when it emerged, it was bent away from the normal. Notice that the deviation is the result of the two normals not being parallel.

If two triangular prisms are placed base to base, as in figure 5-20 (B), parallel incident rays passing through them are refracted and caused to intersect. The rays passing through different parts of the prisms, however, do not intersect at the same point. In the case of two prisms there are only four refracting surfaces. The light rays from different points on the same plane are not refracted to a point on the same plane behind the prism. They emerge from the prisms and intersect at different points along an extended common baseline as illustrated by points A, B, and C of figure 5-20 (B).

Parallel incident light rays falling upon two prisms that have been joined apex to apex (fig. 5-20 (C), are spread apart. The upper prism

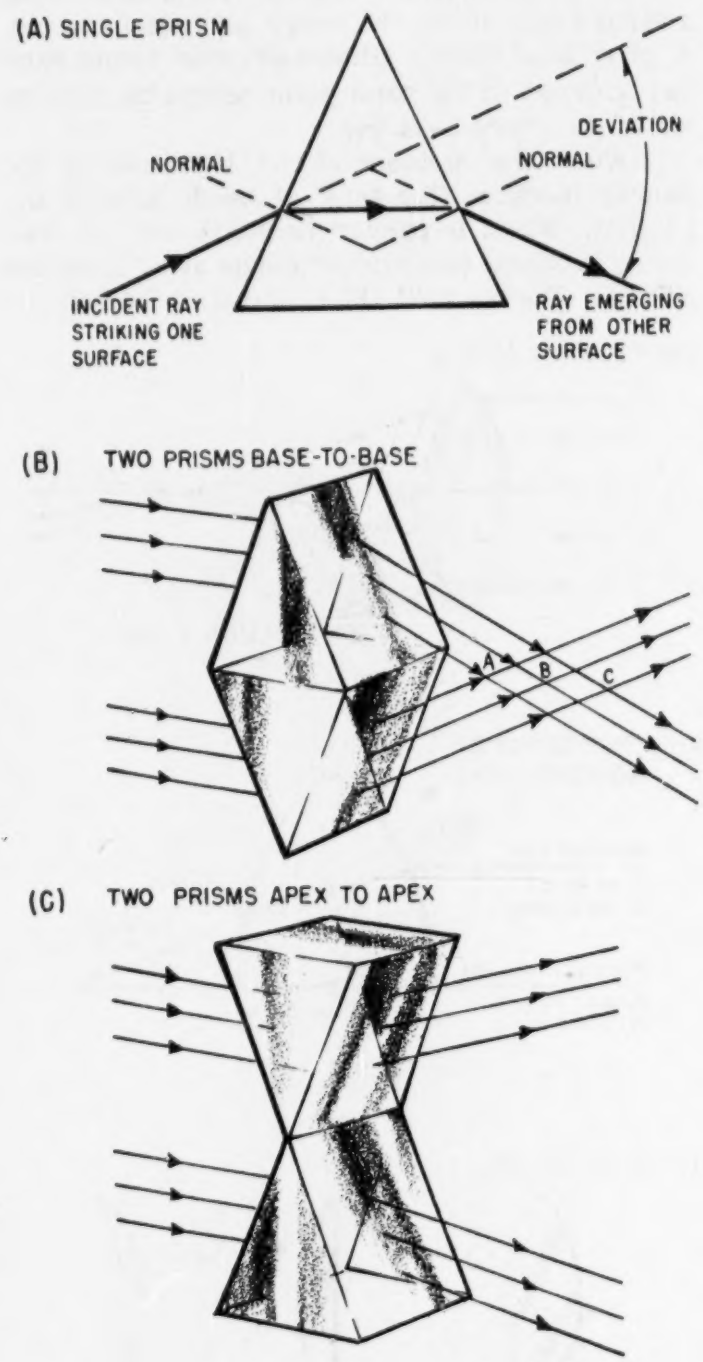

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Figure 5-20.–Passage of light through a prism. (A) Single prism; (B) two prisms, base to base; (C) two prisms, apex to apex.

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refracts light rays toward its base; the lower prism refracts light rays downward toward its base, causing the two sets of rays to diverge.

POSITIVE LENSES.–A positive (convergent) lens acts like two prisms base to base with their surfaces rounded off into a curve. Rays that strike the upper half of the lens bend downward, and rays that strike the lower half bend upward. A good lens causes all wavelengths within each ray to cross at the same point behind the lens as shown in figure 5-21 (A).

When the incident ray of light enters the denser medium (the lens), it bends toward the normal. When it passes through into the less dense medium (the air), it bends away from the normal. Figure 5-21 (B) illustrates the refraction of only one ray of light, but all rays passing through a positive lens are affected in the same way. All incident light rays either parallel or slightly diverging will converge to a point after passing through a positive lens.

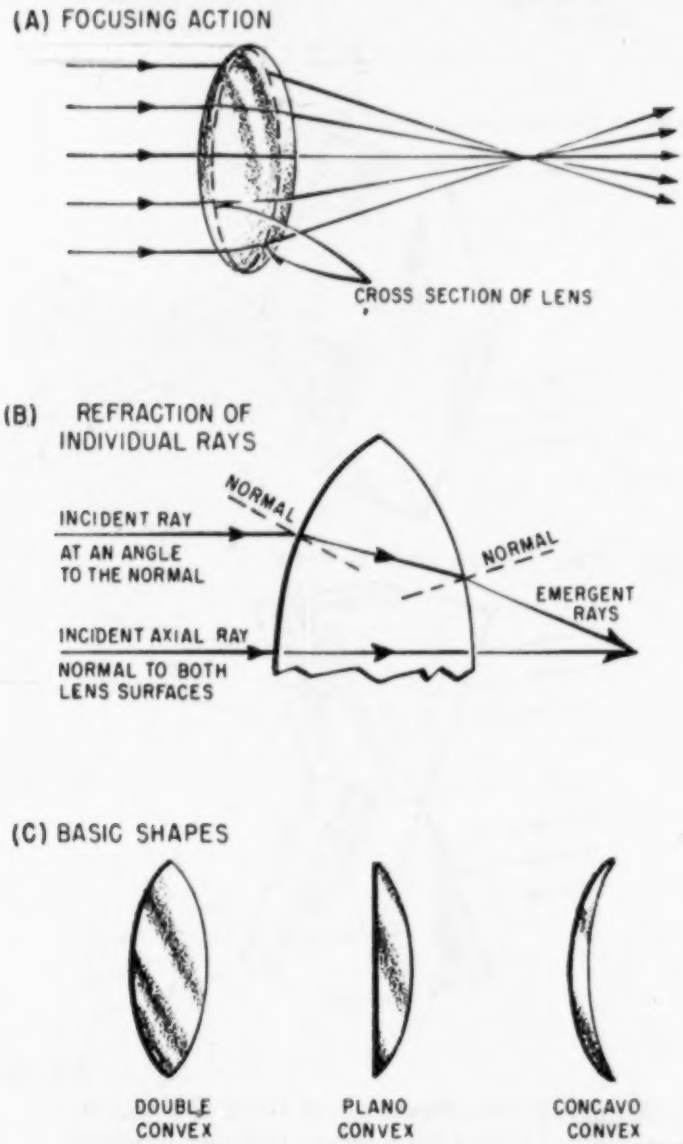

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Figure 5-21.–Positive lenses.

The only ray of light that can pass through a lens without bending is the ray which strikes the first surface of the lens at a right angle, perpendicular or normal to the surface. It passes through that surface without bending and strikes the second surface at the same angle. It leaves the lens without bending. This ray is shown in figure 5-21 (B).

Positive lens and convergent lens are synonymous terms, since either of them may be used to describe the action of a lens which focuses (brings to a point of convergence) all light rays passing through it. All simple positive lenses are easy to identify since they are thicker in the center than at the edges. The three most common types of simple positive lenses are shown in figure 5-21 (C).

NEGATIVE LENSES.–Figure 5-22 illustrates the refraction of light rays by two prisms apex to apex. If the prism surfaces are rounded the result is a negative (divergent) lens. A negative lens is called a divergent lens since it does not focus the rays of light passing through it. Light rays passing through a negative lens diverge or spread apart as shown in figure 5-22 (A).

Figure 5-22 (B) applies the law of refraction to one ray of light passing through a negative lens. Just as in a positive lens, a ray of light passing through the center of a negative lens is not affected by refraction and passes through without bending.

Three simple negative lenses are shown in figure 5-22 (C). They are often referred to as concave lenses and are readily identified by their concave surfaces. The simple negative lenses are thicker at the edges than at the center. They are generally used in conjunction with simple positive lenses where their primary use is to assist in the formation of a sharper image by helping to eliminate or subdue various defects present in an uncorrected simple positive lens.

FREQUENCIES AND COLOR

The electromagnetic waves which produce the sensation of light are all very high in frequency, which means that they have very short

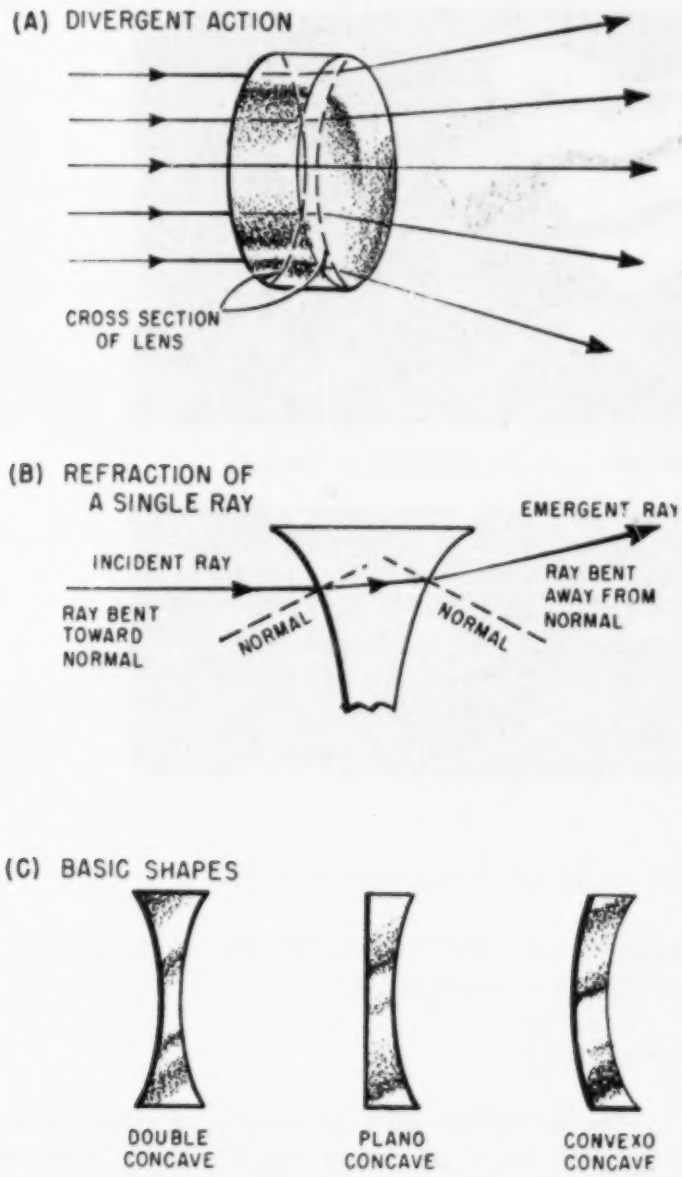

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Figure 5-22.–Negative lenses.

wavelengths. These wavelengths are measured in millimicrons (millionths of millimeters, or 10^{-9} meters). Figure 5-23 indicates that light with a wavelength of 700 millimicrons is red, and that a light with a wavelength of 500 millimicrons is blue-green. This drawing is subject to erroneous interpretation. In actual fact, the color of light is dependent on its frequency, not its wavelength.

When the wavelength of 700 millimicrons is measured in air, it produces a color known as red, but the same wave measured in another medium has a wavelength other than 700 millimicrons. When red light which has been traveling is air enters glass, is loses speed and its wavelength becomes shorter or compressed, but it continues to be red. This illustrates that the color of light is dependent upon frequency and not on wavelength. The color scale in figure 5-23 is based on the wavelengths in air.

All color-component wavelengths of the visible spectrum are present in equal amounts in white light. Variations in composition of the component wavelengths result in other characteristic colors.

When a beam of white light is passed through a prism, as shown in figure 5-23, it is refracted and dispersed into its component wavelengths. Each of these wavelengths reacts differently on the eye which then sees the various colors that compose the visible spectrum. The visible spectrum is recorded as a mixture of red, orange, yellow, green, blue, indigo, and violet. It can be readily demonstrated that white light results when the PRIMARIES (red, green, and blue) are mixed together in over-lapping beams of light. (NOTE: These are not the primaries used in mixing pigments.) Furthermore, the COMPLEMENTARY or secondary colors (magenta, yellow, and cyan) may be shown with equal ease by mixing any two of the primary colors in overlapping beams of light. Thus, red and green light mixed in equal intensities will make yellow light; green and blue will produce blue-green light which is termed cyan; and blue and red light correctly mixed will render magenta (a purplish red).

It should be noted that a few modern texts vary the treatment of the color scale slightly from the seven spectral colors. This is due partly to developments in the mixing values of pigments (paints). This difference in approach is based on a theory that the retina of the eye is equipped with three varying groups of nerves, sensitive roughly to red, green, and blue-violet light.

SOUND

BASIC CONSIDERATIONS

The term sound as generally used refers to hearing; but when used in physics, the term has to do with a particular type of wave motion and with the generation, propagation, transmission, characteristics, and effects of those waves.

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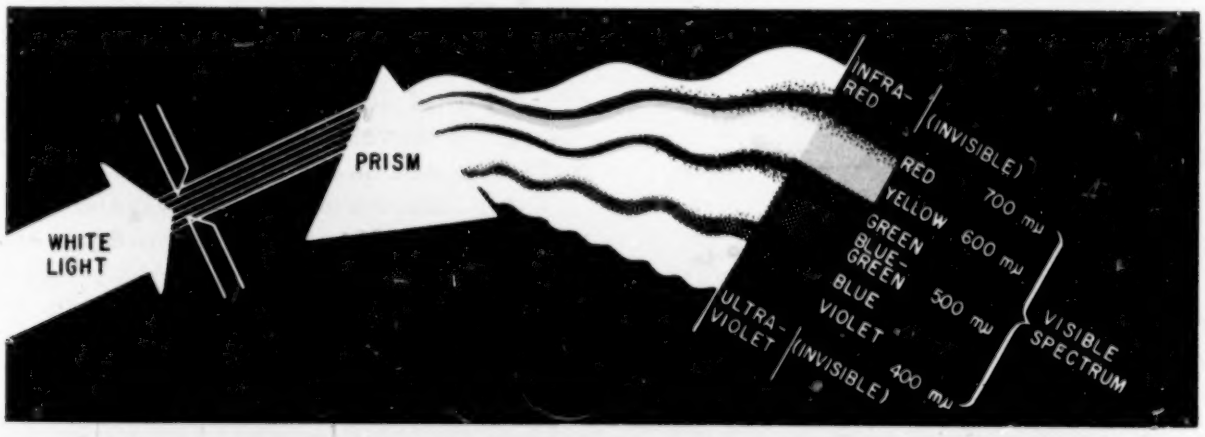

REFRACTION OF LIGHT BY A PRISM. THE LONGEST RAYS ARE INFRARED; THE SHORTEST, ULTRAVIOLET

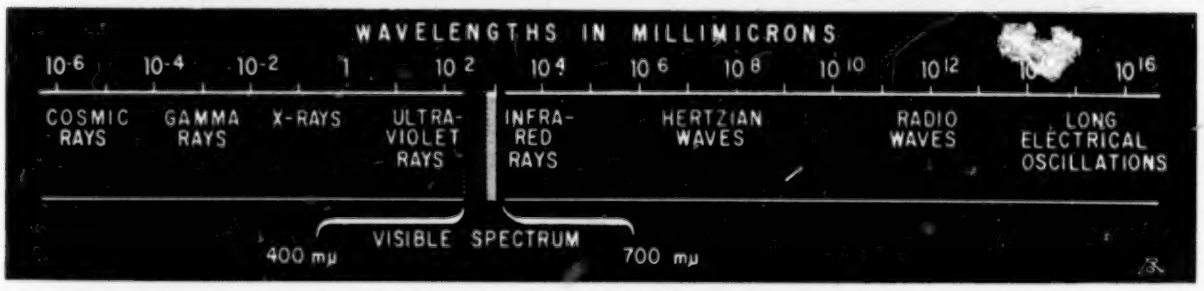

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Figure 5-23.–Electromagnetic wavelengths and the refraction of light.

One example of the generation and propagation of sound waves is the tuning fork discussed earlier in this chapter. Any object which moves rapidly to and fro, or which vibrates rapidly in such a manner as to disturb the surrounding medium, may become a sound source. Sound requires three components–a source, a medium for transmission, and a detector. As widely different as sound sources may be, the waves they produce have certain basic characteristics.

Wave Motion

Sound waves are longitudinal type waves which rely on a physical medium for propagation and transmission. Since the waves are transmitted by the compression and rarefaction of particles of matter in the medium, they cannot be transmitted through a vacuum. Sound waves are similar to waves of other types in that they can be reflected, absorbed, or refracted according to the laws previously discussed; they are also subject to the Doppler effect.

The major differences between the waves of sound and the waves of heat and light are the frequencies, the nature of the wave, and the velocities of wave travel.

Frequencies

Sound waves vary in length; a long wavelength is heard as a low sound, while a short wavelength is heard as a high sound. If the sound is below 15 hertz per second or above 20,000 hertz per second, it normally cannot be heard by the human ear. The frequency range over which sound can be heard is called the audible range, and the sounds heard are known as sonics. Sounds below 15 hertz per second are subsonics; those above 20,000 hertz per second are ultrasonics.

Conduction Media and Velocity of Transmission

In any uniform medium under given physical conditions, sound travels at a definite speed. In some substances, the velocity of sound is higher than in others. Even in the same medium under different conditions of temperature and pres-

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PREFACE

Machine drafting, Volume I, is based on practical experience acquired while teaching the subject for many years. It is organized into a series of drawing plates that teach the elements of drafting and drafting skills along with the making of typical shop drawings. Brief information has been given relative to instruments and equipment, lines, lettering, and constructions. More will be learned by the student as he needs it, in actually carrying out drafting problems and in added information conveyed in Volumes II and III.

Many drawing problems in the book may be done either free-hand or with drawing instruments; the possibility of such choice is indicated. Others, involving geometrical constructions, must be done with drawing instruments.

It is the author's fervent wish that the student draftsman concentrate first on quality and then on speed and eventually combine both factors to become a happy and proficient draftsman.

sure, the velocity of sound varies. Density and elasticity of a medium are basic physical properties which govern the velocity of sound.

At a given temperature and pressure, all sound waves travel at the same speed in air, regardless of frequency or wavelength. The speed of sound, however, does increase with temperature at the rate of 2.0 feet per second (fps) per degree centigrade. For practical purposes, the speed of sound in air may be considered 1,100 fps. Refer to table 5-3 for speed of sound in various media at different temperatures.

As previously stated, a sound wave is a compressional wave transmitted through an elastic medium. Sound travels faster through water (4,800 fps) than air (1,087 fps) because the elasticity of water is greater than that of air.

For a fixed temperature, the velocity of sound is constant for any medium and is independent of the period, frequency, or amplitude of the disturbance. Thus, the velocity of sound in air at 0° C (32° F) is 1,087 fps and increases by 2 fps for each degree centigrade rise in temperature (1.1 fps for each degree Fahrenheit).

The velocity of sound also varies with a change in altitude. With an increase in altitude, the atmospheric pressure is reduced, and the medium is less dense. Sound waves travel slower in a less dense medium. Therefore, it may be considered that the velocity of sound varies inversely with the altitude.

Table 5-3.—Comparison of velocity of sound in various media.

Medium	Temperature (° F)	Velocity (ft/sec)
Air	32	1,087
Air	68	1,127
Fresh water	32	4,629
Fresh water	68	4,805
Salt water	32	4,800
Salt water	68	4,953
Steel	32	16,410
Steel	68	16,850

Characteristics

Numerous terms are used to convey impressions of sounds, including whistle, scream, rumble, and hum. Most of these are classified as noises in constrast to musical tones. The distinction is based on the regularity of the vibrations, the degree of damping, and the ability of the ear to recognize components having a musical sequence.

The ear can distinguish tones that are different in pitch, intensity, or quality. Each of these characteristics is associated with one of the properties of the vibrating source or of the waves that the source produces. Thus, pitch is determined by the number of vibrations per second, intensity by the amplitude of the wave motion, and quality by the number of overtones (harmonics) which the wave contains. A sound wave can best be described by its frequency rather than by its velocity or wave-length, as both the velocity and the wavelength change when the temperature of the air changes.

PITCH.–The term pitch is used to describe the frequency of a sound. The outstanding recognizable difference between the tones produced by two different keys on a piano is a difference in pitch. The pitch of a tone is proportional to the number of compressions and rarefactions received per second, which in turn is determined by the vibration frequency of the sounding source.

Pitch is usually measured by comparison with a standard. The standard tone may be produced by a tuning fork of known frequency or by a siren whose frequency is computed for a particular speed of rotation. By regulating the speed, the pitch of the siren is made equal to that of the tone being measured. The ear can determine this equality directly if the two sources are sounded alternately, or by the elimination of beats by regulating the speed of the siren if the two sources are sounded together.

INTENSITY.–When a bell rings, the sound waves spread out in all directions and the sound is heard in all directions. When a bell is struck lightly, the vibrations are of small amplitude and the sound is weak. A stronger blow produces vibrations of greater amplitude in the bell, and the

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sound is louder. It is evident that the amplitude of the air vibrations is greater when the amplitude of the vibrations of the source is increased. Hence the loudness of the sound depends on the amplitude of the vibrations of the sound waves. As the distance from the source increases, the energy in each wave spreads out, and the sound becomes weaker.

The intensity of sound is the energy per unit area per second. In a sound wave of simple harmonic motion, the energy is half kinetic and half potential; half is due to the speed of the particles, and half is due to the compression and rarefaction of the medium. These two energies are 90° out of phase at any instant–that is, when the speed of particle motion is at a maximum, the pressure is normal; and when the pressure is at a maximum or a minimum, the speed of the particles is zero.

The loudness of sound depends upon both intensity and frequency. The intensity of a sound wave in a given medium is proportional to the following 4 quantities:

1. Square of the frequency of vibration.
2. Square of the amplitude.
3. Density of the medium.
4. Velocity of propagation.

At any distance from a point source of sound, the intensity of the wave varies inversely as the square of the distance from the source.

As a sound wave advances, variations in pressure occur at all points in the transmitting medium. The greater the pressure variations, the more intense the sound wave will be. It can be shown that the intensity is proportional to the square of the pressure variation regardless of the frequency. Thus, by measuring pressure changes, the intensities of sounds having different frequencies can be compared directly.

QUALITY.–Most sounds and musical notes are not pure tones. They are mixtures of tones of different frequencies. The tones produced by most sources can be represented by composite waves in which the sound of lowest pitch, the fundamental tone, is accompanied by several harmonics or overtones having frequencies that are 2, 3, 4 or more times that of the fundamental frequency. The quality of a tone depends on the number of overtones present and on their frequencies and intensities relative to the fundamental tone. It is this characteristic of difference in quality that distinguishes tones of like pitch and intensity when sounded on different types of musical instruments (piano, organ, violin, etc.).

ACOUSTICS

Acoustics is the science of sound, including its propagation, transmission, and effect. The performance of an announcing system or sound system when used in a room or enclosed space depends on the acoustical characteristics of the enclosure. Sound originating in an enclosed space is partly reflected and partly absorbed by enclosing surfaces such as the walls, ceiling, and floor of a room. This action introduces echoes and reverberations, which may seriously impair the quality or character of the sound.

Acoustical Disturbances

Light is often thought of first whenever reflection is discussed; however, reflection is equally common in other waves. As an example, echoes are caused by reflection of sound waves.

ECHO.–An ECHO is the repetition of a sound caused by the reflections of sound waves. When a surface of a room is situated so that a reflection from it is outstanding, it appears as a distinct echo, and is heard an appreciable interval later than the direct sound. If the surface is concave, it may have a focusing effect and concentrate the reflected sound energy at one locality. Such a reflection may be several levels higher in intensity than the direct sound, and its arrival at a later time may be particularly disturbing. Some possible remedies for this condition are as follows:

1. Cover the offending surface with absorbing material to reduce the intensity of the reflected sound.
2. Change the contour of the offending surface and thus send the reflected sound in another direction.
3. Locate the loudspeaker in a different position.
4. Vary the amplitude or the pitch of the signal.

REVERBERATION is the persistence of sound due to the multiple reflection of sound waves between several surfaces of an enclosure. It is one of the most common acous-

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tical defects of a large enclosure. Its duration varies directly with the time interval between reflections (the size of the enclosure) and inversely with the absorbing efficiency of the reflecting surfaces. The result is an overlapping of the original sound and its images. If excessive, reverberation causes a general confusion that is detrimental to speech intelligibility. The hangar deck of an aircraft carrier is an example of an extremely reverberant area. The volume is large, and the hard steel interior surfaces offer very little absorption to sound.

If a single loudspeaker is mounted in a large reverberant area, such as a hangar deck, the intelligibility directly in front of the loudspeaker is satisfactory. The intelligibility decreases rapidly with an increase of either the distance from the loudspeaker or the angle between the listener and the loudspeaker's sound axis. In other words, sound from a loudspeaker in a reverberant space is composed of direct sound that reaches the listener directly without any reflection, and indirect sound that has received at least one reflection.

Intelligibility under these conditions is related to the ratio of direct sound to indirect sound. As the listener moves away from the loudspeaker, the ratio of direct sound to indirect sound at the listening position decreases, and the intelligibility decreases correspondingly. Hence, in a highly reverberant space the intelligibility decreases with distance from the loudspeaker.

To prevent the sound from becoming unintelligible in a highly reverberant space, several speakers can be installed about the area rather than just one. The power requirements remain the same; one 25-watt speaker could be replaced by 5 speakers, each consuming 5 watts. This would greatly increase the direct-to-indirect sound ratio.

INTERFERENCE.–Two sound waves moving through the same medium at the same time will advance independently, each producing the same disturbance as if it were alone. The resultant of the two waves can be obtained by adding algebraically the ordinates (instantaneous magnitudes) of the component waves.

Two sound waves of the same frequency, in phase with each other and moving in the same direction are additive. The resultant wave is in phase with, and has an amplitude equal to, the sum of the component waves.

Two sound waves of the same frequency, in phase opposition and moving in the same direction, are subtractive. If the component waves have equal amplitudes, the resultant wave is zero. This addition or subtraction of waves is often called interference.

Two sound waves of slightly different frequency and moving in the same direction produce a beat note. If the two waves originate from two vibrating sources at the same point, and the frequency of one wave is one vibration per second greater than that of the other at a particular instant, the sources will produce additive disturbances at some points and subtractive disturbances at some other points on the relative positions of the waves. These changes will continue to occur as long as the sources are kept vibrating.

The resultant wave has a periodic variation in intensity at a frequency equal to the difference between the original frequencies of the component waves. The difference frequency, referred to as the beat frequency, produces a type of pulsating interference particularly noticeable in sound waves. The effect of beat frequency, called beats, produces alternately loud and soft pulses or throbs. The effect is most pronounced when the component waves have equal amplitudes.

STANDING WAVES.–Two sound waves of equal frequency and amplitude moving in opposite directions through the same medium may produce standing waves. Standing waves are set up by the reaction of the two waves on each other. At certain points they are in phase and at other points they are 180° out of phase. Because their amplitudes are equal, when the two waves act in opposition on a particle, the particle remains motionless. At these points in a standing wave, there is no vibration and the points are called nodes. At the points where the two waves reinforce each other they produce maximum vibrations on a particle. These points are called antinodes. The distance between successive nodes (or antinodes) is a half wavelength.

RESONANCE.–Resonance, or sympathetic vibration, is a common problem encountered in acoustics. It is somewhat more serious than some of the other problems discussed, because

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the possibility exists for damage to equipment. Reverberation and resonance are frequently confused, but they are distinctly different in nature. Reverberation is a result of the reflection of sound waves and of the interaction between the direct and reflected sound. There is only a single source involved. In resonance, however, the offending object becomes a sound source under certain conditions. This may be explained by the following example:

Assume that the natural frequency of vibration of a steel shaft, which is weighted on one end and held firmly on the other, is 25 vibrations per second. Suppose that with the system at rest, a sound wave produces a force which acts on the shaft with a to-and-fro motion 125 times per second. This force sets the system vibrating at 125 vibrations per second. These vibrations would be of a small amplitude because the rod and weight are trying to vibrate at their natural rate of only 25 vibrations per second. During part of the time the system is resisting the driving force. The motion of the system in this case is called a forced vibration.

If the force is slowed from 125 vibrations per second to its natural frequency of 25 vibrations per second, the amplitude of vibration becomes very large. The amplitude will build up to a point where the driving force is enough to overcome the inertia of the system.

When these conditions exist, the system is said to be in resonance with the driving force, and sound waves are produced by this vibration.

A common example of resonance is found in a crystal oscillator circuit. When an alternating voltage is applied to a crystal that has the same mechanical (resonant) frequency as the applied voltage, it vibrates and only a small applied voltage is needed to sustain vibration. In turn, the crystal generates a relatively large voltage at its resonant frequency.

Measurement of Sound

The range of sound that the human ear can detect varies with the individual. The normal range extends from about 20 to 20,000 vibrations per second. In the faintest audible speech sounds, the intensity at the ear is about 10^{-16} watts/cm^2. At the threshold of feeling, the maximum intensity that the ear records as sound is about 10^{-4} watts/cm^2.

The human ear is a nonlinear unit that functions on a logarithmic basis.

If the ear is tested with tones of any one frequency, the threshold of audibility is reached when the intensity is reduced to a sufficiently low level so that the auditory sensation ceases. On the other hand, the threshold of feeling is reached when the intensity is increased to a sufficiently high level so that the sound produces the sensation of feeling and becomes painful. If this procedure is performed over a wide frequency range, the data can be used to plot two curves, one for the lower limit of audibility and the other for the maximum auditory response (fig. 5-24). Below the lower curve, the sound is too faint to be audible. Above the upper curve, the sensation is one of feeling rather than of hearing; that is, the sensation of sound is masked by that of pain. The area between the two curves shows the pressure ranges for auditory response at various frequencies. Note that the scales of frequency and pressure are logarithmic. An advance of one horizontal space doubles the frequency, and an advance of one vertical space multiples the pressure by ten.

SOUND UNITS.–The loudness of sound is not measured by the same type of scale used to measure length. Units of sound measurement are used that vary logarithmically with the amplitude of the sound variations. These units are the bel and decibel, which refer to the difference between sounds of unequal intensity or sound levels. The decibel, which is one-tenth of a bel, is the minimum change of sound level

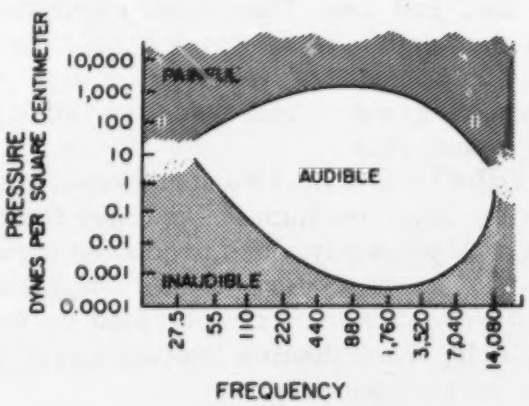

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Figure 5-24.–Field of audibility.

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perceptible to the human ear. Hence, the decibel merely describes the ratio of two sound levels. A sound for which the power is 10 times as great as that of another sound level differs in power level by 1 bel, or 10 decibels. For example, 5 decibels may represent almost any volume of sound, depending on the intensity of the reference level or the sound level on which the ratio is based.

In sound system engineering, decibels are used to express the ratio between electrical powers or between acoustical powers. If the amounts of power to be compared are P1 and P2, the ratio in decibels (db) is

$$db = 10 \times \log \frac{(P2)}{(P1)}$$

(NOTE: When the logarithmic base is not indicated, it is assumed to be 10. The subjects of logarithms and logarithmic relationships are covered in Rate Training Manual, Mathematics, Vol. 2, NavPers 10071-B.)

If P2 is greater than P1, the decibel value is positive and represents a gain in power. If P2 is less than P1, the decibel value is negative and represents loss in power.

INTENSITY LEVEL.–An arbitrary zero reference level is used to accurately describe the loudness of various sounds. This zero reference level is the sound produced by 10^{-16} watts per square centimeter of surface area facing the source. This level approximates the least sound perceptible to the ear and is usually called the threshold of audibility. Thus, the sensation experienced by the ear when subjected to a noise of 40 decibels above the reference level would be 10,000 times as great as when subjected to a sound that is barely perceptible.

ACOUSTICAL PRESSURE.–Typical values of sound levels in decibels and the corresponding intensity levels are summarized in table 5-4. The values in this table are based on an arbitrary zero reference level. Note that for each tenfold increase in power, the intensity of the sound increases 10 decibels. The power intensity doubles for each 3-decibel rise in sound intensity.

POWER RATIO.–The decibel is used to express an electrical power ratio, such as the gain of an amplifier, the output of a microphone, or the power in a circuit compared to an arbitrary reference power level. The value of decibels is often computed from the voltage ratio SQUARED or the current ratio SQUARED. These are proportional to the power ratio for equal values of resistance. If the resistances are not equal, a correction must be made.

Table 5-4.–Values of sound levels.

Sound level (decibels)	Intensity level (watts/cm^2)
0	10^{-16}
60	10^{-10}
80	10^{-8}
100	10^{-6}
110	10^{-5}
120	10^{-4}
130	10^{-3}

To find the number of decibels from the voltage ratio, assuming that the resistances are equal, substitute E^2 for P in the basic equation:

$$db = 10 \times \log \frac{E2^2}{E1^2} = 10 \times \log \left(\frac{E2}{E1}\right)^2$$

$$db = 20 \times \log \frac{E2}{E1}$$

To find the number of decibels from the current ratio, assuming that the resistances are equal, substitude I^2 for P in the basic equation:

$$db = 10 \times \log \left(\frac{I2}{I1}\right)^2$$

$$db = 20 \times \log \frac{I2}{I1}$$

The power level of an electrical signal is often expressed in decibels above or below an arbitrary power level of 0.001 watt (1 milliwatt) as

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$$\text{dbm} = 10 \times \log \left(\frac{P}{0.001}\right)$$

where dbm is the power level above one milliwatt in decibels, and P is the power in watts.

The volume level of an electrical signal comprising speech, music, or other complex tones is measured by a specially calibrated voltmeter called a volume indicator. The volume levels read with this indicator are expressed in "v units" (vu), the number being numerically equal to the number of decibels above or below the reference volume level. Zero vu represents a power of 1 milliwatt dissipated in an arbitrary load resistance of 600 ohms (corresponds to a voltage of 0.7746 volt). Thus, when the vu meter is connected to a 600-ohm load, vu readings in decibels can be used as a direct measure of power above or below 1 milliwatt. For any other value of resistance the following correction must be added to the vu reading to obtain the correct vu value:

$$\text{vu} = \text{vu reading} + 10 \times \log \frac{600}{R}$$

where vu is the actual volume level, and R is the actual load, or resistance, across which the vu measurement is made. If the volume levels are indicated in units other than vu, the meter calibration, or reference level, must be stated with the decibel value.

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CHAPTER 6

ELECTRONIC POWER AND COOLING SYSTEMS

In order to operate and maintain the complex electronic installations of modern naval aircraft, the technician must be familiar with the electric power system of the particular aircraft with which he is associated. Since the electronic installations of aircraft vary widely according to the size and application of the aircraft, the electric power requirements and the electric system components of aircraft also vary. Therefore, the technician must also have a basic understanding of the component parts of the electric system–the power generation equipment, the conversion units, the power control, regulation, and protection components, and the general distribution systems–of typical aircraft.

Today's technician must also have an understanding of the capabilities and limitations of the auxiliary power sources provided for use in ground servicing and maintenance of aircraft. He must be able to operate these units, and must be familiar with the proper procedures for connecting and disconnecting the auxiliary power units to the aircraft. He must know the proper procedures for servicing the auxiliary units, and must observe and enforce all safety precautions and regulations concerning these operations.

The technician must also know the requirements for cooling the various electronic equipment while on the ground. He must be familiar with the sources of auxiliary air and cooling. He must know the operating procedures, as well as the capabilities and limitations of the various cooling units.

This chapter is devoted to a discussion of these topics. In most sections, the topics are discussed in general; in a few instances details are presented as they pertain to specific topics or items of equipment. Coverage of equipments is limited to those expected to be in common usage during the life of this manual.

TYPICAL AIRCRAFT SYSTEMS

The electric power system of an aircraft consists of the power source and its associated controls, the generation system and its associated control and regulation systems, the conversion units, the feeder and distribution system and its component parts, and the various protective devices used throughout the installation.

Most older types of aircraft used engine-driven generators to produce d-c power at a nominal 27.7 volts. Inverters and dynamotors were used as conversion units to produce the voltages required for operation of the individual equipment. With the comparatively simple installations then in use, this arrangement was satisfactory; however, as the installations became more complex, weight problems arose. The increased weight (which resulted from the addition of more and more inverters and dynamotors) soon became prohibitive. A new approach to the problem was required.

As part of the overall effort to standardize aircraft and electronic installations, the supply and distribution of power offered a logical starting point. The first step was to standardize the supply voltages and power frequencies, and to use generators which would provide the required power. Later in the standardization program, the generation of d-c power was discontinued, and the primary power became exclusively a.c.; the d-c requirement was supplied through transformer-rectifiers. This re-

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duced the number of voltages generated, reduced the number of rotary devices, and allowed the use of smaller conductors in the distribution system. The result was a drastic decrease in the total weight of a given installation, which in turn permitted a more complex installation for a given weight allowance.

Even a partial listing of the considerations involved in any discussion of aircraft electric systems must include the following items in order to be of any real value:

1. A "main generating source" refers to all generator units driven by a specified engine; thus a single-engine aircraft can have only one main source.

2. Multiengine aircraft may have a main generating subsystem for each engine. This is the usual practice, but it is not universally followed.

3. In multigenerator systems, provisions may or may not be made for parallel operation of generators producing similar power. If parallel operation is provided, provisions must also be made for individual operation of the subsystems in the event of a failure within the paralleling system.

4. Adequate frequency regulation and stability in a-c generation systems required some method of speed control of the generator's rotor drive mechanism.

5. Provisions must be made to insure that adequate power is available in each mode of operation. In the event of failure of the aircraft engine or its associated generation system, the maximum amount of power which can be produced is decreased. In the case of single-engine aircraft this automatically constitutes an emergency situation.

6. The failure of a single generator or engine in a multiple installation does not constitute the same degree of emergency as the same failure in a single-engine installation. Although some restrictions are placed on operational capabilities, some degree of safety may usually be maintained with the remaining engines and generators.

7. Provisions should be made to enable use of external power sources for starting the engines while on the ground and for ground operation without using the aircraft engines. The aircraft electric system must include provisions to prevent applying both internally-generated power and externally-furnished power to the system at the same time.

AIRCRAFT ELECTRIC SYSTEMS

The electric system of each model aircraft has features which are peculiar to it alone, while other features are common to most models. This section is devoted primarily to a general discussion of the electrical system of a typical aircraft, with some subsequent details concerning the electric systems of actual aircraft.

Source of Power

The basic source of power for the electrical system is the aircraft engine. An a-c generator requires a constant rotational speed in order to produce a constant frequency output. In most modern aircraft, a constant speed drive (CSD) unit is inserted between the aircraft engine and the a-c generator for this purpose.

The constant speed drive unit acts as a variable-ratio differential transmission system which converts the variable speed of the engine to the constant speed required by the generator. The engine is mechanically coupled to the input of the CSD unit; the output of the CSD is mechanically coupled to the rotor of the generator. Internal coupling between the input and output sections of the CSD unit is usually hydraulic, using the engine's oil supply as the transmission coupling medium. Output speed of rotation is controlled by means of mechanical governors and/or electronic speed regulators.

Generation System

The heart of the electric generation system is the constant-speed, wye-connected, a-c generator. This unit normally produces a 3-phase output voltage of about 120/208 volts at 400 Hz which is subsequently regulated to 115/200 volts. The basic theory of a-c generators is discussed in chapter 16 of Basic Electricity, NavPers 10086-B.

An underspeed switch is normally connected to the output shaft of the CSD unit. This is a centrifugally-operated switch and is normally in the open position; it closes only when the output end of the CSD (which is also the gen-

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erator shaft) reaches a preset speed of rotation. When the switch is open, the electrical system cannot be energized. An overspeed switch is also sometimes used.

STATIC EXCITER.–In most aircraft generators, the rotor receives its excitation from a separate static exciter rather than from a primary rotating exciter (as in the system described in Basic Electricity, NavPers 10086-B). Use of the static exciter eliminates the commutator and its associated problems; coupling from the exciter output to the generator rotor is accomplished through the simpler brush and slipring arrangement.

The heart of the static exciter is the saturable current potential transformer (SCPT). Figure 6-1 shows one phase of the exciter operation. The SCPT is a 3-phase transformer with four separate windings. The current windings carry all of the output current of the generator and, when the load equipment is being used, these windings supply most of the field power requirements. The potential winding is used mainly during initial buildup (when there is no load current flowing).

In series with the potential winding is a linear reactor which shifts the phase of the signal derived from line voltage and reduces it to the correct magnitude. The third winding is the transformer output winding which delivers field power to the generator. The output winding voltage is rectified in a 3-phase full-wave rectifier circuit and fed to the field of the generator (through a brush and slipring assembly).

The last winding is the d-c control winding, which is connected to the output of the voltage regulator and controls the saturation of the transformer core. As more control current flows in the control winding, there is less coupling between the primaries and the secondary or output transformer windings. The control winding (in effect) changes the unit from an iron core to an air core transformer by controlling the saturation level of the magnetic cores.

PARALLEL OPERATION. – Most multiengine aircraft utilize more than one a-c generator to supply the electrical and electronic loads. The practice of operating multigenerator systems in parallel makes possible the equal distribution of loads between the generators. Parallel operation simplifies the problem of transferring loads when one of the generators is removed from the line and permits a finer frequency control than is provided by the basic constant speed drive governor.

Paralleling circuitry senses both the frequency and the phase relationship between individual generators. If either the frequency

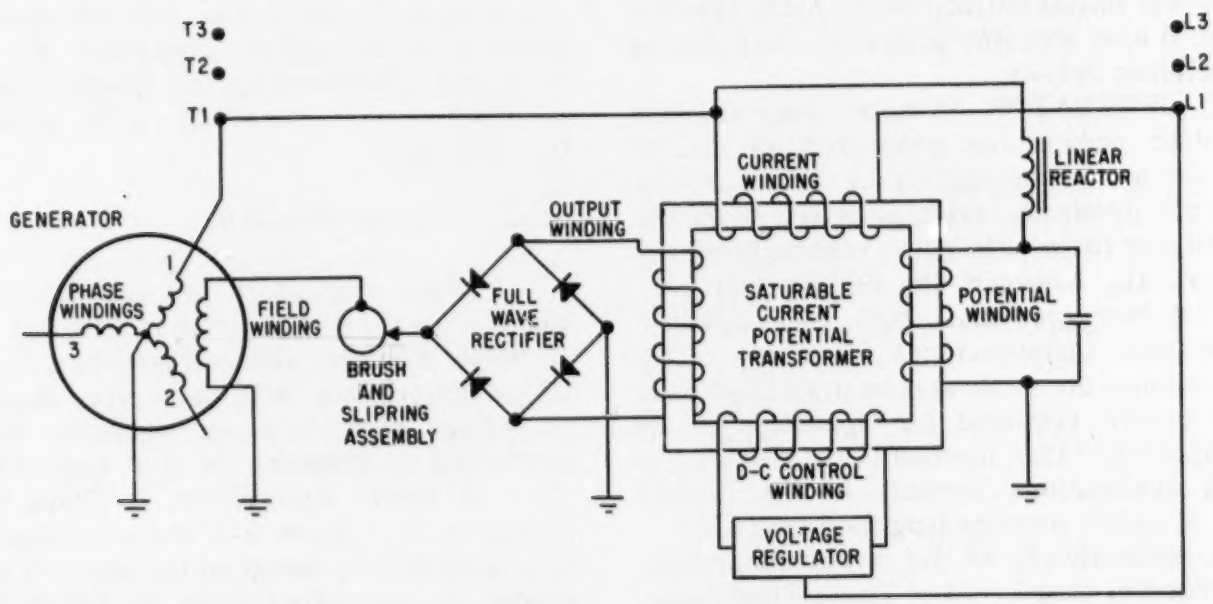

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Figure 6-1.–Static exciter, simplified diagram.

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or the phase relationship of the generators is not within permissible limits, parallel operation is not possible. When both these parameters are within tolerance, a paralleling relay operates and supplies power to the coil of a bus tie contactor. Once the bus tie contactor energizes, it is kept closed through an auxiliary set of its own contacts. If the operation of either generator exceeds allowable limits, the bus tie contactor opens and the generators are returned to individual operation.

Division of generator loads involves distributing both the real load (watts) and the reactive load (volt-amperes, reactive). In most parallel systems real loads are equalized by controlling the torque input of each CSD as a function of the difference in watts output. In systems which also equalize the reactive loads, an imbalance activates a reactive biasing circuit. This circuit develops error/correction signals for each generator so as to reestablish a reactive output current balance between the individual generators.

SINGLE-PHASE PMG.–Some main 3-phase a-c generators incorporate a small single-phase permanent magnet generator (PMG) as an integral part of the unit. The permanent magnet rotor is mounted on the main generator shaft, and contains the same number of poles as the main generator; therefore it produces the same output frequency.

The PMG is used to provide the power required for initial buildup of the main generator field; it also supplies power for the controls and regulation system.

D-C GENERATOR.–In most older aircraft all electric power was generated as d.c. In most of the newer aircraft no d.c. is generated; the d-c requirements are met by transforming and rectifying the a.c. In some presently operational aircraft, however, the main power generation system provides both a-c and d-c voltages from a common unit. In other aircraft models, a separate generator is used to provide the d-c power required for operation of the d-c components. This method is not common in airborne applications because of the limited number of prime movers (engines) available.

The basic theory of d-c power generators is presented in chapter 18 of Basic Electricity, NavPers 10086-B.

EMERGENCY GENERATORS.–In the event of failure or shutdown of the aircraft's engines or main generators, the electric system becomes inoperative. The aircraft, however, must have electrical power in order to maintain adequate flight control. All naval aircraft incorporate an auxiliary or emergency generator which operates independently of the aircraft engine.

The most common type of emergency generator is the ram air turbine (RAT). It is normally enclosed within the fuselage, being projected into the airstream when its operation is necessary. Driving power for the rotor is derived from the movement of a turbine through the air; it can be operated only in flight or with blast air when on the ground.

Due to its relatively small size, the emergency generator cannot supply the electric loads required for normal operation of the aircraft. Therefore only those systems and equipments considered essential for the maintenance of flight are operable when the aircraft is dependent on the emergency generator.

Because the rotor of the ram air turbine generator turns at a variable speed (dependent on the speed of the aircraft in flight), frequency stability is not so refined as that of the main generators. A governor is usually incorporated to limit rotational speed; the frequency is thus prevented from becoming too high. No solution has yet been found for maintaining operation of the generator when the aircraft speed drops below a certain point. Therefore, in the event of a power-off landing, all electric power and stability control is lost before the aircraft rolls to a full stop.

System Voltage Regulation

Voltage regulators are incorporated in all electric generation systems. Although similar in basic purpose, the configuration and details of operation vary with each type. Basic theory of voltage regulation and regulator devices is presented in chapters 16 (for a.c) and 18 (for d.c.) of Basic Electricity, NavPers 10086-B. A practical 3-phase a-c static voltage regulator, specifically designed for aircraft usage, is shown in simplified form in figure 6-2 and discussed in the following paragraphs.

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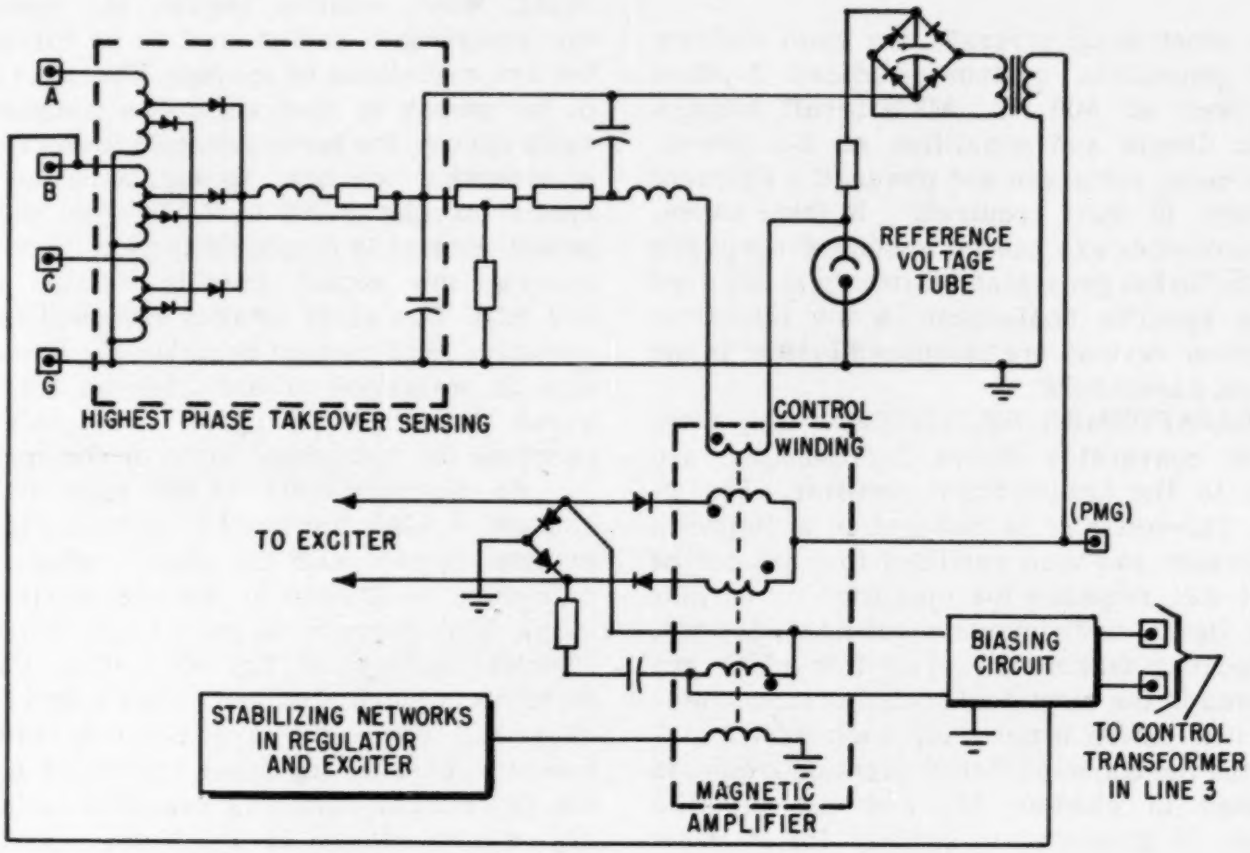

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Figure 6-2.–Voltage regulator, simplified schematic.

The voltage sensing circuit of the regulator incorporates a highest phase takeover (HPT) circuit developed specifically for aircraft systems. This circuit permits regulation of the average of the 3-phase voltages during normal system operation and during slightly unbalanced conditions of the system. Large unbalanced load conditions result in large unbalanced voltages. The HPT circuit allows regulation of the highest individual phase-to-neutral voltage. The unit thus incorporates the advantages of both the average voltage sensing circuit and the highest phase voltage sensing circuit.

The output of the HPT circuit is compared with an accurate voltage obtained from a cold cathode voltage reference tube. Any difference between the sensed voltage and the voltage reference causes a current to flow in the control winding of a magnetic amplifier. This amplifier is energized by a single-phase a-c voltage, such as that produced by the permanent magnet generator previously discussed. The current in the control winding determines the current output of the PMG to the magnetic amplifier output circuit. The output of the magnetic amplifier supplies the control winding of the saturable current potential transformer.

If the voltage rises at the generator terminals, the output voltage from the sensing circuit increases. This in turn increases the error signal between the sensing circuit and the glow tube reference, and adds to the current in the control winding of the magnetic amplifier. The increased current tends to increase the magnetic amplifier's output current, which then passes through the control winding of the SCPT and makes it behave more like an air core transformer. This reduces the output power. Since the output power of the SCPT is the input power to the generator field, the terminal voltage of the generator is lowered to its required level.

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Power Conversion Devices

In most naval aircraft, the main electric power generation system produces 3-phase a-c power at 400 Hz. All aircraft require various levels and quantities of d-c power, and in many instances a-c power of a different frequency is also required. In these cases, various devices are needed to convert the power from the forms generated into the form required for the specific application. A few important conversion devices are discussed briefly in the following paragraphs.

TRANSFORMER-RECTIFIERS.–The most common conversion device for changing a-c to d-c is the transformer-rectifier. The 3-phase, 115-volt a.c. is reduced in a stepdown transformer and then rectified to produce the 28-volt d.c. required for operation of various relays, lights, instruments, mechanical devices, etc. Specific transformer-rectifier units are discussed in the electrical section of the maintenance instruction manual for each model aircraft; the fundamental theory of transformers is discussed in chapter 16, and the metallic rectifier is discussed in chapter 15, of Basic Electricity, NavPers 10086-B.

INVERTERS.–An inverter is a rotating electromechanical device used to convert low voltage d.c. into a.c. It consists essentially of a speed governed d-c motor, an armature and brush assembly, and a permanent magnet inductor type a-c generator, all within a single unit the armature and the permanent magnet rotor are usually mounted on a common shaft. Figure 6-3 and the following paragraphs are based on the E1616-2 inverter used in the P-3 Orion patrol aircraft.

The d-c motor is of the compound-wound type discussed in chapter 19 of Basic Electricity. Motor speed is controlled by a resistor in series with the ground end of the shunt field. The resistor is cut in or shorted out of the circuit by action of a centrifugal switch mounted on the rotating shaft. Electrical connection to the switch is provided by a brush and slipring arrangement. When the inverter is at rest the switch contacts are closed, and the resistor is shorted out as shown in the top section of figure 6-3 (C).

When line voltage is initially applied (fig. 6-3 (B)), full field strength is developed, resulting in large starting torque. Acceleration is rapid. When rotation begins, the contacts of the centrifugal switch tend to be forced open but are restrained by springs. The upper contact of the switch is restrained by a comparatively weak spring; the bottom contact is restrained by a somewhat stronger spring. At some preset speed (usually 5,000 to 7,000 rpm) the upper switch contact is displaced by centrifugal action, opening the switch (middle section of fig. 6-3 (C)). The short is thus removed from the resistor, field current is reduced, and magnetic flux is weakened. These changes combine to result in armature speed acceleration and increase the centrifugal force on the springs.

At approximately 12,000 rpm the lower contact is also displaced by centrifugal action, making contact with the upper contact (whose movement is limited by the preadjusted screw stop). The resistor is once again shorted out (bottom section of fig. 6-3 (C)), the field strength is increased, and motor speed tends to decrease. The speed does not drop noticeably, however, because the make-and-break action of the centrifugal switch is repeated rapidly with any slight change in rotational speed. This feature provides a high degree of speed stability and minimizes the hunting effect.

The generator section features a permanent magnet rotor, mounted on the same shaft as the rotor of the motor. Rotation of the shaft causes an a-c voltage to be induced into the generator's output windings in the stator. The magnitude of the voltage is determined by the strength of the permanent magnet, the number and position of the turns in the windings, and the rotational speed of the magnet. Output frequency is determined by the number of pole pairs of the rotor and the speed of rotation. Since the inverter provides good speed stability, the output voltage and frequency are fairly well regulated. Filtering and additional regulation are included because of possible effects of the load on the line voltage.

The inverter's output frequency and voltage should be checked periodically to assure that they are within prescribed limits. Should adjustment be required, notify the electrical shop since adjustment of inverters is a responsibility of the AE rating.

DYNAMOTORS.–A dynamotor is a rotating electromechanical device used to change (usually,

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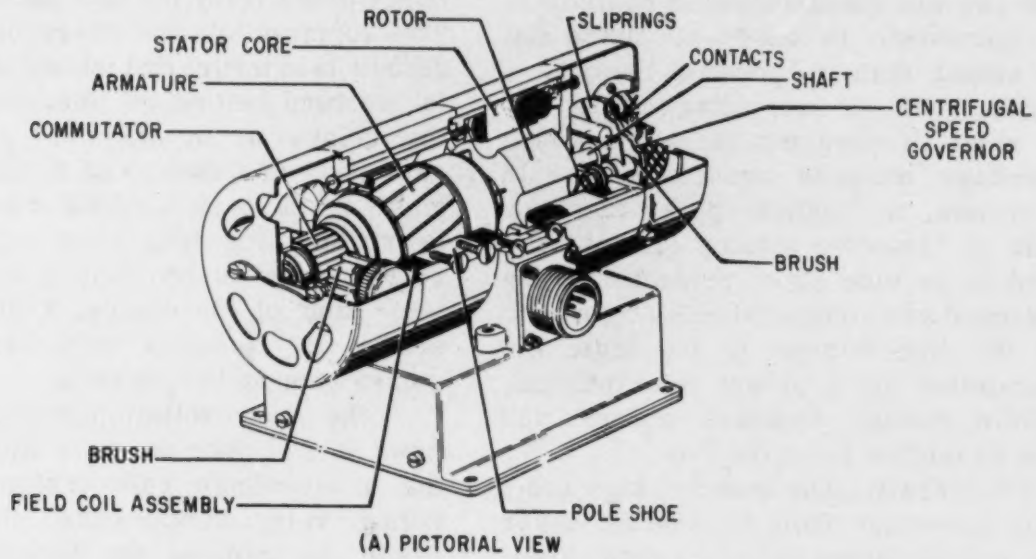

(A) PICTORIAL VIEW

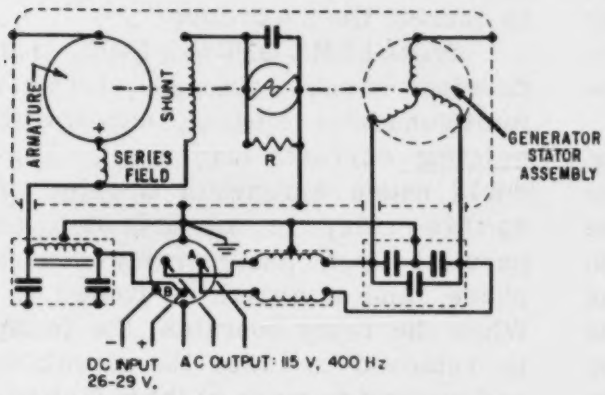

(B) SIMPLIFIED SCHEMATIC

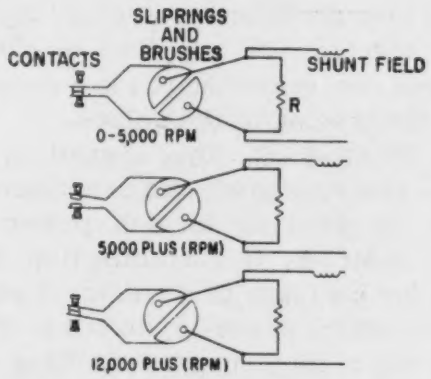

(C) CENTRIFUGAL SWITCH OPERATION

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Figure 6-3.–E1616-2 inverter. (A) Cutaway view; (B) simplified schematic; (C) governor contact operation.

to increase) the level of a d-c voltage. It is essentially a d-c motor and a d-c generator mounted or wound on a common form and shaft, and contained within a single housing. A single stationary field is used to provide the magnetic field for both the motor section and the generator section. The armature consists of two sets of rotor windings wound on a common core mounted on the rotating shaft; the two sets of rotor windings are connected to separate commutators. The motor section serves to produce the driving force; the generator section produces a d-c output whenever the shaft rotates.

Although dynamotors were quite prevalent in older aircraft and electronic systems, they are no longer in common usage.

FREQUENCY CHANGERS.–When a-c voltages of a frequency different from that produced by the main generator are required, suitable motor-generator combinations are used. Main electric power frequency is usually 400 Hz; many aircraft provide a 60-Hz source for test equipment and an 800-Hz source for certain instruments or components.

System Protection

The aircraft electric system incorporates circuits designed to protect the system from damage which could result from malfunction or nonoperation of components in the generation system. Protection requirements and system

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components vary in different model aircraft, so the circuits are not standardized in configuration. This discussion is based on functional application rather than on operating theory.

OVERVOLTAGE.–In overvoltage protective circuits, a relay deenergizes the system when the line voltage exceeds preset limits. In elaborate system, a "highest phase takeover circuit" and a "reactive biasing circuit" are incorporated to provide added protection. Line voltage is sensed and compared with a reference voltage. If the line voltage is too high, and remains excessive for a preset time interval, the protective circuit assumes control and removes the generator from the line.

UNDERVOLTAGE.–The undervoltage relay removes the generator from the line whenever the system voltage drops below a preset limit; sensed voltage is compared with the same reference as that used in the overvoltage protective circuit. Thus the system is protected whenever the voltage supplied to the line is either above or below the narrow range established by the biasing of the relays.

PMG TRANSFER.–This circuit is used in generation systems in which a permanent magnet generator is used to furnish power for the generator controls. If a malfunction occurs in the PMG (or its leads to the control panel), the source of control power is shifted to one of the phases of the main generator. Shifting of power sources is accomplished without interruption by operation of the permanent magnet generator control transfer relay. Once the system has become deenergized, however, the main generator cannot be built up again using the failed PMG.

DIFFERENCE CURRENT.–This circuit is used in paralleled multigenerator systems where the load is evenly distributed between the generators. As soon as the circuit detects an imbalance in excess of allowable limits, a thermal time delay is initiated. If the unbalanced condition persists, the thermal delay relay opens and locks the bus tie contactor out of the system. The individual generators then operate as isolated systems, each supplying its own loads.

SELECTIVE EXCITATION.–This circuit operates in conjunction with the overvoltage and undervoltage relay circuits in paralleled multigenerator systems. If one generator becomes overexcited for any reason, it normally produces an overvoltage and should trip the overvoltage relay for that particular generator. The function of the overexcitation protection circuit is to insure that the overexcited generator is disabled before the malfunction can trip out the relays in an unfaulted generator. Overexcitation is sensed and a signal is developed and routed to each of the overvoltage relays, decreasing the trip point on the overvoltage relay of the faulty circuit and increasing the trip point of the others. Thus the faulty generator is removed from service, while the others remain in operation.

The underexcitation protection circuit functions in a similar manner, except that it biases the undervoltage relay rather than the overvoltage relay. In both cases, the biasing changes result in tripping the faulty generator. The circuit allows tripping of the other generators only if the removal of the faulty generator fails to correct the overvoltage.

PARALLEL OPEN PHASE.–If an open phase develops in one of the generators of a paralleled multigenerator system, excessively high circulating currents may result. These currents could cause erroneous tripping of the overvoltage relay in an unfaulted generator. A parallel open phase relay senses any open phase, and a signal is routed to the relay. When the relay operates, the faulty generator is removed to lower the circulating currents and prevent tripping of the unfaulted generators.

ANTICYCLING.–Systems which are protected by disabling relays are inherently subject to cycling operation. That is, when the operation of a relay removes a faulty component from the line it also removes the cause of its own initial operation; therefore the relay returns to its normal condition and the faulty component is returned to the circuit. If the faulty condition still exists, it trips the relay again, and starts another cycle. Anticycling protection consists of a lockout relay that operates to lock in an open position through a set of its own contacts. Thus the faulty circuit cannot cycle itself–the system remains inoperative until the tripped generator control switch is turned to the OFF position and then returned to the ON position.

External Power

Essentially all aircraft have provisions for application of electric power from an external

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source for starting the aircraft engines and/or for ground servicing and maintenance without operating the engines. This power, while not generated within the aircraft, is part of the overall electric system of the aircraft. It must be in all aspects compatible with the power generated within the aircraft. Under no circumstances may the internal and external power be utilized at the same time. This is one of the functions of the distribution system, which is discussed briefly below. (The equipments used to supply power in the external mode of the electric system are discussed briefly in a later portion of this chapter.)

Distribution System

Once the electric power has been generated and some of it transformed, it must be distributed to the various components and equipment where it is to be used. In a simple system, with comparatively few equipments and requiring only a single form of electric power, a simple distribution system could be used. In modern naval aircraft, however, with the complex electrical and electronic installations requiring many forms of power, an extremely complex distribution system is required.

Each model aircraft has different electrical requirements; therefore, each distribution system must differ from all others in accordance with individual requirements. The following discussion is presented to illustrate general principles and considerations, rather than to describe any particular system.

The major area of difference between distribution systems of different model aircraft lies in the switching arrangement used to change electric loads from one source to another in the event of a malfunction.

Long range patrol aircraft normally carry a flight engineer as part of its operating flight crew. The flight engineer is responsible for monitoring the operational status of many different systems within the aircraft. In some aircraft he is responsible for distributing individual electric loads among the various sources so as to provide for essentially balanced loads. He is usually responsible for recycling failed systems when it is assumed that the fault has been corrected. Interceptor and other carrier-based aircraft usually do not have a separate flight engineer. The distribution system for these two systems must be quite different in details, even though they may both incorporate all the same basic requirements and capabilities for load distribution.

P-3 ELECTRIC SYSTEM

This aircraft represents an outstanding example of versatility and flexibility in electric systems. It also illustrates several concepts which will probably find general application in future versions of long range aircraft.

The P-3 "Orion" is a land-based, four-engine, long range patrol type aircraft used primarily for ASW operations. Its electric system includes three main generators, which are driven by engines No. 2, 3, and 4. The No. 1 engine is not used in the generation of electric power. Engines No. 2 and 3 operate at a constant speed regardless of power settings, therefore a separate CSD unit is not required—the frequency regulation requirement is supplied by the engine itself. Under normal conditions of operation the entire electric load is supplied by generators driven by engines Nos. 2 and 3. Engine No. 4 is identical to the others. The generator driven by engine No. 4, however, is driven through a 2-speed gearbox. This feature permits the generator to supply power while the aircraft is on the ground and operating with decreased engine power. During normal operation the No. 4 generator is not feeding the loads, but is in a standby condition ready to assume the load of either generator if necessary.

The main generators are statically excited, statically regulated, and controlled from power produced by a PMG mounted on the generator shaft. Power produced by each generator is 117/202-volt, 3-phase, 400 Hz a.c.; the generators are not paralleled. Each has a capacity well in excess of its normal operating loads. Except under conditions of severe icing, only a slight reduction in total load is required for continued operation with a single generator supplying the entire load. To supply deicing power, however, a more drastic reduction in operating loads is needed.

Each generator is provided with undervoltage, overvoltage, differential current, and frequency protection. In addition, a failure warning light is connected to a "run strip" in

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the generator rotor which indicates any rotor-to-stator short. For generator No. 4, a "disengage" light is connected to high temperature and low pressure sensors in the two-speed gearbox oil system.

Failure of one generator causes no interruption of power because the standby generator automatically and immediately assumes the load normally supplied by the failed generator. "Generator Off" lights are installed for each generator to advise the flight crew when the unit is not available for operation.

Reverse phase protection of the external power connection prevents the power relay from closing if the phase rotation is incorrect.

Power produced by the generators is supplied to a main load center which houses the exciters, regulators, and control and protection devices for each generator. (See fig. 6-4 (A).) The same load center also contains the power transfer relays, the main power distribution buses, two transformer-rectifiers, and miscellaneous circuit breakers, switches, relays, and minor items of equipment. (A third transformer-rectifier is located in the forward load center.)

The power transfer relays are so connected that any of the generators can supply power to either or both buses. Additional relays and wiring (called the "runaround" circuit) permit bypassing the normal transfer relays and distribution feeders, thus supplying power from anyone of the three generators to the essential a-c bus. The three transformer-rectifiers are so connected that the necessary d-c control power is available for all possible connections of the a-c buses. The buses and the switches and relays controlling their connections are indicated in figure 6-4 (B). Reference to this figure should be made at frequent intervals throughout the remainder of this discussion.

Operation of the system during normal flight conditions is entirely automatic. The crew needs only to monitor the circuit breaker and control panels at the load centers for any indication of malfunction.

Control of the system is also automatic during ground operation, except switching to and from external power. A light is provided in the flight station and at the external power receptacle to indicate when external power is being used.

During engine speed changes, the No. 4 engine speed should be reduced first and the No. 4 generator will temporarily be shut off by the frequency sensing relay while the speed is changing and the gearbox shifts; it will then come back on and be available to pick up the aircraft loads when generators No. 2 and 3 drop out due to underfrequency (as a result of reduced engine speed). The speed of engines No. 2 and 3, on the other hand, should be increased before No. 4 and will automatically take over their respective buses when they reach normal operating speed. Power interruption during speed changes is thus limited to the time (30 milliseconds, approximately) required for a normal bus transfer.

Temporary loss of all generator power requires that a source independent of the engine's generators be made available for starting the aircraft engines. Conditions of flight and the size of the essential flight loads are such that the use of a ram air turbine generator for emergency power has been deemed impractical. A 24-volt, 11-ampere-hour, lead-acid storage battery is provided to supply power for ignition and for flashing the field of the generator. (Engine rotation results from windmilling propellers.) Starting load requirements also include a.c., which is supplied by a battery-driven 100-ampere-hour inverter. The inverter and its loads are connected through a "start essential" bus; switching control is through the start selector switch. The bus switches to the battery if no other source of d-c power is available.

To provide for prolonged loss of generator power, a bypass and load monitoring system has been provided. This system provides for three levels of emergency, as follows:

1. BUS A and BUS B switches, when actuated to the OFF position remove all loads except those classed as essential.
2. Actuating the essential bus switch to the OFF position, in addition to the above, removes all but the minimum necessary flight loads.
3. Lifting the guards and turning all three generator switches to the OFF position removes ALL loads on the aircraft except a turn-and-slip indicator, two cockpit utility lights, emergency warning indicator, and the d-c control supplied by the battery.

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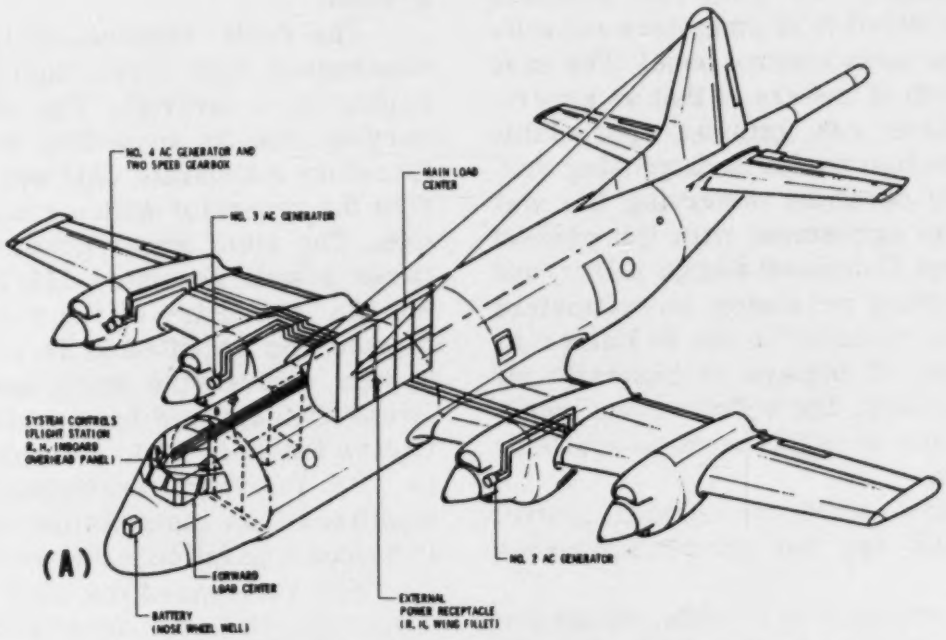

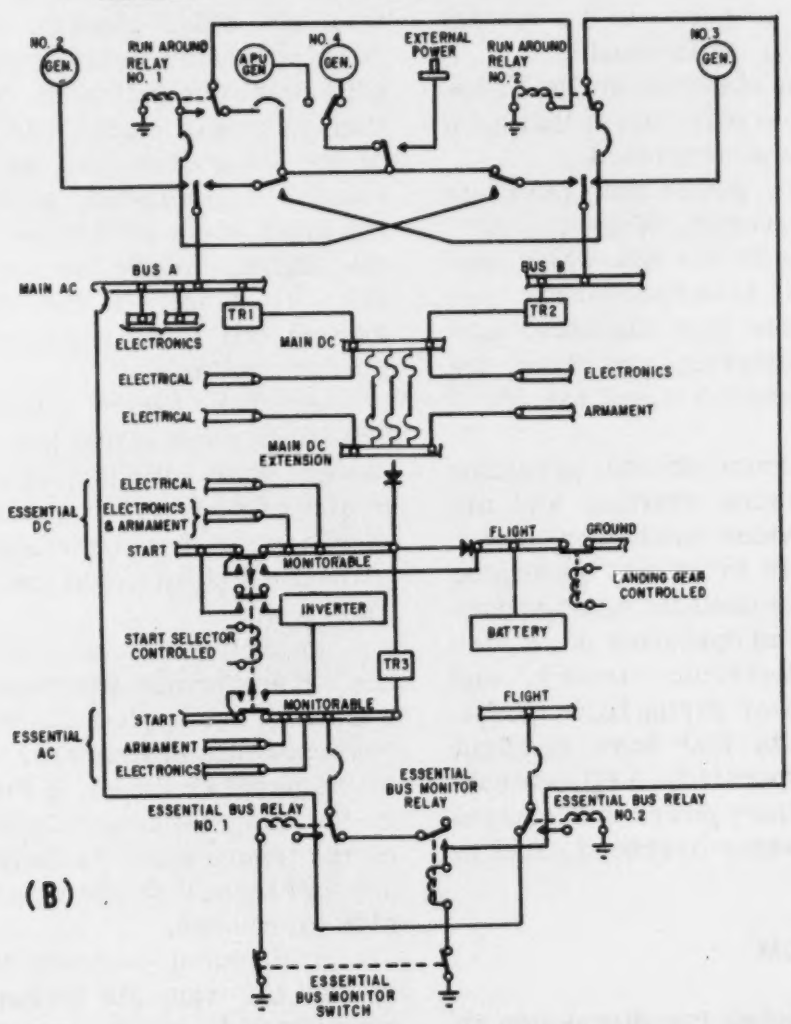

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Figure 6-4.–Electric power distribution in P-3, simplified.

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One additional feature of many new models of aircraft, including the P-3, that deserves discussion is the deletion of ammeters and voltmeters from the main control panel. The case for the installation of meters is that an experienced crewmember can gain an appreciable amount of information useful in diagnosing system problems by carefully observing the meters. However, in agreement with the present Naval Air Systems Command design policy, and based on the following reasoning, no voltmeters or ammeters are installed in the P-3 aircraft.

1. The value of meters is basically for maintenance purposes. The voltage is automatically regulated and no adjustment is available to the flight crew.

2. The meters used in conventional control panel installations are not good maintenance instruments.

3. It is not practical to provide voltage and current indications for all points in the system that need to be checked in maintenance.

4. The information obtained by the flight crew from meters may do more harm than good in that it is frequently misinterpreted.

NOTE: An auxiliary power unit (APU) is installed in some P3 aircraft. When the APU is installed, the battery in the nosewheel well is changed from a 24v, 11-ampere-hour type to a 24v, 34-ampere-hour type. On newer aircraft incorporating a starting capability, the 2-speed gearbox is removed from the No. 4 engine.

The APU is gas turbine-driven, providing compressed air for engine starting and air conditioning; it also provides mechanical power to drive a 60-kva Bendix brushless generator whose electrical output is used for ignition during engine starting, ground operation of all aircraft electrical and electronic circuits, and emergency electrical power during flight (possible only on those units that have in-flight starting capability incorporated). APU controls are mounted on the auxiliary power unit control panel which is on the center overhead panel in the flight station.

F-4B ELECTRIC SYSTEM

The F-4B was selected for discussion in this chapter because it offers an example of the continuous process of improving the reliability and simplifying operation of the overall electric system.

The F-4B "Phantom II" is a carrier-based, two-engine, high speed, high altitude, jet interceptor type aircraft. The engines operate at varying speeds according to power settings; therefore a separate CSD unit is needed to provide the generator with a constant speed of rotation. The main power generation system produces a well regulated 115/200-volt, 3-phase, 400-Hz a.c. Part of the a-c power is transformed and rectified to 28-volt d-c power. The system utilizes the static excitation and regulation systems, and incorporates numerous protective features. Main a-c buses are operated in parallel for improved frequency regulation and equalized load distribution, with provision for individual operation in the event of bus tie failure.

New versions of the basic aircraft have incorporated an automatic CSD disconnect system. In older models, the engine was shut down whenever overheating of the generator or CSD unit was indicated. This required operation on single engine and attempted air-starts of the secured engine, with many aborted missions and emergency alerts. With the new unit installed it is no longer necessary to secure the engine, unless the cause of overheating is low oil supply in the engine-CSD-generator system (all three units use a common oil supply for cooling).

Another recent modification, the use of brushless generators, has resulted in increased power output ratings coupled with improvements in the control and regulating components. The modification has decreased total weight, improved reliability, and lowered maintenance requirements.

In early versions of the aircraft, damage to the transformer-rectifiers was frequently caused by the application of external power with reversed phase, improper voltage or frequency, or some other defect. A fuse has been installed in the external power circuit to protect the external transformer-rectifier from damage when any parameter of the external power falls outside tolerances.

A problem common to many aircraft involves the ram air turbine (RAT) emergency generator. In early versions of the Phantom II, the emergency generator supplied hydraulic power in addition to the electric power, for use

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when both engines were inoperative. This combined requirement limited the RAT to fairly high flying speeds and resulted in the loss of emergency power prior to touchdown in the dead-engine emergency landing. Recent modifications have allowed removal of the hydraulic provisions from the RAT. Improvements to the turbine and its associated generator have permitted the production of adequate emergency electric power at a much lower speed. The newer aircraft can maintain emergency electric power with a speed below that of normal touchdown. Since power decreases rapidly after touchdown, a cutout switch has been installed in the landing gear system. This switch removes the emergency generator from the line upon touchdown and protects the essential bus equipments and components from the effects of low voltage and frequency.

Improvement of the emergency generator system is expected to bring about changes in the essential bus system. The extent and exact nature of these changes is not known at the time of this writing. It is also expected that the parallel operation feature of the main a-c system will be eliminated in an effort to simplify the overall operation of the system.

CIRCUIT PROTECTION AND CONTROL DEVICES

The electric system of an aircraft is protected from damage and failure by fuses, current limiters, and circuit breakers. Control and distribution of power is accomplished by the use of switches and relays. Each of these components is available in many styles and sizes, some of which are ideally suited for use in aircraft while others are limited to use in shop installation. The following section presents a brief discussion of these components.

FUSES

Fuses provide a controlled, intentionally weakened link in an electric circuit. It serves as a safety device in the event of undesired overloads. Fuse sizes are available with ratings of from two milliamperes to several hundred amperes; fuses of most ratings are available for normal, slow-action or fast-action operation.

A fuse is a heat-sensitive, heat-operated device. When operated at rated current it consumes electrical power and dissipates this power in the form of heat. Under normal operating conditions, the dissipated heat is not sufficient to cause the unit to fail; however, when the fuse is operated above the normal current rating, the overload current generates additional heat which melts the fusible element.

Voltage Rating

A fuse can be operated at any circuit voltage, if it is mounted in a sufficiently well insulated holder (as long as the fusible element is able to fail without suffering arc damage). When a fuse fails due to excessive current, the full circuit voltage appears across the open fuse; if inductance is present in the circuit, a surge is generated which may cause a destructive arc to be formed within the fuse. Under these conditions, intense heat and pressure develop and the fuse may literally explode.

Fail-Time Characteristics

The fail-time characteristic of a fuse depends on the percent of rated current and the thermal inertia of the fuse. Overload currents (currents larger than the maximum value for which the fuse is rated) when flowing through a fuse, heat the element beyond normal capacity; after a period of time, the fusible element fails.

Fuse elements with a large thermal inertia increase the length of time before failure. Fuses containing such elements are known as slow-acting, slow-blow, or time-delay fuses. Slow-action fuses are constructed with a compound element; a thermal cutout and a fusible link that melts on short circuits or very high overloads. Small, light fuse elements reduce the thermal inertia and therefore are faster acting. This type of fuse is known as a fast-action fuse and is used principally for the protection of sensitive instruments.

In the selection of a fail-time characteristic, both the steady state and the transient or surge currents are considered. If currents of 200 to 400 percent of normal can be tolerated for periods of 10 seconds, a slow-acting fuse is specified. If the circuit requires immediate

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protection for any current above normal, a fast-acting fuse is specified. If the current must be limited to 200 percent of the rating for periods less than one second, then a normal, or medium, fail-time characteristic is specified. (See fig. 6-5.)

When possible, a fuse should be operated at about 75 percent of its rated value; this provides a good balance between protection and reliability.

Vibration Resistance

Fuse protection for equipment subject to vibration can be provided by special vibration-resistant construction. This type of fuse has a spring formation, with winglike extensions which bear on the inside wall of the glass body, to decrease vibration of the fuse element. For slow-action fuses, a different construction, consisting of a compound spring and link structure, is used. On moderate overloads, as the compound element reaches the melting point, the spring pulls away from the link; on short circuits, the link fails.

Identification Coding

Fuses and their corresponding fuse holders are numbered according to a standardized system for easy identification. The numbering system is illustrated and explained in figure 6-6; some actual fuses are shown in figure 6-7.

Fuse Holders

The most common class of fuse holders used in Navy equipment is the post type holder shown in figure 6-7. It may be a screw-in or a bayonet type, both of which are securely mounted to the chassis or front panel of the equipment. The purpose of the holder is the same, regardless of type– to hold the fuse securely with good electrical connection and physical stability for protection from mechanical vibration and electrical short circuit.

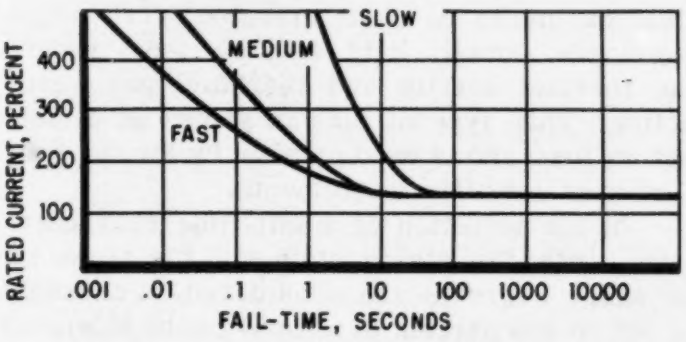

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Figure 6-5.–Fail-time characteristics of fuses.

Care should be used to insure that the fuse is of a physical size compatible with the holder. Fuses which are too small allow physical movement and arcing, resulting in a blown fuse or a damaged holder; fuses which are too large may cause cracking or breaking of the holder. Force should never be applied to either the fuse or the holder, since both these are quite delicate.

Post type fuse holders are normally series-connected in the line, with the end connection to the power source and the center connection to the load. When connected in this fashion, the equipment is protected in the event of a broken holder–a short circuit from fuse holder to chassis ground will result in a blown fuse and excessive current will not flow. Reversed connections will not furnish this protection. Connection is normally made by solder connection, although some fuse holders are connected by use of the screw and lug method.

Current Limiters

Devices somewhat similar to fuses, called current limiters, are used in aircraft circuits that carry high currents. (See fig. 6-7.) The current limiter consists of a copper link of carefully predetermined sections. The sections melt when abnormally high currents start to flow. The melting sections have a high arc resistance to keep the circuit current within the capacity of the limiter. If the excessive current is only a temporary surge, the melting ceases and the circuit continues to operate as if no abnormal current had been present. Repeated applications of excessive current, or uninterrupted application for a period of several seconds, melt through the sections and cause the limiter to "blow" in the same manner as a fuse.

CIRCUIT BREAKERS

In modern naval aircraft, circuit breakers have replaced fuses as the main circuit protec-

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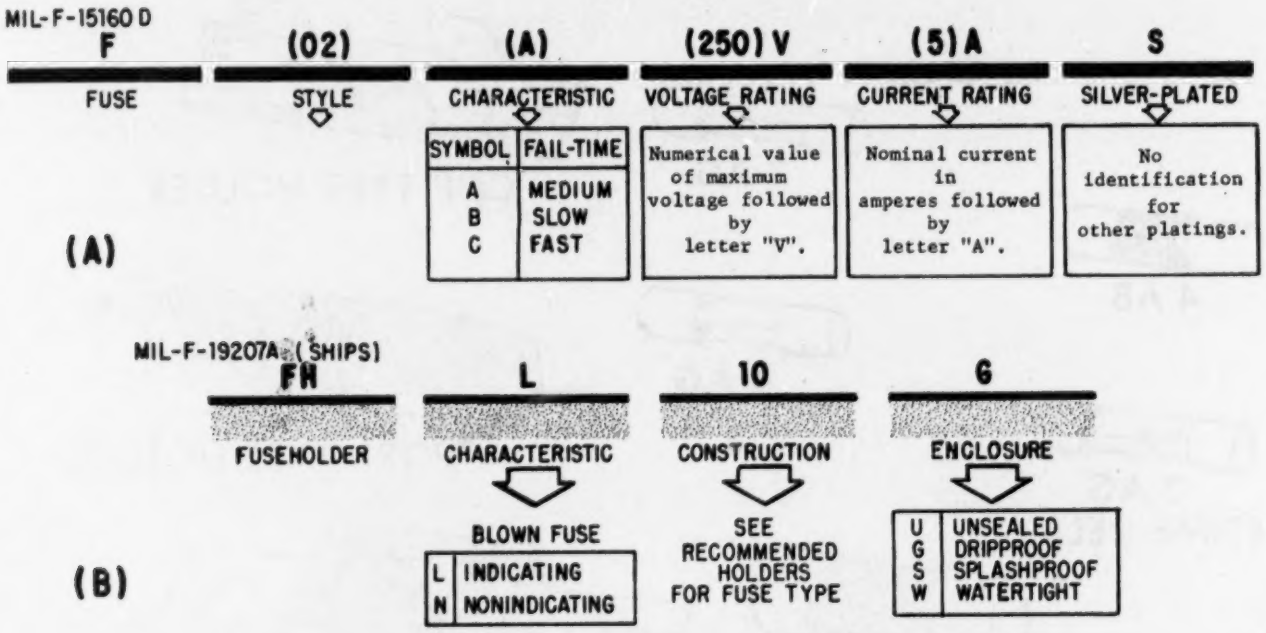

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Figure 6-6.—Identification coding. (A) Fuses; (B) fuse holders.

tion device for most of the wires and cables making up the electrical system. The circuit breaker is designed to open the circuit under short-circuited or overloaded conditions without injury to itself. Thus, it performs the same function as the fuse, but has the advantage that it is capable of being reset and used again. Circuit breakers are rated in amperes and volts.

There are three basic types of circuit breakers (thermal, magnetic, and thermomagnetic), but the following discussion is directed mainly toward the thermal type because it is more generally used. Circuit breakers are divided into three categories—the pushbutton reset type, the toggle type, and the automatic reset type (sometimes called a circuit protector).

The pushbutton reset type consists of a bimetallic, thermally actuated, spring loaded device which closes two electrical contacts when set. This is shown in figure 6-8. An excessive current through the device causes an uneven expansion of the bimetallic mechanism (thermal release) which releases a trigger escapement and permits the spring loading to separate the contact members.

A visual indication of the automatic opening is provided by causing the pushbutton to move to an easily noticed "tripped" position. In this position the button is fully extended and the white ring plus the inner red section of the button is showing. The latest type of pushbutton breakers have a pullout feature which permits manual opening of the circuit, but this type should not ordinarily be used as a switch.

Another type of circuit breaker uses a toggle lever instead of the pushbutton. It operates in the same manner as the previously discussed breaker, with the exception that the tripped condition is indicated by the toggle lever being in the OFF position. This type of circuit breaker has the apparent advantage of also being usable as a switch.

Manual resetting of the circuit breaker may be accomplished by means of the actuator (either pushbutton or toggle lever) whenever the bimetallic thermal element cools sufficiently for the trigger to engage its latching mechanism. In connection with resetting, there are two classifications for circuit breakers; namely, trip-free and non-trip-free.

The non-trip-free circuit breakers can be prevented (by the operator's action) from tripping even though a tripping condition exists. This should be done only in an emergency; since this action is apt to change the calibration, the breaker should be replaced as soon as conditions permit. This type breaker is no longer being installed in new aircraft; however, it is still found on some older models.

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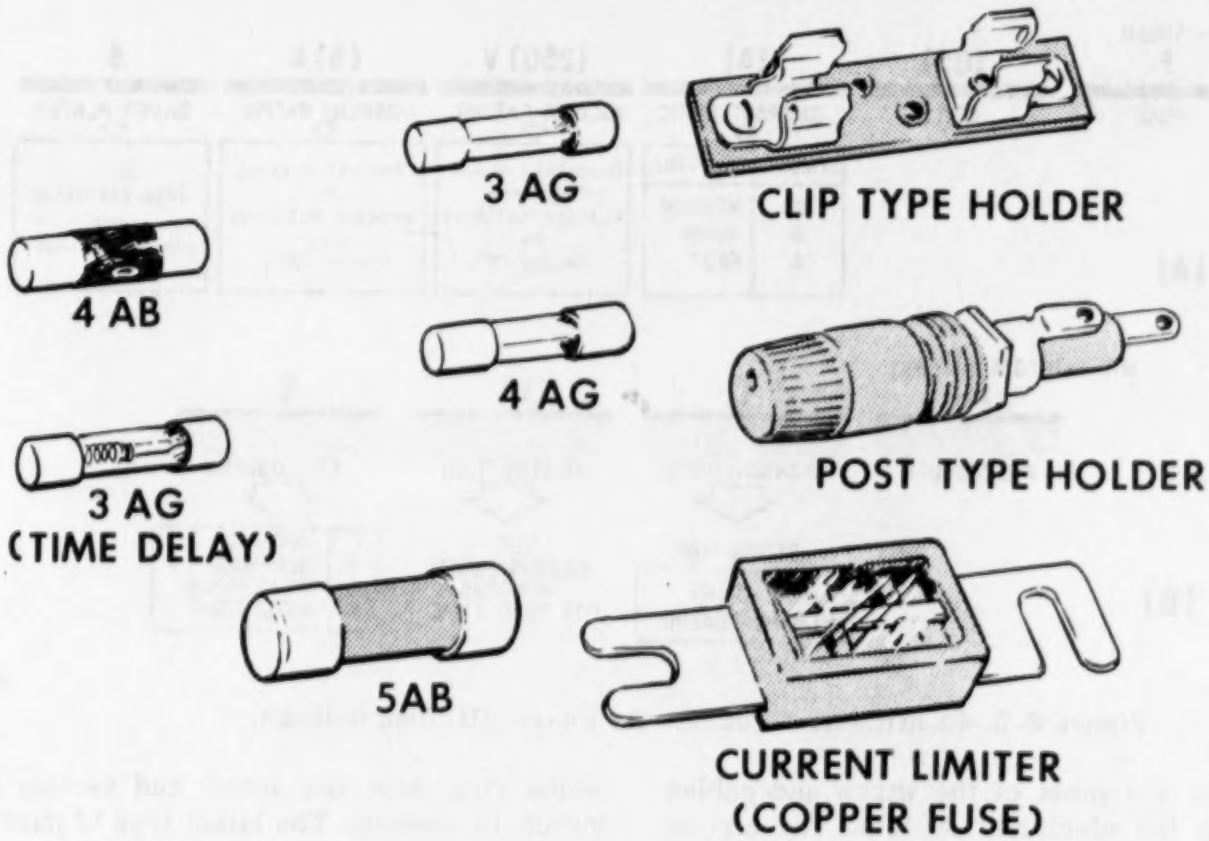

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Figure 6-7.–Aircraft fuses and fuse holders, typical examples.

In the trip-free class, the contacts cannot be kept closed by holding the actuator in the closed (or reset) position as long as an overload condition persists which would otherwise cause normal tripping.

A disk type thermal circuit breaker is shown in figure 6-9. This breaker consists of a conductive bimetallic snap-acting disk which bridges two electrical contacts. When this disk is heated by the excess current through it, it snaps to the reverse position, opening the contacts and breaking the circuit. In circuit breakers having low ratings, a resistance wire is inserted; current through this wire provides the heat necessary to snap the disk. These breakers are reset by pressing a button, restoring the disk to its original position. When circuit breakers of this type are closed, they cannot be reopened manually. They are also nonindicating; that is, the position of the breaker (open or closed) cannot be determined by visual inspection.

The automatic reset type circuit breaker is similar to the bimetallic disk type just described, except that it has no reset pushbutton; it resets itself automatically. After a short time, when the disk has cooled sufficiently, it will bend back and close the circuit, resetting itself. If a constant overload exists, the breaker will intermittently break the circuit.

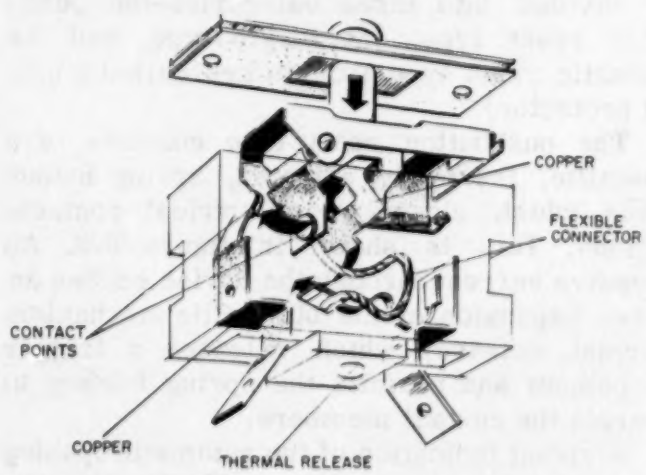

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Figure 6-8.–Thermal circuit breaker.

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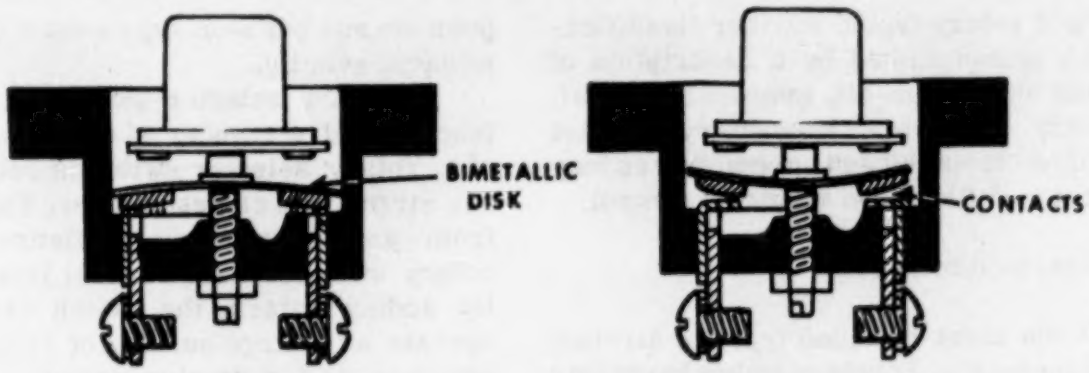

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Figure 6-9.—Thermal circuit breaker (disk type).

Another type of circuit breaker is the switch toggle variety based on magnetic instead of thermal operation. This type can be made to open almost instantly when more than the rated current flows in the circuit. An electromagnet is placed in series with the spring-loaded contacts, and the contacts are mounted so that an armature acts as a latch to hold them closed. When an excess current flows, the armature is pulled toward the electromagnet, releasing the contacts and opening the circuit. To reset the circuit breaker, the contacts are closed manually and the spring-loaded armature returns to its normal position.

SWITCHES

A switch may be described as a device used for making, breaking, or changing connections in an electrical circuit. Switches are rated in amperes and volts; the rating refers to the maximum allowable voltage and current of the circuit in which the switch is to be used. Since it is placed in series, all the circuit current will pass through the switch; because it opens the circuit, the applied voltage will appear across the switch in the open circuit position. Switch contacts should be opened and closed quickly to minimize arcing; therefore, switches normally utilize a snap-action.

Many types and classifications of switches have been developed. A common designation is by the number of poles, throws, and positions. The number of poles indicates the number of terminals at which current can enter the switch. The throw of a switch signifies the number of circuits each blade or contactor can complete through the switch. The number of positions indicates the number of places at which the operating device (toggle, plunger, etc.) will come to rest. Figure 6-10 presents the schematic diagram of some typical switches.

An example of the switch position is a toggle switch which comes to rest at either of two positions, opening the circuit in one position and completing it in another. This is called a two-position switch. A toggle switch which is spring loaded to the OFF position and must be held in the ON position to complete the circuit is called a single-position switch. If the toggle switch will come to rest at any of three positions, it is called a three-position switch.

Another means of classifying switches is the method of actuation; that is, toggle, pushbutton,

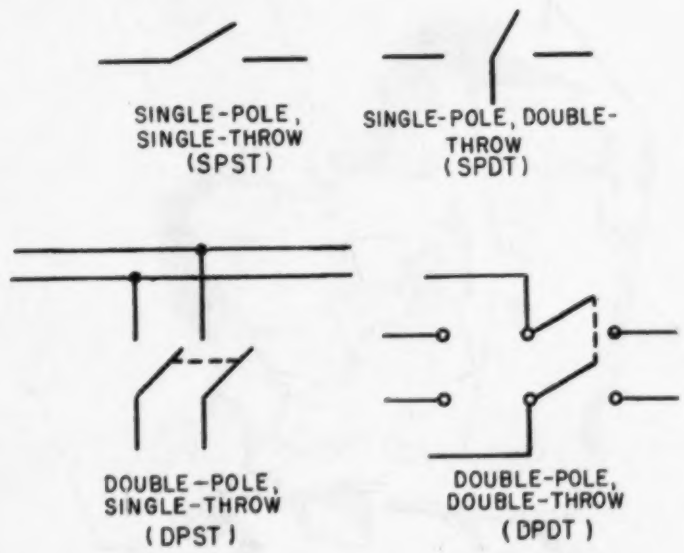

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Figure 6-10.—Schematics of commonly used switches.

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precision, and rotary types. Further classification can be accomplished by a description of switch action such as on-off, momentary on-off, on-momentary off, etc. Momentary contact switches hold a circuit closed or open only as long as the operator deflects the actuating control.

Manually Operated Switches

One of the most common types of aircraft switches is the toggle. Toggle switches have their moving parts enclosed. A double-pole, double-throw, on-off-on toggle switch is shown in figure 6-11. These switches have many uses and are used especially for applying power to various circuits. They are often provided with a luminous tip on the lever so as to be visible in the dark.

Pushbutton switches have one or more stationary contacts and one or more movable contacts. The movable contacts are attached to the pushbutton by an insulator. These switches are usually spring loaded and are of the momentary contact type. They have many uses, such as indicator light checks and circuit reset. The push-on and push-off type switch is seldom used in naval aviation.

A rotary selector switch may perform the functions of a number of switches. As the knob of a rotary selector switch is rotated, it opens one circuit and closes another. This can be seen from an examination of figure 6-12. Some rotary switches have several layers of wafers. By adding wafers, the switch can be made to operate as a large number of switches. Ignition switches and voltmeter selector switches are typical examples of this type.

Mechanically Operated Switches

Mechanically operated switches are used in many types of installations, such as radar limit switches for antenna throw, as interlock switches to disable the power to equipment when removing the case, and as communication transceiver control box switches. Many of these are the precision, snap-acting switches found in all aircraft. They are widely used because of their small size, light weight, and excellent dependability. (The term Micro switch, although frequently used in referring to all switches of this type, is a trade name for the switches made by the Micro Switch Division of the Minneapolis Honeywell Regulator Company.)

These switches will open or close a circuit with a very small movement of the tripping device (1/16 inch or less). They are usually of the pushbutton variety, and they usually depend on one or more springs for their snap action. For example, the heart of the Micro switch is a beryllium copper spring, heat-treated for long life and unfailing action. The simplicity of the one-piece spring contributes to the long life and dependability of this switch. The basic Micro switch is shown in figure 6-13.

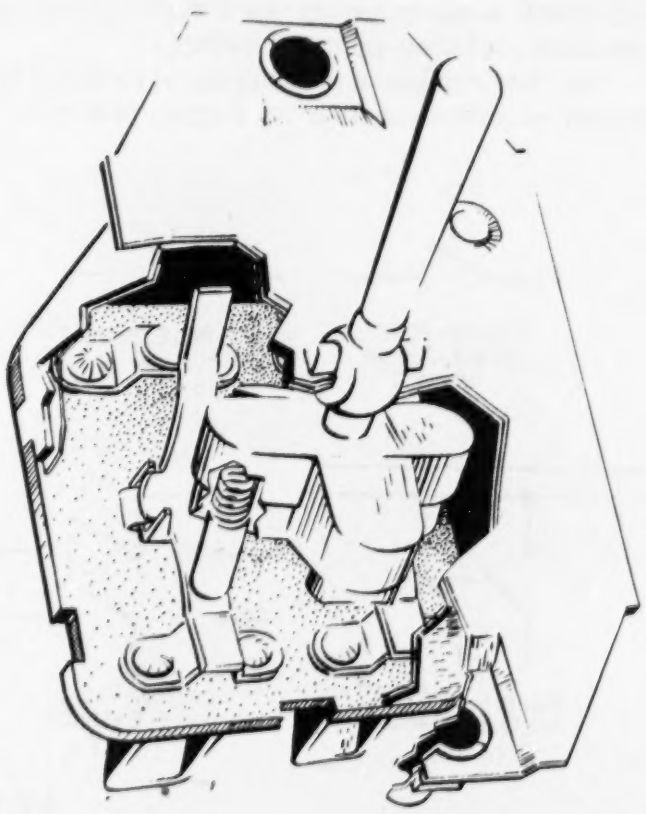

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Figure 6-11.–Toggle switch.

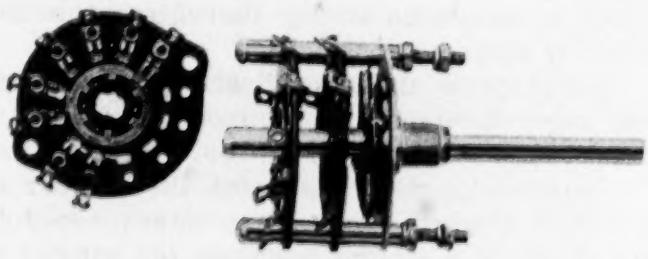

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Figure 6-12.–Rotary selector switch.

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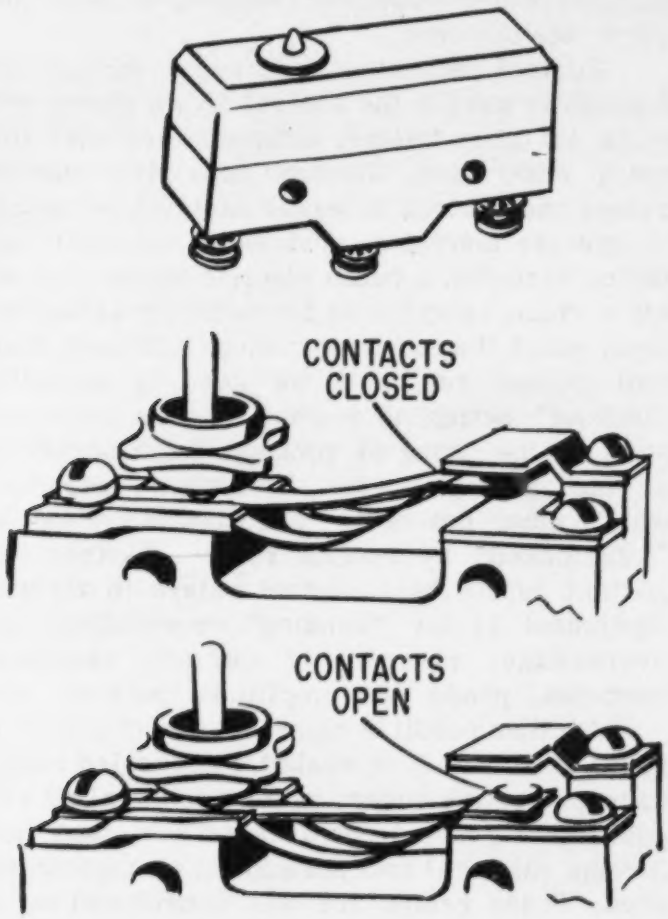

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Figure 6-13.–Micro switch.

The versatility of the snap-action switch is indicated in figure 6-14, which shows how the basic switch may be used with different type enclosures and actuators. The particular type of switching unit used depends upon the function it is to perform and upon environmental conditions. Figure 6-14(A) shows a lightweight aluminum enclosure which may contain one or more plastic-enclosed basic switches. The plastic enclosure provides electrical insulation between the housing and the live electrical parts, support for the terminals, and a dusttight box around the electrical contacts.

Figure 6-14 (B) shows one of the various types of switch actuators used with basic switches when complete enclosures are not needed. They provide a means for protection and mounting of the switch. They relay the operating motion from a cam or slide to the basic switch in a way that assures long life and dependability. Figure 6-14 (C) shows a toggle switch which uses one or more of the basic subminiature switches. These subminiature switches are smaller than the conventional Micro switch and are finding wide use in various switching arrangements.

Pressure-operated switches usually have Bourdon tubes, syphons, or diaphragms against which fluid operates to actuate the switch. Some low-frequency transmitters use pressure switches to reduce transmitter power at high altitude (and thus prevent arcing).

Thermal switches usually incorporate a bimetallic sheet that bends or snaps at a desired temperature to actuate the switch. They are used extensively as circuit breakers and also find application in controlling the igniter circuit on heaters, and in operating signal lights at critical temperatures.

Maintenance

While the switch itself is relatively simple to check, it sometimes offers difficulty in maintenance because of its location in inaccessible places. After a visual inspection of the connections and the switch, a continuity test will indicate any malfunctions. When the switch mechanism is found to be defective, it normally is not repairable and therefore should be replaced.

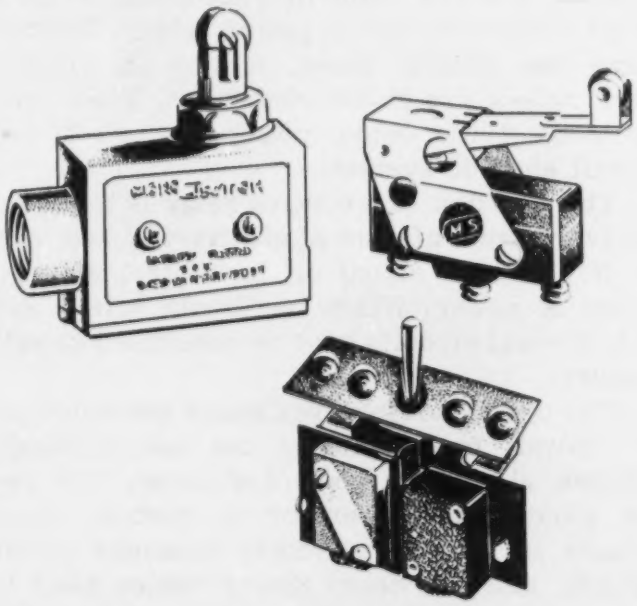

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Figure 6-14.–Snap-action switching units.

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When enclosed switches are used, failure to seal properly around cable openings is the most common cause of trouble. Altitude changes permit "breathing" of moist air into enclosures within the switch enclosure. The condensation can short across the switch terminals, or it can corrode the switch actuators and make them inoperative. This problem can be eliminated by carefully sealing the openings, or by using hermetically sealed switches. (Hermetic sealing will also prevent dust and dirt from reaching the contacts and thereby reduce the possibility of high resistance shorts and open circuits.)

Some switches are damaged during installation, particularly those with plastic housings. Proper care in installing or replacing plastic-enclosed switches will help to eliminate this type of trouble.

Some switch assemblies are equipped with adjustments which enable them to operate at a preset temperature, pressure, position, etc. Caution should be exercised in making these adjustments; if they are not accurate, damage to the switch or to the equipment can result.

RELAYS

Types

Relays are electrically operated control switches, and are classified according to their use as control relays or power relays. Control relays are usually known simply as relays; power relays are called contactors. Power relays control the heavy power circuits of the aircraft electric system.

The function of a control relay is to take a relatively small amount of electrical power and use it either to signal or to control a large amount of power. Where multipole relays are used, several circuits may be controlled simultaneously.

The use of relays saves space and weight in the aircraft by permitting the use of small switches at remote control stations. The relays permit the operator to control large amounts of current at other locations in the aircraft, and the heavy power cables need to be run only to the point of use. Only lightweight control wires are connected to the control switches. Safety is also an important reason for using relays, since high power circuits can be switched remotely without danger to the operator.

Control relays, as their name implies, are frequently used in the control of low power circuits or other relays, although they also find many other uses. Electron tube plate current relays can control the larger currents necessary to operate electrical devices. In automatic relaying circuits, a small electric signal may set off a chain reaction of successively acting relays, which then perform various functions. Control relays can also be used in so-called "lockout" action to prevent certain functions, such as the firing of rockets, from occurring at the improper time. Electrical operations which must not occur simultaneously can be "interlocked" by control relays. Another important function of control relays in aircraft equipment is for "sensing" undervoltage and overvoltage, reversal of current, excessive currents, phase and amplitude, polarity, etc.

Another possible classification of relays is open, semisealed, or sealed. Semisealed relays have protective covers which are installed with gaskets to prevent entrance of salt, dust, and foreign material into the contact or mechanism area. These relays are still considered satisfactory for certain applications in present-day aircraft.

For most applications in today's high altitude, high speed aircraft, however, it is necessary to go beyond the protection offered by semisealed relays. When such relays are used, quick changes in altitude, humidity, and temperature can cause condensation of moisture within the unit. Subsequent low temperatures may then freeze the moisture on the contactor.

Hermetically sealed relays were developed to answer the demands of most modern aircraft equipment. A true hermetic seal is generally considered one that is metal to metal or glass to metal. Plastic or plastic-rubber type gasketed seals are not generally considered true hermetic seals. However, both semisealed and hermetically sealed relays are used. In some applications a gasket sealed relay may be adequate, but the true hermetically sealed type is generally considered to be more desirable. In addition to being independent of altitude changes, the hermetically sealed relay also has the advantage of being protected from improper adjustments.

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Operation

In general, the basic components of a relay are the coil (or solenoid), the iron core, the fixed and movable contacts, and the mounting (and if sealed, the can). A manual switch, limit switch, or other small control device starts and stops the flow of current to the coil. The flow of electric current through the coil creates a strong magnetic field around and within the coil. This magnetic field moves a clapper or plunger which completes the magnetic circuit. Figure 6-15 (A) shows a basic single coil clapper type relay. The dashed lines indicate the magnetic lines of flux. For a more complete analysis of magnetic theory and basic relay operation, see Basic Electricity, NavPers 10086-B.

The second basic type of relay is the rotary (fig. 6-15 (B)). Although this type of construction is not as common as the clapper type, the rotary type has greater vibration and shock resistance than the others. Their main disadvantage is that they are somewhat sluggish and require higher operating power. The rotary relay operates on the principle of an electric motor, but turns through only a small angular arc. The problem of hanging contacts on such a mechanism is a difficult one, and therefore the use of these devices is limited. When used with standard wafer switch assemblies, this type of relay provides a means for assembling a switching device of any degree of complexity.

Some relays operate from an a-c supply. A-c relays depend upon the same fundamental principles as the d-c relay; that is, magnetic fields. When alternating current is applied to an electromagnet, the current passes through zero twice every cycle. Since the pull on the armature is proportional to the current through the electromagnet, the armature tends to open every time the current nears zero, causing the relay to chatter. To prevent this, shading coils (sometimes called shaded poles) are used.

A shading coil consists of a copper band or stamping which is short-circuited and embedded around part of the electromagnet pole face. By being placed around part of the pole face, it acts as a shorted transformer secondary. The current in the main coil lags the applied voltage by approximately 90°; the flux is in phase with the current. The voltage of the shading coil is an induced voltage, and it lags the current in the main coil by 90°. Since the shading coil acts like a shorted secondary (resistive), the current in the shading coil is in phase with the induced voltage. Therefore, the magnetic field of the shading coil lags the magnetic field of the main coil by 90°. Flux continues to exist in the electromagnet even when the main coil current becomes zero; thus chattering is prevented.

Relay contacts are arranged in many different forms. Usually the number and sequence of switching operations to be performed dictates the contact arrangement.

It is often desirable to introduce time delays by use of relays. One method is to use a thermal relay for a time delay. The operation of this type relay is similar to that of the thermal circuit breaker, with the exception that it closes the circuit (rather than opens it), when heated. Due to the simplicity of the mechanism, it can be made very small and can be hermetically sealed, making it ideal for use in aircraft. Because the thermal relay is activated by heat, it can be used on either a.c. or d.c.

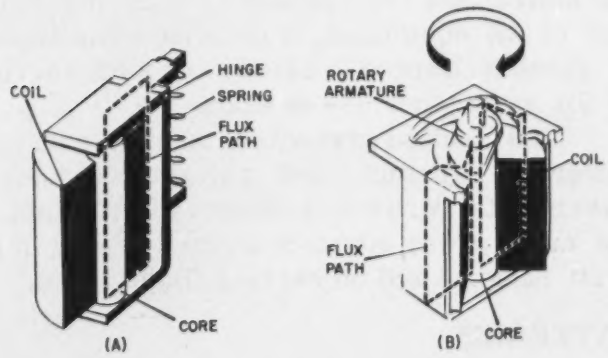

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Figure 6-15.—Basic types of relays.

Maintenance

The relay is one of the most dependable electromechanical devices in use; but like any other mechanical or electrical device in aircraft equipment, relays occasionally wear out or become inoperative for one reason or another. Should an inspection determine that a relay is defective, the relay should be removed immediately and replaced with another of the same type. Care should be exercised in obtaining the same type replacement because relays are rated in voltage, amperage, type of service, number of contacts, continuous or intermittent duty, and similar characteristics.

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Relay coils usually consist of a single solenoid. If a relay fails to operate, the coil should be tested for open circuit, short circuit, or ground. An open coil is a common cause of relay failure.

The formation of film on the contact surfaces of a relay may be considered as another principal cause of relay trouble. Although film will form on the contacts by the action of atmospheric and other gases, grease film is responsible for a lot of contact trouble. Carbon formations, caused by the burning of a grease film or other substance (during arcing), also can be troublesome because carbon forms rings on the contact surfaces. As the carbon rings build up, the relay contacts are held open.

When current flows in one direction through a relay, the contacts may be subjected to an effect called "cone and crater." The crater is formed by the transfer of the metal of one contact to the other contact, the deposit being in the form of a cone.

Some relays are equipped with ball shaped contacts. In many applications this type of contact is considered superior to the flat surface. Dust or other substances are not as readily collected on a ball shaped surface. In addition, a ball shaped contact can penetrate film more easily than a flat contact. When cleaning or servicing ball shaped relay contacts, extreme care must be taken to avoid flattening or otherwise altering the contact's rounded surfaces.

Under normal operating conditions, most relay contacts spark slightly; however, this type of sparking must not be confused with the spitting and arcing which causes burning and pitting of the contacts.

All relays require maintenance and care. Contact clearances or gap settings must be maintained in accordance with the relay's operating specifications. Relay contact surfaces must be kept clean and in good operating condition.

For detecting potential relay trouble during preventive maintenance, the following guides are suggested: Check for charred or burned insulation on the relay and for darkened or charred terminal leads coming from the relay. Both of these indicate overheating. If there is even a slight indication that the relay has overheated, it should be replaced with a new relay of the same type. Overheating is sometimes caused by the power terminal connectors not being tight enough; screw connections should always be checked during preventive maintenance.

NOTE: Life of relays may be increased by removal of a light film buildup with recommended spray contact cleaner and lubricant.

Extreme care should be taken in removing and replacing covers on semisealed relays. The entry of dust or other foreign material may cause contact discontinuity. When the relay is installed in a position where there is a possibility of contact with fuel fumes, extra care should be taken with the cover gasket. Any damage to the gasket, or incorrect seating of the gasket, increases the possibility of igniting vapors.

AUXILIARY POWER SOURCES

The electric power requirements for starting and servicing modern aircraft are very high. Even in those aircraft which have batteries installed, routine servicing and operational testing of the electronics system require that either the aircraft engines be operating or that an external source of electric power be used.

There are many auxiliary power units (APU's) available for supplying electric power to the aircraft for engine starting, ground servicing, and operational testing. External power receptacles are mounted on all aircraft to provide a means of connecting the external sources to the aircraft.

Some aircraft are also furnished with an airborne auxiliary powerplant (APP) installed aboard or attached externally to the aircraft. The auxiliary powerplant usually consists of an independently operated gasoline engine or turbine which drives a generator. The generator supplies power to the electric system on the ground and in the air. Although the airborne auxiliary powerplant is not capable of supplying the entire load requirements for normal operation of all equipment, it does have the capacity to furnish limited loads for ground servicing or for emergency use in flight.

This section presents a brief discussion of batteries, ground- and ship-based auxiliary power units, airborne auxiliary powerplants, and the main power sources normally found in aircraft hangars and on carrier flight decks.

BATTERIES

The function of the aircraft storage battery is to provide an emergency source of electri-

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cal power for operating the electrical systems of an aircraft. The battery also functions in such a manner that it eliminates the commutator ripple produced by the d-c generator. During normal aircraft operation, the generator supplies the primary source of electrical energy, and maintains the battery in a charged state. The battery supplies power to the aircraft only when the speed of the engine or gererator drive system becomes so slow that the generator's output voltage falls below the battery voltage.

The battery is the emergency power source for the aircraft. Therefore, the battery should never be used for starting engines or servicing equipment if another source of power is available. Such unnecessary usage tends to shorten the life of the battery and keeps the battery in poor condition to meet emergency operation requirements. During the periods when the engines are idling or being started, the electrical loads should be kept at a minimum. The service life of the aircraft battery depends a great deal upon the frequency and quality of care it is given. Batteries that are abused or that receive careless treatment and servicing generally have their service life ended prematurely.

Since it is important to keep their weight at a minimum, aircraft batteries have a small capacity. Consequently, they must be used with great care.

Most aircraft batteries are equipped with a quick-disconnect unit as shown in figure 6-16 This unit is a heavy-duty connector with a handle attached to a threaded post. The battery cables can be disconnected from the battery post simply by turning the handle and pulling the quick-disconnect unit.

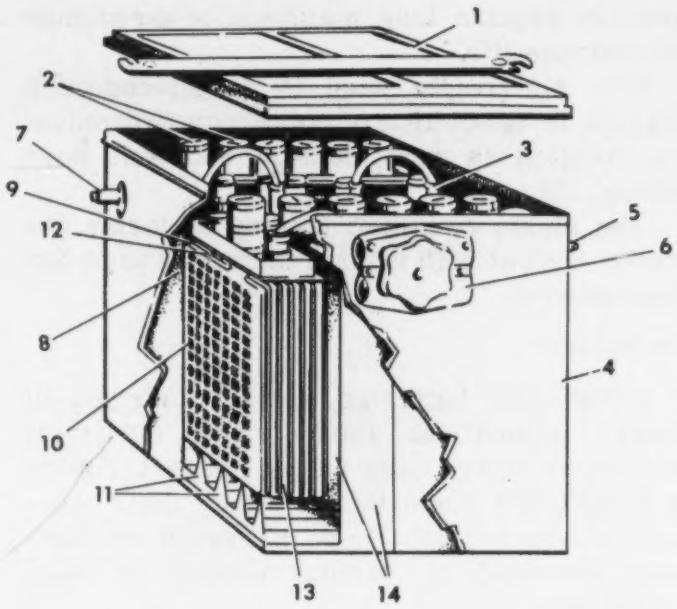

1. Metal cover.
2. Filler cap and vent plugs.
3. Cell connectors.
4. Metal container.
5. Vent.
6. Quick-disconnect receptacle and plug.
7. Vent.
8. Cell container.
9. Positive plate group strap.
10. Plate.
11. Plate supports.
12. Negative plate group strap.
13. Separators.
14. Cells.

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Figure 6-16.–Typical aircraft lead-acid storage battery.

Aircraft batteries require a great deal more care than automobile batteries because of the unusual conditions under which they operate. The aircraft battery is usually shielded by enclosing it in a grounded, metal housing. (See fig. 6-16.) This completely shields the battery and the terminal connections. This shielding eliminates, to a large degree, radio-frequency interference from being induced into the communication system from the battery and its associated components.

Lead-Acid

The most common aircraft battery in use today is the lead-acid type. However, two recent types, which are known as the nickel-cadmium and the silver-zinc batteries, are being used in some aircraft.

Fundamentally, there is no difference in the operation of the lead-acid aircraft battery and the lead-acid automobile battery. Both types of batteries have their plates immersed in a solution of sulfuric acid and water and operate on the same basic principles. Batteries are covered in more detail in chapter 3 of Basic Electricity, NavPers 10086-B.

Nickel-Cadmium

Some nickel-cadmium batteries used in naval aircraft are physically and electrically interchangeable with the lead-acid type, while some are sealed units which use standard plug and receptacle connections which are used on

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other electrical components. These batteries generally require less maintenance throughout their service life.

The electrolyte used in nickel-cadmium batteries is a solution of potassium hydroxide. This solution is very caustic and will burn clothing, skin, etc.

The nickel-cadmium battery performs especially well at high discharge rates and at low temperatures.

Silver-Zinc

Silver-zinc batteries are used largely in military applications and in some industrial applications where their unique characteristics are sufficiently important to justify their comparatively high cost. These batteries are currently installed in various models of Navy helicopters.

The silver-zinc battery was developed for one major and one secondary purpose. The major purpose was to secure a large quantity of electrical power for both ground and emergency flight operations. The secondary purpose was to permit a design weight savings in new aircraft. A lightweight, silver-zinc battery provides as much electrical capacity as a much larger lead-acid or nickel-cadmium battery.

The battery's high electrical capacity per unit of space and weight is a result of the close plate spacing, the large degree to which the active plate materials are utilized, and the absence of heavy supporting grids in the plate. Silver-zinc batteries are capable of producing as much as six times more energy per unit of weight and volume than other types. Silver-zinc cells have been built with capacities ranging from tenths of ampere-hours to thousands of ampere-hours.

Silver-zinc batteries have a maximum service cycle life which is less than that of other types, but their life expectancy compares favorably with that of other types of batteries that are designed for maximum capacity per unit of space and weight such as nickel-cadmium.

AUXILIARY POWER UNITS

In this discussion the term auxiliary power unit is limited to those units which are portable, but are not installed aboard the aircraft. The units may be self-propelled, towable, or merely transportable; they may use diesel fuel, jet fuel, or gasoline. The generators may be driven by the unit's engine or it may have its own prime mover. Several types are discussed; however, before beginning a discussion of specific types of individual models, several generalizations should be mentioned.

When moving the APU into the vicinity of the aircraft, care should be taken to avoid collision with aircraft or other equipment. Flight lines and aircraft parking areas are normally crowded, and space between aircraft and equipment may not be sufficient to allow passage of the APU. Equipment and/or aircraft may have to be moved and repositioned to permit access to the aircraft to be serviced. When movement of the aircraft is necessary, the line crew should be notified, and requirements should be outlined. Local procedures and policies must be followed, and line safety regulations observed. Under NO conditions should the APU be used to move the aircraft, not even "a couple of feet."

Once access to the aircraft has been gained, the APU must be connected to the aircraft. Each unit has its own procedures for operation, but some general considerations apply to all. Prior to connecting the APU to the aircraft to be serviced, all aircraft power switches should be checked and placed in the proper position. (This requires familiarization with the aircraft; the information is available in the Flight Manual and in the Maintenance Instructions Manual for each model aircraft.)

Prior to making the actual connection, the cable and the receptacle should be inspected carefully for general condition and for correct polarity/phase. Many flights are aborted because external power cables have been inserted into aircraft with polarity or phase reversed due to careless insertion or defective cables.

The APU should not be connected to the aircraft with a "hot line"; the generator power switches should be off. After connection, the generator may be activated, and the switches turned on when stable operation is obtained.

During high load operation of APU's, the power cables frequently heat excessively and the cable voltage drop is quite noticeable. Nearly all of the mobile electric power plants (MEPP's) have an output current capability well in excess of the current rating of the cables. Therefore, when supplying power to large loads, the current ratings of the cables must be considered. If

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UNIT I - INTRODUCTION

Application of Drafting — Lesson 1

OBJECTIVE: To learn the importance of drafting and why we study it.

RELATED INFORMATION:

Drafting is the graphic language used in the industrial world by engineers and designers to express and record the ideas and information necessary for the building of machines and structures.

By using a logical system of related "views" known as an orthographic projection (see Fig. 1), intricate and complicated shapes may be clearly shown, exact sizes given, individual parts identified for assembly, and parts located in a machine in their correct functional position. (See Fig. 2)

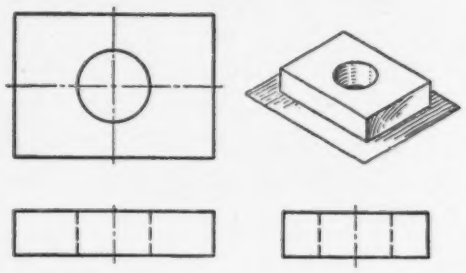

FIG. 1

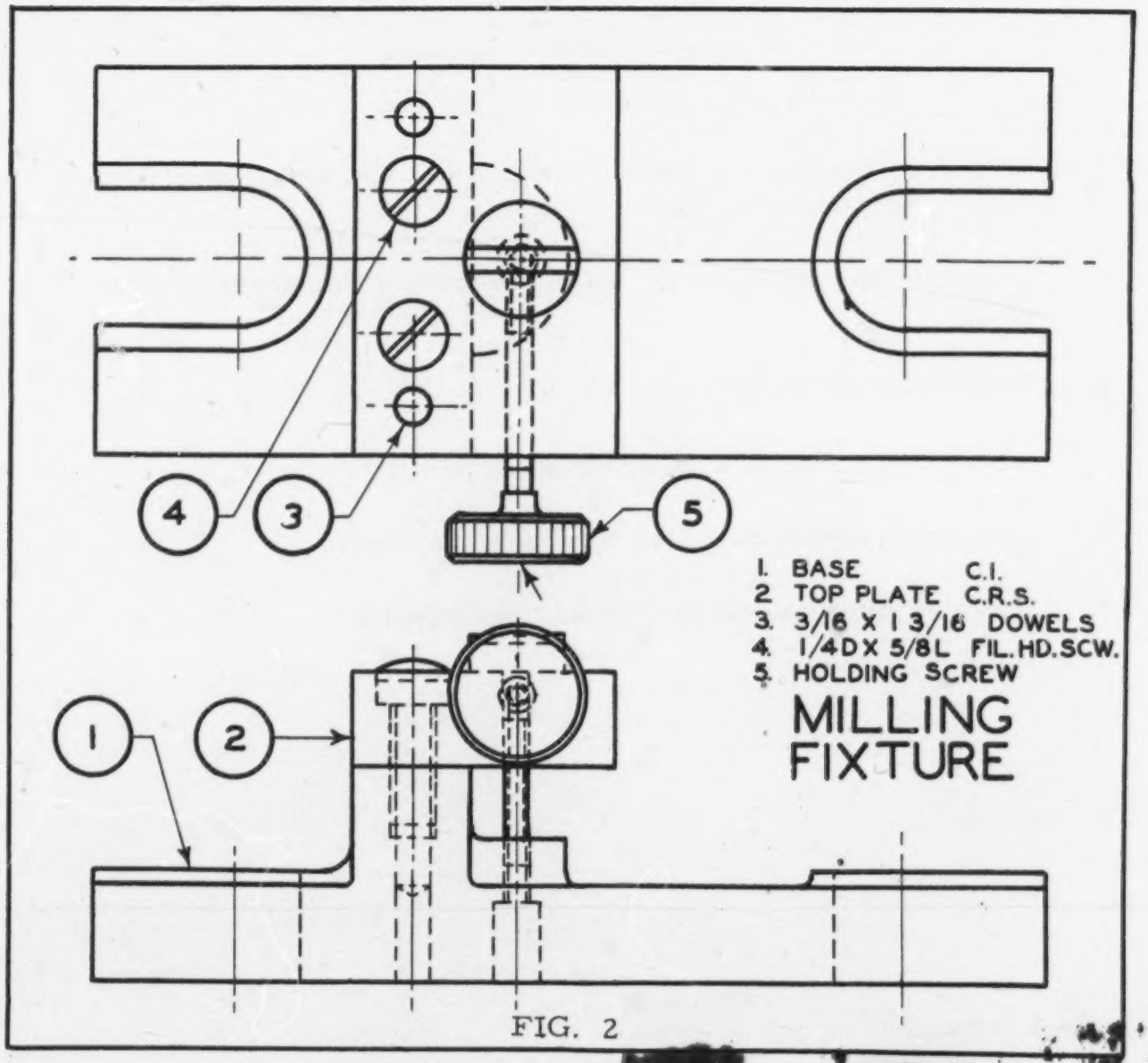

FIG. 2

the load requirements exceed the rating of the cable, the load should be reduced or a higher capacity APU should be obtained.

Mobile Electric Powerplants

NC-10 AND NC-10A.–The NC-10 and NC-10A powerplants are diesel engine-driven mobile powerplants, designed to supply 90 kva at 115/200 volts, 3-phase, 400 Hz for servicing, starting, and maintaining helicopters and jet aircraft. A portion of the generated electric power is rectified to supply 28 volts d.c. at 750 amperes (1,000 amperes intermittent) for aircraft starting.

The powerplant is enclosed in a steel housing, fabricated in two sections which are easily removed for servicing of the unit. Operating components are mounted on a four-wheel trailer, which is equipped with mechanical type internal expanding front wheel brakes. The brakes may be set by a hand lever or automatically set when the tow bar is in the vertical position.

Double hinged doors provide access to the control panel, starting components, and three output power cables.

The plant's electrical system is protected from overload by output circuit contactors, circuit breakers, over- and under-voltage relays, over- and under-frequency relays, thermal overload relays, and fuses.

The NC-10 powerplant was designed for use on carriers and shore stations. The NC-10A (fig. 6-17) was especially designed for Marine Corps shore duty activities. The operating features and technical data are the same for both plants, except that the NC-10A employs a self-propelled feature.

NC-12 AND NC-12A.–The NC-12 and NC-12A are diesel engine-driven powerplants, designed to supply 125 kva at 115/200 volts, 3-phase, 400 Hz for servicing, starting, and maintaining helicopters and jet aircraft. A portion of the generated electric power is rectified to supply 28 volts d.c. at 750 amperes (1,000 amperes intermittent) for aircraft starting. These units utilize dual power output circuits which make them capable of simultaneously delivering electric power for two P-3A aircraft.

The powerplants and components are mounted on a four-wheel trailer, equipped with mechanical front wheel brakes which are actuated by a hand lever or the spring-loaded tow bar. These units do not come equipped with self-propelled features; they must be towed.

The NC-12 AND NC-12A are similar except the NC-12 was designed for shore duty operation, while the NC-12A was designed for either carrier or shore-based use. The electrical characteristics are identical. Figure 6-18 depicts the NC-12A.

The technician will come in contact with many new types of powerplants such as the NC-10 series and NC-12 series, which will eventually replace the older plants such as the NC-5, NC-6, and NC-7 series.

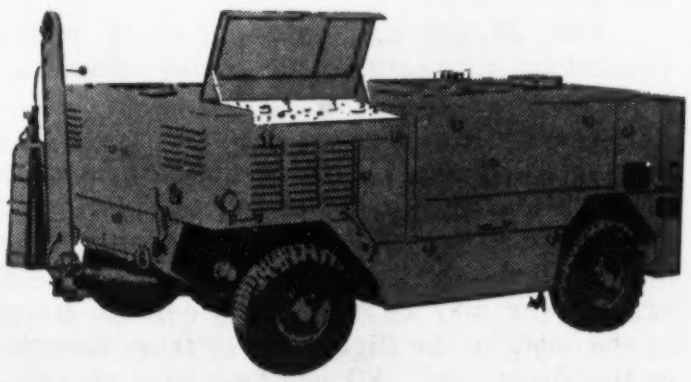

AT.60

Figure 6-17–Mobile Electric Powerplant Type NC-10A.

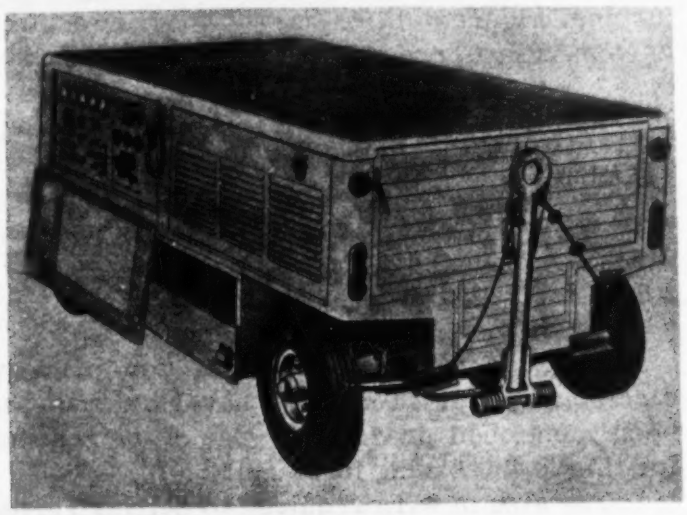

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Figure 6-18.–Mobile Electric Powerplant Type NC-12A.

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(NOTE: Most naval air stations and activities have training courses available to provide instruction in the use and operation of mobile powerplants, only licensed operators should operate this type equipment.

Table 6-1 shows a comparison of the major characteristics of the mobile electric powerplants discussed in the preceding paragraphs, as well as some older types still in common usage.

AIRBORNE AUXILIARY POWERPLANTS

Some of the larger aircraft are equipped with auxiliary powerplants installed at different locations on different aircraft. They are used to furnish electric power when engine-driven generators are not operating or when external power is not available. Aircraft auxiliary powerplants are particularly useful on seaplanes, which are often moored to buoys for long periods of time. Mooring lights must be on and communications equipment used while moored. The APP is utilized to furnish power since excessive battery usage must be avoided.

Another particular application for the powerplants is in large land-based aircraft. Here they are used to provide a constant voltage at a constant frequency. This is advantageous because the output of the APP is not dependent on aircraft engine rpm.

Some of these units use a gasoline engine to drive the generator, while others use a gas turbine. Figure 6-19(A) shows a gasoline engine-driven APP; figure 6-19(B) shows a gas turbine type.

Auxiliary powerplant logbooks must be kept on each powerplant. The operator of the powerplant is responsible for entering the operating time in the log each time the powerplant is used.

RECTIFIER UNITS

The use of a-c generators for primary electrical power in modern naval aircraft has been mentioned previously. One of the reasons for this is the saving in weight.

The size of wire required to deliver a given wattage can be considerably smaller, if the voltage is 115 volts a.c. rather than 27.7 volts d.c. Due to higher voltage and a four-wire (grounded neutral) system, the current carried in each wire is only a fraction of that required for the same power in a 28-volt d-c system. This permits the use of much smaller aircraft wiring with a great saving in weight. The a-c generator itself, especially in the larger sizes, is lighter than a d-c generator of comparable output. Many of the components for system control and protection are also lighter than comparable d-c components.

Even though the d-c generator is eliminated by the utilization of a.c. as a primary source of power, d-c voltages are required for proper functioning of many systems. This d-c voltage is obtained from a transformer-rectifier assembly.

Figure 6-20 is a schematic drawing of a transformer-rectifier unit. The transformer is a 3-phase, 400 Hz, stepdown type. The input is 115 volts a.c. to a delta connection, and the output is 22 volts a.c. across each leg of a wye connection. The rectifiers are of the selenium dry disk type, forming a bridge unit. After rectification (and minus the voltage drop across the rectifier), the output is 28 volts d.c. (Refer to chapter 16 of Basic Electricity, NavPers 10086-B for discussion of 3-phase power components.)

DECKEDGE POWER

The primary function of the deckedge electrical power system installed on aircraft carriers is to provide a readily accessible source of servicing and starting power to aircraft at almost all locations on the carrier's flight and hangar decks.

The 28-volt d.c. is supplied by motor-generators or rectified a.c. from remote a-c generators.

The 400 Hz, 3-phase a-c servicing voltage is usually supplied by these same a-c generators through stepdown transformers. Figure 6-21 shows a diagram of an electrical system which may be found on a modern carrier. The deckedge power may be supplied by service outlets at the edge of the flight deck or from recesses in the flight deck. All systems have standard remote control switches, service outlet boxes, and portable cables. Figure 6-22 shows a typical deckedge installation.

13293

Table 6-1.—Characteristics of mobile electric powerplants.

Type	Methods of propulsion	Generator drive	Operating environment	Power ratings		Starting Power		Service power	
				d. c.	a. c.	Jet	Recip.	Jet	Recip.
NC-5, NC-5A, NC-5B	Self-propelled gasoline engine vehicle	Main vehicle engine	Shore based only	28/35v 200/500a 1000a int	115/200v 400 Hz, 3Ø 30/45 kva	d. c. only	d. c. only	a. c. d. c.	a. c. d. c.
NC-6, NC-6A	Towed trailer	Gasoline engine	Shore based only	28.5v 200a 32/45 kw	120/208v 400 Hz, 3Ø 30 kva	DNA	DNA	a. c. d. c.	a. c. d. c.
NC-7, NC-7A, NC-7B, NC-7C	Towed trailer, or self-propelled within narrow limits	Gasoline engine	Shore based only	28.5v 750a 1000a int 45 kw	115/200v 400 Hz, 3Ø 35 kva 0.75 PF	d. c. only	d. c. only	a. c. d. c.	a. c. d. c.
NC-10	Towed trailer	Diesel engine	Shore or carrier based	28v 750a 1000a int	115/200v 400 Hz 90 kva	d. c. only	d. c. only	a. c. d. c.	a. c. d. c.
NC-10A	Towed trailer or self-propelled	(same)	(same)	(same)	(same)	(same)	(same)	(same)	(same)
NC-12	Towed trailer	Diesel engine	Shore based only	28v 750a 1000a int 45 kw	115/200v 400 Hz 125 kva	d. c. only	d. c. only	a. c. d. c.	a. c. d. c.
NC-12A	(same)	(same)	Shore or carrier based	(same)	(same)	(same)	(same)	(same)	(same)

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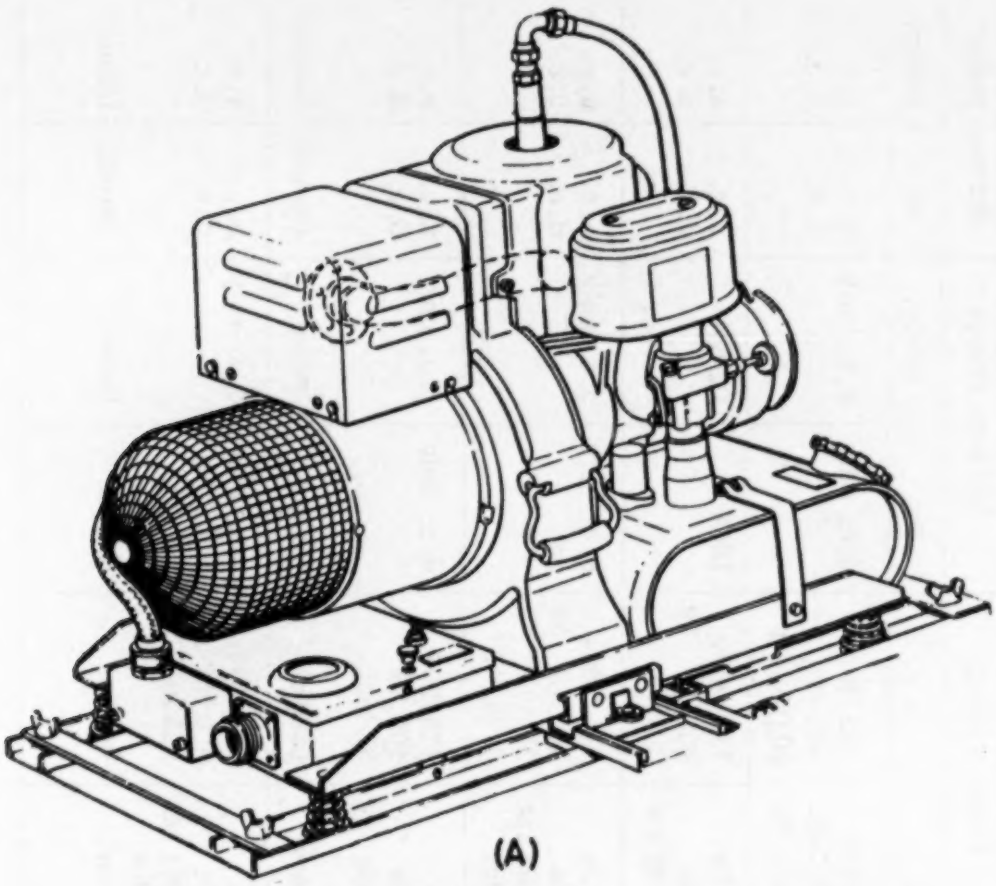

(A)

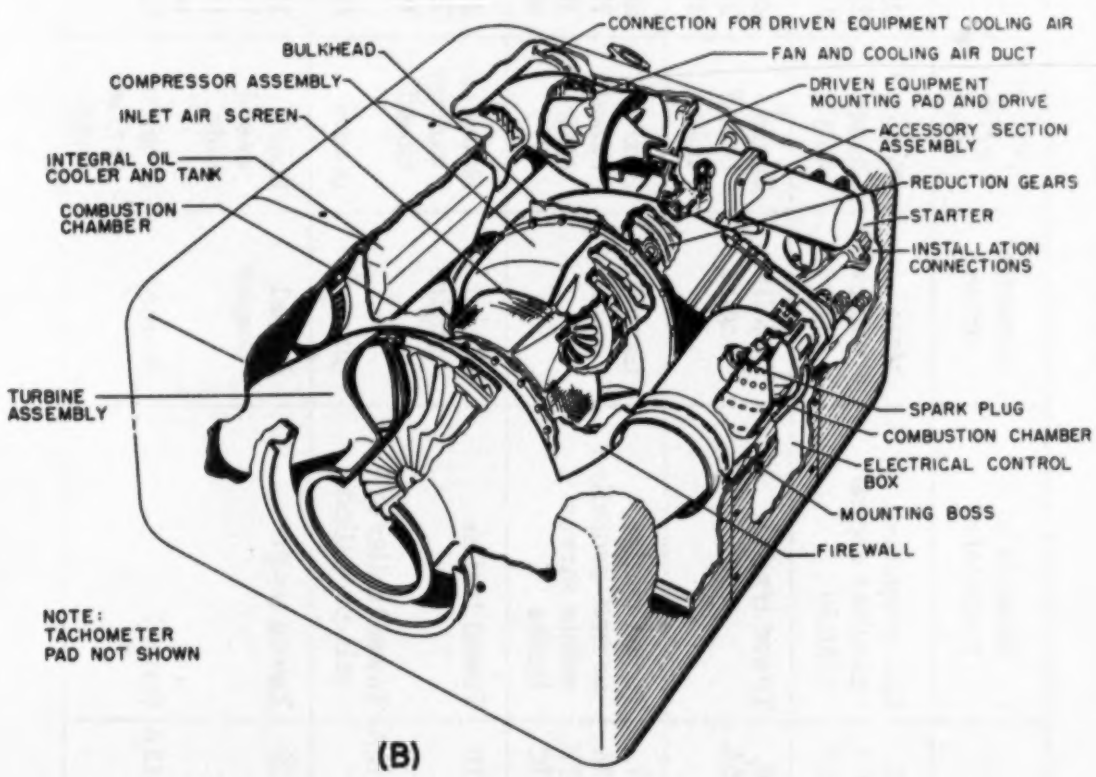

(B)

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Figure 6-19.–(A) Gasoline engine-driven APP; (B) gas turbine type APP.

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Although there are some variations between carriers of different classes and aircraft of different models, this discussion and the associated figures represent a typical example. For explicit details concerning a specific installation, check the deckedge station and its power cables.

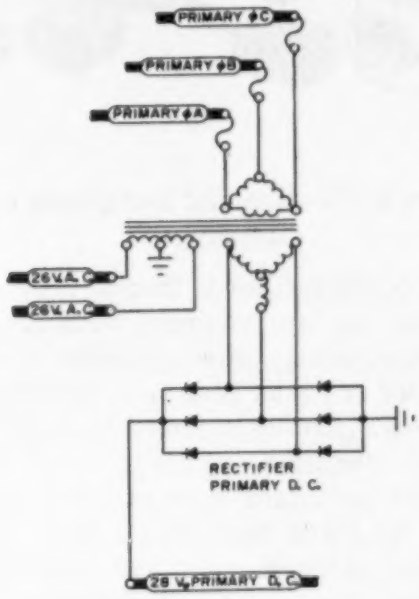

AT.64

Figure 6-20.—Transformer-rectifier.

The d-c service outlet box contains two male plugs. One is rectangular in shape and the other is oval. The rectangular plug provides servicing power and the oval plug provides starting power for aircraft with electrical starters.

The aircraft is equipped with an oval-shaped plug for applying d-c servicing power and a rectangular-shaped six-pin plug for applying 3-phase, 400 Hz, a-c servicing power. Power is applied to the aircraft by connecting the portable cables between the deckedge and aircraft plugs. To obtain d-c servicing power, the oval end of the portable cable is connected to the oval plug in the aircraft and the opposite (rectangular) end is connected to the rectangular deckedge plug.

To obtain 3-phase, 400 Hz, a-c service power, the portable a-c plug is connected to the aircraft and the opposite end to deckedge a-c service power box. The ends of the a-c portable cable are interchangeable.

Figure 6-23 illustrates how these connections may be made. To obtain d-c servicing

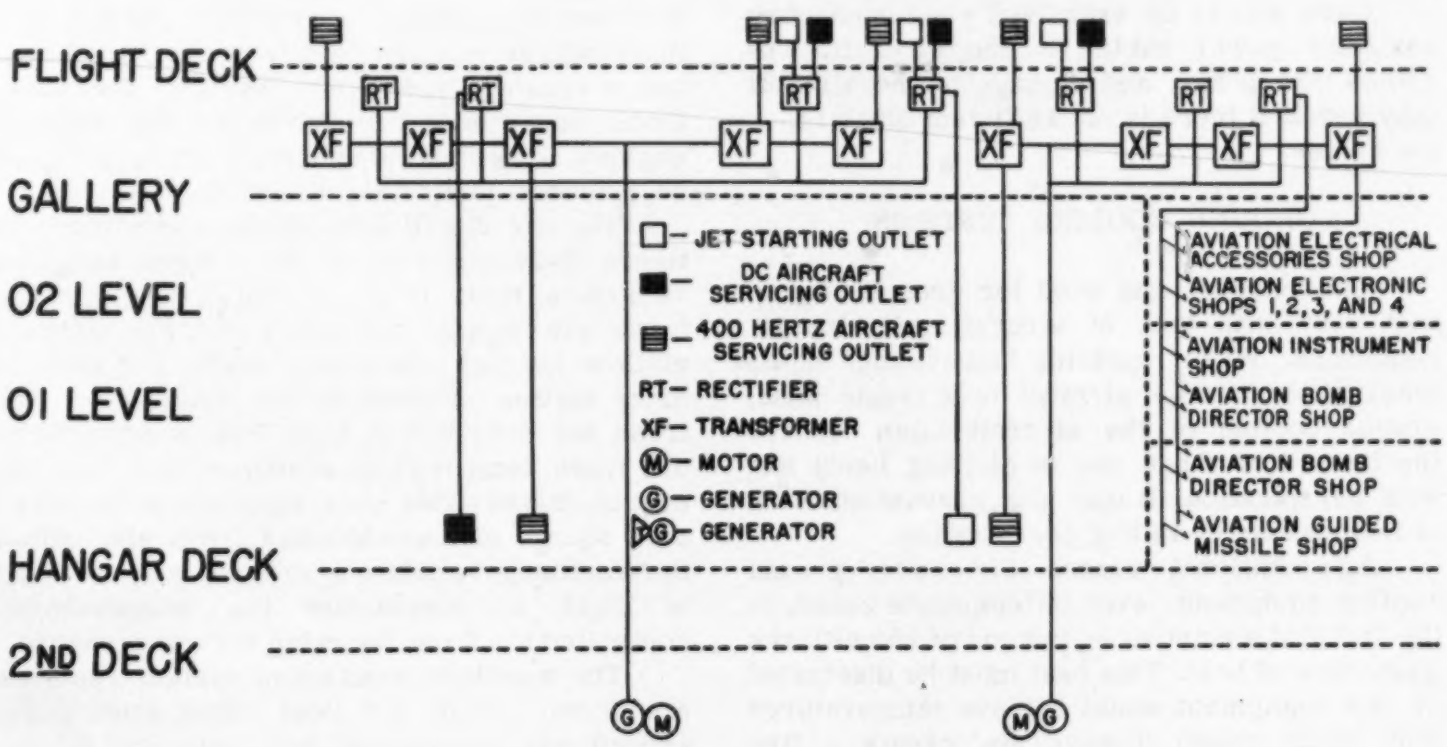

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Figure 6-21.–Deckedge electrical system.

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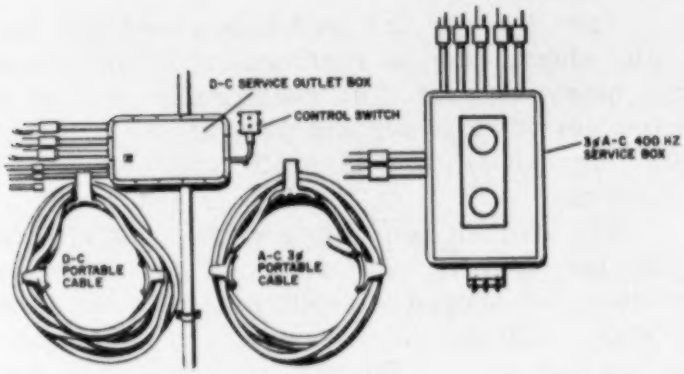

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Figure 6-22.–Typical deckedge installation.

AT.67

Figure 6-23.–D-c and a-c power cables and plugs.

power to the aircraft, connect the cable from A to A'; to obtain a-c service power connect it from B to B'.

The a-c service power is usually provided at the same station as the d-c power. The cable is usually permanently attached to the service outlet box. Although its plug is rectangular, there is no danger of connecting it to the d-c service power receptacle as the size and number of pins are not the same.

Care should be exercised when connecting auxiliary power cables to the aircraft. The cables are heavy, and damage to the aircraft may result if there is not sufficient slack in the cables.

GROUND COOLING SYSTEMS

The purpose and need for ground cooling will vary with type of aircraft and climatic conditions. When repairing high-voltage equipment aboard large aircraft in a tropic zone, ground cooling of the aircraft cabin reduces the hazard of shock due to clothing being wet with perspiration. It may also prevent shorting of components by falling perspiration.

An additional reason for using ground cooling equipment, even in temperate zones, is the fact that electronic equipment produces large quantities of heat. This heat must be dissipated or the equipment would achieve temperatures that could cause damage and create a fire hazard.

The combination of tropic heat and equipment heat in an aircraft without a cooling system operating often creates a hazard of heat-stroke or heat exhaustion. When the aircraft is airborne, various means are used to accomplish the required cooling. Some electronic equipments have fans built in for cooling. Others generate so much heat that a blast of air from outside the aircraft must be used. Some large magnetrons are liquid cooled–the liquid, in turn, is cooled by air directed over a radiator.

When a large quantity of air is required for cooling, a common source for the air is the aircraft's ventilation system. However, line maintenance, ground operational checks, and functional checks are usually performed without the aircraft's ventilation system operating, since this system is driven by the aircraft engines. Therefore, a substitute air supply must be provided for the air distribution system.

The air distribution system illustrated in figure 6-24 consists of two subsystems. One subsystem controls and distributes the incoming fresh air supply; the other controls exhaust airflow through electronic racks and tactical crew station cabinets to the atmosphere. The fresh air distribution subsystem is designed to use fresh, temperature-controlled air from two engine-driven cabin air compressors. An alternate source of unconditioned fresh air, called the auxiliary ventilation system, may be used in flight to supplement the temperature-controlled air from the cabin air compressors.

The auxiliary ventilation system receives air from a ram air inlet. This inlet and a ground air connection are adjacent to one another in the nosewheel well and connect to a

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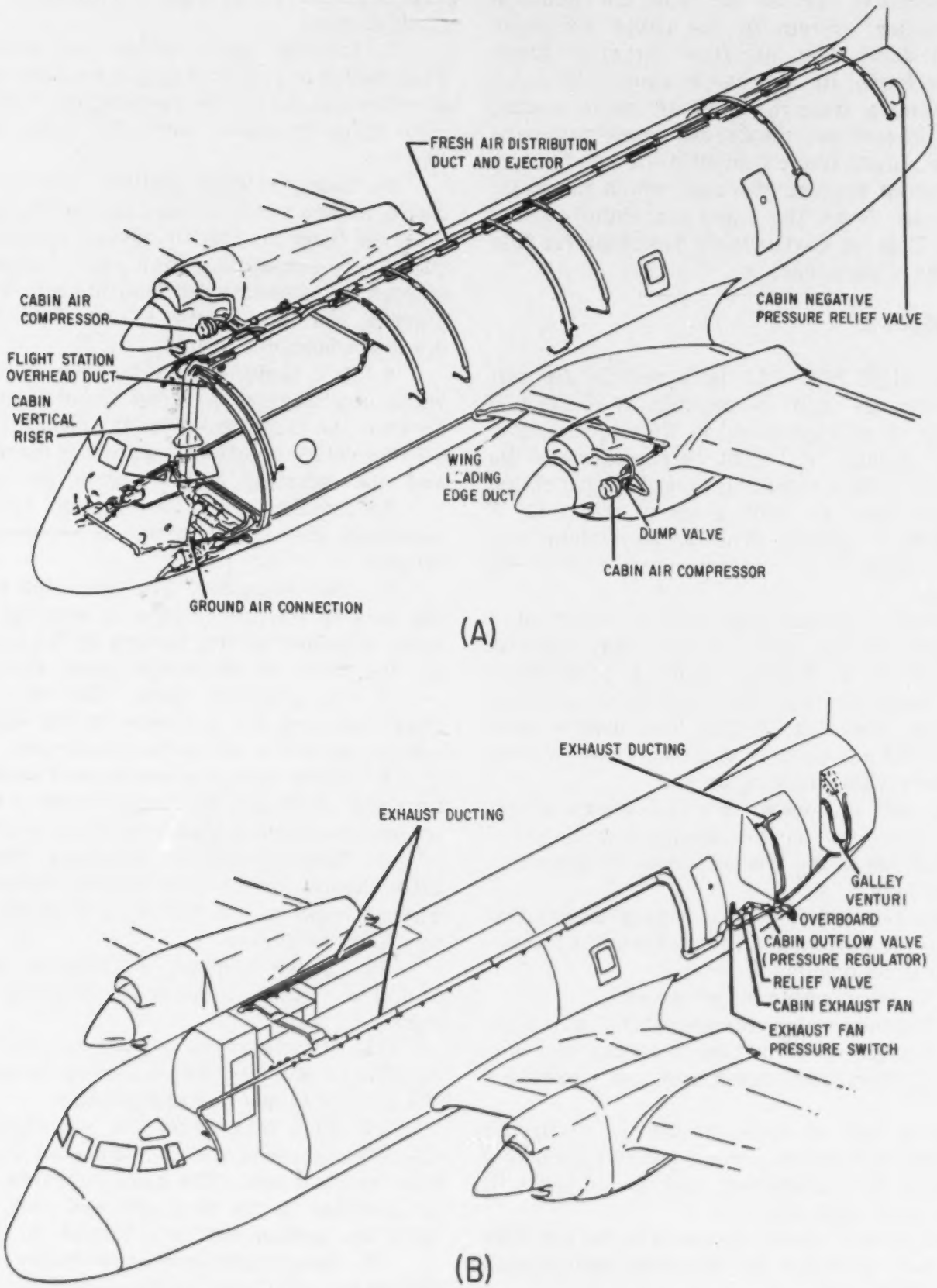

Figure 6-24.–Air distribution system of an aircraft. (A) Inlet air system; (B) exhaust air system. AT.68

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common duct. This duct connects to the duct which normally carries air from the cabin air cycle cooling system to the cabin air riser (vertical duct). The air from either of these alternate fresh air sources is routed the same as air coming from the cabin air cycle cooling system. Therefore, the ground connection permits the output from a mobile air conditioner to be routed through the duct which normally carries air from the cabin air cycle cooling system. This is particularly desirable for line maintenance purposes.

ACM-2905-F22

The ACM-2905-F22 is a mobile aircraft air conditioner that is capable of delivering 21.9 tons of refrigeration at 2,500 cfm (cubic feet per minute). A ton of refrigeration is the amount of cooling resulting from the absorption of enough heat to melt a ton of ice at 32° F in a 24-hour period. This is equivalent to a cooling capacity of approximately 12,000 Btu per hour.

The air conditioning unit consists of a 7-cylinder, 40-ton radial compressor directly connected to a 150-hp internal combustion engine; large cooling coils; and an evaporative condenser. (See fig. 6-25.) The engine uses conventional automotive type electrical starting and battery charging equipment.

The unit is housed in a 12-foot truck body and is controlled from a simple panel located on the outisde of the truck for ease of operation. (See fig. 6-26.)

A built-in safety system cuts off the ignition to the air-conditioning unit whenever the following conditions occur:

1. Loss of engine oil pressure.
2. Engine water termperature too high.
3. Compressor suction pressure too low.
4. Compressor discharge pressure too high.

Should any of these conditions occur, an alarm bell will sound, a red light on the control panel will be illuminated, and the engine will automatically shut down.

The control panel, mounted in the left side of the unit, contains the following instruments and controls:

1. Panel lights and switch. Two panel lights are supplied to provide illumination for the control panel.
2. Interior light switch and pilot light. This switch is provided to operate lights situated at other points in the installation. The green pilot light indicates when the interior lights are on.
3. Safety release switch. This is a push-button switch which is used to remove the safety controls from the circuit. Should a shutdown occur due to excessively high water temperature, it might be necessary to hold this button in while starting the engine after the cause of the shutdown has been corrected.
4. Key ignition switch. This switch prevents unauthorized persons from attempting to operate the machine. When the switch is turned off, the entire electrical system is disconnected and the starting motor cannot be operated.
5. Tachometer. The electric tachometer indicates the engine speed in revolutions per minute.
6. The ammeter. The ammeter indicates the rate of charge or flow of electric current being supplied to the battery by the generator, or the rate of discharge from the battery.
7. Oil pressure gage. The oil pressure gage indicates the pressure of the engine oil, not the amount of oil in the crankcase.
8. Water temperature gage. The temperature gage indicates the temperature of the cooling system of the engine (not the air conditioner).
9. Starting button. Pressing the button, after the key switch is turned on, completes the circuit between the battery and starting motor to crank the engine.
10. Choke control. Pulling the choke out supplies a richer mixture for starting when the engine is cold.
11. Vernier type throttle control. The throttle is equipped with a locking device to hold the control in any desired position.
12. Fuel tank gage. The fuel gage is electrically operated and is connected to the fuel tank sensing unit. The gage indicates the level of gasoline in the tank and will only register after the ignition switch is turned on.
13. Evaporator-condenser water tank gage. Operating similarly to the above, this gage in-

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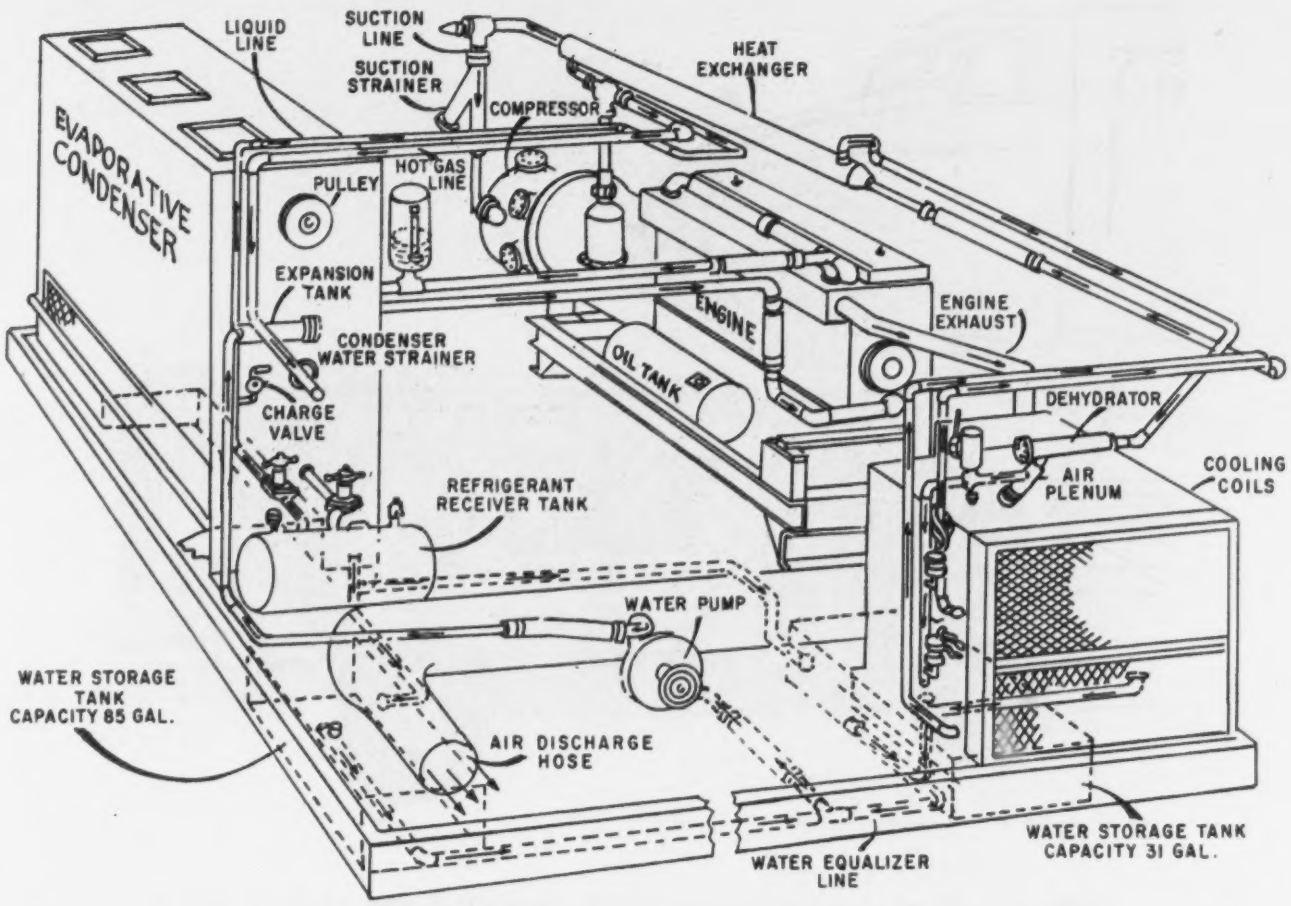

AT.70

Figure 6-25.—Air-conditioning unit, functional diagram.

dicates the water level in the evaporative condenser supply tank.

14. Winter switch. This switch is used to operate a solenoid valve in the refrigerant line. In winter, when it is desired to operate the engine without refrigeration, the switch is to be set at the OFF position. For normal operation, however, the switch is to be left ON.

15. Refrigeration gages. These three instruments (reading from left to right when facing the control panel) are: Compressor suction pressure gage, compressor oil pressure gage, and compressor discharge pressure gage.

KOKA 567A

This unit, described as "air conditioner, portable electric," is basically an electric-driven air-conditioning unit mounted on a four-wheel trailer. The unit is intended for use on the flight line to supply cooling air to aircraft during electronic testing or other operational testing.

With a refrigerating capacity of 31.2 tons, the unit uses an 8-cylinder compressor driven by a 60-hp, 440-volt, 3-phase, 60-hertz motor to deliver a maximum of 3,500 cfm of air at a minimum temperature of 45° F. This airflow may be varied by means of a manual damper located in the supply air outlet. Adjustment to requirements can be made by the operator and airflow readings of pressure and volume can be read directly at the instrument panel. An automatic temperature control device will maintain the leaving-air temperature (at the setting of a thermostat with a range of 0° to 120° F, located on the control panel) by varying the volume damper to control airflow. This feature permits maintaining constant air temperature with a slight variation of supply airflow.

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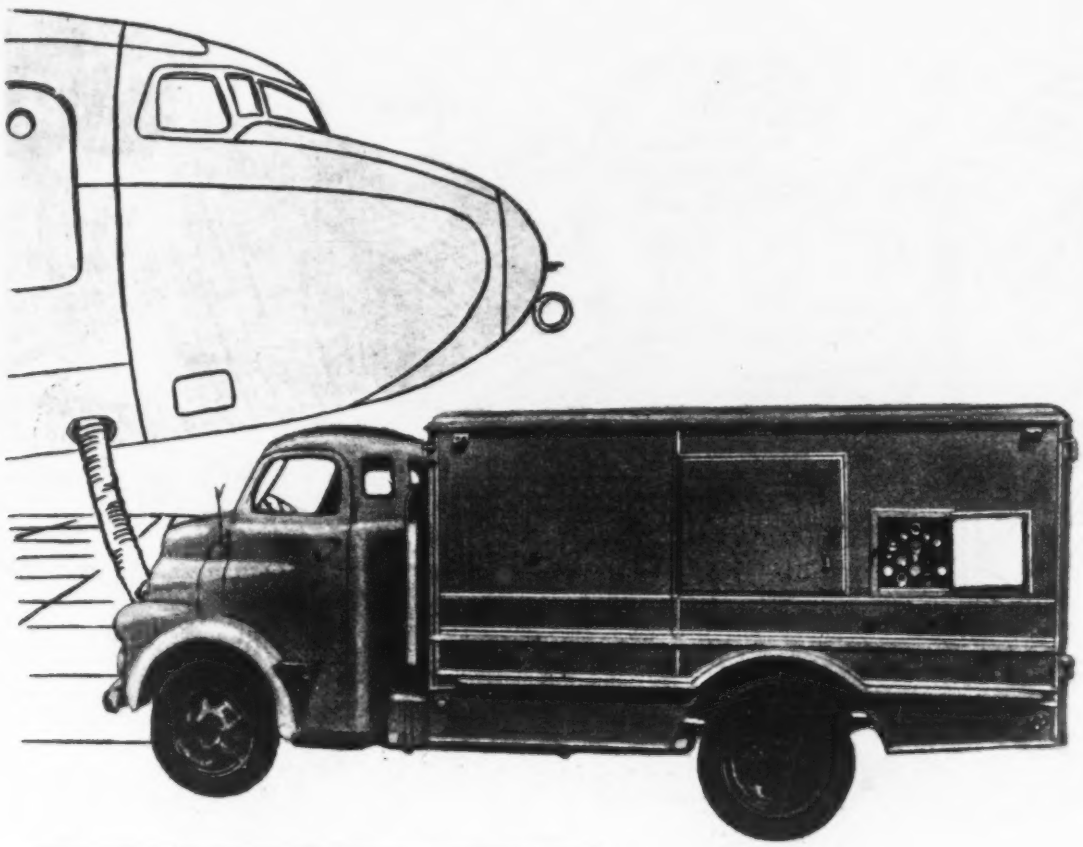

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Figure 6-26.–Air-conditioning truck mounting and control panel.

The refrigeration unit is automatically prevented from operating when the outside ambient air temperature is less than 40° F.

NR-3

The NR-3 is a trailer-mounted, Freon cycle, 120-hp, engine-driven mobile air-conditioning unit. (See fig. 6-27.) This unit is completely selfsustaining and carries enough fuel and water to provide 4 hours of continuous operation. A lunette eye, with a shock control device, is attached to the end of a steerable tow bar and will allow the air conditioner to be towed up to speeds of 40 mph on paved surfaces. A tow bar retainer allows the tow bar to be stowed in the vertical position when not in use. A parking brake provides a means of securing the fully loaded unit on grades up to 35 percent.

This air-conditioning unit supplies cool, moisture-free air to the cabin conditioning and cooling equipment systems during ground checkout and testing of an aircraft's various systems. The unit is capable of delivering 294,000 Btu (24.5 tons gross) of conditioned air. This produces 100 pounds of airflow, at a pressure of 3 pounds per square inch, throughout a range in ambient temperatures from 10° C (50° F) to 43° C (133° F) when measured at sea level. The equipment is designed to operate at altitudes up to 5,000 feet above sea level.

SERVICING UNIT CP 105

The AiResearch CP 105 is a gas turbine-driven power and refrigeration aircraft ground support unit furnished to the Navy in three different configurations. It is used primarily in support of the RA-5C and F-4B aircraft. All three arrangements employ basically the same system, using a small gas turbine to supply electric power and air for refrigeration, main aircraft engine starting, and pilot suit pressurization.

13301

If this were not done, chaos and disorder would result from the lack of a standardized method of conveying a message or idea through means of drawings.

To be able to write this graphic language easily and accurately, the aid of drawing instruments is required. When these implements are used, the drawing is called an instrument drawing. When done without the assistance of instruments, it is known as freehand drawing. Training in both of these methods is necessary for the draftsman.

Our basic objective then, is to study this language so that we may write it, express ourselves clearly to one familiar with it, and be able to read it readily when written by another.

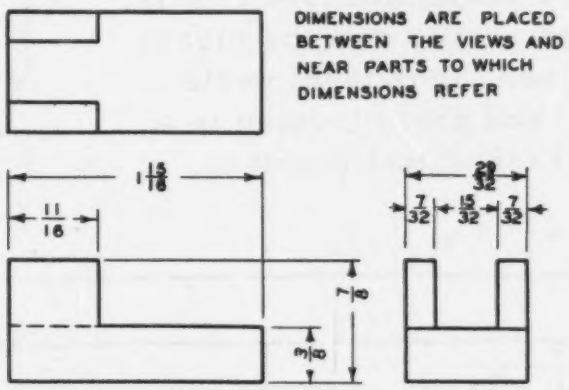

QUESTIONS: In answering the questions, use the drawing of the block shown above.

1. Give the overall (length, width, height) dimensions of the block.

2. What does the dotted line mean?

3. In your opinion, why is drafting important?

4. List some applications of the drafting trade.

5. Why are dimensions placed on the drawing?

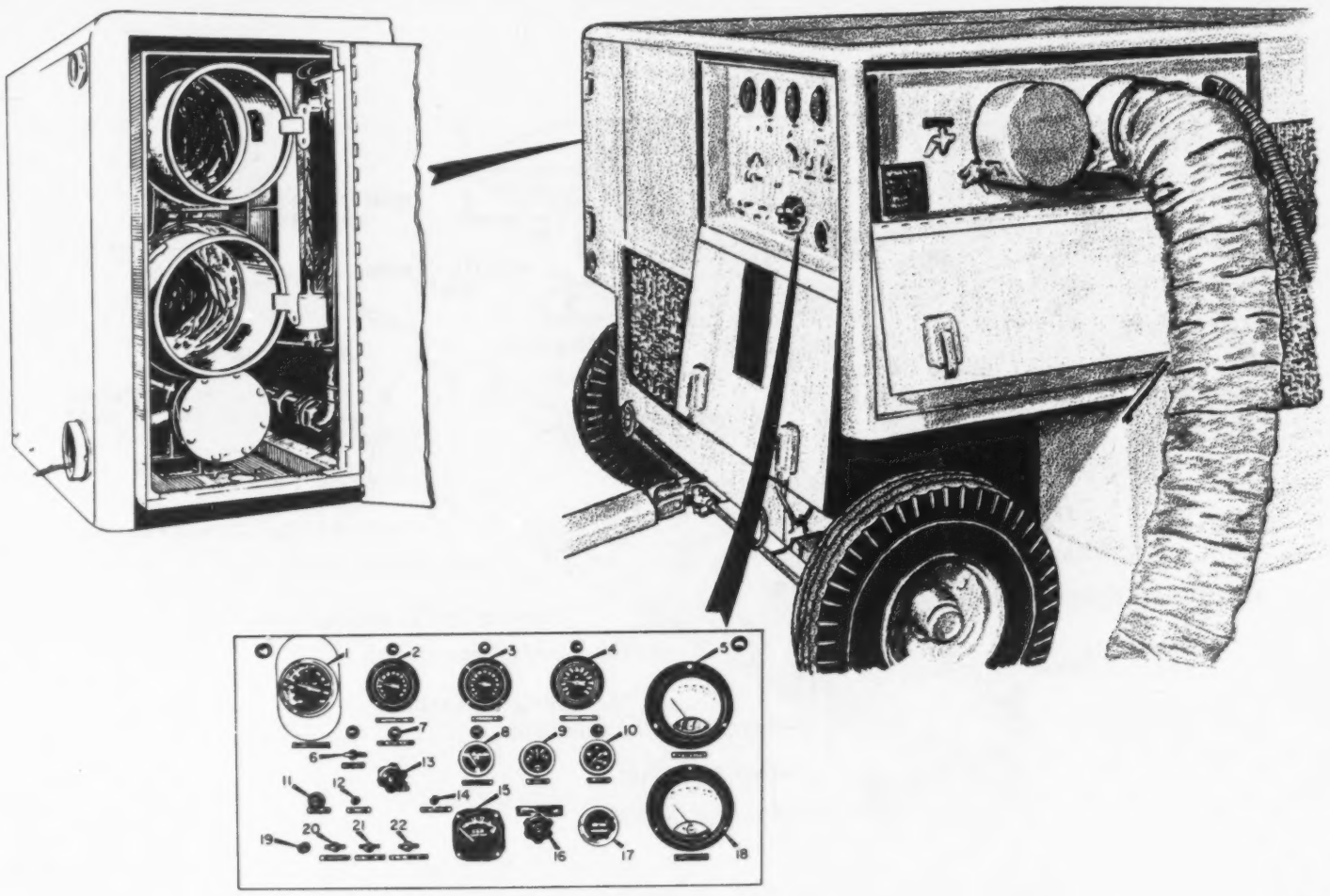

AT.72

Figure 6-27.–NR-3 air conditioner.

(NOTE: Electric power is generated by an air-driven turbine.)

The RCPP 105 (one of the three available models) is mounted in a 22-foot long aerodynamic pod for air transportation as an aircraft external store. On the RA-5C, the pod is transported under the wing; on the F-4B, it is carried under the fuselage. A cradle type towable trailer is provided for ground movement of the unit. (See fig. 6-28.)

The RCPT 105 is mounted on a self-propelled, low-silhouette (38 inches from the ground) trailer.

The tractor unit is similar to the RCPT 105 except that the turbine-driven unit is mounted on a diesel tractor.

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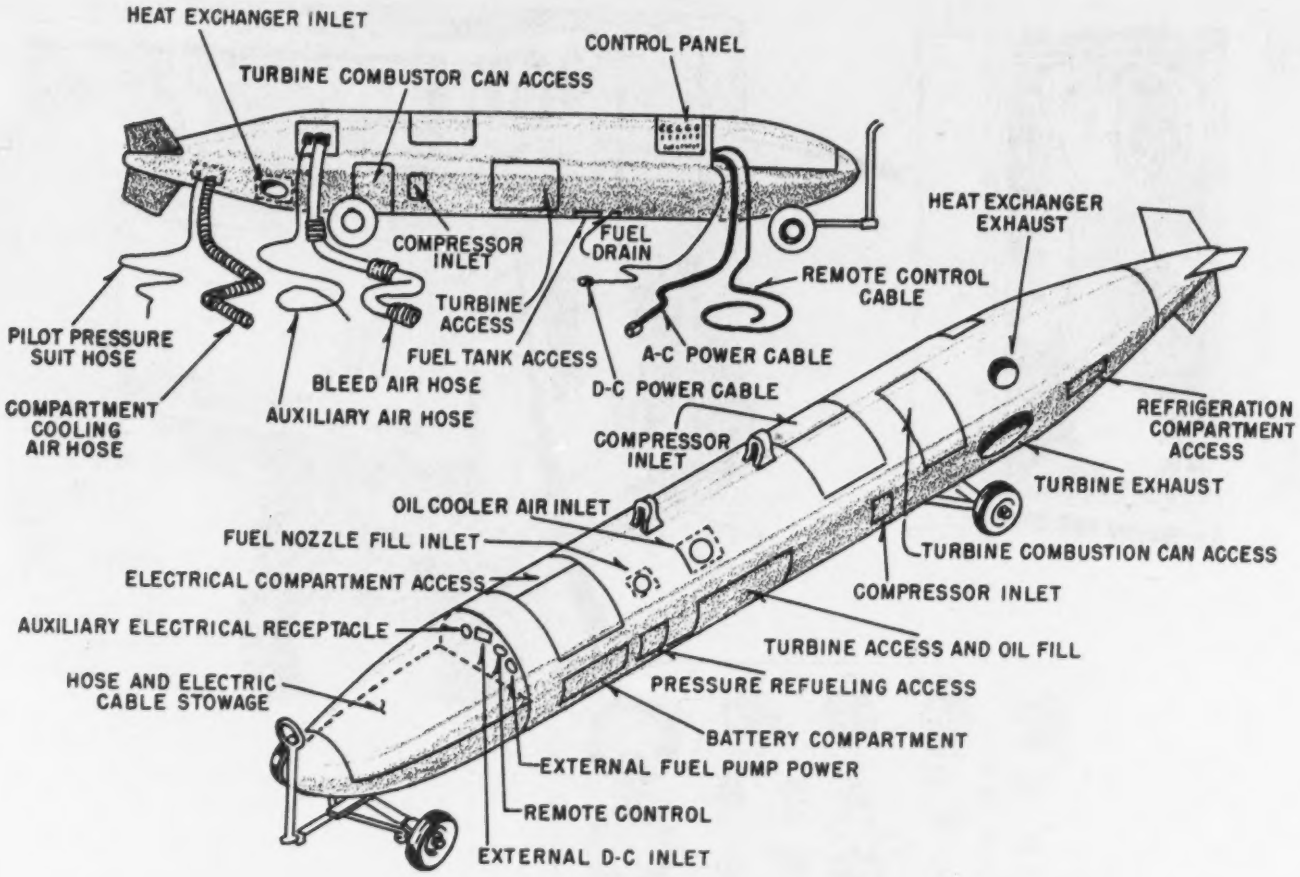

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Figure 6-28.–RCPP 105, showing external connections.

SUCCI 13303

CHAPTER 7

HANDTOOLS

A skilled technician can be identified by the way he handles and cares for his tools and materials. Tools are a costly investment and should be cared for and used to full advantage. There seems to be something about a good tool that helps the average technician turn out better than average work. This fact alone more than justifies the slightly higher cost of quality tools. Even more important is the fact that low quality tools become defective more readily and can result in injury to the user or damage to the equipment undergoing repair.

In the same manner, proper use of quality materials improves the quality of any maintenance task and reduces the possibility of new failures. The primary duties of all maintenance personnel are to become thoroughly familiar with the tools and materials of his trade and be proficient in their care and use.

HANDTOOLS

For purposes of this discussion, the term "handtools" will be used to refer to the small portable or fixed power tools commonly available in electronics maintenance shops or used by electronics maintenance personnel during work on aircraft, as well as those normally classified as nonpowered handtools.

SAFETY, USE, AND CARE OF HANDTOOLS

Carelessness is the greatest menace in any shop. It must come from the man himself; the machine alone cannot inflict injury. Lack of care is the cause of most accidents in electrical and electronics shops today. It should be remembered that all power tools are potentially dangerous. It is unsafe to lean against any that is in motion, or that may be started in motion by anyone else. Treat a machine with businesslike respect and there is no need to fear it. Do not start a machine until its operation has been fully explained by a competent instructor.

Chapter 3 of this manual contains some information concerning safety precautions and practices involving machinery and tools; that material should be reviewed frequently. Other excellent sources of information regarding handtools and their use and care are the Rate Training Manuals Airman, NavPers 10307-B, and Basic Handtools, NavPers 10085-A. Since these manuals are basic to all aviation ratings, the material covered in them is not duplicated in this discussion; review of that material should be accomplished before proceeding with this manual.

The following two basic safety precautions may be used to summarize this idea, and they cannot be emphasized too strongly:

1. Use the proper tool for its own specific function, and use it in the proper manner.
2. Maintain all tools in proper working order and in a safe condition. Sharpen or replace dulled cutting tools, replace broken or defective tools, and protect tools from damage while in use or in storage.

When performing any function requiring the use of tools and/or materials, arrange them so that they are easily accessible but are not in a position to interfere with the work. This arrangement increases efficiency as well as safety.

Tools should be cleaned and inspected after the job has been completed. Return all tools to their proper storage place. If a tool becomes worn, damaged, or broken, report it to the senior member of the shop so that proper steps may be taken for replacement or repair.

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GENERAL TOOLS

Although the previously mentioned basic courses provide many details regarding the common general tools, a few additional comments are of importance to the avionics maintenance technician.

Never use a center punch on extremely hard metals or to remove bolts by force; to do so will dull the point. Never use a pin punch as a starting punch–a hard blow may cause the slim shank to break. Always use the largest starting and pin punches that will fit the hole. When using punches, do not strike a glancing blow; the punch may break, and broken pin punches are difficult to remove.

Do not hammer on a screwdriver. If an obstruction is in the slot, apply a driving force with the heel of the hand or remove the obstruction with a file. Never use a screwdriver as a pry bar, lever, or chisel. Do not use pliers or wrenches on a screwdriver to increase torque.

When using a grinding wheel, insure that the guard is in place. If it is necessary to use the wheel with the guard removed, stand to one side to avoid flying particles of emery or metal. Use safety goggles when grinding screwdriver blades or other metal objects. Nonferrous metals should never be ground with ordinary grinding wheels due to the danger of the wheel becoming loaded with the material and possibly exploding. Use the rest stand when possible, but insure that the rest is close to the grinding wheel.

When drilling, never use the hand to hold the work being drilled. Use a vise or a clamp. The same idea applies to work being soldered, filed, or sawed.

Know Your Screwdrivers

Using a Reed and Prince screwdriver for working on Phillips screws (or vice versa) can result in a ruined tool or a ruined screwhead, making it difficult to remove the screw. Because of the difference in design of the two screws, the screwdrivers should not be used interchangeably. In general, Reed and Prince screws are used for airframe structural applications, while Phillips screws are found most often in component assemblies.

Figure 7-1 shows the differences between types. The Phillips screwdriver has about 30-degree flukes and a blunt end, while the Reed and Prince has 45-degree flukes and a sharper, pointed end. The Phillips screw has beveled walls between the slots; the Reed and Prince, straight, pointed walls. In addition, the Phillips screw is not as deep as the Reed and Prince.

Ways to identify the right screwdriver are as follows:

1. If it tends to stand up unassisted when the point is put in the head of a vertical screw, it is probably the proper one.
2. The outline of the end of a Reed and Prince screwdriver is approximately a right angle, as seen in the illustration.
3. Know the descriptions of both types. Using the right tool saves time and trouble, and is good maintenance practice.

Soldering Iron

All high quality irons operate in the temperature range of 500° to 600° F. Even the little 25-watt midget irons produce this temperature. The important difference in iron sizes is not temperature, but thermal inertia (the capacity of the iron to generate and maintain a satisfactory soldering temperature while giving up heat to the joint to be soldered).

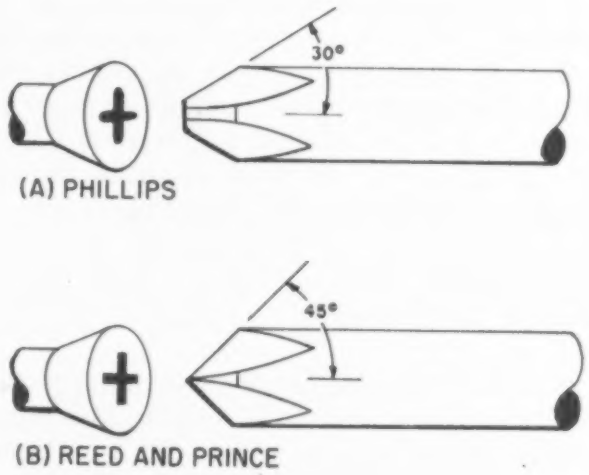

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Figure 7-1.–Matching cross-slot screws and drivers.

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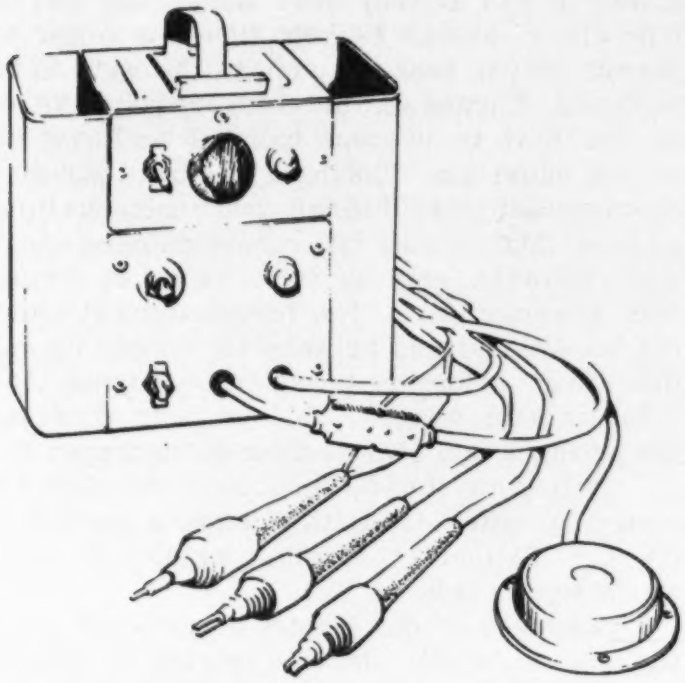

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Figure 7-2.–Resistance soldering unit.

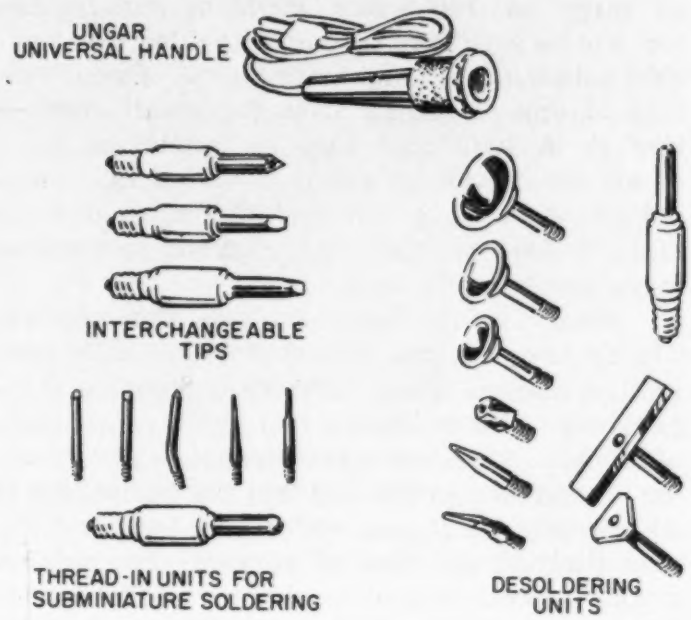

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Figure 7-3.–Pencil iron kit with special tips.

adjusted for as long as 3 seconds soldering time. This set is especially useful for soldering cables to MS/AN plugs and similar connectors–even the smallest types available.

In use, the double-tip probes of the soldering unit are adjusted to straddle the connector cup to be soldered. One pulse of current heats it for tinning and, after the wire is inserted, a second pulse of current completes the job. Since the soldering tips are hot only during the brief period of actual soldering, burning of wire insulation and melting of connector inserts are greatly minimized.

The greatest difficulty with this device is keeping the probe tips free of rosin and corrosion. A cleaning block is mounted on the transformer case for this purpose. Some technicians prefer fine sandpaper for cleaning the double tips.

CAUTION: Do not use steel wool. It is dangerous when used around electronic equipment.

Pencil Iron and Special Tips

An almost indispensable item is the pencil type soldering iron with an assortment of tips (fig. 7-3). Miniature soldering irons, with wattage ratings of less than 40 watts are easy to use and are recommended. In an emergency, larger irons can be converted and used on subminiature equipment as described later in this section.

One type of iron is equipped with several different tips that range from one-fourth to one-half inch in size (diameter) and are of various shapes. This feature makes it adaptable to a variety of jobs. Unlike most tips which are held in place by setscrews, these tips have threads and screw into the barrel. This feature provides excellent contact with the heating element, thus improving heat transfer efficiency. A pad of "antiseize" compound is supplied with each iron. This compound is applied to the threads each time a tip is installed in the iron, thereby enabling the tip to be easily removed when another is to be inserted.

A special feature of this iron is the soldering pot that screws in like a tip and holds about a thimbleful of solder. It is useful for tinning the ends of large numbers of wires.

The interchangeable tips are of various sizes and shapes for specific applications.

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Extra tips may be obtained and shaped to serve special purposes. The thread-in units are useful in soldering subminiature items. The desoldering units are specifically designed for performing special and individual functions.

Another advantage of the pencil soldering iron is its possible use as an improvised light source for inspections. Simply remove the soldering tip and insert a 120-volt, 6-watt, type 6S6, candelabra screwbase lamp bulb into the socket.

If leads, tabs, or small wires are bent against a board or terminal, slotted tips may be used to simultaneously melt the solder and straighten the leads.

A hollow tip, which fits over a pin terminal, may be used to desolder and resolder wiring at cables or feed-through terminals.

Many microminiature components have multiple connections, all of which must be desoldered to permit removal of the component in one operation. These connections may be desoldered individually by heating each connection and brushing away the solder. With this method, particular care must be taken to insure that loose solder does not stick to other parts or become lodged where it may cause a short circuit. A more efficient method is to use the specially shaped desoldering units (fig. 7-3). Select the proper size and shape tip that will contact all terminals to be desoldered—and nothing else. Do not permit the tip to remain in contact with the terminals too long at one time.

If no suitable tip is available for a particular operation, an improvised tip may be made. Wrap a length of copper wire around one of the regular tips and bend the wire into the proper shape for the purpose. Insure that the improvised tip contacts all connections and nothing else. This method also serves to reduce tip heat when a larger iron must be used on miniature components. (See fig. 7-4.)

In connection with the discussion of soldering tools and devices, the selection of solder and flux is also critical. A small diameter rosin core solder with a high tin-lead ratio is normally preferred (63/37 or 60/40). Normally the higher the lead content, the higher the melting point. In miniature circuits heat is critical, and the higher tin-to-lead ratio requires less heat to make a strong and lasting joint. An exception is in soldering a silver plated or solid silver item. For this application the solder must contain 2 to 3 percent silver to prevent chemical action which could destroy the component.

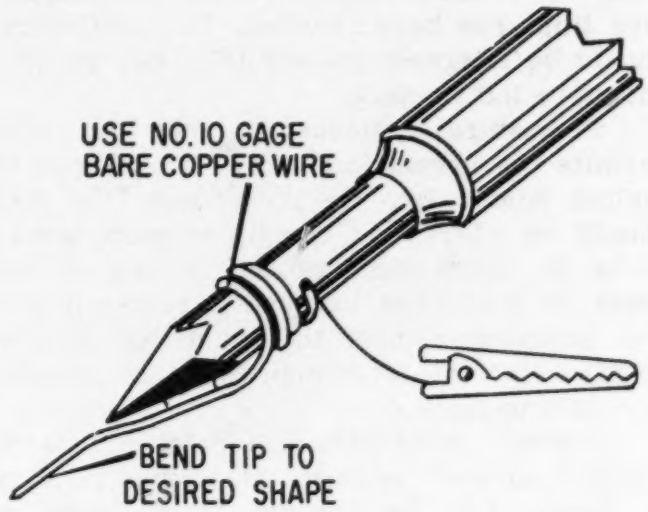

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Figure 7-4.—Improvised tip to reduce heat.

Any flux used must be noncorrosive and nonconductive, to prevent corrosion, shorts, and electrical leakage.

Soldering Aids

Several devices other than the soldering iron and its tips are required in soldering miniature circuits.

Some type of thermal shunt is essential in all soldering operations which involve heat-sensitive components. Pliers, tweezers, or hemostats may be used for some applications, but their effectiveness is limited. A superior heat shunt is shown in figure 7-5. Proper use of the heat shunt permits soldering the leads of component parts without overheating the part itself.

For maximum effectiveness, any protective coating should be removed before applying the heat shunt. The shunt should be attached carefully to prevent damage to the leads, terminals, or component parts. The shunt should be clipped to the lead, between the joint and the part being protected. As the joint is heated, the shunt absorbs the excess heat before it can reach the part and cause damage.

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A small piece of beeswax may be placed between the protected unit and the heat shunt. When the beeswax begins to melt, the temperature limit has been reached. The heat source should be removed immediately, but the shunt should be left in place.

Premature removal of the heat shunt permits the unrestricted flow of heat from the melted solder into the component. The shunt should be allowed to remain in place until it cools to room temperature. A clip-on type shunt is preferred because it requires positive action to remove the shunt, but does not require that the technician maintain pressure to hold it in place.

Another invaluable soldering aid is the "solder sucker" syringe. One type is shown in figure 7-6. Its purpose is to "suck up" excess solder (and incidentally the excess heat) from a joint. The only requirements of an efficient solder sucker are a controllable source of vacuum (squeeze bulb), a solder receiver, and a tip. The tip must be able to withstand the heat of molten solder. Teflon is ideal, but is difficult to acquire through Navy supply channels. A silicon rubber-covered Fiberglas sleeving with an inner diameter of 0.162 inches (FSN 9N5970-285-0488) and the bulb from a medicine dropper makes a suitable syringe. (The glass or plastic tip of the medicine dropper cannot withstand the heat.)

SOLDER

Two types of solder are available—the tin-lead alloy known as soft solder and the so-called hard or silver solder. Soft solder alloys permit the use of lower soldering temperatures and are therefore recommended for electronic applications. Where a joint of greater strength is required, silver solder is employed.

Most solder alloys do not liquefy immediately as the temperature is increased. Ordinarily they change from the solid state to a plastic semiliquid, and finally become completely liquid. Most tin-lead solders enter the plastic state at 358° F and become wholly liquid at various temperatures, dependent upon the individual composition. A combination of 63 percent tin and 37 percent lead has the lowest melting point (361° F) for the tin-lead group. However, since it changes from solid to liquid without an intervening plastic state, it is susceptible to fracture from slight vibration while cooling.

(Solder is commonly referred to as 70/30, 60/40, etc. This is the tin-lead content.)

FLUXES

All common metals are covered with a nonmetallic film, usually an oxide of the material, which prevents them from making the intimate contact so necessary for a good electrical connection. The purpose of a flux is to remove the oxide from the surfaces to be soldered, not to clean them. Flux cannot replace good cleaning methods in preparing surfaces for soldering. Without a clean, inti-

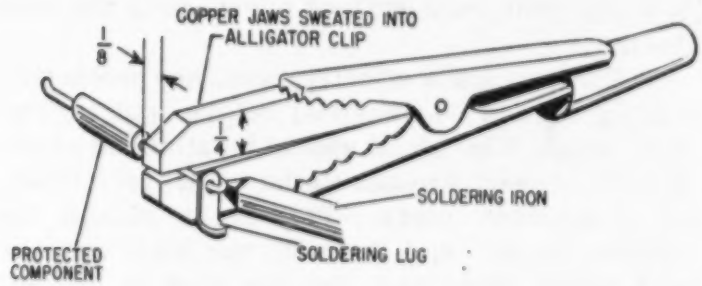

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Figure 7-5.–Heat shunt.

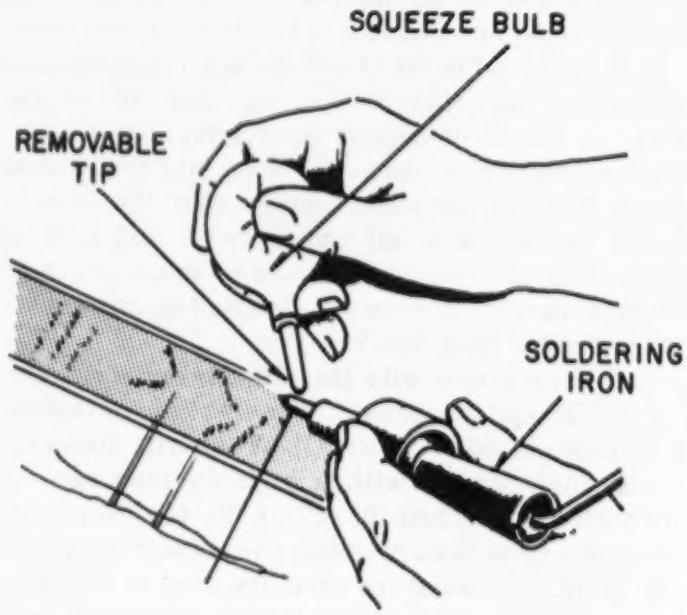

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Figure 7-6.–Solder sucker.

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mate contact, poor soldering techniques may result in a mechanically weak, high resistance joint—a so-called rosin joint in the case of rosin-base flux.

Solder fluxes may be divided into three general groups—rosin, organic, and chloride (sometimes called acid). The residue from the rosin-base fluxes is noncorrosive and electrically nonconductive, making them highly acceptable for use in military electronic equipment. The organic and chloride types are seldom used (sometimes even prohibited) because of their corrosiveness. Actually, only rosin-base flux is recommended for electronic applications.

ROSIN flux is actually very active when melted by heat. However, after the normal heat of the soldering operation is removed, the dry solid residue is noncorrosive and electrically nonconductive. Activated or intensified rosin-alcohol fluxes are permitted by MIL-S-6872 if they are noncorrosive. (For details, consult this specification.)

ORGANIC fluxes consist of mild organic acids and bases. These fluxes are almost as active as the organic salts, but their period of activity is brief due to their susceptibility to thermal decomposition. This limits corrosion and therefore may be used in applications where the soldered assembly lends itself to residue removal.

CHLORIDE type fluxes are not recommended for electronic applications.

SPECIAL TOOLS

A wide variety of special tools is required to maintain the modern aircraft of today's Navy. These tools are furnished by the manufacturers of the aircraft, engines, and related equipment.

Proper use of special tools greatly reduces the man-hours required for maintenance work.

These tools are listed in allowance lists published by the Naval Air Systems Command, and their use is explained in the Maintenance Instructions Manual or the Service Instruction Manual covering the particular aircraft, engine, or piece of equipment for which they were designed. An example of a special tool that is required for special maintenance of equipment, is the cable assembly connector wrench. This wrench is used to remove the sonar dome from the electrical special purpose cable assembly. (See fig. 7-7.)

NONMAGNETIC TOOLS

Tools made of nonmagnetic materials are available through normal supply channels. They are used for performing specific maintenance functions on certain classes of equipment or components—such as maintaining the detecting heads of MAD equipment. These tools, normally made of beryllium-copper, are used because steel tools may become magnetized through normal use.

Restricting the use of the nonmagnetic tools to the purpose for which they are intended will increase their value to the technician. Use of these tools for general maintenance would allow them to transfer metal or other foreign particles into electronic equipment. The gears and bearings of the detecting head are easily fouled by small particles of dust or metal. In addition to mechanical fouling, the introduction of metal particles that are magnetized would cause magnetic noise in the detecting head.

Nonmagnetic tools should also be used in tuning RF circuits which are susceptible to frequency change resulting from the introduction of new magnetic fields (or the distortion of the existing magnetic fields). Many slug-tuned IF circuits involve this potential trouble.

Good general maintenance practice involves wiping the tools before use and again after use. This is especially advisable in the case of nonmagnetic tools. A lint-free cloth dampened with a suitable cleaning solvent may be used for this purpose.

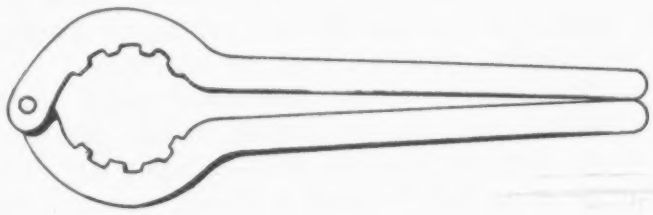

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Figure 7-7.—Cable assembly connector wrench.

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Nonmagnetic metals are usually softer than steel, so use of these tools for general maintenance could also damage the tools.

INSULATED TOOLS

Safety considerations require use of insulated tools whenever the danger of electrical shock or short circuit exists. Many types of tools are available in insulated form directly through supply channels at little or no additional cost. These tools should be obtained and used whenever available. However, many types of insulated tools are not readily available (or are available only at considerable added expense). If essential, these tools should be procured or conventional tools may be modified. Insulated sleeving may be put on the handles of pliers and wrenches and on the shanks of screwdrivers. Tools modified in this manner should be used only for low voltage circuits because of the limitations of the insulating materials. For higher voltage uses, special insulating handles are available for many of the common types of tools.

In some instances, it is necessary to use tools which are made of insulating material, rather than merely having an insulating handle. In these instances, the tools should be requisitioned through normal supply channels, if possible. If they are not available through normal supply channels, they may be purchased on the open market.

TORQUE WRENCHES

There are times when, for engineering reasons, a definite pressure must be applied to a nut. In such cases a torque wrench must be used. The torque wrench is a precision tool consisting of a torque-indicating unit and appropriate adapter or attachments. It is used to measure the amount of turning or twisting force applied to a nut, bolt, or screw.

The three most commonly used torque wrenches are the deflecting beam, dial indicating, and micrometer setting types (fig. 7-8.) When using the Deflecting Beam and the Dial Indicating torque wrenches, the torque is read visually on a dial or scale mounted on the handle of the wrench.

To use the micrometer setting type, unlock the grip and adjust the handle to the desired setting on the micrometer type scale, then relock the grip. Install the required socket or adapter to the square drive of the handle. Place the wrench assembly on the nut or bolt and pull in the desired direction with a smooth, steady motion. (A fast or jerky motion will result in an improperly torqued unit.) When the torque applied reaches the torque value which is indicated on the handle setting, the handle will automatically release or "break" and move freely for a short distance. The release and free travel is easily felt, so there is no doubt the torquing process is complete.

To assure getting the correct amount of torque on the fasteners, all torque handles must be tested at least once a month or more often if usage indicates it is necessary.

The following precautions should be observed when using torque wrenches:

1. Do not use the torque wrench as a hammer.
2. When using the micrometer setting type, do not move the setting handle below the lowest torque setting. However, it should be placed at its lowest setting prior to returning to storage.
3. Do not use the torque wrench to apply greater amounts of torque than its rated capacity.
4. Do not use the torque wrench to break loose bolts which have been previously tightened.
5. Never store a torque wrench in a toolbox or in an area where it may be damaged.

Torque Information

The torque table (table 7-1) may be used as a guide in tightening nuts, bolts, and screws whenever specific torque values are not called out in maintenance procedures. Using the proper torque allows the structure to develop its designed strength and greatly reduces the possibility of failure due to fatigue.

Threads must be free from grease or oil. Lubrication changes the torque value and will result in overtorquing.

When castellated nuts are used, they should be tightened to the lower torque limit; then continue tightening until cotter pin hole is

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UNIT I - INTRODUCTION

How to Sharpen a Drawing Pencil — Lesson 2

OBJECTIVE: To learn the art of sharpening a drawing pencil.

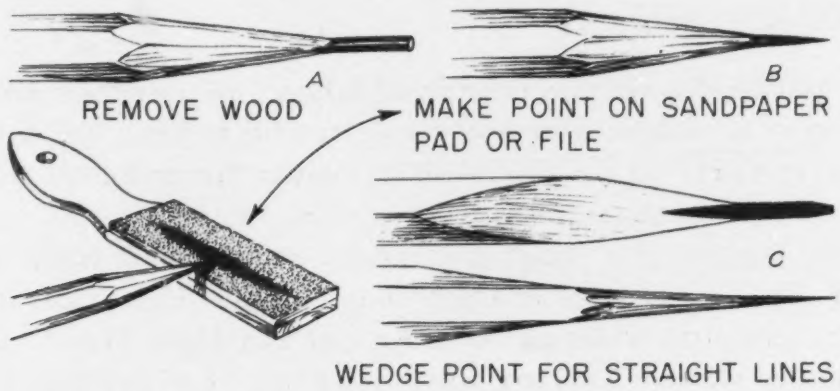

RELATED INFORMATION:

In order for one to draw sharp, clear lines - which is imperative in drafting - he must learn to sharpen a drawing pencil properly. First, cut away the wood from the unlettered end with a penknife to make a long point, as shown at A, and then sharpen the lead by turning or twirling the pencil against the sandpaper pad. The result should be a conical point as shown at B. Naturally, it will take experience and practice to achieve best results.

Some draftsmen prefer a flat or wedge point (see C). For this type of point, the draftsman in sharpening the pencil should attempt to flatten the lead on the sandpaper pad. This is merely another method of sharpening a drawing pencil which certain individuals prefer. The end result, however, should be the same - sharp, clear lines.

Today, many draftsmen use mechanical drawing pencils. Here a long lead is inserted in the pencil and sharpened as above. There are also modern mechanical sharpening devices issued by several manufacturers of drafting equipment.

QUESTIONS:

1. Why use so much time in sharpening a drawing pencil?
2. Why must a draftsman use sharp, clear lines?
3. Explain the care and use of a mechanical drawing pencil.
4. Why must a draftsman be neat?

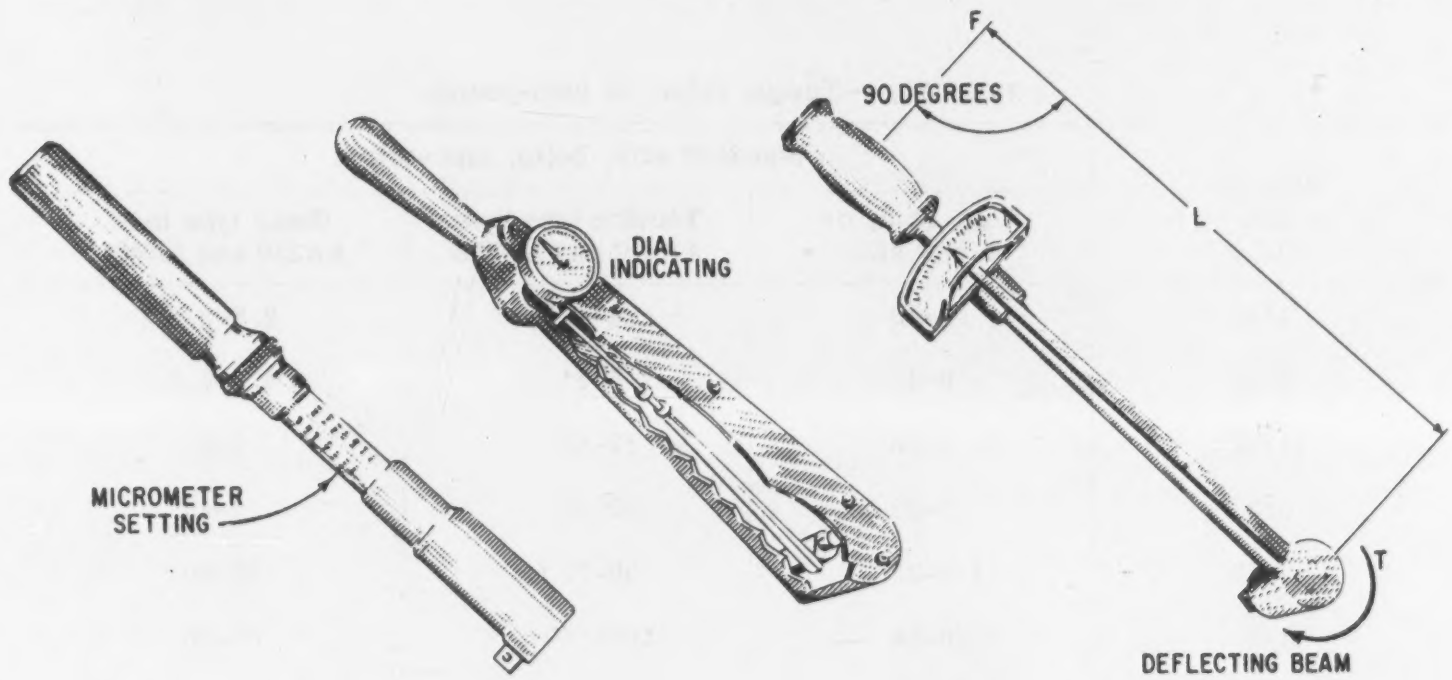

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Figure 7-8.–Torque wrenches.

alined with slots in nut. Do not back off nut to aline hole.

When it is necessary to tighten from the bolthead, use the high side of the torque range. If necessary, the maximum allowable tightening torque may be used.

When corrosion-resistant steel bolts are used, they should be lubricated with an anti-seize compound. Corrosion-resistant steel bolts and nuts must be used together. Use shear nut torque values when tightening these bolts.

RELAY TOOLS

Two of the more common handtools used to repair relays are the burnishing tool and the point bender. The use of these two items is discussed in the following paragraphs.

Burnishing Tool

Many relays have been damaged or ruined by the use of sandpaper or emery cloth to clean the contact points. Use of these abrasives causes bending of the contacts; and attempts to straighten them with long nosed pliers cause further damage, eventually requiring replacement of the relays. This can be avoided by using a burnishing tool to clean dirty contact points.

Figure 7-9 illustrates a burnishing tool being used on a relay.

Two common types of burnishing tools are stocked in supply activities and may be obtained through normal supply channels. These two common burnishing tools are 2 33/64 inches and 5 inches in length.

Be sure to clean the tool thoroughly with alcohol and do not touch the tool surface with your fingers prior to use.

Burned and pitted contacts cannot be repaired by burnishing. Relays having trouble this serious should be replaced.

Point Bender

Another handy tool that is often found in a toolbox is a point bender. The point bender (fig. 7-10) is used to straighten bent relay contacts. This bender can be fabricated locally from 0.125-inch diameter rod stock according to the dimensions in the figure.

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Table 7-1.—Torque values in inch-pounds.

Wrench size (in.)	Standard nuts, bolts, and screws		
	Bolt, stud, or screw size	Tension type nuts AN310 and AN365	Shear type nuts AN320 and AN364
1/4	4-48	4-5.5	2.5-3.5
5/16	6-40	7.5-11	4.5-6.5
11/32	8-36	12-15	7-9
3/8	10-32	20-25	12-15
7/16	1/4-28	50-70	30-40
1/2	5/16-24	100-140	60-85
9/16	3/8-24	160-190	95-110
5/8	7/16-20	450-500	270-300
3/4	1/2-20	480-690	290-410
7/8	9/16-18	800-1,000	480-600
15/16	5/8-18	1,100-1,300	660-780
1 1/16	3/4-16	2,300-2,500	1,300-1,500
1 1/4	7/8-14	2,500-3,000	1,500-1,800
1 7/16	1-14	3,700-5,500	2,200-3,300

NOTE: To convert to foot-pounds, divide inch-pounds by 12

WIRE AND CABLE TOOLS

An innovation in electrical connectors is the taper pin electrical connector for aircraft. The taper pin works on the principle of driving a taper wedge into a tapered hole and depending on friction to retain the pin in the hole. The taper pin connector makes a very good electrical and mechanical connection because of the high metal to metal contact pressure developed during the driving action of the insertion tool. Taper pins permit circuit changes to be quickly and easily performed without a soldering iron. Tests show that vibration and corrosion, over a period of time, improve the electrical continuity and increase the mechanical pulling force required to remove a taper pin. Another advantage of taper pins is the accessibility of test points for voltage and circuit continuity checks.

Insertion and Removal

A special tool, shown in figure 7-11, is used to properly insert the taper pin into the terminal block socket. The insertion tool has a calibrated

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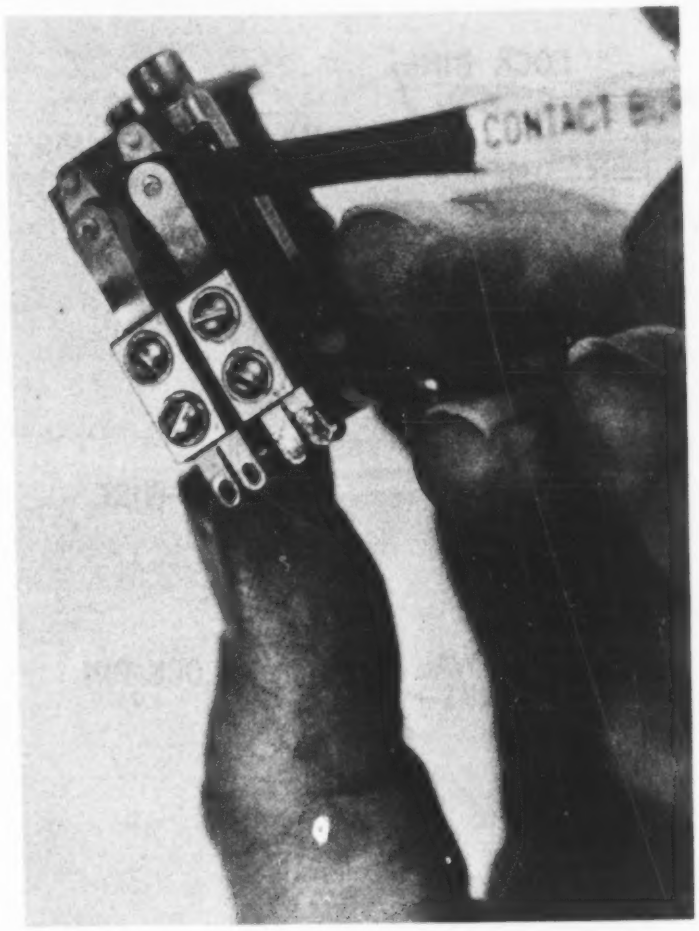

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Figure 7-9.–Burnishing tool.

driving spring, a calibrated pull test spring, a taper pin captive key, and a taper pin removal feature.

The driving spring adjusts to apply the proper driving impact to the pin. The pull test spring adjusts to apply the correct pull force on the pin to check for proper pin insertion. The captive key insures that each taper pin has a 100 percent pull test before the tool is disengaged from the pin. The removal lever is rotated to remove the taper pin from the terminal block socket.

In order to maintain the reliability of the system, it is imperative that the taper pin be properly inserted into the terminal block sockets. Pushing the pins into the sockets with the fingers or pliers will not make them stay–they must be driven in with the insertion tool. The tool must be calibrated to insure that the proper pressures are used. When inserting the taper pins, the insertion tool must be held at right angles to the terminal block, and pushed straight toward the terminal block without twisting the tool. The pins are very sensitive to twists, which could cause a faulty connection or a broken pin. Bent or broken pins should always be replaced. However, if correct installation procedures are followed, a taper pin may be installed and removed as many as 25 times before a replacement is necessary. A properly installed taper pin will pass the pull test of the insertion tool.

Three different sizes of taper pins are used to terminate wires from size 16 through size 22. The sizes are identified by color coding of the insulating sleeves. A crimping tool is used to attach the taper pin to the wire. This taper pin crimping tool is similar to other types of wire terminal crimping tools, such as those discussed later in this chapter.

Stripper

Nearly all wire and cable used as electrical conductors are covered with some type of insulation. In order to make electrical

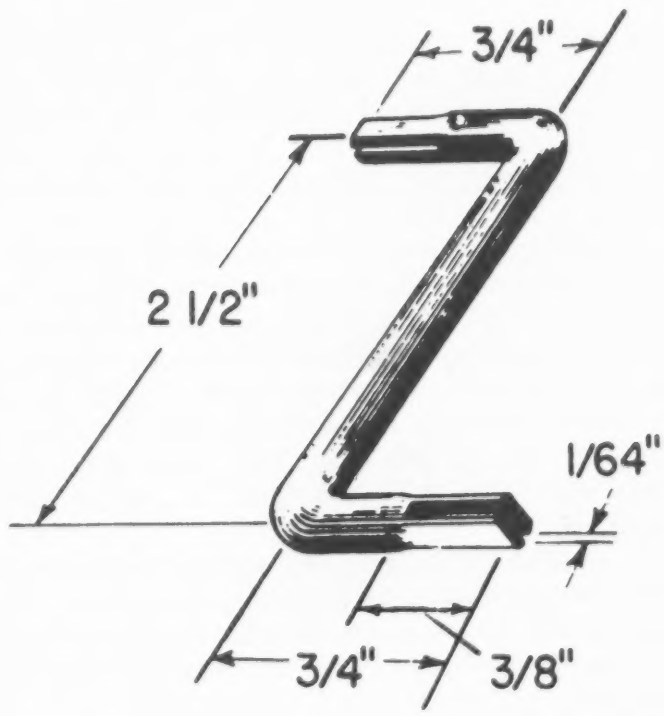

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Figure 7-10.–Point bender.

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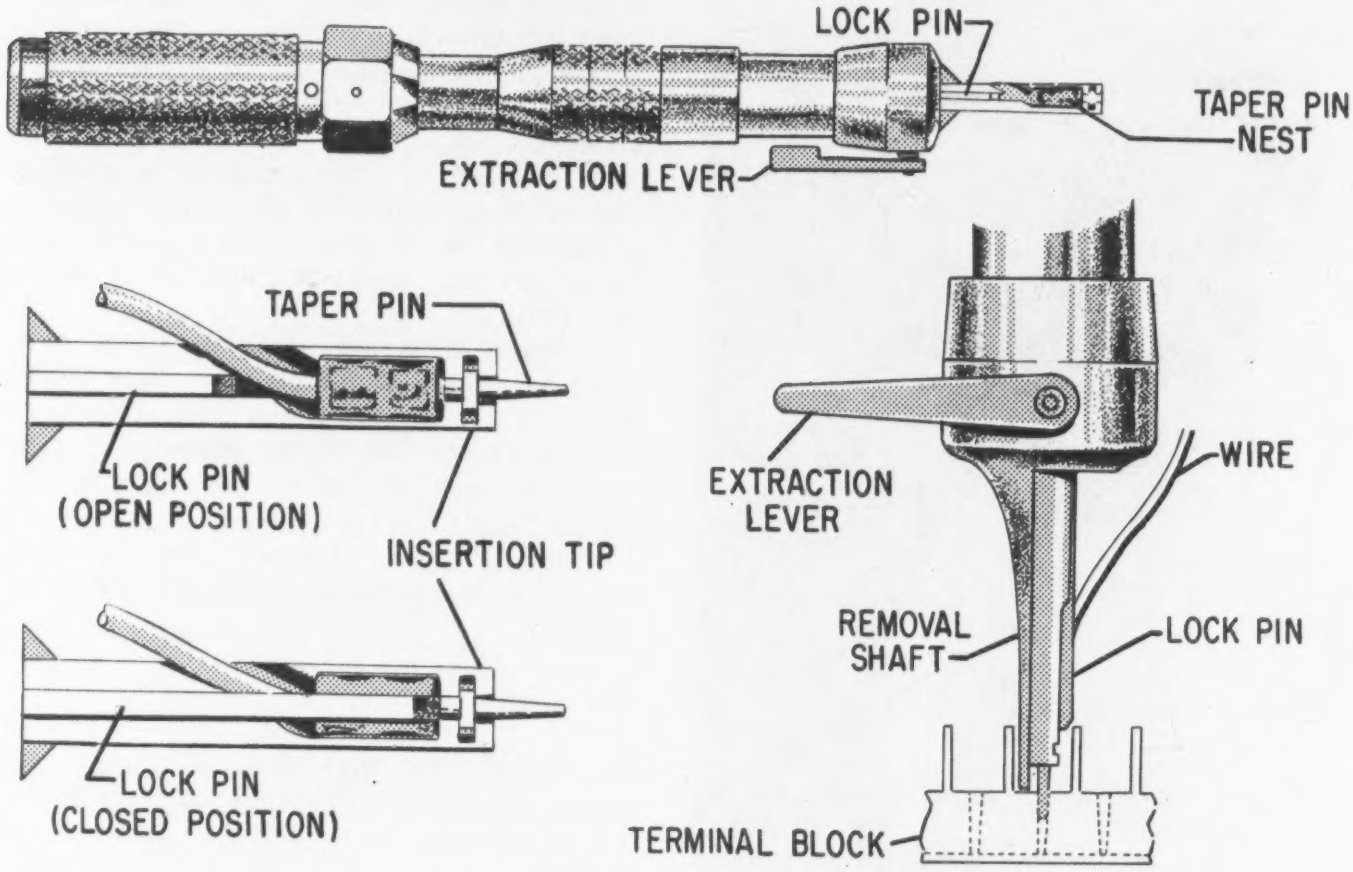

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Figure 7-11.–Taper pin insertion and removal tool.

connections with the wire, a part of this insulation must be removed, leaving the end of the wire bare. To facilitate the removal of this insulation, use a wire and cable stripping tool similar to the one shown in figure 7-12.

Although several variations of this basic tool are available, the most efficient and effective is the type illustrated. Its operation is extremely simple–insert the end of the wire in the proper direction to the depth to be stripped, position the wire so that it rests in the proper groove for that size wire, and squeeze. The tool functions in three steps as follows:

1. The cable gripping jaws close, clamping the insulated wire firmly in place. The wire must be inserted so that the jaws clamp the main section of the wire rather than the end to be stripped.

2. The insulation cutting jaws close, cutting the insulation. If the wire is not inserted in a groove, the conductor will also be cut. If the wire is positioned into too small a groove, some of the strands will be severed. If the groove is too large, the insulation will not be completely severed. Inserted properly into the correct groove, the insulation will be cut neatly and completely, and the wire will not be damaged.

3. The two sets of jaws separate, removing the clipped insulation from the end of the wire.

If cable and wire strippers of this type are not available, notches may be cut in the jaws of diagonal pliers or pocket fingernail clippers, using jeweler's files. Care must be taken to file the grooves into the proper positions in opposing jaws, and the size of the groove must be appropriate for the size wire on which it is to be used. When properly modified, these tools will perform satisfactorily if the more desirable stripper is not available.

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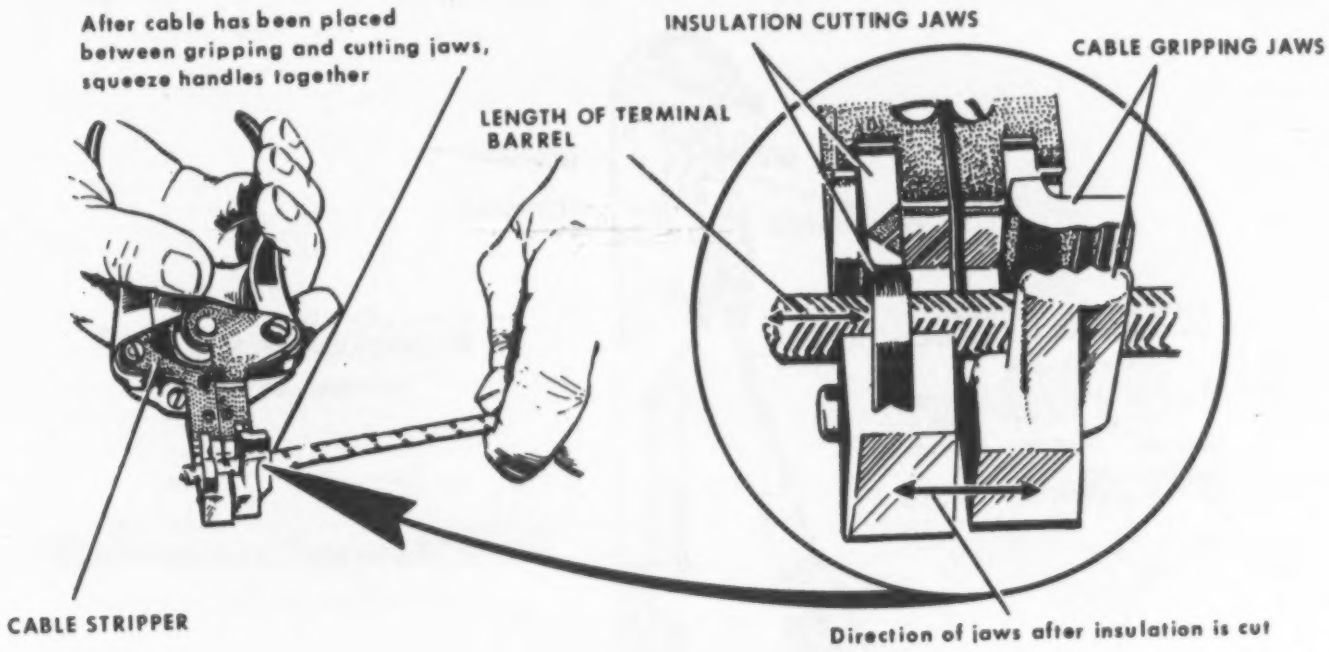

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Figure 7-12.–Wire and cable stripper.

CRIMPING TOOLS

Type MS 25037-1

The standard tool MS 25037-1, issued for crimping solderless terminals, is for use with standard insulated copper terminal lugs manufactured according to MS 25036. The standard tool employs a double jaw to hold the terminal lug or splice. One side of the jaw applies crimping action to fasten the terminal to the bare wire when the terminal is inserted, as shown at the left in figure 7-13. When the tool is used correctly, a deep crimp is placed in the B area of terminal lugs and splices, as shown in diagrams on the right of the figure. A shallow crimp is applied to the portion of the terminal or splice which extends over the insulation of the wire, as indicated by the A area in the diagrams. This clamping action is provided by a recessed portion in the other side of the divided jaw. A guard, which should be in the position shown when crimping terminals, aids in proper positioning of the terminal. However, the guard must be moved out of the way when the tool is used for crimping splices.

Without the guard, the tool may be used incorrectly; for example, the terminal might be inserted from the wrong side of the tool. The result is that the deep crimp is placed in the A area of the terminal or splice and, although the wire may be held securely in place, the connection is poor. Common sense indicates that the deep crimp must clamp the metal of the terminal to the bare metal of the wire in order to provide a good electrical and mechanical connection.

The MS 25037-1 tool requires occasional checking. A No. 36 (0.106) drill rod should not be able to enter the smaller (red or blue) nest when the tool is fully closed. If it does enter, have the tool repaired.

Instruction in proper crimping procedure should be furnished to all who need to make solderless terminal connections. Handbook of Installation Practices for Aircraft Electric and Electronic Wiring, NavAer 01-1A-505, contains detailed procedures for using many solderless connector tools.

Type MS 3191-3

This tool is the latest standard crimping tool designed specifically for use with type MS 3191 contacts for electrical connectors.

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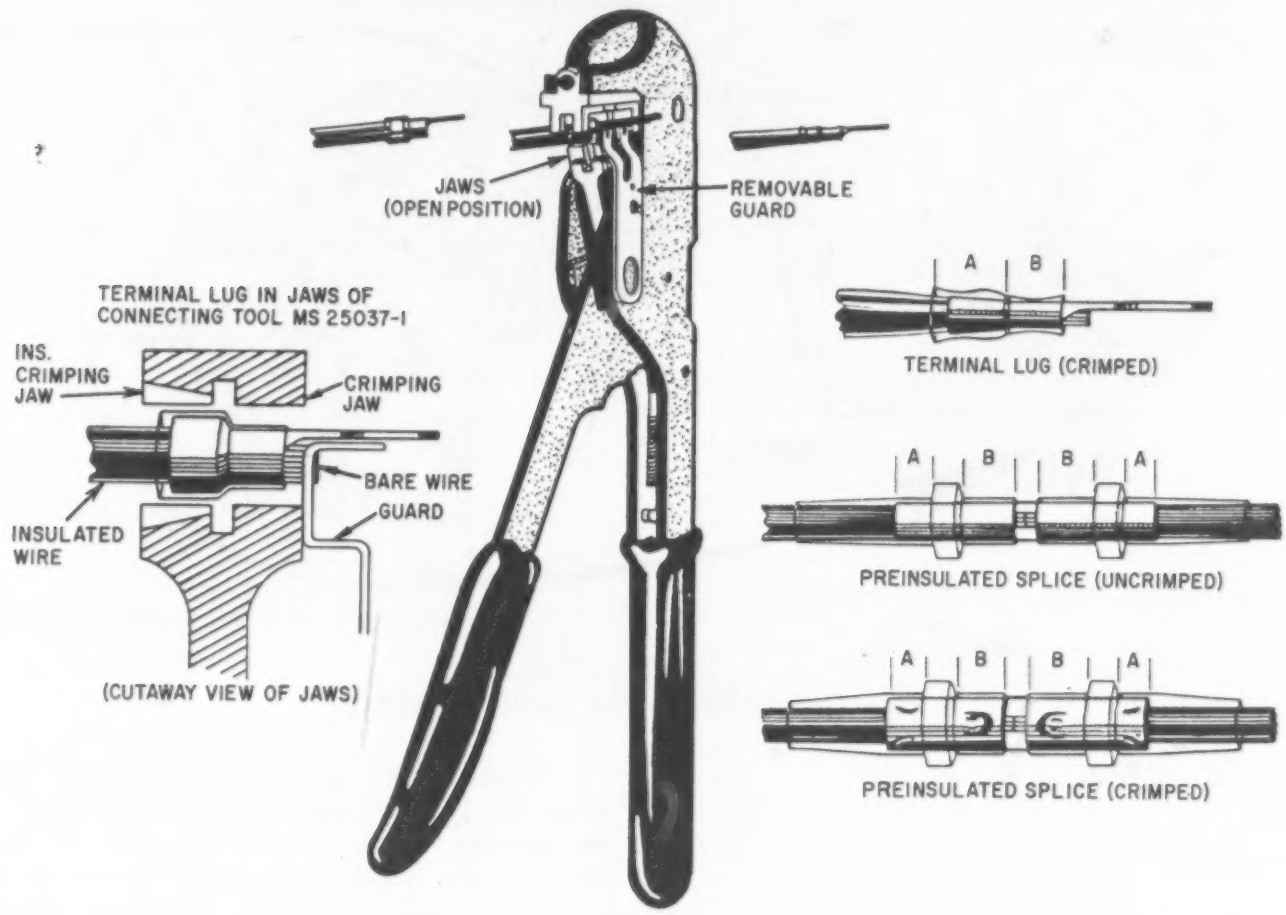

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Figure 7-13.–Crimping tool MS 25037-1.

It features interchangeable heads to accommodate various size terminals. It may be used with the turret (fig. 7-14 (A)) for normal use, or without the turret (fig. 7-14 (B)) for eyeball crimping.

Before using the tool, the correct selection must be made on the positioner head and also on the indentor gap selector plate. To release the turret for indexing, press the trigger and the spring-loaded turret snaps out to its indexing position. Select the desired position from the color-coded nameplate and rotate the turret to aline the selected positioner with the index. Depress the turret until flush, and the turret will automatically lock into place. To prevent further indexing, insert lockwire through the hole provided in the trigger.

To crimp a terminal, select the proper size and type terminal and insert the prepared wire into the contact pocket until the wire seats on the bottom. The wire should be visible through the inspection hole and the insulation should enter the contact insulation support. Insert the contact and wire into the terminal crimping tool, making sure that the contact is properly seated in the positioner. Actuate the crimping tool handles to crimp the contact and wire. At the completion of the stroke the ratchet releases; open the handles and remove the crimped contact from the tool.

Inspect the crimped terminal and wire. The wire must be visible through the inspection hole. The insulation must be inside the insulation support. The crimping indents must be positioned between the inspection hole and the front of the insulation support. The contact must not be bent. The crimped contact is now ready to be installed into a connector.

For eyeball crimping, remove the head assembly from the tool. Select the proper wire size and move the thumb button until the pointer is alined with the selected wire size

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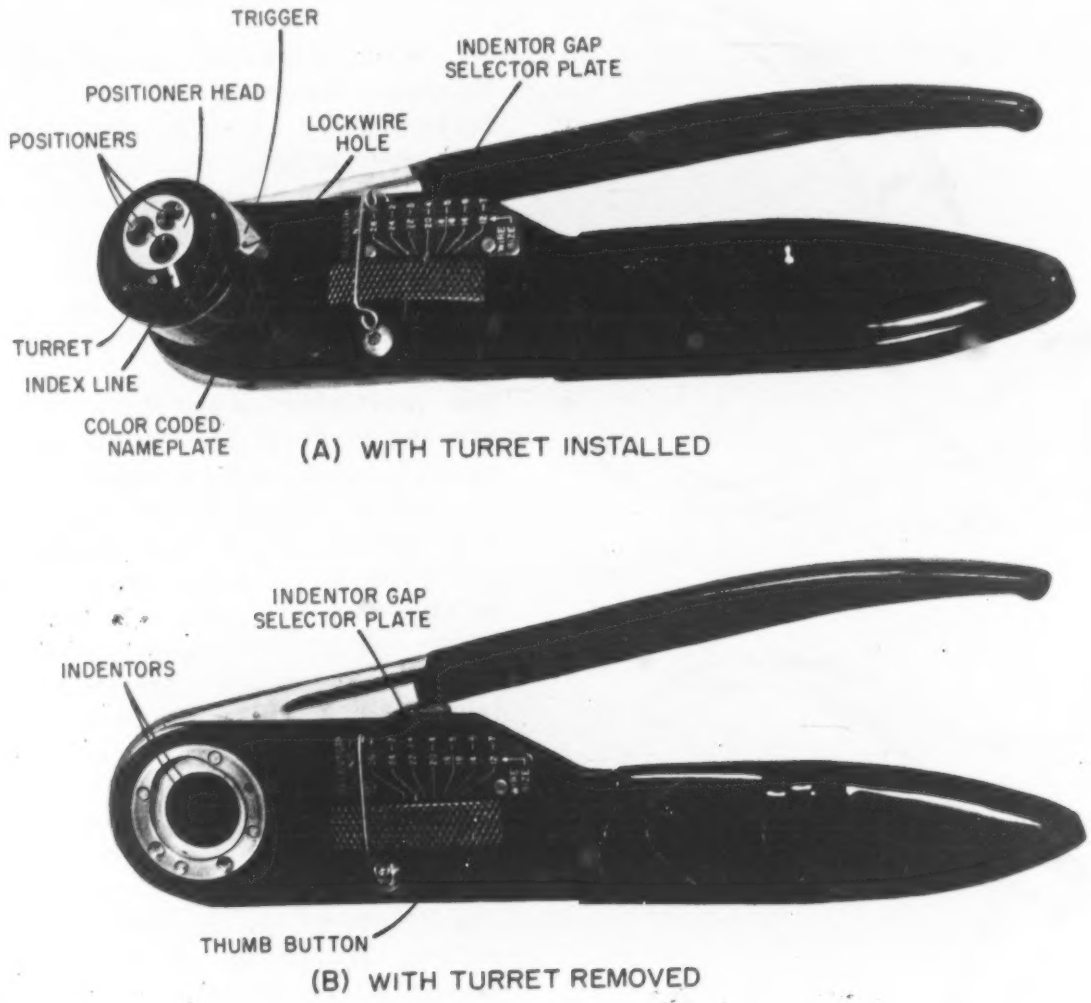

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Figure 7-14.–Crimping tool MS 3191-3.

on the indentor gap selector plate. Holding the contact in the crimping tool, slowly close the handles and at the same time position the contact so that the indentors are positioned midway on the contact barrel. Insert the wire, making sure it is bottomed in the contact, then close handles fully.

After releasing the handles, remove and inspect the crimped contact. The contact must not be fractured, and the conductor must be visible in the inspection hole.

DIAGONAL PLIERS

Diagonal pliers are described briefly in Basic Handtools, NavPers 10085-A. The following discussion describes a modification which is advantageous when the diagonal pliers are used in the maintenance of equipment aboard aircraft where working clearances are likely to be close.

The diagonal pliers (fig. 7-15) have been modified by adding potting compound to the jaws. This prevents loss of small pieces of wire into the equipment when cutting wire. The potting compound also allows the technician to cut the wire without holding onto the piece being cut away. (Figure 7-15 (A) shows the diagonals before being modified.) If you do not have a pair of these modified diagonal pliers, manufacture your own by adding potting compound. Before applying the potting compound, clean the diagonals with solvent; then secure the handles with a rubberband (fig. 7-15 (C)) and apply the compound. Allow 24 hours for the compound to dry. The jaws may be separated by slicing them apart with a single edge razor blade.

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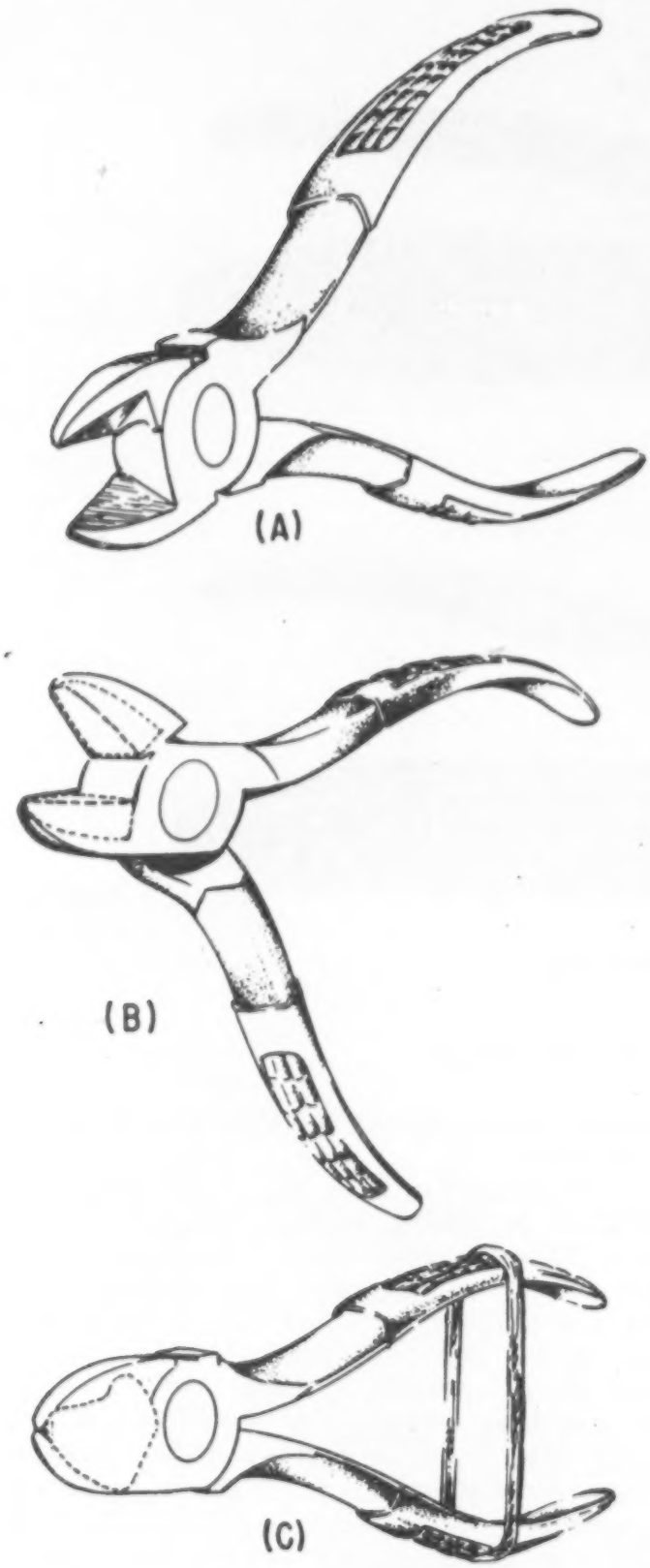

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Figure 7-15.–Diagonal pliers. (A) Without compound; (B) with compound; (C) applying compound.

SAFETY WIRING PLIERS

When installing equipment in aircraft, it becomes necessary to lockwire (usually referred to as safety wire) designated parts of the installation. The process of lockwiring can be accomplished faster and neater with the use of special pliers. However, the use of these pliers requires extreme care. The wire must be installed snugly, but not so tight that the part of the wire is overstressed. The routing of the twisted wire is prescribed by the particular installation, and in many instances is designated in the appropriate Maintenance Instructions Manual.

Safety wiring pliers (fig. 7-16) are three-way pliers, which hold, twist, and cut. They are designed to reduce the time used in twisting safety wire on nuts and bolts. To operate, grasp the wire between the two diagonal jaws, and the thumb will bring the locking sleeve into place. A pull on the knob twirls the twister, making uniform twists in the wire. The spiral rod may be pushed back into the twister without unlocking it, and another pull on the knob will give a tighter twist to the wire. A squeeze on the handle unlocks the twister, and the wire can be cut to the desired length with the side cutter. The spiral of the twister should be lubricated occasionally.

MECHANICAL FINGERS

Small articles which have fallen into places where they cannot be reached by hand may be retrieved with the mechanical fingers. This tool is also used when starting nuts or bolts in difficult areas. The mechanical fingers (fig. 7-17) have a tube containing flat springs which extend from the end of the tube to form claw-like fingers, much like the screw holder. The springs are attached to a rod that extends from the outer end of the tube. A plate is attached to the end of the tube, and a similar plate to be pressed by the thumb is attached to the end of the rod. A coil spring placed around the rod between the two plates hold them apart and retracts the fingers into the tube. With the bottom plate grasped between the fingers and enough thumb pressure applied to the top plate to compress the spring, the tool fingers extend from the tube in a grasping position. When the

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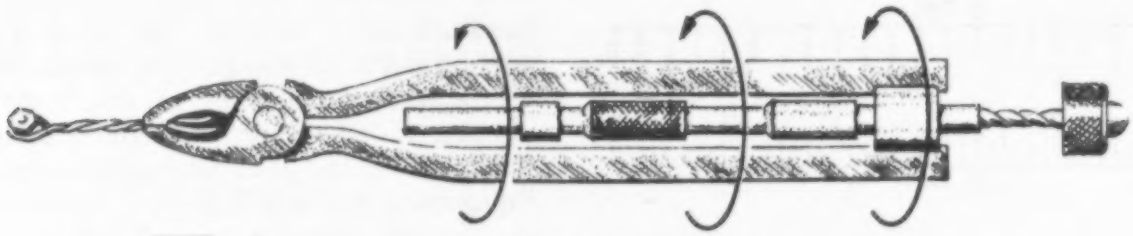

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Figure 7-16.–Safety wiring pliers.

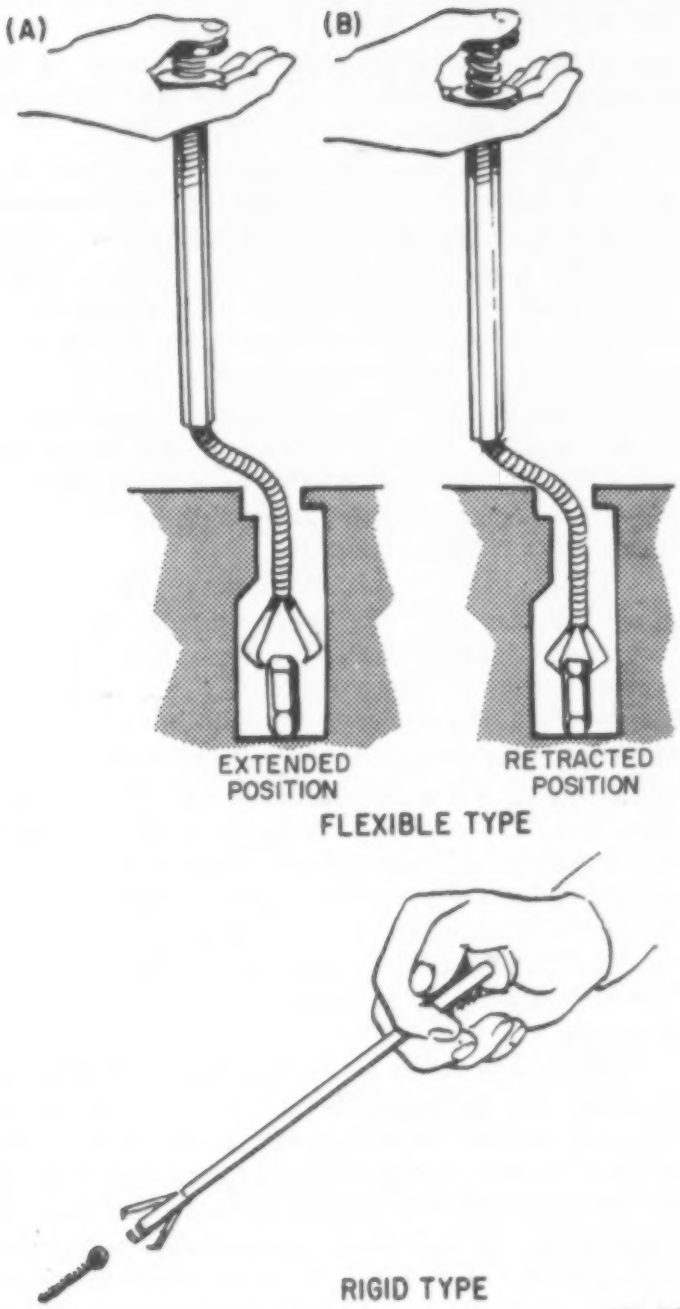

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Figure 7-17.–Mechanical fingers.

thumb pressure is released, the tool fingers retract into the tube as far as the object they hold will allow. Thus, enough pressure is applied on the object to hold it securely. Some mechanical fingers have a flexible end on the tube to permit their use in close quarters or around obstructions.

NOTE: Mechanical fingers should not be used as a substitute for wrenches or pliers. The fingers are made of thin sheet metal and can be easily damaged by overloading.

STEEL SCALE

The steel scale (fig. 7-18) is a measuring device that will usually be found in a toolbox. It is graduated in divisions of 1/8 and 1/16 inch on one side and 1/32 and 1/64 inch on the other side. The steel scale most commonly used is 12 inches long.

Measurements are taken with a steel scale by holding it on its edge on the surface of the subject being measured. This will prevent making errors which might be caused by the thickness of the scale. Such thickness causes the graduations to be a slight distance away from the surface of the object. Measurements are read at the graduation which coincides with the distance to be measured.

FLASHLIGHT

Each toolbox should have a standard Navy vaporproof two-cell flashlight. The flashlight is used constantly during all phases of maintenance. Installed in both ends of the flashlight are rubber seals which keep out all vapors. The flashlight should be inspected periodically for the installation of these seals, the spare

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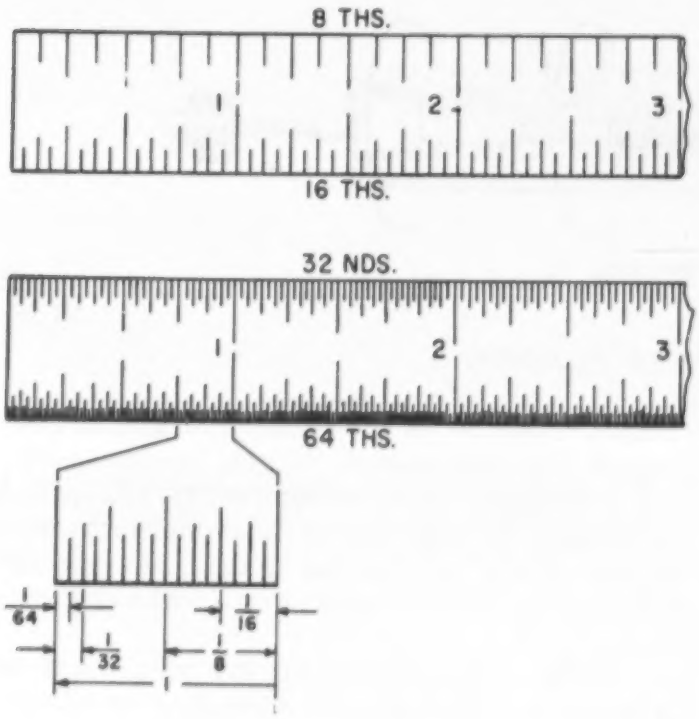

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Figure 7-18.–Steel scale.

bulb, and red lens which are contained in the end cap. NOTE: Do not throw away the red lens; it will be necessary during night operations.

INSPECTION MIRROR

There are several types of inspection mirrors available for use in aircraft maintenance. The mirror is issued in a variety of sizes and may be round or rectangular. The mirror is connected to the end of a rod and may be fixed or adjustable. (See fig. 7-19.)

The inspection mirror aids in making detailed inspection where the human eye cannot directly see the inspection area. By angling the mirror, and with the aid of a flashlight, it is possible to inspect most required areas.

TOOL KITS, SHOP TOOLS, AND TOOL CRIBS

One of the first steps taken when a new man reports for duty in a squadron or activity is to issue him an individual toolbox. The toolbox should contain the low-cost, high-usage handtools that will enable him to perform the tasks assigned. The purpose of the individual handtool kit is to make the necessary tools for performance of line and/or hangar maintenance immediately available to the individual. The contents of the individual handtool kit are among the tools listed in Consumable General Support Equipment for All Types, Classes, and Models of Aircraft, NavAir 00-35QG-016.

Under the crew leader concept of maintenance, the crew leader's kit has the same type tools as the individual handtool kit. It is issued to an individual of a crew, and is to be used by all members of that crew. Thus, the crew leader's handtool kit will have several of the same type and/or size tool where the individual kit has only one.

Shop tools are the larger, low-usage, and special tools for use on specific equipments. A shop tool bin is normally utilized to make available those special tools and medium-usage tools needed to perform the various phases of shop maintenance. However, shop tools also include any handtools required to perform more extensive maintenance than can be accomplished from a toolbox or a crew leader's kit. To determine the types and number of shop tools allowed, refer to the applicable allowance list from the NavAir 00-35QG-0 series.

Frequently, a squadron tool crib has the responsibility for all tools in the squadron, including issuance of tools, inventory of toolboxes, and ordering new tools for replacement of broken or lost tools. A squadron tool crib is set up under the responsibility of the maintenance department. Its purpose is for the stowage and issuance of low-usage handtools and those which are common to more than one shop. Special tools provided by the aircraft manufacturer are also stowed in the tool crib. A complete list of these special tools can be found in the Maintenance Instructions Manual, section one, for each type aircraft.

The tools used in an aircraft maintenance activity are determined by the mission of the activity and the type aircraft to be maintained. In view of this, there is no hard and fast rule as to the type and/or number of tools that may be supplied in the different handtool kits and cribs. The quantity and types of tools allowed for an activity may be found in the appropriate allowance list.

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UNIT I - INTRODUCTION

Sketching Freehand Lines — Lesson 3

OBJECTIVE: To learn how to sketch freehand lines.

RELATED INFORMATION:

In order to properly sketch freehand lines, remember to relax and hold the pencil with freedom and not close to the point. In drawing any straight line, be it vertical or horizontal, keep the eyes on the point to which the line is to go rather than on the point of the pencil. Do not try to draw the whole length of a line in a single stroke. It may be an aid to draw a very light line first and then correct the direction of the light line with the finished line without rubbing out the light line. Do not be too disturbed by any waviness, for the accuracy of direction is more important than the smoothness of the line. Once more bear in mind that practice and experience alone will enable you to be a better sketcher. This is important in the field of drafting, for oftentimes you will be called upon to quickly sketch a drawing rather than make a formal instrument drawing.

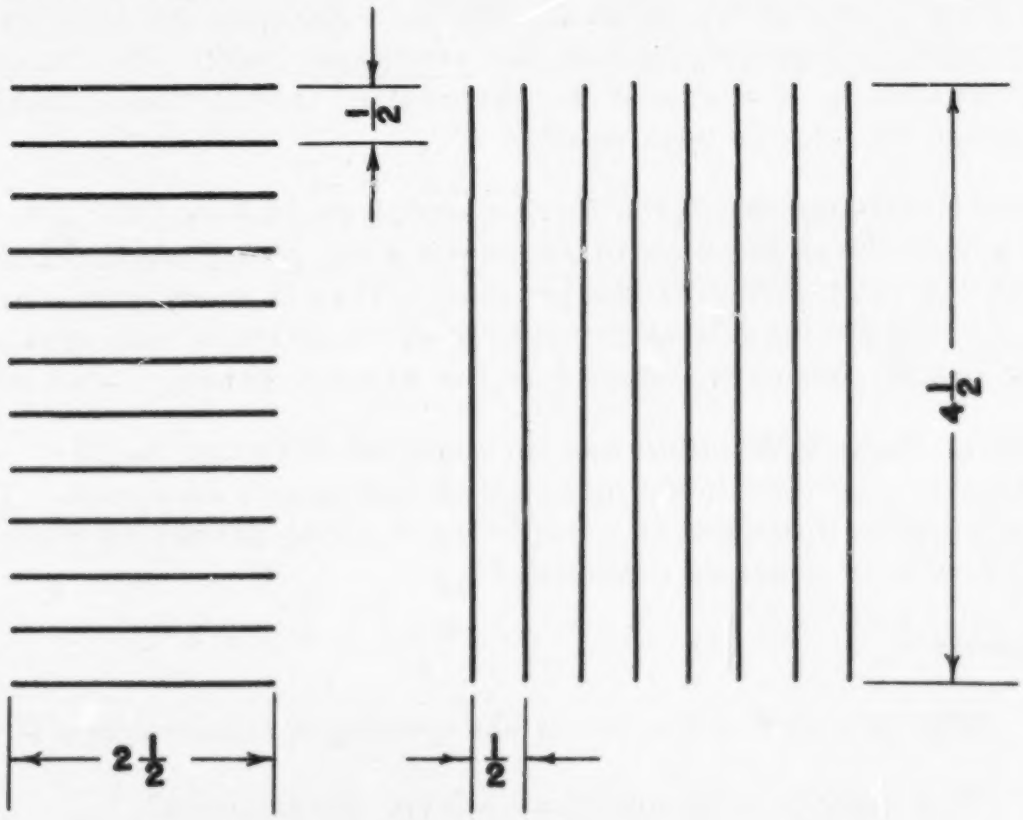

THIS IS A SAMPLE OF MY LETTERING.
JOHN JONES SEPT.10, 1963.
215 LEXINGTON AVE. ELIZ. N. J.
T. A. EDISON VOC.& TECH. H. S.

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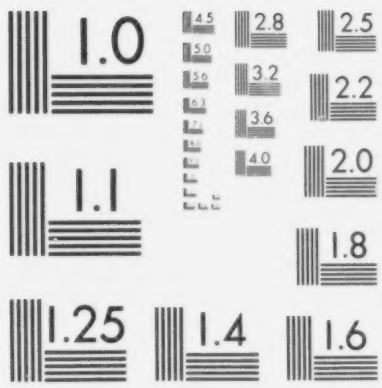

MICROCOPY RESOLUTION TEST CHART

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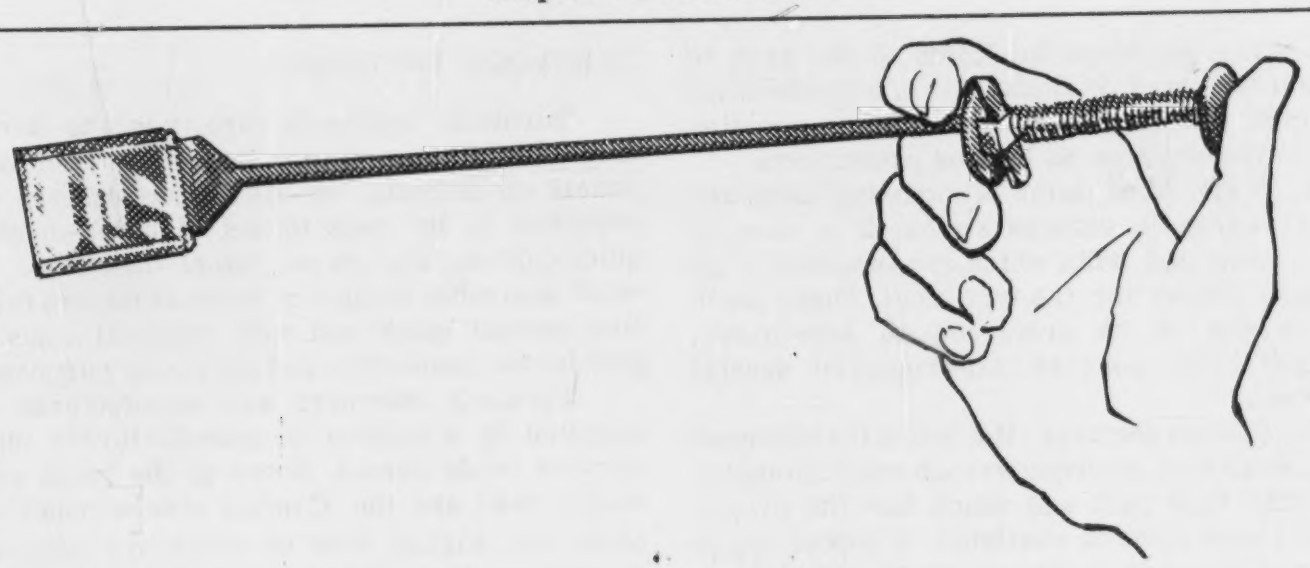

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Figure 7-19.—Typical inspection mirror

AIRCRAFT HARDWARE

MOUNTING PARTS

Items of hardware used when installing equipment in aircraft are specified in the applicable Maintenance Instructions Manual. In all instances, the proper parts should be used; if substitution becomes necessary, care must be taken that the substitute item is satisfactory in all respects.

It is not always desirable to use the same mounting parts that were removed from the installation. Prior to reinstalling the same items, an inspection must be made to insure that the parts are of the type specified, and are not defective or damaged. It must also be determined that instructions do not forbid their reuse. Then, and only then, may the removed parts be reinstalled.

General information regarding such mounting parts as screws, nuts, bolts, washers, etc., is included in the Rate Training Manual Airman, NavPers 10307-B. Aircraft Structural Hardware for Aircraft Repair, NavWeps 01-1A-8, is a valuable source for detailed information.

Substitution of Parts

If the specified mounting parts cannot be obtained, a temporary installation may be made using suitable substitute parts; but these parts should be replaced with the proper items as soon as they can be obtained. When making parts substitutions, special attention must be given to the following considerations:

1. Corrosion. The chemical or metallic composition of the part must be such that its use does not contribute appreciably to the danger of corrosion.

2. Strength. The strength of the substitute part must be the same, or greater than the ones prescribed. (When determining the strength, consideration should be given to the tensile, compression, and/or shear strength, as applicable to the specific use.)

3. Size. Substitute bolts and screws should be the same size as the prescribed item. If a detachable nut is to be used, a different thread may be tolerated; if a threaded hole or an anchor nut is involved, the thread must be the same as the one prescribed. In all cases, washers must have the same inner diameter as the prescribed item, but a different outer diameter or thickness may sometimes be permitted.

4. Length. Substitute screws or bolts must have a length which is sufficient for the particular installation, but must not be so long that they are in the path of any moving part. They must not be in contact with other aircraft items such as electrical wiring, hydraulic lines, etc.

5. Magnetic properties. Specific areas of the aircraft (for example, vicinity of such items as the magnetic compass, magnetic anomaly detection equipment, radio direction finder, or gyros) should not be changed in a manner that

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may cause the magnetic fields of the area to become distorted. In these areas, any substitute part must possess the same magnetic properties and characteristics as the one prescribed.

6. Style. Most items of mounting hardware are available in various styles. It is easy to find screws and bolts which are identical in all respects except for the type head. These parts are usually to be preferred as substitutes, provided they possess all required special features.

7. Special features. If a bolt is to be torqued to a given value, a torque wrench which is usable with that type part and which has the proper torque range must be available. If lockwiring is required, the part must have suitable provisions.

8. Lubrication or coating. If specific instructions call for lubrication or coating of the parts, they must be followed for the substitute part as well as for the prescribed part. If no lubrication is permitted, the substitute part is not to be lubricated.

TURNLOCK FASTENERS

Turnlock fasteners are used to secure inspection plates, doors, and other removable panels on aircraft. Turnlock fasteners are also referred to by such terms as quick-opening, quick-action, and stress panel fasteners. The most desirable feature of these fasteners is that they permit quick and easy removal of access panels for inspection and servicing purposes.

Turnlock fasteners are manufactured and supplied by a number of manufacturers under various trade names. Some of the most commonly used are the Camloc stress-panel fastener and Airloc, both of which are discussed in this section. Other turnlock fasteners are covered in the Rate Training Manual Airman, NavPers 10307-B.

Camloc Stress-Panel Fasteners

The Camloc stress-panel fastener (fig. 7-20) is a high-strength, quick-release, rotary

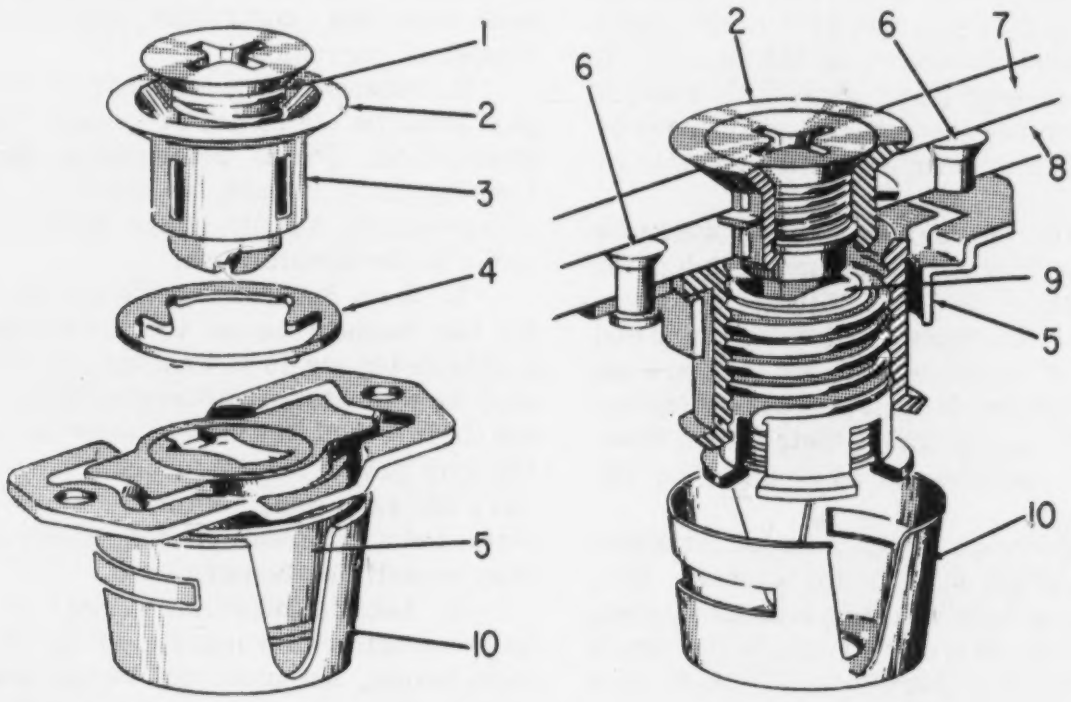

1. Tension spring.
2. Stud assembly.
3. Bushing.
4. Retaining ring.
5. Receptacle assembly.
6. Receptacle attaching rivets.
7. Outer skin.
8. Inner skin.
9. Insert
10. Cover.

AT.85

Figure 7-20.—Camloc stress-panel fastener.

type fastener and may be used on flat or curved, inside or outside panels. The fastener may have either a flush or nonflush stud. The studs are held in the panel with flat or cone-shaped washers, the latter being used with flush fasteners in dimpled holes.

This fastener may be distinguished from screws by the deep No. 2 Phillips recess in the stud head and by the bushing in which the stud is installed. A threaded insert in the receptacle provides an adjustable locking device. As the stud is inserted and turned counterclockwise 1/2 turn or more, it screws out the insert sufficiently to permit the stud key to engage the insert cam when turned clockwise. Rotating the stud clockwise 1/4 turn engages the insert; and continued rotation screws the insert in, tightening the fastener. Turning the stud 1/4 turn counterclockwise will then release the stud but will not screw the insert out far enough to permit reengagement in installation. It is necessary to turn the stud at least 1/2 turn counterclockwise to reset the insert.

To unlock the stress-panel fastener and reset it in the same operation, use a No. 2 Phillips screwdriver (or equivalent), turning the stud counterclockwise 1/2 turn or more. Do not turn the stud past stop.

CAUTION: Do not use a power screwdriver on this fastener.

To lock use a Phillips No. 2 screwdriver (or equivalent) push the stud in and turn clockwise until increased torque is felt; then continue turning until the fastener is tight.

NOTE: When installing a large panel, it may be necessary to engage all the fasteners before tightening. This is done by pushing each stud in and turning it clockwise 1/4 turn. The stud should engage the receptacle but remain loose. If the stud does not engage, it will pop out, indicating that the insert must be reset by turning the stud counterclockwise 1/2 turn or more.

Airloc Fastener

The Airloc fastener consists of a stud, stud cross pin, and a receptacle. (See fig. 7-21.) The stud is attached to the access cover, and is held in place by the cross pin. The receptacle is riveted to the access cover frame. A quarter turn of the stud (clockwise) locks the fastener in place, and turning the stud counterclockwise unlocks the fastener.

THREADED FASTENERS

Threaded fasteners are covered in the Rate Training Manual Airman, NavPers 10307-B. However, a brief discussion of a new development in threaded fasteners is included in this text.

"Torq-Set" Screws

"Torq-Set" machine screws (offset cross-slot drive) have recently begun to appear in new equipment. The main advantage of the newer type is that more torque can be applied to its head while tightening or loosening than any other screw of comparable size and material without damaging the head of the screw.

Torq-Set machine screws are similar in appearance to the more familiar Phillips machine screws.

Since a Phillips driver could easily damage a Torq-Set screwhead, making it difficult if not impossible to remove the screw even if the proper tool is later used, maintenance personnel should be alerted to the differences. (See fig. 7-22.)

ACCOUNTABILITY

A definition of the word accountability is "the state or quality of being responsible–a charge (object) for which one is responsible or accountable." The Navy has a code that is called Material Accountability Recoverability Codes (MARC's). These codes appear in column 3 of the Section G Allowance List, NavAir 00-35-QG-0 Series and are illustrated by the following examples:

Code:

B—Exchange consumables—requiring old items for replacement items such as items containing precious metal, highly pilferable items, or certain high cost items. Example: Drill, electric portable, FSN 9Q 5130-226-5384.

C—Consumables—expendables. Example: Stripper, wire, FSN 9Q 5110-268-4220.

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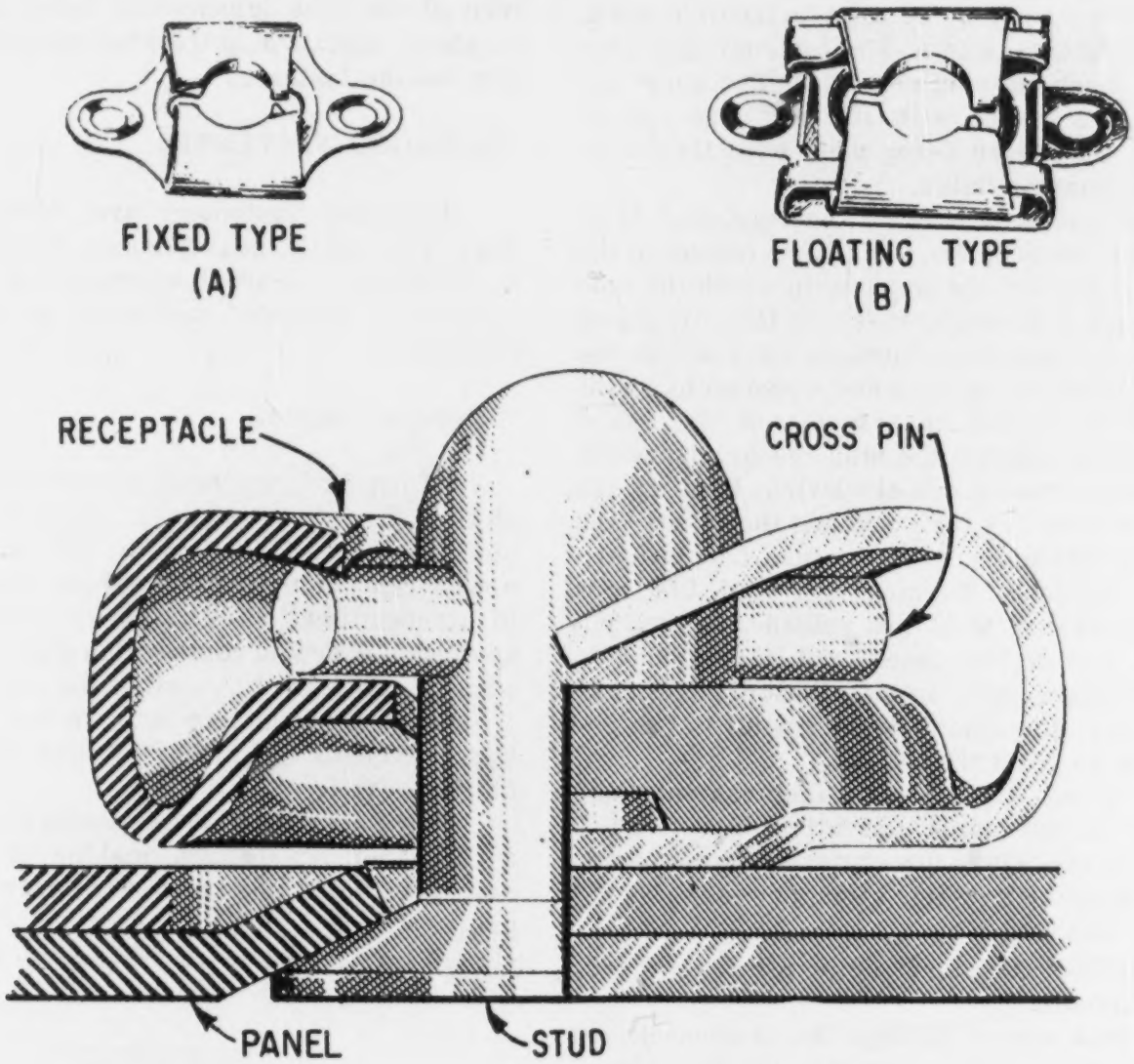

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Figure 7-21.–Airloc fastener.

ALLOWANCE LISTS

Allowance lists are lists of equipments, material, and/or tools made available to an organization for performance of maintenance.

NavAir 00-35QG-0 Series

These allowance lists contain allowances of shop and general support equipment and material which will be made available for maintenance support of aircraft as may be assigned or supported by the following levels of maintenance:

1. Intermediate level (shop).
2. Organizational level (hangar/line).
3. Advanced base components, excluding Aircraft Fleet Marine Force activities supported by tables of basic allowances.

CUSTODIAL RESPONSIBILITY

Most handtools are not feasibly repairable. Due to this fact and their original low cost (compared to shop tools), they are classed as consumable. However, the activity must pay for replacements. Therefore, it is the duty of each individual to help eliminate the need for replacements. One method of accomplishing this is by carrying an inventory of tools in your toolbox so that upon completion of a job you can be sure that all of the tools are ac-

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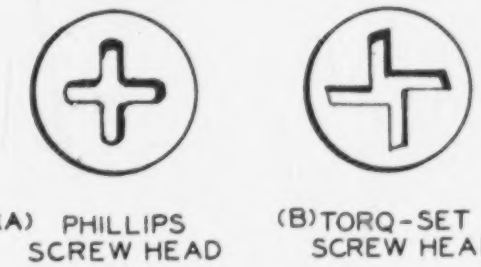

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Figure 7-22.—Comparison of Phillips and Torq-Set screwheads.

counted for. A tool that has been lost represents a waste of funds; in addition, it is a definite liability. If it has been left loose in an aircraft, it can become a dangerous missile when the aircraft is launched or when the aircraft is performing violent maneuvers.

Inventory Requirements

The basic objective of an inventory is to insure a proper balance between the supply of, and the demand for, those tools required for the efficient operation and maintenance of a squadron or maintenance activity. To accomplish this objective it is necessary that tools be identified and cataloged to provide accurate knowledge of the tools being used. Each item should be accounted for every 30 to 90 days in accordance with squadron instructions. The number of handtools on hand in relation to the number required by the activity should be indicated by the inventory.

Reordering Tools

Tools are reordered as the inventory requirements dictate. Usually the senior petty officer or his delegate reorders all tools—both shop tools and those for individual toolboxes, as they are needed. However, squadron or maintenance activity policy is followed in all cases.

It is unwise to wait until the number of tools needed is too large, as it is easier for the supply department to fill a small order rather than a large one.

Tools are ordered by reference to Consumable General Support Equipment for All Types, Classes, and Models of Aircraft, NavAir 00-35QG-016.

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CHAPTER 8

ELECTRONIC TEST EQUIPMENT

Other chapters of this manual discuss the basic principles and concepts of some of the equipment which the technician may encounter. An understanding of the theory of operation of these equipments forms only a portion of the knowledge necessary to successfully perform the maintenance tasks required. A thorough knowledge of electrical and electronic test equipment is also needed.

All electronic test equipment is designed and constructed to perform tests of one or more specific types. These tests are used to determine the proper operation or alinement of electronic sets, circuits, or parts. The performance of electronic ASW units in the aircraft is determined by the accuracy of the test equipment used to calibrate and aline them and the care with which the technician performs these jobs. Without test equipment very few electronic devices could be used; therefore, it follows that every technician should learn to use test equipment properly.

The test equipments discussed in this chapter are typical of the ones currently in use in the fleet. No attempt is made to include theory beyond that necessary to describe the operation of the test set under discussion. Whenever the technician must use a piece of test equipment with which he is not familiar, he should always consult the appropriate instruction manual. These publications contain detailed and specific information on the particular equipment. The purpose of this chapter is to discuss some of the different test equipments from the standpoints of operation and general operational and maintenance procedures.

CARE AND USE OF TEST EQUIPMENT

All electronic maintenance shops are provided with a variety of test equipment to be used in maintaining the many different types of electronic units its supports. However, there are very few spare test sets. When a test set becomes inoperative, shop maintenance suffers. Therefore, every man must use the test equipment only for the purposes and in the manner for which it was designed. Protect the equipment from physical harm that may result from dropping, falling, or any other careless misuse, and always observe proper operating techniques.

One of the chief causes of test set failure is carelessness. The user can be careless in operating procedure or in handling the set. The usual carelessness in operating procedure is improper selection of range for the quantity to be measured, such as attempting to measure 250 volts on the 50-volt scale of a meter. If there is any doubt about proper usage of a test set, it is wise to refer to the manual issued with the set.

Much damage to test equipment results from improper handling. Technicians often place test sets near the edge of the bench where they can easily be knocked off or pulled off by the test leads. Read the instructions for proper handling and operating procedure, and think while using the equipment.

CALIBRATION

Most test sets require occasional checks to determine if they are within operating tolerances. Some test sets are used as frequency standards and require periodic calibration. In every case the recommendations of the manual

or pamphlet issued with the set should be followed, unless those recommendations have been changed by current instructions.

Calibration is normally performed in a shop that is equipped with special purpose test sets. It is seldom accomplished at the organizational level of maintenance.

REPAIR

Minor repair of test sets is often accomplished at the organizational level of maintenance. When calibration of the set is not involved. Repairs are usually limited to replacement of test leads and fuses. Current instruction on repair of test equipment should be consulted before attempting any repairs of a major nature.

HANDLING PRECAUTIONS

Some equipments may require special handling; however, there are several precautions which apply to test equipments in general. Rough handling, moisture, and dust all affect the useful life of such devices. Bumping or dropping a test instrument, for example, may destroy the calibration of a meter or short circuit the elements of an electronic tube within the instrument. Creasing or denting coaxial test cables will alter their attenuating effect, thereby affecting the accuracy of any RF measurements made with these cables in the circuit.

To reduce the danger of corrosion to untreated parts, always store test equipment in a dry place when it is not in use. Excessive dust and grime inside a test equipment also affects its accuracy. Be sure that all the assembly screws which hold the case of the test equipment in place are tightened securely. As an added precaution, all dust covers should be placed on test equipments when they are not in use.

Meters are the most delicate parts of test equipments. In order to insure that the meter will maintain its accuracy, these additional precautions should be followed:

1. Make certain that the amplitude of the input signal under test is within the range of the meter.
2. Keep meters as far away as possible from strong magnets.
3. When servicing an item of electronic equipment which contains a meter, disconnect the meter from the circuit before making resistance or continuity tests.

(The latter precaution will eliminate the possibility of burning out the meter.)

The instructions for properly stowing test equipment cables and other accessories, as set forth in the instruction manuals accompanying the equipment, should be carefully read and strictly followed. Improper stowage of accessories results in changes in cable characteristics, intermittent shorts in cables and leads, and, in general, causes unreliable test equipment indications.

MEASURING INSTRUMENTS

The term "measuring instruments," as used in this discussion, includes only that class of test equipments which measure the basic parameters of an electronic equipment. The basic parameters are (in this application) voltage, current, resistance, power, frequency, and field intensity.

The discussion of measuring instruments includes test equipment classes designated as multimeters, electronic voltmeters, power measuring devices, frequency meters, and field intensity measuring devices.

REVIEW OF METER OPERATION

There must be some source of power available to operate a meter. Some meters are powered by batteries installed in the meter case, others are supplied through an electrical power cord which is plugged into a power receptable; a vacuum tube volt meter (VTVM) is an example of the latter type. The power to operate some meters (such as the megger) is produced by manual operation of a handcrank. Each of these three types are described in the following paragraphs.

Most meters are designed to be used for measuring more than one electrical quantity, and are called multimeters. Before discussing any one particular type meter, a brief review of each of the basic meters is presented.

Ammeter

The amplitude of current flow through the basic meter mechanism limits it to measuring a fixed range of only a fraction of an ampere. To

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overcome this limitation, and to protect the mechanism, a current shunt is used. This device, which is actually a resistance of low value, permits the instrument to serve as a d-c ammeter in the measurement of relatively large direct currents.

The current distribution between meter movement and shunt is inversely proportional to their individual resistances. Thus, the shunt (which has less resistance) carries the majority of the current. Since the meter coil carries only a small portion of the circuit current, it is capable of indicating relatively large values of circuit current. The instrument may be adapted to a variety of current ranges by the use of shunts of different values which are switched in or out as required. Figure 8-1 shows a simplified schematic diagram of an ammeter-section taken from a typical volt-ohm-milliammeter.

Ohmmeter

For any given ohmmeter, midscale deflection is obtained when the current drawn by the meter is one-half the value of the current at full-scale (zero ohms) deflection. This condition exists when the resistance being measured is equal to the total meter circuit resistance. Analysis of the circuit in figure 8-2, shows the full-scale deflection is obtained when the meter probes are shorted together, and that less than full-scale deflection is obtained when the resistance to be measured, R_X, is connected into the circuit. If the meter now reads one-half of its former current, it follows that the total curcuit resistance has doubled, indicating that R_X is equal to the total meter circuit resistance.

Since the ohms-calibrated scale is nonlinear, the midscale portion represents the most accurate portion of the scale. However, the usable range extends with reasonable accuracy on the high end to ten times the midscale reading, and on the low end to one-tenth of the midscale reading.

To extend the range of an ohmmeter, the proper values of shunt and series resistors and battery voltages are connected into the circuit so that with the test leads shorted the meter will read full scale. Figure 8-3 shows a simplified schematic diagram of an ohmmeter section taken from a typical volt-ohm-milliammeter.

Voltmeter

To make the basic meter mechanism suitable for measuring d-c voltages, the voltage multiplying resistor is added. The voltage multiplying resistor is placed in series with the coil (fig. 8-4) and limits the flow of current to a safe value.

Since the value of the resistor is constant for any given application, the flow of current

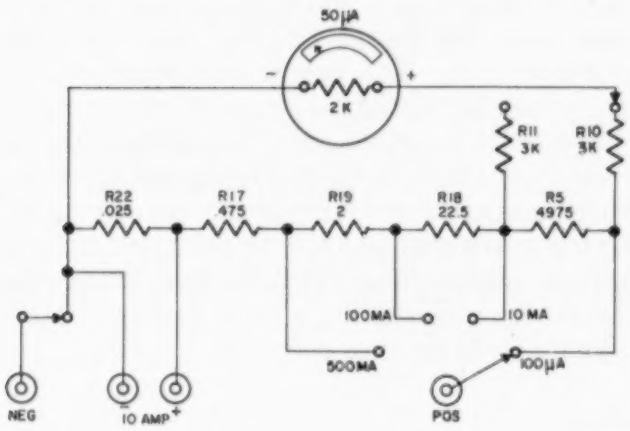

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Figure 8-1.–Simplified schematic diagram of an ammeter.

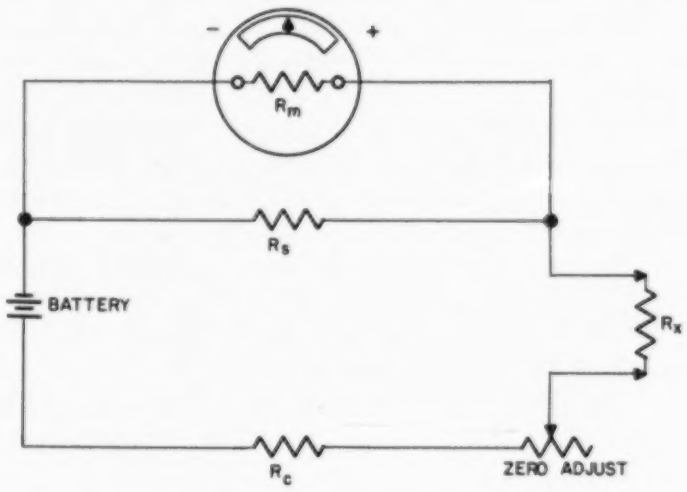

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Figure 8-2.–Series type ohmmeter basic circuit.

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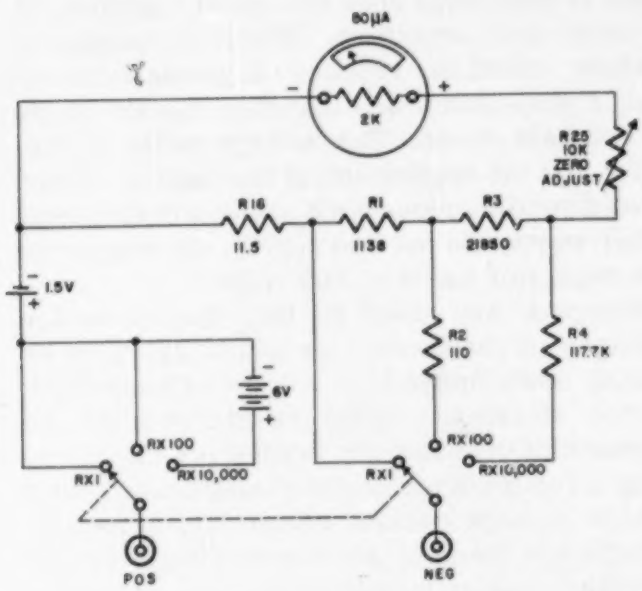

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Figure 8-3.–Simplified schematic diagram of an ohmmeter.

through the coil is proportional to the voltage under measurement. By proper calibration of the dial, the instrument may be made to indicate voltage although it is actually activated by currents. In practice, the voltage ranges of the instrument are established by the use of different values of multiplying resistors.

NONELECTRONIC METERS

Much of the technician's work requiring the use of a volt-ohm-milliammeter can be accomplished with a portable, battery operated multimeter. Many shops employ the TS-352, Simpson 260, or the PSM-4 for field use (troubleshooting in the aircraft, for instance). The technician will, however, often need a more sensitive meter–one that gives more accurate readings and has wider ranges.

Equipment schematics and wiring diagrams often specify that voltages indicated at test points were obtained by using a meter of a certain sensitivity, such as a 20,000-ohms-per-volt meter. A meter of the same sensitivity should be used when repairing that equipment in order to obtain accurate readings.

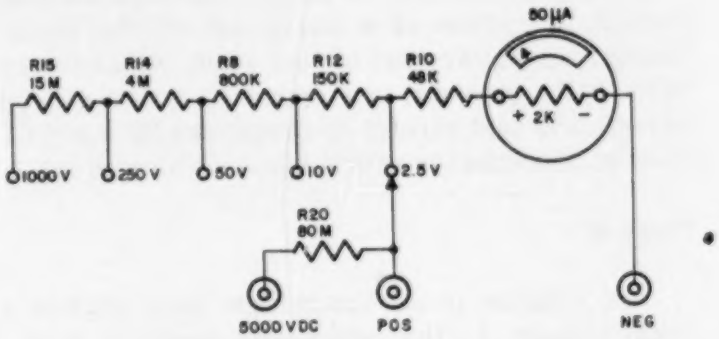

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Figure 8-4.–Simplified schematic diagram of a d-c voltmeter.

Multimeter AN/PSM-4C

This multimeter is a portable, general purpose, nonelectronic instrument designed for general electrical and electronic service and maintenance functions. Multiple ranges are provided for resistance, a-c and d-c voltages, and current. Test results are indicated directly on a wide-faced panel meter. It employs a 20,000-ohms-per-volt movement to provide accurate measurement on low voltage ranges.

Range and function selectors and a meter adjusting control are provided. This meter is designated as a replacement for the TS-352 series multimeters, although the older type is still in fairly common usage.

Milliohmmeter AN/USM-21A

The AN/USM-21A low range ohmmeter can measure resistances in the range of 10 milliohms or less. Most ohmmeters read zero at such a low value. Several troubleshooting problems can be solved easily with such an instrument. One of the most common and troublesome is to find the exact location of a short circuit in a power distribution circuit involving many parallel paths.

In using the milliohmmeter, several problems are encountered. These problems include stray circuit resistances such as contact resistance, test lead resistance, and switching resistance. In using the conventional low range ohmmeters, the primary limitation is in the contact resistance at the test probes.

The AN/USM-21A was designed principally to overcome the contact resistance problem.

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ASSIGNMENT: Use the figure shown above as a model.

1. On the sheet of graph paper issued to you, start at a point 2" from the top border and $\frac{1}{2}$" from the left-hand border and proceed to sketch the horizontal lines freehand.

2. At a point 2" from the top border and 4" from the left-hand border, draw the vertical lines freehand. Use the same paper.

3. On the bottom portion of the paper, letter the following $\frac{1}{4}$" high.

   THIS IS A SAMPLE OF MY LETTERING.

   YOUR NAME _____ DATE _____

   YOUR ADDRESS _____ YOUR SCHOOL _____

A measured current is passed through the test circuit by means of a heavy set of clip leads. Using an auxiliary set of test leads which carry very little current, the resulting voltage drop across the test circuit is measured by a sensitive millivoltmeter which senses this voltage.

Megger

A megger is an instrument that applies a high voltage to the component under test and measures the current leakage of the insulation. Thus a capacitor or insulated cable can be checked for leakage under much higher voltages than an ohmmeter is capable of supplying. It consists of a hand-driven, d-c generator and an indicating meter. The name megger is derived from the fact that it measures resistances of many megohms.

There are various resistance ratings of meggers with full-scale values as low as 5 megohms, and as high as 10,000 megohms. Figure 8-5 shows the scale of a 100-megohm, 500-volt megger. Notice that the upper limit is infinity and that the scale is crowded at the upper end. The first scale marking below infinity represents the highest value for which the instrument can be accurately used. Thus, if the pointer goes to infinity while making a test, it means only that the resistance is higher than the range of the set.

There are also various voltage ratings of meggers (100, 500, 750, 1,000, 2,500 etc.). The most common type is the one with a 500-volt rating. This voltage rating refers to the maximum output voltage of the megger. The output voltage is dependent upon the speed of turning of the crank and armature. When the megger's armature rotation reaches a predetermined speed, a slip clutch will maintain the armature at a constant speed. The voltage rating is important, for the application of too high a voltage to even a good component will cause a breakdown. In other words, do not use a 500-volt megger to test a capacitor rated at 100 volts.

Meggers are used to test the insulation resistance of conductors in which shorting or breaking down under high voltage is suspected. In some situations, meggers are used in the prevention of unnecessary breakdowns by maintaining a record of insulation resistance of power and high voltage cables, motor and generator windings, and transmission lines. These records will reflect fluctuations in resistance and aid in determining when the components should be replaced to prevent a breakdown.

Meggers are used for testing capacitors whose peak voltages are not below the output of the megger. They are also used for testing for high resistance grounds or leakage on such devices as antennas and insulators.

Precautions to be followed in the use of the megger are as follows:

1. When making a megger test, the equipment must not be energized. It must be disconnected entirely from the system before it is tested.

2. Observe all rules for safety in preparing equipment for test and in testing, especially when testing installed high voltage apparatus.

3. Use well-insulated test leads, especially when using high range meggers. After the leads

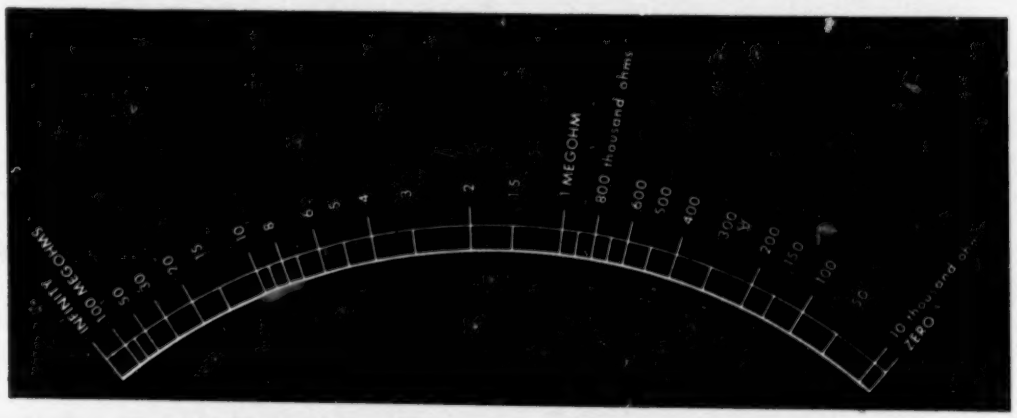

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Figure 8-5.–Scale of 100-megohm, 500-volt megger.

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are connected to the instrument and before connecting them to the component to be tested, operate the megger and make sure there is no leak between the leads. The reading should be infinity. Make certain the leads are not disconnected or broken by touching the test ends of the leads together while turning the crank slowly. The reading should be approximately zero.

4. When using high range meggers, take proper precautions against electric shock. There is sufficient amount of capacitance in most electrical equipment to "store up" sufficient energy from the megger generator to give a very disagreeable and even dangerous electric shock. Owing to a high protective resistance in the megger, its open circuit voltage is not as dangerous, but care should be exercised.

5. Equipment having considerable capacitance should be discharged before and after making megger tests in order to avoid the danger of receiving a shock. This can be accomplished by grounding or short circuiting the terminals of the equipment under test.

ELECTRONIC METERS

Electronic meters are used primarily for the same purposes as are the nonelectronic meters. Some characteristics of their operation, however, give them definite advantages. In the electronic multimeter, the current and resistance measuring circuits function in a manner identical to the corresponding nonelectronic measuring instruments. The measurement of voltage, however, involves the use of an amplifier which in turn requires that the meter be calibrated prior to use.

Proper calibration and use of the instruments vary slightly according to model. Details are included in the Operation Instruction Manual for each model.

The ordinary voltmeter has several disadvantages that make it practically useless for measuring voltages in high impedance circuits. For example, suppose that the plate voltage of a pentode amplifier is to be measured. (See fig. 8-6.) When the meter is connected between the plate and cathode of the electron tube, the meter resistance R_m, is placed in parallel with the effective plate resistance R_{eff}, thereby lowering the effective plate resistance. The effective plate resistance is in series with the plate load resistor, R_L, and this series circuit appears across the supply voltage, E_{bb}, as a voltage divider. Since the overall resistance is lowered, it follows that current through R_L will also increase, the voltage drop across R_L will also increase, and the voltage drop across R_{eff} will decrease. The result is an incorrect indication of plate voltage, and is called loading effect.

Calculation of Loading Effects

Before the voltmeter is connected, the plate current is determined by the effective resistance of the plate circuit, the plate load resistor, and the plate voltage. If the tube has an effective resistance of 100,000 ohms, a plate load resistance of 100,000 ohms, and the plate power supply is constant at 200 volts, then the plate current is

$$\frac{200\text{v}}{200{,}000\Omega}$$

or 0.001 ampere. The plate voltage (plate to cathode) is 0.001 x 100,000, or 100 volts.

Assume that the voltmeter used to measure the plate voltage of the tube has a sensitivity of 1,000 ohms per volt and that the selected meter range is from 0 to 250 volts. The meter will then have a resistance of 250,000 ohms. This resistance in parallel with the tube resistance of 100,000 ohms produces an effective resistance of 71,400 ohms in series with the plate load resistor. The total resistance across the

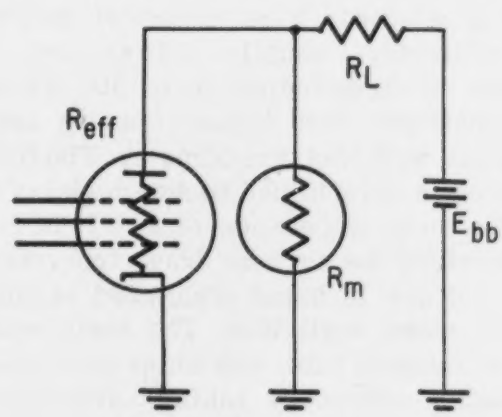

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Figure 8-6.–Loading effect created by meter resistance.

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B supply is therefore 171,400 ohms instead of the 200,000 ohms before the meter was applied, and the current through the plate load resistor is

$$\frac{200\ v}{171{,}400\Omega},$$

or 0.00117 ampere. Across the plate load resistor the voltage drop is 0.00117 x 100,000, or 117 volts, and the plate-to-cathode voltage on the tube is 200-117, or 83 volts when the meter is connected, thus causing an error of 17 volts. The lower the sensitivity of the meter, the greater the error will be; in this example, the error of 17 volts when the reading should be 100 volts is a 17 percent error.

A meter having a sensitivity of 20,000 ohms per volt and a 250-volt maximum scale reading would introduce an error of about 1 percent. However, in circuits where very high impedances are encountered, such as in grid circuits of electron tubes, even a meter of 20,000 ohms per volt sensitivity would impose too much of a load on the circuit.

VTVM Advantages

Another limitation of the alternating current, rectifier type voltmeter is the shunting effect at high frequencies of the relatively large capacitance of the meter's rectifier. This shunting effect may be eliminated by replacing the usual metallic oxide rectifier with a diode electron tube; the output of the diode is applied to the grid of an amplifier in which the plate circuit contains the d-c meter. Such a device is called an electron tube voltmeter or a vacuum tube voltmeter, usually abbreviated VTVM. Voltages at frequencies up to 500 megahertz, and sometimes even higher, can be measured accurately with this type of meter. The frequency limitation is determined by the model of VTVM.

The input impedance of a VTVM is large, and therefore the current drawn from the circuit whose voltage is being measured is small and in most cases negligible. The main reason for using a vacuum tube voltmeter is to overcome the loading effect by taking advantage of the VTVM's extremely high input impedance. A VTVM that is used extensively for electronics maintenance is contained in the TS-505 multimeter.

Vacuum Tube Voltmeter TS-505

Figure 8-7 shows a front panel view of the TS-505. The VTVM measures d-c voltages from 0.05 volt to 1,000 volts (in 9 ranges), and a-c voltages from 0.05 volt to 250 volts rms (in 7 ranges), at frequencies from 30 Hz to 1 MHz. With the RF adapter that is used with the d-c voltage measurement circuit, RF voltages may be measured from 0.05 volt to 40 volts rms at frequencies from 500 kHz to 500 MHz. D-c resistances from 1 ohm to 1,000 megohms may be measured.

The accuracy of this meter is good, being 5 percent for d-c voltages and 6 percent for a-c and RF voltages. The meter movement requires 1 ma for full-scale deflection.

The input impedance to the meter is 6 megohms at audiofrequencies, 40 megohms on

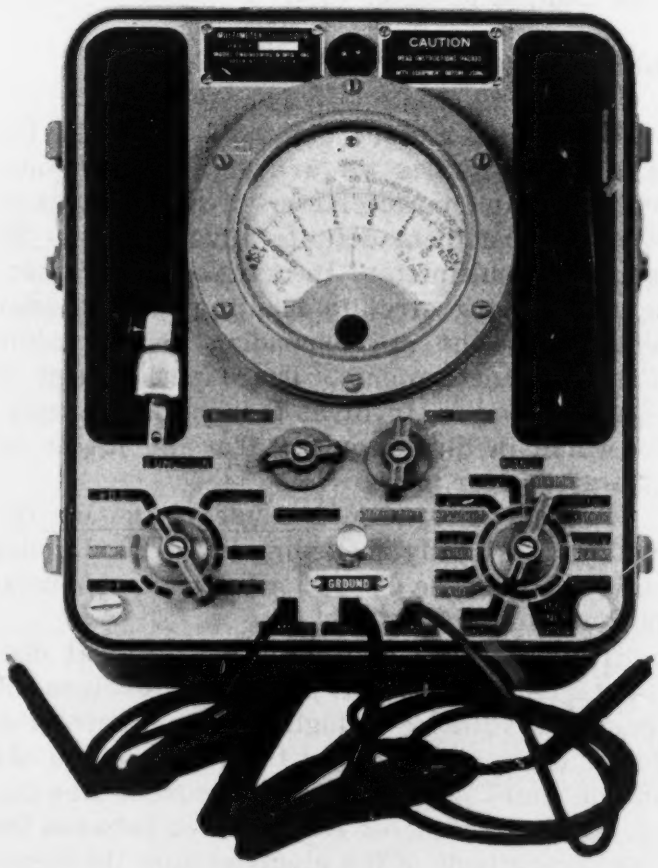

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Figure 8-7.–TS-505 multimeter, front panel.

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the 1,000-volt d-c range, and 20 megohms on all other ranges.

The power requirement is 98 to 132 volts, single phase, 50 to 1,000 Hz, at about 21 volt-amperes.

The removable cover of the TS-505 contains accessories such as alligator clips, an RF adapter, and miniature probe tips. The miniature tips slip over the regular tips when working in confined areas.

OPERATING CONTROLS.–The controls that you will use when operating the meter (fig. 8-7) are as follows:

1. FUNCTION switch: Selects the type of multimeter operation desired and turns the multimeter on or off.

2. RANGE switch: Selects various voltage or resistance measurement ranges.

3. ZERO ADJ. control: Controls pointer of indicating meter. Used to set the meter pointer at zero on the +DC, -DC, AC, or OHM scale, or at midscale on the ±DC scale.

4. OHMS ADJ. control: Controls pointer of indicating meter. Used to set the meter pointer at ∞ on the OHMS scale when the FUNCTION switch is set on OHMS position.

5. Meter: Indicates the value of voltage or resistance measured.

6. AC LINE cord: Connect multimeter to a-c power source.

7. COMMON probe: Connects the ground, or common circuit of the multimeter, to the equipment under test.

8. DC probe: Connects equipment under test to the d-c measuring circuit of the multimeter.

9. OHMS probe: Connects equipment under test to the ohmmeter circuit of the multimeter.

10. AC probe: Connects equipment under test to the a-c measuring circuits of the multimeter.

11. Pilot light indicator: Lights when power is applied to the multimeter.

TECHNIQUES FOR USE.–The operation of this meter is virtually self-explanatory. By studying the controls and their respective markings, you should be able to determine the steps to follow when making a particular measurement. Do not attempt to use this instrument unless you have studied the technical manual which sets forth the operating procedures, or unless you have been instructed in its proper usage, under the direction of your shop supervisor.

Two peculiarities of this meter are:

1. In order for it to indicate accurate readings it must warm up. This usually takes about 10 minutes. During this period the meter pointer may drift rapidly; this is normal.

2. Voltage measurements cannot be read directly on the meter scale when the function switch is set at the ±DC position.

The purpose of the ±DC position (zero center scale) is to determine the polarity of an unknown d-c voltage or to indicate a zero d-c voltage input to the multimeter.

CAUTION: The maximum d-c voltage which may be applied to the multimeter when the function switch is set at the ±DC position is one-half of the voltage indicated by the panel marking opposite the range switch setting.

The major difference between any VTVM and a conventional multimeter is that the VTVM utilizes a vacuum tube in its input. For a detailed explanation of the circuitry of the TS-505 VTVM consult the manufacturer's manual or the Operation and Service Instruction Manual.

Phase Angle Voltmeters

The overall accuracy of many electronic equipments is determined by measuring phase angles in computing transformers, computing amplifiers, and resolver systems. In the past, one of the most common methods used for measuring phase shift or phase angles between signals was observing patterns on an oscilloscope. With this method, it was hard to determine small angles, and difficult to translate various points into angles and sines of angles. The most limiting factor in using oscilloscope patterns developed when one of the signals contained harmonic distortion or noise.

In any complex waveform containing a fundamental frequency and harmonics, measuring phase shifts presents problems. In most applications, interest lies in the phase relationship of the fundamental frequency, regardless of the phase relationship of any harmonics which may be present. One of the requirements of a phase measuring device is to measure the phase difference between two discrete frequencies, regardless of the phase and amplitude of other components of the waveform.

The basic block diagram of a phase angle voltmeter is shown in figure 8-8. There are

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two inputs–the signal and the reference. Both channels contain filters which pass only the fundamental frequency. All other frequencies are highly attenuated. Each channel has a variable amplitude control and amplifiers to increase the variety of signals that can be checked.

A calibrated phase shifter is inserted into one channel; that channel signal can be phase shifted to correspond to the other channel. This is detected in the phase detector and observed on the meter.

The calibrated phase shifter is made up of a switch (whose position corresponds to the 0°, 90°, 180°, and 270° phase shift) and a potentiometer (whose dial is calibrated from 0° to 90°). The total phase shift is made up of the sum of the two readings.

The phase detector is a balanced diode bridge type demodulator. Its output is proportional to the signal frequency amplitude times the cosine of the angle of phase difference between the signal input and the reference input.

If the reference input is phase shifted until it is in phase or 180° out of phase with the signal input, the output from the phase detector is proportional to the signal input amplitude (the cosine of the angle is unity). If the reference input is phase shifted until it is 90°or 270° from the signal input, the phase detector output is zero (the cosine of the angle is zero).

The point at which the two signals are in phase or 180° out of phase is the point of maximum deflection on the meter. The difference between the in phase and the 180° out of phase points is in the direction in which the needle swings–not the distance it swings. As the point of maximum deflection is approached, the rate of change of the meter reading decreases because the cosine has a small rate of change near 0°. This makes it difficult to read the exact point of maximum deflection.

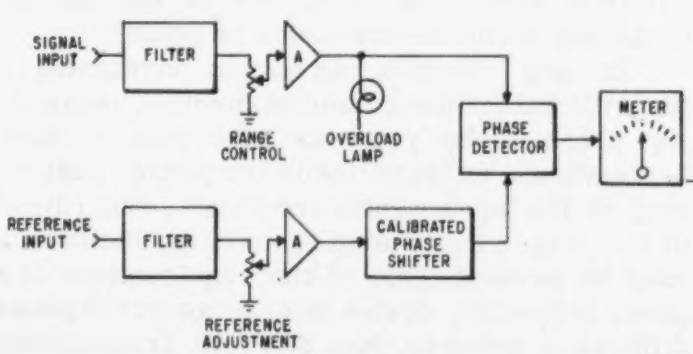

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Figure 8-8.–Phase angle voltmeter, block diagram.

Because the cosine has a maximum rate of change as it approaches 90 (and thus gives a better indication on the meter), most commercial voltmeters are set to determine the point at which the signals are 90° out of phase–"quadrature." When the voltmeter is set for this point, there must be some way of converting the phase shifter reading so that it shows the correct amount of phase shift rather than 90°more or less than the actual amount. Some confusion exists in this area because different manufacturers have different methods of determining the signal quadrant. Manufacturers also differ on whether the final reading is a leading or a lagging phase shift. This means the technician must be familiar with as many types of phase angle voltmeters as the Navy has in the field. He cannot assume that the method he uses to determine phase angle on one type of meter can be used on another; nor can he assume that, because one meter gives him a leading angle between signal and reference waveforms, another manufacturer's meter also gives leading phase shift.

Differential Voltmeter

The differential voltmeter is a realible precision item of test equipment. Its general function is to compare an unknown voltage with an internal reference voltage, and to indicate the difference in their values. The differential voltmeter in most common use in Navy applications is the 803D/AD (fig. 8-9), manufactured by the John Fluke Co. The remaining portion of this discussion is based on that instrument.

The 803D/AD is usable as an electronic voltmeter, as a precision potentiometer, and as a megohmmeter. It can also be used to measure the excursions of a voltage about a reference value. Ease of operation, inherent protection from any accidental overload, and high reliability of readings are additional advantages of the instrument. It is accurate enough for precision work in calibration laboratories, yet rugged enough for general shop use.

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Figure 8-9.–Differential voltmeter, Model 803D/AD.

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The heart of the unit is a precision 500-volt d-c reference power supply. This 500 volts can be precisely divided into increments as small as 10 microvolts by means of 5 voltage dials. Unknown a-c or d-c voltages are matched against the precise internal voltage until no deflection occurs on the panel meter. The unknown voltage is then simply read from the voltage dials. In the highest null sensitivity range, a potential difference between unknown and reference voltage as small as 0.01 volts causes full scale meter deflection.

At null, the differential voltmeter presents an "infinite" input impedance to the voltage under measurement, almost completely eliminating circuit loading.

A functional schematic diagram of the differential voltmeter is shown in figure 8-10. The principal circuit divisions are as follows:

1. A 500-volt d-c reference power supply.
2. Precision voltage divider network.
3. VTVM.
4. Chopper-amplifier.
5. Converter and converter power supply.

The system circuitry is designed with two separate common returns. One of these, the return for the converter power supply and reference power supply, provides a safety factor for personnel and a capability for measuring a potential difference between two voltages. The other, which is the common return of the VTVM power supply, is connected to the known reference voltage output from the precision voltage divider network. This arrangement provides a constant d-c voltage of +108 volts across the differential amplifier regardless of the d-c potential applied to the grid.

D-C REFERENCE POWER SUPPLY.–A full wave rectifier with its associated filter network supplies a d-c voltage of approximately 1,000 volts to a conventional electron controlled voltage regulator. The regulated output is maintained at 500 volts ±0.01 percent.

In the 500 V DC position, the RANGE switch (S2E) passes this 500 volts directly to the precision voltage divider. In the 50 V DC, 5 V DC, and 0.5 V DC positions, range resistors S2F divide the reference voltage to 50, 5, and 0.5 volts d.c., respectively. In all a-c positions of the RANGE switch, only 5 volts of the reference supply is used, due to the fact that the maximum output of the a-c to d-c converter is 5 volts.

PRECISION VOLTAGE DIVIDER.–Each of the four precision voltages available from the reference supply must be made adjustable through a precision divider network so that unknown voltages may be nulled or matched exactly. The five decade resistor strings (fig. 8-11) accomplish this function.

Note that each string, with the exception of the first, parallels two resistors of the string that precedes it. Between the two wipers of S4, there is a total resistance of 40K and a total

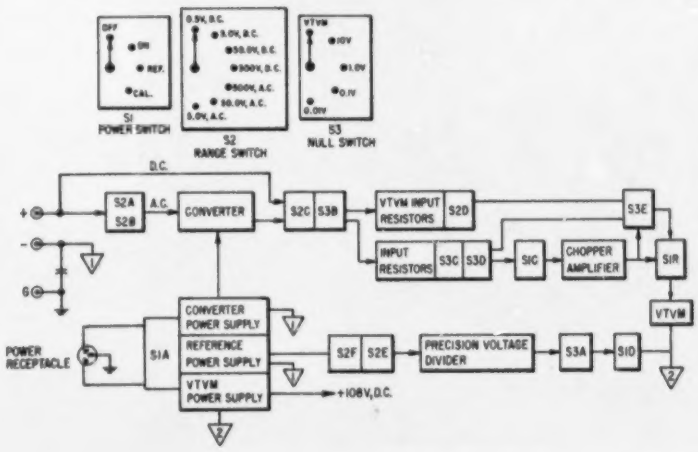

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Figure 8-10.–Differential voltmeter, functional schematic diagram.

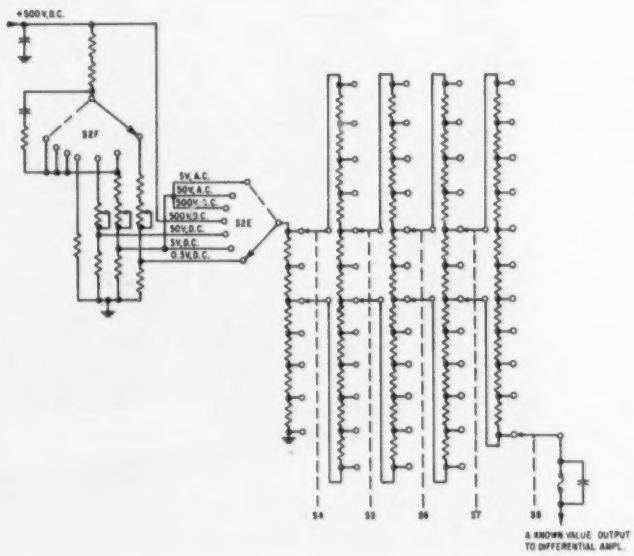

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Figure 8-11.–Precision voltage divider.

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voltage of 100 volts d.c. with the RANGE switch in the 500 V DC position. Across the wipers of S5, S6, and S7, there are 10, 1, and 0.1 volts d.c., respectively. Switch S8 selects increments of 0.01-volt d.c. from the last decade. These voltages are reduced by a factor of 10 for each successively lower voltage range.

All resistors of each decade are matched and all decades are matched for each instrument, providing an overall divider accuracy of 0.005 percent.

With the NULL switch in any null range, the output of the precision voltage divider appears at the grid of one-half of the VTVM differential amplifier. A one two-hundredths ampere (5 milliampere) fuse protects this output.

VACUUM TUBE VOLTMETER.–When operating in the differential mode, output voltage from the precision voltage divider appears on the grid of V4B, one-half of the differential amplifier. (See fig. 8-12). The unknown voltage appears on the grid of V4A, the other half of the differential amplifier. Any difference between these potentials is indicated by the meter coupled between the cathodes of V4A and V4B. When the output voltage exactly matches the unknown, the meter reads zero and no current is drawn from the source being measured, because the same potential exists on both sides of the input resistances.

When used as a conventional VTVM, the grid of V4B is connected to the 0-volt bus, or negative binding post. With the range switch in the 0.5 V DC position, the unknown voltage appears directly on the grid of V4A and the meter indicates the approximate value of the unknown. Input divider resistors maintain the 0 to 0.5 grid voltage range for all instrument voltage ranges. The input resistance of the instrument in the VTVM position is 10 megohms.

CONVERTER.–All a-c measurements are made by first converting the a-c input to a d-c voltage. The converter provides a maximum d-c output of 5 volts for a maximum a-c input of 5 volts rms. In the 5 V AC position, range switch sections of S2A and S2B couple the converter amplifier input directly to the binding post. In the 50 V AC and 500 V AC positions, input attenuators reduce the unknown a.c. to provide a maximum of 5 volts a-c input to the first converter amplifier.

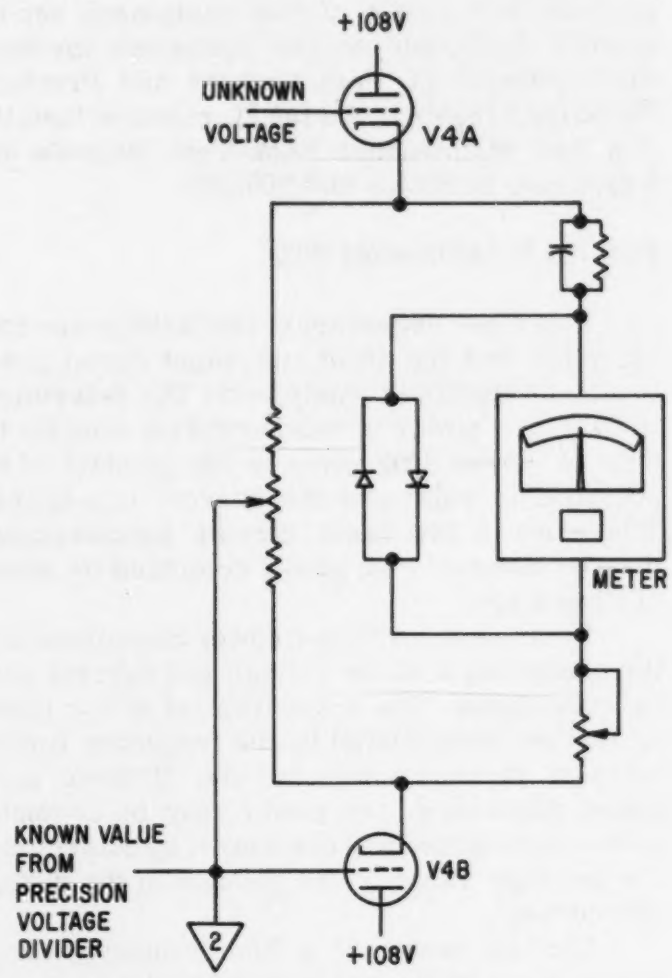

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Figure 8-12.–Differential amplifier.

The overall frequency response of the converter is essentially flat from 30 Hz to 10 kHz.

Repair

The procedures for repairing a defective VTVM are basically the same as for any other electronic equipment. The first step is to sectionalize the fault to the circuit responsible for the abnormal operation of the equipment. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition.

Some faults, such as burned-out resistors, arcing, shorted transformer, leaky capacitors, or broken wires, often can be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and

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resistances. For further information on trouble-shooting and repair of test equipment, see the manual applicable to the equipment involved, the Handbook of Test Methods and Practices NavShips 91828(A), and the Electronics Installation and Maintenance Book-Test Methods and Practices, NavShips 900,000.103.

POWER MEASUREMENTS

It is often necessary to check the power consumption and the input and output signal power levels of electronic equipment. The determination of d-c power is comparatively simple; the unit of power (the watt) is the product of the potential in volts and the current in amperes. Therefore, a few basic circuit measurements may be taken and the power computed by means of Ohm's law.

To make accurate a-c power measurements, the phase angle of the voltage and current must be considered. The measurement of a-c power is further complicated by the frequency limitations of various power meters. If there is no phase difference, a-c power may be computed in the same manner as d-c power, by determining the average value of the product of the voltage and current.

Electric power at a line frequency of approximately 60 Hz may be measured directly by a dynamometer type wattmeter. This type of meter (discussed in Basic Electricity) indicates the actual power; and therefore, the phase angle of the voltage and current does not have to be determined. Normally, the exact power consumption of equipment is not necessary for maintenance, and a current measurement is sufficient to decide whether the power consumption is within reason.

In the audiofrequency range, power levels have to be determined in the course of routine checks and during corrective maintenance procedures. When working with audiofrequency amplifiers, it is ordinarily easier and more convenient to measure voltage, current, and impedance and then compute the power than it is to measure power directly.

Power measurements for audiofrequency circuits are usually indicated in terms of decibels (db), decibels referenced to 1 milliwatt (dbm), or volume units (vu). The power gain of an amplifier can be expressed in db. The power level of a sinusoidal signal compared to a 1-milliwatt reference is indicated in dbm. The power level of a complex signal, such as voice, music, or multiplexed information, compared to a reference level of 1 milliwatt is indicated in vu.

Many a-c voltmeters have scales calibrated in decibels or voulume units. Such meters are useful for making measurements where direct indication in decibels is desired. However, it must be remembered that these are voltmeters, and that power measurements are not meaningful unless the circuit impedance is known. (The topic of decibels is discussed in some detail in Basic Electronics.)

At radiofrequencies below the UHF range, power is usually determined by voltage, current, and impedance measurements. One common method, used to determine the output power of RF oscillators and radio transmitters, consists of connecting a known resistance to the equipment output terminals, measuring the current flow through the resistance, and then calculating the power as the product of I^2R. Since the power is proportional to the current squared, the meter scale can be calibrated to indicate power units directly. A thermocouple ammeter is usually used for measurement of RF current. The resistor used to replace the normal load is usually specially designed to have low reactance, and has the ability to dissipate the required amount of power. Such resistors are commonly called "dummy loads" or "dummy antennas."

In the UHF and SHF portion of the radiofrequency spectrum, it is usually difficult to accurately measure the voltage, current, and impedance. These basic measurements may change greatly at slightly different points in a circuit, and are appreciably affected by small changes in the placement of parts in the vicinity of the tuned circuits. To measure the output of microwave radio or radar transmitters, test instruments which convert RF power to another form of energy, such as light or heat, can be used to indirectly measure the power. A method which measures the heating effect of a resistor load on a stream of passing air can be used. Accurate measurement of large magnitude power can be achieved by measuring the temperature change of a water load. The most common type of power meter for use in this frequency range employs a bolometer. The bolometer is a loading device that undergoes

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changes of resistance as changes in the power dissipation occur. Resistance is measured before and after RF power is applied, and power can be determined by the change in resistance.

Field Intensity and Noise

The magnitude of the electric field of a radio wave at a given point is known as the "field intensity" or "field strength" of that wave, and is usually measured in terms of millivolts or microvolts per meter. The field strength of a radio wave is determined by measuring the RF voltage induced in a receiving antenna. The unit of field strength is the volt per meter; but since the actual values of induced voltage are quite small, the microvolt per meter is a more convenient unit in practical applications.

Several types of test equipment are available for the measurement of field strength and noise. They are known as "radio test sets," "field strength meters," and "radio noise meters." These instruments can be used to indicate either the relative or the absolute magnitude of the field intensity of the energy radiated by a transmitter antenna. The equipment necessary for a specific test is determined by the frequency of the signal to be measured and the accuracy required. Field strength and noise measurements are required to determine antenna efficiency, directivity characteristics, and signal coverage. This information is valuable for selecting antenna sites and for detecting spurious harmonic radiation. Interference, either radiated or conducted, can be detected and located by the use of radio test sets.

The measurement of relative field strength can be made with rather simple test equipment; sometimes a grid-dip meter will suffice. Other test equipment circuits utilize a pickup antenna and a diode (or crystal) detector in connection with a microammeter. In circuits using this combination, the meter reading indicates the relative strength of the field acting on the pickup antenna, and is not directly proportional to the field intensity because of the nonlinearity of the detector.

More elaborate test equipment, for the measurement of absolute field intensity, compares the voltage induced in a pickup antenna with a voltage generated by a self-contained calibrated oscillator. The antenna is connected to a sensitive receiver, which usually incorporates two calibrated attenuators, one between the antenna and mixer stage, and the other in the first IF amplifier stage. A meter in the test equipment measures the diode current in the second detector and indicates the field intensity, usually in terms of microvolts per meter.

In (A) of figure 8-13, a schematic of a simple type of crystal detector field strength meter is shown. The crystal detector is mounted in the center of a pickup antenna, whose length ideally is one-half wave at the frequency of the received signal. The crystal is coupled to a 0-1 milliammeter through radio frequency choke coils. The induced signal is rectified by the crystal, and the resulting current is indicated on the milliammeter. This type of meter is used at distances of four or five wave lengths from the transmitting antenna and for low power transmitter measurements.

In (B) of figure 8-13, a schematic of a considerably more sensitive field strength meter is shown. Tube V1 is an RF amplifier, the output of which is impedance coupled to the diode section of V2, a detector amplifier. The rectified signal voltage is developed across R1, one end of which is attached to the filament-cathode of the amplifier tube. The voltage developed across R1 controls the plate current of V2 which is read on the milliammeter in the plate lead. The amount of change in the plate current is an indication of the strength of the signal induced in the pickup antenna of the field strength meter.

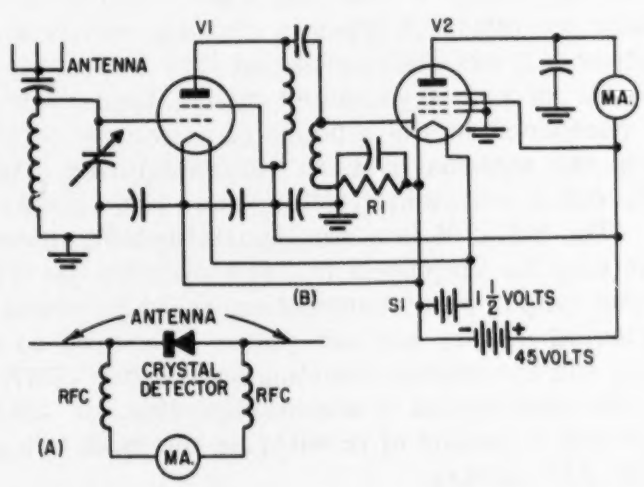

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Figure 8-13.–Field strength meters.

Lettering Lesson 4

OBJECTIVE: To study the form and shape of proper lettering and the method of achieving good results.

RELATED INFORMATION:

A beginner in the field of drafting seldom realizes the importance of good lettering until he becomes an applicant for a position. Employers are very conscious of this and keep a wary eye in that direction. It is thus obvious that the student needs to practice lettering seriously and often, for without the ability to letter properly, obtaining initial employment becomes more difficult.

Vertical lettering rather than slanted is used more commonly in industry; we shall therefore concentrate on this form of lettering.

It is virtually impossible to do consistently good lettering without the use of guide lines, and almost all draftsmen use them. These are drawn lightly with a hard pencil (preferably 6H). Always use upper case capital letters when lettering. Practice diligently, for there is no short approach to becoming a good letterer. Fig. 1 shows correctly how to letter, along with the proper usage of guide lines. The correct height to letter is approximately $\frac{1}{8}''$, but for practical purposes, $\frac{1}{2}''$ lettering is easier.

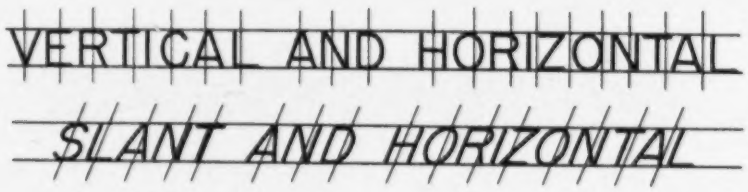

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Tube V2 is a variable mu pentode. In this type of amplifier, large signal voltages are amplified by a relatively small amount, and small signal voltages receive much greater amplification. The e_c-i_b curve of such a tube is essentially a logarithmic curve. As a result of this fact, the meter in vacuum tube field strength circuits of this type can be calibrated directly in decibels, a logarithmic unit of power or voltage level.

When using field strength meters, errors and erratic readings can be caused by the presence of objects or persons near either the radiating source or the test meter, resulting in shadows and reflections in the radiated field.

The antenna of the test meter should always be extended to its full length so as to keep its effect on the tuning circuit constant.

Many types of field strength indicators are intended for use within 25 feet of the equipment being tested when antenna adjustments are made to achieve maximum radiation. The distance which results in the most satisfactory operation of the instrument for this test varies with the type of equipment being tested. Usually it is desirable to select a distance for the measurements which give a meter reading at about half-scale.

Standing Waves

It is often desirable to determine how much of the generated RF power is actually radiated from the antenna, or more specifically, to check the transmission line for losses. This test is made by using a standing wave ratio meter. There are different types of standing wave ratio meters. All are similar in that they indicate the amount of power produced by the transmitter as compared to the amount of power reflected from the antenna back to the transmitter. The MM-706 is a typical standing wave ratio meter.

The MM-706 is a small portable instrument that may be employed to read directly the RF power output of a transmitter; incident power, reflected power, and net power delivered to a load; and the voltage standing wave ratio (VSWR) of the associated transmission line. It also provides a means of monitoring the modulation on an AM carrier.

This instrument may also be used as an absorption type wattmeter by employing an appropriate dummy load resistor adapter supplied for that purpose.

The unit may be installed permanently in a transmitting system to provide continuous indications, or it may be used only during tuning and test procedures. The output of the transmitter under test is attached to one end of the coupler unit, and the load (or antenna) is connected to the other end.

The coupler unit has negligible effect on the operation of the transmitter or the load. A sample of the RF energy passing through the coupler is applied to the indication circuit of the instrument. The RF energy is rectified by a series crystal unit and applied to the indicator meter.

The particular function of the instrument is selected by means of a switch on the front panel. If remote indication is desired (a remote meter, or headphones), the lead to the remote indicator is connected through the jack on the front panel. When a remote indicator is used, the circuit to the local meter is opened.

Figure 8-14 is a schematic diagram of the meter. Coupler Z2 is connected in the line between the transmitter and the antenna. RF power passes through this unit. This power is sampled by means of a pickoff in Z2 and coupled through the crystal unit CR2 to P2. The prop-

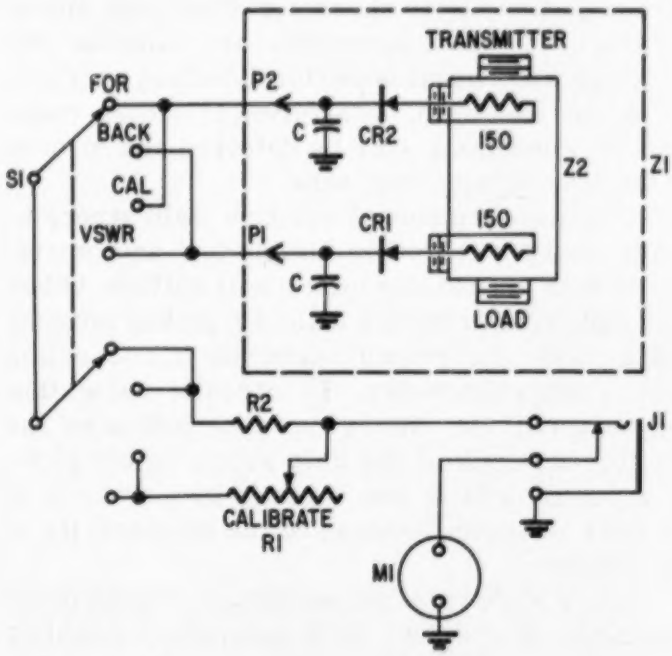

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Figure 8-14.—MM-706 VSWR meter, schematic.

erties of CR2 are such that in the direction indicated by the arrowhead in figure 8-14 the resistance is low; whereas in the opposite direction, the resistance is very high and conduction is practically negligible.

When S1 is in the FOR position, the sampled RF power is rectified by CR2 and applied through the two sections of the switch, resistor R2, and the normally closed contacts of J1 to the meter.

Filtering of the rectified voltage is obtained by means of a capacitor built into the cap which secures the crystal units in the plugs.

When S1 is placed in the BACK position, the sampled RF power is taken from the load end of coupler Z2. Rectification occurs in the same manner as previously explained, and meter M1 reads the reflected power.

The standing wave ratio of a transmission line is the ratio of the maximum RF power to minimum RF power. With S1 in the CAL position, the meter is reading forward power or, almost directly, the power output of the transmitter. The circuit to the meter bypasses fixed resistor R2 and includes potentiometer R1. This potentiometer is adjusted to produce full scale deflection of the meter. This is the maximum power.

Placing the selector switch in the VSWR position causes the RF power at the load end of the coupler unit to be sampled. At this point the reflected power from the antenna back toward the transmitter is bucking the forward power. Therefore, the load end is a low power point. Since the meter was set for full scale deflection at the maximum power point, the reading obtained from the low power point is a direct indication of the voltage standing wave ratio.

FREQUENCY MEASUREMENT

Frequency measurements are often an essential part of preventive and corrective maintenance for electronic equipment. Rotation frequencies of some mechanical devices must be determined. The output frequency of electric power generators is checked when the engine is started and during preventive maintenance routines. Equipment which operates in the audiofrequency range must be adjusted to operate at the correct frequencies. Radio transmitters must be accurately tuned to the assigned frequencies to provide reliable communications and avoid interfering with radio circuits operating on other frequencies. Radar sets must be properly tuned to obtain satisfactory performance.

The rotation frequency of rotating machinery such as radar antennas, servomotors, and other types of electric motors can be measured by the use of a stroboscope. Stroboscopic methods compare the rate of one mechanical rotation or vibration with another or with the frequency of a fluctuating source of illumination. Tachometers can be used to measure the rotation frequency of armatures in electric motors, dynamotors, and engine-driven generators.

The electrical output frequency of a-c power generators can be measured directly by vibrating reed, tuned circuit, or crossed-coil iron-vane type meters. The vibrating reed device is the simplest type of frequency meter, and has the advantage of being rugged enough to be mounted on generator control panels. It is also used to check the line voltage in the shop to insure that the proper frequency is supplied to the equipment and/or test sets.

Frequency Meters

"Frequency meter" is a term generally applied to denote an item of test equipment which is used to indicate the frequency of an external signal. Although some models of frequency meters generate signals having a basic frequency, they should not be confused with that class of test equipment known as signal generators. (Signal generators are discussed later in this chapter.) The signal generator develops a frequency used to operate an external circuit; the frequency meter measures the frequency of a signal developed in an external circuit.

As mentioned previously, some frequency meters generate a signal frequency; others do not. The group in which no frequency is generated internally is properly called a "wavemeter." Wavemeters are of two basic types—reaction and absorption. Those frequency meters which do generate an internal frequency may use either electronic or mechanical oscillation as the frequency generator.

Measurement Methods

Frequency measurements in the audio-frequency range can be made by the comparison method or by a direct-reading frequency meter. Frequency comparisons can be made by the use of a calibrated audiofrequency signal generator in conjunction with either an oscilloscope or a modulator and a zero-beat indicator device. Direct-reading frequency measurements can be made by instruments using series frequency-selective electrical networks, bridge test sets having null indicators, or counting type frequency meters.

Frequency measurements for radio equipment are made during tuning, preventive maintenance, and corrective maintenance procedures. The type of test equipment selected depends on the frequency to be measured and the required accuracy. Signal frequencies of radio transmitters which operate in the low frequency to the VHF range are normally measured by absorption type wavemeters, reaction type wavemeters, heterodyne type frequency meters, or calibrated radio receivers. Where accuracy is not of prime importance, rapid frequency checks may be made by the absorption type wavemeter. Since the wavemeter is relatively insensitive, it is very useful in determining the fundamental frequency in a circuit generating multiple harmonics. Calibration of test equipment measure signals in this frequency range can be checked by comparison with standard frequency signals broadcast by the National Bureau of Standards.

The signal frequencies of radio and radar equipment which operate in the UHF and SHF range can be measured by resonant cavity type wavemeters, resonant coaxial line type wavemeters, or Lecher-wire devices. When properly calibrated, resonant cavity and resonant coaxial line wavemeters are more accurate and have better stability than wavemeters used for measurements in the low frequency to VHF range. These frequency-measuring instruments are often furnished as part of communication and electronic equipment, but are also available as general purpose test sets.

Heterodyne Type Meters

Heterodyne type frequency meters are available in several varieties. Although they all function in the same general manner, some differences exist in the manner of accomplishing their purpose.

Test instruments of this class generate a signal within the test set. This signal is mixed with a signal from the equipment under test to obtain a beat frequency. The frequency of one signal is then changed to obtain a zero beat. (The beat frequency is the difference frequency which results from heterodyning two signals. A zero beat is obtained when heterodyning two signals of the same frequency.) The frequency of the unit under test may be determined by reading the frequency indicator of the test set.

A heterodyne type frequency meter usually consists of a heterodyne oscillator, an RF harmonic amplifier, a crystal-controlled oscillator, a mixer or detector, a modulator, an AF output amplifier, and a means for indicating frequency. (See fig. 8-15.) Most models are furnished with a set of calibration charts giving the dial readings for the frequencies listed, together with a table of the crystal harmonics; thus a complete and accurate frequency coverage over the designed range is provided. Some models indicate the frequency directly on dials.

The crystal-controlled oscillator operates at a fixed frequency, but is also capable of emitting various harmonic frequencies of the crystal for use as check frequencies. These checkpoints are then used for adjusting the heterodyne oscillator, thus insuring more accurate operation. Provisions are usually made within the crystal-controlled oscillator for precise adjustment to its assigned fundamental frequency.

The TS-186D/UP test instrument is a general purpose, crystal-controlled, heterodyne

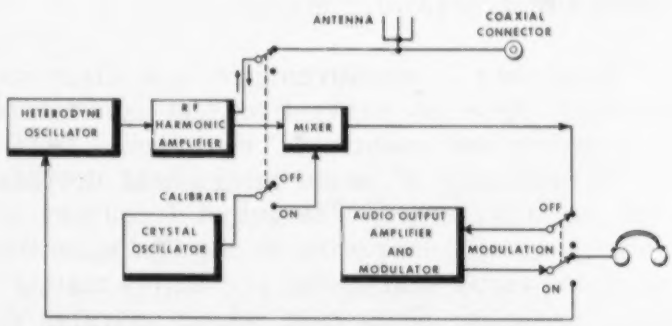

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Figure 8-15.–Crystal-calibrated heterodyne frequency meter, block diagram.

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type frequency meter used to measure the frequency of transmitters, oscillators, or signal generators. It provides both visual and aural indications of signal frequency by means of a beat indicating meter, headphones, and a video output jack for observation on an oscilloscope, as desired. A vernier tuning dial and an associated calibration chart are used in making frequency measurement determinations. The instrument is usable for either field or depot level maintenance testing.

The RF input is routed through waveguide and coaxial cable to a detector mixer, where it is mixed with the output of a heterodyne oscillator. From these inputs, the difference signal is then routed through an audio amplifier. A crystal oscillator, when substituted for the input signal, is used to check the frequency calibration of the heterodyne oscillator. This checking is done at specified checkpoints near the frequency at which the frequency measurement is to be made.

A d-c milliammeter is included for the following functions:

1. Help to indicate a zero beat.
2. Measure the grid current of the crystal oscillator when used.
3. Measure the cathode current of the detector mixer.
4. Measure the cathode current of the heterodyne oscillator.
5. Measure the cathode current of the various indicators.

A selector switch determines which value is to be measured. The indicator circuit causes a dip in meter reading near the zero-beat indication. The meter, however, does not respond to frequencies less than 100 Hz; therefore, a pair of headphones is used to provide more accurate indications of zero beat. The video output is obtained through a jack in the output of the detector mixer circuit.

The instrument is usable for CW, MCW, or pulsed signals in the frequency range of 100 to 10,000 MHz, with signal input magnitudes of 500 μ v to 1 v. The bandpass of the audio amplifier is 100 kHz, to 100 kHz; audio output impedance is 600 ohms. For airborne use, the equipment is usable up to altitudes of 10,000 feet without requiring additional pressurization.

Wavemeters

Wavemeters are calibrated resonant circuits used to measure frequency. Although the accuracy of wavemeters is not as high as that of heterodyne frequency meters, they have the advantage of being comparatively simple and can be easily carried about.

Any type of resonant circuit may be used in wavemeter applications. The exact kind of circuit employed depends on the frequency range for which the meter is intended. Resonant circuits consisting of coils and capacitors are used for low frequency wavemeters. Butterfly circuits, adjustable transmission line sections, and resonant cavities are used in VHF and microwave instruments.

There are three basic kinds of wavemeters—the absorption, the reaction, and the transmission types.

Absorption wavemeters are composed of the basic resonant circuit, a rectifier, and a meter for indicating the amount of current induced into the wavemeter. In use, this type of wavemeter is loosely coupled to the circuit to be measured. The resonant circuit of the wavemeter is then adjusted until the current meter shows a maximum deflection. The frequency of the circuit under test is then determined from the calibrated dial of the wavemeter.

The reaction type derives its name from the fact that it is adjusted until a marked reaction occurs in the circuit being measured. For example, the wavemeter is loosely coupled to the grid circuit of an oscillator, and the resonant circuit of the meter is adjusted until it is in resonance with the oscillator frequency.

The setting of the wavemeter dial is made by observing the grid current meter in the oscillator. At resonance, the wavemeter circuit takes energy from the oscillator, causing the grid current to dip sharply. The frequency of the oscillator is then determined from the calibrated dial of the wavemeter.

This type is commonly referred to as a "grid-dip" meter, and is discussed in Basic Electronics.

The transmission wavemeter is an adjustable coupling link. When it is inserted between a source of radiofrequency energy and an in-

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dicator, energy is transmitted to the indicator only when the wavemeter is tuned to the frequency of the source. Transmission wavemeters are widely used in measuring microwave frequencies. Units of this type are included in echo boxes. The additional provisions for echo boxes permit additional testing functions.

Many actual wavemeters are used in performing various functions. Cavity type wavemeters are the type most commonly used, and only this type is discussed in detail.

Cavity Wavemeters

Figure 8-16 shows a typical cavity wavemeter. The wavemeter illustrated is of the type commonly used for the measurement of microwave frequencies. The device employs a resonant cavity which effectively acts as a high-Q, LC tank circuit. The resonant frequency of the cavity is varied by means of a plunger which is mechanically connected to a micrometer mechanism. Movement of the plunger into the cavity reduces the cavity size and increases the resonant frequency. Conversely, an increase in the size of the cavity (made by withdrawing the plunger) lowers the resonant frequency. The microwave energy from the equipment under test is fed into the wavemeter through one of two inputs, A or D. A crystal rectifier then detects (rectifies) the signal, and the rectified current is indicated on the current meter, M.

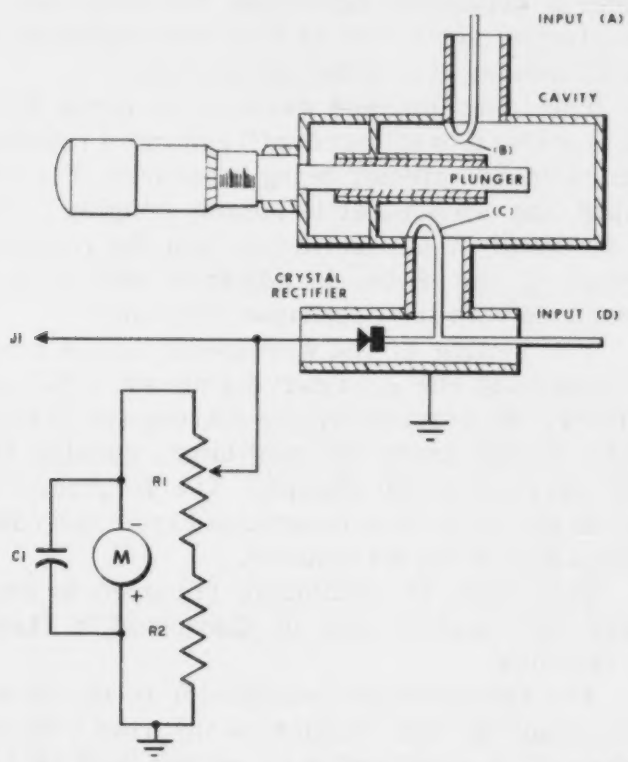

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Figure 8-16.—Typical cavity wavemeter.

This specific instrument can be used as either a transmission type or an absorption type wavemeter. When used as a transmission wavemeter, the unknown signal is coupled into the circuit by means of input A. When the cavity is tuned to the resonant frequency of the signal, energy is coupled through coupling loop B into the cavity and out through loop C to the crystal rectifier. It is rectified and current flow resulting from this rectification is indicated on the meter. At frequencies off resonance, little or no current flows in the detector and the meter reading is small. The micrometer and attached plunger are varied until a maximum meter reading is obtained. The micrometer setting is then compared with a calibration chart supplied with the wavemeter to determine the unknown frequency.

When the unknown signal is relatively weak, such as the signal from a klystron oscillator, the wavemeter is usually used as an absorption type of device. Connection is made to the instrument at the input D. The RF loop C then acts as an injection loop to the cavity. When the cavity is tuned to the resonant frequency of the klystron, maximum energy is absorbed by the cavity and the meter dips, indicating a reduction of current. When the cavity is not tuned to the frequency of the klystron, high current is indicated on the current meter. Therefore, the cavity is tuned for a minimum reading, or dip, in the meter; and the resonant frequency is determined from the micrometer setting and the calibration chart.

Potentiometer R1 is used to adjust the sensitivity of the meter from the front panel of the instrument. J1 is a video jack and is provided for observing video waveforms with a test oscilloscope.

A directional antenna is used in conjunction with the instrument for making relative field strength measurements of radiated signals, for use in measuring the frequency of radar transmitters, and for constructing radiation patterns of transmitting antennas.

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In radiation pattern measurements, the directional antenna is connected to the wavemeter input, and the instrument is tuned to the frequency of the system under test. The cavity is then locked on this frequency by an AFC system. The output signal being measured must be continuous and constant for reliable results. This is necessary in order for any variation in the meter reading to be caused directly by a change in the actual field strength of the signal when the position of the wavemeter is changed with respect to the transmitting antenna. After establishing a reference level on the meter, the position of the wavemeter is then changed by moving it around the radiating antenna, maintaining a fixed distance from it. The wavemeter readings at various positions around the transmitting equipment are recorded on polar graph paper, and the field pattern is thereby determined.

Counting Type

Frequency Meter AN/USM-26 is a precision instrument that automatically measures frequencies to 100 MHz and automatically displays its measurements in digital form on an 8-place panel indicating system. In addition to making direct measurements of frequency, the AN/USM-26 also measures period (time of one cycle of periodic wave), time intervals, and frequency ratios, and may be used to count random events such as those encountered in nuclear work. The equipment further includes a self-check feature that enables the operator to verify the proper operation of the equipment for most types of measurements.

By use of the Frequency Converter AN/USA-5 plug-in unit, the useful operating range of the USM-26 is extended to 220 MHz. Similarly, using the Transfer Oscillator CM-102/USM-73 in conjunction with the USA-5 further extends the frequency range to the vicinity of 5 GHz (gigahertz) before the harmonics become too weak for use. Use of a tunable detector allows the operator to resonate the signal to be measured, thus increasing the sensitivity of the equipment for detection of harmonics. This extends the upper limit of operation to about 12 GHz. A second tunable detector can be used to further increase the sensitivity by resonating the desired harmonic produced by the transfer oscillator.

Because of the accuracy with which it measures frequencies, the USM-26 equipment can be considered to be a new type of secondary frequency standard that replaces more elaborate installations of conventional precision frequency-measuring equipment. For example, the meter has been found particularly useful for frequency measurements in quartz crystal grinding work as well as for general laboratory quality frequency measurements. Other typical frequency-measuring applications for the equipment include calibration of transmitters, oscillators, signal generators, etc.

In combination with tachometer generators or other suitable transducers, the equipment can be used to make precision tachometry measurements. In tachometry work it is particularly useful for measuring the rotation frequency of high speed devices. When used in conjunction with a sensitive radioactivity detector and a suitable transducer, the USM-26 can provide an extremely accurate indication of the radio-activity radiation level.

Time measurements that the equipment will make include pulse length, pulse interval, time delay, etc.

Since the indicating system in the equipment presents the measured frequency in as many as eight significiant figures, the equipment is especially useful for measuring very small frequency changes such as are encountered when making measurements of frequency stability of oscillators and similar frequency generators.

COMPONENT TESTERS

This section discusses the testing of components considered to be most essential in any electronic circuit. These components include the transistor, crystal diode, and the electron tube. During the process of maintaining the equipment for which the technician is responsible, these three particular components are the ones with which he becomes most involved.

ELECTRON TUBE TESTER

Before discussing the testing of electron tubes on the tube tester, the substitution method of testing is described.

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Substitution of a tube known to be good is a simple and reliable method of determining the quality of a questionable tube. Usually this method cannot be used to eliminate more than one tube in a single circuit. For instance, if both an RF amplifier and an IF amplifier are defective in a receiver, replacing either one does not correct the trouble. Also the practice of replacing several tubes in a circuit, all at one time, will usually result in misalinement of a tuned circuit. Under conditions such as these, the use of test equipment designed for testing the quality of a tube saves valuable time.

Experience has shown that tube failures may be roughly classified as follows: mechanical defects and gas within the tube, filament (or heater) burned out, change in tube characteristics, physical damage, and intermittent shorts. Mechanical defects and rise of gas pressure within the tubes are attributed to faulty construction and processing. Some of these defects cannot be detected by standard testing methods until the tubes have been in operation for some time. Filament burnout may be caused by repeated sudden application of full voltage to the filament. Initial heating of the filament is nonuniform. As a result, mechanical stresses due to thermal expansion are set up, and these stresses weaken the filament structure and hasten its failure.

Change in tube characteristics is a broad classification and covers decreasing emission, change in cutoff voltage, changing transconductance, etc. Such changes are usually the result of deterioration of the cathode structure, or formation of a cathode interface surface in the tube or changes in alinement of the electrode parts. Physical damage is largely accidental. It includes such causes as breakage, bending of pins, and inadvertent application of excessive voltages. Intermittent shorts are caused mainly by foreign matter, such as lint within the tube assembly.

Two common types of tube-testing equipment are the emission tube tester and the transconductance tube tester. These types may also incorporate circuits for making important tests other than emission and transconductance. Several types of tests are described in the following paragraphs.

Emission Tube Tester

The emission tester measures the condition of the cathode emitting surface. The end of the useful life of a tube is usually preceded by a reduction in electron emissivity, that is, the cathode becomes unable to supply the number of electrons necessary for proper tube operation. Also, if the tube has an open element, the defect prevents proper emission, and the tester indicates it as a reject. Both multigrid and diode tubes are tested for cathode emission.

The emission tester has certain limitations and disadvantages. Since the manufacturer of a tube does not state a definite 100 percent emission point which could be used for reference, the emission test is not conclusive. High emission does not necessarily indicate a good tube, because this condition might be present in a tube with a faulty grid structure or one which has a highly emissive spot on its cathode. Very high emission has also been observed just before a tube fails completely; hence, fairly low emission does not necessarily indicate in all cases that a tube is near its end-of-life point.

A further disadvantage of the emission test is that gas is liberated within the tube when a-c test voltages are applied unless the test is made quickly. Also, because the tube is not tested with its circuit d-c electrode voltages in this test, it is not tested under actual operating conditions. It is also possible for a tube to show normal emission and still not operate properly. The reason for this is that the efficiency of a tube depends on the ability of the grid voltage to control the plate current. The emission type tester tests only the plate current developed, and not the ability of the grid to control the plate current. The transconductance type tester checks the latter characteristic.

Transconductance Tube Tester

The term transconductance (also called mutual conductance) expresses the effect of grid voltage upon the plate current of a tube. By measuring the transconductance of a tube it is possible to evaluate the condition of the tube much more accurately than by measuring its cathode emission, because this test more closely approximates actual circuit conditions.

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Transconductance is expressed mathematically as the ratio of a change in plate current to a change (small) in control-grid voltage with all other electrode voltages held constant. Transconductance is measured in units of conductance called micromhos. The equation for transconductance is:

$$G_m = \frac{\Delta I_p}{\Delta E_g}$$

where G_m is the transconductance in micromhos, ΔIp is the change in plate current in microamperes, and ΔEg is the change in control-grid voltage. When the control-grid voltage changes 1 volt (positive or negative), the current change in microamperes is equal to the transconductance in micromhos. In other words, if an amplifier tube has a transconductance of 2,000 micromhos, a 1-volt change in the control-grid voltage will cause a plate-current change of 2,000 microamperes. The transconductance of a tube may be measured by two methods: one method is the static (d.c.) method and the other is the dynamic (a.c.) method.

STATIC METHOD.–In the static method (also called the "grid shift" method) of measuring transconductance, the d-c bias voltage on the control-grid of the tube under test is changed, and the resultant change in the steady plate current is measured with a current meter. The test circuit is shown in (A) of figure 8-17.

With switch S set to position 1, a negative bias voltage is applied to the control grid of the tube and causes a certain value of plate current to flow. When switch S is set to position 2, the control-grid voltage becomes less negative, and the plate current increases to a new value. If the control-grid voltage is varied by 1 volt, the transconductance is the difference (in microamperes) between the initial plate current reading and the new value of plate current. When such a circuit is used to test various types of tubes, the voltage applied to the electrodes must be made adjustable, so that the correct operating conditions for each tube type may be attained.

DYNAMIC METHOD.—The dynamic method of determining transconductance makes use of a circuit which applies an a-c signal to the

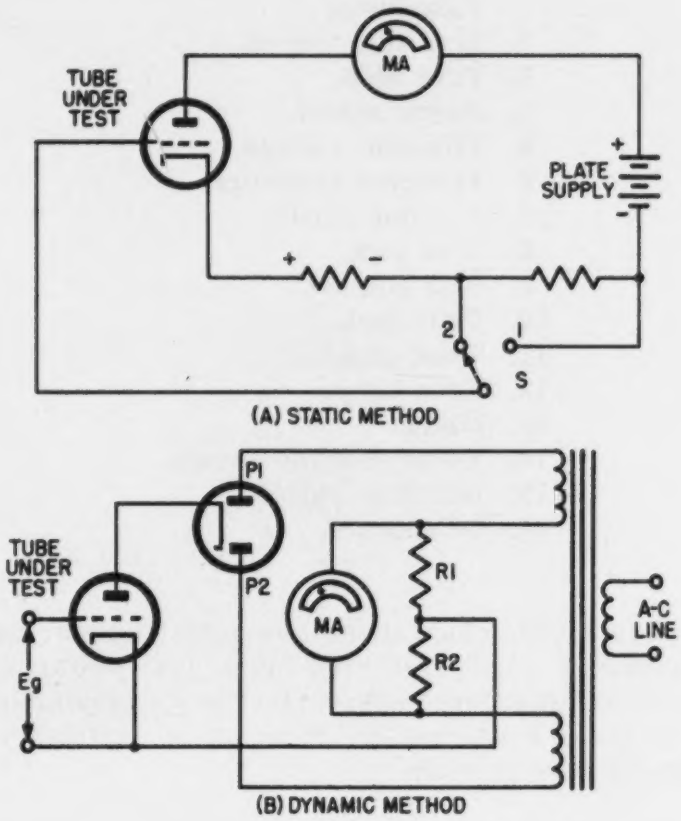

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Figure 8-17.—Basic circuits used for transconductance test.

control grid of the tube under test, in addition to a fixed (operating) control-grid bias. The basic circuit is shown in (B) of figure 8-17. The tube under test serves as the load for the rectifier circuit. The d-c milliameter is connected across a center-tapped resistor, the upper and lower parts of which are designated as R1 and R2. The meter and resistor combination is placed in series with two secondary windings of the a-c line-voltage transformer. With a fixed value of bias voltage (E_g) applied to the control grid of the tube under test, the circuit operates as a simple full-wave rectifier.

On the half-cycle of the a-c voltage when plate P1 of the double diode is positive, there is a current flow through R1, and the force exerted on the meter pointer attempts to deflect it in one direction. When the a-c voltage reverses and plate P2 is positive, the current flows through R2, and the force exerted on the meter pointer is equal and opposite to the pre-

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Nomenclature for figure 8-18.

1. Fuse lamp.
2. Line adj. control.
3. Pilot light.
4. Power switch.
5. Filament voltage.
6. Filament selectors.
7. A-c line cord.
8. Grid jack.
9. Bias control.
10. Plate jack.
11. Shunt control.
12. Neon lamp.
13. Meter.
14. Meter reverse switch.
15. Rectifier switch.
16. OZ4 switch.
17. Gas 2 switch.
18. Gas 1 switch.
19. Mut. Cond. switch.
20. Diode switch.
21. Line adj. switch.
22. Function switch.
23. Suppressor selector.
24. Cathode selector.
25. Screen selector.
26. Plate selector.
27. Grid selector.
28. Power cord.
29. Test leads.
30. Pin straighteners.
31. Adapter.
32. Test data book.

vious force. Since these alternations occur at a rather rapid rate (60-hertz line voltage), the resultant force exerted on the meter pointer is zero; consequently, it remains stationary in the zero position.

Operation of a Typical Tube Tester

The tube-testing equipment discussed in this section is a typical, general-purpose test equipment of the transconductance type. The TV-7/U tube tester (fig. 8-18) is representative of this type equipment.

The front-panel controls on this tester adjust (or switch) the various potentials necessary for the testing of tubes. The tube data chart (booktype) which is supplied with the equipment, lists the control setting for the various types of tubes generally encountered in the field.

CAUTION: Before the tube to be tested is inserted in the correct test socket, make certain that the front-panel controls are set to the positions listed for that type tube in the data chart. This precaution is necessary to prevent excessive voltage from being applied to the tube elements (especially the filament).

LINE VOLTAGE ADJUSTMENT AND TEST.–The line voltage adjustment is necessary so that the line voltage applied to the primary of the transformer can be preset to an operating value. A 93-volt potential is used as a test reference point, regardless of the variations caused by different tube loads or fluctuations in the a-c supply. Applied voltages may range from 105 to 130 volts and still be adjustable. Depressing the LINE TEST button connects the meter of the tube tester to read the "B" supply voltage. The test equipment is calibrated at the factory so that the meter pointer is approximately centered when the voltage across the primary is 93 volts. Since various types of electron tubes draw different values of currents, a LINE ADJUSTMENT rheostat (connected in series with the primary) is provided. The primary voltage can thus be set to the designed operating voltage before any test is begun. A small protective lamp which will burn out on overload is connected in series with the primary of the transformer to prevent equipment damage.

SHORT CURCUIT AND NOISE TEST.–It is very important that the technician apply the test for short-circuited elements to a tube of doubtful quality before any other tests are made. This procedure protects the meter (or any other indicator) from damage. Also it follows logically that, if a tube under test has elements which are short-circuited, there is no further need to apply additional tests to that tube. Short-circuit tests are usually sensitive enough to indicate leakage resistance less than about one-fourth megohm. The proper heater voltage

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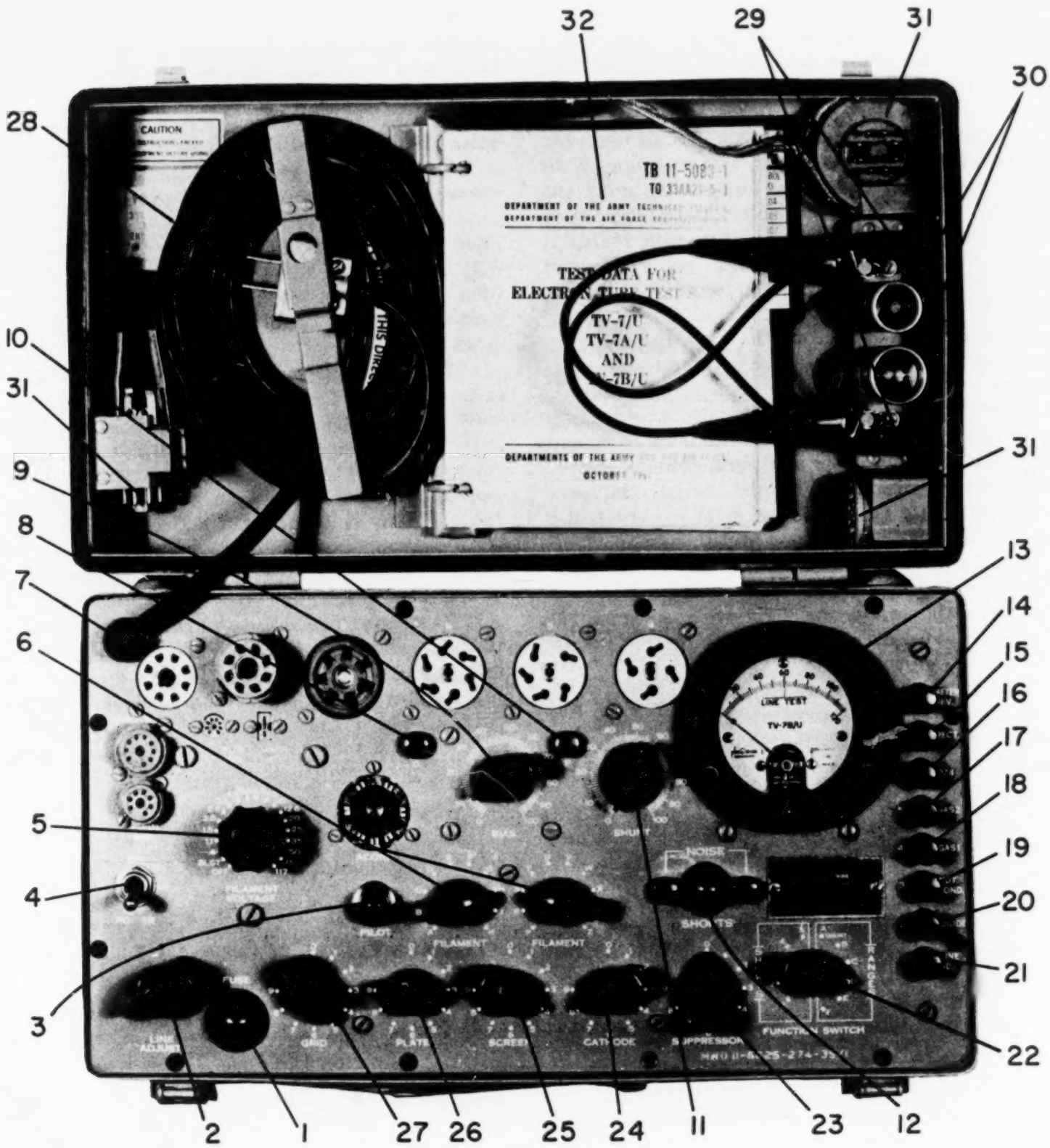

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Figure 8-18.–Electron Tube Test Set TV-7/U.

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ASSIGNMENT:

On the 17" x 22" buff paper issued to you, draw a horizontal line $1\frac{1}{4}$ inches from the bottom border. This space can be used for the title block, which includes the name of the school, student's name, etc. Lay out two $8\frac{1}{2}$" x 11" lettering blocks so that the spaces between the blocks and the margin are equal. Draw the $\frac{1}{2}$-inch border inside the blocks as shown in Fig. 2.

When all the guide lines are drawn, place a piece of tracing paper over the drawing sheet and proceed to practice, freehand, the letter strokes as shown in Fig. 2. Use a soft pencil.

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is applied so that any tube elements which might short as a result of the heating process will be detected. The short-circuit test is similar to the test used to detect noisy (microphonic) tubes caused by loose elements. Since the only difference between the two tests is in the sensitivity of the device used as an indicator, the noise test is discussed as part of the short-circuit test.

Figure 8-19 shows a basic circuit used for detecting shorted elements within a tube. With the switch set to position 2 as shown, the plate of the tube under test is connected to the leg of the transformer secondary containing the neon lamp. All the other elements are connected through switches to the other leg of the secondary. If the plate element of the tube is touching any other element within the tube, the a-c circuit of the secondary is completed and as a result, both plates of the neon lamp glow. If no short exists, only one plate of the neon lamp will glow. Each of the other elements is tested by means of the switching arrangement shown. Resistor R2 limits the current through the neon lamp to a safe value. Resistor R1 bypasses any small alternating currents in the circuit which might be caused by stray capacitance and thus prevents the neon lamp from indicating erroneously. Tapping the tube lightly is recommended to detect loose elements which might touch when the tube is vibrated.

In the test set shown in figure 8-18 the circuit used to test for shorts is similar to the basic circuit of figure 8-19. By means of the function switch the electrodes of the tube under test are switched in turn across a neon SHORTS lamp, which is connected in series with the secondary of the transformer. Shorted tube elements (and any other internal tube connections) complete the a-c circuit, causing both plates of the neon lamp to glow. Momentary flashes of the neon SHORTS lamp may be caused when the switch is rotated. These flashes are caused by the charging of the small inter-electrode capacitances of the tube when the voltage is applied, and do not indicate short circuits. If the tube under test has a shorted element, the neon lamp will glow continually on one or more switch positions. Since the filament circuit and other internal tube connections will show up as short circuits in this test, the tube data chart should be consulted for pin connection information before interpreting the results of the test.

The noise test is used to check for intermittent shorts or microphonic noise. The circuit used is the same as that employed for the short-circuit test. In tests for noise, the antenna and ground terminals of a radio receiver are connected to the NOISE TEST receptacles. Any intermittent short between tube electrodes permits the a-c voltage from the power transformer to be applied momentarily to the neon lamp.

The brief oscillation of this lamp contains various radiofrequencies which are reproduced as audible signals in the receiver speaker. A less sensitive noise test can be made using a pair of headphones instead of the radio receiver. The tube should be tapped while it is being tested.

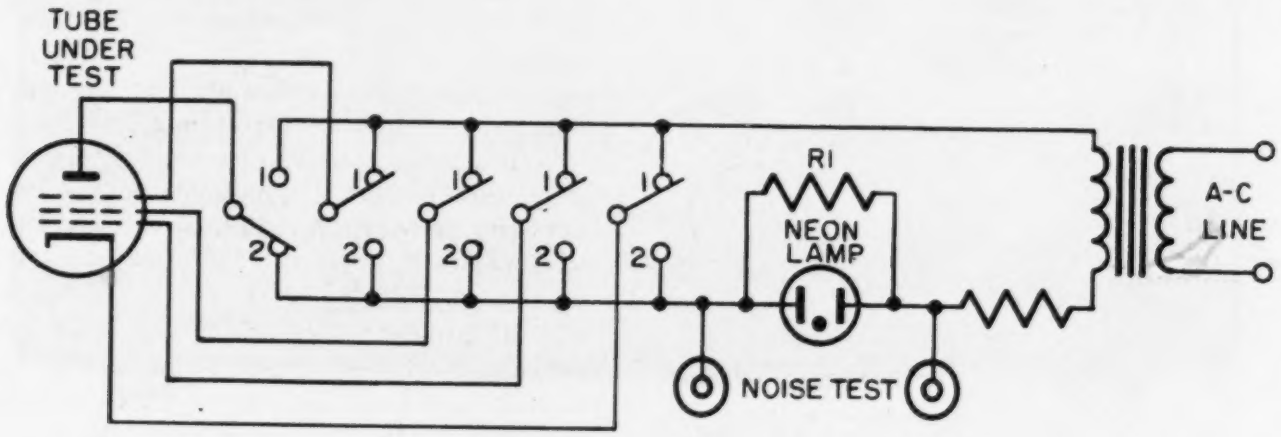

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Figure 8-19.–Basic circuit used for short circuit and noise tests.

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GAS TEST.–In all electron tubes, except some types of rectifier tubes and thyratrons, the presence of any appreciable amount of gas is extremely undesirable. When gas is present, the electrons emitted by the cathode collide with the molecules of gas. As a result of these collisions, electrons (secondarily emitted) are dislodged from the gas molecules, and positive gas ions are formed. These ions are attracted by (and cluster around) the control grid of the tube, because it is negative (bias) and absorbs electrons from the grid circuit in order to revert to the more stable gas molecules (not ionized). If the amount of gas in the tube is appreciable, the collisions between the numerous gas molecules and the cathode-emitted electrons release many secondarily emitted electrons, and the resulting flow of grid current is high.

The basic circuit used for the gas test is shown in figure 8-20. With switch S set to position 1, a certain value of plate current is measured by the d-c milliammeter. If there is no gas (or a negligible amount) present in the tube, setting switch S to position 2 does not change the plate-current reading. If gas is present, current flows through the grid resistor (large value), causing a voltage drop to develop with the polarity as shown. The net effect is to reduce the negative bias voltage on the grid of the tube resulting in an increase of plate current. Small plate current increases are normal; large increases indicate excessive gas.

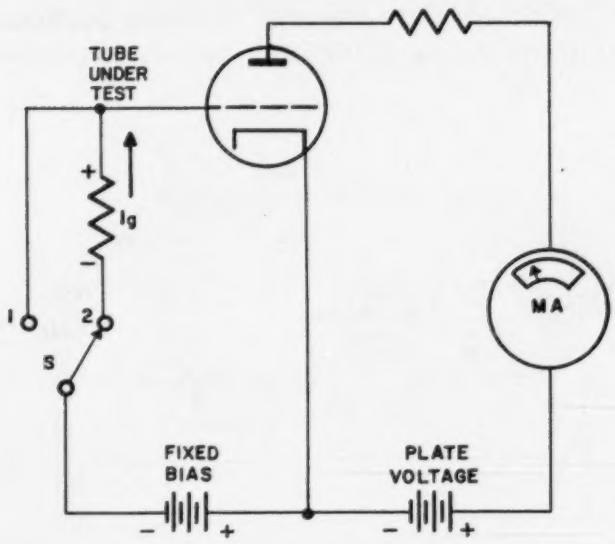

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Figure 8-20.–Basic circuit used for gas test.

The value of the grid resistor used in the typical tube tester is 180,000 ohms. Two push-button switches, labeled GAS No. 1 and GAS No. 2, are used for gas test. GAS No. 1 button is first depressed and the plate current reading on the meter is noted. Depressing the button marked GAS No. 2 inserts the 180,000-ohm resistor into the grid circuit. If gas is present in the tube, the grid current that flows reduces the normal bias on the tube and increases the plate current measured by the meter. A tube with a negligible amount of gas produces an increase in plate current of less than one scale division when GAS No. 2 button is depressed. An increase of more than one scale division indicates an excessive amount of gas in the tube.

CATHODE LEAKAGE TEST.–The cathode element of an electron tube is essential because it supplies the electrons necessary for tube operation. Electrons are released from the cathode by means of some form of energy–generally heat–which is applied to it. An indirectly heated cathode consists of a heater wire (usually a tungsten alloy) enclosed in, but insulated from, a metal sleeve (nickel). This sleeve is coated with an electron emitting material (usually strontium or barium compounds) on its outer surface, and is heated by radiation and conduction from the heater. Useful emission does not take place from the heater wire.

When a tube which uses an indirectly heated cathode develops noise, it is almost a certain indication that a leakage path is present between the cathode sleeve and the heater wire. This assumption is justified because in the design of a tube the heater must be placed as close as possible to the cathode so that maximum tube efficiency is attained. Continual heating and cooling of the tube structure may cause small amounts of the insulation between the cathode and heater to become brittle or deteriorate, leaving a high resistance leakage path between these elements. Under extreme conditions the insulation may shift enough to allow actual contact of the elements. Since the heater and cathode are seldom at the same potential, any form of leakage causes noise to develop in the tube.

The cathode normally is maintained at a higher positive potential, because cathode bias

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is the most common type of bias utilized. The heater circuit is usually grounded to chassis, either on one side of the filament supply or by a center-tap arrangement. Therefore, if a resistance path is present, a leakage current may flow from the heater to the cathode. Thus, in effect the cathode functions in the same manner as the plate of a tube; that is, it receives electrons. Assuming the existence of a high-resistance short, the current flow from the heater to the cathode will vary with any vibration of the tube because vibration varies the amount of resistance. If the cathode and heater are completely shorted (zero ohms), it is impossible for the tube to develop any cathode bias.

A cathode leakage test is sometimes made while a tube is being tested for short-circuited elements or noise. However, some tube-testing instruments incorporate the cathode leakage test as an additional test which is not part of the short-circuit test. Figure 8-21 shows a basic circuit which is used to detect leakage between the heater and cathode elements of a tube. With switch S set to position 2, a certain value of plate current flows.

When switch S is set to position 1, the cathode becomes a floating element; if no leakage path is present, the plate current should fall to zero. If the elements are completely shorted, the plate current reading remains the same as the initial reading (switch S in position 2); if they are only partially shorted, a plate current less than normal but greater than zero is indicated.

FILAMENT ACTIVITY TEST.–The filament activity test is used to determine the approximate remaining life of an electron tube insofar as the longevity of the cathode emitter is concerned. The test is based on the principle that the cathode in almost all electron tubes is so constructed that a decrease of 10 percent of the rated heater voltage causes no appreciable decrease in emission.

On a tube-testing equipment incorporating this test there is a two-position switch (FILAMENT ACTIVITY TEST) which has one position marked NORMAL and the other marked TEST. The switch remains in the NORMAL position for all tests other than the filament activity test. When the switch is set to the TEST position, the filament (or heater) voltage which is applied to the tube under test is reduced by 10 percent.

The filament activity test is performed as follows: After the quality test is made, the TUBE TEST button is held depressed, and the filament activity test switch is set to TEST position. If the indicator shows a decreased reading after a reasonable time is allowed for the cathode to cool, the useful life of the tube is nearing its end.

RECTIFIER TEST.–The circuit used for testing full-wave rectifiers, diodes, and 0Z4 tubes is an emission test circuit which is similar to the basic circuit shown in figure 8-22. An a-c voltage of definite value is applied to the tube under test, and the meter indicates the rectified plate current. The two sections of a full-wave rectifier are tested separately.

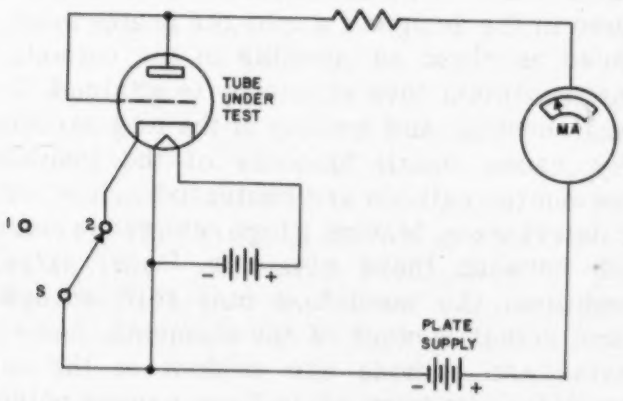

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Figure 8-21.–Basic circuit used for cathode leakage test.

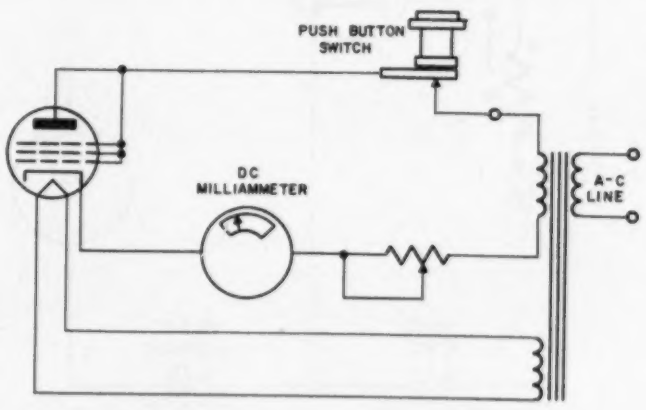

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Figure 8-22.–Basic circuit used for emission test.

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The button for testing OZ4 cold-cathode rectifier tubes provides a higher a-c voltage than is normally used for heater (or filament) type rectifiers. The button for diode tubes provides a lower voltage than that used for regular rectifiers, and also inserts a protective series resistance.

QUALITY TEST.–For the quality test, the d-c grid bias for the tube under test is supplied by a rectifier tube. The correct value of this grid bias is obtained when the bias control is rotated to the setting listed in the test data chart, for the tube being tested. An a-c voltage (4.7 volts rms), which is taken from a separate winding on the power transformer, is applied in series with the grid bias. This voltage causes the grid to deviate in positive and negative directions from the d-c bias level, thereby effecting the grid-voltage change (ΔE_g) required for a dynamic transconductance test. The plate voltage of the tube under test is supplied by a rectifier tube. The meter which indicates the plate current change (ΔI_p) is in the return circuit of the rectifier supply. The meter indicates the tube condition in arbitrary numerical units from 0 to 120. The tube test data book, mounted inside the cover of the equipment, lists the minimum numerical value of meter reading for satisfactory performance. Tubes reading below this value are not considered suitable for use in military equipment. The shunt control is used to control the sensitivity of the meter. Setting of the dial is required only when the function switch is in the RANGE (A) SHUNT position. The setting for this switch is determined by the type of tube being tested and is listed in the tube data chart. The operation of this circuit is the same as that of the basic circuit shown in part (B) of figure 8-17.

SEMICONDUCTOR TESTERS

Since semiconductors have replaced vacuum tubes in many new equipments, the testing of semiconductors has become increasingly vital. Two basic types of equipment are discussed in this section. They are the crystal diode tester and the in-circuit transistor tester, represented by the TS-1100/U.

Microwave Crystal Test Set

Microwave Crystal Test Set, Type 390 is used to provide an accurate and reliable indication of the quality of mixer crystals. Its accuracy is comparable to that of more elaborate laboratory test setups, but its testing versatility is more limited.

The quality of a microwave crystal can be determined by measurement of its conversion loss and noise temperature. The Type 390 is designed specifically to perform these tests on crystals intended for use at frequencies of 10,000 MHz and lower. For crystals used at frequencies above that figure, the readings are relative—crystals can still be selected in the order to comparative quality.

Conversion loss is defined as the ratio of the power available from the RF signal source to the power available at the IF output of the mixer. Noise temperature is defined as the ratio of the IF noise power available from the crystal to the thermal noise power available from a resistance (equal to the RF resistance of the crystal) at room temperature. The theory of the mixer crystal test set is based on the fact that the minimum conversion loss and noise temperature can be determined from the degree of nonlinearity of the static voltage-current (E-I) curve of a mixer crystal.

The Type 390 measures this nonlinearity by measuring the incremental change in crystal current (Δi) caused by an incremental change in voltage (Δe) applied to the crystal in the "forward" direction. Adjustment is made to the variable resistor R101 with the CAL-TEST switch in the CAL position. (See fig. 8-23.) If the E-I curve of the crystal under test were linear, a midscale reading would be obtained on meter M101 when S101 was switched to the TEST position. If the reading actually obtained is below midscale, the E-I curve of the crystal is nonlinear. The amount by which the reading falls below the midscale point is a measure of the degree of crystal's nonlinearity. The lower the meter reading below midscale, the more nonlinear the E-I curve for that crystal, and the lower its conversion loss and noise temperature.

Figure 8-23 is a schematic diagram of the test set. The initial adjustment of voltage V_i is made using variable resistor R101 with the

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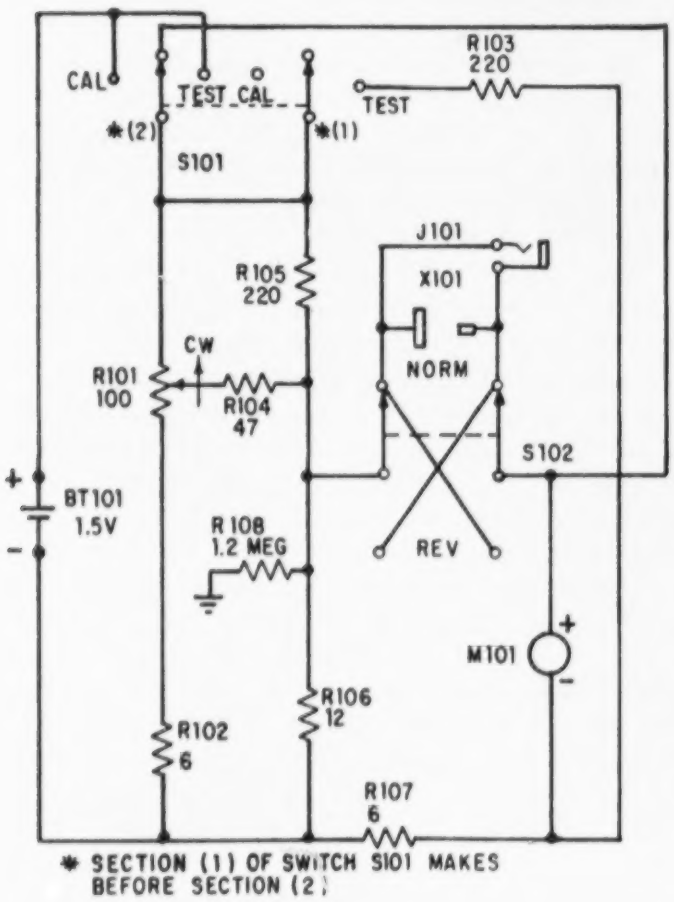

AT.110

Figure 8-23.–Microwave Crystal Test Set, Type 390, schematic diagram.

CAL-TEST switch S101 in the CAL position. (An incorrect adjustment of R101 may apply excessive voltage to M101, causing damage to the pointer. For this reason, R101 should always be set fully clockwise before switching to the CAL position). Also, see figure 8-24.

Fixed resistors R102, R104, R105, and R106 determine the limits to which V_i can be adjusted. The voltage increment (Δe) is established by R103 and R107 when in the TEST position; it has the same value for all crystals.

When a crystal is to be tested, it is placed in crystal holder X101. The crystal should always be handled by the base; while inserting the crystal, any static charge should be removed by touching the base to the grounding spring on the holder. The switch is set to the CAL position, and R101 is adjusted until the meter indication coincides with the calibration scale reading of R101. When S101 is moved to the TEST position, M101 indicates the quality of the crystal. With the aid of a chart supplied with the test set, the reading of M101 can be

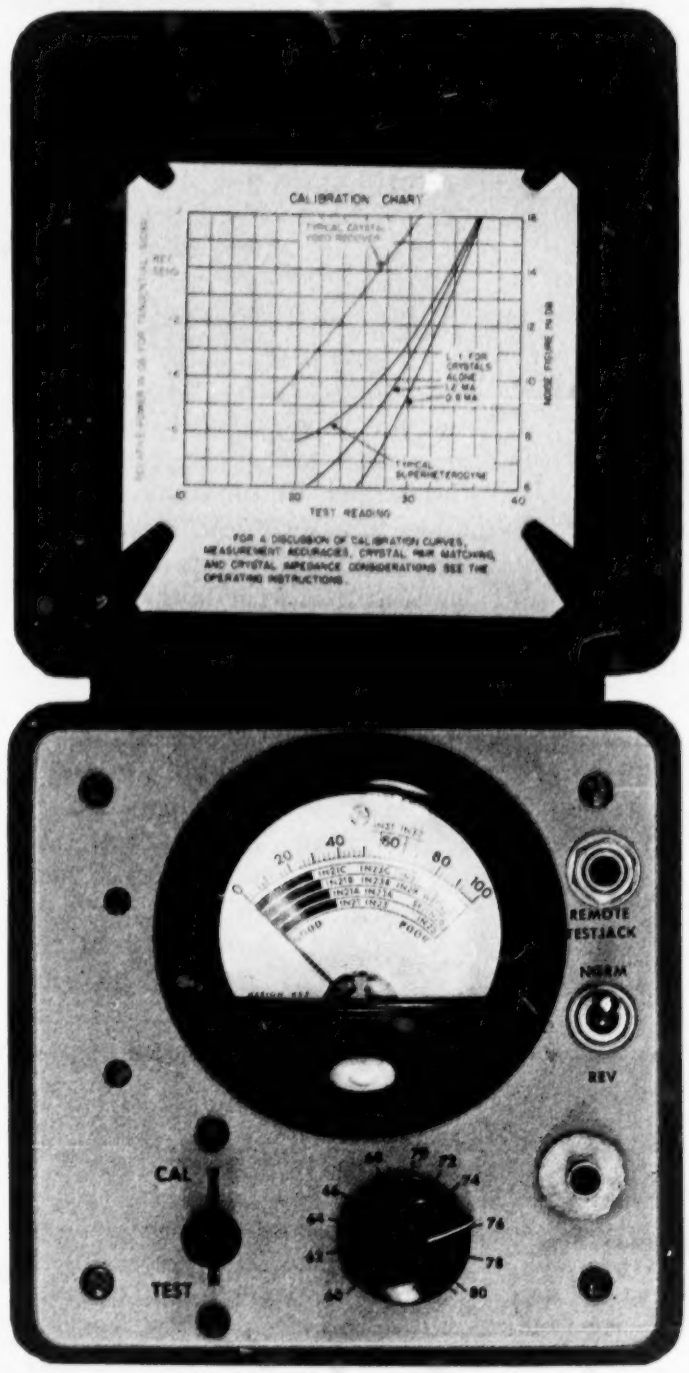

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Figure 8-24.–Type 390 microwave crystal checker.

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converted to the actual conversion loss and noise temperature. Block sections on the meter scale help ease the acceptance or rejection of crystals according to the type being tested.

The purpose of the NORM/REV switch (S-102) is to provide the correct bias-voltage polarity for the crystal diode being tested; and to determine the polarity of a crystal diode when it is not known or when the crystal diode is located remotely from the test set.

In-Circuit Transistor Checkers

Test Set, Transistor TS-1100/U (fig. 8-25) is designed to measure the beta parameter of a transistor when the transistor is connected in a circuit, and to measure beta and I_{co} parameters with the transistor removed from the circuit.

AT.112

Figure 8-25.–Test Set, Transistor TS-1100/U.

The characteristics of the test set are:

1. Range of beta 10 to ∞ in a single band.
2. Leakage current measurements: 0° to 50 microamperes.
3. Temperature range: 0° C to +50 C.
4. Power Supply: Battery operated.

The equipment contains two separate battery power supplies. One provides the power for the internal circuits, and the other furnishes the bias voltage required for the transistor under test. Either the mercury type of zinc-carbon batteries may be used for operation of the test set.

Low impedance techniques are used for measurement to isolate the transistor under test from the surrounding circuitry. The measurement accuracy of the tester is within ±20 percent provided that the loading of the emitter-base diode or the collector-base diode is not below 500 ohms, and the loading between the collector and the emitter is not below 500 ohms. If the emitter-base load contains a diode, the series impedance should not fall below 7,000 ohms to maintain this accuracy.

With the use of an appropriate shorting technique, the accuracy can be improved. The shorting technique consists of connecting a jumper wire between the emitter of the transistor under test and the far side of all components connected to the base electrode of the transistor. This technique is not universally applicable, and it should be employed only by skilled personnel.

The range of beta that can be measured is between 10 and ∞. A beta of infinity (∞) corresponds to zero microamperes on the readout meter scale. A transistor having a beta below 10 will cause the pointer of the meter on the tester to move off the scale. Because of the nonlinear characteristic of the meter scale, which causes crowding at the high end, the readout accuracy for betas above 100 is impaired.

The following controls, as seen on the front panel (fig. 8-25), are incorporated in the test set:

1. POWER switch (labeled ON-OFF): Turns the internal power source on or off.
2. PNP-NPN (transistor select) switch: Selects proper collector bias polarity for the type transistor under test.
3. BETA switch: Permits readout of beta.
4. BIAS SELECT switch: Used to set proper collector bias voltages (nominally 3, 6, or 12

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volts). Also checks the condition of internal battery when in the TEST position.

5. RED LINE SET control: Adjusts the amplitude of the test signal.

6. SHORT switch (labeled CB, CE, BE): Enables measurement of a short circuit or a low impedance in the collector-base (CB), collector-emitter (CE), or base-emitter (BE) circuits.

7. I_{CO} switch: Enables readout of transistor leakage.

8. SHORT indicator: The indicator lamp will light when a short circuit or low impedance exists in either the transistor under test or in the surrounding circuitry. If the lamp lights, this indicates a load of less than 500 ohms.

9. TEMPERATURE indicator: The indicator lamp will light when the ambient temperature surrounding the equipment exceeds +50° C. This indicates that the equipment is operating in an environment beyond that for which it has been designed, and that measurement inaccuracies will arise.

10. METER: Indicates magnitude of beta; indicates magnitude of I_{CO}; and indicates the condition of the internal battery. (The battery is good when the meter needle moves under the green band on the dial.)

11. PROBE connector: For connecting the cables (furnished with the test set) to the transistor to be tested.

12. TRANSISTOR socket (labeled E-B-C): Enables direct connection between the test set and transistor to be tested.

13. BATTERY DISCONNECT switch (upper left corner of panel–not labeled): Disconnects the internal battery when the front cover is snapped in place.

For proper procedure in operating the test set, refer to Technical Manual for Test Set Transistor TS-1100/U, NavShips 93277.

FUNCTIONAL DESCRIPTION.–The block diagram (fig. 8-26) consists essentially of a reference oscillator, a tuned amplifier, and a variable bias supply. The oscillator is used to generate a test signal, the tuned amplifier is used to measure the second harmonic component of the current of the transistor under test, and the bias circuit furnishes the appropriate voltages to the transistor under test.

The reference signal source is a Hartley oscillator operating at a frequency of 1,125 Hz.

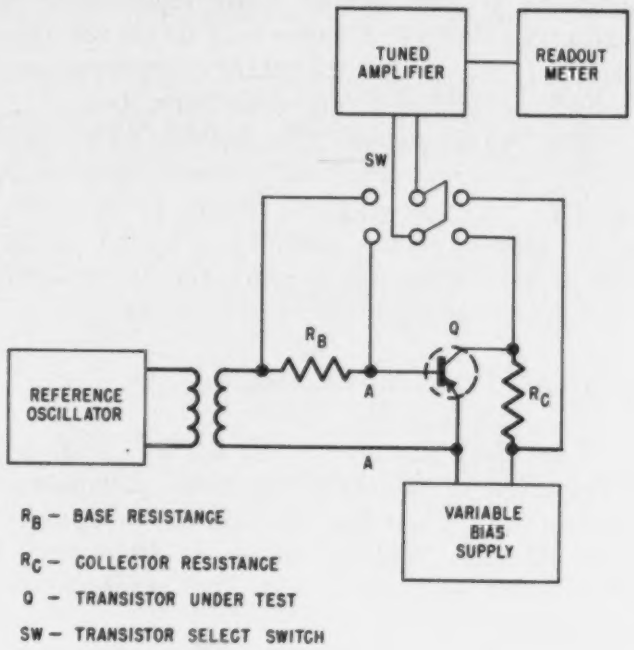

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Figure 8-26.—TS-1100/U, block diagram.

The transistor under test is biased for approximately class B operation. Thus, the transistor conducts only when the input signal level exceeds the work function of the emitter-base diode. The input signal is adjusted until the average collector current is 1 milliampere. The current passes through the collector load resistor, and a voltage is developed across it. This signal is first coupled through a high gain, narrowband amplifier, having a center frequency of 2,250 Hz, and then through a d-c microammeter. The amplifier gain has been adjusted so that the red line on the meter face corresponds to an average collector current of 1 milliampere.

The bandpass amplifier and meter are then switched across the base load resistor, and the meter then reads the magnitude of the average beta directly for a given transistor. Since the collector current is held constant for all transistors under test, the base current is inversely proportional to beta.

Direct measurement of the average collector and base current cannot be made on a d-c meter placed in series with these electrodes. This is because of the large errors which may result from the presence of "sneak paths" provided by the external network, since it is possible to have a direct current flow in these paths from the collector bias supply.

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By making an a-c measurement, the problems of erroneous direct current are eliminated, but others are introduced. If the a-c components of the collector current and base current were measured without filtering, the readout meter would not be able to differentiate between the normally rectified signal of the transistor and a nonrectified signal caused by the a-c sneak paths. To eliminate these erroneous signals, the second harmonic component of the signal current is measured.

TRANSISTOR CURVE TRACER (TEKTRONIX 575)

The Transistor Curve Tracer 575 is employed to plot or trace characteristic curves of transistors and other semiconductor devices. There are two different methods to plot the characteristic curves of a transistor. One is to apply d-c voltages and take measurements point-by-point. The other method is to use changing voltages and display the curve on an oscilloscope.

The 575 displays the curves by the use of the oscilloscope. There are several advantages in the use of the second method. To begin with, it is faster and more accurate than the point-by-point method. The point-by-point method may allow small irregularities in the characteristics to go undetected. Since heat is a major factor in transistor operation, errors caused by heat are reduced because the periods of applied power are shorter. Another definite advantage is that permanent records of the curves traced out on the oscilloscope may be easily produced at a reasonable cost by the use of photographic equipment.

This equipment is also provided with a self-calibration test. The operator can quickly reassure himself of the accuracy of the test set by the use of this built-in calibration check, in case a displayed curve deviates from the published nominal characteristic curve. The following paragraphs describe briefly how the 575 works and outlines a method for determining dial settings for transistors found in the fleet.

An illustration of the front panel of the equipment is shown in figure 8-27. As can be seen the controls are grouped into five blocks, with a test connector panel at the base of the test set. In addition to the block arrangement the panel is also color coded to simplify the operation. The collector currents and voltages are referenced by the sections of the panel etched in red; the sections etched in blue refer to the base currents and voltages. An exception to this color code is when a common base transistor configuration is being tested, at that time the blue is in reference to the emitter.

In the description of the five functional divisions that follows, refer to figure 8-27 for the item numbers listed; a functional block diagram is also given in figure 8-28.

The collector sweep circuit supplies the transistor under test with a collector voltage which is the output of a full-wave rectifier without any filtering. The 60-Hz line voltage is supplied to the full-wave rectifier and the output of the rectifier is 120-Hz pulses. The output waveform varies from zero volts to some peak value which can be controlled from the front panel (items 2 and 4). The peak voltage can be varied in two ranges, from 0 to 20 volts and from 0 to 200 volts. The polarity of the sweep voltage can be reversed in order to check both PNP- and NPN-type transistors (item 3). A variable amount of resistance can be placed between the collector sweep supply and the transistor under test in order to limit the maximum amount of collector dissipation (item 1).

Base Step Generator

The step generator develops currents and voltages which change value in stairstep fashion in synchronization with the collector sweep voltage (items 12, 16, 17, and 18). The output of the generator can be reversed in polarity and can be connected to either the base or the emitter of the transistor under test (item 13). The number of steps can be varied from 4 to 12 according to the type of display desired (item 14).

Display Function

The display function includes the three major functional blocks remaining; the vertical and horizontal amplifiers, and the cathode-ray tube. (A description of the operation of a cathode-

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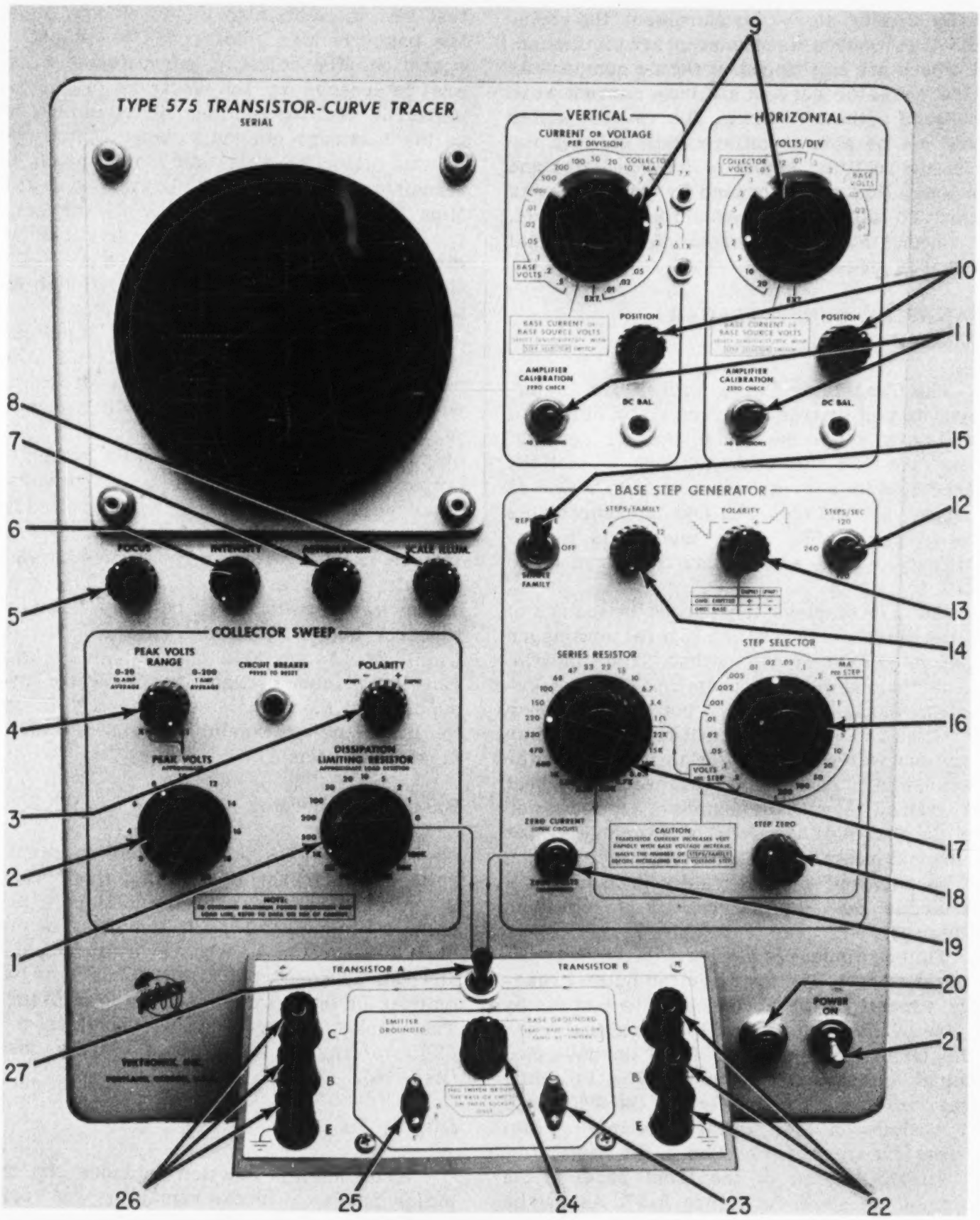

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Figure 8-27.–Transistor curve tracer (Tektronix 575).

Nomenclature for figure 8-27.

1. Dissipation limiting resistor.
2. Peak volts control.
3. Polarity switch.
4. Peak volts range.
5. Focus control.
6. Intensity control.
7. Astigmatism control.
8. Scale illumination.
9. Vertical/horizontal select.
10. Display position.
11. Amplifier calibration.
12. Steps/sec selector.
13. Polarity switch.
14. Steps/family.
15. Repetitive/single family.
16. Step selector.
17. Series resistor.
18. Step zero.
19. Zero current/voltage.
20. Indicator lamp.
21. Power ON-OFF.
22. Binding posts B.
23. Socket B.
24. Configuration switch.
25. Socket A.
26. Binding posts A.
27. Comparison switch.

ray tube is given in Basic Electronics; an oscilloscope is also discussed later in this chapter.)

The horizontal and vertical amplifiers of the cathode-ray tube display can be driven by several different inputs, depending upon what characteristics are of interest (item 9). The horizontal amplifier can select any of four inputs and display one of them on the horizontal axis. The four inputs are base volts, collector volts, base current or base-source volts, and external. In the base volts position, the horizontal amplifier is connected to the base of the transistor under test. In the collector volt position, the horizontal amplifier is connected to the collector of the transistor under test. Both of these inputs have several positions so that the scaling factor can be changed. The base-current or base-source volts position connects the output of the base step generator into the horizontal amplifier. The external position connects the horizontal amplifier to two coax connectors on the rear of the instrument.

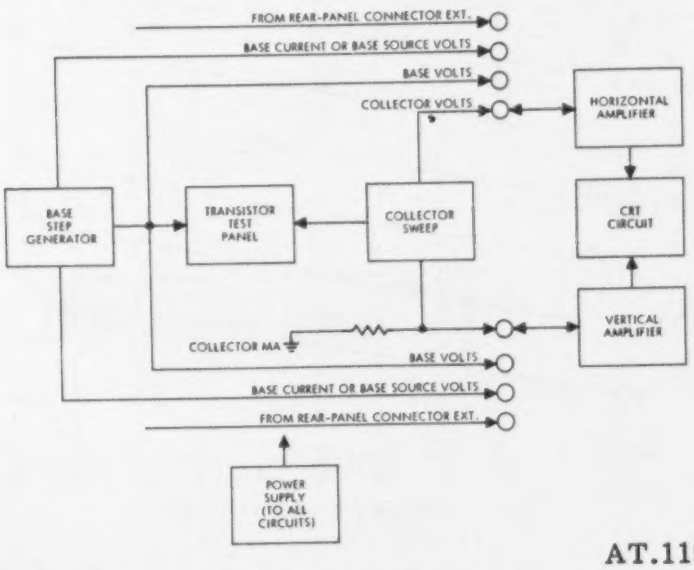

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Figure 8-28.–Transistor curve tracer block diagram.

The vertical amplifier can also select from four different inputs: collector MA, base volts, base current or base-source volts, and external. Base volts, base current or base-source volts, and external positions are the same as described for the horizontal amplifier, but in the collector MA position, the vertical axis will give a plot of collector current.

INTERPRETING THE DISPLAY.–As the collector voltage changes from zero to some peak value and back to zero again, the step generator output remains at some specific level and then changes to some new level for the next collector voltage cycle. The collector voltage is swept at a rate of 120 Hz, and the step generator changes steps or level after every cycle (in the 240 steps per second, the step generator changes at both the zero point of the collector sweep and at the maximum point). Figure 8-29 is a plot of collector sweep voltage and base step generator current. It should be noted that the collector sweep makes a complete excursion, while the base is at some steady value. As the next collector sweep starts, the base current is changed to the next value of current selected by the dials on the front of the instrument, and again the base current will remain steady while the collector voltage is varied.

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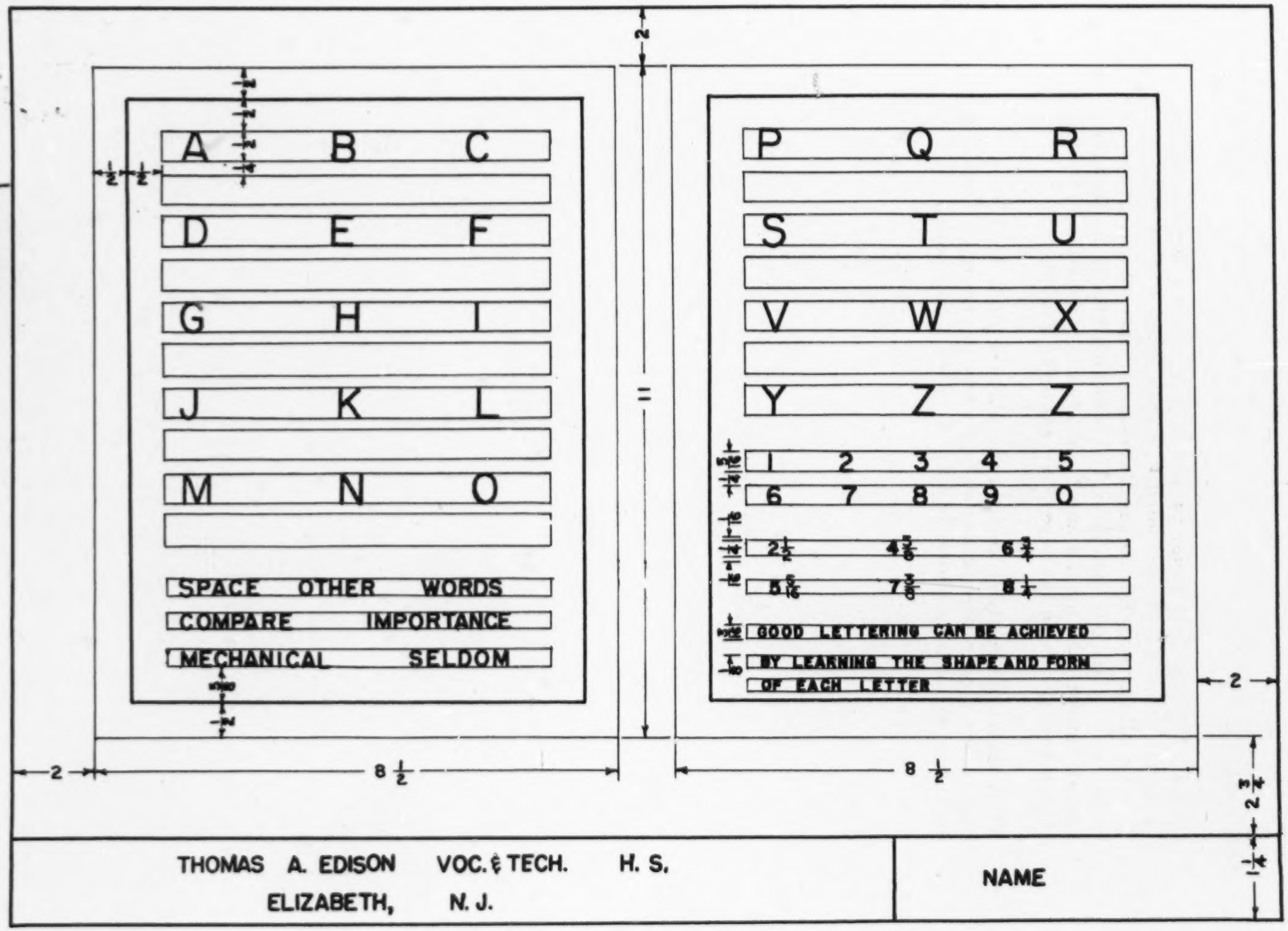

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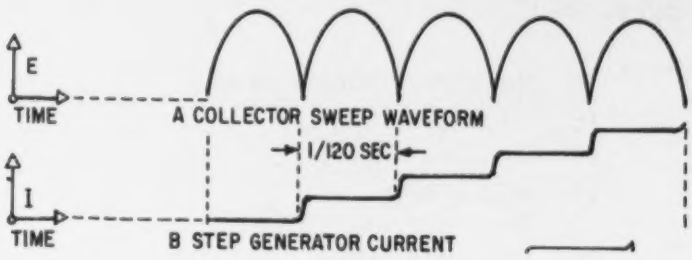

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Figure 8-29.–Waveforms of collector sweep versus step generator current.

As previously mentioned, the waveforms of figure 8-29 can be reversed by switches on the front panel in order to check either PNP or NPN.

Figure 8-30 is a plot of collector voltage and collector current for given values of base current for an NPN transistor. For this type of transistor, it is a convention to have the lower left-hand corner represent zero collector voltage and current. In this graph, it was arbitrarily decided that each division to the right of the lower left-hand corner of the horizontal axis would represent a collector voltage change of one more volt positive. This would indicate a collector voltage swing of zero to 10 volts positive. The vertical axis is a plot of collector current varying from zero milliamperes in the lower left-hand corner to 10 milliamperes at the top of the graph in 1 milliampere steps. The different lines on the graph represent different values of base current; in this case, each line represents a change of 0.01 milliampere. If this graph had been for a PNP rather than for an NPN, the upper right-hand corner would have represented zero collector voltage and zero collector current. The divisions to the left would have represented negative collector voltage and the divisions downward from the top would have indicated the amount of negative current. This would have made the family of curves to appear as shown in figure 8-31.

These curves are known as the static collector characteristics for a common emitter configuration or output characteristics curve. Curves can be developed for common base and common collector also, but normally the information is available for the common emitter mode. Using this configuration, it is easier to check the transistor. To thoroughly describe how a transistor is going to work in a circuit,

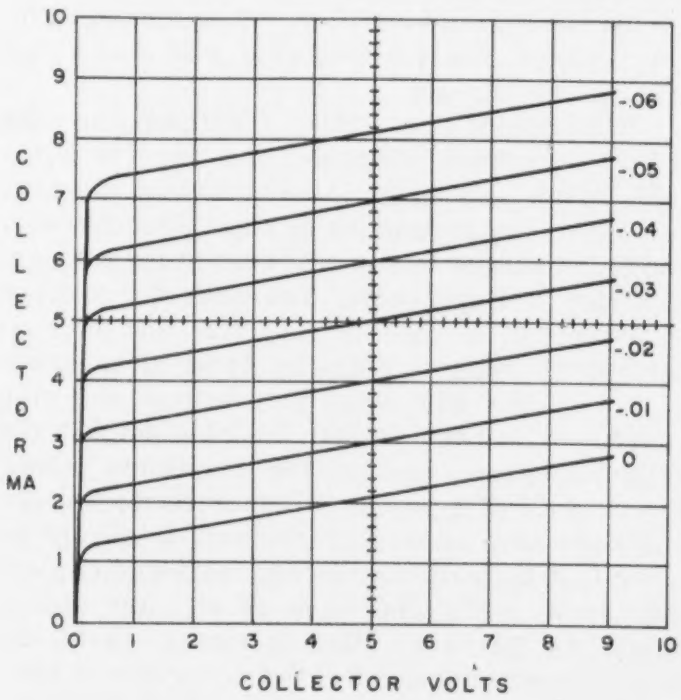

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Figure 8-30.–Typical NPN collector curves.

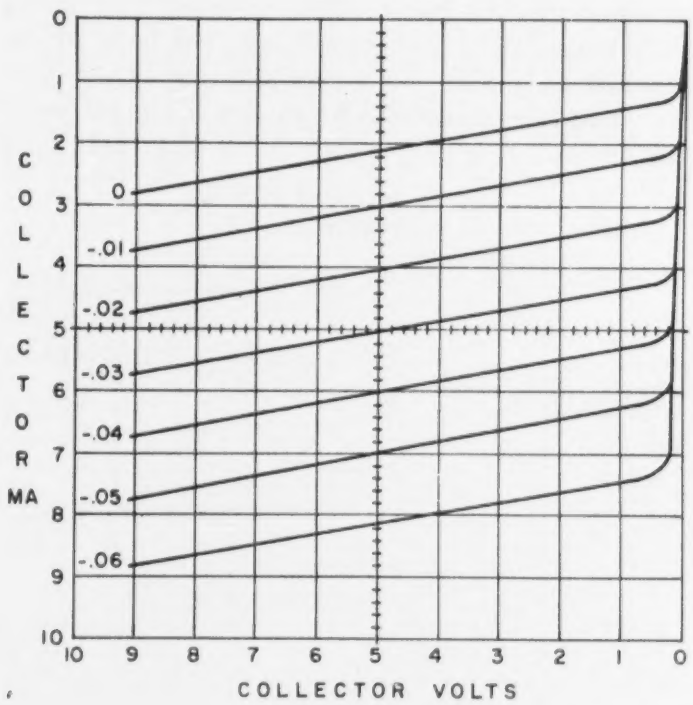

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Figure 8-31.–Typical PNP collector curves.

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it is necessary to know the input characteristic curve as well as the output curve. The input characteristic curve is developed by plotting base current on the horizontal axis, base to emitter voltage (V_{RE}) on the vertical axis at different values of collector to emitter voltage (V_{CE}). Although it is necessary for the design engineer to know the input characteristic curve when designing a circuit, the output characteristic curve will normally give the maintenance technician enough information to allow him to evaluate a transistor.

Measuring Beta (h_{fe})

One means of measuring the quality of a transistor is the Beta (β) or current gain in the common emitter configuration. Mathematically, Beta is represented by the formula

$$\beta = \frac{\Delta ic}{\Delta ib}$$

where V_{CE} is constant. Beta is also called the forward current transfer ratio and represented by the symbol h_{fe}, which is derived from the hybrid equivalent circuit of a transistor. To determine the Beta from the output characteristics, measure the change in collector current between two values of base current at some constant collector voltage; for instance, in figure 8-30, to determine the Beta at a collector voltage of 5 volts, measure the change in collector current between the base current curves of 0.02 ma and 0.03 ma. In this example, the change in collector current measures 1 ma, so the Beta is equal to the change in collector current divided by the change in base current or

$$\frac{1 \times 10^{-3}}{0.01 \times 10^{-3}} = 100$$

Measuring I_{CO}

Another characteristic of a transistor is the I_{CO}, also called I_{CBO}. This is the collector current when the collector is biased in the reverse direction (high resistance, normal connection) with respect to the base, and the emitter is open-circuited. The I_{CO} of a transistor is highly temperature-dependent and the measurement made with the curve tracer will be at the ambient temperature only; but it is still significant. The method used to measure the I_{CO} is shown schematically in figure 8-32. Notice that the emitter is not connected.

The display of the curve tracer when measuring I_{CO} is shown in figure 8-33. The vertical axis indicates collector current, just as it did when Beta was being measured; but now the vertical amplifier is adjusted to afford maximum gain so that the small amount of current causes a noticeable deflection. The horizontal axis is still calibrated to show collector voltage.

The technician must know the Beta and I_{CO} of a transistor in order to tell whether or not the one he is testing is good. Since no manual describing the characteristics of different transistors is provided with the curve tracer, it is necessary to obtain this information from other sources. NavWeps 16-1-530 Replacement Guide, Semiconductor Device (Transistors and Semiconductor Diodes), dated May 1963, is an excellent source. For those transistors not listed in this publication, a specification sheet can be obtained from the manufacturer.

Section 1A of NavWeps 16-1-530 is a list of transistor replacements. Section 1A also gives the technical section in which a specific transistor is listed. These are Sections 2 through 10. To use this manual, look up the transistor in the technical section which applies; descriptions at the top of each page tell whether the transistor is germanium or silicon, PNP or NPN, low or high power. The important columns

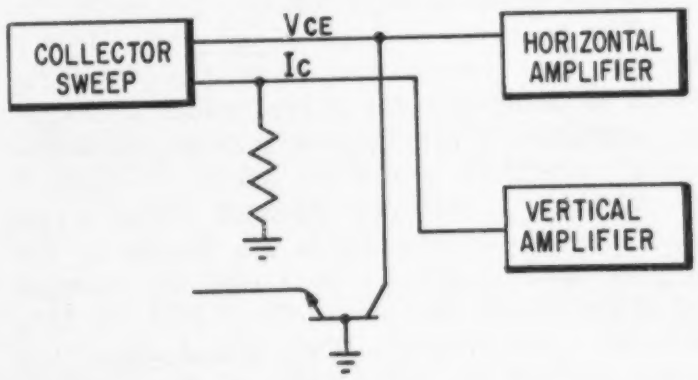

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Figure 8-32.—Connections for checking I_{CO} (I_{CBO}).

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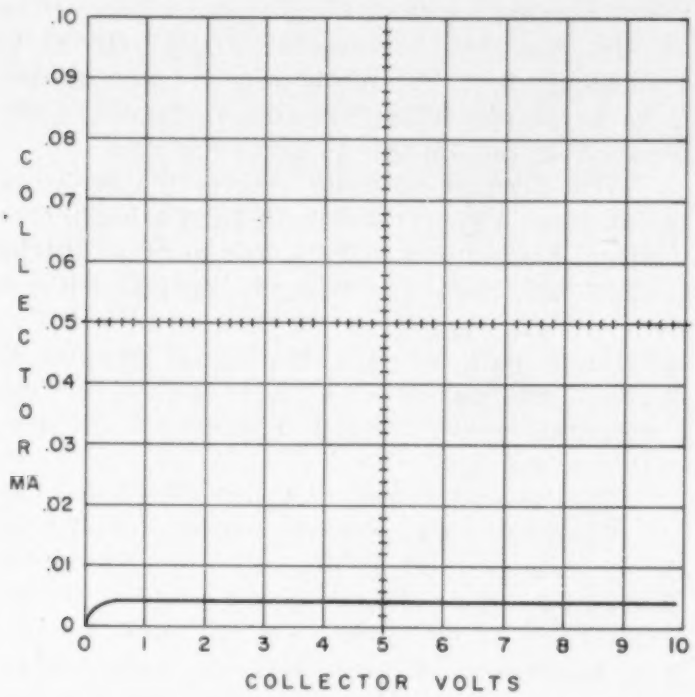

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Figure 8-33.–Typical display of $I_{CO}(I_{CBO})$.

in the technical section needed to obtain information on testing are MAXIMUM COLLECTOR DISSIPATION, ABSOLUTE MAX RATINGS, MAX I_{CBO} at MAX V_{CB}, Typical "h" Parameters at 25° C.

Under the column labeled Typical "h" Parameters, there is listed a typical h_{fe} or a minimum and maximum value of h_{fe} depending on which technical section the transistor is listed in. In the same column is listed the collector voltage and collector current at which this h_{fe} is to be obtained.

The collector voltage (V_{CE}) and collector current (I_C) provide the starting points from which to determine the curve tracer settings; for instance, if the V_{CE} is 5 volts, the horizontal amplifier would be set to COLLECT or VOLTS, 1 volt per division. This would place the 5-volt position in the middle of the display, and if the I_C is 1-ma, the vertical amplifier would be set to COLLECT or MA, 0.2 MA per division. This would place the 1-ma position in the middle of the display. The collector sweep can be determined from these settings, since the horizontal amplifier is set to 1 volt per division. The collector voltage varies a total of 10 volts, so the PEAK VOLTS RANGE is in the 0 - 20 position and the PEAK VOLTS control is set at 10. To determine the setting for the DISSIPATION LIMITING RESISTOR, obtain the maximum collector dissipation from the column in the technical section labeled MAX COLL DISS. This, in conjunction with the setting of the PEAK VOLTS control, can be plotted on the chart on top of the curve tracer to obtain the correct setting of the limiting resistor.

The step generator is set up in the following manner. The switch labeled REPETITIVE-OFF-SINGLE FAMILY is set to REPETITIVE, and the control labeled STEPS/FAMILY is set counterclockwise. This gives four steps per family, which is usually sufficient; but if more are desired, set STEPS/FAMILY to any value. The switch labeled POLARITY has a chart under it showing the correct position for NPN and PNP. Use the portion of the chart pertaining to grounded emitter-type circuits. The switch labeled STEPS/SEC can be in either of the two 120 positions or in the 240. The only difference in the two 120 positions is that at one of them, the step generator changes level when the collector is at zero volts; and at the other position, the step generator changes level when the collector is at the maximum voltage. In the 240 position, the step generator changes level at both the zero collector voltage and at the maximum point. The step selector can be set by starting at the smallest change per step (0.001 ma) and increasing the size of the step until the display has the necessary separation between the values of base current to determine Beta. In the alternative procedure, the Beta listed in the technical section can be divided into the amount of collector current and the result used as the setting of the step selector. If there isn't enough separation between the lines representing the base current to accurately determine the Beta, increase the amount of each base step until a good display is obtained.

To check the I_{CO} of the transistor, disconnect the emitter and change the current per division setting on the vertical amplifier to the most sensitive position (0.01 ma). Set the step zero very accurately, as described in NA 16-45-107, which is the Service Instruction Manual and Operating Instruction Manual for the curve tracer. After setting the step zero, note the difference between the step zero and

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the present position of the trace; this is an indication of the I_{CO}. The I_{CO} of the transistor is listed in the technical section, in the column MAX I_{CBO} at MAX V_{CB}, which describes the I_{CO} at BV_{CBO}—the breakdown voltage, collector-to-base with emitter open.

By measuring Beta (h_{fe}) and I_{CO} (I_{CBO}), a fair picture of the condition of a transistor is presented. There is one thing that should be mentioned in connection with the curve tracer, however; matching of transistors. Some Navy equipments have matched pairs of transistors, but unless the specifications are checked, it cannot be automatically assumed that Betas of the transistors are matched. Sometimes the Betas are matched, sometimes they are not; many times several characteristics are matched.

SIGNAL GENERATORS

The principal function of a signal generator is the production of signals having the specific characterstics required for the test or measurement in question. It is very important that the amplitude of the generated signal be correct. In many generators, output meters are included in the equipment so that the output may be adjusted and maintained at a standard level over a wide range of frequencies.

When using the generator, the test equipment output signal is coupled into the circuit being tested. Its progress through the equipment may then be traced by the use of high impedance indicating devices such as vacuum tube voltmeters or oscilloscopes. In many signal generators, attenuators are provided. These are used to regulate the voltage of the output signal and also provide correct impedance values for matching the input impedance of the circuit under test. Accurately calibrated attenuators are desirable since the signal strength must be regulated to avoid overloading the circuit receiving the signal.

There are many types of sinusoidal signal generators. It is possible to classify them roughly by frequency into audio generators, generators of both the audio and video ranges, radiofrequency generators, frequency-modulated RF generators, and special types which combine all of these frequency ranges.

In addition, signals other than sinusoidal are also generated for testing of equipment. The signal generators producing nonsinusoidal outputs are usually classified according to the type of signals they produce. Some signal generators produce several types of signal waveforms.

In almost all currently used types of signal generators, electron tube oscillators are used to produce the initial signal. In order to achieve accurate results in the use of the signal source, it is necessary to allow the oscillator circuits to reach a condition of stable operation before applying the output. This condition is reached when the tubes and circuit elements attain the temperature at which the instrument was calibrated.

A preliminary warmup should always be given the generator when accurate and stable signals are desired. The minimum warmup time for the generator is contained in the Service Instruction Manual for each model. The general properties and functions of signal generators are covered in Basic Electronics. In the sections immediately following, there is a discussion of several types of generators.

In testing the receiver section of a transceiver, the output of the signal generator is usually connected to the antenna terminal of the transceiver. If the transceiver is then keyed, damage to the signal generator results. This damage usually includes burning out of the resistive elements of the signal generator output circuits; these elements are rated only for the comparatively low power of the signal generator. In this type testing configuration, it is essential that some form of protection be given the test equipment.

One form of protection which can be provided is a fuse in series between the signal generator output terminal and the transceiver antenna terminal. The value of the fuse is dictated by the output limitations of the signal generator—usually about 1/16 ampere is recommended.

SINE WAVE GENERATORS

Sine wave generators will be discussed under the heading of three classes. These classes are audio, video, and radiofrequency. The sine wave generator is used to produce simulated conditions for the alinement and testing of equipments.

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Audio and Video

Audio signal generators produce stable audiofrequency signals used for testing audio equipment. Video signal generators produce signals which include the audio range and extend considerably further into the RF range. These generators are used in testing video amplifiers and other wideband circuits. In both audio and video generators, the major components include a power supply, an oscillator (or oscillators), one or more amplifiers, and an output control. Voltage regulation circuits are necessary to insure stability of the oscillator in generators which derive power from 115-volt, a-c sources. In portable generators, battery power supplies are usually used, and these require no voltage regulation.

In the audio and video generators of the beat-frequency type, the output frequency is produced by mixing the signals of two radiofrequency oscillators, one of which is fixed in frequency and the other variable. The difference in frequency of the two is equal to the desired audio or video frequency. For example, if the fixed and variable oscillators both produce a frequency of 400 kHz, the resultant output frequency is zero. If the variable oscillator is changed to 401 kHz, the resultant is then 1 kHz. By action of this type, any desired frequency in the range of the circuits may be produced in the output.

Audio signal generators often include RC oscillators in which the audio frequency is directly produced. In these, a resistance-capacitance circuit is the frequency determining part of the oscillator. The frequency varies when either the resistance or the capacitance is changed in value. In commercial generators, however, the capacitance alone is often chosen as the variable element. The change in frequency which can be produced by this method is limited, and it is usually necessary to cover the entire range of the generator in steps. This is accomplished by providing several RC circuits, each corresponding to a portion of the entire range of frequency values. The RC circuits in the oscillator are switched to cover the desired portion of the audio range.

The amplifier section of the block diagram of figure 8-34 usually consists of a voltage amplifier and one or two power amplifiers.

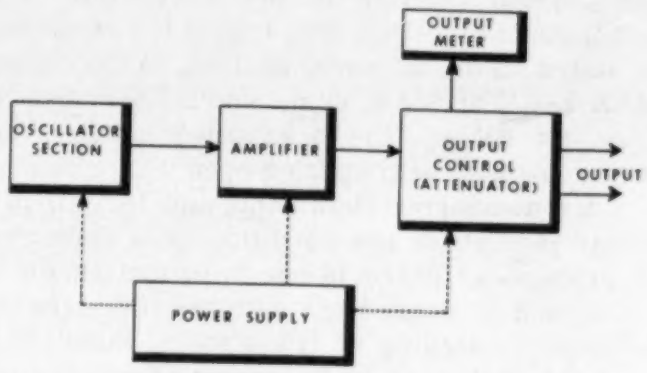

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Figure 8-34.–Block diagram of typical audio or video signal generator.

These are coupled by means of RC networks, and the output of the final power amplifier is often coupled to the attenuator, or output control, by means of an output transformer.

The output control section provides a means of matching the output signal to the input of the equipment under test and regulating the amplitude of the signal. The settings of the output control knob provide output voltage values which are either inscribed directly on the knob or which can be interpreted by reference to the instruction manual provided with the generator.

Radiofrequency

A typical radiofrequency signal generator contains, in addition to the necessary power supply, three main sections–an oscillator circuit, a modulator, and an output control circuit. The internal modulator modulates the radiofrequency signal of the oscillator. In addition, most RF generators are provided with connections through which an external source of modulation of any desired waveform may be applied to the generated signal. Metal shielding surrounds the unit to prevent the entrance of signals from the oscillator into the circuit under test by means other than through the output circuit of the generator.

A block diagram of a typical RF signal generator is shown in figure 8-35. The function of the oscillator stage is to produce a signal which can be accurately set in frequency at any point in the range of the generator. The type of oscillator circuit used depends on the range of frequencies for which the generator

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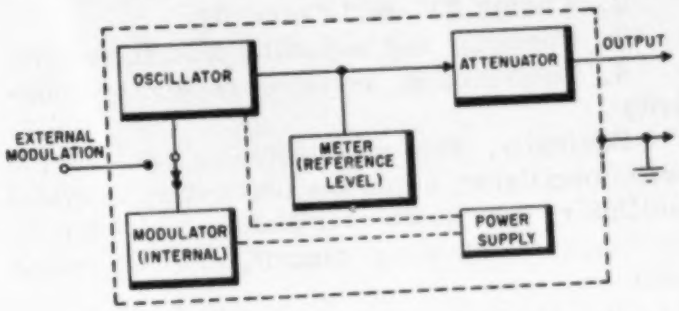

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Figure 8-35.–Block diagram of a radiofrequency signal generator.

is designed. In low frequency signal generators, the resonating circuit consists of one of a group of coils combined with a variable capacitor. One of the coils is selected with a range selector switch which attaches it to the capacitor to provide an LC circuit which has the correct range of resonant frequencies.

In signal generators designed for the higher frequencies, the resonating circuits are usually in the form of butterfly tuning circuits and resonant cavities. Reflex klystron oscillators are often used in generators of frequencies above 1000 MHz.

In any signal generator, it is required that the oscillators have good stability both in frequency and amplitude over a wide range of output frequencies.

The function of the modulating circuit is the production of an audio (or video) voltage which can be superimposed on the RF signal produced by the oscillator. The modulating signal may be provided by an audio oscillator within the generator (internal modulation), or it may be derived from an external source. In some signal generators, either of these methods of modulation may be employed. In addition, a means of disabling the modulator section is used whereby the pure unmodulated signal from the oscillator can be used when it is desired.

The type of modulation used depends on the application of the particular signal generator. The modulating voltage may be either a sine wave, a square wave, or pulses of varying duration. In some specialized generators, provision is made for pulse modulation in which the RF signal can be pulsed over a wide range of repetition rates and at various pulse widths.

Usually the output circuit of the generator contains a calibrated attenuator and often an output level meter. The output level meter gives an indication of, and permits control of, the output voltage of the generator by indicating arbitrary values of output read in tenths through the value of one.

The attenuator selects the amount of this output. The attenuator, a group of resistors forming a voltage-dropping circuit, is controlled by a knob which is often calibrated in microvolts. When the control element is adjusted so that the output meter reads unity (1.0), the reading on the attenuator knob gives the exact value (no multiplication factor) of the output in microvolts.

If output voltage is desired at a lower value, the control is varied until the meter indicates some decimal value less than one; this decimal is multiplied by the attenuator reading to give the output in microvolts.

SG-85/URM-25D.–RF Signal Generator Set AN/URM-25D is typical of most RF signal generators in common usage. It consists of Signal Generator SG-85/URM-25D, its case, and an assortment of accessory items.

It is intended primarily for bench testing of electronic equipment, covering the frequency range from 10 kHz to 50,000 kHz. This frequency coverage is accomplished in eight bands, and the RF output can be either modulated or unmodulated. The frequency generated can be read from a main frequency scale within an accuracy of ±0.5 percent; and by proper use of a 1-MHz internal crystal calibrator, the accuracy can be increased to 0.05 percent above 1 MHz.

This test set also generates an audio signal of 400 or 1000 hertz, which is used to modulate the RF carrier. The audio signals are also separately available at the front panel.

Operational procedure, technical characteristics, and theory of the SG-85/URM-25D can be found in NavShips 92134(A).

FM SIGNAL GENERATORS.–Frequency-modulated RF signal generators are widely used for testing frequency-modulated receivers and for visual alinement (using an oscilloscope) of AM receivers. A frequency-modulated signal is an alternating voltage in which the frequency varies above and below a given center frequency value. The overall frequency change is called the frequency swing.

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There are several methods by which the frequency of the oscillator in the signal generator may be frequency modulated. In one type of FM generator, use is made of a vibrating plate which forms one of the elements of the tuning capacitor of the oscillator to be modulated. The plate is driven by a device similar to a magnetic loudspeaker. The audio modulating voltage is applied to the driving coil which moves in the field of a permanent magnet and vibrates the plate of the capacitor at the applied audiofrequency. Movement of the plate causes variation of the capacitance in the oscillator tuning circuit with the result that the frequency of the oscillator is periodically raised or lowered.

Another method of producing frequency modulation is based on the action of a reactance tube which is connected in parallel with the tuning circuit of the oscillator to be modulated. A reactance tube is an electron tube in which the plate current is made either to lead or to lag the plate voltage variations by 90°. Because of this phase difference, the plate circuit of the tube is electrically equivalent either to a capacitor or to an inductance. The modulating voltage is impressed on the grid of the reactance tube, causing the capacitive (or inductive) reactance of the plate circuit of the tube to vary. Since the reactance tube plate circuit is a part of the oscillator tuning circuit, variation in the reactance value causes the generated frequency to vary in step with the modulating voltage.

In signal generators of microwave frequencies, frequency modulation is easily accomplished in the oscillator by applying the modulating voltage to the repeller plate of the reflex klystron tube which is usually employed in these generators.

SWEEP GENERATOR AN/URM-75

Sweep Generator AN/URM-75 is a versatile precision test instrument used for alining and checking radio receivers in the frequency range of 5 to 220 MHz. Its major component is the SG-93/URM-75 sweep generator, which supplies signals for the following functions:

1. Observing frequency response, relative gain, and bandpass characteristics of RF, IF, and video stages.
2. Alining RF and IF circuits.
3. Checking and adjusting discriminators.
4. Determining relative receiver sensitivity.

Basically, the unit consists of an FM sweep oscillator, a marker oscillator, a crystal oscillator, an audio oscillator, a frequency converter, a blanking circuit, and two output jacks.

The FM sweep oscillator is tunable over a frequency range of 50 to 220 MHz. In conjunction with the sweep converter stage, the oscillator produces a sweep signal which is variable from 5 to 220 MHz. This extended range is covered in two bands.

On band B, the sweep converter is disabled and the sweep oscillator operates alone to cover the range of 50 to 220 MHz. On band A, the sweep oscillator signal is beat against a 116.5 MHz signal from a fixed frequency oscillator in the converter stage. This beat produces a signal which is variable from 5 to 50 MHz. The sweep output is available at the MIXED OUTPUT jack. The signal may be used alone or in conjunction with a marker signal.

The marker oscillator operates over a frequency range of 4 to 220 MHz, covered in 6 bands. The marker signal, either modulated or unmodulated, is then supplied to both the MKR OUT jack and the MIXED OUTPUT jack. By means of this signal, the exact frequency may be determined for any point along a frequency response curve produced by the sweep signal.

The crystal oscillator is normally operated at a fundamental frequency of 10 MHz. By insertion of the appropriate crystal, however, oscillation may occur between 4 and 15 MHz. The crystal oscillator output, either modulated or unmodulated, is supplied to both output jacks. This signal provides a means of correctly calibrating the marker oscillator, or of calibrating external signals.

The audio oscillator generates a signal of 600 Hz which may be used to modulate the marker output and/or the crystal oscillator output, if desired. It is not available as a separate output.

The generator incorporates an optional blanking circuit which produces a 60-Hz sine wave. The positive half of the sine wave is

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eliminated, and the negative half is applied to the grid of the FM sweep oscillator. This input cuts off the FM sweep during the period of the half cycle. Thus, when the operator activates the blanking circuit, the FM sweep oscillator produces pulses of energy occurring at a 60-Hz rate.

PULSE GENERATOR AN/URM-44A

The generation of pulse signals involves many fundamental electronic circuits and some special purpose tubes. Some of the circuits involved are multivibrators, limiters, clampers, discriminators, oscillators, and sawtooth generators. One of the special purpose vacuum tubes is the reflex klystron, which is used as an oscillator.

The TS-622A/U is a typical pulse generator. It is the main component of Radio Test Set AN/URM-44A.

The TS-622 is a signal generator of low power output and is used in the maintenance of radio and radar equipment operating in the frequency range between 7,000 and 10,750 MHz. It produces continuous-wave, pulse-modulated, and frequency-modulated signals. The output frequency and power level of the test set are indicated on separate direct reading dials located on the front panel.

In the pulse-modulated mode of operation, pulse widths of 0.5 to 10 microseconds may be obtained, and the pulse repetition may be adjusted from 40 to 4,000 pulses per second. Pulse modulation is obtained from a multivibrator which produces square waves of the above mentioned pulse widths and frequency.

In the frequency-modulated mode of operation, a sawtooth generator supplies a sawtooth of voltage to the reflex klystron to cause the signal to be frequency modulated.

In the CW mode of operation, the klystron is permitted to free-run at the frequency selected.

This test set includes an internal synchronizing generator (the multivibrator), and has provision for applying an external synchronizing signal of either positive or negative polarity. It also has provision for an external modulating signal to be applied.

The front panel provides the following three outputs:

1. The RF output, which is the output from the klystron oscillator.
2. An undelayed sync (undelayed synchronizing voltage).
3. A delayed sync. The syncs are either the output from the internal sync generator or an input from the external sync source.

The Service Instruction Manual, AN 16-30URM44-2, contains a breakdown of all circuits of the test set and detailed theory of operation of each. Also included in the manual is a master block diagram to simplify the explanations.

PULSE GENERATOR AN/UPM-55

This equipment is basically a pulse generator and a synchroscope, combined into a single unit. It is used to generate, display, and measure pulse test signals. It consists of Pulse Generator SG-30/UP, its transit case, and the associated cables, adapters, accessories, and technical manuals. Operation of the equipment involves the use of high potentials which are dangerous to life. Safety precautions must be observed.

The Pulse Generator SG-30/UP has been designed to furnish rectangular voltages of adjustable duration, amplitude, and repetition frequency. These pulses are delayed so that they follow trigger pulses by an adjustable time interval. The equipment may be triggered by an external signal, or it may be triggered by an internally generated audio-frequency signal. Internally generated pulse, trigger, and audio signals are made available at output terminals on the front panel.

The synchroscope located in the same unit is capable of accurately determining the waveshape, amplitude, duration, and time relationship of the output pulses. The equipment is suitable for use in maintaining airborne or ground electronic equipment. The design and construction of the unit makes it adaptable for work performed in laboratories or in maintenance shops located aboard ship or on land.

MULTIPLE-SIGNAL GENERATORS

Signal Generator SG-321A/U provides multiple output signals which are essentially transient-free over a frequency range of 0.008

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to 1200 cps in 5 bands. The versatility of the equipment and the quality of its generated signals make the SG-321 useful for any general purpose testing application within its frequency range. It is especially useful in the testing of servosystems and mechanically operating systems, and in the electrical simulation of mechanical operations.

The outputs available from this equipment include square and triangular waveforms, both of which are inherent in the basic oscillating system. In addition, a sine wave is developed by modifying (synthesizing) the triangular waveform. A sync output pulse is also made available for external use.

The basic oscillating systems uses a type of relaxation oscillator that is especially well adapted to the generation of very low frequencies. Both the triangular and the square wave of voltage as a function of time are inherent in the systems.

Any type of AVC system causes a delay in the stabilization of an output response following a change in operating frequency. The oscillating system of the SG-321A/U is a constant amplitude device which requires no AVC system. The output amplitude and distortion of signals is therefore almost completely independent of frequency.

The signal generator is rated to deliver at least 30 volts peak to peak to a 4000-ohm load. The sync output is a negative pulse of 10 volts amplitude and a duration of less than 5 microseconds. The sync pulse occurs at the crest of the sine wave, and at corresponding points on the other waveshapes.

SIGNAL ANALYZERS

Signal analyzers, while used in many different situations, generally aid in the accomplishment of only one function, that is to check the response of an equipment under simulated conditions of specific operations.

MODULATION MEASUREMENT

Modulation characteristics can be determined by waveform measurement or by use of modulation meters (which are special applications of basic test equipment). Modulation measurements are sometimes required during tuning procedures to adjust transmitting equipment for the proper amount of modulation. During maintenance tests of modulated transmitter equipment, the amount of distortion of the output signal and the modulation level or index should be determined.

The modulation level of carrier signals in multiplexing equipment is usually set at the factory or in the shop during corrective maintenance procedures. Proper adjustment of the input signal level and automatic signal level regulation circuits provide the correct amount of modulation. Defects in modulation circuits can be detected by measurements of the quality of the received signals. Corrective maintenance analysis of multiplex equipment modulation circuits can usually be made by signal level measurements. Therefore, specific modulation measurements are normally not required for a carrier equipment which operates in the audiofrequency to medium frequency RF range.

Most amplitude modulated radio transmitters which operate in the low frequency to high frequency range must be adjusted for correct modulation during normal tuning procedures. If the modulation level is low, the transmitter is not operating at its maximum efficiency; on the other hand, modulation in excess of 100 percent procedures serious distortion. Since either of these conditions is undesirable, amplitude modulation should be maintained between 60 and 95 percent when possible. The modulator amplifier gain can be initially adjusted by use of an oscilloscope or a modulation meter.

The modulation level or index of AM and FM radio transmitters which operate in the VHF range is usually adjusted by the manufacturer or in the shop during corrective maintenance. Amplitude modulation of radio transmitters in this frequency range can usually be measured by the same methods employed for transmitters in the LF to HF range.

Frequency modulation measurements can be obtained by the use of an audiofrequency signal generator and a receiver with a beat-frequency oscillator. The modulation index can also be determined by a comparison method, using a frequency-modulated signal generator having a calibrated modulation control, an AF signal generator, a radio receiver capable of detecting FM signals, and an output signal level indicator.

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UNIT II - USE OF DRAWING INSTRUMENTS

Drawing Board and T-Square Lesson 1

OBJECTIVE: To learn how to maintain and use a drawing board and T-square.

RELATED INFORMATION:

FIG. 1

The drawing board shown (Fig. 1) is 18 inches wide and 24 inches long, a convenient size. It is made from well-seasoned basswood, joined together by tongue-and-groove construction. Either side may be used when drawing. Both its sides and edges should be kept free of dents, knife marks, and holes. Dampness or excessive heat will cause the board to warp; do not store it near a radiator. This board should be kept clean and free of pencil lines. It may be used on top of work benches or drawing tables when they are available.

The T-square shown in Fig. 2 is used for guiding the pencil when drawing horizontal lines, and for supporting the triangles when drawing vertical and oblique lines. It consists of a head and a blade with transparent edges. Care should be taken not to dent the edges, for smooth lines cannot be drawn against a dented edge. When not in use, the T-square is hung up, a hole in the blade being provided for this purpose. A good cleaning fluid such as carbon tetrachloride should be used to clean the T-square whenever needed, for a dirty instrument will smudge a drawing.

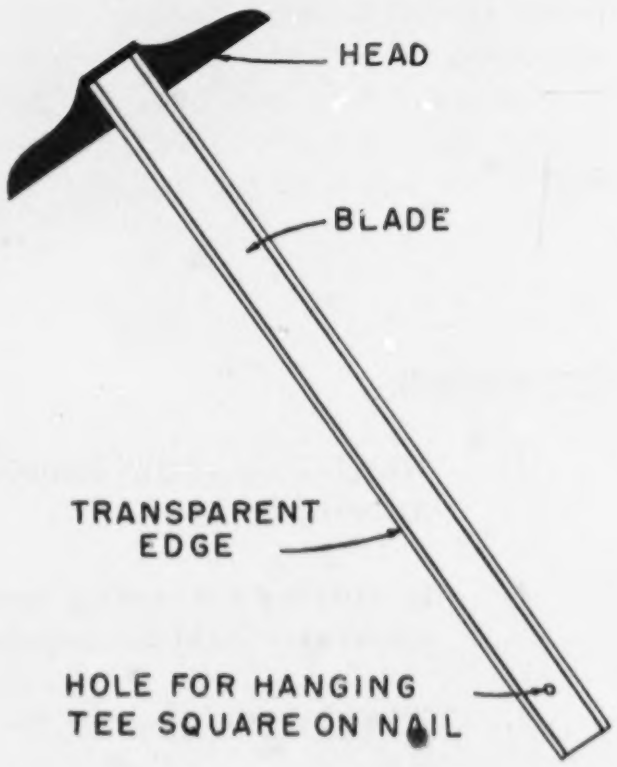

FIG. 2

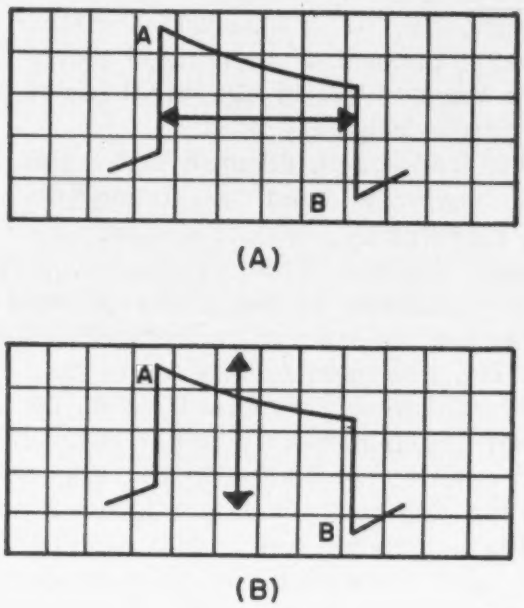

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Figure 8-36.–Typical waveform display.
(A) Measurement of elapsed time;
(B) measurement of voltage difference.

small series resistor and look at the voltage wave across the resistor with the oscilloscope. Other quantities such as temperatures, pressures, speeds, and accelerations can be translated into voltages by means of suitable transducers, and then viewed on the oscilloscope.

Interpreting the Display

To find the elapsed time between two points on the graph (fig. 8-36 (A)) such as A and B, multiply the horizontal distance between these points in major graduated divisions by the setting of the TIME/DIV (time per division) control. This control sets the horizontal sweep rate of the oscilloscope. The distance between points A and B is 4.8 major divisions. If the TIME/DIV control is set at 100 microseconds per division, then the elapsed time between points A and B must be 4.8 x 100 = 480 microseconds. In general, elapsed time = horizontal distance in divisions X TIME/DIV setting.

If a MULTIPLIER control is associated with the TIME/DIV control, multiply the above result by the setting of the MULTIPLIER. If a MAGNIFIER is in operation, divide the result by the amount of magnification.

To find the voltage (fig. 8-36 (B)) difference between any two points on the graph, such as A and B, multiply the vertical distance between these points in major graduated divisions by the setting of the VOLTS/DIV control. This control sets the vertical deflection factor or sensitivity of the oscilloscope. The vertical distance between points A and B is 4.0 divisions: If the VOLTS/DIV control is set at 0.5 volts per division, then the voltage difference between points A and B must be 4.0 x 0.5 = 2.0 volts.

The quantity called pulse repetition rate (or pulse repetition frequency) for periodic pulses can be expressed as the number of pulses per unit of time. Examples: 10 pulses per second and 50 pulses per microsecond.

In using the oscilloscope to measure the frequency or repetition rate of periodic waveforms, first read the horizontal distance in major divisions between corresponding points on two succeeding waves. This is the horizontal distance occupied by one cycle of the wave. Multiply this by the setting of the TIME/DIV control in seconds, milliseconds, or microseconds. Take the reciprocal of this product; that is, divide it into 1. The result is the desired frequency or repetition rate.

It is convenient to use square waves, rather than other forms of waves, for testing of equipment because the nature of a defect, rather than simply its presence, is suggested by the kind of distortion which occurs to a square wave. By observing the squarewave response, it is easy to tell whether the transmission of low or high frequencies is affected. This observation is not so well separated with regard to frequency if waves other than square waves are used.

If two linear devices give identical responses when square waves are fed into them, they can, in general, be expected to give responses similar to each other when other waveforms are fed into them.

Information Contained in a Square Wave

It can be shown that a periodic wave contains the following components; (1) a fundamental wave, which is a sine wave having a frequency equal to the repetition frequency of the square wave, and (2) an infinite series of harmonics–sine waves having frequencies which are equal to whole numbers multiplied by

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the fundamental frequency. The harmonics must be properly related in phase and in amplitude to the fundamental.

Waveform D of figure 8-37 depicts a periodic rectangular wave (square wave). In the case of the square wave, the only harmonics present are the "odd" harmonics (those whose frequencies are equal to the fundamental frequency multiplied by odd whole numbers); and the strengths of the harmonics vary in inverse proportion to the frequencies of the harmonics, the fifth harmonic being one-fifth as strong as the fundamental, for example. The way in which these waves combine to make up a square wave is suggested by figure 8-37.

The four curves shown in figure 8-37 illustrate the following:

1. Curve A the fundamental sine wave.
2. Curve B the sum of the fundamental and third harmonic.
3. Curve C the sum of the fundamental plus third and fifth harmonics.
4. Waveform D is the ultimate square wave.

It will be noted that the first few harmonics combine with the fundamental to provide an approach to an actual square wave. Additional harmonics, of higher frequencies, would cause the leading edge of the wave to rise more rapidly, and produce a sharper corner between the leading edge and the top of the wave. It would require an "infinite" range of harmonics to produce a truly vertical leading edge and an actual sharp corner, and this situation is physically impossible to produce. But waves can be generated which are very close to this ideal situation. (The same considerations apply to the falling edge of the waveform, and the following corner.)

Information regarding the amplitude and phase relationships of the higher harmonics is, then, contained in the leading-edge steepness and in the sharpness of the corner.

If low frequency components (fundamental and the first few harmonics) are not present in the proper amounts and in the correct phase relationships, the part of the square wave affected will be the flat top. Figure 8-38 (A) shows the location of the low and high frequency information in a square wave. Low frequency defects will appear in the form of slope or general curvature in the top, as shown in (B) and (C) of the figure. In (B) of the figure, the low frequency components have leading phase angles and are attenuated. In (C) the low frequency components have lagging phase angles and are accentuated.

Oscilloscope Block Diagram

Figure 8-39 is a block diagram of a typical oscilloscope, omitting power supplies. The

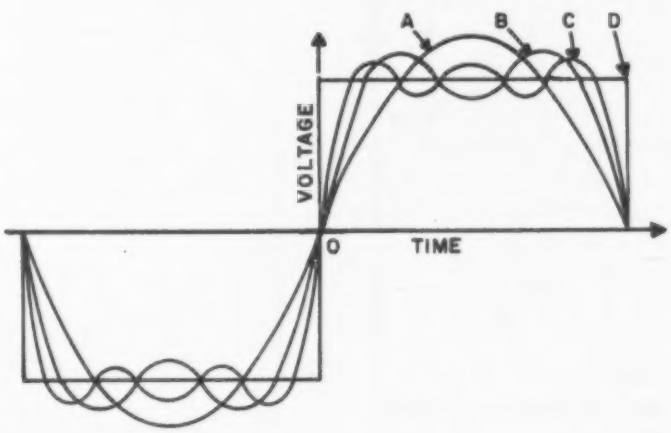

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Figure 8-37.–Addition of harmonics to fundamental waveform.

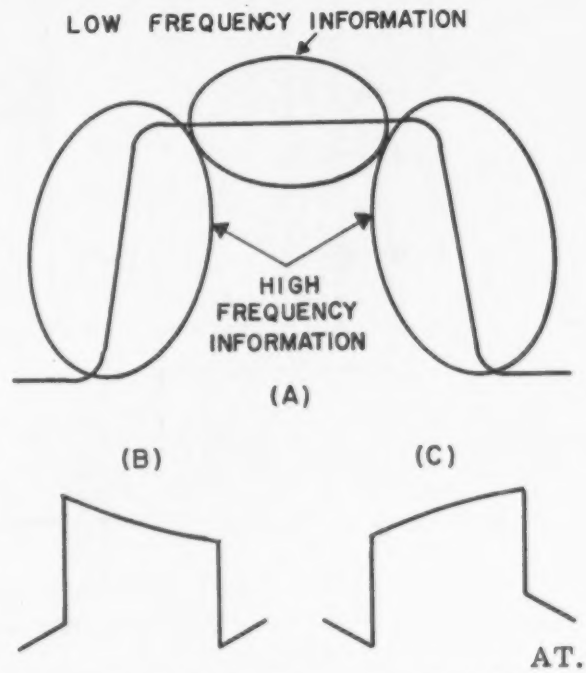

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Figure 8-38.–Information found in a square wave.

waveform (A) to be observed is fed into the vertical amplifier input. The calibrated VOLTS/DIV control sets the gain of this amplifier. The push-pull output (B and C) of the vertical amplifier is fed through a delay line to the vertical deflection plates of the cathode-ray tube.

The time base generator or "sweep generator" develops a sawtooth wave (E) that is used as a horizontal deflection voltage. The rising or positive-going part of this sawtooth, called the "runup" portion of the wave, is linear. That is, it rises through a given number of volts during each unit of time. This rate of rise is set by the calibrated TIME/DIV control. The sawtooth voltage is fed to the time base amplifier. This amplifier supplies two output sawtooth waveforms (G and J) simultaneously–

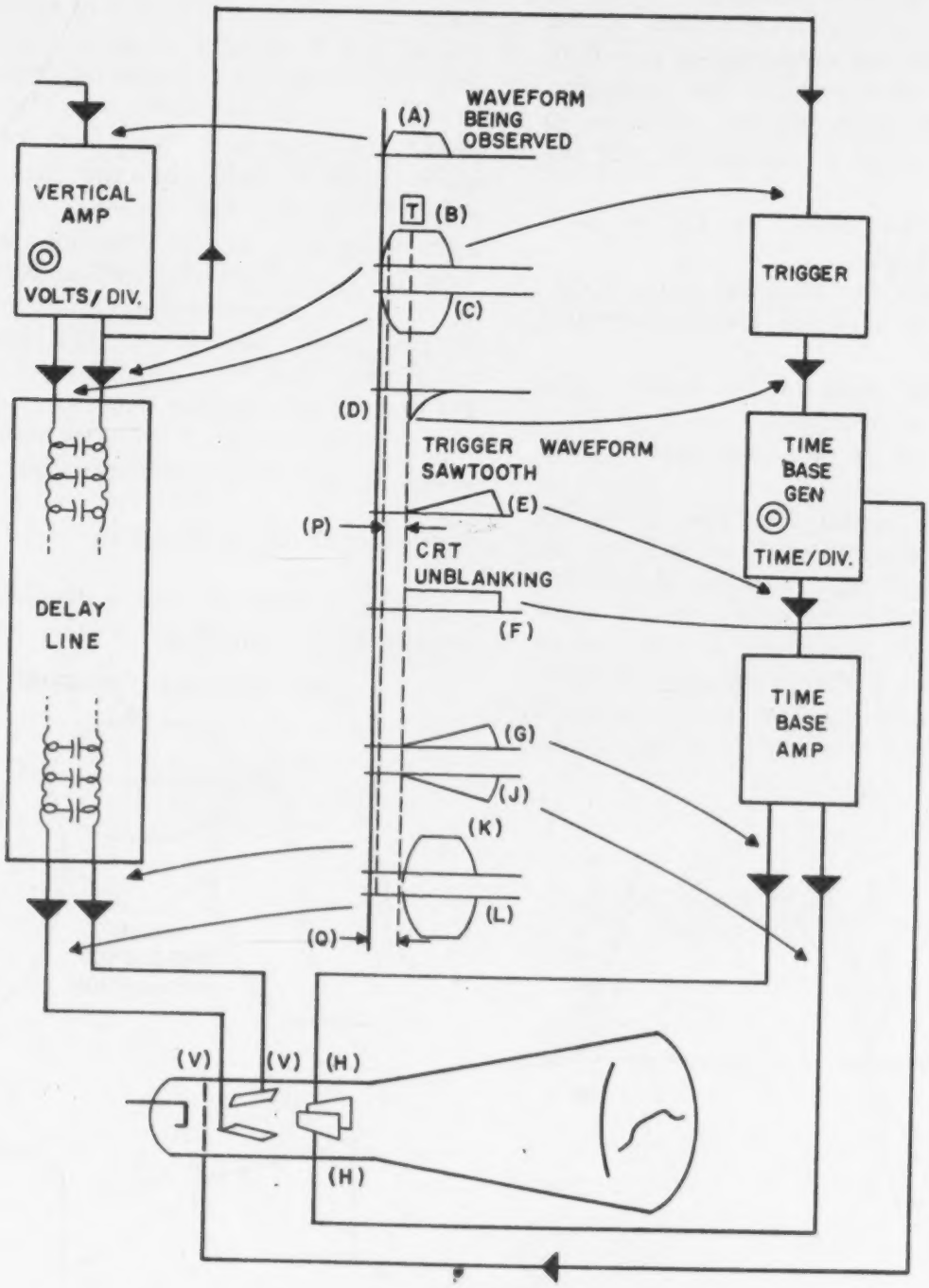

Figure 8-39.–Typical oscilloscope block diagram.

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one of them positive-going, like the input, and the other negative-going. The positive-going sawtooth is applied to the right-hand horizontal deflection plate of the cathode-ray tube, and the negative-going sawtooth is applied to the left-hand deflection plate. As a result, the cathode-ray beam is swept horizontally to the right through a given number of graduated divisions during each unit of time, the sweep rate being controlled by the TIME/DIV CONTROL.

In order to maintain a stable display on the cathode-ray tube screen, each horizontal sweep must start at the same point on the waveform being displayed. To accomplish this, a sample of the displayed waveform is fed to a "trigger" circuit which gives a negative output voltage spike (D) at some selected point on the displayed waveform. This triggering spike is used to start the rising portion of the time base sawtooth. As far as the display is concerned, then, "triggering" can be taken as synonymous with the starting of the horizontal sweep of the trace at the left-hand side of the grid.

The rectangular "unblanking" wave (F) derived from the time base generator is applied to the grid of the cathode-ray tube. The duration of the positive part of this rectangular wave corresponds with the duration of the positive-going or rising part of the time base output, so that the beam is switched on during its left-to-right travel and is switched off during its right-to-left retrace.

In many cases the leading edge of the waveform being displayed is used to actuate the trigger circuit. Yet it may be desirable to observe this leading edge on the screen-and the triggering and unblanking operations require a measurable time (P), often about 0.15 microsecond. To permit the leading edge to be seen, a delay (Q) of about 0.25 microsecond is introduced by the delay line in the vertical deflection channel after the point where the sample of the vertical signal is tapped off and fed to the trigger circuit.

The purpose of the delay line is to retard the application of the observed waveform to the vertical deflection plates until the trigger and time base circuits have had an opportunity to begin the unblanking and horizontal-sweep operations. This permits viewing the entire desired waveform—even though the leading edge of that waveform was used to trigger the horizontal sweep.

If the delay line were not used, only that portion of the waveform following the instant (T) in waveform (A) could be seen.

Oscilloscope Probe

The input circuit to the vertical amplifier of an oscilloscope can be simulated by a high resistance R shunted by a small shunt capacitance C, as shown in figure 8-40.

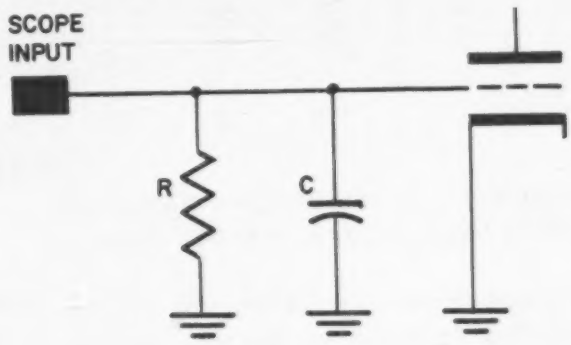

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Figure 8-40.—Oscilloscope vertical amplifier input circuit.

In some applications, even this high resistance and small capacitance can produce undesirable loading upon the circuit whose waveforms are being examined by means of the oscilloscope. This loading can cause the oscilloscope presentations to be different from the waveforms that would be present with the oscilloscope disconnected. One use of a passive probe is to reduce this resistive-capacitive loading on the circuit under investigation.

The probe includes a resistor R_p shunted by a capacitor C_p, (fig. 8-41). This combination is connected in series with the inner conductor of the cable to the oscilloscope input. The result is that, when the probe is connected to the circuit under investigation, there is connected to that circuit a new effective loading capacitance smaller than the original capacitance C and a new effective loading resistance larger than the original resistance R. Thus the loading effect of the

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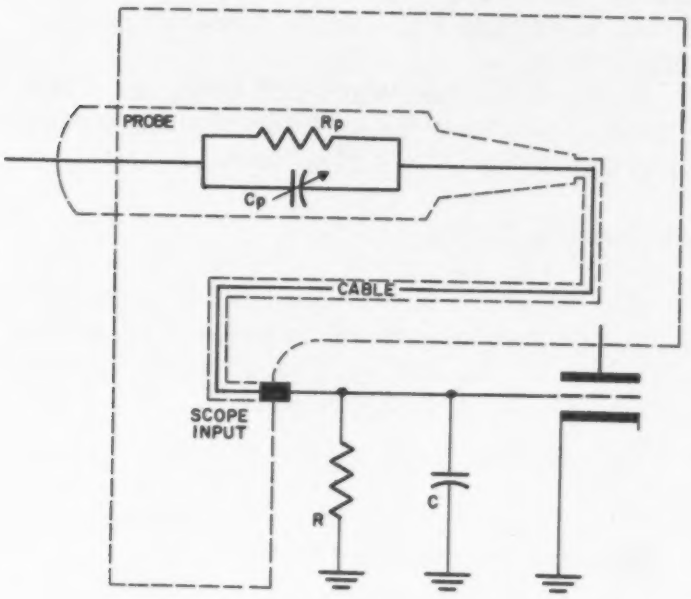

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Figure 8-41.–Oscilloscope vertical amplifier using a passive probe input.

oscilloscope input-circuit on the circuit under investigation is reduced through the use of the probe.

A second effect of the probe is to reduce the amount of signal voltage applied directly to the oscilloscope input connection for a given amount of original signal voltage. This occurs because of the voltage-divider action of R_p and R. This effect is taken into account in the "attenuation ratio" marked on the probe. Thus if the probe is marked "10X ATTEN" all oscilloscope voltage indications must be multiplied by 10.

If an oscilloscope equipped with a probe is used to look at a square wave, and the probe capacitor C_p is too small, some of the high frequency components of the square wave will be bypassed around the oscilloscope input terminals by the input capacitance C. Thus the steepness of the leading edge of the displayed square wave is reduced. (See fig. 8-42 (A)).

If the probe capacitor is adjusted to the correct value, a compensating amount of high frequency information is bypassed around the probe resistor R_p to make up for the loss through C, and the leading edge of the displayed square wave will be restored to its original steepness (B). If C_p is made too large, the high frequency response of the circuit will be overcompensated and apply too much high frequency information to the oscilloscope input connection. This results in an overshoot in the displayed waveform that was not present in the original (C). C_p can be adjusted to its correct value by using the probe to display the square wave generated by the voltage calibrator that is a part of the oscilloscope. Adjustment is made to display a square wave with as flat a top as possible.

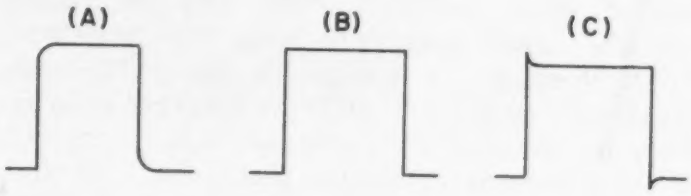

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Figure 8-42.–Effects of probe adjustment.

Probe adjustment must be checked whenever a probe is used with an oscilloscope or a plug-in preamplifier that has an input capacitance different from that of the instrument with which the probe was previously used.

NOTE: As indicated in figure 8-42, the attenuation achieved is a result of R as well as R_p, which means that, though probes may be swapped for use with other types of oscilloscopes, the calibration may be in error, even though the waveform distortion may possibly be adjusted out.

AN/USM-140B Oscilloscope

The front panel arrangement of a dual-channel oscilloscope that was especially designed for general purpose use is shown in figure 8-43. Most of the controls and connectors normally used by the operator are indicated in the figure and are self-explanatory. Those that are not are listed and described below.

CALIBRATOR switch (item 2): This switch is used to control the output of the self-calibrator which supplies a 1-kHz signal used as a standard to check the accuracy of the vertical and horizontal sensitivity selectors. The signal is available at either of the two connectors just below the switch depending on the amplitude required. Amplitude of the signal is controllable from 0.2 millivolts to 100 volts.

ASTIGMATISM control (item 7): This control adjusts the sharpness of the trace. It is used in conjunction with the focus control.

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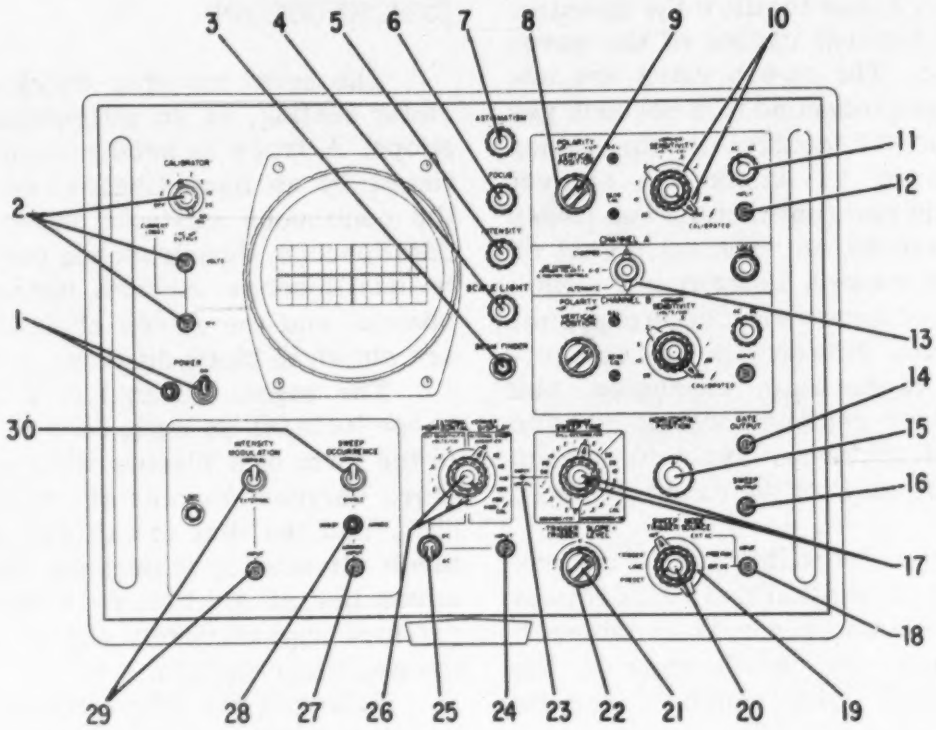

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1. Power ON-OFF/indicator lamp.
2. Calibrator switch and connectors.
3. Beamfinder.
4. Scale illumination.
5. Intensity control.
6. Focus control.
7. Astigmatism control.
8. Vertical position.
9. Polarity switch.
10. Sensitivity switch.
11. Ac-dc switch V.
12. Channel A input.
13. Channel selector
14. Gate output.
15. Horizontal position.
16. Sweep output.
17. Sweep time.
18. External trigger.
19. Trigger source.
20. Sweep mode.
21. Trigger slope.
22. Trigger level.
23. Sweep uncal.
24. Horizontal input.
25. Ac-dc switch H.
26. Horizontal display.
27. Arming input.
28. Sweep armed.
29. Intensity modulation.
30. Sweep occurrence.

Figure 8-43.–Oscilloscope AN/USM-140B.

POLARITY switch (item 9): This switch selects the type of input coupling. Either capacitive for a-c signals or direct for d-c signals. Channel B has an identical control.

GATE OUTPUT (item 14): The gate output provides a +50-volt unblanking pulse during horizontal sweep time.

SWEEP OUTPUT (item 16): The sweep output provides a voltage ramp of approximately -50 to +50 volts coincident with the horizontal sweep.

TRIGGER SOURCE (item 19): The trigger source selects the source of the signal to be used to trigger the sweep.

SWEEP MODE (item 20): The sweep mode provides a variable sensitivity adjustment for the sweep circuit. It also allows for the selection of either a triggered or a free running sweep.

TRIGGER SLOPE (item 21): This switch selects the portion of the waveform used to trigger the sweep either positive or negative.

This instrument is a high-speed, precision oscilloscope for displaying the waveforms of electrical voltages that range from a frequency of 22 megahertz to direct current. Vertical deflection sensitivity ranges from 20 millivolts to 200 volts per centimeter. Horizontal deflection sensitivity ranges from 0.1 volt to 100 volts per centimeter at frequencies from direct current to 1 megahertz per second.

The sweep generator, which is a part of the horizontal deflection system, provides a vari-

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able range of sweep times to allow the operator to display one or several cycles of the waveform, as required. The sweep rates are adjustable from 0.1 microsecond to 5 seconds per centimeter. A vernier control in the sweep circuit can be used to extend the slowest sweep to 15 seconds per centimeter. The sweep can be synchronized by an external signal or by the signal being viewed. Polarity and sensitivity of synchronization are selectable to permit synchronization from different points on complex waveforms. Sweep rate, expansion, and sensitivity are direct reading controls and are provided with potentiometer type continuous adjustment between each of the calibrated step selections.

Two identical probes with a 10 to 1 attenuation are provided in addition to an assortment of connector adapters and two coaxial cables to facilitate connecting the oscilloscope to the variety of equipment with which it can be used.

Maintenance of the oscilloscope by operating personnel is limited to checking and adjusting vertical sensitivity and balance, cleaning the air filter in the cooling air inlet, and replacing fuses. In many cases a calibration adjustment is required when replacing tubes and semiconductors. Therefore, only qualified technicians should attempt replacement of such parts. Operating personnel other than those qualified to make calibration adjustments should refrain from repair of this type except in an emergency.

The useful life of an oscilloscope can be materially extended by using normal care in handling and operating. When in use, the area behind the cooling air inlet must be kept clear to allow flow of the cooling air through the ventilating door. This oscilloscope is provided with a thermal switch to protect it from overhearing. If the instrument goes off during use, removal of the dual trace preamplifier plug-in unit will allow the operator to view a neon type indicator lamp. If the lamp is lit, the oscilloscope is overheated. Turn off the power and investigate the cause of overheating.

CAUTION: This instrument contains voltages as high as 8,600 volts, which can be fatal. Turn the instrument off before touching any internal part.

SYNCHROSCOPE

The synchroscope, which is widely used in radar testing, is an adaptation of the oscilloscope. A trace is produced only when it is initiated by an input trigger, as contrasted with the continuous sawtooth sweep provided by the oscilloscope. Synchroscope circuits are similar to oscilloscope circuits except for the signal channel and the sweep channel. These circuits are shown in block diagram form in figure 8-44.

The signal channel of a typical synchroscope includes an input circuit, which is usually in the form of a 72-ohm adjustable-step attenuator. Various degrees of attenuation are available, and the dial is calibrated to indicate how much attenuation is present. The attenuator insures that all signals, regardless of amplitude, produce approximately the same input level to the amplifier section.

Following the attenuator is an artificial delay line, which is a low pass filter with a cutoff frequency higher than the highest frequency to be passed, and which has an impedance of 72 ohms. The delay line is terminated with a 72-ohm gain control. One purpose of the delay line is to delay presentation of the signal to be observed until the sweep trace has been initiated by an undelayed portion of the input signal. If the delay line were not used, the initial portion of the waveform would not appear on the trace, because a certain amount of time is required for the input signal voltage to rise to the level needed to trigger the sweep circuit. With the delay line in use, the signal does not reach the amplifier until one-half microsecond after the trace starts; as a result, the entire pulse is seen. A secondary purpose of the delay line is to provide, by means of reflection, a series of accurately spaced pulses suitable for calibration of short time intervals.

To accomplish the secondary purpose, a switch is provided to cause a mismatch in the termination of the delay line. When a sharp pulse is applied into the line, a series of reflections occurs similar to those shown in figure 8-45. Since the time required for a pulse to travel down the line and back is 1 microsecond, a series of pulses occurring 1 microsecond apart is produced. Each successive pulse is smaller because of the losses in the delay line, but enough pulses

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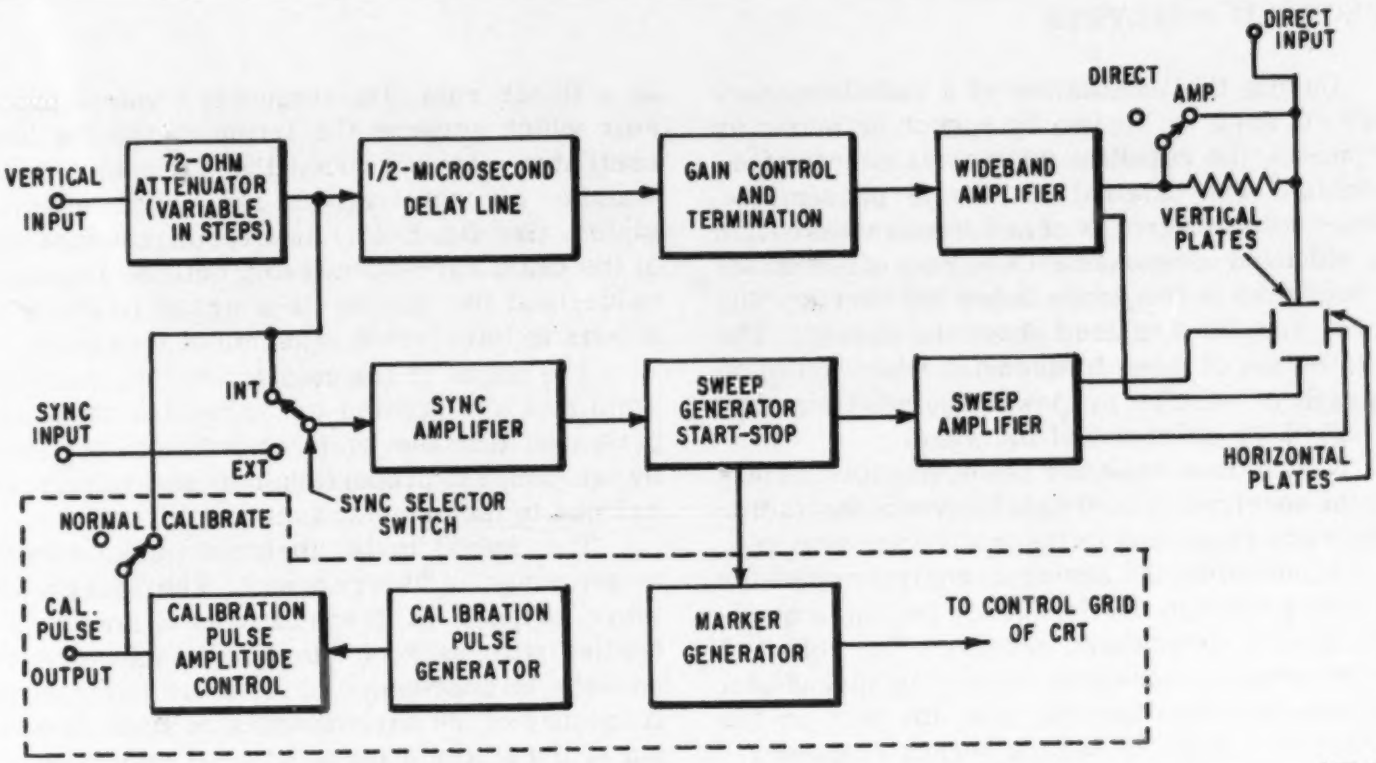

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Figure 8-44.–Typical synchroscope, block diagram.

are visible for most high speed calibration purposes.

The gain control feeds a wideband or video amplifier, which is connected to the vertical deflection plates. In addition, an external connection is provided to the vertical plates.

The horizontal circuit consists of a sync switch for either internal or external sync, a sync amplifier with a gain control, and a start-stop sweep generator, which will not develop a sweep voltage until a pulse of sufficient amplitude is supplied. The duration of the sweep, or sweep speed, is made adjustable from a very few microseconds to about 250 microseconds. The sweep generator is followed by a conventional horizontal amplifier. Since the trace is triggered by the input signal, the synchroscope may be used to observe nonperiodic pulses, such as those occurring in a radar system with an unstable PRF generator.

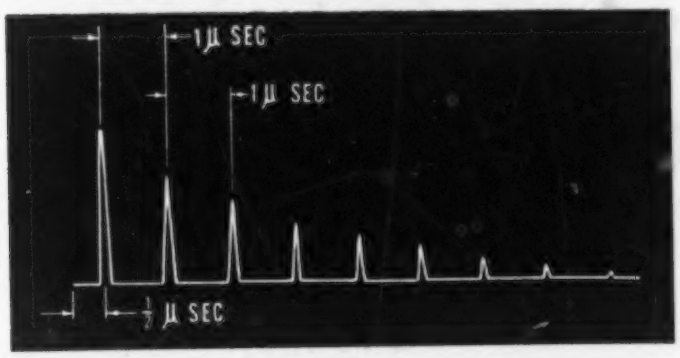

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Figure 8-45.–Pulse reflection on a mismatched line.

In later designs, it is common to find provisions for calibration of input voltages and sweep time. Voltage calibration is made by comparing the unknown voltage with a variable-voltage pulse of known value, generated internally. The calibrating pulse is adjusted to be equal in amplitude to the unknown voltage; the value is then read from the dial that controls the calibrating pulse. Sweep time calibration is made with the aid of marker pulses produced by accurately adjusted tuned circuits. The marker pulses appear on the trace as a series of bright dots spaced at intervals chosen by the operator. In a typical synchroscope, marker intervals of 0.2, 1, 10, 100, and 500 microseconds may be selected in accordance with the time duration of the pulse under test; for greater accuracy, interpolation may be used.

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SPECTRUM ANALYZER

During the modulation of a radiofrequency carrier wave by keying, by speech or music, or by pulses, the resulting wave contains many frequencies. The original carrier is present, together with two groups of new frequencies called the sideband components. One group of sidebands is displaced in frequency below the carrier. The other group is displaced above the carrier. The distribution of these frequencies when shown on a graph of voltage or power against frequency is called the spectrum of the wave.

A spectrum analyzer is a device for exhibiting the spectrum of modulated waves in the radiofrequency range and in the microwave region.

In principle, the spectrum analyzer operates by tuning through the frequency region in question, using a narrowband receiver. The output of the receiver is measured, usually by means of a cathode-ray oscilloscope, and the plot on the screen is a graph of voltage versus frequency.

The device is essentially a superheterodyne receiver with a very narrowband intermediate frequency amplifier section. The local oscillator frequency is varied between two values at a linear rate. The frequency-control generator which governs the frequency of the local oscillator also produces the horizontal sweep voltage for the cathode-ray tube deflection plates. (See fig. 8-46.) As a result, each position of the beam corresponds to a definite frequency value; and the display is a graph in which the X-axis is interpreted in terms of frequency.

The output of the detector in the receiver is amplified and applied to the vertical deflection plates so that the beam is deflected vertically by an amount proportional to the voltage developed in the detector (and amplifier).

The signal to be analyzed is fed into the mixer stage of the receiver. The local oscillator changes in frequency at a linear rate, beating with each of the signal frequency components in succession to form the intermediate frequency of the narrowband amplifier. The output of the IF amplifier is detected, amplified, and applied to the vertical deflecting plates.

Spectrum analyzers designed for analysis of microwave signals are equipped with klystron tubes in the local oscillator stage. In analyzers

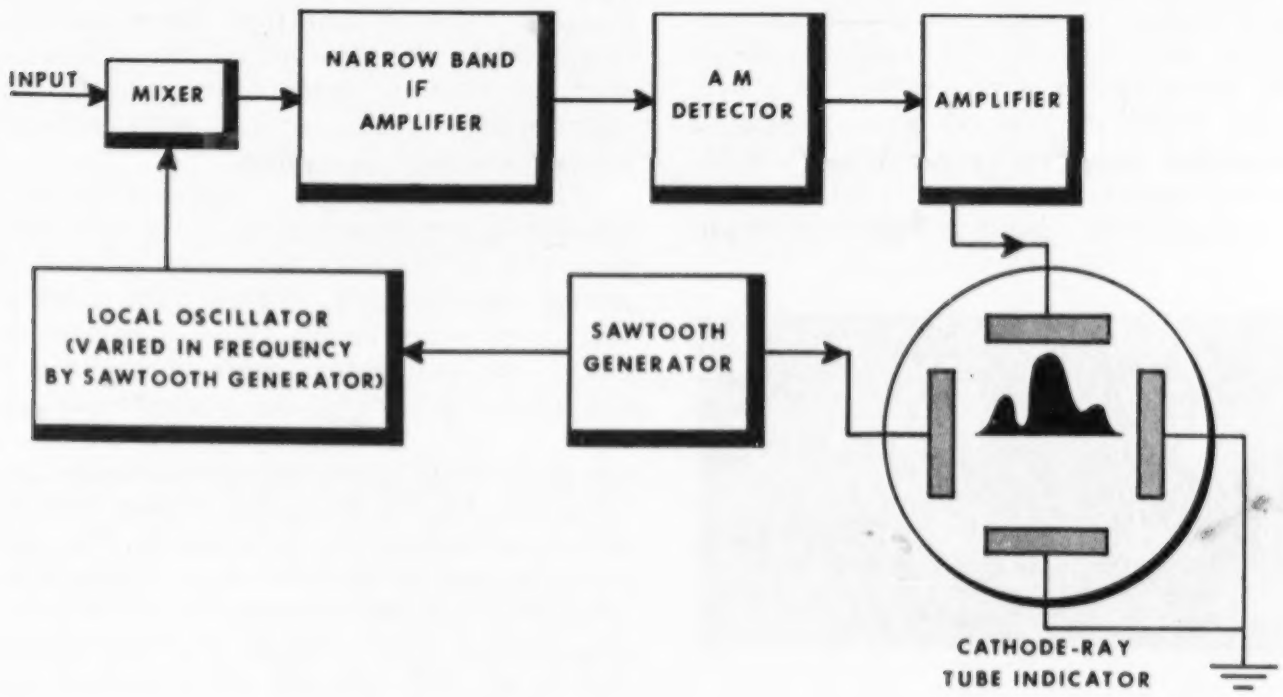

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Figure 8-46.–Typical spectrum analyzer, block diagram.

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adapted for lower frequency RF signals, triode oscillators are used which are varied by means of reactance-tube modulators.

Spectrum analyzers are employed extensively in studying the output of pulse radar transmitter tubes such as the magnetron. In this kind of analysis, unwanted effects such as frequency modulation of the carrier can be easily detected. In pure amplitude modulation of a carrier wave by a square pulse, the spectrum is symmetrical about the carrier frequency. Lack of symmetry indicates the presence of frequency modulation. A spectrum representing the ideal condition is shown in (A) of figure 8-47.

Examples of undesirable magnetron spectra are shown in (B) and (C) of figure 8-47. These forms indicate trouble in the modulator, the tuning system, or in the magnetron tube itself.

The carrier frequency is best defined as the center frequency in a symmetrical spectrum such as that shown in (A) of figure 8-47. In some analyzers this principle is used as a means of carrier frequency measurement. A sharply resonant circuit is provided in the receiver which acts as a trap to prevent an extremely narrow range of frequencies from appearing in the output of the IF amplifier. The result of its use is that a gap appears in the display, and the gap corresponds to the resonant frequency of the trap. The adjustment of the trap is calibrated in frequency, and the circuit can be adjusted to make the gap occur in the center of the spectrum. The frequency of the carrier is then read from the calibration of the trap.

For an additional coverage of spectrum analyzers, consult Basic Electronics, NavPers 10087-B. Also, a discussion of spectrum analyzers appeared in the June 1963 issue of the DIGEST. That article is recommended for personnel desiring additional information concerning this class of test equipment.

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Figure 8-47.–Frequency spectra.

WAVE ANALYZER

The wave analyzer is used to measure amplitude and frequency of the components of a steady state complex electrical waveform. These include the components of harmonic distortion, intermodulation distortion, hum, and noise.

Specific uses of the wave analyzer include the measurements of distortion components in AF equipments; radio receivers and transmitters; oscillators, amplifiers, and vacuum tube circuits in general; harmonic studies of electrical power system and electrical machinery, hum measurement in a-c operated communication equipment; and noise analysis. As a sharply tuned voltmeter, it is useful in the measurement of the transmission characteristics of electric wave filters and as a null detector for impedance bridges. The unit may be used as a detector for intermodulation distortion measurements when a two-signal audio generator is used as a source.

The wave analyzer discussed in the following paragraphs is a heterodyne type vacuum tube voltmeter. The IF amplifier includes a selective filter using three quartz crystals. The use of a heterodyne method makes it possible to vary the frequency response while using a fixed frequency filter.

The output of the local oscillator and the whole of the complex waveform to be examined are fed to a balanced modulator where their combination produces both sum and difference frequencies, or sidebands in the output. The original of the complex waveform is not passed by the modulator intermediate frequency output transformer and the local oscillator carrier frequency is suppressed in the output because of the two-tube, balanced modulator employed.

The 50-kHz component of the upper sideband, proportional to the voltage of that frequency present in the original wave to which the main dial is set, is selected and amplified by the intermediate stages. The step attenuators provide for measurement of a wide range of voltages.

The equipment is mounted in a shielded oak cabinet, and all critical parts are hermetically sealed.

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Fig. 3 shows the position of the hand and pencil for drawing horizontal lines. Note that the pencil is inclined in the direction the line is drawn, that is, towards the right.

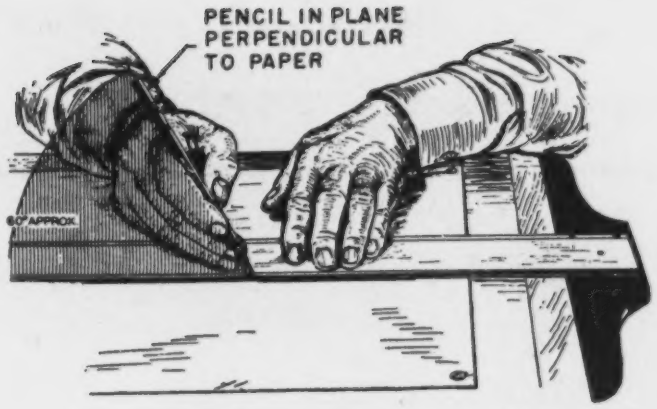

FIG. 3

Caution must be taken when using the T-square in that the head must be placed flat against the left edge of the board if you are right handed, or against the right edge of the board if you are left handed.

White or buff drawing paper of various standard sizes is used at first for the required drawing plate. This is because this type of paper is easy to work with and it is comparatively inexpensive. Blueprints, however, cannot be made from this paper because it is not transparent. Therefore when blueprints are desired, a tracing of the drawing must be made on transparent paper. Later, projects may be drawn directly on tracing paper, which is the accepted method used in drafting rooms.

Scotch drafting tape (Fig. 4) is used instead of thumb tacks to fasten paper to the drawing board. Thumbtacks mar the board and are difficult to remove. A $\frac{1}{2}$-inch length of tape across each corner is sufficient to fasten the paper to the board.

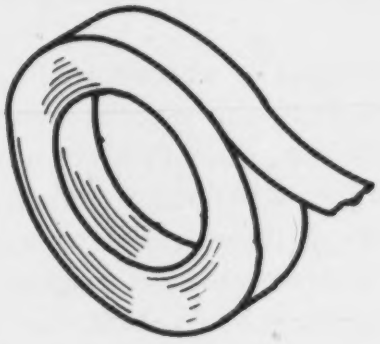

FIG. 4

QUESTIONS:

1. Which side of the drawing board should be used when drawing?

2. In storing a drawing board, why should dampness and excessive heat be avoided?

3. What are the uses of the T-square?

4. Why should you avoid denting the edges of the T-square?

5. Why clean a T-square regularly?

A detailed discussion of wave analyzers is beyond the scope of this training manual, but the foregoing discussion should serve to familiarize the technician with some of the basic principles used in the design of a wave analyzer.

MULTIPLE-FUNCTION EQUIPMENT FOR SYSTEMS TESTING

The numerous and complex operations required for servicing and maintaining radar requires, in some instances, numerous classes of test equipment. Therefore, a test set such as the UPM-32, combining the functions of several test sets, is very practical. This combination test set performs most of the functions necessary for radar maintenance in its frequency range.

This test equipment (fig. 8-48) is portable and is designed primarily for use with radar systems operating in the frequency range of 8,500 to 10,500 MHz. It functions as a power meter, a frequency meter, a spectrum analyzer, a signal generator, and a general purpose syn-

1. Cable assembly.
2. Gaskets.
3. Test antenna.
4. Adapters.
5. Waveguide.
6. RF cable.
7. Power cable.

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Figure 8-48.–Radar Test Set UPM-32.

chroscope. The general capabilities of the test set are as follows:

1. Measurement of power, frequency, spectrum, and frequency pulling of conventional and multipulsed radar transmitters.
2. Measurement of sensitivity and bandwidth of a radar receiver.
3. Measurement of the frequency and spectrum of a radar receiver's local oscillator.
4. Adjustment of a radar receiver's local oscillator.
5. Measurement of TR recovery time.
6. Observation of video signals.
7. Providing pulsed, FM, or CW microwave signals.

Radar Test Sets AN/UPM-32 (for X-band radars) and AN/UPM-44C (for S-band radars) are very similar in function and in operation. Each is usable for the same general functions. Both are generally reliable instruments, but are susceptible to mixer crystal damage due to improper manipulation of the control. For this reason, every technician should receive a thorough indoctrination in the proper use and operation of these equipments when they are available in his particular shop. Although this requirement is generally applicable for all test equipment (and other electronic equipments), it is especially important in equipments where the probability of damage from improper operating procedures is so great.

LINE TEST EQUIPMENT

The purpose of this section is to discuss some of the more common test sets that are used during line maintenance by Organizational Maintenance Activities. It is not intended that this discussion be all inclusive of all line test equipment, but only some of the more common line test sets.

The majority of line test equipment are of the GO - NO GO type. In other words, the test set indicates that the electronic system under test does or does not meet the minimum acceptable standard. Some of the more intricate line test equipment can be used to determine faulty units (black boxes) of a system. Operational tests of a system after installation of a repaired unit may also be made with this type of test equipment.

IFF

Radar Test Set AN/UPM-8B is a portable, a-c operated instrument, designed to perform rapid preflight checks of installed transponders, such as those of the Mark X IFF system. Its testing capabilities include checking the above transponders when they are operated in association with Selective Identification Feature (SIF) coding equipment, such as Coder Group AN/APA-89. The following features of transponders or associated SIF equipment can be checked simultaneously:

1. Transmitted frequency.
2. Relative transmitter power output.
3. Decoding of mode 1, 2, or 3 interrogations (challenges).
4. Reply coding (number but not spacing of pulses for Mark X).
5. Receiver frequency.
6. Relative receiver triggering level.
7. Proper code configurations (when SIF equipment is employed).
8. Pulse spacing (when SIF equipment is employed).

The results of these checks are simultaneously resolved into a single REJECT or ACCEPT indication of an operating panel meter. The REJECT-ACCEPT meter on the operating panel may also be used to give an indication of the general operating condition of the test set itself.

TACAN

Radio Test Set AN/URM-101A is a lightweight, easy-to-use unit developed to provide preflight check of the normal operation of airborne TACAN sets. The test set may be hand-carried to the vicinity of the aircraft equipped with the radio set and placed on the deck, or any other suitable support. During operation of the test set, visual and aural indications at the radio set will enable an observer to determine, whether the radio set is operating properly. The test set receives from and transmits to the TACAN radio set either by radiation from the antenna or by a direct connection with a coaxial cable. The test set will operate with up to four TACAN radio sets simultaneously.

The test set simulates signals such as those produced by Radio Beacon Set AN/URN-3, and

which would normally be received by airborne TACAN sets at a particular bearing and distance from the beacon set. The test set generates a continuous tone signal, which provides aural indication when received. The test set transmits a continuous pulse train consisting of main and auxiliary reference pulse groups (bursts), identity pulses and equalizing pulses. In addition, when interrogated, it introduces reply pulses delayed to simulate distances of 5 miles and 100 miles. All of these pulses are amplitude-modulated with 15 and 135 hertz sine waves and are synchronized to give a bearing display of 140° on the airborne azimuth indicating equipment. A power output level control adjusts the RF unit to a constant power output, which is indicated on a panel meter. A range switch sets the desired 5-mile or 100-mile delay.

RADAR

The echo box is used in field testing, troubleshooting, and adjustment of pulsed type radar systems. Although simple in construction and operation, it is versatile in its applications. Properly used within its design limitations, the echo box can frequently eliminate the need for a complex test setup and an elaborate step-by-step testing procedure. The echo box uses passive circuitry, which does not require any external power (other than that of the radar set whose signal is to be analyzed). External power requirement is a critical factor with most other test sets.

The echo box is similar to a tuned cavity frequency meter, with additional capabilities. The tuned cavity frequency meter can be used to measure the frequency of CW or pulsed RF signals in the microwave range. The echo box, however, has no practical application in the testing or analysis of CW equipment signals. Figure 8-49 indicates the basic functional elements of a typical echo box.

Energy from the radar transmitter is fed through the directional couplers to the resonant cavity. When the cavity length is properly adjusted, resonant oscillations are set up by each

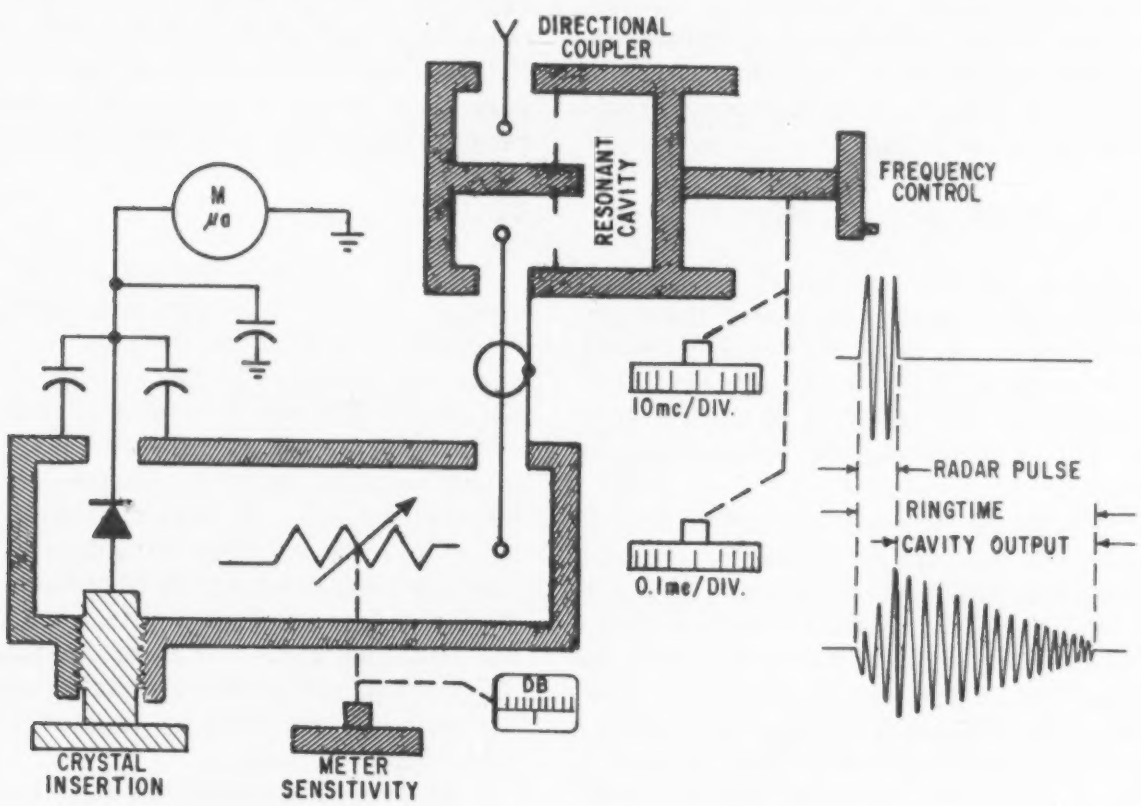

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Figure 8-49.–Typical echo box, functional circuit.

successive pulse of microwave energy. Maximum amplitude of oscillation occurs when the cavity is tuned precisely to the signal frequency. These cavity oscillations are detected by the crystal diode and indicated on the meter as an average d-c current. The amplitude of oscillation and the average current reading are proportional to the transmitter power output.

Oscillations in the tuned cavity are also coupled back to the radar set under test, where it is processed as an echo signal. This signal, when viewed on the indicator CRT, permits analysis of the radar pulse, and presents an indication of the general operating condition of the radar set.

Due to the manner in which the energy builds up in the cavity, saturation of the cavity is possible. If saturation does occur, distortion of the waveform and erroneous values of the measurements result. If the directional couplers do not prevent cavity saturation, additional attenuation must be provided.

A fairly complete functional analysis of the operating condition of a radar set can be obtained through analysis of the displayed waveform. Among the most important of the factors that can be determined are frequency and bandwidth, power and frequency spectra, sensitivity, pulse width and condition, and recovery time. Analysis of the waveform can also prove helpful in locating the cause of malfunctions within the radar set.

It must be remembered, however, that the echo box presents only relative (rather than absolute) values of power and sensitivity, and only rough values of frequency. Accuracy of these quantities is not comparable to the corresponding values obtainable from a spectrum analyzer. The primary value of the echo box lies in its regular usage. For maximum benefit, the values obtained from a given test must be compared to corresponding values obtained from a test on a radar set known to be operating properly.

In general, however, the echo box is an extremely valuable instrument. When used in a continuing maintenance program, it can enable the operator to maintain his equipment in peak operating condition. It can also provide him with indications of deterioration before actual malfunctions occur.

For personnel desiring additional information concerning echo boxes, the October 1965 issue of the DIGEST is recommended.

ALTIMETER

Delay Line MX-1381/APM-66 (fig. 8-50) is a portable unit of the Radar Test Set AN/APM-66 and consists of a coaxial cable delay line and two horn-type antennas. The two horns are connected together by a length of RG-55/U cable that is wound on two drums within the unit.

When the delay line unit antennas are mated with the altimeter receiver-transmitter antennas, the RF output of the transmitter is fed into one of the horn antennas, passes through the coaxial cable to the other antenna, and is fed out to the receiving antenna of the altimeter where it arrives delayed in time by an amount that is equal to the propagation time (electrical length) of the coaxial cable. This produces an altitude signal in the altimeter that is identical to that produced in normal altimeter operation when the altimeter is at an altitude that yields the same total propagation time down to the terrain and back again. Since two-way propagation is involved in normal operation, the altitude signal produced by a delay line will be equal to one-half the electrical length of the cable.

The length of the coaxial cable required for a delay line of this type may be determined from the formula:

$$L = V \times \text{altitude} \times 2$$

Where

L = physical length of the cable

V = velocity of wave propagation of the cable.

The delay line contains 228 feet of cable (330 electrical feet) and produces an altitude signal of 165 feet. The total attenuation of the cable and the two antenna horns is such that the altimeter that produces an altitude indication of 165 feet, minus the residual altitude, when coupled to the delay line can be considered as having adequate sensitivity for normal flight operation.

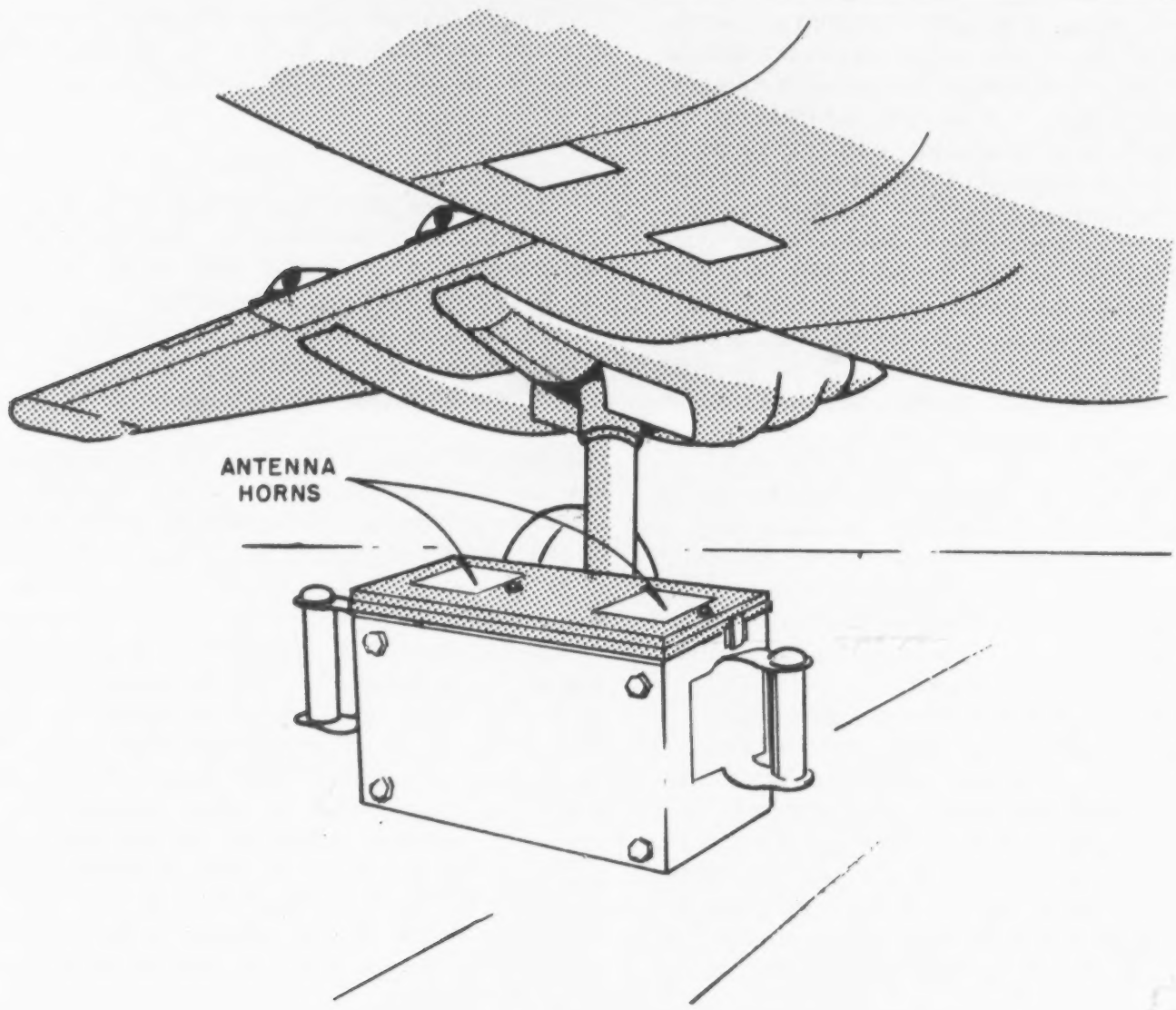

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Figure 8-50.–Delay line MX-1381/APM-66.

TEKTRONIX TYPE 453 OSCILLOSCOPE

The Tektronix Type 453 Oscilloscope is a lightweight, transistorized portable oscilloscope which has high frequency capabilities. The input signal range is from d.c. to 50 MHz. Input power to the scope is either 115 volts a.c. or 230 volts a.c. at line frequencies from 45 to 440 Hz. The power consumption is approximately 100 watts.

Some of the capabilities of the 453 Oscilloscope are as follows:

1. Display of two independent sweep signals simultaneously.
2. Display a signal which has an intensified portion, and this portion is also displayed as a complete separate sweep.
3. Various-time measurements.
4. Peak-to-peak signal measurements.
5. Voltage measurements of any point of a signal.
6. Voltage comparisons.
7. Frequency measurements.
8. Phase difference measurements.
9. Rejection of unwanted signals.

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CHAPTER 9

ELECTRONIC PRINCIPLES

This chapter is intended to provide an introduction to some of the more important topics and principles of electronics which do not fit into any specific chapter of this manual. In some cases, the information is of a general nature, applicable to many systems or equipments. In other instances, the data are based on relatively new developments and concepts which have not as yet reached the point of general applicability.

MODULATION AND DEMODULATION

Modulation is a process that permits the transmission of intelligence by superimposing it on an RF carrier. The carrier is normally of a constant frequency and amplitude; modulation varies one or more characteristic of the carrier in accordance with the intelligence to be transmitted. The characteristics of the carrier which may be varied are the amplitude, frequency, and phase. The type of modulation is designated by the particular characteristic which is to be varied. Demodulation is a process by which the intelligence is extracted from the transmitted wave and reproduced either in its original form or in some other form.

There are many ways to impose the intelligence on the carrier. In radiotelegraphy the operator depresses a key (switch) which activates the transmitter as long as the key is depressed. In radiotelephony the transmitter is operative as long as the microphone is activated; the sound picked up by the microphone is converted into an electrical signal and superimposed on the carrier. In radar the transmitter is activated automatically and regularly by pulses from the synchronizer. Regardless of the method of modulation, the modulating circuit functions to change the a-c output of the carrier generator in accordance with the instantaneous values of the intelligence signal. The demodulator (detector) must be matched with the system so as to respond to the particular type of modulation used.

MODULATION SYSTEMS

Each type of modulation has its own specific advantages and disadvantages, its own characteristics, and its own applications. In the discussion which follows, several types of modulation are compared.

The original and still the most commonly used type is amplitude modulation. Its major disadvantage is its susceptibility to noise. In order to overcome this disadvantage, frequency modulation is becoming more popular. Closely resembling frequency modulation is the process of phase modulation, a system which is not in common usage.

Amplitude Modulation

The RF carrier portion of the amplitude modulated wave is of fixed frequency and constant amplitude. An audiofrequency modulation signal is superimposed on the carrier in a manner that causes the amplitude of the carrier to vary, leaving the carrier frequency unchanged.

An amplitude modulated wave is composed of a number of frequencies, as shown in figure 9-1 (A) and (B). These frequencies are the carrier, the audio signals, the sum frequencies, and the difference frequencies. In the example, the frequencies are indicated as frequency bands on a spectrum graph because of the complexity of the audio signals, which normally include an enormous number of individual frequencies.

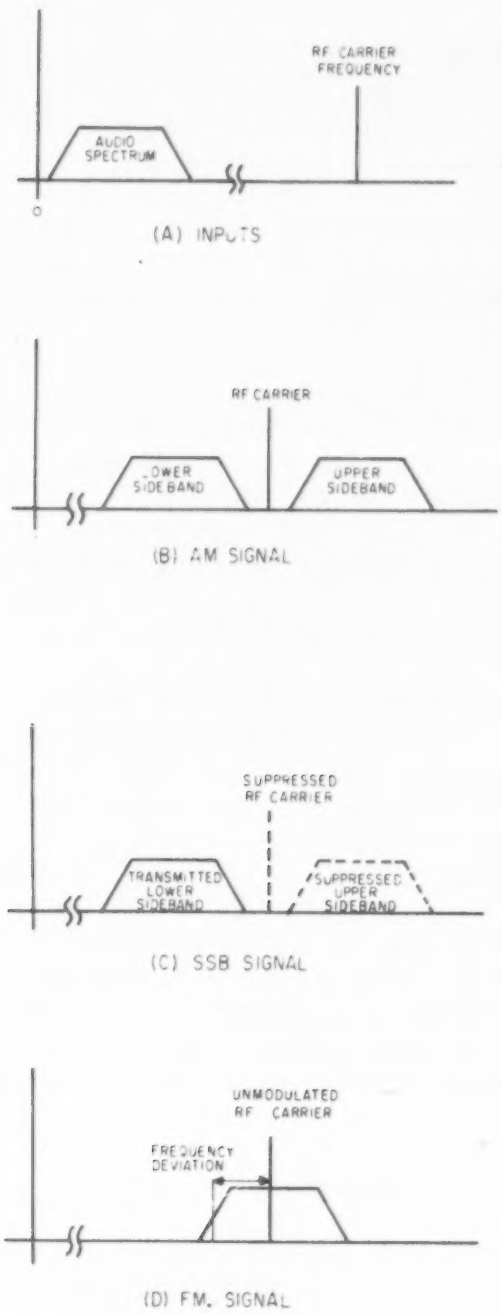

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Figure 9-1.–Signal spectrum, comparison.

The sum and difference frequencies are known as the sidebands, and carry the intelligence. When an RF carrier is modulated by a voice signal or by music, the side frequencies constitute a band of frequencies above (the sum) and below (the difference) the carrier. The width of each band is determined by the highest and lowest frequencies included in the modulating signal. The overall bandwidth required in the transmitter and the receiver is determined by the difference between the low end of the lower sideband and the high end of the upper side band. As each sideband contains identical infromation, the sidebands are redundant with only one sideband and the carrier being needed in AM detection.

Single Sideband

Single sideband has proved to be a more efficient and reliable means of voice communications, than has amplitude modulation. Efficiency has been improved by the concentration of the entire transmitter RF output into a single frequency spectrum rather than the division of power by the AM transmitter into a lower sideband, a carrier, and an upper sideband. This division of power in an AM transmitter results in less RF energy available at the AM receiver for detection of the modulated audio than would be available at an SSB receiver if a single sideband transmitter were being used.

In a single sideband system, the audio spectrum is mixed with an RF carrier in a balanced mixer. The output of the balanced mixer contains the carrier frequency minus the audio signal (lower sideband, LSB) and the carrier frequency plus the audiofrequency (upper sideband, USB). The design of the balanced mixer is such that the carrier frequency is suppressed. The output of the balanced mixer is applied to a mechanical filter which passes only one sideband. The output of the mechanical filter is essentially the audiofrequency translated up to the carrier frequency, plus or minus the audiofrequency. (See fig. 9-1 (C).) Transmitter and receiver bandpass is determined by the upper and lower limits of the sideband transmitted.

The sideband is thus heterodyned up to the desired operating frequency, amplified in the transmitter power amplifier, and fed to an antenna. Sideband power applied to the antenna is greater with single sideband than with AM because all transmitted power is contained within a single sideband. (Either sideband may be used.)

To receive a single sideband signal, it is necessary to translate the signal back to the original audiofrequency intelligence signals. The carrier frequency, which was removed at the transmitter prior to radiation, is generated locally at the receiver and mixed with the received sideband signal. The result of this mix-

ing is the original audio signal, which is subsequently separated from the RF in the detector.

Frequency Modulation

In frequency modulation the carrier amplitude remains constant and the output frequency of the transmitter is made to vary about the carrier (or rest) frequency at a rate corresponding to the audiofrequencies of the intelligence signals.

The extent to which the frequency changes in either direction from the unmodulated carrier frequency is called the frequency deviation (fig. 9-1 (D)). It corresponds to the change of signal amplitude in AM.

In frequency modulation systems there is no "percentage of modulation" to correspond with that of AM systems. The frequency deviation is dependent on the design of the specified equipment and is only indirectly determined by the modulating signal.

The ratio of the maximum frequency deviation to the audiofrequency of the modulating signal is called the modulation index, or deviation ratio. Allowable frequency deviation is determined by the frequency separation of adjacent channels, and this maximum deviation and the frequencies involved in the intelligence signals combine to determine the maximum modulation index.

Phase Modulation

In phase modulation, the instantaneous phase relationship between the modulated signal and the unmodulated carrier is varied. During a change in phase the instantaneous frequency of the signal also changes, so that the two methods (phase and frequency) are quite similar. Identical receivers may be used to receive either phase modulated or frequency modulated transmissions. Since phase variations are essentially equivalent to frequency variations, phase modulators are commonly used to develop FM signals.

Although the end result is essentially the same, phase modulation has the advantage that the carrier frequency can be stabilized (for example, with a crystal oscillator), while in FM the RF must be permitted to change in frequency during modulation.

Frequency-Shift Keying

Transmissions used in radioteletype, facsimile, and some data link equipments utilize a modulating system known as frequency-shift keying. In this equipment a keyer replaces the oscillator of a conventional CW transmitter. The keyer supplies a source of RF excitation that can be shifted slightly either up or down (or both) in order to make a distinction between pulses and spaces.

During unmodulated (continuous wave transmission) frequency-shift operation, the transmitter operates with a specified carrier frequency. When a MARK on a PULSE is to be transmitted, the transmitter frequency is shifted slightly (usually downward). In the three-level type operation (which is not in common usage at present), the frequency is shifted in one direction for a digital ONE, in the opposite direction (by the same frequency deviation) to represent a ZERO.

HETERODYNING

Heterodyning is a process by which two or more frequencies are combined in a nonlinear device so as to develop a composite output. In a heterodyne circuit (mixer) the frequencies involved are the original input frequencies, the sum frequency, and the difference frequency. (The modulation systems thus far discussed involve heterodyning action.) A nonlinear device is required to provide the mixing action; in a linear device, no mixing takes place.

Heterodyning is also involved in the creation of the intermediate frequency in receivers. In this application, the incoming modulated signal is mixed with the constant frequency out of the local oscillator. The result is the IF.

PULSE MODULATION

An example of pulse modulation systems is the conventional radar set. A pulse of short time duration is developed in a synchronizer, and is used to trigger the transmitter. The transmitter operates for the duration of the pulse input, and then rests until the next input once again serves to trigger it into operation. This intermittent operation of the transmitter permits the trans-

mission of relatively large values of power for short times (peak power), while allowing a long rest period to keep the average power within the limitations of the equipment.

Pulse modulation is also employed in the operation of computers and in digital data transmission systems. These topics are developed in some detail in various chapters of this manual; the current discussion is intended primarily to present some details regarding the pulses involved in the systems. (In connection with the discussion, make frequent reference to fig. 9-2.)

The main characteristics of a pulse are based on time, general shape, and magnitude of voltage or current change. For purposes of this discussion, the pulse is assumed to be a theoretical square wave of positive-going voltage. (This is the type pulse most commonly used in radar modulators, as well as in digital data systems, computers, etc.) It is further assumed that all actions are initiated by a trigger pulse which occurs at a TIME ZERO reference.

Since the pulse represents a change of voltage level, some passage of time is required for this change to occur. Although this elapsed time is undesirable in most applications, it is unavoidable. For purposes of this analysis, the pulse may be divided into three parts: leading edge, top, and trailing edge. Normally it is desired that the leading and trailing edges be as sharp as possible, and that the top be flat. The terms used in the discussion and indicated on figure 9-2 are fairly well standardized in pulse applications. Each time increment gives a direct indication of the quality of operation of the circuitry involved in the use or generation of these pulses.

Pulse Duration and Magnitude

The duration of a pulse is normally considered to be the time interval between the 50 percent points in the rise and fall of voltage levels. (Some references use the 90 percent points for this consideration.)

The magnitude of a pulse is the difference in voltage level between the maximum (signal) state and the minimum (quiescent) state.

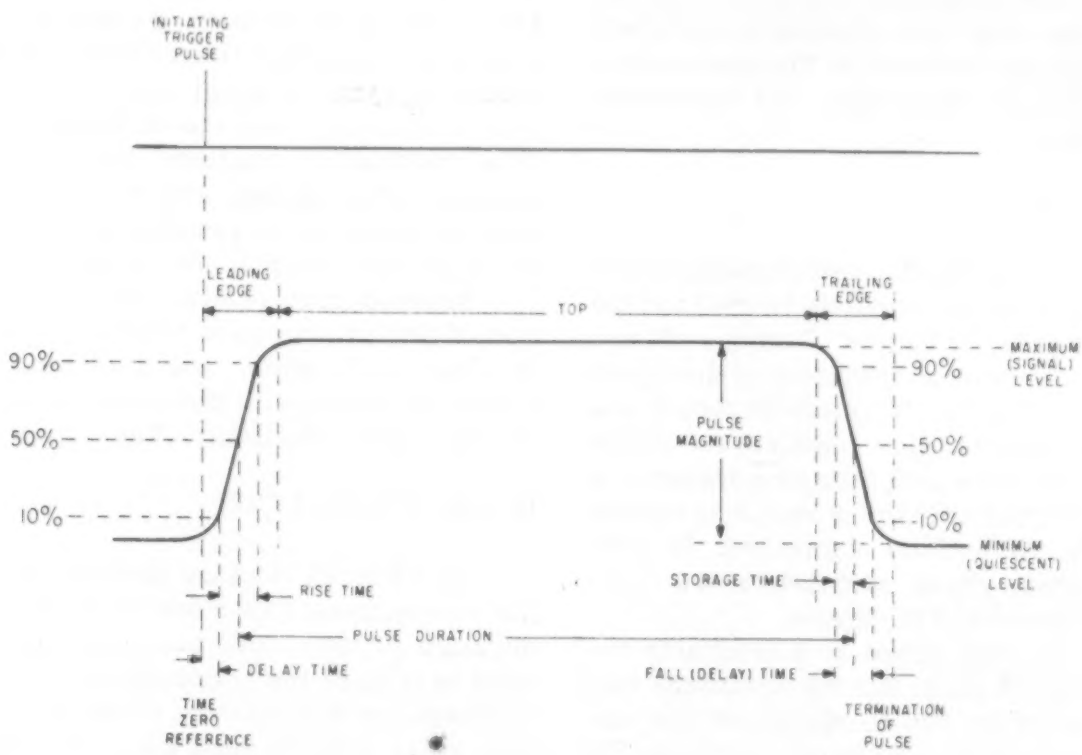

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Figure 9-2.–Pulse characteristics.

Leading Edge

The leading edge of a pulse is that portion which represents the increase of voltage from the quiescent level to the stabilized maximum level. In some pulses there is some overshoot and revovery (not shown in fig. 9-2); these increments are included in the leading edge.

Following the initiating action of the trigger pulse, the voltage level begins to rise. The DELAY TIME represents the period required for the pulse to reach 10 percent of its ultimate magnitude. Until the 10 percent value is reached, it is assumed that the pulse amplitude is not sufficient to perform its normal functions. Delay time is the result of the time required for the active components of the circuit (transistors or vacuum tubes) to switch from one state to the other.

The RISE TIME represents the period required for the pulse to increase from 10 to 90 percent of its ultimate magnitude. This increment is normally associated with the charging of lumped or distributed capacitances or the building of magnetic fields within various circuit components. In practical waveform analysis this is the period usually used to describe the steepness of the leading edge of the waveform.

Once the pulse has reached 90 percent of its ultimate magnitude, it is considered to be fully capable of performing all the functions required of the pulse.

Trailing Edge

The trailing edge of a pulse represents the return of voltage from the stable operating level to the stable quiescent level. It includes any overshoot and recovery which may be present.

In computer work, the interval during which the pulse decreases from 90 to 50 percent of its maximum value is referred to as the STORAGE TIME. It is during this time that the pulse is usually routed to the memory unit.

The FALL TIME (or the DECAY TIME) denotes the period during which the pulse voltage decreases from 90 to 10 percent of its maximum value. It includes storage time. The fall time interval is normally used to evaluate the quality of the trailing edge.

Once the pulse has decreased to the 10 percent level, it is considered incapable of performing its assigned functions.

Pulse Top

The pulse top refers to that portion during which the voltage level remains relatively constant at its high signal value. The term may be used to refer to the pulse segment falling between the 90 percent voltage points. More commonly, however, it is used to refer to the portion between the first attainment of maximum voltage level to the beginning of the rapid decline in voltage.

In most pulses, once the voltage has reached its maximum level, it tends to decrease slightly during the "flat" portion. The longer the pulse duration, the more drastic this deterioration usually becomes. The deterioration is frequently the result of capacitor charge leakage. Whatever the cause, in radar transmitters this decrease in voltage level of the modulator pulse may result in a change in the operating frequency and/or the output power of the magnetron.

PULSE-TIME MODULATION

Pulse-time modulation is a refinement of the pulse modulation technique. In pulse modulation, the transmitter is keyed or triggered; in pulse-time modulation, this triggering is encoded in some manner involving time. In this system the timing of the pulse is part of the intelligence to be conveyed, and compatible pulse-time circuitry is required to extract the intelligence from the wave.

An example of pulse-time modulation is the TACAN system (discussed in some detail in chapter 17 of this manual.) In this system, the transmitter sends out a comparatively large number of pulses, most of which are meaningless. The only pulses which convey intelligence are those with a definite time relationship to each other. A receiver which does not have a compatible decoding circuit would be incapable of demodulating the signal and using the information.

Digital computers and data transmission systems use a somewhat different version of pulse-time modulation. In these equipments,

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6. Why do we use white or buff drawing paper?

7. Why do we use Scotch drafting tape to fasten the drawing to the board?

ASSIGNMENT:

Fasten an $8\frac{1}{2}$" x 11" piece of buff drawing paper to the board. Beginning from the top and using your T-square, draw horizontal lines $\frac{1}{2}$-inch apart across the paper until the sheet is filled. Within one of the $\frac{1}{2}$-inch spaces, draw three horizontal guide lines $\frac{1}{8}$ inch apart and proceed to letter as previously instructed, your name, address, and the alphabet.

the coding is accomplished by converting the intelligence into binary form and routed as a pulse or no-pulse train.

In both examples, the timing of the pulses conveys an integral part of the intelligence, but the methods and meanings are different. In the TACAN system, randomly-spaced pulses constitute most of the transmitted signal; in digital work the pulse and no-pulse intervals are evenly spaced and controlled by "clock pulses."

DEMODULATION

As mentioned previously, a nonlinear device is required to modulate a carrier frequency. A nonlinear device is also required to demodulate that carrier in order to extract the intelligence from it. Detectors, crystal mixers, discriminators, and coincidence gates are examples of circuits used as demodulating devices.

Demodulation is a process by which the intelligence superimposed on the carrier is removed and reconverted into the original modulating signal.

ELECTROMAGNETIC RADIATION

A general discussion of wave motion is presented in chapter 5 of this manual. Basic Electronics contains a basic discussion of the radiation of electromagnetic waves. Certain aspects of radio waves, especially those applicable to radio direction finding equipment, are discussed briefly in chapter 17 of this manual.

The current discussion of electromagnetic wave radiation is intended as a brief summary of the data contained in those sources. It is also an expansion of some specific topics dealing with the general subject. The discussion is limited primarily to radio waves, and includes general characteristics, propagation principles and methods, and polarization techniques.

CHARACTERISTICS

Electromagnetic waves are complex waves. They consist of two mutually perpendicular fields—electric and magnetic. They travel at a relatively constant velocity of 300,000,000 meters per second in space, and at a slightly different velocity in other media. They tend to travel in a theoretically straight line in a direction which is mutually perpendicular to the two component fields. They are, however, subject to reflection, refraction, diffraction, and absorption (with or without reradiation).

The frequency spectrum of electromagnetic waves extends from somewhat below 30 kHz upward to some unspecified limit. The usable spectrum is being extended in both directions as new developments occur. The spectrum includes those frequencies generally called radio waves, heat, infrared, light, ultraviolet, X-rays, etc. Each broad division of the spectrum possesses easily distinguishable characteristics as well as characteristics common to all electromagnetic waves.

Figure 9-3 is an illustration of the spectrum of electromagnetic wave radiation, with the broad limits of each band designated. The limits of the band are more or less arbitrarily chosen for convenience—there is no sharp division between adjacent bands.

PROPAGATION

As discussed in Basic Electricity, NavPers 10086-B, an electric current flowing in a wire sets up a magnetic field about that wire. If the current is alternating, the magnetic field will expand and collapse, reversing direction in synchronism with the current which produced it. If this alternating magnetic field cuts a wire, it will produce an alternating current in that wire.

The principles of the radiation of electromagnetic energy are based on the laws that a moving electric field creates a magnetic field, and a moving magnetic field creates an electric field. The created field is always in time phase with its parent field, but it is perpendicular to it in space. These laws hold true whether a conductor is present or not.

In systems making use of electromagnetic waves in the radiofrequency spectrum, an antenna is used to convert electric current into fields for transmission, and to convert fields into electric current during reception. Basically, an antenna is a conductor or a system of conductors which serves to radiate or to intercept waves of electromagnetic energy. Basic theory of operation of antennas is dis-

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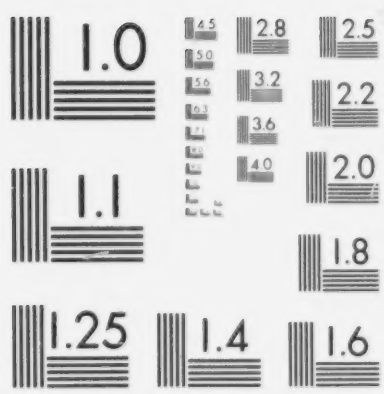

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cussed in Basic Electronics, and a discussion of several major types of antennas may be found in chapter 11 of this manual.

POLARIZATION

Polarization of an electromagnetic wave is the directional characteristic of the electric and magnetic fields of the wave. In general usage, the electric field is used as the reference. The polarization phenomenon is found throughout the entire range of known electromagnetic radiations.

The type and direction of polarization are defined by looking at the polarization vector in the direction of propagation, rather than by looking at the wave as it approaches the observer. Polarization is frequently classified as linear (horizontal or vertical), or circular, depending on the direction of the electric field. In linear polarization the field is considered to maintain a constant direction; in circular polarization it is considered to rotate as it progresses away from the propagating antenna.

As the wave travels through the atmosphere or ionosphere, it is reflected and refracted by particles and other electromagnetic fields. This results in rotation of the polarization from its original state. In addition, a second component appears that follows a different path, with attenuation and phase shift characteristics different from the original wave. The result is an elliptically polarized wave. In recently modified theories, the linear and circular polarization are considered as special cases of an elliptically polarized wave.

Unpolarized Waves

In an unpolarized electromagnetic wave, the electric field appears to have random orientation with respect to the earth's surface. In a plane perpendicular to the direction of propagation, the electric field seems to have approximately equal magnitude in all directions. Radiation from atomic or nuclear processes is normally unpolarized; thus, ultraviolet, visible light, and infrared radiations emanating from heated bodies, electrical discharges, or nuclear agitations are normally unpolarized.

Polarized Waves

In a polarized wave, however, the orientation of the electric field is completely predictable. Electromagnetic waves originating in vacuum tube or transistor oscillators, resonant cavities, etc., are always polarized. The electric vector of the wave may lie in a plane with a constant relationship to the propagation, or the electric field may tend to rotate about the axis of propagation as it travels away from the transmitting antenna.

The initial polarization of a radiated wave is a function of the orientation of the radiating antenna. The shape of the antenna, the distributribution of current and voltage, and the radiation characteristics of the antenna determine the polarization with respect to the antenna. The orientation of the antenna with respect to the surface of the earth then determines the polarization of the wave with respect to the earth.

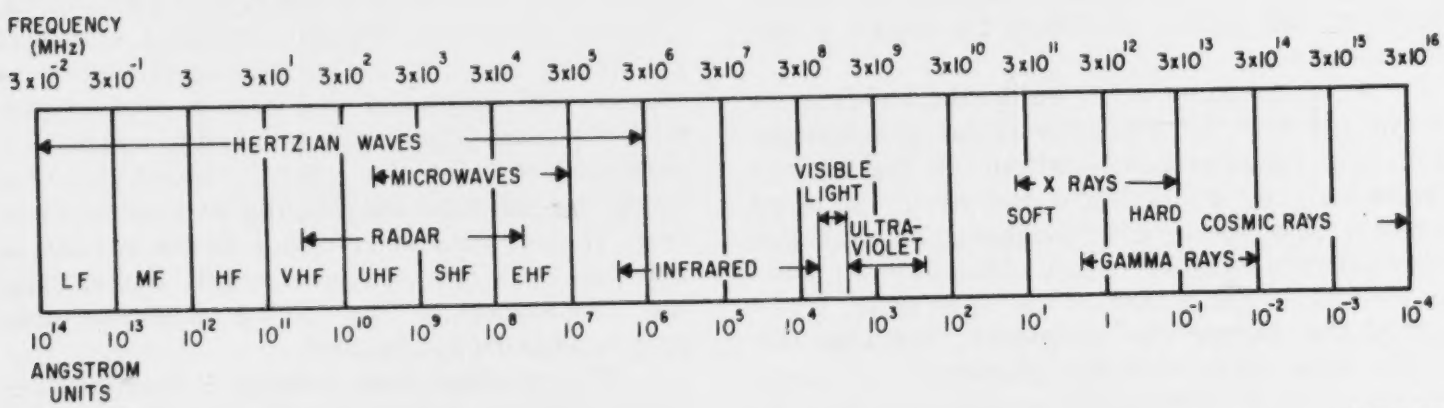

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Figure 9-3.—Spectrum of electromagnetic waves.

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Vertical Polarization

An electromagnetic wave cannot be propagated without both the electric and the magnetic fields. A propagated wave has both a groundwave (or direct) component and a skywave (or reflected) component. At frequencies up to about 1500 kHz, the groundwave is generally more useful than the skywave. At the time of transmission, the two components are indistinguishable; the groundwave is simple that portion of the transmitted wave that travels along the surface of the earth and the skywave is that portion that does not. Thus, the polarization of the two components is exactly the same at the time of transmission.

A dipole antenna mounted so that its physical axis is vertical to the earth's surface propagates vertically polarized waves. That is, the electric field is vertical and the magnetic field is horizontal.

The earth's conductivity determines the rate of attenuation of the groundwave. With perfect conductivity no horizontal component of the groundwave could be sustained, because the earth shorts out any horizontal component of the electric field. The earth, however, is an imperfect conductor, so the horizontal component of the electric field in the groundwave is attenuated at a rate depending on the conductivity of the earth in the local area.

With horizontal polarization, this condition results in a proportionately large loss of the signal. With vertical polarization, however, the portion of the wave front traveling along the surface is slightly retarded. This causes the wave front to lean slightly in the direction of propagation; it thus tends to follow the curvature of the earth, extending the range of the groundwave.

At frequencies below 1500 kHz, the groundwave permits the use of vertical polarization for long range communications. At higher frequencies, the groundwave component is more greatly attenuated, with a consequent decrease in maximum effective range obtainable from the groundwave component of the wave front. However, the higher the frequency, the less the wave front tends to lean. Therefore, progressive increase in frequency approaches line-of-sight transmission, rather than following the earth's curvature.

Horizontal Polarization

At higher frequencies (or when skywave operation is desired), horizontal polarization is normally used. This condition permits attenuation of the groundwave, as previously mentioned, but has little effect on the skywave component. Long range coverage is obtained by using the reflective and refractive properties of the ionospheric layers.

At frequencies above about 30 MHz, however, the skywave is not returned to the earth's surface, so the range is decreased considerably and tends toward line-of-sight coverage.

Use of the skywave component creates problems of polarization shift. These problems are discussed later in this section under the heading of elliptical polarization.

Circular Polarization

Circular polarization describes an electromagnetic wave whose electric and magnetic fields rotate about the axis of propagation, maintaining their perpendicular relationship. This rotation is, in effect, similar to the rotating magnetic field of a polyphase a-c motor. Two-phase motors use two alternating currents of the same frequency but with a 90° phase relationship to supply two field windings which are physically oriented at right angles to each other. If the two currents are of the same frequency, equal magnitudes, and 90° phase displacement, the resultant field will rotate in direction and maintain a constant magnitude.

Circular polarization of electromagnetic waves may be obtained through the use of two linearly polarized dipole antennas mounted physically at right angles and supplied driving signals 90° displaced in phase. In actual practice the same signal may be used to excite both antennas, with the phase displacement resulting from use of different lengths of transmission line. If the transmission line to one antenna is effectively a quarter-wavelength longer than the transmission line to the other antenna, proper phasing is obtained.

The resultant wave rotates at the same frequency as the driving signal, and maintains a constant magnitude; it is thus circularly polarized. Direction of rotation is determined by the

time sequence of the signals to the separate antennas.

Optimum reception of circularly polarized waves requires the use of a receiving antenna which is circularly polarized in the same direction as the wave. Nonrotation or rotation in the opposite direction results in cancellation of components of the received signal.

One important practical application of the use of circularly polarized waves is found in some search radar equipment. Circular polarization of the radar beam provides the advantage of reduced echo magnitude from rain. This advantage is not obtained without some decrease in returns from other targets. When using circular polarization, rain echoes are reduced by approximately 20 db; however, normal target returns are also reduced–by approximately 3 db. This results in a loss of about 18 percent in usable radar range. Circular polarization should therefore be used only when the radar targets would otherwise be lost in the rain returns.

Elliptical Polarization

A circular wave can be thought of as consisting of two linear waves, as indicated previously. An elliptical wave can similarly be thought of as consisting of two circular waves. An elliptically polarized wave may also be considered as a wave produced by two unbalanced linear waves, as described in the following discussion.

The same elements which were described for the circularly polarized wave may be used to describe the elliptically polarized wave. If the signal applied to one antenna is attenuated as well as delayed, unequal drive and unequal radiation result. Under these conditions rotation still occurs, but the magnitude of the resultant wave is not constant. A graph of the strength of the radiated signal resembles an ellipse. The same condition may be obtained by changing either the physical orientation of the dipole antennas or the phase relationship of the two feed signals.

It has been mentioned that all electromagnetic waves may be considered to have elliptical polarization, with linear and circular polarization being merely special cases. It has also been stated that the use of the reflective and refractive properties of the ionosphere introduced polarization shifts and rotations that may offer problems. The following paragraphs discuss these topics.

Assume a wave which is polarized perfectly horizontal with respect to the earth's surface. Unless the ionosphere is also perfectly horizontal and of perfectly uniform density, the reflection or refraction is nonuniform. The nonuniformity results in the introduction of a second factor which tends to react with the main wave.

The interaction between the original wave and a reflected or refracted wave tends to change the phase relationship of the two wave components. Changing the phase relationship results in some degree of rotation, effectively changing the polarization of the wave in the field of radiation. Thus the wave may be polarized horizontally as it leaves the transmitter antenna, but vertically polarized by the time it reaches the receiving antenna.

In actual practice, the shifting occurs to some degree in all propagated waves. Atmospheric and ionospheric particles and extraneous electromagnetic fields react with the signal wave to produce a constantly changing wave polarization. If the total rotation-producing forces cancel, the resultant wave is linearly polarized; if they are of equal magnitude and proper phasing, circular polarization results.

FREQUENCY

As previously discussed, propagated electromagnetic waves of various frequency ranges exhibit certain characteristics which may not be important at other frequencies. Alternating currents and voltages which are not propagated also exhibit characteristics which are peculiar to the frequencies involved.

EFFECTS OF INCREASING FREQUENCY

At frequencies normally designated as "power" frequencies, circuit components (resistors, capacitors, and inductors) are invariably lumped quantities. That is, the values of the components are considered to be constant, and are relatively easy to calculate. They are based primarily on the physical dimensions of

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the components themselves, and are not appreciably affected by other circuit elements.

As frequency is progressively increased, however, the apparent values of these components change, and the total effect of the components in the circuit cannot be explained by the lumped values alone. Distributed and stray values of resistance, capacitance, and inductance become relatively large with respect to the lumped values, and must be considered. With increasing frequency, these values become progressively more important in determining overall circuit parameters and circuit operational characteristics.

Distributed properties may be defined as the resistance, capacitance, and inductance spread uniformly along the entire length or area of a circuit element. Stray properties refer to the resistance, capacitance, and inductance which exist between a given circuit element and all other objects and between the circuit element and ground.

For example, a 1/4-inch diameter copper rod 4 inches long, placed in free space where no external influences are present, would possess small but definite values of R, C, and L. If the conductor were cut in half, each part would have exactly half the previous values. In other words, the distributed properties are uniform as long as the conductor itself remains uniform in cross sectional size, shape, and conductivity, and provided that no external influences exist. If the conductor is not uniform, the distributed properties still exist, but their distribution is not entirely uniform.

If the conductor is placed in an actual circuit, it retains these distributed properties, and it also acquires stray properties because of its closeness to other components in the circuit. These stray and distributed properties exist in all conductors and conducting elements. They even exist in lumped property components and in the leads. At power frequencies, the distributed and stray values are so small compared to the lumped values that they may be conveniently ignored. In fact, it is usually practical to ignore these values at frequencies up to about 30 MHz, except in such circuit elements as self-resonant sections of transmission lines and antennas.

At frequencies above about 30 MHz, however, distributed and stray values may become so large (compared to the lumped values) that they can no longer be ignored. This happens because of a double-ended change which takes place in circuit elements. On the one hand, increasing the frequency of operation usually requires smaller values of lumped properties. On the other hand, increasing the frequency results in greater interaction between each circuit element and the other components in the circuit. In addition, the actual values of R, C, and L contained in a given component are not constant–they tend to change when frequency is varied. The following paragraphs discuss the changes which occur, and the effects of these changes on circuit operation.

Inductance

The term "distributed inductance" refers to the self-inductance distributed along the length of any type of conductor, whether it is or is not meant to act as an inductor. Inductance, as defined in Basic Electricity, NavPers 10086-B, is the property of a conductor that tends to oppose any change of electron flow (current) through the conductor. Inductance reveals itself only when current is varying in the conductor; a back emf (electromotive force) is induced in a direction that tends to oppose the change in current flow. Even a very short section of straight wire possesses self inductance. The conductor does not have to be wire, however; it can be any conductor, any shape or size.

Usually, the actual amount of self-inductance is small, but its effect becomes important at frequencies above 30 MHz. The effect may be desirable or unwanted, but it cannot be ignored. A complex equation is needed to find the actual value of self-inductance, but the important point here is that the value depends directly on the number of lines of flux surrounding the conductor. Self-inductance is highest at the center of any conductor carrying alternating current, and tapers off toward the outside surface. This is the cause of skin effect, explained later.

UNDESIRABLE EFFECTS.–The property of distributed inductance can cause serious RF losses if leads and connecting linkages are not kept as short as possible. Figure 9-4 demonstrates how this loss takes place. The plate

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tank circuit (A) is designed to operate at a frequency of 4 MHz. The inductor is connected to the tube plate by a wire having a self-inductance of approximately 0.1 microhenry (μh).

Ignoring loading and other factors, calculation shows that the resistive impedance offered by the tank circuit at reasonance is 4,710 ohms, where the inductive reactance ($X_L = 2\pi fL$) of the connecting wire is approximately 2 ohms, and is so small in proportion to 4,710 ohms that it can be neglected at this low frequency.

When the operating frequency is raised to 100 MHz (fig. 9-4 (B)), the inductance of the tank coil must be reduced to resonate at the higher frequency. At 100 MHz, the self-inductance has decreased slightly but the increase in frequency raises the inductive reactance of the plate lead to 59.6 ohms. The resistive impedance of the tank circuit is still 4,710 ohms at resonance. A voltage divider effect occurs, which prevents the entire RF signal output of the tube from being impressed across the tank circuit and results in a loss of gain. In addition, the introduction of an inductive component causes a phase lag that is undesirable in certain applications. At higher frequencies, the effect becomes even more pronounced, introducing larger losses.

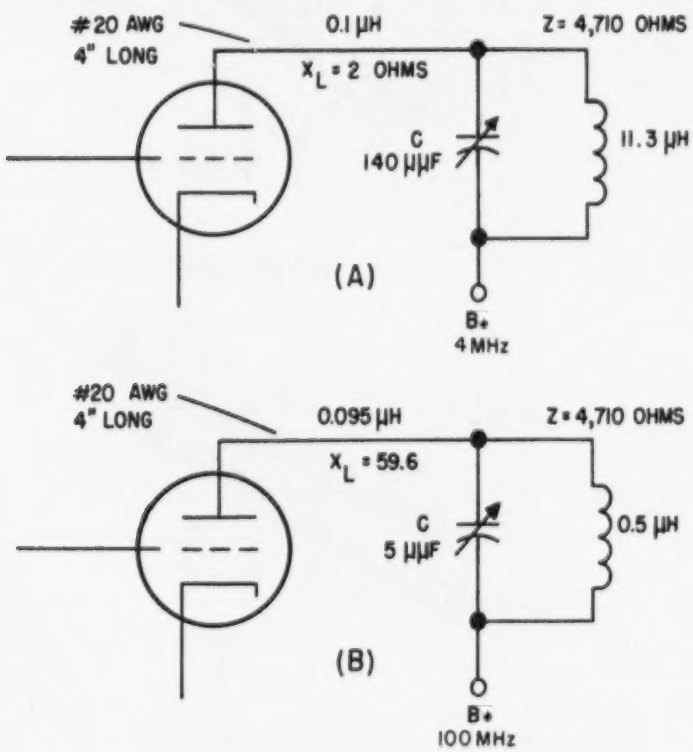

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Figure 9-4.–Inductance at high frequencies.

DESIRABLE EFFECTS.–In certain circuits, a condition of series or parallel resonance is desired, and the property of distributed inductance, distributed capacitance, or a combination of both, may be used to achieve this. For example, to provide a bypass for signal voltages from the low-impedance end of an IF tank circuit back to the cathode of the tube, a series resonant circuit offers the lowest impedance path. When the IF is above 30 MHz, it is possible to get the effect of series resonance by cutting the leads of the capacitor to lengths offering the necessary series inductance. This is shown in figure 9-5 (A). Note that the capacitance is lumped, but the inductance is the distributed inductance of the capacitor leads. (See fig. 9-5 (B).) However, the signal voltage sees a certain value of each property, regardless of whether the properties are lumped, distributed, or any combination thereof.

INDUCTIVE COUPLING.–When a conductor carrying alternating current runs sufficiently close to another conductor, its magnetic field induces an electromotive force in the second conductor, causing a current to flow. This is the effect of mutual or stray inductance.

The study of mutual inductance and coupling at lower frequencies usually is restricted to coils and transformers, but above 30 MHz the effect of coupling between two conductors–even two straight pieces of wire–becomes important. This is true because the amount of coupling or mutual reactance between two inductors increases as the frequency is increased, if the physical relationship remains the same.

Some effects of coupling between distributed inductances are undesirable. For instance, if the grid and plate leads of a single tube amplifier stage are permitted to run close to each other, signal energy from the plate circuit may be coupled back to the grid, causing either regeneration or degeneration. Distributed capacitance also is present, but only the inductive coupling effect is considered at this time. As another example, a current-carrying wire may be too near a tube shield, inducing an emf that causes current to flow in the shield. This current flow through the shield is a power loss that can be supplied only from the current-carrying wire.

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When inductive coupling causes circuit imbalance or power loss, it usually is spoken of as stray coupling. The amount or degree of coupling depends directly on the relative positions of the conductors as well as their distance from each other. Figure 9-6 shows the effect of physical position on the degree of coupling. In (A) the coupling is loose, inasmuch as the leads are crossing at right angles, and minimum mutual inductance results. The coupling

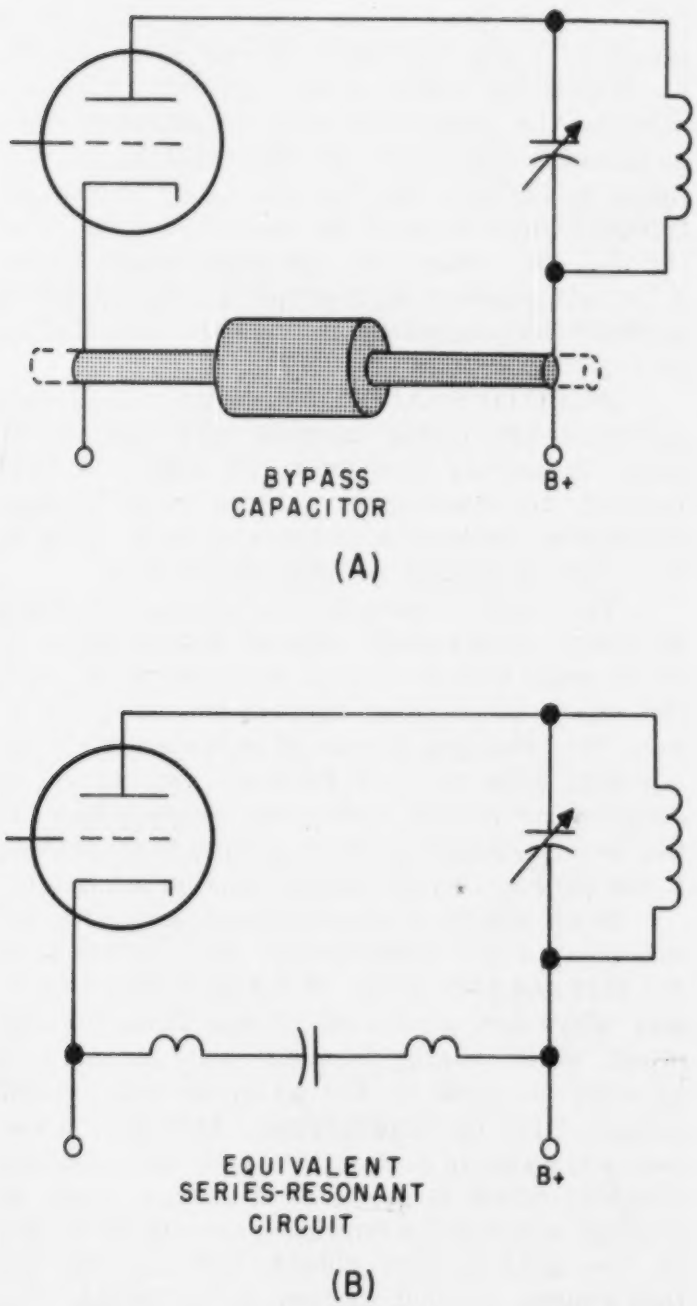

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Figure 9-5.–Series self-resonance.

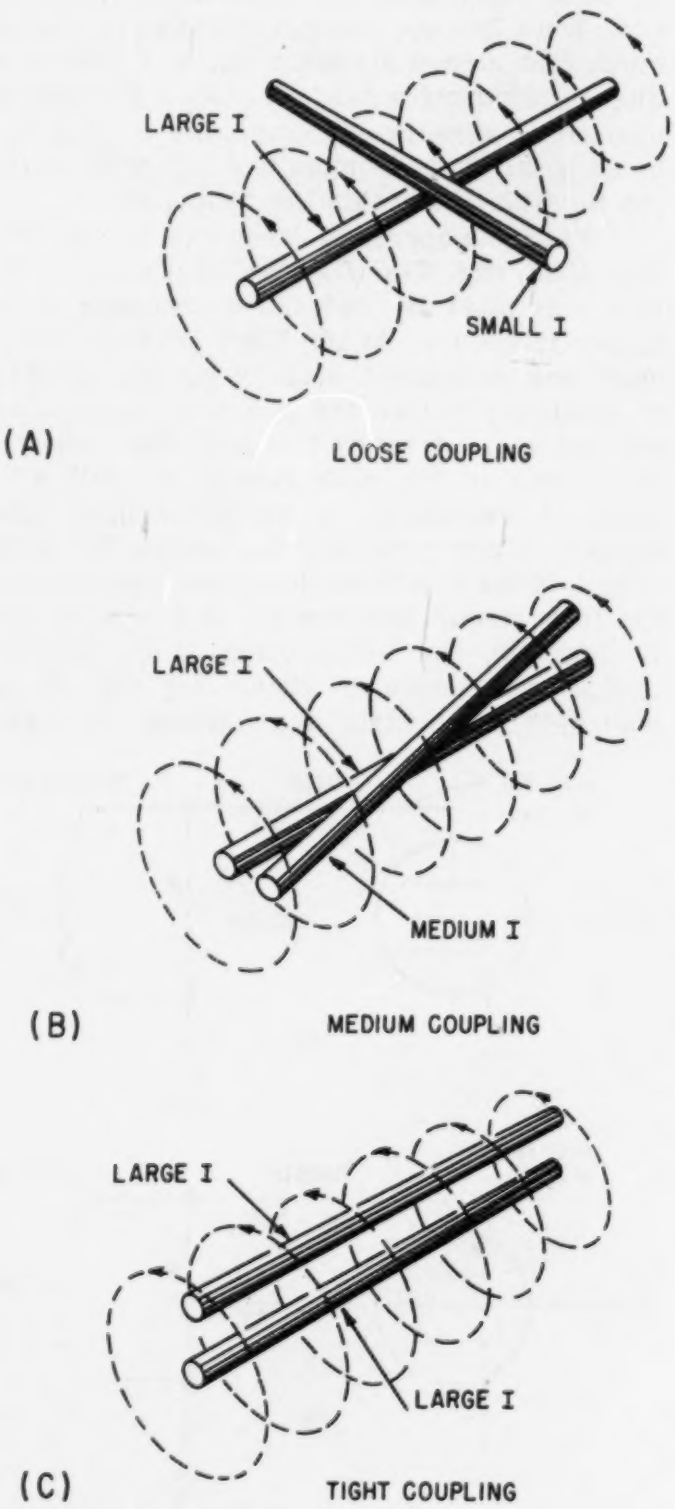

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Figure 9-6.–Inductive coupling effects.

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between the wires (B) and (C) increases because of the greater amount of mutual inductance. Practical circuits are laid out with the shortest possible leads, well separated from one another, and distant from the chassis and shields. If two wires must cross, they should cross at right angles, because this produces the smallest mutual inductance.

Capacitance

The term "stray capacitance" refers to the capacitance between any point on a conductor and all surrounding objects. Capacitance exists between any two points that are at different electrical potentials. This is true whether the points of different potential are in different conductors or in the same conductor. Although the distributed self-capacitance of a conductor is of relatively little importance, except in special circuits, the effect of the stray capacitance between two conductors must be taken into consideration at higher frequencies. This is because of the capacitance that exists between the parts of circuit elements and the electrodes of electron tubes, as well as between leads and switch contacts.

The actual value of capacitance changes only slightly with frequency, but the reactance changes greatly. The formula for capacitive reactance $\left(X_C = \frac{1}{2\pi fC}\right)$ shows that, if the value of capacitance remains the same, increasing the frequency causes the capacitive reactance to decrease. Therefore, a small value of distributed capacitance at the lower frequencies offers a high reactance to the flow of a.c., but at higher frequencies it offers a lower reactance. This effect is often undesirable when it occurs accidentally between two conductors in a circuit, but may be used deliberately to achieve series or parallel resonance in resonant line sections. The losses in distributed capacitance are lower than those in lumped capacitors because the dielectric is usually air, instead of a solid, and because the RF resistance (discussed later) and distributed inductance values are smaller.

UNDESIRABLE EFFECTS.–An example of the manner in which stray capacitance may upset the proper operation of a circuit is shown in figure 9-7.

Assume that C_d represents a distributed or stray capacitance of 1 $\mu\mu$f appearing between ground and the lead from the coupling capacitor to the grid of tube V2. The stray capacitance

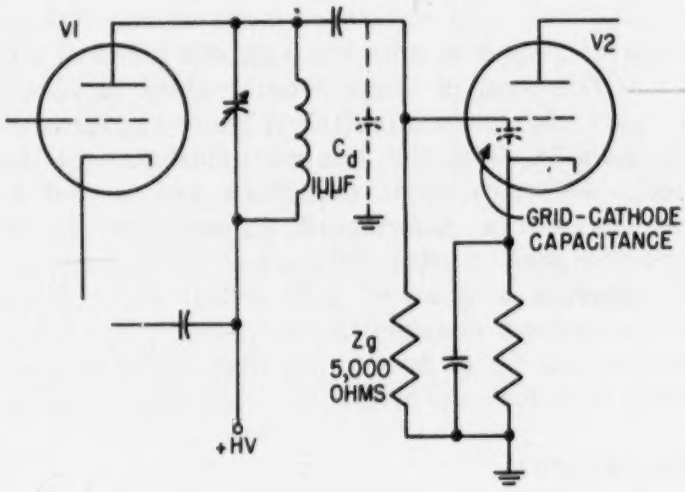

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Figure 9-7.—Capacitance at high frequencies.

C_d effectively shunts the 5,000-ohm grid impedance Zg. If an RF signal at a frequency of 2 MHz is traveling from the tank circuit of V1 to the grid of V2, the 1 $\mu\mu$f distributed capacitance offers a capacitive reactance of 79,618 ohms to the signal. This value is so high in relation to Zg that its effect is negligible at this frequency and similar low frequencies. If, however, a 100 MHz signal voltage is coming from the tank circuit of V1, the same 1 $\mu\mu$f stray capacitance offers only 1,592 ohms of capacitance reactance.

Now the signal voltage sees a relatively low impedance path across the stray capacitance, offering less than one-third the opposition of the grid impedance Zg. Therefore, more than two-thirds of the signal voltage is shunted across this path and lost. If the frequency of the signal voltage is increased to 400 MHz, the reactance drops to 398 ohms, and only a very small amount of the signal voltage reaches the grid impedance.

To keep the stray capacitance at a minimum, the circuit wiring is kept well spaced with short leads that run at right angles to one another whenever possible.

DESIRABLE EFFECTS.–For certain applications, such as IF amplification, a parallel LC (inductance-capacitance) circuit, resonant at a single frequency, is useful. A simple way of achieving this is to wind a coil in such a manner that the total (distributed and stray) capacitance is used to make the coil self-resonant at the desired frequency.

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Part (A) of figure 9-8 shows the distributed capacitance that exists because of the difference of potential between adjacent turns of any coil. The sum of these small values is shown in part (B) as an effective value of capacitance in parallel with the lumped inductance of the coil. Although most inductors are wound to minimize the distributed capacitance, some are designed to offer the necessary capacitance to provide a desired L/C ratio. This offers an advantage because the response of the tuned circuit can be made sharper than would be possible with lumped-property coils and capacitors.

Resistance

The term "distributed resistance" seldom is used, because it is necessary to distinguish between the resistance offered to d.c. and low frequency a.c. and the resistance offered to RF currents at the higher frequencies.

Depending on the conductivity of the metal or alloy, all conductors have d-c resistance.

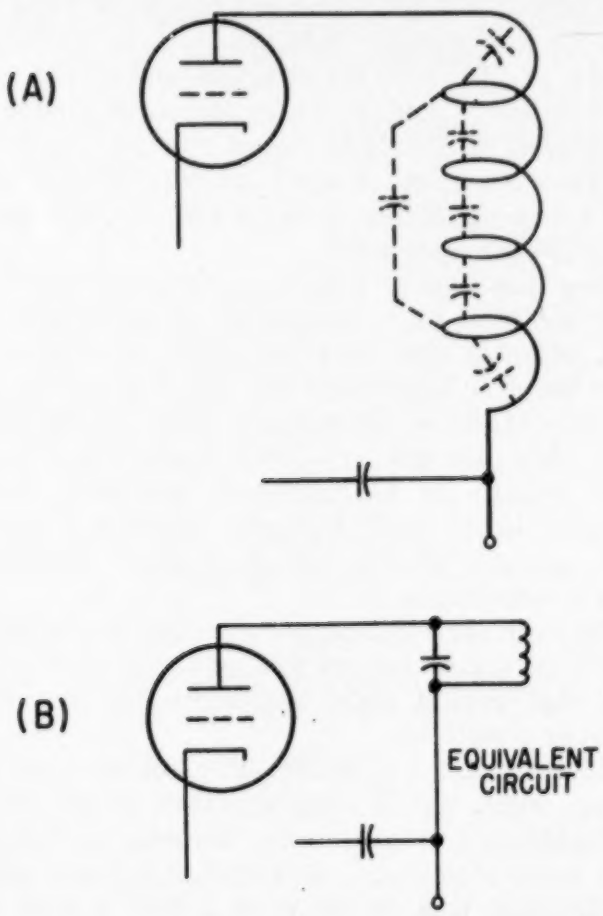

Figure 9-8.–Parallel self-resonance.

It is distributed uniformly along conductors that are uniform in cross sectional area, shape, and conductivity. Resistance to RF, however, is caused by d-c resistance plus the effect of self-inductance, which is greater at the center of a conductor than at the surface. At the lower frequencies, this self-inductance has little effect on the flow of current because the values of inductive reactance are extremely small. As the operating frequency increases, the inductive reactance at the center of the conductor becomes higher, and the current seeks the lower reactance path toward the surface, resulting in a current distribution that is not uniform.

This tendency of the current to flow on or near the surface of a conductor is called SKIN EFFECT. As the frequency increases, less current flows in the center of the conductor and more flows on the surface. The result is that more current is forced through less conductor material, with higher losses and more heating. Because the center of the conductor is not carrying current, the effect is the same as using a smaller conductor. The RF resistance at higher frequencies can amount to several times the d-c resistance of the same conductor.

MINIMIZING SKIN EFFECT.–Skin effect takes place regardless of the shape of the conductor, but it causes less RF resistance in conductors having rectangular cross sections than in those that are circular. Flat copper strips are sometimes used, but are more expensive and not easy to work.

Litz wire, as it commonly is called, is made up of many strands of very fine enameled wire woven together. The current is divided among the strands, and the skin effect on any single conductor is extremely small. Litz wire is comparatively expensive, however, and is not widely used.

Probably the best method of avoiding losses from RF resistance is by silver plating the conductors. This does not eliminate skin effect, but takes advantage of it. When the plated conductor carries RF current, skin effect takes place as usual. Now however, the current is flowing in the silver plating, which has less d-c resistance than ordinary conductors; therefore, the RF resistance is reduced considerably. In practice, plating is expensive, limiting its use.

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OBJECTIVE:

To learn to use the 30°/60° and 45° triangles.

RELATED INFORMATION:

Triangles commonly used in the field of drafting are the 8-inch 45° triangle and the 10-inch 30/60° triangle (Fig. 1). They are used for drawing vertical lines. This use and other uses are shown in Fig. 2. To draw vertical lines, set the triangles against the T-square with the perpendicular edge nearest the head of the square and thus toward the light. These lines are always drawn upward from bottom to top. Triangles are used even more, perhaps, than the T-square; therefore you should constantly practice using them until you have mastered the technique required for their correct use.

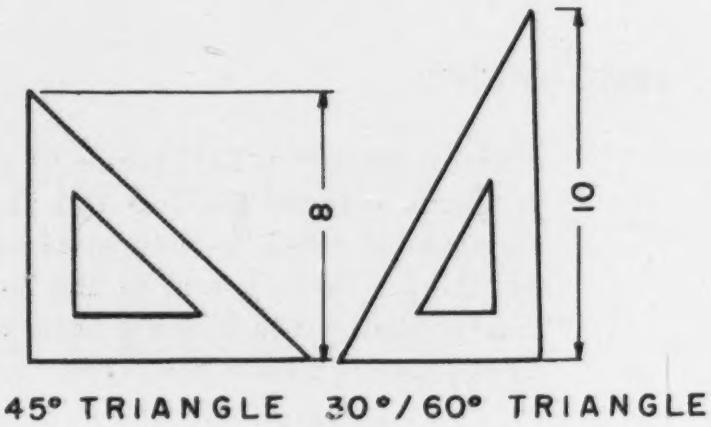

FIG. 1

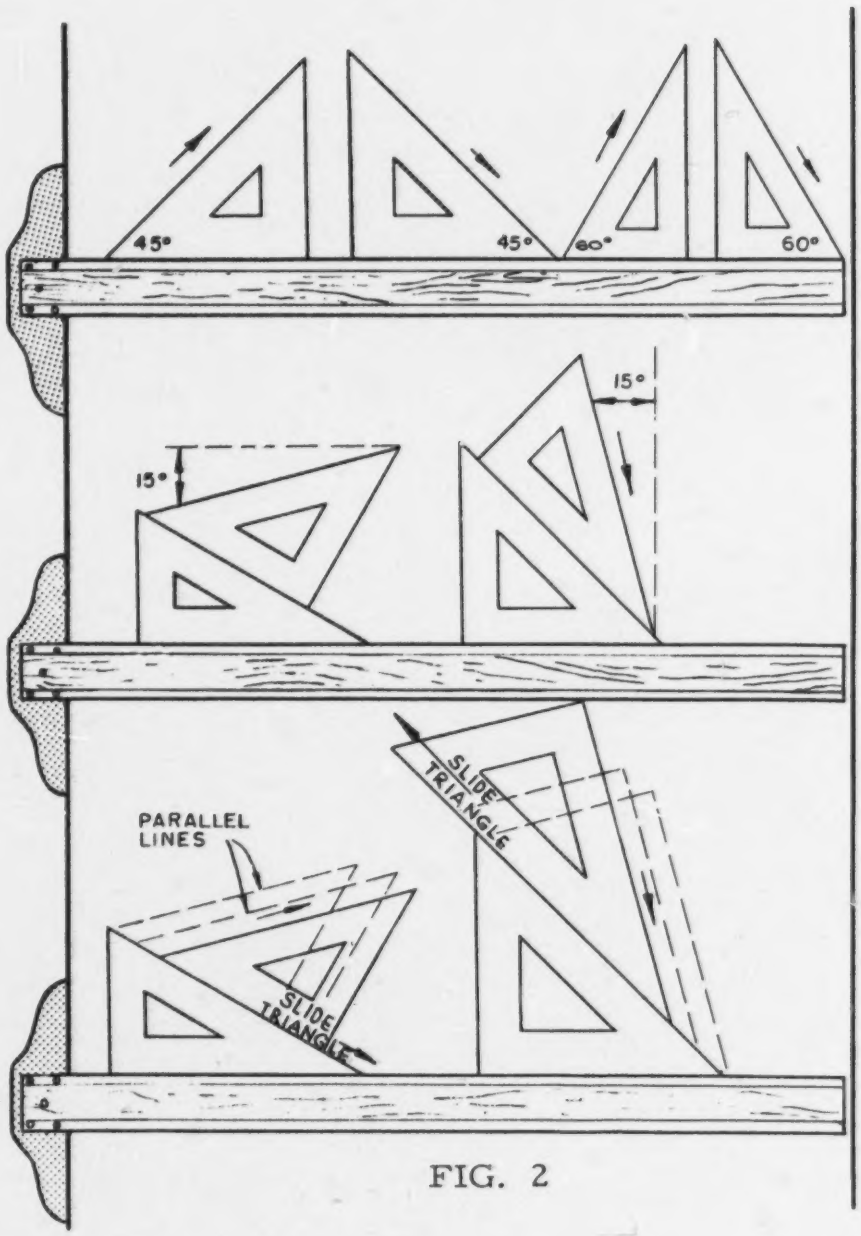

FIG. 2

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The most common means of reducing RF resistance is to use a hollow conductor or one of larger diameter. Again, this does not eliminate skin effect. The depth to which the current penetrates is affected only by the frequency and the conductor material; consequently, when the diameter is increased, the current layer has the same thickness but more cross sectional area in which to flow. This reduces the effective RF resistance.

Electrical Losses

As the frequency of operation is raised, the electrical loss in lumped property components increases until a frequency is reached beyond which this increasing loss cannot be tolerated. The increasing loss is, in reality, a combination of three distinct effects–dielectric loss, RF resistance, and radiation loss.

Even in the best dielectric materials, losses increase with frequency. A definite amount of applied energy is lost in each cycle; the more cycles occurring in a specified time, the greater the amount of heat generated in the dielectric.

The RF resistance loss increases with frequency because of increased skin effect.

Radiation loss occurs in any RF circuit. This loss results from direct radiation of energy from individual parts. As long as the circuit element is not more than about one-tenth of a wavelength in any physical dimension, the radiation loss is usually negligble. With increasing frequency, however, it eventually becomes impossible to scale down the physical size of components in proportion to the decrease in wavelength. Losses from radiation increase thereafter. The addition of RF shielding around the circuit decreases the radiation loss, but causes energy to be lost in heating the shield.

The increasing losses which result from increasing frequency reduce circuit efficiency. This factor makes it desirable to use circuit elements and arrangements which have lower built-in losses. As yet it has not been possible to construct lumped property components which do not have some amount of the other properties distributed within them. Increasing the frequency increases the effects of these distributed properties, resulting in increased electrical losses and decreased circuit efficiency.

It has been found practical, however, to take advantage of the stray and distributed properties. Circuit elements and configurations have been designed for operation at high frequencies, using the stray and distributed properties to supplement or to replace lumped components. At the same time, these configurations are designed to decrease the total electrical losses of the circuit. The operating efficiency of these circuits may be greater than that of equivalent circuits using lumped components.

Vacuum Tubes

Although the basic principles of vacuum tube operation remain unchanged, some factors which could be disregarded at low frequencies become important in tube operation at high frequencies. The inductance of electrodes and their leads and the capacitances between electrodes are quite small in absolute value, but at high frequencies their reactances become significant. Skin effect in the electrodes and their leads increases the RF resistance with increases in frequency. Some power is lost due to direct radiation from the electrodes and their leads. Dielectric losses in the insulating electrode supports are also increased. In addition, electrons do not travel instantaneously from cathode to plate, but require TRANSIT TIME. Transit time produces a phase difference between the cathode and plate signals. At sufficiently high frequencies, this phasing can be a considerable portion of a cycle at the operating frequency.

The overall effect of these factors is to reduce tube operating efficiency as the operating frequency is progressively increased. The factors are always present in a vacuum tube, regardless of the operating frequency. As frequency is increased the effects increase and may become so large that they place an upper limit on usable operating frequency. Although it is not necessary to learn new operating principles, it is important to understand the effects of frequency on the operation of tubes and their associated circuits.

CONSTRUCTION FACTORS.–As the wavelength is made shorter, it becomes comparable in length to the physical length and spacing of tube electrodes and leads. The apparent solution to this difficulty is to scale down the entire

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tube structure. There is a practical limit, however, governed by the power handling capacity required. New tube designs have been developed that successfully overcome one or more of the limitations without requiring a drastic size reduction. For further details on tube design, review chapter 1 of Basic Electronics.

When the tube is cold, the dielectric between electrodes is mostly vacuum. In operation this vacuum is partially filled with a stream of electrons, producing a change in the dielectric constant. The dielectric constant, and therefore the interelectrode capacitance of the tube, changes with variations in the electron stream. The normal capacitance values are measurable, and are listed in tube characteristics tables.

Not only does interelectrode capacitance limit the frequency by establishing a minimum value below which it is impossible to go, but it also varies with the applied voltages and with the loading of the oscillator. This causes frequency instability, particularly when the interelectrode capacitance forms a large part of the tuning capacitance.

TRANSIT TIME.–The effect of transit time is of special concern in connection with the input impedance of the tube. The signal applied to the grid causes a change in the density of the flow of electrons past the control grid. This in turn, causes a current to be induced into the grid. The induced grid current may flow either into or out of the grid, depending on the relative grid voltage at the time. Part of the current flowing in the grid is the current which charges the grid to plate capacitance. The voltage which produces this current is the vector sum of the input voltage (grid to cathode) and the output voltage (across the plate load).

Grid current may flow absorbing power from the input signal, even though the grid is always negative. It has the same effect as if a shunt resistance and a shunt capacitance were connected across the grid and cathode terminals of the tube. The loss of signal energy brought about in this manner is the most important effect of transit time, and the loss increases as the frequency increases.

At lower frequencies with a resistive load, the input and output voltages are (for practical purposes) 180° out of phase and add algebraically to determine the charging current for the grid to plate capacitor. This current is 90° out of phase with the input voltage. At higher frequencies, where transit time is an important factor, the plate current lags appreciably behind the input voltage. At these frequencies, the plate voltage is less than 180° out of phase with the input voltage, and the voltage across the capacitor lags the input voltage slightly. As a result, the charging current is no longer 90° out of phase, but now has an in-phase component. The in-phase current results in power being consumed in the grid circuit. The consumption of power is effectively the same as adding a high resistance between the grid and cathode, with the resistance decreasing as the frequency is increased.

Transit time effects can be minimized by scalling down tube dimensions or by increasing operating voltages. Amplifiers designed for use above 30 MHz usually have close interelectrode spacing. Many transmitting tube types are very small in proportion to their power ratings, and require cooling by forced air draft.

Screen grid tube types have naturally shorter transit time than triodes, and are used in many equipments to reduce transit time effects.

MISCELLANEOUS EFFECTS.–Other effects on electron tubes at the higher frequencies are caused by grid gas current, grid emission, and heat radiation.

In any electron tube there are always some molecules of gas, because it is impossible to produce a perfect vacuum. When electrons collide with these molecules, positive ions are created and are attracted to the negative control grid. This causes a grid current to flow when the grid is negative. The grid current thus produced is small but has the effect of making the grid less negative, which is undesirable in view of the effects of input resistance in this frequency range.

Any metal emits electrons if heated sufficiently, although some are much more efficient in this respect than others. In miniature tubes suitable for use at frequencies higher than 30 MHz, the grid is heated because of its nearness to the cathode as well as by the in-phase grid currents. Some electrons strike the grid even though it is negative, with the possibility

of secondary emission. As a result, there is a possibility of both primary and secondary emissions from the grid. This adds to the space charge and is undesirable because it varies erratically.

FREQUENCY BANDS

The radiofrequency portion of the electromagnetic spectrum(designated "Hertzian waves" in figure 9-3) extends from approximately 30 kHz to approximately 3,000 GHz. As previously discussed, both propagated and nonpropagated waves exhibit characteristics which depend on frequency. As a matter of convenience, this part of the spectrum is broken down into "bands" of frequencies. Peculiar characteristics of radio waves are then described in terms of the frequency bands in which they occur.

It must be remembered that there is no sharp division between frequencies at which these changes occur. Rather, the changes occur gradually, becoming more or less pronounced as the operating frequency shifts in one direction or the other. When a peculiarity is attributed to a band of frequencies, the designated limits of the band should be considered as falling somewhere near the center of a transitional range of frequencies through which the change occurs.

As an example of the previous statement, the upper limit at which radio signals can be returned effectively to the earth's surface from the ionosphere is considered to be about 30 MHz. For this reason 30 MHz was chosen as the lower frequency limit of the VHF band (fig. 9-3); HF and lower frequencies are considered capable of reflection, while all higher frequencies are considered limited to direct transmission (line of sight). In actual practice, this 30-MHz dividing line is not an abrupt one. There is no abrupt change in the ability of the ionosphere to return waves to the earth as the operating frequency is increased or decreased. The change in the behavior of the ionosphere takes place over a wide region of the frequency spectrum, with the region centering about 30 MHz. The point of highest reflectible frequency may be considerably higher or lower at any given time under given conditions.

The 300-MHz dividing line between the VHF and UHF bands and the 3,000-MHz upper limit of the UHF band are also more or less arbitrary figures, agreed upon for convenience. They do not represent sharp divisions, but rather as the approximate center point of transitional region.

Transmitters and receivers installed in naval aircraft are frequently classified as VHF or UHF equipment. In practice, these equipments usually cover only a portion of the designated band. VHF equipments normally cover frequencies between 115 and 156 MHz. UHF equipments usually operate from 225 to 400 MHz. Although this frequency range includes the upper portion of the VHF band, the equipments are designated as UHF.

CHARACTERISTICS OF VHF AND UHF

The outstanding characteristic of propagated waves in the VHF and UHF bands is its line-of-sight limitation. As previously stated, these frequencies are not usually returned to earth from the ionosphere. Even in the VHF band, however, sporadic ionospheric reflections occasionally permit long-range use of these waves. Since sporadic conditions are not consistent and predictable, ordinary usage of this band is limited to line-of-sight operations.

The outstanding characteristics of electronic equipment designed to operate in these bands are noted in the size of components and in the use of stray and distributed properties of L, C, and R to supplement the properties of lumped components.

In VHF equipments, the L, C, and R are usually lumped components. Due to the frequencies involved, the required values of L and C are smaller than those required at lower frequencies. This factor permits use of inductors which consist of only a few turns of wire—the high frequency permits even this small value of inductance to produce the high reactance required. The high frequency also permits use of capacitors with smaller plate areas.

In circuit design the stray and distributed properties of L and C and the a-c resistance are taken into consideration, and these factors are then used to supplement the lumped values. In maintenance procedures, it is important to avoid excessive movement of components or wiring, since this movement affects the stray inductance and capacitance of the circuit.

The use of small series resistors to suppress parasitic oscillation (undesired resonance within a stage due to the effects of stray

L and C) is common in VHF and UHF equipment. Also common in these circuits is the use of coiled interconnecting leads to introduce inductance into d-c and low frequency a-c signal paths. With normal operating conditions, this small inductance has neglible effect, so signal characteristics are not affected. High frequency signals are, however, present within the equipment, and these signals are coupled (through stray L and C) into low-frequency leads. The large inductive reactance which is produced by these signals prevents the introduction of large magnitudes of high frequency signals into the low frequency circuit.

Tubes used in VHF equipment are usually of the miniature or subminiature type, to take advantage of the low interelectrode capacitance and decreased transit time.

Components used in UHF circuits carry the same efforts even further. Parasitic suppression is accomplished in the same manner as in VHF circuits. Frequent use of series inductors and shunt capacitors in d-c leads is an additional filtering method designed to keep RF signals out of the d-c supply. In many circuits the lumped L and C components are completely eliminated, and resonance is achieved through distributed and stray values alone. Where "lumped" components are still used, they often consist of a looped wire–a half-turn "coil" may comprise the resonant tank.

Hollow (tubular) conductors, mounted parallel to each other and connected by a sliding capacitor or shorting bar (for tuning) are frequently used as the resonant tank in medium and high power oscillators and amplifiers. Other such stages make use of special tubes built with the tube elements internally connected to concentric cylinders.

Transmission lines for VHF and UHF equipment are usually coaxial cables, but in the upper part of the UHF range, some use is made of waveguide.

MICROWAVE CHARACTERISTICS

Microwave circuits are characterized by the almost complete absence of lumped inductance and capacitance; maximum use is made of the distributed propeties of conductors. Tank circuits usually consist of resonant cavities, with klystrons and magnetrons supplying the required power. The transmission line is almost invariably waveguide in high power circuits, although coaxial cable is sometimes used to transfer low signal magnitudes.

Within the microwave circuit, signal transfer is usually accomplished in the form of electromagnetic waves rather than as voltage or current variations. This method of signal transfer practically eliminates the effect of a-c resistance, which could be excessive at these frequencies.

Input and output impedances and the selection of alternate signal paths are controlled by the use of waveguide sections. These sections are built or adjusted to the proper length so as to supply the desired impedance, from open circuit to short circuit. By selecting specific methods of coupling or by changing the contours of the inside of the waveguide, it is possible to control signal magnitudes and to determine the reactive component of the signal.

The basic components of microwave systems are discussed individually in chapter 11 of this manual. Brief discussions of the overall operation of specific microwave systems appear in chapter 18.

MICROELECTRONICS

The Naval Air Systems Command uses the term MICROELECTRONICS to refer to those processes and techniques involved in the construction of circuits in a relatively small, nonseparable form. Active elements such as transistors, and passive elements such as resistors and capacitors are closely integrated on a single wafer or block to form a functional circuit.

Microelectronics includes the construction technique referred to as integrated circuitry; it also includes the use of thin-film techniques; and, in some cases, it includes the use of discrete microcomponents (for example, a transistor made separately and then added to an assembled unit). The term is not used to include construction using miniature (but otherwise conventional components with interconnecting wiring between the individual components, even though some wiring may be required between assemblies in microelectric construction.

MICROMINIATURIZATION, on the other hand, is a term generally having a broader meaning. This term is used to refer to all efforts directed toward making electronic devices as small as possible. The Army's micromodular construction technique, for example, is excluded from the NavAir concept of microelectronics, although it represents a good example of microminiaturization. The micromodule consists of tiny wafers of insulating material, on each of which is mounted an electronic element such as a diode, capacitor, transistor or resistor. These elements, some the size of pinheads, are connected by wire threads. Micromodules represent the last practical step in the process of miniaturizing conventional electronic devices. Hundreds of thousands of such elements can be crammed into a cubic foot of space. Microelectronic devices are even smaller than micromodules.

PURPOSES OF MINIATURIZATION

In conventional circuits, electrical connections are the cause of numerous failures. As electronic systems become more complex, the increase in the number of parts used and of the connections between them decreases the potential reliability of the circuitry. A characteristic of microelectronic devices which is even more important than their small size is the drastic reduction in the number of soldered connections required. Using a single block of semiconductor material, it is possible to fabricate complete functional subassemblies which require connections only for inputs and outputs from the assembly.

The major objective of the microelectronics trend is to develop building blocks, with each block capable of performing the function of a complete circuit or group of circuits. With this capability, the block should then have one or more of the following characteristics:

1. Perform more electronic functions per unit of volume, weight, cost, power input, and power dissipated than is possible with even the most advanced components and circuit assembly techniques currently available.
2. Possess considerably higher reliability than their conventional counterparts.
3. Require a minimum of maintenance as a result of improved reliability.
4. Achieve low unit cost, making throwaway maintenance practices economically practicable.
5. Perform certain new functions which are not possible with presently available components.

Size reduction alone is not always the aim of microelectronics; small size is inherent in the technology. Although the size and weight reductions are highly significant, in some applications they do not justify the development of an entirely new system of fabrication.

Trouble isolation to a module rather than a specific component part reduces the number of items to be checked, and thus decreases maintenance time. The requirement of increased reliability at reduced cost is inherent in this form of maintenance. By mechanizing production and improving processing techniques, the initial cost can be drastically reduced; by automatic system checkout techniques, trouble isolation can be made almost completely automatic.

CLASSES OF COMPONENTS

The conventional circuit with normal or miniature components will continue to be used. Some components such as the magnetron and high power-consuming devices do not, at present, lend themselves to drastic size reduction. Miniature components, although they do not compare with thin-film or solidstate integrated circuitry in size reduction, will also continue to be used in military applications. Unfortunately, only a limited selection of miniature components, modules, and packaged assemblies is available. It is estimated that 25 to 30 percent of all military needs for electronic circuits will continue to be filled for years to come by normal or miniature components.

This discussion describes the various classes of microminiature components now being used, reviews a few of the present applications, and notes some of the problems yet to be solved in the microelectronic techniques.

Discrete Components

In reducing weight and bulk, the microminiature component goes one step farther than the miniature component. Capacitors, resistors,

transistors, and diodes are currently being used in conjunction with passive thin films. By micropackaging techniques, size and weight reduction is realized, but the connection into usable circuits is a time-consuming and tedious operation, and the soldered connections do not realize full reliability potential.

Hybrid Circuits

Hybrid circuits using thin-film subassemblies of passive elements to which the active elements are attached represent the next logical step in fabrication. The number of soldered connections is reduced and the number of wafers is also decreased. Thus, this method is a slightly improved example of microminiaturization which is sometimes included in the definition of microelectronics.

Thin-Film Devices

Thin-film microelectronic devices consist of passive elements (currently limited to resistors, capacitors, and small inductors) on substrates of glass, ceramic, steatite, or other suitable insulating material. All active elements, and some passive elements, are added to the circuit as discrete components.

Solidstate Integrated Circuits

Solidstate integrated circuits represent an extension of silicon transistor technology. These circuits derive their name from the fact that the circuit is formed in a single block of silicon semiconductor material. They contain both active and passive circuit elements interconnected with deposited metal patterns. The selection of circuits fabricated on the solidstate principle is at present the limiting factor in utilization of the solidstate module. Considerable development emphasis is being given to this limiting factor.

TECHNIQUES

There is a difference between microelectronics and micropackaging. The latter generally refers to the assembly of discrete, miniaturized components within a single enclosure and electrically connected by wires and deposited films. This technique is similar to conventional methods in that separate, discrete components are used. The individual component cases or enclosures may, however, be removed and the individual components bonded to a common substrate and interconnected, with the complete subassembly then hermetically sealed in a single package. The individual components must be individually processed, handled, and interconnected. This decreases the reliability of the assembly, and increases the unit cost. It does, however, approach the size and weight reduction of microelectronic circuits.

In the true microelectronic technology, all the equivalent components (active and passive) are fabricated in one continuous operation on an entire block of material. The components need never be handled as individual items, and all connections except input to and output from the circuit are an integral part of the block. This technique maximizes reliability because of the lack of separate interconnections within the individual module. Computer-controlled automatic processing techniques will standardize construction and reduce unit cost of producing the modules, making throwaway maintenance economically practicable.

Actual production and manufacturing techniques presently in use are summarized briefly in the following paragraphs.

Deposited Film Technique

This technique involves the fabrication of circuits which are composed of thin films of metallic or semiconductor material deposited on substrates. The individual elements of these circuits cannot be disconnected from each other.

Several methods are used to deposit the film. The most commonly used method consists of evaporating a metallic or dielectric material in a high vacuum and condensing the vapor onto a thin inactive wafer. Carefully prepared masks control the areas exposed for deposition. By successive steps of depositing metallic or dielectric films, resistors, capacitors, and conductors can be deposited onto a single wafer. (Note that reference is made to the conventional types of components as used in the part. The differences are that there are no leads between components, and

that circuit interconnections are an inherent part of the process.)

Other methods used to deposit the film include the oxidation of certain metals, thermal decomposition of gaseous compounds, and "sputtering." In the oxidation process, the metal is first deposited onto the substrate, and a specified section is then oxidized to obtain special characteristics. In thermal decomposition, extremely close tolerances are required in the masking, purity of the compound, temperature, and exposure time.

Some materials have extremely high melting temperatures and are therefore almost impossible to deposit by the evaporation technique. For these materials, the sputtering technique has been developed. In this process, the material is boiled under extreme heat in a high vacuum, and then deposited in small droplets onto the substrate wafer.

Silk Screen Technique

In this process, a mixture of special sand and fluxes is applied to a ceramic substrate and then the unit is fired (in a manner similar to the ceramic painting and glazing process). Prior to firing, interconnections are screened on, using metallic "inks"; external connections are welded, brazed, wire-bonded, or soldered after firing. Use of the silk screen technique results in a film of considerably greater thickness than that of the thin-film technique.

Semiconductor Growth

This technique is the one most commonly used in the production of solidstate circuits. The process begins with a single bulk-form block of semiconductor material as the substrate. Impurities are alloyed or diffused into the material to form PN junctions. (The semiconductor material itself is used in the formation of resistors and capacitors.)

In most cases the elements themselves and their interconnections are integral parts of the semiconductor substrate; differentiation between the elements and the substrate becomes vague. Internal interconnections are reduced by designing one element to begin where another ends.

MANUFACTURING PROCESS. –The manufacturing process consists of a number of steps using silicon dioxide masks to control the doping of the semiconductor material. By use of computer-controlled equipment, the original block of semiconductor material is progressively masked, doped, oxidized, etched, and otherwise processed to form junctions which possess the desired characteristics. Thus a single block of material may contain the equivalent of various combinations of transistors, diodes, resistors, capacitors, and interconnecting wires, with areas provided for connecting leads for input signals, power, and output signals.

CHARACTERISTICS. –The performance of solidstate circuits is limited by the capacitance of the back-biased junctions between the silicon substrate and the N-type islands in which the circuit elements are diffused. This parasitic capacitance has been a limiting factor in obtaining good high frequency response.

Resistance and capacitance values are somewhat more limited in solidstate circuits than they are in thin-film networks, and inductance is as yet unattainable. Circuit resistor tolerances of closer than 20 percent are difficult to attain. Temperature coefficients are relatively large for all components. Capacitors have low values of Q, are polarity-restrictive, and have comparatively low voltage breakdown values.

The absence of interconnections in completely integrated circuits should lead to greatly improved reliability, simplified maintenance practices, and shorter "downtime" losses.

Power capabilities are limited by the drift in circuit characteristics caused by internally generated circuit heat. Power dissipation is therefore greatly restricted.

APPLICATIONS

Microminiaturized and microelectronic circuits and components are appearing in virtually all new equipments. It is expected that microcomponents and microcircuits will eventually replace about 75 percent of those in present use. However, there are some specific applications especially well suited for their usage.

13406 CONFIDENTIAL

In chapters (15 through 20) numerous equipments are discussed. Many of these equipments indicate that the module is the basic functional unit, or that the module is the smallest maintainable item. Equipments involved in automatic data processing, logical computations, sequential switching, or precise navigation are currently being designed as integral parts of an overall weapon system—and they are being designed with microcircuit techniques. Another area particularly well suited for miniature and microcircuits is the survival transceiver packed in the liferaft of ejections seats.

PRINTED CIRCUITS

This type circuit appears more and more in electronic equipment, and has proven itself to be equal in operation to conventional type construction. A few simple machine operations automatically produce circuits that formerly required a production line of workers performing the same jobs by hand.

One method of manufacturing a printed circuit is the "photoetching" process. A plastic or phenolic sheet with a thin layer of copper coating may be used. The copper coating is covered with a light-sensitive enamel, and a template of the circuit that will ultimately appear on the plastic sheet is placed over it. The entire sheet is then exposed to light. The area of the copper that is exposed reacts to the light. This area is then removed by an etching process. The exposure of the printed circuit is similar to a photographic exposure. The enamel on the unexposed circuit protects the unexposed copper from the etching bath that removes the exposed copper. After the etching bath, the enamel is removed from the printed circuit. This leaves the surfaces in a condition for soldering parts and connections.

BOOK CIRCUITS

Figure 9-9 shows an improved type of construction, from the troubleshooter's standpoint, consisting of a removable subassembly of the type called "books." These books are readily removable and have numerous internal and external test points to facilitate troubleshooting. The books are built of easily replaceable standard parts. Most test racks have plug extensions

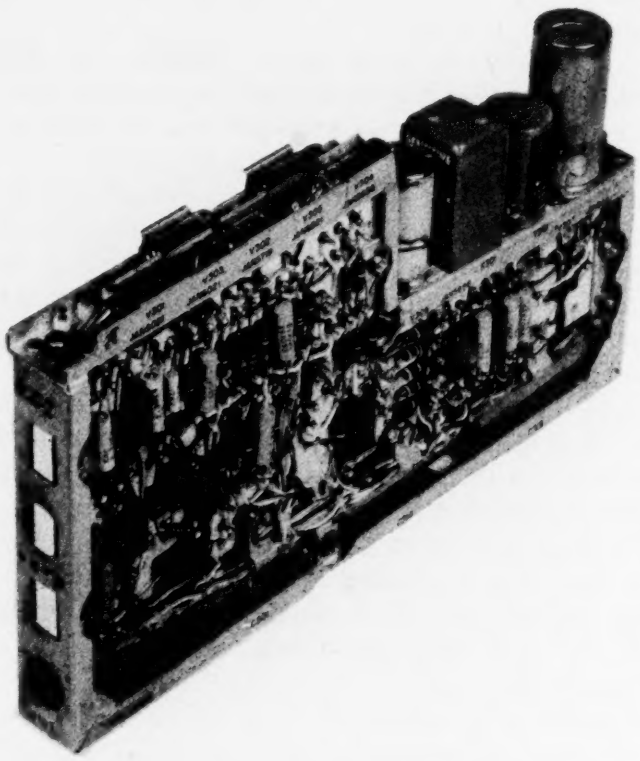

AT.146

Figure 9-9.—Electronic "book" construction.

that permit any book to be raised, making all parts accessible for checking and repairing. The book is not expendable, but can be easily repaired since all parts are of conventional design. Miniature and subminiature parts are so common in today's electronic equipment that they are now considered to be conventional.

DOPPLER PRINCIPLE

The topics of waves and motion were discussed separately in chapter 5 of this manual. The Doppler principle involves the effect of motion on a wave which has been generated and propagated. This effect is based on the fact that all waves, once they have been propagated into space or into a conducting medium, travel at a velocity which is independent of the wave source. The effect was first noted in connection with sound waves; it has subsequently been observed throughout the entire frequency spectrum. In all cases, a shift in the apparent frequency occurs when the wave source and the detector move toward or away

BOOK 1348[illegible]

from each other. If the distance separating the source and the detector remains constant, no frequency shift occurs. The present discussion is limited to the implications of this principle in electronic applications.

PRINCIPLE

For this discussion, assume that a wave source is moving in the direction of its propagation. As the source moves, it partially overtakes one wave front before the next is emitted. This has the apparent effect of decreasing the distance between corresponding points on successive waves. (The speed of wave travel is independent of the motion of the source, and need not be considered in the discussion.) The wavelength (as the waves reach a stationary detector located ahead of the source) is shorter than the original frequency would indicate; the detector apparently receives a frequency higher than that propagated. If the source moves in a direction opposite to the direction of propagation, the frequency is decreased in a corresponding manner.

The same effect is noted in the case of a stationary source and a moving detector. In this case, the detector is overtaking part of the wave front, and the time and wavelengths are shortened, and the frequency is apparently increased.

THEORY

This discussion of the Doppler principle is somewhat simplified in order to present the fundamental theory involved. In the explanation that follows, three aspects of a given radar beam are discussed. These are the generated signal wave, the incident wave, and the received wave. The timing of the wave is discussed and illustrated to show how phase shift and frequency shift occur.

An examination of one microsecond of the signal radiated from a CW radar transmitter shows that the signal is composed of many cycles of RF energy. In the time of 1 microsecond, a radar that operates at 13.3 GHz will radiate 13,300 cycles of RF energy, only a few of which are shown in figure 9-10 (A). Each cycle occupies a definite period of time and has a definite physical wavelength. At the frequency mentioned, each cycle occupies 75 micromicroseconds and has a phsycial wavelength of 22.5 millimeters. An expanded view of one cycle of RF energy at 13.3 GHz is shown in (B) of the figure. This cycle will later be shown with one cycle of incident signal superimposed on it to demonstrate expansion due to Doppler effect.

At this point two approaches to explain the effect of signal expansion are used; one involves the action of a cycle of energy as it leaves the antenna, and the other considers the shape of each cycle to be an arc of wave energy. First, consider a single cycle as it leaves the antenna.

The cycle shown in figure 9-10 (B) occupies a certain discrete distance in space and is, in fact, the wavelength of the signal at the frequency shown. When transmitted from a stationary antenna, the leading edge will move out into space 22.5 millimeters by the time the trailing edge leaves the antenna. However, if that cycle is emitted from an antenna pointed aft from a moving aircraft, then the antenna will move a small distance during the time that the cycle is being transmitted. The trailing edge will, therefore, be a greater distance away from the leading edge than it was when the cycle was transmitted from the stationary antenna. This is expansion.

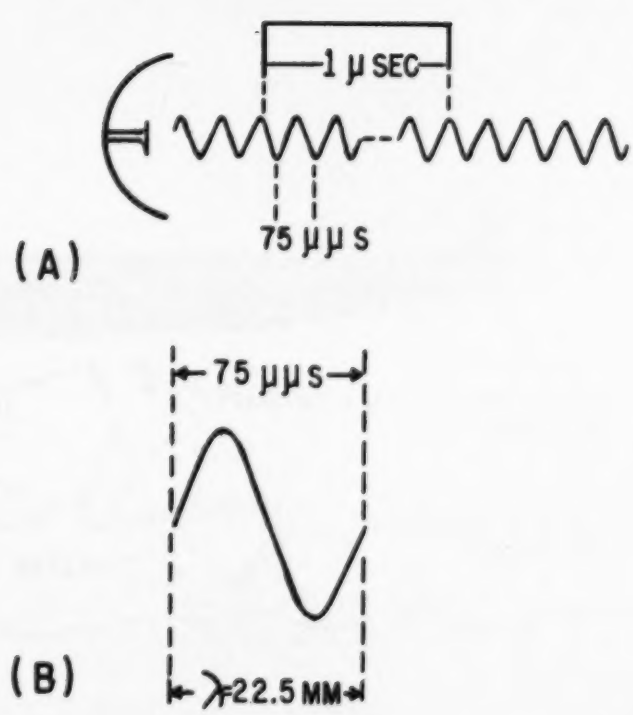

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Figure 9-10.–Examination of a pulse.

Figure 9-11 illustrates this effect and shows, by the dotted line, the space that a cycle would have occupied had the antenna been stationary. Inasmuch as the cycle has been expanded, it occupies more distance in space, the wavelength has been increased, and the frequency has been proportionately decreased. The difference in frequency for this first Doppler shift is proportional to the sine of the radar beam angle multiplied by the ratio of the aircraft velocity to the generated wavelength. In symbols, this would be

$$D.s. = \frac{V}{\lambda} x \sin \phi$$

When the signal is reflected from the ground and returns to the antenna, a similar expansion occurs. A slightly longer time is required for the cycle to reenter the moving antenna than that would be required if the antenna were stationary. Thus, a double expansion has occurred. This double frequency expansion can be measured by the formula.

$$D.s = \frac{2V}{\lambda} x \sin \phi$$

The change in frequency is slight, but measurable, and is a direct indication of the speed of the aircraft.

Compression of the signal will result if the antenna is pointed in the forward direction. The explanation is similar to that of expansion except that the leading and trailing edges of the cycle will be closer together (cycle compressed). The effect will be to shorten the wavelength and increase the frequency.

Another approach to compression and expansion is to consider that a CW signal consists of waves of energy radiated from the antenna. Figure 9-12 illustrates the spacing between the waves of a signal from both stationary and moving antennas. The effect is the same as that previously described. The increased spacing (wavelength) between adjacent waves of energy is a direct indication of frequency change. The received signal frequency, when mixed with the generated signal frequency, produces a difference frequency which falls in the audio spectrum. This audio-frequency is a direct indication of the aircraft's speed.

Several specific equipments which make use of the Doppler principle are discussed in some detail in chapter 17 of this manual.

MASERS AND LASERS

The maser (Microwave Amplification by Stimulated Emission of Radiation) is an impor-

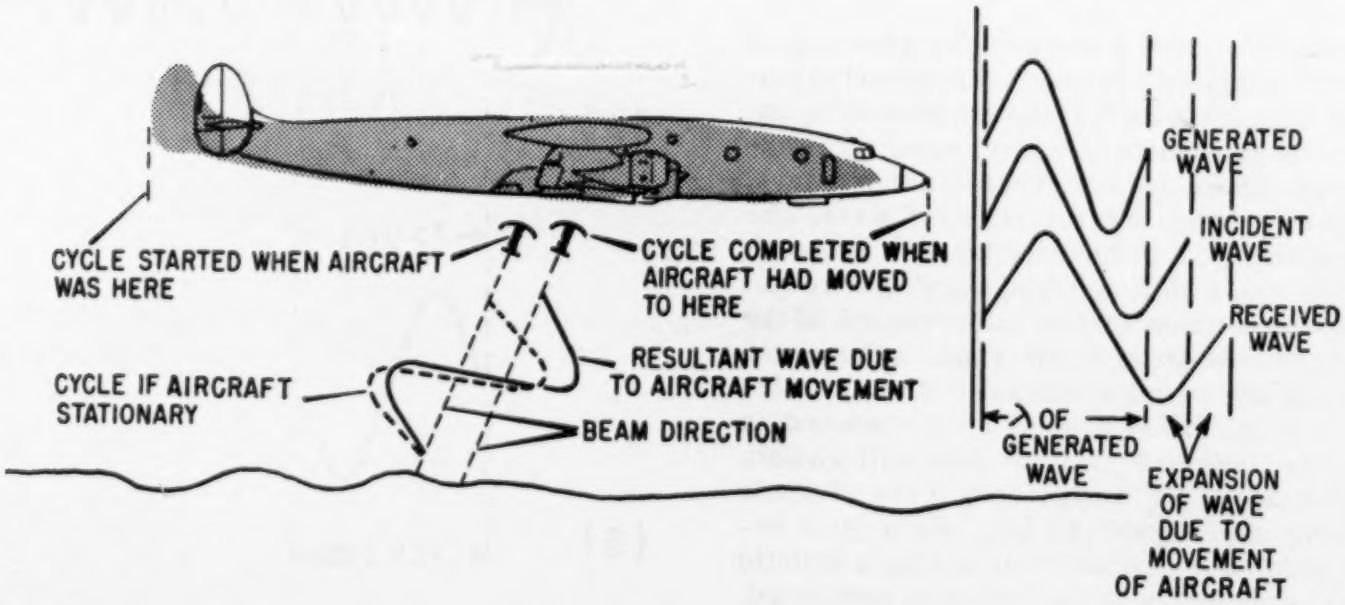

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Figure 9-11.–One cycle expansion.

Use caution in their care and upkeep and avoid denting or dropping them, for this will hinder the drawing of straight lines. Keep them clean with a good cleaning agent.

QUESTIONS:

1. Why must the triangle be placed perpendicular against the T-square?
2. Which two triangles are most commonly used?
3. Why keep triangles clean?
4. Can both the 30°/60° and 45° triangles be used for drawing vertical lines?
5. How would you clean a triangle?

ASSIGNMENT:

Draw a $\frac{1}{2}$-inch border all around the buff paper issued to you. Proceed to draw the lines as shown, using your T-square and triangles.

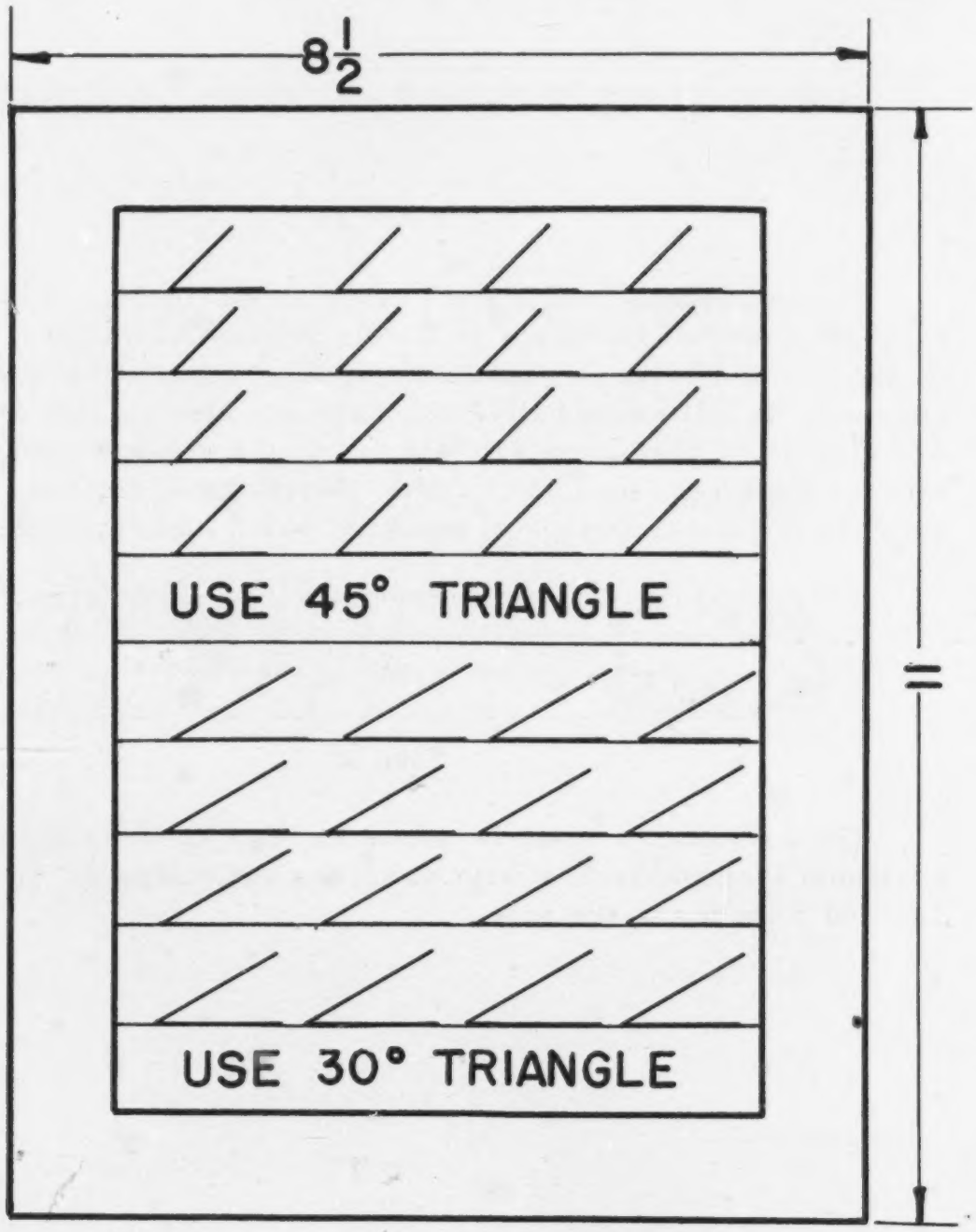

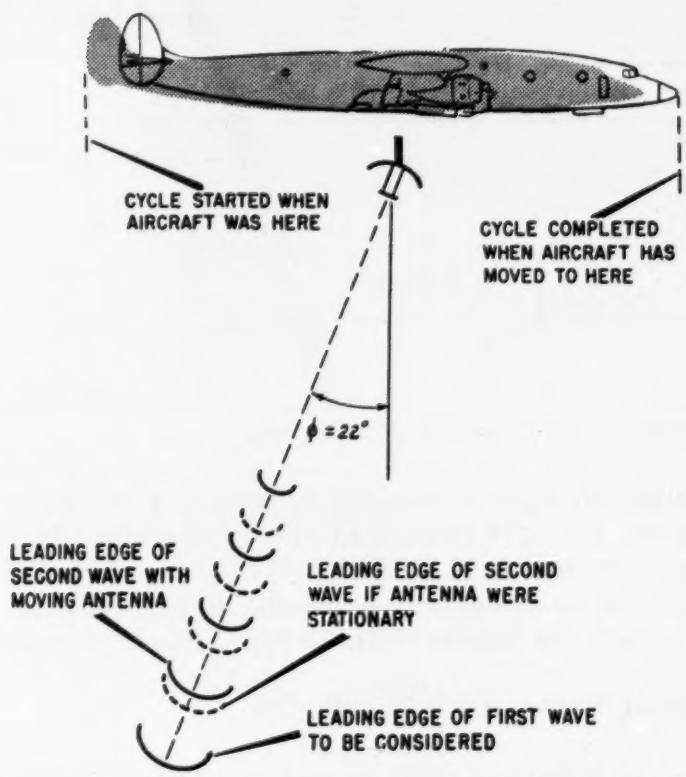

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Figure 9-12.–Energy wave spacing.

tant member of the rapidly growing family of quantum electronic devides. The optical maser, or laser, operates in the visible and near infrared portion of the electromagnetic spectrum.

The feasibility of an optical maser was first suggested in 1958. The first operating laboratory model was constructed in 1960, less than 2 years later. Research, development and application of the laser are currently proceeding at a pace exceeding that of any other device in the history of electronics.

THEORY OF OPERATION

The generation of coherent radiation in the visible region of the electromagnetic spectrum involves interaction of radiation and matter. (See fig. 9-13.) Electromagnetic energy is always absorbed or emitted by an ion or atom in discrete units (photons). For radiation at a given frequency, all photons emitted have energy equal to the product of hf, where $h = 6.624 \times 10^{-27}$ erg sec is Planck's constant, and f = frequency.

A given ion (or atom) can make the transition to a higher energy level by absorbing a photon from the electromagnetic field. It can make a transition to a lower level in either of two ways: spontaneous emission (a random process), or stimulated emission (a coherent process–the phase of the impinging wave is retained in both time and space).

When radiation of the proper frequency enters an area containing ions in thermal equilibrium, it will strike an ion. The ion struck will, if at the upper energy level, transfer to the lower energy level by stimulated emission; but if it is at the lower energy level, it will transfer to the upper level via absorption. Since under equilibrium conditions (fig. 9-14) there are always more ions at the lower energy level than at the higher level, the overall net effect is absorption. If it were possible, however, to begin the operation with more ions in the high energy state than in the low energy state, the reverse would be true. Then entering electromagnetic energy of the correct frequency would cause net stimulated emission, radiation.

Several different techniques for producing population inversion are employed. The method commonly used in solid state lasers is described in terms of ruby, an aluminum oxide containing chromium. The energy levels responsible for the absorption process are shown in figure 9-14. An ion in state 1 absorbs green light and goes to state 3. It rapidly gives up energy in the form of heat and drops to state 2. The mean time that the ion remains at the metastable level, state 2, is on the order of 1 millisecond (about 200 times as long as at state 3); then it spontaneously returns to the ground level by emitting a particular frequency in the red region of the spectrum. If the crystal is illuminated with sufficient green light of the correct wavelength, the population inversion can be maintained. This illumination is commonly termed "pumping."

If the material is properly selected and sufficiently pure, the stimulated emission can be limited to specific frequencies; i.e., frequencies that are known and determined by the physical properties of the elements involved.

LASER OPERATION

The active ion makes a transition from the ground energy level to the pump level when it absorbs energy from the pump sorce. The ideal pump source would emit photons of only the de-

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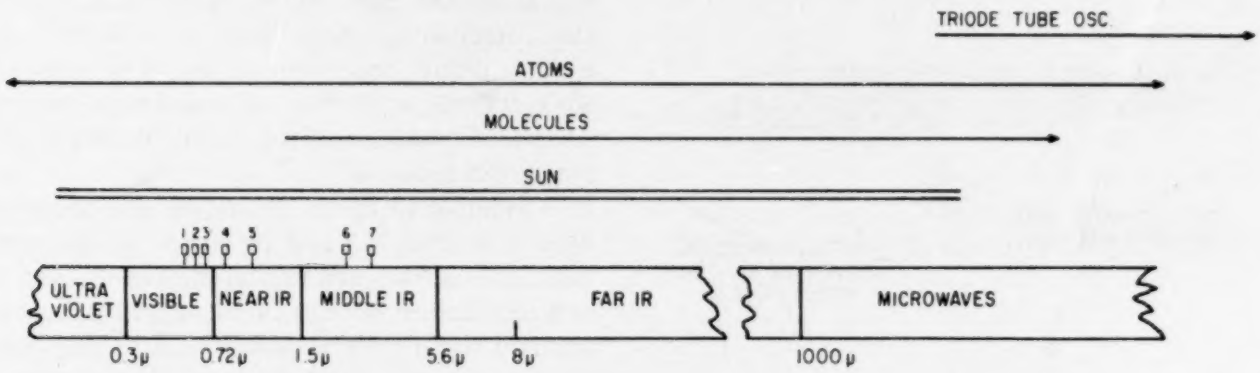

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Figure 9-13.–Spectral range of sources of electromagnetic waves.

sired energy (frequency); however, since such sources are rarely available, it is usually necessary to compromise and use white light. This pump energy could be focused on the laser by sunlight, electronic flashtube, or any other sufficiently intense course.

The ion rapidly falls from the unstable pump band to the metastable level by a photon transition. The metastable level tends to become heavily populated if the pump rate is sufficiently high to put ions into the metastable state faster than they drop back to ground state by spontaneous emission.

After slightly more than half of the ions have been pumped from the ground state to the metastable state (several hundred microseconds for a typical ruby laser), any spontaneously generated light at the correct frequency

$(f = \frac{h}{E})$, corresponding to the energy difference

between the ground and metastable energy levels, will cause net stimulated emission. The device will generate coherent electromagnetic energy, coherent light. Because of the design of the equipment, the light generated will be of a given frequency; will have a fixed phase relationship; and will be radiated, parallel to the longitudinal axis through the lightly silvered end of the laser rod.

PRACTICAL REQUIREMENTS

A practical laser device must meet the following requirements:

1. Select a material (gas or solid) which emits light of the desired frequency and is transparent to that frequency. The first gaseous laser, using a helium-neon mixture, emitted light at a wavelength of 1.15 microns (1.15×10^{-6} meters) or 260 terahertz (2.6×10^{14} Hz). The bandwidth spectrum of the emitted light was about 25 kHz because of frequency-pulling caused by mechanical vibration in the structure.

2. Insure adequate purity of the material. Impurities tend to absorb or refract the emitted energy, interfering with the laser action, lowering efficiency and causing unwanted hot-spots.

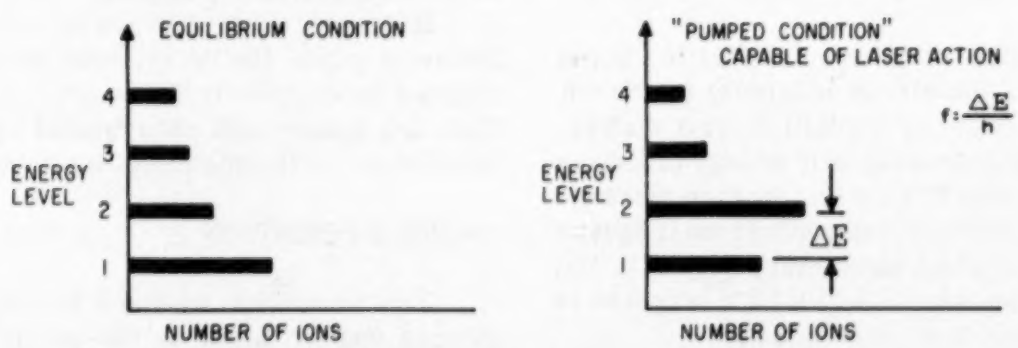

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Figure 9-14.–Energy levels of typical laser materials.

3. Encapsulate the selected material to promote optimum efficiency. Proper design insures maximum coupling or pump energy to the laser. Correct dimensioning insures the maximum level of stimulated emission in the desired direction of propagation.

4. Find an efficient pump source, that is, a source which will maintain the desired energy level inversion with the minimum amount of applied energy. This increases efficiency and decreases heat dissipation problems. The ruby laser has two pump frequency bands, centering on 4100 and 5600 angstroms ($1A = 1 \times 10^{-10}$ meter).

The laser shown in figure 9-15 is refined as follows: a highly pure ruby crystal is grown, machined and polished to a right circular cylinder using techniques developed by transistor technologists. One end is polished optically flat and silvered to become completely reflective to visible frequencies. The other end is also polished optically smooth, but is only partially reflective. The crystal is machined to an exact multiple of the wavelength of the desired operating frequency of the laser; the crystal thus acts as a resonant chamber, continuously reflecting energy along the longitudinal axis. The lightly mirrored end will transmit a portion of the energy which strikes normal (perpendicular) to its surface.

The emitted energy can be focused or otherwise treated in the same manner as ordinary light. It differs from normal light in that it is composed of an extremely narrow band of frequencies and it has a definite spatial phase relationship.

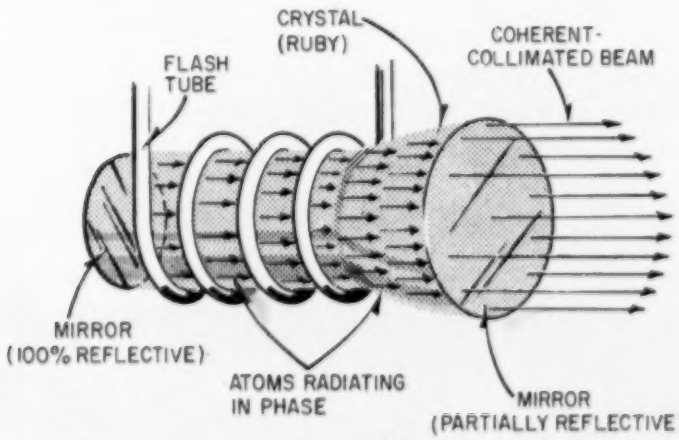

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Figure 9-15.—Simple laser.

APPLICATIONS

It is anticipated that lasers and masers will find extensive applications in many major fields. In view of the known characteristics of masers and lasers, studies are currently conducted to find specific applications in the following fields:

1. Surgical tool. Using a converging lens system, the laser beam can be focused to approach a true point source of light at the focal point. The theoretical limit of the spot diameter would be approximately 1 wavelength (6943 angstroms for the ruby laser). The entire energy radiated could be focused at one spot, creating at that spot a temperature more intense than that at the surface of the sun. This laser beam could be used as a superscalpel, or welding torch, for surgical operations on the human eye and nerves.

2. Communications device. The laser beam can be used as a super-directional communications link in a new uncluttered part of the spectrum. Many researchers are experimenting with methods of modulating the laser beam. One method of modulating the beam with audiofrequencies has already been developed.

3. Energy transfer device. The laser beam constitutes the most intense form of energy propagation yet put at man's disposal. Laboratory models have been used to burn holes through sheet steel. If a sufficiently high-power laser were available, it could radiate sufficient energy from the ground to power satellites or robot helicopters, with practically no energy loss due to transmission.

4. Frequency and distance standard. Since the frequency emitted by a laser depends upon the atomic properties of the material used, the frequency would be known with a high degree of accuracy and would remain constant for the operating life of the laser. The laser will permit all research laboratories to maintain an accurate secondary frequency/distance standard. (1 meter = 1,650,763.73 wavelengths of the orange-red spectral line of krypton 86.)

5. Precision radar system. Lasers have such high spectral purity and directionality that they can be used as precision radar systems. An earth-based laser radar, with an optical system only inches in diameter, has such a high resolution that the beam at the surface of the moon would only be a few miles wide. In a

recent test at the MIT Lincoln Laboratory, the beam of a laser was focused on the moon by a telescope; and returned radiation was detected by a photomultiplier tube after being collected by another telescope. The illuminated area on the surface of the moon was estimated to be 2 miles in diameter.

6. Undersea utilization. Researches are attempting to develop a laser which will operate in the blue-green portion of the visible spectrum. Water is quite transparent at this band of frequencies. A secure undersea communications link or an undersea optical radar has understandably desirable qualities.

In early November 1962, IBM, GE, and Lincoln Laboratory announced simultaneous development of a new laser-a gallium arisinide diode. This new laser has a much higher efficiency potential and far simpler modulation mechanism than its predecessors. It constitutes the next major step forward in laser development. Excited by high current densities (greater than 10,000 amp/cm^2) at its junction, it emits coherent light in the near IR (8400 angstroms) from its polished surface with a beam width on the order of 4 degrees.

The optical laser is destined to become an important segment of the electronics industry. Most high frequency systems (radar, guidance, communications) will employ masers of some type. In the optical region, the laser, only a theory a few years ago, fulfills for the first time the dream of scientists since Newton-a source of coherent light.

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CHAPTER 10

ELECTRONIC CIRCUITS

Within any class of electronic equipments there are a large number of identical functions to be performed–and there are usually many different circuit designs used to perform them. Usually no one design is especially better than another. In the interest of standardization, it has been found desirable to concentrate on a few circuit designs for a given function; "preferred circuits" have been selected for standardization and reliability improvement. These circuits have been developed using the latest techniques and fabrication methods. Their use provides maximum flexibility in the performance of specific functions. Economy in parts usage, fabrication costs, and maintenance efforts have been the guiding factors in the adoption of specific circuit designs as the "preferred" circuit.

The preferred circuit configurations and specifications have been made available to all manufacturers of electronic equipment. They are contained in Handbook Preferred Circuits Navy Aeronautical Electronic Equipment, NavWeps 16-1-519 (Series). (Separate volumes are published for vacuum tube and transistorized circuits.) Although use of these circuits is not mandatory in the development of electronic equipments for Navy use, most manufacturers have made extensive use of them.

As a result of the use of these preferred circuits, development of new equipment has become more rapid. Of greater concern to the maintenance technician, however, is the similarity between circuits in different equipments designed to perform identical or similar functions.

Some circuits discussed in this chapter are the standardized preferred circuits. The discussions are necessarily brief; if further information of a general nature concerning a specific type of circuit is needed, Electronics Installation and Maintenance Book, Electronic Circuits, NavShips 0967-000-0120, provides an excellent reference. For the theory of operation of a circuit in a specific equipment, the technical manual applicable to that equipment is recommended.

Several major classes of circuits are not discussed directly in this chapter. Basic Electronics presents basic operating theory of many of these classes. Where that coverage is considered adequate, the circuits are omitted from this discussion.

GENERATING CIRCUITS

Generating circuits, as used in this discussion, refer to those circuits which develop an a-c signal (or a varying d-c level of voltage) as a result of circuit operating characteristics. Signals are broadly classifiable as sinusoidal or nonsinusoidal. Nonsinusoidal signals include square waves, sawtooth waves, pulses, and miscellaneous other types.

Sinusoidal waveform generators comprise the class of electronic circuits called oscillators. A basic discussion of the main types of oscillators is presented in Basic Electronics.

MULTIVIBRATORS

Multivibrators are normally classified as a form of relaxation oscillator. Three basic types are used–astable (free-running), monostable (one-shot), and bistable (flip-flop). The electron tube and transistorized versions of all three types are discussed briefly in Basic Electronics. In the present discussion, three actual circuits are discussed. The first circuit

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is the preferred electron tube astable multivibrator; the second is the preferred transistorized monostable multivibrator; third is the Schmitt trigger circuit used in many equipments. The Schmitt circuit discussion compares the electron tube and the transistorized versions of the basic circuit.

Multivibrators may be distinguished as to type by the cross-coupling networks between the plates and grids (or between the collectors and bases). In the astable circuit, the cross-coupling networks provide a-c coupling only; the bistable circuit provides d-c coupling for both sections. In the monostable circuit, only one section provides d-c coupling; the other provides a-c coupling only.

Astable PRF Multivibrator

The astable, plate-to-grid coupled multivibrator shown in figure 10-1 is used as a moderately stable repetition-rate generator. It has greater frequency stability than the blocking oscillator and is more economical of components than the Wien bridge oscillator. One disadvantage of the multivibrator is that the output impedance for positive pulses is essentially equal to the plate-load resistance (which must be relatively high for good frequency stability).

The circuit normally uses a miniature or subminiature twin triode and relatively high values of plate-load resistors.

The speed of transition, as in all multivibrators, depends to some extent upon the capacitance between the tube elements, but no special precaution is required in this circuit. The positive-going transition is retarded by the relatively high plate-load resistance and by the timing capacitance, which shunts the output circuit of the tube during turnoff. The negative-going transition is much faster because it is generated at a lower impedance and is slowed only by the output capacitance of the tube and by stray capacitance shunting the

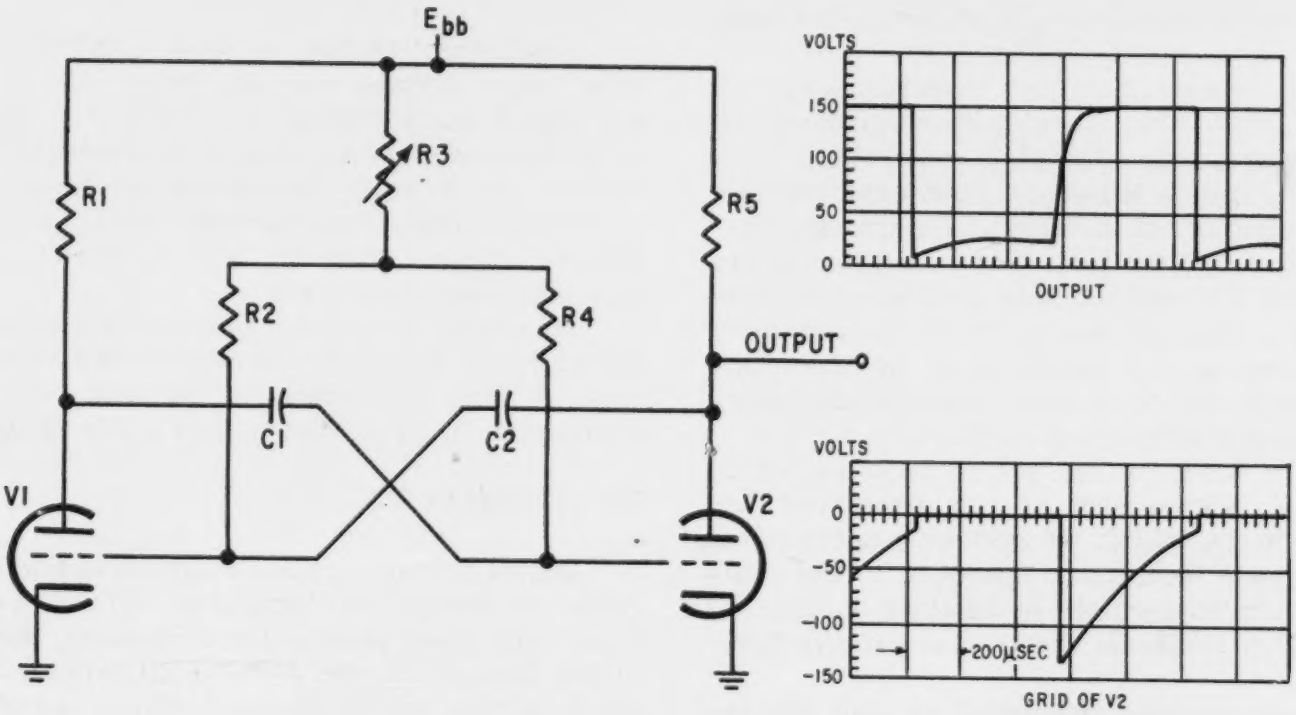

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Figure 10-1.–Astable PRF Multivibrator, preferred circuit diagram and waveforms.

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plate circuit. The faster, negative-going transition is recommended as a timing waveform.

The total period of a symmetrical, astable multivibrator with grid resistors returned to a positive voltage may be approximately determined from the equation

$$T = (2RC)\ l_n \frac{E_{bb} + E_o}{E_{bb} + E_c}$$

where T = period in seconds

R = value of either grid resistor in ohms (including the active portion of potentiometer R3)

C = value of cross-coupling capac- (C1 or C2) in farads

E_{bb} = voltage to which grid resistors are returned

E_o = voltage drop across either plate resistor when corresponding tube is conducting

E_c = absolute value of grid cutoff voltage with full plate supply voltage on corresponding plate

l_n = natural logarithm (of the fraction)

The frequency stability of a multivibrator is improved by making the timing waveform on the grid of the cutoff tube very large in amplitude and as steep as possible at the time this voltage is approaching the cutoff voltage. In this circuit a large timing waveform is obtained by using a high resistance in the plate circuit. The full voltage drop across this resistor, when the tube is conducting, is applied to the opposite grid as the timing waveform. This waveform is made steeper by returning the grid resistor to a positive voltage instead of to ground. (The exponentially rising voltage on the grid will then be farther from its final value and will be changing more rapidly as it passes through cutoff.)

The equation for pulse repetition period shows the dependence of the repetition frequency on the grid resistors and cross coupling capacitors. When these components vary, the frequency varies slightly. This variation can be compensated for by adjustment of R3. Periodic adjustment of R3 will also compensate for the variation in repetition frequency caused by tube changes. The potentiometer should be readjusted each time the multivibrator tube is changed.

The output-voltage amplitude varies directly as the plate supply voltage. The frequency change caused by variations in the plate supply voltage is in addition to the frequency changes compensated for by R3.

Monostable Multivibrator

Figure 10-2 shows a transistorized monostable multivibrator. The circuit appears symmetrical except for the cross-coupling networks between collectors and bases. Note that C1 permits a-c coupling only between Q1 and Q2, while R6 permits d-c coupling between Q2 and Q1. Notice that C1 has not been assigned a value. As will be shown later, the value of C1 in conjunction with R3 will determine the time delay that can be obtained.

In this circuit, the transistors are PNP types; Q2 is on and Q1 is off. The base of Q2 is connected to -6 volts through R3, providing forward bias for the emitter-base junction of Q2. Q2 remains in saturation in the absence of external signals; thus it has a low resistance, and its collector voltage is nearly 0 volts. The divider network, consisting of R6 and R2 connected to + 6 volts, makes the base of Q1 slightly positive. Its emitter-base junction is reverse biased and it is in the off condition; Q1 appears to have a high resistance. Diode CR2 clamps the collector of Q1 at -6 volts; CR4 clamps the collector of Q2 to -6 volts when Q2 is turned off. Diode CR1 prevents positive noise pulses (which appear on the -18-volt supply line) from being coupled to the base of Q2.

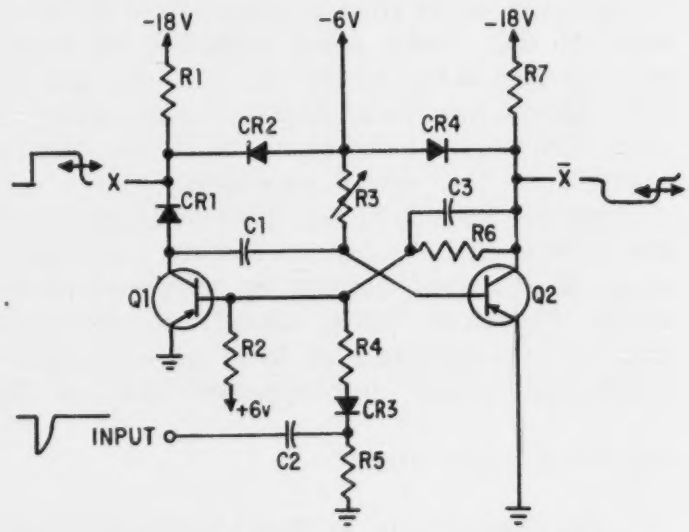

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Figure 10-2.–Monostable multivibrator.

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Under these conditions, then, the input required to turn on Q1 is a negative-going pulse with sufficient amplitude and pulse width to insure its starting. The trigger input network consisting of CR3, C2, and R5 comprises an input gate circuit which discriminates against positive signals and passes negative pulses.

A negative input pulse is differentiated in the input RC network, passes through CR3, and drives the base of Q1 negative with respect to ground. Q1 is now forward biased; and a rapid buildup of Q1 collector current occurs, causing the Q1 collector potential to go from -6 volts toward 0 volts. With Q1 in saturation, the left side of C1 is clamped to ground and a +6 volt step is impressed on the base of Q2, causing Q2 to come out of saturation rapidly.

Q2 collector voltage, however, does not fall abruptly since the associated collector load capacitor must discharge. The negative collector voltage of Q2 is applied to the base of Q1 through the divider consisting of R2 and the C3-R6 network, keeping Q1 on.

C1 then begins to discharge through Q1, the power supply, and R3. The voltage at the base of Q2 is changing exponentially from nearly +6 volts to -6 volts. When the base of Q2 goes slightly negative, Q2 conducts again. Q2 collector voltage rises to 0 volts; and the positive-going waveform is applied to the base of Q1. Q1 is turned off; and C1 charges to -6 volts through R1, CR1, and the emitter-base junction of Q2. The circuit is again in its stable state, awaiting the next input trigger pulse.

Circuit delay time is determined by the off time of Q2. Total delay includes the turnon and turnoff delay times of both Q1 and Q2. For delay intervals greater than about 10 μsec, transistor delay times can be considered negligible. The actual time delay varies with changes in R3 and/or C1. These variations are due to the initial tolerances of the components plus the changes caused by temperature and aging. Therefore, R3 is usually made variable and C1 is selected to have a temperature coefficient equal and opposite that of R3.

Schmitt Trigger Circuit

The Schmitt trigger (fig. 10-3) is a bistable multivibrator. It consists of a two-amplifier regenerative circuit which can stay in either of its two stable states indefinitely. In either state, one amplifier is conducting heavily and the other is cut off. The circuit switches states very rapidly on command. The very fast rise and decay times are useful for triggering other circuits. The circuit can also be used as a gate generator, an amplitude comparator, or a "squaring" circuit.

In the vacuum tube Schmitt circuit (fig. 10-3 (A)), amplifier Ais d-c coupled to the grid of amplifier B and the cathode of amplifier B is d-c coupled to the cathode of amplifier A. Cathode-to-cathode coupling is provided by an unbypassed common resistor.

Figure 10-3 (B) shows the transistorized equivalent of the same Schmitt trigger circuit. An output versus input waveform is illustrated in (C). The output curve shown is based on arbitrary operating limits as discussed in the following paragraphs.

The switching from one state to the other occurs when the input rises to a certain level in one case and when the input falls to a certain level for the other case. The region between the two switching levels or trip points is a backlash or hysteresis region. Note in (C) that the input rises to the upper switching level, causes a switching of states, and then varies considerably but has no switching effect until it falls to the lower switching level. This action is somewhat analogous to driving a gear train which has backlash–the gear train input shaft can be turned back and forth indefinitely and no output shaft movement will occur until the backlash has been taken up.

The loop gain of the circuit determines the width of the hysteresis region. For a loop gain of unity, the hysteresis limits coincide; the circuit switches states each time the input passes the single switching level, regardless of the direction of approach. The no-hysteresis Schmitt circuit is seldom used–slight circuit changes could cause the loop gain to become less than unity. With a loop gain less than unity, both amplifiers of the circuit act as fairly linear amplifiers, and no switching occurs. For hysteresis to exist in the circuit, the loop gain must be greater than unity–the greater the loop gain, the wider the hysteresis region.

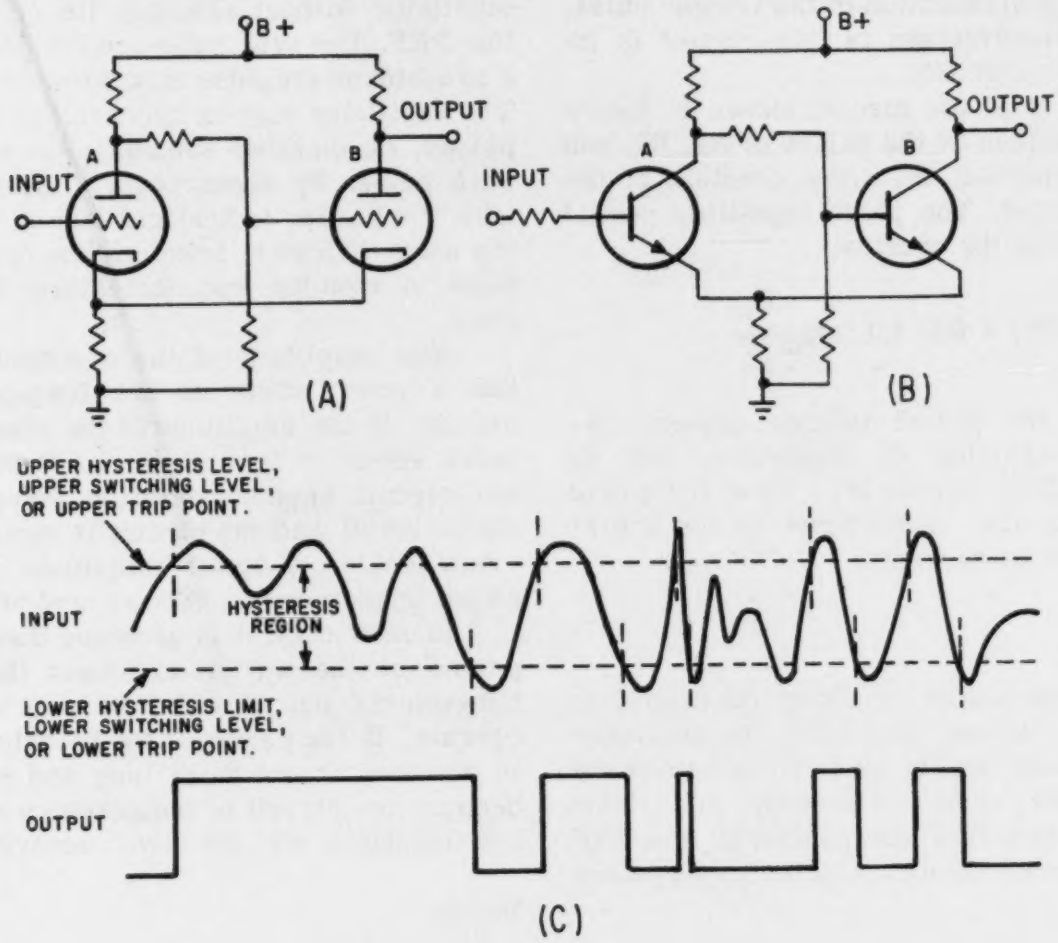

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Figure 10-3.–Schmitt trigger circuits.

BLOCKING OSCILLATORS

The blocking oscillator is another type of relaxation oscillator. It can be free running, synchronized at each cycle or at a submultiple frequency, or it can be driven in the manner of a one-shot multivibrator.

A blocking oscillator is any oscillator which uses the accumulation of a negative charge on the grid capacitor to cut itself off after one or more cycles. Thus, in an oscillator in which the grid swings positive with respect to the cathode, electrons are attracted to the grid and (during charge of the capacitor) accumulate on the plate of the grid capacitor nearest the grid. Since these electrons cannot return to the cathode through the tube during charge of the capacitor, they must return through the grid-to-cathode resistance. If this resistance is sufficiently large, electrons may accumulate on the capacitor faster then they can return to the cathode. A negative charge is thus built up at the grid and may bias the tube beyond cutoff. Once the tube is cut off, no additional electrons are supplied to the grid capacitor. The capacitor then discharges through the resistor, and a point is eventually reached where the tube again conducts. The process is repeated and the tube becomes an intermittent oscillator. The period (rate of the recurrence of operating conditions) is determined by the RC time constant of the grid circuit.

Free-Running

The free-running blocking oscillator is frequently used in radar systems to generate a repetition rate where stability requirements are low. The output can be used as a trigger without additional shaping, but in practice addi-

tional shaping is usually incorporated in conjunction with the amplification of the trigger pulse. The major disadvantage of this circuit is its poor frequency stability.

The period of the circuit shown in figure 10-4 is determined by the values of R1, R2, and C1 which comprise the time constant of the discharge circuit. The pulse repetition period is determined by the equation

$$T = (R1 + R2)\ C1\ \log_n \frac{E_i}{E_f}$$

where E_i is the initial voltage across R1+ R2 at the beginning of discharge, and E_f is the final voltage across R1 + R2 at the end of discharge. C1 also contributes to the determination of the pulse width.

Synchronized

The synchronized blocking oscillator is used as the timing oscillator in auxiliary equipment whose timing must be synchronized to that of the radar. Normally, the radar produces its own PRF independently (the PRF oscillator is free-running.) Synchronizing pulses can be introduced at the plate of a blocking oscillator without changing its circuit to vary the PRF. The sync pulse amplitude is such that a predetermined pulse makes the circuit operate. The oscillator may be synchronized on alternate pulses, or on other submultiples, as well as on each pulse. By synchronizing the auxiliary set with the radar, indications can be displayed on the main indicator, relieving the operator of the need to monitor two indicators at the same time.

The amplitude of the synchronizing pulse has a great effect on the frequency of this circuit. If the amplitude of the synchronization pulse shown is increased, the first pulse after the circuit begins operation brings the grid above cutoff and the circuit is synchronized on every pulse. A lower amplitude pulse could cause triggering on every second or third pulse.

In each case, it is assumed that the natural period of the circuit is longer than the time between the pulses which cause the circuit to operate. If the period of the blocking oscillator is shorter, it produces long and short cycles because the circuit is triggered on some pulses but conducts on its own accord at times.

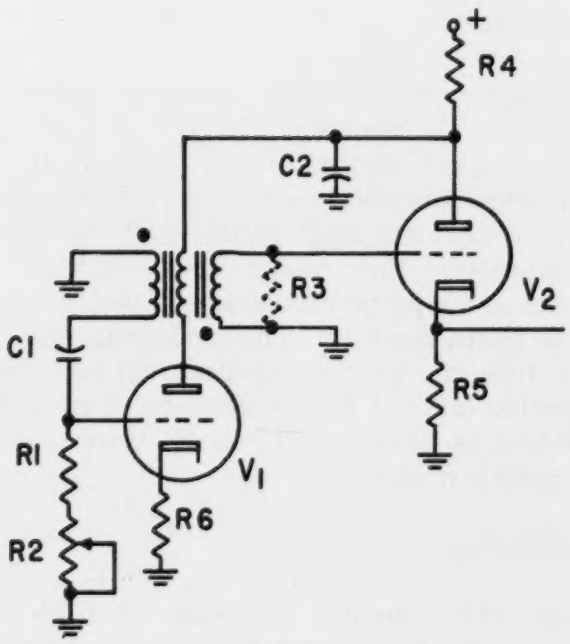

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Figure 10-4.–Free-running blocking oscillator.

Driven

Some electronic circuits require a blocking oscillator which operates only when triggered. Such a circuit might be called a BLOCKED OSCILLATOR (since a permanent d-c blocking voltage prevents the circuit from oscillating of its own accord). In this type circuit only a positive voltage on the grid or a negative voltage on the cathode can cause the tube to conduct. If the voltage is a pulse, the circuit goes through a cycle of operation, cuts itself off, and the d-c voltage maintains it below cutoff. Cutoff is maintained by a voltage divider from the plate-supply voltage.

The trigger pulse must be large enough in amplitude to start a cycle of operation. The normal discharge of the grid capacitor reduces the grid voltage after a cycle of operation, but the discharge does not raise the grid bias to the cutoff level, so the circuit does not again conduct without another trigger pulse. The positive trigger pulse is applied to the grid. The output may be taken from the plate, where a large negative pulse is available, or from a

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UNIT II - USE OF DRAWING INSTRUMENTS

Scales Lesson 3

OBJECTIVE: To learn how to interpret and use a scale.

RELATED INFORMATION:

In the making of working drawings, the draftsman must be precise and prepared to draw an object either full size, or, if necessary, smaller or larger. Therefore he should possess full command of the proper usage and reading of scales. There are many scales to choose from with different graduations and styles, but for our purposes we shall study the two most common types, the mechanical engineer's flat scale and the architect's triangular scale.

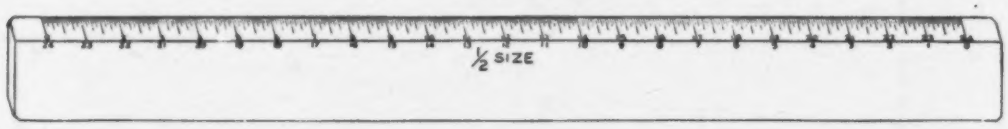

FIG. 1

The mechanical engineer's scale shown in Fig. 1 is divided and numbered so that fractions of inches represent inches. Each "inch" is divided into halves, quarters, eighths, sixteenths and thirty-seconds. A full and a half-size scale are also included. These scales are also often graduated with the marked divisions numbered right to left, as well as from left to right. Mechanical engineer's scales are used mostly for drawings of machine parts and small structures.

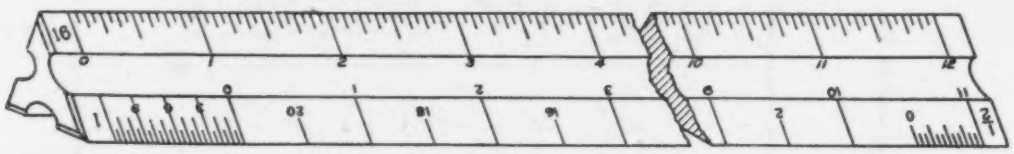

FIG. 2

The architect's scale is shown in Fig. 2. It is divided into proportional feet and inches with divisions indicating $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, $1\frac{1}{2}$, and 3 inches to the foot.

third transformer winding where a pulse similar to the plate pulse can be obtained with either polarity.

SWEEP GENERATORS

Sweep generators are used to develop a waveform of voltage which changes level gradually over a period of time. Common uses of this type waveform include CRT sweep and deflection systems, local oscillator AFC tuning systems, certain classes of variable time delay systems, and FM modulating systems. The voltage variation is basically a sawtooth type waveform, but it may be modified to a trapezoidal waveshape for certain applications. It may be generated continuously, or it may be intermittently triggered or gated.

Theory of operation of the basic sawtooth generator is discussed in Basic Electronics. One major disadvantage of that circuit is its inability to generate a linear sweep of voltage. The output voltage wafeform is normally taken across a sweep capacitor; a capacitor always charges exponentially. If only the first 10 percent of the capacitor's charging curve is used, the waveform is considered to have adequate linearity. Under these conditions, the magnitude of the output waveform is small.

Bootstrap Sweep Generator

The bootstrap sweep generator develops a linear sawtooth of voltage which has relatively large amplitude. The circuit shown in figure 10-5 produces a positive-going voltage rise during the application of a negative-going rectangular pulse.

In this circuit, V1 acts as a switch to control the charge and discharge of timing capacitor C3. The cathode follower, V2, and the bootstrap diode, V3, provide a means for making the charging curve linear instead of exponential.

In the absence of a negative gate, all three tubes are conducting. Most of the B-plus voltage appears across R3 and R4, and capacitor C2 is charged nearly to the B-plus voltage. Timing capacitor C3 is charged only to the low plate potential of V1.

A negative gate input to the grid cuts off V1. The timing capacitor, C3, starts charging

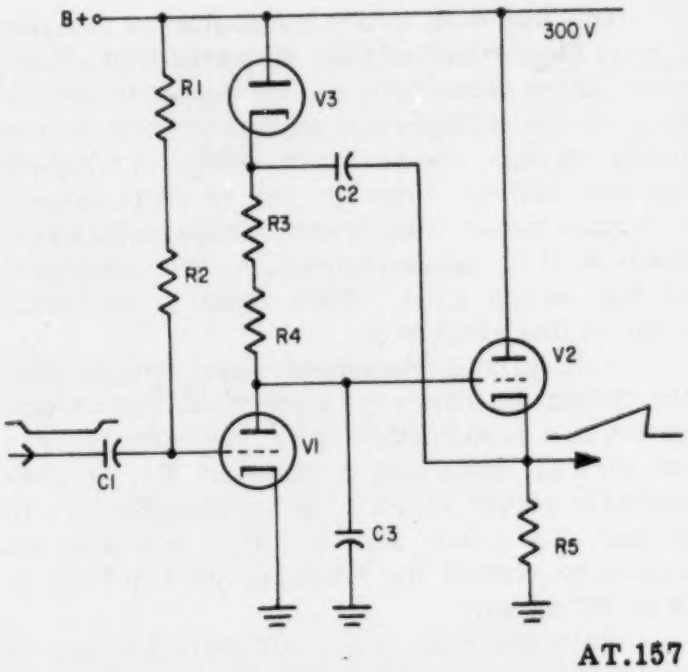

Figure 10-5.–Bootstrap sweep generator.

through R3 and R4. The rising voltage on C3 is applied to the grid of cathode follower V2. The voltage on C3 and the grid of V2 begins to rise toward the voltage of C2. The cathode current of V2 increases, increasing the voltage drop across R5. This increase of voltage is added to the voltage of C2; the cathode of V3 becomes more positive. Thus the voltage drop remains relatively constant as C3 charges.

With a constant voltage across resistors R3 and R4, the current is constant, and the voltage on C3 rises linearly. The output is taken from the cathode of V2. The bootstrap diode V3 ceases to conduct when the potential of its cathode rises above that of its plate, and effectively disconnects the charging circuit from the B-plus supply. Thus, the voltage of the linear waveform is not limited to the B-plus voltage but continues to rise linearly until the negative gating pulse is removed from the grid of V1. When V1 again begins conducting, C3 discharges to its static low voltage level, and the extra voltage across R5 disappears. Since the cathode of V3 is then slightly less positive than its plate, the tube conducts. The generator remains in this static state until another gating pulse arrives at V1.

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Trapezoidal Waveshape Generator

The sawtooth sweep generator is suitable for an electrostatistically deflected CRT. However, most radar sets employ magnetic deflection; sweep voltages are applied to coils. In long range sweeps, the sawtooth voltage is adequate for the desired linearity, but on short ranges, a special sweep voltage with a trapezoidal waveform must be applied to overcome the inductance of the sweep coils. (This topic is discussed later in this chapter.)

A simplified trapezoidal waveshape generator circuit is shown in figure 10-6. The circuit shown is a modification of the sawtooth generator circuit. Note that a resistor, R2, is connected in series with the timing capacitor, C, to ground. The triode serves only as a high speed switch to control the charging and discharging of an RC circuit.

When the tube is cut off (switch opens) by the negative input pulse, the plate voltage rises toward the applied B-plus voltage. The voltage rise is at the rate at which the timing capacitor, C, charges. In an RC circuit, at the first instant of a switching action, the entire voltage present in the circuit is impressed across the resistance; the capacitor charge cannot change instantaneously. However, some of the resistance of the RC circuit (that voltage impressed across R2) is between the plate and ground. This causes a voltage division, and the output voltage (as indicated in fig. 10-6) jumps immediately toward the applied voltage.

The applicable waveforms are shown in figure 10-6 (B). The total of the capacitor voltage plus the sum of the individual resistor voltages always equals the full voltage effectively present in the circuit. The resistive voltage is divided proportionately according to the individual resistances. The curve for R2 voltage is thus a miniature replica of the total resistive voltage.

The output voltage waveform of this circuit is the sum of the R2 voltage and the capacitor voltage. This is the waveform shown in the last graph of figure 10-6 (B), and represents the trapezoidal waveform of voltage required by the electromagnetic deflection sweep coil circuits.

Miller Sweep Generator

In the Miller linear sweep generator (fig. 10-7) the suppressor grid is normally biased negative to prevent plate current flow, while the

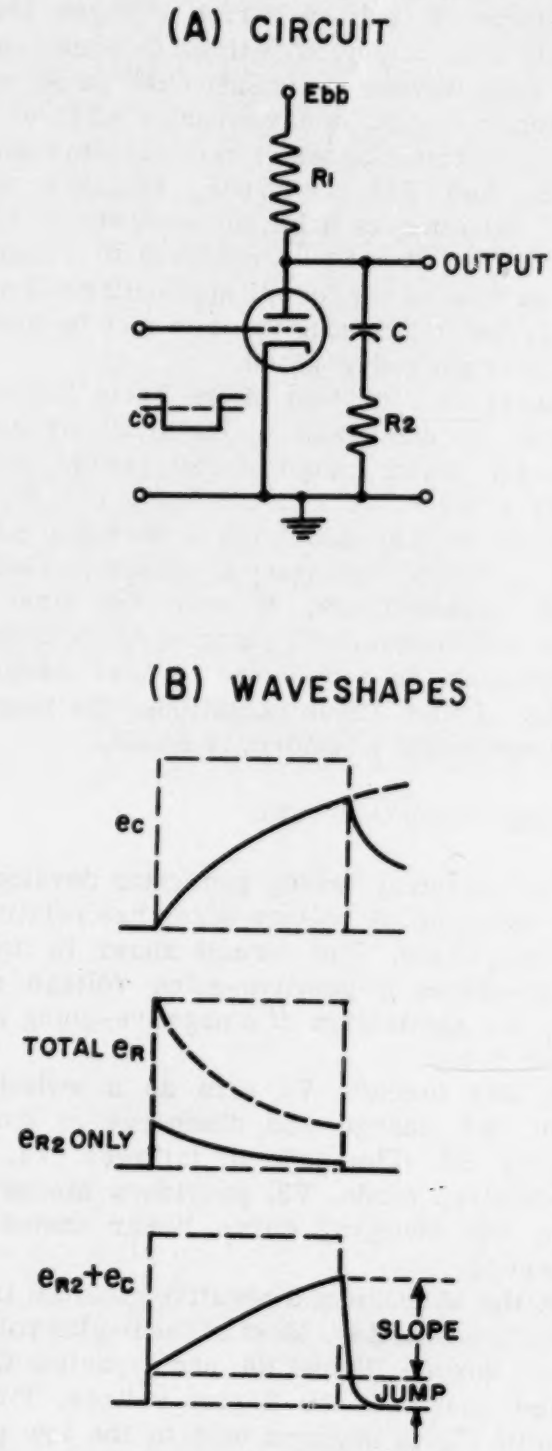

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Figure 10-6.—Trapezoidal sweep generator.

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screen conducts heavily. The control grid is returned to B-plus through a resistor so that it is effectively at zero potential, and the cathode is grounded. Observe that the screen is not coupled, that a separate bias source is used for the suppressor, and that an external sweep gate is necessary.

When a positive gate is applied to the suppressor, plate current flows and produces a voltage drop across the plate load resistor. This negative swinging plate voltage is fed back through a small capacitor to the grid, and quickly drives the grid negative. It maintains the plate current at a small value and greatly reduces the screen current.

Reduction of the heavy screen current produces a large positive swing on the screen. The tube remains in this condition, producing a positive screen gate. Meanwhile the plate current (under control of the feedback voltage applied to the grid) flows until no further feedback is produced. During this time the plate current increase is linear, and the plate voltage continues to drop.

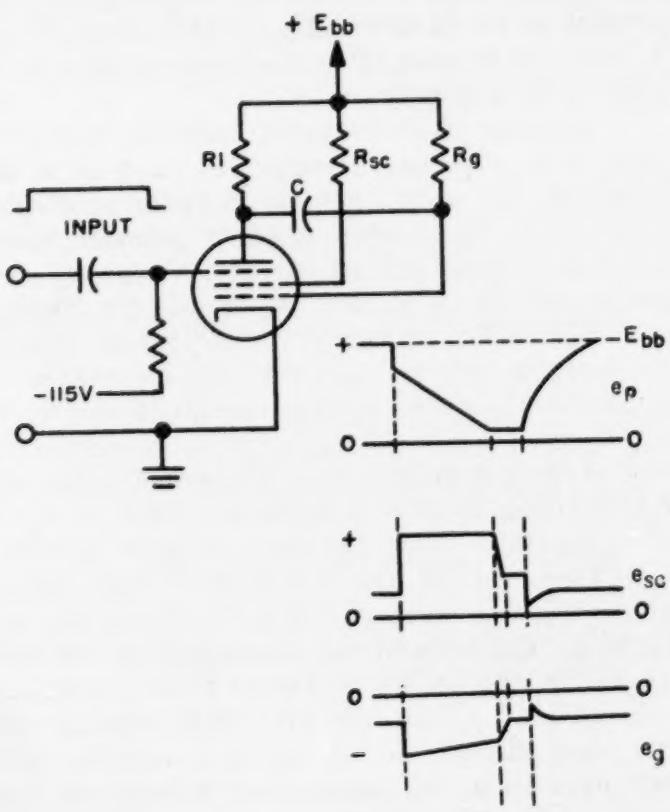

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Figure 10-7.–Miller linear sweep generator.

The normal discharge of C through Rg would cause the current through the tube to increase in an exponential manner, causing the plate voltage to drop exponentially. However, any exponential change is fed back to the grid 180° out of phase with the normal discharge of C, causing a linear increase in plate current.

At a point about 2 volts above ground, no further plate swing is possible. The screen again conducts heavily, returning almost to the initial operating point. When the suppressor gate ends, the plate current is cut off, the screen returns to its initial operating point, and the cycle is ready to be resumed under control of the next gate.

Changing the applied plate voltage determines the point, and the time, at which the plate voltage reaches a minimum (with respect to the leading edge of the input waveform) and the screen resumes control. Changing the values of feedback capacitor C and grid resistor R will also determine the time of operation (by controlling the speed of the grid-plate feedback action).

TIMING AND PULSE GENERATORS

Many avionic systems require accurately timed sequences of operation. Radar systems demand various degrees of accuracy in PRF and pulse width. TACAN and IFF systems depend on pulse-pairs which have specific time intervals between the individual pulses of a pair. Computers and data systems rely on synchronization between clock and data pulses. CRT's are normally blanked during retrace, and the sweep may be delayed for various time increments from the initiation of the overall operating cycle.

Synchronization and time-sequenced operation are usually accomplished through the use of pulses. The time duration of these pulses may be relatively short (trigger) or relatively long (gate). In synchronous operation, the functions may occur simultaneously or one operation may be delayed for some time period from the occurrence of another.

Many of the circuits used in timing and pulse generations are also used for other functions. The present discussion is devoted to brief indications of the functions performed by these

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circuits, followed by a discussion of the phantastron delay circuit.

Pulse Generation

The use of a sinusoidal waveform in synchronizing a multivibrator is discussed in Basic Electronics, NavPers 10087-B. The sine wave may also be used as the basic source of timing pulses. One such system requires the use of limiters (or overdriven amplifiers), differentiators, sweep voltage counting circuits, and triggered pulse generators.

In the system outlined above, the clippers are used to convert the sine wave to a square wave. The differentiator circuit converts this square wave into voltage spikes. The spikes are then superimposed onto a sweeping voltage waveform to govern the selection of the specific spike to be used in the generation of the delayed pulse.

Relatively short time pulses used for triggers are frequently generated by blocking oscillators. They may, however, be produced by differentiating the output of a multivibrator.

The longer time pulses required for gating are normally produced by multivibrators.

Time Delay

Time delay circuits are utilized when two or more functions must be performed with a specific time relation, but not simultaneously. Such a time relationship may be either fixed or variable. Variable delays may be in multiples of a designated interval, or they may be smoothly variable with no relationship to any specific interval.

Incremental delay circuits normally incorporate a basic generating circuit and a counting circuit. In the synchronized blocking oscillator discussed earlier, operation may be synchronized by an associated sine wave. By proper operation of the blocking oscillator circuit, synchronization may occur on the first, second, third, etc., cycle (of the synchronizing waveform) following the last triggering action. In this system, the blocking oscillator acts as its own counter.

Another type of incremental delay circuit uses a separate counter circuit. In radar range mark systems, an accurate and stable basic generator is used to develop signals corresponding to 1 radar range mile. A counter circuit is then used to produce an output corresponding to 2, 5, 10, etc., miles.

Another circuit which is used to provide a time delay function in electronic equipments is the monostable multivibrator discussed previously. This circuit may be activated simultaneously with the first of the time sequenced operations. Its output is then used to activate another circuit at the instant the multivibrator regains its stable state. The operation of the second circuit is thus delayed with respect to the first. The system time delay is equal to the time duration of the unstable state of the multivibrator.

Phantastron Circuit

The phantastron circuit is a relaxation oscillator similar in operation to the multivibrator. The multivibrator derives its timing waveform from an RC circuit; the phantastron uses a basic Miller type sweep generator. The output waveform of the phantastron is a linear function of the input (control) voltage.

The phantastron is usually triggered on by the leading edge of a gating or trigger pulse, and is shut off by an internally generated waveform. It can also be shut off by the trailing edge of the gate or by a trigger.

Because of its extreme linearity and accuracy, the phantastron output is used as a delayed timing pulse, usually in radar or display equipment. It is also used to produce time-delayed trigger pulses for synchronizing purposes and movable marker signals for display.

SCREEN-COUPLED CIRCUIT.—A typical monostable screen-coupled pentode circuit is shown in figure 10-8. This circuit is started by a positive trigger applied to the suppressor grid, and at the end of operation it returns to the initial starting condition, ready to repeat its cycle of operation when the next trigger arrives.

Three steps are involved in the circuit action—turnon, linear sweep development, and turnoff. The waveforms developed in the tube elements are shown in figure 10-8 (B). Before initiation of action, the circuit is resting with the plate current cut off, due to a negative voltage applied to the suppressor through R3. Resistors R1, R2, and R3 form a combined suppressor and screen grid voltage divider con-

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nected between B-plus and C-minus. The values are such that the screen is positive and the suppressor is sufficiently negative to cut off plate current. Since they are directly connected, both elements are d-c coupled; also, through capacitor C1 they are a-c coupled. Therefore, both d-c and a-c voltages appearing on one element also affect the other element.

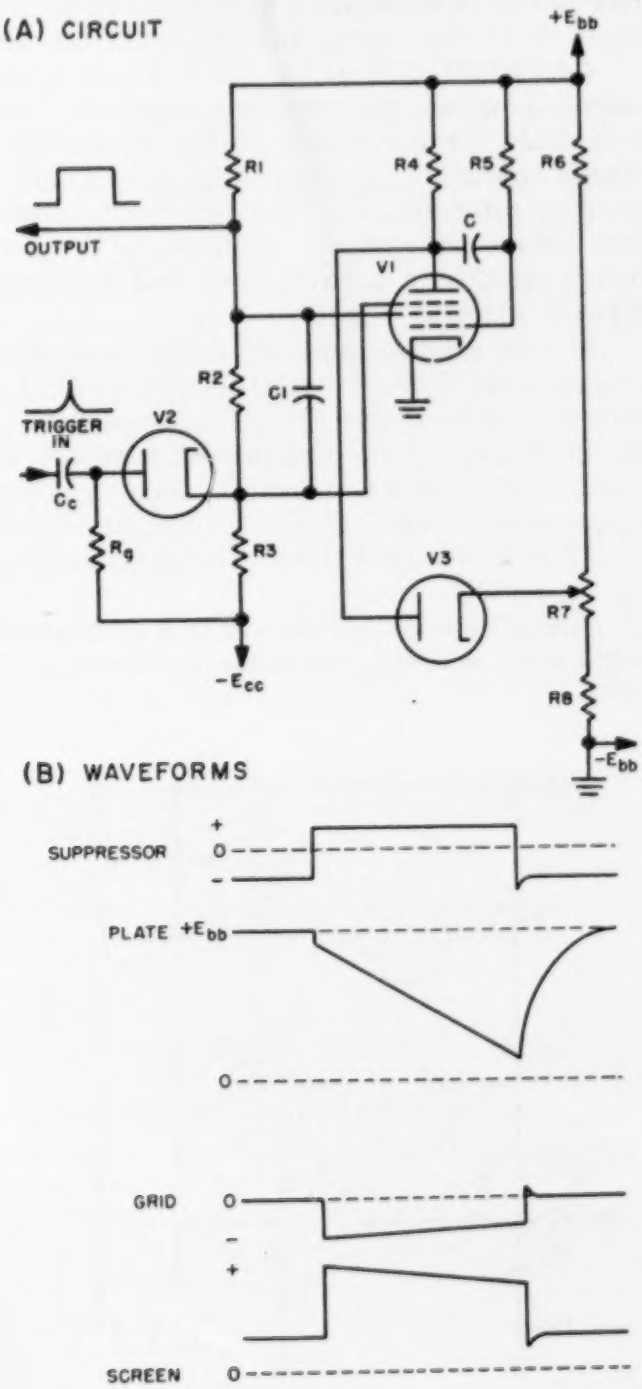

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Figure 10-8.–Basic screen-coupled phantastron.

Since the cathode is grounded and the grid is connected through R5 to B-plus, the grid remains near zero bias. Thus, although the plate current is cut off, the screen current is heavy. When a positive trigger is applied to the plate of disconnecting diode V2 through coupling capacitor Cc, the diode conducts. The positive trigger thus appears across R3 and is applied to the suppressor of V1. The trigger is large enough to overcome the fixed negative bias and drive the suppressor positive. Therefore, plate current flows through R4. (Since R4 is a relatively large value resistor, the plate current quickly goes from zero to a low value; simultaneously, the negative swing produced across R4 is applied through C to the grid, driving it from zero to a negative value. This value is only a few volts, but is sufficiently negative to reduce the total cathode current.)

The grid is now in full control, and the reduction of screen current produces a large positive increase in screen voltage. The positive-going screen voltage is fed back through C1 to the suppressor, so that the action is regenerative. As a result, the tube is quickly triggered from the static condition to the operating condition, which produces a screen waveform with a sharp leading edge. The linear sweep development or timing cycle now begins, with the plate current of V1 increasing steadily.

Since the grid is returned to B-plus, the grid voltage attempts to reach the zero bias level. It can change only slowly, however, because the plate side of feedback capacitor C is steadily decreasing. Any positive grid swing is immediately counteracted by a negative plate swing fed back to the grid. Therefore, capacitor C starts to discharge and electrons flow from the plate of V1, discharging C through R5. (Thus C discharges at a rate determined by the time constant of C and R5.) In some circuits, R5 is made variable to permit changing the rate of operation.

In discharging, the grid side of capacitor C gradually becomes more positive, causing an increased current flow through R4 and producing a constant decrease in plate voltage. The positive increment on the grid is always slightly greater than the negative plate swing it produces; therefore, the grid potential gradually rises, and the plate potential gradually drops. When the plate reaches the point where a voltage change on

the grid will produce no further plate-voltage change, the turnoff point is reached.

Up to this time a positive gate has been produced in the screen circuit and coupled to the suppressor. A negative gate has been developed on the grid which is slightly smaller in amplitude from the leading edge to the trailing edge. The amount is dependent upon the gain of the tube.

The tube plate voltage is now only a volt or so above zero and the plate current can no longer increase. The grid voltage, however, is still rising toward zero, causing an increase in total current flow. Therefore, the screen current increases. The moment the screen current increases, the screen voltage drops and feeds back a negative swing through C1 to the suppressor. The suppressor grid then resumes its original negative condition, stops any flow of plate current, and assumes control again.

Since this action is regenerative, a sharp trailing edge is produced. Simultaneous with plate current cutoff, the plate voltage swings positive and feeds back to the grid a positive voltage, which helps the grid to return to normal zero bias condition. Since the charge on C cannot change instantly, the plate swing tapers off exponentially and the tube is not ready for another trigger cycle until it has completely recovered.

Diode V3, called a "plate-catching" diode (because of the way it "catches," or arrests, the positive excursion of the plate voltage), operates to catch the plate at a specific voltage. Thus, with a fixed bottoming point, the length of the output pulse (and its time duration) depend on the plate voltage fixed by V3. The cathode of V3 is biased positive by the voltage divider consisting of R6, R7, and R8, as controlled by potentiometer R7. When the plate voltage of V1 is greater than the positive voltage applied to the cathode of V3, the diode conducts and quickly bring the plate voltage of V1 down to the level of the cathode voltage.

The linear sweep action always starts at the voltage set by R7, and the duration of the phantastron gate (or the length of the sweep) is thereby determined. Because the amplitude of the plate sweep depends on the level at which it starts, R7 directly controls the amplitude. The amplitude of the screen gate is determined by the voltage applied and the screen current, and is only slightly affected by R7.

Operation occurs at a rate fixed by the discharge of C through R5. In some circuits R5 is made variable to set the maximum time delay, and R7 is provided as an external control to permit selection of the exact time duration required. Feedback capacitor C provides regenerative feedback from plate to grid, to allow quick response to any changes in the plate circuit.

CATHODE-COUPLED CIRCUIT.–A typical cathode-coupled pentode is shown in figure 10-9. This circuit is also started by a positive trigger applied to the suppressor grid and turns itself off automatically. The output can be taken from either the screen or cathode, or both. The screen output is a positive gate, and the cathode output is a negative gate.

In this circuit, tube V1 is the basic phantastron, with diode V3 operating to control the plate voltage level and determine the duration of the output gate. To minimize overshoot (positive on the control grid and cathode, negative on the screen grid), diode V2 is connected between R1 and R2 on a voltage divider network consisting of R1, R2, and R3.

The voltage on the cathode of V2 is normally 1 or 2 volts less than the cathode voltage of V1.

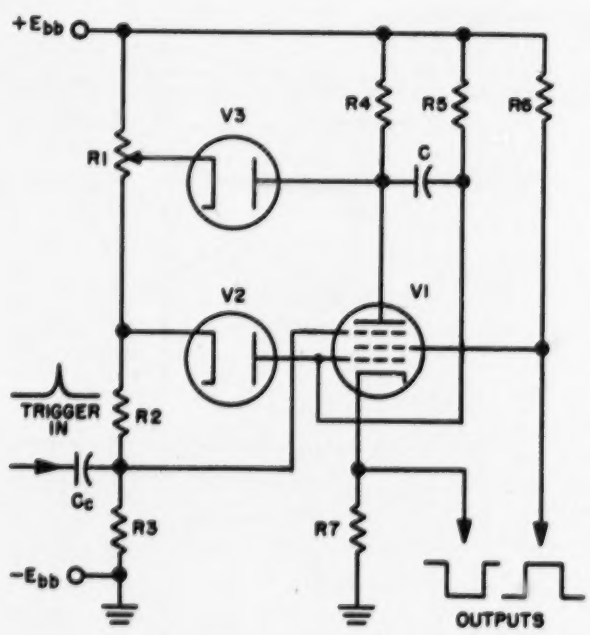

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Figure 10-9.–Basic cathode-coupled phantastron.

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No negative supply is needed to bias the suppressor; cathode bias is used, and the suppressor is held at a lower positive potential than the cathode. Thus, the suppressor is effectively biased negative with respect to the cathode, cutting off plate current. The screen is drawing current, which produces a positive voltage on the cathode. When a positive input trigger appears across R3, it is applied to the suppressor. This trigger is prevented from affecting the control grid by automatically reverse-biasing diode V2.

The grid is normally biased near zero, being held by diode V2 at a potential determined by the voltage divider (R1, R2, and R3) connected between B-plus and ground, and the cathode is positive with respect to the grid by approximately 1 or 2 volts.

When the trigger is applied, it overcomes the bias between the suppressor and cathode, and plate current flows. The decrease in plate voltage, due to the flow of plate current, is fed back to the grid through capacitor C. This causes the tube current to decrease and the cathode voltage to drop. The drop in cathode voltage further decreases the bias between the suppressor and cathode, and plate current increases further. Since the total tube current is decreasing and the plate current is increasing, the screen current must decrease. This action is regenerative, and plate current will jump from zero to a value determined by the tube characteristics.

Note that the bias between the cathode and suppressor is decreasing, causing the plate current to increase. The bias between the cathode and grid is increasing. This degenerative action decreases the total tube current. Therefore, there must be a point where these two effects are equal and the current will stabilize for an instant. At this instant there is no further change in plate voltage, and the grid voltage increases in the positive direction (at a rate determined by C and R5) since it is returned to E_{bb} through resistor R5. This causes the plate current to increase.

As the plate current increases, the plate voltage decreases, and this negative change is coupled through C to the grid. This signal is degenerative, and prevents the plate current from increasing rapidly. This action continues, providing a linear sweep until the plate voltage drops to a level at which it can no longer cause an increase in plate current. At this time, degenerative feedback to the grid stops, and the grid goes in a positive direction more quickly. This causes an increase in the total tube current, and thus an increase in cathode voltage, an increase in cathode-to-suppressor bias, and a decrease in plate current.

With the total tube current increasing and the plate current decreasing, the screen current must be increasing. The action taking place is regenerative, as the plate goes positive, the grid goes positive; the plate current goes rapidly to cutoff, leaving the tube in its pretriggered condition. The positive swing in the grid is limited by the catching diode, V2. Before the circuit is ready for the next cycle of operation, capacitor C must recharge through R3, R2, V2, and R4.

RESHAPING CIRCUITS

Many different waveshapes are required in the operation of modern electronics equipment. These various waveforms are frequently generated in one form and must then be reshaped into another form for use in specific circuits. Various pulse type waveforms are sometimes deteriorated or distorted by circuit components; they must then be reshaped for use.

The basic operation of many reshaping circuits is discussed in Basic Electronics; the present discussion comprises a brief summary of the main functional applications.

LIMITERS AND CLIPPERS

The basic function of a limiter (also called a clipper) circuit is to control the extreme excursions of a waveform. The circuit accomplishes this function by removing (clipping) any portion of a waveform in excess of specified limits. Thus it limits the maximum excursion of its output waveform by clipping the extremities of the signal.

The circuit, with appropriate changes, may be used to limit the positive or the negative portion, or both. It may also incorporate amplification of the waveform, although this feature is not essential to its operation as a clipper.

Functional applications of clipping circuits include the following general classes:

1. Changing the basic shape of the waveform by eliminating the top (and/or bottom) by clipping.

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2. Improving the basic shape of the waveform by eliminating the overshoots and/or undershoots on leading and trailing edges.

3. Improving the usefulness of a waveform by clipping each cycle to the same amplitude.

4. Improving the usefulness of a waveform by making each cycle have the same time duration.

5. Eliminating possible interference in the overall system by eliminating pulses of the wrong polarity.

CLAMPING CIRCUITS

Clampers, although not actually reshaping circuits, are frequently associated with limiters in functional classification. One of the disadvantages of limiters used alone is that they tend to operate around an average voltage which is established by the signal voltages. Clampers are used to overcome this fault by establishing either a positive or negative reference to which the signal voltage variations are referenced before clipping.

DIFFERENTIATORS AND PEAKERS

This class of reshaping circuits makes use of the exponential charge and discharge characteristics of RC and L/R circuits. "Differentiator" usually refers to RC circuits having a relatively short time constant with respect to the period of the input waveform. "Peakers" are usually L/R differentiators.

These circuits are normally used in pulse systems; their main application is to produce a peaked waveform or spike output. Used with square or rectangular inputs, they produce output spikes of alternate direction which are coincident with the leading and trailing edges of the input. Time duration of each pulse peak depends on the charge/discharge time constant.

INTEGRATORS

The differentiating circuit may also be used as an integrating circuit by merely changing the output tap. Differentiating circuit outputs are normally taken across the resistive component; integrators use the reactive component waveform.

RESONATORS

Some electronic equipments require oscillatory signal generation only during specified intervals. One example of this requirement is the magnetron oscillator used in pulsed radar systems. In this example, a pulse of voltage is applied to the magnetron for a short period, and then is removed for a considerably longer period. The magnetron oscillates only during that period when the pulse is applied. Effectively, a rectangular waveform of voltage has been "reshaped" into sinusoidal waveform oscillations—but only intermittently.

The same general principle is used in some range mark circuits. When the transmitter magnetron is fired, a gate circuit is also generated. This gate has a time duration approximately equal to the time required for maximum range operation. A relatively high frequency oscillator is gated by this waveform so that it produces variations to be used in the generation of range marks for timing purposes.

Another type of resonator is the ringing oscillator, where a signal is injected into a tuned circuit, which then oscillates at its resonant frequency. This type circuit is common in frequency multiplier applications, and in resonant cavities which are discussed in chapter 11 of this manual.

COUNTING CIRCUITS

A level counting circuit is one which receives uniform pulses, representing units to be counted, and produces a voltage proportional to the frequency. Either positive or negative pulses may be counted, requiring only minor changes (in the connections of the diode counting element).

With certain other modifications to the circuit, the counter may also be used, in conjunction with generating circuits, to produce a trigger pulse which is a submultiple of the PRF of the applied pulses.

All pulses applied to the counting circuit must have the same amplitude and time duration if an accurate frequency division or counting is to be made. Therefore, this circuit is usually used in conjunction with pulse shaping and limiting circuits. These circuits are used to insure

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standardized input pulses, with uniform amplitude and width. Pulse frequency then represents the only variable; this permits accurate measurement of the frequency variations, or division of the pulse repetition frequency.

Operation of the basic circuits is discussed in Basic Electronics. Several examples of their functional application have been presented in earlier discussion in this chapter.

OTHER CIRCUITS

Since the duration of the output waveform of the monostable multivibrator can be made almost constant, this circuit can be used as a pulse restorer. Given an input waveform of varying width, the circuit can produce output pulses having a constant duration. Many digital computer equipments make use of this circuit to restore the shape of deteriorated clock and data pulses after circulation and prior to storing.

Video mixers are frequently used to combine several individual waveforms into a single, more complex waveform. Although not a reshaping function, it should be mentioned in this section.

DEMODULATING CIRCUITS

Demodulating circuits accept composite signal inputs and separate them into their component parts. Two basic classes of demodulating circuits are considered in this discussion. The first class extracts the intelligence component from the composite input, the other class eliminates an undesirable component of the signal. The classes are distinguished by basic intent, rather than by the overall results obtained.

For example, in an amplitude modulated radio wave, the intelligence is carried in the audio component of a composite signal. In the detector circuit, this audio component is extracted from the wave. The same composite wave also contains undesired components of noise; these components are eliminated from the composite signal by filters, and by squelch and muting circuits.

Chapter 10 of Basic Electronics contains a discussion of some basic demodulating circuits. The basic circuits discussed include several types of AM detectors and several types of FM detectors. In this discussion, AM detectors are discussed under the heading "Detectors," while FM detectors are discussed under the heading "Discriminators." Noise detectors and eliminators are discussed under the heading "Squelch and Muting Circuits."

DETECTORS

All detectors incorporate nonlinear devices and signal-selective filtering. The diode is a simple device possessing nonlinear characteristics, and is the active element most commonly used in this application. The diode may be a semiconductor or a vacuum tube.

In the common diode AM audio detector circuit, the composite signal is first rectified, then the RF component is filtered out. This leaves only the audio signal component, which is then amplified and used to reproduce the transmitted intelligence. Other types of detectors perform effectively the same functions.

In the detection of AM signals, rectification is essential. The signal variations (envelope) are effectively sinusoidal in amplitude, varying about an average (reference) value. Filtering out the RF component without previous rectification would leave only the reference value, which does not vary. By the preliminary rectification process, however, one-half of the RF variations is eliminated, leaving the other half (which varies sinusoidally at an audio rate). The average (reference) value of the remaining portion of the signal does vary, so that subsequent filtering out of the RF component leaves the audio signal variations (which contain the impressed intelligence).

DISCRIMINATORS

AM detectors, as discussed previously, respond primarily to variations in the amplitude of a composite signal. FM detectors, however, respond primarily to frequency variations, although they are somewhat sensitive to amplitude variations also. Variations in the amplitude of the applied signals tend to produce distortion in the output signal, therefore most FM detectors are preceded by one or more stages of amplification and a limiting circuit.

Theory of the basic types of discriminators is presented in Basic Electronics. Three actual discriminator types in common usage are dis-

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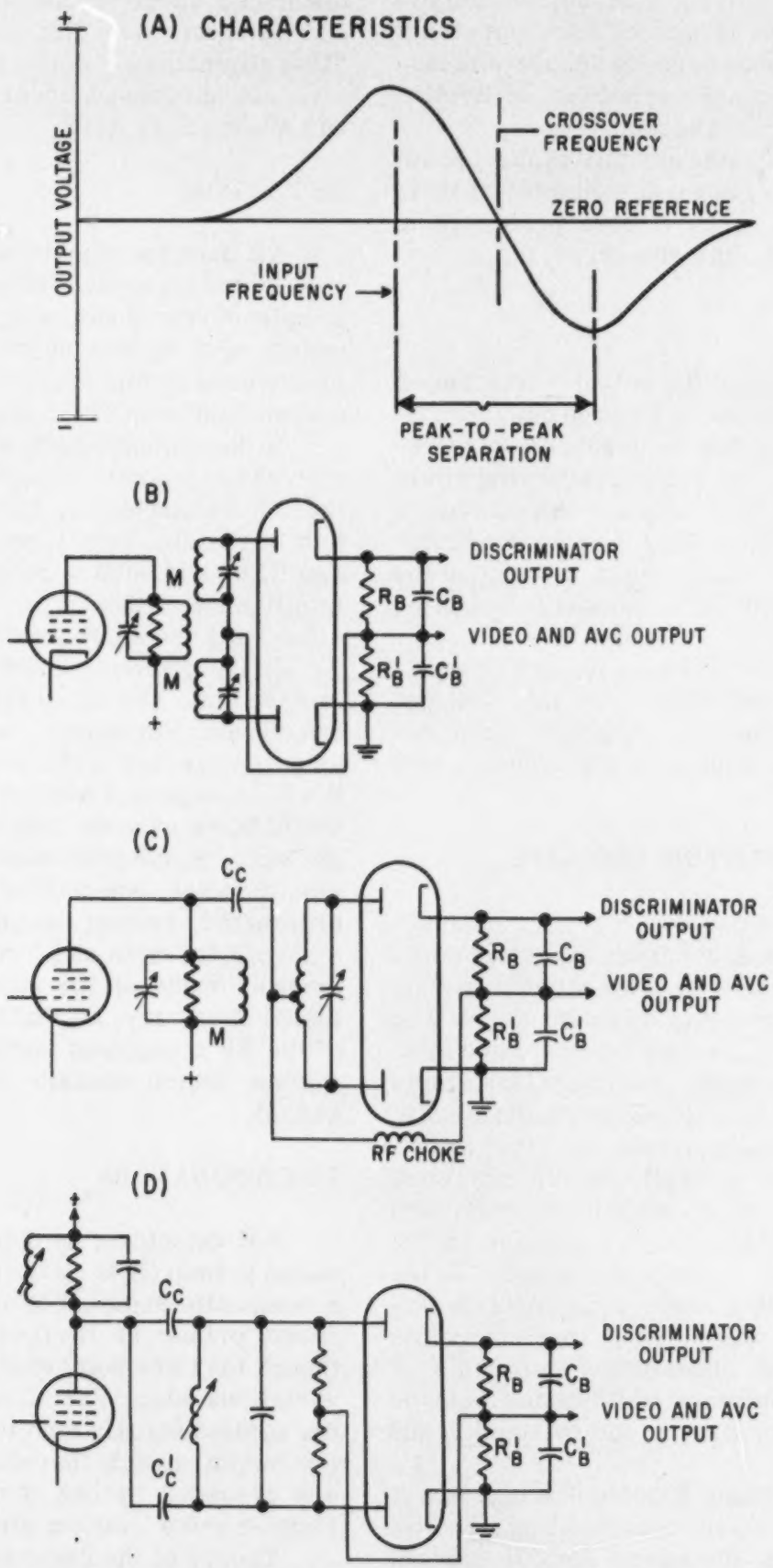

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Figure 10-10.–Discriminators.

To become an accurate draftsman, it is imperative to learn to use the scale correctly. When making measurements, be sure to lay the scale close to the line and look directly down on the point where the measurement is to be made (Fig. 3) and mark the point on the paper with a well-sharpened pencil point.

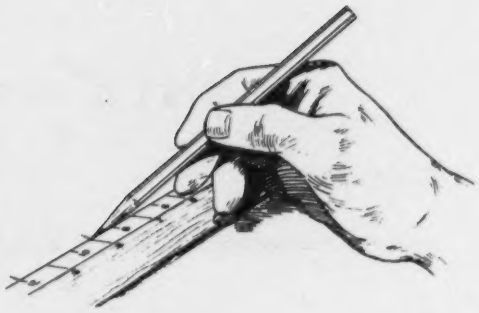

FIG. 3

ASSIGNMENT:

Give the correct measurement for each of the illustrations shown below.

1

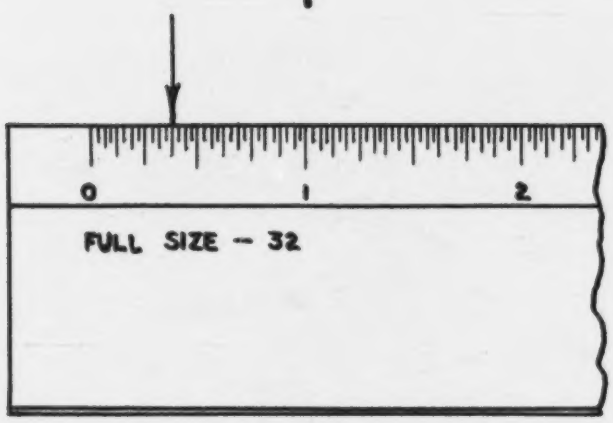

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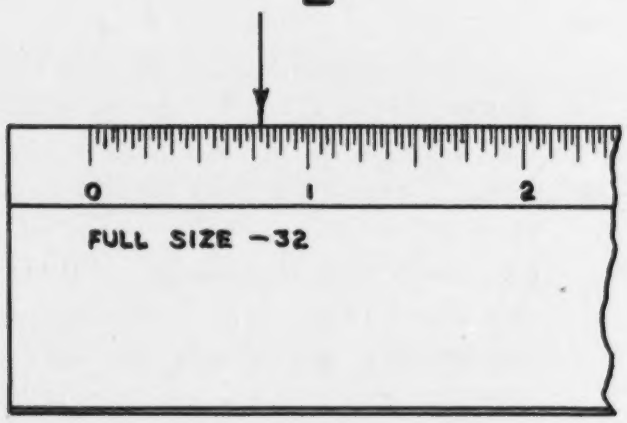

3

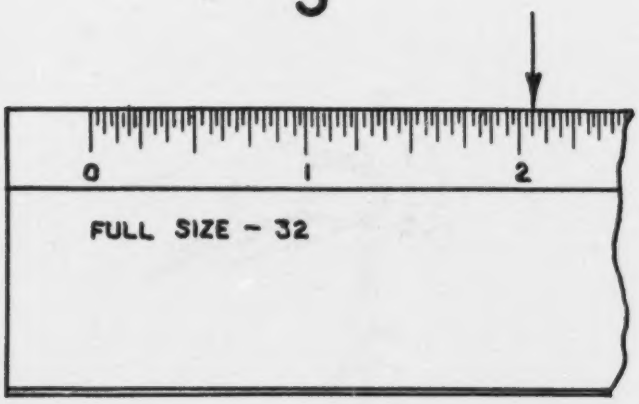

4

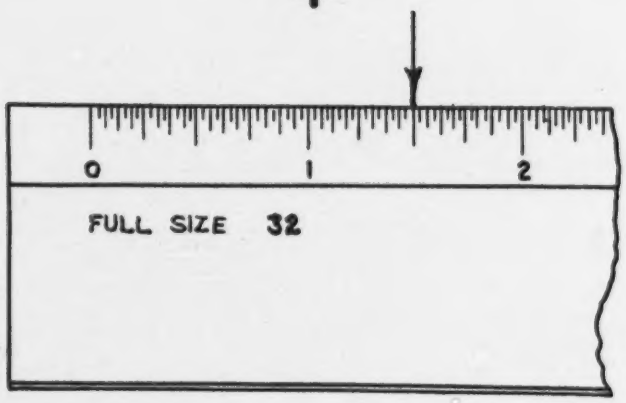

cussed briefly in the following paragraphs. Emphasis is placed on the differences and similarities between the circuits, rather than on the operation of the individual types. Figure 10-10 (A) illustrates some of the basic terminology involved in the discussion; sections (B), (C), and (D) of the same figure show simplified circuit diagrams of the discriminators discussed.

The zero reference (fig. 10-10 (A)) may be at some d-c level other than at ground potential. The "zero" level to which polarities are referred in the discussion is the d-c voltage at the output terminals with no signal at the input terminals. The crossover frequency is the frequency lying between the two output peaks for which the output voltage is zero.

If the IF input signal consists of continuous waves, the output voltage will be d-c. If the IF input signal is in the form of a series of short pulses, the output voltage will consist of a series of pulses whose amplitude and polarity vary as indicated in figure 10-10 (A).

The TRAVIS type discriminator circuit depends upon the action of two resonant circuits. One is tuned above the desired crossover frequency and the other is tuned below. Detectors across the two circuits are connected back-to-back. The individual resonant elements are double tuned.

When close coupling is used, each side of the discriminstor characteristic may be double humped. (This is not possible in either of the other circuits.) If the peak-to-peak separation is too great for the circuit Q's in any of the circuits, the characteristic will have a "chair" shaped waveform.

Three factors may be adjustable. Crossover frequency may be shifted by tuning the two resonant elements in the same direction. Peak-to-peak separation may be adjusted by tuning the two circuits in opposite directions. A slight adjustment of the primary circuit adjusts the symmetry of the overall circuit response.

In the FOSTER-SEELEY discriminator (fig. 10-10 (C)) the mutual inductance determines the peak-to-peak separation while the crossover frequency is the resonant frequency of the secondary.

The Weiss discriminator (fig. 10-10 (D)) was developed in an attempt to reduce the detrimental effect of stray capacitances by making them serve a useful function. This is essentially the capacitance-coupled analog of the Foster-Seeley. These two discriminators have substantially identical electrical performance (gain-bandwith product).

The Weiss requires accurate control over the small difference between values of the coupling capacitors (required for a narrow band characteristic). The Foster-Seeley suffers at large bandwidths because of the large variation in mutual inductance with small displacements of the coils.

SQUELCH AND MUTING CIRCUITS

As stated previously, detector and discriminator circuits are used to extract usable components from a composite signal. Squelch and muting circuits, on the other hand, are used to extract and eliminate undesirable components from the signal. Detectors and discriminators usually accept RF or IF inputs and supply audiofrequency outputs. Squelch and muting circuits usually have noise or distorted audiofrequency inputs from which the noise and distortion are to be eliminated.

The distinction between squelch and muting circuits is quite vague. In actual practice, the same basic circuit is referred to as both squelch and muting.

Squelch circuits are usually found in ICS of in sensitive communications receivers which incorporate automatic gain control circuits. The squelch circuit is used to perform one or both of the following functions:

1. To reduce the objectionable increase in the noise output level as the receiver is tuned from one station to another.

2. To silence the receiver audio output or the ICS until a signal of usable magnitude is received.

Figure 10-11 illustrates a simplified version of a common squelch circuit.

With this type of circuit it is desirable for the receiver to come into operation with the weakest possible signal voltage. To achieve high sensitivity without excessive background noise from various sources, it is desirable to have a variable "threshold" control. This control, which is located in the cathode circuit (R8 and C3) varies the amount of bias on the squelch tube and therefore controls the sensitivity of the circuit. The squelch tube is used as a d-c amplifier to

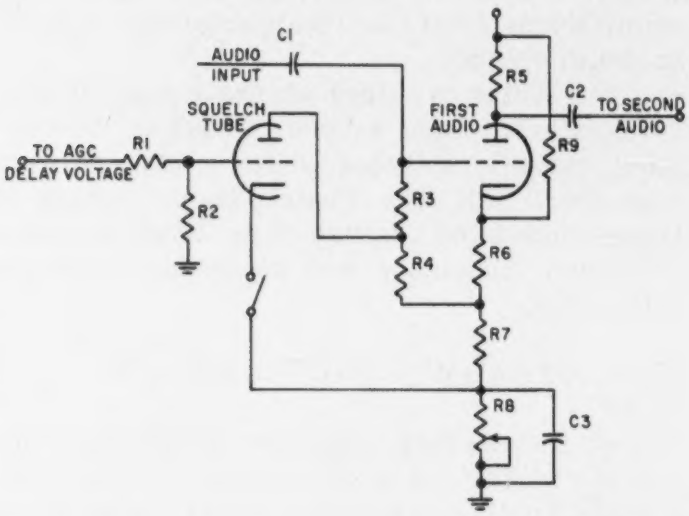

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Figure 10-11.–Typical squelch circuit, simplified.

control the amount of bias on the first audio stage.

With no input signal to the receiver, the AGC delay voltage (which is positive) appears on the grid of the squelch tube, causing the tube to draw maximum current. The current flowing through the high value plate resistor produces a voltage drop at the grid of the first audio, cutting off the stage.

For signal conditions, the grid of the squelch tube becomes negative, due to AGC action, so that this stage is cutoff and the first audio amplifier operates at normal gain.

The cathode circuit of the squelch is completed through a switch, which is normally closed. By opening the switch the squelch is made inoperative. The bias on the cathode is varied from maximum to minimum sensitivity by the threshold control R8.

COUPLING CIRCUITS

The term "coupling circuits," properly used, includes any circuit or component grouping which is used to convey the output of one functional circuit or stage to the input of another. Thus, the methods used for connecting the individual stages of amplification (discussed in Basic Electronics) are included in the general term. Also included are the various feedback methods used to produce regenerative or degenerative action in various types of circuits.

In this chapter, the discussion of coupling circuits includes tuned circuits (filters and wavetraps), transmission lines of various types and applications, delay lines (natural and artificial), and impedance matching and attenuation devices.

FILTERS AND WAVETRAPS

Chapters 3 and 4 of Basic Electronics contain a discussion of the basic theory of LCR filter circuits. The following discussion points out some important characteristics of filters and describes some other types of filters.

In electronic applications, the term "filter" refers to a frequency-selective device which operates on the basis of reactance. The usual measure of the effectiveness of a reactor device is the "quality factor (Q)." The value of Q is the ratio of the reactance to the series resistance of a coil or capacitor. The higher the value of Q, the better the filter that can be designed.

As discussed in chapter 9 of this manual, values of Q in lumped components at radio frequencies are quite limited. At progressively higher frequencies, increased use is made of the distributed properties of L and C. This permits the attainment of higher values of Q than are attainable in lumped components.

In electronic design, gain is usually cheap, but selectivity is expensive. Since filters must be frequency-selective, they are usually designed to provide the special characteristics required for their specific applications.

Characteristics of Filters

The frequency response of a circuit is a plot of the output signal strength or magnitude over a range of frequency variations, using an input of constant amplitude. Frequency response is the basis for classification of filters as low pass, high pass, band pass, and band reject. Wavetraps are usually used as band reject filters placed in the input stages of a receiver to eliminate a signal with a frequency which would cause excessive interference with reception.

Filters provide differences in output magnitudes by introducing varying amounts of attenuation at different frequencies. In addition, being reactive devices, filters introduce varying amounts of phase shift to the signal.

This phase shifting characteristic is especially important in equipments using pulse signal systems. Rapid changes in signal voltage must not generate large overshoots or undershoots. (Such conditions could damp desired oscillation, or they could cause undesirable oscillation.)

The "group delay" characteristic refers to the relative phase shift (delay) of the various frequency components of a waveform as the signal travels through the filter. A flat group delay response is usually desired because such a curve indicated that all passed frequencies are delayed by an equal amount. This reproduces the desired signal with minimum distortion. If unequal amounts of delay are desired, the filter elements must be adjusted accordingly.

Filter Types

Several types of filters other than the lumped LCR devices are used in electronic circuits and equipments. Most of these types make use of some form of resonance or near resonance as the basic operating principle.

The piezoelectric crystal resonator has a Q of several thousand. It is also relatively stable with time and environmental conditions. With such resonators, filters with high selectivity and very narrow bandwidths have been developed. The crystal, however, tends to oscillate in modes other than the fundamental frequency. The spurious modes are undesirable and unpredictable, thus limiting the usefulness of this type filter. When used, it is usually within the range of several kHz to about 20 MHz.

In single sideband applications, the mechanical filter (described in chapter 16 of this manual) is used extensively. An interesting characteristic of this type filter is its frequency response curve–sharp cutoff on one end, sloping response on the other.

Many types of filters make use of resonance in distributed properties. These include various types of transmission lines, coaxial resonators, waveguide sections, resonant cavities, etc. The July 1964 issue of the DIGEST contains an article which discusses filters in electronics.

PRESELECTOR FILTERS.–These filters are required at the input (front end) of all sensitive receivers to separate the desired signal or signals from the unwanted signals. Because the desired signal is always low in amplitude while the undesirable signals, including noise, may be appreciably greater, the preselector must have a low insertion loss to the desired signal and high attenuation to undesirable signals.

SSB FILTERS.–In contrast with the very symmetrical preselector filters, the single sideband filters for a modern communication scheme require nonsymmetrical attenuation on opposite sides of the passband; indeed, the filters in such a scheme become the heart of the system. Sometimes, instead of filters, phase difference networks are used to eliminate the unwanted sideband. In either case the purpose of the network is to suppress the second sideband to such a degree that it does not contribute appreciably to the amplitude distortion and instability of the received signal.

COMB FILTERS.–The optimum filters can extract a predetermined signal from a medium where noise is prevalent or jamming is introduced. In general, the optimum filter is a device whose input consists of a signal representing the mixture of information-bearing signal and noise. At the output of this same filter, only a signal closely approximating the useful signal will be present. This is a most important application of information theory. For a signal represented by a periodic series of pulses such an "optimal" filter will be a "comb" filter which consists of a chain of narrow band filters passing spectral lines over the frequency spectrum of the signal. The comb filters pass discrete frequency components and discriminate against noise.

MULTIPLEXING FILTERS.–These filters provide multiple use of a broad frequency spectrum beam between terminal stages of a radio relaying system. It is possible to create up to one thousand telephone channels in one microwave link. In the case of a wire carrier communication network, the frequency range extends from the audio band up to 200 kHz (the same for power line communication). The use of coaxial lines widens the range of frequencies, and more communication channels can be created. The one requirement of such a filter is to obtain the sharpest possible attenuation outside of the pass band to suppress crosstalk between channels.

ANTIJAMMING FILTERS.–Artificially created noise for jamming can completely destroy the target signal if no antijamming features are

point vary sinusoidally, the positions at which the maxima and minima occur do not move.

The terms maximum and minimum points, as used above, do not imply that the value of voltage or current at a point remains constant. The instantaneous values vary sinusoidally, as stated. At a maximum point, however, the value at any instant is greater than that at any non-maximum point at the same instant. As in any sinusoidal variation, the polarity of the signal reverses each half-cycle.

The extremes of unmatched impedances used for terminating a line are the open circuit and the short circuit. A line with an open circuit termination displays a voltage maximum at the load end, and at each half wavelength from the end. The current at the termination is minimum, with a maximum current point occurring at the voltage minimum points. A line with the short circuit termination displays the opposite characteristics.

Lines with terminal impedance other than those mentioned above display standing waves, with intermediate voltage and current values at the end, and with the minimum and maximum points shifted to positions toward or away from the termination.

In a line terminated with an impedance greater than the characteristic impedance, the voltage maximum will appear less than a quarter-wavelength from the end. Terminated with an impedance less than Z_0, the voltage maximum will be more than a quarter wavelength from the termination. Relative locations of the voltage and current maxima and minima, with respect to each other, remains unchanged; position with respect to the termination, however, does vary with terminal impedance. The magnitude of standing waves also varies with the degree of mismatch between the characteristic and terminating impedances.

The standing waves on a transmission line are used as an indication of the efficiency of the line in energy transfer. The voltage standing wave ratio (VSWR) is the ratio of the voltage magnitudes at the maximum and minimum points. A line which is terminated in its characteristic impedance has no standing waves, as previously stated. The maximum and minimum points do not exist–the voltage is at an equal level throughout the length of the line. Therefore, the ratio of voltage is unity, or the VSWR is 1:1. This represents the maximum transfer of energy, and is called an impedance match. For maximum transfer of energy throughout the system, both the source and the load should be matched to the line. Any impedance mismatch causes standing waves, with a resultant energy loss in the line. Effectively, this constitutes an attenuation of the signal.

Although the previous discussion is based on the two-wire line, the same basic theory is equally applicable to other types. Transmission lines in common avionic usage include the coaxial cable, unshielded twin lead, shielded twin lead, dual coaxial cables, waveguides, high attenuation cables, delay lines, and low noise cables.

ATTENUATORS

Throughout the microwave region, the VSWR of a flexible transmission line may vary over a wide range. The magnitude and the frequency of occurrence of such variations increase with an increase in cable length. The changes in VSWR are due to additive or subtractive reflections. The reflections, in turn, are caused by variations of the impedance at various points along the line. Variations in the diameter or spacing of the conductors, dielectric composition or thickness, or conductivity of the individual conductors cause variations in the L, C, and R components of the sections along the line. At microwave frequencies, small variations result in relatively large reactive components of impedance, with the result that sections of the line may have Z_0 values somewhat different from that of the line. Each variation of Z_0 results in an impedance mismatch and standing waves.

Variations in the Z_0 result in variations of the VSWR. In general, the overall impedance of the line is increased, with resultant increase in signal energy losses. This constitutes increased attenuation, and is usually undesirable. Since the variations tend to increase with length of the line, the lines are usually made as short as possible at microwave frequencies.

For some applications, however, increased attenuation is desirable. Two fundamental methods are used to introduce increased attenuation: the integral and the terminal attenuators.

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Integral Attenuators

Integral attenuators are used to decrease the magnitude of a signal in transit through the circuit path. The attenuator may be in the form of a high impedance cable or some other form of attenuating coupler.

High attenuation, or lossy cables, are used to provide isolations of 5 to 20 db between functional portions of a system. They reduce interaction between units which must be separately used in the same system, but whose simultaneous operation could cause undesirable interference with other circuits. This type cable is also used as dummy loads, and is capable of dissipating peak or average power values in excess of those which can be handled by most other fixed attenuators.

The easiest methods of increasing attenuation would be by changing dielectric composition or thickness, or by changing the size, spacing, or composition of the conductors. Increasing the dielectric loss is undesirable because of the variations of Z_0 with frequency changes. The most common method uses a resistive wire as the conductor. This provides increased impedance and attenuation, relatively free of changes caused by frequency variations.

In the common coaxial transmission line system, the limiting factor with respect to VSWR and operating voltage is usually the coaxial connector. The attenuation introduced by the connector is usually fairly small, but it must be considered. Total attenuation increases rapidly with an increase in the number of such devices, therefore the number of connections in a coaxial line is usually kept to a minimum.

In systems where attenuation is desired special attenuating connectors are used. These attenuators usually use a resistive wire center conductor within a circular or rectangular metal box. A conventional coaxial receptacle is normally connected at each end, and the amount of attenuation is stamped on the box. Some devices are available with tapped connections to provide a choice of attenuation. The attenuation value is stamped at each terminal.

Terminal Attenuators

Terminal attenuators are connected to the output end of the circuit. Usually called "dummy loads," their purpose is to dissipate the power developed in the equipment. Normal usage is in the tuning and testing of equipments. The dummy antenna, used in tuning transmitters, permits the loading of transmitter circuits for accurate frequency control but prevents radiation of the energy. Radiation during tuning operations creates signals detrimental to good reception at that frequency.

Use of a terminal attenuator also permits the testing of a section of a system without requiring operation of the section fed by the portion under test.

For proper operation, the terminal attenuator should present the same impedance as the unit it replaces in the system.

DELAY LINES

Artificial delay lines of the electromagnetic type are used to generate rectangular pulses of fixed duration (in radar receiver and transmitter applications); to produce a rectangular waveform from a step function of voltage (as used in starting and delay triggers for test equipment and video display units); to terminate a pulse produced by a regenerative device such as a blocking oscillator or multivibrator (as used in radar, timing circuits, and computers); and to duplicate an existing pulse at a later time (a simple case of time delay). These lines are commonly used for many types of waveshaping and pulse-forming applications.

Delay Cables

Delay cables originated as high impedance cables for better matching of high impedance circuits. High impedance is achieved by increasing the series inductance of the center conductor, which results in phase and attenuation characteristics approaching those of a low pass filter. The parameters are comparatively constant with frequency until cutoff is reached, beyond which the attenuation rises and the delay falls off rapidly.

Delays of less than a hundredth of a microsecond to 10 microseconds can be achieved with cutoff frequencies from 5 MHz to approximately 100 MHz.

These cables are used for pulse-forming networks, phase equalization and timing circuits

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in computers, data transmission, color television, and similar applications. (They are also very versatile in the laboratory, since their parameters can be adjusted "by the inch.")

The center conductor consists of a fine enameled wire closely spiraled around a polyethylene core. To increase the time delay per unit length, the permeability of the core can be increased by the incorporation of finely divided magnetic materials. In these types, the magnetic losses generally limit the upper frequency to about 5 MHz, which is adequate for most pulse applications.

Pulse Delay Network

The delay characteristics and charging action of RF lines make them useful in some radar applications. They cannot, however, be used in others, chiefly because they would have to be too long. An actual RF line would have to be several hundred feet long for some uses in radar. Even if a line of such length were coiled up, it would occupy more space than is available Thus, so far as airborne equipment is concerned, artificial lines are used instead of actual lines.

Artificial lines possess all the electrical characteristics of actual lines, but do not have the physical bulk. They lump the required L and C values into equivalent inductors and capacitors. The result is an electrically equivalent (but physically different) line. Lumped sections of inductance and capacitance take three configurations: "L," "T," and "π." Of these, the "L" section is the one most commonly used. For this reason, the following explanation will be confined to this type.

In any line, a time interval is required for any voltage change to travel the length of a line. This time characteristic makes it possible to slow down the transfer of a voltage change in its travel from one circuit to another.

The artificial line shown in figure 10-12 provides a means of delaying a pulse voltage 10 microseconds. This line contains an inductance of 0.5 millihenry and a capacity of 0.05μf in each of the two sections. The time for a voltage change to move through one section may be determined from the formula $TD = \sqrt{LC}$. Total delay of the line is $TD = n\sqrt{LC}$ where n is the number of identical line sections.

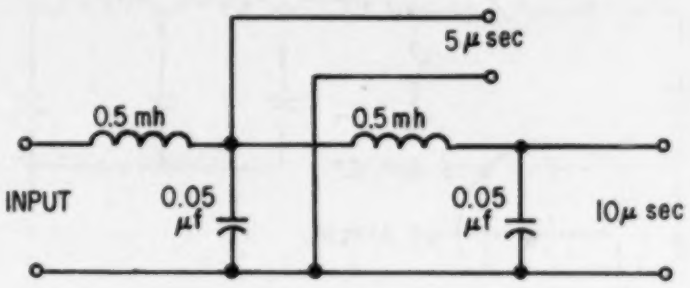

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Figure 10-12.–Pulse delay network, simple circuit.

If the individual sections are not identical, time delays can be computed for each section individually, and then added together for the total delay. In most pulse delay networks in actual use, the delay times for each tapped output terminal is stamped on the unit. If necessary, inputs and outputs may be reversed; the computation of the delays between taps is based on the difference between the figures stamped at those points.

Pulse Forming Network

Another characteristic of RF lines is the manner in which the lines charge and discharge when a d-c voltage is applied to them. When d.c. is applied to an open-ended line is which the source impedance is equal to the line impedance, half the source voltage appears instantaneously across the line impedance. The change in voltage travels down the line, charging the line as it goes. When it reaches the open end, it is reflected in phase and starts back along the line. (See fig. 10-13.) All capacitors are charged to half the applied voltage during the trip down, and to full value of the applied voltage during the trip back. When all capacitors have been charged to a value equal to the applied voltage, current stops flowing. On an oscilloscope across the impedance of the source, the wave shape appears as shown in figure 10-13(B). Note that the voltage felt across the impedance of the load is half of the applied voltage during 2TD. At the end of 2TD, the PFN is charged to the full value of the applied voltage and current stops.

When the line is discharged into a resistance equal to its characteristic impedance, the result is a square wave. The wave has a con-

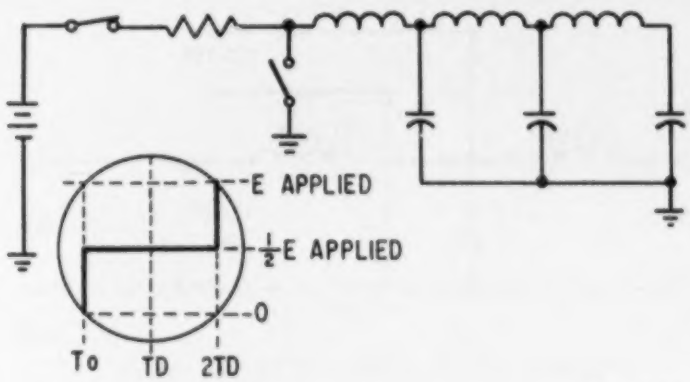

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Figure 10-13.–Charging a pulse forming network.

stant amplitude, and a duration equal to twice the time for the pulse to travel the length of the line. The amplitude is equal to half the charge voltage because the line discharges through its own impedance and the load impedance (R_L) in series. This cuts the load voltage by half and produces a drop of voltage which immediately travels down the line and back to the starting end, as shown in the illustration in figure 10-14.

As the end of the line is open, the reflection is in phase. This produces a voltage across the load impedance (R_L) equal to half the charge voltage and which lasts for twice the time of one-way travel on the line. Usually, an artificial line is used to generate a square wave. When the L and C are known, the time duration of the square pulse (PW) is equal to

$$PW = 2n\sqrt{LC}$$

When the termination is not equal to the characteristic impedance of the line, discharge cannot be completed in a single round trip. As indicated in figure 10-14 (B), several trips are required for complete discharge of the capacitors. The total number of trips required is dependent on the degree of mismatch between the line and its terminating impedance; the greater the mismatch, the more trips required. An artificial pulse line is capable of producing a perfectly measured square wave pulse with an amplitude of several thousand volts.

Another use of an artificial line is for forming pulses when the receiving end is shorted.

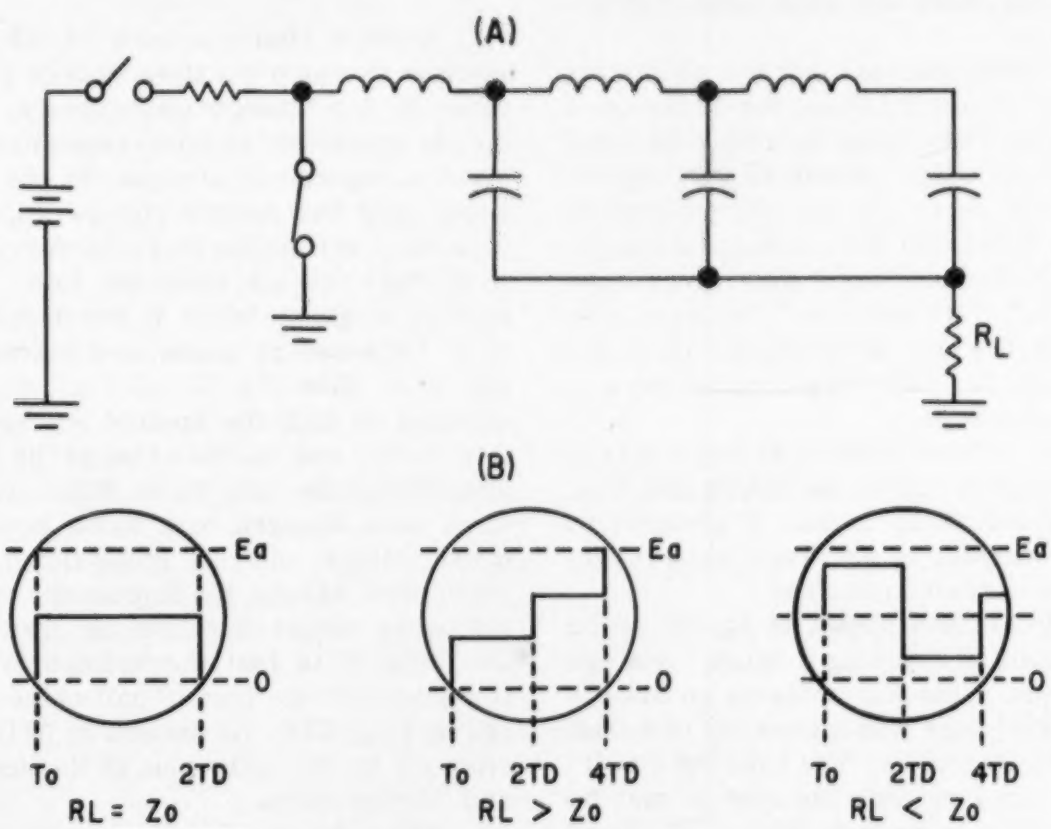

AT.166

Figure 10-14.–Discharging a pulse forming network.

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The operation of the line in this case depends on energy stored in the magnetic fields around the inductors in the line. When the voltage is applied to the line as shown in figure 10-15 (A), it moves down the line and charges each capacitor. At the short circuit, the voltage turns around and returns up the line. On its return trip, it discharges all capacitors. Meanwhile, the current also moves down the line and is reflected back at the short. On its return trip up the line, its value is doubled. After one round trip, the voltage across the line at all points is zero, while the current at all inductors is high.

When a load is suddenly connected to the line, the current in the inductors flows through the load. This current drops to half its previous value, proceeds, to the shorted end and back, maintaining a current flow for the time of one round trip through the line.

In many radar systems, the short circuit action is produced by the firing of a thyratron tube. The resulting pulse is then used to trigger the magnetron into operation for a controlled period of time.

IMPEDANCE MATCHING DEVICES

Impedance is a complex characteristic of all a-c circuits. It consists of both resistance and reactance. Every stage, circuit, and unit within the signal path of electronic equipment or system possesses an inherent impedance with respect to the applied signal. The inherent impedance is a characteristic impedance of the functional element concerned. In addition to the inherent impedance, the input and output impedances of the element are important considerations.

The input impedance of a circuit is the impedance presented to a signal at the input to the circuit. It represents a combination of effects on the signal by the circuit and the load connected to its output. The output impedance represents the combined effects of the circuit and

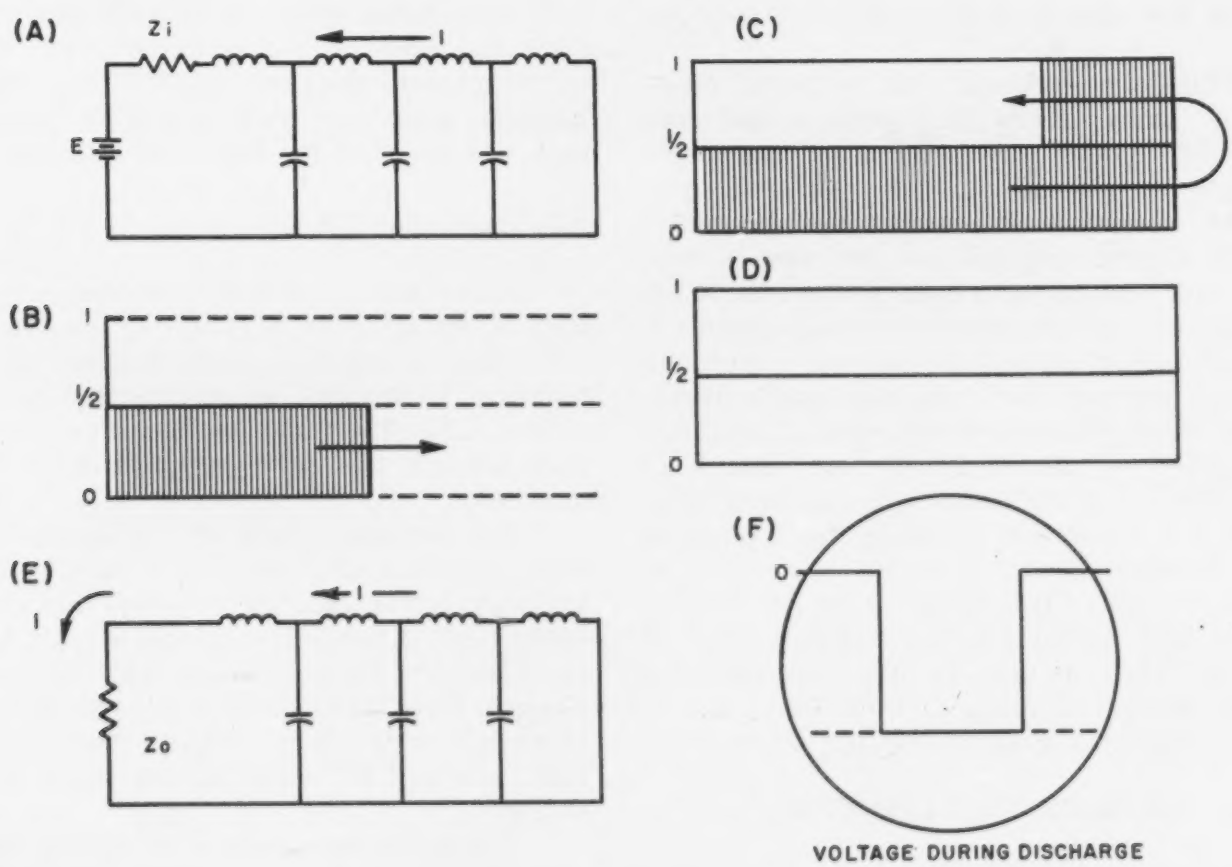

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Figure 10-15.–Pulse formation, using a shorted line.

its inputs, as felt by the circuit load. These values, as shown in the discussion on transmission lines, may be equal or different.

Impedance matching is the process by which the functional circuit element is coupled to either or both the input and output circuits for optimum transfer of energy. This requires matching not only the resistive component of impedance, but the reactive component as well. For maximum transfer, the resistive components are made equal, but the reactive components are made opposite (but equal in magnitude). Thus for a capacitive reactance of one element, an equal value of inductive reactance must be found in the other.

The calculation of inherent, input, and output impedances is a complicated process beyond the scope of this course. It involves the progressive simplification of series-parallel networks of resistance and reactance components with reflected and distributed properties. Many of the individual values cannot be measured directly. These values must be calculated under varying conditions of frequency and load, including the effects of tube and transistor operation.

Fortunately, however, the technical manuals for many electronic systems and test equipments contain data concerning the input and output impedances recommended for proper matching. Numerous devices are available which have the proper impedances for use in connecting test equipment to units under test. Many technical manuals also contain the specifications and construction details for making impedance matching devices for common applications.

For most common needs, coaxial adapters are supplied as part of newer test sets. This greatly simplifies the impedance matching procedures. As a means of checking the impedance match between physical units, especially at microwave and UHF frequencies, a special class of test equipment, the "slotted line" is provided. This device is used to measure standing waves of voltage on the line, and is usually adjusted for unity standing wave ratio.

CATHODE-RAY CIRCUITS

The circuits used for the electrostatic type of cathode-ray are functionally similar to those used for the electromagnetic type of tube, but differ in the manner of accomplishing their function. Basically, the cathode-ray tube provides a fast moving, easily and quickly deflected electron beam for use in waveform viewing and analysis, and for special display purposes. Generally speaking, the display types of CRT are magnetically controlled, while the types used in test oscilloscopes and synchroscopes (for waveform checking) are electrostatically controlled.

All cathode-ray tubes have basic control circuits which are necessary if the tube is to be used at all. These circuits control intensity (brilliance), focus, and beam positioning (centering, both horizontal and vertical). Other circuits with which the CRT is concerned are horizontal and vertical amplifiers, sweep circuits, and synchronizing circuits. All of the latter are standard circuits, with special attention paid to the design for bandwidth, response, and linearity. In some special cases there are peculiar circuits which are mainly combinations of standard circuits used for packaging the component into a convenient size, and for economy. For example, while a console unit may have high and low voltage supplies, they are usually separate and use separate transformers, whereas the conventional oscilloscope uses one transformer to supply both high and low voltage, bias, and filament power.

FOCUSING METHODS

Three basic focusing systems are used in CRT's, but all three accomplish the same function: they focus the electron beam so that it forms a sharp spot as it impinges on the face of the CRT. The three systems are the permanent magnet, the electrostatic, and the electromagnetic.

The permanent magnet and the electromagnetic systems are identical in effect; they differ only in the manner of producing the magnetic field. A form of electromagnetic focusing is discussed (in connection with klystrons) in chapter 11 of this manual. Although that method is considerably more complex than is normally the case in CRT circuits, the basic action is similar.

The permanent magnet focusing method is usually found in commercial television receivers; it is not in common usage in avionic equipments. Electrostatic focusing is found in

UNIT II - USE OF DRAWING INSTRUMENTS

Compass Lesson 4

OBJECTIVE: To learn to use a compass properly.

RELATED INFORMATION:

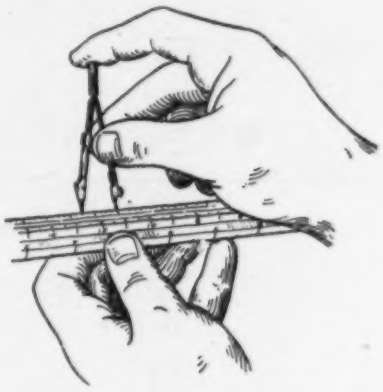

FIG. 1

The main function of a compass is to draw circles. To do this properly, set the compass on the scale as shown in Fig. 1 and adjust it to the radius needed; then place the needle point at the center-point on the drawing, guiding it with the left hand (Fig. 2). Raise the fingers to the handle and draw the circle in one sweep, rolling the handle with the thumb and forefinger, inclining the compass slightly in the direction of the line (Fig. 3).

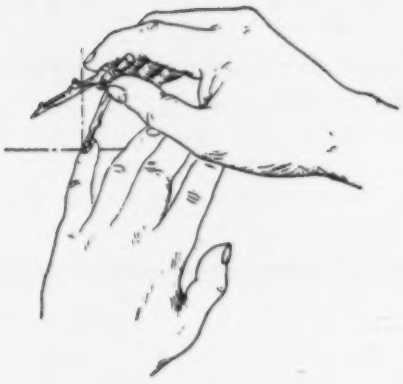

FIG. 2

FIG. 3

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small-screen CRT's used in test oscilloscopes and in the auxiliary indicators of some radar sets.

ELECTROSTATIC DEFLECTION

The following circuits were chosen as basic examples of the circuits generally used in electrostatic CRT's and oscilloscopes. Each was selected to bring out the basic principles and requirements necessary for circuits used in waveform analysis. The discussion is limited to the essentials needed for describing their use with cathode-ray tubes.

Beam-Positioning Circuits

A simple oscilloscope using basic beam-positioning circuits is shown in figure 10-16.

Note that the voltages are taken from a common voltage divider between B-plus and B-minus. The divider is grounded at a convenient point, usually at the positive voltage required for the accelerating anode (A2), and both ends are above ground. With the positive low voltage and negative high voltage at above ground potential, the case and chassis can be grounded for protection of the operator. This system also permits the anode and one of each pair of deflection plates to be grounded, to form a simple unbalanced deflection or positioning circuit. This connection also keeps the deflection plates and accelerating anode at the same potential and avoids defocusing effects from differences in potential between them.

In the balanced positioning circuits (fig. 10-17), each deflecting plate (D1 through D4) is controlled by a separate potentiometer, and the plates are isolated and balanced equally by being connected to the position controls through equal resistors. Each plate is also connected to the deflection amplifiers, through a coupling capacitor, in a push-pull arrangement. Thus the CRT is balanced for d.c., for a.c, and for any stray capacitance to ground. Since the isolating resistors (R1, R4, R5, and R8) are always of a very large value, the deflecting plates may be connected into any circuit without danger to the operator. (It takes a current of only a few microamperes to drop the positioning voltage to zero).

Sweep Circuit

To provide a time base for the waveform, the CRT beam must be deflected horizontally across the face of the tube from left to right, then caused to return quickly from right to left, ready to resume another cycle of operation.

Some oscilloscopes provide blanking for the retrace period so that the return sweep cannot be seen. A typical thyratron type sweep generator for general oscilloscope use is illustrated and explained in Basic Electronics.

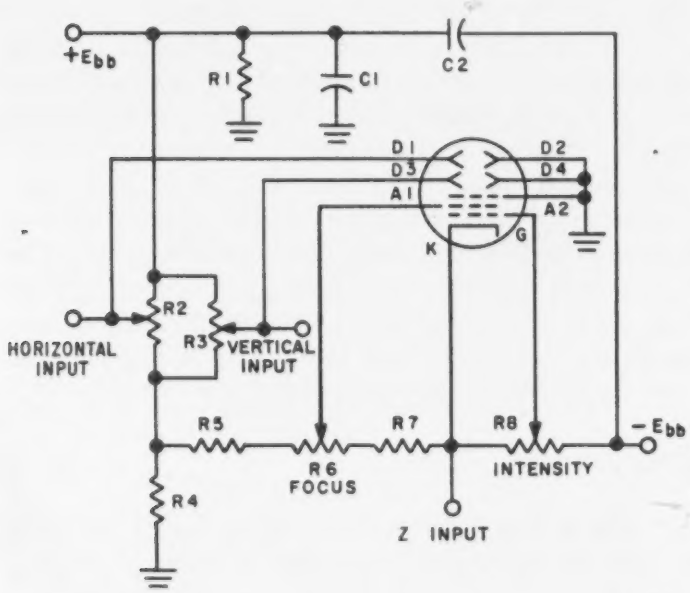

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Figure 10-16.–Simplified schematic of basic oscilloscope.

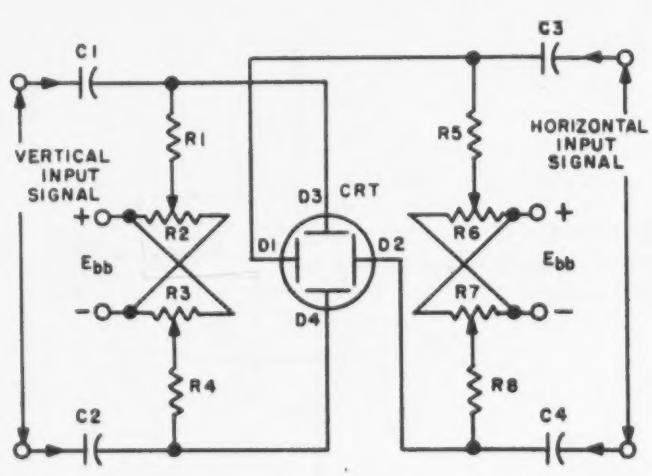

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Figure 10-17.–Balanced positioning circuit.

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Other types of relaxation oscillators, such as a neon tube, a vacuum tube RC oscillator with discharge tube, or a multivibrator, could be used, provided that a reasonably linear sawtooth sweep waveform is produced.

Synchronizing Methods

To keep the waveform stationary on the face of the CRT, the sweep frequency must be an exact multiple or submultiple of the waveform under observation. To avoid the need for constant resetting of the sweep frequency control (because of drift, power supply voltage changes, etc.) a sweep-locking or synchronizing circuit is provided.

Since some circuits do not have an output of the proper polarity for synchronization, an adjustable synchronizing circuit is sometimes included to permit selection of sync signal and choice of sync polarity. Figure 10-18 shows a typical sync input circuit of this type. Switch S1 selects one of three inputs: an external synchronizing signal, a 60-hertz signal (usually taken from a filament winding), or the output from the vertical amplifier (this is the signal under observation, but it is called internal sync). It then applies the input through coupling capacitor C1 to the grid of V1.

Tube V1 is a paraphase amplifier, with the grid returned to ground through R1. The tube is cathode-biased and unbypassed; the plate and cathode resistors (R2 and R3) are of the same value, so that for the same current identical signals are developed in the plate and cathode circuits (except of opposite polarity). For a positive input signal, a negative plate output signal is developed, and the cathode output signal is positive. For a negative input signal, a positive plate output signal is developed, and the cathode is negative. Both plate and cathode outputs are coupled (through capacitors C2 and C3) to a common variable load resistor, grounded at a center tap. At the ground position, both signals are of zero amplitude; therefore, no output is obtained.

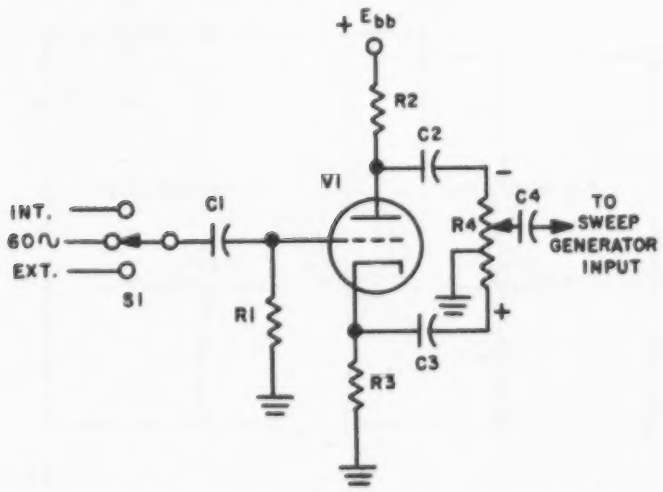

Figure 10-18.–Typical sync input circuit.

As R4 is rotated in either direction, the signal amplitude is increased. Since the synchronizing signal to the sweep generator must be of positive polarity, for a negative input to V1 a positive signal is available on the plate side, and for a positive input to V1 a positive signal is available on the cathode side. Thus a signal similar to the input signal but of positive polarity is obtained and coupled through C4 to the sweep generator.

When the sweep generator is adjusted to a slightly lower frequency than that desired, a positive-going sync signal is applied to the grid, the sweep generator locks in and operates at the same frequency as the sync signal. Thus the CRT waveform remains stationary, rather than drifting across the screen, because it is synchronized so that the sweep occurs at the same place (at the same time) each sweep.

To produce satisfactory deflection with small signals, it is necessary to employ both vertical and horizontal deflection amplifiers. These stages may be single-ended or push-pull (unbalanced or balanced); they are conventional video amplifiers designed for the desired frequency response and linearity. The horizontal amplifier in a good scope is identical to the vertical amplifier, permitting the same signal to be applied to the X (horizontal) axis or to the Y (vertical) axis.

Attenuators

Since the vertical amplifier must be able to amplify very weak signals with sharply rising waveforms, it must have good frequency response and large amplification. To cover the range of signal amplitudes encountered, the vertical input is usually provided with an at-

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tenuator. Three types of attenuators are shown in figure 10-19.

The simple circuit shown in (A) uses a potentiometer as the output load resistor of an RC coupling network. The grid-to-ground impedance of the input tube is in shunt across the lower portion of the potentiometer and in series with the upper portion. As the potentiometer arm is moved upward, the impedance presented to the circuit under test is decreased. This results in less attenuation of the signal and less loading of the circuit.

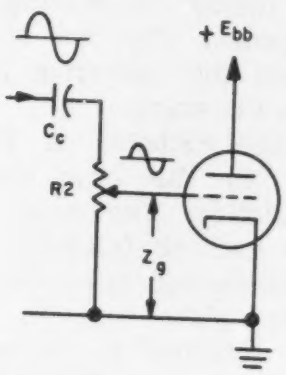

(A) POTENTIOMETER

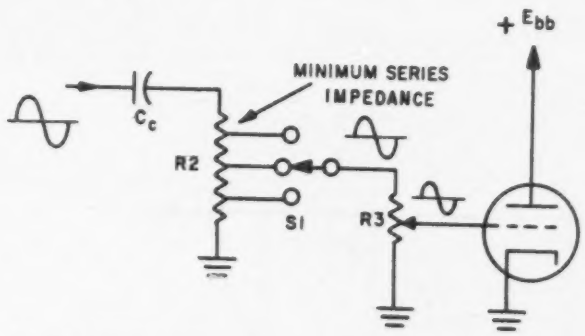

(B) STEP POTENTIOMETER

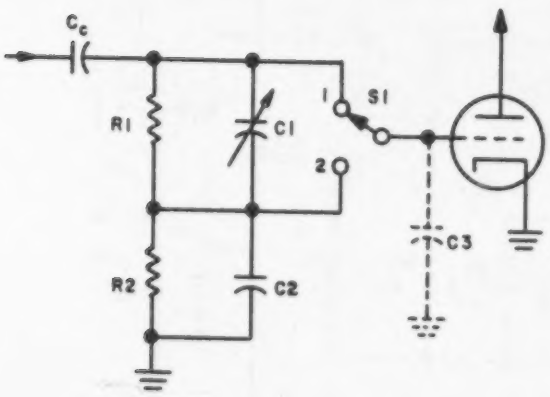

(C) FREQUENCY COMPENSATED STEP

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Figure 10-19.–Attenuators.

The simple step attenuator circuit shown in (B) is a better type of input circuit, allowing coarse selection of the attenuation ratio with switch S1, and fine adjustment with potentiometer R3. Even for the smallest input step resistance, the full range of R3 is available for control. With the available settings of S1, the input impendance will never decrease to a value less than the series section of R2 (that portion above the upper tap) plus the parallel combination of the remainder of R2, R3, and the grid-to-ground impedance of the input tube.

The most desirable input impedance is in the range of megohms, with little or no shunting capacitance to ground. To achieve this result, a cathode follower input stage is sometimes combined with a step attenuator to isolate the oscilloscope input from the stage being tested.

Frequency compensated attenuators are used in the better type of oscilloscopes to minimize the effect of input capitance (fig.10-19 (C)) by presenting identical impedance response curves to the circuit under test for the various attenuator settings.

Frequency compensated attenuators provide the same voltage division ratio to resistive and reactive components of the input signal, so that the drop in signal level at the higher frequencies can be compensated in the video amplifiers. Attenuator compensation is usually effective over the entire useful frequency range of the oscilloscope.

Most attenuators and amplifiers have reduced high frequency response because of the shunting effect of stray capacitance. A parallel RC circuit is usually inserted in series with the input lead to boost the relative response of the attenuator at high frequencies. Another device is an input probe located at the end of a special connecting cable which applies the input to the vertical amplifier. The probe houses a frequency compensated voltage divider, to reduce the amount of shunt capacitance at its input terminals. This is usually called a DC probe (or simply input probe), as distinguished from an

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RF probe which contains a diode rectifier to remove the modulation.

Signal Amplifier

A typical three stage signal amplifier is shown schematically in figure 10-20; it drives a conventional push-pull paraphase deflection output amplifier. The input signal is applied through blocking and coupling capacitor C1 to a cathode follower attenuator stage incorporating triode V1. The attenuator is a two step, frequency compensated type.

Y-gain (vertical) control R6 controls the amplitude of the input signal to the video amplifier consisting of V2 and V3. Both high frequency and low frequency compensation are employed in each stage. The cathode of V2 is bypassed by a small capacitor, which makes it degenerative for low frequencies, thus reducing the response and flattening out the low frequency response. The high frequency response is increased by peaking coils L1 and L2 (which compensate for the shunting effect of tube and wiring capacitance and provide a reactance which increases with frequency).

Amplifier V3 is fixed-biased by connecting the cathode to the junction of R13 and R14, which are connected in series between the plate supply and ground. Cathode resistor R14 is also unbypassed so that the circuit is completely degenerative for high and low frequencies, further improving the overall frequency response. The use of the fixed cathode bias sets the operating point of V3 and helps stabilize the stage.

An output from the cathode of V3 is taken for application to the sync circuit for internal synchronization. The main output of V3 is fed to cathode follower output stage V4, which is biased positive with respect to ground by plate current, even though the cathode is returned to the minus supply. Variable potentiometer R16 serves as output control to adjust the signal amplitude for application to a paraphase amplifier.

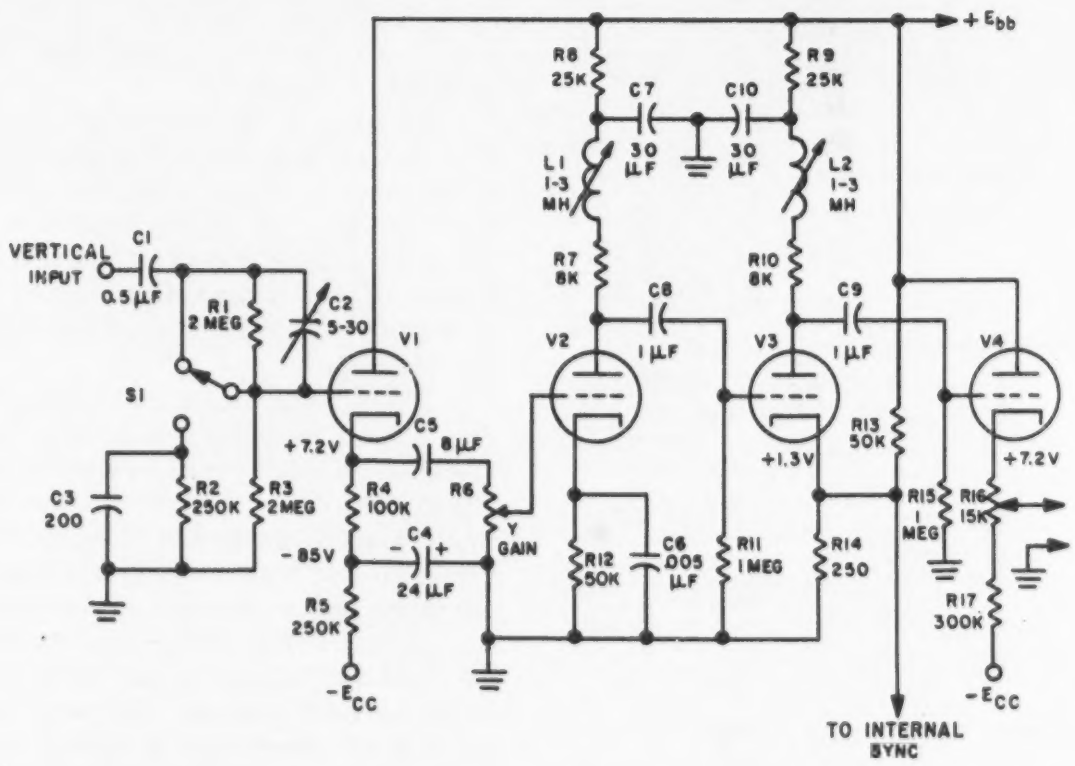

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Figure 10-20.–Three-stage signal amplifier.

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Deflection Amplifier

A common type of deflection amplifier used for electrostatic deflection is the paraphase amplifier, shown in figure 10-21. In this type of circuit, a balanced output is obtained from a single ended input signal by means of common coupling in the cathode circuit of both tubes. (The circuit is known as a cathode-coupled paraphase amplifier.)

The input signal, shown as a positive pulse, is applied to the grid of V1, with the grid returned to ground through R1. Cathode bias is obtained by means of R2, which is common to both V1 and V2. Since R2 is unbypassed, the input signal at the grid of V1 also appears at the cathode, while the inverted signal appears at the plate as one output of the circuit. The signal at the cathode of V1 is applied, through direct connection to the cathode of V2.

The grid of V2 is connected to a balance potentiometer which acts as a voltage divider between E_{bb} and ground. Thus the output signal of V2 can be adjusted to equal that of V1. The positive pulse at the cathode of V2 increases the bias, decreases the plate current, and produces a positive output at the plate of V2. The plate output signal of V2 is reversed in polarity from the input signal, as in any ordinary vacuum tube amplifier.

The input to V2 is the signal voltage developed across R2. This signal is applied to the cathode of V2 (which has its grid returned to ground through R5 and is thereby at ground potential to the signal). Therefore, the output signal at the plate of V2 has the same polarity as the input signal at the cathode of V2 or the input signal at the grid of V1. In this way, the output signals from the plates of V1 and V2, which are applied to the deflection plates of the CRT, are equal in amplitude but opposite in polarity (phase).

The circuit operation and the schematics given above have, for simplicity, omitted the additional compensation networks which are often included in specific applications. In order that deflection amplifiers do not restrict the bandwidth of the input signal, they must have wide frequency response, low distortion, and time delay proportional to frequency, similar to the characteristics of video amplifiers.

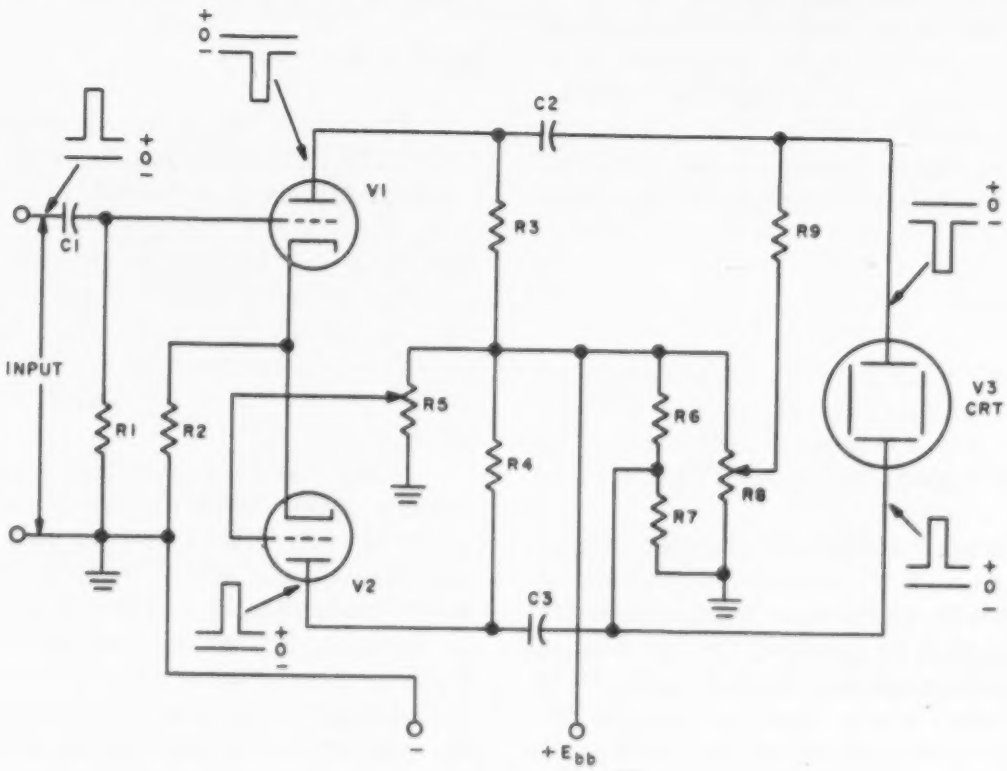

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Figure 10-21.–Paraphase voltage deflection amplifier.

ELECTROMAGNETIC DEFLECTION

When a very large screen is used and correspondingly large deflections are required, it is not practical to use electrostatic deflection. The extent of deflection desired would require greater spacing between the deflection plates and, consequently, unusually high signal voltages would be necessary. It is simpler to obtain large deflections in a relatively short tube by means of magnetic fields. In addition, with magnetic deflection, it is easier to obtain the special types of sweep required by radar PPI, scanning sonar, and television picture tubes.

It should be noted that both the electrostatic and electromagnetic deflection systems have their advantages and disadvantages. The electrostatic deflection systems are used when high sweep frequencies are needed. The electromagnetic systems have the disadvantages of frequency limitations and high weight and large size.

The common method of obtaining electromagnetic deflection is to use two pairs of electromagnets around the neck of the CRT. This simplifies the construction of the tube since no internal deflection plates are required and focusing is also accomplished electromagnetically. Instead of applying a signal voltage across deflection plates, the final signal amplifier tubes send a strong signal current through the electromagnets. The amount of current varies to follow the signal that is being examined, and thus the electron beam deflection is proportional to the signal.

Trapezoidal Input

Figure 10-22 illustrates a simplified typical deflection amplifier for producing a horizontal time base using magnetic deflection. The input signal is a trapezoidal waveform of voltage as shown in the illustration.

The input is applied through coupling capacitor C1 to the grid of V1, which is operated as a Class A stage with fixed bias. Sufficient negative bias is applied to prevent the grid from going positive with maximum signal input. V1 is a pentode or a beam power type, in order to obtain the power amplification required to furnish current to the deflection coil (This coil may require between 50 and 100 milliamperes of current for maximum beam deflection.)

The output of V1 is applied to the deflection coil, which in the illustration is represented by an inductance, L1, with a resistance, R2, in series with it. R2 is shown as a dotted resistance because it is actually a part of L1. The output voltage waveform at the plate of V1 is trapezoidal; when this waveform is applied to the series R-L circuit (deflection coil), the voltage waveform appearing across the resistance is resolved to a sawtooth shape, while that appearing across the inductance is resolved to a square-wave shape.

The square wave of voltage across the inductance causes a sawtooth wave of current through it, which is the required waveform for producing a horizontal time base deflection on the screen of the cathode-ray tube. The development of the sawtooth current waveform from the trapezoidal voltage input waveform is shown in figure 10-23.

The trapezoidal voltage input waveform to the grid of amplifier V1 is shown in (A); the differentiated voltage which appears across the inductance is shown at (B); the integrated voltage which appears across the resistance (of the coil) is shown at (C); the current through the deflection coil, which is the composite result of waveforms (B) plus (C) is shown at (D).

Square Wave Input

The input signal to the amplifier (shown in fig. 10-24 (A) is a square wave, instead of the trapezoidal wave required in the previous circuit. This signal is applied to the grid of V1. The grid is returned to ground through resistor R1. The positive voltage applied to the cathode of V1 (from the plate supply by means of the voltage divider action of R3 and R2) maintains V1 biased to cutoff in the absence of an input signal.

When the first positive pulse of the input square wave reaches the grid, the tube conducts heavily. The resulting plate current, flowing through deflection coil L2 and inductor L1, rises exponetially toward a value which would be limited only by the resistance of the circuit. Before this limiting point is reached, however, conduction of the tube is suddenly interrupted by the negative going end of the square wave input pulse. In this way, only a relatively linear portion of the exponentially rising waveform is utilized.

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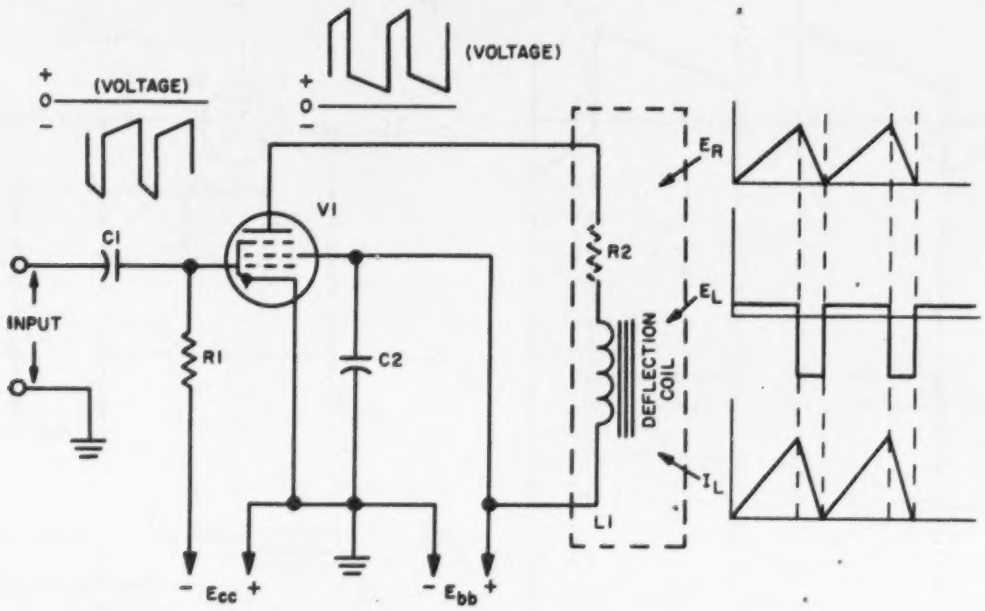

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Figure 10-22.–Electromagnetic deflection amplifier.

When the conduction of the tube is interrupted at the end of the positive square wave, V1 is cut off, and the current decays rapidly to zero. This rapid decay is due to a change in the time constant of the circuit between the rise and fall of the current.

During the rise of current, the circuit time constant (L/R) is long. The resistance is composed of cathode resistor R2 and the low value of plate resistance of V1. During the decay of current, the time constant is made short, as a result of the increase in the value of plate resistance when V1 stops conducting. With the shortened time constant, the current decays rapidly.

The sudden decay in current flowing in the deflection coils when the tube stops conducting causes a counter emf in the coil, which opposes the current decay. In addition, the circuit may be shock excited into oscillation by the sudden change in value of current. Although the oscillations gradually die out, they may continue into the following sweep, especially if the circuit Q is high. This condition may result in a nonlinear start of the buildup of current in the coil, and therefore a nonlinear sweep, as shown in figure 10-24 (B).

These oscillations can be eliminated, or damped out, by lowering the Q of the circuit by means of a resistor shunted across the coil. This wastes some of the deflection current, however. A more satisfactory method incorporates the use of a damping diode shunted across the deflection coil, as shown in figure 10-24 (C), where diode V2 acts to damp out the oscillation.

The current through V1 is increasing during the rise of the sawtooth current wave shown in (B), to provide the sweep deflection. The voltage at the plate of V1 is lower than the plate supply voltage by the amount of voltage drop in the deflection coil and inductor. The cathode of damping diode V2 is therefore more positive than its plate, and the diode will not conduct.

When the current through V1 falls to zero at the end of the sawtooth current wave, the voltage at the plate tends to rise above the plate supply voltage due to the fact that the cemf (generated by the inductance) adds to the plate supply voltage. When this condition is reached, damping diode V2 conducts, and any oscillations are dissipated in resistor R5.

Balanced output (push-pull) circuits, when used, usually operate by means of a phase inverter circuit fed from a single ended source. In some radar deflection circuitry, the two outputs obtained by means of a phase inverter are separately amplified by individual single ended deflection amplifiers, and then applied to the two separate windings of a split winding deflection yoke.

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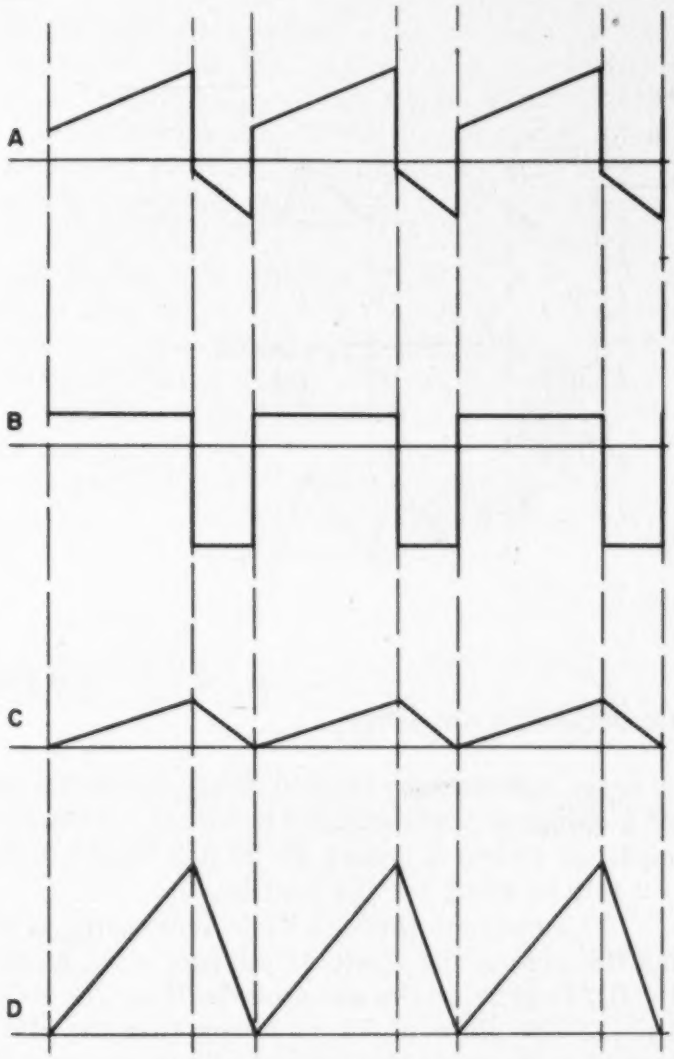

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Figure 10-23.–Development of sawtooth current waveform.

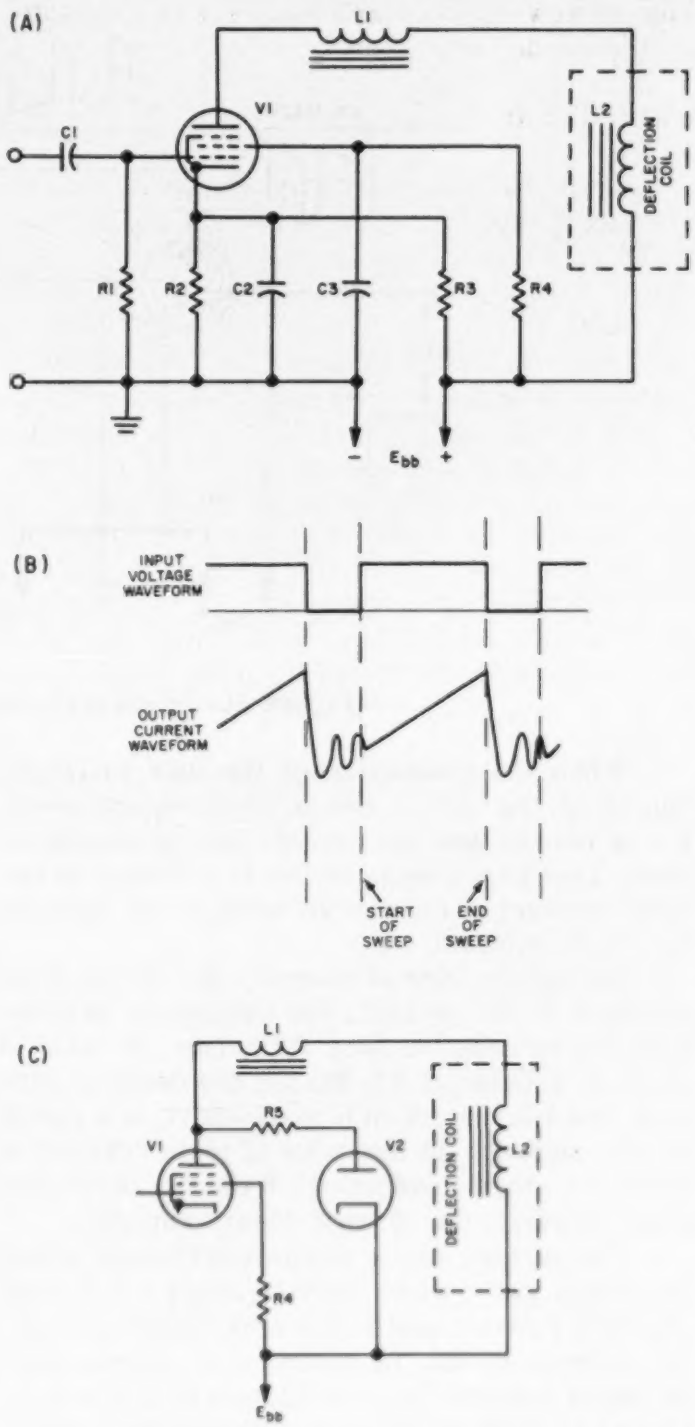

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Figure 10-24.–Deflection amplifier, square wave input.

CONTROL CIRCUITS

This discussion will cover some of the commonly used circuits which control the voltage gain of an amplifier stage or control the frequency of a local oscillator stage.

AGC AND AVC SYSTEMS

In common electronics usage, the terms "automatic gain control" (AGC) and "automatic volume control" (AVC) are used almost interchangeably. Technically, however, AVC is properly applied only to circuits whose ultimate output is an audible signal. AGC is a broader term which includes audible signals and inaudible signals of all varieties. The circuit itself provides a means of automatically controlling the output of an amplifier, by regulating the gain in accordance with the strength of the input signal. Since the same basic circuit is used for both the audible and the inaudible signal, this discussion will use the term AGC in all applications.

In most circuits controlled by AGC voltages, remote cutoff amplifiers are used. Before proceeding with the discussion of AGC systems, a

brief review of the characteristics of a remote cutoff pentode is presented.

Remote Cutoff Pentode

Figure 10-25 shows the E_c/I_b characteristic curve for a typical remote cutoff pentode used as an RF or IF amplifier, and the effect on plate current variations caused by changes in control grid bias.

When the signal input to the tube is small (e_g1), the developed voltage is low and the plate current variation (i_p1) is centered about point A. When the signal input to the receiver is large (e_g2), the developed voltage increases and the plate current variation (i_p2) is centered about point B. The plate current variation resulting from a small input and the plate current variation resulting from a large signal input are approximately equal, in theory; this should produce output signals of approximately the same amplitude.

Although the relationships given in the illustration are idealized, they serve to show the effect of applying a negative control voltage to an amplifier stage. In actual practice, it is necessary to supply the AGC voltage to several

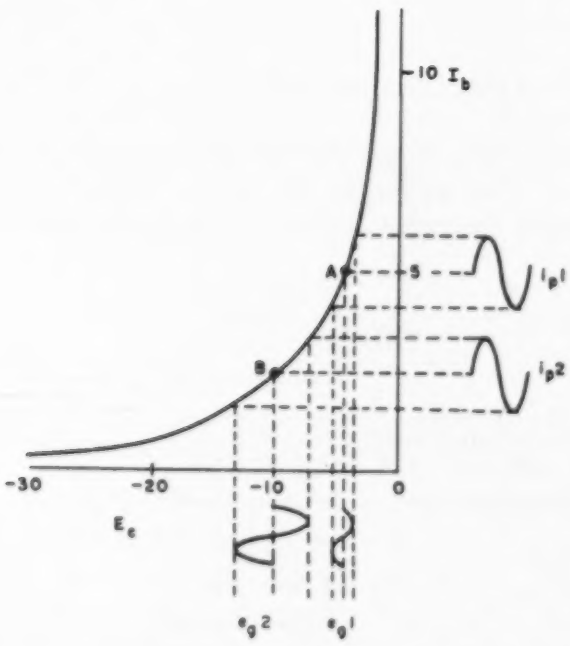

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Figure 10-25.–Remote cutoff pentode E_c/I_b curve.

effect of applying a negative control voltage to an amplifier stage. In actual practice, it is necessary to supply the AGC voltage to several remote cutoff amplifier stages simultaneously in order that the cumulative effect will produce a satisfactory control of signal amplification by the controlled stages.

Circuits vary somewhat because of the overall gain characteristics required of the receiving system. However, most AGC circuits fall into one of three general classifications: simple AGC, delayed AGC, and amplified and delayed AGC. These three classifications of AGC circuits are described briefly in the paragraphs which follow.

Simple AGC

A simple AGC circuit and a diode detector circuit are very similar in many respects. For this reason, the AGC circuit and the signal detector circuit of a receiving system are frequently combined within a single stage. Figure 10-26 illustrates a simple AGC system. This system makes use of a negative d-c control voltage obtained directly from the signal detector output, since the rectified voltage produced by the detector is proportional to the amplitude of the received carrier.

The RF amplifier, mixer, and first IF amplifier stages are series fed and controlled by AGC voltage taken from the detector diode. (The second IF amplifier stage is self-biased and is not controlled by AGC voltage.) R1 is the detector load resistor and capacitor C1 is the RF bypass capacitor for R1. Resistor R2 and capacitor C2 form an RC network to filter the AGC voltage obtained from the detector. Resistor R3 and capacitor C3 form a decoupling network for the mixer stage; similarly, resistor R4 and capacitor C4 form a decoupling network for the RF amplifier stage.

The time constant of the RC filter is long enough to remove the lowest modulation frequencies from the d-c voltage, but short enough that the d-c bias level changes in response to moderately rapid changes in received signal strength (due to signal fluctuations, fading, etc.). The simple AGC circuit is employed in many typical AM superheterodyne receivers which use a diode type detector; it is also employed in some FM receivers which use a ratio-type detector.

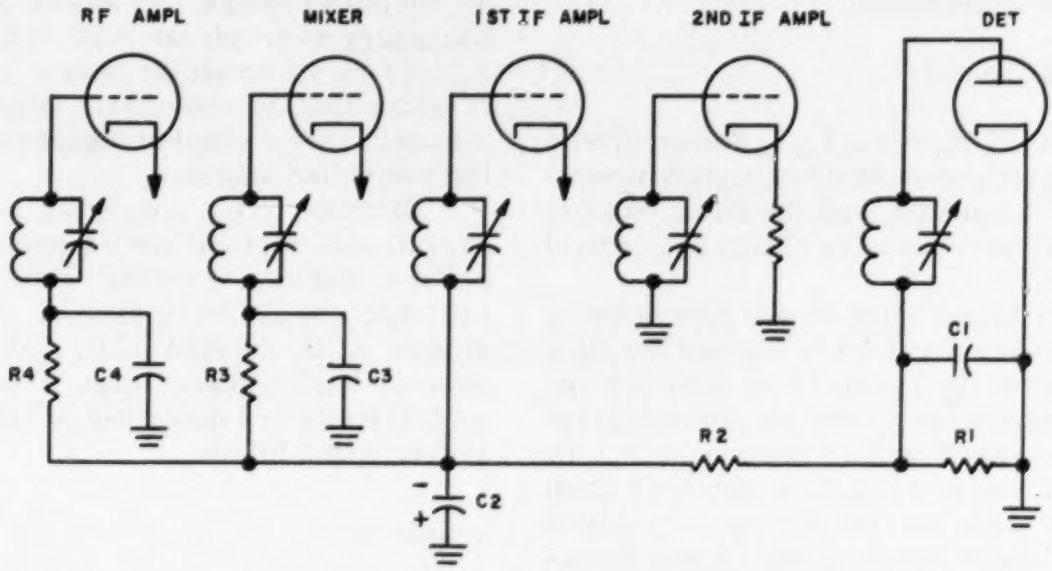

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Figure 10-26.–Simple AGC system.

Delayed AGC

The term delayed AGC is used to denote a voltage delay, and should not be confused with a time delay. The simple AGC system just described is effective on all received signals, from the weakest to the strongest. It has the disadvantage of developing an AGC voltage even for very weak received signals. As a result, the sensitivity of the receiver to weak signals is reduced considerably. In order to increase sensitivity and enable the receiver to respond to weak signals, it is desirable to provide a means of delaying the application of AGC voltage until the received signal reaches a predetermined value, sometimes called the threshold level of AGC. Figure 10-27 illustrates a typical delayed AGC system.

The delayed AGC system makes use of a fixed delay voltage applied to a separate AGC detector. The delayed AGC detector must be a separate diode, independent of the signal detector (demodulator) because the fixed delay voltage prevents the AGC detector diode from rectifying an RF signal until the signal level exceeds the value of the delay voltage. (If separate diodes were not used, the delay voltage would prevent the detector diode from rectifying weak signals below the threshold level established by the value of the delay voltage.) Once the signal level exceeds the value of the delay voltage, the AGC detector begins to rectify the signal, and produces a d-c output voltage which is then applied as bias to the controlled stages. Filtering of the d-c output voltage removes amplitude modulation components; the RC time constant considerations are essentially the same as for the simple AGC system. The delayed AGC circuit is employed in many AM superheterodyne receivers, as well as in microwave and radar receiving systems.

Amplified and Delayed AGC

There are many variations in amplified and delayed AGC systems. However, these can be classified according to two categories: systems

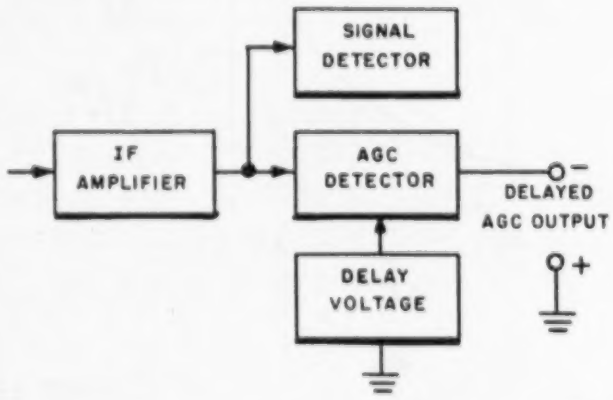

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Figure 10-27.–Delayed AGC system.

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The position of the fingers after the rotation is shown in Fig. 4. The pencil line can be brightened, if necessary, by making additional turns. Circles up to perhaps 3 inches in diameter can be drawn with the legs of the compass straight, but for larger sizes, both the needle-point leg and the pencil or pen leg should be bent at the knuckle joints so as to be perpendicular to the paper (Fig. 5). The 6-inch compass may be used in this way for circles up to perhaps 10 inches in diameter; larger circles are made by using the lengthening bar, as illustrated in Fig. 6.

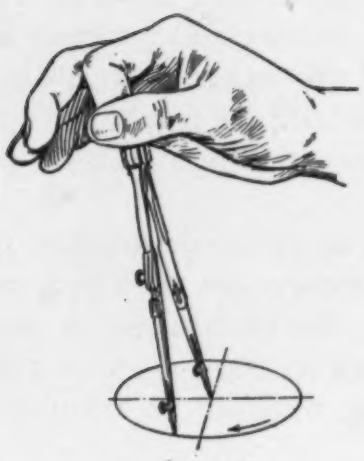

FIG. 4

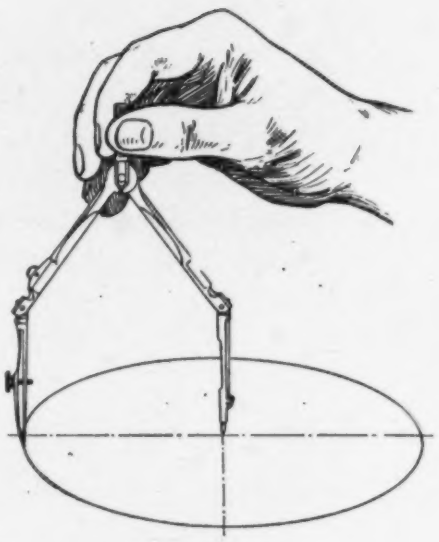

FIG. 5

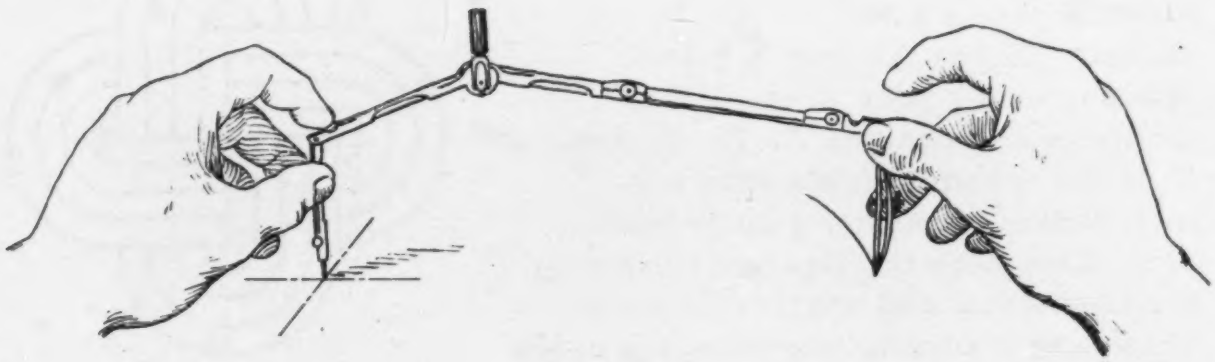

FIG. 6

which amplify a signal before rectification to obtain the AGC voltage, and systems which amplify the AGC voltage after signal rectification. In either case, a form of delayed voltage is incorporated so that the maximum sensitivity of the receiver can be realized for weak signal reception. When amplified and delayed AGC is used to control a receiving system, the overall output versus signal input characteristics can be made to approach an almost ideal condition.

Figure 10-28 shows block diagrams for two basic types of amplified and delayed AGC systems. Section (A) of the figure shows a system in which the signal is amplified by an AGC IF amplifier before rectification by the AGC diode. Section (B) shows a system in which the signal voltage is amplified by a d-c amplifier after rectification by the AGC diode. The d-c amplifier stage is followed by a delay diode. AGC voltage is supplied to the controlled stages only when the diode's cathode is negative with respect to its plate, and the diode conducts. When the delay diode is not conducting, the AGC output voltage is zero and the receiver gain is at maximum for signals below the threshold of AGC operation.

The delay voltage is applied to the AGC detector, which follows a separate amplifier. The AGC IF amplifier receives its signal from the last IF amplifier of the receiving system.

A variation of this AGC system employs an independent AGC amplifier channel consisting of several stages with greater overall amplification (gain) than does the signal IF amplifier channel. In the system illustrated in (B), the delay voltage is applied to the d-c amplifier stage. Almost all AGC circuits using a d-c amplifier to control the AGC voltage employ a delay diode in the output to prevent the d-c output voltage from ever becoming positive with respect to ground.

AFC

Automatic frequency control (AFC) systems are commonly incorporated into radio or radar

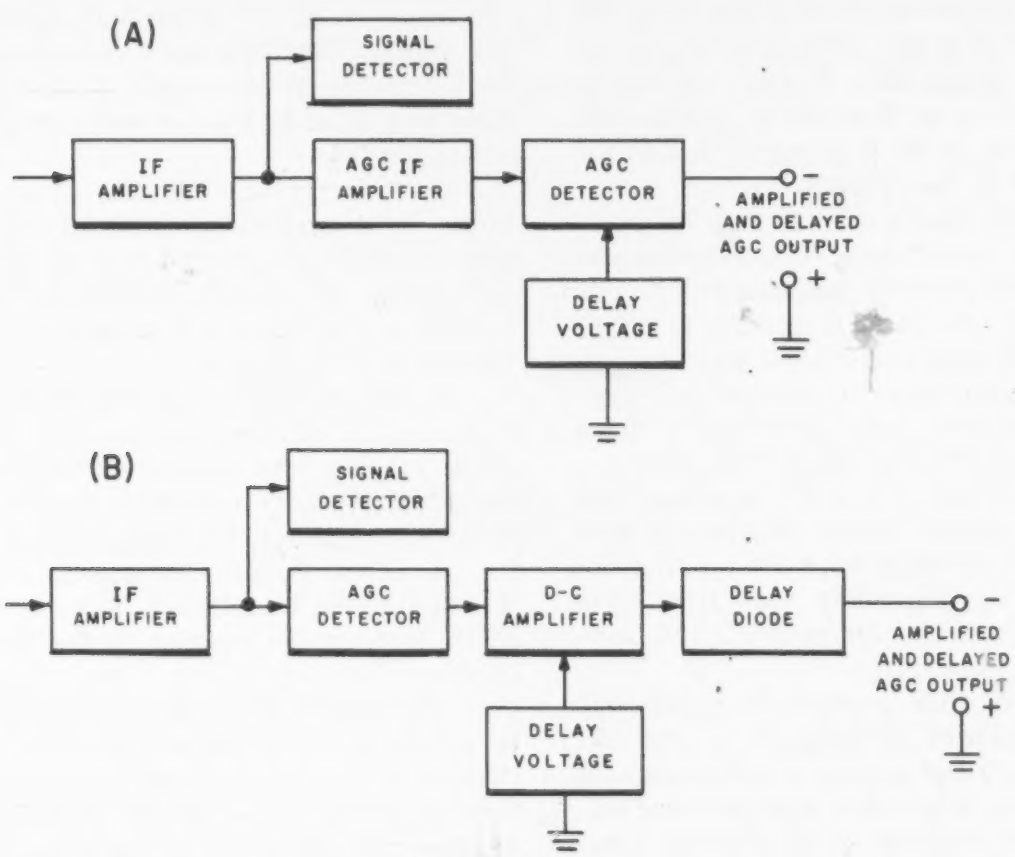

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Figure 10-28.–Amplified and delayed AGC systems.

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receiving circuitry. The purpose of an AFC system is to maintain the appropriate operating frequency of the local oscillator. Oscillators in the UHF and microwave regions have generally poor frequency stability; this instability is often caused by factors which are negligible at lower frequency ranges. Among the major factors are the following:

1. Physical size. The frequency-determining components are necessarily small. Any condition that changes their shape or size causes a change in frequency. Such conditions include vibration, thermal expansion, etc.

2. Frequency pulling. Changes in load cause changes in energy reflections, which effectively means a change in the nature of circuit impedance. The reactive component of the impedance change is combined with the frequency-determining reactances. Thus the operating frequency is also changed. Changes in load may result from such factors as changes in the characteristics of transmission lines, or from reflected energy (echoes) from nearby objects (such as sea return, ECM chaff, aircraft structures, the radome, etc.). Reflected energy changes may also result from variations of the surrounding air (density, moisture content, temperature, etc.).

3. Voltage variations. These variations may be caused either by fluctuations in the primary power source or by poor regulation in the power supply unit of the system.

Because of the inherent frequency instability, it is important that tuning of microwave oscillators be accomplished automatically. For this reason, some type of AFC system is incorporated in all airborne radar sets, and in many other classes of microwave receivers and transmitters. AFC systems are classified in three ways, all according to some aspect of operation. One classification divides AFC systems into single mixer or double mixer classes. A second classification distinguishes the hunting and nonhunting classes. The other classification is according to "absolute frequency" or "frequency difference" operation.

Chapter 11 of this manual, in connection with microwave mixers, contains some information on single ended and double ended mixers. A comparison of that discussion and the information in the present chapter could produce some confusion. As occasionally happens, the same or similar words are used in the classification of two different types of systems. The present discussion is concerned with the operation of AFC systems, which include mixers; the chapter 11 discussion is concerned with the operation of the mixer itself.

All AFC systems require the use of some form of discriminator to detect frequency differences between the oscillator and the reference frequency standard. Also required in all AFC systems is a control circuit to compensate for the difference by shifting the oscillator's frequency.

The type circuitry and provisions for control used in a given set depend on the particular type and specific application of the system.

The following paragraphs present a very brief summary of some important considerations for each of the six basic classes of AFC systems.

Single Mixer

In a single mixer AFC system (fig. 10-29) a portion of the transmitter output is leaked into the mixer, where it beats with the local oscillator signal. The difference frequency (the IF signal) appears at the ouput of the mixer and is then amplified by one or more stages of IF preamplification.

At this point, the IF signal follows two paths–it is further amplified and fed to the detector, and it is also fed into the AFC discriminator. The output voltage from the discriminator varies in amplitude and polarity with changes in the applied frequency.

If the applied frequency (the IF) is at the resonant or center frequency of the discriminator circuit, the output voltage is zero. If the applied frequency is either above or below the desired frequency, the output of the discriminator is either positive or negative depending on the direction of deviation. Voltage magnitude is dependent on the amount of the frequency difference.

The output of the discriminator is then fed to either a d-c amplifier or to some other type control circuit which controls the klystron's reflector voltage. Variations in reflector voltage causes the klystron to shift its frequency of oscillation.

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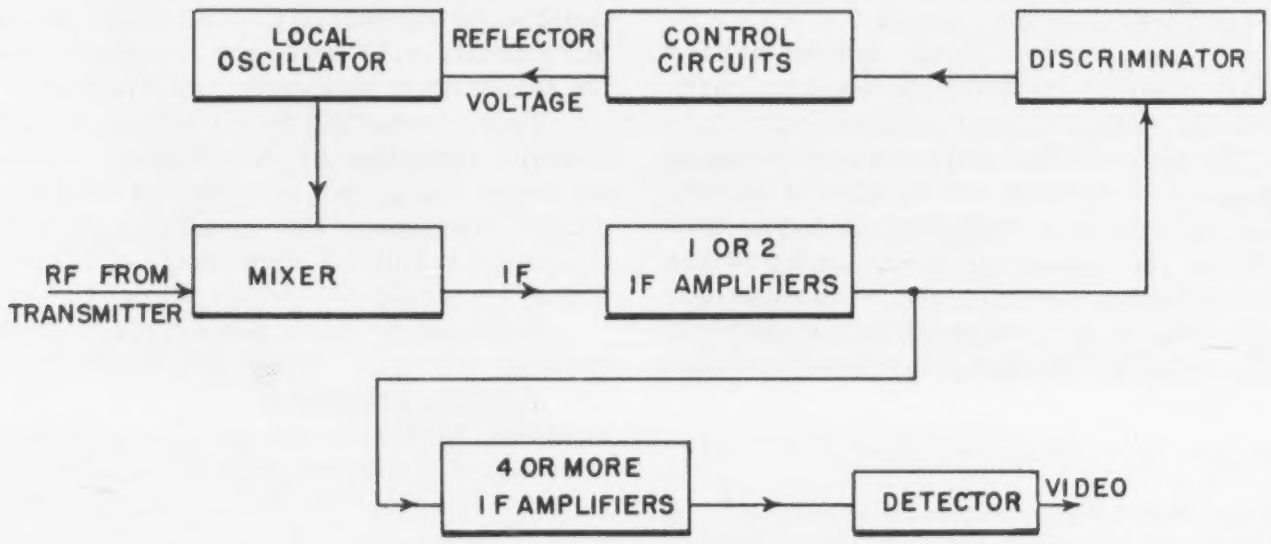

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Figure 10-29.–Single mixer AFC system.

Double Mixer

Most modern radar systems utilize a double mixer AFC system such as that shown in figure 10-30. The separate signal mixer and the AFC mixer are both connected to the same local oscillator. The AFC mixer is coupled to the transmission line through an attenuator which reduces the transmitted pulse and the received echoes by the same ratio. With this arrangement, strong signals from nearby radar, jammers, or sea returns cannot affect the operation of the AFC loop. The double mixer system is similar to the single mixer system, except that the former contains an AFC attenuator and separate IF stages.

Hunting

Almost all radar sets in naval aircraft use the hunting method of AFC. Basically, the hunting system causes the oscillator to sweep through a wide frequency range–wider than the frequency variation range of the radar. This sweep of operating frequency permits the AFC system to find the correct frequency, lock on, and automatically maintain the oscillator on that frequency. This method offers the advantage of automatically locating the new frequency in the event of a sudden large frequency deviation.

Sweeping of the frequency range is usually accomplished by applying a sawtooth of voltage to the reflector of a klystron oscillator. The

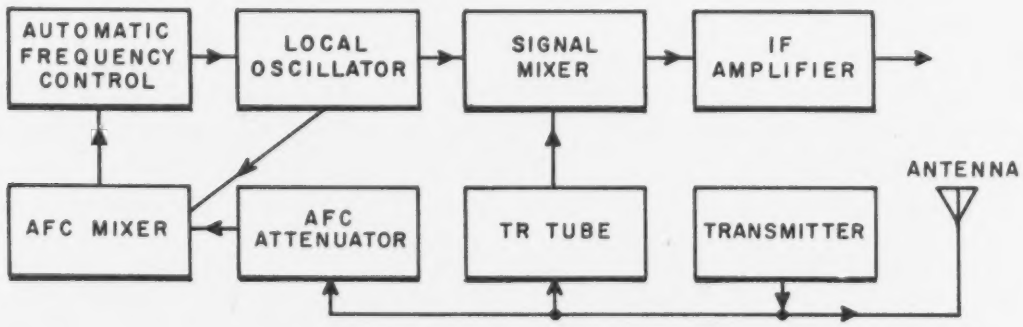

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Figure 10-30.–Double mixer AFC system.

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most commonly used sawtooth generators for this purpose are the thyratron and the phantastron, but other types may be used.

A variation of the hunting system utilizes an audiofrequency sine wave superimposed on the sawtooth. This method improves the lockon feature of the basic system and increases the speed of response to frequency shifts. Almost all AFC systems incorporates some type of lockon feature. When the oscillator is operating at the proper frequency, sweeping action is stopped and slight variations are compensated. In the event of a large sudden shift, lock is broken and sweeping is resumed.

Nonhunting

In the nonhunting system, the oscillator is manually tuned to the correct frequency and is then maintained electronically at that frequency. Usage of the nonhumting system is normally limited to equipments where transmission and reception are independent operations (such as single sideband and data link) requiring precise frequency of operation.

Although no sweeping is accomplished, a discriminator is used to detect frequency changes. The discriminator output, in turn, is used to shift the frequency of the oscillator as required, within a narrow allowable frequency range. This method is not usually used in radar systems due to the narrow allowable drift range.

Absolute Frequency

In the absolute frequency system, the operating frequency is determined by a precision frequency standard such as a high-Q cavity. This system is used to maintain the oscillator at the assigned frequency of a transmitter at some remote location. It may also be used to maintain the transmitter at an assigned frequency.

This system has the advantage of permitting reliable reception of intermittent signals with no delay while the receiver searches for the proper frequency. The disadvantage is that the transmitter and receiver must operate on the same frequency, or no reception is probable.

In order to maintain such a precise frequency, eleborate voltage regulation, isolation, and shielding provisions are required. For these reasons, airborne use of this system is not common. Even in data link applications, the frequency difference method is usually employed.

Difference Frequency

In the difference frequency system, the local oscillator is maintained on a frequency which is greater or less than the magnetron frequency. The difference in frequencies is an amount equal to the IF of the receiver. This maintains the tuning of the receiver during search operations.

In normal radar operation, the received echo is of the same frequency as the transmitted pulse (disregarding the slight Doppler shift). Therefore, a fixed tuned IF channel can be used to provide maximum gain. Bandwidth need be only wide enough to cover the normal frequency drift–hunting may be incorporated for unusual shifts.

CHAPTER 11

SPECIAL CIRCUITS AND COMPONENTS

ELECTROMECHANICAL DEVICES

In modern naval aircraft, mechanical and electrical devices for sensing changes in direction and attitude are indispensable. Among the systems which depend upon such devices for their operation are the following:

1. Gyrocompass systems.
2. Flight control systems and autopilots.
3. Radar, camera, and gun platform stabilization systems.
4. Antenna tracking rate measurement systems.
5. Inertial navigation systems.

In addition to sensing devices, aircraft systems require that indications be made available to the pilot, navigator, and operating personnel concerning the operation of many equipments and systems. Many of these indications originate in equipment which must be physically located in places not accessible to the personnel responsible for monitoring them. Electromechanical devices are frequently employed to provide these remote indications.

Among the devices discussed in this section are the synchro, the gyro, the accelerometer, and the servosystem.

SYNCHROS

A synchro is an electromechanical analog converter. It may, through inductive means, give an electrical output which is a function of its rotor position; or it may position its rotor to an angle which is a function of the electrical input. The term synchro, as it was originally used in the Navy, included a category of induction devices. The term is now used rather loosely in general application. According to the military specification, however, proper use of the term is limited to one of five types of devices, as listed below.

1. Synchro transmitter–converts a mechanical input (rotor position) into an electrical output.
2. Synchro receiver–converts an electrical input into a rotor position (mechanical output).
3. Synchro differential transmitter–gives an electrical output which is a function of two inputs, an electrical input and its rotor position.
4. Synchro differential receiver–gives a mechanical output which is a function of two electrical inputs, the primary and secondary.
5. Control transformer—gives an electrical output, with a varying magnitude and polarity, which depends on the relative position of the rotor and stator.

Theory of Operation

A basic introduction to synchros is presented in chapter 19 of Basic Electricity, NavPers 10086-B. The discussion presented in the following paragraphs is intended to summarize the basic manual and to present additional details and data of practical use to the technician.

In normal operation, a synchro can be treated as a complex transformer in which the coupling coefficient is proportional to the cosine of the angle between the primary and the secondary. All synchros use a WYE connected stator winding. The rotor is either a WYE or a single winding, depending on the device.

A synchro is a single phase, 60- or 400-hertz device. The output voltages, line to line, are either in phase or 180° out of phase with the rotor voltage. The three-line-to-line stator volt-

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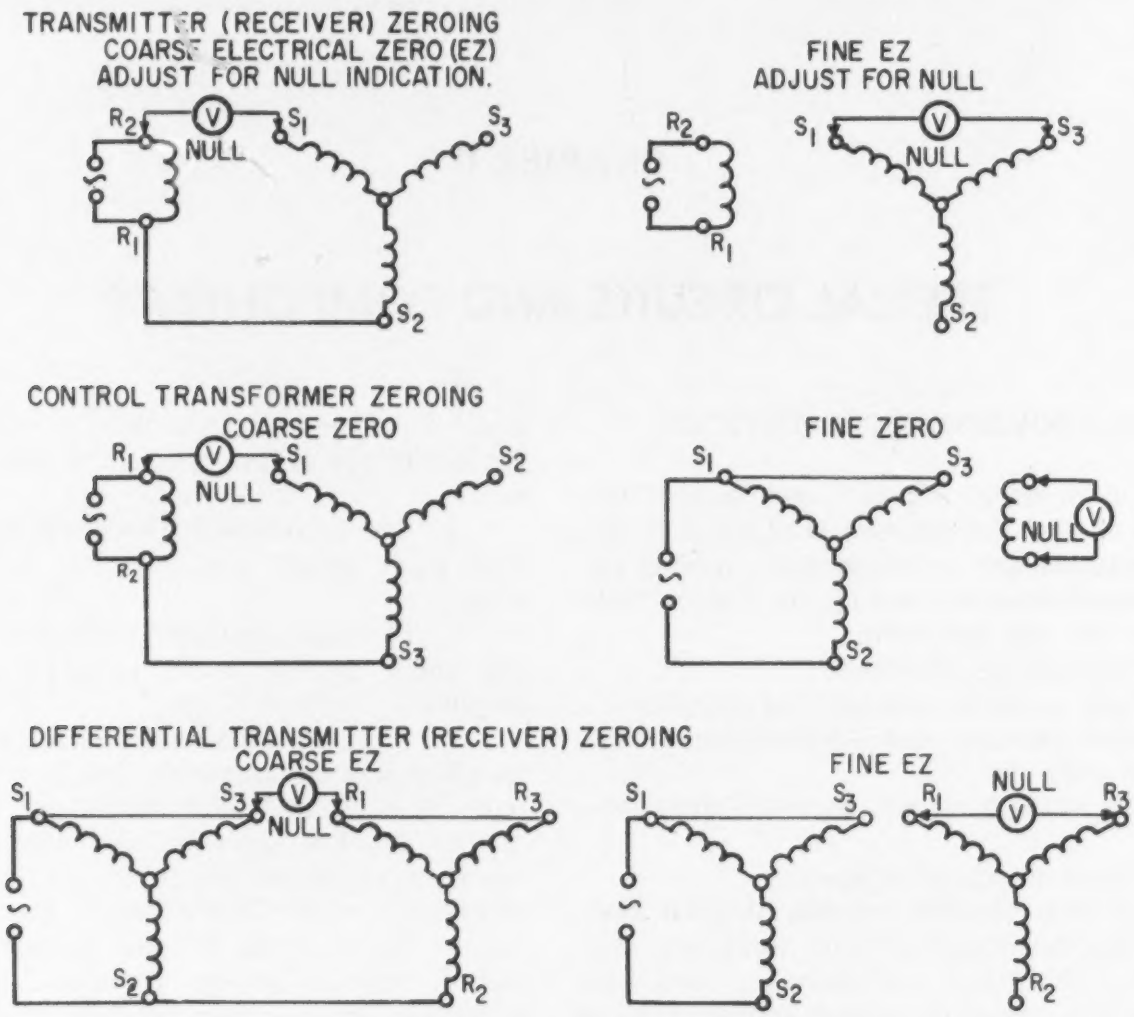

Figure 11-1.–Electrical zeroing procedure.

ages uniquely identify a single electrical angle between 0° and 360°.

In order to identify the electrical angle, an arbitrary electrical zero (EZ) has been chosen for each device. (See fig. 11-1.) This electrical zero is an internal reference–the angle that the rotor makes with respect to the stator under specified conditions.

If a voltage of known amplitude and frequency is impressed on the rotor of a synchro, the voltages induced in the stator describe a single angle. This mechanical-to-electrical analog is the principle of the synchro transmitter. If these three voltages are applied to the stator terminals of a synchro, the voltage induced in the secondary (rotor) is proportional to the sine of the difference between the electrical angle represented by the stator voltages and the mechanical rotor angle.

In the synchro control transformer, the output voltage is normally supplied as an error signal driving a device which turns the rotor. The rotor continues to be turned until the synchro's electrical angle coincides with the input (command) angle. At this position the output voltage of the transformer drops to zero.

In the synchro receiver, the secondary (rotor) is connected to the same a-c excitation as the transmitter. The two synchros, transmitter and receiver, are connected in parallel. When both rotors make the same electrical angle, identical voltages are induced in the respective transmitter and receiver stator windings. Since the voltages are identical, no current flows in the external wires or in the stator winding; therefore, no magnetic field is induced. If the rotors do not make the same angle, the voltages induced in the transmitter stators are different

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from those in the receiver stators, and currents flow, creating an associated (stator) magnetic field in both synchros. The magnetic field of the rotor, interacting with the magnetic field of the stator, attempts to turn the rotor until the fields coincide. If the transmitter rotor is not permitted to turn, the receiver rotor turns until the turning force reaches zero. Both torque arm and magnitude decrease as the error angle–the difference between the transmitter and receiver angles–approaches zero. At angles near zero, only a weak magnetic field is induced by the stator currents; therefore, to prevent overshoots and resulting oscillations, receiver rotors are provided with additional mechanical damping.

The chief difference between synchro units is in rotor design; each device is designed to have the best electrical properties when connected into the system in the expected manner. Any one of them could be connected as either of the others (transmitter as receiver or transformer, etc.), but with attendant problems such as hunting or decrease in accuracy and speed.

The differential transmitter and the differential receiver have a WYE connected rotor as well as a WYE connected stator. They are designed to supply an output angle which is the sum, or difference, of two input angles; the differential transmitter combines an electrical and a mechanical angle to furnish an electrical output. The receiver combines two electrical inputs to furnish a mechanical output. As in the other synchros, the major difference between the transmitter and the receiver is in rotor construction, the receiver rotor being designed to provide increased damping.

When the stator is excited by voltages normally supplied by a synchro transmitter, voltages are induced into each of the rotor windings. The voltage induced into each secondary winding varies with mechanical displacement in the same manner as in a regular synchro, except that in this case there are three outputs, displaced 120° electrically from each other.

The primary input voltages to the stator create a resultant magnetic field. Changing the input voltages to indicate a different angle will change the orientation, but not the magnitude of the resultant field. It is thus possible to have this primary field represent any angle with respect to zero. At the same time, it is also possible to position the rotor, causing the output electrical data to be advanced an electrical angle equal to the mechanical deviation from electrical zero.

In the differential receiver, the stator and rotor fields form a magnetic couple as in the synchro receiver. (Each field inside the case may be considered as that of a simple bar magnet.) The rotor will turn, if free to do so, until the two fields are alined.

System Alinement

Since the stator is normally fixed with respect to the case, the internal reference is easily extended by turning the case until the electrical zero angle coincides with a convenient external reference point. In a particular system this point may be identified by a scribe mark, by a locking pin, by an optical sight arrangement, or by a zero reading on a dial or gage. The particular means used is not important, except that the adjustment can be repeated with greater accuracy in some kinds of systems than in others.

All synchros in a system having an external reference should be alined to that reference. Not infrequently, systems are "adjusted" by turning any intermediate device until the output indication agrees with the input. When a unit is changed, angular agreement is lost, to be regained by turning the case of a convenient synchro. This solution requires only one step to aline the synchro system each time a component of the system is changed. It may be acceptable if useful data is taken out of the system at only one point.

If a number of outputs are taken from different points in the system, it becomes imperative that the system be properly alined and that all components indicate proper angles at all times, rather than a + 15° error at one point in the system balancing a -15° error some place else in the system. This can be done either by completely alining the system, starting at a known good zero reference and working toward the final transmitter, or by establishing an external standard and insuring that all synchros are properly zeroed to this standard prior to installation. This second solution becomes very tricky if there are any mechanical linkages required in the installation; if all linkages are electrical, a synchro will automatically indicate the correct angle when installed.

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GYROS

Although every spinning object exhibits some gyroscopic properties, a true gyroscope is a complex item designed and mounted specifically to utilize these properties. Several types of gyros have been developed for various applications. Although each type exhibits its properties in a somewhat different manner, all operate on the same basic principle.

Basic Principles

Every object possess inertia; it tends to maintain its present position if at rest, or to continue in uniform motion if moving. A moving body also possess momentum; the amount of momentum depends on the mass of the body and its velocity. A body possessing circular motion (a revolving body) must maintain a balance of forces in order to revolve in a uniform path. A rotating mass represents a special type of revolving body, where the center of mass and the center of revolution coincide. Basically, a gyroscope is a spinning mass which has a high mass-to-size ratio and a high speed of rotation.

The spinning mass, called the rotor, is in itself the gyroscopic element. It is mounted in such a manner that the friction at all points is kept as small as possible, and is equally distributed to present balanced forces acting on the common centers of mass and rotation.

Figure 11-2 illustrates a demonstration gyro used to explain and demonstrate gyroscopic terms, principles, and operation. This figure should be used for reference throughout the following discussion of the basic gyro. (The rotor shaft mentioned previously is actually the spin axis.)

The rotor is mounted so that it is free to spin on its axis. As the rotor spins, its momentum increases with an increase in rotational speed. Each particle of the rotor which is not located on the axis of rotation possesses some momentum, depending on its mass and its linear velocity. The total momentum of the rotor is the total of the momentum forces on all particles. Figure 11-3 and the subsequent discussion show how the distribution of rotor mass affects rotor momentum. The three rotors shown are assumed to have the same specific density (mass-to-volume ratio), equal mass, and equal angular velocity.

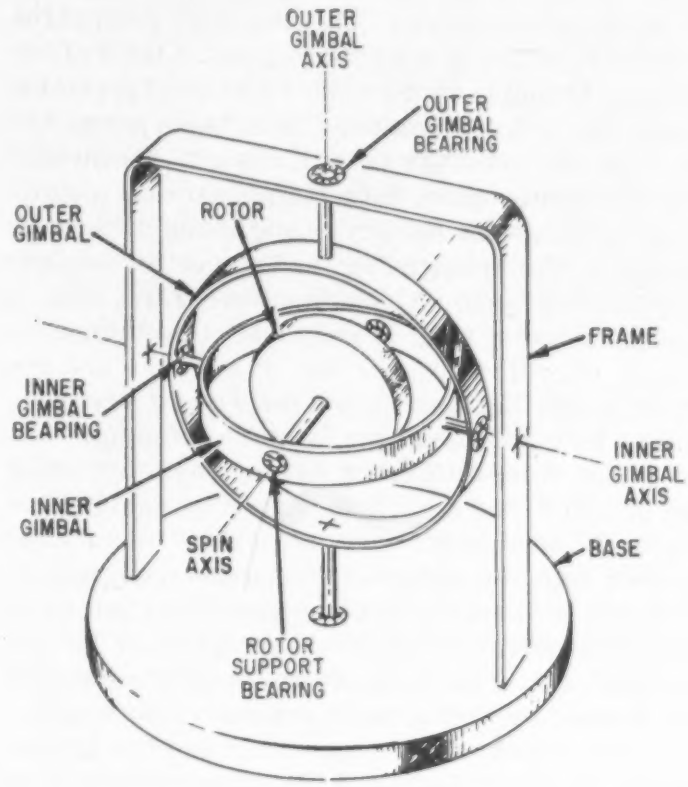

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Figure 11-2.–Demonstration gyro.

As previously stated, momentum varies directly with both mass and linear velocity. Since in the present discussion the mass of each rotor, as well as the mass of each particle of each rotor, is assumed to be equal, mass may be disregarded in the following comparisons.

Linear velocity varies directly with the angular velocity and with the effective radius of rotation. In the current discussion, the angular velocity (revolutions per second) is assumed to be the same for each rotor, and may

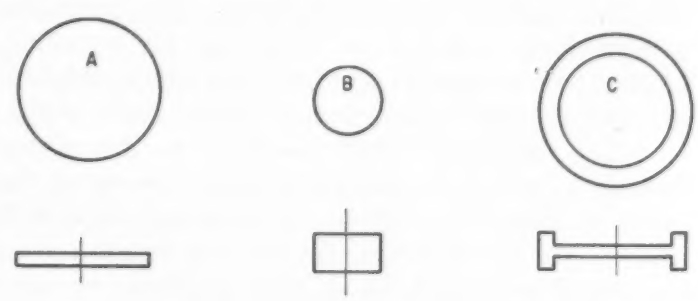

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Figure 11-3.—Effect of rotor design on momentum.

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therefore be disregarded. Thus, for the three rotors shown in figure 11-3, a comparison can be made on the basis of the effective radius of rotation.

Rotor A (fig. 11-3) is a thin disk with a comparatively large radius and uniform thickness. In this instance, the effective radius is equal to one-half the radius of the rotor (due to the uniform distribution of particles). Rotor B also has uniform distribution of particles; but due to its shape (thick and with a comparatively small diameter), its effective radius is somewhat smaller. This rotor possesses less momentum than rotor A at the same angular velocity.

Rotor C, on the other hand, does not have a uniform distribution of its mass. Due to its shape, the particles are concentrated toward the outer rim, and the effective radius is somewhat more than one-half radius of the rotor. A rotor with this shape would normally have greater momentum than either of the others illustrated.

In effect, the momentum of the rotor acts in a plane which contains the center of rotation and the orbit of the average particle of the rotating mass (the plane of rotation).

The rotor must be built so that the plane of rotation is perpendicular to the spin axis. As shown in figure 11-2, the rotor shaft is supported by low friction bearings mounted in the rotor support. The momentum of the rotor acts to maintain rotation within the plane. It resists any attempt to change the plane of rotation by tilting the spin axis to an angle not perpendicular to the original plane. A stationary gyro is relatively free to move in any direction as long as the spin axis maintains its perpendicular relationship with respect to the original plane of rotation.

Properties of Gyroscopes

DEGREE OF FREEDOM.–A rotor mounted in a rigidly fixed support would serve no useful purpose. A practical gyro must be constructed in such a manner that the base can be maneuvered or changed with respect to the spin axis and the plane of rotation. When the base is rotated in such a direction that the plane of rotation is not changed, the gyro is said to possess FREEDOM in that direction.

Gyro freedom is provided through the use of GIMBALS (fig. 11-2). A gimbal is a supporting structure that is able to revolve so as to provide the gyro with a DEGREE OF FREEDOM. A gyro having two degrees of freedom is able to maintain its plane of rotation regardless of the movement of the base, and is called a FREE gyro. Free gyros require two gimbals.

The term "degrees" of freedom must not be confused with angular measurements. As applied to gyros, the term indicates the number of directions in which the base may be rotated without disturbing the plane of rotation.

In figure 11-2 note that each gimbal is supported through an axis which is perpendicular to the axis of the element which is supported by the gimbal. Each gimbal is mounted in low friction bearings to provide greater precision and less opposition to desired motion.

RIGIDITY.–As previously discussed, one of the basic properties of the gyroscope is its opposition to any change in its plane of rotation. It tends to maintain a fixed position in space. This property is called RIGIDITY. A gyroscope possesses rigidity because of, and in an amount directly related to, the momentum of its rotor. Gyroscopic rigidity is not absolute, however; the plane of rotation can be changed in several ways.

PRECESSION.–If a force is applied to the rotor shaft, the spin axis of the gyro may be tilted. The tilting represents rotation of the axis, and occurs in the manner shown in figure 11-4 and described in the following paragraph.

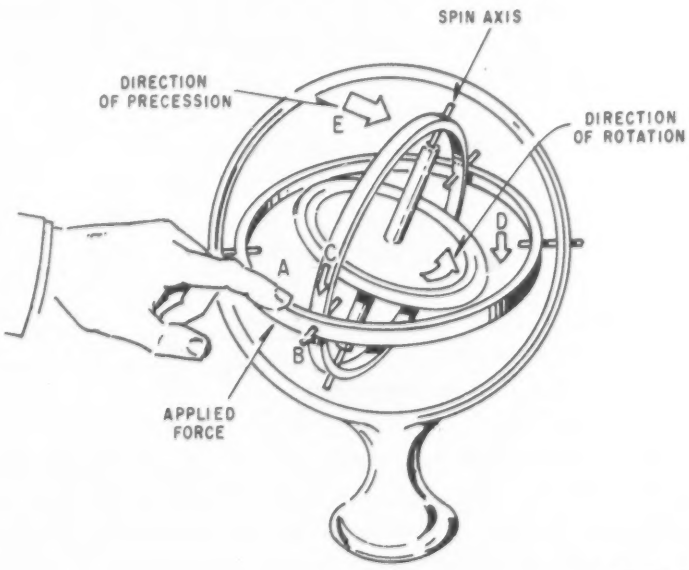

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Figure 11-4.–Gyroscopic precession.

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A downward force applied to the outer gimbal at point A is transferred through pivot B to the inner gimbal, and is felt as a downward force at point C. The downward force on the inner gimbal at point C, in turn, travels 90° in the direction of rotation and causes a downward movement of the rotor at point D. This downward movement of the rotor at point D represents a rotation of the spin axis in the direction indicated by the arrow at point E. This rotation of the spin axis is called precession.

The property of precession is closely associated with the property of rigidity. The two properties are mutually dependent; a gyro does not possess rigidity if it does not precess, and a precessing gyro always offers some amount of rigidity.

The tilting force which causes a gyro to precess is called a TORQUE. It acts at some distance from the center of gravity, and has a magnitude which depends on the amount of force and the distance at which it is applied. It produces angular displacement of the spin axis (and the plane of rotation); angular displacement is a partial rotation. Precession of a gyro is always a reaction to an applied torque. (One cannot precess a gyro–one can only apply a torque that will cause a gyro to precess itself.)

A force applied to the rotor at its center of gravity does not tend to precess the gyro. A spinning gyro can be moved in any direction as readily as a gyro at rest, provided the spin axis remains parallel to its original position in space. (This type of motion is called TRANSLATIONAL motion.) Because of this feature, a gyro cannot provide stabilization in planes perpendicular to the spin axis–the gyro makes no response to motion in these directions. For complete stabilization in aircraft, two gyros, with their spin axes perpendicular to each other, are required. Motions which do not affect one gyro produce the necessary response in the other. The dual installation permits the establishment of reference lines from which any changes in pitch, yaw, or roll may be measured.

Thus far the discussion of precession has centered on the precession of a gyro as viewed in relation to its established position in space. This is referred to as REAL precession. A free gyro which is stationary with respect to a fixed point on the surface of the earth exhibits an additional property called APPARENT precession. Rigidity fixes the spin axis in space; the earth, which is rotating, revolves around the rotor. Thus, as viewed from its fixed position on the surface of the earth, the axis of the gyro appears to tilt (or precess) at a rate which corresponds to the rate of rotation of the earth about its spatial axis.

Apparent precession makes a completely free gyro unfit for use as a reference for earth-bound equipment over an extended period of time. To compensate for apparent precession, an ERECTING mechanism is normally incorporated to maintain the spin axis in a fixed position relative to the earth's surface.

DRIFT.–The gyro spin axis does not always point in the direction it theoretically should. This error in the gyro is produced by random inaccuracies in the system. The resulting change in position of the spin axis is called DRIFT. There are three general sources of drift in a gyroscope, as follows:

1. Imbalance. A gyroscope often becomes dynamically unbalanced when operating at a speed or temperature other than that for which it was designed. Some imbalance exists in any gyro since manufacturing processes do not give perfect symmetry.

2. Bearing friction. Friction in the bearings of the gimbals results in lost energy and incorrect gimbal positions. Friction in the spin axis bearing causes drift only if the friction is not symmetrical; an even amount of friction all around in a bearing results only in a change of the rate of rotation.

3. Inertia of gimbals. Energy is lost whenever a gimbal rotates because of the inertia of the gimbal. The greater the mass of the gimbal, the greater the drift from this source.

Complete elimination of drift in gyroscopes appears to be impossible. However, great strides have been made in recent years twoard reducing the amount.

Types of Gyros

A gyro is a bilateral device. If a torque is applied, the gyro precesses at an angular rate proportional to the magnitude of the applied torque. If a gyro is caused to precess at an angular rate, the gyro develops a torque which is proportional to the rate of precession. This feature indicates the two basic types of gyros–distinguished mainly by the input and output devices.

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The bow instruments are used for small circles, particularly when a number are to be made of the same diameter. Small adjustments should be made with one hand with the needle point in position on the paper (Fig. 7).

FIG. 7

There is no doubt that continuous practice in the proper use of a compass will greatly improve the technique of using it. Repeated exercises in the use of a compass will aid the beginning draftsman immeasurably.

ASSIGNMENT:

1. Draw a horizontal line through the approximate center of your drawing paper. On it, mark off radii for 8 concentric circles $\frac{1}{4}$ inch apart. Draw the smallest circle first. See illustration.

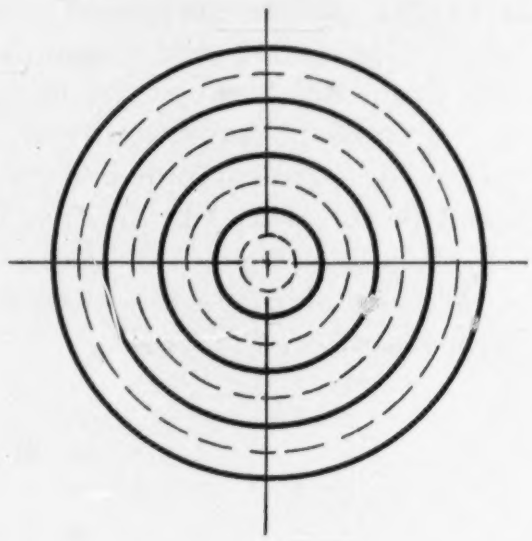

2. Draw a 2-inch square in the approximate center of your drawing paper. Identify points A, B, C, D, E, as shown. Divide AE into 4 $\frac{1}{4}$-inch spaces, using your scale. With compass and centers A, B, C, and D, draw 4 semicircles with a $\frac{1}{4}$-inch radius, 4 with a $\frac{1}{2}$-inch radius, etc. Complete the figure by drawing the horizontal and vertical lines as shown. Be sure to use your triangles and T-square.

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DISPLACEMENT GYRO.–This type of gyro is used to measure angular displacement of the base mounting from an established reference line. The reference line is established by the spin axis and is maintained fixed by the rigidity of the gyro. In aircraft gyro systems, motion of the aircraft with respect to sensitive axes (roll, pitch, and/or yaw) results in angular displacement of the gimbals with respect to the spin axis and plane of rotation. Angular displacement is measured by means of synchros, potentiometers, capacitive or inductive bridges, etc. The device used to detect angular displacement and develop the error signal is called a PICKOFF.

RATE GYRO.–A rate gyro usually has a single degree of freedom, and is subjected to an angular rate about its sensitive axis as illustrated in figure 11-5. In response to displacement in the sensitive (quadrature) axis, the gyro develops a torque which is proportional to the rate of angular displacement. Instead of allowing complete freedom of motion about the gimbal axis, the rate gyro has a restraining device (spring). The gimbal is able to rotate about its axis only until the restraining force becomes equal to the torque developed by the gyro. A pickoff arranged to measure the angular displacement of the gimbal axis may be used to measure the angular rate of the input.

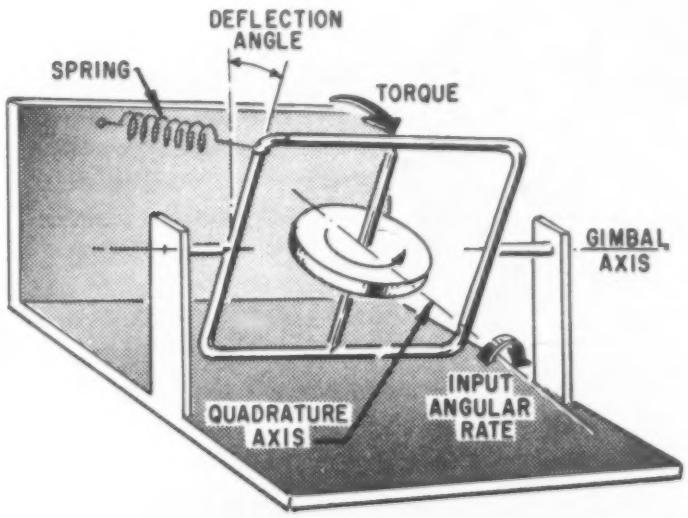

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Figure 11-5.–Simplified rate gyro.

ACCELEROMETERS

Accelerometers have been used for many years, but until the last few decades they were used mainly in laboratories. They are now in common use as a means to measure an aircraft's rate of change or deviation from its planned course. They are used in conjunction with autopilots, inertial navigation systems, etc. They are also used to help the pilot land his aircraft by indicating the vertical acceleration. An additional use of the accelerometer is to judge the amount of dynamic and aerodynamic force imposed upon the pilot.

Acceleration can be defined as the rate of change of velocity of a moving object with respect to time. Velocity is the rate of change of distance with respect to time.

An example of a simple accelerometer is shown in figure 11-6. Although this is a simplified version, the basic accelerometer principles may be observed. When there is no acceleration (as shown in (A)), the two springs attached to the mass maintain the mass in the center, or null, position. Therefore, the meter indication is zero.

If an application of force causes the accelerometer housing to move suddenly from left to right, the mass (conforming to Newton's law) tends to remain stationary. This causes the meter needle to pivot about its axis and give the indication shown in (B). When the force is no longer applied, the springs again center the mass and the meter returns to zero. Conversely, if the force is applied from the opposite direction, the same principle causes the mass to react in the same manner, but with the opposite indication on the meter. The damper pistons and cylinders

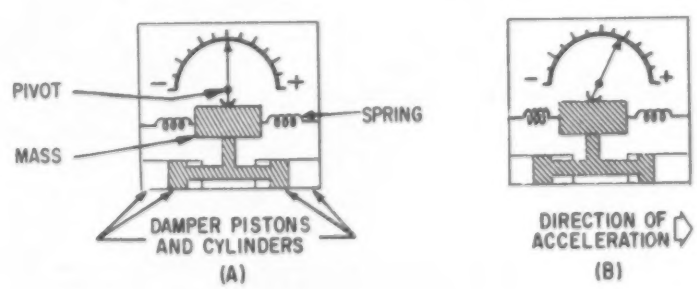

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Figure 11-6.–Simplified accelerometer.

prevent vibration and over sensitivity of the accelerometer by damping transient movements.

Vertical Reference Accelerometer

Figure 11-7 is a mechanical schematic of a vertical reference accelerometer currently used in naval aircraft. The three pointers on the face of the dial indicate instantaneous negative or positive vertical acceleration as well as the maximum acceleration in either direction during any selected period of time. With the aircraft in level flight, the instantaneous acceleration pointer reads positive 1 G.

As illustrated in the schematic, vertical movement of the mass causes the cord-pulley assembly to move. This turns the main pointer shaft and rotates the main pointer. As the shaft rotates, the main pointer driver arm moves toward one of the auxiliary pointer driver arms. If the G force is larger than any previously encountered, the two driver arms make contact

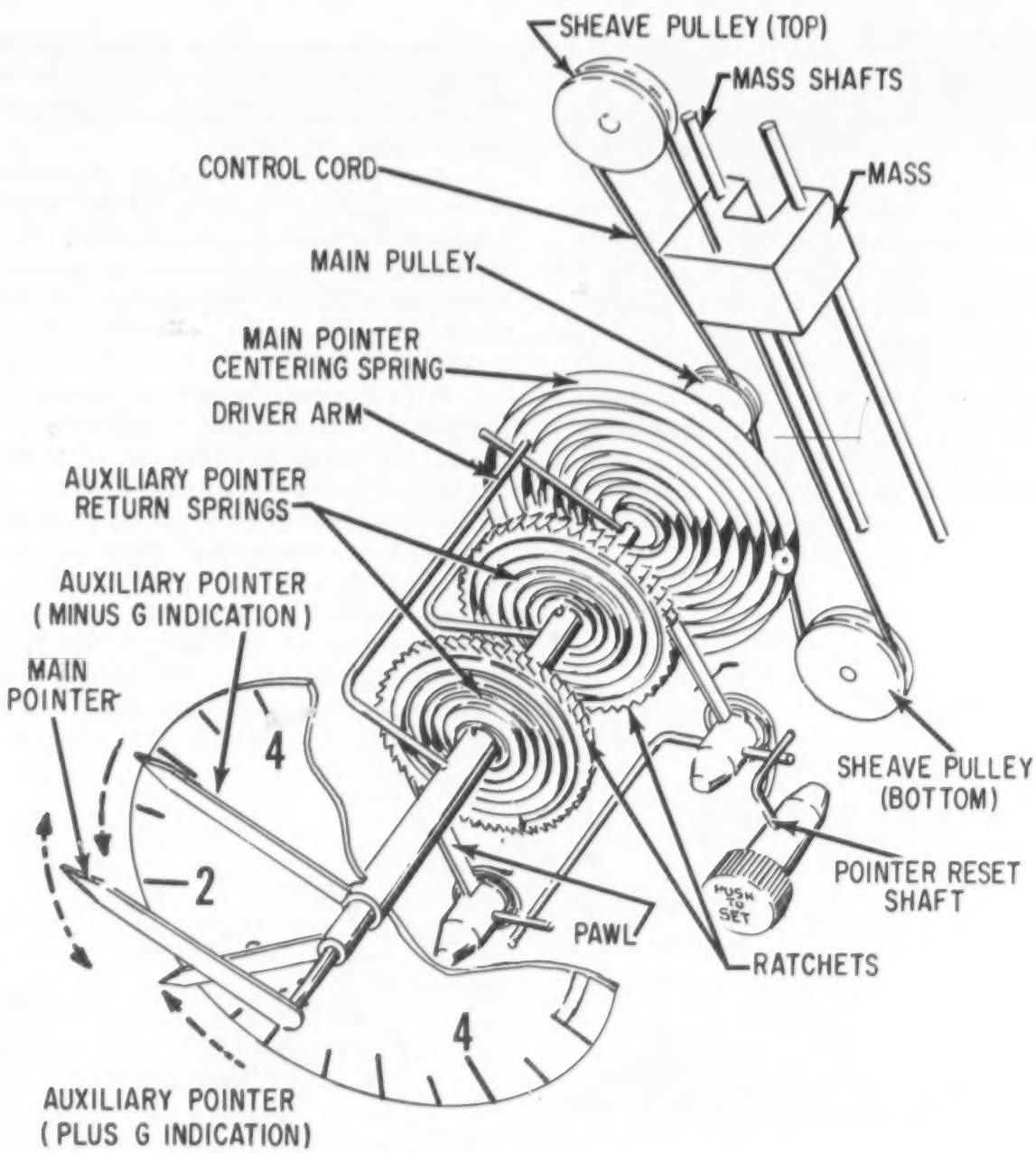

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Figure 11-7.–Vertical reference accelerometer.

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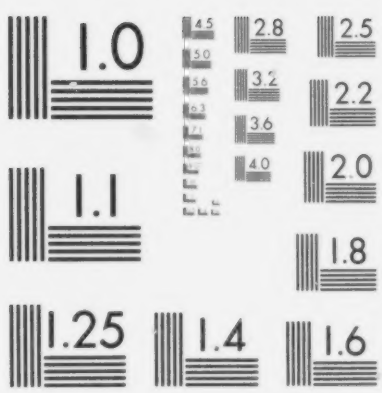

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

and the auxiliary pointer is driven in coincidence with the main pointer.

As the auxiliary pointer rotates, the pawl slides over the ratchet teeth; but when the G forces start to diminish, the pawl engages one of the ratchet teeth and holds the auxiliary pointer at its maximum excursion of travel. This indicates the maximum G force in that particular direction. The RESET knob on the face of the instrument allows the pointers to be returned to the null position when desired. It should be noted that the direction of vertical acceleration determines which auxiliary pointer will rotate.

Force Balance Accelerometer

An accelerometer commonly used with inertial navigation systems is the force balance accelerometer. A schematic representation of this type is shown in figure 11-8. The pickoff coil, the mass, and the torquer coils are all situated on a common movable shaft, which has the ability to make a partial rotation about its pivot point axis.

With zero acceleration, the induced current in the pickoff coil is balanced and the torquer coils keep the mass in the null position. However, as acceleration occurs, the mass velocity tends to remain constant. Since the stationary portion of the accelerometer assumes the new velocity, it causes one of the exciter coils to move closer to the pickoff coil and the other exciter coil to move farther away. Which exciter coil comes nearer to the pickoff coil depends upon the direction of acceleration. As the distance changes between the exciter coils and the pickoff coil, an unbalanced condition occurs in the pickoff coil circuit. This causes an error signal to be induced, which is amplified, changed to d.c., and applied to the torquer coils. Windings of all the coils are such that any unbalanced condition in the circuits produces a bucking (or reverse) current which counteracts the field of the torquer magnets and keeps the mass near mechanical zero. As the acceleration force increases, the amount of current necessary to keep the mass near the null position also increases. Since the current is proportional to the acceleration, the voltage drop across Rp, a precision resistor, is also indicative of acceleration. This voltage drop, E_{R_p}, then becomes the electrical output from the accelerometer. It can then be supplied to flight control systems as a function of acceleration.

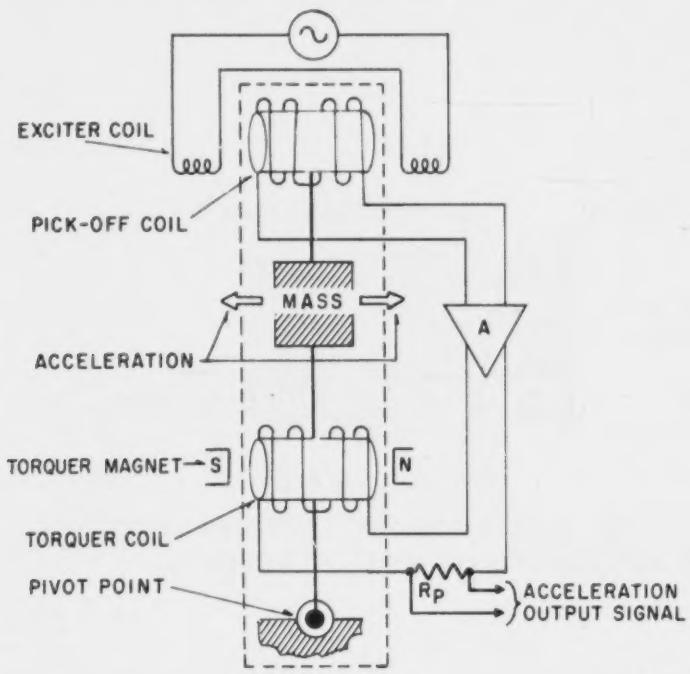

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Figure 11-8.–Force balance accelerometer.

Pulse Counting Accelerometer

Though the output of a force balance accelerometer is an analog current proportional to acceleration, there is need for accelerometer output signals to be in digitalized form. Pulse counting accelerometers satisfy this need, since their pulse output can be supplied directly to computers. A schematic of a pulse counting accelerometer circuit can be seen in figure 11-9 (A), while the cutaway view is shown in figure 11-9 (B).

With velocity remaining constant, the brush spring holds the mass at null and the brush rests on the reset contact of the switch. As acceleration occurs, the tendency of the mass to remain at a constant velocity causes the spring to compress. In doing so, it allows the brush to move off the reset contact; and if acceleration is great enough, the brush will pass over the switch contacts for acceleration levels 1, 2, 3, and 4. These levels are determined by the stiffness of the spring.

As the brush passes over each contact (in a positive direction), an output pulse from each

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contact is coupled to one of four counters. This advances the counter one-half count. The accelerometer is so designed that as acceleration decreases and the mass tends to assume the new velocity, the counters will not advance the remaining half count until the brush once again touches the reset contact. With this type of pulse output, it is possible to record each time gravity forces have reached a predetermined level.

Applications

There are many types of accelerometers in use today; the examples given constitute only three of them. However, since the basic principle that a mass in motion tends to remain in motion and one at rest tends to remain at rest applies to all accelerometers, all of them can be considered similar.

Vertical reference accelerometers are used to measure either position or negative acceleration, while the counting accelerometer determines vertical movement in one direction only. Force balance accelerometers aid in determining an aircraft's present geographical position in relation to its previous geographical position. This is accomplished by computing the aircraft's acceleration in both the North-South and East-West directions. The aircraft's navigation system combines this information with other inputs to determine the distance the aircraft has traveled and the direction of travel from a previous position.

MAGNETIC COMPONENTS

A basic coverage of magnetism and magnetic properties and components is presented in Basic Electricity and in Basic Electronics. The discussion in the current chapter is devoted to some of the specific details and applications of primary interest to personnel involved in maintenance of avionic equipment which make use of these devices.

Both permanent magnets and electromagnets are employed in airborne electronic equipment. A few of the many specific uses of permanent magnets are in the focusing of CRT electron beams, in the rotors of electric generating devices, in variable reluctance pickoff devices, and in magnetrons. A few of the many specific applications of electromagnets are in relays, in CRT deflection systems, in rotating electrical devices, and in magnetic amplifiers.

The main distinction between the two basic types lies in the fact that electromagnets retain their magnetic properties only while the electrical energy is applied; the permanent magnet requires no electrical energy in order to retain its magnetic state.

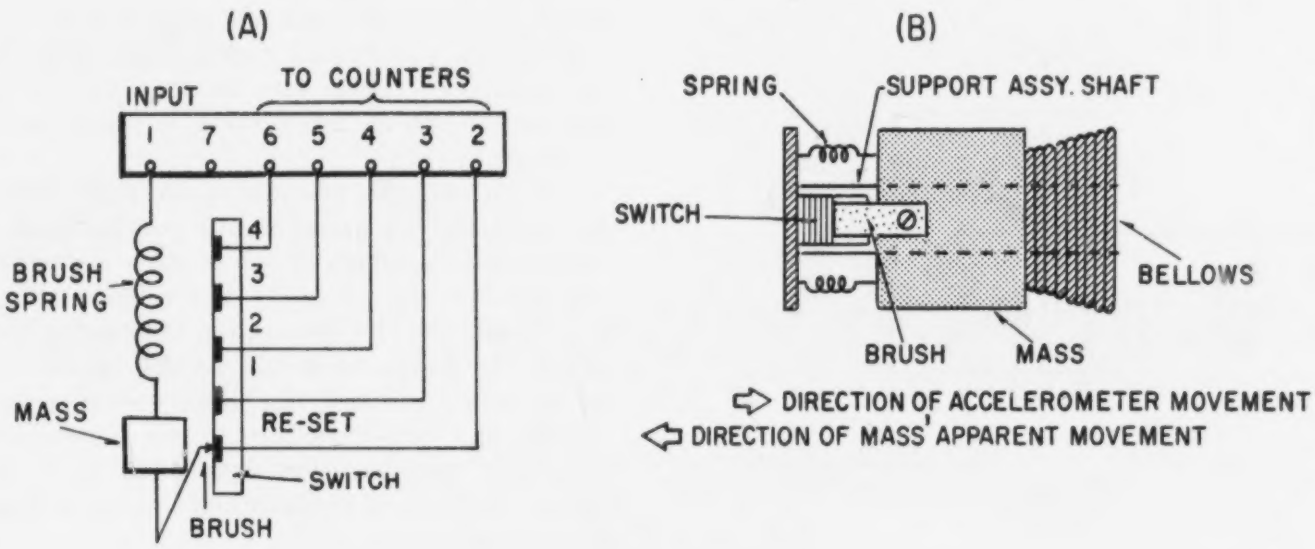

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Figure 11-9.–Pulse counting accelerometer.

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FERRITE MATERIALS

Magnetic materials are those materials which, either as their natural condition or due to some external influence, possess magnetic properties. The term FERRITE is applied to that portion of the latter group which possesses specific useful characteristics. Ferrites are hard, brittle, crystalline materials produced from a mixture of powdered materials including iron oxides.

By altering the mixture, ferrites may be developed to exhibit a variety of magnetization characteristics. Some ferrites are well adapted for use at low frequencies (such as magnetic amplifier cores and memory cores in computers), but are not usable at high frequencies (especially those frequencies falling in the microwave region). Microwave ferrites will be discussed in a later section of this chapter; the current discussion is limited to those ferrites used in lower frequency ranges.

The basic theory of magnetization is presented in Basic Electronics. Although that discussion is concerned primarily with general magnetic materials, it is equally applicable to ferrites. As mentioned previously, ferrites are a special class of magnetic materials developed to exhibit special characteristics.

Ferrites are classified in accordance with the special characteristics they exhibit. These characteristics include the relative and specific B-H relationships, flux densities attainable, eddy current and hysteresis losses, residual losses, permeability, temperature coefficient, and magnetic retentivity. For practical usage, the ferrite material is selected on the basis of the values of these characteristics required in the particular application.

Table 11-1 illustrates some practical applications of ferrite materials at low frequencies, and lists the properties of each. In this table, Q is a figure of merit representing the energy ratio of useful conversion (into magnetic energy) to losses.

MAGNETIC AMPLIFIERS

Magnetic amplifiers, as the name implies, are amplifiers which operate through magnetic properties rather than electron tube principles. In aviation electronics applications, their major function is as a servomechanism control device. As an amplifier, this device permits the use of a small control signal to govern the operation of a much larger device requiring considerable power.

A typical magnetic amplifier consists of multiple windings on a common core. (See fig. 11-10.) Under static (no signal) conditions, the core is partially saturated by the flow of a d-c current in one of the windings (bias). An error signal (either a-c or d-c voltage) applied to a second (control) winding varies the degree of saturation, thus changing the permeability of the core. The changing permeability controls the flux cutting the third (load) winding, and permits the change in magnitude and instantaneous polarity of the voltage applied to the servomechanism to control the direction and speed of correction.

In closed loop servosystems, the magnetic amplifier has a fourth (reference) winding which applies the feedback signal to the system. This system improves circuit operation by decreasing the hunting effect and canceling the error input when actual operation of the load coincides with the desired operation.

Magnetic amplifiers used in airborne electronic equipment are of many different configurations, depending on specific application. The saturable current potential transformer is one type of magnetic amplifier.

Magnetic amplifiers may be broadly classified as belonging to the saturable reactor type or to the self-saturation type. These two types are discussed very briefly in the following paragraphs. If more details are desired a comprehensive discussion is available in a series of articles appearing in the DIGEST during 1963 and 1964. Reprints of this series are also available in booklet form.

Saturable Reactors

A magnetic amplifier is classed as a saturable reactor if the individual load currents are bidirectional, even though the load circuit may employ rectifiers to operate a d-c operated load.

The reactor core normally has a rectangular B-H loop. The no-signal flux is established by the d-c bias winding; the error signal is applied in series with this d-c to vary the degree of saturation. This combined signal and biasing ar-

Table 11-1. —Summary of ferrite applications.

Type of components	Typical frequency	Characteristics desired
LINEAR B-H CHARACTERISTICS:		
Filter inductors	100 kHz	High Q, precision, stability, low modulation.
IF transformers	465 kHz	High Q, stability, adjustability.
Antenna cores	1,000 kc to 15 mHz	Moderate Q, stability.
Wideband transformer	1,000 kc to 15 mHz	Reproducible transmission properties.
Adjustable inductors	Various	Adjustment range 20 percent.
Tuners	Various	Adjustment range greater than 10:1.
Miniature inductors	Various	Moderate Q, small size.
Loading coil	Voice	Stability, low modulation, low flux leakage.
NONLINEAR B-H, MEDIUM TO HIGH FLUX DENSITIES:		
Flyback transformers	15-100 kHz	Low losses, moderate size, retentivity, high Curie temperature.
Deflection yokes	Pulse	Same as above.
Miniature transformers	Pulse	Small size, easy mounting.
Carrier power transformers	Various	Low eddy current, high μ, high resistive impedance.
Supression heads	Various	Same as above.
Recording heads	Various	Very high μ, low eddy current, mechanical rigidity.
HIGH NONLINEAR, RECTANGULAR LOOP:		
Memory cores	Pulse	Two stable states, fast flux reversal, low eddy current.
Switching cores	Pulse	Fast flux reversal, high output.
Multiaperture cores	Pulse	Fast flux reversal, low eddy current.
Magnetic amplifiers	Various	High μ, up to saturation, almost horizontal B-H line above saturation.
MAGNETOSTRICTION AND OTHER PROPERTIES:		
Delay lines	Pulse, various	Low B's are acceptable, high μ at high frequencies.
Filters and oscillators	100 kHz	Same as above.
Temperature controls	Various	Sensitivity to temperature.
Transducers	20-30 kHz	High power outputs, mechanical strength.

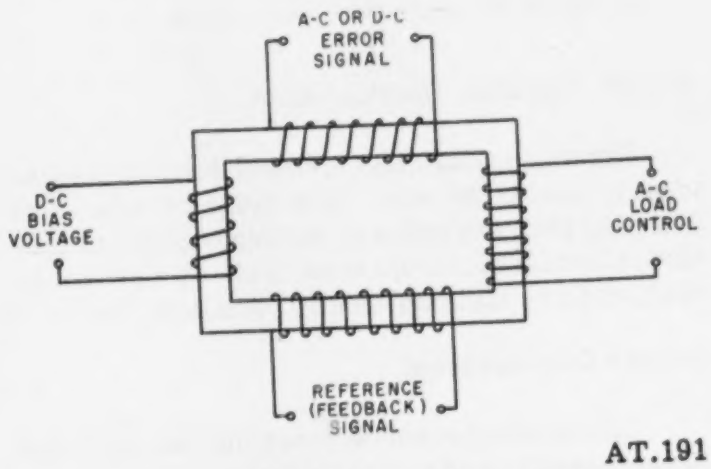

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Figure 11-10.–Typical magnetic amplifier, simplified.

rangement controls the permeability of the core, and thus the inductive reactance of the a-c load winding. The inductive reactance of the a-c load winding, in turn, governs the power applied to the load. (See fig. 11-11.) Control of a d-c load requires the use of rectifiers in series with the load (not shown).

Self-Saturating Reactors

A magnetic amplifier is of the self-saturating type if the individual load currents are unidirectional, being gated on and off by rectifiers for some period less than one-half the a-c voltage cycle. The major difference in the construction of the self-saturating reactor (fig. 11-12) and the saturable reactor (fig. 11-11) is the addition of the rectifier in the load circuit and the reversal of the bias voltage. Differences in operation, however, are somewhat more extensive.

The self-saturating magnetic amplifier is limited in use to d-c loads, but is capable of a much higher gain. Instead of merely increasing or decreasing the flux, the self-saturating amplifier is capable of changing the flux from almost zero to nearly complete saturation.

INDICATORS

Many different types of indicators are used in airborne electronics equipment for numerous purposes. The indicators of greatest concern to the technician use the cathode-ray tube to furnish a visual display. Other important types of indicators include the various meters, dials, etc., used in test equipment, computers, communications equipment, electronic navigational aids, and radar applications.

CRT DISPLAYS

Basic discussions of the cathode-ray tube and its applications and associated circuitry appear throughout Basic Electronics and the present manual. Basic Electronics presents information on the CRT itself and its applications in oscilloscopes and synchroscopes, some of the major types of scans used in radar equipment, and the sawtooth generators which develop sweep voltages. The present manual presents discussions of many of the circuits used in CRT indicators and numerous actual applications of the CRT indicator in operational and test equipment. The cathode-ray tube indicator, therefore, is not discussed in detail at this point.

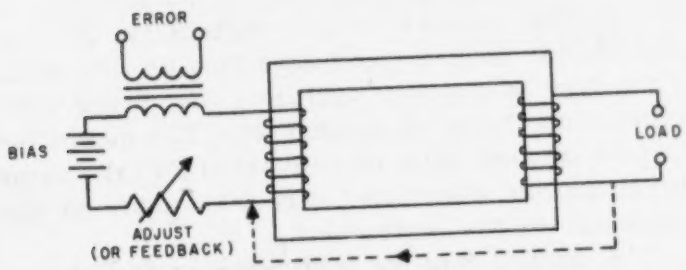

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Figure 11-11.–Saturable reactor type magnetic amplifier, simplified.

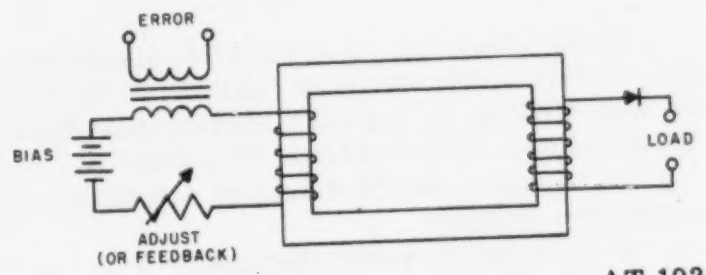

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Figure 11-12.–Self-saturating magnetic amplifier, simplified.

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OTHER INDICATOR TYPES

Indicators may be classified in many different ways. One method of classification is based on the affected sense. Technicians are concerned with two classes–visual and aural. Since aural indications are comparatively unreliable for accurate interpretation, their use is limited to rough analyses of loudness and intelligibility. This discussion, therefore, is limited to visual indicators.

Visual indicators are also classifiable by many systems. For this discussion, classification is based on the basic operating principle of the device. A listing of the types of indicators would include the following classes, as well as many others:

1. Lights.
2. Rotary counters.
3. Linear displacement mechanisms.
4. Direct angular displacement devices.
5. Remote angular displacement devices.

Lights

Indicator lights are commonly used to indicate the operating status of circuits or equipment. Many items of test equipment use lights to indicate that power is applied to the equipment. Some use additional lights to denote whether the equipment is in full operation or on standby. Aircraft consoles use trouble lights to designate malfunctioning circuits or components. Computers use lights as readout devices for some purposes.

Indicator lights may be coded as to color, sequence, or position. They may also be controllable as to intensity. They may be stationary or rotating.

Rotary Counters

Rotary counters, as used in this discussion, are similar to the odometer (mileage indicator) on automobiles. In avionics applications, their most common usages include the following:

1. Distance and/or direction indicators in navigation systems.
2. Computer readout devices.
3. Frequency channel indicators in communications equipment.
4. Elapsed time indicators.
5. Specific occurrence counters.

Direct Angular Displacement

Direct angular displacement devices are also usually analog devices. This class of indicators includes the conventional current-operated meters, altimeters, compasses, etc., as well as the dials used to indicate switch positions, etc.

Linear Displacement

Linear displacement mechanisms, although not commonly used as final indications in avionics work, are frequently used as input devices. These devices are usually analog devices, rather than direct-reading indicators. The linear displacement of a moving part of the device is proportional to some quantity to be measured. The final indicating device is usually driven through a converter and some type of servosystem.

Remote Angular Displacement

Remote angular displacement indicating devices are those which are driven through a synchro system which is, in turn, driven by a direct angular displacement device.

Multipurpose Indicators

The avionic installations of modern aircraft have become extremely complex. Space and weight factors prohibit the use of single-purpose devices to provide each required indication. Multipurpose instruments are becoming increasingly common in aircraft, and may be broadly classified into three types.

One type of multipurpose indicator uses a single indicating mechanism for all indications. The circuit connections are switched so that any one of the various quantities may be indicated. This type is used in multimeters, radar systems, navigation equipment, etc. The quantities to be indicated must be converted into the same form in the associated circuitry prior to application to the instrument.

A second type of multipurpose instrument can provide several indications simultaneously on a single instrument. This type uses angular

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displacement, with all pointers using a common axis of rotation. Each pointer is driven by its own mechanism through concentric shafts.

The third type of multipurpose instrument consists of a completely separate mechanism for each indication, with all mechanisms enclosed within a single housing. The individual mechanisms may be of the same or of different basic types. Two actual instruments falling in this class are the bearing-distance-heading indicator (BDHI) and the horizontal situation indicators (HSI) discussed in the following paragraphs.

In the horizontal situation indicator (HSI) the lubber line and aircraft symbol (fig. 11-13) are fixed in position and are used as basic references for all angular indications. The command heading marker may be positioned manually by the heading set knob, or it may be automatically positioned during computer navigation mode of operation. Indicator lights behind the various mode words are used to indicate the mode of operation of the navigation system, and to designate which equipment is selected for positional and bearing reference.

The compass card, bearing pointer, command heading marker, and course pointer revolve around a common axis. The course deviation bar revolves around a central point; movement may thus appear as both linear and angular displacement.

The to-from pointer is a two-position indicator used with TACAN, as described in chapter 17 of this manual. The course set knob is used to position the course pointer.

The instrument also includes counters to indicate course and distance to a TACAN station or to a selected point. Bearing, without distance, may also be indicated to a navigation station or any UHF station under proper operating mode selections.

MICROWAVE COMPONENTS

As discussed in chapter 9 of this manual, the effects of stray and distributed capacitance and inductance increase as the operating frequency is raised. Chapter 10, in the discussion of transmission lines, presents an example of how the distributed properties are used. The

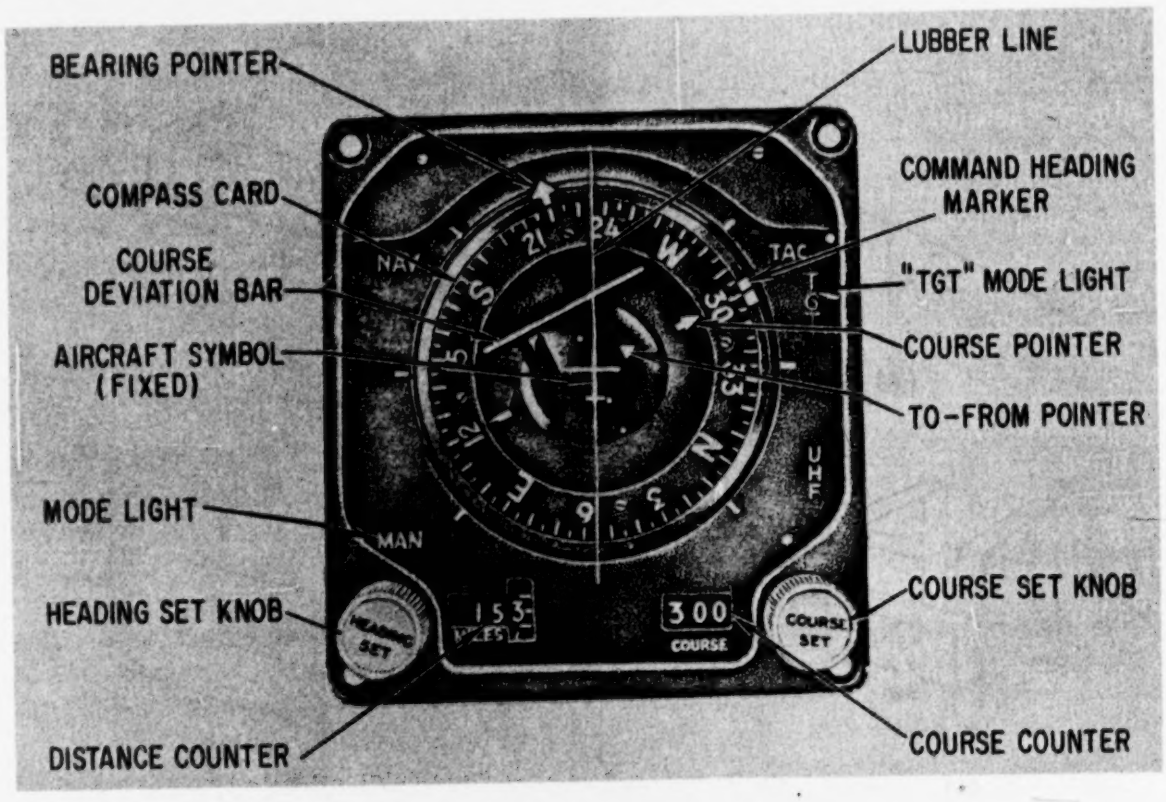

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Figure 11-13.–Horizontal situation indicator.

Case 3468

UNIT II - USE OF DRAWING INSTRUMENTS

Protractor Lesson 5

OBJECTIVE: To learn to use a protractor.

RELATED INFORMATION:

A protractor is used to measure angles (Fig. 1). The intersection of the two hair lines at O is placed at the origin of the angle, with the horizontal line along one of the given sides. The angle is then read along the scale. Angles from 0° to 180° can be read directly, either from right to left or from left to right.

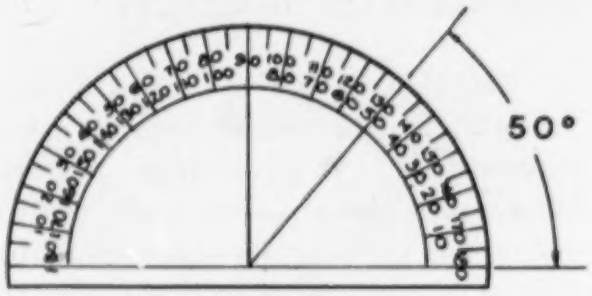

PROTRACTOR

FIG. 1

The smallest division represents one half degree. In the event that a problem requires a measurement between a half degree and a full degree, it must be estimated.

ASSIGNMENT:

Construct the polygon shown below, drawing the horizontal line AK of indefinite length about 1 inch above the bottom of your drawing paper. From A draw and measure AB. Proceed in the same way for the remaining sides. Use your protractor to obtain the angles.

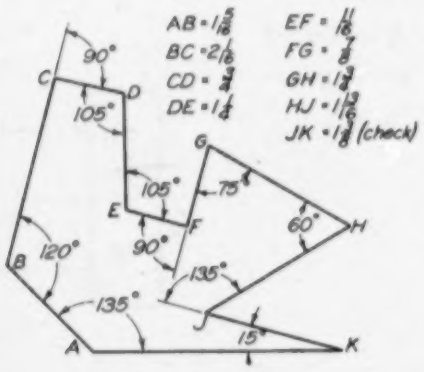

present discussion shows how the properties are used in components developed for use in microwave applications. It also includes a brief discussion of the ferrites used in microwave systems.

WAVEGUIDES

Basically, the waveguide is a special class of transmission line. The development of the waveguide from the two-wire transmission line (which was discussed in chapter 10 of this manual) is illustrated in figure 11-14. In a two-wire line, a quarter-wave section at the signal frequency presents a highly resistive impedance. Thus, a quarter-wave shorted stub may be used as an efficient insulator. If the stub offers adequate mechanical strength, it may be used to support the line while insulating it.

A rigid quarter-wave stub connected between the leads of a two-wire open transmission line (as shown in (A) of fig. 11-14) provides a starting point from which to discuss the development of a waveguide. In this type transmission line, efficient operation is limited to a single frequency. For all other frequencies, the insulating properties of the stub are decreased. A given stub represents a quarter wavelength at only one frequency (usually called the resonant frequency). At signal frequencies higher than resonance, the stub appears longer than a quarter wavelength, and presents an inductive impedance. At frequencies below resonance, the stub appears shorter than a quarter wavelength and offers a capacitive impedance. The greater the difference between the signal frequency and the resonant frequency of the stub, the smaller the total impedance offered by the stub. Since the stub normally has a very high Q, the effective useful range of frequencies is critical.

A metallic quarter-wave stub insulator may be placed at any point along a two-wire line. Use of several such stubs placed at convenient points along the line (as shown in (B)) improves the mechanical support of the line. Whether the stubs are used to support from above or below the line makes no difference.

If the stubs are connected together, the conductivity of the line is improved. Figure 11-14 (C) shows adjacent stubs connected by a switch. When the switch is open, each stub is excited

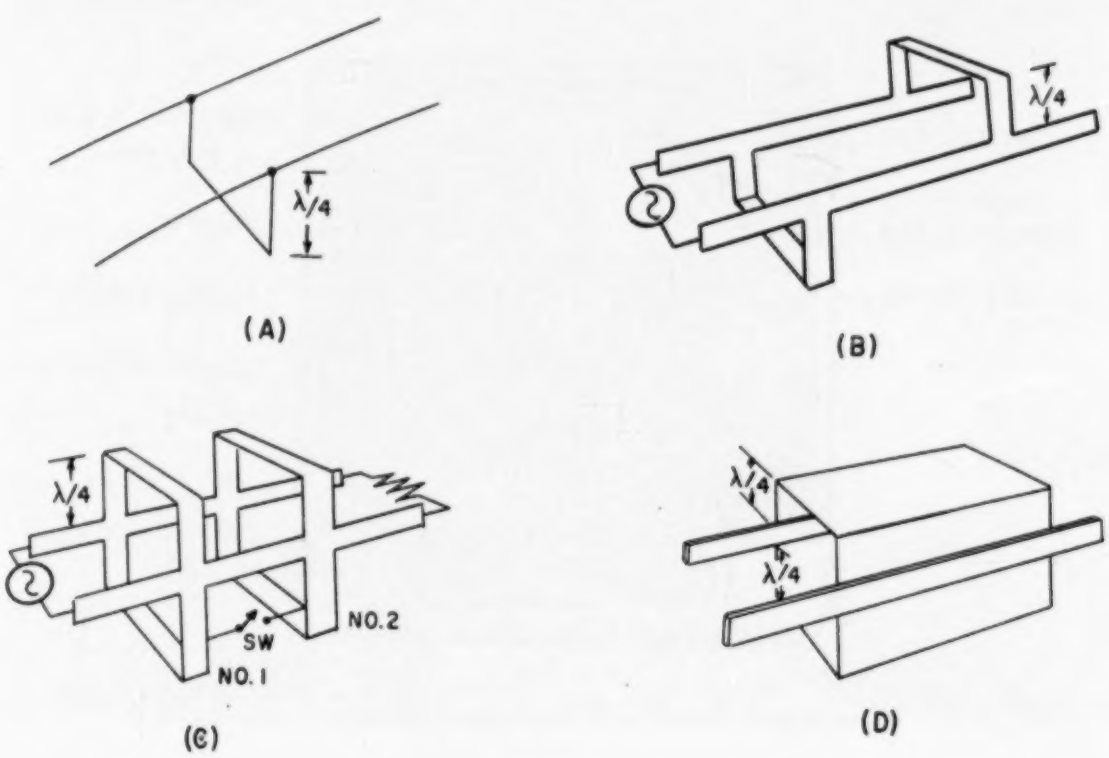

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Figure 11-14.–Development of a waveguide.

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separately by the signal in the main line. Standing waves are present on the line. Stub No. 1 is excited first, No. 2 at some time later. When the switch is closed, however, the No. 2 stub is excited partially by the signal on the main line, and partially by the No. 1 stub (through the switch). If the switch is connected to corresponding points on the two stubs, the relative phase relationship of the signal at the connections is the same. Thus, the No. 2 stub requires less excitation energy; the parallel paths offer less resistance (and therefore less copper loss) and energy transfer is more efficient.

Increasing the number of stubs increases the operating efficiency. A hollow rectangular tube effectively represents a parallel line with an infinite number of stubs. Given the proper dimensions, this device becomes a highly efficient transmission line. In the waveguide shown in figure 11-14 (D), successive "stubs" are in physical and electrical contacts with each other. This effectively connects corresponding points together, and automatically provides for proper phasing.

Dimensions

As discussed previously, the stub length in open two-wire transmission lines is quite critical. In waveguides, however, the dimensions are somewhat less restricted. Figure 11-15 indicates the main dimensions of rectangular waveguides.

The waveguide shown in figure 11-15 is operating at a frequency which is the approximate minimum usable frequency. At this frequency, the waveguide is effectively a two-wire transmission line with an infinite number of shorted stubs (indicated by dashed lines in the figure). At any signal frequency higher than the one illustrated, the width of the two leads of the effective line is increased, and the remaining portion of the stub then represents a quarter wavelength. At frequencies lower than the one illustrated, however, the stubs are less than a quarter wave and the leads are not adequately insulated. Thus it may be assumed that the (a) dimension of the waveguide is not critical, except that the signal must be at least a certain minimum frequency.

In open transmission lines, the spacing of the lines is critical only with respect to voltage breakdown. If the wires are placed too close together, arcing can occur, and energy losses become excessive. The same principle applies to the (b) dimensions of the waveguide.

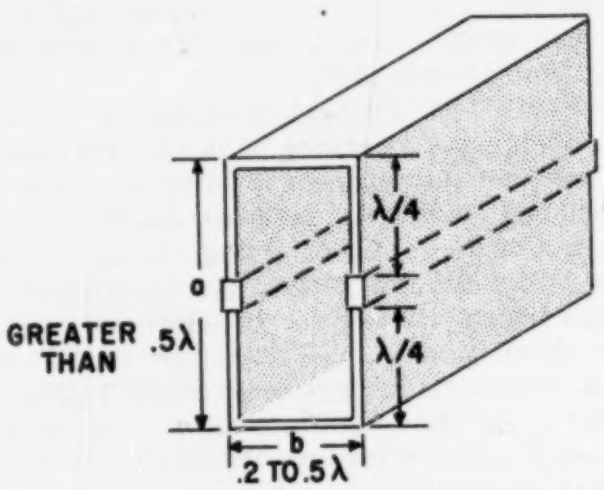

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Figure 11-15.–Dimensions in rectangular waveguides.

The main limitation on the length of either the open line or the waveguide is the energy losses incurred by the signal in transit through the device from one end to the other.

The frequency at which the quarter-wave stub sections appear to meet and cease to exist is called the CUTOFF FREQUENCY, and the corresponding wavelength is called the CUTOFF WAVELENGTH. Thus the analogy provides a basis for the formula $\lambda_{co} = 2a$ (given in Basic Electronics). In this formula, λ_{co} is the wavelength at the cutoff frequency of the waveguide, and (a) is the wide dimension as indicated in figure 11-15. In practical waveguides, the (b) dimension is normally between 0.2 and 0.5 wavelength at the cutoff frequency.

Energy in Waveguides

Energy is transferred within the waveguide by electromagnetic fields; currents and voltages merely aid in establishing these fields. In understanding the operation of waveguides, it is important to know when a good current path is required and where the voltage must be high. It is also important to know where strong fields will exist and to understand the composition of the fields. It is normally by means of fields that energy is introduced into or removed from the

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waveguide. The operation of the waveguide involves two field components–the electric field and the magnetic field.

ELECTRIC FIELD.–As discussed in Basic Electricity, the existence of an electric field indicates that a difference of potential exists between two points. An excited transmission line has a standing wave of voltage along its path; part of the line is positive, part is negative. An instantaneous field is set up between the wires. The standing wave, and therefore the electric field, varies in magnitude (intensity) progressively along the line. Since the exciting voltage varies at a sine wave rate, the electric field also varies sinusoidally.

The electric field, as it exists in a waveguide, is shown in figure 11-16 (A). This is an instantaneous representation of the field at its peak. Over a period of time (during each cycle), the field decreases to zero, reverses polarity and builds up to another maximum, decreases to zero, then reverses and expands again. Successive zero points occur at half-wave intervals along the length of the line; successive maxima, alternating in polarity, also occur at half-wave intervals.

NOTE: In illustrating the direction of the fields, standard practice is to use dots (·) and crosses (x). The (·) inducates that the direction of the field is toward the observer; the (x) indicates that the field is away from the observer.

Note that the lines of force which make up the electric field (called the E-lines) exist between the (b) dimension walls, and are perpendicular to the wide (a) dimension walls. Also note that the field has maximum intensity halfway between the (b) dimension walls, decreasing toward zero as it nears the wall. (The importance of this characteristic is covered later in this discussion.)

MAGNETIC FIELD.–Any expanding and collapsing electric field creates an alternating magnetic field. A visual representation of the sinusoidal magnetic field at an instantaneous maximum point is shown in figure 11-16 (B). Note that the field forms closed loops approximately half a wavelength long, with successive loops reversed in polarity. Note also that the magnetic lines (called H-lines) are parallel to the walls of the waveguides.

The magnetic field is strongest at the edges of the waveguide and weakest at the center of each loop (where the standing wave of current is zero at all times).

COMPOSITE FIELD.–Electromagnetic waves are made up of electric and magnetic field components. Energy travels down the waveguide in the form of wavefronts.

As the wavefront progresses down a waveguide, it interacts with a wavefront reflected from the other end. This interaction results in standing waves (similar to the standing waves of current and voltage in transmission lines). It is in these standing waves that the energy exists within the waveguide. Figure 11-16 (C) illustrates the composite electromagnetic standing waves in a section of waveguide.

In the figure, note that the electric and magnetic components of the composite field are oriented mutually perpendicular to each other and to the direction of propagation. Also note that the points of maximum electric and magnetic field intensity coincide, as do the points of minimum field strength. Propagation of energy in waveguides differs in some respects from that in free space.

In free-space propagation, the transmitted wave expands in an everwidening circle. In waveguides, it is confined within the conductive walls, and no electromagnetic field exists outside the waveguide. Instead, as the wave travels down the guide, it strikes the walls at an angle and is reflected at an equal angle. If energy propagation is to be sustained within the waveguide, two major "boundary" conditions must be fulfilled.

BOUNDARY CONDITIONS.–The first boundary condition that must be met is that there must be no component of the electric field tangent to the walls of the waveguide. An electric field is equivalent to a voltage; when impressed across a perfect conductor (the walls of a waveguide), it is decreased effectively to zero. Thus the parallel component of the E-field diminishes to zero as it approaches the walls. The remaining component of the E-field is perpendicular to the walls in the (a) dimension.

The second boundary condition concerns the magnetic field. No component of the magnetic field can exist perpendicular to the inner surface of the waveguides. Since the electric and magnetic components of the composite field are mutually perpendicular, satisfaction of one boundary condition usually guarantees satisfaction of the other also.

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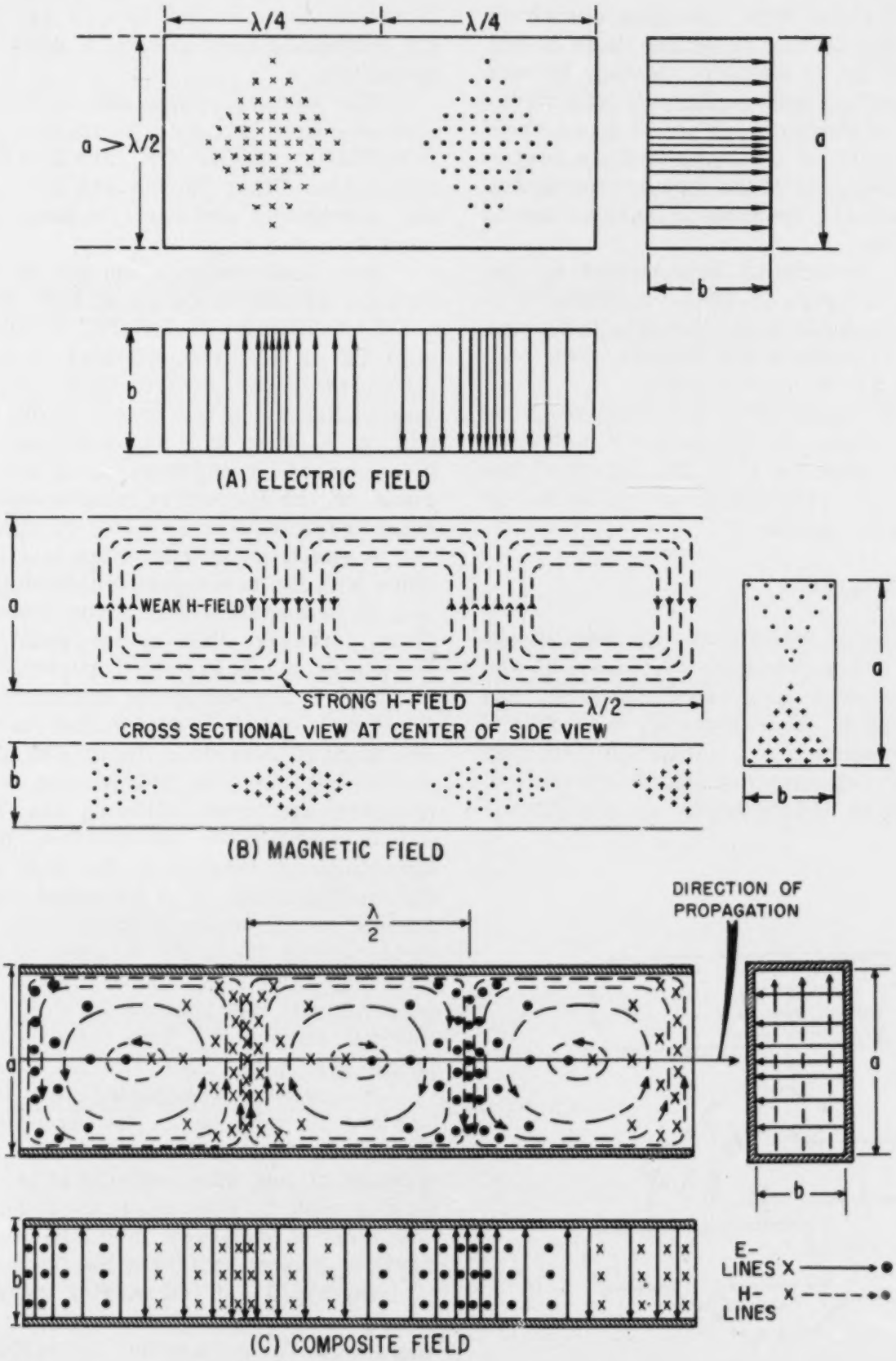

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Figure 11-16.–Fields in waveguides. (A) Electric; (B) magnetic; (C) composite electromagnetic.

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Circular Waveguides

Waveguides have been developed which have a circular cross section as well as those having a rectangular cross section. Although in less common usage than rectangular, circular waveguides have characteristics which make them particularly useful in some applications. In general, the development of the circular waveguide may be explained in the same manner as that of the rectangular.

The two conductors represented by the dashed lines in figure 11-17 are assumed to be part of the waveguide wall. The remaining part of the wall represents the quarter-wave stub section which act as the insulators.

The cutoff wavelength of the circular waveguide is 1.71 times the diameter of the guide. The diameter must be 1.17 (2/1.71) times the (a) dimension of a rectangular waveguide having the same cutoff frequency.

Modes in Waveguides

As mentioned previously, at frequencies higher than cutoff, the wide dimension of the waveguide becomes increasingly greater than a half wavelength. At a frequency twice that of cutoff, this dimension is a full wavelength, with each stub then representing a half-wave section. If the waveguide and its fields are to fulfill the boundary conditions required for propagation, the field configuration must be quite different from that previously indicated. In other words, the waveguide must assume a different mode of operation.

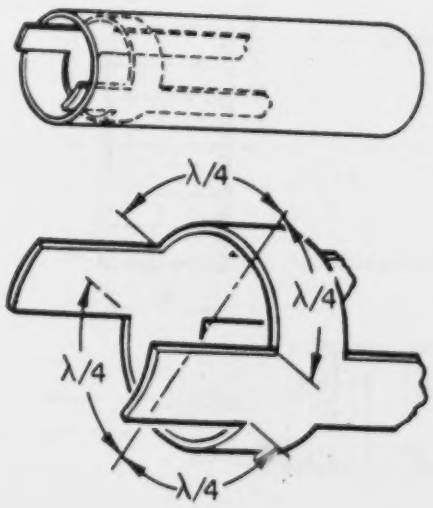

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Figure 11-17.–Circular waveguide.

The normal configuration of the electromagnetic field in a given waveguide is called the DOMINANT MODE OF OPERATION of that waveguide. Other modes are also possible in any waveguide, and some of these modes are used in radar applications.

Any field configuration can be classed as either a TRANSVERSE ELECTRIC MODE or as a TRANSVERSE MAGNETIC MODE (abbreviated TE or TM, respectively). In a TE mode, all parts of the electric field are transverse (perpendicular to the length of the waveguide) and no E-lines are sustained parallel to the direction of propagation. In a TM mode, the plane of the H-field is transverse and no H-lines are parallel to the direction of propagation.

A wavefront in free space is a TEM mode, since both fields are perpendicular to the direction of propagation. Due to the boundary conditions, however, this mode cannot exist in a waveguide. Under any set of operating conditions, one field in any waveguide will be predominantly transverse–this field determines the basic classification of the mode as TE or TM. To complete the description of the field pattern, two subscript numbers are used following the TE or TM.

In rectangular waveguides, the field is described in relation to the wide and narrow dimensions. The first subscript indicates the number of half-wave patterns of the transverse field across the wide dimension. The second subscript indicates the number of half-wave patterns of the transverse field across the narrow dimension. Both measurements are made across the center of the cross section.

In circular waveguides, the field is described in relation to the circumference and diameter. The first subscript indicates the number of full-wave patterns of the transverse field around the circumference of the waveguide. The second subscript indicates the half-wave patterns occurring across the diameter.

Figure 11-18 illustrates several modes which occur in waveguide operation. The dominant mode for rectangular waveguides is shown in (C), and the dominant mode for circular waveguides is shown in (F).

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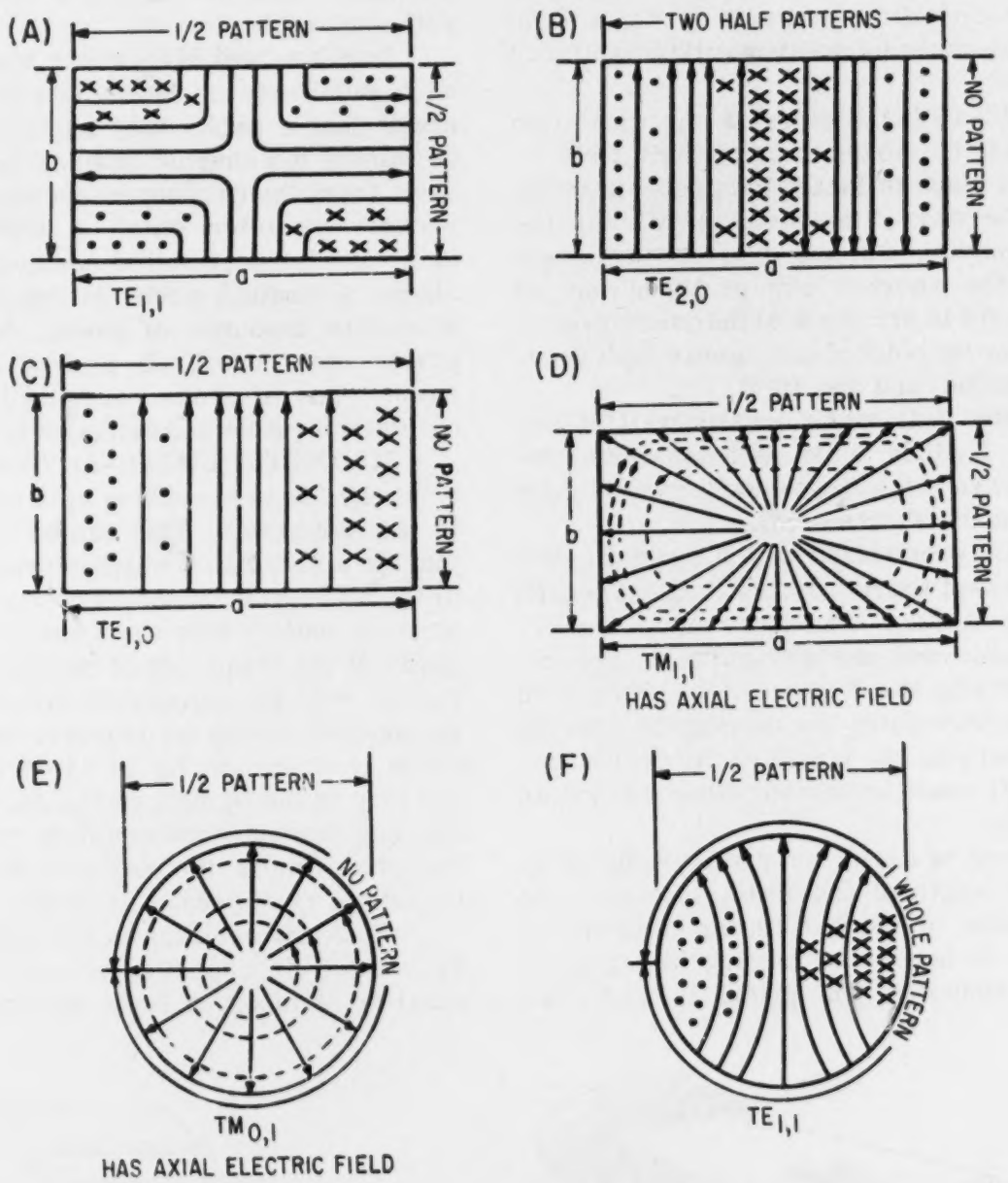

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Figure 11-18.–Modes and field configurations in waveguides.

Note in (D) and (E) that the electric field is axial; therefore the magnetic field is transverse and the modes are designated TM.

Excitation of Waveguides

As with any transmission line, the waveguide must be properly excited in order to carry the energy from one point to another. Waveguides, however, do not have the two convenient connection points possessed by the conventional RF line. In waveguides, the energy is in the form of an electromagnetic wave; therefore the excitation device must cause these fields to be created within the guide. Excitation may be in either of three principal forms–electric fields, magnetic fields, or electromagnetic fields.

ELECTRIC FIELD.–Inserting a small probe or antenna into a waveguide and applying an RF signal causes current to flow in the probe. This current sets up an electrostatic field; E-lines detach themselves from the probe and propagate in the waveguide. The propagating E-lines establish corresponding H-lines and result in the formation of a composite electromagnetic field within the waveguide. If the probe is positioned

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in the proper location and supplied the proper signal for a specific waveguide mode, a field having considerable intensity may be established and sustained.

Figure 11-19 (A) illustrates the excitation of a waveguide by means of an electric field.

The best place to locate the probe is in the center of the wide dimension, parallel to the narrow dimension, and one-quarter wavelength away from the shorted end of the guide, as shown (the field is strongest at the quarter-wave point). This is the point of maximum coupling between the probe and the field.

The probe will work equally well at any point where E-lines exist with maximum intensity (for example, a three-quarter wavelength distance from the shorted end).

Usually the probe is fed with a coaxial cable. This cable is kept short to derive greatest benefit from the waveguide. Impedance matching between the cable and the waveguide is accomplished by varying the distance of the probe from the end of the waveguide (by moving the shorted end) or by varying the length of the probe. Any mismatch will cause unwanted reflections within the waveguide.

The degree of excitation can be reduced by reducing the length of the probe, moving it out from the center of the E-field, or shielding it. Where it will be necessary to vary the degree of excitation frequently, the probe is made retractable, and the end of the waveguide is fitted with a movable plunger.

In pulse-modulated radar systems there are wide sidebands on both sides of the carrier. In order that a probe feed system does not discriminate too sharply against frequencies which vary from the carrier frequencies, WIDEBAND probes are often used. A wideband probe is large in diameter and is conical or doorknob in shape. A conical probe is capable of handling moderate amounts of power, but for the high power sets, doorknob probes are used. The same types of probes are used to take energy out of waveguides and deliver it to coaxial cables.

MAGNETIC FIELD.–Another way of exciting a waveguide is by setting up a magnetic H-field in the waveguide. This can be accomplished by placing a small loop which carries a high current in the waveguide. A magnetic field builds up and expands until it fills the space within the waveguide. If the frequency of the current is correct, energy will be transferred from the loop to the waveguide. A loop for transferring energy into a guide is shown in figure 11-19 (B). Notice that the loop is fed by a coaxial cable. The location of the loop for optimum coupling to the guide is at the place where the magnetic field, which is to be set up, is of greatest strength.

When less coupling is desired, the loop may be rotated or repositioned until it encircles a smaller number of lines of force.

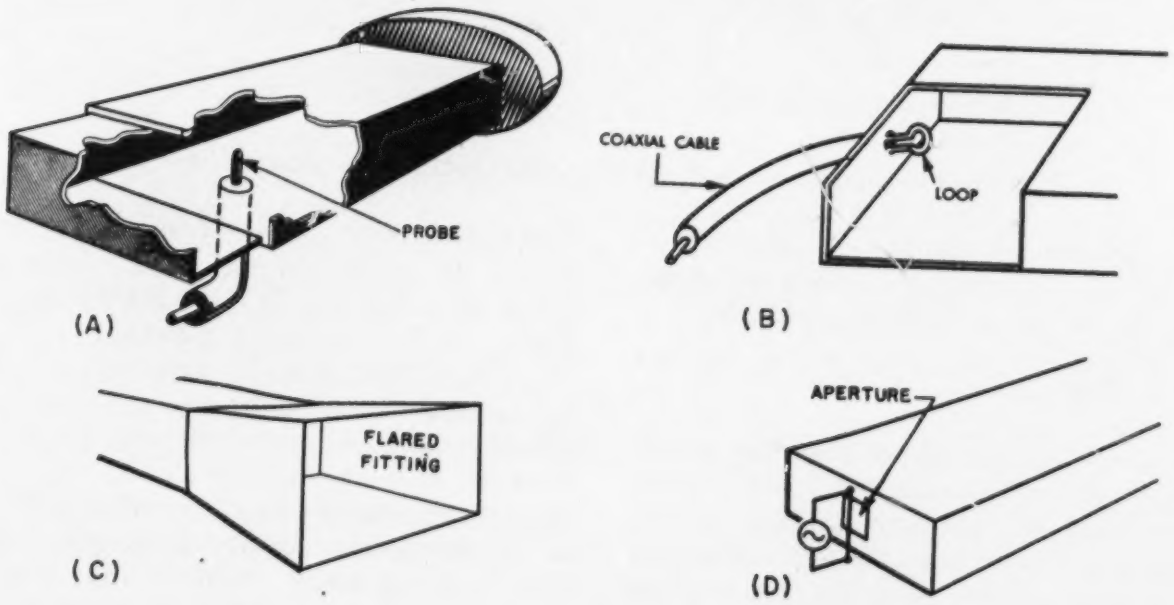

Figure 11-19.–Exciting a waveguide.

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When an excitation loop is used in radar equipment, its proper location is often predetermined and fixed either during construction or final tuning at the factory. In test or laboratory equipment, the loop is often made adjustable.

When a loop is introduced in a guide at a point where an H-field is present, a current will be induced in the loop itself. Thus, the loop may take energy out of the waveguide as well as put energy into it.

ELECTROMAGNETIC FIELD.—It might seem that a good way to excite the waveguide or to couple energy out of it is simply to leave the end open. However, this is not the case; when energy leaves a guide, fields exist around the end which result in mismatch. In other words, reflections and standing waves would result if the end were left open. Thus, simply leaving the end open is not an efficient way of letting energy out of the waveguide.

In order for energy to move smoothly into or out of a guide, the opening of the guide may be flared like a funnel. This makes the guide similar to a V-type antenna. This method, shown in (C) is called a horn and in effect eliminates reflection by matching the impedance of free space to the impedance of the waveguide. When the mouth of the horn is exposed to electromagnetic fields, they enter and are gradually shaped to fit the waveguide. The horn is directional in characteristic. It sends or receives the greatest amount of energy in front of the opening.

Another method for either putting energy into or removing it from waveguides is through slots or openings. This method is sometimes used when very loose coupling is desired. In this method (fig. 11-19 (D)), energy enters the guide through a small aperture. Any device which will generate an E-field may be placed near the aperture, and the E-field will expand into the waveguide. A single wire is shown; on it, E-lines are set up parallel to the wire due to the voltage difference between parts of the wire. The E-lines expand first across the aperture, then across the interior of the waveguide. If the frequency is correct and the size of the aperture properly proportioned, energy will be transferred to the waveguide with a minimum of reflections.

EXTRACTION OF ENERGY.—In waveguides, as with many other electrical networks, reciprocity exists in the excitation system. Reciprocity means that energy may be either introduced into the waveguide or removed from the waveguide, using the same coupling devices and methods, with the same efficiency of transfer.

RESONANT CAVITIES

By the simple expedient of closing the ends of a waveguide to form an enclosure, a cavity is formed. If this cavity is then excited in a proper manner by the proper frequency, it will resonate. The resonant frequency of the cavity is determined by the dimensions, which are somewhat more critical than those of a waveguide.

In order to resonate, the cavity makes use of the distributed inductance and capacitance of the enclosing box. This limits the practical use of resonant cavities to microwave frequencies. However, at microwave frequencies, resonant cavities normally possess value of Q considerably in excess of any value obtainable with lumped components at lower frequencies.

Fields in Resonant Cavities

As in the waveguide, operation of the resonant cavity is best described in terms of the fields rather than in terms of currents and voltages. Cavities may have various physical shapes. A chamber enclosed within conductive walls may resonate at any of several frequencies and thus produce a number of field configurations, depending on the size and shape of the chamber. As in waveguides, these field configurations are called modes. Figure 11-20 illustrates several shapes of cavities and the dominant mode of each.

Of the types shown in the figure, the cylindrical type cavity (B) is useful in wavemeters or other frequency measuring devices. The cylindrical ring (E) and doughnut (D) are used in many microwave oscillators as the frequency-determining element. The waveguide section (F) is used in some radar systems as a mixing chamber for combining signals from two sources. The cube (A) is a special type of waveguide section. The sphere (C), although not in common usage, may be used for mixing multiple inputs, for extracting multiple outputs, for changing the mode of operation, or for impedance matching.

Note that in each type cavity shown, the voltage is represented by E-lines between the top and

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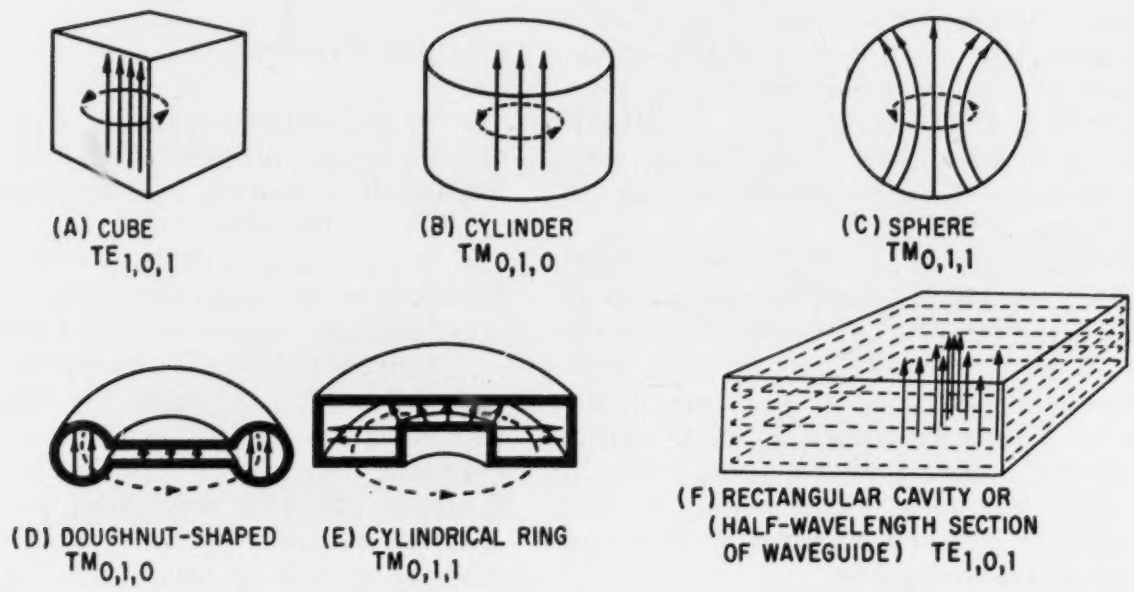

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Figure 11-20.–Fields in resonant cavities.

bottom of the cavity. The current, due to skin effect, flows in a thin layer on the surface of the cavity. The H-field is strong where the current is high; the strongest H-field is at the vertical walls of the cavity, and diminishes toward the center where the current is zero. This characteristic results from the presence of standing waves, similar to the action on a quarter-wave section of transmission line or waveguide. The E-field is maximum at the center and decreases to zero at the edge where the vertical wall is a short circuit to the voltage.

The modes in a cavity are identified by the same numbering system that is used with waveguides, except that a third subscript is used to indicate the number of patterns of the transverse field along the axis of the cavity (perpendicular to the transverse field). For example, the cylindrical cavity shown in (B) is a form of circular waveguide. The axis is the center of the circle. The transverse field is the magnetic field; therefore, it is TM (transverse magnetic). Around the circumference there is a constant magnetic field. (The H-lines are parallel to the circumference.) Therefore, the first subscript is 0. The distance across the diameter is one-half wave; thus the second subscript is 1. Through the center, along the axis, the H-field strength is a constant zero; this makes the third subscript 0. The complete description of the mode is $TM_{0,1,0}$.

When a section of waveguide is closed on both ends in the form of a rectangular cavity, shown in (F) of figure 11-20, standing waves are set up and resonance occurs. The simple mode in this cavity is the same as the dominant mode of a rectangular waveguide; that is, it is $TE_{1,0}$. The third subscript of the mode, which is determined by a plane perpendicular to the E-field, is 1. Thus the complete description of the simple mode in the rectangular cavity is $TE_{1,0,1}$ (transverse electric).

Exciting the Cavity

A cavity resonator may be excited in any of three predominant methods. These methods are illustrated in figure 11-21.

The first method (A) is by inserting a probe into the cavity. The voltage applied to the probe sets up an E-field with the E-lines parallel to the probe. As the E-field expands, it in turn sets up an H-field. These fields expand and collapse; the wavefronts travel through the cavity and are reflected from the end. If the physical dimensions are correct, these wavefronts will return at the proper time to reinforce the original fields and produce standing waves. Due to

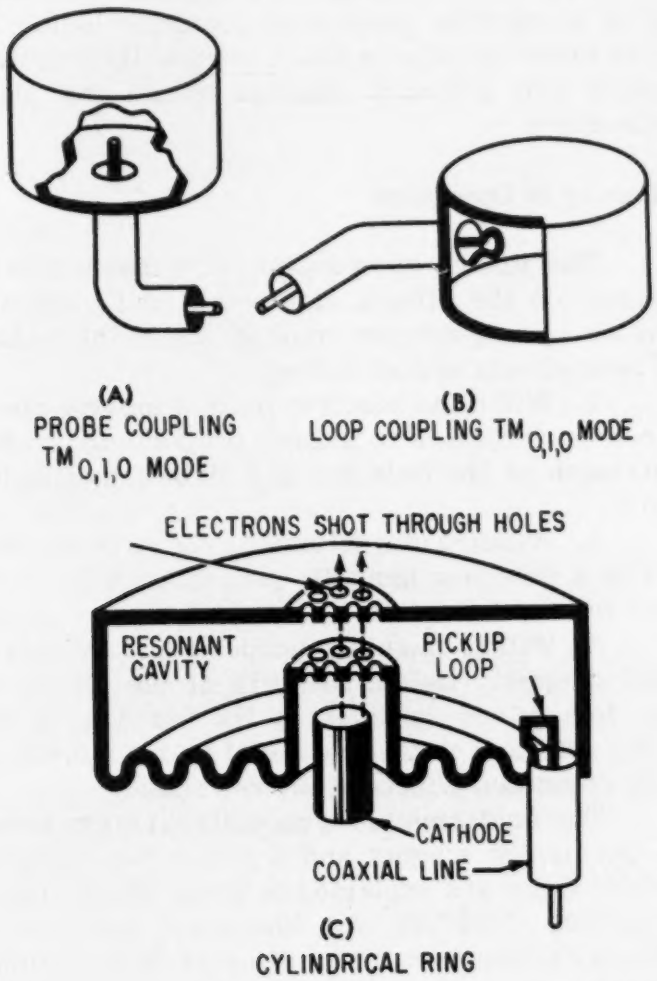

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Figure 11-21.–Exciting the cavity.

the high Q of the cavity, these oscillations will sustain themselves for an appreciable time, thus requiring only occasional excitation.

Another method (B) uses a magnetic loop. The loop is placed in a region where the magnetic field will be located. The currents in the loop set up an H-field within the cavity. The expanding and collapsing of the fields and the reflection of the wavefronts combine to maintain each other (if the size of the cavity is correct).

Either of the above methods may also be used to remove energy from the cavity.

A third method (C) is used with a cylindrical ring type cavity. The energy is placed into the cavity by clouds of electrons, which are virtually "shot" through the holes in the center of a perforated plate. As each cloud passes through, it creates a disturbance in the space inside the cavity until a field is set up. It may be said that the cloud of electrons produces a voltage difference between the perforated plates, and thus sets up an E-field.

Tuning the Cavity

Three methods for adjusting the resonant frequency in a cavity are shown in figure 11-22. One method uses a cylindrical cavity with an adjustable disk. When a $TE_{0,1,1}$ mode is used, the size of the cylinder may be changed along the axis to change the resonant frequency. The smaller the volume of the cavity, the higher the resonant frequency. The movement of the disk may be calibrated in terms of frequency. Usually in the case of high frequency equipment, a micrometer adjustment is used to change the position of the disk.

A second method of tuning the cavity employs threaded plugs which are inserted in the side of the cavity. The plug reduces the length of the magnetic field in the cavity in a manner similar to reducing the inductance of the tuned circuit.

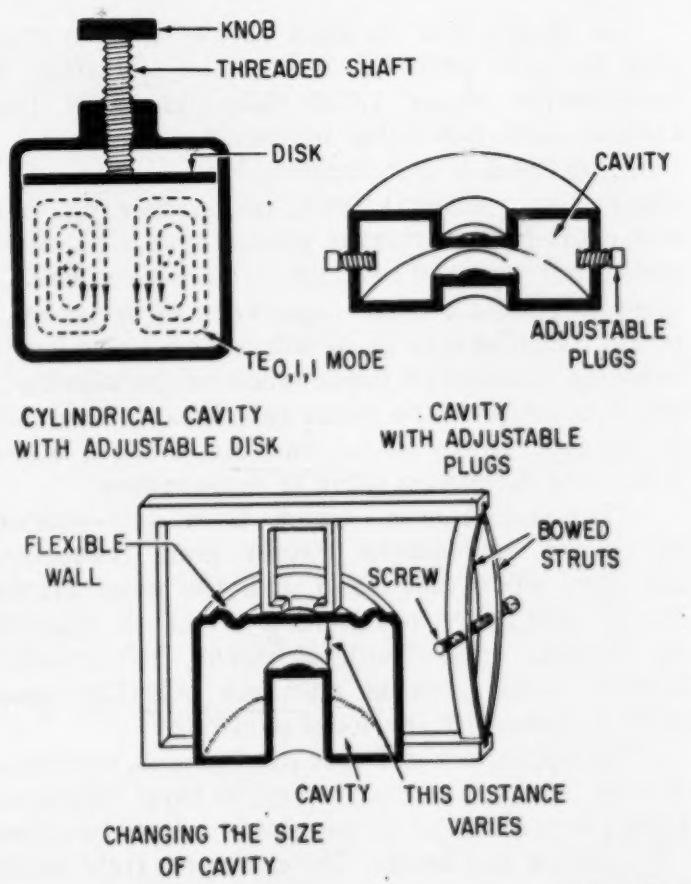

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Figure 11-22.–Tuning the cavity.

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UNIT III - DRAWING GEOMETRIC CONSTRUCTIONS

Bisecting a Line — Lesson 1

OBJECTIVE: To learn to bisect a line using ruler and compass.

RELATED INFORMATION:

In almost all machine drawings some form of geometric construction is required to permit the draftsman to prepare his drawing quickly and accurately. A good understanding of geometric constructions is very important because of their practical application in drafting. Several of the most commonly used geometric constructions will be discussed in this unit, along with their applications.

Bisecting a straight line consists of finding the exact center of the line without measuring its length.

To bisect the given line AB, place the needle point of your compass at point A and open the compass to any convenient radius of more than one-half the length of the line. Strike the arc as shown. With the same radius, set the needle point of the compass on point B and strike an arc intersecting the first arc at two points. Draw a straight line with a straightedge through the points where the arcs intersect. The line drawn will bisect the line AB.

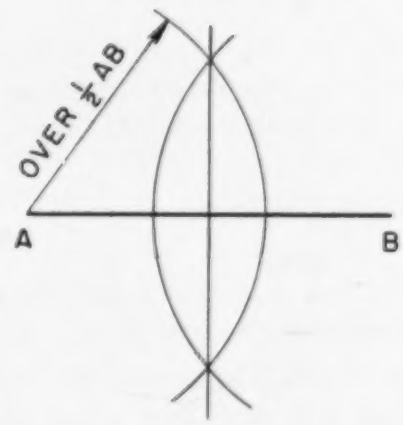

FIG. 1

Application:

To locate a hole in the center of the shaft shown in Fig. 2, proceed as stated above. Draw both views. Scale the dimensions needed from the drawing shown.

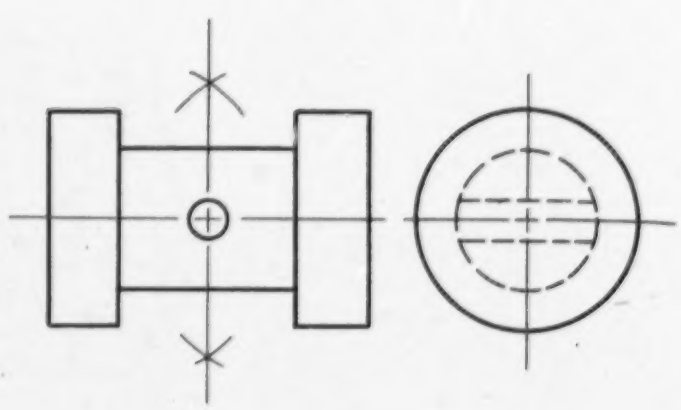

FIG. 2

The deeper the plug extends into the cavity, the higher the frequency.

In the third method, the interior of the cavity, which is part of the interior of a vacuum tube, is sealed and evacuated. In this method a frequency change occurs whenever the top and the bottom of the cavity are moved away from (or toward) each other. This is accomplished by turning a screw which passes through two bowed struts. As the distance varies, the volume and the capacitance between the top and bottom of the cavity are changed. As the change in capacitance is the chief result of the change in the distance between the plates, the resonant frequency is proportional to the distance from the top to the bottom.

Another way of changing the frequency (not shown) is by changing the method of exciting the circuit. This can be done by making the exciting element either capacitive or inductive. (This can occur either accidentally due to improperly tuned circuits or deliberately as a means of tuning the cavity.)

MAGNETRONS

A magnetron is used as the transmitting tube in most pulsed transmitters operating at frequencies above 1,000 MHz. The fact that transit time has little influence on the magnetron, whereas it is a limiting factor in the operation of conventional tubes, makes this type tube desirable for microwave pulsed operation. Several other types of oscillators have been developed to compete with magnetrons as radar high power oscillators. In addition, there are some velocity modulated tubes (such as the klystron) which operate in the radar range and are capable of greater power output than the triodes. Klystrons are discussed later in this chapter.

The magnetron, which is a self-excited oscillator, possesses rather poor frequency stability when compared with the most stable lower frequency oscillators (electron coupled or crystal controlled). However, the overall system does provide adequate stability when AFC is used with the local oscillator.

As explained in Basic Electronics, the magnetron is a type of diode having an axial magnetic field perpendicular to the electric field between its cathode and anode. The magnetic field could be produced by an electromagnet but is usually provided by a permanent magnet.

The tube consists of a cylindrical plate, with a cathode positioned coaxially inside it. The tuned circuits in which the oscillations take place are resonant cavities within the plate structure.

Theory of Operation

The theory of operation of a magnetron is based on the effects of electric and magnetic fields upon electrons moving within the fields. These effects are as follows:

1. Within an electric field, a moving electron is subjected to a force proportional to the strength of the field and in a direction opposite to it.
2. Within a magnetic field, the force exerted is in a direction mutually perpendicular to both the field and the direction of electron movement.
3. Within mutually perpendicular electric and magnetic fields, the path of the electrons is determined initially by the velocity of the electron, and is then modified by the individual and combined effects of the two fields.

The fundamentals of magnetron action, using a permanent magnet and a pulsed d-c electrostatic field, are explained in Basic Electronics, NavPers 10087-B. An important conclusion, which results from the fundamental observations found in Basic Electronics, is summarized in the following paragraph.

For a fixed applied d-c potential, the radius of curvature of the electron path is determined by the strength of the magnetic field. By increasing the d-c potential, however, the velocity of the electron is increased and the magnetic field has a greater effect on the electron path, decreasing its radius. Thus the path of the electron can be altered by changing the strength of either the electric field or the magnetic field. The strength of these fields is critical, because they determine the path of the electrons, thus determining the efficiency of the tube.

GENERATION OF A. C.–In order to produce an a-c voltage in a magnetron, a split (or segmented) anode and a strong axial H-field are required; a high d-c potential is then applied to all anode segments. (The anode must be split into an even number of segments, and the cathode preheated to emit electrons.) As soon as the d-c voltage and the magnetic fields are applied, oscillations build up and the segments become

alternately positive and negative. The a-c power is generated by transferring a portion of the d-c power (consumed in the circuit) into a-c energy (in the oscillations) as described below.

The applied d-c voltage accelerates the electron, which starts to move toward the anode segment having the higher positive potential at that instant. The energy of the applied d. c. is thus transferred to the electron as kinetic energy. Strong magnetic fields force the electron to follow a sharply bent spiral path. As the field reverses, the electron is slowed down (due to a decrease in the accelerating force of the d-c field) and transfers some of its kinetic energy to the a-c field of oscillation. The electron may spiral several times before reaching the anode, thus giving up most of its energy to the alternating field. (See fig. 11-23.)

In this magnetron, the frequency of oscillation is determined by the transit time of the electrons, and is quite unstable. Electrons arriving at the anode segments a little early tend to increase the frequency, while those arriving late tend to decrease it. In order to provide better stability, resonant circuits are introduced between adjacent anode segments, or between each anode segment and the cathode. The frequency of oscillation is then determined by the resonant frequency of these circuits. Since the stability of the circuit can be improved by using a higher Q resonant circuit, the use of resonant cavities is standard at those frequencies high enough to make this practical.

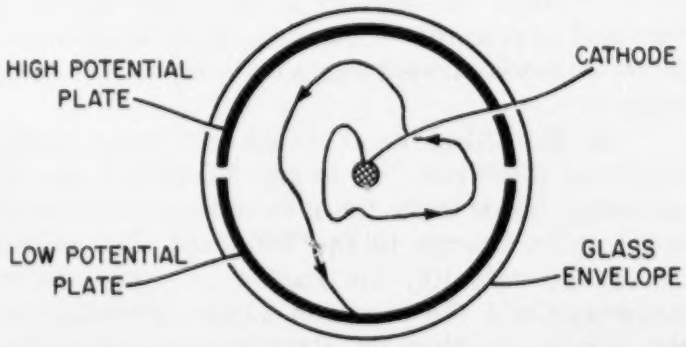

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Figure 11-23.–Split anode magnetron.

The RF fields in the cavities may or may not be in phase. The phase relationship is determined mainly by the applied voltage and the strength of the magnetic field, but some improvement in the phasing may be realized due to the coupling between the cavities. The desired coupling may be obtained by connecting selected segments together. This procedure is known as STRAPPING, and is covered in more detail in a later discussion.

The multicavity magnetron requires an even number of anode sections (usually eight or more) situated around a cylindrical chamber (called the INTERACTION SPACE) with the cathode coaxially centered inside it. A resonant cavity is located between each pair of anode segments, and may be connected to the interaction space by a narrow slot. (See fig. 11-24.)

The body of the magnetron and the anodes are at d-c ground potential, and a highly negative d-c potential is applied to the cathode. The resonant frequency is determined by the physical dimensions of the cavities. Due to the oscillations, high frequency potentials are imparted to the anode segments.

If each cavity is at a 180° phase relation with its neighbors, adjacent anode segments have opposite polarities at any given time. An oscillating E-field exists between each pair of segments in the path of the electrons. Strength of the magnetic field is relatively fixed; therefore the voltage applied to the cathode must be adjusted so that the majority of the electrons move against these oscillating fields and surrender most of their energy to the RF field, thus helping to sustain oscillation.

ELECTRON SPACE CLOUD.–Electrons within the interaction space do not travel individually, nor are they evenly spaced. Rather, they tend to gather into spoke-shaped clouds. In figure 11-24 (A), the space charge is shown as it would exist in a magnetron that is not oscillating (due to the lack of a d-c potential). In (B), the application of a d-c voltage sets up the d-c electric field as shown. The arrows indicate the direction of the field (positive to negative). It must be remembered that electrons will be accelerated so that they move in a direction opposite to that of the field.

With the establishment of the d-c field, the magnetron is shocked into oscillation, and RF fields are established. These RF fields set up

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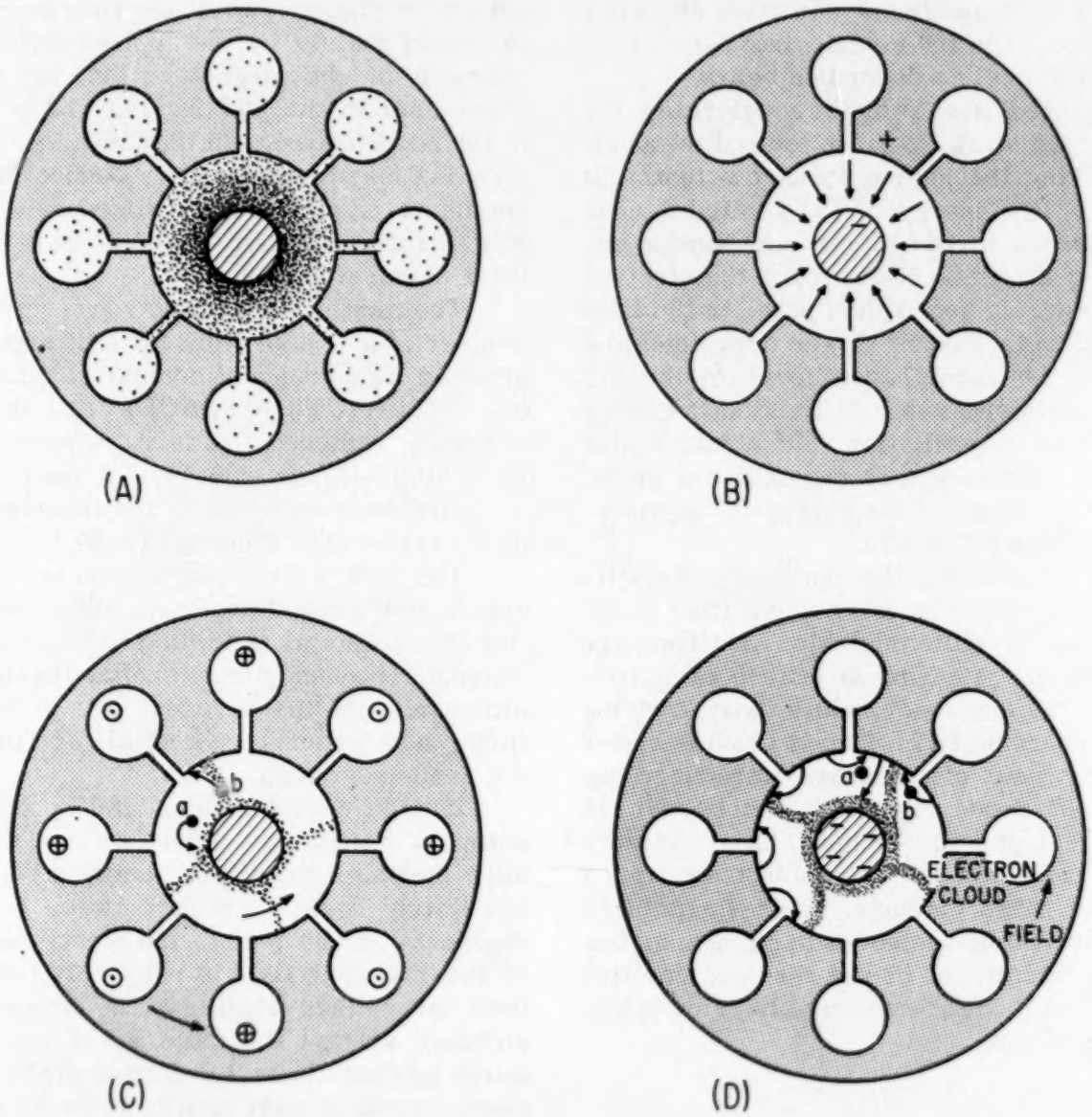

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Figure 11-24.–Action of space cloud.

alternating polarities on adjacent anode segments. The alternating fields aid or oppose the d-c fields, and tend to accelerate or retard electrons in the space cloud.

Electrons being accelerated due to the addition of the two fields (such as electron "a" in (C) of figure 11-24) tend to absorb energy from the RF field. Due to their high velocity, the magnetic field has greater effect upon them, decreasing the radius of curvature and causing them to return to the cathode. They strike the cathode with high velocity, cause secondary emission, and give up their kinetic energy to the cathode in the form of heat. This is known as cathode back-heating. (Back-heating is often great enough to require a decrease or even removal of filament voltage from the magnetron as its cathode current nears its normal operating value.)

On the other hand, those electrons being retarded (electron "b" in fig. 11-24 (C)) due to opposing fields have their velocities decreased and impart energy to the RF field. Due to the decreased velocity, the radius of curvature is increased and the electron paths terminate at the anode. Sorting of electrons in the space charge tends to create spokes in the electron cloud. The spokes rotate in synchronism with

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the RF fields and the space cloud. Loss of sync between the clouds and the RF field tends to kill oscillation. The applied potential and the strength of the magnetic field are fairly critical, since they determine the intial velocity of the electron and vary radius of curvature during transit, respectively.

The spokes are rather narrow, with sharply defined boundaries–the result of focusing by the RF field. In (D), electrons traveling in advance of the spoke "a" are in an area where the radial components of the d-c and RF fields oppose. The velocity of the electron is decreased and the radius of curvature is increased, allowing the spoke to catch up and collect the electron. Those electrons which lag the spoke "b" are in an area of aiding fields. Their velocity is increased, the radius of curvature is decreased, and the electron catches up with the spoke and is captured. Thus, capturing of electrons tends to focus the electrons into tight spokes, and keeps the edges sharply defined.

As the spokes of the electron cloud pass an anode segment, electrons are repelled from that segment, traveling around the cavity on either side to other segments. This action creates a positive charge on the segment being passed by the cloud. As the cloud rotates to the next segment, it encounters a maximum negative polarity (due to the electrons repelled from the previous segment). It again displaces electrons as previously, causing a polarity reversal. This displacement current is the principal current of the RF oscillation. If the alternation of RF field and the rotation of the space cloud are properly synchronized, the electrons reaching the anode from the interaction space have a 90° phase relationship and do not contribute to the oscillation. Electrons passing the gap (cavity) give up part of their energy to the RF fields, sustaining oscillation.

By varying the magnetic field strength or the d-c voltage applied to the cathode, it would be possible to "kick" the anodes slightly early or slightly late, thus varying the resonant frequency. However, there is a very narrow range through which the frequency can be varied in this manner, and the magnitude of oscillation decreases very rapidly with any change of sync. Therefore, this method is not in common use.

Modes of Operation

There are various modes of a magnetron, and they are identified by the number n, which specifies the number of cycles of variation of the field quantities that occur around the circumference of a circle surrounding the cathode. For each mode of oscillation of a magnetron, like those of other cavity resonators, there is a particular pattern of field variations. In the zero mode, the fields do not enter the anode cavities and the frequency of the mode is not controlled by the cavities; thus this is an undesirable mode of operation. With the exception of the π mode, all modes are degenerative. Degenerative modes are in reality a combination of two or more modes having the same resonant frequency. In the π mode of operation, adjacent anode segments are exactly 180° (one-half cycle, or π radians) apart in phasing.

These degenerative modes are caused by very close coupling between resonators having the same frequency, allowing the mutual inductance to either add or substract from the natural inductances of the cavities.

Since a slight variation may cause a shift from one of these modes of operation to another with a resultant change in output frequency, these modes are highly undesirable. Since the π mode of operation is not degenerative, it is the preferred mode of operation.

In order to insure operation in the π mode, the procedure known as STRAPPING is used. Since in the π mode of operation adjacent segments must be operating with a 180° phase relation, then alternate segments should be in phase. In order to guarantee this in-phase condition, alternate segments are connected as shown in figure 11-25 (A).

While operating in the π mode, there is no current flow through the straps, so there is a negligible inductive effect on the cavities. On the other hand, there is a very high electric field between each strap and the anode segment to which it is not connected. This adds an effective capacitance to the associated cavity, lowering its frequency. If the adjacent segments are not phased 180° apart, the magnetron tries to oscillate in an undesirable mode; the straps are then connected to points of unequal potential, and current flows in the straps. This current makes

each strap appear as an effective inductance in parallel with the cavity, increasing the frequency of this undesired mode and giving better mode separation. The potential difference between the strap and the segment decreases, presenting a lower effective capacitance to the cavity and increasing the frequency of the undersired mode even more.

NOTE: Some magnetrons make use of double ring strapping as illustrated in figure 11-25 (B).

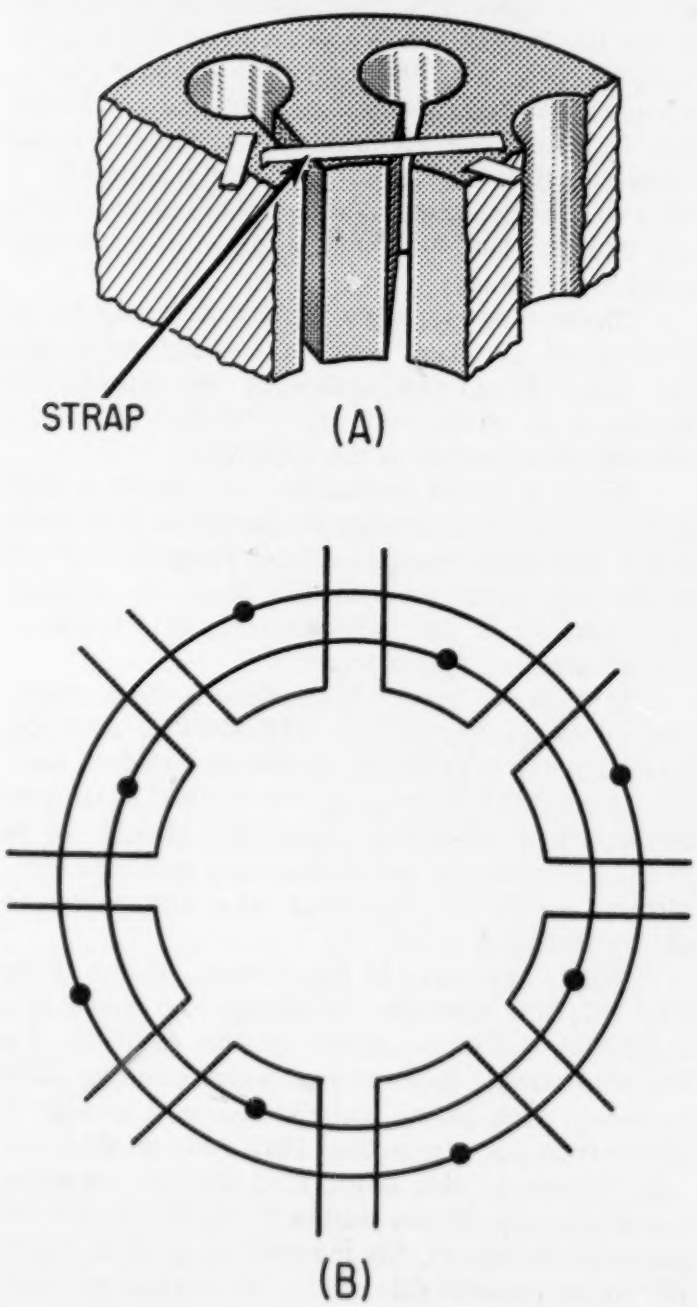

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Figure 11-25.–Strapped magnetron.
(A) Cutaway view; (B) double strap.

In addition, there are other strapping methods (not shown). All methods are used for the same purpose, but some are more effective than others.

Types of Cavities

The anode of a magnetron is usually a copper block into which resonant cavities have been cut. Several forms of these cavities are shown in figure 11-26.

The capacitance of the cavity is primarily the distributed capacitance between the anode segments forming the resonator; the inductance is distributed around the inner perimeter of the cavity. Each resonator is essentially a parallel resonant circuit, and all are connected effectively in series.

In figure 11-26, the SLOT type anode (A) is effectively a high C/L ratio, the HOLE and SLOT (B) is a medium C/L ratio, and the VANE (C) is a high L/C ratio. The RISING SUN (D) provides excellent separation at high frequencies without strapping.

In the rising sun type anode, the overall resonant frequency lies somewhere between that of the large cavities and that of the small ones. A degree of coupling exists between the cavities of the same size, and the resultant frequency differs from the extremes by an amount depending on the amount of that coupling. Optimum separation between the π mode and the low and high frequencies is obtained through anode block design.

The RF voltage across the large cavities is greater than that across the smaller ones, so the RF field is not uniform. The circulating currents in the large cavities are all in the same direction, and are greater than those in the small cavities; therefore, there is a net circulating current. By applying the proper values of voltage and magnetic field strength, the proper relationship between electron velocity and resonant frequency may be attained.

Output Coupling

In multicavity magnetrons, the output coupling is built into the magnetron, where it is not readily accessible for adjustment. The type and the degree of coupling must be fixed in the design and construction of the magnetron. How-

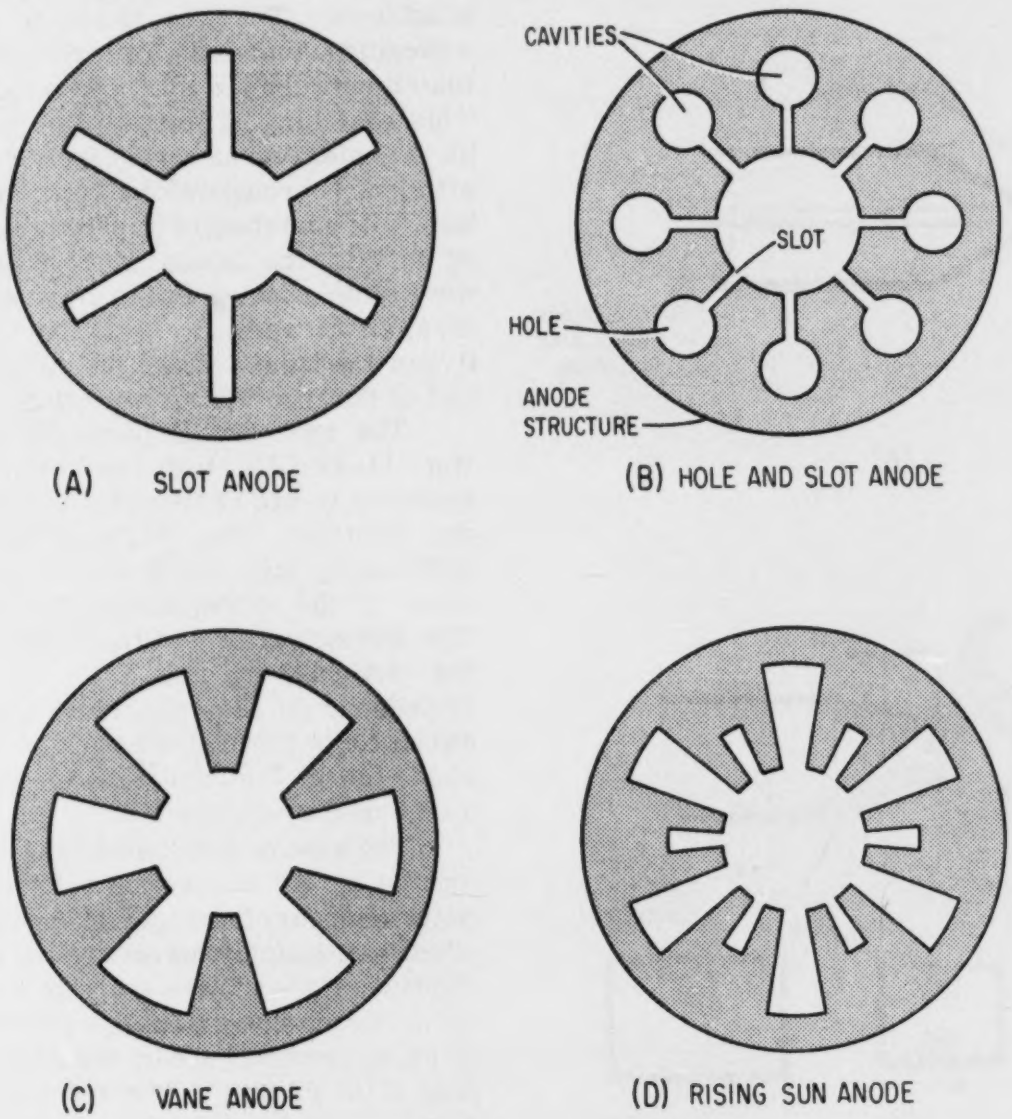

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Figure 11-26.—Types of anode blocks.

ever, in order for the technician to properly analyze the operation of radar sets, he must have a basic understanding of the function of the coupling devices, the principles involved in the operation of the devices, and the effects they have on the overall operation of the magnetron and the radar set as a whole.

Because the magnetron is highly evacuated, and the waveguide (when used) is usually pressurized, a pressure seal is required where the power is to be taken out of the magnetron. This seal is probably the weakest point in the entire system for voltage breakdown and power output limitations.

Basically, there are two methods for classifying magnetron coupling systems—by the type transmission line involved (coaxial cable or waveguide), or by the type element used for the coupling (loop or aperture).

LOOP COUPLING.—Loop coupling is normally used for transferring energy into coaxial lines. Figure 11-27 (A) shows one example of the loop method of coupling, where the loop is inserted into one of the cavities of the magnetron. The loop is positioned in an intense magnetic field, so that the plane of the loop is perpendicular to the field; thus maximum energy is transferred to the loop.

The transfer of power is affected by the area of the loop and by the leakage inductance. The loop is usually made of a broad strip of copper, and the wall of the cavity is used as part of the loop.

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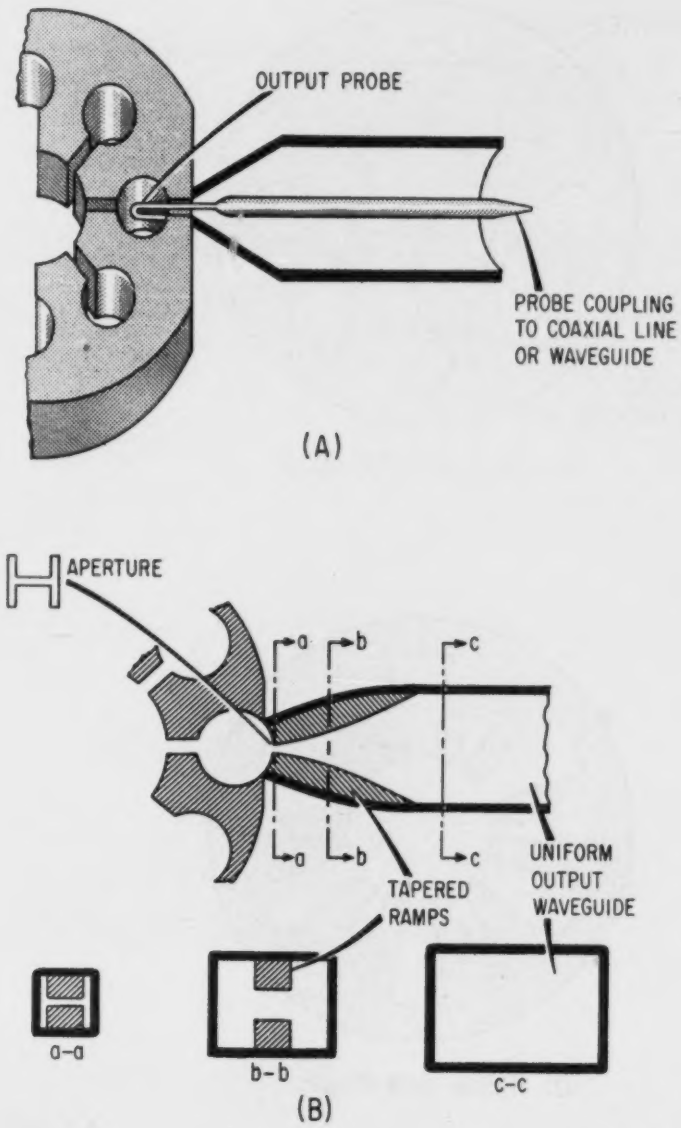

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Figure 11-27.–Coupling power out of the magnetron.

Coaxial coupling is limited to relatively low power output circuits, due to the limitations of voltage breakdown and arcing imposed by the coaxial cable.

APERATURE COUPLING.–Transferring power from the magnetron into waveguides normally involves aperture coupling. Such a coupling device consists of two main parts–the TRANSFORMING SECTION of waveguide, and the aperture and WINDOW through which the energy passes from the magnetron to the waveguide. (See fig. 11-27 (B).)

If the guide were connected directly to the magnetron, power transfer efficiency would vary rapidly with any change in frequency or loading conditions. The transforming section of the waveguide functions to provide an impedance match between the magnetron and the waveguide. This matching of impedances permits power to be transferred at a relatively constant level of efficiency throughout the entire range of operation. The matching of impedance is accomplished by making the inside of the first portion of the waveguide section the same shape as the aperture, then gradually changing the section until it has the same shape as the waveguide at the end of the transforming section.

The aperture is normally shaped as an H (fig. 11-27 (B)), with the vertical lines corresponding to broad openings in the ends of one of the cavities. The vertical lines maintain a sufficiently high cutoff wavelength to keep operation of the waveguide in the dominant mode. The horizontal line of the H-shaped aperture is the determining factor in the characteristic impedance of the aperture, and represents a narrow slot through the back of the cavity in the anode block. This aperture effectively functions as a capacity-loaded slot.

The window functions as an air pressure seal and as an RF connection between the inner and outer sections of waveguide. A good window must present practically no loss and no reflections. Reflections at the window are kept to a minimum by selecting the material composition (special glass, mica, or ceramic) and by the diameter and thickness of the window. A non-reflecting window may be considered as a short length of waveguide having the same characteristic impedance as the waveguide into which the window is inserted.

The breakdown strength of the window is greater than that of the coaxial output, but is still not adequate for the higher power magnetrons unless the entire system is built for a very efficient power transfer. Any mismatch caused by improper installation, dirt or grease films, excessive moisture, etc., increases the danger of arcing and the resulting loss of power and possible damage to the components. Mica or a special ceramic material is used for the window to improve the power transfer capability of the system.

Additional Features of Magnetrons

In airborne equipments that use a magnetron, the magnetic field is provided by a per-

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manent magnet. Most magnetrons have built-in magnets and are called PACKAGED MAGNETRONS. Thus, whenever a magnetron is replaced, the magnet must also be replaced.

Depending upon the type of magnetron and the type of equipment, it is sometimes necessary to season a new magnetron since it may not withstand the immediate application of full power plate voltage. This is accomplished by subjecting the magnetron for a period of a few hours to filament voltage only. After this warmup period, the plate voltage is applied (at low power settings if possible) and a check is made to determine if the magnetron is arcing. Should arcing be detected, it may be necessary to remove the plate voltage and again subject the magnetron to an additional period of seasoning. The Service Instruction Manual for the specific equipment generally contains information on this phase of maintenance.

Where the magnets are not built in, magnetic polarity should be observed. Theoretically, if the magnetic field of the magnetron is reversed, there should be no change in magnetron operation. This may not always be true since the construction of the magnetron may not be perfectly symmetrical. Thus, if the magnet is removed, it is important that it be reinstalled in its original position. (Generally the polarity of a magnet is indicated, and this may be used as an aid in maintenance.) The magnet should never be removed when the magnetron is operating (nor should the magnetron be operated with the magnet removed) since this would cause electrons to strike the anode at high velocity and result in excessive heating. (With no magnetic field, there is nothing to limit magnetron current.)

The magnetron tube is a delicate unit and must be treated as such. The tube must be handled very carefully. Should it be dropped, or should the tube elements be moved, there is the possibility of a plate to cathode short or a change in spacing of the elements. Either of these will cause the tube to operate improperly or not at all.

Cathodes of magnetrons usually are oxide coated, indirectly heated surfaces. The pulse currents developed are larger than can be produced by thermionic emission alone. The large number of electrons responsible for these currents are developed by secondary emission from the cathode as the cathode is bombarded by high velocity electrons returned by the magnetic field and the RF oscillatory voltage.

Since much of the heating of the cathode is obtained through bombardment of the cathode by the electrons returning to it, the filament voltage is usually reduced after the high voltage is applied. This reduction is accomplished by adding a tapped filament transformer or a series limiting resistor in the circuit. In some equipments the filament voltage is removed completely after anode current reaches a sufficient value.

Metallic cathodes with good secondary emission characteristics have been used satisfactorily. The cathodes are designed with end shields to prevent the escape of electrons from the interaction space between the cathode and the anode block. The magnets, which are made of a special alloy called Alnico, are unusually strong. The field strength required is dependent upon anode potential and operating frequency.

The magnets should not be struck with metallic substances of any hard material because this will cause them to lose some of their magnetism, resulting in a shift in operating frequency, shifting modes of oscillation, and instability of frequency and power output.

Extreme care must be used in handling and even in storing magnetrons. They must not be stored too close together or near other ferrous (magnetic) materials. Carefully observe the instructions in the applicable Service Instruction Manuals and any precautions in or on the shipping container for the magnetrons.

The design of anode blocks determines the frequency and power output. Most anode blocks have cooling fins around the outside for forced air cooling, while other (high power) magnetrons have jackets for liquid cooling.

KLYSTRONS

Klystrons depend upon the formation and control of a high velocity electron beam, and are therefore termed VELOCITY MODULATED TUBES. The tube is usually divided into three functional sections–the electron gun, the cavity/drift space region, and the collector. Klystrons are available in low power models and in high power models. They are also available in basic form and in a modified form called the REFLEX

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KLYSTRON. They are used almost exclusively at microwave frequencies as oscillators or as amplifiers.

Basic Klystron

The electron beam is simply a fast-moving stream of electrons expelled from the electron gun into the cavity/drift space regions as shown in (A) of figure 11-28. The electrons forming the beam are emitted from a heated cathode, and flow away from the cathode along converging paths created by the specially shaped electric fields formed by the electrodes. These paths converge to form a beam along an imaginary line extending from the cathode through the drift tubes to the collector. This line is termed the KLYSTRON AXIS.

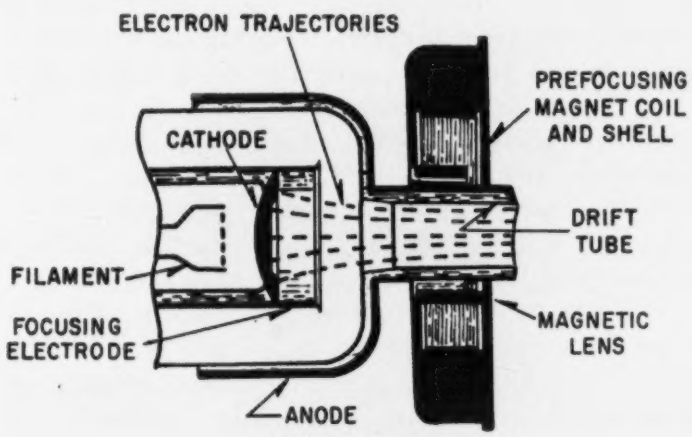

(A)
THE ELECTRON GUN

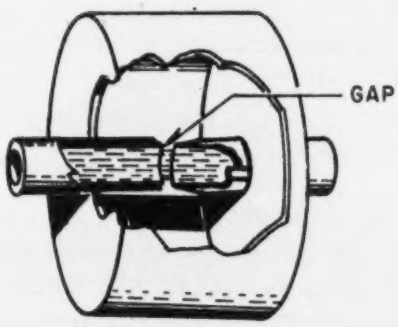

(B)
CAVITIES OF CATCHER AND BUNCHER REGIONS

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Figure 11-28.–Klystron. (A) Electron gun; (B) cavities.

The cathode is a concave section of a sphere located inside one end of a cylindrical metal piece called a FOCUSING ELECTRODE. Just beyond the opposite end of the focusing electrode, the anode cup and first cavity/drift space regions are located. The focusing electrode is maintained at the same potential as the cathode, or at some negative potential determined by the anode potential (which is always positive with respect to the cathode). The positive charge applied to the anode causes the electrons to flow away from the cathode toward the anode, and the negative or zero charge applied to the focusing electrode causes the electrons to move in toward the axis. As a result of the two forces acting on the electrons, they form a converging beam which focuses inside the first cavity/drift space region.

The cavity/drift space region of the klystron is made up of the drift tube and two to four resonant cavities which surround it at intervals along its length. The DRIFT TUBE is an axial-interrupted tube in which the electrons are neither accelerated nor decelerated; its length is about 20 times its diameter. Each interruption along the drift tube, called a GAP, forms the entrance to an associated resonant cavity, and is constructed so that the ends of the drift tube sections protrude into the cavity (refer to (B) of figure 11-28) at opposing high voltage points on the cavity wall. Thus the drift tube tips become the capacitive loading elements in the cavity, and large RF voltages are impressed across them when the cavity is excited at resonance. The cylindrical structure forms the inductive element of the cavity. Such cavities are not necessarily cylindrical; some klystrons use gaps surrounded by cylindrical ceramic envelopes that perform the following three basic functions:

1. Maintain a vacuum with a metal-to-ceramic seal.
2. Maintain the proper spacing of the gap.
3. Facilitate the mounting of a detachable rectangular cavity box.

The electron beam transfers some of its energy to the cavities as it flows along the drift tube section of the klystron, and it carries the balance of its energy out of the cavity/drift space region into an electrode called the

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COLLECTOR. The collector gathers the electrons after their function has been accomplished and transfers them out of the klystron into the external circuits leading to the positive terminal of the beam power supply. The large energy content of the partially spent beam must be dissipated by the collector. When the electrons collide with the collector surface, all of their kinetic energy is transformed into thermal energy, which heats the collector. The thermal energy is then transferred to the surrounding environment by cooling the collector with a liquid or by air. (See fig. 11-29.)

Figure 11-29 illustrates the assemblies which comprise a typical high power klystron. Frequent reference should be made to this figure during the following discussion.

This high power klystron requires a strong axial magnetic field to maintain and direct the electron beam throughout the length of the drift tube. This axial field is a result of the prefocus coil, the three body coils, and the collector coil shown in (D). (The field could be produced by permanent magnets, although this feature is seldom used in airborne equipment.)

The electron beam tends to disperse because of mutual repulsion between electrons. The axial magnetic field overcomes the tendency by exerting forces on any electrons that try to move in a direction not parallel to the klystron axis. Thus, electrons attempting to leave the axis are forced to remain within the confines of the beam.

At the beginning of its passage through the drift tube, the electron beam is a continuous stream of electrons moving at a constant velocity. Although it is not confined to a wire, the beam is nevertheless considered to be direct current flowing through the free space enclosed by the drift tube. Ideally, the beam would never touch the drift tube, but in practice there are always some electrons which stray far enough from the center of the beam to be caught by the drift tube walls. Just as a direct current produces no detectable sound as it flows through a headphone, a direct-current electron beam can produce no detectable radiofrequency power as it flows through a klystron. It must be changed in some manner before it can be useful. This is accomplished in the klystron at the cavity/drift tube gaps, which change the relative velocity of the electrons comprising the beam.

It was previously mentioned that a drift tube gap is formed by the ends of drift tube sections which enter the cavity axially from opposite ends. The cavity is designed so that the drift tube tips become its highest voltage points, in order to build up strong RF fields in the gap (fig. 11-28 (B)).

Consider a single electron after it leaves the electron gun region: see axial electron in figure 11-30. As it approaches the first drift tube gap, often called a BUNCHER GRID, the electron absorbs energy from the high voltage power supply, E_{dc}. Notice that instantaneously both buncher grids are at a high d-c potential with respect to the cathode, but there is no RF voltage between the grids at this time. As the axial electron is accelerated toward the first buncher grid, electrons within the first buncher grid structure tend to move away from the axially moving electron and toward the second buncher grid. The movement of electrons within the buncher grid structures constitutes current flow. An RF voltage is created between the buncher grids (labeled $E_{dc} + E_{ac}$ in fig. 11-30) at the point in time when the axial electron is moving in the plane of the first buncher grid. The instantaneous polarities are also shown in figure 11-30.

When the axial electron has passed the first buncher grid and has moved to a point midway between the buncher grids (gap), its field interacts equally on both grids. Electrons in these grid structures are neither repelled nor attracted at this time, and current ceases to flow. The RF potential between the buncher grids (across the gap) reduce to zero volts. E_{dc}, the high d-c voltage applied to the buncher cavity, however, continues to accelerate the electron toward the second buncher grid.

The axial electron then passes the second buncher grid structure; the electrons tend to move away from the axial electron. This constitutes current flow once again, but this time in the opposite direction (shown as $E_{dc} - E_{ac}$ in fig. 11-30). The maximum value of instantaneous voltage occurs when the axial electron is actually passing through the plane of the second buncher grid.

The axial electron now moves beyond the buncher grids into the drift space region. This electron is now moving faster than before it entered the buncher grids, but it has left a positive

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UNIT III - DRAWING GEOMETRIC CONSTRUCTIONS

Bisecting an Angle Lesson 2

OBJECTIVE: To learn to bisect an angle, using ruler and compass.

RELATED INFORMATION:

For bisecting the given angle (Fig. 1), strike the arc BC, using A as center and any convenient radius. With a radius approximately equal to AB, and using points B and C as centers, strike arcs intersecting at point D. Draw a straight line from D to A: this will bisect the angle.

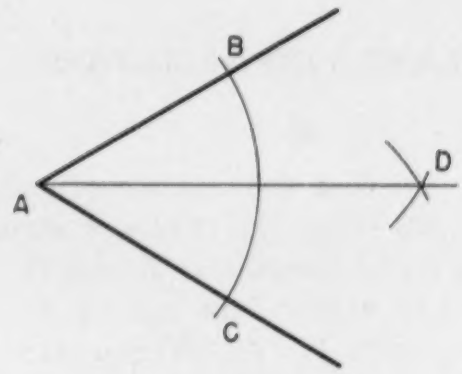

FIG. 1

Application:

To locate two end holes in a bracket (Fig. 2), proceed as stated above. Scale the dimensions needed from the drawing shown.

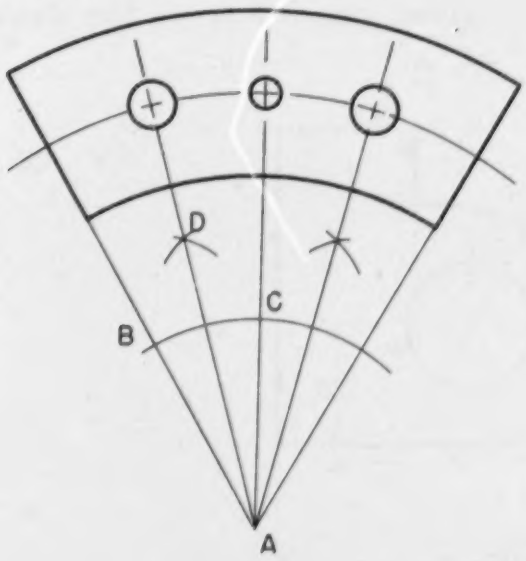

FIG. 2

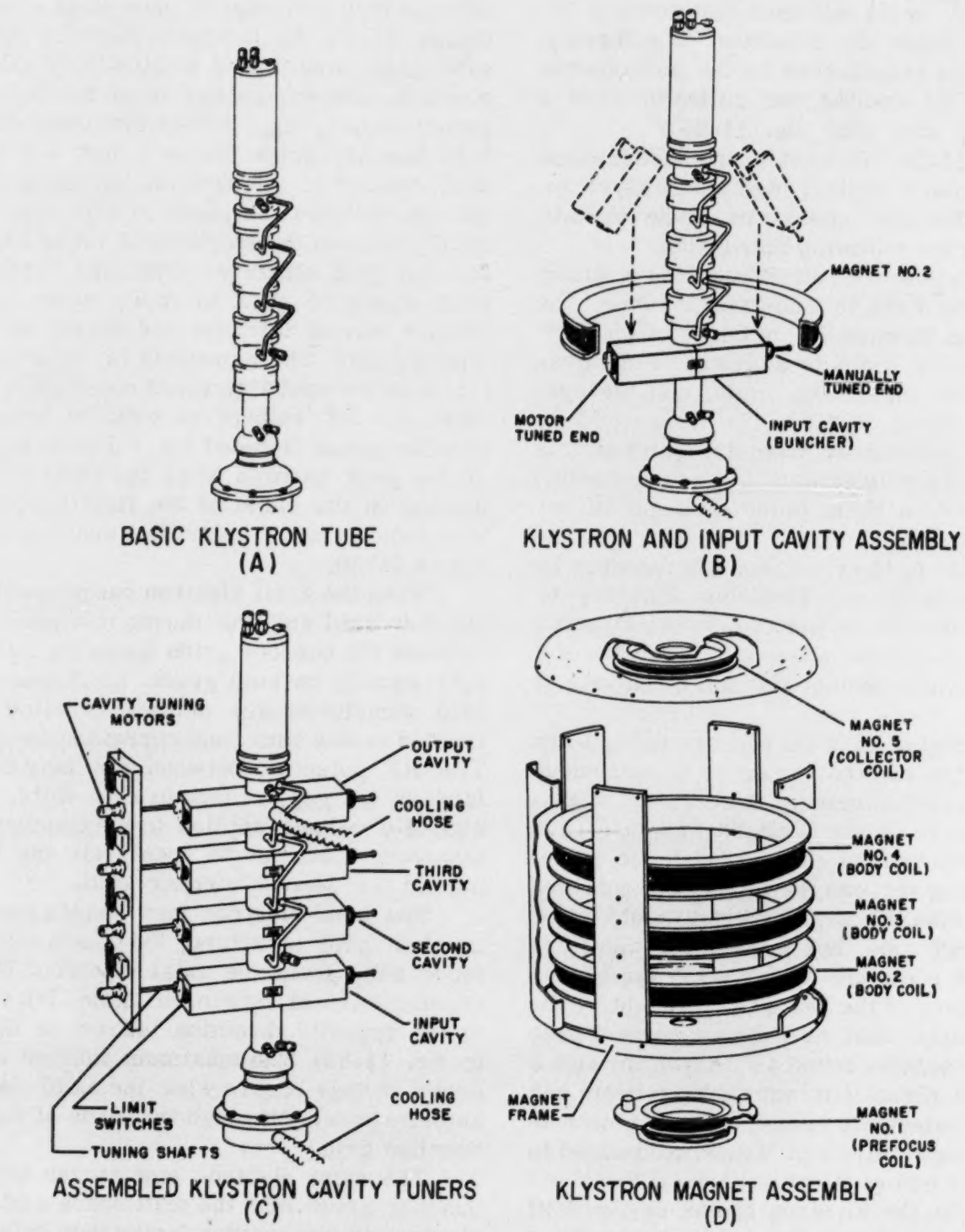

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Figure 11-29.—High power klystron, assembly.

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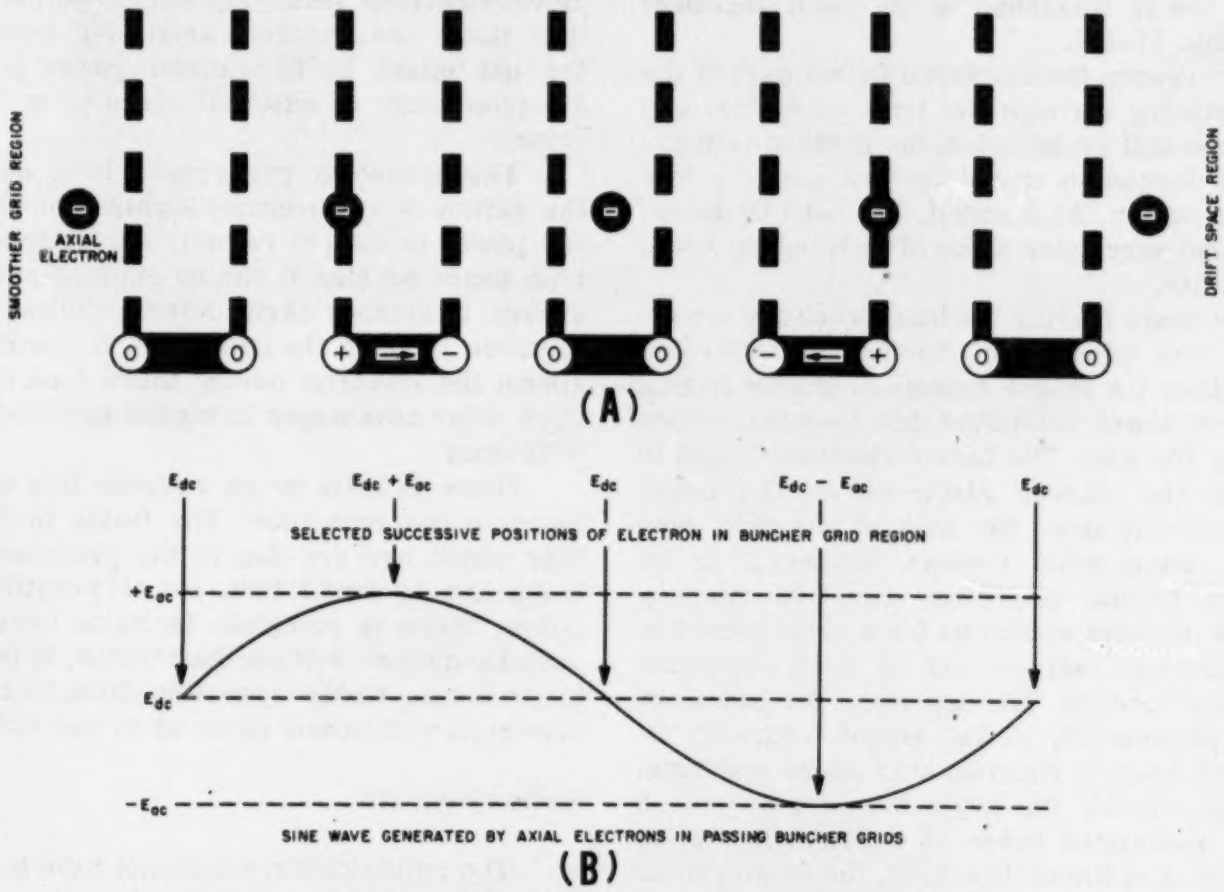

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Figure 11-30.–Buncher grid action.

charge on the second buncher grid, due to E_{ac}, and would be attracted backwards if it were not for the velocity and momentum the electron has acquired.

There are three major points of consideration applicable to buncher grid operation. First, the number of electrons leaving the buncher grids is equal to the number of electrons entering the buncher grids; hence, the electron density remains unchanged. Second, the individual velocities of the electrons leaving the buncher grids are higher because of acceleration by E_{dc}, and their exit velocities are higher or lower than the E_{dc} level (by an amount due to the E_{ac} voltage generated by the axially moving electron itself). Third, E_{ac}, created by the movement of the axial electron, varies in a sinusoidal manner. Hence, the exit electron creates the RF field, E_{ac}, which in turn governs the approach velocity of the entry electron.

Since E_{ac} varies in a sinusoidal manner, the preceding axial electrons approaching the buncher grids will be affected as follows:

1. When the sinusoidal voltage, E_{ac}, is positive, it aids E_{dc} in accelerating the axial electron, so that buncher exit velocity is greater than buncher entry velocity.

2. When the sinusoidal voltage, E_{ac}, is zero, E_{dc} is the only acceleration acting upon the axial electron, so that buncher exit velocity relative to E_{ac} is the same as buncher entry velocity.

3. When the sinusoidal voltage, E_{ac}, is negative, it opposes E_{dc} in accelerating the axial electron, so that buncher exit velocity is lower than buncher entry velocity.

Those electrons in the parts of the beam passing the first gap when it is positively polarized experience an increase of velocity because they flow from a region of negative charge toward a region of positive charge. The negative region repels the electrons and the positive region attracts them, with the result that the velocity and energy content of that part of the beam are increased. The energy gained by the faster parts of the beam is provided by the

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driving power furnished to the input (buncher) cavity (fig. 11-29).

Conversely, the electrons in that part of the beam passing through the first drift tube gap during the half cycles when the polarity is negative are forced to travel from a positive to a negative region. As a result, they will be decelerated and surrender some of their energy to the input cavity.

The beam leaving the buncher cavity is continuous and of uniform density, but alternate parts along its length contain electrons having higher or lower velocities than they had before entering the gap. The faster electrons begin to overtake the slower electrons as the beam travels freely down the axis of the drift tube until, at some point a short distance from the gap, the fastest electrons travel in company with the slowest electrons for a brief period of time. During that period of time, optimum "bunching" occurs. The density of the beam now varies periodically at the signal frequency as observed from a fixed point in space and time. In other words, the beam has now become a density-modulated beam. If a gap is located at the point of optimum bunching, the beam can be made to surrender many times as much energy as was originally required to produce velocity modulation; therefore, the klystron acts as an amplifier.

The function of the catcher grid gap (output cavity, fig. 11-30) is to extract energy from the passing beam of electrons. Energy is extracted from the bunched beam by the same method used to velocity modulate it in the first gap. As the beam travels through the catcher gap, the instantaneous gap polarity varies in such a way that the denser portions of the beam are decelerated and the less dense parts of the beam are accelerated. As the different groups of axial electrons were gated through the buncher grids one at a time, some emerged with high velocities and others emerged with low velocities. As they progressed through the drift space, the two groups caught up with each other. At this instant both groups are intercepted by the catcher grids. Although the average power through the klystron has not changed from buncher to catcher cavity gaps, the instantaneous (peak) power is very high when the catcher cavity gaps intercept the combined energy of the merged groups of axial electrons. As a result, there are many more electrons giving up energy to the circuit than there are electrons absorbing energy, and the net effect is to transfer power from the electron beam to external circuits of the klystron.

The preceding paragraphs have described the action of a two-cavity klystron in which the RF power is used to velocity modulate an electron beam so that it can be made to surrender energy to another cavity after traveling a short distance through the drift tube. Experience has shown the klystron having more than two cavities offer advantages in higher gain and higher efficiency.

There is little or no reverse flow of electrons in the drift tube. The fields in the drift tube which are not due to the presence of the beam are so small that, for all practical purposes, there is complete isolation between the output and input cavities. As a result, it is possible to obtain stable operation from four-cavity klystrons with power gains up to one million.

Reflex Klystron

The reflex klystron does not have a buncher and catcher cavity as separate units; a single cavity is employed. The same pair of grids at the entrance to the cavity acts as a buncher grid at one instant and as a catcher grid at the next instant. The control or smoother grid is operated at a positive potential with respect to the cathode. The cavity grids are operated at a still greater positive potential with respect to the cathode. The repeller plate is operated at a large negative potential with respect to the cathode.

Electrons emitted by the cathode are immediately accelerated to high velocities by the positive potential applied to the smoother grid, and a beam is thereby formed. Consider a group of axial electrons, all with approximately the same energy levels, approaching the cavity grids at the same instant. These axial electrons will be highly accelerated by the cavity grids because of E_{dc}. Notice in figure 11-30 that there is no a-c voltage developed between the cavity grids at this point in time; therefore, E_{dc} is the only accelerating voltage acting upon the electrons.

As the accelerating axial electrons approach the first cavity grid, electrons contained within

the metallic cavity-grid structure move toward the second cavity grid because of the mutual repulsion of like charges. The movement of electrons within the grid structures constitutes an electrical current; hence, an instantaneous RF voltage, E_{ac}, is created across the two cavity grids with the polarity shown in figure 11-30. The maximum value of this instantaneous voltage occurs when the axial electrons are actually passing through the plane of the grid structure. The instantaneous polarity of the first cavity grid is now negative, as shown in figure 11-30, and has three effects. First, the effect upon the axial electrons is one of mutual repulsion between like charges. Second, the axial electrons are attracted toward the second cavity grid, which is now positive. Third, any additional electrons approaching the first cavity grid from the smoother grid region will encounter the present negative voltage on the first cavity grid, and their velocity will be reduced because of the repulsion of like charges.

When the axial electrons have moved to a point midway between the two cavity grids, their effect on both grids is equal and the voltage E_{ac} is reduced to zero. These axial electrons, as well as any other electrons approaching the cavity grids from the smoother grid region, are accelerated by a gain-absorbing power from the high voltage power supply.

As the axial electrons approach the second cavity grid, an instantaneous current flow is created once again, but the polarities of the two cavity grids are reversed. The maximum value of E_{ac} occurs when the axial electrons are actually in the plane of the grid structure.

As the axial electrons move away from the second cavity grid, the instantaneous voltage E_{ac} is reduced to zero again. Hence, an alternating voltage is created when the axial electrons move past the cavity grids. This RF voltage causes a change in the velocity of other electrons attempting to pass through the cavity grids.

When the electrons enter the drift space, they come under the influence of the repeller plate. This plate is operated at a highly negative potential with respect to the cathode. Its value is not necessarily fixed, but is so considered during this discussion. Those electrons which were gated through the cavity grid region when E_{ac} was positive possess high velocities and have acquired enough energy to travel far into the drift space, resisting the forces of mutual repulsion centralized at the repeller plate. Eventually, the electron velocity will be reduced to zero, and the electrons will then be attracted back to the cavity grids. (See figs. 11-31 and 11-32.)

Those electrons which were gated through the cavity grid region when E_{ac} was negative not only have low velocity and energy levels, but also passed the grids a half cycle later in time. These low velocity electrons will not travel very far into the drift space region before their velocities are reduced to zero by the forces of mutual repulsion centralized at the repeller plate. (See fig. 11-32.)

Both the fast and the slow axial electrons will be reduced to zero velocity at the same time, but they are widely separated in physical distance. At this point in time consider the forces acting upon the two electrons in the drift space. First, there is the stationary electron located very near the highly negative repeller plate. The forces of attraction centralized at the cavity grids tend to pull this electron back to the grids, but this is very slight compared to the forces of repulsion centralized at the repeller plate. Hence, the electron that originally had a high velocity will be accelerated to high velocity again but toward the cavity grids. Second, there is the stationary electron located very near the highly positive cavity grids. The forces of attraction for this electron are very high, while the forces of repulsion centralized at the repeller plate are comparatively weak. This electron is also attracted back toward the cavity grids, but its velocity is still low. Eventually, the high velocity electron overtakes the low velocity electron, and ideally the cavity grids should be located at the point where this action occurs.

The first and second cavity grids now act as a catcher grid to extract the energy from both electrons as they move past the two grid structures. After the electrons emerge on the other side of the cavity grids, they are once more in the region of the smoother grid. Because of their high velocity and mutual repulsion with respect to the electron beam formed by the smoother grid, these high velocity electrons are deflected toward the shell or body of the klystron (also at a positive potential with respect to the cathode), where they are returned to

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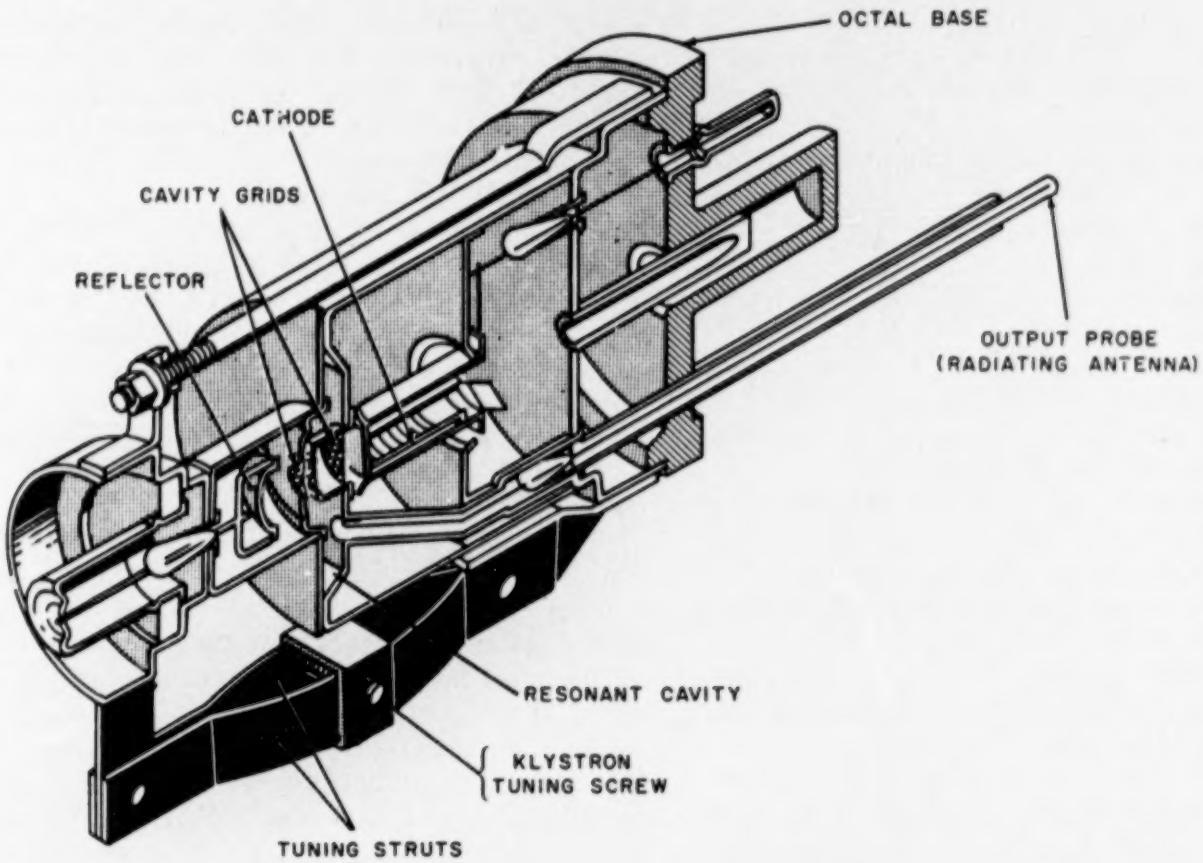

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Figure 11-31.–Reflex klystron, cutaway view.

the plate power supply. The energy extracted by the cavity grids is coupled by the resonant cavity to the output terminals of the klystron.

It was previously stated that the repeller plate voltage was not necessarily fixed. When an alternating voltage such as an audiofrequency is applied directly to the repeller, the rate at which the axial electrons are repelled changes; consequently, the output frequency of the klystron changes or deviates from its average value. This is known as frequency modulation.

In radar equipments using klystrons as the local oscillator, the repeller plate voltage is frequently varied so as to change the frequency of the oscillator. This is the function of the automatic frequency control.

PLUMBING

Many additional microwave components and devices are required to perform specific functions. As a group, these devices are commonly called microwave plumbing devices. Most of these devices make use of sections of waveguide, with internal characteristics and connection methods designed to produce the desired results. This section is devoted to a brief discussion of microwave plumbing devices used for the following purposes:

1. Changing the direction of the signal path (bends, twists, and joints).
2. Connecting signal paths (junctions and couplers).
3. Switching signal paths (duplexer systems).
4. Matching impedances (terminations, reactive devices, and attenuators).
5. Modulation and demodulation of microwave signals (mixers).

Following this section is a brief discussion of the ferrite devices used in microwave systems.

Changes in Signal Path

It is impractical to construct a complete microwave system for an airborne radar set in one straight piece. In an airborne installation,

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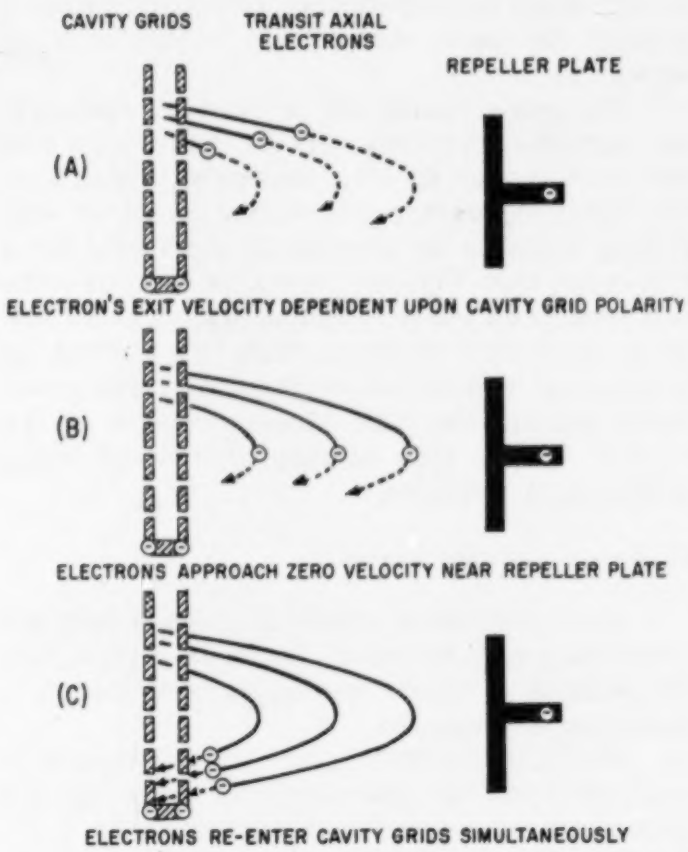

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Figure 11-32.–Drift space action in reflex klystron.

each microwave assembly must be mounted in an appropriate location, and the waveguide routed so as to connect them. This requires the use of various bends, twists, and joints in the waveguide structure. (See fig. 11-33.)

In order to transmit energy from one end of a waveguide to the other without reflections or losses, the size, shape, dielectric material, and direction must be constant throughout its entire length. Any abrupt change results in reflections and associated energy losses. By keeping all such changes gradual, the undesirable results can be minimized.

BENDS AND TWISTS.–A gradual bend or twist must have a radius of curvature greater than two full wavelengths in order to minimize reflections. Although the change in direction may be any amount, it is usually made in steps not exceeding 45° each.

A bend is used to change the direction of signal path without changing the orientation of the signal and associated fields and thus the mode of operation. A bend may be made in either the narrow or the wide dimension. When it is desired to rotate the electromagnetic fields, a twist is inserted. Gradual twists are normally used in order to minimize reflections.

When it is necessary that a change be abrupt, special devices must be used. Normally, in a sharp bend, reflections occur and result in considerable power loss. In order to avoid this, the guide is bent twice, at 45° each, a quarter wave apart. The first bend results in a reflection; the second also results in a reflection, but inverted. The combination of the direct reflection and the inverted reflection cancels, leaving the field oriented as though no reflection has occurred.

FLEXIBLE WAVEGUIDE.–To permit use of any special bend or twist required by a specific installation, some sections of waveguide may be made flexible. These sections can be bent or twisted within limits (in most cases the minimum radius of bend or twist is greater than two wavelengths). Because of their flexibility, these sections also help to absorb vibration, permitting shock mounting of units rather than requiring rigid mounting.

Flexible waveguide sections usually consist of a spiral-wound ribbon of brass, the winding having the same cross-section dimensions as the waveguide into which it is inserted. Skin effect keeps current flow at the inner surface; to provide for maximum conductivity, the inside surfaces of the flexible winding are silver plated. To retain flexibility while providing airtight and moistureproof construction, the outside surface is covered with rubber or a flexible insulation material.

Although bends and twists may be incorporated into rigid sections of waveguide, they are often supplied as separate sections, which must then be connected to the main waveguide by joints. Flexible waveguide sections must always be connected to rigid waveguide sections by joints.

JOINTS.–It might seem that joining two sections of waveguide would require only that the sections be the same size and fit tightly at the joint. Irregularities at the joint, however, could set up standing waves and result in energy leakage and dissipation of power.

PERMANENT JOINTS are used only in waveguide sections which do not require disassembly. During the manufacturing process at

the factory, the sections are machined to close tolerances, welded together, and smoothed to a mirror finish on the inside surfaces. This process results in a hermetically sealed joint which has negligible effect on the fields.

If maintenance procedures require that the two sections be disconnected, semipermanent joints are normally used. The most common semipermanent joint is the CHOKE JOINT, illustrated in figure 11-33 (B). The joint consists of two mating flanges, one flat and the other slotted, which connect the waveguide sections at their center. The slot is a quarter wavelength deep at a distance of a quarter wavelength from the point where the walls of the waveguide are joined.

The quarter-wave slot is shorted at the end; the distance down one side and back up the other side is effectively a half wavelength. Thus, the short circuit reflects a short at the point where the walls are joined. Electrically, this creates a short at the junction of the two waveguide sections.

The two sections could actually be separated from each other by as much as one-tenth of a wavelength without creating excessive standing waves or energy loss. Such a separation leaves room to insert a pressurizing seal at the joint. When a seal is to be inserted, the quarter-wavelength distance from the walls to the slot is modified slightly to compensate for the reactances introduced.

In most airborne radar systems, the transmitter is mounted stationary while the antenna must be free to scan or to rotate. This feature requires a ROTATING JOINT, which separates the sections mechanically while efficiently connecting them electrically. (See fig. 11-33 (C).) In a circular waveguide operating in a mode such as $TM_{0,1}$, the fields are symmetrical about the axis. In this system, a simple choke joint may be used; the waveguide rotates, but the field orientation remains fixed. Since the field remains effectively undisturbed, reflections are held at a minimum.

Although this method is satisfactory in theory, most airborne systems use rectangular waveguides, thus requiring a different type of joint. A coaxial cable provides the axial symmetry required for the fields, and also provides the circular cross section required for rotation. In the rotating joint, a probe is the center conductor of the coaxial section. The probe extracts energy from one waveguide section, conducts it through the cable, and injects it into the other waveguide section.

The center conductor is fixed in relation to the stationary section, and the rotating section revolves around it. For electrical connection, the outer conductor can either be fitted with sliding contacts or coupled to the tubing by a half-wave slot. The slot, which is shorted at the end, reflects a short circuit at the junction of the outer conductor sections. With this method, no mechanical connection is required between the outer conductors. The inner conductor of the coaxial section may be supported by insulating washers, if required.

Connecting Signal Paths

Most microwave systems require multiple paths for signal transfer. The connection of signal paths is normally accomplished by the use of junctions and couplers.

JUNCTIONS.–When a section of waveguide is connected into the side of another waveguide, the connection is normally referred to as a T-junction. The junction may be made in either the wide or the narrow side, as indicated in figure 11-34 (A) and (B). When the junction is made in the plane of the H-lines, it is called an H-TYPE junction; when in the plane of the E-lines, it is an E-TYPE junction.

The H-type junction (fig. 11-34 (A)) is effectively a parallel connection with the main line. When the end of the T-section is short circuited at a distance of a half wave from the center of the waveguide, the result is an equivalent parallel circuit. This section will reflect a short circuit at the line and will not allow any energy to pass. Similarly, in the waveguide itself a short circuit is reflected to the center where the E-lines are supposed to be. Since an E-line cannot exist at a short circuit, no energy will pass that point. If the shorted end of the T-section were only a quarter wave from the center of the waveguide, an open section would be reflected there and the passage of energy would be unaffected.

The E-type joint (fig. 11-34 (B)) is effectively a series connection with one side of the main line. In this case, if the section added to the waveguide is a half wave long, it will act as a

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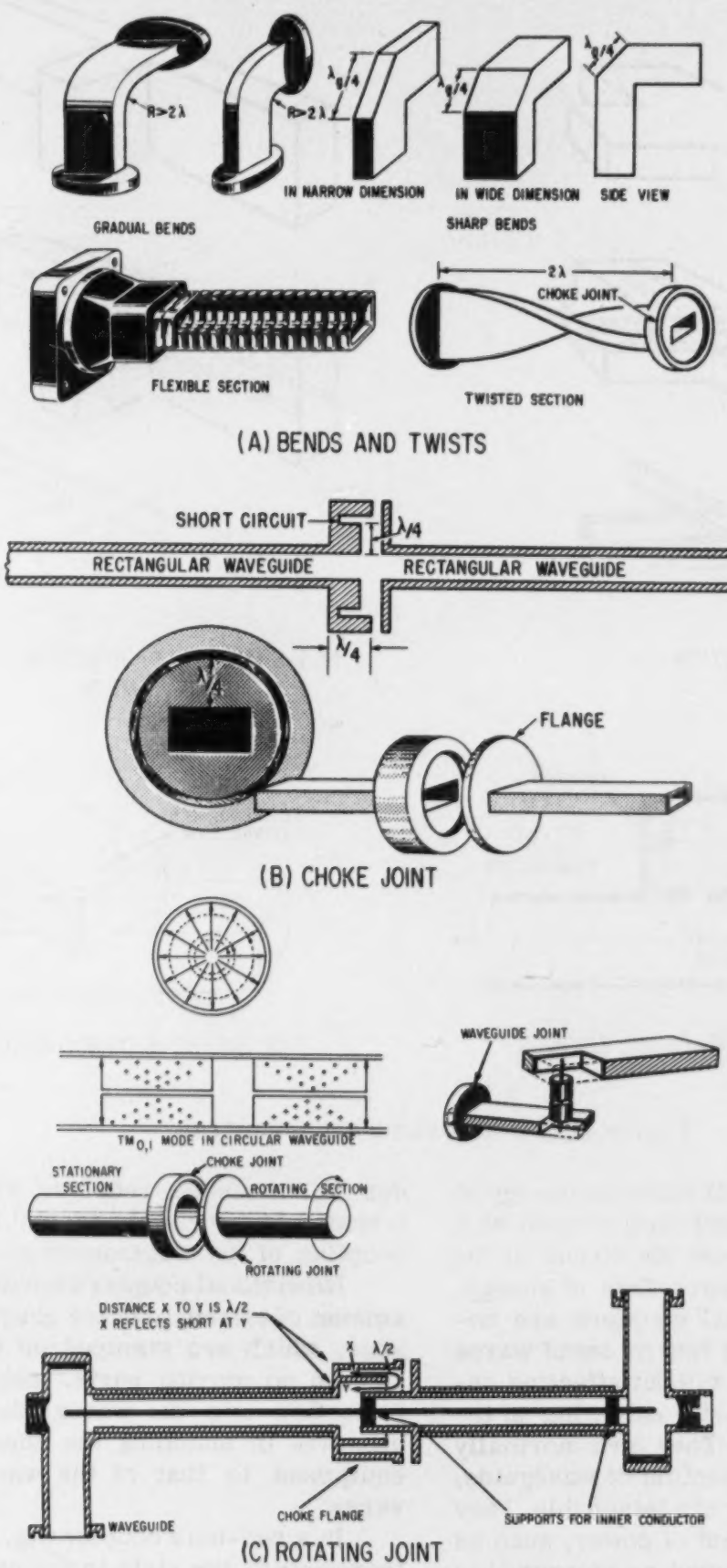

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Figure 11-33.–Waveguide bends, twists, and joints.

A to D via the path B-C. The two paths differ in length by a half wavelength, so that signals arriving by both paths are 180° out of phase and cancel. Any signals traveling to the right in the upper section are in phase, but are lost in the absorbing material.

If the wave in the main guide moves to the left, the two paths by which waves arrive at point D (path BCD and path BAD) are equal in length, and a wave proceeds to the left in the upper guide and is picked up by the test equipment probe. The absorbing material receives little or no energy, since waves to it (paths BADC and BC) cancel. Thus, energy from the transmitter passing to the left in the guide will reach the test equipment connection with a desirable amount of fixed attenuation, but energy picked up by the antenna and passing to the right will not reach the test equipment.

A signal injected at the test equipment probe can travel toward the receiver (which is between the directional coupler and transmitter) but cannot pass to the left toward the antenna.

A one-hole directional coupler is shown in figure 11-34 (D). Coupling from the main guide to the branch is accomplished by the electric and magnetic fields. The phase of the magnetic field is changed by the coupling so that the waves in the branch are canceled in one direction and reinforced in the other. In contrast to the two-hole coupler, the one-hole coupler transmits a wave in a direction opposite to that of the wave in the main line. Proper coupling to obtain the desired directional characteristic depends on the orientation angle between the main guide and the branch guide and the size of the hole between the two guides.

The branch guide is terminated at one end with a resistive material to absorb unwanted power; the other end contains a probe for connection to the test equipment.

Switching Signal Paths

In microwave systems it is sometimes necessary to switch signal paths within a complex system with several modes of operation. One common example of this requirement is found in the waveguide network used with radar antennas. The same antenna is used for transmission and reception, and energy flow in the antenna feed system must be efficient. During transmission, a very high level of energy must flow from the transmitter to the antenna for radiation. During reception, received echoes (which have a very low energy level) must flow from the antenna through the same waveguide to the receiver.

Although the directional couplers previously discussed are capable of switching signal paths, they are not adequate for this task. The power level of the transmitter signal would permit enough leakage through the coupler to damage the sensitive receiver input circuits. The coupler would also permit excessive leakage of the received signal into the transmitter, decreasing the effective overall sensitivity of the system.

In a radar system, the receiver must be disconnected from the signal path during transmission, and the transmitter must be disconnected during reception. Due to the short period of time available for the switching action, the switching device must be automatic and very fast acting. Such a device commonly used in airborne radar systems is the DUPLEXER. A simplified cross sectional view of a waveguide system duplexer is shown in figure 11-35.

The illustrated system consists of a main waveguide section between the transmitter and the antenna, with two branches attached through T-junctions. One branch leads to the receiver, and a TR tube is inserted in this branch. The other branch contains an ATR tube. In most systems the TR and ATR tubes are of the same type; differences in their operation result from differences in installation.

TUBE CHARACTERISTICS.–A TR tube is effectively a gas-filled spark gap tube with three electrodes. Two of the electrodes comprise the main gap (which does the switching); the third electrode is called the keep-alive electrode. The keep-alive electrode is mounted close to one of the main gap electrodes, and is supplied with a relatively high d-c potential.

At sea level pressures of air, approximately 30,000 volts (called the breakdown voltage) are required to break down a spark gap of 1 inch. Once the arc is established, approximately 50 volts (called the running voltage) are required to sustain ionization. Once the running voltage is removed, a period of approximately 10μ sec (called recovery time) is required for deionization. By enclosing the spark gap in a partially evacuated envelope and substituting an appro-

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UNIT III - DRAWING GEOMETRIC CONSTRUCTIONS

Bisecting an Arc — Lesson 3

OBJECTIVE: To learn to bisect an arc, using ruler and compass.

RELATED INFORMATION:

To find the center of the given arc AB (Fig. 1), draw a straight line between points A and B. Proceed to bisect line AB as described in Lesson 1. As previously explained, point C will bisect the arc.

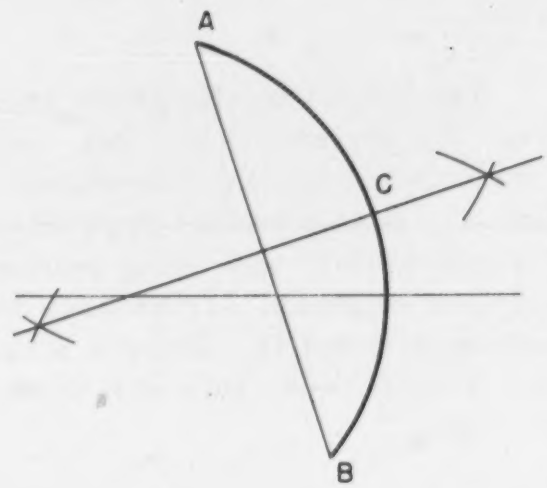

FIG. 1

Application:

To locate a hole on a line bisecting an arc (Fig. 2), proceed as stated above. Scale the dimensions needed from the drawing shown.

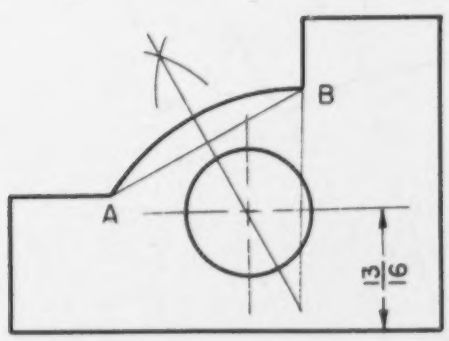

FIG. 2

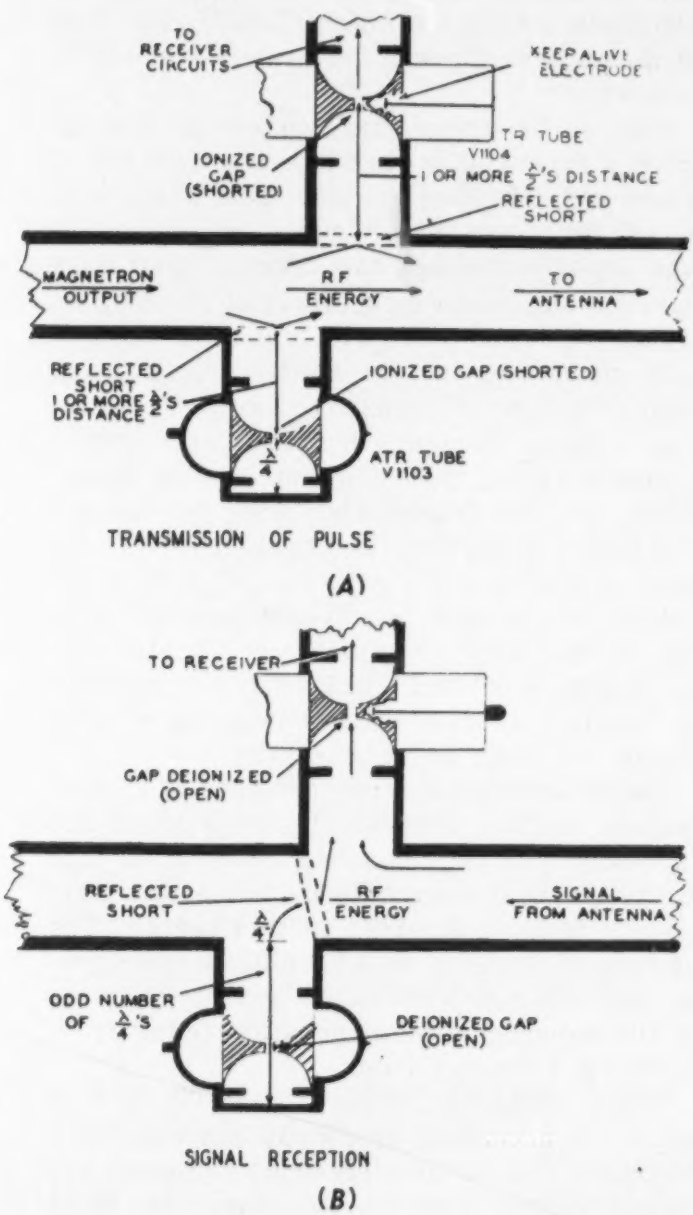

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Figure 11-35.–Waveguide system duplexer.

priate gas for the air, the breakdown voltage, running voltage, and recovery time may be reduced. Application of the proper keep-alive voltage keeps the TR tube on the verge of ionization. Thus the magnitude of the ignition spike and the pulse duration may be reduced, while at the same time insuring almost instantaneous firing of the tube for each pulse of the magnetron.

ASSEMBLY OF COMPONENTS.–For optimum overall system efficiency, the power dissipated in the TR and ATR tubes must be minimized. The tubes must maintain a properly matched line while fired; at the same time, they must afford adequate attenuation to prevent excessive leakage into the alternate signal paths. The manner in which these requirements are fulfilled depend on the assembly and tuning of the individual components of the duplexer system (fig. 11-35).

The TR tube is placed an even number of quarter wavelengths from the waveguide. A short circuit existing within the tube reflects an effective short at the entrance of the receiver T-junction. This short prevents the RF pulse from reaching the crystal and receiver circuits, but allows the pulse to proceed unimpeded to the antenna.

The ATR tube is also located an even number of quarter wavelengths from the waveguide. When the transmitter fires, the gap of the ATR tube breaks down and an effective short circuit is reflected across the opening at this T-junction. The wall of the waveguide appears continuous, and the pulse of energy from the transmitter passes unimpeded.

The ATR waveguide section is constructed so that an odd number of wavelengths exists between its shorted end and the opening to the main waveguide. Normally, the tube is deionized, and an effective open circuit appears at the T-junction. A short circuit is thus reflected across the waveguide adjacent to the TR opening (a quarter wavelength away), as shown in figure 11-35 (B). The received signal is thus guided into the TR opening instead of proceeding to the transmitter.

Matching of Impedances

In order to effectively transfer energy throughout an entire waveguide network, it is necessary to maintain a proper impedance match at each transfer point. At every place where waveguides, cavity resonators, or any of the coupling devices are to be joined, the impedances of the input and output devices must be matched for best (but not necessarily maximum) transfer of energy. Improper impedance matching results in undesirable standing waves, loss of power, and decrease of operating efficiency.

The basic principles of impedance matching are discussed in chapters 4 and 12 of Basic

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Electronics. A thorough review of these principles may prove helpful before proceeding with this discussion.

The characteristic impedance (Z_0) of a waveguide is not as easy to define as that of a coaxial line. The characteristic impedance of a waveguide is approximately equal to the ratio of the strength of the electric field to the strength of the magnetic field. This ratio is equivalent to the voltage to current ratio in coaxial lines on which there are no standing waves.

The lowest characteristic impedance of a circular waveguide is about 350 ohms. In a rectangular waveguide, it may be any value, depending on the dimensions of the waveguide and the frequency of the electrical energy. In this guide, it is directly proportional to the narrow (b) dimension when the wide (a) dimension and the frequency are fixed, and may vary from approximately 0 to 465 ohms.

On a waveguide there is no practical place to connect a fixed resistor to terminate it in its characteristic impedance as there is on a coaxial cable. However, there are a number of special arrangements which accomplish the same purpose.

In many cases it is desirable to match the impedance of the guide in order to insure a minimum of reflection. On the other hand, there are many instances where it is desirable for all the energy to be reflected from the end of the waveguide. Both of these, and some other methods of matching or modifying impedances of the guides, are discussed below.

MINIMUM REFLECTIONS.–One method of terminating a waveguide for minimum reflections consists of filling the end of the guide with a graphite-sand mixture, as shown in (A) of figure 11-36.

As the fields enter the mixture, currents flow in it and create heat, which is instrumental in dissipating energy. None of the energy thus dissipated as heat is reflected back into the guide.

Another method for terminating a waveguide is to use a wedge of high resistance as shown in (B). The plane of the wedge is placed perpendicular to the H-lines. When the H-lines cut the wedge, a voltage is induced; the current produced by the induced voltage produces an I^2R loss. Similarly, E-lines produce current flow and an I^2R loss. These losses are dissipated in

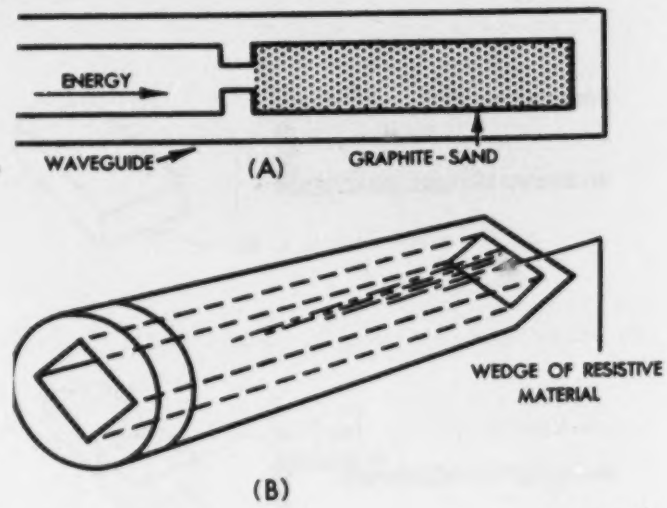

AT.217

Figure 11-36.–Termination for minimum reflections.

the form of heat, and very little energy is permitted to reach the closed end to be reflected.

These terminations are used as transmitter dummy loads for testing and shop operation. They are generally constructed with external cooling fins for better heat dissipation.

MAXIMUM REFLECTIONS.–When it is desirable to terminate the waveguide in such a manner as to obtain maximum reflection of energy from the end of the waveguide, there are several methods that may be used. Some of these are shown in figure 11-37.

One method is to weld a permanent metal shield (plate) at the end of the waveguide, as shown in (A). When it is necessary that the end be removable, a removable end plate is attached to the end of the guide. For this method to be satisfactory, the contact between the guide and the end plate must be exceptionally good in order that the H-field will not be attenuated when current flows.

Perfect contact is not required when the connection is made at a point of minimum current. (This point is located a quarter wave from the end.) When connection is made at this point, a cup is used (as in (B)) instead of the end plate. This cup is a quarter wave long and large enough to fit over the end of the guide. The voltage between opposite sides of the cup opening is high; but as the reflected H-field cancels the incident H-field, the resulting current is very small and power loss is at a minimum.

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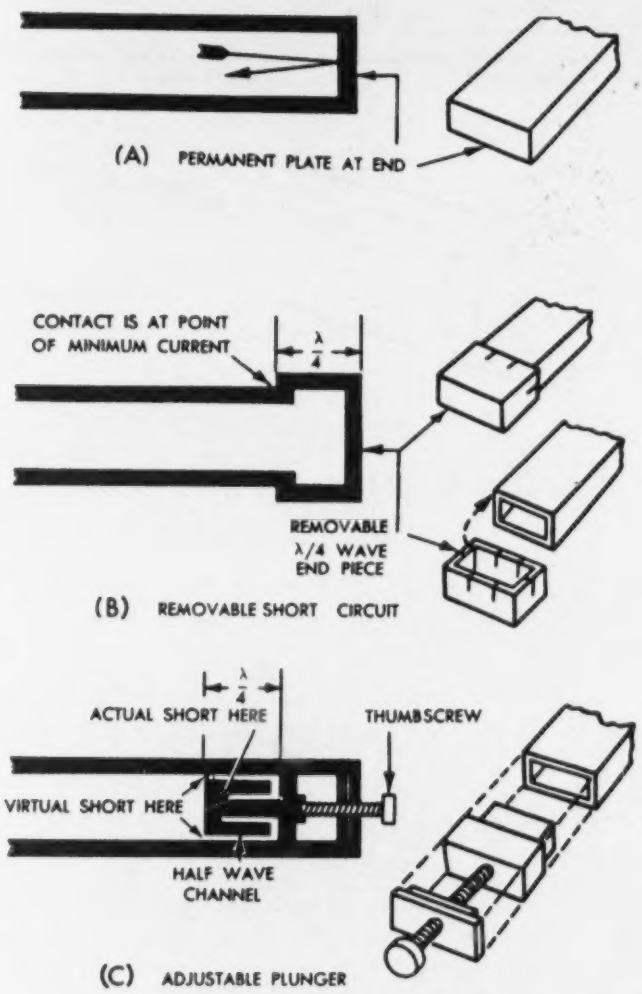

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Figure 11-37.–Termination for maximum reflections.

When the end must be adjustable, the contact must be nearly perfect. However, it is impossible to get a perfect contact. The best arrangement, one which is similar to the choke joint previously explained, consists principally of an adjustable plunger which fits into the guide as shown in (C). The walls of the waveguide and the plunger form a half-wave channel. The half-wave channel is closed at one end and reflects a short circuit across the other end, where a perfect connection is supposed to exist between the wall and the plunger. The actual physical contact is made at a quarter-wave distance from the short circuit, where the current is minimum due to the standing waves. This makes it possible for the plunger to slide loosely in the guide at a point where the contact resistance to current flow is very low.

REACTIVE DEVICES.–Some devices which are used in radar introduce inductance or capacitance into the circuit. Sometimes these reactances are deliberately introduced. Other times when they are present and not desired, they can be tuned out with small fins or plates in a waveguide.

Figure 11-38 shows a number of reactive plates which are deliberately used to introduce capacitance or inductance into a waveguide. In (A) the edges of the plates are parallel to the E-lines. The electric field causes current to flow along the edges. The current flow causes a magnetic field to be generated, and thus the partition acts as an inductance. The partition also causes higher order modes; but since the waveguide is too small for these modes, they are rapidly attenuated and are not propagated. This causes a small loss of power. The amount of inductive reactance produced by these plates depends on the spacing between them. The wider the spacing, the greater the inductive reactance, and the smaller the effect on the fields.

In (B) the edges of the plates are at right angles to the E-field. Electrons accumulate first on one edge and then on the other, and the plates act as a capacitor. Higher modes are produced (as with the inductive plates); and the wider the spacing between the plates, the greater the capacitive reactance.

From these facts it would seem that a resonant circuit might be produced by combining both types of plates and leaving a small opening in a large guide, as shown in (C). This is approximately true, provided that the dimensions are correct. Such a waveguide would, in effect, have a parallel resonant circuit connected across it.

Mixing Microwave Signals

The usual function of the mixer in a superheterodyne receiver is to combine the frequency of the incoming signal with that of the local oscillator, and to produce from this combination a third (IF) frequency. The IF is usually much lower than either of the two input frequencies. The IF is then amplified and used to carry the impressed intelligence through the rest of the RF circuits. (The basic principles of superheterodyne receivers are discussed in Basic

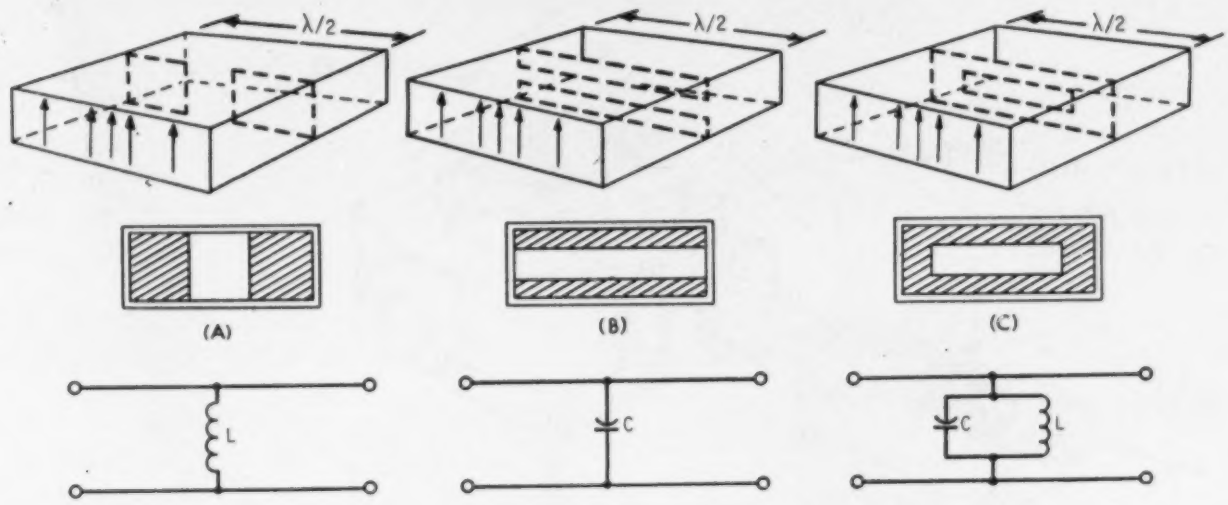

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Figure 11-38.–Reactive plates in waveguide, $TE_{1,0}$ mode.

Electronics.) Use of vacuum tube mixers is usually restricted to receivers in and below the UHF range. At microwave frequencies, the mixer is almost always of the crystal type.

Crystals are extremely delicate, and must be well protected by the TR device as discussed previously. Echo signals of a microwave radar system, after passing through the TR device, are applied to the crystal mixer. Local oscillator voltage is also applied to the mixer. Signals at the intermediate frequency are derived at the mixer output during the time of each return echo.

SINGLE-ENDED MIXERS.–Figure 11-39 illustrates the important features of a single-ended mixer used in the 10-cm frequency range with coaxial line inputs. Part (A) is a cutaway pictorial representation; part (B) illustrates the equivalent circuit.

Echo signals are coupled into the transmission line section between the TR cavity and the crystal by means of a coupling loop which penetrates a short distance into the cavity. The crystal fits snugly into the inner conductor of the line and is held concentric with the outer conductor by means of a dielectric bead. The local oscillator signal is introduced into the mixer assembly by means of a coupling probe located approximately a quarter wave (at the local oscillator frequency) from the coupling loop in the TR cavity. A high impedance in the direction of the cavity is thus presented to the local oscillator signal at the probe. The strength of the local oscillator signal at the crystal may be changed by varying the distance the probe extends into the main line. Power from the local oscillator is conducted to the probe via a section of transmission line.

Connection between the crystal and the inner conductor of the line section carrying IF signals is provided by a spring contact. The half-wave RF choke appearing on the IF side of the crystal provides an electrical short circuit for radio-frequency signals at point B. The d-c return path for crystal current is provided at the RF end of the mixer assembly by the TR coupling loop and at the IF end by a shunt inductance element located in the grid circuit of the input IF amplifier stage (not shown).

A two-wire equivalent circuit of the mixer is given in figure 11-39 (B). If small losses in the RF line and TR cavity are ignored, the portion of the RF transmission system between antenna and output terminals of the TR cavity may be represented by a signal current source I_s in shunt with the characteristic resistance R_c of the transmission line. Because the local oscillator is loosely coupled to the main line, negligible admittance appears in shunt with the lines A and B in the figure. Elements L1 and C1 represent the RF choke at the IF end of the crystal and are series resonant at the echo signal frequency. Hence, line B is terminated by the crystal at the echo signal frequency. For maximum receiver sensitivity it is important that essentially all the echo power available at the TR device be transferred to the crystal. The

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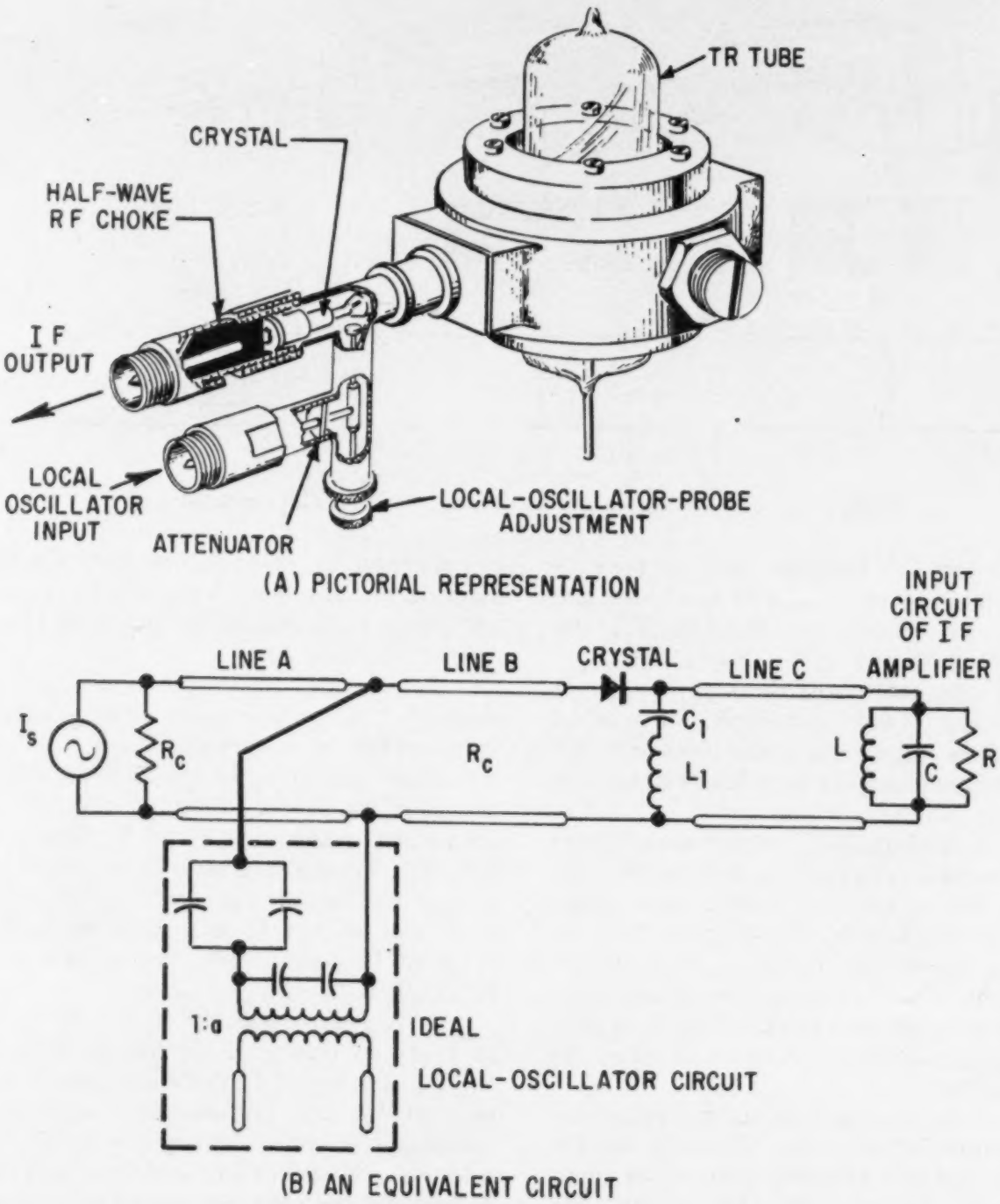

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Figure 11-39.–Single-ended 10-cm coaxial-fed mixer.

crystal should therefore present a matched load termination to the main line section. Fortunately 10-cm crystal units, when operated with 5/16-inch 50-ohm coaxial lines, provide essentially a matched RF load for the line. An impedance changing device between the crystal and the TR cavity is therefore usually unnecessary.

Because the local oscillator is loosely coupled to the main line containing the crystal, an appreciable mismatch of impedance exists on the local oscillator line at the coupling probe. A large impedance mismatch is, in general, undesirable because of the wide variations in the local oscillator load impedance (and hence power output) that result when the oscillator frequency is varied. A good impedance match is particularly important if the line between the local oscillator and the probe is long. To insure a rela-

tively constant load impedance for the oscillator, a resistance disk type of attenuator is often inserted in the local oscillator line, as shown in (A), in order to terminate the line section between the oscillator and the disk in its characteristic resistance. An alternative to the resistance disk is a length of "lossy" cable, which may be inserted between the local oscillator and the mixer assembly. (NOTE: Lossy cable uses resistance wire for the center conductor. An example of lossy cable is RG-21/U.)

Mixer assemblies often include, in addition to the circuit that supplies IF echo signals, a separate mixer for generating IF signals for the automatic frequency control circuit. An example of a 3-cm mixer assembly of this type is shown in figure 11-40. Part (A) is a cutaway pictorial representation; part (B) is an equivalent schematic.

Although this mixer uses two mixing crystals and separate waveguide channels, it is classed as a single-ended mixer because the output signals are independent of each other (due to the use of different signal inputs). Actually, this circuit could be appropriately described as two single-ended mixers.

Local oscillator power and RF echo signals from the TR cavity are coupled into waveguide 1, which serves as the echo signal channel. A crystal extends between the top and bottom walls of the guide, the lower end of the crystal being isolated from the guide by means of a dielectric washer. Echo signal voltages in the IF band appear between the lower end of the crystal and the waveguide, and are conducted to the input circuit of the IF amplifier, usually by coaxial cable.

Waveguide 3 is similar in construction to waveguide 1 and serves as the AFC channel. Power from the local oscillator and a small amount of the transmitter power are applied to the AFC crystal. IF signals for the AFC circuit are derived at the lower end of the crystal mount, as before. Attenuation between the main guide and guide 3 is provided by means of a circular waveguide section operating below cutoff. A disk type attenuator is sometimes included in the circular section to further reduce the amount of transmitter power reaching the mixer assembly.

The local oscillator tube is mounted above waveguide 2 in a manner that permits the local oscillator output probe to extend a short distance into guide 2. The coupling probe may be displaced slightly from the center of the transverse axis of the guide. This method is used to obtain a load impedance for the oscillator which provides a reasonably uniform power output over the tuning range.

Local oscillator power is coupled from guide 2 into guides 1 and 3 through coupling apertures located in the side walls of the guides. A matching post and tuning screw extending from the top and bottom walls of the guides at the aperture locations serve to regulate the amount of local oscillator power coupled to the mixer circuits.

For optimum performance of the radar system, the echo signal channel of the mixer should provide a matched load impedance to the waveguide transmission system. The elements that determine the mixer input impedance are shown in the equivalent circuit (B). The equivalent circuit is derived by dividing waveguide 1 into three sections of lengths (Bd_1, Bd_2, and Bd_3), and representing the sections by equivalent lengths of transmission lines (lines A, B, and C). The signal current generator I_s in shunt with R_c in the equivalent circuit accounts for the portion of the RF system between antenna and mixer. The coupling aperture between the local oscillator and mixer guides (guides 1 and 2) is represented by a variable inductance L, and in shunt with L is an impedance Z which accounts for the impedance seen in the direction of the local oscillator guide. The parallel combination of L and Z terminates a quarter-wave section of line which is in shunt with lines A and B. At the echo signal frequency, the impedance of L and Z in parallel is maintained small enough (in comparison with the characteristic resistance of the quarter-wave line) to make the input impedance of the quarter-wave section extremely high; hence, the amount of echo signal power entering the local oscillator guide is extremely small.

The crystal is located at the junction of lines B and C; across the crystal output terminals is a series RLC circuit. (The counterpart of the RLC combination is an RF choke in the IF output lead of the mixer. The choke prevents RF signals from entering the input circuit of the IF amplifier.)

The length of the shorted-end line C must be such that the input admittance of line C, in shunt with the RF admittance of the crystal, provides essentially a matched load for line B.

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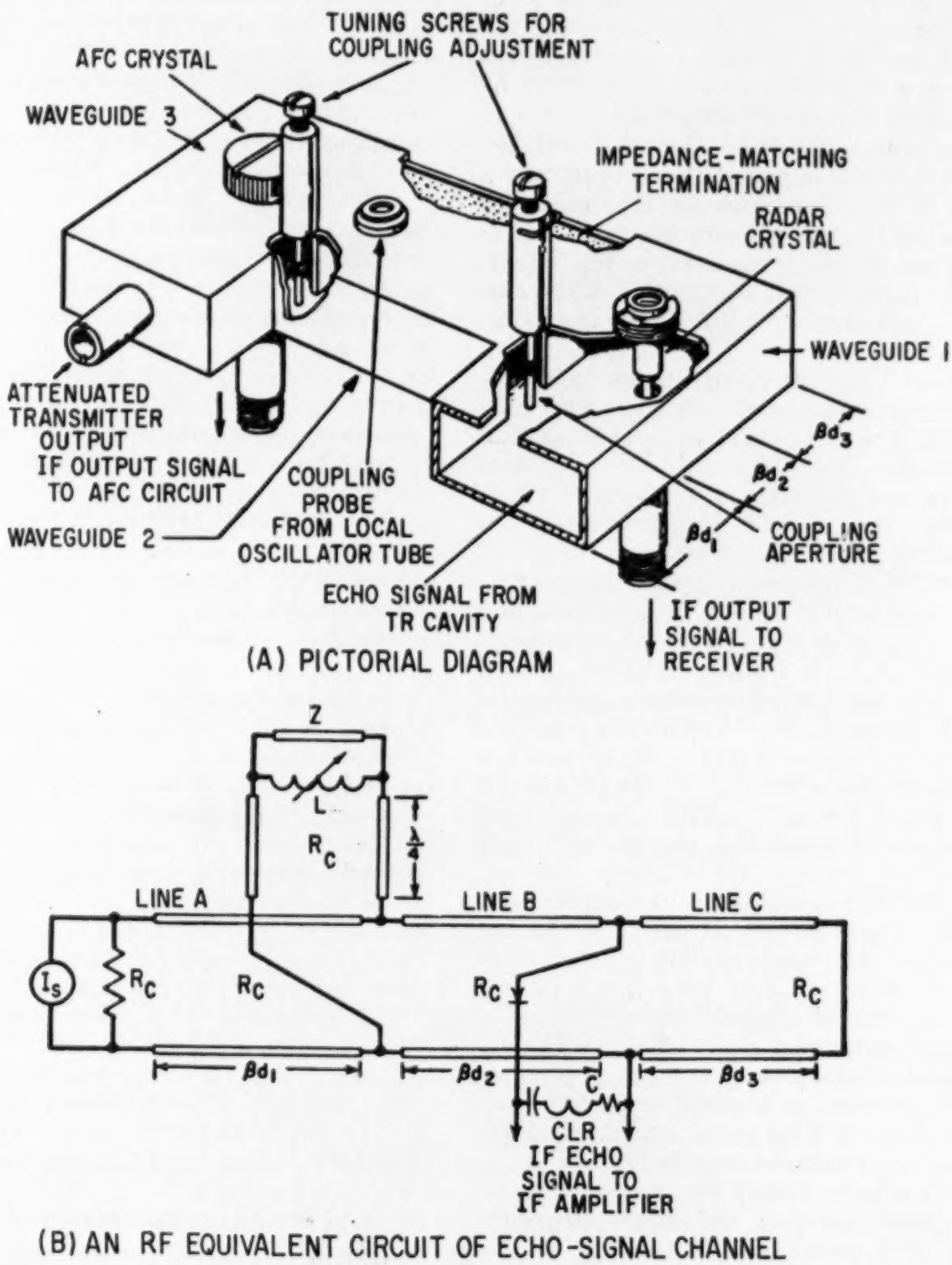

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Figure 11-40.—Single-ended 3-cm waveguide-fed mixer.

Varying the length of line C changes the susceptance component of the total admittance at the crystal location. A length of approximately $\lambda/4$ is usually preferable in order to minimize changes in admittance with frequency variations.

BALANCED MIXERS.–The noise introduced into the input circuit of a microwave receiver by the local oscillator may be reduced appreciably through use of a balanced mixer. An input circuit of this type employs two crystal mixers connected so that the local oscillator voltages applied to each crystal are in phase and the echo signal voltages at each crystal are phased 180°. This method of circuit connection causes the IF components of local oscillator noise to cancel in the IF amplifier input circuit, and the IF components of the signal to add. Because of their ability to suppress local oscillator noise and because of certain additional advantages to be discussed later, balanced mixers are often preferable to single-ended mixers. They are presently finding wide use in microwave radar systems.

The basic principles of a balanced mixer may be explained from the diagram of figure 11-41, which shows two crystals mounted a half wavelength apart (at the signal frequency) between conductors of a coaxial line section. Each crystal is located a quarter wave from the nearer end of the line, and the local oscillator signal is probe coupled to the line at a point midway between the crystals. The output terminals of the crystals are connected to an IF transformer, the primary winding of which is balanced to ground. The signal current generator I_S in shunt with resistance R_C accounts for signals entering the mixer from the TR device.

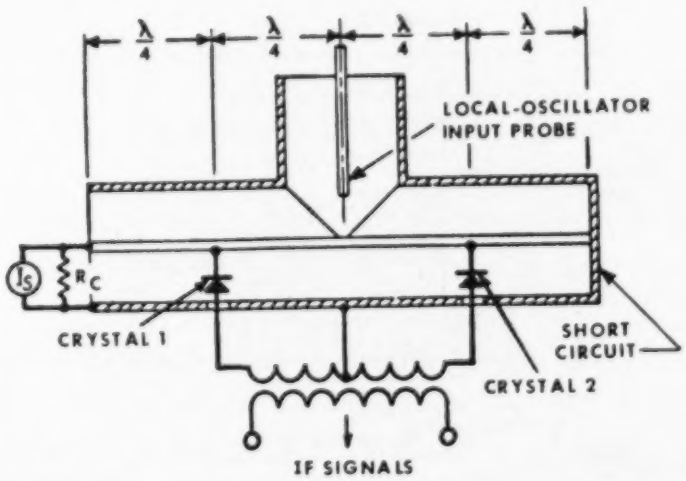

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Figure 11-41.–Coaxial line balanced mixer circuit.

The local oscillator coupling probe gives rise to two waves traveling in opposite directions in the coaxial line. Assume that the local oscillator frequency at the TR device presents a short circuit to the local oscillator wave traveling to the left, and that the crystals have identical RF impedances equal to twice the characteristic resistance of the line. Then equal-amplitude, in-phase, local oscillator voltages appear at the crystals. Because of the half-wave spacing between crystals, the RF echo signal voltages at the crystals are also of equal amplitude but are 180° apart in phase. An in-phase relation between the local oscillator and echo signal voltages produces an IF signal voltage of one phase, and a 180° phase relation between the local oscillator and echo signal produces an IF signal voltage of opposite phase. Thus the two IF echo signal voltages add in the balanced input circuit of the IF amplifier. Because the noise that accompanies the local oscillator signal produces voltage components that bear the same phase relation to the local oscillator voltage at each crystal, the corresponding IF components of noise at the output of each crystal are in phase, cancel, and hence produce no resultant noise voltage across the IF transformer.

In order to realize full benefit from use of a balanced mixer circuit, the crystal should have similar RF impedance as assumed above, and in addition they should have similar conversion gains. Under these conditions of operation, only one-half the available RF power is applied to each crystal; but since the power in the IF signals from the two crystals add together, the total IF power is the same as that obtained from a single-ended mixer. Since IF components of the local oscillator noise are completely eliminated, maximum reduction in overall noise figure is obtained.

An imbalance in conversion gain yields an imbalance in the IF signal voltages obtained from the crystals, and also an imbalance in the IF components of local oscillator noise voltages at the crystal output terminals. However, since the IF signal voltages are additive and the local oscillator noise components are subtractive,

small imbalances in conversion gain do not seriously affect the overall receiver noise figure.

More important are the effects of a difference in the RF admittances of the crystals. An imbalance of this type causes both the echo signal power and the local oscillator power to divide unequally between the two crystals. As a result, the IF signal power obtained from the mixer is appreciably reduced, and the IF components of local oscillator noise are prevented from canceling completely. Crystals intended for use in this type of mixer must be carefully selected on the basis of equal RF admittance in order to insure most satisfactory operation.

MICROWAVE FERRITES

The most common ferromagnetic substances (iron, nickel, cobalt, and their alloys) are good electrical conductors. They cannot, therefore, be used as magnetic materials at the higher frequencies because of eddy current losses. Ferrites, however, are not subject to eddy currents. Even though their magnetic susceptibility is much lower than that of the ordinary ferromagnetic substances, they can be used at the higher frequencies. Ferrites are unique because they have useful magnetic properties and are also insulators. RF fields can penetrate a ferrite; this is not possible in a conducting magnetic substance.

At microwave frequencies, the greatest use of ferrites is in nonreciprocal propagation devices. Nonreciprocal devices can be used to isolate a signal source from its load. A magnetron or other microwave signal source operating into a varying mismatched load (as in the case of a scanning antenna which is fed by a line with rotating joints;) tends to "pull" in frequency. If the reflected energy caused by mismatch is absorbed or diverted before it reaches the source, the source will "see" a constant load.

Nonreciprocal ferrite devices make use of the interaction of the electron's spin with an external magnetic field.

Ferromagnetic Resonance

When a ferrite is placed in an external magnetic field, the "atomic" magnets within the ferrite tend to line up with the external field. A spinning electron has gyroscopic properties. When an external force attempts to change the spin axis, the electron precesses. Any gyro has a preferred or natural precession frequency which is proportional to the strength of the external field. By proper choice of ferrite material and external field strength, the natural precession frequency can be made to coincide with any selected microwave frequency.

An electromagnetic wave traveling down a waveguide will produce, at a point off the centerline of the guide, a rotating magnetic field. This is illustrated in figure 11-42(A). As the wave advances from right to left, the stationary point A sees a clockwise rotating magnetic field. A wave traveling from left to right will produce, at point A, a magnetic field with counterclockwise rotation.

A slab of ferrite placed off center in a waveguide, as shown in (B), will act as a one-way device at a frequency which depends on the external magnetic field strength. If the ferrite's preferred electron precession frequency matches the frequency of an RF wave traveling from left to right in the guide, the ferrite will absorb most of the energy in the wave; the rotating magnetic field as seen at point A will aid electron precession. The electrons will

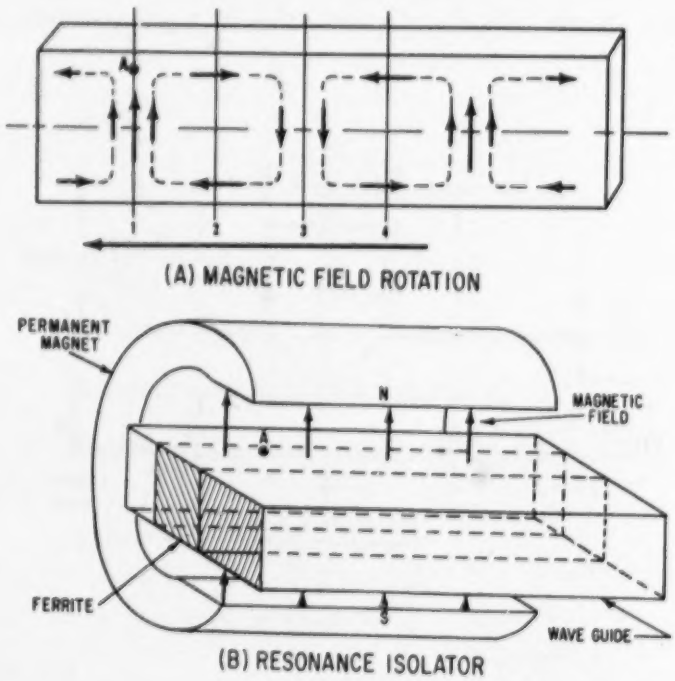

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Figure 11-42.–Ferromagnetic resonance.

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precess vigorously and convert the RF energy to heat. This phenomenon is known as ferromagnetic resonance. A wave traveling from right to left will be attenuated very little because its rotating magnetic field will oppose electron precession. The one-way device shown is a RESONANCE ISOLATOR.

Faraday Rotation

If a plane-polarized wave is propagated through a circular (or square) waveguide containing an axially mounted ferrite rod, the plane of polarization will be rotated when a magnetic field is applied parallel to the direction of propagation. The amount of rotation will depend on the strength of the applied field and the dimensions of the ferrite rod. The sense or direction of rotation will depend only on the polarity of the magnetic field. Figure 11-43 illustrates Faraday rotation.

Faraday rotation occurs as the wave travels past the ferrite rod. The plane of rotation is shifted in the same direction, regardless of the direction of wave propagation, as can be seen by comparing (A) and (B) of the figure.

An isolator which uses the Faraday effect is shown in figure 11-44 (A) and (B). A plane-polarized wave comes down the guide and goes through a rectangular-to-round waveguide transition. As the wave passes the ferrite in (A), its plane of polarization is rotated 45° clockwise, and it leaves through the rectangular guide. If a wave comes down the guide in the reverse direction, it will also be rotated 45° clockwise (as viewed from the left) as shown in (B). The wave will be 90° from the transmission plane of the rectangular guide (the guide will be cut off for this polarization), and the wave will be reflected. Properly oriented vane type absorbers will absorb this energy without affecting waves traveling in the other direction.

In isolators designed to handle high power, the reflected wave can be coupled out to a separate power-absorbing load. An isolator of this type is shown in figure 11-44 (C).

Switches

A Faraday isolator can be modified to act as a single pole, double throw, WAVEGUIDE SWITCH. In the waveguide switch, the output end of the device has two rectangular output

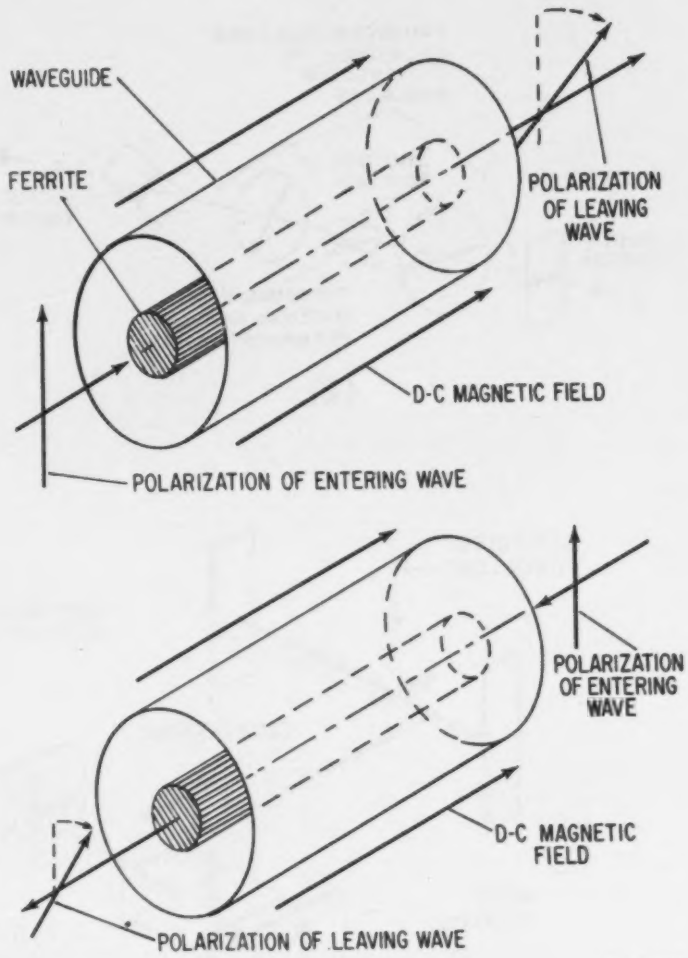

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Figure 11-43.–Faraday rotation.

guides 90° apart. Each output guide is 45° from the input guide at the other end of the device. An electromagnet supplies the external field. Switching is accomplished by reversing the direction of current flow in the electromagnet. Current in one direction causes the RF wave polarization to be rotated clockwise 45°. Electromagnetic current in the opposite direction causes the wave polarization to rotate 45° counterclockwise. In each case, only one of the output guides will accept the RF wave. Switching times of less than 1μsec are possible. Isolation between the output guides (if they are properly terminated) is on the order of 40 db. This type of switch can be used to switch a transmitter between two antennas.

Circulators

A CIRCULATOR is a device which allows one-way propagation of signals through it. It

UNIT III - DRAWING GEOMETRIC CONSTRUCTIONS

Dividing a Line Into a Number of Equal Parts Lesson 4

OBJECTIVE: To learn to divide a line into any number of equal parts.

RELATED INFORMATION:

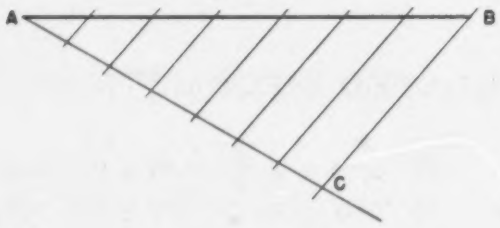

TO DIVIDE A LINE INTO SEVEN EQUAL SPACES

FIG. 1

The illustration given here will show how to divide a line into seven equal parts: The same method can be used for any number of equal parts. In Fig. 1, the given line is AB. Draw the light line AC at an angle approximately equal to 30°. On line AC, step off with your compass seven equal spaces, of any convenient length. (All seven parts on line AC must then be equal to that length.) Connect the last, or seventh, part with B. Through the other points on line AC, draw lines parallel to BC. The points thus found on line AB will divide AB into seven equal parts.

Application:

To drill six holes, equally spaced, on a piece of sheet steel (Fig. 2), proceed as stated above. Scale any dimensions needed from the drawing shown.

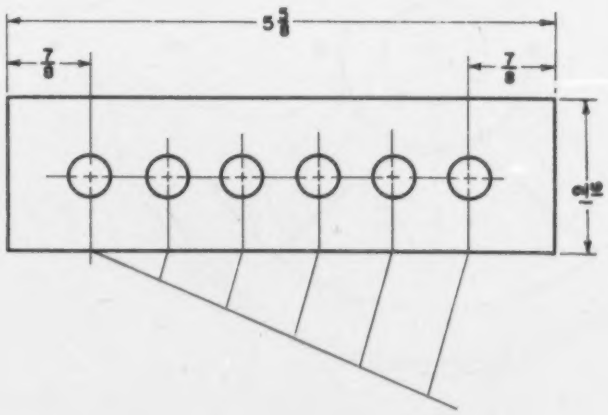

APPLICATION- SIX HOLES EQUALY SPACED

FIG. 2

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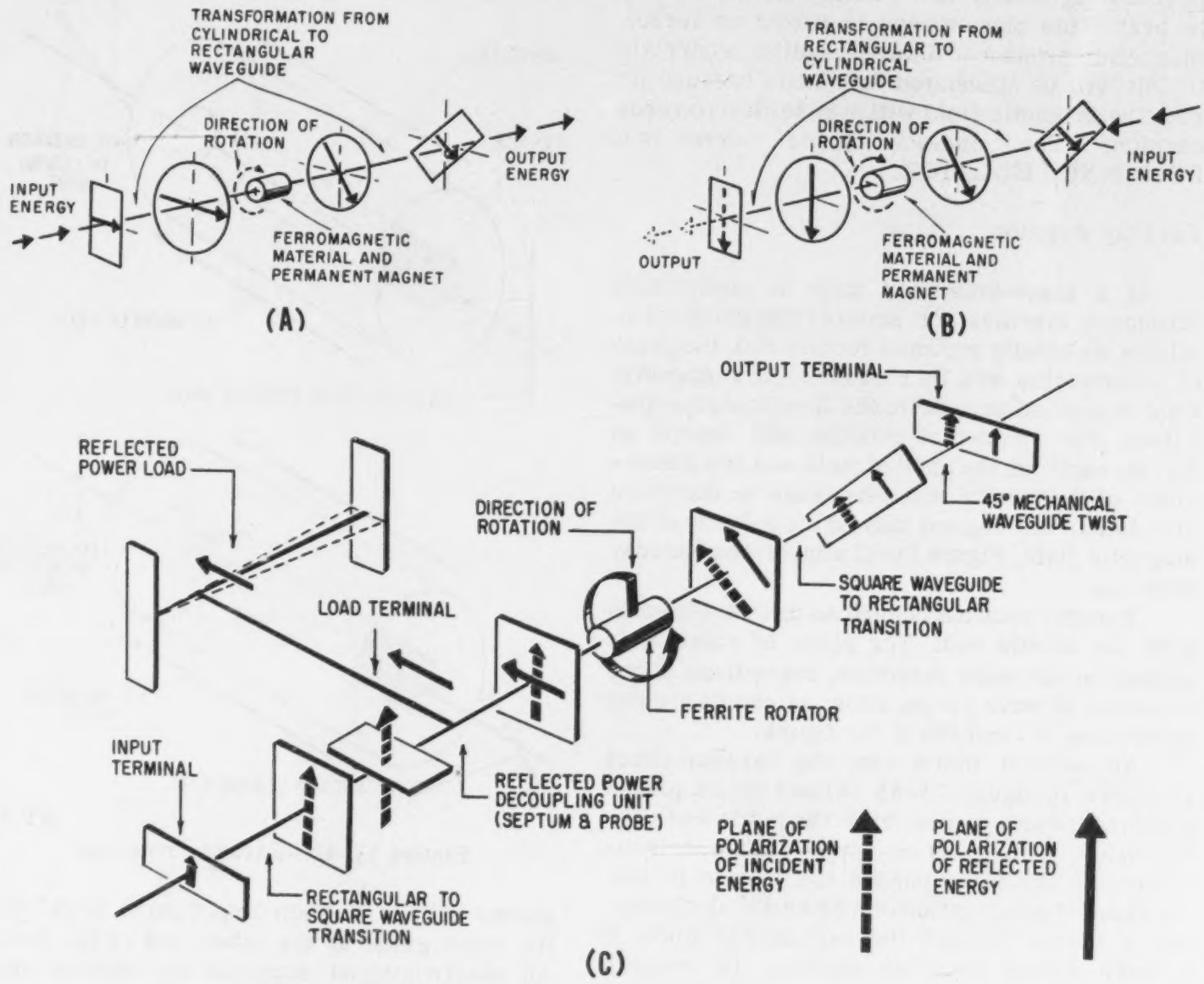

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Figure 11-44.–Faraday isolators.

may have several input-output ports. Figure 11-45 is a schematic of a four-port circulator. The arrow shows direction of power flow within the circulator. Power entering port 1 leaves by port 2 only; power entering port 2 leaves by port 3 only, etc. This one-way power flow between ports results from rotation of the signal polarization between ports. Each port is so oriented that it will be cut off for all signals except those which entered the port just before it. Each port, if it is properly terminated, will accept all of the power from the preceding port. A four-port circulator may be used as a radar duplexer. The load at port four absorbs any local oscillator signal from the receiver and prevents it from being radiated.

ANTENNAS

An antenna is a special type of electrical circuit intentionally designed to radiate and/or receive electromagnetic energy. In an ordinary circuit, the inductance, capacitance, and resistance are lumped constants and therefore the electromagnetic field is confined to the circuit where it performs useful work. In an antenna, the L, C, and R properties are distributed and the electromagnetic field is not confined–it is spread

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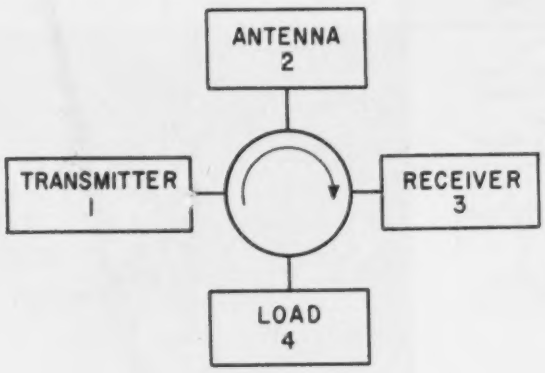

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Figure 11-45.–Circulator.

out and tends to escape or radiate. It is this radiated field which provides the link between a transmitter and receiver.

The method of propagation is of interest, but of more concern to the technician is how the energy can be directed (the radiation pattern) and concentrated (the beamwidth), and how the efficiency (gain) can be enhanced. A familiarity with the basic types of antenna systems and the polarization of the transmitted wave provides a background of information and an appreciation of the problems involved in the selection of a suitable antenna type for a specific application.

Several of the more common antenna configurations with typical operating frequency ranges and radiation patterns are shown in figures 11-46 and 11-47. These figures should be consulted throughout the discussions which follow. Table 11-2 lists the normal polarization and directional characteristics of certain antenna types.

While the simplest type of antenna is the bidirectional dipole, limitations in directivity, frequency passband, and gain somewhat restrict its use. Other dipole configurations such as the ram's horn and the corner reflector are used for special applications.

Although the crossed dipole, the whip, the top-loaded vertical, or the "J" is sometimes used, the ground plane antenna is probably the most popular when reception or transmission

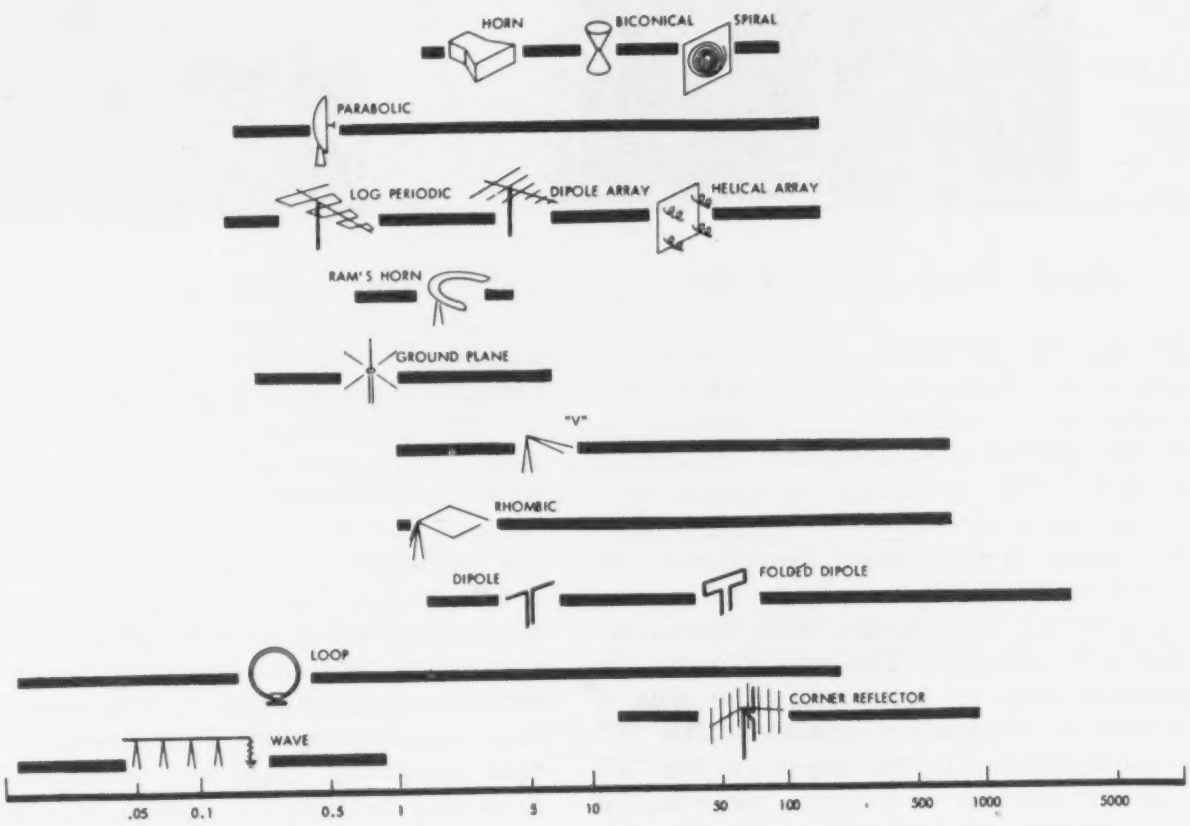

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Figure 11-46.–Antenna selection based on typical operating frequencies in megahertz.

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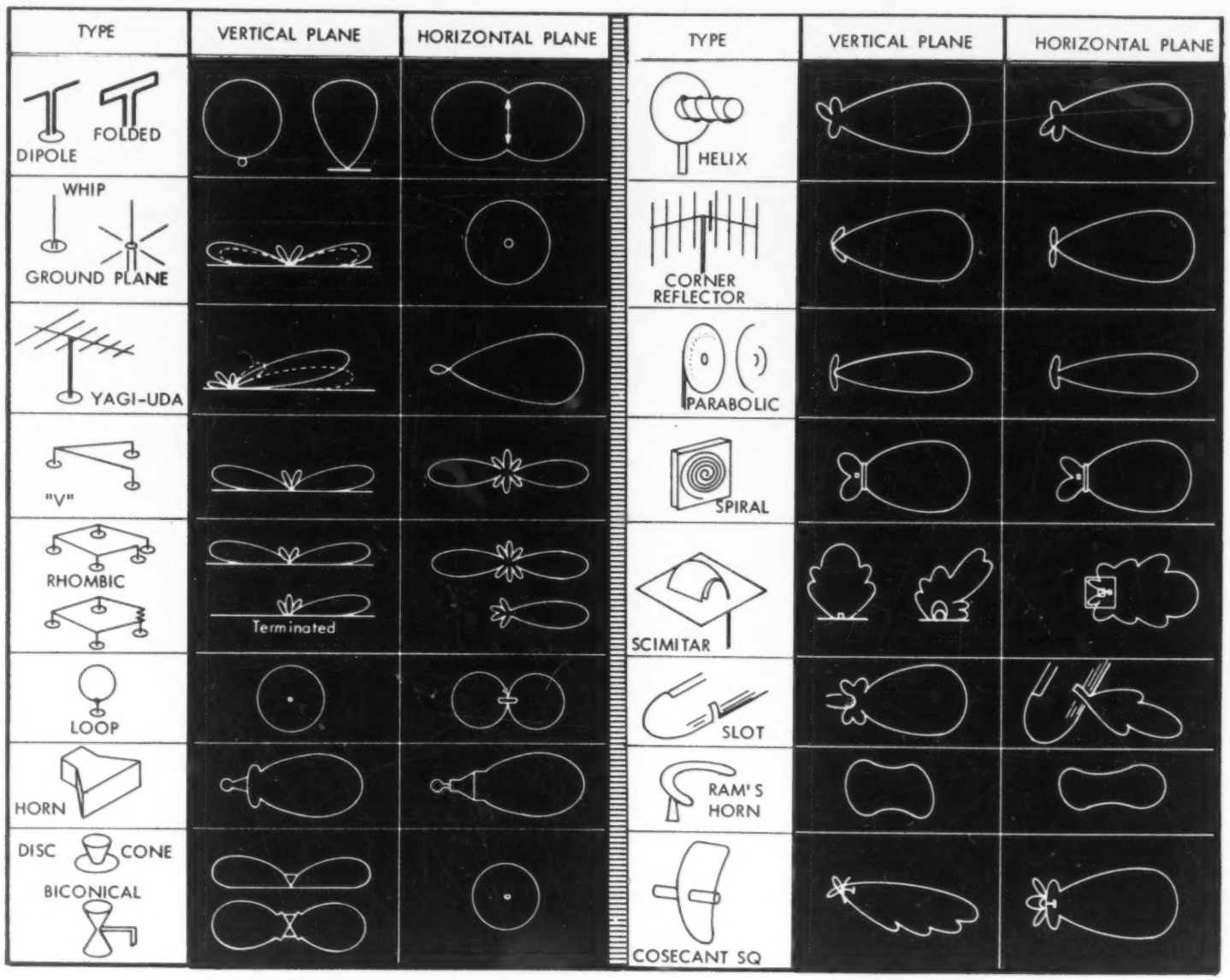

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Figure 11-47.–Typical radiation patterns for selected types of antennas.

must be equally effective in all directions (omnidirectional). For much higher frequencies, the biconical or the disk horn is recommended.

The log periodic, helical, and flat-spiral antennas are noted for their extremely wide (as high as 20:1) operating frequency range.

When space is not a controlling factor, the rhombic and the "V" type are often used to provide high gain and directivity. Both types normally are bidirectional. The rhombic can be made unidirectional by terminating the ends of the legs with a noninductive resistor. The "V" is made unidirectional by the use of another "V" spaced an odd number of quarter wavelengths behind the original. Typical legs for the rhombic are three to four wavelengths; for the "V" type, legs of eight wavelengths are not uncommon.

The parabolic antenna is capable of producing high gain and excellent directivity. Although screen mesh or even a grid or rods may be used where wind resistance is a design factor, the reflector element generally consists of a solid surface. Physically the reflector should be several wavelengths in diameter. Additional gain also can be obtained by mounting a hemispherical reflector in front of the dipole, provided its surface area does not appreciably shadow the rear parabolic reflector. The radiating element may be a dipole, a horn, or other suitable radiator.

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Table 11-2.—Antenna characteristics.

Type	Usual polarization	Directivity
Dipole	Horizontal	Bidirectional
Dipole array	Horizontal	Unidirectional
Ground plane	Vertical	Omnidirectional
Parabolic	Horizontal	Unidirectional
Horn	Horizontal	Unidirectional
Corner reflector	Vertical	Unidirectional
Helical array	Circular	Unidirectional
Ram's horn	Horizontal	Bidirectional
Rhombic	Horizontal	Bidirectional, unidirectional
Log periodic	Horizontal	Unidirectional
Spiral	Circular	Bidirectional
Loop	Horizontal	Bidirectional
Biconical	Horizontal	Omnidirectional

13512

CHAPTER 12

SERVOSYSTEMS

There are many types of servosystems in use, such as electronic, hydraulic, and amplidyne. There are also many different variations and combinations of these basic types. It is beyond the scope of this training manual to describe all systems in detail, since each servosystem is designed for a specific task. Therefore for each specific system the applicable manual should be referenced.

It is recommended that the basic theory of synchros and servomechanisms as discussed in Basic Electricity, NavPers 10086-B be reviewed before proceeding in this manual.

BASIC TYPES OF CONTROL

A servomechanism, in carrying out its orders, accomplishes its task by exercising control over a source of power. Control implies the conditional use of an external source of power, which in most cases is substantially greater than the controlling power. Almost unlimited quantities of mechanical or electrical power can be controlled by opening or closing a simple valve or switch.

Since a servomechanism is a device for exercising control of some external source of power, it is well to consider the various basic types of controls and their characteristics. A control system may encompass the control of electrical, mechanical, hydraulic, pneumatic, or thermal units, or of various combinations of different units.

The simplest form of control can be illustrated by the elementary electric circuit shown in (A) of figure 12-1. The circuit contains a source of power; a switch, or controlling device; and a load consisting of a heater element. The components are connected in series; and when the switch is closed, energy flows to the load and performs useful work; when the switch is opened, the energy source is disconnected from the load. Thus, the flow of energy is either zero or a finite value determined by the resistance of the circuit. Operation of this general type is called discontinuous control.

In (B) of figure 12-1 the circuit shown is modified by substitution of a rheostat for the switch; and the circuit now provides continuous control. By displacing the rheostat contact, the circuit resistance is varied continuously over a limited range of values. The energy expended in the load is then varied or regulated over a corresponding range rather than by intermittent, or on-off, action as in discontinuous control. These examples represent a fundamental property of control systems in general; the energy required to control the system is small compared with the quantity delivered to the load.

As discussed above, the power source is controlled directly by the manual adjustment of a switch or of a rheostat. In more complicated systems, control signals are applied to the power device by the action of an automatic electrical or mechanical device rather than by manual means. The device which develops the control signals is called an automatic controller, and the entire system is known as an automatic control system.

Automatic control systems can be divided into two basic types: open-loop and closed-loop systems. An example of an automatic open-loop control system is an electric timer used to control the action of the heating element. (See fig. 12-1 (C).) Although the heater is switched on and off automatically, the temperature of the oven in no way affects the switching action of the timer. The initiating action (timer) is independent of the results obtained.

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If a bimetallic spring type thermostat is substituted for the switch as shown in figure 12-2, the temperature of the oven will control the power applied to the heater. When the temperature rises to a predetermined level, the thermostat will open the circuit. When the temperature falls slightly below this point, the spring cools, closing the contacts, and the heater again begins operation. The controlling device is affected by the results of the load and is known as a closed-loop system.

All controls described are used to regulate the power to the heater. Thus, they may be classified as regulating controls. An example of their application in electronic equipment may be found in the regulation of pressure, temperature, and speed.

Another type of control is the positioning control. As the name implies, the positioning control is used to position a shaft or some other form of load. The basic fundamentals applicable to regulating controls also apply to positioning controls. Thus, positioning controls may be continuous or discontinuous, open-loop or closed-loop, and manual or automatic. However, most controls with which the technician is concerned are of the continuous, automatic, closed-loop type.

To insure a thorough understanding of this type of control, briefly review what it encompasses. A block diagram of such a system is shown in figure 12-3. An order is issued by the

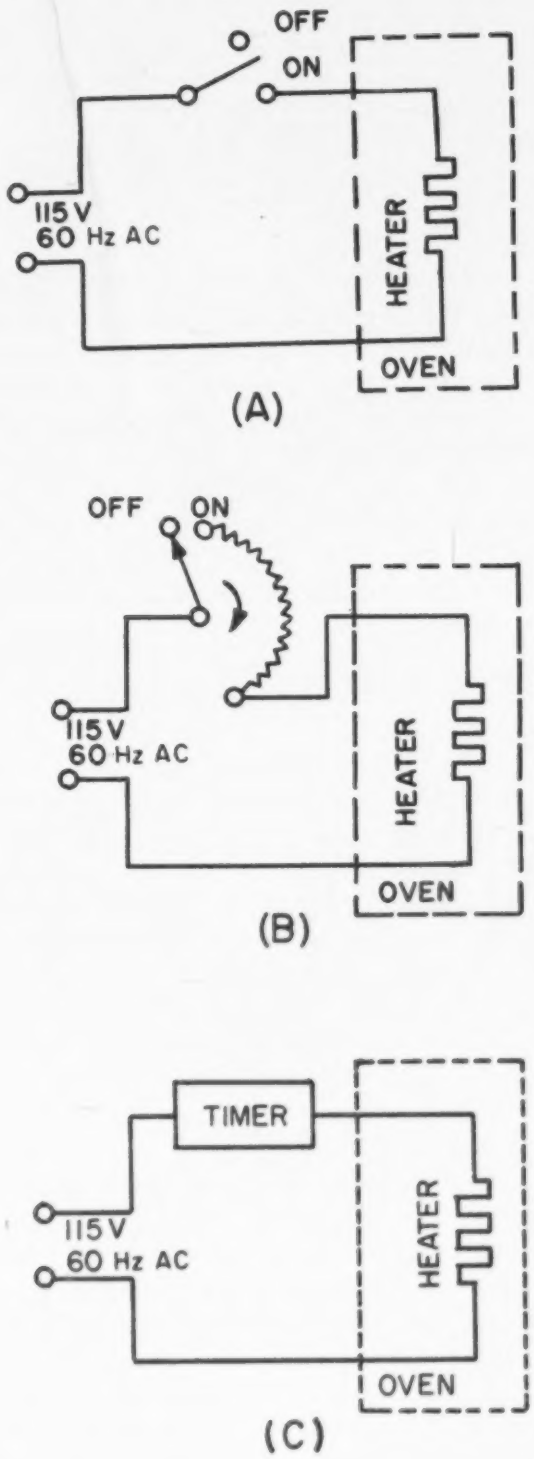

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Figure 12-1.–(A) Discontinuous control; (B) continuous control; (C) automatic control.

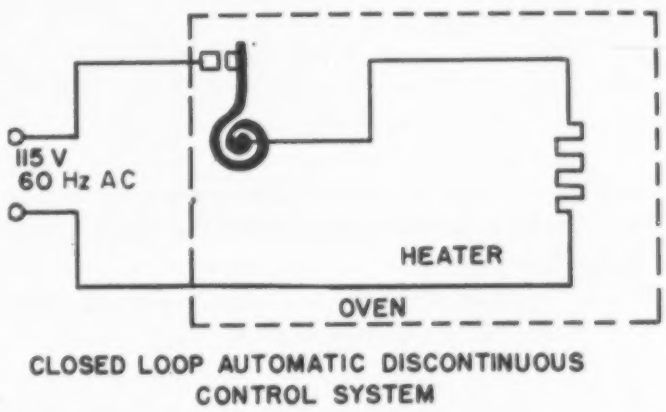

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Figure 12-2.–Closed-loop, automatic discontinuous control system.

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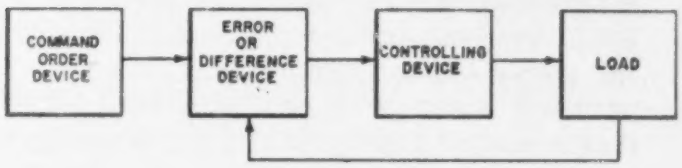

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Figure 12-3.–Block diagram showing continuous, automatic, closed-loop type of control system.

command order device to change the position of the load to a certain location. The error or difference measuring device receives the order, compares it with the present position of the load, and issues an order to the controlling device based on the difference between the ordered location and present location. This is a continuous process until the load reaches the ordered position.

A type of automatic closed-loop positioning control system frequently used in aviation electronic equipment is the servomechanism. A servomechanism may be defined as a feedback automatic control system that measures the output, compares it with the input, and uses the resulting error signal to control comparatively large amounts of load power.

BASIC SERVOMECHANISMS

The essential components of a servomechanism are the data transmission system, the servocontrol amplifier, and the servomotor. These components are shown in the block diagram of figure 12-4 and are discussed in the following paragraphs.

The functions of the data transmission system are as follows:

1. To measure the servo output.
2. To transmit or feed back the signal, which is proportional to the output, to the error detector (a differential device for comparing two signals).
3. To compare the input signal with the feedback signal to the servo.
4. To transmit to the servoamplifier a signal which is proportional to the difference between the input and output signals.

The signal obtained by comparing the servo input and output is called the servo error, and is represe. y the sumbol E. Figure 12-4 shows that the servo error (E) is the difference between the input (θ_i) and the output (θ_o). This is stated mathematically as $E = \theta_i - \theta_o$.

In many servosystems the physical location of the servo input device and output device are remotely located from each other and may also be remotely located from the servoamplifier. This requires some means of transmitting the output information back to the device receiving the input command. This transmission system as well as the comparing device (called an error detector) is part of the data transmission system.

The function of the servoamplifier is to receive the error signal from the error detector, amplify it sufficiently to cause the output device to position the servo load to the commanded position, and to transmit the amplified signal to the servomotor.

The servomotor functions to position the servo load. The motor must be capable of positioning the load so as to require a minimum response time based on the requirements of the system.

ERROR DETECTORS

The component of the data transmission system that compares the input with the servomechanism output is the error detector. An error detector can be either a mechanical or an electrical device. A simple form of a mechanical error detector is the differential. However, most error detectors are electrical devices because of their adaptability to widely separated or remotely installed components. Most of the electrical devices used are of either the potentiometer (resistive) or one of several magnetic devices.

Electrical error detectors may be either a-c or d-c devices depending upon the requirements of the servosystem. An a-c device used as an error detector must compare the two input signals and produce an error signal of which the phase and amplitude will indicate both direction and amount of control necessary for correspondence. A d-c device differs in that the polarity of output error signal determines direction of the correction necessary.

Error detectors are also used extensively in gyro stabilized platforms and rate gyros. In

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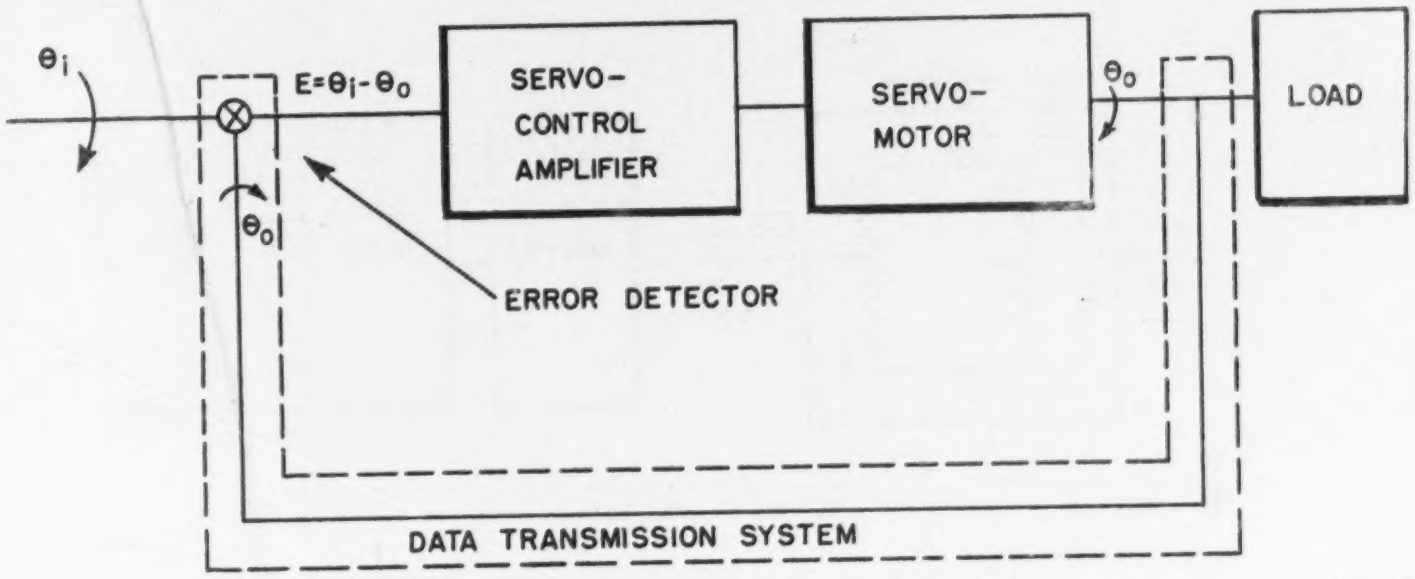

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Figure 12-4.–Simplified block diagram of a servomechanism.

the stabilized platform, synchros are attached to the gimbals. Thus, any movement of the platform around the gyro axes is detected by the synchro and the error voltage is sent to the appropriate servosystem.

In rate gyros, the E-transformer (discussed later) is commonly used to detect gyro precession. It is extremely sensitive to very slight changes, but its movement is limited to a very small amount. Thus, it is extensively used with constrained gyros.

POTENTIOMETER

Potentiometer error detector systems are generally used only where the input and output of the servomechanism has limited motion. They are characterized by high accuracy, small size, and the fact that a d-c or an a-c voltage may be obtained as the output. Their disadvantages include limited motion, a life problem resulting from the wear of the brush on the potentiometer wire, and the fact that the voltage output of the potentiometer changes in discrete steps as the brush moves from wire to wire. A further disadvantage of some potentiometers is the high drive torque required to rotate the wiper contact.

An example of a balanced potentiometer error detector is shown in figure 12-5. As stated above, the purpose of the circuit is to give an output error voltage which is proportional to the difference between the input and output signals.

The command input shaft is mechanically linked to R1 and the load is mechanically linked to R2. An electrical source of 115 volts a.c. is applied across both potentiometers.

When the input and output shafts are in the same angular position, they are in correspondence and there is no output error voltage. If the input shaft is rotated, moving the wiper contact of R1, an error voltage is applied to the control amplifier. This error voltage is the difference of the voltages at the wiper contacts of R1 and R2. The output of the amplifier causes the motor to rotate the load and the wiper contact of R2 until both voltages are equal; thus, there is no output error voltage.

Figure 12-5 illustrates R1 and R2 grouped together. In actual practice the potentiometers may be positioned remotely from each other, with R2, the output potentiometer, being located at the output shaft of the load. This remote location of one of the components does not remove it from being a part of the error detector.

E-TRANSFORMER

A type of magnetic device which is used as an error detector is the E-transformer. Its application is useful in systems that do not require the error detector to move through large angles. A simplified drawing, which is one of several possible devices in this category, is shown in figure 12-6.

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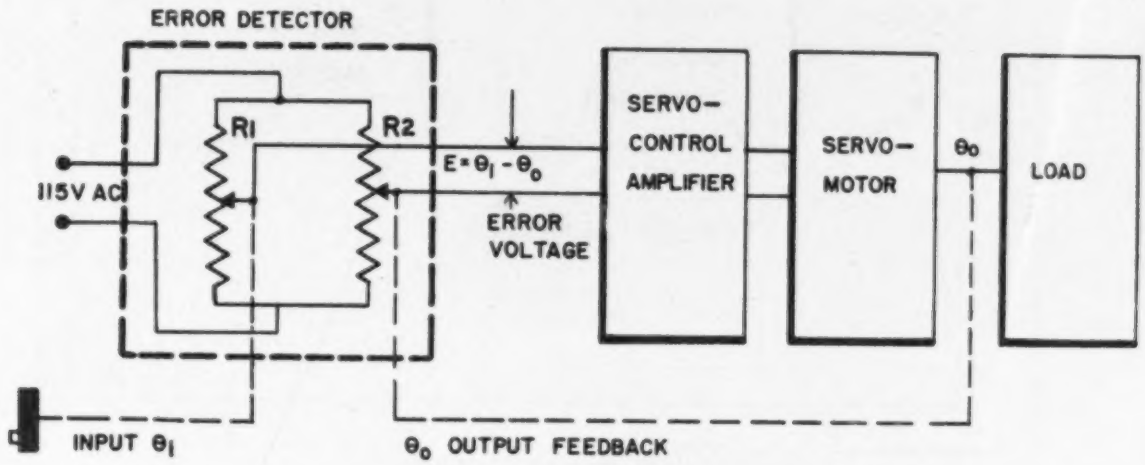

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Figure 12-5.–Balanced potentiometer error detector system.

The primary excitation voltage is applied to coil A on the center leg of the laminated core. The coupling between coil A and the secondary windings, coils B and C, is controlled by the armature which is displaced linearly by the input signal. At the position of the armature where the coupling between the windings is balanced, the output voltage is minimum because of the series-opposing connections of the secondary windings. The phase of the output voltage on either side of the voltage null differs by 180°, and by proper design of the transformer the amplitude can be made proportional to the displacement of the armature from its null voltage position. This type of error detector possesses the advantages of small size and high accuracy, but has the disadvantage of permitting only limited input motion.

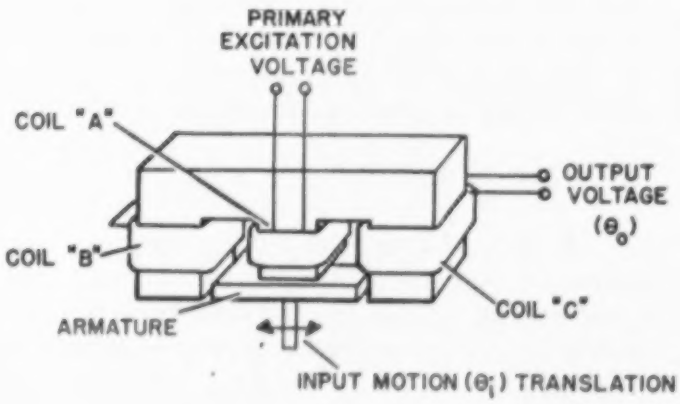

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Figure 12-6.–E-transformer error detector.

CONTROL TRANSFORMER

Synchros have been developed to a point of relatively high accuracy, low noise level, reasonably small driving torques, and excellent life. These qualities are also applicable to the synchro control transformer. A primary advantage over other types of error detectors is its unlimited rotation angle; that is, both the input and the output to the synchro control transformer may rotate through unlimited angles. Among the disadvantages of synchros (including the synchro control transformer) are the large size necessary to maintain high accuracy, the power consumed, and the fact that the output supplied to the servocontrol amplifier is always a-c modulated with the servo error and must be demodulated in the servocontrol amplifier if it is to be applied to a d-c servomotor.

The synchro data transmission system is comprised of a synchro transmitter, a synchro control transformer, and in some cases a differential transmitter for additional servo inputs. The synchro transmitter transforms the motion of its shaft into electrical signals suitable for transmission to the synchro control transformer, which comprises the error detector. (See fig. 12-7.)

The stator of the transmitter consists of three coils spaced 120 electrical degrees apart.

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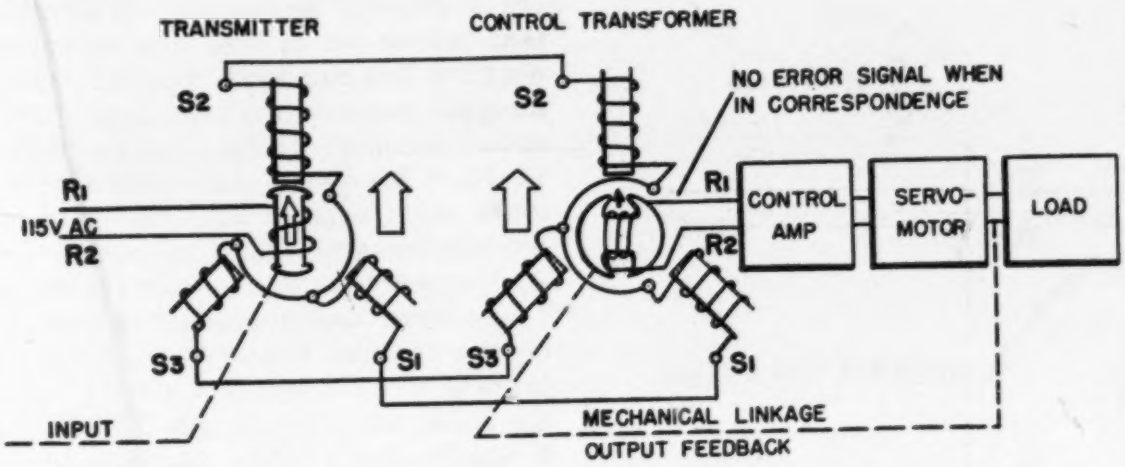

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Figure 12-7.–The control transformer as an error detector.

The voltage induced into the stator windings is a function of the transmitter rotor position. These voltages are applied to the three similar stator windings of the synchro control transformer. The voltage induced in the rotor of the synchro control transformer depends upon the relative position of this rotor with respect to the direction of the stator flux.

The variation of the synchro control transformer output voltage as a function of the rotor position relative to an assumed stator flux direction is shown in figure 12-8. While there are two positions of the rotor, 180° apart, where the output voltage is zero, only one corresponds to a stable operating position of the servo.

In cases where a synchro differential transmitter is used for additional inputs to the servosystem, it is connected between the synchro transmitter and the synchro control transformer. (See fig. 12-9.) When the synchro differential rotor is in line with its stator windings, the differential transmitter acts as a one-to-one ratio transformer and the voltages applied to the synchro control transformer are the same as the voltages from the synchro transmitter. If the synchro differential transmitter rotor is displaced by a second input, the voltages from the synchro transmitter to the control transformer are modified by the synchro differential transmitter by the amount and direction of its rotor displacement. Thus, the two inputs are algebraically added and fed to the synchro control transformer as a single input. Where a synchro differential is used as a receiver, the rotor shaft indicates the angular sum or difference between two transmitter positions.

Magnetic error detectors are not limited to E-transformers and synchro devices as other types may be encountered in equipment where special requirements must be met.

MULTIPLE-SPEED DATA TRANSMISSION SYSTEMS

The static accuracy of a servomechanism is frequently limited only by the accuracy of the data transmission system. The accuracy of the data transmission system may be increased considerably by employing a multiple-speed data transmission system along with the single-speed system. The error-detector elements of the multiple-speed transmission system rotate at some multiple of the shaft being controlled, while the elements of the single-speed transmission system operate one to one with respect to the controlled shaft.

The schematic diagram of a multiple- and single-speed system is shown in figure 12-10. If the input shaft turns through 1° in this example, the single-speed synchro transmitter also is rotated 1° while the multiple-speed unit is rotated 10°. The synchro control transformer associated with each of these transmitters is geared in similar ratios with respect to the servo output shaft. A 1° error between the position of the input and outputs shafts therefore produces a relative rotor displacement of 1° in the single-speed synchros and 10° in the multiple-

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UNIT III - DRAWING GEOMETRIC CONSTRUCTIONS

Drawing a Circular Arc Tangent to Two Given Lines — Lesson 5

OBJECTIVE: To learn to draw a circular arc of any radius tangent to two given lines.

RELATED INFORMATION:

To draw a $\frac{3}{4}$-inch-radius circle tangent to two given lines AB and CD, as shown in Fig. 1: Draw a light line parallel to and $\frac{3}{4}$ inch away from each of the given lines. Where the two light lines meet at point O, place the needle point of the compass; strike an arc tangent to the two given lines. The radius for this arc will be $\frac{3}{4}$ inch.

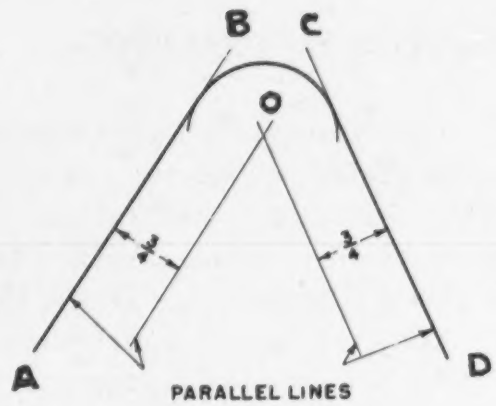

TO CONSTRUCT A $\frac{3}{4}$-IN. RADIUS TANGENT TO TWO GIVEN LINES

FIG. 1

Application:

To draw a circular arc of $1\frac{1}{4}$-inch radius between the spokes of an idler pulley (Fig. 2), proceed as stated above. Scale any dimensions needed from the drawing shown.

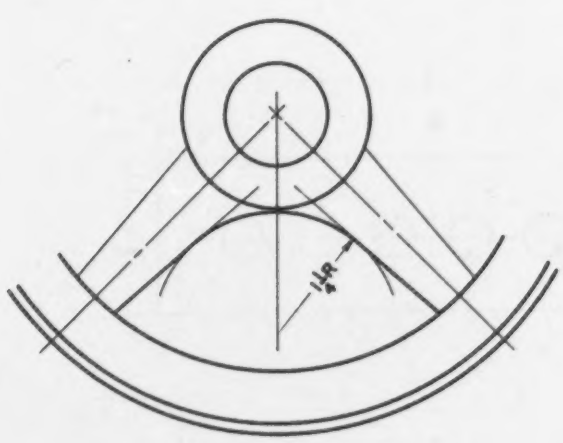

APPLICATION- RADIUS BETWEEN SPOKES OF PULLEY

FIG. 2

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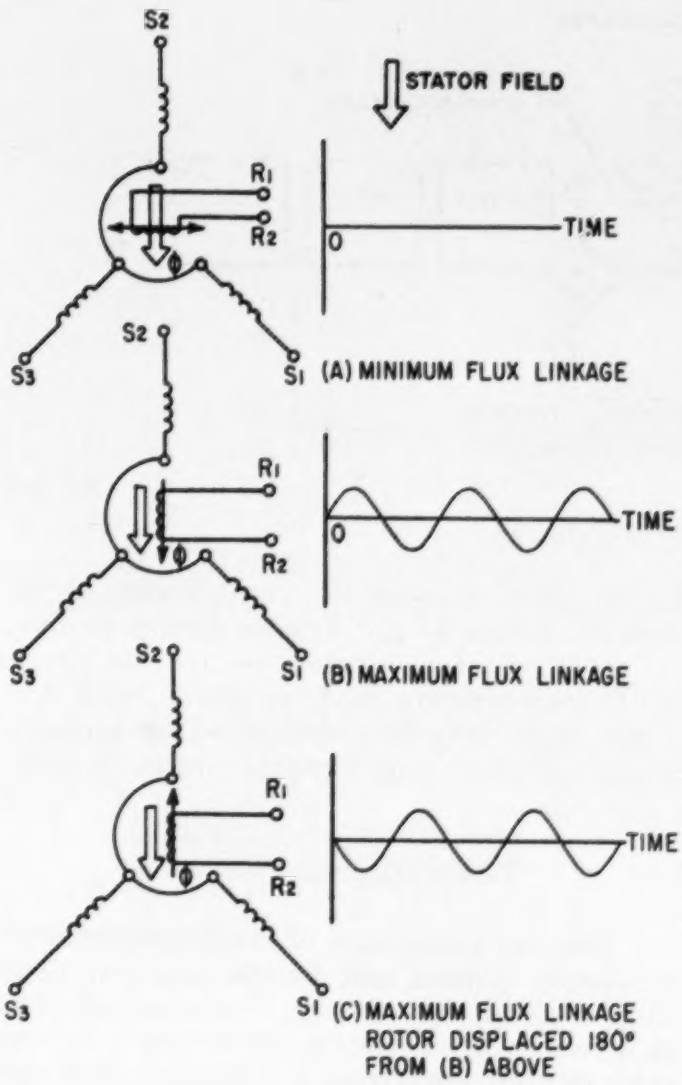

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Figure 12-8.–Induced voltage in synchro control transformer rotor.

speed synchros. If the relation between the rotor displacement and output voltage is linear, the error signal from the multiple-speed system is 10 times that from the single-speed system. This amplification of the error signal in the data transmission link reduces the signal amplification required in the servocontroller. If the synchro has an inherent error of 0.1° with respect to its own shaft, the consequent servo error introduced by a single-speed data transmission system will be of corresponding magnitude, but the consequent servo error introduced by a 10-speed data transmission system will be only one tenth as great, or 0.01°.

A disadvantage of using a multiple-speed error detector lies in the possibility of the system falling out of step and synchronizing in a position differing from the correct position by an integral number of revolutions of the multiple-speed synchro. In the example shown in figure 12-10, if the output shaft were held fixed and the input shaft rotated 36°, the 10-speed synchro transmitter would turn one complete revolution. At this point the error signal from the multiple speed error detector would be zero. If the output shaft were then released, the system would operate in a stable fashion with a 36° error between the input and output shafts. The purpose of using a single-speed error detector along with the multiple-speed detector is to prevent this ambiguous synchronization.

An error signal selector circuit is provided which switches control of the servo to the single-speed data transmission system whenever the servo error becomes large enough to permit the multiple-speed system to synchronize falsely.

The simplest device imaginable that could control an error-selector circuit is shown in figure 12-10. It is essentially a single-pole, double-throw relay actuated by the output of the single-speed error detector. The relay is shown in the deenergized position. When the output of the single-speed synchro is high, the relay is energized and the single-speed circuit controls the servomotor. When the output is low, the relay opens and the 10-speed synchro controls the circuit. Keep in mind that the synchro output is high only when there is a large error.

The relationship of the coarse (single-speed) synchro output and the fine (10-speed) synchro output is shown in figure 12-11 (A). The shaded portion represents the area where control can be switched from single-speed circuit to the 10-speed circuit. With the selector circuit shown it is still possible to have a single ambiguous synchronizing point. This point is at the 180° position of the single-speed (coarse) synchro. At this point the single-speed (coarse) and 10-speed (fine) shafts are nulled (but are 180° out of phase) and control is switched to the 10-speed circuit.

One way of elininating this false synchronization position is to drive the multiple-speed synchro at any odd multiple of the single-speed

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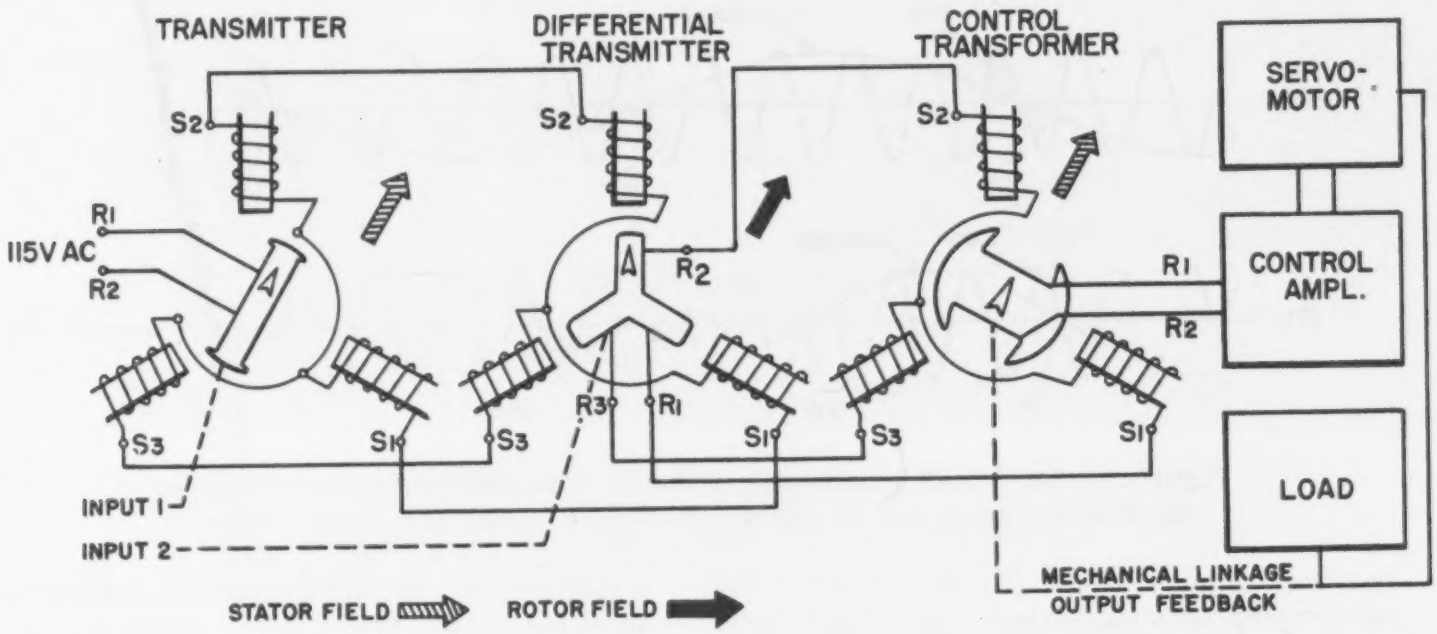

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Figure 12-9.–Synchro differential transmitter used for additional input.

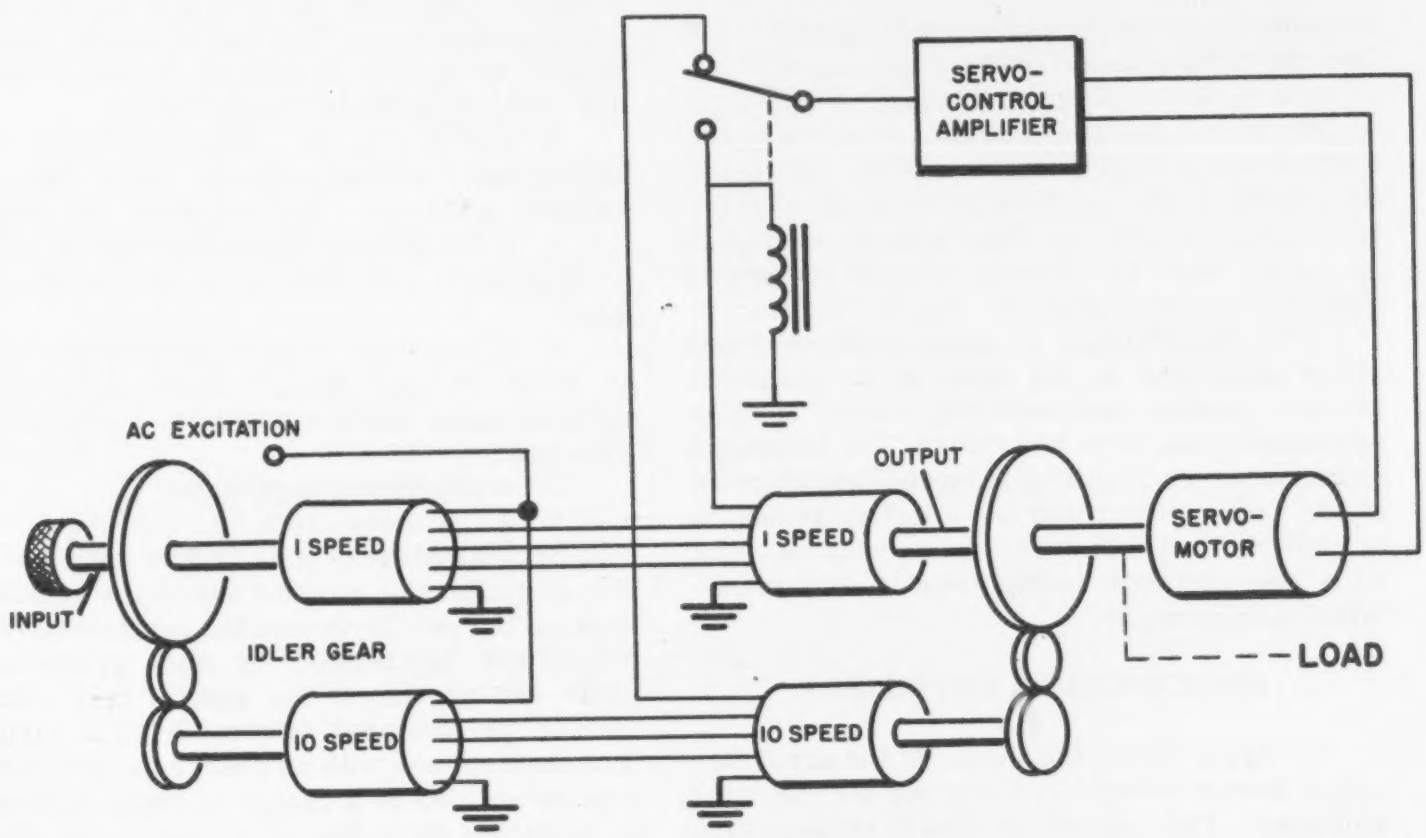

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Figure 12-10.–Multiple-speed data transmission system.

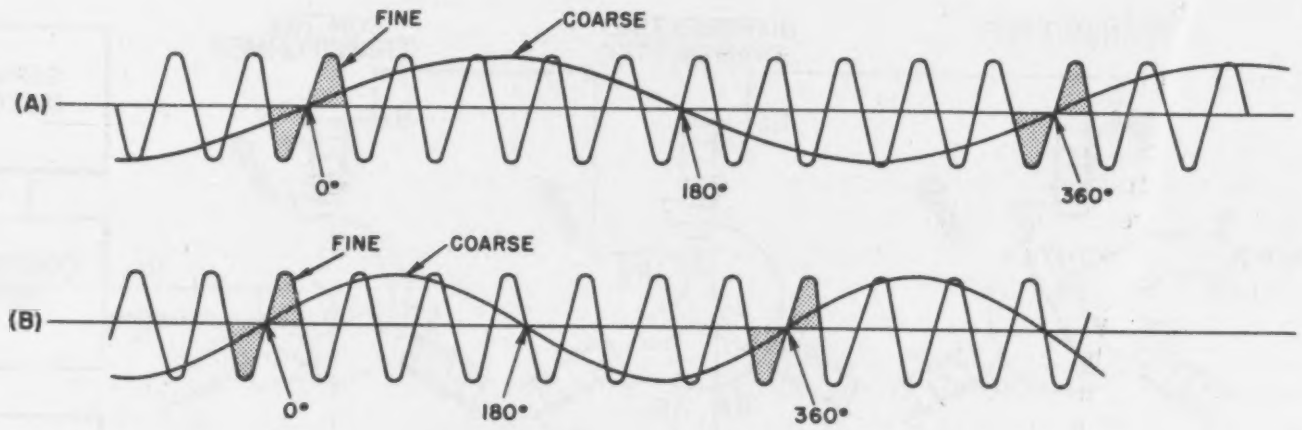

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Figure 12-11.–Phase relationships of fine and coarse synchro voltages. (A) Single speed and 10 speed; (B) single speed and seven speed.

synchro. Figure 12-11 (B) shows the phase relationship of a single-speed and seven-speed system. Although there is still a null of both synchros at the 180° position of the single-speed synchro, their outputs are in phase. This position is an unstable one and the servo will not remain at this point.

The system illustrated in figure 12-10 is not found in operating equipment due partly to the load the relay places on the single-speed synchro. In actual practice, the relay could be controlled by an electronic circuit operated by the synchro voltages. A method commonly used feeds the outputs of the synchros to an electronic circuit biased so that the fine-synchro voltage is not used when the coarse-synchro voltage is high. This method does not require a relay.

The disadvantage of using multiple-speed error detectors is the need of an additional synchro system and switching circuit if false synchronization is to be avoided. The increased servo accuracy resulting from the amplification of the error signal and the effective reduction of inherent synchro errors account for the wide use of these multiple-speed data transmission systems.

SERVOCONTROL AMPLIFIERS

In figure 12-5, the output of the error detector (error voltage) is fed to the servocontrol amplifier. This signal is small in amplitude and requires sufficient amplification to allow actuation of the prime mover. In addition to amplification, the servocontrol amplifier must, in some cases, transfer the error signal into suitable form for controlling the servomotor or output member. It may also include provisions for special characteristics necessary to obtain stable, fast, and accurate operation.

Servoamplifiers used in aircraft armament control equipment are limited to electronic and magnetic types. The operation and explanation of electronic amplifiers and their circuits are covered in Basic Electronics.

In addition to the requirements of basic amplifiers, servoamplifiers must also meet certain additional requirements as follows:

1. A flat gain versus frequency response for a frequency well beyond the frequency range used.
2. A minimum of phase shift with a change in level of input signal. (Zero phase shift is desired but a small amount can be tolerated if constant.)
3. A low output impedance.
4. A low noise level.

Servoamplifiers may utilize either a-c or d-c amplifiers or in some instances a combination of the two. However, the application of d-c amplifiers is limited by such problems as drift and provisions for special bias voltages needed in cascaded stages. Drift, a variation in output voltage with no change in input voltage, can be caused by a change in supply voltage or a variation in value of a component. Consequently, many servoamplifiers utilize a-c amplifiers for voltage amplification. Amplifiers

are discussed further in conjunction with other circuits later in the chapter.

MODULATORS

As pointed out previously, a-c amplifiers are more satisfactory for amplifying the error signal. However, some aviation armament control equipment utilize a d-c voltage for an error signal. The d-c error voltage may be changed to an a-c signal by the use of a modulator (sometimes called a chopper). Modulator circuits used in servocontrol amplifiers must be phase sensitive and produce an a-c output signal that is proportional to the d-c input signal in amplitude and the phase of it indicative of the polarity.

Vibrator Modulators

A modulator may be either an electromechanical vibrator or an electronic circuit. An example of a vibrator is shown in figure 12-12. An a-c supply voltage is employed to vibrate the contacts of the vibrator in synchronism with the supply voltage. The d-c error voltage is applied to the center contact of the vibrator. Assume that the reference voltage will cause the center arm to contact point A during the first half cycle and point B during the second half cycle. The output is represented by waveform B if the error voltage is positive and by waveform C when the error voltage is negative.

Electronic Modulator

An example of an electronic modulator circuit is shown in figure 12-13. The input d-c error voltage is impressed between E1 and ground. The a-c reference voltage along with the action of V1, V2, R2, and R3 effectively clamp the output E2 at zero potential for onehalf cycle of the reference voltage. To accomplish this, the following conditions must exist:

1. R1 must be much larger than R2.
2. R2 and R3 are equal.
3. V1 and V2 must be matched.

With no reference voltage applied, the output E2 is the same as E1, the error voltage. With a reference voltage applied, making the plate of V2 positive and the cathode of V1 negative, current flows through V1, R2, R3, and V2. Since R2 equals R3, the voltage E3 equals E4. This effectively clamps the voltage at the junction of R2 and R3 at ground potential giving a zero output

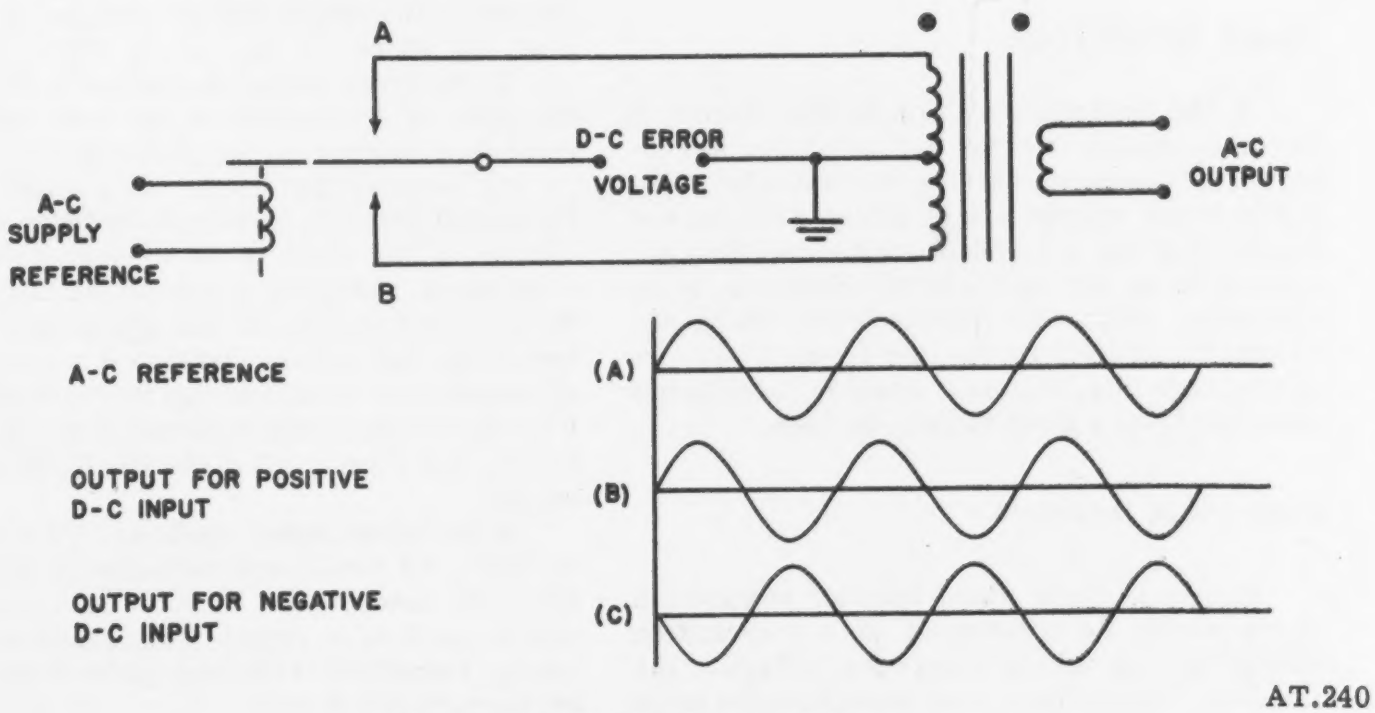

Figure 12-12.–Vibrator modulator.

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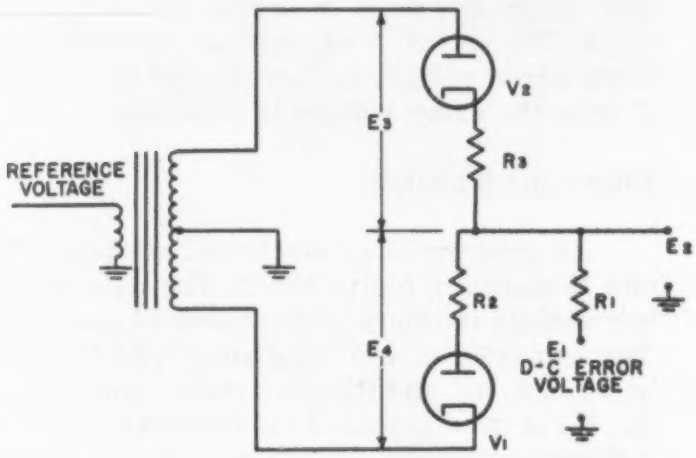

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Figure 12-13.–Electronic modulator.

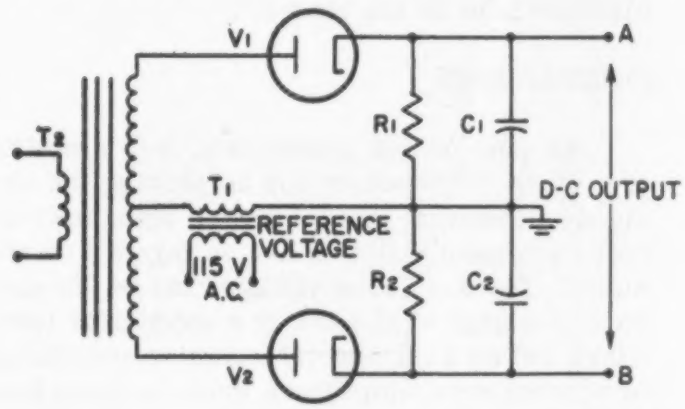

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Figure 12-14.–Diode phase detector.

at E2. On the reverse half cycle V1 and V2 are nonconducting with E2 equaling E1. This results in an a-c output whose amplitude is determined by the amplitude of the d-c error signal and whose phase is determined by the polarity of the error voltage.

The examples shown above are representative of those used in aviation electronic control equipment. Variations of these circuits may be encountered. However, they all perform the same function with only slight differences in their operating principles.

PHASE DETECTORS

In the preceding section of this chapter, it has been stated that the a-c amplifier has inherent advantages over the d-c amplifier, that a d-c error voltage can be changed into an a-c signal, and the a-c signal can be amplified and applied to an a-c servomotor. However, some equipment utilize d-c servomotors which necessitates converting the a-c signal to d.c. To accomplish this, a phase detector, sometimes referred to as a demodulator, is used.

Diode Phase Detectors

A typical diode phase detector is shown in figure 12-14. As illustrated, an a-c excitation voltage serves as the reference voltage to the detector. This voltage must come from the same source that is supplying a-c excitation to the synchro system, or whatever type of error detector that is being employed, and must be in phase with the excitation voltage. This permits a phase comparison of the error voltage with the reference voltage. The plates of the two diodes are supplied with this reference voltage in such a manner that the two plate voltages are in phase. Assuming that there is no error signal from T2 to the plates of the diodes at the time the plate voltages are on a positive half cycle, the two diodes conduct equally. The voltages produced across R1 and R2 are equal, making the cathode of V1 and V2 at equal potential with respect to ground. With the two output terminals at the same potential, the output voltage remains at zero as long as there is no error signal applied.

If an error signal is applied to T2 making the plate of V1 positive at the same instant the reference voltage on the plates of V1 and V2 is on its positive half cycle, V1's conduction is increased over the no-signal condition while the voltage at the plate of V2 is decreased with a consequent reduction in conduction of V2. Since the voltages applied to the plates are both alternating, the voltage developed across R1 and R2 would also be alternating. However, R1C1 and R2C2 form a long time constant to the input frequency and filter most of the ripple, giving a d-c output.

If the error signal applied to T2 is changed by 180°, V2 would now increase its conduction while the conduction of V1 would be reduced. This would result in an output voltage of reversed polarity. Variations of the diode phase detector may be encountered; however, their principle of operation is essentially unchanged.

Triode Phase Detectors

A phase detector using triode tubes (fig. 12-15) also provides amplification of the error signal in addition to phase detection. In this circuit, as in the previous one, the plates of the tubes are supplied with the a-c reference voltage in such a manner that the plate voltages are in phase. For the purpose of explanation, assume that no error signal is present at T2. When the plates of V1 and V2 are positive, the two tubes conduct equally. The plate current that flows sets up magnetic fields in the d-c motor exciter windings that are equal and opposite; therefore, the fields cancel and produce no output. When the plate voltages are on a negative half cycle, C1 and C2 discharge through their respective exciter windings to maintain a constant direct current through the windings.

If an error signal is introduced into the primary of T2 with a phase relationship that causes the grid of V1 to be positive at the same instant that the plate of V1 is positive, the following conditions exist:

1. On this half cycle the conduction of V1 is increased above its no error signal condition.
2. The heavier plate current causes a stronger field to be created in the upper exciter winding.
3. At this same instant, since the grid of V2 is on a negative half cycle, its average conduction is reduced to a level below that of its no error signal condition.
4. The lower level of plate current causes a weaker field to be produced in the lower exciter winding.

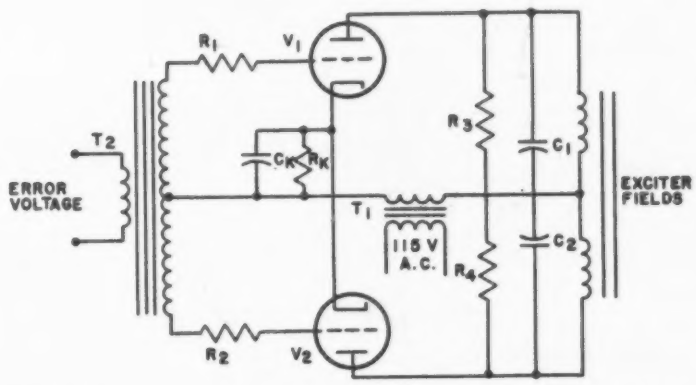

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Figure 12-15.–Triode phase detector.

5. Since the magentic fields produced in the exciter windings are no longer of equal amplitude, they no longer cancel each other.
6. The exciter produces an output voltage of a polarity controlled by the polarity of the resultant field and of an amplitude controlled by the relative strength of this resultant field.
7. The exciter output causes the proper mechanical actions necessary to reduce the amplitude of the error to zero.
8. As the error signal is reduced to zero, the current conduction through V1 and V2 is again balanced. Also the exciter fields are equal and opposite, canceling each other, reducing the exciter output to zero, and stopping the mechanical action. Resistors R1 and R2 prevent excessive grid current when the error angle is large.

SPECIAL CIRCUITS

It has been shown how a servocontrol amplifier may have provisions for changing a d-c error signal to an a-c signal and how an a-c error signal may be detected to supply a d-c voltage to a servomotor or controller. In the following paragraphs other special amplifier circuits are discussed.

Two-Stage D-C Servocontrol Amplifier

If somewhat more power is required by the servomotor than can be supplied by the servoamplifier (fig. 12-15), a push-pull d-c amplifier can be inserted between the phase-sensitive triodes and the servomotor. In the schematic diagram (fig. 12-16), the output of the phase detector triodes is now taken across the parallel RC networks in the plate circuit.

The bias source, E_{CC}, for the d-c amplifier is connected with its positive terminal on the grid side. This positive voltage subtracts from the highly negative voltage across the capacitor to give a resulting negative voltage which allows the tube to operate on the linear portion of its characteristic curve.

When there is no signal input from the error detector, the plate currents of the phasesensitive rectifiers are equal. The outputs of V1 and V2 are applied to the grids of V3 and V4, respectively. Equal output from V1 and V2 causes equal currents to flow in V3 and V4. With R5 and R6 equal in resistance and current, the volt-

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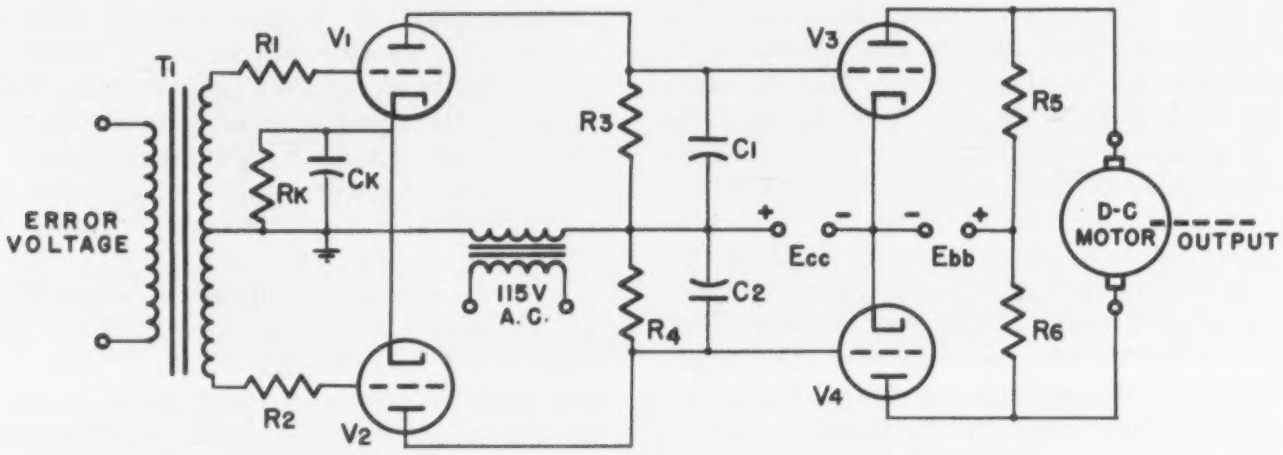

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Figure 12-16.–Two-stage d-c servocontrol amplifier.

age across the motor is zero. Consequently, the motor does not turn.

When there is a signal output from the error detector, the following action occurs. Assume that the error signal makes the grid of V1 positive and the grid of V2 negative. The plate current of V1 increases and the plate current of V2 decreases. An increasing plate current in V1 increases the charge on capacitor C1 and conversely a decreasing plate current in V2 decreases the charge on capacitor C2. As a result of this change in error signal, the voltage on the grid of V3 is now more negative than the voltage on the grid of V4. This increased negative voltage on the grid of V3 decreases its plate current and the voltage e3 decreases. The decreased negative voltage on the grid of V4 increases its plate current and the voltage e4 increases. As a result, a voltage difference appears across the motor armature and the motor rotates.

When the output signal from the error detector reverses in phase, the sequence of events that follow will cause the motor to reverse its direction of rotation.

Magnetic Amplifiers as Servocontrol Amplifiers

The servomotor used in conjunction with the magnetic amplifier shown in figure 12-17 is an a-c type. The uncontrolled phase may be connected in parallel with transformer T1 by utilizing a phase shifting capacitor, or it may be connected to a different phase of a multiphase system. The controlled phase is energized by the magnetic amplifier and its phase relationship is determined by the polarity of the d-c error voltage.

The magnetic amplifier consists of a transformer (T1) and two saturable reactors, each having three windings. Note that the d-c bias current flows through a winding of each reactor and the windings are connected in series-aiding. This bias current is supplied by a d-c bias power source. A d-c error current also flows through a winding in each reactor; however, these windings are connected in series-opposing.

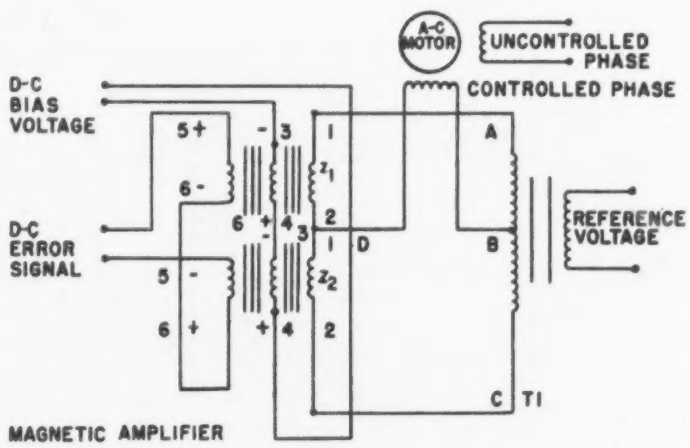

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Figure 12-17.–Magnetic amplifier servocontrol amplifier.

The reactors Z1 and Z2 are equally and partially saturated by the d-c bias current when no d-c error signal is applied. The reactance of Z1 and Z2 are now equal, resulting in points B and D being at equal potential. There is no current flow through the controlled phase winding.

If an error signal is applied causing the current to further saturate Z2, the reactance of its a-c winding is decreased. This current through Z1 tends to cancel the effect of the d-c bias current and increase the reactance of its a-c winding. Within the operating limits of the circuit, the change in reactance is proportional to the amplitude of the error signal. Hence, point D is now effectively connected to point C causing motor rotation. Reversing the polarity of the error signal causes the direction of rotation to reverse since point D is effectively connected to point A.

The basic magnetic servoamplifier discussed above has a response of approximately 6 to 20 hertz. In some applications this delay would be excessive, creating too much error. However, this delay can be reduced to about one hertz by using special push-pull circuits.

Amplifier Integrator

A simple and commonly used integrator consists of two circuit elements: a resistor and capacitor. (See fig. 12-18.) The voltage across the capacitor is proportional to the integral of the charging current. It can be explained by considering that the voltage across a capacitor is

$$E = \frac{Q}{C}$$

For any given capacitor (C), the voltage depends directly on the charge (Q) which is the imbalance of electrons on the two capacitor plates. The amount of this charge depends on the current flow and the time which this flow exists.

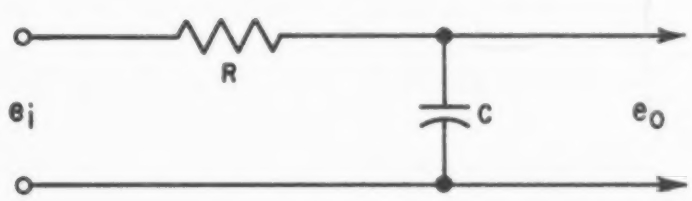

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Figure 12-18.–Simple integrator.

The fact that the voltage is proportional to the integral of the charging current allows the RC circuit to be used as an integrator. The capacitor voltage is the integrator output. Provision must be made to supply a charging current that is proportional to the input information. The purpose of the resistor is to produce this proportional current from an input signal voltage "e_i." At the instant this voltage is applied, the charging current becomes

$$i = \frac{e_i}{R}$$

Unfortunately this proportionality does not continue to exist. As the capacitor becomes charged, the capacitor voltage opposes the charging current, and the charging current becomes less proportional to the input signal. This results in an error in the output. The ideal output, for a constant input signal is a steadily increasing output. This steady increase is attained only when the signal voltage is first applied and the capacitor has not become appreciably charged.

A remedy to this error in the RC integrator is to use a circuit with a long time constant. Such a circuit delays the charging of the capacitor. The result is a more accurate integration of an input signal. The ideal output would be a perfect triangular wave. Although a long time constant produces more accurate results, it also provides a much lower output for the same input signal. Better integration is possible by the use of a high gain, feedback amplifier.

An amplifier integrator is illustrated in figure 12-19. This circuit arrangement uses a high gain amplifier and is known as the Miller integrator. The amplifier produces an output which is not limited by the input signal as it is in the simple RC integrator. The amplifier also supplies any energy which is required in the output. The function of the input signal is to control the charging current.

The operation can be explained by assuming a constant input as shown in figure 12-19 (A). At the start, assume the initial condition is zero, that is,

$$e_i = e_g = e_o = 0$$

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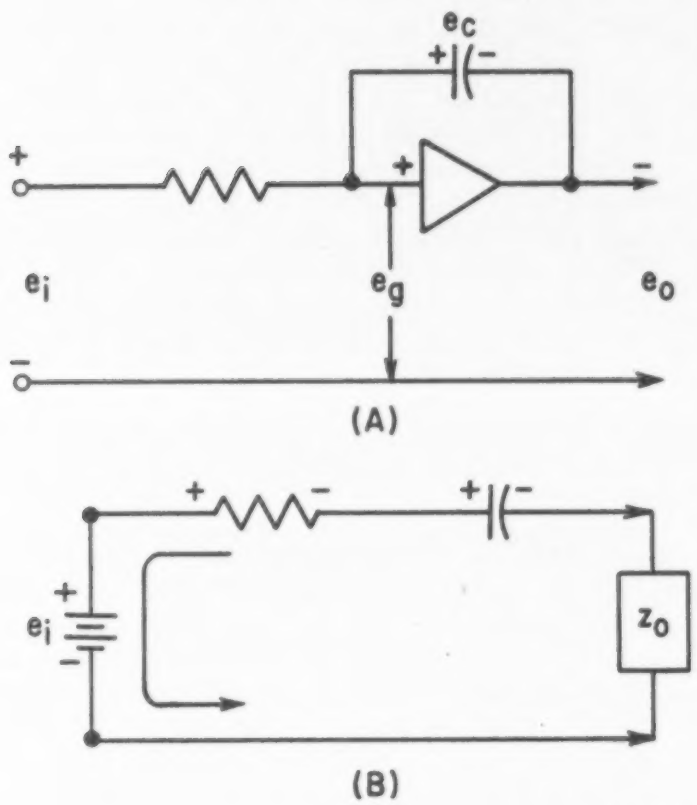

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Figure 12-19.–Amplifier integrator.

Also assume that the capacitor is discharged. The positive voltage to be integrated, "e_i," is then applied. The capacitor charges with a polarity as shown, since electrons are attracted from the left plate. The charging path is shown in figure 12-19 (B).

A voltage measured at the amplifier input, "e_g," tends to rise in the positive direction since this point is directly coupled to "e_i," However, this rise tends to be opposed by the degenerative feedback voltage from the output. The output will be $-Ae_g$ (e_o). The letter "A" stands for the amplifier gain. The minus sign indicates that the out polarity or phase is opposite to the input. The output changes "A" times faster or steeper than "e_g." The output voltage is negative and aids the charging of the capacitor.

For a certain input voltage, the charging current is limited to a particular value which tends to keep "e_g" practically zero. If the current should exceed this value, "e_g" would decrease a small amount due to the increased voltage drop across R. Then e_o would decrease, and the charging current would decrease to the original value. If the initial charging current should decrease, the opposite action would occur. The value of the charging current is therefore stabilized to a specific value proportional to the input voltage. This eliminates the error caused by "e_i" and the charging current not remaining proportional in the fundamental RC integrator.

This constant charging current must be produced by "e_o" despite the fact that the steadily increasing capacitor voltage opposes the charging current. To do this, "e_o" must also steadily increase. This steady increase in "e_o" is exactly the integrator output voltage desired for a constant signal input.

Similar action would be produced for a condition in which the input signal suddenly became negative. Polarities then would be in reverse to those shown in the example given. Remember that simple examples are used for explanation on the assumption that the desired result also will be produced for a more complicated signal input. Removal of "e_i" would produce little effect upon the the output which existed at that instant, since the amplifier output would oppose the tendency for the capacitor to discharge.

The limits for "e_o" are determined by the amplifier and not by "e_i" or the range of "e_g." The output range would be designed to produce an increasing output for any probable input amplitude and period of application. The exception to this would be an integrator which was designed to function also as a limiter.

OUTPUT DEVICES

The output of the servocontrol amplifier is fed to an output device. The functions of this device, usually a servomotor, are to supply torque, power, and dynamic characteristics required to position the servo load. Ideally, the power device should require small power from the control amplifier, accelerate rapidly, be of small size and weight, be of lasting endurance, have small time lags, and have an adequate speed range. In aviation electronic systems, the electric motor is most frequently used as an output device.

ELECTRIC MOTORS

In aviation electronic equipment, electric motors are primarily used to drive the servo

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load. The type of electric motor used within a particular equipment is determined by such factors as type of power available, output power, speed range, inertia, and electrical noise.

Alternating-Current Motors

Alternating-current motors are frequently used in low power servo applications because of their simplicity, reliability, absence of commutator sparking, and rapid response. However, they have a disadvantage of having a narrow speed range characteristic. The theory of operation of a-c motors is discussed in Basic Electricity. However, this training manual briefly discusses the types of motors applicable to servosystems.

The 2-phase induction motor is the most widely used a-c servomotor. The stator of the motor consists of two similar windings which are positioned at right angles to each other. The rotor may be wound with short-circuited turns of wire or it may be a squirrel cage rotor. The squirrel cage rotor is the type most frequently encountered. It is made up of heavy conducting bars which are set into armature slots, the bars being shorted by conducting rings at the ends.

Two a-c voltages 90° out of phase must be applied to the stator windings in order for the motor to turn. These out-of-phase voltages generate a rotating magnetic field which induces a voltage in the rotor. This induced voltage generates a magnetic field in the rotor that is displaced 90° from the stator magnetic field. The interaction of the two magnetic fields causes the armature to rotate.

As stated previously, the voltage to the two stator windings must be 90° out of phase to cause the rotor to turn. The direction of rotation is determined by the phase relationship of the stator windings which, in turn, is determined by the servo error detector. One phase is connected directly to one of the stator windings while the other phase is used to energize an error detector. The resulting error voltage is either in phase or 180° out of phase with the signal applied to the error detector. This will cause the controlled phase to either lead or lag the uncontrolled phase by 90°.

Most induction motors have low starting torque and high torque at high speed. For servo applications, it is desirable to have high starting torque in order that the system may have a low time lag. This may be accomplished by increasing the armature resistance with the use of materials such as zinc for the conducting bars. This increased torque at low speed results in decreased torque at high speed. However, increased stability of the servosystem is a desirable result of this change.

Split-phase a-c motors are similar to the 2-phase induction motor. It differs only in that a phase shifting network is used to shift the phase of the voltage supplied to one of the windings by 90°. This is usually accomplished by connecting a capacitor in series with the uncontrolled winding of the stator. Direction of rotation and reversal is accomplished in the same manner as in the 2-phase motor discussed above.

Other types of motors that may be used with an a-c power supply are shaded pole, universal, and repulsion motors. They utilize various methods of obtaining rotation reversal.

Direct-Current Motors

Direct-current motors have an advantage of having higher starting torque, reversing torque, and less weight for equal power than a-c motors.

Series motors are characterized by their high starting torque and poor speed regulation with a change in torque. Higher torque can be obtained on reversal of direction with a series motor than any other type. However, it is a unidirectional motor and requires special switching circuits to obtain bidirectional characteristics. This is normally done by switching either the armature or field connections but not both.

A variation of the series motor that has bidirectional characteristics is the split-series motor. The motor has two field windings on its frame, only one of which is used for each direction of rotation. This reduces the number of relay contacts required for reversing by one-half. This double winding also reduces the torque capabilities of the motor as compared to a straight-series motor wound on the same frame.

The most frequently used d-c servomotor is the shunt motor. Its direction of motion is controlled by varying the direction of flow of either the armature or field current. The uncontrolled current is usually maintained constant to preserve a linear relationship between the motor output torque and the voltage or cur-

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UNIT III - DRAWING GEOMETRIC CONSTRUCTIONS

Constructing an Approximate Ellipse by the Four-Center Method — Lesson 6

OBJECTIVE: To learn the four-center method of approximating an ellipse.

RELATED INFORMATION:

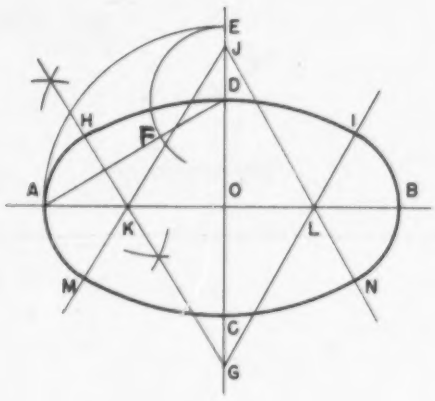

TO CONSTRUCT AN APPROXIMATE ELLIPSE BY THE FOUR CENTER METHOD

FIG. 1

To draw an approximate ellipse through the given points A, D, and B by the four-center method (Fig. 1): Draw the major axis AB and the minor axis CD as shown. Let the minor axis equal approximately one-half the major axis. Note: The minor axis may be any length, so long as it is smaller than the major axis. Draw line AD. With O as a center and radius OA, scribe arc AE. With D as a center and radius DE, scribe arc EF. Bisect line AF. Where the bisector of line AF meets the extension of the minor axis at point G, we have the center for the arc HDI. Step off distance OJ equal to OG and OL equal to OK. Draw lines from point J through K and L. With J as a center and a radius equal to JC, scribe arc MCN. Complete the ellipse with K and L as centers and radii equal to KA and LB respectively.

Application:

To construct the front view of an angle support (Fig. 2), proceed as stated above. Scale any dimensions needed from the drawing shown.

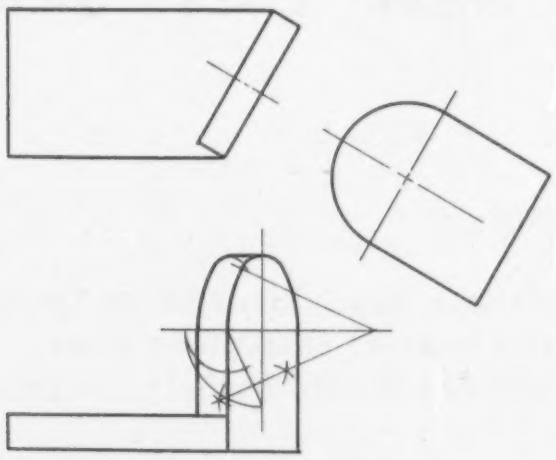

APPLICATION - ANGLE SUPPORT

FIG. 2

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rent input. The field windings are usually two differentially wound coils to facilitate direction control of the field current by the servocontrol amplifier. The field current is usually controlled with receiving type vacuum tubes. The larger armature currents require thyratrons or generators as current regulators.

MAGNETIC CLUTCHES

Any device utilizing an electrical signal that may be used to control the coupling of torque from an input shaft to an output shaft is a magnetic clutch. This coupling may be accomplished by the contact between friction surfaces or by the action of one or more magnetic fields. A magnetic clutch is used only to couple the input torque to the output shaft. Thus, it is capable of controlling large amounts of power and torque for its size and weight. The magnetic clutch may be used with a large flywheel driven at high speed by a small motor. This allows the flywheel to impart very large acceleration to the load when the magnetic clutch is energized.

There are two distinct types of magnetic clutches. Some transmit torque by physical contact of frictional surfaces. Others utilize the action of magnetic flux produced by two sets of coils or one set of coils and induced eddy currents resulting from rotating the one set of coils near a conducting surface. The eddy current type of clutch offers smoother operation and has no problem of wear due to friction. Both types have suitable control characteristics and are found in servomechanisms.

HYDRAULIC DEVICES

Hydraulic components used in servomechanisms are frequently found in aviation electronic equipments such as radar antennas. Hydraulic power devices, such as motors and associated control valves, have an advantage of a response much faster than the best electric motors and equal to that of a magnetic clutch system. They also require a minimum of maintenance, have very high accuracy, and are well adapted to heavy loads.

The essential components of a hydraulic system are:

1. Source of high pressure oil and sump to receive discharged oil.
2. Control valve and means of employing an actuating signal.
3. Actuator (motor or cylinder).

The theory of operation of a hydraulic system is discussed in Fluid Power, NavPers 16193-A.

The source of high pressure oil serves as a source of power to operate the actuator. However, this source of power is controlled by the control valve. This valve is actuated by the output from the servocontrol amplifier. This control is normally accomplished by feeding the error signal to a solenoid controlled valve. However, the error signal could be used to drive an electric motor which, in turn, actuates the control valve. The actuator is usually in the form of an axial motor which must be a reversible and variable speed type. Some applications may employ a cylinder where linear motion is required for positioning.

SERVOMECHANISM OSCILLATION

Servomechanisms are utilized for various functions and must meet certain performance requirements. These requirements not only concern such things as speed of response and accuracy, but the manner in which the system responds in carrying out its command function. All systems contain certain errors, the problem being to keep them within the allowable limits.

As discussed previously, the servomotor must be capable of developing sufficient torque and power to position the load in a minimum of time. The servomotor and its connected load have sufficient inertia to drive the load past the point of command position. This overshooting results in an opposite error voltage, reversing the direction of rotation of the servomotor and the load. The servomotor again attempts to correct the error and again overshoots the point of correspondence with each reversal requiring less correction until the system is in correspondence. The time required for the oscillations to die out determines the transient response of the system and can be greatly reduced by the use of damping.

DAMPING

The function of damping is to reduce the amplitude and duration of the oscillations that may exist in the system. The simplest form of

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damping is viscous damping. Viscous damping is the application of friction to the output load or shaft that is proportional to the output velocity. The amount of friction applied to the system is critical and will materially affect the results of the system. When just enough friction to prevent overshoot is applied, the system is said to be critically damped. When the friction is greater than that for critical damping, the system is overdamped. However, when damping is slightly less than critical, the system is said to be slightly underdamped, which is usually the desired condition. The application of friction absorbs power from the motor and is dissipated in the form of heat.

A pure viscous damper would absorb an excessive amount of power from the system. However, a system having some of the characteristics of a viscous damper with somewhat less power loss is used in actual practice. The first of this type of damper to be discussed utilizes a dry friction clutch to couple a weighted flywheel to the output drive shaft. A flywheel has the property of inertia which may be defined as that property of matter by which it will remain at rest or in uniform motion in the same straight line or direction unless acted upon by some external force.

However, since the flywheel is coupled to the output shaft with a friction clutch, any rapid change in velocity of the output member causes the clutch to slip. This slipping effectively disconnects the flywheel instantaneously but allows sufficient power to be coupled to the flywheel to overcome its inertia. As the inertia is gradually overcome, the flywheel gains speed and approaches the velocity of the output member. As the point of correspondence is neared and the error signal is reduced, the inertia of the flywheel gives up power to the system, causing the load to increase its overshoot. When the system attempts to correct for this overshoot, the inertia of the flywheel adds to the output load, reducing the effect of the correcting signal. This effect dampens the oscillations in the system, reducing its transit time.

Another type of damper used is the eddy current damper. This damper utilizes the interaction of induced eddy currents and a permanent magnet field to couple the output shaft to a weighted flywheel.

The effect of damping is shown in figure 12-20. The soild line shows the action of the load without damping. The time required to reach a steady-state condition without damping should be noted. This time is greatly reduced although the initial overshoot is increased.

As shown in figure 12-20, viscous dampers effectively reduced transient oscillations, but it also produced an undesired steady-state error (velocity lag or position error). Since the friction damper absorbs power from the system, its use is normally limited to small servomechanisms.

To overcome the disadvantages of the viscous dampers and still provide damping, error-rate damping is used. This type of damping consists of introducing a voltage that is proportional to the rate of change of the error signal. This voltage is fed to the servocontrol amplifier and combined with the error signal. Figure 12-21 shows the effect of error-rate damping on the torque output of the servomotor. Curve A shows the torque resulting from the error voltage; curve B shows the torque resulting from the error-rate damper; and curve C depicts the resultant of curves A and B. It should be noted that torque resulting from the damper increases the total torque as long as the error component is increasing. Once the error component starts to decrease, the error-rate damper produces a torque in an opposite direction reducing the transit time of the system.

There are two methods of generating an error-rate voltage normally found in aviation

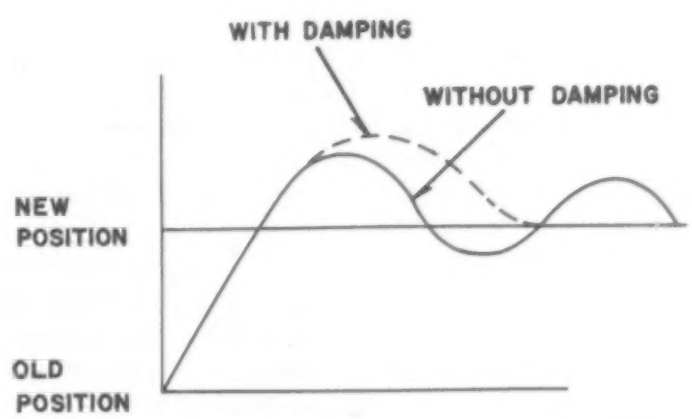

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Figure 12-20.–Effect of friction damper.

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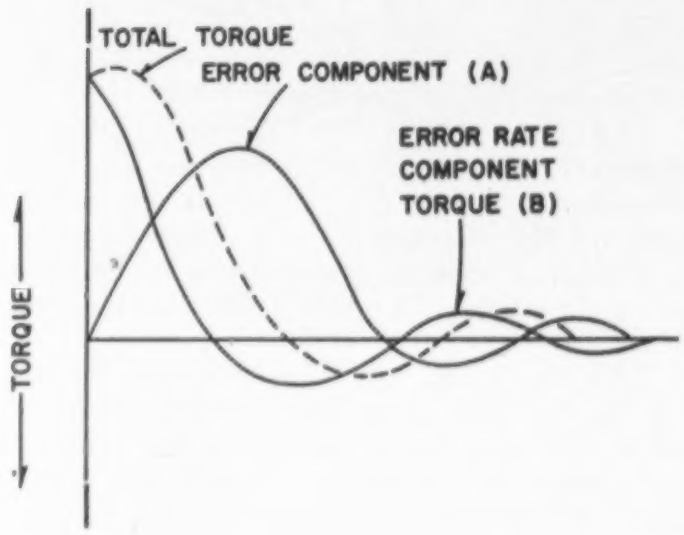

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Figure 12-21.–Torque variations using error-rate damping.

electronic equipments. They are the tachometer and electrical networks. The tachometer error-rate damper utilizes a device which is essentially a generator having an output voltage proportional to its shaft speed. The tachometer is connected to the shaft of the output member giving a voltage proportional to its speed. The output voltage is fed to a network that modifies this voltage so that it is proportional to a change in input voltage. This voltage is fed back to the servocontrol amplifier and added with the error signal as shown in figure 12-21.

Electrical networks used for error-rate damping consist of a combination of resistors and capacitors used to form an RC differentiating network. For a detailed explanation of RC circuits, refer to Basic Electricity. These networks, sometimes referred to as phase advance or lead networks, vary in design, depending on the type of error signal. However, in practice, networks are normally limited to the d-c type. (See fig. 12-22.) This is because of the unstable results that would be caused by a small change in frequency of the power source. An a-c system may utilize a d-c network by first using a demodulator (detector) prior to the network. However, the output of the network must be modulated for use in the remainder of the a-c system. Like the tachometer, the output of the network is fed to the servocontrol amplifier.

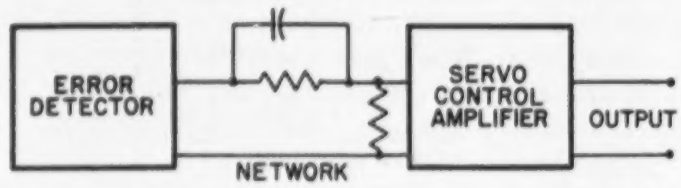

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Figure 12-22.–Error-rate stabilization network.

INTEGRAL CONTROL

Servomechanisms used in electronic equipment are sometimes required to follow an input function, the magnitude of which changes at a constant rate with time. Thus, if the input is the angle of a shaft, the velocity of the shaft may be constant for a substantial percentage of time. The servomechanism may be required to respond to this type of input with substantially zero error. The error that characterizes the servo response to a constant velocity input is known as the velocity error.

To correct for velocity error or an inaccuracy due to a steady-state error, an integral control may be used. This control modifies the error voltage in such a manner that the signal fed to the servocontrol amplifier is a function of both the amplitude and time duration of the error signal. This is accomplished by the use of a variable voltage divider whose output would increase with time for a constant input. As in all voltage dividers, the output is only a portion of the input which effectively reduces the amplitude of the error signal. To compensate for this loss of amplitude, additional amplification must be used either in the form of a preamplifier or a higher gain servocontrol amplifier. With the overall gain of the system now increased to give a normal output for transient error signals, small velocity or steady-state error signals of long duration will result in somewhat increased output to the servomotor due to the action of the integral control.

The integral control (fig. 12-23) consists of a combination of resistors and capacitors connected to make an integrator circuit for a d-c error signal. The value of the components are such that the capacitor does not have sufficient

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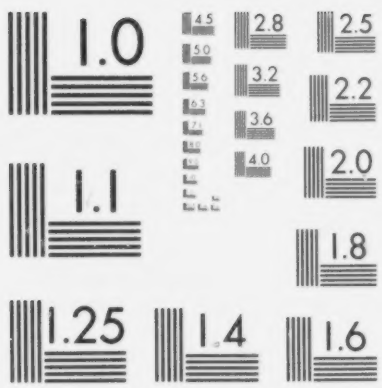

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

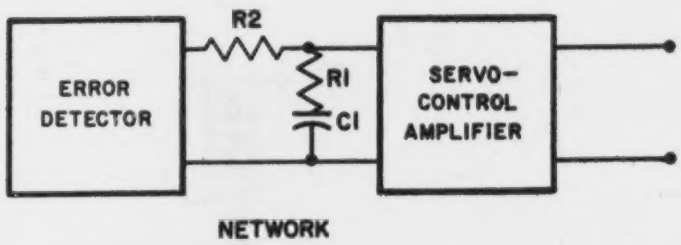

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Figure 12-23.–Integral stabilization network.

time to change with fluctuations in error voltage. Only that portion of the transient error signal developed across R1 is impressed on the amplifier. However, with a velocity error or steady-state error of longer duration, the capacitor (C1) charges, increasing the amplitude of the amplifier input.

Networks shown in figure 12-23 are not limited to d-c systems as a demodulator may be used prior to the integrator and its output modulated for easier amplification.

GAIN, PHASE, AND BALANCE

The overall system gain has a most important effect on the servomechanism response characteristics and is one of the more easily adjustable parameters in electronics servocontrollers. Increasing the system gain reduces the system velocity errors and those steady-state errors resulting from restraining torques on the servo load or misalinement in the system. An increase in system gain also increases the speed of response to transient inputs. However, excessive gain always decreases the rate at which oscillatory transients disappear, and continue increase in the system gain eventually produces instability.

Servosystems using push-pull amplifiers must be balanced to insure equal torque in both directions of the servomotor. This adjustment should be checked periodically as a change in value of a component may cause an unbalanced output. Balancing is accomplished by adjusting the system for zero output with no signal applied.

A phase control is included in some servosystems using a-c motors. The two windings of the a-c servomotor must be energized by a-c signals that are 90° apart. A phasing adjustment is normally included in the system to compensate for any phase shift in the amplifier circuit resulting in unstable operation of the system. This adjustment may be located in the control amplifier, or in the case of a split-phase motor, it may be in the uncontrolled winding.

ZEROING SYNCHRO UNITS

In this chapter the importance of accuracy of servomechanisms has been stressed. In any servomechanism using synchro units, it is also very important that the units be zeroed electrically.

For a synchro transmitter or receiver to be in a position of electrical zero, the rotor must be alined with S2, the voltage between S1 and S3, as shown in figure 12-24 (A), must be zero, and the phase of the voltage at S2 must be the same as the phase of the voltage at R1.

TRANSMITTERS AND RECEIVERS

The most common methods of zeroing synchro transmitters and receivers are the a-c voltmeter method and the electrical lock method. The method used to zero a synchro depends upon how the synchro is used. Where the rotor is free to turn the electrical lock method can be used. This is accomplished by connecting S1 and S3 to R2 using a jumper wire and connecting S2 to R1. (See fig. 12-25.) When power is applied, the rotor will position itself in the zero position. After the synchro is zeroed, the pointer is adjusted to indicate zero.

Possibly the great majority of synchros used in aviation electronic equipment have their rotors gear driven or mechanically coupled to a driving member. In these cases it is necessary to use the a-c voltmeter method, zeroing the synchro by rotating the stator or housing until its electrical zero is reached. Before zeroing the synchro, the mechanical unit that positions the synchro must be set to its indexing or ZERO position. This is done by alining the unit to its index and installing its indexing pins in the holes provided for this purpose. The pins hold the unit to its index and keep it from moving.

The a-c voltmeter method is done by connecting the meter and jumper wires as shown in (A) of figure 12-26. Rotate the energized synchro

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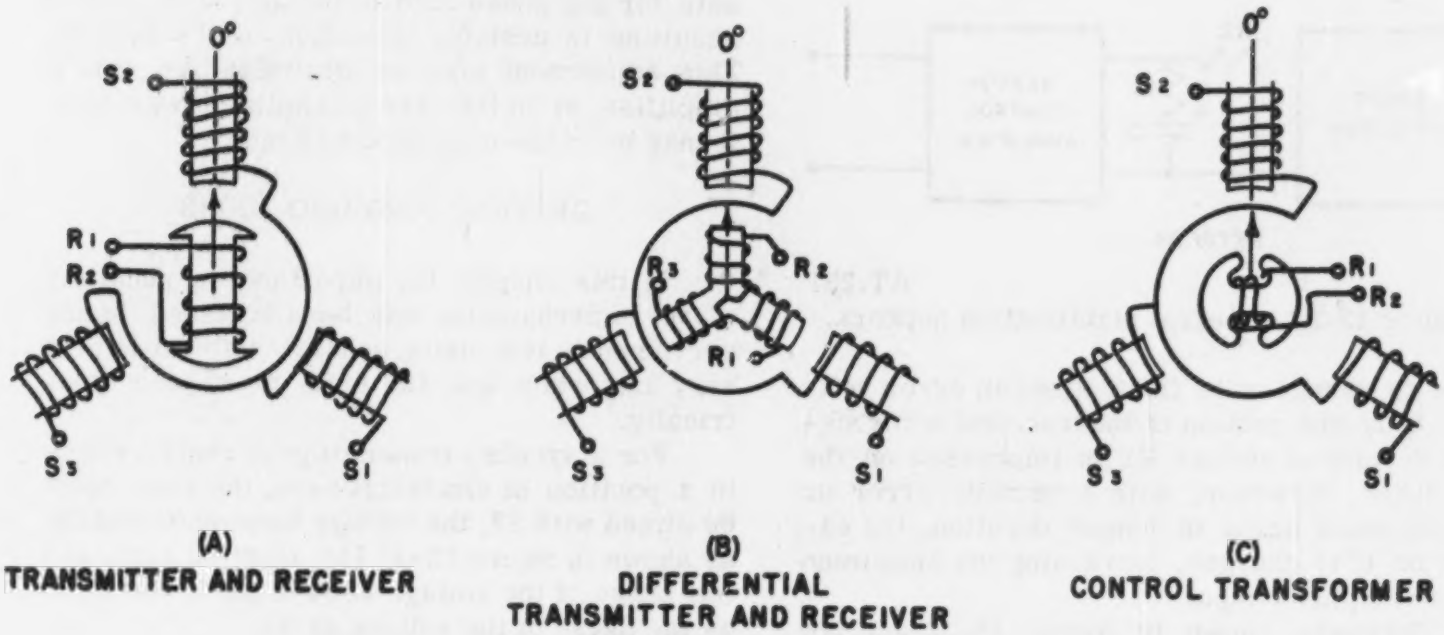

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Figure 12-24.–Synchro electrical zero positions.

until a zero reading is obtained on the voltmeter. Since rotor positions of zero degree and 180° produce this zero reading, it is necessary to determine if the phase of S2 is the same as that of R1. Make the connections as shown in (B) figure 12-26. If the proper polarity relationship exists, the voltmeter indicates less than the excitation voltage being applied to the rotor. If the indication is greater than the rotor excitation voltage, the rotor (or stator) must be rotated 180° and the previous step must be performed again.

The electrical zero position of a synchro differential transmitter or receiver is when the three windings of the rotor are in correspondence with their respective stator windings and their respective voltages are in phase. (See fig. 12-24 (B).)

Because the differential transmitter synchro is normally used to insert a correction into a synchro system, it is usually driven either directly or through a gear train. Before zeroing the differential transmitter synchro, the unit whose position the differential synchro transmits should first be zeroed. After this has been accomplished, connect the differential synchro as shown in figure 12-27 (A). Turn the synchro in its mounting until the voltmeter shows a minimum indication. After completing this step, make the connections shown in figure 12-27 (B). Again turn the synchro slightly in its mounting, until a minimum voltage is indicated by the voltmeter.

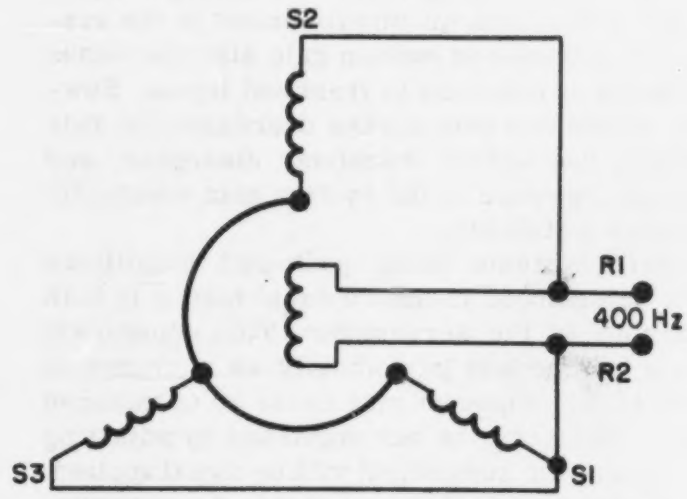

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Figure 12-25.–Electrical lock method of zeroing a synchro.

Electrical zero for a differential receiver is illustrated in figure 12-24 (B). To zero a differential receiver synchro, make the connections shown in figure 12-28. As soon as the power is applied to the synchro, the rotor assumes a position of electrical zero. The dial can be set at zero and the unit reconnected to its circuit.

The synchro control transformer is normally zeroed by using the a-c voltmeter method. It should be remembered that the electrical zero position of the control transformer is 90° from that of a receiver since the rotor winding must be perpendicular to the stator's resulting magnetic field to have a zero output. (See fig. 12-24 (C).) The coarse adjustment is made by connecting the meter and unit as shown in figure 12-29(A). The rotor is rotated to give a minimum or null reading on the voltmeter. The final adjustment is made by connecting the unit as shown in figure 12-29 (B) and displacing the rotor a few degrees in both directions to determine the null or electrical zero position. Once the

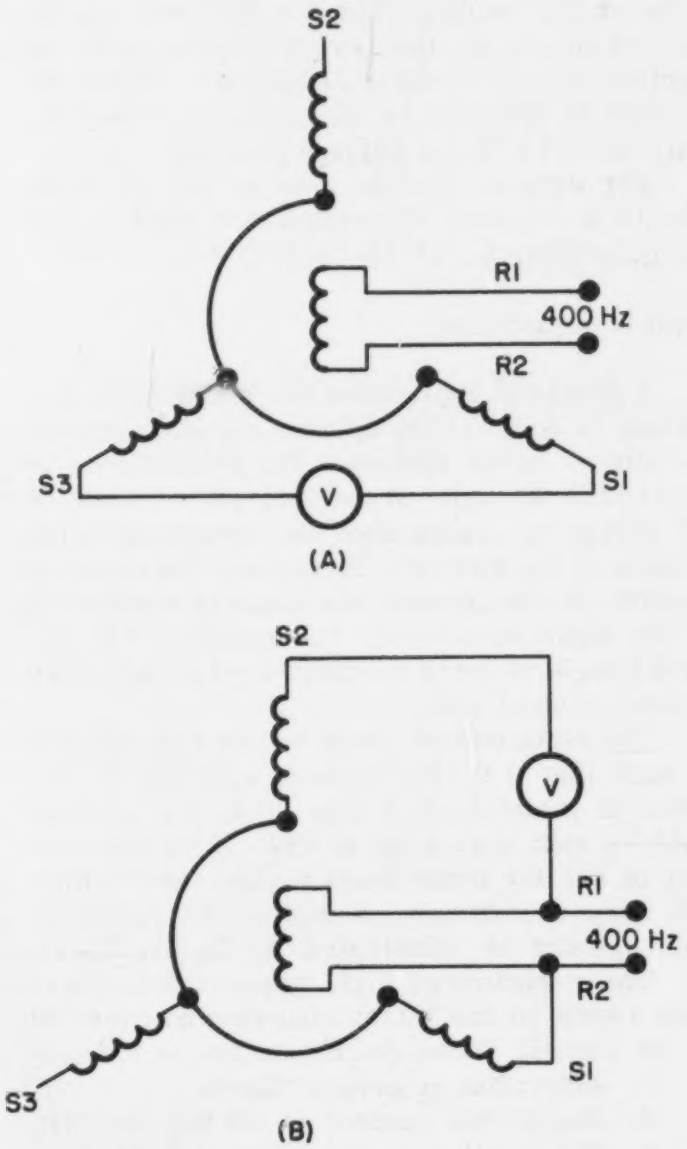

Figure 12-26.–A-c voltmeter method of electrically zeroing synchro receiver or transmitter.

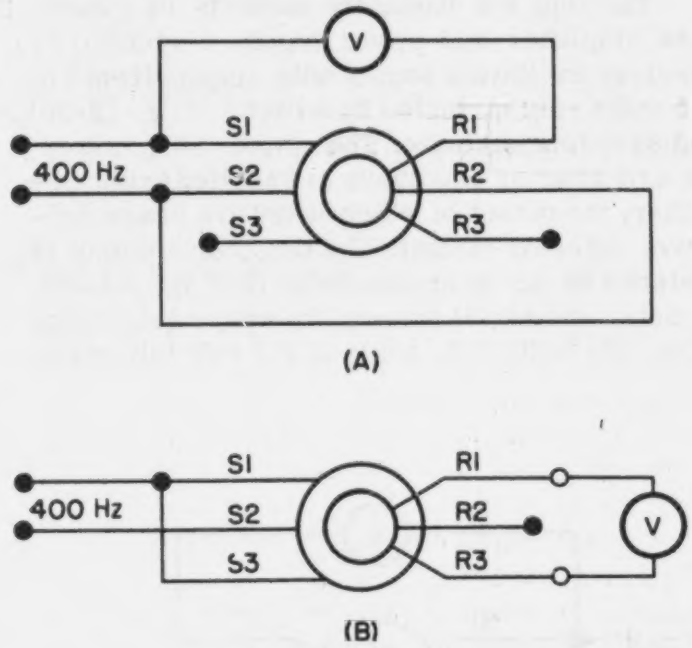

Figure 12-27.–Electrically zeroing a differential transmitter.

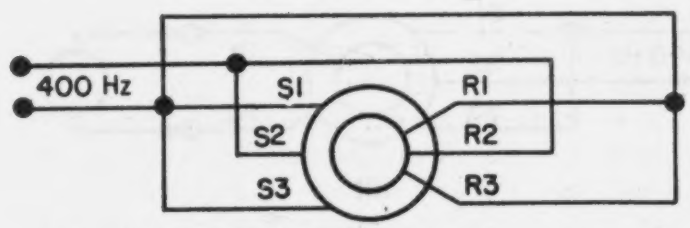

Figure 12-28.–Electrically zeroing a differential synchro receiver.

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zero position has been determined, the unit must be locked as discussed previously.

SYNCHRO ALIGNMENT SET TS-714/U

The Synchro Alignment Set TS-714/U (fig. 12-30) is a portable, general purpose test set used to check the alinement of synchros or resolvers. It can be used to aline any 400-Hz synchro or resolver. In addition to its higher sensitivity, the test set has an additional advantage over the methods previously discussed in that the test set can also supply excitation voltage for the synchro or resolver being alined.

The test set basically consists of a bandpass amplifier and power supply, a synchro or resolver excitation supply with outputs from 3 to 115 volts rms (selected by switch 1 of fig. 12-30) and switching circuits. The output voltages from the synchros or resolvers are applied to the amplifier, the output of which is fed to a phase sensitive detector circuit. The detector's output is metered by the microammeter (2 of fig. 12-30). A meter switch (3) selects the meter sensitivity from 300 volts full scale to 0.1 volt full scale; it also has a calibrate position and an off position.

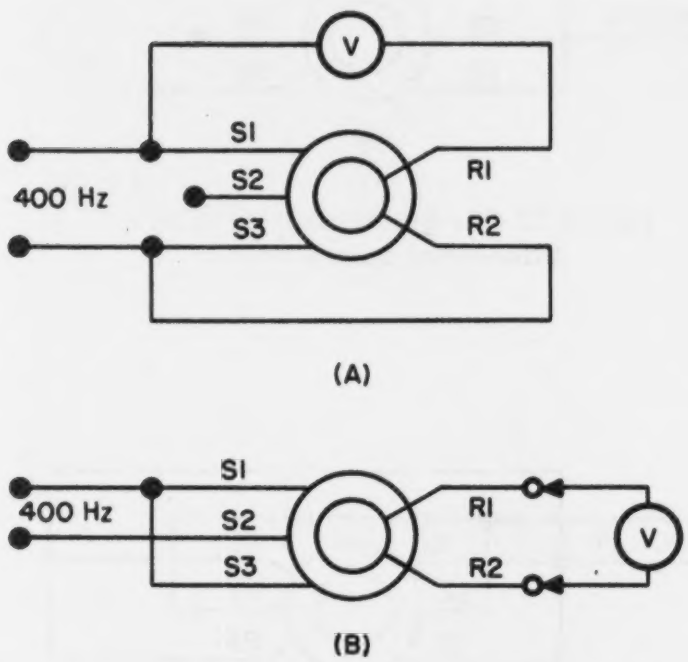

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Figure 12-29.–Electrically zeroing a control transformer synchro.

The meter has a zero-center scale and indicates zero when the synchro or resolver is adjusted to either of its two nulls. The synchro or resolver is adjusted to a null position with the function switch (4) in the ZERO position. When the null is reached, the function switch is switched to the POL position and note is taken of the meter reading. Then the function switch is returned to ZERO position and the synchro is rotated 180° to its opposite null. When the opposite null is reached, the function switch is again switched to the POL position and a note made of the reading. The correct null will be the one indicating the lowest reading with the function switch in the POL position. When the synchro is adjusted to this null, it is electrically zeroed with the correct polarity.

For detailed instructions on the use of the TS-714/U, consult Operation and Service Instruction Manual, NA 11-70-FAG-510.

Typical Application

A practical application of a complete servosystem is found in the antenna tilt stabilization circuits of radar systems. Tilt stabilization is used to tilt the angle of the transmitted beam of RF energy to compensate for deviations in the attitude of the aircraft. Throughout the scanning azimuth of the antenna, the beam is maintained at the angle selected by the operator. The selected angle is set by the tilt control on the radar antenna control unit.

The stabilization range on one type of radar is such that if the tilt control is set for 0°, the beam is maintained at this angle for aircraft pitch or roll angles up to -30°. If the tilt control is set for other beam angles, these limits will vary accordingly. A typical tilt stabilization system is illustrated in figure 12-31.

The conditions of flight assumed for reference result in the waveforms shown at the left of the figure. These conditions are as follows:

1. Aircraft is entering a climb.
2. Manual tilt control is set for zero tilt.
3. Tilt stabilizer mechanism is functioning in response to gyro signals.
4. Scanner's instantaneous position is "dead ahead."

NOTE: The amplitude for waveforms 7 and 8 are not drawn to comparative scale.

The tilt stabilization system, shown in figure 12-31 consists of a gyroscope unit, a servoamplifier, the resolver synchro, manual tilt synchro, tilt torque motor, damping signal gengenerator, and followup synchro. The gyroscope unit is separately mounted on the aircraft structure, and the resolver synchro and the servoamplifier are mounted on the antenna frame. The tilt torque motor, damping signal generator, and followup synchros are contained in the tilt servo unit mounted on the rotary section of the antenna. The manual tilt synchro is mounted on the antenna control box.

Stabilization is effected by the use of two signals—the resolver synchro signal, and the manual tilt synchro signal. Separate pitch and roll signals originating in the gyroscope unit are combined in the resolver synchro to produce the single resolver synchro signal. The manual tilt synchro signal originates in the followup synchro and provides the tilt stabilization system with continuous information as to the tilt angle of the reflector. This signal passes through the manual tilt synchro in the antenna control where it is modified according to the setting of the tilt control. The resolver synchro signal and the manual tilt synchro signal differ in phase by 180°. They are combined at the input of the servoamplifier. The amplifier resultant, or error signal, is used to control the tilt torque motor, which corrects the tilt angle of the reflector.

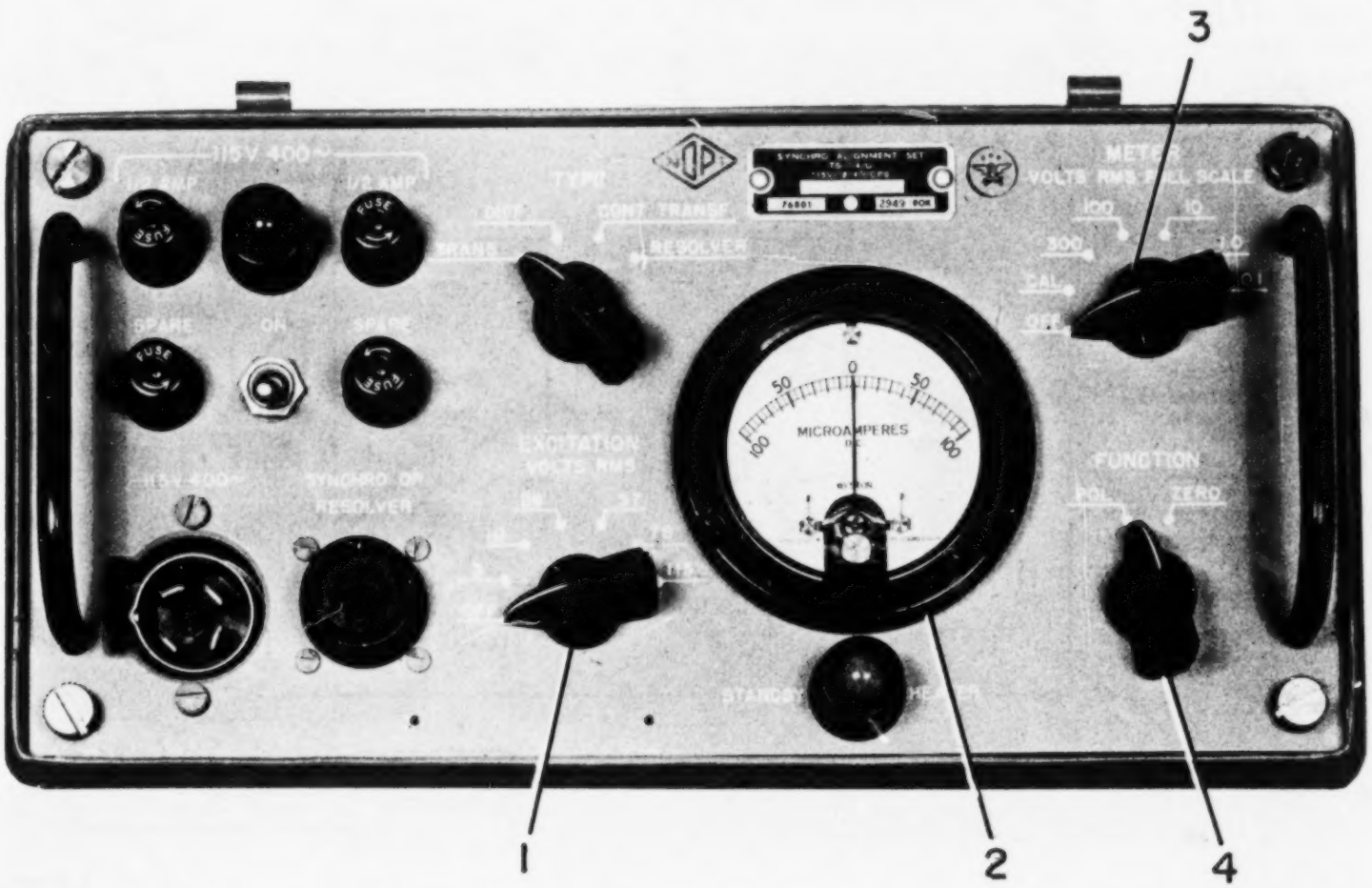

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Figure 12-30.—Synchro Alignment Set TS-714/U, front panel.

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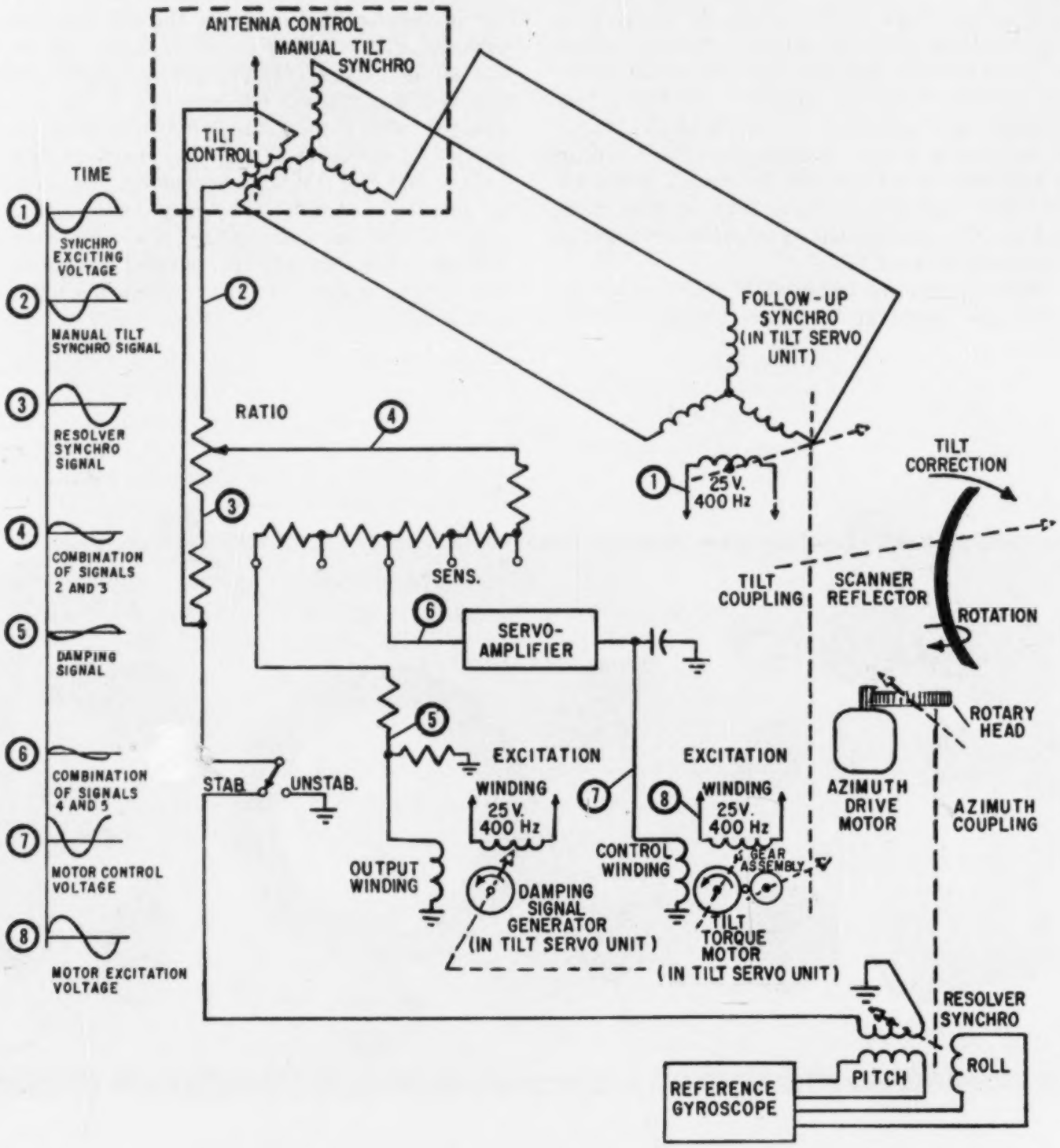

Figure 12-31.–Radar antenna tilt stabilization servosystem.

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Learning the Alphabet of Lines — Lesson 1

OBJECTIVE: To learn the different types of lines used in the field of drafting.

ALPHABET OF LINES

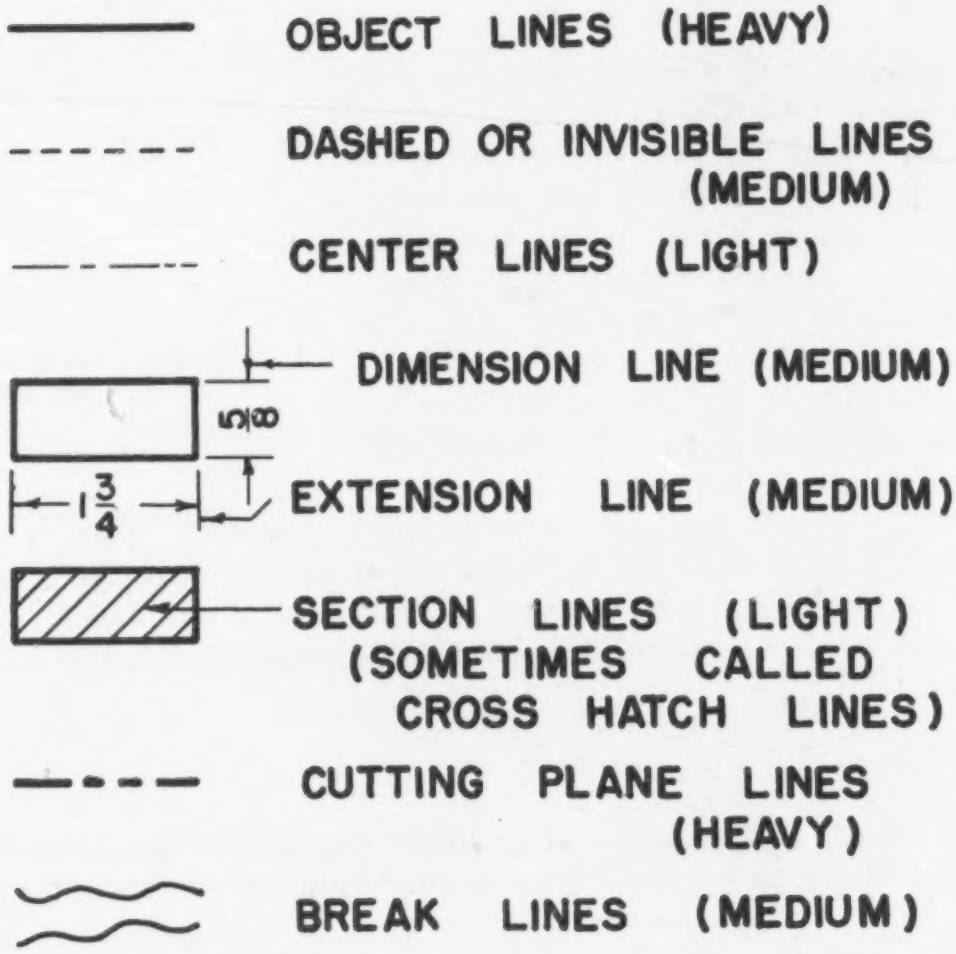

FIG. 1

RELATED INFORMATION:

1. Object lines. - These lines describe the shape of the object and are generally heavier than other lines. They must be of uniform weight and should not thin out near their ends.

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CHAPTER 13

ELECTRONIC MAINTENANCE, PART I

The purpose of this chapter is to set forth general maintenance procedures rather than the detailed procedures used with specific units and sets; however, for purposes of illustration, specific electronic units and sets are mentioned. Discussion is given to the troubleshooting procedures used in aircraft as well as on the bench, and repair information concerning electronic circuit construction, replacement of parts, electrical connectors, cables, and terminal blocks.

TROUBLESHOOTING

Much of the technician's time is spent troubleshooting the equipment in the squadron's aircraft. The technician's job is to maintain a great number of units and systems, many of which are quite complex, and which might seem at a glance beyond his ability to maintain. However, the most complex job usually becomes much simpler if it is first broken into successive steps. Any maintenance job should be performed in the following order:

1. Analyze the symptom.
2. Detect and isolate the trouble.
3. Correct the trouble and test the work.

AIRCRAFT PROCEDURES

In troubleshooting, as in most other things, there is no substitute for commonsense. A mistake made by most beginners is to remove major units from the aircraft unnecessarily. When a "squawk" is received, the first step is to determine if the equipment in question is actually faulty. Very often a preliminary check of the system in the aircraft will disclose a faulty control box, frayed or broken wiring, corroded or wet connectors, and, in rare cases, improper operating procedure—especially with new equipment. (Improper operating procedures are especially common when the reported discrepancy involves new equipment or personnel undergoing indoctrination.)

If there is no power present at the input to the equipment, it may be assumed (temporarily) that the set is not defective. Check all applicable switch positions, circuit breakers, fuses, etc., then check for power at the bus which feeds the equipment. Check the tightness and the physical condition of interconnecting cables. Using the wiring diagrams in the applicable manuals, check at successive tie points and splices for continuity, short circuits, or grounds. The procedures to be followed with these tests are discussed later in this chapter under the heading Basic Tests.

If a circuit breaker is tripped or if a fuse is blown, a circuit malfunction is indicated. Power to the circuit containing the "open" should be turned off, and should not be reapplied until the malfunction is located and corrected. The most common causes of tripped or blown circuit protectors are short circuits, faulty grounds, or overload conditions. However, circuit protectors sometimes fail due simply to age or to transient conditions. If, after a thorough check, no apparent reason for the failure can be found, the breaker may be reset or the fuse replaced with the proper size and type, and the power reapplied. If the protector fails again, a malfunction is definitely indicated.

If the analysis does not indicate the existence of a short circuit, faulty ground, or overload condition, but the equipment still does not operate, continue to take measurements with power applied. These measurements should be taken systematically at progressive checkpoints. Particular faults which may interrupt current

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through a circuit include broken wiring, loose or faulty terminal or plug connections, faulty relays or switches, and uncoupled splices. Be alert for these conditions.

If the defective unit cannot be identified while still installed in the aircraft, it may be advisable to turn off the power and substitute units, one at a time with units which are known to operate properly. As each unit is replaced, power should be reapplied and the system checked for operation or for symptoms of nonoperation. If the system operated normally, the faulty unit has been identified, and the faulty unit may be taken to the shop for corrective maintenance. At this stage of the overall maintenance process, it is also advisable to try to determine the reason for the failure of the unit–it is conceivable that the new unit may also be damaged if the basic cause is not corrected.

Following removal of the defective unit and the subsequent analysis, all other items of the original installation should be reinstalled and safety wired, and an operational check performed. During the operational check, any readjustments or calibrations should be accomplished as required. This should be done prior to clearing the discrepancy on the Maintenance Action Form.

Basic Tests

Several rules are set forth below and are intended as a guide to follow when making the tests described in this section.

1. Always connect an ammeter in series.
2. Always connect a voltmeter in parallel.
3. Never connect an ohmmeter to an energized circuit.
4. Select the highest range first then switch to lower ranges as needed.
5. When using an ohmmeter, select a scale that will result in a midscale reading.
6. Do not leave the selector switch of a multimeter in the resistance position when the meter is not in use because the leads may short together and discharge the internal battery. There is less chance of damaging the meter if it is left on a high a-c volts setting or in the off position if it has one. Meters that have an off position dampen the swing of the needle by connecting the meter movement as a generator. This prevents the needle from swinging wildly when the meter is moved.
7. View the meter from directly in front to eliminate parallax.
8. Observe polarity when measuring d-c voltage or direct current.
9. Do not place meters in the presence of strong magnetic fields.
10. Never attempt to measure the resistance of a meter or a circuit with a meter in it as the high current required for ohmmeter operation may damage the meter. This also applies to circuits with low-filament current tubes and some types of semiconductors.
11. When measuring high resistance, be careful not to touch the test lead tips or the circuit as body resistance will shunt the circuit and give an erroneous reading.
12. Connect the ground lead of the meter first when making voltage measurements. Work with one hand whenever possible.

CONTINUITY TEST.–Open circuits are those in which the flow of current is interrupted by a broken wire, defective switch, or any means by which the current cannot flow. The test used to check for opens (or to see if the circuit is complete or continuous) is called continuity testing.

An ohmmeter (which contains its own batteries) is excellent for a continuity test. In an emergency, a continuity tester can readily be made from a flashlight. Normally, continuity tests are performed in circuits where the resistance is very low (such as the resistance of a copper conductor). An open circuit is indicated by a very high or infinite resistance. Such a condition would be an open conductor.

The diagram in figure 13-1 shows a continuity test of a cable. Notice that both connectors are disconnected and the ohmmeter is in series with the conductor under test. The power must be off. Checking conductors A, B, and C, the current from the ohmmeter will flow through plug No. 2, through the conductor, and plug No. 1. From this plug it will pass through the jumper to the chassis which is "grounded" to the aircraft's structure. The structure will serve as the return path to the chassis of unit 2 completing the circuit to the ohmmeter. The ohmmeter will indicate a low resistance.

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Checking conductor D (fig. 13-1) will reveal an open. The ohmmeter will indicate maximum resistance because current cannot flow. With an open circuit, the ohmmeter needle is all the way to the left since it is a series type ohmmeter (reads right to left).

Where conditions exist that the aircraft structure cannot be used as the return path, one of the other conductors may be used. For example, to check D (fig. 13-1) a jumper is connected from pin D to pin A of plug 1 and the ohmmeter leads are connected to pins D and A of plug 2. This technique by the process of elimination will also reveal the open in the circuit.

GROUNDED CIRCUIT TEST.–Grounded circuits are caused by some conducting part of the circuit making contact either directly or indirectly with the metallic framework of the aircraft. Grounds may have many causes, the most common of which is perhaps the fraying of insulation from a wire allowing the bare wire to come in contact with the metal ground.

Grounds are usually indicated by blown fuses or tripped circuit breakers. Blown fuses or tripped circuit breakers, however, may also result from a short other than ground. A high resistance ground may also occur where sufficient current does not flow to rupture the fuse or open the circuit breaker.

In testing for grounds, the ohmmeter is used. Other continuity testers may also be used. By measuring the resistance to ground of any point in a circuit, it is possible to determine if the point is grounded. By considering figure 13-1, one possible means of testing a cable for grounds can be seen. If the jumper is removed from pin D of plug No. 1, a test for grounds is made for each conductor of the cable. This is accomplished by connecting one meter lead to ground and the other to each of the pins of one of the plugs. A low resistance will indicate that a pin is grounded. Both plugs must be removed from their units; if only one plug is removed, a false indication is possible for a conductor may be grounded through the unit.

SHORT TEST.–A short circuit, other than a grounded one, is one where two conductors accidentally touch each other directly or through another conducting element. Two conductors with frayed insulation may touch and cause a short. Too much solder on the pin of a connector may short to the adjacent pin. In a short circuit, sufficient current may flow to blow a fuse or open a circuit breaker. However, it is entirely possible to have a short between two cables carrying signals; such a short will not be indicated by a blown fuse.

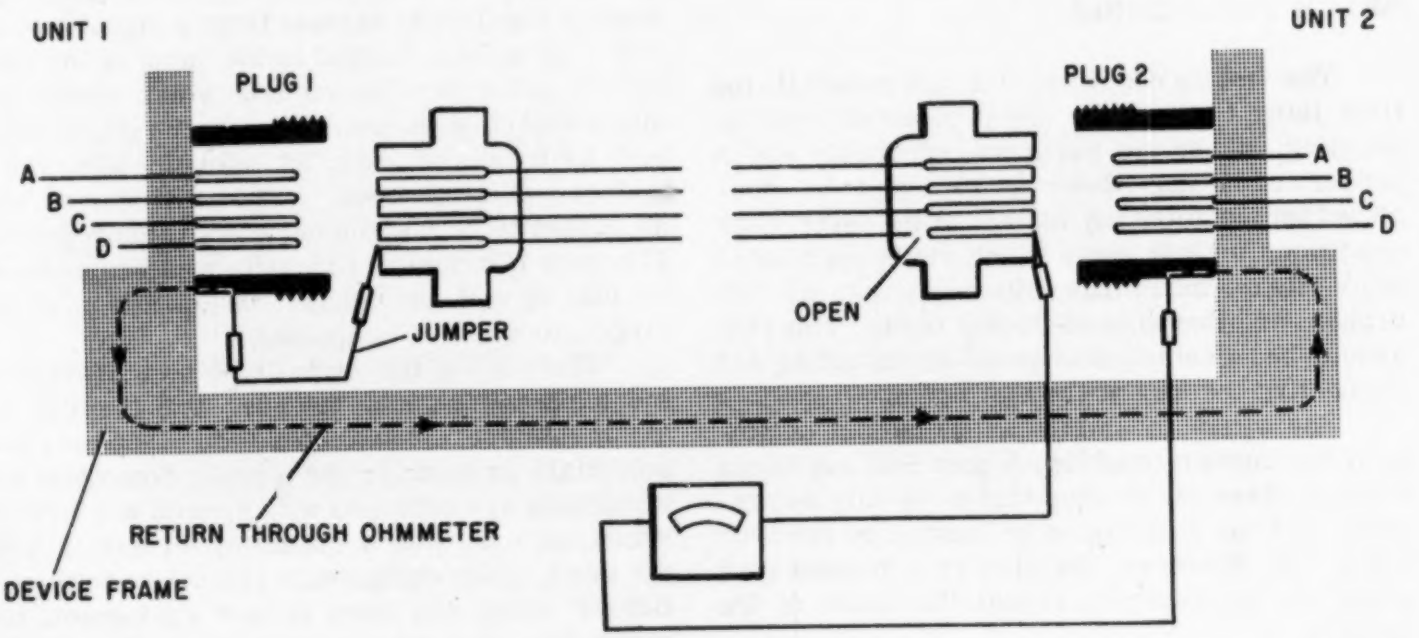

Figure 13-1.–Continuity test.

As when checking for a ground, the device used for checking for a short is the ohmmeter. By measuring the resistance between two conductors a short between them may be detected by a low resistance reading. In figure 13-1 by removing the jumper and disconnecting both plugs, a short test may be made. This is performed by measuring the resistance between the two suspected conductors.

Shorts are not reserved for cables, they occur in many components, such as transformers, motor windings, capacitors, etc. The major test method for testing such components is a resistance measurement, and then comparing the indicated resistance with the resistance given on schematics or in maintenance manuals.

VOLTAGE TEST.–The voltage test must be made with the power applied; therefore, the prescribed safety precautions must be followed to prevent injury to personnel and damage to the equipment. The technician will find in his maintenance work that the voltage test is of utmost importance. It is used not only in isolating casualties to major components but also in the maintenance of subassemblies, units, and circuits. Before checking a circuit voltage, a check on the voltage of the power source should be made to be sure that the normal voltage is being impressed across the circuit.

BENCH PROCEDURES

The visible condition of a unit is usually the first thing to check in any process of troubleshooting. If certain parts are obviously not in proper condition, these faults must be corrected before going any further in the tests. Such conditions include parts which are burned, loose from their mountings, disconnected, dented, broken, or otherwise obviously faulty. This step should be accomplished prior to installing and connecting the unit at the test bench.

The sense of smell can be helpful in pinpointing certain troubles. A part that overheats usually gives off an odor that is readily detectable, and can sometimes be located by the odor given off. However, location of a burned part does not necessarily reveal the cause of the trouble.

In determining the cause of the trouble it is usually necessary to refer to the Service Instruction Manual. This manual will be a valuable source for constant reference when performing maintenance on electronic equipment. Few technicians are so thoroughly familiar with an electronic unit that they do not have to use the manual when performing maintenance. Chapter 4 of this training manual contains a detailed description of the information that is presented in the Service Instruction Manuals.

Signal Tracing

The following procedure is given for tracing signals in RF receivers and audio amplifiers; however, this general procedure, with modifications, can be applied to most electronic troubleshooting. In radar the frequencies are higher, the methods of signal application differ, and the output in the final stage is video (veiwed) on a scope, instead of audio (heard) from a speaker or headset. The applicable Service Instruction Manual contains detailed procedures for testing most units or circuits.

Signal tracing is a very effective method for locating defective stages in many types of electronic sets. It is especially useful when servicing sonobuoy receivers, audio amplifiers, and other equipment which normally contain no built-in meters. In signal tracing, a signal voltage (similar to that which is present under operating conditions) is taken from a signal generator and is then applied to the input of the circuit in question. The signals which result are then checked at various points in the stage, using test instruments such as vacuum tube voltmeters, oscilloscopes, output meters, or any high impedance instrument which is appropriate. (The test instrument should have high impedance so that it will not change the operation of the circuit to which it is applied.)

When using the signal tracing technique to measure a-c signals, be sure that the test instruments are adequately isolated from any d-c potentials present in the circuit. Some test instruments are equipped with special a-c probes which incorporates a capacitor in series with the input; other equipments are not so equipped. Before using any item of test equipment, the technician must familiarize himself with the characteristics and proper use of the test equipment, as well as with the equipment under test.

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By signal tracing methods, the gain or loss of amplifiers can be measured; and the points of origin of distortion and hum, noise, oscillation, or any abnormal effect can be localized.

The gain measurement can be used as an example of an important method in signal tracing. By this procedure, a defective stage can be found quickly in a radio sonobuoy receiver or audio amplifiers. A signal generator, with the output attenuator calibrated in microvolts, and an output meter are used. It is helpful to have data concerning the normal gain of the various stages of the device. These data are generally found in the Service Instruction Manual for the receiver under test.

The output meter may be connected across the headset (or the voice coil of a speaker) or across the secondary of the output transformer. The output of the signal generator is applied to the grid circuit of the stage under test. The attenuator of the signal generator is then adjusted until the output meter reads a value appropriate to serve as a reference figure. The output of the signal generator is then applied to the output of the stage under test (or to the input of the next stage), and the attenuator is adjusted until the same reference value is again registered on the output meter. The gain of the stage is found by dividing the second value of the signal (taken from the calibrated attenuator) by the value of the signal applied to the input of the stage.

As an example, suppose the signal generator supplies a voltage of 400 microvolts to the grid of an IF amplifier. This voltage causes the output meter to indicate some value that can be used as a reference. When the generator signal is applied to the following grid, the signal strength must be increased (to 4,000 microvolts) to cause the output meter to indicate the same reference value. The gain of the stage is equal to

$$\frac{E_{in}\ \text{2nd stage;}}{E_{in}\ \text{1st stage}} \quad \text{that is,} \quad \frac{4{,}000}{400} = 10$$

If similar measurements made in the remaining stages of the receiver reveal one stage in which the gain is lower than normal or is zero, that stage can then be thoroughly checked by voltage measurement, by the resistance measurement, or by simple replacement of parts until the defective one is found.

When making stage gain measurements in receivers, the value of the applied signals must be low enough to prevent the AVC system from functioning; otherwise, the measurements will not be accurate. In the Service Instruction Manual, the recommended signal values are usually stated in terms of the reference value to be used at the output meter.

Test Probe Substitution

Using a test equipment probe with equipment other than that for which it was designed may result in considerable error. Any differences in the internal resistance of the probe and input circuitry of the equipment precludes substitution without calibration. For example, the internal resistance of a 10:1 probe is, in most cases, nine times higher than the input circuitry of the equipment. It should be noted that 2:1, 50:1, and 100:1 probes are available as well as 10:1 probes.

Test probes which are not recommended for specific equipments should not be used, because they may not have sufficient capacitive adjustment to preserve the waveshape of the observed signal. A sound rule is to use all test probes only with the equipment for which they were designed.

Voltage Checks

Voltage measurements are made at various points in the stage suspected of being at fault, and the observed voltage values are compared with the normal voltage values given in the Service Instruction Manual.

When making voltage checks for comparison with a chart, be sure to use a voltmeter with the proper ohms-per-volt rating (sensitivity). Voltmeters are connected in shunt with the circuit elements under test, resulting in circuit loading. (Circuit loading is discussed in Basic Electronics and in chapter 10 of this manual.) If the sensitivity of the test instrument is the same as that of the instrument used in making the readings on the chart, the loading effect will be the same in both cases, and the readings obtained are reliable. Another important point to remember is that if the meter sensitivity is too low, loading effect may be so severe as to prevent proper

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operation of an otherwise normally functioning circuit.

From this comparison, the defect can often be isolated. Voltage checks are most effective when applied within a single stage, after previous checks have been made to localize the defect. This is true because modern electronic equipment is complex, and a great deal of time is required to check all the voltages present in all the stages.

Some electronic sets have built-in meters or plugs for front panel application of meters. These meters usually work in conjunction with a selector switch, and will read values of voltage or current at designated points. A defective stage can often be isolated in this manner.

Once the defective stage is isolated, it becomes a matter of point-to-point checking to isolate the fault within the stage itself. A voltmeter will pinpoint the trouble, but it often becomes necessary to use an ohmmeter to determine the exact cause of trouble, such as shorted capacitors, open resistors or transformers, or wire grounded to chassis.

Resistance Checks

Resistance checks are similar to voltage checks except that the power is removed from the set. Resistance values are measured with an ohmmeter, and the readings are compared with the normal values given in the maintenance publications. Resistance checking, like voltage measurement, is most effective after the trouble has been isolated to a particular stage. Reliance on resistance measurement alone is too time consuming to be efficient. After the trouble has been isolated, the ohmmeter is a very useful instrument and often quickly leads the technician to the cause of the trouble.

NOTE: In order to prevent damage to the ohmmeter, always be sure that there are no voltages present in the equipment prior to beginning the resistance checks. Turn off the power switches, discharge power supply and other large capacitors, and bleed off any other residual charges in the set. Also observe proper precautions when connecting or disconnecting the ohmmeter across large inductors.

A typical example of a routine resistance check applied to a single part is the ohmmeter method of checking electrolytic capacitors. A resistance measurement is made on the discharged capacitor, using the high resistance range of the ohmmeter. When the ohmmeter leads are first applied across the capacitor, the meter pointer rises quickly and then drops back to indicate a high resistance. The test leads are then reversed and reapplied. The meter pointer should rise again–even higher than before–and again drop to a high value of resistance. The deflections of the meter are caused when the capacitor is charged by the battery of the ohmmeter. When the leads are reversed, the voltage in the capacitor adds to the applied voltage, resulting in a greater deflection than at first.

Do not leave the ohmmeter connected across an electrolytic capacitor for any appreciable period of time. Electrolytic capacitors are polarity-sensitive, and reverse polarity of voltage (even from an ohmmeter) may cause excessive current which could result in overheating and possible explosion of the capacitor.

If the capacitor is open-circuited, no deflection will be noted. If the capacitor is short-circuited, the ohmmeter indicates zero ohms. The resistance values registered in the normal electrolytic capacitor result from the fact that there is some current leakage between the electrodes. Because the electrolytic capacitor is a polarized device, the resistance is greater in one direction than the other.

Should a capacitor indicate a short circuit, one end of it must be disconnected from the circuit and another resistance reading taken to determine if the capacitor is actually at fault.

Unless the ohmmeter has a very high resistance scale the deflection of the meter when checking small capacitors will not be noticeable. Even a scale of R x 10,000 is not sufficient for very small capacitors; the smaller the capacity the less leakage across the plates, therefore the more resistance.

When making resistance checks, be sure to determine what circuits are connected to the points where the checks are made. The Service Instruction Manual will indicate what resistance should be found at various checkpoints throughout the set, and will contain a complete schematic of the set as well as a circuit schematic of the stage under test. The schematics may set up conditions under which voltage and resistance measurements are to be made, such as positions of switches and control knobs, relays energized

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or deenergized, tube in socket, etc. These conditions will duplicate the conditions under which the measurements were first made. A typical condition might be: "Power switch OFF–all controls on the control box fully CCW (counterclockwise)." It is important that these instructions be followed to obtain accurate values to compare with specified values. Otherwise incorrect values may be obtained.

Defective Components

Before replacing a defective part it is necessary to determine if such an operation may be performed by the unit or squadron. This is determined by the level of maintenance that has been assigned to the squadron. Increasing complexity and compactness of electronic equipment have resulted in a trend toward replacement of subassemblies rather than individual parts. This trend is caused by the necessity of exact parts replacement, and the difficulty of working in small spaces where even the amount of solder used on a connection can be of importance. However, there are many parts that may be replaced at any level of maintenance. The general rule is to replace any defective part with an exact duplicate.

Publications may be consulted to aid in obtaining information (such as stock number and description) about a particular part. The publications which will most often be used when ordering parts are the IPB and the Section R list for the particular equipment under repair. Chapter 4 of this training manual explains the use of the IPB and the Section R lists, and also the Standard Aeronautical Electronics Material Section R, NavWeps 00-35QR-4.

Should it become necessary to replace a part with a substitute, the technician must make sure that the substitute part is a proper replacement. With resistors, for instance, several characteristics must be considered–ohmic value, wattage rating, tolerance, physical size, and type of construction. Capacitors involve consideration of physical size, capacity, tolerance, temperature coefficient, and voltage rating. Plugs and connectors will almost invariably have to be exactly as prescribed since it is difficult to find items of this type that are interchangeable. Familiarity with the IPB is a definite asset to the technician who must determine exactly what part to order.

Basic Electronics contains information on color codes for capacitors and resistors. Refer to this manual for information on standard codes, specifications, physical shapes, methods of reading, and tolerances.

Checking After Repair

No repair job is complete until the repaired unit or set is reinstalled and actually operating properly. The set must be bench checked after the trouble is remedied, usually before the set is completely reassembled, and any alinement adjustments necessary to assure proper operation should be made. After reassembly of the set–replacement of dust and shielding covers, installation of set in outer case (and pressurization if necessary)–a final bench operational check should be performed. Oftentimes a shield or plate that has been installed will touch a bare wire or other contact and will render the set inoperative, or cause substandard operation. It is much better to discover such a fault at the bench than in the aircraft.

After the set is reinstalled in the aircraft and properly secured for flight, it must be given a final operational test. It cannot be assumed that because the set operated properly on the bench it will do so in the aircraft. The most important test is an operational check under exact operating conditions. When the set performs properly in the aircraft and is securely mounted, the discrepancy sheet may be signed. This signature indicates that the electronic set should operate properly under normal flight conditions.

The troubleshooting information described in the preceding paragraphs is summarized in figure 13-2, which shows in chart form a general troubleshooting procedure. The directions given in blocks 1 through 5 are steps to be used in locating trouble, and the directions given in blocks 6 and 7 are steps in repairing the set. (Steps 2, 3, 4, and/or 5 may sometimes be eliminated, but steps 6 and 7 will always be followed.)

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REPAIR INFORMATION

As was mentioned previously, increasing complexity and compactness of electronic equipment have caused a trend toward replacement of subassemblies rather than individual parts. This trend is caused by the necessity of exact parts replacement, and the difficulty of working in small spaces where even the amount of solder used on a connection can be of importance. However, there are many parts that will need to be replaced, and the rule is to replace a defective part with an exact duplicate.

The trend toward replaceable units has led to several new methods of construction of electronic equipment. Two examples are MICRO-ELECTRONICS and PRINTED CIRCUITS. These circuits are designed for speed and economy of manufacture, and speed and ease of maintenance, as well as saving of space and weight.

SOLDERING

Soldering operations are a vital part of electronics maintenance procedures. It is a manual skill which can and must be learned by all personnel assigned electronics maintenance shop duties. Practice is required to develop proficiency in the techniques of soldering; however, practice serves no useful purpose unless it is founded on a thorough understanding of basic principles. This discussion is devoted to providing information regarding some important aspects of soldering operations.

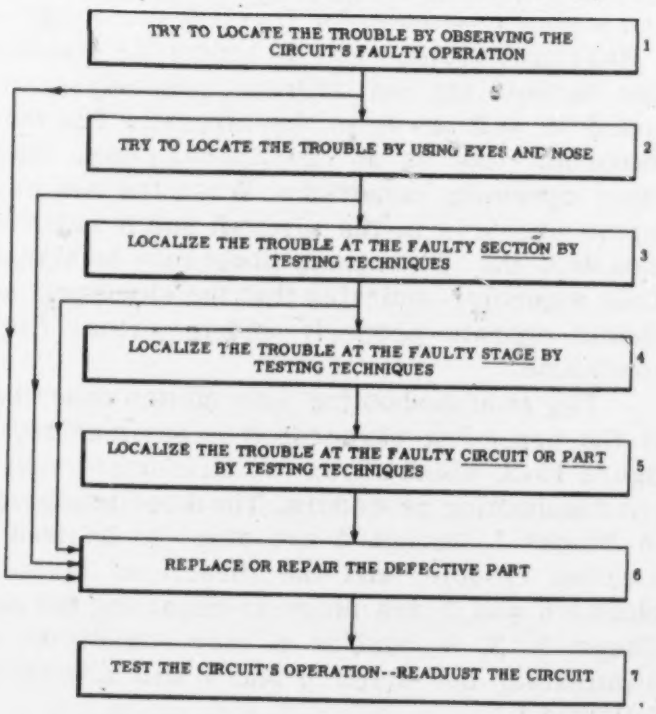

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Figure 13-2.–Troubleshooting procedure.

Soldering Iron

Proper preparation of the soldering iron is essential. The iron to be used should be selected on the basis of heat required. A 100-watt iron is satisfactory for splices and terminals; a 30-watt iron should be used for repair of printed circuits.

The tip must be free of oxide, scale, and carbonized flux, and should be smooth and completely tinned prior to use. Solder dissolves copper gradually, causing pits in the tip. Such pits should be filed smooth and the tip retinned.

During use, periodically wipe the tip to remove excess solder and flux.

Temperature

Both the solder and the material to be soldered must be heated to a temperature which allows the solder to flow. If either is heated inadequately, "cold" solder joints result. Such joints do not provide either the physical strength or the electrical conductivity required. Appreciably exceeding the flow point temperature, however, is likely to cause damage to the parts being soldered. Various types of solder flow at different temperatures. In soldering operations it is necessary to select a solder that will flow at a temperature low enough to avoid damage to the part being soldered, or to any other part or material in the immediate vicinity.

The duration of high heat conditions is almost as important as the temperature. Insulation and many other materials in electronic equipment are susceptible to damage from heat. They are damaged if exposed to excessively high temperatures, or deteriorate if exposed to less drastically elevated temperatures for prolonged periods. The time and temperature limitations depend on many factors–the kind and amount of metal involved, the degree of cleanliness, the ability of the material to withstand heat, and transfer and dissipation characteristics of the surroundings.

Soldering Process

Cleanliness is a prime prerequisite for efficient, effective soldering. Solder will not adhere to dirty, greasy, or oxidized surfaces. Heated metals tend to oxidize rapidly, and the oxide must be removed prior to soldering. Oxides, scale, and dirt can be removed by mechanical means (such as scraping or cutting with an abrasive) or by chemical means. Grease or oil films can be removed by a suitable solvent. Cleaning should be accomplished immediately prior to the actual soldering operation.

Items to be soldered should normally be tinned before making mechanical connection. When the surface has been properly cleaned, a thin, even coating of flux may be placed over the surface to be tinned to prevent oxidation while the part is being heated to soldering temperature. Rosin core solder is usually preferred in avionic work, but a separate flux may be used instead. Separate flux is frequently used when tinning wires in cable fabrication. Acid core solder or acid flux should be avoided due to its corrosive action.

The tinning on a wire should extend only far enough to take advantage of the depth of the terminal or receptacle. Tinning or solder on wires subject to flexing causes stiffness, and may result in breakage.

The tinned surfaces to be joined should be shaped and fitted, then mechanically joined to make good mechanical and electrical contact. They must be held still with no relative movement of the parts. Any motion between parts will likely result in a poor solder connection.

SOLDERED CONNECTIONS.–Frequent arguments occur in electronics maintenance shops concerning the proper method of making soldered connections to terminals and binding posts. For many years it was considered necessary to wrap the lead tightly around the terminal, so as to provide maximum mechanical support and strength. According to MIL-S-6872, General Specification for Soldering Process, "The parts to be joined shall be held together in such a manner that the parts shall not move in relation to one another during the soldering process. The joint shall not be disturbed until the solder has completely solidified."

The Navy Electronics Laboratory tested many standard capacitors and resistors soldered to terminals of various types. The joints were then subjected to vibrations far in excess of those encountered in military ships, aircraft, and armored vehicles. The connections were made with various degrees of wrapping around the terminals, with main reliance for physical strength being placed on the solder. As a result of this test and other conducted by other organizations, the joints illustrated in figure 13-3 are recommended. Wrappings of three-eights to three-fourths turn are usually recommended so that the joint need not be held during the application and cooling of the solder.

Excessive wrapping of leads results in increased heat requirements, more strain on parts, greater difficulty of inspection, greater difficulty of assembly and disassembly of the joints, and increased danger of breaking the parts or terminals during desoldering operations. Insufficient wrapping may result in poor solder joints due to movement of the lead during the soldering operation.

The areas to be joined must be heated to or slightly above the flow temperature of the solder. The application of heat must be carefully controlled to prevent damage to components of the assembly, insulation, or nearby materials. Solder is then applied to the heated area. Only enough solder should be used to make a satisfactory joint. Heavy fillets or beads must be avoided.

Solder should not be melted with the soldering tip and allowed to flow onto the joint. The joint should be heated and the solder applied to the joint. When the joint is adequately heated, the solder will flow evenly. Excessive temperature tends to carbonize flux, thus hindering the soldering operation.

No liquid should be used to cool a solder joint. By using the proper tools and soldering technique, a joint should not become so hot that rapid cooling is needed.

If, for any reason, a satisfactory joint is not initially obtained, the joint must be taken apart, the surfaces cleaned, excess solder removed, and the entire soldering operation (except tinning) repeated.

After the joint has cooled, all flux residues should be removed. Any flux residue remaining on the surface of electrical contacts may collect dirt and promote arcing at a later time. This

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cleaning is necessary even when rosin-core solder is used.

Connections should never be soldered or desoldered while equipment power is on or while the circuit is under test. Always discharge any capacitors in the circuit prior to any soldering operation.

MICROMAINTENANCE

Microelectronic technology by itself will not solve the maintenance problem. In spite of the greatly increased reliability, failures will still occur. When they do, the faulty items must be isolated and repaired or replaced.

With the discrete miniature component (transistor, resistor, capacitor, etc.), the maintenance technician can test individual circuit elements and thus determine the cause of failure. Repairs can then be made by replacing the faulty component.

With the integrated circuit, replacement of an individual part is impossible because the unit is designed and exists only as a complete functional element. The maintenance process then becomes a matter of isolation and replacement of the defective "chip," "flat-pack," board, or module.

Modules

Modular assemblies are mechanically more rugged than conventional circuits. They are, however, susceptible to damage from improper handling, electrical overload, or overheating. Techniques of maintenance and servicing are similar to those used with conventional circuits, but require somewhat more care in execution.

The small size and close spacing of the parts within the assembly require more care and smaller tools than are normally required in conventional maintenance. Additional devices and maintenance aids are of great help in developing the precision needed for such close work. Many components are inherently susceptible to damage from various causes. These factors require modification of some of the basic maintenance techniques and the use of some new ones.

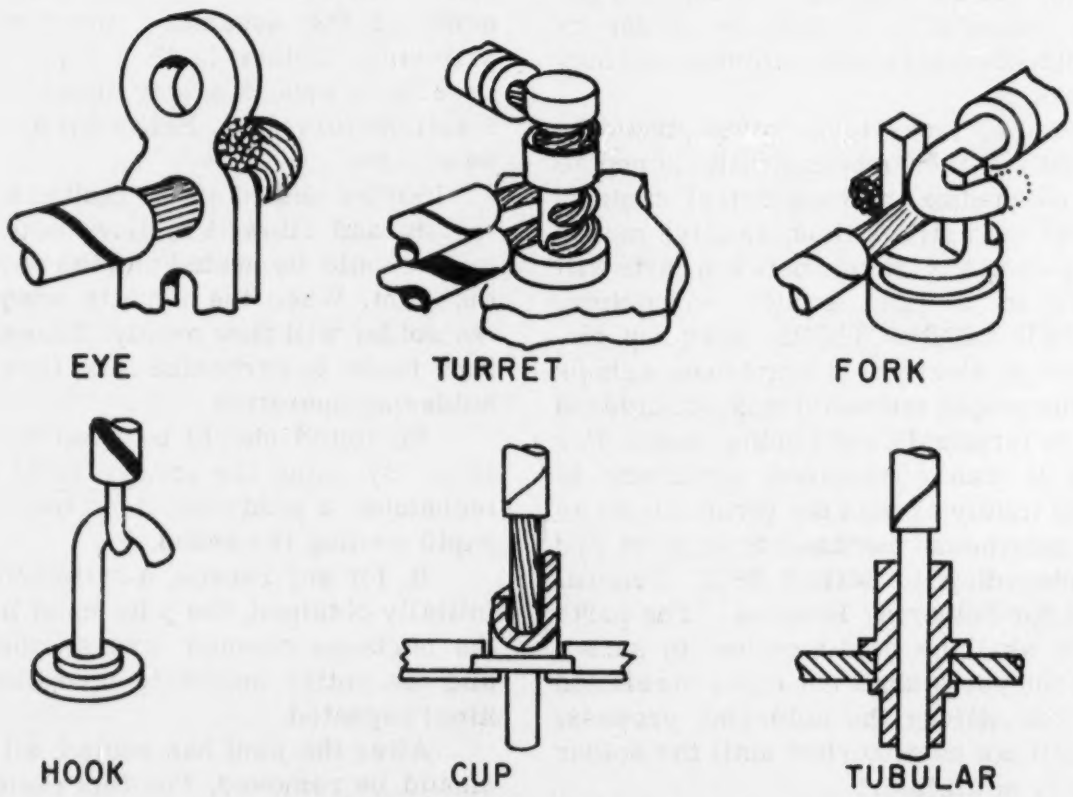

Figure 13-3.–Wrapping of terminals for soldering.

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2. Dashed or invisible lines. - These lines (short dashes about $\frac{1}{8}$ inch long) indicate edges, surfaces, and shapes of parts that are invisible, that is, hidden by another part of the object.

3. Center lines. - These lines are drawn as a series of thin long and short lines. They are quite important for centering or locating parts. The center line often serves as a line from which measurements are taken.

4. Dimension and extension lines. - Dimension lines indicate the extent of a given dimension. They terminate in an arrowhead which touches the extension line. Both extension and dimension lines are usually drawn with a harder pencil. This is done to enable one to see the line thickness differentiation between object and dimension and extension lines.

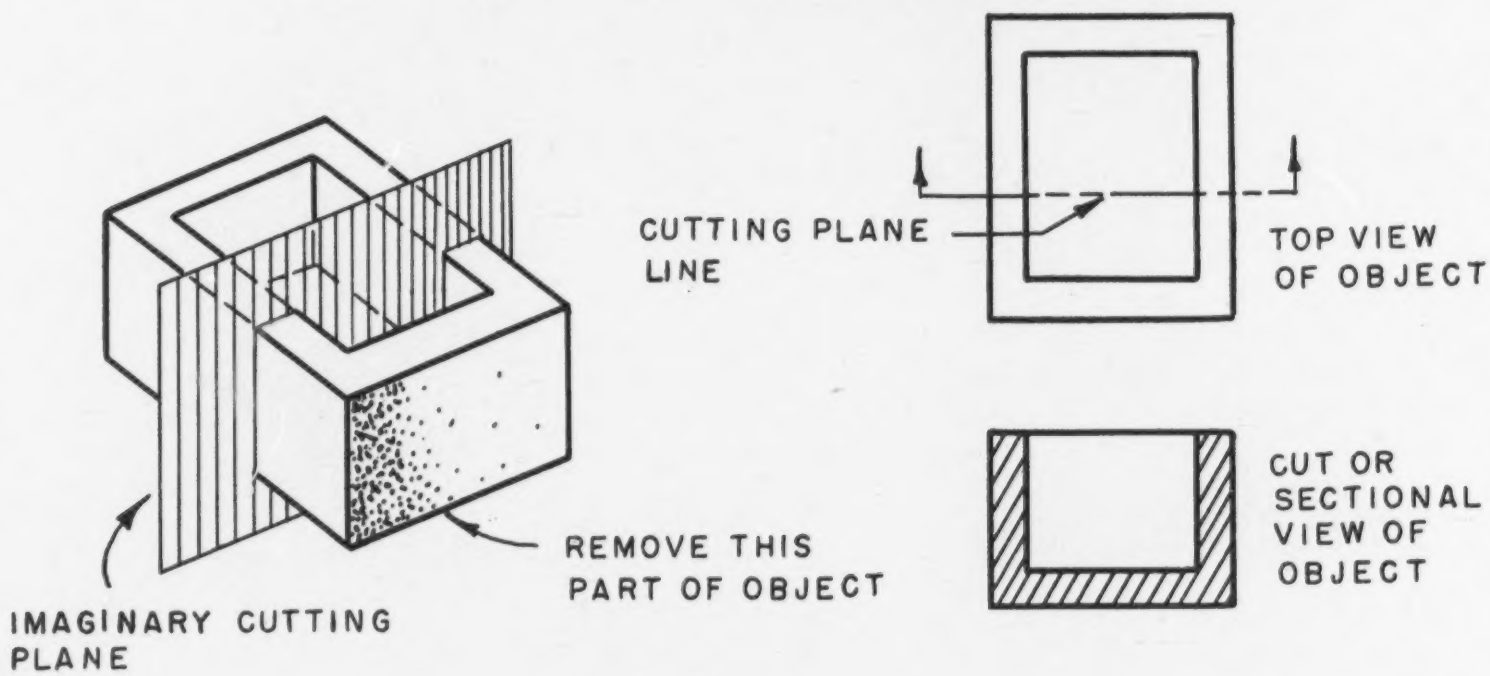

FIG. 2

5. Section or cross hatch lines. - These lines "shade" that portion of an object which has been "cut" by a cutting plane (Fig. 2). Sometimes section lines are drawn in a certain pattern to indicate a particular kind of material. If this be the case, the employer will notify the draftsman and supply him with a chart showing different symbols for different materials. Section lines are usually drawn to the convenient angle of 45°, using a triangle to obtain this result. The section line itself should be similar in weight to a dimension or extension line.

Component damage during maintenance is usually the result of excess heat during repair, reversed polarity of ohmmeters while checking for continuity, application of excessive voltages or signal magnitudes during testing, rough handling, or use of the wrong tools or materials.

Loosening connections, disconnecting parts, inserting or removing transistors, and changing modular units should not be done with the power on or while the circuit is under test. These actions (or a loose connection of any type) will cause an inductive kickback, which may damage the component.

It is also important to remove any capacitive charge from parts, tools, or test equipment before connecting them to any modular unit. A grounding clip should be connected from the item to the modular chassis before making any other contact. When disconnecting, the grounding clip should be removed last.

Leads to transistors, printed circuit boards, etc., as well as many miniature components are easily damaged in handling, stowage, or shipping. Proper precautions should be used at all times.

It should be emphasized that these miniature components and circuits can be repaired, if adequate care and proper techniques are used.

Maintenance Aids

In maintenance of microcircuits special devices are needed to extend the vision, aid the reach, and act as a third hand for the technician. Special tool and device requirements depend on the equipment to be serviced and on the maintenance operations involved. Many of the tools and devices discussed in this section are useful in all maintenance activities; others have limited applicability. The assortment of tools should be kept to the minimum required for effective and efficient maintenance of assigned equipment. A few useful special tools are shown in figure 13-4.

Many dental implements no longer usable for their original purpose can be readily adapted for use by the technician. These include various knives for scraping protective coatings and excess solder, brushes for cleaning, probes and mirrors for inspecting in crowded spaces, and drills for making small repairs. Tweezers and surgical hemostats are useful for grasping and holding small parts. Although they may also be used as heat shunts in soldering, their effectiveness is limited. A more desirable heat shunt is described later in this section. Hypodermic syringes (not shown) are useful in oiling hard-to-reach points.

A pin vise is useful in drilling through plastic, bakelite, or the copper-ribbon conductor strips of a printed circuit board. It may also be used to clean solder from hollow receptacles and terminals. In addition, it can hold many sizes and shapes of hooks and probes made from spring wire. These attachments are useful in inspection and servicing in confined spaces.

A magnifying device for inspecting minute parts is essential. If the magnifier is mounted on a stand it leaves the technician with both hands free for other tasks.

When working on a printed circuit or terminal board which has been removed from its mounting, the work must be held firmly. An easily built device suitable for this purpose is the jig shown in figure 13-5. The jig will provide support and prevent flexing or slipping. Securing the jig to the worktable leaves the technician with both hands free during the maintenance process.

For any desoldering operation, the part should be mounted so that the terminals are pointed out and downward. Place the soldering iron under the terminals so the solder flows away from the joint. To resolder the joint, invert the part.

A drawer or box with a white cloth can be used to catch any small parts dropped during maintenance. A drawer and sheet (or a cigar box and handkerchief) should prove adequate. (See fig. 13-6) in attaching the cloth, leave a little slack to form a pocket in the middle. When the jig (fig. 13-5) is mounted immediately above the trap any part dropped should find its way to the center of the cloth.

PRINTED CIRCUITS

Although maintenance procedures for printed circuits are similar to those for other circuits, they require more skill and care. Any defective part should be pinpointed by careful analysis of the symptoms before attempting to trace trouble on a printed circuit board.

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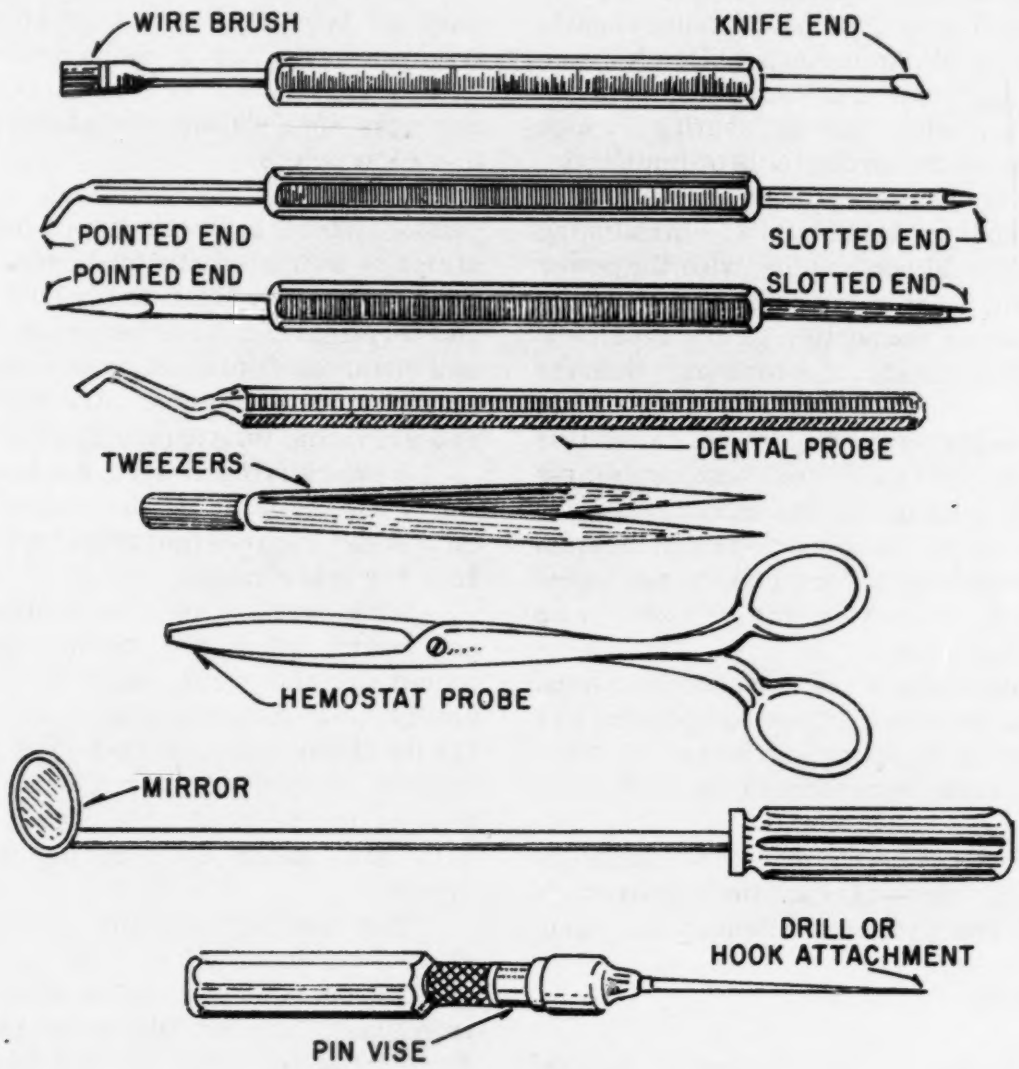

SOLDERING AIDS

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Figure 13-4.–Special tools.

Breaks in the conducting foil strip can cause either permanent or intermittent trouble. When searching for a break in the foil, first determine whether the strips have a protective coating. If so, it will be necessary to penetrate this film when checking for continuity. A needlepoint probe works very nicely.

Use a multimeter or an ohmmeter for checking continuity. Use a meter that passes no more than one milliampere. If the circuit contains transistors or other semiconductors, observe proper biasing conditions.

First check for continuity from one end to the other of each strip (being sure to penetrate the protective coating, but being careful not to damage the strip). If an open is indicated, move the probes one at a time until continuity is indicated. The break then lies between the last two positions of that probe. Carefully inspect the break to determine its extent and the repair process needed.

If the break is small, carefully scrape away any protective coating, clean the area with a firm bristle brush and an approved solvent, and flow solder over the break as indicated in figure 13-7 (A). If there is any indication that the strip might peel loose from the board, bridge the break with a small section of bare wire as indicated in figure 13-7 (B). Apply solder along the entire length of the wire to bond it firmly to the

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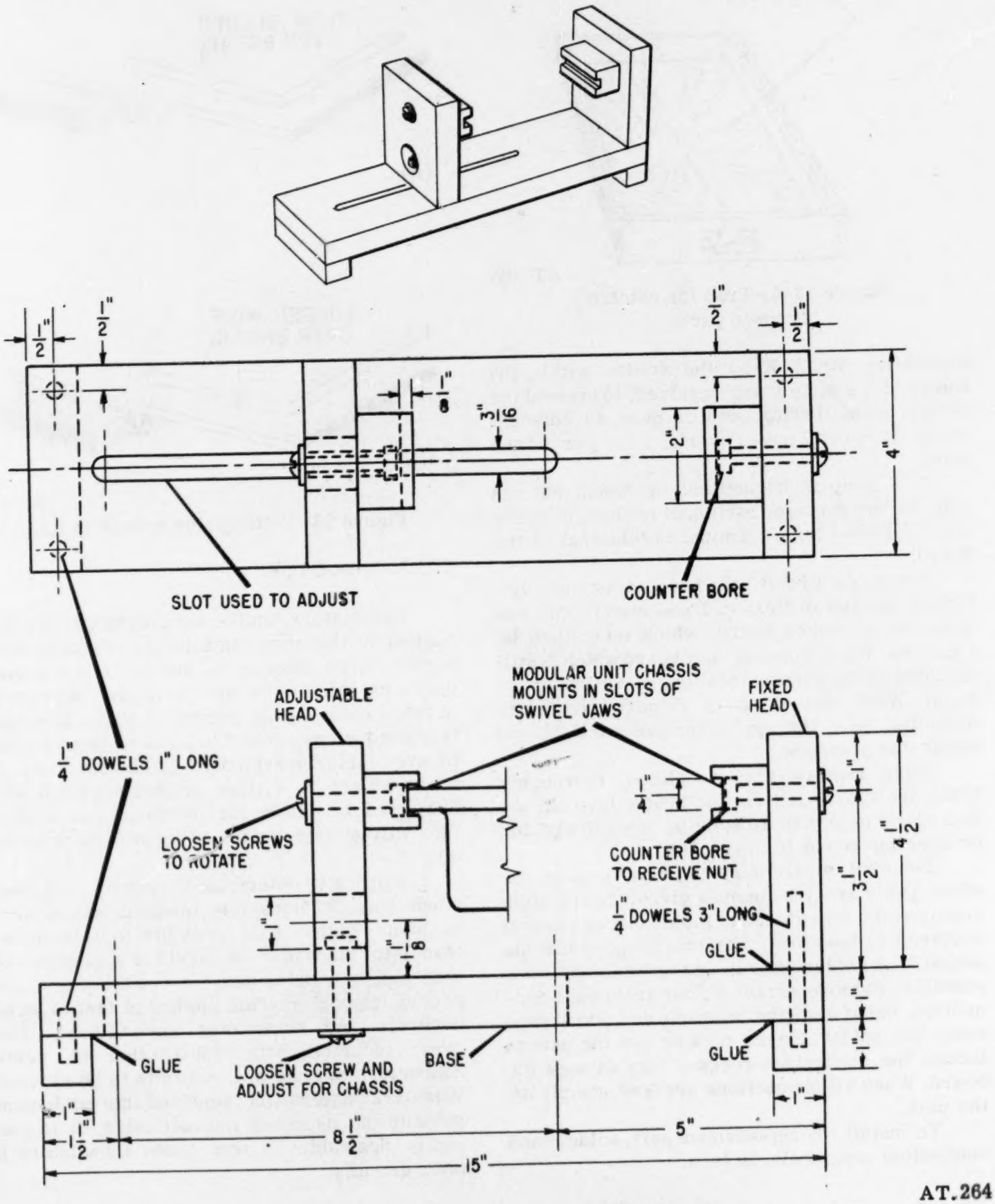

Figure 13-5.–Jig for holding terminal blocks.

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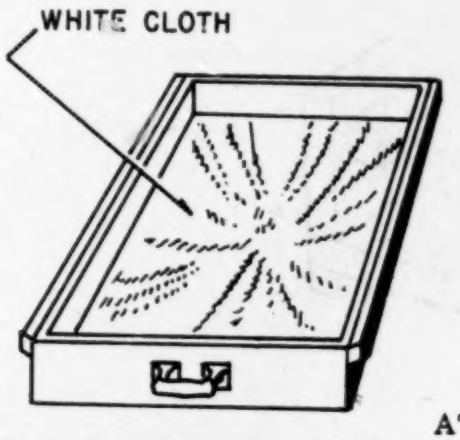

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Figure 13-6.–Trap for catching dropped parts.

conducting strip. Keep the solder within the limits of the strip being repaired, to prevent the solder from flowing onto or near an adjacent strip. Be careful not to overheat any part of the area.

If a strip is burned out or fused, cut and remove the damaged strip and replace it with a wire soldered from terminal to terminal on the board.

A printed circuit board can withstand only a limited amount of flexing. Excessive flexing results in a broken board, which must then be replaced. When working on a board which is still mounted in its normal location, never use pressure. When the board is removed from its mounting, use the jig described earlier, and never use pressure.

After repairs are completed, thoroughly clean the board, restore the protective coating, and allow to dry thoroughly before reinstalling or applying power to the circuit.

Removal of transistors, tube sockets, or other parts from a printed circuit board often requires the simultaneous movement of several soldered connections. For this purpose use the pencil type soldering iron and special tips when possible. Remove excess solder from each connection, using a scribe or needle probe to scrape away the solder. Do not rock or pry the part to loosen the connection–rocking may damage the board. When all connections are free, simply lift the part.

To install the replacement part, solder each connection separately, in turn.

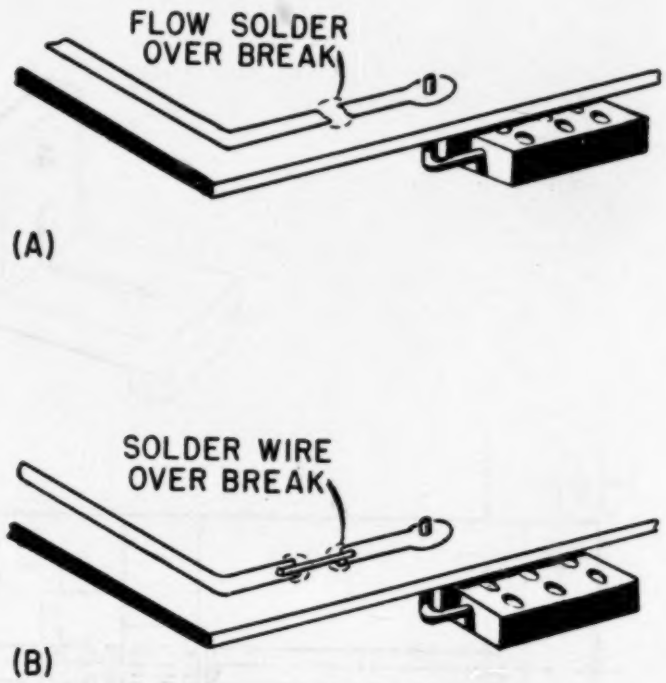

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Figure 13-7.–Repairing breaks in foil.

SEMICONDUCTORS

Transistors, unlike vacuum tubes, are very rugged in that they can tolerate vibration and a rather large degree of shock. Under normal operating conditions they will give dependable service over a long period of time. However, transistors are subject to failure when subjected to even minor overloads. Crystal detectors are also subject to failure or deterioration when subjected to electrical overloads; in addition they will deteriorate from long periods of normal use.

In order to determine the condition of semiconductors, various test methods can be used. In many cases it is possible to substitute a transistor known to be good for a questionable one; and thus determine the condition of a suspected transistor. This method of test is highly accurate and sometimes expeditious. However, indiscriminate substitution of semiconductors in critical circuits is to be avoided. When transistors are soldered into equipment, substitution becomes impracticable; it is generally desirable to test these transistors in their circuits.

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Since certain fundamental characteristics are an indication of the condition of semiconductors, test equipment is available for determining these characteristics with the semiconductor both in and out of their circuits. Crystal-rectifier testers normally test only the forward and reverse current ratio of the crystal. Transistor testers are capable of measuring several characteristics, such as the leakage current (I_{CO}), the current gain (beta), and the four-terminal network parameters. The most useful characteristic for test purposes is determined by the type of circuit in which the transistor will be used. The beta measurement is preferred for a-c amplifiers or oscillator applications. For switching-circuit applications, a direct-current measurement may be more useful.

Semiconductor Designation

Semiconductors are designated by the use of number and letter combinations that have been accepted as standard. The first number indicates the number of junctions and the letter "N" indicates a semiconductor. The number following the letter indicates the registration order. An example is the 1N21B. The "1" preceeding the "N" indicates a diode. The "N" indicates a semiconductor. The 21B indicates the 21st registration and the "B" indicates a modification of a 1N21A semiconductor.

Transistors also are identified by the number-letter-number sequence, that is, a 2N130 would be a triode transistor, registration number 130. Even though the above information is considered to be standard, different manufactures will sometimes use their own numbering system.

Semiconductor Basing and Basing Diagrams

Diodes have only two leads and a dot or color indicates the cathode terminal. Transistor leads generally have a color dot to indicate the collector lead or the collector is spaced farther from the other leads. The lead farthest from the collector, in line, is usually the emitter and the base lead is between the collector and emitter leads. This is shown in figure 13-8 (A). When the leads are evenly spaced, a red dot indicates the collector, as shown in figure 13-8 (B). If the base is circular, a red line indicates the collector and the emitter lead is the shortest lead. This is shown in figure 13-8 (C). In figure 13-8 (D), the triangular arrangement is off-set and the lead opposite the blank quadrant is the base lead. The collector is the first lead clockwise from the base. In power transistors, the collector lead is usually connected to the mounting base and the emitter lead will be identified by a color, as shown in figure 13-8 (E). One method of identifying leads of tetrode type transistors is shown in figure 13-8 (F).

Whenever a doubt exists regarding a particular type of semiconductor, a transistor manual or manufacturer's specification sheet should always be consulted.

SEMICONDUCTOR MEASUREMENTS

Because of the reliability of semiconductor devices, servicing techniques developed for transistorized equipment differ from those normally used for vacuum tube circuits. Vacuum tubes are usually considered to be the circuit component most susceptible to failure, and are therefore, normally the first components to be tested. Transistors are capable of operating in excess of 30,000 hours at maximum rating without appreciable degradation, and are often soldered into the equipment in the same manner as resistors and capacitors.

Substitution Test

Substitution of a crystal diode or transistor, known to be in good condition is a simple method of determining the quality of a questionable semiconductor device. This technique should be used only after voltage and resistance measurements are made to insure that there is no circuit defect that might damage the substituted semiconductor device. If more than one defective semiconductor is present in the equipment section where trouble has been localized, this method becomes cumbersome, since several semiconductors may have to be replaced before the trouble is corrected. To determine which stage failed and which semiconductors are not defective, all of the removed semiconductors must be tested. This can be accomplished by observing whether the equipment operates cor-

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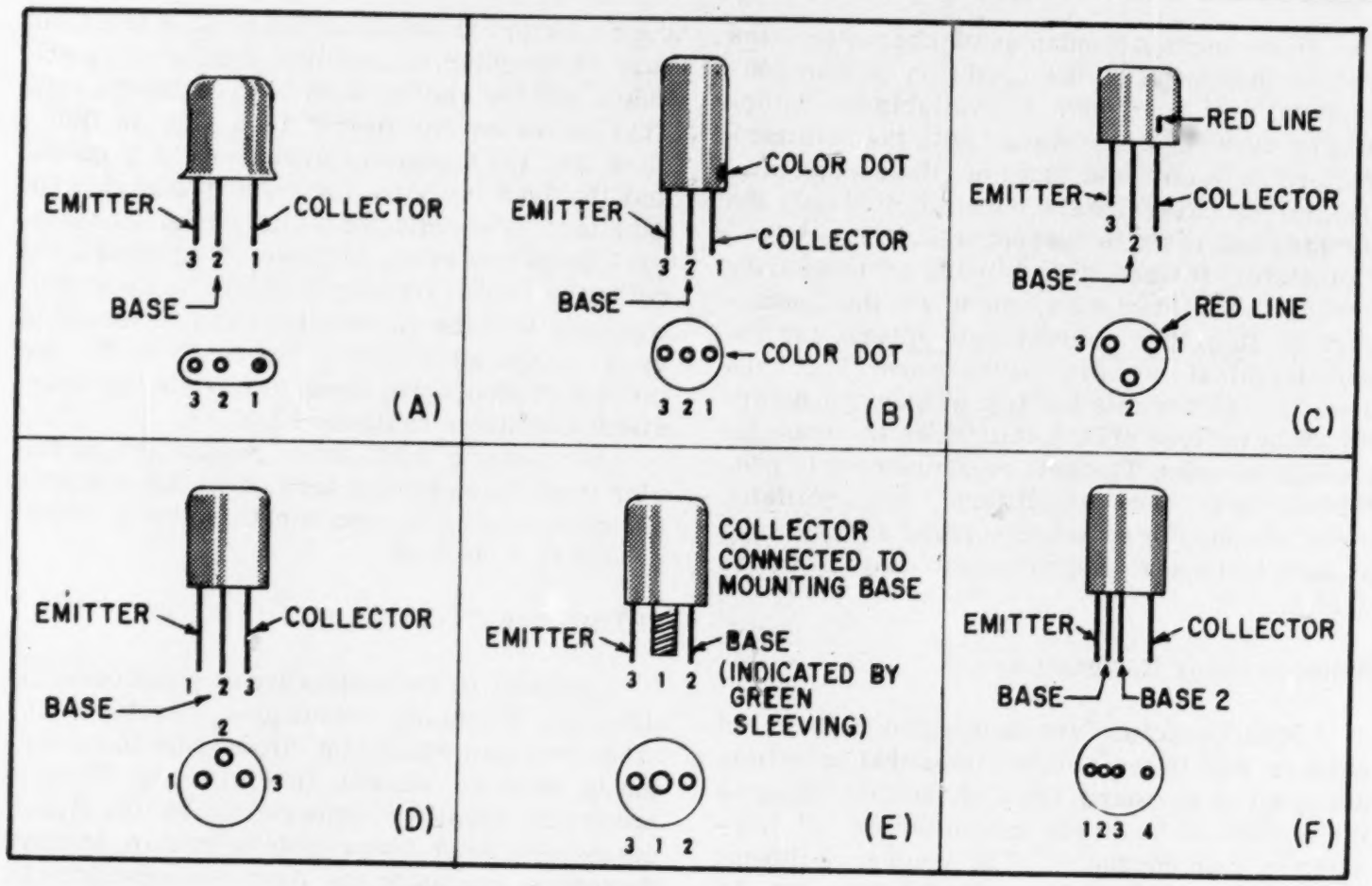

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Figure 13-8.–Transistor lead identification.

rectly as each of the removed semiconductor devices is reinserted into the equipment.

TRANSISTOR MEASUREMENTS

When trouble occurs in transistorized equipment, power supply voltage measurement, waveform checks, signal substitution or tracing methods are normally the first tests made. If a faulty stage is isolated by one of these test methods, voltage, resistance, and current measurements can be made to locate the defective part. When making these measurements care must be taken to make certain that the voltmeter resistance is high enough to have no appreciable effect upon the voltage being measured, and that the current from the ohmmeter will not damage the transistor. If the transistors are not soldered into the equipment, it is usually advisable to remove the transistors from their sockets during resistance tests. Transistors should be removed from or reinserted into their sockets only after power has been removed from the stage, since damage by surge current may otherwise result.

Transistor circuits other than pulse and power amplifier stages are usually biased so that the emitter current is in the vicinity of 0.5 to 3 milliamperes and the collector voltage is 3 to 15 volts. The emitter current can be measured by opening the emitter connector and inserting a milliammeter. When making this measurement, some change in bias should be expected due to the meter resistance. The collector current can often be determined by measuring the voltage drop across a resistor in the collector circuit and calculating the current by ohms law. If the transistor itself is suspected, it can be tested by the method described previously.

Resistance Test

An ohmmeter can be used to test transistors by measuring the emitter-collector, base-

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emitter, and base-collector forward and back resistances. Check the ohmmeter handbook to determine the polarity of the test leads. Some models apply reverse voltage from the internal battery.

CAUTION: Any ohmmeter used which is capable of delivering current in excess of 1 millampere may damage the transistor. USE ONLY AN APPROVED TYPE OHMMETER.

A back-to-forward resistance ratio on the order of 500 to 1 should be obtained for the collector-to-base and emitter-to-base measurements. The forward and back resistances between the emitter and collector should be nearly equal. All three measurements should be made for each transistor tested, since experience has shown that transistors can develop shorts between the collector and emitter and still have good forward and back resistance for the other two measurements.

Because of shunting resistances in transistor circuits, it will normally be necessary to disconnect at least two transistor leads from the associated circuit for this test. Caution must be exercised during this test to make certain that current during the forward resistance tests does not exceed the rating of the transistor.

HANDLING TRANSISTORS

Transistors, although generally more rugged mechanically than vacuum tubes, are susceptible to damage by excessive heat and electrical overload. The following precautions should be taken in servicing transistorized equipment:

1. Test equipment and soldering irons must be checked to insure that there is no leakage current from the power source. If leakage current is detected isolation transformers must be used.

2. Ohmmeter ranges which require a current of more than 1 milliampere in the test circuit should not be used for testing transistors.

3. Battery eliminators should not be used to furnish power for transistor equipment because they have poor voltage regulation and, possible, high ripple voltage.

4. The heat applied to a transistor, when soldered connections are required, should be kept to a minimum by using a low-wattage soldering iron and heat shunts, such as long-nose pliers, on the transistor leads between the iron and the transistor.

5. All circuits should be checked for defects before a transistor is replaced.

6. The power should be removed from the equipment before replacing a transistor or other circuit part.

7. When working on equipment with closely spaced parts, conventional test probes are often the cause of accidental short circuits between adjacent terminals. Momentary short circuits, which rarely damage a vacuum tube, may ruin a transistor. To avoid accidental shorts the test probes can be covered with insulation for all but a very short length of the tips.

SERVICING SEMICONDUCTOR CIRCUITS

Most new circuit design is based on the use of semiconductors. While some devices operate safely at high temperatures, the majority of transistors and crystal diodes in present use are particularly sensitive to temperature.

When transistors are mounted in sockets, they should be removed from the sockets before beginning any soldering operations on the terminals. Some transistors and most crystal diodes in printed circuits, however, are soldered directly in place. All connections must be desoldered before the semiconductor can be removed. Semiconductors cannot safely withstand the heat produced even with the pencil soldering iron. It is necessary, therefore, to use a heat shunt.

The soldering gun should not be used to solder or desolder semiconductor components in equipment. The strong electromagnetic field produced by the gun may cause induced currents great enough to damage the component.

Even conventional irons should be grounded to the chassis of transistorized equipment under repair, as mentioned previously, to prevent damage from accumulated electrical charges.

Semiconductors and many other miniature components are extremely susceptible to damage from electrical overloads. The maximum ratings for components are usually given in the technical manuals and in the charts and tables supplied for each equipment or major component. These ratings should not be exceeded.

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Transistors and similar components require various power supply connections. When preparing a unit for operation on the test bench or in a breadboard type hookup, check the voltages and their polarities against the tables and drawings before activating the power. When using an ohmmeter for continuity testing, check the range and short circuit current rating of the meter before attaching it to the transistor.

Reversing the plate voltage on a triode vacuum tube will generally keep the tube from operating, but will normally not damage the tube. Semiconductors, however, are polarity-sensitive. Reversing the collector voltage polarity of a transistor or other semiconductor may ruin it instantly and permanently.

Leakage current from test equipment to the modular unit can also destroy transistors and other semiconductors. To prevent this, the use of an insolation transformer is recommended for those test sets which do not operate with transformer supplies to produce their operating voltages. In any event, the use of a grounding strap is recommended for all test equipments and instruments used in servicing or testing these circuits. The ground should be connected first to the module chassis, then to the test equipment ground post or chassis.

High magnitude pulses will also destroy transistors. Test equipment should be connected with minimum output or maximum attenuation settings, and gradually adjusted to the desired level.

TERMINAL BOARDS

It is often possible to replace a defective resistor or capacitor without removing the board from the chassis. If the leads extending from the defective component are long enough for a replacement part to be soldered to them, they may be cut where they enter the defective component. If the leads are not long enough, it is possible to get extra length by the method shown in figure 13-9. Cut the part in half and crush each half to take advantage of the lead length within the part. Make a hook in the remaining length of lead, then connect the new part.

When any soldering operation is necessary, use the pencil iron and its special tips, or the improvised tips described previously, with a ground lead connected from the tip of the soldering iron to the chassis of the part. Usually it is more convenient, and it is always safer, to completely remove the module and work on an insulated surface, using a jig.

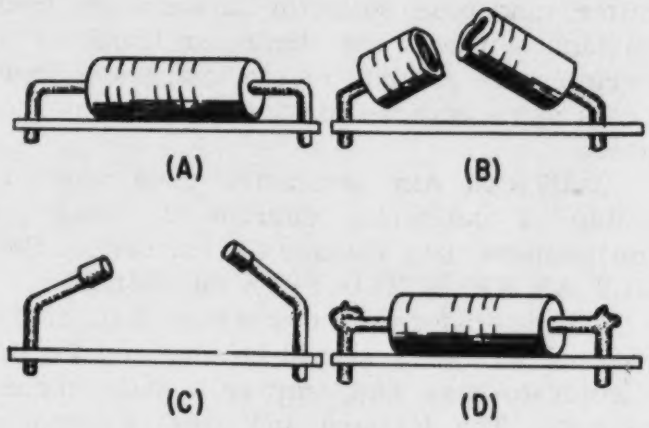

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Figure 13-9.–Replacing resistor.

Any part to be removed should never be pried or forced loose. Any attempt to force a part loose may result in a broken or separated printed circuit panel. If the terminals do not pass easily through their holes, chances are that all the solder has not been removed. If any solder is left in the terminal hole after removing the leads, apply the soldering iron to the hole just long enough to soften the solder, and then gently poke the softened solder out with a toothpick, scribe, or small brush; or if necessary use a pin vise and drill.

RESISTORS

When a resistor must be replaced, one of the important considerations in selecting the replacement is the wattage value. In general, the wattage rating is a measure of the ability of the resistor to dissipate heat, and the value is related to the physical size of the resistor.

The selection of a safe wattage value is based on a consideration of the working conditions of the resistor in the circuit. Consider as an example the replacement of an 850-ohm resistor with one of equal ohmic value but which has a tolerance of ±20 percent. Suppose the normal voltage existing across the resistor is 40 volts. Because of the 20 percent tolerance, the actual resistance of the replacement may be as much as 1,020 ohms or as little as

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680 ohms. Taking the lesser value (the more unfavorable from a heat-dissipating standpoint), the power that may be developed in the resistor under circuit conditions is found as follows:

$$W = \frac{E^2}{R}$$

$$W = \frac{40 \times 40}{680}$$

W = 2.35 watts, approximately

A resistor should be capable of dissipating from 1.5 to 2 times the power actually encountered, to allow sufficient margin of safety. In the example, this value is not more than 4.7 watts. Since a 5-watt resistor is the next standard size above the 4.7-watt value, this is a desirable wattage rating for the replacement.

Under emergency conditions, it is sometimes necessary to combine resistors in series or in parallel to obtain a desired resistance value. When this is done, care should be taken to avoid a voltage distribution (or current distribution) which causes any low-wattage resistor in the combination to dissipate an excessive amount of heat. For example, suppose two 10-watt resistors of 1-ohm value were combined in series with a 2-watt resistor of 10 ohms. The total wattage dissipated when the series combination is connected across 12 volts is 12 watts. But the power dissipated by the 10-ohm, 2-watt resistor is 10 watts, a value far in excess of its capabilities. It is necessary to consider each resistor in the combination and select a wattage value based on the voltage developed across the individual unit.

AIRCRAFT AND EQUIPMENT WIRING

Wiring in aircraft normally runs from point to point, or plug to plug, without interruption (no splices). However, there are methods of splicing wires in aircraft that are acceptable as permanent splices.

Wiring in aircraft is identified by a system of numbers and letters stamped on each wire, as described in chapter 4 of this manual. The Service Instruction Manual and the Maintenance Instructions Manual give the number of each wire involved in cabling of electronic equipment. Should it become necessary to trace and repair a wire in the aircraft, refer to these manuals to determine the routing of the wire involved.

Wiring data for all electrical and electronic systems in each model aircraft are contained in the Wiring Data section of the applicable Maintenance Instructions Manual. The diagrams are prepared separately for each circuit and provide all data necessary to understand the construction of each circuit, to trace each circuit within the system, to make continuity and resistance checks, and to perform specific troubleshooting on inoperative or malfunctioning circuits. Schematic diagrams for circuits and related components are found in those volumes of the Maintenance Instructions Manuals specifically covering a system or systems.

An excellent source of information in connection with power distribution and aircraft wiring is Installation Practices for Aircraft Electric and Electronic Wiring, NavWeps 01-1A-505. This manual presents the recommended practices and techniques to be used for installing, repairing, and maintaining aircraft electric wiring. It includes information under the following headings: Wire and cable preparation; general-purpose connectors; RF connectors and cabling; solderless terminations and splicings; thermocouple wire soldering and installation; bonding and grounding; bus bar preparation; conduit fabrication; installation of bus bars, conduit, junction boxes, protective devices, and terminal strips; electrical wiring installation; lacing and tying; safety wiring; and emergency repairs. This information is summarized in the following paragraphs. Refer to the manual for additional details.

CONNECTORS

In the discussion which follows, the word "connector" is used in a general sense. It applies equally well to connectors designated by "AN" numbers and those designated by "MS" numbers (fig. 13-10 (A)). AN numbers were formerly used for all supply items cataloged jointly by the Army and Navy. Many items, especially those of older design, continue to carry the AN designator, even though

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the supply system is shifting over to MS (Military Specification) numbers.

AN specification numbers for connectors have been generally superseded by MS numbers. However, many instances will occur in which connectors are still referred to as "AN connectors."

Inspection

Connectors are inspected when the major units that they connect are inspected. During this inspection, the mating parts of the connectors are separated and the contacts examined for corrosion. If corrosion is present, the surfaces are cleaned with a brush or clean rag and a noncorrosive solvent. The coupling ring is inspected for battered threads, and should be replaced if the threads are not in good condition. When attaching or detaching the connector, care should be taken to avoid damaging the coupling or bending the coupling nut. (See fig. 13-10(B).)

If the connector does not contain a moistureproofing compound, the conductors should be inspected where they are soldered to the pin contacts. Short circuits are often caused by a frayed strand of one conductor touching the solder cup of another conductor within the plug. If this is the case, the frayed strand may be clipped. Check to see that all soldered connections are adequate and that no cold solder joints exist.

Connectors do not require lubrication except for the coupling ring threads. Occasionally, they should be given a light coat of antiseize compound to insure smooth operation.

Maintenance

At times, operating conditions demand that ordinary electrical connectors be given a moistureproofing treatment. The basis of moistureproofing is the application of a sealing compound.

Moistureproofing reduces failure of electrical connectors and reinforces the wires at the connectors against failure caused by vibration and lateral pressure, both of which fatigue the wire at the solder cup.

The sealing compound also protects electric connectors from corrosion and contamination by excluding metallic particles, moisture, and aircraft liquids. As a result of its improved

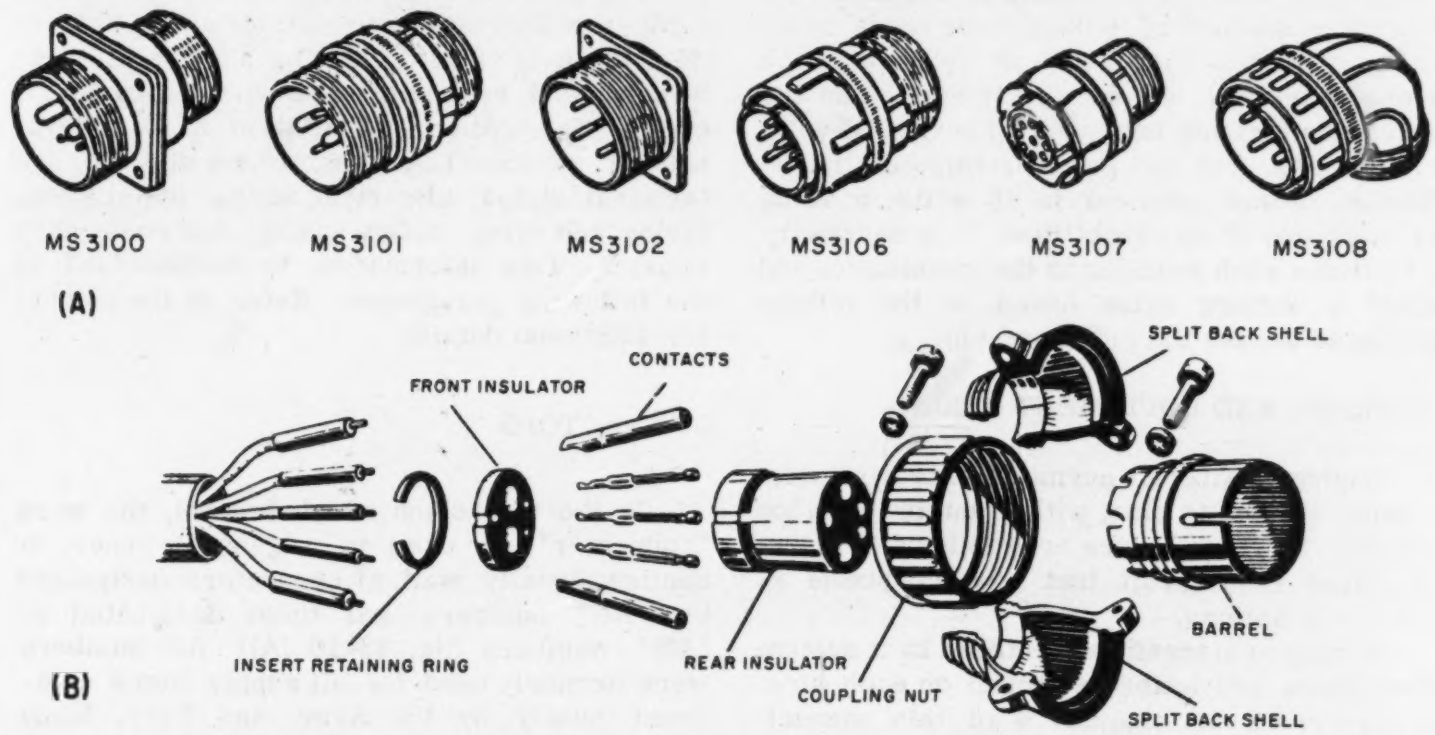

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Figure 13-10.–(A) Connector shells; (B) exploded view of a connector.

6. Cutting plane lines. - A cutting plane line indicates where one view has been "cut" in order that a sectional view may be drawn to show the shape of the object in the plane of the cut.

7. Break lines. - Break lines indicate that a portion of an object has been omitted from a drawing (Fig. 1).

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dielectric characteristics, it reduces the possibility of arc-over between pins at the back of electric connectors.

The sealant is provided in kit form through the normal supply channels. Sealing (or potting, as it is called) is not required on environment-proof E connectors or connectors located in areas where the temperature exceeds 200° F. The sealing compound deteriorates after long exposure to ambient temperature above 200° F.

The detailed instructions for performing sealing operations may be obtained from the current Electronic Material Change covering this subject. A summary of the procedures involved in sealing a connector is as follows:

1. Prepare a used connector by removing existing sealants and by cleaning. The cleaning solvent used must clean thoroughly, evaporate quickly, and leave no residue. Remove all sleeving from the wires. Resolder loose or poorly soldered connections and add a length of wire approximately 9 inches long to each unused pin. Remove any excess rosin from around the pins and the insert; a stiff bristle brush is helpful in doing this. Now, repeat the cleaning, and then separate the wires evenly.

2. Thoroughly mix the accelerator and base compound (fig. 13-11). The ratio of the amount of accelerator to the amount of base compound is critical; therefore, the entire quantity of accelerator furnished must be added to the base compound.

3. Place the plugs or receptacles on a table, arranging them so that gravity will draw the sealer to the bottom of the plug. Box receptacles or plugs without back shells must be fitted with a mold made of masking tape or cellophane tape or equivalent. (See (A) of fig. 13-12.) This will retain the sealant during the curing process. If the back shell is used, apply a slight amount of oil to the inner surfaces to prevent the compound from adhering to it.

4. The compound is applied by a spatula, putty knife, or paddle. It should be packed around the base of the pins. The part being potted should be completely filled or at least to a point to cover three-eights inch of insulated wire. The compound is now allowed to cure; temperature will affect the curing time. The normal curing time is approximately 24 hours.

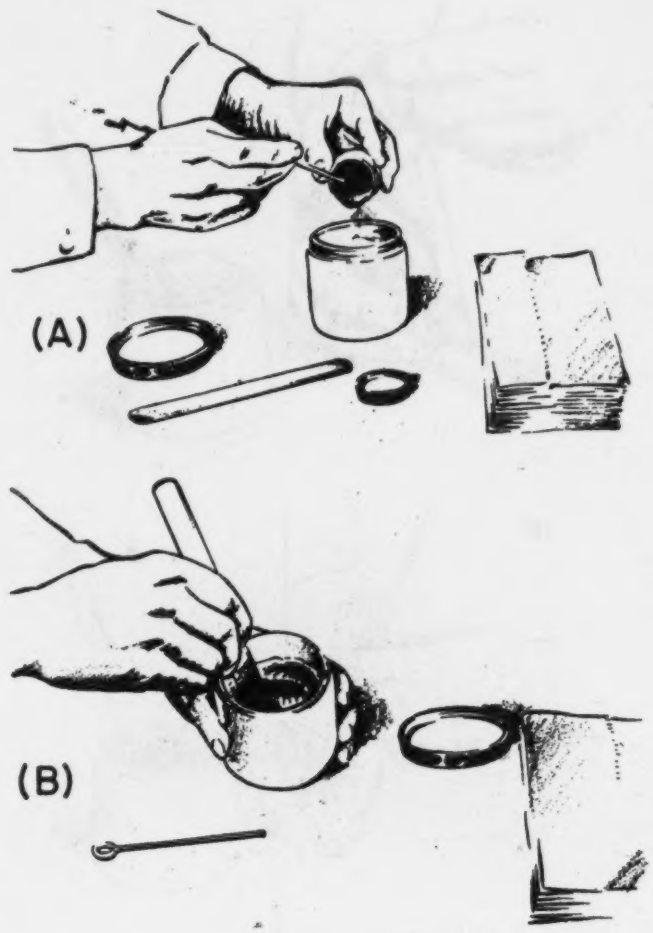

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Figure 13-11.–Combining accelerator with base compound.

If it is desired that the entire connector assembly (plug and receptacle) be sealed against fluid entering or collecting between the two parts, it is necessary that a rubber O-ring be fitted over the barrel of the plug. This will provide a seal when the two parts are engaged securely. If properly installed, this seal will prevent moist air from entering due to variations in temperature, altitude, or barometric pressure on the ground. Rubber packing O-rings are available for this purpose through normal supply channels. Due to the aging of these rings in service, it is necessary to examine them each time the connector is disassembled. If deteriorated, they must be replaced.

The purpose of soldering a short length of wire to each spare pin is to provide for two

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Figure 13-12.–(A) Making mold from masking tape; (B) finished potted plug.

eventualities: to allow for growth requiring additional circuits to be included in the connector, and to reduce the need of repairing a single wire which may have failed with the connectors by making a splice to one of the spare wires.

CONDUCTORS AND TERMINALS

Although modern technical literature has been emphasizing the use of printed circuits and microelectronic components in contemporary electronic equipment, conductors are still important as a signal- or current-carrying device. (For the purpose of this discussion the term conductor will refer to both wire and cable.) As a significant part of operating equipment, conductors deserve appropriate attention.

Wire

For wire replacement work, the Maintenance Instructions Manual for the particular aircraft or equipment should first be consulted since it normally lists the wire used. When this information cannot be obtained from the manual, the repairman must select the correct conductor needed for the job. The three major factors involved in this selection in descending order of importance, are size, insulation, and the characteristics required to satisfy specific environments in which the wire must function.

CONDUCTOR SIZE.–For d-c applications, the allowable voltage drop and current-carrying capacity govern the choice of size. At radio-frequencies, the skin effect and inductance may become a controlling factor, although generally (except in inductors or RF transformers) these parameters need not be considered. Wire size is therefore basically a function of the current or the allowable resistance, except when this results in a very small conductor size.

Small conductors are difficult to handle and are subject to breakage in soldering or due to vibration. Experience has shown that these difficulties may be avoided by using No. 22 or No. 24 AWG for general circuit wiring and at least No. 20 AWG for parallel connected tube filaments. Solid wire should be used only for short jumper connections not exceeding 3 inches in length, unless the parts being connected are solidly mounted and not subject to vibration. Clamps or "dress lugs" are recommended for long leads. In other words, the use of stranded copper wire whenever possible is strongly recommended, although under extreme conditions of vibration or where high flexibility is required, oxygen-free copper is sometimes specified. Copperclad steel is another possibility for applications requiring greater strength and rigidity.

INSULATION.–A wide variety of insulating material is available, which makes its specification particularly important. Since each insulation has its peculiar characteristics, no single type is therefore always suitable for general usage. The major insulation requirements include good dielectric strength, high

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damaged in the process. This eliminates the necessity of taping or tying an insulating sleeve over the joint.

Cable Splicing

A cable splice, other than one made with the crimp-on splice or connector, is employed as an emergency measure only. Solder may or may not be used, as the condition warrants, but in any case the splice should give a good electrical and mechanical joint without solder. The splice should be taped to give insulation equivalent to the rest of the cable. A permanent repair must be made as soon as possible.

Consult section XII of Engineering Handbook Series for Aircraft Repair, Aircraft Structural Hardware (AN 01-1A-8), and/or Installation Practices for Aircraft Electrical and Electronic Wiring, NavWeps 01-1A-505, for detailed information dealing with attaching cable terminals, forming terminals for emergency use, and repairing damaged or broken cables.

Terminal Blocks and Junction Boxes

Terminal blocks are made from an insulating material which supports and insulates a series of terminals from each other as well as from ground. They provide a means of installing terminals within junction boxes and distribution panels.

Two methods of attaching cable terminals to terminal blocks are illustrated in figure 13-14. In (A) of the figure a standard nonlocking nut is used. In this method of installation, the use of a lockwasher is necessary. The preferred method is shown in (B) of the figure. An anchor nut, or self-locking nut, is used and the lockwasher is retained for additional security. The use of anchor nuts is especially desirable in areas of high vibration. In both installations, it is required that a flat washer be employed, as shown in the drawing.

Junction boxes are installed to accommodate electrical terminals or other equipment, such as relays and transformers. Individual junction boxes are named according to their function, location, or equipment with which they are associated. Junction boxes are usually provided with a drain hole (except boxes labeled "vapor-

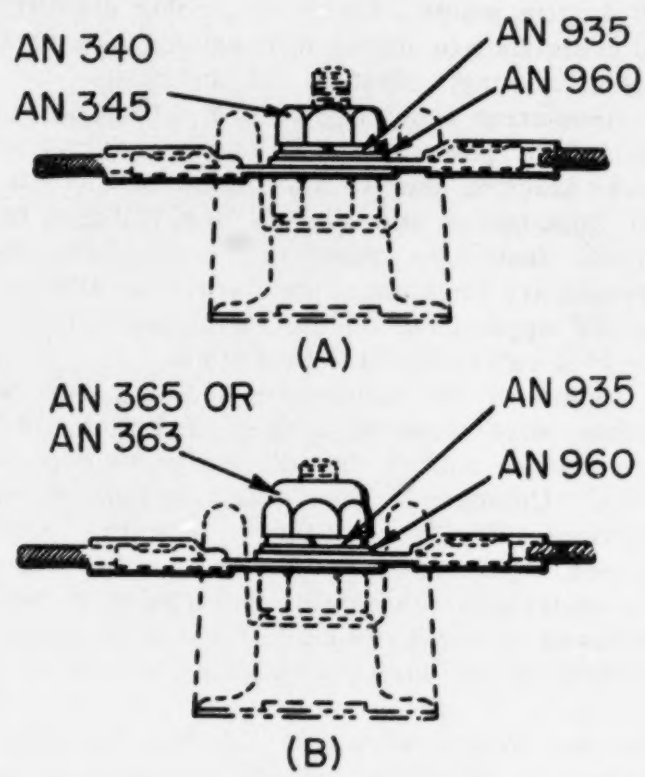

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Figure 13-14.–Installation of cable terminals on terminal block.

tight") located at the lowest point so that water, oil, condensate, or other liquids will not be trapped.

Insulating Sleeving

Insulating sleeving (commonly called "spaghetti") is used in electronic maintenance operations in many aviation activities. Among the operations involving use of the sleeving are the fabrication of cable connectors, connection to relays and terminal strips, crimped or soldered terminal lugs or splices, tie points on terminal strips or terminal boards, etc.

Support Clamps

Clamps are used to provide support for open wiring, and to serve instead of (or in addition to) lacing on open wiring. They are usually supplied with a rubber cushion. When used with shielded conduit, the clamps are of the bonded type (fig. 13-15(A)); that is, provision is made

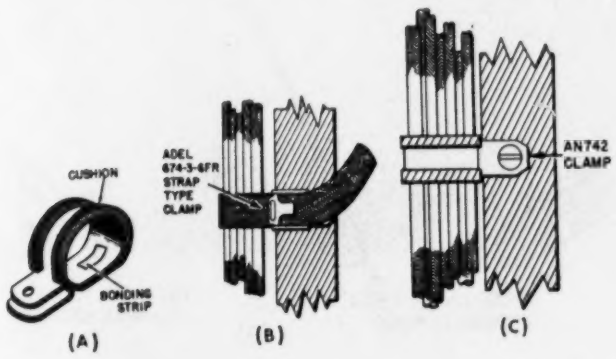

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Figure 13-15.–Cable clamps.

for electrical contact between the clamp and conduit. Unbonded clips are used for the support of open wiring.

Long runs of cable between panels are supported either by a strap type clamp, shown in (B) of figure 13-15, or by a clamp of the type shown in (C) of the same figure. The preferred method of supporting cables for all types of runs is with the type shown in (C). When the strap type clamps are used, precautions must be exercised to insure that they will hold the cables firmly away from lines, surface control cables, pulleys, and all movable parts of the aircraft; these clamps should be used only as an emergency measure.

When cables pass through lightening holes, the installation should conform to the examples shown in figure 13-16. The cable should be routed clear of the edges of the lightening hole, to avoid any possibility of chafing of the insulation.

Lacing and Tying

Wire groups and bundles are laced or tied to provide ease of installation, maintenance, and inspection. The purpose of lacing or tying is to keep all cables neatly secured in groups and thus avoid possible damage from chafing against equipment or interference with equipment operation.

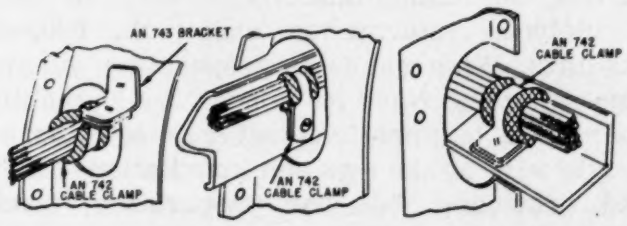

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Figure 13-16.–Routing cables through lightening holes.

TYING is the securing together of a group or bundle of wires by means of individual pieces of cord tied around the group or bundle at regular intervals. LACING is the securing together of a group or bundle of wires inside enclosures by means of a continuous piece of cord forming loops at regular intervals around the group or bundle.

A wire group is two or more wires tied or laced together to give identity to an individual system. A wire bundle is two or more wires or groups tied or laced together to facilitate maintenance.

Cotton, nylon, or Fiberglas cord is used for tying or lacing. The cotton cord must be waxed to make it moisture and fungus resisting. Nylon and Fiberglas cords are in themselves moisture and fungus resisting and are not usually waxed. Pressure sensitive vinyl electrical tape is used only where the use of tape instead of cord is specifically permitted.

When lacing or tying (fig. 13-17 and 13-18), observe the following precautions:

1. Lace or tie bundles tight enough to prevent slipping, but not so tight that the cord cuts into or deforms the insulation.

NOTE: Coaxial cables have been damaged by the use of lacing materials or by methods of lacing or tying wire bundles which cause a concentrated force on the cable insulation. Elastic lacing materials, small diameter lacing cord, and excessive tightening deform the interconductor insulation and result in short circuits or impedance changes. Avionics Bulletin No. 8 of May 1963 directs the use of the flat nylon braided waxed lacing tape (FSN 4020-730-2622-L980) for lacing or tying any wire bundles which include coaxial cables.

2. Do not place ties on that part of a wire group or bundle that is located inside a conduit.

3. Lace wire groups or bundles only when they are inside enclosures, such as junction boxes. Use double cord on groups or bundles larger than 1 inch in diameter. Use single or double cord for groups or bundles 1 inch or less in diameter.

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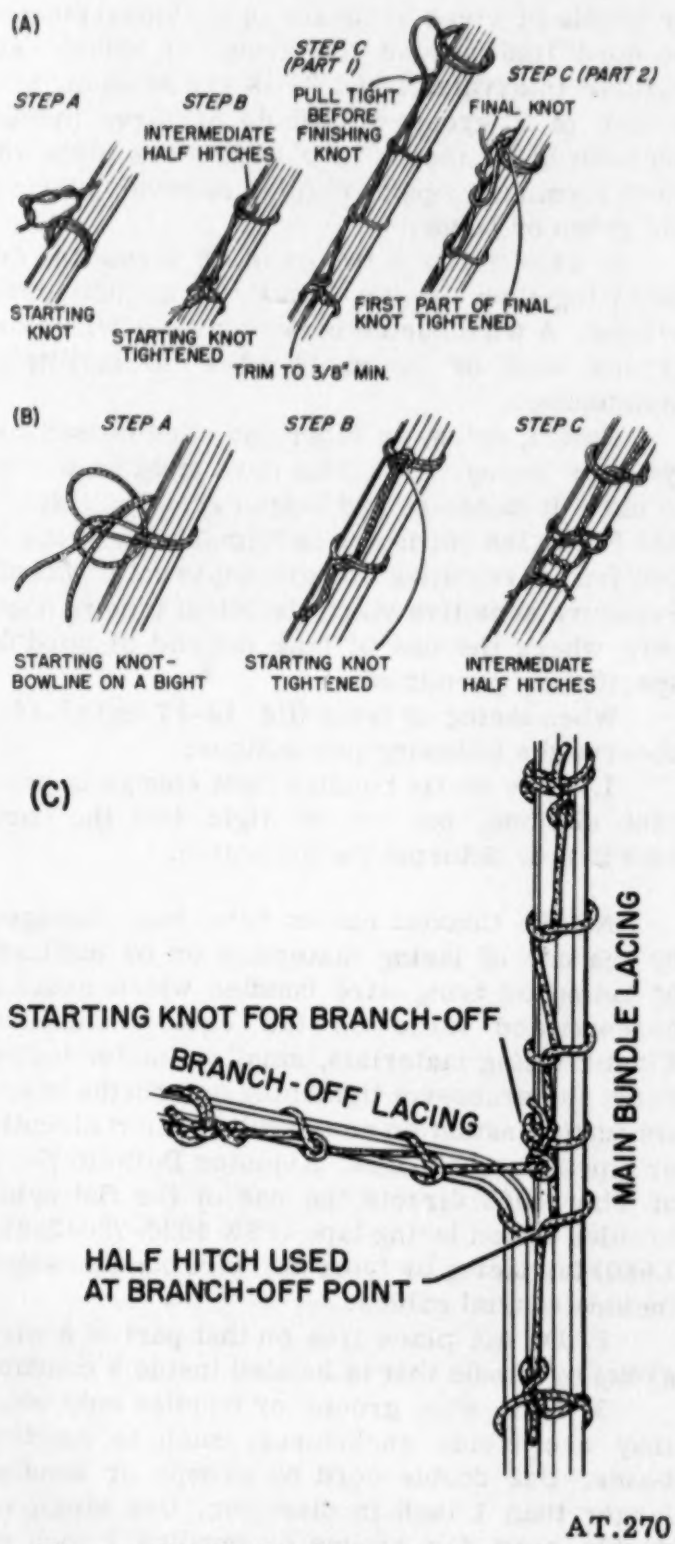

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Figure 13-17.–Lacing wire groups or bundles.

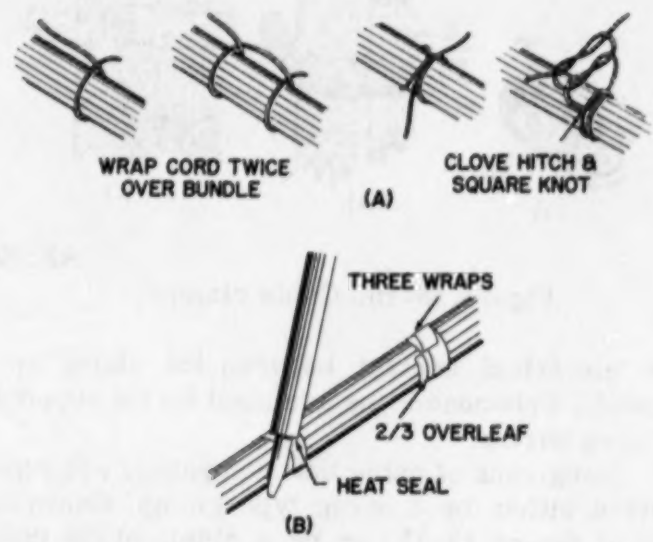

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Figure 13-18.–Tying wire groups or bundles.

In some instances groups or bundles may be secured with tape. (See fig. 13-18(B).) The following method should be employed:

1. Wrap tape around wire group or bundle three times, with a two-thirds overlap for each turn.

2. Heat-seal the loose tape end with the side of a soldering iron heating element.

Do not use tape for securing wire groups or bundles which may require frequent maintenance.

An excellent source of additional information in connection with power distribution is NavWeps 01-1A-505, Installation Practices for Aircraft Electric and Electronic Wiring. This manual presents the recommended practices and techniques to be used for installing, repairing, and maintaining aircraft electric wiring. It includes information under the following headings: Wire and cable preparation; general-purpose connectors; RF connectors and cabling; solderless terminations and splicings; thermocouple wire solderings and installation; bonding and grounding; bus bar preparation; conduit fabrication; installation of bus bars, conduit, junction boxes, protective devices, and terminal strips; electrical wiring installation; lacing and tying; safety wiring; and emergency repairs.

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BONDING

A bond is any fixed union existing between two metallic objects that results in electrical conductivity between them. Such a union results from either physical contact between conductive surfaces of the objects or from the addition of a firm electrical connection between them. Aircraft electrical bonding is the process of obtaining the necessary electrical conductivity between the component metallic parts of the aircraft. An isolated conducting part of an object is one that is physically separated by intervening insulation from the aircraft structure and from other conductors which are bonded to the structure.

A bonding connector provides the necessary electrical conductivity between metallic parts in an aircraft not in sufficient electrical contact. Examples of bonding connectors are bonding jumpers and bonding clamps. (See fig. 13-19.)

An aircraft can become highly charged with static electricity while in flight. If the aircraft is improperly bonded, all metal parts will not have the same amount of charge. A difference of potential will then exist between various metal surfaces. The neutralization of the charges flowing in paths of variable resistance, due to such causes as intermittent contact from vibration or the movement of the control surface, will produce electrical disturbances (noise) in the radio receiver. If the resistance between isolated metal surfaces is great enough, charges can accumulate until the potential difference becomes sufficiently high to cause a spark. In addition to creating radio interference, this also constitutes a fire hazard. In the case of lightning striking the aircraft, a good conducting path is necessary for the heavy current in order to minimize severe arcs and sparks which would damage the aircraft and possibly injure its occupants.

The aircraft structure is also the ground for the radio. For the radio to function properly, a proper balance must be maintained between the aircraft structure and antenna. This means the surface area of the ground must be constant. Control surfaces, for example, may at times become partially insulated from the remaining structure due to a film of lubricant on the hinges.

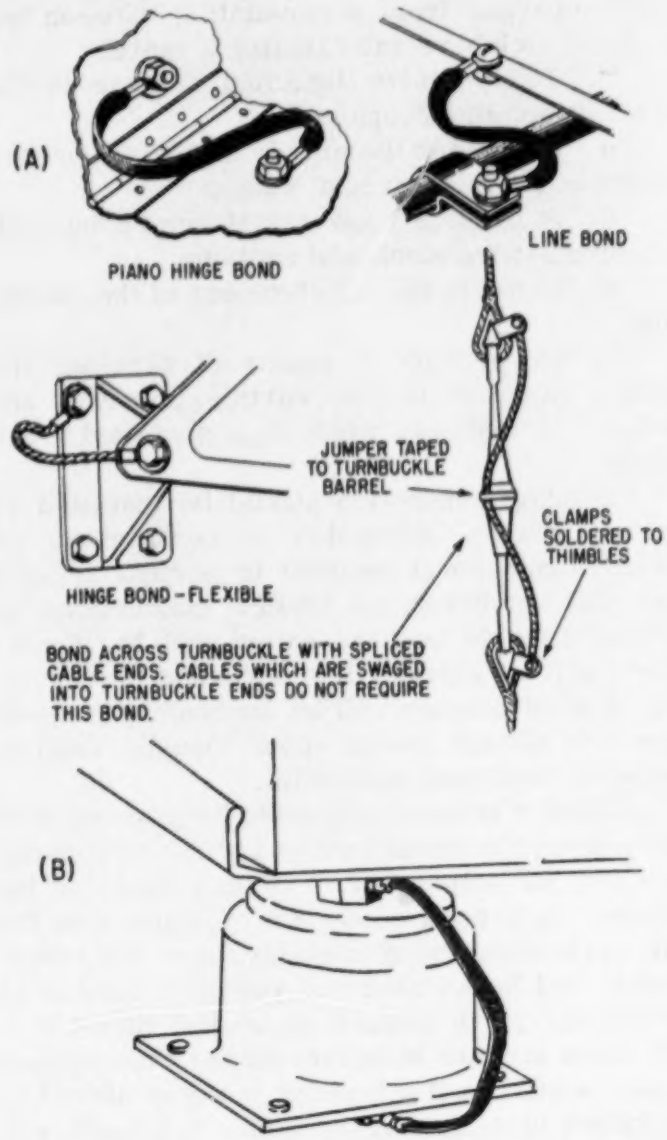

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Figure 13-19.–Bonding methods.

This would affect radio operation if the condition were not taken care of by bonding.

Bonding also provides the necessary low-resistance return path for single-wire electrical systems. This low-resistance return path also aids the effectiveness of the shielding, and provides a means of bringing the entire aircraft to the earth potential when it is grounded.

The reason for bonding may be summed up as follows:

1. To minimize radio and radar interferences by equalizing static charges that accumulate.

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2. To eliminate a fire hazard by preventing static charges from accumulating between two isolated members and creating a spark.

3. To minimize lightning damage to the aircraft and its occupants.

4. To provide the proper ground for proper functioning of the aircraft radio.

5. To provide a low-resistance return path for single-wire electrical systems.

6. To aid in the effectiveness of the shielding.

7. To provide a means of bringing the entire aircraft to the earth's potential and keeping it that way while it is grounded to the earth.

Bonding connection should be installed so that vibration, expansion or contraction, or relative movement incident to normal service use will not break the bonding connections or loosen them to such an extent that the resistance will vary during the movement. The bonding of most concern will be the bonding jumpers that are placed across shock mounts, used to support electronic equipment.

Since a primary objective for bonding is to provide an electrical path of low d-c resistance and low RF impedance, it is important that the jumper be a good conductor of ample size for the current-carrying capacity, have low resistance, and be as short as possible. Insofar as practical, parts should be bonded directly to the basic aircraft structure rather than through other bonded parts. Bonding jumpers should be installed in a manner so as not to interfere in any way with the operation of movable components of the aircraft.

Contact of dissimilar metals in the presence of an electrolyte, such as salt water, produces an electric action (battery action) which causes a pitting in one of the metals. The intensity of this electric action varies with the kinds of metals. Bonding frequently necessitates the direct contact of dissimilar metals. In such cases the metals used are of the kind that will produce a minimum of corrosion. The connections are also made so that if corrosion does occur, it will be in replaceable elements, such as jumpers, washers, or separators, rather than in the bonded or bonding members. Thus, washers made of the same material as the structural member should be used against the structural member, and washers of the same material as the bonded member should be in contact with that item.

Self-tapping screws should not be used for bonding purposes nor should jumpers be compression-fastened through plywood or other nonmetallic material. When performing a bonding operation, the contact surfaces should be cleaned of insulating finishes or surface films before assembly, and then the completed assembly refinished with a suitable protective finish.

Consult Installation Practices for Aircraft Electric and Electronic Wiring, NavWeps 01-1A-505, for more detailed information dealing with bonding.

SHOCK MOUNTS

Electronic equipment is sensitive to mechanical shock and vibration; therefore, units of electronic equipment are normally shock mounted to provide some protection against in-flight vibration and against launching and landing shock. The specific type shock mount is prescribed in the Maintenance Instructions Manual for the specific aircraft, and substitution should not be made.

Periodic inspection of shock mounts is required, and defective mounts should be replaced with the prescribed type. In the inspection, the main factors are chemical deterioration of the shock absorbing material, stiffness and resiliency of the material, and overall rigidity of the mount. If the mount is too stiff or too rigid, it may not provide adequate protection against the shock of launching and landing; if it is not stiff or rigid enough, it may permit prolonged vibration following an initial shock. When determining the limits of rigidity and resiliency, consideration must be given to the weight of the mounted unit as well as the amounts of positive and negative acceleration to which it is subjected.

Shock absorbing materials commonly used in shock mounts are usually electrical insulators. For the sake of safety, it is required that each electronic unit mounted in this manner must be electrically bonded to a structural member of the aircraft. (See fig. 13-19 (B).) The bonding strap should also be included in the inspection of the shock mounts, and defective or ineffective bonds should be replaced or reinstalled.

SAFETY WIRING

Before an installed unit can be considered secured for flight, it must be safety wired properly. Two common methods—the single twist and the double twist—are used. Figure 13-20 illustrates typical examples of each method.

Specific items which normally require safety wiring include cable connectors, drilled-head bolts or screws and nuts, thumbscrews and wingnuts on mounting racks, switchguards which are required to retain a switch in a specified position but which could be placed inadvertently into the wrong position, and most threaded items which do not use cotter pins or self-locking nuts.

The double twist method is the most common method of safety wiring, and should essentially be as shown in figure 13-20(A). The twisting may be accomplished by hand with the exception of the final few twists which should be done with pliers in order to apply tension and secure the ends of the wire properly. The safety wire should always be installed and twisted so that the loop around the head stays down and does not tend to come up over the bolthead, causing a slack loop. Extreme care must be used when twisting the wires together to insure that they are tight but not overstressed to the point where breakage will occur under slightly greater than normal load or vibration.

The single twist method of safety wiring may be used on small screws in a closely spaced area, if the screws form a closed geometrical pattern. Figure 13-20(B) illustrates a typical application where the single wire method may be used.

Finished ends of safety wire should be bent back or under to prevent injury to personnel (fig. 13-20(C)). The safety wire should be as short as practicable, and must be installed in such a manner that the pull on the wire is in the direction which tightens the movable item (fig. 13-20(D)).

When safety wiring widely spaced bolts by the double twist method, a group of three should be the maximum number in a series. When safety wiring closely spaced bolts, the number that can be safety wired by a 24-inch length of wire should be the maximum number in a series.

Torqued parts being safety wired should be torqued to recommended values and holes alined before attempting to proceed with the safetying operation. Never overtorque or loosen a torqued nut to aline safety wire holes.

Whenever a safety wire is broken for maintenance or other cause, it must be replaced using the proper procedure. Any time a required safety wire is not replaced, an in-flight failure may result.

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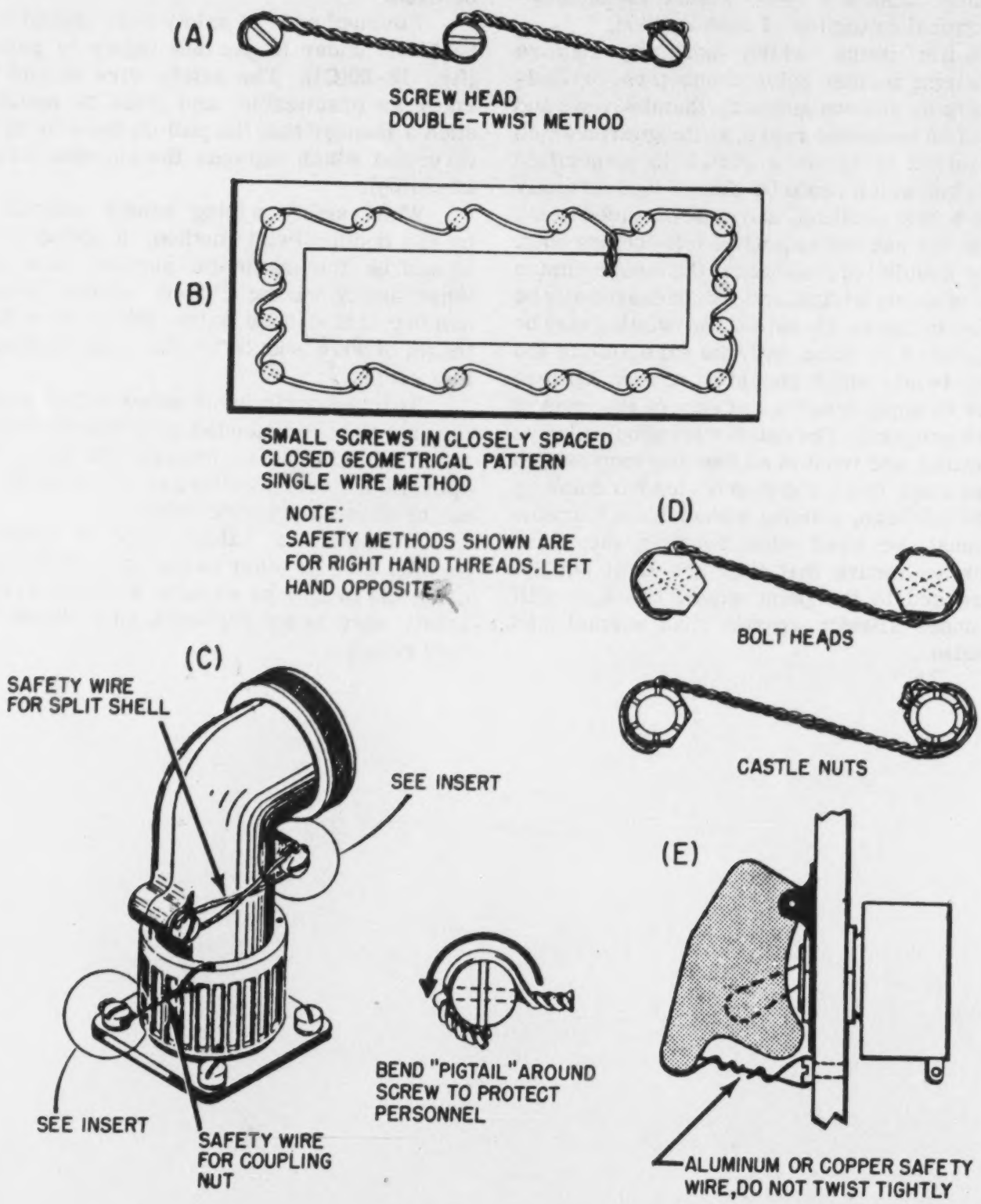

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Figure 13-20.–Safety wiring methods.

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QUESTIONS:

1. Which line is generally drawn heaviest on a drawing?
2. Which line centers or locates parts?
3. What does a line consisting of short dashes mean to you?
4. Which line terminates in an arrowhead?
5. Which line shades a portion of an object which has been cut?
6. At what angle is a section line drawn?
7. Which line indicates where one view has been cut?
8. Should dimension, extension, and section lines be drawn similar in weight?
9. Does a dimension line indicate the extent of a given dimension?
10. The center line often serves as a line from which measurements are taken. Explain.

ASSIGNMENT:

In the drawing below, identify the names of lines A through F.

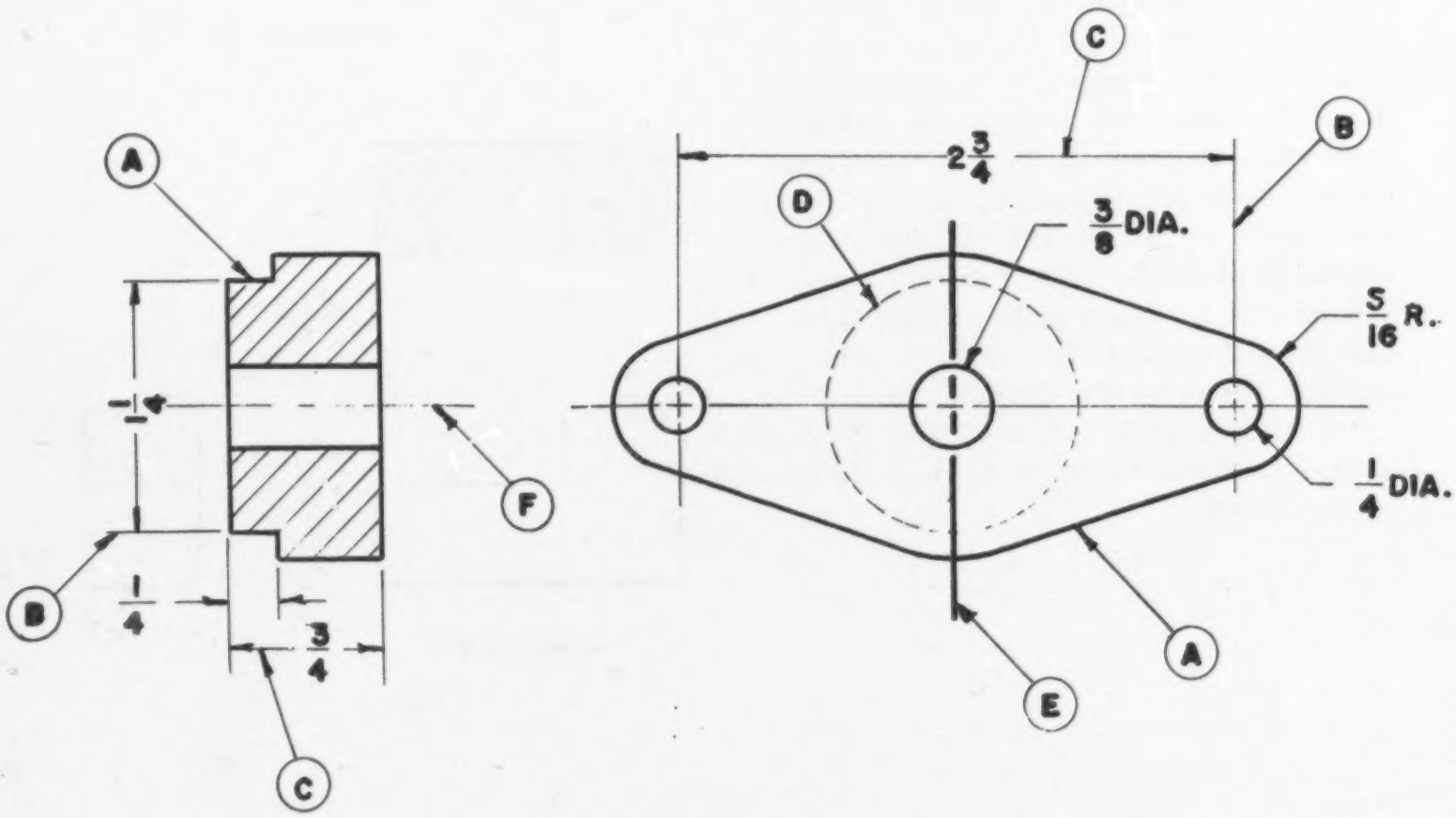

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CHAPTER 14

ELECTRONIC MAINTENANCE, PART II

ENVIRONMENTAL PROBLEMS

Although the need for reliability in military avionics equipment has remained relatively constant since the start of World War II, the difficulty of attaining this reliability has increased. The continually increasing complexity of avionics equipment and the subjection of equipment to more and more rigorous environmental conditions are among the chief causes of equipment failure. For these reasons the technician should understand the effects of environmental conditions on the equipments and the design techniques used to minimize these effects.

The environmental factors that should be understood in order to maintain the design characteristics include temperature, humidity, pressure, and abrasive conditions.

TEMPERATURE

Extensive research has been conducted to develop external component parts that are better able to withstand operation under extreme temperatures. Extremely low temperatures cause brittleness in metal and loss of flexibility of rubber, insulation, and similar materials. Extremely high temperatures may cause deformity and deterioration of these items. Most internal component parts are not able to withstand these extreme temperatures.

Because equipment is normally installed in confined spaces aboard aircraft, the generated heat causes the temperature to rise; therefore, many units have fans installed to increase the air circulation, thus reducing the temperature within the unit. Most of the new models of aircraft utilize the electronic equipment compartment concept, and use blast air from outside the aircraft or from the aircraft's air-conditioning system for cooling.

HUMIDITY

Humidity, a measure of water content in the air, is a possible cause of avionic equipment or component failure. High humidity (that is, a high water content in the air) provides a possible environment for corrosion and fungus growth. A high moisture content in the air may cause short circuiting between points of high potential.

In certain cases the removal of heat from equipment requires the use of external air. If this external air has a high moisture content, the cooling may be accomplished by one of two ways. First, the high humidity air may be directed through an air jacket which surrounds the equipment. In this case the heat is removed without allowing the humid air to come in contact with the internal equipment components. Second, when the internal equipment components require direct air for heat removal, the direct air is passed through silica-gel crystals, removing the moisture from the air. It should be apparent that the second method is less troublesome because the first case does cause corrosion within the air jacket.

PRESSURIZATION

When high-voltage avionics equipment is operated at high altitudes without being pressurized, there may be the problem of arc-over. This is caused by the reduced dielectric strength of the air as it becomes less dense. To reduce the possibility of arc-over, the equipment is pressurized.

When troubles occur in the system, a check for evidence of arc-over should be made. This may be indicated by blown fuses, charred

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insulation, and pitting of metal close to high voltages.

ABRASIVE CONDITIONS

Sand, dust, and other substances which are abrasive in nature affect many components. Generally these components are parts that are not sealed off from the atmospheric conditions. In some cases the abrasive material is formed even though the unit is sealed. Examples are generators, motors, and dynamotors which use brushes. Also the protective coating may be removed from a part by the movement of the abrasive material in the air that is used for cooling. This may allow the unprotected metal to corrode.

Modern aircraft configurations employ the use of air-conditioning systems for the purpose of cooling the avionics equipments. The external air is used to cool the heat exchanger while the internal air used to remove heat from the equipment may be pressurized. The use of the pressurized air for equipment heat removal minimizes the undesired environmental effects of temperature, humidity, arc-over, and abrasive conditions. An example of a single equipment air-conditioning system is shown in figure 16-18 of chapter 16. Multiple equipment packages utilize the air-conditioning system of the aircraft.

CORROSION CONTROL

In modern aircraft, the need for corrosion control has become a major concern in the availability and maintenance of our striking forces. This is because corrosion is something that destroys equipment and is active 24 hours a day. It is of the utmost importance that its nature be understood in order to combat corrosion.

Most of the useful metals used today have been refined from natural ores found in the earth's surface. These metals are extracted from the ore and are used in various combinations to form alloys with distinct properties. Some of these properties are light weight, strength, and resistance to extreme temperatures. These refined metals have a tendency to return to their natural state, but proper corrosion control will prevent this action taking place.

With the strength demands being made of metals, corrosion control becomes more important because corrosion weakens the metals, thereby causing structural failure. This type failure will cause aircraft safety to decrease and cost of repairs to increase.

CHEMICAL CORROSION

Most surface corrosion is chemical in nature and is generally caused by salts, acids, or gases coming in contact with the metallic surfaces of the aircraft or equipment.

Aircraft and their associated equipment which are based aboard ship are particularly vulnerable to salt spray and gases which originate on board a ship. Shore-based aircraft are also exposed to contamination, but to a somewhat lesser degree. Although salt spray and gases in the atmosphere cause rapid chemical corrosion, it should be understood that some corrosion will take place under the most ideal situations.

Chemical corrosion is a chemical process which is esentially the reverse of the process of extracting the metals from their ores. For the most part, metals occur naturally as metallic oxides. After refining, regardless of whether or not alloyed, base metals generally possess a tendency to return to their natural state. However, this is not sufficient in itself to initiate and promote this reversion. There must also exist a corrosive environment in which the significant element is oxygen. Corrosion, then, is the process of oxidation.

ELECTROCHEMICAL CORROSION

While chemical corrosion is generally readily apparent, electrochemical corrosion is insidious in its destruction. Electrochemical corrosion includes galvanic or dissimilar metals corrosion. This type of corrosion is caused by an exchange of electrons between two metallic areas of different activity (potential) by way of an electrolyte. Three conditions must be present in order for electrochemical corrosion to take place. The first condition is that two or more areas of metal are needed to act as electrodes. The second condition is the requirement of the presence of an electromotive force. The last requirement is the presence of an electrolyte to complete the formation of a cell.

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It is not necessary to know all the theories concerning electrochemical corrosion, but a brief understanding of the deterioration of metals will be beneficial in combating this type of corrosion.

An ordinary flashlight cell serves as a good subject to explain electrochemical corrosion. (See fig. 14-1.) The outside container is made of zinc and serves as the anode which is corroded as the cell is operated. The cathode of the chemical cell is the carbon electrode in the center of the cell. The moist ammonium and zinc chloride paste within the zinc container is the electrolyte which electrically connects the carbon electrode with the zinc anode.

If a conductor is connected externally to the electrodes of a cell, electrons will flow under the influence of a difference of potential across the electrodes from the zinc (-) through the external circuit to the carbon (+) returning within the electrolyte to the zinc. As the electrons flow, the zinc coating will oxidize. This oxidation is the same as corrosion. For a more detailed explanation of the operation of a cell, refer to Basic Electricity, NavPers 10086-B.

Since the only requirements for a cell are cathode, anode, and electrolyte, it should be apparent that the physical size of a cell is dependent only on the physical size of its components. A cell may be formed where a resistor lead is soldered to a terminal, two sheets of metal are joined, or around a rivet head and the adjacent metal. (See fig. 14-2 (A) and (B).) A cell may even be formed when an electrolyte is present on one piece of metal where two metallic crystals in the same alloy, but of different composition, are in electrical contact with each other. (See fig. 14-2 (C).)

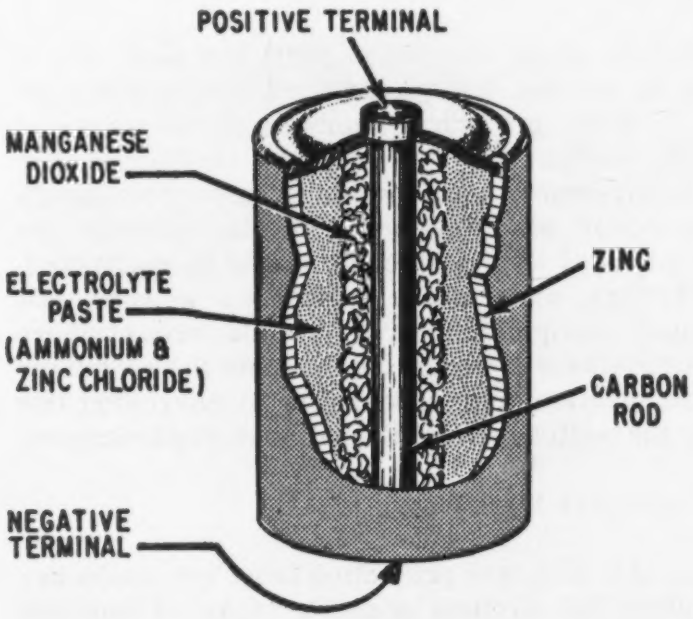

Figure 14-1.–Dry cell, cross sectional view.

While the formation of one minute cell may be insignificant, it should be understood that a cell will continue to grow as long as the corrosion action is allowed to continue. This cell expansion may take place in a short period of time and become a significant structural safety factor due to the deterioration of the metal.

It should be apparent that the presence of an electrolyte allows corrosion to take place. The more efficient the electrolyte and the greater the potential difference between anode and cathode, the higher the corrosion rate (growth) will be. It should be noted that the anode and cathode are always present and cannot be removed; therefore, the solution to the problem of corrosion is to remove the electrolyte. When the electrolyte is removed, a cell no longer exists and corrosion is held to the minimum.

Both types of corrosion normally depend on moisture to form an electrolyte. Even moisture in the air is often sufficient to start the corrosion action. All attacks of corrosion start on the surface of the metal where it is exposed to the corrosive environment; and if allowed to progress, it will work its way into the core of the material. Since corrosion never originates in the core, there is always some form of evidence of corrosion on the surface.

CORROSION PREVENTION

Now that it is understood that the "villain" of corrosion is the electrolyte, the solution to corrosion prevention is to keep any electrolyte from coming into contact with the electrodes. This is accomplished by keeping a protective coating on the metallic surfaces.

Much has been done to improve the corrosion resistance of naval aircraft. This is in the area of improvement in materials, surface treatments, insulation, and protective finishes.

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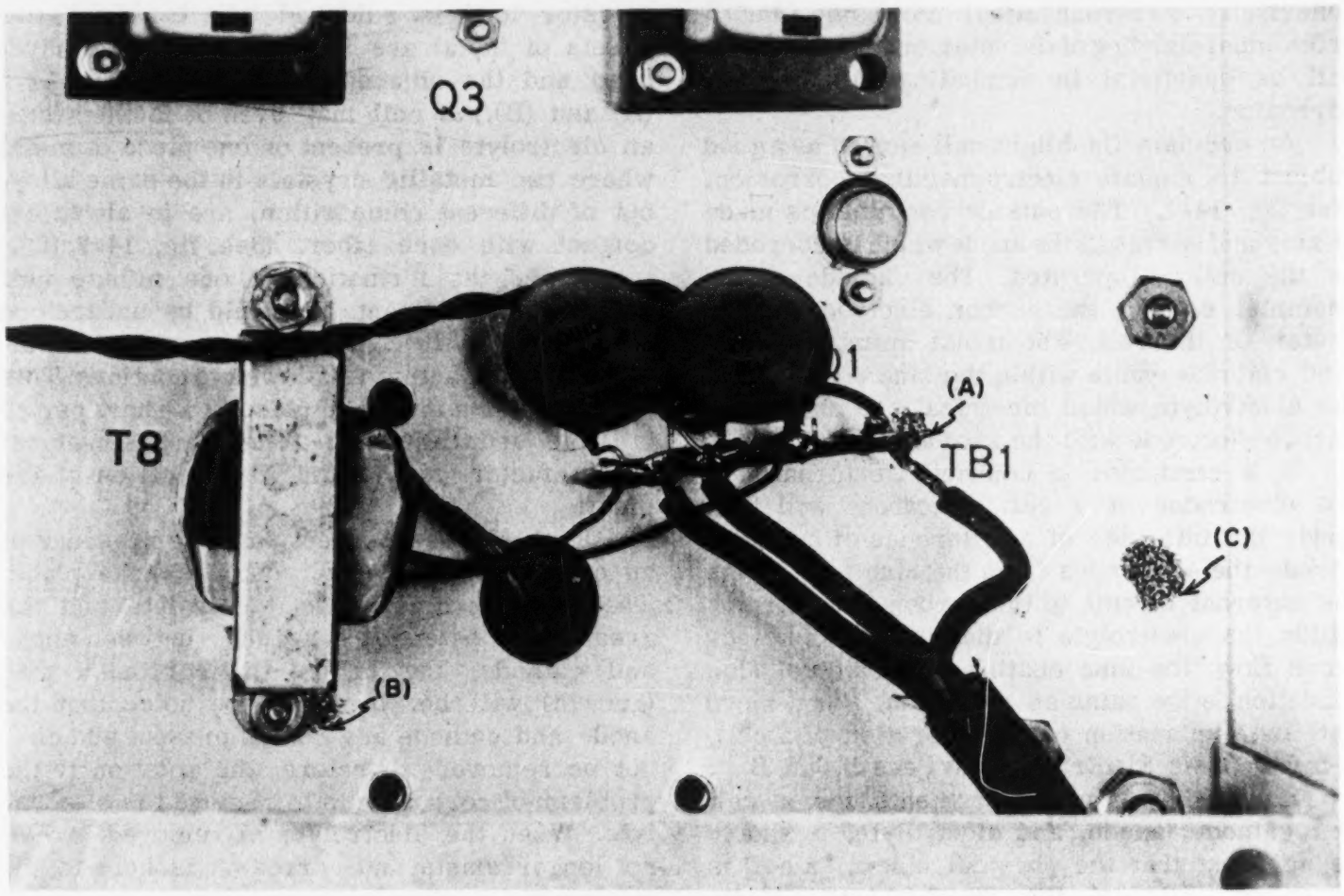

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Figure 14-2.–Electrochemical corrosion.

All of these have been aimed at reducing maintenance effort as well as improving reliability. In spite of these improvements, corrosion and its control are very real problems that require a continuous preventive maintenance program.

Corrosion preventive maintenance includes the following special functions:

1. An adequate cleaning program.
2. Thorough periodic lubrication.
3. Detailed inspection for corrosion and failure of protective systems.
4. Prompt treatment of corrosion and touchup of damaged protective coating.

Inspection

Inspection for corrosion is a continuing problem and should be handled on a day-to-day basis. Overemphasizing a particular corrosion problem when it is discovered, and then forgetting about corrosion until the next crisis, is an unsafe, costly, and troublesome practice.

Most periodic maintenance requirement information has been placed on Maintenance Requirements Cards which are complete enough to cover all equipments in the aircraft. No equipment of the aircraft should go unchecked. Through experience, it will be learned that most equipments have trouble areas where corrosion will occur. Equipments in helicopters are particularly susceptible to corrosion due to the tactics in which the helicopters participate.

Protective Measures

An effective protection from corrosion requires the earliest possible repair of damaged protective coatings, including the removal of corrosion products and the restoration of corroded surfaces. This involves the maximum use

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of supplementary protective agents during any waiting periods or until such time as more positive protection can be restored. It must be a continuous program and recognized as a specific responsibility.

Periods of neglect or touchup maintenance, which may be necessaay under operating conditions, should be followed by a period of concentrated effort to correct any deficiencies which have started. A successful preventive maintenance program will tend to reduce the effects of severe service environments and the susceptibility of most aircraft and equipment to damage by these environments.

ANTICORROSION MATERIALS.– During manufacture, electronic equipments are usually sprayed with a protective coating that seals out moisture, thus preventing corrosion and fungus growth. In repair of these equipments, it is sometimes necessary to remove the protective coating by scraping or by the use of a solvent cleaner.

After making circuit repairs, the protective coating should be replaced. Rosin fluxes form coatings on solder connections that prevent oxidation during and after the soldering process, thus providing one form of replacement. A good general rule is that materials used should be those covered and controlled by military specifications, preferably those authorized specifically for use on aircraft. Use nonspecification materials only in emergencies, or where specific instructions so direct.

FUNGUS-RESISTANT MATERIALS.–Fungus susceptibility of materials has long been a serious problem, particularly with electronic equipments which may be subjected to extremes of humidity under tropical temperatures. While the fungus itself is objectionable since it generally "fouls" all types of equipment, its most serious effect is the increased possibility of shorting and arcing because of its moisture content.

The fungus problem has been further aggravated in the past decade by the increased use of a large number of organic materials in equipment used by the Navy. These materials vary in nature and size from large sheets of reinforced plastic for structural components to special dielectric substances used in complex electronic gear.

Fungus removal generally follows the same procedures of corrosion removal.

CORROSION REMOVAL

In corrosion control, time is of the essence. Until the electrolyte is removed, the chemical reaction will continue. Although most of the electrolyte is removed, some will remain in inaccessible locations of the chassis or modules making the cleaning process particularly difficult.

When this occurs, the proper procedures and cleaning materials must be used. The remainder of this discussion will be devoted to the techniques and materials used in correcting this problem.

The extent of cleaning, using the following techniques, requires the decision of the Corrosion Control Officer assigned to the organization.

Dry Cleaning

When corrosion or salt crystals are discovered in a piece of equipment, as much of this as possible should be removed by dry methods. This entails breaking the solids from the metallic parts by wiping with a dry cloth or brushing with a stiff bristle brush. Care should be taken not to damage any of the components of the equipment.

Any loose residue should be removed by the use of low pressure dry air.

Although it may appear that all of the contamination has been removed, this generally is not the case. At this point a decision must be made as to the possibility of contamination existing in the inaccessible or undetectable areas of the equipment. If this decision indicates that contamination still remains in the equipment, then further steps must be taken in the form of liquid cleaning.

Fresh Water

Although immersion or flushing of electronic and other equipment in or with water violates previous training, fresh water is one of the agents used to remove salt water and deposits from equipments. After the equipment has been subjected to fresh water, the water

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must then be removed. This may be accomplished by dry air pressure, by the use of a spray (displacement) fluid, or by a drying oven.

DRY AIR PRESSURE.–If compressed air is not available, any type of compressor that will deliver clean dry air at 80 psi will be adequate to furnish air for spray cleaning and for blowing as much water as possible from the wet equipment before using the water-displacing fluid.

WATER-DISPLACING FLUID.–This fluid is generally available in pressurized aerosol cans or in drums and is called a spray-dry water-displacement composition. A paint spray gun or other spraying equipment for applying bulk water-displacing composition in a fine mist may be used if an aerosol-pressurized water-displacing composition is not available.

The equipment is sprayed with this composition, and then some means of drying such as heat oven, air pressure, or natural evaporation should be employed.

DRYING.–Forced draft ovens with accurate temperature control large enough to accommodate the equipment being cleaned are preferable for final drying of the cleaned equipment. If ovens are not available, a small room equipped with an exhaust fan and heaters can be used. The temperature in the drying facilities should be between 120° and 160° F, depending upon the temperature sensitivity of the equipment being dried. If a heated room is used for drying, its temperature should be at least 30° F above the ambient temperature.

Detergent

In some cases a detergent must be used. The detergent is available in aerosol type containers or in bulk form. Detergent is used because salt crystals have formed on the equipment or an oily deposit is present in the equipment. The detergent will dissolve the salt crystals and will also emulsify and suspend oil deposits in the solution. In either case, fresh water must be used to rinse the contaminated solution from the equipment.

Ultrasonic Tanks

An ultrasonic tank is a container for fresh water or a cleaning agent. The solution is vibrated either by a transducer or by forced air. The agitation helps remove particles from inaccessible areas of the electronic equipments. The frequency of the transducer is in the ultrasonic range (above 15 kilohertz) and accomplishes the cleaning in a much shorter period of time than the forced air. When equipment has been removed from an ultrasonic tank, the previously mentioned procedures for drying should be completed.

SALVAGE PROCEDURES

The following steps comprise the routine procedure for salvaging sea water contaminated electronic equipment:

1. Immediately after removal of the equipment from sea water contamination, the equipment should be flushed thoroughly with fresh water.
2. The equipment should be disassembled to units of a size that permits immersion in an ultrasonic bath and to allow better access of cleaning solutions.
3. Remove contamination with emulsion cleaning composition in the ultrasonic tank.
4. Rinse in an ultrasonic tank of fresh water or rinse with a fresh water spray.
5. Blow the rinse water from the equipment with clean compressed air and follow with an application of water displacing composition.
6. Dry in an oven or by natural evaporation.
7. Check for damage, repair and lubricate as required, then return to service.

Equipment which cannot be dismantled or is too large for cleaning in the ultrasonic tank can often be cleaned by spraying with a cleaning emulsion. Upon completion of the emulsion application, the equipment should be rinsed and dried as previously indicated.

CARE AND SERVICING

The operating quality, stability, and reliability of electronic equipment are strongly affected by the quantity and quality of maintenance. Shiny dials and polished handles may be impressive, but it is the care and upkeep of the equipment behind the front panel that determines the operational capabilities of an electronic system.

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The minimum requirements for routine care and servicing are listed in the inspection requirements for aircraft and in the technical manuals for specific equipments. The discussion in this chapter is limited to specific items that present special problems or that require special techniques.

SPECIFICATIONS AND PROCEDURES

Detailed instructions, procedures, and specifications for the care, handling, stowage, and servicing of electronic items of equipment are contained in the Operation and Service Instruction Manual for each equipment and in the Maintenance Instructions Manual for each aircraft in which that item is installed. All such procedures must be followed exactly; the specifications must be closely observed. Some components, however possess certain characteristics which warrant special discussion in this context. It must be noted that many of the considerations listed in the following discussion as applying to specific components are, in fact, general considerations which apply to many other components as well.

SPECIAL COMPONENTS

The purpose of this discussion is to provide the information needed to handle magnetrons and other electron tubes properly and to understand why careful handling is necessary. Most of the information supplied may also be applied to other items of electronic equipage.

Magnetrons

Although magnetrons are usually large and heavy, and appear to be rugged, they are actually extremely delicate items. Many of the individual parts are very delicate, and they must remain in precise alinement if the magnetron is to operate properly. Jars, jolts, and vibrations can cause misalinement and render the magnetron useless. The magnet itself, although made of solid metal, can lose its magnetic strength if improperly stowed or handled, resulting in poor performance of the magnetron.

Manufacturers of magnetrons are required to package them according to very rigid specifications. The containers are designed to give the magnetron mechanical support to prevent crushing damage, resilient support to cushion it against shocks and vibrations, and a safe minimum distance from other magnets or ferromagnetic materials. (Magnets stowed close together or close to steel shelves, bulkheads, or other ferromagnetic objects will gradually lose their magnetic strength.)

A magnetron should be retained in its original container until needed for immediate installation. It should not be removed from its carton to conserve space and weight, but should be stowed in the complete container, regardless of the weight and space factors involved.

When unpacking a magnetron for immediate installation, all parts of the container–the outer and inner casings, the support brackets and braces, the mounting hardware, the plastic covers for receptacles and mechanical connectors, the cushion materials, etc.–should be retained for packing the magnetron removed from service.

Magnetrons which have been removed from service are often returned to the manufacturer or some other activity for analysis. These magnetrons must be treated in the same manner as when new–magnetrons damaged after removal from service cannot be analyzed for the cause of original failure. The container should be plainly marked to indicate that it contains a used tube.

Whenever a used magnetron is reshipped, it must be accompanied by all papers and records pertaining to its performance history, hours of operation, and reason for removal. Such paperwork is valuable in the analysis of the failure, and results in improved reliability of magnetrons.

The ceramic window and insulator are convenient places on which to make notations. Such markings form conduction paths which can cause arc-over; therefore, notations should never be made at these locations. (If notations are deemed necessary, use a tag tied at a convenient and acceptable location, or tacked to the outer container).

Magnetrons themselves are not sensitive to either high or low temperatures. However, to avoid possible damage from freezing, liquid-cooled magnetrons must be thoroughly drained and dried before repacking and stowage. If

the coolant does not contain an antifreeze, the magnetron should be flushed with ethylene glycol or alcohol before drying in case some liquid remains trapped in the cooling jacket. These steps should be taken any time a magnetron is repackaged, whether for reshipment or for stowage.

Electron Tubes

Electron tubes are generally considered among the most essential components in electronic equipment. Many types of receiving tubes have an expected useful life of 2,000 hours or more when used within their design limitations. Some types of transmitter tubes have similar life expectancies. However, many of the tubes used in airborne military equipment are not operated within design limitations, and therefore may have somewhat shortened life expectancies. Some of the more important factors which affect the actual useful life of electron tubes are discussed briefly in the following paragraphs.

Receiving tubes used in blocking oscillators, peaking or squaring amplifiers, or similar circuits are violently overdriven. It is reasonable to expect that such treatment may shorten the operating life of such tubes. On the other hand, operating a tube well below its power rating may be expected to lengthen its useful life. Thus it may be seen that the operation of the tube in its particular circuit application helps determine its operating life expectancy.

Filament burnout may be caused by repeated sudden application of full voltage to the filament. Since the initial surge of current through the cold filament is many times the rated operating current, initial heating of the filament is non-uniform. As a result, mechanical stresses due to thermal expansion are set up; these stresses weaken the filament structure and hasten its failure. In equipments where the filament power is switched on and off, these mechanical stresses may reasonably be expected to shorten tube life. In equipments where the filaments are left on and the plate voltages are switched, tubes should last longer.

In circuits where the filaments are frequently switched on and off, the tube elements expand and contract during the process of heating and cooling. The electrodes may soon begin to lean or sag, causing excessive noise loosened or broken elements, or microphonics to develop. While testing a circuit suspected of microphonics, an indication of loose elements or microphonics may be obtained by sharply tapping the tube while in operation, and noting the effects on the output indications. If the tube has no defects, there should be no appreciable change in the output indications.

Mechanical defects and increased gas within the tube may be due to faulty construction or to subsequent physical damage. Some manufacturing defects may not be detectable by standard testing methods until tubes have been in service for some time. Physical damage to a tube is usually the result of accidental abuse. It includes such factors as breakage, bent pins, loosened or detached tube parts due to excessive vibration or shock, leakage in the glass-metal seal, application of excessive voltage, etc.

Tubes with glass envelopes provide visible evidence of open filaments, excessive plate current, gas, or arcing. Metal-encased tubes may be felt to determine whether the filament is operating.

Changes in tube characteristics occur as a natural result of aging. Decreased emission results from deterioration of the cathode surface, formation of cathode interface surface in the tube, or decreased heating effeciency of the filament. Changes in cutoff voltage and in transconductance results from changes in the alinement of tube elements. Intermittent shorts are caused mainly by foreign matter, such as lint or loosened tube parts which are free to move within the tube assembly.

It has been found that by preoperating new tubes in a test rack prior to actual use, many early failures may be eliminated. For preoperation a steady current may be passed through the tube so that the plate and screen operate between one-half and full-rated dissipation. Such preoperation reveals short time changes of tube characteristics, improper emission, inherent mechanical defects, gassy conditions, warping or sagging of grid structures, poor welds, and cracked envelopes. Tubes which survive the first 100 to 300 hours with only minor changes in characteristics are considered good risks for several thousand hours of satisfactory operation in actual equipment.

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Tube defects contribute to many equipment failures. For this reason it is good practice for the technician, when troubleshooting equipment, to immediately eliminate any tube known to be faulty. Blind replacement of good tubes by new spares, however, should be avoided. Tubes that have operated for many hours with relatively stable characteristics are more reliable than new tubes just taken out of stock. In general, it is not advisable to replace all the tubes of a group after a predetermined number of hours without regard to their condition. In fact, if the tubes have operated satisfactorily for an appreciable length of time, the intervals between testing may be lengthened. However, certain tubes are notorious for having limited operating lives; in such cases periodic changing will prevent much trouble. The transmit-receive tube used in radar equipment is a good example of a tube that should be changed at regular intervals. In all cases, however, the procedure directed by higher authority must be followed.

CRYSTAL MATCHING

Many pulsed microwave equipments require matched sets of detector crystals for satisfactory operation. The matching of crystals may be accomplished under operating conditions, without elaborate calibration procedures, using normally available test equipment. In this discussion "matching" indicates that if the same amount of pulsed RF energy is applied to two or more detector crystals, the output pulses will not vary by more than a given ratio. If a given signal produces a 0.004-volt peak-to-peak pulse from one crystal and a 0.005-volt peak-to-peak pulse from a second crystal, the ratio is 5 to 4, or 1.2. Converting this to decibels,

$$20 \log 1.2 = 20\ (0.08) = 1.6 \text{ db}$$

Thus these crystals match within 1.6 db.

A practical method which is usable is indicated in figure 14-3. It is used to measure the calibrated power (supplied by the pulsed signal generator) required to produce a prescribed output (indicated on the oscilloscope). If two crystals require -15.5 dbm and -16 dbm, respectively, to produce a 0.004-volt peak-to-peak pulse, these crystals match within 0.5 db.

The signal generator used will depend on the frequency or frequencies where matching is desired. The crystal holder, bias source, and oscilloscope used will depend upon what is available and what crystals are being matched. Figure 14-3 (B) shows a bias source which may be locally made if a ready-built one (such as the AN/USA-7 unit No. 1) is not available.

TESTING

The term testing, as used in this section, refers to the use of associated equipment to determine or to evaluate the condition or quality of operation of a unit, circuit, or component. Proper testing procedures must begin with the selection of the test equipment. This equipment must be used according to specific instructions. The testing must follow detailed procedures. The results must be evaluated in light of itemized specifications.

The following paragraphs discuss some aspects of the selection of proper test equipment, followed by some special considerations in the testing of certain circuits and components.

SELECTION OF TEST EQUIPMENT

The first requirement of any test equipment is its ability to perform the test required; secondly, it must be compatible with the equipment under test. Chapter 8 of this manual is devoted to a discussion of test equipment. The present discussion is confined to the compatibility between test equipment and the equipment under test, followed by some factors regarding the evaluation of the results of certain tests.

Impedance Matching

Closely associated with circuit loading is the idea of impedance matching. As it pertains to test equipment usage, impedance matching involves the reactive components as well as the resistive component of circuit impedance. For a maximum transfer of power the resistance of the source must equal the resistance of the load and the reactive components must cancel. However, in many testing situations this condition is undesirable.

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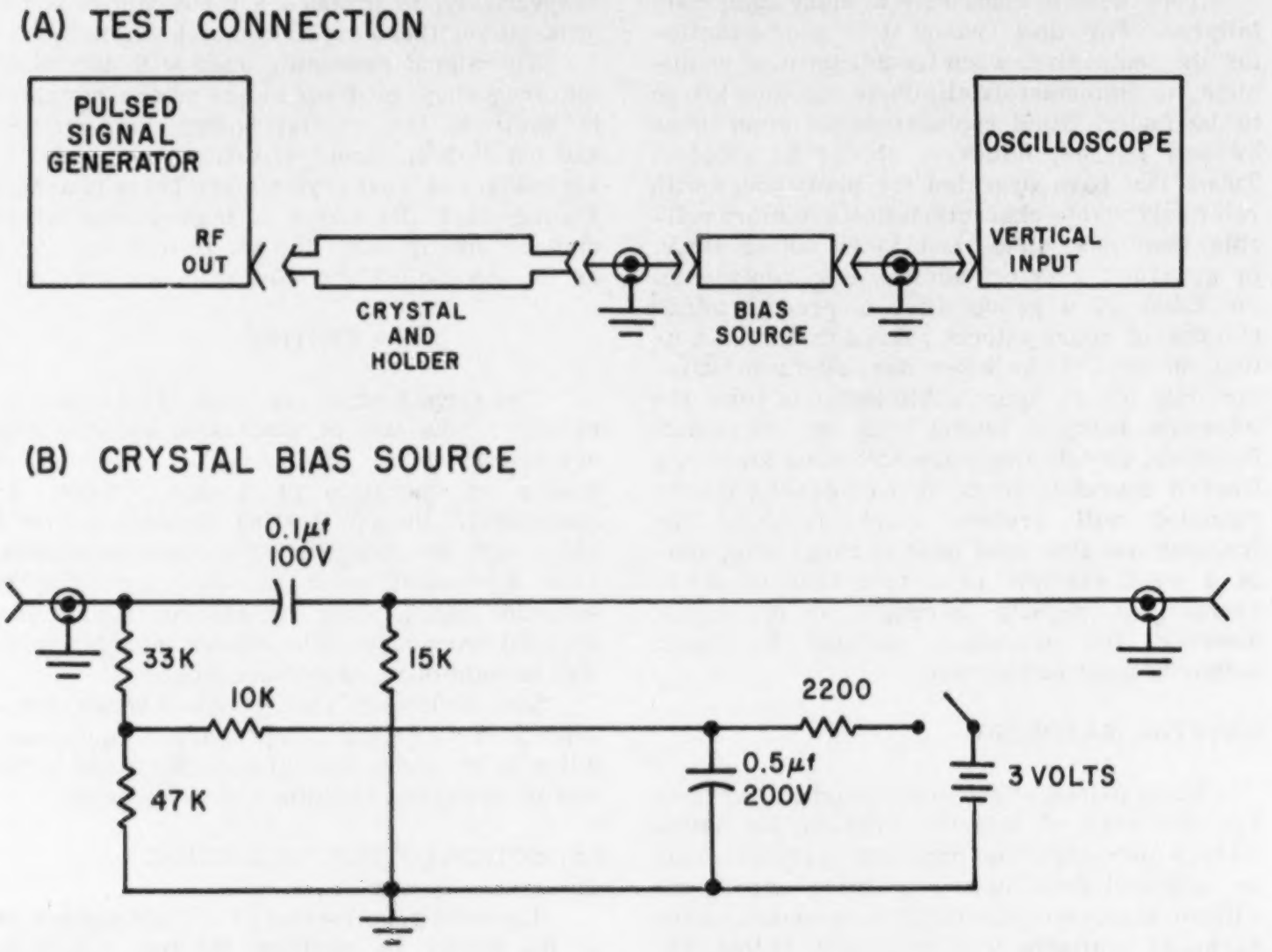

Figure 14-3.–Crystal matching procedure.

Most items of electronic and test equipment are rated according to input and/or output impedances. Coaxial cables and coaxial adapters are usually supplied with test sets normally used in testing of electronics equipment. The test procedures which govern the use of a specific equipment for a specific test on a specific equipment contain itemized lists of the items required. Use of the specified items provides adequate impedance matching.

As mentioned previously, the cables and fittings supplied with a given test set should be used with that set–substitution of cables frequently causes mismatching of impedance and results in erroneous test results.

Frequency

Another important consideration in the selection of test equipment involves the respective frequency ranges of the test set and the equipment under test. Signal generators must supply frequencies within the response band of tuned circuits; frequency meters must be responsive to the frequencies in the outputs of tuned circuits.

Amplitude

The output signal magnitude of the generator must be large enough to cause a response in

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UNIT IV - ORTHOGRAPHIC PROJECTION

Principles of Visualization Lesson 2

OBJECTIVE: To learn how to visualize objects.

RELATED INFORMATION:

If a draftsman hopes to be successful, he must be able to determine the number of views needed to produce a satisfactory and easily read drawing. This is one of his prime functions on the job. In drawing, the draftsman is confronted with objects which have three distinct types of surfaces, namely: (1) regular, (2) inclined plane, (3) curved surfaces.

We will first discuss objects which have regular surfaces. Surfaces of such objects are vertical and horizontal planes. The regular-surface object in Fig. 1 is shown as a pictorial (or 3-dimensional drawing) at the top and as an orthographic projection (or 2-dimensional drawing) underneath. Considering only the orthographic projection, the front view of the three-view drawing is the most descriptive of the object's shape. The top view is placed, or projected, directly above the front view, while the side view is directly beside the front view. This arrangement of views must always be observed for all two-dimensional drawings. The side view may be either left or right of the front view, and it is also possible in rare cases to show a bottom view directly below the front view if it is felt that this view will allow the drawing to be better visualized by the reader.

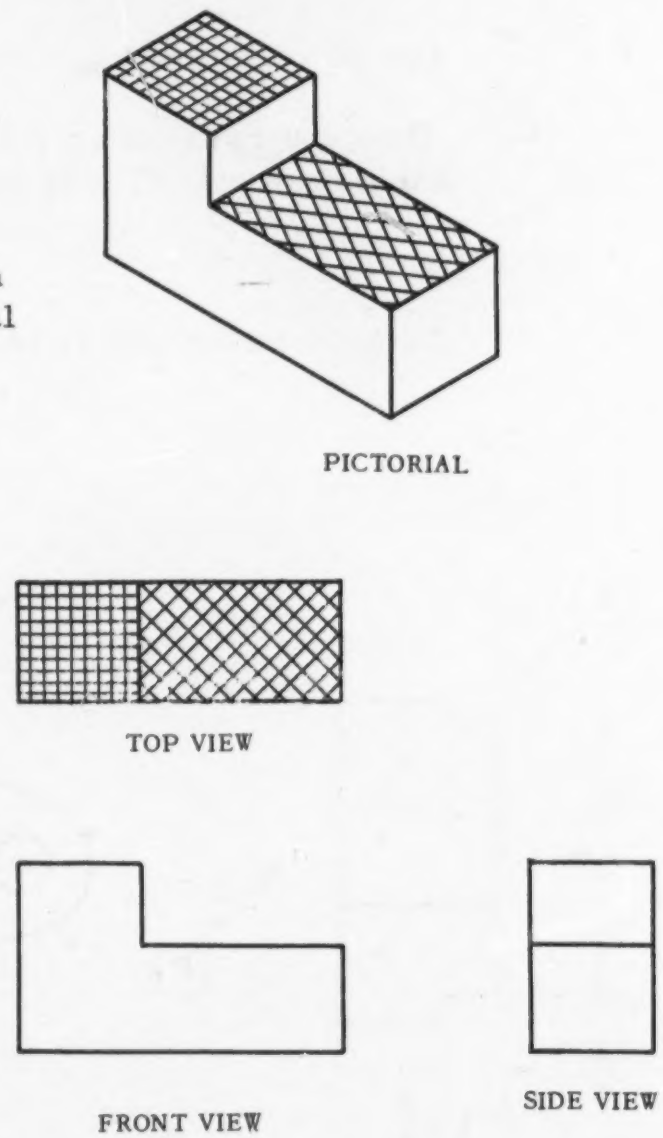

FIG. 1

the circuit under test. To test the output of that circuit, the test set must have sufficient sensitivity to respond to the signal. In either case, however, signal amplitude must not be so large that it overdrives or damages the equipment. If signals are too large, reduced coupling or increased attenuation may be used to reduce its size. This change must be considered in any evaluation of the test.

Polarity

Many nonsinusoidal signals are used in electronics equipment. Test equipment used in checking circuit operation must be capable of generating (or responding to) the proper polarity input. An example of this requirement is found in the triggering signals of radar synchronizers. Signals having the wrong polarity fail to activate the triggered circuit, and may erroneously indicate a malfunctioning circuit.

CIRCUITS AND COMPONENTS

The most frequently encountered areas of testing are concerned with tubes, tuned circuits, and power measurements.

Testing of Electron Tubes

As previously mentioned, tubes cause more than 50 percent of all electronic equipment failures. The condition of a tube can be determined by substituting a tube known to be good for the questionable one. However, indiscriminate substitution of tubes is to be avoided, as detuning of circuits may result. In addition, a tube may not operate properly in a high frequency circuit, although it performs well in a low frequency circuit. Therefore, in order to service electronic equipment, a knowledge of tube testing devices and their limitations, as well as correct interpretation of the test results obtained, is indispensable for accurate and rapid job performance.

In order to determine the condition of an electron tube, some method of testing is necessary. The operating capabilities (and design features) of a tube are shown by its electrical characteristics. A tube is tested by measuring its characteristics and comparing them with representative values established as standard for that type of tube. Tubes which read abnormally high or low with respect to the standard are subject to suspicion. Practical considerations take into account the limitations of the tube test in predicting actual tube performance in a particular circuit. For most applications the testing of a single tube characteristic is enough to determine whether a tube is performing satisfactorily.

Testing the emission characteristic of the cathode or filament is perhaps the simplest method of determining the condition of a tube. Since emission normally decreases as the tube ages, low emission is normally indicative of the end of tube serviceability. This test is subject to limitations because it tests the tube under static conditions and does not consider the actual circuit operation of the tube. Furthermore, coated cathodes or filaments may develop highly emissive spots, so that the relatively small grid area adjacent to these spots cannot control the electron stream. Under these conditions, testing the total emission may indicate the tube to be satisfactory, while in reality it is defective.

The transconductance (Gm) of a tube used in an amplifier stage is normally a more useful characteristic to measure than the emission. Transconductance is the change of plate current which results from a change in grid voltage. This characteristic, therefore, indicates the ability of the tube to amplify a-c signals. The most common military tube testers provide dynamic transconductance measurements, although some of the testers are limited to static measurements of this characteristic.

It should be kept in mind that a tube-testing device only compares the characteristic of a given tube with a standard for that particular type of tube. Since the operating conditions imposed upon a tube may vary over wide limits, it is not possible for the tube tester to evaluate a tube in terms of performance capability for all applications. Therefore, the tube tester is not always considered the final authority in deciding whether or not a tube is satisfactory. Substituting a good tube in the equipment, and observing the performance of the equipment, provides the most reliable evidence concerning the condition of the tube in question. Substitution is also the only method for testing many high power tubes used for transmitter applications.

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Nevertheless, the tube tester plays a very important function in most cases because it provides a quick and satisfactory check on tube serviceability.

Alinement of Tuned Circuits

Tuned amplifier, oscillator, detector, and filter circuits must be properly adjusted for optimum performance of communication and electronic equipment. The signal generator, in conjunction with various indicating devices, is used for most alinement procedures in receiving equipment. Transmitter oscillators can be tuned to the correct frequency by frequency measuring instruments, and transmitter amplifier stages can be adjusted by means of output meters or grid and plate current measurements. However, it is sometimes advantageous to tune transmitter amplifier stages by injecting a known signal from a signal generator in the same manner that receiver amplifier stages are tuned. The type of test equipment necessary for a particular tuning procedure is determined by frequency, power level, accuracy, allowable distortion, and modulation requirements.

The principal purpose of a signal generator is to provide a known signal with adjustable characteristics. There is need, on occasion, for square or other nonsinusoidal waveforms; however, in general, test procedures require the use of sine waves of variable frequency and amplitude.

The need for tuning electronic equipment may be indicated by reduced levels in signal outputs; however, alinement procedures should not be undertaken before general operating tests are made. Every equipment that is operating poorly requires maintenance, but it does not follow that every equipment that needs maintenance also needs alinement. Repairs which require the replacement of parts or the redressing of wiring may make subsequent alinement necessary. Therefore, no alinement should be attempted until all apparent troubles have been corrected and all defective parts replaced. Haphazard attempts at alinement by inexperienced or careless personnel may do more harm than good, and may increase the time required for making relatively minor repairs. Before alinement is attempted, all available instructions should be carefully consulted.

Power Measurement

One very common error in maintenance and in testing is the tendency to underestimate the meaning of decibel readings. As an example, test specifications for a particular portion of the testing procedure of a radar set might call for a decibel reading of 75 db. Upon performing the test in exactly the prescribed manner, it is determined that the decibel reading is 72 db. Too many technicians tend to assume that "this is good enough." It must be remembered, however, that a decrease (in power level) of 3 db represents a 50 percent reduction in power. This condition is intolerable when performing most tests.

SYSTEMS TESTING

Combinations of communication and electronic equipment and facilities are interconnected to form systems capable of performing specific functions. To meet reliability requirements and to comply with operating restrictions, technical personnel must be able to apply general test methods and practices to the installation, tuning, and maintenance of these combinations of equipment and facilities. This may entail a knowledge of many types of communication, and electronic equipment. Radar, communication and fire control equipment, when interconnected, may require different maintenance procedures than when operated separately. Revised test procedures may be necessary, any detrimental interactions between equipment or facilities must be corrected, and effective preventive maintenance must be programed for all equipment and facilities within the system. System quality figures, such as sensitivity and coverage, must be initially determined and measured during equipment preventive maintenance checks to assure efficient operation.

Receiver Sensitivity

The one measurement which provides maximum information about receiver condition in field operation is that of sensitivity. This measurement ordinarily requires the application of an input signal of variable voltage (which is accurately known by calibration) to the antenna terminals of the receiver, through an impedance which approximates that of the

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antenna with which the receiver is designed to be used. Any external impedance which is added to the signal-generator impedance to simulate the antenna impedance is usually known as a dummy antenna. It insures that the signal current in the input circuit of the receiver is the same as would appear with the known signal induced in an ideal receiving antenna, and it also insures that the input circuit of the receiver is "loaded" the same as it would be by an ideal antenna.

CONDITIONS FOR SENSITIVITY MEASUREMENT.–For measurement of sensitivity, the receiver is adjusted for the type of reception desired, and facilities such as tone controls or audio filters, AGC, silencer, noise limiter, etc., are placed in or out of operation as required or are set at appropriate control positions. The power-line voltage applied to the receiver should be well within the normal recommended operating range. The receiver output terminals should be properly loaded. At the headphone or audio-line terminals, unless otherwise specified in the instruction book for the equipment, the load should be a 600-ohm noninductive resistor (such as one of the composition type) capable of continuously dissipating the maximum receiver audio power output that can be produced at these terminals. High-impedance headphones may be used in shunt with the load for monitoring the output. Low-impedance phones may load the output appreciably and may have to be removed when data are being taken. The output voltage should be measured with a high-impedance audio voltmeter, capable of accurate indication from 0.1 volt to 100 volts, that will not appreciably load the output circuit. Although some receivers are equipped with audio-output meters, the meters provided may not indicate required standard noise levels with sufficient accuracy.

RECEIVER SENSITIVITY (AUDIO-OUTPUT) TESTS.–Receiver output power is measured, as part of a sensitivity test, to determine whether the receiver is performing according to the required sensitivity specifications. (The sensitivity is the value of signal voltage (in microvolts) fed to the antenna terminals that will produce a specified power output–usually 6 milliwatts–at the receiver output terminals with a signal-to-noise ratio of 10:1.) A simple way to check audio-power output is to use an a-c voltmeter (either a copper-oxide-rectifier type or an electronic voltmeter) across a resistor of the correct value, as specified in the instruction manual. With the signal generator delivering an input voltage to the receiver antenna terminals, the voltmeter measures the output voltage across the resistor. The power output is then computed by using the formula $P = E^2/R$.

Transmitter Power Output

Electrical power delivered to a load at any instant is equal to the product of the voltage across the load and the current passing through it, or P - EI. Under stable d-c conditions, this product is also equal to the average power consumed. In a-c circuits, on the other hand, the presence of either inductive or capacitive reactance means that the apparent power, EI, where both voltage and current are rms values, must be multiplied by a number called the power factor to obtain the true power. Briefly, this is necessary because pure inductors and capacitors store energy furnished by the line and, during a later portion of the cycle, restore such energy to the line. If purely reactive circuits were possible, none of the power would be dissipated. Naturally, resistance is an unavoidable component of any reactance, so from a strict standpoint nondissipative networks are not attainable. In practical a-c circuits, the power dissipated is equal to the apparent power multiplied by the cosine of the phase angle between the voltage and current.

Calibrated voltmeters and ammeters are used as a direct approach to power measurements in d-c circuits. Usually, approximate indications of power are satisfactory in electronic circuit work, so that neither the expense nor the inconvenience of two separate meters is justified. A typical instance is that of determining whether the power rating of a resistor is adequate. It is generally acceptable to measure the voltage across the resistor and then to calculate the power by the basic equation $P = E^2/R$. For current rather than voltage measurement, the power is equal to I^2R. If the designated resistance of the part is not sufficiently reliable, it may be measured approximately with an ohmmeter. Conceivably, an extremely accurate measurement may be

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required, in which case a determination by means of a Wheatstone bridge can be made. Similarly, it may be necessary to determine the a-c power dissipated by a resistive load, either at audiofrequency or radiofrequency. The same method is reliable, provided the resistance of the device is known at the frequency in question.

Power Supply Measurements and Adjustments

Power supplies that are commonly used in avionic equipment are either regulated or unregulated. An unregulated supply usually provides filtered but unregulated low B-plus (under 300 v d.c.) or high B-plus (over 300 v d.c.) in addition to a-c heater power for vacuum tubes and in some cases relay-operating power. The regulated power supplies consist of an unregulated supply and the associated circuitry necessary to regulate the B-plus output. Chapter 3 of Basic Electronics, NavPers 10087-B, contains a discussion of power supply operation.

Power supplies used to provide the d-c voltage sources for operation of electronic equipments are of various types, such as half-wave and full-wave rectifiers. The type circuitry employed for a particular application depends on such factors as current and voltage load requirements, available space, weight, degree of voltage regulation required, etc. Electronic systems are generally complex and contain one or more power supplies which provide several voltage outputs. The design performance of these equipments depends upon the proper operation of the power supplies. For this reason, power supply tests are included in the preventive maintenance test procedures prepared for most equipments. Many equipments are provided with easily accessible test points for ease in performing these tests. The more common type of power supply test is a simple voltage reading taken with the equipment in operation.

To operate radar equipment, various d-c voltages are required. The transmitter requires a high voltage source capable of delivering a large current for short intervals of time. The regulation or ripple content of this voltage is not critical. The cathoderay tube requires a high accelerating voltage which is usually easy to regulate because of the low current drain which results in a constant small load. The plate voltage supply for the receiver and the indicator sweep circuits require a source of good regulation and very little ripple. Voltages are also required for relays, blower motors, antenna control motors, etc. Combinations of vacuum tubes, rectifiers, vibrators, transformers, voltage dividers, etc., are used to provide these different voltages.

Power supplies of various types occur throughout the radar system because it is impractical to install all of them in a central location. Even though in some equipments the power supply may lose its identity as a separate unit, the function is still performed and must be tested and maintained at its rated performance.

Intermittent Troubles

Intermittent troubles are probably the most aggravating and irritating problem faced by the technician. The equipment always seems to be in proper operation while under observation, only to malfunction as soon as the technician turns his back. There is no single method for resolving this difficulty. The procedure to be used depends on the individual situation–the technician, the equipment, the available information, the peculiarities of the installation, etc. A thorough knowledge of the operation of the equipment, and an understanding of the most common causes of intermittent troubles should help to alleviate the suffering of the maintenance-man.

Some of the most common causes of intermittent troubles are loose vacuum tube elements, poor electrical connections, poor solder joints, leaky capacitors, arcing, broken terminal boards or printed circuit boards, fused conducting strips, and mechanical vibration. Vibration is usually associated with one or more of the others listed, either as a basic cause or as a contributing factor; therefore it should always be investigated early in the troubleshooting procedure. If the equipment seems to operate properly after a visual inspection fails to reveal the cause of the intermittent trouble, vibrate the equipment by tapping or jiggling while watching for indications of arcing, etc. If this fails to produce meaningful indications, methodical and patient troubleshooting procedures must be followed.

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MISCELLANEOUS PROBLEMS

Generally, problems of the mechanical type are caused from excessive wear or carelessness on the part of the technician.

INSTALLATION OF EQUIPMENT

Although itemized installation procedures are listed in the Maintenance Instructions Manual for each model aircraft, and in the Operation and Service Instruction Manual for electronics equipment, this phase of the maintenance process presents a great deal of trouble. Most of the troubles in this category result from carelessness and oversight on the part of the technician. Specific instances are loose cable connections, switched cable terminations, improper bonding, lack of (or improper) safety wiring, remote switches in the wrong positions, failure to perform operational check after installation, failure to pressurize specified units, etc.

Two additional points concerning installation of equipment in aircraft need emphasis. Prior to reinstalling any unit or component, inspect its mounting for proper condition of shock mounts and bonding straps. After installation, safety wire as appropriate.

DISASSEMBLY AND REASSEMBLY

Problems are encountered in the removal and replacement of units in the aircraft and the disassembly and reassembly of subunits in the shop. Some of these problems are considered in this discussion. Most of these problems are created by the technician because of either carelessness or lack of understanding on his part.

One of the problem areas is the threaded fasteners used in the mounting of parts or subunits. Broken or stripped bolts, damaged heads or threads, etc., hamper the disassembly and reassembly process. The use of the proper tools and techniques are very important in keeping this problem to a minimum.

Some units that contain autotune systems that mechanically tune more than one subunit are a problem if these subunits are not properly alined mechanically before insertion into the autotune mechanism. If these subunits have mechanical stops and are inserted into the autotune system improperly, they can be damaged.

Pin or plug alinement before insertion into its mate is necessary if damage is to be prevented. Some of these pins are very small and delicate and will not withstand any bending or distortion without breaking. Some subunits or modules have different pin arrangements though their shell dimensions may be identical; therefore, great care must be taken to insure that the subunits or modules are installed in the proper location.

Coaxial connectors can also be a source of problems. When connecting or disconnecting these connectors, always use great care that the coaxial cable is not separated from the connector. Miniature coaxial connectors can be damaged very easily if handled roughly during connection or disconnection.

ROTATING EQUIPMENT

A great variety of rotating units are employed in naval aircraft. The electrically driven units are usually electric motors. In applications where only small movements are required, solenoids are frequently used (for example, ratchet stepping relays use solenoids).

Although the variety of rotating equipment is great, certain general maintenance procedures are common to the majority of them. Inspections are conducted on rotating equipment as a precaution against failure. Since most rotating units are installed in sections of the aircraft not accessible during flight, the first indication of trouble in many instances is complete failure. When failure occurs or when there are indications that the unit is operating improperly, remove the unit for shop inspection of bearings, commutator and sliprings, and brushes.

Bearings

Antifriction bearings are either ball or roller bearings. These, especially ball bearings, are widely used in aircraft rotating electrical machinery such as dynamotors, inverters, generators, and motor generators. In modern electrical machines, extensive use of sealed bearing assemblies is made. This makes mainte-

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nance and lubrication very easy since sealed bearings are prelubricated and require almost no attention during normal operation of the machine in which they are installed.

As a guide to proper maintenance of ball bearings in aircraft rotating equipment, the detailed recommendations of the manufacturer as given in the Service Instruction Manual should always be followed. Excessive lubrication leads to bearing trouble, and an undue amount of grease in the slipring or commutator compartment of the machine may result. Brush and slipring wear increases appreciably if a large amount of lubricant is present. Excessive lubricant should be removed with a cleaning solvent, and the bearings properly lubricated.

Commutators

The connection of the armature conductors to the individual commutator segments is made at the part of the segment referred to as the "riser." This connection is secured by use of hard solder or silver solder. Insulation of all segments from each other and from the armature shaft and core is accomplished by thin sections of mica between each segment and between the segments and the clamps which hold the segments to the shaft. The mica between the segments is cut to the same shape as the segments. That part of the mica directly under the brush is cut below the surface of the commutator bars.

When shop checking, insure that the commutator has a smooth, worn surface around the entire circumference throughout the area spanned by the brushes. It should have an even brown or chocolate color. Any dirt, oil, or grease on the commutator must be removed. Check for brush sparking as evidenced by rough and pitted commutator bars. Look for loose connections to the commutator risers. This may be indicated by specks of solder on the surrounding field coils and connections.

Should the commutator be dirty, it must be cleaned. Oil and dirt tend to glaze the surface with a high-resistance coating. Remove the brushes; blow loose dirt out with air, being careful not to blow it into the housing. Wipe oil and grease out with a lintless cloth moistened with an appropriate cleaning solution.

As the surface of the commutator gradually wears, the mica will eventually become flush with the brush surface of the segments. If this condition is not corrected by undercutting the mica, rapid brush wear is apt to result. Extreme care must be taken when undercutting to prevent the cutting tool from leaving the slot and scoring the brush surface of the commutator; also, great care must be exercised to avoid sharp edges on the commutator bars.

Brushes

The following checks should be made when checking the generator brushes and brush rigging:

1. Look for cracks in the brush holder yoke and check for tightness.
2. Check for loose screws and defective safety wires.
3. Check for loose brush holders and for dirt, grease, and oil.
4. Check for security of jumper leads between holders of like polarity.
5. Check to see that no brush holder is bent out of alinement.
6. Check for broken brush springs.
7. Check the freedom of the brush in the brush holder. The brush should not bind or drag in the holder, but neither should there be enough clearance that a sloppy fit is obtained.
8. Check all brushes for security of the pigtail to the brush and to the terminal, and see that the wire is not worn or frayed.
9. Check the brushes to see that they are not cracked or chipped. Check for pits due to sparking. Check for oil-soaked brushes. If the brush is oil soaked, it must be replaced. The oil acts as an insulator and terminal voltage is lowered.

When reinstalling the original brushes, make certain that they are replaced in their original holders; otherwise, it may be necessary to refit the brushes. When brushes are placed in their holders, the brush springs should be carefully lowered until they make contact with the brush. Never release the brush spring unless it is in contact with the brush since this allows the spring to strike the brush sharply, causing possible damage to the brush. Check for brush wear by measuring the length of the brush. It must be within the limits specified by the manufacturer.

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CAUTION: Brushes that have grease and oil on them must be replaced. They cannot be cleaned because a cleaning solvent will not remove all of the oil or grease and will change the electrical characteristics of the carbon. The brush holders and brush rigging should be cleaned before inserting the new brushes.

When it becomes necessary to install new brushes, the following procedure is recommended. Pull brush springs back only as far as necessary to allow removal of old brushes; this may be easily done by using a hook made of stiff wire. Attach brush pigtails of new brushes to proper connections and secure electrically. Insert brushes in brush holders. After the new brushes have been installed, steps must be taken to remove the old commutator film, fit the new brushes, and establish a new film.

For this purpose, a brush seater should be used. (Never use emery paper or any other kind of paper or cloth containing a metallic abrasive.)

The brush seater consists of a mildly abrasive material loosely bonded and formed in the shape of a stick about 5 inches in length. The brush seater is applied to the commutator while the machine is running, and therefore every precaution must be taken to prevent injury to the person applying it. The brush seater is applied lightly, for a second or two, exactly at the heel of each brush (fig. 14-4).

If the seater is placed even one-fourth inch away from the heel of the brush, only a small part of the abrasive will pass under the brush.

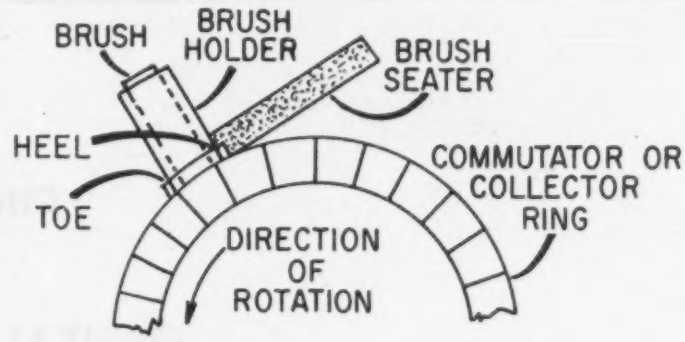

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Figure 14-4.–Using the brush seater.

Pressure is applied to the brush by setting the brush spring tension at maximum (during the seating operation) or by pressing a stick of insulating material against the brush. Dust is removed during the operation, and the machine is thoroughly cleaned afterwards.

Sliprings

Sliprings must be inspected periodically for smoothness of surface, diameter of the rings, and alinement of the rings on the shaft. The sliprings require the same careful attention as a commutator. Out-of-round conditions of the rings may be corrected in the same manner as for commutators, except for the fact that crocus cloth is used to apply a mirror-like finish following any turning or grinding operations.

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CHAPTER 15

DIGITAL COMPUTERS

Present and future technicians will be faced with a collection of electronic equipments which use computers as integral portions of the overall system. To understand the operation of the system in general, and the computer portion in particular, it is necessary to have a basic understanding of computer functions, circuitry, terminology, and applications. Basic Electronics, NavPers 10087-B, chapter 16, presents a basic coverage of the purpose, operation, and theory of computers, together with some of the terminology peculiar to them. Review and study of these basic coverages will aid in understanding the material covered in this chapter.

INTRODUCTION TO DIGITAL COMPUTERS

In the past few years, the term digital computer has appeared in Navy nomenclature. This term refers to an electromechanical device which is used in applications such as fire control, communications, and tactical data processing. Digital computers accomplish things that were impossible before, and they speed up processes which formerly required considerable time. Although the operations of computers are not new, the techniques of electronics have made possible a computer contained in a small, lightweight package which is adaptable to aircraft systems. Also, prior to the incorporation of electronics in digital computers, the great speed of operation required was impossible with purely mechanical devices.

The technician of today is faced with equipments which have the computer used as an integral part of the overall system. Therefore, the technician must have a basic understanding of computer functions, the circuitry involved, the numbering system used, and computer terminology.

The definition of a computer is: Any device capable of accepting information, applying mathematical operations to that information, and obtaining useful results of these operations. Therefore, a computer must have an input, processing, and output section.

Before any problem can be solved by a computer, the quantities involved must be expressed in terms of common units; that is, digital computation is the process in which digits alone are used to solve the problem.

Basically, the purpose of a digital computer is the same as that of any other computational aid. However, it is more accurate within practical limits of speed. Computers can perform thousands of repetitive computations involving hundreds of thousands of digits without making an error. Further, they can store millions of items of information for future use.

Digital computers also have limitations in that a continuous variable cannot be processed. Simple and explicit instructions (programing) must be provided for each operation that is to be performed. Instructions as to where information is stored, how to use it, what to do with it, and what step is required next are sometimes more complicated than the problems the computer is used to solve. Approximations and rounding off are also problems encountered with computers.

A digital computer performs its calculations by counting and comparing. With this simple capability, it can add, subtract, multiply, divide, and make logical decisions. Therefore, to perform computations with a digital computer, all that is needed is the provision of a method which will enable the machine to count, compare,

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and transfer a digit from one place to another. Therefore, before a discussion of computer devices, it is necessary to learn the language of the computers.

NUMBERING SYSTEMS

While there are many different numbering systems, this discussion will deal with only two; that is, the base ten (decimal) and base two (binary) systems. The binary system will be compared with the decimal system because most computers utilize the binary system and most readers understand the decimal system. The bistable nature of simple electronic components such as switches (open or closed) and tubes and transistors (conducting or cutoff) makes the binary numbering system quite usable.

In the decimal system there are ten digits used (0 through 9), and in the binary system there are two digits used (0 and 1). The symbols or digits used are repeated as many times as desired or needed. Both systems also use the place value or positional notation concept. This means that a numeral has a specific value by virtue of its position.

An example of place value is shown in the two numbers 230 and 203. The 3 has a different value in each numeral by virtue of its position.

POSITIONAL NOTATION

In the previous example the numeral 230 when stated by the reader to be two hundred thirty, some assumptions are made which must be understood in order to compare the decimal and binary systems.

The first assumption the reader made was that when the number 230 was first looked upon, the number was assumed to be a decimal number. When no base symbol is given, the decimal system is assumed. If the number had been a base four number, it would have been written as $230_{(4)}$ with the 4 indicating the base of the numbering system. Some examples and their numbering base symbols are as follows:

Number	Base
398	ten (decimal)
$342_{(5)}$	five (quinary)
$101_{(2)}$	two (binary)

Therefore, when a number is written in base ten, no base indicator is given. If the number is written in a base other than ten, the base indicator is used.

Another assumption made is that the number 230 is two hundred thirty; that is, the digit 2 indicates hundreds, the digit 3 indicates tens, and the digit 0 indicates units. In base ten, this is true. The digits have specific values according to their position. Place value or positional notation for the number 378924 in the decimal system is as follows.

Place value	10^5	10^4	10^3	10^2	10^1	10^0
	100000	10000	1000	100	10	1
number	3	7	8	9	2	4

Notice that the place value column on the right is 10^0 or 1. The increasing place values, moving to the left, are indicated by the base (10) raised to one greater power. The second place value column is, then, 10^1, the third is 10^2, etc.

The number 378924, then, is

$$3(100000) + 7(10000) + 8(1000) + 9(100) + 2(10) + 4(1)$$

The place value columns for the binary (base two) system follow the same pattern as the base ten system except the base two is used.

For example, the number $10110_{(2)}$ is indicated in the place value chart for base two as follows:

Place value	2^4	2^3	2^2	2^1	2^0
	16	8	4	2	1
Number	1	0	1	1	0

The number $10110_{(2)}$, then, is

$$1(16) + 0(8) + 1(4) + 1(2) + 0(1) = 22_{(10)}$$

Notice that place value in base two has a different value than the same place in base ten.

COUNTING IN BASE TWO AND BASE TEN

In base ten, when counting from 0, the numbers are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

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The next number to be counted is ten, but there is no single symbol in base ten to indicate the next number. Therefore, a combination of symbols is used by repeating the 0 and indicating a 1 in the tens column. This means one group of tens and no groups of units.

When counting in base two, there are only two digits or symbols; that is, 1 and 0. The same mechanical process is used in base two that was used in base ten. Starting with 0, in base two, the count is 0, 1.

There are no other symbols to indicate the next number so a 1 is written in the next place value column to the left and a 0 is written in the first place value column; that is, 0, 1, $10_{(2)}$.

This last number, then, indicates one group of two and no groups of units. The next number is $11_{(2)}$ which means one group of twos and one group of units. A number such as $1101_{(2)}$ would indicate one group of eights, one group of fours, no group of twos, and one group of units, and in this case is the same as decimal number 13.

Counting comparisons between the decimal and binary systems are made as follows:

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
16	10000
17	10001

Notice that when counting objects, the decimal 17 and binary 10001 refer to the same object; therefore, decimal 17 must be equivalent to binary 10001.

CONVERSIONS

If the binary number 101 is to be converted to a decimal number, the binary number is written in expanded notation; that is

$$101_{(2)} = 1(4) + 0(2) + 1(1)$$

and the indicated multiplication, by terms, is carried out and yields

$$4 + 0 + 1 = 5$$

The 5 is a base ten number; that is, if objects were counted in a row and stopped with the decimal 5 and then the same objects were counted again in binary, the same object would be indicated with one-zero-one ($101_{(2)}$).

Example: Convert $11101_{(2)}$ to base ten.

Solution: Write $11101_{(2)}$ in expanded notation as

$$1(16) + 1(8) + 1(4) + 0(2) + 1(1)$$

and carry out the multiplication to obtain

$$16 + 8 + 4 + 0 + 1 = 29$$

Problems: Convert the following binary numbers to base ten.

1. 111
2. 1001
3. 11111
4. 1000001

Answers:

1. 7
2. 9
3. 31
4. 65

To convert the decimal number 26 to binary, first intuitively determine the largest place value column contained in the number; that is, in the place value chart

2^5	2^4	2^3	2^2	2^1	2^0
32	16	8	4	2	1

Objects that contain one or more plane surfaces which are neither horizontal nor vertical are known as inclined plane surfaces. The lightly shaded portion of the pictorial drawing in Fig. 2 represents an inclined plane. On the three-view (orthographic) drawing shown, the inclined plane is also represented by lightly shaded portions. In the front and top views, the inclined plane appears flat and similar to vertical or horizontal surfaces. In the side view in Fig. 2, however, the inclined plane is represented by the diagonal dashed line. Without this dashed line, the 3-view drawing could never be clearly read or understood.

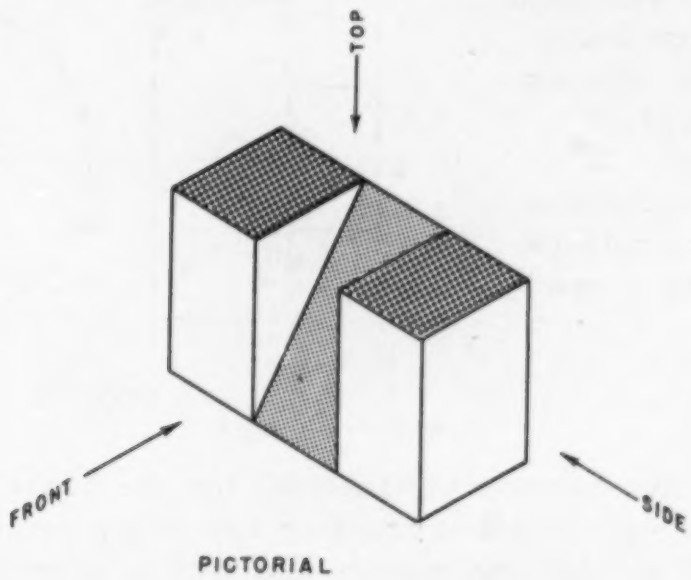

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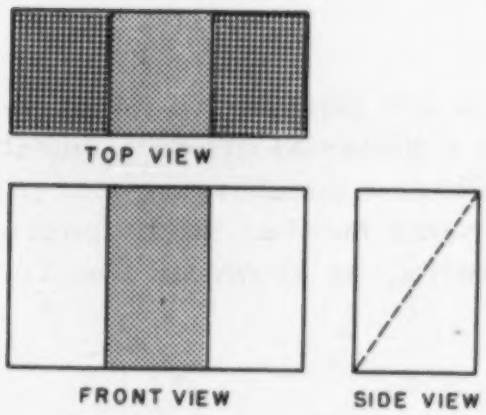

FIG. 2

there is one group of 16 or 2^4 in 26. Also, there must be five digits in the representation of 26 in binary because the place value column for 2^4 is the fifth place value column from the right. This is indicated by drawing lines for each digit as follows:

2^4	2^3	2^2	2^1	2^0
—	—	—	—	—

There is one group of 16 in 26; therefore, write

2^4	2^3	2^2	2^1	2^0
1	—	—	—	—

Sixteen is indicated leaving 26 - 16 to be accounted for, or ten. There is one group of 2^3 in ten so write

2^4	2^3	2^2	2^1	2^0
1	1	—	—	—

After accounting for one group of 16 and one group of 8, 2 is left. There are no groups of 2^2 in 2 so write

2^4	2^3	2^2	2^1	2^0
1	1	0	—	—

and then find there is one group of 2^1 in 2 and write

2^4	2^3	2^2	2^1	2^0
1	1	0	1	—

leaving 0. Finally there is no group of 2^0 in 0 so write

2^4	2^3	2^2	2^1	2^0
1	1	0	1	0

Therefore, 26 in decimal is equal to 11010 in binary.

This type conversion is quite complicated in dealing with large numbers. There is a technique which enables us to convert from decimal to binary quite simply by continual division of the decimal number by the base of the binary system, indicating the remainder after each division operation until the quotient is zero. This is shown in the following:

Convert 26 decimal to binary–

```
2|26
  13     remainder is 0
2|13
   6     remainder is 1
2|6
   3     remainder is 0
2|3
   1     remainder is 1
2|1
   0     remainder is 1
```

The remainders are read from the bottom to the top to obtain the binary equivalent of the decimal number; that is;

$$26 = 11010_{(2)}$$

The division process may be combined as follows:

Convert 38 to binary–

```
2/38
2/19   0
2/9    1
2/4    1
2/2    0
2/1    0
  0    1
```

and the binary equivalent of 38 is $100110_{(2)}$.

Problems: Convert the following decimal numbers to binary.

1. 29
2. 624

Answers:

1. 11101
2. 1001110000

BINARY ARITHMETIC

Familiarity with the basic arithmetic operations in the binary system is needed in order to enhance the understanding of computers;

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therefore, a comparison between the decimal and binary systems will be discussed.

Addition

When counting in the decimal system, a limit is reached where the next number cannot be indicated in a single column; that is,

0
1
2
3
4
5
6
7
8
9

At this point a "carry" is made; that is, the first digit (0) is repeated and a 1 is indicated in the tens column. This means one group of tens and no groups of units, and is indicated by 10.

The ADDITION facts of the DECIMAL system are shown in the truth table below:

+	0	1	2	3	...
0	0	1	2	3	...
1	1	2	3	4	...
2	2	3	4	5	...
3	⋮	⋮	⋮	⋮	

for example:

+	0	1	2	3
0				↓
1				↓
2	→	→	→	5
3				

means

2 + 3 = 5

Binary addition is similar to decimal addition, except in binary only two digits, 0 and 1, are available. The mechanical procedure is the same.

The ADDITION facts of the BINARY system are as follows:

+	0	1
0	0	1
1	1	10

That is,

+	0	
0	0	

means

0 + 0 = 0

and

+		1
0		1

means

0 + 1 = 1

or

1 + 0 = 1

and

+	0	
1	1	

means

1 + 0 = 1

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or

$$0 + 1 = 1$$

and

+		1
1		10

means

$$1 + 1 = 10$$

This means that

$$0 + 0 = 0$$
$$0 + 1 = 1$$
$$1 + 0 = 1$$
$$1 + 1 = 10$$

When adding numbers in base ten, the following mechanical procedure is followed:
Add 172 and 32

```
  172
+  32
  104 partial sum
 +100 carry overs
  204 final sum
```

When adding two binary numbers, the process is

```
  0101
 +0111
  0010 partial sum
 +1010 carry overs
  1000 partial sum
 +0100 carry overs
  1100 final sum
```

The previous addition may be stated as follows:

Starting from the right column, one plus one equals 0 and 1 carry. The carry plus zero plus one equals zero and one carry. The carry plus one plus one equals one and one carry. The carry plus zero plus zero equals one.

Problems: Add the following binary numbers.

1. 1001 and 101
2. 1101 and 1111

Answers:

1. 1110
2. 11100

Computer Addition

The computer technique of addition utilizes the process of half add, carry, and final sum. Half add means to add two digits and neglect the carry. The carry is written below the half add sum and then added to this half add sum. An example in decimal is as follows:
Add 3562 and 2149

```
  3562
 +2149
  5601  half add
 +0110  carry overs
  5711  final sum
```

If other carry overs are required, they are handled as follows:
Add 4965 and 5247

```
  4965
 + 5247
  9102  half add
 + 1110  carry overs
  0212  half add
 +10000  carry overs
 10212  final sum
```

Problem: Add the following, indicating half adds and final sums.

1. 9328 and 6973
2. 9323 and 739

Answers:

1. 5291 half add
   16201 half add
   16301 final sum
2. 9052 half add
   0062 half add
   10062 final sum

The computer technique is used in binary as it is used in decimal.

Example: Add the binary numbers 11101 and 1101.

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Solution:

```
   11101
+   1101
   10000  half add
+  11010  carry overs
   01010  half add
+100000   carry overs
  101010  final sum
```

Example: Add the binary numbers 1101 and 110.

Solution.

```
    1101
+    110
    1011  half add
+   1000  carry over
    0011  half add
+  10000  carry over
   10011  final sum
```

Problems: Add the following binary numbers indicating half adds and final sums.

1. 110 and 10
2. 11011 and 111

Answers:

1. 100 half add
   000 half add
   1000 final
2. 11100 half add
   11010 half add
   10010 half add
   00010 half add
   100010 final sum

Subtraction

Both the direct and complement method of subtraction will be discussed. The methods will also be compared in the decimal and binary systems.

DIRECT SUBTRACTION.–In the decimal system, when subtractions are made, the terms to be subtracted are named as follows:

```
 7  minuend
-2  subtrahend
 5  difference
```

In cases where the subtrahend, in a particular column, is greater than the minuend, a borrow must be made; that is, a digit must be moved from a higher place value column to a lower place value column. An example is

```
 76
-39
```

where 9 is to be subtracted from 6.

In this case one group of tens must be borrowed from the 7 group of tens. This is shown by

```
 76
-39
```

is

```
   10
 6  6
-3  9
```

and 9 from 16 is 7. Therefore,

```
 6 16
-3  9
  37
```

This concept may be applied to as many columns as necessary. For example, in the problem

```
 9326
-7438
```

one group of tens is borrowed from the two groups to give

```
     10
 931  6
-743  8
    8
```

then one group of hundreds is borrowed from the three groups to give

```
     10 10
 92  1  6
-74  3  8
    8  8
```


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The next step is

```
  10 10 10
   8 2  1  6
  -7 4  3  8
  ----------
   8  8  8
```

and finally

```
  10 10 10
   8 2  1  6
  -7 4  3  8
  ----------
   1 8  8  8
```

The subtraction problem difference may be verified by adding the difference to the subtrahend to give the minuend. This shown by

```
  1888
 +7438
 ----
  9326
```

Binary subtraction problems are solved in the same manner as decimal subtraction problems except base two is used. One fact may cause problems; that is, when 1 is subtracted from 0, the difference is 1 if a borrow of 1 is made. An example of this is shown by the following:

```
  10
 - 1
 ---
```

A borrow of 1 is made, to give

```
  10
  0 0
 - 1
 ---
```

10 (which must be read as "one-zero," and not as "ten") in base two is really 2 in decimal, and 1 from 2 is 1. Therefore,

```
  10
  0 0
 - 1
 ---
   1
```

When no 1 is available in the next higher place value column, a higher place value column must be used. This is shown in the following example of binary subtraction:

```
  100
 - 1
 ---
```

A borrow from the 2^2 column is made, giving 10 in the 2^1 column.

```
   10
  0 0 0
 -   1
 -----
```

Then, a borrow of 1 is made from the 10 in the 2^1 column, leaving 1 in this column and giving a 10 in the 2^0 column, and 10 minus 1 is 1,

```
   10
  0 1 0
 -   1
 -----
```

Therefore,

```
   10
  0 1 0   minuend
 -   1    subtrahend
 -------
  0 1 1   difference
```

Verification of this difference is made by adding the subtrahend to the difference to yield the minuend.

```
  011
 + 1
 ---
  100
```

Problems: Find the difference in the following binary subtraction problems.

```
1.  101        2.  10101
   - 10           - 111
   -----          -----
```

Answers:

1. 11 2. 1110

SUBRACTION BY COMPLEMENTS (BASE TEN).–Digital computers are generally unable to perform subtraction in the manner previously discussed because the process of borrow involves operations which are impractical to incorporate into a machine. The process which involves complements is used in digital computers. By complement, it is meant the number

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or quantity required to fill or complete something. The complement of a number is, therefore, another number which completes the original number with respect to a known reference.

For example, the nines complement of a number is that number when added to the original number that will yield all nines in the place value columns used. An example of this is as follows:

What is the nines complement of 32?

What number, when added to 32, will produce 99?

Intuitively, it can be seen that the number is

$$99 - 32$$

or

$$67$$

If one is now added to the nines complement, the tens complement results; that is,

$$67 + 1 = 68$$

and 68 is the tens complement of 32. Notice that if 68 is added to 32, the sum is 100. Therefore, the tens complement of a number is defined as that number which, when added to the original number, yields a 1 in the next high place value column and zeros in all other columns. The tens complement of 78 is

$$100 - 78 = 22$$

Notice that the tens complement is in reference to a power of ten one place value higher than the highest place value of the original number.

Number	Tens complement	Reference
7	3	10^1
21	79	10^2
309	691	10^3

Rather than subtract the subtrahend from the minuend, the tens complement of the subtrahend (found with reference to the power of ten one place value higher than either the subtrahend or minuend) may be added to the minuend and then decrease this sum by the reference power of ten used to obtain the difference. A step-by-step process is shown to explain the preceding statement.

Example: Subtract 26 from 49

Solution: Write

$$\begin{array}{r} 49 \\ \underline{-26} \end{array}$$

then find the tens complement of 26 which is

$$100 - 26 = 74$$

This may be rearranged as follows:

$$100 - 74 = 26$$

Now, instead of writing

$$49 - 26$$

write

$$\begin{aligned} & 49 - (100 - 74) \\ = {} & 49 - 100 + 74 \\ = {} & 49 + 74 - 100 \\ = {} & 23 \end{aligned}$$

This indicates that the minuend (49) plus the tens complement of 26 (that is, 74) are added, then the reference power of ten used (100) is subtracted to give the difference which is 23. Notice that

$$\begin{aligned} & 49 - 26 \\ = {} & 49 + 74 - 100 \\ = {} & 123 - 100 \\ = {} & 23 \end{aligned}$$

the digit (1) found in the place value column higher than the highest place value column of the subtrahend had only to be dropped. Generally, this digit (1) which is developed indicates the difference (23) is a positive value.

Example: Subtract 36 from 429

Solution: Write

$$\begin{array}{rl} 429 & \text{minuend} \\ -\ 36 & \text{subtrahend} \end{array}$$

then

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```
   429 minuend
 + 964 tens complement of subtrahend
 1|393
 =+|393 remainder
```

The process of subtracting a larger number from a smaller number, using the tens complement, is slightly different from the example previously shown. Instead of developing a 1 in the higher place value column, a zero will be present. The complement of the apparent remainder will indicate the actual negative remainder.

Example: Subtract 362 from 127

Solution: Write

```
   127 minuend
 - 362 subtrahend
```

then

```
   127 minuend
 + 638 tens complement of
       subtrahend
 0|765 apparent remainder
 =-|235 tens complement of apparent
       remainder
```

which is

```
 - 235 actual negative remainder
```

SUBTRACTION BY COMPLEMENTS (BASE TWO).–Digital computers use the complementary addition technique for subtraction, which has been discussed in decimal notation; and they also use the base two system. The process for base two is similar to base ten.

The ones complement of a binary number is that number with all 1 digits changed to 0's and all the 0 digits changed to 1's. This process is termed inversion. Therefore, the ones complement of 10110 is 01001. The twos complement of a binary number is its ones complement plus 1; that is,

Number	Ones complement	Twos complement
01	10	11
111	000	001
1110	0001	0010

Notice that the number 01 plus its twos complement 11 equals 100 which is a 1 in the next higher place value column followed by zeros.

The twos complement may also be determined by inverting every digit after the first one (1); that is, starting with the smallest place value and moving toward the largest place value (right to left). This method is normally less time consuming than determining the ones complement and then adding one to form the twos complement. For example: the twos complement of

```
      001101011|10     The first one (from
    ←invert all|        right to left) does
is              |       not invert.
      110010100|10
```

This indicates that the same procedure used for decimal numbers may be used for binary numbers to perform subtraction by the addition of the complement.

Problems: Find the ones and twos complements of the following binary numbers.

1. 101
2. 101101

Answers:

	Ones complement	Twos complement
1.	010	011
2.	010010	010011

Example: Subtract the binary number 01101 from the binary number 11001.

Solution: Write

```
 11001 minuend
 - 01101 subtrahend
```

then

```
   11001 minuend
 + 10011 twos complement of the subtrahend
 1|01100 difference
 =+|01100 positive difference
```

Notice that the same number of place value columns must be used in both the subtrahend and minuend.

Example: In binary, subtract 1110 from 1111.

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Solution: Write

```
  1111  minuend
- 1110  subtrahend
```

then

```
  1111  minuend
+ 0010  twos complement of the subtrahend
  1|0001  difference
= +|0001  positive difference
```

As in the decimal system, if a one is developed, it indicates plus. If a zero is present, it indicates a negative apparent answer and the complement of the apparent answer is used, preceded by a minus sign.

Example: In binary, subtract 1011 from 1001.

Solution: Write

```
  1001  minuend
- 1011  subtrahend
```

then

```
  1001  minuend
+ 0101  twos complement of the subtrahend
  0|1110  apparent difference
- |0010  twos complement of the apparent
        difference
= -|0010  negative difference
```

Problem: Subtract in binary, using complementary addition.

1. 1101 from 1110
2. 111 from 10

Answers:

1. +0001
2. -101

A verification of the preceding problems may be made by changing the binary numbers to decimal, carrying out the subtraction, then changing the difference back to binary.

This is as follows:

	binary		decimal
1.	1101	=	13
	1110	=	14

and

$$14 - 13 = 1 = 1_{(2)}$$

	binary		decimal
2.	111	=	7
	10	=	2

and

$$2 - 7 = -5 = 101_{(2)}$$

Multiplication

The direct method of multiplication of decimal numbers is shown in the following example.

Example: Multiply 32 x 25

Solution: Write

$$25 = 20 + 5$$

then

$$32\ (20 + 5)$$

Using the distributive principle

$$\begin{aligned} &32\ (20 + 5) \\ &= 32\ (20) + 32\ (5) \\ &= 640 + 160 \\ &= 800 \end{aligned}$$

The same problem written as

```
  32
x 25
```

gives

32 x 5
= 160 partial product

and

32 x 20
= 640 partial product

then

160 + 640
= 800 product

The technique generally used is

```
   32
 x 25
  160
 64
  800
```

Notice that the 64 really represents 640, but the zero is omitted.

Direct binary multiplication uses the same technique as direct decimal multiplication.

Example: Multiply the following binary numbers.

110 and 1101

Solution: Write

```
   1101
 x  110
   0000
  1101
 1101
1001110
```

This may be verified by changing the factors to decimal, multiplying and obtaining the decimal product, then changing the decimal product back to binary.

Problems: Multiply the following pairs of binary numbers.

1. 11 and 101
2. 11011 and 1011

Answers:

1. 1111
2. 100101001

Repetitive Addition

The idea that multiplication is repetitive addition is of beneficial use when working with computers. When multiplication is to be accomplished with a computer, the process of repeated addition is used.

If two numbers are to be multiplied together, write the following:

Multiply

231 by 45

Write

231 (40 + 5)

then

(231 x 40) + (231 x 5)

Multiplying each term gives the following:

```
  231        231
 x 40  and  x 5
 9240       1155
```

Notice that 231 could have been added forty (40) times to satisfy one half of the above problem and 231 could have been added five (5) times to satisfy the other half.

```
  231 ⎫                  231 ⎫
  231 ⎪                  231 ⎪
  231 ⎪                  231 ⎬ 5 times
  231 ⎪                      ⎪
   "  ⎬ 40 times          231 ⎪
   "  ⎪                + 231 ⎭
   "  ⎪                 1155
+ 231 ⎭
 9240
```

Rather than write 231 forty times, 2310 could have been written four times; that is,

```
  231 x 40
= 231 x 4 x 10
= 231 x 10 x 4
= 2310 x 4

= 2310
  2310
  2310
+ 2310
  9240
```

9240 + 1155 = 10395

When the repetitive addition type of multiplication is used in a computer, it would appear as follows. Two registers are used; that is, the accumulator and the multiplier. The accumulator maintains a constant subtotal and the

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multiplier keeps account of the addition to be performed.

The problem is to multiply 231 by 45.

Accumulator	Multiplier	
000000	45	These operations represent the five ones
+ 000231		
000231	44	
+ 000231		
000462	43	
+ 000231		
000693	42	
+ 000231		
000924	41	
+ 000231		
001155	40	These operations represent the four tens
+ 002310		
003465	30	
+ 002310		
005775	20	
+ 002310		
008085	10	
+ 002310		
0010395	00	

Notice that the multiplier indicated the number of times the number 231 was added and the accumulator maintained the subtotal. When the multiplier indicated 40, the 231 was changed to 2310 and the multiplier then would indicate addition of the 2310 four times. The overall effect was to move the zero in the 40 to the 231.

The binary system follows the previous techniques as shown in the following example. Multiply 1011 by 1101.

Accumulator	Multiplier
00000000	1101
+ 00001011	
00001011	1100
+ 00101100	
00110111	1000
+ 01011000	
10001111	0000

Division

The direct method of division of decimal numbers is shown in the following example:

Example: Divide 30 (dividend) by 5 (divisor).

Solution: Write

$$5\,\overline{)\,30}$$

Five is not contained in 3 but is contained in 30. How many 5's are contained in 30? The answer is 6, so write 6 above the zero

$$\begin{array}{r} 6 \text{ (quotient)} \\ 5\,\overline{)\,30} \end{array}$$

Multiply the 6 and 5 together and find the product which is 30. Write 30 under the 30 and subtract.

$$\begin{array}{r} 6 \\ 5\,\overline{)\,30} \\ \underline{30} \\ 0 \end{array}$$

There are no 5's in zero; therefore, the answer is 6.

Direct binary division follows the same procedure.

Example: Divide 1110 by 111.

Solution: Write

$$111\,\overline{)\,1110}$$

There is one 111 in 111 so write 1 above the right hand one in 111 as follows:

$$\begin{array}{r} 1 \\ 111\,\overline{)\,1110} \end{array}$$

Multiply 111 by 1 and write the product under the 111, and subtract, and bring down the last zero.

$$\begin{array}{r} 1 \\ 111\,\overline{)\,1110} \\ \underline{111} \\ 0000 \end{array}$$

There are no 111's in 0000; therefore, write zero after the 1 in the answer and find 10 is the answer.

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We have now seen that all lines represent edges which occur at the intersection of two surfaces of an object. In a top view of a rectangular table top, the lines would represent the intersection of the top surface of the table with its side surfaces. However, on curved surfaces, object lines are not always edge lines but are sometimes known as tangent lines. In Fig. 3 for example, the top horizontal line of the front view is a tangent line. It is not caused by the intersection of two surfaces but merely represents the top of the curved object.

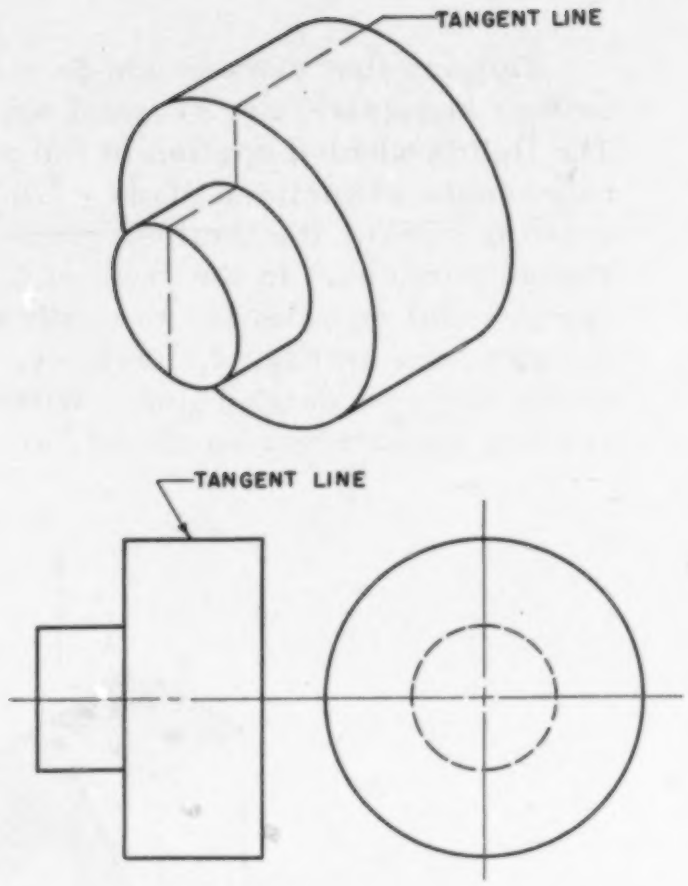

FIG. 3

Much can be written about visualization, but the basic fact still remains that only through constant practice and study can you hope to achieve success in visualizing objects and then in drawing them.

ASSIGNMENT:

The following exercises are intended to increase your visual ability. Each figure shows a pictorial drawing and its corresponding orthographic projection. Place a number on each surface in the pictorial drawing, and the same number on the corresponding surface of the two-dimensional drawing, as shown on No. 1.

```
        10
111 / 1110
      111
        0
        0
```

Example: Divide 10010 by 110, all in binary.
Solution: Write

```
        1
110 / 10010
```

Multiply quotient and divisor and subtract from dividend.

```
        1
110 / 10010
      110
       11
```

Bring down last zero.

```
        1
110 / 10010
      110
      110
```

Find 110 goes into 110 one time and write

```
       11
110 / 10010
      110
      110
```

Multiply quotient and last dividend digit and find

```
       11
110 / 10010
      110
      110
      110
      000
```

and the answer is 11.

Problems: Divide the following binary numbers.

1. 10010 by 110
2. 10000111 by 101

Answers:

1. 11
2. 11011

Repetitive Subtraction

In multiplication, repeated addition is used; in division, repeated subtraction is used.

If one number (the dividend) is to be divided by another number (the divisor), write the following:

Divide 126 by 6
Write

```
126
- 6
120
- 6
114
- 6
108
- 6
"
"
```

Subtracting 6 from 126 twenty-one times registers a zero remainder.

A computer does the same thing except it utilizes powers of ten.

Use is still made of the accumulator and register as in repetitive addition but the technique is operated in reverse order.

Example: Divide 40320 by 126.

Accumulator	Quotient register	
40320		(a) Put the dividend in the accumulator.
	0000	(b) Set the register to zero.
-12600		(c) Put the divisor in the largest power of ten that is equal to or less than the value of the dividend that is in the accumulator.
	+0100	(d) Put the power of ten into the register.
27720		(e) Subtract.
	+0100	(f) Add the sums in the quotient register.

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Accumulator	Quotient register	
-12600	+0100	(g) Repeat steps (c), (d), (e), and (f) as shown.
15120	0200	
-12600	+0100	
2520	0300	
- 1260	+0010	
1260	0310	
- 1260	+0010	
0000	0320	Answer.

Example: Divide 126 by 6.

Accumulator	Quotient register	
126	000	
- 60	+010	
066	010	
- 60	+010	
006	020	
- 6	+001	
000	021	Answer

The same procedure applies to binary division except the highest power of 2 (in binary) is used.

Example: Divide 100111 by 11.

Accumulator	Quotient register	
100111	00000	
- 11000	+01000	Add 2^3 to quotient register.
1111	01000	
- 1100	+00100	Add 2^2 to quotient register.
11	01100	
- 11	+00001	Add 2^0 to quotient register.
0	01101	Answer

CODING

As stated previously, electronic circuit elements of computers are inherently binary; that is, they will have two stable states. Therefore, the base ten numbering system cannot be used efficiently in computers. While people communicate and calculate using letters of the alphabet and numbers of the decimal system, digital computers communicate and calculate using groups of binary symbols called codes.

Coding is the means by which data in one form is represented in another form which is acceptable to the computer. A form of coding is used in the Morse code in which letters are represented by dots and dashes. This makes the alphabet acceptable to transmission by radio.

Of the many coding systems, three of the most common ones are discussed. It should be understood that memorization of these codes is not necessary, but the understanding of the reasons for the codes is desirable.

BINARY CODED DECIMAL (B.C.D.)

This code makes use of groups of binary bits (binary symbols) to represent a decimal digit. In the decimal system there are only ten digits; therefore, only ten groups of binary bits must be remembered. EACH DECIMAL DIGIT IS REPRESENTED BY A GROUP OF FOUR BINARY BITS. The ten groups to remember are as follows:

Decimal digit	Binary - coded decimal digit			
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

To write ten in B.C.D., the use of two groups is required; that is,

Decimal	1	0
B.C.D.	0001	0000

Any two-digit decimal number requires two groups of B.C.D. etc.

Decimal	7	3	8
B.C.D.	0111	0011	1000

The separation of the B.C.D. groups is shown for ease of reading and does not neces-

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sarily need to be written as shown; 738 could be written as 011100111000. One advantage of the B.C.D. over true binary is ease of determining the decimal value. This is shown as follows:

B.C.D.	0111	0011	1000
= decimal	7	3	8

738 in true binary is 1011100010

and, true binary 1011100010

$= \text{decimal } 1(2^9) + 0(2^8) + 1(2^7) + 1(2^6) + 1(2^5) + 0(2^4) + 0(2^3) + 0(2^2) + 1(2^1) + 0(2^0)$

$= 512 + 128 + 64 + 32 + 2 = 738$

The ease of converting from decimal to B.C.D. and from B.C.D. back to decimal should be apparent in the following.

Problems: Convert the following decimal numbers to B.C.D.

1. 7
2. 4200

Answers:

1. 0111
2. 0100001000000000

Problems: Convert the following B.C.D.'s to decimals.

1. 010000110001
2. 0101000001111000

Answers:

1. 431
2. 5078

The comparative ease of conversion in B.C.D. is related to the difficulty of conversion in true binary by the following.

Problems: Convert

1. 438 to binary
2. 100101101 to decimal

Answers:

1. 110110110
2. 301

One serious disadvantage of the B.C.D. is that this code cannot provide a decimal carry. The following examples are given to show this.

Example: Add the following:

Decimal		B.C.D.
5	=	0101
+ 3	=	0011
8	=	1000

Notice that there was no carry in the decimal addition and the answer in B.C.D. is equal to the answer in decimal. The B.C.D. is in correct notation and does exist.

Example: Add the following:

Decimal		B.C.D.
8	=	1000
+ 5	=	0101
13	=	1101

Notice that the B.C.D. answer is correct in true binary, but $1101_{(2)}$ does not exist in B.C.D. The correct B.C.D. answer for 13 should be 0001 0011. Therefore, when a carry is made in decimal, the B.C.D. cannot indicate the correct answer in B.C.D. form.

Excess Three Code

The excess three code is used to eliminate the inability of the binary carry. It is really a modification of the B.C.D. so that a carry can be made.

To change a B.C.D. number to excess three, add three to the B.C.D.; that is,

B.C.D.	1000
	+ 0011
Excess three	1011

In excess three code 1011 is 8 in decimal. The following chart shows the decimal, B.C.D., and the excess three code.

Decimal	B.C.D.	Excess three
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100

As previously stated, the excess three code will provide the capability to carry in binary. The following is given for explanation.

13600 10381

Example: Add $6_{(10)}$ and $3_{(10)}$ in excess three.

Solution: Write

Decimal		Excess three with three groups possible
6	=	0011 0011 1001
+ 3	=	0011 0011 0110
9		

Notice that in group one the six and three are indicated. In groups two and three a zero (0011) in excess three is indicated.
Add as follows

0011	0011	1001	(Excess three)
0011	0011	0110	(Excess three)
0110	0110	1111	(Excess six)

But our answer is in excess six. Therefore, three must be subtracted from each group in order to return our answer to excess three.

0110	0110	1111	
-0011	-0011	-0011	
0011	0011	1100	(Excess three)
0	0	9	Answer in decimal

When a carry is developed in any group, the following procedure is used.

Example: Add $9_{(10)}$ and $3_{(10)}$ in excess three.

Solution: Write

Decimal	Excess three			
9	0011	0011	1100	(Excess 3)
+3	0011	0011	0110	(Excess 3)
12	0110	0111	0010	(Excess 6)

NOTE: Since group one created a carry, as shown, three must be added instead of subtracted in order to place group one into excess three. The other groups follow the previous example.

0110	0111	0010	(Excess six)
-0011	-0011	+0011	
0011	0100	0101	(Excess three)
0	1	2	

The above procedure will hold for any number of group indicators the computer possesses.

Problems: Add the following numbers using excess three and give the answers in excess three with three indicator groups.

1. 5 and 3
2. 4 and 3
3. 58 and 77

Answers:

1.	0011	0011	1011
2.	0011	0011	1010
3.	0100	0110	1000

A further advantage of excess three code is the ease with which the nines complement of a number indicated in excess three may be found; that is, the nines complement of 7, indicated in excess three as 1010, is found by inverting each digit in 1010 to read 0101. This 0101, in excess three, is 2 which is the nines complement of 7.

The following table shows the nines complement of the decimal digits:

Decimal	Excess three	Excess three inverted	Nines complement
0	0011	1100	9
1	0100	1011	8
2	0101	1010	7
3	0110	1001	6
4	0111	1000	5
5	1000	0111	4
6	1001	0110	3
7	1010	0101	2
8	1011	0100	1
9	1100	0011	0

GRAY CODE

This code is a modification of the binary counting system. In the Gray code sequence counting, only one bit will change as each count proceeds. When counting in binary from $7_{(10)}$ ($0111_{(2)}$) to $8_{(10)}$ ($1000_{(2)}$), notice that four bits had to be changed.

The Gray code is shown for comparison.

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056 238

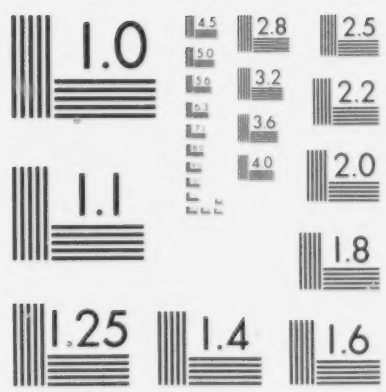

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Decimal number	Pure binary	Gray code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111

In the Gray code when counting from $7_{(10)}$(0100) to $8_{(10)}$(1100), notice that only one bit changed.

One of the primary purposes of this code is the reduction of operational errors by changing only one digit at the time during the process of converting mechanical changes into numerical expressions. For example, to convert the shaft rotation (output of an analog computer) from seven to eight degrees would require only a change of one bit as previously indicated.

To convert a binary code to its Gray code equivalent, the following addition WITHOUT CARRY is used.

Example: Convert binary 0100 to its Gray code equivalent.

Solution: Keep the most significant bit as is.

Binary	0	1	0	0
Gray	0	—	—	—

Next, add horizontally the most significant bit to the next significant bit in the binary number and carry the sum to the Gray code as follows:

Binary	0	1	0	0
Gray	0	1	—	—

now add and continue as shown

Binary	0	1	0	0
Gray	0	1	1	—

then

Binary	0	1	0	0
Gray	0	1	1	0

Therefore, 0100 binary is equivalent to 0110 in the Gray code.

Example: Convert $14_{(10)}$ to Gray code.

Solution: Write

Decimal 14 = 1110 binary

Binary	1	1	1	0
Gray	1	—	—	—

then

Binary	1	1		
Gray	1	0		

add without the carry

then

Binary	1	1	1	0
Gray	1	0	0	—

then

Binary	1	1	1	0
Gray	1	0	0	1

therefore, 1110 binary is equivalent to 1001 in Gray code.

Problems: Convert the following decimal numbers to the Gray code.

NOTE: This transition must include the binary code.

1. 12
2. 35

Answers:

1. 1010
2. 110010

A method is also needed to convert Gray code to binary code.

Example: Convert 1101 in Gray code to binary.

Solution:

Gray	1	0	0	1	Retain the most significant
Binary	1	—	—	—	Gray code bit.
Gray	1	0	0	1	Add diagonally without a
Binary	1	1	—	—	carry.

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Gray 1 0 0 1 Continue diagonal addition.
Binary 1 1 1 _

Gray 1 0 0 1 Continue.
Binary 1 1 1 0 Therefore, Gray 1001 is equivalent to binary 1110.

Problems: Convert the following gray codes to binary.

1. 10000
2. 0001

Answers:

1. 11111
2. 0001

OCTAL NUMBERS

Octal numbers are base eight numbers; that is, there are only eight digits in base eight. These are 0, 1, 2, 3, 4, 5, 6, and 7. Because eight is a power of two, the octal system has special characteristics that make it especially useful in situations involving binary numbers. This is illustrated as follows:

A decimal number can be converted to octal by the same method described for decimal to binary; that is, to change 334 to octal write

	Remainder
8 / 334	
8 / 41	6
8 / 5	1
0	5

Therefore,

334 decimal = 516 octal or $516_{(8)}$

The same decimal number when changed to binary is 101001110.

Since things equal to the same thing are equal to each other

$$516_{(8)} = 101001110_{(2)}$$

Notice that the true binary number is separated into groups of three digits from the right as follows:

101 001 110

and by observation, notice that each group represents the following:

101 001 110
5 1 6

which is 516 in octal.

To convert from binary to octal, it is only necessary to divide the binary number into groups of three and read each group as the octal representation in place value.

To convert from octal to binary, the reverse operation is used; that is,

5 1 $6_{(8)}$
101 001 110

Example: Convert 40 decimal to octal, then to binary.

Solution: Write

	Remainder
8 / 40	
8 / 5	0
0	5

Therefore,

$$40_{(10)} = 50_{(8)}$$

and then

$50_{(8)}$
101 000

The preceding conversions from binary to octal and from octal to binary are possible because 2^3 is the same as 8^1.

Problems: Convert the following binary numbers to octal.

1. 101101
2. 1110110

Answers: (In base eight)

1. 55
2. 166

Problems: Convert the following octal numbers to binary.

1. 482
2. 761

Answers: (In binary)

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1. Impossible to have an 8 in base eight (is not an octal number).

2. 111110001

The octal number system affords many conveniences. When recording a binary number on paper, it is usually more convenient to write it in octal. For example, computer programers and programing manuals use the octal system as a convenient notation for binary numbers. Also, when converting a large decimal number to binary, it is usually more convenient to convert it to octal first and then to binary since fewer divisions are required in dividing a decimal number by 8 instead of 2.

A number in any base that is smaller than ten can be converted to a number in base ten (decimal) by the following method: Multiply the most significant digit (MSD) by the present (old) base, add the next MSD to the product of the last multiplication and multiply the sum by the present (old) base, continuing until the least significant digit (LSD) is added.

EXAMPLE: Convert
to decimal

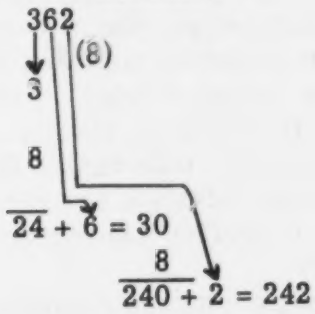

INPUT AND OUTPUT DEVICES

An analog device yields an output in the form of a varying voltage, current, resistance, or mechanical shaft rotation. This form of output is unusable as an input to a digital computer. Since the majority of military indicating devices are of the analog type, their outputs must be converted to be used as inputs for the digital computers.

INPUT DEVICES

An input device is considered to be any device which yields an output which is usable for the particular computer it feeds. The devices which will be discussed are referred to as converters or encoders because they convert analog information into digital information.

V-Scan Converter

The V-scan converter continuously converts a changing mechanical position (analog information) into pulses (binary information) with an accuracy of plus or minus one bit (binary digit).

The basic method of converting a mechanical position into a binary code involves an arrangement of brushes and contacts. The mechanical movement positions the brushes relative to the contacts. The conducting contacts contain a voltage level which represents a binary 1 and the insulating contacts contain no voltage which represent a binary 0. The contact arrangement necessary to produce a natural binary code ranging from 0 to 15 is illustrated in figure 15-1.

NOTE: For the purpose of discussion, consider the contact arrangement in figure 15-1 as being attached on the side of a tank containing a liquid. The brushes are controlled by the level of the float which varies with the level of the liquid in the tank. Notice that, as shown, when the brushes move downward, a binary indication of the amount of liquid expended is indicated. The dark areas are conducting contacts and the light areas are insulating contacts. The four squares at the top of the contact arrangements represent four in-line brushes. The position of the in-line brushes, as shown, indicate a binary 0000 or zero. The analog output moves the brushes down the contacts to indicate any binary number from 0000 (zero) to 1111 (fifteen).

Unfortunately, there is an ambiguity associated with the use of the in-line brushes and the natural binary code. This problem arises at any point where two or more brushes are required to switch at the same moment from one type of contact to the other; that is, from conducting to insulating or from insulating to conducting.

Figure 15-2 shows a portion of a four-bit binary coding plate and reveals the exact nature of the problem. Note that the brush positions that are indicated by x's are reading a 6 (0110). At this instant the brushes are obviously providing the correct reading. Ex-

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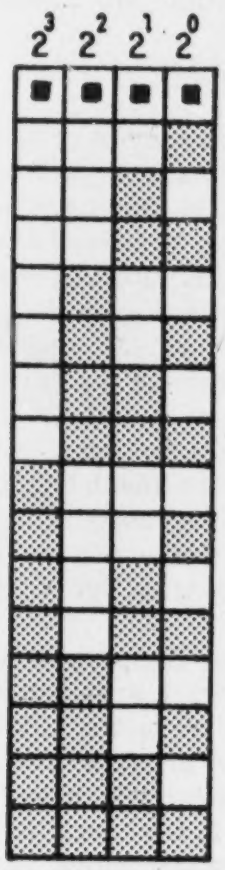

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Figure 15-1.–Natural binary code contact arrangement.

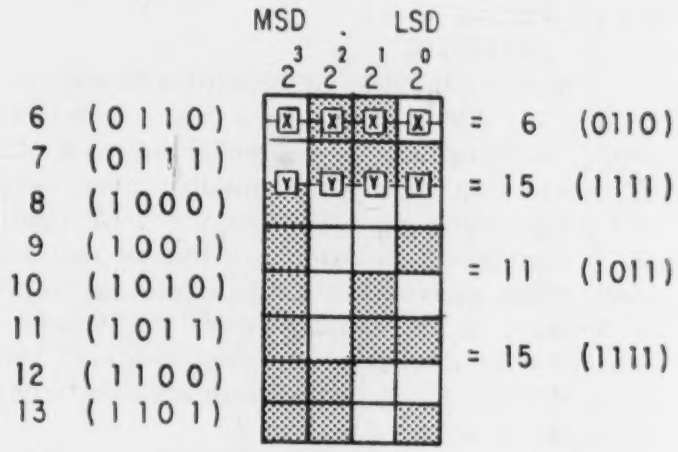

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Figure 15-2.–Ambiguity with the natural binary code.

amination of the next position of the brushes, indicated by y's, however, reveals ambiguous readings. For this example, the brush position is at the switching point from 7 (0111) to 8 (1000). The brush in the 2^3 column is making contact with the conducting material, while brushes in the 2^0, 2^1, and 2^2 columns are still making contact with the conducting material. The output from the brushes at this time is 15 (1111), which should not occur when moving from 7 (0111) to 8 (1000). This produces an erroneous reading. Note that erroneous readings are also obtainable at the 9 to 10 switching point and at the 11 to 12 switching point.

Obviously, the possibility of reading a 15 when it should actually be switching from 7 to 8 (or reading 11 when it should be switching from 9 to 10, or of reading any of the other ambiguous numbers that may be produced) makes it impossible to read instantaneous values with any high degree of certainty. The major factors in determining the accuracy of the natural binary-coded converter are the positioning of the contacts, the positioning of the brushes, the size of the contacts, and the thickness of the brushes. The perfect converter, in order to preclude ambiguities, would have each contact exactly in its required position, all brushes in a straight line perpendicular to the direction of movement, all contacts exactly the same size, and the brushes infinitesimally narrow and exactly uniform. Meeting the prestated requirements for a perfect converter is a physical impossibility.

The V-scan converter employs a method of conversion whereby the physical requirements allow almost perfect conversion. This is accomplished by the use of a double brush (except for the 2^0 column brush) system. The particular relationship between the brushes is predetermined. The direction of movement to be used when describing one set of brushes as leading and one set of brushes as lagging is determined by the design of the grid. In figure 15-3 the direction which will determine the leading or lagging brushes is downward. This direction must be used regardless of whether the float is causing the brushes to move downward or upward. This may occur when filling or emptying the tank.

When reading the brush positions from right to left, two rules are followed:

1. If a bit is read as a one (electrical contacts touching) in a place value column, the

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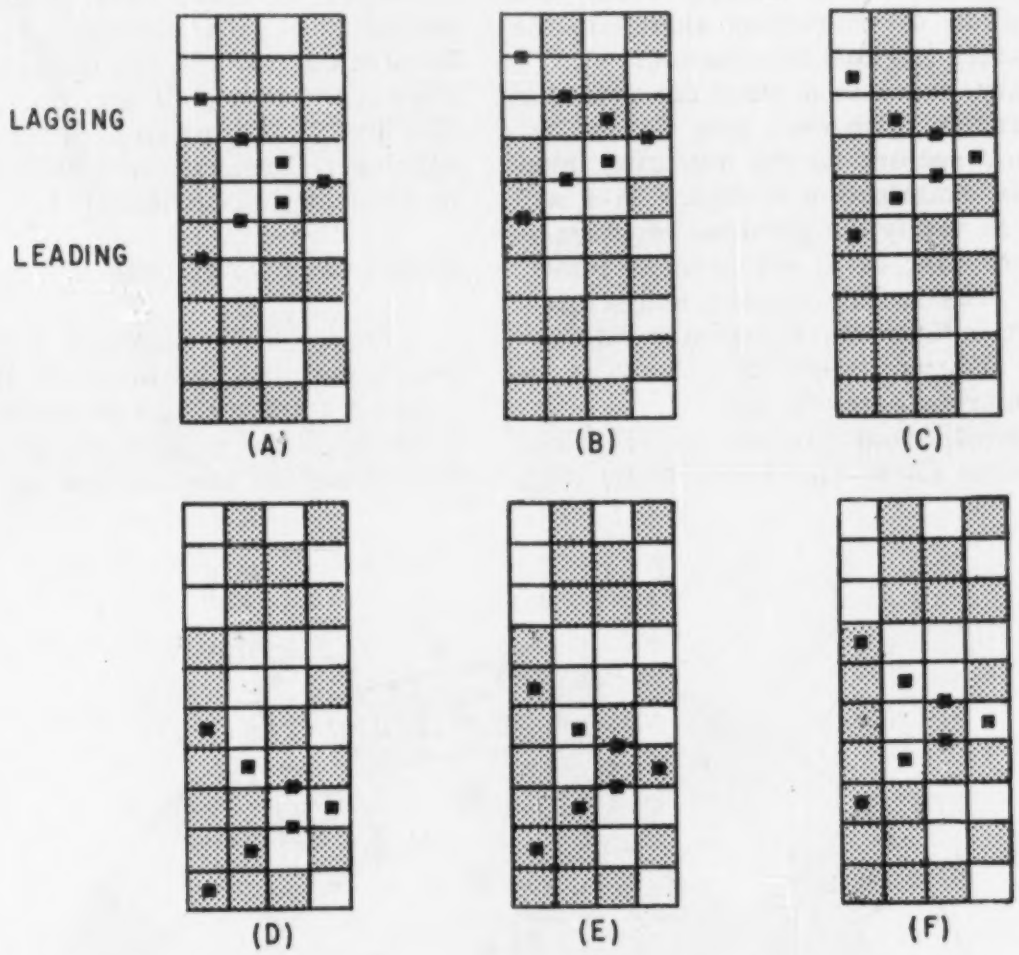

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Figure 15-3.–Natural binary code contact arrangement showing V-scan brushes.

next larger place value column is read on the lagging brush.

2. If a bit is read as a zero (nonconducting contact) in a place value column, the next larger place value column is read on the leading brush.

The determination of whether a leading or lagging brush is used at any particular time is a design function of this converter and will not be discussed.

Since the least significant digit (LSD) column has but one brush, it will always be the reference. As shown in each section of figure 15-3, there are some brushes that are touching conducting and nonconducting segments at the same time. By applying the previously stated rules, figure 15-3 (A) is read as follows:

Column 1: This is our reference brush and since it is conducting a binary 1 is read.

Column 2: Read the lagging brush position because column 1 brush was conducting. The lagging brush position indicates a zero.

Column 3: Read the leading brush position because column 2 brush was not conducting; therefore, a zero is read for column 3.

Column 4: Read the leading brush position which indicates a zero. Therefore, figure 15-3 (A) is indicating $1001_{(2)}$ or $9_{(10)}$.

The following sections of figure 15-3 indicate:

Figure 15-3 (B) - $0111_{(2)}$ or $7_{(10)}$

Figure 15-3 (C) - $1000_{(2)}$ or $8_{(10)}$

Figure 15-3 (D) - $1100_{(2)}$ or $12_{(10)}$

Figure 15-3 (E) - $1011_{(2)}$ or $11_{(10)}$

Figure 15-3 (F) - $1010_{(2)}$ or $10_{(10)}$

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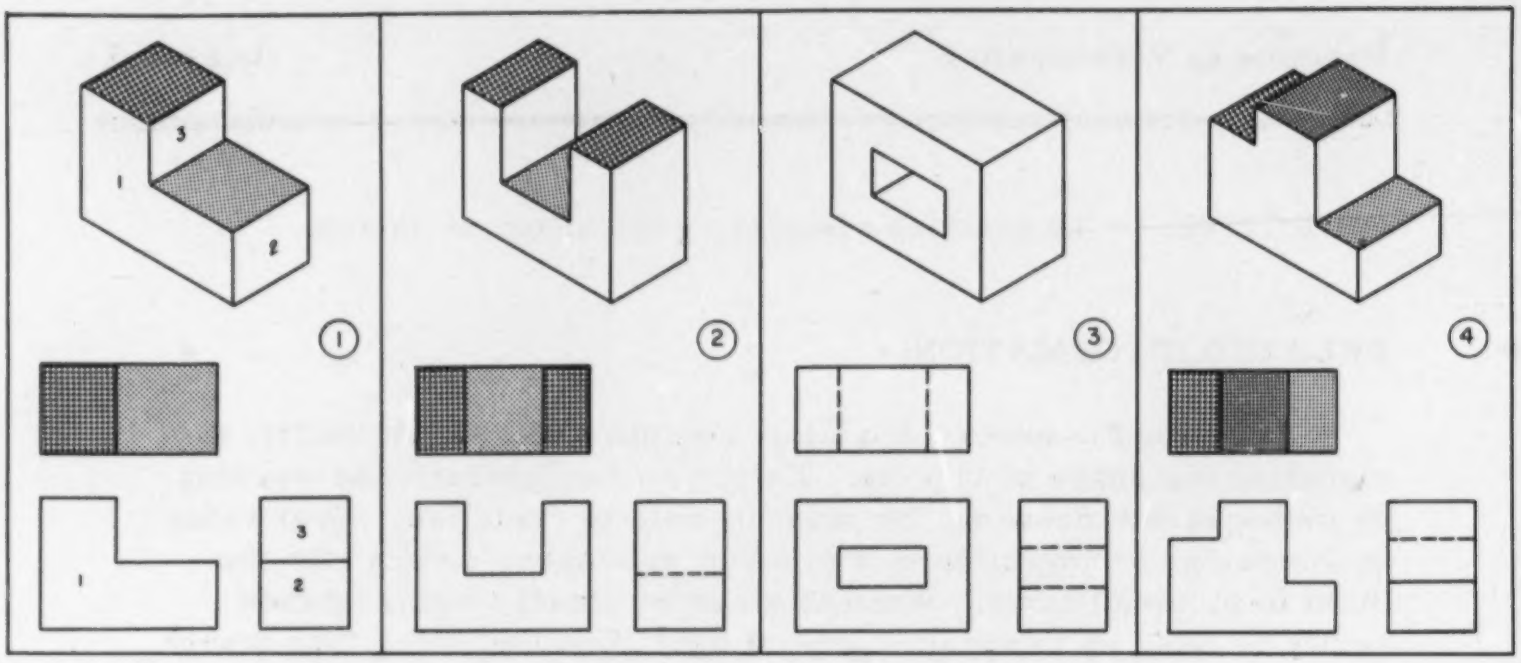
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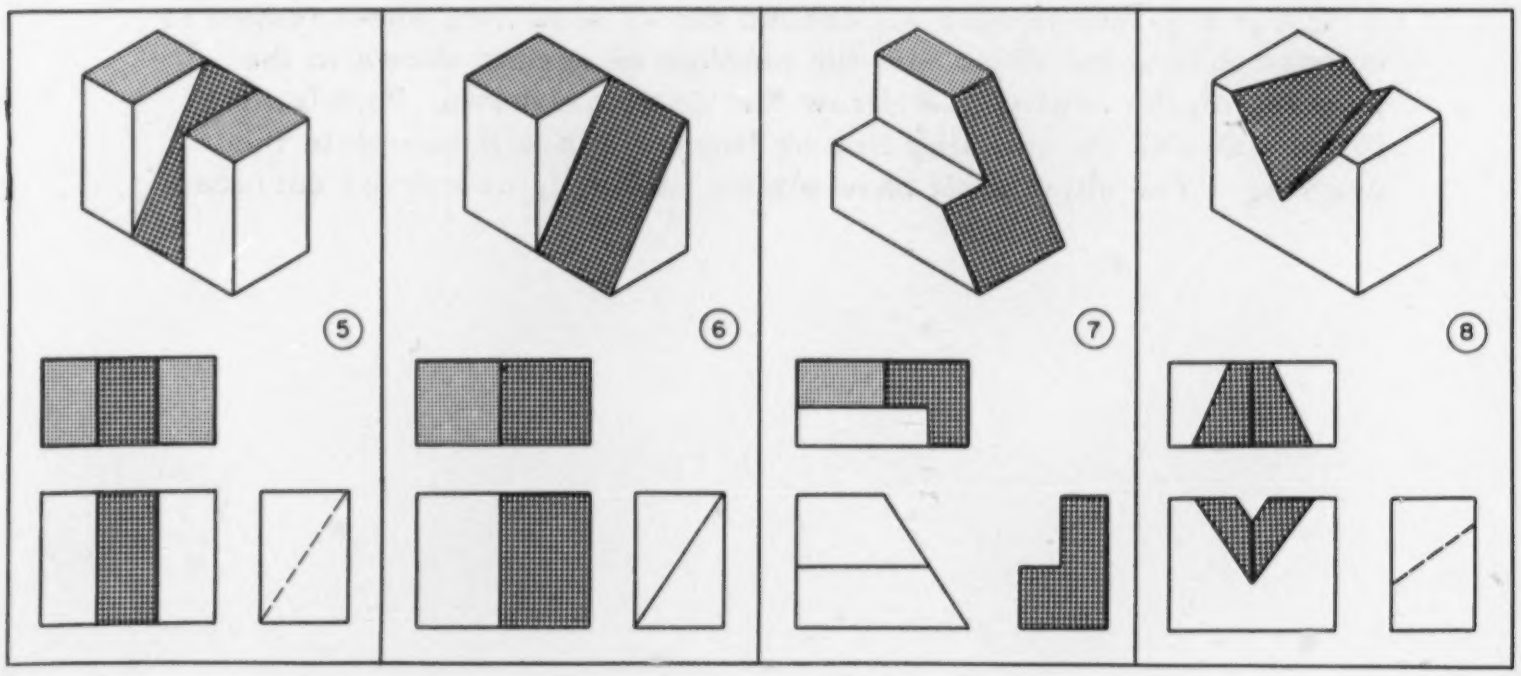
5
6
7
8

BINARY WHEEL.–The binary wheel is a basic application of converting shaft rotation (analog) to binary (digital) information.

The binary wheel is a plane comprised of concentric circles, with each ring divided into twice as many sectors as the adjoining inner ring. A close examination of figure 15-4 will show that it is really the previous rectangular set of contacts (fig. 15-2) set up in concentric rings. If the brushes are located in a straight line, as shown in figure 15-4, the same difficulty of erroneous indications will be present as the brushes move around the circles.

By installing dual brushes in all rings except the outer (least significant digit) ring, as shown in figure 15-5, and properly placing the brushes, the erroneous readings may be eliminated. The number indications are read as previously indicated for the V-scan readings. The direction of rotation of the disk determines which set of brushes will be leading or lagging–in this case, clockwise.

Binary Gray Coded Grid

Figure 15-6 shows a grid (coded in the Gray code) with five brushes. The shaded blocks indicate 1 binary, and the blank blocks indicate 0 binary. This is the same as previously used. Notice that as the brushes (x) more down the

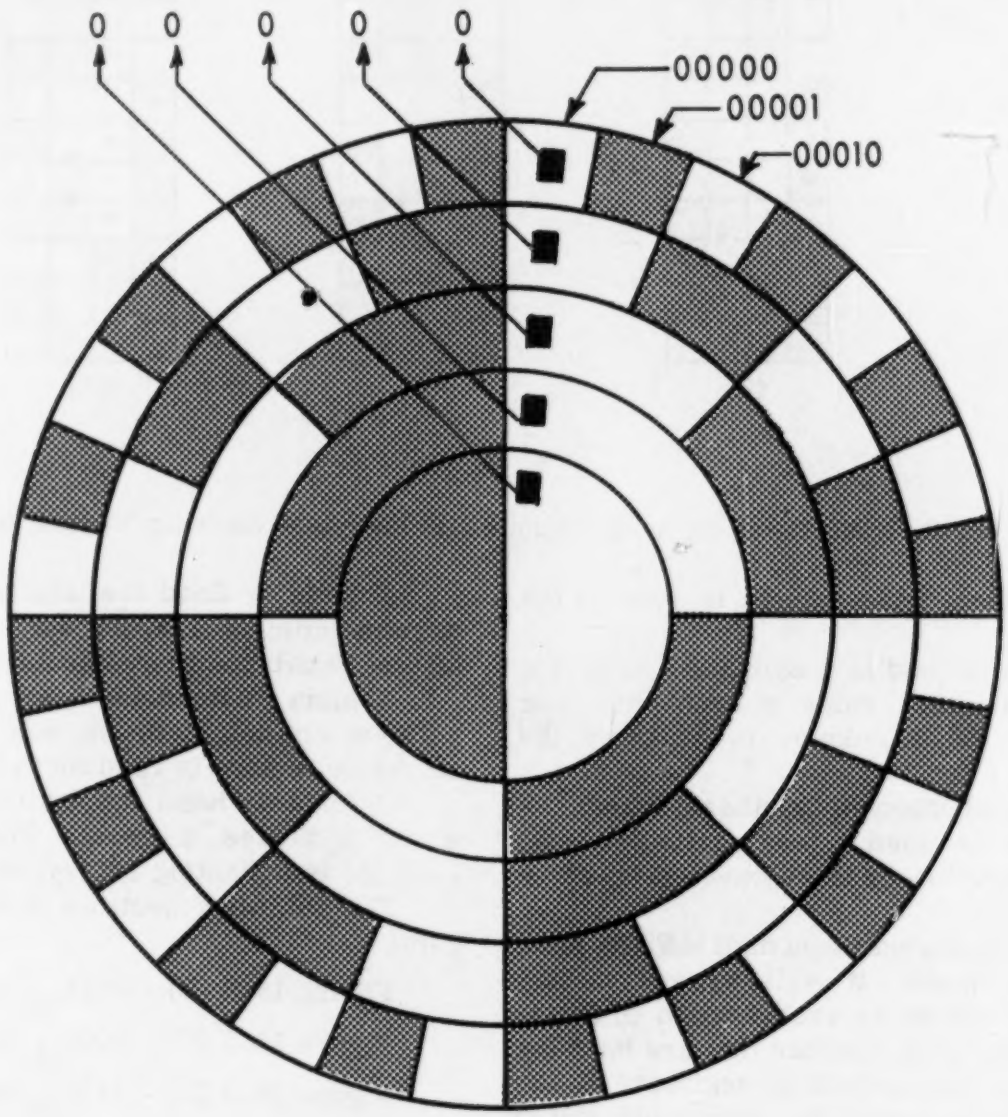

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Figure 15-4.–Simple five-bit shaft encoder.

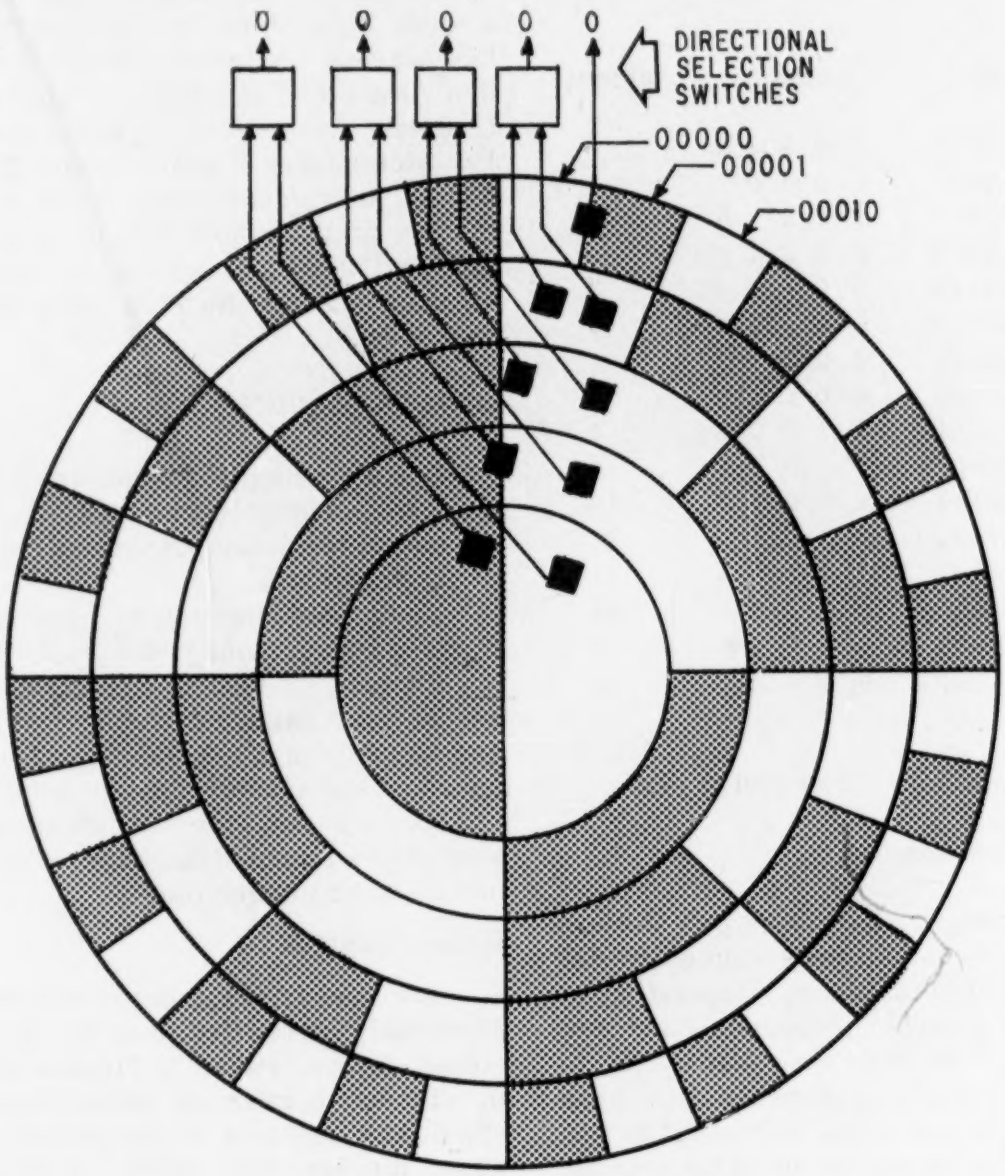

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Figure 15-5.–Five-bit V-scan encoder.

grid, only one brush will change its state (conducting to nonconducting or nonconducting to conducting) as the number is increased by one.

The brushes are shown to be indicating two in Gray binary; and as they move to 3 Gray binary, only one brush changed state. In figure 15-2 the movement from 7 to 8 caused an erroneous reading. Notice that as the brushes (y) shown in figure 15-6 move from 7 to 8, an erroneous reading does not occur because only one brush changed state.

BINARY GRAY CODED WHEEL.–Figure 15-7 shows the binary Gray coded wheel in which angular position of the brushes is represented by a Gray coded number. In changing from one number to the next, only one brush changes state. Notice that one set of brushes allows indications in sequential steps without ambiguous readings when moving from one number to the next.

In figure 15-7, the brush reading line shows the reading to be 01001 in Gray code. This indication could represent bearing, speed, direction, or any of many analog positions.

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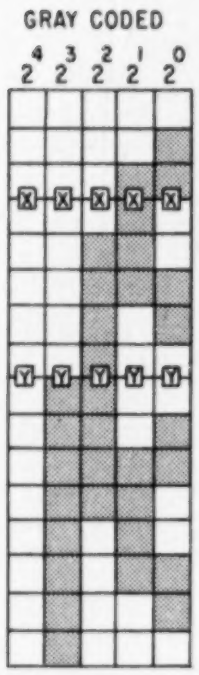

GRAY	BINARY	DECIMAL
00000	0 0 0 0 0	0
00001	0 0 0 0 1	1
00011	0 0 0 1 0	2
00010	0 0 0 1 1	3
00110	0 0 1 0 0	4
00111	0 0 1 0 1	5
00101	0 0 1 1 0	6
00100	0 0 1 1 1	7
01100	0 1 0 0 0	8
01101	0 1 0 0 1	9
01111	0 1 0 1 0	10
01110	0 1 0 1 1	11
01010	0 1 1 0 0	12
01011	0 1 1 0 1	13
01001	0 1 1 1 0	14
01000	0 1 1 1 1	15

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Figure 15-6.–Binary Gray coded grid.

Brush Encoder Problems

The disadvantages of brush type encoders are early and frequent failures caused by excessive brush and disk wear, frequent miscounting, critical brush alinement, and low operating speeds. Brushes are susceptible to vibration and acceleration forces that can cause intermittent contact and shifts in brush position. High rotational speeds cause wear of the brushes and particle contamination of the code disk, which lead to a diminution of accuracy. Brush bounce at high speeds may be severe, resulting in extraneous pulse outputs. Although a compromise may be reached by an increase in brush-contact pressure, this also increases the load torque, aggravates the problem of wear of the brush contacts, and reduces life of the code wheel. The results are encoders which are unreliable, have a short useful life, require frequent and costly maintenance and/or replacement, and are limited in operating speed.

Optical Encoders

In optical encoders, there are no contacting surfaces other than bearings. Photocells are used to detect light from a light source through a code disk which has alternately opaque and transparent segments. Electronic amplifying, discriminator, and logic circuitry is required to optain the desired digital output. Continuous low-voltage d-c tungsten lamps are usually used as the light source, which has a predicted life of over 10,000 hours. The mean-time-between-failure (MTBF) of optical encoders is at least 10 times greater than that of comparable brush encoders.

OUTPUT DEVICES

Input and output devices are similar in operation but perform opposite functions. It is through the use of these devices that the computer is able to communicate.

Output information is also made available in three types: human information, such as codes or symbols presented on a cathode-ray screen which are used by the operator to answer questions or make decisions; information which operates a control device such as a lever, aileron, or actuator; or information which is stored in a machine language or human language, on tapes, or printed media.

Wheel Displays

Any one of the angle to number converters previously described can be connected as an output device, either to furnish an angle signal or display (pointer or servo signal) or to mechanically position a particular symbol on a wheel display. The symbol to be displayed can be any arbitrary number, letter, word, or other symbol selected by the designer.

The wheel can be positioned by a servomotor, by a step counting switch, by a digital to analog converter coupled with a motor, etc. The only limitation on the positioning system is that it must be able to drive the wheel until the correct symbol is displayed.

The display may be generated by wheels geared together in a fixed ratio (as in an odometer) or with each wheel individually driven and positioned. A disadvantage of the second system is the increased space required to accommodate the separate drive mechanisms. The number of symbols to be displayed is limited by the size of the wheel and by the number of discrete positions that can be selected.

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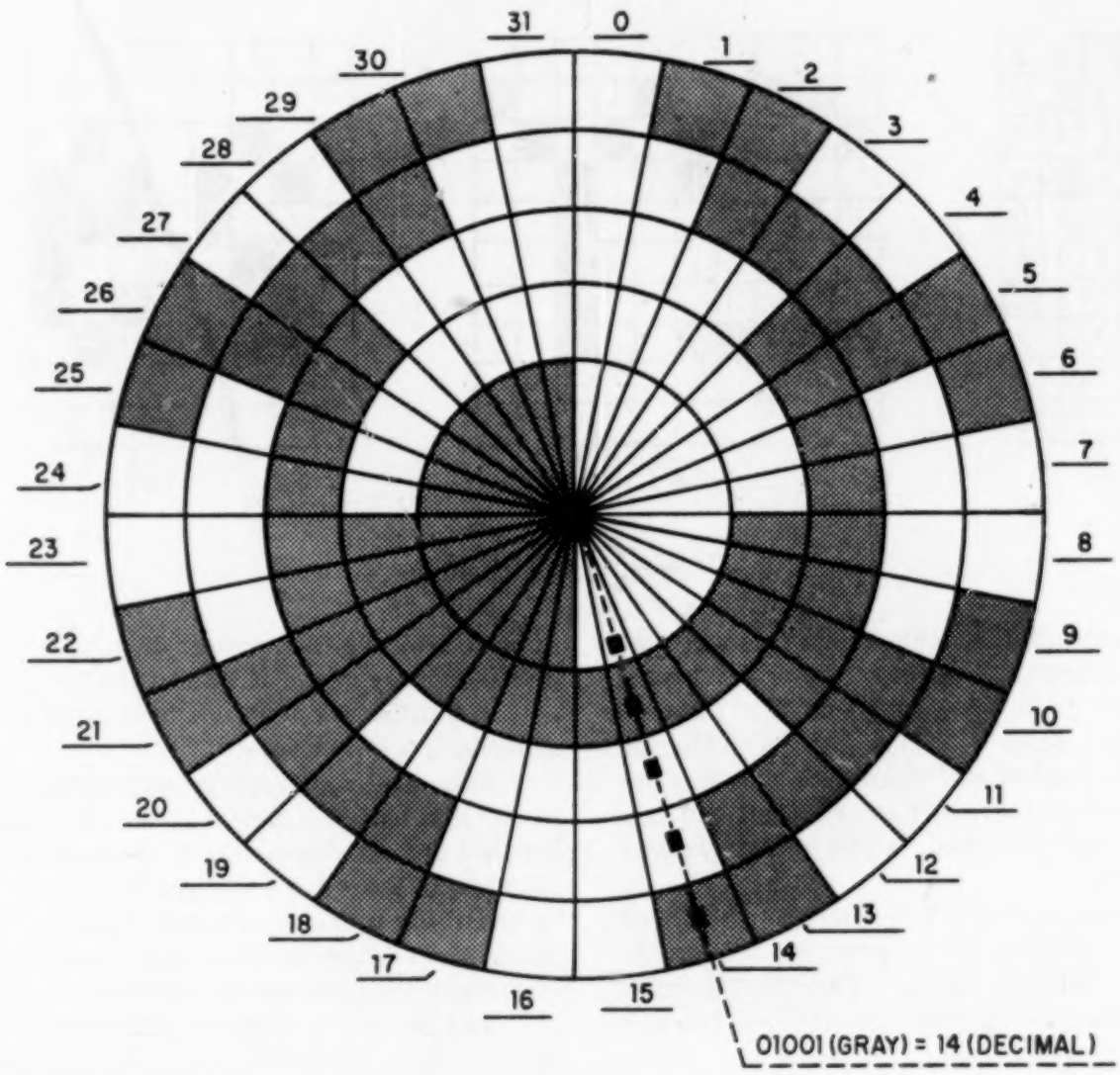

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Figure 15-7.–Binary Gray coded wheel.

Practically any encoder can be used as a decoder (digital-to-analog converter) either directly or by positioning it with a null-seeking driver.

Lights

Each individual light may be considered as the equivalent of a binary stage: ON–true or one; OFF–false or zero. Lights are used to display such discrete data as failsafe, on-off, and warning. They may be used in groups and in conjunction with ring counters to form binary to decimal conversion displays. Each individual light is sequenced and illuminates the appropriate digit when switched on by the counters. (See fig. 15-8 (A).)

MULTIFILAMENT LIGHTS.–These lights may display numbers, letters, symbols, or combinations of these. Filaments may "edge light" lucite cards to illuminate engraved symbols, or may actually be shaped in the form of the symbol and glow when switched on. (See fig. 15-8 (B) and (C).)

Lights require appreciable current–greater than that which is normally available directly from the computing circuits. Therefore, a buffer or amplifier stage is usually required to furnish the additional current. Since a single display illuminates multiple symbols and requires at

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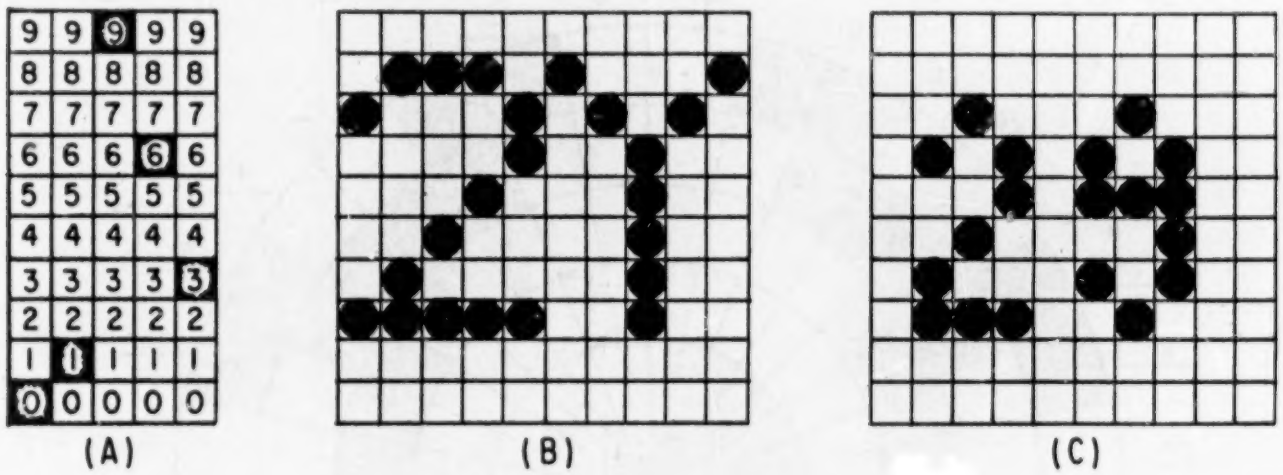

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Figure 15-8.–Light displays.

least one terminal for each, it may require its own counter circuits to convert from binary code to the display code, or it may share a common converter with several other circuits. On the other hand, the individual filaments may be prewired to a printed circuit board, and the appropriate display selected and switched by computer circuitry.

The value or quantity being measured may be represented by a positioned display of multiple filament lights. The digital voltmeter is a fairly common example of the use of these lights.

APPLICATIONS

Digital computers are finding increasingly wide application in Navy aircraft. Some aircraft now operational, and others that will become operational in the near future, have computers installed as integral parts of the electronics system. Among the more common applications in Navy aircraft at present are the navigation systems, weapon delivery systems, tactical communications systems, ASW and ECM systems, and automatic flight systems.

The digital computer receives problems involving distinct and fixed numerical quantities, and produces the solution of these problems also as distinct and fixed quantities; that is, for a specific problem, the digital computer produces one specific answer which is based on the data supplied to the computer. If any factor in the problem is varied, it must then be treated as a new and different problem and the entire problem must be recomputed.

The digital computer expresses magnitude as a number of digits, and its accuracy is limited only by the number of significant figures provided. Increased accuracy can be obtained by utilizing more significant figures. The basic principle of operation of any digital computer is simply the process of counting.

The ability to make calculations is built into the computer by using appropriate combinations of relatively simple circuits. A computer also has the ability to retain information by storing it in memory banks. This information, fed to the computer by an operator, must be available whenever the operator calls for it.

When a computer performs an operation, it does so by comparing quantities representing data that have been placed into it. Its output consists of data that must be "read" and automatically translated into some form of understandable language.

There are two types of digital computers. The special purpose computer, designed to do a limited number of jobs, has a memory that is fixed (usually wired in). The general purpose computers, like the Univac, are capable of many jobs; but their circuitry, while fundamentally the same as that of the special purpose computer, becomes very complex when considered as a whole.

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Instructions are stored in the memory unit by a process called "readin." These instructions may be changed simply by reading in the desired new set of instructions. General purpose machines have great flexibility because of the ease with which the instructions may be changed; thus, they are able to do many jobs.

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CHAPTER 16

COMMUNICATION FACILITIES, PRINCIPLES, AND EQUIPMENT

DISTRESS FREQUENCIES AND PROCEDURES

The assignment of radiofrequencies is an extremely important problem. Increasing use of the radiofrequency spectrum, by civilian as well as military communicators, means that the portions of the spectrum available for Navy use are limited.

Maximum economy in frequency usage is therefore essential and must be constantly exercised by assignment authorities. To prevent harmful interference, thorough coordination of frequency usage is essential. Coordination of frequency usage, by international agreement, is a responsibility of the constitutional authority of the governments concerned. In the case of active theaters of operations, however, this responsibility rests with the theater commander. In other areas where the national authorities consider it expediant, coordination of military assignments is normally undertaken by frequency coordination committees. Committees have been established in areas throughout the world to arrange for speedy and satisfactory coordination of frequency assignments with a minimum of interference.

The publication which outlines distress procedures and frequencies is Communications Instructions Distress and Rescue Procedure, ACP135 (current edition). This Allied Communication Publication (ACP) was developed for allied use. The sections of this ACP which are of particular interest to the technician are reviewed briefly in part in the following paragraphs.

INTERNATIONAL DISTRESS FREQUENCIES

The following list contains certain frequencies which are especially important:

1. 500 kHz–International Calling and Distress, preferably A2 (MCW) or B (damped wave) for aircraft, or survival craft using frequencies in the band from 405 kHz to 535 kHz when requesting assistance from the maritime services. It is used for the distress call, distress traffic, urgency signal, and safety signal.

2. 2182 kHz–Maritime Mobile Service Calling and Distress, for radiotelephone stations working in the authorized bands between 1605 kHz and 2850 kHz.

3. 8364 kHz–International Lifeboat, Liferaft, and Survival Craft, for operators equipped to transmit on frequencies between 4000 kHz and 23,000 kHz who wish to establish communications relating to search and rescue.

4. 121.5 MHz–International Aeronautical Emergency, for aircraft and those aeronautical stations primarily concerned with the safety and regulation of flights using national or international civil air routes and operating in the band between 118 MHz and 132 MHz.

Two frequencies, 121.5 MHz and 243.0 MHz, are distress and emergency frequencies for use by units of the services of nations equipped to operate in the VHF/UHF band. These frequencies are used only to provide a communications channel between airborne and ground stations, or between surface craft experiencing an actual emergency or distress condition. Other aircraft or surface units in the area can utilize these frequencies in taking immediate action to allevi-

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ate or avert the distress or emergency condition; however, these frequencies are not intended for communications incident to a coordinated search and rescue operation.

The first transmission by an aircraft is on the air/ground frequency in use. If the aircraft is unable to establish communications on this frequency, it should broadcast the distress or urgency call on the aeronautical emergency frequency or on any other frequency in an effort to establish contact. However, prior to changing frequency, and if time permits, the aircraft should transmit an appropriate phrase or "Q signal" indicating the frequency to which it intends to change.

A number of communication channels are required to execute the various phases of search and rescue operations and to communicate with aircraft in distress. These channels are listed as follows:

1. Control channel for the operation of search aircraft.

2. Control channel for the operation of search surface craft (including submarines).

NOTE: The frequencies for channels 1 and 2 above are assigned by the local Theater Commander or the local agency responsible for the assignment of frequencies.

3. Communication between survival craft and search aircraft and surface vessels (including submarines). For communication between the survival craft or ground survivors of an accident and ground search parties, search aircraft, search vessels and ground or air monitoring stations, assigned frequencies are 500 kHz, 2182 kHz, and 8364 kHz, 121.5 MHz, and 243.0 MHz.

4. Intercommunication channels between search aircraft and surface vessels (including submarines) are assigned the frequencies 3023.5 kHz, 5680 kHz, 121.6 MHz, 123.1 MHz, 138.78 MHz and 282.8 MHz. The use of 121.5 MHz is also authorized if necessary, but this frequency should be avoided, if at all possible, for search coordinating purposes.

The 123.1 MHz channel is intended for use inside the NATO European area, the 121.6 MHz channel for use in the United States and Canada, and the 138.786 MHz channel for use outside these areas.

DISTRESS PROCEDURES

Distress Signals

In radiotelegraphy, the distress signal consists of the letters SOS (di di dit dah dah dah di di dit) transmitted as a single signal ($\overline{SOS}$) in which the dashes must be emphasized so as to be clearly distinguishable from the dots.

In radiotelephony the distress signal consists of the word "MAYDAY," which is derived from the French expression "m'aider." These distress signals indicate that the ship, aircraft, or other vehicle sending the distress signal is threatened by grave or imminent danger and requests immediate assistance.

Alarm Signal

When the international distress frequency of 500 kHz is used, the distress call should, if practicable, be preceded by the alarm signal (twelve 4-second dashes, with intervals of 1 second between dashes) using A2 or B emission. If circumstances permit, the transmission of the full distress call should be separated from the end of the alarm signal by an interval of 2 minutes. The alarm signal should always be followed immediately by the distress signal, $\overline{SOS}$, sent three times, in order to operate automatic apparatus which may depend on the distress signal for activation.

Distress Call

The distress call and message are sent only on the authority of the person in command of the ship, aircraft, or other vehicle carrying the mobile station. The distress call has absolute priority over other transmissions. All stations which receive it must immediately cease any transmission capable of interfering with the distress traffic and must listen on the frequency used for the distress call. This call is not addressed to a particular station, and acknowledgement of receipt is not to be given before the distress message (see below) is sent.

The distress call transmitted by radiotelegraphy consists of:

1. The distress signal, transmitted three times.

2. The prosign DE.

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3. The call sign of the mobile station in distress, sent three times.

When the distress call is sent by radiotelephony it consists of:

1. The distress word MAYDAY, spoken three times.
2. The proword THIS IS.
3. The identification of the mobile station in distress, spoken three times.

Distress Message

The distress call must be followed as soon as possible by the distress message. As a general rule, a ship signals its position in latitude and longitude and when practicable, the true bearing and distance in nautical miles from a known geographical point may be given. An aircraft in flight should, if time permits include in its distress message the following information:

1. Estimated position and time of the estimate.
2. True heading and indicated airspeed.
3. Altitude.
4. Type of aircraft.
5. Nature of distress.
6. Intention of person in command (such as forced alighting on the sea or crash landing).

After transmission of its distress message, the mobile station transmits two dashes of approximately 10 seconds duration each, followed by its call sign, to permit direction-finding stations to determine its position.

The distress message must be repeated at intervals especially during "periods of silence," as follows: For 3 minutes, twice each hour, beginning at 15 and 45 minutes past the hour on 500 kHz and on the hour and at 30 minutes past the hour on 2182 kHz in certain designated regions. ("Periods of silence" are defined as periods of time during which all transmissions, except those of an emergency nature, are prohibited. All stations are required to maintain a listening watch on international distress frequencies during these periods.) The intervals used with other repetitions must be long enough to allow time for stations preparing to reply to operate their transmitters.

Immediately before a crash landing or a forced landing (on land or sea) of an aircraft, as well as before total abandonment of a ship or an aircraft, the radio apparatus should be set for continuous emission.

Distress Action

A mobile station which learns that another mobile station is in distress may transmit a distress message if the station in distress is not itself in position to transmit it or if the person in command of the ship, aircraft, or other vehicle, carrying the station which intervenes, believes that further help is necessary.

Mobile stations receiving a distress message which, beyond any possible doubt, is from a mobile station in their vicinity, must immediately acknowledge receipt (unless under radio silence). If the station in distress is not in their vicinity, they must allow a short interval of time before acknowledgement in order to permit stations nearer to acknowledge without interference.

Every mobile station that acknowledges receipt of the distress message and is in position to render assistance, must, on the order of the person in command, transmit the following information as soon as possible; its identification, its position, and the speed at which it is proceeding to the station in distress. Before sending this message, however, the station must insure that it will not interfere with the emissions of other stations better situated to render immediate assistance to the station in distress.

Any mobile station which is not in position to render assistance, and which has heard a distress message that has not been immediately acknowledged, must take all possible steps (unless under radio silence) to attract the attention of other mobile stations which are in a position to render assistance.

Distress Traffic

Distress traffic comprises all messages relative to the immediate assistance required by the mobile station in distress. In distress traffic, the distress signal must be sent before the call and at the beginning of the preamble of any message.

The control of distress traffic is the responsibility of the mobile station in distress, or the mobile station which has sent the distress call.

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These stations may, however, delegate the control of the distress traffic to another station.

The station in distress, or any mobile station near the distress station, may request silence from any or all stations which interfere with the distress traffic. It addresses these instructions to all stations or to a particular station only, depending on the circumstances.

When distress traffic has ceased or when silence is no longer necessary, a station which has controlled such traffic transmits on the distress frequency (and, if necessary, the frequency used for distress traffic) a message addressed to all stations indicating that the distress traffic has ceased.

URGENCY SIGNAL

The urgency signal indicates that the calling station has a very urgent message to transmit concerning the safety of a ship, aircraft, or other vessel, or of some person aboard or within sight. It has priority over all other communications, except distress. When the urgency signal is sent from a mobile station, it must, as a general rule, be addressed to a specific station and may be transmitted only on the authority of the person in command.

In radiotelegraphy, the urgency signal consists of three transmissions of the letter group XXX; in radiotelephony, it consists of three transmissions of the word PAN.

When an urgency signal is sent and followed by a message intended for all stations and calling for action by all stations, the station responsible for its transmission must cancel the signal as soon as it knows that the action is no longer necessary. This message of cancellation must be addressed to all stations.

SAFETY SIGNAL

The safety signal indicates that the station is about to transmit a message concerning safety of navigation or giving important meteorological warnings. The safety signal and the message which follows are sent on the distress frequency. With the exception of messages transmitted at fixed times, the safety signal, when used in the maritime mobile service, must be transmitted toward the end of the first available period of silence.

In radiotelegraphy, the safety signal consists of three transmissions of the letter group TTT; in radiotelephony, it consists of the word "SECURITE" (say-cur-i-tay) spoken three times.

The following type messages should be transmitted without delay and must be repeated at the end of the first period of silence:

1. Meteorological warnings.
2. Presence of tropical cyclones.
3. Presence of dangerous ice, wrecks, or other imminent danger to maritime navigation.

PRINCIPLES OF SINGLE SIDEBAND

Single sideband is not a new method of radio communication. It was first conceived in 1915, and has been in use since 1927. The decided advantages offered by SSB (single sideband) make it desirable to develop this method of communication with the possibility that it may eventually replace the DSB (double sideband) in present use.

Production of SSB units was delayed principally because of design obstacles affecting the high degree of stability required in both the transmitter and receiver units. Modern techniques of manufacture have perfected oscillators and filter circuits with sufficient stability and accuracy to make SSB feasible. In the relatively short period of time during which SSB has been in use in naval communications systems, it has produced highly satisfactory results.

The purpose of this discussion is to explain how SSB signals are generated, transmitted, and received, and also present the advantages of SSB over DSB.

To aid in understanding SSB, this discussion presents a review of amplitude modulation and shows a comparison between SSB and present day DSB operation. SSB is amplitude modulation with one sideband and the carrier removed. A more complete discussion of modulation is covered in Basic Electronics, NavPers 10087-B.

There are several methods of obtaining SSB or "semi-SSB" operation. Television, for example, employs a method of transmission whereby most, but not all, of one sideband is suppressed. In some installations the carrier is greatly, but not entirely suppressed. The greatly suppressed carrier is called a "pilot carrier." The pilot carrier is used in the receiver for reference and automatic control. True SSB has

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UNIT IV - ORTHOGRAPHIC PROJECTION

Practice in Visualization — Lesson 3

OBJECTIVE: To practice visualizing the shape of objects.

RELATED INFORMATION:

A draftsman is never adequately equipped without the ability to visualize the shape of objects. Before he can produce any working or orthographic drawing, he must be able to visualize. Every idea in the design or invention of a piece of machinery comes into the mind in pictorial form. When this can be clearly seen, he then knows he has, so to speak, come of age. Coupled with other facets of the trade, he then can seek more learned areas, once he has firmly grasped visualization and the proper placement of views.

ASSIGNMENT:

Place a $\frac{1}{2}$-inch border all around the 17 x 22 inch sheet issued to you and divide the sheet into the number of spaces shown in the drawing on the next page. Draw the views as shown, Problems 1 to 16, and add the missing line or lines which will complete the drawing. The objects all have plane, inclined, or curved surfaces.

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the carrier and one sideband entirely suppressed, with only the remaining sideband to be transmitted. Personnel requiring more detailed information on single sideband communications principles than that contained in this manual may refer to Fundamentals of Single Side Band, NavShips 93271.

AMPLITUDE MODULATION

Without modulation, the output of a transmitter is radio energy that has a frequency corresponding to the station's transmitting frequency. This is usually referred to as an unmodulated carrier. The unmodulated carrier is a continuous wave (CW) signal and occupies essentially no bandwidth in the frequency spectrum. Any single radiofrequency (RF) signal can be represented by an infinitely thin vertical line on a plot of amplitude versus frequency.

If a radio wave is to convey voice intelligence, some feature of the wave must be varied in accordance with the voice intelligence to be transmitted. Amplitude modulation consists of varying the amplitude of radiofrequency waves at an audio rate. Amplitude modulation may be defined as the variation of the strength of the RF output of a transmitter at an audiofrequency (AF). In other words, the RF energy has to increase and decrease in power, according to the audiofrequencies. If the audiofrequency is high, the radiofrequency must vary in amplitude more rapidly than if the audiofrequency is low. At the receiver, if the audio note is loud in volume, the radiofrequency energy must be increasing and decreasing by a larger percentage than if the audio note were soft. Thus, the RF variation introduced by the modulation process must correspond in every respect with the AF variations.

High Level

High level plate modulation is so named because the audio signal is injected in the plate circuit of the final RF power amplifier. The plate circuit of the triode class C power amplifier, V1 of figure 16-1, is tuned to a resonant frequency of 1 megahertz which is the transmitter carrier frequency. The plate current is 100 ma and the plate voltage supply is 1,000 v. The grid input driving voltage is produced by an RF oscillator and a buffer amplifier (used to isolate the oscillator from the power stage).

An audio signal of approximately 1,000 volts (peak) having a sine waveform and a frequency of 1,000 hertz is produced by the AF section and

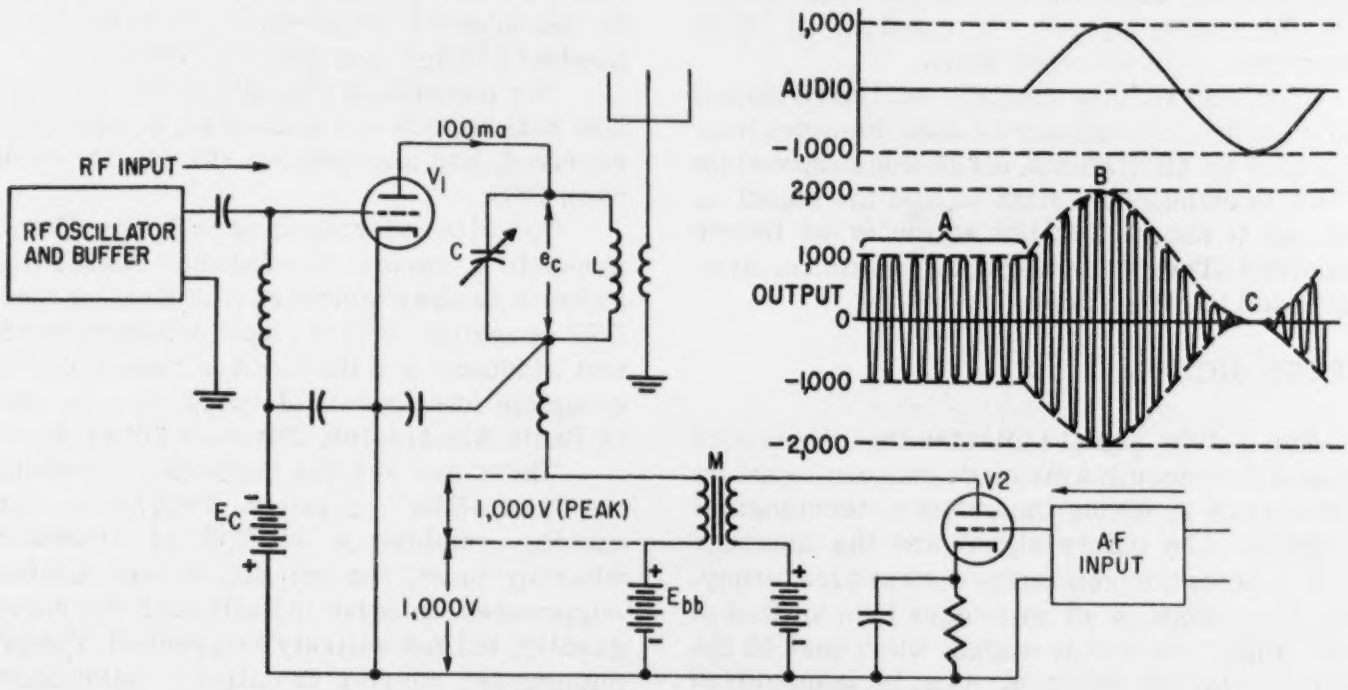

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Figure 16-1.–High level modulation.

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appears as an output of the modulation transformer M. This audio output voltage is in series with the RF tank circuit, LC, and the plate power supply of B+ voltage Ebb.

Before an audio-modulation signal is introduced, the RF signal applied to the grid of V1 causes the triode to conduct periodically. During each conducting period, capacitor C charges. When the grid swings below cutoff, the triode stops conducting and the capacitor discharges through the coil.

The exchange of energy between the coil and capacitor accounts for the RF voltage developed across the tank. In this example, the voltage across the tank capacitor C which receives its charge from the 1,000-volt B+ supply is 1,000 volts neglecting losses.

Plate voltage varies above and below 1,000 volts as the capacitor varies between +1,000 and -1,000 volts. The value of the plate voltage is above that of the B+ supply during the part of the cycle when the grid voltage is below cutoff and the triode is not conducting. Plate voltage is below the B+ supply voltage during the time the grid is above cutoff and the triode is conducting. The output of the transmitter is an unmodulated carrier corresponding to the A portion of the output waveform shown in figure 16-1.

Now, assume that the AF (1 kHz) sinusoidal voltage is introduced at M in series with the RF tank and the B+ supply. The frequency of the RF voltage developed across the plate tank is 1,000 times the audiofrequency. Thus the time for one complete audio cycle is long enough to include 1,000 cycles of RF energy in the tank circuit, LC. Consider that portion of the AF cycle in which the voltage is gradually rising according to the sine wave variation so that the polarity aids the voltage of the B+ supply. For 250 cycles of radiofrequency (one-quarter of one AF cycle), the total voltage available for charging capacitor C in the plate tank circuit is increasing from 1,000 volts to a maximum of 2,000 volts. Assume that the capacitor charges to 2,000 volts. The plate voltage at the end of the 250 RF cycles is a maximum of 2,000 plus 2,000 or 4,000 volts. Thus with 100 percent modulation, the value of the peak-to-peak voltage across capacitor C has approximately double the peak-to-peak value it would have without modulation, or four times the B+ supply voltage as shown at point B.

The tank voltage starts to decrease between the 250th RF cycle and the 500th RF cycle, as the AF voltage falls from a maximum of 1,000 volts to zero volts during this period. From the 500th to the 750th RF cycle, the polarity of the AF voltage is reversed and reaches a maximum negative value at the 750th RF cycle, and the tank capacitor charges up to the difference voltage between the 1,000-volt B+ supply and the instantaneous AF value. At the instant the AF voltage is maximum negative (-1,000 volts at the 750th RF cycle), the tank capacitor is not charging at all, the tank voltage is zero, and the RF output energy is zero (point C). The AF voltage starts to rise from maximum negative to zero and the opposition that it offers to the plate supply voltage is reduced. The plate tank capacitor starts charging again, the RF tank current again gradually increases, and the output voltage increases.

The transmitting antenna is coupled to the tank, and the instantaneous antenna current increases and decreases in accordance with the tank current variation. The signal transmitted is 1 MHz modulated at 1 kHz.

Percentage of Modulation

The degree of modulation is expressed by the percentage of the peak-to-peak voltage of the audio to the plate B+ voltage. The effect of a modulated wave as measured by receiver response is proportional to the degree or percentage of modulation.

The percentage of variation of the total voltage of the final RF amplifier stage in high-level plate modulation depends upon the ratio of AF to unmodulated RF plate voltage. For example, if the plate voltage of the RF amplifier is 1,000 volts, and the AF voltage is 1,000 volts, the two voltages add (when they are acting in the same direction) to give 2,000 volts. They subtract (when they are acting in opposite directions) to give zero volts. The modulated plate voltage of the RF amplifier varies between zero and 2,000 volts at the audio rate. Since the variation is equal to the RF voltage variation of 2,000 volts (peak-to-peak) the transmitter signal is said to be modulated 100 percent.

It is important that the transmitted RF energy be kept as close to 100 percent modulation as possible because the output of a detector in a

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radio receiver varies with the amplitude of the AF component of the received signal. This is why a comparatively low-power station, well modulated, will often produce a stronger signal at a given point than a much higher powered but poorly modulated transmitter located at the same distance from the receiver. The useful limit for the percentage of modulation is 100 percent; this is obtained when the modulating voltage is equal to the plate supply voltage of the modulation amplifier. Under this condition the plate voltage of the amplifier is alternately zero and double the supply voltage (peak values). If the modulating voltage is greater than the supply voltage, over modulation can result; this condition is normally avoided since overmodulation causes severe distortion of the signal.

SIDEBANDS

The circuit of figure 16-1 may be regarded as being composed of two sources of signal voltage and a common load in series. One source is the RF generator, the other is the AF generator, and the load is the resonant tank circuit coupled to the antenna.

When two frequencies are introduced into a circuit having a common nonlinear load impedance (the class C amplifier), these two frequencies combine to produce two additional frequencies. These additional frequencies are called sidebands or sideband frequencies; they are the sum and difference of the original frequencies. However, this is not the complete picture. The nonlinear device will heterodyne or "beat" to produce a theoretically infinite number of frequencies in the output. These exist at the plate of V1 in figure 16-1.

The frequencies fall into four groups:

1. Frequencies identical with those introduced. The amplitude of the current of each frequency in this group is proportional to the amplitude of the voltage of the same frequency in the input wave.

2. Frequencies which are twice the frequency of each component in the input wave—(second harmonics). Harmonics other than the second are produced, but they are very weak and easily dispensed with.

3. Frequencies which are equal to the sum of each frequency in the input with every other frequency in the input; in this case, carrier frequency plus modulating frequency, or upper sideband frequency.

4. Frequencies which are equal to the difference of each frequency in the input from every other frequency in the input; in this case, carrier frequency minus modulating frequency, or lower sideband frequency.

In this example of the principle of modulation, the two frequencies, 1,000,000 hertz (RF) and 1,000 hertz (audio) are impressed on the nonlinear impedance. The following distortion frequencies will also exist: 2,000,000 hertz, 999,000 hertz, 1,001,000 hertz, and 2,000 hertz.

When the carrier plus its upper and lower sidebands are transmitted through a tank circuit resonant at the carrier frequency, each component of a pair of sideband frequencies is shifted in phase. One is advanced and the other retarded by equal amounts as shown in figure 16-2. The curves show how the carrier and sidebands combine algebraically to produce an amplitude-modulated wave with 100 percent modulation by a steady tone.

Figure 16-3 illustrates that the only frequencies (contained in the total output) that fall within the range of the resonance curve are the 1000 kHz, the 999 kHz, and the 1001 kHz. The transmitter final amplifier plate resonant circuit is tuned to the carrier frequency and it attenuates all frequencies present at the plate except the carrier and its upper and lower sideband.

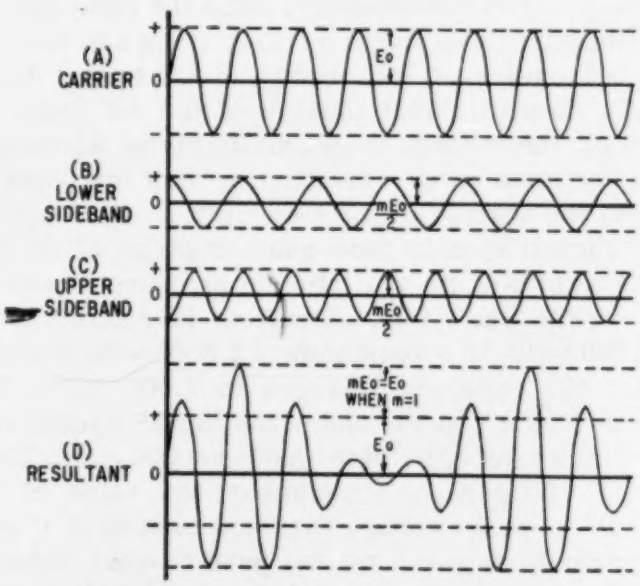

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Figure 16-2.–Modulation waveforms.

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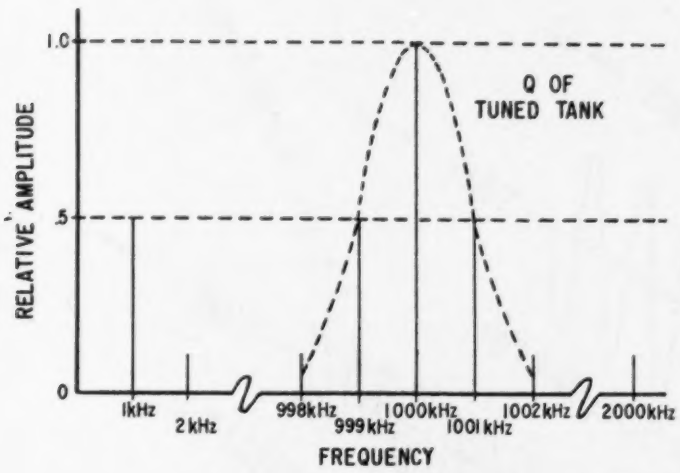

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Figure 16-3.—Selectivity curve.

In actual practice (for communication uses) the modulating wave is usually a complex wave instead of a simple sinusoidal one. In the case of speech or music, the modulating wave may be a wide band of frequencies. For example, if the modulating wave should include frequencies throughout the range of 100 hertz to 5,000 hertz and the carrier is still 1000 kHz (1,000,000 hertz), then two sidebands would be produced. The upper sideband would be from 1,000,100 hertz to 1,005,000 hertz, and the lower one would be in the range of 995,000 hertz to 999,900 hertz. For each component of the original complex audio input band there is a corresponding component in both the upper and lower sidebands.

Since the purpose of this discussion is to emphasize the sideband characteristics of RF waves, as related to communication, it is convenient to use a sideband label for amplitude modulation. This type of modulation can be called double sideband (DSB), to distinguish it from SSB. Double sideband is a better term because, instead of transmitting only one frequency, the antenna is actually radiating two sidebands plus the carrier frequency. These frequencies are close together and within the bandwidth of the RF amplifier resonant circuit.

Double Sideband Power Requirements

The amount of power required to modulate a DSB transmitter depends on the percentage and type of modulation. To modulate a carrier 100 percent with a pure sine wave of audiofrequency requires an audio power source equal to one-half the RF carrier power. With 100 percent modulation, the amplitude of each sideband is one-half the amplitude of the carrier. Power is proportional to the square of the current; thus each sideband contains one-half the current and one-fourth the power. This is shown in figure 16-4 which depicts the carrier and the sideband waveforms which are the resultant of modulating a 1000 kHz carrier with a 1 kHz tone, assuming 100 percent modulation.

As shown in figure 16-4 if power output is to remain constant, it would be necessary to increase the input power by 50 percent when shifting from unmodulated to tone modulated operation, assuming 100 percent modulation. In voice modulation the greatest portion of the AF components will not modulate the carrier 100 percent. Thus, the power requirements are considerably less than that required for tone modulation.

An amplifier in a modulation circuit must handle extremely high peak currents; up to four times the power it dissipates during the periods when no modulation is applied.

Demodulation

New frequencies are created in the process of demodulation. For example, if a 1 kHz signal modulates a 1000 kHz carrier, sidebands of 1001 kHz and 999 kHz are created as shown in figure 16-4. Also, if the 1000 kHz signal were made to modulate the 1001 kHz sideband, an upper frequency of 2001 kHz and a lower frequency of 1 kHz would be created. Provided that propagation does not cause any shift in their phases relative to each other, the 1 kHz signals are in phase. Note that 1 kHz is the original modulating frequency. This is the mechanism of the demodulation action. A carrier frequency and received sideband frequencies modulate one another and produce new frequencies, among which is the desired audiofrequency.

Sum and difference frequencies are important in the modulation and demodulation of DSB waves. To produce sum and difference frequencies, it is necessary to change the shape of the input waves. This is done by impressing the waves on a nonlinear device. DSB modulators and demodulators are usually nonlinear devices, such as class C amplifiers and diodes.

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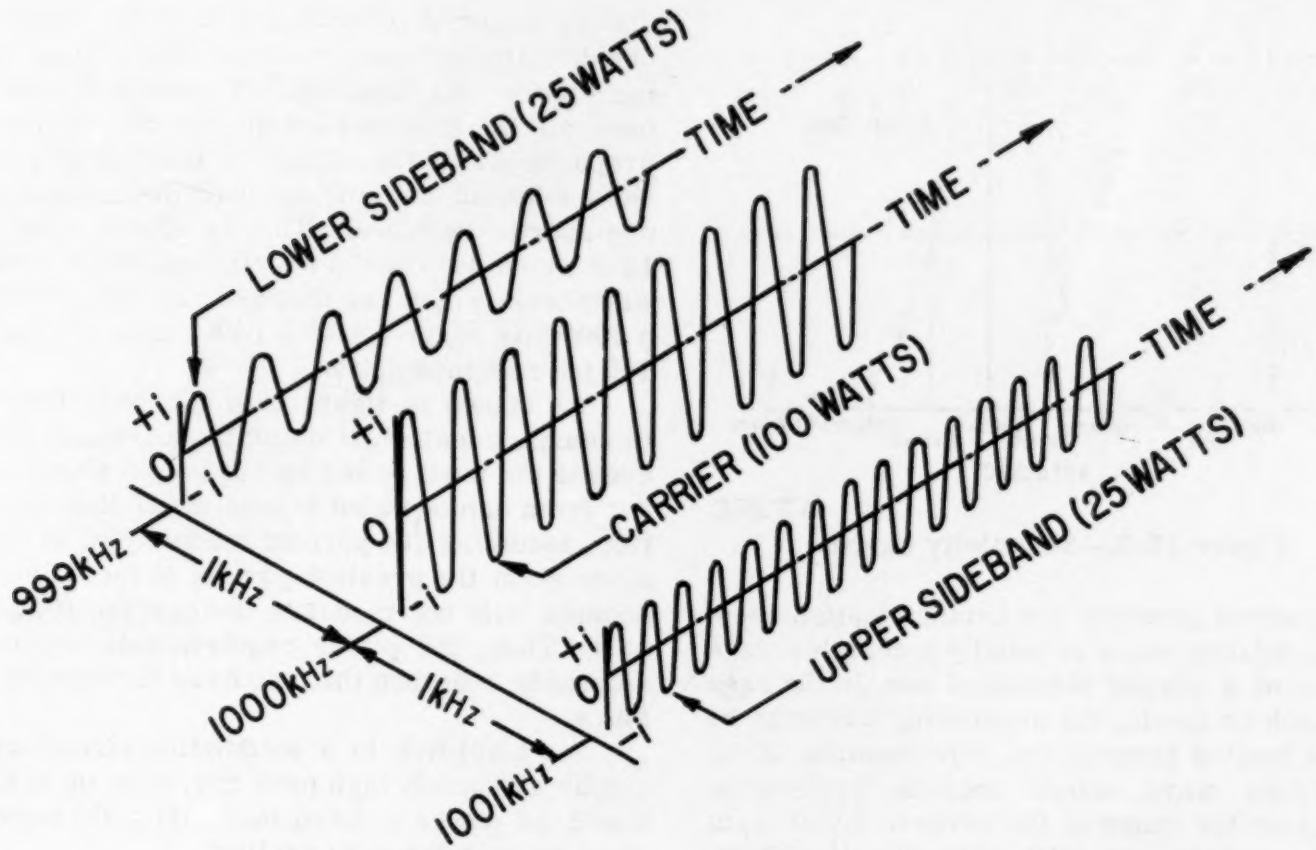

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Figure 16-4.—Carrier and sideband power.

It has been pointed out that in DSB systems there exists two sidebands that are demodulated in the receiver to produce a single audio signal that carries the voice intelligence heard in a speaker or headset. In the process of demodulation a signal equal to the original audio signal is produced from two sources; one by each sideband beating with a signal of the same frequency as the carrier frequency. Since either sideband contains all the intelligence, one sideband may be removed by a filter without interfering with the overall transmission of the original audio signal. The total RF transmission band covered would be cut in half if one sideband were eliminated, with the result that more channels could be operated within a given range of frequencies. In addition, distortion caused by propagation effects would be eliminated.

The only purpose of the carrier is to serve in the demodulation of the incoming signal. Since the carrier is used in the demodulation process, it is possible to eliminate the carrier at the transmitter and reintroduce it at the receiver. This carrier elimination is the major principle of SSB operation, and is discussed in subsequent paragraphs.

CARRIER AND SIDEBAND SUPPRESSION

The carrier may be eliminated or suppressed by some arrangement such as the balanced-modulator circuit shown in figure 16-5.

The carrier voltage is applied to the two modulator tubes in the same phase (push-push) while the modulator signal voltage is applied in opposite phase (push-pull) to the two grids by means of the center-tapped transformer. The outputs in the plate circuits of the two tubes are combined through a transformer with a center-tapped primary in such a way that voltages applied to the two grids in push-push cancel each other in the output (plate circuit); whereas voltages applied to the two grids 180° out of phase (push-pull) are added in the output. Thus the carrier voltage, which is applied to the two tubes

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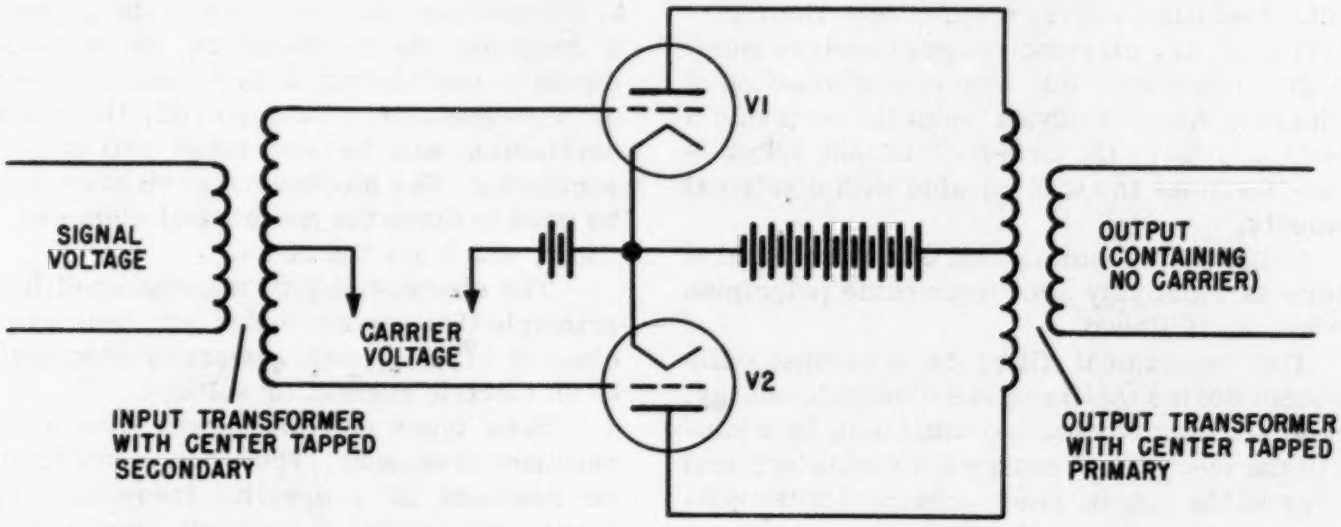

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Figure 16-5.–Balanced modulator.

in push-push, does not appear in the secondary of the output transformer. On the other hand, the sideband components (audio), which are applied in push-pull, are added in the output. The result is an output that is a modulated wave from which the carrier component has been removed.

The output from the balanced modulator tubes contains three of the four groups of frequencies already mentioned in the discussion of nonlinear devices. These groups are as follows:

1. Frequencies identical with the components of the signal voltage in the input, but none at the frequency of the carrier.

2. Frequencies equal to the sum of the carrier frequency and each component in the signal.

3. Frequencies equal to the difference between the carrier frequency and each component in the signal.

Now that the carrier has been eliminated, all that remains is to eliminate one of the sidebands. This can be accomplished by either the filter method or the phasing method. These methods are explained following a discussion of the various types of filters.

Both SSB transmitters and SSB receivers require extremely selective bandpass filters in the region of 100 kHz to 500.

In receivers, a high order of adjacent channel rejection is required if channels are to be closely spaced for conservation of spectrum space. In SSB transmitters, the signal bandwidth must be limited sharply in order to pass the desired sideband and reject the other sideband. The filter used, therefore, must have very steep skirt characteristic (fast cutoff) and a flat bandpass characteristic in order to pass all frequencies in the band equally well. These filter requirements are met by crystal filters, LC filters, and mechanical filters.

Suppression Devices

CRYSTAL FILTERS.–Until recently, crystal filters used in commercial SSB equipments were in the 100 kHz range. Such filters have excellent selectivity and stability characteristics, but their large size makes them subject to shock or vibration deterioration. Also, their cost is quite high.

Crystal filters with extended frequency range, and smaller in size, are being developed. These filters are more acceptable for use in SSB equipment.

LC FILTERS.–LC filters have been used at IF frequencies in the region of 20 kHz. However, generation of the SSB signal in this low frequency range requires an additional mixing stage to obtain a transmitting frequency in the high-frequency range. For this reason, LC filters are not widely used in SSB equipment.

MECHANICAL FILTERS.–Recent advancements in the development of mechanical filters have led to their acceptance in SSB equipment.

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Mechanical filters have excellent rejection characteristics, are extremely rugged, and are small enough to be compatible with miniaturization of equipment. Another advantage of the mechanical filter is a Q in the order of 10,000, which is about 100 times the Q obtainable with electrical elements.

Although the commercial use of mechanical filters is relatively new, their basic principles are well established.

The mechanical filter is a mechanically resonant device that receives electrical energy, converts it into mechanical vibration, then converts the mechanical energy back into electrical energy at the output. The mechanical filter consists basically of four elements:

1. An input transducer that converts the electrical input into mechanical oscillations.
2. Metal disks that are manufactured to be mechanically resonant at a certain frequency.
3. Coupling rods that couple the metal disks.
4. An output transducer that converts the mechanical oscillations back into electrical oscillations.

Figure 16-6 shows the elements of the mechanical filter.

The transducer may be either a magnetostrictive device or an electrostrictive device.

The magnetostrictive transducer utilizes the principle that certain materials can be made to elongate or shorten when in the presence of a magnetic field. Therefore, if an electrical signal is sent through a coil whose core is made of a magnetostrictive material, the electrical oscillation will be converted into mechanical oscillation. The mechanical oscillation can then be used to drive the mechanical elements of the filter, which are the disks.

The electrostrictive transducer utilizes the principle that certain materials, such as piezoelectric crystals, will compress when subjected to an electric current or voltage.

Both types of transducers have a natural resonant frequency. They are manufactured to be resonant at a specific frequency. Transducers are chosen for a particular application, such as the ability to pass the frequencies of one sideband and reject all other frequencies.

Figure 16-7 (A) is the block diagram of an SSB transmitter that utilizes mechanical filters. Filtering action by the mechanical filter (similar to that shown in fig. 16-6) is accomplished in the following manner. The first bandpass filter will receive only the two sidebands of the modulated signal from the low-frequency modulator. (Elimination of the carrier by the balanced modulator was explained earlier.)

The metal disks of the mechanical filter pass only the frequencies of the desired sideband. Although the transducer driving rod applies the frequencies of both sidebands to the

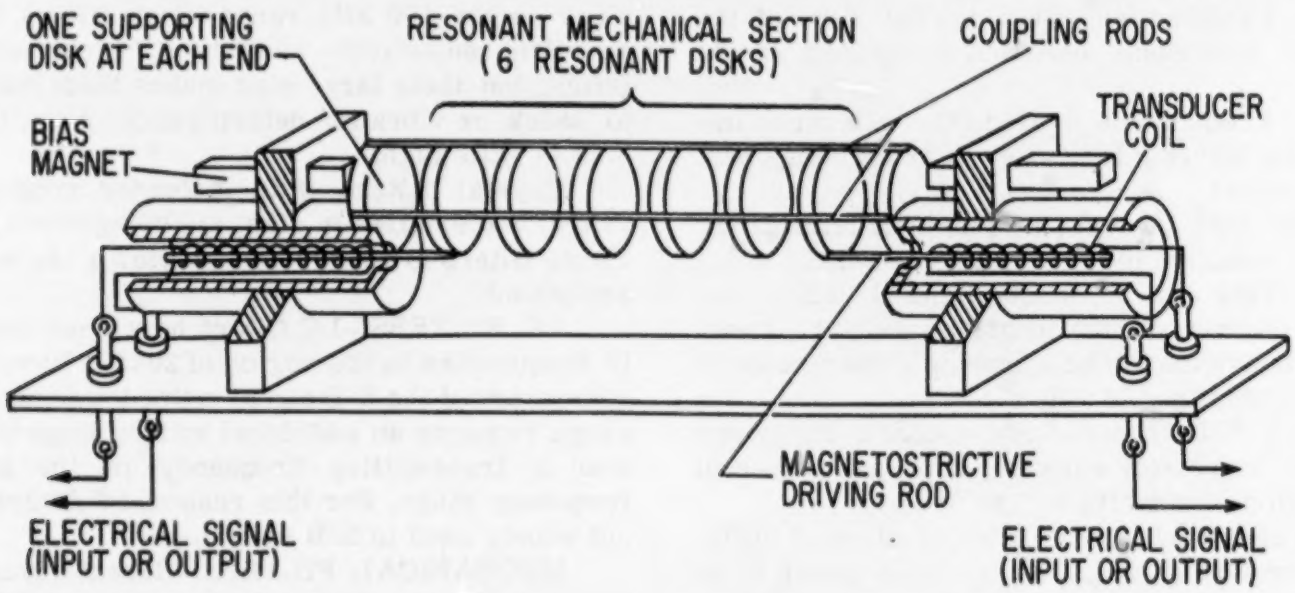

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Figure 16-6.—Mechanical filter.

the terminal end of the filter. It is interesting to note that either end of the filter may be used as the input, and either end used as the output.

By varying the mechanical coupling between the disks (that is, by making the coupling rods larger or smaller) the bandwidth of the filter is varied. Because the bandwidth varies approximately as the total area of the coupling rods (in magnetostrictive transducers), the bandwidth can be increased by using either larger coupling rods or more coupling rods. Mechanical filters with bandwidths as narrow as 0.5 kHz and as wide as 35 kHz are practical in the 100 kHz to 500 range.

Suppression Methods

The most simple and direct means of accomplishing SSB transmission by the filter method would be to filter out the carrier and one sideband of the conventional DSB system. This is not feasible since, if this system were used with conventional DSB transmitter circuits, filters capable of dissipating large amounts of power would be required in the transmitter output stage. This would result in a waste of power. To avoid this, the balanced modulators and filters are used in the low-power stages of a transmitter. The filter is required to accomplish the following:

1. Pass the desired sideband.
2. Limit the bandwidth of the desired sideband to that required for an intelligible communications circuit.
3. Provide adequate suppression of the undesired sideband.
4. Provide some attenuation of any remaining carrier frequency.

The ideal filter characteristics are shown as a solid line in figure 16-8. The solid line represents the ideal filter curve, which would pass only the upper sideband and reject the carrier and the lower sideband. The dotted line represents the filter curve that usually exists, which may vary depending on the type of filter used. A filter having those characteristics would be used as the first filter in figure 16-7 (A). In actual practice such a filter does not exist. But there are some filters that approach the requirements stated above, such as the electromechanical bandpass filter and the crystal lattice filter.

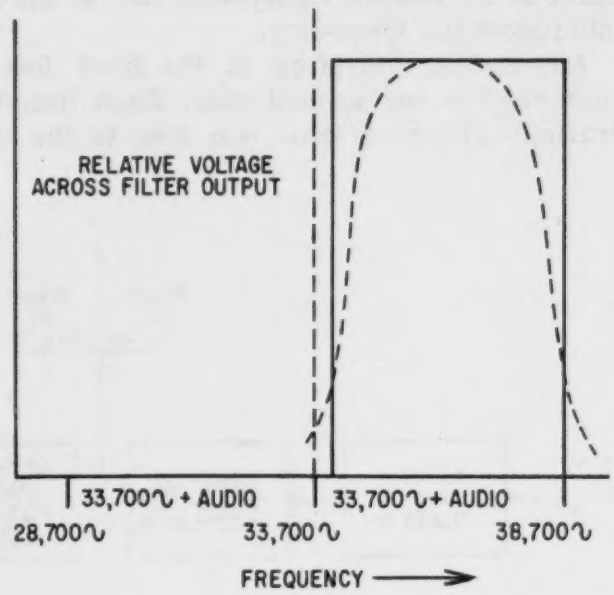

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Figure 16-8.–Filter characteristics.

Refer again to the block diagram in figure 16-7 (A) which is a block diagram showing the use of mechanical filters and a balanced modulator. The frequencies used in the illustration are the result of using a 2,000 hertz single-tone audio signal. In actual practice a complex audio signal would normally be utilized.

The 2 kHz audio signal is amplified and mixed in the balanced modulator with a 100 kHz carrier. Remember, the carrier does not appear in the output of the balanced modulator. When mixed, however, the sum and difference frequencies do appear in the output. The 2 kHz (fundamental) signal is so far from the frequency of the mechanical filter that it can be ignored. The dotted line shows where the carrier has been removed. Removal of the lower sideband is accomplished by the mechanical filter.

Because the remaining sideband is too low in frequency, it must be mixed again with a 3 MHz signal to raise it to the desired transmitter frequency. Again, the balanced modulator removes the two fundamentals and applies the two new sidebands (sum and difference) to the linear power amplifier. The input and output circuits of the linear power amplifier are tuned to reject one sideband and pass the other to the antenna for transmission.

In actual practice a high frequency oscillator, shown in dotted lines in figure 16-7 (A), would be used prior to the power stage. Also, the medium frequency oscillator is variable so that transmitter output frequency can be varied.

The power stage may be two or three power amplifiers. Since the carrier is suppressed in the balanced modulators and one sideband is removed by the filters, all of the transmitted energy is in the single sideband. This is sometimes called "talk power." Since only the talk power is radiated, it follows that when no audio is being applied to the transmitter there is no transmitter output, even though the transmitter is fully activated.

Since only one sideband is required for signal transmission, single sideband transmitters may be used to transmit two messages, one by the lower sideband and the other by the upper sideband. In order to do this, each message modulates the same carrier but in different modulators, as illustrated in figure 16-9. In a transmitter of this type, the outputs of the two modulators usually contain the same carrier (reduced) as well as the different sidebands.

Filter circuits are provided for removing the upper sideband from one modulator output and the lower sideband from the other. The remaining sideband frequencies are then radiated from one antenna along with the reduced or suppressed carrier. Thus, each of the two sidebands conveys a separate message and may be used to provide a separate audio channel. Reception of the two channels requires only one receiver with suitable circuits for separating and demodulating each channel.

Phase cancellation can also be used to eliminate the unwanted sideband. One system uses two balanced modulators connected as shown in figure 16-7 (B). Balanced modulator No. 1 has the carrier and modulating signals directly applied, while in balanced modulator No. 2 both signals are shifted 90° in phase. When the outputs of these two modulators (Nos. 1 and 2) are added, one phase is eliminated or canceled, and the other is reinforced.

SSB AMPLIFICATION

The most desirable combination of characteristics in linear amplifiers combines low distortion with maximum power gain. A linear amplifier is an amplifier having a certain power or voltage gain and an output waveform which exactly resembles the input waveform. Speech amplifiers or modulators are linear

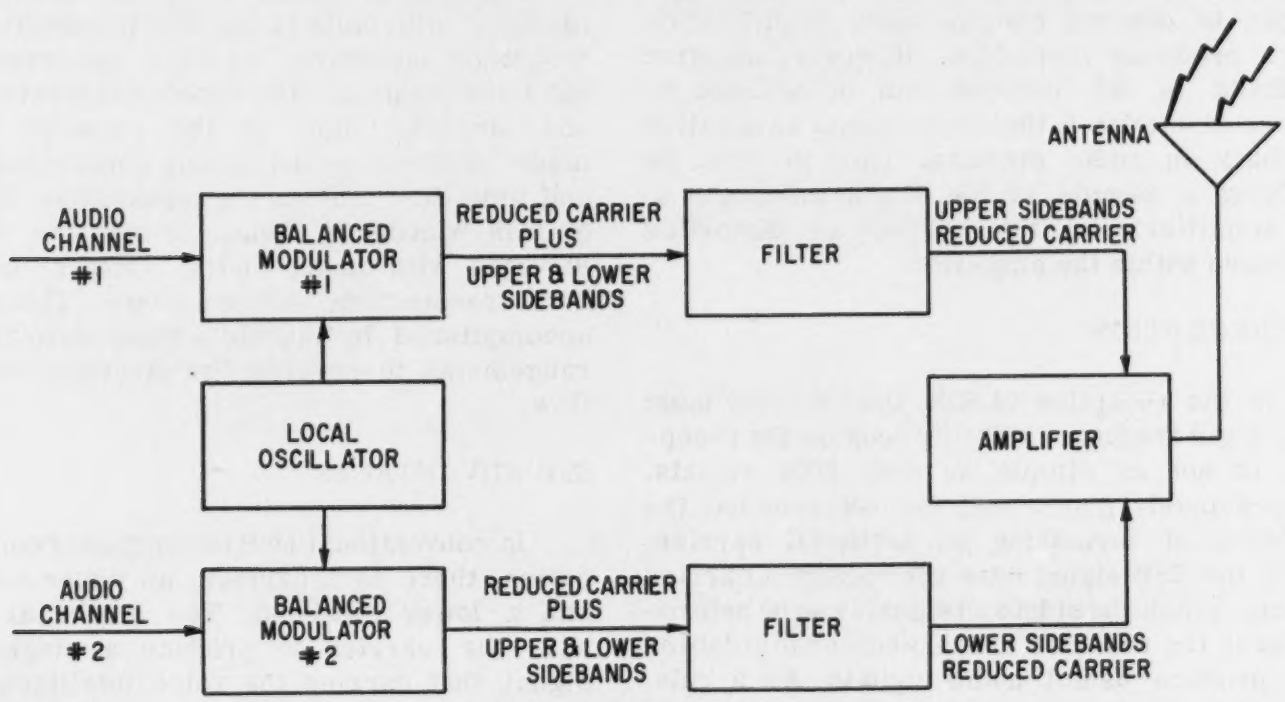

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Figure 16-9.–Two-channel SSB system.

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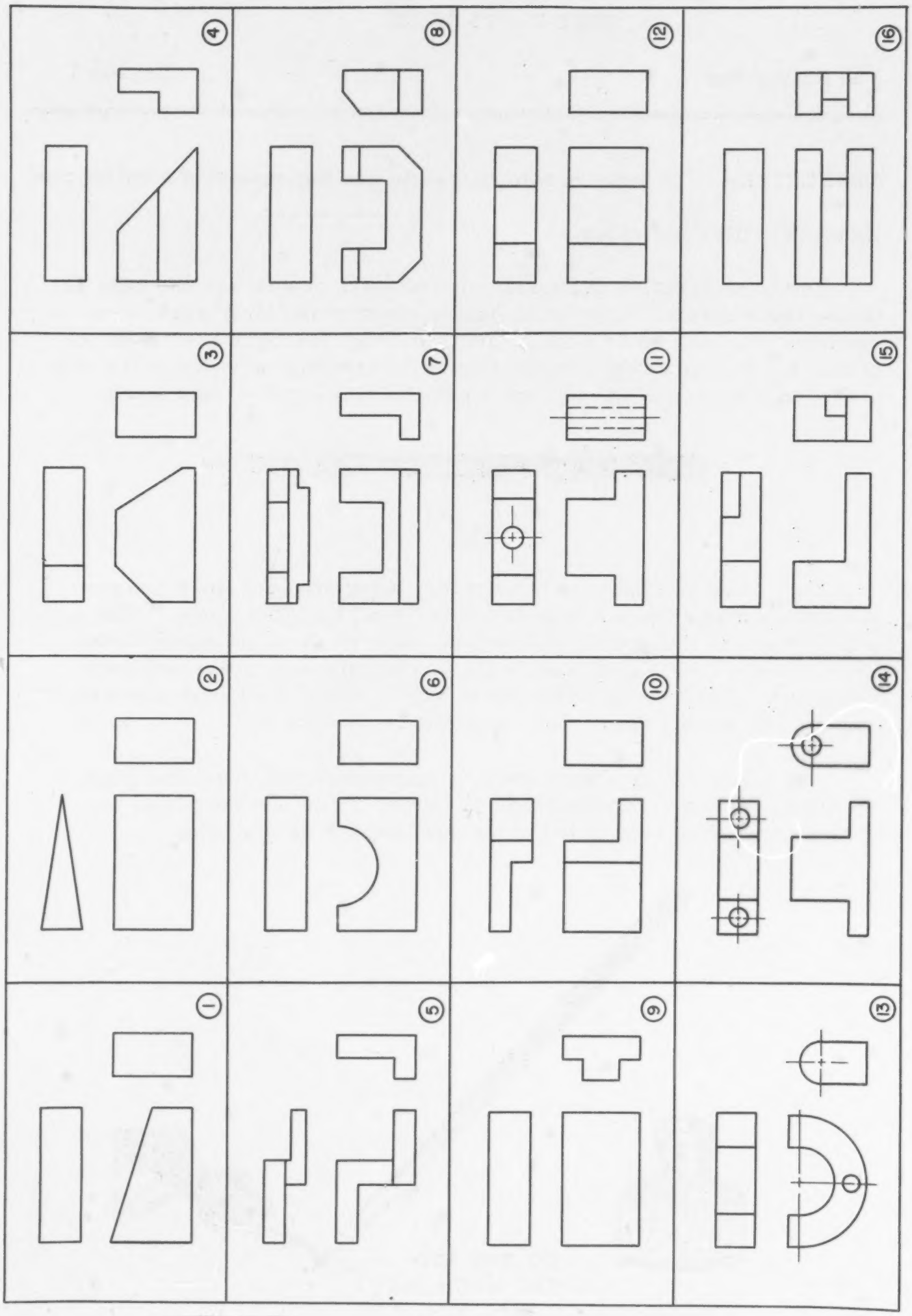

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amplifiers. The speech amplifiers are linear audio voltage amplifiers while the modulators are linear audio power amplifiers. The only difference between linear audio amplifiers, and SSB amplifiers is the frequency involved—one is audiofrequency and the other radiofrequency. The same operating conditions are used, such as plate voltage, bias, load impedance, and so forth, in both cases. As has already been mentioned, nonlinearity produces distortion and distortion is highly objectionable in SSB because it can produce splattering into adjacent channels. This splattering is easily detected by sensitive receivers.

Class A operation of amplifiers gives a high degree of linearity and they are usually the ones referred to when speaking of linear amplification. But these have low power gain, and thus would result in a considerable power loss in high-power transmitters. Class AB operation is used in amplifiers when higher power gain is needed. High gain is required in SSB amplifiers because the modulated signal is usually generated at low levels (1 watt or less). To raise this level to a kilowatt requires high gain. To obtain high gain with a minimum number of stages and circuits requires the use of high gain tetrodes or pentodes, usually operated class AB. A minimum number of amplification stages is desired because each amplification stage produces distortion. However, negative feedback in RF circuits can be utilized to reduce distortion in the same manner as negative feedback in audio circuits. This is done by applying a sample of the output waveform to the amplifier's input to correct any distortion produced within the amplifier.

SSB RECEPTION

In the reception of SSB, the receiver must have rigid frequency stability because the reception is not as simple as with DSB signals. As previously mentioned, the receiver has the problem of furnishing an artificial carrier, since the SSB signal does not contain a carrier against which the sideband signals can be heterodyned in the receiver to demodulate the sideband and produce useful audio signals. As a rule, the artificial carrier is furnished by a highly stable beat frequency oscillator in the receiver.

It is necessary that the SSB transmitter have the same degree of stability as the receiver. The maximum allowable drift between transmitter frequency and receiver frequency is about 50 hertz for good voice reception. A 50 hertz difference between transmitter and receiver will distort or change the pitch of the person's voice by 50 hertz. Although the intelligence is still there, it does not constitute "good voice reception."

Figure 16-10 is a block diagram showing the essential functions of an SSB receiver.

The receiver employs necessary switch and tuning circuits to receive any signal within its frequency range, and to switch from upper sideband to lower sideband reception.

After the received signal is amplified, it is applied to mixer stages that lower the frequency. This is done in the same manner by which the frequency was raised in the transmitter. The carrier, necessary for heterodyning in the detector, is then inserted. Notice that the carrier generator is controlled by a frequency standard, as is the stabilized master oscillator (SMO), to maintain rigid frequency stability. After detection the original 2 kHz signal is fed to conventional audio amplifier stages.

Many of the units of an SSB receiver are identical with units of the SSB transmitter. The frequency standard, carrier generator, and SMO are identical. The double conversion mixer and amplifier unit of the receiver can be made identical to the double conversion mixer and amplifier unit of the transmitter. Because of this similarity, transceivers can be constructed with much of the circuitry used for both transmitting and receiving. This can be accomplished by merely adding switching arrangements to reverse the direction of signal flow.

SSB ADVANTAGES

In conventional DSB techniques of communication, there is a carrier, an upper sideband, and a lower sideband. The sidebands "beat" with the carrier to produce a single audio signal that carries the voice intelligence that is heard in the speaker or headset. If the upper or lower sideband is shifted in phase due to

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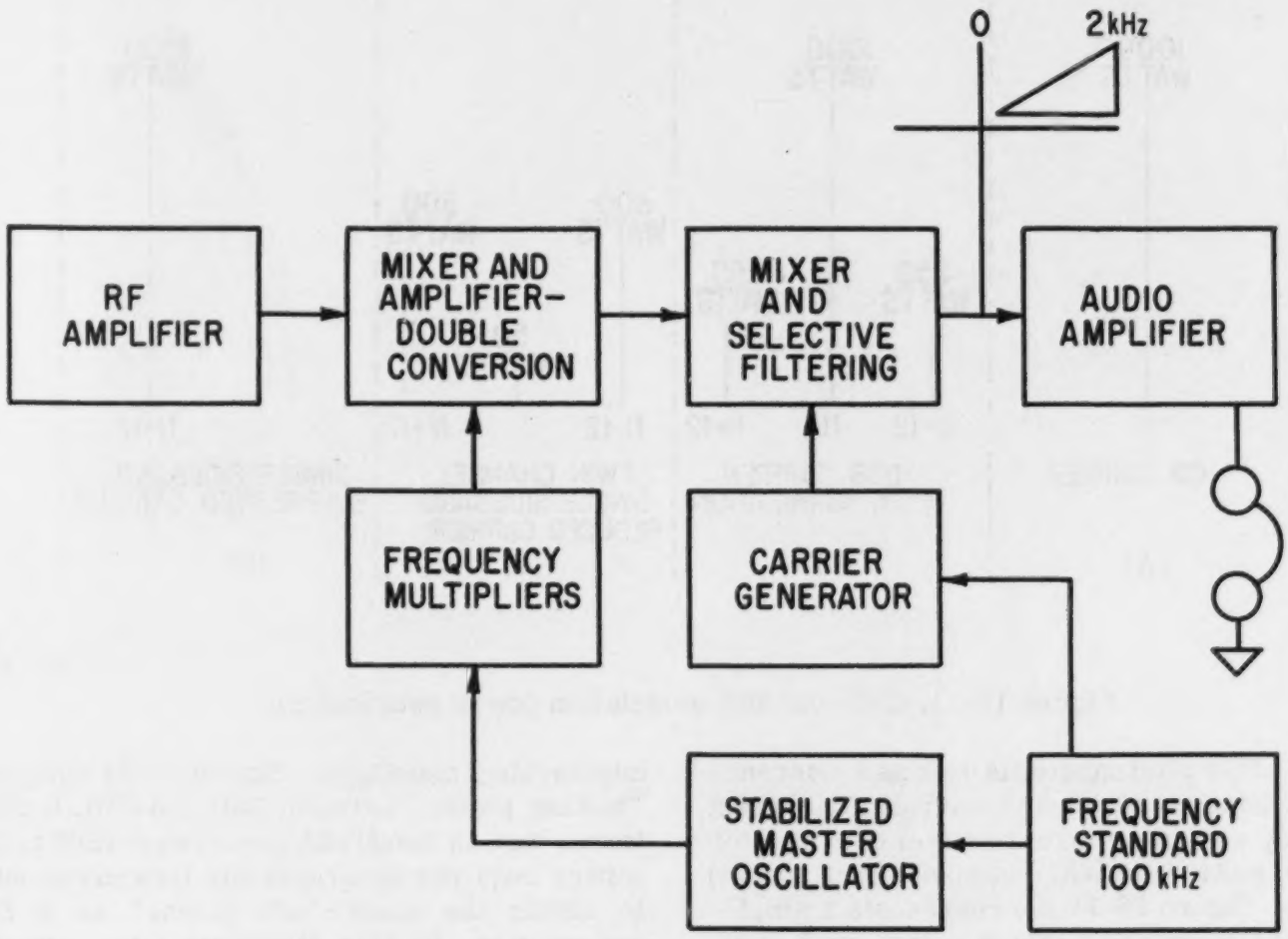

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Figure 16-10.—SSB receiving system.

multipath skywave propagation conditions, the signal heard is fuzzy, distorted, and in all probability quite loud. It is not uncommon to receive a report stating "loud but distorted." One sideband may experience a slight phase shift, thereby nearly canceling the other. The distortion produced causes the loss of intelligibility. Fading or slight phase shift of the carrier can also produce similar results. These problems reportedly do not exist in the suppressed-carrier type of SSB, particularly in the frequency range below 14 MHz.

In conventional DSB technique of communication, with 100 percent modulation, approximately (neglecting losses) two-thirds of the transmitter's radiated power is in the carrier, and the remaining one-third is divided equally between the two sidebands. DSB and SSB modulation relationship is illustrated in figure 16-11. An unmodulated carrier of frequency f1 with an average of 1,000 watts is shown in (A) of the figure. Information can be transmitted by keying the carrier on and off, as in CW. The entire 1,000 watts of carrier power is used in transmitting information. In figure 16-11 (B) the same transmitter is shown being modulated 100 percent by a single sinewave tone of frequency f2. The useful information is contained only in the upper sideband frequency (f1 + f2) and lower sideband frequency (f1 - f2) that exist on either side of the carrier frequency.

Notice that the useful power is only 50 percent of that attained by the CW in figure 16-11 (A). For practical voice modulation waveforms, this useful power may not exceed 30 percent of the total power. Figure 16-11 (C) represents a method of transmission known as a twin-channel single-sideband reduced-carrier system. (See fig. 16-9.) The carrier is not completely suppressed, but is reduced approximately 20 db in amplitude, serving as a pilot

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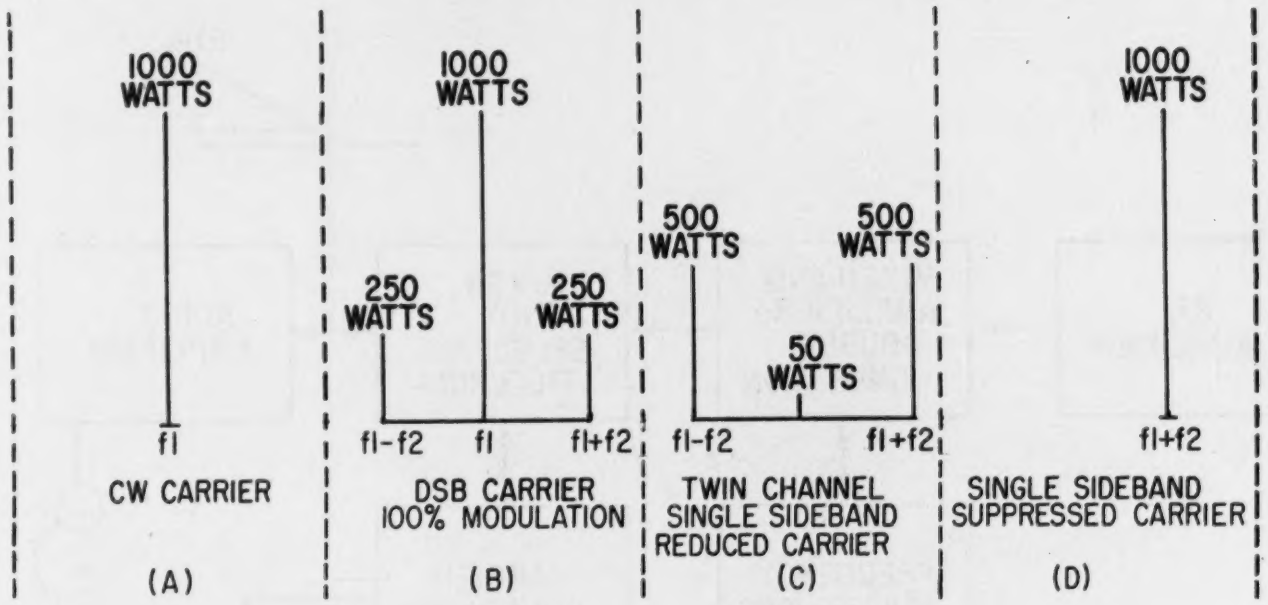

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Figure 16-11.–DSB and SSB modulation power relationship.

carrier. This pilot carrier is used as a reference for obtaining a reinserted carrier of correct frequency and phase in the receiver demodulator circuits, and for the AGC (automatic gain control) circuits. Figure 16-11 (D) represents a single-sideband suppressed-carrier system with complete suppression of the lower sideband and carrier. The only energy radiated by this method is modulation energy.

In this method a higher degree of oscillator frequency stability is required for both the transmitter and receiver circuits than for the method using the pilot carrier. Thus, with the suppressed-carrier SSB system, all of the power goes into the single sideband which carries the useful voice intelligence.

Since there are good and poor suppressed-carrier SSB signals as well as good and bad DSB signals, it would not be fair to compare a good DSB signal with a bad suppressed-carrier SSB signal, or vice versa.

In any system of comparison, it is essential that conditions under which the comparison is made be clearly defined. Figure 16-12 illustrates one method of comparison of suppressed-carrier SSB and DSB. The comparisons made here assume coherent detection of sidebands in DSB and also ignore the possible differences that can occur under various propagation and interference conditions. Figure 16-12 compares "talking power" between DSB and SSB. It illustrates that as bandwidth is decreased SSB transmitter requires progressively less power output to obtain the same "talk power" as a DSB transmitter. In this illustration the output of the DSB transmitter is 1,000 watts.

Figure 16-12 (A) illustrates that a 1,000-watt DSB transmitter will "talk" just as loud as a 1,000-watt SSB transmitter if both are received on a wide-band (6 kHz) receiver. Figure 16-12 (B) illustrates that under optimum conditions–that is, DSB received at bandwidth of 6 kHz and SSB received at bandwidth of 3 kHz–the talking power of a 500-watt suppressed carrier SSB transmitter is equal to that of a 1,000-watt DSB transmitter. Figure 16-12 (C) illustrates that if both DSB and suppressed-carrier SSB are received on a narrow bandwidth receiver, then the talking power of the 250-watt SSB transmitter is equal to that of a 1,000-watt DSB transmitter.

It has generally been accepted that, under normal operating conditions with moderate signal-to-noise ratios, the improvement in gain using SSB is between 6 and 9 db over the gain of an equivalent DSB transmitter. The suppressed-carrier SSB transmitter provides 6 db gain and the remaining db gain is derived from

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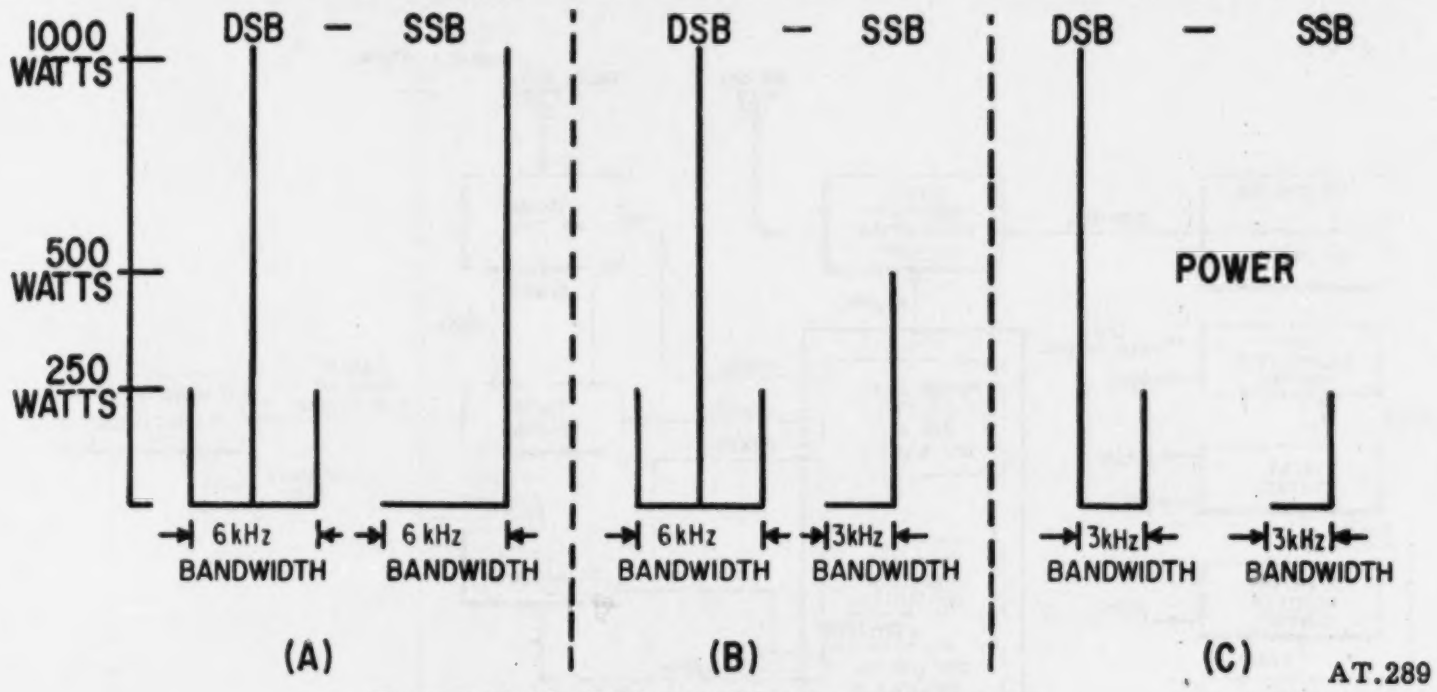

Figure 16-12.–DSB and SSB power comparison.

the narrow-band single-sideband receiver's selectivity. Propagation conditions determine the relative advantages of suppressed-carrier SSB over DSB. As the interference and/or selective fading becomes worse, SSB indicates a greater advantage over DSB.

Another advantage of SSB operation is that interference is reduced. In normal voice DSB communication, the carrier of the transmitter remains on the air until the transmitter is turned off. If a second transmitter transmits while the carrier of the first station is on the air, distortion results. Squeals and howls are caused by the heterodyning of two or more signals being transmitted at the same time. With SSB, as soon as the sender stops speaking into the microphone, "talk power" in the sideband leaves the air even if the transmitter is still on; receiving equipment is not affected by the SSB carrier (reduced carrier when used) alone.

When two SSB stations transmit at the same time, a receiving station can receive through the interfering station in the same way that an individual is able to listen to more than one conversation at the same time.

INTEGRATED COM-NAV-IFF SYSTEMS

The integrated communications, navigation, and identification system was brought about by the advent of the weapons system concept in naval aircraft. This system, called COM-NAV-IFF (CNI) in some installations and INTEGRATED ELECTRONIC CENTRALS (IEC) in others, is the natural result of the expanded electronic functions, restricted space, critical weight factors, and more severe environmental conditions imposed upon the newer high performance naval aircraft.

BASIC CONCEPTS

The integrated units for specific aircraft are designed to best fit into the overall weapon system of the aircraft. The system is designed to combine into one integrated system the functions previously performed by numerous independent electronic equipments. Figure 16-13 is a block diagram of a typical CNI system. Functional names of components are used; rather than AN nomenclature, since this diagram is representative of a general system rather than a specific aircraft configuration.

In most CNI systems the mounting racks serve a dual purpose. They act as shock mounts and in addition serve as a specialized chamber for distributing cooling air to each of the major components. In addition, components which contain high voltage circuits are pressurized to prevent arc-over at high altitude. The units

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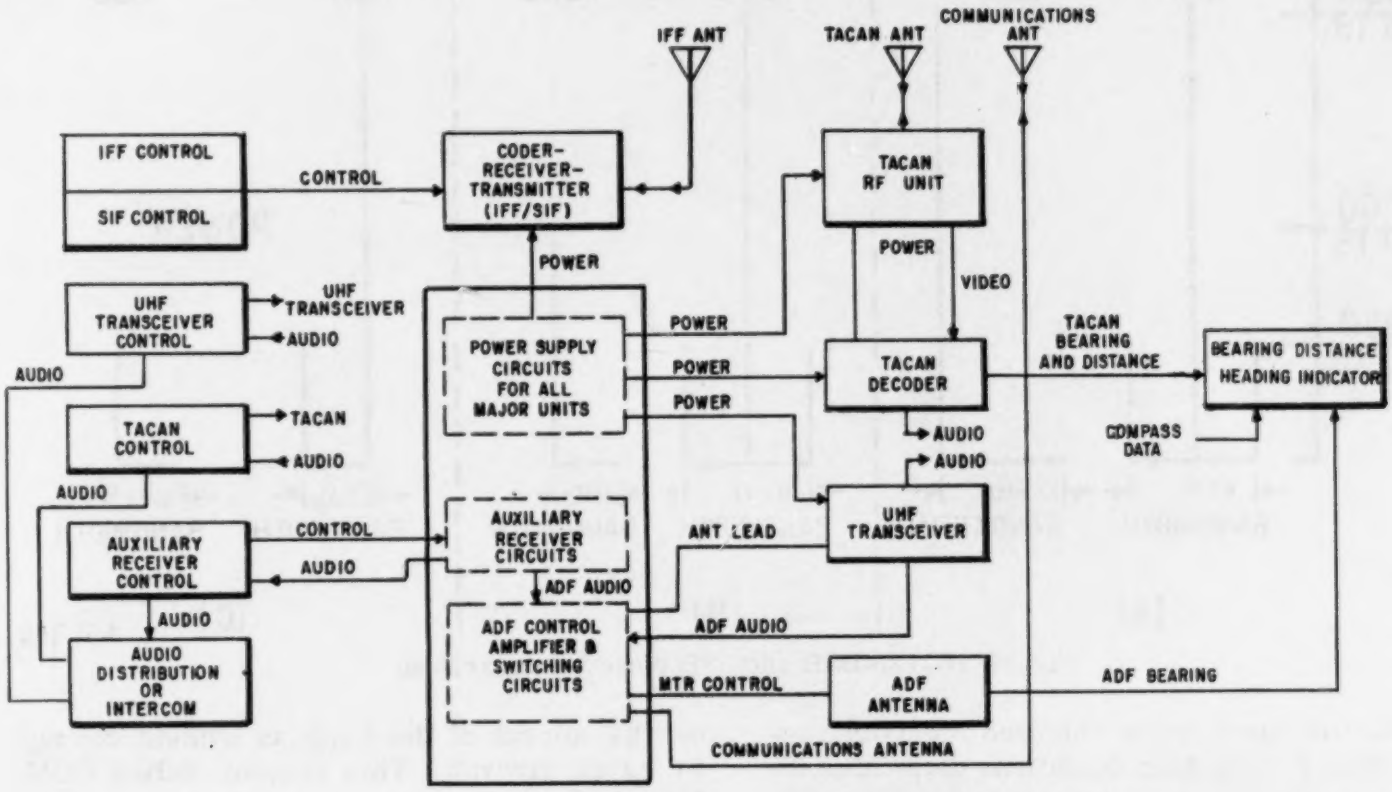

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Figure 16-13.–Typical CNI system.

which do not require pressurization are supplied directly with cooling air.

Communications Function

UHF radio communication facilities are provided by one or more transceiver units, permitting voice transmission and reception on any of 1750 channels in the frequency range of 225.0 MHz to 399.9 MHz. A separate fixed frequency guard channel receiver in the transceiver unit is normally tuned to the emergency frequency of 243.0 MHz. An auxiliary UHF receiver is also normally included in the system. This receiver operates on any one of 20 preset channels in the frequency range of 265.0 MHz to 284.9 MHz, and on an additional guard channel. The auxiliary receiver is employed with the UHF ADF system in order to provide independent UHF direction-finding functions without disrupting the normal communications facilities.

Navigation Function

The navigation function includes both TACAN and ADF. The TACAN facilities are provided by two units, a radio receiver-transmitter and a pulse decoder. The output of the pulse decoder is used to drive indicators which display bearing and distance to the selected TACAN beacon, deviation from a selected course, and TO-FROM information to indicate whether the selected course is to or from the beacon.

The UHF ADF can be operated using two receiver sources, the UHF communications receiver or the auxiliary receiver.

Indentification Function

The identification facilities are provided by a pulse type transponder which automatically radiates replies to interrogations from ground, shipboard, or airborne IFF stations. Either normal (Mark X IFF) or selective indentification feature (SIF) coding of the replies may be utilized. This facility performs the functions provided by both the AN/APX-6B and the AN/APA-89 in older aircraft.

Power Supplies

Power supply modules distribute power from a centralized source to the major units. Special emergency switching features remove power from certain navigation functions to reduce the load on the power source in case of flame out, generator failure, or other emergency. The specific functions which are not available in an emergency will vary from one aircraft to another; information on this subject may be found in the technical manuals for specific aircraft models.

The centralized power supply provides a means of saving weight in an integrated installation. The components utilized in power supplies are often very heavy when compared to other electronic components, therefore, combining the power supplies eliminates numerous heavy components.

F-4B CNI SYSTEM

The CNI system for the F-4B aircraft is the Integrated Electronic Central AN/ASQ-19. It provides UHF communications, TACAN and ADF navigation, radar identification (IFF), instrumentation, and interphone functions. It is packaged in five major units: UHF Communications, unit 1; Navigational RF, unit 2; Navigational Instrumentation, unit 3; IFF/Coder, unit 4; and Auxiliary Receiver/ADF/Power Supply, unit 5. Placement of these units as well as some minor units and associated components is depicted in figure 16-14.

Units 2 through 5 are mounted above and below a common shelf installed aft of the aircraft's nosewheel well. The shelf as a whole is shock-mounted; it provides interunit wiring and connections, and serves as a plenum chamber for refrigerated air. Of these four units, the Navigation RF Unit is the only one in a pressurized case.

UHF Communication Unit

The UHF communication unit (fig. 16-14, unit 1), is located in the aft cockpit; it, too, is pressurized, but has a self-contained blower circulating cockpit air through a heat exchanger. Accessories to the system include fore and aft integrated control boxes, unit 6; fore and aft station intercommunication system, units 7 and 8; ADF antenna, unit 9; and bearing-distance-heading indicator, unit 10.

In general, the modules, though improved for the CNI system, were utilized in previously developed Navy modularized equipment. Radio receiver-transmitter, unit 1, is designed to provide AM radiotelephone communication in the frequency range 225.0 MHz to 399.9 MHz. It operates on any one of 1750 frequency channels with 100 kilohertz spacing at 20 watts power output. A guard channel is provided by a separate guard receiver module incorporated as part of the circuitry of unit 1.

TACAN Units

The TACAN subsystem, units 2 and 3, uses pulsed radio signals from 962 MHz to 1213 MHz to measure aircraft distance and bearing to a TACAN surface station. There are 126 preset channels available to the operator.

Distance-measuring pulses originating in the airborne transmitter are transmitted to the ground radio station which acts as a transponder. Distance of aircraft to station is determined by measuring the elapsed time between the transmission of a challenging or interrogation pulse signal from the airborne transmitter, and the receipt of a corresponding reply pulse from the radio beacon.

Reference bursts and amplitude modulation intelligence are produced in the radio station to provide bearing and identification information for the aircraft. The radio station antenna pattern rotates at 900 rpm and produces a varying field intensity at the receiving antenna. This varying signal intensity produces the 15 Hz and 135 Hz amplitude modulation of the signal received by the airborne receiver. The reference bursts bear a constant relationship to the maximums and minimums of the rotating antenna pattern, and the consequent phase relationship of the AM and the reference bursts received by units 2 and 3 are used to determine the bearing of the aircraft with respect to the radio station.

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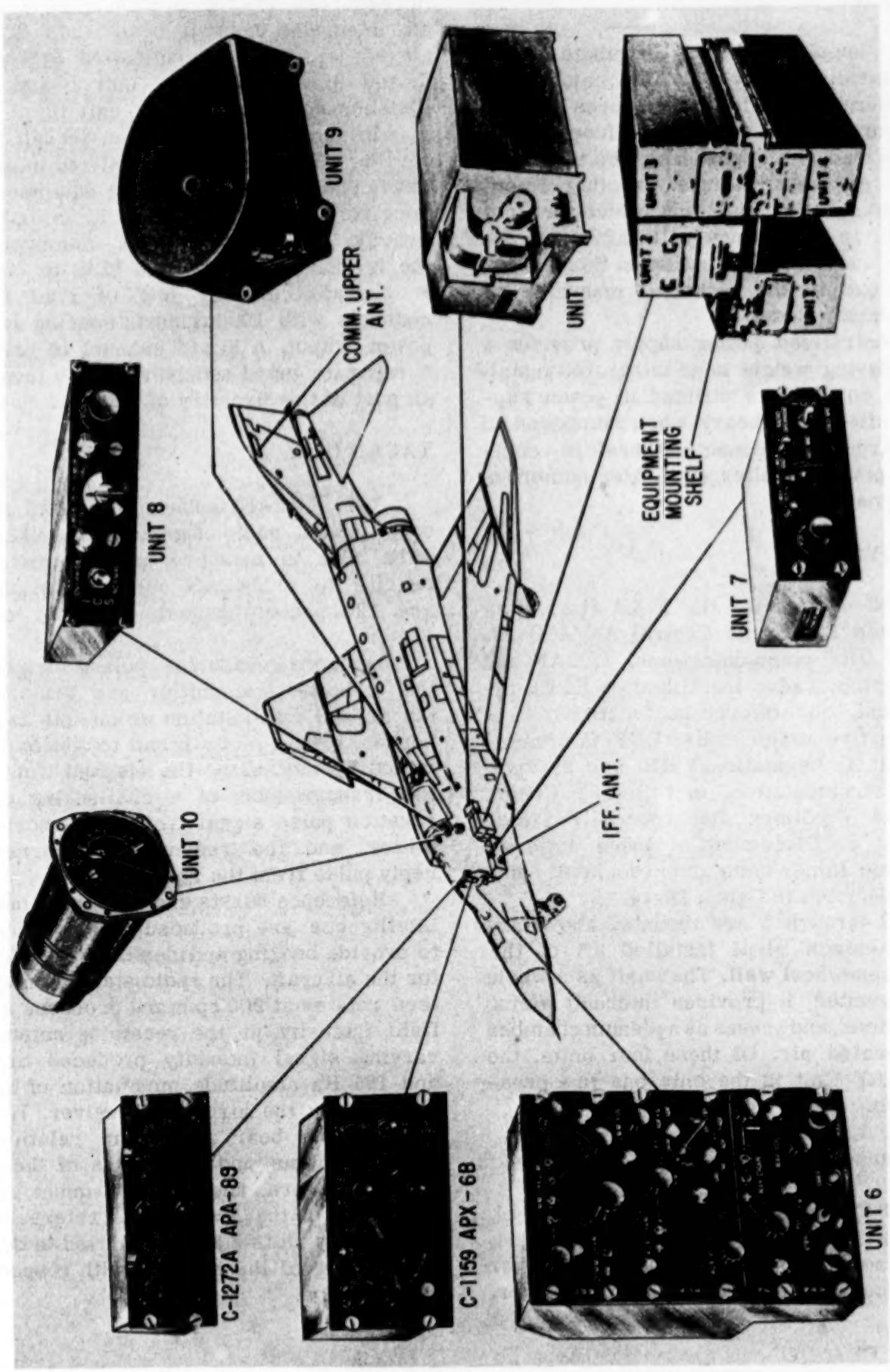

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Figure 16-14.–Integrated Electronic Central AN/ASQ-19.

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IFF Coder Unit

The IFF-Coder, unit 4, is a pulse type transponder using a single omnidirectional receiving and transmitting antenna. The equipment normally receives on 1030 MHz and transmits on 1090 MHz. An IFF control box (Radar Set control C-1159/APX-6B) is used to turn on the equipment and to select some of the modes of operation. The various Selective Identification Feature (SIF) reply codes for two of the three challenging signals are set up on an SIF control box (Radar Set Control C-1272A/APA-89). The third SIF code (mode 2) is set up directly on unit 4. Selection of Mark X or SIF replies is made by a switch on unit 4, and cannot be changed during flight.

The airborne antenna receives a challenging signal from interrogator equipment. This consists of pairs of pulses, with a definite time interval between the two pulses of each pair. The receiver detects and amplifies the signal and delivers it to the decoder circuits. If accepted by the decoder circuit in the equipment, the Mark X signal will go directly to the transmitter, and a reply signal is transmitted to the interrogator equipment, where the signal is then displayed on a radar indicator.

If the IFF-Coder is interrogated by an SIF challenge, the decoder output signal goes to a coding circuit in which a reply pulse train is generated. The pulse train is delivered to the transmitter. Upon being received at the interrogator, the pulse train is decoded, and the decoded signal is displayed on the the radar indicator.

Auxiliary Receiver/ADF/Power Supply Unit

The system central power supply portion of unit 5, provides the B + voltages of less than 500 volts necessary for operating all units of the system. The input a-c and d-c power is supplied from two separate sets of aircraft power buses designated main and essential. When an aircraft emergency arises, power is removed from the main buses and the emergency relays are energized automatically, placing the CNI system in emergency operation. The units operating after this emergency switching takes place are the UHF Communications Unit, at reduced power, and the radar identification (IFF) equipment. The ADF and TACAN functions are inoperative since the auxiliary receiver and TACAN B + voltage is removed.

For checking the system on the ground, external power is applied to the main aircraft buses through the ground power connector. A CNI ground power switch located in the left main wheel well is provided and must be manually thrown to energize the equipment. This switch is an electrically held type that must be reset if the ground external power is interrupted. Aircraft power bypasses this switch when the engines are operating; and during flight, the system cannot be deenergized.

The remaining portions of unit 5 are the ADF and the auxiliary receiver. The ADF subsystem uses either the auxiliary receiver in unit 5 or the main receiver, unit 1, in conjunction with the ADF antenna, unit 9, to determine the bearing to a received station. The antenna element has a cardioid pattern which is switched 180° at a 100 Hz rate. The switching action produces modulation on the RF signal (which is detected in the receiver and supplied as an error signal to a servoamplifier). The servosystem positions the antenna element until it is alined with the wave front of the received signal. The antenna maintains this relationship with respect to the signal throughout normal flight maneuvers of the aircraft. The position of the antenna element, relative to the aircraft, is transmitted to the Bearing-Distance-Heading Indicator (BDHI), unit 10, and displayed on the No. 1 pointer. ADF information is also supplied to the Horizontal Situation Indicator (HSI), a part of the instrument system.

The auxiliary receiver in unit 5 is normally used for ADF, and it provides 20 preset channels over the 265.0 MHz to 284.9 MHz range, plus one guard frequency channel at a fixed 243 MHz.

Integrated Control Unit

The communication and navigation functions of the AN/ASQ-19 are controlled by the integrated control, unit 6, selected by the "take command" relays. Two take command pushbotton switches are located on the lower position of each unit 6. One, labeled COM CMD, determines who has control of unit 1. The other, labeled NAV CMD, determines who has

control of TACAN. The frequency control for the communication system, the auxiliary receiver, and TACAN are independent of each other. The TACAN function selector also is independent. The function selector switch provides selection of the UHF communication and auxiliary receiver functions.

Intercommunication Units

The intercommunication units, units 7 and 8, of the AN/ASQ-19 provide intercockpit communication in the F-4B aircraft. Unit 7 is the intercom station in the pilot's cockpit; unit 8 is the intercom station in the radar observer's cockpit. An external intercom connection is incorporated into the system for ground personnel. The intercom stations receive and amplify signals from units 1, 2, 3, and the auxiliary receiver of unit 5. In addition, the microphone output in either cockpit is connected to the transmitter of unit 1 by operating the push-to-talk button, thus allowing either pilot or radar operator to communicate. Two transistorized, encapsulated amplifiers are used in units 7 and 8 to amplify the AF output from the microphone and the external audio inputs. Emergency switching facilities allow any one amplifier to be bypassed in the event of their failure. This permits intercockpit communication to be maintained if one amplifier goes dead in each unit.

Antenna System

The antenna system of the F-4B has a pair of antennas, upper and lower, used for both the IFF and TACAN at L band frequencies with two independent automatic antenna switches. The antennas are standard annular slot antennas. A modified blade antenna is mounted in the fin cap and used for the upper communications antenna. A low drag blade is used for the lower antenna. The pilot has the option of selecting either antenna by an antenna selector switch located on the left console of the forward cockpit. The ADF antenna, unit 9 is located on the underside, aft of the radome. This antenna works in conjunction with either the auxiliary receiver or the UHF communication system, whichever is selected for the ADF function on the integrated control box.

Construction

In the CNI system aboard the F-4B aircraft, the modular construction concept has been applied. Circuits have been broken down into functional subdivisions and packaged independently as plug-in modules adhering to a standard size factor. A major functional unit consists of a group of these modules mounted on a chassis in a case which provides interconnecting wiring, radio interference filtering, and cooling distribution.

The modular approach has given a high degree of flexibility in view of the mission and space considerations of this aircraft. It has also reduced costs and accelerated the engineering production cycle, helping to put the full weapon system into the air faster.

Cooling System

Improved thermal design is another important feature of the CNI system. Basically, the problem is to maintain the surface temperature of each component in the system at a value which will insure a high degree of component reliability. This must be done with a cooling system having the smallest possible size and weight.

Neither natural convection and radiation nor the use of integral blowers are acceptable means of cooling if high ambient temperatures (due to local heat dissipation or high aircraft skin temperatures) exist in an equipment rack. The problem is aggravated at extreme altitudes where mass flow from integral blowers drops to negligible values. A forced-air cooling system using an outside source of cooling air is required to hold the component temperatures within acceptable limits.

Since the cooling system must be held to a minimum size and weight, the CNI system is designed to minimize the power dissipation required. Careful circuit design keeps the dissipation in each module as low as practicable. The elimination of individual blowers with their inherent heat dissipation, and the use of a central power supply further reduce the overall heat produced in the system. High temperature components are used as extensively as possible to reduce the amount of cooling air required. Finally, and perhaps most im-

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portant, the flow of cooling air through each module is carefully controlled to give a high degree of cooling efficiency and still prevent overcooling of any module. In this manner, the required capacity of the cooling system is kept at a minimum, and the reliability and total life of the equipment are extended to a maximum.

COMMUNICATIONS RECEIVERS AND TRANSMITTERS

One of the duties of a technician may be to operate and maintain many different types of aircraft communication equipments. These equipments differ in many respects; however, in other respects they are similar. It is beyond the scope of this training manual to present information that relates to all of the many different equipments; therefore, only representative sets are discussed.

Distinctive features of naval airborne communications equipment include automatic tuning, subassembly and modular types of construction, shock mounting of major units, and pressurization, as well as the electronic components and circuitry employed.

Automatic tuning, which makes possible rapid selection of preset channels, is used in most modern naval airborne communication systems. This feature is essential because channel changes must be made accurately and quickly. Since the automatic system provides great simplicity of control, the entire operation is usually accomplished by means of a single dial.

The use of shock mounting is required because of vibration and the extreme physical forces present in normal operation in aircraft. The construction of electronic equipment in subassemblies and modules simplifies maintenance and repair. It permits the removal and replacement of sections containing defective or malfunctioning parts without dismantling the entire equipment.

All radio communication equipments, whether military or civilian, are designed for operation within certain well-defined frequency limits. In this chapter the terms used in reference to frequency bands designate major portions of the radio spectrum as discussed in chapter 9 of this manual. The designations and abbreviations are those in general use.

GENERAL PURPOSE RECEIVER AN/ARR-41

Radio Receiving Set AN/ARR-41, consisting of the receiver R-648/ARR-41 and its mounting, is a radio receiver that finds general application in naval aircraft. It is a superheterodyne receiver capable of receiving RF signals from 190 kHz to 550 kHz and from 2 MHz to 25 MHz, covered in five frequency bands. A mechanical type counter, located on the front panel of the receiver, indicates the frequency (in megahertz) of the received signals. It can receive signals which are of the AM, unmodulated CW, or frequency shift keyed types. Accurate frequency calibration is obtained through a built-in circuit consisting of a 500 kHz crystal-controlled oscillator and a multivibrator. Construction is of the subassembly design.

The Service Instruction Manual for the receiver presents in detail the theory and operation of the receiver, the maintenance, test, and alinement procedures and specifications, and the complete list of test equipment required. Only a brief summary of the theory of operation of the (R-648) ARR-41 is presented in this chapter.

Theory of Operation

This receiver employs double conversion; that is, all received RF signals (except for band 2) are first converted to a variable IF, amplified, and then converted to a fixed IF. (Band 2 covers the range of 2 megahertz to 4 megahertz; signals within this band are shunted around the first converter, or mixer.) Some of the benefits obtained by double conversion are high gain and sensitivity.

For CW reception the set employs a beat frequency oscillator (BFO), with a control for variable pitch or tone. A CW signal contains no modulation, so a separate oscillator must be built into the receiver in order to receive CW. The principle of the BFO is discussed in Basic Electronics, NavPers 10087-B.

Figure 16-15 is a block diagram of the receiver. Reference to this diagram, in connection with the discussion that follows, simplifies the explanation of the receiver's operation. Particular attention should be paid to the direction of the arrows.

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UNIT V - TRACING

The Ruling Pen Lesson 1

OBJECTIVE: To learn how to correctly use and maintain a ruling pen.

RELATED INFORMATION:

Every prospective draftsman should learn how to use and care for inking instruments. More than likely, some of the first work he encounters will have to be done in ink. Although inking doesn't hold the prominent position it once maintained in the drafting field due to its cost, many industries still have all or a portion of their drawings inked.

FIG. 1

The ruling pen (Fig. 1) is used for inking straight lines and non-circular curves. A pen in poor condition will render sloppy, dull lines, whereas a properly sharpened, clean pen makes sharp, clear lines. Every draftsman must learn to keep his pens clean and well sharpened. This can be achieved by wiping them clean with a moist rag and sharpening them when required on an oilstone.

The ruling pen is always used in connection with a guiding edge, T-square, triangle, straightedge or curve. The T-square and the triangle should be held in the same postions as for penciling.

FIG. 2

The incoming RF signal is received by the antenna and applied to one of five tuned circuits, depending upon the band of reception. The signal is then applied to the grid of the first RF amplifier, V701, for amplification. After the first stage of RF amplification, frequencies within the range of bands 1, 3, 4, and 5 are applied through tuned circuits to the second RF amplifier and then through more tuned circuits to the first mixer, V703. The function of the first mixer is to heterodyne the output of the RF oscillator, V601, with the incoming RF and produce a variable IF of 2 MHz to 4 MHz. Band 2 frequencies are 2 MHz to 4 MHz without heterodyning and therefore are switched around the second RF amplifier and first mixer circuits. (The switches in the block diagram are shown in band 2 position.)

At this point, any signal, regardless of the original frequency, is within the range of 2 MHz to 4 MHz and is applied through the variable IF tuned circuits to the variable frequency oscillator converter, V15001. Mixer V15001 heterodynes the variable IF 2 MHz to 4 MHz signal with a locally generated 2.5 MHz to 3.5 MHz signal, producing an output of 500 kHz, the fixed intermediate frequency.

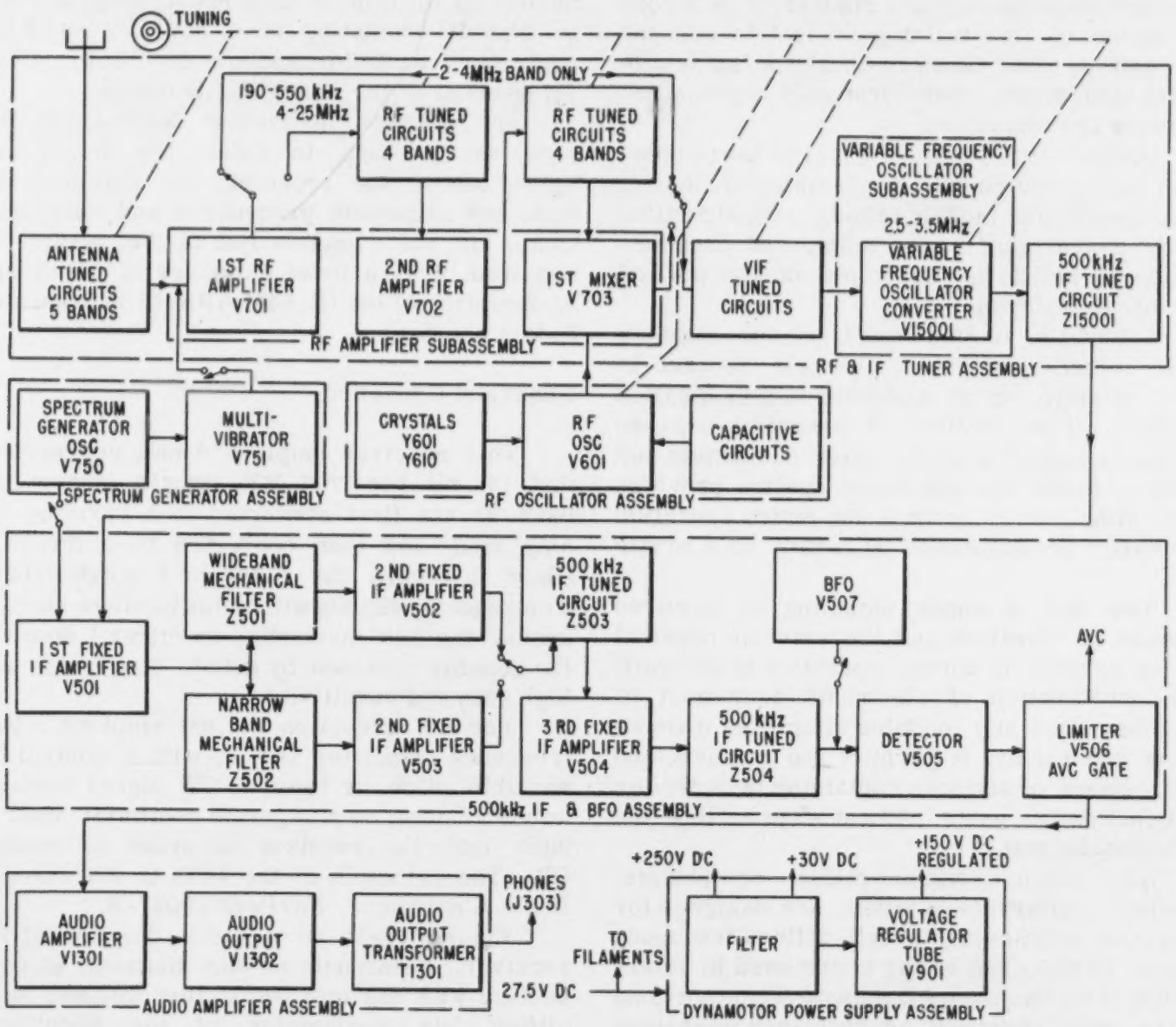

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Figure 16-15.–Block diagram of Radio Receiver R-648/ARR-41.

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The 500 kHz signal is applied to the grid of V501 for first IF amplification. This output passes through either a broad band or narrowband mechanical filter (fully explained in chapter 16 in connection with single sideband) and through one of two second IF amplifiers. Bandwidth selection (broad or narrow) depends upon the setting of the emission switch. The IF signal is then applied through another tuned circuit to the grid of the third IF amplifier, V504, the plate circuit of which contains the IF tuned circuit Z504. Tuned circuit Z504 couples the output of IF amplifier V504 to the detector tube V505. The functions of V505 are to recover the modulation component of the IF signal (detection) and to produce a negative voltage proportional to the carrier level for automatic volume control (AVC).

The BFO may be switched into the detector input by operation of the emission switch to the CW or CW SHP positions. In this manner a beat note is produced with the 500 kHz IF signal, which is a variable tone to be used for CW reception. Output from the detector is applied to V506, the limiter and AVC gate. One-half of dual diode V506 functions as an AVC gate control and prevents application of AVC voltage to the various amplifiers until full receiver sensitivity has been reached. The other half of V506 is a noise limiter which suppresses undesired noise pulses. The output of V506 is an audio voltage proportional to the modulation of the incoming RF signal. Audio amplifier V1301 and audio output V1302 serve to amplify the audio signal. Phone jack J303 is connected to audio output transformer T1301, and is available on the front panel of the receiver.

The spectrum generator consists of a crystal-controlled oscillator and a multivibrator divider circuit. The crystal-controlled oscillator, V750, serves to produce an accurate 500 kHz signal. The 500 kHz signal is applied to the grid of the first IF amplifier, V501, and to one plate and grid of the multivibrator divider, V751. The multivibrator fires on every fifth input pulse and produces an output, to the first RF amplifier, of 100 kHz. This 100 kHz output signal is rich in harmonics and allows the RF circuits to tune to a particular harmonic, depending upon the resonant frequency of the tuned circuits. A beat note is produced as a result of heterodyning the 500 kHz signal applied to the first IF amplifier with the selected harmonic of the multivibrator. This beat note is heard when the receiver frequency is varied around the selected multivibrator harmonic and the correct receiver frequency is known on the basis of the counter reading. The counter may then be set to the exact 100 kHz multiple and calibration is completed.

Operation

Complete details regarding the operating procedures of the AN/ARR-41 are contained in the Operation Instruction Manual, NavAer 16-30ARR41-501. This discussion is presented only to provide a few details concerning capabilities of the receiver.

The emission selector switch has two positions which are used when noise interferes with reception of voice or CW signals. By switching to either of these two sharp positions, a narrowband filter is inserted into the IF circuit to reduce the effective noise level.

Selected frequency is indicated on three counter dials. Selected band is indicated on a fourth dial located immediately to the left of the frequency counters. Interpolation to within 0.1 kHz is made possible by the arrow located to the right of the right-hand counter.

Calibration and Maintenance

Calibration and maintenance procedures and specifications are contained in the Service Instruction Manual, NavAer 16-30ARR41-502. Organizational maintenance is made relatively easy and rapid because of the interchangeable subassembly type construction of the unit.

VHF TRANSCEIVER AN/ARC-44

Radio Set AN/ARC-44 is a subminiature airborne frequency modulated receiver-transmitter. It operates in the frequency range of 24.0 MHz to 51.9 MHz. Its primary function is to provide two-way voice communications between aircraft, or between an aircraft and ground stations. Normally, use of the equipment is limited to line-of-sight distances; by use of a retransmit feature (which requires a dual installation of AN/ARC-44) the equipment

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can serve as a radio relay, thus extending the operating distance. A second auxiliary function permits use of the equipment to home on any station within range. Another feature permits control of the other radio transmitters and receivers and the ICS equipment through the AN/ARC-44 control box switches.

The AN/ARC-44 is installed primarily in older type aircraft. It is not part of any specific integrated system, but is adaptable to almost any communication/navigation system in present use.

Input power requirement for the equipment is limited to 27.5 volts d.c. from the main aircraft supply. A dynamotor is used to convert the input power into +150 volts d.c., -150 volts d.c., and 27 volts 400 hertz single-phase a.c. These output voltages are then distributed to the appropriate circuits throughout the equipment.

Interunit connecting wiring is primarily of the cable harness type. Multiple-pin receptacles are mounted on each unit and mounting rack, with a central terminal box used to terminate the other end of each cable. Necessary connections are made within the terminal box.

Cooling of the main receiver-transmitter unit is accomplished by means of an exhaust air blower. Air leaks into the unit from its immediate surroundings, the air is heated by the operating equipment, and is then exhausted back into the space surrounding the equipment.

Double-conversion superheterodyne circuits are used in conjunction with the receiver circuits to change an incoming modulated RF signal in the range of 24.0 MHz to 51.9 MHz to a modulated IF signal of 2.9875 MHz; they are used in conjunction with the transmitter circuits to change a modulated 2.9875 MHz oscillator signal to a modulated RF output between 24.0 MHz to 51.9 MHz. In each case, the change is accomplished in two mixer stages.

Frequency modulation of the transmitted signal is accomplished by use of a reactance tube modulator and a "sidestep" oscillator. These stages produce a 2.9875 MHz carrier which is modulated by the incoming audio signal. (See fig. 16-16.)

The sidestep oscillator is a Lampkin type oscillator. It employs a free-running, temperature compensated circuit and operates at a center frequency of 2.9875 MHz. The oscillatory tank circuit consists of L1703 and C1707, together with trimmer C1708. The portion of L1703 between C1705 and a-c ground (at the top of C1706) is common to both the plant and grid circuits. It is through this common path that regenerative feedback occurs continuously.

One side of C1708 is placed at a-c ground potential to facilitate mounting of this capacitor. The tuning range of C1708 is determined by the position of the L1703 tap for feedback coupling capacitor C1705. Resistor R1706 is the grid leak resistor.

The advantage of this type of oscillator is that variations which occur in tube characteristics have a minimum effect on the tank circuit frequency. Temperature compensation within the tank circuit is achieved by making the end plate of C1707 from a bimetallic material. Any variations in tank coil inductance produced by temperature variations will be compensated by capacitance variations in C1707.

RF voltages appearing across the oscillator tank also appear across the phase shifting network in the modulator input by way of d-c blocking capacitor C1710. This network consists of resistor-capacitor combinations R1709/C1709 and R1712/C1711 plus the internal resistance (plate-cathode circuit) of V1703. The voltage drop across C1711, by reason of the phase-shifting network, lags the tank voltage by 90°. Since the modulator RF plate current responds in the same phase as the grid voltage, it also lags the tank voltage by 90°. The RF plate current flows through the tank circuit and vectorially adds with the current therein to produce a resultant current differing in phase from the original tank current. This is equivalent to adding a reactance to the oscillator tank or, in other words, to changing the oscillator frequency.

Because of the phase difference existing between the modulator plate current component and the original oscillator tank current component, the phase of the resultant current depends on the magnitude of either of these out-of-phase components. This characteristic is used to produce the frequency modulation.

Audio voltages applied to the control grid of the modulator change the magnitude of the RF plate current in direct proportion to the audio voltage swing. Thus, due to the changing RF plate current components, the phase of the resultant tank current (and the frequency of the

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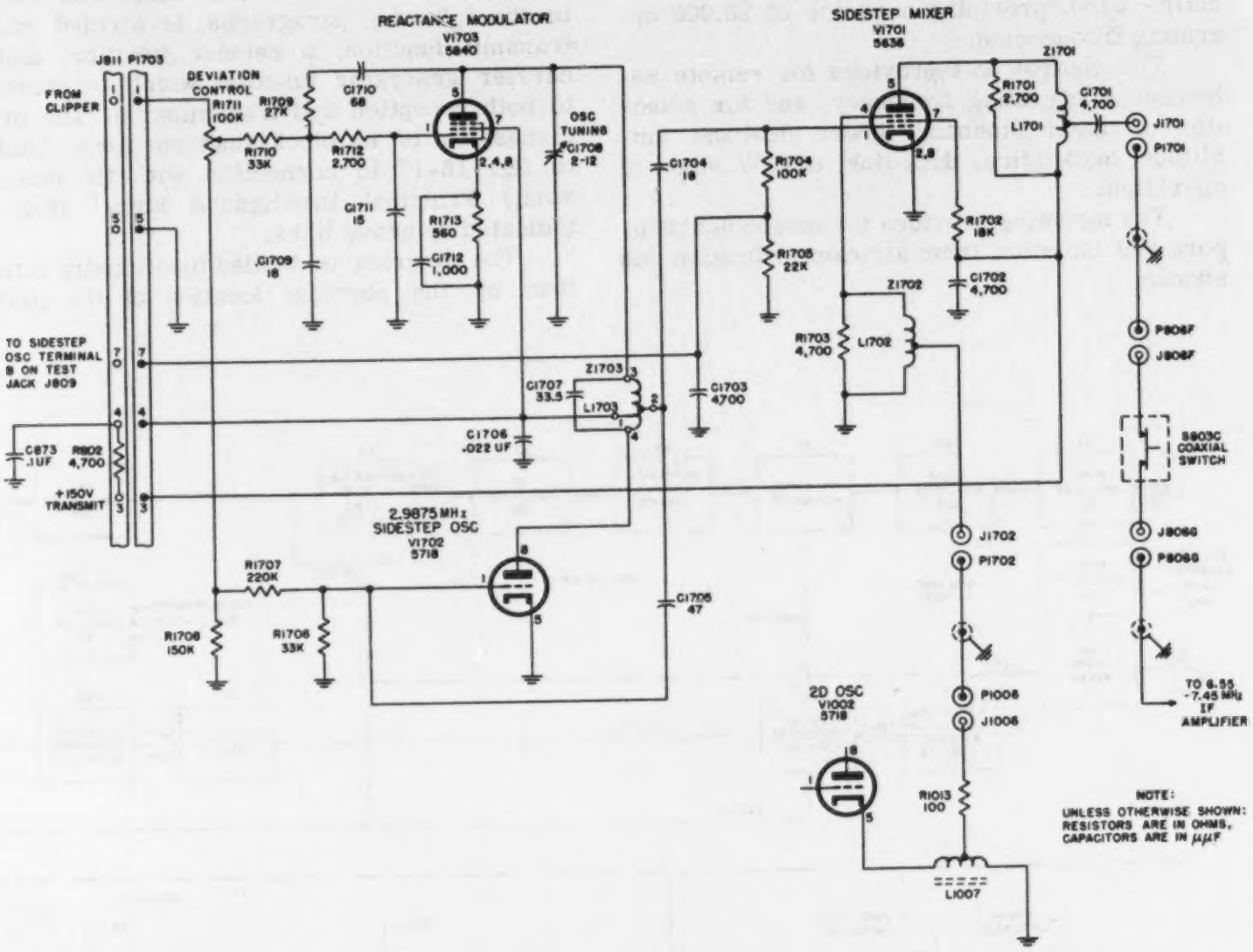

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Figure 16-16.–Reactance modulator and sidestep circuits.

oscillator) varies in accordance with the amplitude variations of the audio signal.

Selection of operating frequency is accomplished through use of a tuning drive mechanism, which automatically adjusts the appropriate stages of both the receiver and transmitter.

Additional details concerning Radio Set AN/ARC-44 may be found in NavWeps 16-30ARC-44-1.

SINGLE SIDEBAND TRANSCEIVER AN/ARC-94

Radio Set AN/ARC-94 provides facilities for communication between aircraft, and between aircraft and fixed or mobile ground communications stations. The AN/ARC-94 transmits and receives communications in the high-frequency (HF) band and can operate over the 28 megahertz band between 2,000 megahertz and 29.999 megahertz. The set includes Radio Receiver-Transmitter RT-648/ARC-94, Radio Set Control C-3940/ARC-94, and Mounting MT-2641/ARC-94. The RT unit is of modular construction for ease of maintenance. In addition to the set components, the complete aircraft installation requires a headset, microphone, key, antenna coupler, and antenna.

The RT unit functions as a part of an overall HF communications system. Frequency

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selection is in increments of 1 kHz over the entire band, providing a choice of 28,000 operating frequencies.

The control unit provides for remote selection of operating frequency, and for selection of upper sideband, lower sideband, amplitude modulation, data link, or CW mode of operation.

The mounting provides for mechanical support and isolation from airframe vibration and shocks.

Operation of the set, as discussed briefly in the following paragraphs, is divided into a transmit function, a receive function, and a carrier generator function which is common to both reception and transmission. The brief discussion is in block diagram form. (Refer to fig. 16-17 in connection with the discussion.) Principal intelligence signal flow is indicated by heavy lines.

The diagram is divided functionally rather than by the physical location of the parts.

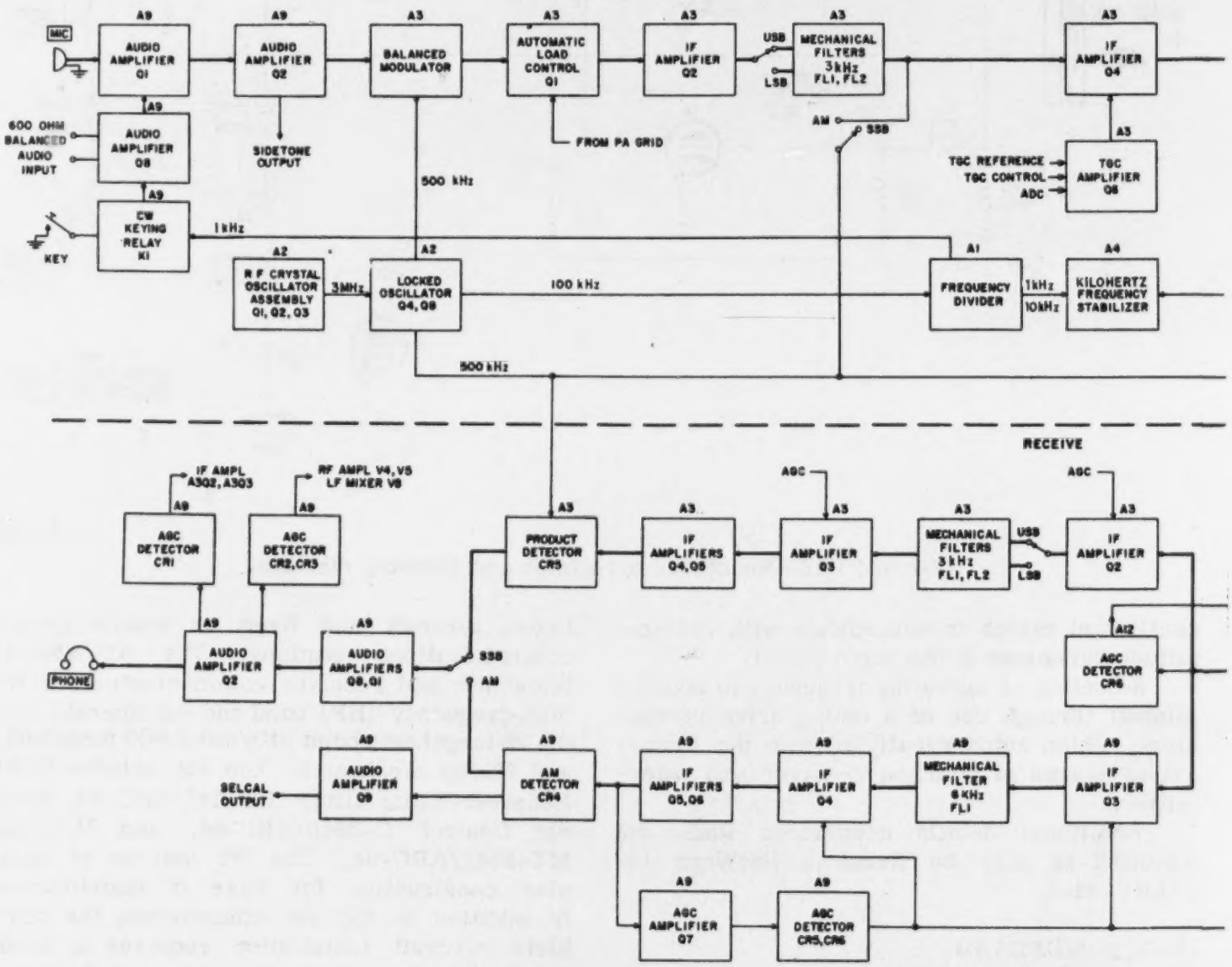

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Figure 16-17.–AN/ARC-94, simplified block diagram.

Blocks and individual component parts mentioned in the discussion are referenced in the standard manner for modular construction. Modules are referenced as A1, A2, etc. Where detail parts are considered in a discussion, the module designation and the part designation are combined into a compound reference, such as A1R2, A2R2, etc., to indicate the module and specific part. Parts located on submodules are designated by a triple compound designation such as A12A2C3, where A12 is the module, A2 is the submodule, and C3 is the detail part of interest.

Transmit Function

The transmit function includes an AF input section, an IF translator section, an RF translator section, and a power amplifier section.

The AF input section provides coupling and amplification for the voice intelligence to be transmitted. The IF translator section contains the circuitry for selecting the desired mode of operation and the stages that modulate and process the desired signal accordingly. The RF translator section performs the final conversion

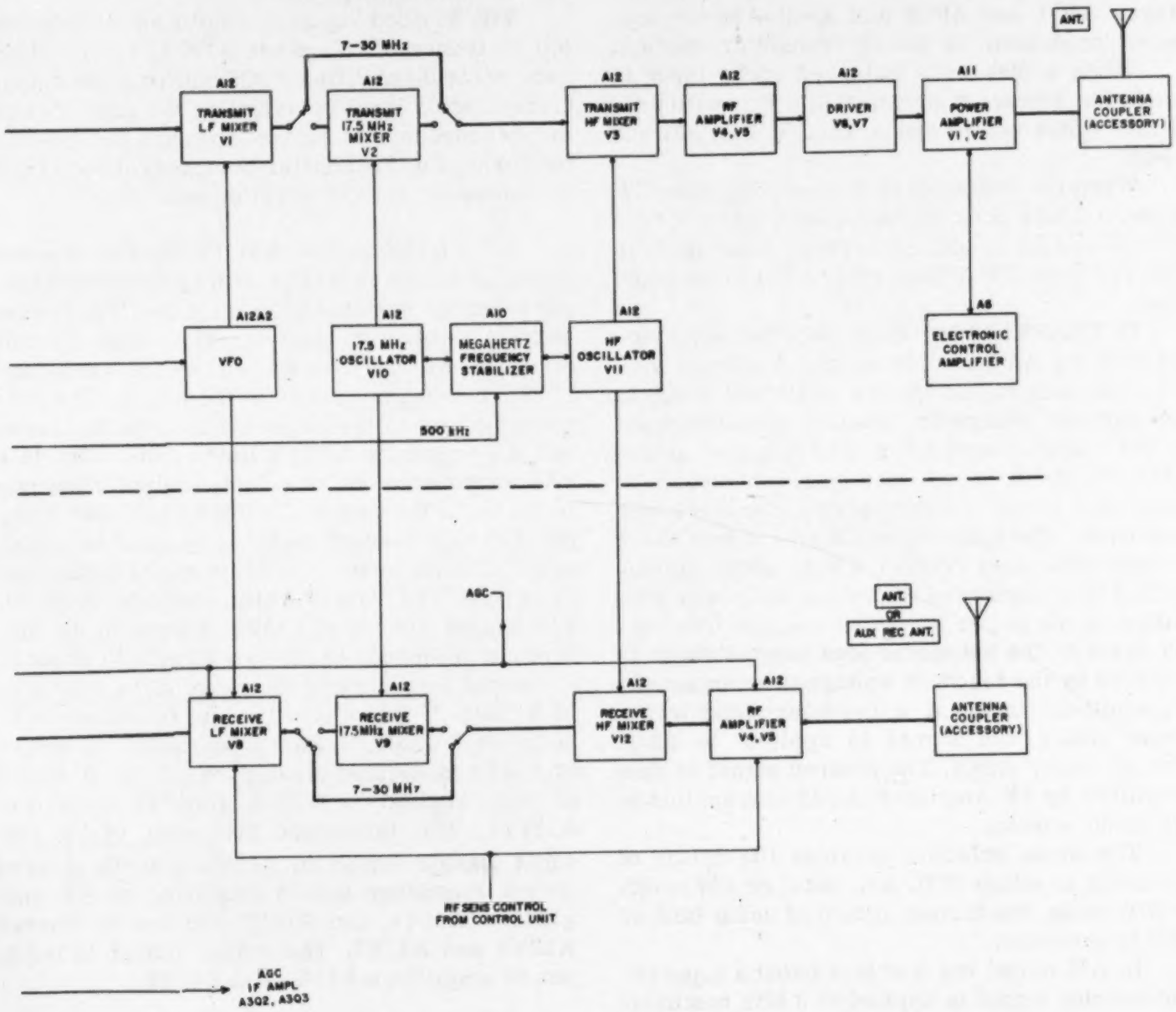

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Figure 16-17.–AN/ARC-94, simplified block diagram–Continued.

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step in translating the modulated signal information to the frequency band selected for transmission. The carrier generator function provides all the frequencies required for the double conversion transmit function The carrier generator function also provides all the frequencies required for demodulating in the receive function. Tuning is carried out within the carrier generator function by means of an autopositioner system similar to that of the AN/ARC-88.

AF INPUT SECTION.–An audio signal from the operator's microphone, fed into the 100-ohm, unbalanced input, is amplified in audio amplifier stages A9Q1 and A9Q2 and applied to the balanced modulator in the IF translator section.

When a 600-ohms balanced audio input is used, the signal is preamplified by audio amplifier A9Q8 before being applied to A9Q1 and A9Q2.

When the transmitter is operating in the CW mode, a 1 kHz audio signal is obtained from frequency divider module A1. This 1 kHz signal is then fed from CW keying relay A9K1 to the audio input.

IF TRANSLATOR SECTION.–The audio signal from the AF input section and a carrier signal from locked oscillators A2Q4 and A2Q8 in the carrier generator function are combined in the balanced modulator. The balanced modulator yields a suppressed carrier amplitude modulated output consisting of upper and lower sidebands. The balanced modulator output is fed to automatic load control A3Q1, which is controlled by a signal fed back from the power amplifier in the power amplifier section. The output level of the automatic load control stage is adjusted by the feedback voltage to maintain the transmitter output at a predetermined level. From A3Q1, the signal is applied to A3Q2 through relay A3K5. The desired signal is then amplified by IF amplifier A3Q2 and applied to the mode selector.

The mode selector provides the option of operating in either SSB, AM, data, or CW mode. In SSB mode, the further option of using USB or LSB is provided.

In AM mode, the double-sideband suppressed carrier signal is applied to 3 kHz mechanical filter A3FL1, which passes only the upper sideband. A 500 kHz carrier signal from the carrier generator function is reinserted into the upper sideband at the output of filter A3FL1.

In SSB mode, the carrier reinsertion capability is disabled. The double-sideband suppressed carrier output of A3Q2 is switched to a 3 kHz mechanical filter, either A3FL1 or A3FL2, depending on the setting of the mode selector. Filter A3FL1 passes only the USB and A3FL2 passes only the LSB. The sideband not passed is suppressed. An intelligence consisting of a USB or LSB signal is then fed through relay A3K5 to IF amplifier A3Q4.

The data and CW modes are similar in function to the SSB modes since USB is always used for data and CW operation.

The desired signal is amplified in A3Q4 and fed to transmit LF mixer A12V1. Transmitter gain control amplifier A3Q6 controls the output transmission level by adjusting the gain of A3Q4 in accordance with control voltages provided in the form of a transmitter gain control signal and an automatic drive control signal.

RF TRANSLATOR SECTION.–The desired signal is mixed in A12V1 with a preselected output from the variable frequency oscillator in the carrier generator function. The output circuit of A12V1 is tuned to the difference frequency of the two signal inputs to the mixer. The frequency range of the output signal from the transmit LF mixer is 2.001 MHz to 3.000 MHz in 1 kHz increments. If the selected output frequency is to be in the range of 2.0 MHz to 6.999 MHz, the LF mixer output signal is coupled to transmit 17.5 MHz mixer A12V2. A signal is also applied to A12V2 from 17.5 MHz oscillator A12V10. The output circuit of A12V2 is tuned to the difference frequency of the two signals to produce an output frequency in the range of 14.5 MHz to 15.5 MHz. If the selected output frequency is to be in the 7.0 MHz to 30.0 MHz range, the output of A12V1 is coupled directly to A12V3. A signal is also applied to A12V3 from HF oscillator A12V11. The difference frequency of the two input signals mixed in A12V3 is at the desired output frequency and is amplified by RF amplifiers A12V4 and A12V5 and fed to drivers A12V6 and A12V7. The driver output is fed to power amplifiers A11V1 and A11V2.

POWER AMPLIFIER SECTION.–The power amplifier is band-switched by the autopositioner and tuned by a servo-driven inductance in electronic control amplifier module A6. The output

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of the power amplifier is designed for a 52-ohm unbalanced load and is applied to the transmitting antenna through an antenna coupler.

Receive Function

The receive function includes an RF input section, a first and second conversion section, an SSB channel, an AM channel, and an audio section.

The RF input section receives the desired signal broadcast by the remote station. The signal is amplified and sent to the first and second conversion sections, where a double conversion is performed to bring the signal to the desired intermediate frequency. In SSB, data, and CW modes, the AM channel is disabled and the desired signal is brought to the SSB channel. After being amplified to a suitable level, the desired SSB signal is demodulated in a product detector. The resultant audio signal is amplified in the audio section and applied to headset phones.

In AM mode, the SSB channel is disabled and the desired signal is brought to the AM channel. In the AM channel, a standard AM detector is used to demodulate the signal. All other functions are similar to those which occur in the SSB channel.

COMMON STAGES.–The receive function of the AN/ARC-94 uses many stages in common with the transmit function. Function selection is controlled by the operator with a push-to-talk switch. When the switch is operated, the transmit function is actuated. At all other times the receive function is actuated. A relay operated switching system shifts the assignments of the common stages between transmit and receive functions as required.

RF INPUT SECTION.–The RF input section receives the desired signal from a remote station. The impedance of the antenna is matched to that of amplifiers A12V4 and A12V5 by a suitable coupler device to insure maximum energy transfer. The amplifiers step up the received signal and apply it to receive HF mixer A12V12 in the first conversion group. RF gain is manually adjustable from the C-3940/ARC-94. The RF amplifiers are also under AGC system control.

CONVERTER SECTION.–The output of A12V4 and A12V5 is fed to receive HF mixer A12V12 where it is mixed with the signal from HF oscillator A12V11 in the carrier generator section. The output of A12V12 is coupled to receive 17.5 MHz mixer A12V9 if the operating frequency is in the range of 2.0 MHz to 6.999 MHz. It is coupled to receive LF mixer A12V8 if the operating frequency is in the range of 7.0 MHz to 30.0 MHz. The output from A12V8 is a 500 kHz IF signal. The 500 kHz IF signal is fed to either the SSB or AM channel.

SSB AND AM CHANNELS.–In SSB mode, the 500 kHz IF signal is applied to one of two mechanical filters, A3FL1 or A3FL2. Each mechanical filter has a bandwidth of 2.7 kHz. One filter passes the upper sideband, and the other passes the lower sideband. The appropriate filter is selected at the mode selector on the C-3940/ARC-94. The filter output is amplified in IF amplifiers A3Q3, A3Q4, and A3Q5. The output of A3Q5 is applied to product detector A3CR5 which recovers the audio signal.

In AM mode, the output of A12V8 is fed to IF amplifier A9Q3 for amplification and is coupled to 6 kHz mechanical filter A9FL1. The signal is then fed to three more IF amplifiers, A9Q4, A9Q5, and A9Q6. The output of A9Q6 is fed to diode detector A9CR4 which recovers the audio signal and applies it to the audio section.

AUDIO SECTION.–In either channel, the desired audio signal is amplified in audio amplifiers A9Q1, A9Q8, and A9Q2, and fed to the operator's headset. Selcal (selective calling) signals detected in AM detector A1CR4 are fed to audio amplifier A9Q9 and are coupled to the rear connector of the RT-648/ARC-94. Selcal signals are detected in all modes of operation.

Carrier Generator Function

The carrier generator function includes RF oscillator A2, frequency divider A1, kilohertz-frequency stabilizer A4, variable frequency oscillator (VFO) A12A2, 17.5 MHz oscillator A12V10, megahertz-frequency stabilizer A10, and HF oscillator A12V11.

FREQUENCY GENERATION AND STABILIZATION.–The AN/ARC-94 transmits and receives on every 1 kHz increment from 2,000 MHz to 29.999 MHz. This provides 28,000 possible separate operating frequencies. The operating frequency is selected at the C-3940/ARC-94. The 100 kHz, 10 kHz, and 1 kHz fre-

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quency selector knobs on the C-3940/ARC-94 actuate autopositioner A12A1. The autopositioner mechanically tunes variable frequency oscillator A12A2 over the range from 2.501 MHz to 3.500 MHz in 1 kHz increments. The megahertz frequency selector knob on the C-3940/ARC-94 controls a motor in RF translator module A12. This motor switches tuning elements which tune HF oscillator A12V11 to one of 28 different frequencies. The HF oscillator, in conjunction with 17.5 MHz oscillator A12V10, provides 28 1 MHz bands for each of the 1 kHz increments from variable frequency oscillator A12A2.

Megahertz-frequency stabilizer module A10 stabilizes the frequency of A12V10 and A12V11 by comparing each oscillator frequency with the frequency of a spectrum point derived from the 500 kHz output of RF oscillator module A2. The coarse frequency of A12V11 is controlled by the motor in RF translator module A12. The frequency range of A12V11 is 8.5 MHz to 32.0 MHz. The output of A12V11 is tuned to the second harmonic of the fundamental oscillator frequency when the selected operating frequency of the RT-648ARC-94 is in the range of 14.0 MHz to 29.999 MHz. This signal is coupled to transmit HF mixer A12V3, and to receive HF mixer A12V12.

The extremely high stability of the AN/ARC 94 operating frequency is obtained by basing frequency control of the entire RT-648/ARC-94 on the frequency of a very stable crystal oscillator located in RF oscillator module A2. Frequency stability of this crystal oscillator is assured by utilizing a temperature-compensating network.

The HF and 17.5 MHz oscillators are frequency locked, and the variable frequency oscillator is phase locked to the crystal generated reference frequency by circuits in the megahertz- and kilohertz-frequency stabilizer modules. The IF injection frequency is derived from the crystal oscillator. The RT-648/ARC-94 operating frequency is thus held accurate within ±0.8 part per million per month from -40° C (-40°F) to +75°C (+167°F).

Keying Circuits

When the RT-648/ARC-94 is keyed, the keying circuits actuate the stages that must operate if the RT-648/ARC-94 is to transmit, while disabling receiver circuits that would interfere with transmission. When the key is released the keying circuits operate to switch off the transmitter and switch common stages from the transmit to the receive function.

Sidetone Circuits

The sidetone signal is taken from audio amplifier stage A9Q2 to provide audio monitoring in the transmit mode. The audio signal from the audio amplifier is fed through a keying relay and a sidetone relay (not shown) to the audio output. A combination of two voltages is used to energize the sidetone relay.

One voltage is derived from the RF output of power amplifier module A11. This RF output is rectified, filtered, and applied to the sidetone relay coil.

The second voltage, from three-phase high-voltage power supply module A7 (not shown) is proportional to the power amplifier plate current. This voltage is the same one used for transmitter gain control in IF translator module A3. To energize the sidetone relay, sufficient plate current and plate voltage swing must be present in the power amplifier. A capacitor is placed across the coil of the sidetone relay to keep the relay energized in the sideband transmit mode when the plate current varies with the applied audio signal.

Recycle Circuits

The recycle circuits are activated when any of the frequency selector knobs on the C-3940/ARC-94 are turned. When any autopositioner operates, the recycle relay (not shown) is energized, and remains energized so long as any tuning motor is operating. The recycle relay has the following functions:

1. Disconnects transistor supply voltage to the audio amplifier in order to mute the audio during the tuning cycle.
2. Provides a ground to activate the antenna tuner.
3. Interrupts the operation of kilohertz-frequency stabilizer module A4 during the tuning cycle.

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4. Disconnects the keying circuit so that the transmitter cannot be keyed during the tuning cycle.

UHF TRANSCEIVER (FM) AN/ARC-88

The purpose of Radio Set AN/ARC-88 is to provide a UHF frequency-modulated radio link between aircraft, shore, and ship. Radio Receiver-Transmitter RT-649/ARC-88 is a partially transistorized equipment capable of transmitting and receiving on any one of 1750 frequency channels, spaced at 100 kHz intervals in the 225.0 MHz to 399.9 MHz range. The equipment receives and transmits multiplexed data information originating in the form of digital pulses from an associated equipment of a digital data communication system.

Radio Set AN/ARC-88 is supplied digital information from the associated data equipment and transmits it on a frequency modulated carrier signal. It also receives a similar frequency-modulated signal, demodulates the signal, and supplies the resulting pulses to the associated data equipment. Reception and transmission are on the same frequency and utilize the same antenna.

Radio Set Control C-2736A/AR provides remote selection of the 1750 frequency channels or 19 preset channels within the specified range. (The frequencies of the 19 preset channels are determined by adjustment of a memory drum on the front panel.)

Major Components

Radio Set AN/ARC-88 consists of Radio Receiver-Transmitter RT-649/ARC-88, Mounting MT-2653/ARC, Standing Wave Ratio Indicator IM-178/ARC-88. Electronic Equipment Air Cooler HD-513/ARC, and Radio Set Control C-2736A/AR. The following paragraphs provide a brief description of these components, followed by a brief discussion of the general principles of operation of the equipment.

RECEIVER-TRANSMITTER.–Radio Receiver-Transmitter RT-649/ARC-88 consists of a main chassis, dust cover, and nine plug-in modules. The nine plug-in modules are mounted on the main chassis and enclosed in an aluminum case. An airtight seal is provided between the cover and the main chassis to permit the modules of the component to be pressurized. External cooling air is forced by the external blower through the base casting to the heat exchanger and expelled at the bottom of the unit. (See fig. 16-18.) Internal air is circulated through the internal cores of the heat exchangers, through the plenum chamber formed by the main chassis, and through each module by an internal blower. In this manner, the heat from the component is dissipated.

An antenna, two power connectors, and a pressurizing valve are mounted on the front panel. A toolkit containing special tools for maintenance is supplied with Radio Receiver-Transmitter RT-649/ARC-88.

MOUNTING.–Mounting MT-2653/ARC provides a mounting base for Radio Receiver-Transmitter RT-649/ARC-88. Vibration isolators which are usually a part of the mounting are an integral part of the mounting base casting of the RT-649/ARC-88.

SWR INDICATOR.–Standing Wave Ratio Indicator IM-178/ARC-88 provides the operator with a remote indication of transmitter power output. It is secured to the front panel of the RT unit by three cross-recessed screws. When the set is in transmit operation, the remote meter indicates incident power. By changing the connection of the remote power indicator to the other wire on the multiwire cable, a reflected power measurement may be obtained.

AIR COOLER.–Electronic Equipment Air Cooler HD-513/ARC is made up of a casting, single-phase blower motor, and an air inlet filter assembly. It is secured to the rear of the RT unit by four hex-socket screws. The HD-513/ARC operates when the internal temperature of the RT unit exceeds 35°C (95°F).

CONTROL UNIT.–Radio Set Control C-2736/AR is used to control Radio Receiver-Transmitter RT-649/ARC-88. A selector switch on the front panel makes 19 preset channels available to the operator. This selector switch has complete control of selection unless it is set to the M position. In the M position, adjustment of the four MANUAL frequency controls operates switches which activate an autopositioner, located in the RT unit, to set up operation at the selected frequency. A three-position rotary power switch on the front panel controls

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To fill the pen, take it to the bottle and touch the quill filler between the nibs, being careful not to get any ink on the outside of the blades (Fig. 2).

The pen should be held in the fingertips, as shown in Fig. 3. The position shown aids in keeping the pen at the proper angle and the nibs aligned with the ruling pen. If the ink refuses to flow, it may be because it has dried in the extreme point of the pen. If pinching the blades slightly does not start the flow of ink, the pen should be immediately wiped out and fresh ink supplied. Always wipe pens clean after using.

FIG. 3

QUESTIONS:

1. Why doesn't industry in general ink more drawings?
2. What is the best way of keeping a ruling pen clean?
3. What type of stone should be used for sharpening a pen?
4. If you are drawing dull ink lines, what does this indicate?
5. Can circles be drawn with a pen?

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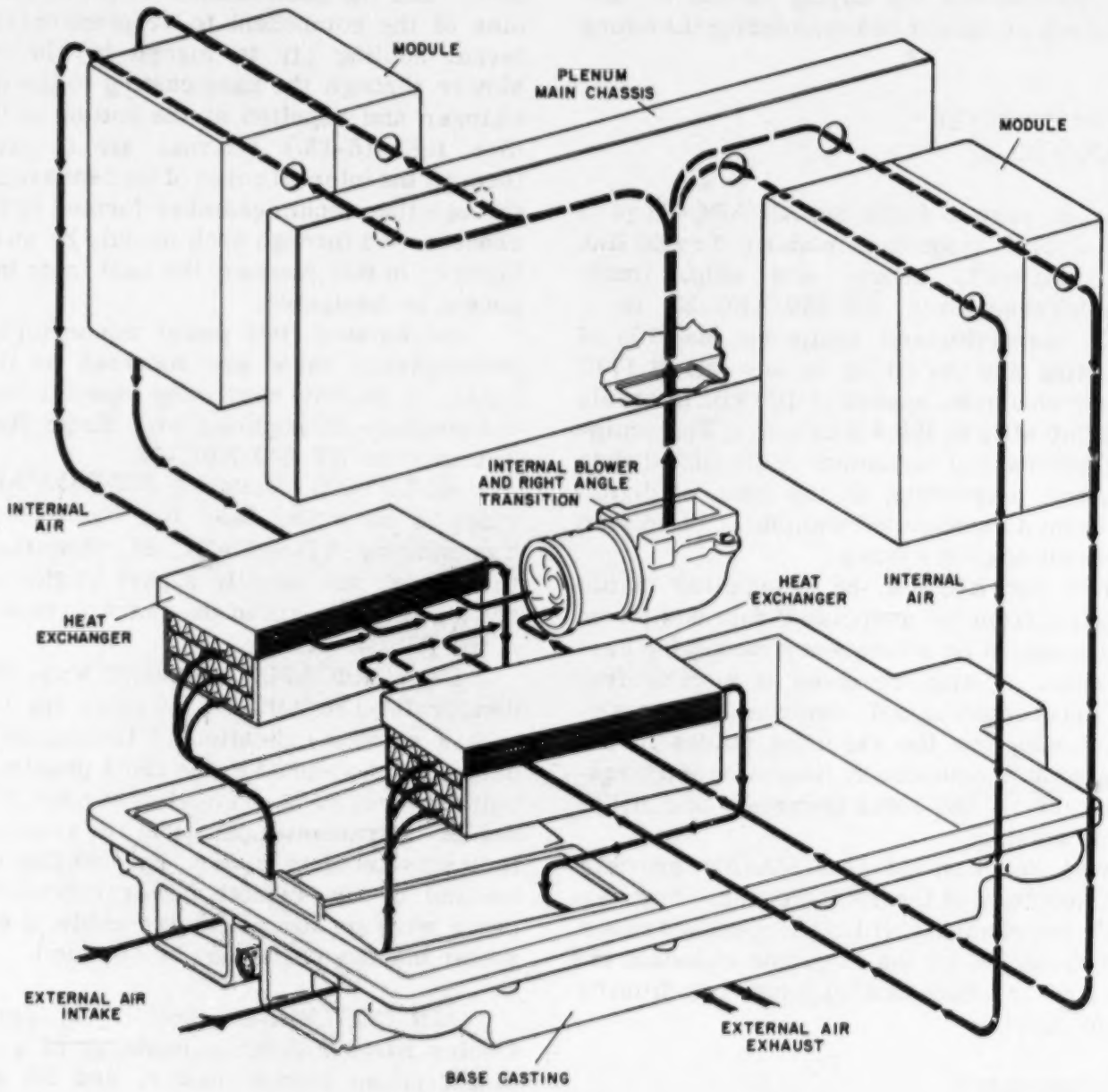

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Figure 16-18.–Cooling airflow diagram.

the power on-off and the selection of the associated radio equipment. Frequency adjustments for preselected channels are made by lowering a small panel at the bottom of the front panel.

Principles of Operation

Radio Receiver-Transmitter RT-649/ARC-88 is a remotely controlled receiver and transmitter which makes use of the double-conversion superheterodyne principle. Two sources of injection frequencies are heterodyned with the signal input during receiving operation, or heterodyned with a developed carrier during transmitting operation, to produce the desired intermediate frequencies. (See fig. 16-19.)

The higher injection frequencies are developed in the spectrum generator module and are in the 200 MHz to 370 MHz range. The fundamental signals are produced by a crystal oscillator, fed through a frequency multiplier, amplified, and then applied to the first receiver mixer or the second transmitter mixer stage.

The lower injection frequencies in the 21.85 MHz to 31.75 MHz range are produced in the oscillator stages of the 20-30 MHz IF am-

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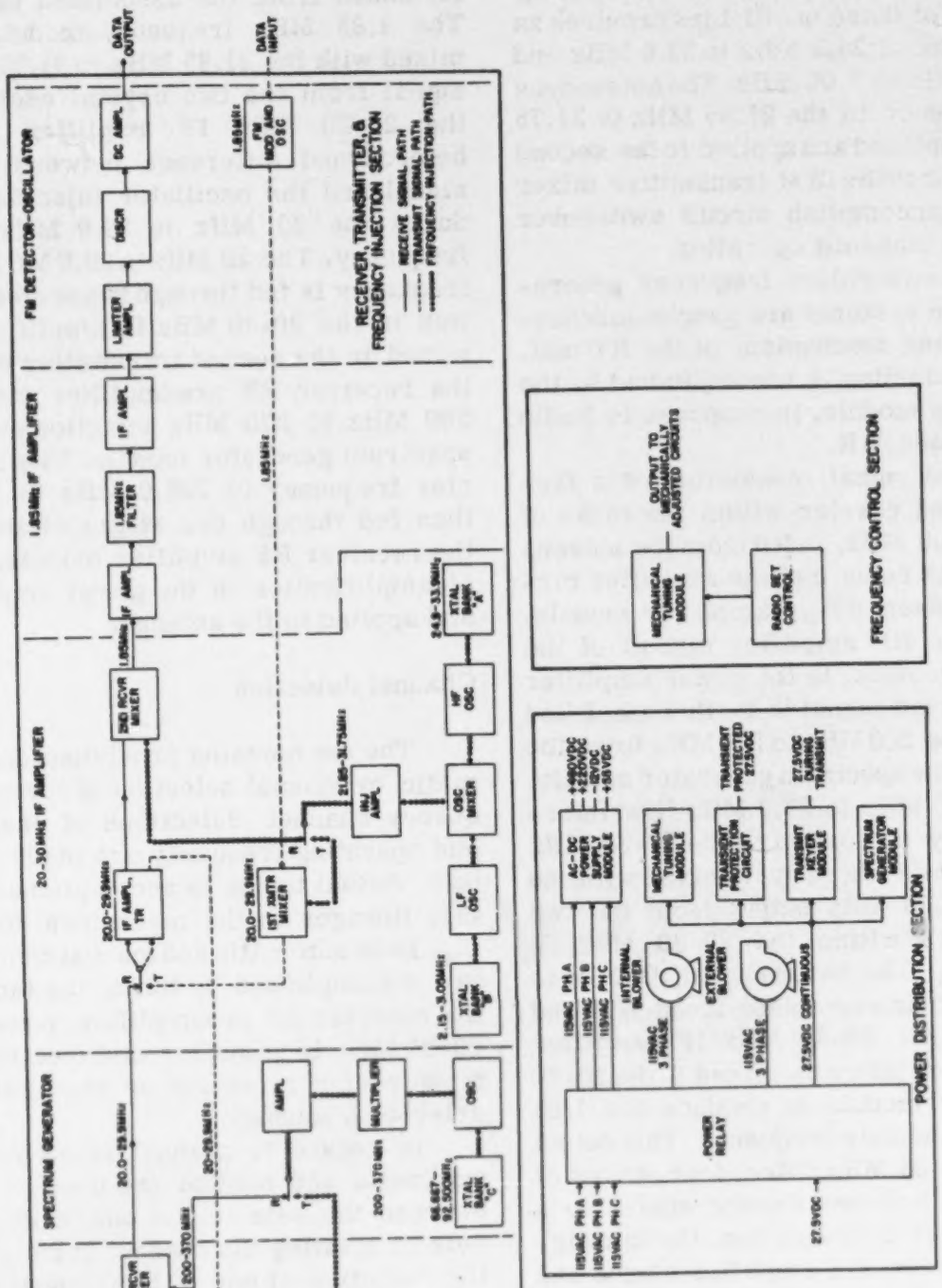

Figure 16-19.—AN/ARC-88, simplified block diagram.

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plifier module by mixing the output of two crystal oscillators. One of these oscillators provides an output in the range of 24.9 MHz to 33.9 MHz and the other 2.15 MHz to 3.05 MHz. The heterodyne difference frequency in the 21.85 MHz to 31.75 MHz range is amplified and applied to the second receiver mixer or to the first transmitter mixer stages. Relays accomplish circuit switchover from receiver to transmit operation.

The crystal-controlled frequency generation and injection systems are ganged mechanically to the tuning mechanism of the RT unit. All tuning or channeling is accomplished by the mechanical tuning module, in response to Radio Set Control C-2736A/AR.

The received signal, consisting of a frequency shift keyed carrier within the range of 225.0 MHz to 399.9 MHz, is fed from the antenna through an antenna relay into the amplifier circuits of the receiver RF preamplifier module, and applied to an RF amplifier circuit of the power amplifier module. In the power amplifier module, the received signal is further amplified and mixed with the 200 MHz to 270 MHz injection voltage output of the spectrum generator module. The resultant 20.0 MHz to 29.9 MHz first intermediate frequency is applied to the 20-30 MHz IF amplifier module where it is mixed with the 21.85 MHz to 31.75 MHz output from the two crystal oscillators within the 20-30 MHz IF amplifier module. The heterodyned difference between the first intermediate frequency and the output from the 20-30 MHz IF amplifier module crystal oscillators is mixed in the 20-30 MHz IF amplifier module to produce the 1.85 MHz second intermediate frequency. This output is fed through a 1.85 MHz filter, four stages of IF amplification, and two limiter stages to a discriminator. After demodulation, the data signal is amplified in two d-c amplifier stages and fed to the associated data equipment.

The operation of transfer relays and electron tube switching, from receive to transmit or from transmit to receive operation, is accomplished by the transmit keyer module in response to data input signals from the associated data equipment.

During transmission, the initial excitation is obtained from a frequency modulator and oscillator in the FM detector-oscillator module which operates at a center frequency of 1.85 MHz and is frequency modulated with the data information furnished from the associated data equipment. The 1.85 MHz frequency-modulated signal is mixed with the 21.85 MHz to 31.75 MHz injection signal from the two crystal oscillators within the 20-30 MHz IF amplifier module. The heterodyned difference between the 1.85 MHz signal and the oscillator injection signal produces the 20 MHz to 29.9 MHz intermediate frequency. The 20 MHz to 29.9 MHz intermediate frequency is fed through two stages of amplification in the 20-30 MHz IF amplifier module and mixed in the second transmitter mixer stage of the receiver RF preamplifier module with the 200 MHz to 370 MHz injection output from the spectrum generator module. The resultant carrier frequency of 225.0 MHz to 399.9 MHz is then fed through two stages of amplification in the receiver RF amplifier module, three stages of amplification in the power amplifier module and applied to the antenna.

Channel Selection

The set contains provisions for either automatic or manual selection of the operating frequency channel. Selections of channeling mode and operating frequency are made at the control unit. Actual tuning is accomplished by mechanical linkages in the mechanical tuning module.

Both automatic and manual channel selection are accomplished by tuning the tank circuits of the receiver RF preamplifier, power amplifier, 20-30 MHz IF amplifier, and spectrum generator modules for reception or transmission on the selected frequency.

In regard to channel selection, the terms automatic and manual are used to differentiate between the selection of one of 19 preset channels by rotating the channel selector switch and the selection of one of 1750 frequency channels by individual setting of the manual frequency controls. In either case, the actual mechanical and electrical tuning operations within the equipment are fully automatic.

Selection of any frequency is initiated when the operator rotates the decade selector to the desired frequency. By rotating a particular decade selector, the switch circuit that corresponds to the new frequency setting is grounded. By grounding the switch circuit, the positioning system of the mechanical tuning module is energized and produces a synchronized

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rotation of the gear train in the prescribed direction by a predetermined amount. The motion imparted to the gear train automatically adjusts the module tuned circuits for operation of the equipment on a selected frequency.

A simplified positioning system to illustrate the principle is shown in figure 16-20. The selector switch (remote control switch) chooses the operating frequency, and the seeking switch determines the angular position to which the drive motor rotates the shaft for a specific selected frequency. As shown, the equipment is at rest with the selector switch and the seeking switch at position 1. When the switches are at the corresponding position, no contact of the seeking switch is grounded through the selector switch; the electrical circuit of the drive motor is broken by the open motor control contacts of the deenergized relay.

The drive motor, which has driven the seeking switch to rest at position 1, has also driven the module tank circuits to the selected frequency in the same angular rotation.

Assume the selector switch is rotated so that the tab of the selector contacts the terminal at position 2. A closed path to ground then is completed from the +27.5-volt supply through the relay coil, the common contact and contact 2 of the seeking switch, through contact 2 of the selector switch, and to ground through the common contact of the selector switch. Relay K1 is energized and closes the motor control contacts; the drive motor then rotates in the predetermined direction. The seeking switch, which is geared to the drive motor, is driven until the cutout of the seeking switch is adjacent to position 2. At this position, the 27.5-volt path is opened, the relay releases, the motor stops, and the system comes to rest. Since the seeking switch and the tuned circuits are gear-driven by the motor, the tuned circuits are driven through the required angular displacement, which is proportional to

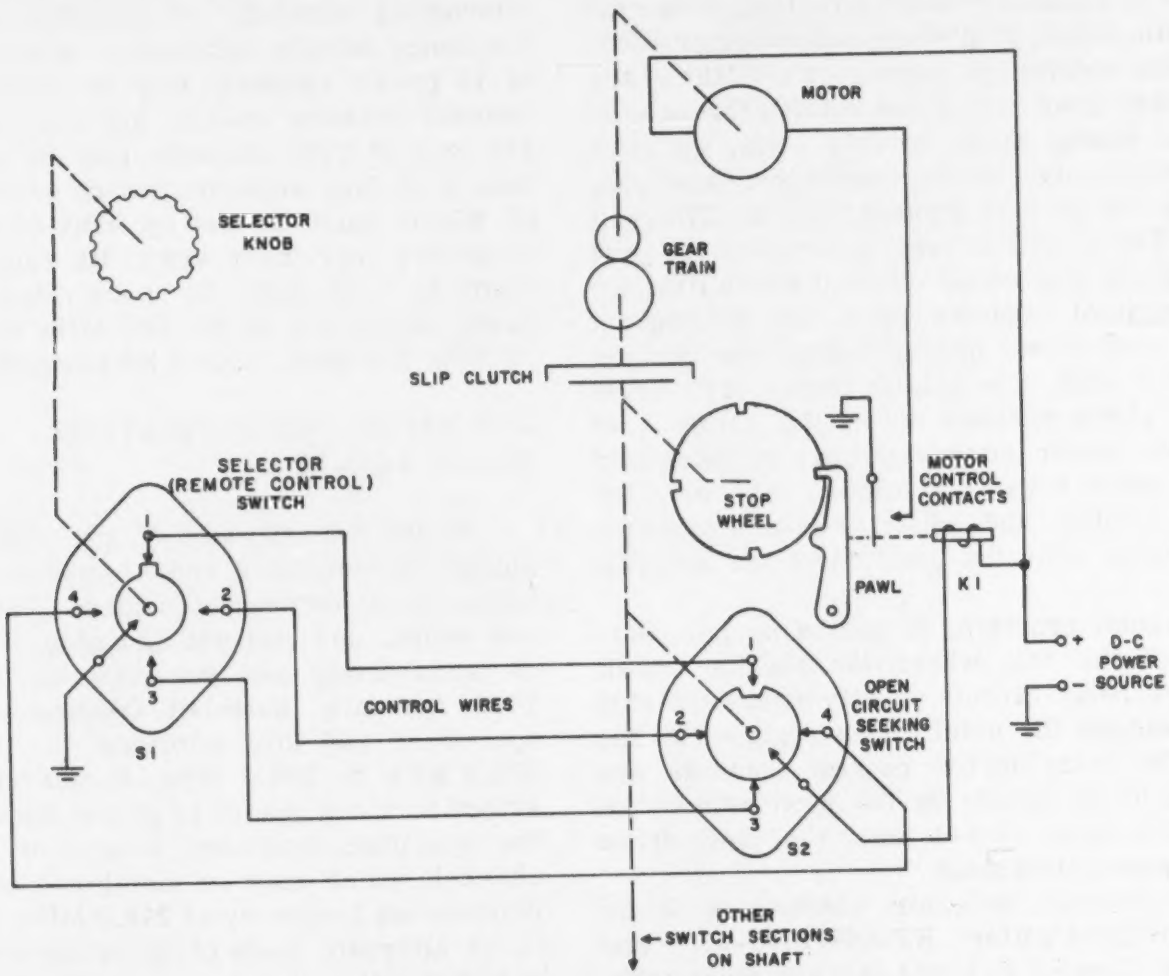

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Figure 16-20.–Automatic positioning, functional diagram.

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the seeking switch travel from position 1 to position 2.

As illustrated in figure 16-20, the switch arrangement includes a notched stop wheel and pawl that accurately positions the seeking switch as soon as the drive motor is deenergized, and a clutch that decouples the switches from the drive motor and gear train when the final position is reached. Although not shown in figure 16-20, the clutch permits a single motor to drive several seeking switch shafts.

Assume the selector switch is rotated so that the circuit having the increments of the selected frequency is grounded. A complete path to ground is provided from the 27.5-volt supply through the relay coil, the seeking switch, the applicable control wire, and the selector switch. The actuated relay withdraws the pawl from the notch along the periphery of the stop wheel and energizes the drive motor through the closed motor control contacts of the relay.

The subsequent rotation of the drive motor, which is in a predetermined direction, drives the gear train, clutch, stop wheel, and seeking switch. The motor rotation is continuous until the motor (and tuning gear train) has rotated through the required tuning angle; at this point, the corresponding contact of the seeking switch is open, breaking the path to ground from the 27.5-volt supply. The relay releases, permitting the pawl to engage a stop wheel notch at which time the motor control contacts open. The subsequent loss of stop wheel motion brakes the seeking switch and shaft. The kinetic energy of the drive motor (which persists after the removal of the drive motor source power) is dissipated in the gear train and clutch. At rest, the seeking switch and shaft are in a position synchronous with the position of the selector switch.

In actual practice, to insure proper positioning of the stop wheel, the seeking switch opens the relay circuit shortly before the stop wheel reaches the notch to be engaged by the pawl. The relay motor control contacts are operated mechanically by the pawl arm so the contacts remain closed until the pawl drops into the prescribed notch.

The channel selector circuits of Radio Receiver-Transmitter RT-649/ARC-88 and Radio Set Control C-2736A/AR are more complex but use the principles of the single selector-seeking system shown in figure 16-20. The actual system, however, employs three selector-seeking switch groups which are driven by a single motor. (Refer to figure 16-21.) Each of the three groups has individual switch connections, relay, pawl, stop wheel, and relay motor contacts.

The seeking switches are driven by the motor through three separate friction type slip clutches, one of which is attached to each of the three primary shafts. When a pawl is not engaged in a stop wheel notch, the tension in the clutch spring is sufficient to allow the motor to turn the seeking switch shaft. When the stop wheel is held by the pawl, the motor side of the clutch can rotate while the seeking switch side of the clutch remains motionless. Several seeking switch shafts thus may be independently positioned by a single drive motor and gear system.

The channel selector system is, essentially, a three-section decade system that allows two alternative methods of inserting a different frequency setting: automatic, wherein any one of 19 preset channels may be selected by the channel selector switch, and manual, wherein any one of 1750 channels may be selected by means of four separate decade selectors, each of which must be set up individually for the frequency increment within its range. The two methods may both be subdivided into four parts consisting of the 200 MHz to 300 MHz, 10 MHz, 1.0 MHz, and 0.1 MHz decade selectors.

AUTOMATIC COMMUNICATIONS RELAY AN/ARC-52

Radio Set AN/ARC-52 provides two-way, amplitude-modulated radiotelephone communication (A-3) between aircraft in flight, aircraft and shore, and aircraft and ship. It is capable of transmitting and receiving on any one of 1750 manually selected frequency channels, spaced at 100 kHz intervals, in the band of 225.0 MHz to 399.9 MHz. It also permits the selection of any one of 18 preset channels within the specified frequency range, or the guard channel, which may be monitored on the predetermined frequency of 243.0 MHz. Auto relay is an alternate mode of operation which makes possible automatic communication relay operation.

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Two receiver-transmitter units operate identically and are completely interchangeable providing correct input power is present. The only difference between the two receiver-transmitters is the input power required. Receiver Transmitter RT-332/ARC-52 requires both a-c and d-c power, while Receiver-Transmitter RT-424/ARC-52X requires only d-c power.

Unless otherwise noted, Auto Relay Control C-2791/ARC may be used interchangeably where Radio Set Control C-1607/ARC-52 is referenced, and Receiver-Transmitter RT-424/ARC-52X is used interchangeably where Receiver-Transmitter RT-332/ARC-52 is referenced.

Automatic direction finding (ADF) operation is provided by the AN/ARC-52 when used in conjunction with Direction Finder Group AN/ARA-25. During ADF operation, the AN/ARC-52 receives RF signals from a direction finding antenna and delivers appropriate signal components to the direction finder amplifying and indicating equipment.

Emergency or direction finding (DF) operation is provided by a self-generated tone that occurs between 920 and 1120 hertz. The tone modulation (A-2) is a continuous signal, the interception of which may be used to locate the sending apparatus.

Automatic relay operation may be provided by two Radio Sets AN/ARC-52 connected in tandem between two prime stations. However, to provide this operation Auto Relay Control C-2791/ARC must be substituted for Radio Set Control C-1607/ARC-52 in at least one of the Radio Sets AN/ARC-52. When connected in this manner, an incoming signal received on one radio set is retransmitted automatically from the second radio set but on an alternate frequency. The range of the prime stations is thus extended since the automatic relay station effectively increases the line of sight between the two prime stations.

The intercom provision is an optional facility which can be connected for use as a

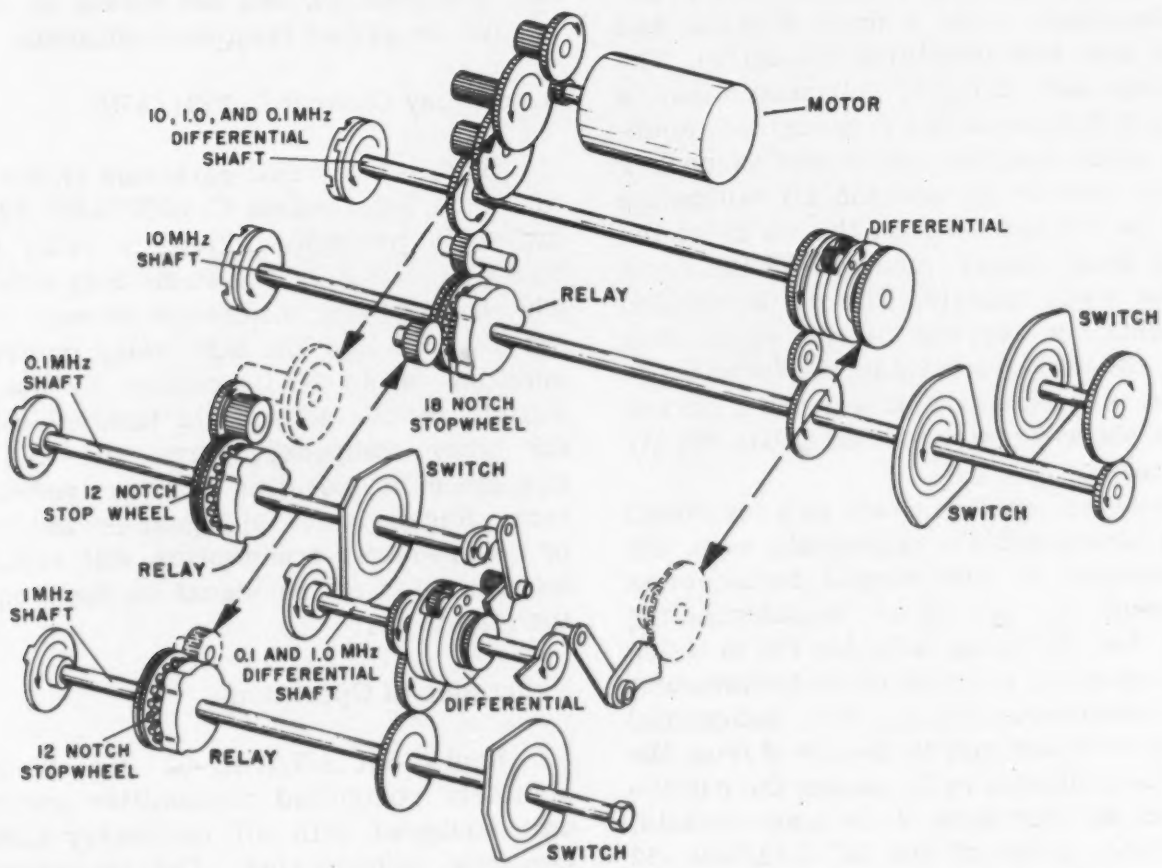

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Figure 16-21.–Mechanical tuning linkages.

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backup in case the separate intercom amplifier system of the aircraft fails. When operated in this mode, the transmit function is limited to the pilot only, unless special connections are included at the time of intercom installation.

Optimum performance may be attained through the use of either a carbon or a dynamic microphone, which provides a high degree of flexibility. A change of connections within the RT unit is required when a change from a carbon type microphone to a dynamic type microphone (and vice verse) is made.

The RT unit may be installed anywhere within the aircraft through Mounting MT-1477/ARC-52. Since installation is usually external to the pressurized aircraft cabin, the RT unit case has been pressurized. The pressurized case and relatively inaccessible location prohibits the replacement or repair of equipment parts while in flight. The control unit does not require a pressurized case.

RT-332/ARC-52 Unit

The RT-332/ARC-52 consists of a pressurized aluminum case, a main chassis, and 13 plug-in unit subassemblies (modules). The main chassis with mounted subassemblies, is enclosed in a double-walled, pressurized aluminum case which functions as a heat exchanger between the outside air and the air within the case. Air is forced between the walls of the case by a dual blower mounted on the front panel of the main chassis. The air is expelled through vents in the top of the case, thus dissipating the heat absorbed by the inner walls of the case. An axial-flow blower and a blower mounted on the a-c power unit circulate the air inside the case.

The modules, each of which is a functional entity, are comparatively accessible when the case is removed, so that module replacement may be used as an initial troubleshooting procedure. The mounting base for the modules is the main chassis, which provides the interunit electrical connections, plugs, jacks, and coaxial cables. The modules may be removed from the top of the main chassis by loosening the captive screws from the underside of the main chassis.

The front panel of the RT-332/ARC-52 contains the external blower and the antenna input jack. Headset and microphone jacks, test jacks, and sensitivity controls are located on the main chassis right-hand gusset plate. All jacks and controls on the gusset plate provide local maintenance facilities to the AN/ARC-52 repairman.

RT-424/ARC-52X Unit

The RT-424/ARC-52X is identical to the RT-332/ARC-52 except it contains only 12 plug-in unit subassemblies. The a-c power unit and rectifier unit used in the RT-332/ARC-52 are removed, and a new dynamotor power supply unit is installed in its place. Circulating air is provided by the internal blower motor of the dynamotor, and by an external d-c blower motor.

Radio Set Control C-1607/ARC-52

The C-1607/ARC-52 permits remote control of the RT-332/ARC-52 operation. These controls permit the selection of operational mode, volume control, frequency channel selection (channeling), and the means to set up and record the preset frequency channels.

Auto Relay Control C-2791/ARC

The C-2791/ARC performs all the functions of Radio Set Control C-1607/ARC-52 and additionally provides automatic relay (back-to-back) operation of two Radio Sets AN/ARC-52. The only visual difference between the radio set control and the auto relay control is the addition of an REL position to the function switch. By the addition of internal relays and the other component parts, the C-2791/ARC can place in operation two receiver-transmitters. Reception of a signal on the frequency of one receiver-transmitter will result in retransmission of the signal on the frequency of the other.

Principles of Operation

Radio Set AN/ARC-52 (fig. 16-22) is a remotely controlled transmitter and receiver unit equipped with all necessary control and mounting accessories. The transmitting and receiving components operate bilaterally; during reception the signal path is in one direction,

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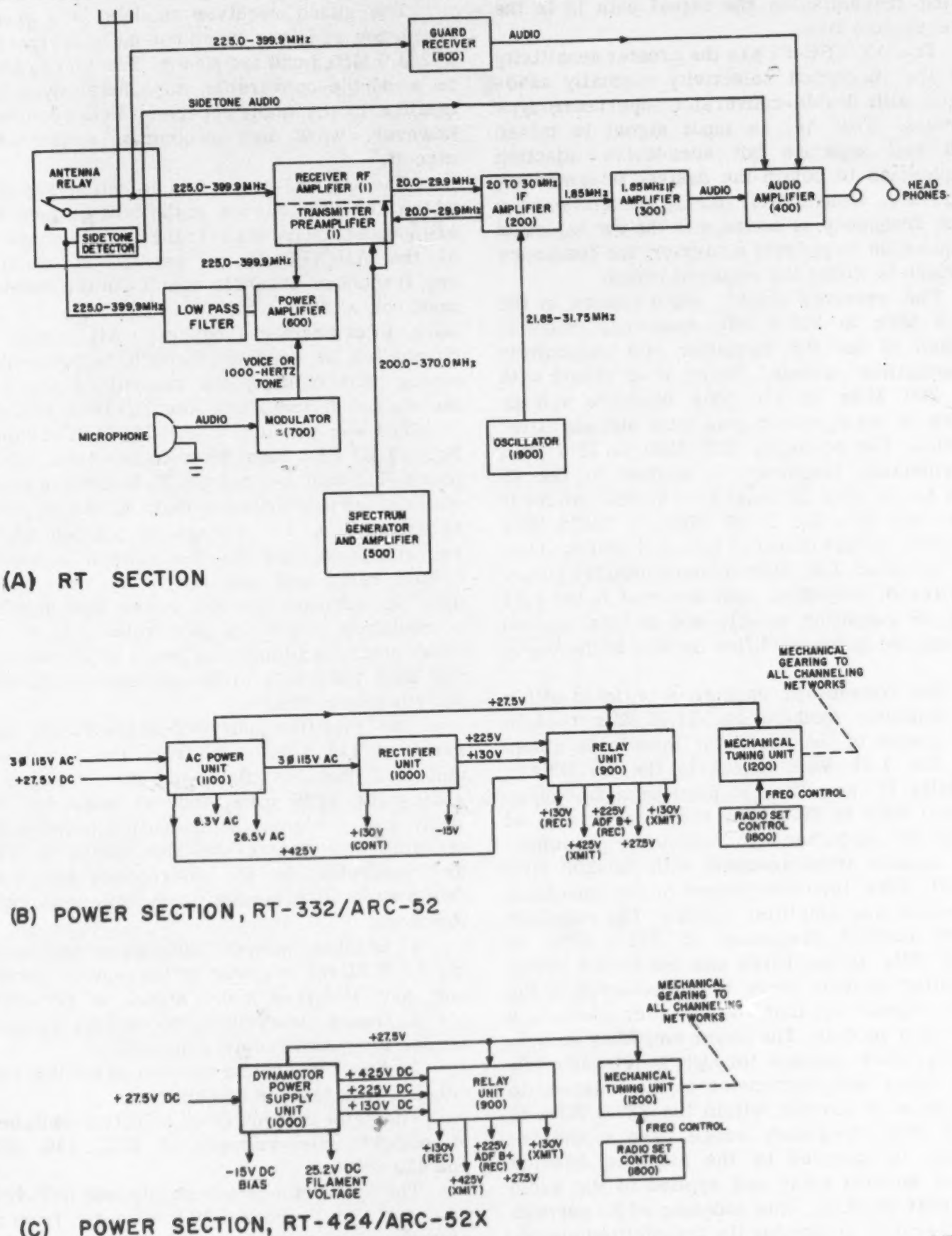

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Figure 16-22.–AN/ARC-52 RT unit, block diagram.

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during transmission the signal path is in the reverse direction.

The AN/ARC-52 has the greater sensitivity and the increased selectivity normally associated with double-conversion superheterodyne circuits. That is, an input signal is mixed with two separate but successive injection frequencies to obtain the desired intermediate frequency. Conversely, during transmission a basic frequency is mixed with the two injection frequencies to provide a carrier, the frequency of which is within the required range.

The received signal, which occurs in the 225.0 MHz to 399.9 MHz frequency range is applied to the RF amplifier and transmitter preamplifier module, where it is mixed with the 200 MHz to 370 MHz injection voltage output of the spectrum generator and amplifier module. The resultant 20.0 MHz to 29.9 MHz intermediate frequency is applied to the 20 MHz to 30 MHz IF amplifier module where it is mixed with the 21.85 MHz to 31.75 MHz injection voltage output of the oscillator module. The resultant 1.85 MHz intermediate frequency is filtered, amplified, and detected in the 1.85 MHz IF amplifier module and is then applied through the audio amplifier module to the headset.

The transmitter carrier is initiated within the oscillator module. The 21.85 MHz to 31.75 MHz output of the oscillator module is mixed with the 1.85 MHz signal in the 20 MHz to 30 MHz IF amplifier to produce a frequency of 20.0 MHz to 29.9 MHz frequency is applied to the RF amplifier and transmitter preamplifier module simultaneously with the 200 MHz to 370 MHz injection output of the spectrum generator and amplifier module. The resultant mixed carrier frequency of 225.0 MHz to 399.9 MHz is amplified and fed to the power amplifier module where it is modulated by the audio signals applied via the microphone and modulator module. The power amplifier module output, which passes through a 400 MHz low pass filter and terminates at the antenna, is a modulated carrier within the 225.0 MHz to 399.9 MHz frequency range. The modulated carrier is sampled by the sidetone detector of the antenna relay and applied to the audio amplifier module. This sidetone audio permits the operator to monitor the transmitted signal.

The guard receiver module is a single-frequency receiver which normally operates on a 243.0 MHz input frequency. The guard circuit is a double-conversion, superheterodyne type similar to the main receiver. Both receivers, however, work into a common audio output circuit.

The crystal-controlled injection systems, which are the sources of the beat frequencies, are ganged mechanically to the tuning mechanism of the AN/ARC-52 so that the selection of any frequency channels results in the development of a 20.0 MHz to 29.9 MHz and a 1.85 MHz intermediate frequency. All tuning, or channeling, is operated through the mechanical tuning unit module, the control of which is maintained at Radio Set Control C-1607/ARC-52.

The a-c power unit (RT-332/ARC-52 only, fig. 16-22 (B)) receives voltages from the 3-phase, 115-volt a-c and the 27.5-volt d-c power sources and distributes them to the required modules. The a-c voltage is applied to the rectifier unit, and the d-c voltage is applied to the relay unit and the mechanical tuning unit. In addition, the a-c power unit supplies a rectified output of 425 volts d.c. to the relay unit, and filament supplies of 6.3 volts a.c. and 26.5 volts a.c. to the appropriate filament distribution points.

The rectifier unit (RT-332/ARC-52 only) receives 115 volts a.c. from the a-c power unit and provides plate and bias voltages of +130 volts, +225 volts, and -15 volts d.c. The relay unit controls the transition between the transmit and receive function which, in turn, are controlled by the microphone press-to-talk switch. It provides three power switching functions:

1. Disable, wherein channeling will cause the AN/ARC-52 to revert to the receive function and any received audio signal is grounded.
2. Guard, wherein plate voltage is controlled for guard receiver operation.
3. Tone, wherein a continuous homing signal, 1000-Hz tone, is transmitted.

The relay unit provides selective switching of positive d-c voltages of 27.5, 130, 225, and 425 volts.

The dynamotor power supply unit (RT-424/ARC-52X only) receives 27.5 volts d.c. from an external power source and distributes this

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voltage to internal circuits. The same voltage also excites a dynamotor to produce d-c voltages of +425 and +130. From these voltages, additional d-c voltages of +225 (regulated) and -15 are developed. All d-c output voltages from the dynamotor power supply unit are applied, either directly or through the relay unit, to the plate, screen, and grid circuits in the receiver-transmitter.

A mechanical tuning unit controls the frequency selection of the equipment and, in turn, is remotely controlled from Radio Set Control C-1607/ARC-52. It operates in a manner similar to that on the AN/ARC-88.

TRANSCEIVER ALINEMENT AND TRACKING

A transceiver is a self-contained transmitter and receiver which share common circuits. The transmitter and receiver both operate on the same frequency, and the microphone switch determines when there is an output from the transmitter. In the absence of transmission, the receiver is sensitive to incoming signals.

Some of the common circuits are the antenna, master oscillator, and RF and AF amplifiers. Advantages of these common circuits are the overall reduction of the size and weight, and the lower power demand on the aircraft system.

Since there are circuits common to both the transmitter and the receiver, alinement and tracking are unique problems of the transceiver. Alinement is the adjustment of circuits to specific frequencies, and tracking is maintaining a constant frequency relationship between two or more circuits.

In order to aline and track common circuits in a transceiver, it is necessary to refer to the Service Instructions Manual for the particular equipment being used. This is because the circuits common to both the transmitter and receiver will vary from equipment to equipment; for example, between the ARC-44, ARC-52, ARC-88, and the ARC-94.

INTERCOMMUNICATION SYSTEMS

All aircraft intercommunication systems perform essentially the same basic functions. They deliver audio to one or more selected stations on board the aircraft to permit crewmembers to speak to each other. They also provide control of the communication facilities so that various members of the crew may receive incoming radio messages or initiate messages with the aircraft transmitters. It is also often necessary that the intercommunication system contain facilities for operating recording equipment so that permanent records may be made of the various receptions and transmissions occurring during flight.

It is not possible in the limits of the present discussion to describe all types of intercommunication systems installed in naval aircraft. A few examples are given which show characteristics common to most installations, while at the same time presenting characteristics which represent the newer developments in this type of equipment.

INTERCOMMUNICATION SET AN/AIC-14

The AN/AIC-14 ICS is an airborne internal communication system which integrates and coordinates all the audio facilities of the communication and other electronic equipment. The overall design is based on modular construction to provide a very high degree of versatility and reliability. Easily replaceable plug-in transistorized amplifier modules insure reliability under severe environmental conditions. A variety of individual component parts and subassemblies are available for use with and within the system, permitting adaptation of the basic system for use in many different types of installations having various audio requirements. Thus the basic system and its numerous variations provide for almost trouble-free service over prolonged operating periods.

The maximum capability for AIC-14 interphone installations in a single system permits operation of any combination of up to 30 individual stations without readjustment of the interphone volume control. Under maximum usage the overall output level from the control unit does not vary by more than 3 db. All signal inputs are isolated from each other by at least 50 db, thus minimizing the effect of a single station on the operation of the overall system.

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ASSIGNMENT:

On an 8" x 11" buff drawing paper, draw in ink a $\frac{1}{2}$-inch border all around. Through the middle of the paper draw a line across the sheet. Draw the lines shown below, spacing them $\frac{1}{2}$ inch apart. When completed, clean pen thoroughly and store.

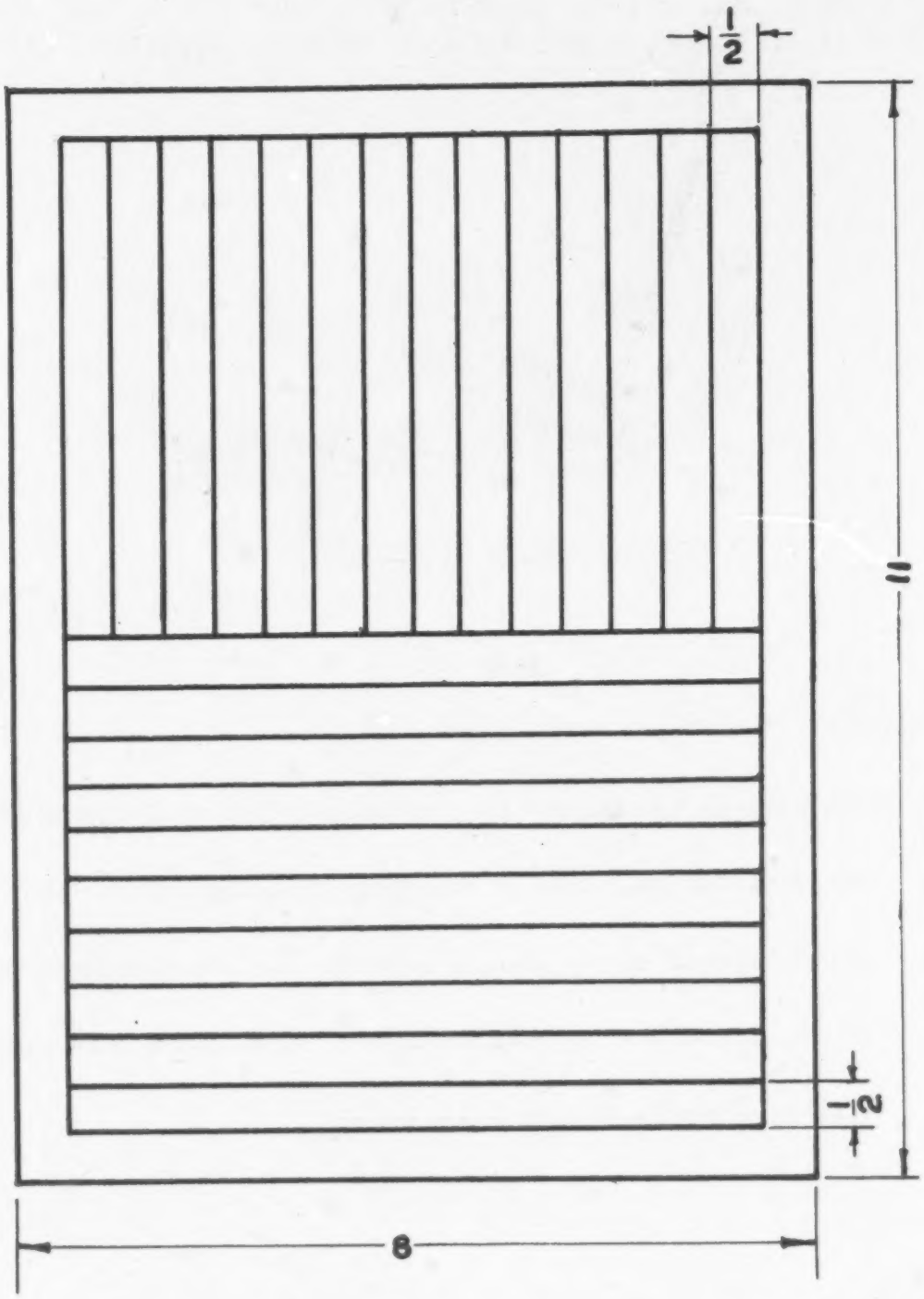

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In addition to the interphone stations which are normally manned during aircraft operations, auxiliary stations may be provided for use by ground personnel during maintanance, inspection, or servicing of the aircraft. Any combination of audio inputs (up to a total of 30) may be monitored without requiring adjustment of the volume control. Through operation of control switches, up to 11 outputs may be controlled.

The selection and monitoring of interphone and radio receiver signals, as well as the selection of transmitters to be keyed, is accomplished through selector switches and controls located on the front panels of the units to be controlled. The modes of operation (normal or auxiliary) and the energizing or deenergizing of interphone station microphones are controlled by operating appropriate switches on the front panel of the interphone control. The interphone control also permits the use of external keying switches.

To illustrate the flexibility and versatility of the AN/AIC-14 system, some of the various types of components and accessories are described briefly. The discussion is limited to the important features and peculiar applications of each item discussed. The list, although quite extensive, is far from a complete listing of items used in conjunction with the AN/AIC-14 Intercommunication Set.

Control Units

Control, Interphone C-2645A/(or C-2645B)/AIC-14 is the master control unit for the system, and is located at all manned interphone stations. Two transistorized plug-in amplifier modules (one isolation and one interphone) are included in each unit. The isolation amplifier provides the amplification and isolation necessary for all incoming audio (interphone and radio receiver). The interphone amplifier provides the amplification and isolation necessary for all outgoing audio (from the station's microphone). Each amplifier is capable of delivering a nominal output power of 300 milliwatts to the stations' earphones or to the interphone line.

The control unit also provides an alternate mode of operation for either or both amplifiers. If one amplifier becomes inoperative, its functions may be shifted to the other; if both the amplifiers become inoperative, they may be bypassed by switching to the EMERG position. In the emergency mode, incoming signals are supplied directly to the headset and outgoing signals are fed directly to the transmitter; no interphone communication is possible.

In almost all aircraft, additional control units are used to extend and expand the capacity of the ICS. A few such auxiliary control units are discussed briefly in the following paragraphs.

The C-2642/ or C-2642A/AIC-14 provides a means for selecting transmitter or interphone operation, interphone disconnect, and volume adjustment of incoming radio receiver signals. Any one of up to 11 transmitters can be selected.

The C-2643/AIC-14 is a selector panel for radio receivers and transmitters, permitting selection of any combination of two transmitters and four receivers. It incorporates isolation networks for all incoming signals.

The C-2644/AIC-14 incorporates facilities for selecting transmit or receive operation, a volume control for mixed radio receiver signals, and isolation for all incoming signals.

The C-2646/AIC-14 is an auxiliary control used primarily by maintenance personnel. It is located at auxiliary stations not normally manned during flight. It uses the common audio line for both incoming and outgoing interphone signals, and permits communication with any station which is connected to the common audio line.

The control contains a single amplifier. Incoming audio signals are isolated and amplified; in this case the amplifier acts as an isolation amplifier. When a push-to-talk circuit is energized, the microphone input is amplified and fed to the common line; the amplifier then switches to interphone operation.

The microphone and headset jacks can be used only with a 600-ohm headset and a carbon microphone with a nominal impedance of 100 ohms. When a dynamic microphone and low impedance headset are used, signal preamplification and transformer matching are required. This may be conveniently accomplished with the use of associated accessory cordsets discussed later in this chapter.

The mounting plate MT-2075/AIC-14 is used in conjunction with the C-2646. It includes a quick-dismounting feature provided by four slide fasteners which are secured by lockwire.

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The C-2647/ or C-2647A/AIC-14 provides facilities for increasing the number of either receivers or interphone stations. It provides isolation for all signals. The function as interphone station selector or as receiver selector is determined by the position of an internal plug-in unit. This function is established at the time of installation, and is not normally changed thereafter.

When used as a receiver selector, any one or any combination of 12 receivers may be selected and isolated. When used as an interphone station selector, the unit selects and isolates any one or any combination of 12 signals. An alternate provision enables position 12 to be used either to select a specific station or as an "all-call" for up to 11 stations.

The C-2648/ or C-2648A/AIC-14 control permits selection of six additional receivers or interphone stations. In other respects it is similar to the C-2647.

Interconnection Box J-1013/AIC

This accessory enables the AN/AIC-14 to operate with either carbon or dynamic microphones and either high or low impedance headsets. The unit contains a 60-db transistorized preamplifier and two impedance matching transformers. The preamplifier and transformers may or may not be used, depending on the position of the connecting links in the box. A table illustrating the link settings for various types of microphones and headsets is located on the inside of the cover plate.

Microphones

A carbon microphone may be connected directly into the AN/AIC-14 Intercommunication Set, or it may be connected through a J-1013 interconnection box. If the J-1013 is used, the links must be set so as to bypass the microphone preamplifier. Dynamic microphones, if used, must be connected through the J-1013. The links must be set so that the 60-db gain of the microphone preamplifier is used.

The RS-38D-2 is a hand-held, high output (0.25-volt, rms), noise-canceling carbon microphone. Its termination (plug PJ-068) mates with the MIKE jack on the interphone control C-2646 or on any installation which accommodates conventional carbon microphones.

The M-3A/A is a high output (0.25-volt, rms), boom-mounted, noise-canceling carbon microphone. Its termination (PJ-292) is a two-prong plug which mates with the receptacle on the H-173/AIC headset and the CX-1301/AR cordset.

The ANB-M-C1 is a high output (0.25-volt, rms) carbon microphone normally used in oxygen masks. It terminates in the PJ-292 plug.

The M-92/U is a hand-held, noise-canceling, dynamic microphone with a built-in transistorized amplifier. In appearance and characteristics it is the equivalent of the RS-38D-2 carbon microphone, and may be used interchangeably with it. If a J-1013 is used, the link settings should bypass the preamplifier.

The M-96/A is a boom-mounted, noise-canceling, dynamic microphone similar in appearance to the M-3A/A carbon microphone and terminated in the same type (PJ-292) plug. In use, however, the two are not interchangeable. The M-96/A has a nominal output impedance of 7 ohms, and delivers an output voltage of 300 to 500 microvolts. The J-1013 must be used, and the microphone preamplifier and the appropriate impedance matching transformer must be connected by the changeable links.

The M-94/A is the dynamic microphone used in oxygen masks. In appearance it resembles the AMB–M-C1, but the two are not operationally interchangeable. In electrical characteristics and service limitations, the M-94/A resembles the M-96/A.

Earphones and Headsets

Several types of earphones and headsets are used with the AN/AIC-14 system. In actual practice the headsets may be so constructed that the earphones are either used separately (split-phone) or connected in parallel. They may have either a low or a high impedance.

Earphones H-87B/U are the dynamic type commonly used in helmets and headsets. The earphones have an impedance of 7 ohms as compared to the 600-ohm impedance of the ICS. The phones may be connected to a 25020 cordset which is terminated in a short plug. In this arrangement, an impedance matching transformer in the plug permits the H-87B/U to be inserted directly into the ICS control box. If connected through the J-1013, the links should bypass the impedance transformers.

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By using the cordset CX-4832 the earphones are connected in parallel, offering a 7-ohm impedance. This combination requires use of the J-1013 and its impedance matching transformers.

The H-173/AIC headset is a lightweight unit which is designed for maximum wearing comfort. It contains the H-87B/U earphones and incorporates provisions for mounting boom microphones. The earpieces eliminate most of the surrounding noise. A quick-disconnect feature provides safety and ease of handling.

The H-3/ARR-3 is a dynamic headset with built-in impedance matching transformer, which adapts the 7-ohm phones to the 600-ohm system. This allows the headset to be directly inserted into the ICS. If connected through a J-1013, the impedance transformer must be bypassed.

Cordsets

Many types of cordsets are used with the AN/AIC-14. These cordsets are used for connecting the various types of microphones, headsets, and connection boxes within the system. Some include amplifiers and/or impedance transformers; others do not. The following paragraphs present a brief discussion of several of these cordsets.

The CX-1301/AR is a coiled cordset terminated on one end with a Junction Box J-193/AR and on the other end with a U61-U receptacle. The cordset is normally used with carbon microphones and high impedance headsets. If incompatible accessories are used, the J-193/AR is removed from its mounting and the CX-1301/AR is replaced by a J-1013. The mounting holes of both connecting boxes coincide.

The CX-4620/AR is a 75-foot, 5-conductor cable with an in-the-line switch containing a preamplifier, impedance transformer, and microphone keying switch. One end is terminated in a connector which mates with the J-1013 input connector. The other end mates with the H-173/AIC headset or a hardhat. This cordset may be used only with a dynamic microphone and a low impedance headset. However, the adjustable links in the J-1013 must be set to accommodate a carbon microphone and high impedance headset combination.

The CX-4621/AR is a 6-foot, 5-conductor, coiled cordset with terminations identical to those of the CX-4620/AR. Since it contains no preamplifier or impedance matching transformers, it may be used with either type headset and microphone. However, the links in the J-1013 must be connected accordingly.

The CX-4623/AR is a 9-foot, 5-conductor, coiled cordset. It includes an in-the-line switch similar to that in the CX-4620/AR, and is terminated in the same type connectors. It may be used only with a dynamic microphone and low impedance headset, but the J-1013 links must be set for the carbon microphone and high impedance headset combination.

The CX-4832/AR cordset is used to connect the earpieces of the H-87B/U in parallel, thus providing a low impedance output.

INTERCOMMUNICATION SET AN/AIC-15

The AN/AIC-15 system, marks a milestone in adaptation of transistor circuits to airborne applications in a form suitable for manufacture on a production basis. The total equipment consists of six types of major components; four types of station control boxes, a recorder control, and an interconnecting box.

Each of the control boxes with the exception of the recorder unit contains one microphone amplifier and one receiver amplifier. The type of box installed at a particular station of the aircraft is determined by the communication functions to be performed at that station. All boxes provide essentially the same intercom and receiver facilities. The system is not restricted to use with any specific radio receiver, recorder, or transmitter, but may be used with many different radio communication equipments.

System Operation

The major components of the AIC-15 are connected as shown in the block diagram in figure 16-23. The master unit (C-1908) contains controls for the complete set of radio and intercom facilities. The flight crew control (C-1910) provides the means for controlling two radio transmitters and for listening to two radio receivers. The recorder control (C-1912)

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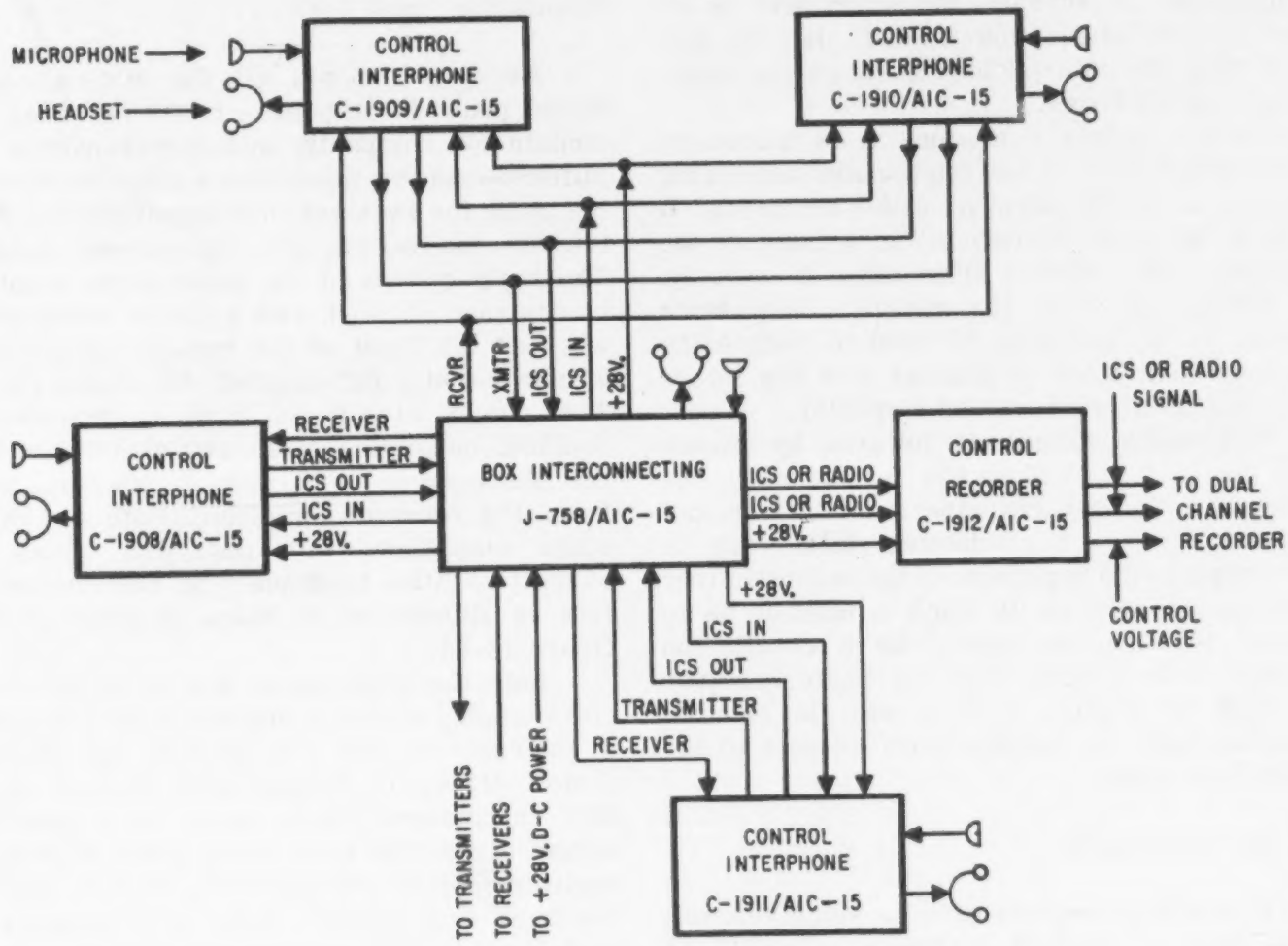

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Figure 16-23.–AN/AIC-15, system block diagram.

serves to route any of the signals present to a tape recorder so that it is possible to preserve the audio information exchanged during operation.

The central unit of the system, Interconnecting Box, J-758, connects incoming receiver signals to the various stations and also connects the control boxes to the aircraft transmitters for control of the latter during transmission. The interconnecting box can also be used as an additional control station since it contains jacks for a microphone and a headset.

Each of the station control boxes contains a microphone amplifier and a receiver amplifier and is therefore independent of any outside aid except d-c power. Thus, external cables are not required as would be the case with external amplifiers; and smaller wires are used due to lower power requirements. As a result, approximately 60 pounds of cable weight are eliminated in comparison with electron-tube counterparts of the system. An additional advantage of this compact method of amplifier packaging is increased flexibility, in that the number of control units can be decreased or increased without causing any deterioration in the performance of the system.

Because of the relatively low power consumption of the AIC-15, the system contains no on-off switch as such. The equipment is powered from a 28-volt, d-c supply and remains in the ON condition as long as the aircraft power system is in operation.

All audio switches are semiconductor devices. By placing an appropriate d-c bias on a particular interphone line, audio on that line can be routed into the control boxes attached to it. The audio switch for each interphone line is a germanium diode which acts as a short circuit to audio when a forward d-c bias is

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established. Conversely, the diode acts as an open circuit when back biased, thereby disconnecting the interphone line from the associated control boxes.

Under certain conditions it is necessary to use the intercom facilities while monitoring the output of the aircraft radio receivers. It is then desirable to reduce the volume of the receiver audio without eliminating it entirely. To accomplish this, the nonlinear impedance feature of a transistor is used to reduce the receiver audio that is present with the interphone signal at the receiver amplifier.

The radio volume is lowered by means of a d-c bias applied to the volume-reduction transistor, thereby changing the latter from a nonconductive to a conducting state. This, in turn, changes the impedance of the radio receiver audio input network in such a manner as to reduce the applied audio. As a result, the volume of the output from any radio receiver selected at a given control unit is reduced approximately 10 decibels with respect to the interphone level.

Interphone Circuits

A single interphone line is employed with each type of control station in the AIC-15 system. For example, the pilot, copilot, and radio operator are on a single interphone line and the remaining crew stations are on another. There is also a separate line to which all control stations are connected, which makes it possible to talk from any control box to all other stations in the system.

An emergency, or override, feature is provided by a separate line under control of the pilot, copilot, or radio operator. The emergency line can be switched on quickly and communication established with all crewmembers on the aircraft.

In addition to the interphone facilities, the AIC-15 circuits provide the means for listening to any combination of 9 radio receivers and for controlling the operation of any of 9 radio transmitters. The total number of stations may be as high as 13, a relatively large capability which is achieved with comparatively small requirements of space, weight, and power. The system is designed to operate on 10 watts of 28-volt, d-c power per control unit.

Transistor Amplifiers

As stated above, all the station control boxes (with the exception of the recorder unit) contain two compactly packaged transistor amplifiers—one for microphone amplification and the other for receiver audio amplification. Electrically, the two amplifiers are almost identical. The input circuit of the microphone amplifier is designed to work with a carbon microphone, whereas the input of the receiver amplifier is a conventional RC coupled, 600-ohms circuit. The output circuit in both is transformer coupled, consisting of an 800-ohm output from the microphone unit and a 600-ohm output from the receiver amplifier. Both are three-stage amplifiers with push-pull output and overall negative feedback. The receiver amplifier is illustrated in block diagram form in figure 16-24.

Both the microphone and receiver amplifiers employ silicon transistors. The input stage of the receiver unit is a type 904. The 951 transistor driver is transformer coupled to two 951 transistors which serve as a push-pull output stage. The first two stages are grounded emitter circuits with collector-to-base negative feedback and emitter resistance temperature stabilization. The output stage is a grounded base circuit biased for class B operation. An overall negative feedback loop of about 20 decibels is used to further stabilize the circuit operation.

The overall dimensions of each AIC-15 amplifier are 2.44 by 1.72 by 1.00 inches. The maximum power gain is approximately 35 decibels with a gain control provided to reduce the output signal to zero. The amplifiers are capable of an output of 300 milliwatts at less than 10 percent distortion and an output of 150 milliwats at less than 5 percent distortion. The frequency response is flat within ±2 decibels

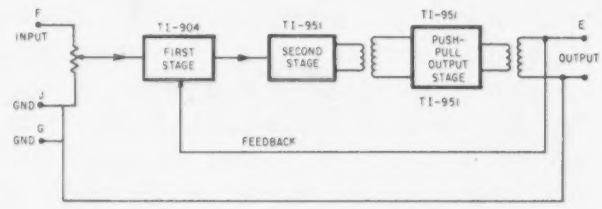

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Figure 16-24.—Block diagram of the transistorized receiver amplifier.

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from 400 to 6,000 hertz. Satisfactory operation is maintained over the input B-plus voltage range of 22 to 30 volts d.c. About 80 milliamperes of current are required at the 28-volt B-plus level.

The amplifiers are potted to reduce vibration damage. For maintenance, the entire unit is replaced and no attempt is made to repair any component within the amplifiers. The weight of each amplifier is approximately 5 ounces, a very favorable figure when compared with a weight of 13 to 15 pounds in comparable units of older systems. Also with lower power requirements, an approximate reduction in load of 20 percent is realized.

Intercommunication Set AN/AIC-15 is of considerable importance for the Aviation Electronics Technician since it is one of the first completely transistorized electronic systems which have demonstrated capability of meeting all military requirements of its class and which has definite advantages when compared with hitherto standard designs. Among these are a relatively larger number of facilities controlled, less size and weight, lower power requirements, and greater reliability and flexibility as compared to its vacuum tube counterparts. The design specifications require at least 2,000 hours of satisfactory service without removal for bench servicing, a feature of essential importance for maintenance personnel. From the standpoint of operation, one of the outstanding features of the system is its clearness of transmission.

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CHAPTER 17

AIRBORNE NAVIGATION EQUIPMENT

Airborne navigation equipment is a term embracing many systems and instruments. The technician is required to maintain and, in some instances, to operate various equipments. This chapter includes a discussion of the major navigational systems in present use, with reference to some typical equipments. These systems include electronic altimeters, radio range and related facilities, loran, radio direction finders, Doppler radar systems, and inertial navigation equipment.

ELECTRONIC ALTIMETERS

Electronic altimeters may be classified as radio or radar altimeters. They may operate on frequency modulation principles, or they may be pulsed. Electronic altimeters are frequently referred to as absolute altimeters, because they are used to measure height above the terrain rather than with respect to sea level.

This chapter contains a brief discussion of two of the later and more accurate altimeters in present use in the fleet.

ELECTRONIC ALTIMETER AN/APN-120

The Altimeter Set, Electronic, AN/APN-120 furnishes accurate radar altitude (above terrain) indications over all types of terrain and under any weather conditions. It operates on two ranges. The low range measures altitude up to 3,000 feet; the high range measures altitude from 500 feet to the maximum altitude of the aircraft. It is installed in the RA5C model aircraft and is an integral part of the weapons system. In addition to furnishing accurate altitude data for the pilot, the system also supplies data for correcting the barometric altitude calculated by the air data system. The final corrected barometric altitude information is used by the bomb directing set to compute weapon delivery patterns.

Characteristics

The altimeter system consists of a hybrid radar system. The low altitude subsystem consists of an amplitude-modulated, frequency-modulated, continuous-wave (AM-FM-CW) C-band radar set; the high altitude subsystem is of the pulsed type. Provisions are made for a low altitude warning light, which actuates at 400 feet altitude above terrain, and an indicator of signal reliability.

System functional loops represent the complete paths of signal flow within the system, subsystems, and circuits. These loops are not limited by their packaging or "black box" location.

Theory of Operation

For purposes of this discussion, the theory of operation for the AN/APN-120 is divided into a brief discussion of the functional loops. For detailed information regarding this equipment, refer to the applicable technical manuals. Figure 17-1 is a simplified block diagram of the altimeter, and should be referred to frequently in connection with this discussion.

LOW ALTITUDE MEASUREMENT LOOP.– The low altitude system transmits and receives an RF carrier in the C band of radar frequencies. The carrier is frequency modulated by 25 kHz, which is itself amplitude modulated by a 400 hertz voltage. (The 25 kHz modulation is required to develop frequencies representative of altitude.

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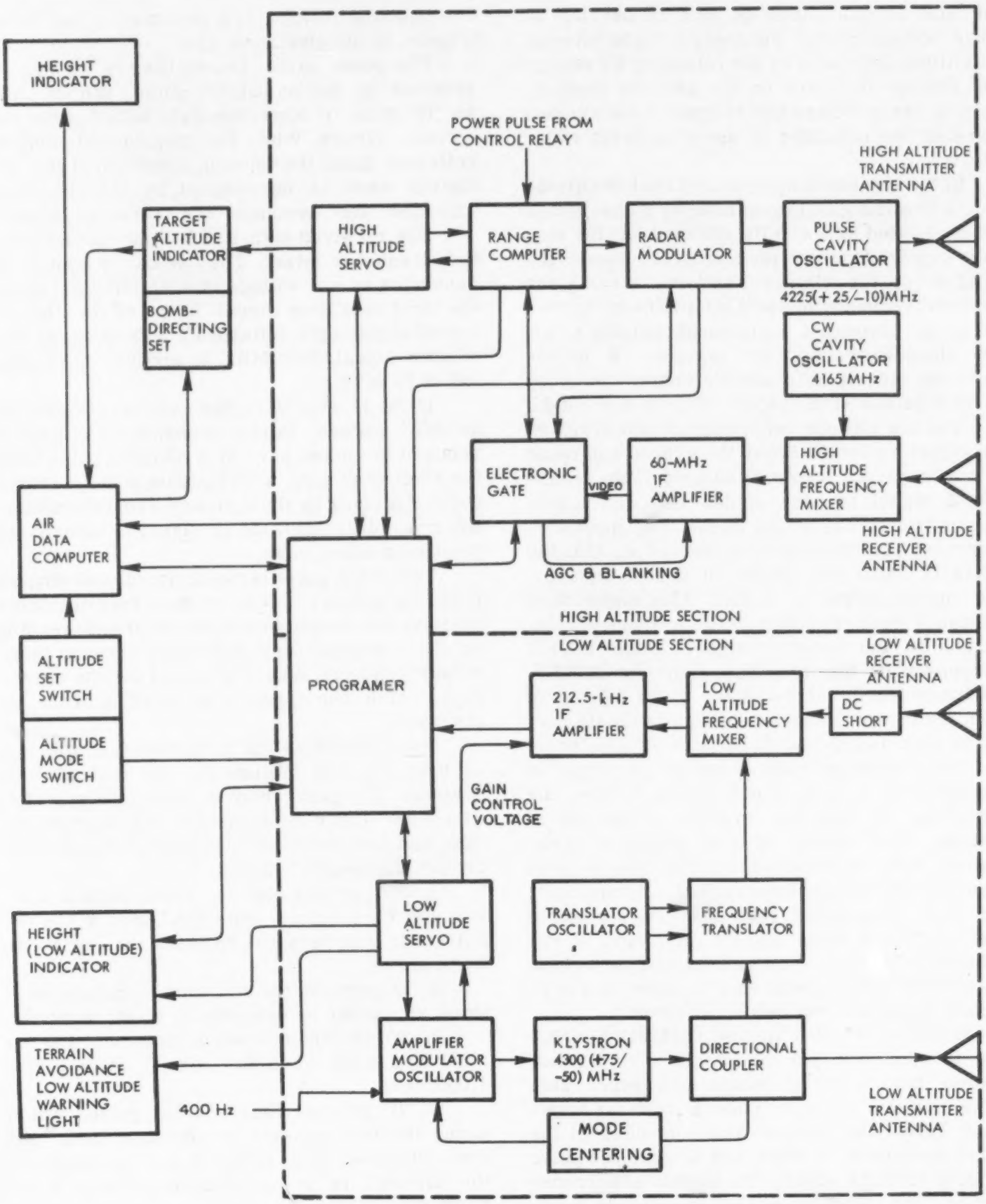

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Figure 17-1.–Altimeter Set, Electronic, AN/APN-120, simplified block diagram.

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The 400 Hz modulation is used to develop an error voltage when a difference exists between the altitude indicated by the returning RF energy and altitude indicated on the altitude readout. When an error voltage is developed, the servoloop corrects the indicator to agree with the radar return.)

In the transmitting portion of the low altitude loop, a 25 kHz signal is generated by an oscillator and modulated by a 400 Hz voltage from the aircraft supply. This complex signal is routed to the repeller of the klystron, thereby varying the klystron frequency of oscillation. The modulated RF is fed through a directional coupler to the low altitude transmitter antenna. A mode-centering circuit maintains the center frequency of the klystron at the center of its power mode.

The low altitude receiving antenna receives the signal reflected from the ground and feeds it to a frequency mixer. A sample of the transmitted signal is also routed (through a frequency translator) to the mixer. The input frequency of the translator is shifted so that the output is 262.5 kHz above the input frequency. The mixer output is a 262.5 kHz signal with sidebands corresponding to the frequency modulation on the received signal. Since the FM component of the received signal is 25 kHz, sidebands occur at multiples of 25 kHz away from the center frequency. This composite signal is then fed to the 212.5 kHz IF amplifier.

The maximum gain of the IF amplifier is governed by a gain control voltage from the servoloop, so that the gain is a function of altitude. The output of the amplifier programer unit is detected and filtered to produce an AM component and a d-c component. The d-c component provides the automatic gain control voltage and an indication of reliability. The AM component is compared with the aircraft 400 Hz reference to produce a correction signal for the height indicator.

HIGH ALTITUDE MEASUREMENT LOOP.–The transmitting portion of the high altitude system begins at the range computer. This stage initiates a trigger pulse at a stable repetition rate. The trigger pulse is used in the radar modulator to time and trigger the pulse forming circuits which pulse modulate the transmitter. The modulator also supplies a negative blanking voltage, synchronized by the same trigger, to the electronic gate.

The pulse cavity transmitter is caused to resonate by the modulator pulse, and supplies an RF pulse at approximately 4225 MHz to the antenna arrays. When the transmitted pulse is reflected from the terrain, a portion of the reflected wave is intercepted by the receiving antennas and becomes the received signal.

The received signal is fed into the high altitude frequency mixer. The CW cavity oscillator generates an a-c voltage at 4165 MHz for use as the local oscillator signal. In the mixer, the received signal (4225 MHz) beats with the local oscillator signal (4165 MHz) to produce an IF signal of 60 MHz.

In the IF amplifier, the gain is regulated by an AGC voltage. During transmit time, gain is reduced to almost zero by a blanking pulse from the electronic gate. This blanking pulse prevents self-triggering by the system's own transmitter. After amplification, the IF signal is detected to produce a video pulse.

The video pulse is gated, timed, and shaped in the programer unit to produce the altitude indication for comparison with the altitude reading on the indicator. Any difference between these values produces an error signal for the servoloop, which then corrects the reading of the instrument.

PROGRAMER.–The programer is common to both the low altitude and the high altitude systems. The programer is made up of circuits, which are partly interdependent in their operation, and performs the following functions which are not discussed in detail:

1. To process the d-c error signals (for low and high altitude range) to provide the required driving signal voltage for the respective servomotor.

2. To perform the required switching functions according to operational mode selection.

3. To provide automatic turn-on of the low altitude system when the altitude is less than 4,000 feet.

4. To provide time-sharing pulses which cause the two systems to alternate their "on" time whenever both systems are operating and the aircraft is at an altitude between 0 and 4,000 feet.

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RADAR ALTIMETER AN/APN-141(V)

Electronic Altimeter Set AN/APN-141(V) is a C-band, pulsed, rangetracking radar that locks onto the leading edge of the echo pulse. It provides a continuous, highly accurate indication of absolute altitude from 10 to 5,000 feet above water or terrain. The accuracy and the reliability make possible extremely low altitude instrument flight missions in familiar or level territory. It also increases the safety of moderately low-level instrument flight missions into territory where the barometric pressure and terrain elevation data are unreliable or unknown.

The equipment consists of the radar transmitter-receiver unit, an RF switching unit, a height indicator, and two antennas.

Characteristics

Altitude information is continuously displayed, in feet of absolute altitude, on a panel-mounted indicator. This information is developed by radiating pulses of microwave energy downward and by monitoring the time required for the return of each pulse as an echo. Monitoring of pulse transit time is accomplished by means of a leading-edge electronic tracking loop which, in effect, locks onto the range of the water or terrain, and follows variations of clearance resulting from aircraft maneuvers or terrain elevation.

Leading-edge tracking provides for an indication of the nearest terrain under the aircraft, and not necessarily the terrain directly under it. Thus, the altimeter set will track a mountainside or a cliff ahead or to the side of the aircraft if this terrain is closer than the ground directly below the aircraft. This feature provides essential warning of rapidly decreasing absolute altitude on low-level missions.

The system has two altitude modes of operation–one for low altitudes and one for high altitudes. At low altitudes (0 to 195 feet ascending and 165 to 0 feet descending), a very narrow, low-powered transmitted pulse is utilized to obtain maximum range resolution. The low altitude pulse is also programed in width to provide the proper strength of the ground return signal with altitude variation. At altitudes above the ascending and descending upper altitude limits, a wider high-power transmitted pulse is utilized to obtain sufficient ground return energy for tracking.

The altimeter system also has two ranging modes of operation–the search mode and the tracking mode. In the search mode, the system successively examines increments of range with each cycle of operation until the complete altitude range is searched for a ground return signal. When the altitude range is found, the system switches over to the tracking mode of operation. In the tracking mode, the system locks onto and tracks the leading edges of the ground return pulses and presents continuous altitude information.

Altitude information is obtained by measuring the time intervals from the instant that each pulse of RF energy leaves the transmitter until the leading edge of the ground return signal is detected in the receiver. The system converts this time interval information to a d-c range voltage which is offset in amplitude to form an altitude d-c voltage analog. This analog is fed to the height indicator which indicates altitude in feet proportional to the amplitude of the d-c voltage.

Theory of Operation

For the following general discussion of the theory of operation for Electronic Altimeter Set AN/APN-141(V), refer to figure 17-2. For more detailed information, refer to the applicable technical manuals.

TRANSMISSION.–Clock pulse 1 functions as the basic system timing trigger. This pulse is generated at a 3 kHz rate in the time comparator and is fed to the modulator where it triggers each transmission and cycle of operation. The modulator pulses the transmitter cavity and produces a crystal switch drive signal for gating the narrow RF pulse transmitted during low altitude operation. This gating is accomplished in the RF switching unit. The modulator also produces a range-timing ramp trigger for use in the time comparator during low altitude operation. The modulation pulse drives the transmitter cavity into oscillation, and the transmitter cavity energy is applied to the RF switching unit. A detected sample of the energy is taken from the cavity as a range-timing ramp trigger for use in the time comparator during high altitude operation.

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UNIT V - TRACING

How To Sharpen a Pen — Lesson 2

OBJECTIVE: To learn the art of sharpening a pen.

RELATED INFORMATION:

As previously stated, beginning draftsmen should possess some competence in the art of inking, for they most assuredly will be called upon to use this technique at one time or another throughout their careers.

In order to draw well in ink, the pen must be kept sharp. This lesson will be devoted to teaching you the art of sharpening a pen.

When preparing to sharpen a pen, an oil stone usually affords best results. The nibs of the pen must first be brought to the correct shape, as shown in Fig. 1. When the nibs are touching, draw the pen back and forth on the stone, starting the stroke with the handle at 30° or less with the stone. The nibs will then be brought to exactly the same shape and length, leaving them very dull. At this point open them slightly and sharpen each blade in turn on the outside only, until the bright spot on the end has just disappeared.

FIG. 1

Now, as in Fig. 2, hold the pen at a small angle with the stone and rub it back and forth with a slight rocking motion to conform to the shape of the blade.

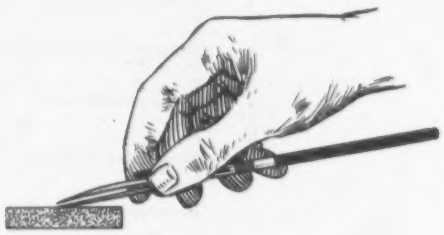

FIG. 2

To believe that you will achieve good results initially is foolhardy. Practice and more practice, alone, will enable you to sharpen a pen properly.

QUESTIONS:

1. Why bother to sharpen a pen?
2. Which part of the pen is sharpened?
3. Describe the correct shape of the nibs after sharpening?
4. Why should you learn to ink drawings?

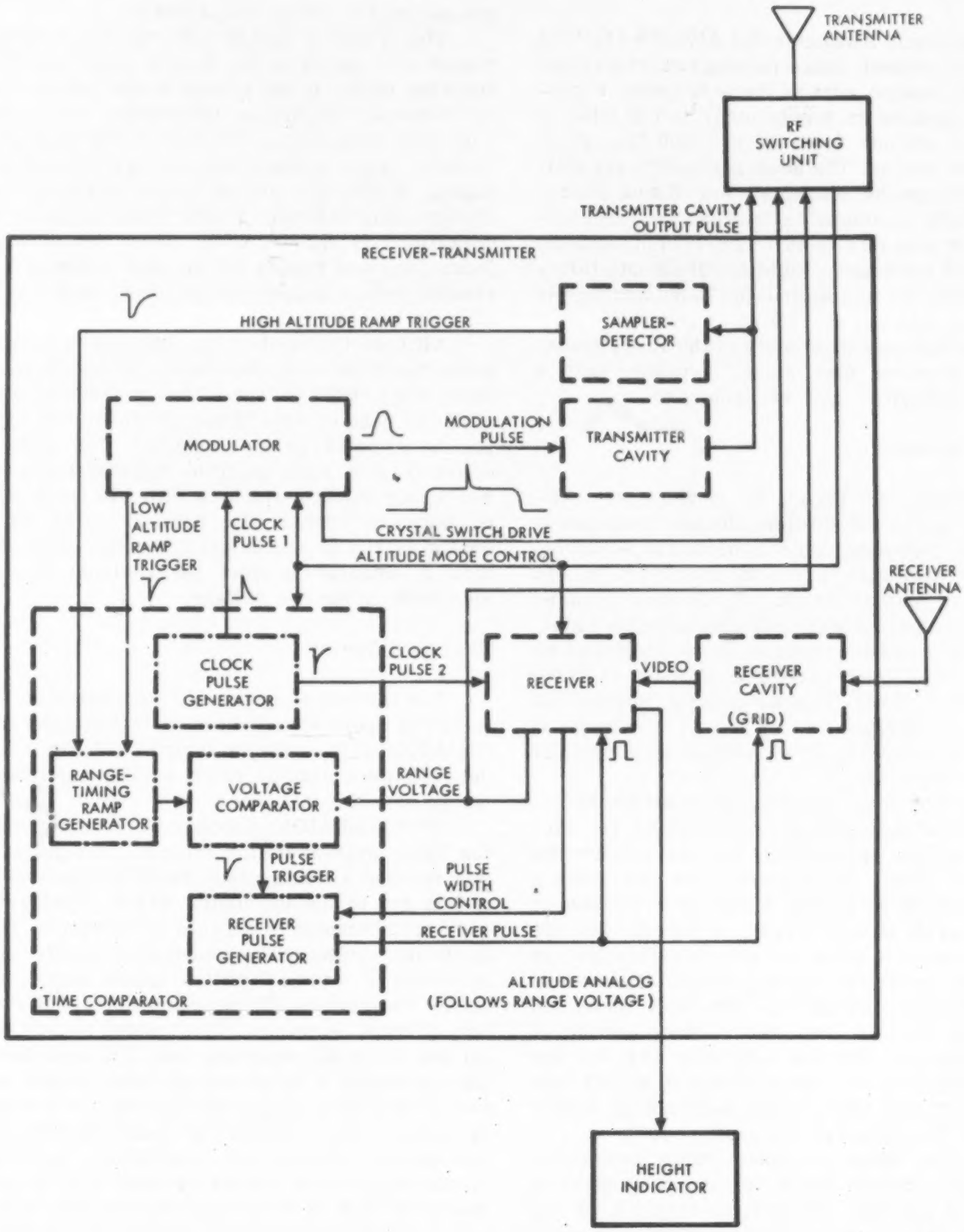

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Figure 17-2.–Altimeter AN/APN-141(V), block diagram.

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The RF switching unit is controlled by the d-c level of the range voltage input from the receiver, and performs two basic functions: gating of the peak power and width of the transmitted pulse, and switching of the potential on the altitude mode control line. During high altitude operation, the unit routes the full 1-kilowatt output of the transmitter cavity directly to the transmitter antenna and grounds the altitude mode control line. During low altitude operation, the unit attenuates, narrows, and programs the width of the cavity output pulse before application to the antenna. It also places a positive voltage on the altitude mode control line. The potential on the altitude mode control line enables or inhibits circuits in the modulator, time comparator, and receiver to provide the proper gating and timing in these three modules for each altitude mode.

RECEPTION.–The receiver antenna senses ground return signals and applies these pulses of RF energy to the receiver cavity. The receiver cavity is a superregenerative detector that generates an output only when pulsed by a positive grid signal. This signal is supplied by the receiver pulse generator in the time comparator. The cavity generates an output each time the receiver pulse is applied, but this output is of greater peak amplitude when ground return energy is present in the cavity than when this energy is absent.

The receiver pulse is generated twice during each operational cycle: First, for detecting the possible presence of ground return energy in the cavity, and later, when no ground return energy can be present for sampling the noise level in the cavity. Either type of cavity output is detected, and resulting high or low amplitude video signal is fed to the receiver. Simultaneous with cavity grid pulsation, the receiver pulse activates the receiver for two brief intervals in the operational cycle.

During the first interval, the receiver examines the video signal for the possible presence of a ground return signal. If the signal is absent, the receiver maintains the system in the search mode of operation. If the signal is present, the receiver switches the system over to the tracking mode.

During the second interval, the receiver samples the noise level in the cavity and utilizes the low amplitude video input to regulate the width of the receiver pulse for the automatic stabilization of receiver gain.

The receiver also utilizes its range voltage output to regulate the width of the receiver pulse for the adjustment of receiver sensitivity to ground return pulses with variations in altitude. Clock pulse 2, from the time comparator, triggers a circuit in the receiver that generates the receiver pulse width control signal.

SEARCH MODE OPERATION.–Figure 17-3 shows the idealized basic waveforms and time relationships involved in altitude acquisition and tracking. The (A) set of waveforms is common to both modes, and shows the basic timing and transmission references. The (B) set of waveforms applies to the search mode of operation, and the (C) and (D) sets apply to the tracking mode. The 3 kHz pulse repetition frequency of clock pulse 1 establishes a basic system period of approximately 333 microseconds for both the high and low altitude modes of operation. The signals and events required for altitude acquisition and tracking occur during the first 10 microseconds of this period over the interval of the range-timing ramp. (Since a radar time of 2 microseconds is approximately equivalent to an altitude of 1,000 feet, this first 10-microsecond timing interval corresponds to the 5,000 foot maximum altitude capability of the system.)

In the search mode, the range voltage from the receiver is a freerunning sweep of 2.5-second duration. The range-timing ramp and the range voltage sweep are both fed to a voltage comparator in the time comparator. When voltage coincidence of the ramp and range sweep occurs, the voltage comparator triggers the receiver pulse. The receiver pulse biases the receiver cavity into conduction and triggers a gate in the receiver that momentarily enables amplification and switching circuits to examine an increment of altitude. With no ground return signal present, the receiver cavity generates a small video signal that results from the buildup of the noise level in the conducting cavity.

The equal intervals in the first train of ground return signals shown in figure 17-3(B) represent the pulses present in the receiver cavity at a constant altitude. Over successive cycles of operation, the receiver pulse approaches the ground return pulse in time because of the successive delays in ramp and

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range sweep voltage coincidence. Throughout a complete 2.5 second range voltage sweep, the receiver pulse is generated approximately 7,500 times, and the altitude is effectively probed in increments of 1 foot. When the receiver pulse reaches the ground return signal in time, the video output from the receiver cavity builds up considerably above the previous levels attained by noise buildup, and switches the receiver from the search to the tracking mode of operation. The video input is then used as a range voltage amplitude control, resulting in the leveling of the range voltage at an amplitude equivalent to the time interval between the transmitted and ground return pulses.

TRACKING MODE OPERATION.–When switched over to the tracking mode, the receiver and the time comparator operate together to time the occurrence of the receiver pulse with a point on the slope of the leading edge of the ground return pulse. (See fig. 17-3(C).) With a constant altitude and a consequent steady range voltage, as well as fixed ground return period, this synchronism is merely coincidental. The automatically controlled synchronism required for following altitude changes is provided by a tracking servoloop consisting of the same basic components used in the search mode (switched to the tracking mode of operation).

In the tracking mode, the range voltage still tends to rise, but with a much shallower slope than in the search mode. The tracking servoloop utilizes both this slight tendency of the range voltage to rise if uncontrolled and the sensitivity and power buildup characteristics of the receiver cavity as a governing mechanism for locking onto and tracking altitude changes. At the leading edge of the receiver pulse, cavity sensitivity rises sharply to a maximum value and then falls off exponentially to a zero value near the trailing edge of the grid pulse.

The center set of curves in figure 17-3(D) shows the operation of this governing mechanism at a constant altitude. Here the leading edge of the grid pulse is timed to coincide with a nominal power level on the leading edge of the ground return pulse. The point of maximum cavity sensitivity coincides with this nominal RF power level. The buildup of cavity output power, because of the exponential curve of the sensitivity characteristic, is linear. Averaged over succeeding cycles of operation, the buildup is just sufficient to keep the range voltage at a constant level, maintaining a constant period of ramp and range voltage coincidence and a consequent fixed grid-pulse spacing. The results are a steady d-c voltage analog to the height indicator and a constant altitude indication.

The lower set of waveforms in figure 17-3 (C) shows how the system tracks a ground return pulse train whose period shortens successively with decreasing altitude. The second receiver pulse, whose spacing from the first pulse is governed by the previous coincidence of ramp and range voltage, occurs slightly delayed with respect to the ground return pulse. Receiver cavity buildup of video output power increases and drives down the range voltage and altitude analog. This causes range and ramp voltage coincidence to occur earlier and the receiver pulse to follow the leading edge of the ground return pulse.

The left set of curves in figure 17-3(D) shows the operation of the tracking servoloop with a decreasing altitude (or with any tendency of the grid-pulse spacing to drive toward a longer period than that required for tracking). The ground return pulse arrives slightly earlier than for a constant altitude, and the leading edge of the grid pulse coincides with a higher power level on the leading edge of the ground return pulse. The consequent higher peak buildup of cavity output power, averaged over a number of operational cycles, drives the range voltage and altitude analog down.

The right set of curves in figure 17-3(D) shows the operation with increasing altitude (or with any tendency of the grid-pulse spacing to drift toward a shorter period than that required for tracking.) The ground return pulse arrives slightly later than for a constant altitude, and the leading edge of the grid pulse coincides with a lower power level. The consequent lower peak buildup of cavity output power, averaged over a number of cycles, allows the range voltage and altitude analog to rise. Thus, the time coincidence of the ramp and range voltage, controlled by the amount of peak video power developed from the initial level of RF signal power at the leading edge of the grid pulse, adjusts the spacing of the receiver pulse automatically to track the leading edge of the ground return pulse. The resulting altitude analog, which follows the range voltage, thus tracks a balance of two op-

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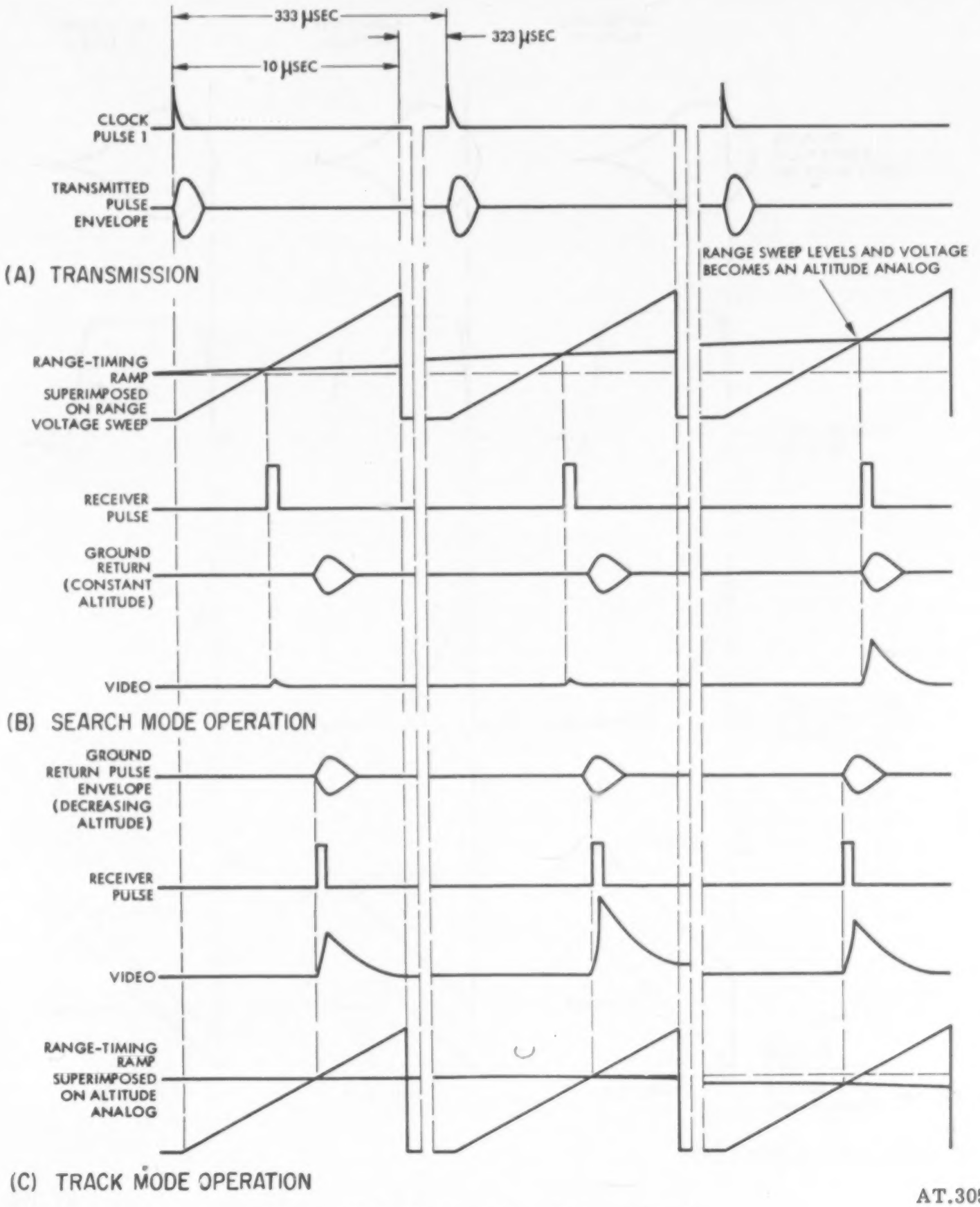

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Figure 17-3.–Basic system timing sequence.

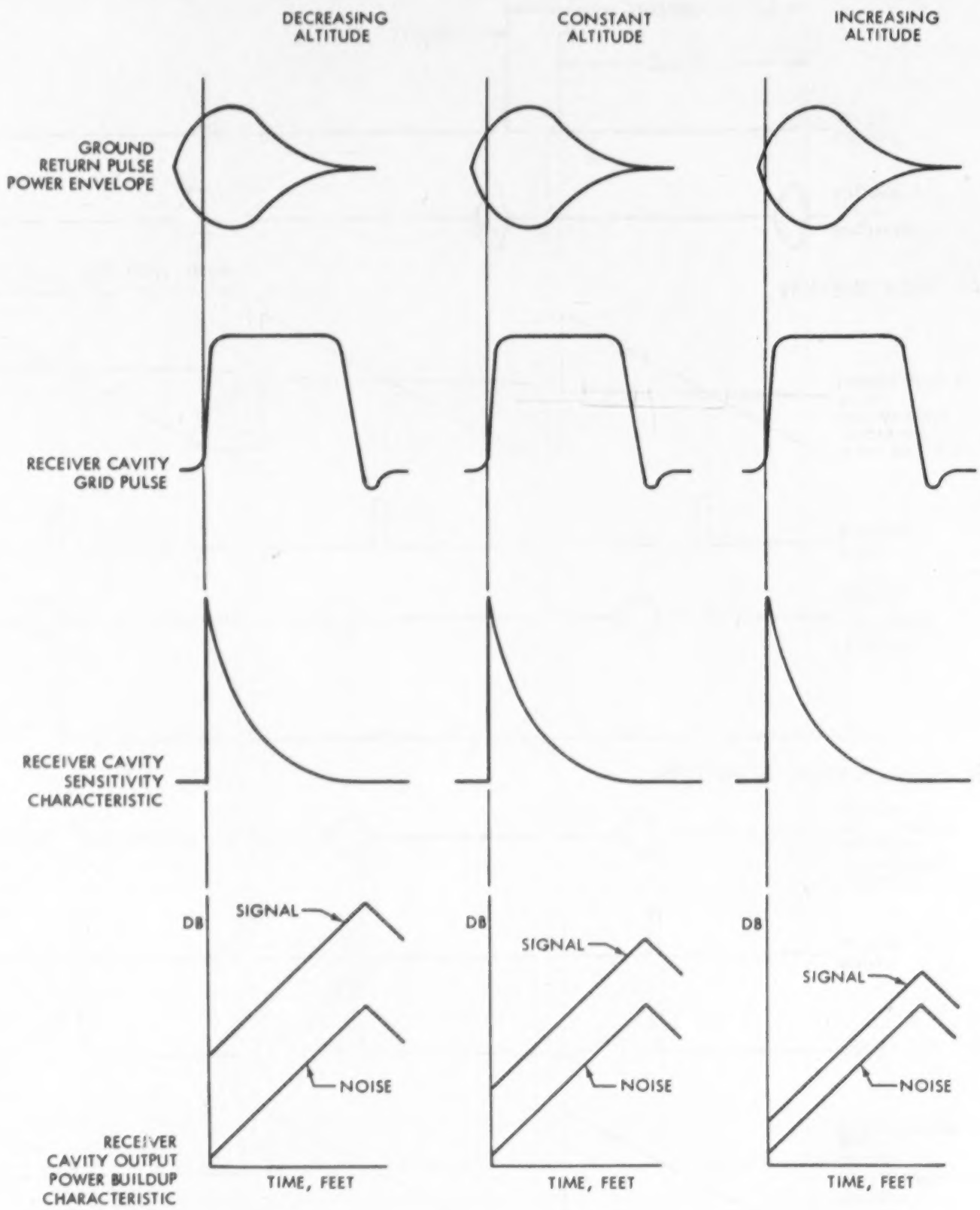

(D) TRACKING SERVOLOOP

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Figure 17-3.–Basic system timing sequence–Continued

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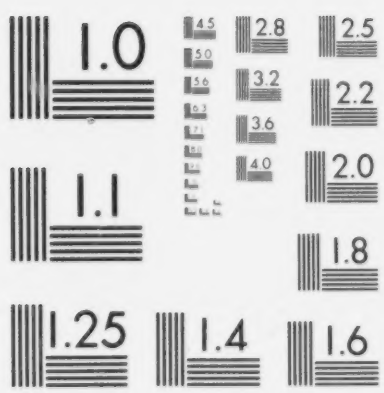

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

posing forces–the tendency of the range voltage to rise as the output of a shallow sweep generator, and the force of the average video power that drives the outputs of the sweep generator down.

ALTITUDE INDICATION.–The height indicator is a servo-driven device that positions the pointer at an altitude proportional to the d-c voltage analog from the receiver. In addition, the indicator provides two alerting functions. An OFF flag comes into view in the center of the indicator dial whenever the altimeter is not tracking a ground return signal. A low altitude warning system, which can be set to any altitude from 0 to 5,000 feet, causes a red warning light (in some aircraft installations) on the aircraft instrument panel to illuminate when the aircraft descends below the preset altitude.

BENCH TEST AND CALIBRATION

Most of the later electronic altimeters require the use of a specific test set that is designed only for that particular model altimeter. Some altimeters, such as Electronic Altimeter Set AN/APN-120, are a part of a larger navigation system and have the advantage of being checked for operation and calibration while in stalled in the aircraft by the use of the aircraft system computer.

Other altimeter types can only be checked in the aircraft by the use of a test set commonly known as a "GO-NO GO checker." This test set is normally a fixed delay line. Test sets of this type are discussed under line test equipment in chapter 8 of this manual.

The Integrated Weapons Shop Test Set AN/USM-124 is specifically designed for shop bench test and for calibration of the AN/APN-120 altimeter. By using the Line Test Set AN/USM-125, a programed tape, and the aircraft computer, faulty units can be located very readily during line maintenance.

The AN/APN-141(V) altimeter also has its own bench test set, Altimeter Test Bench Set TS-1979A/APN-141(V). Any time that maintenance is to be performed on either the transmitter-receiver or the RF switching unit, both units must be calibrated as a matched pair with the bench test set.

Earlier altimeters, such as the AN/APN-22 and AN/APN-117, utilize the Radar Test Set AN/APM-66. This test set also provides a means of calibrating, checking the operation, and facilitating the maintenance of both sets. A unit of this test set (Delay Line MX-1381/APM-66) provides a "GO-NO GO" test for line maintenance of either altimeter. The electronic control amplifiers and the transmitter-receiver units must be calibrated on the test bench as a matched set for proper operation in the aircraft.

RADIO RANGES AND RELATED FACILITIES

A radio range is a CW station, whose radiation produces directional courses or "tracks." These courses remain stationary with respect to the surface of the earth, and serve to guide aircraft over long distances.

OMNIDIRECTIONAL RANGE

As the name VOR (VHF, omnidirectional range) implies, the omnidirectional or all-directional range station provides the pilot with courses from any point in its service area. It produces an unlimited number of radials, any one of which is a radio path connected to the station. The radials should be considered as lines which originate at the station and radiate outward like the spokes of a wheel. Operation is in the VHF portion of the radio spectrum with the result that interference from atmospheric and precipitation static is negligible. The navigational information is presented in a visual form, is constantly available, and is provided regardless of the position of the aircraft in the service area.

The basic provision of the VOR facility is a means of determining the angular position, or azimuth, of an aircraft with respect to the station. This measurement is made in the airborne receiver which determines the phase difference of two 30 hertz tones derived from two signals radiated from the range station transmitting antenna array. One signal, called the reference phase, is broadcast in a nondirectional radiation pattern. At all points on a circle having the station as its center, corresponding parts of this 30 hertz modulation occur at exactly the same time. Since the phase of this signal is independent of azimuth, it is used as a reference for comparison with another 30 hertz variation derived from a signal called the variable phase.

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The variable phase signal is radiated in a figure-of-eight pattern which revolves about the transmitting antenna in a way somewhat similar to a rotating searchlight beam. The pattern consists of a positive and a negative lobe which turn together at 1,800 rpm (30 rps). As a result of the rotation of the pattern, the signal induced in the receiver is amplitude modulated with 30 hertz variations. The receiver develops this tone and compares it with the reference signal. The amount of phase difference between the two depends on the location of the aircraft with respect to the station. A phase measuring circuit in the receiver enables the pilot to determine the magnetic bearing, and also to select and fly a range course to the station on any desired bearing.

As shown in figure 17-4, the VOR transmitter is modulated both by a 9.96 kHz subcarrier and by an additional component either of voice or the station identification code characters. The subcarrier is frequency modulated at 30 Hz and is generated by a notched tone wheel rotating in a magnetic field. The purpose of the subcarrier is to provide a means for separating the 30 hertz tone of the reference phase from the variable tone of the same frequency.

The modulated output of the transmitter is applied both to a modulation eliminator and to the center loop antenna of a five-element array. There it is radiated to form the reference phase signal. The modulation eliminator is a clipper which removes the amplitude modulation from the carrier. The unmodulated output is fed to a

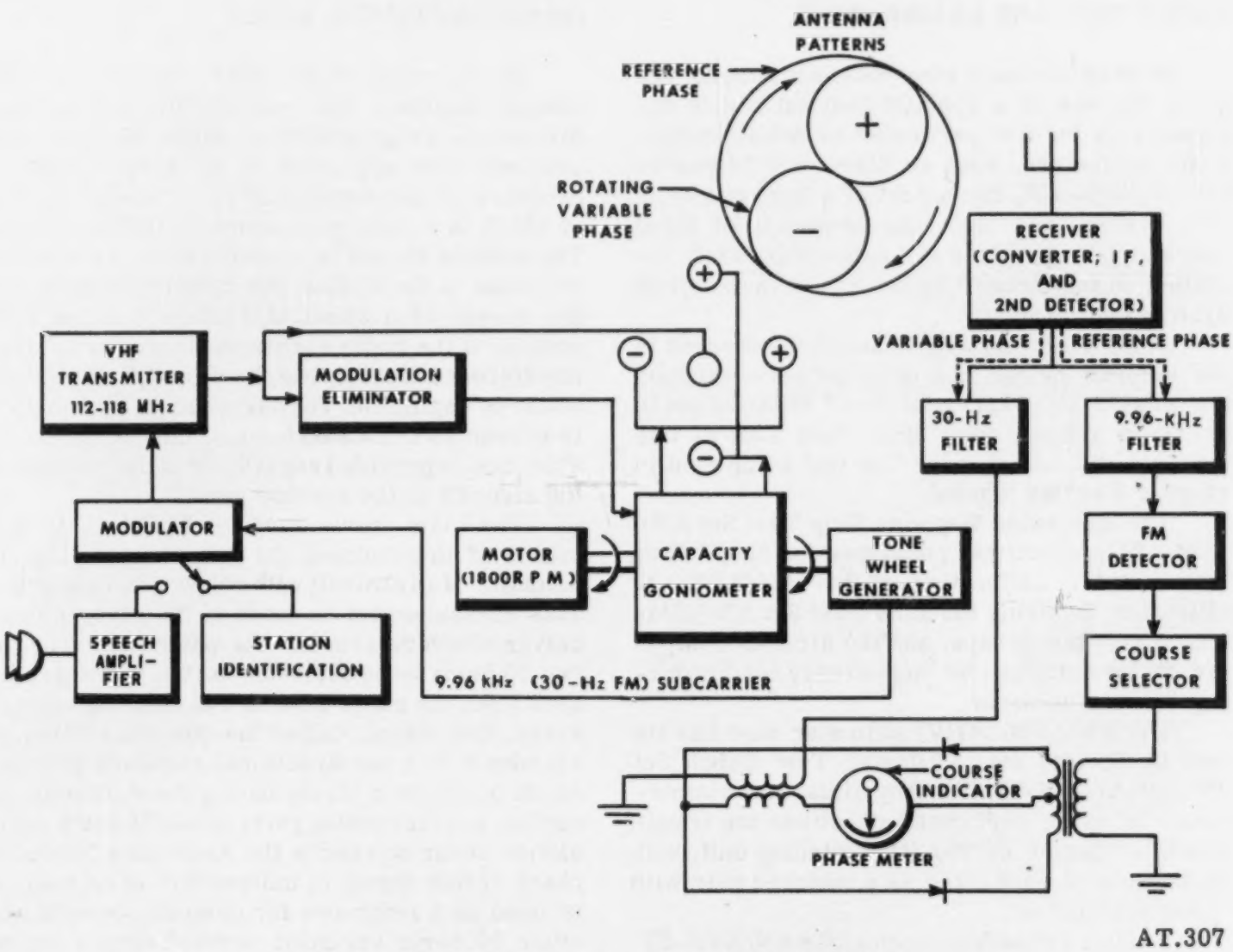

Figure 17-4.–Omnirange system fundamentals.

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capacity goniometer which serves as a mechanical sideband generator. The goniometer is a motor-driven, double capacitor in which one set of stator plates is displaced 90° from the other set. The rotor plates to which the RF signal is applied are driven at 1,800 rpm (30 rps).

Two outputs are derived, one from each set of stator plates. These two signals contain modulation components (30 Hz) which differ in phase by 90° because of the capacitor plate relationship. One output is fed to one pair of diagonally opposite loop antennas, and the other is fed to the remaining pair of loops in the square array. Each pair of corner antennas produces a figure-of-eight radiation pattern. These two patterns are displaced from each other by 90° both in space and in time phase. The resultant pattern is the sum of the two crossed figure-of-eight patterns and consists of the rotating field described above.

Figure 17-4 shows in simplified form the essential elements of the receiver which enable the pilot to select and fly a range course to the omnidirectional station. In the VOR transmitting system, the reference and the variable signals are in phase along the 0° radial (bearing due north of the station). The phase difference between the signals changes proportionately with the change in bearing to the station. The airborne receiver measures the magnetic bearing of the range station by the following general method:

1. The reference and variable signals are received and separated.

2. The two signals are then applied to a phase bridge containing a zero-center meter (the vertical pointer instrument used with the ILS localizer beam).

3. The reference signal is applied through a phase shifter, or course selector, equipped with a dial calibrated in degrees from 0 to 360.

4. The reference signal is shifted (in phase) by adjustment of the calibrated course selector until the phase bridge is brought to a zero indication. The amount of phase shift required to zero the bridge is proportional to the magnetic bearing of the range station.

To fly a given course to the station, the pilot sets the phase shifter until the calibrated dial reads the desired course. With this setting the reference signal is phased so that a balanced condition of the course indicator needle is shown as long as the aircraft is on the selected radial. To follow the radial to the station (usually described as "flying inbound"), the pilot flies so as to keep the vertical needle of the course indicator in the center position. The terms RADIAL and COURSE do not always mean the same thing. To fly INBOUND on the 045° radial, the pilot must fly a course of 225°. To fly INBOUND on a course of 130°, the pilot must use the 310° radial.

As indicated in figure 17-4, the receiver is an ordinary superheterodyne through the second detector. Following the second detector, filter circuits separate the 9,960 hertz subcarrier and the variable phase 30 hertz signals. The FM subcarrier is then applied to an FM detector which recovers the 30 hertz reference voltage. After passing through the phase shifter (course selector), the reference voltage is combined with the variable signal in the phase meter circuit.

The phase meter is a bridge which is balanced (indicated by a center position of the course indicator) when the two 30 hertz variations applied to it differ in phase by 90°. With this relation, the vector sum of the voltages in the upper half of the circuit is equal to the vector sum of those in the lower half. The two sums are converted into d.c. by rectifiers and applied to the zero-center instrument with opposite polarity.

The phase shifter contains two transformer windings mounted at right angles, and these two are fed with two components of the reference signal. A third winding rotates inside the other two coils, and a voltage is induced in it with a phase angle which depends on the rotor position with respect to the two primaries. The rotor coil is attached to a counter type dial which is calibrated in degrees to indicate the magnetic bearing to the omnirange station. A manually adjustable set knob is used to position the rotor for the desired magnetic course.

The vertical pointer of the course indicator remains in the center as long as the aircraft is on the selected course line, whether inbound or outbound. (This results from the fact that there are two positions of the phase shifter which will balance the bridge circuit.) Since the course line consists of two radials which are reciprocals of each other, an indicator is needed so that the pilot will know which radial (that is, which side of the station) he is on. The TO-FROM indicator tells the pilot whether the selected course line,

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once he is on it, will take him to the station or from the station.

For example, suppose the aircraft is on the 90° radial. To fly to the station, the pilot takes a heading of 270° and dials 270° on the course selector. The TO-FROM indicator reads TO while the aircraft is approaching the station from the east. After passing over the station, continuing westbound, the TO-FROM indicator reads FROM.

INSTRUMENT LANDING SYSTEM

The instrument landing system, (ILS), one of the facilities of the federal airways, operates in the VHF portion of the spectrum. The entire system consists of a runway localizer, a glidepath signal, and marker beacons for position location.

The localizer equipment produces a radio course alined with the center of an airport runway. The on-course signal results from equal reception of two signals-one containing 90 hertz modulation, and the other containing 150 hertz modulation. On one side of the runway centerline, the radio receiver develops an output in which the 150 hertz tone predominates. This area is called the blue sector. On the other side of the centerline, the 90 hertz output is greater. This area is called the yellow sector.

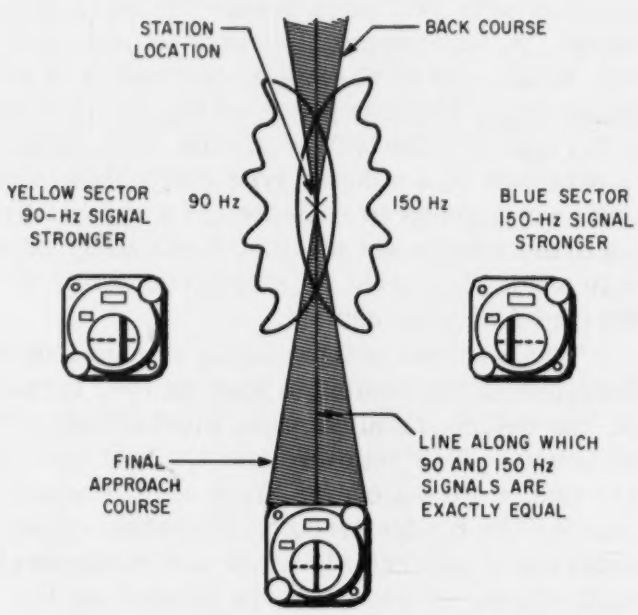

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Figure 17-5.–Tone localizer pattern and instrument indications.

In the aircraft receiver, the output circuit contains a balanced rectifier connected to a zero-center microammeter which remains centered as long as equal amounts of the two tones are present. Deviation of the aircraft to either side of the final approach course results in deviation of the indicator as shown in figure 17-5.

The localizer transmitter operates at about 110 MHz. The transmissions are made from an antenna array containing eight loops situated about 1,500 feet from the end of the runway. Three kinds of transmissions are made. Six of the loops radiate sideband energy only. Sidebands containing 90 hertz modulation and those bands containing 150 hertz modulation are separated by a sharp null directed along the centerline of the runway. Two of the loops radiate the carrier wave containing equal amounts of 90 hertz and 150 hertz tones, and this signal is sent along the null separating the sectors. Signals are received in any location; but as indicated in the figure, only along the runway centerline are the 90 hertz and 150 hertz tones received in exactly equal amounts.

The glidepath is a radio beam which gives vertical guidance to the pilot, assisting him in making the correct angle of descent to the runway. Glidepath signals are radiated from two antennas which are driven by a crystal-controlled transmitter operating at about 330 MHz. The power output is about 25 watts.

One antenna radiates a beam which is very broad in the vertical plane. This beam contains signals modulated by a 90 hertz tone. The other antenna emits signals modulated at 150 hertz in many lobes which are very narrow in the vertical plane. The undesired lobes are too high (fig. 17-6) to be encountered in a normal approach. The glidepath is an area of intersection between the broad 90 hertz lobe and the lowest of the 150 hertz lobes. In this area, which is a conical beam, the receiver develops equal amounts of 90 hertz and 150 hertz signals in the output. The beam is inclined about 2.5° with the horizontal.

The glidepath receiver is a crystal-controlled superheterodyne which is powered entirely from a 28-volt, d-c source and requires no high voltage power. The receiver audio output containing the 90 hertz and 150 hertz tones

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ASSIGNMENT:

You will have issued to you an old, dull ruling pen and an 8" x 11" buff drawing paper. Draw a $\frac{1}{2}$-inch border all around the paper and proceed to draw a single set of lines as shown in half the drawing below. When this is completed, clean the pen and sharpen it on the oil stone. Turn the buff paper around and draw the other set of lines. If your pen has been sharpened properly, you will notice a vast improvement.

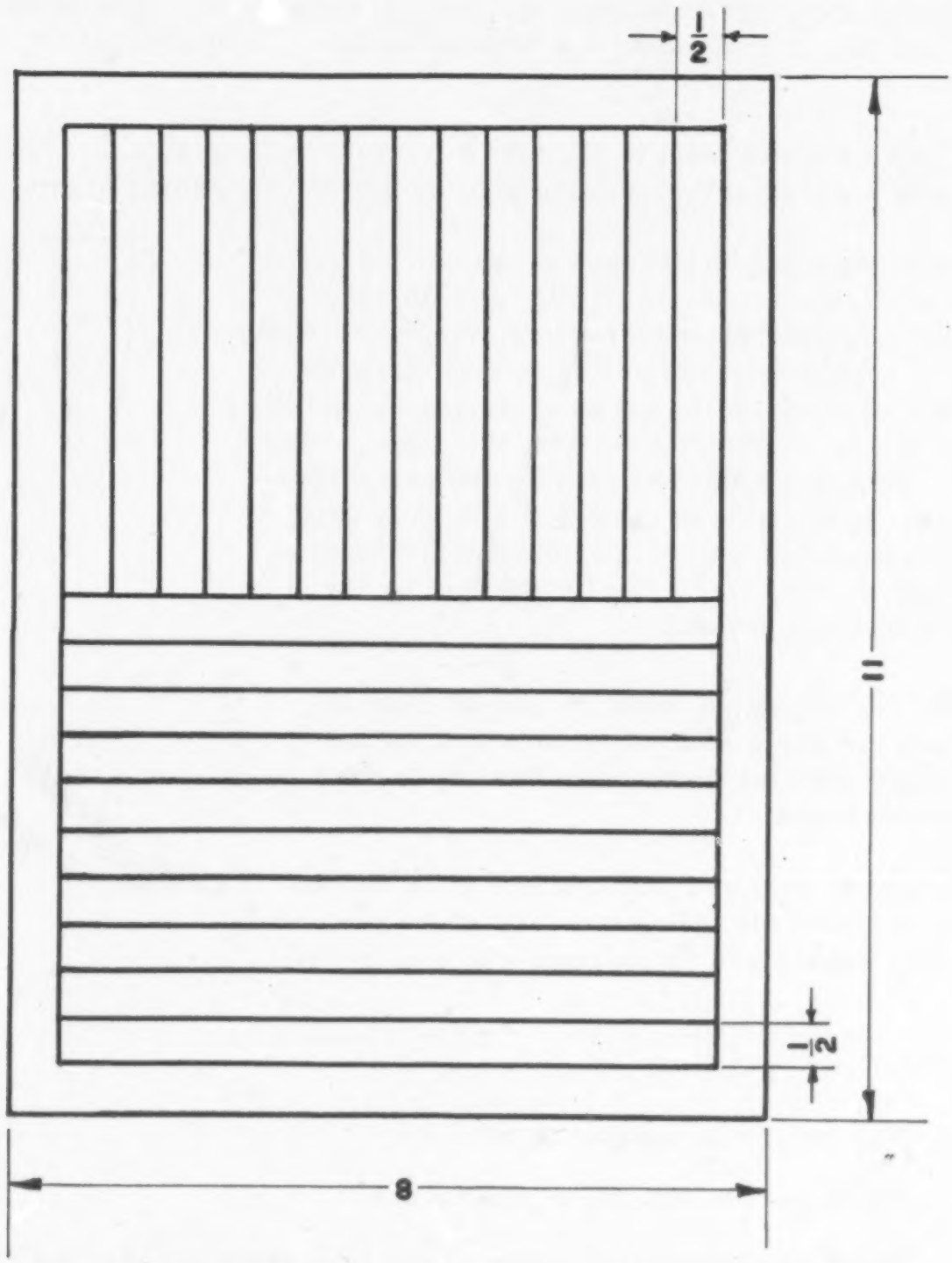

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is filtered, and the two signals are rectified separately. The resulting direct current is applied to a zero-center microammeter which indicates by means of a horizontal pointer. (The localizer and glidepath indicators are actually mounted on the same instrument. However, in many military installations the glidepath equipment is not employed.) The pilot flies the glidepath by keeping the horizontal pointer in the center of the dial.

Figure 17-6 shows how the glidepath would appear. The cross section is shown from the runway to a distance of 10 miles. At that range the glidepath appears to be 920 feet thick (vertically) and 4,600 feet wide. By keeping both pointers centered, the pilot may fly to the runway without seeing the ground. However, once over the runway, the pilot must be able to see the runway in order to land.

Marker beacons and compass locators are used in connection with the instrument landing system. The markers are signals which indicate the position of the aircraft along the approach to the runway. Two markers are used in each installation. The location of each is identified both by tone modulation and by a signal lamp. The outer marker is located about 4.5 miles from the end of the runway. The signal is modulated by a 400 hertz tone and is keyed in long dashes (two dashes per second). The inner marker, located at a distance of 3,500 feet, is modulated at 1300 hertz (a higher pitched tone) and is keyed with alternate dots and dashes.

Compass locators are low-power nondirectional beacons which provide signals for automatic direction-finding equipment. They operate between 200 kHz and 400 kHz and are located near the marker beacon transmitters. The locator near the outer marker is coded with the first two letters of the localizer transmitter identification letters, and the locator near the inner marker employs the last two letters of the call signal.

DISTANCE MEASURING EQUIPMENT

Eventually, each omnirange station will be equipped with distance measuring equipment (DME). By means of this facility, the pilot is provided with constant visual indication of his distance from the range station; and the combined VOR and DME data include all the information required for point-to-point navigation. These data consist of exact knowledge of the

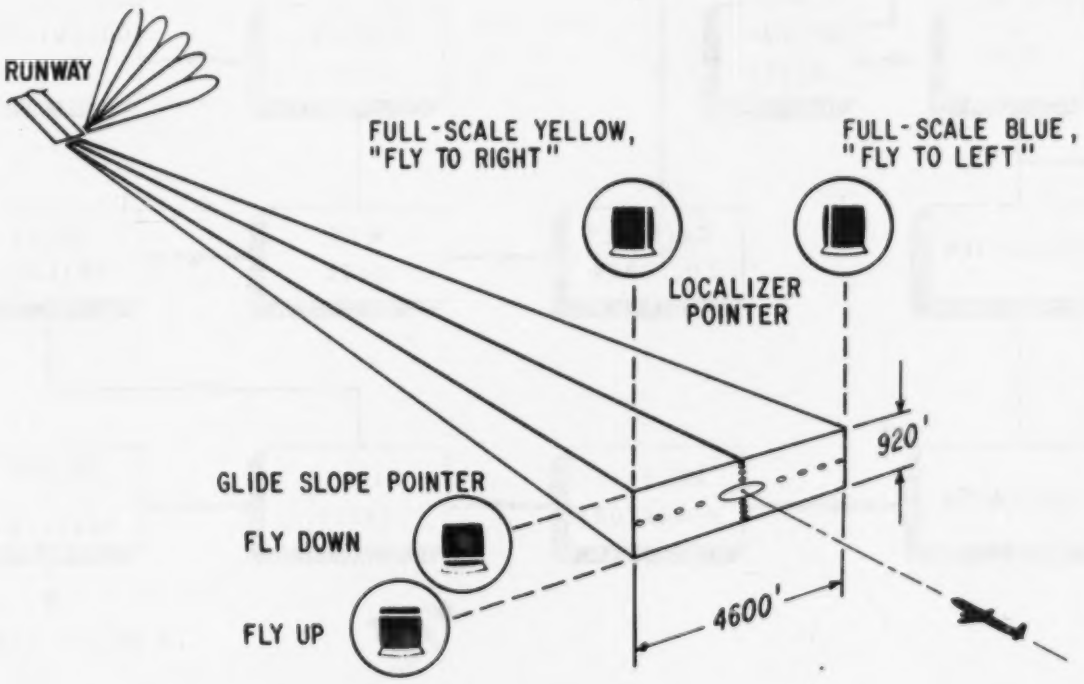

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Figure 17-6.–Cross section of ILS course.

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distance of the aircraft from one or more range stations together with the direction of each.

The operation of DME units is similar to that of IFF. The airborne unit, called the interrogator, transmits a train of short pulses which are received by the ground unit, called a transponder. After reception of the challenging pulses, the ground station uses suitable circuits to shape them into trigger impulses which modulate a pulse transmitter to send a reply to the aircraft. Upon reception of the signal by the interrogator, the elapsed time between the challenge and the reply is measured. This interval is a measure of the distance separating the aircraft and the transponder station.

The challenge sent by the aircraft consists of spaced pulses in the 960-990 MHz band. The ground station equipment is set to accept only those signals which have the correct spacing and which are on the correct frequency. The frequency and the pulse spacing characteristics define a challenge channel. The reply consists of a train of RF pulses in the 1185-1215 MHz band. The combination of the challenge and reply channels is called an operating channel.

Up to 50 aircraft can use the same ground station to obtain DME information without interference.

A typical airborne unit, shown in block diagram form in figure 17-7, consists essentially of timing circuits, search and tracking circuits, and the indicator meter.

The timing circuits measure the time interval between the transmission of a challenging pulse from the transmitter and the reception of the corresponding reply pulses. As in radar operation, this time value is a measure of the distance separating the aircraft and the station.

The search circuits operate by causing the equipment to seek out a reply after each challenge. Briefly, the search function is as follows: The receiver is triggered on by gating circuits and operates for a very brief period of time after each challenge. The gate pulse which activates the receiver is separated from the

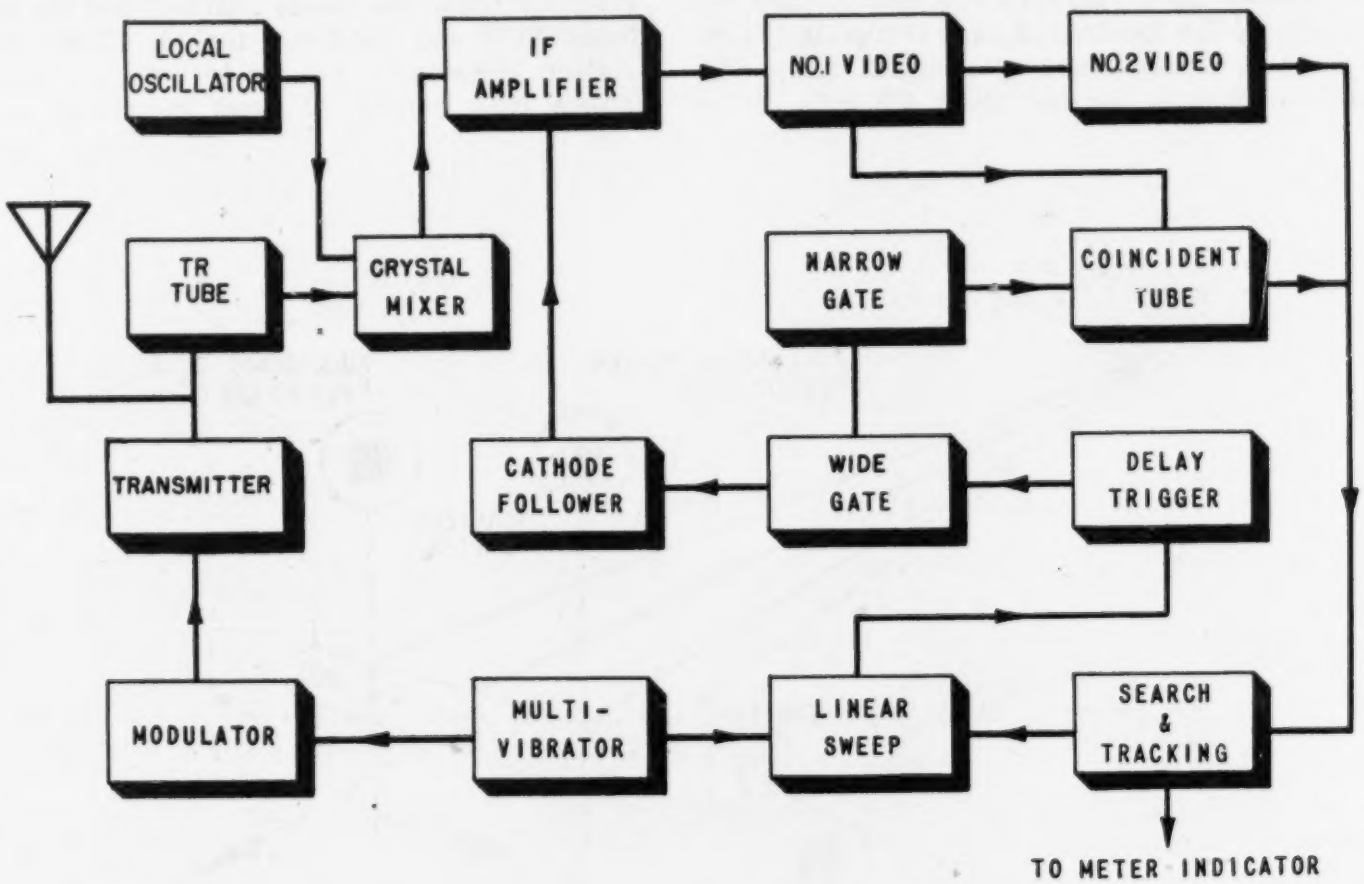

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Figure 17-7.–Block diagram of a typical DME system.

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challenge by an interval of time delay, T. Interval T is made to vary between 0 and 1,200 microseconds, corresponding to a range of distances from 0 to approximately 112 miles. The receiver goes into operation after each challenge, but is delayed by a different interval of time after each emitted signal. The receiver can accept beacon replies only when the delay time, T, is equal to the time required for a challenge signal to reach the station and the reply to return. When the time delay is such that the station reply is received, the search circuits are disconnected and the tracking operation begins. During tracking, the receiver holds the signal which it has found. When this occurs, the distance of the station is indicated on the dial of the indicator. This is accomplished by measuring the delay time, T. The value of T is controlled by a voltage to which it is directly proportional. When the search circuits have discovered a reply, the control voltage is applied to the voltmeter which is calibrated in miles.

The tracking circuits of the equipment adjust the time of operation of the receiver so that the receiver station reply is accepted even though the distance between the aircraft and the ground station is constantly changing. In tracking operation, the receiver is controlled by the action of two gating impulses–the wide gate (20 microseconds) and the narrow gate (10 microseconds). A signal received in the wide gate increases the delay time, and one received during the narrow gate decreases it. Thus the two control gates effectively bracket the reply signal and keep the receiver operating at the time when the reply pulses arrive. As a result, the distance meter continually indicates the number of miles between the aircraft and the station.

The automatic search circuits can be started again when the pilot wishes to track on another station. If the new station is more distant than the first, a release switch is pressed which causes the delay to increase. The search circuits then begin operating to seek out the delay time corresponding to the station. If the alternative beacon is nearer than the first, a zero switch is pressed which causes the delay time to start again from zero before resuming search operation.

A pilot lamp, found in some installations near the DME meter, indicates the presence or absence of a signal, and is illuminated if no signals are present. The station transmissions are gap-coded; that is, the replies are arranged so that intervening spaces form the Morse code letters assigned to identify the station. When the signals are being received, the pilot lamp flashes on and off, giving the station code identifier. When the aircraft is at a distance beyond the operating range of the station, the light burns continuously to warn the pilot that the meter reading is no longer the true distance but is the distance at which the signal was last received.

TACAN SYSTEM

TACAN, standing for TACtical Air Navigation, is an air navigational system operating at UHF frequencies to provide aircraft with continuous accurate range and bearing information. The system consists of an airborne UHF transmitter-receiver (AN/ARN-21) and a surface station (AN/URN-3). Bearing information is accurate to within 0.25°. The maximum slant range is 195 nautical miles with an error of less than 1,000 yards. The error at close range is less than 200 yards. The system has 126 two-way operating channels in the range of 962 to 1213 MHz. Each channel uses two separate frequencies spaced 63 MHz apart. Adjacent channels are separated by 1 MHz. Each of the 126 channels is capable of providing full service without interference to over 100 aircraft. The method used by the system to transmit bearing information is similar to that of the VOR, and the range information is similar to that of the DME. A simplified block diagram of a complete system is shown in figure 17-8.

Both the AN/ARN-21 and the AN/URN-3 contain a receiver and a pulsed transmitter. The surface station continually transmits signals consisting of randomly spaced pulse pairs, pulse-pair distance replies, and evenly spaced and coded groups of paired pulses. Due to the antenna configuration and rotation, all of these signals arriving at a given location are amplitude modulated at both 15 and 135 Hz. The surface station transmits approximately 3,600 pulse pairs per second. The main azimuth reference burst is transmitted each time the antenna passes a given azimuth (usually magnetic east) and consist of 12 pulse pairs with 30 microseconds between pairs. The antenna rotates at 15 rps (12 x 15 equals 180 pulse pairs per sec-

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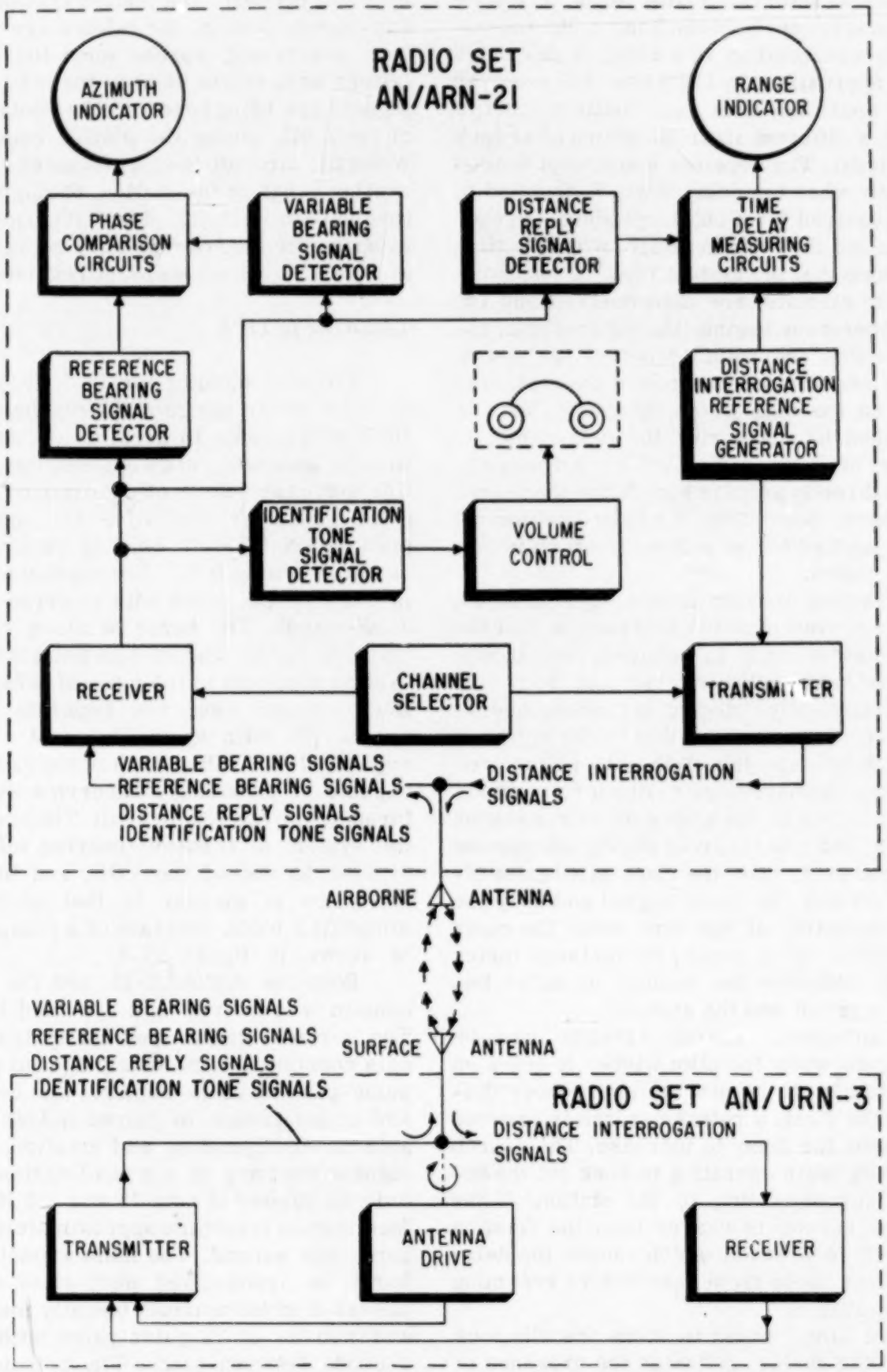

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Figure 17-8.–Simplified block diagram of the TACAN system.

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ond). The auxiliary reference bursts are transmitted eight times during one revolution of the antenna and consist of 6 pulse pairs with 24 microseconds between pairs (8 x 15 x 6 equals 720 pulse pairs per second). This gives a total of 900 pulse pairs per second used for azimuth reference signals. The remaining 2,700 pulse pairs per second are transmitted at random. Some of these random pulse pairs are controlled by distance interrogation signals from aircraft to give distance replies. Also, at intervals (usually every 37.5 seconds), the random pulse pairs are replaced by pulse pairs with fixed spacing arranged to form Morse code.

Whenever the surface station receives a distance interrogation pulse-pair from any aircraft, it transmits a pulse-pair reply (using one of the 2,700 random pulse pairs) exactly 50 microseconds after receiving the interrogating pulse pair.

TACAN ANTENNA

The AN/URN-3 antenna consists of a central stationary driven element with a rotating array of one main parasitic reflector element and nine auxiliary parasitic reflector elements to give an antenna pattern that is a combination of a cardioid with nine lobes superimposed on it. (See fig. 17-9.) Every time the main lobe of the antenna passes magnetic east, the AN/URN-3 transmits the main reference burst of 12 pulse pairs (30 microseconds between pairs). Every time one of the other eight auxiliary lobes passes magnetic east, the AN/URN-3 transmits an auxiliary azimuth reference burst of 6 pulse pairs (24 microseconds between pairs). Since the pattern is rotating at 15 rps, an aircraft in the position shown would receive a signal containing pulse pairs amplitude modulated at both 15 Hz and 135 Hz. (See fig. 17-10.) One is called the 15 Hz variable bearing signal, and the other is called the 135 Hz variable bearing signal.

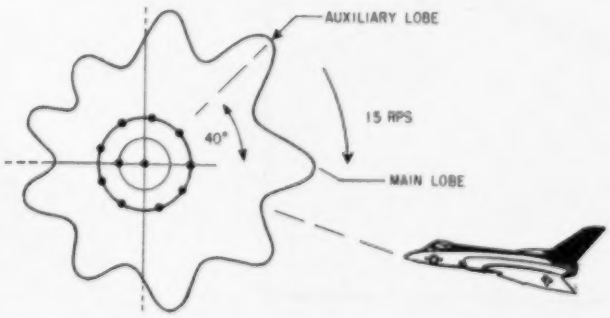

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Figure 17-9.–Rotating antenna pattern of AN/URN-3.

AIR-TO-AIR-TACAN

The original TACAN system was limited to an air-surface application–no provisions were made for air-to-air ranging. However, the newer concept of TACAN includes this feature and uses the AN/ARN-21D or the AN/ARN-52(V) equipment.

In the AN/ARN-21D, the air-to-air link functions primarily because of a modification permitting "image frequency" reception. Ranging is made possible by adding a transponding function to the airborne equipment. Both ends of the link display distance information simultaneously; therefore, the technique is called "bilateral ranging." The TACAN ground station is not involved in the air-to-air link.

The airborne sets receive on frequencies displaced 63 MHz from their transmitting frequencies. Considering the ground station system as normal TACAN, the air-to-air system uses the "image" frequency. This idea is illustrated in figure 17-11.

In both systems, the transmit and receive frequencies are separated by 63 MHz. However, in the normal system, reception is below transmit frequency for channels 1-63 and above for channels 64-126. For the air-to-air (A/A) system, these situations are reversed. Thus, any AN/ARN-21D set for normal operation will not respond to A/A transmissions, regardless of the channel selected. (See fig. 17-12.)

Careful study of figure 17-12 (A) illustrates the following details of TACAN operation:

1. Aircraft A and the ground station set to the same channel, aircraft set on normal mode, operation is normal. Aircraft B and C are not involved.

2. Aircraft B and C are set to channels separated by 63 MHz both aircraft on air-to-air mode, bilateral ranging is performed. Aircraft A and the ground station are not involved.

3. Aircraft A and C are set to the same channel, but on different modes. They do not respond to interrogations by the other aircraft.

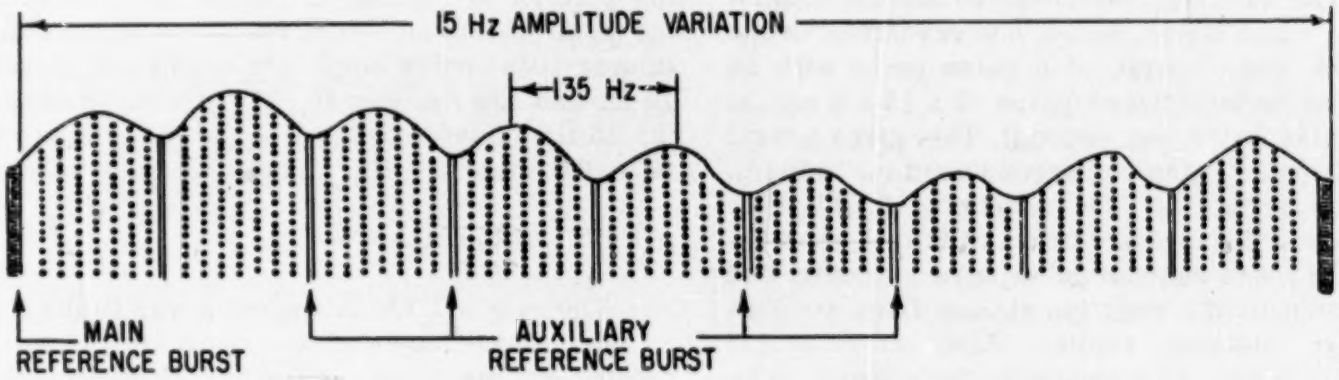

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Figure 17-10.–Signal received by an aircraft at 150°.

Figure 17-12 (B) illustrates the simultaneous ranging of aircraft A and C on aircraft B, but not on each other. Aircraft B will indicate the range to one of the aircraft (which one is mere chance).

In order to prevent aircraft from replying to replies, the interrogation consists of pulse pairs, while replies consist of single pulses. Replies are made only to pulse pairs.

AN/ARN-21 (Series) TACAN Receivers

Radio Set AN/ARN-21B is the general airborne TACAN unit used for air-to-surface operation as described previously. When modified to incorporate the air-to-air capability, the equipment is designated AN/ARN-21D and functions in either mode as selected from the control unit. In principle, operation is similar

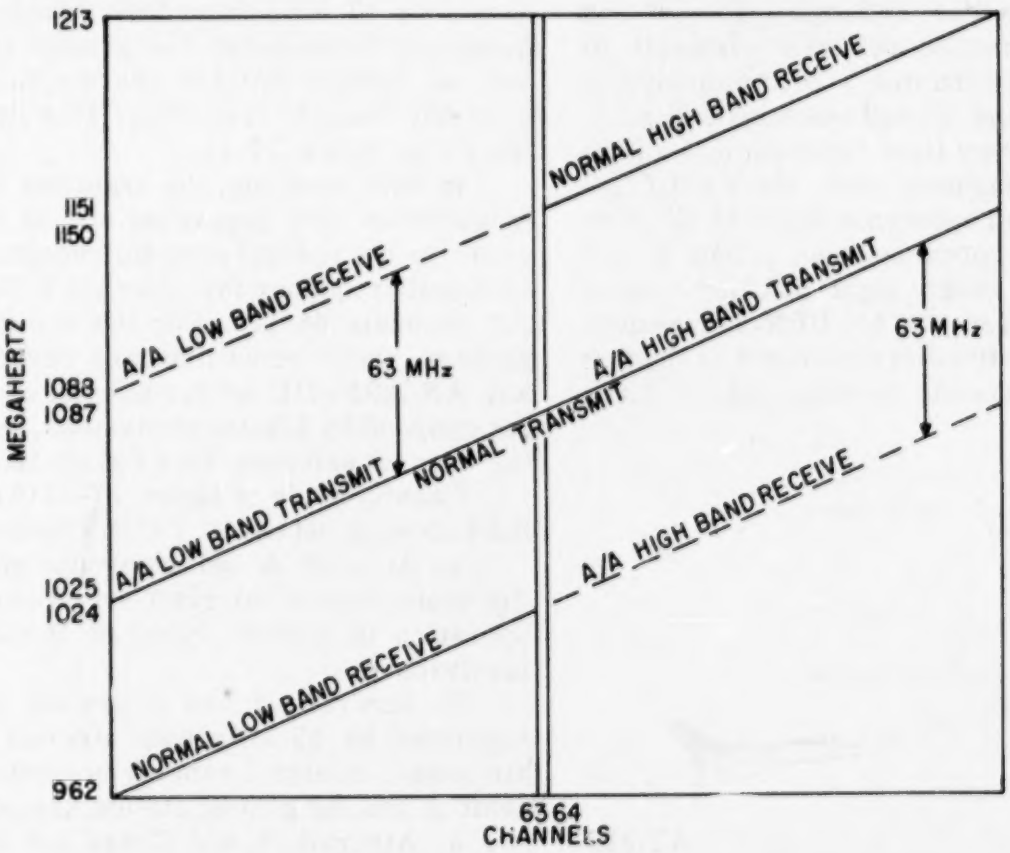

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Figure 17-11.–TACAN frequency spectrum.

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to the AN/ARN-52(V) discussed in the following section. The AN/ARN-52(V) is a newer and somewhat improved airborne TACAN unit.

The AN/ARN-21 (Series) uses a 42 MHz oscillator and 42 crystals to produce the frequencies needed for the 126 channels.

The AN/ARN-52(V)

The AN/ARN-52(V) contains additional features and improvements, even though it is slightly smaller and approximately 20 pounds lighter than the AN/ARN-21. In addition to the air-to-surface and air-to-air features, the AN/ARN-52(V) contains built-in range and bearing mechanical modules. Minimum power output has been increased to 1.5 kw, and the range readout has been increased to 300 miles. It also uses 126 crystals—one for each channel, instead of the 42 MHz oscillator and 42 crystals used in the AN/ARN-21B. In air-to-air mode, it responds to a maximum of five interrogating aircraft.

The AN/ARN-52(V) can be adapted to supply and process distance and bearing information for use in various indicators, automatic pilots, and computers. The indicators used in conjunction with this equipment include a bearing-distance-heading indicator (BDHI) such as the ID-663/ARN, a course indicator such as the ID-387, a radio bearing indicator such as the ID

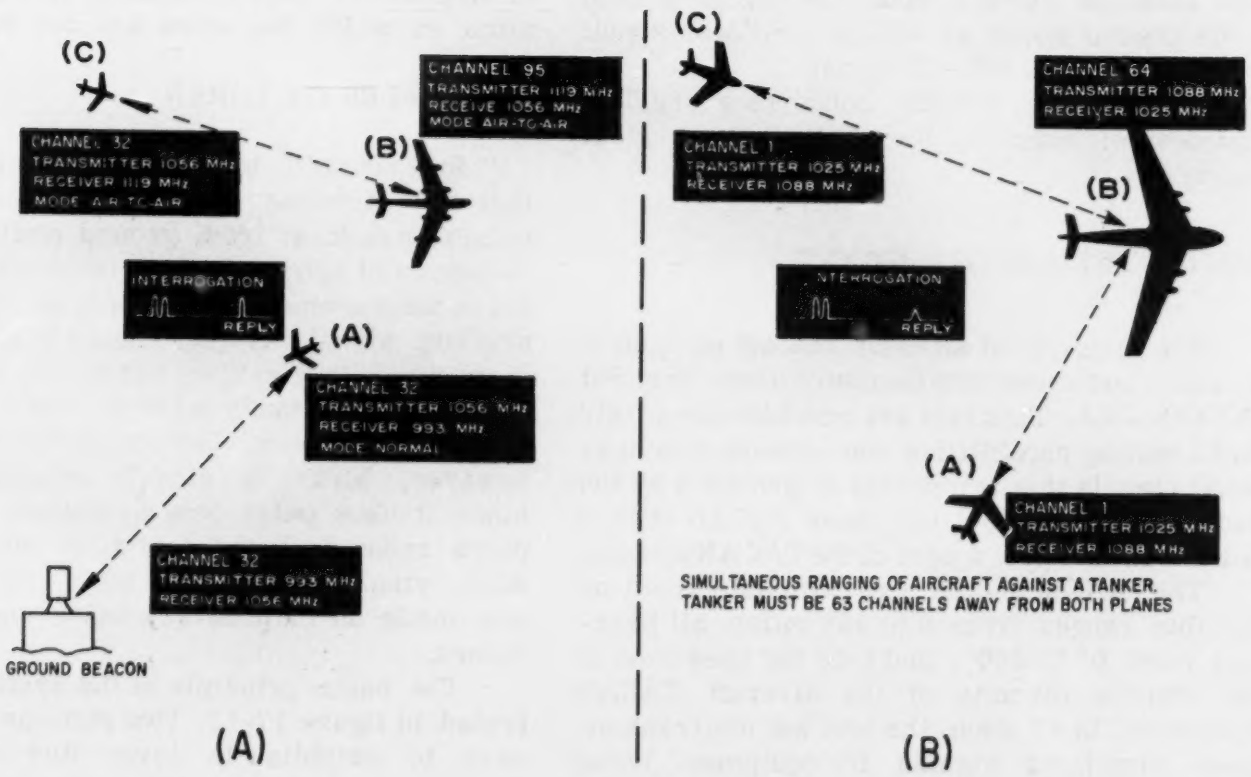

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Figure 17-12.–TACAN system operation.

250, and/or a distance indicator such as the ID-388.

The AN/ARN-52(V) operates in any of three modes. It can receive bearing and station identity information; receive range, bearing, and station identity information, or receive and transmit bilateral air-to-air ranging information.

As installed in an aircraft, the AN/ARN-52(V) uses two antennas mounted in such a manner that any "blind" spot of one antenna is covered by the other. An automatic antenna selector circuit connects the RF circuits to that antenna which provides a usable TACAN signal. In the absence of a usable signal, this circuit switches the equipment back and forth between the two antennas. When a suitable signal is received at one antenna, the equipment is locked to that antenna. Loss of a usable signal initiates a memory period to prevent loss of lock resulting from short-duration transient conditions.

The basic frequency of the selected crystal (42.7 to 47.9 MHz) goes through several stages of multiplication and amplification to produce two outputs at the transmission frequency. One signal is amplified, pulse modulated, and radiated from the antenna. The other signal is used in the crystal mixer as a local oscillator signal to produce the 63 MHz IF signal.

For further details concerning TACAN equipments, refer to the applicable technical manuals.

BENCH TEST AND ALINEMENT

The majority of aircraft TACAN equipment is tested and alined with the use of Radio Test Set AN/ARM-22A. This test set provides air-to-air (A/A) testing capabilities and simulates navigational signals that are normally provided by the Radio Set AN/URN-3 (or other TACAN station radio transmitter), a part of the TACAN system.

The AN/ARM-22A can simulate fixed or variable ranges from 0 to 198 miles, all bearings from 0° to 360°, and tone for operation of the identity circuits of the aircraft TACAN equipment. In addition, the test set can transmit these simulated signals to equipment being tested on any one of 126 preselected channels.

The radio test set may be mounted on a mobile dolly to facilitate flight line testing of airborne components.

When the radio test set is used in conjunction with Test Set Indicator AN/ARM-31, the capabilities of the equipment are increased. The simulated information sent to and then processed by the equipment being tested is displayed on the test set indicator in the AN/ARM-31. This enables the operator to test individual components of the aircraft equipment.

LORAN

The word LORAN is formed from the words LOng RAnge Navigation. It is a navigational system developed primarily to provide a means for making geographical fixes by the use of long range radio signals. The system is a valuable aid to navigation, since loran fixes can be made quickly and accurately both by night and day. It is reliable for both air and surface navigation under most weather conditions. Loran signals can often be received even during storms, except those involving severe electrical disturbances. The principal value of loran lies in its capability of continued operation during conditions which make celestial navigation difficult or impossible. Such conditions include any situation in which the stars are not visible.

PRINCIPLES OF LORAN

In principle, loran differs from radar in that the airborne unit simply receives radio pulses broadcast from ground stations, and no reception of echo signals is involved. The basic loran measurement is that of time difference of arriving signals with no regard to the direction from which they arrive; hence, the complicated directional antennas used in radar equipment are not necessary. Despite these differences, however, loran is closely related to radar since it uses pulse type equipment, and it employs radar techniques of time measurement. Also, visual displays of the signals received are made on cathode-ray tubes used as indicators.

The basic principle of the system is illustrated in figure 17-13. Two stations are necessary to establish a loran line of position. The master station (A) emits a continuous series of uniformly spaced pulses at a stable pulse recurrence rate. The slave station (B) sends out a similar series of pulses which are

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synchronized with the master pulses. The master and slave stations are usually 200 to 400 miles apart. The line joining the two stations is called the baseline, and the perpendicular at its center is called the centerline. The baseline extension is a straight line drawn beyond either station as a continuation of the baseline.

Assume that the two stations are sending out pulses simultaneously; then at any point along the centerline, the two signals arrive at the

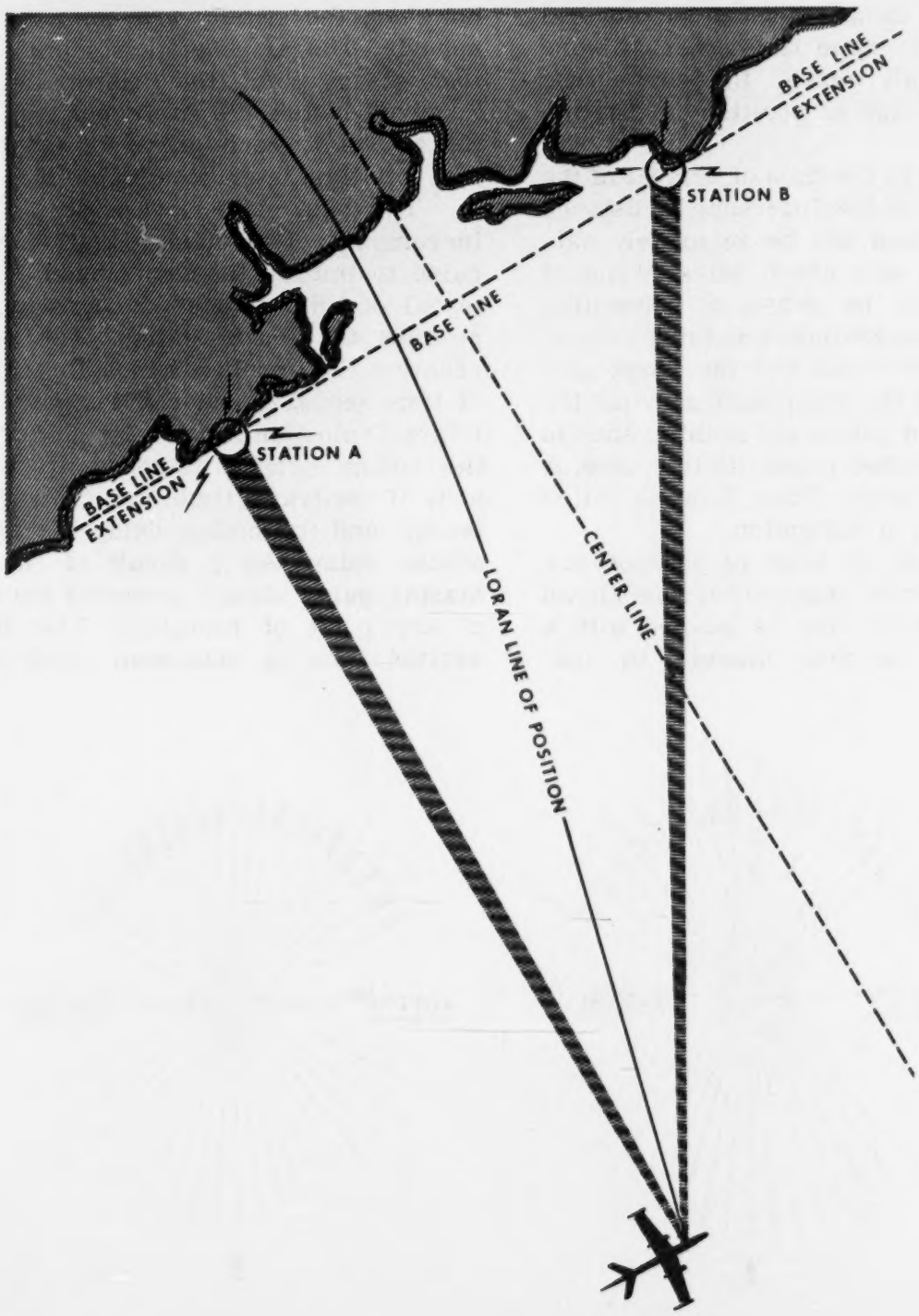

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Figure 17-13.–The principle of loran.

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same instant (since all points of the line are equidistant from the two transmitters). If an observer is located nearer station A than station B, the A pulse arrives at his position first, followed (after a measurable time interval) by the corresponding B pulse. By moving to different positions located in the same vicinity, the observer could record the time interval (difference in arrival time of the A and B pulses) corresponding to each position. If several positions having the same time interval were joined by a smooth curve, the curve thus traced would be a line of position for station pair A and B.

The difference in the time of arrival of the pulses corresponds to the difference in distance from the stations, and can be accurately calculated and plotted on a chart. Selected line of position curves may be drawn by connecting points of equal computed time or distance values. Each curve so constructed has the shape of a hyperbola, which is the mathematical name for a curve consisting of points whose difference in distance from two fixed points (in this case, A and B) remains constant. Thus, loran is called a hyperbolic system of navigation.

A large number of lines of position are drawn for each pair of transmitters as shown in figure 17-14. Each line is labeled with a number indicating the time interval in microseconds between the arrival of the corresponding loran pulses.

In (A) of figure 17-14, zero time difference exists along the centerline, while maximum time difference exists along the baseline extensions. Lines with equal time difference may be noted on each side of the centerline, since there is no way to determine which pulse is received from which station. In actual practice, however, the signals are not emitted simultaneously. The slave station pulse is delayed so that, at any point, the master station pulse is received before the corresponding slave pulse. As a result, each curve of the family has a discrete time interval value as indicated in (B).

The delay of the slave pulse includes several increments. The master station transmits a pulse to initiate the sequence of events. An interval of time elapses during which the signal reaches the slave station. The slave station receives the impulses and waits an initial period of time (equal to one-half the pulse recurrence interval) plus an additional period of time (called the coding delay). It then emits a pulse. The sum of the travel time, half the recurrence interval, and the coding delay is called the absolute delay. As a result of the delay, the master pulse always precedes the slave signal at any point of reception. The difference in arrival time is maximum along the baseline

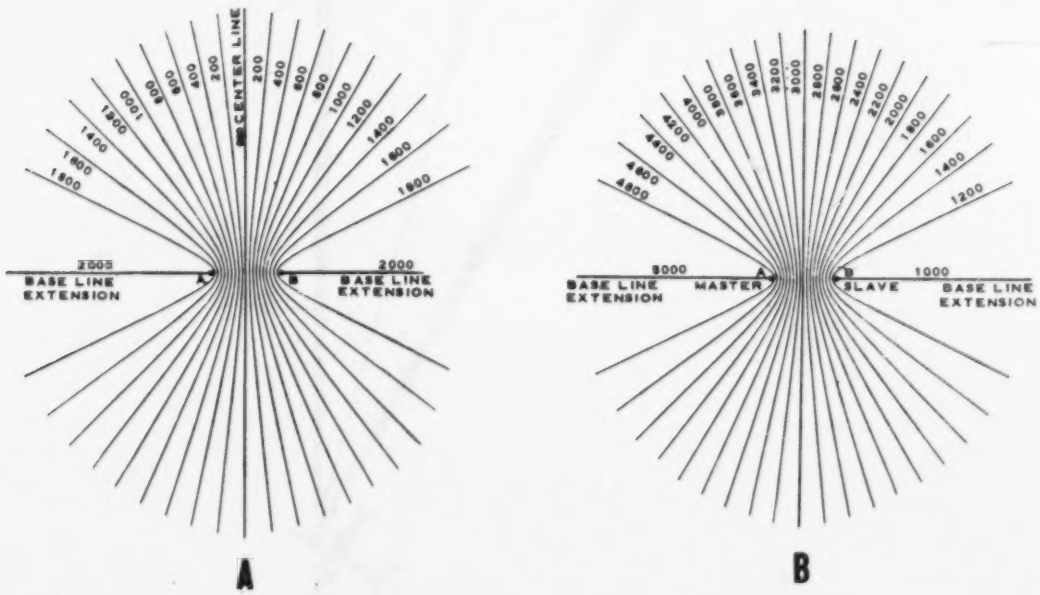

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Figure 17-14.–Lines of position. (A) No time delay; (B) 3,000-microsecond delay.

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Order of Inking Lesson 3

OBJECTIVE: To learn the proper procedure when inking.

RELATED INFORMATION:

When inking, for best results always use black drawing ink (for this prints best) and be sure your pens are sharp and in good condition. In the event that an ink line may have to be removed, use a hard ink eraser, being careful not to go through the paper or cloth. Some draftsmen prefer to use a sharp knife or razor when erasing, but in either case, after the erasure is made, rub some pounce into the erased area. This will help prevent the ink from running when redrawing over the area. When inking, attempt to use the following order:

1. Ink in all full-line circles, beginning with the smallest.
2. Ink dotted circles and arcs.
3. Ink any irregular curved line.
4. Ink straight full lines in this order - horizontal, vertical, and inclined.
5. Ink straight dotted lines in the same order.
6. Ink center lines.
7. Ink extension and dimension lines.
8. Ink arrowheads.
9. Ink section lines representing cut surfaces.
10. Ink in the dimensions.
11. Ink the border.
12. Check the inked drawing.

extension beyond the master station and minimum on the baseline extension beyond the slave station.

LORAN NAVIGATION

The loran navigation network is designed to cover a vast ocean area. This fact, coupled with the long distance usage, requires a fairly large number of stations. However, loran stations operate in a crowded portion of the radio spectrum; therefore, only a few specific frequencies are available. At the present time, only 3 channels are used, but as many as 24 station pairs may be operated on each. This is made possible by using a different pulse recurrence rate for each station pair on any channel. The equipment can thus distinguish between various pulse pairs and measure the time interval for any selected pair—Other pulse pairs are not synchronized with the CRT sweep, and therefore drift across the screen.

In order to determine a position by loran, it is necessary to obtain intersecting lines of position from two or more station pairs, then refer to a special loran chart to locate the position of that intersection.

The U.S. Navy Hydrographic Office publishes loran charts (which are standard Mercator charts with loran lines of position superimposed). The use of the chart in obtaining a "fix" is illustrated in figure 17-15.

A loran chart shows the lines of position of one station pair crossing those of another. In many installations, the two pairs consist of a single master station operating in conjunction with two slave stations. This is called double-pulsed transmission and is the type represented in figure 17-15. The common master station emits two sets of pulses. Each set is synchro-

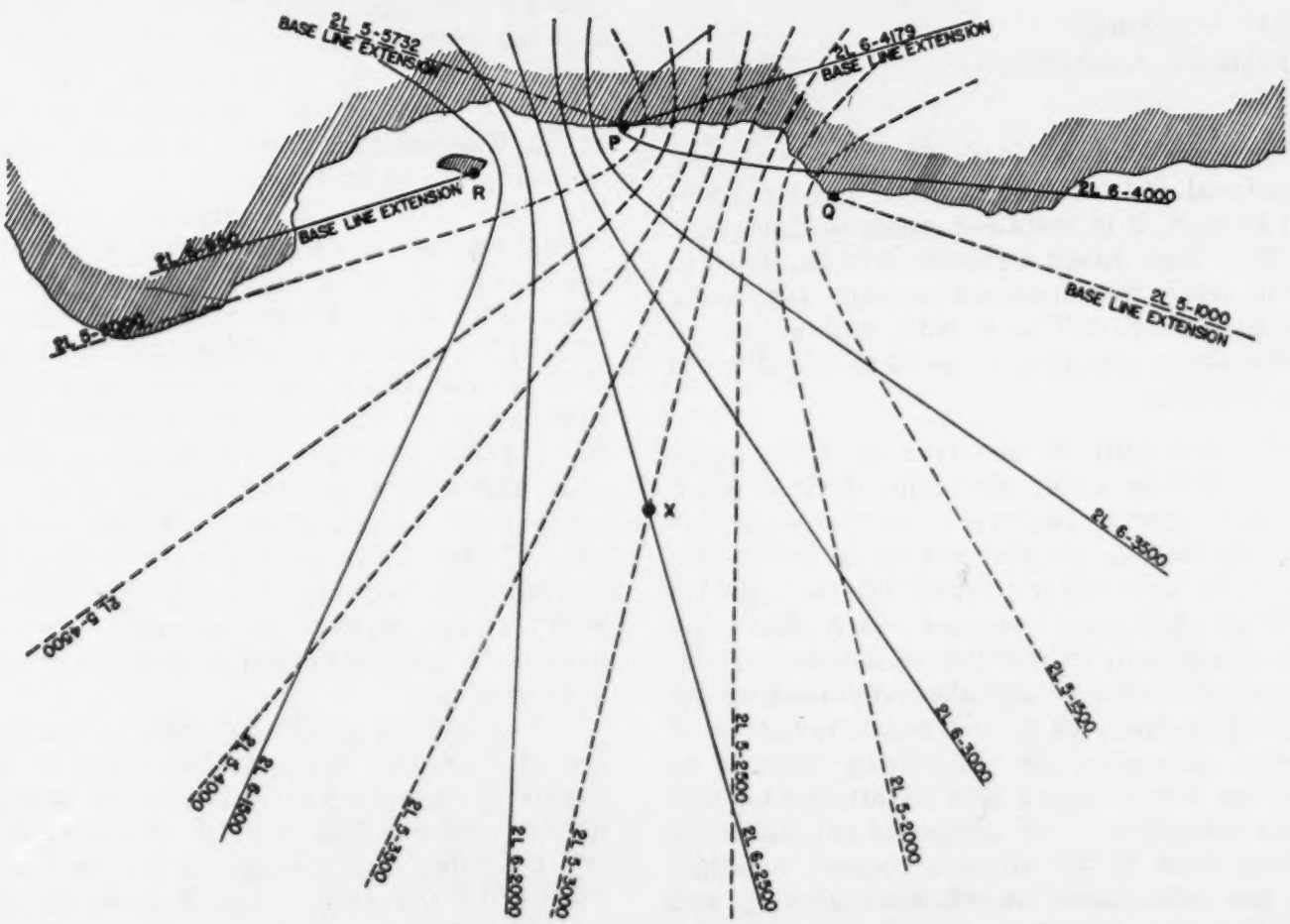

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Figure 17-15.–Obtaining a loran fix.

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The two readings given by the revolution counters are plotted on loran charts and enable the operator to determine his location.

The electron beam in the indicator tube traces two time baselines, one above the other, as indicated in figure 17-16. Moving from left to right, the beam slowly traces the upper line in a period of time equal to one-half the pulse recurrence interval. It quickly retraces, jumping to the left and below. It then traces the lower baseline in one-half the recurrence interval before rapidly returning to the start of another top line.

The master station pulse is superimposed on the upper baseline, and the slave pulse appears on the lower. When the receiver is correctly adjusted, the station pulses are displayed above pedestals (rectangular deflections) in the time baselines. The pedestals indicate portions of the display which can be expanded and examined in greater detail for accurate measurement. The time difference to be measured is represented by the horizontal distance between the master pulse on the left and the slave pulse below it to the right. This method of measuring the time difference automatically cancels the fixed delay of one-half the recurrence rate by which the slave pulse was retarded during transmission.

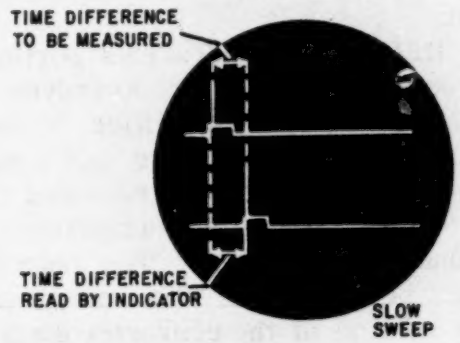

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Figure 17-16.–Time difference measured on a a loran indicator.

Theory of Operation

The APN-70 receiver assembly is composed of three major units: the RF receiver, the timer, and the deflection units. These sections are shown in block diagram form in figure 17-17,

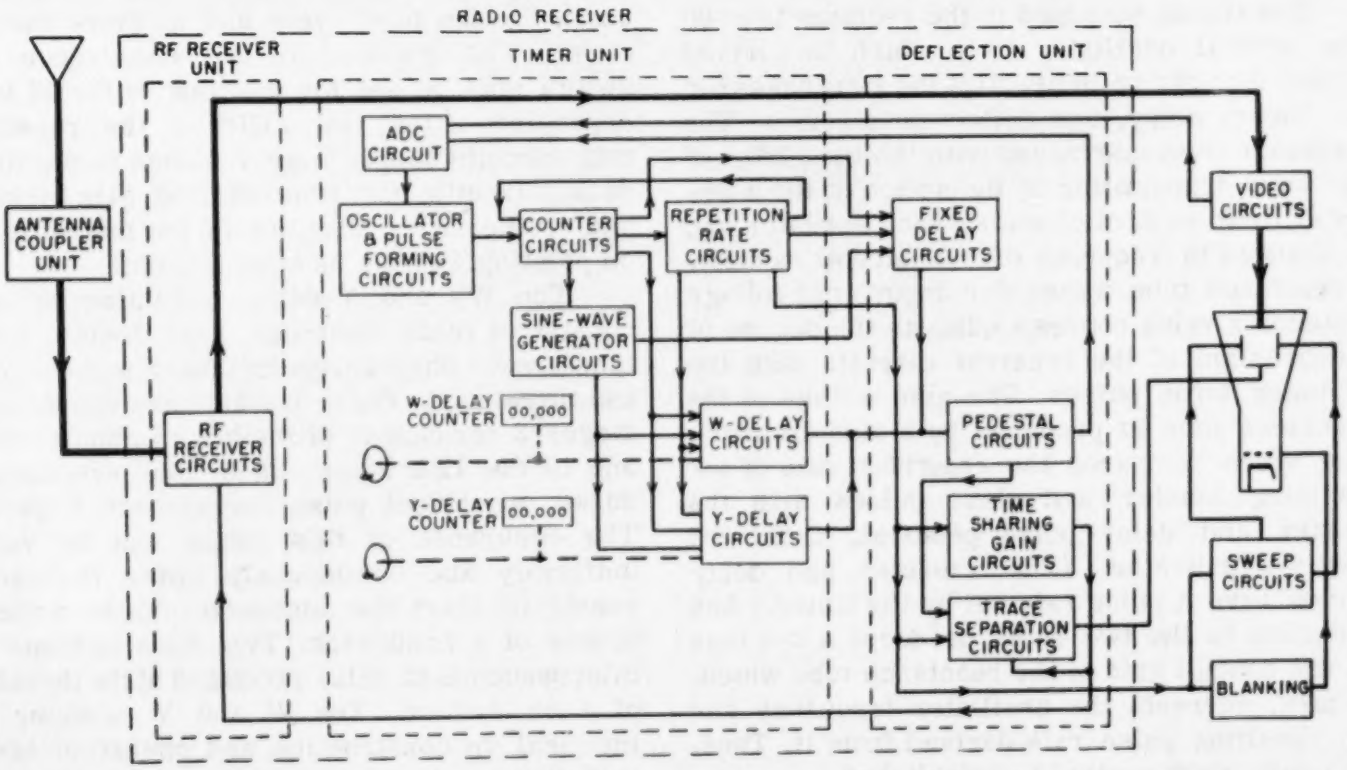

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Figure 17-17.–Receiver, AN/APN-70, block diagram.

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which also includes the components of the loran indicator.

RF RECEIVER UNIT.–This portion of the loran receiver is a superheterodyne system, which contains an RF amplifier, a converter, two IF amplifiers, a detector, and a video amplifier. Loran signals are received from the antenna coupler by the RF amplifier, a tuned-grid, tuned-plate circuit. The output of the amplifier is applied to the converter stage.

One section of the converter stage is used as a crystal oscillator circuit that produces mixing voltages. The IF output of the converter, is amplified in the two IF amplifiers and fed to the detector. The resulting video pulses pass through one stage of amplification and are coupled through a cathode follower and the video section of the indicator to the vertical deflection system of the cathode-ray tube.

TIMER UNIT.–This unit generates a series of pulses serving as the time base of the equipment and produces the variable-delay intervals used to measure the time differences of the loran pulses. Also, to insure that the receiving set and the transmitter system are operating at the same recurrence rate, the timer contains circuits for synchronizing the two.

The timing standard in the receiver is an 80 kHz crystal oscillator from which is derived (either directly or indirectly) the time bases for the timer, delay, and deflection circuits. The oscillator is synchronized with the time base of the loran transmitter by the action of the automatic drift control circuits. The oscillator can be changed in frequency over a narrow range by a reactance tube whose d-c input grid voltage assumes a value corresponding to the degree of synchronism of the receiver circuits with the incoming loran pulses. The grid voltage of the reactance tube is produced by a discriminator tube which compares the repetition rate of the incoming master and slave pulses with the master and delay pulse pedestals from the receiver-indicator. (The master and delay pulses have a pulse rate set by the timer.) Any variation in the two rates produces a d-c bias on the control grid of the reactance tube which, in turn, corrects the oscillator frequency and the resulting pulse rate derived from it. Thus, automatic drift control is established.

The sine-wave output of the crystal oscillator is shaped to produce a sharp negative driving pulse which is applied to the counter circuits. The electronic counter contains 12 identical multivibrators and 10 identical interstage amplifiers. Each counter stage is a binary counter (divides the input pulse rate by 2). The first 11 of these stages, together with 10 interstage amplifiers, are used to obtain the repetition rate. The 12th stage is driven by the output of the repetition rate circuits to obtain a square wave which is equal to the recurrence rate of the loran transmitting stations selected.

The first multivibrator of the counting series is triggered by 80 kHz pulses derived from the pulse forming circuits. The output of the first stage is fed to the grid of the first interstage amplifier tube which drives the second multivibrator. This sequence is repeated throughout the first 11 stages so that the overall division ratio is 2,048 to 1; hence, the counter chain gives one output pulse for every 2,048 pulses fed into it when all 11 counters are used.

The repetition rate circuits accept the output of the counter section and produce the reset pulses which determine the time at which the counter stages reach the count selected by the position of the recurrence rate switch. At that time a pulse is generated to reset the counter chain for the next cycle and to drive the 12th stage. The position of the recurrence rate switch may be set for any one of the 24 loran repetition rates. In addition, the repetition rate circuits supply trigger pulses to the fixed-delay circuits, the time-sharing gain circuits, and to the sweep circuits in the indicator unit on position 1 of the function switch.

The W- and Y-delay indicating systems consist of dials, switches, gear trains, gating tubes, wave shapers, goniometers, pulse formers, and thyratrons. These systems are connected to stages 3 through 11 of the binary counter chain and to the 12th stage. Each delay system produces one output pulse during each L period. The occurence of this output can be varied uniformly and continuously (after the second reset) to start the succeeding loran cycle by means of a handcrank. Two dials indicate the microseconds of delay produced at the thyratron of each system. The W and Y systems are identical in construction and operation except that their outputs appear in successive L/2 periods for operation with low frequency loran signals (dual presentation). With high frequency

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(single presentation) loran reception, only one delay system operates, as determined by the setting of the W-Y switch.

DEFLECTION UNIT.–In addition to the low voltage power supply, the deflection chassis contains circuits that receive signals from the timer unit. These signals are used to synchronize and trigger waveforms that perform the following functions:

1. Generate three independent bias voltages for the three time-sharing gain circuits.
2. Generate waveforms to drive the sweep generator in positions 2, 3, 4, and 5 of the function switch.
3. Generate trace-separation waveforms when required by the function selected at the control panel.

In single presentation, the time-sharing gain controls enable the operator to adjust the receiver gain to an independent level on each trace appearing on the indicator screen. Either the W- or the Y-delay system may be independently selected by a control switch. In dual presentation, the delay reading and the gain setting of one pair of loran stations may remain on one counter dial and gain control knob while the operator is matching a second pair of loran pulses using the second delay system. The output of the time-sharing gain circuits supplies bias to the RF and IF stages of the RF receiver unit.

The trace-separation circuits are connected to the lower vertical deflection plate of the cathode-ray tube. The fixed-delay circuits provide a 1,625-microsecond delay for the trigger governing the appearance of the master pedestal. For dual presentation, one trigger signal for every L/2 interval is provided; in single presentation, only one trigger signal for every alternate L/2 is required.

The pedestal circuits receive pulses from the fixed-delay and variable-delay circuits and generate waveforms to produce the master and slave pedestals. The output waveforms are supplied by a cathode-coupled, one-shot multivibrator which provides a pedestal of approximately 400 microseconds in positions 3 and 5 of the function switch in single and dual operation. The pedestal is 1,200 microseconds long in position 1, 2, and 4 of the function switch in single operation, or 1,750 microseconds long in dual operation. In position 1 of the function switch, the multivibrator generates the pedestals seen on the traces on the indicator tube. In other positions of the switch, the pedestals are used to generate the traces, and only the video signals present during the portion of the pedestal covered by the trace are shown on the indicator tube.

LORAN INDICATOR.–As shown in figure 17-17, the loran indicator contains the sweep circuits for developing the horizontal deflection voltages, the cathode-ray tube blanking circuits, the video circuits, and the cathode-ray tube. In addition, the assembly contains two high voltage rectifiers which supply d-c potentials for the CRT.

The sweep and blanking circuits are triggered by the reset pulses from the repetition rate circuits on function 1 and by the pedestal generator circuits on functions 2, 3, 4, and 5. A horizontal sweep generator supplies a sawtooth voltage waveform that is applied to the left horizontal deflection plate of the CRT. A portion of the output is also fed to a phase inverter stage to give an output wave 180° out of phase with the sweep generator output and which is applied to the right deflection plate thus providing a push-pull horizontal deflection.

The blanking circuit extinguishes the electron beam in the indicator tube during retrace intervals in which the grid in the indicator tube is driven highly negative with respect to the cathode. A d-c restorer diode clamps positive swings of the CRT grid to the voltage set by the brilliance control and establishes the level about which blanking takes place. An RC combination in the blanking circuit insures that the traces seen on the screen of the indicator tube are delayed until after the start of the sweep to remove irregularities in the initial parts of the sweep cycle.

Video signals derived from the RF receiver unit are amplified in the video circuits and are applied to the upper vertical deflection plate of the CRT.

The d-c voltages needed for operation of the CRT are supplied by low voltage regulator power supplies in the receiver unit and by the two high voltage rectifiers in the indicator assembly. One high voltage rectifier produces a d-c potential of 1,300 volts, positive with respect to ground, which is applied to the indicator tube through a cap connection. The other high voltage supply develops 1,300 volts, negative with respect to

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ground, and is applied to the cathode of the tube.

AUTOMATIC RADIO DIRECTION FINDER

Automatic direction finders are radio receivers equipped with directional antennas which are used to determine the direction from which signals are received. Most units of this class provide facilities for manual operation in addition to automatic direction finding (ADF). The automatic mode involves the use of motor-driven antennas which are positioned by means of closed-loop control circuits.

Before the development of radar and loran, radio direction finding was one of the principal means for determining the position of aircraft in bad weather. When an aircraft is within reception range of a radio station, the ADF equipment provides a means of fixing the position with fair accuracy. In addition to its usefulness as a navigational aid, the automatic direction finder is also employed as one of the basic devices of electronic countermeasure systems.

BASIC PRINCIPLES

When a conductor is cut by magnetic lines of force, or lines of flux, a voltage is induced in the conductor. In order to cut lines of flux, the conductor must be perpendicular or must have a component that is perpendicular to the lines of flux; and the relative motion between flux and conductor must have a component in a direction that is perpendicular to both the lines of flux and the conductor.

A vertically polarized wave has a vertical electric (E) field and a horizontal magnetic (H) field; therefore, the wave induces voltage in vertical conductors only. A vertical wire, or monopole, is the simplest type of antenna. When a vertically polarized radio wave induces voltage in a monopole, the induced voltage is in phase with the incident wave and is the same for all horizontal angles of incidence. (See fig. 17-18.) This similarity of response pattern, in all directions simultaneously, suggests the name omnidirectional (omni means "all") for this type of antenna.

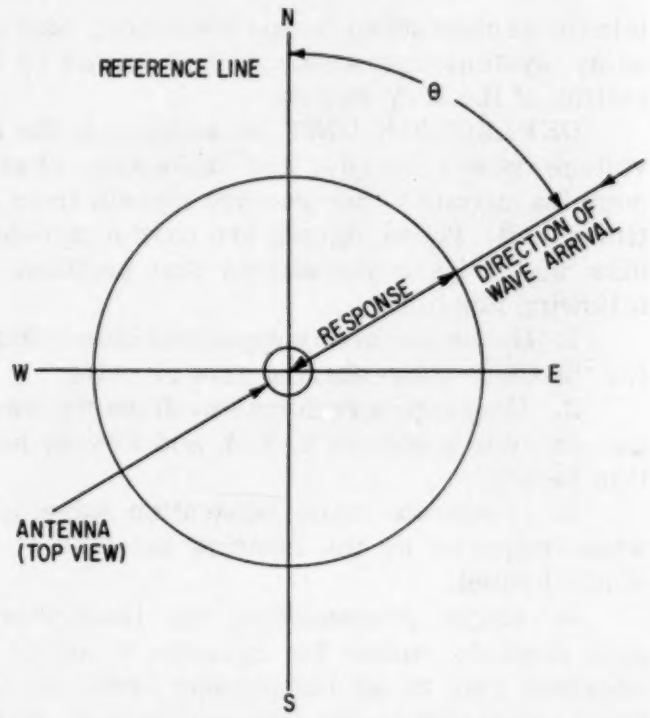

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Figure 17-18.–Polar response of a monopole (sense) antenna.

Loop and Sense Antenna

The response of a loop antenna is different from that of a vertical monopole (called a sense antenna in this discussion). A rectangular single-turn loop with dimensions that are small compared to the wavelength of an incident radiation field is shown in figure 17-19. As the loop is rotated about the axis XX', the angle θ (between the plane of the loop and the direction of propagation of the wave) is changed.

If the loop is placed in a radiation field like the one shown in figure 17-19, the H vectors of the field cut the sides AB and CD at slightly different times because the wave travels at a finite speed. At any instant, therefore, the voltage induced in arm AB is slightly different from the voltage induced in arm CD. (The arms BC and AD are not affected by the H lines of a wave polarized at right angles to them, and do not contribute to the induced voltage in the loop because the horizontal members are parallel to the H lines.)

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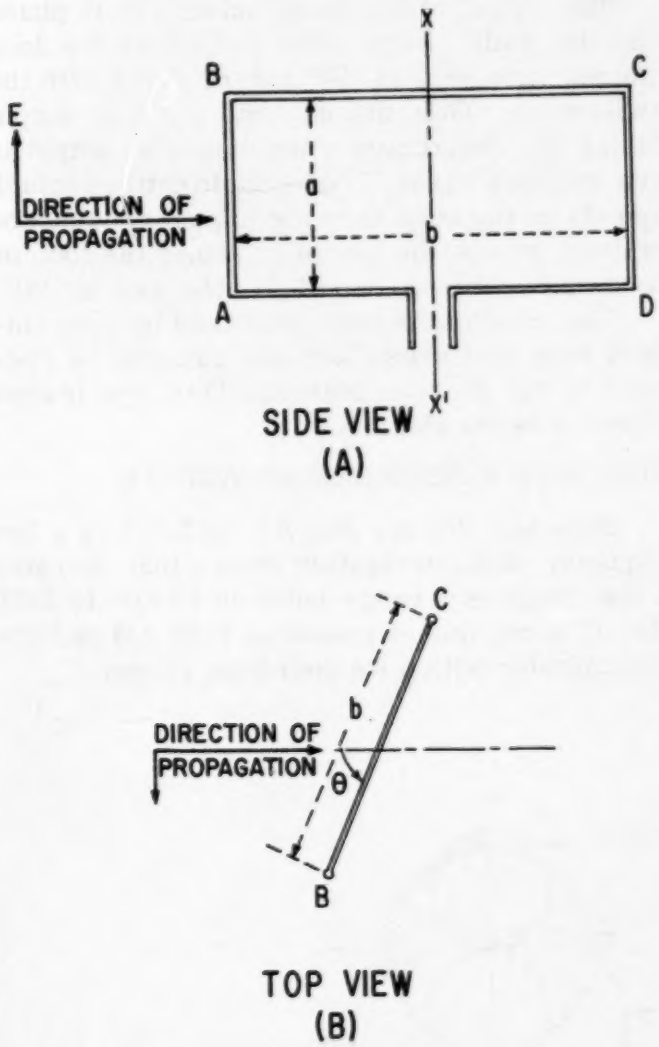

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Figure 17-19.–Loop antenna in a radiation field.

If the loop is turned so that its face is perpendicular to the direction of arrival of the wave–that is, $\theta = 90°$, the sides AB and CD are cut by the H vector at the same instant. The voltages induced in arms AB and CD are then the same magnitude and phase and neutralize each other, so that no current flows in the antenna loop.

Since the magnetic field of the radio wave alternates at the frequency of the wave, the instantaneous flux density at any point along the path of arrival varies sinusoidally. Thus the voltage induced into arms AB and CD are sinusoidal voltages with a phase difference θ. The total loop voltage is the sinusoidal voltage which represents the integration of the sums of all the instantaneous voltages induced into the two arms. It may be shown mathematically that this resultant voltage is proportional to the cosine of θ.

The pattern of the response is similar to the figure 8. (See fig. 17-20.) It is by using the response as shown in this figure that all medium frequency direction-finding equipments obtain bearings.

The directional characteristic of the loop antenna is called a cosine, or figure-of-eight pattern. When the loop is oriented so that the received signal is a maximum, a small change in orientation produces a small change in signal. However, when the loop is at a null position, a small change in orientation of the loop produces a large change in output voltage. Furthermore, there is a reversal in phase of the signal as the loop passes through a null point. For these reasons, the null points rather than the maximum-response points are used in radio direction finding to obtain a line bearing or line of arrival of a radio wave.

As there are two null positions 180° apart, the loop can give a line of bearing (the actual bearing or its reciprocal) but cannot determine the absolute direction of the transmitter from the direction finder. The determination of absolute direction, or sense, is obtained by adding the output of a vertical sense antenna to that of the loop antenna. When the two antennas are properly connected, the combined response is not ambiguous.

Signal Comparison

The figure-of-eight pattern of a loop has two null positions for one incident radio wave (fig. 17-20). If the outputs of a loop and a sense antenna are combined in phase, the response of the two antennas is the algebraic sum of their individual diagrams. In order to produce a

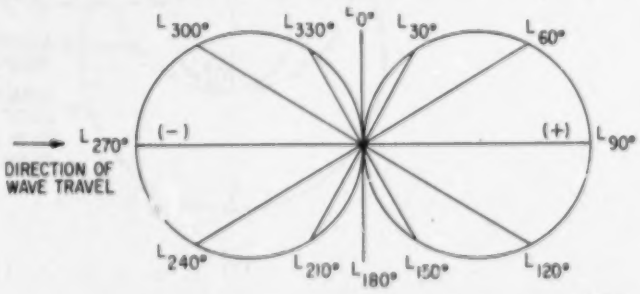

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Figure 17-20.–Polar response of a loop antenna.

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given response, the magnitude of the individual signals must be considered. Refer to figure 17-21 for the following discussion.

This figure illustrates four possible responses caused by differences in the relative amplitudes of the sense and loop outputs. The desired response shown in (C) has one sharp null.

The output of the vertical sense antenna is independent of the horizontal direction of arrival of the wave, so it may be considered to have positive polarity. Because the phase of the loop voltage changes as the loop passes through a null, one-half of the figure-of-eight pattern may be said to have positive polarity and the other half to have negative polarity. The addition of the loop and sense curves gives the responses shown. The shape of the resultant curve is called a cardioid because of its similarity to a heart.

The output of the sense antenna is in phase with the radio wave. The output of the loop antenna, however, is 90° out of phase with the radio wave. This means that the loop output voltage is a maximum when the sense output is zero and vice versa. The cardioid pattern (which depends on the outputs being in phase) cannot be obtained unless the phase of either the loop or the sense antenna signal is changed by 90°.

The cardioid pattern produced by the combined loop and sense antenna can also be produced by the rhombic antenna. This type is used without a sense element.

DIRECTION FINDER SET AN/ARD-13

Direction Finder Set AN/ARD-13 is a low frequency radio navigation device that operates in the frequency range between 90 kHz to 1800 kHz. It is capable of receiving both AM and CW transmission within its operating range.

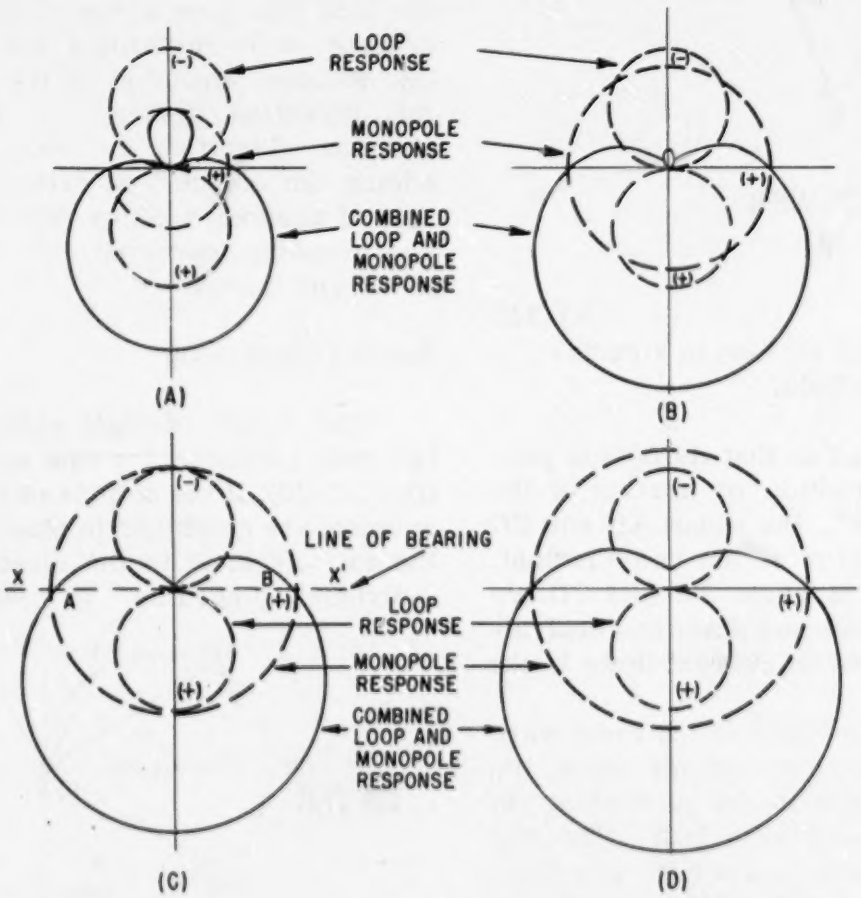

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Figure 17-21.–Response of the combined sense and loop antenna.

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The direction finder has three modes of operation which are selected remotely at the control unit. In the ANT mode, the RF input to the receiver is from the sense antenna; the direction finder operates as a nondirectional low frequency receiver. The RF input in the LOOP mode is from the loop antenna. The LOOP mode may be used for manual direction finding by rotating the loop for an audio output null or a tuning meter null. (A 180° ambiguity in direction is possible in the LOOP mode since the loop antenna pattern has two nulls 180° apart.) The direction from which signals are best received can be chosen manually from the control box by positioning the loop. In the ADF mode, the receiver combines signals from both the sense and loop antennas to determine whether the loop is pointed to the left or to the right of the signal source. The receiver commands clockwise rotation of the loop if the loop axis is pointed to the left of the signal source. Counterclockwise rotation is commanded if the loop axis is to the right of the signal source. Rotation ceases when the loop axis is pointed directly at the signal source.

The position of the loop is continuously transmitted to the bearing indicator. The bearing indicator reads the bearing to the station in the ADF mode, because the loop is kept pointed directly at the station. The bearing indicator combines the bearing information from the direction finder with navigation data received from other equipment. Audio signals in all three modes are supplied to the intercommunication system in the aircraft. The audio level to the ICS is varied manually from the control box. (See fig. 17-22.)

Theory of Operation

ANT (ANTENNA) MODE.–Radiofrequency signals from the sense antenna are coupled to the RF amplifier through the impedance-matching network in the sense antenna couplet. The only signal input to the RF amplifier in the ANT mode comes from the sense antenna; the loop amplifier and the balanced modulator are disabled. The oscillator and mixer convert the output of the RF amplifier to 455.7 Hz, the intermediate frequency of the receiver. The oscillator is tuned from the control box by the tuning servo. One of two mechanical filters passes the desired signal and attenuates the undesired signals. The broad filter provides selectivity of 3.1 kHz, and the sharp filter provides receiver selectivity of 1.5 kHz. The narrow band output of the mechanical filters is amplified by the IF amplifier and is applied to the detectors. The output of one detector is used as the automatic volume control (AVC) signal to limit the gain of the RF and IF amplifiers. The AVC signal is also applied to the tuning meter. The output of the other detector is applied to the audio amplifier. The audio gain control is bypassed in ANT mode and manual control of receiver gain is with the RF gain control. The audio amplifier increases the output of the detector to the level required by the ICS in the aircraft.

LOOP MODE.–Rotation of the loop antenna is controlled by the LOOP switch on the control box. The LOOP switch applies either of two phases of 400 Hz a.c. from the receiver to the loop rotating motor in the loop antenna. In practice, the operator uses the LOOP switch to drive the loop antenna to the position of minimum reception of the received signal. This position of minimum reception, which occurs when the loop antenna is pointed directly at the signal source, is called the null position. The angle of the transmitting station, with respect to aircraft heading, can then be read accurately on the bearing indicator. The RF output of the loop antenna is applied to the balanced modulator through the loop amplifier. The balanced modulator is unbalanced during loop operation and couples the output of the loop amplifier to the RF amplifier. Signals from the balanced modulator are the only input to the RF amplifier in the loop mode. The input to the RF amplifier is the same as in the antenna mode operation.

ADF MODE.–The RF output of the loop antenna has either of two phases relative to signals from the sense antenna. Phase A, as shown, occurs when the loop antenna is to the right of the null position. Phase B occurs when the loop is to the left of the null. The loop antenna has no output when in the null position. Either output phase of the loop antenna is modulated by a 47 Hz signal in the balanced modulator stage. The results of modulation for either phase input are shown.

The output of the balanced modulator is added to signals from the sense antenna by the RF amplifier. Note that there is a 180° difference in phase between the envelope of A, present

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when the loop antenna is to the right of the null, and envelope B, present when the loop antenna is to the left of the null. The output of the IF amplifier is amplified and detected, and is applied to the audio amplifier. The output of the audio amplifier is processed and applied to the 47 Hz amplifier.

The amplified 47 Hz component of the output of the audio amplifier is applied to the discriminator. The discriminator compares the phase of the 47 Hz signal from the 47-Hz amplifier with the reference phase from the 47 Hz oscillator. If the two are in phase, the discriminator applies a positive d-c level to the 400 Hz modulator. If the two are out of phase, the discriminator applies a negative d-c level to the 400 Hz modulator.

The 400 Hz modulator applies either phase A or phase B 400 Hz signal to the loop servo-amplifier, which is connected to one winding of the loop antenna drive motor; phase A if the d-c level from the discriminator is positive, and phase B if the input from the discriminator is negative. Phase A causes the loop antenna to rotate to the left, phase B to the right. Thus, the signal that drives the loop antenna motor

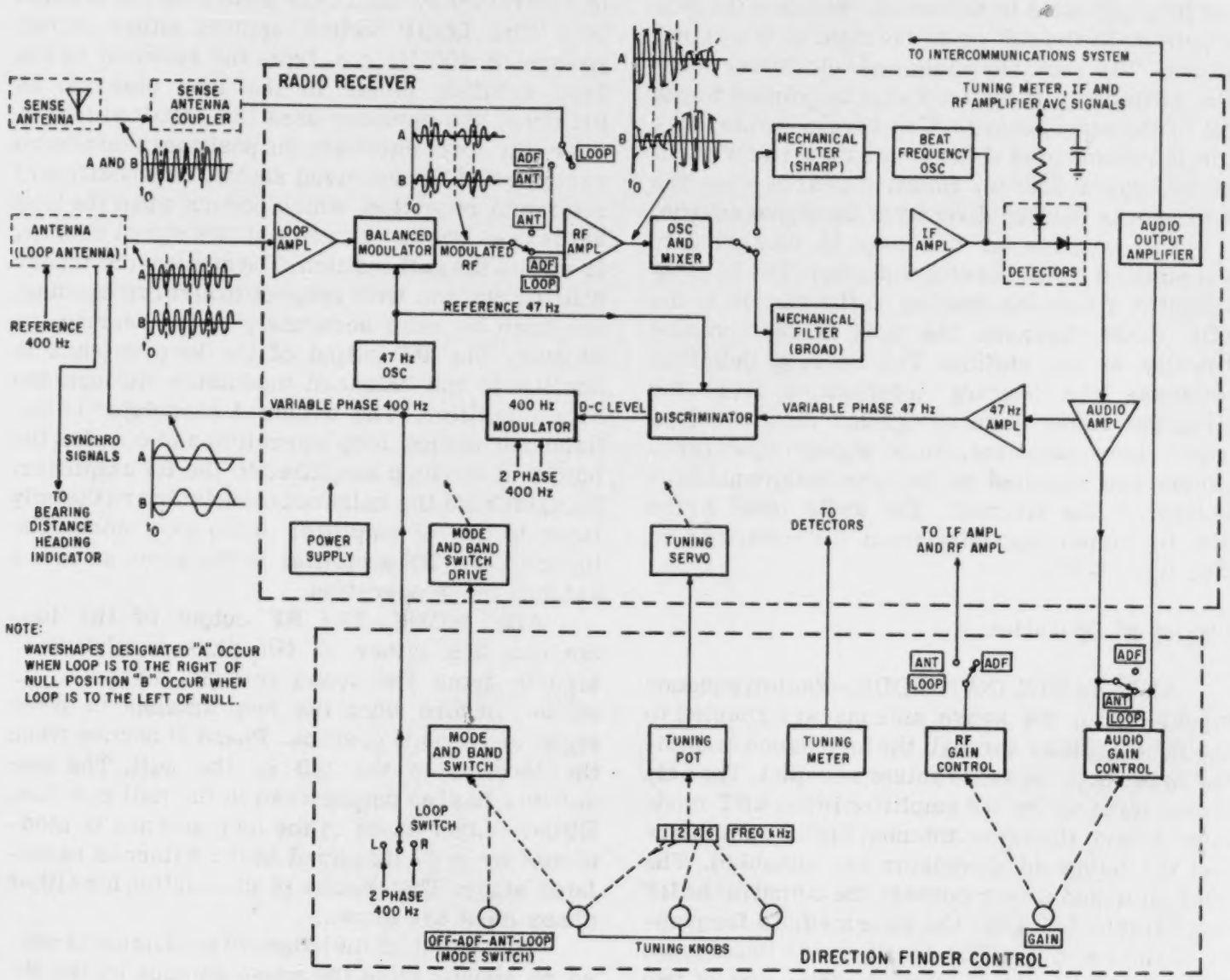

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Figure 17-22.–AN/ARD-13, simplified block diagram.

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ASSIGNMENT:

Draw the object below on an 8" x 11" buff drawing paper in pencil. When completed, lay a sheet of tracing paper over the drawing and proceed to ink it, using the inking order described above.

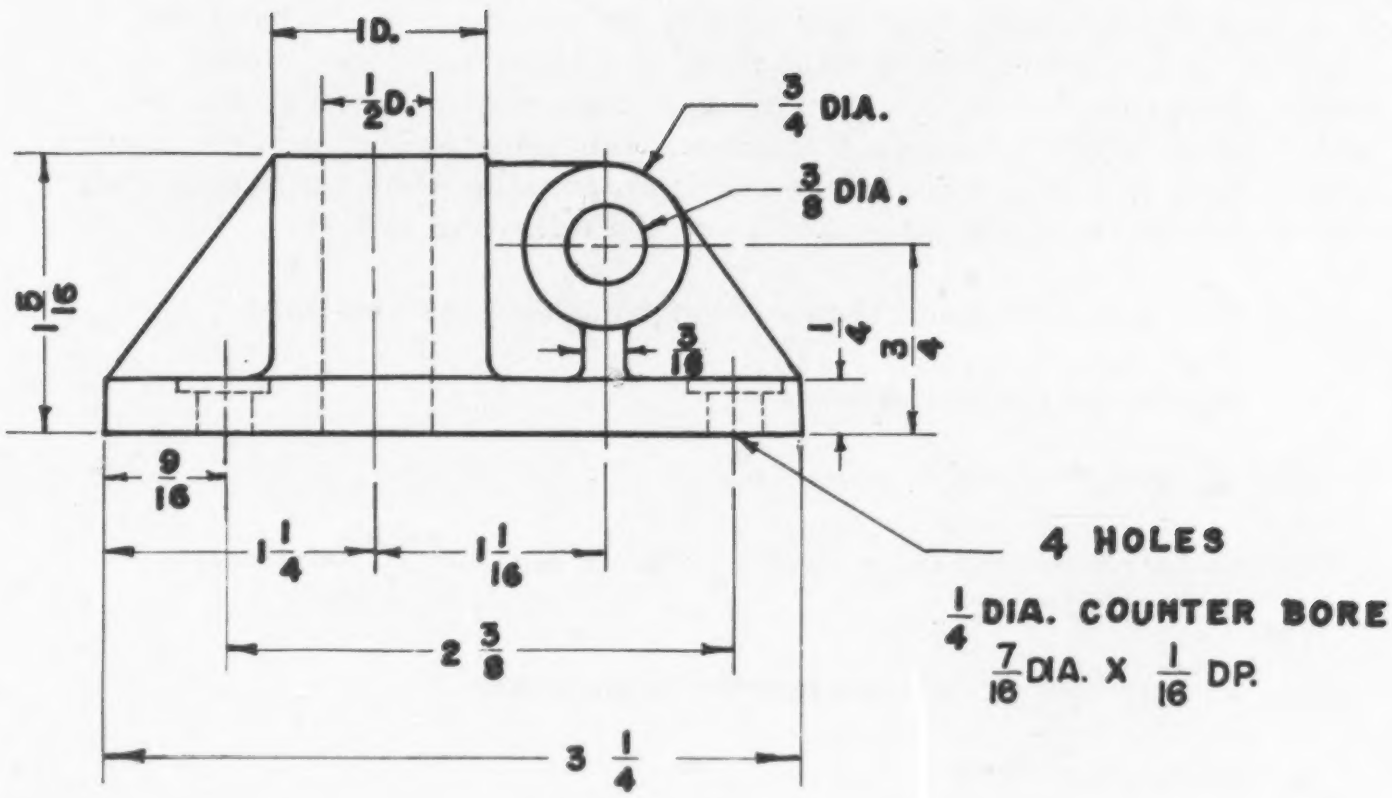

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will always cause the loop antenna to rotate toward the null position.

The bearing indicator, electromechanically coupled to the loop antenna by synchros, reads the position of the loop and thus the direction to the signal source.

In the ADF mode, the RF gain control is inoperative. The audio gain control is used to vary the audio output level of the receiver.

ENVIRONMENTAL CONDITIONS

The environmental conditions under which an automatic direction finder must operate are important in determining the effectiveness of the equipment and the reliability of radio bearings. Satisfactory reception of radio signals depends on many factors. These factors may be broadly classified according to position, propagation characteristics, frequency characteristics, atmospheric conditions, and equipment capabilities.

Position

The farther a receiver is removed from the transmitter, the weaker the signal becomes. Pilots flying a radio beam sometimes use this gradual "fading" to determine the direction of the station. However, fading may result from many other causes, and is therefore frequently unreliable as an indication. In general, fading may result from the simultaneous reception of direct and reflected waves tending to cancel, thus decreasing signal strength.

Propagation Characteristics

A radiated electromagnetic wave tends to travel in a straight line, as discussed in chapter 5 of this manual. However, as discussed in chapter 9, there is a "bending" effect which occurs in radio wave travel. The actual amount of the bending depends on atmospheric density, temperature, and humidity. It is also affected by the electrical conductivity of the surface over which the wave travels.

In addition to the bending (refraction and diffraction), radio waves are also susceptible to reflection. Reflection may occur at the surface of the sea or land, from a mountainside, from ships, or from the ionosphere. It may have a relatively constant effect on the signal, or it may have a merely transient effect.

Some of the more important effects on radio wave propagation are the result of changes in the location and ionization of the ionospheric layer. This is discussed in basic form in Basic Electronics, NavPers 10087-B.

Night effect, occuring at both dusk and dawn, results from a shift in the ionospheric layer. At night, the height of the ionosphere is at a lower level with respect to the earth's surface than in the daytime. During the transitional intervals (dawn and dusk), the ionospheric layer bends as the height change progresses. This means that the radio waves strike the layer at a varying angle, and the reflection angle varies accordingly.

Shoreline effect results from variations of temperature and humidity and from differences in electrical conductivity between sea and land masses. The resultant changes in refraction affect the accuracy and reliability of radio bearings taken in this area.

Frequency Characteristics

As discussed in previous chapters of this course, the frequency of a radio wave affects its range, its propagation characteristics, and its susceptibility to interference. In general, range varies inversely with frequency–above some certain frequency limit, operational usage is limited to the line-of-sight range. Below that limit, the refraction index varies and the resultant maximum range is affected.

Atmospheric Conditions

In airborne applications, radio reception is affected by weather. In addition to the temperature, humidity, and density mentioned previously, reception is also affected by the electrical charge of the atmosphere. Lightning disrupts radiowave usage during the period of the flash for normal frequencies. Extremely high frequencies, however, may be usable in spite of lightning.

Two additional static disturbances are created as a result of the aircraft flying through the charged atmosphere. Precipitation static results when atmospheric particles strike the aircraft and create a static charge on the air-

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craft. Static discharge interference results when charges built up on the aircraft are discharged into the atmosphere. Normally, these conditions are relatively minor; but under certain atmospheric conditions, they may render the radio bearings unusable.

Equipment Capabilities

As with any type of electronics equipment, the actual effectiveness of the AN/ARD-13 depends on the design characteristics, the installation details, the qualifications of the operator, and the quality of the maintenance performed. Design features may eliminate many problems; but within the design limits of the equipment, maintenance and calibration determine its actual effectiveness. The maintenance practices and procedures, as prescribed in the appropriate technical manuals for the equipment and for the aircraft in which it is installed, must be adhered to.

CALIBRATION

The radiofrequency field pattern in the vicinity of the aircraft is distorted by the configuration of the aircraft itself. This distortion varies with respect to the earth's magnetic field, with the heading of the aircraft, and with the electromagnetic fields resulting from the operation of various equipment.

Although it is possible to compensate for many factors while on the ground, the final calibrations should be done in the air. It must be repeated when the operating area of the aircraft is changed. The procedure is elaborate and time consuming, but it is essential if the full value of the equipment is to be realized. For details concerning the calibration procedure, consult the appropriate volume of the Maintenance Instructions Manual for the specific model aircraft.

OTHER ADF EQUIPMENTS

AN/ARN-41A Direction Finder

Radio Receiving Set AN/ARN-41A is a combination automatic direction finder and radio receiver designed for use in aircraft. When signals from the sense antenna alone are selected, the equipment functions as a conventional radio receiver for continuous-wave and amplitude-modulated signals. When signals are selected from both the loop and sense antennas, the equipment functions as an automatic direction finder (ADF), providing automatic visual and aural indications of the relative direction from which radio signals are being received. The equipment frequency range is from 190 kHz through 430 kHz and from 480 kHz through 1,725 kHz. This is covered in three bands. The equipment may be used as an ADF or radio receiver on all its bands.

The AN/ARN-41A can be used for homing on a single station, or for triangulation position fixing using two or more stations, or for position fixing on a single station using any of the double bearing methods presently in use. Only ground waves of the transmitting station are used in ADF operation.

AN/ARA-25 UHF Direction Finder

The AN/ARA-25 is an ultrahigh frequency ADF that is used on most naval aircraft having UHF transceivers.

Desirable performance of the AN/ARA-25 and its relative freedom from serious maintenance problems, have proven it to be a reliable homing equipment. Accurate bearings on received signals at relative bearings of 000° and 180° are rapidly obtained; and while this is being accomplished, communication with the UHF Station is interrupted for only short periods of time. Bearings at other than 000° or 180° relative are not as accurate due to deviation.

The heart of the AN/ARA-25 ADF is the directional antenna. Because of the design of the antenna, no sense antenna is necessary. The AN/ARA-25 antenna is a flat, diamond-shaped (rhombic) plate placed over a tapered cavity. The cavity is designed to maintain a 50-ohm characteristic impedance at frequencies in the range of 225 MHz to 400 MHz.

BENCH TEST AND ALINEMENT

To either bench test or aline an ADF, the first consideration is whether the particular set is a complete receiver or an auxiliary piece of equipment. If it is an auxiliary equipment such as

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the AN/ARA-25 or AN/ARA-50, it must be placed in a bench set with the parent equipment. The parent equipment usually supplies the auxiliary with its power needs.

Normally there is no special test equipment needed that is peculiar to the ADF. Therefore, the important aspects of test equipment selection is the operating frequency of the ADF and test equipment, the type of modulation used by the ADF and test equipment, and the output signal of the particular ADF.

DOPPLER NAVIGATION SYSTEMS

Doppler navigational radar automatically and continuously computes and displays groundspeed and drift angle of an aircraft in flight without the aid of ground stations, wind estimates, or true airspeed data. This is done by utilizing auxiliary inputs from an altitude rate sensor and from the aircraft's vertical reference system. The Doppler navigation radar section does not sense range and bearing (direction) as ordinary search radar does. It employs continuous carrier wave transmission energy and determines the forward and lateral velocity components of the aircraft by utilizing the apparent frequency change phenomenon (Doppler shift) in the RF range.

The radar emits CW energy at one frequency; these waves of energy strike earth's surface and are reflected. Energy waves returning appear to be spaced differently than the waves that were transmitted.

The receiver of the Doppler radar system detects this apparent change in frequency; this is accomplished by use of two signal inputs–one from the transmitter and one from the receiver antenna. The input signal from the transmitter is at all times the same frequency as the signal being radiated; the receiver antenna signal frequency will vary with the relative speed. The two frequencies are compared in the receiver, and the difference frequency is a direct indication of the groundspeed of the aircraft.

An analysis of the Doppler shift, as it applies to RF frequencies, is presented in chapter 9 of this manual. Review of that material should prove helpful in understanding the discussions of actual Doppler radar navigational equipment.

TWO-BEAM SYSTEM (AN/APN-122)

One type of airborne Doppler navigation equipment is the AN/APN-122, an all-weather, self-contained system. It radiates two narrow, fixed beams of CW energy downward, outward, and rearward (thus the ground becomes an opening target) from the aircraft's longitudinal axis. The ground-returned energy is intercepted by the receiver and compared with the outgoing transmitter energy. The difference (due to the Doppler effect) is used to develop velocity component information for use in the computing section. The velocity component, with the aid of roll angle, pitch angle, and altitude rate data furnished from auxiliary equipment, derives the groundspeed and drift angle in the computing section.

The groundspeed and drift angle information is continuously displayed on an indicating dial. It is also made available as a continuous synchro output signal for tie-in with other navigational equipment–position computers, bomb directors, and/or integrated flight director systems.

Operating Principles

The receiver-transmitter unit, shown in figure 17-23, consists of a Fiberglas paraboloid which contains a waveguide assembly, two crystal mixer assemblies, and a klystron oscillator assembly. The inner surface of the paraboloid is sprayed with a metallic reflecting material. As well as serving as a container for the various units, the paraboloid also serves as the transmitting and receiving antenna. The paraboloid is divided in the center by a wall called the septum, in which the waveguide is mounted.

The transmitting waveguide originates at the klystron and is a T-shaped section terminating in two transmitting horns (only one transmitting horn is visible in figure 17-23). Two receiving waveguide sections are attached to the transmitting section. They have crystal mixer cavities mounted at the upper ends, receiving horns at the lower ends, and coupling slots provided between each receiving and transmitting section.

The klystron, mounted at the center of the waveguide, receives d-c filament and cathode power from the high voltage power supply and

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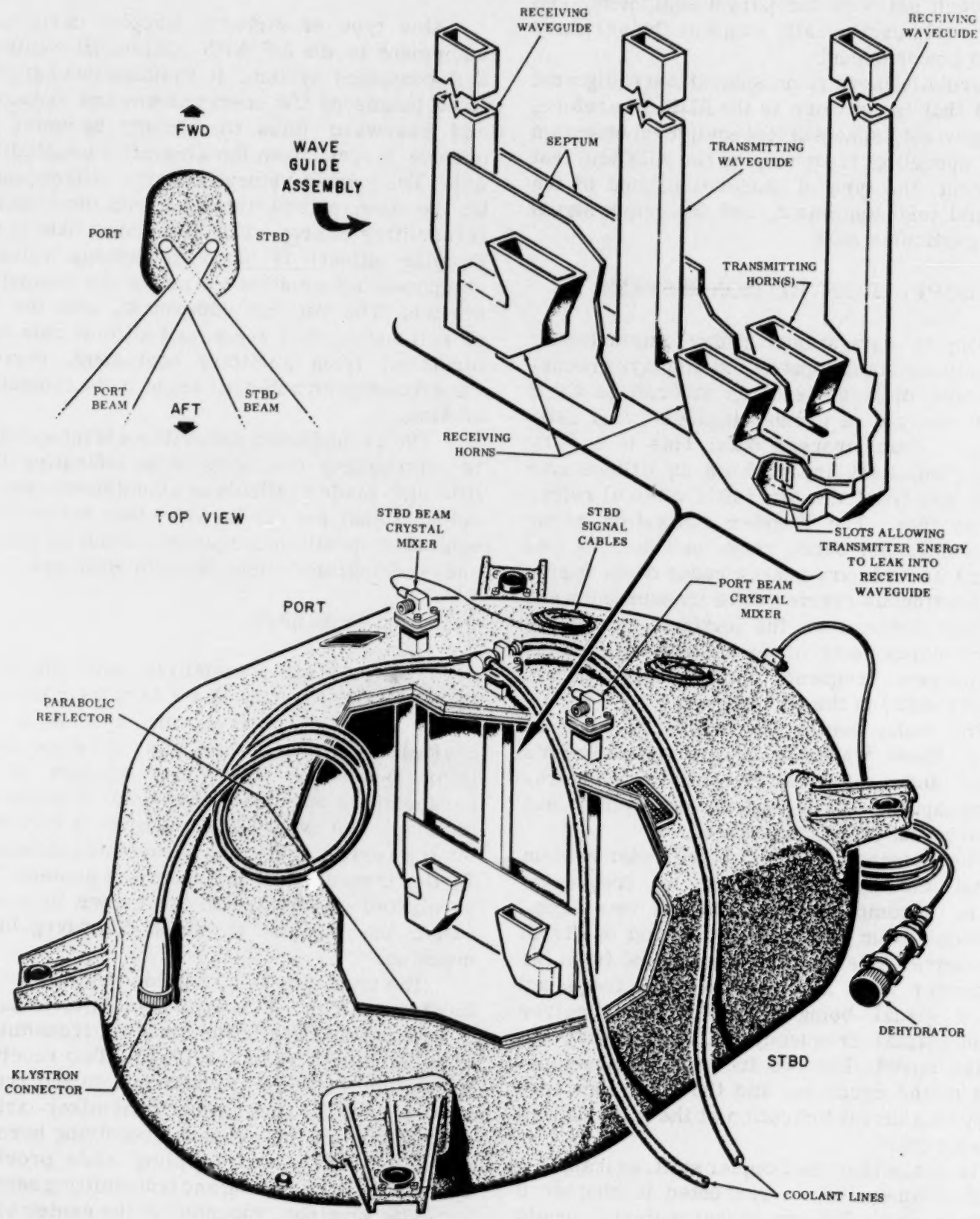

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Figure 17-23.–Receiver-transmitter unit, mechanical assembly.

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liquid coolant from the electron tube liquid cooler. The klystron is a dual cavity resonator. The CW energy from the klystron cavity is coupled to the waveguide through an impedance matching aperture located in the end of the waveguide, and through a coupling choke built into the waveguide flange. The energy is coupled down through the waveguide to the T-section where a power divider sends half of the energy to each transmitting horn. The power divider is a small probe located across the waveguide at the center of the T-section.

The reflecting surface of the antenna dish concentrates the energy into two narrow beams on opposite sides of the aircraft. These beams are directed outboard and downward to the rear of the aircraft, as shown in figure 17-24. The beams are directed outboard from the aircraft through an angle of 11°; simultaneously, they are directed aft through an angle of 22°.

Although the angular width of the radar beam is narrow, its linear width increases with increasing distance from the aircraft. As a consequence, the angle of incidence of different parts of the beam and the direction of the energy reflected from the ground vary. Specifically, the result is that the energy striking the ground at the steepest angle relative to the longitudinal axis of the aircraft returns at the highest frequency, producing the lowest Doppler frequency; and the energy striking the ground at the flattest angle returns at the lowest frequency, producing the highest Doppler frequency. There will be a general frequency band or spectrum between these two Doppler frequency extremes, and the energy transmitted at the center and received from the center of the radiation lobe will be at the greatest power and at approximately the center frequency of this band.

The reflected energy is picked up by the receiving half of the antenna and focused into the receiving horns. This energy is directed through the waveguides to the receiving crystal mixer cavities. The impedance of the waveguide is matched to the crystal mixer by a matching aperture located at the coupling flange. The flange also contains a coupling choke to prevent loss of energy at this junction. A sampling of the transmitter's energy leaks into the receiving waveguides through two narrow coupling slots between the two sections of the

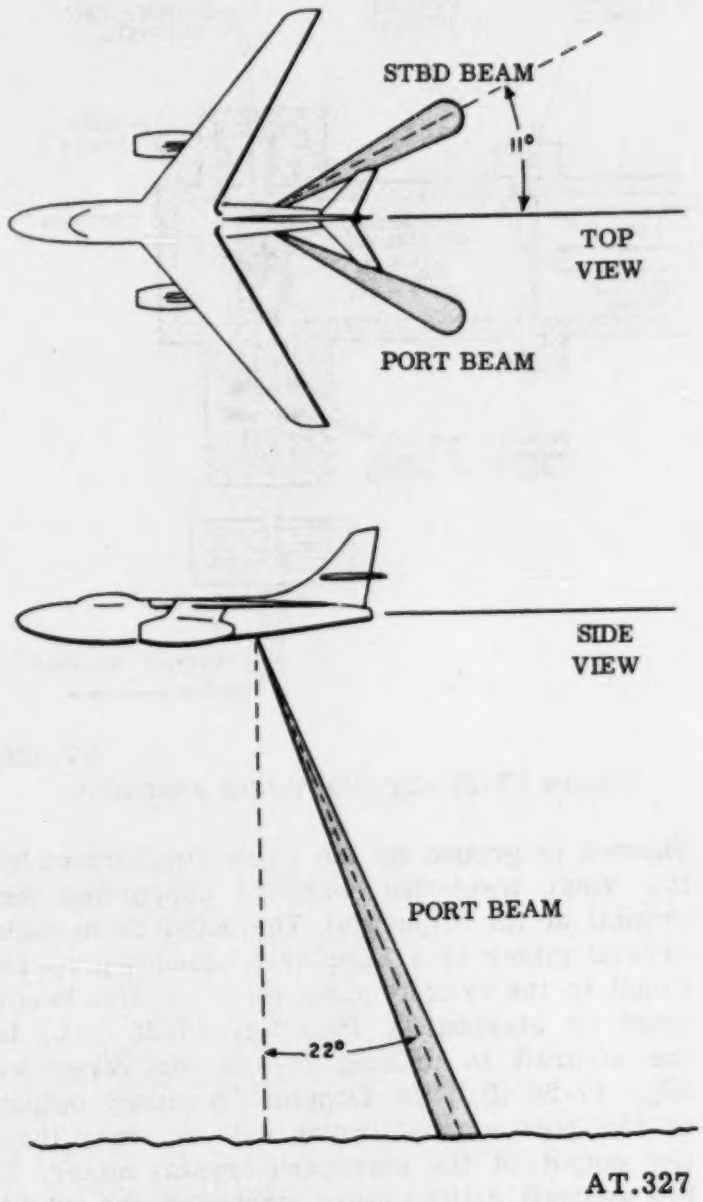

Figure 17-24.–Radar beam orientation.

transmitting and receiving waveguides. (See fig. 17-23.) These coupling apertures attenuate the transmitted energy so that only a small portion of its power is supplied to the receiving waveguide.

The crystal is placed across the cavity at a voltage point, as shown in figure 17-25, and functions as a pickup probe and as a mixer. Both the transmitted and received signals appear across the crystal; and since it is a nonlinear device, mixing action results. The sum and difference, and each of the two output frequencies, appear across the output of the crystal, but the sum and the two input frequencies are

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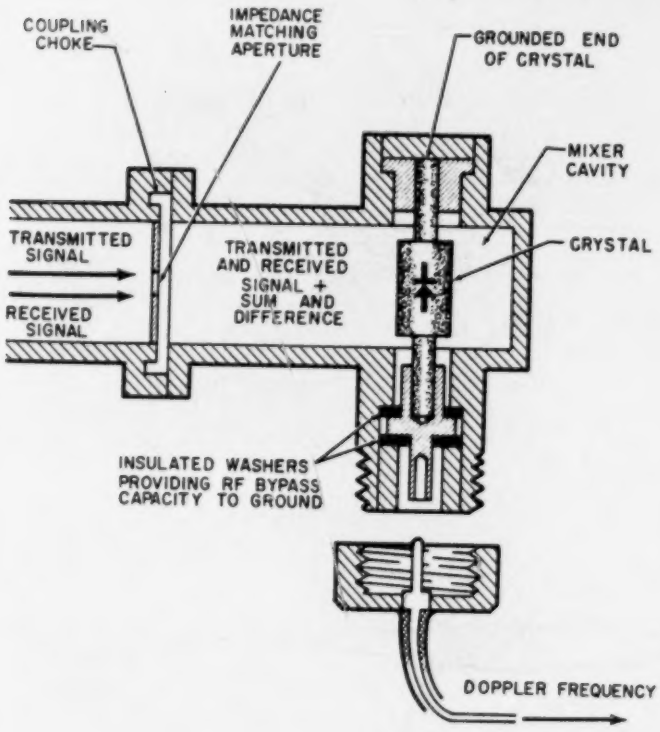

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Figure 17-25.–Crystal mixer assembly.

shunted to ground by the capacities formed by the vinyl insulating washers supporting the crystal at its output end. The output from each crystal mixer is a Doppler frequency proportional to the velocity along its respective beam (port or starboard). (See fig. 17-26 (A).) If the aircraft is drifting in the port direction (fig. 17-26 (B)), the Doppler frequency output of the port crystal mixer will be lower than the output of the starboard crystal mixer. If the aircraft drifts toward starboard, the output of the starboard mixer will be lower. The difference or Doppler frequency is within the audio spectrum.

Equipment Theory

Figure 17-27 shows a simplified block diagram of the AN/APN-122 system. The receiver-transmitter unit operation was discussed previously. The audiofrequency Doppler shift signal is coupled from each crystal to the amplifier assembly.

The port and starboard signals are amplified by separate channels and then routed to the signal data converter. As soon as satisfactory acquisition is made of the center Doppler frequencies in the search mode, the circuitry automatically switches to the track mode. Two voltages are produced–analogs of the center Doppler frequency of each channel (port and starboard)–and represent the velocity component of aircraft motion measured in the direction of the two radiation beams. (The average signal represents the velocity along the fore and aft axis, while the difference between the two signals represents the side to side velocity.)

A memory circuit is included to maintain track in the event of momentary loss of signal. The analog voltages are routed to an electromechanical analog computer. The computer converts the signals (which are proportional to the aircraft's velocity components relative to the radar beams) into potentials representative of the heading and drift velocity components of the aircraft. The resultant groundspeed and drift angle information is displayed on an appropriate indicator.

FIXED-WING SYSTEM (AN/APN-153)

The AN/APN-153(V) is a lightweight, miniaturized groundspeed and drift angle measuring system which is designed to satisfy the navigational requirements of modern military fixed-wing aircraft. It uses Doppler pulsed radar techniques to measure groundspeed and drift angle directly, continuously, and accurately. It operates anywhere, is relatively unaffected by weather conditions, and is independent of ground-based navigational aids. Its small size and light weight permit it to be easily installed in almost any fixed-wing aircraft.

The radar's groundspeed and drift angle data, together with aircraft heading data from any standard compass, are used to compute an aircraft's track projected on the ground. Using this information and conventional dead reckoning techniques, a pilot can navigate accurately over long distances.

Application

Groundspeed and drift data, in addition to being presented on a counter and dial, are available as electrical outputs. These outputs

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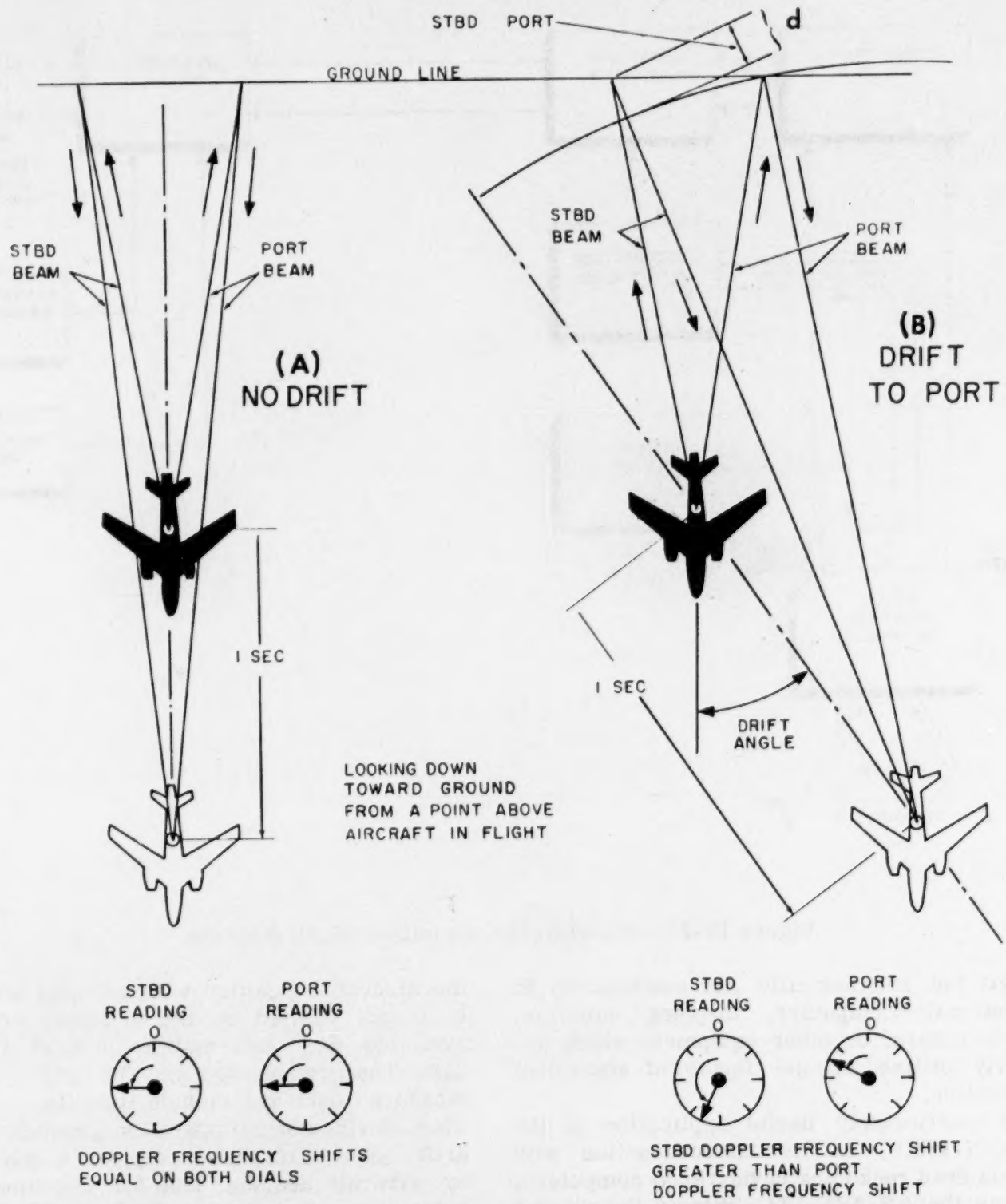

HEADING AND **DRIFT** VELOCITY INFORMATION } DERIVED FROM { **SUM** AND **DIFFERENCE** OF PORT AND STBD DOPPLER FREQUENCY SHIFTS

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Figure 17-26.–Doppler frequency shift–effect of shift on dual beams.

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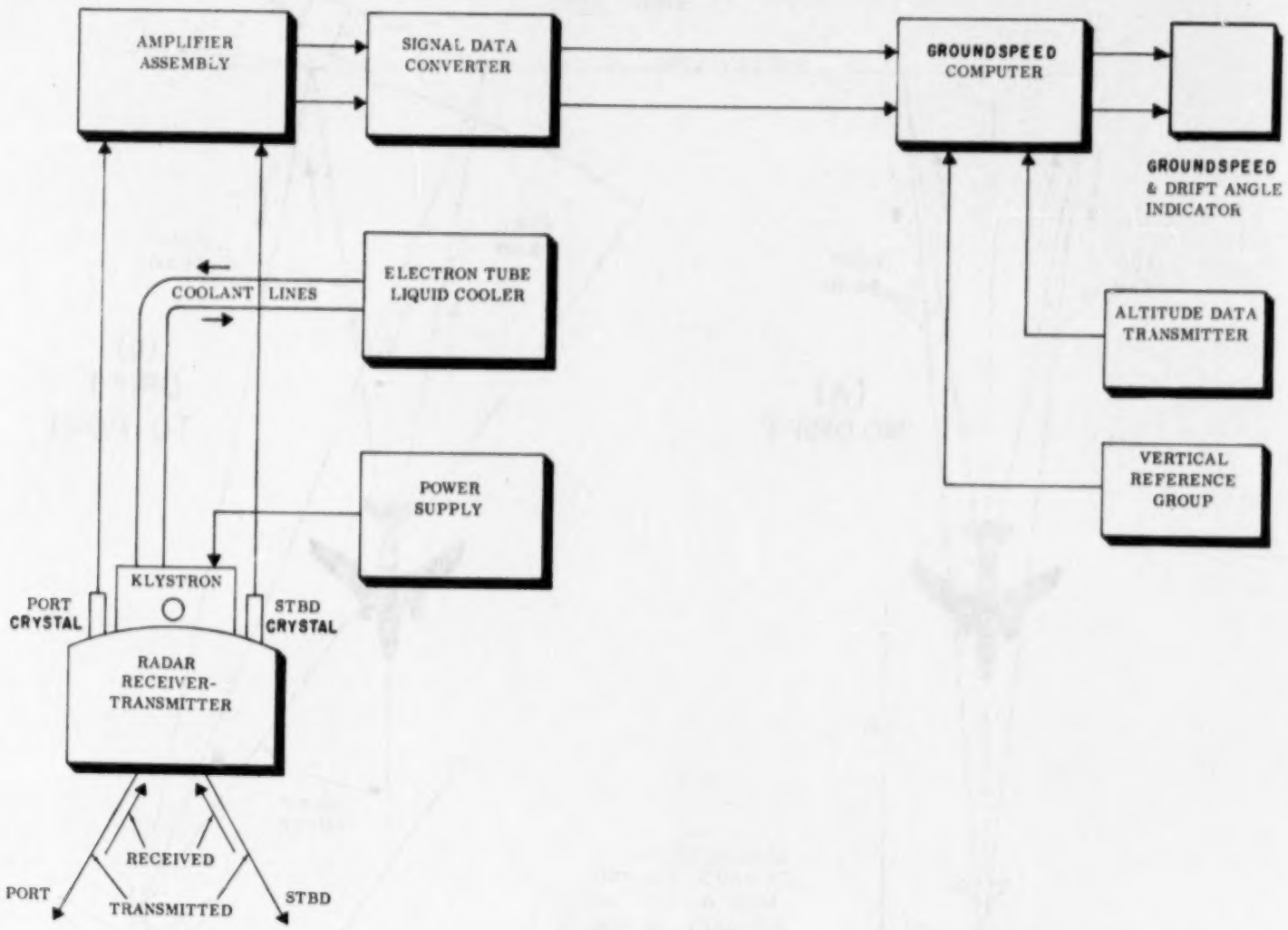

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Figure 17-27.–AN/APN-122, simplified block diagram.

can be fed automatically and continuously to navigational computers, mapping cameras, search radars, or other equipment which ordinarily utilize manual inputs of equivalent information.

A particularly useful application of the AN/APN-153(V) is its interconnection with various dead reckoning navigational computers, such as the AN/ASA-13A. Without the aid of a groundspeed and drift angle measuring system, navigational computers are sharply limited by the accuracy of the input information. The input data may consist of windspeed and direction, true airspeed, and aircraft heading. Only aircraft heading is usually obtainable with any high degree of accuracy.

Interconnection with this type of computer provides an automatic navigator which presents the aircraft's position with extreme accuracy. It is not limited by the accuracy of either available wind information or true airspeed data. The groundspeed and the drift angle are measured data and include the effect of wind. Thus, during normal operation, groundspeed and drift angle data need only be supplemented by aircraft heading data for continuous and automatic computation of the aircraft's position (given certain initial conditions).

Operating Principles

The AN/APN-153(V) emits short pulses of microwave energy, so the transmitter is not operative while an echo is being received. Therefore, in a single-beam radiation pattern there would be no second frequency with which

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to compare the echo. However, two beams—one projected dead ahead and the other directly behind—would experience equal but opposite Doppler shifts. In this event, one-half the difference between the two echo frequencies is the Doppler shift of either beam, and is proportional to groundspeed. This condition assumes no drift. If drift were present, the two-beam system described above would not detect it when used with pulsed beams. Antennas radiating to the left and right would detect sideways motion, but not fore and aft motion.

In order to make simultaneous measurement of both groundspeed and drift angle, the AN/APN-153(V) uses a modification of the two-beam pattern. The vicinity of the aircraft is divided into four quadrants—left forward, left rearward, right rearward, and right forward. (See fig. 17-28(A).) Simultaneous beams are radiated into diagonal quadrants, with switching of the quadrants at regular intervals.

When there is no drift, the ground track and aircraft heading coincide. In this condition, as shown in (B) of figure 17-28, the radiation pattern is symmetrical about the axes of the aircraft, and the left and right beams are at the same angle from ground track. The Doppler shift is equal in the beams.

When the antenna is not alined with ground track (fig. 17-28(C)), an angle exists between the antenna axis and ground track, and the beams experience unequal shifts. The difference frequency resulting from one pair of beams is higher than that from the other. As the switching action occurs, this difference is processed as an error signal which, through servo action, drives the antenna into alinement with ground track.

When the antenna is alined with ground track, the angle between the antenna axis and the aircraft heading represents the drift angle. Through a synchro system, this information is supplied to the computer along with the groundspeed data.

Advantages and Disadvantages

Due to its special radiation pattern, the AN/APN-153(V) is not affected by the vertical component of velocity which occurs during ascending or descending flight. Changes of altitude affect each beam equally, so the difference frequency remains the same. It is the difference frequency which is utilized to represent velocity.

Small roll and pitch angles of the antenna exist during normal flight. Roll angles introduce a greater shift into one beam and a smaller shift into the other, but the difference frequency is changed only slightly. Therefore, the inaccuracy of groundspeed measurements resulting from roll variations is very slight. Pitch angles do, however, cause inaccuracies which are significant. Therefore, the antenna is stabilized in its pitch axis to minimize pitch errors.

ROTARY-WING SYSTEM (AN/APN-130(V))

The AN/APN-130(V) is a four-beam navigation set which provides information for use in helicopter automatic navigation, as well as control during hovering and directional flight. This equipment is a representative advanced Doppler equipment used for measuring ground velocity components of helicopters and other air vehicles having hovering and negative speed capabilities. The set incorporates an antenna design featuring narrow beam widths, low sea effect errors, fully automatic navigate-hover transition, and automatic frequency trackers.

Operating Principles

The set employs four narrow beams of continuous-wave energy directed downward and outward, fore and aft, and in symmetrical configuration with respect to the aircraft, as shown in figure 17-29. Frequency shifts occurring in each beam are proportional to the components of aircraft velocity along the respective antenna beam. The frequency shifts, which are due to the Doppler effect, are detected by mixing a portion of the transmitting signal with the received signal and detecting the audio beat frequency.

After detection, the continuous Doppler audio signals are amplified and supplied to the signal data converter which converts the signals into voltages proportional to the aircraft heading velocity, drift velocity and vertical velocity. Outputs proportional to these voltages are provided in proper electrical form to drive the appropriate auxiliary equipment.

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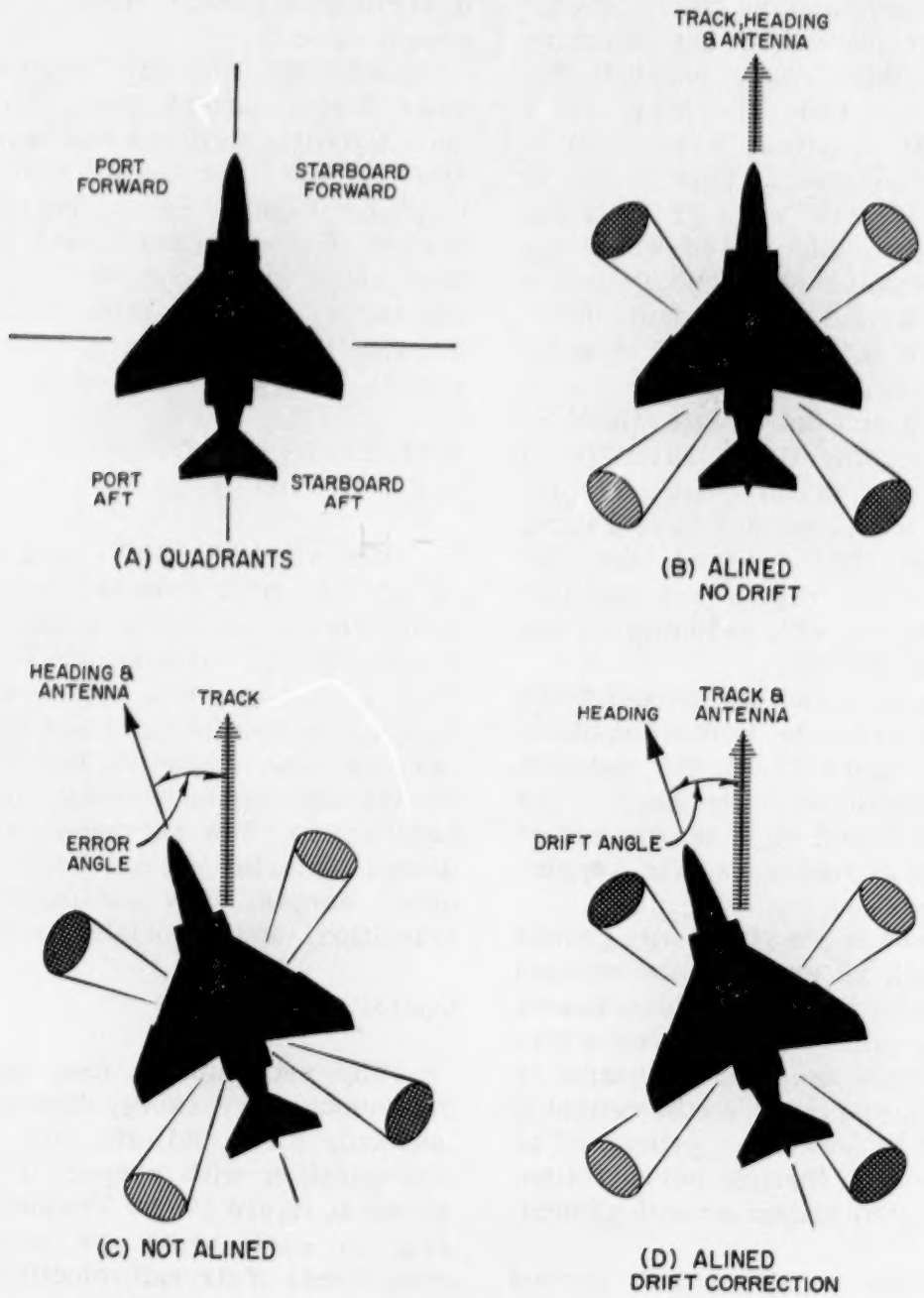

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Figure 17-28.–Four beam pattern, using two-beam transmission.

Equipment Theory

The klystron tube in the radar receiver-transmitter generates continuous-wave RF energy at a frequency of 13.3 GHz± 5 MHz with a minimum power of 4.5 watts. The RF energy is coupled into the four transmitting wave guides and transmitted toward the earth in four narrow beams. A small portion of the transmitted energy is coupled into each pair of receiving waveguides through directional coupling slots spaced (electrically) 180° apart. (See fig. 17-30.) A portion of the transmitted energy is reflected from the earth to a parabolic reflector and into the four receiving horns. The RF energy for each beam is divided and coupled into two receiving waveguides for each beam. At this point, the two received

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UNIT VI - DIMENSIONING

How to Draw Arrowheads — Lesson 1

OBJECTIVE: To learn how to properly draw arrowheads.

RELATED INFORMATION:

When properly drawn, arrowheads can enhance the appearance of a drawing appreciably but when done sloppily, they can ruin an otherwise good drawing. Prospective employers attach great importance to a clean, neat drawing.

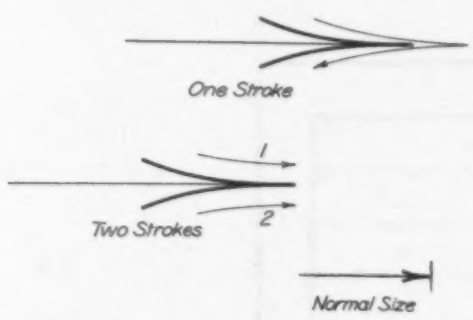

FIG. 1

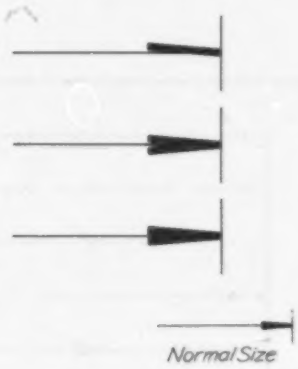

FIG. 2

Arrowheads can be drawn freehand, making the sides either in one stroke, or in two strokes toward the point, as shown enlarged in Fig. 1. Most employers, however, prefer the solid-head type as shown in Fig. 2. This head is usually made thinner and longer than the open-head type and has very little curvature to the sides. It is made in one stroke and then filled if necessary. A good rule to remember is that the bases of arrowheads should not be made wider than one-third the length. Attempt to make all arrowheads on the same drawing the same type, open or solid, and the same approximate size, except in unususual cases. Depending on the drawing size, arrowheads will vary somewhat, but a good general rule to remember is that $\frac{1}{8}$ inch is a good length, and $\frac{3}{16}$ inch for larger drawings. Remember once more that poor arrowheads can ruin the appearance of an otherwise excellent drawing.

QUESTIONS:

1. What approximate size should arrowheads be drawn?

2. Are arrowheads drawn freehand?

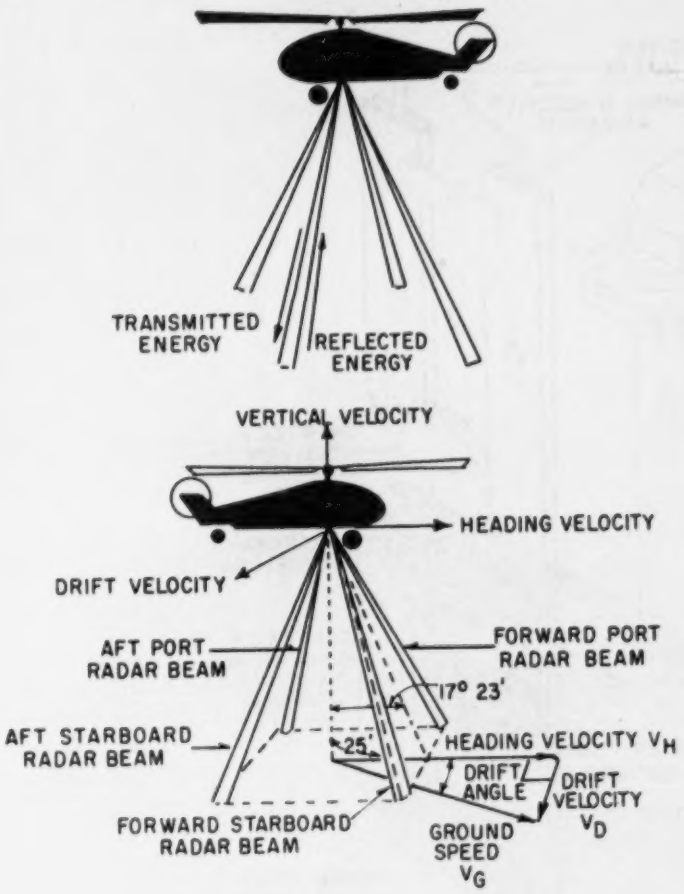

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Figure 17-29.–Antenna beam orientation.

signals for each beam are designated A and B. The configuration of the A and B channel waveguides is such that the A signal is shifted 1/4 wavelength or 90° from the B signal. The eight received signals are heterodyned with the transmitted signal at the crystal detectors. The eight low-level Doppler signals are fed to the amplifiers where they are amplified to a sufficient level for transmission to the signal data converter.

Four pairs of signal channels in the signal data converter receive the corresponding pairs of quadrature signals from the audio amplifier subassemblies of the radar receiver-transmitter. Each pair of signal channels corresponds to one of the four antenna beams. (See fig. 17-31.)

The signal data converter provides two basic modes of operation–hover and navigate. Transition between these two modes is automatic when the HOV/AUTO switch on the control-indicator is in the AUTO position. In the HOV position, all channels of the signal data converter are locked in the HOVER mode of operation. In the AUTO position, each channel pair is switched to either the HOVER or the OMNIDIRECTIONAL NAVIGATE mode independently of the other channels, or all channels may be switched simultaneously to the FORWARD NAVIGATE mode. The switching is controlled by the signal-to-noise density ratio and the frequency of the Doppler signal in each channel. A fail-save feature is provided wherein each channel is automatically switched from either of the navigate modes in the event that the Doppler signal is lost for a period exceeding approximately 2 seconds.

In fixed-wing aircraft, forward flight can be assumed. This is not logical in aircraft capable of negative velocities. Rapid direction sensing, as well as accurate velocity measurement, is extremely important for helicopter maneuvers at low velocities and during operations requiring hovering. The hover mode then requires coherent counting. Coherent counting, as used in this application, refers to the method used to develop an analog d-c output signal whose amplitude is proportional to aircraft velocity and whose polarity is an indication of aircraft direction. The Doppler signal in itself is not an indication of aircraft direction.

It is safe to assume that when a helicopter is traveling at some high rate of speed, the direction of flight is limited to forward flight with limited drift angle. Under these conditions, it is not necessary that each counter sense aircraft direction; therefore, the counters may operate in the noncoherent mode as long as the output polarities have been correctly established in velocity-sensing circuits.

ASSOCIATED EQUIPMENT

As mentioned previously, Doppler navigational radar equipment by itself cannot determine aircraft position or navigate the aircraft to a predetermined point. However, when used with associated navigational computers, these operations can be accomplished. The major function of the Doppler equipment is to supply extremely accurate data concerning velocity and drift angle.

Although there are many airborne navigational computers in use at the present time (and

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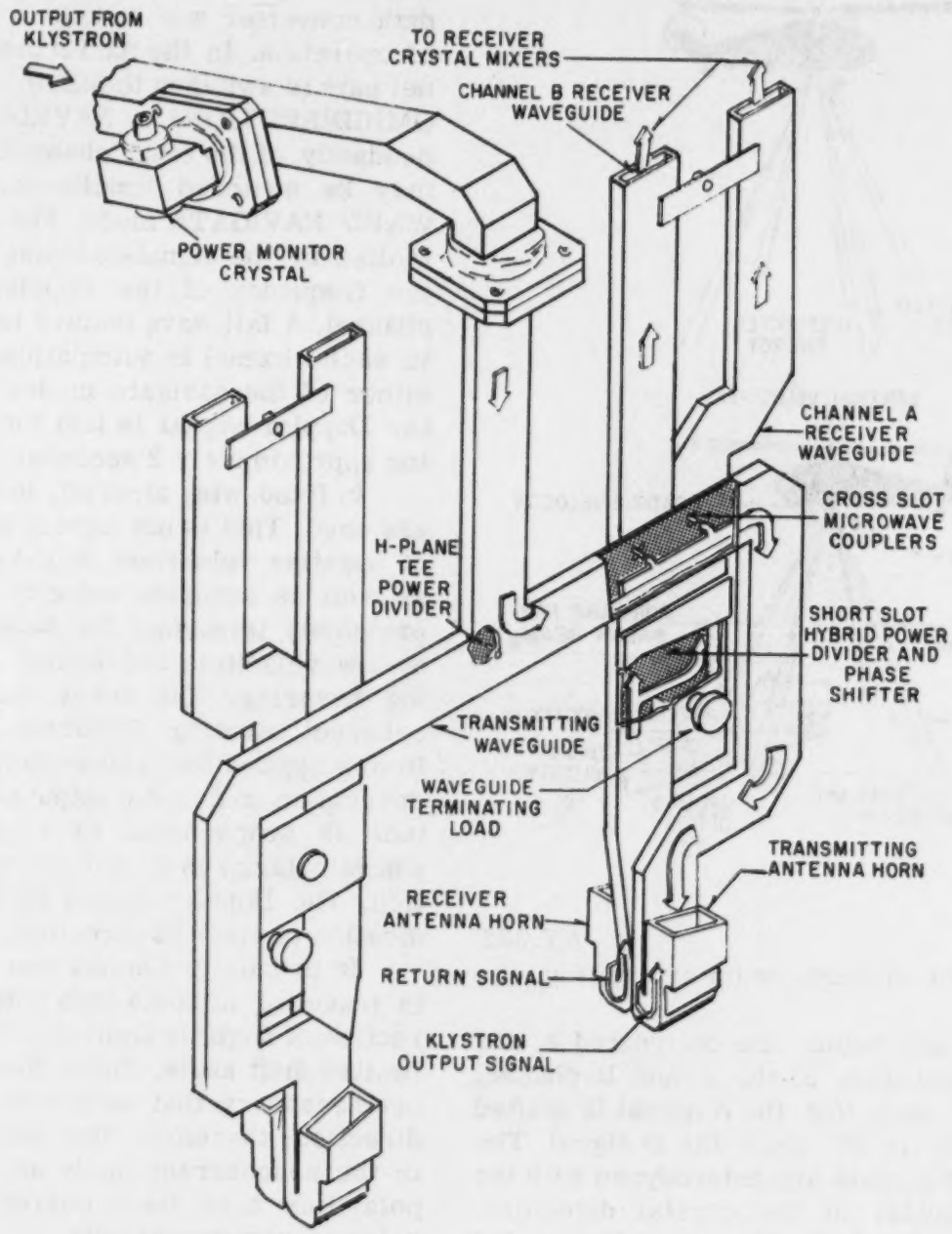

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Figure 17-30.–Waveguide subassembly, receiver-transmitter coupling.

more are being introduced each year), a brief discussion of the AN/ASA-13A and its plotting board OA-1768/ASA will illustrate the overall system.

The AN/ASA-13A

Navigational Computer Group AN/ASA-13A is an airborne dead reckoning computer which continuously determines displacement from an initial reference. Displacement is computed in E-W and N-S coordinates from information obtained from within the aircraft. These coordinates, in the form of d-c voltages, are used to displace CRT sweep origins for ground stabilized PPI displays.

The computer (fig. 17-32) resolves and combines voltages representing the airspeed and wind vectors. The resultant ground velocity (in component form) is then integrated to

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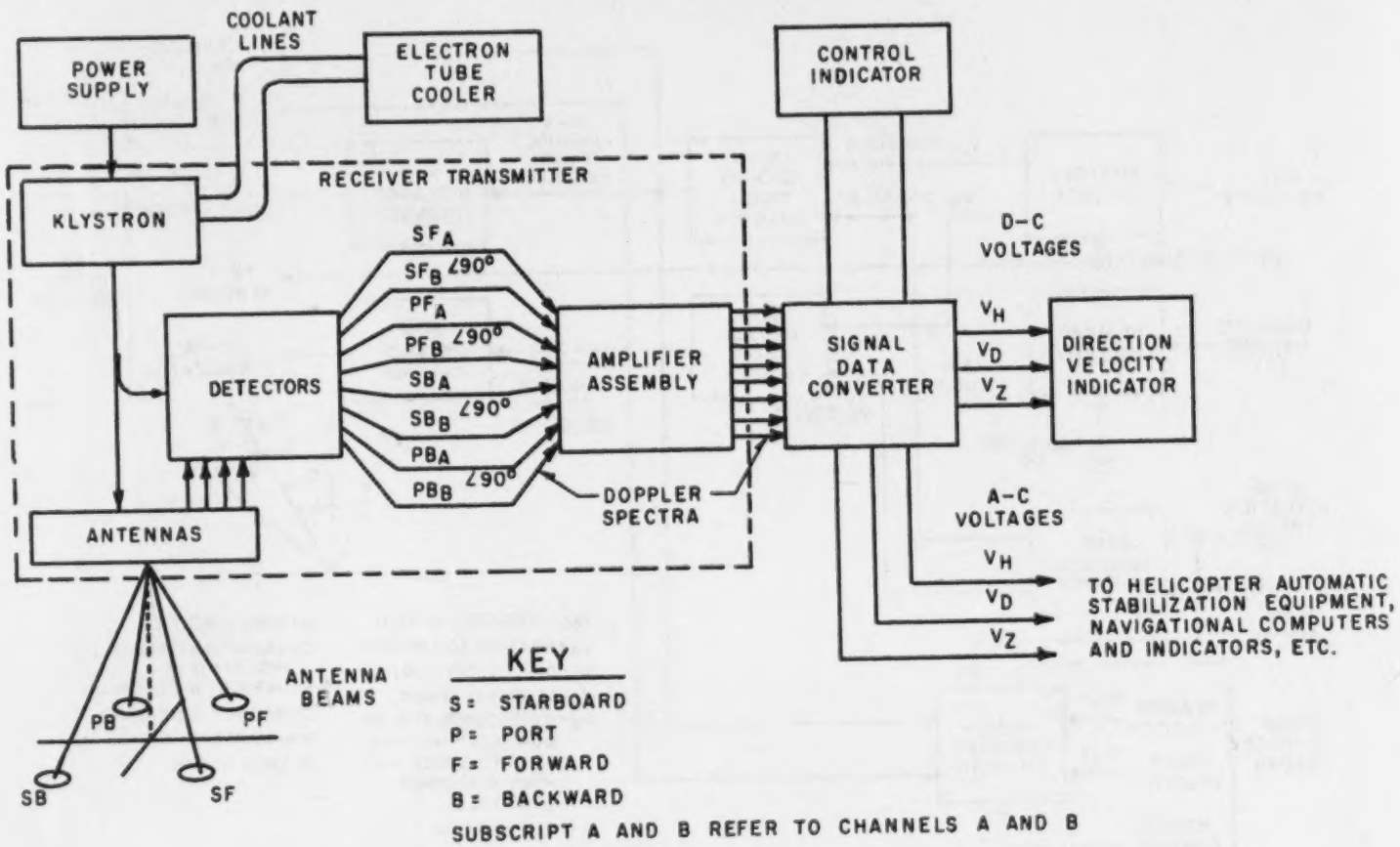

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Figure 17-31.–Functional block diagram.

provide an indication of N-S and E-W ground displacement (distance) from an initial reference point. Inputs of magnetic heading and pitot pressure are automatically and continuously supplied from aircraft instruments. By manually inserting local variation, magnetic heading is changed to true heading. Pitot pressure is converted to airspeed data. The airspeed vector, defined by airspeed and true heading, is resolved into N-S and E-W components. The wind vector is similarly resolved and combined with the components of airspeed to provide ground track data.

The wind vector may be obtained from the Doppler radar system (when operating) or from the Doppler radar's memory circuit (when not tracking), or it may be manually inserted when the Doppler radar is not operating.

The OA-1768/ASA-13

Display-Plotting Board Group OA-1768/ASA-13 is a short-range airborne navigational device used to display ground track of the aircraft and target position data. It is used in conjunction with the AN/ASA-13 or -13A and a search radar system to provide a readily available view of the overall tactical situation. It is used during ASW or AEW maneuvers to provide an accurate reference on which to base tactical decisions.

The plotting board may be used to indicate as well as record the following:

1. The position of the aircraft with respect to a preselected origin.
2. The position of a target relative to a remote reference point.
3. The present position of the aircraft and its position relative to the target.

The display, in the form of an illuminated arrow (called the crab), is continuously oriented to correspond to aircraft heading and ground track. The crab is driven by servomechanisms in response to N-S and E-W data supplied by the navigational computer.

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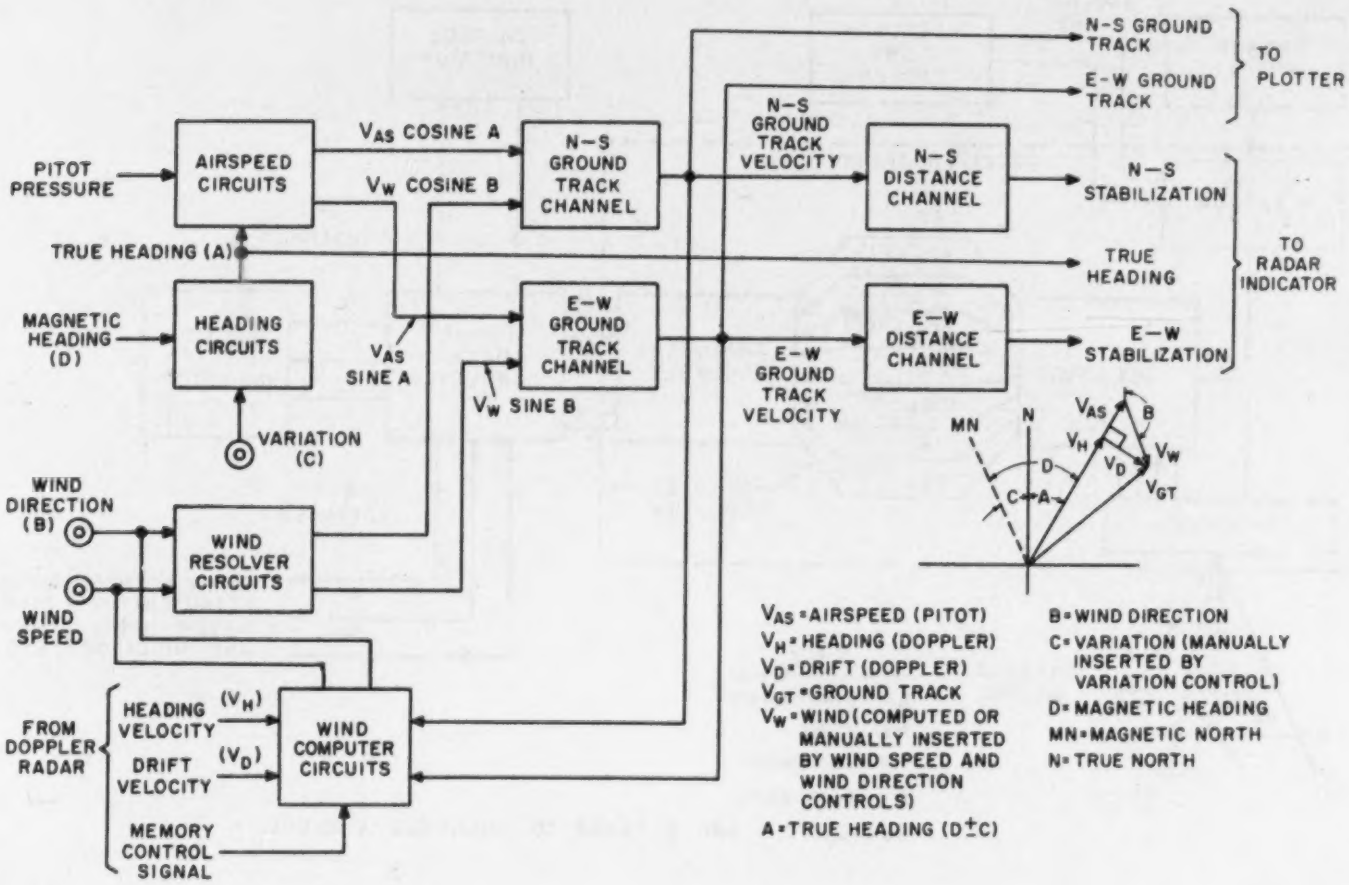

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Figure 17-32.–AN/ASA-13A, block diagram.

INERTIAL NAVIGATION

The introduction into the fleet of aircraft with inertial navigation systems (INS) has created a whole new set of problems for the maintenance technician, and emphasized some of the older problems. The use of INS has required increased utilization of gyros, accelerometers, synchros, servos, and other mechanical devices. It has also resulted in increased utilization of analog computers. When integrated with other equipment to provide a complete tactical system, it has also required the increased utilization of the digital computer. These individual topics have been discussed separately in previous chapters of this course. The remaining section of this chapter illustrates the combination of these components to form an inertial navigation system and indicates how the INS is utilized to provide data for inclusion into a complete tactical system.

BASIC THEORY

Inertial navigation is a type of dead reckoning. Equipments presently in use have very good accuracy, and this accuracy is being constantly improved through improvement of components and alinement techniques. Instead of measuring speed directly, the system derives it from measurement of the vehicle's accelerations. Two accelerometers are required–one referenced to north, the other referenced east. The accelerometers are mounted on a gyrostabilized unit (called the stable platform) to avert the introduction of errors resulting from the acceleration due to gravity.

Initial conditions are set into the system, and the navigation process is begun. The accelerometers sense accelerations in the N-S and E-W directions. These accelerations are doubly integrated with respect to time, and changes are continuously made to aircraft positional data.

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NOTE: Integration and differentiation are specific types of mathematical computations, and are discussed in Mathematics, Vol. 2, NavPers 10071-B. In general, differentiation consists of breaking a relationship into small increments, while integration consists of combining increments into a larger idea. For example, in the relationship of acceleration, velocity, and distance, acceleration is a change in velocity per unit of time. Acceleration must be integrated with time (average acceleration multiplied by the time through which the acceleration is effective) to obtain the change in velocity. "Double integration" means that the first integral (velocity) must be integrated with time to form the second integral (distance).

STABLE PLATFORM

The stable platform (fig. 17-33) is attached to the vehicle through a gimbal system which permits it to assume any orientation with respect to the vehicle. In this typical system, three gyros are used, with their sensitive axes mutually perpendicular. The X-axis is oriented north and south, the Y-axis is oriented east and west, and the Z-axis is oriented perpendicular to both the other axes and in line with the earth's radius. Positive directions along the axes are defined as north, east, and toward the center of the earth. This terminology has been well standardized in all INS equipments.

Each gyro senses angular rate of displacement about its sensitive axis and precesses in accordance with the rate of displacement (as discussed in chapter 9 of this manual). It uses a pickoff unit to detect the precession in each axis and, through a servoloop, to drive a platform control torquer to null out the sensed rate and keep the platform "space stabilized" while the vehicle maneuvers about it. An additional correction is required to stabilize the platform with relation to the earth in order to eliminate errors of gravity. The method of compensating for this error is not discussed in this manual.

Displacement

As discussed in chapter 5 of this manual, motion of a body may be caused by either of two types of forces–contact forces or field forces. It is important to note that an accelerometer cannot distinguish between these forces. Newton's second law of motion describes acceleration force as follows:

The acceleration of a body is directly proportional to the magnitude of the applied force and inversely proportional to the mass of the body; acceleration is in the direction of the applied force.

It should be understood that the accelerometer will provide no output while it is moving at a constant velocity and its sensitive axis is perpendicular to the gravitational force. If the sensitive axis should become misalined, gravitational acceleration will result in a force which displaces the mass, causing the accelerometer to give an erroneous indicationof the vehicle's acceleration.

INITIALIZATION

In inertial navigation, the term initialization is used to denote the process of bringing the system to a set of initial conditions from which it can proceed with the navigation process. These conditions include leveling the platform, alining the azimuth reference, setting the initial velocity, setting the initial position, and making any computations required to start the navigation.

Failure to achieve the proper initial conditions is disastrous to navigational accuracy. Although all inertial navigation systems must be initialized, the procedure varies according to the equipment, the type aircraft in which it is installed, and whether the system is shore based or ship based. Initialization must be accomplished with great care and accuracy, and in strict accordance with prescribed procedures. These procedures are detailed in appropriate technical manuals.

INERTIAL NAVIGATION SYSTEM AN/ASN-36

The Inertial Navigation System AN/ASN-36 (INS) measures aircraft velocities in the north-south, east-west, and vertical directions. Aircraft pitch and roll data are furnished to associated flight systems and instruments for navigational computations and displays. Magnetic heading, true heading, heading error, and magnetic variation data are also generated and supplied. Indications of aircraft latitude and local

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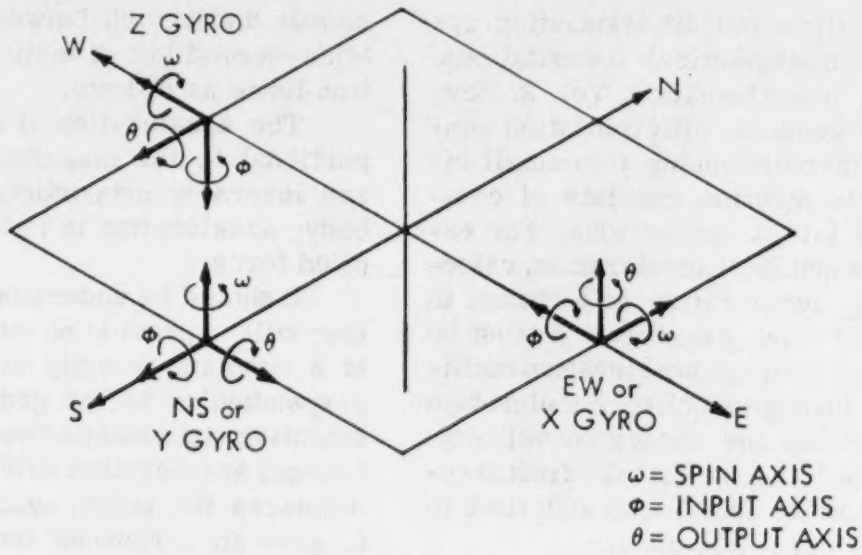

PLATFORM GYRO-VECTOR ORIENTATION

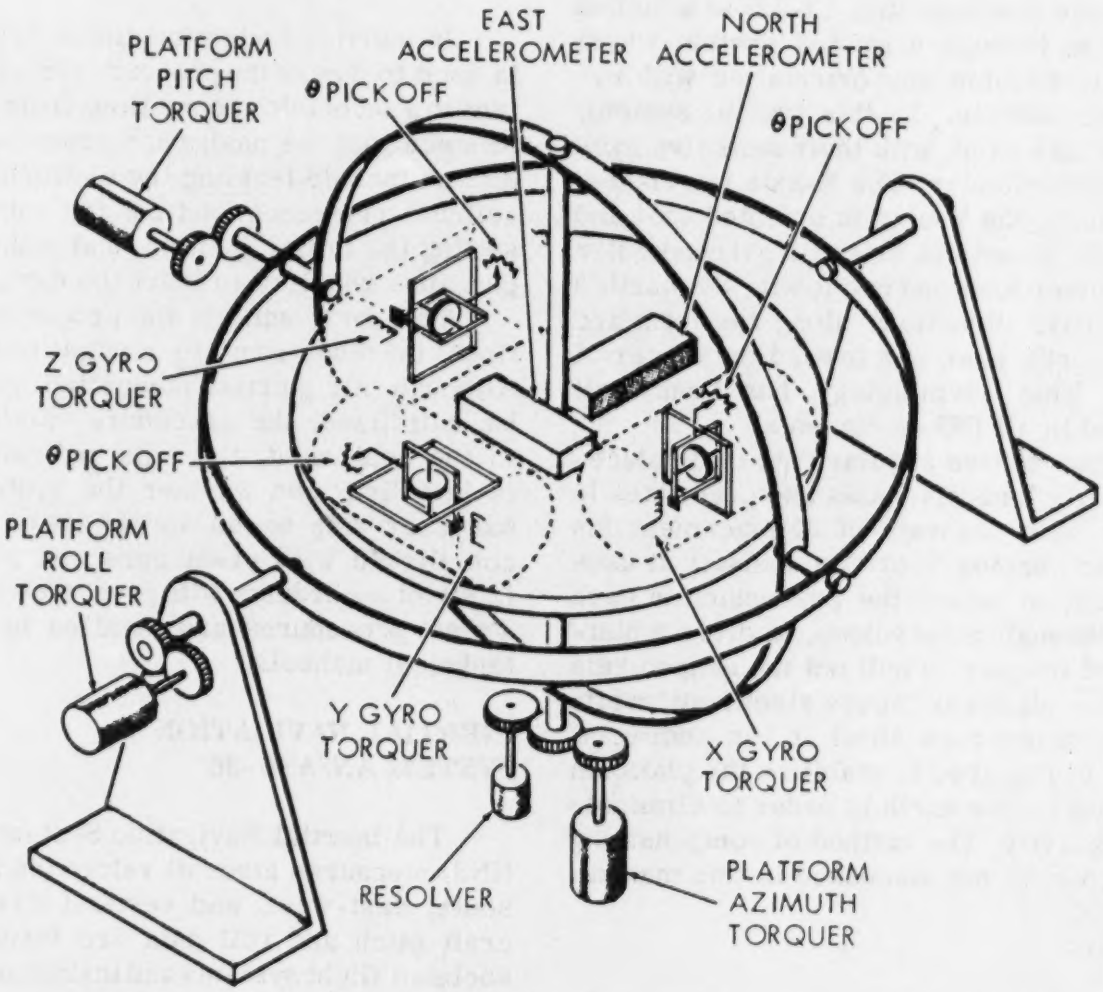

PHYSICAL ORIENTATION

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Figure 17-33.–Platform control components and gyro vector orientation.

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magnetic variation are continuously displayed by the associated computer-indicator group.

Figure 17-34 comprises a simplified system block diagram of the AN/ASN-36 INS, showing inputs, outputs, and interconnecting signal paths.

In the normal INS operating mode, the navigation problem is continuously solved. Thus, aircraft true heading attitude (pitch and roll), and velocity data are provided continuously as INS outputs. Linear velocities of the aircraft relative to earth are obtained by intergration of the linear aircraft accelerations measured by the accelerometers.

To isolate these measurements from the effects of gravity accelerations, the system accelerometers are continuously maintained alined to earth-referenced spatial coordinates. This requires that the three accelerometers are mounted at right angles on the platform, and that the platform be maintained continuously perpendicular to the local gravity and alined in azimuth to true north. In the horizontal plane, sensed values of N-S and E-W accelerations are integrated, becoming linear velocities along these axes. Since the platform is maintained stable, aircraft heading and attitude angles are referenced to the platform. Synchro transmitters provide INS electrical outputs which represent these angles.

Two gyros and three accelerometers are mounted on the platform. Each gyro has two degrees of freedom. The gyro and accelerometer outputs are amplified and applied to the platform computer where they are summed and integrated. The aircraft velocities obtained by integration are used for computing the present aircraft position in terms of latitude and longitude. They are also summed with correction signals to develop gyro torquing signals to maintain the platform level.

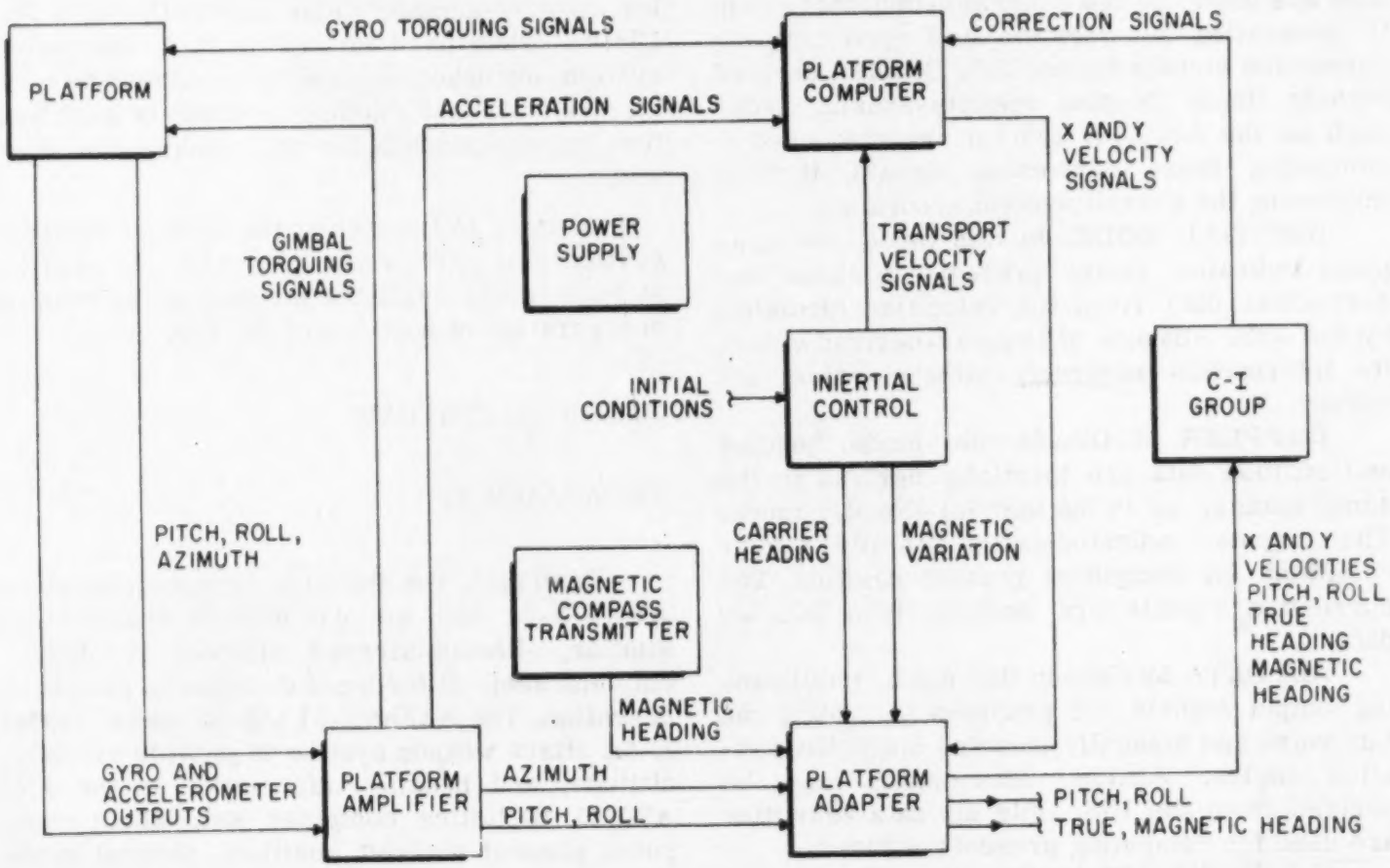

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Figure 17-34.–AN/ASN-36 INS, simplified system block diagram.

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The gyros sense displacement of the platform's coordinate axes. Gyro outputs (precession signals) are applied to three servoloops whose outputs are converted into aircraft roll, pitch, and heading error signals, which are used to maintain the platform's initial orientation.

Synchro transmitters on the platform gimbals indicate aircraft attitude in the three axes, and their signals are processed and applied to other aircraft systems.

Operating Modes

The INS operates in several navigational modes. Inertial-Doppler is the normal mode; the others are provided for tactical reasons or to permit uninterrupted operation in the event of failure of other associated equipments.

INERTIAL-DOPPLER MODE.–In this mode, the INS outputs are relative velocities along the X and Y axes, aircraft pitch and roll, true heading, and magnetic heading. The relative velocities are used by the computer-indicator group in generating acceleration and gyro torquing correction signals for the INS. Doppler-derived signals (from Doppler velocity-sensing radar such as the AN/APN 153(V)) are also used in computing these correction signals, thereby improving the overall system accuracy.

INERTIAL MODE.–In this mode, the computer-indicator group presents position and correction data from the velocities furnished by the INS. Absence of Doppler-derived velocity information adversely affects system accuracy.

DOPPLER MODE.–In this mode, heading and attitude data are inertially derived in the same manner as in the inertial-Doppler mode. The computer-indicator group uses only Doppler velocities for computing present position. The correction signals are derived from Doppler data.

AIR DATA MODE.–In this mode, true heading output signals are provided by adding the flux valve and manually inserted magnetic variation angles. Attitude information may be derived from the INS. Only air data velocities are used for computing present positions.

C-I GROUP OFF MODE.–When the computer-indicator group is turned off, acceleration and gyro torquing correction are not supplied to the INS. Acceleration correction signals are generated within the platform computer by inertially derived quantities. Although there is some sacrifice in accuracy, the INS continues to function as an attitude reference, and supplies pitch, roll, magnetic heading, and true heading data to other aircraft systems. It also computes and displays (on its control unit) accurate latitude information.

ASSOCIATED EQUIPMENTS

In AEW aircraft such as the E-2A, the AN/ASN-36 inertial navigation system comprises a portion of the overall Doppler-inertial navigation system used to provide accurate velocity, attitude, and heading data. These data are then used in the digital data processing system, the AN/ASA-27 control-indicator group, for computing the aircraft's present position.

The INS is used in conjunction with a Doppler velocity-sensing radar such as the AN/APN-153(V). When used in combination, the overall system accuracy is greatly improved by making use of the outstanding features of each system to compensate for the weaknesses of the other.

In most INS systems, the aircraft compass system and pitot pressure system are used (or at least made available for use) in the event of nonoperation of portions of the INS.

OTHER INS SYSTEMS

The AN/ASN-31

Basically, the theories of operation of the AN/ASN-31 and the AN/ASN-36 systems are similar, although aircraft missions are different, and some differences do exist in details of operation. The AN/ASN-31 INS is used in model A-6A attack weapon system to provide velocity, attitude, and heading information to the AN/ASQ-61 ballistics computer set, which computes present aircraft position. Several modules are interchangeable between the two equipments.

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The AN/ASN-31 has provisions for switching from a navigation coordinate system referenced to true north to a system referenced to grid north when the aircraft is flying inside the polar region (inside 70° latitude north or south). Grid north is a line parallel to the line of longitude which was used for initial INS alinement. The AN/ASN-36 does not possess this feature.

The LN-12

This INS is a small, compact, lightweight system used in the F-4B high speed intercept fighter. It is used in conjunction with the AN/ASN-46 navigation computer set, which computes the great circle (shortest) route to the target or base using spherical trigonometry.

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CHAPTER 18

AIRBORNE RADAR

The term radar is used to describe electronic systems which are used to locate airborne or surface targets. A review of the introduction to radar in Basic Electronics, NavPers 10087-B, reveals that the word RADAR is an abbreviation for RAdio Detection and Ranging. In addition to indicating the presence of targets, radar may also be used to determine bearing, distance, elevation, speed, relative size, and identification. The accuracy of each use of radar is determined by several characteristics.

CHARACTERISTICS OF RADAR

RANGE

Radar measurement of range or distance is possible because of the fact that radiated RF energy travels through space in a straight line at a constant velocity. The straight path and constant speed are changed slightly when the RF waves enter the atmosphere and will vary with atmospheric and weather conditions. (This is discussed later in this chapter.)

Velocity

RF energy travels at the speed of light, about 186,000 statute miles (162,000 nautical miles) per second. This is 300,000,000 meters per second in the metric system. Radar timing is usually expressed in microseconds, and the velocity of radar waves is often given as 328 yards of 984 feet per microsecond.

One nautical mile is equal to approximately 6,080 feet. This means that it takes RF energy approximately 6.18 microseconds to travel 1 mile.

Range Measurement

The pulse type radar set determines range by measuring the elapsed time during which the emitted pulse travels to the target and returns. Since two-way travel is involved, a total time of 12.36 microseconds per nautical mile will elapse between the start of the pulse from the antenna and its return from a target. The range in nautical miles of any object can be found by measuring the time elapsing during a round trip of the radar pulse (in microseconds) and dividing this quantity by 12.36. In equation form, this is:

$$\text{Range} = \frac{\text{elapsed time}}{12.36}$$

MINIMUM RANGE.–The minimum range capability of a radar is determined by the time of the transmitter pulse, or pulse width (PW), plus the recovery time of the duplexer and the receiver. (For purposes of this explanation, recovery time may be considered as the time required for the receiver to become operative after the transmitter has fired.)

The minimum range in yards, at which a target can be detected, is equal to the PW plus the recovery time, divided by 2 and multiplied by 328 yards (328 yd/μsec.).
Stated in formula:

$$\text{Minimum range} = \frac{\text{PW + recovery time}}{2} \times 328 \text{ yd}$$

$$= (\text{PW + recovery time}) \times 164 \text{ yd}$$

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3. How many strokes may be used to draw the sides of the arrowhead?

4. Is there a standard method of drawing arrowheads?

5. How many different sizes of arrowheads would you use on a drawing?

ASSIGNMENT:

Draw a $\frac{1}{2}$-inch border all around the 8" x 11" buff drawing paper. Draw the practice plate shown below, being sure to use both open and solid types of arrowheads as shown.

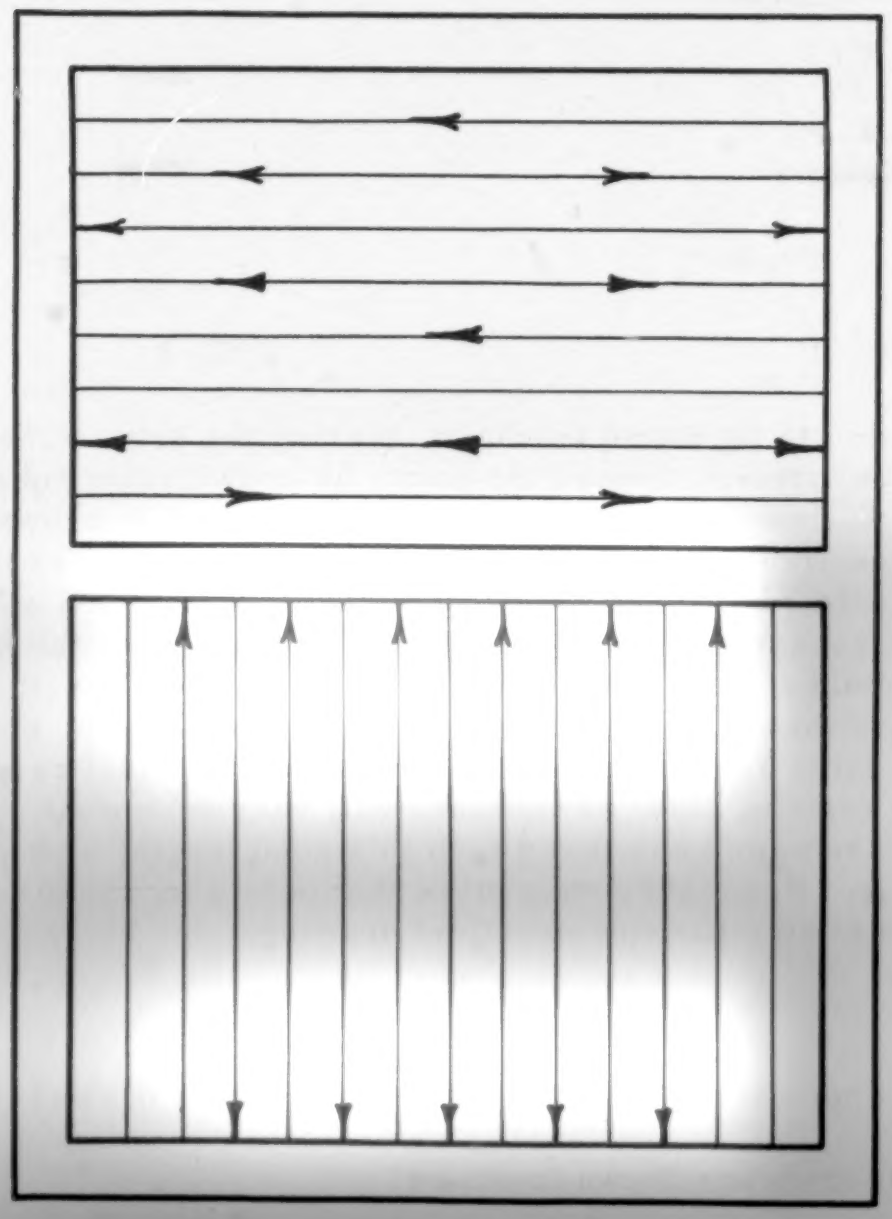

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Targets closer than this range are not seen because the receiver is inoperative for the period of time necessary for a signal to travel this distance.

An increase in recovery time (bad TR tube in the duplexer) not only increases the minimum range, but also decreases the receiver sensitivity.

MAXIMUM RANGE.–The higher the frequency of a radar wave, the greater the attenuation (decrease in signal strength) due to weather effect. Gases and water vapor that make up the atmosphere absorb energy from the radiated pulse. Frequencies below 3,000 MHz are not appreciably attenuated under normal conditions, while frequencies above 10,000 MHz are highly attenuated. Attenuation of the transmitted pulse results in a decrease in the ability of the radar to produce usable echoes at long ranges. A usable echo may be defined roughly as the smallest signal which a receiver-indicator system is able to detect, amplify, and present so that the observer can visually distinguish it from the noise signals on the CRT.

At lower frequencies, higher transmitter power can be developed more easily. Also, there is greater refraction and diffraction (bending of the waves). Lower radar frequencies are therefore superior for extremely long-range search radar. The effect of atmospheric conditions on radar signals is discussed in more detail later in this chapter.

The maximum range of any radar depends upon transmitted power, pulse repetition frequency, and receiver sensitivity. The peak power of the transmitted pulse determines the maximum range that the pulse can travel to a target and return in usable echo strength. Sufficient time must be allowed between transmitted pulses for an echo to return from a target located at the maximum range (established by design) of the system.

The maximum range is sometimes extended and vertical coverage reduced by the trapping of the radar beam in a DUCT. A duct is created by abnormal weather conditions; further coverage on ducts is given later in this chapter.

AZIMUTH

The azimuth (bearing) of a target is its clockwise angular displacement in the horizontal plane with respect to true north as distinguished from magnetic north. This angle may be measured with respect to the heading of an aircraft containing the radar set; in this case, it is called relative bearing. The angle may be measured from true north, giving true bearing, if the installation contains azimuth stabilization equipment. The angle is measured by utilizing the directional characteristics of an unidirectional antenna, and determining the position of the antenna when the strongest echo is received from the target.

Radar antennas are constructed of radiating elements and reflectors, and some types use a director element to produce a narrow beam of energy in one direction. The pattern produced in this manner permits the beaming of maximum energy in a desired direction. The transmitting pattern of an antenna system is also its receiving pattern. An antenna can therefore be used to transmit energy, to receive echoes (reflected energy), or both.

RESOLUTION

The range resolution of a radar is the minimum resolvable separation in range of two targets of the same bearing. Range resolution is a function of the width of the transmitted pulse, the type and size of the targets, and the characteristics of the receiver and indicator. With a well-designed radar, sharply defined targets on the same bearing should be resolved if their ranges differ by the distance the pulse travels in one-half of the time of the pulse width (164 yards per microsecond of PW). If a radar set has a pulse width of 5 microseconds, the targets would have to be separated by more than 820 yards before they would appear as two pips on the scope.

The azimuth resolution is the ability to separate targets at the same range but on different bearings, and is a function of the antenna beam width and the range of the targets. Antenna beam width may be defined as the angular distance between the half-power points of an antenna's radiation pattern. (Half-power points are those points at which the transmitted power is one-half

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the maximum value of energy that is radiated along the lobe center.) Two targets at the same range, in order to be resolved as being two targets instead of one, must be separated by at least one beam width.

Strong multiple targets appearing as one target can often be resolved in azimuth and bearing by reducing the gain of the receiver until only the strongest portions of the echoes appear on the CRT.

ACCURACY

The accuracy of a radar is a measure of its ability to determine the correct range and bearing of a target. The degree of accuracy in azimuth is determined by the effective beam width and is improved as the beam width is narrowed. On a PPI scope the echo begins to appear when energy in the edge of the beam first strikes the target. The echo is strongest as the axis of the beam crosses the target, but the echo continues to appear on the scope as long as any part of the beam strikes the target. The target appears wider on the PPI than it actually is, and the relative accuracy of the presentation depends in a large measure on the width of the radar beam and range to the target.

The true range of a target is the actual distance between the target and the radar set (fig. 18-1). In airborne radar, the true range is often called SLANT RANGE. The term slant range is used to indicate that the range measurement includes the effect of difference in altitude.

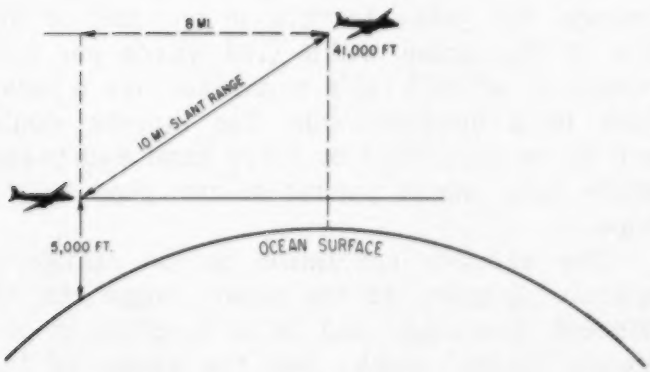

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Figure 18-1.–Slant range versus horizontal range.

The horizontal range of a target is a straight line distance (fig. 18-1) along an imaginary arc parallel to the earth's surface. This concept is important to the radar observer because an airborne target, or the observer's aircraft, need only to travel the distance represented by its horizontal range to reach a position directly over its target. For example, an aircraft at a slant or true range of 10 miles, and at an altitude of 36,000 feet above the radar observer's aircraft, possesses a horizontal range of only 8 miles.

The timing sequence of a radar range indicating device starts at the same instant that the transmitter starts operation. Therefore, with airborne surface-search radar, the first targets seen are those directly beneath the aircraft. However, on the PPI scope, there is a hole in the middle of the picture (fig. 18-2), with a minimum radius corresponding to the altitude of the aircraft. In some systems the radius of the altitude ring will vary as the lower limit of the vertical radiation pattern is increased by raising the tilt of the radar antenna. Objects which are actually directly beneath the aircraft appear on the scope at a distance equal to the distance between the aircraft and ground. For greater accuracy of surface ranges, the relationship between the range of the target and the range of the altitude ring must be considered.

FACTORS AFFECTING RADAR

There are many factors, or elements (including atmospheric conditions), that affect radar performance. One of the principal factors is maintenance. The ability to keep the equipment operating at peak efficiency will influence the overall capabilities and limitations of the radar.

Another important factor is the radar operator's knowledge of the equipment. He must know the maximum and minimum ranges at which he can expect to pick up various targets, range and bearing accuracy of the gear, and range and bearing resolution. If the radar is a height finder, the operator must know the altitude determination accuracy and the altitude resolution. Information on these factors is con-

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tained in the Operation and Service Instruction Manual for each radar.

Peak Power

The peak power of a radar is its useful power. Range capabilities of the radar will increase with an increase in peak power. Doubling the peak power (a 3-db gain) will increase the range capabilities by about 25 percent.

Pulse Width

The longer the pulse width, the greater the range capabilities of the radar. This is due to the greater amount of RF energy sent out in each pulse. In addition, consider the fact that narrow bandpass receivers may be used, thus reducing noise level. An increase in pulse width, however, reduces the range resolution capabilities of the system.

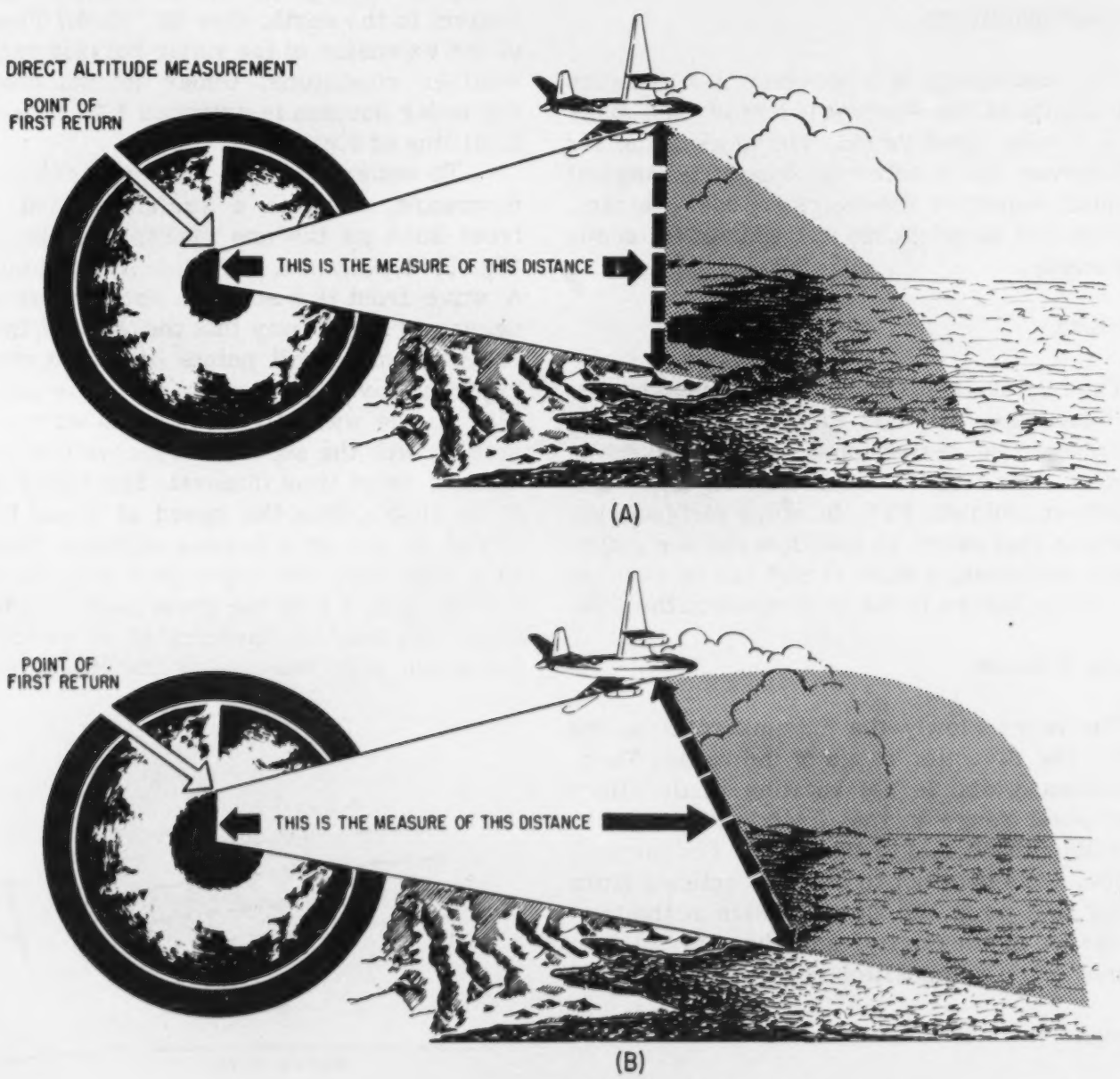

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Figure 18-2.–Effect of altitude on radar. (A) Radar tilted down; (B) radar with zero tilt.

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Beam Width

The beam width is specified in degrees between the half-power points in the radiation pattern.

The effective beam width of a radar is not a constant quantity because it is affected by the receiver gain (sensitivity) and the size and range of the target.

The narrower the beam width, the greater the concentration of energy. The more concentrated the beam, the greater the range capabilities for a given amount of transmitted power.

Receiver Sensitivity

The sensitivity of a receiver is a measure of the ability of the receiver to amplify and make usable a very weak signal. The more sensitive the receiver, the greater the detection range of the radar. Sensitive receivers are easier to jam, however, and interference will show on the scope more easily.

Indicators

The choice of the type of scope used to display weak pips will add to the capabilities of the radar. The deflection-modulated A-scope is more sensitive to weak echoes than the intensity-modulated PPI. In some airborne installations that carry an oscilloscope for maintenance purposes, a weak target can be seen on the A-scope before it can be detected on the PPI.

Antenna Rotation

The more slowly the antenna rotates, the greater the detection range of the radar. Thus, an antenna which is not rotating would afford the greatest range in the direction it is pointing, within the limits of the radar. For tactical reasons, it is best not to stop the antenna from rotating and point the antenna beam at the target, except momentarily, and then only to gain information on composition of a target.

Atmospheric Conditions

The paths followed by microwave and VHF signals, whether direct or reflected, usually are slightly curved. The signals travel through the atmosphere at speeds that depend on temperature, atmospheric pressure, and the amount of water vapor present in the atmosphere. Generally, the higher the temperature the faster the signal; the lower the atmospheric pressure, the faster the signal; and the less the amount of water vapor present, the faster the signal. The net result of these influences is that the signal speed changes with altitude and, under normal atmospheric conditions, the variation is a small and uniform increase in the speed of the signal with increasing altitude. This causes all paths to curve slightly downward, as shown in figure 18-3, extending the radar horizon beyond a tangent to the earth. (See fig. 18-4.) The amount of the extension of the radar horizon varies with weather conditions. Under normal conditions, the radar horizon is extended 1.25 times the optical line of sight.

To understand the reason for this curving downward, imagine a surface called a wave front such as the one represented by line AB (fig. 18-3), where A is higher in altitude than B. A wave front is a surface, not necessarily flat, chosen in such a way that the phase of the signal is the same at all points on the surface. The signal always travels in a direction perpendicular to the wave front. Now, as wave front AB moves with the signal, it reaches position A'B' after a short time interval. The speed at A and A' is faster than the speed at B and B', since A and A' are at a greater altitude. Therefore, in a given time, the upper part of the wave front moves farther than the lower part, and the wave front tips slightly forward as it moves along. Since the path followed by the signal is always

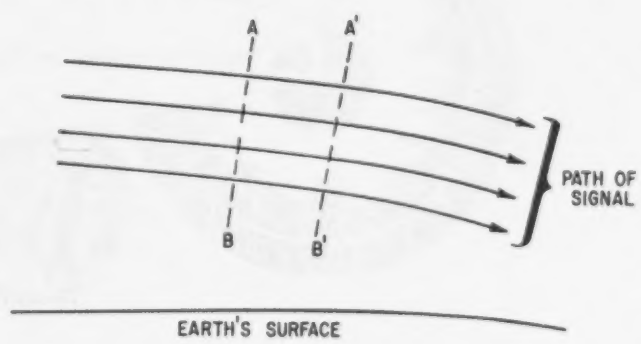

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Figure 18-3.–Microwave path.

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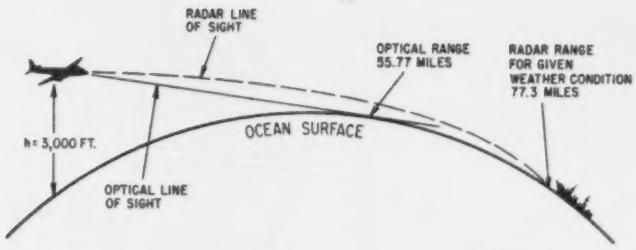

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Figure 18-4.–Extension of radar horizon.

perpendicular to the wave front, it curves slightly downward as the wave front tips.

The bending of radio or radar waves due to a change in the density of the medium through which they are passing is termed refraction. The measure of the bending that occurs is indicated by the difference in index of refraction from one substance to another. The density of the atmosphere changes at a gradual and continuous rate; therefore, the index of refraction changes gradually with increased height.

The temperature and the moisture content of the atmosphere normally decrease with height above the surface of the earth. Under certain conditions, the temperature may first increase with height and then begin to decrease. Such a situation is called temperature inversion. More important, the moisture content may decrease more rapidly with height just above the sea. This effect is called moisture lapse.

Either temperature inversion or moisture lapse, alone or in combination, may produce a great change in the index of refraction of the lowest few hundred feet of the atmosphere, resulting in greater bending of the radar waves. This may greatly extend or reduce the radar horizon, depending on the direction in which the radar waves are bent. The height of the radar antenna with respect to the DUCT formed by this strange occurrence is of much importance.

Although duct conditions can happen any place in the world, the climate and weather in some areas make their occurrence more likely. In some parts of the world, particularly those having a monsoonal climate, variation in the degree of duct formation is mainly seasonal, and great changes from day to day may not take place. In other parts of the world, especially those in which low barometric pressure areas recur often, the extent of nonstandard propagation conditions varies considerably from day to day, even during the season when they are most common.

Sometimes, for various reasons in different areas, some upper level air becomes heated and often partially dried out. This effect is associated with clear weather rather than with storms. The temperature inversion and a layer of very dry air, which spreads out horizontally, create conditions favorable to the formation of a sky duct. The top of a duct can often be recognized by a thin layer of haze. The haze is a result of the moisture in the warm air condensing as the air starts to get colder.

The height and width of ducts can be predicted by the meteorological office. This is done by plotting temperature variations versus height. Figure 18-5 shows a standard variation chart compared with charts of nonstandard conditions.

TYPES OF AIRBORNE RADAR

The fundamental principles of all radar are similar; however, there are two basic types of radar systems–pulse and CW (continuous wave). FM radar is a type of CW radar. The Doppler principle can be used in both CW and pulse radars. The distinction between CW and pulse radar becomes less clear in systems where a combination of pulse and CW techniques is used. In general, a radar system is considered a pulse system when the RF energy is emitted less than 10 percent of the time. Most pulse radars emit energy less than 0.1 percent of the time. When the radar emits energy more than 10 percent of the time, it is classified as a CW radar system.

Most of the emphasis in radar development has been on pulse radar systems, primarily because of the rate at which information is collected, as compared to CW radar. However, there are specific applications in which CW radar performs more efficiently than pulse radar; for example, working to zero range and reduction of ground clutter.

Radar is a powerful aid to the aircraft, and the aircraft is an aid to the radar. The aircraft supplies an elevated platform to the radar, thereby extending the effective range at which objects can be detected. The application of radar to airborne operations has been most successful

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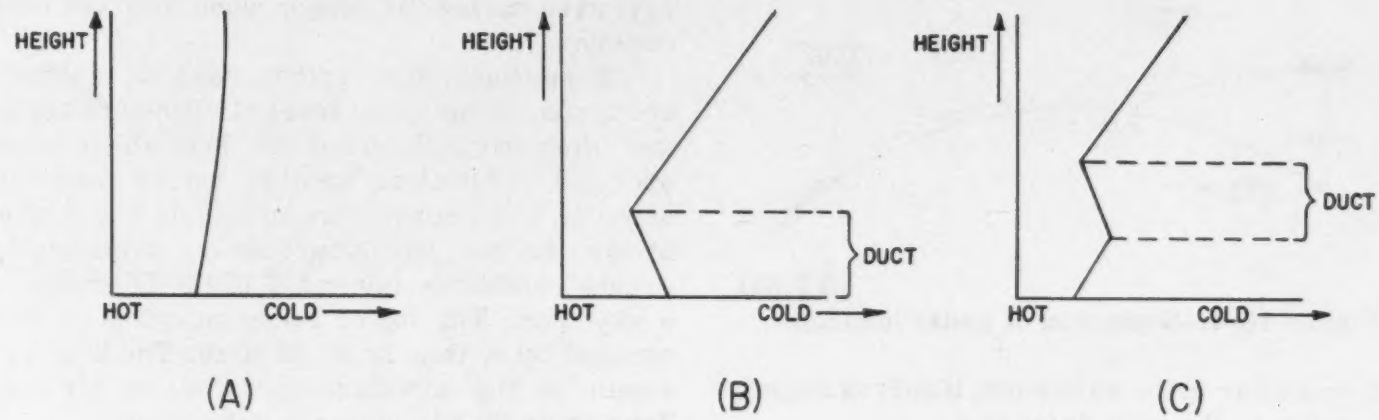

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Figure 18-5.–Height versus temperature. (A) Standard variation; (B) surface duct; (C) sky duct.

and airborne radar is an indispensable part of the Navy's fighting team. In naval aircraft, radar has many different uses, each requiring a different application of the fundamental principles.

SEARCH

Search radar, the basic type used in many radar-equipped aircraft, shows the range and azimuth of targets such as ships, islands, coastlines, and other aircraft within the reach of its beam. Search radar is an effective aid to air navigation since it exhibits land masses and storm clouds on the radar screen. In larger aircraft the IFF interrogation antenna is mounted on the search radar antenna in order to obtain IFF target bearing and range, which identifies ships and aircraft as friendly or hostile by means of coded replies.

Airborne search radar is generally classified as medium range and operates in either S-band or X-band. Figure 18-6 indicates the relative positions of the S-band and the X-band. The pulse width utilized by the radar is variable, depending on the range selected: on shorter ranges a narrow pulse width (0.5μsec.) is used; longer ranges may use a pulse width up to 5μ sec. The narrow pulse width permits a short

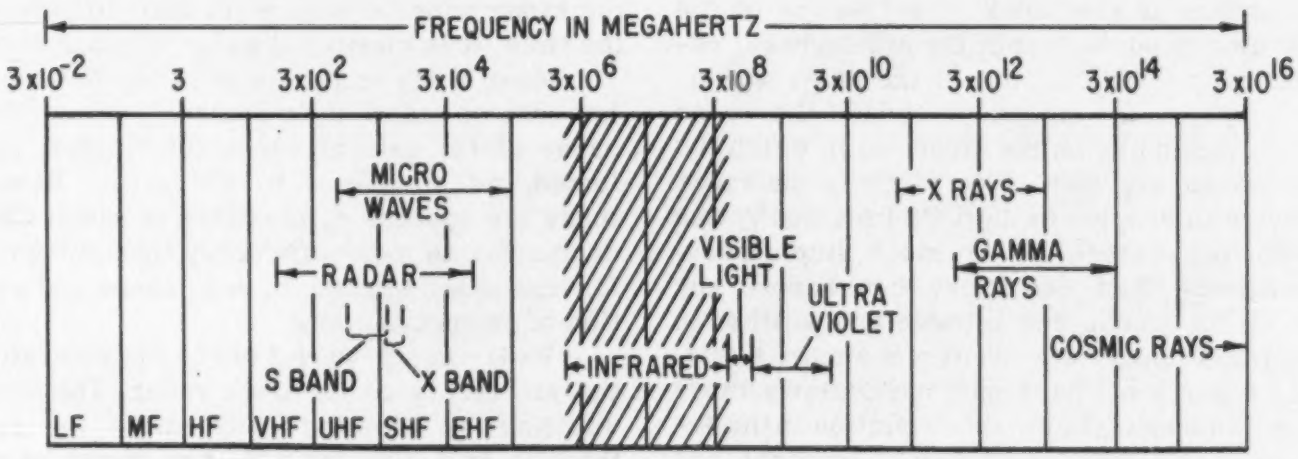

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Figure 18-6.–Electromagnetic energy spectrum.

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minimum range, a high degree of range resolution, and greater range accuracy. The wide pulse width is used to aid in detecting small targets at greater distances.

The pulse repetition frequency (PRF) of the radar also usually varies with the ranges used– a high PRF is used on the shorter ranges for better target illumination, and a low PRF is used for obtaining greater maximum ranges.

HEIGHT FINDING

Height-finding radar is used to determine the altitude of a target by placing a narrow vertical beam on the target and measuring the position angle. The position angle is combined with the slant range to compute the altitude of the target above the horizontal. In airborne use the computed altitude of the target may be either the height above your aircraft or the height above ground. For computation of the target's altitude above ground, the altitude of your aircraft must be set in.

Another type of height-finding radar is the absolute altimeter. The absolute altimeter (radar altimeter) measures the distance from the aircraft to the ground or objects below. This is done by transmitting RF energy down, and receiving the reflected energy at the aircraft. In FM equipment the altitude is determined by the frequency difference between the reflected signal and the transmitter signal. In pulse equipment the altitude is determined by measuring the time required for the transmitted pulse to hit the ground and return. The indicating instrument will indicate the true altitude of the aircraft, which is its height above water, mountains, buildings, or other objects on the surface of the earth.

FIRE CONTROL

There are three basic types of fire control systems found in naval aviation. They are the day intercept system (visual), the all-weather intercept system, and the missile control system. (NOTE: For purpose of clarity, missile control systems are covered separately.) The day intercept system currently uses either of two types of automatic range only (ARO) radar.

One type uses a fixed antenna and furnishes range information to a computer group. The pilot, with the aid of the optical sight, aims his aircraft at the target. The radar then locks on the target and furnishes range information to the computer. Range may also be indicated on a meter or range indicator in the cockpit.

Another type of ARO radar has an antenna that scans in azimuth and indicates the heading and range to a target on a CRT. It also displays an artificial-horizon bar to aid the pilot in flying the aircraft. The search mode of this type radar provides range and direction information for use in maneuvering the aircraft to within visual attack range. Once visual contact is made, the antenna is locked in the dead ahead position and the attack is completed, using the optical system with the radar supplying range and range rate information to the computer.

The all-weather firecontrol system uses radar rather than optical means to search out a target. Once a target is found and selected, the radar tracks the target in range, elevation, and azimuth, and presents steering information on the flight indicator screen (CRT). This equipment may also provide a surface-search mode of operation. In the all-weather mode of operation, the computed lead angles are presented on the CRT. In the visual mode, the radar antenna is pointed dead ahead and the set functions as an ARO radar.

Missile Control

The radar used in the missile control system is essentially the same as that used in the all-weather system with the addition of a CW radar group. The CW radar is used to illuminate the target and usually shares the same antenna with the pulse radar. Since modern missiles utilizing CW radar carry their own computing circuits and determine their own flightpath, the CW radar can be a relatively simple system. In use, the target is detected and tracked with the pulse radar, while the CW radar illuminates the target with CW energy. The missile homes on this reflected CW energy.

NAVIGATION

Doppler navigational radar automatically and continuously computes and displays groundspeed and drift angle of an aircraft in flight without the aid of ground stations, wind estimates, or true airspeed data. This is done by

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utilizing auxiliary inputs from an altitude rate sensor and from the aircraft's vertical reference system. The radar section does not sense range and bearing (direction) as ordinary search radar does. Instead, it is speed-conscious and drift-conscious. It employs continuous carrier wave transmission energy and determines the forward and lateral velocity components of the aircraft by utilizing the principle known as Doppler effect.

The Doppler effect, or frequency change of a signal, can be explained in terms of an approaching and receding audio sound emitter. As shown in figure 18-7 (A), the sound emitter is on a moving ambulance and the receiver is the ear of a stationary listener. Assume that the frequency of the siren is 1,000 Hz.

Notice the spacing between the waves from the stationary emitter, as illustrated in figure 18-7 (B). If the emitter and listener were standing still, then 1,000 waves of sound energy would reach the listener in one second.

In figure 18-7 (C), the emitter is moving toward the listener (closing). The emitter moves a little closer to the listener between successive waves of energy, so each wave reaches the listener sooner than it would if the emitter were stationary. This means that the listener hears more than 1,000 waves of energy in one second, and consequently the sound is higher in pitch.

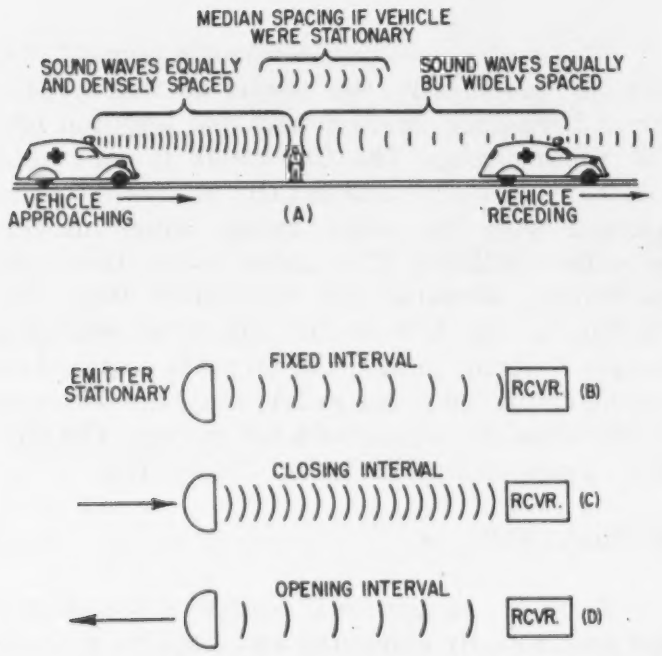

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Figure 18-7.–Doppler effect with sound waves.

The reverse is true in figure 18-7 (D). The emitter is moving away (opening), so the interval between successive waves is greater. Since the listener hears less than 1,000 waves in one second, the frequency of the emitter seems lower than it actually is.

Doppler radar employs the frequency change phenomenon just described, except in the RF frefrequency range.

The radar emits CW energy at one frequency, and these waves of energy strike the target and are reflected. Energy waves returning from the target are spaced differently than the waves striking the target. A closing target moves a little closer to the radar between successive waves, and reflects the waves sooner than if it were stationary. The closer-spaced waves mean that the frequency has increased slightly.

If the target moves toward the radar or if the radar moves toward the target faster, the waves of energy will be even closer together, causing a greater frequency change. The faster the closing speed, the higher will be the frequency of the returning waves.

The receiver of the Doppler radar system has two signal inputs–one from the transmitter, and one from the receiver antenna. The input signal from the transmitter is at all times the same frequency as the signal being radiated; the receiver antenna signal frequency will vary with the relative speed of the target and the radar. The two frequencies are compared in the receiver, and the difference frequency is a direct indication of the closing or opening speed of the target.

The Doppler effect is present any time there is relative motion (opening or closing distance) between the radar and the target. Therefore, the radar could be moving toward a stationary target and the effect would be the same as if a target moved toward a stationary radar.

One type of airborne Doppler navigation equipment is an all-weather, self-contained system. It radiates two narrow, fixed beams of CW energy downward, outward, and rearward (thus the ground becomes an opening target) from the aircraft's longitudinal axis. The ground-

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returned energy is intercepted by the receiver and compared with the outgoing transmitter energy. The difference (due to the Doppler effect) is used to develop velocity component information for use in the computing section. The velocity component, with the aid of roll-angle, pitch-angle, altitude, and altitude-rate data furnished from auxiliary equipment, derives the ground-speed and drift angle in the computing section.

The groundspeed and drift angle information is continuously displayed on an indicating dial. It is also made available as a continuous synchro output signal for tie-in with other navigational equipment–position computers, bomb directors, and integrated flight director systems.

RADAR CIRCUIT THEORY

Radar equipments vary considerably in detail, depending on the amount of information and the accuracy of the data which they are required to supply. However, all radar systems using pulse modulation work on essentially the same principles, and their basic operations depend on the same kinds of major components. A basic radar system is shown in simplified block diagram form in figure 18-8.

SYNCHRONIZER

The synchronizer is the timing unit which is the heart of the entire system. It produces trigger pulses which control and coordinate the circuits of the system so that each operates at the correct time. In most systems it governs the number of pulses the transmitter produces in each second. It coordinates the sweep voltage (or current) to the indicator tube with the firing of the transmitter, and contains provisions for delaying the beginning of the sweep to give special types of display (such as open center and target discrimination operation). The synchronizer contains the circuits which generate the range marker voltages and the trigger pulses which unblank the indicator tube when the trace starts to appear on the screen. Pulses supplied by the synchronizer are also used to indirectly control the associated equipment used with the search system.

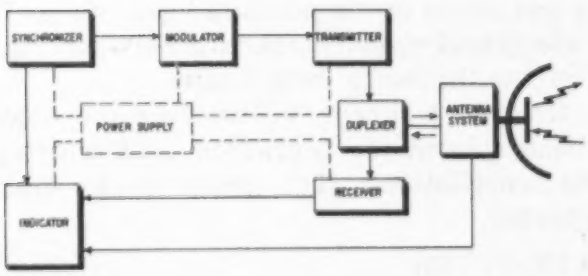

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Figure 18-8.–Block diagram of basic airborne radar system.

In some equipments the master trigger is synchronized with the aircraft's 400 Hz a-c power. The 115-volt a-c power input to the synchronizer (fig. 18-9) is connected to peaking choke L1. The output from the choke is a positive and a negative pulse at line frequency or 380 Hz to 420 Hz. The choke output is fed to a biased cathode follower, V1A. This tube is biased below cutoff; therefore, only the positive pulse is applied to the input of blocking oscillator V1B. The output (PRF) from the blocking oscillator is the same as the powerline frequency.

Eight output triggers are developed from the master trigger. Two of the output triggers are coincident with the master trigger. The other six triggers are delayed in delay lines. Taps are provided on the synchronizer delay lines for the following delays: one fixed at 15μsec., another fixed at 24 μ sec., two fixed at 30μ sec., and two jointly variable from 15 to 32μ sec. The variable delay is provided by switches and a relay. The relay is controlled by a remote switch at the operator's station and provides the modulator with a choice of two trigger delays for sonobuoy or search operation. This variable delay is adjustable by two coarse and two fine controls on the front of the synchronizer. Cathode followers provided low-impedance outputs for the triggers. The block diagram in figure 18-10 illustrates the sequence and use of the output triggers.

Some radar synchronizers utilize a multivibrator for the master oscillator. They normally contain switching provisions for changing the output frequency (PRF).

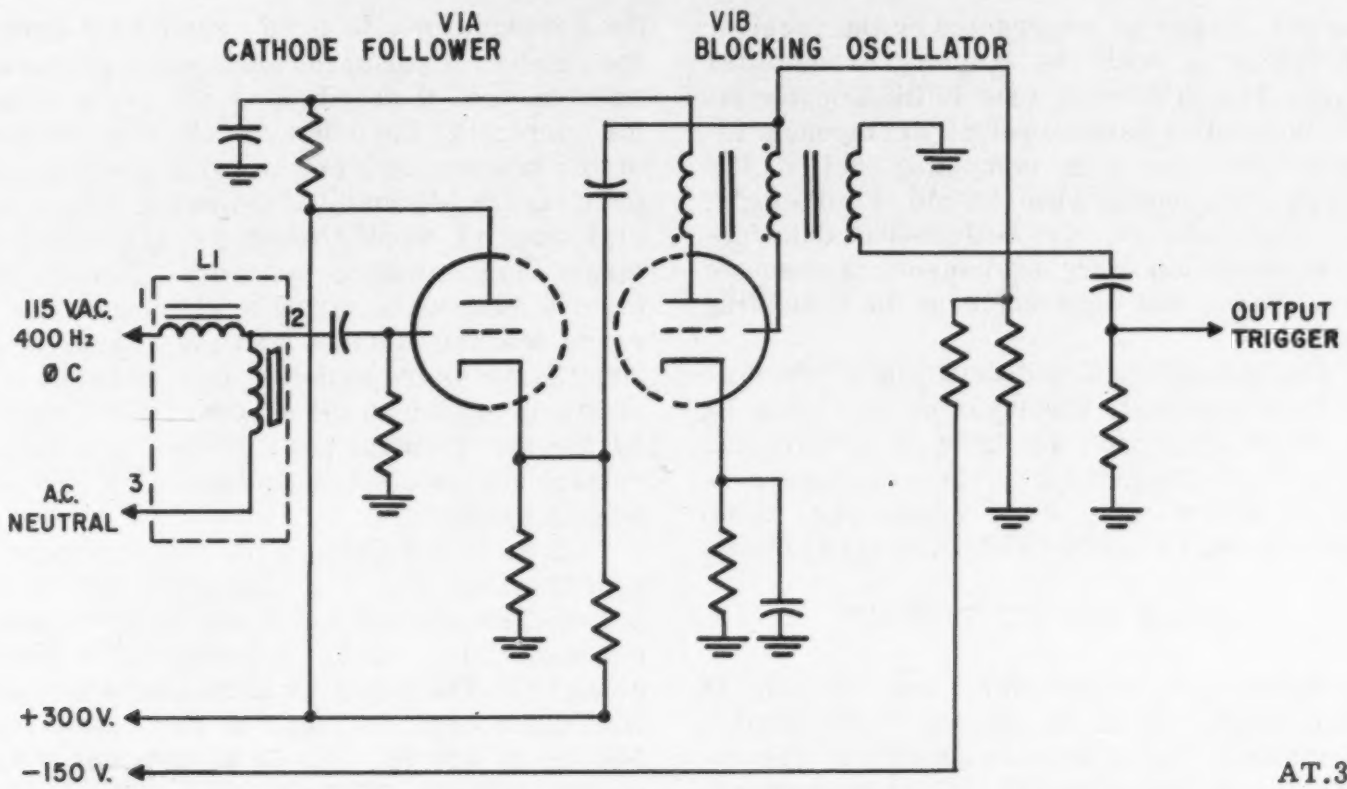

Figure 18-9.–Master trigger circuit.

MODULATOR

The modulator controls the operation of the transmitter by applying high-voltage pulses of rectangular shape. The pulses are usually supplied by charging a section of artificial transmission line in the modulator to a high potential during the interval between pulses. The modulator action begins when a trigger pulse from the synchronizer is applied to an electronic switch tube in the modulator unit. The switch tube terminates the artificial line and causes it to discharge a rectangular pulse through the transmitter tube. The length of time during which energy is transmitted is called the pulse width. In airborne applications, the modulator unit is usually enclosed in a container and operated under a constant pressure to prevent high-voltage arcing.

Figure 18-11 illustrates a block diagram of a modulator and high-voltage power supply.

Three-phase, 400 Hz power is supplied to the modulator through a variable power transformer (autotransformer or Variac). This transformer controls the amplitude of the high-voltage pulse to the magnetron by controlling the input voltage to the high-voltage rectifier.

The output from the high-voltage rectifier is applied through charging choke L1 to the series-resonant pulse forming network (PFN), Z1. Charging diodes hold the peak voltage on the PFN after the charge cycle is over.

To discharge the PFN, the thyratron switch tube is ionized by a trigger from the synchronizer. When the thyratron is ionized, it acts as a shorting switch on the input terminal of the PFN. The PFN is discharged through the primary of a transformer in the receiver-transmitter.

Inverse diode CR6 shunts the pulse forming network to damp out switching oscillations, and to shunt to ground any negative voltage appearing on the input terminal of the PFN caused by the magnetron or by waveguide arcing.

Blocking oscillator V2 increases the amplitude and shape of the positive input trigger from the electrical synchronizer for reliable triggering of the thyratron switch tube.

Cathode follower V3 isolates the blocking oscillator from the thyratron grid, which prevents oscillations that could cause multiple triggering.

TRANSMITTER

The transmitter consists principally of a magnetron which oscillates at extremely high frequency throughout the interval of the pulse applied by the modulator. The magnetron produces the electromagnetic energy which is

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UNIT VI - DIMENSIONING

Drawing Figures — Lesson 2

OBJECTIVE: To learn how to properly draw and place figures including fractions.

$2\frac{1}{2}$ $\underbrace{2\frac{1}{2}\ 2\frac{1}{2}\ 2\,1/2\ 2\ \frac{1}{2}}_{\text{Avoid}}$

Correct

FIG. 1

RELATED INFORMATION:

Common fractions should be drawn with the fraction bar parallel to the guide lines of the figure, and with the numerator and denominator each somewhat smaller than the height of the whole number, so that the total fraction height is twice that of the integer (Fig. 1). Avoid the incorrect figures shown. Be sure to draw clearly, for a mistaken figure can cause numerous problems.

All figures should be so arranged as to be readable from the bottom or right side of the drawing only. This method enables the reader of the drawing to find the dimensions much more easily.

QUESTIONS:

1. Should the numerator be drawn smaller than the whole number?
2. Should the denominator be drawn smaller than the whole number?
3. Why be careful in drawing figures?
4. Should a figure be drawn so that it is readable from the left side of the drawing?
5. How can you improve your technique in drawing fractions?

ASSIGNMENT:

Lay a piece of tracing paper over the row of figures drawn below and trace all the figures.

$8\frac{3}{4}$ $3\frac{1}{4}$ $2\frac{1}{3}$ $5\frac{3}{4}$ $7\frac{1}{8}$ $6\frac{3}{8}$ $4\frac{1}{2}$ $5\frac{3}{4}$ $9\frac{5}{8}$

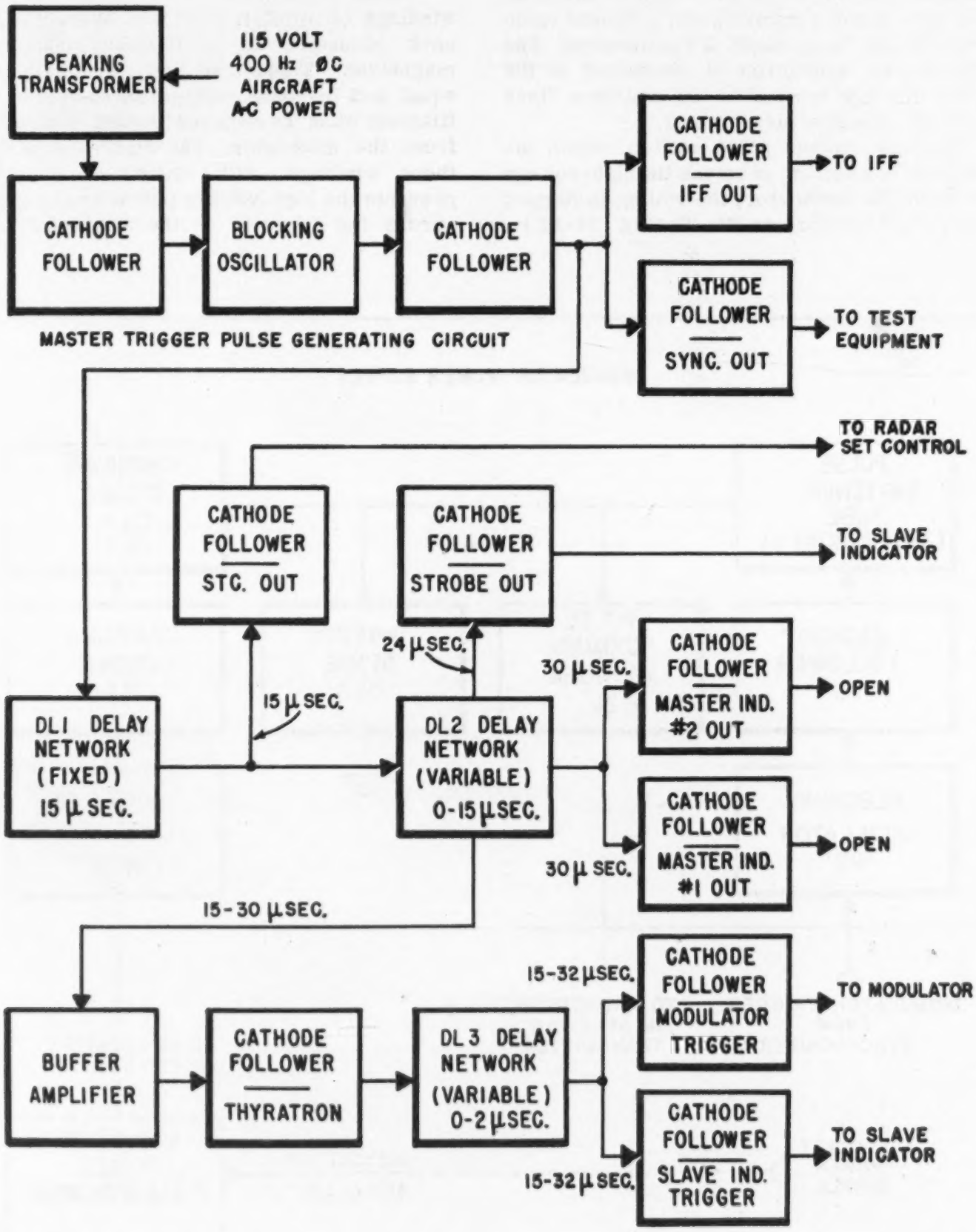

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Figure 18-10.–Block diagram, synchronizer.

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radiated from the antenna into space. Airborne radar sets employ microwaves, a typical value of wavelength being about 3 centimeters. The output of the magnetron is conducted to the antenna through waveguide transmission lines consisting of hollow metal tubing.

The high-voltage pulse section, which includes the magnetron, receives the high-voltage pulse from the modulator; the voltage is stepped up by pulse transformer T4. (See fig. 18-12.)

Pulse transformer T4 has two secondary windings of similar electrical characteristics, each connected to a filament lead of the magnetron. These two windings maintain an equal and in-phase voltage on each side of the filament when T4 receives the high-voltage pulse from the modulator. The electrical action of these windings, with associated capacitors, prevents the high-voltage pulses from appearing across the filament of the magnetron or the

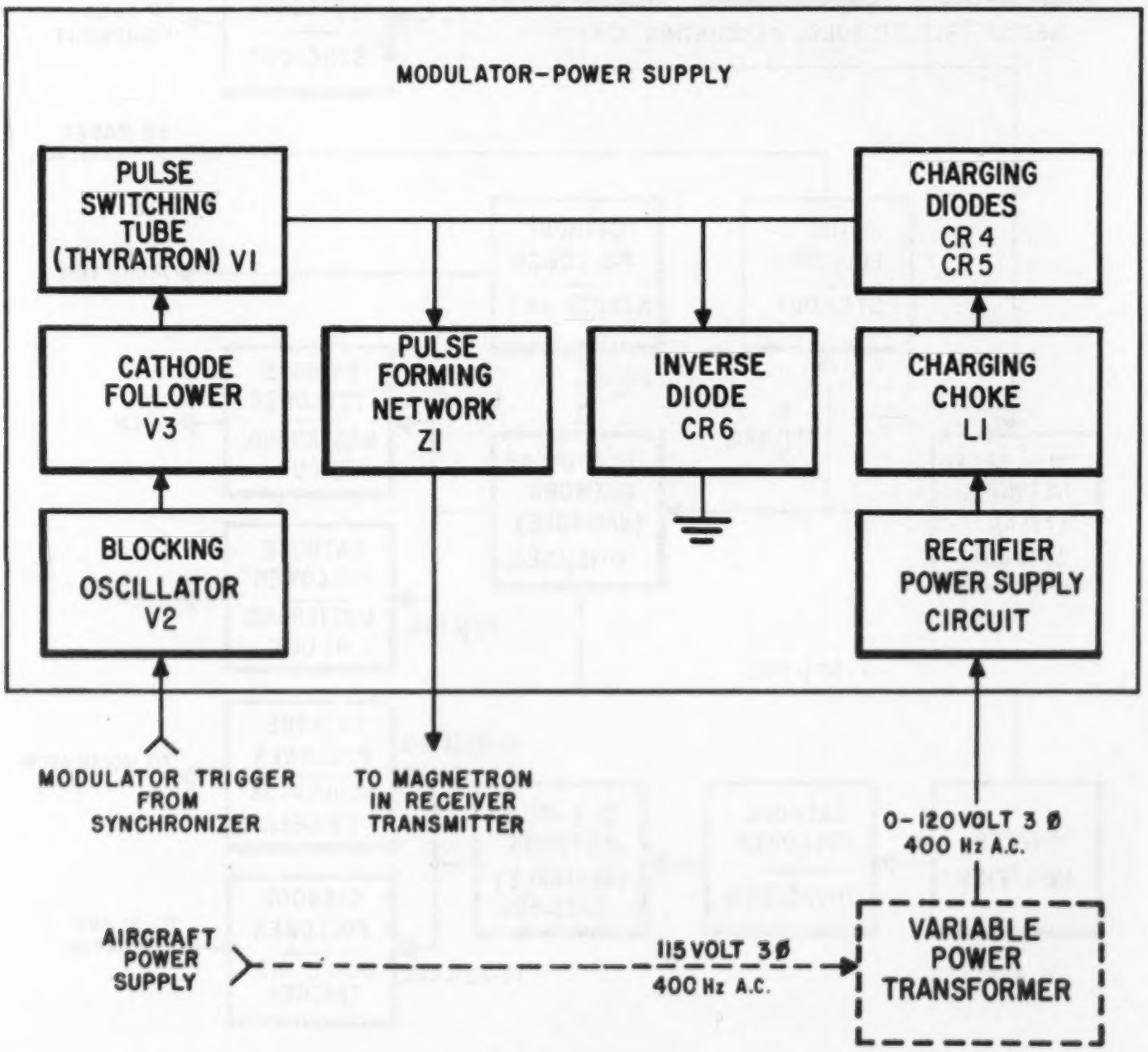

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Figure 18-11.–Block diagram of modulator function.

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secondary of the magnetron filament transformer.

Each pulse drives the cathode of the magnetron negative. This causes the magnetron to oscillate for the duration of the pulse. These high-power pulses of RF energy are coupled into the waveguide section duplexer.

WAVEGUIDE AND DUPLEXER

The waveguide assembly (fig. 18-13 couples RF from the magnetron to the antenna for transmitting and the received echo from the antenna to the receiver.

All coupling between sections is accomplished by choke coupling. Choke coupling is accomplished by standard fittings designed to present low-impedance points at the junctions of the inside walls of the waveguide.

The transmitter and the receiver are effectively isolated from each other during each function by means of a load isolater and the duplexer assembly. The RF output from the magnetron is coupled to the duplexer through a section of waveguide that contains a ferrite load isolator.

The load isolator, W2, is a section of waveguide containing a ferrite element and a

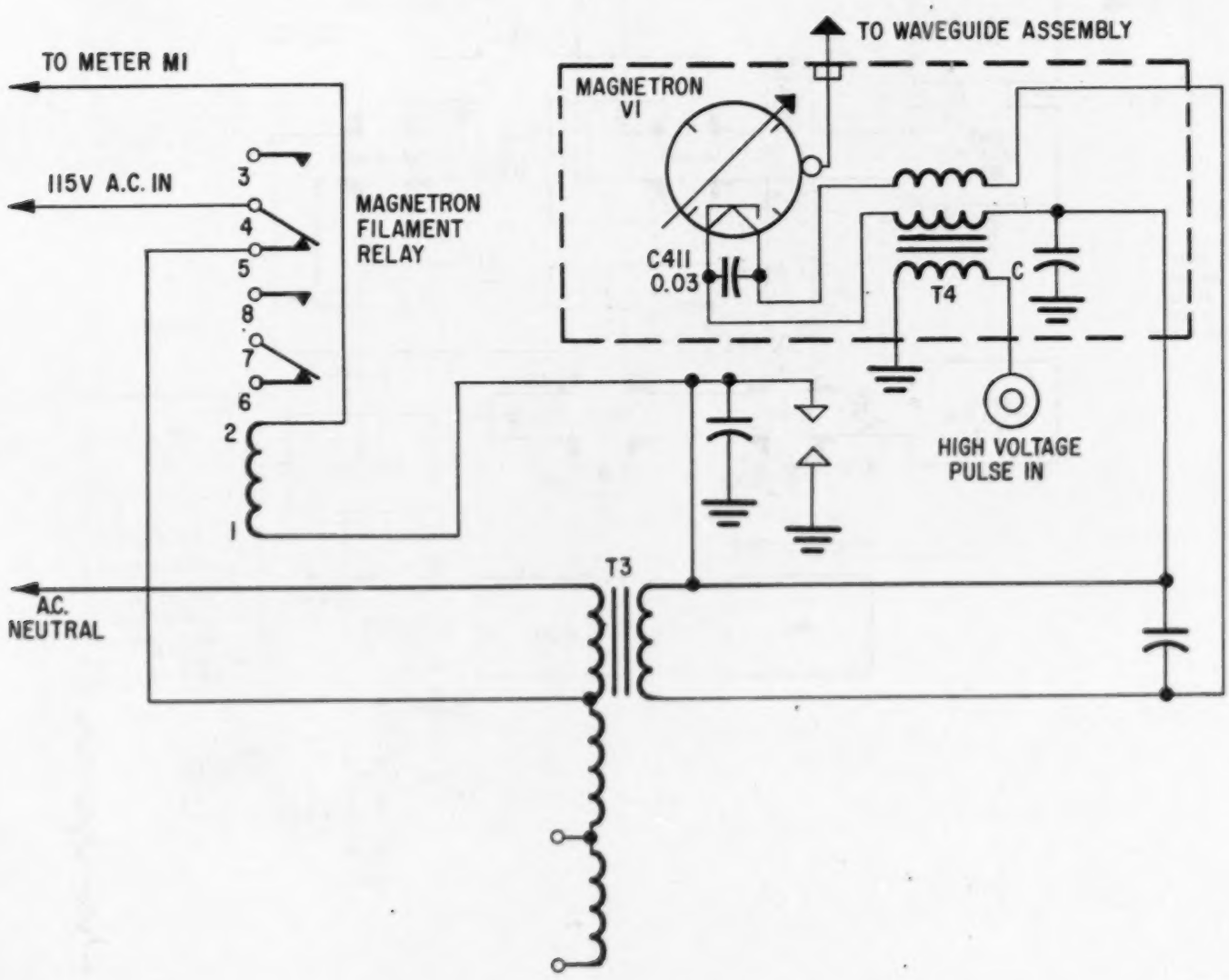

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Figure 18-12.–Transmitter and associated circuits.

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permanent magnet. It allows power generated by the magnetron to be transmitted with very little loss, but will appear as a high-level attentuator to any reflected energy. This allows the magnetron to work into a matched load, thus providing very stable tube operation.

The RF energy from the load isolater enters the transmitter side the hybrid section of the duplexer. The high-level RF energy will excite TR tube V3 and ionize the gas contained therein. This ionized section will appear as a short across the waveguide, and the electrical characteristics of the hybrid will direct the reflected energy to the antenna side of the hybrid and thence to the output flange of the receiver-transmitter. Thus in the transmit condition, the

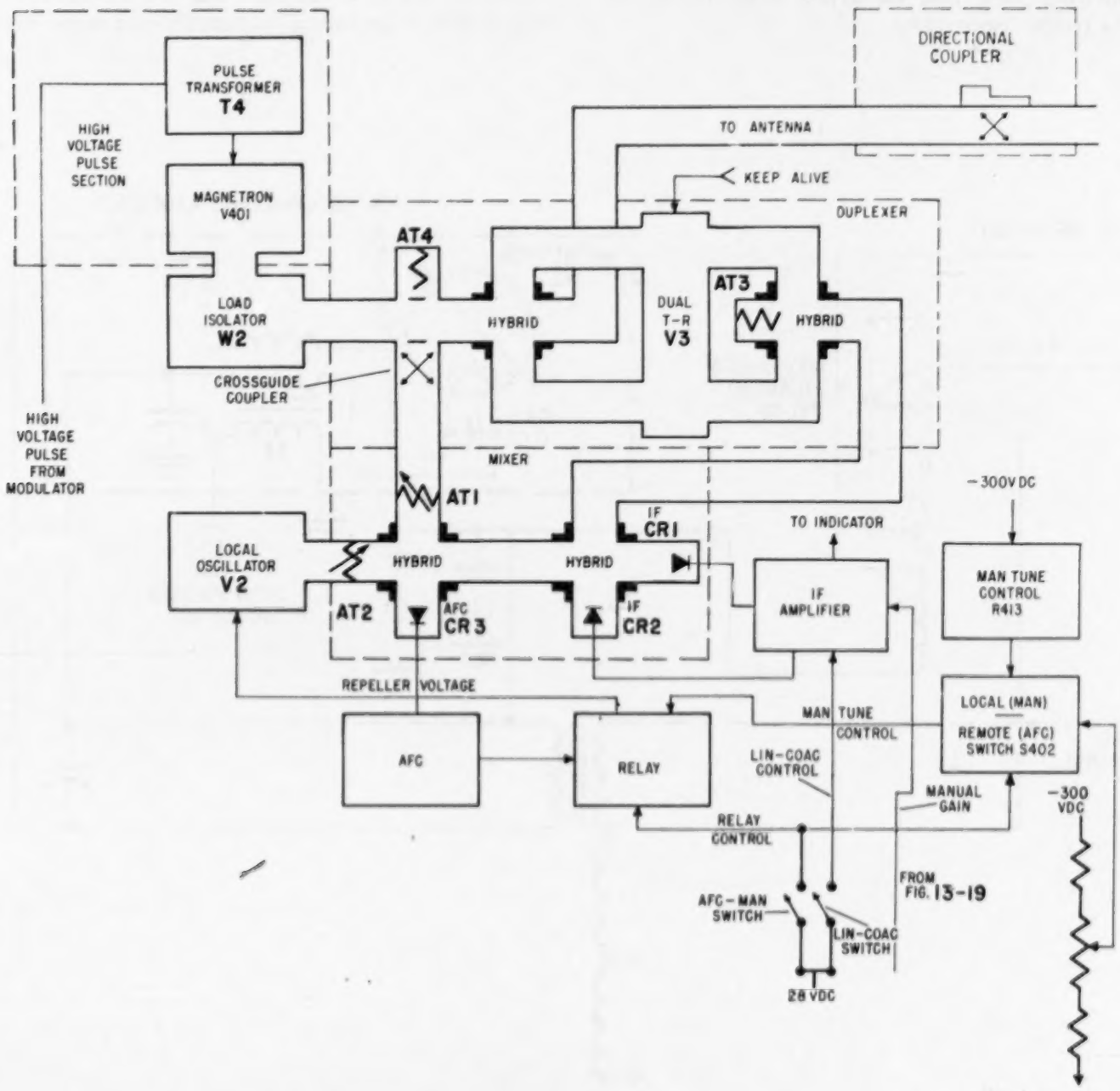

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Figure 18-13.–Waveguide assembly.

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duplexer prevents the high-level RF energy from entering the receiver portion of the waveguide and directs it toward the antenna.

ANTENNA

The RF energy from the transmitter is coupled to the antenna through several sections of waveguide, a directional coupler, and a waveguide switch.

The directional coupler is a section of waveguide that provides a fitting for attaching test equipment to measure the transmitter power output and the receiver sensitivity.

The waveguide switch is used to couple RF energy from the transmitter to the antenna assembly or to an electrical dummy load.

The antenna reflector focuses and directs RF energy generated by the radar transmitter and collects the RF energy reflected from targets. The antenna also provides azimuth information to the associated indicator groups by employing a servomechanism to transfer azimuth data.

The radiated beam of energy can be elevated or lowered to cover the desired areas by manipulation of the manual-tilt control on the antenna control. This changes the tilt angle of the reflector with respect to the aircraft's fuselage or to the true horizontal, depending on whether or not the radar has tilt stabilization incorporated. The true horizontal is determined by a gyro reference system.

Tilt Stabilization

Tilt stabilization is used to correct the tilt angle of the transmitted beam of RF energy to compensate for deviations in the attitude of the aircraft, thereby maintaining the beam throughout the scanning range at the angle selected by the tilt control on the antenna control. The stabilization range on one type of radar is such that, if the tilt control is set for 0°, the beam is maintained at this angle for aircraft pitch or roll up to ±30°. If the tilt control is set for other beam angles, these limits vary accordingly. A typical tilt-stabilization system is shown in figure 18-14.

The conditions depicted in figure 18-14 resulting in the waveform shown at the left, are as follows:

1. Aircraft is entering a climb.
2. Manual-tilt control is set for zero tilt.
3. Tilt-stabilizer mechanism is functioning in response to gyro signals.
4. Scanner's instantaneous position is "dead ahead."

NOTE: The amplitudes for waveforms 7 and 8 are not drawn to comparative scale.

The tilt-stabilization system shown in figure 18-14 consists of a gyroscope unit, a servoamplifier, the resolver synchro, manual-tilt synchro, tilt-torque motor, damping signal generator, and followup synchro. The gyroscope unit is separately mounted on the aircraft structure, and the resolver synchro and the servoamplifier are mounted on the antenna frame. The tilt-torque motor, damping-signal generator, and followup synchro are contained in the tilt-servo unit mounted on the rotary section of the antenna. The manual-tilt synchro is mounted on the antenna control box.

Stabilization is effected by the use of two signals: the resolver synchro signal, and the manual-tilt synchro signal. Separate pitch and roll signals originating in the gyroscope unit are combined in the resolver synchro to produce the single resolver-synchro signal. The manual-tilt synchro signal originates in the followup synchro and provides the tilt-stabilization system with continuous information as to the tilt angle of the reflector. This signal passes through the manual-tilt synchro in the antenna control where it is modified according to the setting of the tilt control. The resolver-synchro signal and the manual-tilt synchro signal, which differ in phase by 180°, are combined at the input of the servoamplifier, and the amplified resultant, or error signal, is used to control the tilt-torque motor in correcting the tilt angle of the reflector.

RECEIVER

The typical radar receiver is an extremely sensitive superheterodyne containing circuits with bandwidth capable of passing pulses of the type emitted by the transmitter. It is important that the receiver generate as little local noise voltage as possible to avoid masking weak echo signals.

In the receive condition, the magnetron is not being pulsed and the TR tube is not fired. Energy received by the antenna is directed to

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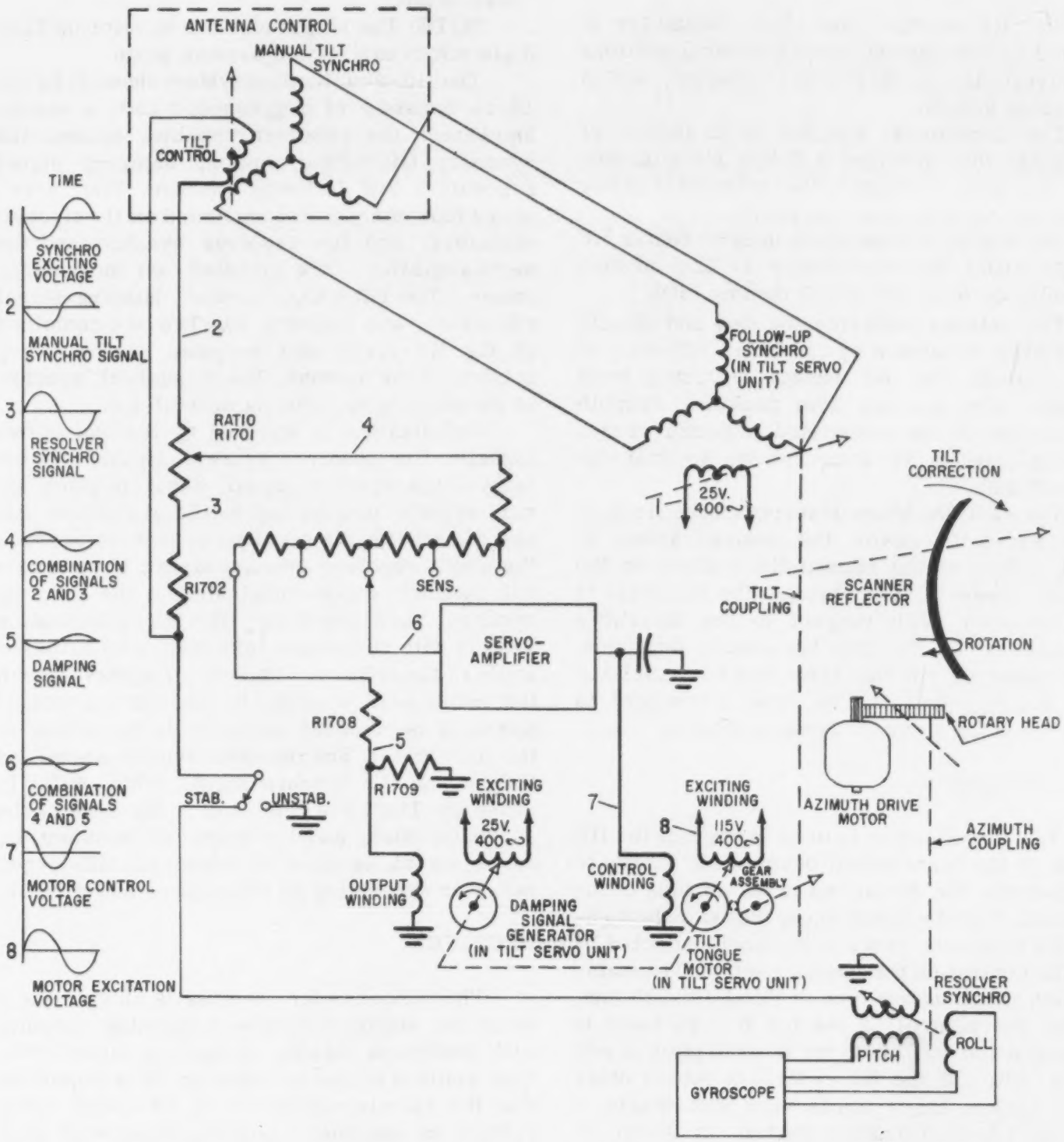

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Figure 18-14.–Antenna tilt-stabilization servosystem.

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the receiver, where it enters the duplexer on the antenna side (fig. 18-13). This energy is at a very low power level; consequently, the TR tube will not fire and will appear as a continuous open waveguide. After traveling through the TR tube, the received energy enters the low-power hybrid section of the duplexer, which directs it to a crystal mixer. The electrical characteristics of the duplexer provide directivity in such a manner as to minimize received energy losses in the transmitter portion of the waveguide. Received energy is directed from the duplexer into the mixer where it is heterodyned with the output of the local oscillator (a reflex klystron) at the mixer crystals to produce the required IF of the receiver. The local oscillator is stabilized by an AFC system to keep the receiver intermediate frequency from drifting.

The IF output resulting from the mixing process is then amplified in a number of IF stages. In most aircraft radar receivers, the intermediate-frequency value is between 15 and 60 megahertz. A video detector converts the IF energy into video pulses. After passing through one or more stages of video amplification, the signals are applied to the cathode-ray indicator.

AFC System

A cross guide coupler, located on the transmitter arm of the waveguide, continuously couples a small portion of the transmitter output to a separate mixer in the receiver called the AFC mixer, to which some of the output of the klystron local oscillator is also applied. The AFC mixer develops the difference frequency of the two and applies this signal to a discriminator circuit. The disciminator output voltage is at a reference level when the correct intermediate frequency is produced. But if the receiver local oscillator attempts to drift off frequency, the discriminator produces a d-c voltage which is positive or negative from the reference level, depending on whether the local oscillator frequency is too high or too low. The d-c output of the discriminator is then applied through associated circuits to the repeller plate of the klystron local oscillator. This corrects the klystron frequency until it differs from the transmitted frequency to produce the correct IF.

IF Amplifier and AGC

The outputs of the receiver crystals in the mixer assembly are brought into the IF amplifier through coaxial lines. The IF amplifier of the receiver is a linear amplifier employing a changeover circuit, with an instantaneous automatic gain control (AGC) circuit. A relay provides the changeover from linear to COAC (clutter-operated anticlutter) when selected. Linear (LIN) operation of the receiver presents the target on the companion CRT at the true representative length and overall intensity. COAC causes the target to be presented on the indicator CRT with the leading edge of the target at normal intensity and the remainder of the target at reduced intensity. This feature allows a target to be seen which might otherwise be obscured by clutter (fig. 18-15). In LIN operation, only the land mass can be seen. However, the intensity of the land mass is reduced in COAC operation (except for the leading edge) and the otherwise obscured target can be seen.

AGC is a negative voltage applied to the suppressor grids of the IF amplifiers, except the first two and the last one, to reduce the receiver gain when signals of large amplitude and long duration are received. AGC is accomplished by detecting the negative portion of the IF pulse (fig. 18-16). The negative d-c pulses from the plate of V5 are filtered, coupled through the control relay K1 (when in COAC operation), and mixed with the manual GAIN control d-c voltage and sensitivity time control voltage (when STC is selected) on the grid of V6A.

The output is taken off the cathode of V6A and applied to RC network C3, R7 and C4. Due to the relatively long RC time constant of R7 and C3, the negative voltage pulse is not immediately applied to the AGC bus. CR1 does not conduct; it appears as a high resistance for the charge of C3. From the time the pulse starts (t1) until C3 is charged (t2), the receiver gain is essentially linear; that is, it operates with limited AGC. This allows the leading edge of any signal to be amplified at full gain before the AGC voltage is applied. Thus the output video signal consists of the leading edge of the signal at full amplitude and the remaining part of the signal at reduced amplitude. At the trailing edge of a pulse, the negative voltage on C3 and the AGC

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line will discharge quickly through the low forward resistance of diode CR1. In this way, the recovery time following a pulse is reduced to a minimum.

Sensitivity Time Control (STC)

STC provides reduced receiver sensitivity within a range which is variable from 0 to 45 miles from the radar set. This feature may be used to reduce clutter on the indicator CRT caused by close-in targets, such as land masses and sea return.

For STC operation (fig. 18-17) a positive trigger pulse (STC OUT), from the electrical synchronizer, is fed to the grid of V1A in the radar set control. V1A is pulsed into conduction by the input pulse. While V1A is conducting

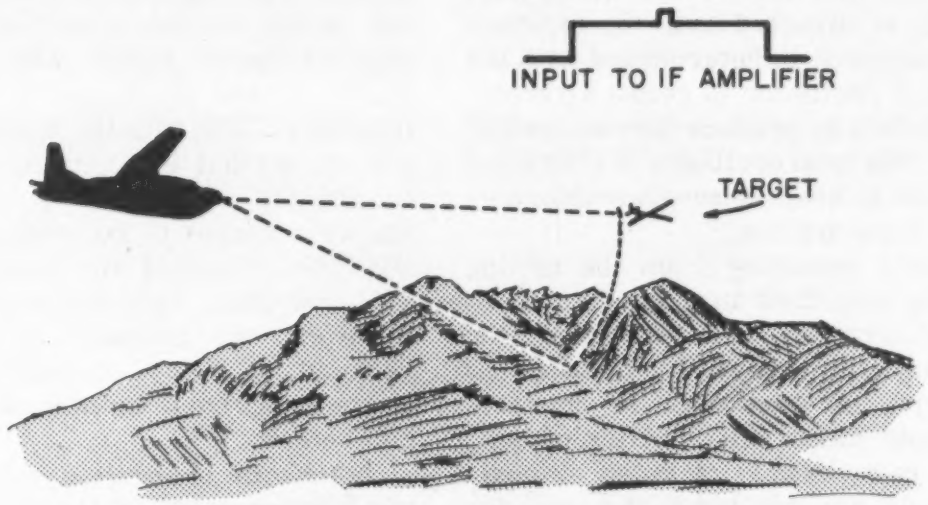

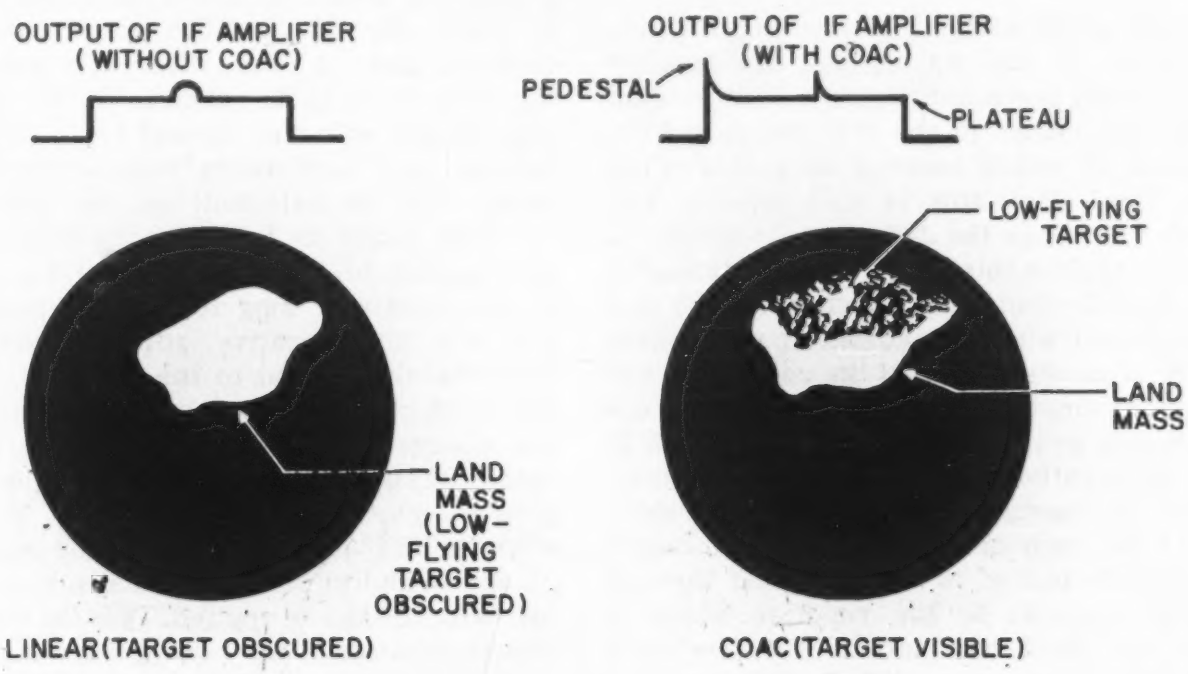

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Figure 18-15.–Linear vs. COAC operation.

capacitor C2 is charged negatively. The amount of negative voltage change on C2 is controlled by the setting of depth control (R8). The voltage magnitude controls the amount of reduction in receiver sensitivity. Following the trigger pulse, V1A is cut off and capacitor C2 discharges. The discharge time of C2 is determined by the range control setting. The exponential voltage rise from C2 is coupled through cathode follower V1B. The voltage output from the cathode follower is clamped by capacitor C4 and diode CR1 to the d-c potential provided by the manual gain control.

The exponential voltage amplitude determines the amount of reduction of receiver sensitivity and is controlled by R8, the depth control.

The length of time that the exponential voltage is present determines the range of STC and is controlled by R7, the range control.

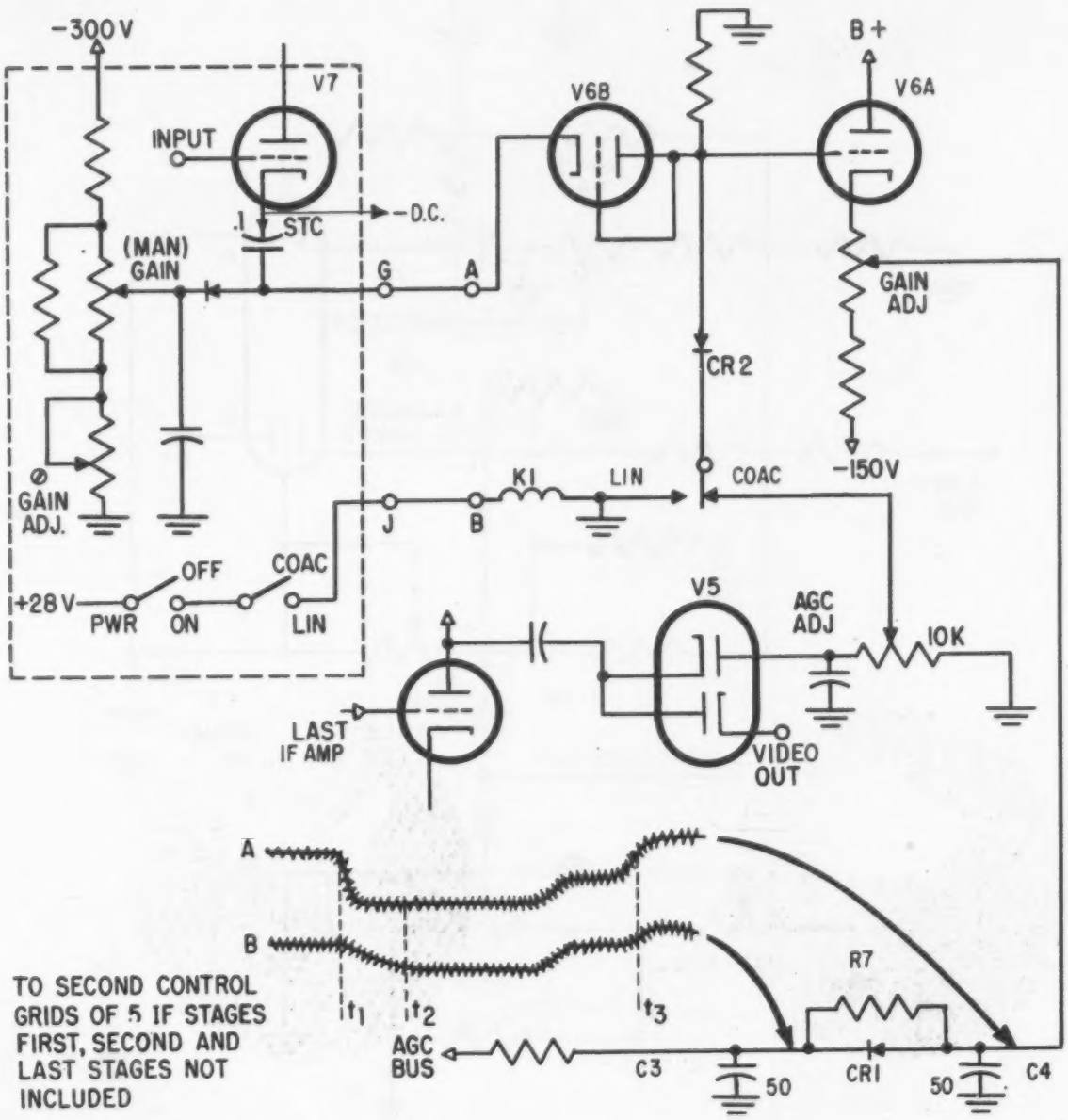

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Figure 18-16.–AGC circuit.

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INDICATOR

The indicator accepts the radar data such as video pulses, range marker voltages, and sawtooth timing waves, and represents them in a visual display on the screen of a cathode-ray tube. The entire assembly contains the cathode-ray tube and various electronic circuits necessary for presenting the desired information on the screen. These circuits include video amplifiers, diode clamping tubes, and the controls for adjusting the brilliance of the visual pattern.

Sawtooth timing waves of voltage or current are applied to the deflection circuits of the CRT to produce the time trace or sweep in the pattern. The synchronizing pulse which triggers the modulator and transmitter also serves to coordinate the start of the sweep with the action of the transmitter to make range measurements

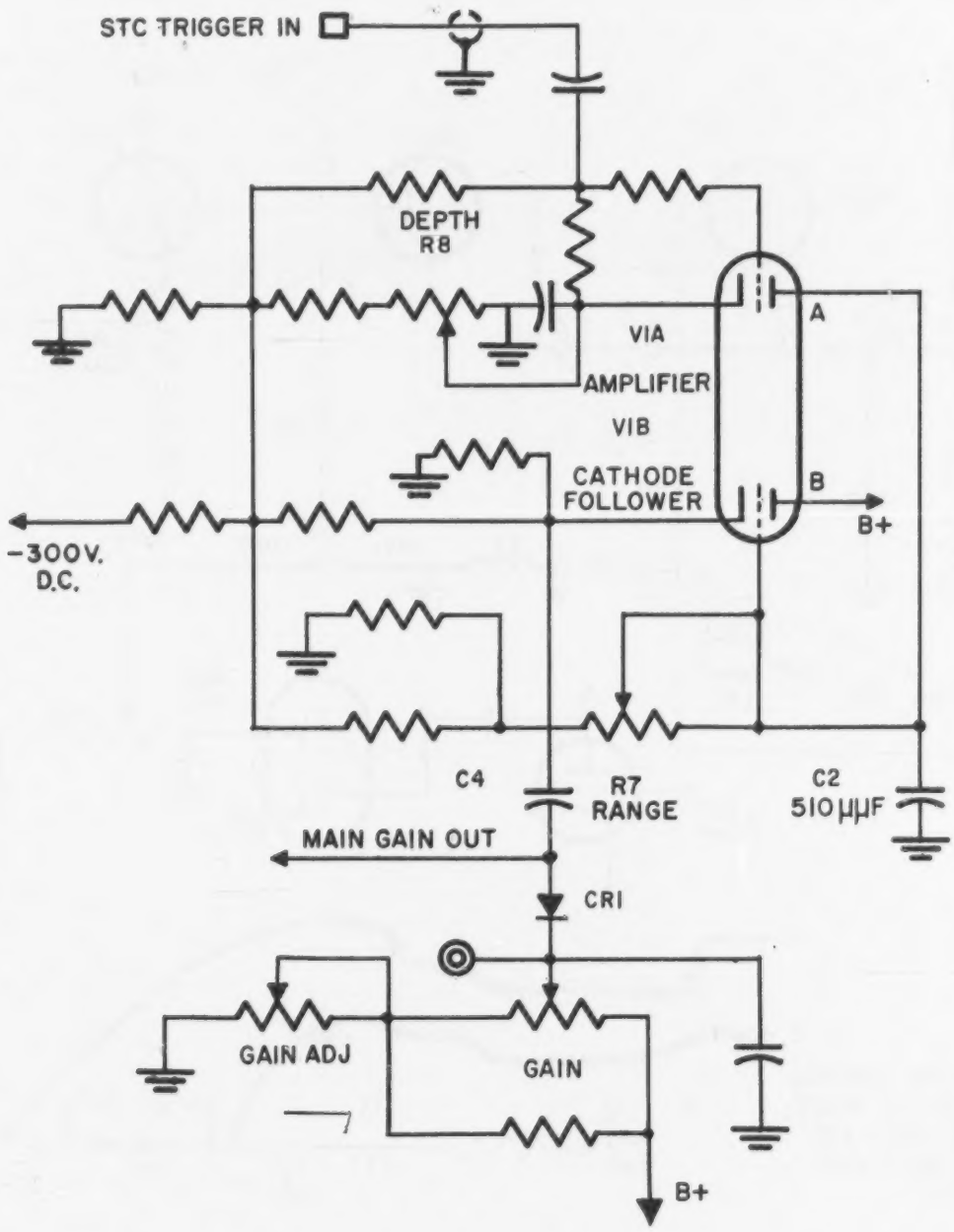

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Figure 18-17.–STC generator.

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UNIT VI - DIMENSIONING

The Selection of Dimensions — Lesson 3

OBJECTIVE: To learn how to dimension properly.

RELATED INFORMATION:

The most common shapes the draftsman will encounter in his work are the square, the rectangle, and the triangle. Each of these shapes has three dimensions making up the object - its height, width, and depth - which we must indicate in the dimensioning of the part.

The cylinder is the next most common shape, and here we require only two dimensions, diameter and length. Partial rounds such as fillets are dimensioned by radius instead of diameters. A good rule to remember is this: Dimension full circles with a diameter and partial circles with a radius.

There is no set basic rule for choosing which dimensions to indicate, but the draftsman should try to select dimensions convenient for the workman to use. Therefore the superior draftsman will not be satisfied to know engineering drawing as a language, but he will try to supplement his total knowledge by learning shop methods. In this way, he can dimension from a practical viewpoint and not complicate his drawing with too many dimensions or leave the workman at sea because he has not put in enough.

Always remember in drawing extension and dimension lines that they are drawn lighter than the object lines. The extension lines extend approximately $\frac{1}{16}$ inch away from the drawing.

Oftentimes when holes and diameters are to be dimensioned, or other information must be given that cannot be shown by dimensioning, a note is included instead. Feel free to use notes, for oftentimes this clarifies situations.

QUESTIONS:

1. What are the most common shapes the draftsman will encounter in his work?

2. What is the next most common shape?

possible. Target bearing in most displays is indicated by synchronizing the position of the sweep line on the screen with the position of the antenna.

In addition to video pulses, range marker pips, and sweep voltages, a square wave pulse is applied to the indicator tube which blanks the beam between sweeps so that retrace lines do not appear on the screen.

Figure 18-18 illustrates, in block diagram form, the circuitry of a typical radar indicator for general-purpose use.

Types of Modulation

Two general types of presentation are used in aircraft radar indicators. They are the deflection-modulated and the intensity-modulated displays. The electron beam can be deflected from its normal linear sweep across the screen of a CRT. When this type of deflection is initiated by the radar echo, it is called deflection modulation. If the radar echo is caused to intensify the electron beam of the CRT without deflecting it, intensity modulation results. In both types of modulation, the range sweep is modified at a distance from its origin that is proportional to the target's slant range.

In the deflection method, the video pulse causes a momentary deflection of the cathode ray electron beam and produces a pip in the trace to indicate a target echo. In the intensity method, the video signal is applied to the element of the CRT which controls the intensity

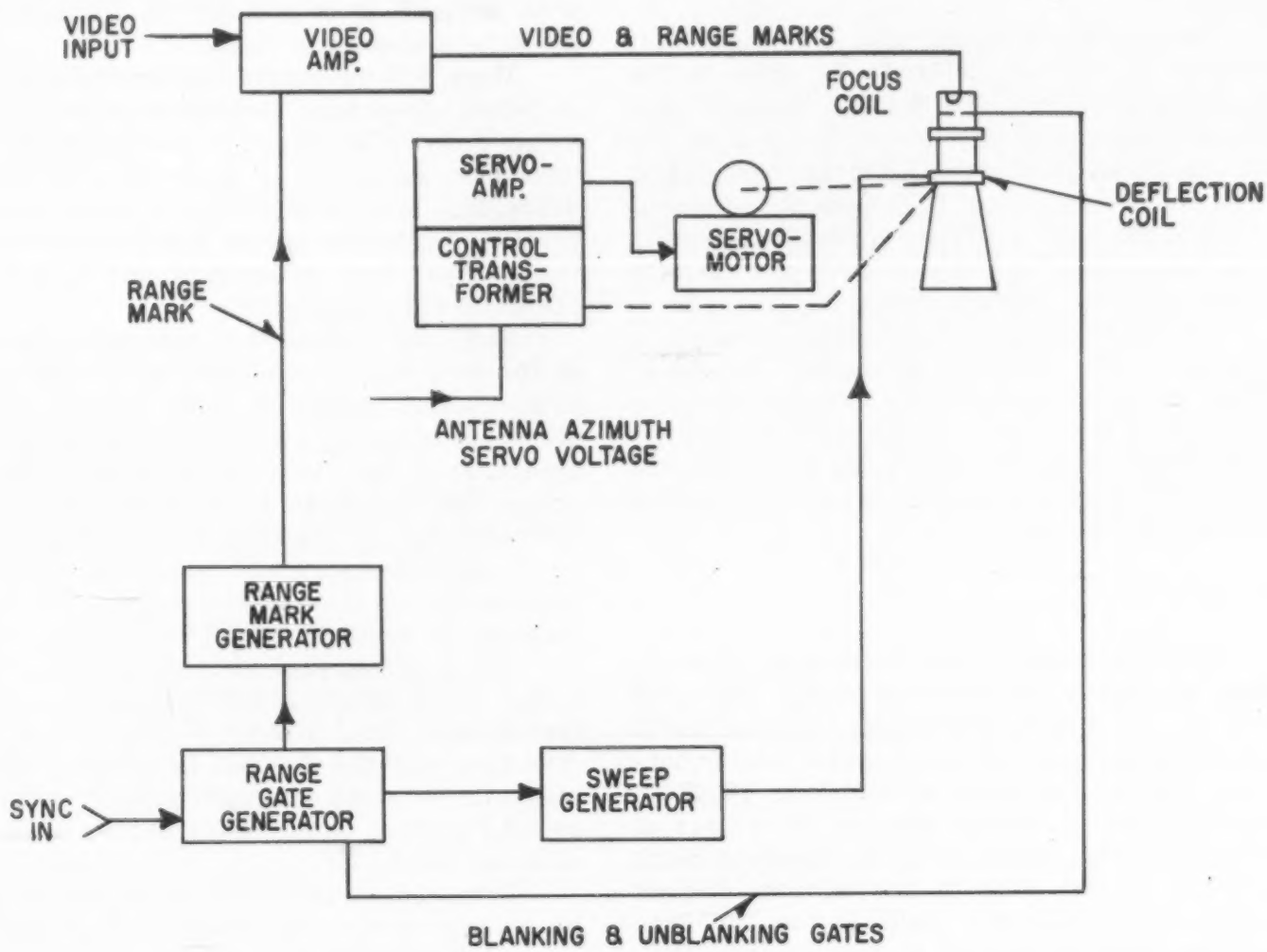

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Figure 18-18.–Radar indicator, block diagram.

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of the electron beam, and the resulting target image is a bright spot of light. The A–scope is an example of the deflection method and the PPI is a typical intensity presentation.

Spatial Dimensions

Space is commonly considered to have three dimensions; that is, the position of a point in space can be described by three quantities. In terms of radar, these three quantities are slant range (distance), bearing angle (horizontal direction), and elevation angle (vertical direction). A display of information is one-, two- or three dimensional, according to the number of dimensions presented. Thus the reading of a radar altimeter is one-dimensional, and a chart or PPI is two-dimensional. When slant range, bearing, and elevation are all given on a single screen, a three-dimensional display results.

The display of a particular radar is a compromise in the emphasis to be given to the spatial dimensions. The various types of display are designated by letter–A-scope, B-scope, etc.–designation being applied to the presentation itself and, by extension, to the unit that produces it. Thus, the letters PPI are applied to a piece of radar equipment and also to the type of display shown by a plan position indicator.

The more basic facts concerning A-scopes, B-scopes, PPI, and range-height indicators (RHI) are given in Basic Electronics, NavPers 10087-B. Some of this information is reviewed in the following paragraphs, along with additional details relating the various types of scopes of aircraft utilization.

Typical Indicators

The PPI scope is one of the most common types of display for airborne radar. The CRT used in a PPI scan is intensity modulated with the sweep moving radially from the center outward. Basic Electronics, NavPers 10087-B, explains how a voltage applied to a pair of deflecting coils would cause the electron beam to move to one side of the screen, at right angles to the magnetic field. In the PPI scan the time base is applied in this manner; distance is measured from the beginning of the sweep, the center of the screen. If the deflecting coils are made to revolve slowly around the neck of the tube, in synchronism with revolutions of the directional antenna, a polar map is developed on which the range is plotted radially against the position in azimuth through 360°. The top of the screen can represent dead ahead of the aircraft, or it can be oriented to true north. In some aircraft installations it is possible to synchronize the PPI picture with the fluxgate compass so that the top of the screen represents true north.

Range markers are used with most PPI scopes. The timing system is made to produce equally spaced concentric circles about the scope center which show the distances of objects from the transmitter. Muptiples of 5, 10, or 20 nautical miles are often used.

Most PPI indicators use a pair of deflecting coils which are rotated around the cathode-ray tube to produce the rotating sweep. However, if it is desired, it is possible to accomplish the rotation by electrical means.

Many PPI indicators have provision for what is called sector scan. Revolution of the antenna is stopped, and it is caused to move back and forth through a sector up to about 60°. The antenna scans this area at about two to three times the rate of normal revolution. Thus the search area is covered more frequently and targets are observed more distinctly.

There are two ways to view the picture seen of the PPI scope, depending on whether or not azimuth stabilization is used. With the azimuth stabilization in use, the output of the fluxgate compass is tied into the radar set. The PPI scope then becomes another remote compass indicator and the pattern on the scope is seen as it appears on a chart. The top of the scope represents either true or magnetic north, depending on whether variation has been set in.

It is easier to navigate with azimuth stabilization on. A bright line on the scope, known as the lubber line, always points in the same direction that the aircraft is heading. True or magnetic bearings are read on the azimuth scale, and the pattern on the scope is always oriented with the chart.

With azimuth stabilization off, the top of the scope represents true heading. Bearings taken are relative bearings.

A-SCOPE.–On the A-scope, only range is presented, but accurate bearings may be obtained

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with auxiliary aids. Ordinarily, a single line (the time base) appears across the scope. If the gain is stepped up, the time base may appear as grass, so called because it looks like grass. (The grass results from amplification of electronic noise when the gain is increased.) When a target is within range, it appears as a sort of peak (called a pip) sticking up from the line or out of the grass. For bearing, antenna rotation may be stopped at the point where the target pip is of maximum size. Bearing may then be read from a counter or dial linked to the antenna.

B-SCOPE.–The B-scope gives bearing and range in rectangular coordinates. The bearing scale is along the horizontal axis, the range scale along the vertical. This presentation is often used in fighter aircraft; the scope shows a sector of perhaps 130° or 150° ahead, with "dead ahead" represented by the center line of the scope. Since the B-scope presentation puts a pie-shaped sector into a rectangular presentation, it is distorted and does not show a "map" of the section it scans. Still, it is close enough to a map to give you a good quick picture of the situation ahead. Since small deviations in bearing become more conspicuous as the target gets closer, it is a good scope to use when closing in on a target or to avoid obstructions. The B-scope gives very good resolution in range and bearing; that is, targets very close together can be distinguished as separate targets.

RHI SCOPE.–An RHI scope is essentially a normal PPI laid on its side so that the antenna scans vertically instead of horizontally. Range is still shown radially, but the angle that was formerly the bearing angle becomes the elevation angle. The vertical plane in which the RHI scans can be rotated about a vertical axis, as the horizontal plane of a normal PPI can be tilted around a horizontal axis. In an RHI, targets in a vertical plane only are displayed. The RHI screen shows a side view of this plane (fig. 18-19), the horizontal axis showing the range in miles and the vertical axis showing directly the height of the target aircraft in feet, and not the elevation angle. Height instead of elevation angle is obtained by electronically combining the range with the sine of the elevation angle. The height scale must be increased or stretched if significiant information is to be obtained, particularly for distant aircraft. Figure (18-19)

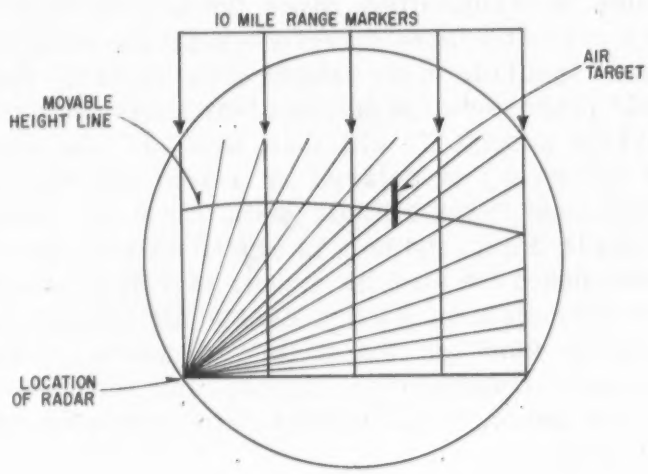

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Figure 18-19.–RHI scope presentation.

shows a height scale which has been stretched so that 5 nautical miles (30,000 feet) is equivalent to about 20 nautical miles of range.

Variations in Scope Presentation

On some scopes used in aircraft all three coordinates–azimuth, elevation, and range–can be obtained. Since scopes are basically two-dimensional, the azimuth-elevation or range-elevation presentation must be superimposed on the range-azimuth presentation, with a switch to select one or the other; or one presentation may be placed above the other so that, in effect, you have two scopes.

Most radars have both long- and short-range scales, and some have several intermediate scales. The long scale may give ranges out to 100 miles or more; the short scale may be less than a mile. For instance, one type of night search and intercept radar has scales of 1,500 yards and 2, 8, 20, 50, 100, and 150 miles. Most antisubmarine warfare radar and airborne early warning radar have a maximum long-range scale of 200 miles. This scale could be very valuable in making a landfall, establishing position in off shore flight, and in the surveillance of maritime shipping.

In a number of radars, a sweep delay control makes it possible to eliminate the nearby areas from the presentation and show only the

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areas farther out. This is done by delaying the sweep on the scope. Ordinarily, the sweep on the scope starts at the same instant that the radar pulse is transmitted. Since the closest targets are normally those directly beneath the aircraft, there is a hole in the middle of the picture. This hole represents the distance between the aircraft and the ground. To eliminate this hole, the start of the sweep is delayed by a selected amount equivalent to the altitude. With this delay, called altitude delay, the hole is closed up and objects underneath the aircraft appear near the center of the PPI picture. Altitude delay also performs another function. As it is a measure of the distance between the aircraft and the ground or sea below, it can be used to indicate absolute altitude.

Provisions are also made for sweep delay in larger increments in order to give a more detailed picture within certain ranges. Some equipments provide altitude delay up to approximately 35,000 feet and sweep delay up to 200 miles in units of 10 miles. With a 20-mile range setting and no altitude delay, but with sweep delay set at 20 miles, the picture in this equipment would show returns from the area between 20 and 40 miles distant.

Ground Stabilization

Search radar produces a PPI display that constantly changes as the aircraft moves across an area. Since the sweep starting point represents the position of the aircraft in the center of an area, it follows that the PPI presentation will change as the aircraft travels. Also, any targets on the scope will move across the scope. If, however, a target is selected and the radar sweep is "ground stabilized," the sweep starting point will change and the targets will remain fixed in place on the scope. The radar continues to view only the selected area in which the target lies. This is accomplished by the use of auxiliary ground position indicating equipment and off-centering circuits within the indicator.

Ground position indicating (GPI) equipment continuously indicates the ground position of a flying aircraft from an initial reference point. One of its functions is to show north-south and east-west distances from the reference point on direct reading dials. Its primary function is to furnish voltages which will ground stabilize a radar sweep. The PPI sweep remains fixed geographically.

POWER SUPPLY

In airborne equipment, the primary a-c and d-c voltages are supplied from the aircraft's power system to the various units in the radar system. Within the various power supplies the voltage is stepped up or down, and if necessary rectified, to fulfill the requirements of the radar.

The power supplies used in radar are of many different types–bridge, half-wave, full-wave, voltage doubler, etc., and some have voltage regulating circuits to maintain critical voltage levels. Various types of power supplies are covered in Basic Electronics, NavPers 10087-B, and should be reviewed before you continue the study of this subject. A brief description of a typical 3-phase, half-wave rectifier is given in the following paragraphs.

The primary power supplied to most aircraft radar installations is 115-volt, 3-phase, 400 Hz. A 3-phase, half-wave rectifier acts like three half-wave rectifiers operated so that each rectifier tube plate becomes positive once every 360 electrical degrees of phase rotation. Because of the 3-phase connection of the rectifiers, the circuit will deliver a comparatively large amount of power. The output ripple voltage is 1,200 Hz, and a minimum amount of filtering is required. Figure 18-20 shows a 3-phase power supply and the wave-forms.

The waveforms show that curve 1 starts to rise from point zero. After 120 degrees, curve 2 starts to rise from zero, and curve 1 is starting to return to zero after passing through a peak. After another 120 degrees, curve 3 starts to rise from zero and, at the same time, curve 1 has almost reached a peak in the negative direction, and curve 2 is returning to zero after passing through a peak. After 360 degrees, curve 1 has returned to point zero, curve 2 has returned to point zero after passing through a positive peak, and curve 3 has almost reached a peak in the negative direction. The output waveform is a series of overlapping positive cycles of voltage that never falls below 50 percent of the voltage maximum. When this condition is compared to other forms of rectification, the reason for less filtering is readily apparent. For example, the output waveform of a full-wave, single-phase

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rectifier falls to zero volts once for each 180°(ripple frequency 800 Hz), and the half-wave, single-phase rectifier waveform falls to zero once each 180° and remains at zero for the next 180° (ripple frequency 400 Hz).

Since the frequency of the ripple voltage is higher, it is possible to use comparatively small filter chokes and capacitors in a 3-phase power supply. In high-power radar power supplies, gas diodes are used because of their efficiency. However, recent development of high-efficiency, heavy-duty germanium diode rectifiers has resulted in a trend away from vacuum tubes because of savings in space. In addition, no filament power is required for the germanium diodes, which results in even greater savings in space and weight.

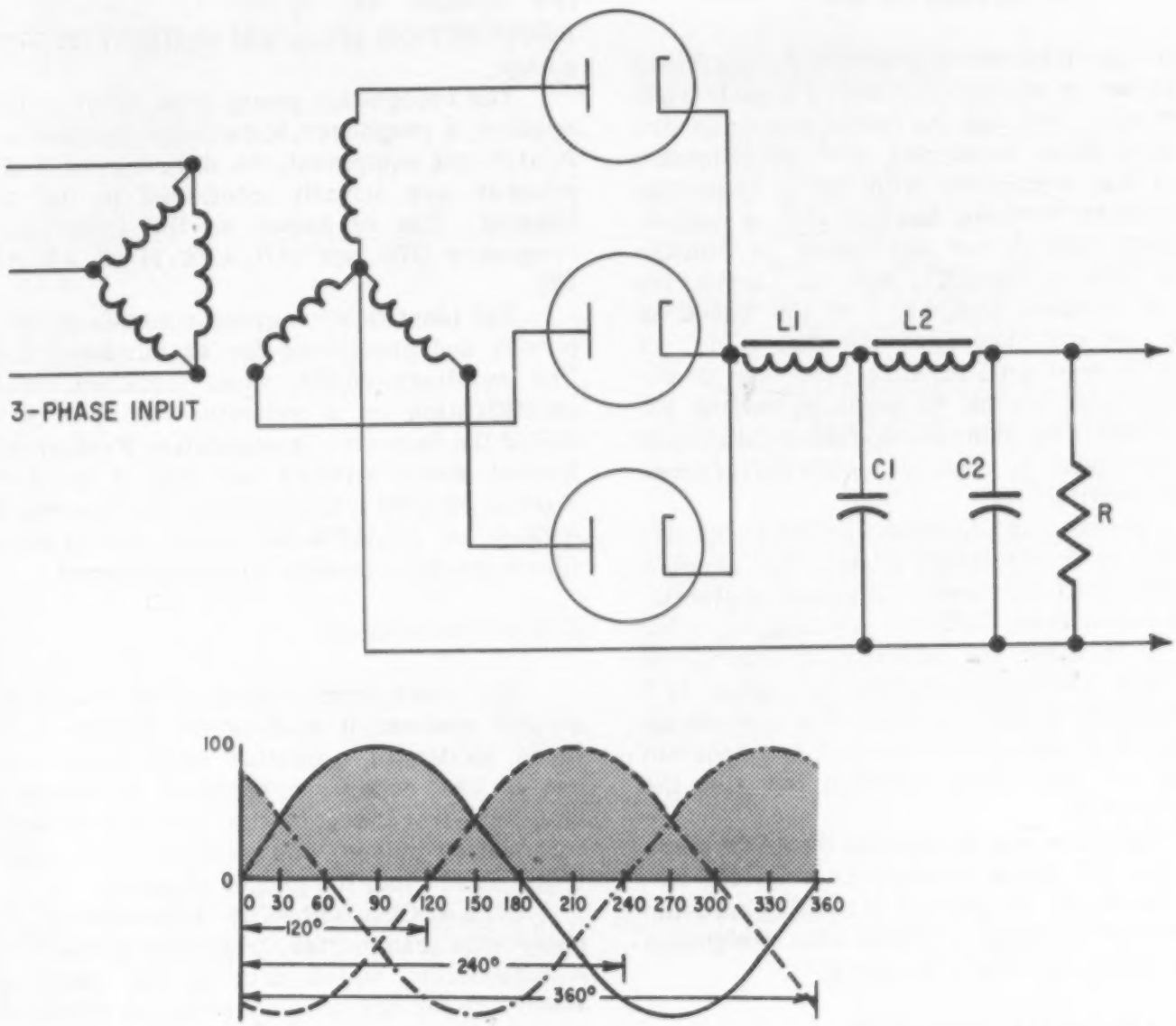

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Figure 18-20.–Schematic diagram of 3-phase power supply and waveforms.

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CHAPTER 19

PRINCIPLES OF IFF

FUNCTION OF IFF

The age-old problem of distinguishing friend from enemy in warfare increased greatly when aircraft came into use. As faster ships and aircraft have been developed, the identification problem has increased. Although a radar can detect targets (both sea and air) at long ranges, it displays both friend and enemy as similar spots of light on the CRT. With the destructive power of modern weapons and the speed of modern weapon delivery systems, it is not practical to wait until the target has been identified by visual means to begin preparing for battle. Therefore, some method other than visual recognition must be used to identify the target as early as possible.

The problem of identification led to the development of an electronic system that permits a friendly craft to identify itself automatically when interrogated, before approaching near enough to threaten the security of other naval units. This electronic system is called IFF (identification, friend or foe). For operations involving only friendly aircraft, it is important to know not only their location but also the identity of each.

IFF systems are designated by MARK numbers. The IFF mark number is a Roman numeral (Mark X), to prevent possible confusion with fire control radar systems also designated by mark numbers (Mark 29, etc.).

MAJOR AND AUXILIARY UNITS

The IFF system consists basically of a pair of special transmitter-receivers, working in conjunction with a radar set. Figure 19-1 shows the units required for the basic operation of an IFF system. The system is composed of a RECOGNITION group and an IDENTIFICATION group.

The recognition group consists of an interrogator, a responser, and a coder-synchronizer. In airborne equipment, the interrogator and responser are usually contained in the same housing; this is known as the interrogator-responser (IR) unit (AN/APX-71 or AN/APX-72).

The identification group consists of a transponder and provisions for an auxiliary coder. The auxiliary coder, when installed, enables identification on a selective basis; it is thus called the Selective Identification Feature (SIF). Almost every aircraft and ship of the Armed Forces carries a transponder (such as the AN/APX-6 or AN/APX-64), since this is the unit which provides identity when challenged.

Coder-Synchronizer

The coder-synchronizer is the main unit of an IFF system; it enables the system to have three modes of operation on a time-sharing basis. The coder-synchronizer performs two functions–it generates the selected coded interrogation pulses, and separates the received video pulses into the proper channels.

INTERROGATOR.–The interrogator is a pulse type transmitter, triggered by the coder-synchronizer, which acts as the challenger. When a radar operator observes an unidentified target on the radar, he sets the interrogator in operation and it emits coded challenging (interrogation) pulses.

The challenge is a pair of UHF pulses emitted a few microseconds after the radar pulse. There are three types of challenge signals,

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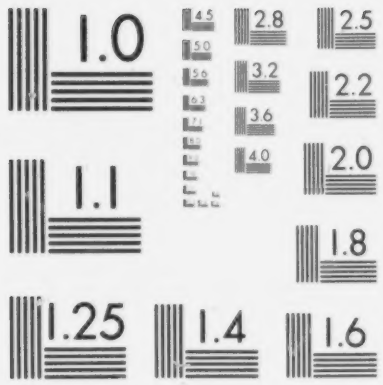

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

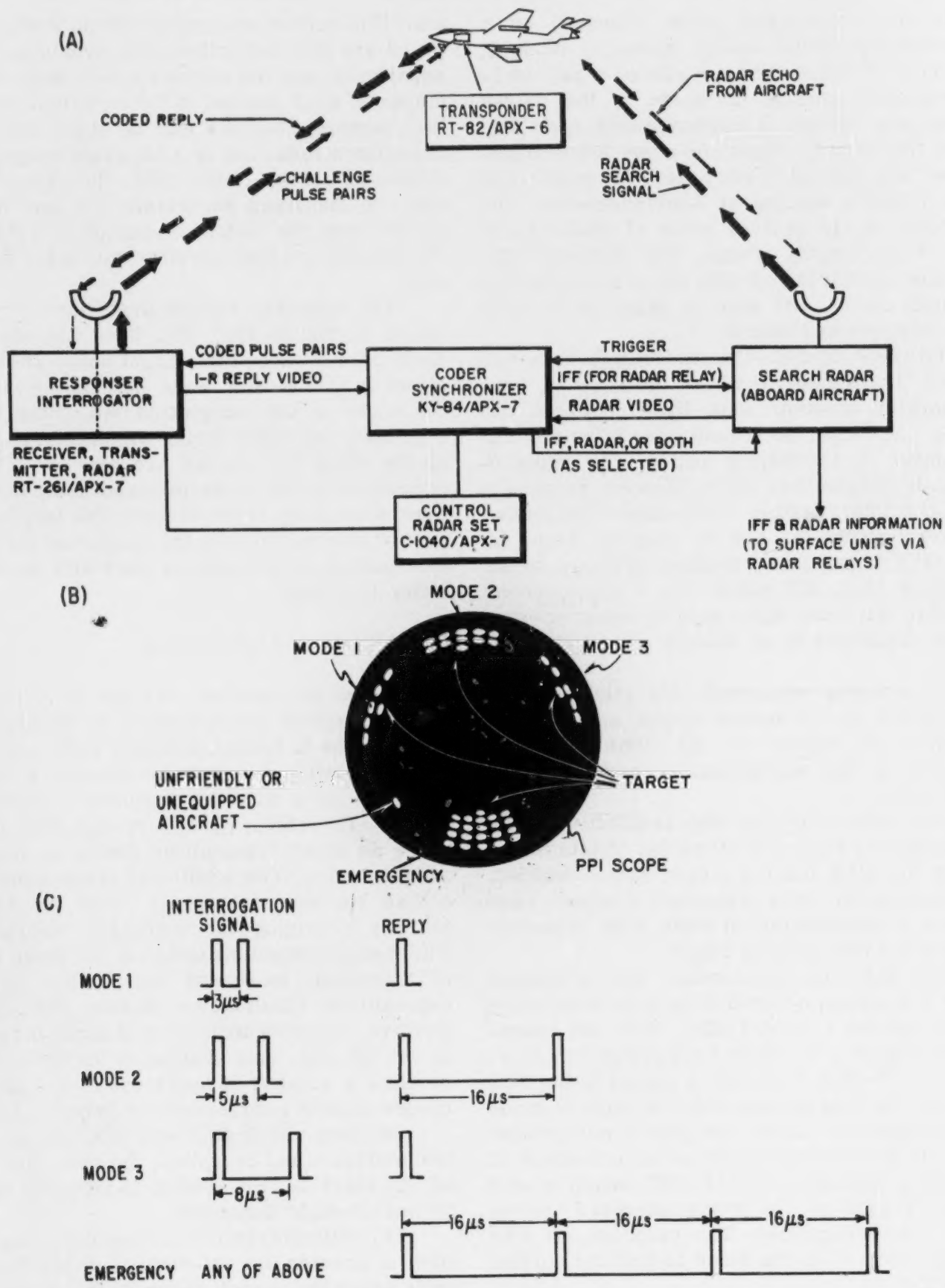

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Figure 19-1.–IFF system.

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which are transmitted (when selected) on a time-sharing basis, called mode 1, mode 2, and mode 3. Each mode produces a pair of 1-microsecond pulses. In mode 1, the paired pulses are spaced 3 microseconds apart between the leading edges; in mode 2 the paired pulses are spaced 5 microseconds apart; and mode 3 has a spacing of 8 microseconds. The selection of the desired mode of challenge is done at the display station. The challenge signals are synchronized with the pulse of the associated radar, but with a delay of 0 to 40 microseconds introduced.

TRANSPONDER.–The challenge is received by the transponder, which is a pulse type transmitter-receiver unit. Upon receiving the proper challenge, the transponder automatically transmits an identifying reply. The reply is normally transmitted on a different frequency from the interrogation (challenge). The modes of interrogation for, and the response from, an aircraft's transponder (without SIF) are shown in figure 19-1. All pulses are 1 microsecond in width. All time spacing is in microseconds and is measured from leading edge to leading edge.

In airborne equipment, the pilot controls the replies to all modes except mode 1. His selection of replies to all other modes is governed by the operational procedures in use at the time.

The airborne transponder is able to generate an emergency reply for all modes of interrogation if the pilot has the proper switch enabled. The emergency reply comprises 4 pulses; each pulse is 1 microsecond in width, with 16 microseconds between leading edges.

The airborne transponder has a special mode 2 function, controlled by a three-position switch labeled I/P-OUT-MIC. With the transponder replying to mode 1 interrogations only, and the I/P-OUT-MIC switch placed in the MIC position, the transponder will not reply to mode 2 interrogations unless the pilot's microphone button is pressed for radio communications. If the spring-loaded I/P-OUT-MIC switch is held in the I/P position, the transponder will reply to mode 2 interrogations. The response for this special mode 2 is the same as that for normal mode 2.

RESPONSER.–Replies from the transponder are received by the responser in the recognition unit. The replies are converted into video pulses, which are then fed to the coder-synchronizer for separation into the correct mode channels. The output of each channel is fed to a final recognition section. The CRT may be either that of the associated radar set or a separate scope. When displayed on the radar CRT, the video pulses may be displayed separately, or they may be mixed with the radar presentation if desired. Provisions are also provided for an SIF decoder unit.

The airborne replies are shown in a PPI scope in figure 19-1 (B). They are shown as dashed lines beyond the target echo. The dashed effect is due to the mode interlacing action of the coder in the recognition unit. Blank spaces represent the time during which interrogations on the other two modes are sent out. The IFF presentation can be distinguished from the radar presentation by these dashes. The length of the dashed line varies with the range and the radiation pattern of the antenna used with the recognition (IR) unit.

Capabilities and Limitations

In the IFF system, the use of a receiver and transmitter (transponder) at the target not only serves to furnish a strong reply signal for the recognition set, but also permits replies to be made on a different frequency, eliminating clutter. Therefore, the IFF system does not require as much transmitter power as does the search radar. The additional transponder also allows the use of separate codes for replies, thereby providing for increased information. The distinctive coding used for the three modes of operation increases the traffic handling capabilities, eliminates confusion, and provides positive, rapid identification of unknown targets. In the IR unit, time sharing of the three modes permits a number of operators to use different modes without interference or delays.

Because ultrahigh frequencies are used for transmission and reception, the operation range of the Mark X IFF system is virtually limited to line-of-sight distances.

IFF will often provide recognition responses over a greater line-of-sight distance than that over which the search radar (associated with the interrogator) can respond to its own echo signals. The explanation is simple: Radar energy re-

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turned as an echo is only a very small percentage of the energy that was initially transmitted from the radar in an ever-widening beam, while the response from an IFF transponder is a much stronger signal that travels only one way–to the responser. The interrogation radar energy that strikes a distant target may be of sufficient strength to trigger the IFF transponder but not to return a usable echo. (For the purpose of this discussion, a usable signal is one having sufficient strength, when returned to the radar receiver, to be detected, amplified, and displayed as a target.) The IFF response in this case will be usable, while the radar echo will be of insufficient strength to be usable.

THEORY OF IFF

INTERROGATOR-RESPONSER AN/APX-7

The AN/APX-7 is an airborne IR unit which forms an integral part of the Mark X IFF system. It consists of Radar Receiver-Transmitter RT-261/APX-7, Coder-Synchronizer KY-84/APX-7, Radar Set Control C-1040/APX-7, and mountings.

The primary purpose of the AN/APX-7 is to challenge the identity of targets which are detected and displayed by the search radar set with which it is associated, distinguishing between friendly targets and enemy targets. In addition, the AN/APX-7 provides detailed recognition information on friendly targets for additional security and tactical purposes. Both the radar and IFF replies may be shown on the same display without compromising the radar's performance.

Functional Block Diagram

Figure 19-1 (A) is a simplified block diagram of an IFF system using Radar Recognition Set AN/APX-7. (The block diagram for a surface craft would be the same; only the components would be different.)

The search radar aboard the aircraft picks up an unknown target. The radar operator, wishing to identify this target, operates his recognition set, causing challenge signals in the form of coded pairs of RF pulses to be transmitted in synchronism with the associated radar set. If the interrogated target is equipped with an operating IFF transponder (APX-6), it identifies itself by detecting and analyzing the coded interrogation and automatically transmitting the reply signals. These replies are picked up by the recognition set, converted into video signals, and displayed on the search radar indicator. By observing this display, it is possible to determine instantly the identity of the challenged target.

Only the recognition set which transmits the challenge signal can synchronize the coded replies for useful display. Replies which are transmitted in response to challenges from other recognition sets also may appear on the radar indicator screen. However, they will be seen as random, nonsynchronous, momentary flecks of light.

The AN/APX-7 is designed so that IFF replies may be displayed on remote indicator units aboard the aircraft as well as on the search radar indicator screen. In addition, all IFF and radar information received and displayed aboard the aircraft can be made available to certain shipboard and other aircraft radars by means of an associated radar relay transmission system.

Time Sharing and Transmitting

The time-sharing function of an IFF system is accomplished by use of a coder-synchronizer. The trigger pulse (cosine pulse) from an associated radar is applied to a countdown multivibrator (fig. 19-2). The multivibrator provides one output for each input trigger, provided that the cosine's PRF does not exceed 320 pps. If the PRF is greater than 320 pps, the output will be the largest submultiple between 160 and 320 pps; for example, 500 pps in - 250 pps out.

The countdown output is then applied to three circuits–the coder (pulse pair generator), the coded IR circuits, and the triple gate generator. The pulse to the triple gate generator is either applied directly or further counted down by a counter circuit which divides the frequency of the pulse rate by a factor 2, 4, 8, or 16, depending upon the setting of switch S1001. The

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3. List the set basic rules for dimensioning.

4. How would you dimension a full diameter?

5. How far from the drawing do extension lines extend, approximately?

6. Explain why a note is useful on a drawing.

7. What is wrong with including too many dimensions?

8. Explain why dimensioning from a practical, shop viewpoint is desirous.

ASSIGNMENT:

Draw the views of the object shown below and dimension fully. Obtain dimensions by scaling drawing.

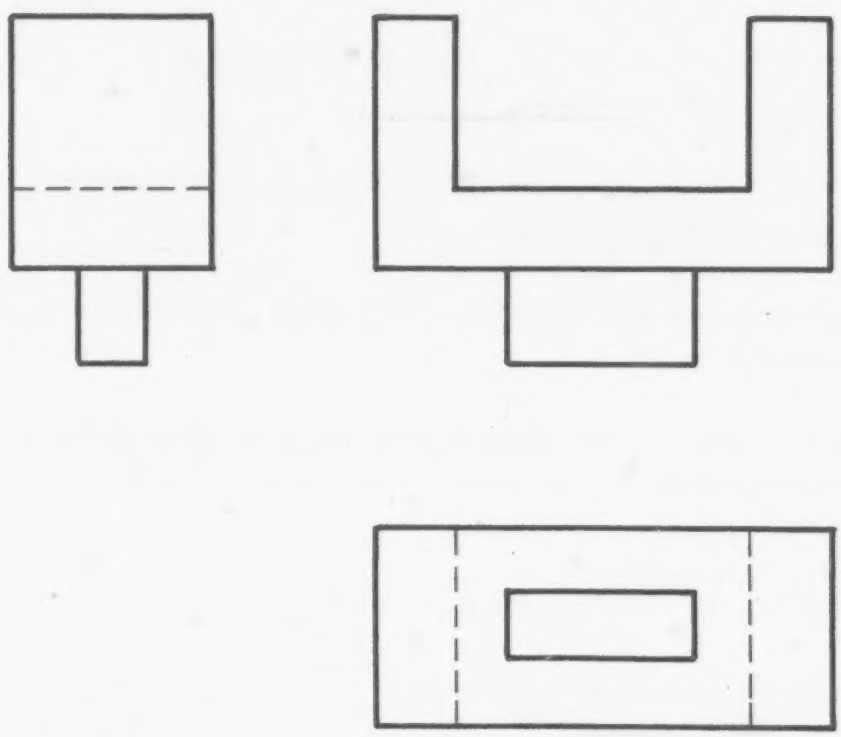

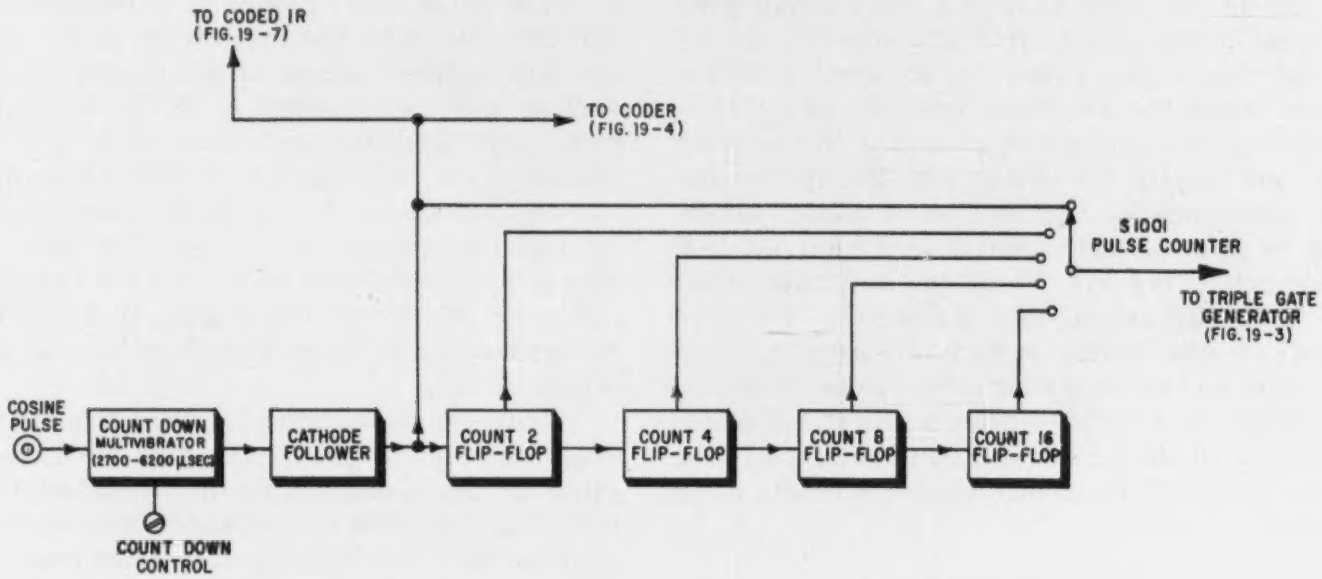

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Figure 19-2.–Pulse countdown and counter, block diagram.

reason for the second countdown will be described later.

TRIPLE GATE GENERATOR.–The pulse (through S1001) triggers a delay multivibrator (fig. 19-3) whose duration (delay time) is adjustable from 2,700 to 6,200 microseconds. Since the trailing edge of the delay gate is used

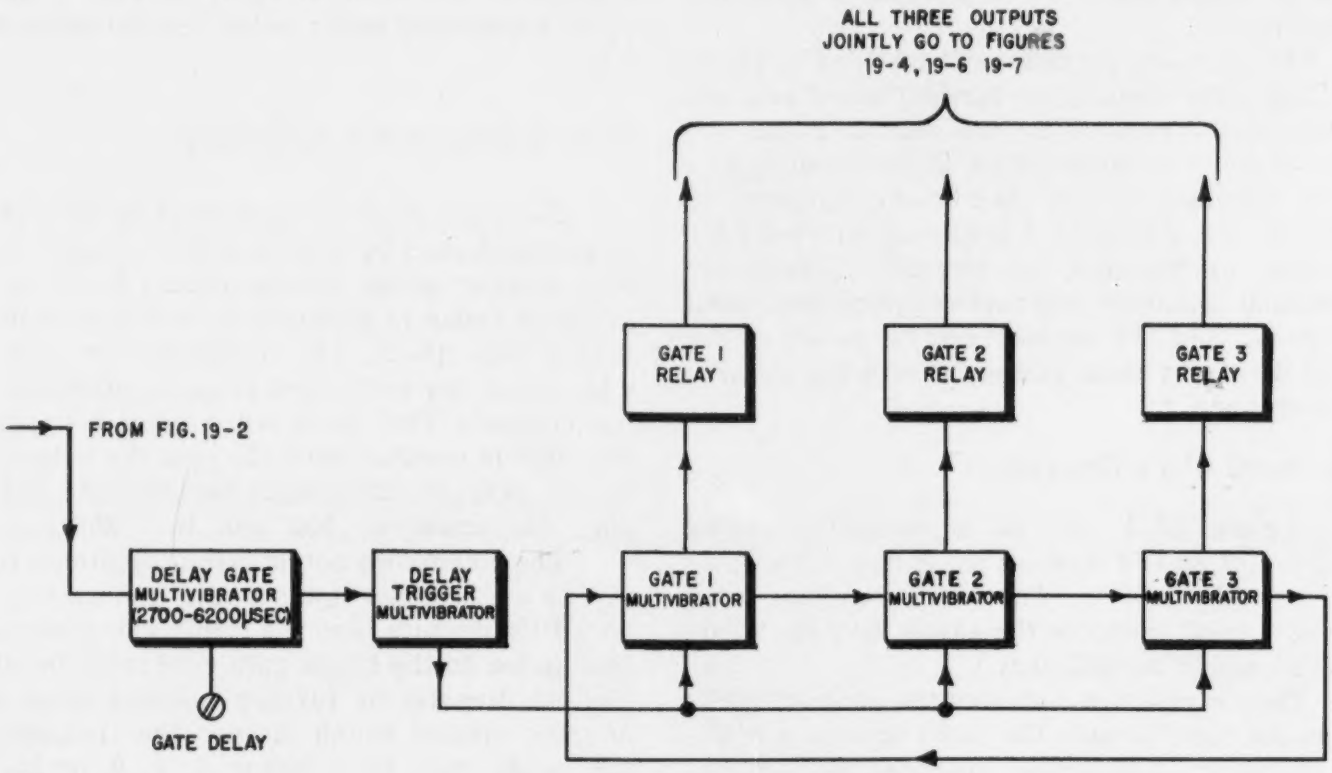

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Figure 19-3.–Triple gate generator, block diagram.

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to trigger the gate circuits, generation of the gate is delayed by the same period.

The purpose of this delay is to make sure that mode switching does not occur exactly when a coded pulse pair is being generated. The delay also allows sufficient time after transmission of a coded pulse pair for all replies to be picked up by the receiver. The amount of delay selected is dependent on the associated search radar range, and properly synchronizes the IFF operating range with the radar.

The gate generator furnishes three gating pulses which are used to enable use of modes 1, 2, and 3 in rotating (or time sharing) sequence. Each delayed pulse stops one gate and starts the next. Mode 1 gate starts when mode 3 ends, mode 2 starts when mode 1 ends, mode 3 starts when mode 2 ends. The duration time of each gate is a function of the type of count selected; a 1, 2, 4, 8, or 16 count may be selected (by S1001) in the counter circuit.

CODER.–The coder generates the coded pulse pairs which are fed to the modulator in the transmitter-receiver (interrogator) unit. In mode 1 the pulse generator will generate a pair of pulses that are 3 microseconds apart. Mode 2 pulses will be 5 microseconds apart and mode 3 pulses will be 8 microseconds apart. (See fig. 19-1.)

The trigger pulses from the first countdown circuit (fig. 19-2) are fed to a delay multivibrator (fig. 19-4) which provides trigger pulses that can be delayed from 6- to 50-microseconds (maintenance adjustment). This stage is used to delay the transmission of each pulse pair so that it occurs after the associated radar transmission, thereby, causing the IFF return signal to be displayed beyond the radar return target on the radar scope. The delay multivibrator would be adjusted for a delay of 40 microseconds if the associated radar had a 30-microsecond delay between the generation of the cosine trigger and the firing of the transmitter. Thus, the IFF return would be displaced 10 microseconds after the radar return target.

The output from the delay multivibrator is a positive square wave whose trailing edge triggers a blocking oscillator (fig. 19-4). The output of the blocking oscillator is a positive pulse of approximately 1 microsecond duration which appears across the cathode load resistor in the delay line (fig. 19-5).

The delay line is a lumped-constant line with taps for 8, 5, 3, and 0 microseconds of delay. The outputs from the 3-, 5-, and 8-microsecond taps are coupled to the control grids of the first-pulse-gated amplifiers (fig. 19-6) for modes 1, 2, and 3, respectively. The 0-microsecond tap is coupled to the control grid of the second-pulse-gated amplifier.

The four gated amplifiers (fig. 19-6) are coincidence amplifiers and are normally cut off by the combined negative voltages applied to the suppressor and control grids. These stages will conduct only when positive voltages are simultaneously applied to both the suppressor and control grids. The suppressor grids of modes 1, 2, and 3 first-pulse-gated amplifiers are connected to gate 1, gate 2, and gate 3 output terminals respectively (fig. 19-3) of the triple gate subassembly.

This mode-enabling gate voltage is automatically selected when the operator chooses the desired interrogation mode. The IFF control box has a rotary mode switch for selection of mode 1, 2, or 3. By selecting a particular mode, the appropriate gate relay is energized thereby allowing the positive gate voltage to be applied to the appropriate first-pulse-gated amplifier suppressor grid in the Coder and IR Coder sections.

Therefore, when a mode-enabling gate voltage is applied to the suppressor grid of one of the first-pulse-gated amplifiers, (figs. 19-4 and 19-6) the amplifier will conduct as the positive pulse from the delay line appears on the control grid. As a result, a negative-going pulse is developed across the plate load resistor, R134 (fig. 19-6). This plate load resistor is common to modes 1, 2, and 3 first-pulse-gated amplifiers and to the second-pulse amplifier.

The negative-going output pulse developed across the common plate load resistor is applied first to a multivibrator, (fig. 19-4) then to a cathode follower operated at cutoff. The cathode follower provides a low-impedance output from the coder section and for the input to the modulator of the transmitter section (fig. 19-8). The cathode follower output is also applied to a pulse-stretching network.

The pulse-stretching network consists of a very long RC network that effectively stretches the pulse width from 1 microsecond to at least 9 microseconds. The stretched pulse is applied to the suppressor grid of the second-pulse-gated

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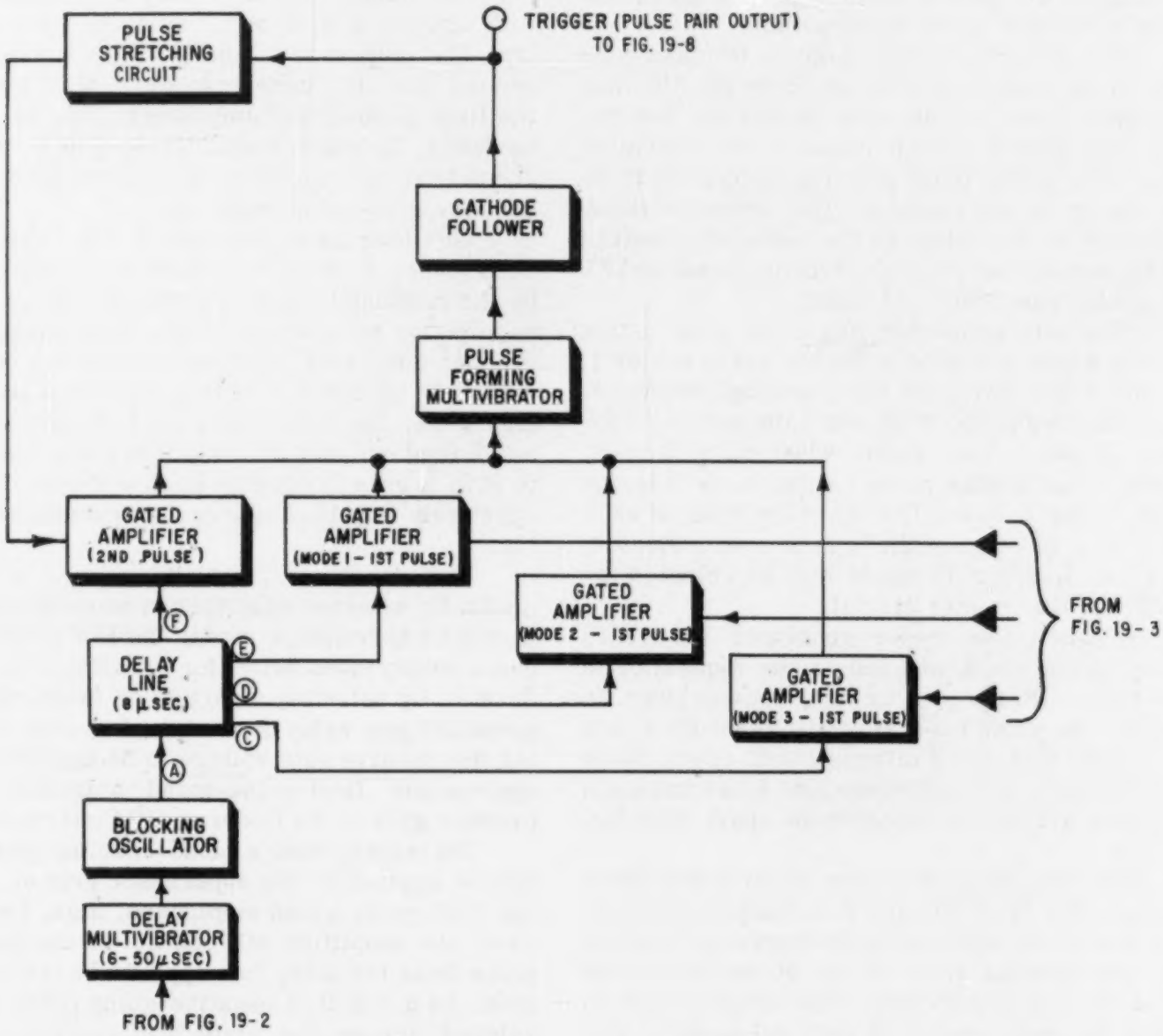

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Figure 19-4.–Delay multivibrator, block diagram.

amplifier (fig. 19-5 and 19-6). Thus, this amplifier will conduct when the delay-line pulse (in moving along the delay line) reaches the 0 delay tap and is applied to the grid of the second-pulse-gated amplifier. The second-pulse-gated amplifier will develop the second negative going pulse across the common amplifier load resistor R134. This pulse is also applied to the pulse forming multivibrator, cathode follower, and the coder section output. For every first pulse generated, a second pulse is also generated. A third pulse can not be generated even though the second pulse is returned thru the stretching network because there is no positive pulse applied from the delay line. The pulse pair is generated only at the PRF rate of the count down multivibrator (fig. 19-2).

In summary, refer to figures 19-4, 19-5, and 19-6. In mode 3 operation and with a single pulse appearing at (B), the following occurs:

1. The pulse will appear at point (C).
2. Point (C) is connected to the grid of the first-pulse-gated (mode 3) amplifier. This amplifier will conduct because the positive gating voltage (mode 3) has been applied to its suppressor grid.

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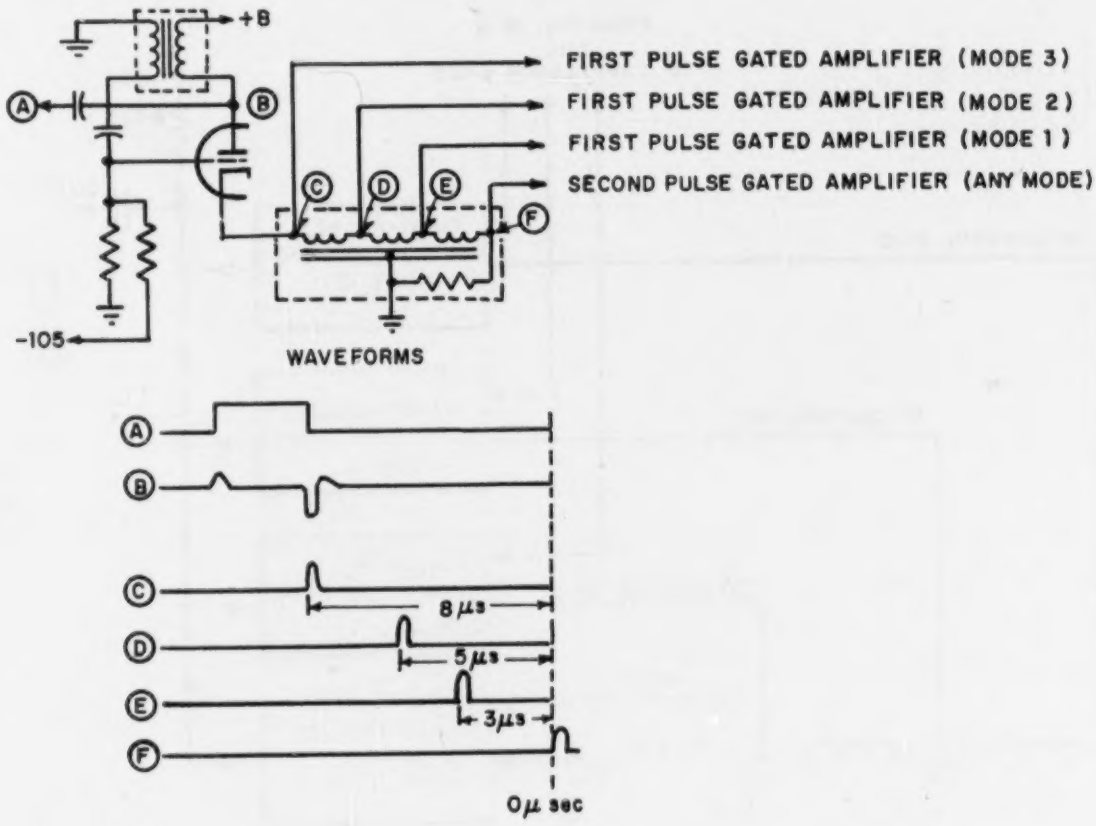

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Figure 19-5.–Blocking oscillator and delay line.

3. The output from this amplifier creates the first pulse as well as applying it to the pulse stretching circuit. The stretching output places a positive voltage on the second-pulse-gated amplifier suppressor grid. The second-pulse-gated amplifier is now in a condition to conduct when the delay line pulse reaches point (F) and is applied to its grid.

4. As the pulse passed thru points (D) and (E), the first-pulse-gated amplifiers of modes 1 and 2 could not conduct because there was no positive gating voltage applied to their suppressor grids.

5. After a total of 8 microseconds, from point (C), the pulse arrives at point (F).

6. The pulse at point (F) will cause the second-pulse-gated amplifier to conduct because the stretching circuit is holding a positive voltage on its suppressor grid. The second pulse now appears across the common load resistor 8 microseconds after the first pulse.

7. If the operator had interrogated mode 2, rather than mode 3, as the delay-line pulse reached (D), it would have created a mode 2 first pulse rather than the previously mentioned mode 3 first pulse resulting in a coded pair of pulses that are 5 microseconds apart. In mode 1 operation the coded pair would have been 3 microseconds apart.

CODER IR CIRCUITS.–The coder IR subassembly (fig. 19-7) accepts triggers from the first countdown (fig. 19-2), together with the mode-enabling gate pulse from the triple gate circuit (fig. 19-3), and generates three distinctive "coded IR" pulses, one for each mode of operation.

The coded IR pulses occur 15, 20, and 25 microseconds after the trigger which is used to actuate this circuit for modes 1, 2, and 3, respectively.

The selected IR pulse and corresponding IFF video are fed to video time-sharing circuits in the associated radar synchronizer. There they are mixed with data transmission generated in the synchronizer and fed to the relay link. The ONLY function of the coded IR pulses is to permit selection and display of the correct video

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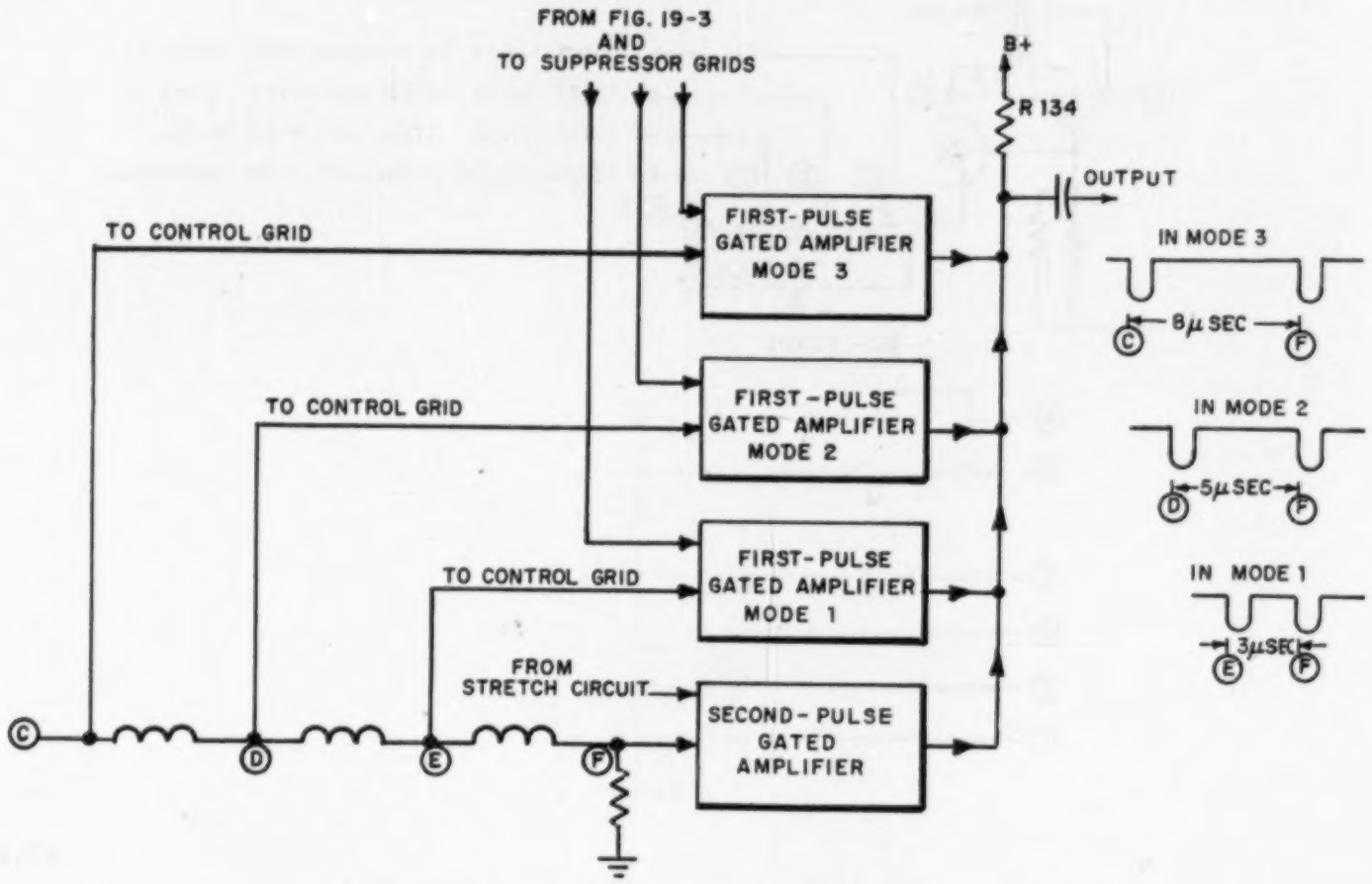

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Figure 19-6.–Pulse pair generator (coder).

at the remote indicator through a relay data system.

UHF TRANSMISSION.–The UHF transmitting section generates, modulates, and transmits coded RF challenge pulse pairs. Figure 19-8 is a simplified diagram of the transmitting section. This section consists of transmitter multiplier Z202, modulator Z102, frequency converter transmitter Z101, and the required power supplies.

The transmitter multiplier subassembly contains a crystal oscillator (V206) and necessary amplifiers and frequency multipliers (V207 through V210) to provide a signal at the required frequency between 336.3 MHz and 343.3 MHz. The output of the transmitter multiplier subassembly is fed to the frequency converter subassembly.

V211 functions as a tripler with the cathode-grid line tuned in the frequency range of 336.6 MHz to 343.5 MHz, and the grid-plate line to the final output of 1,010 MHz to 1,030 MHz.

The input pulse pairs fed to the modulator are positive trigger pulses delivered by the coder subassembly of the coder-synchronizer. These pulses are applied across the primary of a step-up input transformer T401. The transformer is connected in such a manner that the voltage pulses applied to the grid of driver stage V401 are of positive polarity. V401 is biased below cutoff by the negative voltage on its control grid. The pulses appearing at the output of T401 have an amplitude of approximately 160 volts, which drives V401 into heavy conduction. Since the tube is biased below cutoff, and is driven to saturation by the applied pulse, the output is effectively clipped and is essentially a square waveform. The output of V401 is transformer coupled to V402 by means of interstage transformer T402. V402 employs a circuit similar to V401 and develops its output pulse across the primary of T403, a phase inverting, pulse modulation transformer which has two output taps.

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The outputs from T403 furnish high-level pulse modulation of the AN/APX-7 transmitter. There are two outputs from T403–a low-voltage pulse pair, approximately 300 to 400 volts; and a high-voltage pulse pair, approximately 2,400 volts. The low-voltage pulses furnish plate voltage for V208, V209, and V210 in the transmitter multiplier. The high-voltage pulses furnish plate voltage to the high-power drivers and output stage (V211 through V214).

Coils Z401, Z402, Z210, and Z211 serve two important functions. The first is their action as peaking coils, isolating the capacitance of the transmitter tubes from the modulator output, thereby improving the video waveform which is applied to the plates of the transmitter tubes. Second, they delay application of the video pulses to the plate until the RF energy in the grid circuit has a chance to build up to its maximum value.

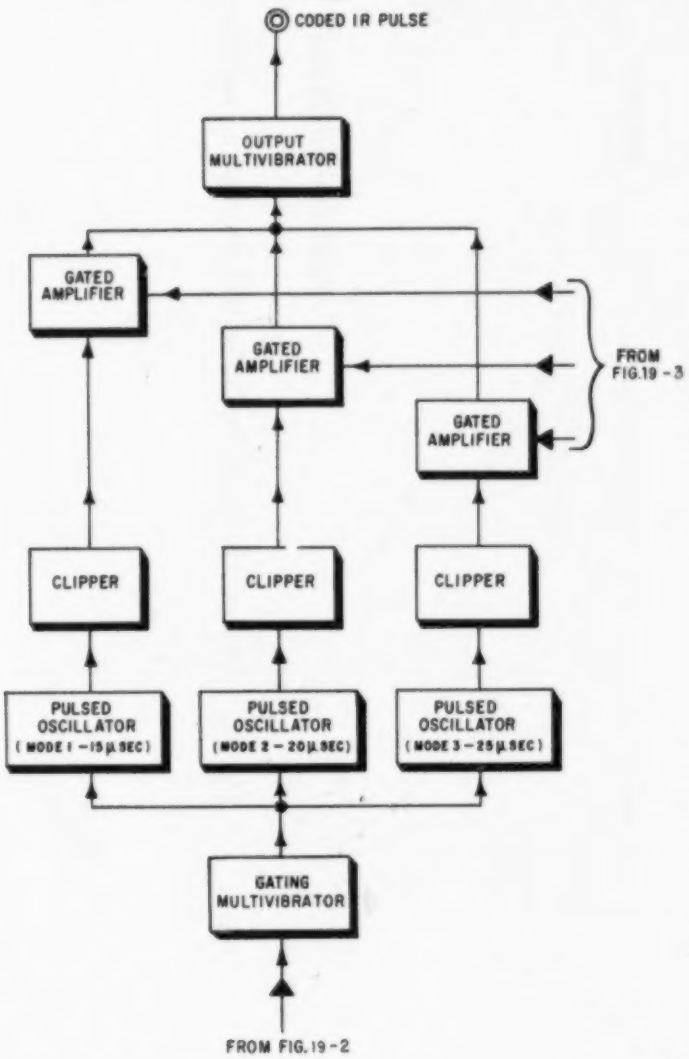

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Figure 19-7.–IR coder.

The high-power stages of the transmitter consist of coaxial line type cavities using 2C39A lighthouse tubes. The coaxial line type cavity has a high inherent Q and low radiation, making isolation of circuits relatively easy.

Each 2C39A employs two coaxial line cavities, each electrically equal to approximately one-quarter wavelength at the desired operating frequency. One cavity forms the cathode-grid circuit while the other forms the grid-plate tank circuit. Thus, each stage constitutes a grid-separation amplifier with grounded grid. RF excitation is applied to the cathode-grid input circuit, and output is taken from the grid-plate line. Exact tuning for the particular operating frequency is accomplished by means of an adjustable tuning ring in the grid-plate line. (See fig. 19-9.) This ring acts as a variable capacity which effectively lengthens or shortens the cavity according to the frequency being used.

Figure 19-9 shows the physical construction of the 2C39A circuit used in this equipment; figure 19-10 shows the electrical equivalent of this circuit. As seen in these figures, the input RF power is fed to the circuit via a coaxial line whose center conductor extends into the grid-cathode line. RF power developed in this cavity is then amplified by the tube and appears in the grid-plate line. Note that there is no direct coupling between the grid-cathode and grid-plate lines although a common grid line is used. This is true since, at microwave frequencies, current flows only at the surface of the conductor. Consequently, the cathode-grid current flows only on the INNER SURFACE of the grid line. Plate-grid current flows only on the OUTER SURFACE of this line. There is essentially no coupling (at microwave frequencies) between the inner and outer surfaces of the line.

The RF power developed in the grid-plate line is picked up by a loop connected to the inner conductor of a coaxial line at the output of the cavity. This coaxial line transmits the energy to the next stage, where similar construction is used.

The output of the final amplifier V214 is loop coupled to the antenna by means of antenna coupling post Z207A (fig. 19-8) which is mounted between the grid-plate cavity of V214 and first preselector Z207B. The antenna coupling is used

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for transmission of V214 output and for reception of a response.

DECODING CIRCUITS.–The IFF replies are picked up and detected by the receiver in the IR unit. The mixed video signals (all three modes) are fed to the input circuit of the video separator subassembly (in the coder-synchronizer). The video separator performs the function of separating the IFF video pulses into three channels, one for each mode.

The function of the video separator is illustrated by the block diagram in figure 19-11. Amplifying is done by a dual stage amplifier that operates without any phase reversal of input to output. A schematic diagram of the amplifier is shown in figure 19-12. The video pulses from the receiver are applied to the cathode of a grounded-grid amplifier. The signal is taken off the plate and applied to the grid of a cathode follower. The input to the cathode follower is limited by V1502A, so that the output does not exceed 6 volts. The output of the cathode follower is applied to the grids of modes 1, 2 and 3 separators and to another cathode follower. (See fig. 19-11 also.) The separators for modes 1, 2, and 3 are biased considerably below cutoff, and the video pulses alone are not enough to cause conduction. Each separator is controlled by a time-shared, positive-going square wave through a gating diode circuit.

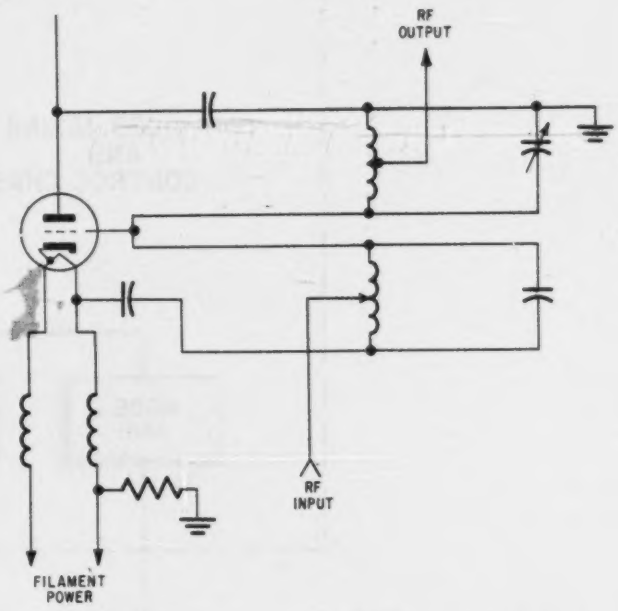

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Figure 19-10.–Type 2C39A, equivalent circuit.

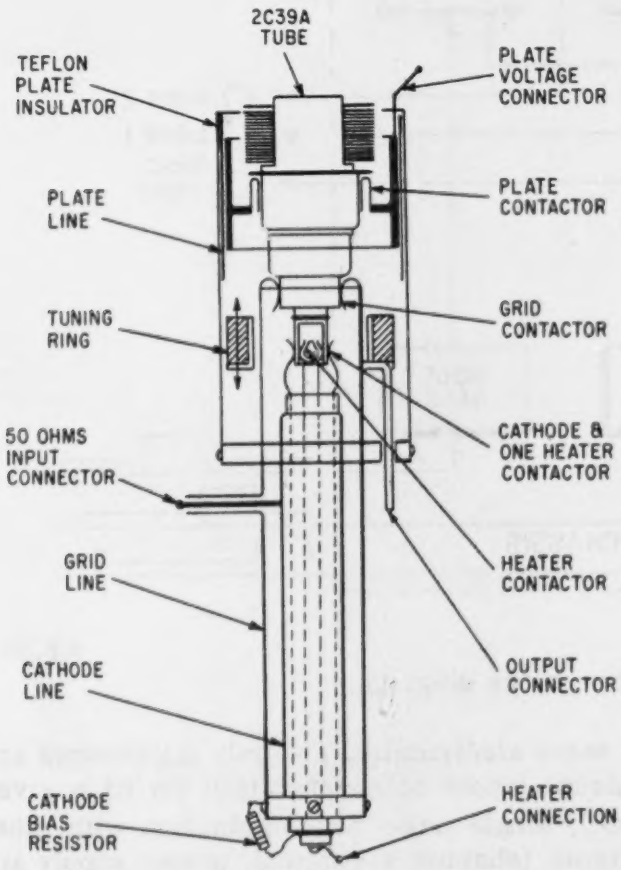

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Figure 19-9.–Type 2C39A, tube and cavity, simplified.

Mode 1 separator and gating diode are shown in figure 19-12. Modes 2 and 3 separator circuits (not shown) are similar to mode 1.

When a gate voltage is applied to V1503, a cathode follower, the tube can conduct. During the time of the gate voltage, any video pulses coupled to the grid of V1503 from the cathode of V1501 will appear across the cathode load resistor (R1513) of V1503. (Load resistors are front panel mounted potentiometers.)

For the period of time during which a gate voltage is applied to V1503, it is also applied to the mode 1 channel of the interrogator. For this period of time the interrogator will issue only mode 1 challenges; in this manner, only mode 1 replies will appear at the output of V1503.

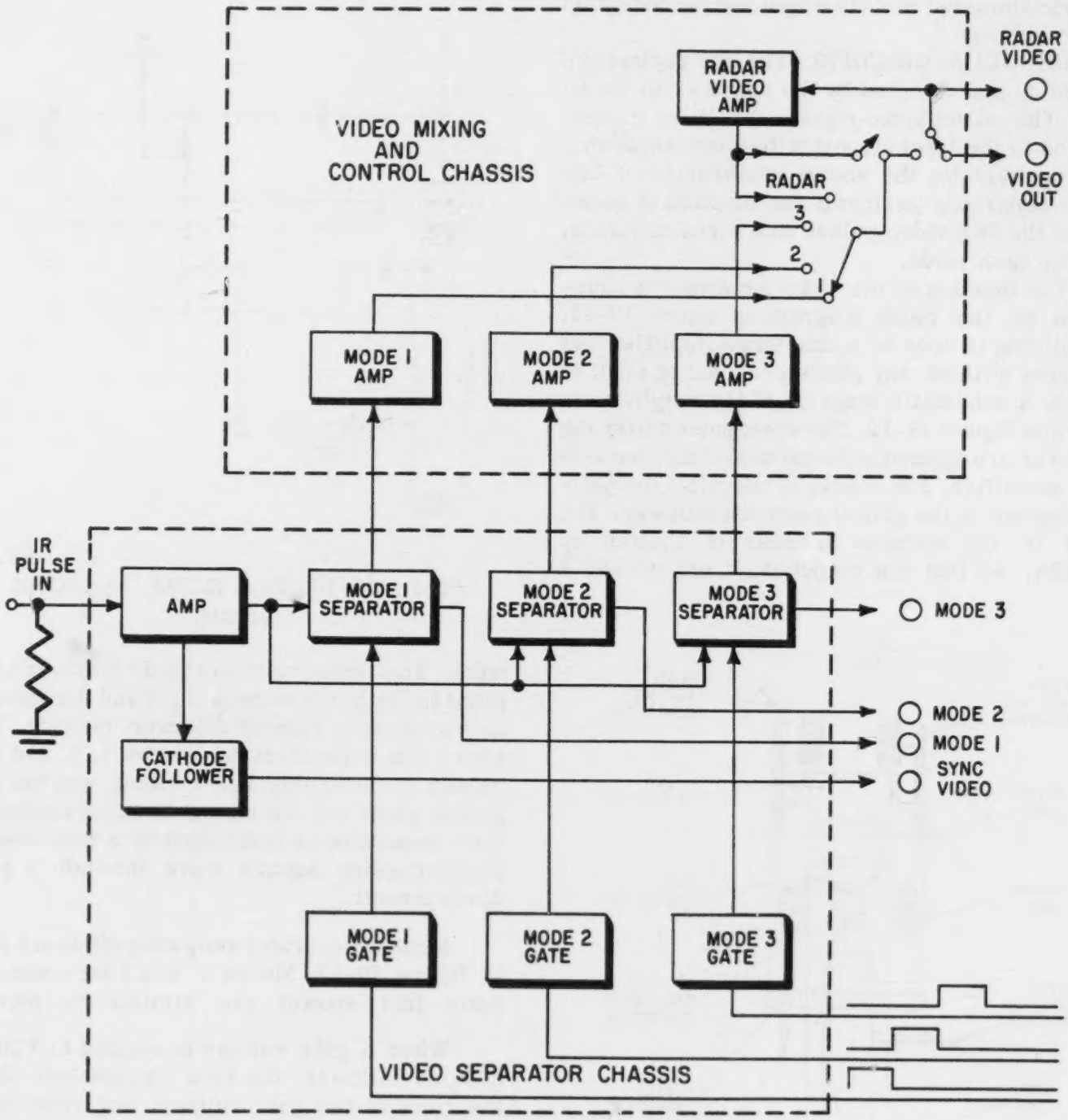

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Figure 19-11.–Video separator, block diagram.

TRANSPONDER AN/APX-6

There are several different Mark X aircraft transponders in use, according to the type of aircraft in which they are installed. They all perform the same function and are basically the same electrically. The only differences are different layout of construction (to fit a given space); single unit; or combination with other systems (sharing a common power supply and housing) for the conservation of weight and space.

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Functional Operation

The function of an IFF transponder may be more easily understood by referring to the simplified block diagram (fig. 19-13) in connection with the following description. The main signal channel, which is indicated by heavy lines, is arranged in the form of a loop, using a common omnidirectional antenna for reception and transmission. The equipment contains a superheterodyne receiver with broad bandwidth characteristics. The output of the receiver actuates a pulse type transmitter through a decoder and a reply pulse generating circuit.

Interrogation pulses received by the antenna pass through the preselector to the crystal mixer, where they are mixed with the output of the local oscillator. The output of the crystal mixer is filtered to remove the RF components and is fed to the IF amplifiers.

Six stages of amplification are used, in which degenerative feedback and other broadband methods provide wide bandwidth characteristics. Automatic-overload-control (AOC) and automatic-volume-control (AVC) voltages act on some of the IF amplifiers to progressively reduce the gain under conditions of excessive rate of interrogation or high levels of signal. The AOC is intended to prevent overloading of the equipment and also to maintain effectiveness of transponder operation in areas of heavy interrogation, where it is more important that the

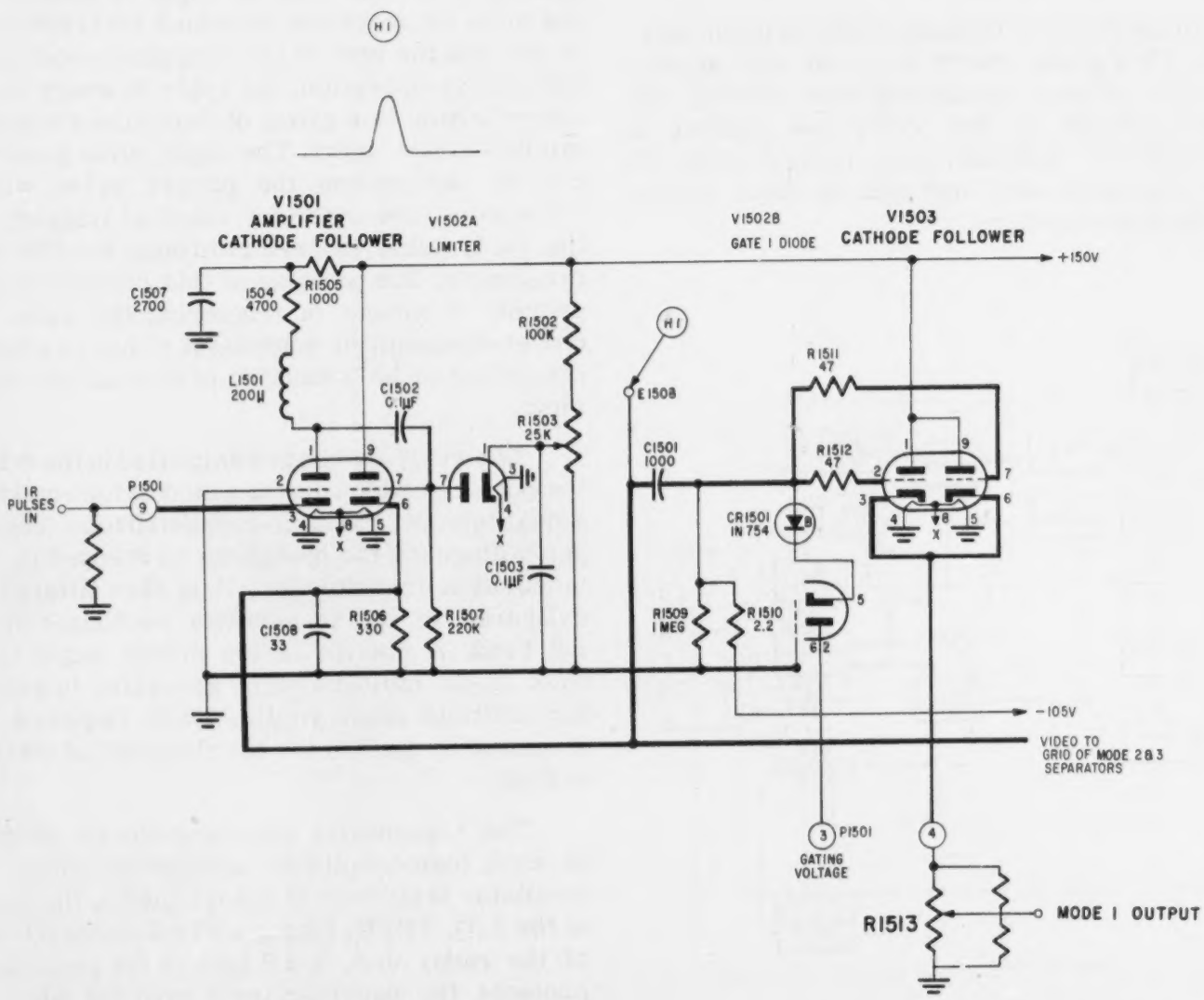

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Figure 19-12.–Amplifier, mode 1 video separator.

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Placement of Dimensions Lesson 4

OBJECTIVE: To learn the proper placement of dimensions.

RELATED INFORMATION:

There are no hard- and - fast rules for dimensioning procedures. If possible, however, adhere as closely as you can to the following principles in the placement of dimensions.

1. Dimensions outside the view are preferred.

2. When there are dimensions between views, the extension lines should be drawn from one view, not both.

3. Dimensions should be placed on the view that shows a distance in its true length.

4. Dimension lines in general, should be spaced $\frac{1}{2}$ inch away from the outlines of the view.

5. Parallel dimension lines should be spaced uniformly, with at least $\frac{3}{8}$ inch between lines.

6. Staggered dimensions may be used, depending upon convenience and readability.

7. Always place the longer dimension outside the shorter ones to avoid crossing dimension lines with the extension lines of other dimensions.

8. Dimensions should never be crowded.

9. All notes must read horizontally.

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transponder reply to nearby than to distant interrogation. The AVC is intended to reduce the harmful effects of CW jamming. To minimize the effects of strong echo pulses which, in conjunction with other signals, might falsely trigger the transponder, suppression circuits are included in the IF strip.

A diode detector demodulates the IF pulses, and the resulting video pulses are amplified first by two video stages in the IF strip, and then by three video stages, one of which is also a spike discriminator. The AOC/AVC voltages also bias the diode detector to produce the same effects as in the IF amplifiers.

A differentiating circuit, part of the first video stage, decreases the width of single pulses that might falsely trigger the decoders, and also minimizes the effect of strong off-tune interference.

Three decoder circuits block the main channel to all signals except the pulse pair signals with the proper characteristics. Setting the master switch of the radar set control to EMERGENCY automatically insures that all three decoders are operated by their correponding interrogations.

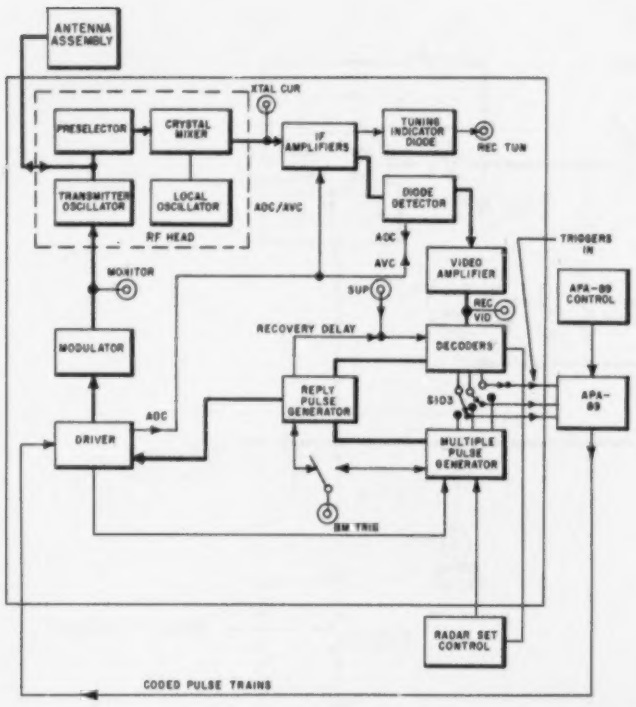

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Figure 19-13.–Radar receiver-transmitter.

The main signal channel is automatically blocked at the decoders for a short, fixed interval (75 to 125 microseconds) following the transmission of each reply pulse or pulse code group. This prevents the transponder from replying more than once to multiple path interrogations, and helps to avoid overloading. External suppression pulses from associated equipment may be injected into the transponder, through the SUP receptacle, to disable all reply transmissions for fixed intervals, during which the associated equipment can operate without interference.

Whenever one of the decoders is triggered into operation, its output is fed into the reply pulse generator, either directly or through the multiple generator, producing a reply pulse or pulse group. The type of reply is governed by the mode of operation for which the transponder is set and the type of interrogation received. In emergency operation, the reply to every type of interrogation is a group of four pulses spaced 16 microseconds apart. The reply pulse generator circuit determines the proper pulse widths. Provisions are made for external triggering of the reply pulse generator through the BM TRIG receptacle. The purpose of this receptacle is to provide a means of triggering the radar receiver-transmitter equipment either as a testing procedure or as a function of an auxiliary equipment.

The reply pulses are amplified in the driver, the output of which drives a modulator employing a dual tetrode, parallel-connected tube. The output voltage of the modulator is stepped up by a modulation transformer. It is then filtered and delivered to the transmitter oscillator in the RF head. A portion of the driver output is fed back to the multiple pulse generator to provide for multiple pulse replies when required, and a portion is used in the development of the AOC voltage.

The transmitter oscillates for the duration of each high-amplitude modulating pulse. The oscillator frequency is determined by the setting of the L.O. FREQ. tuning control on the RF head of the radar unit. A TR tube in the preselector protects the receiver input circuits while the RF energy is generated by the transmitter oscillator and delivered to the antenna.

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RF Head

The RF head receives and transmits pulsed ultrahigh-frequency signals. It employs an integral, enclosed RF section, using a lighthouse tube as a transmitter oscillator, another lighthouse tube as a receiver local oscillator, and a crystal diode as a mixer. The tuned circuits consist of singly and doubly reentrant resonant line chambers. The RF head block diagram (fig. 19-14) indicates the main signal path through the RF head.

Front and top views of the RF head mechanical assembly are shown in figure 19-15. The mechanical assembly consists of three vertical cylinders emerging from a rounded, boxlike lower section. The RF head houses a doubly reentrant resonant line and two singly reentrant resonant lines, used respectively by the transmitter oscillator, the preselector, and the local oscillator.

Coupling to and from the RF head is provided by the following:

1. The horizontal cylinder terminating in the antenna receptacle J401.

2. The right-angle cylinder, which houses the crystal mixer and filters and terminates in the mixer output connector J404.

3. A receptacle (J401) in the transmitter oscillator anode chamber, into which modulation pulses are injected through a cable terminated by connector P411.

4. A feed-through type capacitor (C403) located on the local oscillator chamber, through which the local oscillator plate voltage supply is fed.

5. A 9-pin connector (J454) to which plate and filament voltages are fed.

Special Circuits

TUNING MECHANISM.–The tuning mechanism controls the resonant frequency of the reentrant lines. Three knurled, disk type controls identified as TRANS-FREQ., L.O. FREQ., and RCVR-FREQ. are mechanically linked to pistons which control the frequency of the transmitter, local oscillator, and receiver RF section, respectively. These controls are shown in figure 19-15.

When any one of the controls is turned, its associated piston is raised or lowered in the resonant line. This causes the resonant frequency of the line to change; the direction of change depends on the direction in which the control is rotated. If dial rotation is in such a direction as to cause maximum piston insertion, the lowest frequency is obtained. Maximum rotation of the dial in the opposite direction then causes the piston to be withdrawn from the line and increases the frequency.

For convenience in making frequency settings, each of the tuning controls has a micrometer scale which ranges numerically from 0 to 3 in steps of 0.01. A calibration chart, furnished with the equipment, lists the proper micrometer settings of the three dials for a particular assigned frequency. The receiver is tunable over

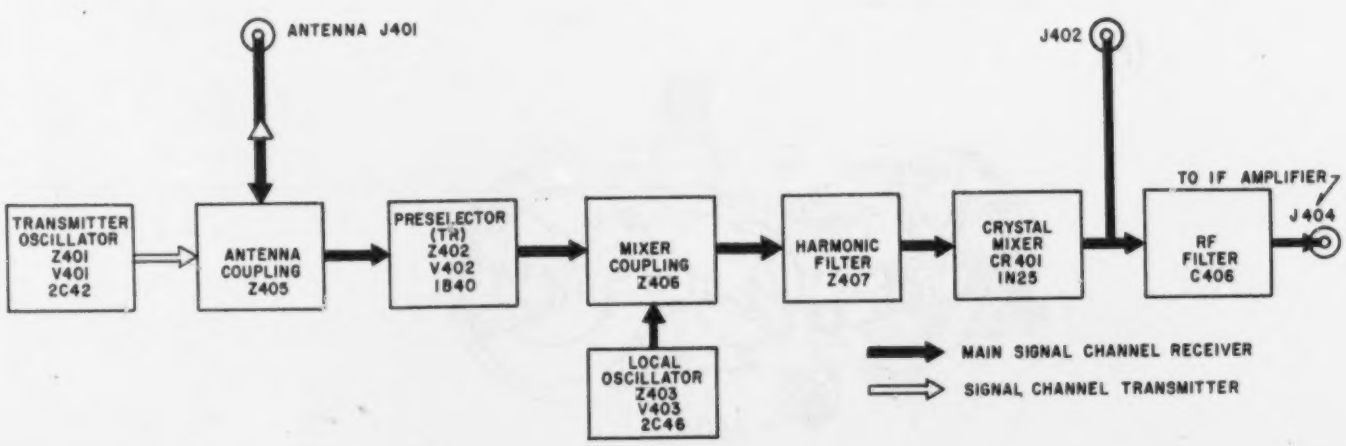

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Figure 19-14.–RF head, block diagram.

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a range of 990 to 1,050 megahertz; the transmitter tuning range is 1,070 to 1,130 megahertz.

As shown in figure 19-16, each tuning control has a stationary scale and a movable scale. The stationary scale is graduated from 0 to 3 with scale divisions at 0.25 intervals. The movable scale is graduated from 0 to 25 and makes possible accurate interpolation of the readings of the stationary scale, since a complete revolution of the movable scale equals 0.25, or one division, on the stationary scale.

The movable scale is attached to the knurled dial; therefore, it is rotated by the movement of the knurled dial of the tuning control. Thus to set a tuning control to a particular frequency, determine the correct numerical setting from the

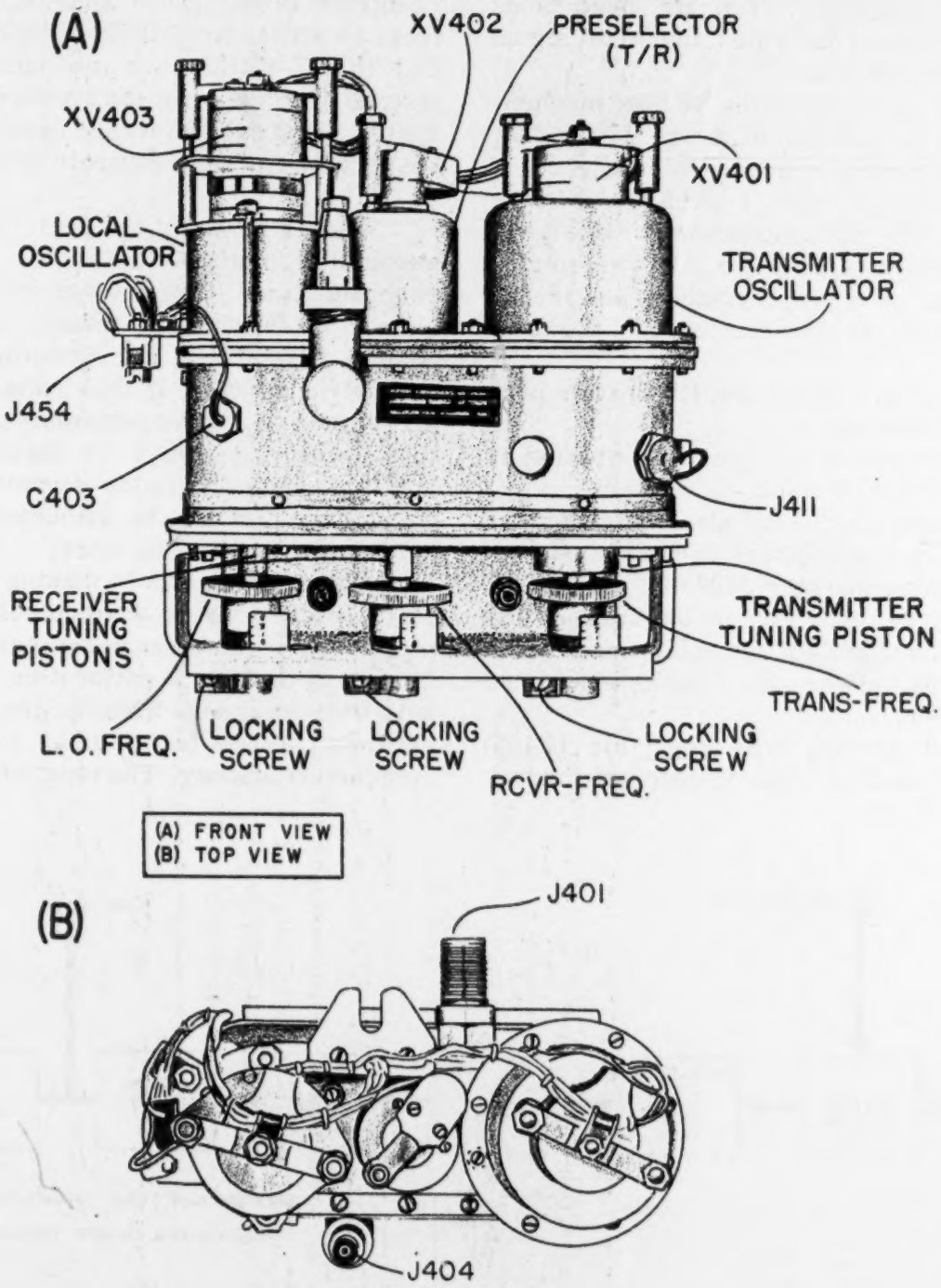

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Figure 19-15.–RF head. (A) Front view; (B) top view.

calibration chart and rotate the dial until the sum of the two scale readings equals that number.

PRESELECTOR.–As shown in figure 19-14, the preselector is located between the transmitter oscillator and the local oscillator, sharing with the former a common coupling to antenna receptacle J401, and sharing with the latter a common coupling to the mixer. Received signals enter the preselector through J401, and then are transferred to the mixer (together with the CW output of the local oscillator).

Functionally, the preselector is an open circuit, single reentrant, half-wave resonant line, capacitively loaded by a type 1B40 gas switching tube V402. This tube is inserted in the top of the chamber, and its envelope is held between two narrowly spaced contact rings that form the TR gap. During transmission, some of the RF energy generated in the transmitter-oscillator chamber enters the preselector, causing the gas to ionize. This prevents transmitter energy from entering the main signal channel of the receiver. During reception, the TR tube is substantially deionized (although a keep-alive voltage is applied across its electrodes to maintain the gas in a state of partial ionization). Since the energy level of received signals is too low to ionize the tube, the preselector acts as a tuned circuit for the crystal mixer, thus providing a maximum transfer of RF energy from the antenna line to the mixer.

LOCAL OSCILLATOR.–As shown in figure 19-15, the local oscillator chamber is located at one end of the RF head. Energy from its single reentrant line is delivered to the mixer through an iris and the mixer coupling Z406. The oscillator is a type 2C46 lighthouse tube, the output of which is set 59.5 megahertz above the frequency of received signals. The local oscillator circuit is unconventional because it makes use of a factor that normally would disable a single tuned oscillator–a considerable transit time between plate and grid. In a conventional low-frequency oscillator, where transit time is negligible, the grid and plate of the oscillator tube are connected to opposite ends of the tank circuit, as shown in figure 19-17. The phase of the plate-to-grid feedback voltage is shifted 180° to aid the grid input voltage and to produce oscillations in the tank circuit. However, in the present circuit, transit time causes a phase shift of

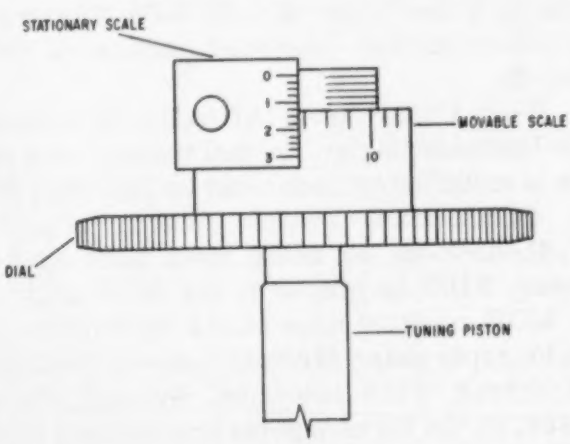

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Figure 19-16.–Tuning control.

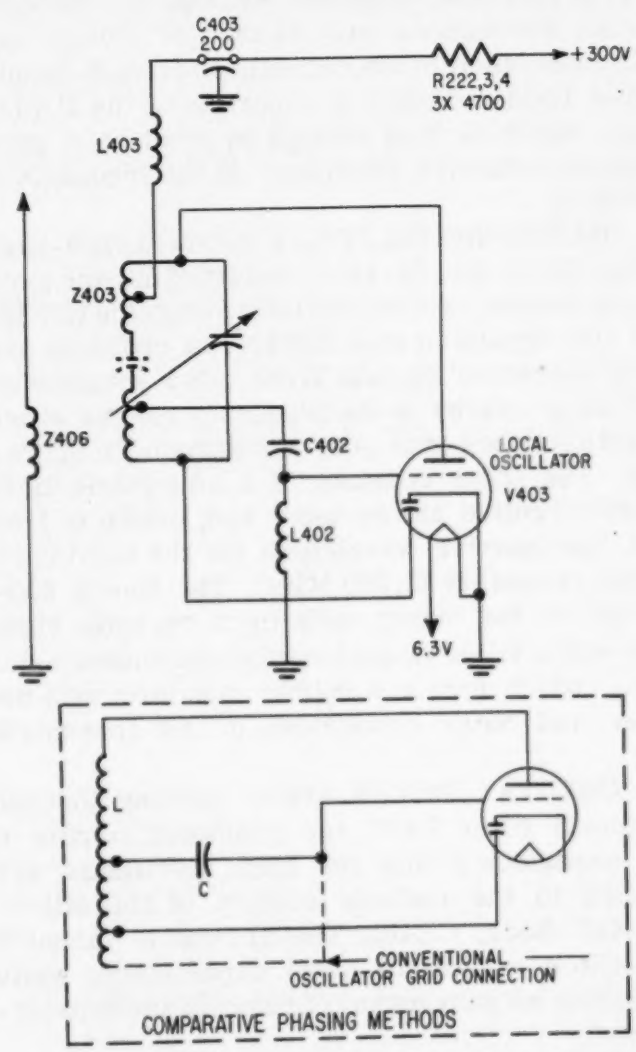

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Figure 19-17.–Local oscillator, equivalent circuit.

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180° between current leaving the cathode and current entering the plate; and this, for instantaneous values, causes grid and plate voltages to be in phase. This condition would prevent oscillation in a conventional oscillator circuit but, when modified as in the present circuit, produces satisfactory oscillation. This is done by reversing the grid and cathode connections to the tank circuit. The plate and cathode are connected to opposite ends of the tank circuit, and the grid voltage is tapped off at the point on the line that provides feedback voltage of suitable amplitude and phase angle to sustain oscillations.

The local oscillator circuit (fig.19-17) may be considered as a UHF variant of the Colpitts circuit. Capacitance C402 and inductance L402 form a voltage divider that establishes the proper grid potential. Separate RF and d-c cathode ground connections are utilized to isolate any self-inductance in the d-c cathode circuit. Supply choke L403 consists of a portion of the B-plus lead, which is long enough to produce a pronounced inductive reactance at the frequencies involved.

HARMONIC FILTER.–A harmonic low-pass filter (Z407, fig. 19-14) is inserted into the main signal channel between the mixer coupling (Z406), and the crystal mixer (CR401) in order to bypass undesired signals from other equipments operating nearby in the frequency ranges which might interfere with proper transponder operation. The filter consists of a concentric line, short-circuited at the input end, which is less than one-quarter wavelength for the third harmonic frequency (3,090 MHz). The line is supported at the output ends by a ceramic ring. The entire filter is enclosed by a grounded metal shell, which forms a double capacitor with the inner and outer conductors of the concentric line.

CRYSTAL MIXER.–After passing through harmonic filter Z407, the combined outputs of the preselector and the local oscillator are applied to the cathode contact of the silicon crystal diode, CR401. The crystal is mounted so that it minimizes shunt capacitance, while providing an easy means of removal and replacement.

The output of the crystal mixer includes the original carrier frequency, the local oscillator frequency, and combination frequencies of which the difference frequency (59.5 MHz) is the desired intermediate frequency. The IF input circuit is resonant at 59.5 megahertz; therefore, the difference frequency of 59.5 megahertz is fed with a minimum attenuation to the IF amplifiers. Capacitor C406 functions as an RF filter capacitor to bypass the undesired higher frequencies to ground. This capacitor offers 10 ohms (approximately) of capacitive reactance to 1,000-megahertz signals, and still less to higher frequency signals. The crystal current can be measured at the XTAL CUR receptacle; crystal-current measurement serves as a convenient check on the operation of the local oscillator and the crystal mixer.

SIF AUXILIARY CODER AND DECODER

The Selective Identification Feature (SIF) for IFF Mark X was developed for the purpose of expanding the utility of the MARK X system by increasing its flexibility through a multiple-code transponder reply technique.

By such means, selective and individual identification of aircraft is entirely practicable, facilitating ground control of friendly aircraft, providing operational flexibility associated with the identification process, and thereby incurring a measure of additional security in use of the Mark X system.

The Mark X aircraft transponders have the capability of operation with an auxiliary coder group. This coder is not to be confused with the BLACK MARIA. Coder Group AN/APA-89 is the principal airborne component required to equip IFF Mark X with the selective identification feature. Video Coder KY-81/APA-89 comprises the electronically operated portion of the AN/APA-89.

When Coder Group AN/APA-89 is employed with the transponder, normal transponder operation is modified considerably by S103 (fig. 19-13), the NORM-MOD switch. When Video Coder KY-81/APA-89 is being used with the transponder, S103 is placed in the MOD position. In the MOD position none of the multiple-reply or single-reply pulse circuits between the decoders and driver V110 are used. Instead, the reply pulses, in the form of pulse trains, are generated in Video Coder KY-81/APA-89 and injected at the grids of driver V110. Since the transmitter circuitry has not been altered, transmission of

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the coded pulse trains occurs in the same manner as if normal replies were being transmitted.

For normal operation without the use of an auxiliary coder, S103 is placed in the NORM position.

THEORY OF OPERATION OF CODER

The output of the receiver portion of an aircraft transponder when used with the AN/APA-89 consists of single, positive pulses of an amplitude of approximately 7 volts and a duration of 1 microsecond in any one of the three modes. The mode of the interrogating signal received by the associated transponder determines whether the input pulse appears in mode 1, mode 2, or mode 3, since the output from the transponder is used to trigger one of the gate generators (See fig. 19-18 for remainder of coder discussion.)

Each of the gate generators is a one-shot multivibrator. In each, the output is a positive gate pulse whose width (between 35 and 55 microseconds) is determined by circuit parameters. The output of the gate generator (only one is operative at any one time) is applied to the common delay-line driver, and to a corresponding crystal-coincidence circuit.

The delay-line driver operates as a blocking oscillator, generating a pulse approximately 1.35 microseconds wide for each gate pulse it receives.

The 1.35-microsecond pulse is applied to the delay line to establish the pulse train. It is also applied to the pulsed sine-wave oscillator for synchronization.

The delay line is tapped at fixed intervals. The pulse output from each tap may be selected by individual switches, through equalizing resistors and crystal-diode isolating elements, for feeding to a common collector bus.

Three distinct common collector buses are used in the equipment, one for each mode. Separate sets of mechanical or electronic switches are provided so that only those pulses which are desired for a pulse train appear on the collector buses. Therefore, the outputs on each mode collector bus consist of trains of pulses, spaced at fixed intervals, as selected by the mode-selector (mechanical or video) switches.

In order to select and transmit the proper mode coding, three crystal-coincidence circuits are used, one for each mode. Each of these circuits has two input terminals. Each circuit will conduct only when the proper input signals are applied simultaneously to the input terminals. The proper coded pulse train selected for the mode is always fed to one input terminal. Fed to the other input terminal is the signal provided by the gate generator for the mode. Obviously, if either of these two signals is absent, no output will be derived from the circuit. Conversely, if both signals are applied simultaneously, an output will appear, but only for the length of time during which the circuit is gated to the on condition by the gate-generator pulse.

The output of the crystal-coincidence circuit consists of a train of pulses substantially equal in amplitude and spacing to that appearing on the mode-collector bus of the mode-collector switches. Further, since the design of the transponder prevents triggering of more than one gate generator at a time, no gate pulses appear at the input of the remaining two crystal-coincidence circuits. For this latter reason, the remaining two crystal-coincidence circuits are not gated to the on condition, and the output signal appearing on the common coincidence bus consists only of the coded pulse train of the mode in use.

Accurate spacing of the pulses in the train is of prime importance. This accuracy is achieved by utilizing the signal from a pulsed sine-wave oscillator to control the spacing. This oscillator, generating a signal whose frequency corresponds to the pulse-to-pulse spacing of delay-line taps, is started by the same pulse which drives the delay line. The oscillator signal is coupled to the second control grid of the coincidence mixer.

The function of the coincidence mixer is to provide an electrical location where the pulses from the delay line, constituting the coded pulse train, may be mixed by being superimposed upon the positive peaks of the signal from the pulsed sine-wave oscillator. Electrically, the pulses derived from the delay line and applied to the first control grid of the coincidence mixer act as gates which allow the tube to conduct. As a result of this conduction, the output of the coincidence mixer consists of pulse-train signals substantially the same as those from the crystal-coincidence circuits but with one significiant exception. Whereas the pulses appearing at the output of the crystal-coincidence circuits have

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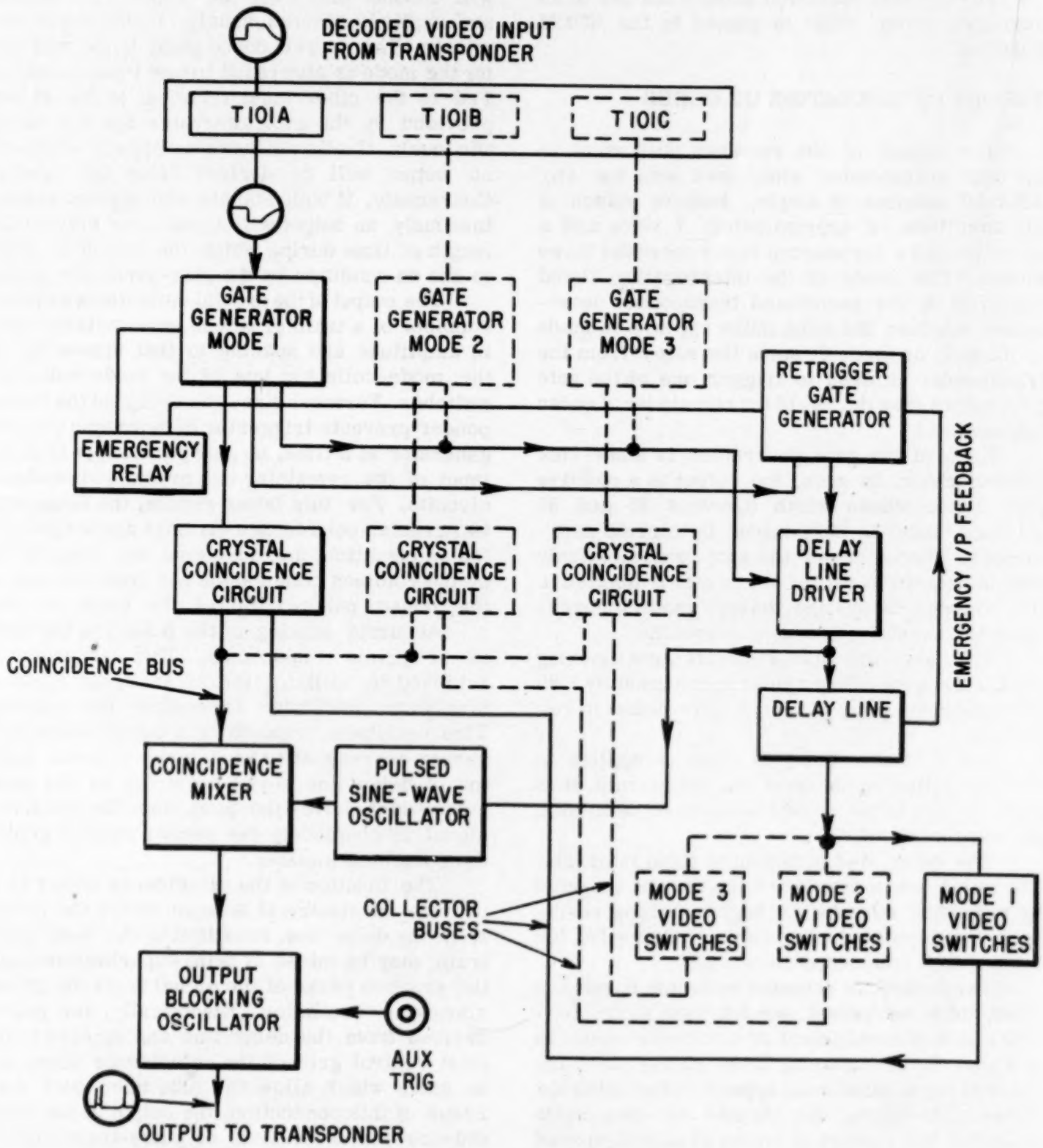

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Figure 19-18.–SIF, block diagram.

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spacings determined by the accuracy of the delay-line configuration, those pulses appearing at the output of the coincidence mixer have time-controlled spacings determined by the frequency of the pulsed sine-wave oscillator.

The pulse train from the coincidence mixer is applied to the output blocking oscillator. In the process, a ringing circuit is used to shape the individual pulses. The output blocking oscillator generates a train of pulses at a high amplitude across an impedance of 90 ohms for application to the transmitter portion of the transponder.

Pilot Identification (I/P)

Pilot Identification or I/P is accomplished by utilizing a retrigger gate generator operated by the output of the mode 1 gate generator and the "Emergency-I/P Feedback" pulse from the delay line to produce an extra pulse train. Until the I/P feature is desired, the retrigger gate generator is quiescent. When the I/P switch is closed, however, the following takes place: (1) the grid of the first half of the retrigger gate generator is raised to ground potential from its normal below-cutoff level, and (2) the leading edge of the differentiated mode 1 gate-generator pulse applied to this grid initiates multivibrator action. A rectangular pulse is thus produced which corresponds in width to that from the mode 1 gate generator.

The positive pulse generated by the retrigger gate generator is coupled to the anode terminal of a crystal diode inserted in the "Emergency-I/P Feedback" bus. If no pulse from the delay line exists on this bus, the retrigger gate-generator output is effectively shorted to ground by the low impedance presented by the delay-line terminating resistor. If, however, a pulse from the delay line appears on the "Emergency-I/P Feedback" bus, the crystal diode is cut off and the retrigger pulse from the delay line is coupled to the input grid of the line driver. When this pulse appears, the line driver retriggers and an extra train on pulses is generated.

This generation of additional pulse trains in groups of two continues for the length of time the I/P switch is held closed and for approximately 30 seconds after it is opened, provided that incoming trigger pulses actuate the mode 1 gate generator. The 30-second continuation of pulse trains is accomplished by a resistor-capacitor network in the bias circuit of the retrigger gate generator. This network is completely discharged by the closing of the I/P switch. When the switch is opened, the resistor-capacitor combination is allowed to charge from the bias supply. When the combination has charged sufficiently (in about 30 seconds), the retrigger gate generator is cut off and the tube reverts to its quiescent condition.

Emergency

The emergency feature makes use of the same circuitry as does the I/P feature. In addition, however, a relay is provided and is actuated by the closing of the emergency switch on the transponder set control. One set of contacts on this relay is used to connect additional capacitance in the grid circuit of the mode 1 gate generator, approximately doubling the width of the pulse produced by this multivibrator. Another set of contacts shorts to ground the grid return of the retrigger gate generator.

When the relay is energized, the following events take place: (1) upon receipt of an incoming mode 1 trigger, the mode 1 gate generator produces a gate pulse approximately 110 microseconds wide, and (2) the retrigger gate generator performs as it did during I/P operation, producing a positive rectangular pulse approximately the same width as that of the mode 1 gate generator. Again the line driver is retriggered as it was in I/P operation. During emergency operation, however, the number of output pulse trains is increased to four for each mode 1 incoming trigger pulse. When the emergency relay is deenergized, the system reverts to normal and the retrigger gate generator is again quiescent.

Pulse Train Coding

The coding of each mode is accomplished by the use of the octal code. (Reference may be made to chapter 15 of this manual.) Up to three bits are used for each number. This means that we may select a number of 0, 1, 2, 3, 4, 5, 6, or 7 by use of a maximum of three octal bits. For a number such as 37 (eight) two groups of bits in octal form are necessary. They would be 011 octal to obtain the 3 and 111 octal to obtain the 7. Now consider the grouping for the 3 as

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group "A" and the grouping for the 7 as "B." Therefore, for a four digit number the grouping from LEFT to RIGHT would be A, B, C, and D. It must be understood at this point that there will be no more than three pulses created to represent each coded number group. To create a 77, six pulses are necessary.

The code structure created by the APA-89 is established on a 20.3-microsecond time base as measured between the leading edges of the "start bracket" pulse and the "stop bracket" pulse. (See fig. 19-19.) The information pulse positions are shown in the composite code train and are used for the pulse coding. Twelve pulse positions are necessary to represent four octal coded numbers. The twelve pulse positions are divided into four equal groups and are designated A, B, C, and D.

Group A and group B pulse positions are used for reply codes in mode 1, mode 2 (6-pulse), and mode 3. Therefore, two octal numbers are assigned. Four-place octal numbers can be assigned to mode 2 (12-pulse) codes.

In mode 1 there are 31 code structures (01 to 73). Mode 2 (6-pulse or two numbers) and mode 3 have 64 code structures (00 to 77).

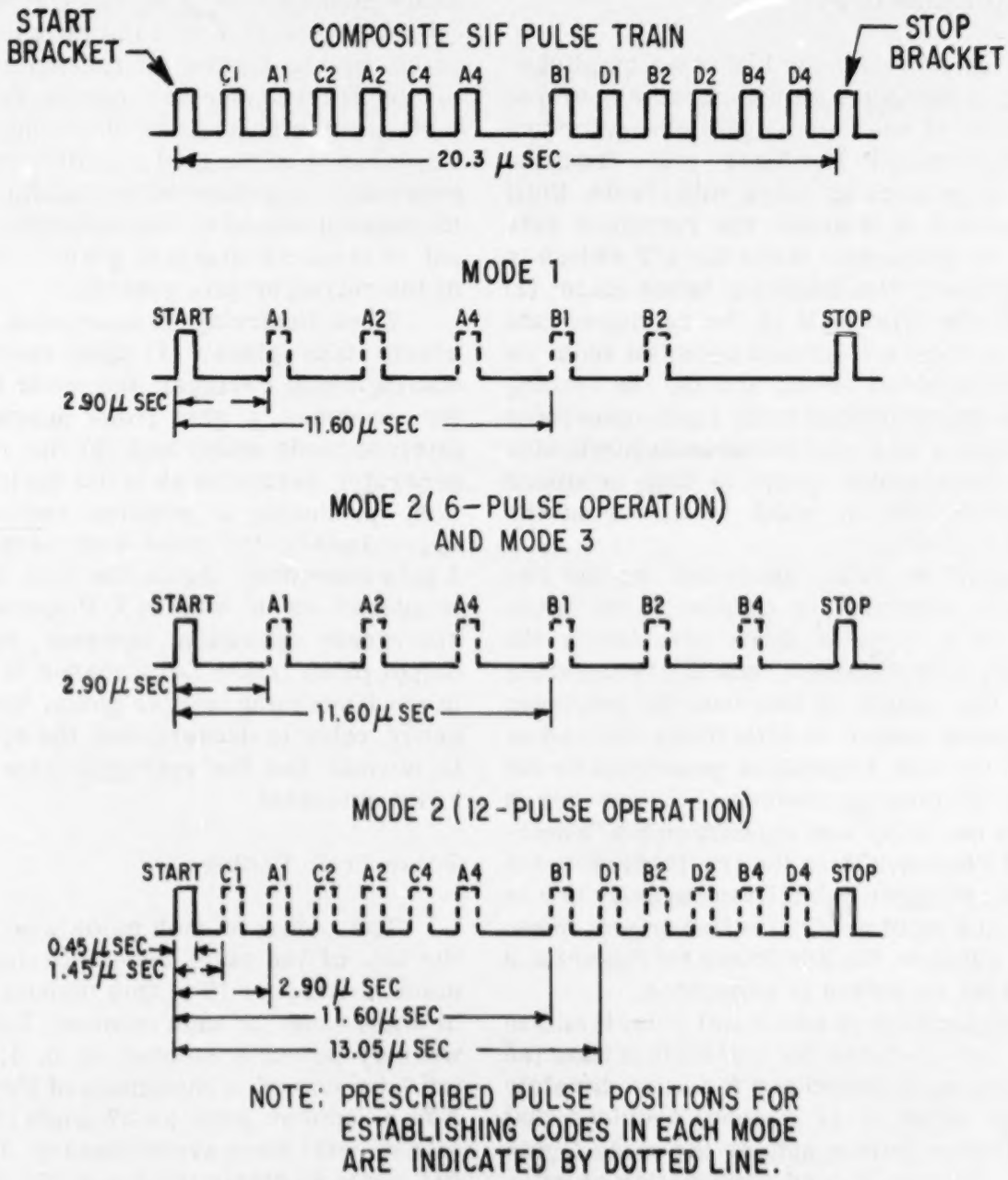

Figure 19-19.—IFF-SIF reply code structure. AT.375

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Mode 2 may be assigned four numbers (0000-7777). In this case, it would have to use all 12 pulse positions and there would be 4096 possible code structures.

To code a reply of 35 (octal) requires that a pulse be present at the prescribed position for start pulse, A1, A2, B1, B4, and stop pulse and that no other pulses be present at the other prescribed positions of the code train. A mode 2 (12-pulse) code of 7264 would have pulses of start pulse, A1, A2, A4, B2, C2, C4, D4, and the stop pulse.

THEORY OF OPERATION OF DECODER

The KY-364/APX Video Decoder is a compact, transistorized instrument incorporating all functional controls and decoding circuitry within a single unit. It provides SIF decoding capability in an airborne radar recognition facility of the IFF Mark X (SIF) system. The purpose of the KY-364/APX unit is to accept mode-separated (SIF) IFF video pulses, process them, and supply decoded output pulses for display as the IFF target on an associated PPI scope. (See fig. 19-20.)

Figure 19-1 shows an overall airborne IFF system without the SIF feature. The specific equipment discussed is used as a teaching vehicle. Although there are many adaptations and later equipment, basically the theory of operation is the same.

Upon receiving a signal resulting from interrogation, the video decoder of the APX-7 supplies output signals for use in conjunction with the associated KY-364 decoder. (See fig. 19-20.) The information pulses of each reply code train are provided by the KY-84 coder synchronizer. A bracket coincident gate is also furnished for the KY-364 decoder.

The code train input is applied to a multiple-tapped delay line and is processed by logic circuits to derive a PASSIVE DECODE signal and a BRACKET DECODE signal. A provision is made to bypass the logic circuits and generate the CODE video output. The video pulse outputs of the decoder are applied to the azimuth-range indicator (PPI type) and are displayed as the IFF target. For each reply-code received from a challenged aircraft, two logical operations are available and, depending on the reply code structure, two discrete signals are generated. The CODE video output is always available since it is not processed through the logic circuits. One of the three outputs, PASSIVE DECODER, BRACKET DECODE, or CODE video, is selected for PPI display by a front panel switch (fig. 19-21).

Passive Decode

The passive decode function is a check for equality between the reply code train and the preset code of the video decoder. If the reply code is equivalent to the preset code, a single decode pulse is generated. (See fig. 19-22 (A).) If it is not equivalent, a decode pulse is not generated. An acceptable code for each of the three operating modes is set individually and can be changed readily by means of code select switches on the front panel. (See fig. 19-21.)

Bracket Decode

The bracket decode function is a check for coincidence of the start and stop pulses that frame an SIF reply code train at precisely 20.3 microsecond duration. A single bracket output is generated (fig. 19-22 (B)) if these two pulses are present. The bracket start and stop pulses are required in any SIF reply code train. Consequently, when selected, the bracket decode output displays responses from all SIF-equipped targets regardless of reply-code and preset-code equality.

Delay Code Video

After the DELAY CODE VIDEO bypasses the logic circuits, it is delayed 40.8 microseconds from the time of input. In the DELAY CODE position, both the SIF pulse coded trains and the basic (non-SIF) IFF reply pulses from all challenged targets are displayed. (See fig. 19-22 (C).)

Additional Features

A degarble feature incorporated in the video decoder is controlled by a front panel switch. When activated, the degarble circuits detect the presence of reply code train interference and prevent decode outputs of garbled pulse trains. This feature partially reduces the occurrence of false IFF target displays. Garble interference is

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ASSIGNMENT:

Draw the views of the object shown below and dimension fully. Obtain any dimensions needed to draw the part by scaling the drawing.

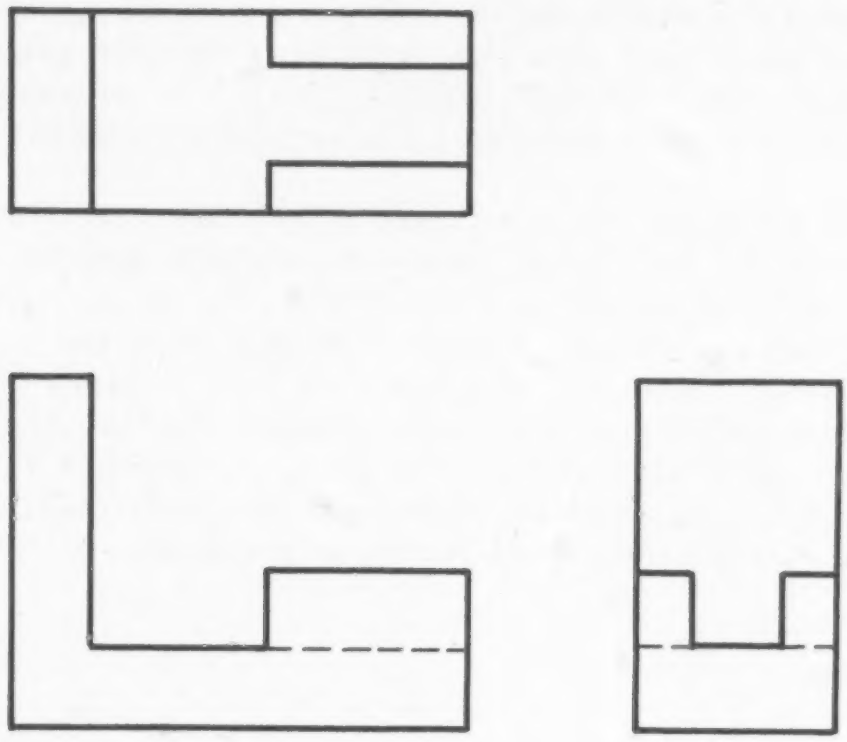

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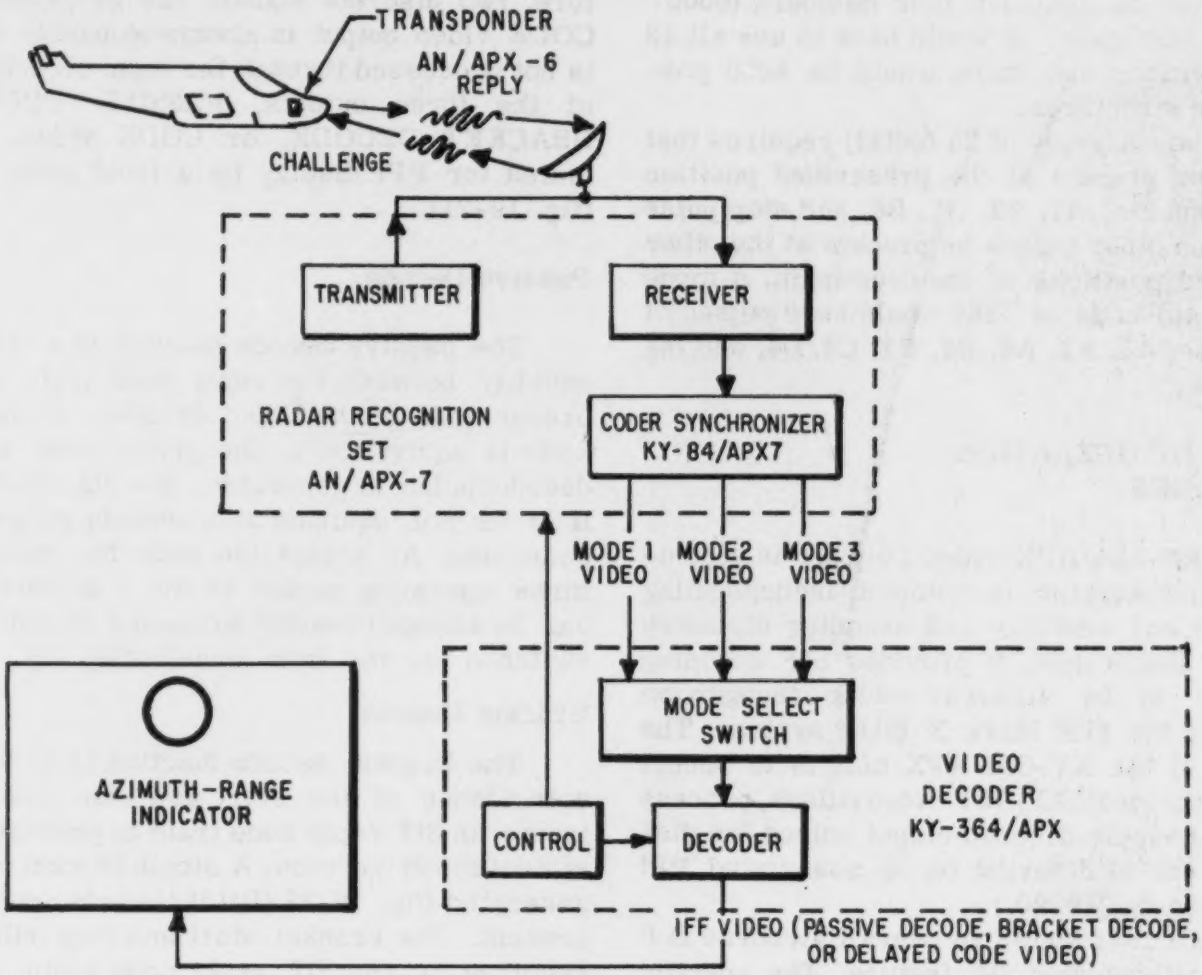

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Figure 19-20.–Airborne Radar Recognition System, block diagram.

created under various and random conditions. The replies of two or more challenged targets at approximately the same range and bearing may be garbled. Multipath reception from a single target may result in a garbled reply; and, in areas of high-density traffic (around large airports), nonsynchronous replies will often cause replies to be garbled. The video decoder has the capability to individually decode four interleaved 6-pulse code trains, or two interleaved 12-pulse code trains. The accurate decode tolerances of the video decoder significantly increases reliability for resolving interleaved replies and rejecting garbled replies.

Selective Identification

Utilization of the selective identification feature (fig. 19-21) may be accomplished as follows:

With the OUTPUT switch in the BRACKET or CODE position, all SIF target replies for the set mode of challenge are displayed on the PPI. Then, by setting the MODE 1 CODE, MODE 2 CODE, or MODE 3 CODE switches to the preassigned code and by placing the OUTPUT switch in DECODE position, a specific target, or group of targets, whose reply-code is equivalent to the preset code is displayed. The MODE SELECT switch may be rotated through its three positions to monitor on the PPI scope each mode of operation. This may be accomplished by sector scanning or on successive antenna revolutions.

Indicator Presentations

A typical PPI display is shown in figure 19-22 for each selectable output of the video

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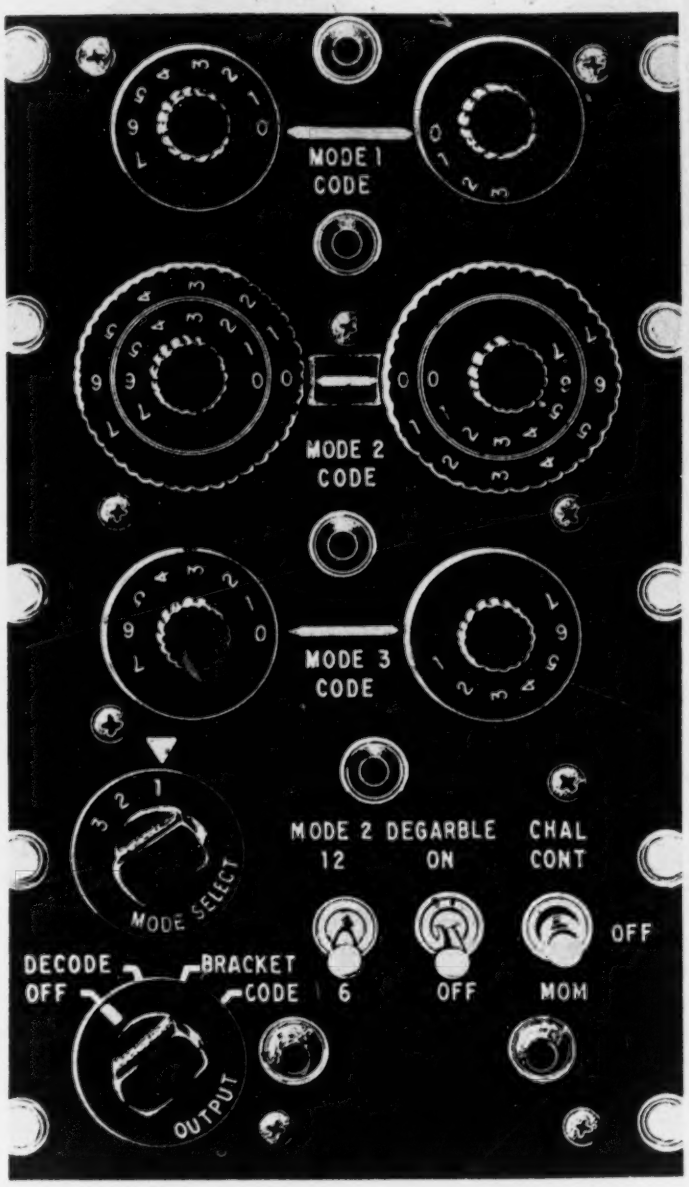

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Figure 19-21.–Video Decoder KY-364/APX.

decoder. These displays show IFF responses. If radar targets are also displayed, the IFF response appears at a greater range than the radar target because of the preset delay in the IFF equipment.

BENCH TEST AND ALINEMENT

For specific procedures for testing and alinement of specific equipment, refer to the appropriate equipment manual.

The purpose of this section is to discuss various pieces of shop test equipment that are used with the IFF Mark X equipment in general.

AN/UPM-4

One of the earliest pieces of shop test equipment was the AN/UPM-4. This equipment was capable of testing the earlier APX-equipment; but with the advent of the SIF, this equipment became obsolete.

AN/UPM-70

The AN/UPM-70 superseded the AN/UPM-4. It provides complete facilities for performing corrective maintenance on operational (and some test) equipment in the IFF Mark X system. This test set consists of two basic units, an oscilloscope and a coder simulator. It could also be used for making some of the more common tests required for maintenance of radar equipments operating in the 925 to 1225 megahertz frequency range.

The following list briefly outlines the tests that can be performed with the Radar Test Set AN/UPM-70:

1. Measurement of RF power.
2. Measurement of RF frequency.
3. Investigation of RF pulse characteristics.
4. Equipment analysis using simulated IFF Mark X codes, both the basic modes and the SIF codes.
5. Measurement of receiver bandwidth, frequency, and sensitivity.
6. Measurement of PRF.
7. Video pulse analysis.
8. Signal tracing.

AN/UPM-98

The AN/UPM-98 is a single unit test set that has an advantage in the ability to make rapid checks.

It performs the following checks on a transponder and SIF codes.

1. Receiver rapid check of sensitivity and tuning.
2. Transmitter rapid check of power output, tuning, frequency, SIF coding, and emergency and I/P function.
3. SIF coding check.
4. Mark X Coding check (non-SIF).

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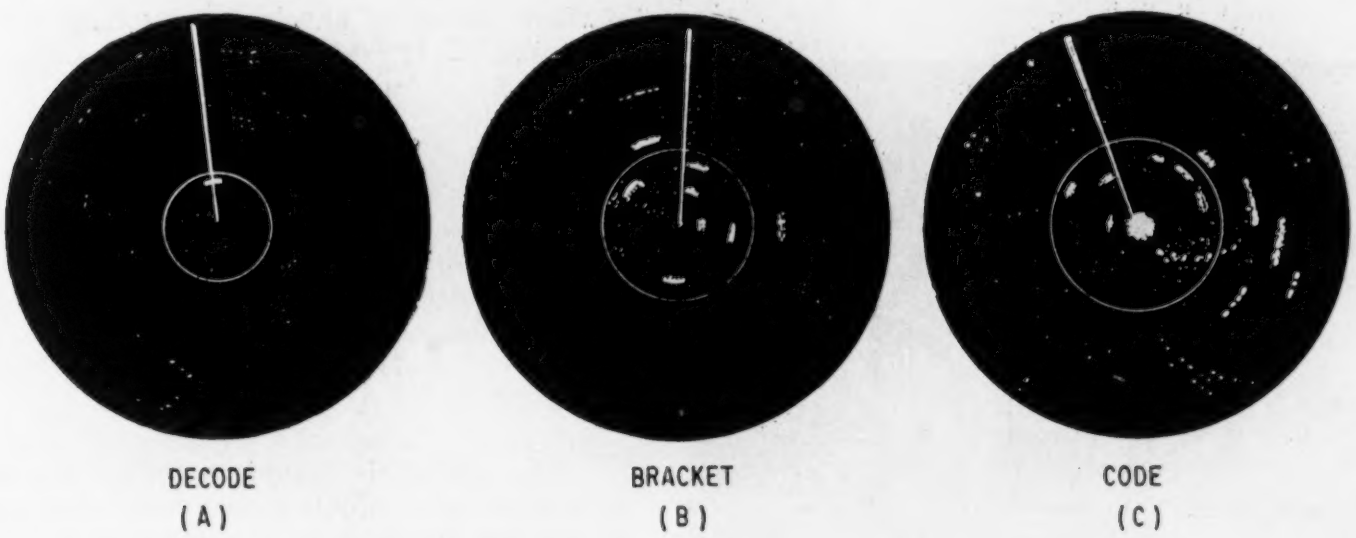

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Figure 19-22.–Typical PPI displays.

5. Automatic overload circuit check.
6. Recovery and suppression check.
7. Bandwidth and tuning indicator check.

On the interrogator-responses (IR) unit it will check the following:

1. Count down circuits.
2. Triple gate generator.
3. Coder pulse pair spacing and width.
4. Coded IF pulses.
5. Transmitter frequency.
6. Transmitter power and pulse shape.
7. Receiver sensitivity, frequency, and video output.
8. Suppression adjustment.
9. Receiver gate adjustment.

AN/UPM-99

The AN/UPM-99 Radar Test Set is basically an AN/UPM-4A with a new display unit attached. Individual checks and adjustments may be performed without the necessity of performing the entire procedure.

This test set will perform any check that the AN/UPM-98 can perform.

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CHAPTER 20

ELECTRONIC COUNTERMEASURES

It is the purpose of this chapter to introduce the general principles involved in the operation of electronic countermeasures devices. In the discussion which follows, examples of countermeasures equipments are described to illustrate these principles. The descriptions of the units included here are not intended to provide detailed information concerning maintenance and operation, but are given solely to present the broad basic facts which are common to many examples of countermeasures equipments, both old and new.

It is a basic rule of warfare that for each weapon used by the enemy a counterweapon must be developed. This rule is clearly expressed in modern war by the development and use of electronic countermeasures (ECM). The counterweapon in this case is used against enemy electronic equipment–against radar, communication transmitters and receivers, navigation aids, and electronically controlled weapons (such as guided missiles and proximity fuses). The objective of ECM is to make the enemy's use of these electronic devices ineffective.

SIGNAL CHARACTERISTICS

To prepare effective countermeasures against communication systems and navigation aids, information is needed concerning the frequencies of the emissions, the types of modulation used, the polarization of the transmitted waves, and the exact locations of the stations. For countermeasures against enemy radar, much more information is required. The principal signal characteristics of importance are the carrier frequency, the pulse repetition frequency, and the pulse width. In addition, other data are very desirable. These include the type of scan employed, the rate of scan, the beam width, and the polarization of the antenna.

CARRIER FREQUENCY

The carrier frequency of the enemy radar is the starting point from which the other signal characteristics are determined. Knowledge of the frequency is necessary for determining the type of the radar and its probable function and for preparing effective jamming operation.

PULSE REPETITION FREQUENCY

The second most distinguishing characteristic of the radar is its pulse repetition frequency (PRF), which is the number of pulses emitted per second. The PRF value is a factor in determining the maximum range of the unit since it governs the time interval between the pulses. Long range air search radars must necessarily use low PRF values, since the pulses need to be spaced at intervals sufficient to allow echo signals to return from the most distant object within the desired range. Higher values of PRF are used in surface-search radars designed for detecting objects at shorter ranges. Extremely high pulse rates are employed in such equipment as fire control radars, which have very short range but extreme accuracy.

PULSE WIDTH

It is desirable to know the pulse width of radar signals since this value is the basis for estimating the minimum range of the unit. Pulse width is the interval of time during which the radar transmitter is energized; as a result, it

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determines the minimum range at which target echoes can be received.

TYPE AND RATE OF SCAN

The type of scan, the method by which the radar beam searches the target area, is a good indication of the nature and action of the radar. Types of scan include 360-degree, sector, lobe-switching, conical, and spiral scans. The simplest way of distinguishing the scan type is by listening to the intercepted signals. Signals from search radars usually cause a whine in the headphones, the tone being produced by the constant pulse rate. In a 360-degree scan, the signal strength varies periodically as the beam sweeps over the search aircraft. As long as the signal variations continue, the radar is searching; but if the sound becomes loud and steady, the indication is that the set has probably detected the search aircraft and is concentrating its attention on it. Fire control radars often use lobe switching in which the beam locks first to one side of the target and then to the other side. The shifting of the beam takes place rapidly and brackets the target while the radar compares the echoes from each beam position. Lobe switching is easily detected by visual indications of the signals on panoramic adapters, pulse analyzers, and direction finders. It also causes a characteristic chatter in the headphones as the beam position varies.

The rate of scan, or number of scanning sweeps made per minute, is related to the probable maximum range of the radar. Slow scanning is characteristic of long-range search sets, while short-range radars and fire control systems employ much higher scan rates. The rate is usually measured in terms of the time required for one scan. The signals are observed on the screen of a panoramic adapter or the scope of a direction finder. The operator logs the time interval between successive indications of maximum signal strength.

BEAM WIDTH AND POLARIZATION

The measure of the beam width gives an indication of the azimuth accuracy of the enemy set. The width of the beam, which is expressed by the number of degrees between the half-power points, is generally computed from data provided by automatic recorders which give information concerning the amplitude of the signals.

The polarization of the radar antenna is considered in planning effective methods of jamming. This characteristic can be determined by use of direction finders of the type which makes a visual display of the reception. The direction finder is equipped with two antennas—one polarized horizontally and the other vertically. Either antenna can be used for reception, and the polarization of the incoming signals is learned by comparing the patterns resulting from each.

A rough determination of polarization can be made by alternate shifting from vertical to horizontal receiving antennas. The antenna which is of proper polarization for the signal being received will provide an audible response indicating greater signal strength. Circular polarization will give approximately a uniform response on either antenna.

PASSIVE ECM

Passive ECM operations are those which cannot be directly detected by the enemy; examples include reconnaissance and search operations, in which enemy transmitters are detected and located and as many as possible of the signal characteristics are determined. Passive countermeasures also include evasive tactics taken to avoid detection, and methods of controlling the radiations from friendly equipments to prevent the enemy from using our signals for homing, direction finding, or for any other purpose.

SEARCH RECEIVERS

The success or failure of an intercept mission depends largely on the proper functioning of the search receiver, the basic type of passive countermeasures equipment. By means of the receiver, the ECM operator detects the presence of radar and radio emissions, monitors enemy transmissions, learns the types of modulation used, and records indications of relative signal strength.

Search receivers are designed for intercepting signals occurring throughout wide ranges of frequency. Receivers are usually equipped

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with several tuning units, each of which can be either manually tuned or automatically swept over a selected frequency sector by motor-driven tuning circuits.

Tape and film recorders are used to make records of the signals received by the associated search receiver as it is tuned rapidly through the spectrum. The recording, which is analyzed after the flight, gives information concerning the frequencies of the signals, the amplitude, and the time of reception.

When searching for enemy radar locations, the ECM receiver operates at a fundamental advantage with respect to the radar. Radar detects objects by reflection, or two-way transmission, in which the reduction of signal strength is proportional to the fourth power of the distance covered by the waves. The receiver, on the other hand, detects the radar by a one-way transmission in which signal reduction is proportional only to the square of the distance. As a result, the presence of the radar can be detected at a distance greater than the maximum range at which the radar can detect the search aircraft.

Receiver Operation

Most search receivers employ superheterodyne circuits that can be tuned rapidly over various bands. The extremely wide frequency coverage required is provided by the use of several tuning units, each of which covers a part of the total tuning range of the receiver. Tuning units usually consist of a tuned antenna circuit, a local oscillator, and a mixer stage. The receiver produces three types of output–video signal voltages for use in a panoramic adapter, video signals which are applied to a pulse analyzer, and an audio output for the headphones. (A panoramic adapter is a cathode-ray indicator that enables the operator to sweep a broad spectrum of frequencies during a short period of time.) When a signal that the operator desires to inspect closely is displayed on the adapter, it is fed to the pulse analyzer for closer study.

In figure 20-1, a block diagram of a typical ECM superheterodyne receiver system is shown. The receiver covers a wide tuning range by employing several selectable RF tuners.

Signals intercepted by the antenna are fed to a connection on the receiver through a switching assembly. This assembly enables the operator to select the proper antenna for the frequency range to be covered. From the antenna connection, the incoming signals are applied to one of the tuning units.

The tuning unit (fig. 20-2) contains an RF amplifier, a local oscillator, a crystal mixer, an IF amplifier, and a d-c motor which is mechanically coupled to a synchro generator. The motor is also coupled to a counter which indicates the frequency to which the preselector is tuned. The synchro generator transfers frequency information to a cathode-ray indicator unit.

Since there are no manual controls in these tuning units, they are usually remotely mounted to provide better utilization of space in the aircraft. The d-c motor also automatically tunes the RF amplifier and the local oscillator through their frequency range. When the frequency is too high for use with conventional RF amplifier circuits, tunable cavities are incorporated instead. The popular name for these cavities is "RF preselector."

Mixing of the input signal with the signal from the local oscillator, in a crystal mixer, produces an IF frequency. This IF signal is amplified through several stages of preamplification. The preamplifiers are stagger tuned; that is, each stage of preamplification is tuned to a slightly different frequency. This staggered tuning gives a very broad bandpass which is desirable for video work. Impedance matching is used in the output to feed the signal into the next section, a mixer amplifier.

The mixer amplifier (fig. 20-3) contains a main IF amplifier strip, a second IF amplifier strip, and the video and audio circuits of the receiver. It also contains a sweep oscillator, a fixed oscillator, and beat frequency oscillator (BFO). The BFO is a heterodyning oscillator used for detecting CW or MCW transmissions. The sweep oscillator sweeps through a spread of frequencies equal to the receiver bandpass. The sweep oscillator output is mixed with the signal from the main IF amplifier in the mixer stage to produce a new and lower IF frequency. This system of going from one IF to a lower IF is called double conversion and is done to produce a still lower frequency which is easier to amplify. The lower frequency allows the use of simpler circuitry throughout the remainder of

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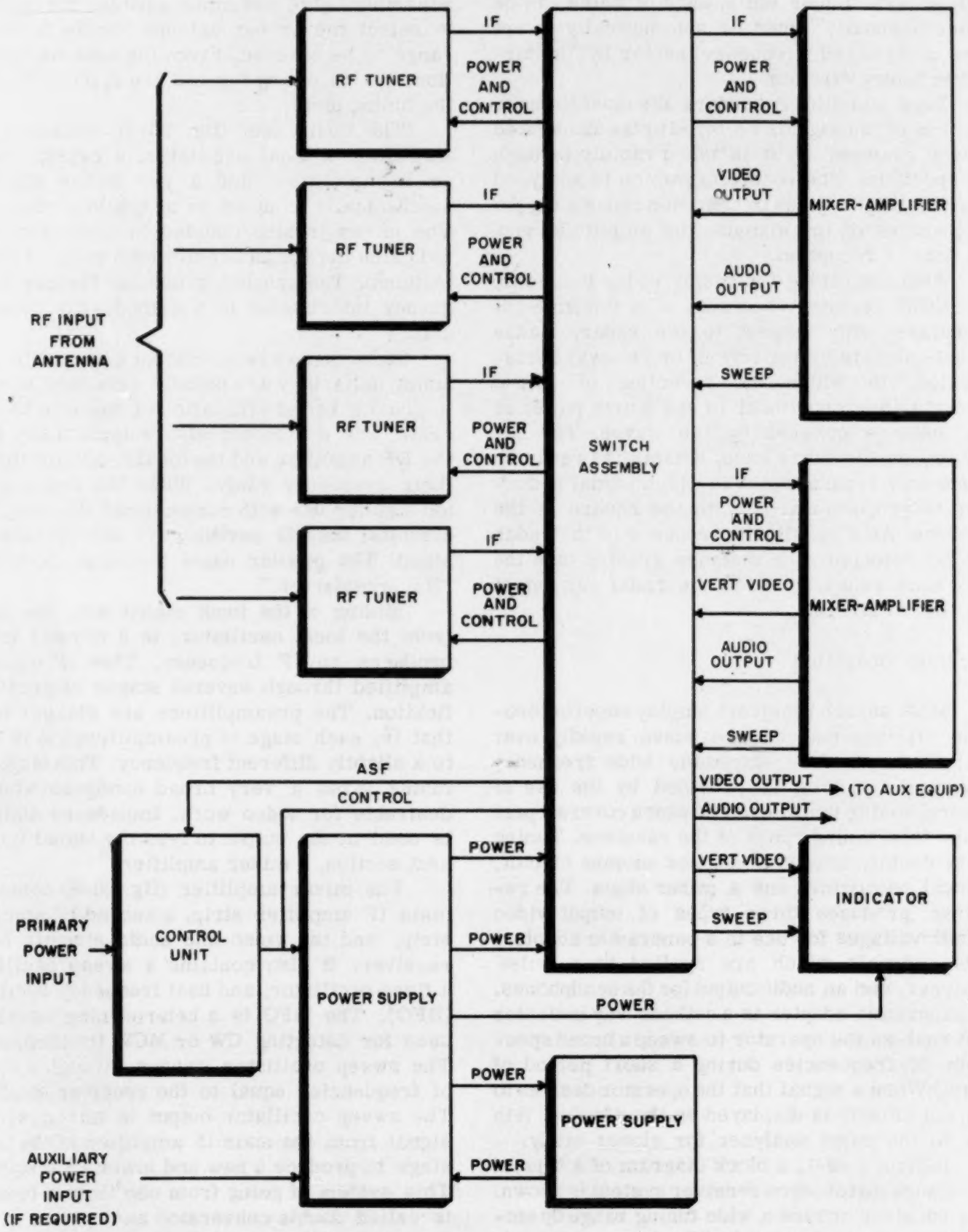

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Figure 20-1.–Typical multiple tuner block diagram.

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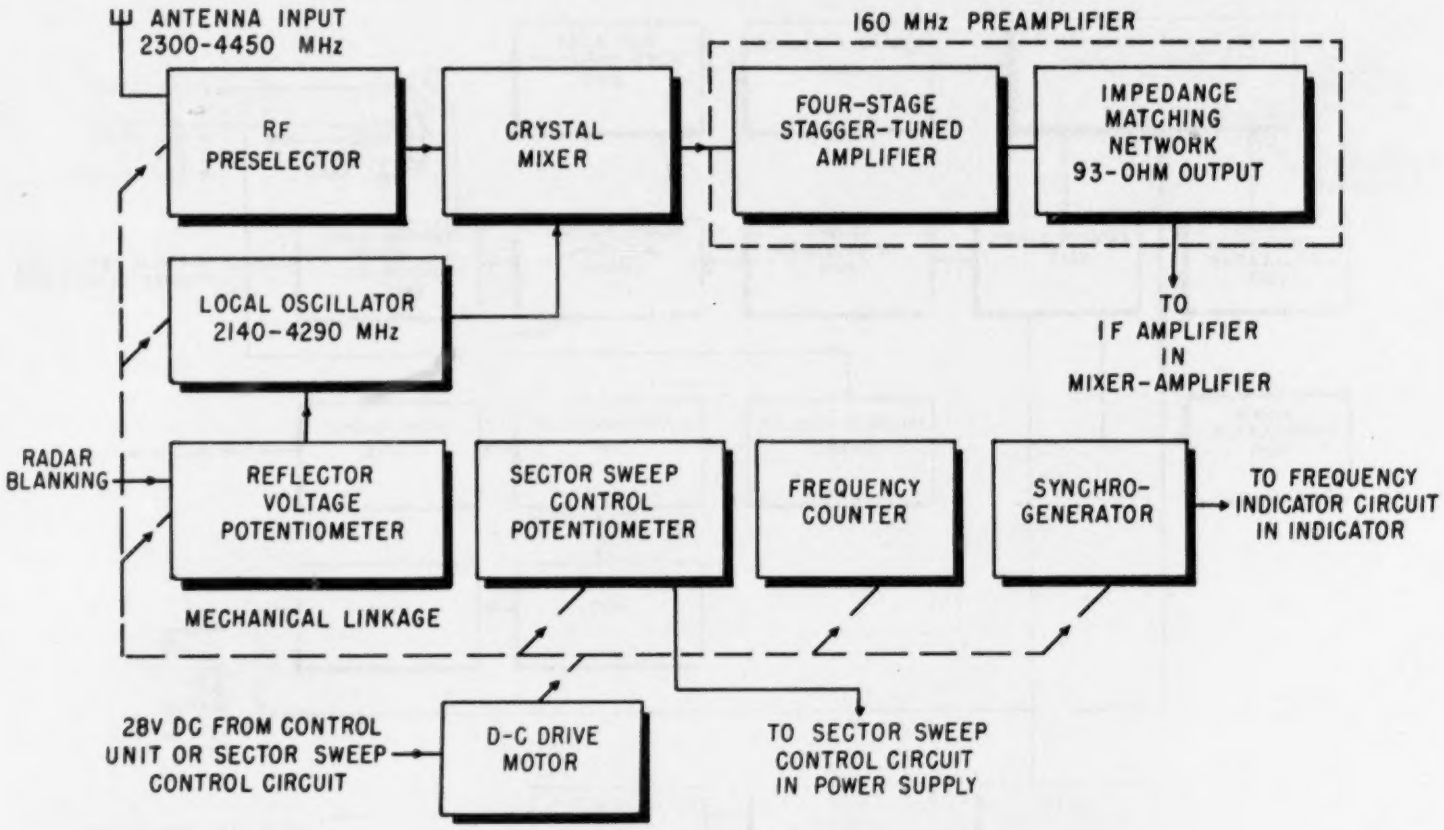

Figure 20-2.–RF tuner block diagram.

the receiver. This second IF signal is fed through several stages of amplification, then to a detector stage. The detector stage produces a video pulse which is available for presentation on the panoramic and pulse analyzer scopes.

During broadband operation the receiver may receive one or more signals simultaneously. In order to view one signal at a time, the receiver is switched to narrowband operation. Since it is mechanically difficult to stop the sweeping oscillator at the exact frequency needed for double IF conversion, a fixed oscillator is provided. The signal from the fixed oscillator is fed into the mixer during narrowband operation.

From the main IF amplifier strip a signal can be detected, amplified, and then made available as a video input for some auxiliary equipment such as a pulse analyzer, a direction finder, or a remote indicator. Provisions are also incorporated so that any signal present will be amplified through an audio circuit to give an audio tone. This tone may be used to aid the operator in detecting signals. He can listen as well as look. This is desirable since eye fatigue is a problem when he must look at the scope continuously.

From the second IF of the mixer amplifier the video signal is fed to the CRT indicator for panoramic or pulse analyzer indication. The signal may also be fed to auxiliary equipment for further pulse analyzing or direction finding.

WAVE TRAPS.–Search receivers of the superheterodyne type often produce spurious responses caused by image reception in which a station is received at two different positions of the tuning dial. A second type of spurious response also frequently occurs; it is caused by harmonics of the local oscillator. These harmonics beat with strong signals being received at frequencies other than that indicated by the dial, and produce the intermediate frequency with the result that the unwanted stations are heard in the output.

There is another type of spurious response, called pseudoimage frequency, which is a strong signal beating with the fundamental

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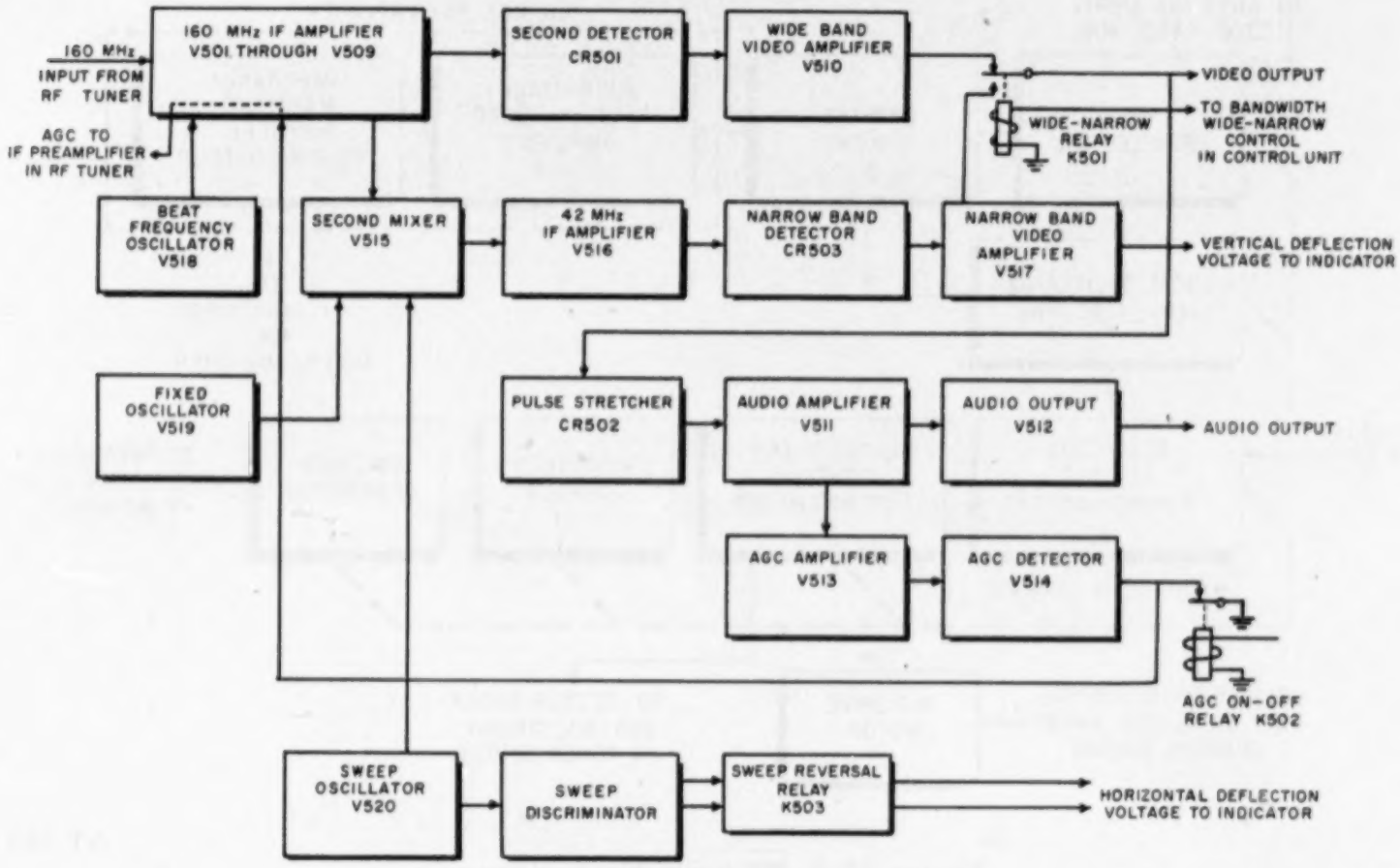

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Figure 20-3.–Mixer amplifier block diagram.

IF frequency. Since one of the primary functions of the receiver is to enable the operator to determine the frequency of an intercepted signal by means of the dial reading, some device is needed to assist him in distinguishing true signals from spurious responses. For this purpose, wave-trap stubs or tunable filters are often used in conjunction with these receivers. The wave-trap stubs have a dial calibrated in frequency and can be switched into or out of the antenna lead-in. When the trap is in the circuit and tuned to the frequency of an incoming signal, the signal is filtered out and disappears from the output. By means of the calibration on the wave-trap, the operator can decide whether or not the signal frequency is actually that indicated by the dial reading at which he receives it. Generally, ECM receivers used in the fleet today have image rejection ratios sufficient to permit direct dial readings.

Automatic Search Receivers

Modern ECM receivers use automatic tuning. The receiver's tuning section is driven by an electric motor which tunes the receiver across its entire tuning range. The tuning is continuous; that is, when the upper end of the tuning range is reached, the motor automatically reverses and the receiver is tuned down to the lower end of the band where again the motor reverses and the receiver is tuned to the upper end of its range.

"Fully automatic" search receivers are similar in operation to those called automatic. However, there is one major difference. This difference is that fully automatic search receivers automatically stop tuning operations when a signal is detected. (NOTE: This is usually referred to as receiver lock-on.) The signal may then be observed and its frequency noted by the operator. When the operator completes his observation, a button is pushed (on

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the control box) and the tuning drive again starts through its tuning sequence from the point at which it was last locked.

Panoramic Adapters

Panoramic adapters are specialized indicators. Used for monitoring a wide range of frequencies, they provide visual displays of the signals intercepted by the search receiver. The signal indications appear on the screen of a cathode-ray tube. The station to which the search receiver is tuned appears as an inverted-V deflection at the center of the screen; and signals above and below this frequency show similar deflections to the right or left of center, depending on their values. The amplitude of any deflection is determined by the strength of the corresponding signal, so that the panoramic screen provides a plot of signal intensity versus frequency. (Signal intensity is indicated on the vertical axis, and relative frequency is represented on the horizontal.)

In search operations, the panoramic adapter is used principally as a tuning aid since the signals from many stations are indicated simultaneously. It can also be used to determine the types of modulation of intercepted signals and for observing the effects of the search aircraft's own jamming emissions.

INTERPRETATION OF PATTERNS.–Since a comparatively large number of signals may be observed simultaneously on the screen of the panoramic adapter, the instrument has great value in detecting enemy transmissions. Furthermore, the experienced operator can obtain additional information concerning the nature of the transmissions by inspection of the patterns. The oscillograms produced by several types of signals are shown in figure 20-4.

A constant carrier appears as a deflection with fixed height as shown in (A) of figure 20-4. Amplitude-modulated carriers appear as deflections which vary in height. If the modulating frequency is high, the sideband frequencies appear separately, causing pips on either side of the carrier deflection. Modulation with a single audio tone produces the pattern shown in (B) of the figure. A frequency-modulated carrier appears to wobble to the side. When the carrier is frequency modulated by voice or music, the appearance is a number of deflections which spread across a variable band as in (C). Pulse modulation gives the pattern shown in (D) when the pulse repetition frequency is considerably greater than the rate of sweep of the indicator beam.

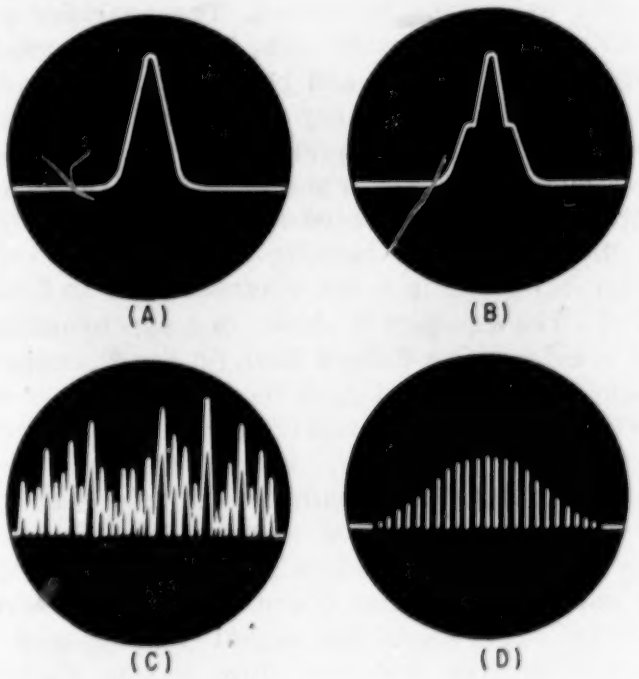

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Figure 20-4.–Panoramic adapter patterns.

A CW signal appears and disappears with the keying of the transmitter. Two signals which are near enough in frequency to produce an audible beat note appear on the screen as a single carrier which varies in amplitude at the beat frequency. Noise voltages which vary regularly produce deflections which move across the screen in either direction, the motion being caused by the fact that the noise pulses are not synchronized with the panoramic sweep. Noise and interference, such as static bursts which are not periodic, produce irregular deflections and flashes along the length of the screen.

If image reception takes place in the associated receiver, the image signal has the same sort of appearance as the true signal. However, when the receiver tuning dial is rotated, the image pip moves in the direction opposite to that of the true signal deflection.

PULSE ANALYZERS

Pulse analyzers are used in ECM operations for measurement of the pulse repetition frequencies and pulse widths of radar signals de-

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UNIT VII - WORKING DRAWINGS

Scale of Drawings Lesson 1

OBJECTIVE: To learn how to increase or decrease the size of a drawing.

RELATED INFORMATION:

Oftentimes the draftsman is confronted with the problem of drawing a particular piece part on a size of paper either too small or too big for this particular job. He then either increases or decreases the size of the drawing but always maintains the same size dimensions.

As an illustration, the draftsman must draw a flat washer 8 inches in diameter and 1 inch thick, with a 2-inch hole directly through the center. In all probability he would reduce the scale of this drawing to either half or quarter size, but he must still draw the 8-, 1-, and 2-inch dimensions. He does this to reduce the cost of paper and produce a clearer drawing. A note shall also be made that the drawing has been reduced to a particular scale. The decision to either reduce or increase the scale of a drawing rests with the draftsman, and only experience will aid him in his choice of decisions.

QUESTIONS:

1. Why is a drawing size increased or decreased?

2. Whose responsibility is this?

3. If a drawing is increased in scale, which dimensions are put on the field of the drawing?

4. How does one determine what scale a particular drawing has?

5. Always try to maintain full scale on a drawing. Explain.

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tected by search receivers. The analyzer can also supply information concerning lobe switching, rotation rates, and beam widths of radar transmissions. In many pulse analyzers, the data are presented visually by means of cathode-ray tubes, although in some the pulse width and PRF values are indicated on meters. An example of the type using a cathode-ray tube as an indicator is shown in block diagram form in figure 20-5. The equipment shown is a synchroscope. (A synchroscope differs from an oscilloscope in that an input signal must be used to trigger the sweep. In actual practice this signal results from the interception of an enemy transmission.)

This analyzer's cathode-ray tube is unique in that it contains five separate electron guns within one glass envelope. The horizontal beam of each electron gun sweeps at a different frequency. Therefore, the signal that appears is shown on five different time bases. Various scales are engraved on the cursor so that desirable readings may be obtained. The two top traces show wide pulses so that pulse width may be observed. The three bottom traces indicate pulses repetition frequency.

The pulse from the search receiver follows two paths after it is fed into the pulse analyzer. One path leads to a pulse shaper which produces pulses having the same width and repetition frequency as the received video signal, as well as constant amplitude and rise time. The shaper output starts the horizontal sweeping action that unblanks each scope.

The other path is through a delay line to the vertical plates of the five guns in the CRT. This delayed signal is the deflecting voltage which produces a deflection of each time base so that signal characteristics are indicated. The delay is for a very short period of time. This insures that the leading edge of the pulse will be presented on the scope. In the last three electron guns, the horizontal sweep frequency is sometimes so low (slow sweep) compared to the signal frequency that the signal does not appear on the CRT. (Signal pulses appear but are too narrow to be seen.) In this case a stretching circuit can be switched in. The stretching circuit broadens, or stretches, the signal enough so that it shows on the scope.

When lobe switching is used by the enemy, the pulse width pattern appears as shown in figure 20-6. Because of lobe switching, the trace is not steady but appears to jump up and down. Although figure 20-6 shows a lobe-switching pattern on only one line, in actual practice the pattern would appear on all five lines.

Cathode-ray oscilloscopes and audio oscillators are sometimes used to measure the repetition frequencies of radar pulses when a pulse analyzer is not available. The pulse repetition frequency is determined from the patterns which result from application of the received signal to the vertical deflection plates of the scope while sweeping the beam horizontally with the output of the calibrated audio oscillator.

The information derived with these various types of search equipment consists of the characteristics of the enemy signals. These properties form the basis for estimating the capabilities and weaknesses of the electronic installations and for devising effective jamming techniques to be used against them.

DIRECTION FINDERS

One of the essential things to learn about any radar or radio station operated by the enemy is its exact location. In search intercept flights this information can be obtained by the use of airborne ECM direction finders which have been developed for this particular purpose. The enemy transmitter reveals its location as long as it is sending out radio waves; but the problem of analyzing the emissions is complicated by the fact that the enemy may choose either vertical or horizontal polarization. Consequently, the direction finder must be capable of receiving either type of transmission.

In ECM direction finders designed for higher frequencies, typical equipments employ continuously rotating antennas which are highly directional. Signals received are displayed on a cathode-ray indicator on which is presented a polar diagram of reception obtained throughout 360 degrees of rotation of the antenna. The pattern contains a major lobe which indicates the relative bearing of the station whose signals are displayed.

To locate a particular transmitter, the operator makes several readings of its relative bearing by means of the direction finder display. Each of these readings is called a "cut." With each cut, the operator records the time and the

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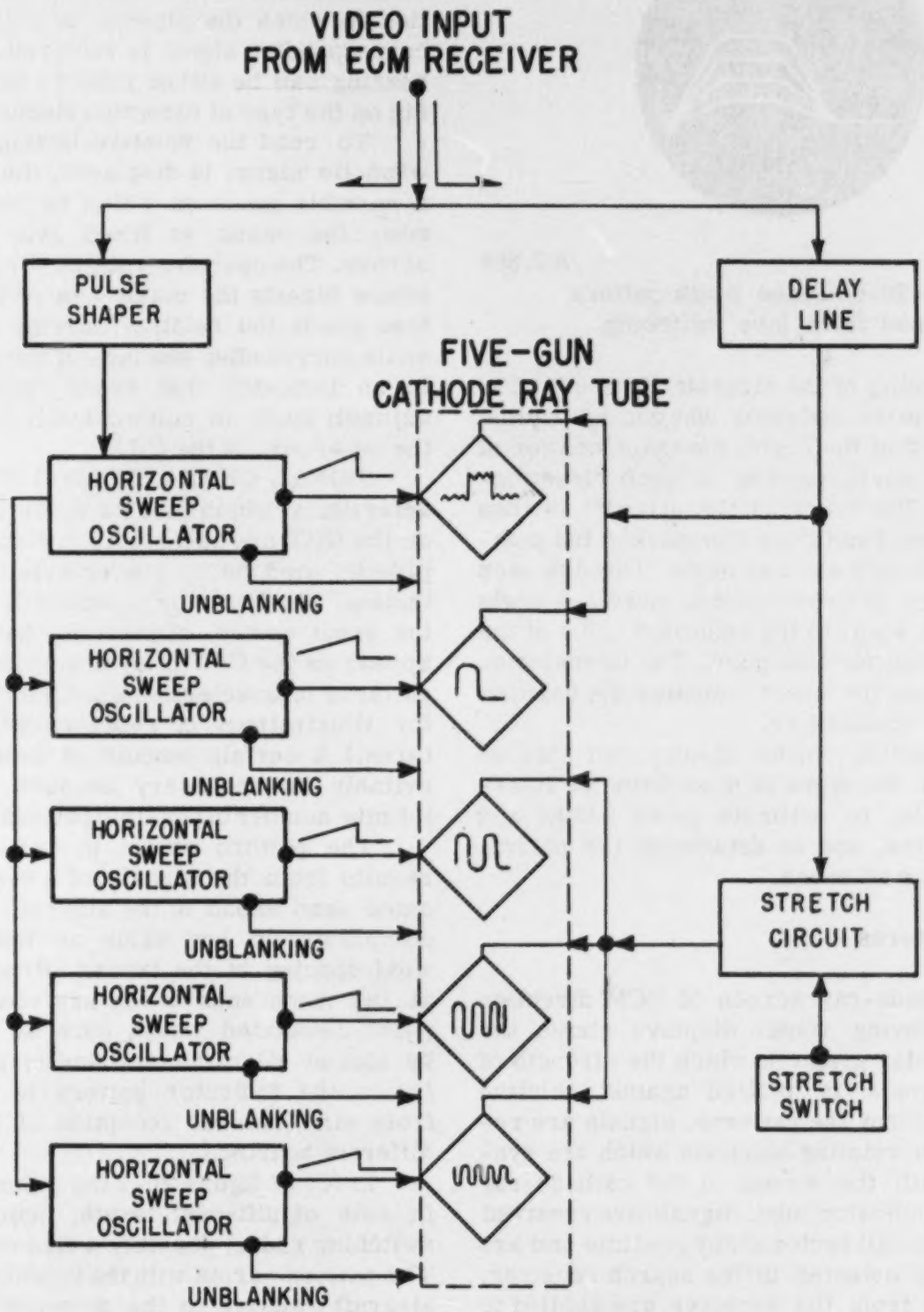

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Figure 20-5.—Block diagram of a pulse analyzer.

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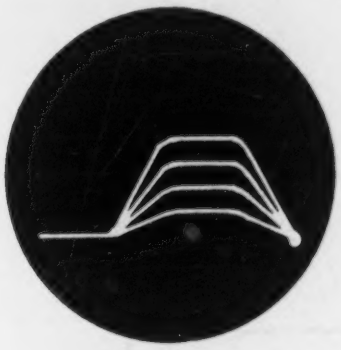

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Figure 20-6.–Pulse width pattern obtained from lobe switching.

compass heading of the aircraft. This information is given to the navigator, who can determine, from the track of the flight, the exact location of the aircraft corresponding to each direction-finding cut. The track of the aircraft is then drawn on a chart and along it is marked the position at which each cut was made. Through each position a line is drawn, which makes an angle with the track equal to the recorded value of the relative bearing for that point. The intersection of the lines on the chart indicates the position of the enemy transmitter.

The direction finder display can also be used to learn the types of modulation of intercepted signals, to estimate pulse widths and repetition rates, and to determine the polarization of radar antennas.

Indicator Patterns

The cathode-ray screen of ECM direction finders employing visual displays shows the operator a polar graph on which the strength of received signals is plotted against relative bearing. To form the patterns, signals are received by the rotating antennas which are synchronized with the sweep of the cathode-ray beam of the indicator tube. Signals are received from a very small sector at any one time and are amplified and detected in the search receiver. Video pulses from the receiver are applied to the direction finder for further amplification. When they are applied to the indicator tube, they produce patterns similar to those shown in figure 20-7.

With each video pulse the electron beam in the CRT is deflected outward from the center of the screen; thus the length of the trace indicates the relative signal strength. The angular direction of each trace line represents the direction in which the antenna is pointing when the corresponding signal is received. The indicated bearing can be either relative or true, depending on the type of direction finder being used.

To read the relative bearing of a station when its signal is displayed, the operator uses a movable mask on which is inscribed an arrow; the mask is fitted over the indicator screen. The operator rotates the mask until the arrow bisects the major lobe of the pattern and then reads the relative bearing on a graduated scale surrounding the face of the indicator tube. In an indicator that reads true bearing, the azimuth scale is automatically rotated around the outer rim of the CRT.

SIGNAL CHARACTERISTICS.–Signal characteristics which create a distinctive pattern on the CRT are radar PRF, relative signal amplitude, modulation characteristics, and polarization. The best way to gain skill in interpreting the great variety of patterns that may possibly appear on the CRT is by observing known scope patterns (characteristics). (Refer to figure 20-7 for illustrations of representative scope patterns.) A certain amount of deduction will inevitably be necessary because of the almost infinite number of possible pattern combinations.

The pattern shown in (A) of figure 20-7 results from the signals of a search radar located dead ahead of the aircraft. The PRF is a comparatively low value as indicated by the wide spacing of the traces. Bright tips appear at the trace ends which are characteristic of pulse-modulated waves such as those emitted by almost all radar transmitters. In (B) of the figure the indicator pattern is that resulting from simultaneous reception of two radars on different bearings.

In (C) of figure 20-7 the pulses are grouped in sets of different length, indicating a lobe-switching radar, possibly a fire control system. The pattern varies with the location of the search aircraft relative to the direction of the radar lobes. When the pulse groups form a smooth pattern with all traces of equal length, the indication is that the aircraft is being bracketed by the switching lobes of the radar and that the guns controlled by it are probably trained on the observer.

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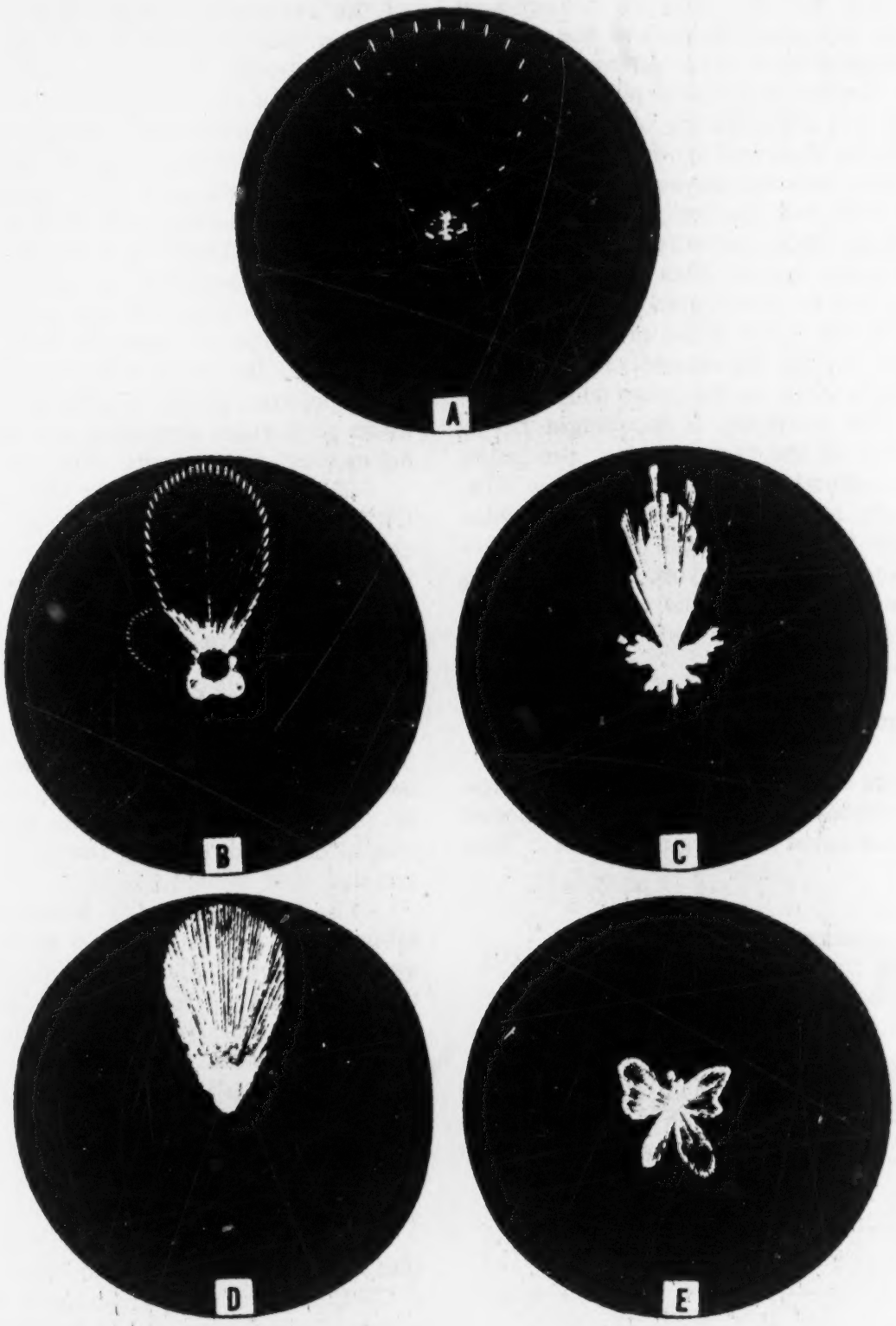

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Figure 20-7.–Direction finder patterns.

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A signal from a communications transmitter employing voice modulation is shown in (D) of the figure. Communication signals are easily identified by the fact that they do not produce bright tips on the trace lines and the pattern has a fuzzy appearance. The pattern shown in (E) does not display a marked major lobe and indicates that the polarization of the direction finder antenna is different from that of the polarization of the received waves.

In radar patterns, the lengths of the bright tips on the trace lines provide a means of estimating the pulse width. With the unit whose display patterns are illustrated in (A) and (B) of figure 20-7, the ratio of the bright length to the total trace length expressed in percentage is approximately equal to the pulse width in microseconds. For example, if the bright tip is about 5 percent of the trace length, the pulse width is approximately 5 microseconds. The pulse repetition rate of the radar can be estimated roughly by the amount of spacing between the trace lines; however, the spacing is governed to some extent by the rate of rotation of the receiving antennas as well as by the PRF of the signals.

Equipment Components

An example of ECM direction-finding equipment which provides the type of display discussed above is illustrated in figure 20-8. This direction finder, when used with suitable radio or radar receivers, provides visual indications on a CRT. Such indication gives the true bearing of the received radio or radar signals. The direction indication is converted to true bearing by an azimuth scale which rotates around the outer rim of the CRT. Other information can be obtained from the CRT picture, such as approximate PRF, relative signal amplitude, modulation characteristics, and signal polarization.

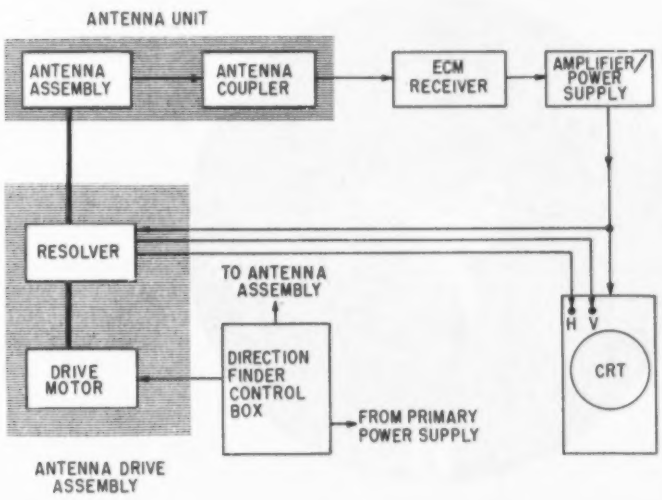

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Figure 20-8.–Block diagram of an ECM direction finder.

The typical direction finder consists of five major units. These are an antenna unit, an antenna drive assembly, an amplifier/power supply unit, an azimuth indicator, and a control box. The type of receiver used was previously discussed. Its output video signal is supplied to the amplifier/power supply unit; this unit consists of a video amplifier and the power supply necessary to operate the direction finder.

The azimuth indicator unit contains a small CRT indicator. It has external adjustments for controlling the vertical and horizontal positioning, and the focus and intensity. The indicator unit also has a torque unit and a gear train These rotate the moving scale for the azimuth reading.

The control box is located at the operator's position. It provides means for selecting the proper antenna, varying the speed at which this antenna is rotating, switching the polarization of the antenna, varying the gain of the video amplifier, and turning the primary power off and on.

The antenna drive assembly has a d-c motor and a gear train to drive the resolver and the antenna. The video signal from the intercept receiver is amplified and then passed through the resolver which is geared to the antenna drive shaft. This resolver voltage is then delivered to the plates of the CRT. It impresses on the tube a signal which is a radius vector rotating about the center of the CRT. The rate of rotation is the same speed as the antenna's rotation.

The combined function of all of the units that make up the direction finder is to produce a CRT pattern of the received radio or radar signal. This pattern is produced in such a manner as to indicate the direction from which the signal is being received and then to convert that direction indication into a true bearing by means of the rotating azimuth scale.

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ANTENNAS

The antenna assembly is an essential unit of an ECM installation. Ideally there would be two directional antennas for each frequency range, one polarized vertically and the other polarized horizontally. From the standpoint of space and weight this is impractical for aircraft installations. Aircraft ECM antennas are constructed so that they cover a broad band of frequencies and possess different polarization characteristics. Also, more than one antenna is mounted on the same antenna base. In many of the units, the assembly includes built-in impedance-matching sections.

Direction Finding Antennas

Figure 20-9 shows a type of construction that is used in ECM direction finder antennas. Notice that there are three separate directional antennas. This practice makes possible the coverage of different frequency ranges. Also notice the different types of polarization used.

The three antennas are mounted on the same disk and may rotate through 360 degrees. Only one antenna is active at a time as selected by a polarization switch on a remote control panel. This polarization switch selects the frequency band desired and the type of polarization used with the selected antenna. The feed of the parabolic reflector antenna is rotatable through a 90-degree angle to provide for reception of both vertically and horizontally polarized signals.

Search Antennas

Since enemy signals may appear over very wide ranges of frequency, the antennas used with ECM search receivers must necessarily be very broad in frequency response. To insure this, the antennas are made thick and stubby in structure so that the inductance value is low. As a result, the antenna stores very small amounts of energy and has a low Q with the broad frequency response which is characteristic of all low-Q circuits.

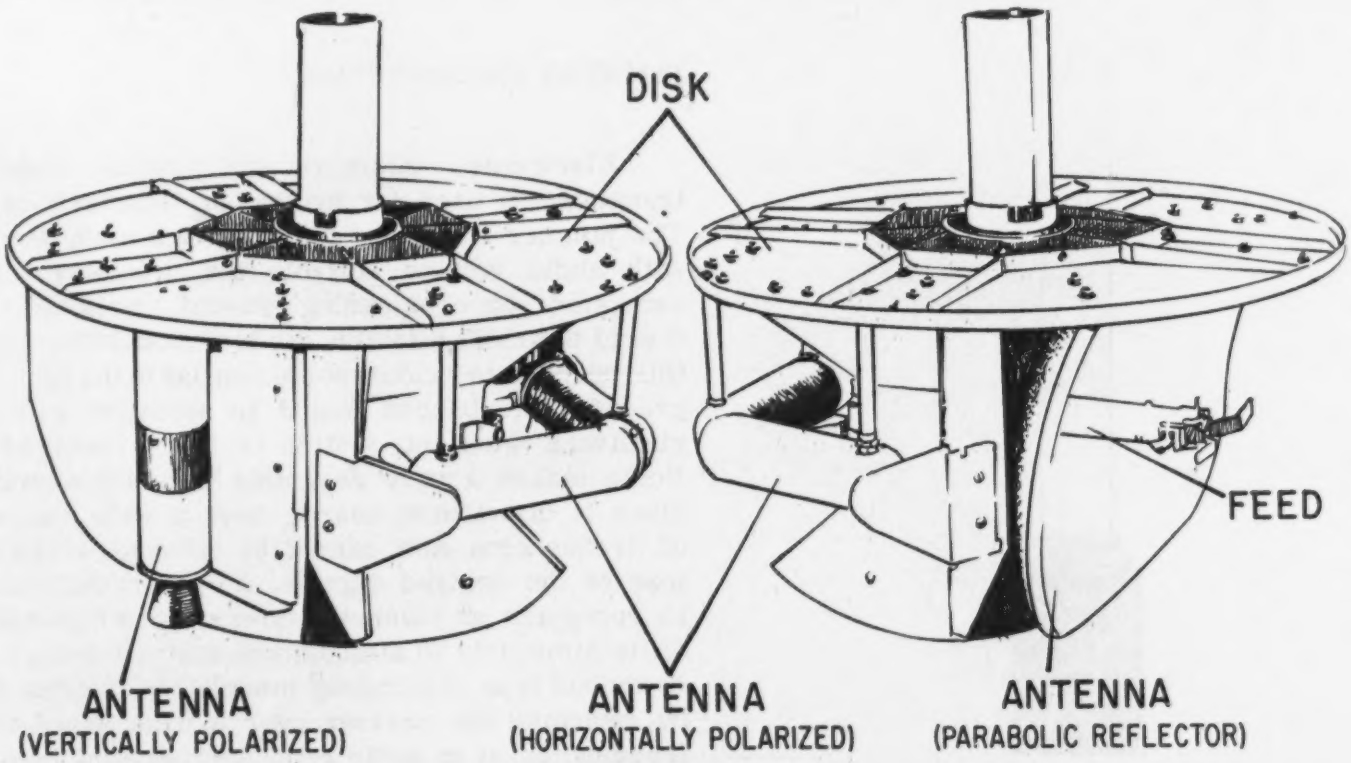

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Figure 20-9.—Direction finder antennas.

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A type of ECM antenna used with airborne search receivers is shown in figure 20-10.

The stub antenna consists of a wooden mast about 22.5 inches in length which is covered with a thick metal plating. The plated area in a typical installation is connected to a receptacle for attachment to a 50-ohm coaxial cable.

ACTIVE ECM EQUIPMENT

Active ECM actions can be detected by the enemy and tend to prevent him from making effective use of his equipment. These actions consist of jamming, of deception, or a combination of both. The equipments used are of two general types: electronic and nonelectronic. The electronic type includes jamming transmitters and pulse-repeating receivers. The jamming transmitters are used to produce interference with radar, navigation, and communications reception so that enemy receiver are subjected to obscuring and confusing radiations. Pulse-repeating devices are used for deception and are similar to radar beacons. They receive radar signals and respond with pulses which give the enemy false information concerning bearing or range.

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Figure 20-10.–Stub antenna.

Nonelectronic jamming is often accomplished by the use of strips of metallic foil released from aircraft (and sometimes fired in projectiles). The falling strips intercept radar waves and reradiate them, causing numerous false targets to appear on the enemy radar-scope so that the operator is unable to detect desirable targets and fire control radar is unable to see attacking aircraft.

Before active countermeasures can be undertaken, an extensive search, or intercept, campaign must be made to learn what types of electronic equipment are in active enemy use and the purposes for which they are employed. To gain this information, intercept flights are made in aircraft which carry special ECM equipment. With the equipment, the ECM operator tunes in signals from enemy units and measures their characteristics. He records the results in a log or acquires tape or film records which are later submitted to tactical officers for analysis and evaluation. The information gained is then used in planning active countermeasures, such as jamming, for directing control of radiation from friendly units, and for devising means of evading detection by the enemy equipments reported.

JAMMING TRANSMITTER

Electronic jammers are tunable radio transmitters used for producing interference. The jammer radiates a carrier wave modulated with audio voltage suitable for drowning out reception or overloading enemy receivers. One of the most effective kinds of modulation for this purpose is random noise similar to the background disturbances heard in sensitive radio receivers when no station is being received. Noise makes a very desirable jamming signal since it distributes energy over a wide range of frequencies and cannot be filtered without loss of the desired signals. It is also difficult to recognize as manmade interference because of its similarity to atmospheric static impulses. A second type of jamming modulation is caused by sweeping the carrier over a wide range of frequencies at an audio rate. Another type consists of a repetition of several audio tones, three to five in number, which give rise to a wailing sound when received.

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When operated against radar receivers, the ECM jammer works at a distinct advantage since the echoes returned from most targets are very weak, and the jamming signal usually competes only with low-level radar signals. An output power in the order of tens of watts can effectively overcome radar pulses originally emitted at a peak power in the order of kilowatts. As a result, low-powered transmitters can sometimes jam enemy radar reception at far greater than the maximum effective range of the radar. However, it is often necessary that the jamming signal be radiated continuously, and that the output power of the ECM transmitter be as great as the average power of the radar it can successfully jam. Because of these requirements, adequate cooling must be provided. This is usually accomplished by fans, but may be accomplished by other means such as a water jacket around the transmitter to remove the heat.

ECM transmitters are used in one or two ways, called spot jamming and barrage jamming. In the first of these, the operator tunes the jammer to the exact frequency of the receiver to be victimized by first tuning in the enemy signal with a search receiver. He then adjusts the output of the transmitter until the two signals coincide in frequency. Tuning for spot jamming is usually done in flight. Barrage jamming is accomplished by using a number of transmitters as in a formation of aircraft with each aircraft carrying at least one jamming transmitter. The units are pretuned to frequencies which differ by about 3 megahertz, a typical value of the bandwidth of an ECM transmitter. When all units are turned on, a wide range of frequencies is completely covered.

An example of an airborne jamming transmitter is shown in block diagram form in figure 20-11.

The typical countermeasures transmitting set is an airborne noise-modulated transmitting system. It is designed to jam enemy radar signals of any polarization over a wide frequency range. Such a transmitting set is suitable for use as a spot or sweep jammer, and for manual use with currently used ECM receivers. This set is a lightweight, airborne, noise-modulated jamming system which may be controlled either automatically or manually. The jamming transmitter is similar to the ECM receiver in that it covers a wide frequency range by using plug-in tuning

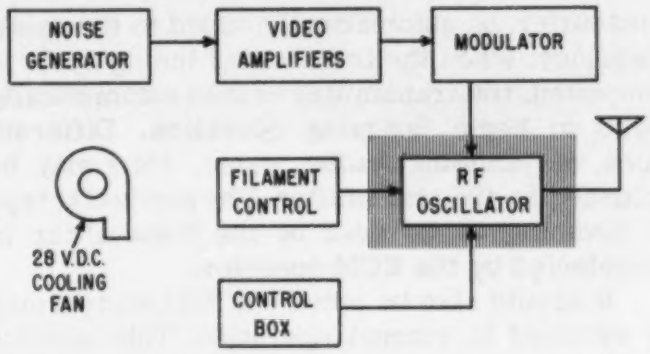

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Figure 20-11.—ECM jamming transmitter.

heads. The noise source is generated by a special type tube. This noise is amplified through several stages of video amplification. This broad band of frequencies is fed to a pair of high-powered modulator tubes.

The RF oscillator stage is the stage that is replaced when different tuning heads are used. Each stage contains a mechanically tunable magnetron oscillator which is modulated by the generated noise signal. The cathode filament of the magnetron receives enough power from back bombardment of electrons, when plate voltage is supplied, to materially shorten the life of the magnetron. Therefore, a-c power applied through the filament transformer must be varied to keep filament temperature constant. This is the function of the filament control unit.

The operator selects the mode of operation of the transmitter with the control box. Transmitter frequency may be changed manually by the operator turning a knob, or it will change automatically if set for automatic operation. A switch is incorporated on the control box which allows the operator to switch out the noise generator. When this is done the transmitter produces CW transmission; otherwise the output is modulated. The purpose of this switching arrangement is to produce another confusion factor for the enemy.

Automatic Jamming Equipment

Automatic jamming equipment consists of an automatic search receiver and an automatically tuned jamming transmitter.

The sequence of operation is as follows: The receiver searches a desired frequency range, and when a signal is detected, the receiver locks-on this signal. As the receiver locks-on, the

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transmitter is automatically tuned to the same frequency. When the transmitter tuning cycle is completed, the transmitter is then automatically keyed to begin jamming operation. Different types of jamming (pulse, noise, etc.) may be produced by the transmitter. The particular type of jamming to be used by the transmitter is preselected by the ECM operator.

It should also be noted that this system may be switched to manual operation. This enables the ECM operator to manually perform the sequence of steps in the operation of the system.

ANTIJAMMING CIRCUITS

An ECM development relating to active jamming is the antijamming circuit often installed in receivers, particularly those in radars. The antijamming device is designed to decrease the effectiveness of enemy jamming and hence is called a "counter-countermeasure." These circuits have two uses: They prevent interfering signals from overloading the receiver, and tend to separate the desired signals from the jamming signals. Typical antijamming circuits are simple inductance-resistance filters of the high-pass type. The effect of the circuit, which is usually associated with the video detector section in the receiver, is to pass the high frequencies present in the signal and suppress low-frequency components. As a result, the leading edges of pulses are accepted by the circuits following the filter and large blocks of jamming voltages are excluded from the video amplifier circuits.

NONELECTRONIC JAMMING

WINDOW and ROPE are code names for strips of aluminum foil used for nonelectronic jamming. The strips act as reflectors; and when released from aircraft, they return echoes to enemy radar receivers.

Window

Window (also called chaff) is tuned material. The strips of foil are cut to one-half wavelength of the radar signal to be reflected, and each strip acts as a resonant dipole antenna which intercepts and reradiates energy. The dipoles are packaged in cardboard folders which are either dropped manually or released by automatic window dispensing devices. Each package contains foil cut for a certain frequency so that a folder may contain from 50 to 200,000 dipoles, depending on the wavelength of the system for which it is prepared. Typical bundles contain several thousand strips, and weigh less than two ounces. When the package is released, it opens so that the dipoles scatter into the air and begin falling at the rate of about 400 feet per minute.

Skilled radar operators can distinguish between aircraft pips and a single window echo; for this reason, window is seldom dropped in isolated packages. Usually, a lead aircraft lays down a path consisting of many packages spaced at intervals of 1,000 feet or less. The aircraft which follow in the formation fly through the resulting clouds of reflectors, and enemy operators find it difficult to separate the single pip of an aircraft from the mass window echoes. Thus, the following aircraft are protected from radar-controlled antiaircraft fire and concealed from air search radars. On the radarscope, the dispensing aircraft appears as a pip which divides into two parts. The pulse representing the aircraft moves across the screen while additional echoes appear behind it and remain stationary. As the dipoles disperse in the air, the stationary pip grows into a shapeless mass in which the following aircraft are practically invisible. Aircraft must be inside the cloud of reflectors to be hidden; those behind but not within the cloud can be detected by radar waves which pass through the strips.

Window is often used in conjunction with electronic jamming transmitters to protect a formation of aircraft from radar-controlled gunfire.

Rope

Rope is similar to window in that it is a confusion reflector, but it differs from it in length and also in the fact that it is untuned. Strips of rope are aluminum ribbons about 400 feet in length and about one-half inch in width. The ribbons are used as nonresonant reflectors for jamming low-frequency radars and are also employed in regions where the enemy operates many units which differ considerably in frequency. The rope material is dispensed in the form of a roll, one end of which is attached either to a small paper parachute or to a square

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of cardboard. The rolls equipped with parachutes assume a vertical position while falling and reflect waves that are vertically polarized. Those attached to cardboard squares unwind and float downward in a horizontal position, thereby reflecting horizontally polarized radar pulses.

CHAFF DISPENSERS

Chaff dispensers, together with the dispenser control (fig. 20-12) are designed for use with a variety of military aircraft. Their purpose is to carry and dispense packaged chaff material for jamming and deceiving enemy radar equipment. They are similar in size and shape to a droppable fuel tank, and have a large container inside for carrying the chaff material.

The chaff material is held firmly in place in the container by the package holddown assembly. (See fig. 20-13). The holddown assembly is in the DOWN position (after loading) until ready to dispense the chaff material. To start the operation the operator moves the DISP-OFF-HOLD switch from HOLD to the DISP position, energizing the holddown motor and raising the holddown pad until the pad actuates an up-limit switch (normally open) supplying power to the drive motor. The drive motor pulls the tape, which carries the chaff material aft over the idler rollers and into the airstream coming from two air ducts in the dispenser body. The airstream deflects the chaff material down and out of the opening in the aft underside of the dispenser. A tape cutting feature is incorporated in the dispenser to prevent long streamers of chaff tape fouling the packages or tail assembly of the carrying aircraft. An automatic motor disconnect switch is provided to automatically open the motor circuit when all the chaff packages have been dispensed.

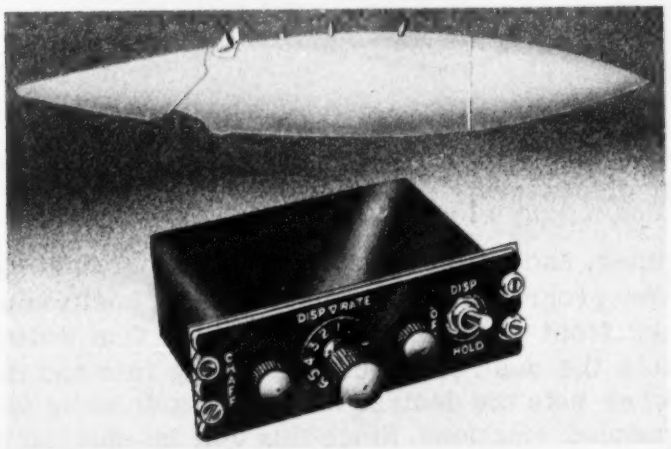

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Figure 20-12.–Dispenser and control.

The dispenser consists of three detachable sections which latch together to form a streamlined fairing. The center section contains the chaff package container, package holddown mechanism, and dispenser drive mechanism. Some models include a tape cutting assembly incorporated into the drive assembly. The nose and tail sections steamline the unit and detach to facilitate loading and servicing. (see fig. 20-13.)

Dispenser Control

The dispenser control (fig. 20-13) is installed within the aircraft either on the cockpit panel or in some convenient location, and contains all necessary controls for the operation of the dispensing system. The control consists of a DISP-RATE selector, a DISP-OFF-HOLD switch, and two panel light assemblies (connected to the aircraft cockpit panel light circuit). The DISP-RATE selector consists of a double wafer, a ten-position switch, a knob, and a plastic dial.

The DISP-OFF-HOLD control is a three-position toggle switch, spring loaded from HOLD to OFF positions. The DISP position controls the power to the dispensing mechanism, and the HOLD position actuates the package holddown mechanism within the dispenser.

Maintenance of the dispenser and the dispenser control and loading of the chaff materials within the dispenser are the responsibility of the Avionic's personnel.

The dispenser is approximately 117 inches long and 18.4 inches in diameter at its thickest part. The weight when empty is 86 pounds as compared to 210 pounds when loaded. The dispenser is loaded on a bomb rack, and receives operating power from the aircraft's 28-volt d-c supply through the dispenser control.

Figure 20-14 shows an internally mounted chaff dispenser. Two of these units are normally installed in one aircraft. Each dispenser unit consists of thirty discharge tubes joined together in parallel. One end of each tube is open and the other end is closed. The closed ends contain

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ASSIGNMENT:

1. Draw the shim shown below to double size. Dimension fully.

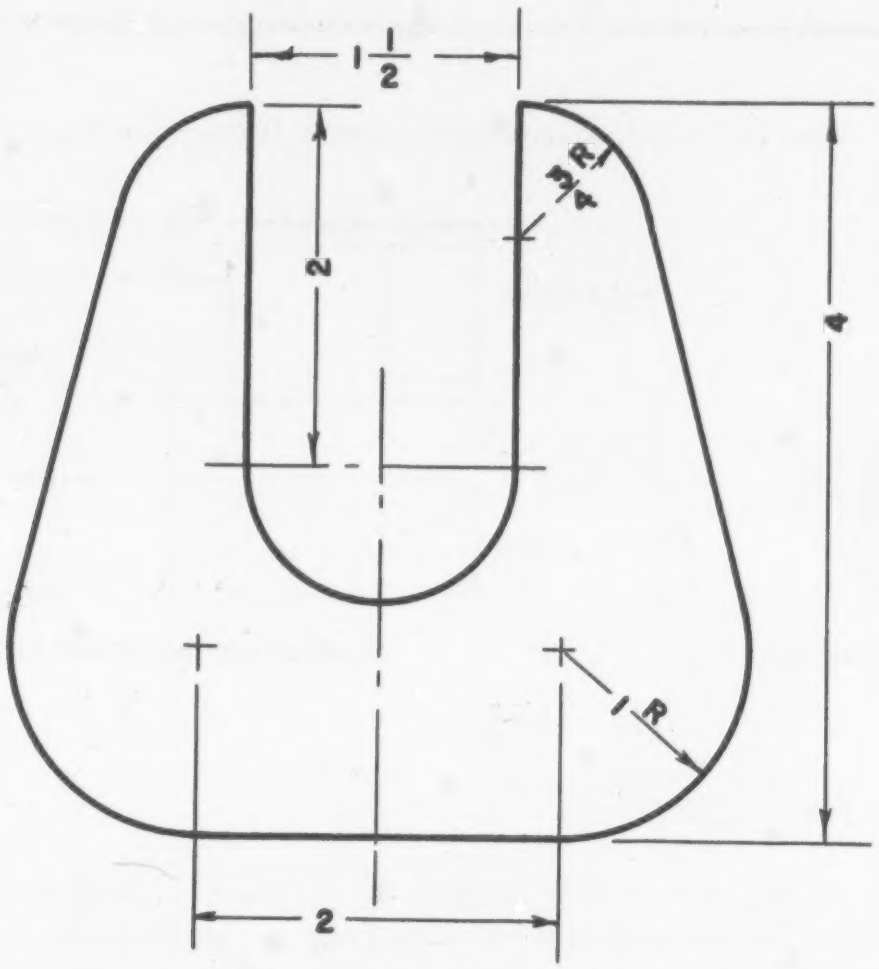

2. Draw the washer shown below to half size. Dimension fully.

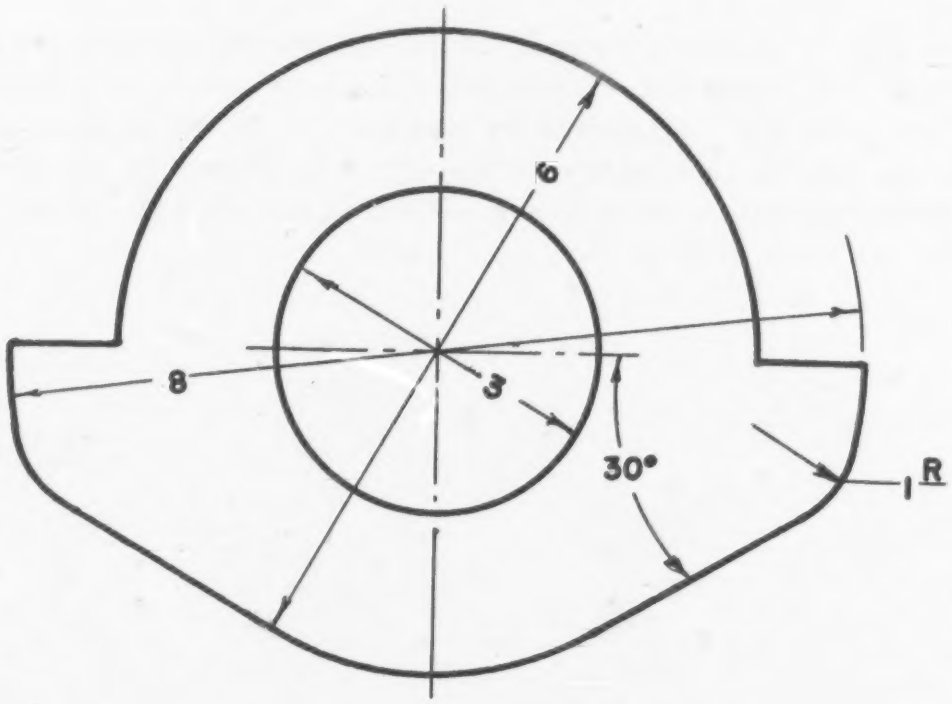

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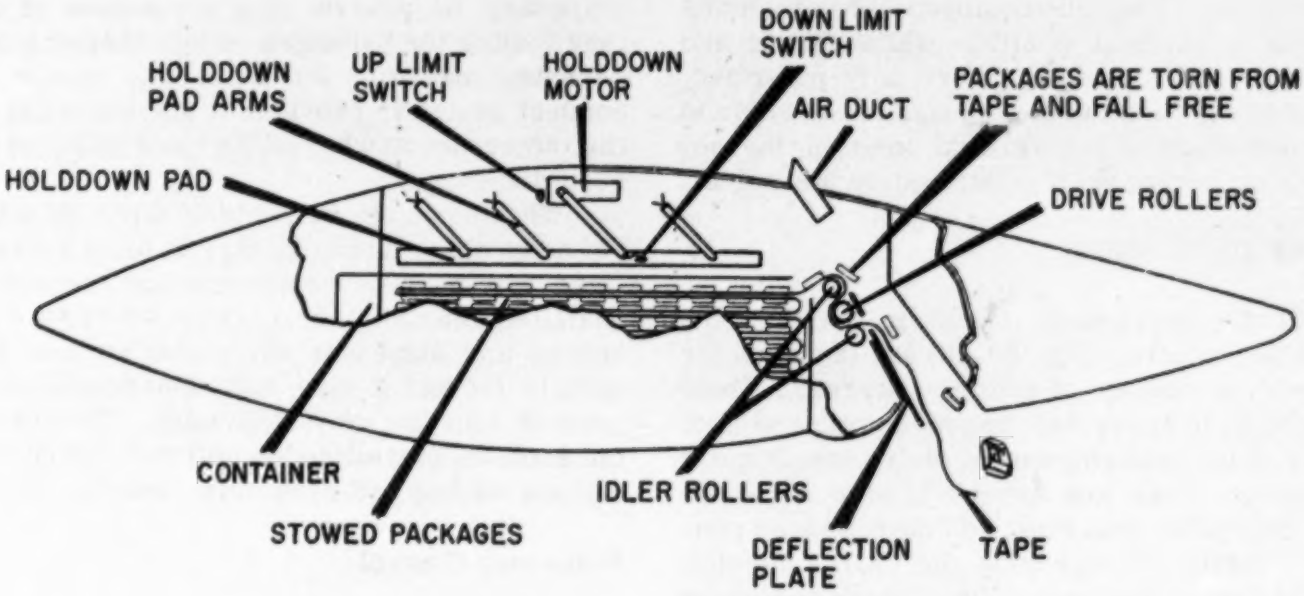

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Figure 20-13.–Principles of operation (chaff dispenser).

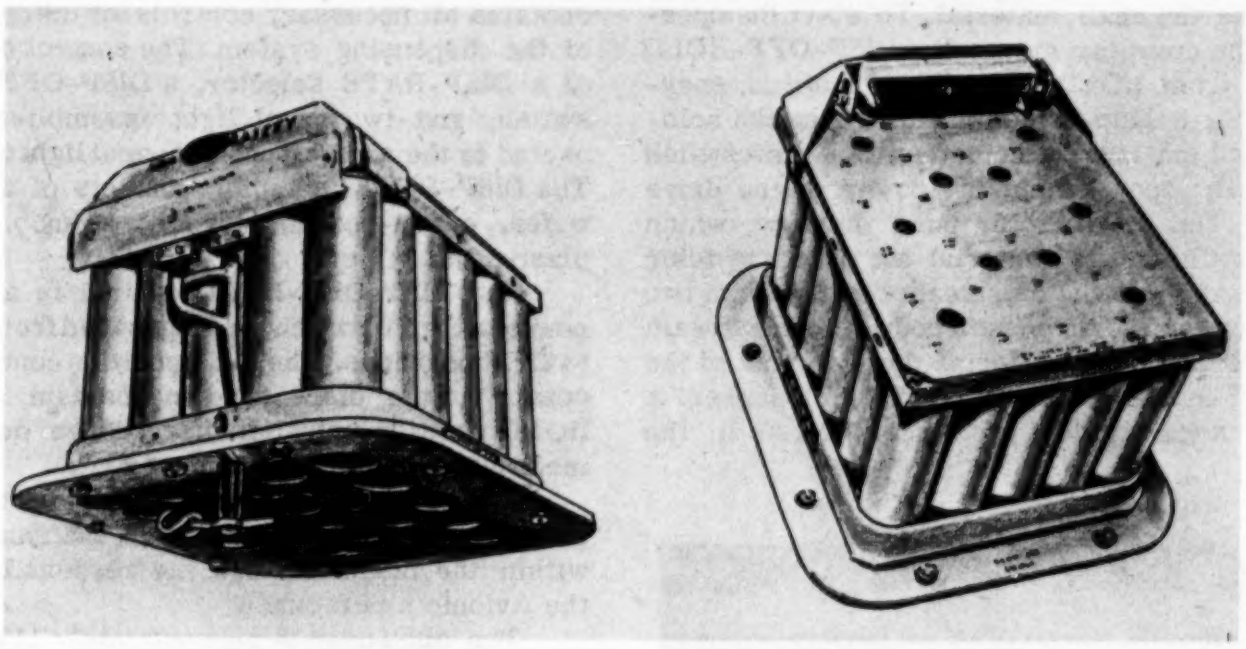

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Figure 20-14.–Chaff dispensers.

electrical contacts which operate an electrical initiator. The open ends are connected to a platform which serves as a mounting flange for the unit. The initiators serve as the propelling force to discharge the tubes load through the open end into the atmosphere.

This system has a control unit (not shown) that contains an intervalometer, a repeat cycle timer, and a time-delay relay for programming. The programing is accomplished by positioning two front panel mounted switches. One switch sets the desired sequential timing rate and the other sets the desired number of automatic sequenced ejections. Since this unit is mounted in an area not accessable to the pilot, these settings must be determined and adjusted before flight.

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An ON-OFF power switch to control the power to the system, a momentary "auto" switch for initiation of an automatic cycle dispensing operation, a momentary "single-fire" switch for initiation of a single-fire dispensing operation, and a solenoid-operated numerical counter to register each pulse from the dispensing set and read out the number of loads (chaff) remaining in the dispenser units are located in the cockpit for pilot control.

ECM TEST EQUIPMENT

Most of the test equipment used in the maintenance of ECM equipment is common to many other types of electronic equipment. The test equipment that may be considered special ECM test equipment comprises the RF signal generator(s) used to aline the ECM receivers.

Each generator used usually covers only one relatively small band of frequencies. Several generators are needed to maintain a complete set of ECM receivers. These RF generators (above VHF frequencies) produce various kinds of modulated RF signals. For example, continuous wave (straight RF), modulated continuous wave (audio-tone modulated), or pulse modulation may be selected. With the tone modulation, various tone frequencies may be selected. With the pulse modulation, various pulse widths and different pulse repetition frequencies may be selected.

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CHAPTER 21

INFRARED DETECTION

Infrared, or IR as it is sometimes called, is assuming increasing importance in missile guidance, target detection, fire control, communications, and mapping. Like radar, infrared was developed and used for military purposes during World War II. Unlike radar, however, the use of infrared has received little publicity. In some military applications, infrared energy has advantages over radar. Infrared, used as a medium of communications, is usually less susceptible to counterdetection and interference than is radar or visible light. Infrared equipment is generally less complex than radar equipment used for similar tasks.

ELECTROMAGNETIC SPECTRUM

IR is a form of electromagnetic energy, with certain characteristics identical to those of light and RF waves. Among these characteristics, some of the more important ones are reflection, refraction, absorption, and speed of transmission. Infrared waves differ from light, RF, and other electromagnetic waves only in wavelength and frequency of oscillation.

The frequency of IR ranges from approximately 300,000 megahertz to 400 million megahertz. Its place in the electromagnetic spectrum (fig. 21-1) is between visible light and the microwave region used for high definition radars. This part of the spectrum is usually discussed in terms of wavelength, and it is generally accepted that the IR spectrum lies between 0.72 and approximately 1,000 microns (1 micron equals 0.0001 centimeter).

The IR portion of the electromagnetic spectrum is frequently divided into the following three parts:

1. The near infrared (NIR) which extends from the visible region out to around 1.5 microns.
2. The intermediate infrared (IIR) which extends from 1.5 to 5.6 microns.
3. The far infrared (FIR) which extends from 5.6 microns to microwave frequencies.

Some confusion in terminology exists because infrared energy is so close to the visible range of wavelengths in the electromagnetic spectrum. Thus, it is not uncommon to hear references to "infrared light," although the term is inaccurate. Infrared waves are also loosely referred to as heat waves, because of the well-known fact that a solid object subjected to radiation by infrared energy undergoes an increase in temperature. Heat differs from infrared waves in much the same way that electricity differs from radio waves.

INFRARED RADIATION

All objects above absolute zero (0° K or -273° C or -460° F) emit infrared radiation. Radiation from any given object is emitted over a wide range of wavelengths, but it reaches a peak at one particular wavelength. This point is of considerable interest in military applications, as will be shown later. Detection of infrared energy depends on the contrast between IR from the source under consideration and the radiation emitted by the background. A cold object with a warm background has just as good target definition as a warm object with a cold background.

There are a number of advantages in using IR for target detection rather than some other form of electromagnetic transmission. Among these are the following:

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1. IR systems are passive.
2. Although IR systems can be confused, complete jamming is just about impossible.
3. Military targets are usually good sources of IR.
4. IR systems may be made smaller, lighter, less complex, and less expensive than other comparable systems.
5. IR systems have higher target resolution.

EMISSIVITY

One of the most useful concepts employed when working with IR is the "black body." A black body is defined as an object which absorbs all radiation incident on it. Conversely, the radiation emitted by a black body is the maximum possible for any given temperature. This black body is then a perfect absorber and

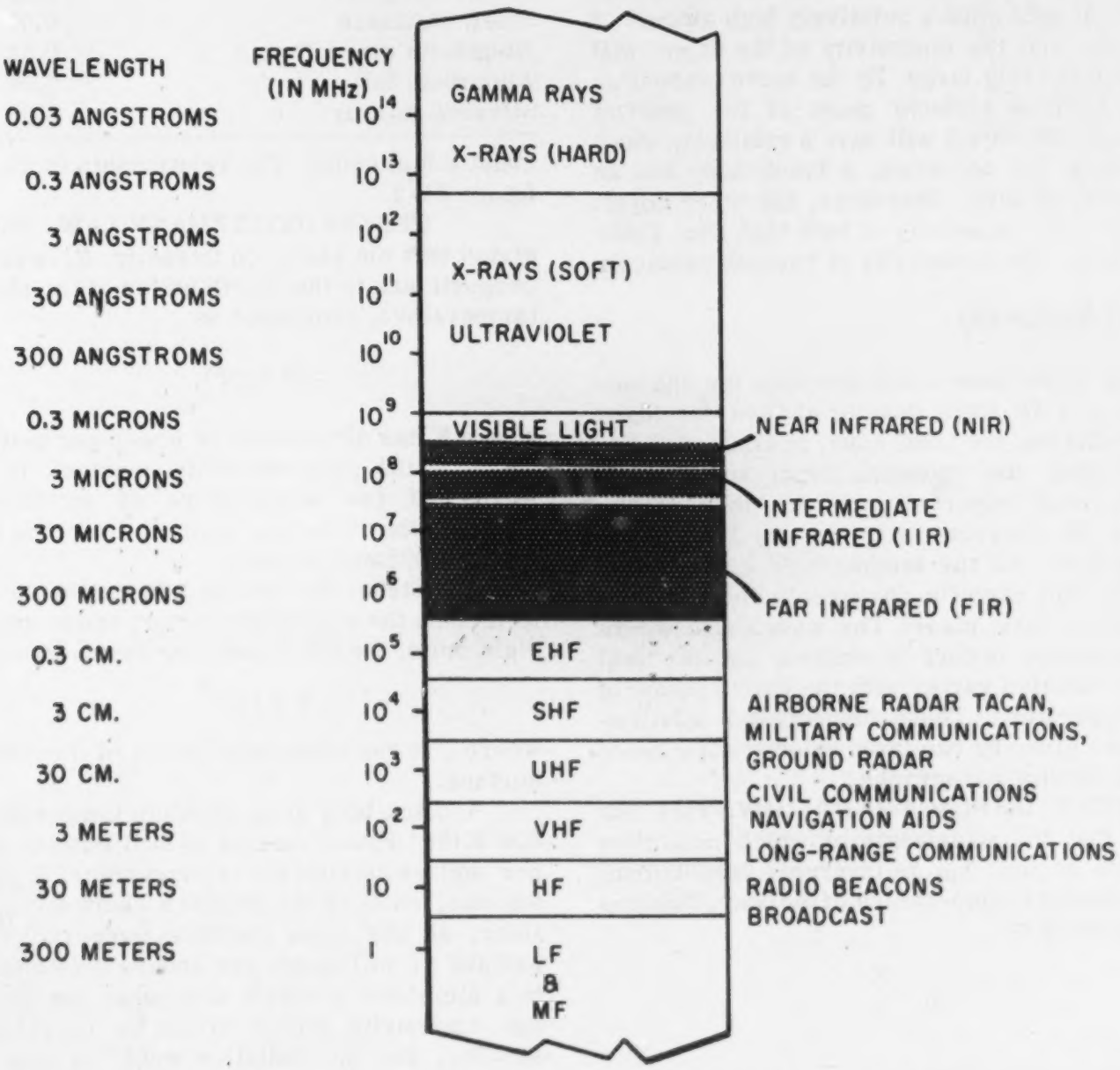

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Figure 21-1.—Electromagnetic spectrum, showing different wavelength units used in different bands of the spectrum.

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radiator of IR at all temperatures and for all wavelengths.

In order to compare the radiation emitted by an actual source with that of a perfect radiator, the concept of emissivity is employed. Emissivity is defined as the ratio of the total radiation emitted by any object at any temperature (T) to the total radiation which would be emitted by an ideal black body at the same temperature. The emissivity of any object depends on the amount of energy its surface can absorb. If the surface absorbs most of the IR striking it, then it will emit a relatively high amount of radiation, and the emissivity of the object will be comparatively large. By the same reasoning, if the surface reflects most of the incident radiation, the object will have a relatively small emissivity. By definition, a black body has an emissivity of unity. Therefore, any other object will have an emissivity of less than one. Table 21-1 shows the emissivity of various surfaces.

Table 21-1.–Emissivities of various surfaces.

Surface	Emissivity
Black body	1.00
Lampblack	0.95
Painted	0.90
Steel, cold-rolled	0.60
Aluminum paint	0.25
Steel, stainless	0.09
Aluminum aircraft skin	0.08
Aluminum foil	0.04
Silvered mirror	0.02

Laws of Emissivity

The basic laws which describe the characteristics of IR were developed first for black body radiation, the ideal case, and then modified to describe the radiation from any source.

The most important parameter in determining the IR characteristics of any body is its temperature. As the temperature of an object changes, two specific changes in the IR characteristics take place: The wavelength where peak radiation occurs is shifted, and the total energy radiated varies with the fourth power of the temperature. These fundamental relationships are given by two laws which are discussed in the following paragraphs.

WIEN'S DISPLACEMENT LAW.–This law states that the wavelength at which maximum radiation occurs, λ_m is inversely proportional to the absolute temperature of the body. This can be expressed by

$$\lambda_m = \frac{K}{T}$$

where the wavelength is given in microns, and the constant (K) has a value (for a black body) of about 2,900. For example, a block of ice emits its peak energy at about 10 microns, while energy emitted from a jet aircraft engine peaks at about 3.5 microns. The relationship is shown in figure 21-2.

STEFAN-BOLTZMANN LAW.–This law states that the radiation intensity, E, is directly proportional to the fourth power of the absolute temperature, expressed as

$$E = \Sigma T^4$$

where E has dimensions of power per unit area, and Σ is the proportionality constant. In other words, if the temperature of an object is doubled, the radiation emitted from the object will be 16 times as much.

The Stefan-Boltzmann Law can be modified to include the emissivity factor; and by using the right units, the total radiation can be obtained by

$$E = \epsilon \Sigma T^4$$

where ϵ is the emissivity factor of the radiating surface.

A black body at an absolute temperature of 300°K (81° F) will radiate 46 milliwatts of power per square centimeter of its surface. A painted surface, such as the skin of a commercial airliner, at the same absolute temperature will radiate 41 milliwatts per square centimeter. If this aluminum aircraft skin were not painted, the emissivity factor would be considerably smaller, and the radiation would be less than 4 milliwatts of power per square centimeter. As mentioned previously, IR from a source will be distributed over a good part of the spectrum, but the maximum radiation occurs at some specific wavelength. Figure 21-3 shows the dis-

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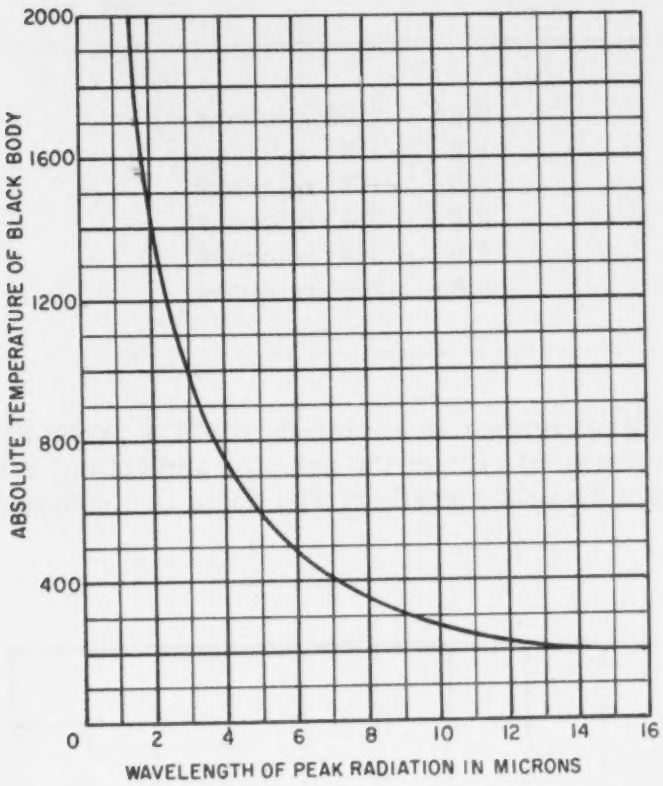

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Figure 21-2.–The wavelength of the peak radiation from a black body in relation to its temperature.

tribution of energy radiated from a black body at various temperatures.

As an example, IR from jet and rocket engine exhaust plumes is primarily due to the molecular excitation of water vapor and carbon dioxide which are characteristic byproducts of combustion. This molecular radiation peaks at 2.7 microns (due to water vapor and carbon dioxide) and 4.3 microns (due to carbon dioxide alone). In a practical situation, however, more usable radiation is obtained from the hot tailpipe and other heated surfaces.

TRANSMISSION CHARACTERISTICS

In military applications of IR systems, the transmitting medium is generally the atmosphere. The effect of the atmosphere on the transmission of IR is a very important factor in considering the overall effectiveness of the system.

Atmospheric Absorption

There are two primary causes of atmospheric attenuation: scattering by suspended solids, and absorption by free molecules. These two influences on the attenuation are additive, but the absorption is the most important factor.

The amount of scattering caused by particles depends on the relationship between the wavelength of the radiated energy and the size of the particles. If the wavelength involved is considerably shorter than the dimensions of the particles, then the scattering is just about independent of wavelength. Since this is generally the case in the IR spectrum, the attenuation due to scattering can be measured at one wavelength and then applied over a relatively wide band of wavelengths.

This technique does not work, however, with attenuation due to molecular absorption. The amount of absorption is closely connected with the wavelength. The two substances in the atmosphere which absorb the most radiation are water vapor and carbon dioxide. In both of these substances, there are several wavelength bands where the absorption is relatively large. This condition is caused by molecular resonance. (Each molecule has a "natural frequency" of vibration, or resonant frequency.)

The resonant frequencies of these molecules are in the infrared region, and their structure is such that this natural vibration creates an oscillation of electric charge in the molecules which increases the absorption. At low altitudes, where the atmosphere is more dense, this absorption is so great that in some wavelength bands the percentage of radiation transmitted drops rapidly to zero. Between these absorption bands are areas where the atmospheric attenuation is not so great. These transmission bands are called "windows." The transmission windows in the atmosphere are approximately as shown in table 21-2.

Figure 21-4 shows the transmission characteristics of the atmosphere at two different altitudes. It will be noted by reference to figure 21-4 that the 2.7 and 4.3 micron radiation readings from a jet exhaust plume occur at frequencies of high absorption. The radiation resulting from hot tailpipe surfaces is a function of tailpipe material and temperature, usually peaking at about 3.5 microns. This frequency is

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in the region of an atmospheric window or low absorption band. It will also be noted that the absorption bands are much narrower at high altitudes due to the thinner atmosphere. These absorption bands will, therefore, be of lesser consideration in the design of high altitude systems.

OPTICAL DEVICES

Because of the similarity between infrared and visible light, optical devices are usually employed to gather and focus the infrared radiation upon the detector. A simplified infrared optical arrangement is shown in figure 21-5. This illustration shows a simple optical system which could be used to focus IR radiation. The entire system is enclosed within a protective housing to protect the detector and optical system from the weather. The dome is a continua-

Table 21-2.–Wavelength limits of IR transmission windows in the atmosphere.

0.95 - 1.05 microns
1.2 - 1.3 microns
1.5 - 1.8 microns
2.1 - 2.4 microns
3.0 - 5.0 microns
8.0 -12.0 microns

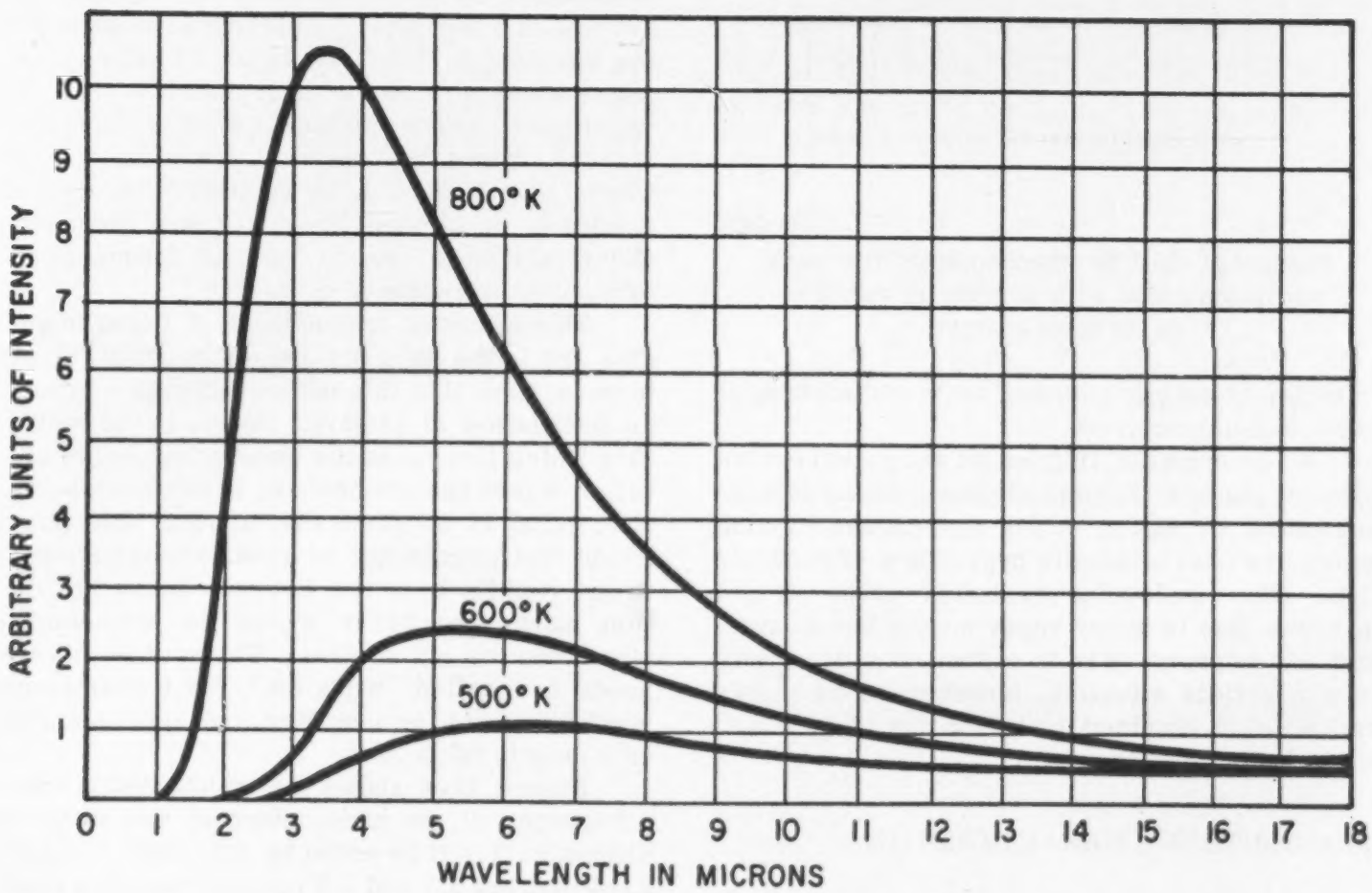

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Figure 21-3.–IR distribution curves for a black body at various temperatures.

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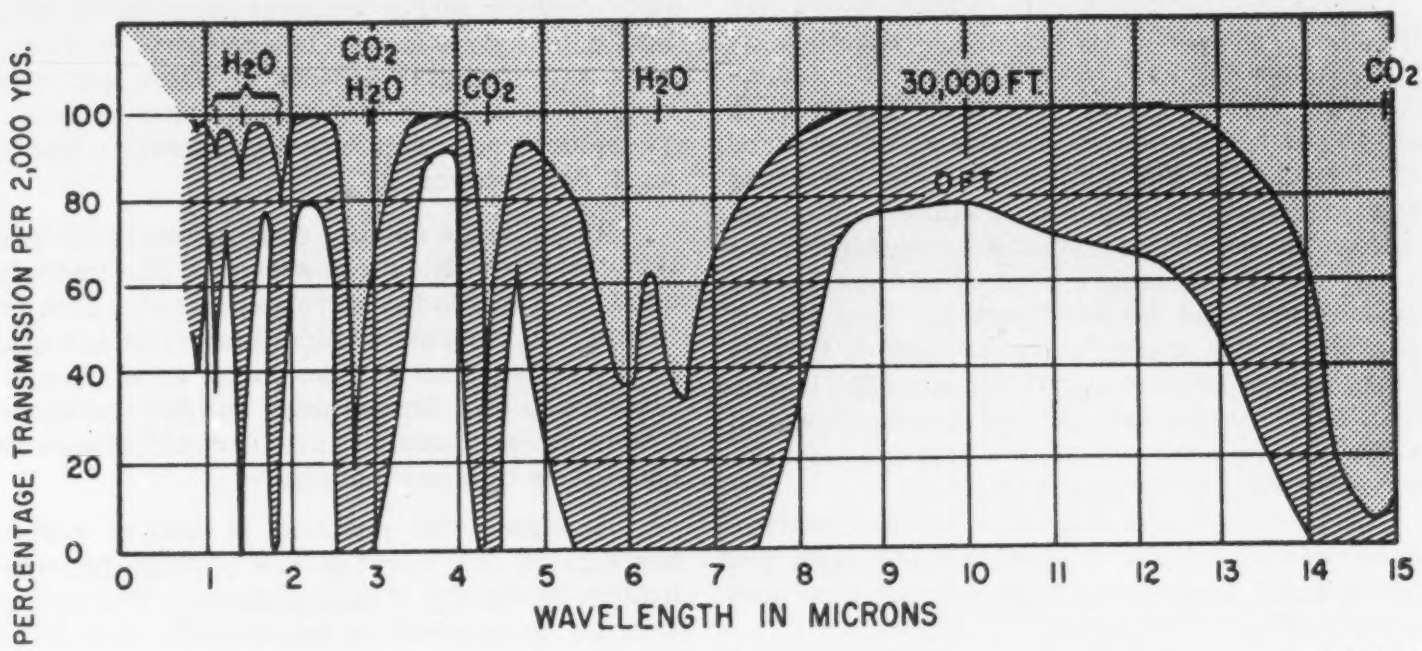

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Figure 21-4.–Atmospheric transmission characteristics.

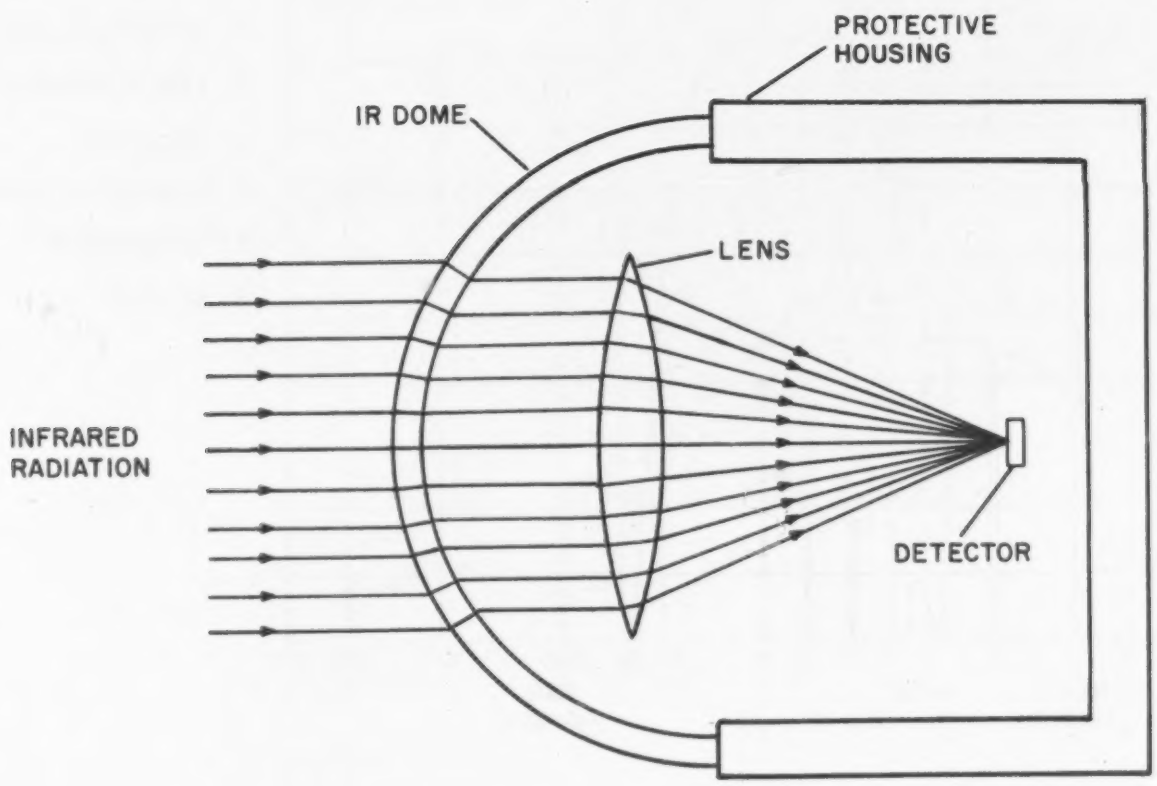

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Figure 21-5.–Simple IR optical arrangement.

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tion of the protective housing and must be able to pass infrared radiation easily.

Typical materials from which domes are fabricated include glass, quartz, synthetic sapphires, germanium, and silicon. The transmission coefficient of the optical material is an important factor in the design of infrared equipment. For NIR, and generally for IIR, glass and quartz are satisfactory. Figure 21-6 shows that glass, quartz, and synthetic sapphires have excellent transmission characteristics in the visible and near infrared regions. They cut off sharply in the middle infrared region. Optical glass is completely opaque to wavelengths longer than 3 microns, quartz cuts off at 4 microns, and synthetic sapphire loses its transparency at wavelengths greater than 6 microns.

Germanium and silicon are semiconductor materials which are opaque to visible light and transparent throughout most of the near and middle infrared regions.

A wholly different type of optics is required for FIR. Single crystals of silver chloride, rolled flat, are satisfactory windows for the transmission of FIR. Sodium chloride (rock salt), grown in single crystals and cut and ground into a lens or window, is excellent. However, rock salt is highly soluble in water and must be protected from the atmospheric moisture. Therefore, rock salt is not practical to use as an IR dome material.

There are a number of problems involved in the design of IR optical systems. The material used must match the wavelength to which the detector will respond. Optical materials are generally weak physically, and many have a low resistance to high temperature and thermal shock. Chemical reactions and pressure will change the properties of some materials.

Another vital problem is that of system heating. If any part of the system becomes heated by energy it has absorbed, this energy will be reradiated at wavelengths that differ from those of the original radiation. If the detector is sensitive to these new wavelengths,

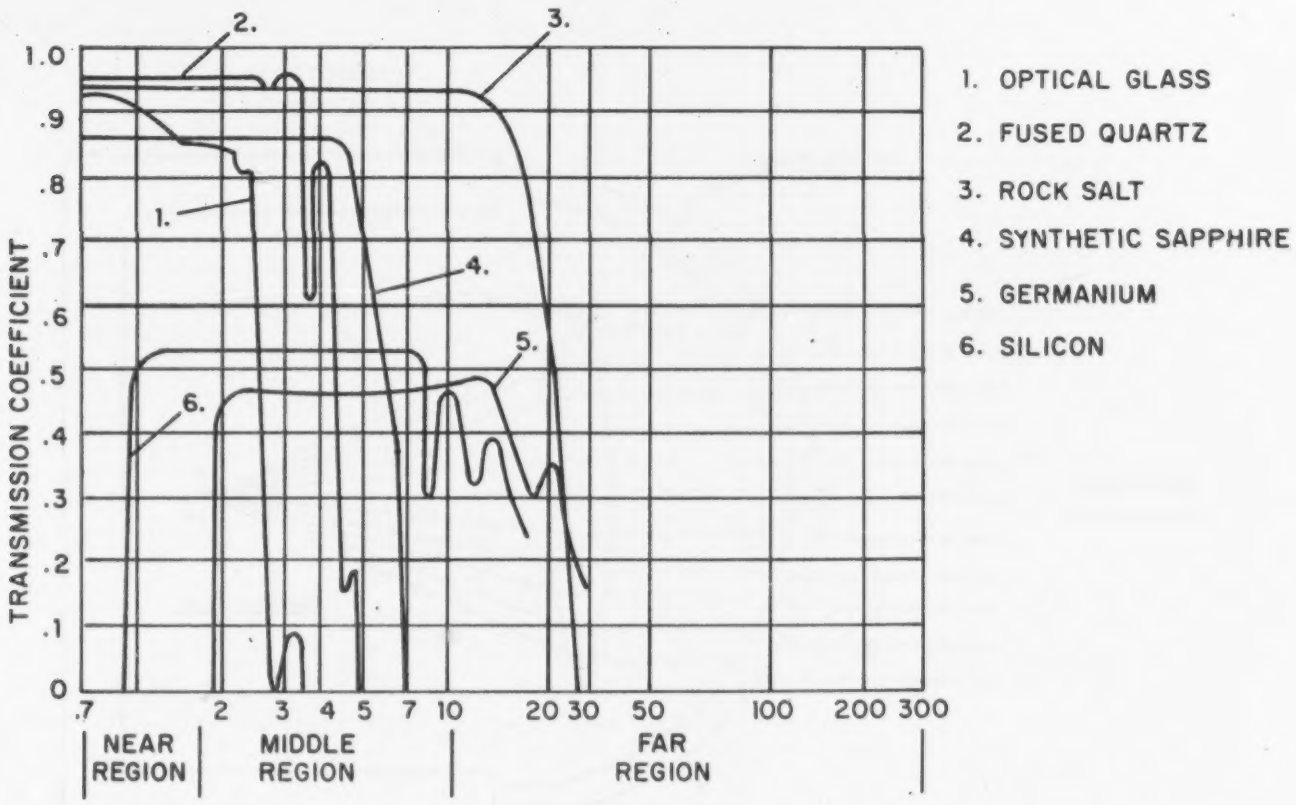

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Figure 21-6.–Wavelength vs. transmission coefficient.

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this source which is much closer than the target will obscure the target or cause "ghost" images.

Attenuation in optical materials is primarily due to two things: surface reflections, usually overcome by antireflection coatings; and attenuation by the material. The latter is the more serious problem.

IR systems often have a chopping reticle in the principal focal plane. The chopper is generally a rotating disk with some clear and some opaque areas. Although a chopper is not absolutely necessary in a search system, it has several useful properties. The chopping rate furnishes a conveniently high carrier frequency for the electronic amplifiers. The reticle pattern can operate as a discriminator or filter. For example, it can be designed for the type of backgrounds expected in order to provide better differentiation of target and background.

Optical filters are used in IR instruments to isolate certain wavelength regions of interest, such as atmospheric windows, and to screen out undesired wavelengths. Three general types of filters are as follows:

1. Those which pass short waves.
2. Those which pass a particular band of waves.
3. Those which pass long waves.

DETECTORS

The most critical component of any IR system is the detector. The characteristics of the atmosphere and the source, if it is a military target, cannot be changed. Optical materials are somewhat standardized, as are display devices and control circuits. Although research and development in the last decade has resulted in some very good all-round detectors, it is still necessary to use care in choosing the proper one for a particular application.

Many variables must be considered in the choice of a detector. The characteristics of the radiation involved will determine which type of detector will best fit the needs of the system.

DETECTOR CHARACTERISTICS

In order to compare the relative merits of different detectors in different situations, it is necessary to introduce several parameters of detector operation. These parameters make it possible to discuss the characteristics of a particular detector in terms which can be applied to any detector.

Responsivity

When IR strikes a detector material, either photoelectric or thermal, a change takes place which produces an electrical output signal, indicating that the material has been exposed to IR. The amount of signal produced by each unit of input radiation intensity is called the responsivity (R) of the detector, and is expressed as

$$R = \frac{\text{output}}{\text{input}}$$

generally in volts per watt. Many factors influence the responsivity, such as temperature of the detector and source, detector area, spectral distribution of the radiation, detector time constant, etc.

Spectral Response

One important influence on the responsivity of a detector is the change in detector sensitivity with changes in the wavelength of received radiation. The spectral limit of responsivity is considered to be the wavelength where the responsivity is half that of its maximum value. Since the spectral response is a nonlinear characteristic, it must be known for each wavelength considered, and any discussion of values must include the details of the conditions involved.

Time Constant

In any IR scanning system, the time constant of the detector must be such that the detector can fully respond before the radiation intensity changes. The time constant is considered to be the time required for the detector to develop 63 percent of its maximum output signal. The maximum scanning rate is dependent upon this time constant.

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OBJECTIVE: To learn when and how to use three-view drawings.

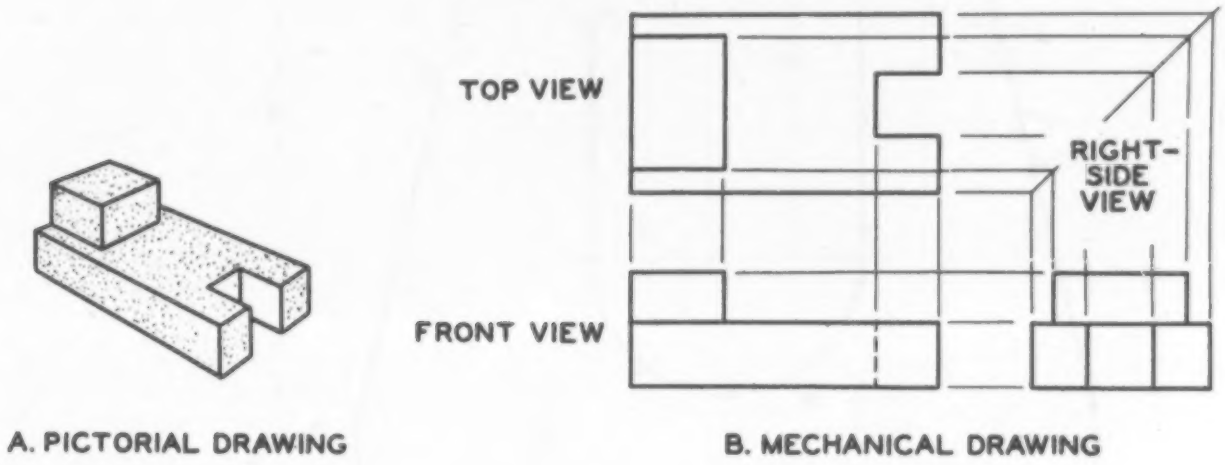

FIG. 1

RELATED INFORMATION:

Fig. 1 shows the difference between a pictorial drawing of an object and a mechanical drawing shown in orthographic projection. Part A of Fig. 1 is a pictorial drawing of an object and indicates only its general shape and size, as seen from one direction. It does not show the sizes of various parts of the object in their true ratio to one another.

Part B of Fig. 1 is a mechanical drawing shown in orthographic projection. Though not complete, since the dimensions are not shown, it gives important information needed by workmen. It represents the object as it actually is, not as it appears to the eye. In order to show this, mechanical drawings often show three views of the object: front, top, and right side, as in B of Fig. 1.

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Noise

Noise exists in any circuit that carries current. Most outside noises can be eliminated or drastically reduced by shielding and proper design, but thermal noise is an ever-present problem.

Power supplies employed with IR detectors must be extremely well filtered. Since the IR radiation received by the detector is very small, noise of any appreciable amount could be sufficient to mask weak IR signals or cause false targets. Transistors, for an example, are useless in IR amplifiers because of their inherent noise characteristics.

Many different types of noise are generated within IR systems. Among these, the most important are as follows:

1. Current noise, caused by bias currents within the detector.

2. Johnson (thermal) noise, caused by thermal fluctuations in the detector material.

At low bias voltages, current noise is negligible and the output noise voltage consists almost entirely of Johnson noise. The current noise increases linearly with bias voltages and may eventually become the primary source of noise.

NOISE EQUIVALENT POWER.–Another useful and important detector parameter is the noise equivalent power (NEP) of a detector. NEP is the radiation power in watts which must strike a detector to produce a signal response from the detector equal to the noise output (in other words, signal to noise ratio of 1) over a reference bandwidth.

When comparing two different IR detectors, the one with the lower NEP has the higher useful sensitivity. Since this tends to be confusing, another parameter is used–the detectivity. This figure is simply the reciprocal of the given NEP of a detector, so that the higher detectivity a cell has, the higher is its useful output. For example, a detector with an NEP of 4.0×10^{-9} will have a detectivity of 2.5×10^{8}.

The best IR detector would be one having the greatest possible responsivity, the widest possible spectral response within the frequency band of interest, and the lowest possible NEP (or highest possible detectivity). A properly chosen detector, with the necessary operating conditions, might have a maximum range of 90 miles with a signal to noise ratio of 5 from a 1 square meter target at 300° Kelvin. This range is equivalent to an ability to detect IR emitted by a cubic inch of ice at 3 miles.

PHOTODETECTORS

The three major types of photodetectors are photoconductive, photovoltaic, and photoemissive. Signal to noise ratio of the detector is the limiting factor in determining its effectiveness. These are used in the near infrared spectrum.

Photoconductors use a semiconductor crystal that absorbs the photon energy from the radiation which strikes the surface of the crystal, changing its resistance or conductivity. Quite a number of materials have been used for this type of photodetector, including lead sulfide, lead telluride, lead selenide, cadmium sulfide, and many others. Gold-doped germanium has been established as a good detector material, but some difficulties, such as the long time constant, must be considered.

Photovoltaic cells are similar to solar cells. These are semiconductors with a high resistance photosensitive barrier between the two layers. When exposed to IR, this cell builds up a potential difference between the two layers.

Photoemissive cells operate on the principle that electronic emission is caused by exposing the cathode to IR. In this type of emission, the number of electrons emitted depends on the intensity of the IR striking the cathode.

THERMAL DETECTORS

Thermal detection is accomplished by sensing the change in temperature of the detector material as a result of IR striking its surface. There are three different types of sensing elements employed in modern detectors to sense this temperature change. These are as follows:

1. The thermopile, which is a series combination of several thermocouples.

2. Bolometers, which sense the change in resistance of the detector material.

3. Pneumatic cells, which use the expansion of a gas as an indicator.

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Thermocouple

One of the basic heat detectors is the thermocouple. When two dissimilar metals such as iron and copper are joined together and heat is applied to the junction, a measureable voltage will be generated between them. Figure 21-7 shows a basic thermocouple.

The voltage difference between two metals is quite small, but the sensitivity can be increased to a point at which the thermocouple becomes useful as a detector of IR. The increase in sensitivity is obtained by connecting or stacking a number of thermocouples in series, so that they form what is known as a thermopile. The complete thermopile action is similar to that obtained when a number of flashlight cells are connected in series; that is, the output of each individual thermocouple is added to the output of the others. Thus, ten thermocouples, with individual output voltages of 0.001 volt, would have a total output of 0.010 volt when connected in series.

The effective sensitivity of a thermopile can be further increased by mounting it at the focal point of a parabolic reflector. When this method is used, IR given off by the target is focused on the thermopile by the reflector.

Bolometers

A bolometer is a very sensitive material whose resistance will vary, depending on the amount of IR to which it is exposed. There are two main classes of bolometers – barretters and thermistors.

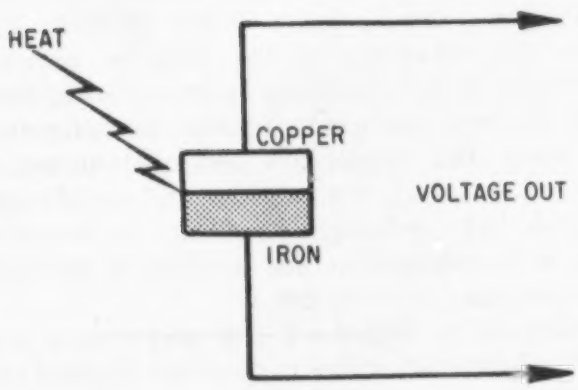

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Figure 21-7.–Thermocouple.

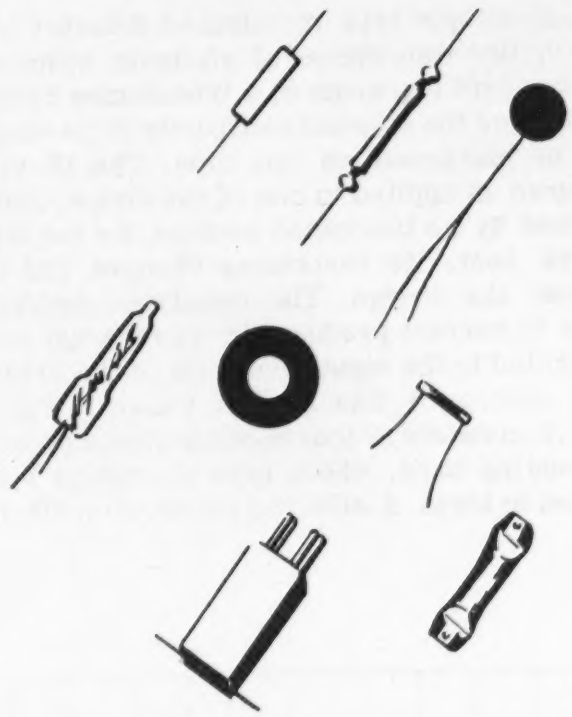

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Figure 21-8.–Various thermistors.

A barretter consists of a short length of very fine wire (usually platinum) which has a positive temperature coefficient. (A substance has a positive temperature coefficient if its resistance increases with temperature, and a negative coefficient if its resistance decreases with an increase in its temperature.)

The thermistor is a type of variable resistor made of semiconducting material, such as oxides of manganese, nickel, cobalt, selenium, and copper. The thermistor has a negative temperature coefficient of resistance. Thermistors are made in the form of beads, disks, rods, and flakes, some of which are shown in figure 21-8.

The heat sensitive materials of thermistors are mixed in various proportions to provide the specific characteristics of resistance versus temperature necessary for target detection.

Figure 21-9 shows the change in resistance which can be produced in a typical thermistor material and in a barretter. This comparison shows that the thermistor has the steeper tem-

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perature coefficient of resistance curve, and therefore is the more sensitive of the two sensors.

One simple type of infrared detector consists of two thin strips of platinum which are used to form two arms of a Wheatstone bridge. To increase the thermal sensitivity of the strips, each is blackened on one side. The IR to be measured is applied to one of the strips, and is absorbed by its blackened surface. As the strip absorbs heat, its resistance changes and unbalances the bridge. The imbalance causes a change in current produced by an external voltage applied to the input terminals of the bridge.

A device of this kind is shown in figure 21-10. It consists of four nickel strips supported by mounting bars, which have electrical leads attached to them. A silvered parabolic reflector

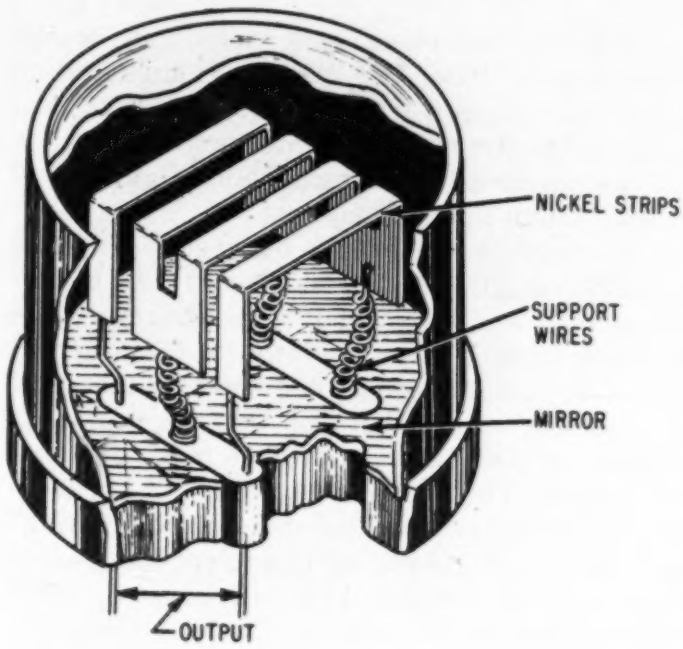

AQ.257

Figure 21-10.–Infrared detecting device.

(mirror) is used to focus the IR on the nickel strips. The change of resistance in the strips produces unbalanced conditions in the bridge circuit which can be used to produce correction signals.

Pneumatic Cell

Another unique infrared detector is the pneumatic cell or GOLAY detector shown in figure 21-11. This detector is actually a miniature heat engine.

Infrared energy entering the window causes expansion of a volume of gas located between the reflecting diaphragm and the window. The lamp at the after end of the detector emits a light beam which is focused by the lens and then passes through the grid and onto the reflecting diaphragm. The expansion and contraction of the gases between the window and diaphragm will cause the diaphragm to change its shape in response to changes in the amount of infrared energy entering the window.

Changes in shape of the diaphragm will cause its light-reflective properties to vary accordingly, modulating its light output. The light reflected from the diaphragm will then pass back through the grid which is designed to in-

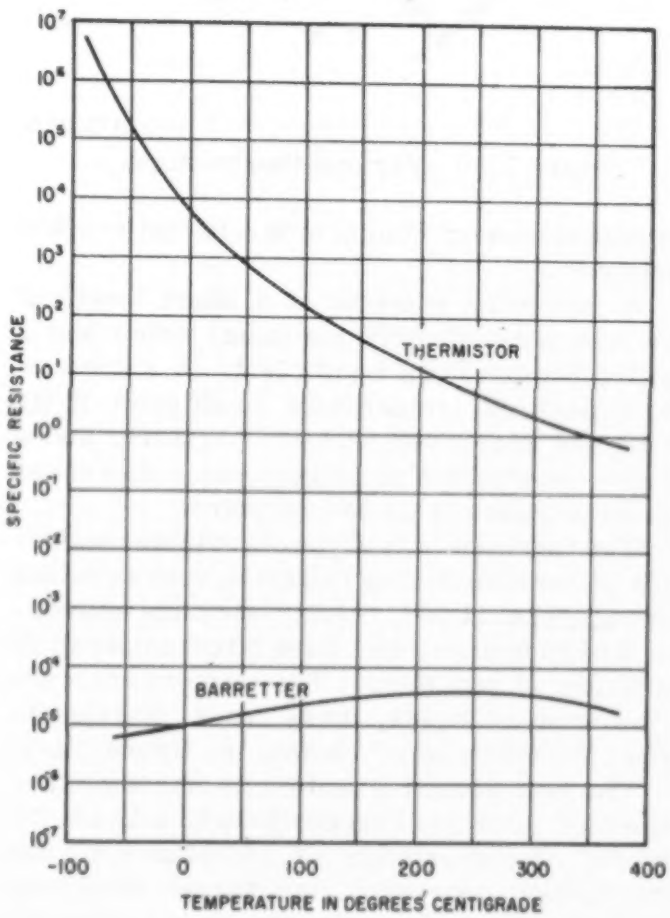

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Figure 21-9.–Comparison of thermistor and barretter sensitivity.

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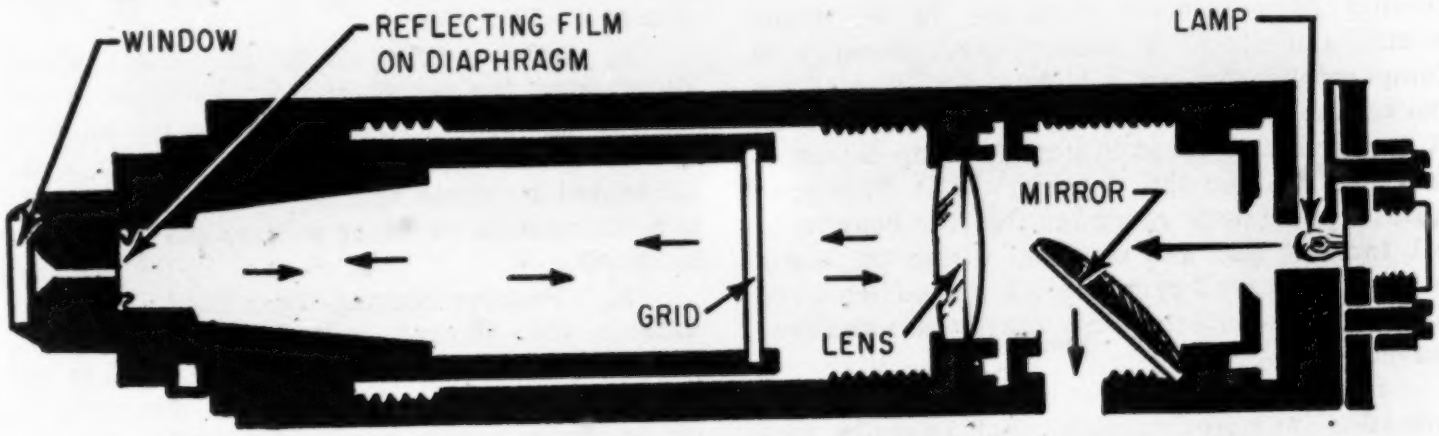

AQ.258

Figure 21-11.—Golay detector.

tensify the variations of the reflected light. After passing through the grid, some of the light strikes the mirror and is reflected to a photocell of high sensitivity (not shown in the figure). The modulated output of the photocell is a voltage proportional to the intensity of the IR entering the window.

The Golay detector has the most rapid response of any infrared detector, but it can operate only when radiant heat is received intermittently. An optical chopper may be used to interrupt the flow of IR to the cell periodically. Another advantage of the Golay detector is its extremely wide bandwidth, making it a very good choice for use in IR spectrum analysis.

APPLICATIONS

Military and industrial applications of IR have grown in number considerably in the last decade. A complete discussion of all applications would be beyond the scope of this manual. However, some of the systems and concepts applicable to military situations are discussed in the following paragraphs.

MILITARY USES OF INFRARED

Infrared devices found their first military uses during World War II as a snooperscope which operated in total darkness and outlined enemy troops by the heat radiated from their bodies. A rifle with a device known as the sniperscope made it possible to see a target in total darkness and fire with normal accuracy without the enemy becoming aware of one's presence.

Since infrared is invisible but behaves much like visible light (that is, it can be reflected and controlled in a beam pattern), it has served as a means of communication for specific wartime purposes. Development of equipment which would receive the invisible light was the foundation for the design and successful use of some highly important weapons. Infrared, when used for short-range communication between sea-level stations, such as ships, affords excellent security. Infrared rays are limited to line of sight, and are rapidly attenuated at sea level; thus, IR acts in favor of security for short-range communications. Military use of infrared for communications therefore requires a powerful source that can be modulated and sensitive receivers for detecting the modulated source. Such sources and receivers have been developed for near infrared energy.

Infrared is used in photography as it is effective against camouflaged targets. Night photography using infrared can produce a better visual presentation of terrain than the best mapping radar.

Infrared has invaded the navigation field. Groundspeed indicators are being developed that will compete with Doppler radar. Anticollision circuits are under experimentation.

IR is also used in image forming devices, thermal or ship detection, and infrared radar. The portable infrared detector (PID) is a passive

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far infrared (FIR) equipment used for the detection of personnel, vehicles, tanks, small boats, and ships. It detects the difference in temperature between a body and its immediate background and provides an audible signal output. A larger far infrared system for ship detection is the stabilized ship detector (SSD). This provides a permanent record of the true bearing of all targets that are detected within the angle scanned. Infrared radar uses a pulsed IR source and receives reflected IR energy as in microwave radar.

Infrared has excellent application to guided missiles. Military targets, such as ships, factories, and aircraft, are normally warmer than their surroundings. The presence of these targets may be detected by the heat radiation they emit. The radiation of heat at lower temperatures is particularly important in the passive detection of surface targets, since there is no economical way by which the enemy can camouflage his self-radiated heat.

The Felix bomb was the first guided missile to utilize IR. It was automatically guided by an infrared homing device in the nose of the bomb. The Felix bomb was thoroughly tested and declared reliable and adequate for operational use, but World War II ended before it could be used under combat conditions. This opened the way to a new and different method of guidance, infrared homing.

Homing guidance systems control the path of the missile by a device in the missile that reacts to some distinguishing feature of the target. They are the most accurate of all guidance systems. Homing systems are divided into the following three types, depending upon the source of target radiations:

1. Active homing–both the source which illuminates the target and the receiver which detects the echoes are carried in the missile.
2. Semiactive homing–the target is illuminated by some source outside the missile and the missile receiver utilized the target reflections.
3. Passive homing–the missile receiver detects the natural radiation of the target.

Active and semiactive types generally use radar, whereas passive types use heat or light, or in some cases, home on a radio or radar transmitter.

The Sidewinder is probably the simplest and cheapest of all guided missiles. It uses an infrared homing system and is designed to destroy high-performance aircraft from sea level to about 50,000 feet.

The experimental Midas satellite, which was launched by the United States, employs infrared principles. It is equipped with an infrared scanning device capable of instantaneous spotting and reporting of the launching of a hostile ballistic missile. It is expected to provide complete and constant scanning of the earth's surface. Flashing an alarm of the blast-off of enemy missiles, would give the United States 30 minutes to prepare for nuclear bombardment.

While it is unlikely that radar will ever be entirely replaced by IR, it is already an established fact that IR possesses certain advantages over radar. It is expected that radar and IR will work as a team in many applications, such as fire control, guidance, and even search.

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APPENDIX I
FORMULAS

Ohm's Law for D-C Circuits

$$I = \frac{E}{R} = \frac{P}{E} = \sqrt{\frac{P}{R}}$$

$$R = \frac{E}{I} = \frac{P}{I^2} = \frac{E^2}{P}$$

$$E = IR = \frac{P}{I} = \sqrt{PR}$$

$$P = EI = \frac{E^2}{R} = I^2R$$

Resistors in Series

$$R_T = R_1 + R_2 + \ldots$$

Resistors in Parallel

Two resistors

$$R_T = \frac{R_1R_2}{R_1 + R_2}$$

More than two

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

RL Circuit Time Constant

$$\frac{L \text{ (in henrys)}}{R \text{ (in ohms)}} = t \text{ (in seconds), or}$$

$$\frac{L \text{ (in microhenrys)}}{R \text{ (in ohms)}} = t \text{ (in microseconds)}$$

RC Circuit Time Constant

R (ohms) x C (farads) = t (seconds)

R (megohms) x C (microfarads) = t (seconds)

R (ohms) x C (microfarads) = t (microseconds)

R (megohms) x C (micromicrofarads) = t (microseconds)

Capacitors in Series

Two capacitors

$$C_T = \frac{C_1C_2}{C_1 + C_2}$$

More than two

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$$

Capacitors in Parallel: $C_T = C_1 + C_2 + \ldots$

Capacitive Reactance: $X_C = \frac{1}{2\pi fC}$

Impedance in an RC Circuit (Series)

$$Z = \sqrt{R^2 + (X_C)^2}$$

Inductors in Series

$L_T = L_1 + L_2 + \ldots$ (No coupling between coils)

Inductors in Parallel

Two inductors

$L_T = \frac{L_1L_2}{L_1 + L_2}$ (No coupling between coils)

More than two

$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots$ (No coupling between coils)

Inductive Reactance

$$X_L = 2\pi fL$$

Q of a Coil

$$Q = \frac{X_L}{R}$$

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Impedance of an RL Circuit (Series)

$$Z = \sqrt{R^2 + (X_L)^2}$$

Impedance with R, C, and L in Series

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Parallel Circuit Impedance

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

Sine-Wave Voltage Relationships

Average value

$$E_{ave} = \frac{2}{\pi} \times E_{max} = 0.637E_{max}$$

Effective or r. m. s. value

$$E_{eff} = \frac{E_{max}}{\sqrt{2}} = \frac{E_{max}}{1.414} = 0.707E_{max}$$
$$= 1.11E_{ave}$$

Maximum value

$$E_{max} = \sqrt{2}\,(E_{eff}) = 1.414E_{eff}$$
$$= 1.57E_{ave}$$

Voltage in an a-c circuit

$$E = IZ = \frac{P}{I \times P.F.}$$

Current in an a-c circuit

$$I = \frac{E}{Z} = \frac{P}{E \times P.F.}$$

Power in A-C Circuit

Apparent power: $P = EI$

True power: $P = EI \cos\theta = EI \times P.F.$

Power Factor

$$P.F. = \frac{P}{EI} = \cos\theta$$

$$\cos\theta = \frac{\text{true power}}{\text{apparent power}}$$

Transformers

Voltage relationship

$$\frac{E_p}{E_s} = \frac{N_p}{N_s} \text{ or } E_s = E_p \times \frac{N_s}{N_p}$$

Current relationship

$$\frac{I_p}{I_s} = \frac{N_s}{N_p}$$

Induced voltage

$$E_{eff} = 4.44 \times BAfN \times 10^{-8}$$

Turns ratio

$$\frac{N_p}{N_s} = \sqrt{\frac{Z_p}{Z_s}}$$

Secondary current

$$I_s = I_p \times \frac{N_p}{N_s}$$

Secondary voltage

$$E_s = E_p \times \frac{N_s}{N_p}$$

Three-Phase Voltage and Current Relationships.

With wye connected windings

$$E_{line} = \sqrt{3}(E_{coil}) = 1.732E_{coil}$$

$$I_{line} = I_{coil}$$

With delta connected windings

$$E_{line} = E_{coil}$$

$$I_{line} = 1.732I_{coil}$$

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With wye or delta connected winding

$$P_{coil} = E_{coil} I_{coil}$$

$$P_t = 3P_{coil}$$

$$P_t = 1.732 E_{line} I_{line}$$

(To convert to true power multiply by $\cos\theta$)

Resonance

At resonance

$$X_L = X_C$$

Resonant frequency

$$F_o = \frac{1}{2\pi\sqrt{LC}}$$

Series resonance

$$Z \text{ (at any frequency)} = R + j(X_L - X_C)$$

$$Z \text{ (at resonance)} = R$$

Parallel resonance

$$Z_{max} \text{ (at resonance)} = \frac{X_L X_C}{R} = \frac{X_L{}^2}{R}$$

$$= QX_L = \frac{L}{CR}$$

Band width

$$\Delta = \frac{F_o}{Q} = \frac{R}{2\pi L}$$

Tube Characteristics

Amplification factor

$$\mu = \frac{\Delta e_p}{\Delta e_g} \text{ (i_p constant)}$$

$$\mu = g_m r_p$$

A-c plate resistance

$$r_p = \frac{\Delta e_p}{\Delta i_p} \text{ (e_g constant)}$$

Grid-plate transconductance

$$g_m = \frac{\Delta i_p}{\Delta e_g} \text{ (e_p constant)}$$

Decibels

NOTE: Wherever the expression "log" appears without a subscript specifying the base, the logarithmic base is understood to be 10.

Power ratio

$$db = 10 \log \frac{P_2}{P_1}$$

Current and voltage ratio

$$db = 20 \log \frac{I_2 \sqrt{R_2}}{I_1 \sqrt{R_1}}$$

$$db = 20 \log \frac{E_2 \sqrt{R_1}}{E_1 \sqrt{R_2}}$$

NOTE: When R_1 and R_2 are equal they may be omitted from the formula. When reference level is one milliwatt

$$dbm = 10 \log \frac{P}{0.001} \text{ (when P is in watts)}$$

Synchronous Speed of Motor

$$r.p.m. = \frac{120 \times \text{frequency}}{\text{number of poles}}$$

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Comparison of Units in Electric and Magnetic Circuits

	Electric circuit	Magnetic circuit
Force.	Volt, E, or e.m.f.	Gilberts, F, or m.m.f.
Flow	Ampere, I	Flux, Φ , in maxwells
Opposition.	Ohms, R	Reluctance, $\mathcal{R}$
Law.	Ohm's law, $I = \frac{E}{R}$	Rowland's law, $\Phi = \frac{F}{\mathcal{R}}$
Intensity of force	Volts per cm. of length.	$H = \frac{1.257IN}{L}$, gilberts per centimeter of length.
Density.	Current density—for example, amperes per cm^2.	Flux density—for example, lines per $cm.^2$, or gausses.

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APPENDIX II

SYMBOLS

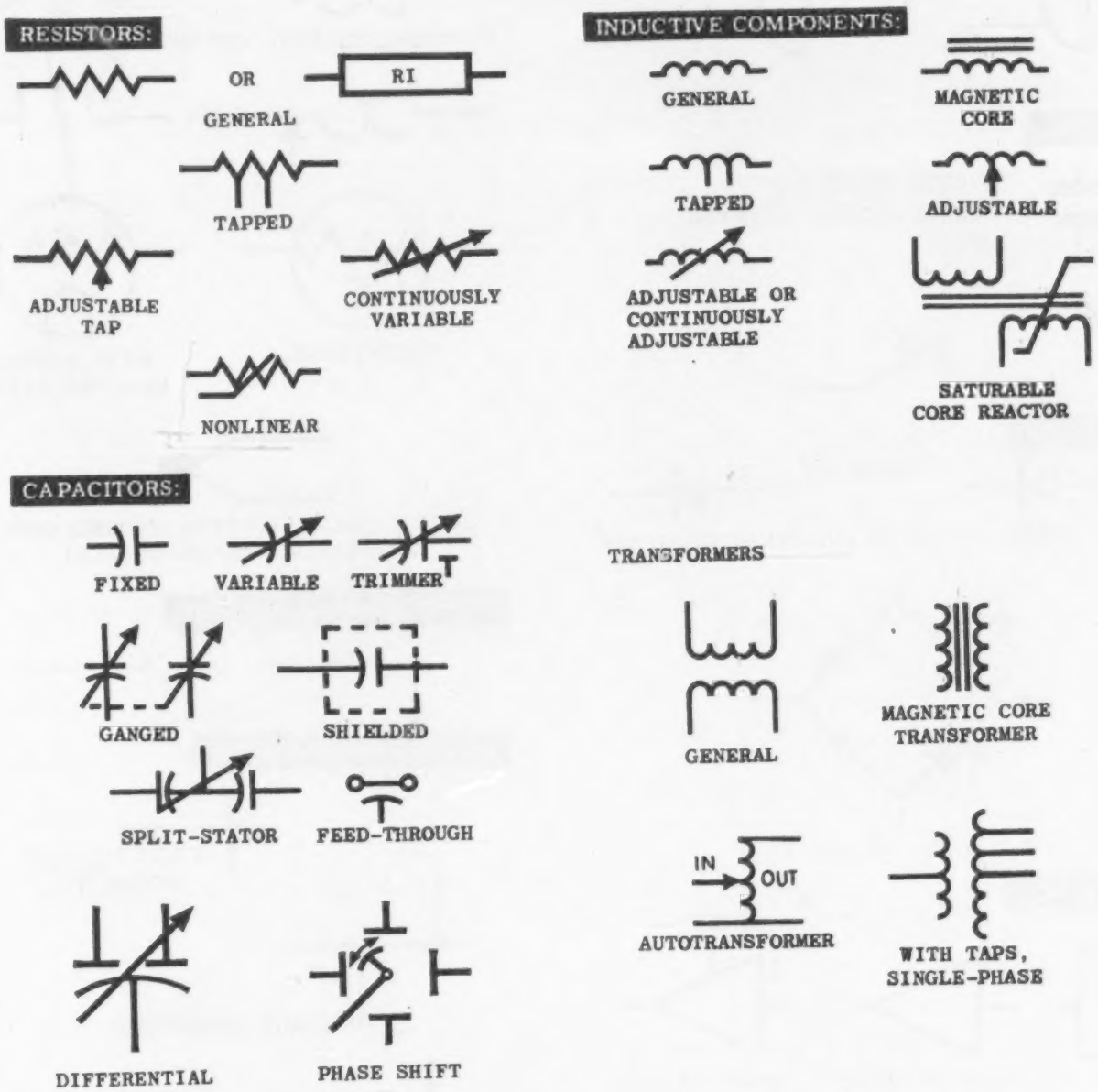

(WHEN CAPACITOR ELECTRODE IDENTIFICATION IS NECESSARY, THE CURVED ELEMENT SHALL REPRESENT THE OUTSIDE ELECTRODE IN FIXED PAPER-DIELECTRIC AND CERAMIC-DIELECTRIC, THE NEGATIVE ELECTRODE IN ELECTROLYTIC CAPACITORS, THE MOVING ELEMENT IN VARIABLE AND ADJUSTABLE CAPACITORS, AND THE LOW POTENTIAL ELEMENT IN FEED-THROUGH CAPACITORS.)

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ASSIGNMENT:

Below are pictorial and mechanical drawings of four objects. In the mechanical drawings at the right, lines or views are missing in each. On your paper copy each mechanical drawing as given. Then complete each one by adding the missing lines or views.

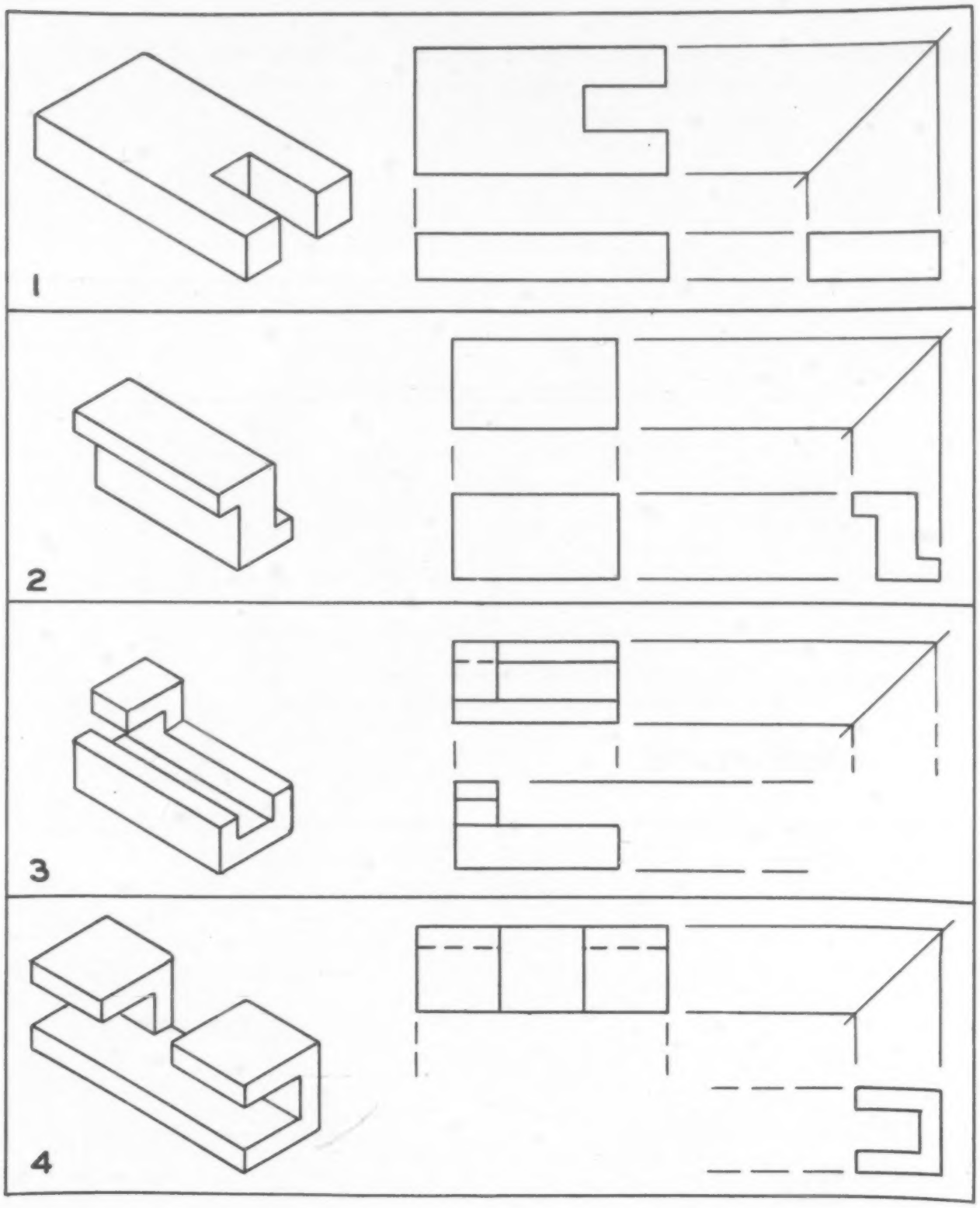

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INDICATOR LAMP

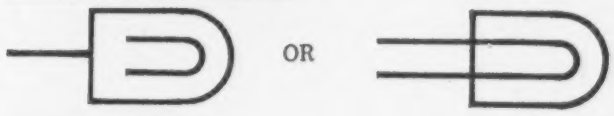

MICROPHONE

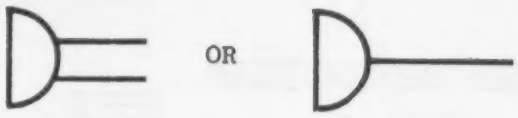

CRYSTAL

QUARTZ CRYSTAL;
PIEZOELECTRIC CRYSTAL
UNIT.

KEY

RECTIFIER

GENERAL

SEMICONDUCTOR

NORMAL CURRENT FLOW IS AGAINST THE ARROW

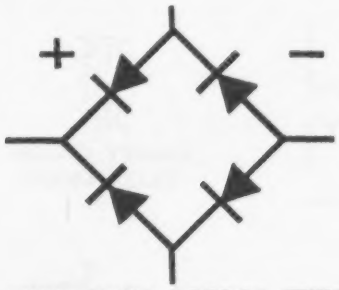

FULL WAVE BRIDGE TYPE

AMPLIFIER

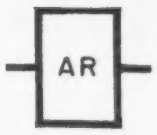

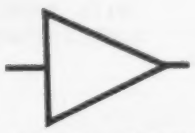

TRIANGLE POINTS
IN DIRECTION OF
TRANSMISSION
(SIGNAL FLOW)

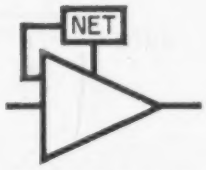

AMPLIFIER WITH
EXTERNAL
FEEDBACK PATH

BASIC SYMBOL INDICATES ANY METHOD OF AMPLIFICATION EXCEPT THAT OPERATING ON THE PRINCIPLE OF ROTATING MACHINERY.

THERMAL ELEMENTS

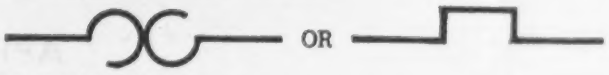

THERMAL RELAY WITH
NORMALLY CLOSED
CONTACT.

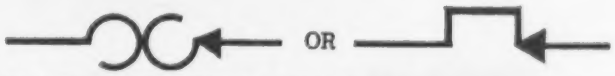

FLASHER; THERMAL CUTOUT

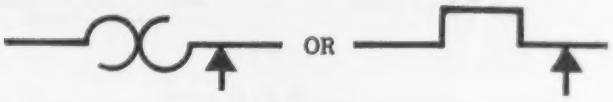

THERMISTOR

WITH INTEGRAL
HEATING ELEMENT

TEMPERATURE-MEASURING THERMOCOUPLE
(DISSIMILAR METAL DEVICE)

INPUTS (NONSTANDARD)

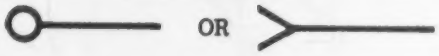

PATH, TRANSMISSION

CROSSING NOT
CONNECTED

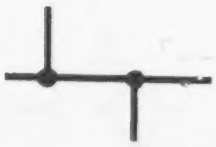

JUNCTION CONNECTED

TWISTED PAIR

AIR OR SPACE PATH

COAXIAL

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GROUPING OF WIRES IN BUNDLES

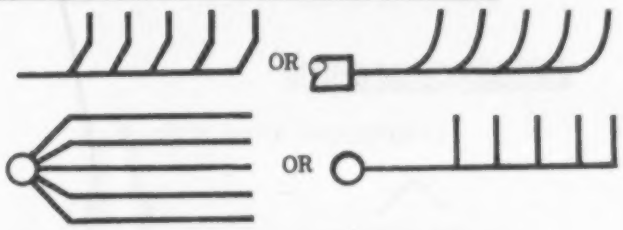

GROUPING OF WIRES IN CABLES

CABLES

FIVE-CONDUCTOR CABLE

SHIELDED FIVE-CONDUCTOR CABLE

GROUNDED SHIELD

NUMBER OF CONDUCTORS MAY BE ONE OR MORE AS NECESSARY

SWITCHES

GENERAL (SINGLE THROW)

GENERAL (DOUBLE THROW)

TWO POLE DOUBLE THROW SWITCH

KNIFE SWITCH

PUSHBUTTON (MAKE)

PUSHBUTTON (BREAK)

PUSHBUTTON TWO CIRCUIT

SELECTOR SWITCHES

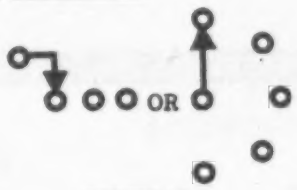

GENERAL

ANY NUMBER OF TRANSMISSION PATHS MAY BE SHOWN. ALSO BREAK BEFORE MAKE SWITCH.

MAKE BEFORE BREAK

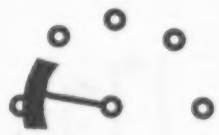

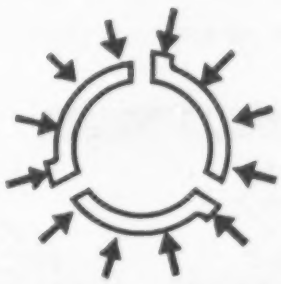

WAFER, TYPICAL 3-POLE, 3-CIRCUIT SWITCH. VIEWED FROM END OPPOSITE CONTROL KNOB. FOR MORE THAN ONE SECTION, #1 IS NEAREST CONTROL KNOB.

CIRCUIT RETURNS

CHASSIS CONNECTION

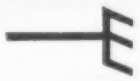

(THE CHASSIS OR FRAME IS NOT NECESSARILY AT GROUND POTENTIAL.)

GROUND

CONTACTS (ELECTRICAL)

SWITCH

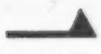

MOMENTARY SWITCH

LOCKING

NONLOCKING

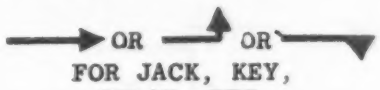

FOR JACK, KEY, RELAY, ETC.

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CONTACTS (ELECTRICAL) (Continued)

CONTACT ASSEMBLIES

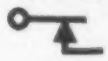

CLOSED CONTACT (BREAK)

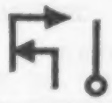

MAKE BEFORE BREAK

OPEN CONTACT (MAKE)

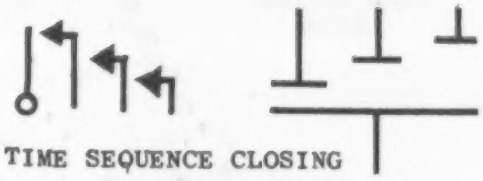

TIME SEQUENCE CLOSING

DISCONNECTING DEVICES

MALE (PIN CONTACT)

FEMALE (SOCKET CONTACT)

ENGAGED (PIN-TO-SOCKET)

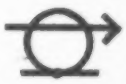

COAXIAL (MALE)

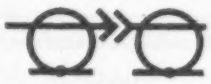

COAXIAL CONNECTORS MATED

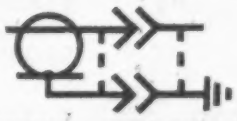

COAXIAL CONNECTED TO SINGLE CONDUCTOR

THE CONNECTOR SYMBOL IS NOT AN ARROWHEAD. IT IS LARGER AND THE LINES ARE DRAWN AT A 90° ANGLE.

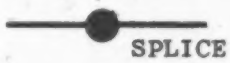

SPLICE

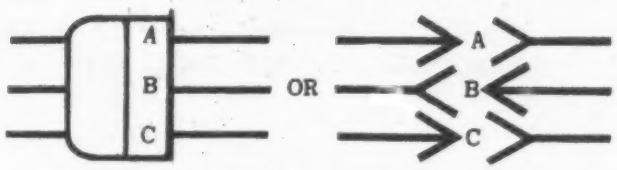

CONNECTOR ASSEMBLY (GENERAL)

ELECTRON TUBES

COMPONENT TUBE SYMBOLS

DIRECTLY-HEATED (FILAMENTARY) CATHODE

INDIRECTLY-HEATED CATHODE

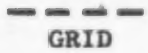

GRID

POOL CATHODE

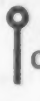

COLD CATHODE

ANODE OR PLATE

PHOTOCATHODE

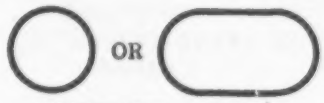

ENVELOPE (SHELL)

GAS FILLED ENVELOPE

SPLIT ENVELOPE

SEMICONDUCTOR DEVICES

DIODE

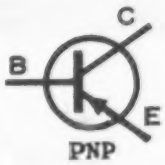

PNP

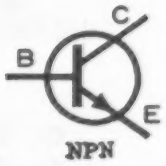

NPN

TRANSISTORS

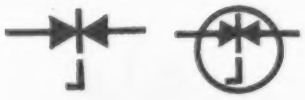

BREAKDOWN DIODE, BIDIRECTIONAL

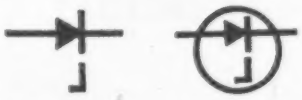

BREAKDOWN DIODE, UNDIRECTIONAL (ALSO BACKWARD DIODE)

PHOTODIODE

SEMICONDUCTOR DEVICES: (Continued)

TEMPERATURE DEPENDENT DIODE

PNPN SWITCH

TUNNEL DIODE

TYPICAL ELECTRON TUBES

COLD CATHODE GAS TUBE

PHOTOTUBE SINGLE UNIT, VACUUM

DIODE

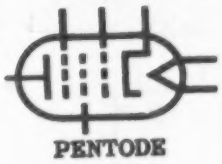

PENTODE

TWIN TRIODE ILLUSTRATING ELONGATED ENVELOPE

DIODE SHOWING BASE CONNECTIONS

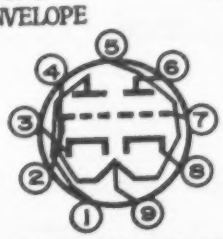

TWIN TRIODE WITH TAPPED HEATER

TYPICAL CATHODE RAY TUBES

MAGNETIC DEFLECTION

ELECTROSTATIC DEFLECTION

WAVEGUIDES

CIRCULAR

RECTANGULAR

RIDGED

ROTARY JOINT

DIRECTIONAL COUPLERS

GENERAL

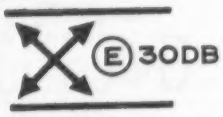

E PLANE APERTURE COUPLING, 30 DB TRANSMISSION LOSS

COUPLING METHODS

GENERALLY USED FOR COAXIAL AND WAVEGUIDE TRANSMISSION.

COUPLING BY APERTURE WITH AN OPENING OF LESS THAN FULL WAVEGUIDE SIZE. TYPE OF COUPLING WILL BE INDICATED WITHIN CIRCLE (E, H, OR HE).

COUPLING BY LOOP TO SPACE

COUPLING BY LOOP TO GUIDED TRANSMISSION PATH

COUPLING BY PROBE FROM COAXIAL TO RECTANGULAR WAVEGUIDE WITH DIRECT-CURRENT GROUNDS CONNECTED

TYPICAL MAGNETRONS AND KLYSTRONS

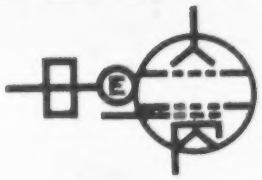

REFLEX KLYSTRON, APERATURE COUPLED

TUNABLE MAGNETRON, APERTURE COUPLED

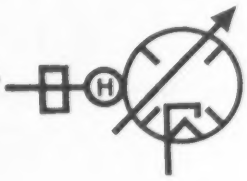

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TYPICAL MAGNETRONS AND KLYSTRONS (Continued)

RESONANT TYPE WITH COAXIAL OUTPUT

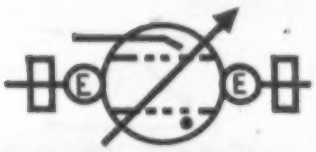

TRANSMIT-RECEIVE (TR) TUBE GAS FILLED, TUNABLE INTEGRAL CAVITY, APERTURE COUPLED, WITH STARTER

ROTATING MACHINES

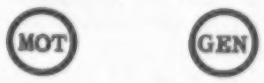

MOTOR GENERATOR

TYPES OF WINDINGS

SERIES

SHUNT

SEPARATELY EXCITED

DYNAMOTOR

WINDING SYMBOLS

SINGLE-PHASE

TWO - PHASE

THREE-PHASE (WYE)

THREE-PHASE (DELTA)

LOGIC FUNCTIONS

AND FUNCTION

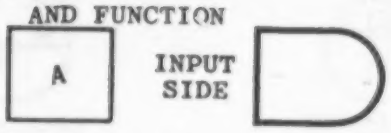

INCLUSIVE OR FUNCTION

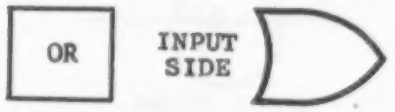

EXCLUSIVE OR FUNCTION

FLIP-FLOPS

LATCH

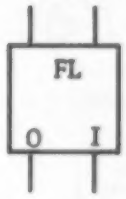

COMPLEMENTARY

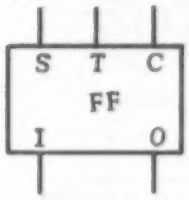

S-SET T-TRIGGER C-CLEAR

NEGATION

ELECTRIC INVERTER

TIME DELAY

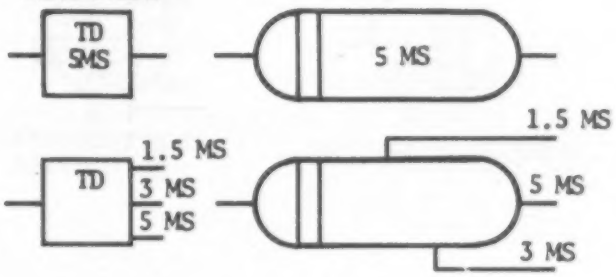

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LOGIC FUNCTIONS (Continued)

SINGLE SHOT

SCHMITT TRIGGER

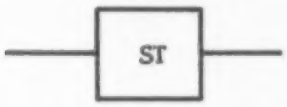

OSCILLATOR

SYNCHROS

GENERAL

A LETTER COMBINATION FROM THE FOLLOWING LIST MAY BE PLACED ADJACENT TO THE SYMBOL TO INDICATE THE TYPE OF SYNCHRO:

- TX - TORQUE TRANSMITTER
- TDX - TORQUE DIFFERENTIAL TRANSMITTER
- CX - CONTROL TRANSMITTER
- CDX - CONTROL DIFFERENTIAL TRANSMITTER
- TR - TORQUE RECEIVER
- CT - CONTROL TRANSFORMER

SYNCHROS (Continued)

TRANSMITTER, RECEIVER, OR CONTROL TRANSFORMER

DIFFERENTIAL TRANSMITTER OR RECEIVER

RESOLVER (SYNCHRO)

SINGLY-WOUND ROTOR

DOUBLY-WOUND ROTOR

RESOLVER

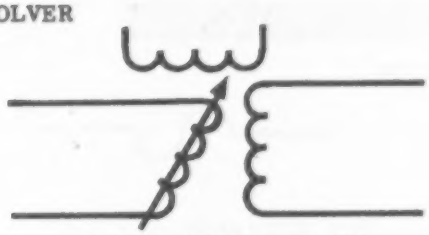

SINGLY-WOUND ROTOR

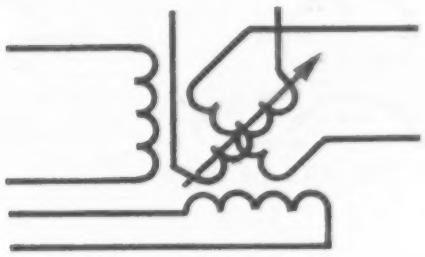

DOUBLY-WOUND ROTOR

13811

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PICKUP HEADS

GENERAL

WRITING; RECORDING; HEAD, SOUND RECORDER

READING; PLAYBACK; HEAD, SOUND REPRODUCER

APPLICATION: WRITING, READING, AND ERASING

ERASING; ERASER, MAGNETIC

BATTERIES

ONE CELL MULTICELL TAPPED MULTICELL

(LONG LINE IS ALWAYS POSITIVE)

CIRCUIT PROTECTORS

FUSE

CIRCUIT BREAKERS

SWITCH

GANGED

PUSH PULL OR PUSH

ATTENUATORS

GENERAL BALANCED UNBALANCED

ANTENNAS

GENERAL DIPOLE

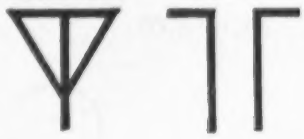

PARABOLIC

LOOP

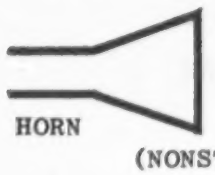

HORN

(NONSTANDARD)

METERS

A - AMMETER

CRO - OSCILLOSCOPE

G - GALVANOMETER

MA - MILLIAMMETER

OHM - OHMMETER

V - VOLTMETER

HEADSET

OR

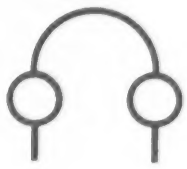

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199 OF 327

ED

056 238

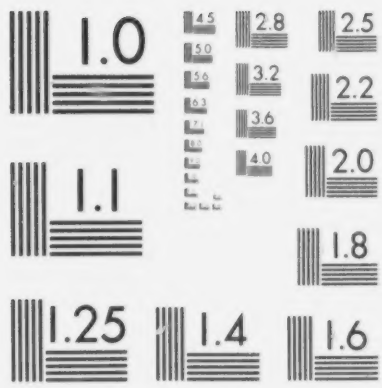

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX III

LAWS OF EXPONENTS

The International Symbols Committee has adopted prefixes for denoting decimal multiples of units. The National Bureau of Standards has followed the recommendations of this committee, and has adopted the following list of prefixes:

Numbers	Powers of ten	Prefixes	Symbols
1,000,000,000,000	10^{12}	tera	T
1,000,000,000	10^{9}	giga	G
1,000,000	10^{6}	mega	M
1,000	10^{3}	kilo	k
100	10^{2}	hecto	h
10	10	deka	da
.1	10^{-1}	deci	d
.01	10^{-2}	centi	c
.001	10^{-3}	milli	m
.000001	10^{-6}	micro	u
.000000001	10^{-9}	nano	n
.000000000001	10^{-12}	pico	p
.000000000000001	10^{-15}	femto	f
.000000000000000001	10^{-18}	atto	a

To multiply like (with same base) exponential quantities, add the exponents. In the language of alegebra the rule is $a^m \times a^n = a^{m+n}$

$$10^4 \times 10^2 = 10^{4+2} = 10^6$$

$$0.003 \times 825.2 = 3 \times 10^{-3} \times 8.252 \times 10^2$$

$$= 24.756 \times 10^{-1} = 2.4756$$

To divide exponential quantities, subtract the exponents. In the language of algebra the rule is

$$\frac{a^m}{a^n} = a^{m-n} \text{ or}$$

$$10^8 \div 10^2 = 10^6$$

$$3,000 \div 0.015 = (3 \times 10^3) \div (1.5 \times 10^{-2})$$

$$= 2 \times 10^5 = 200,000$$

To raise an exponential quantity to a power, multiply the exponents. In the languague of algebra $(x^m)^n = x^{mn}$.

$$(10^3)^4 = 10^{3x4} = 10^{12}$$

$$2,500^2 = (2.5 \times 10^3)^2 = 6.25 \times 10^6 = 6,250,000$$

Any number (except zero) raised to the zero power is one. In the language of algebra $x^0=1$

$$x^3 \div x^3 = 1$$

$$10^4 \div 10^4 = 1$$

Any base with a negative exponent is equal to 1 divided by the base with an equal positive exponent. In the language of algebra $x^{-a}=\frac{1}{x^a}$

$$10^{-2} = \frac{1}{10^2} = \frac{1}{100}$$

$$5a^{-3} = \frac{5}{a^3}$$

$$(6a)^{-1} = \frac{1}{6a}$$

To raise a product to a power, raise each factor of the product to that power.

$$(2 \times 10)^2 = 2^2 \times 10^2$$

$$3,000^3 = (3 \times 10^3)^3 = 27 \times 10^9$$

To find the nth root of an exponential quantity, divide the exponent by the index of the root. Thus, the nth root of $a^m = a^{m/n}$.

$$\sqrt{x^6} = x^{6/2} = x^3$$

$$\sqrt[3]{64 \times 10^3} = 4 \times 10 = 40$$

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APPENDIX IV

GREEK ALPHABET

Name	Capital	Lower Case	Designates
Alpha	A	α	Angles, coefficient of thermal expansion.
Beta.	B	β	Angles, flux density.
Gamma.	Γ	γ	Conductivity.
Delta	Δ	δ	Variation of a quantity, increment.
Epsilon.	E	ε	Base of natural logarithms (2.71828).
Zeta.	Z	ζ	Impedance, coefficients, coordinates.
Eta	H	η	Hysteresis coefficient, efficiency, magnetizing force.
Theta	Θ	θ	Phase angle.
Iota	I	ι	
Kappa	K	κ	Dielectric constant, coupling coefficient, susceptibility.
Lambda	Λ	λ	Wavelength.
Mu.	M	μ	Permeability, micro, amplification factor.
Nu	N	ν	Reluctivity.
Xi	Ξ	ξ	
Omicron	O	ο	
Pi	Π	π	3.1416
Rho	P	ρ	Resistivity.
Sigma.	Σ	σ	Summation symbol (cap).
Tau	T	τ	Time constant, time-phase displacement.
Upsilon.	Υ	υ	
Phi	Φ	φ	Angles, magnetic flux.
Chi	X	χ	
Psi	Ψ	ψ	Dielectric flux, phase difference.
Omega	Ω	ω	Ohms (capital), angular velocity (2 π f).

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UNIT VII - WORKING DRAWINGS

Practice in Making Three-View Drawings — Lesson 3

OBJECTIVE: To gain skill in making three-view orthographic projections from a pictorial drawing.

ASSIGNMENT: From the pictorial drawings shown below, draw a front, top, and right-side view of each object. Dimension fully.

1.

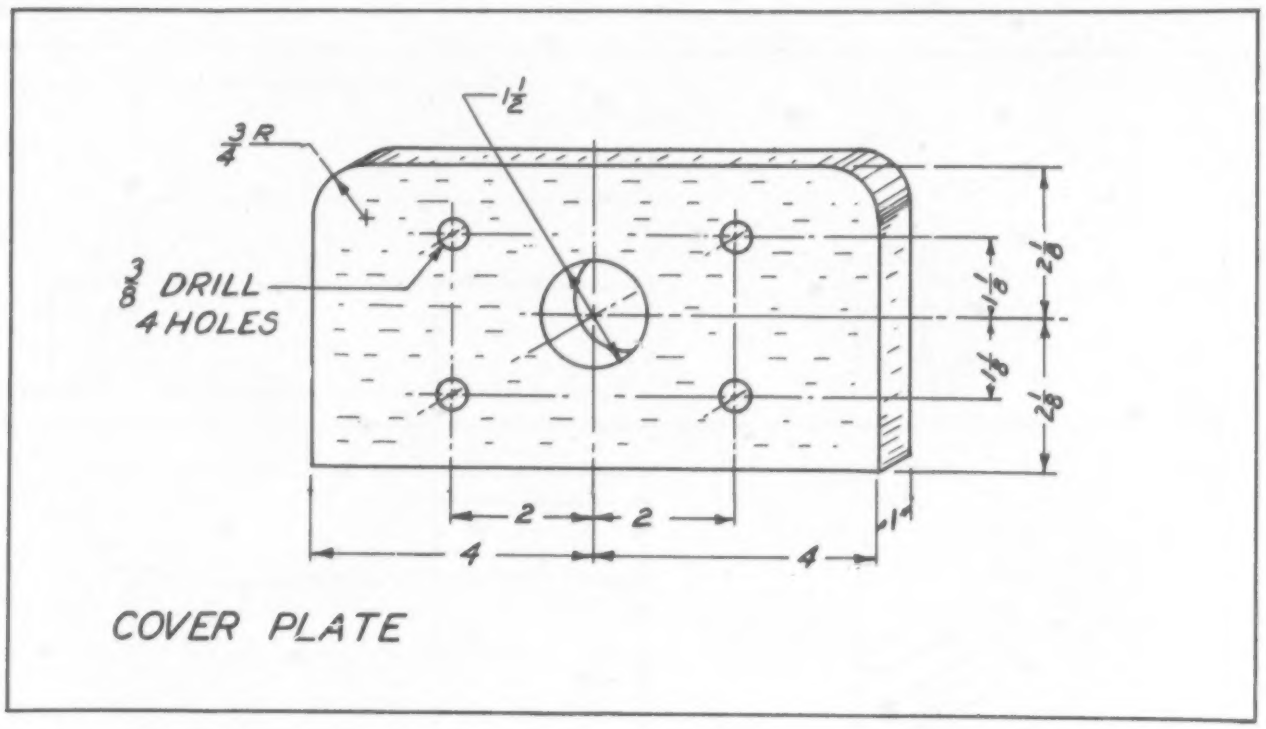

COVER PLATE

1379

AN/URM-101A, radio test set, 249, 250
AN/URN-3 TACAN antenna, 547
AN/USM-21A milliohmmeter, 197
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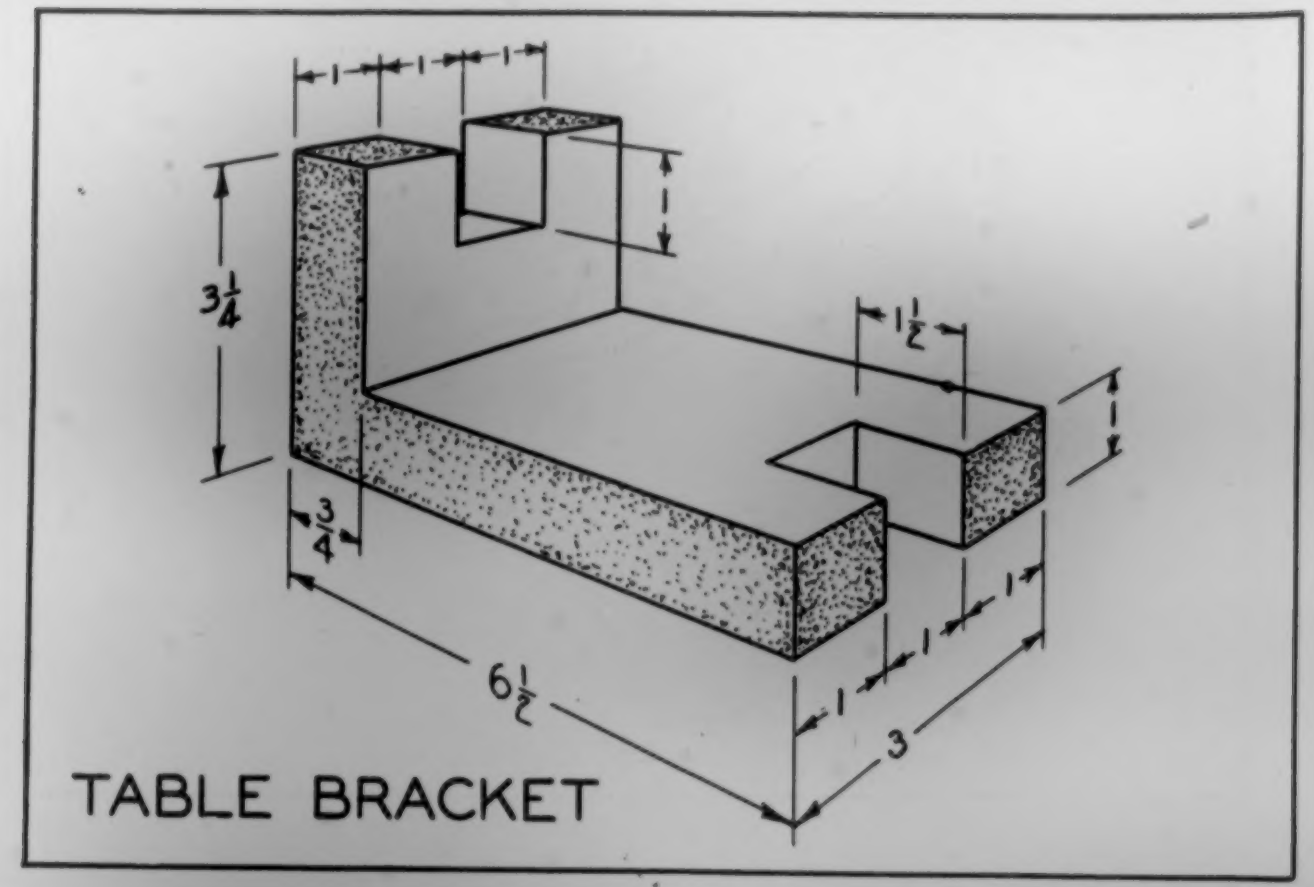
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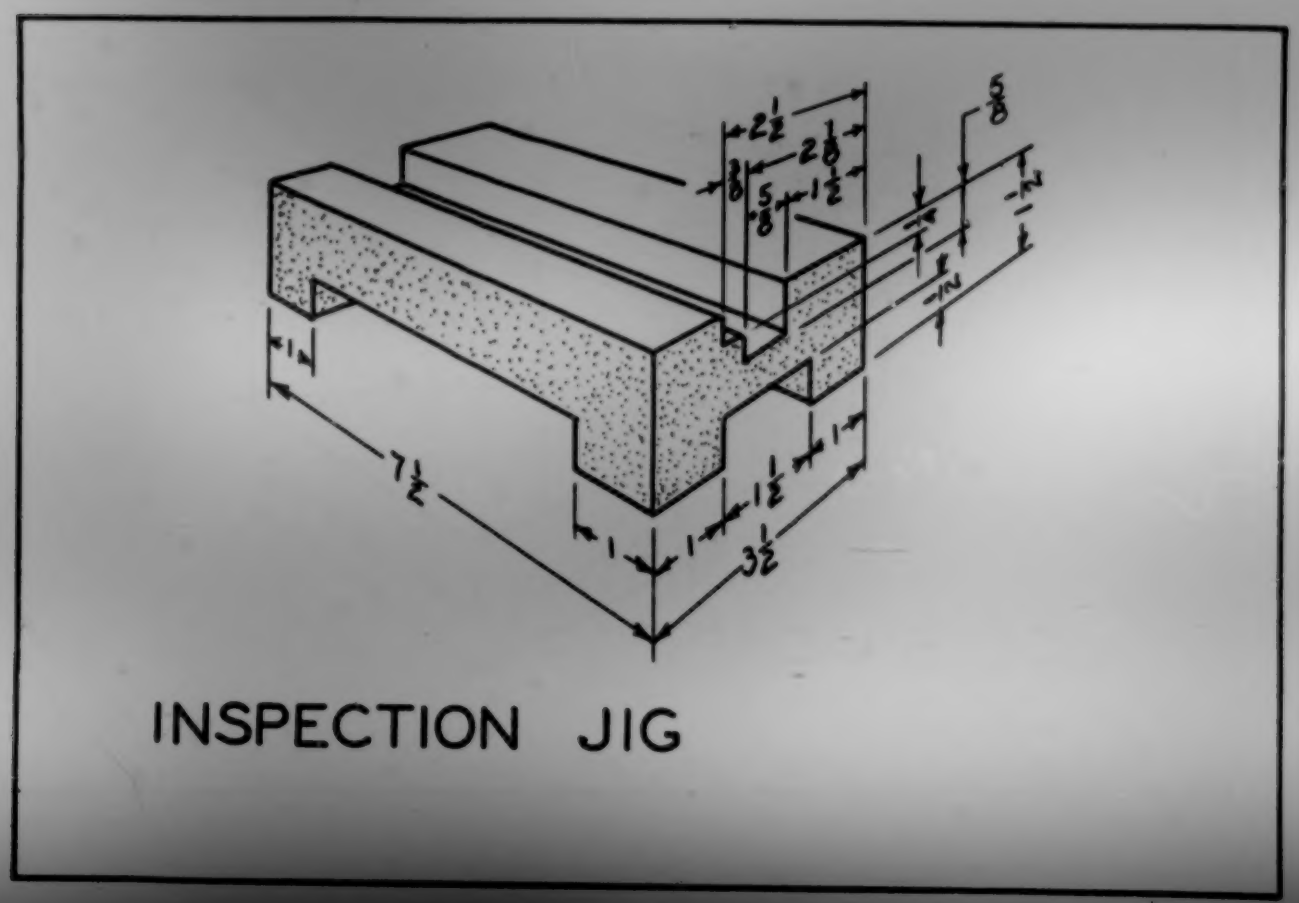
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ABSTRACT - Issued by the Instructional Materials Laboratory of the Department of Practical Arts and Vocational-Technical Education of the University of Missouri in cooperation with the Vocational Education Division of the State of Missouri, this teaching guide is for instructor and student use in vocational agriculture classes. The material is designed for use over one semester (90 days), and is the basic course for a later series dealing with tractors and machinery. The contents are divided into 15 units, with each unit containing several problem sheets. Most sheets contain the stated problem area, the specific problem, the job title, study questions, a summary of the information, teaching suggestions, and references. A list of suggested prime references, a list of supplemental references, a tool list, and addresses of several companies are included. (GEB)

VT 012 791

INTERNAL COMBUSTION ENGINES

by

Curtis R. Weston
Lyndon Bays
Glen C. Shinn
Richard Linhardt

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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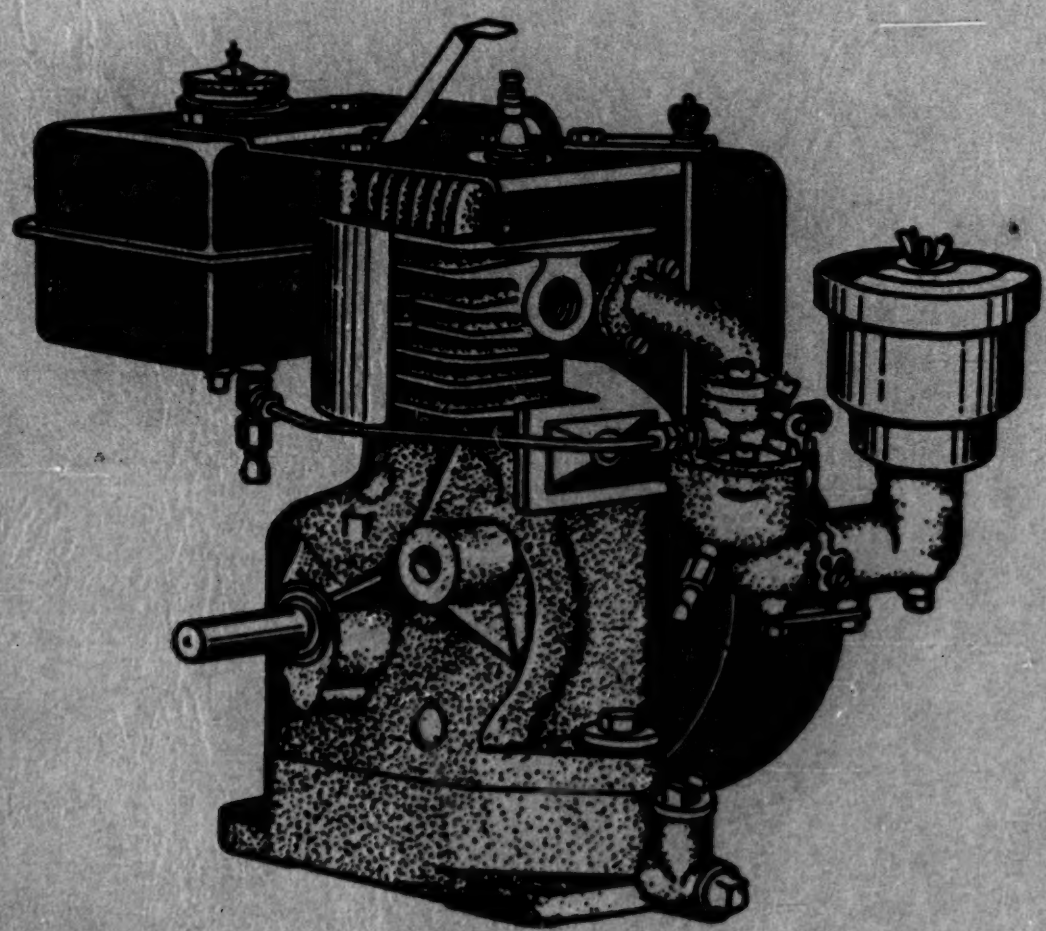

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State Department of Education
Jefferson City, Missouri 65101

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COURSE BREAKDOWN

Problem	Page	Days
Introduction and History	3-4	1
Principles of Engine Operation	5-17	6
Measurement	18-19	1
What Needs to be Repaired	20-21	2
Ignitions	22-35	7
Carburetion	36-43	6
Valves	44-58	6
Lubricating Systems and Lubricants	59-65	3
Cooling Systems	66-67	1
Repairs	68-85	11
4 Cycle Engines	86-88	2
Trouble Shooting	89-97	5
Governors	98	1
Starters	99-102	1
Repair of Engines (laboratory)	103	31
Testing and Slack		6
		90

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Preface

This course is designed as a special vocational agriculture course to be taught as a semester course. This course is the basic course to a later series of courses dealing with tractors and machinery. It is assumed that juniors and seniors would be enrolled in the course. It is designed to operate most effectively in a class of about 10 students.

The references listed on the following page are considered the prime references necessary to teach this semester course. Supplemental references can be found at the end of the teaching unit.

The demonstration lesson plans are designed to be used with the Briggs and Stratton six and eight cubic inch engines. However, many of the procedures used will be the same for most other gas engines.

There are numerous films and other teaching materials available from various small engine companies which are not listed here but would be quite helpful. It may be possible to have representatives from various related companies help out in some phases of this course.

Curtis R. Weston

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SUGGESTED

REFERENCES FOR CLASS USE

1. Briggs and Stratton, General Theories of Operation, Briggs and Stratton Corporation, Milwaukee, Wisconsin.

2. Briggs and Stratton, Repair Instruction II, (Lab Manual) Briggs and Stratton Corporation, Milwaukee, Wisconsin.

3. Purvis, Jud, All About Small Gas Engines, The Goodheart Willcox Company, Inc., Chicago, Illinois (text).

4. Technical Publications, Inc., Small Engines Service Manual, 1014 Wyandotte Street, Kansas City 5, Missouri (Reference Manual).

5. Slide Film Sets No. 1, 3, 4, 5, 7, 9, 20 and 21 Briggs and Stratton Corporation, Milwaukee, Wisconsin.

   1 - Complete Overhaul, 6 and 8 cu. in. Aluminum Alloy Engines - (68 slides)
   3 - Resizing Cylinders - (11 slides)
   4 - Value and Seat Reconditioning - (12 slides)
   5 - Replacing Main Bearings - (12 slides)
   7 - Start-Stop-Store - (28 slides)
   9 - Pulsa-Jet Carburetors - (14 slides)
   20 - Checking Carburetors - (15 slides)
   21 - Checking Ignition Systems - (28 slides)

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Problem Area: Small Gas Engines

Problem: Introduction and History

Job: Construction of the Gasoline Engine

Motivation: Imagine your farm at home with no internal combustion engines. How many think they understand how an engine works? How often do they need some kind of attention? How many know how to do all they need?

Study Questions:

1. Make a list of internal combustion engines you have at home.
2. Why is a steam engine or turbine not an internal combustion engine?
3. When was the first successful internal combustion engine made?
4. How can the burning of gasoline in an engine create a force?
5. What are the main parts necessary to internal combustion engines?
6. What are the three main kinds of internal combustion engines?
7. What are the differences between the 3 kinds?
8. For what is each kind most generally used?
9. What sequence of events is necessary in any internal combustion engine?

Summary of Information:

1. Make a class survey list on the board to determine kind, sizes, and types most common.
2. The combustion takes place outside the working parts and is transferred in while in the internal combustion the working parts move as a direct result of the force created.
3. A. In 1680 Huygens of Holland tried to make an engine run on gun powder but was unsuccessful.

   B. 1860 - Etienne Lenoir of France made the first successful model.

   C. 1862 - De Rochas of France set forth principles of the 4 stroke cycle.

   D. 1876 - Otto of Germany made the first successful 4 stroke cycle engine. It burned illuminating oil.

13832

13831

E. 1885 - A carburetor was developed so that gasoline could be used.

4. When the combustion takes place expansion always results.

5. Pistons, crankshaft, carburetor, valves, cylinder block.

6. Two stroke cycle and four stroke cycle and diesel.

7. Two stroke - fires every time the piston comes up,

less working parts.

Four stroke - fires every other time the piston comes up,

requires valves and a camshaft.

Diesel - burns low grade fuel,

doesn't use a spark plug ignition system.

8. 2 stroke cycle - small equipment, chainsaws, boat motors, lawnmowers.

4 stroke cycle - tractors, trucks, cars, lawnmowers.

Diesel - tractors and trucks. Large equipment.

9. A. Fill the cylinder with an explosive mixture.

B. Compress this mixture into a smaller space.

C. Ignite the mixture or cause it to explode.

D. Utilize the explosive or expansive force for power production.

E. Remove the burned out mixture from the cylinder.

Ref. Purvis, pages 9-16.

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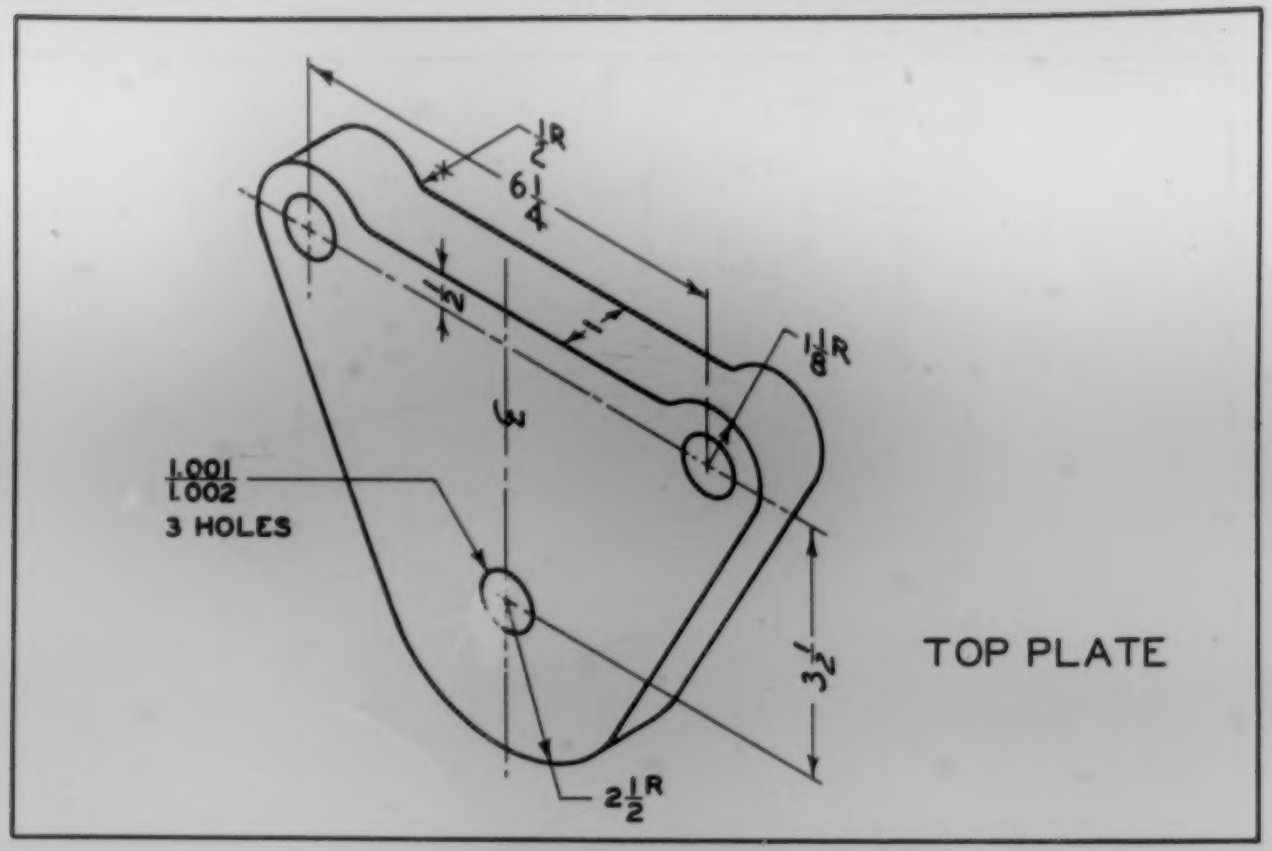
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3 1/2
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TOP PLATE

5.

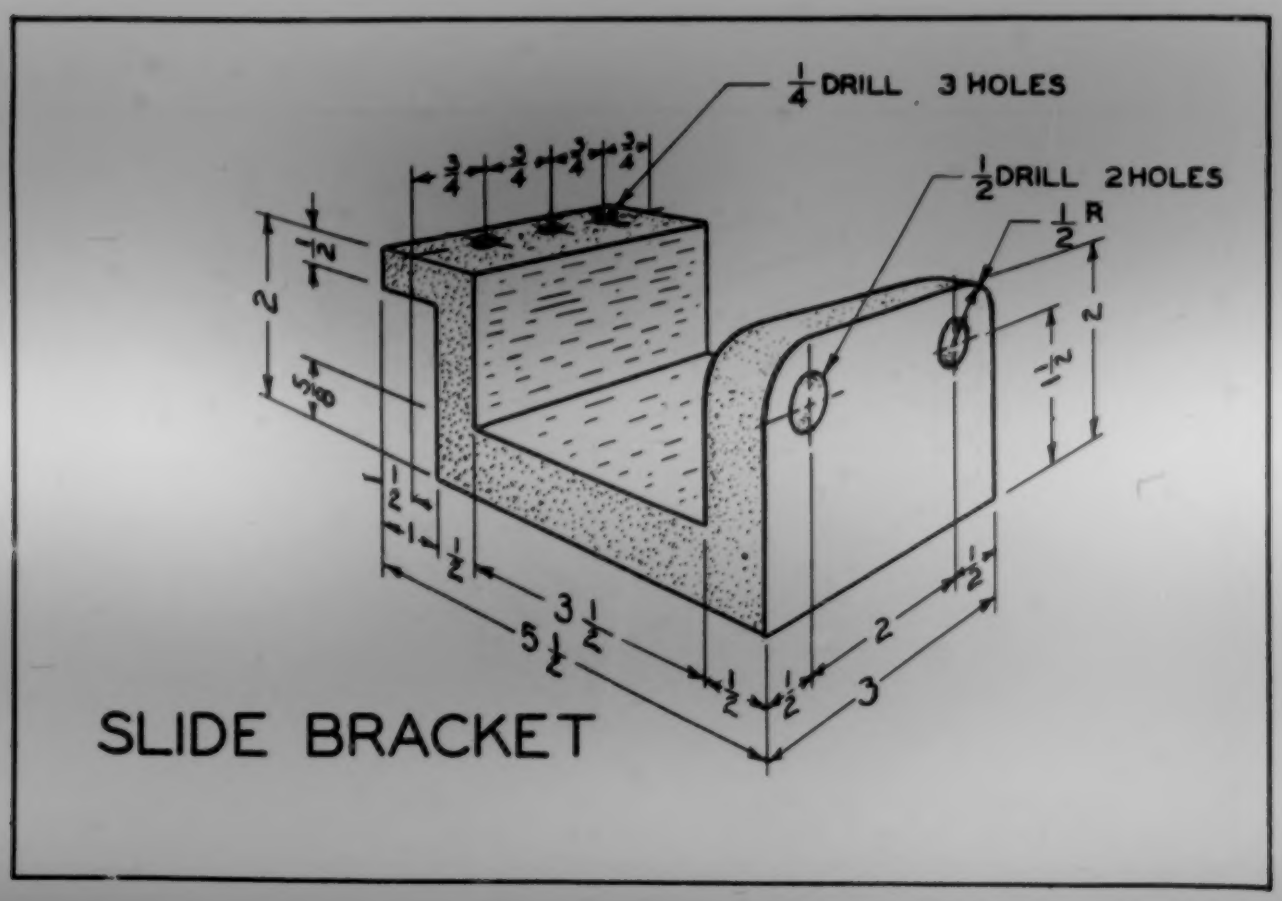
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SLIDE BRACKET

Problem Area: Small Gas Engines

Problem: Principles of Engine Operation

Job: Definition of Terms

Motivation: How many moving parts of an engine can you name? Engines are rated by displacement, stroke, bore, compression ratio, and horsepower. Can you explain and figure each of these?

Study Questions:

1. What is the function of each of the following parts: a. piston, b. cylinder, c. piston pin (wrist pin), d. connecting rod, e. crankshaft, f. flywheel, g. valve, h. camshaft.

2. What is meant by compression? What is the effect of high compression?

3. What is the stroke?

4. What is the bore?

5. How can you figure displacement?

6. How is the compression ratio figured?

7. What are the methods of determining horsepower?

8. What is meant by torque? How is it measured?

9. What is the combustion chamber?

Summary of Information:

1. A. Piston - to receive the force of expansion from combustion.

   B. Cylinder - encases the piston allowing it to move up and down.

   C. Piston pin (wrist pin) - connects the piston to the connecting rod.

   D. Connecting rod - connects the piston to the crankshaft.

   E. Crankshaft - changes the reciprocating motion to circular motion

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F. Flywheel - cuts down on vibration of the crankshaft and makes it run at an even speed.

G. Valve - opens and closes to let gases in or out of the combustion chamber.

H. Camshaft - opens valves at the proper times.

2. Compression is the pressure built up in the cylinder above the piston. High compression gets more power.

3. The stroke is the movement of the piston in the cylinder.

4. The bore is the diameter of the cylinder.

5. Stroke X (pi) X r^2 X number of cylinders

6. The compression ratio is determined by comparing the volume above the piston at top dead center to the volume at bottom dead center.

7. By a brake force - "Prony Brake". Dynamometer - energy transferred in a revolving armature or paddle wheel. Indicate HP - force of expanding gases HP - 33,000 lbs. moved 1 foot in 1 minute.

8. Turning effort. Measured in foot pounds. Force measured at a point 1 foot from the center of the drive shaft.

9. The area above the cylinder in which the firing and burning of gas takes place.

Ref. Purvis, pages 16-30.

Teaching Suggestions: Have samples of each part discussed. Use sample problems for figuring compression and displacement. Have students learn to work these out. Have students work out problems figuring horsepower with torque and time given.

13835

Problem Area: Small Gas Engines

Problem: Principles of Engine Operation

Job: Engine Construction

Motivation: Why do some people like one engine brand better than another.

Study Questions:

1. What properties must a cylinder wall possess.
2. How should bearing surfaces be made?
3. How can warpage be a problem?
4. How must the moving parts fit together?
5. What are the types of head design?
6. Why is aluminum used for engine blocks and heads?

Summary of Information:

1. Cylinder walls must be hard, tough and smooth. (Figure a problem to illustrate how far a piston travels in a cylinder in an hour of running time.)
2. Bearing surfaces should be hard and smooth. The amount of contact affects wear and friction.
3. Blocks or head may warp causing cylinder to be out of round, cause cracking, or leaking. This may be caused by improper casting and manufacture, but more likely by overheating, or uneven tightening of bolts.
4. All moving parts should fit precisely; even on all sides, enough clearance to reduce friction yet tight enough to limit slack or knock. Sleeve bearing surfaces should have slack from side to side to allow for free movement.

5

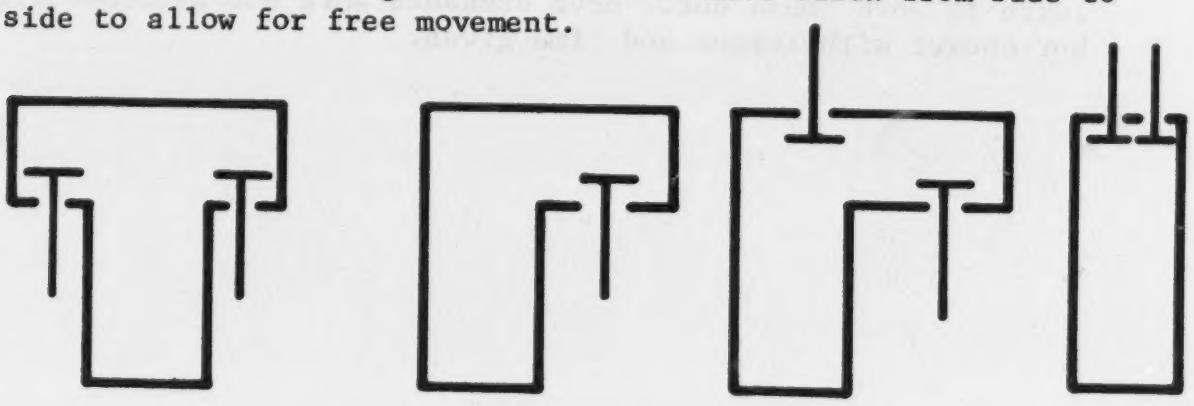

T-Head L-Head F-Head I-Head

Figure I

13836

6. It transfers heat quickly to the outside to be taken up by the cooling system. Aluminum has good wearing properties and is light in weight.

Ref. Purvis, pages 39-48.

Teaching Suggestions: If possible have parts for exhibit that are improperly fitted, warped, scored, or cracked. Do a demonstration showing heat transfer of aluminum and iron. Get 2 pieces the same size and put a piece of wax on the end of each, then heat the other end.

13837

Problem Area: Small Gas Engines

Problem: Principles of Engine Operation

Job: 2 Stroke Cycle

Motivation: Why are chainsaws, boat motors, 2 stroke cycle? How many could recognize a 2 stroke cycle engine by observing the external structure. How many could recognize it if it were taken apart?

Study Questions:

1. What is meant by the term "2 stroke cycle"?

2. What are the advantages of this type?

3. What are the disadvantages?

4. Explain what takes place during one cycle of the engine.

5. What keeps the incoming gases from going out the exhaust when it is at the bottom of the stroke?

6. Does a 2 stroke cycle engine need a carburetor? A spark plug? A valve? A camshaft assemble?

7. Make a diagram of a 2 stroke cycle engine near the top of the stroke going down and one near the bottom of the stroke going up. Label parts and explain.

Summary of Information:

1. It fires after 2 strokes. In otherwords fuel injection, exhaustion, compression, and ignition all take place in 2 strokes so that it fires every time the piston comes to the top.

2. More power per pound. Less working parts, less expensive to buy, and less vibration on a single cylinder engine.

3. Fuel mixture is controlled with some difficulty; power and speed are difficult to control; cooling and lubrication are difficult; less efficient and some what harder to start.

4. Use a mock-up engine or a cutaway model to show 2 cycle principle. On the upward stroke, gasoline vapor is pulled into the crankcase and the mixture in the cylinder is compressed. Just before top dead center ignition takes place. On the downward stroke, gases in the crankcase are compressed. At a point near the bottom the exhaust port is open. A little later the intake port from the crankcase is open. The gasoline air mixture rushes in from the crankcase and waste gases go out the exhaust port.

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5. There is a deflector on top of the piston.

6. Carburetor - yes. Spark plug - yes. Valve assembly - no.

7. Two-Cycle Engine Operation

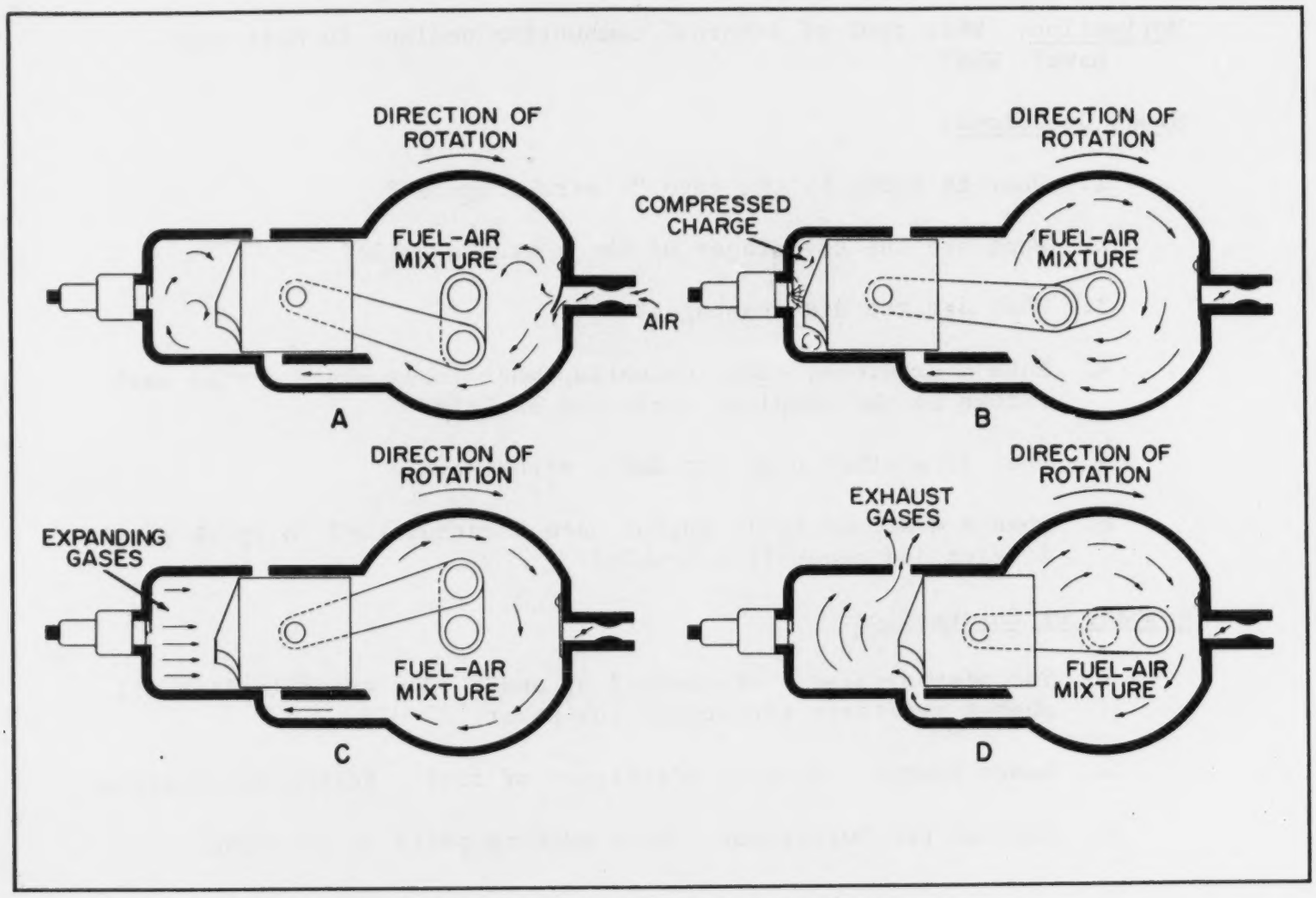

Figure 2 Courtesy of Lawson Power Products

Ref. Purvis, pages 12-17.

Teaching Suggestions: Use a cutaway engine or a wooden mock-up of a 2 cycle engine. Use charts. Use a piston to show the deflector.

13839

Problem Area: Small Gasoline Engines

Problem: Principles of Engine Operation

Job: Four Stroke Cycle Engines

Motivation: What type of internal combustion engines do most cars have? Why?

Study Questions:

1. What is meant by the term "4 stroke cycle"?
2. What are the advantages of the 4 stroke cycle?
3. What are the disadvantages?
4. Make 4 drawings, each indicating what takes place during each stroke in the complete cycle and explain.
5. What is another name for the 4 stroke cycle?
6. Does a 4 stroke cycle engine need a carburetor? A spark plug? A valve and camshaft assembly?

Summary of Information:

1. The piston makes 4 strokes: 2 up and 2 down to accomplish all phases necessary for combustion power.
2. Lasts longer. Greater efficiency of fuel. Better lubrication.
3. Heavier per horsepower. More working parts to go wrong.
4.

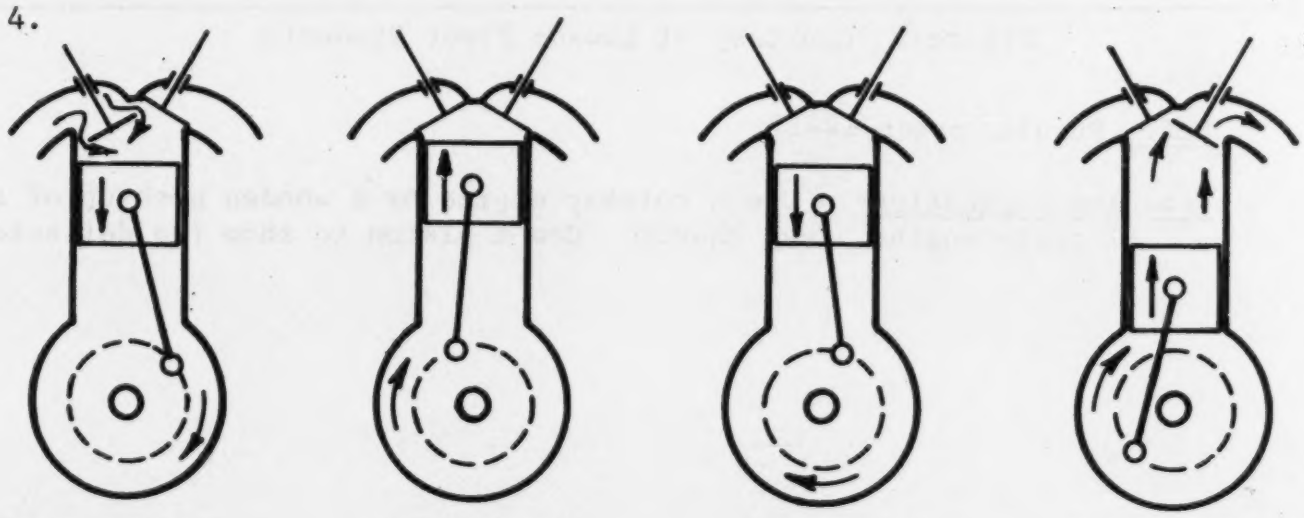

Intake Stroke | Compression Stroke | Power Stroke | Exhaust Stroke

Figure 3

13840

5. Otto cycle, named after the inventor

6. Carburetor - yes. Spark plug - yes. Valve assembly - yes.

Ref. Purvis, pages 12-15; Briggs and Stratton General Theories, pages 3-7.

Teaching Suggestions: Use a cutaway or a wooden mock-up of a single cylinder 4 stroke cycle engine. Use charts.

13841
13842

Problem Area: Small Gasoline Engines

Problem: Principles of Engine Operation

Job: Diesel Engines

Motivation: How many of you have a diesel engine at home? Why do you have a diesel instead of a gasoline engine? Diesels come in sizes from the model airplane to an ocean liner, with a bore of several feet.

Study Questions:

1. How many strokes are in one cycle of the diesel engine?

2. What is the compression ratio of a diesel as compared to a gasoline engine?

3. What ignites the fuel?

4. What fuel is used? Why couldn't a gasoline-air mixture work?

5. Which of the following parts does a diesel have? a. carburetor, b. spark plug, c. valve.

6. What is the function of the injection system?

7. What mechanism does the 2 cycle diesel engine have that the 2 cycle gasoline engine does not have?

Summary of Information:

1. Either 2 or 4.

2. Much higher. About 18 to 1 while 10 to 1 is high for gasoline.

3. The heating which results from the compressing process.

4. Low grade petroleum. Gasoline would ignite before the piston reached the top of the cylinder.

5. Valves - some have a glow plug for starting.

6. a. Measure or meter the quantity of fuel entering each cylinder.

   b. Provide enough pressure to force the fuel into the cylinder at peak compression.

   c. Inject the fuel at the precise time it can burn to best advantage.

   d. Atomize the fuel as completely as possible at the instant of injection.

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7. A blower to force air into the combustion chamber, and exhaust valves.

Ref. Purvis, pages 104-110.

Teaching Suggestions: Charts showing diesel operation.

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6.

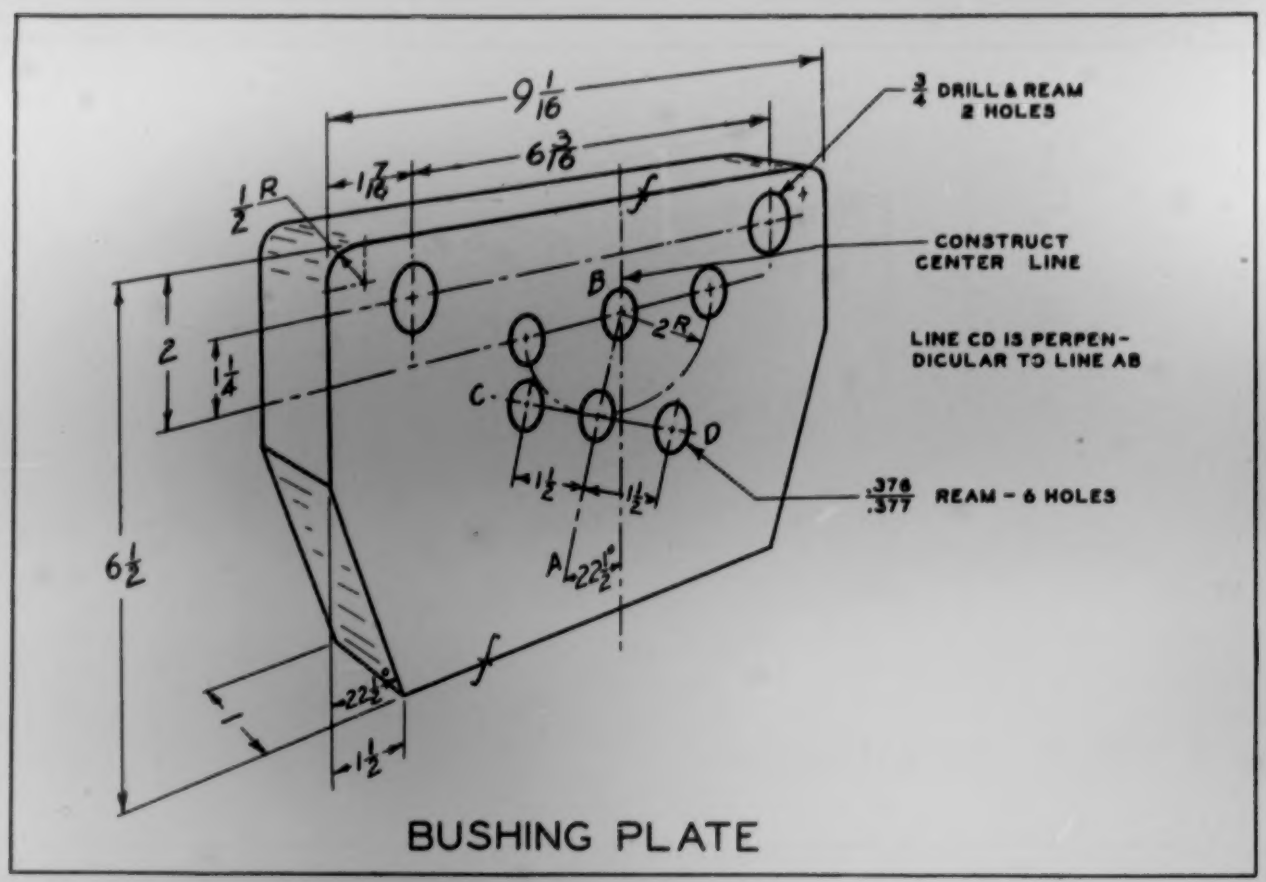
9 1/16
6 3/16
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1/2 R
3/4 DRILL & REAM 2 HOLES
CONSTRUCT CENTER LINE
LINE CD IS PERPENDICULAR TO LINE AB
2R
B
C
D
A
22 1/2°
2
1 1/4
6 1/2
1 1/2
.376 .377 REAM - 6 HOLES
BUSHING PLATE

7.

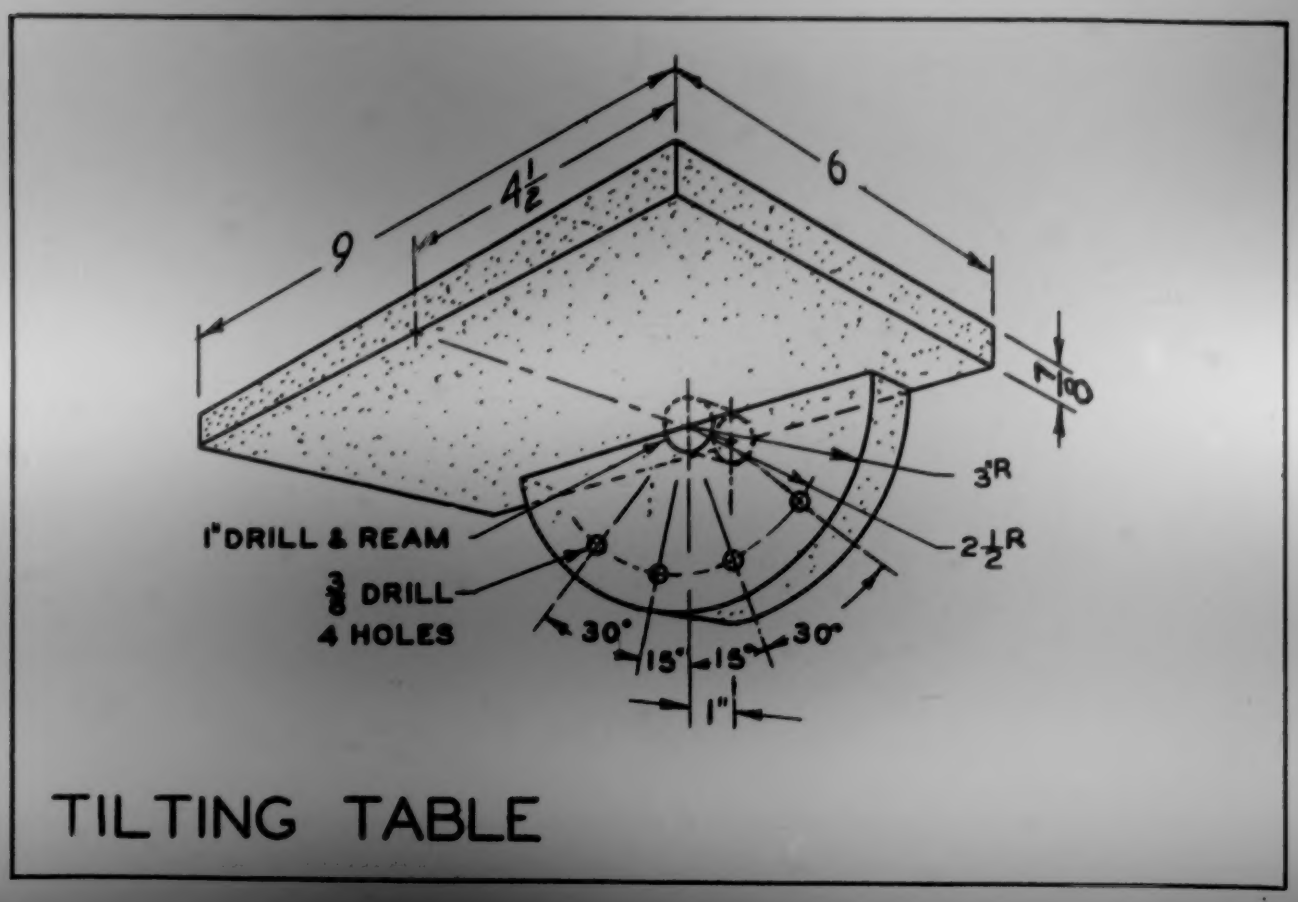
9
4 1/2
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3"R
2 1/2 R
1" DRILL & REAM
3/8 DRILL 4 HOLES
30°
15°
15°
30°
1"
TILTING TABLE

Problem Area: Small Gas Engines

Problem: Principles of Engine Operation

Job: Multi-cylinder Engines

Motivation: Why does an 8 cylinder run smoother than a 4 cylinder? Then why not have all 12 cylinder engines?

Study Questions:

1. Why is it better to have several small cylinders instead of one large one.

2. Explain what is happening at a given instant in each of four cylinders. Use a drawing.

3. What would happen if the No. 1 and No. 4 plug wires were switched?

4. What are some of the differences in the total systems of a single cylinder engine and a 6 cylinder engine?

5. What determines the firing order?

6. What cylinder arrangements may be made on multi-cylinder engines.

7. Why not have a lawn mower engine with 4 small pistons?

Summary of Information:

1. There is less interval between firing causing smoother operation.

2.

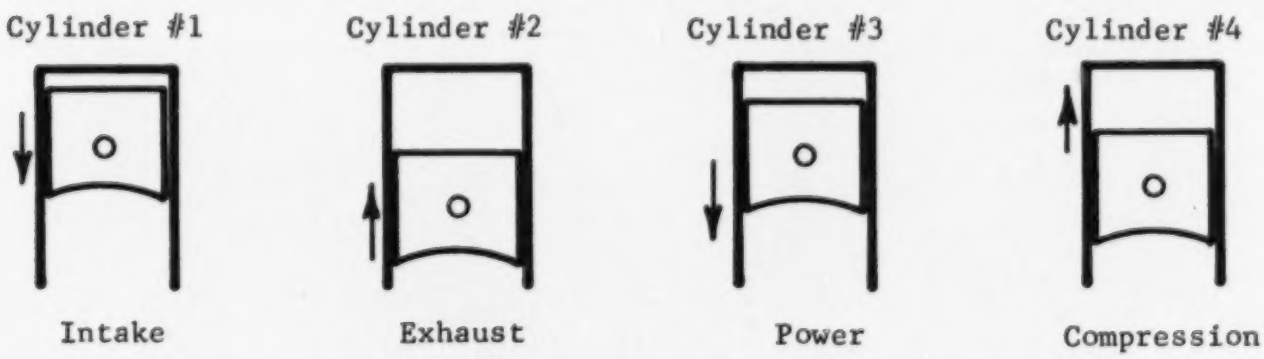

Figure 4

13844

3. When either cylinder plug sparked the intake valve would not be open but would open at the wrong time.

4. Single cylinders, are usually air cooled and have no distributor.

5. The position of the lobes on the camshaft.

6.

Vertical

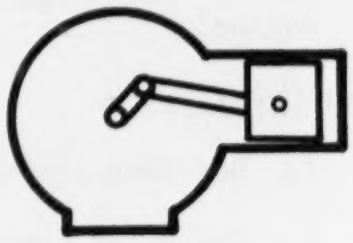

Horizontal
(example John Deere 2 cyl.)

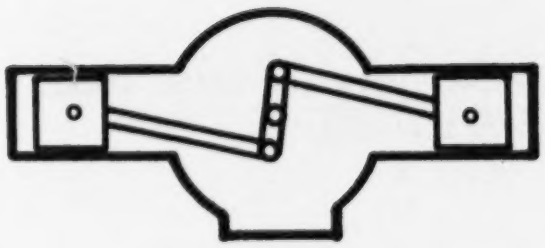

Opposed
(Corviar, Volkswagon)

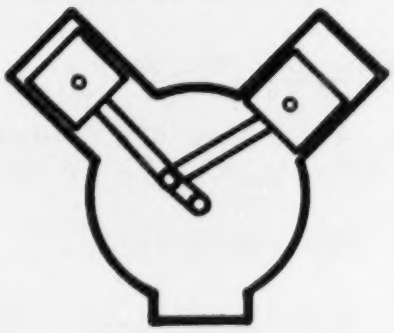

V-type
(V-8 engines)

Figure 5

7. There would be too many parts to complicate it. This would not be necessary with this low power requirement.

Ref. Purvis, pages 11, 30-34.

Teaching Suggestions: Use a chart showing what is happening in each cylinder at a given time. A movable model would be quite helpful.

138451

Problem Area: Small Gas Engines

Problem: Principle of Engine Operation

Job: Engine Timing and Condition

Motivation: How do valves happen to open at the correct time during the cycle? What does an oversized camshaft do to "soup up" a hot rod engine?

Study Questions:

1. How does the camshaft cause the valves to open?
2. How often does each valve open during the complete cycle?
3. How is the camshaft run at the proper speed so the valves open at the right time?
4. How does the engine get lubricated?
5. Why does an engine burn oil?

Summary of Information:

1. There are off center lobes in contact with the valve stems. Use a mock-up or model to show this.
2. Once each cycle.
3. A gear ratio of 2 to 1.
4. Oil is concentrated in the crankcase.
5. The rings are not fitting tight enough in the cylinder. This is usually the main cause.

Ref. Purvis, pages 51-53; Briggs and Stratton General Theories, pages 7-10.

Teaching Suggestions: Have students learn parts of the engine and illustrate the above questions on the disassembly job page 20.

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Problem Area: Small Gas Engines

Problem: Measurements

Job: Use of Micrometer

Motivation: How can you measure the thickness of a fingernail (.002) or the diameter of a ball bearing or even the thickness of a tin can or a sheet of glass?

Study Questions:

1. What is a micrometer?

2. What is a micrometer used for in small gas engines?

3. How do you read a micrometer?

Summary of Information:

1. Micrometer: A measuring instrument for either external or internal measurement in thousandths and sometimes ten thousandths of an inch.

2. It is used to measure engine parts which have a very small tolerance.

   "Miking" should be done very carefully and accurately.

3. A. Scale on thimble reads from 0 to .025.

   B. Scale on sleeve reads from 0 to 10 (0" - 1.0").

      1. From 0 to 1 equals 1/10th inch; 0 to 2 equals 2/10ths inch; 0 to 5 equals 5/10th inch; etc.

      2. From 0 to 1 is subdivided into 4 parts (1/25th inch).

   C. Adjust micrometer to read 0.1 inch.

      1. Sleeve scale reads 1.

      2. Thimble scale reads 0.

   D. Now as you turn the thimble, the measurement reads 0.11; 0.12; 0.13; etc.

   E. Notice that on .125, the thimble now reads and the sleeve now is on the first subdivision (1/125th).

   F. Now turn thimble 1 revolution: Now reads .0150.

   G. Now turn thimble 1 revolution: Now reads .0175.

13847

H. Now turn thimble 1 revolution: Now reads .0200.

Ref. Shopwork On The Farm, M. M. Jones, page 411.
How To Run A Lathe, South Bend Lathe Company, page 39.

Teaching Suggestions: Demonstrate the use of a micrometer. Have students practice use of micrometer. Make transparencies of the following material for use in practice readings.

Study Guide on Micrometer

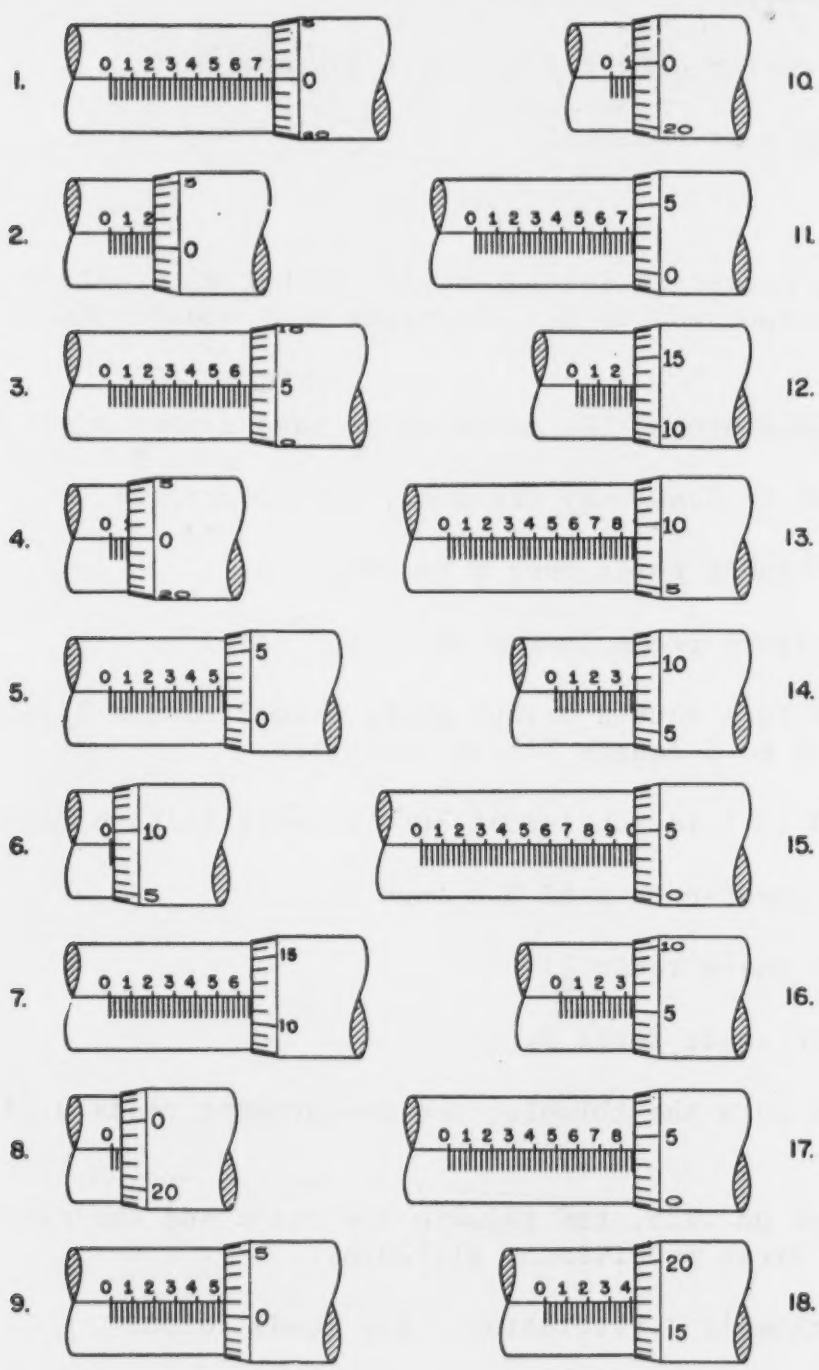

(1) 0.750
(2) 0.201
(3) 0.655
(4) 0.075
(5) 0.527
(6) 0.009
(7) 0.662
(8) 0.048
(9) 0.526
(10) 0.099
(11) 0.728
(12) 0.263
(13) 0.859
(14) 0.358
(15) 0.979
(16) 0.331
(17) 0.854
(18) 0.417

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Problem Area: Small Gas Engines

Problem: What Needs To Be Repaired

Job: Disassembly and Checking the Engine

Motivation: How should a small engine be disassembled? What parts should be checked for wear?

Demonstration: Follow the disassembly procedure in Briggs and Stratton Repair Instruction II. Show Briggs and Stratton slides on disassembly.

Steps in disassembly and checking.

1. Drain oil.
2. Remove air cleaner and stud and any other parts of the engine that are made of plastic.
3. Drain fuel tank.
4. Remove blower housing.
5. Clean the engine with steam or solvent (cover the coil as solvent or steam might damage it).
6. Disassemble and check starter mechanism.
7. Spin flywheel to check compression.
8. Check spark.
9. Check air gap.
10. Check governor blade for wear.
11. Remove valve cover and check valve clearance.
12. Remove cylinder head bolts, indicate where long bolts belong, demonstrate threading and removal of stud that has been twisted off.
13. Remove valves and springs (point out different kinds of valve keeper and how they are removed).
14. Inspect valves and seats.
15. Check valve guides.

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16. Remove starter pulley or starter clutch.

17. Remove flywheel. Demonstrate how to remove with Briggs and Stratton puller and removing the flywheel by striking the crankshaft sharply with a plastic mallet, while lifting on the flywheel.

18. Check flywheel key.

19. Remove breaker point cover (indicate the use of a sealer where the coil wire enters).

20. Check breaker point gap.

21. Remove condenser and points.

22. Check breaker point plunger and plunger hole.

23. Test condenser.

24. Test coil.

25. Check crankshaft end play.

26. Remove burrs from crankshaft extension and use emery paper to remove all rust so that bearing will not be distorted.

27. Remove base or sump.

28. Remove oil slinger.

29. Remove and check cam gear (emphasize timing marks, if they cannot be found use a punch to make the timing marks).

30. Remove and check tappets.

31. Ream ridge from top of cylinder.

32. Remove and check piston and rod.

33. Remove and check crankshaft.

34. Check cylinder bore.

35. Check main bearings.

36. Check condition of all threads and bolts. Remove any studs that have been twisted off and thread or use insert thread to restore original condition.

Ref. Briggs and Stratton Repair Instruction II

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Teaching Suggestions: All of the repair procedures should be demonstrated when each of the areas are studied.

Problem Area: Small Gas Engines

Problem: Ignition System

Job: Function and Parts

Motivation: What takes the place of the battery system in supplying the electrical spark for a small gas engine?

Study Questions:

1. What is the purpose of the ignition system?
2. What are the two types used?
3. Which of these is most common on small engines?
4. What is the principle difference between the two?
5. What are the advantages of the magneto system?
6. What are the parts of the magneto?
7. How do these parts function to provide a hot spark?
8. When should the spark occur?
9. What is the importance of a condenser?

Summary of Information:

1. Purpose - to ignite the air-fuel charge by means of a high voltage spark.
2. Types - magneto and battery.
3. Most common - magneto type.
4. Differences - principal difference is source of electrical current. In the magneto, the armature must be rotated to produce the necessary current. In the battery system, current is produced by chemical action.
5. Advantages - A. Does not require a battery for starting.
   B. Intensity of voltage increases with engine speed.
   C. Longer life span.

13851

6. Parts: A. Primary circuit:

1. Rotor with magnets - may be located in flywheel or in a rotor mounted on a crankshaft.

2. Laminated shoe plates or armature.

3. Laminated core inside of coil.

4. Primary windings, larger wires with few windings. (about 35 feet of wire)

5. Breaker points to open mechanically on a cam to open the primary circuit.

6. Condenser to store electricity when points are open.

7. Switch used to ground circuit to stop engine.

B. Secondary circuit:

1. Secondary winding, small wires with many windings, used to increase voltage. (about 3520 feet of wire)

2. High tension lead to spark plug.

3. Spark plug which ignites fuel in cylinder.

7. How parts function:

A. Rotor with magnets turn with crankshaft.

B. Flow of current changes direction every half revolution of rotor and is greatest just before a reversal of the magnetic flux.

C. Points are opened to cause an interruption in the flow of current in the primary winding.

D. Connected across the points is a condenser to absorb the surging current when the points are opened: preventing arcing and burning of the points.

E. Condenser storage action is followed by a quick and complete collapse of the magnetic field in the coil.

F. Collapse of primary current induces a secondary current.

13852

G. A much higher voltage is developed, since there are many more turns in the wire of secondary circuit.

H. High voltage enters the center of distributor cap which directs a hot spark to each plug just as the mixture has been compressed for burning.

I. In a 2-cycle engine, this sequence of events occurs 6000 times a minute. In a 4-cycle, it occurs 3000 times per minute at full RPM.

8. Spark occurs:

A. When starting: near HDC on compression stroke.*

B. For full speed: 25° - 30° BHDC on compression stroke.**

C. Proper engine timing means valves, magneto, and breaker points must be in proper relation to crankshaft rotation. (1/50th of a second off and engine might not run.)

9. Condenser:

A. It is a safety valve for primary circuit. If it shorts out, the points will burn and spark will be weak.

B. Current stored in condenser is used to re-energize the primary circuit when points are closed.

Ref. Purvis, pages 182-204; Briggs and Stratton General Theories, pages 19-24.

Teaching Suggestions: Have various parts of the ignition system available for student inspection. Use charts. Use actual engine to demonstrate on.

* HDC is an abbreviation for "head dead center". Sometimes referred to as TDC or "top dead center".

** BHDC means "bottom head dead center". Sometimes referred to as BDC or CDC which is "bottom dead center" or "crank dead center".

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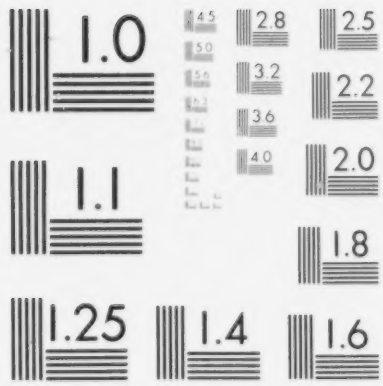

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Problem Area: Small Gas Engines

Problem: Ignitions

Job: Magneto Care and Ignition Adjustment

Motivation: In a two cycle engine, spark occurs 6000 times per minute at this speed everything must function perfect.

Study Questions:

1. How can you check magneto output?
2. What type lubricant is used?
3. What points should be lubricated?
4. At what intervals should points be regapped?
5. What other adjustments can be made on the ignition system?

Summary of Information:

1. Output - gap a spark plug at 3/16" (.187) and connect the lead. Hold the plug against the head or block and crank the engine. If fire jumps readily across the 3/16" gap, the output is adequate. Or a spark tester can be used.

2. Lubricant - a light grade engine oil or highly refined lubrication oil should be used, but used sparingly.

3. Lubrication points - A. A few drops of oil should be applied to armature, or rotor bearings and to distributor bearings.

   B. If impulse is sluggish, flush with kerosene and reoil with light grade oil.

4. Regapping - points usually needed regapping or replaced after 200 to 300 hours of operation.

5. Adjustments -

   A. Spark plugs:

      1. Clean and file electrodes.

      2. Set proper gap. Use wire gauge.

      3. Replace if necessary.

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B. Breaker point gap:

1. File lightly.

2. Replace if pitted.

3. Use flat feeler gauge and set according to specifications.

C. Air gap:

1. Use feeler gauge and set according to specifications. Or paper tags can be used.

D. Breaker point plunger hole:

1. If loose, it will leak oil on points.

E. Check condenser.

Ref. Purvis, pages 193-205; Briggs and Stratton General Theories, pages 19-24.

Teaching Suggestions: Demonstrate the various ignition repair procedures, see demonstrations next five pages.

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SERVICING THE IGNITION SYSTEM*

Breaker points

Remove the breaker point cover and examine the condition of the points. If they are burned or pitted, they should be replaced. If you replace the points, have the condenser tested or replace it too.

Adjust the clearance between the breaker points when fully open to that recommended. For our example engine this clearance is .020. Wipe the blade of your feeler gauge clean of oil or grease before you use it to check point setting.

Spark plug

Inspect the spark plug for fouling, wide gap, or burned condition. Cleaning a dirty plug is a questionable practice. If in doubt, it is best to replace it with a new plug of the proper number as specified by the engine manufacturer.

Adjust the plug gap to the recommended clearance. For the example engine this is .025.

Coil and ignition wiring

The coil and ignition circuit can be tested with a 6-volt lantern battery as shown in Fig. 6. It is convenient to have a clip on the end of one battery wire and a test prod on the end of the other.

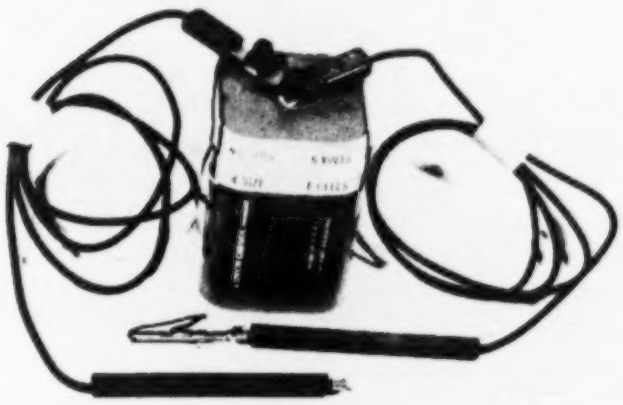

Figure 6. A coil and ignition circuit tester.

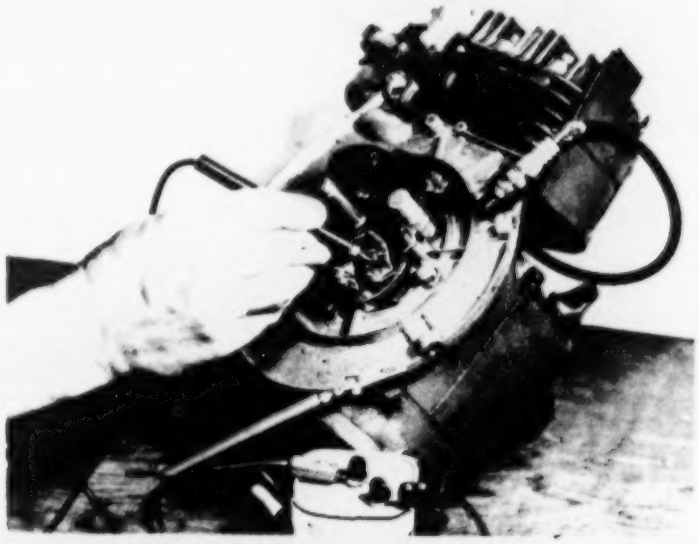

Figure 7. Clip one battery wire to the engine frame. Scratch the insulated breaker point with the prod and a spark should jump the plug gap.

13856

Connect the spark plug wire to the plug and lay the base of the plug in contact with the engine head. Clip one battery wire to the engine frame. Turn the engine until the points are fully open and scratch the insulated part of the breaker point assembly with the test prod (Fig. 7). A spark should jump the gap at the plug. The spark is most intense when you touch the prod to the insulated point for a moment and then break contact quickly. This simulates the action of the breaker points when the engine is running.

If you get no spark at the plug, do not conclude immediately that the coil is defective. The trouble may be in the points, in the primary wire leading from the points to the coil, in the coil grounding wire, or in the secondary wire leading from the coil to the plug.

Note what kind of a spark, if any, occurs when you scratch the insulated point with the battery prod.

No spark. This means that the current is not going through the primary ignition circuit. Look for a poor connection or a break in the wire leading from the point assembly to the coil. A loose connection at the point where the coil winding is grounded will also cause this fault (Fig. 8).

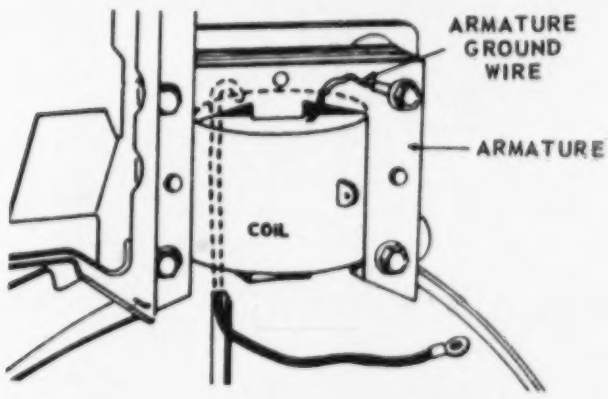

Figure 8. The armature ground wire must be tight.

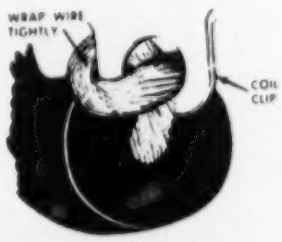

Figure 9. The spark plug wire should be pinched tight but not soldered.

Small spark. A small spark of the same intensity that you get when you scratch the prod on the engine frame indicates that the insulated breaker point assembly is grounded somewhere. This may be due to the lug on the wire attached to the insulated point touching the frame, or to a break in the insulation on the wire leading from the point to the coil. Do not overlook the shorting mechanism that may be used to stop the engine. If your engine has a switch to turn it off, or if you close the throttle to stop it, this mechanism may be shorting out the points continuously.

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Bright spark. This indicates that the primary circuit of the coil is probably all right. When you energize the primary circuit, a magnetic field builds up in the coil. When you break this circuit, the primary field collapses, giving a momentary surge of fairly high voltage back through the primary circuit. This causes a bright blue spark at your prod.

If you still get no spark at the plug and you are sure the plug base is making good contact with the engine head, look for trouble in the secondary circuit. Check the connection of the spark plug wire to the coil. It should be pinched tight as shown in Fig. 9 but not soldered.

Look next for worn insulation on the spark plug wire, particularly where it passes through openings in the frame or under metal clips. High-voltage current may be shorting to the frame at these points. There may also be a break in the wire somewhere between the coil and the plug. To check these possibilities, disconnect the spark plug wire from the coil and connect a new piece of wire directly to the coil and plug.

If the plug still fails to fire, you may conclude that the coil is defective and should replace it with a new one.

*University of Illinois, Small Engine-Repairs and Over-haul

13858

Problem Area: Small Gas Engines

Problem: Ignition

Job: Replacing Breaker Point Plunger Bushing

Demonstration:

1. Check breaker point plunger for length, reject at less than .870 inch.

2. Check breaker point plunger hole with plug gauge 19055.

3. Use reamer 19056 to ream plunger hole (remove all ignition parts from block).

4. Drive in bushing with bushing driver 19057 so the upper end of bushing is flush with the boss.

5. Finish ream the bushing with reamer 19058.

6. Insert new plunger with groove to the top.

Ref. Briggs and Stratton Repair Instruction II, page 16.

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13860

Problem Area: Small Gas Engines

Problem: Ignition

Job: Installing and Adjusting Points and Condenser

Demonstration:

1. Install mounting post of breaker arm in recess so that groove in post fits into the notch in the recess and tighten.

2. Place spring on arm and place in the groove on the post.

3. Connect primary coil wire on condenser and install the condenser. If ground wire for stopping the motor is present attach it to the condenser also.

4. Turn crankshaft until points are open as far as they will go.

5. Loosen the condenser and insert a .020 flat feeler gauge between the points. Move condenser to correct setting with a screw driver and tighten condenser bracket.

6. Always check to see that there is no grease or other foreign material on the points and that the points are meeting squarely.

7. Place a little sealer on the slot through which the coil wires pass on the breaker point cover so that dirt will not enter.

Ref. Briggs and Stratton Repair Instruction II, page 16.

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13860

Problem Area: Small Gas Engines

Problem: Ignition

Job: Setting Armature Air Gap

Demonstration:

1. Place coil on engine and tighten one screw to hold it in the highest position

2. Place proper thickness gauge between armature and flywheel. Refer to Briggs and Stratton Repair Instruction II, page 18.

3. Point out differences between aluminum and zinc flywheels.

4. Loosen the one mounting screw, the magnets should pull the coil down firmly against the thickness gauge.

5. Tighten the mounting screws.

6. Rotate flywheel to remove thickness gauge.

Ref. Briggs and Stratton Repair Instruction II, page 18.

13861

Problem Area: Small Gas Engines

Problem: Ignition

Job: Spark Plug

Motivation: New plugs may reduce fuel consumption 14.2% or from 10 gallons per hour to 8.6 gallons per hour. This results in a savings of approximately 32¢ per hour.

Study Questions:

1. What is the function of the spark plug?
2. What are the three types of spark plugs?
3. Does a "hot" plug deliver a hotter spark than a "cold" plug?
4. What is the difference in the three plugs?
5. How do you determine the heat type needed?
6. What is the danger of plugs overheating?
7. What type gauge should be used to gap plugs?
8. What is meant by spark plug "reach"?
9. What are the common lengths of "reach"?
10. What torque should be used for spark plugs?

Summary of Information:

1. Function - to transfer a high voltage spark from the lead wire to the combustion chamber.
2. Different plugs - "hot" - "normal" - "cold".
3. Hotness of spark - the voltage of the spark is the same in any of the three plugs.
4. Differences - the difference in the three plugs is the length of insulator tip. The length determines how rapidly heat passes from the spark plug to the engine cooling system.
5. Heat type -

   A. Hot plugs have a long insulator nose, therefore, heat must travel farther to reach coolant. This type is used for low-quality fuels or at low operating speeds.

   B. Normal plugs are used for average conditions.

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C. Cold plugs have a short insulator nose, and operate at a lower temperature. They are used on high-quality fuels or at high operating speeds.

6. Overheating - this may cause blistering, burning of electrodes and engines knock. Engine knock is caused by hot plugs that ignite the fuel charge before the spark plug fires. This is at a temperature of 1600° - 1700°.

7. Plug gap - should be set with a wire gauge to insure proper gapping of convex or concave areas.

8. "Reach" refers to the distance from the top of the copper gasket to the bottom of the ground electrode.

9. In the 14 mm plug, there are four different lengths, of "reach"; 3/8, 7/16, 1/2, 3/4. These are designed to fit different types of engine heads so the base of the plug will be even with the inside of the combustion chamber.

10. Torque - cast iron heads - 30 foot lbs.
aluminum heads - 25-27 foot lbs.

Ref. Purvis, pages 205-209.

Teaching Suggestions: Have plugs of the various types available for observation. Follow this lesson with a few days in laboratory with students working on the ignition systems of small engines.

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8.

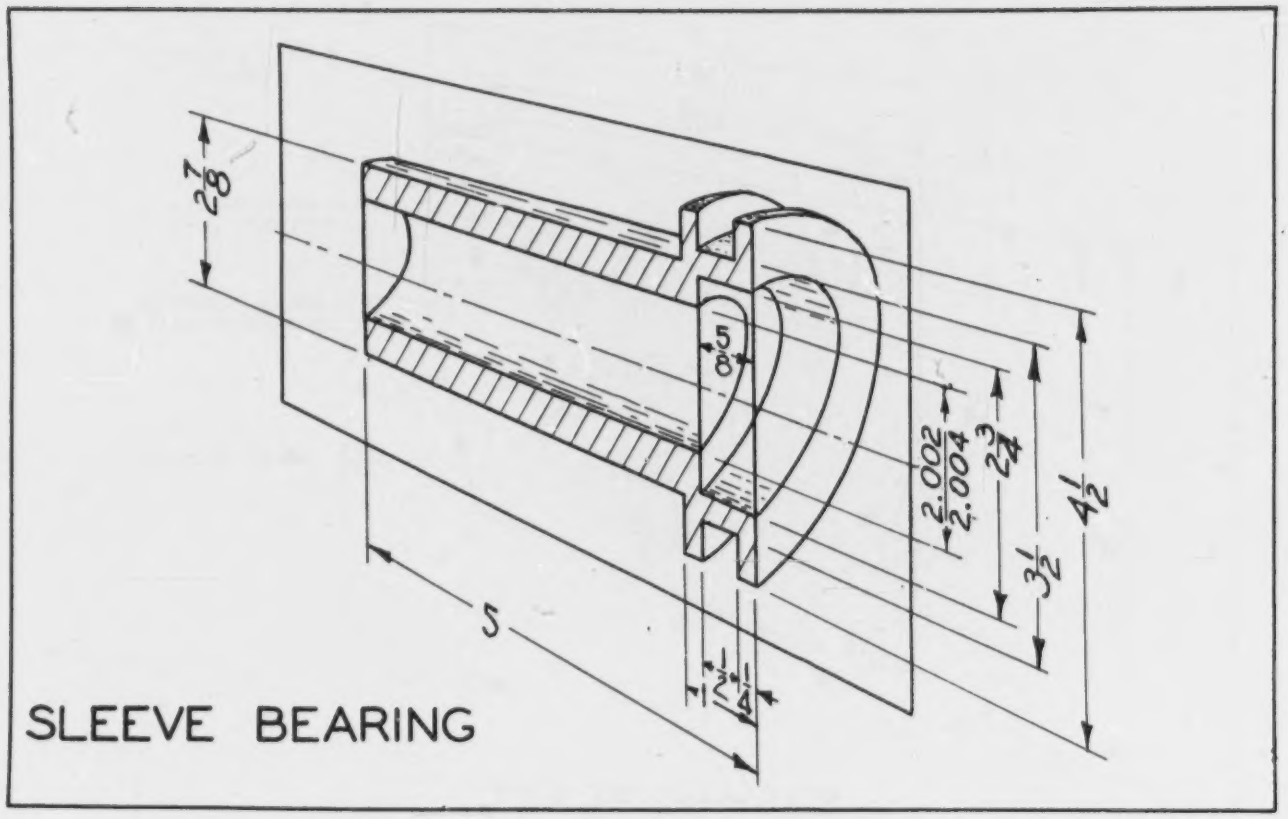
2 7/8
5/8
2.002
2.004
2 3/4
3 1/2
4 1/2
5
1/2
1/4
SLEEVE BEARING

9.

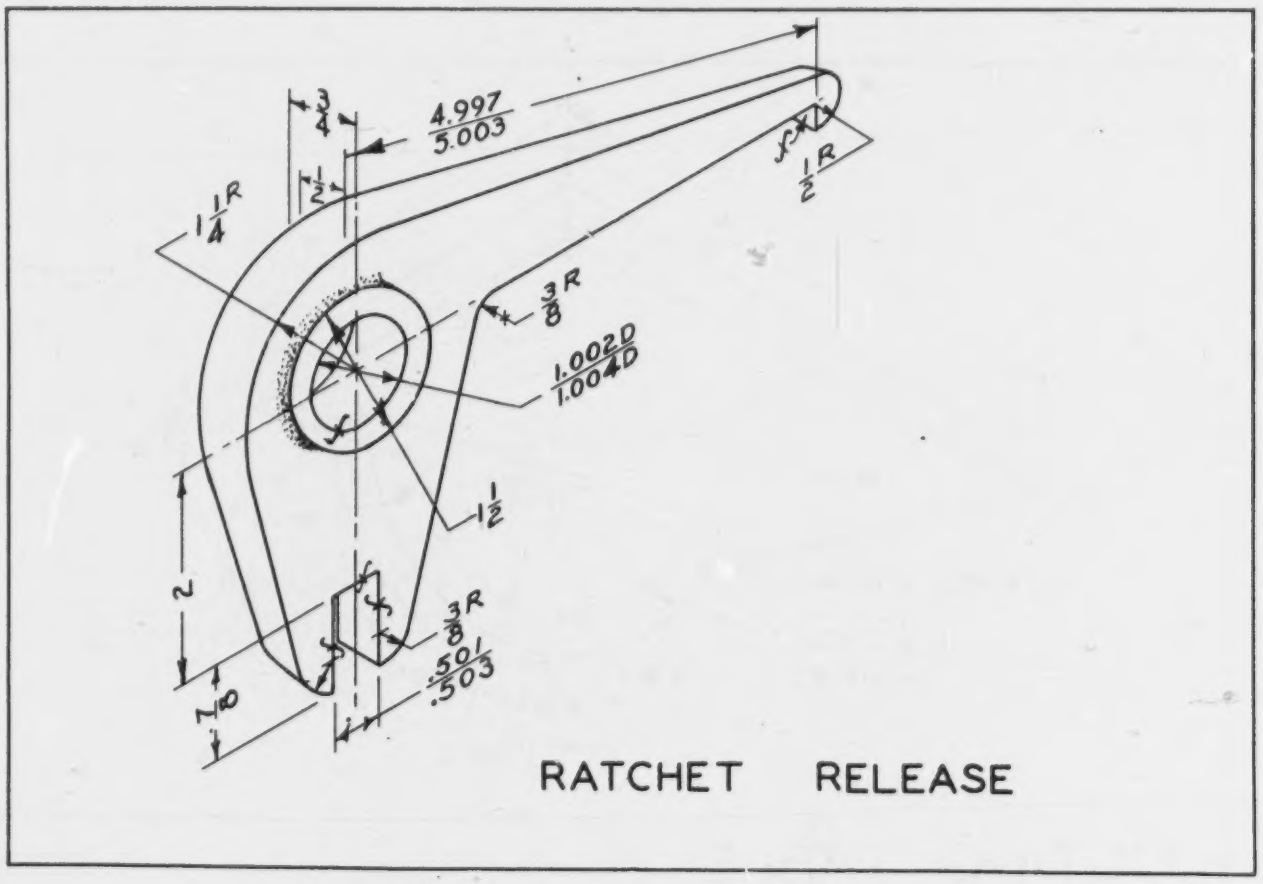
3/4
4.997
5.003
1/2
1 1/4 R
1/2 R
3/8 R
1.002D
1.004D
1 1/2
2
7/8
3/8 R
.501
.503
RATCHET RELEASE

1383

Problem Area: Small Gas Engines

Problem: Ignition

Job: Checking, Cleaning and Setting Spark Plugs

Demonstration:

1. Remove dirt from around spark plug seat.

2. Remove spark plug from the engine (emphasize proper procedure and tools to keep from breaking plugs).

3. Clean the plug.

4. Show correct procedure for setting and gapping a spark plug. Illustrate why a wire gauge is better than a flat feeler gauge for gapping spark plugs.

5. Clean plug in solvent to remove any sand left from the cleaning procedure.

6. Replace plug in engine and tighten until spacer washer is depressed. Emphasize right amount of torque in tightening so as not to strip the threads in aluminum heads.

13863

13864

Problem Area: Small Gas Engines

Problem: Carburetion

Job: Principles of Carburetion

Motivation: Why not just put gasoline directly into the cylinder? Why have a 4 barrel carburetor instead of one large one?

Study Questions:

1. What is the basic purpose of the carburetor?
2. What is a venturi?
3. What is an airfoil?
4. In what ways may gasoline get into the carburetor?
5. What does the carburetor float do?
6. Explain how the fuel goes from the carburetor into the cylinder?
7. What is the ideal combustion mixture of air and gasoline?

Summary of Information:

1. To vaporize the gasoline and mix it with air.
2. A narrow area through which air must flow. It causes an increase in speed and a decrease in pressure of the air.
3. A tube in a stream of air inside the venturi which creates an air pattern with low pressure on one side.
4. Gravity feed, fuel pump, suction of the carburetor.
5. Regulates the amount of fuel in the bowl of the carburetor.
6. As the engine is turned over, the intake stroke creates a suction in the manifold and through the carburetor. Air rushes in through the venturi. Gasoline is already in the nozzle located in the venturi. As the low air pressure is produced on the backside by the airfoil the fuel comes out through little holes and is mixed with the air rushing into the manifold.
7. 14 to 15 lbs. of air to 1 pound of gasoline.

Ref. Purvis, pages 137-151; Briggs and Stratton General Theories, pages 10-19.

Teaching Suggestions: Use Briggs and Stratton, General Theories of Operation, as an additional reference on carburetion.

138658

Problem Area: Small Gas Engines

Problem: Carburetion

Job: Types of Carburetors

Motivation: We know there must be differences in carburetors since we hear about 2 barrel and 4 barrel carburetors. How much difference is there other than this? Show several different carburetors.

Study Questions:

1. What parts are about the same in all types?

2. What parts differ among them?

3. What problem of carburetion is taken care of with modern types of carburetors, but was overlooked in early carburetion systems.

4. What methods are used to overcome this problem and how does each work?

5. What is the difference between updraft, downdraft, and side carburetors?

Summary of Information:

1. Float system, throttle and choke systems, and the relationship of parts to obtain fuel air mixture.

2. Number of jets and position of jets. Angle to manifold may vary.

3. When the engine is idling, it needs a richer mixture than when operating at medium speeds. At maximum power, a rich mixture is again needed.

4. A. Idling Jet. The idling jet is necessary at low speeds because the vacuum is too low to bring fuel through the regular jet. It discharges fuel into the mixing tube close to the throttle in the closed position. The vacuum is high at that point when the throttle is closed. As soon as the throttle is opened, the vacuum shifts from above the throttle to below it and receives fuel from the main jet instead of the idle jet.

   B. Double nozzle. (D-8, p. 142) Purvis.

   In addition to the main nozzle, there is another nozzle with a constant rate of discharge. The compensating nozzle receives its supply from a standpipe connected to the float chamber and open to the atmosphere so that it delivers at a constant rate.

138661

C. Air Bleed Principle (D-9, p. 144) Purvis.

Consists of a secondary venturi, a well jet, and a discharge jet in addition to a regular carburetor. Air going through the discharge jet at low speeds decreases surface tension and allows more fuel to flow in at low vacuum. A small amount of air enters through the well vent. A ring discharge in the secondary venturi takes care of fuel at high speeds.

5. A. Updraft - connects below the manifold.

B. Downdraft - connects on top of the manifold. (This way in car engines.)

C. Side - comes into the side of the manifold, and has a horizontal air passage.

Ref. Purvis, pages 137-151, Briggs and Stratton General Theories, pages 10-19.

Teaching Suggestions: Use cutaways or old carburetors to show types. Use charts showing internal structure of carburetors.

13867

Problem Area: Small Gas Engines

Problem: Carburetion

Job: Adjusting the Carburetor

Motivation: Could you adjust a carburetor for top efficiency? Is top efficiency the same as top performance?

Study Questions:

1. How do you adjust a carburetor to have maximum power?

2. What do we mean by a lean mixture? What's wrong with a lean mixture?

3. How does the throttle work?

4. How is the idle mixture adjusted?

5. How does the choke accomplish its purpose?

Summary of Information:

1. Run the engine at operation speed. Turn the needle valve until the engine slows down. Then turn the needle valve out until the engine speeds up then slows down. Turn the valve back to a point half-way between these two points.

2. A small amount of gasoline compared to the air in the mixture. Not economical, causes overheating, detonation, and short valve life.

3. A butterfly is located above the venturi which regulates the fuel mixture going into the cylinder.

4. Set the engine at idle (about 1750 RPM) turn the valve down until it slows, then back it up until it speeds up then slows down. Turn it back to half-way between.

5. The choke is a butterfly placed below the venturi. It regulates the flow of incoming air. When it is closed the ratio of air to fuel is low or the mixture is rich.

Ref. Purvis, page 146, Briggs and Stratton General Theories, pages 10-19.

Teaching Suggestions: Demonstrate adjusting 2 or 3 kinds of carburetors. Try the engine at different adjustments to show the effects on engine operation.

13868

Problem Area: Small Gas Engines

Problem: Carburetion

Job: Rebuilding Carburetors

Motivation: Faulty carburetors are the leading cause of small engine failures. How can a carburetor be repaired?

Study Questions:

1. Why is it necessary to replace carburetor gaskets?

2. How do you check for upper carburetor warpage?

3. When will needle valves, idle valves and float valves need to be replaced?

4. How can you check throttle shaft wear?

5. How can the float adjustment be made?

Summary of Information:

1. Gaskets may harden or crack and cause leakage.

2. Insert .002 feeler gauge between upper and lower body. If feeler gauge will go the upper body will need to be replaced.

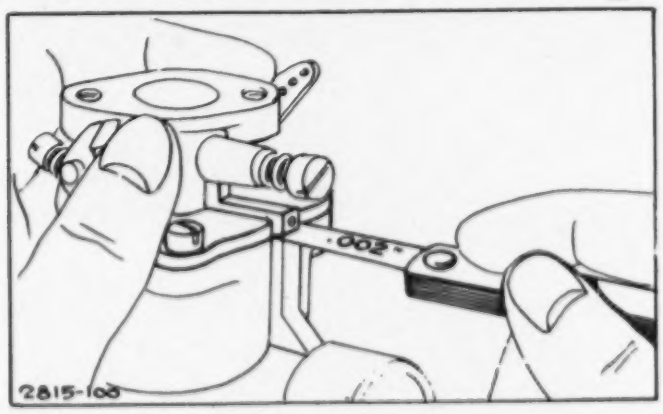

Figure 10 Checking Carburetor Body Warpage
Courtesy Briggs and Stratton

3. When any of the needle valves have ridges worn or have seats damaged they will usually both need replacing.

4. Replace bushing if throttle shaft has .010 or more play. Place and iron bar under throttle shaft, use a feeler gauge and lift shaft. If .010 or more play is found it will need bushing.

13869

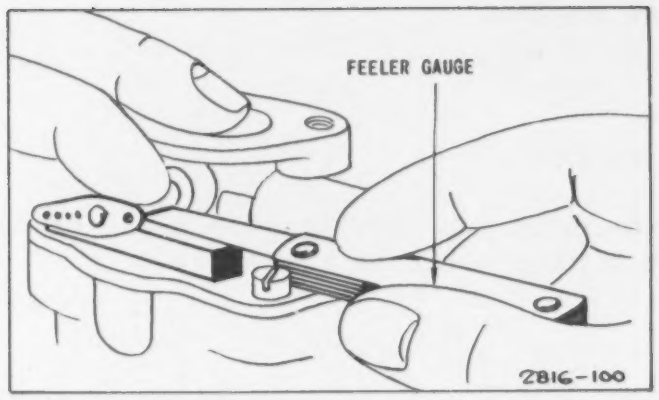

Figure 11 Checking Throttle Shaft Wear
Courtesy Briggs and Stratton

5. Adjustment is made by bending tang. It should be the same distance from each side of the float to the carburetor body.

Ref. Briggs and Stratton Repair Instructions II page 23-40.

13870

Problem Area: Small Gas Engines

Problem: Carburetion

Job: Rebuilding Carburetors

Demonstration:

1. Demonstrate the disassembly of a carburetor.

   a. Stress how easily carburetor parts can be lost or misplaced.

   b. Indicate the correct use of tools.

   c. Show students how jets can be removed without damaging carburetor body.

2. Demonstrate how parts are to be prepared to put into carburetor cleaner. Emphasize the caustic actions of the cleaning material.

3. Replace throttle shaft bushing.

4. Demonstrate correct assembly procedures.

Ref. Briggs and Stratton Repair Instruction II, page 25.

Teaching Suggestions: Show slide on carburetor overhaul by Briggs and Stratton.

13871

Problem Area: Small Gas Engines

Problem: Carburetion

Job: Fuels

Motivation: Why do we have several grades of gasoline?

Study Questions:

1. What kind of gasoline is recommended for small 4 cycle engines?
2. What is meant by a volatile fuel?
3. What is vapor lock: What causes it? How can it be prevented or corrected?
4. How should an engine which will not be used for a month or more be stored?
5. What function does the air cleaner have? How important is this?
6. How does the fuel for a two cycle engine differ from that for a 4 cycle? Why is this?

Summary of Information:

1. Regular grade. Use winter grade in winter and summer grade in summer.
2. One which evaporates at a low temperature.
3. The fuel vaporizes before it goes into the venturi. Low air pressure, high temperatures or too volatile a fuel. Use proper fuel, don't allow the engine to run too hot because of overload or poor adjustment. Put heat dissipating fins on the fuel line.
4. The fuel should be drained from the tank and the carburetor.
5. It traps dust and grit from the air so the air going into the carburetor is clean. Grit in the cylinder can wear it out very quick. There is about 390 cubic feet of air per hour at 24 miles per hour entering the engine.
6. It contains an oil mixed with the gasoline. This is the only means of lubrication since the fuel goes into the crankcase before going into the combustion chamber.

Ref. Purvis, pages 137-151; Briggs and Stratton General Theories, pages 10-19.

Teaching Suggestions: Prepare an engine for storage. Take a dirty air cleaner off and show what it has taken out of the air. Mix some fuel for a 2-cycle engine.

13872

Problem Area: Small Gas Engines

Problem: Valves

Job: Principles

Motivation: Valves in the internal combustion engine are possibly a greater problem than any other part of the engine. They are exposed to extremely high temperature and open 2000 times per minute when the engine is running 4000 RPM.

Study Questions:

1. What is the purpose of the valve?
2. What are the various types of valves?
3. What are the parts of the valve train?
4. What are the two valves found in the engine?
5. What is the greatest problem concerning valves?
6. How is this heat dissipated?
7. What is the operating temperature of the valve face?
8. Why does the temperature differ from the valve and the cylinder?
9. Does air become cooler or warmer with movement?
10. What are some methods of cooling valves that are not used?
11. Why aren't the items in number 10 above used?

Summary of Information:

1. To permit a fuel charge to enter and escape from the combustion chamber.
2. A. Poppet

   B. Rotary

   C. Sleeve

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10.

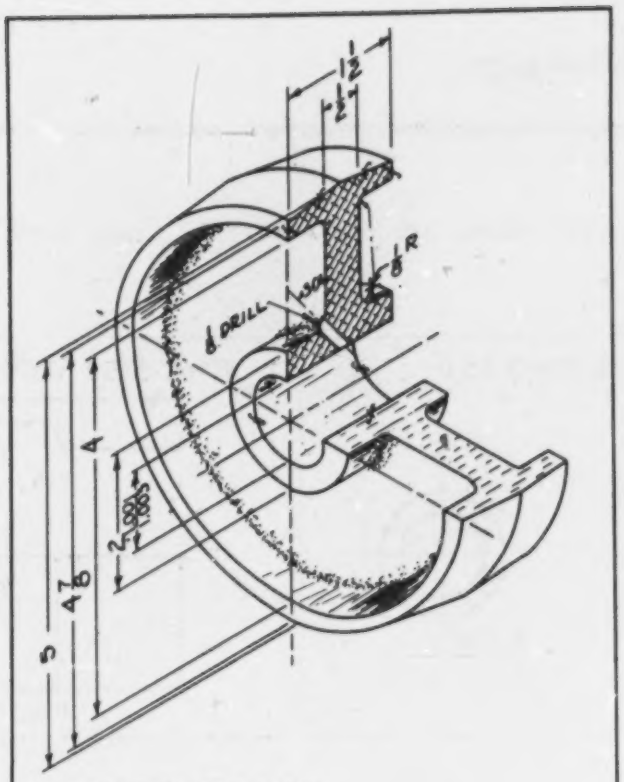

IDLER PULLEY

11.

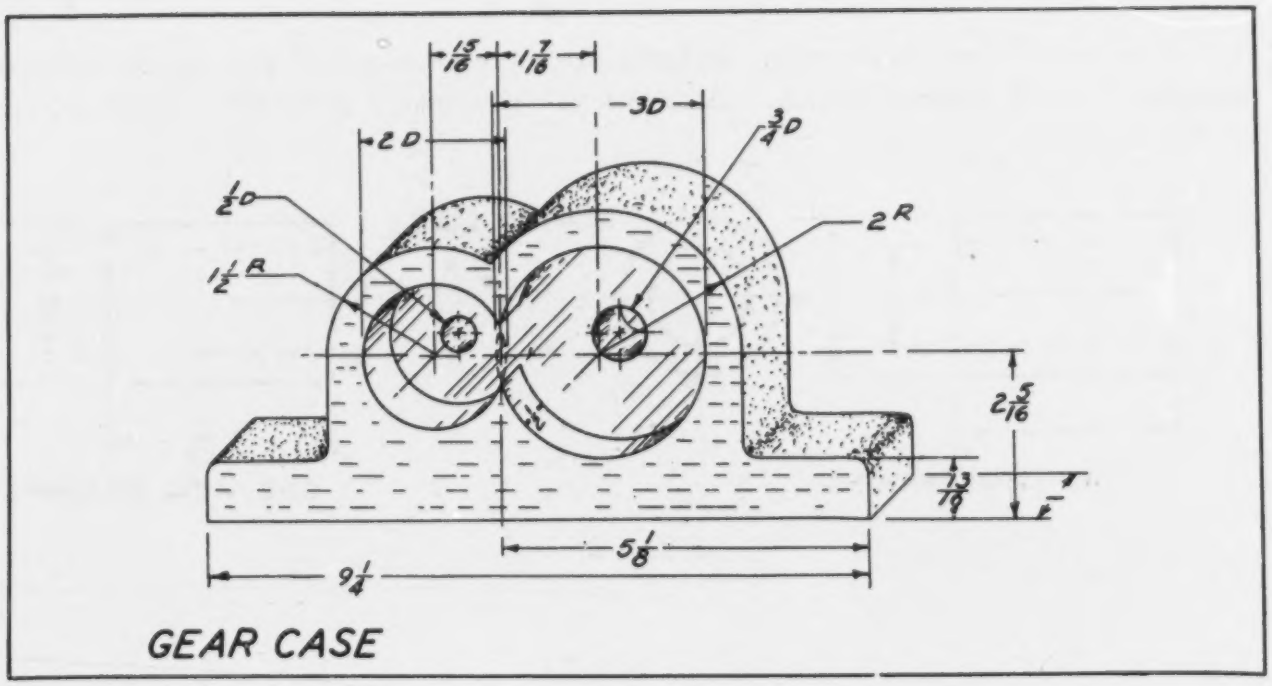

GEAR CASE

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3.

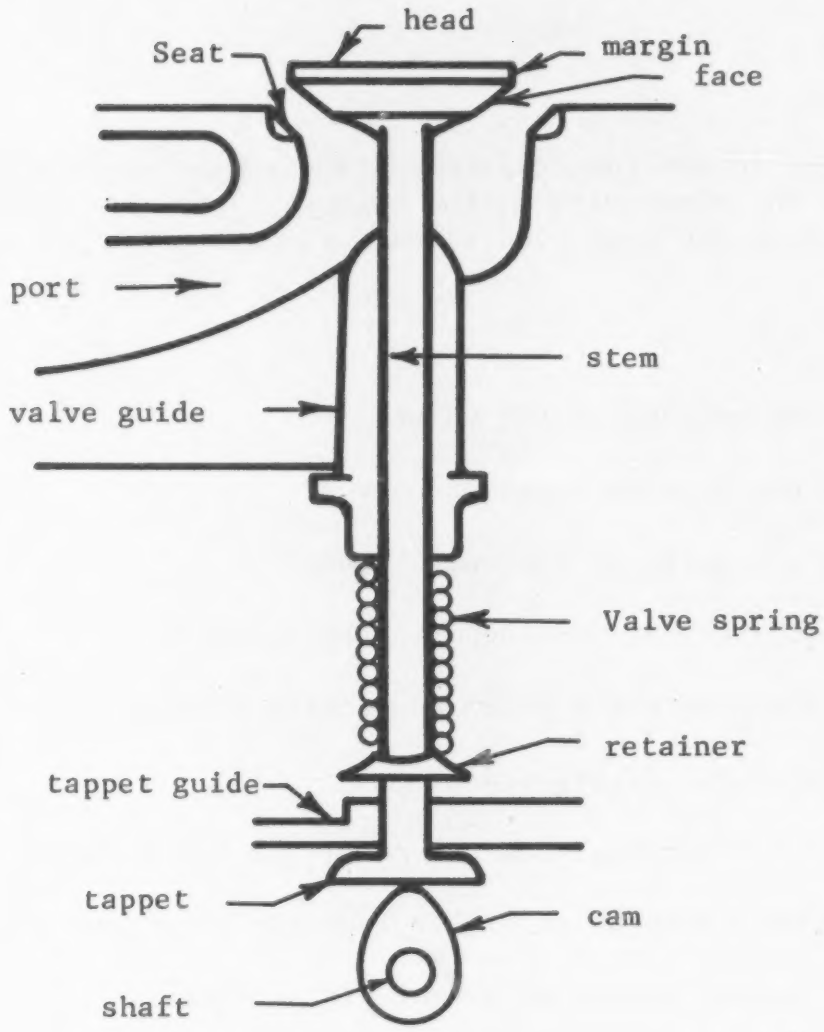

4. A. Intake

   B. Exhaust

5. Many may reach 5000° which is beyond the melting point of iron. Exhaust valves often operate at a red heat.

6. How is this heat dissipated?

   A. Top of intake is cooled by incoming air.

   B. Contact between valve and cylinder and block.

   C. Heat flows from valve head to valve seat. (slight)

   D. Valve stem is hollow and filled with metallic sodium.

   E. Heat is transferred from valve stem to tappet and camshaft assembly.

13874

7. About 1000° to 1200° with the center reaching 1400°.

8. Heat will flow through a solid piece of metal more efficiently than from one piece to another.

9. Temperature of air rises in direct proportion as speed is increased.

10. A. Larger openings in order to slow air speed.

    B. Surface contact between valve stem and block.

    C. Increase weight of valve.

11. A. Limited space in combustion area.

    B. Valves often need replacement and guides may need to be replaced.

    C. Valve speed requires as light a weight as possible

Ref. Purvis, pages 80-95; Briggs and Stratton General Theories, pages 7-10. Briggs and Stratton - Wall Charts.

Teaching Suggestions: Use a large chart showing parts of the valve. Use a cutaway or partly torn down engine. Show some valves and valve seats that are defective in some way.

13875

Problem Area: Small Gas Engines

Problem: Valves

Job: Valves for 2-cycle Engines

Motivation: Do 2-cycle engines have valves? What actually is a valve?

Study Questions:

1. How does the 2-cycle engine differ from the 4-cycle engine?
2. How is the air taken into the cylinder?
3. List the action of the intake leaf valve.
4. How does the exhaust open and close?

Summary of Information:

1. Instead of true valves, the 2-cycle engine uses a check valve system.
2. A. Piston creates a vacuum which draws a charge of air in at atmospheric pressure.

   B. Special blowers, or superchargers are used on the large 2-cycle engines (GM diesel).
3. A. The leaf is open when the piston is compressing the charge in the cylinder.

   B. The leaf is open when plug fires.

   C. The leaf is closed on the power stroke.

   D. The leaf is closed when exhausting burned gases.
4. The piston covers the port to seal any leakage. In the 2-cycle, the piston does all of the work of the valve.

Ref. Purvis, pages 14-15.

Teaching Suggestions: Show students a check valve in a 2-cycle engine. Use chart or mock-up or a 2-cycle engine to explain valve action.

13876

Problem Area: Small Gas Engines

Problem: Valves

Job: Valve Distortion

Motivation: You can imagine the results if a valve is bent. With the valve moving so rapidly, heat can easily build up and cause distortion. How can we prevent this?

Study Questions:

1. What is valve distortion?
2. What is the primary factor causing face and seat distortion?
3. How is the seat affected?
4. How does distortion affect the clearance of the valve?
5. Why is aluminum used for heads and blocks?
6. Why aren't valves made from aluminum?

Summary of Information:

1. A hot spot which causes unequal expansion of the valve which caused improper seating or uneven wear.
2. The rim (margin) is too thin or uneven. A margin of 1/32" is considered minimum.
3. When the valve and seat are cold, they may mate properly but when hot, the valve may "climb off of the seat". B-61, P.84, Purvis.
4. Due to expansion of the stem, the valve may tend to leak when at operating temperatures.
5. Aluminum is a rapid conductor of heat which offers heat dissipation more readily.
6. The melting point of aluminum is low, about 1200°F.
   Note: Demonstrate the heat conductivity of various metals, the rate of expansion and the melting points. Show a cutaway valve and the principles of the valve action in the cutaway engine.

Ref. Purvis, pages 80-86.

Teaching Suggestions: Show a valve and seat that has worn unevenly. Show a proper fitting valve in seat.

13877 13876

Problem Area: Small Gas Engines

Problem: Valves

Job: Lapping and Springs

Motivation: How many have ever done or helped do a valve job on any engine?

Study Questions:

1. What is hand lapping of valves?
2. Why was this method unacceptable?
3. What is concentricity of valve with the seat?
4. Why is the valve spring important?
5. What should be checked on the springs?
6. Why should the above be checked?

Summary of Information:

1. Placing a grinding compound, which was usually an abrasive paste (emery powder and vaseline) on the surface of the valve and oscillating the valve until the valve and seat are mated.

2. Little attention was given to valve seat width, heat dissipation, concentricity of valve with seat, strength of valve spring or wear in the guides.

3. Concentric -- that which has a common center with something else. The valve must have a common center with the seat.

4. The valves are opened by the cam lobe with lightning-like speed and the spring is expected to close just as fast. (1/50th of a second).

5. A. Squareness

   B. Free and compressed length

   C. Pounds of compression

   D. Etching

6. A. If the spring isn't square, it will tend to pull the stem to one side and cause undue wear on the stem and guide.

   B. If spring is too short, it will not properly close the valve.

13878

Problem Area: Small Gas Engines

Problem: Valves

Job: Grinding Valves and Seats

Motivation: How many know how to adjust valves? What is the purpose of grinding valves?

Study Questions:

1. What is the usual tolerance for valve stems?
2. At what angle should the valve seat be ground?
3. At what angle should the valve face be ground?
4. What are the steps in replacing the seat?
5. What tolerance should be maintained between valve and tappet?
6. What adjustments can be made as to valve tolerance?
7. What is the purpose of the camshaft?
8. What are the parts of the camshaft?
9. How is the lobe designed?

Summary of Information:

1. .002-inch with a margin of 1/32-inch.
2. 45 degrees*.
3. 45 degrees*.

Valve Dimension

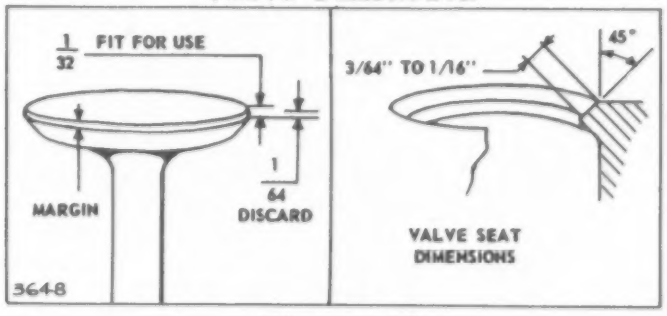

Figure 12
Courtesy of Briggs and Stratton

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4. A. If screw in type, unscrew old seat.

   B. Pull or break out old seat.

   C. Block should be cleaned and free from carbon.

   D. Freeze new seat and fit into position.

   E. Check for proper fit. Maybe it will be necessary to oversize seat.

   F. Peen to secure position.

5. .014 - .016"*.

6. A. Often an adjusting tap is located on the tappet.

   B. If model does not have tap, valve stem must be ground or filed to tolerance. Care should be taken not to remove too much of the stem.

7. To control the action of the valves.

8. Nose, ramp, heel.

9. To open the valves smoothly. The valve is forced open gradually as the tappet starts up the ramp. The valve is in a full open position when tappet is on the nose.

Ref. Purvis pages 80-95.

Teaching Suggestions: Demonstrate adjusting tappet clearance. See demonstration lesson plan on next page. Use engine cutaway to show how camshaft and valves operate.

*The operators manual should be used as engines differ in specifications.

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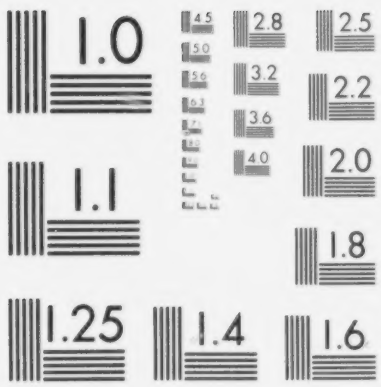

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Problem Area: Small Gas Engines

Problem: Valves

Job: Replacing Valve Guides

Demonstration:

1. Check valve guides with gauge 19122. If flat end goes in more than 5/16 of an inch then bushing is necessary.

2. Use reamer 19064 in drill press, drill only 1/16 inch deeper than the length of the new bushing.

3. Clean all metal cuttings from valve guides.

4. Use bushing driver 19065 to press bushing in until top is flush with valve guide.

5. Finish ream the bushing with reamer 19066.

Ref. Briggs and Stratton Repair Instruction II, page 9.

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UNIT VII - WORKING DRAWINGS

One- and Two-View Drawings Lesson 4

OBJECTIVE: To learn when and how to use one- and two-view drawings.

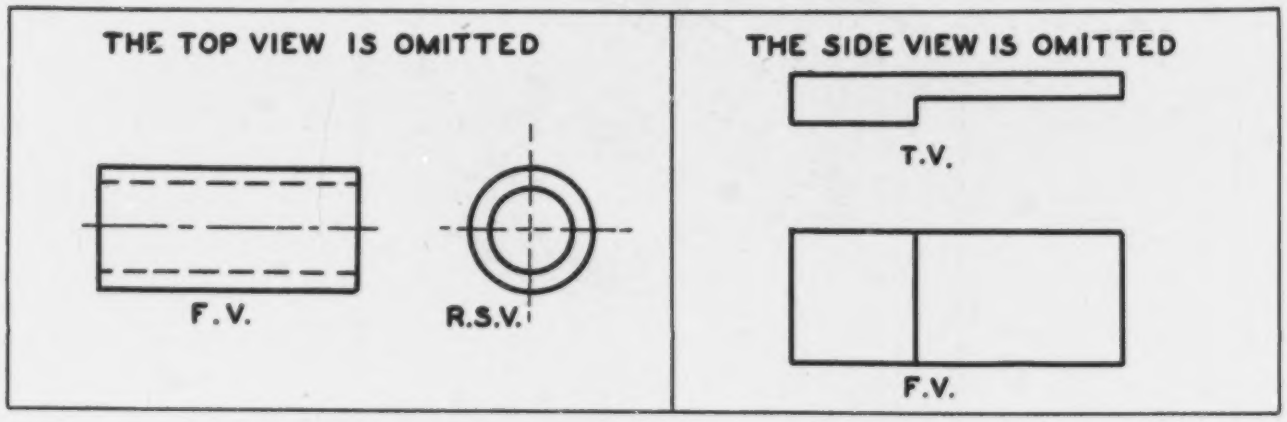

FIG. 1

RELATED INFORMATION:

An object is always drawn with the least number of views that will describe its form and size. Sometimes the number of views can be reduced from three to two, by dropping either the top or side view (Fig. 1). This is done when all features can be read either from the front and side views, or from the front and top views.

For two-view drawings, select views which show the most information and the fewest hidden lines. A front view usually presents most features of the object.

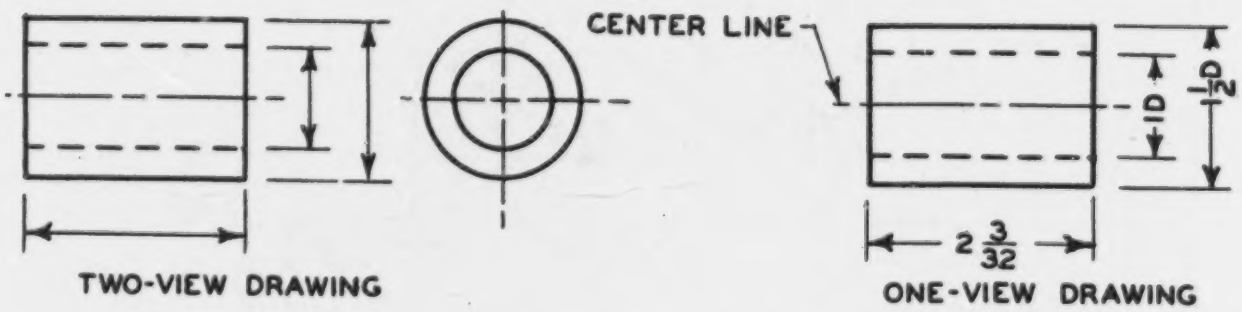

FIG. 2

1385

Problem Area: Small Gas Engines

Problem: Valves

Job: Grinding Valves

Tools and Supplies Needed: Valve spring compressor, screw driver, needle nose pliers, lapping tool, lapping compound, valve grinding machine.

Demonstration:

1. Remove valve spring cover.
2. Set valve spring compressor and compress valve spring.
3. Use pliers to remove pin, or retainer.
4. Pull valve from guide. It is very important that valves be handled so that they are not dropped as they can be easily damaged.
5. Remove valve spring and retainers.
6. Use a wire brush and carbon scraper to remove all carbon from the valve.
7. Check valve for excess wear. If margin is less than 1/64 inch discard.
8. Grind valve face to 45 degrees. Check valve on light cut to determine any warpage or bent valve stem. Check again to see if margin is over 1/64 inch.
9. Clean valve thoroughly with a solvent cleaner to remove any grit.
10. Proceed to problem on cutting valve seats.

Ref. Briggs and Stratton Repair Instruction II, page 8.

Teaching Suggestions: See illustration on page 61.

13883

Problem Area: Small Gas Engines

Problem: Valves

Job: Cutting Valve Seats

Motivation: Why should one cut the valve seats after bushing the valve guides?

Demonstration:

1. Check to be sure that seat is free of carbon and is secured in the block.

2. Insert proper pilot into valve guide.

3. Place cutter on pilot, use proper side (44 degree), see instruction manual.

4. Always check cutter to see that it is set for that particular seat and that the adjustments are tight.

5. Apply wrench and handle, turn 2-3 rounds applying a slight down pressure.

6. Remove cutter and check valve seat. Continue cutting until seat is cut all the way around.

7. Check seat for proper width (3/64 inch to 1/16 inch) if it is to wide turn the cutter over using the 30 degree side to narrow. Cut a slight amount and check width. Care should be taken not to over cut.

8. Take the previously ground valve, apply a small amount of lapping compound and place valve in seat. Then with the lapping tool, lap valve until you are sure valve is making contact all the way around.

9. Use a solvent and clean valve, seat and guide thoroughly.

Ref. Briggs and Stratton Repair Instructions II, page 8.

Teaching Suggestions: See Figure 13 and 14, page 57.

13883
13884

Problem Area: Small Gas Engines

Problem: Valves

Job: Replacing Valve Seats

Demonstration:

1. After cleaning valve seats check for cracks, eroded spots or loose seats. Should you find any of these a valve seat should be replaced.

2. If valve seat is bad use seat insert puller according to manual and remove seat.

3. Select the valve seat insert, correct pilot and drive according to manual.

4. Face seat in same manner as preceeding job "Cutting Valve Seats".

Ref. Briggs and Stratton Repair Instructions II, page 10.

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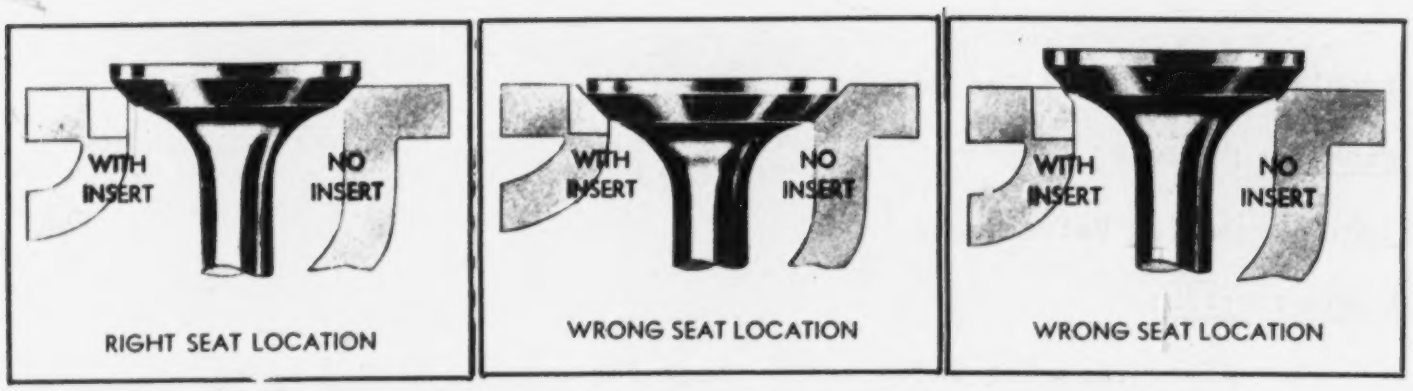

Figure 13
Courtesy Ethyl Corporation

Valve Seat Location

Usually after grinding valve seats the seat is too wide. This can be changed by using either a 30 degree stone or a 60 degree stone for a seat cut at 45 degrees. Narrowing the seat in this manner will many times change the inside or outside diameter of the seat. Thus the location of the seat with the valve face will be changed. To correct this the seat will need to be relocated.

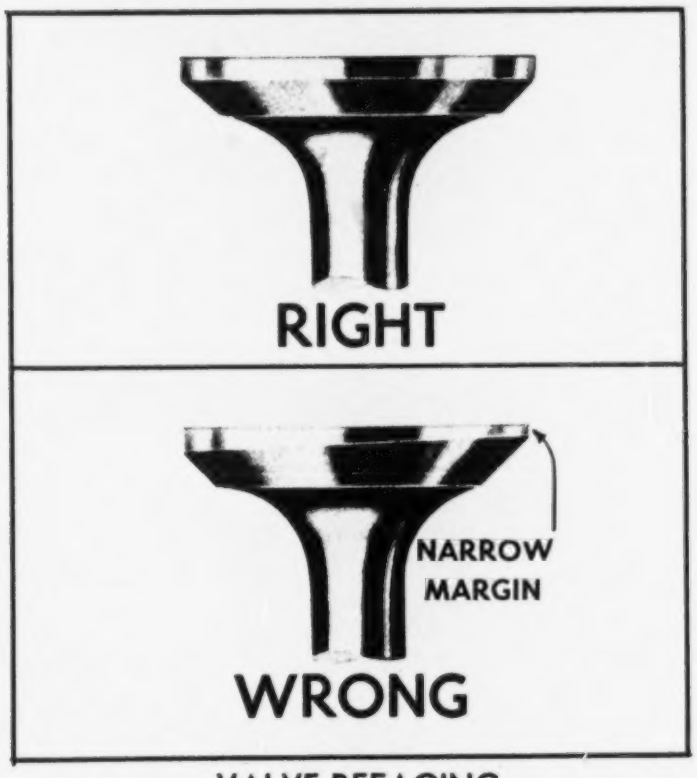

VALVE REFACING

Figure 14
Courtesy Ethyl Corporation

Valve Margin

Valve margin should be checked after they have been ground. If the margin varies over .002 inch it is warped or has a bent stem.

New valves have been found to be damaged in shipment. It is therefore a good policy to grind a new valve.

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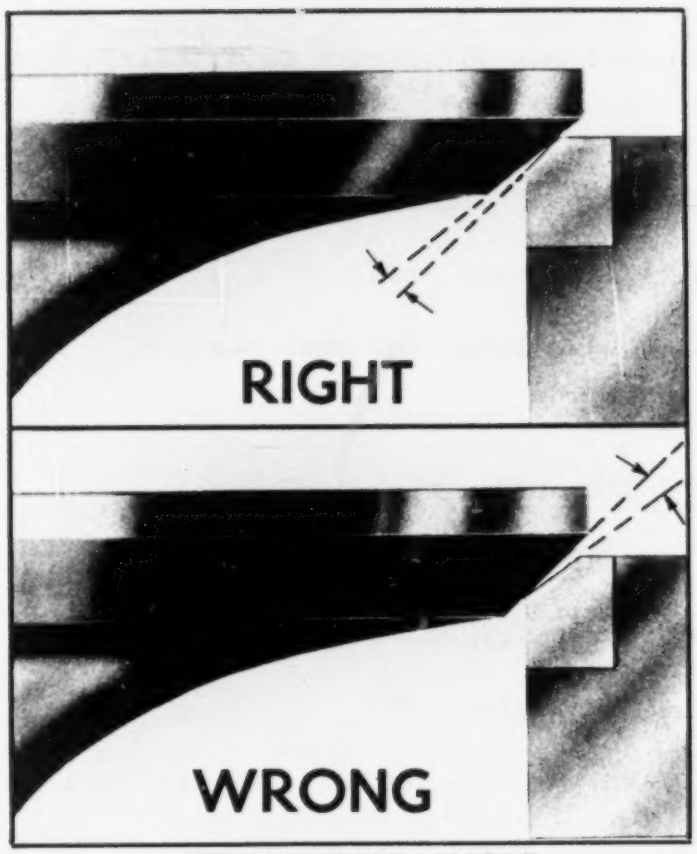

INTERFERENCE ANGLE

Figure 15
Courtesy Ethyl Corporation

Interference Angle

Interference angles is the difference between the angle of the seat and the valve face. This angle is usually between 1/2 and 1 1/2 degrees. It is believed that this technique will provide a line contact between valve face and valve seat. Thus improving valve seating after repair and contributing to longer valve life.

13887

Problem Area: Small Gas Engines

Problem: Lubricating Systems and Lubricants

Motivation: How many have ever heard the statement, "the engine burned up"? Is there really any difference in different brands of oil?

Study Questions:

1. What is the purpose of lubricants?
2. What are lubricants made from?
3. What are the jobs a lubricant must perform?
4. What is meant by "viscosity"?
5. What does the SAE oil number mean?
6. Can the quality of the oil be judged by the SAE number?
7. What are the common weights that are used?
8. What does the "W" designate?
9. What does ML, MM, MS, DG, DM, and DS mean when stamped on the oil can?

Summary of Information:

1. To reduce internal friction in order to (1) obtain more usable horsepower and (2) to reduce operating temperatures.
2. They are made from the same crude oil from which we obtain gasoline. Often they contain animal fats, vegetable oils, and other ingredients such as silicones.
3. A. To reduce friction between moving parts.
   1. reduce heat that would be generated.
   2. conserve power.

   B. Act as a seal to prevent leakage.

   C. Carry away heat.

   D. Wash away abrasive metal.
4. The resistance to flow or adhesiveness characteristics of an oil.

13888

5. Various weights of oil are assigned a number by the society of automotive engineers. The lower the number the lighter the oil.

6. No. Only the weight.

7. Summer - 30 weight.

   Winter - 10 weight.

8. The "W" indicates that the oil has the ability to remain fluid at a lower temperature. IOW-30 means the oil is 30 weight yet will flow at the same temperature as 10 weight.

9. ML, MM and MS are designations for gasoline engine service.
   ML - light service, MM - moderate service, MS - severe service.
   DG, DM and DS are designations for diesel engine service.
   DG - general, DM - moderately severe, DS - very severe.

Ref. Purvis pp. 101-102; Standard Oil FT-53 Farm Tractors, pp. 66-80.

Teaching Suggestions: Use old oil cans and discuss labeling.

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Problem Area: Small Gas Engines

Problem: Lubricating Systems and Lubricants

Job: Oil Selection

Motivation: How can there be any difference in oil? What is the difference in the origin of oil and grease? Show the difference in the way different oils pour.

Study Questions:

1. What factors are considered in recommending weights of oils?
2. What weight might be used in a new engine?
3. What weight might be used in an old engine?
4. What is a general rule that should be followed?
5. What are the advantages of a light oil?
6. What are the disadvantages of a light oil?
7. What are the three factors with which oil must contend?

Summary of Information:

1. A. Existing temperatures.
   B. Engine clearance.
2. A. Summer - 20 weight.
   B. Winter - 5-10 weight.
3. A. Summer - 30 weight.
   B. Winter - 20 weight.
4. Use the lightest weight that can be used safely.
5. A. Allows easier starting.
   B. Attains circulation faster.
6. It may not maintain a film of protection between moving parts.

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7. A. Heat; head often reaching 1000° to 1200°.

   B. Speed; up to 6000 - 7000 RPM's.

   C. Pressure; as the piston travels up, it pushes against the cylinder wall.

Ref. Purvis pp. 102-103, Standard Oil FT-53 Farm Tractors pp. 66-80.

Teaching Suggestions: Use chart relating to oil selection.

13891

13835

Problem Area: Small Gas Engines

Problem: Lubricating Systems and Lubricants

Job: Lubrication Methods

Motivation: Would it be possible to have all engine parts submerged in oil? If not how can oil get to all working parts?

Study Questions:

1. What are the two types of lubrication?
2. Which of these is most common on small engines?
3. How does the spash method work?
4. How is the upper cylinder lubricated in a 2-cycle engine?
5. How does the pump operate?
6. How many pounds of pressure does the pump operate?
7. What is the advantage of each system?

Summary of Information:

1. A. Splash.

   B. Pump.

2. The splash method is most common but both may be used.
3. By employment of a cup which is attached to the cap of the connecting rod. This dips into the oil with each revolution in order to lubricate the journal. Also this splashes oil over other moving parts. (Show splash cup)
4. Oil is mixed with the gasoline (1:16) and when injected into the combustion chamber, it will cling to the walls.
5. The pump supplies oil under pressure to all moving parts of the engine. This assures a continuous oil supply.
6. Depending on the size of the engine. Small engines operate at from 4-6# while truck engines may run at 45-60#.
7. A. Splash: fewer parts, less maintenance.

   B. Pump: assured lubrication; lubricates all parts regularly.

Ref. Purvis 103. Standard Oil FT-53 Farm Tractors pp. 66-80.

Teaching Suggestions: Use an oil pump for observation.

13892

Some objects, such as cylinders, have all cross sections of the same shape. These can be shown in one-view drawings.

As Fig. 2 indicates, one-view drawings differ from two-view drawings by omission of the end or side view and the substitution of a notation to indicate the cross-sectional shape. Single-view drawings are usually made for objects whose cross sections are rectangular, square, hexagonal, octagonal, or round.

QUESTIONS:

1. Name two cross-sectional forms that are adaptable to one-view drawings.

2. How does a one-view drawing differ from a two-view?

3. What advantages arise from using fewer views of an object?

4. Who makes the decision as to the number of views to be used?

5. In making a two-view drawing, which views should be selected?

Problem Area: Small Gas Engines

Problem: Lubricating Systems and Lubricants

Job: Accessories.

Motivation: Why is it important to make sure that the air is filtered before it enters the carburetor? What other parts or precautions are taken to make sure dirt does not enter the working parts of the engine? Show a dirty air filter. And bring the point, what would happen if all this dirt was in the cylinder and carburetor.

Study Questions:

1. List two of the accessories found on a 4-cycle engine.
2. Why is it necessary to have an air cleaner?
3. What are two types of air cleaners?
4. How often should the oil bath cleaner be serviced?
5. How should they be cleaned?
6. How does the oil-bath cleaner operate?
7. What is the function of the gasoline strainer?
8. How often should the strainer be checked?

Summary of Information:

1. A. Air cleaner.

   B. Gasoline strainer.

2. The engine burns 16-17 parts of air to 1 part of gasoline by weight. This means that 8000 gallons of air is burned to every gallon of gasoline.

3. A. Oil bath type.

   B. Dry type.

4. In dirty conditions, every day (10) hours.

5. By washing with gasoline. Breather caps should never be burned as this leaves carbon in the cap.

6. Air is drawn through the oil and then filtered.

13834

13893

7. To prevent sediment, dirt and water from entering the carburetor.

8. Every day (10 hours).

Ref. Purvis, page 149; Standard Oil FT-53 Farm Tractors, pages 32-55.

Teaching Suggestions: Demonstrate servicing an air cleaner of each type. Demonstrate servicing a gasoline filter. Demonstrate cleaning a breather cap. Use large diagram to illustrate air cleaner.

13894

13893

Problem Area: Small Gas Engines

Problem: Cooling System

Job: Principles of Air Cooled Engines

Motivation: What difference is there in the appearance of an air cooled and a water cooled engine? What difference does this make in the way you would want to operate them?

Study Questions:

1. At what temperature should an engine be used?
2. What percentage of the heat energy is used?
3. How is the heat dissipated in an air cooled engine?
4. Why is aluminum used in air-cooled engines?
5. What is the function of the fins on the head?
6. Why should the head be kept clean?
7. What precaution should be used on water cooled engines?
8. Why will lime deposits retard cooling?
9. What occurs when lime or rust accumulates in the engine?
10. What is the danger of adding water to a hot engine?

Summary of Information:

1. The jacket should be about 200°.
2. 33% is used for power, 33% is unused and 33% is handled by the cooling system.
3. The heat is transferred to the extremities of the engine.
4. Because of its rapid heat conductivity.
5. To increase the surface area of the engine.
6. To permit rapid air exchange.
7. Always make sure the water is clean and free from mineral deposits.

13895

8. Both lime and rust are poor heat conductors.

9. It causes hot spots and may cause distortion of engine parts.

10. It causes rapid and uneven cooling which may crack the head or block.

Ref. Purvis, pages 97-101.

Teaching Suggestions: Have students examine the case of an air cooled engine. Have them figure a problem to determine the increase in surface area gained by using fins.

13896

Problem Area: Small Gas Engines

Problem: Repair

Job: Checking Piston and Cylinder Tolerance

Motivation: Poor fitting parts allow excessive oil consumption and loss of horsepower. Air cleaners play a very important role in maintaining engine life.

Study Questions:

1. What is the first step prior to the removal of the piston?
2. What precautions should be taken when removing the piston?
3. How do you check tolerance on pistons?
4. Where does the cylinder wear most?
5. How do you determine clearance?
6. What should the skirt clearance measure?

Summary of Information:

1. Carbon should be removed from the top of the cylinder. In some engines it will be necessary to remove a ridge above the piston before removing the piston.
2. A. Do not drive on any part if parts are to be re-used.
   B. Mark piston, rod, and cap for reuse.
   C. Inspect all parts of damage and measure for wear.
3. A. Measure skirt clearance.
   B. Measure top land clearance.
   C. Measure cylinder wall from top to bottom.
   D. Check to see that all carbon is removed from ring grooves.
4. On the thrust side (when the piston is pushing against compression).

13897

5. Cylinder diameter - 2.3755
   -Skirt diameter - 2.3695
   Skirt clearance - .0060

6. This will vary from make to make. Always check operators manual.

Ref. Clinton Engines or Small Engines Service Manual; Purvis, pages 59-80.

Teaching Suggestions: Have students study the parts of the piston on the following two pages.

13898

A. Land
That part of the piston above the top ring or between ring grooves.

B. Compression Distance
The distance from the center of the pin hole to the top of the piston.

C. Piston Head
The top piston surface against which the combustion gases exert pressure.

D. Piston Pin
Connections between the upper end of the connecting rod and the piston.

E. Skirt
That part of the piston located between the first ring groove above the pin hole, and the bottom of the piston.

F. Pin Hole
An opening through the piston skirt to carry the piston pin.

G. Piston Pin Bushing
A bushing fitted between piston pin and piston pin hole to obtain a better bearing material.

H. Oil Ring Groove
A groove cut into the piston around its circumference, at the bottom of the ring belt or at the lower end of the piston skirt.

J. Groove Root Diameter
Diameter of the piston measured at the bottom of the groove.

K. Land Diameter
Diameter of the land being measured.

L. Land Clearance
The difference between the diameter of the land and cylinder diameter.

M. Skirt Clearance
The difference between piston skirt diameter and cylinder diameter. (M shows ½ the total clearance)

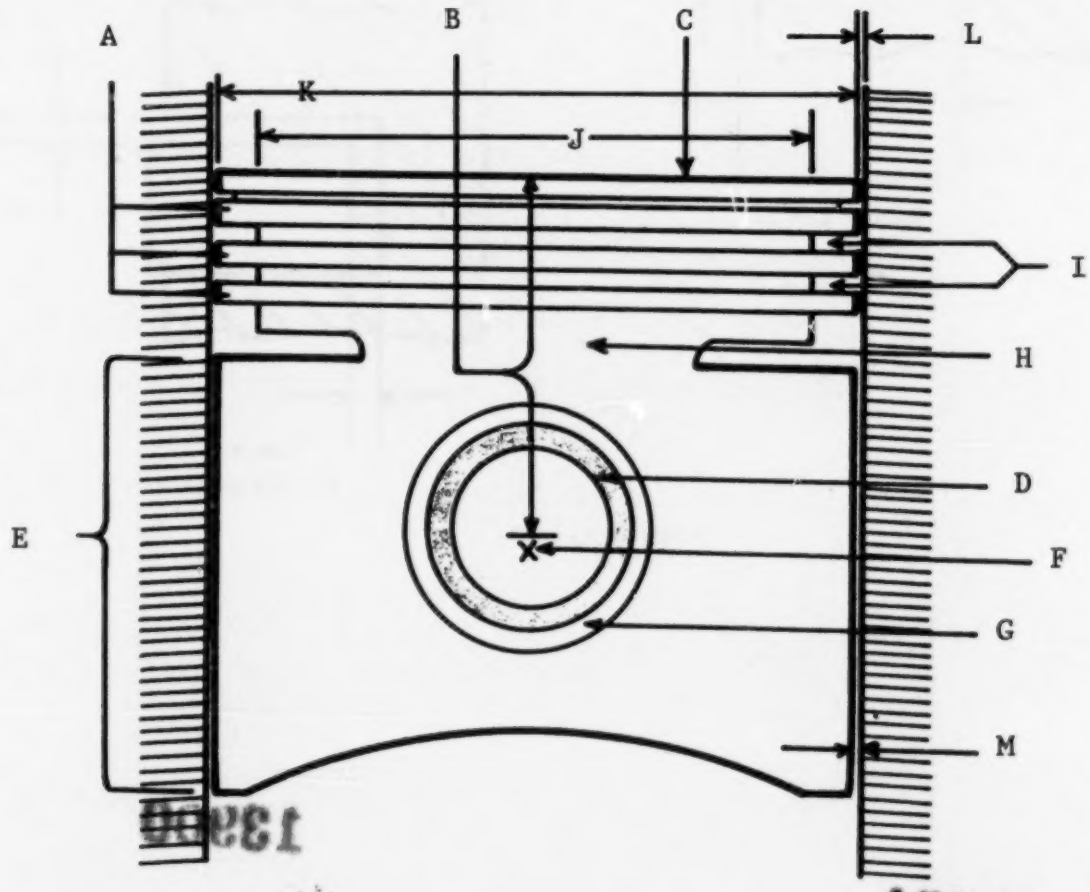

Figure 16

13899

Ring Width

The distance from top to bottom of the ring measured in fractions of an inch. See illustration below.

Side Clearance

Axial or "up and down" clearance between the side of the ring and the ring groove. See illustration below.

Back Clearance

Clearance between the back side of the ring and the bottom of the ring groove when both piston and ring are centered in the cylinder. See illustration below.

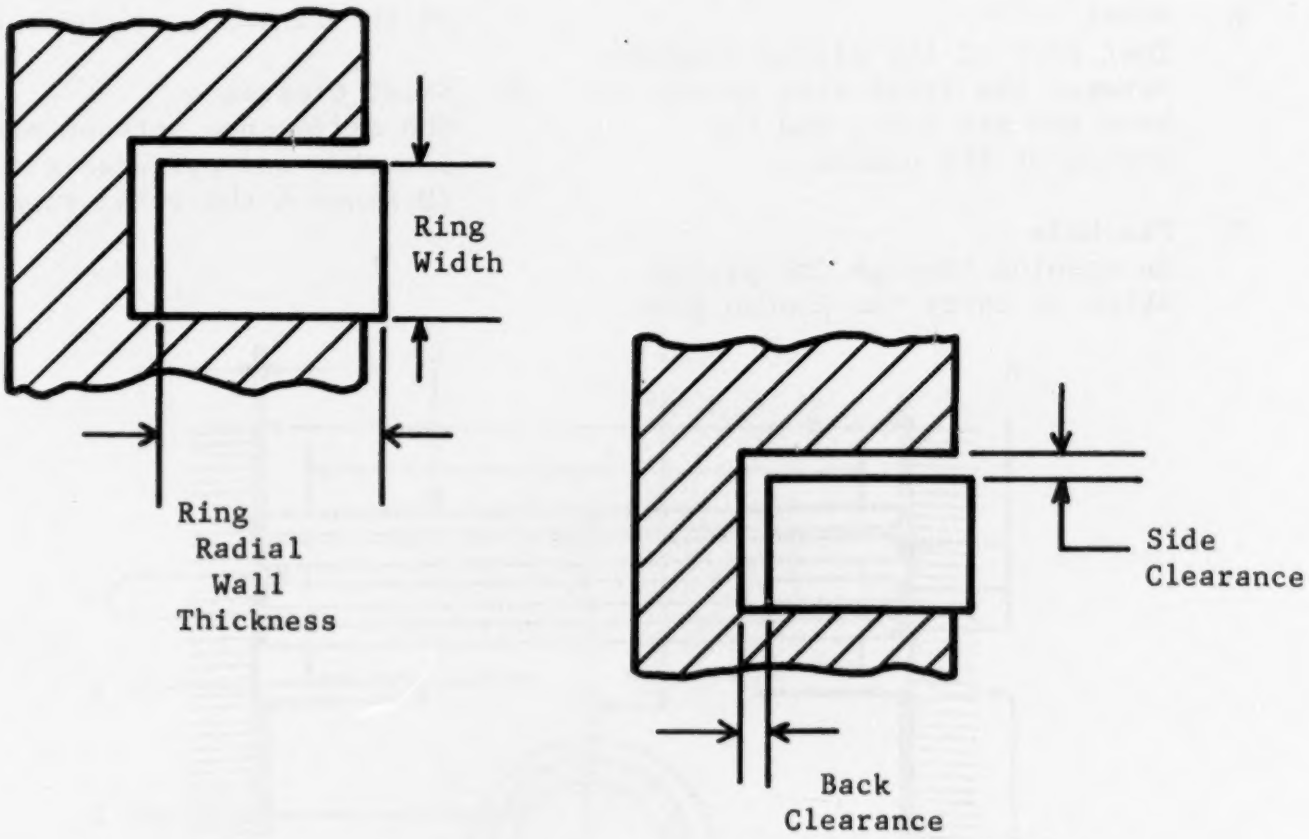

Figure 17

13900

Problem Area: Small Gas Engines

Problem: Repair

Job: Honing and Deglazing Cylinders

Motivation: How does cylinder wear take place? What's wrong if the engine still uses oil after installing new rings?

Study Questions:

1. What is the purpose of "deglazing" cylinders?
2. What grit stone should be used?
3. What precaution must be taken when honing?
4. Should oil be used in the honing operation?
5. How often should the cylinder be checked?
6. What tool is used to remove large amounts from the cylinder?
7. What should be used to clean the cylinder after honing is completed?
8. Why should solvent or gasoline not be used?

Summary of Information:

1. A. To remove the vertical marks in the cylinder.

   B. To straighten the cylinder from top to bottom.

   C. To correct a small amount of out of round.

   D. To remove any foreign materials.

   E. To cross-hatch and enable cracks to be seen.

2. 150 grit - 240 grit.
3. Always start hone in the narrowest point of the cylinder (usually the crankcase end).
4. Only on "wet stones". Oil should not be used on the "dry-stone" type.
5. After every few seconds when near the desired measurement.

13901

6. A boring bar should be used to remove large amounts.

7. A. Hot soapy water.

   B. Rag soaked in cylinder oil.

8. It will remove the oil from the cylinder and leave the metal chips and foreign material in the cylinder.

Ref. Purvis, pages 127-131; Briggs and Stratton Repair Instructions II, page 41.

Teaching Suggestions: Demonstration next page.

13901

13902

ASSIGNMENT:

From the pictorial drawings shown below, draw a front and top view. Dimension fully.

1.

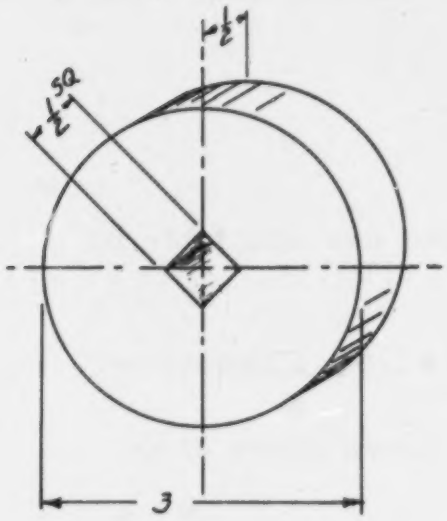

GEAR BLANK A-6B

2.

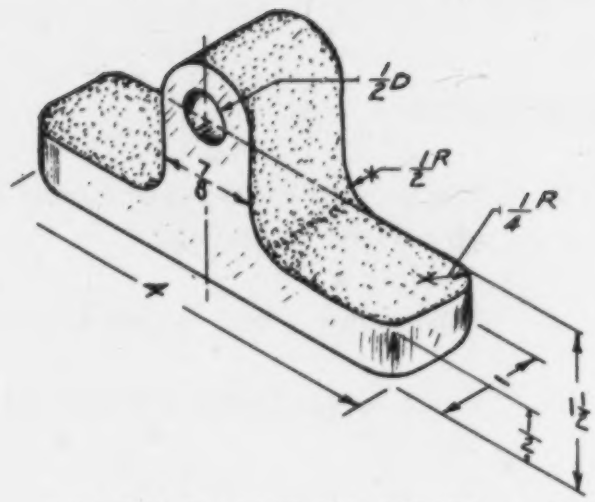

PINION SHAFT BEARING A-6C

From the pictorial drawing shown below, draw a front and right-side view.

3.

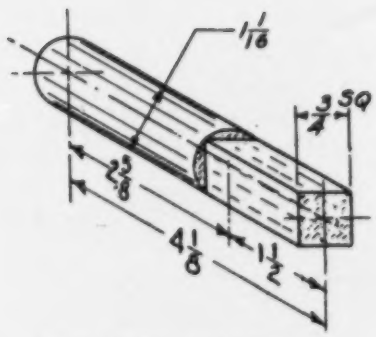

PINION SHAFT B-8B

4.

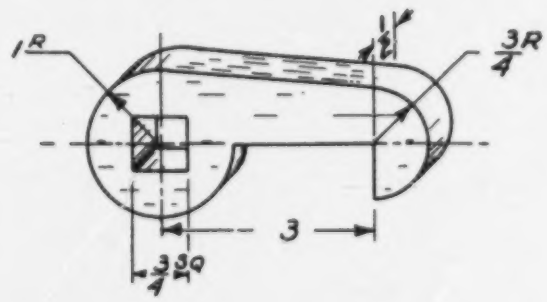

SHAFT STOP B-8C

Problem Area: Small Gas Engines

Problem: Repair

Job: Honing and Deglazing Cylinders

Demonstration:

Materials needed: micrometer, cylinder hone, honing oil, drill press, metal jig (see drawing next page on cylinder holder) and a level.

Procedure:

1. Thoroughly clean the cylinder to be honed.

2. Secure cylinder to jig and make sure it is level (See Figure 18).

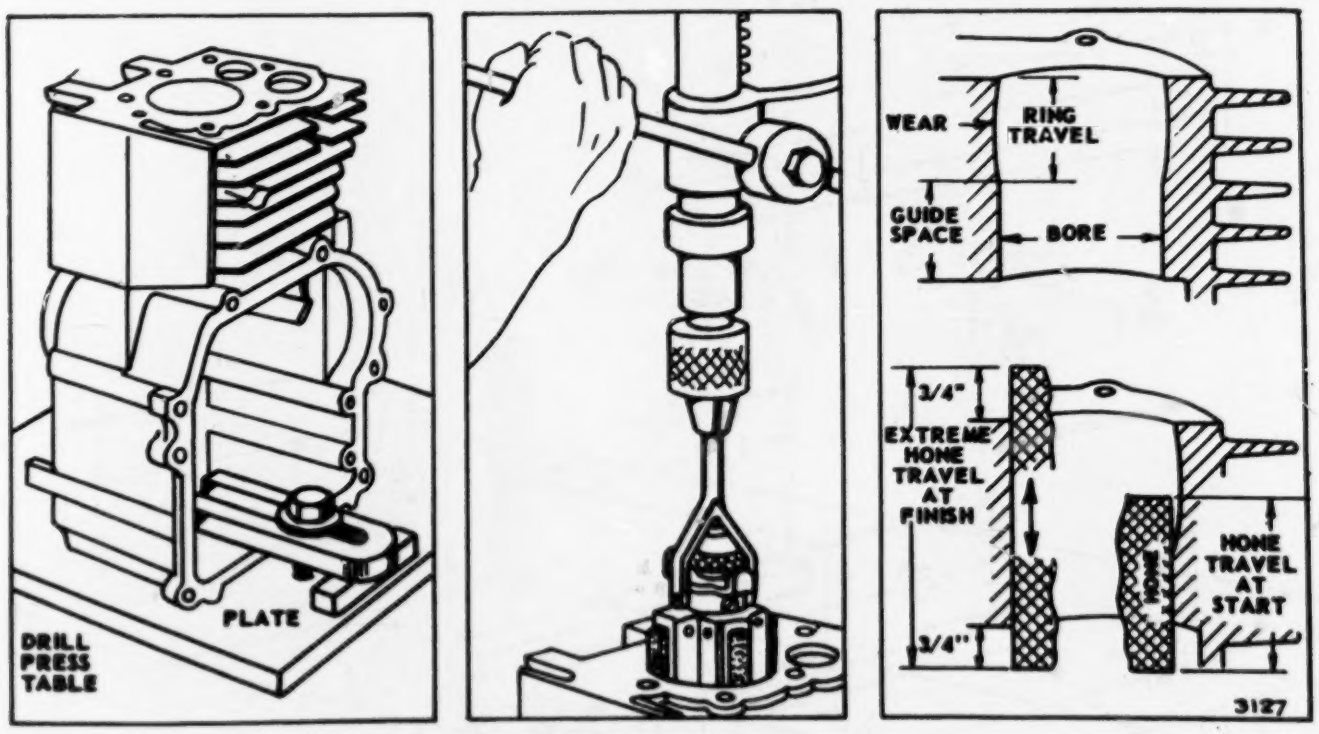

Figure 18
Courtesy Briggs and Stratton

3. Oil surface of drill press table, then set block and jig on table. Be sure the block is free to move so the hone will stay in alignment.

4. Determine what oversize the cylinder is to be honed. Glaze can be removed in the same manner except that it requires a lot less time.

5. Set drill to operate between 300 and 700 R.P.M.

13904

13903

BRIGGS & STRATTON CORP.

CYLINDER HOLDER

FOR RESIZING 6, 8, AND 14 CU. IN. ALUMINUM ALLOY CYLINDERS

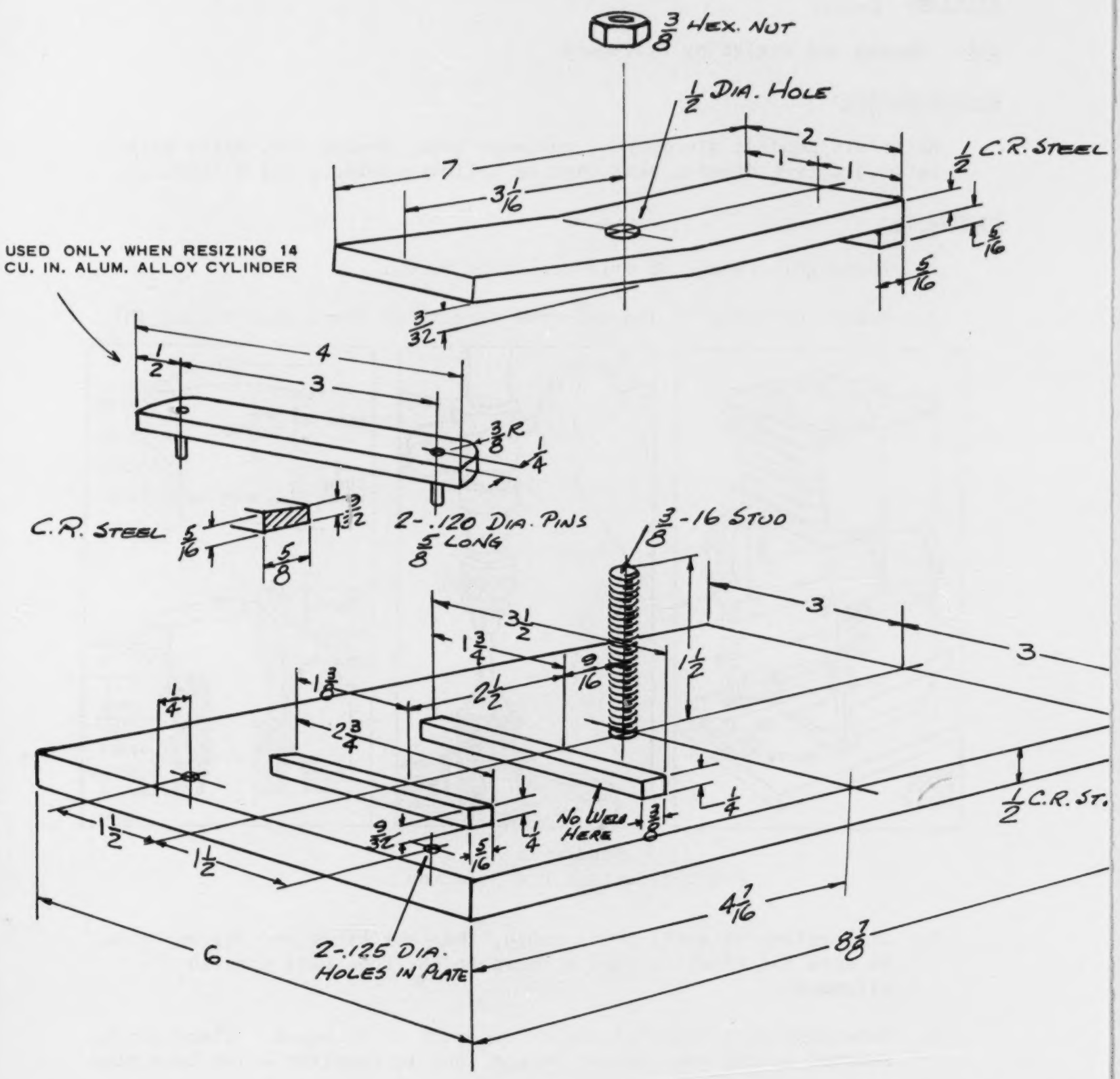

Figure 19

13904

6. Set hone in cylinder and set drill stops so that hone will not extend over 3/4-inch from top or bottom. See Figure 18 on page 74.

7. Place hone in middle of bore and tighten until stone fits snugly. Start drill at bottom and hone (adding oil to lubricate hone) from bottom and finishing at top. Change from rough to finishing hone when within .0015-inch. To give cross-hatch pattern move the hone from top to bottom rapidly for the last few seconds (See Figure 20).

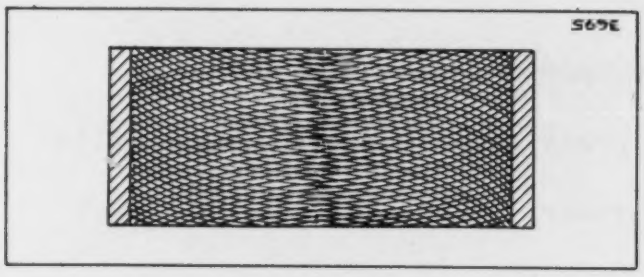

Figure 20
Courtesy Briggs and Stratton

8. Check cylinder size frequently.

9. Clean the cylinder with solvent, and then wash with soap and water. Emphasize removing all of the grit and metal cutting that are embedded in the cylinder wall.

10. Check cylinder bore with ring, measuring the ring gap after the block has had time to cool. It is usually desirable to hone .0005-inch larger than the desired reading because the cylinder wall will shrink as it cools.

Ref. Briggs and Stratton Repair Instruction II, page 41.

13905

Problem Area: Small Gas Engines

Problem: Repair

Job: Installation of Rings

Motivation: What happens when you buy a set of 40 thousandths oversize rings for an engine. You have to get these particular rings from Chicago. Then by improper methods of installation you break one ring.

Study Questions:

1. What is the purpose of rings?

2. Do the rings press against the cylinder walls?

3. What is the primary problem in piston rings?

4. What is ring blow-by?

5. When is blow-by the greatest problem?

6. What are the functions of each of the rings?

7. Show the typical piston ring installation.

Summary of Information

1. A. To prevent loss of compression.

   B. To control the loss of oil.

2. Yes, about 8-12 pounds of pressure.

3. That pistons, rings, and cylinders warp at operating temperatures.

4. The compression and explosion pressure can go past the ring.

5. When the cylinder is out-of-round.

6. A. Compression ring; usually a plain ring, rectangular in cross-section or with a groove cut in the inner top corner (Figure B-42 p. 71, Purvis).

   B. Compression ring; usually a plain ring and may also be used to control oil.

   C. Oil rings; used to control the loss of oil and may be in several shapes and designs. (Figure B-44, p. 72, Purvis)

13906

7. See illustration below (Figure 21)

   A. Full face contact - pressure over a large area.

   B. Narrow contact surface - high pressure on the area. Seats quickly.

   C. Two narrow contacts, scrape oil from cylinder wall. These may be in combination.

Ref. Purvis, pages 63-78.

Teaching Suggestions: Demonstrate proper technique.

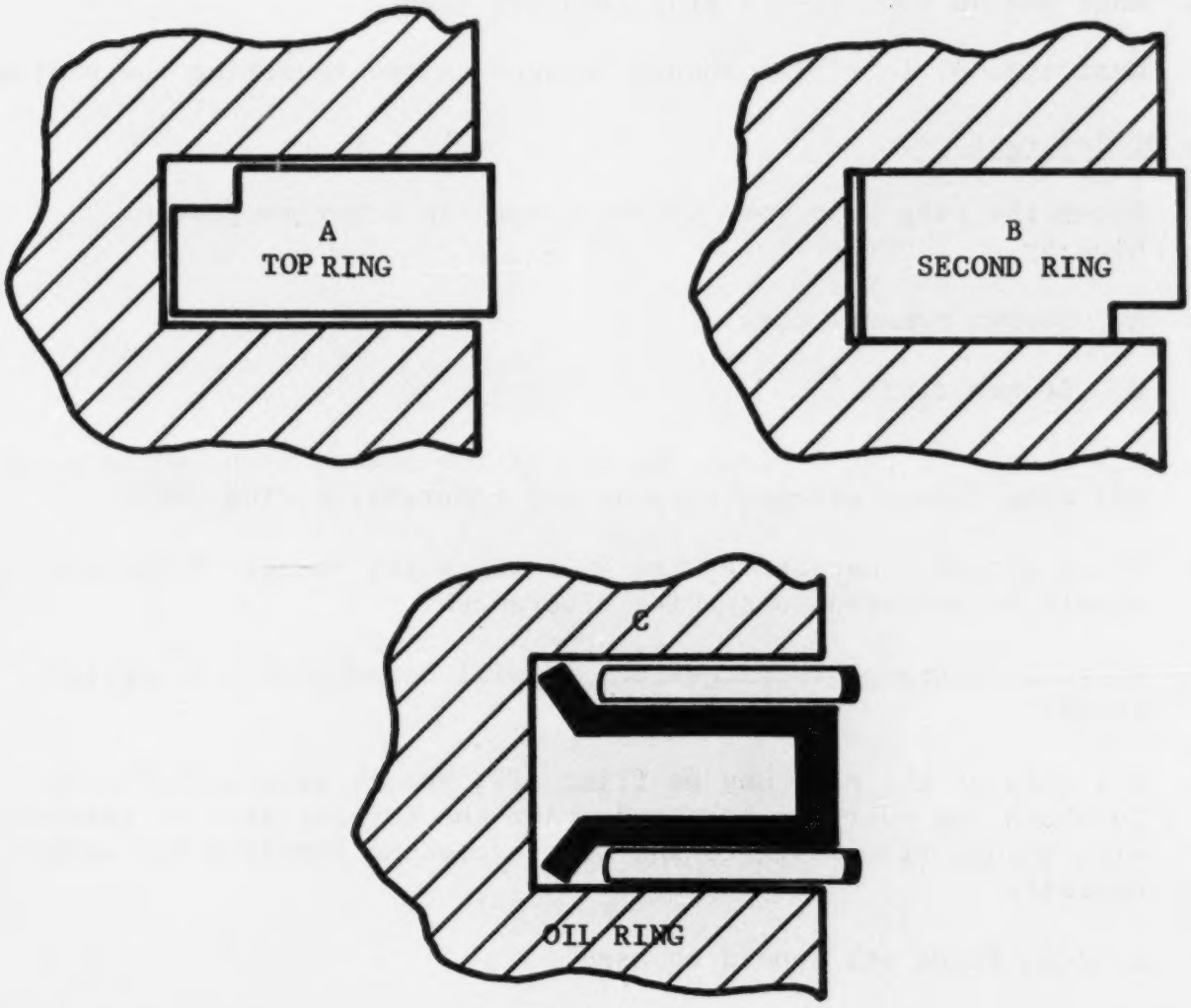

Figure 21

13907

Problem Area: Small Gas Engines

Problem: Repair

Job: Installation of Rings

Study Questions:

1. Why must the ring groove be clean?
2. How can you clean the ring grooves?
3. In what order should the rings be put on the piston?
4. What is the next step in installing rings?
5. When should rings be replaced?
6. What can be done if the ring fits too tight?
7. What type of lubricant should be used before inserting the piston?

Summary of Information:

1. Often the ring must work in the groove in order to prevent blow-by.
2. A. Carbon removal tool.

   B. Broken ring.
3. All should be put on from the top of the piston down, which means oil ring first, scraper second, and compression ring last.
4. Check groove clearance by use of a thickness gauge. Tolerance should be compared to service clearances.
5. If ring clearance is excessive, it will be necessary to replace rings.
6. The ends of the ring may be filed off, but it is usually better to check the cylinder bore and order the correct size or replace with chrome ring designed for wear exceeding standard but under oversize.
7. A clean light oil should be used.

Ref. Purvis, pages 63-78.

Teaching Suggestions: See demonstration plan on page 83.

13908

Problem Area: Small Gas Engines

Problem: Repair

Job: Checking and Correcting Crankshaft End Play

Demonstration:

1. Fasten a dial indicator on sump so that indicator touches the crankshaft. Turn crankshaft a number of times if indicator shows more than .002 discard crankshaft. The crankshaft may also be checked by placing it between centers on a lathe and mount dial indicator in tool post.

2. Check all points of the crankshaft for wear with a micrometer. Check manual for discard sizes.

3. Reassemble crankshaft into sump and block.

4. Check crankshaft end play with a dial indicator. End play should range from .002 to .008.

5. Follow procedure on page 53 of Briggs and Stratton Repair Instructions II, if end play is beyond these limits.

Ref. Briggs and Stratton Repair Instructions II, page 53.

13909

13910

Problem Area: Small Gas Engines

Problem: Repair

Job: Replacing Main Bearings

Demonstration:

1. Drive out old bushing with bushing driver 19124 and support 19123. If there is no bushing then ream cast as follows:

   A. Place pilot in opposite bearing.

   B. Assemble sump to block.

   C. Guide bushing should be placed in oil seal slot on side.

   D. Assemble 19099 reamer on pilot 19096.

   E. Place pilot through guide bushing pilot on opposite side and begin to ream in a clockwise motion with steady pressure until reamer goes all the way through. Do not back the reamer out. To remove reamer separate sump from block. Ream dry.

   F. Clean parts with solvent.

2. Stake mark in hole with chisel.

3. Insert bushing with driver. Use crankcase support, make sure oil holes are aligned, drive bushing in until flush.

4. With a blunt chisel drive a portion of the bushing into the notch previously made in 2 above.

5. Ream with finish reamer 19095 same as in (1e) except that a lubricant should be used.

6. Replace oil seal.

Ref. Briggs and Stratton Repair Instruction II, page 55-60.

Teaching Suggestions: See page 82 for cylinder vise support.

C0CC1

13910

Briggs & Stratton Engine

SMALL ALUMINUM CYLINDER VISE SUPPORT

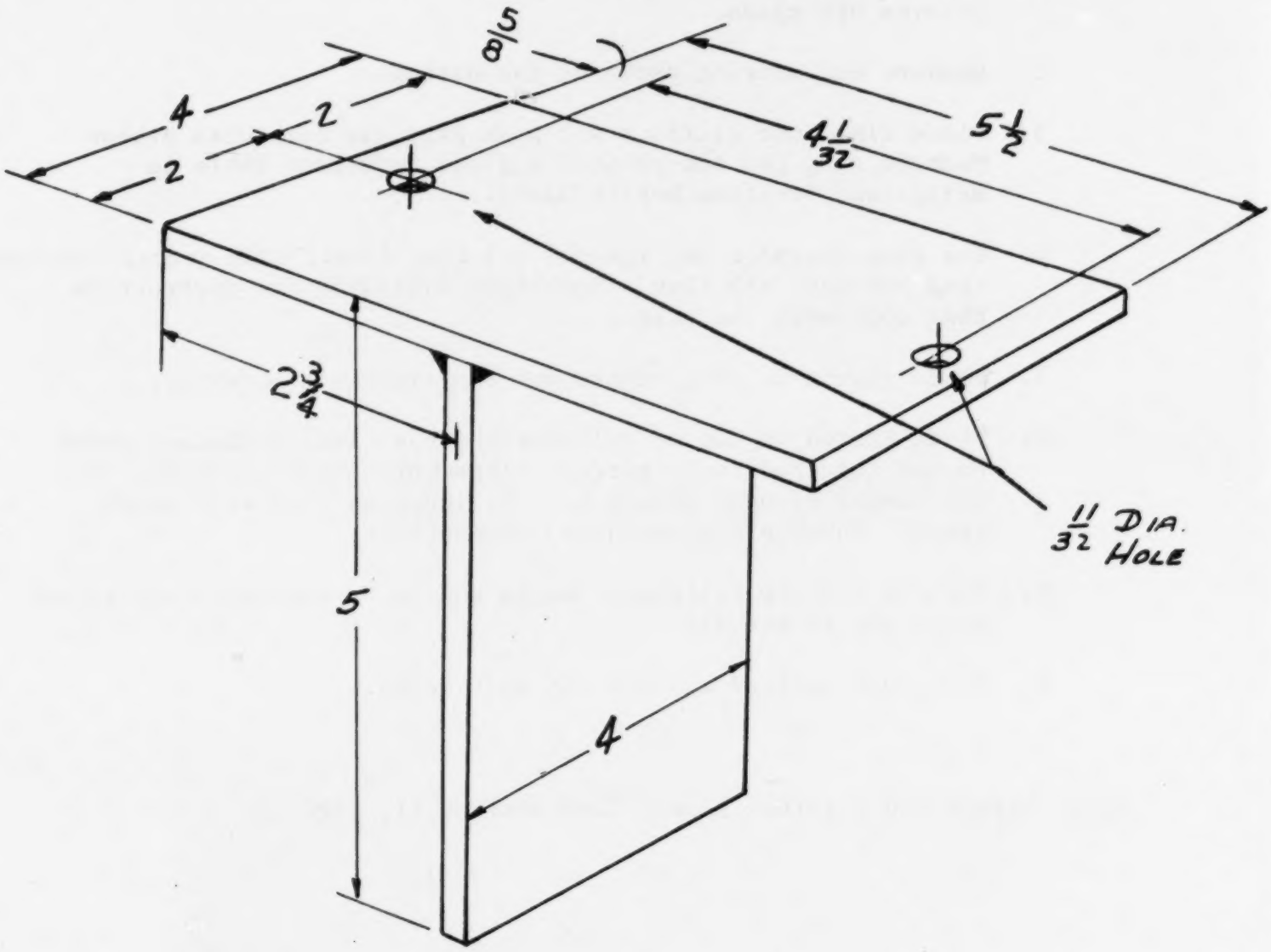

Make From 1/4" Steel Plate (Welded)

Figure 22

13911

steel

Problem Area: Small Gas Engines

Problem: Repair

Job: Installing Rings and Pistons

Demonstration:

1. Inspect piston to be sure that oil holes are open and that ring grooves are clean.

2. Measure all wearing parts of the pistons.

3. Place ring into cylinder and push part way down with piston. Measure ring gap and compare against rejection table in Briggs and Stratton Repair Manual.

4. Use ring expander and install oil ring first, then center compression ring and then top ring. Emphasize following the instruction that come with the rings.

5. Place piston in ring compressor and tighten compressor.

6. Place piston on top of cylinder and push into cylinder. Check to see that rod is in correct alignment with crankshaft. Do not hammer or beat piston into cylinder as this will break rings. Thumb pressure should be adequate.

8. Install rod cap (alignment marks should be observed) and torque according to manual.

9. Bend locking lugs against rod bolt heads.

Ref. Briggs and Stratton Repair Instructions II, page 45.

13912

UNIT VII - WORKING DRAWINGS

Sketching Pictorials — Lesson 5

OBJECTIVE: To practice visualization by sketching freehand pictorials.

RELATED INFORMATION:

A draftsman is never adequately equipped without the ability to sketch pictorially. Before he can produce any working or orthographic drawings, he must be able to visualize the shape of an object. Every idea in the design or invention of a piece of machinery comes into the mind in pictorial form; preliminary sketches made in this form preserve the idea as visualized.

A pictorial drawing is often required if the orthographic drawing is difficult to read. Learning to sketch pictorially early in training not only gives you the opportunity to apply this knowledge when employed as a draftsman, but will also prove conclusively that you can visualize the orthographic drawing. Pictorial sketches need not be artistically executed, but should be drawn proportionally correct.

QUESTIONS:

1. Why learn to sketch pictorially?
2. Must sketches be artistic?
3. Would a soft or hard drawing pencil be better for sketching?
4. Explain how the ability to sketch helps the designer.
5. Is a draftsman adequately equipped without the ability to sketch pictorially? Explain.

ASSIGNMENT:

The isometric method of sketching is most commonly used. For practice, sketch freehand on cross-section paper the following three problems. Note the orthographic drawings given and then follow the steps suggested for sketching.

138

Problem Area: Small Gas Engines

Problem: Repair

Job: Reassembly

Demonstration:

1. Insert tappets, crankshaft, and cam gear. (lubricate all parts)
2. Assemble piston and connecting rod and install.
3. Secure oil slinger and install sump. Adjust the crankshaft end play.
4. Set valve clearance.
5. Replace valve assembly.
6. Assemble coil, governor blade and ignition cable.
7. Install points and condenser.
8. Adjust points.
9. Install breaker point cover, seal wires with gasket sealer.
10. Install flywheel.
11. Adjust air gap.
12. Check ignition by checking spark.
13. Install air cleaner.
14. Place cylinder head and gasket in place and tighten to proper torque.
15. Install spark plug.
16. Tighten muffler if it has been removed.
17. Assemble carburetor and linkage.
18. Install governor.
19. Install blower housing.
20. Connect fuel lines.
21. Fill crankcase with oil.

13914

13913

22. Fill gas tank.

23. Start engine.

24. Re-torque head.

25. Make fine adjustments on carburetor and governor.

26. Fill air cleaner.

27. Paint engine.

28. Apply decals.

13914

Problem Area: Small Gas Engines

Problem: 4-cycle Engines

Job: General Structure

Motivation: We should understand the principles of 4-cycle operation by now and we can repair 2-cycle engines. What additional parts are involved to be repaired in the 4-cycle engine?

Study Questions:

1. What are two main types of 4-cycle engines?
2. What is different about the structure of the 1 cylinder, 4-cycle engine and the 1 cylinder 2-cycle engine?
3. What is the purpose of the camshaft gear?
4. What does the camshaft on a single cylinder engine consist of?
5. What type engine valve arrangement is common in 1 cylinder engines?

Summary of Information:

1. Air cooled and water cooled.
2. The 4-cycle contains a camshaft and valves. The oiling is accomplished by regular oil in the crankcase and usually using the splash method. The carburetor is of a different type.
3. To engage the camshaft with the crankshaft.
4. There are 2 lobes. One in position to operate the intake valve and one to operate the exhaust valve.
5. L head design.

Ref. Purvis, pages 12-18, 35-36, 51-52.

Teaching Suggestions: Have camshaft and gear for observation.

13915

Problem Area: Small Gas Engines

Problem: 4-cycle Engines

Job: Repair of Camshaft

Motivation: Why is it so important that valves work properly in a 4-cycle engine?

Study Questions:

1. What similarities and differences would you expect in repairing a 4-cycle engine as compared to a 2-cycle engine?

2. List the parts and what to check for in repairing the valve system.

3. How can the valves be repaired?

4. Where is the automatic spark advance located?

5. How can you tell when you have the cam gear in the correct position in relation to the crankshaft?

Summary of Information:

1. Everything learned about repair of cylinders, pistons, crankshafts, and carburetors apply to both. Camshaft and valve parts are only in the 4-cycle engine.

2. A. Valve seats - pitting or burning.

   B. Valves - pitting or burned edges or warpage.

   C. Valve guides - worn too loose.

   D. Tappet - flat face should be checked for wear. These usually do not need replacing.

   E. Gears - excess wear.

   F. Camshaft bearings - looseness.

3. If they are badly burned or worn, it is probably better to replace them and lap the new ones by using a grinding compound. Valve seats may be replaced if they are bad enough. Valves may be refaced or valve seats reground with special equipment.

4. In the camshaft gear.

13916

5. There is a timing mark on both gears. These should be matched. If there is no mark, they should be marked before disassembly.

Ref. Purvis, pages 51-52.

Teaching Suggestions: Demonstrate procedure of checking and repairing valve and camshaft assembly. Have students spend several days in shop repairing 4-cycle engines.

13917

Problem Area: Small Gas Engines

Problem: Trouble Shooting

Job: Oil Consumption and Overheating

Motivation: It's common to say an engine needs rings when it is using oil. This may or may not be so, but it usually needs other things too. You wouldn't want to tear an engine down, put in rings and put it back together only to have it continue to use oil.

Study Questions:

1. Make a list of things that can cause high oil consumption.
2. How can you find out what things are the cause?
3. How can overheating cause increased oil consumption?
4. Make a list of factors that can cause engine overheating.
5. What process is used to determine the causes?

Summary of Information:

1. Worn cylinder bores.
2. Tapered cylinder bores.
3. Distorted cylinder bores.
4. Worn pistons.
5. Collapsed pistons.
6. Improperly fitted pistons.
7. Stopped up piston drain holes.
8. Worn piston ring grooves.
9. Worn piston rings.
10. Wrong size piston rings.
11. Incorrectly installed piston rings.
12. Rings too tight in ring grooves.
13. Improperly fitted rings.
14. Clogged piston ring slots.

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15. Worn piston pins.

16. Worn piston pin bushings.

17. Bent or twisted connecting rods.

18. Worn connecting rod bearings.

19. Loose connecting rod bearings.

20. Excess side clearance in connecting rod bearings.

21. Worn main bearings.

22. Loose main bearings.

23. Excess crankshaft end play.

24. Bent crankshaft.

25. Out-of-round crankshaft journals.

26. Damaged crankshaft end play.

27. Damaged crankshaft oil slingers.

28. Worn intake valves.

29. Worn intake valve guides.

30. Worn camshaft bearings.

31. Worn camshaft journals.

32. Engine overheating.

33. Clogged water jackets.

34. Oil level too high.

35. Excessive oil pressure.

36. Clogged oil return from valve chamber.

37. Clogged oil return from timing gear case.

38. Clogged breather pipe.

39. No baffle in breather pipe.

40. Broken oil line.

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41. Oil leaking past front and rear main bearings.

42. Cracked crankcase.

43. Crankcase gasket leaks.

44. Defective crankshaft seals.

45. Leaking timing gear case gasket.

46. Leaking valve cover gasket.

2. By tearing the engine apart and checking possible causes.

3. By oil vaporization at high temperatures and by causing the cylinders to get out of round.

4. 1. Scale and rust in cylinder head.

   2. Scale and rust in cylinder block water passage.

   3. Cylinder head gasket blown.

   4. Incorrect cylinder head gasket.

   5. Cylinder block hot spot.

   6. Worn water pump impeller or housing.

   7. Sheared impeller pin or key.

   8. Clogged muffler

   9. Valve timing late.

   10. Worn timing chain.

   11. Leaking valves.

   12. Ignition timing late.

   13. Defective ignition spark advance.

   14. Carburetor mixture too rich.

   15. Leaking piston rings.

   16. Overload engine.

   17. Low engine oil level.

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18. Stiff engine (after overhaul).

19. Obstructed air passages (or dirt on air cooling fins).

20. Bent fan blades.

21. Worn fan belt.

22. Loose fan belt.

23. Worn drive pulleys.

24. Undersupply of coolant.

25. Foaming of coolant.

26. Leaking cylinder head.

27. Leaking cylinder head gasket.

28. Leaking cylinder block.

29. Leaking expansion plugs.

30. Leaking water pump housing.

31. Leaking water pump shaft.

32. Leaking water pump gasket.

33. Leaking drain cocks.

Ref. Purvis, pages 115-118.

Teaching Suggestions: Have students solve verbal trouble shooting problems; then have them actually determine the trouble in some engines.

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Problem Area: Small Gas Engines

Problem: Trouble Shooting

Job: Engine Noise

Motivation: Some mechanics can usually tell which bearings an engine needs by listening to it run.

Study Questions:

1. What methods may be used in determining what is causing a knock?

2. What are the characteristics of a knock from each of the following sources?

   A. Connecting rods.

   B. Piston pins.

   C. Main bearings.

   D. Flywheel.

   E. Crankshaft end play.

   F. Timing gears.

   G. Piston slap.

   H. Ring noise.

   I. Valves.

3. What if all of these are all right and the engine still knocks?

Summary of Information:

1. Listening for certain tones in the knock or characteristics of the sound itself. Using a kind of stethoscope to determine the location of the knock. To observe the running conditions necessary to hear the knock.

2. A. Will be heard at all speeds. One rod will be distinct, several will cause a clatter.

   B. When a stethoscope is used, the knock is loudest on the block. Shorting a spark plug will change the intensity of the knock.

   C. A bump which may be located by shorting out plugs. Loudest when lugging. Heavier and duller than connecting rod knock.

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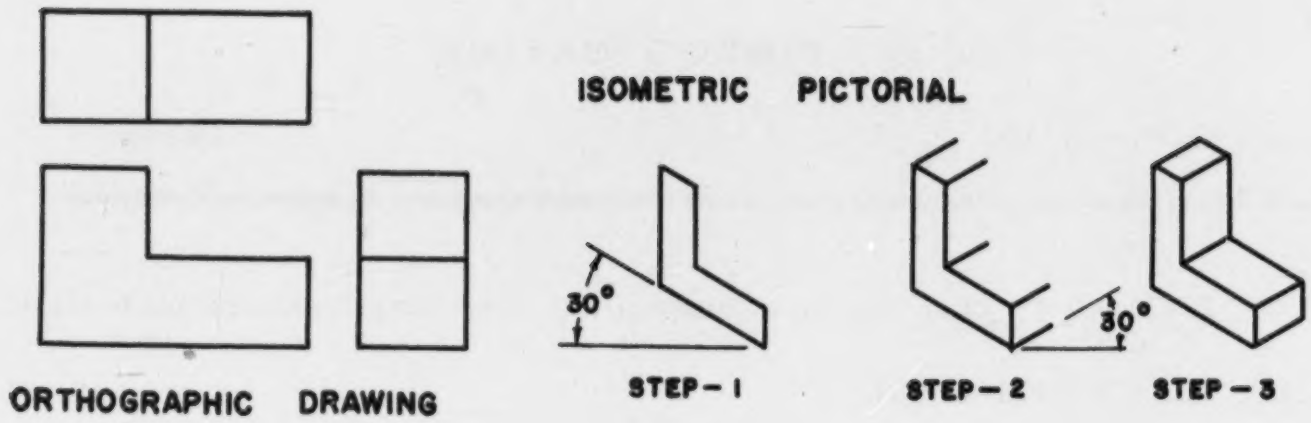

PROBLEM 1

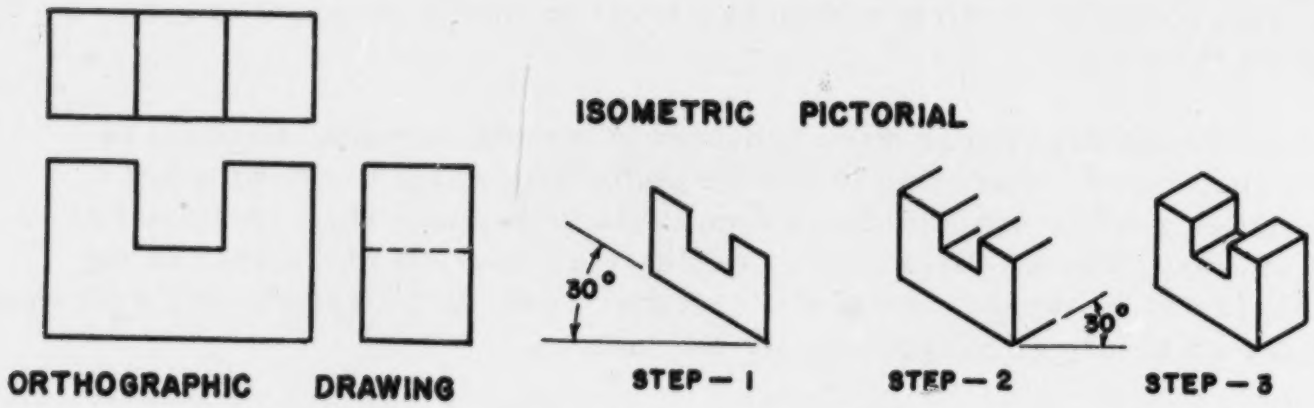

PROBLEM 2

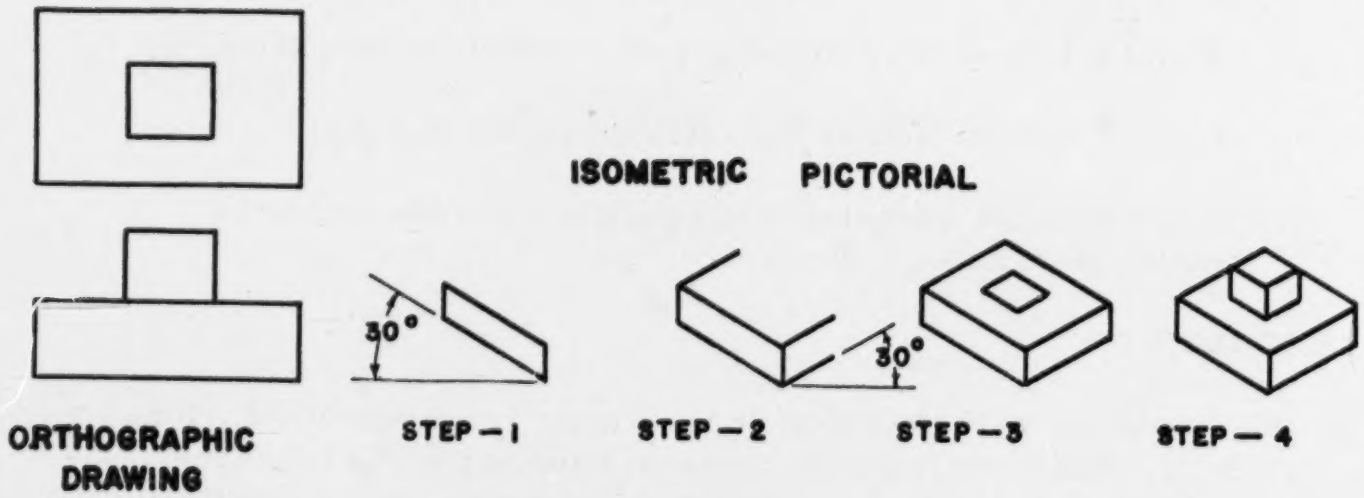

PROBLEM 3

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D. Similar to main bearing except not affected by shorting out spark plug. Shut off the engine and turn it on again as it is about to stop.

E. Sharp intermittent rap or knock.

F. Need a stethoscope to determine location as it occurs at all speeds.

G. Decreases as engine warms up.

H. Clicking noise.

I. Use a stethoscope. Check valve tappet clearance.

3. These knocks are due to misalignment or endwise motion of parts.

Ref. Purvis, pages 118-121.

Teaching Suggestions: Have students work with engines having some of these things wrong with them. Demonstrate use of the stethoscope.

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Problem Area: Small Gas Engines

Problem: Trouble Shooting

Job: Ignitions

Motivation: If you knew that the spark plug was not firing, what would you do to correct it?

Study Questions:

1. How must you test most parts of the ignition system?

2. What might be the cause of arcing at the points?

3. What might be wrong causing only a weak spark and the engine will not start?

4. How could you detect a cracked spark plug, a bad wire, or a short circuit anywhere in the system?

Summary of Information:

1. A special ignition testing device may be used.

2. A bad condenser.

3. A bad magneto, bad connection somewhere, or an improperly adjusted plug.

4. You'll get a shock when you touch a bad wire with the engine running. A weak spark may indicate a cracked plug or short circuit after all other possible causes are checked.

Ref. Purvis, pages 182-193, 205-210.

Teaching Suggestions: Demonstrate methods of checking ignition system. Review page 27 and 28.

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Problem Area: Small Gas Engines

Problem: Trouble Shooting

Job: Carburetor Trouble

Motivation: Have you ever seen ice form on a carburetor when the engine is running? Did you ever have trouble with an engine that would run all right until you closed the throttle to idling, then die?

Study Questions:

1. What causes carburetor icing?
2. What does it do that causes trouble?
3. If the engine does not run, would you check the carburetor first?
4. How can a carburetor be cleaned?
5. Make a list of possible causes for poor carburetor performance.
6. Make a list of things that might cause poor idling.
7. Make a list of things you would check if the carburetor floods.

Summary of Information:

1. Certain weather conditions. Usually 28-55°F and 65 to 100 per cent humidity. Rapid vaporization of the fuel lowers the temperature, then vapor in the air freezes.
2. Ice forms around the throttle so that it does not allow proper flow of fuel from the idling jets.
3. No. Check the ignition system, compression, and the fuel supply. If these are all right, then check the carburetor.
4. Use a carburetor cleaning solution. Take the carburetor apart and clean and inspect each part.
5. A. Air leaks at carburetor or manifold.

   B. Clogged fuel lines.

   C. Defective fuel pump.

   D. Incorrect fuel level.

   E. Clogged fuel screen.

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F. Dirt in carburetor jets and passages.

G. Damaged or wrong size main metering jet.

H. Worn idle needle valve and seat.

I. Loose jets in carburetor.

J. Defective gaskets in carburetor.

K. Worn throttle shaft.

L. Leaking vacuum lines to accessory equipment.

6. A. Incorrect adjustment of idle needle valve.

B. Incorrect float level.

C. Sticking float needle valve.

D. Defective gaskets in carburetor.

E. Defective gaskets between carburetor and manifold.

F. Loose carburetor to manifold nuts.

G. Loose carburetor to block nuts.

H. Idle discharge holes partly clogged.

I. Loose jets in carburetor.

J. Leaking vacuum lines to accessory equipment.

7. A. Fuel level too high.

B. Stuck float needle valve.

C. Defective gaskets in carburetor.

D. Cracked carburetor body.

E. Excessive fuel pump pressure.

Ref. Purvis, pages 139-151.

Teaching Suggestions: Let students determine what is wrong with a carburetor and repair it.

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Problem Area: Small Gas Engines

Problem: Governors

Job: Principles of Operation

Motivation: How can a governor control the speed of an engine?

Study Questions:

1. What are the two types of governors used on Briggs and Stratton engines?

2. How are the two types different in operation?

3. What is the basic purpose of a governor?

4. How can the speed of the engine be changed by the governor?

5. What is meant by governed speed?

Summary of Information:

1. Mechanical and air vane.

2. The mechanical governor has counter weights operating by centrifugal force, which tend to hold the throttle closed, this force tends to increase as the engine speed increases. This force is off set by a governor spring where tension is increased or decreased by the hand throttle setting.

   The air vane governor works off the air current coming off the vanes of the flywheel. This air current over-rides the spring tension in the same way as the mechanical governor.

3. To maintain a desirable engine speed, with varying loads.

4. The governed speed is changed by varying the spring tension.

5. When the force opposing the governor spring and the force of the spring are equal or balanced.

Ref. Repair Instruction II, ppages 73-87.
Purvis, pages 113-114.
Briggs and Stratton General Theories

Teaching Suggestions: Demonstrate the operation of both types of governors and how they are adjusted.

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Problem Area: Small Gas Engines

Problem: Starters

Job: Repair

Demonstration:

New or old style starter assemblies can be identified by the spring in rewind starter housing. Old style spring has a hook on the end for attaching to the pulley. New style has a tapered end which is inserted into a slot in the pulley. Repair procedures are the same except where noted.

1. Cut knot at starter pulley and remove rope.

2. Remove the spring by grasping outer end of spring and pull out of the pulley as far as it will go. Bend the retaining tangs up and remove pulley and spring. Clean the entire assembly and coat with light oil.

3. Installation of spring.

New Style

Insert spring through slot in blower housing, and hook the end of the spring into pulley hub. Place dab of grease on under side of pulley. Place pulley in housing and carefully bend tangs to within 1/8 inch of the pulley.

Old Style

Insert end of the spring with straight hook through housing above slot. Hook the end of the spring into the slot of the pulley. Push spring retainer into place with split portion of retainer opposite spring end.

4. The procedure for the rest of the installation is the same for both the old and the new style rope starter.

   A. Put the starter tool into the center of the pulley hub. See Figure 23 and 24 page 101.

   B. Place screwdriver through one of the holes at the top end of the square tubing and wind the pulley 13 1/4 turns, counter-clockwise.

   C. Hold the tool with your hand and remove the screwdriver and relocate the screwdriver through one of the holes at the bottom of the tubing.

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D. Pierce end of rope with rope inserter tool (see Figure 24 page 101) and place rope through hole in pulley.

E. Remove rope inserter and tie knot in the end of the rope.

F. Hold the rope and remove steel tubing.

G. Rope should not rewind into pulley.

Ref. Briggs and Stratton, Repair Instruction II, page 62.

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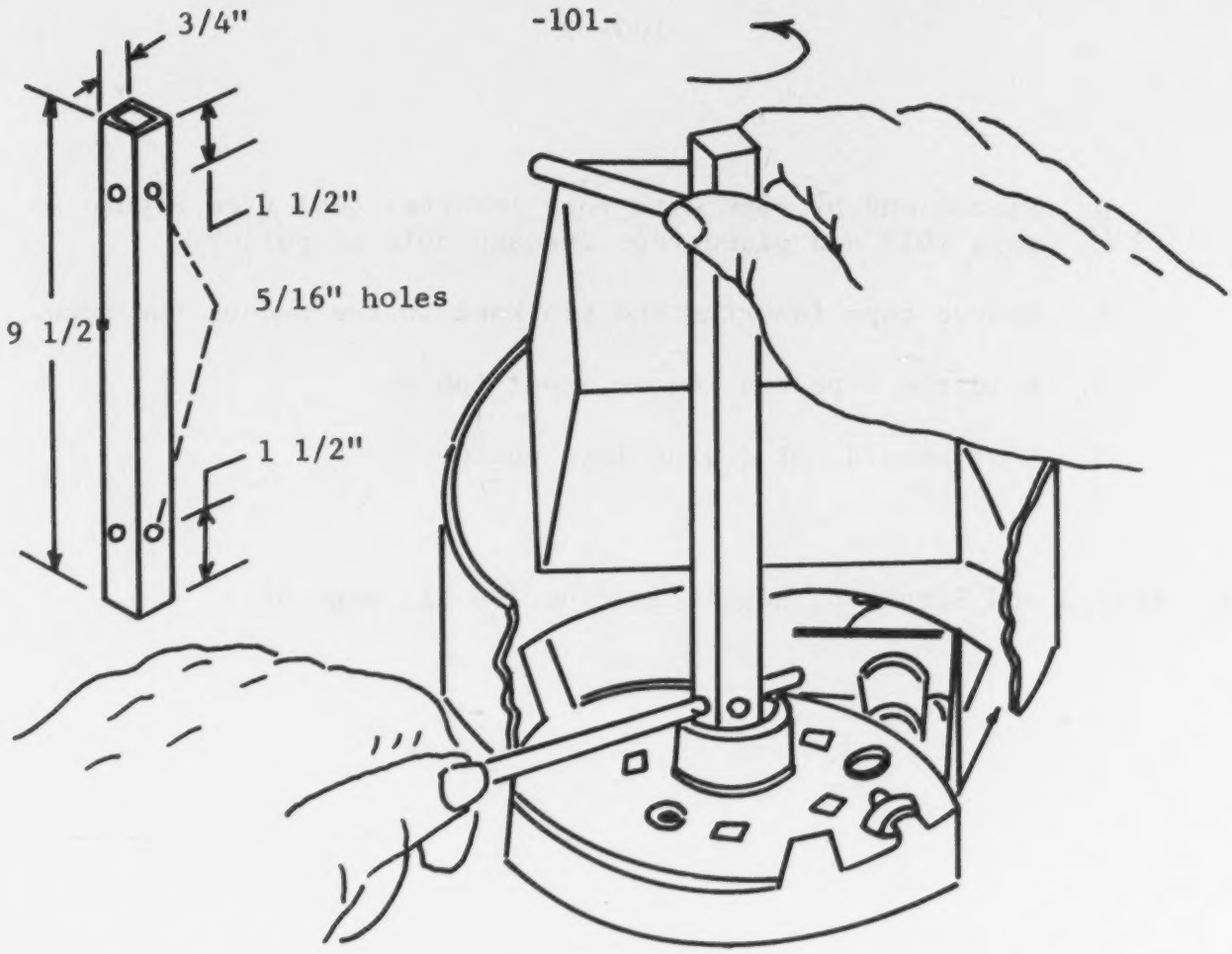

Figure 23
You can make a tool like the one in the upper left hand corner from a 9 inch section of 3/4 inch square tubing, with holes drilled 1 1/2 inches from either end.

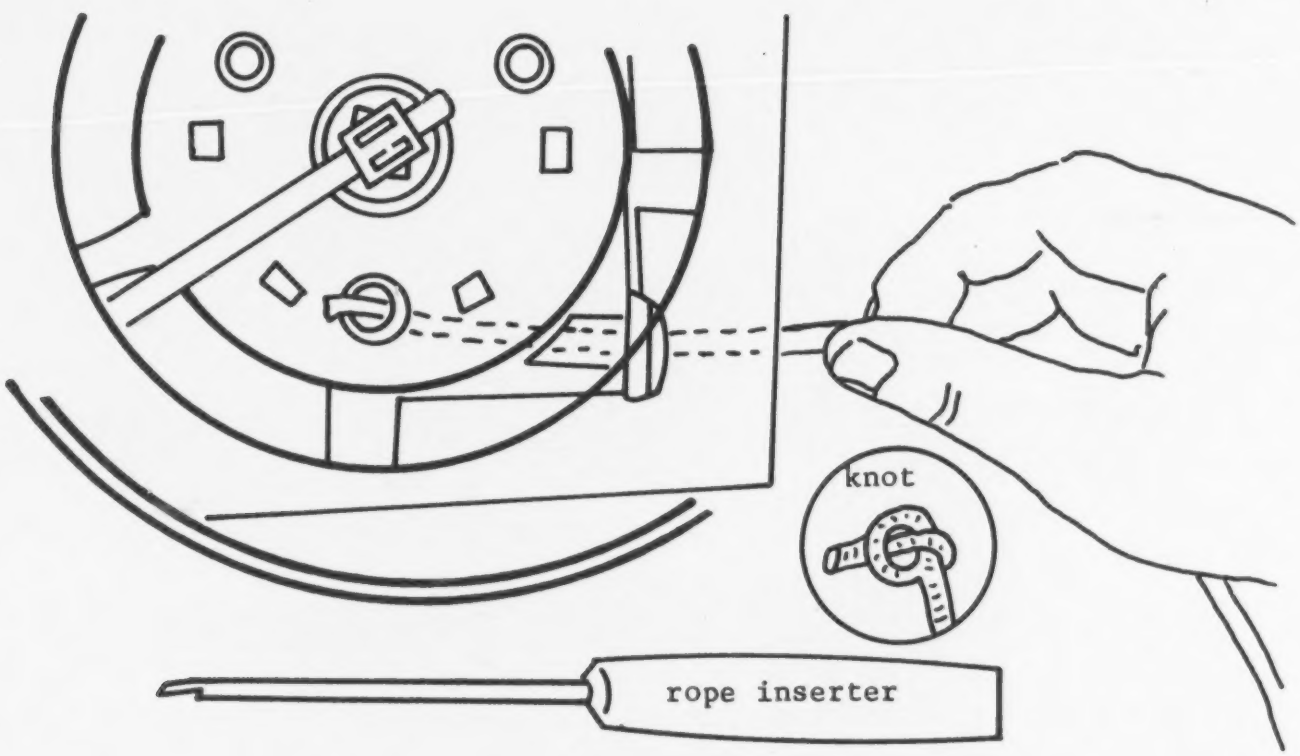

Figure 24
A rope inserter tool may be made from piano wire pounded flat at one end as shown.

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STARTER TANG TOOL

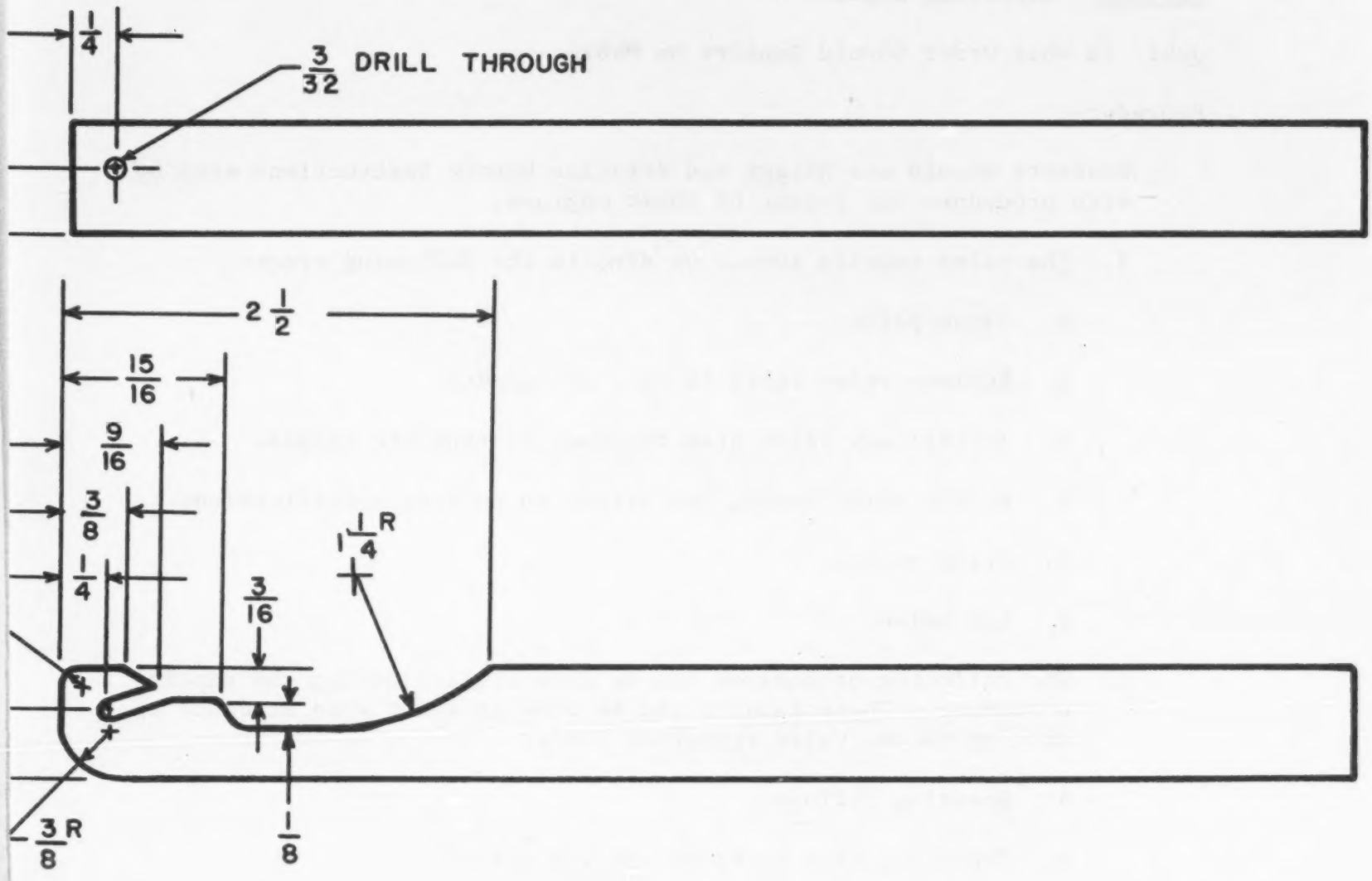

Figure 25

1. Material required is 7 1/2" length of 5/8" square stock steel.

2. Drill 3/32" hole as indicated in top drawing.

3. Cut and grind to dimensions shown in bottom drawing.

The above drawing is for special starter tang tool for lifting tangs on Windup Starters. See Briggs and Stratton Repair Instructions II, page 63.

Starter Tang Tool
Scale - 12" = 1' - 0"
Date - 6 July 1965

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Problem Area: Small Gas Engines

Problem: Repairing Engines

Job: In What Order Should Repairs be Made?

Procedure:

Students should use Briggs and Stratton Repair Instructions step by step procedure for repair of their engines.

1. The valve repairs should be done in the following order:

   A. Clean parts.

   B. Replace valve seats if they are needed.

   C. Install new valve stem bushings if they are needed.

   D. Reface valve seats, and narrow to correct specifications.

   E. Grind valves.

   F. Lap valves.

2. The following procedures can be done anytime during the repair procedure. These repairs can be done at times when students are waiting to use valve repairing tools.

   A. Resizing cylinder.

   B. Replacing main bearings and oil seals.

   C. Rebuild carburetor.

   D. Replace breaker point bushings.

   E. Repair starter assembly.

   F. Repair threads.

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OBJECTIVE:

To learn the usage and application of auxiliary views.

RELATED INFORMATION:

An auxiliary view is defined as an orthographic projection on a plane perpendicular to one of the principal planes of projection but inclined to the other two (Fig. 1).

The chief reason for using an auxiliary view is to show the true shape of a slanting surface. If we used the conventional three views - front, top and side - the slanted surface would appear distorted and not true in length. Thus the edge view of the auxiliary plane therefore should be parallel to the edge view of the slanting surface. Holes or rounded surfaces which appear round in normal views will appear elliptical in shape in other views. (Fig. 2).

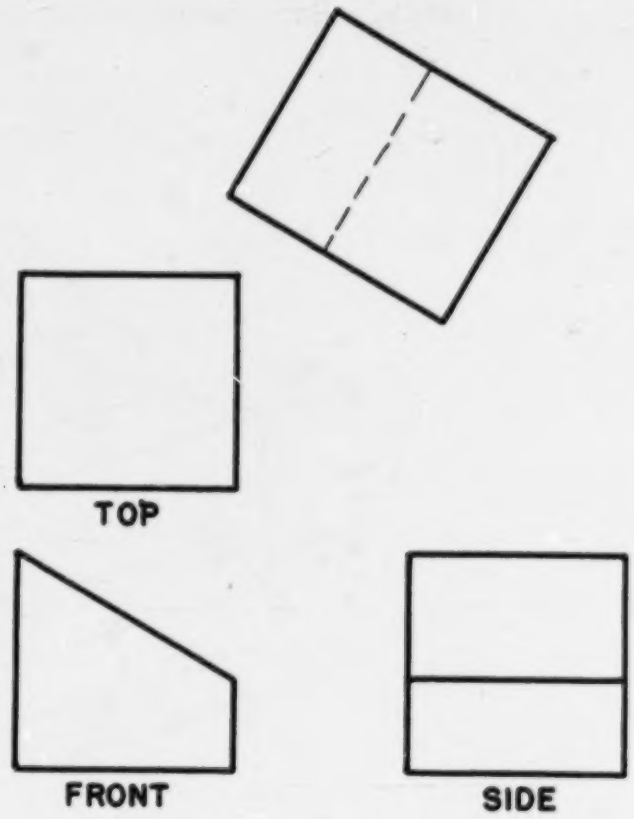

FIG. 1

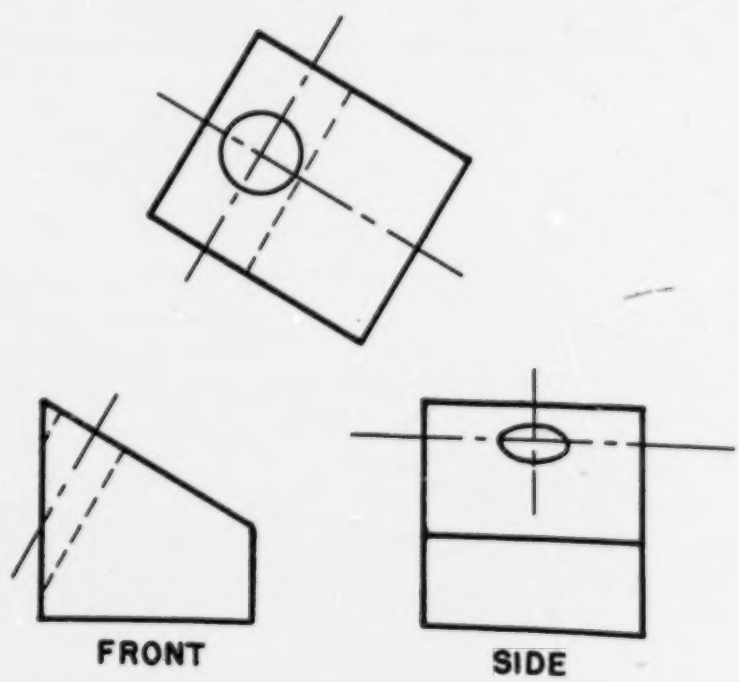

FIG. 2

ACCA 1390

Supplemental References

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2. Lawson-Power Products Parts Depot, Mechanics Handbook, Tecumseh Products Company, Grafton, Wisconsin, 1961.

3. Wisconsin Motor Corporation, Instruction Book and Parts List, Wisconsin Motor Corporation, Milwaukee 46, Wisconsin.

4. Perfect Circle Corporation, Service Manual, Hagerstown, Indiana.

5. Brown and Morrison, Farm Tractor Maintenance, The Interstate, Danville, Illinois.

6. Ethyl Corporation, Technical Notes, Detroit, Michigan.

7. University of Illinois, Small Engines - Repair and Overhaul, Urbana, Illinois.

8. Jones, M. M., Shopwork On The Farm.

9. Standard Oil FT-53 Farm Tractors, Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

10. 3M Transparency Originals, Visual Products, 3M Company.

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Overhaul Tool List - Small Gas Engines

The following list is divided into three parts. Part I lists essential tools to completely overhaul the Briggs and Stratton Engines with 6 and 8 cubic inch displacement. Part II lists those tools which are not absolutely necessary, but add to the ease and convenience of engine overhaul. Part III could be classed as essential supplies. Prices are effective September 1, 1968 and subject to change without notice.

Part I

Number of Tools	Name of Tool	Company	Number	Price
1	Adj. Valve Seat Cutter Kit	Neway	102A	34.50
1	Cylinder Hone Set	Ammco	3950	58.50
1	Cylinder Hone Stone Roughing Set	Ammco	3951	5.30
1	Cylinder Hone Stone Finishing Set	Ammco	3952	5.30
2	Cylinder Hone Stone Aluminum Set	Ammco	3955	5.30
1	Piston Ring Expander	Ammco	8332	2.80
1	Slide Film Sets No. 1, 3, 4, 5, 7, 9, 20, 21	Briggs & Stratton		18.90
1	Tool Kit (Main Bearing Overhaul)	Briggs & Stratton	19158	52.00
1	Tool Kit	Briggs & Stratton	291661	28.00
2	Clutch Wrench	Briggs & Stratton	19114	1.85
2	Flywheel Holder	Briggs & Stratton	19167	3.35
1	Pilot for Valve Seat Inserts	Briggs & Stratton	19126	4.40
1	Driver for Valve Seat Inserts	Briggs & Stratton	19136	2.50
1	Planer Shank - Driver for Seat Cutter	Briggs & Stratton	19129	4.05
1	T Handle for Planner Shank	Briggs & Stratton	19130	1.00
1	Counter Bore Cutter for Cutting New Valve Seats	Briggs & Stratton	19133	10.60
1	Valve Insert Puller	Briggs & Stratton	19138	12.80
1	Valve Insert Puller Nut	Briggs & Stratton	19182	2.60
1	Valve Refacing Lathe	Zim	525	59.00
1	Valve Spring Compressor	Briggs & Stratton	19063	2.25
1	Piston Ring Compressor	Briggs & Stratton	19070	.95
1	2" - 3" Micrometer	Starret	1913	23.15
1	0" - 1" Micrometer	Starret	1911	16.50
1	2" - 3" Telescoping Gage	Starret	579E	5.60
1	Valve Lapping Tool 3/4" Cup	Woods Mfg. Co.		6.75
4	Flat Feeler Gage	Craftsman, Sears	9K40801	1.94
4	Wire Feeler Gage		9K40801	1.78
6	Assorted Screwdrivers Sets (Standard)		9K 4150	3.55
6	Assorted Screwdrivers Sets (Phillips)		9K 4147	3.85
6	Combination Wrench Set, 10 pc		9K 4496	14.99
6	1/4" Socket Set, 16 pc Midget		9K44148	12.79
6	3/8" Socket Set, 10 pc		9K 4395	7.79
6	Needle Nose Pliers		9K44993	4.25
6	3/8" Drive Spark Plug Socket		9K43321	1.63
6	3/8" Rachet Wrench		9K43785	5.39
1	Torque Wrench, 100 ft/lb 3/8" Drive		9K44481	11.95

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Number of Tools	Name of Tool	Company	Number	Price
6	Socket Extension, 1/4"		9K43371	1.85
1	Combination Ignition Wrench Set, 10 pc		9K43441	5.79
6	Universal Joints, 3/8" Drive	Craftsman, Sears	9K 4435	2.47
6	Socket Adaptor, 3/8" to 1/4"		9K 4257	.96
6	Allen Wrenches, 14 pc set		9K46683	1.19
2	Squirt Oil Cans, 6 oz. capacity		9K 5581	1.96
1	Hand Level for Leveling Engine Heads			
1	Hand Drill For Reaming			
1	8" Adjustable Wrench		9K44652	3.39
1	6" Adjustable Wrench		9K44651	2.95
1	Ball Peen Hammer, 4 oz.		9K38461	2.99
1	Gear Puller, 0 to 5½"		9K46901	6.39
1	3/4" Square Tubing 9" in length			
1	Drill Press for Honing Cylinders and Reaming (300-700 RPM)			
1	T Block Vise Support for Cylinder	shop made		
1	Cylinder Holder for Honing	shop made		.90
1	Rotary Blade Balancer	Smith Implement		

Part II

1	Ridge Reamer	Ammco	3700	10.50
1	Magneto Ignition Analyzer #98	Merc-o Tronic	98	159.95
1	RPM Indicator	Stewart-Warner	758A	3.90
1	Magnetic Key Inserter	Ammco	8336	3.10
2	.010 Feeler Gage Stock			
2	.005 Feeler Gage Stock			
1	Dial Indicator for End Play	Lufkin	299A	24.10
1	Starter Tang Tool	shop made		
2	Wash Pans			
1	Gas Can			
1	Steam Cleaner (for cleaning engines)	Clayton	S-840	433.00
1	Valve Grinding Machine	Sioux	#624	328.50
1	Small Engine Dynamometer	Go Power	Dy-5e	259.00
6	Apprentice 1" - 2" Micrometer	Craftsman	9K40702	5.42
1	1¼" -2 1/8" telescoping gage	Starret	579D	4.60
1	Ignition Tester	Sears	28AR2186	10.89

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Number of Tools	Name of Tool	Company	Number	Price
Part III				
1	Permatex (for gaskets) pint		Super 300	3.23
1	Valve Grinding Compound, 1 oz can		34A	.80
5 lbs.	Lubriplate (for bearings or seals)			4.50
3 gal.	Carburetor Cleaner (Gunk or equal)			13.50
5 gal.	SAE 30 Motor Oil			5.50
1 gal.	Honing Oil			2.00
Asst.	Decals for Repainted Engines			
Asst.	Cans of Spray Lacquer or Enamel			1.00
25	Rags for Cleaning			
1 gal.	Fuel Oil or Kerosene or Stoddard Solvent (for reaming)			
30 gal.	Cleaning Solvent (for parts washing)			12.00

ADDRESSES OF COMPANIES

Ammco Tools, Inc.
2100 Commonwealth Avenue
North Chicago, Illinois 60064

Briggs and Stratton Corporation
2711 North 1st Street
Milwaukee 1, Wisconsin 53233

Clayton Mfg. Co.
Box 550
El Monte, California 91734

Ki-Sol Corp.
3134 Washington Avenue
St. Louis, Missouri 63103

Medart Engine & Parts
900 S. Teresa
St. Louis, Missouri 63103

Merc-o Tronic Instrument Corp.
Almont
Michigan 48003

Sears, Roebuck & Company
3625 Truman Road
Kansas City, Missouri 64127

Smith Implement
Carthage
Illinois 62321

Stewart Warner Corp.
Chicago 14
Illinois 60612

Sunnen Products Company
St. Louis 17
Missouri 63130

Woods Power Grip Mfg. Co.
233 Cascade
Wolf Point, Montana 59201

Zim Manufacturing Co.
3047 W. Carroll Avenue
Chicago 12, Illinois 60612

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VT 012 799
Teaching Guide for an Aerospace
Communications Laboratory.

Federal Aviation Administration, Washington,
D.C. Office of General Aviation Affairs.
Department of the Air Force, Washington, D.C.
Civil Air Patrol.
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DESCRIPTORS - *TEACHING GUIDES; *WORKBOOKS;
*TRADE AND INDUSTRIAL EDUCATION; *TEACHING
METHODS; VOCATIONAL EDUCATION; AVIATION
TECHNOLOGY; GLOSSARIES; RESOURCE MATERIALS;
EDUCATIONAL OBJECTIVES; ROLE PLAYING;
COMMUNICATIONS SKILLS; *AEROSPACE TECHNOLOGY

ABSTRACT - Developed to help students learn
the language of aircraft pilots and
astronauts this document consists of a
teaching guide for an aerospace
communications laboratory plus a student
workbook. The teaching guide lists
educational objectives and includes
information on: (1) Aerospace Messages, (2)
How Numbers are Spoken, (3) Aircraft Call
Signs, (4) Teaching Aids, (5) Role Playing,
(6) The International Phonetic Alphabet, and
(7) Aerospace Words and Phrases. The student
workbook includes exercises covering call
signs, the international phonetic alphabet,
and the communication of messages. A glossary
is also included. (JS)

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TEACHING GUIDE

FOR AN

AEROSPACE COMMUNICATIONS LABORATORY

U.S. DEPARTMENT OF HEALTH,
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TEACHING GUIDE FOR
AN
AEROSPACE COMMUNICATIONS LABORATORY

I. INTRODUCTION

Aviation and space are affecting the daily lives of more and more people. This impact of aerospace is growing rapidly. Young people especially have an urgent requirement to develop the knowledge, skills, and attitudes that will enable them to percieve the effects of aviation and space exploration on our way of life.

The language of aerospace is unique. It is also fascinating to most people. This teaching guide for an aerospace communications laboratory is designed to help students learn to speak the language of aircraft pilots and astronauts -- the language of aerospace.

II. OBJECTIVES

To create teaching-learning experiences that will:

1. Motivate students to develop, through active participation, essential communication skills.

2. Provide an environment for educational leadership in the communication arts.

3. Improve vocabulary, develop capabilities of expression, and extend communications horizons.

4. Improve methodology in the communication arts by utilizing multimedia educational techniques.

5. Introduce the interrelationships between aviation and space communications and other subjects in the school curriculum.

6. Interpret the effects of aviation and space exploration on the social, economic, political, and cultural structure of the world.

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III. AEROSPACE MESSAGES

Aerospace messages are transmitted and received by aircraft pilots, control tower operators, astronauts, and space capsule communicators. Student pilots flying light airplanes, control tower operators at small airports, airline captains in big jets, air traffic controllers at large metropolitan airterminals, and astronauts in space capsules all rely on aerospace communications to transact their "business."

Messages are sent while air and space vehicles are on the ground and at altitudes ranging from a few feet to the apogees of space vehicle orbits. All aerospace communications have two things in common -- they are necessary and they are as brief and as clear as possible. Emergency messages receive priority.

The following sections of this guide explain how pilots and astronauts talk with each other and with radio stations on the ground.

IV. THE INTERNATIONAL PHONETIC ALPHABET

The International Phonetic Alphabet consists of 26 code words. Code words in the alphabet are used to represent single letters, to spell out groups of letters, or to make sure that difficult or unfamiliar words are understood. The code words in the phonetic alphabet are approved by the International Civil Aviation Orgainzation (ICAO). They are used worldwide in aviation and space communication.

Letter	Code Word	Pronunciation	Letter	Code Word	Pronunciation
A	Alfa	(AL-FAH)	N	November	(NO-VEM-BER)
B	Bravo	(BRAH-VOH)	O	Oscar	(OSS-CAH)
C	Charlie	(CHAR-LEE)	P	Papa	(PAH-PAH)
D	Delta	(DELL-TAH)	Q	Quebec	(KEH-BECK)
E	Echo	(ECK-OH)	R	Romeo	(ROW-ME-OH)
F	Foxtrot	(FOKS-TROT)	S	Sierra	(SEE-AIR-RAH)
G	Golf	(GOLF)	T	Tango	(TANG-GO)
H	Hotel	(HO-TEL)	U	Uniform	(YOU-NEE-FORM)
I	India	(IN-DEE-AH)	V	Victor	(VIC-TAH)
J	Juliett	(JEW-LEE-ETT)	W	Whiskey	(WISS-KEY)
K	Kilo	(KEY-LOH)	X	Xray	(ECKS-RAY)
L	Lima	(LEE-MAH)	Y	Yankee	(YANG-KEY)
M	Mike	(MIKE)	Z	Zulu	(ZOO-LOO)

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V. HOW NUMBERS ARE SPOKEN

Numbers spoken over the radio are pronounced to sound like this:

Number	Sound	Number	Sound
1	WUN	6	SIX
2	TOO	7	SEV-EN
3	TREE	8	AIT
4	FOW-ER	9	NIN-ER
5	FIFE	0	ZERO

Each number is pronounced individually. The number 55397 is spoken: FIFE FIFE TREE NIN-ER SEV-EN. When numbers are combined with letters of the alphabet, the phonetic code work for each letter is spoken. Y4395 is pronounced like this: YANG-KEY FOW-ER TREE NIN-ER FIFE.

VI. AEROSPACE WORDS AND PHRASES

Pilots, astronauts, control tower operatios, and space capsule communicators use these words and phrases to make sure that their communications are brief and easily understood:

Primary Words and Phrases

Word or Phrase	Meaning
OVER	I expect a reply from you.
ROGER	I have received and understand your last message.
WILCO	I will do as you direct. I will comply.
OUT	My message is ended. No reply is expected.
NEGATIVE	No, or that is not correct.
SAY AGAIN	Repeat what you said.
CORRECTION	An error has been made. The correct words are..... (give correct message).
SPEAK SLOWER	Speak slower.
STAND BY	Wait a few seconds, a delay is necessary.

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Secondary Words and Phrases

Word or Phrase	Meaning
I SAY AGAIN	I will repeat what I said.
GO AHEAD	Go ahead with your message.
THAT IS CORRECT	Correct.
HOW DO YOU HEAR ME	Tell me how you hear me.

VII. PARTS OF A MESSAGE

Each radio message has three parts. Each part is as brief as possible. These parts are the Call-Up, the Message, and the Ending.

The Call-Up

1. Identifies the caller and the receiver.
2. Determines that both persons can hear each other.
3. Sets the stage for communicating the message.

The Call-Up includes the call sign of the station being called, the words THIS is, the call sign of the caller, and the word OVER.

Example

Pilot: GALVESTON TOWER, THIS IS CESSNA AIT WUN FOW-ER WUN. OVER.

Tower: CESSNA AIT WUN FOW-ER WUN, THIS IS GALVESTON TOWER. OVER.

The Message

1. Gives or requests information as clearly and briefly as possible.
2. Allows the receiver to reply if necessary.

Example

REQUEST LANDING INSTRUCTIONS. OVER.

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The Ending

1. Acknowledges receipt of a message.
2. Terminates radio contact.

The Ending includes the aircraft call sign, the word ROGER, and if the contact is to end, the work OUT.

Example

CESSNA AIT WUN FOW-ER WUN, ROGER. OUT.

Sample Message

Pilot: CLEVELAND TOWER, THIS IS BEECHCRAFT WUN AIT FOW-ER WUN. OVER.

Tower: BEECHCRAFT WUN AIT FOW-ER WUN, THIS IS CLEVELAND TOWER. OVER.

Pilot: CLEVELAND TOWER, THIS IS BEECHCRAFT WUN AIT FOW-ER WUN, FOW-ER MILES SOUTH AT WUN THOUSAND, LANDING AT CLEVELAND. OVER.

Tower: BEECHCRAFT AIT FOW-ER WUN, FOW-ER MILES SOUTH AT WUN THOUSAND CLEARED TO ENTER TRAFFIC PATTERN, RUNWAY WUN AIT. WIND WUN AIT ZERO DEGREES AT WUN TOO.

Pilot: BEECHCRAFT AIT FOW-ER WUN. ROGER. OUT.

Tower: CLEVELAND TOWER. OUT.

VIII. AIRCRAFT CALL SIGNS

Civilian Pilots

During the first contact with a ground station, the complete aircraft call sign is used. Civil aircraft pilots include the make or type name of their aircraft. This is followed by the aircraft's registration number.

Example

CESSNA WUN TOO TREE FOW-ER TANG-GO (Cessna Aircraft Number 1234T)

PIPER NIN-ER SEV-EN SIX ZERO (Piper Aircraft Number 9760)

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Airline Pilots

Airline pilots use the airline name. This is followed by the flight number.

Example

UNITED TOO FIFE (United Air Lines Flight 25)

DELTA WUN AIT (Delta Air Lines Flight 18)

Military Pilots

Military pilots frequently use the name of their Service followed by the last five numbers in the aircraft's serial number.

Example

AIR FORCE ("JET" when appropriate) FOW-ER FOW-ER NIN-ER TREE TOO (Air Force Aircraft Number 44932)

AIR FORCE TOO WUN TOO WUN SIX (Air Force Aircraft Number 21216)

After radio contact has been established, and when conditions allow, the call signs may be reduced to the aircraft type or make followed by the last three numbers or letters of the full call sign.

Example

CESSNA SIX TOO YANG-KEY (Cessna Aircraft Number 1262Y)

BEECH WUN TOO ZOO-LOO (Beech Aircraft Number 6812Z)

After contact has been definitely established, communication may be continued without further call-up or identification.

IX. SAMPLE MESSAGES

Aviation

1. PURPOSE: A pilot wishes to request taxi and takeoff instructions.

Pilot: BAKER GROUND CONTROL, THIS IS (call sign). OVER.

Tower: (Call sign), THIS IS BAKER GROUND CONTROL. OVER.

Pilot: BAKER GROUND CONTROL, THIS IS (call sign). REQUEST TAXI-TAKEOFF INSTRUCTIONS. OVER.

Tower: (Call sign), THIS IS BAKER TOWER. RUNWAY WUN AIT. WIND WUN SIX ZERO DEGREES AT WUN TOO. ALTIMETER TREE ZERO ZERO FOW-ER. TIME WUN FOWER TOO SIX. OVER.

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2. PURPOSE: A pilot in flight desired permission and instructions for landing at Baker Airport.

Pilot: BAKER TOWER, THIS IS (call sign). OVER.

Tower: (Call sign), THIS IS BAKER TOWER. OVER.

Pilot: BAKER TOWER, THIS IS (call sign), WUN TOO MILES WEST. REQUEST LANDING INSTRUCTIONS. OVER.

Tower: (Call sign), THIS IS BAKER TOWER. REPORT BASE LEG FOR RUNWAY WUN AIT. WIND WUN SEV-EN ZERO DEGREES WUN SIX.

Pilot: BAKER TOWER, THIS IS (call sign). ROGER. OUT.

3. PURPOSE: A pilot in the traffic pattern at Baker Airport, turning base leg, needs approval to land.

Pilot: BAKER TOWER, THIS IS (call sign). OVER.

Tower: (Call sign), THIS IS BAKER TOWER. OVER.

Pilot: BAKER TOWER, THIS IS (call sign), TURNING BASE LEG FOR LANDING ON RUNWAY WUN AIT. OVER.

Tower: (Call sign), THIS IS BAKER TOWER. CLEARED TO LAND RUNWAY WUN AIT. OVER.

Pilot: BAKER TOWER, THIS IS (call sign). ROGER. OUT.

Space

4. PURPOSE: The Gemini 4 crew gives the Capsule Communicator (Cap Comm) the go-ahead to resume the countdown.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. OVER.

Cap Comm: GEMINI FOW-ER, THIS IS CAP COMM. OVER.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. ALL SYSTEMS ARE GO. RESUME COUNTDOWN. OVER.

Cap Comm: GEMINI FOW-ER, THIS IS CAP COMM. ROGER. COUNTDOWN IS RESUMING AT T MINUS FIFE ZERO SECONDS AND COUNTING. OVER.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. ROGER. OUT.

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5. PURPOSE: Gemini 4 requests information about weather in the recovery area.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. OVER.

Cap Comm: GEMINI FOW-ER, THIS IS CAP COMM. OVER.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. REQUEST WEATHER DATA FOR RECOVERY AREA. OVER.

Cap Comm: GEMINI FOW-ER, THIS IS CAP COMM. WEATHER IN RECOVERY AREA IS GOOD. TREE FOOT WAVES. WIND AIT KNOTS. VISIBILITY WUN ZERO MILES. OVER.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. ROGER. OUT.

6. PURPOSE: Cap Comm advises Gemini 4 that the landing point is 20 miles long.

Cap Comm: GEMINI FOW-ER, THIS IS CAP COMM. OVER.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. OVER.

Cap Comm: GEMINI FOW-ER, THIS IS CAP COMM. YOUR LANDING POINT IS TOO ZERO MILES LONG. OVER.

Gemini 4: CAP COMM, THIS IS GEMINI FOW-ER. ROGER. OUT.

X. MICROPHONE TECHNIQUE

Proper microphone technique is important in aerospace communications. Correct radio procedures must always be observed. Messages should be spoken in a normal tone of voice.

Pilots should keep messages as brief as possible. They should not read back information to control towers except to verify or clarify instructions. Remember, other pilots are waiting to use the channel.

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XI. TEACHING AIDS

The following teaching aids are recommended:

1. Airport Model. Include runways, wind tee, and control tower. Construct with paper, cardboard, cloth, or other readily available materials.

2. Model Aircraft. Construct with note paper. Use directions in the MODEL AIRCRAFT LABORATORY pamphlet listed in the bibliography.

3. Model Spacecraft Center. Construct with note paper, cardboard, or other available materials.

4. Globe. Available in classroom or school library. Use desk lamp to cast shadows, show day and night, and visualize spacecraft orbits.

5. Bulletin Board. Display charts showing International Phonetic Alphabet and pronunciation of numbers, words, and phrases used in radiotelephone communications.

6. Classroom Exhibits. Use models, pictures, or cutouts of aircraft, space vehicles, tracking stations, control towers, or other air or space equipment.

7. Student Workbook. Available in quantity for use with this guide. Write to National Headquarters, Civil Air Patrol, Maxwell Air Force Base, Alabama 36112, for free copies.

8. Communications Trainers (Basic). Construct using two tin cans, waxed string, and buttons, as follows:

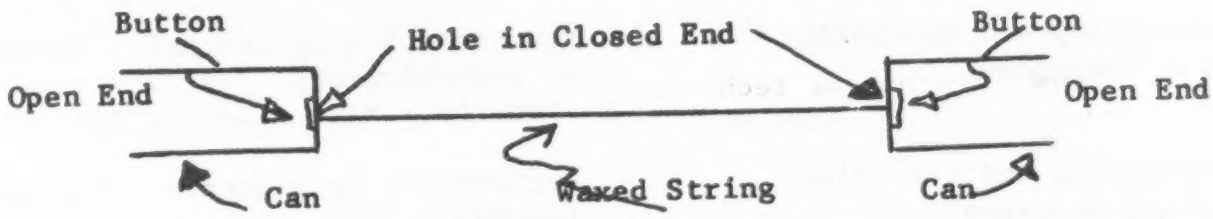

9. Communications Trainers (Tube). Use long paper tubes, such as mailing containers. Glue together short sections to provide desired length.

10. Communications Trainers (Electronic). Use modified tape recorders, walkie-talkies, or other electronic communications equipment.

11. Recordings. Obtain and use recordings of aviation and space radio communications.

12. Printed Message. Newspapers, magazines, and other publications print the entire text or selected parts of aerospace communications during special air and space events. Obtain and use these to stimulate additional interest.

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XII. TEACHING METHODS AND TECHNIQUES

Topic	Suggested Teaching Methods
International Phonetic Alphabet	Use INTERNATIONAL PHONETIC ALPHABET: A PROGRAMED LEARNING EXERCISE. (See bibliography.)
Code Word Pronunciation	Demonstration by teacher. Performance by students. Recitation. Test.
Aerospace Words and Phrases	Demonstration by teacher. Performance by students. Recitation. Test.
Pronunciation of Numbers	Demonstration by teacher. Performance by students. Recitation. Test.
Parts of a Message	Demonstration by teacher. Performance by students. Recitation. Test.
Message Procedure	Demonstration by teacher. Identification by students. Performance by students. Practice communications.
Aircraft Call Signs	Designation of students. Demonstration by teacher. Performance by students. Practice communications.
Microphone Technique	Demonstration by teacher. Practice communications.
Transmitting and Receiving Sample Messages	Demonstration by teacher. Designation of communicators. Performance by students. Evaluation by teacher.
Transmitting and Receiving Original Messages	Performance by students. Evaluation by teacher.

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XIII. ROLE PLAYING

Educational authorities agree that students learn best by doing. Role playing offers an excellent opportunity for students to project themselves into the roles of pilots, astronauts, control tower operators, and space capsule communicators.

A simple method of doing this is to assign each student a call sign and having each "report" or respond to roll call each day using aerospace communications procedures.

The following technique is suggested: Assign each teacher a call sign, such as BAKER TOWER. Assign each student a call sign, such as CESSNA WUN NIN-ER (roll number), followed by the initials of the student's first and last names. (CESSNA WUN NIN-ER GOLF HOTEL would be the call sign of student number 19 on the roll, whose name is George Holt.) Have the students respond to roll call using the above procedures.

As the course progresses and the students become more proficient, role playing may progress to include origination, transmission, and reception of simulated aerospace messages that stimulate additional interest and generate new motivation. Students should be encouraged to participate in role-playing activities to develop proficiency in the origination, transmission, and receipt of the following types of messages: (1) Pilot to Tower, (2) Astronaut to Capsule Communicator, (3) Tower to Pilot, (4) Capsule Communicator to Astronaut.

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XIV. BIBLIOGRAPHY

AIRMAN'S INFORMATION MANUAL. Washington, D. C.: Federal Aviation Administration. 1967. $13.00 annual subscription. Published in three parts and can be purchased separately: Part 1, Basic Flight Manual and ATC Procedures - $2.00; Part 2, Airport Directory - $2.00; and Part 3 and 3a, Operational Data and Notices to Airmen -- $9.00.

AIRPORTS, AIRWAYS, AND ELECTRONICS. National Headquarters, Civil Air Maxwell Air Force Base, Alabama, 36112. 1963. 75¢

DAWNING SPACE AGE, THE. National Headquarters, Civil Air Patrol, Maxwell Air Force Base, Alabama 36112

INTERNATIONAL PHONETIC ALPHABET: A PROGRAMMED LEARNING EXERCISE, THE. National Headquarters, Civil Air Patrol, Maxwell Air Force Base, Alabama 36112. 1964. 15¢

INTRODUCTION TO AEROSPACE. National Headquarters, Civil Air Patrol, Maxwell Air Force Base, Alabama 36112. 1963 75¢

MODEL AIRCRAFT LABORATORY. National Headquarters, Civil Air Patrol, Maxwell Air Force Base, Alabama 36112. 1964. Free.

XV. GLOSSARY

Aerospace. The earth's atmosphere and the space above it.

Apogee. That point in an orbit that is most distant from the earth.

Base Leg. The segment of a landing pattern just before final approach.

Beechcraft. Aircraft manufactured by the Beech Aircraft Corporation.

Cap Comm. Space Capsule Communicator.

Cessna. Aircraft manufactured by the Cessna Aircraft Company.

Control Tower. A tower at an airport that is operated to regulate air traffic.

Piper. Aircraft manufactured by the Piper Aircraft Corporation.

Recovery. The act of retrieving a space vehicle after launch.

Runway. An airport surface used by aircraft to take off and land.

Taxi. Moving an aircraft on the ground, under its own power.

Tracking Station. A station set up to track an object moving through air or space.

Traffic Pattern. The routes above an airport that are followed by aircraft before landing and after takeoff.

Wind Tee. A large weather vane shaped like a "T" or like an airplane.

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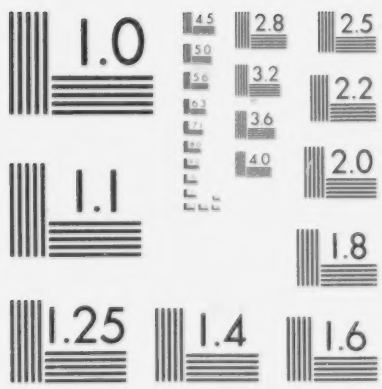

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OBJECTIVE: To learn how to make and use revolved sections.

RELATED INFORMATION:

In machine drafting, sections play an important role in visualizing a part. Without sectional views it would be extremely difficult to illustrate a part clearly in a drawing, or, in many cases, impossible to understand a part at all. In the case of the support arm shown in Fig. 1, it would not be possible, from the two views shown, to know if the top of the web were rounded off or if it were rectangular. The revolved section clearly describes the top of the web and shows that it is rounded off.

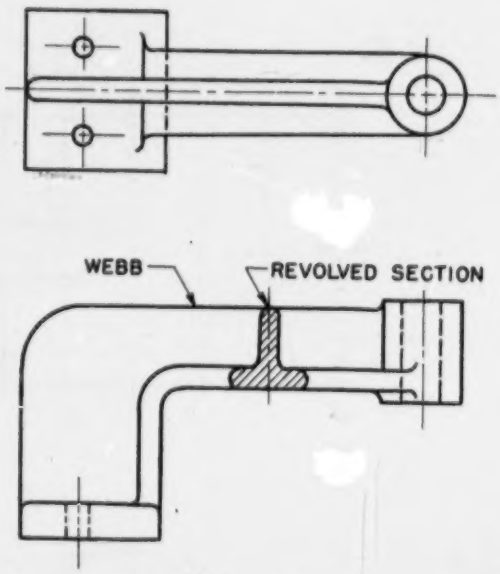

FIG. 1

A similar condition exists for the link shown in Fig. 2. Without the revolved section, the part connecting the cylinders could be rectangular instead of elliptical.

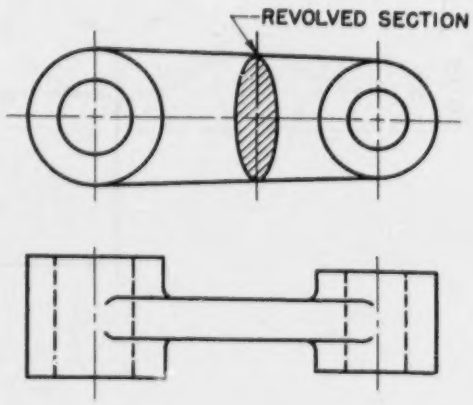

FIG. 2

GOCI 1392

STUDENT WORKBOOK

AEROSPACE COMMUNICATIONS LABORATORY

Name _____

Call Sign _____

Teacher _____

Room Number _____

School _____

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STUDENT WORKBOOK

AEROSPACE COMMUNICATIONS LABORATORY

I. MY CALL SIGN

My call sign is _____

II. AEROSPACE MESSAGES

As a pilot I will be talking with _____
(Teacher's Call Sign)

As an astronaut I will be talking with _____
(Teacher's Call Sign)

III. THE INTERNATIONAL PHONETIC ALPHABET

The code words in the International Phonetic Alphabet are:

A - _____	J - _____	R - _____
B - _____	K - _____	S - _____
C - _____	L - _____	T - _____
D - _____	M - _____	U - _____
E - _____	N - _____	V - _____
F - _____	O - _____	W - _____
G - _____	P - _____	X - _____
H - _____	Q - _____	Y - _____
I - _____		Z - _____

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IV. HOW NUMBERS ARE SPOKEN

Numbers spoken over the radio are pronounced to sound like this. (Write in the sound of each number. Pronounce each number aloud.)

Number	Sound	Number	Sound
1	_____	6	_____
2	_____	7	_____
3	_____	8	_____
4	_____	9	_____
5	_____	0	_____

V. AEROSPACE WORDS AND PHRASES

These words and phrases are used in air and space communications. This is what they mean:

Words and Phrases	Meaning
Over	_____
Roger	_____
Out	_____
Say again	_____
Wilco	_____
Correction	_____
Negative	_____
Speak slower	_____
Stand by	_____
I say again	_____
Go ahead	_____
That is correct	_____
Do you hear me	_____

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VI. PARTS OF A MESSAGE

Each radio message has three parts. The three parts are (A) the Call-Up, (B) the Message, and (C) the Ending.

(A) Example of a Call-Up

Pilot: "Galveston Tower, this is Cessna Ait Wun Too Wun. Over."

Tower: "Cessna Ait Wun Too Wun, this is Galveston Tower. Over."

Write two other Call-Ups here:

1. Pilot: _____

   Tower: _____

2. Pilot: _____

   Tower: _____

(B) Example of a Message

Pilot: "Galveston Tower, this is Cessna Ait Wun Too Wun. Request landing instructions. Over."

Tower: "Cessna Ait Wun Too Wun, this is Galveston Tower. Runway Wun Six. Over."

Write two other Messages here:

1. Pilot: _____

   Tower: _____

2. Pilot: _____

   Tower: _____

(C) Example of an Ending

Pilot: "Galveston Tower, this is Cessna Ait Wun Fow-er Wun. Roger. Out."

Tower: "Cessna Ait Wun Fow-er Wun, this is Galveston Tower. Out."

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Write two other Endings here:

1. Pilot: _____

   Tower: _____

2. Pilot: _____

   Tower: _____

V. AIRCRAFT CALL SIGNS

Civilian Pilots

Civilian pilots use the make of their aircraft and its certification number, like this:

"Cessna Nin-er Sev-en Six Zero" (This is Cessna Aircraft Number 9760.)

Write two more civilian pilot call signs here:

1. _____

2. _____

Airline Pilots

Airline pilots use the airline name and the flight number, like this:

"United Too Fife" (This is United Air Lines Flight No. 25.)

Write two more airline pilot call signs here:

1. _____

2. _____

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Military Pilots

Military pilots frequently use the name of their Service, followed by the last five numbers in their aircraft's serial number, like this:

"Air Force Wun Wun Too Wun Six" (This is Aircraft Number 11216.)

Write in here the call sign used by two other military pilots:

1. _____

2. _____

Student Call Signs

Your teacher has assigned each student a call sign. Write in the call signs of two other students here:

1. _____

2. _____

VI. SAMPLE MESSAGES

Here is a sample message from a pilot requesting taxi and takeoff instructions:

Pilot: "Baker Tower, this is Cessna Wun Wun Too Wun. Over."

Tower: "Cessna Wun Wun Too Wun, this is Baker Tower. Over."

Pilot: "Baker Tower, this is Cessna Wun Wun Too Wun. Request taxi and takeoff instructions. Over."

Tower: "Cessna Wun Wun Too Wun, this is Baker Tower. Cleared to runway Wun Ait. Wind Wun Six Zero degrees at Wun Tree. Over.

Pilot: "Baker Tower, this is Cessna Wun Wun Too Wun. Roger. Out."

Your Messages

Use your own call sign and write in here another message requesting information:

Pilot: _____

_____

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Tower: _____

_____

Pilot: _____

_____

Tower: _____

_____

Pilot: _____

_____

Use this space to write other types of messages as follows:

1. Pilot to Tower
2. Astronaut to Cap Comm
3. Tower to Pilot
4. Cap Comm to Astronaut

<u>Pilot to Tower</u>

1. Pilot: _____

_____

Tower: _____

_____

Pilot: _____

_____

Tower: _____

_____

Pilot: _____

_____

<u>Astronaut to Cap Comm</u>

2. Astronaut: _____

_____

Cap Comm: _____

_____

Astronaut: _____

_____

Cap Comm: _____

_____

Astronaut: _____

_____

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Tower to Pilot

3. Tower: _____

Pilot: _____

Tower: _____

Pilot: _____

Tower: _____

Cap Comm to Astronaut

4. Cap Comm: _____

Astronaut: _____

Cap Comm: _____

Astronaut: _____

Cap Comm: _____

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BAKER SCHOOL
AEROSPACE COMMUNICATIONS LABORATORY
CALL SIGN ROSTER

*TEACHER: MRS. HELEN WILKENING. AIRCRAFT: BEECHCRAFT. SPACECRAFT: GEMINI.
MRS. WILKENING'S CALL SIGNS: (AIR) BEECHCRAFT ZERO H W; (SPACE) GEMINI ZERO H W

1. CYNTHIA ARNOLD:	(BEECHCRAFT 1 CA (GEMINI 1 CA	16. THERESA PALMER:	(BEECHCRAFT 16 TP (GEMINI 16 TP
2. JOE CHAPMAN:	(BEECHCRAFT 2 JC (GEMINI 2 JC	17. JAIMIE LU PARKER:	(BEECHCRAFT 17 JP (GEMINI 17 JP
3. ROBERT CHAVIERS:	(BEECHCRAFT 3 RC (GEMINI 3 RC	18. DANIEL PORTER:	(BEECHCRAFT 18 DP (GEMINI 18 DP
4. STEPHEN CHILDERS:	(BEECHCRAFT 4 SC (GEMINI 4 SC	19. JIMMY PUCKETT:	(BEECHCRAFT 19 JP (GEMINI 19 JP
5. DEBRA FLORANCE:	(BEECHCRAFT 5 DF (GEMINI 5 DF	20. RONALD QUESTED:	(BEECHCRAFT 20 RQ (GEMINI 20 RQ
6. TERRI GARRETT:	(BEECHCRAFT 6 TG (GEMINI 6 TG	21. WERNER ROBERSON:	(BEECHCRAFT 21 WR (GEMINI 21 WR
7. MARK GRANGER:	(BEECHCRAFT 7 MG (GEMINI 7 MG	22. KEITH RUENHECK:	(BEECHCRAFT 22 KR (GEMINI 22 KR
8. CHRIS HOLMES:	(BEECHCRAFT 8 CH (GEMINI 8 CH	23. MARK RUSHING:	(BEECHCRAFT 23 MR (GEMINI 23 MR
9. TERRI LEE HUSS:	(BEECHCRAFT 9 TH (GEMINI 9 TH	24. RANDY STOCKWELL:	(BEECHCRAFT 24 RS (GEMINI 24 RS
10. RACHEL JOHNSON:	(BEECHCRAFT 10 RJ (GEMINI 10 RJ	25. THERESA ANN THROWER:	(BEECHCRAFT 25 TT (GEMINI 25 TT
11. GREGG JONES:	(BEECHCRAFT 11 GJ (GEMINI 11 GJ	26. PATRICIA TOMBERLIN:	(BEECHCRAFT 26 PT (GEMINI 26 PT
12. ANITA KULBETH:	(BEECHCRAFT 12 AK (GEMINI 12 AK	27. MICHAEL TRAYLOR:	(BEECHCRAFT 27 MT (GEMINI 27 MT
13. DANIEL MC NEILL:	(BEECHCRAFT 13 DM (GEMINI 13 DM	28. STEPHEN WOOD:	(BEECHCRAFT 28 SW (GEMINI 28 SW
14. MICHAEL MILLS:	(BEECHCRAFT 14 MM (GEMINI 14 MM	29. DANETTE MOSTEIT:	(BEECHCRAFT 29 DM (GEMINI 29 DM
15. GAINES OTWELL:	(BEECHCRAFT 15 GO (GEMINI 15 GO		

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BAKER SCHOOL
AEROSPACE COMMUNICATIONS LABORATORY
CALL SIGN ROSTER

*TEACHER: MISS BLANCHE MILLER. AIRCRAFT: CESSNA. SPACECRAFT: APOLLO
MISS MILLER'S CALL SIGNS: (AIR) CESSNA ZERO B M; (SPACE) APOLLO ZERO B M

1.	DIANE ASKINS:	(CESSNA 1 DA (APOLLO 1 DA	16.	TODD MALONE:	(CESSNA 16 TM (APOLLO 16 TM
2.	MIKE BOAZE:	(CESSNA 2 MB (APOLLO 2 MB	17.	ANDREA MARTIN:	(CESSNA 17 AM (APOLLO 17 AM
3.	DARLENE BOOTH:	(CESSNA 3 DB (APOLLO 3 DB	18.	TERRY MILLER:	(CESSNA 18 TM (APOLLO 18 TM
4.	TERRI BUXTON:	(CESSNA 4 TB (APOLLO 4 TB	19.	MARK NEBRIG:	(CESSNA 19 MN (APOLLO 19 MN
5.	ROY FOLLIS:	(CESSNA 5 RF (APOLLO 5 RF	20.	CARY NELSON:	(CESSNA 20 CN (APOLLO 20 CN
6.	TERESA FREEMAN:	(CESSNA 6 TF (APOLLO 6 TF	21.	GARY SHORT:	(CESSNA 21 GS (APOLLO 21 GS
7.	CAROLYN GOAD:	(CESSNA 7 CG (APOLLO 7 CG	22.	JAIMIE SLIGHT:	(CESSNA 22 JS (APOLLO 22 JS
8.	KENNETH GOLDEN:	(CESSNA 8 KG (APOLLO 8 KG	23.	JEFFREY SORENSON:	(CESSNA 23 JS (APOLLO 23 JS
9.	STEPHEN HARDESTY:	(CESSNA 9 SH (APOLLO 9 SH	24.	VICKI SUTHERS:	(CESSNA 24 VS (APOLLO 24 VS
10.	GINNY HAULBROOK:	(CESSNA 10 GH (APOLLO 10 GH	25.	WALTER TILTON:	(CESSNA 25 WT (APOLLO 25 WT
11.	CYNTHIA HAWES:	(CESSNA 11 CH (APOLLO 11 CH	26.	SCOTT WILLIAMS:	(CESSNA 26 SW (APOLLO 26 SW
12.	MIKE JESSIE:	(CESSNA 12 MJ (APOLLO 12 MJ	27.	ERNIE WOODALL:	(CESSNA 27 EW (APOLLO 27 EW
13.	DEBRA KILPATRICK:	(CESSNA 13 DK (APOLLO 13 DK	28.	VALERIE DORTCH:	(CESSNA 28 VD (APOLLO 28 VD
14.	DOUGLAS LANE:	(CESSNA 14 DL (APOLLO 14 DL	29.	LINDA SCHMIDT:	(CESSNA 29 LS (APOLLO 29 LS
15.	LOU LUEDICKE:	(CESSNA 15 LL (APOLLO 15 LL	30.	ROSEMARY LOKKEN:	(CESSNA 30 RL (APOLLO 30 RL

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ASSIGNMENT:

In the drawing below, a front and top view are given, showing a revolved section. Draw the two views shown, including the revolved section, and add a right-side view. Dimension fully.

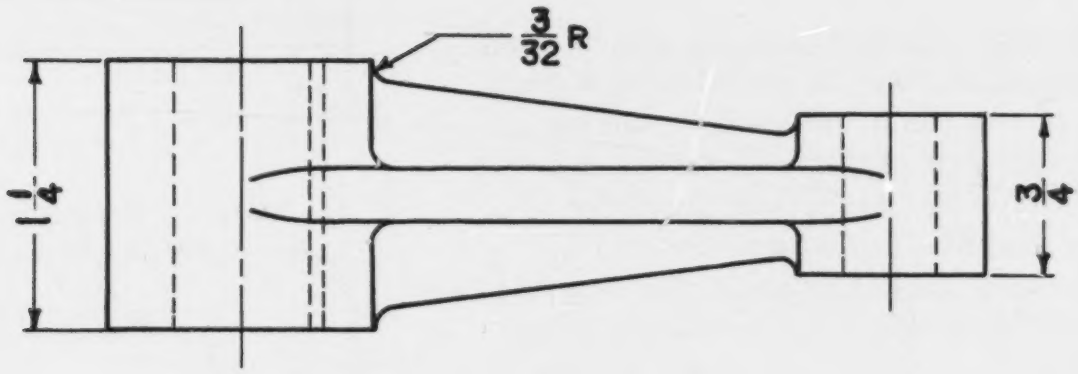

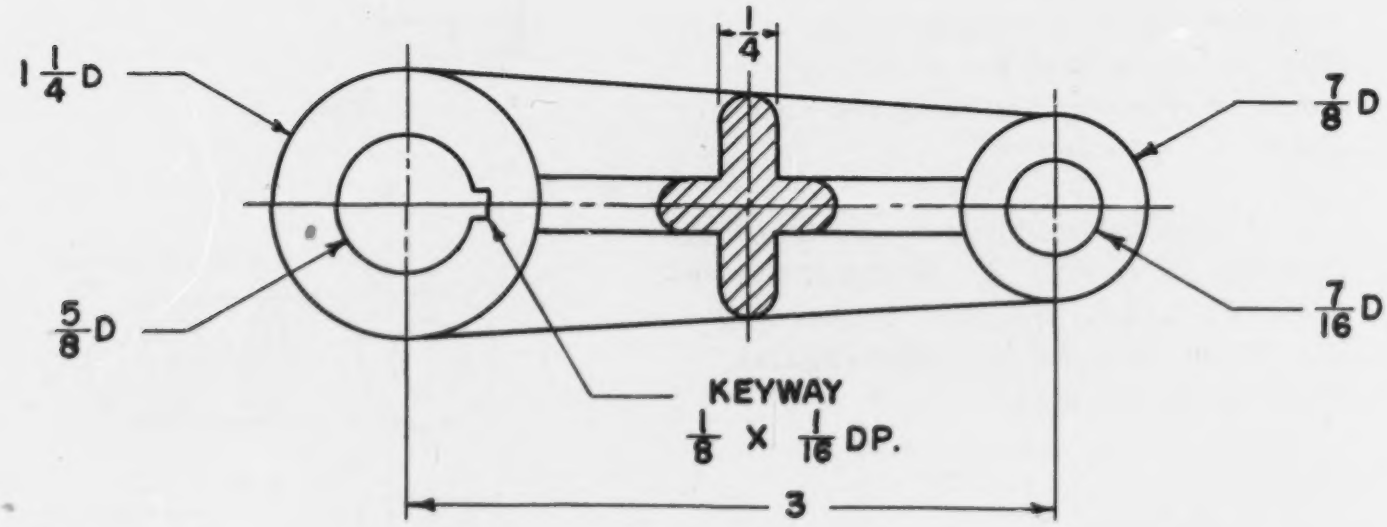

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BAKER SCHOOL
AEROSPACE COMMUNICATIONS LABORATORY
CALL SIGN ROSTER

*TEACHER: MRS. YETIVE RAMSAY. AIRCRAFT: PIPER. SPACECRAFT: MERCURY.
MRS. RAMSAY'S CALL SIGNS: (AIR) PIPER ZERO Y R; (SPACE) MERCURY ZERO Y R

1.	MARLA BENTER:	(PIPER 1 MB (MERCURY 1 MB	16.	LORI LOWE:	(PIPER 16 LL (MERCURY 16 LL
2.	JANET CARMIN:	(PIPER 2 JC (MERCURY 2 JC	17.	DIANNE LUND:	(PIPER 17 DL (MERCURY 17 DL
3.	CECIL CARROLL:	(PIPER 3 CC (MERCURY 3 CC	18.	BUFFORD MOORE:	(PIPER 18 BM (MERCURY 18 BM
4.	BILLY CLEMMONS:	(PIPER 4 BC (MERCURY 4 BC	19.	ELAINE PADGETT:	(PIPER 19 EP (MERCURY 19 EP
5.	DIANNE COX:	(PIPER 5 DC (MERCURY 5 DC	20.	HENRY RODRIGUEZ:	(PIPER 20 HR (MERCURY 20 HR
6.	JOHN DAVIS:	(PIPER 6 JD (MERCURY 6 JD	21.	ALLAN STEGALL:	(PIPER 21 AS (MERCURY 21 AS
7.	RICHARD FOLLIS:	(PIPER 7 RF (MERCURY 7 RF	22.	CHARLES THOMAS:	(PIPER 22 CT (MERCURY 22 CT
8.	DEBORAH GOSS:	(PIPER 8 DG (MERCURY 8 DG	23.	JULIE THOMPSON:	(PIPER 23 JT (MERCURY 23 JT
9.	STEPHEN HALL:	(PIPER 9 SH (MERCURY 9 SH	24.	DONALD VEAL:	(PIPER 24 DV (MERCURY 24 DV
10.	DAVID HARPOLD:	(PIPER 10 DH (MERCURY 10 DH	25.	PATRICIA WALKER:	(PIPER 25 PW (MERCURY 25 PW
11.	RICHARD HOGAN:	(PIPER 11 RH (MERCURY 11 RH	26.	SPENCER WOLFE:	(PIPER 26 SW (MERCURY 26 SW
12.	TERRY IVEY:	(PIPER 12 TI (MERCURY 12 TI	27.	ELAINE ROSENBAUM:	(PIPER 27 ER (MERCURY 27 ER
13.	MICHALL KING:	(PIPER 13 MK (MERCURY 13 MK	28.	DEBORAH HAMM:	(PIPER 28 DH (MERCURY 28 DH
14.	TERI ANN KUEHL:	(PIPER 14 TK (MERCURY 14 TK	29.	JOY HAAS:	(PIPER 29 JH (MERCURY 29 JH
15.	ELIZABETH LIND:	(PIPER 15 EL (MERCURY 15 EL			

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Montana Aeronautics Committee
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ABSTRACT - Designed as a 1-semester course in aviation science, this teaching guide was developed by educators and aviation personnel as a means of teaching practical physical science to high school students. A secondary purpose of the course is to inform students of career opportunities available in this field. Arranged in 14 chapters, the guide outlines information on: (1) Power Plant, (2) Aerodynamics, (3) Basic Flight Instruments, (4) Airports, (5) Instrument Flying, (6) Flight Planning, and (7) Careers and Vocational Opportunities. Objectives and suggested teaching methods are listed for each chapter. A glossary, sources of teaching aids, and list of flight line operators in Montana are appended. (JS)

VT 012 800

ED0 56238

A STUDY GUIDE IN

AVIATION SCIENCE

for

GRADES 11 & 12

Developed by

Aviation Science Guide Committee

* * *

STATE DEPARTMENT OF PUBLIC INSTRUCTION

MONTANA AERONAUTICS COMMISSION

1965

Harriet Miller
State Superintendent of Public Instruction
Helena, Montana

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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TO THE TEACHER

This course guide was formulated to serve those secondary schools wishing to offer a sound course in aviation science.

That such a course could be valuable is demonstrated by: (1) the fact that civil aviation has experienced a tremendous growth during the past few years, with future projections showing the growth trend will continue; (2) that a large number of young people now in school will earn their living in some segment of aviation; (3) that basic scientific principles can be more easily taught if placed in a context interesting to the student; (4) that citizenship in a society influenced so much by aviation requires some degree of understanding of what it involves.

The emphasis in this outline is not directed toward teaching the student to fly; indeed, the airplane will be used only as a laboratory tool in demonstrating certain learnings. Rather, the emphasis is on learning practical physical science.

The committee who developed this guide are:

Dr. Wesley Caspers, Dean of Education, Western Montana College, Dillon, Montana.
Mr. Robert Anderson, Science Instructor, Great Falls High School, Great Falls, Montana.
Mr. Wayne Hoffman, Science Instructor, Helena High School, Helena, Montana.
Mr. Ronald Kologi, Science Instructor, Shelby High School, Shelby, Montana, and instructor at Aviation Education Workshop, Montana State University, Missoula, Montana, in 1964.
Mr. William Young, Science Instructor, Broadus High School, Broadus, Montana.
Mr. Jack Hughes, Chief Pilot, Johnson Flying Service, Missoula, Montana, technical consultant.
Mrs. Mary Jo Janey, Supervisor of Aviation Education, Department of Public Instruction and Montana Aeronautics Commission, Helena, Montana. (As of '66 assoc'd w/Cessna Aircraft Co.)
Mrs. Imogene Peek, secretary to the committee, Helena, Montana.

In addition to developing the course guide, the committee made the following suggestions: (1) that it be offered at the 11th and 12th grade level; (2) that math requirements be at least a year of algebra, with some geometry desirable. It is a one-semester course.

Each chapter has its own objectives and varying suggestions for methods. The appendix contains film lists, bibliography, and glossary of terms, as well as other items of interest. An optional chapter has been included to cover career opportunities in aviation. The chapter arrangement was purposely designed to provide maximum motivational effect,

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and at the same time to be in logical sequence. Individual teachers may wish to modify the sequence to suit themselves.

The committee recognizes that use of the outline will reveal weaknesses, and it urges that teachers using the outline write their recommendations to the committee to be considered when the guide is put in final form.

Basic textbooks recommended for use in the course are: Fundamentals of Aviation and Space Technology, University of Illinois, Urbana, Illinois; Private Pilot's Handbook of Aeronautical Knowledge, Federal Aviation Administration, Washington, D. C. 20590.

Other resource material will be necessary. The starred items in the bibliography can be considered necessary classroom material, but need not be furnished to all students.

Other equipment needs will be noted in each chapter outline.

Now a word about the use of airplanes in this course. Maximum effectiveness of the course will be achieved by planned use of airplanes, the airport, and airport facilities through field trips, suggestions for which are made in the appropriate chapter outlines. These will be used as a community resource to enhance motivation. It will be noted that in the opening chapter an early visit to the airport with an orientation or familiarization ride in an airplane is strongly recommended. This visit and flight will provide the springboard for launching the succeeding chapters.

Schools will find local flight operators to be very cooperative in supporting activities connected with the course. Most will provide the flight portions at cost. It would be advisable to consult with the local operator well in advance of the course, as he may have valuable suggestions. A listing of most local operators will be found in the appendix.

Finally, the Supervisor of Aviation Education will be available to assist in any way possible.

The committee would like to acknowledge and commend the Montana Aeronautics Commission, whose financial assistance made the course guide possible. Thanks go also to the Federal Aviation Administration, the administrators of Great Falls Public High School, Shelby High School, Broadus High School, Helena High School, Western Montana College, and the Montana Aviation Trades Association for support and encouragement.

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AVIATION SCIENCE

I. INTRODUCTION

Objectives: (1) To develop interest and a favorable attitude toward the course; to allay fears.
(2) To develop general familiarity with aircraft, with emphasis on personal flying.

Suggested Methods: Field trip to the airport.
Visual devices such as pictures, slides, films.

A. You probably can and probably should become a pilot.

1. Business and pleasure of flying

a. Speed and convenience
b. Extent of private plane use
c. Brief survey of occupational opportunities

2. Preparations for flying

a. Many similarities to an automobile (gas,oil,tires, mechanical inspections)
b. Major differences in the medium of air (wing, propeller,electrical systems)
c. Orientation rides, etc.

3. Taxi to the warm-up area

a. Warm-up check list
b. Communications with the tower (police function of the FAA)
c. The student and private pilot's license

4. One function of this course is to prepare for written FAA exam.

a. Nature of the exam
b. Relationship of examined knowledge to ability to fly

B. Know your aircraft

1. Advantages and disadvantages of current types

a. Tricycle gear
b. High or low wing
c. Helicopters, VTOL aircraft
d. Recognition drills

2. Flying characteristics of various common types

a. Manuals of various aircraft
b. Aircraft operation and limitations
c. Aircraft operation manuals

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3. A short history and trends in aircraft development

   a. Improvements in controls and stability
   b. Jet engines for private aircraft

4. The trainer--advantages and disadvantages

   a. Types
   b. Availability in local area

C. Getting up is easy

1. Check list for take-off

2. Take-off procedure

3. Flying speed

   a. Lift in air
   b. Maintaining thrust
   c. Stalls and slips

4. Straight and level flight

   a. Control surfaces
   b. The trim tabs or controls
   c. Slight adjustments--big corrections

D. Landing is a bit more difficult

1. Gliding

   a. Drag
   b. Gravity

2. Momentum

   a. Potential energy
   b. Newton's Laws

3. Effect of winds

4. Round-out, float and touch down

5. Relax slowly

   a. Ground loops
   b. Emergency procedures

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E. Caution and knowledge will keep you alive.

1. Weather dangers
2. Aircraft dangers
3. Pilot error

   a. Physiological
   b. Attitudes toward regulations
   c. Alcohol and gas do not mix

4. Regulations to protect the pilot and public

   a. General operating and air traffic rules
   b. Regulation of the student pilot

5. Overview of course stressing <u>reasons</u> for knowing

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II. POWER PLANTS

Objectives: (1) To understand reliability of engines
(2) To understand basic thrust
(3) To know advantages and disadvantages of different types of power plants

Methods: Audio-visual aids, films, filmstrips, etc.
Demonstrate model engines, aircraft, auto, other.
Experiments showing combustion, etc.
(Bivisible engines are available at hobby supply shops.)

A. Reciprocating Engine

1. Types of engines

a. Inline
b. V type
c. Fantype (Double V)
d. X type
e. Opposed (flat type)
f. Radial type

1. Single row
2. Double row

2. Engine Parts

a. Cylinder
b. Crankshaft
c. Piston
d. Connecting rod
e. Valves

3. Four cycle principle

a. Intake
b. Compression
c. Power
d. Exhaust

4. Lubrication system

a. Wet-sump
b. Dry-sump

5. Fuels

a. Octane
b. Quality
c. Full systems

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OBJECTIVE: To learn how to make and use full sections.

RELATED INFORMATION:

A full section is a part drawn as though cut in half. By this theoretical halving, it is possible to visualize clearly the interior of the part. Drawing the section also eliminates many dashed lines, which often make reading or visualizing very difficult.

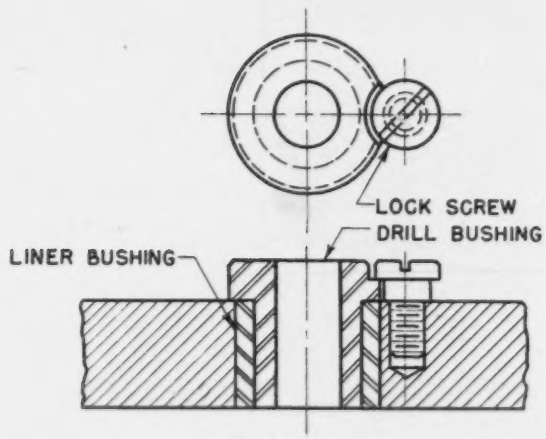

FULL SECTION

FIG. 1

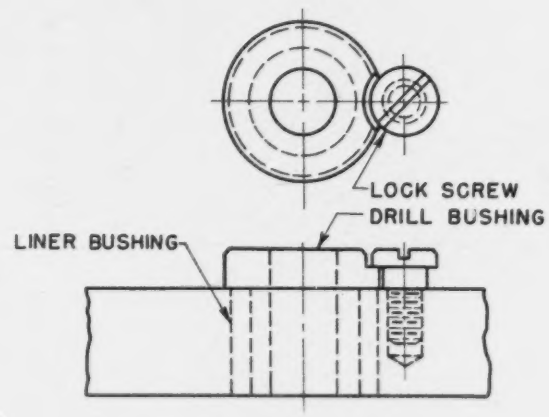

VIEW NOT SECTIONED

FIG. 2

Fig. 1 is an example of a full section. Compare this with Fig. 2, which is the same drawing but not sectioned. It can easily be seen which view is clearer. Note the absence of difficult-to-read dashed lines in the sectional view; instead you see solid lines and cross-hatch lines drawn at 45° in opposite directions by the draftsman. These lines aid you to read and visualize much more clearly. Shafts, pins, screws, rivets, and bolts are not cross hatched.

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6. Carburetors

   a. Types of carburetors

      1. Float-type
      2. Pressure
      3. Direct injection

   b. Supercharger
   c. Carburetor icing

7. Ignition system

   a. Magneto
   b. Distributor
   c. Spark plug
   d. Two complete ignition systems

      1. Better ignition
      2. Safety factor

8. Cooling system

   a. Liquid cooled
   b. Air cooled
   c. Oil cooled

B. Jets

   1. Newton's Laws
   2. Ramjet
   3. Pulse Jet
   4. Turbojet

      a. Air compressor
      b. Combustion chamber
      c. Turbine wheel

   5. Turboprop
   6. Turbofan
   7. Augmentation

      a. Afterburner
      b. Water injection

   8. Sound-suppressor
   9. Thrust reverser

C. Rockets

   1. History

      a. Chinese
      b. Dr. Goddard

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1. United States
2. Germany

c. Military application

2. Solid-Propellant rocket

a. Unrestricted burning
b. Restricted burning

3. Liquid-Propellant rocket

a. Monopropellant
b. Bipropellant

4. Nuclear rocket
5. Ion rocket
6. Plasma, photon and water rockets

D. Maintenance and operations of power plants

1. Regulations, FAA
2. Safety Practices (care and feeding of engines)

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III. AERODYNAMICS

Objectives: (1) To understand what makes an airplane fly.
(2) To understand that an airplane will fly without power.

Methods: Use dime-store model gliders.
Construct propellers from balsa wood. Use spool, shaft, string and propeller to show lift.

Build models for demonstration.
Build wind tunnel. (Surplus property may be checked for instruments, blowers, etc.)

A. Aerodynamics

1. Subsonic)
2. Transonic) Characteristics
3. Supersonic)

B. Theory of Flight

1. Air as a fluid
2. Lift

   a. Bernouli's Principle (Venturi)

      1. Negative pressure
      2. Positive pressure

   b. Airfoils

      1. Leading edge
      2. Trailing edge
      3. Chord line
      4. Camber

   c. Angle of incidence
   d. Angle of attack

3. Gravity

   a. Center of gravity
   b. Acceleration

4. Thrust

   a. Torque
   b. Propeller - Airfoil

      1. Fixed-pitch
      2. Adjustable-Pitch
      3. Controllable-Pitch

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4. Constant-speed
5. Feathering
6. Reverse thrust

5. Drag

   a. Parasitic
   b. Induced
   c. Streamline

6. Equilibrium

   a. Balance of forces
   b. Forces of inertia

7. Application of theory and controlling an aircraft (attitude)

   a. Pitch
   b. Yaw
   c. Roll
   d. Speed

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IV. GENERAL STRUCTURE OF AIRCRAFT

Objectives: (1) To understand how aircraft are built for strength, light weight, and aerodynamic efficiency.

Methods: Films, field trip to maintenance shop, model building

A. Lighter-than-air craft

B. Heavier-than-air craft

1. Wings

a. Method of wing attachment

1. High-wing
2. Low-wing
3. Midwing

b. Structure

1. Aluminum
2. Fabric

c. Secured to airplane

1. Full cantilever
2. Externally braced

d. Ailerons
e. Flaps
f. Rotary wing aircraft

2. Fuselage

a. Aerodynamic shape

1. Providing space for pay load
2. Streamlined

b. Structure

1. Truss - steel tubing
2. Semi-monocoque - metal skin

3. Empennage

a. Horizontal stabilizer

1. Elevator
2. Trim tab

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b. Vertical fin

1. Rudder
2. Trim tab

c. Tail rotor system

4. Landing Gear

a. Wheels

1. Conventional
2. Tricycle
3. Bicycle

b. Floats
c. Skis

5. Materials in structures

a. Metals

1. Steel
2. Aluminum
3. Magnesium
4. Titanium

b. Alloys

1. Stainless steel
2. Aluminum alloys
3. Bronze - brass

c. Non-metals

1. Plastics
2. Wood
3. Fibers

6. Regulations governing safety in aircraft structures

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V. BASIC FLIGHT INSTRUMENTS

Objectives: (1) To know that certain instruments are required for elementary flight.
(2) To interpret the display presented by the basic flight instruments.

Method: Build an instrument panel.

A. Airspeed indicator

B. Altimeters

1. Indicated altitude
2. True altitude
3. Density altitude
4. Absolute altitude

C. Magnetic compass

1. Compass deviation card

D. Directional gyro

E. Turn and Slip Indicator

1. Ball
2. Turn needle

F. Attitude indicator

G. Electric attitude indicators

H. Clock

I. Vertical velocity indicator

1. Determine rate of climb or descent

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VI. AIRPORTS

Objectives: (1) To know the function of the airport and its components
(2) To understand the orderly movement of air traffic on the ground and in flight
(3) To know the services provided at a modern airport

Methods: Build scale-model airport
Use diagrams and scale drawings of various airports
Films

A. Airport Traffic Control

1. Taxiing
2. Landing and Take-off
3. Taxi Patterns

   a. Downwind Leg
   b. Base Leg
   c. Final Approach

4. Light-Signal Procedures

   a. Amber light
   b. White rotating light
   c. Green and white rotating light

B. Air Traffic Control

1. Vertical Separation
2. Longitudinal Separation
3. Lateral Separation
4. Radar Traffic Control
5. IFR Clearances
6. Specified Altitude Clearance

C. Flight Following Function of the ATC Center

1. Position
2. Listening Watch

D. Control of Instrument Approaches

1. Holding
2. Stacking
3. Missed Approaches
4. Approach Control
5. Departure Control

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E. Emergency Procedures

1. Radar Assistance

F. Limitations of ATC

G. Services and Organizations

1. Flight operator

2. Federal Aviation Administration

a. Systems Research and Development Service
b. Flight Standards Service
c. Air Traffic Service
d. Airman's Information Manual

3. Civil Aeronautics Board

a. Organization
b. Functions

4. Montana Aeronautics Commission

a. Airport Directory
b. Search and Rescue

H. Federal Aviation Regulations

1. General Operating and Flight Rules - FAR 91
2. General - FAR 91 Subpart A 91.1 - 91.49
3. General Flight Rules - FAR 91 Subpart B - 91.61 - 91.104
4. Visual Flight Rules - FAR 91.105 - 91.109
5. Instrument Flight Rules - FAR 91.115 - 91.129
6. Air Traffic and General Operating Rules - FAR 93
7. Acrobatic Flight - FAR 91.71
8. Takeoff and Landing under IFR - FAR 91.117
9. Operation on and in the vicinity of an airport - FAR 91.85
10. Water operations - FAR 91.69
11. Flight plans - FAR 91.83

I. Field Trip to Airport

1. Layout
2. Services

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VII. NAVIGATION

Objectives: (1) To understand principles of cross-country flying
(2) To know basic flight planning procedure
(3) To increase map reading skills

Methods: Use maps, charts, films to demonstrate procedures.

Materials Needed: Charts, maps, protractor, ruler

A. The Globe

1. Introduction, Explanation

a. Our position in space
b. General properties
c. Revolution

1. Seasons
2. The Year

d. Rotation

1. Day and night
2. Time lines

e. The Earth Axis

1. Equinox
2. Solstice

2. The grid system on the globe

a. The great circle
b. Meridian, parallel, longitude, latitude
c. Great circle plotting and the spherimeter

3. Projections

a. Types

1. Cylindrical (mercator)
2. Conic (lambert conformal and polyconic)
3. gnomonic
4. polar

4. Charts, Navigation

a. Geographical
b. Landmark
c. Astrogation (celestial)

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ASSIGNMENT:

1. Draw the collar shown below in full section. Draw the centerlines first, then the end view. Project the circles and lay out the lengths of the sectioned view. Place all dimensions as indicated. Draw the cross-hatch lines at a 45° angle. The distance between these lines is approximately $\frac{1}{16}$ inch, spaced by eye. Do not use a mechanical device for spacing lines. Learn to space lines evenly by eye.

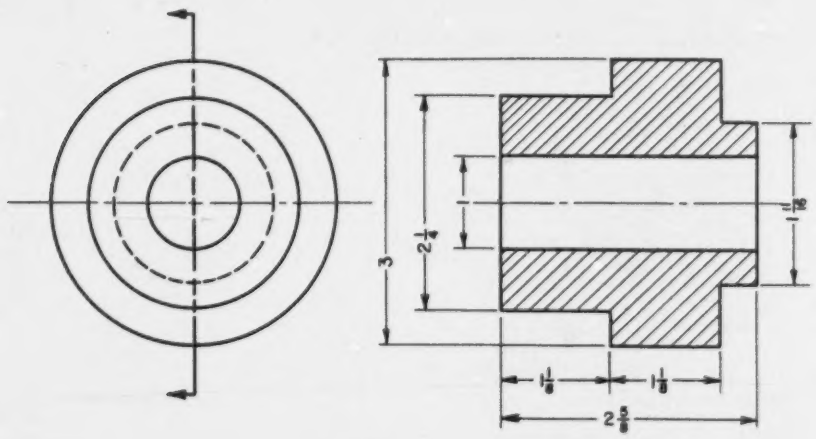

COLLAR
FULL SECTION

2. Draw the two views as shown below, with dimensions. Take a full section of the object through the center, as indicated by the heavy cutting-plane line.

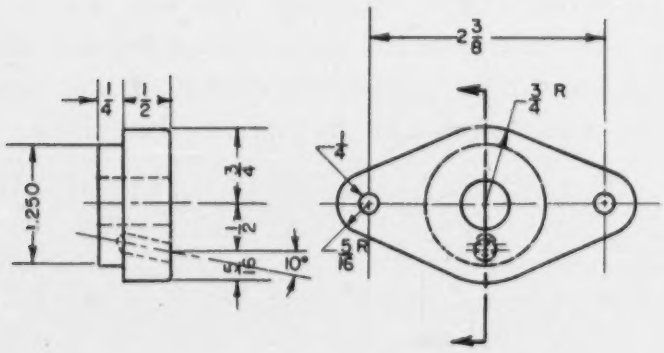

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d. Radio facilities
e. World
f. Sectional
g. Local
h. Planning
i. Route

B. Pilotage and Dead Reckoning

1. Definition and explanation

a. When and where used
b. Used by whom
c. Limitations

2. The sectional and world chart

a. Identification
b. Marginal information
c. Scale and distance measure
d. Position, latitude and longitude
e. True course line
f. The back of the chart
g. Chart folding
h. Renewal and additional charts
i. Obligations to correct

3. Dead reckoning problems

a. Wind drift
b. Variation
c. Deviation
d. Combining

true course

± wind drift =

true heading

± variation +

magnetic heading

± deviation +

compass heading

e. Ground speed
f. Flight time
g. Fuel rate (and consumption)
h. Planning an alternate airport

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4. Planning and Executing a Trip

   a. Find compass heading
   b. Check points
   c. Side and end brackets
   d. Indications of wind

C. Celestial Navigation (optional)

   1. Definition and Explanation

      a. When and where used
      b. Used by whom
      c. Pros and cons

   2. Use of sextant and tables
   3. Theory of "fixing" a position
   4. Methods of "fixing" a position

D. Radio Navigation

   1. Explanation and Definition

      a. When and where used
      b. Used by whom
      3. Pros and cons

(Covered further in Unit X)

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VIII. INSTRUMENTS AND SYSTEMS

Objectives: (1) To identify the more sophisticated instruments
(2) To understand the principles of their operations

Methods: Gyroscopes, suction pumps, pitot-static system, demonstrations, drawings and diagrams

A. Pitot-Static and Gyro-Suction Instruments

1. The Pitot-Static source and system
2. The vacuum source and system
3. Pitot-Static instruments

   a. Airspeed indicator

      1. I.A.S.
      2. C.A.S.
      3. T.A.S.

   b. Vertical speed indicator
   c. Altimeter

      1. Reading, setting
      2. Types
      3. Using the altimeter
      4. True altitude
      5. Pressure altitude
      6. Density altitude
      7. Absolute altitude
      8. Temperature correction
      9. Altitude errors

4. Gyro-Suction instruments

   a. The Gyroscope (properties)
   b. The turn and bank indicator

      1. The ball
      2. The turn needle

   c. Gyro-heading indicator

   d. Suction operated horizon indicator

      1. Errors
      2. Caging

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B. Electric Instruments

1. Electric source and system
2. Electric turn and bank indicator
3. Electric gyro heading indicator
4. Electric horizon indicator
5. Compass-controlled heading indicator

C. Miscellaneous Instruments

1. Magnetism and magnetic fields
2. Magnetic compass

   a. Variation
   b. Deviation
   c. Magnetic dip
   d. Acceleration error
   e. Oscillation error

3. Engine instruments

   a. tachometer and motor synchronizer

      1. Magneto check

   b. Oil temperature
   c. Oil pressure
   d. Fuel guage
   e. Manifold pressure
   f. Cylinderhead temperature

4. Radar instruments

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IX. INSTRUMENT FLYING

Definition: Any flight conducted without visual reference to the ground or horizon.

Objectives: (1) To give the student a basic understanding of the need for instrument flight
(2) To give the student an understanding of how these instruments are interpreted

Suggestions for introducing this unit:
(1) A brief history of the unexplained crashes of the early days
(2) Discussion of such terms as:
(a) Flying by the seat of the pants (deep sensations of the viscera)
(b) Graveyard spiral
(3) An explanation of the nature of the inner ear and how it functions
(a) Reasons for vertigo
(b) Need for disregarding sensations of vertigo when they conflict with instrument readings

Materials needed: Radio facilities, charts, plotters, computers

A. Attitude instrument flight, controls

Definition of Attitude: The relationship of the longitudinal axis and the lateral axis to the earth's surface or any plane parallel to the earth's surface.

1. Using the throttle to control altitude
2. Using the elevators to control the pitch
3. Bank control
4. Trim control

B. Fundamental aircraft accessories related to instrument flight

1. Pitot static tube
2. Venturi tube
3. Electrical system
4. Anti-icing equipment

C. Gyroscope, interpretation of

1. Momentum and its resistance to change of direction
2. Precession and its application to flight instruments
3. Drift and its relation to instrument error

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4. Methods of maintaining rotation of the gyroscope

   a. Electric
   b. Vacuum

      1. Venturi
      2. Engine driven pump

D. Interpretation of Flight Instrument Readings

   1. Sensitive altimeter
   2. Vertical speed indicator (rate of climb indicator)
   3. Turn and bank (rate of turn indicator)
   4. Horizon indicator (artificial horizon, gyro-horizon)
   5. Airspeed indicator
   6. Heading indicator (gyro-compass)
   7. Magnetic compass

E. Maintaining attitude by instruments

   1. Instrument coverage techniques (scanning)
   2. Instrument interpretation
   3. Aircraft control

F. Radio facilities available to the instrument pilot

   1. Radio facilities charts, Jeppeson and U. S. Coast

G. FAA Regulations pertaining to instrument flight

   1. Requirements
   2. Maintaining proficiency

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X. METEOROLOGY AND WEATHER

Objectives: (1) To enable students to obtain and interpret weather data
(2) To recognize severe or dangerous conditions

Methods: Field trip to weather bureau
Build observation station
Films

A. Much current weather data is available

1. Visit a weather bureau station
2. Teletype circuits
3. Facsimile transmissions
4. Weather satellite photos

B. Making weather observations

1. Sky conditions and visibility
2. Temperature and dew point
3. Atmospheric pressure and changes
4. Wind direction and velocity
5. Radar weather

C. Analysis of data

1. Weather maps
2. Upper air analysis
3. Winds aloft charts

D. Air mass theory

1. Types and source regions
2. Characteristic weather phenomena
3. Air and pressure pattern movements
4. Relationship of air mass to surface

E. Fronts and severe weather

1. Cold fronts
2. Warm fronts
3. Occlusions
4. Effects on aircraft

F. Local topographical effects

1. Upslope fog and weather
2. Mountain weather
3. Elevation, temperature and air density

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G. Preparing forecasts

1. Projecting weather patterns
2. Anticipating characteristic weather
3. Diurnal effects

H. Interpreting and evaluating weather reports and forecasts

1. Symbols and abbreviations
2. Recognizing dangerous conditions
3. Effects of winds and weather on flight plans
4. Obtaining and using weather information in flight

I. Federal Regulations applicable

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XI. RADIO COMMUNICATIONS AND RADIO NAVIGATION

Objectives:
(1) To acquaint the student with services available to airplanes with radio equipment
(2) To give the student an understanding of how to use the radio for navigation
(3) To give the student an understanding of how to transmit and receive voice on a radio set
(4) To acquaint the student with Federal Air Regulations pertaining to the use of two-way radio by pilots

Suggestions for introducing this unit:
(1) Discuss advantages and safeties provided by radio in connection with airplane flight
IFR - Simplified Navigation
VFR - Traffic control, weather and airport information, emergencies
(2) The nature of radio waves and natural laws which affect them (Doppler effect)
Line of sight transmission, interference, frequencies
(3) A comparison of low frequencies and high frequencies (disadvantages and advantages) or <u>adaptability</u>
(4) Memorize the frequencies ranges

A. Using a radio set for communication

1. Verbal skills required

a. Phonetic alphabet
b. Numbers and their pronunciation
c. Phraseology and its purpose
d. Courtesies of use
e. Types of messages and the methods used in each

2. Situations

a. Taxiing and take-off
b. Landing
c. In flight

1. PIREPS
2. Unicom
3. Weather

d. Emergency

B. Using Radio for Navigation

1. Low frequencies and radio range
2. Medium frequencies and the A.D.F.

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3. VHF (Omnirange [VOR] Stations)

   a. The nature of the station and the signal sent
   b. The receiver and its facilities
   c. Skills required

      1. Using chart and map information
      2. Use of To-From indicator
      3. Use of the radial or bearing selector
      4. Flying a radial
      5. Intercepting a radial
      6. Fixing a position
         Without DME
         With DME

4. Other radio navigation facilities

   a. ILS facilities
   b. Marker beacons
   c. Radar

C. Services available to pilots using two-way radio

   1. ATC
   2. FSS
   3. FI Watch
   4. Emergency homing
   5. Victor airways

D. Aids to radio navigation

   1. Maps
   2. Radio
   3. Charts
   4. Flight information manual

E. Federal Communications Commission regulations

   1. The Aircraft
   2. The Pilot

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3. Draw the two views as shown below, with dimensions. Take a full section of the object through the center, as indicated by the heavy cutting-plane line.

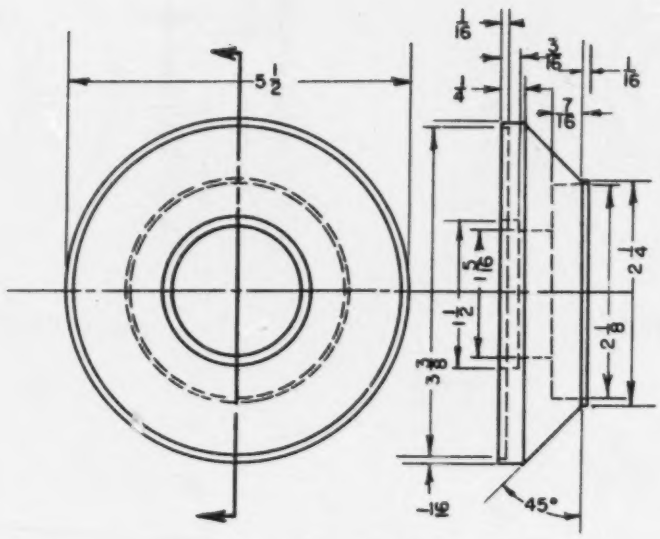

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XII. FLIGHT PLANNING

Objectives: (1) To use acquired skills in planning a flight
(2) To demonstrate organization and use of information

Methods: Plan an actual or simulated cross-country flight
Each student plan flight and keep log

Materials: Maps, charts, plotter, computer, weather data, flight information manuals

A. Flight Plan

1. File
2. Close
3. Enroute change
4. Enroute report

B. Dead reckoning

1. Computer
2. Clock

C. Map reading

1. Airport directories
2. Jeppeson charts
3. Maps

D. Aircraft characteristics

1. Cruising altitude
2. Oxygen or pressurization
3. Distance of flight as compared to fuel range of airplane
4. Navigation equipment
5. Owner's manual

E. Weather

F. Route

G. Fuel requirements

H. Position determination

I. Airways Flying

J. Regulations

1. Violations of regulations
2. Accident report

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XIII. REVIEW FOR EXAM

A. Theory of Flight

B. Aircraft Instruments and Instrument Flying

C. Basic Flight Techniques

D. Weather

E. Navigation

F. Flight Control Agencies

G. Aircraft Maintenance

H. Regulations

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XIV. CAREERS AND VOCATIONAL OPPORTUNITIES (Optional)

This unit may be used directly after Unit XI, or at any time the teacher desires. Its purpose is to survey the wide range of vocational opportunities in the field of aviation.

A. Outline of the aerospace industry

1. Aerospace manufacturing industry

   a. Aircraft
   b. Aircraft engines
   c. Aircraft parts and accessories
   d. Missiles
   e. Spacecraft

2. Air transport industry

   a. Domestic scheduled airline

      1. Trunk lines
      2. Local service lines
      3. Helicopter airlines
      4. Supplemental carriers

   b. International and overseas airlines
   c. Alaskan carriers
   d. Intra-Hawaiian carriers
   e. All-cargo carriers

3. General aviation

   a. Business flying
   b. Commercial flying
   c. Instructional flying
   d. Personal flying

B. Types of jobs

1. Airline operations
2. Aircraft manufacturing
3. Agricultural operations
4. Aviation in government (non-military)
5. Military aviation

C. Employment outlook

1. Professional and semi-professional
2. Skilled
3. Semi-skilled
4. Unskilled

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D. Choosing a career in aviation

1. Needs of industry (present and anticipated)
2. Age and background
3. Interests and aptitudes
4. Wages and working conditions
5. Hours and advancement
6. Where the employment is
7. Nature of a union
8. Labor-management relationship

E. How this course can help you as a student

1. Contact with needs and opportunities
2. Early evaluation of personal interests and aptitudes
3. Broad knowledge of the whole field helpful
4. Specific knowledge of piloting techniques

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APPENDIX 1

Chapter 1—BASIC FLIGHT MANUAL

GLOSSARY OF AERONAUTICAL TERMS

ADVISORY SERVICE—Advice and information provided by a facility to assist pilots in the safe conduct of flight and aircraft movement.

AIR DEFENSE IDENTIFICATION ZONE (ADIZ)—The area of airspace over land or water within which the ready identification, the location, and the control of aircraft are required in the interest of national security. For operating details see ADIZ procedures.

AIRPORT ADVISORY AREA—The area within five statute miles of an uncontrolled airport on which is located a Flight Service Station so depicted on the appropriate Sectional Aeronautical Chart.

AIRPORT ADVISORY SERVICE—A service provided by a Flight Service Station to enhance the safety of terminal operations of airports where a station is operating but where there is no control tower.

AIRPORT INFORMATION DESK (AID)—A local airport unmanned facility designed for pilot self-service briefing, flight planning and filing of flight plans.

AIRPORT SURFACE DETECTION EQUIPMENT (ASDE)—Radar equipment specifically designed to detect all principal features on the surface of an airport, including vehicular traffic, and to present the entire picture on a radar indicator console in the control tower. ASDE has a maximum range of four miles, though its 16 inch diameter scope usually displays an area of only one mile radius about the control tower.

AIRPORT SURVEILLANCE RADAR (ASR)—Radar providing position of aircraft by azimuth and range data without elevation data. It is designed for a range of 50 miles.

AIRPORT TRAFFIC AREA—Unless otherwise specifically designated (FAR Part 93), that airspace with a horizontal radius of five statute miles from the geographical center of any airport at which a control tower is operating, extending from the surface up to, but not including, 2,000 feet above the surface.

AIR ROUTE SURVEILLANCE RADAR (ARSR)—Long range radar which increases the capability of ATC for handling heavy en route traffic. An ARSR site is usually located at some distance from the ARTCC it serves.

AIR ROUTE TRAFFIC CONTROL CENTER (CENTER)—A facility established to provide air traffc control service to aircraft operating on an IFR flight plan within controlled airspace and principally during the en route phase of flight.

AIR TRAFFIC—Aircraft operating in the air or on an airport surface, exclusive of loading ramps and parking areas.

AIR TRAFFIC CLEARANCE (CLEARANCE)—An authorization by air traffic control for the purpose of preventing collision between known aircraft, for an aircraft to proceed under specified traffic conditions within controlled airspace.

AIR TRAFFIC CONTROL SERVICE (CONTROL)—A service provided for the purpose of promoting the safe, orderly, and expeditious flow of air traffic, including airport, approach, and enroute air traffic control service.

ALTITUDE RESERVATION (ALTRV)—Airspace utilization under prescribed conditions, normally employed for the mass movement of aircraft or other special user requirements which cannot otherwise be accomplished. ALTRV's are approved by the appropriate FAA facility.

APPROACH CONTROL SERVICE—Air traffic control service, provided by a terminal area traffic control facility, for arriving and departing IFR aircraft and, on occasion, VFR aircraft.

APPROACH FIX—The fix from or over which final approach (IFR) to an airport is executed.

APPROACH SEQUENCE—The order in which aircraft are positioned while awaiting approach clearance or while on approach.

AUTOMATIC TERMINAL INFORMATION SERVICE (ATIS)—The continuous broadcast of recorded noncontrol information in selected high activity terminal areas. Its purpose is to improve controller effectiveness and to relieve frequency congestion by automating the repetitive transmission of essential but routine information.

CARDINAL ALTITUDES OR FLIGHT LEVELS—"Odd" or "even" thousand-foot altitudes or flight levels. Examples: 5000, 6000, 7000, FL 250, FL 260, FL 270.

CAUTION AREA—Airspace within which military activities are conducted that are not hazardous but are of interest to nonparticipating pilots.

CEILING—The height above the earth's surface of the lowest layer of clouds or obscuring phenomena that is reported as "broken," "overcast," or "obscuration" and not classified as "thin" or "partial."

CENTRAL ALTITUDE RESERVATION FACILITY (CARF)—An Air Traffic Service facility established to conduct the volume of coordination, planning and approval of special user requirements under the altitude reservation concept.

CLEARANCE LIMIT—The fix to which an aircraft is issued an air traffic clearance.

CODES—The numbers assigned to the multiple pulse reply signals transmitted by ATCRBS and SIF transponders.

CONSOLAN—A low frequency, long-distance navaid used principally for transoceanic navigation.

CONTACT APPROACH—An approach wherein an aircraft on an IFR flight plan, operating clear of clouds with at least one mile flight visibility and having received an

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GLOSSARY OF AERONAUTICAL TERMS

air traffic control authorization, may deviate from the prescribed instrument approach procedure and proceed to the airport of destination by visual reference to the surface.

CONTERMINOUS U.S.—Forty-eight states and the District of Columbia.

CONTINENTAL U.S.—Forty-nine states. The original 48 states and Alaska.

CONTROLLED AIRSPACE—Airspace designated as continental control area, control area, control zone, or transition area, within which some or all aircraft may be subject to air traffic control.

Continental control area—Airspace at and above 14,500 feet MSL of the 48 contiguous states, the District of Columbia, and Alaska south of Lat. 68°00′00″N, excluding the Alaska peninsula west of Long. 160°-00′00″W; but does not include airspace less than 1,500 feet above the surface of the earth, and prohibited and restricted areas (except certain specified restricted areas).

Control area—Unless otherwise specified, airspace extending upward from 700 feet above the surface of the earth (until designated from 1,200 feet or more).

Control zone—Airspace extending upward from the surface of the earth which may include one or more airports and is normally a circular area of five statute miles in radius with extensions where necessary to include instrument approach and departure paths.

Transition area—Airspace extending upward from 700 feet or more above the surface of the earth when designated in conjunction with an airport for which an approved instrument approach procedure has been prescribed, or from 1,200 feet or more above the surface of the earth when designated in conjunction with airway route structures or segments. Unless otherwise limited, transition areas terminate at the base of the overlying controlled airspace.

COURSE—The intended direction of flight in the horizontal plane. Also a leg of an L/MF range.

CRUISE—A word used instead of the word "maintain" in an ATC clearance to indicate to a pilot that climb to and descent from the assigned altitude may be made at his discretion.

CRUISING ALTITUDE—A level determined by vertical measurement from mean sea level.

DEPARTURE CONTROL—A function of approach control providing service for departing IFR aircraft and on occasion, VFR aircraft.

DISCRETE FREQUENCY—A frequency assigned a particular function.

DISTANCE MEASURING EQUIPMENT (DME)—Equipment (airborne and ground) used to measure, in nautical miles, the distance of an aircraft from a navaid.

DME FIX—A geographical position determined by reference to a navaid which provides distance and azimuth information and defined by a specified distance in nautical miles and a radial in degrees magnetic from that aid.

DME SEPARATION—Spacing of aircraft in terms of distance determined by reference to distance measuring equipment (DME).

EN ROUTE AIR TRAFFIC CONTROL SERVICE—Air traffic control service provided aircraft on an IFR flight plan, generally by centers, when these aircraft are operating between departure and destination terminal areas.

EXPECTED APPROACH CLEARANCE TIME (EAC)—The time at which it is expected that an arriving aircraft will be cleared to begin approach for a landing.

EXPECTED FURTHER CLEARANCE TIME (EFC)—The time at which it is expected that additional clearance will be issued to an aircraft.

FINAL APPROACH—IFR—The flight path of an aircraft which is inbound to the airport on an approved final instrument approach course, beginning at the point of interception of that course and extending to the airport or the point where circling for landing or missed approach is executed.

FINAL APPROACH—VFR—A flight path of a landing aircraft in the direction of landing along the extended runway centerline from the base leg to the runway.

FINAL CONTROLLER—That controller providing final approach guidance utilizing precision approach radar equipment.

FIX—A geographical position determined by visual reference to the surface by reference to one or more radio navaids, by celestial plotting, or by another navigational device.

FLIGHT LEVEL (FL)—A level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Each is stated in three digits that represent hundreds of feet. For example, FL 250 represents a barometric altimeter indication of 25,000 feet. FL 255 indicates 25,500 feet.

FLIGHT PLAN—Specified information relating to the intended flight of an aircraft that is filed orally or in writing with an air traffic control facility.

FLIGHT SERVICE STATION (FSS)—A facility operated by the FAA to provide flight assistance service.

FLIGHT VISIBILITY—The average forward horizontal distance from the cockpit of an aircraft in flight at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night.

FLIP—Flight Information Publication.

GROUND VISIBILITY—Prevailing horizontal visibility near the earth's surface as reported by the U.S. Weather Bureau or an accredited observer.

HERTZ (Hz)—Cycle or cycles per second.

HOLDING—A predetermined maneuver which keeps an aircraft within a specified airspace while awaiting further clearance.

HOLDING FIX—A specified fix used as a reference point in establishing and maintaining the position of an aircraft while holding.

"IDENT" FEATURE—The special feature in ATCRBS equipment and the "I/P" feature in certain SIF equipment used to distinguish one displayed select code from other codes.

IFR CONDITIONS—Weather conditions below the minimum prescribed for flight under VFR.

INTENSIVE STUDENT JET TRAINING AREA—Airspace which contains the intensive training activities of military student jet pilots and in which restrictions are imposed on IFR flight.

INTERROGATOR—The ground-based surveillance radar beacon transmitter-receiver which scans in synchronism with a primary radar, transmitting discrete radio signals

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GLOSSARY OF AERONAUTICAL TERMS

which repetitiously request all transponders, on the mode being used, to reply. The replies received are then mixed with the primary radar video to be displayed on the same plan position indicators. **"I/P" FEATURE**—(See "IDENT" feature.)

JET ADVISORY SERVICE—The service provided certain civil aircraft while operating within radar and nonradar jet advisory areas. Within radar jet advisory areas, civil aircraft receiving this service are provided radar flight following, radar traffic information, and vectors around observed traffic. In nonradar jet advisory areas, civil aircraft receiving this service are afforded standard IFR separation from all other aircraft known to ATC to be operating within these areas.

JET ROUTES—A high altitude route system, at the above 18,000 feet MSL, predicated on a network of designated high altitude VHF/UHF facilities. (For operating procedures applicable to this system see EN ROUTE).

JOINT USE RESTRICTED AREA—A restricted area within which IFR and/or VFR flight operations may be authorized by the controlling agency (a FAA facility) when not in use by the using agency.

MAXIMUM AUTHORIZED ALTITUDE (MAA)—The highest altitude on a Federal airway, jet route, or other direct route for which a MEA is designated in F.A.R. Part 95 at which adequate reception of navigation aid signals is assured.

MINIMUM CROSSING ALTITUDES (MCA)—The lowest altitudes at certain radio fixes at which an aircraft must cross when proceeding in the direction of a higher minimum en route IFR altitude.

MINIMUM EN ROUTE IFR ALTITUDE (MEA)—The altitude in effect between radio fixes which assures acceptable navigational signal coverage and meets obstruction clearance requirements between those fixes.

MINIMUM OBSTRUCTION CLEARANCE ALTITUDE (MOCA)—The specified altitude in effect between radio fixes on VOR/LF airways, off-airway routes on route segments, which meets obstruction clearance requirements for the entire route segment and which assures acceptable navigational signal coverage only within 22 nautical miles of a VOR.

MINIMUM RECEPTION ALTITUDE (MRA)—The lowest altitude required to receive adequate signals to determine specific VOR/VORTAC/TACAN fixes.

MODE—The number or letter referring to the specific pulse spacing of the signal transmitted by an interrogator.

MOVEMENT AREA—The runways, taxiways, and other areas of an airport which are used for taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and parking areas.

NOTICE TO AIRMEN—A notice identified either as a NOTAM or Airmen Advisory containing information concerning the establishment, condition, or change in any component of, or hazard in, the National Airspace System, the timely knowledge of which is essential to personnel concerned with flight operations.

(1) *NOTAM.* A Notice to Airmen in message form requiring expeditious and wide dissemination by telecommunications means.

(2) *Airmen Advisory.* A Notice to Airmen normally only given local dissemination, during preflight or in-flight briefing, or otherwise during contact with pilots.

OUTER FIX—A fix in the destination terminal area, other than the approach fix, to which aircraft are normally cleared by an air route traffic control center or a terminal area traffic control facility, and from which aircraft are cleared to the approach fix or final approach course.

PRECISION APPROACH—An instrument approach conducted in accordance with directions issued by a controller referring to the surveillance radar display until the aircraft is turned onto final approach and, thereafter, to a precision approach radar display.

PROHIBITED AREA—Airspace of defined dimensions identified by an area on the surface of the earth within which flight is prohibited.

RADAR (RADIO DETECTION AND RANGING)—A device which, by measuring the time interval between transmission and reception of radio pulses and correlating the angular orientation of the radiated antenna beam or beams in azimuth and/or elevation, provides information on range, azimuth and/or elevation of objects in the path of the transmitted pulses.

Radar beacon (secondary radar)—A radar system in which the object to be detected is fitted with cooperative equipment in the form of a radio receiver/transmitter (transponder). Radio pulses transmitted from the searching transmitter/receiver (interrogator) site are received in the cooperative equipment and used to trigger a distinctive transmission from the transponder. This latter transmission rather than a reflected signal, is then received back at the transmitter/receiver site.

RADAR ADVISORY—The term used to indicate that the provision of advice and information is based on radar observation. (See Advisory Service)

RADAR CONTACT—The term air traffic controllers use to indicate that an aircraft is identified on the radar display and that radar service can be provided until radar identification is lost or radar service is terminated, and that when the aircraft is informed of "radar contact" it automatically discontinues reporting over compulsory reporting points.

RADAR FLIGHT FOLLOWING—The radar tracking of identified aircraft targets and the observation of the progress of such flights sufficiently to retain identity.

RADAR HANDOFF—That action whereby radar identification of, radio communications with and, unless otherwise specified, control responsibility for an aircraft is transferred from one controller to another without interruption of radar flight following.

RADAR IDENTIFICATION—The process of ascertaining that a radar target is the radar return from a particular aircraft.

RADAR SERVICE—A term which encompasses one or more of the following services based on the use of radar which can be provided by a controller to a pilot of a radar-identified aircraft.

Radar Separation—Radar spacing of aircraft in accordance with established minima.

Radar Navigation Guidance—Vectoring aircraft to provide course guidance.

Radar Monitoring—The radar flight following of aircraft, whose primary navigation is being performed by the pilot, to observe and note deviations from its

GLOSSARY OF AERONAUTICAL TERMS

authorized flight path airway, or route. This includes noting aircraft position relative to approach fixes and major obstructions.

RADAR SURVEILLANCE—The radar observation of a given geographical area for the purpose of performing some radar function.

RADAR VECTOR—A heading issued to an aircraft to provide navigational guidance by radar.

RADIAL—A radial is a magnetic bearing extending from a VOR, VORTAC, or TACAN.

REPORTING POINT—A geographical location in relation to which the position of an aircraft is reported.

RESTRICTED AREA—Airspace of defined dimensions identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restrictions.

ROUTE—A defined path, consisting of one or more courses, which an aircraft traverses in a horizontal plane over the surface of the earth. (See JET ROUTES)

SELECT CODE—That code displayed when the ground interrogator and the airborne transponder are operating on the same mode and code simultaneously.

SEPARATION—Spacing of aircraft to achieve their safe and orderly movement in flight and while landing and taking off.

SEPARATION MINIMA—The minimum longitudinal, lateral, or vertical distances by which aircraft are spaced through the application of air traffic control procedures.

SPECIAL VFR CONDITIONS (SPECIAL VFR MINIMUM WEATHER CONDITIONS)—Weather conditions which are less than basic VFR weather conditions and which permit flight under Visual Flight Rules.

SPECIAL VFR OPERATIONS—Aircraft operating in accordance with clearances within control zones in weather conditions less than the basic VFR weather minima.

STRAIGHT-IN APPROACH—IFR—An instrument approach wherein final approach is begun without first having executed procedure turn.

STRAIGHT-IN APPROACH—VFR—Entry of the traffic pattern by interception of the extended runway centerline without executing any other portion of the traffic pattern.

SURVEILLANCE APPROACH—An instrument approach conducted in accordance with directions issued by a controller referring to the surveillance radar display.

TRACK—The flight path of an aircraft over the surface of the earth.

TRAFFIC INFORMATION–RADAR—Information issued to alert an aircraft to any radar targets observed on the radar display which may be in such proximity to its position or intended route of flight to warrant its attention.

TRAFFIC PATTERN—The traffic flow that is prescribed for aircraft landing at, taxiing on, and taking off from an airport. The usual components of a traffic pattern are upwind leg, crosswind leg, downwind leg, base leg, and final approach.

TRANSPONDER—The airborne radar beacon receiver-transmitter which automatically receives radio signals from all interrogators on the ground, and which selectively replies with a specific reply pulse or pulse group only to those interrogations being received on the mode to which it is set to respond.

VFR CONDITIONS—Basic weather conditions prescribed for flight under Visual Flight Rules.

VISIBILITY, PREVAILING—The horizontal distance at which targets of known distance are visible over at least half of the horizon. It is normally determined by an observer on or close to the ground viewing buildings or other similar objects during the day and ordinary city lights at night. Under low visibility conditions the observations are usually made at the control tower. Visibility is REPORTED IN MILES AND FRACTIONS OF MILES in the Aviation Weather Report. If a single value does not adequately describe the visibility, additional information is reported in the "Remarks" section of the report.

VISIBILITY, RUNWAY—The horizontal distance at which a stationary observer near the end of the runway can see an ordinary light (about 25 candlepower) at night or a dark object against the horizon sky in the daytime. In practice the human observer is used very little for this observation. Instead runway visibility is normally determined by a transmissometer (a photoelectric device calibrated in terms of a human observer). It is REPORTED IN MILES AND FRACTIONS OF MILES in the "Remarks" section of the Aviation Weather Report. A meter in the control tower gives the FAA traffic controller a continuous indication of the runway visibility at transmissometer locations. Runway visibility, where available, is used in place of prevailing visibility for the determination of minimums on a transmissometer runway. This program is gradually being replaced by Runway Visual Range at transmissometer locations.

VISIBILITY, RUNWAY VISUAL RANGE (RVR)—An instrumentally derived value, based on standard calibrations, that represents the horizontal distance a pilot will see down the runway from the approach end; it is based on the sighting of either high intensity runway lights or on the visual contrast of other targets—whichever yields the greater visual range. RVR, in contrast to prevailing or runway visibility, is based on what a pilot in a moving aircraft should see looking down the runway. RVR is horizontal, AND NOT SLANT, visual range. It is based on the measurement of a transmissometer made near the touchdown point of the instrument runway and is REPORTED IN HUNDREDS OF FEET. At the present time, RVR observations are automatically furnished to FAA tower controllers at approximately 25 locations from readout equipment connected to the remote transmissometer installation. RVR provides an additional operating minimum at fields equipped with specified navigational aids. For example, at the present time the RVR minimum at Newark is 2000 ft. (in combination with a minimum descent altitude of 218′ MSL) for both takeoffs and landings regardless of the reported ceiling and visibility.

VISUAL APPROACH—An approach wherein an aircraft on an IFR flight plan, operating in VFR conditions and having received an air traffic control authorization, may deviate from the prescribed instrument approach procedures and proceed to the airport of destination by visual reference to the surface.

VOT (VERY HIGH FREQUENCY OMNITEST)—A ground originating test signal used to check the accurate alignment of a VOR receiver.

WARNING AREA—Airspace which may contain hazards to nonparticipating aircraft in international airspace.

14000

APPENDIX II--BIBLIOGRAPHY

RECOMMENDED TEXTS

Fundamentals of Aviation and Space Technology. University of Illinois, Institute of Aviation, 318 Civil Engineering Hall, University of Illinois, Urbana, Illinois. 1963

Private Pilot's Handbook of Aeronautical Knowledge. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 1965 - $2.75.

NAVIGATION

Aviation Education Research Group (from series "Air Age Education Series"). Science of Pre-Flight Aeronautics. New York: Macmillan.

Bauer, Hubert A. Globes, Maps, and Skyways. New York: Macmillan. (from series "Air Age Education Series")

Caidin, Martin. Flying. New York: Holt, Rinehart and Winston, Inc.

Federal Aviation Administration. Facts of Flight. AC 00-4. Revised May 1963. (50¢ - GPO)

Federal Aviation Administration. FLIGHT the story of ELECTRONIC NAVIGATION. FAA Academy, Oklahoma City, Oklahoma. 41 p. Free

INSTRUMENT FLYING

Federal Aviation Administration. Instrument Flying Handbook. AC 61-27. 1966. ($1.75 -- GPO)

Tower, Merril E. Flight Facts for Private Pilots. Los Angeles, California: Aero Publishers, Inc., 1960

METEOROLOGY AND WEATHER

Battan, Louis J. The Nature of Violent Storms. Doubleday, 158 p. illus. 1961. Paperback 95¢.

Bell, Thelma Harrington. Thunderstorm. Viking, 128 p. illus., 1960. $3.00.

Campbell, Ethel M. The Wind--Nature's Great Voice. Denison, 45 p. illus, 1950, $3.00.

S0041

14001

Federal Aviation Administration/Weather Bureau. AVIATION WEATHER 1965. AC 00-6. ($2.25--GPO)

Fisher, Robert Moore. How About the Weather? Harper, 186 p. illus. rev. 1958. $3.75

Fisher, Robert Moore. How to Know and Predict the Weather. Signet Books, 50¢.

Forrester, Frank H. 1001 Questions Answered About the Weather. Dodd, Mead. 419 p. illus. 1957 $6.00

Ley, Willy. Man and Weather Satellites. Singer, 48 p. illus, 1959. Paperback, 60¢.

Orr, Clyde, Jr. Between Earth and Space. Macmillan, 253 p. illus. 1959. $4.95

Parker, Bertha Morris. Ask the Weatherman. Row Peterson, 35 p. illus. 1959. Paperback 52¢.

Scoree, R. S. Weather. Roy, 57 p. illus. 1959. $2.50

Spar, Jerome. The Way of the Weather. Creative, 224 p. illus. 1957. $7.75.

Aviation Series (Weather Bureau) (Complete set 75¢)

1. Flying Weather Forecasts
2. Ice on Aircraft
3. Jet Stream
4. Turbulence, Its Causes and Effects
5. Mountain Wave
6. Storm Detection Radar
7. Thunderstorms
9. Flying Weather Information
10. Ceiling
12. Tips on Weather for VFR Flight
13. Fronts
17. Severe Weather Forecasts
18. Altimeters, How Their Readings are Affected by Temperature.

Available from:
Superintendent of Documents
Government Printing Office
Washington, D. C.

FLIGHT PLANNING

Boyes, Lindy. Pilot's Weather Guide. Sports Car Press, 120 p. illus. 1962. Available from Crown Publishers, 419 Park Ave. South, New York.

Cantzlarr, George. Your Guide to the Weather. Barnes, 242 p. illus. 1964. (105 Fifth Ave., New York.)

14002

OBJECTIVE: To learn how to make and use half sections.

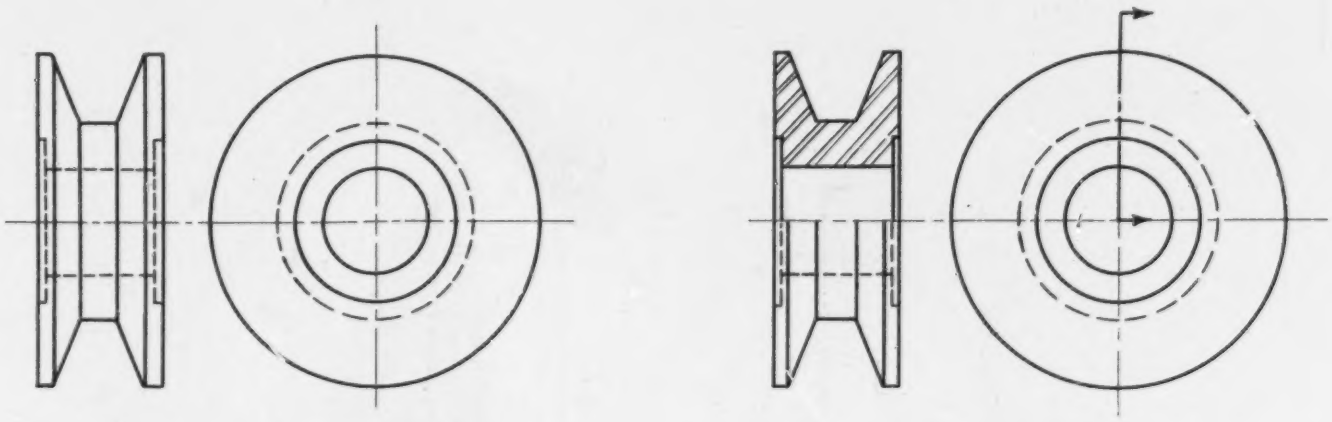

VIEW NOT SECTIONED (a)

HALF SECTION (b)

FIG. 1

RELATED INFORMATION:

Not all drawings require full sections. Many times it is preferable to draw a half section, so that a single drawing can show part of the outside and part of the inside. Note the pulleys shown in Fig. 1. See how the pulley not shown in section (View a) is so much more difficult to read.

ASSIGNMENT:

The front and right-side view of a collar are shown below. Draw the front view as shown but change the right-side view to a half section. Dimension fully.

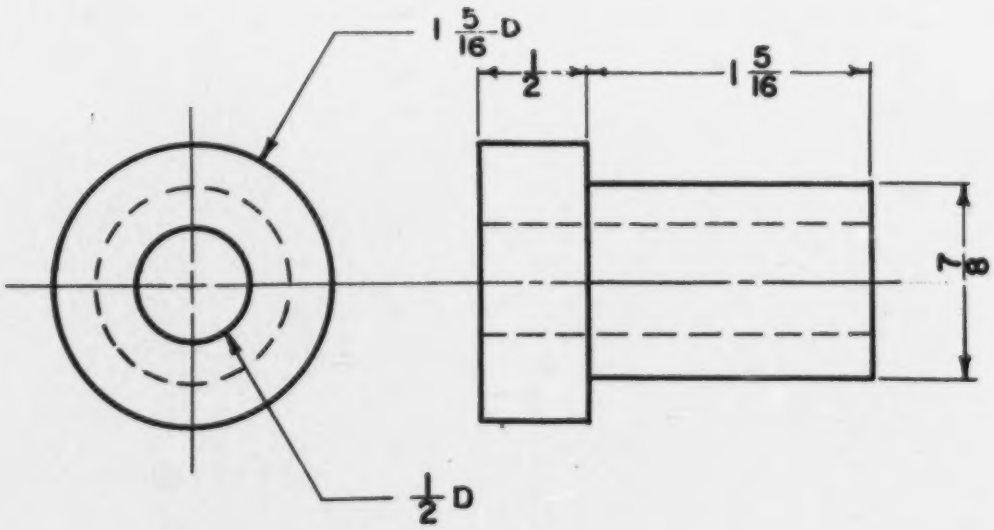

GENERAL

Airman's Information Manual: (Each part on a subscription basis.)
Part 1, issued quarterly -- Basic Flight Manual and ATC Procedures ($2.00 p/a --GPO)

Part 2, issued semi-annually -- Airport Directory ($2.00 p/a--GPO)

Part 3, issued every 28 days, Supplemented by NOTICES TO AIRMEN every 14 days midway of the 28 day cycle. ($9.00 p/a--GPO)
Terrain Flying (40¢)
Private Pilot's Handbook of Aeronautical Knowledge ($2.75 GPO)
Federal Aviation Regulations
Part 1 - Definitions and abbreviations (25¢)
Part 61 - Certification: Pilots and Flight Instructors (30¢)
Part 91 - General Operating and Flight Rules (30¢)
Private Pilot (Airplane) Flight Training Guide ($1.00)
Private Pilot Airplane--Single Engine.
Superintendent of Documents, Government Printing Office, Washington, D. C. 20402

American Council on Education, Committee on Aviation Education. Aviation in School and Community. Washington, ACE. H. E. Mehrens, 1954.

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Bergman, Jules. Anyone Can Fly. 1st ed. 225 pp. illus. Garden City, N. Y.: Doubleday, 1964.

Bernardo, James V. Aviation in the Modern World. Dutton, 1960. 352 p. $5.95.

Boughton, Terence. The Story of the British Light Aeroplane. 321 pp. illus. London: J. Murray, 1963.

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Cooke, David C. Jet and Rocket Planes That Made History. 72 p. illus. Putnam, 1961.

Dohm, John, editor. The New Private Pilot. 301 p. illus. Pan American Navigation Service, rev. 1961. Paperback, $5.00.

Duke, Neville and Edward Lanchberry, editors. The Saga of Flight. 406 p. Day, 1961. $5.95

Editors of Year. Flight. 256 p. illus. Year, 1961. $7.95

Federal Aviation Administration. Student Pilot Guide. 28 p. Year 1965. .15¢ Government Printing Office, Wash.D.C.20402.

Floherty, John J. and McGrady, Mike. Whirling Wings. 156 p. illus. Lippincott, 1961. $3.00

Hall, Charles Gilbert. The Sky's the Limit. Jobs in Commercial Aviation. 195 pp. New York: Funk and Wagnalls, 1943.

Hyde, Margaret Oldroyd. Flight Today and Tomorrow. New York: Whittlesey House, 1953.

Lindbergh, Charles Augustus. The Spirit of St. Louis. 562 pp. illus. New York: Scribner, 1953.

O'Connor, Mary. Flying Mary O 'Connor. 144 pp.illus. Rand, 1961. $2.50

Schneider, Leo and Ames, Maurice U. Wings in Your Future. 146 pp. illus. Harcourt, rev. 1960. $2.95

Sunderman, James F., editor. Early Air Pioneers: 1863-1935. 256 pp. illus. Watts, 1961. $4.95

Tower, Merrill E. Flight Facts for Private Pilots. 212 pp. illus. Aero, 1960. $5.00

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PAMPHLETS AND BIBLIOGRAPHIES OF SOURCE MATERIAL

Careers

Career Opportunities With the Airlines
Air Transport Association of America
1000 Connecticut Ave., N. W.
Washington, D. C. 20036 Free

Career Opportunities in Aviation
National Aviation Education Council
806 15th Street N.W.
Washington, D. C. 20005 (50¢)

General

Exam-O-Grams
FAA Flight Standards Service
Operations Airman Exam Section Free Series
P. O. Box 25082
Oklahoma City, Oklahoma 23125

FAA's Aviation Education Bibliography - 1967
Federal Aviation Administration
Office of General Aviation Affairs
Aviation Education
Washington, D. C. 20590 Free

Pictures, Pamphlets and Packets for Air/Space Education
National Aerospace Education Council
806 15th Street N.W.
Washington, D. C. 20005 (50¢)

List of Aerospace and Related Films
State Department of Public Instruction
Helena, Montana 59601

14005

APPENDIX III--FILMS

(Addresses of sources listed below)

Unit	Title	Time (min.)	Source
I	The Air Age	36	State Film Library #4031
	An Airplane Trip	12	State Film Library #118
	Airplanes	12	State Film Library #2814
	Man in Flight	30	State Film Library #4268 & Mont. Aeronautics Commission
	Wings for Beginners	27	Piper Aircraft Corp.
II	Airplanes, Metals, Fuels, Lubricants	37	Bureau of Mines
	Corrosion in Aircraft	17	Douglas Aircraft Co.
	The Gas Turbine	15	Shell Oil Co.
	Jet Propulsion	15	State Film Library #3766
	Man in Space	33	Mont. Aeronautics Commission
III	Aerodynamics Air Flows	18	State Film Library #3872
	Airplanes, Principles of Flight	12	State Film Library #5493
	Approaching the Speed of Sound	28	Shell Oil Co.
	How an Airplane Flies (Series of Six)		Shell Oil Co.
	Mach Busters	9	North American Aviation
	Problems of Flight (1942)	12	State Film Library #165
	Theory of Flight (1942)	12	State Film Library #208
	Transonic Flight	24	Shell Oil Co.
IV	The Earth; Its Atmosphere	12	State Film Library #5036
	The Gyrosyn Compass	25	Sperry Gyro Co.
	Romance of the Gyroscope	10	Sperry Gyro Co.
V	The Airport	12	State Film Library 4055
	Flight	28	Federal Aviation Administration
	A Traveler Meets Air Traffic Control	33	Federal Aviation Administration
VI	Celestial Navigation	24	State Film Library #549
	The Earth	12	State Film Library #833
	Earth in Motion	12	State Film Library #3
	The Great Circle	24	State Film Library #2060
	The Shape of the Earth	36	State Film Library #5040
	Earth and the Sun's Rays	6	State Film Library #3235
	Earth--Rotation and Revolution	12	State Film Library #1547
	Space Navigation	13	U.S. Air Force
	Latitude and Longitude		United World Films
	Maps for a Changing World	12	State Film Library #330

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ADDRESSES OF FILM RESOURCES AND AVAILABILITY INDEX

Associated Films
Western Area Exchange
799 Stevenson Street
San Francisco, California 94103

Bailey Films, Inc.
6509 DeLongpre Avenue
Hollywood, California 900028 — Rental

Bureau of Mines
United States Department of Interior
Graphic Services
4800 Forbes Avenue — Borrower pays return postage
Pittsburgh, Pennsylvania 15213

Coronet Films
Coronet Building
Chicago, Illinois 60601

Douglas Aircraft Co., Inc.
Advertising Film Services, G-83
3000 Ocean Park Blvd. — Free Loan
Santa Monica, California 90405

Encyclopedia Britannica Films, Inc.
1150 Wilmette Avenue
Wilmette, Illinois 60091

Federal Aviation Administration
Film Library, AC - 921
FAA Aeronautical Center — Free Loan
P. O. Box 25082
Oklahoma City, Oklahoma 73125

International Business Machines Corp.
Film Activities
Department of Information
590 Madison Avenue
New York, New York 10022

Montana Aeronautics Commission
P. O. Box 1698 — Free Loan
Helena, Montana 59601

94008

NASA
National Aeronautics and Space Administration
Distribution & Central Film Depository Services
Washington, D. C. 20546

North American Aviation
Film Library
Public Relations Department
Los Angeles Division — Borrower pays return postage
International Airport
Los Angeles, California 90045

Piper Aircraft Company
Lock Haven, Pennsylvania 17745 — Free Loan

Shell Oil Company
Film Library
430 Peninsular Avenue — Free Loan
San Mateo, California 94401

Sperry Gyroscope Co.
Public Relations Department
Division of Sperry-Rand Corp. — Free Loan
Great Neck, New York 11020

State Film Library
Department of Public Instruction
Helena, Montana 59601

United States Air Force
Film Library Center
8900 S. Broadway — Free Loan
St. Louis, Missouri 63125

United World Films, Inc.
1445 Park Avenue
New York, New York 10029

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APPENDIX IV--RECORDINGS, FILMSTRIPS, CHARTS

RECORDINGS

Instrument Flight	Aero Progress #7002
Tower Communications	#7003
On Course, On the Glide Path	#7001
ATC Clears	#7004

May be borrowed from the State Department of Public Instruction of the Montana Aeronautics Commission.

FILMSTRIPS

Global Geography Short Cuts	Coast Visual Education Co.
We Live on a Large Ball	Popular Science Publishing Co.

Civil Air Patrol

Aviation and You	
Aircraft in Flight	Headquarters Civil Air Patrol--
Power for Aircraft	USAF
Airports, Airways & Electronics	Maxwell Air Force Base,
Navigation & the Weather	Alabama 36112
The Problems of Air Power	$5.75 each

Sanderson Audio Visual Ground School Course
Records and Filmstrips
Private Pilot's, Commercial, and Instrument Courses
Limited loan from Montana Aeronautics Commission, or
may be purchased from Sanderson Films, Inc.
P. O. Box 2544
Wichita, Kansas 67201

Airco Audio-Visual Ground School Course for Private Pilot
Records and Filmstrips
Limited loan from Montana Aeronautics Commission, or
may be purchased from Airco
155 E. Ohio Street
Chicago, Illinois 60611

CHARTS

"Time Zone Charts for TWA International Routes," Trans World Airlines, 380 Madison Avenue, New York 17, New York

Sectional Air Charts, U. S. Coast and Geodetic Survey

World Aeronautical Charts, U. S. Coast and Geodetic Survey

Radio Facilities Charts and Approach Plates, U. S. Coast and Geodetic Survey, Washington, D. C.; Jeppeson and Company, Denver, Colorado

Flight Information Manual, Federal Aviation Administration

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APPENDIX V--FLIGHT LINE OPERATORS

Aerial Survey, Inc.
Kalispell, Montana 59901

Albright Flying Service
Roundup, Montana 59072

Anaconda Airport (Sky Lodge)
Anaconda, Montana 59711

Anderson Field
Wolf Point, Montana 59201

Bethel Aviation
Baker, Montana 59313

Big Sky Air Taxi
Libby, Montana 59923

Boles Aviation
Hardin, Montana 59034

Butte Aero Sales & Service
Municipal Airport
Butte, Montana 59701

Central Air Service
Lewistown,Montana 59457

Chester Aviation
Chester, Montana 59522

Choteau Flying Service
Choteau, Montana 59422

Columbus Flying Service
Columbus, Montana 59019

Custom-Aire Flying Service
Hamilton, Montana 59840

Cut Bank Flying Service
Cut Bank, Montana 59427

Dillon Flying Service
Dillon, Montana 59725

Doyle's Spray Service
Turner, Montana 59542

E & G Rotor Port
Butte, Montana 59701

Fairhurst Flying Service
Three Forks, Montana 59752

Flight Line, Inc.
Belgrade, Montana 59714

Flying A. Sprayer
Choteau, Montana 59422

Gallatin Flying Service
Belgrade, Montana 59714

Gillis Aviation
Logan Field
Billings, Montana 59101

Glacier View Skyways, Inc.
Kalispell, Montana 59901

Glendive Flying Service (Soare's)
Glendive, Montana 59330

Al Hardy
P. O. Box 181
Plentywood, Montana 59254

Hensley Flying Service
Havre, Montana 59501

Herrod Aviation Co.
Logan Field
Billings, Montana 59101

Hoffman's Custom Flight Service
Billings, Montana 59101

Johnson Flying Service
Missoula, Montana 59801

Kruger Flying Service
Cut Bank, Montana 59427

Laurel Helicopter Services
Laurel, Montana 59044

14011
S1011

Lien Flying Service
Poplar, Montana 59255

Arnie Lindberg
Cut Bank, Montana 59427

Livingston Flying Service
Livingston, Montana 59047

Lohse Flying Service
Valier, Montana 59486

Lynch Flying Service
Logan Field
Billings, Montana 59101

Mendel Flying Service
Malta, Montana 59538

Miles City Aero Service, Inc.
Miles City, Montana 59301

Missoula Skyflite Inc.
Missoula, Montana 59801

Modern Aire Flight Service
Culbertson, Montana 59218

Montair (Montana Airmotive)
Logan Field
Billings, Montana 59101

Morrison Flying Service
Municipal Airport
Helena, Montana 59601

Montark, Inc.
Lewistown, Montana 59457

Northern Aviation, Inc.
Great Falls, Montana 59401

Northwest Mooney
Great Falls, Montana 59401

Obie Flying Service
Chinook, Montana 59523

Point Aero Service
Municipal Airport
Wolf Point, Montana 59201

Pondera Flying Service, Inc.
Conrad, Montana 59425

Red Lodge Airways
Red Lodge, Montana 59068

Ridonlee Copters (FC Airport)
Big Fork, Montana 59911

Severson Air Activities
Great Falls, Montana 59401

Shelby Flying Service
Shelby, Montana 59474

Skycraft
Lewistown, Montana 59457

Sky Flight Inc.
Big Timber, Montana 59011

Skyway Flying Service
Great Falls, Montana 59401

Sports Flites Inc.
Ennis, Montana 59729

Stephens Spraying Service
Dutton, Montana 59433

Stockhill Aviation Inc.
City Airport
Kalispell, Montana 59901

Timm Aero Service
Polson, Montana 59860

Tope's Air Spray
Fort Benton, Montana 59442

Town Air
Broadwater County Airport
Townsend, Montana 59644

Ullman Air-Ag Co.
Billings, Montana 59102

Wetherell Air Taxi
White Sulphur Springs, Montana 59645

Wokal Flying Service
Glasgow, Montana 59230

14012

UNIT I - INTRODUCTION

ACHIEVEMENT TEST

QUESTIONS:

1. What professions use drafting?
2. Why is drafting important?
3. Give a practical application of drafting.
4. Can an individual who is sloppy by nature hope to be a successful draftsman?
5. In your own words, briefly explain orthographic projection.
6. Why is lettering considered important?
7. Explain the use of guide lines.

PROBLEMS:

On the $8\frac{1}{2}$ x 11 inch buff paper issued to you, draw horizontal guide lines $\frac{1}{8}$ inch apart across the paper, allowing $\frac{1}{4}$ inch between each pair of lines.
Letter the following:

a. Any three sentences.

b. Bill of materials.

c. Thomas A. Edison Vocational & Technical High School, Elizabeth, N. J.

NASA
National Aeronautics and Space Administration
Distribution & Central Film Depository Services
Washington, D. C. 20546

North American Aviation
Film Library
Public Relations Department
Los Angeles Division — Borrower pays return postage
International Airport
Los Angeles 45, California

Piper Aircraft Company
Lock Haven, Pennsylvania — Free Loan

Shell Oil Company
Film Library
430 Peninsular Avenue — Free Loan
San Mateo 8, California

Sperry Gyroscope Co.
Public Relations Department
Division of Sperry-Rand Corp. — Free Loan
Great Neck, New York

State Film Library
Department of Public Instruction
Helena, Montana

United States Air Force
Film Library Center
8900 S. Broadway — Free Loan
St. Louis 25, Missouri

United World Films, Inc.
1445 Park Avenue
New York 29, New York

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APPENDIX IV--RECORDINGS, FILMSTRIPS, CHARTS

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Global Geography Short Cuts	Coast Visual Education Co.
We Live on a Large Ball	Popular Science Publishing Co.

Civil Air Patrol

Aviation and You	
Aircraft in Flight	Headquarters Civil Air Patrol--
Power for Aircraft	USAF
Airports, Airways & Electronics	Ellington Air Force Base,
Navigation & the Weather	Texas
The Problems of Air Power	$5.75 each

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Chicago 11, Illinois

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"Time Zone Charts for TWA International Routes," Trans World Airlines, 380 Madison Avenue, New York 17, New York

*Sectional Air Charts, U. S. Coast and Geodetic Survey

*World Aeronautical Charts, U. S. Coast and Geodetic Survey

*Radio Facilities Charts and Approach Plates, U. S. Coast and Geodetic Survey, Washington, D. C.; Jeppeson and Company, Denver, Colorado

*Flight Information Manual, Federal Aviation Agency

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Libby, Montana 59923

Boles Aviation
Hardin, Montana 59034

Butte Aero Sales & Service
Municipal Airport
Butte, Montana 59701

Central Air Service
Lewistown,Montana 59457

Chester Aviation
Chester, Montana 59522

Choteau Flying Service
Choteau, Montana 59422

Columbus Flying Service
Columbus, Montana 59019

Custom-Aire Flying Service
Hamilton, Montana 59840

Cut Bank Flying Service
Cut Bank, Montana 59427

Dillon Flying Service
Dillon, Montana 59725

Doyle's Spray Service
Turner, Montana 59542

E & G Rotor Port
Butte, Montana 59701

Fairhurst Flying Service
Three Forks, Montana 59752

Flight Line, Inc.
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Flying A. Sprayer
Choteau, Montana 59422

Gallatin Flying Service
Belgrade, Montana 59714

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Logan Field
Billings, Montana 59101

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Billings, Montana 59101

Hoffman's Custom Flight Service
Billings, Montana 59101

Johnson Flying Service
Missoula, Montana 59801

Kruger Flying Service
Cut Bank, Montana 59427

Laurel Helicopter Services
Laurel, Montana 59044

Lien Flying Service
Poplar, Montana 59255

Arnie Lindberg
Cut Bank, Montana 59427

Livingston Flying Service
Livingston, Montana 59047

Lohse Flying Service
Valier, Montana 59486

Lynch Flying Service
Logan Field
Billings, Montana 59101

Mendel Flying Service
Malta, Montana 59538

Miles City Aero Service, Inc.
Miles City, Montana 59301

Missoula Skyflite Inc.
Missoula, Montana 59801

Modern Aire Flight Service
Culbertson, Montana 59218

Montair (Montana Airmotive)
Logan Field
Billings, Montana 59101

Morrison Flying Service
Municipal Airport
Helena, Montana 59601

Montark, Inc.
Lewistown, Montana 59457

Northern Aviation, Inc.
Great Falls, Montana 59401

Northwest Mooney
Great Falls, Montana 59401

Obie Flying Service
Chinook, Montana 59523

Point Aero Service
Municipal Airport
Wolf Point, Montana 59201

Pondera Flying Service, Inc.
Conrad, Montana 59425

Red Lodge Airways
Red Lodge, Montana 59068

Ridonlee Copters (FC Airport)
Big Fork, Montana 59911

Severson Air Activities
Great Falls, Montana 59401

Shelby Flying Service
Shelby, Montana 59474

Skycraft
Lewistown, Montana 59457

Sky Flight Inc.
Big Timber, Montana 59011

Skyway Flying Service
Great Falls, Montana 59401

Sports Flites Inc.
Ennis, Montana 59729

Stephens Spraying Service
Dutton, Montana 59433

Stockhill Aviation Inc.
City Airport
Kalispell, Montana 59901

Timm Aero Service
Polson, Montana 59860

Tope's Air Spray
Fort Benton, Montana 59442

Town Air
Broadwater County Airport
Townsend, Montana 59644

Ullman Air-Ag Co.
Billings, Montana 59102

Wetherell Air Taxi
White Sulphur Springs, Montana 59645

Wokal Flying Service
Glasgow, Montana 59230

U. S. GOVERNMENT PRINTING OFFICE : 1968 O - 287-386

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VT 012 813
Fabriele, Peter, Comp.
Health Careers Bibliography for Guidance Counselors. Second Edition.

New Jersey Health Careers Service, Trenton.

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PUB DATE - 70 129p.

DESCRIPTORS - *BIBLIOGRAPHIES; *HEALTH OCCUPATIONS; *HEALTH OCCUPATIONS EDUCATION; *OCCUPATIONAL GUIDANCE; CAREER CHOICE; VOCATIONAL COUNSELING; *OCCUPATIONAL INFORMATION

ABSTRACT - The 1,500 health career brochures, pamphlets, monographs, fact sheets, abstracts, job series, briefs, books, and others, published since 1964 were screened and evaluated according to National Vocational Guidance Association (NVAG) standards. Entries are arranged alphabetically by author or title according to health career designations and code numbers of the Directory of Occupational Titles. Each entry includes author, title, publication information, pagination, cost, a letter referring to the type of publication, and a number referring to the NVAG recommendation. Indexes of publishers and occupations are provided. (FM)

VT 012 813

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Health Careers Bibliography

FOR Guidance Counselors

OFFICERS • ANESTHETISTS • ANIMAL TENDERS • AUDIOLOGIS
OGISTS • BOOKKEEPERS • BUSINESS MACHINE OPERATORS •
PSYCHOLOGISTS • CYTOLOGICAL TECHNOLOG
ISTS • DIETETIC CLERICAL WORKERS • DR
RS • FOOD SERVICE WORKERS • FOOD T
TAL HOUSEKEEPERS • HOSPITAL NURS
NDUSTRIAL SURGEONS • INFORMATIO
RATORY-PROCEDURE ANALYSTS • L
ANTS • MEDICAL ILLUSTRATORS •
• MEDICAL SECRETARIES • MEDICAL SO
GIST AIDES • NUTRITIONISTS • OBSTETRICIANS • OCC
OLOGISTS • ORAL SURGEONS • ORDERLIES • ORTHODONTISTS •
PARASITOLOGISTS • PATHOLOGISTS • PEDIATRICIANS • PEDODO
ANS • PHYSICAL THERAPISTS • PHYSICIANS • PHYSICISTS • PHYSI
VATE DUTY NURSES • PROC TS •
CHIATRIC SOCIAL WORKERS • S •
LTH NURSES • PUBLIC HEAI LTH
BLIC HEALTH VETERINARIANS • PURCHASING OFFICERS • RADIOIS
ACISTS ANITARIANS • SANITARY ENG
ISTS • SOCIAL SCI S • SPEEC
ETITIAN ROLOGISTS • VETERINARIANS
LUNTARY HE ES • WARD CLERKS • X-RAY

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HEALTH CAREERS
BIBLIOGRAPHY
FOR
GUIDANCE COUNSELORS

Second Edition

1970

Peter Fabriele, Research Assistant

Carrie R. Losi, Consultant

Under a Project Grant from
New Jersey Health Careers Service
Thomas F. Caldwell, Executive Director

375 West State Street
Trenton, New Jersey 08615
$2.00 per copy

14019

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14020

PREFACE

The first edition of HEALTH CAREERS BIBLIOGRAPHY FOR GUIDANCE COUNSELORS that was published in 1964 by the New Jersey Health Careers Service proved to be a very valuable and effective reference tool for guidance counselors and others charged with the responsibility of helping young people with their career planning and vocational decisions. That the BIBLIOGRAPHY filled a basic need is indicated by its extensive use as a quick and easy guide to health career information; and by numerous requests for current, supplementary data pertaining to the expanding and newly developing job opportunities in the health field.

Disseminating occupational information carries with it responsibility for keeping it accurate, recent, comprehensive, and available. Busy counselors find it difficult to keep pace with the increasing output of publications on health careers that appear in many printed forms with varying degrees of quality and usefulness. They seek and welcome authoritative sources of such data.

In response to requests for up-to-date and authentic resources covering the increasing and changing occupational opportunities within the health manpower area, the New Jersey Health Careers Service provided a grant for a special project to revise, expand, and update the first edition of HEALTH CAREERS BIBLIOGRAPHY. This second edition supplements the first effort, listing only those materials published since 1964 to the present. References can still be made to the first edition for earlier publications.

The arduous task of gathering, reviewing and evaluating quantities of printed materials that describe health occupations was undertaken by Peter Fabriele, a guidance counselor with an M.A. in Student and Personnel Services. Appreciation is extended to him for endless hours of research to produce this BIBLIOGRAPHY. Over 3500 items were examined of which 1500 were selected for inclusion in this edition, based upon evaluation standards of NVGA criteria.

This HEALTH CAREERS BIBLIOGRAPHY is unique in that it brings together in a single publication such a large body of references on such a large spread of occupations in the health field. It is hoped that further revisions and supplements can be made from time to time to keep it accurate and up-to-date so that it can continue to serve as a

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valuable resource aid for presenting occupational information to young people interested in pursuing careers in health.

The New Jersey Health Careers Service is a state-wide voluntary organization made up of different professional associations in the State representing health and educational groups, civic and community organizations who share a common interest in helping to motivate interest of young people in health careers. This BIBLIOGRAPHY and other aids such as a quarterly Newsletter, films and audio visual materials, speakers, etc., are available upon request from the New Jersey Health Careers Service, 375 West State Street, Trenton New Jersey 08618, (609-695-9445).

Carrie R. Losi, Consultant
New Jersey Health Careers Service

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UNIT II - USE OF DRAWING INSTRUMENTS

ACHIEVEMENT TEST

On the sheet of paper issued to you, write the word or phrase (found in the parentheses below) that best completes the following questions or statements.

1. The main function of a T-square is to guide a pencil when drawing (vertical, parallel, horizontal)lines.

2. The best method for cleaning a T-square is to use (water, crumpled paper, eraser, good cleaning fluid).

3. Drawings made on white or buff drawing paper cannot be (traced, erased, blueprinted).

4. The best method for fastening drawing paper to a board is to use (thumbtacks, Scotch drafting tape, staples, rubber cement).

5. The most useful pencil for drawing guide lines is (soft, hard, medium).

6. The most useful pencil for sketching freehand is (soft, hard, medium).

7. The most commonly used triangles are the (30°, 40°, 45°, 60°, 70°, 80°).

8. The main function of the triangles is to guide a pencil when drawing (vertical, parallel, horizontal) lines.

9. There are numerous scales to choose from, but for our purposes we shall use the (mechanical engineer's, carpenter's, architect's, plumber's) scale.

10. A bow compass is used for (drawing circles, measuring angles).

11. A protractor is used to (draw circles, measure angles, mark off distances).

12. If a particular problem on a protractor requires a measurement between a half degree and a full degree, it must be (estimated, computed, use a scale).

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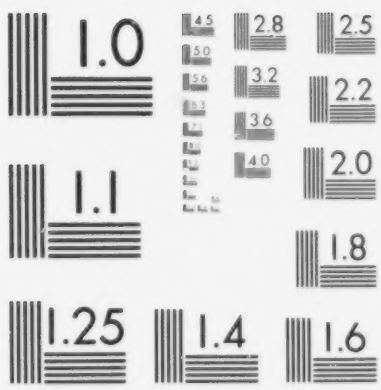

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

INTRODUCTION

The overwhelming task of gleaning from currently published occupational literature those items which meet professional standards of accuracy, reliability, and currency is indeed a formidable one. Under several occupational headings, the counselor finds a dearth of materials, under others there is an excess. Some materials approach a high degree of accuracy and reliability, others are less desirable and often misleading, and provide little, if any, value.

The first edition of Health Careers Bibliography for Guidance Counselors published in 1964 by the New Jersey Health Careers Service analyzed the bulk of extant occupational literature from this maze of data and compiled a classified, alphabetical listing of health careers publications that were screened and evaluated according to National Vocational Guidance Association (NVGA) Standards for Use in Preparing and Evaluating Occupational Literature. The Bibliography proved to be a very valuable and useful tool for counselors who were responsible for helping students with their career planning.

The thrust of this revised Bibliography was to supplement the earlier effort by investigation of newly published materials, rather than to repeat inclusion of items that already appear in the first edition. Accordingly, materials reviewed for the second edition represent those published since 1964 up to the present. Materials for this revised edition were assembled from more than 400 sources including: publishers, professional organizations, federal and state agencies, hospitals, schools, and industries. Over 3,000 health career brochures, pamphlets, monographs, fact sheets, abstracts, job series, briefs, books, etc., were reviewed and evaluated, using the NVGA Standards as a basis for selection. Included are the medical careers and the related careers that are necessary in the coordination and maintaining of essential health services. Several new careers have been added, such as areas of aerospace medicine, computer operator, counselor, and others. There is represented a wide range of occupations requiring differing levels of education, training, intellectual abilities, skills and responsibilities that are found in the many different work settings and types of activities in health careers.

After careful research and evaluation, those items deemed appropriate were classified alphabetically according to the health career designations and code numbers of the Dictionary of Occupational Titles (DOT). This classification and coding system enhances the effectiveness of the Bibliography for counseling purposes. It simplifies the filing and

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retrieving of occupational data. Also, at the end of each item, letters from A to N refer to the type of publication; and the numbers 1, 2, and 3 refer to the kind of recommendation, whether it is highly recommended, recommended, or useful, as presented in the NVGA Classification and Coding Guide on the following page.

Expenditures necessary to purchase the various items listed in the Bibliography vary. Many of the paperback materials, pamphlets, booklets, and fact sheets are relatively inexpensive; in many instances they are free. Hard cover materials or books of biography and other non-fiction, cost considerably more, within a wide price range. Selection of books was necessarily limited. Only those books which would have motivational value for counseling young people were chosen. Selections were further limited, since the output of suitable career books during the years 1965-69 was not extensive. References to books published prior to 1965 can be made to the first edition of the Bibliography.

Gratitude is extended to the many groups and organizations who have contributed materials and information that made this publication possible. It is hoped that counselors will find this revision and updating of the Health Careers Bibliography a valuable resource aid.

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CLASSIFICATION AND CODING GUIDE *

	Type of Publication
A-Career Fiction	An account, portrayed through the experiences of one or more fictional characters, of an occupation which may encompass duties, qualifications, preparations, conditions, and nature of work and advancement.
B-Biography	An account of the life of a successful man or woman in a given field of endeavor portraying the problems faced by these people in preparing for an advancement in their careers.
C-Occupational Monograph	Extensive coverage of all phases of an occupation. A detailed, comprehensive analysis of a field of work and its related occupations. (about 4,000 - 8,000 words)
D-Occupational Brief	Covers the various types of specialization in an occupational field in general terms. Not as extensive as a monograph, yet describes all phases of the various job opportunities. Usually prose style. (about 3,000 words)
E-Occupational Abstract	A concise summary of a job in an occupational area citing the duties and nature of employment, etc., in general terms. May be in prose or outline form. (about 1,500 words)
F-Occupational Guide	Brief facts about various phases of an occupational title. Contains general information about the occupation but does not describe any particular job. May be in outline form. Often a booklet or leaflet.
G-Job Series	Broad coverage of an entire occupational area giving brief accounts of all job opportunities in the field. May be book, manual, or article.
H-Business and Industrial descriptive literature	Describes a particular business or industry. May show scope and pattern of occupational opportunities.

* NVGA Bibliography of Current Occupational Literature 1966 Edition, Career Information Review Service of the National Vocational Guidance Association, APGA, Washington, D. C.

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I-Occupational or industrial description	Describes the principal opportunities of an occupation in one industry or one occupation in several industries. Discusses an occupation as it relates to employment opportunities in industry. May include a brief account of the industry or industries.
J-Recruitment literature	Descriptive promotional information pointed toward recruiting young men and women in an occupation or career field. Brief coverage of facts.
K-Poster or Chart	Occupational information presented by pictures, graphs, tables, etc., in black and white or color, portraying information about jobs, opportunities, trends, qualifications and preparation. Data in concise summarized form permitting a quick review of, or stimulating an interest in, a major occupational group.
L-Article or reprint	An account of an occupation, a phase of an occupation, or a person performing the occupation. Covers most phases of the job. Varies in length and degree of coverage. May also be a fact sheet, series of tables, etc. Usually, but not necessarily, in prose style. May be newspaper, magazine, or other publication.
M-Community survey economic report, job analysis	Very accurate, highly statistical, comprehensive reports made as the result of local, national, or industrial studies. Professional studies not easily adapted to student use.
N-Other	Specialized occupational studies, general occupational reviews, technical reports, or portions thereof, if applicable, and other miscellaneous occupational information. Information presented by types other than those listed above should be accounted for here. Includes occupations in relation to specific college curricula.

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	Recommendation
1-Highly recommended	Maximum adherence to NVGA Standards. Adequately meets most of the points outlined. A very high caliber publication--comprehensive, authentic, objective, readable, and up-to-date.
2-Recommended	General adherence to NVGA Standards. Adequately meets more than half the points outlined. A high caliber publication--authentic, objective, readable, up-to-date, but not necessarily as comprehensive.
3-Useful	Does not adequately meet NVGA Standards because limited in scope. However, contains information helpful to students making it worth including in an occupational file or library. In all cases, applicable information is authentic, objective, readable and timely.

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ACCOUNTANT
160.188

A Career as a Certified Public Account. New York, New York: Accounting Careers Council, 1964, 32pp., free. C-1

Accounting is Business Leadership. New York, New York: Accounting Careers Council, (no date), 4pp., free. J-3

The Business Side of Your Practice. Chicago, Illinois: Society of Professional Business Consultants (Medical), 1968, 9pp., free. E-2

James A. Cashen, C.P.A. Careers and Opportunities in Accounting. New York, New York: E. P. Dutton, Inc., non-fiction, 1965, 224pp., $4.95. G-1

Careers in Financial Management and Controllership. New York, New York: Accounting Careers Council, (no date), 6pp., free. F-2

Employment Outlook for Accountants. Washington, D. C.: U. S. Government Printing Office, 1968, reprint from the 1968-69 Occupational Handbook, Bulletin #1550.1, 3pp., 05¢. L-1

Ray, Robert H. and James H. MacNeill. Horizons for a Profession. New York, New York: American Institute of Certified Public Accountants, 1967, 354pp., $7.50. N-1

The Making of a C.P.A. New York, New York: American Institute of Certified Public Accountants, 1968, 14pp., free. L-2

Management Accounting, Opportunities Unlimited. New York, New York: Accounting Careers Council, December 1967, 5pp., free. J-2

Management Accounting - Opportunities Unlimited. New York, New York: National Association of Accountants, (no date), 4pp., free. J-3

Preparing for Your Career in Business. New York, New York: Accounting Careers Council, (no date), 31pp., 25¢. J-1

Qualifications of the Hospital Accountant. Joseph Tonascia, Largo, Florida: Careers, 1967, 1pp., subscription. L-2

Rohn, Fred H. So You Want to be an Accountant. New York, New York: Harper and Row Publishers, Inc., 1965, 173pp., $3.50. G-2

Wanted - A Career in Accounting is Waiting. New York, New York: Accounting Careers Council, (no date), 1pp., free. K-3

14028

ADMINISTRATOR, HOSPITAL
187.118

Kirk, Weir R. A Definitive Study of Your Future in Hospital Administration. New York, New York: Richards Rosen Press, Inc., December 1968, 154pp., $2.79. J-1

Concordia College Record - Major in Hospital Administration. Muncie, Indiana: Registry of Medical Technologists of the American Society of Clinical Pathologists, April 1966, 3pp., free. N-2

Educational Qualifications of Medical Administrators of Specialized Health Programs. New York, New York: American Public Health Association, Inc., February 1968, 3pp., free. L-2

Employment Outlook for Hospital Administrators. Washington, D. C.: Bureau of Labor Statistics, U. S. Department of Labor, 1966, 4pp., 05¢. D-1

Graduate Program in Hospital Administration. Berkeley, California: University of California, July 1968, 7pp., free. N-2

Hospital Administration. Chicago, Illinois: American College of Hospital Administration, November 1966, 7pp., free. J-2

Hospital Administration as a Career. Chicago, Illinois: American College of Hospital Administration, 1968, 6pp., free. J-2

The Hospital Administrator. Chicago, Illinois: Association of University Programs in Hospital Administration, 1968, 1pp., free. L-2

Hospital Administrator. Largo, Florida: Careers, revised September 1966, 7pp., 25¢. D-1

Hospital Administrator. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-2

Hospital Administrators. Chicago, Illinois: Science Research Associates, Inc., 1967, 4pp., 45¢. D-1

Hospital Public Relations Officer. Chicago, Illinois: American Hospital Association, 1968, 3pp., free. E-1

Should You be a Hospital Administrator? New York, New York: New York Life Insurance Company, 1967, 7pp., free. J-2

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14029

The Association of University Programs in Hospital Administration. Washington, D. C.: The Association of University Programs in Hospital Administration, 1969, 1p., free. L-2

ADMITTING OFFICER
237.368

Hospital Admitting Officer. Chicago, Illinois: American Hospital Association, 1966, 3pp., free. E-2

Supportive Nursing Personnel. Chicago, Illinois: American Hospital Association, 1966, 3pp., free. E-2

AEROSPACE MEDICINE
002.081

Aeronautical Engineer. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-2

Aerospace (Aeronautical) Engineer. Largo, Florida: Careers, revised November 1965, 7pp., 25¢. D-1

Atomic Energy Engineers and Scientists. Largo, Florida: Careers, revised 1967, 7pp., 25¢. D-1

Bulletin of the American Board of Preventive Medicine. Baltimore, Maryland: American Board of Preventive Medicine, 1968, 15pp., free. N-3

Careers in Aerospace Medicine and Life Sciences. Washington, D. C.: Aerospace Medical Association, (no date), 11pp., free. F-2

Careers in Atomic Energy. Moravia, New York: Chronicle Guidance Publications, Inc., 1967, 4pp., 35¢. D-2

Careers in Atomic Energy. Washington, D. C.: United States Atomic Energy Commission, September 1968, 27pp., free. F-2

Nuclear Engineer. Moravia, New York: Chronicle Guidance Publications, Inc., 1969, 4pp., 35¢. D-2

14030

N A S A Counsels the Earthbound. Paul Gardner. Moravia, New York: Chronicle Guidance Publications, Inc., reprint from Occupational Quarterly, May 1966, 4pp., (no price). L-1

ANATOMIST
041.081

Your Career in Anatomy. Ann Arbor, Michigan: University of Michigan, Department of Anatomy, 1963, 12pp., free. J-1

ANESTHETIST
070.108

Anesthesia: Which Drugs are Used When. Golden G. Gree. Park Ridge, Illinois: American Society of Anesthesiologists, reprint from Better Homes and Gardens, 1965, 2pp., free. L-1

Anesthesia and You. Park Ridge, Illinois: American Society of Anesthesiologists, 1968, 8pp., single copy free. N-2

Anesthetists. Chicago, Illinois: Science Research Associates, Inc., 1966, 4pp., 45¢. D-1

The Story of Anesthesia. Park Ridge, Illinois: American Society of Anesthesiologists, 1965, 8pp., single copy free. N-2

ARCHITECT
001.081

Designing a Better Tomorrow. Washington, D. C.: American Institute Of Architects, 1966, 18pp., free. F-2

Employment Outlook for Architects. Washington, D. C.: U. S. Government Printing Office, 1968, 3pp., 05¢. Reprint from the 1968-69 Outlook Handbook, Occupational Outlook Report Series, Bulletin # 1550-5.

14031

Draw a Maltese Cross

Draw a 4-inch square and a $1\frac{3}{8}$-inch square with the same center. From each corner of the inner square draw lines to the outer square at 15° and 75° from the horizontal. Come $\frac{1}{4}$ inch inside each line of this outside cross and complete the figure as shown below.

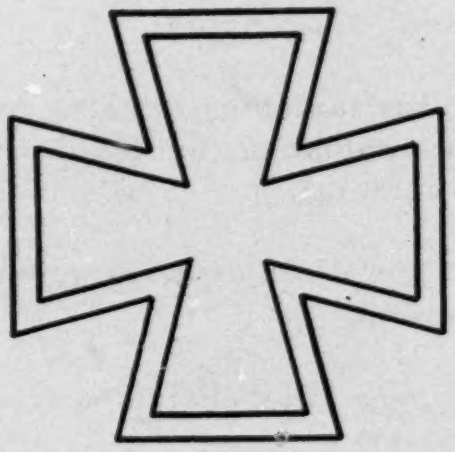

1400

AUDIOLOGIST
079.108

A Career for You as an Audiologist and Speech Pathologist. Washington, D. C.: Veterans Administration Department of Medicine and Surgery, April 1966, 3pp., free. J-2

Audiologist: A Career in Communications. Aaron Cohodes, Largo, Florida: Careers, 1965, issue of Blue Print for Health, 3pp., free. L-2

Audiologist. Largo, Florida: Careers, revised September 1966, 7pp., 25¢. D-1

Hearing and Speech Careers. Washington, D. C.: National Association of Hearing and Speech Agencies, 1967, 8pp., free. J-1

Hearing Clinician. Largo, Florida: Careers, revised 1966, 7pp., 25¢. D-1

Hearing Loss: Hope Through Research. Washington, D. C.: National Association of Hearing and Speech Agencies, April 1968, 34pp., 25¢. N-2

Rehabilitation of the Deaf Training Programs. Washington, D. C.: U. S. Department of Health, Education and Welfare, Vocational Rehabilitation Administration, September 1967, 2pp., free. N-1

Traineeships for Graduate Study in Speech Pathology and Audiology. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Vocational Rehabilitation Administration, September 1968, 9pp., free. N-1

BAKER
526.781

Baker. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-2

Bakers. Chicago, Illinois: Science Research Associates, Inc., 1967, 4pp., 45¢. D-2

Employment Outlook for Baking Industry. Washington, D. C.: U. S. Government Printing Office. Occupational Outlook Report Series. 1968-69, 8pp., 05¢. L-1

14032

BIOCHEMISTS
041.081

Biochemist. Largo, Florida: Careers, revised October 1965, 7pp., 25¢. D-1

Biochemist. Moravia, New York: Chronicle Guidance Publications, Inc., 1965, 4pp., 35¢. D-2

Biochemists. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

BIOLOGIST
041.081

Arthritis and Research. Bethesda, Maryland: National Institute of Arthritis and Metabolic Disease, 1968, 17pp., free. N-3

Biologist. Largo, Florida: Careers, revised 1968, 7pp., 25¢. D-1

Biologist. Moravia, New York: Chronicle Guidance Publications, Inc., 1965, 4pp., 35¢. D-2

Biologist. Minneapolis, Minnesota: Finney Company, 1968, 4pp., Unit price. C-2

Biologist Assistant. Largo, Florida: Careers, revised 1968, 2pp., 20¢. L-1

Botanist. Largo, Florida: Careers, revised 1966, 7pp., 25¢. D-1

Botanist. Minneapolis, Minnesota: Finney Company, 1968, 4pp., Unit price. E-2

Career as a Biological Scientist. Washington, D. C.: B'Nai B'Rith Vocational Service, 1965, 16pp., 35¢. D-1

Careers in Biology. St. Louis, Missouri: American Association of Bioanalysts, 1967, 18pp., free. D-1

Careers in Biology. Washington, D. C.: American Institute of Biological Sciences, 1967, 18pp., free. C-2

Closing In. New York, New York: Leukemia Society of America, 1967, 128pp., free. N-2

SE004033

Entomologist in the Medical Service Corps. Washington, D. C.: Department of the Army, Office of the Surgeon General, October 1968, 5pp., free. F-2

Young, Richard S. Extraterrestial Biology. New York, New York: Holt, Rinehart and Winston, Inc., 1966, 119pp., $2.95. N-2

Fishery Bacteriologist. Minneapolis, Minnesota: Finney Company, 1968, 4pp., Unit price. E-2

Geneticist. Largo, Florida: Careers, revised 1968, 2pp., 15¢. L-1

Information Pertaining to Accreditation of Bioanalysts. St. Louis, Missouri: American Association of Bioanalysts, (no date), 1pp., free. L-1

Mycologist. Largo, Florida: Careers, 1965, 2pp., 15¢. L-1

Of Paper and Opportunity. New York, New York: American Paper and Pulp Association, 1965, 12pp., free. L-3

The Human Cell and the Cytotechnologist. Brunswick, Maine: American Cancer Society, Maine Division, Inc., January 1965, 6pp., free. J-2

U. S. Public Health Service - Scientist. Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967, 7pp., free. J-2

Zoologist. Moravia, New York: Chronicle Guidance Publications, Inc., 1967, 4pp., 35¢. D-2

BIOMATHEMATICIAN
020.188

A Career in Statistics with the National Center for Health Statistics. Washington, D. C.: U. S. Department of Health, Education, and Welfare, August 1968, 27pp., free. J-2

Careers in Statistics. Washington, D. C.: American Statistical Association, November 1966, 23pp., free. F-1

14034

BIOPHYSICIST
041.081

Biophysicist. Largo, Florida: Careers, revised 1968, 2 pp., 15¢. L-1

CHEMIST
022.081

A Bright Future for You as a Chemical Technician. Washington, D. C.: Manufacturing Chemists Association, Inc., 1968, 8pp., free. J-1

Automation. Washington, D. C.: American Chemical Society, 1966, 4pp., (no price). L-2

Careers Ahead in the Chemical Industry. Washington, D. C.: Manufacturing Chemists Association, Inc., 1969-70, 25pp., free. I-1

Chemical Engineering. Moravia, New York: Chronicle Guidance, Inc., 1967, 4pp., 35¢. D-2

Chemist. Detroit, Michigan: Michigan Employment Security Commission, April 1968, 2pp., free. F-2 (for Michigan)

Chemist. Juneau, Alaska: Alaska State Department of Health and Welfare, February 1968, 2pp., free for Alaska. J-2

Chemist. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-1

Chemistry and Your Career. Washington, D. C.: American Chemical Society, 1967, 20pp., free. F-1

Frontiersman of the Future. Washington, D. C.: Manufacturing Chemists Association, Inc., 1969-70, 15pp., free. J-1

Is Chemical Technology the Career for You? Washington, D. C.: American Chemical Society, 1968, 12pp., free. E-3

Shall I Study Chemistry? Washington, D. C.: American Chemical Society, 1967, 14pp., free. D-1

14035

CHIROPRACTOR
079.108

A Professional Career in Chiropractic. Des Moines, Iowa: American Chiropractic Association, 1968, 4pp., free. N-3

Announcing Scholarships in Chiropractic. Des Moines, Iowa: American Chiropractic Association, (no date), 1pp., free. K-2

Approved Chiropractic Colleges. Davenport, Iowa: International Chiropractors Association, 1968, 18pp., free. N-2

Chiropractic - A Career for your Son or Daughter. Davenport, Iowa: International Chiropractors Association, (no date), 8pp., free. J-1

Chiropractic - A Career with a Future. Davenport, Iowa: Palmer College of Chiropractic, 1968, 12pp., free. N-3

Chiropractic - A Good Career for a Woman. Des Moines, Iowa: American Chiropractic Association, (no date), 11pp., free. J-2

Chiropractor. Largo, Florida: Careers, revised December 1968, 2pp., 20¢. L-1

Chiropractor. Moravia, New York: Chronicle Guidance Publications, Inc., 1965, 4pp., 35¢. D-1

Facts About the Modern Doctor of Chiropractic. Des Moines, Iowa: American Chiropractic Association, 1968, 10pp., free. F-2

For a Rewarding Professional Career. Davenport, Iowa: Palmer College of Chiropractic, 1968, 5pp., free. J-3

Information on Chiropractic as a Professional Career. Davenport, Iowa: Palmer College of Chiropractic, 1969, 6pp., free. F-1

Medicine and Chiropractic. C. W. Weiant, New York, New York: 1966, 136pp., $6.00. N-1

Opportunities in a Chiropractic Career. New York, New York: Universal Publishing and Distributing Corporation, Vocational Guidance Manuals, Inc., 1967, 126pp., $1.65. C-1

Questions and Answers Relating to Chiropractic. Davenport, Iowa: Palmer College of Chiropractic, 1968, 6pp., free. F-2

14036

Bach, Marcus. The Chiropractic Story. Los Angeles, California: De Vorss and Company, Inc., 1968, 250pp., $5.95. N-1

Your Career as a Doctor of Chiropractic. Davenport, Iowa: International Chiropractors Association, (no date), 10pp., free. F-1

CLERKS, GENERAL OFFICE
1-04; 1-05

Clerical Occupations for Women Today and Tomorrow. Washington, D. C.: U. S. Department of Labor. 1964, 69pp., 35¢. N-2

Employment Outlook for Cashiers. Washington, D. C.: U. S. Government Printing Office. Occupational Outlook Report Series. 1968-69, 8pp., 05¢. L-1

CLINICAL PSYCHOLOGIST
045.108

Clinical Psychologist. Juneau, Alaska: Alaska State Department of Health and Welfare, July 1, 1967, 2pp., free for Alaska. J-2

Clinical Psychologist Assistant. Juneau, Alaska: Alaska State Department of Health and Welfare, July 1, 1967, 2pp., free for Alaska. J-2

Senior Clinical Psychologist. Juneau, Alaska: Alaska State Department of Health and Welfare, July 1, 1967, 2pp., free for Alaska. J-2

COMPUTER OPERATOR
003.181

ABC's of Automatic Data Processing. Park Ridge, Illinois: Data Processing Management Association, 1967, 25pp., free. N-2

Carroll, John M. Careers and Opportunities in Computer Science. New York, New York: E. P. Dutton and Company, Inc., 191pp., $3.95. G-1

Computer Careers. Montvale, New Jersey: American Federation of Information Processing Societies, 1968, 24pp., free. C-2

14037

Data Processing Manager. Largo, Florida: Careers, 1969, 2pp., 20¢. E-2

Davis, Sidney. Your Future in Computer Programming. New York, New York: Richards Rosen Press, Inc., 1969, 143pp., $3.64. N-1

Fisher, George. Your Career in Computers. New York, New York: Meredith Press, 1968, 194pp., $4.95. G-1

Jobs in Computer Programming. New York, New York: Alumnae Advisory Center, Inc., reprinted from Mademoiselle, January 1967, 5pp., 25¢. L-1

Krasnoff, Sidney O., M.D. F.A.C.P. Computers in Medicine. Springfield, Illinois: C. C. Thomas, 1967, 126pp., $6.75. N-1

Seligsohn, I. J. Your Career in Computer Programming. New York, New York: Simon and Schuster, Inc., 1968, 222pp., $3.95. J-1

Your Career in Data Processing. Park Ridge, Illinois: Data Processing Management, 1967, 2pp., free. J-3

COOK
315.381

Chef. Moravia, New York: Chronicle Guidance Publications, Inc., 1967, 4pp., 25¢. D-2

Klein, Camille. The Professional Cook. New York, New York: Helios Book Publishing Company, 1965, 91pp., $2.95. N-2

COUNSELOR
045.108

McDonough, Thomas. A Definitive Study of your Future as a Guidance Counselor. New York, New York: Richards Rosen Press, Inc., 1968, 160pp., $4.00. N-1

Certification Requirement for School Pupil Personnel Workers. Washington, D. C.: U. S. Department of Health, Education and Welfare, 1967, 147pp., 60¢. N-1

14038

Counselors. Detroit, Michigan: Michigan Employment Security Commission, 1966, 20pp., free. C-2 (for Michigan)

Guidance Counselor. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-2

High School Counselor. Largo, Florida: Careers, 1965, 2pp., 15¢. D-2

School Counselor. Sacramento, California: California State Department of Employment, 1967, 5pp., free. F-2 (for California)

School Counselors. Chicago, Illinois: Science Research Associates, Inc., 1966, 4pp., 40¢. D-1

DENTAL ASSISTANT
079.378

Dental Assistant. Columbus, Ohio: Ohio State Employment Service, January 1968, 2pp., free. L-2

Dental Assistant. Largo, Florida: Careers, revised 1969, 7pp., 35¢. D-1

Dental Assistant. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-2

Dental Assistants. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., free. D-1

Brauer, John C. and Richard Richardson, eds. The Dental Assistant. New York, New York: McGraw-Hill Book Company, Inc., 1964, 715pp., $10.00. N-2

There's an Action Career Ahead when you Become a Trained Dental Assistant. Chicago, Illinois: American Dental Association (no date), 2pp., free. J-1

Why Employ a Currently Certified Dental Assistant? Chicago, Illinois: American Dental Assistant Association, 1968, 4pp., free. F-2

Your Future as a Dental Assistant. New York, New York: Richards Rosen Press, 1970, 138pp., $4.00

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DENTAL HYGIENIST
078.368

Paige, Barbara E. A Definitive Study of Your Future as a Dental Hygienist. New York, New York: Richards Rosen Press Inc., 1969, 142pp., $3.78. J-1

A Mirror Image of a Dental Hygienist. Chicago, Illinois: American Dental Hygienists' Association, (no date), 3pp., free. J-2

Accredited Dental Hygiene Program. Chicago, Illinois: American Dental Hygienists' Association, January 1969, 5pp., free. N-1

Bulletin - Courses for Dental Hygienists. New York, New York: Columbia University School of Dental and Oral Surgery, 1969-70, 40pp., free. N-2

Careers in Dental Hygiene. Chicago, Illinois: American Dental Hygienists' Association, (no date), 5pp., free. F-2

Columbia University Bulletin - Courses for Dental Hygienists. New York, New York: Columbia University, School of Dental and Oral Surgery, 1969-70, 38pp., free. N-1

Courses in Dental Hygiene. New York, New York: Columbia University School of Dental and Oral Surgery, (no date), 15pp., free. N-2

Dental Hygiene - A Career with a Future. Chicago, Illinois: American Dental Hygienists' Association (no date), 1pp., free. J-2

Dental Hygienist. Columbus, Ohio: Ohio State Employment Service, September 1967, 2pp., free. L-2

Dental Hygienist. Detroit, Michigan: Michigan Employment Security Commission, May 1967, 2pp., free. F-2 (for Michigan)

Dental Hygienist. Largo, Florida: Careers, revised 1968, 7pp., 25¢. D-1

Dental Hygienist. Moravia, New York: Chronicle Guidance Publications, Inc., 1965, 4pp., 35¢. D-1

Dental Hygienists. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

The Registered Dental Hygienist. Washington, D. C.: United States Department of Health, Education, and Welfare, 1966, 8pp., 15¢. J-1

14041
14040

DENTAL TECHNICIAN
712.381

Accredited Dental Laboratory Technology Programs. Chicago, Illinois: The American Fund for Dental Education, June 1969, 2pp., free.

Approved Dental Laboratory Technology Programs. Washington, D. C.: National Board of Certification, April 1968, 1pp., free. L-2

Dental Laboratory Technician. Chicago, Illinois: Science Research Associates, Inc., 1969, 4pp., 45¢. D-1

Dental Laboratory Technician. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-1

Dental Technician. Columbus, Ohio: Ohio State Employment Service, September 1967, 2pp., free. L-2 (for Ohio)

Dental Technician. Largo, Florida: Careers, revised 1965, 2pp., 15¢. L-1

Hands that Think - A Word about Careers in Modern Dental Laboratory Technology. Washington, D. C.: National Board of Certification, July 1968, 5pp., free. F-1

DENTIST
072.108

Accredited Dental Schools. Chicago, Illinois: American Dental Association, January 1969, 5pp., free. N-1

Careers in Dentistry. Chicago, Illinois: American Association of Dental Schools, 1966, 18pp., free. J-1

Careers in Dental Industry. Washington, D. C.: American Dental Trade Association (no date), 6pp., free. J-2

Dental Health Research Grants. Washington, D. C.: United States Department of Health, Education, and Welfare, 1965, 2pp., free. N-2

Dentist. Largo, Florida: Careers, revised December 1968, 7pp., 35¢. D-1

14041

UNIT III - DRAWING GEOMETRIC CONSTRUCTIONS

ACHIEVEMENT TEST

PROBLEMS:

1. Bisect a line $2\frac{5}{8}$ inches long.

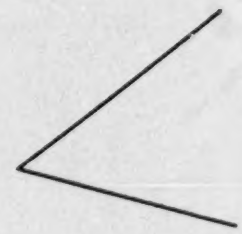

2. Construct a 1-inch radius on the acute angle shown in Fig. 1.

TO CONSTRUCT A 1" ROUND OR FILLET ON AN ACUTE ANGLE

FIG. 1

3. Bisect the arc shown in Fig. 2.

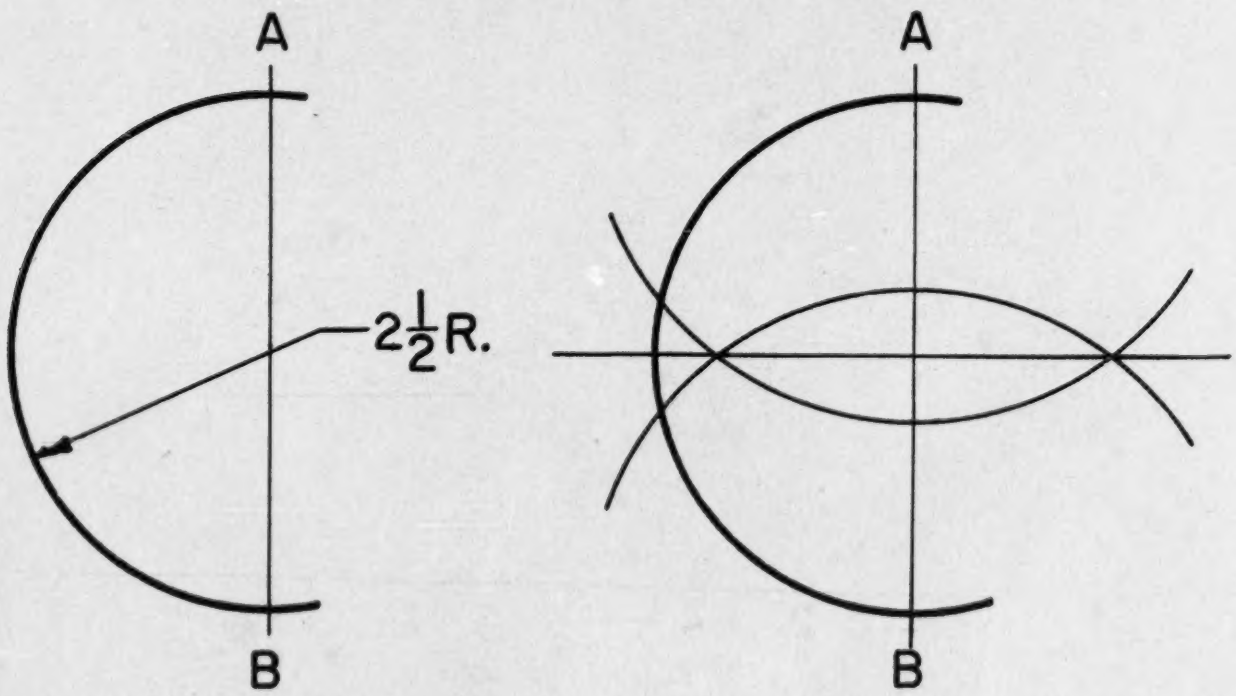

FIG. 2

4. Draw a circular arc of 1-inch radius tangent to the two given lines shown in Fig. 3.

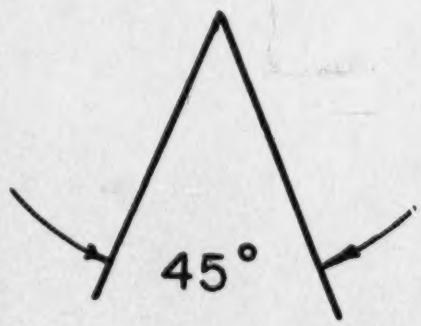

FIG. 3

5. Draw an approximate ellipse by the four-center method. The major diameter is 4 inches and the minor diameter is 2 inches.

1401

Dentist. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-1

Dentistry. Chicago, Illinois: Health Careers Council of Illinois, (no date), 4pp., free. J-3 (for Illinois)

Dentistry - A Career for Women. Chicago, Illinois: American Dental Association, (no date), 7pp., free. J-1

Dentists. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

Educational Qualifications of Public Health Dentist. New York, New York: American Public Health Association, Inc., April 1967, 10pp., free. L-2

Financial Aid for Dental Students. Chicago, Illinois: American Association of Dental Schools, (no date), 10pp., free.

For the Young Man Interested in Building a Career by Planned Development in the U. S. Army Dental Corps. Washington, D. C.: U. S. Department of the Army, Office of the Surgeon General, (no date), 9pp., free. F-2

Grants for Residency Programs in Preventive Medicine and Dental Public Health. Washington, D. C.: United States Department of Health, Education, and Welfare, January 1968, 9pp., free

Grant Programs in Dental Public Health. Washington, D. C.: United States Department of Health, Education, and Welfare, 1967, 12pp., free. N-1

Hands that Think. Washington, D. C.: National Association of Certified Dental Laboratories, (no date), 5pp., free. E-3

Information Concerning Certification as a Specialist in Dental Public Health. Ann Arbor, Michigan: American Board of Dental Public Health, September 1966, 9pp., free. N-3

Other Careers in Dental Health. Chicago, Illinois: Health Careers Council of Illinois, (no date), 5pp., free. J-2 (for Illinois)

Greenberg, Saul M. D.D.S. and Joan R. So You Want to be a Dentist. New York, New York: Harper and Row Publishers, Inc., 1963, 168pp., $3.79. N-2

14042

The Challenge of Dentistry. Chicago, Illinois: American Association of Dental Schools, (no date), 10pp., free. J-2

Your Future in Dentistry. Chicago, Illinois: American Association of Dental Schools, 1968, 6pp., free. J-2

DIETITIAN
077.168

Paris, Jeanne. A Definitive Study of Your Future as a Home Economist. New York, New York: Richards Rosen Press, Inc., December 1968, 160pp., $2.79. J-1

A Dietetic Internship. Chicago, Illinois: The American Dietetic Association, revised April 1968, 14pp., free. J-2

Westbrook, James H. Aim for a Job in Restaurants and Food Service. New York, New York: Richards Rosen Press, Inc., (no date), 191pp., $3.78. G-2

Careers - Home Economists Here and Abroad. Dr. Helen G. Canoyer. New York, New York: State of New York, Department of Commerce, (no date), 3pp., free. G-1

Careers in Dietetics. Washington, D. C.: U. S. Civil Service Commission, August 20, 1968, 6pp., free. F-1

Careers in Nutrition. Bethesda, Maryland: American Institute of Nutrition, (no date), 3pp., free. J-2

Dietetics and Nutrition. Chicago, Illinois: Health Careers Council of Illinois: (no date), 4pp., free, J-2 (for Illinois)

Dietetics as a Profession. Chicago, Illinois: The American Dietetic Association, revised March 1966, 37pp., 50¢. G-1

Dietetics in Health Agencies. Chicago, Illinois: The American Dietetic Association, 1967, 1pp., free. K-3

Dietetics in Hospitals. Chicago, Illinois: The American Dietetic Association, 1967, 1pp., free. K-3

Dietetics in Industry. Chicago, Illinois: The American Dietetic Association, (no date), 1pp., free. K-3

14043

Dietetics in Universities. Chicago, Illinois: The American Dietetic Association, (no date), 1pp., free. K-3

Dietitian. Largo, Florida: Careers, revised November 1967, 7pp., 25¢. D-1

Dietitian. Moravia, New York: Chronicle Guidance Publications, Inc., 4pp., 35¢. D-1

Dietitian - A Stimulating Career. Washington, D. C.: Veterans Administration, Department of Medicine and Surgery, September 1965, 3pp., free. J-2

Dietitians. Chicago, Illinois: Science Research Associates, Inc., 1967 4pp., 45¢. D-1

Dietitians in Veterans Administration Hospitals and Clinics Nationwide. VA Pamphlet No. 10-55. Arlington, Virginia: Veterans Administration, revised May 1967, 4pp., (no price). F-1

Do You Know Them? Dietitians, Nutritionists. Chicago, Illinois: The American Dietetic Association, (no date), 4pp., free. F-2

Spencer, Lila. Exciting Careers for Home Economists. New York, New York: Simon and Schuster, Inc., 1967, 191pp., $3.95. J-1

Extension Home Economist. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-1

Krause, Marie. Food Nutrition and Diet Therapy. Philadelphia, Pennsylvania: W. B. Saunders Company, 1966, 687pp., $7.50. N-2

Home Economics Careers for You. Washington, D. C.: American Home Economics Association, (no date), 3pp., 10¢. J-3

Home Economics Careers in Health and Welfare. Washington, D. C.: American Home Economics Association, 1965, 9pp., 25¢. F-1

Home Economics - It May be for You. Trenton, New Jersey: New Jersey Department of Education, Division of Vocational Education, 1969, 1pp., free. K-2

Home Economics Three Futures. Trenton, New Jersey: New Jersey Department of Education, Division of Vocational Education, 1969, 5pp., free. J-3

14044
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Home Economist. Chicago, Illinois: Science Research Associates, Inc. 1969, 4pp., 45¢. D-1

Home Economist. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-2

Home Economists as Members of Health Teams. Washington, D. C.: American Home Economics Association, reprint from Journal of Home Economics, June 1968, 5pp., subscription. L-2

New Directions Ahead. East Orange, New Jersey: Dairy Council of Northern New Jersey, Inc., (no date), 11pp., free. E-2

U. S. Public Health Service - Nutritionist. Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967, 8pp., free. J-2

American Dietitians' Association. Your Future as a Dietitian. New York, New York: Richards Rosen Press, Inc., December 1968, 160pp., $2.79. J-1

ELECTROENCEPHALOGRAPH TECHNICIAN
078.368

Electroencephalograph Technician. Detroit, Michigan: Michigan Employment Security Commission, October 1967, 2pp., free. F-2

ENGINEER
007.181

An Engineering Career for You in the Soil Conservation Service. Washington, D. C.: Soil Conservation Service, U. S. Department of Agriculture, January 1965, 11pp., 10¢. J-2

Engineering, A Career of Opportunity. Washington, D. C.: National Society of Professional Engineers, November 1967, 14pp., free. F-2

Beakley, George C., and Leach, H. W. Engineering, An Introduction to a Creative Profession. New York, New York: MacMillan Company 1967, 548pp., (no price). N-2

Engineers in a Health Program for American Indians. Washington, D. C.: United States Department of Health, Education, and Welfare, July 1968, 6pp., free. J-2

14045

Engineers Unlimited - Your Career in Engineering. Harry Neal. New York, New York: Julian Messner, 1968, 192pp., $3.95. N-2

Sources of Engineering Career Information. New York, New York: Engineers' Council for Professional Development, January 1969, 17pp., single copy free. N-1

U. S. Public Health Service - Engineers. Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967, 7pp., free. J-2

Why Not Be an Engineer? Washington, D. C.: U. S. Department of Labor, Women's Bureau, 1967, 8pp., 05¢. J-1

EXECUTIVE HOUSEKEEPER
187.168

Executive Housekeeper. Chicago, Illinois: Science Research Associates, Inc., 1967, 4pp.. 45¢, D-1

Executive Housekeeper. Largo, Florida: Careers, revised 1969, 2pp., 20¢. L-1

In Choosing a Career - Consider Executive Housekeeping. Gallioplis, Ohio: National Executive Housekeepers' Association, (no date), 2pp., free. J-2

FOOD SERVICE SUPERVISOR
319.138

Careers in Food Services Administration. Rochester, New York: Rochester Institute of Technology, 1967, 23pp., free. G-1

Careers in the Quantity Food Service. Chicago, Illinois: National Restaurant Association, (no date), free. 19pp. F-2

Food Service Supervisor. Largo, Florida: Careers, revised November 1965, 2pp., 15¢. L-1

14046

FOOD TECHNOLOGIST
022.081

Agricultural Engineer. Moravia, New York: Chronicle Guidance Publications, Inc., 1969, 4pp., 35¢. D-2

Choosing Agriculture. Trenton, New Jersey: New Jersey Department of Education, Division of Vocational Education, 1969, 1pp., free. K-2

Choose Agriculture. Trenton, New Jersey: New Jersey Department of Education, Division of Vocational Education, 1969, 5pp., free. J-3

Food Technologist. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-2

Food Technologists. Chicago, Illinois: Science Research Associates, Inc., 1969, 4pp., 45¢. D-1

Scientific Careers in the Agricultural Research Service. Washington, D. C.: U. S. Government Printing Office, September 1967, 35pp., 35¢. E-1

Soil Scientists. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

Students...Start Your Career in SCS Before You Graduate. Washington, D. C.: Soil Conservation Service, U. S. Department of Agriculture, 1966, 8pp., 05¢. J-2

The Science and Technology of Food. Chicago, Illinois: Institute of Food Technologists, May 1964, 13pp., free. G-1

Brissey, George E. Your Future in Food Technology. New York, New York: Richards Rosen Press, Inc., 1967, 159pp., $3.78. J-1

HEALTH EDUCATION TEACHER
0-31.01

Health Education as Your Career. Washington, D. C.: American Association for Health, Physical Education and Recreation, 1966, 7pp., free. J-2

Health Education Materials. Washington, D. C.: Health Insurance Association of America, 1968, free. N-1

14047

HEALTH OFFICER
168.168

Medical Officer. Juneau, Alaska: Alaska State Department of Health and Welfare, January 9, 1968, 2pp., free. J-2 (for Alaska)

Regional Health Officer. Juneau, Alaska State Department of Health and Welfare, October 1968, 2pp., free. J-2 (for Alaska)

HEALTH PHYSICIST
079.021

American Board of Health Physics. Boston, Massachusetts: American Board of Health Physics, (no date), 7pp., free. N-3

Careers for Women in Physics. Dr. Elizabeth A. Wood, New York, New York: American Institute of Physics, March 1967, 18pp., free. D-1

Health Physicist. Largo, Florida: Careers, 1969, 7pp., 35¢. D-1

Health Physicist. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-1

Physicist. Moravia, New York: Chronicle Guidance Publications, Inc., (no date) 1pp., free. K-3

Physics as a Career. New York, New York: American Institute of Physics, March 1966, 24pp., free. F-2

The Physicist in Industry. Donald H. Loughridge, New York, New York: American Institute of Physics, June 1967, 25pp., free. D-1

HEALTH PHYSICS TECHNICIAN
199.187

Health Physics Technician. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-1

14048

HISTOLOGIC TECHNICIAN
078.381

Histologist. Largo, Florida: Careers, 1967, 2pp., 15¢. L-1

Histology Technician. Largo, Florida: Careers, revised 1969, 2pp., 20¢. L-1

HOME HEALTH AIDE AND HOMEMAKER AIDE
354.878

A Fact Sheet. New York, New York: National Council for Homemaker Services, 1969, 2pp., free. L-3

Career Opportunities in Homemaker Home Health Aide Service. New York, New York: National Council for Homemaker Services, November, 1968, 2pp., free. L-2

Help at Home. New York, New York: National Council for Homemaker Services, (no date), 5pp., free. J-2

Homemaker - Home Health Aide Service. Hartford, Connecticut: State of Connecticut, State Department of Health, December 1965, free. L-2 (for Connecticut)

Homemaker Service - How it Helps Children. New York, New York: National Council for Homemaker Services, 1967, 24pp., free. E-2

Homemaker Services in Public Welfare. New York, New York: National Council for Homemaker Services, January 1965, 43pp., free. N-2

The Dollar and Sense of Homemaker Service. New York, New York: National Council for Homemaker Services, (no date), 7pp., free. E-2

HOSPITAL ENGINEER
007.187

Hospital Attendant. Columbus, Ohio: Ohio State Employment Service, January 1968, 2pp., free. L-3 (for Ohio)

Hospital Attendant. Detroit, Michigan: Michigan Employment Security Commission, November 1967, 2pp., free. F-2 (for Michigan)

14049

Hospital Engineer. Chicago, Illinois: American Hospital Association, 1967, 3pp., free. E-2

INDUSTRIAL HYGIENIST
079.188

Graduate Programs in Industrial Hygiene. Boston, Massachusetts: Howard School of Public Health, 1968, 5pp., free. N-1

Industrial Hygienist. Detroit, Michigan: American Industrial Hygiene Association, 1966, 4pp., free. D-1

INHALATION THERAPIST
079.368

A Career in Inhalation Therapy. Summit, New Jersey: Inhalation Therapy Department, Overlook Hospital, (no date), 13pp., free. F-1

Approved Schools of Inhalation Therapy. Summit, New Jersey: Inhalation Therapy Department, Overlook Hospital, September 15, 1968, 2pp., free. N-1

Inhalation Therapy. Chicago, Illinois: Health Careers Council of Illinois, (no date). 4pp., free. J-3 (for Illinois)

Inhalation Therapy - Editorial Notes. Summit, New Jersey: Inhalation Therapy Department, Overlook Hospital, reprint from Journal of the American Hospital Association, September 1, 1968, vol. 42, 15pp., (no price) L-2

Inhalation Therapy Education and Training Programs. Summit, New Jersey: Inhalation Therapy Department, Overlook Hospital, reprint from the Journal of American Medical Association, January 13, 1969, vol. 207, No. 2, 4pp., free. L-1

Inhalation Therapists. Chicago, Illinois: Science Research Associates, Inc., 1966, 4pp., 45¢. D-1

The Career You Want. Jersey City, New Jersey: TB Respiratory Association of Central New Jersey, May 1967, 7pp., free. J-3

14050

LABORATORY TECHNICIAN
041.081

Careers in Medical Laboratories. Chicago, Illinois: Health Careers Council of Illinois, (no date), 4pp., free. J-3 (for Illinois)

Chemical Laboratory Technician. Moravia, New York: Chronicle Guidance Publications, Inc., 1965, 4pp., 35¢. D-1

Educational Qualifications of Public Health Lab Workers. New York, New York: American Public Health Association, Inc., March 1967, 7pp., free. L-2

Fact Sheet on the Medical Laboratory. Washington, D. C.: Intersociety on Pathology Information, April 1967, 4pp., free. F-1

Laboratory Careers in Alabama. Montgomery, Alabama: Alabama State Department of Health, 1966, 6pp., free. J-3

Laboratory Sciences Officers in the Army Medical Department. Washington, D. C.: Department of the Army, Office of the Surgeon General, October 1968, 5pp., free. J-2

Laboratory Tester. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-1

Physicist Technician. Largo, Florida: Careers, revised 1968, 2pp., 20¢. L-1

Technician. Moravia, New York: Chronicle Guidance Publications, Inc., 1967, 4pp., 35¢. D-2

Technicians. Electrocardiograph and Electroencephalograph. Chicago, Illinois: American Hospital Association, 1967, 3pp., free. E-2

The Training of Health Laboratory Personnel. New York, New York: World Health Documents, The American Public Health Association, Inc., 1966, 31pp., 60¢. M-2

What Kind of a Career Could I Have in Medical Laboratory? Chicago, Illinois: College of American Pathologists, (no date), 15pp., single copy free. F-1

14051

UNIT IV - ORTHOGRAPHIC PROJECTION

ACHIEVEMENT TEST

Draw a front, top and right side view of the pictorial drawing shown below. Dimension fully.

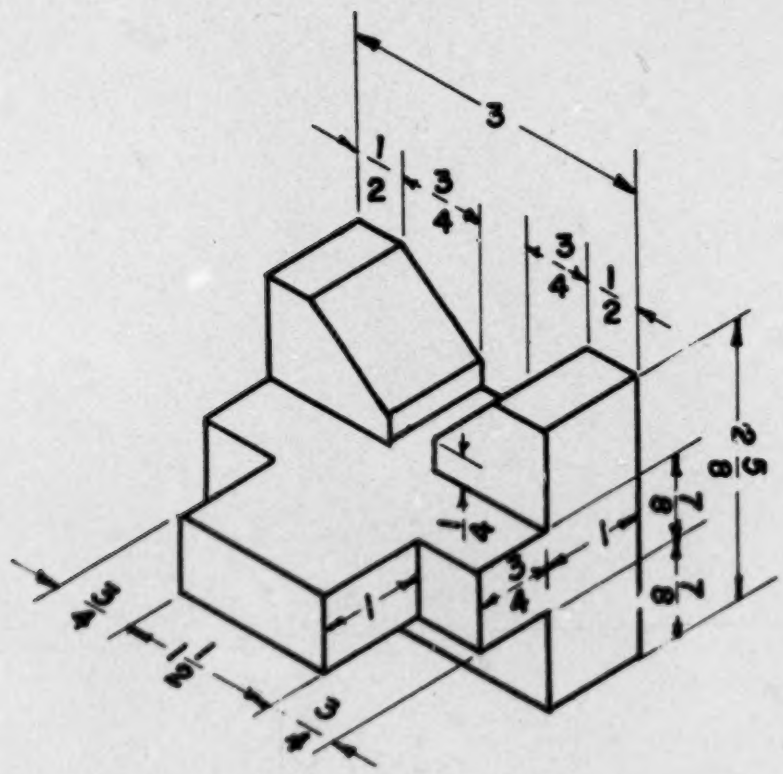

1402

LIBRARIAN
100.168

Librarian. Moravia, New York: Chronicle Guidance Publications, Inc., 1969, 4pp., 35¢. D-1

Librarian, Special. Moravia, New York: Chronicle Guidance Publications, Inc., 1969, 4pp., 35¢. D-1

Library Services. Chicago, Illinois: American Correctional Association, 1966, 16pp., free. L-2

Public Library Services for the Handicapped. Earl C. Sraham, Chicago, Illinois: American Library Association, February 1967, 9pp., free. L-2

Special Librarian. Chicago, Illinois: Science Research Associates, Inc., 1966, 4pp., 45¢. D-1

Special Library Careers in Aerospace. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Biological Science. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Chemistry. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Electronics. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Medicine. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Nuclear Science. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Pharmaceutical Librarian. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Science and Technology. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

Special Library Careers in Social Science. New York, New York: Special Libraries Association, May 1968, 1pp., single copy free. L-2

14052

MANAGER, CREDIT AND COLLECTION
168.168

Initiation to Achievement. New York, New York: American Management Association, 1967, 32pp., free. C-1

The Medical Group Manager. Denver, Colorado: Medical Group Management Association, 1964, 16pp., free. E-1

U. S. Public Health Service - Management Intern Program. Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967, 7pp., free. J-2

MEDICAL ASSISTANT
079.368

Bulletin - Announcing Courses for Medical Assistants. Jersey City, New Jersey: Jersey City State College, 1968, 1pp., free. N-2

Bulletin - Eastern School for Physicians' Aides. New York, New York: Eastern School for Physicians' Aides, 1969, 37pp., free. N-1

Dodge, Bertha S. Hands that Help. Careers for Medical Workers. Boston, Massachusetts: Little, Brown and Company, 1967, 247pp., $4.75. N-3

Jobs for Medical Laboratory Assistant. William J. McCollum. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., (no price). D-1

Medical Assistant. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-1

Medical Laboratory Assistant. Columbus, Ohio: Ohio State Employment Service, January 1968, 2pp., free. L-3 (for Ohio)

Medical Laboratory Assistant. Largo, Florida: Careers, revised 1967, 2pp., 15¢. L-1

Medical Laboratory Assistants. Chicago, Illinois: Science Research Associates, Inc., 1966, 4pp., 45¢. D-1

Medical Office Assistant. Largo, Florida: Careers, revised 1968, 2pp., 20¢. L-1

14053
SEOA1

Medical Technical Assistant. Washington, D. C.: U. S. Civil Service Commission, April 20, 1965, 4pp., free. L-1

Plan Your Career as a Medical Assistant. Chicago, Illinois: American Association of Medical Assistants, 1969, 4pp., single copy free. J-2

Bredow, Miriam. The Medical Assistant. New York, New York: McGraw-Hill Book Company, Inc., 1964, 477pp., $7.95. N-2

Training of Medical Assistants and Similar Personnel. New York, New York: World Health Documents, The American Public Health Association, Inc., 1968, 26pp., 60¢. M-2

Norma B. Chernok. Your Future in Medical Assisting. New York, New York: Richards Rosen Press, Inc., 1967, 127pp., $3.78. N-2

MEDICAL ILLUSTRATOR
141.081

Art as Applied to Medicine. Baltimore, Maryland: The Johns Hopkins Medical School, 1967, 2pp., free. N-3

Biological Photography...What's That? Philadelphia, Pennsylvania: Biological Photographic Association, Inc., (no date), 2pp., free. F-2

Health Information Writer. Minneapolis, Minnesota: Finney Company, 1969, 4pp., Unit price. E-2

Medical Illustrator. River Forest, Illinois: Association of Medical Illustrators, (no date), 4pp., free. E-3

Technical Illustrator. Largo, Florida: Careers, revised September 1967, 2pp., 15¢. L-1

MEDICAL LIBRARIAN
100.168

A Career in Hospital and Institution Librarianship. Chicago, Illinois: American Library Association, (no date), 4pp., single copy free. J-3

Medical Librarian. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

14054

Medical Librarian. Largo, Florida: Careers, revised 1969, 2pp., 20¢. L-1

Medical Librarian Association. Chicago, Illinois: Medical Library Association, Inc., 1968-69, 5pp., free. M-3

Medical Library Careers. Chicago, Illinois: Medical Library Association, Inc., September 1967, 8pp., free. J-2

The Library in the Hospital. Chicago, Illinois: American Library Association, 1969, 6pp., free. J-1

MEDICAL RECORD LIBRARIAN
100.388

Medical Record Librarian. Chicago, Illinois: American Association of Medical Record Librarians, (no date), 3pp., free. F-2

Medical Records - Medical Record Librarians and Medical Record Technicians. Chicago, Illinois: American Association of Medical Record Librarians, (no date), 4pp., free. L-3

Medical Record Technician. Chicago, Illinois: American Association of Medical Record Librarians, 1967, 5pp., free. F-2

Studying in Eden on the Bayous. Chicago, Illinois: American Association of Medical Record Librarians, reprint from Medical Record News, June 1966, 5pp., free. L-3

MEDICAL SECRETARY
201.368

Medical Secretary. Columbus, Ohio: Ohio State Employment Service, January 1968, 2pp., free. L-3 (for Ohio)

Medical Secretary. Moravia, New York: Chronicle Guidance Publications, Inc., 1965, 4pp., 35¢. D-2

14055

MEDICAL SOCIAL WORKER
195.108

Medical Social Worker. Juneau, Alaska: Alaska State Department of Health and Welfare, July 1, 1967, 2pp., free. J-2 (for Alaska)

Social Worker, Medical. Columbus, Ohio: Ohio State Employment Service, September 1967, 2pp., free. L-2 (for Ohio)

Social Worker, Medical. Largo, Florida: Careers, revised 1969, 2pp., 20¢. L-1

MEDICAL TECHNOLOGIST
078.381

A Career Ladder for Medical Laboratory Personnel. Park Ridge, Illinois: American Medical Technologists, (no date), 3pp., free. F-3

Answers to Your Questions About an Exciting Career in Medical Technology. Park Ridge, Illinois: American Medical Technologists, (no date), 5pp., free. E-3

Accredited Schools of Medical Technology. Houston, Texas: American Society of Medical Technologists, September 1967, free. N-2

Approved Schools of Cytotechnology. Chicago, Illinois: American Society of Clinical Pathologists, September 15, 1968, 3pp., free. N-1

Approved Schools of Medical Technology. Chicago, Illinois: American Society of Clinical Pathologists, revised September 15, 1968, 26pp., free. N-1

Career Opportunities in Medical Technology. Washington, D. C.: U. S. Civil Service Commission, September 17, 1968, 6pp., free. J-1

Careers in Medical Laboratory. Houston, Texas: American Society of Medical Technologists, August 1968, 4pp., free. L-2

Careers in the Medical Laboratory. Muncie, Indiana: Registry of Medical Technologists of the American Society of Clinical Pathologists, August 1965, 4pp., free. L-2

Choose Medical Technology. Jefferson City, Missouri: Missouri Council on Health Careers, (no date), 6pp., free. E-2

14056

Choose Medical Technology - Educated Minds, Trained Hands. Brunswick, Maine: American Cancer Society, Maine Division, Inc., June 1966, 7pp., free. J-2

Job Training Suggestions for Women and Girls. Washington, D. C.: U. S. Department of Labor, Women's Bureau, May 1968, 12pp., free. J-2

Medical Equipment Serviceman. Minneapolis, Minnesota: Finney Company, 1969, 4pp., unit price. E-2

Medical Laboratory Careers with a Future. Houston, Texas: American Society of Medical Technologists, (no date), 2pp., free. J-3

Medical Research. Chicago, Illinois: Health Careers Council of Illinois. (no date), 4pp., free. J-3 (for Illinois)

Medical Technician Assistant Aide. Washington, D. C.: U. S. Civil Service Commission, August 20, 1968, 10pp., free. F-1

Medical Technologist. Columbus, Ohio: Ohio State Employment Service, January 1968, 3pp., free. L-3 (for Ohio)

Medical Technologist. Juneau, Alaska: Alaska State Department of Health and Welfare, July 1, 1967, 2pp., free. J-2 (for Alaska)

Medical Technologist. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-2

Medical Technologist. Renee Manley, Moravia, New York: Chronicle Guidance Publications, Inc., 1967, 4pp., 35¢. L-2

Medical Technology. Chicago, Illinois: Health Careers Council of Illinois, (no date), 6pp., free. J-2 (for Illinois)

Opportunities Unlimited - Your Career Ladder in Medical Technology. Park Ridge, Illinois: American Medical Technologists, (no date), 3pp., free. J-3

Schools for the Training of Certified Laboratory Assistants. Chicago, Illinois: American Society of Clinical Pathologists, August 1, 1967, 4pp., free. L-2

The Human Cell and the Cytotechnologist. Houston, Texas: American Society of Medical Technologists, 1968, 6pp., free. E-2

14057
COPY

The Profession of Medical Technology. Rochester, New York: Rochester Institute of Technology, (no date) 4pp., free. F-1

The Registry of Medical Technologists of the American Society of Clinical Pathologists. Chicago, Illinois: American Society of Clinical Pathologists, February 1969, 18pp., (no price). N-1

The Registry of Medical Technologists of the American Society of Clinical Pathologists. Chicago, Illinois: American Society of Clinical Pathologists, January 1968, 17pp., free. N-2

What Kind of Career could I have in a Medical Laboratory? Chicago, Illinois: American Society of Clinical Pathologists, (no date), 16pp., 05¢. F-1

What is a Medical Technologist? Kalamazoo, Michigan: Upjohn Company, 1966, 4pp., free. E-1

Why not be a Medical Technologist? Washington, D. C.: U. S. Department of Labor - Woman's Bureau, 1968, 6pp., free. J-2

MICROBIOLOGIST
041.081

Microbiologist. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

Microbiologist. Juneau, Alaska: Alaska State Department of Health and Welfare, December 1968, 2pp., free. J-2 (for Alaska)

Microbiologist. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-2

NURSE
075.378

Adelaide, Humphries. Nurse in Flight. New York, New York: Thomas Bouregy and Company, Inc., 1968, 189 pp., $3.50. A-2

Brown, Annora. No Man Stands Alone. Canada: Grap Publisher, 1965, 138pp., $3.60. A-2

14058

Colber, Alice R. Vicky Barnes, Junior Hospital Volunteer. The Story of a Candy Striper. New York, New York: Dodd, Mead and Company, 1966, 173pp., $3.50. A-1

Dickens, Monica. One Pair of Feet. Leicester, England: Ulverscroft Series, 1967, 224pp., (no price). B-3

Dodge, Bertha S. Ill by Barbara Corrigan. The Story of Nursing. Boston, Massachusetts: Little Brown and Company, 1965, 244pp., $4.50. B-2

Harmelink, Barbara. Florence Nightingale. New York, New York: Watts, Inc., 1969, 116pp., $3.95. B-1

Laklan, Carli. Nancy Kimball, Nurse's Aide. Garden City, New York: Doubleday and Company, Inc., 1962, 142pp., $3.50. A-2

Laklan, Carli. Nurse in Training. Garden City, New York: Doubleday and Company, Inc., 1965, 144pp., $3.50. A-1

Laklan, Carli. Second Year Nurse. Garden City, New York: Doubleday and Company, Inc., 1967, 144pp., $3.50. A-1

MacLeod, Ruth. Arlene Perry, Orthopedics Nurse. New York, New York: Simon and Schuster, Inc., 1966, 192pp., $3.50. A-1

McCall, Virginia. Navy Nurse. New York, New York: Julian Messner, Inc., 1968, 191pp., $3.50. A-2

McComb, Katherine. Nurse April. New York, New York: Bouregy and Company, Inc., 1967, 191pp., $3.50. A-2

McDonnell, Virginia B. Aerospace Nurse. New York, New York: Simon and Schuster, Inc., 1968, 192pp., $3.50. A-1

Murray, Jill. Nurse Doyle in Danger. New York, New York: Bouregy and Company, Inc., 1968, 190pp., $3.50. A-2

Roberts, Suzanne. Holly Andrews, Nurse in Alaska. New York, New York: Simon and Schuster, Inc., 1967, 190pp., $3.50. A-1

Schima, Marilyn and Bolian, Polly. I Know a Nurse. New York, New York: Putnam, 1969, 47pp., $2.52. A-1

Stone, Patti. Judy George, Student Nurse. New York, New York: Simon and Schuster, Inc., 1967, 192pp., $3.50. A-1

14059

Way, Isabel Stewart. Nurse Christy. New York, New York: Bouregy and Company, Inc., 1968, 192pp., $3.50. A-2

Wilkie, Katharine E. and Elizabeth R. Mosley. Frontier Nurse: Mary Breckinbridge. New York, New York: Julian Messner, Inc., 1969, 195pp., $3.50. B-2

Yost, Edna. American Women of Nursing. New York, New York: J. B. Lippincott Company, 1965, 197pp., $3.95. B-1

NURSE ANESTHETISTS
075.378

Anesthesia-A Special Type of Nursing. Chicago, Illinois: American Association of Nurse Anesthetists, 1965, 7pp., free. J-2

Anesthesia-An Art and A Science. Chicago, Illinois: American Association of Nurse Anesthetists, (no date), 11pp., free. J-3

Approved Schools for Nurse Anesthetists. Chicago, Illinois: American Association of Nurse Anesthetists, August 1968, 16pp., free. M-2

Nurse Anesthetist. Chicago, Illinois: American Association of Nurse Anesthetists, 1967, 6pp., free. F-2

Nurse Anesthetist. Chicago, Illinois: American Association of Nurse Anesthetists, 1969, 7pp., free. E-2

Nurse Anesthetist. Largo, Florida: Careers, revised 1969, 2pp., 20¢. L-1

NURSE INDUSTRIAL
075.128

Have You Considered a Career in Occupational Health Nursing? New York, New York: American Association of Industrial Nurses, (no date), 2pp., free. J-3

Occupational (Industrial) Health Nurse. Largo, Florida: Careers, revised 1968, 2pp., 20¢. L-1

Occupational (Industrial) Health Nurse. New York, New York: American Association of Industrial Nurses, revised 1968, 2pp., 20¢. F-2

14060

The Industrial Nurse. New York, New York: American Association of Industrial Nurses, (no date), 4pp., 10¢. L-2

The Occupational Health Nurse Goes to College. New York, New York: American Association of Industrial Nurses, October 1966. 12pp., 50¢. L-1

NURSE - MIDWIFERY
075.378

A Program of Study in Nurse-Midwifery. New York, New York: Maternity Center Association, 1969, 5pp., free. N-2

A Program of Study Leading to Certification in Nurse-Midwifery. Baltimore, Maryland: Johns Hopkins Hospital School for Nurse-Midwives, (no date), free. K-2

Bulletin of American College of Nurse-Midwifery. New York, New York: American College of Nurse-Midwives, 1965, 2pp., free. B-3

Bulletin of American College of Nurse-Midwifery. New York, New York: American College of Nurse-Midwives, 1965, 61pp., free. N-1

Frontier Graduate School of Midwifery. Windover, Kentucky: Frontier Nursing Service, 1968-69, 12pp., free. N-2

Nurse Midwives. New York, New York: American College of Nurse-Midwives, April 1968, 9pp., free. E-2

Nurse-Midwifery - A Clinical Nursing Specialty. New York, New York: American College for Nurse-Midwives, (no date), 14pp., free. F-2

Nurse-Midwifery. Baltimore, Maryland: Johns Hopkins School for Nurse-Midwives, (no date), 15pp., free. J-3

The Johns Hopkins School of Hygiene and Public Health. Baltimore, Maryland: Johns Hopkins Hospital School of Nurse-Midwives, 1968-69, 3pp., free. N-1

The Midwife in Maternity Care. New York, New York: World Health Documents, 1966, 20pp., 60¢. M-2

What is a Nurse-Midwife? New York, New York: American College of Nurse-Midwives, (no date), 3pp., free. F-2

14061

UNIT V - TRACING

ACHIEVEMENT TEST

On the 8" x 11" buff drawing paper, draw in ink a $\frac{1}{2}$-inch border all around. Draw the figure shown below in pencil. When completed, lay a piece of tracing paper over the drawing and proceed to ink. Obtain dimensions by scaling the drawing.

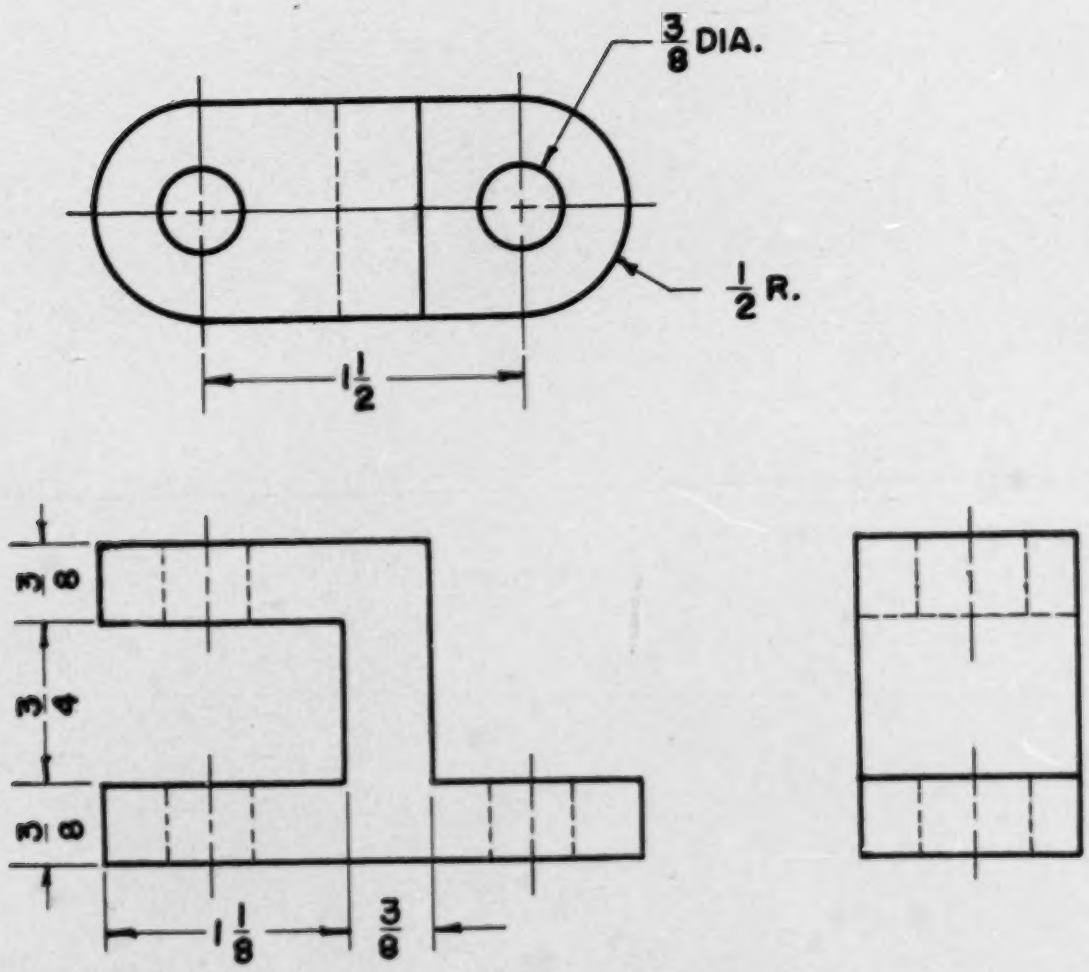

1403

NURSE - PRACTICAL
354.878

Career Opportunities as a Licensed Practical Nurse. New York, New York: National Association for Practical Nurse Education and Service, Inc., 1968, 44pp., free. N-2

Deaconess Hospital Offers Opportunities for Education. Spokane, Washington: Deaconess Hospital, (no date), 11pp., free. N-3

Licensed Practical Nurse. Columbus, Ohio: Ohio State Employment Service, January, 1968, 2pp., free. L-2 (for Ohio)

Licensed Practical Nurse. Trenton, New Jersey: New Jersey Department of Labor and Industry, August 1968, 10pp., free. C-1

Practical Nurse. Juneau, Alaska: Alaska State Department of Health and Welfare, July 1, 1967, 2pp., free. J-2 (for Alaska)

Practical Nurse. Largo, Florida: Careers, revised 1965, 7pp., 25¢. D-1

Practical Nurse Education. Chicago, Illinois: Health Careers Council of Illinois, (no date), 4pp., free. J-3 (for Illinois)

Practical Nursing - A Career that Counts. New York, New York: National Association for Practical Nurse Education and Service (no date), 5pp., free. J-2

Practical Nursing in the Veterans Administration. Washington, D. C.: Veterans Administration Department of Medicine and Surgery, May 1965, 11pp., free. J-2

Programs Preparing for Practical Nursing. New York, New York: American Nurses' Association, 1967, 38pp., 15¢. N-1

Statement of Functions of the Licensed Practical Nurse. New York, New York: National Federation of Licensed Practical Nurses, 1964, 4pp., free. E-3

Brownell, Kathryn and Vivian Culver. The Practical Nurse. Philadelphia, Pennsylvania: W. B. Saunders Company, 1965, 573pp., $6.75. N-2

140620

NURSE - PROFESSIONAL
075.378

McDonnell, Virginia B., R.N. A Definitive Study of Your Future in Nursing. New York, New York: Richards Rosen Press, Inc., December 1968, 157pp., $2.79. J-1

A List of Project Grants Awarded for Improvement in Nurse Training. Washington, D. C.: United States Department of Health, Education, and Welfare, July 1968, 48pp., free. N-1

Associate Degree Education for Nursing. New York, New York: American Nurses' Association, 1968, 5pp., 25¢. N-1

College Education: Key to a Professional Career in Nursing. New York, New York: American Nurses' Association, 1968, 15pp., 25¢. N-1

College Education: Key to Professional Career in Nursing. New York, New York: National League for Nursing, 1969, 15pp., 35¢. N-1

Columbia University - Department of Nursing. New York, New York: Columbia University, 1968, 1pp., free. N-3

Do You Want to Be a Nurse? New York, New York: American Nurses' Association, 1966, 24pp. 15¢. F-1

Do You Want to Be a Nurse? New York, New York: National League for Nursing, March 1966, 22pp., free. J-1

Expanding Horizons in Patient Care. New York, New York: National League for Nursing, Inc., June 1965, 18pp., free. N-2

Facts About Nursing Careers. Madison, Wisconsin: Health Careers Program, August 1968, 2pp., free. L-1

Financial Aids for Nursing Careers. Madison, Wisconsin: Health Careers Program, 1968, 4pp., free. N-3

For Nurses - Cystic Fibrosis. New York, New York: National Cystic Fibrosis Research, November 1968, 4pp., free. E-2

Frontier Nursing Service, Inc. Windover, Kentucky: Frontier Nursing Service, 1968-69, 29pp., free. B-2

General Duty Nurse. Trenton, New Jersey: New Jersey Department of Labor and Industry, April 1969, 17pp., free. F-1

14068

Introduction to Schools of Nursing. Elizabeth, New Jersey: Elizabeth General Hospital and Dispensary, 1966, 20pp., free. N-2

Information for Students - Nursing Educational Opportunity Grants. Washington, D. C.: United States Department of Health, Education, and Welfare, 1968, 1pp., free. K-2

Join the Hospital of Tomorrow Today. Livingston, New Jersey: St. Barnabas Medical Center, (no date), 1pp., free. K-2

Male Nurse. Minneapolis, Minnesota: Finney Company, 1969, 4pp., unit price. E-2

Manual of Policies and Procedures Opportunity Grant for Nursing Education. Washington, D. C.: United States Department of Health, Education, and Welfare, June 7, 1967, 29pp., free. N-1

Masters Education - Route to Opportunities in Modern Nursing. New York, New York: American Nurses' Association, 1968, 15pp., 25¢. N-1

Medical Service Corps. New York, New York: United States Navy Nurse Corps., 1967, 24pp., free. C-1

Nurse. Juneau, Alaska: Alaska State Department of Health and Welfare, July 1, 1967, 2pp., free. J-2 (for Alaska)

Nurse - A Position for You with the American Red Cross as a Nursing Consultant. Washington, D. C.: American National Red Cross, September 1968, 1pp., free. J-2

Nurse - Husband/Father/Humanitarian/Specialist. New York, New York: American Nurses' Association, 1967, 8pp., 25¢. J-1

Nurse, Man. Largo, Florida: Careers, revised 1969, 2pp., 20¢. L-1

Nurse, Man. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-1

Nurse, Professional. Moravia, New York: Chronicle Guidance Publications, Inc., 1968, 4pp., 35¢. D-1

Nurse, Registered. Columbus, Ohio: Ohio State Employment Service, January 1968, 3pp., free. L-2 (for Ohio)

Kay, Eleanor, R.N. Nurses and What They Do. New York, New York. Franklin Watts, Inc., 1968, 123pp., $3.95. G-1

14064

Nursing. Chicago, Illinois: Health Careers Council of Illinois, (no date), 5pp., free. J-3 (for Illinois)

Nursing. Indianapolis, Indiana: Indiana Health Careers, Inc., May 1967, 2pp., free. K-1 (for Indiana)

Nursing. Lansing, Michigan: Michigan State Department of Mental Health, 1968, 5pp., free. J-3 (for Michigan)

Nursing. New York, New York: Alumnae Advisory Center, Inc., reprint from Mademoiselle, December 1967, 6pp., 35¢. L-1

Nursing as a Career. Hartford, Connecticut: State of Connecticut, State Department of Health, August 9, 1965, 1pp., free. L-2 (for Connecticut)

Nursing Education Accreditation. New York, New York: National League for Nursing, Inc., January 1967, 10pp., free. N-3

Nursing Home Fact Book. Washington, D. C.: American Nursing Home Association, 1968, 20pp., free. M-2

Nursing - Information Sheet - Field Assignment. San Diego, California: Project Concern, 1969, 2pp., free. M-3

Nursing, One of Many Fast Growing Health Careers. Hartford, Connecticut: State of Connecticut, State Department of Health, January 1967, 1pp., free. L-2 (for Connecticut)

Nursing Student Loan Program. Washington, D. C.: U. S. Department of Health, Education, and Welfare, revised July 1968, 5pp., free. N-2

Professional Nurse Traineeship Program. Washington, D. C.: U. S. Department of Health, Education, and Welfare, August 1968, 11pp., free. N-2

Psychiatric Nurse. Largo, Florida: Careers, revised 1966, 2pp., 15¢. L-1

Psychiatric Nursing Supervisor. Juneau, Alaska: Alaska State Department of Health and Welfare, September 30, 1968, 2pp., free. J-2 (for Alaska)

Reference Tools for Nursing. Chicago, Illinois: American Library Association, revised April 1968, reprint from Nursing Outlook, May 1966, 4pp., free. L-2

140C5

Registered Nurse. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-2

Registered Nurse. Detroit, Michigan: Michigan Employment Security Commission, September 1967, 2pp., free. F-2 (for Michigan)

Registered Nurse in the Psychiatric Setting. New York, New York: National Association for Mental Health, April 1968, 4pp., free. J-1

Route to Opportunities in Modern Nursing. New York, New York: National League for Nursing Committee Careers, 1968, 16pp., free. N-1

School of Nursing, Series, No. 18 - Bulletin. New Haven, Connecticut: Yale University, September 1968, 57pp., free. N-2

Schools of Nursing - R.N. New York, New York: American Nurses' Association, 1968, 36pp., 15¢. N-1

Schools Offering Nurse Traineeships for Full-Time Academic Study. Washington, D. C.: U. S. Department of Health, Education, and Welfare, August 1968, 18pp., free. N-2

Selecting a Career in Nursing. Muriel R. Carberry, New York, New York: State of New York, Department of Commerce, (no date), 4pp., free. G-1

Should You Be a Nurse? Ruth Sleeper. New York, New York: New York Life Insurance, 1965, 7pp., free. L-2

Something New in White. Washington, D. C.: U. S. Department of Health, Education, and Welfare, rev. 1967, 5pp., free. J-1

Special Nurse Research Fellowships. Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967, 8pp., free. N-2

The Division of Nursing's Grants and Awards. Washington, D. C.: U. S. Department of Health, Education, and Welfare, revised 1966, 7pp., 10¢. N-2

Kay, Eleanor, R.N. The First Book of Nurses. New York, New York: Franklin Watts, Inc., 1968, 56pp., $2.65. G-2

Kriegel, Julia. The Head Nurse. New York, New York: MacMillan Company, 1968, 197pp., $6.95. N-2

14066

The Hospital School of Nursing. Chicago, Illinois: American Hospital Association, 1967, 8pp., free. J-2

The Mount Sinai Hospital School of Nursing. New York, New York: Mount Sinai Hospital, 1967-68, 20pp., free. N-2

The Navy Nurse. New York, New York: U. S. Navy Nurse Corps, April 1968, 16pp., free. C-1

The New Look in Nursing. New York, New York, Columbia University, Department of Nursing, (no date), 4pp., free. N-3

The Professional Nurse in the U. S. Air Force. Washington, D. C.: U. S. Government Printing Office, 1967, 17pp., free. F-1

The Role of Nursing in Programs for Patients with Cerebral Palsy and Related Disorders. Una Haynes, R. N. November 1967, 44pp., 25¢. N-2

There's a Star in Your Future, VA Pamphlet No. 10-30. Arlington, Virginia: Veterans Administration, revised June 1969, 12pp., (no price). J-1

This is Nursing. Washington, D. C.: American Association for Health, Physical Education, and Recreation, (no date), 3pp., free. E-2

This is School Nursing. Washington, D. C.: American Association for Health, Physical Education, and Recreation, (no date), 5pp., free. L-2

Traineeship in Rehabilitation Nursing. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Vocational Rehabilitation Administration, November 1968, 3pp., free. N-3

What It's Like to Be a U. S. Army Nurse. Washington, D. C.: Department of the Army, Office of the Surgeon General, October 1968, 12pp., free. F-1

World Directory of Post-Basic and Post-Graduate Schools of Nursing. New York, New York: World Health Documents, 1965, 223pp., $5.25. N-2

NURSE - PUBLIC HEALTH
075.128

Careers in the U. S. Public Health Service - Nurse. Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967, 7pp., free. J-2

Kentucky Needs Public Health Nurses. Frankfort, Kentucky: Kentucky Commonwealth Department of Health, June, 1964, 5pp., free. J-3

Nurse, Public Health. Largo, Florida: Careers, revised 1968, 2pp., 20¢. L-1

Nurses in Public Health. Washington, D. C.: U. S. Department of Health, Education, and Welfare, revised 1967, 54pp., 40¢. M-1

Public Health Nurse. Chicago, Illinois: Science Research Associates, Inc., 1966, 4pp., 45¢. D-1

Public Health Nurse. Juneau, Alaska: Alaska State Department of Health and Welfare, July, 1967, 2pp., free. J-2 (for Alaska)

Public Health Nursing - An Adventure...A Career. Atlanta, Georgia: Georgia State Department of Public Health, (no date), 5pp., free. J-2

Public Health Nursing Career for You. Berkeley, California: California State Department of Public Health, 1968, 5pp., free. J-2 (for California)

Public Health Nursing Consultant. Juneau, Alaska: Alaska State Department of Health and Welfare, 1967, 2pp., free. J-2 (for Alaska)

Public Health Nursing Offers You a Career. Minneapolis, Minnesota: Minnesota Department of Health, February 1965, 3pp., free. J-3

Public Health Nursing Supervisor. Juneau, Alaska: Alaska State Department of Health and Welfare, October 6, 1967, 2pp., free. J-2 (for Alaska)

School Nurse. Largo, Florida: Careers, revised 1966, 2pp., 15¢. L-1

This is School Nursing. Washington, D. C.: American Association for Health, Physical Education and Recreation, (no date), 5pp., free. F-1

This is School Nursing. Washington, D. C.: American Association for Health, Physical Education and Recreation, 1968, 2pp., free. J-2

14068

Traineeship Grants to Schools of Nursing for Basic Public Health Training for Registered Nurses. Washington, D. C.: U. S. Department of Health, Education, and Welfare, revised June 1968, 12pp., free. N-1

NURSE'S AIDE
355.878

Hospital Attendants. Chicago, Illinois: Science Research Associates, Inc., 1967, 4pp., 45¢. D-1

Nurse Aide. Largo, Florida: Careers, revised January 1965, 2pp., 15¢. L-1

Nurse Aide. Talahassee, Florida: Florida State Employment Service, August 1968, 2pp., free. F-3 (for Florida)

Nurse Aide. Trenton, New Jersey: New Jersey Department of Labor and Industry, April 1969, 9pp., free. F-1

Orderly. Talahassee, Florida: Florida State Employment Service, August 1968, 2pp., free. F-3 (for Florida)

Psychiatric Aide. Largo, Florida: Careers, revised 1966, 2pp., 15¢. L-1

Isler, Charlotte, R. N. The Nurse's Aide in the Hospital. New York, New York: Springer Publishing Company, Inc., 1968, 146pp., $3.00. N-1

OCCUPATIONAL THERAPIST
079.128

Shuff, Frances L., O.T.R. A Definitive Study of Your Future in Occupational Therapy. New York, New York: Richards Rosen Press, Inc., December 1968, 152pp., $2.79. J-1

Can You Deal with These Problems? New York, New York: American Occupational Therapy Association, 1968, 2pp., free. L-3

Careers in the U. S. Public Health Service - Occupational Therapist. Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967, 7pp., free. J-2

14069

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14070

UNIT VI - DIMENSIONING

ACHIEVEMENT TEST

Write the numbers 1 to 15 and write the letter T or F (True or False) after each number, whichever correctly describes the statements below.

1. Dimension and extension lines are drawn to the same thickness.
2. They should be drawn very heavy.
3. Arrowheads must not be drawn freehand.
4. Most employers prefer the solid-head type of arrowhead.
5. The solid-type head is made thinner and longer than the open-head type.
6. When drawn properly, arrowheads improve the appearance of a drawing.
7. Employers do not particularly care whether a drawing is neat or sloppy, so long as it is accurate.
8. Depending on drawing size, arrowheads will vary slightly.
9. All dimensions should read from the bottom or right side of the drawing.
10. The extension lines begin approximately $\frac{1}{16}$ inch away from the drawing.
11. The placing of notes on drawings should be discouraged.
12. You can confuse a workman by placing too many dimensions on a drawing.
13. There are no hard- and- fast rules for dimensioning.
14. Learning shop procedures will help you dimension better.
15. A good rule to remember when drawing fractions is that the total fraction height is twice that of the integer.

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14081

Study the drawing shown below. Draw a front, top, and right-side view of this object and dimension fully. Obtain any dimensions needed by scaling drawing.

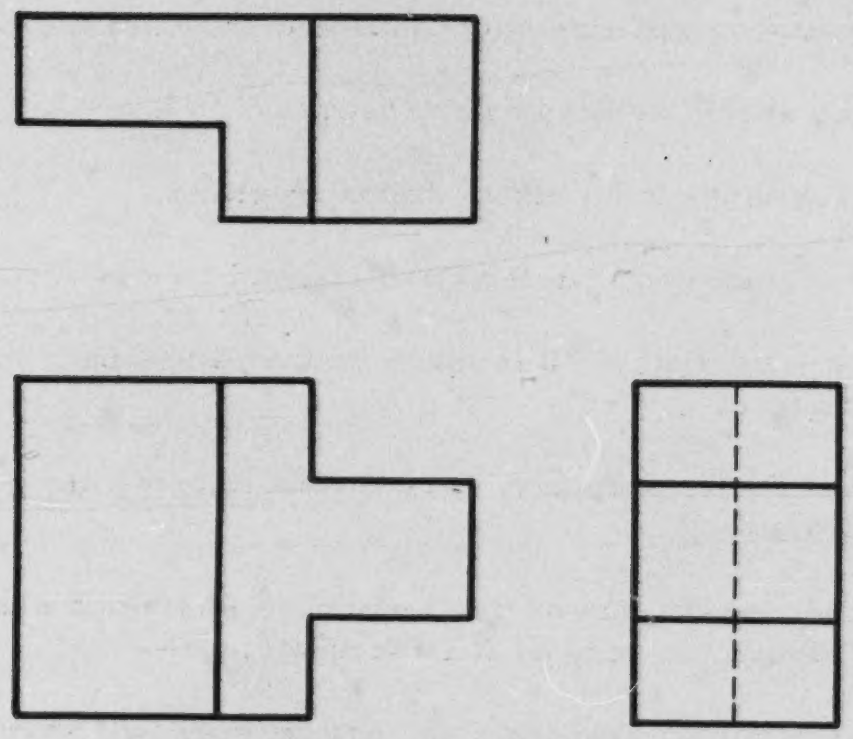

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ERRATA

The following corrections should be made in this copy of HEALTH CAREERS BIBLIOGRAPHY.

1. Title page: NJHCS zip code (bottom right) should be 08618.

2. Pg. 81, Item 12: Has been published annually in HOSPITALS, J. A.H.A. 1970 Edition will list this item under new title of Educational Programs in the Health Field.

3. Pg. 107, Items 4 & 10: addresses should be 3801 Mount Vernon Ave., Alexandria, Virginia 22305.

4. Pg. 108, Item 5: address number should be 1740 Broadway.

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Radiological Health, An Integral Part of Environmental Health. Denver, Colorado: National Association of Sanitarians, (no date), 4pp., free. F-2

Should You Be a Physicist? Arthur H. Compton. Washington, D. C.: United States Atomic Energy Commission, 1967, 11pp., free. J-2

Your Body and Radiation. Washington, D. C.: United States Atomic Energy Commission, October 1968, 79pp., free. N-2

Your Future in Physics. Raymond Bell. New York, New York: Richards Rosen Press, Inc., 1967, 138pp., $3.78. J-1

RADIOLOGICAL TECHNOLOGIST
078.368

Atomic Energy Technicians. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

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Radiological Technologist. Detroit, Michigan: Michigan Employment Security Commission, February 1967, 2pp., free. F-2 (for Michigan)

Radiological Technologist. Moravia, New York: Chronicle Guidance Publications, Inc., 1966, 4pp., 35¢. D-1

Radiologic Technologists. Chicago, Illinois: Science Research Associates, Inc., 1967, 4pp., 45¢. D-1

Radiologic Technology. Chicago, Illinois: Health Careers Council of Illinois, (no date), 6pp., free. J-3 (for Illinois)

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Dance Therapy - Careers for Men and Women. Washington, D. C.: American Association for Health, Physical Education, and Recreation, 1967, 6pp., free. J-2

Hospital Recreation Specialist. Washington, D. C.: Veterans Administration, Department of Medicine and Surgery, March 1965, 3pp., free. J-2

Institutions of Higher Learning with Curriculums in Parks and or Recreation. Washington, D. C.: National Recreation and Park Association, (no date), 18pp., (no price). N-3

Music Therapist. Minneapolis, Minnesota: Finney Company, 1969, 4pp., unit price. E-2

Music Therapy as a Career. Lawrence, Kansas: National Association for Music Therapy, Inc., 1969, 4pp., single copy, free. F-2

Recreation as Your Career. Washington, D. C.: American Association for Health, Physical Education, and Recreation, (no date), 7pp., free. J-2

Recreation Leadership with the Ill and Handicapped. Washington, D. C.: National Therapeutic Recreation Society, (no date), 5pp., free. D-2

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Recreation Worker. Chicago, Illinois: Science Research Associates, Inc., 1968, 4pp., 45¢. D-1

The Future is Yours in Parks and Recreation. Washington, D. C.: National Recreation and Park Association, (no date), 4pp., free. J-3

The Recreational Therapist. New York, New York: National Association for Mental Health, April 1968, 4pp., free. E-1

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045.108

A Chance to Help - The Story of Sweat. Washington, D. C.: Rehabilitation Services, Administration, U. S. Department of Health, Education, and Welfare, (no date), 13pp., 25¢. J-2

Career and Traineeship Information for Graduate Study in Rehabilitation Counseling. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Vocational Rehabilitation Administration, September 1968, 9pp., free. E-1

Educational Vocational Counseling. Esther M. Westervelt, New York, New York: State of New York, Department of Commerce, (no date), 4pp., free. G-1

How Will You Choose to Help Others? Washington, D. C.: National Rehabilitation Counseling Association, (no date), 5pp., free. J-2

Look to Your Future. Washington, D. C.: National Rehabilitation Counseling Association, (no date), 4pp., free. J-2

Occupational Guides for Epilepsy. Washington, D. C.: Epilepsy Foundation, (no date), 8pp., free. N-3

Patient and Community Services. New York, New York: Muscular Dystrophy Association of America, Inc., August 1968, 17pp., free. N-3

14091

UNIT VII - WORKING DRAWINGS

ACHIEVEMENT TEST

From the pictorial drawing shown below, draw a front, top, and right side view of the object. Dimension fully.

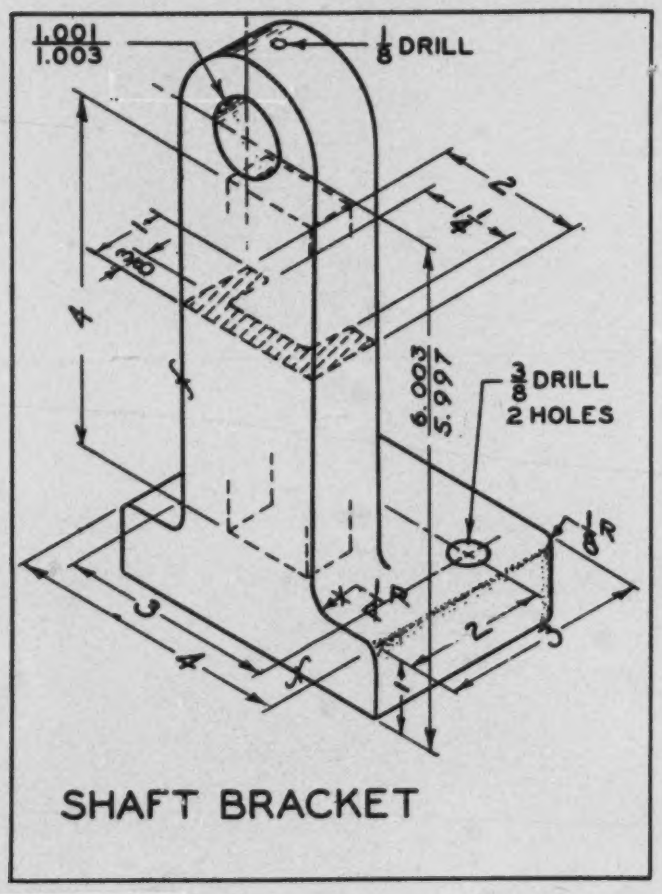

SHAFT BRACKET

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Rehabilitation Counselor. Sacramento, California: California State Department of Employment, 1967, 4pp., free. F-2 (for California)

Rehabilitation Counselor - Helper of the Handicapped. New York, New York: Public Affairs Pamphlets, Elizabeth Ogg. 1966, 28pp., 25¢. C-1

Scholarship Program Education of Handicapped Children. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Vocational Rehabilitation Administration, 1968, 45pp., free. N-1

Supportive Personnel in Rehabilitation Centers: Present Practices and Future Trends. Washington, D. C.: Association of Rehabilitation Centers, Inc., 185pp., $1.00. F-2

The Most Important Thing in the World. Chicago, Illinois: National Society for Crippled Children and Adults, 1968, 24pp., 25¢. F-2

The Rehabilitation Counselor. New York, New York: National Association for Mental Health, April 1968, 3pp., free. E-1

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Training Grant Program - Description of Programs and Procedures in Applying for an Administering Grant. Washington, D. C.: Rehabilitation Services Administration, 1967, 56pp., free. N-2

Up Against the Wall. Washington, D. C.: National Rehabilitation Counseling Association, (no date), 5pp., free. J-2

Vocational Rehabilitation Administration. Washington, D. C.: U. S. Department of Health, Education, and Welfare, Vocational Rehabilitation Administration, 1967, 3pp., $1.00. L-2

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14032

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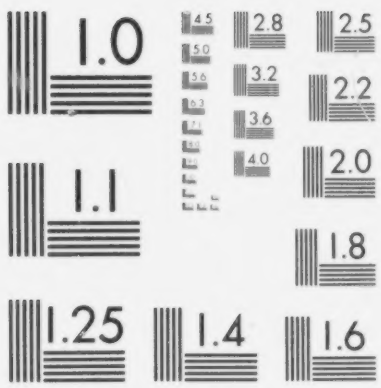

MICROCOPY RESOLUTION TEST CHART

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Executive Director

14093

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pc

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Vocational Rehabilitation Counselors. Chicago, Illinois: Science Research Associates, 1965, 4pp., 40¢. F-2

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Want to Make the World Better? Chicago, Illinois: National Easter Seal Society for Crippled Children and Adults, 1968, 3pp., (no price). D-3

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Sanitarian Wanted. Montgomery, Alabama: Alabama State Department of Health, 1966, 6pp., free. J-3

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Luchtev, Hope J. and William Mitchell. Kinship and Casework. New York, New York: Russell Foundation, 1968, 343pp., $7.50. N-2

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Twenty Questions and Answers About Social Work. Albany, New York: National Commission for Social Work Careers-Public Sales Office, May 1968, 14pp., F-1

Unlock the Power of Human Resources. New York, New York: National Federation of Settlements, Inc., December 1967, 4pp., free. F-2

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14100

UNIT VIII - SECTIONAL DRAWINGS

ACHIEVEMENT TEST

Write the numbers 1 to 10 and write the letter T or F (True or False) after each number, whichever correctly describes the statements below.

1. The preferred angle for drawing cross-hatch lines is 45°.

2. Cross-hatch lines are drawn $\frac{1}{8}$ inch apart, each distance being measured by a ruler.

3. A full section is one which shows one view of the drawing as though it were cut in half.

4. Full sections are used only for cylindrical objects.

5. A half section is one which shows one view of a drawing as though it were cut in half.

6. A revolved section is used when the views of a drawing do not fully describe the shape of the part.

7. Shafts, pins, screws, rivets, and bolts are always cross hatched.

8. The advantage of the half section is that one half of the drawing shows an interior view and the other half an exterior view.

9. Without sectional views, it would be extremely difficult to illustrate some drawings.

10. Full sections eliminate many dashed lines, which often make reading or visualizing difficult.

ROM 1407

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091.228

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Safety Education as Your Career. Washington, D. C.: American Association for Health, Physical Education, and Recreation, (no date), 7pp., free. J-2

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094.228

A Career for You Teaching Blind Children. Atlanta, Georgia: Southern Regional Education Board, (no date), 2pp., free. J-3

Challenging Careers in Rehabilitation of Blind Persons. Kalamazoo, Michigan: Western Michigan University, 1968, 3pp., free. N-2

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For Your Consideration-Five Careers. New York, New York: American Foundation for the Blind, 1967, 10pp., free. F-2

Look to Your Future. Washington, D. C.: American Association of Instructors of the Blind, (no date), 2pp., free. E-2

Orientation and Mobility. New York, New York: American Foundation for the Blind. July 1968, 1pp., free. L-3

Parapitologist. Minneapolis, Minnesota: Finney Company, 1968, 4pp., unit price. E-2

Rehabilitation Teacher. New York, New York: American Foundation for the Blind, July 1968, 1pp., free. L-2

There is a Career for You in Orientation and Mobility. Chestnut Hill, Massachusetts: Department of Graduate Education, Boston College, 1968, 9pp., free. N-1

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094.228

No One Can Make This Decision for You. Washington, D. C.: Alexander Graham Bell Association for the Deaf, 1969, 4pp., free. J-3

Will You be My Teacher? Washington, D. C.: Alexander Graham Bell Association for the Deaf, (no date), 3pp., free. J-3

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Opportunities for Graduate Study in Special Education Rehabilitation. Pittsburgh, Pennsylvania: University of Pittsburgh, (no date), 1pp., free. N-3

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Professional Standards for Personnel in the Education of Exceptional Children. Washington, D. C.: Council for Exceptional Children, 1966, 87pp., $1.95. N-1

Special Education Teacher Education Directory 1968-69. Washington, D. C.: Council for Exceptional Children, 1969, 99pp., $2.50. N-1

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139.088

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American College of Laboratory Medicine. Washington, D. C.: American College of Laboratory Animal-Medicine, August 1968, 5pp., free. N-3

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Career Facts about Veterinary Medicine. Chicago, Illinois: American Veterinary Medical Association, (no date), 5pp., free. E-2

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Career Opportunities in Laboratory Animal Science. Joliet, Illinois: American Association for Laboratory Animal Science, 1967, 2pp., free. E-3

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14104

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Draw the V-belt pulley shown below. Lay out the centerline first; then complete a circular view before projecting to a principal view. Draw the pulley in half section. Note how clearly the half section describes the pulley. The double-spaced 45° cross-hatched lines indicate that the material is steel. Cross hatch lines are drawn in after all dimensions have been indicated.

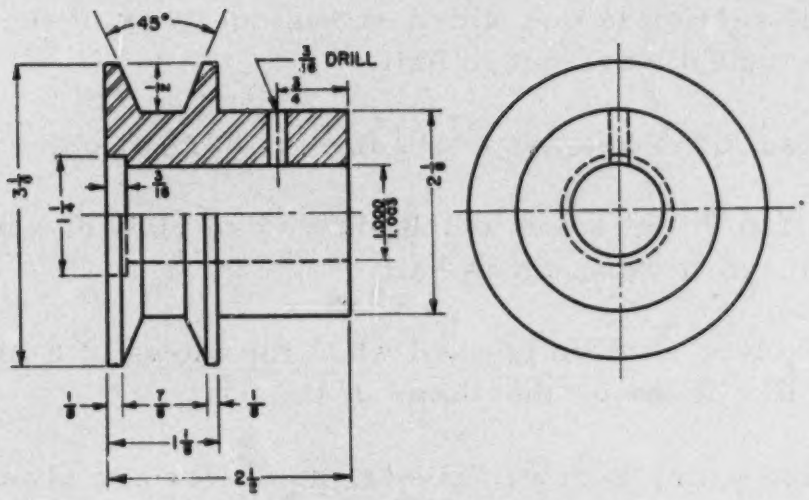

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ABSTRACT - Designed to aid adult education directors and instructors in developing and implementing courses in clothing construction, this guide provides instructional techniques and methods for preparing trainees to become competent garment fitters, tailor's helpers, seamstresses, women's garment finishers, and garment rippers. Contents are divided into three sections, the first of which is concerned with administrative considerations, including utilization of the advisory committee, selection of instructor and trainees, facilities, and organizing and promoting the course. Section II presents a suggested state course of study, broken down into six units or major areas of learning, including: (1) Use and Care of Fabrics, (2) Selection, Use, and Care of Sewing Equipment, (3) Techniques of Sewing, (4) Elements and Principles of Design, (5) Preparation for Employment, and (6) Management of a Garment Alterations Business. Units provide required job competencies, motivating procedures, suggested learning experiences, and instructional materials and references. Ways to adapt the state course to local situations are presented in Section III. Samples of instructional aids are appended and a bibliography is also included. (AW)

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Aerospace Medical Association, Washington National Airport, Washington, D. C. 20001

Air Pollution Control Association, 4400 Fifth Avenue, Pittsburgh, Pennsylvania 15213

Alabama State Department of Health, State Office Building, Montgomery, Alabama 36104

Health Careers Council of Alabama, 901 South 18th Street, Birmingham, Alabama 35205

Alaska State Department of Health and Welfare, Alaska Office Building, Juneau, Alaska

Alexander Graham Bell Association for the Deaf, Headquarters: Volta Bureau, 1537 35th Street, Washington, D. C. 20007

Allergy Foundation of America, 801 Second Avenue, New York, New York 10017

Allied Health Services, Indiana University Medical Center, 1100 West Michigan Street, Indianapolis, Indiana 46202

Alumnae Advisory Center, 514 Madison Avenue, New York, New York 10002

American Academy of Pediatrics, 1801 Hinman Avenue, Evanston, Illinois 60201

American Academy of Physical Medicine and Rehabilitation, 30 North Michigan Avenue, Chicago, Illinois 60602

American Association for Health, Physical Education, and Recreation, National Education Association, 1201 6th Street, N.W., Washington, D. C. 20006

American Association for Laboratory Animal Science, P.O. Box 10, Joliet, Illinois 60434

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American Association of Bioanalysts, 805 Ambassador Building, St. Louis, Missouri 63101

American Association of Certified Orthoptists, c/o Miss Velma Ritter, President, Orthoptic Clinic, 1 Room CL-317E, University of California, San Francisco Medical Center, San Francisco, California 94122

American Association of Dental Schools, 211 East Chicago Avenue, Chicago, Illinois 60611

American Association of Industrial Nurses, 170 East 61st Street, New York, New York 10021

American Association of Instructors of the Blind, 711 14th Street, N.W., Washington, D. C. 20005

American Association of Medical Assistants, 510 North Dearborn Street, Chicago, Illinois 60610

American Association of Medical Record Librarians, 21 East Chicago Avenue, Chicago, Illinois 60611

American Association of Nurse Anesthetists, Suite 3010, Prudential Plaza, Chicago, Illinois 60601

American Association of Opthalmology, 1100 17th Street, N.W., Washington, D. C. 20036

American Association of Orthodontists, 7477 Delmar Boulevard, St. Louis, Missouri 63130

American Board of Dental Public Health, School of Public Health, 311 Victor Vaughn House, The University of Michigan, Ann Arbor, Michigan 48103

American Board of Health Physics, c/o Dr. Date W. Mueller, School of Public Health, Harvard University, 665 Huntington Avenue, Boston, Massachusetts 02115

American Board of Preventive Medicine, 615 North Wolfe Street, Baltimore, Maryland 21205

American Cancer Society, Inc., 219 East 42nd Street, New York, New York 10007

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American Chemical Society, 1155 Sixteenth Street, N.W., Washington, D. C. 20006

American Chiropractic Association, 2200 Grand Avenue, P. O. Box 1535, Des Moines, Iowa 50306

American College of Hospital Administration, 840 North Lake Shore Drive, Chicago, Illinois 60611

American College of Laboratory Animal-Medicine, Institute for Laboratory Animal Resources, 2101 Constitution Avenue, Washington, D. C., 20418

American College of Nurse-Midwives, 50 East 92nd Street, New York, New York 10028

American College of Surgeons, 40 East Erie Street, Chicago, Illinois 60611

American Dental Assistant Association, 211 East Chicago Avenue, Chicago, Illinois 60611

American Dental Association, 211 East Chicago Avenue, Chicago, Illinois 60611

American Dental Hygienists Association, 211 East Chicago Avenue, Chicago, Illinois 60611

American Dental Trade Association, 1100 Vermont Avenue, N.W., Washington, D. C. 20005

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American Foundation for the Blind, 15 West 16th Street, New York, New York 10011.

The American Fund for Dental Education, 211 East Chicago Avenue, Chicago, Illinois 60611

The American Dietetic Association, 620 North Michigan Avenue, Chicago, Illinois 60611

American Home Economics Association, 1600 Twentieth Street, N.W., Washington, D. C. 20009

American Hospital Association, 840 Lake Shore Drive, Chicago, Illinois 60611

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American Industrial Hygiene Association, 14125 Prevost, Detroit, Michigan 48227

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YNECOLOGISTS • HEMATOLOGISTS • HISTOLOGIC TECHNICIANS •

ARMACISTS • HOSPITAL PLANT SUPERINTENDENTS • INDUSTRIAL H

HALATION THERAPISTS • INTERNISTS • LABORATORY GLASS WASH

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• RA

CH SCIENTISTS • RE

Y INSPECTORS • SCHOOL HEALTH EDUCATORS • SCIENCE WRITER

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VITAL STATISTICIANS • VOCATIONAL REHABILITATION COUNSELO

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VT 012 827

Parker, Kenneth A.; Woodin, Ralph J.
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Ohio State Univ., Columbus. Dept. of Agricultural Education.
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DESCRIPTORS - *AGRICULTURAL EDUCATION; *VOCATIONAL AGRICULTURE; *WORKBOOKS; *WORK EXPERIENCE PROGRAMS; *HORTICULTURE; WORK EXPERIENCE; HIGH SCHOOL STUDENTS; AGRICULTURAL OCCUPATIONS; COOPERATIVE EDUCATION; RECORDS (FORMS)

ABSTRACT - This recent book for students in a supervised occupational experience program of vocational horticulture was developed by the Agricultural Education Service and The Ohio State University Department of Agricultural Education. The following forms are provided: (1) Occupational Goals, (2) Experience Program, (3) Employment Agreement, (4) Record of Hours Worked and Wages Received, (5) Record of Proficiency, (6) Record of Teacher Visitation, (7) Financial Statement, and (8) Evaluation of Occupational Experience. (GB)

VT 012 827

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RECORD OF SUPERVISED OCCUPATIONAL EXPERIENCE FOR STUDENTS OF VOCATIONAL HORTICULTURE

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by

Kenneth A. Parker

and

Ralph J. Woodin

Student's Name _____ Year In School ____

Address _____ Phone _____

Social Security Number ____/____/_____ Age _____

School _____ Phone _____

Title of Course _____

Instructor _____ Phone _____

Experience Provided At _____ Phone _____

Record For Period _____/_____/_____
Month Day Year

To

_____/_____/_____
Month Day Year

Agricultural Education Service
State Department of Education

Department of Agricultural Education
The Ohio State University

1970

VT012827

INTRODUCTION*

A program of vocational horticulture must provide meaningful personal experience for students enrolled along with formal classroom and laboratory experiences. Experiences may be obtained through supervised occupational experience programs. Occupational experience programs should include objectives which all students can obtain. Students should achieve the following objectives as part of their supervised occupational experience programs.

1. The supervised program should provide experiences necessary for the development of abilities important to the students success in a horticultural occupation.

2. The program should include a financial arrangement providing an equitable division of the costs and returns for the parties involved.

3. The program should provide opportunities for a financial return to the student each year.

4. The program should be continued and expanded to increase size, scope, and managerial responsibilities during each school year.

5. The program should be commensurate with the interests and personal capabilities of the student as well as his resources in terms of labor and capital.

6. The program should provide experience in risk bearing, financing, marketing and the use of credit when possible.

7. The program should provide opportunities for experience in decision making as well as managerial skills.

8. The program should utilize the occupational opportunities available in the school community.

9. The program should fully appraise the student of all the advantages and disadvantages of making horticulture a lifetime career.

10. The program should help the student develop proper attitudes toward work, the employer, fellow employees, customers and the industry as a whole.

11. The program should assist in helping the student make a firm vocational choice.

This book is a record of the students supervised occupational experience program. This book will be used as one means of judging the students success in achieving the above objectives through the experience program he has chosen through conferences with his parents and teacher. The student should read all instructions carefully and record all material in a complete, correct and clear manner so any person who examines this book can judge as to the worth of the student and his experience program.

---

*Adapted from Objectives Of A Supervised Occupational Experience Program, Professor Ralph J. Woodin, The Ohio State University, Columbus, Ohio.

14152

MY OCCUPATIONAL GOALS IN HORTICULTURE

I am interested in the following horticultural occupations. (check one or two)

_____	Florist	_____	Produce Merchandising
_____	Horticultural Mechanics	_____	Greenhouse Production
_____	Landscaping	_____	Horticultural Supply Service
_____	Turf Management	_____	Horticultural Education
_____	Garden Center	_____	Other Horticultural Occupations

With the aid of your teacher, describe the education and experience needed to reach your occupational goal, and outline your plans for reaching this goal. Your plan should cover the period from the present until you enter into your chosen occupational area. Make your plans as specific as possible including dates, hours of experience, capital investments, and similar items.

MY FIRST OCCUPATIONAL GOAL	PLANS FOR REACHING MY GOAL
EXPERIENCE NEEDED:	
EDUCATION NEEDED:	
COST:	
OTHER:	

MY SECOND OCCUPATIONAL GOAL	PLANS FOR REACHING MY GOAL
EXPERIENCE NEEDED:	
EDUCATION NEEDED:	
COST:	
OTHER:	

APPROVED BY INSTRUCTOR (DATE) _____ _____

14153

MY OCCUPATIONAL EXPERIENCE PROGRAM

Keeping in mind the goals that you outlined on the previous page, you should plan your experience program in such a way as to aid you in attaining your occupational goals. In order to get an overall view of the methods you will use during your vocational horticulture program, you should record a brief description of your goals for each of the areas listed and indicate the year in which you intend to achieve that goal.

1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR
PRODUCTION PROJECTS:			
IMPROVEMENT PROJECTS:			
IN-SCHOOL PROJECTS:			
CO-OP PROGRAM:			
FFA OR OTHER YOUTH ORGANIZATIONS:			
NET WORTH:			

APPROVED BY INSTRUCTOR (DATE) _____ _____ _____

_____

THE HORTICULTURAL BUSINESS OR SERVICE WHERE I WORK

After you have found an employer, with the aid of your teacher, in your chosen occupation you should learn about the horticultural activities of this business or service. This will help you to further develop your cooperative education program.

In the space below give a brief description of the business or service where you are to be employed as a trainee in terms of products produced, merchandised or processed; size or volume of business; equipment or facilities available; and the number of people employed and their major responsibilities.

BUSINESS NAME:
NAME OF COOPERATOR:

BUSINESS NAME:
NAME OF COOPERATOR:

APPROVED BY INSTRUCTOR (DATE) _____ _____

14155

Students Copy 5

EMPLOYMENT AGREEMENT FOR THE SUPERVISED OCCUPATIONAL EXPERIENCE PROGRAM

OF A STUDENT OF VOCATIONAL HORTICULTURE

To insure a permanent basis of understanding and to promote better working relations, this agreement is established on _____ 19 ___.

The work will start on _____ 19 ___ and will terminate on or about _____ 19 ___. (Subject to further agreement for continued work)

Name of Business or Service: _____

The person in industry who will be responsible for the training of the student will be _____

The usual working hours will be as follows:

When attending school _____

While not attending school _____

Provisions for time off are _____

Provisions for overtime are _____

Liability insurance coverage is _____

Compensation during the trial period will be _____

Compensation during the remainder of the agreement will be _____

The student will be paid on (day) _____

THE EMPLOYER AGREES:

To provide the student with opportunities to learn how to do well as many jobs as possible, with particular reference to those contained in the training plan.

To coach the student in the ways which he has found desirable in doing his work and handling his problems.

To make an honest appraisal of the student's performance on the job at the end of a specific period agreed upon.

To give the instructor time for short conferences regarding the progress of the student.

To avoid subjecting the student to unnecessary or unusual hazards.

To notify the parent and school immediately in case of accident, sickness, or any other serious problem which might arise.

To permit the teacher of the student to take whatever time necessary for supervisory visits to the industry.

(remove from book and give to employer) Employers Copy 5a

EMPLOYMENT AGREEMENT FOR THE SUPERVISED OCCUPATIONAL EXPERIENCE PROGRAM

OF A STUDENT OF VOCATIONAL HORTICULTURE

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The usual working hours will be as follows:

When attending school _____

While not attending school _____

Provisions for overtime are _____

Provisions for time off are _____

Liability insurance coverage is _____

Compensation during the trial period will be _____

Compensation during the remainder of the agreement will be _____

The student will be paid on (day) _____

TEAR OUT ON THIS LINE

THE EMPLOYER AGREES:

To provide the student with opportunities to learn how to do well as many jobs as possible, with particular reference to those contained in the training plan.

To coach the student in the ways which he has found desirable in doing his work and handling his problems.

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To permit the teacher of the student to take whatever time necessary for supervisory visits to the industry.

(copy to be retained in school file) School Copy 5b

EMPLOYMENT AGREEMENT FOR THE SUPERVISED OCCUPATIONAL EXPERIENCE PROGRAM

OF A STUDENT OF VOCATIONAL HORTICULTURE

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Provisions for overtime are _____

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To notify the parent and school immediately in case of accident, sickness, or any other serious problem which might arise.

To permit the teacher of the student to take whatever time necessary for supervisory visits to the industry.

TEAR OUT ON THIS LINE

THE STUDENT AGREES:

To notify the employer at once when found necessary to be absent from work for a justifiable cause.

To do a good day's work according to his age and ability, recognizing that the employer must profit from his labor in order to justify hiring him.

To keep the employer's interest in mind, being punctual, dependable, and loyal.

To follow instructions, avoid unsafe acts and be alert to unsafe conditions.

To be courteous and considerate of the employer, his family and others.

To keep such records of his work experience and to make such reports as required by the school.

THE INSTRUCTOR, ON BEHALF OF THE SCHOOL, AGREES:

To visit the student on the job at frequent intervals for the purpose of instruction and to insure that he gets the most out of his experience.

To show discretion in the time and circumstances of these visits, especially during emergency periods when the work is pressing.

THE PARENT AGREES:

To assist in promotion of the value of the student's experience by cooperating with the employer and the teacher of vocational horticulture.

To satisfy himself in regard to living conditions made available to the student if the student is housed away from home.

ALL PARTIES AGREE:

That the initial working days be regarded as a trial period to allow the student time to adjust and prove himself.

That in the event of difficulties in the interpretation of the terms of this agreement, the vocational horticulture instructor shall be the mediator.

This agreement may be terminated for cause at any time by either party after due notice, but not without first consulting the school.

STUDENT_____	EMPLOYER_____
ADDRESS_____	ADDRESS_____
TELEPHONE NO._____	TELEPHONE NO._____
APPROVED:	APPROVED FOR THE SCHOOL:
PARENT_____	INSTRUCTOR_____
ADDRESS_____	HOME PHONE NO._____
TELEPHONE NO._____	SCHOOL PHONE NO._____

(remove from book and give to employer) Employers Copy

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STUDENT _____
ADDRESS _____
TELEPHONE NO. _____

EMPLOYER _____
ADDRESS _____
TELEPHONE NO. _____

APPROVED:

PARENT _____
ADDRESS _____
TELEPHONE NO. _____

APPROVED FOR THE SCHOOL:

INSTRUCTOR _____
HOME PHONE NO. _____
SCHOOL PHONE NO. _____

Foreword

The need for people skilled in altering garments is increasing. Today's shopper purchases more ready-to-wear garments and is more demanding regarding their quality and fit. Also, technological developments in the field of textiles and clothing are constantly appearing which require new competencies in the handling of fabrics. This publication is designed to help the director of adult education and the instructor develop a course for individuals who have competencies in clothing construction and who wish to expand them into salable skills for the job market.

Appreciation is expressed to Jean McCracken, continuing education clothing instructor, Guilderland Central School, for her efforts in developing the instructional materials. The Bureau is grateful to Selma Karam, merchandise manager and counselor of Softline Home Furnishings and Fabric Division, The Boston Store, Utica, who provided information relative to the training needs of personnel in alteration departments of retail businesses.

Assistance relating to content was provided by Janet E. Popp, Associate in the Bureau of Home Economics Education. Nelson S. Maurer, Associate in the Bureau of Continuing Education Curriculum Development, coordinated the project and prepared the manuscript for publication.

HERBERT BOTHAMLEY, *Chief*
Bureau of Continuing Education
Curriculum Development

WILLIAM E. YOUNG, *Director*
Curriculum Development Center

1413

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STUDENT _____
ADDRESS _____
TELEPHONE NO. _____

EMPLOYER _____
ADDRESS _____
TELEPHONE NO. _____

APPROVED:

PARENT _____
ADDRESS _____
TELEPHONE NO. _____

APPROVED FOR THE SCHOOL:

INSTRUCTOR _____
HOME PHONE NO. _____
SCHOOL PHONE NO. _____

RECORD OF HOURS WORKED AND WAGES RECEIVED

Month _____ 19__

This page serves two purposes. It provides a record of hours and wages and secondly it provides a record of the different tasks which you have performed. For each pay period record the hours worked and wages received and use as many lines as necessary to record the major tasks performed during the period. Monthly totals should be made and carried forward to page 21.

Monthly evaluations of the quality of your work should be made by your teacher and employer using this page as a source of information.

DATE	LIST THE DIFFERENT KINDS OF JOBS PERFORMED THIS MONTH	HOURS WORKED		WAGES RECEIVED
		UNPAID	PAID	

204 OF 327

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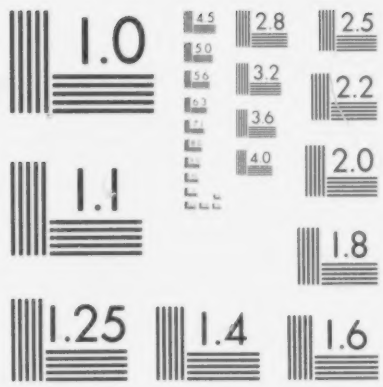

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RECORD OF HOURS WORKED AND WAGES RECEIVED

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DATE	LIST THE DIFFERENT KINDS OF JOBS PERFORMED THIS MONTH	HOURS WORKED		WAGES RECEIVED
		UNPAID	PAID	
	TOTAL FOR MONTH Forward to page 21			

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14163

DATE OF TEACHER-STUDENT EVALUATION _____, _____

RECORD OF HOURS WORKED AND WAGES RECEIVED

Month _____ 19__

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DATE	LIST THE DIFFERENT KINDS OF JOBS PERFORMED THIS MONTH	HOURS WORKED		WAGES RECEIVED
		UNPAID	PAID	
	TOTAL FOR MONTH Forward to page 21			14164

DATE OF TEACHER-STUDENT EVALUATION _____, _____

RECORD OF HOURS WORKED AND WAGES RECEIVED

Month _____ 19__

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		UNPAID	PAID	

Message to the Instructor

This publication is designed to provide instructional techniques and methods to help prepare individuals to become competent garment fitters, tailor's helpers, seamstresses, women's garment finishers, and garment rippers. Trainees for this course should have some proficiency in clothing construction. A carefully planned screening process will help locate individuals who can best profit from this program.

The course is organized to provide sequential units to help meet the varying ability levels and needs of the trainees. Methods for organizing and promoting the course are given in Section I. A suggested course of study composed of six units or major areas of learning is presented in Section II. Also included are required job competencies, motivating procedures, and suggested learning experiences. Ways to adapt the State course to the local situation are suggested in Section III. Samples of instructional aids are included in the Appendix, and useful books and pamphlets are listed in the Bibliography.

Other Department publications that will be helpful include *Tips for Teaching Textiles and Clothing*, *Resource Courses for Planning Local Adult Homemaking Programs*, and *Training Guide for Clothing Services*. The services of the staff of the Bureau of Home Economics Education are available for help in organizing local courses, training instructors, and working with advisory committees.

Instructors are urged to communicate to this Bureau their comments regarding the usefulness of the publication and to suggest additional materials that might be included in a subsequent revision.

LAURA M. EHMAN, *Chief*
Bureau of Home Economics Education

JOHN E. WHITCRAFT, *Director*
Division of Occupational Education

1414

RECORD OF HOURS WORKED AND WAGES RECEIVED

Month _____ 19__

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		UNPAID	PAID	
	TOTAL FOR MONTH Forward to page 21			

DATE OF TEACHER-STUDENT EVALUATION _____, _____

14171

RECORD OF HOURS WORKED AND WAGES RECEIVED

Month _____ 19__

This page serves two purposes. It provides a record of hours and wages and secondly it provides a record of the different tasks which you have performed. For each pay period record the hours worked and wages received and use as many lines as necessary to record the major tasks performed during the period. Monthly totals should be made and carried forward to page 21.

Monthly evaluations of the quality of your work should be made by your teacher and employer using this page as a source of information.

DATE	LIST THE DIFFERENT KINDS OF JOBS PERFORMED THIS MONTH	HOURS WORKED		WAGES RECEIVED
		UNPAID	PAID	

RECORD OF HOURS WORKED AND WAGES RECEIVED

Month _____ 19__

This page serves two purposes. It provides a record of hours and wages and secondly it provides a record of the different tasks which you have performed. For each pay period record the hours worked and wages received and use as many lines as necessary to record the major tasks performed during the period. Monthly totals should be made and carried forward to page 21.

Monthly evaluations of the quality of your work should be made by your teacher and employer using this page as a source of information.

DATE	LIST THE DIFFERENT KINDS OF JOBS PERFORMED THIS MONTH	HOURS WORKED		WAGES RECEIVED
		UNPAID	PAID	

RECORD OF PROFICIENCY

This page is to provide you with a record of the various tasks you perform in your cooperative work experience and of the time at which you became proficient in each job or task.

Record the date of your first experience in the column provided and also keep a tally of the number of times the operation is repeated. In the "Performed Satisfactorily" column have your instructor or employer initial the date at which you gained reasonable competency.

MAJOR JOBS OR TASKS	FIRST EXPERIENCE DATE:	NUMBER OF REPETITIONS OF JOB OR TASK:	PERFORMED SATISFACTORILY DATE:

EXPERIENCES PLANNED	FIRST EXPERIENCE DATE:	PERFORMED SATISFACTORILY DATE:	INITIALS FOR VERIFICATION DATE:

RECORD OF TEACHERS VISITATION

When the teacher visits your occupational experience program, he may see areas where you have done outstanding work or areas where improvement is needed. In the space below record his comments for future reference.

DATE	COMMENTS OF TEACHERS

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Secure deductions from previous pages.

ANNUAL FINANCIAL SUMMARY OF CASH EARNINGS FROM WAGES

YEAR / DATE	EMPLOYER(S)	TOTAL PAID HOURS 1	TOTAL UNPAID HOURS 2	GROSS AMOUNT EARNED 3	DEDUCTIONS			TAKE HOME PAY 7
					SOCIAL SECURITY 4	INCOME TAX 5	OTHER 6	
				$	$	$	$	$

SUMMARY OF NON-CASH EARNINGS

In addition to the cash wages, you may receive other items of value for your work. You may be provided with meals or lodgings either regularly or at certain times. You may be given the use of land, buildings, or equipment for an enterprise of your own. Possibly you may have been given some plants, fertilizer, etc. Make a record of such items and their value here. Include prizes and awards also. This information may be helpful when applying for achievement awards in the FFA or other youth organizations.

A. LIVING ACCOMMODATIONS AND SERVICES
(Room, meals, laundry, etc.)

DATE	ITEM	QUANTITY	VALUE
			$
	TOTAL		

B. RESOURCES FOR PERSONAL USE IN HORTICULTURE
(Equipment, fertilizer, seedlings, etc.)

DATE	ITEM	QUANTITY	VALUE
			$
	TOTAL		

C. OTHER NON-CASH EARNINGS
(Discount on items bought, gifts, etc.)

DATE	ITEM	QUANTITY	VALUE
			$
	TOTAL		
	GRAND TOTAL VALUE $		

SUMMARY

1. Grand Total Value of Non-Cash Earnings (this page) $_____
2. Grand Total Value of Cash Earnings (previous page) $_____
3. Total Earnings from Occupational Experience (1 & 2) $_____

APPROVAL OF INSTRUCTOR (DATE) _____, _____, _____

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FINANCIAL STATEMENT

This page makes it possible for you to determine your net worth each year.

YEAR: BEGINNING _____, 19__; ENDING _____, 19__.

ITEMS	BEGINNING OF YEAR		END OF YEAR	
ASSETS (VALUE OF STUDENTS SHARE)	$		$	
1. Cash on hand				
2. Checking account in bank				
3. Savings account in bank				
4. Cash value of life insurance				
5. Value of land owned				
6. Value of land owned in partnership				
7. Value of harvested crops on hand				
8. Value of harvested crops on hand owned in partnership				
9. Value of crops in progress owned (current market price)				
10. Value of crops in progress owned in partnership (current market price)				
11. Value of equipment, buildings and equipment owned (dep. value)				
12. Value of equipment, buildings and equipment owned in partnership (dep. value)				
13. Personal share of auto				
14. Notes and bonds (value)				
15. Personal accounts receivable				
16. Gifts, etc.,received				
17. Other assets:				
18.				
19.				
A. TOTAL ASSETS	$		$	
LIABILITIES				
1. Unpaid bills				
2. Notes to be paid				
3. Mortgages to be paid off				
4. Interest due				
5. Pledges promised				
6. Other liabilities				
7.				
8.				
B. TOTAL LIABILITIES	$		$	
STUDENTS NET WORTH (ITEM A MINUS B)	$		$	
NET GAIN OR LOSS (indicate by + or -)			$	

APPROVAL OF INSTRUCTOR (DATE)_____, _____, _____

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YOUR OBSERVATIONS

Enter here the special events and conditions that affected the success of the horticultural enterprise in which you were employed. Record new practices, procedures and methods that may be useful to you in the future. List ways in which procedures can be improved in the future.

DATE	OBSERVATIONS

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EVALUATION OF OCCUPATIONAL EXPERIENCE

Section A

The purpose of this page is to help you evaluate your entire program of occupational experience at the close of the year or at it's conclusion. Pages 1, 2, and 3 list some of the goals which you set up for yourself. In making your evaluation consider how many of these goals you were able to achieve and the quality of your work in meeting these goals. List each project of work experience on a separate line.

In section A rate each part of your program in terms of E = Excellent, G = Good, F = Fair, and P = Poor.

Rating of Occupational Experience

Type	Rating	Major Outcomes
Production Projects		
Improvement Projects		
In-School Projects		
Coop Work Experience		
F.F.A. Activities		

APPROVED BY INSTRUCTOR (DATE) _____

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STUDENT APPRAISAL OF OCCUPATIONAL EXPERIENCE

Section B

In narrative form discuss the strengths and weaknesses of your Occupational Experience Program in terms of the purposes listed on page 1. Suggest further improvements which you believe are needed as well as the major values of this program contributing to your employment in the field of horticulture.

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ACKNOWLEDGEMENT

This record book represents ideas gathered from several sources but particularly from "Records of Supervised Occupational Experiences and Training In Vocational Agriculture," published by The French Bray Printing Company, Baltimore, Maryland.

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IDENTIFIERS - MILITARY RANK

ABSTRACT - Prepared by the Navy Training Publications Center for the Bureau of Naval Personnel, this study guide is designed for use by all personnel of the Regular Navy and Naval Reserve who are studying for advancement in the Aviation Maintenance Administrationman rating. Professional qualifications for advancement to the rates of AZ1 and AZC provide a base for the content. This manual is divided into seven chapters: (1) Aviation maintenance administration rating, (2) Maintenance management organization, (3) Supervision and Administration, (4) Maintenance control, (5) Data services and maintenance data analysis, (6) Quality assurance, and (7) Material control. A film list and a reading list are included. (GEB)

VT 012 839

ED0 56238

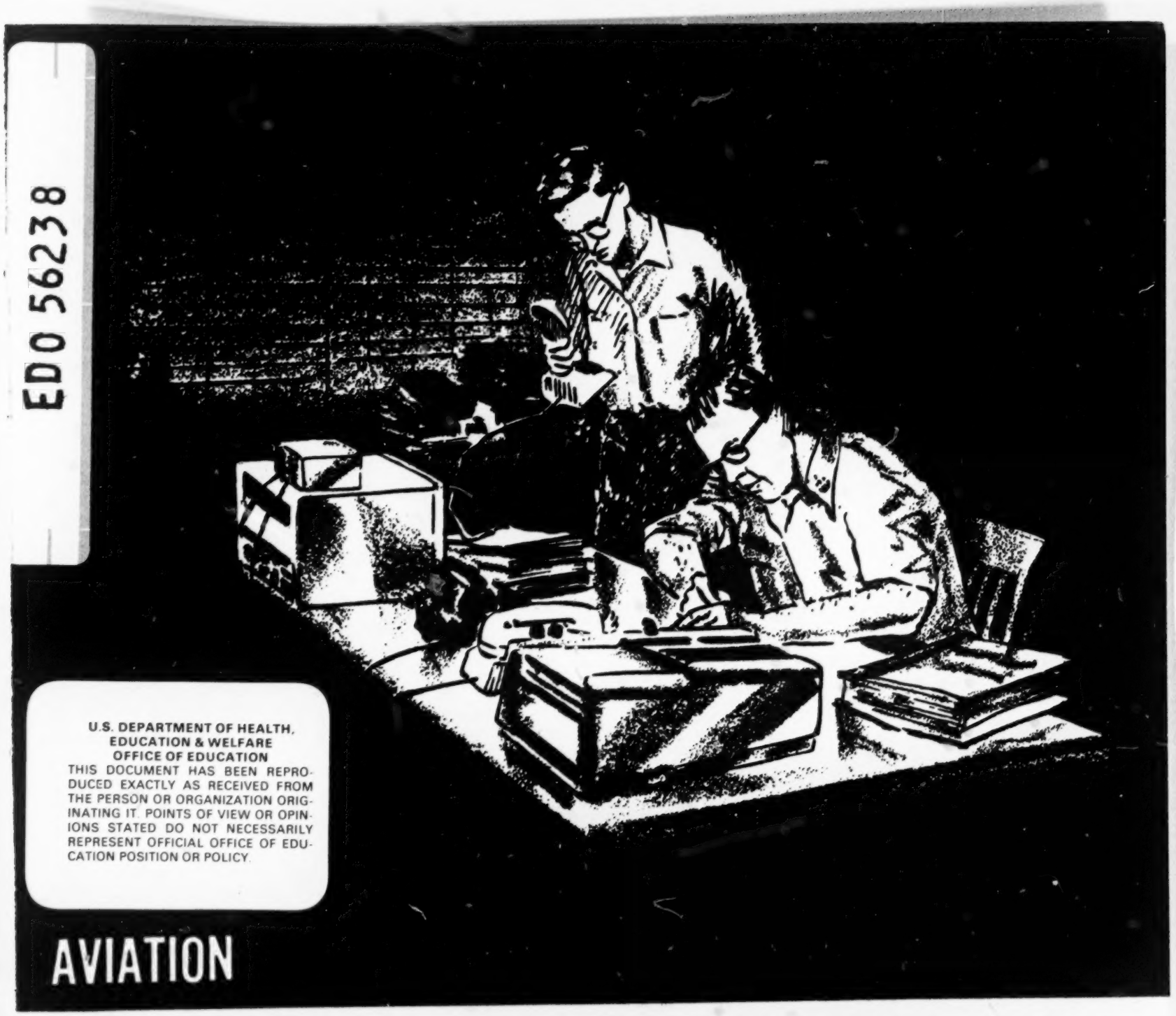

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AVIATION

MAINTENANCE ADMINISTRATIONMAN 1 & C

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10392-A

VT012839

PREFACE

This Navy Training Course is one of two training courses prepared especially for all enlisted personnel of both the Regular Navy and Naval Reserve who are studying for advancement in the Aviation Maintenance Administrationman (AZ) rating. As indicated by the title, the course is based on the professional qualifications for advancement to the rates of AZ1 and AZC, as stated in the Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series). Each person should familiarize himself with these qualifications prior to starting work on this course. A reading list, which includes other publications recommended as study material, is provided in the front of the book.

Combined with the necessary practical experience, the completion of this course will greatly assist the AZ2 and AZ1 in preparing for advancement examinations. This training course should also be valuable as a review source for the more senior rates.

This training course was prepared by the Navy Training Publications Center, Memphis, Tennessee, for the Bureau of Naval Personnel. Credit is given to personnel of the Aviation Maintenance Administrationman Course, Class A, and the Data Analysis Course, Class C, located at NATTC, Memphis, Tennessee, and to the Naval Air Systems Command for technical reviews of the manuscript.

1969 Edition

Stock Ordering No.
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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $1.75

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READING LIST

Aviation Maintenance Administrationman 3 & 2, NavPers 10391-A

Navy Security Manual, OpNav Instruction 5510.1 (Series)

Aircraft Accounting System, OpNav Instruction 5442.2 (Series)

Navy Correspondence Manual, SecNav Instruction 5216.5 (Series)

Navy Aircraft Engine Management Program, BuWeps Instruction 13700.1

Navy Aircraft Maintenance Program (Chapters 7, 8, 10, 11, 12, and 15), NavAir Instruction 4700.2 (Series)

Aviation 3-M Manual (Chapters I, II, III, IV, V, VII, and VIII)

USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Educations Services' Officer.* The following course is recommended:

E 545 Office Management

*"Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified on the active duty orders."

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CHAPTER 1

AVIATION MAINTENANCE ADMINISTRATIONMAN RATING

This training course is designed to aid the AZ2 in preparing for advancement to AZ1 and the AZ1 in preparing for advancement to AZC. It is based primarily on the professional requirements or qualifications for AZ1 and AZC, as specified in the current edition of the Manual of Qualifications for Advancement in Rating, NavPers 18068. In preparing for advancement examinations, this course should be studied in conjunction with Military Requirements for Petty Officers 1 & C, NavPers 10057-B. The latter covers the military requirements for all senior petty officers.

In preparing this training course, every effort has been made to cover professional matters adequately and yet within reasonable bounds. It has been designed to give the prospective AZ1 or AZC a good working knowledge of all subjects covered by the professional qualifications for advancement. It includes some new material required as a result of new or revised maintenance programs and qualification changes. The AZ1 and AZC are expected to be proficient in the field of maintenance administration.

Since senior AZ's are largely occupied with planning, supervision, and training, this course has been slanted for maximum use in these phases. A course of this type cannot present all the detailed knowledge which is required in every duty assignment. Particular details should always be checked in applicable manuals or instructions.

A brief summary of the contents of this training course is given in the following paragraphs.

Chapter 2 discusses organizational structure, starting at the Department of Defense level and working down to the maintenance department of aviation squadrons. This chapter is primarily concerned with relationships and responsibilities of commands concerned with naval aircraft maintenance. This chapter also contains a brief introduction to the Navy Maintenance and Material Management System. The latter part of the chapter provides information on organization principles and management functions.

Chapter 3 discusses some of the aspects of office supervision and duties of a supervisor. Included are sections on planning office arrangement, scheduling and assignment of workloads, work simplification, preparation, routing, and filing various types of correspondence and reports pertaining to aircraft maintenance, maintenance and disposal of logs and records, and the manhour accounting system.

Chapter 4 presents information on production control operations and procedures. Included are sections on planning and scheduling aircraft through various types of maintenance, aircraft acceptance and transfer, aircraft and engine accounting, and maintenance support available at Depot level activities.

Chapter 5 deals with data services and maintenance data analysis. Some of the responsibilities of data services and the analysis division are discussed along with maintenance data reports, analysis techniques, and analysis products.

Chapter 6 is concerned with quality assurance. Coverage is devoted to some of the functions in which AZ's are involved, the technical manual system, and technical library management.

Chapter 7 presents information on the aviation supply system and the material control work center. Included are sections on appropriations, operating budgets, the Federal Stock Numbering System, allowance lists, issue, turn-in, and survey of material, and the general functions of certain sections of the local supply system under the Navy Maintenance and Material Management System.

The remainder of chapter 1 is devoted to information which should be helpful in preparing for advancement. It is strongly recommended

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Administrative Considerations

The success of a course depends upon the competency of the people who plan and guide its development and upon the initiative of the people who provide instruction and create an effective learning environment. Some procedures which may assist in establishing the course include utilizing an advisory committee, employing a qualified instructor, screening applicants, providing adequate training facilities, and publicizing the course. Below are suggestions for implementing each of these procedures.

UTILIZATION OF AN ADVISORY COMMITTEE

An advisory committee can assist in establishing the course in the following ways:

- Securing and analyzing information concerning local opportunities for employment
- Preparing job analyses
- Suggesting content for the local curriculum
- Developing and strengthening relationships with potential employers
- Interpreting the program to the general public
- Evaluating successful practices

The appointment of advisory committee members is made cooperatively by the chief school administrator, director of adult education, and home economics personnel. Representation should be from such groups as secondary home economics teachers, employment service personnel, local employers, and related trade and professional organizations. Some decisions that need to be determined before selecting an advisory committee include the purpose of the committee, rotation of committee members, and means of communicating with members to inform them of needed assistance and of any progress being made.

SELECTION OF A QUALIFIED INSTRUCTOR

The best qualified instructor for the program is a person certified in home economics education and who has had work experience in the field of garment alterations. Consultants may be used to enrich the content of the training program. The following understandings and competencies are recommended for the instructor:

- Ability to use the equipment needed to perform the identified jobs

that this material be studied carefully before beginning intensive study of the remainder of the course.

ENLISTED RATING STRUCTURE

The present enlisted rating structure includes two types of ratings: general ratings and service ratings.

GENERAL RATINGS are designed to provide paths of advancement and career development. A general rating identifies a broad occupational field of related duties and functions requiring similar aptitudes and qualifications. General ratings provide the primary means used to identify billet requirements and personnel qualifications. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Subdivisions of certain general ratings are identified as SERVICE RATINGS. These service ratings identify areas of specialization within the scope of a general rating. Service ratings are established in those general ratings in which specialization is essential for efficient utilization of personnel. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

AZ RATING

The Aviation Maintenance Administrationman rating is a general rating and is included in Navy Occupational Group IX (Aviation). There are no AZ service ratings.

Where occupational content is related, general ratings are sometimes combined at certain pay grades to form broader occupational fields. Until recently, this was true of the AZ rating. At the present time, however, the AZ rating retains its identity through the E-9 level.

Figure 1-1 illustrates the path of advancement from Airman Recruit to Master Chief Aviation Maintenanceman, Warrant Officer (W-4), or Limited Duty Officer.

Shaded areas in figure 1-1 indicate places in the enlisted path of advancement where qualified personnel may advance to Warrant Officer (W-1), and selected Commissioned Warrant Officers (W-2 and W-3) may advance to Limited Duty Officer. Personnel in enlisted rates and Warrant ranks not in a shaded area (fig. 1-1) may advance only as indicated by the connecting arrows. Additional information concerning promotion to Warrant and Commissioned Officer is presented later in this chapter.

The Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series), establishes the AZ's technical responsibilities. Aviation Maintenance Administrationmen perform administrative, management, and clerical duties required in implementing and supporting the Naval Aircraft Maintenance Program; plan, schedule, and coordinate the aircraft maintenance workload; schedule special and calendar aircraft inspections and incorporation of changes and modifications to aircraft and equipment; set up and maintain status boards; collect, compile, and record data pertaining to the history, operation, maintenance, configuration, receipt, and transfer of naval aircraft and related aeronautical equipment; prepare reports and correspondence required in the Naval Aircraft Maintenance Program; determine requirements for, requisition, and control issue of change kits; requisition publications, forms, and microfilm; organize, maintain, and operate technical libraries; and perform other duties required in aircraft maintenance offices.

In addition to the above listed requirements the First Class or Chief Aviation Maintenance Administrationman should be qualified to supervise and direct the operations of production control work centers and aeronautic technical libraries; supervise the manhour accounting program; interpret directives from higher authorities; and maintain the highest possible state of quality work for which he is responsible.

Selected AZ's also perform analysis functions on the data collected under the Maintenance Data Collection System. Those AZ's selected to accomplish these functions normally complete the Data Analysis Course at NATTC Memphis prior to performing duties as a data analyst.

The AZ1 and AZC have varied types of duty billets. Each may be assigned to a billet in which he is involved with only a small portion of the duties covered by his rate, or where a large part of his duties are concerned with other areas of maintenance administration. This, however, does not mean that he is not required to keep abreast of the changing conditions and instructions pertaining to all duties of his rate. The AZ must be qualified in all phases in order that he

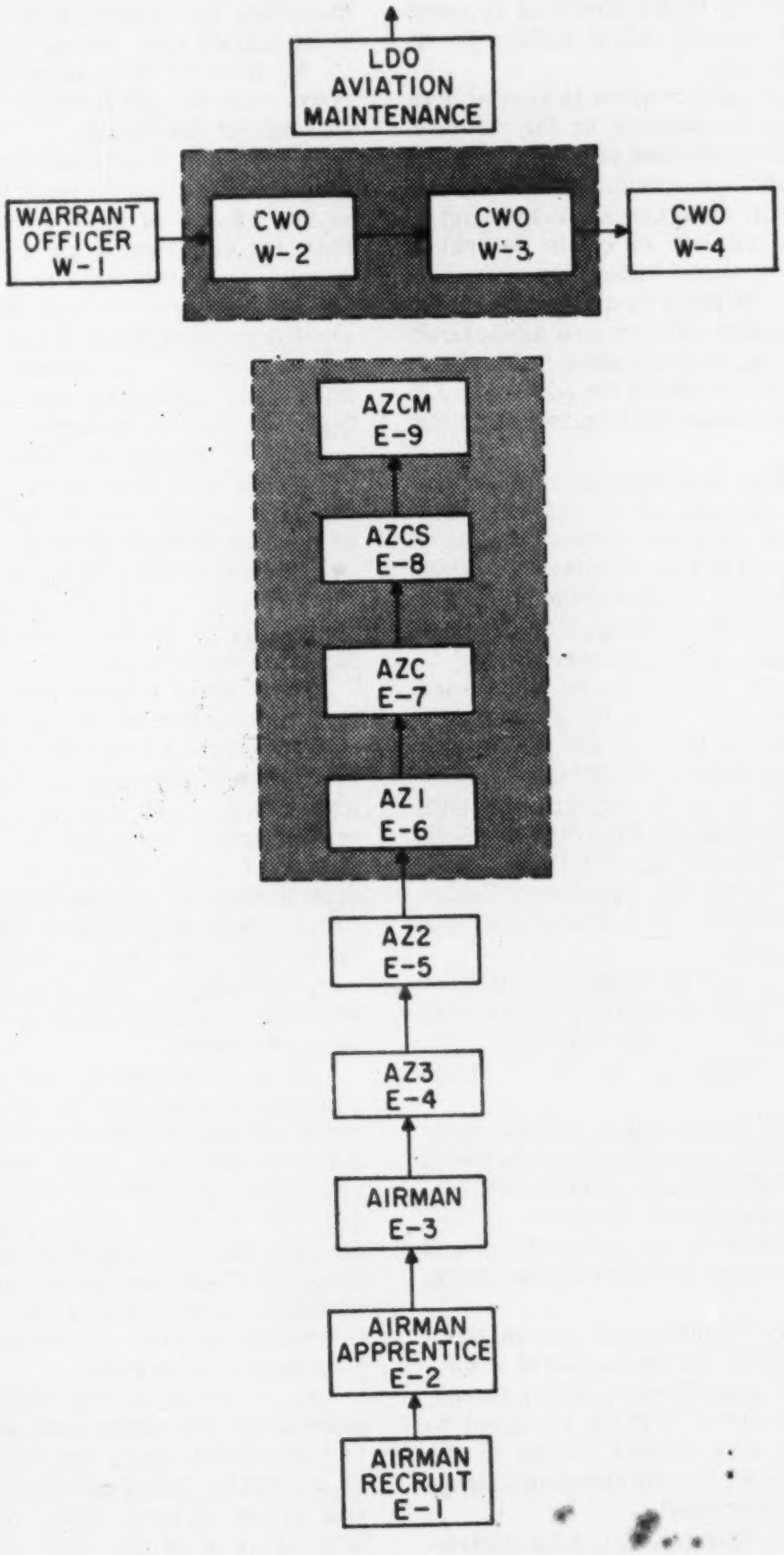

Figure 1-1.—Path of advancement.

may be assigned to the billet where he is most needed. The Navy cannot tailor billets to fit individual qualifications.

A wide variety of assignments is available to the AZ1 and AZC. In addition to the various types of maintenance activities afloat and ashore to which AZ personnel are assigned, the AZ1 and AZC are eligible for assignment to instructor duty as well as a number of other desirable shore billets. Most of these billets are under the management control of BuPers and are directly associated with training. Others are associated with research, testing, or evaluation. Some of the more desirable billets to which the AZ1 and AZC may be assigned are described in the following paragraphs.

1. Instructor duty is available to both the AZ1 and AZC at several Navy schools. The Aviation Maintenance Administrationman Class A Course and the Aviation Maintenance Data Analysis Class C Course located at the Naval Air Technical Training Center, Memphis, Tennessee, utilize AZ1's and AZC's as instructors.

In addition to the above listed instructor billets, the AZ1 and AZC may be assigned to instructor duty with a unit of the Naval Air Maintenance Training Group (NAMTG). Units of NAMTG are located at shore stations on both coasts. Personnel assigned to this duty are first sent to Naval Air Maintenance Training Group Headquarters at Memphis for a period of indoctrination and instruction prior to being assigned to one of the many units.

Instructor billets are normally filled on a voluntary basis. Detailed information concerning assignment to instructor duty is contained in the Enlisted Transfer Manual, NavPers 15909 (Series).

2. Chief Aviation Maintenance Administrationmen are eligible for assignment to duty with the Navy Training Publications Center (NTPC), NAS, Memphis, as Technical Writers. CPO's assigned to NTPC assist in the preparation and revision of Navy Training Courses for the Group IX ratings.

3. Chief Aviation Maintenance Administrationmen are also eligible for assignment to duty with the Naval Examining Center, Great Lakes, Illinois, as Item Writers. CPO's assigned to billets at the Examining Center assist in the preparation of servicewide advancement examinations for enlisted personnel.

4. Chief Aviation Maintenance Administrationmen are regularly assigned to various staff billets. This includes the staff of one of the major operating commands, area subordinate command staff (COMFAIR), or air wing/group staff.

5. Attaché duty is another possibility. This duty may be performed at numerous places throughout the world.

There are a number of special programs and projects to which enlisted personnel may be assigned. Some of these involve research, others may involve testing or evaluation. An example of such an assignment is with the Weapons Personnel Research Branch (WPRB), NATC, Patuxent River, Maryland. Their mission is to develop recommended personnel requirements for squadrons operating and maintaining the latest types of weapon systems.

For a listing of other special programs, reference should be made to the Enlisted Transfer Manual. Others are also announced from time to time in BuPers Notices.

Personnel may indicate their desire for assignment to a specific program or project by indicating it in the "remarks" block of their Rotation Data Card.

As a petty officer you are already aware of the importance of the AZ rating to naval aviation. Everyone from the commanding officer to the worker depends on the AZ for planning, scheduling, and coordination of the aircraft maintenance workload as well as the maintenance of records and the timely and proper distribution of related publications. As aviation progresses, improved techniques must be developed. Thus, the AZ's job involves new and greater responsibilities, and from the lowest level up, he must possess greater technical knowledge than ever before.

When advanced to AZ1 or AZC, even more responsibilities are to be yours. As a senior petty officer you must possess more than technical knowledge. You must assume greater responsibility not only for your own work, but also for the work of others who serve under you. Briefly, the AZ1 and AZC must be a supervisor, inspector, and instructor, as well as an accomplished military leader. Senior petty officers are therefore vitally concerned with the Naval Leadership Program.

As a result of the Naval Leadership Program a considerable amount of material related to naval leadership for the senior petty officer is available. Studying this material will make you aware of your many leadership responsibilities as a senior petty officer and will also be of great help in developing leadership qualities. It will not in itself, however, make you a

good leader. Leadership principles can be taught, but a good leader acquires that quality only through hard work and practice.

As you study this material containing leadership traits, keep in mind that probably none of our most successful leaders possessed all of these traits to a maximum degree, but a weakness in some traits was more than compensated for by strength in others. Critical self-evaluation will enable you to realize the traits in which you are strong, and to capitalize on them. At the same time you must strive to improve on the traits in which you are weak.

Your success as a leader will be decided, for the most part, by your achievements in inspiring others to learn and perform. This is best accomplished by personal example.

ADVANCEMENT

By this time, you are probably well aware of the personal advantages of advancement—higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen career. By this time, also, you have probably discovered that one of the most enduring rewards of advancement is the training you acquire in the process of preparing for advancement.

The Navy also profits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By advancement, you increase your value to the Navy in two ways: First, you become more valuable as a technical specialist; and second, you become more valuable as a person who can supervise, lead, and train others and thus make far-reaching contributions to the entire Navy.

Since you are studying for advancement to PO1 or CPO, you are probably already familiar with the requirements and procedures for advancement. However, you may find it helpful to read the following sections. The Navy does not stand still. Things change all the time, and it is possible that some of the requirements have changed since the last time you went up for advancement. Furthermore, you will be responsible for training others for advancement; therefore, you will need to know the requirements in some detail.

HOW TO QUALIFY FOR ADVANCEMENT

To qualify for advancement, a person must:

1. Have a certain amount of time in grade.
2. Complete the required military and professional training courses.
3. Demonstrate the ability to perform all the PRACTICAL requirements for advancement by completing applicable portions of the Record of Practical Factors, NavPers 1414/1 (formerly NavPers 760).
4. Be recommended by his commanding officer.
5. Demonstrate his KNOWLEDGE by passing a written examination on (a) military requirements, and (b) professional qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-2 gives an overall view of the requirements for advancement of active duty personnel; figure 1-3 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your educational services office to be sure that you know the most recent requirements.

When you are training lower rated personnel, it is a good idea to point out that advancement is not automatic. Meeting all the requirements makes a person ELIGIBLE for advancement, but it does not guarantee his advancement. Such factors as the score made on the written examination, length of time in service, performance marks, and quotas enter into the final determination of who will actually be advanced.

HOW TO PREPARE FOR ADVANCEMENT

Preparation for advancement includes studying the qualifications, working on the practical factors, studying the required Navy Training Courses, and studying any other material that may be specified. To prepare yourself for advancement or to help others prepare for advancement, you will need to be familiar with (1) the "Quals" Manual, (2) the Record of Practical Factors, NavPers 1414/1, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052 (Series), and (4) Navy Training Courses. The following sections describe these materials and give some information on how to use them to the best advantage.

"Quals" Manual

The Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series), gives the minimum requirements for advancement to

REQUIREMENTS*	E1 to E2	E2 to E3	#† E3 to E4	#E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service— or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3	12 mos. as E-4	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3, AME 3, HM 3, PN 3, FTB 3, MT 3,			Class B for AGC MUC, MNC.††		
PRACTICAL FACTORS	Locally prepared check-offs.	Record of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.	Counts toward performance factor credit in advancement multiple.						
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer	Naval Examining Center						

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-7, E-8 and E-9.
# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.
†† Waived for qualified EOD personnel.

Figure 1-2.—Active duty advancement requirements.

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REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	6 mos.	12 mos.	24 mos.	36 mos. with total 8 yrs service	36 mos. with total 11 yrs service	24 mos. with total 13 yrs service
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit in accordance with BUPERSINST 5400.42 series.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam		Standard Exam required for all PO Advancements. Also pass Military Leadership Exam for E-4 and E-5.					Standard Exam, Selection Board.
AUTHORIZATION	Commanding Officer		Naval Examining Center					

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-3.—Inactive duty advancement requirements.

each rate. This manual is usually called the "Quals" Manual, and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications. Military requirements apply to all rates (pay grades). Professional qualifications are technical or professional requirements that are directly related to the work of each rate (pay grade) within career fields.

Both the military requirements and the professional qualifications are divided into subject matter groups. Then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS.

The qualifications for advancement and a bibliography of study materials are available in your educational services office. The "Quals" Manual is changed more frequently than Navy Training Courses are revised. By the time you are studying this training course, the "quals" may have been changed. Never trust any set of "quals" until you have checked the change number against an UP-TO-DATE copy of the "Quals" Manual.

In training others for advancement, emphasize these three points about the "quals":

1. The "quals" are the MINIMUM requirements for advancement. Personnel who study MORE than the required minimum will have a great advantage when they take the written examinations for advancement.

2. Each "qual" has a designated rate level—chief, first class, second class, or third class. You are responsible for meeting all "quals" specified for the rate level to which you are seeking advancement AND all "quals" specified for lower rate levels.

The written examinations for advancement will contain questions relating to the practical factors AND to the knowledge factors of BOTH the military requirements and the professional qualifications.

Record of Practical Factors

A special form known as the Record of Practical Factors, NavPers 1414/1, is used to record the satisfactory performance of the practical factors. This form lists all military and all professional practical factors. Whenever a person demonstrates his ability to perform a practical factor, appropriate entries must be made in the DATE and INITIAL columns. As a PO1 or CPO, you will often be required to check the practical factor performance of lower rated personnel and to report the results to your supervising officer.

As changes are made periodically to the "Quals" Manual, new forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the "Quals" Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rate but which are not identified as minimum qualifications for advancement. Keep this in mind when you are training and supervising other personnel. If a person demonstrates proficiency in some skill which is not listed in the "quals" but which is within the general scope of the rate, report this fact to the supervising officer so that an appropriate entry can be made in the Record of Practical Factors.

When you are transferred, the Record of Practical Factors should be forwarded with your service record to your next duty station. It is a good idea to check and be sure that this form is actually inserted in your service record before you are transferred. If the form is not in your record, you may be required to start all over again and requalify in practical factors that have already been checked off. You should also take some responsibility for helping lower rated personnel keep track of their practical factor records when they are transferred.

A second copy of the Record of Practical Factors should be made available to each man in pay grades E-3 through E-8 for his personal record and guidance.

NavPers 10052

Training Publications for Advancement in Rating, NavPers 10052 (Series) is a very important publication for anyone preparing for advancement. This publication lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement. NavPers 10052 (Series) is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE you have the most recent edition.

The required and recommended references are listed by rate level in NavPers 10052 (Series). It is important to remember that you are responsible for all references at lower rate

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levels, as well as those listed for the rate to which you are seeking advancement.

Navy Training Courses that are marked with an asterisk (*) in NavPers 10052 (Series) are MANDATORY at the indicated rate levels. A mandatory training course may be completed by (1) passing the appropriate Enlisted Correspondence Course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the mandatory training course; or (3) in some cases, successfully completing an appropriate Navy school.

When training personnel for advancement, do not overlook the section of NavPers 10052 (Series) which lists the required and recommended references relating to the military requirements for advancement. All personnel must complete the mandatory military requirements training course for the appropriate rate level before they can be eligible to advance. Also, make sure that personnel working for advancement study the references which are listed as recommended but not mandatory in NavPers 10052 (Series). It is important to remember that ALL references listed in NavPers 10052 (Series) may be used as source material for the written examinations, at the appropriate levels.

Navy Training Courses

There are two general types of Navy Training Courses. RATING COURSES (such as this one) are prepared for most enlisted rates, giving information that is directly related to the professional qualifications. BASIC COURSES give information that applies to more than one rate.

Navy Training Courses are revised from time to time to bring them up to date. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether a Navy Training Course is the latest edition by checking the NavPers number (and the letter following the number) in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061 (Series).

Navy Training Courses are designed for the special purpose of helping naval personnel prepare for advancement. By this time, you have probably developed your own way of studying these courses. Some of the personnel you train, however, may need guidance in the use of Navy Training Courses. Although there is no single "best" way to study a training course, the following suggestions have proved useful for many people.

1. Study the military requirements and the professional qualifications for your rate before you study the training course, and refer to the "quals" frequently as you study. Remember, you are studying the training course primarily to meet these "quals."

2. Before you begin to study any part of the training course intensively, get acquainted with the entire course. Read the preface and the table of contents. Check through the index. Thumb through the course without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

3. Look at the training course in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book.

4. When you have a general idea of what is in the training course and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

5. In studying each unit, write down questions as they occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

6. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill, or a situation, ask yourself some questions. Does this information tie in with past experience? Or is this something new and different? How does this information relate to the qualifications for advancement?

7. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Without looking at the training course, write down the main ideas you have learned from studying this unit. Do not just quote the book. If you cannot give these ideas in your own words, the chances are that you have not really mastered the information.

8. Use Enlisted Correspondence Courses whenever you can. The correspondence courses

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well on its way to becoming a bad habit. You will have to learn the difference between oversupervising and not supervising enough. No one can do his best work with a supervisor constantly supervising. On the other hand, you cannot turn an entire job over to an inexperienced person and expect him to do it correctly without any help or supervision.

In training lower rated personnel, emphasize the importance of learning and using correct terminology. A command of the technical languages of your occupational field enables you to receive and convey information accurately and to exchange ideas with others. A person who does not understand the precise meaning of terms used in connection with his work is definitely at a disadvantage when he tries to read official publications relating to his work. He is also at a great disadvantage when he takes the examination for advancement. To train others in the correct use of technical terms, you will need to be very careful in your own use of words. Use correct terminology and insist that personnel you are supervising use it too.

You will find the Record of Practical Factors, NavPers 1414/1, a useful guide in planning and carrying out training programs. From this record, you can tell which practical factors have been checked off and which ones have not yet been done. Use this information to plan a training program that will fit the needs of the personnel you are training.

On-the-job training is usually controlled through daily and weekly work assignments. When you are working on a tight schedule, you will generally want to assign each person to the part of the job that you know he can do best. In the long run, however, you will gain more by assigning personnel to a variety of jobs so that each person can acquire broad experience. By giving people a chance to do carefully supervised work in areas in which they are relatively inexperienced, you will increase the range of skills of each person and thus improve the flexibility of your working group.

Working With Others

As you advance to PO1 or CPO, you will find that many of your plans and decisons affect a large number of people, some of whom are not even in your own occupational field. It becomes increasingly important, therefore, for you to understand the duties and the responsibilities of personnel in other ratings. Every petty officer in the Navy is a technical specialist in his own field. Learn as much as you can about the work of others, and plan your own work so that it will fit into the overall mission of the organization.

Keeping Up With New Developments

Practically everything in the Navy—policies, procedures, publications, equipment, systems—is subject to change and development. As a PO1 or CPO, you must keep yourself informed about changes and new developments that affect you or your work in any way.

Some changes will be called directly to your attention, but others will be harder to find. Try to develop a special kind of alertness for new information. When you hear about anything new in the Navy, find out whether there is any way in which it might affect your work. If so, find out more about it.

SOURCES OF INFORMATION

As a PO1 or CPO, you must have an extensive knowledge of the references to consult for accurate, authoritative, up-to-date information on all subjects related to the military and professional requirements for advancement.

Publications mentioned in this chapter are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to revision, make sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made.

A list of training courses and publications that will be helpful as references and for additional study in preparing for advancement is included in the reading list at the beginning of this text. Additional training courses that are applicable are available through your educational services officer.

In addition to training courses and publications, training films furnish a valuable source of supplementary information. A selected list of training films that may be useful appear in the appendixes of this training course. Other films that may also be helpful are listed in the U.S. Navy Film Catalog, NavAir 10-1-777.

ADVANCEMENT OPPORTUNITIES FOR PETTY OFFICERS

Making chief is not the end of the line as far as advancement is concerned. Proficiency pay,

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- Proficiency in basic sewing methods, tailoring techniques, and altering different types of garments
- Comprehensive knowledge of textiles including finishes, characteristics, and weaves
- General understanding of the practices of potential employers
- Concepts of current styles and fit of clothing
- Skill in using teaching techniques

SELECTION OF TRAINEES

The trainees should have certain basic sewing skills before they are accepted into the course including the ability to:

- Use a home-type sewing machine
- Use a commercial pattern
- Cut fabric accurately
- Use marking, cutting, and measuring equipment
- Sew a plain seam
- Construct and attach a collar
- Apply a set-in sleeve
- Apply a facing
- Put in a hem

Pretesting of trainees will help determine their competence and facilitate the selection of individuals for the course. This may be done before or during the first lesson. Factors determining the number and type of pretests to use include the jobs for which training is offered, time available for testing, and the number of applicants for the course.

Suggested methods for screening and/or pretesting trainees are:

- Encourage the applicant to assess his qualifications for the course by providing requirements in the promotional materials.
- Evaluate garments made by the applicant to quickly assess the level of his ability.
- Interview applicant to ascertain his motivation for taking the course, sewing background, basic understanding of construction methods, and ability to communicate ideas.

advancement to Senior (E-8) and Master (E-9) Chief, and advancement to Warrant Officer and Commissioned Officer are among the opportunities that are available to qualified petty officers. These special paths of advancement are open to personnel who have demonstrated outstanding professional ability, the highest order of leadership and military responsibility, and unquestionable moral integrity.

PROFICIENCY PAY

The Career Compensation Act of 1949, as amended, provides for the award of proficiency pay to designated enlisted personnel who possess special proficiency in a military skill. Proficiency pay is given in addition to regular pay and allowances and any special or incentive pay to which you are entitled. Certain enlisted personnel in pay grades E-4 through E-9 are eligible for proficiency pay. Proficiency pay is allocated by ratings and NEC's, with most awards being given in the ratings and NEC's which are designated as critical. The eligibility requirements for proficiency pay are subject to change. In general, however, you must be recommended by your commanding officer, have a certain length of time on continuous active duty, and be career designated.

ADVANCEMENT TO SENIOR AND MASTER CHIEF

Chief petty officers may qualify for the advanced grades of Senior and Master Chief which are now provided in the enlisted pay structure. These advanced grades provide for substantial increases in pay, together with increased responsibilities and additional prestige. The requirements for advancements to Senior and Master Chief are subject to change but, in general, include a certain length of time in grade, a certain length of time in the naval service, a recommendation by the commanding officer, and a sufficiently high mark on the Navy-wide examination. The final selection for Senior and Master Chief is made by a regularly convened selection board.

Examination Subjects

Qualifications for advancement to Senior Chief Petty Officer and Master Chief Petty Officer have been developed and published in the Manual of Qualifications for Advancement in Rating, NavPers 18068 (Series). They officially establish minimum military and professional qualifications for Senior and Master Chief Petty Officers.

Training Publications for Advancement in Rating, NavPers 10052 (Series) contains a list of study references which may be used to study for both military and professional requirements.

The satisfactory completion of the correspondence course titled Navy Regulations, NavPers 10740-A, is mandatory for advancement to E-8, and the course titled Military Justice in the Navy, NavPers 10993, is required of all personnel advancing to E-9.

ADVANCEMENT TO WARRANT AND COMMISSIONED OFFICER

The Warrant Officer program provides opportunity for advancement to warrant rank for E-6 and above enlisted personnel. E-6's, to be eligible, must have passed an E-7 rating exam prior to selection.

The LDO program provides a path of advancement from warrant officer to commissioned officer. LDO's are limited, as are warrants, in their duty, to the broad technical fields associated with their former rating.

If interested in becoming a warrant or commissioned officer, ask your educational services officer for the latest requirements that apply to your particular case.

Chapter 2

MAINTENANCE MANAGEMENT ORGANIZATION

Our fast moving world with its scientific and technological advances and the role of our nation in international affairs have thrust upon the United States tremendous responsibilities and challenges. The organization of the Department of Defense is the method by which the efforts of the military and civilian personnel are systematically coordinated to shoulder the responsibilities and to meet these challenges.

Senior Aviation Maintenance Administrationmen deal not only with other divisions and departments within their own activity, but also deal with various commands and offices of the Department of the Navy. The need for a thorough understanding of the organizational structure through which the AZ meets his responsibilities cannot be overemphasized.

Organization is the means by which management plans, directs, coordinates, and controls operations and activities. It is the division of work into logical groupings of functions and the establishment of channels of authority, communications, and control between the personnel assigned to the various functional groupings.

Able, dedicated personnel can accomplish any assigned task, no matter how poorly they are organized; however, with a good organization, the task can be accomplished more effectively and efficiently. The objective of modern management is to accomplish assigned tasks effectively, efficiently, and economically.

The purpose of this chapter is to acquaint the senior AZ with some of the organizational aspects of the Department of Defense and the Department of the Navy. Navy organization is continuously changing to keep pace with requirements created by improvements in procedures, technological advances, modifications in functions, and new management concepts.

Contained within the pages of the Naval Aircraft Maintenance Program, NavAir Instruction 4700.2 (Series), and the Naval Aviation Maintenance and Material Management Manual (3-M) are all the essential elements to a smooth functioning aircraft maintenance program. However, in order to understand the position of the maintenance effort in the overall plan of Navy operations, certain command relationships and the general aircraft maintenance responsibilities assigned these commands must first be established.

DEPARTMENT OF DEFENSE

The Department of Defense was created as a part of a comprehensive program designed to provide for the future security of the United States. This is accomplished through the establishment of integrated policies and procedures for departments, agencies, and functions of the government relating to national security.

ORGANIZATION AND FUNCTIONS

The Department of Defense consists of the Secretary of Defense, the Deputy Secretary of Defense, the Defense Staff offices, the Joint Chiefs of Staff and the Joint Staff, the three military departments and the services within, the unified and specified commands, and other agencies that the secretary of Defense may establish to meet specific requirements.

The Defense Staff offices and the Joint Chiefs of Staff provide immediate staff assistance and advice to the Secretary of Defense. They are organized separately but function in full coordination and cooperation. The Defense Staff offices consist of the offices of the Director of Defense Research and Engineering, the various Assistant Secretaries of Defense, the General Counsel of the Department of Defense, and such other staff offices that may be established by the Secretary of Defense to assist him in carrying out his duties and responsibilities.

Each military department is separately organized under its own secretary.

Commanders of unified and specified commands have full operational control over their assigned forces and are responsible to the President and the Secretary of Defense for the accomplishment of assigned military missions.

The Department of Defense maintains and employs armed forces for the following:

1. To support and defend the Constitution of the United States against all enemies, foreign and domestic.
2. To insure by timely and effective military actions, the security of the United States, its possessions, and areas vital to its interest.
3. To uphold and advance the national policies and interest of the United States.
4. To safeguard the internal security of the United States.

Secretary of Defense

The Secretary of Defense is the principal assistant to the President in all matters relating to the Department of Defense. He also serves as a member of several important councils. All functions in the Department of Defense are performed under his direction, authority, and control. He is appointed from civil life by the President, with the advise and consent of the Senate. During his absence or disability the Deputy Secretary of Defense acts for and exercises the powers of the Secretary. The Secretary of Defense has numerous assistants and advisers; however, the only ones discussed in this course are those associated with the Department of the Navy.

DEPARTMENT OF THE NAVY

The primary objectives of the Department of the Navy are to organize, train, equip, and maintain the readiness of Navy and Marine forces for the performance of military missions as directed by higher authority, and to support Navy and Marine forces including the support of such forces of other military departments which are assigned to unified or specified combatant commands. This support includes administrative, personnel, material and fiscal support, and technological support through research and development. It is composed of the executive part of the Department of the Navy, the Headquarters United States Marine Corps, the entire operating forces, and all shore (field) activities, headquarters, forces, bases, installations, activities, and functions under the control or supervision of the Secretary of the Navy. It also includes the Coast Guard when operating as a service in the Navy.

The term "Navy Department" refers to the central executive offices of the Department of the Navy located at the seat of government. It includes the following:

1. The office of the Secretary of the Navy.
2. The office of the Chief of Naval Operations and the headquarters organizations of the Marine Corps, of the Naval Material Command, and of Other Supporting Organizations.

In order to provide for its total administration, the Department of the Navy is organized into four principal parts—the Operating Forces, the Marine Corps, the Naval Material Command, and Other Supporting Organizations.

OFFICE OF THE SECRETARY OF THE NAVY

The Secretary of the Navy (SecNav) administers the Department of the Navy as one of three military departments under the Secretary of Defense and the President. As head of this Department, he is responsible for the policies and control of the Department of the Navy, including its organization, administration, operation, and efficiency. He is appointed from civil life by the President.

The Secretary of the Navy is assisted in his duties by the members of his executive administration. This includes both civilian and military assistants. The civilian executive assistants consist of the Under Secretary of the Navy, the Assistant Secretaries of the Navy, and the Special Assistant to the Secretary. The naval executive assistants consists of the Chief of Naval Operations (CNO), the Commandant of the Marine Corps, and the Commandant of the Coast Guard when the Coast Guard is operating as a service in the Navy.

Naval Professional Assistants and Staff Assistants are provided by the Naval bureaus, systems commands, boards, and staff officers.

Civilian Executive Assistants are the principal policy advisers and assistants to the Secretary on the administration of the affairs of the Department as a whole. Each assistant is authorized to act for the Secretary within his assigned area of responsibility.

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OFFICE OF THE CHIEF OF NAVAL OPERATIONS

The Chief of Naval Operations is the senior military officer of the Department of the Navy. He is the principal naval adviser to the President and the Secretary of the Navy on the conduct of war, and the principal naval adviser and naval executive to the Secretary of the Navy on the conduct of the activities of the Department of the Navy. He is the Navy member of the Joint Chiefs of Staff. He commands and supervises all activities of the operating forces of the Navy and is responsible for planning, maintaining the readiness of Navy forces, and determining the material support needs of the operating forces (less Fleet Marine Forces and other assigned Marine forces) including equipment, weapons, materials, supplies, facilities, and supporting services. This responsibility includes the determination of the naval characteristics of and priorities for things to be developed or procured, and the determination of the order in which ships, aircraft, weapons or weapons systems, and those facilities which directly support the operating forces of the Navy, are to be acquired, constructed, maintained, altered, repaired, and overhauled.

NOTE: Aircraft maintenance is considered part of readiness.

Naval aviation comprises a large segment of the operating forces. Aircraft is the prime element of naval aviation. The Aircraft Accounting System established by CNO is a prime informational base for management of this element. The data for this system, normally initiated by AZ's, provides CNO and other interested activities with vital information required for proper management of naval aviation.

The Chief of Naval Operations also provided the basis for the Naval Aircraft Maintenance Program (NAMP) and established policies for the assignment of maintenance responsibilities to all Navy activities concerned with naval aircraft maintenance. This program is another important management tool for naval aviation.

Three basic points in CNO's policy concerning aircraft maintenance are as follows:

1. Performance of aircraft maintenance is a responsibility of command.
2. Aircraft maintenance is administered through the military chain of command.
3. Development of maintenance functions necessary to carry out assigned maintenance duties is a responsibility of the Naval Air Systems Command (NavAirSysCom).

With the introduction of more complex types of weapons and weapons systems into the fleet, it became apparent that a new maintenance management program was needed. As a result, CNO has sponsored and directed the establishment of the Navy Maintenance and Material Management System, herein referred to as 3-M or 3-M System. The basic objective of this program is to improve the material readiness of the fleet through improved management of maintenance and material functions. This program is applicable to both ships and aircraft. Parts of the program pertaining to aviation are covered later in this training course.

The Chief of Naval Operations is assisted in the performance of his duties by several assistants. Some of these are of varying interest to the AZ and are covered briefly in the following paragraphs.

Vice Chief of Naval Operations

The Vice Chief of Naval Operations is principal adviser to CNO and performs duties of CNO during CNO's absence.

Assistant Vice Chief of Naval Operations/Director of Naval Administration

This assistant executes CNO's administrative responsibilities for the operating forces and administrative and management responsibilities for shore activities.

Deputy Chief of Naval Operations (Air)

The Deputy Chief of Naval Operations (Air) (DCNO Air) implements CNO's responsibilities for preparation and execution of programs pertaining to naval aviation and is CNO's representative in naval air operational matters involving other government and civil agencies. This deputy chief is also responsible for planning and providing for the naval aeronautical elements of the operating forces including their preparation, training, readiness for war, and their logistic support.

Deputy Chief of Naval Operations (Development)

The DCNO (Development) implements CNO's responsibilities for research, development, test,

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and evaluation programs, including coordination and direction of weapons development.

Deputy Chief of Naval Operations (Fleet Operations and Readiness)

This DCNO implements CNO's responsibilities for employment of the operating forces with the exception of the Military Sea Transport Service.

Deputy Chief of Naval Operations (Logistics)

The DCNO (Logistics) plans and provides for the necessary logistic support and material readiness of operating and inactive forces of the Navy.

Deputy Chief of Naval Operations (Plans and Policy)

The DCNO (Plans and Policy) develops and disseminates plans and policy and advises CNO on Joint Chiefs of Staff and international military matters.

Naval Inspector General

The Navy Inspector General inquires, under the direction of SecNav or CNO, into and reports upon any and all matters affecting the discipline, readiness, effectiveness, efficiency, or economy of the Department of the Navy.

NAVAL MATERIAL COMMAND

The Naval Material Command includes the Headquarters, Naval Material Command, Naval Air Systems Command, Naval Electronic Systems Command, Naval Ship Systems Command, Naval Ordnance Systems Command, Naval Supply Systems Command, Naval Facilities Engineering Command, and shore (field) activities as assigned by the Secretary of the Navy.

NOTE: A recent reorganization of the Department of the Navy established the Naval Material Command and the six systems commands. These new commands replaced the Naval Material Support Establishment which was composed of the Office of Naval Material, the Bureau of Ships, the Bureau of Supplies and Accounts, the Bureau of Yards and Docks, and the Bureau of Naval Weapons. Many directives issued by the abolished bureaus are still effective and will remain in force for some time.

Chief of Naval Material

The Chief of Naval Material, as head of the Naval Material Command, supervises and commands all functions and activities of the various systems commands. He is directly responsible to CNO for providing the material support needs of the operating forces for equipment, weapons or weapons systems, materials, facilities, and supporting services, all consistent with approved programs. He is also responsible to the Commandant of the Marine Corps for providing the material support needs of the Marine Corps which are provided by the Naval Material Command. He plans for the utilization of resources for meeting the material support needs of the operating forces.

He provides CNO and the Commandant of the Marine Corps with timely advice concerning training and technical requirements essential for the operation and maintenance by naval personnel of new equipments under development, and provides the operating forces with timely technical guidance on the operation, repair, and maintenance of all equipments and weapons or weapons systems. The Chief of Naval Material formulates and effectuates policies and methods of procurement, contracting, production of materials, and of procurement and contracting services throughout the Navy.

NAVAL SHIP SYSTEMS COMMAND.—The Naval Ship Systems Command is responsible for the design, construction, conversion, and procurement of ships, boats, and surface craft. This command coordinates with NavAirSysCom in providing adequate aircraft maintenance facilities afloat. The Naval Ship Systems Command is also responsible for the repair and maintenance of all ships and craft except those assigned to the Naval Facilities Engineering Command and to the Military Sea Transport Service. This includes prescribing the standards and procedures for the dry-docking of all vessels and technical direction of the installation, operating procedures, alterations, and maintenance of the hull, machinery, and equipment of all naval ships. The Naval Ship Systems Command is charged with the management control of all U.S. Naval Shipyards.

NAVAL SUPPLY SYSTEMS COMMAND.—The Naval Supply Systems Command formulates, promulgates, and effectuates policies and methods relative to material control throughout the Naval Establishment. This systems command administers the Navy Supply System. The

Naval Supply Systems Command exercises management control over naval supply depots, naval supply centers, Navy exchanges, and Navy commissary stores. Additional responsibilities of this systems command are discussed in chapter 7 of this training course.

NAVAL FACILITIES ENGINEERING COMMAND.—The Naval Facilities Engineering Command is responsible for design, development, construction, alteration, and cost estimates at all shore activities of the Naval Establishment. This systems command coordinates with NavAirSysCom in providing aircraft maintenance facilities at shore activities. The Naval Facilities Engineering Command also supervises the construction of private plant facilities financed with naval funds. This command is responsible for the maintenance of all buildings and structures of the Navy and for utilization of all automotive vehicles. It exercises management control over all Department of the Navy family housing and Public Works Centers.

NAVAL AIR SYSTEMS COMMAND.—The Naval Air Systems Command is responsible for the research, development, design, test, operating standards, manufacture, issue, maintenance, repair, overhaul, and material effectiveness of all naval aircraft and designated weapons systems. This responsibility includes the rework (Depot maintenance) of all Navy and Marine Corps aircraft and associated equipment.

NavAirSysCom is the coordinating authority for the Naval Aircraft Maintenance Program (NAMP) and as such accomplishes the following:

1. Provides aircraft maintenance policy guidance and technical and management review of the NAMP.
2. Establishes definitions of aircraft maintenance levels and assigns the level of maintenance to be performed by each naval activity concerned with aircraft maintenance.
3. Delineates aircraft maintenance functions and responsibilities to be performed at each maintenance level and provides the organization and procedures to be used by all activities of the Naval Establishment concerned with aircraft maintenance.
4. Assists in the development of programs to properly train and utilize aircraft maintenance personnel.
5. Provides aircraft maintenance material allowance lists together with lists of fleet and shore activities authorized, available, and required.

NavAirSysCom is charged with and responsible for the management control of certain test and development activities and all aircraft maintenance activities of the shore establishment. These activities are employed for conducting necessary research, test, and investigations to obtain suitable material for naval purposes and for supporting the functions of CNO and the operating forces.

NOTE: Management control is the exercise of executive authority and responsibility for the performance of the mission, task, and work of shore activities.

In exercising this management control the responsibility of NavAirSysCom includes mission planning; facility development and workload planning; internal organization and procedures; budgeting; accounting; and the utilization of personnel, funds, materials, and facilities. NavAirSysCom also provides appropriate coordination and application of technical direction. This technical direction is the specialized or professional service performed, or professional guidance or direction exercised through promulgation of policies and procedures in technical matters through the Navy Directives System and technical directives system.

NavAirSysCom has provided a completely centralized system for control and issue of all technical directives concerning naval aircraft and it is the only source of authority to modify, or withhold modification of, naval aircraft, except as directed by CNO or for overriding operational requirement reasons. All publications concerning the operation and maintenance of naval aircraft and associated equipment are published under the direction of NavAirSysCom.

To assist in meeting its responsibilities in the tasks of aircraft maintenance, NavAirSysCom has numerous representatives located in the field. Some of these are discussed in the following paragraphs.

Naval Air Systems Command Representatives.—Naval Air System Command Representatives (NavAirSysComReps) represent the NavAirSysCom in assigned geographic areas in liaison with elements of fleet and training commands on matters pertaining to weapons maintenance and the material support necessary for adequate fleet and training readiness. They serve to coordinate the service and material requirements of the operating and training commands with the maintenance and material support services of NavAirSysCom managed

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activities and supporting commercial activities. These representatives monitor the repair operations at support stations and coordinate material requirements between Aircraft Maintenance Department (AMD's) and Naval Air Rework Facilities (NARF's) at various stations. Some of their specific duties include the following:

1. Assist in preparation of aircraft rework schedules.
2. Establish engine rework schedules and requirements for support of activities performing complete repair of Navy and interservice engines.
3. Schedule component rework.
4. Assist in establishing requirements for technical publications. Review for accuracy and adequacy maintenance and overhaul publications and promote proper technical information support.
5. Coordinate requirements for ground support and special support equipment.
6. Coordinate requirements of fleet and operating activities with the engineering services of rework activities.
7. Control and distribute Change kits.

They further provide on-site guidance and technical assistance through locally assigned Field Service Representatives. These representatives assist local commands in the resolution of maintenance, material and repair problems, and in the interpretation of technical directives.

OPERATING FORCES

The operating forces are the fleets, seagoing forces, sea frontier forces, district forces, and such Navy shore activities and commands as are assigned by the Secretary of the Navy. In the final analysis, the operating forces form the naval power of the United States, and it is for their support that the rest of the Department of the Navy exists. The command, administration, and use of the operating forces are the responsibility of the CNO.

Fleet Commands

Two major subdivisions of the operating forces are the Atlantic Fleet and the Pacific Fleet. The Atlantic Fleet is under the command of the Commander in Chief, U.S. Atlantic Fleet (CINCLANTFLT), and the Pacific Fleet is under the command of the Commander in Chief U.S. Pacific Fleet (CINCPACFLT).

Each is organized for both administrative and tactical command. Tactical organization has to do with the actual deployment and utilization of ships and other units in military operations. The function of the administrative organization is to provide logistic support.

Logistics is defined as those measures involved in supplying necessary personnel, material, and equipment where and when needed. Fleet commanders are responsible for keeping the CNO, the appropriate system commands and other activities informed of operational plans which may require changes in logistic support for the operating forces. Fleet commanders establish levels of supply for overseas bases under their logistic control.

Although the fleet commanders have the responsibility of readiness within their respective areas, they have passed the responsibility of aircraft maintenance to their appropriate types commanders.

Type Commands

The Atlantic and Pacific fleets are composed of various ships and crafts classified and organized into commands by types. The type commanders report to CINCLANTFLT and CINCPACFLT, as appropriate. The type commands of primary concern to the AZ are Commander Naval Air Force, U.S. Pacific Fleet (COMNAVAIRPAC), and Commander Naval Air Force, U.S. Atlantic Fleet (COMNAVAIRLANT).

COMMANDER NAVAL AIR FORCE.—COMNAVAIRPAC and COMNAVAIRLANT are aviation type commanders exercising technical control for aeronautical material in their respective areas. These commands are sometimes referred to as "Operating Commands." Included in the functions and responsibilities of these type commands are the following:

1. Coordinate fleet aviation in their respective areas.
2. Recommend policies relating to organization, maintenance, and employment of fleet aviation.
3. Study the strategical situation and make recommendations for distribution of naval air forces and naval air shore activities.
4. Keep appropriate fleet commander advised on air operations and combat readiness of fleet aviation units.
5. Distribute aviation units in accordance with directives received from higher authority.

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6. Initiate recommendations regarding types, military characteristics, and allowances of aircraft required.

7. Administer and allocate funds received from NavAirSysCom for maintenance and operations of assigned aircraft.

8. Allocate and distribute replacement aircraft and aircraft engines.

9. Coordinate rework schedules of aircraft, aircraft engines, and components.

These type commands are controlling custodians of naval aircraft and are responsible for maintaining assigned aircraft at the highest degree of material readiness from the time the aircraft are received in their custody until they are returned to NavAirSysCom custody at designated delivery points.

NOTE: Material readiness is defined as the condition which, achieved and maintained through careful preventive maintenance, repair, replacement, and tests, enables an aircraft, including airframe, engines, accessories, and components and also related support equipment, to fulfill the purpose for which designed.

As a NAMP coordinating authority, these operating commands are responsible for the coordination control of all aircraft upkeep or rework performed on aircraft under their controlling custody.

COMNAVAIRPAC and COMNAVAIRLANT are responsible for the supply readiness of fleet squadrons and ships tending or supporting aircraft. By outfitting directives, they provide for the initial outfitting and reoutfitting of aeronautical spares and equipment for ships. In the case of fleet squadrons, NavAirSysCom designates an outfitting air station to provide initial aeronautical organizational property and support equipment to the squadron. The type commander monitors and assists as necessary in the outfitting of fleet squadrons and provides supply assistance as the need arises.

The operating commands are also charged with the responsibility of exercising fleet (rationing) control over certain aeronautical materials as designated by the Aviation Supply Office.

The operating commands are responsible for the planned assignment and distribution of aircraft and engines to their operating units and support activities. Assignment of aircraft to individual units is made on the basis of authorized allowances established by the CNO, and the planned assignment of aircraft is determined by COMNAVAIRPAC and COMNAVAIRLANT in relation to the available aircraft inventory.

Assignments in excess of the CNO allowance are made only to meet urgent operational or training requirements. Fleet pools of aircraft and engines for backup support are also provided by this type commander. These pool levels are adjusted according to operational and replacement requirements.

Subordinate Area Commands

For administrative purposes, COMNAVAIRPAC and COMNAVAIRLANT are divided into geographical areas with a subordinate type commander for each area. These commands are designated as area subordinate commands, and they assist their type commander in carrying out directives and policies. Examples of these type activities are Commander Fleet Air (COMFAIR) Whidbey, an area subordinate command under COMNAVAIRPAC; and Commander Fleet Air (COMFAIR) Jacksonville, an area subordinate command under COMNAVAIRLANT.

These subordinate area commanders are responsible for exercising control over fleet aircraft and aviation supplies in their respective geographical areas. Some additional responsibilities and functions of these subordinate area commands are as follows:

1. Coordination of type commander aviation matters and control of aviation support to fleet air units in their assigned areas.

2. Act as the NAMP coordinating authority in their geographical areas. Act as the coordinator of administrative authority to insure that maintenance personnel, material, and facilities are used effectively and economically.

3. Administer, control, schedule, and coordinate the operations and training of assigned units.

4. Supervise and coordinate aircraft maintenance performance, including correction of aircraft technical difficulties of fleet air units, both ashore and afloat.

5. In consonance with established practices and policies, conduct investigations and render reports and recommendations on aviation matters such as material and design deficiencies experienced by operating activities; operational support problems; equipment problems and evaluations; material and equipment distribution; technical assistance requirements of fleet air units; and other general related areas.

6. Monitor the performance of aircraft maintenance logistic support functions and tasks

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assigned by NavAirSysCom to fleet support stations and insure that the workload is consistent with assigned functions, tasks, and fleet requirements.

7. Monitor and review for adequacy the assignment of facilities and material allowed for support of fleet activities at aviation shore activities in geographical area of cognizance.

8. Monitor the configuration control program to insure incorporation of required modifications.

9. Administer assigned technical representatives and arrange their services when requested.

10. Insure that aeronautical materials and equipment are distributed and properly controlled in order to achieve the most effective utilization.

Due to their geographical location, certain COMFAIR's have specific duties in addition to the ones previously discussed. Some of these include the following:

1. Exercise overall administration and management control over the Progressive Aircraft Rework (PAR) program and liaison team at certain Depot maintenance activities, acting as the representative of other COMFAIR's concerned and as aircraft custodian agent for the fleet squadrons.

2. Conduct administrative/material, pre- and post-deployment inspections of assigned fleet air units and such other inspections as required by higher authority or as dictated by existing circumstances and known maintenance or material conditions.

3. Supervise and coordinate the assignment, transfer, and shipment of aircraft and engines and administer pools of aircraft and engines.

COMFAIR's are directly responsible for the administration of units or commands assigned to their administrative command or operational control. They are also responsible for the administration, and operations and logistics support of other units or commands of their respective type commander operating in their areas to the extent necessary to secure uniformity, coordination, and effective liaison with shore activities within their area.

FLEET AIR WING.—A Fleet Air Wing (FAW) is a mobile combatant naval air unit consisting of a wing staff, patrol squadrons, aircraft, and other units as assigned. A FAW, as an organized operational/administrative unit, may be deployed to operate in any assigned geographical area.

The FAW Commander exercises control over assigned squadrons. He is cognizant of supply and maintenance matters and exercises supervision of units assigned regarding these functions. He is responsible to the area subordinate commander for training, efficient operation, and administration of the units under his command. This includes the responsibility for the material condition and material readiness of squadrons under his cognizance. He further insures that aircraft maintenance practices and procedures of assigned units are performed in accordance with existing directives and that maintenance quality and safety are not sacrificed to meet operational schedules.

When squadrons of the FAW are deployed, they normally come under the operational control of the area subordinate commander of the deployed area; however, administrative assignment remains with the COMFAIR or FAW at the squadron's permanent duty station.

The mission of a FAW normally includes the following:

1. Gathering and evaluating detailed and accurate information on all phases of the existing situation, which includes strategic, tactical, and logistic information.

2. Preparing plans, schedules, directives, and reports based upon such information, or in compliance with directives received from higher authority.

3. Disseminate information and directives to subordinate commanders and information and reports to higher authority.

4. Supervise and evaluate the execution of the wing commander's directives by subordinate commands.

ATTACK CARRIER AIR WING/CARRIER ANTISUBMARINE AIR GROUP.—An Attack Carrier Air Wing (CVW) consists of a wing commander and his staff; fighter, attack, and heavy attack (reconnaissance attack) squadrons; and detachments with aircraft configured for special purposes such as airborne early warning and photo reconnaissance. A Carrier Antisubmarine Air Group (CVSG) consists of a group commander and his staff; air antisubmarine and helicopter antisubmarine squadrons; and detachments with aircraft configured for special purposes.

For purposes of administrative control and assignment, the air wing/group commanders normally report to the fleet air commander in whose area the air wing/group is home ported. When embarked, the air wing/group commanders

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report with their embarked squadrons and detachments to the commanding officer of the carrier for operational control.

Each air wing/group has its own commander. In the absence of an assigned commander, the senior commanding officer among the squadrons assumes the responsibilities of the wing/group commander.

Air wing/group commanders have related functions and responsibilities. Some of these are as follows:

1. Supervision and coordination of the training and operations of assigned squadrons and detachments.

2. Coordination and review of material and supply functions of assigned squadrons and detachments.

3. Coordination and surveillance of maintenance performance of assigned squadrons and detachments.

4. Tactical command during wing/group operations. Each commander keeps appropriate superiors advised of the state of training and operational readiness of his wing/group.

Commanders of air wings/groups coordinate the aircraft maintenance performed by units under their cognizance to insure effective and economical use of total assigned personnel, material and facilities, and of facilities and material provided by supporting ships or stations. Wing and group commanders also coordinate planning prior to deployments to insure that necessary facilities, material, and services for the support of assigned units will be provided either by the squadron or the supporting ship or station.

The air wing/group maintenance officer is a direct representative of the air wing/group commander and as such is responsible to the commander in many matters pertaining to aircraft maintenance. Some of his primary responsibilities and functions include the following:

1. Be responsible to the wing/group commander for coordinating the proper performance of all aircraft Organizational maintenance.

2. Maintain liaison with Air, Aircraft Intermediate Maintenance, and Supply Departments.

3. Determine depth and range of organizational support equipment to be loaded aboard ship to minimize duplication and insure only items essential to support the specific deployment are placed aboard.

4. Provide timely input to the Aircraft Intermediate Maintenance Department (AIMD) officer to insure Individual Material Readiness List (IMRL) requirements are tailored to support the assigned air wing/group.

5. Determine prior to embarkation, a list by rate and rating of personnel to be temporarily assigned from squadrons and detachments to the AIMD.

6. Attend the periodic supply/maintenance conferences convened by the AIMD officer and insure squadron representation as required.

7. Monitor air wing/group squadrons and detachments to insure that active and effective quality assurance programs exist; correct maintenance department administrative procedures are employed; active corrosion prevention programs are maintained; effective foreign object damage prevention programs are established and implemented; effective maintenance training programs are being conducted; and assistance to assigned units in obtaining contractor technical services personnel.

Aviation Squadrons.—Aviation squadrons are the last link in the chain of command extending from the CNO through the various commands. The mission of aviation squadrons is to maintain assigned aircraft and associated equipment in a maximum state of readiness and to perform training and operational duties as assigned by appropriate authority. This mission is applicable to fleet aviation squadrons as well as aviation squadrons of the training commands. The responsibilities of both of these types of squadrons are closely related. The CNO assigns aircraft maintenance tasks and responsibilities to activities of the operating forces.

It is the responsibility of each squadron commanding officer to maintain assigned aeronautical material at the highest degree of operational readiness. Operational readiness is a measure of the ability of a command to carry out its assigned mission. An acceptable state of readiness permits employment of personnel and equipment with the expectation that each will perform proficiently. The necessary standards of readiness, including instructions for both tactical and technical training of personnel and for maintenance of equipment, are promulgated by higher authority. It is also the responsibility of the squadron commanding officer to insure that aircraft and personnel detailed for a particular mission are capable of performing that mission under existing conditions. This includes the responsibility for insuring that squadron personnel are trained and qualified to perform all routine and

- Determine the skill, speed, and dexterity of the applicant by having him perform such competencies as using a sewing machine, laying a pattern on fabric, and using pattern markings.

- Evaluate the applicant's knowledge and understanding of clothing construction terminology by the use of a written objective test.

An example of a performance pretest is given in Appendix A.

PROVISION OF ADEQUATE FACILITIES

Suitable training facilities may be found in the home economics department of the local school, clothing services laboratory in the area occupational center, home economics cooperative extension meeting room, community room, or factory training room. Two basic areas are needed for successfully conducting this course.

Classroom Instructional Area. A space equipped with light-weight tables and chairs, chalkboards and tackboards, projection screen, teacher's desk and filing cabinets, book shelves, storage cabinets with adjustable shelves, and a variety of audiovisual equipment.

Laboratory Area. A space equipped with both industrial and home-type machines including a lockstitch, zigzag, and buttonholer with machine benches or chairs. Machines may be borrowed or rented from local stores or garment establishments. The pressing center should include ironing boards, steam irons, sleeve board, various sized pressing hams, point presser, pounding block, needle board, seam roll, pressing cloths, distilled water, steaming machines, and small stiff brushes. Storage units for teaching materials as well as individual trainee items and equipment should also be provided.

PROMOTION OF THE COURSE

Carefully planned publicity for a variety of media is important in order to contact eligible individuals. Promotional suggestions include the following:

- Prepare and send press releases to the local newspapers several weeks in advance of the starting date for the course. The release should include the course prerequisities and content, time and place of registration, length of course, and benefits of training. See example in Appendix B.

- Prepare and distribute attractive flyers to such organizations and places as women's clubs, church groups, P.T.A. groups, and libraries. See example in Appendix C.

- Arrange for a radio and/or television interview and spot announcements. Use similar information to that given in flyer or press release.

specialized squadron maintenance functions on assigned aircraft and related equipment.

Aviation squadrons and units to which aircraft and engines are assigned are reporting custodians and as such are responsible for accounting and reporting in accordance with instructions received from higher authority. Commanding officers are responsible for maintaining current configuration of all aircraft and related equipment in their custody in accordance with NavAirSysCom and type commander directives.

Aviation squadrons are responsible for performing Organizational maintenance on assigned aircraft and support equipment. Organizational maintenance is defined as that type of work performed by aircraft squadrons and units on a day to day basis in support of its own operations. This type of maintenance includes servicing, inspections, tests, repairs, and adjustments which do not require shop facilities. This type of work is done in facilities assigned to the operating units on either a joint or an individual basis.

Standard organization has long been recognized as a sound tool of management. Through the issuance of NavAir Instruction 4700.2 (Series) a standard organization for the maintenance department of Organizational and Intermediate activities was established. This organization provides firm lines of authority from the aircraft maintenance officer to the personnel accomplishing the work.

The aircraft maintenance officer is responsible for management of the maintenance department. This is accomplished by planning and exercising proper control for the department. For detailed information on aircraft maintenance department organization, refer to Aviation Maintenance Administrationman 3 and 2.

Supporting Activities

Most naval air stations, naval auxiliary air stations, and certain naval stations are responsible for performing Intermediate maintenance. These NavAirSysCom managed shore activities are not necessarily part of the operating forces, but they are essential elements in the aircraft maintenance program. Maintenance tasks and responsibilities are assigned to these activities by NavAirSysCom.

Intermediate maintenance is defined as that type of work that is performed in centrally located facilities for the support of operating units within a designated area or at a particular base or station. This maintenance includes component repair and test work on aircraft components and equipment from the supported units. Personnel of the Intermediate Maintenance Activity (IMA) also furnish technical assistance to the supported activities.

AIRCRAFT MAINTENANCE DEPARTMENT.—Shore activities assigned the responsibility of performing Intermediate maintenance have established an Aircraft Maintenance Department (AMD) for this purpose. This AMD has the responsibility of performing Intermediate maintenance in support of station aircraft and tenant squadrons, providing Organizational maintenance facilities for tenant activities, and providing prepositioned maintenance support equipment for tenant activities.

Intermediate maintenance activities are staffed in accordance with the maintenance tasks assigned. They are manned by permanently assigned personnel and personnel temporarily assigned from the Organizational maintenance activities being supported.

AIRCRAFT INTERMEDIATE MAINTENANCE DEPARTMENT.—A recent revision in aircraft carrier organization has established the Aircraft Intermediate Maintenance Department. This department has the same basic responsibilities afloat as AMD's ashore—the accomplishment of Intermediate maintenance in support of embarked aircraft and related equipment. In addition, the AIMD is responsible for Organizational maintenance functions relating to the ship's utility aircraft.

This department is headed by the AIMD officer and consists of a nucleus of permanently assigned personnel and temporarily assigned maintenance personnel from the embarked squadrons and detachments.

Some specific responsibilities and functions of the AIMD officer include the following:

1. Administer the AIMD under the direction of the commanding officer in accordance with existing directives.
2. Manage the Intermediate maintenance effort performed in support of embarked aircraft including custody and upkeep of associated maintenance facilities and support equipment.
3. Assume Organizational maintenance responsibility for the ship's aircraft.
4. Provide and maintain aircraft maintenance facilities to support the embarked aircraft.

5. Update facility plans to accommodate deck load changes and new weapons systems.

6. Establish and update ship/wing/group personnel requirements in conjunction with the air wing/group maintenance officer to insure adequate manning for support of the Intermediate maintenance effort.

7. Maintain a current inventory of maintenance facilities and equipment and submit recomendations for changes to the Individual Material Readiness List.

8. Establish and maintain an effective training program and provide for training and licensing of personnel to operate support equipment.

9. Maintain and control a central technical library of publications for performance of Intermediate maintenance on embarked aircraft and assigned equipments.

10. Conduct maintenance/material planning conferences prior to and during deployments.

11. Assume responsibility for coordinating maintenance and security of all Intermediate and Organizational maintenance work spaces.

OPERATIONS MAINTENANCE DIVISION.—An Operations Maintenance Division (OMD) has been established in the Operations Department of Naval shore activities from which naval aircraft are operated. This OMD is responsible for performing Organizational maintenance on all assigned aircraft. Under special circumstances, they perform additional maintenance services within their capability.

Prior to the establishment of the OMD, the AMD had the responsibility of maintaining assigned station aircraft. This newer concept permits the AMD to more completely carry out its mission of support.

NAVAL AIR REWORK FACILITY.—Naval Air Rework Facilities (NARF's) are located at certain air stations in the U.S. NARF's are responsible for performing Depot maintenance.

Depot maintenance is defined as that type of work that must be done in an industrial type facility. These facilities may be either military or commercial. This type of maintenance includes overhaul and major repair and modification of aircraft, components, and related equipment. It also includes the manufacture of designated aeronautical parts and the manufacture of kits for the accomplishment of aircraft and equipment modification. The support rendered by NARF's is servicewide.

NAVY MAINTENANCE AND MATERIAL MANAGEMENT (3-M) SYSTEM

The Navy Maintenance and Material Management System is the Navy's answer to an evolutionary process which has brought weapons systems to higher complexity and national defense dollars to lower purchasing power. The most efficient management of materials and manpower must be exercised if maximum readiness is to be achieved. The cost to maintain an acceptable state of readiness is of prime importance. In reality, readiness and cost considerations complement each other. By analyzing maintenance cost and devising techniques to reduce cost wherever it is economically feasible, many unnecessary actions can be minimized, if not entirely eliminated. Thus, by doing away with that which is not absolutely required, effort can be concentrated on that which is required—increased readiness. The end objective of this system is to insure the highest state of aircraft readiness and reliability at the lowest cost in men, money, and materials. This system insures that maintenance personnel, equipment, and facilities are utilized to the fullest extent in actual maintenance performance.

BASIC PRINCIPLES

With the implementation of the 3-M System it was known that naval organizational and command relationships are evolutionary and subject to continued change. Names and composition of organizations can be expected to change as they have in the past. However, this system is based on certain basic principles which can survive changes in organizational and command relationships. Some of these principles are discussed in the following pragraphs.

Levels of Maintenance

The three levels of maintenance, Organizational, Intermediate, and Depot, as prescribed by the Secretary of Defense, are the basic divisions within the entire spectrum of aviation maintenance upon which this management system is founded.

Lowest Level Maintenance

The requirement of this basic principle is that all aircraft maintenance be performed

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at the lowest possible level. The distribution and the availability of maintenance equipment and facilities determine and govern the performance of maintenance at specific levels. Commands and support agencies are responsible for insuring that the distribution of equipment and facilities is continually reviewed for the purpose of increasing the amount of maintenance performed at the lowest level consistent with available skills and personnel.

Management by Exception

This basic principle is fundamental to the entire management system. It means that actions or incidents which vary noticeably from certain standards or norms are singled out or "excepted" from the whole for special management attention. For example, if certain aircraft models consistently fail to meet established material standards, they would be singled out for special study and corrective action. Likewise, if certain systems or components within an aircraft continually fail and consume abnormal numbers of maintenance manhours or parts, these would also be exception items. The principle of management by exception is not new and is particularly adaptable to aviation maintenance management through the use of modern machine data processing techniques.

Material Control and
Supply Support

Another basic principle upon which this system is based is that maintenance personnel be utilized primarily in actual maintenance work. This system provides for personnel other than assigned maintenance personnel to supply the worker with required parts and materials. The mechanic or technician does not become involved in part chasing, but devotes his time to actual maintenance performance.

COMPONENT PARTS

The 3-M System includes two broad areas, a Planned Maintenance System (PMS) and a Maintenance Data Collection System (MDCS). These areas are discussed briefly in the following paragraphs.

Planned Maintenance System

The PMS pertains to preventive rather than corrective maintenance. The Periodic Maintenance Requirements Manual (PMRM) and the Maintenance Requirements Cards (MRC's) tell what inspections have to be performed; when they should be performed; how they should be performed; what skills, tools, and special equipment are required to perform them; safety precautions to be observed; and the sequence in which individual inspection actions should be accomplished. The PMRM and MRC's provide this information in a form readily accessible and understandable by supervisors as well as by the workers. The PMS for aircraft and related aeronautical equipment is under the cognizance of NavAirSysCom.

Maintenance Data Collection System

The MDCS is a maintenance and material management control and information system which includes maintenance data reporting, among other things. The primary purpose of data collection in this system is to insure that basic data generated by maintenance personnel is recorded once, and only once, and that the system (not the maintenance activity) thereafter provides information to all who have need for it.

Under this system, there are four categories of data recorded by maintenance personnel and collected for machine processing. In order to be machine processed, most of this data is recorded in code form. The four categories of data are manhour data, maintenance data, aircraft statistical data, and aviation maintenance support equipment statistical data.

MANHOUR DATA.—Data on the total utilization of personnel assigned to maintenance activities is recorded and collected, using the exception principle. Whenever personnel assigned to a maintenance activity are utilized for any purpose other than that for which assigned, they record the amount of time so spent on cards which are collected daily and machine processed.

As long as all personnel are utilized 100 percent of the time in their primary maintenance assignments, no manhour cards are submitted. Manhour data provides a measure of exception from the theoretically perfectly manned, organized, and managed maintenance organization. Together with the actual production manhours recorded on other documents, the manhour accounting system provides a valuable tool for measuring the effectiveness of maintenance personnel utilization, the validity of maintenance personnel assignments, and the

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validity of the structure of the maintenance organization.

MAINTENANCE DATA.—This category of data includes the widest range and most complex types of information involved in the MDCS. This data is recorded on five different collection forms. Examples of information recorded on these forms are discrepancy correction, aircraft inspections, component repair, and technical directive compliance.

AIRCRAFT STATISTICAL DATA.—This management system prescribes the use of an Equipment Statistical Data Card for recording aircraft flight, readiness, and inventory change data. These data are recorded on an as-occurring basis and are machine processed. These data provide all the information needed to produce the reports required in aircraft accounting as well as readiness and utilization information for managers to help measure their effectiveness.

AVIATION MAINTENANCE SUPPORT EQUIPMENT STATISTICAL DATA.—Aviation maintenance support equipment statistical data is collected on selected items of support equipment in a similar manner as in aircraft statistical data; that is, the Aviation Maintenance Support Equipment Data Card is used to record inventory changes, status code changes, not operationally ready time by reason, and utilization. These data are collected and machine processed and provide maintenance managers valuable information required for efficient management of aviation maintenance support equipment resources.

ORGANIZATION PRINCIPLES AND MANAGEMENT FUNCTIONS

The specific objective of aircraft maintenance is to keep all aircraft and related equipment in a serviceable status. Although this might appear to be a simple objective, it raises several problems. Gone are the days when a mechanic repaired an aircraft with a pot of glue and bailing wire. In fact, maintenance activities are finding it increasingly difficult to keep pace with the consequently improved performance of Navy Equipment. Further, management and supervisory personnel in maintenance activities must give increased attention to technological progress in order that their activities may be properly geared to meet present needs and be adequately prepared for further advances.

The Navy, like any other branch of the armed services, consists of people, equipment, and facilities. Although it is basic to the Navy's program to make provisions for adequate and balanced equipment and facilities, one of the most pressing problems is the acquisition, training, management, and retention of suitable personnel. Little good would be accomplished if the Navy had the best equipment and facilities in the world yet lacked enough thoroughly trained personnel to operate and manage these activities effectively.

For example, it has been estimated that during World War II personnel of the Armed Forces used mechanical equipment to not more than one-third of its potential effectiveness because personnel did not have the necessary training and experience to do better. Of course, all-out war makes it necessary to get men to the "line" as fast as possible; however, it is easy to see that there would have been less loss and waste during World War II if there had been better training and more experience.

For the most part, the equipment of World War II was simple compared with present day weapons and weapon systems. Some of today's aircraft are so complex that they require as much maintenance as the public utilities of a small city. Likewise, the average length of experience and the amount of training required to operate and maintain Navy equipment and to conduct Navy activities are increasing constantly. Thus, to put the success of technological efforts in operation, managers must have capable individuals, must train them thoroughly, and must use established principles in managing the entire aircraft maintenance program.

Prior to entering into a discussion of maintenance management functions or principles, it is important that the AZ have a knowledge of certain principles of organization. These organization principles are important to management and must be applied in order to properly manage a maintenance activity. Some organization principles are discussed in the following sections.

PRINCIPLES OF ORGANIZATION

Organization principles are like the principles of physics or chemistry in that they are truths upon which other truths are founded. They are guideposts and beacons to the manager and are not guesswork or opinion. They are the basis for management policies, procedures, rules, and decisions. Therefore, any policy

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violating the principles of management is doomed to failure.

Organization exists when two or more persons combine their actions to achieve a common objective. Such combined actions are very numerous. For example, the actions vary from the simple type, such as man and wife acting as a family unit, to the many individual actions involved in the operation of a big business such as the Navy. Experience has shown that many factors are common to an organizational structure. These common factors must be present in order for any unit to be considered well organized, and these factors are called principles of sound organization.

History bears witness to the practicability of the art of organizing. Institutions and states have become great through its application or have decayed because the new management was unable to continue practicing this art. Critical study shows that when principles of organization were properly employed, the resulting organization accomplished its mission more effectively. On the other hand, an organization which violated these principles has usually proved unsound and inefficient.

There are four fundamental principles of sound organization—unity of command, span of control, logical assignment, and delegation of authority.

Unity of Command

Unity of command means that ultimate control of actions toward the determined objective of the organization at any one level is vested in one individual for a group of workers. There should be several parallel groups, each with its own supervisor at each level except the very top; otherwise, the organizational breakdown is not needed. In simple terms, this means that there should be only one boss at each controlling level. Acceptance of this principle provides for the establishment of a definite chain of command and for effective control of subordinates.

In order that an individual can carry out his job as a leader, manager, or supervisor, it is absolutely necessary that he know to whom he reports. Otherwise, he would not know from whom he receives orders or to whom he reports his results. As basic as this idea may seem, it is often ignored or misunderstood, and these relationships are frequently unsatisfactory to a degree that efficiency is seriously impaired. It is a known fact that when personnel are confused the result is a loss of efficiency.

The supervisor must know whom he directs. He must know who is working for him and who is aiding him in accomplishing a particular job. Moreover, a detailed knowledge of whom he directs enables a supervisor to assign responsibility and to delegate authority.

Span of Control

The principle of span of control means that there is a limit to the number of individuals within an organization that a supervisor can effectively control. In all supervisory positions there are three limiting factors which must be carefully considered in establishing procedures which can be effectively controlled. These factors are the number of personnel under one supervisor, the space or distance factor, and the time factor.

In considering the span of control numbers, experience has developed the concept that a supervisor should manage not less than three nor more than seven subordinates doing different jobs. If he supervises less than three, full advantage of his own capabilities has not been made. If he supervises more than seven, he may not be managing efficiently because there is too great a strain on his energy and ability. This concept has been accepted by most authorities on management and is based upon actual observation of management practices in many fields of human endeavor.

If the activities which are to be supervised require frequent personal contact, then the question of the accessibility of these activities must be considered in organization and locating them. The matter of distance from the supervisor has considerable bearing on how well he is able to do his job. If the activities are spread out over a large base, the time required to travel to these activities is excessive, and the transportation required is wasteful. When the distance between the supervisor and the activities is increased to such an extent that he must waste energy and resources, his effectiveness is reduced.

On the other hand, it may be just as unwise to locate a subordinate too close to the supervisor as it is to locate him too far away. Having a subordinate too close may result in oversupervision. It is a natural tendency for a supervisor to oversupervise those personnel who are located nearest to him. This

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oversupervision means interference with the work of the subordinate and frequently results in stifling him to such an extent that he becomes a person who does only what he is told to do and nothing more. Locating him too far away results in undersupervision, and the subordinate begins to operate independently to such a degree that the influence of the supervisor becomes incidental.

The optimum distance between the supervisor and the subordinate should be that distance which minimizes both oversupervision and undersupervision. The determination of this optimum distance becomes a matter of good judgment rather than measurement.

Every supervisor's job should consist of four principal types of work—routine, regular, special, and creative. There is a certain amount of routine work in every supervisory position which should be performed insofar as possible by subordinates. Regular work primarily consists of such duties as normal supervision of activities and subordinates and those duties which can be performed only by the supervisor. Special work is that which is assigned to the supervisor by his superiors or initiated by himself and which is not related to his regular work. Creative work is that which is done to improve the quality or quantity of routine work and is the work which assures progress in an organization.

Hence, the principle of span of control time implies that the supervisor should control his use of time in order to effect accomplishment of all work which he is assigned. Routine work should be kept to an absolute minimum and should be assigned as far as practicable to subordinates. Regular work should be carefully scheduled. If a number of activities are involved, each one should be alloted time proportional to its relative importance. Special work is a recurring factor in the military, and time should be provided for it. Creative work is also necessary on all jobs, and time must be set aside for its accomplishment.

A proper balance of the three factors—numbers, distance, and time—is necessary in any supervisory position if the principle of span of control is to be satisfied. A desirable state of control can be assured only when a supervisor balances all of these factors with respect to his situation. An equally important principle is that of assigning a person to the job he can do best.

Logical Assignment

The principle of logical assignment means that all functions required to accomplish the mission of the organization should be logically grouped and that all individuals should be assigned to these groupings in accordance with their capabilities.

The principle of logical assignment has been applied to the organization of the Navy. The Chief of Naval Operations is charged specifically with the operation and the development of all phases of naval warfare. To discharge this responsibility, the CNO has organized the Navy so that many functions of his overall mission have been assigned as responsibilities to specific individuals and organizations. The operating functions derived from his mission have been analyzed and grouped logically under the major Navy commands. Similarly, his major staff functions have been analyzed and grouped logically within his headquarters and under the major divisions of personnel, development, material, operations, etc.

There are two phases in the application of this principle—the organizing phase and the personnel assignment phase. In the organizing phase the principle is applied by the logical assignment of functions and relationships within the structural framework of the organization. In the personnel assignment phase the principle is applied through the assignment of personnel, based on their abilities and capabilities to perform the logically grouped functions of the organization.

In the final analysis, the application of the principle of logical assignment provides for the following:

1. An assurance of proper assignment of the "right man on the right job." This is extremely important when it is realized that many people have claimed incorrect assignment and improper classification. Consequently, their morale and efficiency are influenced by their grievances.
2. A higher efficiency and speeding up of training by limiting the range of work.
3. The placing of responsibility, giving credit for an accomplishment, and eliminating a failure.

In addition to logical assignments, a further step requires the granting of authority needed by a person to do the job well.

Delegation of Authority

Delegation of authority means that authority given to a subordinate should be proportionate with his assigned organizational responsibilities. It is the application of this principle which motivates an organization. Delegation of authority might be compared to the electrical power emanating from a central generating plant which sets otherwise idle motors to work.

Delegation of authority applies to all types of organizations and to all levels of management. It becomes more important as the scope and degree of responsibility of the individual increases.

Authority is derived from several sources. First, there is the authority represented by force of character and personality. Some people are marked, even in a gathering of strangers, as persons commanding attention or with an "air or authority." Second, there is the authority due to technical knowledge. The possessor of such knowledge is normally accepted as an "authority on a certain subject." Lastly, there is the authority due to position. A certain authority is inherent in the two stars of a rear admiral; and similarly, a certain authority attends the position of a maintenance officer.

A supervisor delegates to a subordinate the authority to do a certain thing. This delegation of authority should be commensurate with the assigned responsibility of the subordinate. Normally, this authority is limited by directive or custom. Authority must always be delegated; otherwise, assigned responsibility has no logical basis. A supervisor should not, of course, hold a subordinate responsible for the accomplishment of a job that the subordinate has not been given adequate authority to accomplish. Delegation of authority, then, is a means with which the supervisor makes use of the assistance of others and motivates their efforts.

These various organization principles apply to a maintenance activity as well as other types of organizations. All of these principles must be considered by maintenance managers and supervisors in order to achieve the desired objective of a particular activity. Some of the principles are taken care of in Organizational and Intermediate level maintenance activities by following established organization procedures outlined in NavAir Instruction 4700.2 (Series). Others must be applied by local level managers and supervisors. The AZ supervisor should strive to apply these principles in his area of responsibility in order to contribute his part to the accomplishment of the overall unit or activity mission.

MANAGEMENT FUNCTIONS

A good manager is one who uses the available resources to the fullest extent in order to accomplish an objective in the most economical manner. When applied to aircraft maintenance, a maintenance manager uses the available resources (facilities, personnel, funds, equipment, etc.) to maintain the highest percent of aircraft operational readiness. In accomplishing this task, a manager or supervisor performs five separate and distinct jobs—planning, organizing, directing, coordinating, and controlling. These are discussed in the following sections.

Planning

There are no prerequisites or technical skills for management planning, since planning is essentially thinking through each job. It includes a realization that no operation is too small to benefit from planning. Planning is foresight directed toward the manipulation of future developments in order that they will serve the purpose toward which the organization is directed.

A manager or supervisor who has neither a general plan nor a plan for each day's work is shirking his job of supervision. The histories of the rise and fall of big and little businesses and even stories of the family picnic have proved that the planned activity is always the most successful.

Successful planning requires at least four steps. First, it requires the ability to visualize not only the end purpose of an operation or the finished job but also the whole procedure involved in reaching that purpose.

Second, the planner must have a background of experience related to the task he is about to plan. Planning implies a comparison of the projected undertaking with past jobs of similar nature.

Third, considering the diversified activities involved, the planner must take measures to insure that these activities will be coordinated. This involves a careful inventory of material, equipment, and personnel requirements.

Finally, the planner must be able to check his plans in terms of their probable strength and weakness.

The good supervisor should begin his planning by deciding upon a major objective. Next, he should break this major objective down into the minor tasks involved. He can then arrange the smaller jobs in a chronological order of their accomplishment. Naturally, these decisions require the gathering of certain facts in a systematic way.

Organizing

The principle of organization must be applied to the supervisor's unit or department. A sound structure can be formed by constantly recalling the purpose of the organization. Organizational planning should be objective rather than personal. It involves three steps which should be followed by the planner—job analysis, the organizational chart, and assignment of personnel.

Directing

The directing function is the "spark plug" of supervision. By using this function, the supervisor gets the organizational process started. His orders actuate the services determined by planning and established by organization. Giving orders is all too often interpreted as the main function of a supervisor; however, an order should not be given without planning, and it cannot be successful without organization, coordination, control, and a knowledge of the art of handling people.

The supervisor should keep the following principles of directing in mind:

1. Base no decisions on doubtful material.
2. Gather all of the facts and make sure they are correct.
3. Never make a decision that might tend to lower the worker's respect for him.
4. Decide in terms of the human element.

To sum up, the directing function involves three steps: (1) assignment of each worker to a specific area or responsibility, (2) making orders clear and following up assignments, and (3) giving specific orders, whether verbal or written.

Coordinating

Coordinating, as applied to maintenance functions means to function harmoniously. Those acts of the manager which are necessary to integrate the functions within his unit and between his unit and other units or organizations are known as the functions of coordination. Thus, a unit is considered coordinated if its integration promotes the unit's functions without impairing the operation of other units.

Primarily, coordination is a balancing agent. By coordinating the work properly, the supervisor can have the right part at the right place at the right time as well as the right man to install the part. Good coordination requires that the efforts of a group of individuals must blend together as smoothly as the thousands of parts in an efficiently operating aircraft engine.

People are not born with a talent for coordination. The efficient supervisor learns to increase his production by using definite methods to coordinate the work of his unit. The root of coordination is good planning, but additional techniques must also be used. Records and reports designed to reveal information are invaluable. Organization charts and routing schedules are tools for planning coordinated effort. Finally, conferences are a check on how well individuals are actually working together.

Another function that the supervisor must perform is one of control. He must know whether his unit and the individuals in it are operating up to a standard and whether they are meeting their deadline or quotas. To insure that they do this calls for skillful use of the controlling function, which is exercised through a number of procedures.

Controlling

The devices set up by higher echelons are the basic controls. These must be supplemented by local controls specifically designed for a particular unit. Statistical controls collect and make available needed information, and manhour controls serve to keep a record of time spent on the job. All of these controls must be set up and administered if a supervisor is to exercise his control function wisely.

Basically, control is that portion of management which is concerned with inspecting, testing, guiding, and limiting. Control has a direct effect on all functions of management. Obviously the supervisor must know how well his unit is working. His control system is the only means he has of determining whether his workers are doing an effective job. Control is often misinterpreted. It does not mean spying on individuals. Control is the objective inspecting and testing of the end product that is produced.

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Chapter 3

SUPERVISION AND ADMINISTRATION

To most personnel an assignment to a supervisory position is a welcome challenge. Most personnel like the feeling of added prestige, authority over others, and the feeling of progress that goes with the assignment. However, the AZ must realize that the job of a supervisor is not as easy as it may have seemed when viewed from any other position.

Every day the supervisor is confronted with many problems and situations requiring immediate action. If the supervisor knows his duties and responsibilities, knows his personnel, knows the different tasks and their priorities, then he may be able to cope with the supervisory job. However, if he does not know these things, troubles may begin to multiply at an alarming rate.

In addition to the supervisory functions, senior AZ's perform many administrative and clerical type duties in support of the Naval Aircraft Maintenance Program. This chapter discusses some of the general duties and responsibilities of the AZ supervisor and some administrative functions he performs.

Prior to entering into a discussion of supervision objectives and the duties of a supervisor, it is important that the AZ clearly understand the meaning of the words supervision and supervisor.

Supervision can be defined as the act of guiding, directing, overseeing, evaluating, and controlling the activities of others in the accomplishment of an objective. Supervision is the total of all activities performed by persons in a supervisory capacity which help achieve the desired objective.

Supervisor can be defined as the person who practices supervision or one who is responsible for and directs the work of others. The supervisor is usually the middleman between the workers and the policymakers. From this position the supervisor represents the policymakers to the workers and the workers to the policymakers.

ROLE OF THE SUPERVISOR

Most of the duties of senior AZ's are performed in an office. A great deal of the time expended is spent performing supervisory duties. The job of supervising the operation of an office is a many-sided task. Some of the techniques will have been learned through past experience. Others will have to be learned during the actual supervision of the office. Still other techniques may be learned from self-study and technical publications.

Supervisors set in motion the plans, schedules, and policies of their superiors. They are primarily concerned with seeing that the job is done, not necessarily performing the work themselves. Supervisors must know their personnel, assign them work to be done, train them to do the best job possible, direct them through the performance of the work, and assume responsibility for seeing that the job is done right. The role of a supervisor requires leadership, commonsense, and respect.

The effective supervisor, faced with a difficult descision, assembles pertinent facts, policies, and procedures; develops and evaluates possible alternatives; objectively selects the best alternative, and when necessary, consults his own supervisor; and then proceeds with the required action. Facing problems squarely promotes the success of an organization. Making sound decisions gains for the supervisor the respect and confidence of superiors and subordinates alike.

The supervisor's duties consist chiefly of planning, direction, and control. Planning is the process by which the supervisor establishes

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"who will do what, when." Direction involves the " doing." Control refers to the process of checking "what was done" against "what was planned."

The importance of the supervisor to the success of the Navy cannot be overemphasized. The supervisors are the people who fit into the organization between policymaking and policy execution. They create the climatic characteristics of an efficient working unit. The cooperation, loyalty, and capabilities of the personnel "who see that the job is done" provides the foundation on which a successful organization is built.

SUPERVISION OBJECTIVES

Supervision objectives may vary from one task to another; however, there are certain supervisory factors which are standard in almost any situation. A specific list of these factors can be made only when referring to a specific position. The following list contains some typical objectives common to AZ supervisors.

1. Correct personnel assignment; that is getting the right person on the job at the right time.
2. Maintaining quality and quantity of work.
3. Keeping accurate records and accurate reports preparation.
4. Planning and scheduling work.
5. Giving orders and directions.
6. Checking and inspecting completed tasks.
7. Using materials economically.
8. Proper care and use of office machines.
9. Training personnel.
10. Promoting teamwork.
11. Maintaining discipline.
12. Keeping morale high.
13. Maintaining liaison with other work centers in the organization.
14. Maintaining good housekeeping.

By analyzing these typical objectives it can be found that they may be grouped into three broad categories. Thus, the objectives of office supervision are as follows:

1. To operate with maximum efficiency.
2. To operate with minimum expense and waste.
3. To operate free from interruption and difficulty.

While these are primary objectives of office supervision, it is well for the AZ who may be assigned these duties to keep in mind the fact that this new assignment is important for personal reasons. It affords an excellent opportunity to gain practical experience toward eventual promotion to AZCS and AZCM.

Operation With Maximum Efficiency

The operational efficiency of an office is dependent to a large extent upon how conveniently the desks and work areas are arranged. The new office supervisor will want to make an evaluation of the existing office layout to assure the most efficient arrangement possible.

The supervisor by virtue of his position has authority over personnel in his charge. He tells them what to do, when to do it, and if necessary how to do it. This authority alone is not enough to get maximum effectiveness from the crew. A supervisor should know the limitations and capabilities of assigned personnel in order to get the most work out of them. If at all possible, a supervisor should assign a well qualified worker to do a certain job and add to the team other individuals who are less qualified but who are professionally ready for advanced on-the-job training.

The supervisor must anticipate the eventual loss of experienced personnel through transfers, discharges, etc., and offset this by the establishment of an effective and continuing training program. In addition to raising the skill level of the office, the training program will insure that personnel, otherwise qualified, will be ready for the advancement examinations.

A knowledge of the principles of manhour accounting is necessary in the efficient utilization of the manpower available. The supervisor should schedule his workload in such a way that planned absences of key workers will not unduly interrupt the daily routine. When scheduling the workload, the supervisor should keep in mind the skill level required for the various tasks and assign individuals to jobs in such a way that the work will still progress if any worker is unexpectedly absent.

Analyzing the discussion thus far would indicate that an efficient office is one whereby the supervisor practices balanced supervision. This means paying proper attention to each phase of the supervisor's responsibility. Production should not be emphasized at the expense of quality workmanship or personnel training. By the same token, the supervisor should not become so concerned with the human element that

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SECTION II

The State Course of Study

The State course of study is so arranged that it may be adapted to a variety of local situations. Also, the course is planned to provide training for a number of different jobs, thus encouraging individuals with varying levels of ability to enroll. The course is organized into units which can be combined to meet individual interests and abilities. Trainees may advance from garment ripper to dressmaker or may leave at different levels with salable skills. Those who complete the entire course may find employment in a variety of jobs.

OVERVIEW OF THE COURSE

The design of the State course of study is to provide instructional units to help prepare individuals to become skilled workers in the area of garment alterations. Jobs for which training is planned include garment ripper, women's clothing finisher, alteration seamstress, alteration tailor's helper, women's garment fitter, and dressmaker. A description of each job is presented in the chart entitled, Job Titles and Descriptions, found on the following page.

The State course of study consists of six units or learning areas and are listed below.

Unit 1 - Use and Care of Fabrics
Unit 2 - Selection, Use, and Care of Sewing Equipment
Unit 3 - Techniques of Sewing
  Topic 1 - Pressing Techniques
  Topic 2 - Construction Techniques
  Topic 3 - Alteration Techniques
  Topic 4 - Repair Techniques
Unit 4 - Elements and Principles of Design
Unit 5 - Preparation for Employment
Unit 6 - Management of a Garment Alteration Business

Each unit and topic contains competencies, a motivating procedure, learning experiences, instructional materials, and instructor references. Content for each unit or topic is implied in the suggested learning experiences. An explanation of each part is given below.

Competencies. Specific skills needed to become proficient in the learning area are listed. These skills may be measured by using a variety of techniques such as observation, a rating scale, or a check list.

Motivating Procedure. A method for gaining the student's interest and pointing up the importance of the material to be learned is suggested. This procedure should create a curiosity and a desire to go further into the topic presented.

production is neglected. Keeping up with the routine paperwork will prevent its accumulation to the extent that very long periods will have to be devoted to catching up, at the expense of other important tasks. The supervisor should always strive to put the proper emphasis on each phase of responsibility to promote office efficiency.

Operation With Minimum Expense and Waste

The AZ as an office supervisor is responsible for the efficient and economical administration of the office to which assigned. This responsibility includes the ordering, accounting for, and proper utilization of supplies and office equipment. All forms of wastefulness should be avoided by insuring that office supplies and equipment are used for only those purposes for which they are intended. Senior AZ's assigned office supervisory billets must impress upon assigned office personnel the need for being thrifty. There are many ways to economize, and the AZ office supervisor should always be on the alert to point out these ways to less experienced individuals.

Sometimes it is difficult for the AZ supervisor to be as cost conscious as he should, because he is not actually handling the money involved. However, a misdirected effort, wasted time, wasted material, etc., represent additional cost and affect the efficiency of an office as well as the efficiency of the overall activity.

Methods of avoiding waste and unnecessary expense should be included in the training program.

Operation Free From Interruption and Difficulty

The meeting of this objective depends largely upon the extent to which the office, office equipment, and files are maintained. Also, the skill level and training of assigned personnel must be considered in meeting this objective. Office machines of the proper type and quantity (and in good working order) and an up-to-date file of applicable instructions, notices, publications, etc., are all important factors which contributes to an efficient job completion with minimum interruptions or difficulties.

The office functions may be smoothed by the judicious delegation of authority to individuals next in seniority to the supervisor. The delegation of authority does not relieve the supervisor of the final responsibility for work accomplished. It is primarily a means of relieving the supervisor of details. A supervisor who allows himself to become too involved with details loses effectiveness as a supervisor. If the office can run smoothly and efficiently under normal conditions without the personal directions and efforts of the supervisor (for a reasonable period of time) then delegation of authority to other members of the crew has been done properly.

PLANNING OFFICE ARRANGEMENT

The average Chief or First Class Aviation Maintenance Administrationman may never have the opportunity of planning the layout of the maintenance office or production control office in a new facility. In almost every case, the new supervisor will take charge of an already functioning office or else, upon deployment or movement to a new base, the supervisor with assigned personnel will usually be assigned to spaces already basically equipped for offices. In either case, a reevaluation of the office's layout is indicated.

Purpose of the Office

A basic consideration in planning an office layout is the purpose of the office. When more than one office space is available, the supervisor must decide which offices will occupy the spaces and, if necessary, which will have to share space. Of two spaces identical in size, one may, for example, be completely unacceptable for a production control office due to its location or the shape of the area. A production control office should be centrally located in the maintenance department, readily accessible to all divisions and branches, and of adequate size to accommodate all required functions. Consideration must be given to the lighting conditions as adequate lighting is a prerequisite to many office functions. Also, bulkhead space must be considered if status boards or other displays are to be mounted. These two factors must also be considered in arranging the furniture and office equipment.

Arrangement

After the decision of what offices are to occupy what spaces or areas within a space comes the arrangement of furniture and office equipment.

The arrangement of the office furnishings should be made on the basis of utility rather than appearance. Moving an item of equipment into a corner may greatly improve the appearance of the office but at the same time reduce the efficiency of personnel using the equipment. For example, if there is only one adding machine in the office and its use is required by several people it should be located in such a position that all concerned have access to it, and not situated in an out-of-the-way corner. A good rule to follow is to locate equipment where it can be used by the greatest number of people with a minimum of effort in the least amount of time.

The office layout should have provisions for an information or bulletin board upon which may be posted maintenance posters, instructions and notices, plan-of-the-day, and such other information as is appropriate from time to time. The bulletin board should be located in a prominent place in the office, preferable near the entrance where everyone assigned will have to pass at one time or another during the day. Material on the bulletin board should be changed frequently, expired notices promptly removed, the current plan-of-the-day posted early, and other posters and material rotated periodically. If the same material is presented in the same format every day, it will not be long before the personnel begin to ignore the bulletin board, and purposes for having it are defeated. New arrangements are noticed and interest is stimulated with variety and changes.

SCHEDULING AND ASSIGNMENT OF WORKLOADS

Among the most important factors with which the senior AZ is concerned as an office supervisor are the assignment and accomplishment of the workload. This objective is the satisfactory completion of assigned tasks in a reasonable length of time, utilizing available personnel and materials as efficiently as possible. In order to achieve this objective, the supervisor must become skilled in estimating the amount of time to allow for the completion of each task. To be able to estimate effectively, the supervisor must have a knowledge of each job as well as a knowledge of the capabilities of each assigned person. The supervisor must realize the importance of assigning both qualified and unqualified personnel to the jobs, consistent with the training program and the priority placed upon the work to be accomplished. Allowances must be made for planned interruptions. When scheduling the work, the supervisor should also allow for unplanned interruptions and not operate on so tight a schedule that minor unplanned interruptions completely disrupt the schedule.

Most office tasks for which the AZ supervisor is responsible are of such a nature that the quality and quantity of personnel assigned to do them directly affect the time that will be required for completion.

Probably the most important single aid in estimating time and personnel requirements for the completion of tasks is a job plan. Within an office or production work center job planning is one of the most important functions of the supervisor. The job plan need not be an elaborate, complicated masterpiece. Instead, it should be simple with a certain amount of flexibility. In order to be of the most benefit it should be realistic.

Proper planning and assignment of the workload saves time, reduces cost, and makes the job easier and more pleasant for the entire crew. It can eliminate friction, jealousy, and confusion, and free the supervisor from detail work. Proper planning expedites the work and eliminates "bottlenecking," and also makes the supervisor's job easier.

The supervisor should start the day by checking over the work to be done. He should plan for maximum utilization of manpower and material. Periodically during the day, checks should be made to insure that things are progressing as planned. At the day's close, the supervisor should check on progress and prepare for the next working day as this is the best way to begin estimating time and personnel requirements.

After job completion, in order to assure that the job is indeed satisfactorily completed, the supervisor should inspect the finished work.

Personnel Work Assignments

Work assignments should be rotated so that all personnel will have an opportunity to develop skills in all phases of the AZ work. When assignments are rotated, the work becomes more

interesting for the personnel. Another reason for rotating work assignments is that if one highly skilled person performs all the work of a certain type, the supervisor and the office would be at a great disadvantage in the event this person is transferred from the office. Less experienced personnel should be assigned to work with the skilled in order to become proficient in accomplishing a particular task.

Strikers should be assigned to various tasks so that they will acquire experience on all kinds of jobs. A special consideration for the assignment of strikers to jobs is that they should be assigned progressively to jobs of ascending levels of difficulty. On some complicated jobs, a striker may be a useful assistant and understand what is being accomplished if basic tasks have been mastered.

Allowing for Planned Interruptions

During a normal workday, occasions will arise when personnel have to leave their working spaces for one reason or another, thereby delaying the completion of the scheduled work. Some delays can be anticipated; some cannot. Among those which can be anticipated are training lectures, immunization schedules, rating examinations, meals, and watches or other military duties.

Before making personnel work assignments, the supervisor should determine what delays can be anticipated. It may be possible to arrange assignments so that work interruptions are held to a minimum. When estimating the completion time of a task, the supervisor should allow for these predictable delays.

WORK SIMPLIFICATION

Work simplification is a common sense, systematic method of identifying and analyzing work problems, developing solutions, and installing improvements. In order to achieve maximum efficiency each supervisor must do his part to improve the work situation and achieve maximum manpower utilization. This implies that the greatest possible use of all resources available be made in order to help accomplish an activity's mission. Work simplification is a tool which can be utilized effectively in the accomplishment of this goal. Work simplification might be considered as human ingenuity applied to the work situation. It is the organized use of common sense and creative thinking in the solution of work problems.

If all men had believed that there could be no better way of doing things, we might still be throwing rocks at game for our food and traveling from place to place on foot. Progress in these fields was not made in a single step but in a series of improvements. These changes occurred slowly over the centuries, growing out of a multitude of small improvements.

The supervisor who lives day to day, satisfied that what he did yesterday is good enough for tomorrow, will, in most cases, leave his job no better from having held it. He leaves nothing significant for other personnel to follow him in his job, and he becomes lost in the shuffle of men who are content with merely living and dying.

The majority of improvements in our world did not come by accident; rather, they came as a result of man's ingenuity, growing out of his sense of imperfection and his constant search for improvement. When an improvement is made, no matter how small, it marks its discoverer as a person of imagination with a real and active interest in his work.

The supervisor who believes in and practices work simplification procedures can look with pride upon his contributions or those of people who work with him. This means that the supervisor should never cease to search for improvement and must encourage his workers to try to improve jobs over which he has control.

The supervisor should always watch for areas where work can be simplified. Work simplification pays immediate dividends by increasing both production quality and quantity. It allows the supervisor to meet work schedules more easily and reduces waste by producing with less effort, increases savings in time and manhours, and thus reduces cost of operation. Work methods improvement aids in establishing standard procedures. These standard procedures aid in training both old and new workers, since most workers are easier to train, and learning is much easier if standard practices are used.

An example of work simplification that is widely used in maintenance activities is a reports tickler file. The tickler file contains information on each report concerning the kind of report required, form or format to be used, due date, address of the office or command to which it is sent, etc. Although the governing directive should be consulted when preparing a report, a properly used reports

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tickler file simplifies and assists in the preparation and timely submission of required reports.

Work simplification should be considered when arranging the furniture and equipment in an office. If possible, the files should be located near the personnel that use them the most as this would save time and steps. In a like manner, the aircraft status board should be located where it is easily viewed without having to disrupt someone from a desk job in order to see it.

It is true that with good leadership personnel can be encouraged to work to the limit of their physical endurance but unless their efforts are used wisely, the most critical resources—manpower—is being wasted. In the final analysis, it is not how hard personnel work but how much quality work is accomplished that matters. Therefore, to help achieve maximum results with minimum expenditure of human effort, the supervisor should always strive to use established work simplification techniques.

Work simplification permits continuous evaluation by analyzing existing methods and procedures with a view toward improving them. There is always a better way of performing a task by using streamlined methods, improved tools, better working conditions, or shorter procedures. However, these better methods are not always apparent. Work simplification should be directed at all work situations where physical effort is expended.

Techniques

There are many techniques for improving work methods. For the most part, these techniques are adaptable to an office or any part of an organization as well as a whole activity. Five of the principal techniques which have been successfully applied to work operations are discussed briefly in the following paragraphs. All of these techniques require the construction, completion, and use of lists, charts, flow diagrams, etc., in order to study and analyze specific areas.

WORK DISTRIBUTION ANALYSIS.—Work distribution analysis is a technique used to analyze objectively the division of work in an office or organization. In order to obtain the most effective distribution of work, it is necessary for the supervisor to have an overall view of the organization and its operations. The supervisor must clearly understand the work that is being done and be able to see the relationship between the overall operation and the individual work units as well as the contribution that each person makes to the work of the whole organization.

Distribution of work is an important factor in efficient use of manpower. Time and effort are saved if related duties are performed by the same person. Thoughtful matching of assignments and qualifications is important so that personnel are not struggling with work that is too hard for them or wasting their time on tasks that might be performed by a less skilled person. Another consideration is distribution of workload to avoid inequalities, since these result in bottlenecks and other inefficiencies.

Work distribution analysis requires that a Task List be completed for each person whose work is being studied. This list contains, in simple statements, tasks the worker performs regularly and the average number of hours spent on each task per week. Next, a Function List is prepared which lists each function performed by the office or unit. Each task reported on the Task List must be related to a specific function. A Work Distribution Chart is prepared from the data collected on the Task List and Function List. This chart presents the work performed in the existing organization under current operating conditions. The chart is then studied and analyzed to find answers to questions such as the following:

1. What functions take the most time?
2. Is there misdirected effort?
3. Are skills being used properly?
4. Are personnel doing too many unrelated tasks?
5. Are tasks spread too thinly?
6. Is work distributed evenly?

A careful study and analysis of the work distribution chart should assist in achieving the following results:

1. Elimination of unnecessary tasks.
2. Reduction of time spent on relatively unimportant functions.
3. Elimination of duplication and overlapping of work.
4. Better balance of workloads.
5. Combination of related tasks.
6. Realistic estimate of personnel needs.
7. Better utilization of skills.
8. Reallocation of misassigned personnel.

WORK COUNT ANALYSIS.—Work count analysis supplements the work distribution analysis and is a technique for determining the

volume of work in terms of measurable units. Information obtained by counting or measuring the work provides a basis for improving methods and procedures, adjusting work assignments, evaluating performance, and eliminating bottlenecks. Such information is useful in assigning and scheduling work to insure that the workload is equitably distributed among all personnel.

Items of work counted should be definite and comparable. For instance, letters typed might be counted whether long or short, but the typing of aircraft status reports, Work Requests, or other items of this nature should not be included with the letters. Items counted should also be representative of work usually performed. Only those should be counted that clarify methods employed. Counting may take place where the work comes into the office or organization, where a decision is made or action is taken, where a process is completed, or where long storage occurs.

Work count information can be used to accomplish the following:

1. Establish how long it takes to do a given piece of work.
2. Indicate whether the volume of a certain piece of work is sufficient to warrant specialization.
3. Show whether work is distributed evenly among workers.
4. Point out bottlenecks where work piles up.
5. Indicate whether the office or organization is adequately manned, overmanned, or undermanned.
6. Stimulate interest of personnel by providing comparisons of one person's work with that of another or with his own record during a different counting period.

FLOW PROCESS ANALYSIS.—Flow process analysis is a technique for analyzing flow and sequence of operations. The purpose of this analysis is to reduce time and distances in a process by eliminating, combining, and changing the sequence of steps in the flow of work. This work simplification technique is particularly applicable to an office where paperwork flow is to be studied.

The principal tool of this technique is the construction of a flow process chart which provides a clear and detailed picture of the flow of work. Recording each step in a procedure helps to identify duplication of effort, backtracking, and other obstacles to the smooth, efficient flow of work.

MOTION ANALYSIS.—Motion analysis is a technique for making maximum use of physical motions. It is a method of studying the motions of individuals in performing their various tasks.

Work distribution and flow process analyses are directed toward improving the division and flow of work. Motion analysis deals with how an individual performs his tasks. It seeks to learn whether the workers are doing their work with minimum fatigue, loss of time, and waste of effort. Improvements are effected by rearrangement of materials and work area and by proper use of equipment. Motion analysis is particularly applicable to repetitive clerical operations.

The simplest way of gathering data for motion analysis is for the supervisor to watch his personnel at work and note useless motions. Motion analysis should result in the elimination of wasteful motions and consequent loss of work time, reduction of fatigue by lessening the amount of physical effort required to complete a task, and increase the efficiency of personnel.

LAYOUT ANALYSIS.—Layout analysis is a procedure designed to lead to better utilization of space, personnel, and equipment. A study of the layout of a working area can provide useful information for improving the work of individuals, distribution of the workload, and flow of work from one person to another. Its purpose is to determine what space is needed for the operations to be performed and how the available space may be used most effectively. Besides shortening and simplifying motions, it should produce working conditions that are as comfortable and personally satisfactory to the workers as possible consistent with efficient and economical operation. This type of analysis is especially useful when planning office arrangement.

The layout chart is the principal tool of this type of analysis. This chart consists of a floor plan of the work space, showing doors, windows, electrical outlets, etc. All features that restrict usable space should be included. Items of office furniture should be added and the flow of work indicated.

The following principles should be kept in mind when studying an office layout chart:

1. Units and individuals having the most frequent contacts should be located near each other.
2. Personnel having heavy in and out traffic should be located near entrances.
3. Arrangement of equipment and facilities should allow for effective supervision.
4. Layout should provide for maintenance of proper security precautions.

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5. Filing cabinets and records should be conveniently accessible to those who use them.
6. Personnel using the same equipment should be grouped together.
7. Office space allocation should be consistent with working conditions.
8. Desks should face in the same direction and should not face the windows.

INSTALLATION OF IMPROVEMENTS.—Briefly speaking, work simplification means improving methods of doing work or finding a better way. Improved methods usually involve eliminating unnecessary parts of the job, combining and rearranging other parts of the job, and simplifying the necessary parts of the job. By improving methods personnel are able to do better work, with less effort, in less time, without hurrying, with greater safety, and with lower cost. The pattern for achieving the benefits of work simplification is as follows:

1. Select the job to be improved.
2. Break down the job in detail.
3. Question the job and each detail of the job.
4. Develop the new method.
5. Apply and install the new method.

The fact that changes are recommended as a result of a work simplification study does not always mean that these changes will or can be made immediately. There are several reasons why a change that many regard as an improvement may be slow in being adopted.

Most any change will draw objections from a certain number of persons. There are two general types of reasons for these objections. First, many people regard a recommended change as a criticism of the way they have been doing their work and therefore resent it. Most of this type of objection can be avoided if those who will be affected by the change can participate in some degree in the analysis so that the whole enterprise becomes a group activity. If this is not possible, at least a clear explanation should be made regarding reason for the change. Emphasis should be on future advantages rather than criticism of old methods. Secondly, most people have a natural dislike to changing established work habits. If advantages of the new method are clearly explained, this resistance lessens considerably.

Before making any changes it is well to consider carefully all likely effects, for sometimes unforeseen effects may cancel out the beneficial aspects of the change. It is important, for instance, when new equipment or facilities are contemplated, to be sure that advantages of the new installations will outweigh cost. Indirect effects of change upon other equipment or conditions should also be considered.

Effects upon interorganizational relationships should also be taken into account. If work procedures are speeded up in one phase of an operation only to create a bottleneck in another, there will be little or no improvement.

MANHOUR ACCOUNTING

The effective employment of personnel resources is an important function of maintenance management. Manpower to the supervisor is perhaps the most important resource that must be conserved in order to have effective management of a maintenance activity. It is a resource which can be misused and wasted, even by a supervisor with the best of intentions, and the misuse or waste can remain undetected for indefinite periods. However, when some system is used that provides an accounting of manhours and the manner in which they were expended, it becomes apparent whether this resource is being properly utilized. The manhour accounting system (used by Navy maintenance activities) provides an automatic feedback of data which enables the supervisor to maintain records, monitor utilization, forecast production capabilities, and perform the necessary analytical studies required of a good supervisor. The analytical studies pinpoint areas where improvement is needed, and these weak areas should be changed to reflect improved personnel utilization, thus, better efficiency.

Accounting of all manhours expended in a maintenance organization includes not only maintenance manhours but all time spent on other activities as well. There are two types or classes of time which are accounted for—exception time and labor hours. Exception time is reported on Manhour Accounting Cards and labor hours are reported on maintenance data collection system source documents. The manhour accounting system provides accurate, uniform accounting. Effective manpower planning and programing depends upon information available only from a complete manhour accounting system.

Maintenance activities within the Navy use the exception time accounting principle. This accounting procedure makes it possible to assign each individual to a specific type of duty (such as direct labor, supervision, maintenance

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training, etc.) and report only the manhours expended (excepted) outside the assigned duty. In essence, the exception time accounting permits the establishment of "accounts" for each work center; each "account" covers the total manhours assigned to the work center by a specific labor code. As long as all personnel are utilized 100 percent of the time in their primary maintenance assignments, no manhour cards are submitted. Whenever personnel assigned to a maintenance activity are utilized for any purpose other than that for which assigned, the amount of time so spent is recorded on cards which are collected daily and machine processed by data services. By operating with only exceptions to adjust this account, the amount of administrative paperwork is reduced.

Operation of the exception time system may be compared to the operation of a bank. Each work center establishes an account (based on the total available manhours) at the beginning of each reporting period, using manhours instead of dollars. As the work center supervisor submits exception cards (on a daily basis), the hours are added to or subtracted from this bank balance by a computer. If a supervisor borrows labor from another work center or has his own personnel work overtime, the available manhours should be increased; in these cases the exception time is added to the account.

Exception time is subtracted from the account in any cases where the worker is not producing according to the exact capacity for which his manhours are "banked." If a worker is loaned to another work center or if he is serving in some other capacity, he is not serving in the capacity for which his manhours were to be expended. This time would therefore be excepted and is subtracted from the balance. At regular intervals the supervisor is furnished reports or "statements," which reflect how well the account is being balanced.

As previously stated, the Manhour Accounting Card is the source document used to report exceptions. One of these cards is initiated each time a person excepts from normal for a period in excess of three-tenths of an hour. The card is completed at the end of the exception. Daily, these cards are machine processed by data services and the accumulated data is provided to maintenance managers and supervisors in the form of reports.

The work center supervisor is the "heart" of the manhour accounting system. He is charged with the management of the system within his work center. This includes screening of all cards for accuracy, submission of all cards, accuracy of rosters, etc. To meet this responsibility the work center supervisor must make sure that each worker thoroughly understands the system and individually gives an accurate accounting of his time.

MANHOUR ACCOUNTING REPORTS

To be of value to management, the manhour data accumulated through the submission of manhour accounting cards must be presented in a logical sequence and usable format. This is accomplished by data services through the use of data processing machines. The resulting listings and summaries are distributed to the maintenance activities as manhour accounting reports. The reports are designed to provide maintenance managers and supervisors with the information required to indicate general trends as well as to present information of a specific nature.

The formats for the standard daily and monthly manhour accounting reports are common. The essential difference between the reports is the amount of data included in each and the manner in which this data is listed or summarized.

There are four standard reports used in the manhour accounting system. These are discussed in the following paragraphs.

Work Center Daily Labor Listing (MHA 1)

This report is designed for the work center supervisor and is a detailed listing, by work center, of all Manhour Accounting Cards submitted the preceding day. It is a mandatory report and is available to the work center supervisors not later than 0800 hours of the first working day following the date of receipt of the manhour accounting cards by data services.

The work center supervisor can use this report to check the validity of cards submitted the previous day, and any erroneous entries can be corrected by forwarding appropriate correction cards. Deviations from the normal, that is, unwarranted loss of personnel to nonproductive labor codes, excessive absence manhours, etc., can be immediately identified and necessary action taken. The loss of direct labor personnel to indirect or other categories of labor

can be monitored on a day-to-day basis. Overtime expenditures can be monitored to determine if any adjustment of the work schedule is indicated.

Work Center Monthly Labor Utilization Report (MHA 2)

This report is also designed for the work center supervisor. It is a summary, by work center, of all labor transactions for the month. It is a mandatory report and is available to the work center supervisors not later than 0800 hours of the third working day following the end of the reporting period.

This report provides the work center supervisor with information as to how his personnel have been employed during the month by showing the amount of manhours expended in each type of labor. The distribution of manhours expended by the work center during the month can be compared to previous or established labor utilization rates to determine if the work center is operating within desired limits. In combination with past statistics, labor utilization trends can be plotted and examined. Factors having an adverse effect on the productivity of the work center may be recognized and cause appropriate remedial action. Manhour expenditures may indicate a need for manning adjustments and loss of personnel to functions outside the work center may be identified.

Branch/Division Monthly Labor Utilization Report (MHA 3)

This is a nonmandatory report and is a summary, by branch or division, of all labor transactions for the month. If used, it provides the branch or division supervisors with the same basic information as the MHA 2 report. The only difference is that the information is applied to a branch or division instead of individual work centers.

Organization Monthly Labor Utilization Report (MHA 4)

This is a mandatory report and is intended for the maintenance officer or comparable managers. It is made available to the applicable recipients not later than 0800 hours of the fourth working day following the end of the reporting period. Some of its uses are as follows:

1. Identification of total number assigned to, and utilized in, each labor code during the month.
2. Identification of total overtime manhours expended in each labor code during the month.
3. Surveillance of broad categories of labor to insure the organization is employing its manpower resources to best advantage.
4. Isolation of potential trouble areas such as low utilization of direct labor personnel, excessive amounts of manhours lost to nonproductive labor, abnormal duty or nonduty absence rates, and similar variations from normal.
5. Comparison of productive and supervisor manhour expenditures to insure overmanagement is not prevalent.
6. Data contained in the report may serve as the basis for reallocation of manpower.
7. Consolidated manhour information for submission to higher authority is available when required.

Special Reports

There may be times when some specific data, not furnished by one of the standard reports, is needed. In such cases, special reporting requirements may be coordinated with the local data services through the analysis division. Special reports should be requested only if the information requested is needed and is not available in any of the standard reports as this may place hardships on data services due to the increased workload.

NAVAL CORRESPONDENCE

Official correspondence in the Navy includes all recorded communications sent or received by a person in the Navy in the execution of the duties of his office. Besides letters, correspondence includes such things as messages transmitted by teletypewriter, radio, telegraph, or automatic tape equipment. It also includes endorsements attached to letters or memos.

Outgoing correspondence is originated for requesting or furnishing information. It follows that a legitimate need for the information must exist. A request for information should be prepared only after the need for the information has been clearly established and after exhausting possible local sources. In general, correspondence furnishing information depends

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upon the needs of other activities and cannot be controlled locally.

Two very good references (in pamphlet form) are available to assist in writing or checking correspondence. One is the Navy Correspondence Manual, SecNav Instruction 5216.5 (Series), which is the standard guide for all types of Navy correspondence. The other is Plain Letters, an aid in composing simple, easily read letters.

In this section, the word "letters" is used as an inclusive term for naval letters, speedletters, and messages.

TRANSMISSION METHODS

After the requirement has been established, the means of communicating must be selected. The normal possibilities are messages, speedletters, naval letters, or a regular business letter.

A naval message is an official communication in brief form transmitted by rapid means such as radio and is used only when the information is of an urgent nature and must be transmitted rapidly. Convenience of preparation and ease of releasing naval messages at most activities leads to abuses of the communications system. Unless specifically directed by higher authority, routine reports are not sent by message. Other messages should be controlled carefully and continuously to reduce traffic as much as possible.

Speedletters may be used for any routine communications. They are more informal than regular letters, and may be written either in message format or regular form. If they are of an urgent nature, requiring immediate action, they should be stamped or marked URGENT in the upper right corner. Replies to speedletters may be made on the same copy received if the originator has supplied an extra copy and space permits.

Naval letters are used for regular routine correspondence, particularly for more formal communications. The format is rigidly observed, as shown in the Navy Correspondence Manual. The makeup normally follows a pattern of introducing the subject and references in the first paragraph, discussing the subject in such detail as is necessary in the second paragraph, and concluding with any request or special comments in the third. The discussion may cover more than one paragraph if the subject matter is such that it can be understood better when handled in segments.

Business letters are used for corresponding with individuals or businesses outside the Navy who are not familiar with the naval letter.

CLASSIFICATION

Proper security classification of correspondence is a serious problem in the Navy, largely through overclassification. The writer should make certain that classification, if assigned, is justified by a genuine need. The classification should be indicated on the rough draft, and the draft handled as required by that classification.

There are no simple rules for security. One just has to digest the various policy directives and then apply commonsense. To overclassify correspondence is to saddle its purpose with administrative shackles resulting in too few people being informed too slowly. Correspondence does not have to be classified according to classification of references unless it reveals a significant part of their content. Sometimes it is convenient to put the really meaty stuff in a letter (or its enclosure), and then explain that the enclosure (or letters) may be treated as unclassified if separated.

Each piece of correspondence should be assigned the lowest classification consistent with the proper protection of the defense information contained in it. The classifying authority should resist the natural tendency to overemphasize the importance of his work by assigning unnecessary classification categories.

Correspondence and documents should be classified according to their own content and not necessarily according to their relationship to other documents. This procedure is particularly important when documents are part of a series. Various paragraphs or sections of a single document may be classified differently, with the whole document bearing the highest classification contained in it.

One part of the classifying process which warrants continuing attention is marking for downgrading or declassification. Provisions for automatic future downgrading or declassification of the document should be carefully considered at the time of the initial assignment of classification. The originator determines, whenever possible, the conditions under which the document can be downgraded or declassified and marks this plainly on the document.

The details of classification assignment and markings are described in the Department of

the Navy Security Manual for Classified Information, OpNav Instruction 5510.1 (Series). All personnel should be familiar with this manual and especially those who have the authority to classify. It should be consulted when in doubt as to the proper assignment of classification to correspondence.

PREPARATION

Several types of written material are originated and produced in an office, among which are letters, directives, and reports. The manner in which production is handled reflects the supervisory ability and attention to duty of the AZ managing the office.

Aircraft maintenance departments receive large quantities of correspondence. Some of the more common types are directives outlining aircraft maintenance policies and procedures, naval letters requesting and furnishing procedural information, and letters and memorandums assigning duties and individual responsibilities.

Since AZ's are regularly assigned duties as office supervisors, they need skill in the preparation of correspondence. Outgoing correspondence is normally drafted by senior petty officers or officers of the maintenance department. There may be times when the AZ will be expected to compose letters from the briefest of notes or even from oral instructions. Under these circumstances, skill in drafting correspondence is required.

Some correspondence originated by aircraft maintenance departments is of a recurring nature and is relatively standard in content. This may include such correspondence as periodic and special reports to higher authority. Correspondence of this nature is normally simple to draft, and file copies of previous correspondence may be used as a guide.

When assigned to a billet requiring the preparation of correspondence, it is necessary to consult local command instructions outlining the details pertaining to the preparation of official correspondence in that command. The Navy Correspondence Manual is the basic instruction concerning preparation of official correspondence and should be consulted to solve problems that arise in correspondence preparation.

Naval letters, speedletters, and messages are related in that they are correspondence used to convey information from one point to another. The major differences in the three are the format in which prepared and the speed and method of transmission.

There are several factors to be considered in preparing correspondence. This section is designed to assist in achieving efficient production by discussing some of the various phases of producing written material.

It is suggested that the chapter on Maintenance Office Administration in Aviation Maintenance Administrationman 3 & 2 be reviewed with this section.

Planning

A more effective letter will be produced if some time is given to planning prior to beginning to write. A plan of some kind is necessary to insure that everything intended will be included in a clear and orderly arrangement. Whether the writer outlines the letter completely, makes brief notes, or carries his plan in mind will depend upon the length of the letter and his own methods of working.

One of the surest ways to write unacceptable letters is to fail to lay the proper groundwork. Laying the groundwork cannot be done without putting thought into what is to be produced. Laborious as it may seem, one must break out references and assure himself that he has all the required information. Then, all the solutions should be considered in the light of this groundwork and the best chosen.

Correspondence which is worth writing must be based on clear thinking, must be carefully prepared, and must be written in clear, concise form. Otherwise, it is usually better left unwritten. In reply to any letter, it is imperative that all questions raised be answered as directly and accurately as possible. This demands thought and research.

Purpose

Planning cannot begin without a clear knowledge of purpose, so it must be understood exactly what the letter is intended to accomplish. Preparing a statement on the subject of the letter will help in clarifying the purpose and will furnish guidelines about what must be included and what should be omitted.

It is possible for a letter to deal with more than one subject, but normally this is not advisable unless the subjects are very closely

JOB TITLES AND DESCRIPTIONS	
JOB TITLE	JOB DESCRIPTION
Garment Ripper, Alteration; Hand Sewer (D.O.T. 782.884)†	Cuts or rips stitches from sections of garments to be altered by following chalk or pin markings and using a razor blade, scissors, or a seam ripper.
Women's Clothing Finisher (D.O.T. 785.381)†	Prepares garments for show window or floor by pressing and sewing on labels. Makes minor repairs such as tightening snaps and replacing buttons.
Seamstress, Alteration Woman, Women's Garment Alterer, Alteration Finisher (D.O.T. 785.381; 782.884)†	Alters women's ready-to-wear garments as instructed. Rips stitches from darts and seams to be altered and then sews by machine or hand the ripped sections of garment to customer's measurements. Presses fabric articles, using steam iron. Repairs fabric articles, replaces parts, and lengthens or shortens garments.
Alteration Tailor's Helper (D.O.T. 785.281)†	Assists tailor in a variety of duties performed in the alteration of tailored garments. Rips stitches from seams and darts to be altered and then sews by machine or hand the ripped sections of garment to customer's measurements. Replaces pockets in men's clothing and cuffs on pants. Presses garments using a steam iron or tailor's pressing equipment.
Women's Garment Fitter, Ladies' Ready-to-Wear Fitter, Dress and Coat Fitter, Women's Garment Alteration Fitter (D.O.T. 785.381)†	Fits women's ready-to-wear garments on customers. Studies garment worn by customer to determine alterations required. Pins altering folds at seams or darts to arrive at desired fit. Measures and marks hem to specified length. Records required alterations and instructions concerning alterations on tag and attaches to garment. May supervise the person who rips and resews garment.
Dressmaker, Ladies' Tailor (D.O.T. 785.381; 785.361)†	Makes, alters, and repairs women's garments such as coats, dresses, skirts according to a pattern or customer's specifications by using hand or machine sewing. Presses articles with a steam iron to smooth seams and remove wrinkles.

†D.O.T. numbers are found in the *Dictionary of Occupational Titles, Volume I-Definitions of Titles;* 3d ed. Washington, D. C. U.S. Government Printing Office. 1965.

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related. A reply on one subject may be prepared in hours, whereas days or weeks may elapse before an appropriate answer can be made on another subject. If both questions are asked in the same original letter, confusion is likely to result. One department of the recipient activity may prepare the reply on one subject and a different department on another. Even though more than one letter may have to be written to an activity the same day, it is better to do so than combine unrelated matters.

Seven different types of letters that are most commonly used are as follows:

1. Request for permission or authorization to act.
2. Request that action be taken.
3. Request for information.
4. Letter supplying information or instructions not requested.
5. Reply to a request for permission or authorization to act.
6. Reply to a request that action be taken.
7. Reply to a request for information.

While not every letter drafted will fall into one of these categories, the categories will serve as examples of how to analyze and plan a letter. For instance, when the purpose is to request something, the writer must be certain that the request is definitely and clearly stated. Usually, there should be a statement as to why the request is being made and any additional explanation or suggestions that are required or appropriate.

When a letter is written in reply to one received, the receipt is acknowledged, not only by citing the letter as reference, but in the body of the reply. If a request has been made, the most important thing in the reply is a clear statement as to whether the request is granted or denied. Further explanation, limitations, or suggestions should be included as appropriate. Long letters frequently need a summarizing statement as the final paragraph.

Organization of Contents

The order in which the various parts of the letter are arranged should be planned with the reader in mind. A letter of request, for instance, may begin with the request itself, followed by an explanation of why the request is made. Sometimes it may be clearer to the reader if the letter begins with a discussion of the situation and leads up to the request. A letter of reply frequently begins by acknowledging the letter received.

Four important factors to be considered in letter organization are as follows:

1. The body of the letter should be a succession of units.
2. These units should be arranged in what seems the most satisfactory order.
3. Complete each unit before moving to the next.
4. Maintain continuity by providing transition from one unit to another.

In letters of average length, each important unit may be one paragraph, although there is no rule about this. For example, an explanation of reasons why something should be done may take more than one paragraph. Some letters, on the other hand, may be so simple that one paragraph is enough for the entire body. Just as each letter has a subject, so each paragraph covers a topic or subtopic. Each paragraph has its own orderly structure, so that one idea leads naturally to another and one paragraph leads to another.

Principles of Good Style

Most people agree that a good letter is clear, concise, direct, courteous, and suited to its purpose. The major problems confronting the writer is how to achieve these qualities. Some progress toward clarity will be made if an orderly plan for the letter has been produced. The rest will depend on the language chosen for carrying out the plan.

The simplest unit of language is, of course, the individual word. Combined in meaningful groups, words become sentences, which in turn are placed in orderly sequence to become paragraphs. Each of these units requires attention if good style is to be achieved.

CHOICE OF WORDS.—Choosing the right words is a long step toward good style. The best words are those that are precise in meaning, suited to the intended reader, and as short, simple, and direct as possible.

Words used in letterwriting should be exact in their meaning. They can miss the mark of exactness in several ways. One of the most obvious is choice of the wrong one from two that sound or look alike. Quite often the words differ not only in their spelling but also in their meaning. The dictionary should be consulted in all cases when there is doubt as to the correct word to use. As the writer becomes better acquainted with meanings, he will find ways of remembering them. Among words

that are related or similar in meaning, the discriminating writer usually will find one that suits his purpose better than another.

In choosing words, always keep in mind the person for whom the letter is intended. For example, when preparing a letter to a senior command, "Your attention is invited" is used rather than "Attention is directed."

A directive addressed to all hands is written in language all can understand. This does not necessarily mean that only one-syllable words are used, but it does mean that the words chosen are meaningful and understandable by all hands.

The use of long words merely for the sake of sounding more important or more dignified should be avoided. Such an attempt usually results only in sounding showy, stuffy, and hard to understand.

While short, simple words are generally best, not everything can be said in words of one syllable. Sometimes the exactly right words to express something might require the use of long words. In this case it would be a mistake to substitute a less accurate term just for the sake of using shorter words. For instance, even if there were shorter words to replace the term "electronic data processing," it is doubtful that they would convey the same meaning.

Using technical language always requires consideration of the reader. If he is a specialist in the technical field under discussion, technical terms may be used freely, but for anyone else, the terms should be carefully chosen, and some may need to be defined. This is true even for well educated readers, since no one can be familiar with all kinds of technical language.

The fault in some writing is not only that long words have been used where short ones would do, but also that more words are used than necessary. Most senior AZ's will probably have the occasion to review another person's letterwriting. While performing this task, the AZ should be careful when making minor changes or additions, for in striving to make the language more precise, he may cause the passage to mean something the writer did not intend.

MISPLACED WORDS.—One of the most common faults in sentence structure is the misplacement of words, phrases, or clauses. This kind of error occasionally trips up even those whose English is otherwise very good. The result is always confusing and often ridiculous.

The problem of misplacement usually arises with modifiers. These misplaced modifiers are commonly called dangling modifiers. Modifiers should be positioned close to the words that they modify, because otherwise, they may seem to modify something else. Haste, carelessness, or lack of understanding of grammar may cause a writer to use a construction without thinking exactly what it is supposed to modify. This kind of error is fairly common in using participles and other adjectives or with adverbial modifiers.

A frequently misplaced word is "only." The following example shows how, by moving this one word around in a sentence, the meaning is entirely changed.

Only he could read the strange dialect. (Nobody else could.)

He could only read the strange dialect. (He could not write or speak it.)

He could read only the strange dialect. (He could read nothing else.)

He could read the only strange dialect. (Only one dialect was strange, and he could read it.)

It should be kept in mind that there are many other words, which if improperly used, can completely change the intended meaning of a sentence.

SENTENCE STRUCTURE.—To be effective, sentences should be grammatically correct. Also, the various types of sentences should be well chosen and effectively combined, with an eye to clarity, emphasis, and interest.

The faults discussed in this section, although fairly obvious, are common enough that it will be worthwhile to review them.

A frequent fault in grammar among inexperienced writers is the incomplete sentence or sentence fragment. By this is meant a sentence that does not contain the two necessary parts, a subject and a verb. It is possible for the subject to be understood rather than stated, but in this case it should be clearly implied. Often an incomplete sentence results from failure to recognize that a modifying phrase or clause is really part of the preceding sentence.

Do not be misled by the fact that some literary men of high reputation deliberately turn out incomplete sentences at times. It is true that fractured sentences may occasionally produce the exact effect desired, but the writer should be sure he knows why they are being used and that they are suitable to what is being written. For example, the fragment "Bigger and better airplanes!" may have a place in some kinds of writing. In official correspondence

this kind of structure should rarely be used.

Beginning a sentence with "but" or another connective is regarded by many as incorrect, largely because the connective standing first seems to indicate a fragment. This is one rule that may occassionally be ignored if by doing so one achieves a more effective statement. It should not be done often or the effect will be lost.

Another common error in sentence structure is the punctuation of two or more sentences as if they were one. These are known as run-on sentences. Usually this occurs with sentences that are closely related in thought. Often a run-on sentence is the result not only of faulty punctuation but also of failure to think the construction through and recognize the relationships of the various ideas.

Sentences may be grammatically correct and still not be as effective as possible, in which case the fault is described as one of style. Style in writing, like style in dress, is a personal thing—a matter of taste and knowing how to combine. A writer's style may be clear or confusing, concise or wordy, lively or dull.

No one can tell a writer exactly how to achieve a suitable and pleasing style, but there are some general rules which, if understood and applied judiciously, will get him started in the right direction.

As in the case of vocabulary, style should, first of all, suit its purpose. A style that might be quite suitable for a human interest story in the newspaper might be inappropriate for an official letter.

Another rule, also mentioned in connection with choice of words, is that simplicity is usually best. One of the classic examples of simplicity, Lincoln's Gettysburg Address, can be clearly understood by children in the lower elementary grades yet retains its appeal to the most sophisticated ear.

Sentence length affects style in several ways. Generally, short sentences are simpler and easier to understand than long ones. Usually too, short sentences are brighter; long sentences, more dignified; and unless the writer is careful, more inclined to dullness. The average length of sentences in any piece of writing should be adjusted to the subject matter, the reader, and the writer's purpose.

Interest and emphasis can often be improved by variation in sentence length. For instance, in a paragraph in which most sentences are of average or no more than average length, an occasional short sentence may serve to stress an important point or to break the pace agreeably.

Sentences that are too short are inclined to produce a choppy effect, the sound of which is not particularly pleasing. Sometimes these sentences should be combined into a longer one that will not only sound better but will also be more meaningful because the relation of the several statements to each other has been clarified.

A periodic sentence is one in which a period cannot be placed before the last word without cutting off a vital part of the sentence. In other words, the sentence usually ends with the verb or with some other vital word rather than a word, phrase, or clause, that merely adds information. A restrictive modifier—one that is necessary to complete the meaning of what has gone before—may stand last, occasionally, in a periodic sentence, but not a nonrestrictive modifier. If the sentence ends with a nonrestrictive word, phrase, or clause, the sentence is called loose.

In the following example, a periodic sentence (1) has been changed into a loose sentence (2), note that in the transformation the emphasis has shifted enough to change the meaning somewhat. The loose sentence implies that selling activities need not comply with local laws except under these circumstances.

1. Whenever small arms and ammunition not required to be demilitarized under this instruction are offered for public sale, the selling activity will comply with the applicable local laws.

2. Selling activities will comply with applicable local laws whenever small arms and ammunition not required to be demilitarized under this instruction are offered for public sale.

Periodic sentences are more deliberately constructed and therefore more formal than loose sentences. The latter are more characteristic of informal conversation. Neither one can be said to be right or wrong. Whether one or the other is used will depend partly on which is more effective in getting across the meaning of the particular sentence. In an official letter or directive, periodic sentences probably should predominate, but there is no need to try to make every sentence periodic. Some loose sentences are desirable to keep the style from sounding stilted.

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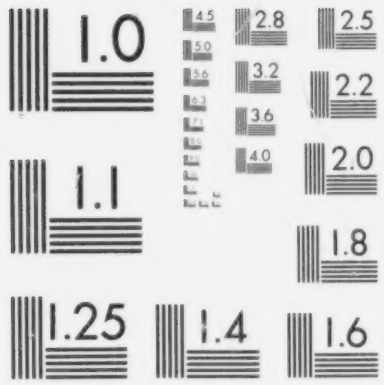

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PARAGRAPHING.— A well written paragraph has unity, which means that the ideas it contains are closely related and are arranged to develop a single topic or subtopic of the general subject. In modern official letterwriting, the tendency is toward short paragraphs, for the sake of readability. This requires not only that unnecessary verbiage be pared away but also that the subject matter be very carefully organized and subdivided.

A fairly long paragraph is frequently made more effective if introduced by a topic sentence. Such a sentence makes a general statement that is developed in greater detail in the remainder of the paragraph.

A topic sentence need not stand at the beginning of a paragraph; in fact, it is possible to have a well written paragraph with a topic sentence in the middle or at the end. In naval correspondence, the topic sentence in the middle of the paragraph is less likely to be used. If placed at the end, it becomes a summary, a very useful device for pulling the paragraph together and leaving a strong final effect. The summary at the end of a paragraph is not used extensively in naval letters and directives. A summary paragraph for an entire letter is sometimes appropriate.

A well organized paragraph has its various ideas introduced in an orderly sequence. This sequence may be place order, chronological order, logical order, or order of emphasis. The purpose of all is the same—to lead the reader along the path one wishes him to take with a minimum of backtracking or skipping about, and thereby to leave a clearer, stronger impression in his mind.

Time honored rules of phraseology have established that, for emphasis, an item should stand first or last. This has been regarded as true whether one is speaking of the sentence, the paragraph, or the piece of writing as a whole. This is what is meant by order of emphasis. Whether the items placed first or last are remembered longest is open to some question, but certainly, the placing of anything, either at the beginning or at the end, gives it emphasis at the moment. Which of the two positions will give the greater emphasis depends upon the individual situation. Newspapers, for instance, feel that the lead paragraph is most important, because people want the news quickly and often do not read through to the end of the story. Orators need a strong beginning and a strong ending. The important thing is that the writer should remember that position is a device for gaining emphasis and should consciously use it.

Originating the Rough Draft

The first time a person is given the responsibility for originating a letter he is likely to feel somewhat panicky. This is not necessary as the letter will almost certainly be a routine letter which can be patterned after others in the file. If it is something out of the ordinary, it will probably be written by someone more experienced in letterwriting.

When given a writing job to do, the writer should find out the deadline or target date. The reason for this is so that he can budget his time effectively. Unless the letter is very brief and routine, a certain amount of time must be allotted for preparatory work, a certain amount for the rough draft, and a certain amount for polishing. The time apportioned for each should be according to the total amount of time available.

The file of related correspondence should be pulled to see how other letters were organized and worded. Thought must be given to all of the things which will be covered prior to writing the rough draft. The next thing is to write a rough draft. The writer should not worry too much at this point about spelling, punctuation, or other aspects of a finished style. The important thing is to get something in writing with concentration toward including all necessary information. Ideas should be expressed as clearly and in as effective order as possible. If the absolutely right word does not come immediately to mind, the writer should put down the best one he can think of, and mark the spot to improve later. If at all possible, the writer should get the rough draft written in some form or fashion because he can come back later and smooth it out.

If possible, the writer should allow a little time to elapse after finishing the rough draft before going over it again. If time permits, the rough draft should be put aside and something else worked on for awhile. When the writer returns to work on the draft he will normally be more objective and ways of improving it are usually more easily noted. Some things to look for are places where the continuity breaks down, where cutting can be done without losing the sense, and where words repeated too often have a jarring effect.

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As one becomes more experienced, he will develop his own individual work habits. As a beginner, the most important thing is to get his train of thought and his flow of language in motion, and keep going with a minimum of interruption.

When first beginning to re-read the letter, it should be gone through from start to finish, stopping only for the briefest of notes at places where the text could be improved. Trying to rewrite during this re-reading is not practical since it will often be found that the rewritten material does not fit with what comes next.

The rough draft should be read with a critical eye to determine that what has been written is correct, that it is clear, and that it is said as effectively as possible. The references should be reviewed in case there is any doubt as to the correctness of certain items or parts. Any matter of accuracy should not be left undetermined.

A writer should not be too upset if he cannot make sense out of some of his own sentences. This happens occasionally to even the best writers. He should be glad that these areas were found and can be corrected. If there is any doubt whether a passage will be clear to the reader, it should be read by someone who has not been thinking about the subject in the same light as the writer. Should this person have difficulty in understanding it, changes should be made even if it means taking out the writer's favorite sentence.

In the interest of effectiveness, the letter should be reviewed for useless words. Lazy and meaningless words should be cut out and the big ones cut down. The intensives (extremely, undoubtedly, very much) and the overworked introductory phrases (it is to be noted, it is a well known fact that, we call your attention to the fact that) should be taken out. The word "overworked" is used advisedly here, because the use of these phrases is not always unnecessary. Sometimes one of these phrases is needed; however, if it is not needed it should be deleted.

While reviewing the rough draft, the writer should look for overuse of certain words and replace them with substitutes. Likewise, all repetition of ideas should be culled out. Some repetition of both words and ideas is useful for emphasis, but a great deal is merely the result of carelessness. If something is not repeated deliberately and for a purpose, it should be changed.

The preferred style of the officer who will sign the letter should be kept in mind while reviewing the letter. Practically every officer who signs correspondence has a few favored words and phrases, and some which he will not allow. The writer should learn these as quickly as possible, thus eliminating a possible source of trouble or inconvenience.

Local policy must be followed regarding approval of rough drafts before smooth typing. In most activities the rule of commonsense is used—this is, if the letter is completely routine in every way, prior approval by the signer is not usually required; if policy is concerned, the draft must be approved.

A writer should not be upset if the rough draft he has written is revised by the reviewer. A rough draft is just that—it is used sometimes only as a point of departure for a complete rewrite. Improvement in letterwriting will be noted with practice; however, a writer may never get a letter out exactly as it was first written. It should be remembered that letters are normally signed by someone other than the drafter and the signer is naturally concerned that they are correct in every detail.

ACCEPTING CRITICISM.—Having reached this stage of correspondence preparation a writer will probably feel a certain pride in his accomplishment, which is only human nature. This is the danger point. A writer should not permit himself to become fond of the way he has expressed something. The minute this happens, he becomes reluctant to change his wording, and this means trouble in two ways. First, most writing can be improved, and therefore the door to criticism should not be closed, either personal criticism or that of another reader. Second, and this is basic to most military writing, the letter will be signed by someone else. If it has to go through several reviewers before it is signed, the writer might as well reconcile himself to the fact that it will be changed. Even if it goes directly to the person who will sign it, the writer should not feel distressed if the signer insists on having it worded his way prior to signing. After all, the signer takes the responsibility for the letter.

This does not mean that a writer should not defend what has been written if there is any misunderstanding, or that any of his reasoning has been overlooked. A certain amount of polite explanation is justifiable, and in fact, a part of a writer's duty. A writer should not feel that criticism is a personal attack on him. If he does,

his capacity to learn from experience and to improve will be diminished.

Checking Finished Correspondence

Correspondence usually must be checked by someone before it is presented for signature. This task commonly falls to the office supervisor in the smaller offices. Correspondence should be checked for the following:

1. Correct subject file classification number.
2. Inclusion of all required information or that the approved draft was followed exactly.
3. Correct titles of all addresses (action, via, and information).
4. Proper chain of command.
5. Enclosures properly labeled and attached in the required number of copies.
6. Proper number of copies.
7. Approved format for its type.

If typographical or spelling errors are found, they should be corrected in the locally approved manner. Ink corrections, if neatly made, are officially acceptable and recommended, but are not always acceptable to the officer signing the letter.

BUSINESS-FORM CORRESPONDENCE

The business-form letter is used for correspondence addressed to persons or agencies outside the Department of Defense who are not familiar with the naval form of correspondence. This includes individual civilians, most business firms, and many federal, state, and city officials. Just as each civilian firm has certain characteristic practices in the preparation of its letters, so the Navy, when it uses business style, follows certain rules.

Format

The format of an unclassified business-form letter prepared for transmission in a window envelope is illustrated in figure 3-1. Frequent reference to this figure will provide a better understanding of the discussion of business-form correspondence.

The first page of a business letter is typed on letterhead stationery. If printed stationery is not available, the letterhead is typed beginning 6 lines from the top of the page, centered on the page. Second and succeeding pages are prepared on plain paper comparable in quality with the letterhead.

A green tissue carbon copy of every outgoing letter should be made for the official files. Letterhead tissue, printed, typed, or stamped, should be used for all copies directed outside the originating office. Additional tissue copies, if required, are made in accordance with the local office practices.

The determining factor in setting the margins of a business-form letter to be transmitted in a regular envelope is its length. A letter less than one page long is centered to give it a well-balanced appearance. The left, right, and bottom margins of full page and multiple page letters are never less than 1 inch, and the top margin of second and succeeding pages is 1 inch.

The identification symbols and date are arranged the same in a business-form letter as they are in a naval letter.

If business-form correspondence is to receive special postal service, the words AIRMAIL, SPECIAL DELIVERY, REGISTERED, or CERTIFIED MAIL are typed in capitals or stamped at the left margin 2 lines above the address when an unclassified letter is to be mailed in a regular envelope, and 3 lines above the address if the letter is classified. On letters to be mailed in window envelopes, the postal designation is typed 4 lines below the last line of the address in the letterhead.

If a business-form letter is classified or designated "For Official Use Only," the appropriate security designation or security markings, including those required to downgrade a letter which is classified solely because it is forwarding a classified enclosure, are shown in the manner prescribed for the naval letter, with only the placement at the top of the page differing. The security classification or special markings are placed at the top of the first page on the line below the special postal service, if any, or 2 lines above the address.

The address begins at the left margin, the distance from the top depending on the length of the letter. If the letter is a full page or more, the address begins 2 lines below the special postal service or classification line, or 7 lines below the last line of the address in the letterhead if there is no special postal service or classification line. It is typed in block style without terminal punctuation. A 2-line address is double spaced. An address of 3 or more lines is single spaced. If it is desired to address the letter to the attention of an individual, the word "Attention," followed by the

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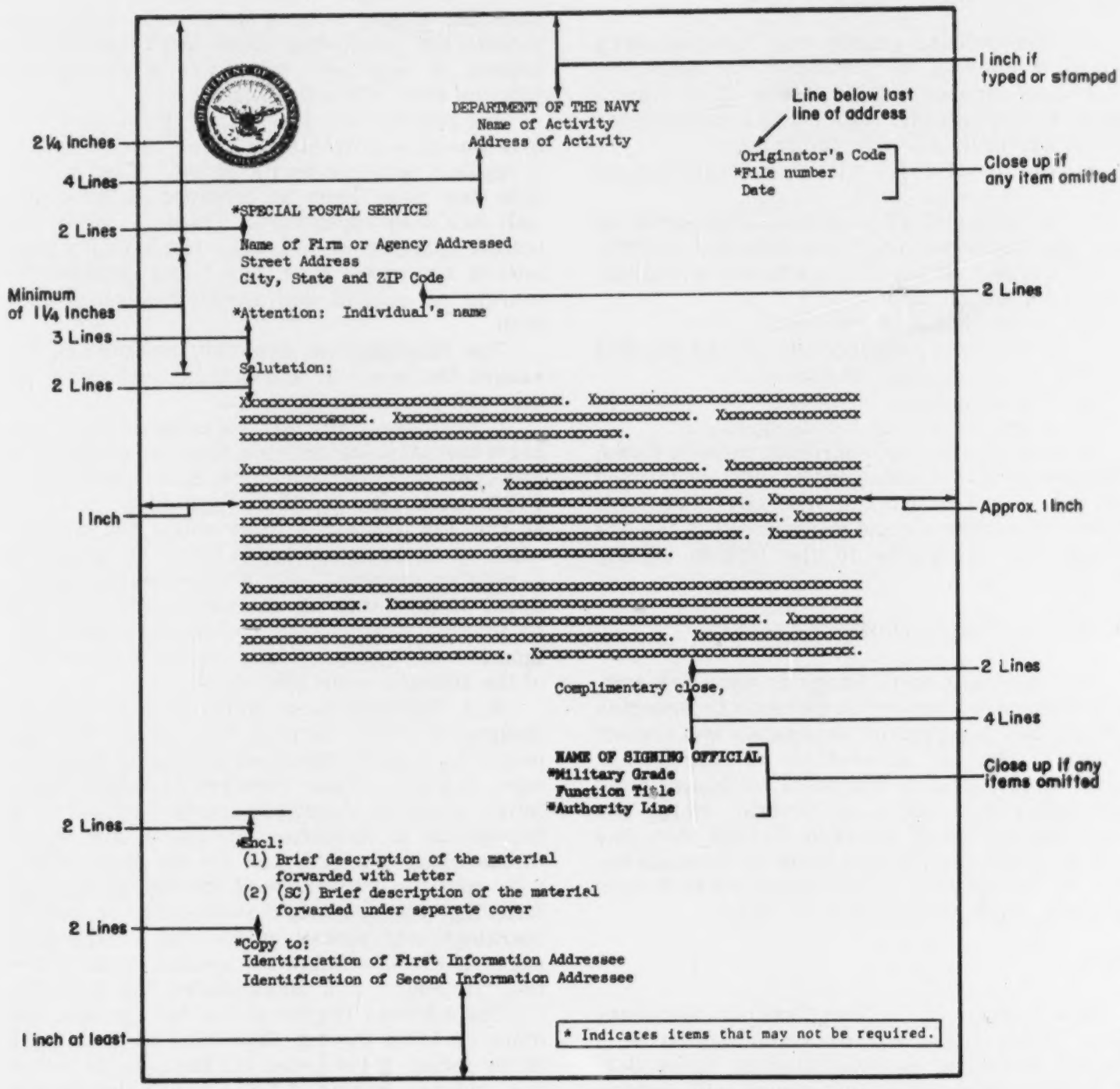

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Figure 3-1.—Unclassified business-form letter format.

individual's name, is typed at the left margin 2 lines below the last line of the address.

When a letter is to be transmitted in a window envelope, the address begins 6 lines below the last line of the address in the letterhead and 2 lines below the special postal service, if any. Only the designation of special postal service, the address, and the attention line should appear in the window.

The salutation, followed by a colon, is typed at the left margin, 2 lines below the address or the attention notation, if the letter is to be

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mailed in a regular envelope. If the letter is to be transmitted in a window envelope, the salutation begins 5 lines below the address, or 3 lines below the attention notation. Generally, the salutation "Dear Mr." or "Gentlemen," is used.

The body or text of the letter begins 2 lines below the salutation. The text is single spaced, with 2 lines after each paragraph and subparagraph. Paragraphs of letters more than 8 lines long are typed in block style. The first lines of subparagraphs and subdivisions are indented 4 spaced successively, with the second and succeeding lines of each paragraph typed flush with the margin of the major paragraph. A letter of 8 lines or less may be double spaced, with the first line of each paragraph indented 4 spaces. Primary paragraphs are not numbered in a business-form letter.

The complimentary close is placed at the center of the page, 2 lines below the text of the letter. The complimentary close "Sincerely yours" is generally used.

The signature information, in block style, begins at the center of the page, 4 lines below the complimentary close. The signature lines consist of the name of the signing official, typed in capital letters; the military grade, if any; the functional title; and the authority line, if any.

When enclosures are to be transmitted with a letter, the abbreviated word "Encl.," followed by a colon, is placed at the left margin, 2 lines below the last line of the signature information. An enclosure list, each of which is numbered with an Arabic numeral in parentheses, followed by a brief description of the material, is typed immediately below the "Encl" notation. Enclosures which accompany the letter carry no special designation, but those which are to be sent under separate cover are identified by the designation "(SC)" in parentheses between the number and the description of the enclosure.

If the carbon copies of a letter are prepared for individuals or organizational units other than the addressee, the distribution appears only on the copies of the letter typed for internal use unless the writer specifically indicates that the distribution should be shown on all copies. When the distribution is shown on all copies, the words "Copy to," followed by a colon, are typed at the left margin 2 lines below the enclosure notation, or 2 lines below the last line of the signature information if there are no enclosures. The list of addressees for whom copies are prepared is typed immediately below the appropriate notation.

Paging, identification of second and succeeding pages, automatic time-phased downgrading and declassification marking, and assembly are as prescribed for a naval letter.

INSTRUCTIONS AND NOTICES

The Navy Directives System is designed to provide a uniform method of issuing written communications which prescribe or establish policy, organization, methods, or procedures, whether they require action or provide essential information. Standardization of subject classification through the use of numbers in definite series facilitates grouping the directives by subject, so that all related directives may be filed together regardless of the originating office. Standardization of the format allows use of binders available everywhere. The directives issued through this system are of two types—Instructions and Notices.

Instructions are those directives containing information of a continuing nature, or requiring action which cannot be completed in less than 6 months. An instruction has continuing reference value and is effective until the originator subsequently cancels or supersedes it.

Notices are directives of a one-time nature which contain information or require an action which is applicable for only a short time. The effective period of time covered by a Notice is limited to 6 months or less except when program requirements extend for a longer but definite period. In no case may a Notice be issued which is effective for more than a year. Each Notice must contain a specific, stated cancellation date for record purposes.

Directives prepared by AZ's are normally local in nature and do not apply to other activities. Local directives are very likely to duplicate others issued by higher authority, often needlessly. Since the Navy Directives System was established, Instructions have multiplied to the point that few personnel have the time to keep up with all those governing their official duties. In addition to this difficulty, local directives seldom are kept current due to the pressure of other work.

The issuance of unnecessary directives has been the subject of official concern on more than one occasion. Perhaps this is best expressed by the following quote from OpNav Notice 5216 of 11 September 1963 (Reduction

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of Administrative Correspondence in the Operating Forces), which was directed to all ships and stations:

"To the maximum practicable extent, avoid issuing repetitive Instructions. If the Navy Directives Manual is complied with, there can be no possible need for all of the duplication now existing. Directives should be complete enough so that no further repetitive issuance is necessary in the chain of command. There is evidence that many Instructions and Notices issued are not being complied with because there are too many for the individual units to keep corrected."

Before local directives are issued, the need for such Instructions and Notices should be established beyond doubt. A system to insure timely revision or cancellation must be installed and maintained conscientiously. An Instruction which is not required or one which is out of date is at best a nuisance, and at worst a serious obstacle.

Number Assignment

All directives issued in accordance with the Navy Directives System are classified by subject matter into one of 13 major numerical groups. Each group contains a thousand numbers, and is commonly referred to by the basic number of thousands; as, for instance, the 5000 series covers general administration and management and the 13000 series covers aeronautical and astronautical material.

The primary subjects are designated by the last three digits (the hundreds) of the numbers. Division into secondary and tertiary subject groups is made by the second and third numbers in the hundreds group, with the extent of division dependent upon the complexity of the subject.

The originator determines the basic number (everything in front of the decimal point) by consulting the detailed listing in SecNav Instruction P5210.11 (Series). Numbers after the decimal point are assigned consecutively for Instructions bearing the same subject classification number issued by the originator.

When there is a substantial change in an Instruction, it is rewritten, reissued, and carries the date of revision. Each revision is assigned the same subject classification number and consecutive number as the superseded Instruction, and is further identified by a suffix capital letter; the first revision A, the second B, etc.

When changes to Instructions are not extensive, they are issued as page replacements or pen changes or a combination of both. Additional pages are also issued as a change. These changes are issued in the form of change transmittals. A change transmittal describes the nature of the change. It is prepared in directive format and is identified by the same number as the instruction which it changes plus the assigned change number. For example, the first change transmittal applicable to OpNav Instruction 5442.2B would be identified as follows: OPNAVINST 5442.2B CH-1.

As in other correspondence, one zero added in front of a number indicates a classification of confidential, and two zeros are used for secret. A capital "P" in front of the subject number or in front of the classification designation indicates a book type, or pamphlet type Instruction.

Notices are issued with only subject classification numbers; that is, there is no decimal or number following the subject classification number. The date of issue serves to distinguish between Notices bearing the same number.

The complete code number P5210.11A on an Instruction can be broken down as shown in table 3-1.

Format

The format for Instructions and Notices is closely related to that of a naval letter. Figures 3-2 and 3-3 illustrate the format of a letter type directive.

The first page is prepared on the printed or a typed letterhead of the originating authority. Continuation pages are prepared on plain bond paper.

The minimum width of the top, bottom, right, and left margins is 1 inch.

The identification symbols are placed on the right side of the page 1 line below the last line of the letterhead. These symbols consist of the abbreviated title of the originating authority followed by "INST" or "NOTE" as appropriate, the subject classification number with applicable prefix-suffix elements, drafter's code or other identification, and the date of signature. These same identification symbols are placed at the top outside margin on continuation pages, except the drafter's code is omitted.

If a directive is classified, the appropriate designation is typed in capital letters 5 lines below the last line of the address in the

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Learning Experiences. Teaching methods and implied content for helping trainees achieve competencies identified for each unit or topic are stated. Each learning experience gives a specific method or methods to present the content, followed by a summary of evaluative techniques appropriate for the content. The learning experiences have been designed to cover the content needed to master the identified competencies.

Instructional Materials. Resources the instructor will need to collect or prepare in order to carry out the suggested learning experiences identified for each unit or topic are listed. Some of the devices are presented in more detail in the Appendix.

Instructor References. Selected books and pamphlets useful to the instructor in teaching the unit or topic are given.

The chart entitled, Time Allocation for Course Units, on page 26, gives the approximate number of hours needed for each unit and topic to prepare trainees to perform the required competencies for the different jobs. This will help the instructor to estimate the average length of training for each trainee. The time estimations are based on the kind of content to be covered in each unit and the degree of skill the trainee is expected to develop in relation to the actual job.

OSDI 1421

Table 3-1.—Breakdown of a complete code number.

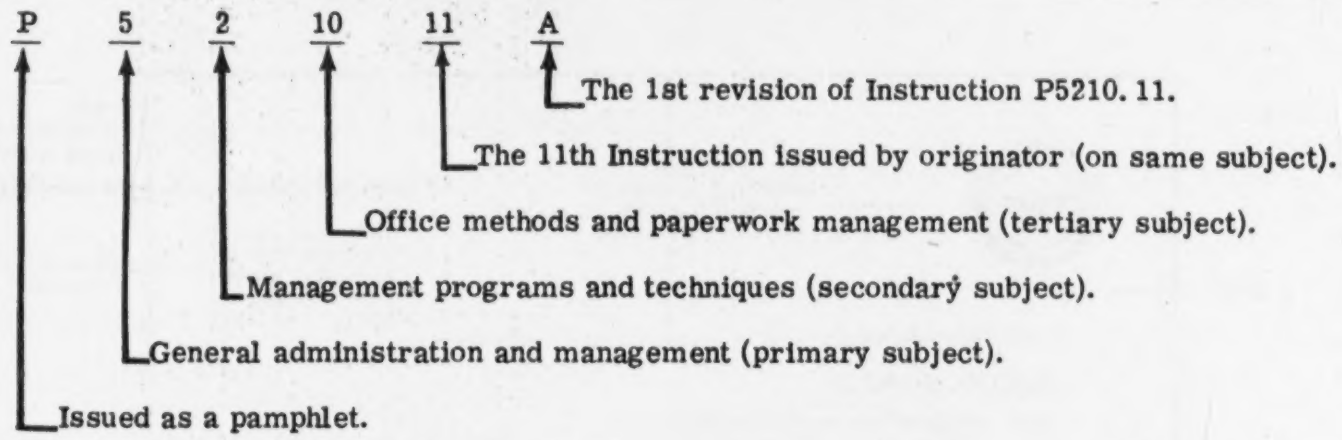

letterhead, beginning at the left margin. In addition, on the first page the classification is marked or stamped at the top outside margin above the identification symbols and also typed in capital letters and marked or stamped at the bottom outside margin of the page. On continuation pages the classification is typed in capitals and marked or stamped at the top and bottom of the page.

The designation of the directive, consisting of the abbreviated title of the originating authority, type of directive (Instruction or Notice), and numerical designation including numerical classification begins at the left margin 2 lines below the classification, if any, or 5 lines below the last line of the address in the letterhead.

The title of the originating authority is shown on the "From" line. Action addressees are shown in the "To" line by individual titles, collective titles, or descriptive titles, depending on which is most appropriate. The words "Distribution List" may be used when the listing will be lengthy.

The "Subject," "Reference," and "Enclosure" lines are the same as in a naval letter.

In the text, paragraphs are normally numbered and lettered as in the naval letter format and paragraph titles are underlined.

Signature, distribution, and stocking information are entered as shown in figure 3-3.

Paragraphing

The arrangement of paragraphs within the directive is largely at the discretion of the originator and depends upon the subject. A few paragraphs are standardized and must be located in a specific sequence.

The purpose of each directive is stated in the first paragraph, including, when appropriate, the general applicability and nature of the action required.

Cancellation of another directive or document is contained in the second paragraph, except that when the sole purpose of a Notice is to cancel another directive, it may be included in the first paragraph.

If applicable, the last paragraph of each Instruction and next to last paragraph of each Notice indicates any reports required and any forms or records prescribed for use and states where the required forms may be obtained.

The last paragraph of each Notice states when or under what conditions the Notice is to be canceled. In all cases, a specific cancellation date (preferably the last day of the month) is provided for record purposes.

Descriptive paragraph titles, usually one or two words, are used for all major paragraphs and may be used for subparagraphs. The titles are written in capitals and lowercase, underlined and followed by a period, commencing two spaces after the number or letter designator on the paragraph or subparagraph. The text begins two spaces after the period on the same line.

Preparation

The first consideration in preparing a directive is that it must be complete. A subject important enough to be covered by a directive is important enough to warrant extra care in preparation. Before the reproducible master is typed, someone who has not worked on the directive should read it over in the rough. If something is not clear, it is relatively easy to correct at this time. Changes issued to correct

14239

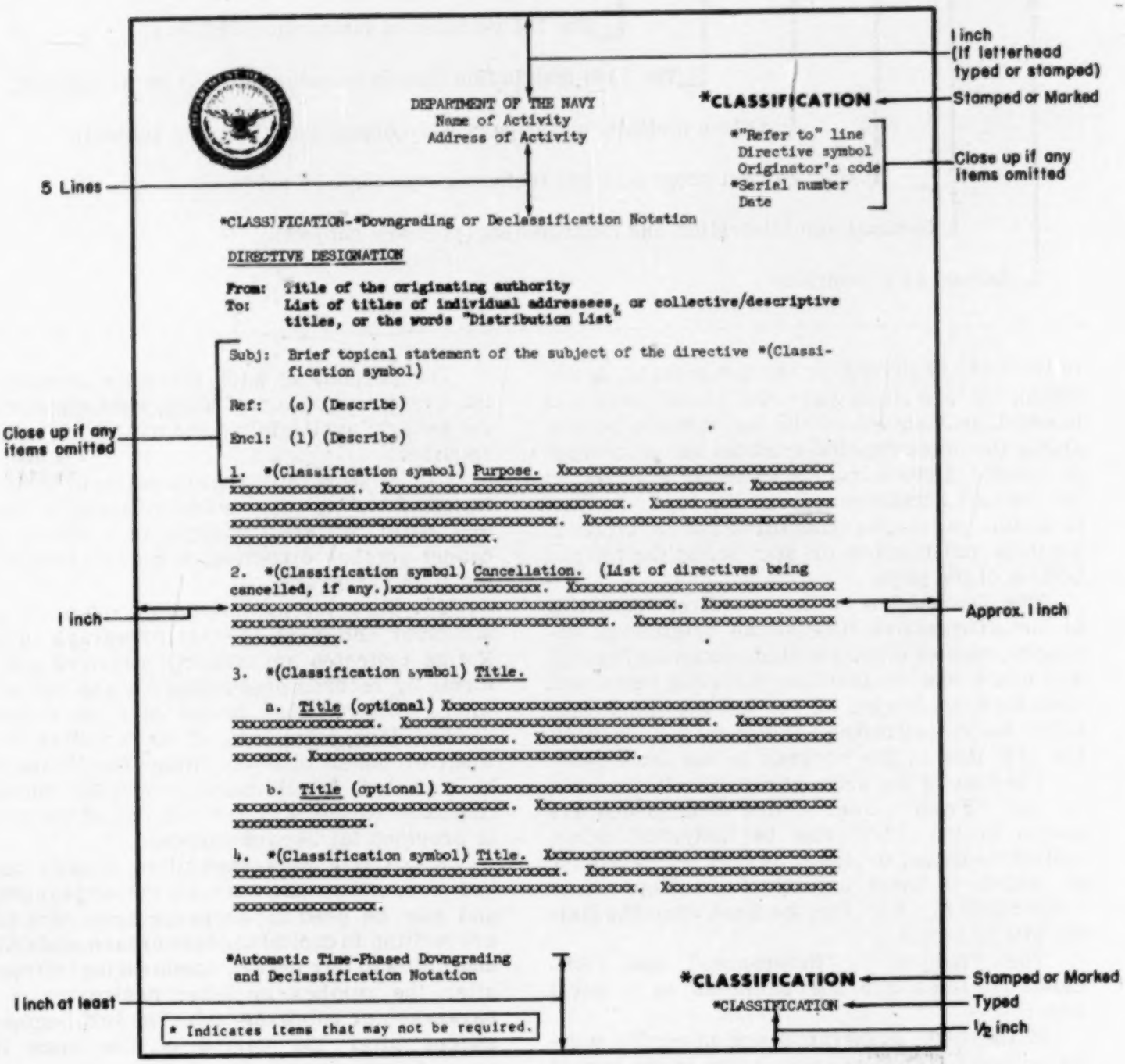
1 inch
(If letterhead
typed or stamped)
DEPARTMENT OF THE NAVY
Name of Activity
Address of Activity
*CLASSIFICATION
Stamped or Marked
*"Refer to" line
Directive symbol
Originator's code
*Serial number
Date
Close up if any
items omitted
5 Lines
*CLASSIFICATION-*Downgrading or Declassification Notation
DIRECTIVE DESIGNATION
From: Title of the originating authority
To: List of titles of individual addressees, or collective/descriptive titles, or the words "Distribution List"
Subj: Brief topical statement of the subject of the directive *(Classification symbol)
Ref: (a) (Describe)
Encl: (1) (Describe)
Close up if any
items omitted
1. *(Classification symbol) Purpose. Xxxx

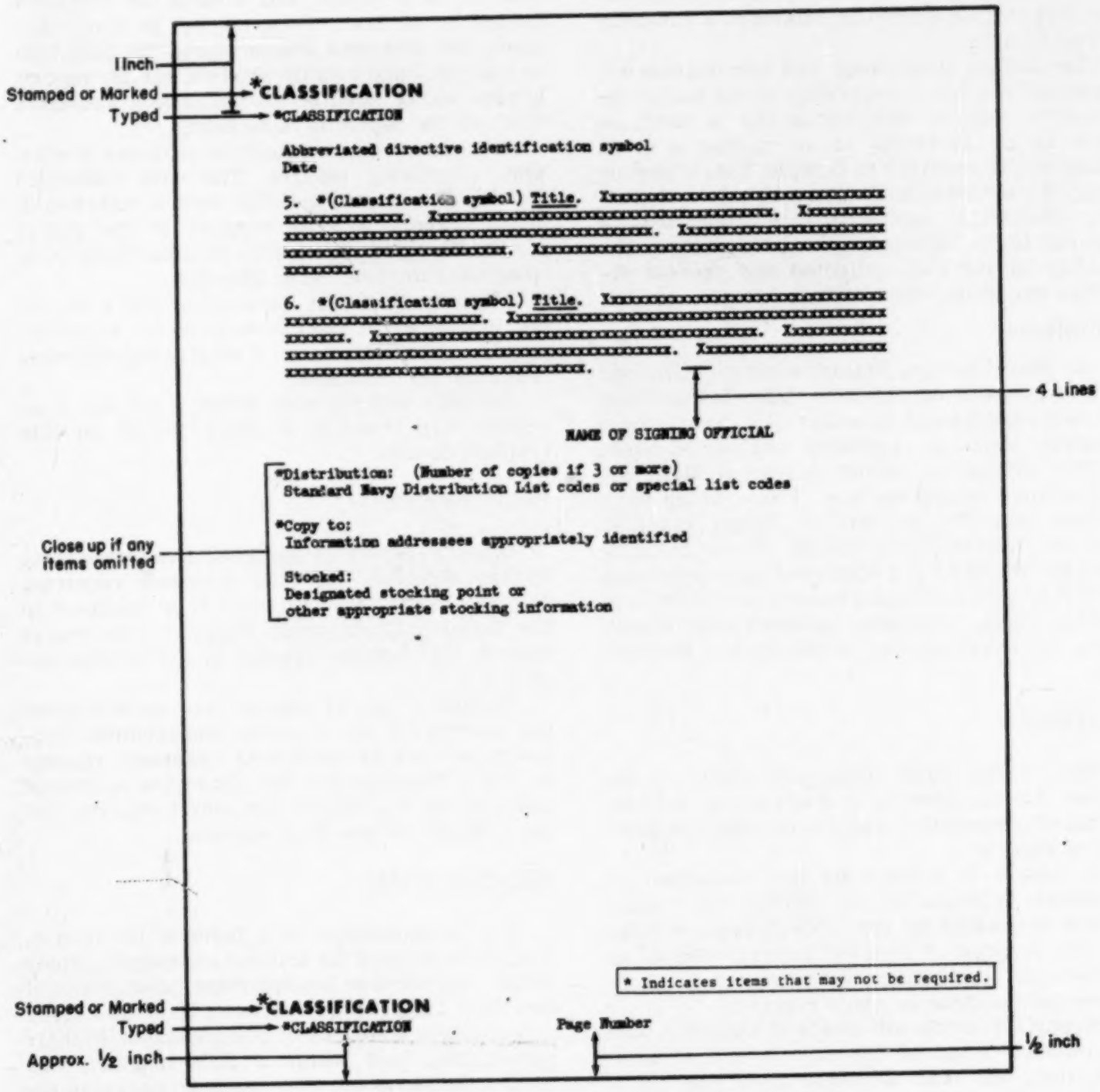
1 Inch
Stamped or Marked
Typed
*CLASSIFICATION
*CLASSIFICATION
Abbreviated directive identification symbol
Date
5. *(Classification symbol) Title. Xxxx

there may be several who are indirectly concerned and who will need copies for information. The distribution should be determined carefully to avoid waste.

The action addressees and information addressees are listed separately at the end of the directive when a distribution list is used, so there is no confusion as to whether a given addressee is required to comply. This is particularly important if the directive requires reporting. Otherwise, confusion may cause certain reports to be delayed enough to destroy the validity of the data collected and prevent effective use of the information.

Cancellation

As stated before, Notices must be published with a specific cancellation date. Instructions are more permanent in nature, but may become obsolete over an extended period of time.

The originator should screen annually all Instructions issued by him. Those which have become obsolete and are no longer required may be canceled by a Notice. Those Instructions for which a need continues may be brought up to date with a change if most of the provisions remain valid. Extensive changes are usually made by rewriting and reissuing the Instruction.

REPORTS

One of the most important duties of the senior AZ assigned to a maintenance activity is that of preparing and supervising the preparation of reports.

A report is defined as any statistical or narrative information in written or tabular format requested by one activity from another for the purpose of forming policy, controlling operations, evaluating performance, or preparing publications or other reports.

Reports provide all levels of authority with information required for smooth and efficient operation. All data collected from reports is used for specific purposes; none is collected out of curiosity or incidental interest.

Reports are classified as (1) recurring reports, those required at specified intervals or on stated dates or upon the occurrence of an event or situation; (2) one-time reports, those required one time only and not intended to be recurring; (3) and feeder reports, those required for the sole purpose of preparing other reports.

Normally, a directive that specifies the submission of a report will furnish the required format to be used. If the report is made on a form, the directive states where the form can be procured and usually shows a sample report. It also shows submission times and activities to which the report is to be sent.

Personnel should exercise extreme caution when preparing reports. The data submitted should be accurate and the format followed in detail. Otherwise, the purpose of the report may be defeated. Erroneous data has little value when used for long range planning.

Reports should be forwarded with a covering letter only if the instructions for reporting require such letters, or if amplifying information must be furnished.

Specific reports with which AZ's are concerned are covered in other places in this training course.

Report Symbols

When a report is assigned a report symbol by the directive or other authority requiring the report, it indicates that it is included in the Reports Management Program. The report symbol will usually appear on the printed report form.

Certain types of reports are exempt from the control of the Reports Management Program, and are designated as "exempt" reports by the requiring authority. Examples of exempt reports are top secret and secret reports, and the majority of one-time reports.

MEMORANDUMS

The memorandum is a form of naval correspondence used for informal communications within and between headquarters components of the Navy Department, between fleet and force commanders and units of commands under their jurisdiction, and within a field activity. The memorandum is used by certain activities for formal communications, and it may be directed to one or more addressees.

For the most part, a memorandum is prepared in the same manner as a naval letter.

A memorandum may be typed on letterhead stationery, plain bond paper, or on U.S. Government Optional Form No. 10. When plain bond paper is used, the letterhead is stamped or typed in the center of the page, 6 lines from the top. Form 10 may be used instead of letterhead for

informal communications within the same command or office and may be typed or written by hand.

Carbon copies are not required of a memorandum dealing with a short-lived or inconsequential subject; however, if it is of significant importance to be a matter of record, a green tissue copy should be made.

Detailed instructions on the use and preparation of memorandums are contained in the Navy Correspondence Manual, SecNav Instruction 5216.5 (Series), which should be consulted in case of difficulty in memorandum preparation.

INCOMING CORRESPONDENCE

Official correspondence received by aircraft maintenance departments should ultimately become a part of the permanent records of the department. The routing required between the receipt of and the filing of the correspondence depends upon the type of information furnished and/or the action required.

The fact that official correspondence is originated implies that information is being requested or furnished. It follows that unless this information is properly disseminated, the mere originating has accomplished very little. Correspondence requesting a report does not produce the report unless the person responsible for its preparation receives the request.

The responsibility for the dissemination and proper handling of official correspondence is assigned to a specific organizational component of aircraft maintenance departments. A First Class or Chief AZ, in many instances, is assigned to this component, and in some cases may head such an organizational component.

Screening

Since most official correspondence is addressed to the commanding officer, it will be received by the administrative department. Correspondence concerning the aircraft maintenance department will be forwarded for appropriate action. Some of it may already have a routing sheet attached when received. The routing sheet attached by the administrative department may not indicate a complete routing for the aircraft maintenance department. Therefore, screening is required by the aircraft maintenance department to make sure it reaches the appropriate personnel.

The primary purpose for screening is to determine who should see the correspondence and in what sequence. Correspondence requiring immediate action should get in the hands of the personnel concerned as soon as possible. Screening of incoming correspondence should be done on at least a daily basis, preferably soon after the time mail is received in the department.

Routing

Immediately after screening has been completed, the correspondence should be routed so that appropriate action can be taken. Local procedures usually prescribe a standard routing for all incoming correspondence in addition to the routing to those individuals or organizational components primarily concerned with the individual communication.

A route sheet similar to the one shown in figure 3-4 is usually employed to insure the proper routing of correspondence. The intradepartmental section is utilized for internal routing within aircraft maintenance departments. The sheet should be prepared in duplicate, with the original attached to the correspondence being routed, and the copy being retained by the correspondence AZ. As the correspondence progresses through the routing indicated, appropriate action is taken and the routing sheet is initialed by the responsible individuals. When the routing is complete, the correspondence with the original route sheet is returned to the correspondence AZ for filing.

If the correspondence is in the nature of information, the routing may be placed on the correspondence itself. This may be accomplished by the use of a rubber stamp similar to that shown in figure 3-5. The date is the Julian date on which the correspondence started in routing.

Sometimes incoming correspondence is of such nature that more copies are needed than have been provided. It may then be necessary to make extra copies. In some cases, copies may be needed at the correspondence AZ's desk during the time the original is being routed. If copies are made for this purpose, they may be destroyed when the original is ready for filing.

Before routing correspondence to the person who is to take action on it, all previous related correspondence and other related documents should be taken from the files and attached. This preparation saves the time of the person who must take action. However, do not delay

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UNCLASSIFIED MAIL CONTROL RECORD

FROM COMNAVAIRPAC	DATE OF CORRESPONDENCE 9 AUG 68
ORIGINATOR'S IDENTIFICATION DATA NAVAIRPAC 70	DATE RECEIVED 16 AUG 68
SUBJECT T56-A-10W Engine; Special Report of	COPIES RECEIVED 1 ENCL. REG. NO./FILE NO. 13720 ACTION DUE DATE 30 AUG 68

INTER-DEPARTMENTAL				INTRA-DEPARTMENTAL			
ACTION	INFO	INITIALS	DATE OUT	ACTION	INFO	INITIALS	DATE OUT
					010		
					110		
				020			

REMARKS *(ACTION OFFICE indicate action taken) (Use reverse, if needed)*

INSTRUCTIONS

1. Primary responsibility for preparing reply, continuing cognizance or compliance is assigned to the officer indicated in the ACTION column. Reply is required prior to the action due date.
2. When appropriate, the following codes will be inserted in the Info. column: R-Retain copy, RE-Retain enclosure, X-Advance copy furnished.
3. This mail control form will accompany the correspondence at all times during routing.

AZ.5

Figure 3-4.—Route Sheet.

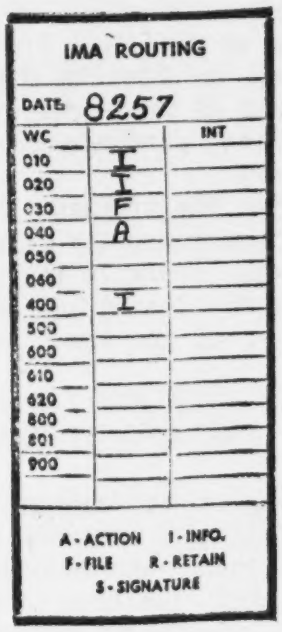

AZ.6

Figure 3-5.—Routing stamp.

delivery of mail while a search is being conducted for these papers.

Filing

Establishing and maintaining an adequate file system for correspondence is one of the easiest tasks the AZ will have, as well as one of the most important. Important correspondence improperly filed is of little value if it takes undue time to find it when needed. While the filing equipment available may not be the most modern and efficient, the senior AZ should have learned through past experience the best ways to utilize the available equipment. Normally, the office manager delegates most of the filing tasks to junior personnel in the office. As in anything else, the manager should be well aware of what is being done and should give such instructions as may be necessary to accomplish the job properly.

SELECTION OF FOLDERS.—One of the first things to be accomplished is selecting the folders which are to be used. Several slightly different kinds of file folders are available. Selection is normally based as much on personal preference as on any tangible evidence of superiority of one type over another. There are, however, a few points which should be considered.

Heavy board folders are relatively expensive. If the files are classed as records and are shipped to a records center, the folders are sent with the records and annual replacement may place a strain on funds. In addition, the added weight of the folders increases the cost of shipment.

Very lightweight folders will withstand normal handling without losing their stiffness. They are inexpensive and annual replacement of files sent to storage is practicable.

Folders with metal tabs or plastic capped tabs in which labels are inserted require more labor to prepare. In a small office, this may not be serious; however, in a large office, the extra time required would be significant. Subject classification numbers may be placed on the folders by any means that will produce neat labels which are easily read. Typed labels may cause eye strain and slow the job of filing if the light is poor, as it often is over files. Stencil pencils with fairly sharp points are easy and quick to use.

Folders are available with a variety of "cuts" indicating the number of different positions across the top for labels. The most common are one-third and one-fifth cuts. However, the most efficient file is one in which all labels are center positioned, so that the hand and eye travel in a straight line to find any folder. Again, this is not likely to be important if all your files are contained in one drawer, but would be a factor to consider in a larger operation.

FILES BY SUBJECT CLASSIFICATION.—The standardized system of filing correspondences is designed to speed the physical processes of filing and locating material for references. It is flexible enough to serve equally the smallest squadron aircraft maintenance office and the largest aircraft maintenance department ashore.

The system is based upon the same subject classification number series used for directives, and the detailed breakdown published in SecNav Instruction P5210.11 (Series) is used for both. For establishing a filing system, however, it is not necessary to have a folder for each subject code number. For example, the following numbers are found listed consecutively within series 13000-13999, "Aeronautical and Astronautical Material," under the primary subject group 13700-13799, "Engines and Engines Systems (Including Components and Accessories)":

13700 . . . .General
13710 . . . .Reciprocating
13720 . . . .Turboshaft and Jet
13730 . . . .Rocket

14245

13740 . . . .Nuclear
13760 . . . .Engine Fuel Systems
13770 . . . .Engine Electrical Systems
13780 . . . .Engine Cooling Systems
13790 . . . .Miscellaneous

If an activity has a heavy load of correspondence in the 13700-13799 area, it is conceivable that a folder for each of these subjects is needed. At the other extreme, a small activity may have few letters dealing with engines. The small activity would therefore ignore the secondary and tertiary breakdowns, indicated by the last two digits, and place all correspondence concerning engines in the folder marked 13700. A subject should be broken down and separated into smaller groups only when the amount of material filed would be bulky in one folder. If the total number of pieces of correspondence filed in the 13000-13999 series will fill only one folder, it is not necessary to make any further breakdowns.

If necessary, a particularly active file may be divided (or broken) into two or more folders, each clearly labeled with the inclusive dates of the material filed. A "general" subject file which needs such division should not be divided by date, but separated into more subjects.

Fastening filed correspondence in folders or on boards is so time consuming that it is now officially discouraged. (Special-purpose files in which the sequence must be preserved may be secured.) New material filed in a loose file should be placed at the back, with the top of the page to the left. Pieces of Correspondence removed from a file for reference purposes are more easily lost than a whole folder, and should be checked out of the file to an individual. A File Out Card (NAVEXOS 4178) should be used to show the location of removed material, with the card inserted in the file where the correspondence was removed. It is thus a simple matter to return the correspondence to the proper place in the sequence.

SEQUENTIAL FILES.—Special-purpose files of letters are sometimes kept in sequential order, such as a temporary accumulation on a board routed for general information. Messages are the only other correspondence normally filed in sequence by AZ's.

Message files must be established and maintained to meet the needs of the activity. An aircraft maintenance department in a squadron may need only two current files, one each for messages received and sent out during the current month. Larger installations may have files for periods as short as 1 day.

Regardless of the time interval used, the messages must be filed by date-time group. Frequent checks of the accuracy of filing are usually necessary, particularly when breaking in new personnel.

To preserve the sequence within the file, the messages are normally secured to a stiff paperboard back. Filing in inverse order (that is, with the latest dates on top) is the preferred method because of the time saved in filing.

MAINTENANCE AND DISPOSAL OF LOGS AND RECORDS

Congress has passed laws governing the disposition of logs and records and has fixed penalities for their unauthorized destruction. These laws apply, not only to those that are classified, but also to all official government records. Therefore, it is imperative that senior AZ's know the importance of maintaining accurate records and procedures for their disposal.

Though sometimes monotonous, all tasks connected with files, including their disposition when no longer needed, must be taken seriously. Since the supervisor is responsible for the work of juniors, he may be directly involved in the problem of disposition.

Decisions whether to save or not to save cannot be avoided by simply saving everything. Sooner or later, filing cabinets fill up and something has to be done. No matter how firmly a person believes that if it is disposed of today, someone will want it tomorrow, he cannot go on collecting forever. On the other hand, the "if in doubt, throw it out" line of thought, if allowed to operate unchecked, goes to the opposite extreme.

Activities subject to periodic deployments should be especially mindful of logs and records disposal. Unnecessary space, time, and money are used if these activities allow their files to become crowded with nonessential material.

One of the duties of the senior AZ is to be able to tell what should be held in the files for a period of time and what should, or must, be destroyed or transferred for preservation.

DEFINITION OF RECORDS

To begin with, it is quite possible that not everything in the files is an official record.

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Pamphlets, books, and spare copies of letters or directives are sometimes allowed to take up space for long periods because no one took the time to decide whether they had any value. The first step in properly disposing of an official record is to be able to recognize one.

The basic legislation covering records disposal (Records Disposal Act of 1943) defines government records essentially as follows: All documentary material, including books, papers, maps, and photographs, made or received by an agency of the U.S. Government in connection with the transaction of public business and appropriate for preservation.

Navy Regulations defines official correspondence as all recorded communications sent or received by a person in the Naval Establishment in the execution of the duties of his office. It further provides that no person shall destroy or remove from official custody any records without proper authority.

Nonrecord material, then, may be defined as any material which serves no documentary or record purpose. Most of the files kept by AZ's fall into this category. Virtually all letters, particularly the important ones, are duplicates of material filed in the administrative department. Also, the administrative department retains a copy of most maintenance department reports for filing, and the maintenance department retains a copy for reference.

It is not always easy to distinguish between records and nonrecord material and apply a standard rule for each item. Disposal of Navy and Marine Corps Records, SecNav Instruction P5212.5 (Series), contains a listing of record material usually found in aeronautical activities and gives retention period for each. Most directives pertaining to aircraft maintenance activities that specify the keeping of records will also state the retention period for these records. It would not be sensible to try to memorize all the different items in the listing, but it would be worthwhile to make a listing of those items kept in aircraft maintenance department files and the retention period.

RECORDS MAINTENANCE

The 3-M System has simplified, to a great extent, the keeping of many aircraft maintenance and associated records through the use of data processing machines. Although there are still certain records which must be maintained, the task of maintaining them is relatively easy.

Most records are maintained for the purpose of providing a history of what has been accomplished or events that have taken place. Maintenance records are used to prepare reports which furnish information to various levels of command. Many maintenance reports are prepared by data services through the use of machines; therefore, maintenance activities have little or no use for certain completed 3-M System source documents.

The production control work center is responsible for maintaining files of completed work records. Most of the 3-M System source documents are retained for only a short period of time; however, local policy may require daily and monthly reports to be maintained for a longer period of time.

Processed source documents with historical value are retained for 6 months. This includes the single copy maintenance action form, copies 1 and 3 of the multicopy maintenance action form, and the technical directive compliance form. Support action forms and configuration control forms are destroyed when local validation of daily reports has been completed.

In addition to source documents, registers should be retained for a minimum of 3 months. A review of completed registers may disclose useful information to be forwarded to a work center regarding associated or repeat discrepancies.

Organizational level activities should file completed forms by bureau/serial number of equipment. Intermediate level activities should file completed forms by individual work center and components.

Completed equipment statistical data cards and aviation maintenance support equipment data cards serve no practical purpose once local validation of daily and monthly reports has been completed.

RECORDS CENTERS

Material not designated as being of permanent value may be held by the activity or shipped to the appropriate Federal records center for temporary retention, depending upon the length of time it is to be held. The retention periods vary from 3 months to several years.

Federal records centers have been established by the General Services Administration at locations conveniently accessible to the various districts and ocean areas.

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Federal records centers store records in cardboard cartons on steel shelving in low-cost warehouse type space. The cost of storing records in these centers is a small fraction of the cost of maintaining them in office spaces. Therefore, activities should utilize these facilities for storing long-term naval records when their use is practical and economical.

Activities are authorized to transfer records to Federal records centers under the following conditions:

1. When the records are specifically designated in SecNav Instruction P5212.5 (Series) for periodic transfer. In these cases, the records should be transferred as scheduled; they should be transferred earlier only if local storage space is not available and reference requirements are such that transfer will not hinder the activity's operations.

2. The records are designated in SecNav Instruction P5212.5 (Series) for permanent or indefinite retention. If no specific periodic transfer is prescribed, these should be transferred as soon as they have served the activity's immediate reference needs and reference to them has become relatively infrequent.

3. The retention period of records of a disestablished activity has not expired and the records are not required either by the cognizant departmental command or office or by an activity assuming responsibility for functions of the disestablished activity.

4. Records have a retention period of more than 4 years.

5. Records are inactive and are not required for local operating purposes, provided it is determined that savings can be effected by the transfer; that is, transportation to the center and center storage costs will not outweigh local storage costs.

Activities should not transfer records to Federal records centers under the following conditions:

1. When inactive files are eligible for destruction within a year. Handling and transportation costs generally will not justify such a transfer. An exception may be made when the volume is large and the records are utilizing urgently needed file equipment and office space.

2. When the quantity is less than 1 cubic foot of records. Small accumulations should be retained until the retention period expires or until the quantity accumulated is sufficient to justify transfer.

3. When retention periods for the file, or for parts of the file, already have expired.

BREAKING FILES

To break the files means simply to close the entire file and start an identical file to run until the next break. The broken file, since it is relatively inactive, is put in a less convenient location.

In order that records may be disposed of systematically and in blocks, files must be broken periodically and a new file series begun. This makes the later job of separation and removing the records for destruction or transfer much easier. When to break the files is a local problem, but the usually accepted method is to do so at the end of each calendar year. If the volume of correspondence is too large for this, this may be done at the end of June as well. Since some records reach the age for destruction every day, it is perfectly legal to remove and destroy them day by day, though it is not very practical.

PACKING FOR SHIPMENT

Records are packed in their original file arrangement in standard cartons 15 by 10 by 12 inches in size. These cartons are supplied by the records center on request. Each carton holds 1 cubic foot of material. Letter-size documents are packed on the 12-inch side of the carton and legal-size documents on the 15-inch side. Odd-size items which are not suitable for shipment in the standard carton may be shipped in the most practical container available. Records are grouped by organizational unit and placed in containers in the original filing sequence.

In addition to the addressee, the name and address of the transferring activity and the sequential box number (i.e. 1 of 10) should be clearly marked on the narrow end of each container. Standard gummed lables are permissive, but crayon or stenciled labels are preferred. They are more readily visible and are easily prepared.

A Records Transmittal and Receipt Form (Standard Form 135) is used as a transfer document when transferring records to a Federal records center. This form should be prepared in triplicate for each records series to be shipped. One copy of the completed form should be placed in front of the first box of the records

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UNIT I - USE AND CARE OF FABRICS

Competencies

- Identify the characteristics of fabrics by label information, appearance, feel, and identification tests.
- Recognize the special features of fabrics which influence the sewing techniques and the equipment used.
- Give proper care to various types of fabrics.

Motivating Procedure

Have students examine a variety of fabrics with different fibers, fabric construction, and finishes. Give a quiz to help trainees pinpoint their scope of knowledge regarding fabrics.

Learning Experiences

- Discuss the information the law requires on labels and also the supplementary information that is often included by using the labels from the fabrics that were displayed.
- Make a chart entitled, Fibers - Characteristics and Care, on the chalkboard and/or distribute charts with the following headings: Generic Term, Trade Name, Fabric Type, Properties, and Care Procedure. Start the chart with four or five labels from ready-to-wear garments and complete by using other resources.
- Have trainees identify the fiber content of several fabrics by using a burning test. Ask trainees to tell how the fiber content affects construction techniques. Use a guide sheet and an information sheet as the basis for the test. See Appendix D and E.
- Arrange a field trip to a store selling fabrics. Have trainees identify fabrics by name and determine fiber content from hang tag or label on bolt of fabric. Discuss good buying habits with the fabric buyer.
- Have students make a collection of fabric samples. For each sample identify the fiber content and give the required care and special sewing instructions.
- Discuss the advantages and disadvantages of various fabric finishes such as permanent press, water resistance, spot resistance, wrinkle resistance, and lamination. Use samples or garments to show construction or alteration techniques needed for each specific fabric finish.

Instructional Materials

- Various types of fabrics

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being readied for shipment. The other two copies should be forwarded under separate cover to the Federal records center to which the records are being shipped. Upon receipt of the shipment, the center will return an acknowledged copy of the transmittal form to the transferring activity.

Activities may prepare the form in quadruplicate and keep the fourth copy as a suspense record of the shipment. When this is done, the suspense copy should be pulled and destroyed as soon as the acknowledged copy is received.

The Standard Form 135 should be properly completed so that it provides the center with adequate information for servicing and disposing of the records. Folder by folder listings or other elaborate descriptions as a rule should not be necessary. The information provided should include the retention period applicable to each record series on the transfer form and the date it will be eligible for destruction.

CLASSIFIED RECORDS

Before classified records are shipped, every effort should be made to declassify or downgrade them under the provisions of OpNav Instruction 5500.40 (Series). Those that cannot be declassified should be carefully inventoried and shipped in accordance with security regulations contained in the Navy Security Manual for Classified Information.

SERVICE ON RECORDS

The term "service" as used in connection with records centers refers to the reference service provided by the centers. Records stored in centers which are needed for references or information may be requested from the center.

Records centers are authorized to provide reference service only to, or with the permission of, the activity transferring the records. Request for information or documents received from other than the transferring activity are honored only with the approval of the transferring activity. If that activity is disestablished, the approval is obtained from the former activity's management command or office. Therefore, to eliminate needless correspondence and the need for repetitive approvals, transferring activities are encouraged to grant blanket approval to the center for the release of information or release of the files. When authorized to do so, the records center holding the records will compile or extract information from the records on request.

RECORDS DESTRUCTION

Most unclassified records are actually destroyed in the office. However, if large quantities are involved, they may be sold for wastepaper or scrapped. Classified items must be destroyed by burning in accordance with current security regulations.

At sea, unclassified records as well as those classified should be burned. Ashore, unclassified records may be scrapped or sold as wastepaper, provided the records are either treated to destroy word content (such as by shredding) or have inserted in the contract a clause prohibiting the resale of the records or their use as records or documents. Nitrocellulose base film, whether at sea or ashore, is usually destroyed by burning, since it can be a fire hazard.

When a state of war exists or when hostile action appears imminent, a commander may destroy records as an emergency measure. Reasons might be that retention of the records is prejudicial to the best interests of the country or that the space that the records take up is urgently needed for more important military purposes. In cases of this nature, the commander notifies the Navy Management Office that the records have been destroyed.

Federal law makes it mandatory that those records scheduled for destruction must be destroyed. This does not mean, however, that each item must be destroyed on the day authorized for destruction. Individual commands may establish the type of destruction program they deem necessary, based on when they break the file, such as quarterly, semiannually, or annually. What the law intends is that those records no longer having value should not take up valuable space over long periods of time. This is especially important on ships, where every square foot of space has at least one allotted purpose.

It might be emphasized that records are not to be destroyed before the scheduled destruction date, except in cases of emergency. They may be sent to a records center for retention until the destruction date.

AIRCRAFT LOGS DISPOSAL

Logs and records for aircraft stricken from the Navy inventory are disposed of as follows:

1. The logs and records of destroyed aircraft are disposed of locally after necessary investigation and preparation of required reports.

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2. The logs and records of aircraft sold or transferred to other than Navy custody accompany the aircraft unless otherwise directed by the controlling custodian. If the logs and records contain classified information, it must be removed or cleared for release through appropriate channels prior to transfer or sale.

3. The logs and records for experimental aircraft and those considered to be of historical value are forwarded to the Director, Federal Records Center, Alexandria, Virginia 22314.

4. The logs and records covering aircraft and/or equipment that have been involved in accidents resulting in death or injury to any person, or substantial damage to other than government property are retained by the operating activity for a period of 1 year. At the end of this period they are forwarded to the Federal Records Center in Alexandria.

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Chapter 4

MAINTENANCE CONTROL

In order for any activity to meet its assigned responsibilities, a certain amount of control must be exercised. In aircraft maintenance activities, most of this control is accomplished by a properly functioning production control work center.

NOTE: The recent reorganization of Organizational and Intermediate maintenance activities not only relocated certain elements, but also made some name changes. One of these name changes is production control which, in the past, was called maintenance control. The terms production control, production control work center, maintenance control, and maintenance control work center are used synonymously in this training course.

The production control work center of aircraft maintenance departments is the starting point of practically all aircraft maintenance operations and is responsible for the production effort of the entire department. It is headed by the Maintenance/Material Control Officer who meets his responsibilities by coordination, monitoring, and direction of all activities of the production divisions, including expeditious processing of parts and materials.

The gathering, recording, and dissemination of all the various types of status information to efficiently employ the maintenance resources are prime responsibilities of production control. Further, the control of the entire workload and work effort of the maintenance department is a significant phase of the overall production control function.

A thorough working knowledge of production control administration should enable a leading AZ to perform his duties effectively. When assigned a task, he will know where to get needed information immediately, as well as the procedures to be followed for procuring parts and equipment. On a day-to-day basis, the knowledge he possesses will be reflected in the smoothness and ease with which he works and in the efficiency of his activity with regard to maintenance problems. Any AZ First Class or Chief competing for advancement in rating should understand that a sound knowledge of aviation maintenance administration is of utmost importance prior to his entering the competition.

The tasks performed in production control of Organizational and Intermediate level maintenance activities are somewhat related, and primary coverage, in this training manual, is devoted to the Organizational level.

ORGANIZATIONAL MAINTENANCE

The functions of production control include planning, scheduling, supervising, and providing positive control of all maintenance performed on assigned aircraft. The priority of work to be accomplished, utilization and adequacy of facilities, and availability of manpower, skills, tools, and support equipment are factors which should be considered when accomplishing these tasks.

All activities that have reporting custody of naval aircraft have the responsibility of maintaining all of the records, including logbooks, for these aircraft and their component parts, in an up-to-date status at all times. Senior AZ's assigned to production control are responsible for the compilation of various records and reports, assist in workload planning and scheduling for the department, and supervise the operation of the production control work center.

Some production control responsibilities are as follows:

1. Plan and schedule maintenance necessary to meet the scheduled mission commitments.
2. Insure all concerned are advised of maintenance capabilities, shortcomings, and adherence to the schedule.
3. Administer work control by authorizing and assigning jobs, work priorities, and completion times.

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4. Schedule aircraft through all phases of maintenance and release to operations.

5. Maintain status and location of each aircraft, critical categories of maintenance support equipment, and all maintenance in progress.

6. Coordinate the scheduling and loading of aircraft, to meet operational schedules, with the armament branch supervisor.

7. Review and determine parts requirements, with appropriate assistance, to complete jobs.

8. Assist in the development of improved maintenance techniques.

9. Coordinate with quality assurance in the scheduling of inspections.

10. Maintain completed source document files.

ORGANIZATION

This section is not intended to portray a standard organization for a production control work center; however, some possible arrangements are discussed.

Current instructions have directed the establishment of the production control work center within the framework of aircraft maintenance departments. As previously stated, the Maintenance/Material Control Officer is in charge of this element, and he is responsible for the production effort of the department.

The Production Control Chief, commonly referred to as the Maintenance Control Chief or Maintenance Chief, is the direct representative of the Maintenance/Material Control Officer. Under the authority delegated to him by the Maintenance/Material Control Officer, and with production division officers' concurrence, he directs, monitors, and supervises the day-to-day efforts of the production divisions. This direction is exercised through production division enlisted supervisors. He maintains liaison with enlisted supervisors of other departments and is responsible to the Maintenance/Material Control Officer for the overall production effort of the department.

In most cases, the production control chief is a Senior or Master Chief; however, due to rate and number of assigned personnel, size of activity, etc., this billet may be assigned to personnel in pay grade E-7. Some activities may have more than one chief assigned to this work center, in which case one would possibly be the production control chief and be primarily concerned with liaison between the production divisions and aircraft readiness, while another may be responsible for the administrative functions of the division. These administrative functions include supervision of logbooks, status boards, and maintenance of files as well as overall supervision of the office personnel.

The variety of tasks performed in production control makes it possible to divide the work center into sections or elements. These could include such as the following:

1. Planning.
2. Scheduling.
3. Records.
4. Reports.

The planning section is concerned with the overall maintenance plan of the department. The various maintenance tasks are scheduled and assigned for accomplishment by the scheduling section. The records section maintains the aircraft logs and related records. All required aircraft and engine accounting reports are prepared by the reports section. In some activities some of these sections may be combined, in which case planning and scheduling might be combined since their functions are related; likewise, the records and reports sections might be combined.

Production control should be located, equipped, and arranged to facilitate the gathering, posting, and recording of status information essential and significant to maintenance for successful support of operations. Production control is the nerve center of the entire maintenance function. It has to be the focal point where all information is assembled, arranged, and weighed to ascertain what actions are necessary to satisfactorily complete a particular standard or objective.

WORKLOAD PLANNING, SCHEDULING, AND ASSIGNMENT

Production control, through proper planning, scheduling, and assignment of the workload, provides all maintenance supervisory personnel with information on what management wants done and when completion is required. Efficient use of maintenance facilities is obtained by following carefully prepared maintenance plans and schedules coordinated with all activities directly or indirectly concerned. Careful planning, scheduling, and assignment insure efficient use of facilities and manpower and result in an uninterrupted flow of high quality maintenance.

Planning and scheduling does not end in production control. Each work center must do its

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own internal scheduling. Each must consider manpower, supplies, facilities, tools, and the overall maintenance schedule. The capabilities of all maintenance activities are directed toward the objective represented by the maintenance schedule. The aircraft and all necessary personnel, tools, equipment, and supplies must be at the proper place at the proper time to allow production to proceed as scheduled.

The effective utilization of maintenance assets depends on the ability of production control to evaluate and use available information and to plan accordingly. Information must be obtained on operational objectives, quantity of aircraft involved, nature of support required, manpower availability, duration of the operation, and availability of material.

In the final analysis the main objective of the maintenance department is to provide operations with the maximum number of ready aircraft. The AZ assigned to production control will find it necessary to maintain close liaison with the operations department in order to meet the assigned operational commitments. He should be familiar with operational schedules as they play an important role in maintenance planning and scheduling.

A prerequisite to maintenance planning is a sound operational schedule insofar as practicable which provides required operational hours and allows sufficient downtime for the accomplishment of quality maintenance. Operational schedules for equipment should be compatible with maintenance capability and afford the best use of maintenance resources to prevent the loss of manhours which result from periods of idleness. When operational schedules are firm, production control personnel can translate the operational schedule into a maintenance plan designed to accomplish the requirement. The welfare of maintenance personnel (duty hours, overtime, etc.) should be considered when forming any work schedule.

One of the first requirements of scheduling is to find out what type and how much equipment is required for an operation, when, for how long, and for what purpose. This requirement is fulfilled by the operational schedule established in coordination with the operations officer. Any operational schedule must be thought of as a team concept where the operations and maintenance departments coordinate their schedules to accommodate the needs of both.

Operations must have enough equipment to fulfill their mission and training requirements, and maintenance must know when and how long the equipment is to be available for maintenance. Aircraft required for operational requirements should be ready as scheduled, and utilized as scheduled. Operational or maintenance delays in the use or provision of the required aircraft disrupts both the operational and maintenance schedules. Weapons loading, maintenance training, etc., should be planned into the schedule.

If possible the operational schedule should be established on a monthly basis and prepared so that the necessary operational hours are distributed as uniformly as possible throughout the month, to employ the maintenance department effectively. The schedule should be published in a form all personnel can easily understand and use. It is essential that wide dissemination be made to the lowest echelon of maintenance supervision and to the pertinent support activities such as supply, AMD, etc.

In order that maintenance can fulfill its obligations, the required number of aircraft and support equipment must be provided at the specified time. Scheduling and planning within maintenance is the only way in which this job can be properly accomplished. Therefore, to implement the maintenance schedule, a monthly maintenance plan should be prepared and published. This plan should include the date and hour, as far in advance as practicable, when scheduled events such as inspections will be performed. Thus, by scheduled control of predictable maintenance consistent with available maintenance resources, a reserve capability is maintained for unpredictable or unscheduled work.

Every effort should be made to prevent disruption of the schedule. Maintenance planning should include predictable maintenance factors such as manhours and material standards, flow times for maintenance, aircraft turnaround, and replacement schedules. Allowances, calculated from the maintenance data collection system, should be made for unpredictable maintenance such as engine failures, equipment failures, etc.

Full consideration must be given maintenance personnel, shop support equipment, electronics, photographic, communications, and weapons requirements so that the maintenance plan is complete and less susceptible to last minute changes. This plan should be reviewed and signed by competent authority and published as a maintenance order. During the month, production control should note variations from the monthly maintenance plan and initiate actions

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necessary to adjust the maintenance capabilities to meet the variations noted. The variations from the previous month's plan should also be noted and used as factors in refining the maintenance plans for the following month's operation.

It is important that the maintenance plan be distributed and made known to all maintenance personnel. Maintenance personnel must be made aware, through complete discussion and understanding, of the participation that will be required. Work center supervisors should plan toward leveling off the peaks and valleys to provide constant production. The plan should be completed and distributed to all work centers involved at least 5 days prior to the beginning of the month.

Although the format and detailed arrangement of the maintenance plan is a command prerogative, the plan should contain information such as the following:

1. Operational hours and total sorties, flights, or commitments.

2. Number of aircraft required to be operationally ready.

3. Workload requirements including aircraft scheduled for inspection or Depot level maintenance with scheduled date of input and output; shop direct support requirements; engine in shop inspection and maintenance requirements; and weapons, photo, etc., requirements and loading.

4. In addition to the overall maintenance planning, detailed support requirements must be planned. Procedures must be established to insure complete coordination between the station/ship. The method of accomplishing this support planning is normally determined by each command.

5. The schedule of preinspection meetings should be included in the maintenance plan.

Monthly operational schedules, manhour accounting and maintenance production reports, and Daily Schedule Maintenance Planning Records are sources of information that may be used to assist in the formulation of the monthly maintenance plan.

Weekly maintenance planning is accomplished to firm the monthly maintenance plan. Maintenance, operations, and other concerned representatives should convene weekly and review the past week's operation and maintenance accomplishments. From this meeting should come the next week's schedule. The weekly maintenance schedule should be distributed no later than Friday preceding the effective week. During this meeting, operations should present any change in requirements from the monthly schedule. Operational requirements should be evaluated against maintenance capability and the schedule adjusted to satisfy each.

In addition to weekly refinements to the overall maintenance plan, day by day detailed planning is necessary. This short range planning can be accomplished in a variety of ways. However, procedures must be established to insure complete coordination between supervisory personnel, production control, and the supporting activities.

The monthly operational schedule may be adjusted weekly to fulfill changes in commitments and allow for changes caused by unforeseen occurrences. Weekly changes should be resolved by operations and maintenance during the latter part of each week prior to the week affected by the change.

Availability of aircraft by bureau number or side number to fulfill the requirements of the operational schedule must be provided to operations by production control. Mission and pilot/crew assignments for these aircraft remain an operations department prerogative.

The operational schedule must take the maintenance capability into consideration. This can be accomplished best by consideration of the workload generation, aircraft turnaround or recovery time, manning effectiveness, adequacy of facilities, and capability estimates for each maintenance activity; knowledge of established maintenance plans and schedules; and pertinent information on aircraft and equipment to be maintained (operationally ready status, Not Operationally Ready Supply (NORS) rates, etc.)

Controlling the flow of equipment to and through maintenance is partially accomplished by insuring that it is available for maintenance as scheduled. Adherence to established schedules is essential for retaining maintenance capability. Adequate control of maintenance requires schedules be maintained in a manner to prevent peaks and valleys in the workload and personnel utilization.

Unscheduled Maintenance

Unscheduled maintenance tasks, due to their nature and occurrence, cannot be included in the monthly maintenance plan. However, this type of maintenance should be anticipated and time allotted for its accomplishment. Unscheduled maintenance includes the correction of discrepancies found and reported on daily, preflight,

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postflight, and pilot's aircraft inspections, as well as those reported on yellow sheets. In most operating activities, the accomplishment of unscheduled maintenance will consume a large portion of the expended maintenance manhours; therefore, it is important that ample time be allotted for completion of this type of maintenance.

It is imperative that the scheduling element of production control be made aware of all discrepancies concerning assigned aircraft and related equipment so appropriate corrective action may be taken. When scheduling and assigning this type of maintenance for completion, particular attention must be given to operational schedules. These schedules normally show the operational commitments of each aircraft; therefore, the urgency of need of the aircraft is a major factor to be considered when planning, scheduling, and assigning this type of maintenance for completion. Other factors to be considered are availability of manpower, type or extent of discrepancies, workload, and work priorities to be assigned.

Work priorities affect all elements of the maintenance activity and should be considered in all actions, especially unscheduled maintenance. Work priorities are essential to the proper and timely distribution of the maintenance effort and should be centrally controlled by production control. Supervisors at all levels must know which job is to be given emphasis; thus, work assignments can be controlled and production effort applied to desired projects. There are three work priorities used by maintenance activities—Priority One, Immediate Action; Priority Two, Urgent Action; and Priority Three, Routine Action.

Work priorities may vary daily or hourly, depending on the flight schedule and the unscheduled maintenance workload. It is important that realistic priorities be assigned to the various maintenance tasks and the system not be abused or the purpose of the system will probably be defeated.

Unscheduled maintenance planning, scheduling, and assignment are required on a day-to-day or even hour-to-hour basis. Normally, very little planning can be done prior to actual discrepancy discovery. By monitoring the flight schedule, production control keeps the various work center supervisors informed of aircraft launch and recovery times. This information makes it possible for the work center supervisors to plan their workload assignments in such a manner as to have maintenance personnel available to perform unscheduled maintenance, should it be required.

Reported discrepancies of such extent as to down the aircraft should naturally receive prime attention and be assigned for completion first; however, up gripes should receive proper attention. If nongrounding discrepancies are allowed to accumulate on a particular aircraft, they may develop into a state which could impair mission capability of the aircraft. Individually, these minor discrepancies may not be cause to down the aircraft, but when considered collectively, they may be of such extent as to prevent the aircraft from performing its assigned function and cause the aircraft to be downed. These discrepancies should be scheduled and assigned for completion as soon as the aircraft is available and the workload permits.

Scheduled Maintenance

Scheduled maintenance consists of those maintenance tasks which are known in advance and can be included in the monthly maintenance plan. This type of maintenance is associated with the Planned Maintenance System and pertains to preventive rather than corrective maintenance. The major portion of scheduled maintenance performed by operating activities consists of calendar periodic inspections and daily special inspections.

Inspections, varying in scope, purpose, and frequency, are required to be performed on naval aircraft to insure that assigned aircraft are retained in a serviceable condition. Under the calendar inspection system, the appropriate inspection is conducted on the expiration of a specified number of calendar weeks. Inspections and maintenance requirements promulgated in Periodic Maintenance Requirements Manuals are programed and referred to as odd and even calendar inspections.

The calendar inspection system is an efficient system from a maintenance management standpoint. When aircraft are inspected under this system, the workload planning operation is simplified and the scheduled maintenance in process is automatically stabilized.

The first inspection interval subsequent to Navy acceptance of a new aircraft commences on the date of the acceptance test flight. A first calendar odd inspection is performed at the completion of this first interval with subsequent inspections performed in the sequence prescribed by the applicable Periodic Maintenance Requirements Manual.

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The standard rework process includes the next calendar inspection due. The first inspection interval subsequent to standard rework commences on the date entered in the Aircraft Logbook by the rework activity certifying accomplishment of the equivalent calendar inspection. The next calendar inspection due is performed at the completion of this first interval and subsequent inspections are in the sequence prescribed by the applicable Periodic Maintenance Requirements Manual.

During special rework, the rework activity accomplishes the next inspection due if the out-of-service time combined with rework is such that one or more periodic inspections become due. The accomplishment of calendar inspections during in-service special rework must be negotiated with the controlling custodian or designated representative prior to induction. Periodic inspections subsequent to special rework therefore continue in the same sequence as they did prior to special rework. All periodic inspections accomplished by rework activities are noted in the Aircraft Logbook and Aeronautical Equipment Service Records.

Aircraft are inspected on the calendar interval established by NavAir Instructions or on an adjusted interval as specified by the controlling custodian. Calendar periodic inspections are programed in multiples of calendar weeks, computed from induction date to induction date, irrespective of days consumed performing the individual inspection. Therefore, an aircraft assigned a 13-week interval would be inducted into the next calendar inspection 13 weeks after the original induction date.

The calendar inspection system is placed into operation by dividing the number of aircraft assigned into the calendar inspection interval (for example, 13, 17, or 22 weeks) and programing scheduled maintenance and inspection requirements accordingly. Figure 4-1 graphically depicts the calendar inspection schedule of a typical 12-aircraft squadron operating an aircraft model that is assigned a 13-week inspection interval. One aircraft could be inducted into check every week for 12 successive weeks and then leave 1 week with no induction. The inspection cycle would start over again following the week with no induction.

To meet unusual situations and facilitate workload scheduling, a period of plus or minus 1 week, or portion thereof, may be applied to the authorized calendar inspection interval. However, in each instance each deviation applies only to the immediate inspection due. Successive deviations, if required, are computed from the date on which the inspection would have been due if the preceding deviation had not been granted.

To eliminate peaks and valleys in the workload, the overall pattern formed by the correct programing of all aircraft should be one of alternating odd calendars and even calendars.

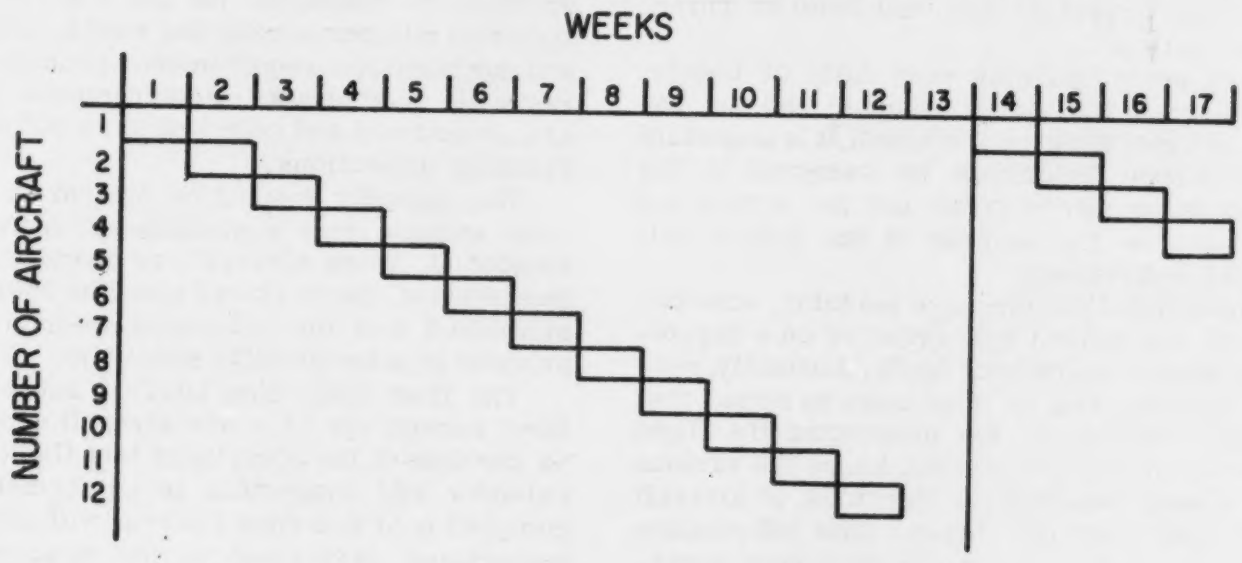

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Figure 4-1.—Typical inspection cycle.

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Once the schedule is established, it should be maintained, except for those vacancies resulting from transfer, strikes, or standard rework. Replacement and/or return aircraft should be positioned in schedule vacancies and schedule integrity maintained.

Induction of new and reworked aircraft into an established calendar inspection schedule may require repeating or performing an otherwise unnecessary inspection to insure that the scheduled workload pattern remains one of alternating odd and even calendar inspections. (See fig. 4-2 for some examples of induction into the inspection cycle.) Newly received aircraft are required to be firmly established in the calendar inspection schedule within a period not to exceed one inspection interval.

Operating activities are authorized to increase the depth of any inspection but cannot decrease it. Whenever the depth of any inspection is increased to meet unusual or special circumstances, the inspection is recorded only as the type which was due in accordance with the programed sequence. Conditional inspections to an appropriate depth may be ordered whenever excessive utilization during the operating interval is considered to have impaired the material reliability or integrity of the aircraft. Such inspections are in addition to programed requirements and in no way affect the requirement for the accomplishment of the next regularly scheduled inspection. Logbook entries are required for conditional inspections.

Oftentimes an activity adds locally established inspection requirements to existing Maintenance Requirements Cards. The need for these requirements may be due to climatic or other environmental operating conditions. A copy of all locally established inspection requirements must be submitted to the Naval Air Technical Services Facility on an Unsatisfactory Material/Condition Report. The material conditions or technical directive generating the inspection requirements must also be noted.

Specific model aircraft inspection requirements as established and published by direction of the Commander, Naval Air Systems Command are minimum requirements and, as such, are mandatory. Temporary waiver of individual inspections may be made by the reporting custodian or higher operational authority in

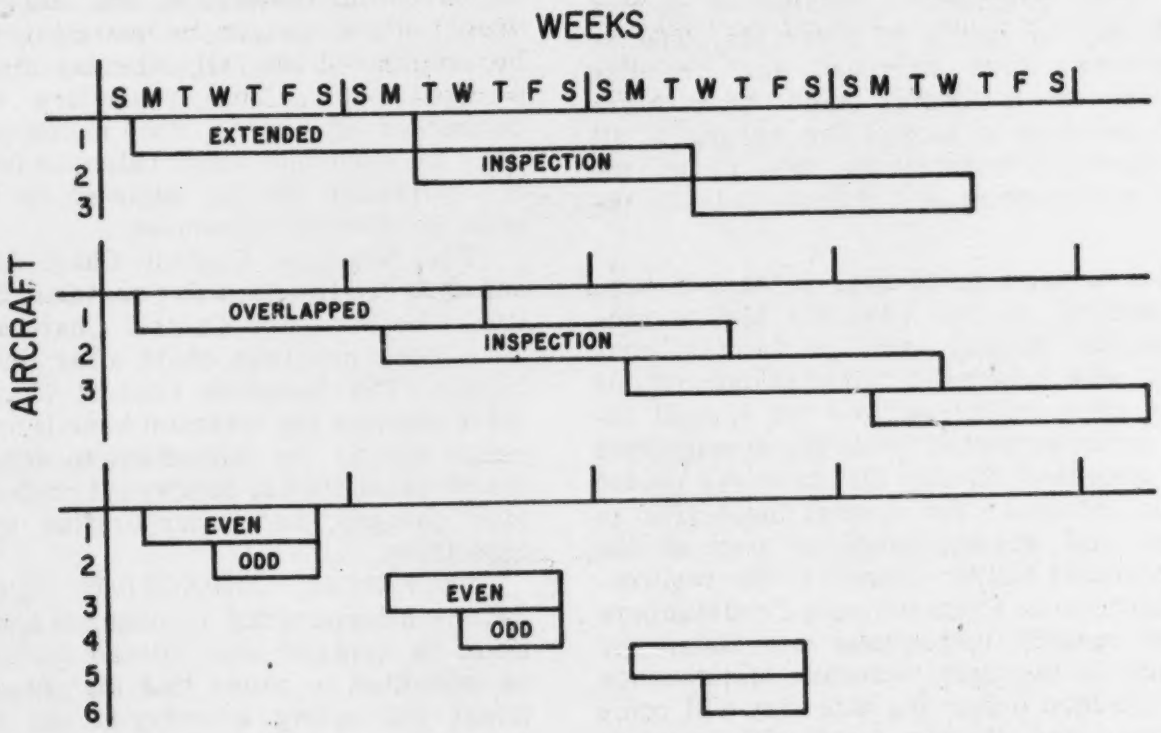

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Figure 4-2.—Examples of induction date scheduling.

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order to meet priority operational commitments or combat necessity. Temporary waiver authority should not cause major schedule disruption; however, should this occur, the normal pattern of inspection schedules should be reestablished as soon as possible.

Although the monthly maintenance plan (previously discussed) portrays the overall scheduled maintenance plan of the particular activity, other planning and scheduling actions are required. Some of these are discussed in the following paragraphs.

The Daily Schedule Maintenance Planning Record, NavAir Form 4730/1, has been provided for use by maintenance activities to plan and project the daily scheduled maintenance requirements for each individual aircraft between calendar periodic maintenance periods. This form is filled out to cover the complete calendar period. It should be completed while the aircraft is undergoing calendar periodic maintenance so that all scheduled maintenance for the subsequent operating period is known at the time the aircraft is returned to an operating status. It aids in assuring that all known maintenance requirements are scheduled on time as well as aids in workload planning.

The form provides a number of spaces for each day in which to enter Maintenance Requirements Card numbers that require compliance on a basis other than every day and provides a means for writing in all other scheduled maintenance due during the calendar maintenance period designated for the aircraft.

Special inspections (7-day, 10-day, 20-day, etc.) specified in the Periodic Maintenance Requirements Manual are performed concurrently with scheduled calendar inspections when the time authorized for the special inspection is not exceeded. When the time interval will be exceeded during the calendar period inspection interval, the special inspection is scheduled and accomplished as part of the daily inspection falling nearest to the requirement. Maintenance Requirements Card numbers for these special inspections are listed for compliance on the Daily Schedule Maintenance Planning Record under the date they will come due. Proper use of this form will assist in the preparation of the monthly maintenance plan.

The Preflight / Postflight / Daily / In-flight Maintenance Record, NavAir Form 4730/2, is used in conjunction with the Daily Schedule Maintenance Planning Record to enable scheduled work to be assigned in a preplanned manner between calendar inspections. This form controls and assigns responsibility for preflight, postflight, in-flight, and daily scheduled maintenance, including the special and conditional work that may be required. These forms may be prepared daily or made up in numbers sufficient to cover a desired period of time.

Another planning action is the precalendar planning conference. Under the direction of the activity maintenance officer, the Maintenance/Material Control Officer holds a planning conference several days in advance of the calendar inspection due date with the calendar maintenance supervisor and representatives from quality assurance, material control, and the calendar inspection team.

The purpose of this conference is to prepare the Sequence Control Chart by adding on any existing additional requirements, procure personnel as required by the scheduled and add-on requirements, and pre-position material required. Representative items added on at this time are recent local or command maintenance items, discrepancies, component replacements, directive incorporations, and other like items which either cannot be anticipated or cannot be programed into all calendar inspections on a fixed basis. This procedure informs all concerned of exactly what management wants done on each individual calendar inspection so the workload can be adjusted as required to meet established schedules.

The Sequence Control Chart is the basic schedule of the calendar maintenance inspection. The Sequence Control Chart also serves as a work progress chart after the inspection begins. The Sequence Control Chart may require changes for optimum benefit and realistic usage during the inspection to schedule local maintenance items, component replacement, engine changes, and incorporation of technical directives.

TECHNICAL DIRECTIVE INCORPORATION.—Incorporation of changes and modifications to aircraft and related equipment must be expedited in order that all possible operational and safety advantages can be derived from the remaining life of the model concerned. Modification must be coordinated to achieve early availability of aircraft with optimum

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- Identification labels for each fabric
- Labels from a variety of ready-made garments
- Forms for developing textile charts
- Copies of Guide Sheet for Burning Test
- Copies of Information Sheet - Burning Fiber Characteristics

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standardized change configuration and minimum disruption of the normal operating cycle.

Letter type technical directives issued by or at the direction of the Commander, Naval Air Systems Command are the official medium for accomplishing aircraft and related equipment changes and modifications. The authorization to prepare a letter type technical directive is normally issued by the Commander, NavAirSysCom or the cognizant NavAirSysComRep. They are prepared by both Navy industrial and commercial activities.

Interim letter type technical directives are initially distributed by the originator to such activities as NavAirSysCom, NavAirSysComReps, CNO, ComNavAirLant, ComNavAirPac, etc. Further distribution of interim directives to operating activities both ashore and afloat is the responsibility of NavAirSysCom, CNO, and the major operating commands.

Formal printed letter type technical directives are distributed by the Naval Air Technical Services Facility. Advance distribution is normally made, as soon as possible, to such activities as NavAirSysCom, NavAirSysComReps, the major operating commands, etc. The Naval Air Technical Services Facility automatically distributes copies to activities and commands concerned in accordance with the requirements reflected in the latest NavWeps Form 5605/2 (Automatic Publications Request) submitted by the various activities. It is emphasized that effective operations of the automatic aeronautical publications distribution system is dependent upon the timely and accurate notification of requirements by means of NavWeps Form 5605/2.

NavAirSysCom instructions contain information relative to the preparation, issue, and incorporation of changes and modifications to aircraft and related equipment. These instructions also establish procedures for recording and listing, by specific aircraft bureau number, the applicability and incorporation of all letter type technical directives which specify a logbook entry. In addition to these instructions, air type commanders have issued instructions concerning the incorporation of changes in their area of control.

On receipt of the advance copy of a change, air type commanders assign to each a code which delineates incorporation tasks. Major consideration in assigning these codes are the magnitude of the work involved and the effect of the changes on flight safety and operational readiness. Code assignments are distributed by the respective NavAirSysComRep on the Aeronautical Technical Directives Not-Incorporated List No. 2. This listing also furnishes information on the kits required to accomplish the change. These codes denote whether the change is to be incorporated by the reporting custodian, by field modification teams, or by rework activities during aircraft rework.

Aircraft maintenance activities receive various directives concerning changes and modifications to assigned aircraft and equipment. A large portion of these directives are of such a nature that they can be scheduled for compliance along with aircraft calendar inspections. Other directives received are of an immediate nature and require incorporation in affected aircraft or equipment prior to further use. Directives of this type should be scheduled and assigned for immediate compliance and normally receive precedence over other nonurgent maintenance.

Changes or modifications may also be scheduled for completion when the particular aircraft concerned will be available due to other maintenance. In this case, particular attention must be given to the areas of the aircraft in which work is required. For example, most Avionics Changes require the removal of the equipment concerned in order to comply with the change/modification.

If the aircraft concerned is down for an engine change, fuel cell replacements, etc., electronics personnel could remove required equipment and incorporate necessary changes/modifications without interfering with other maintenance. Each directive contains a time limit for compliance, therefore, this is another important factor to be considered when scheduling and assigning directives for incorporation. Other factors to be considered are availability of kits/material, aircraft or equipment, and manpower; the workload, and estimated time required to accomplish the change/modification.

Periodically, preferably 3 weeks prior to the precalendar inspection conference, the logbooks, active SAMI file, and applicable configuration lists should be screened by the log yeoman or logbook supervisor. The purpose of this screening is to determine the need for any kits/materials and to insure that all directives not complied with are known at the time of the precalendar inspection conference so appropriate action may be taken to have them scheduled for compliance.

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Production control must initiate action through the material control work center to procure any kits or material required to incorporate a change. This is usually done soon after the receipt of any approved, applicable technical directive requiring kits or material; however, if this system is not followed, screening is required to determine the need for kits or material. If, during screening, it is learned that required kits or materials to accomplish a particular change or modification have not been ordered, immediate action should be initiated for procurement of required materials.

Each technical directive lists the necessary change kits and material required for its compliance as well as a source. After the required materials are on hand, the technical directive should be scheduled and assigned for compliance, keeping in mind the factors mentioned.

The Technical Directives Compliance Form (TDCF) is used by maintenance activities to inform the material control work center of the need for kits or materials and also to record the accomplishment of technical directives. A brief discussion of this form is contained in the following paragraphs. A detailed discussion of this form is contained in AZ 3 & 2, NavPers 10391-A.

The TDCF, illustrated in figure 4-3, is a single page form that is used to document all technical directive maintenance actions. It is also used for preplanning workload and material requirements, assigning a technical directive for completion, and configuration accounting. Data obtained from these forms allows identification of all direct manhours expended complying with technical directives.

The TDCF is prepared and issued by production control. It is normally initiated upon receipt of each approved applicable technical directive or when compliance with a technical directive is assigned for incorporation. Much of the information required for completion of the form is known at this time. Referring to figure 4-3, the typed information is entered by production control and is available at the time of initiation of the form. The handscribed information is entered, as received or as actions take place, by the appropriate work center.

There are several factors which must be considered in determining the number of copies required. Under all conditions, an original and one copy are required. The original is forwarded to the primary work center when the maintenance action specified by the technical directive is assigned for completion. A suspense copy is held by production control until the work has been completed and the original has been received from the primary work center. The suspense copy is then discarded.

If kits or materials are required for completion, one copy is forwarded to the material control work center. This copy serves as the notification for material control to order required material. Upon ordering the material, the material control work center furnishes production control with the date ordered and stub number. This is entered on the original and suspense copy by production control. In a like manner, material control informs production control when the material is received. This date is also entered on both the original and suspense copy.

If more than one work center is involved in completion of the maintenance action, each assisting work center is provided a copy. This copy is used to document the manhours expended by that particular work center.

The TDCF is divided into five sections, and these sections are subdivided into numbered and lettered blocks. The information entered in these blocks consists of many of the same codes used in the completion of other source documents.

For the most part, the entries made on the TDCF by production control are self explanatory. Entries are made in the statistical data section by both production control and the production work center. Only the data from this section is keypunched by data services. The blocks of this section that are completed by production control are 1 through 6, 8, 12, 13, and, when required, 14.

All of the blocks in the maintenance control section are completed by production control. The information to be entered in blocks E through H of this section is normally listed in the technical directive.

The stock number of any material or kits required to accomplish the technical directive is entered in block A of the material control section by production control. Required material or kit stock numbers are usually listed in the technical directive.

The only entry required by production control in the work center section is block B. If applicable, the SAMI or CAMI number which refers to the technical directive being accomplished is entered in this block.

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action required, and replacement schedule of the components which must be replaced. Replacement items are indicated in operating hours, calendar time, or progressive aircraft rework periods, as appropriate.

All replacements designated in a specified number of hours have been based on flight hours with necessary adjustments to compensate for ground operating time. Those items designated for replacement at progressive aircraft rework are not intended for replacement by operating activities except for reasons of malfunction or failure.

The appropriate sections of the logbook should be screened for high time components at the same time screening is done to determine the need for change kits and directive incorporation. If this is accomplished prior to the precalendar inspection conference, personnel concerned can be informed of any components requiring replacement and they can plan accordingly. Once the aircraft enters inspection, replacements for components requiring change are ordered. After the required replacements are available, component replacements are scheduled for change along with other scheduled maintenance.

AIRCRAFT ACCEPTANCE AND TRANSFER

New aircraft are ordinarily accepted into the Navy inventory by the Naval Air Systems Command Representative located at the contractor's plant. Acceptance takes place when legal title to the aircraft leaves the contractor and is assumed by the Navy. The acceptance may be provisional; that is, the producer has some contractual responsibility yet to fulfill before the aircraft can be considered ready for issue. Until this responsibility is fulfilled, the aircraft is in a provisional acceptance status. After this original acceptance, aircraft are usually assigned to operating activities for service.

Once in the Navy inventory, a change in the reporting custody of an aircraft from one reporting custodian to another reporting custodian constitutes a receipt by the unit gaining reporting custody and a transfer by the unit losing reporting custody. The receipt and transfer occur simultaneously upon acceptance by the receiving unit.

If the reporting custodians involved are under different controlling custodians, a change in controlling custody also occurs, one gaining the aircraft simultaneously with loss by the other. Receipt of an aircraft by a reporting custodian without a corresponding transfer by another reporting custodian occurs only when an aircraft is added to the Navy inventory. Every Navy aircraft is at all times, from acceptance to separation, in the custody of one reporting and one controlling custodian. An aircraft remains in the reporting custody of the transferring unit until accepted by the receiving unit.

Operating activities receive and transfer aircraft frequently; therefore, senior AZ's should know some of the action involved. The following paragraphs cover some of the procedures for receiving and transferring naval aircraft.

Receiving Procedures

Aircraft are assigned and transferred from NavAirSysCom custody to the major operating commands on a NavAirSysCom Priority. A letter or message type directive is normally used to effect the transfer of aircraft from the major operating commands to operating squadrons. This transfer directive is known as an Aircraft Transfer Order (ATO). A copy of the ATO is normally received by all activities involved with the transfer and receipt of the aircraft concerned.

If the aircraft is delivered by a ferry pilot, a pilot not attached to either the transferring or receiving activity, every effort should be made to accept the aircraft as soon as possible so the ferry pilot will not be detained. Aircraft ferried by the Fleet Aircraft Ferry Squadrons for other commands are not in the reporting custody of the ferry squadron. The ferry pilot is the agent of the reporting custodian for whom he is ferrying the aircraft; therefore, discrepancies noted upon receipt of the aircraft should be resolved with the transferring activity and not the ferry pilot.

After acceptance of the aircraft, current directives require the accomplishment of an acceptance inspection. This inspection consists of an inventory of installed material and loose gear, configuration verification, functional test of appropriate emergency systems, and a thorough daily inspection. Accepting activities may elect to increase the depth of inspection if the aircraft condition indicates such action is necessary.

The inventory log/record serves as the instrument of transfer and signing of this log/record by the receiving activity denotes acceptance of the aircraft. It is important that

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the date the inventory log/record is signed be used on all records and reports concerning the acceptance of the aircraft.

The logs and records received with an aircraft should be carefully reviewed for completeness and accuracy as part of the acceptance procedure. Although all sections of the Aircraft Logbook are important, particular attention should be directed to the flight, inspection, and technical directives sections.

The flight section provides information relative to the past utilization of the aircraft. This section provides receiving activities required information concerning tour/period number, months accumulated in tour/period, flying hours accumulated in tour/period, and total flying hours since acceptance of the aircraft. This information is needed for proper submission of the OpNav XRAY message.

The inspection section must be consulted when phasing the aircraft into the receiving activity's inspection cycle. In determining the depth of acceptance inspections, consideration must be given to the termination date of the previously programed inspection interval. If induction into the receiving activity's inspection cycle is programed to occur prior to termination of the previously programed inspection interval, no special consideration is necessary. However, in the event induction into the receiving activity's inspection cycle is programed to occur subsequent to termination of the previously programed inspection interval, the acceptance inspection must include the calendar inspection that would have been due at the termination of the previously programed inspection interval.

The technical directives section should be reviewed together with the applicable configuration lists. The active and inactive SAMI files may be used to assist in determining if certain technical directives have been complied with on newly received aircraft. The bureau numbers of newly received aircraft should be added to all active SAMI's for compliance.

Aircraft and equipment logs and records provide a history of maintenance, operation, configuration, and in many cases, a control of maintenance schedules for time replacement of components and accessories. It is of utmost importance that reporting custodians maintain the logbooks and associated records for all assigned aircraft and equipment in an up-to-date status. There have been many instances of incomplete or poor logs and records maintenance that have necessitated unnecessary inspections and even overhaul of aeronautical components.

Activities receiving questionable or incomplete logs and records should request immediate corrective action by the delinquent activity. Obvious mistakes in recordkeeping may be corrected by the current custodian and initialed or signed off, as applicable, without reference to the previous custodian. Discrepancies requiring corrective action by the previous custodian may be signed off by the current custodian after receipt of correspondence conducting corrective action. In extreme cases, a receiving activity is fully justified in refusing to accept custody of aircraft or equipment with doubtful or incomplete logs and records.

The receiving activity should prepare an Aircraft Record "A" Card for its own records and submit an Aircraft Custody/Status Change Report (OpNav XRAY), denoting acceptance of the aircraft, to proper authority not later than 1200 hours of the day following acceptance. Appropriate engine record cards should be prepared and engine reports should also be submitted to proper authority.

In order to maintain local data services inventory control, an Equipment Statistical Data (ESD) Card should be submitted upon gain of an aircraft. The receiving activity should begin reporting as of 0001 hours of the date following the date of receipt. No provisions are made for splitting a day between two units, therefore, the transferring activity reports the aircraft up until 2400 hours of the date of transfer. The submission of the ESD card does not relieve an activity of the responsibility for the timely submission of an OpNav XRAY message. The ESD card reflecting receipt of an aircraft into an activity's custody is handscribed.

NOTE: It is important that the data entered on this card be correct in every respect. The data services unit uses the data entered in blocks 1, 2, 3, and 4 to prepare a supply of prepunched/preprinted cards to be used by the receiving activity in reporting other actions.

Completed ESD cards reporting gains should be forwarded to the analysis division not later than 0900 hours on the first working day following the transaction. The need for timely submission of inventory change data requires strict adherence to this time frame. These cards are processed by data services and the data extracted is used in various phases of aircraft accounting.

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Transferring Procedures

Aircraft transfer is another important task performed by operating activities. Although all divisions of the maintenance department are involved in aircraft transfer, senior AZ's assigned to production control coordinate the efforts of the production divisions and must be familiar with aircraft transfer actions.

There are several different types or categories of aircraft transfers. These include aircraft transferred from one controlling custodian to another controlling custodian for service, intrafleet transfers which apply to aircraft transferred from one reporting custodian to another within the same controlling custodian, and aircraft transferred to NavAirSysCom Fleet Support (NavAirSysCom FS) activities for repair, rework, or storage. The intrafleet transfer is the most common type and is normally directed by the controlling custodian.

The transferring activity should make the aircraft ready for transfer within 7 to 10 working days after receipt of a transfer directive, unless a specific transfer date or deadline is designated in the transfer directive. In instances where the time limit for transfer cannot be met, the transferring activity should notify the receiving activity and the originator of the transfer directive. The reason for delay should be cited and an estimated ready date furnished.

As in the case of aircraft acceptance, current instructions require the performance of a transfer inspection prior to transfer of an aircraft. While this does not necessarily include the performance of a calendar inspection, it should be of sufficient depth to insure that the aircraft is safe for flight. Performance of an odd or even calendar inspection as part of the transfer inspection is not normally required unless the next calendar inspection would become due during the flight to the receiving activity. Performance of special calendar inspections as part of the transfer inspection results, in many cases, in duplication of effort, erroneous logging of inspections, and decreased availability with little or no increase in flight safety. However, the transferring activity should perform such work and examination as required to insure the following:

1. Airworthiness.
2. Good material condition.
3. Proper configuration.
4. Completeness of inventory.
5. That the aircraft can carry out its assigned mission.

If transfer of an aircraft requires a ferry flight for delivery, there are additional requirements to be considered when performing the transfer inspection. NavAir Instruction 3700.3 (Series) sets forth the minimum operating requirements considered necessary for aircraft to be ferried. The enclosures to this instruction are checkoff lists which contain conditions to be met, prior to transfer, of reciprocating, jet, and rotary wing aircraft. Compliance with the provisions of this instructions requires a log entry to be made in the inspection section of the Aircraft Logbook.

Current instructions require the removal of low-time engines from aircraft destined for storage or overhaul. These low-time engines are replaced with engines nearing completion of their service life so as to fully utilize available operating engine hours. Applicable instructions concerning removal of low-time engines should be reviewed prior to completion of the transfer inspection in all cases of aircraft being transferred to storage.

All airframe changes for which approved engineering data and material are available and which are within the maintenance capability of the transferring activity should be incorporated prior to transfer of affected aircraft from one custodian to another unless otherwise agreed to by the receiving custodian. In case agreement cannot be reached, the question should be referred to the immediate common senior responsible for material assistance for resolution.

After completion of the transfer inspection and any additional maintenance tasks, engine changes, airframes changes, etc., the aircraft should have a test flight of sufficient duration to adequately perform the prescribed tests and determine which items, if any, require additional maintenance work.

All ammunition and pyrotechnics should be removed from the aircraft, excepting escape and survival systems. The aircraft must be inventoried and the inventory log/record completed in accordance with current NavAirSysCom instructions. If loose equipment and inventory items are forwarded by separate shipment to a receiving activity, the items shipped must be indicated on the inventory record. The method of shipment, bill of lading, and invoice numbers should be noted on the record or forwarded to the receiving activity by appropriate means as soon as known.

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The aircraft should be cleaned, corrosion removed and arrested, and the proper type of preservation, as specified in current preservation manuals or other appropriate directives, applied. All unit identification markings should also be removed. The aircraft should be transferred complete with all parts, accessories, and equipment. Any change kits on hand that cannot be incorporated should not be transferred as loose equipment, but should be turned back into the supply system.

The Aircraft Logbook should be reviewed to ascertain that it is complete and up to date. The monthly flight summary and equipment operating log(s) should be closed out in accordance with applicable instructions. Test flights performed in conjunction with the transfer should be logged prior to this closeout. All Custody and Transfer Record pages, NavAir Form 13090/21C, should be properly completed. The aircraft transfer order number, message, or other authority directing the transfer should be entered under authority for transfer on the Custody and Transfer Record. Ten most recent "B" parts of yellow sheets plus those that have not been completed should be transferred with the aircraft. In addition, completed Maintenance Action Forms, Technical Directive Compliance Forms, and records of all check flights for the preceding 6 months should be transferred with the aircraft.

When the aircraft is ready for delivery, all concerned should be notified in accordance with OpNav Instructions 3710.6 (Series), which contains instructions concerning ferry movement of aircraft.

After transfer of an aircraft, the transferring activity must submit an ESD card to data services reporting the loss. A prepunched/preprinted card is normally used for this purpose. All loss actions are effective as of 2400 hours on the date of transfer.

One of the final actions required in aircraft transfer is the completion of Transferred To section on the Aircraft Record "A" Card. Once completed, the card should be removed from the active file and retained in an inactive "A" card file for 6 months.

PREPARATION AND REVIEW OF RECORDS AND REPORTS

The senior AZ assigned to production control will be continuously concerned with records and reports. In order to properly manage naval aviation, various commands, offices, and activities must be kept current on what is happening to aircraft and related equipment being used. To furnish this information, operating squadrons must maintain various records from which the required reports are made. It is imperative that all reports submitted to higher authority are correct; therefore, accuracy in records maintenance and reports preparation cannot be overemphasized.

For the most part, reports are prepared and submitted in compliance with a message or instruction. They contain consolidated information or facts of the record of something. Activities must maintain certain records in order that the required information is readily available for reports preparation. In all cases prior to the submission of a report, the directive establishing the report should be consulted. This governing directive furnishes detailed information concerning preparation and submission of the report, including the exact data to be reported, the format or form to be used, the time of submission, and to whom it is to be submitted.

The 3-M System has brought about varied changes in reporting information relating to the inventory, logistics, readiness, and utilization of Navy aircraft. In fact, the Aircraft Accounting System has been changed to conform to 3-M System reporting.

Aircraft Accounting

Most of the information that is provided by the Aircraft Accounting System is accumulated or kept in production control. It is taken from Aircraft Logbooks, yellow sheets, and other forms provided for such recordkeeping. The AZ is normally responsible for recordkeeping; therefore, it is necessary for him to become thoroughly familiar with the reporting procedures required by the Aircraft Accounting System.

The purpose of the Aircraft Accounting System is to establish within the naval organization an aircraft accounting and statistical system of such scope and timeliness as to provide CNO, NavAirSysCom, and other users with sufficient information to plan, direct, and control the aviation element of the Navy; produce comprehensive aircraft inventory and logistics flow; furnish utilization and material readiness data; and to provide a consolidated statistical service to all activities concerned with naval aviation.

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Basically, the system is designed to provide all echelons concerned with naval aircraft with the following data: (1) Who has what aircraft, and in what condition and position in service life is the aircraft (this is inventory data); (2) just what was done, by whom, to aircraft (this is logistic data); and (3) just what was done, by whom, with aircraft, and how ready were the aircraft (this is utilization and readiness data).

The purpose of aircraft inventory, logistics, utilization, and readiness data is fundamentally for management. Management means deciding what is to be accomplished; directing the means (including funds) for doing it; commanding the use of the means; reviewing the whole operation to see how it could be done better; and generally learning and benefiting from experience. The capability for flight or actual flight of armed aircraft on a combat mission is the prime reason for naval aviation. Hence, aircraft is the prime element of naval aviation. Since the Aircraft Accounting System is the prime informational base for management of the aircraft element of naval aviation, accurate and complete data are of critical importance.

All data collected are used for specific purposes. The following are a few examples of uses made of the collected information.

1. Effective management of the maintenance effort requires information as to how many manhours by work center are expended on the various systems of each model. Since discrepancies and checks are usually related to utilization of the aircraft, flight and NOR data are necessary to manage a maintenance organization.

2. An exact knowledge of past flight performance must be known before future flying hour programs may be developed, justified to the Office of the Secretary of Defense and Congress, and finally funded.

3. The position of each aircraft in service tour must be known so that the number of PAR's, overhauls, and other rework operations coming due in coming fiscal years may be calculated, priced out, and budgeted for.

4. A centrally held knowledge of tour end date is necessary to the orderly replacement of aircraft returning for rework.

5. Justifying the purchase of new aircraft is also contingent on knowledge, at the Navy Department level, as to when each aircraft is due to complete its service life.

The term "aircraft," as used in the system, is limited to fixed and rotary wing aircraft, and includes drones (man carrying) and drone antisubmarine helicopter types. This excludes aerial targets (nonman carrying) and guided missiles.

Aircraft becomes subject to the system instantly upon acceptance by the Navy and remain so until stricken. Included in the system is the procedure for retirement and strike of Navy aircraft; that is, the means by which aircraft are officially removed from the Navy inventory. No aircraft can be so removed except in strict compliance with that procedure.

Reporting custodians are the initial source of all data used in the system. Controlling custodians are the users, monitors, and forwarders of this data. Each aircraft, at any point in time, is the accounting responsibility of one reporting and one controlling custodian. Generally, basic information is reported through the controlling custodian to CNO.

Figure 4-4 illustrates the flow of data generated by the Aircraft Accounting System for COMNAVAIRLANT, COMNAVAIRPAC, Naval Air Training Command (NATRA), and Naval Air Reserve Training Command (NART) reporting custodians. The data flow for reporting custodians of Naval Air Bases (NABS) and NavAirSysCom RDT&E is very similar to that illustrated in figure 4-4. The major differences are that XRAY data is submitted directly to CNO instead of first going to a command statistics unit and then to the Navy Information Center (NAVIC), and not ready hours and flight data are submitted by the base data services unit to CNO instead of first going to a command statistics unit and NAVIC.

The following elements of information are reported by each reporting custodian.

1. Whenever an aircraft is received, transferred, stricken, damaged, changed in status or undergoes any other reportable change, the cognizant reporting custodian initiates an OpNav XRAY message, in the prescribed format, reporting the action. Messages to the appropriate controlling custodian or to CNO are required on an asoccurring basis. As shown in figure 4-4 reporting custodians of COMNAVAIRLANT, COMNAVAIRPAC, NATRA, and NART submit XRAY data to the appropriate controlling custodian where it is keypunched and forwarded by the Automatic Transmission of Digital Information Network (AUTODIN) to CNO (NAVIC). After NAVIC processing, selected parts of the

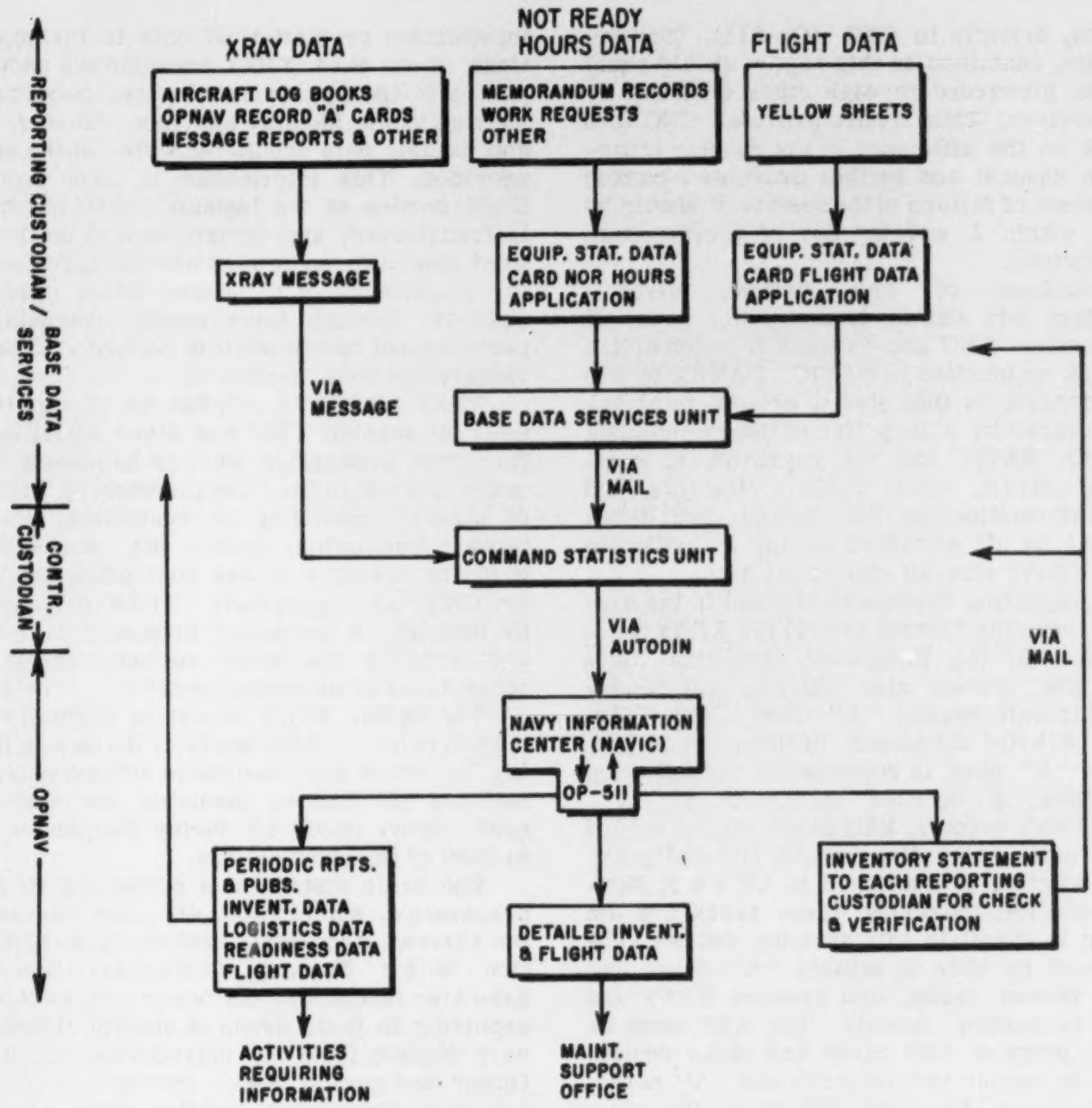

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Figure 4-4.—Aircraft Accounting System data flow diagram.

data, as required, are then directed to the Maintenance Support Office (MSO).

2. Whenever an aircraft accomplishes flight, the cognizant reporting custodian executes an ESD card describing the flight. Completed cards are forwarded daily to the data services unit where they are keypunched. Weekly, data services forwards, by mail, accumulated cards to the appropriate controlling custodian. The cards then move from the controlling custodian to CNO (NAVIC) to AUTODIN. After processing, flight information as required, is directed to MSO.

3. Whenever an aircraft "IN" a NOR reporting status (status codes A, B, or C, less C9) undergoes a period of not ready time, the reporting custodian executes an ESD card. Completed cards are forwarded daily to the data services unit where they are keypunched, the data summarized on a monthly basis, and then forwarded, by mail, to the appropriate controlling custodian, thence by AUTODIN to CNO (NAVIC).

In addition to this data, reporting custodians forward a copy of the Monthly Aircraft Readiness and Flight Report, ASD-3, as prepared by data

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services, directly to CNO (Op-511). The information contained in this report should equal the data forwarded through other channels by data services. This report provides CNO with a check on the efficiency of the regular transmission channel and further provides a backup in the event of failure of the system. It should be mailed within 1 working day of receipt from data services.

Regardless of who submits aircraft accounting data and its transmission path, all data reaches CNO and is used to construct a data bank maintained in NAVIC. NAVIC, by use of computers, is then able to provide information required by a long list of users including the MSO. NAVIC has the capability to summarize, extract, relate various elements, and print information in the format and detail specified by all activities having a legitimate need for Navy aircraft statistical data.

The reporting documents utilized in the Aircraft Accounting System are (1) the XRAY message and (2) the Equipment Statistical Data Card. The system also utilizes one record card, Aircraft Record "A" Card, OpNavForm 5442-9. A brief discussion of these documents and the "A" card is contained in the following paragraphs. A detailed discussion of "A" cards, XRAY reports, ESD cards, engine record cards, engine accounting reports, and configuration accounting is contained in AZ 3 & 2, NavPers 10391-A; therefore, these areas are not covered in detail in this training course. The AZ2 must be able to initiate "A" cards and engine record cards, and prepare XRAY and engine accounting reports. The AZ3 must be able to prepare ESD cards and make routine entries in engine record cards and "A" cards.

The senior AZ must supervise the completion of these tasks and perform review actions as required in order to insure that records are maintained and reports are prepared in accordance with existing directives. In order to properly supervise these tasks and perform the required review actions it is necessary for the senior AZ to be thoroughly familiar with each record and report mentioned. This may require additional study or at least a review of these areas in AZ 3 & 2.

AIRCRAFT RECORD "A" CARD.—The Aircraft Record "A" Card, properly used, provides valuable readily available information concerning each assigned aircraft. When an aircraft is received, an "A" card should be initiated. This consists of filling in the basic information or statistical data in the top sections of the card. XRAY transactions should be posted in the appropriate spaces on an as-occurring basis. Monthly and upon transfer, flight and landing data should be posted in the spaces provided. This information is taken from the flight section of the logbook. When an aircraft is transferred, appropriate spaces on the "A" card should be completed and the card retained for a minimum of 6 months. Blank cards are available through form supply channels, and procurement information is contained in NavSup Publication 2002, Section II.

XRAY REPORTS.—OpNav XRAY reports are used to furnish CNO and other activities information concerning what is happening to the many aircraft in the Navy inventory. All changes of aircraft reporting or controlling custody, model designation, status, etc., are reported daily by message to the controlling custodian or CNO, as appropriate. XRAY data is used to maintain a perpetual inventory of aircraft and reflects the latest custody, status, and other items about each aircraft.

The OpNav XRAY report is normally submitted prior to 1200 hours of the day following that in which any reportable actions occur and includes all actions involving the unit's aircraft which occurred during the hours 0001 to 2400 of the previous day.

The basic instructions pertaining to XRAY preparation, submission, etc., are contained in the Aircraft Accounting System, OpNav Instruction 5442.2 (Series). Controlling custodians have also issued instructions pertaining to XRAY reporting in their areas of control. These may vary slightly from the instructions contained in OpNav Instruction 5442.2 (Series) as controlling custodians may require their reporting custodians to submit additional items of data over and above OpNav Requirements, and controlling custodians are authorized to vary the mode of transmission, precedence, classification, and standard deadline. Controlling custodians may also require that XRAY reports be forwarded to additional information addressees. In all cases, either the appropriate controlling custodian's instruction or the OpNav Instruction should be consulted when preparing or reviewing an XRAY report.

Multiple XRAY actions may be reported with one message as long as the report involves one controlling custodian and one reporting custodian. The items of information for the first action are arranged vertically on the

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UNIT 2 - SELECTION, USE, AND CARE OF SEWING EQUIPMENT

Competencies

- Select appropriate sewing equipment and supplies for the job.
- Clean and maintain sewing equipment.
- Thread and operate a home sewing machine.
- Thread and operate an industrial sewing machine.
- Use sewing machine attachments.
- Make minor adjustments on sewing machine.
- Use sewing supplies economically.
- Store equipment and supplies neatly and orderly.
- Operate sewing equipment in a safe manner.

Motivating Procedure

Display a variety of industrial and home sewing machines commonly used in making alterations such as lockstitch, zigzag, hemmer, and buttonholer. Have class members examine machines and identify the use of each.

Learning Experiences

- Demonstrate the use and care of sewing machines that are not familiar to the trainees. Have students use unfamiliar machines until sufficient skill is developed for making professional alterations. Use score cards and stitching exercises to evaluate competencies of trainees.
- Invite a representative of a sewing machine company to discuss the importance of following the instruction book that accompanies most equipment. Also have the representative demonstrate the use of attachements for the machines.
- Show various pieces of small sewing equipment such as seam ripper, tracing wheel, and point turner or use illustrations from catalogs and magazines. Discuss characteristics and use of each item.
- Discuss procedures for the care of small equipment in relation to storing, sharpening, and maintaining. Have trainees check laboratory for examples of good storage.

Instructional Materials

- Wall charts on threading of machines

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left side of the page. Each additional action is arranged to the right of the first in a vertical column.

FLIGHT, READINESS, AND INVENTORY DATA COLLECTION AND REPORTING.—Reporting custodians use ESD cards to provide data services with three distinct categories of aircraft statistical data needed to produce machine reports or printouts displaying aircraft flight, readiness, and inventory data. Either prepunched/preprinted or handscribed ESD cards may be used in all areas of aircraft statistical data reporting.

The use of electric accounting machines has simplified the process of maintaining records and preparing reports used in aircraft readiness and utilization reporting. In fact, aircraft readiness and utilization data are prepared and submitted by data services.

Reporting custodians use ESD cards to report all flights by listing the flight purpose code, flying hours, and landings by type for each flight conducted by each assigned aircraft. This flight and landing data is extracted from Part D of the yellow sheet. In view of the requirements for reliable flight data for planning and budgeting, it is imperative that each flight be promptly and accurately reported.

Reporting custodians are accountable for each assigned aircraft for 24 hours per day. Each aircraft is considered to be operationally ready (OR) unless reported as not operationally ready (NOR). Readiness data reporting has application to only those assigned aircraft in status codes A, B, and C less C9. An aircraft is "IN" a NOR reporting status when it is in status codes A, B, or C less C9. NOR reporting is required only on aircraft "IN" a NOR reporting status. An aircraft is "OUT" of NOR reporting status when the status code is any other than those previously mentioned.

NOR data is reported on ESD cards; therefore, when an aircraft becomes NOR, for any reason, an ESD card must be initiated. An aircraft is NOR when it becomes known that a maintenance requirement exists which prevents the aircraft from performing its primary mission safely and completely. NOR time may be divided into two categories—not operationally ready maintenance (NORM) and not operationally ready supply (NORS).

After an ESD card reporting NOR data is initiated, it is held in production control until it is closed out. ESD cards reporting NOR data are closed out when the aircraft becomes OR, the aircraft becomes NOR for a different reason, or at the end of the day (2400 hours).

Each data services activity maintains a master file showing the complete aircraft inventory of each organization within the cognizance of that data services activity. This master file is used to prepare periodic machine reports and aircraft master lists. In order for data services to maintain this master file accurately, they must be notified by each reporting custodian of any changes in the aircraft inventory.

ESD cards are utilized to report inventory change data when an aircraft is gained into an activity's custody, an aircraft is lost from an activity's custody, or there is a change in the NOR reporting status of an aircraft (either into or out of NOR reporting status). The submission of an ESD card reporting inventory change data in no way relieves an activity of the responsibility for submission of an OpNav XRAY report.

Completed ESD cards reporting aircraft statistical data are delivered to the analysis division daily. Here they are checked for accuracy, completeness, etc., and forwarded to data services for processing. This processing includes keypunching the required data into decks of cards that are used by data services to produce machine reports. The original cards are then returned to the initiating activity where they are filed. Duplicate decks of cards and machine reports produced from these cards are forwarded to the controlling custodian and CNO, as appropriate, and are used to measure utilization effectiveness. Machine reports are used by both the local reporting custodian and higher level managers.

AIRCRAFT STATISTICAL DATA (ASD) REPORTS.—As previously stated, the completed ESD cards forwarded to data services provides the data required to produce machine reports concerning aircraft readiness, utilization, and inventory data. These reports are produced in two categories—standard reports and special reports.

Standard ASD reports are prepared for all activities to insure uniform reporting of basic aircraft statistical data within the Navy. These reports are prepared in a specified format on a recurring basis and designed for specific

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uses. There are four standard ASD reports.

Special ASD reports are those requested by individual activities on a one-time or continuing basis utilizing locally determined formats and containing selected elements of data. Any information known to exist in ASD files can be obtained in a special report. The contents of special reports depend upon the needs of the requesting activity. Any, or all standard reports may be prepared as special reports upon demand. This occasion could arise from a desire to produce certain reports for a specific period other than the normal reporting period.

A discussion of the standard ASD reports is contained in the following paragraphs.

The Aircraft Master List, ASD-00, is prepared by data services from ESD cards submitted during the month reporting inventory data. This report reflects the true aircraft inventory of an activity as of 0001 hours the first day of the month. It reflects aircraft gained into the inventory during the previous month and current NOR reporting status (IN/OUT) indicated by assigned aircraft hours listed under the applicable columns. Since this report indicates the true inventory picture at the beginning of each month, aircraft losses from inventory during the previous month are not listed. Each aircraft assigned to the reporting custodian is listed along with the activity organization and permanent unit codes, type equipment code and serial number of each aircraft, and the hours IN or OUT NOR reporting status.

The primary purpose of this report is to provide a means of verifying and correcting, when required, data contained in the local inventory data bank maintained by data services. Production control should check the report for accuracy and completeness by using local records of aircraft inventory change transactions which occurred during the previous month. Local methods of correcting the inventory data bank are normally established by the analysis division and data services. One suggested method of making corrections is by use of a marked up aircraft master list. Incorrect data should be lined out and the correct data inserted in red directly above the lined out entries. This corrected list is then forwarded via the analysis division to data services for corrective action as required.

The Daily Flight Report, ASD-1, is a detailed listing of all aircraft flight data submitted on ESD cards during the previous working day. The report may contain data for more than 1 day due to extended flights or flights on weekends or holidays. It indicates flight data collected during shipboard operations and shows landing data, departure and arrival times, date, and the duration and purpose of each flight conducted by each aircraft.

This report provides a means of verifying and correcting information in data services files. It also provides maintenance managers with a means of monitoring aircraft utilization on a daily basis and can be used as a measure of accomplishment of the previous day's schedule. This report is checked daily for accuracy and completeness by production control. Erroneous entries should be lined out and the correct data inserted, in red, directly above the lined out entry. After correction the report is forwarded via the analysis division to data services for correction of errors.

The Daily Aircraft Readiness Report, ASD-2, is a detailed listing of all aircraft NOR and inventory data submitted on ESD cards during the previous working day. Like the ASD-1, it may contain data for more than 1 day. The ASD-2 shows not ready conditions and inventory changes by bureau number. When an aircraft is reported as NOR more than once during the same day, the data for this aircraft is listed in the order the NOR times began.

This report provides a means of verifying and correcting information in data services files. It also provides maintenance managers with a means of monitoring operational readiness on a daily basis.

Maintenance managers use this report to identify specific problem areas that degrade the overall readiness condition. The nature of the problem areas identified may determine what action is necessary to improve readiness. Further, this report provides the means of identifying specific aircraft that detract from overall readiness, measuring the impact of scheduled maintenance, unscheduled maintenance, and supply support on readiness, identifying potential ready hours lost to the awaiting maintenance category, identifying systems or components that contribute to NOR conditions, and computing cumulative readiness rates. The report is checked daily for accuracy and completeness. In the event of errors, the erroneous data is corrected in the same manner as the ASD-1.

The Monthly Aircraft Readiness and Flight Report, ASD-3, is a summary of all flight and NOR ESD cards submitted during the reporting

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period. It shows a summation, by bureau number and type equipment, of inventory status at the end of the month as indicated by the inventory identifier, hours assigned "IN" or "OUT" of a NOR reporting status, NOR hours by category, total flights and flight hours, and flights and flight hours during shipboard operations.

The report aids maintenance managers in their efforts to maintain optimum aircraft readiness and utilization. The format used lends itself to quick analysis of factors that affect aircraft readiness and utilization. This report provides a means to identify the operationally ready rate, not ready hours by reason, awaiting maintenance hours, aircraft lost to an "OUT" of a NOR reporting status, aircraft that continually account for a large portion of NOR hours, the hours flown by each aircraft, the average flight duration, and flights and hours accumulated during shipboard operations.

In addition to these standard reports, reporting custodians may request special reports from data services. It should be remembered that any information known to exist in ASD files can be obtained in the form of special reports. However, if the information desired is already available in another report, a special report should not be requested. Special reports should not be used indiscriminately because of the additional, and often excessive, workload imposed on data services personnel and machines.

AUDITING RECORDS.—At monthly intervals each reporting custodian receives a machine produced Monthly Inventory Accounting Report from CNO. This report is used to check and correct the central data bank. The report shows the current data bank picture of each aircraft in the unit's reporting custody during the month. The report lists all XRAY transactions processed on each aircraft during the month and also includes summary flight and NOR hours data.

The report is provided in triplicate (four copies to NATRA units) to the reporting custodian with an additional copy to the controlling custodian, for informational purposes. The reporting custodian must check the listing against local records for accuracy and completeness. If the data listed is accurate and correct, the report is so marked and returned to CNO (Op-511). If, however, the data is incorrect or incomplete, the reporting custodian must, within 2 working days of receipt, make such additions or changes on the copies as are required to reflect the true situation on each aircraft listed, and return one corrected copy, by fastest mail, to CNO (Op-511).

The corrected report is used to adjust the central data bank; therefore, every effort should be made to insure that any corrections or additions entered on the report be accurate. Figure 4-5 illustrates the format of the Monthly Inventory Accounting Report.

The following paragraphs discuss the format and some record check procedures.

The initial printed line on each bureau number includes the last previous XRAY transaction from a previous month. Flying hours (current month) and NOR hours on that line represent data for the period from the beginning of current month to either the instance of the next XRAY action or end of the current month. If the bureau number was subject to XRAY change during the current month, that change is also listed. Flying hours and NOR hours on this line represent data on the aircraft from the instance of this XRAY until the next action or month end, whichever occurs first.

The file of Aircraft Record "A" cards provides local record of XRAY changes on all assigned aircraft and can be used to verify the XRAY change aspects of the Monthly Inventory Accounting Report.

The Monthly Inventory Accounting Report contains flight-hour data on each aircraft since acceptance, in tour or period, and in current month. The report shows accumulated flight data for the intervals between the beginning of the month to the instance of the first XRAY report, between XRAY actions, and between the last XRAY trasaction and end of month. If the aircraft was in the unit's custody for the entire month, check the totals as of month end. On aircraft transferred during the month, check the totals as of date of transfer.

The Monthly Aircraft Readiness and Flight Report, ASD-3, provided to reporting custodians by data services, can be used to check the flight hours and NOR hours section of the Monthly Inventory Accounting Report.

Aircraft Engine Accounting

Aircraft are of little value to an operating squadron unless serviceable engines are available. In order to plan for the procurement of new engines and rework of engines in service, NavAirSysCom must be furnished information concerning the condition of engines in

DATE	UNIT NAME	PERM UNIT CODE	CONTR. CUST
12 31 68	VF-74	000026	LANT

MODEL	BUNO	ACTION DATE	ACTION CODE	STATUS CODE	TOUR OR CYCLE AND PERIOD NO.	RETURN DATE	EXT.	F/Hs IN LIFE	F/Hs IN TOUR OR PERIOD	F/Hs CURRENT MO.	NOR Hours SUPPLY	NOR Hours MAINT.
F-4B	145614	092368	X	A1	001	0669	0	260	254	36	14	12
F-4B	146810	092768	X	A1	001	0170	0	101	98	31	6	14
F-4B	146810	121868	X	B1	001	0170	0	101	98	0	12	14
F-4B	146810	122168	X	A1	001	0170	0	121	118	20	8	4
F-4B	146814	111668	G	A1	001	0270	0	54	48	31	4	12
F-4B	146816	111768	G	A1	001	0270	0	38	34	16	8	12
F-4B	146816	121868	T	C1	001	0270	0	38	34	0	0	0
F-4B	146818	120368	G	A1	001	0370	0	24	17	17	6	4
F-4B	146818	121468	X	B1	001	0370	0	24	17	0	0	21
F-4B	146818	121568	X	A1	001	0370	0	42	35	18	8	4

Commanding Officer
Fighter Squadron 74
FPO New York, N.Y.

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Figure 4-5.—Monthly Inventory Accounting Report.

service, flying hours accumulated, and stage of progess that unserviceable engines have reached in the maintenance cycle. This is accomplished through the aircraft engine accounting system. This system is designed to provide timely aircraft engine management data to NavAirSysCom with the minimum of reporting effort on the part of reporting custodians.

Engines are the most expensive single item of support for an aircraft; therefore, close management control to reduce out-of-service time and the quantity of spare engines being procured is of prime importance. The current accounting system utilizes automatic data processing to provide NavAirSysCom timely engine data. NavAirSysCom maintains a master engine record file which contains the status, custody, and performance history of each aircraft engine in the active Navy inventory. This file is kept current by daily transaction reports forwarded by controlling custodians and NavAirSysCom FS custodians as changes occur in custody or status. The system also utilizes quarterly reports indicating engine hours since new or overhaul, as appropriate. These reports are used in the preparation of failure rate reports, utilized in overhaul schedule planning.

NavAirSysCom, through their representatives, assigns aircraft engines to the major operating commands. By using past failure rates, flying hours, scheduled commitments, etc., air type commanders are able to estimate, several months in advance, the number of engines required by their reporting custodians. With this information, NavAirSysCom can overhaul and rework unserviceable engines as well as procure new engines in order to meet the needs of the operating commands. Aircraft engines are assigned to the major operating commands and NavAirSysCom FS custodians in much the same manner as aircraft; that is, on a priority according to urgency of need.

Once in the custody of an aircraft engine controlling custodian, serviceable uninstalled engines are distributed to subordinate commands or pools. On occasions, engines are distributed direct to reporting custodians from the controlling custodian. Subordinate commands

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have the responsibility for further distribution and management control of engines located in their respective area. These subordinate commands monitor and initiate corrective action, as necessary, on all reports submitted by reporting custodians who receive engine support from their serviceable uninstalled engine pools.

Although aircraft engines are distributed to a subordinate command pool, they will probably be in the physical custody of supply or an Intermediate level maintenance activity. Engine buildup is a responsibility of Intermediate level maintenance activities, therefore, operating squadrons receive engines from their supporting Intermediate maintenance activity ready for installation.

NavAir Instruction 13700.1 (Series) prescribes reporting procedures for the Navy aircraft engine accounting system. These procedures are directed primarily to controlling custodians and NavAirSysCom FS custodians; therefore, controlling custodians have issued instructions concerning engine accounting in their areas of control. Instructions and directives promulgated by the appropriate controlling custodian should be consulted prior to the preparation or review of any aircraft engine accounting report.

The aircraft engine accounting system utilizes one record card and two reports. The reports are made either by message or on a form, depending on the appropriate controlling custodian's instructions. The record cards, Aircraft Engine Record, NavAir Form 13700/3, is used in engine accounting in much the same way as the Aircraft Record "A" Card is used in aircraft accounting. One card is maintained on each assigned engine. The record card provides a readily available record of the status, operating hours, number of overhauls, etc., on each assigned engine.

ENGINE TRANSACTION REPORT.—An Engine Transaction Report (ETR) is used to advise the controlling custodian of actions concerning the utilization or status code change of assigned engines. They are normally submitted once each work day covering all transactions occurring since the previous report. Some situations which require the submission of an ETR are as follows:

1. The installation of a serviceable uninstalled engine.
2. The removal of an engine and retention as a serviceable uninstalled engine.
3. The removal of an engine as an unserviceable engine.
4. The receipt and transfer of both installed and uninstalled engines.
5. The striking of an engine from the Navy inventory.

There are numerous other situations which require an ETR; however, the ones listed above are most often used by operating squadrons.

Reporting Field Designation Codes (RFDC's) are used to identify the items of engine data submitted in the required reports. These codes are used in all engine accounting reports to describe the items of information that are being transmitted. Certain RFDC's must be listed on every ETR. Others are used only in specified and seldom occurring transactions. The appropriate controlling custodian's instruction concerning engine accounting explains the proper use of RFDC's.

The numbering system for ETR's varies from one controlling custodian to another. One system used is to number them consecutively throughout the calendar year. Another system used is to number them sequentially by calendar quarter, beginning with a new series of numbers each quarter.

Unlike OpNav XRAY's, in which the data is reported in a vertical column, ETR data is submitted in a horizontal format. Each horizontal line in an ETR report details one engine transaction. They are submitted in this format to facilitate the direct keypunching operation required by the controlling custodian prior to forwarding the required data to the NavAirSysCom. The data in each column should be aligned with a straight margin on the left. Unless specified in the controlling custodian's instructions, an ETR should contain only information directly concerned with engine accounting.

If, after submitting an ETR, it is found that incorrect or incomplete data has been reported, a correction ETR should be prepared and submitted immediately. Correction ETR's are submitted by message or on a form, as appropriate, in the same basic format as regular reports. Correction reports are normally submitted as a two-line report—the first line reporting the same data as previously reported, and the second line reporting the correct data. A correction report may be made in conjunction with a regular report.

END-OF-QUARTER REPORT OF FLYING HOURS ON INSTALLED ENGINES.—The End-of-Quarter Report of Flying Hours on Installed Engines (EOQ report) is submitted as of 2400 hours on the last day of each calendar quarter.

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This report includes all engines in an installed status in the custody of the reporting custodian, regardless of location. Therefore, this includes engines in the reporting custodian's aircraft that are in pools, PAR, etc. The method of submission—speedletter, report form, etc.—may vary from one reporting custodian to another, depending on the instructions of the controlling custodian.

The type of engine reported governs the reporting quarters. Reciprocating and opposed type aircraft engines are reported as 2400 hours on 31 January, 30 April, 31 July, and 31 October. Gas turbine engines prefixed with the letters T and/or TF are reported as of 2400 hours on 28/29 February, 31 May, 31 August, and 30 November. Gas turbine engines prefixed with the letter J are reported as of 2400 hours on 31 March, 30 June, 30 September, and 31 December.

A completed EOQ report is very similar in appearance to an ETR, in fact the items of information are reported using the same RFDC's as an ETR uses. All engines should be listed by model in serial number order.

Configuration Reporting

It is the policy of the NavAirSysCom to maintain naval aircraft and related equipment in a configuration which provides the optimum conditions of safety and material and operational readiness. To insure that this policy is carried out it is necessary that operational aircraft and related equipment be maintained in the latest approved configuration. Safety and operational readiness are greatly dependent on the timely compliance with directives received and the reporting of current aircraft configuration.

The Aeronautical Technical Directives Requirements Program, established by NavAirSysCom, is a system for recording by specific aircraft the applicability and incorporated/not incorporated data for all technical directives that require a logbook entry. This program encompasses all aircraft in the naval operating inventory. The listings produced from this data provide managers with statistical information in many areas of the NAMP. This data provides management with assistance in making informed decisions concerning the approval of additional changes by NavAirSysCom, procurement and distribution of change kits, assignment of aircraft, projecting workload requirements for all levels of aircraft maintenance, and evaluation of aircraft readiness and mission capability.

The basic sources of information for aircraft configuration data are those technical directives which require a logbook entry and are issued by NavAirSysCom.

For proper control of the system, NavAirSysCom has established three major control points. NavAirSysComRep-Lant/Pac have been assigned as control points for aircraft under the cognizance of COMNAVAIRLANT and COMNAVAIRPAC and other commands within the cognizant areas. NavAirSysComRep NavAirTraCom is the control point for aircraft under the cognizance of the Chief of Naval Air Training and the Chief of Naval Air Reserve Training and other commands within the cognizant area. These control points have issued instructions concerning configuration reporting in their areas of control. They determine the configuration status of each aircraft within their cognizant area and forward this data to the Naval Air Technical Services Facility (NATSF) where it is consolidated and distributed as required. NATSF maintains a master data bank concerning aircraft configuration that is updated by the reports submitted by reporting custodians.

There are four lists used in the program. These lists provide specific information regarding the applicability and incorporation status of effective technical directives. Some of these lists have little or no application at the reporting custodian level and are not discussed in this training course.

The Aeronautical Technical Directives Not-Incorporated List 2, issued by the appropriate NavAirSysComRep is the one of most concern to the AZ. This is an IBM listing, published monthly, by bureau number, containing all airframe changes, bulletins, etc., that have not been incorporated in a specific aircraft. It is normally issued during the first week of the month. There is a separate listing for each model aircraft which is subdivided into listings for each bureau number assigned. The listing may contain directives that are not required by a particular custodian but may be required by another custodian in the event of a transfer. Therefore, those directives listed that are applicable but not required will remain on the listing.

Two copies of this list are normally received. After making the necessary entries on these copies, one copy is returned to the issuing activity and the other is retained by the reporting custodian. When an aircraft is

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transferred, the current List 2 should be inserted in the Aircraft Logbook prior to transfer.

In completing the listing, compare it with the appropriate part of the technical directives section of the Aircraft Logbook. If a listed directive has been completely incorporated, a red X is placed in the first (asterisk) column. If a particular directive number is listed and has been marked NA in the Aircraft Logbook, an amplifying reason should be given in the REMARKS column on List 2.

This may require research and investigation to validate the entry. If any directive, requiring a logbook entry, has been incorporated since the last report but is omitted from the listing, the directive number and code should be written in the appropriate columns in numerical order and the directive indicated as being incorporated. Any known directive, which is not incorporated, and requires a logbook entry, but is omitted from the listing, should be written in at the bottom of the listing.

The Aeronautical Technical Directives Incorporated Data by Bureau/Serial Number List 4 is a list of affected technical directives applicable to a specific bureau number and reported as incorporated. This listing is received semiannually and contains those technical directives reported as being incorporated on List 2. It is used in the Aircraft Logbook as a record of technical directive compliance. No entries are normally made on this listing by the reporting custodian.

Review of Aircraft Logs, Related Records, and Reports

Detailed discussion of the Aircraft Logbook and the uses of its many forms is contained in the current edition of AZ 3 & 2; therefore, additional coverage is not appropriate in this training course.

Although all AZ's should know how to properly maintain aircraft logs and related records, senior AZ's must be proficient in this task. They will, in most cases, be the supervisor and the person responsible for accurate logs and records maintenance as well as overall supervision of the production control office. The first sections of chapter 3 should be studied carefully as these sections discuss several aspects of supervision. In addition, senior AZ's should possess the "know how" to review all records maintained and all reports submitted, for accuracy and completeness. Basically, this consists of being familiar with the governing instruction requiring a record to be maintained or a report to be submitted, and then following the instructions it contains in detail.

Most of the entries made in aircraft logs and related records, as well as report typing, are accomplished by lower rated personnel; therefore, senior AZ's have numerous review actions. Reports prepared by lower rated personnel should be reviewed by the senior AZ for accuracy, proper format, etc. Also, periodic spot checks should be made of records which furnish information for reports.

Periodically, the complete Aircraft Logbook should be reviewed. One suggested way to accomplish this in conjunction with the screening process accomplished on the logbooks prior to scheduled calendar inspections. In addition to this, the Aeronautical Equipment Service Record or Accessory and Component Service Record should be carefully reviewed, for components replaced, after necessary entries are made and prior to their insertion into the applicable logbook. By following this system, errors found can be corrected at an early stage, thus eliminating duplication of effort. When conducting this type of review particular attention should be directed to the separator pages which precede the various sections of the logbook. These separator pages contain instructions for completion of the various logbook forms as well as illustrations showing sample entries.

Other review actions are required on all reports prepared for submission to higher authority. Reports are required in order to furnish activities various types of information. This information is used by managers in all phases of naval aviation; therefore, it is of utmost importance that all reports submitted be accurate and complete. After typing and prior to transmission, all reports should be carefully reviewed to ascertain that only correct information has been listed. Reports should be compared with the samples illustrated in the governing instruction to insure that the correct format has been used.

In addition to the review actions previously discussed, senior AZ's assigned to production control of an Organizational level maintenance activity are responsible for insuring that aircraft status boards are correct and maintained up-to-date. Normally, the master aircraft status board is maintained in production control. Additional boards may be maintained in the operations department or the squadron duty office,

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depending upon the requirements of each particular activity. The main purpose of an aircraft status board is to display pertinent information so that personnel having a need to know can quickly ascertain the essential facts concerning aircraft status. This purpose is defeated unless status boards are maintained current. Although remote status boards, if used, may not contain detailed aircraft status information, as does the master board, they should portray an overall "up"-"down" picture of assigned aircraft.

The master board should be updated each morning and then throughout the day as maintenance actions and flights involving status changes occur. Monthly, those entries showing accumulated airframe or engine times should be verified with the logbooks. In order to monitor the operating time of certain major components (engines, props, etc.) nearing their scheduled removal time, the hours listed on the status board may be entered or encircled in red during the final 10 percent of their replacement interval. This serves as a caution sign and assists in scheduling and planning actions.

Hourly as discrepancies or other actions affecting aircraft status occur, this information is posted on the status board. Likewise, discrepancies listed should be removed, once maintenance actions on these discrepancies are completed. Production control is normally first to receive word of the completion of maintenance tasks or other actions affecting aircraft status; therefore, the master status board should be updated to show the true picture of aircraft status at all times.

Production control personnel also maintain Organizational Maintenance Control Registers. These registers assist in controlling the maintenance efforts.

WORK REQUEST

NavAir Form 4710/6 (fig. 4-6) has been provided for use as a Work Request Form. The Work Request is originated by a maintenance activity when requesting specific work beyond its capability from a supported activity. This request form is utilized for the following:

1. Requesting check, test, and servicing of items removed from an aircraft or equipment for scheduled maintenance. When requesting work of this nature the request is prepared in duplicate and additional information is required. The job control or request number, bureau or serial number of the aircraft or equipment from which the item was removed, type equipment code, and nomenclature and serial number of items to be checked are listed in addition to the information required by the form.

2. When requesting work or assistance which is beyond the requesting activity's capability and does not involve repair of aeronautical material. When used for this purpose, requests are prepared and processed in accordance with local directives.

3. To induct components into the Intermediate maintenance activity from supply for technical directive compliance, updating, and check and test. Under these conditions, the request is originated by the supply activity.

4. To induct items not part of an aircraft or support equipment that require check, test, servicing, or minor repair. For example, pilot's personal equipment, oxygen masks, life preservers, etc.

The request form is divided into sections. The top section is completed by the supported activity and the bottom section by the supporting activity. Detailed instructions for preparation of the Work Request are printed on the form. Preparation of the form is discussed in the following paragraphs.

The name of the activity requested to perform the work is entered on the "To" line. To the right, and on the same line, the date of the request is entered. On the next line is entered the name of the requesting activity and the work request number. The numbering system is usually established by local policy. One suggested way is to start at the beginning of each calendar year and number them consecutively. For example, 1-68, 2-68, etc.

The justification for the work requested is entered in the next space. Usually, the justification will be a notation that the work requested is beyond the capability of the requesting activity.

The next space is completed to show the physical location of the job. In most cases involving work on small items, the items are delivered to the supporting activity.

The name and telephone number of the person, to be contacted in case additional information concerning the request is required, is entered on the next line. Naturally, this should be the name of the one person knowing the most about the requested work. Opposite this entry the requested completion date should be entered. The date entered should be realistic so the

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WORK REQUEST
NAVAIR FORM 4710/6

TO: AMD Moffett Field	DATE: 17 June 1968
ORIGINATING ACTIVITY: VP-9	WORK REQUEST NO.: 21-68

JUSTIFICATION FOR WORK REQUEST

Beyond capability of Organizational maintenance activity.

LOCATION OF JOB
Will be delivered to AMD hangar.

FOR FURTHER INFORMATION CONTACT (Name and telephone number): L. E. Drake, AFCM, Ext. 364	REQUESTED COMPLETION DATE: 21 June 1968

WORK REQUESTED
(Give complete, accurate and detailed description of desired work. Attach sketch if necessary.)

Incorporate P-3 Airframe Change 114 Part I in P-3A BUNO 150511
(Copy of change attached.)

REQUESTING ACTIVITY WILL FURNISH MATERIAL AS FOLLOWS: V50-1P3-114	REQUESTING ACTIVITY WILL FURNISH ASSISTANCE AS FOLLOWS: 2 men (1 AE3 and 1 AE2)

SIGNATURE (Maintenance Officer of Supported Activity) G. H. Cooper
G. H. Cooper, LCDR, USN

☑ APPROVED ☐ DISAPPROVED	REASON FOR DISAPPROVAL	SIGNATURE (Maintenance Officer of Supporting Activity) Karl H. Bardeaux, Cdr., USN

DATE STARTED	DATE COMPLETED	DATE REQUESTING ACTIVITY NOTIFIED	WORK ORDER NUMBER ASSIGNED
17 JUNE 1968	20 JUNE 1968	20 JUNE 1968	600-06-042

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Figure 4-6.—Work Request.

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supporting activity can assign the correct priority for the completion of the requested work.

In the next space is entered a complete, accurate, and detailed description of the work requested. Any sketches or directives to accompany the request should be listed in this space.

The nomenclature and stock number of any material furnished by the requesting activity is entered in the next space. To the right of this space is entered any assistance which will be furnished by the requesting activity for completion of the job.

The maintenance officer of the requesting activity signs the request in the space provided for this purpose.

The remainder of the form is used by the supporting activity to indicate action taken on the request.

After receipt and review the request is approved or disapproved by entering X in the appropriate block. If the request is disapproved, the reason for such action is entered in the space provided. The form is signed by the maintenance officer of the supporting activity. On the last line of the form is entered the date on which the work requested is started, the date on which the work is completed, the date the requesting activity is notified of its completion, and the production control number (PCN) assigned to the job.

If the requested work is beyond the capability of the supporting activity, the request may be passed to an activity having a higher level of capability for completion.

INTERMEDIATE MAINTENANCE

Intermediate maintenance activities (IMA) are primarily concerned with support of operating units within a designated area or at a particular base or station. The tasks performed by production control personnel of an IMA are somewhat related to those performed at an Organizational level activity. Some of the same records and reports are required as well as certain planning and scheduling actions. Some of the specific functions of the IMA production control are as follows:

1. Exercise direct supervision over the production divisions to insure conformance to established policies.
2. Coordinate the actions of the production divisions to insure prompt movement of components, parts, and material.
3. Maintain liaison with supported activities to provide maximum utilization of the IMA productive capacity and to insure that productive efforts are compatible with workload requirements.
4. Insure compliance with all technical directives by cognizant divisions.
5. Monitor personnel, support equipment, and material utilization of production divisions.
6. Plan and schedule workload as necessary to carry out all commitments.
7. Assign work to the production divisions, including the assignment of priorities and completion times.
8. Maintain master files of outstanding/completed source documents and maintenance instructions.
9. Maintain Aeronautical Equipment Service Records and Accessory and Component Service Records.

As head of production control, the Maintenance/Material Control Officer is charged with the responsibility for accomplishment of these specific functions in addition to the overall responsibility for the production efforts of the department. He is assisted in meeting assigned responsibilities by the Production Control Chief.

With a few exceptions, all Intermediate maintenance activities no longer are reporting custodians of aircraft. This was brought about by the implementation of the three level maintenance concept. Therefore, numerous records, reports, and scheduling actions required by Organizational activities are not required by the IMA.

Since the IMA is primarily concerned with component repair and support of operating units, production control is involved with many components daily. It is neither practical nor desirable to attempt to control each component inducted into the activity from a central production control area if facilities are widely disbursed and hundreds of components are involved daily. Under these conditions, management is accomplished by the delegation of certain production control functions to selected production divisions.

Divisions so designated exercise direct control of the production efforts of assigned work centers, are responsible to production control for the production efforts of the assigned work centers, assign production control numbers to work assigned to work centers, schedule components into work centers, and assign priorities as directed by production control. Even though certain production control functions are delegated to production divisions, production

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- Large and small equipment used for making alterations such as industrial and home sewing machines and marking, measuring, cutting, and ripping equipment
- Stitching exercises
- Machine instruction books
- Examples of clothes with safety features
- Score cards on machine use

Instructor References

BOOKS

Bane, Allyne. *Creative clothing construction;* 2d ed. New York, N.Y. McGraw-Hill. 1966.

Bishop, E. B. & Arch, M. S. *The Bishop method of clothing construction;* rev. ed. Philadelphia, Pa. J. B. Lippincott Co. 1966.

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control always retains the functions of satisfying special requirements of the Supply Support Center, reassignment of support equipment, material or personnel from one work area to another, and placing special priority assignments on the production division efforts.

Production control holds meetings, at frequent intervals, with production and material control personnel to discuss production efforts and problem areas. However, any factors affecting the production effort should be relayed immediately to production control.

A monthly maintenance planning meeting is convened by the IMA. This meeting is attended by representatives of all supported activities on scene at the time of the meeting. The purpose of this meeting is to provide the necessary planning and coordination to improve the overall maintenance program. Supported maintenance representatives discuss the quantity and types of support required, including the schedule of components due for check and test. All factors affecting the anticipated Intermediate maintenance workload are presented by supported representatives.

From the information gathered at this meeting, and other known support requirements, a monthly maintenance plan is published for use by the IMA production divisions. This plan includes a projected schedule of items to be inducted for check and test, anticipated changes in the Intermediate maintenance workload due to operational commitments of supported activities, and other known or anticipated factors affecting the production effort of Intermediate level maintenance.

Due to the fact that Intermediate level maintenance activities are not reporting custodians of aircraft, they are not involved in aircraft accounting and reporting procedures. However, they are responsible for aircraft engine buildup, repair, etc., and therefore, must maintain Aeronautical Equipment Service Records as well as complying with the current instructions concerning engine accounting. Production control should insure that these records are accurately maintained and any required reports properly prepared. Numerous components received into the IMA have Accessory and Component Service Records. Changes, bulletins, repairs, etc., completed on these components should be accurately recorded on the record cards.

Intermediate maintenance activities maintain large quantities of aircraft maintenance support equipment (AMSE). Much of this equipment utilizes maintenance and custody records; therefore, production control personnel must maintain these records. Production control personnel must also initiate AMSE data cards to report AMSE inventory changes, status code changes, NOR time, and utilization.

In addition to the many scheduling actions required to induct components into the production divisions, production control receives work requests from supported units requesting various maintenance tasks. These requests require prompt review in order that the necessary action may be initiated for their completion.

DEPOT MAINTENANCE

It is neither practicable nor possible to discuss, in this training course, all the numerous maintenance tasks performed by Depot level maintenance activities. Likewise, due to their size the organization of these activities is of little concern to the AZ.

In general, these activities have the capability to perform all levels of maintenance on assigned types and models of aircraft, powerplants, and aeronautical equipment. The utilization of this capability is limited, by Navy policy, to performance of only specific tasks which cannot be performed properly, economically, or expeditiously by lower level maintenance activities.

The utilization of commercial or intraservice facilities is limited to the terms of the contract or agreement describing the specific tasks to be performed. These agreements and contracts are based on the same policy as that used in determining the assignment of work to Naval Air Rework Facilities (NARF's).

Guidance for utilization of services of Depot maintenance activities and assistance in determining specific action to be taken can be obtained from NavAirSysCom Hq, NavAirSysComReps, air type commanders, their subordinate commands, or the Depot maintenance activities themselves.

Depot maintenance includes overhaul, modification, and major repair of aircraft and related aeronautical equipments, manufacture of certain aeronautical parts, and the manufacture of kits for the accomplishment of aircraft and equipment modifications. This type of maintenance is usually performed in large industrial type facilities. These facilities are either military or commercial.

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Frequently, Organizational and Intermediate maintenance activities require the assistance of Depot activities to complete maintenance tasks. The following sections contain information on some of the functions performed at Depot level activities which are of concern to the senior AZ.

AIRCRAFT REWORK

Certain facts pertaining to the service life of an aircraft are known at the time of procurement. One of these is that after a certain number of accumulated flying hours or calendar months the aircraft will go to a Depot level maintenance activity for standard rework. Between these standard rework periods, aircraft may receive special rework.

Aircraft rework is categorized as either standard or special rework. Standard rework includes overhaul, progressive maintenance, airline maintenance, and progressive aircraft rework (PAR). These types of rework are required at the completion of a specified tour or period of service. The rework performed is of sufficient depth to provide a finished product that is capable of safe completion of the next tour of service. Special rework includes conversion, in-service repair, modernization, modification, and damage repair at the overhaul level. These types of rework are performed as required and to the degree necessary to meet the requirements of the specific type of rework involved.

Rework is the restoration or added work performed on an aircraft, aircraft equipment, etc., by aircraft industrial establishments or contractors' plants. A rework process extends from the time some of the work is started until all of the work has been completed, including temporary interruptions in direct labor, work evaluation and test, and the correction of discrepancies determined thereby.

The word "Standard" as used with rework does not imply standardization of the work process involved. It only identifies those particular processes which are basic to the standard service life of Navy aircraft as distinct from those processes which are not. For example, overhaul is standard rework because the standard service life of Navy aircraft involves alternating service tours and overhauls; it does not mean that all overhauls follow the same fixed specifications of work to be done. Actually, each aircraft undergoing standard rework is reworked (under nonstandard work specifications) only to the extent necessary to meet certain standard end product specifications.

NavAirSysCom establishes a schedule for standard aircraft rework completions by model and type of rework for each activity performing Depot maintenance. Damage repairs, to overhaul level, are included in this schedule—in-service repairs are not. The schedule is determined by the requirements of the operating forces, as established by CNO, and is constructed within the limitations of aircraft availability for rework, plant capacity and capability, and funds available. Specific inductions, by bureau number, are established through coordination between controlling custodians, NavAirSysComReps, and the Depot maintenance activity concerned.

Special Rework

Special rework is the work done to aircraft, aircraft equipment, and aircraft support equipment to improve or change their capability to perform specific missions or functions by replacement, removal, addition, alteration, or repair of parts of equipment of the aircraft, and without particular regard to the position in standard service life. Special rework is divided into several processes as discussed in the following paragraphs.

Conversion is special rework the accomplishment of which alters the basic characteristics of the aircraft to such an extent as to effect a change in any part of the model designation. If the rework process includes both conversion and overhaul, the proper term is standard rework, overhaul-conversion. If the process includes both conversion and modernization, the proper special rework term is modernization-conversion.

In-service repair is repair by NavAirSysCom FS activities of aircraft damaged beyond the repair capacity of controlling custodian maintenance activities. Controlling custody remains unchanged between or during the changes in physical custody. In-service repair is special rework, and the aircraft undergoes the entire rework process of the NavAirSysCom FS activity concerned, unless specific exceptions are requested by the controlling custodian.

Modernization is special rework performed on new or newly overhauled aircraft withdrawn from storage. It includes incorporation of applicable changes and bulletins, installation of

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acceptable accessories, and flight testing. It also applies to aircraft which do not complete rework due to equipment shortages and other reasons and which are subsequently returned to the rework process for completion. Modernization-conversion is a special rework process involving both modernization and conversion.

Modification is special rework accomplished by NARF's on new production aircraft and aircraft in the controlling custody of the operating commands. It includes only the incorporation of changes and bulletins and the correction of discrepancies as required in the directive authorizing the work to be performed. In effect, the only basic difference between modernization and modification is that modernization applies to aircraft withdrawn from storage while modification does not.

Repair is special rework accomplished to correct material damage and to restore the aircraft to the equivalent material condition which it had prior to the damage. If the rework process includes a combination of either repair and overhaul or overhaul-conversion, the type of rework performed is overhaul or overhaul-conversion, respectively, not repair. Aircraft may be in the controlling custody of either an operating command or NavAirSysCom FS while undergoing repair.

Standard Rework

Standard rework is the work performed on aircraft at NARF's or contractors' plants after (and as a result of) completion of a prescribed period of operational service. The end product specifications of the work permits aircraft to serve a full standard period of operational service before undergoing the rework again. Standard rework is divided into several processes as discussed in the following paragraphs.

Overhaul is standard rework performed on aircraft subject to standard service tours. The scope of the rework includes disassembly sufficient to inspect all the operating components and the basic aircraft structure; followed by repair, replacement, or servicing as necessary; followed by reassembly and flight test. Upon completion of the rework process, aircraft are capable of performing their intended mission for a full service tour. An overhaul is given either upon completion of a given period of time in a standard service tour or upon receiving damage of a severity to warrant the process.

PAR is standard rework performed upon accumulation of a predetermined number of calendar months. In certain cases, accumulation of a predetermined number of flying hours may subject aircraft to the PAR process. Aircraft subject to PAR do not receive a planned overhaul during their service life.

The work performed includes modification/modernization, planned rework to insure compliance with NavAirSysCom functional and safety standards for the prescribed service period, and correction of maintenance deficiencies or discrepancies beyond the ability and/or capacity of the operating units. Most Navy aircraft are reworked under the PAR concept.

PAR-conversion refers to a rework process, involving both PAR and conversion. Likewise, PAR-modernization and PAR-modification refer to standard rework processes involving PAR and modernization/modification, respectively.

Progressive maintenance is standard rework done in a consecutive series of a predetermined number of partial overhaul processes, each with different specifications of work to be done, the composite of which represents a complete overhaul by incremental stages. Aircraft subject to progressive maintenance progress through a series of cycles each of which is composed of a given number of operating periods followed, in succession, by a like number of progressive maintenance periods.

A cycle begins with the first operating and ends upon completion of the last progressive maintenance period specified for the cycle. An operating period begins when the controlling custody of an aircraft changes from NavAirSysCom FS to an operating command and ends when the reverse occurs. The number of the operating period is the same as the number of the progressive maintenance period which immediately follows the completion of the operating period.

An operating period is terminated after a given number of flying hours or a given number of calendar months, whichever occurs first. Aircraft are not operated after termination of an operating period unless an extension has been authorized. The progressive maintenance period is the time while the aircraft is in the controlling custody of NavAirSysCom FS for progressive maintenance. NavAirSysCom specifies the particulars of work to be accomplished during each successive progressive maintenance period. Each progressive maintenance period accomplishes a partial overhaul. When

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a cycle is complete, an aircraft has had the equivalent of one complete overhaul.

Airline maintenance is a form of progressive maintenance distinguished by short operating and rework periods. The aircraft controlling and reporting custodian remains unchanged during or between operating and rework periods.

Analytical rework is a systematic procedure for determining and maintaining reliability through selective equipment sampling and engineering evaluation. This type of rework is normally concerned with particular aircraft parts or components. Analytical rework is performed in selected areas in each aircraft inducted into PAR.

POWERPLANT REWORK

Depot level maintenance activities perform powerplant rework, which consists of both overhaul and repair of engines. Engines processed through overhaul become ready-for-issue and capable of operating for the complete operating interval prescribed. Overhauled engines revert to zero time since overhaul. Engines processed through repair are suitable for continued operation to the prescribed interval. Repaired engines retain time accumulated since last overhaul or since new if never overhauled.

NavAirSysCom establishes rework requirements for engines, by model and activity, for each quarter in terms of completions. The requirements are calculated to support the flying hour program established by CNO within the limitations of backlog availability, plant capacity, and funds. Existing instructions provide for return of unserviceable engines to the designated overhaul point. Specific scheduling and distribution are controlled by the cognizant NavAirSysComRep.

AERONAUTICAL SPARES AND COMPONENT REWORK

Individual Depot and commercial maintenance activities are assigned repair and overhaul cognizance for specific aeronautical spares and components. Spares and components requiring repair or overhaul, beyond the scope of Intermediate maintenance activities, are returned to these designated overhaul points in accordance with current ASO instructions.

Intermediate maintenance activities are assigned screening and repair functions to process such items for their assigned areas, to return to service repairable items, and eliminate unnecessary overhaul and shipping delay and cost. ASO establishes requirements for rework of components based on usage figures and planned aircraft operating programs. NavAirSysComReps direct the Depot or commercial maintenance activity to implement schedules to meet these requirements.

It should be remembered that material cannot be reworked that is not available and future requirements cannot be predicted from incorrect usage data. Therefore, everyone concerned should try to insure expeditious processing of material to be returned for rework and complete reporting of all items used.

CUSTOMER SERVICE

The high cost and complexity of aeronautical material and the need for maximum use of limited assets made necessary the development of efficient procedures for the expeditious repair of items causing NORS conditions. Also, the development of capability to perform aircraft rework, engine rework, and component rework has resulted in providing the Navy a source for "call" type rework or repair to meet unscheduled requirements. Consequently, Depot activities manufacture certain items to satisfy replacement needs for operating units. They also perform rework of specific items urgently needed to meet immediate demands where other sources are unable to provide support. This usually applies to parts not available or not in stock in supply channels. This type of support is classified as Customer Service. The customer service facilities at all Depot activities contribute substantially to satisfy specific maintenance requirements of Organizational and Intermediate activities.

Customer service includes NARF professional services; immediate check, test, and/or repair of operating and maintenance activities' aeronautical materials; processing of material to relieve NORS conditions; and technician services beyond the capabilities of aviation units.

Customer service was instituted to provide direct support to fleet aviation units in their technical and material maintenance problems. This service is extended to all other aviation operating and maintenance activities and units. Customer service supplements, not replaces, existing supply and Intermediate maintenance procedures.

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The following types of support are included in the customer service program:

1. Professional, including engineering and consultation services on aeronautical, electrical, and radio-radar materials and support equipment. Also advisory and consultation services on maintenance operation, minor repairs, and assistance in the indoctrination of personnel on new equipment with which the NARF has had experience.
2. Aircraft weight and balance services.
3. Processing of aeronautical materials and equipment. This includes inspection, bench testing, and functional checking of various accessories and components, provided the operating units or its supporting maintenance activity does not have the necessary testing equipment or other capability.
4. Heat treatment, Magnaflux, electroplating, battery charging, etc.
5. Machinist services to remove stripped or broken studs, spark plugs, helicoils, etc.
6. Chemical, physical, and metallurgical laboratory testing requirements.
7. Preservation of engines.
8. Requirements for dry air for canned engines, accessories, and equipment.

The various NARF's, in conjunction with major commands, operating NavAirSysComReps, and subordinate area commands have promulgated instructions concerning the availability and use of customer services in their areas. These instructions specify the procedures to be followed and the request form to be used when requesting customer service support. Therefore, no attempt is made in this training course to discuss the completion of customer service request forms. Some activities may use the Work Request form, discussed earlier in this chapter, for this purpose.

Organizational level activities normally submit requests for work or assistance concerning NOR conditions to their supporting Intermediate activity. If the work or assistance requested is justifiable, and cannot be provided by the supporting activity, then the request is forwarded to customer service of the appropriate Depot level facility for action.

Because the capacity for customer service type of support is severely limited by manpower, material, and funds, activities requesting customer service should insure that normal support channels, including the capability of lower levels of maintenance in repair or manufacturing, have been exhausted prior to requesting assistance from Depot facilities.

On the other hand, because the capability of each Depot activity is so varied and extensive, it is better to be mistaken on the side of requesting service for which no capability exists than to assume noncapability when the service could be performed.

ENGINEERING SERVICES AND FIELD TEAMS

Depot maintenance activities provide operating squadrons and maintenance activities additional support in the form of engineering services and field teams. A brief discussion of this support is contained in the following paragraphs.

Depot activities assigned the prime responsibility for manufacture or rework of specific equipments maintain engineering staffs capable of solving problems not discussed or provided for in manuals such as Overhaul Instructions or Structural Repair Manuals. Assistance is provided in prototyping special installations or changes. These types of engineering services are available to all maintenance activities on request. Specific engineering assistance can also be obtained from NavAirSysComReps for items manufactured by concerns whose contracts are under their cognizance. Such assistance is obtained by application to the cognizant NavAirSysComRep.

Each NARF has been provided a limited amount of money for the establishment of field team service for special maintenance functions. Scheduling for the utilization of these field teams is done by the cognizant NavAirSysComRep and coordinated by the type commander. This service is usually restricted to incorporation of airframe changes and engineering fixes affecting safety, whose complexity or requirement for special tooling precludes incorporation by lower levels of maintenance.

To conserve the time of field teams so that maximum effort is spent on work which cannot be performed by lower levels of maintenance, field teams should be requested to perform only those maintenance tasks which cannot be completed by Organizational or Intermediate maintenance activities. Specific instructions issued by type commanders provide procedures for requesting field team service.

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Chapter 5

DATA SERVICES AND MAINTENANCE DATA ANALYSIS

Recordkeeping, the preparation of reports, and the maintenance of related data have always been vital functions in the administration of naval aviation. Until recently, most of these functions were performed manually. Equipped with a pencil, a typewriter, and an adding machine, personnel performing clerical duties recorded the expenditure of supplies and money, maintained aircraft readiness and flight records, and prepared many different reports by manually arranging documents and typing long lists of information or adding many sets of numbers.

With the introduction of more complex weapons systems and the growth of the Navy came the requirements for more records to be maintained and many additional reports to be prepared. Data processing systems were developed and adopted to perform many of these functions by mechanical means. By transferring information contained on source documents onto a punched card, a means is provided for mechanically arranging information in any desired sequence, maintaining files, and preparing reports automatically, accurately, and at a high rate of speed. The principle of mechanical recordkeeping is based on the punched card.

Data processing is a series of planned operations upon information to produce a desired result. The procedures and devices used in the data processing routine constitute a data processing system. The development and installation of data processing systems utilizing data processing equipment provide an effective management tool in gathering, compiling, balancing, recording, and reporting information.

Automatic data processing systems comprise all manual, mechanical, electrical, and electronic data processes required in accomplishing the functions stated above. Such systems are built around a group of machines or devices which permit handling much of the data processing routine automatically. These machines and devices generally are classified either as Electric Accounting Machines (EAM) or Electronic Data Processing Systems (EDPS).

Electric accounting machines are designed so that each machine, as a general rule, is used separately to perform one specific processing operation as directed by control panel wiring. Punched cards are the primary medium for supplying source data for processing and manipulation.

This type of equipment is used by most data service activities in processing data collected by aviation maintenance activities in accordance with the Navy Maintenance and Material Management (3-M) System.

To assist management, certain analysis functions are performed on collected data. This is properly the responsibility of the analysis division. Specially trained senior AZ's are normally assigned to this division of Organizational and Intermediate maintenance activities. Most analysts receive this special training by attending the Aviation Maintenance Data Analysis Course, Class C, located at the Naval Air Technical Training Center, NAS, Memphis, Tennessee.

This chapter discusses some of the aspects of data analysis and provides information on data service activities and their responsibilities to the Aviation 3-M System.

DATA SERVICES

Data Services is the functional unit that converts documented data into data processing machine records and utilizes these records to produce (1) machine reports for maintenance and material management at the Organizational and Intermediate levels; (2) machine produced aids that are used by maintenance personnel to report expended manhours and material; and (3) provide a Central Data Processing

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Facility with a duplication of that portion of the data that is required for maintenance and material management above the local level and inclusion in a Navy Maintenance Data bank.

In regard to the manhour accounting system, data services is responsible for the accurate preparation of prepunched/preprinted cards and the timely preparation of required reports. They also perform the following functions:

1. Maintain a master roster deck by organization, work center, and name of each person assigned to the various work centers.
2. Forward a master roster listing to the analysis division for ultimate distribution to the various work centers. This roster is kept current at all times by the work center supervisor and analysis division. Data services produces a new roster, reflecting the previous month's changes, and forwards it to the analysis division not later than the second working day of the reporting period.
3. Furnish a daily labor exception listing for each work center.
4. Forward the monthly actual labor utilization reports for each work center concerned.
5. In coordination with the analysis division, prepare additional manhour reports as required.

The responsibilities of data services in maintenance data reporting are closely related to those previously discussed. In addition to the responsibility for processing collected data and for accurate and timely preparation of reports, data services also prepares prepunched/preprinted SAF's, verifies the source document count on all document control forms in order to insure that no documents are lost, and assists the analysis division in developing procedures for special reports.

Data services is also responsible for processing both aircraft and aviation maintenance support equipment statistical data and providing activities concerned with required reports and and prepunched/preprinted ESD and AMSE cards.

DATA PROCESSING

Data processing consists of performing certain job steps. Each of these steps usually requires a different type of machine to do the job. The number of steps required depends upon the particular application involved. The basic accounting principle consists of converting source data to punched cards, arranging the cards in the desired sequence, and printing reports from them.

The first step in a data processing application is to get the source data into a punched card. This is usually done by using a card punch machine. This machine is similar in operation to the standard typewriter; but, instead of printing when the keys are depressed, it punches holes in the cards representing numbers, letters, and characters. One type of card punch machine has a printing mechanism that allows for printing data on the card at the same time the card is being punched.

Numerical and alphabetical information is recorded in punched cards so that it can be read electrically by data processing machines. These machines can add, subtract, multiply, divide, copy, file cards, and print reports automatically. These functions take place after the machines read the information punched in the cards.

Each type of card is divided into fields, each representing a particular item or items of data. For example, a manhour accounting card has one field assigned for punching the organization code, another for punching the work center code, another for punching the name of the person, etc.

After cards have been punched, the data in them is checked for accuracy. There are two methods of doing this—visual verification and machine verification. Visual verification involves reading the data in printed cards, or on a prooflist, and comparing them with the contents of the source documents. Machine verification is performed by a mechanical card verifier. This machine is similar in appearance and operation to the card punch, except that instead of punching holes in a card, it reads the holes already in a card by a sensing mechanism, which passes through the punched holes when the proper keys are depressed. If the key that is depressed does not correspond to the code punched in the card, an error is indicated.

After verification, cards are seldom in the order in which they are used. To arrange the cards in desired sequence, a sorting machine is used. Sorting occurs one column at a time, and normally begins with the low order position of a field and continues to the high order position of the field. Cards can be sorted into either alphabetical or numerical sequence. In addition, certain cards may be selected or rejected, depending upon the setting of certain switches.

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The final step in a data processing application is usually the printing of a finished report. Accounting machines are designed to print the data contained in punched cards on continuous form paper at speeds far in excess of the fastest typist. Entire lines of data are printed across the form in one operation. Totals are accumulated and printed on the report along with the printed data.

In addition to the data processing steps previously discussed, data services also perform other steps in most accounting and processing procedures. Some of these include interpreting, reproducing, collating, and calculating.

In many instances it is desirable to have the punched card data printed on the card itself. This is especially true when cards must be handled outside of the machine installation. The job of the interpreter is to read the punched holes in a card and translate them into printed information across the face of the card.

Sometimes a duplicate deck of cards is required or information must be added into one deck from another. This could be accomplished by using a card punch machine; however, a much faster way is by use of a reproducing punch. All or any part of one card can be reproduced into another card, depending upon control panel wiring. In addition, common information can be gang punched into all cards. Reproducing punches are also used to punch totals accumulated in the accounting machine when the two machines are connected for a summary punch operation.

Certain jobs require matching two decks of cards, checking sequence of cards, merging groups of cards, or selecting certain cards. These jobs are performed by collators. By proper control panel wiring, these jobs can be performed singly or in conjunction with one another.

Calculating is the computing of a result by multiplication, division, addition, or subtraction. Any combination of these calculations can be performed by calculating punches. Factors to be calculated may be read from each card or from a series of cards, or they may be emitted by a device within the machine. The results of the calculation may be punched into each card or into a trailer card which follows a group.

Most data processing machines can perform more than one function. The machine must know what function it is to perform and how to handle the information it receives. A control panel is provided with most machines to enable the operator to give the machine the proper instructions for obtaining the desired results.

A control panel is a panel or board which, in most cases, can be removed from, or inserted into, the machine when desired. The panel has many small holes into which are inserted wires with special tips to control the functions of the machine. Each of these holes has a specific purpose or function. A control panel is similar in principle to a telephone switchboard. It completes electrical circuits through wires inserted in the panel.

The wiring of control panels for the preparation of MDCS reports requires considerable time and effort on the part of data services personnel. This is one reason why special reports should be requested only when the desired information is not available elsewhere.

Card Type Codes

Card type codes are two-position numerical codes used to identify the various punch cards that emanate from the source documents submitted to data services for processing. In many cases, a single source document can generate as many as three punched cards containing different information. Card codes are punched into columns 79-80 of the card.

For the most part, the source of data for the various punch cards is taken directly from submitted source documents; however, in some cases the punch card data is taken from machine produced reports.

Each card type code is listed in table 5-1 together with the card type and the data source from which the card is produced.

DATA DISTRIBUTION

Source documents received by data services are marked to indicate that all essential data has or has not been keypunched. This is usually accomplished by punching a hole in a specific location in the source document. Blocks on source documents that are not properly filled in or contain information that cannot be keypunched are encircled in red and returned to the originating activity for corrective action. Upon completion of the keypunch operation, all MDR source documents are returned to the originator for filing. Keypunched documents are usually returned on a daily basis.

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Table 5-1.—Card type codes.

Card type code	Card type	Source document
01	Support Action	SAF
11	Maintenance Action	MAF Single
12	Failed Part	MAF Single
16	Removed Item	MAF Single
17	Installed item	MAF Single
21	Maintenance Action	MAF Multi; Copy 1
26	Removed Item	MAF Multi; Copy 1
27	Installed Item	MAF Multi; Copy 1
31	Maintenance Action	MAF Multi; Copy 3
32	Failed Part	MAF Multi; Copy 3
34	Repair Cycle	MAF Multi; Copy 3
39	Repair Cycle	Machine Produced
41	TDC Action	TDCF
46	TDC Old Item	TDCF
47	TDC New Item	TDCF
50	AMSE Transactions	AMSE Data Card
53	Configured Item	CCF
60	Material Transaction	DD 1348 or MAF Multi; Copy 2
61	Material Transaction	DD 1348 or MAF Multi; Copy 2
62	Material Transaction	DD 1348
63	Material Transaction	MAF Multi; Copy 2
64	Material Transaction	DD 1348
65	Material Transaction	DD 1348
66	Material Transaction	DD 1348
70	Aircraft Inventory	ESD Card
71	NOR Data	ESD Card
73	Aircraft Inventory Change	ESD Card
76	Flight Data	ESD Card
79	Aircraft Readiness Summary	Machine Produced
91	MHA Data Summary	Machine Produced

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After processing by data services, data is distributed to required activities. It is distributed in the form of reports or decks of keypunched EAM cards. Figure 5-1 depicts the flow of data from its origin to a Central Data Processing Facility (CDPF).

Selected information which has been collected by the maintenance and material management system is forwarded to a CDPF for inclusion in a data bank of maintenance and material information. Maintenance activities receive required data in the form of standard daily and monthly reports. Additional data may be received in special reports on an as-requested basis.

MAINTENANCE DATA REPORTS

The Support Action Forms, Maintenance Action Forms, and Technical Directive

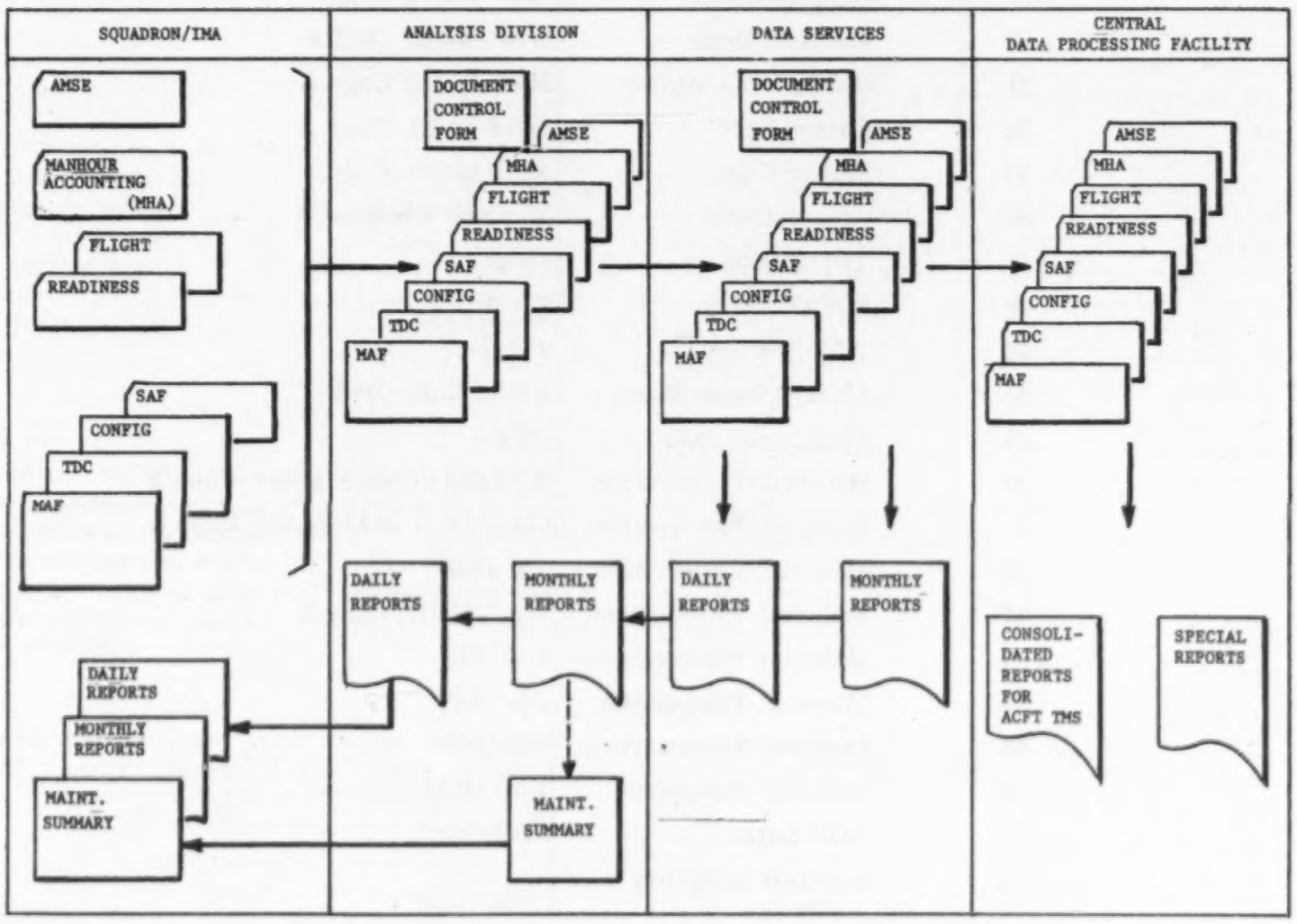

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Figure 5-1.—Data distribution flow.

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UNIT 3 - TECHNIQUES OF SEWING

The content for Unit 3 has been divided into four topics covering the techniques related to pressing, constructing, altering, and repairing garments. Each topic follows the same format as the other units.

TOPIC 1: PRESSING TECHNIQUES

Competencies

- Select pressing equipment appropriate for the job.
- Use hand pressing equipment.
- Use machine pressing equipment.
- Press garments satisfactorily for show window or floor.
- Groom for personal safety.

Motivating Procedure

Display and assign a number to each pressing item listed below under Instructional Materials. Ask trainees to write the name and use of each item opposite the corresponding number on a sheet of paper. Discuss the correct name and use of each item.

Learning Experiences

- Demonstrate the use and care of hand and machine pressing equipment. Discuss the differences in the methods used for pressing various fabrics, garments, and garment parts. Use an information sheet on pressing garments as the basis for discussion. See Appendix F.
- Have trainees use various pieces of pressing equipment on sample garments. Display the pressed garments and evaluate the pressing skills of the trainees.
- Show pictures of clothing, hair styles, and jewelry on an opaque projector. Have trainees identify features that would create safety hazards when using various pressing equipment.

Instructional Materials

- Variety of garments
- Pictures of clothing, hair styles, and jewelry
- Ironing board
- Needle, sleeve, and seam boards
- Machine pressing equipment
- Steam iron and distilled water
- Variety of pressing clothes, hams, and mitts
- Point presser
- Pounding block or clapper
- Stiff brush

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Compliance Forms completed by maintenance activities are forwarded to data services each working day. Through the media of automatic data processing machines, the information contained on these forms is keypunched into punch cards. At periodic intervals, the punched cards are sorted into logical sequence, listed or summarized in a readable format, and provided to the maintenance activity as maintenance data reporting system reports (MDR's).

These reports are designed to furnish management with selected statistics which are used to effectively monitor and direct the maintenance effort. In their entirety, the reports provide a comprehensive source of information relevant to the maintenance endeavor. Properly interpreted, the statistics contained in the reports indicate the extent of maintenance currently performed on the various types of equipment and components. Analysis of the pertinent data can reveal the existence of both favorable and adverse conditions prevalent within the maintenance activity.

A series of reports is prepared by data services for each 3-M oriented maintenance activity. These reports are separated into two categories—Standard Reports and Special Reports. Standard reports are those received by all maintenance activities on a recurring basis (daily, monthly, etc.), utilizing established formats and designed for specific uses. Special reports are those requested by individual maintenance activities on a one-time or continuing basis utilizing locally determined formats, and containing selected elements of data which would not ordinarily be desired by all maintenance activities.

STANDARD REPORTS

To insure the uniform reporting of basic maintenance data by all activities, standard reports are used. Compilation of selected elements of data in a specified format facilitates the preparation of maintenance summaries, allows comparison of statistics collected for similar type organizations and equipment, and simplifies the issuance of reporting instructions and mechanization procedures.

For the most part, standard reports are received on a monthly basis. These reports are delivered to the analysis division at specified times. Daily reports are normally delivered to the analysis division at the time the previous working day's documents are returned. The analysis division is responsible for internal organizational distribution of the machine reports.

A brief discussion of standard MDR's is contained in the following paragraphs.

Daily Production Report (MDR 1)

This report is intended for the work center supervisor and is a detailed listing, by work center, of all maintenance action, support action, and technical directive compliance forms submitted during the previous working day. Typical uses of the report by the work center supervisor are as follows:

1. The validity of forms submitted during the previous day can be checked. Any erroneous entries should be corrected by prescribed procedures.
2. The productive labor output of the work center can be monitored on a daily or cumulative basis.
3. Jobs showing an excessive expenditure of manhours or elapsed maintenance time can be immediately identified and corrective action can be instituted.
4. Conditions affecting the productivity of the work center, lack of parts, tools, etc., can be recognized and brought to the attention of management.

Monthly Production Report (MDR 2)

This report is a summation, by work center, of all maintenance action, support action, and technical directive compliance forms submitted during the month. This report assists the work center supervisor in obtaining maximum utilization of the direct labor available to his work center. The total production manhours expended on maintenance and support actions and technical directive compliance can be compared to the available direct labor manhours to determine if a significant imbalance exists. This report further provides ways of comparing the productivity of the work center to set or desired standards to insure that an adequate outlay of work is being realized.

Job Control Number Consolidation Report (MDR 3)

This report is a consolidated listing, by organization, of all maintenance actions and

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technical directive compliance actions submitted during the month by the parent organization, as well as those submitted by the supporting activity. Support actions are not included in this report. Only those actions which involve maintenance of equipment, component repair, and technical directive compliance are listed.

It is designed for the maintenance officer, in order that he might have at his disposal a comprehensive record of maintenance accomplished on items for which he is responsible. The type equipment and component worked on, maintenance actions performed, description of the malfunction, manhours utilized, failed parts involved, repair activity, date the job was originated, and the date of job completion can be identified to each job control number issued by the organization. This report provides the maintenance officer with a brief summary of who did what for whom, and when it was accomplished.

Intermediate level maintenance performed on components removed from an organization's aircraft, support equipment, etc., is included in this report. This information can be used to determine the defect found in the removed component, the extent of work required to repair the defect, and similar statistics. Additionally, items removed without ample cause can be isolated. Further research may reveal poor troubleshooting techniques, inadequate test equipment, etc.

The MDR 3 is an optional report and it is not prepared by data services unless specifically requested by an activity.

Technical Directive Compliance
Reports (MDR 4, Parts 1 & 2)

These reports provide a detailed listing, by organization, of TDCF's submitted during the month. They are designed for maintenance control managers as an aid in scheduling and maintaining a positive control of technical directives. Parts 1 and 2 of MDR 4 contain identical information; however, they are sorted, tabulated, and totaled differently in order to provide a wider range of useful information.

Typical uses of these reports by maintenance control managers are as follows:

1. Serve as a running account of technical directives complied with by TDC identification, or by individual bureau or serial number in order to maintain a smooth running program.

2. Identification of total manhours utilized in each TDC or in all TDC's combined.

3. Identification of TDC's which did not apply or which had been previously incorporated.

4. Serve as a record of all work centers that worked toward each technical directive compliance whether they were assisting, or had prime responsibility.

The MDR 4, Part 1 is an optional report and it is not prepared by data services unless specifically requested by an activity.

System and Component
Maintenance Report (MDR 5)

This report is a detailed listing of all MAF's and summation of SAF's submitted by each action organization during the month. It is designed to provide maintenance managers a listing of items repaired on equipment, items removed, installed, or replaced, and items processed through maintenance shops. It allows identification of total manhours utilized for each type of support maintenance in order to determine the average time spent on preflight inspection, mission configuration, etc.

Checks can be made of high manhour consumers by systems, or by components within systems, to determine what systems or components caused the most problems. Further investigation may reveal that the inspection of the system is not effective, or, if the same components continue showing up as a discrepancy, perhaps correspondence should be initiated recommending changes to manufacturer's specifications. Selections of repeat failure items can be made with the possibility of establishing the cause of the failure.

When Malfunction Was
Discovered Report (MDR 6)

This report is intended for the maintenance officer and contains data extracted from MAF's. It is used to determine the number of aborts caused by mechanical failure and their causes. It further identifies the number of items processed and manhours expended as a result of discrepancies discovered during acceptance checks on recently assigned aircraft. Additional data is also provided for the identification of the number of malfunctions discovered during quality assurance inspections and during functional test flights.

Maintenance Actions by
Individual Item Report (MDR 7)

This report contains a line entry for each MAF that was submitted during the month on an item of equipment that can be identified by a bureau or serial number. It is intended for the maintenance officer.

Typical uses of the report by the maintenance officer are as follows:

1. Identification of the cost, in manhours, to support a single aircraft.
2. Identification of the cost, in manhours, to support a single system within an aircraft, and identification of the system that caused the most trouble.
3. Identification of the cost, in manhours, of scheduled or unscheduled maintenance performed on the aircraft.

Beyond Capability of
Maintenance and Repair
Data Report (MDR 8,
Parts 1, 2, 3, & 4)

This report is a tabulation of all items processed through an Intermediate level maintenance activity on the No. 3 copy of the multicopy MAF during the month. To facilitate the extraction of information, the report is prepared in four parts. The difference between parts 1, 2, and 3 is the manner in which the data is sequenced or summarized, while part 4 utilizes a different sequence and data source. The report is intended for maintenance managers at the Intermediate level.

The basic design of this report lends itself to determining percentages of items not repaired, items received that require no repair, and items that were repaired. Typical uses of the report by IMA maintenance managers are as follows:

1. Determination of the percent of the total components processed in an IMA that are not repaired.
2. Determination of the percent of the components received in an IMA that do not require any repair.
3. Determination of the percent of the component received in an IMA that are returned to the Supply Support Center in an RFI condition.
4. Identification of a squadron responsible for a high number of processed components that do not require any repair.
5. Determination of the percent of items not repaired that were not repaired because of a lack of spare parts.
6. Determination of the repair capability of individual work centers.
7. Determine the total manhours and elapsed maintenance time expended in the repair of an item by a work unit code.

The MDR 8, Part 1 is an optional report and it is not prepared by data services unless specifically requested by an activity.

Failed Parts Report (MDR 9)

This report is a detailed listing, by organization, of all failed part cards punched from MAF's submitted during the month. It is intended for the maintenance officer. Quality assurance personnel can use the report as a lead-in to parts reliability studies. This report is also used by material control personnel to determine parts usage rates.

Repair Cycle Data
Report (MDR 10)

This monthly report is a detailed listing, by organization, showing the number of days involved in the turn-around time, and the elements that compose the turn-around time, for each reparable component processed through the IMA as documented on the No. 3 copy of a MAF. Typical uses of the report by maintenance managers are as follows:

1. Analysis of elements composing the turn-around time for reparable components.
2. Determination of job standards.
3. Identification of delays encountered in the repair cycle with resulting indications of initial areas to be investigated in order to reduce processing and repair delays.
4. Identification, by component serial number, of components that appear repeatedly in the Intermediate maintenance activity repair cycle.

No Defect Report (MDR 11)

This report is designed for maintenance managers at the Intermediate level. It provides a means to rapidly and accurately identify the areas in which the Intermediate activity is expending effort on components which need no repair. Naturally, actions of this type seriously impair the ability of an Intermediate activity to take rapid action on actual repairs.

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This report provides for the identification of Organizational activities which may have troubleshooting difficulties. It also identifies components which require improvement or for which additional Organizational level test equipment is necessary.

SPECIAL REPORTS

Maintenance managers and analysis personnel have at their disposal an extremely valuable tool in the form of special reports. Many times in the past, an area that should have been studied was avoided because of the difficulty of extracting data from available reports and forms. If the information is known to exist in MDR files, it can be obtained in a special report. Special reports should not be used indiscriminately because of the additional, and often excessive, workload imposed on data services personnel and machines. However, if there is justification, these reports can be readily obtained.

Special reports may be provided on a one-time or recurring basis. Any, or all, standard MDR's may be prepared as special reports upon demand. This occasion could arise from a desire to produce certain reports for a specific period other than the normal reporting period. Standard reports may also be prepared as special reports for maintenance data generated away from home, if an organization spends part of the reporting period away from home and there is a need to reflect these data separately from the total data.

In designing a special report, there are two prime factors which must be considered—the intelligent selection of the applicable data and a method of sorting the punch cards to select those containing the desired information, and the design of the format in which the report is to be printed. It should be remembered that the wiring of a control panel for an EAM is difficult; therefore, whenever possible, the use of a control panel that is used in standard reports preparation should be considered.

The content, or subject matter, of special reports depends upon the needs of the requesting activity. Some activities may use several special reports, whereas others may use none. The special reports discussed in the following sections represent a few typical applications.

Configuration by Individual Item Report (MDR S-1)

This type of special report is prepared from information extracted from the configuration control form. The frequency of the report is dictated by the volume of forms processed, a timely need for the information concerned, and similar criteria. A special report of this type could be used by the log yeoman, or other maintenance personnel involved in changes of equipment configuration, and could be used to monitor changes, verify records, etc.

No Defect Report (MDR S-2)

This type of report may be requested by activities that need additional summarized data on the effort and time expended on maintenance actions in which there were no apparent malfunctions. Some of the types of data required for a report of this nature are as follows:

1. Reported malfunctions which were either nonexistent or could not be duplicated.
2. Manhours used in cannibalization.
3. Manhours expended in removing and installing items with no known malfunction, solely to facilitate other maintenance.
4. Those items removed or installed because of time change or scheduled maintenance.
5. Those items removed and installed because of technical directive compliance.
6. Those items removed as part of a matched set.

After the selection of desired data has been extracted and summarized in report form, it can be readily analyzed and used for conclusions with regard to questions posed by management.

Foreign Object Damage Report (MDR S-3)

A report of this type could be used to measure the maintenance effort attributable to foreign object damage. Components replaced, repaired, condemned, etc., can be identified by means of data contained in the MDR files. Indirectly, a report of this type would reflect current housekeeping conditions (cleanliness of ramps, runways, hangar areas) or the maintenance proficiency of the personnel (adherence to proper maintenance practices). The source of data for this report would be extracted from MAF's which contain malfunction description codes showing foreign object damage.

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Corrosion Control/Treatment Report (MDR S-4)

This special report provides a possible means of monitoring a corrosion control program or investigating the amount of corrective corrosion treatment necessary in an organization. The information for this report is extracted from SAF's and MAF's which are documented showing corrosion control or corrosion treatment actions.

Study of a report of this type would show if any type aircraft required more treatment than others. A check on where these aircraft had been operating might lead to better corrosion control programs for aircraft where special operations or deployment is involved. It would be a simple matter to determine if any specific portion of the aircraft needs a better corrosion control program because of its design or location.

The typical special reports discussed in the preceding paragraphs point out the variety of specialized information that can be provided from the maintenance data reporting system. Carefully selected data, properly displayed, is of utmost assistance to conscientious maintenance managers.

MAINTENANCE DATA ANALYSIS

The MDCS was designed to accumulate factual data pertaining to all phases of aircraft maintenance. As previously discussed, this data is made available to maintenance managers in the form of standard and special reports. The progressive maintenance manager can identify the potential of these reports and successfully use them in the course of managing his particular work center or maintenance activity.

The function of analysis is to examine the data contained in the reports and determine what impact the conditions indicated have on the maintenance effort. Analysis brings to light both good and bad conditions. Maintenance managers should be informed not only of unfavorable conditions in a maintenance activity, but also of those conditions that appear to be favorable. Obviously, the MDCS will be of little value to maintenance managers if its principal characteristic, the ability to furnish data for analysis, is not utilized to the fullest extent. AZ's must exert every effort in the fields of data collection and data analysis to insure that management has the required information. Senior AZ's performing management functions should use the results of analysis in a constructive manner.

It is evident that the time, trouble, and expense involved in collecting and machine processing maintenance data cannot be afforded if the data is not continuously and constructively used by maintenance managers. In order for it to be used, it must first be analyzed. In effect, the processes of data collection and machine processing provide a mass record of what happened. The process of data analysis sorts out from this mass of data significant events which require corrective action or otherwise merit management attention. By this process, managers are provided with filtered facts as a basis for decision.

The depth and amount of analysis performed on collected data vary from one activity to another, dependent upon the mission assigned, special circumstances involved, etc. AZ's performing analysis functions should strive for continual refinement of the data analysis process in order to realize full benefits from the system and also for system improvement.

ANALYSIS DIVISION

The Aviation 3-M System has brought about major changes in the field of data analysis at Organizational and Intermediate level maintenance activities. Numerous reports are analyzed for the purpose of furnishing management factual information. This task is properly the function of the analysis division.

An analysis division has been established in each Organizational and Intermediate maintenance activity. In regard to size, this is probably the smallest division in a maintenance department; however, this is not in keeping with its importance. This division is charged with the responsibility of insuring that the maintenance data collection system is operated in an orderly and efficient manner, and monitoring and controlling the system for the maintenance department. It also serves as the contact point between the activity and data services and coordinates, with data services, the day-to-day system operation.

In regard to organizational structure, the analysis division is located directly under, and operates as a staff division to, the Aircraft Maintenance Officer. This division is responsible for the smooth and correct operation of the 3-M System at Organizational and

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Intermediate level maintenance activities and provides assistance and guidance as needed to achieve this end.

Specific tasks performed by the analysis division for the overall system include the following:

1. Coordinate the expansion of work center and labor codes within the code structure provided in governing instructions.

2. The designation of pickup and delivery points for source documents and machine reports.

3. Coordinate with data services for delivery, pickup, and processing procedures between the maintenance and data services activities.

4. Insure that an adequate supply of necessary manuals, source documents, registers, etc., are available in the various work centers.

5. Coordinate training schedules to insure that all maintenance personnel receive adequate training on the system.

6. Assist work center supervisors by providing on-the-job training as required.

The analysis division has numerous responsibilities and performs various functions in addition to those previously mentioned. Some of these are discussed in the following paragraphs:

In the area of manhour accounting, the analysis division performs the following functions and tasks:

1. Monitors manhour accounting throughout the maintenance organization.

2. Advises maintenance officers of all areas of weakness in the use of the manhour accounting system. Training in manhour accounting is provided through actual demonstration, classroom instruction, or on-the-job training as appropriate.

3. Accomplishes specific analysis of manhour accounting data as necessary.

4. Assists maintenance supervisors in analyzing manhour reports.

5. Coordinates all manhour accounting matters with data services, including the preparation of additional required reports.

6. Monitors the assignment of personnel to work center XXO. This includes the responsibility for submission of applicable newly assigned and transferred cards and for maintenance of the master roster for this work center. NOTE: Work center XXO consists of those aviation maintenance personnel assigned to a maintenance activity that are working in functions outside maintenance. For example, personnel assigned to mess cooking, compartment cleaning, shore patrol, special services, etc., are assigned to this work center.

7. Promulgates listings of work center codes and sublabor codes that are used locally.

The analysis division closely monitors the maintenance of all master roster listings to insure that all permanently assigned and transferred transactions, permanent changes in assigned labor code, and revisions which occurred during the reporting period have been entered. At the end of each reporting period, work center master roster listings are reconciled against the copy maintained by the analysis division, which is updated daily utilizing the assigned, transferred, and revision manhour accounting cards submitted by the work center supervisors. Any differences are resolved with the assistance of applicable work center supervisors.

Upon completion of this reconciliation by the analysis division, the original copies of the master roster listings, amended as necessary, are forwarded to data services for processing. At this time, the analysis division advises data services of the number of original assigned manhours per man in the forthcoming period.

The analysis division is the hub around which an activity's maintenance data reporting system revolves. This division receives all the source documents from all work centers, reviews them for completeness and accuracy, and insures that they are delivered to data services. The analysis division must also review and analyze the resulting reports for information that is of benefit to the maintenance activity. Some of the responsibilities that are assigned to the analysis division in the area of maintenance data reporting are as follows:

1. Sort and arrange all source documents prior to their delivery to data services for keypunching.

2. Monitor the maintenance data reporting system.

3. Collect and maintain in narrative, tabular, chart, or graph form the data needed to monitor, plan, schedule, and control the maintenance effort.

4. Analyze and compare maintenance performance against maintenance plans and workload estimates.

5. Review maintenance data reports for significant variations from normal. Isolate and identify the trouble areas revealed by these reports for further investigation by the maintenance officer and other appropriate supervisors.

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6. Develop methods, in coordination with data services, for extracting selected data from the maintenance data reporting card decks for use in making detailed analyses of particular problem areas.

7. Assist the maintenance officer and other supervisory personnel in developing new types of recurring machine run reports deemed necessary for management of the maintenance effort.

8. Prepare briefs and explanations covering the content of the reports produced by the MDRS. These briefs are presented to the commanding officer, the maintenance officer, and other supervisors as required or requested.

9. Identify and analyze material deficiencies and high manhour consumption areas, and study other pertinent trends.

10. Assist the training section in identifying areas of possible deficiencies in training.

11. Assist the material control work center in relating the contents of monthly maintenance data reports to material consumption and forecasts for material.

12. Train work center personnel in proper documenting procedures, and assist supervisory personnel in the correct interpretation of resulting reports.

13. Assist in the preparation of pertinent reports.

14. Coordinate all data collection matters with data services, including the preparation of additional reports as required.

The responsibilities of the analysis division concerning aircraft and support equipment statistical data are closely related to those previously discussed. In addition to the analysis functions performed on collected data, personnel of the analysis division screen submitted ESD and AMSE cards for accuracy and completeness, distribute both aircraft and support equipment statistical data reports, and assist in the reconciliation of errors.

In summary, the analysis division is the element in aviation maintenance activities in which all data generated from the maintenance organization are collected, broken down, studied, and evaluated. The analyst performs these functions in order to predict future trends, identify potential trouble areas, establish performance standards, develop capabilities, and evaluate the results of statistical studies.

Thus the prime responsibility of the analyst is to insure that management has up-to-date information relative to all areas of the organization at all times. In addition, analysts may be required to assist maintenance supervisors by explanations or interpretations of maintenance reports and summaries. Therefore, the duties of an analyst consist of (1) analyzing maintenance data to compare performance against plans, schedules, and workload estimates, (2) reviewing reports to identify production effectiveness trends and areas requiring management action, and (3) assisting maintenance activities and personnel in the operation, interpretation, and use of maintenance, manhour, aircraft, and support equipment data.

Document Control Form

The Document Control Form (fig. 5-2) is used to control the flow of source documents between the originating activity and data services. Daily, at a specified time, all completed source documents held in the work centers are delivered to the analysis division. The analysis division is responsible for the grouping of documents by type and for the preparation of the Document Control Form.

To maintain an even keypunch workload, it is necessary that all source documents be delivered for keypunching at least once each working day. Two copies of the Document Control Form are prepared each time source documents are submitted to data services. The various source documents are separated, grouped, and counted to aid the data services keypunch operation. The analysis division enters under 1st COUNT the number of documents in each category submitted. Data services verifies this number by entering their count in 2nd COUNT. After the daily process has been completed by data services, the original copy of the form is filed and the carbon copy is returned to the analysis division for filing. The filed copies are maintained for a minimum period of 3 months.

If a particular activity desires to identify the data generated in an away from home situation, a one-character code is entered by the analysis division in the space titled AWAY FROM HOME CODE. Any numerical or alphabetical character desired by the maintenance activity is entered in this space; for example, "F" for USS FORRESTAL, "C" for NAS CECIL FIELD, etc. All source documents submitted with an away from home code on the Document Control Form are processed to include this code in the machine records produced. This control feature can be utilized to produce special reports upon request.

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DOCUMENT CONTROL FORM
MMMPC TEST FORM #13 (REV. 10/66)

DATE (JULIAN) 8101

ORGANIZATION AC4

AWAY FROM HOME CODE

MANHOUR ACCOUNTING CARDS	FORMS COUNT 1	FORMS COUNT 2	FORMS REJECT	ENTRY PROCESS	CONTROL A.	CONTROL B.
N Newly Assigned	1	1		1		
G Temporarily Assigned	12	12		12		
T Transferred	2	2		2		
L Temporarily Transferred	8	8		8		
R Revision						
9 Replenishment						
X Correction						
O Other	72	72	2	70		
MAINTENANCE DATA REPORTING FORMS						
01 Support Action	16	16		58		
11 MAF - Single Copy	26	26		26		
12 Failed Parts From MAF Single Copy						
16 REMOVED Item From MAF Single Copy						
17 INSTALLED Item From MAF Single Copy						
21 MAF - Copy 1	7	7		7		
26 REMOVED Item From MAF - Copy 1						
27 INSTALLED Item From MAF - Copy 1						
31 MAF - Copy 3						
32 Failed Parts From MAF Copy 3						
41 TDC Form	3	3		3		
53 Configuration Control Form						
46/47 Old/New Items on TDC Form						
XX SAF Replenishment						
EQUIPMENT STATISTICAL DATA CARDS						
71 Readiness Transaction	9	9		9		
73 Inventory Change	1	1		1		
76 Flight Transaction	7	7		7		
XX Replenishment						
90 AMSE Data Cards						

TIME RECEIVED 0915

SIGNATURE OF RECIPIENT R. a. Hill

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Figure 5-2.—Document Control Form.

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If, during the keypunch operation at data services, a document is found to be incomplete, in error, or illegible, it is returned to the originating activity for completion or correction. The questionable data is encircled in red by data services. A total of the rejected forms is entered in the appropriate column of the Document Control Form by data services. Rejected documents are corrected and returned to data services with the documents submitted the following working day. Resubmitted documents are totaled with the regular documents on the Document Control Form.

Rejected documents or late documents that are submitted after the end of a reporting period require submission with a special Document Control Form if the data is to be included with the previous month's data. Any such submission requires special coordination with data services.

The ENTRY PROCESS column is completed by data services and represents the total number of punch cards keypunched from each group. The CONTROL columns, A and B, are provided for additional local controls if desired.

Calculating Machines

Senior AZ's performing analysis functions in Organizational and Intermediate level maintenance activities work with large quantities of numbers. Naturally, speed and accuracy are of utmost importance. To simplify many of the required figuring processes, calculators are used. Calculating machines are similar in appearance to adding machines; however, they can perform many additional functions.

Because of the nature of work which a calculator performs, it is a very delicate and intricate machine. Extreme care should be observed when lifting or moving calculators from one place to another. Many precision made parts and mechanisms are required for the accomplishment of its many functions. When the operator of a calculator depresses bars or keys on the keyboard, he sets in motion specific links, levers, bellcranks, cams, etc., for accomplishing a specific function.

Most calculating machines do not use tape for printing desired information. Instead, figures are displayed in small windows or dials. Calculators add, subtract, multiply, divide, and extract square roots. Operation of all types is based upon the principle that all calculations consist of addition, either positive or negative. In other words, multiplication is simply repeated addition, while division is repeated subtraction, or negative addition.

There are several makes and model of calculators used in the Navy. Some of these include those manufactured by Monroe, Remington, Friden, and Burroughs. These machines, although different in some respects, have many similar keys, mechanisms, and parts, because the operations they perform are closely related.

Discussion of the operation of all the various types of calculators that are used in analysis work is not appropirate in this training course. The information provided here is general in nature, and the machine discussed is a representative type of those used in analysis functions.

The Monroe model 8F-213 calculator (fig. 5-3) is one type used by aircraft maintenance activities in performing analysis functions. This particular model is equipped with an automatic decimal system. By setting certain movable decimal markers, located below each column of numbers, and placing required controls in their normal positions, the operator can work problems with decimal numbers and they are pointed off automatically.

In order to better understand operation of this machine, the use of certain locks, dials, and controls is discussed in the following paragraphs. These locks and controls position the carraige automatically, control the entry of figures into a set of dials, and produce selective clearance.

This machine has three dial locks which are located on the left end of the carriage. The uppermost lock, when down, prevents clearing of upper right dials. The normal operating position of this lock is in the UP position. The left and right lower dial locks are below the upper dial lock, and these locks control certain functions of the lower dials. The left lower dial lock, when down, prevents clearing lower dials from 10 to 21. When down, the right lower dial lock prevents clearing lower dials from 1 to 9. The normal operating position for both of these locks is in the UP position.

There are eight tab stops located on the carriage above the right upper dials. These stops, when depressed, stop the carriage in the desired position in multiplication and division.

The two carriage shift keys, located on the right upper part of the keyboard, are used to shift the carriage. These keys are readily identifiable by an arrowhead, one pointing to the left and the other to the right.

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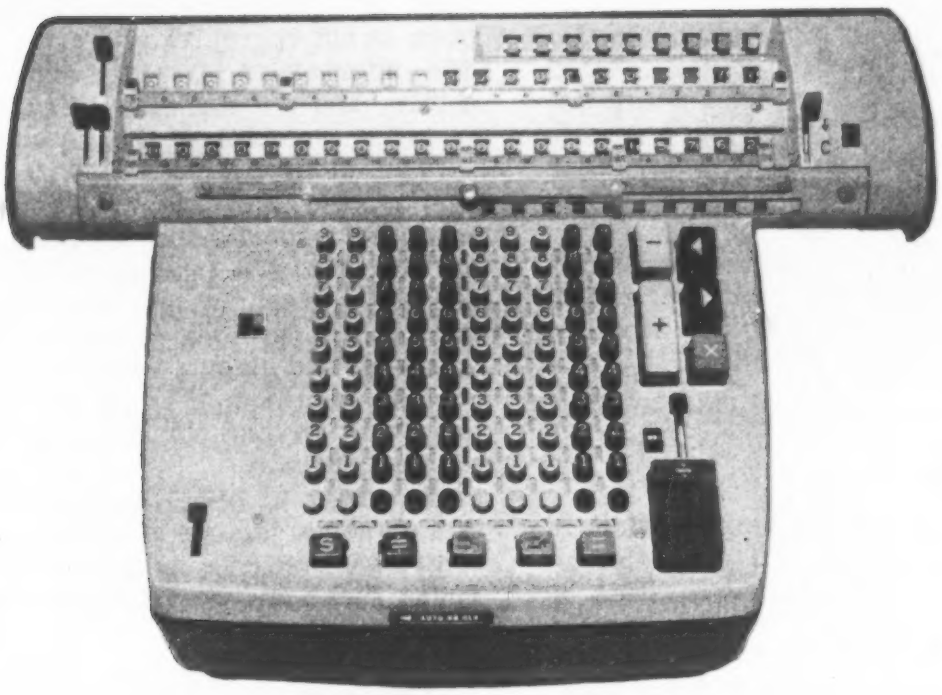

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Figure 5-3.—Monroe model 8F-213 calculator.

This particular model has four different dials, all located on the carriage. The upper dials are divided into two sets, right and left. The right upper registers the multiplier and the quotient and is used in cumulative multiplication. The left upper shows multipliers in black and quotients in red. The lower dials, located directly below the upper sets, register the sum in addition, the remainder in subtraction, and the product in multiplication. They also register the dividend before starting division. The multiplier dials, located below the lower dials, register the multiplier.

The enter multiplier key, identified by X, is located on the keyboard directly below the carriage shift keys and transfers amount set on keyboard to be used as multiplier to multiplier dials.

A constant multiplier lock, located on the right end of the carriage, provides for use of the same multiplier constantly with different multiplicands. The normal operating position for this lock is UP.

The dividend alignment lever, located on the lower left side of the keyboard, controls alignment of the carriage for lining up dividend in

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Instructor References

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lower dials with divisor on keyboard. The normal operating position for this lever is UP.

The automatic keyboard clear control is a two-position control located below the keyboard in the center of the machine. Amounts on the keyboard clear automatically after division or multiplication processes when this control is in the LEFT position. When in the RIGHT position, this control retains the amounts on the keyboard after division or multiplication. The normal operating position is LEFT.

The upper dials control lever, located on the right side of the keyboard below the plus bar, is a three-position control. In the UP or + position, positive amounts are entered on the upper right dials. In the DOWN or - position, negative amounts are entered. In the CENTER or 0 position, all entries except quotients are eliminated from the upper right dials.

The repeat-nonrepeat lever, located to the left of the upper dials control lever, is a two-position control. With this control in the NONREPEAT position, the keyboard is cleared after depressing the plus or minus bar. In the REPEAT position, the amount remains on the keyboard after depressing the plus or minus bar. The normal operating position for this lever is in the DOWN or NONREPEAT position.

The transfer slide, located directly above the multiplier dials, controls the automatic positioning of the carriage. A pullout type knob releases the slide so it can be moved from one numbered position to another.

The three clear keys, located on the lower right side of the keyboard, provide a means of individually clearing the upper and lower dials and the keyboard. The key marked with a U, when depressed, clears the upper dials. Likewise, the L key clears the lower dials and the C key clears the keyboard.

By depressing the stop key, located on the lower left side of the keyboard and identified by an S, all multiplication and division processes are stopped.

The enter dividend key is located directly above the upper and lower dial clear keys. This key is identified by ←÷; and when dpressed, automatically clears the upper and lower dials, shifts the carriage to the right, and clears the keyboard.

Prior to using the calculator for a specific function, it should be checked to insure that the dials are clear and the controls are in the normal operating position. After this has been accomplished, the operation of the machine in performing arithmetic problems is a relatively simple process. The major requirements is the knowledge of basic arithmetic symbols.

For addition, the number or group of numbers to be added is set on the keyboard one at a time. After each number or group is set, the plus bar, located on the keyboard adjacent to the carriage shift keys, is depressed. Each time the plus bar is depressed, the sum is registered in the lower dials.

In subtraction, the minuend is set on the machine and the plus bar is depressed. The subtrahand is set and the minus bar, located on the right side of the keyboard above the plus bar, is depressed. The remainder is registered in the lower dials.

A combination of addition and subtraction is accomplished by setting the numbers to be added and depressing the plus bar after each number or group of numbers. The numbers to be subtracted are set and the minus bar is depressed. The remainder is registered in the lower dials.

There are several multiplication processes that can be performed with this particular model. These include simple multiplication, accumulative multiplication, negative multiplication, multifactor multiplication, and constant multiplication. For the sake of brevity, only the simple multiplication process is explained. Some of the other processes require the use of additional keys located on the bottom row of the keyboard and other keys previously discussed.

For simple multiplication, the multiplicand is set and the enter multiplier key is depressed. The multiplier is set and the multiply key, located to the left of the keyboard clear key, is depressed. The product is registered in the lower dials.

Division is performed by setting the dividend and depressing the enter dividend key. Next, the divisor is entered and the divide key, located on the bottom row of the keyboard to the right of the stop key, is d ressed. This registers the quotient in the upper dials.

In addition and subtraction, the calculator must be manually cleared after each operation; however, in multiplication and division this is not required because the machine clears automatically.

Although calculators perform many more functions than are discussed here, most stem from these basic operations. With proper training and the aid of the manufacturer's technical manual for a particular model, senior AZ's should have little difficulty in the operation of calculators.

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ANALYSIS TECHNIQUES

As has been pointed out previously, the various MDCS reports contain a wealth of valuable information. This information consists of coded elements of data listed or summarized in logical arrangements. To be of practical use to management, selected data elements must be assembled, studied, and suitably presented. The accomplishment of these functions is maintenance data analysis.

One major requirement for the accomplishment of a comprehensive analysis is a thorough knowledge of the contents of each MDCS report and an understanding of basic analysis principles or techniques. These analysis techniques encompass the extraction, examination, and presentation of pertinent data. The resulting analysis products, properly used, assist management in attaining effective and economical utilization of personnel and material resources.

Certain standards have been established which provide all Navy maintenance activities with a "yardstick for measurement" in the maintenance and readiness fields. These include job standards (standard numbers of manhours to perform certain repair or maintenance jobs), readiness standards for various models of aircraft, and overall maintenance personnel utilization standards. For example, a 45-45-10 formula may be used as a standard for maintenance personnel utilization. Of the total manhours available to a maintenance organization over a given period of time, it is expected that 45 percent of them will be expended performing direct maintenance labor; 45 percent in indirect maintenance labor such as supervision, administration, quality inspection, and material control; and the remaining 10 percent going to nonproductive labor such as training, leave, medical, and disciplinary lost time.

When the direct labor portion drops below 45 percent, the indirect labor exceeds 45 percent, or the nonproductive time exceeds 10 percent, the normal expected standards have not been met, and possible corrective action may be required. Detailed analysis of collected data is required in order to determine which standards were met, which were not met, and any requirements for corrective action.

Analysis Requirements

The requirements for analysis may stem from various sources and apply to a wide range of maintenance problems. In most cases, analyses are initiated and performed in order to find answers to specific problems. However, in other situations, analyses of selected areas of maintenance are completed as monitoring actions. In any case, the requirements for analysis should be the result of a need to know situation imposed by management.

In order for any analysis to be effective, it is important that the problems or areas to be analyzed are adequately defined. Senior AZ's performing analyses should clearly understand what information management desires prior to starting the analysis. Next, the data to be analyzed should be carefully selected, analyzed, and presented to management in an understandable format. An analysis which is based on clear, concise requirements and is presented in an easily understood format is more likely to be meaningful and useful to maintenance managers than one based on generalities. The AZ analyst should make known, to management, what information is available through analysis of the various MDCS reports.

Data Selection

Once the subject of the analysis is known, the analyst must determine what data is needed to fulfill the requirement. There are no standard rules that can be applied to this phase of analysis. The training and experience of the analyst, in conjunction with his knowledge of the data actually available in the MDCS reports, have great influence on the selection of correct data. Selected data must be chosen wisely, insuring that all facts having a bearing on the subject will be included in the analysis. It is at this point that the analyst's knowledge of the contents of each MDCS report pays off. He must know which report, or combination of reports, best provides the data he intends to use.

Although all the MDCS reports are of prime importance to all AZ's, it is imperative that senior AZ's performing analysis functions have a thorough knowledge of the data contained in the various standard and special MDCS reports.

Data Extraction

The extraction of data is normally accomplished by a mechanical process. However, certain columns or lines of the various MDCS reports must be carefully screened to identify the desired data. After selection, the data is usually

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transposed to some type of worksheet to facilitate subsequent steps. The design of the worksheet should be simple, allowing ample space for the posting of extracted data in systematic sequence, and providing space for computation of totals and subtotals as needed. Analysts should design worksheets to meet the needs of the particular activity to which they are assigned.

Data Translation

The major portion of extracted data, in its pure form, consists of coded entries. In most cases, this coded data must be translated or changed into an understandable, written description before being used in analysis. Few maintenance personnel are able to sight read and completely understand a series of coded entries. For this reason, much of the coded data must be translated into an understandable, written description. Frequently, the design of worksheets will incorporate translation provisions. For example, columnar headings may contain both the coded and descriptive terminology.

Data Examination

This is the critical stage of analysis, as it involves the detailed study or examination of accumulated data. The extent and the quality of the examination are limited only by the skill, resourcefulness, and imagination of the analyst performing the analysis. In this respect, there are no restrictions as to who may accomplish an analysis. In many instances it is desirable that an analysis be completed in its entirety by personnel technically qualified in the subject being analyzed; however, this is not always possible. Identical results are often obtained through the use of teamwork. For example, personnel assigned to the analysis division may accumulate the required data, call in quality assurance representatives to examine the data, and jointly prepare a commentary pertinent to the analysis. Likewise, quality assurance may accomplish many phases of the analysis, calling on the analysis division only for assistance in the selection and extraction of the desired data.

Regardless of who accomplishes the examination, the intent of the detailed study of accumulated data is (1) to determine if a problem actually exists, (2) to identify factors contributing to the problem, (3) to list possible conclusions, and (4) to suggest possible alternative courses of action.

During this phase of analysis, certain standards, statistical formulas, and other measuring criteria are used. It should be remembered that any decisions or actions based on the detailed study are the responsibility of management, not the analyst.

ANALYSIS PRODUCTS

As has been previously stated, the results of analyses must be presented in such a manner as to be readily understandable by intended users. Various displays in the form of charts, graphs, and tables are used for this purpose in maintenance data analysis. To be effective, these presentations should be designed to meet the needs of intended users. The old saying "a picture is worth ten thousand words" is especially true when applied to analysis products. By use of graphic presentations, a word picture can be made to convey a meaning to others that may otherwise be difficult to understand.

Presentation is as much a part of the job as is data collection and analysis. Effective presentation requires a good deal of imagination and ingenuity on the part of the analyst. The long, tedious hours spent collecting, studying, and analyzing maintenance data may end up being presented orally, narratively, or only as a curved line or several crosshatched bars on a graph.

The way presentations are constructed or designed and the manner in which they are presented may determine the success of failure of the entire study. All conclusions must be interesting, concise, and easily understood, and at the same time be eye appealing and clever enough to hold attention of those managers or other persons for whom the presentation is being made.

In order to acquaint AZ's with some of the many ways of presenting analysis products, the following general information on graphic presentations is provided. While studying the following paragraphs, keep in mind that a graph is a method of presenting statistical data in visual form.

For the sake of simplicity, graphic presentations may be divided into two classes—analysis charts or graphs made for the use of the analyst, and presentation charts and graphs used to present information to other people.

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A bar chart is a visual contrast between quantities by comparison of bars of varying length and uniform width, arranged vertically or horizontally. Two types of bar charts are absolute charts and percent charts. When constructing this type of chart, remember that a bar should be neither short and wide nor long and narrow. Also, if space permits, bars should be separated by spaces about one-half the width of the bar. A scale is generally useful, and guidelines are helpful in reading this type of chart.

A pie chart or diagram is a chart of circular shape broken into subdivisions. The size of the sections indicates the proportion of the component part to the whole. Since this type of chart is in a circle, 1 percent equals 3.6 degrees; and this fact is important when constructing a pie chart depicting percentages.

Sectors should be arranged clockwise according to size, and a uniform arrangement of sectors must be made in comparing charts. A minimum of sectors should be used in pie charts. Whenever possible, wording and percentages should be placed horizontally in each sector. Sometimes the effectiveness of a pie chart is intensified by shading, crosshatching, or using different colors for the various sectors. However, if this is done in place of wording in each sector, a legend should be provided to indicate their meaning. A pie chart is difficult to construct accurately, and it is difficult to estimate visually with any degree of accuracy the proportionate size of the sectors when percentages are not indicated.

Line or curve graphs show variations in data by means of a line or curve. They are used to picture a time series (show a trend) and for showing frequency distributions. These graphs are normally constructed on commercially prepared graph paper or a locally prepared substitute. When constructing these graphs, the starting point is selected where a vertical and a horizontal line meet. This is the 0 point. The vertical line from this point is the Y axis or scale and the horizontal line the X axis or scale. These graphs are constructed by plotting points whose positions are determined by their respective values on the X and Y scales and connecting these points with lines.

There are many kinds of special charts, a few of which are mentioned to give an idea of the possibilities for graphic presentations.

Silhouette charts may be constructed to show positive and negative deviations from a base line filled in.

Component part (band) charts show variation in the component parts as well as the total.

High-low (range) charts may be used to show a range of variation over a period of time.

Regardless of the type of graphic presentation used, there are numerous rules to be considered in their preparation. These include, but are not limited to, the following:

1. Plan in advance of the construction.
2. Keep the presentation simple, honest, and accurate.
3. Try not to create the wrong impression.
4. Use one subject at a time.
5. Keep background clear of unnecessary grids. Grid lines should be drawn very lightly and marginal lines slightly heavier than other grid lines.
6. Do not crowd the material.
7. Title fully and accurately. It should be placed at the top center of the graph and should include nature of data and period covered.
8. Start scales at zero and place scale values along X and Y axes.
9. Be neat and prepare an attractive presentation.
10. Include pertinent comments on charts, graphs, and tables. A presentation worth making is worthy of comment.
11. Use short, complete notes when necessary. Footnotes should be placed under the graph.
12. Indicate the source of the data contained in the presentation under the graph.
13. Place all lettering horizontally, if possible.
14. The presentation should be large enough to be seen by all who need to see it. However, chart proportions should not give misleading impressions.

In the following sections some of the many analysis products that can be derived from MDCS reports are discussed. These are but a few of the many analysis applications, examination methods, and analysis techniques found in maintenance data analysis. The information provided is general in nature and in no way is intended to prescribe standard reporting formats. The illustrations should be studied along with the text in order to more fully understand maintenance data analysis products.

14302

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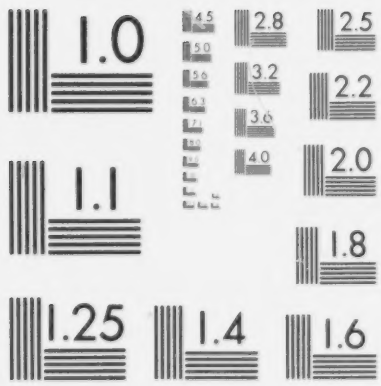

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

MANAGEMENT EVALUATION CHARTS

Analysts construct this type of chart to portray the distribution of manhour assets, by labor category, within a particular activity. The primary objective of this type of chart is to assist in the process of internal management by illustrating the relationship that exists between manhour assets and their actual use. Management evaluation charts may be constructed for individual work centers, branches, or the whole maintenance activity. A work center management evaluation chart is depicted in figure 5-4. This is a simplified version; however, a chart of this type could be modified to include the amount of overtime within individual labor categories or to show productive manhours for selected types of equipment.

As shown in figure 5-4, the source of data for this type chart is MHA 2 and MDR 2. The TOTAL MANHOUR ASSETS column includes the sum of net assigned and gross overtime manhours less overtime reported in absence labor codes (810 through 950). These total assets are divided into the various labor codes in which the manhours were expended. These include direct, indirect, nonproductive, duty absence, and nonduty absence labor codes.

The column titled OVERTIME contains all overtime manhours reported in labor codes 500 through 740. The last column contains the total number of manhours expended by the work center that were documented on maintenance action, support action, and technical directive compliance forms. The percentage shown in this column represents the reporting effectiveness of the work center and is obtained by dividing the manhours entered in this column by the manhours entered in the DIRECT column. The other percentages are obtained by dividing the manhours listed in each labor category by the manhours entered in the TOTAL ASSETS column.

The available direct labor (labor code 500) manhours, shown as 58.3 percent of the total

MANAGEMENT EVALUATION CHART ACTIVITY: VF-14 WORK CENTER: 210 PERIOD: 1 through 30 June 1968

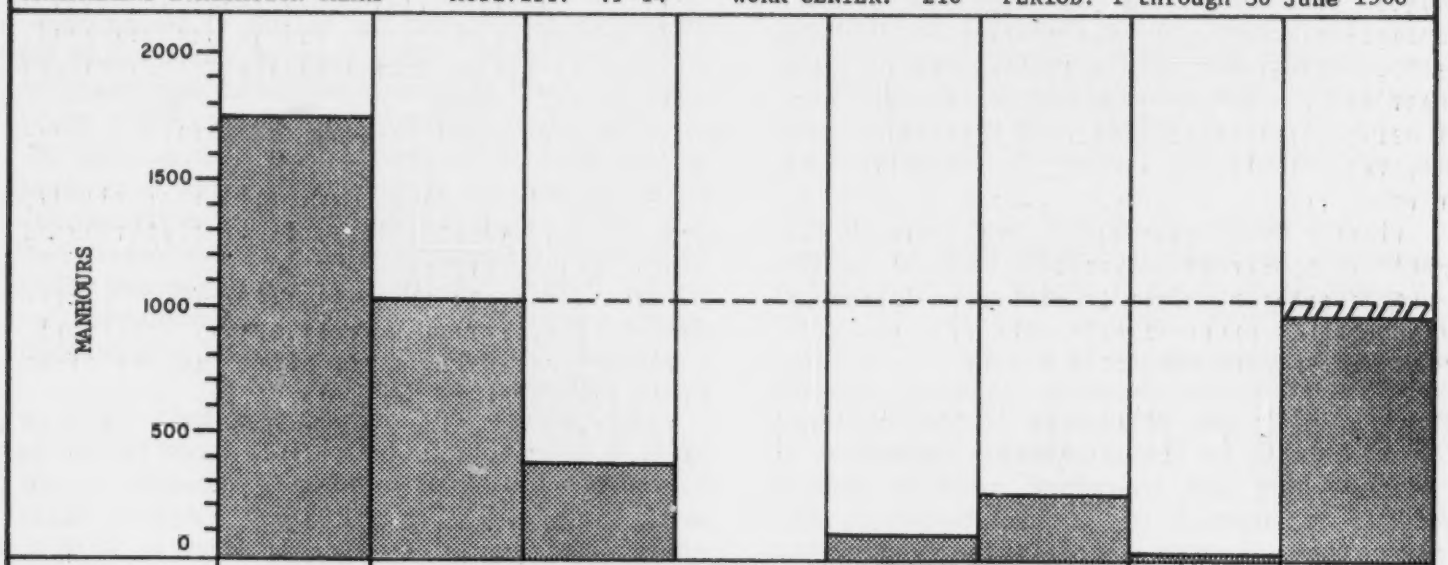

COLUMN TITLES & CODES	TOTAL ASSETS	AVAILABLE MANHOURS DIRECT 500	INDIRECT 600	NON-PRODUCTIVE 700	DUTY ABSENCE 800	NON-DUTY ABSENCE 900	OVERTIME (5,6,700)	MDR
MANHOURS	1,767.7	1,030.6	383.6	5.3	97.2	251.0	14.8	988.0
PERCENTAGES OF TOTAL ASSETS		58.3	21.7	.3	5.5	14.2	.8	95.9 of Direct

COMMENTS: THIS WORK CENTER IS WELL WITHIN ESTABLISHED GOALS.

SOURCE: MHA 2
MDR 2

AZ.16

Figure 5-4.—Work center management evaluation chart.

14303 POCAI

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assets in figure 5-4, is a highly variable item. Much depends on the type of work center involved. The maintenance control work center would probably have no entry in this column, whereas a line division work center would have a high percentage. Maintenance functions which use large amounts of indirect labor cannot be expected to have high percentage in this column.

When evaluating the DIRECT LABOR column, the working environment, personnel assigned, and other similar factors must be considered. The location of a work center may cause its personnel to spend and excessive amount of time traveling to and from jobs. Naturally, this would reduce the manhours available for direct labor. Also, a work center with the majority of assigned personnel in the upper pay grades will ordinarily lose less direct labor manhours to absence categories than one with the majority of personnel in the lower pay grades.

Excluding staff type functions, indirect manhour expenditures usually decrease as the direct manhours increase. The reverse tends to be true when a light workload exists. Other factors which may lead to an increase in indirect labor expenditures are the performance of plant maintenance, the accomplishment of additional technical training within a work center, and the assumption of increased administrative duties.

Nonproductive manhours must be closely monitored, as these contribute little or nothing to the maintenance effort. The manhours listed in the two ABSENCE columns represent those not available to maintenance as a result of watches, inspections, nonmaintenance training, special liberty, leave, etc. Manhours of this type are a direct drain on the manpower resources of a work center and, therefore, must be closely watched to prevent them from becoming excessive and seriously impairing the productivity of the work center.

If the work center is adequately staffed, the workload properly scheduled, and the amount of absence manhours is reasonable, the expenditures shown in the OVERTIME column will be small. An abnormally high utilization of overtime, unless caused by an unpredicted workload, is usually a signal of an unbalanced condition within the work center.

As previously stated, the manhours entered in the MDR column represent those manhours documented by the work center on MDR forms. Ideally, total production manhours should equal the number of hours of available direct labor shown in the DIRECT column. A significant variance between the MDR and DIRECT columns indicates failure of the work center to correctly submit manhour accounting cards for exceptions from assigned direct labor or failure to correctly document production manhours on MDR forms. Therefore, complete and accurate MDR and MHA reporting is essential and must be stressed accordingly.

A management evaluation chart should be accompanied by a brief, written narration. The purpose of this narration is to point out areas of special interest, call attention to significant deviations from desired standards, and give credit for good performance when due.

A chart of this type may be used in either an Organizational or Intermediate level maintenance activity.

PERSONNEL UTILIZATION CHART

A personnel utilization chart is designed to show the utilization of the manhour assets within an activity in the terms of broad categories of labor. This type of chart could be used by both Organizational and Intermediate maintenance activities. The purpose of a chart of this type is to provide the commanding officer an overall picture of how his personnel are being employed and to allow comparisons of current utilization rates with predetermined goals. Figure 5-5 illustrates a personnel utilization chart for a squadron maintenance department. Discussion of the chart is contained in the following paragraphs.

The source of data for this type chart is MHA 4 and MDR 2. The direct labor (MDR) is the total number of manhours expended by all work centers that were documented on MDR source documents. These are listed in MDR 2. The indirect plus nonproductive labor is the sum of available productive indirect (600) and nonproductive (700) manhours. The absence manhours include the sum of duty absence (800) and nonduty absence (900) manhours less overtime manhours reported for these labor codes. Variance represents the difference between available direct labor manhours and MDR manhours. It is obtained by subracting the total MDR manhours from the available direct manhours. The total assets include the sum of net assigned and overtime manhours less overtime reported in absence labor codes.

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PERSONNEL UTILIZATION CHART ACTIVITY: VA-196 PERIOD: 1 through 30 May 1968

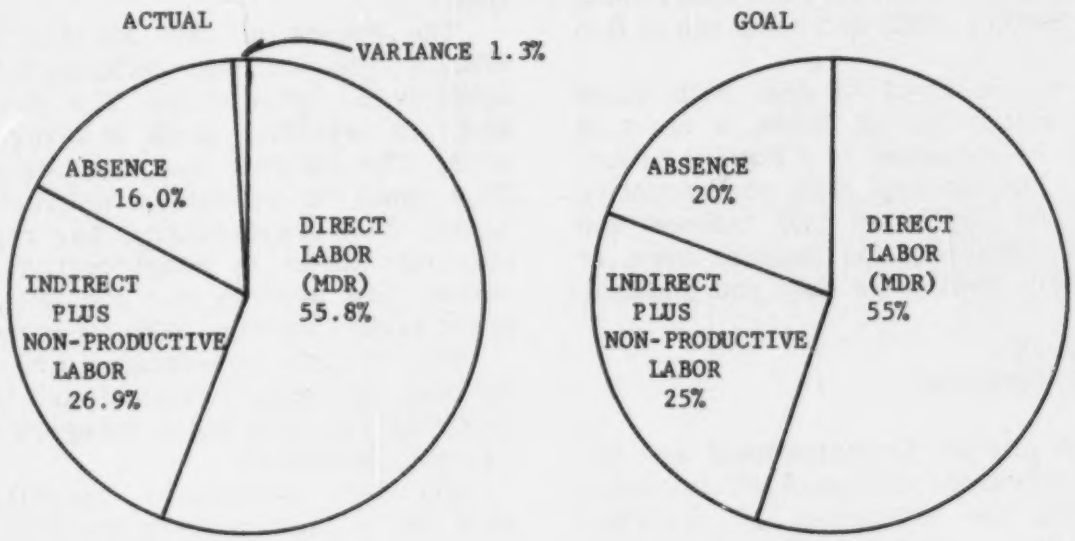

LABOR CATEGORY	MANHOURS
DIRECT LABOR (MDR)	15,910
INDIRECT PLUS NON-PRODUCTIVE (LC 600-700)	7,679
ABSENCE (LC 800-900)	4,569
VARIANCE (LC 500 LESS MDR)	360
TOTAL ASSETS:	28,518

COMMENTS: DIRECT LABOR PERCENTAGE SHOWS IMPROVEMENT OVER PREVIOUS MONTHS; HOWEVER, THE 1.3% VARIANCE INDICATES THE POOREST DOCUMENTATION SINCE IMPLEMENTATION OF THE 3-M SYSTEM.

SOURCE: MHA 4
MDR 2

AZ.17

Figure 5-5.—Personnel utilization chart.

The utilization percentages shown in the actual chart in figure 5-5 are obtained by dividing the manhours employed in each labor category by the total assets. In most cases, MDR manhours are less than available direct (500) labor. Therefore, a variance exists. The variance percentage is obtained by dividing the variance manhours by the total assets and the segment is plotted to the left of the chart centerline.

NOTE: In the event the MDR manhours exceed the direct labor manhours, the sum of direct, indirect, and absence manhours will exceed total assets (100 percent utilization). This variance is indicated as a broken line to the right of the chart centerline.

The personnel utilization goal (fig. 5-5) is used for training purposes only. The standards, or goal, applicable to a given activity are established by appropriate authority. In determining these standards, the following factors must be considered:

1. The primary objective of a maintenance activity is the upkeep and repair of aircraft and related equipment; therefore, the direct labor output of an activity (production manhours documented on MDR forms) must be in alignment with the anticipated workload.

2. Indirect labor expenditures are recognized as essential, but should be held to a minimum. Excessive housekeeping costs have an adverse effect on the direct labor output and can lead to unwarranted overtime.

3. A just portion of the manhour assets should be allocated to absence categories in order to provide for military duty, leave, etc. However, losses to absence should not be allowed to reach unreasonable proportions.

14305

Comparison of the actual distribution of utilized manhours to the established goal will reveal any differences as far as broad divisions of labor are concerned. Such differences may require further study and research to find the cause.

Although not designed to deal with other than general categories of labor, a chart of this type may be expanded to a limited extent. For example, the indirect plus nonproductive segment may be separated into indirect and nonproductive. Likewise, the absence segment may be further divided as duty and nonduty.

UTILIZATION OF OVERTIME MANHOURS

In order to provide Organizational and Intermediate maintenance managers with information concerning the utilization of overtime manhours, a chart similar to that illustrated in figure 5-6 may be used. This chart is designed to show not only the overtime spent by the maintenance department, but also overtime expended in absence status such as watches, inspections, etc. Figure 5-6 represents a squadron maintenance department application.

The source of data for this type chart is MHA 4. The total bar includes total overtime spent in all labor codes. The direct bar consists of overtime spent in direct (500) labor code. The indirect bar consists of the overtime spent in production indirect (600) labor codes. The nonproductive bar represents the overtime spent in nonproductive (700) labor codes. The absence bar consists of overtime spent in duty absence (800) labor codes.

The various percentages are obtained by dividing the total overtime and the overtime reported for each labor category by the total assigned manhours.

Overtime percentage considered acceptable for a given activity must be determined by the commanding officer. Percentage actually utilized compared to a standard will determine if expenditures are within a desired limit. If overtime is excessive, a detailed breakout, by

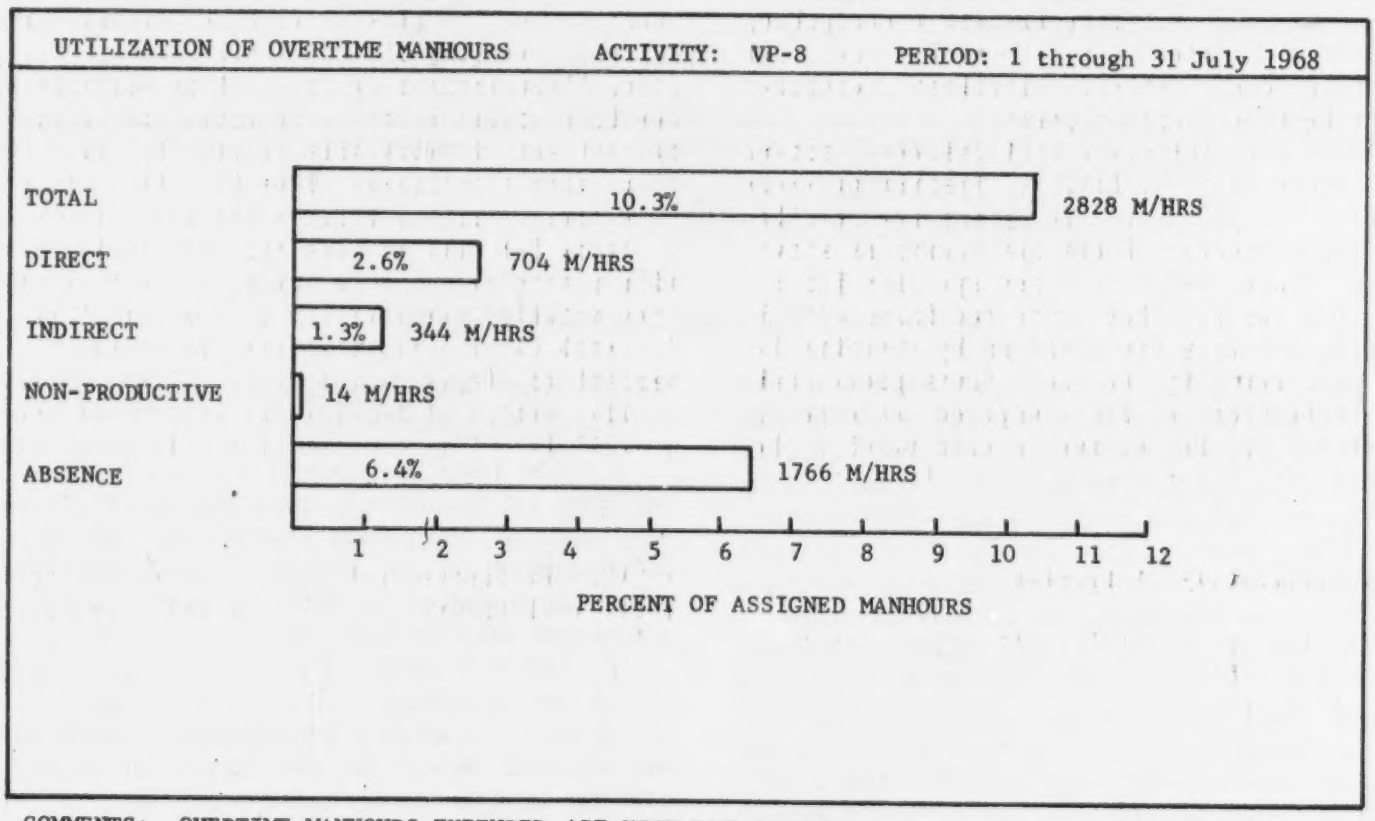

COMMENTS: OVERTIME MANHOURS EXPENDED ARE HIGH DUE TO THE REQUIREMENT FOR ADDITIONAL SECURITY WATCHES ON SQUADRON GEAR PACKED FOR DEPLOYMENT.

SOURCE: MHA 4

AZ. 18

Figure 5-6.—Utilization of overtime manhours chart.

14306 14305

labor code, may be required to isolate the labor code causing the condition. The absence overtime indicates those manhours spent after normal working hours, or on nonworking days, in the performance of nonmaintenance functions such as watches and inspections. Above normal expenditure of overtime in this labor category is of concern to management, from both the standpoint of morale and the loss of potential maintenance manhours.

COMPUTATION OF JOB AVERAGES

The average number of manhours required to accomplish a specific job is often used in conjunction with manning studies, workload scheduling, and similar managerial applications. Job averages may pertain to a simple remove and replace action or encompass the entire look phase of a calendar inspection. Job averages may be limited to the manhours contributed by a single work center or include the manhours documented by all work centers. Local needs dictate the actual extent of a particular job. The source of data for this type of computation is MDR 5. A typical method of computing a job average when only one work center and one maintenance action are involved is discussed in the following paragraph.

First, the applicable work unit code, action taken code, and malfunction description code defining the job must be determined locally. The items processed and the manhours shown on all lines listed for the specific job as defined above are then extracted from MDR 5. The job averages are obtained by dividing the total manhours by the total items processed. The reliability of the computed average is influenced by the amount of data used in the computation. To insure best results, statistics for an extended period of time should be used.

SHOP REPAIR DATA TABLE

The ability of an IMA to repair aircraft components efficiently and return them to RFI status for subsequent issue has a direct bearing on the aircraft operational readiness of supported activities. The IMA maintenance officer is constantly aware of production effort and initiates timely action to insure that an acceptable level of production is maintained. A presentation, similar to the shop repair data table shown in figure 5-7, provides the IMA maintenance officer with information to monitor the repair program and shows where he might increase maintenance repair capabilities.

NOTE: The line numbers, to the left of the action taken code column in figure 5-7, are used only for training purposes and to simplify the following discussion. The lines on an actual table of this type would not be numbered.

All data elements required to construct a table of this nature can be extracted from MDR 8-3. Lines 1 through 14 contain the double asterisk total for each action taken code for each work center. To obtain the total items processed by each work center, the entries in lines 1 through 14 are added and the sum entered in line 15. Line 16 contains the total number of items returned to service by each work center. This is the sum of action taken codes A, B, C, and Z. Line 17 contains the percentage of items processed within each work center that were returned to service. This is obtained by dividing the entry in line 16 by the total items in line 15 and multiplying the quotient by 100.

The total column contains the total items recorded by all work centers for each action taken code. The percent of total column contains the percent of total for each action taken code. This percent is obtained by multiplying the total column, for each action taken code, by 100 and dividing this product by the total of all items processed (line 15, total column).

A trend chart similar to the one illustrated in figure 5-8 may be constructed in conjunction with a shop repair data table. A chart of this type provides management with information on the total items processed and the number and percent of items returned to RFI conditions.

The source of data for this type trend chart is MDR 8-3. The number of months portrayed is normally determined locally; however, sufficient time should be shown to establish a definite trend. The figures used for the month of May in figure 5-8 are the same as those in the total column, lines 15, 16, and 17 of figure 5-7. Although some identical data may be contained in a shop repair data table and a components returned to RFI status trend chart, a table only provides information concerning one month, whereas a trend chart can provide data for several months.

These two analysis products are only a few of the many that can be obtained from the data contained in MDR 8-1 through 8-4. The number and type of components received for which no repair is authorized and the number

14307

TOPIC 2: CONSTRUCTION TECHNIQUES

Competencies

- Lay pattern on fabric and cut out pieces.
- Use staystitching.
- Make fullness in garment.
- Use proper seam construction.
- Pin-fit garments.
- Use hand and machine techniques for basting and removing stitches.
- Join garment parts.
- Apply a variety of interfacings.
- Apply a variety of facings.
- Understitch edges.
- Bind and pipe garments.
- Make different kinds of buttonholes by hand and machine.
- Measure, mark, and sew all types of hems.
- Cuff trousers.
- Line a variety of garments.
- Attach findings.
- Make various kinds of belts.
- Make fasteners.
- Apply commercial trimmings.

Motivating Procedure

Display mockups of various types of construction techniques. Have trainees turn in a list of techniques for which they will need instruction.

Learning Experiences

- Demonstrate and/or use filmstrips to show selected construction techniques.
- Have trainees develop new or improve their sewing skills by constructing a garment for own use, constructing garments for class use, or

ESM 1428

SHOP REPAIR DATA TABLE — ACTIVITY: AMD OCEANA — PERIOD: 1 through 30 May 1968

	ACTION TAKEN	510	511	520	530	540	550	560	610	620	621	630	631	640			TOTAL	%OF TOTAL
		← WORK CENTERS →																
(1)	A										56	27	51	3			137	16.0
(2)	B								1		2		6				9	1.1
(3)	C	1	3				3	2	9	3	273	100	20	1			415	48.5
(4)	Z																0	0.0
(5)	1		2	4		1	22	2	19	2	6	10	111	2			181	21.2
(6)	2			1	2	6	1		3	6	6	4	11	1			41	4.8
(7)	3										1						1	0.1
(8)	4						5	1	1	2	1						10	1.2
(9)	5																0	0.0
(10)	6								1		1			1			3	0.4
(11)	7						1										1	0.1
(12)	8																0	0.0
(13)	9						14		11	12	1	2	10	7			57	6.7
(14)	OTHER																0	0.0
(15)	TOTAL	1	5	5	2	7	46	5	45	25	347	143	209	15			855	
(16)	SUM OF ACTION TAKEN A+B+C+Z	1	3	0	0	0	3	2	10	3	331	127	77	4			561	
(17)	%RETURNED TO SERVICE	100.0	60.0	0.0	0.0	0.0	6.5	40.0	22.2	12.0	95.4	88.8	36.8	26.7			65.6	

COMMENTS: A SHARP INCREASE IN THE NUMBER OF ITEMS PROCESSED BY THE AVIONICS DIVISION WHICH REQUIRED NO MAINTENANCE ACTION (ACTION TAKEN CODE A) IS EVIDENCED THIS MONTH.

SOURCE: MDR 8-3

AZ.19

Figure 5-7.—Shop repair data table.

of components processed that require no repair are other areas which may be analyzed by IMA analysts.

AIRCRAFT READINESS CHART

There are several methods of presenting the results of analysis in the area of aircraft readiness. These presentations provide management with a picture of operationally ready hours and percentage as well as hours and percentages not operationally ready maintenance (NORM) and not operationally ready supply (NORS). Figure 5-9 illustrates an aircraft readiness chart in the form of a pie chart.

The source of data for this type chart is ASD 3. The percent operationally ready is obtained by dividing the number of ready hours by hours IN NOR reporting status. The percent not operationally ready supply is obtained in a similar manner. The NORS hours are divided by the hours IN NOR reporting status. Likewise, the percent not operationally ready maintenance is obtained by dividing the NORM hours by the hours IN NOR reporting status.

An aircraft readiness chart provides management valuable information. If the percent of readiness is not considered acceptable, further analysis may be required to determine what factors have created this situation.

The fact that all aircraft must be periodically grounded for calendar inspections must be considered when performing analysis on NORM hours. However, if an unusual percentage is noted for this category, improper scheduling of inspections or other faulty practices may prevail.

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COMPONENTS RETURNED TO RFI STATUS ACTIVITY: AMD OCEANA PERIOD: JAN through JUN 1968

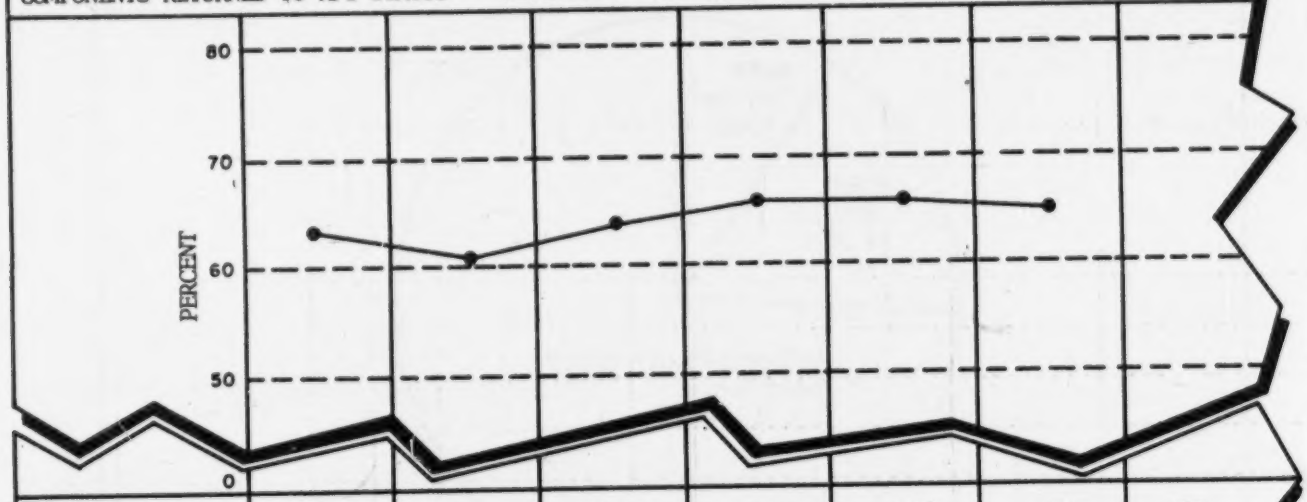

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL
ITEMS RETURNED TO RFI STATUS	498	489	523	550	561	554	
TOTAL ITEMS PROCESSED	797	804	832	846	855	855	
% RETURNED TO RFI	62.5	60.8	62.9	65.0	65.6	64.8	

COMMENTS: THE TREND OF COMPONENTS RETURNED TO AN RFI STATUS HAS REMAINED AT ABOUT 65% SINCE APRIL 1968.

SOURCE: MDR 8 3

AZ.20

Figure 5-8.—Components returned to RFI status trend chart.

Also, unscheduled maintenance should be analyzed on the basis of individual aircraft to determine if excessive unscheduled maintenance is predominant in all aircraft, or is restricted to selected aircraft. This may be accomplished by the construction of a table in which each bureau number is listed and the percent NORS, percent NORM, and percent operationally ready is computed and listed for each aircraft. Excessive unscheduled maintenance for all, or a majority of assigned aircraft, may indicate improper maintenance practices, improper workload scheduling, or improper quality assurance.

In order to monitor aircraft readiness on a daily basis, trend charts reflecting daily aircraft operationally ready and not ready time may be constructed by the analysis division and integrated into local management programs. The concept behind the design of a chart of this type is to provide interested personnel a ready means of reviewing the daily and cumulative operationally readiness trend.

Should this trend fall below established standards for the aircraft model maintained, additional analysis may be required and charts constructed to provide visual evidence of the factors causing the decreased readiness. Not operationally ready supply and not operationally ready maintenance are two areas which could be selected and displayed as possible problem areas. The required data elements for preparation of charts of this nature are found in ASD 2 and local records.

Although charts such as those mentioned above do not solve past problems, they can help forecast possible future problems. When the midpoint of the month has passed, a cumulative percentage below the standard is difficult to bring back up. By using these analysis products, management is kept current on operationally readiness percentage and can take appropriate action to correct problems when they first appear, rather than waiting until the percentage slips below established standards.

1430

AIRCRAFT READINESS CHART ACTIVITY: VP-9 PERIOD: 1 through 30 May 1968

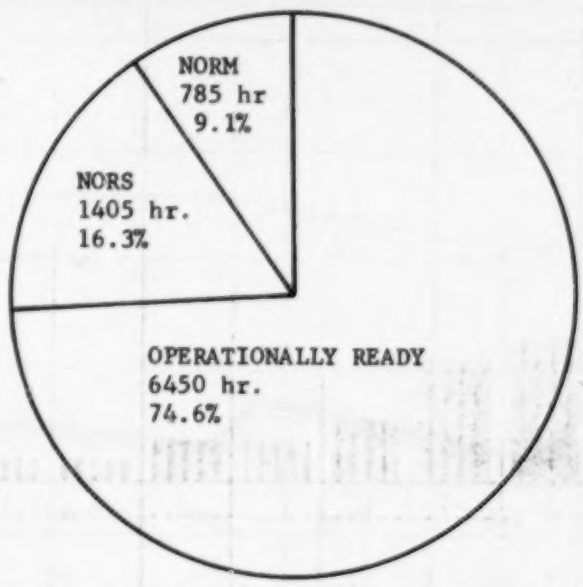

TYPE EQUIPMENT: P-3A TOTAL HOURS POSSESSED: 8640

COMMENTS: OPERATIONAL READINESS IS STILL LESS THAN THE MINIMUM DESIRED; HOWEVER, IT IS AN IMPROVEMENT OVER PREVIOUS MONTHS. THE PERCENT NORS IS HIGHER THAN DESIRED. WITH IMPROVED LOGISTICS SUPPORT, THE ENTIRE PICTURE WOULD BE IMPROVED.

SOURCE: ASD 3

AZ.21

Figure 5-9.—Aircraft readiness chart.

ABORT MALFUNCTIONS CHART

The failure of assigned aircraft to fulfil their scheduled mission (abort) because of malfunctioning equipment is a matter of considerable concern to management. Through the use of data contained in the MDR system, management can be informed of the aircraft systems or components causing these aborts, the number of items involved, when the abort malfunctions occurred, and similar information. The data may be employed to initiate investigation of circumstances leading to aborts. The abort malfunctions chart illustrated in figure 5-10 represents a typical method of presenting this type of data for an Organizational maintenance activity which accomplishes no component repair.

The chart shown in figure 5-10 is divided into three sections, and each section provides different information on the total number of aborts. All the data elements required to construct a chart of this type can be extracted from MDR 6. Prior to any data extraction, MDR 6 must be purified by elimination of entries which do not apply. This is accomplished by lining out those entries listing action taken codes 1 through 9, J, K, L, M, N, Q, T, U, and Y when used with when discovered codes A and C.

Section I of the chart contains information on when the abort malfunctions occurred or were discovered. The total abort malfunctions include the sum of items processed with when discovered codes A and C. The before flight abort malfunctions are the sum of items processed with when discovered code A. The in-flight abort malfunctions are the sum of items processed with when dicovered code C.

Section II contains information on the number of abort malfunctions by system. The figures in this section are obtained by determining the number of items processed with when discovered codes A and C within each system. The various systems are identified by the first two positions of the work unit code.

14310

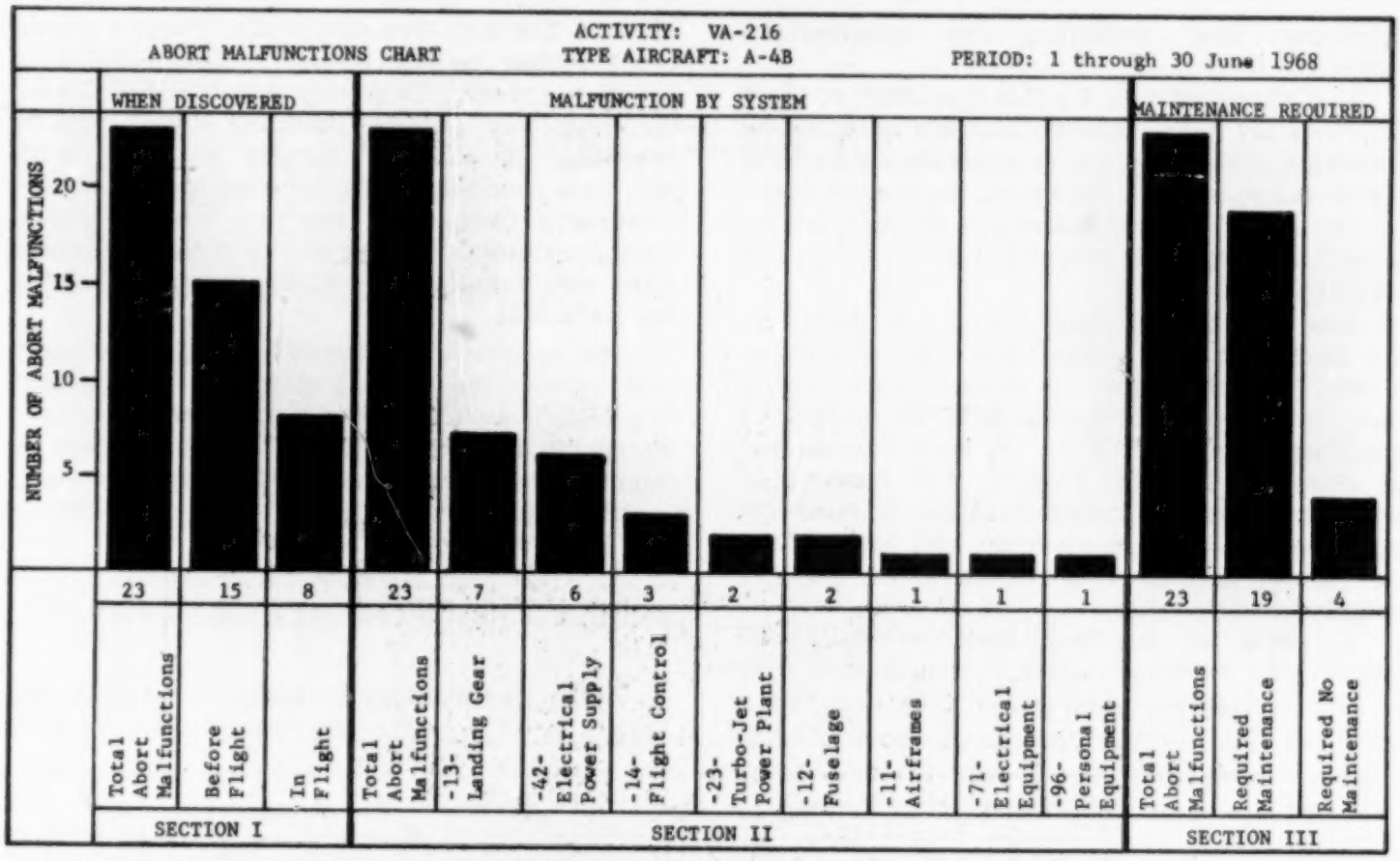

COMMENTS: MOST OF THE BEFORE FLIGHT ABORTS WERE CAUSED BY IMPROPER PREFLIGHT INSPECTIONS. AN EXTENSIVE PREFLIGHT INSPECTION TRAINING PROGRAM HAS BEEN RECENTLY IMPLEMENTED.

SOURCE: MDR 6

AZ.22

Figure 5-10.—Abort malfunctions chart.

Section III contains information on the number of abort malfunctions requiring maintenance actions. The number of abort malfunctions requiring maintenance is the sum of items processed with when dicovered codes A and C, except those listed in conjunction with action taken code A. The number of abort malfunctions requiring no maintenance is the sum of items processed with when discovered codes A and C listed in conjunction with action taken code A.

This particular chart does not identify the number of aircraft aborts occurring during the month. The figures represent only the reported number of items or malfunctions involved in aborts. In numerous cases more than one item or malfunction may be attributed to the same abort. Weather and other factors may also cause aborts.

Possible trouble areas may be revealed by study of the data. A high number of malfunctions being discovered before flight may indicate inadequately daily or preflight inspections. Numerous defects in a certain system may point out a need for engineering changes. A substantial number of reported malfunctions which require no maintenance may be an indication of poor troubleshooting techniques or improper equipment operation.

CANNIBALIZATION TREND CHART

Under ideal conditions, with a well-organized maintenance department and adequate supply resources, there would be little need for cannibalization. However, ideal conditions do not always exist, and it may be necessary to resort to cannibalization. The cannibalization trend chart illustrated in figure 5-11 is one method of informing the maintenance officer of the extent of cannibalization actions within an activity. Reduction or elimination of these actions is of prime concern to maintenance managers. Not only is a shortage of parts evidenced, but an added manhour expenditure is incurred in

1431

removing and replacing the cannibalized items.

The source of data for this type chart is MDR 5. The total items cannibalized are obtained by selection of the total items processed listed for action taken code T. The total number of manhours spent in cannibalization is obtained by selection of the total manhours listed for action taken codes T and U.

The total items cannibalized are plotted on the chart and also listed under the respective month. By connecting the plotted points with a line, an increase or decrease in the number of cannibalized items over a specified period of time is readily visible. The number of manhours spent in cannibalization is also entered to provide management with information on the actual number of manhours expended in cannibalization actions.

A chart of the high five cannibalization items may be constructed in conjunction with a cannibalization trend chart. The data for a chart of this nature can be extracted from MDR 5. The high five cannibalized items should be selected on the basis of the number of times a specific item was cannibalized during the reporting period. Selected items can be presented in tabular format with the work unit code, nomenclature, type equipment, manufacturer's code, part number, and numerical frequency (total number of times the particular item was cannibalized during the month) listed for each item.

The review of a cannibalization trend chart will reveal the overall status of cannibalization within an activity. An increase in the rate of cannibalization is of immediate concern to management. Those items which are frequently cannibalized may merit special investigation to determine the cause.

PROBLEM REFERRAL MEMORANDUM

While performing analyses or during the screening of reports, an analyst may discover

CANNIBALIZATION TREND CHART ACTIVITY: VF-11 PERIOD: JAN. through SEPT. 1968

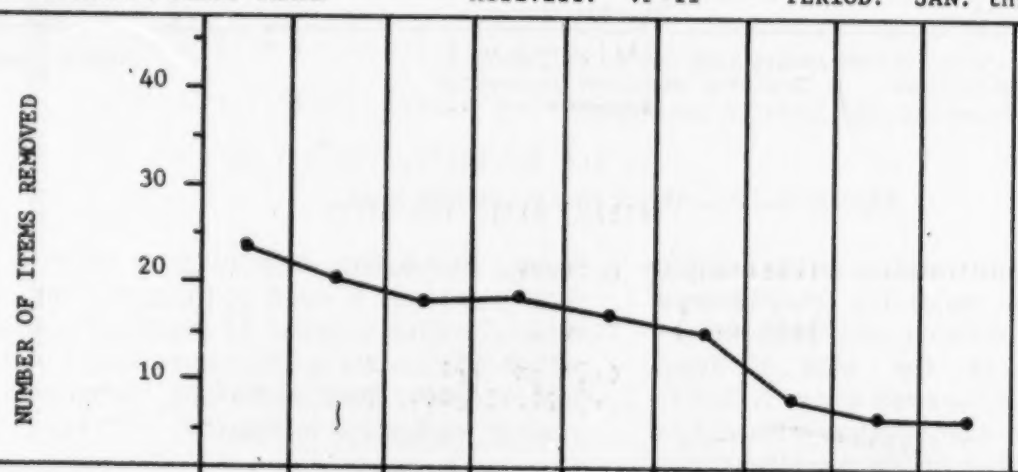

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
(1) TOTAL ITEMS	23	20	18	18	17	15	8	6	6			
(2) TOTAL MANHOURS	88.0	78.5	62.0	82.0	57.0	63.5	32.0	30.5	22.5			

(1) TOTAL ITEMS REMOVED FOR CANNIBALIZATION.
(2) TOTAL MANHOURS INCLUDE MANHOURS EXPENDED FOR REMOVAL AND REPLACEMENT AFTER CANNIBALIZATION.

COMMENTS: CANNIBALIZATION HAS BEEN ON A STEADY DECREASE SINCE JAN. AND STABLE FOR THE LAST THREE MONTHS.

SOURCE: MDR 5

AZ.23

Figure 5-11.—Cannibalization trend chart.

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problems that are not of general interest. These may not warrant management attention; however, they should be brought to the attention of appropriate personnel so corrective action can be taken. A problem referral memorandum similar to that illustrated in figure 5-12 may be used for this purpose.

16 June 1968

From: Analysis Division
To: Work Center 410 (Attn: Chief Smith)

Subj: Erroneous Recording of Type Maintenance

Background: Machine reports indicated erroneous entries in type maintenance column. Type maintenance B (unscheduled maintenance) was used for work performed during a calendar ODD inspection. The correct type maintenance code is P.

(1) Daily reports revealed this was documented against BUNO 148221 on the following Julian dates: 8157, 8158, and 8159.

Conclusion: Training is required in the use of type maintenance codes.

G. B. Sanders, AZ1

AZ.24

Figure 5-12.—Problem referral memorandum.

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MAINTENANCE SUMMARIES

The most widely accepted method of publishing results of maintenance data analysis is through the use of monthly maintenance summaries. A maintenance summary is a publication produced at the local level on a periodic basis and contains charts, graphs, tables, and narrative briefs portraying the maintenance effort since previous publication.

Summaries are often geared to what the analyst feels is required information; however, this is not the desired standard. Instead, summary contents should be based on the concept of what management wants to know. The maintenance officer describes the scope of information required, and the summaries should be geared to these requirements. These requirements include, but are not limited to, analysis of the following subject areas:

1. Utilization and productivity of the labor force.
2. Efficiency of the entire maintenance operation.
3. Direct support cost per flying hour, sortie, or departure.
4. High manhour consumers.
5. High failure rate components.

Many additional subject areas which may, at the option of the preparing activity, be included in the summary as follows:

1. Cannibalization.
2. Malfunctions causing aborts.
3. Shop repair capability.
4. Manhour distribution.
5. Technical directive compliance program.
6. Distribution of possessed aircraft hours.
7. Manhours lost to nonmaintenance functions.
8. Overtime expenditures.

Figures which simply repeat machine reports should not be included unless there is a significant reason for doing so. The use of complicated charts, graphs, and tables should be avoided. Extensive use should be made of narrative briefs. These briefs should be arranged in such a manner that both the display and the brief are visible to the reader at the same time. The format selected for maintenance summaries should be tailored to the needs of the activity concerned. Maintenance summaries should be distributed to all work centers in the preparing activity and to all other interested parties as desired. The contents of maintenance summaries should be evaluated frequently—at least every 6 months.

Maintenance summaries are forwarded to the appropriate air type commander as well as other activities in the chain of command. These commanders have promulgated instructions which prescribe the reporting format and submission requirements of maintenance summaries for activities in their areas of control. These summaries are designed to present summarization of key data to facilitate management appraisal by local or higher levels of command. Some of the analysis products discussed earlier in this chapter are included in these maintenance summaries. Local maintenance managers may require summaries to include additional information from those prepared for higher level command distribution.

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Chapter 6

QUALITY ASSURANCE

As AZ's progress up the ladder of advancement, they will become more and more involved in the field of quality assurance. This does not necessarily mean that they will be quality assurance representatives or collateral duty inspectors, but it does mean that they should be quality conscious, as this is a requirement of everyone in an aircraft maintenance activity; especially those in supervisory capacities.

Properly functioning quality assurance divisions make it possible to determine deficiencies, analyze discrepancy trends, prescribe inspection procedures, determine quality of maintenance accomplished, and provide followup action and functional guidance to stimulate quality assurance on a departmental basis.

The quality assurance division is usually manned by permanently assigned, highly trained, technically competent personnel. The senior AZ may be assigned to a quality assurance division and, although not directly involved in actual maintenance or maintenance inspections, will play an important part in the maintenance organization. First Class and Chief AZ's supervise the operation of technical libraries and assist in other clerical functions of the quality assurance division. The senior AZ should have an understanding of the importance of quality assurance as it applies to aircraft and related equipment maintenance and be familiar with some of the functions of the quality assurance division.

CONCEPT OF QUALITY ASSURANCE

Fundamentally, the quality assurance concept is preventing the occurrence or recurrence of defects. This includes all events from the start of maintenance operations until their completion. Achievement of quality assurance depends on prevention, knowledge, and special skills.

Prevention relies on the principle that it is necessary to preclude maintenance failures. This principle extends to safety of personnel, maintenance of equipment, and virtually every aspect of the total maintenance effort. Prevention is concerned with regulating events, rather than being regulated by them.

Knowledge is derived from factual information. This knowledge is acquired through the proper use of data collection and analysis programs. The Maintenance Data Collection System provides maintenance managers unlimited quantities of factual information. Correct utilization of this information provides management with the necessary knowledge required to achieve maximum readiness of aircraft and weapon systems.

Special skills, not normally possessed by production personnel, are required of a staff of trained personnel for analysis of data and supervision of quality assurance programs.

The quality assurance program provides an efficient method for gathering and maintaining information on the quality characteristics of products and on the source and nature of defects and their impact on the current operation. It permits decisions to be based on facts rather than intuition or memory. It provides comparative data which will be useful long after the details of the particular times or events have been forgotten. Quality assurance requires both authority and assumption of responsibility for action.

A properly functioning quality assurance program will point out problem areas to maintenance managers so they can take appropriate action to accomplish the following:

1. Improve the quality, uniformity, and reliability of the total maintenance effort.
2. Improve the work environment, tools, and equipment used in the performance of maintenance.

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3. Eliminate unnecessary manhour and dollar expenditures.

4. Improve the training, work habits, and procedures of maintenance personnel.

5. Increase the excellence and value of reports and correspondence originated by the maintneance activity.

6. More effectively disseminate pertinent technical information.

7. Establish realistic material and equipment requirements in support of the maintenance effort.

In order to obtain full benefits from a quality assurance program, teamwork must first be achieved. Blending quality assurance functions in with the interest of the total organization produces a more effective program. Each worker and supervisor should be permitted to use an optimum degree of judgment in the course of their daily work, since an individual's judgment plays an important part in the quality of his work. Quality assurance techniques supply each person with information on actual quality. This information provides a challenge to the individual to improve the quality of his work. The resulting knowledge encourages the best efforts of all maintenance personnel.

Quality assurance is designed to serve both management and production equally. Management is served by quality assurance monitoring the complete maintenance effort of the department and furnishing the factual feedback of discrepancies and deficiencies. In addition, the action necessary to improve the quality, reliability, and safety of maintenance is provided. Production is served by having benefit of collateral duty inspectors formally trained in inspection procedures and in receiving technical assistance in resolving production problems. The introduction of quality assurance to the maintenance function does not relieve production of the basic responsibility for quality work; instead, that responsibility is increased by adding accountability. This accountability is the essence of quality assurance. It has long been recognized that quality and safety cannot be inspected into a job—that the worker completing the job assures quality—and that inspection confirms the presence or lack of quality to prevent deficient workmanship. In this regard, the inspection services provided by the collateral duty inspectors are an integral part of the production process. Under the proper concept of quality assurance, the quality of work is assured, not c[illegible]

MAINTENANCE QUALITY RESPONSIBILITY

Although the commanding officer is responsible for the inspection and quality of material under his cognizance, he must have the full cooperation of all hands to meet this responsibility. The responsibility for establishing a successful program to attain high standards of quality workmanship cannot be discharged by merely creating a quality assurance division within a maintenance organization. To operate effectively, this division requires the full support of everyone in the organization. It is the frame of mind of all personnel and not the instruments, instructions, and other facilities for inspection that determines the success or failure in achieving high standards of quality.

One of the major requirements for quality in maintenance is that the supervisors definitely understand that high quality work is a vital contribution to effective operation of any maintenance organization. To have high quality maintenance also requires that each worker understands not merely a set of specification limits, but also the need and intent for these limits.

The person with the most direct concern for quality workmanship is the production supervisor. This factor stems from his responsibility for the proper professional performance of assigned personnel. It is the direct responsibility of production supervisors to assign a collateral duty inspector at the time work is assigned. This procedure allows inspectors to make the progressive inspection required, instead of being confronted with a job already completed, functionally tested, and buttoned up. The completion of production work is not a function of the quality assurance division, and production personnel in the dual role of inspector cannot certify inspection of their own work.

The degree of quality attained in the aircraft maintenance department depends mainly on the training, supervision, and quality attitude of production personnel, and the proper use of current publications, backed by an effective inspection system. The mission of quality assurance can be realized only when it is continually and progressively exercised in all areas, and directed toward improvement of the NAMP.

FUNCTIONS

Due to variations in the mission of activities, and qualifications and numbers of assigned

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personnel, the quality assurance functions may be accomplished differently in each activity. In each case, however, the primary objective is the same—the prevention of the occurrence or recurrence of defects—and should be worked out within the guidelines, policies, and procedures provided in instructions such as NavAir Instruction 4700.2 (Series) and similar directives issued by type commanders.

The functions performed by a quality assurance division are varying and cover a wide area. It is not appropriate that all of them be discussed here. The following sections cover some quality assurance functions of concern to AZ's. It should be kept in mind that senior AZ's may be assigned to the quality assurance division of a maintenance department and perform/assist in the performance of some of these functions.

DATA COLLECTION AND TREND ANALYSIS

Trend analysis is one tool that may be used by the quality assurance division. Properly used, it furnishes maintenance managers factual information in order to get to the root of a particular problem. This problem may be the abnormal use of a particular part or component, the excessive utilization of manhours in the completion of a maintenance task, etc. The information furnished permits maintenance managers to make decisions and take appropriate action based on facts rather than thoughts or intuition. Maintenance managers may request trends in a particular problem area on a one-time or continuing basis.

By careful and continuous reference to completed MAF's, registers, yellow sheets, etc., many times a definite trend in discrepancies can be detected. Detection in itself is not difficult. The big problem is reducing these indications to basic causes or reasons for such trends. Sometimes they can be traced to improper maintenance procedures such as a misalignment caused by maintneance personnel not adhering to specifically outlined procedures. Perhaps the problem will be revealed by an investigation of test equipment being used. Such an investigation might disclose improper operation of test equipment. It may be found that error tolerances have been exceeded. Other times an equipment deficiency, especially in newer type equipments, can be "pinned down" as the reason. No matter what the cause, an analysis of the problem is required when a trend in discrepancies is noted.

The first step in trend analysis is the collection of factual data. This data is of little value unless it is accurately collected and used properly. The following are a few of many sources of data that may aid in the analysis of maintenance difficulties:

1. Completed flight schedules.
2. Recurring discrepancies file.
3. Test flight checksheets.
4. Various MDCS reports.
5. Completed registers.
6. Processed MDR forms.
7. Yellow sheets.

Individually, these sources mean little, but collectively they can indicate and reflect the pulse of the maintenance process.

After the data has been collected, it must be arranged in some fashion before the analysis can start. This arrangement may take many forms, dependent upon the type of data, complexity, amount, and the use to which the data is to be put. There is no standard format for the presentation of collected data; however, the one used should be easily understood and clearly point out the minor as well as the major problems. Various charts and graphs are widely used to portray this data.

The underlying causes of faulty workmanship and material failure can be classified into either of two categories: chance variations or assignable variations. Chance variations occur in a random manner and cannot generally be associated with any continuing causes; for example, compressor being hit by foreign object. Assignable variations occur in a definite pattern, and the source of these variations can usually be found and corrected; for example, faulty overhaul or manufacture of a series of parts. It is desirable to control both of these factors, but because of the nature of chance variations, control is essentially impossible; however, they can be detected and an estimate made of their future occurrence. The problem therefore resolves itself into one of determining the assignable variations.

The evaluation and analysis function of quality assurance involves reviewing the various charts and graphs, noting the values that are excessive, and searching for causes of these variations. The search involves a detailed review of the collected data until a logical reanswer can be found.

This review may bring to light such things as operable aircraft being erroneously grounded

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making parts of a garment such as setting in a sleeve, cuffing trousers, and applying a zipper. Have trainees use score cards to evaluate their sewing techniques. See Appendix G.

- Plan a field trip to several stores to compare the construction techniques used on clothing of different quality. Discuss the factors that determine the techniques used for garment construction.

Instructional Materials

- Mockups and examples of standard construction techniques
- Wall charts and filmstrips showing specific construction techniques
- Fabric for practice experiences
- Score cards for evaluating sewing techniques

Instructional References

BOOKS

Bane, Allyne. *Creative clothing construction;* 2d ed. New York, N.Y. McGraw-Hill. 1966.

Bishop, E. B. & Arch, M. S. *The Bishop method of clothing construction;* rev. ed. Philadelphia, Pa. J. B. Lippincott Co. 1966.

_____ *Fashion sewing by the Bishop method.* Philadelphia, Pa. J. B. Lippincott Co. 1962.

Coats and Clark Inc. *Sewing book newest methods from A to Z.* New York, N.Y. The Corporation. 1967.

Jones, F. M. *Tips and tricks for sewing.* Danville, Ill. The Interstate Printers and Publishers, Inc. 1963.

Manners, R. A. *Sewing simplified.* New York, N.Y. Arco Publishing Co. 1965.

McCall Corporation. *McCall's step-by-step sewing book.* New York, N.Y. The Corporation. 1966.

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due to the lack of knowledge about a particular item by the operator. One solution to this problem is the pilot's discrepancy report, which is prepared and sent to a pilot when it is noted by his discrepancy that he lacks a complete knowledge of the aircraft component in question.

Trend analysis can be completed in many areas of aircraft maintenance departments. Close surveillance of the manhours expended in performing calendar periodic inspections can be maintained by use of a chart or graph. By monitoring the chart/graph, any trend can be noted and appropriate action taken.

Trend analysis may be completed to find out why improvement was noted in a particular area as well as why some particular item fell short of its expected goal. In all cases, the important thing is that the information gained be passed on to others.

MAINTENANCE DIRECTIVE REVIEW

The quality assurance division has the responsibility for reviewing all incoming technical publications and directives affecting the department and determining their application to quality assurance as well as their applicability to the particular organization.

Numerous maintenance directives are received by the quality assurance division. Most of these directives come from the NavAirSysCom, although some, concerning specific applications, are received from the type commander or other authority. In any case, all maintenance directives received should be promptly reviewed by appropriate quality assurance personnel so that they are cognizant of the action required in the event that production division personnel encounter difficulty in interpreting the information or require technical assistance.

Letter type technical directives such as airframe changes, airframe bulletins, accessory bulletins, etc., are published in a standard format. Still other maintenance directives are promulgated as instructions. Regardless of the type received, reviewing to determine applicability and the appropriate action to be taken is a relatively simple task.

Some of the directives received will apply to the type of aircraft and equipment being maintained; others will not. One of the first steps in maintenance directive review is finding out the applicability of the directive. For letter type directives the "application" paragraph states to what aircraft/equipment the directive applies. If only certain bureau numbers or serial numbers are affected, they will be listed in this paragraph. Directives of this type normally furnish some background information or give a reason for the directive. The "compliance" paragraph states the level of maintenance to which the directive applies and also the time limit for compliance. The necessary kits, parts, and materials required for compliance are listed under the "supply data" paragraph as well as their source. The step-by-step procedures to be followed in accomplishment of the directive are stated in the "detailed instructions" paragraph.

Although the quality assurance division performs review actions on maintenance directives to determine applicability and required action, the maintenance control work center is responsible for initiating action for compliance with maintenance directives. This includes planning, scheduling, and actual assignment for completion. The Technical Directive Compliance Form is used to initiate action and document all technical directive maintenance actions.

Some maintenance directives received need further interpretation and amplification before compliance. This is accomplished by the preparation of a Maintenance Instruction.

MAINTENANCE INSTRUCTION PREPARATION

Maintenance Instructions are locally prepared directives used to amplify or interpret directives received from higher authority or implement local instructions. They are issued on NavAir Form 4710/7 in the form of a SAMI, CAMI, or TIMI. The requirement for any Maintenance Instruction will normally be determined by local policy.

Maintenance Instructions are usually prepared by the division/branch concerned, which in some cases may be quality assurance. All Maintenance Instructions should be reviewed by the quality assurance and the maintenance/material control officer prior to their approval by the maintenance officer.

Care must be exercised in the preparation of a Maintenance Instruction as it is a tool by which the division officer directs his personnel. Preparation consists of more than just copying the maintenance directive. Quite often lengthy directives are received in which only certain parts have local application. In these cases the applicable portions should be selected,

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elaborated on or condensed as appropriate, and then written in a form that will meet the needs of the local activity. On the other hand, brief directives may be received which require considerable research work and amplification before they are understandable by production personnel.

Maintenance Instructions requiring the accomplishment of a particular task may be amplified by the use of an illustration. This is done by reproducing an appropriate illustration from the applicable technical manual showing the exact work area. The illustration is attached to and becomes a part of the Maintenance Instruction. Considerable research time may be saved for the production personnel if this method is used.

At times it may be appropriate to attach an extra or reproduced copy of the directive, on which the instruction is based, to the Maintenance Instruction. This provides those concerned with background information that might not be included in the Maintenance Instruction.

INSPECTION TECHNIQUES

The term inspection in the operating forces is related to procedures governing the determination of maintenance work to be performed on aircraft, engines, and related components. Inspection in this sense refers essentially to technical requirements or specifications and answers the question: What must be done to maintain aircraft material readiness? The term inspection with respect to quality assurance is a different term. Essentially, it refers to the completeness of work and answers the following questions:

1. Are responsible personnel performing quality workmanship on the items maintained?
2. Are applicable technical specifications being carried out?
3. Are there discrepancies which have not been covered by applicable specifications and which require immediate attention for safety of flight?

Another traditional usage of the term inspection denotes the acceptance portion of the quality assurance function and, based on a set standard, approves or rejects equipment for operational use. Collateral duty inspectors usually perform this inspection. It should be accomplished during and after the completion of a maintenance task. Inspections in this sense refer to the completeness of work.

Another type of inspection, known as a maintenance evaluation, is performed when analysis of collected data indicates that such action is appropriate. Statistical quality assurance encompasses the prevention portion of quality assurance, using the data generated by inspection to indicate areas requiring action to prevent quality falling below established standards. It also provides a confidence factor in that discrepancy data is used to determine that the quality of conformance is satisfactory. This inspection is conducted by the quality assurance representatives, and it is actually a comprehensive evaluation of the elements comprising the complete maintenance task under consideration. The objective of maintenance evaluations are to determine: (1) if the systems, procedures, and equipment used in the productive effort are such that quality workmanship will be accomplished, and (2) areas where changes can be recommended to improve the quality of the products of the activity.

The organization of the quality assurance function is made up of three main components—acceptance, prevention, and confidence. The ideal arrangement would be to have quality assurance wholly within the quality assurance division. However, in maintenance departments it is usually necessary to accomplish the acceptance portion of quality assurance through inspections by inspectors from the production divisions. The quality assurance divison need not function as an inspection service division for the department; but must, however, concern itself with the prevention and confidence portions of quality assurance.

Accomplishing tasks through inspection of the department output is within the concept or scope of the quality assurance mission. Assuring the quality of work accomplished by the department requires a considerable number of personnel and will, in effect, duplicate the normal inspection conducted by the inspectors within the production divisions. Both routine inspections by production inspectors and quality assurance representatives are aimed at insuring the quality of the production output. The objective of production is to determine if a particular product or job meets a specified quality standard. The objective of the quality assurance inspection is to determine whether or not the systems, procedures, and equipment used in the production effort are such that quality workmanship will be accomplished.

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Quality Assurance Personnel

The nucleus of the quality assurance division is comprised of a group of quality assurance representatives. These permanently assigned representatives are, in most activities, supplemented by designated collateral duty inspectors. Collateral duty inspectors are those personnel permanently assigned to a production division who have a secondary or collateral duty assignment to inspect work accomplished within their assigned production division. The numerical balance between quality assurance representatives and collateral duty inspectors is at the discretion of the particular activity.

The need for quality assurance requires that only skilled mechanics and supervisors be designated as representatives/inspectors. Quality assurance representatives and collateral duty inspectors are highly qualified personnel with the ability to insure quality of maintenance within their technical areas. It must be recognized under this concept that the personnel in the production divisions are ultimately responsible for the quality of work performed in the department. Quality assurance representatives monitor production and insure that high quality workmanship is accomplished by maintenance personnel and that specifications and quality standards are met.

Quality assurance representatives are normally selected by the quality assurance division from all assigned maintenance personnel. Collateral duty inspectors are usually nominated by their respective division. These nominations are approved by the quality assurance division after determining that the nominee is fully qualified to inspect the work for which he is responsible. All personnel performing inspection functions are designated in writing by the commanding officer and their qualifications are reviewed periodically. One accepted method of determining an individual's qualifications is by locally prepared tests administered by the quality assurance division.

Personnel selected for representatives/inspectors should possess the following characteristics:

1. Skill, experience, and the ability to work with others.
2. The ability to read and interpret drawings, technical manuals, and directives.
3. Motivation and personal desire to develop greater knowledge of his technical speciality.
4. Stability and excellence in performance.
5. The ability to write with clarity and accuracy.
6. Observant, alert, and an inquiring nature.
7. A senior in grade and experience.

Even though quality assurance inspections conducted by designated quality assurance representatives are not accomplished on the total productive output of the department, an inspection, in most cases, is accomplished by an authorized collateral duty inspector on all completed work. Quality assurance is concerned with the completeness and adequacy of this inspection and emphasis is placed on the thoroughness of the inspections rather than the number of units inspected.

NOTE: Quality assurance representatives should inspect all maintenance tasks which, at their completion, require the aircraft to be flight tested.

TECHNICAL DATA

The NavAirSysCom furnishes aircraft maintenance activities with technical information and instructions necessary for the operation and maintenance of weapons systems and related equipment. Technical information and instructions are disseminated in the form of manuals and letter type material. To permit attainment of a satisfactory state of readiness, these publications are published and distributed in time to assure availability to users. By proper use of these publications, all aircraft and other aeronautic equipment can be operated and maintained efficiently and uniformly throughout the Navy.

When a new aircraft, weapons system, engine, accessory, or other item of equipment is accepted by the Navy, manuals necessary to insure its proper operation and upkeep are prepared and issued to all activities using and/or maintaining the equipment. Supplemental information and other directive type publications that must be issued from time to time are issued in the form of letter material. Both manual and letter publications may, on occasion, be properly referred to as directives. Broadly speaking, any communication which initiates or governs action, conduct, or procedure is a directive.

The primary purpose of technical publications is to aid maintenance personnel in accomplishing their work. They are written for and communicate information and direction to maintenance personnel in their own specific

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technical language. Technical publications are prepared by the prime airframe and powerplant manufacturers, by the manufacturers of specific equipments, and by the NavAirSysCom or its field activities, in accordance with specifications issued by the NavAirSysCom. They set forth current authoritative information concerned with material upkeep, check, test, repair, and operation in a manner to provide for optimum product performance. It is extremely important that all personnel responsible for the maintenance and operation of naval aircraft and associated equipment be thoroughly familiar with and use the publications provided in the daily execution of their maintenance tasks. The time has long since passed when maintenance personnel could properly perform their work without written technical aid or, at the most, after a thumbing through or a one-time reading of the related technical publication. Modern technology is a dynamic, constantly changing thing and requires continuous reference to and the use of the approved and provided ways and means of keeping technically current.

From the foregoing it can be readily seen that maintenance activities require large quantities of technical data for the proper operation and maintenance of aeronautic equipment. The technical library provides maintenance activities with a central point for the procurement and proper dissemination of this technical data. Since technical information is of prime importance in assuring the quality of work produced, the quality assurance division is responsible for operating the technical library. Another important task of senior AZ's is the supervision of the operation of technical libraries.

NAVAL AERONAUTIC PUBLICATIONS INDEX

All aeronautic publications are assigned a title and code number. When they are available for issue, all publications, except Instructions and Notices, are listed in the Naval Aeronautic Publications Index.

A complete Naval Aeronautic Publications Index consists of several individual publications, each of which serves a specific purpose. They are identified as follows:

Navy Stock List of Forms and Publications, NavSup Publication 2002, Section VIII, Parts C and D.

Equipment and Subject Applicability List, NavAir 00-500A.

Aircraft Application List, NavAir 00-500B.

Directives Application List by Aircraft Configuration, NavAir 00-500C.

A description of these lists and their uses is presented in the following paragraphs.

Navy Stock List of Forms and Publications

The Navy Stock List (NSL) of Forms and Publications (NavSup 2002) contains a listing of all forms and publications issued by the bureaus, systems commands, and offices of the Department of the Navy. NavSup Publication 2002 is a 13-section index; however, only two sections (II and VIII) are of primary concern to the AZ.

Section II lists all the forms used in the Navy. Section VIII of this stock list is the basic index of NavAirSysCom publications and contains a numerical listing of all available aeronautic publications by code number, title, security classification, and the date of latest issue. An additional column in Part C furnishes stock numbers for the different manual publications. An Air Force-Navy cross-reference index and a general alphabetical index are provided in the last sections of Part C.

The Numerical Index of Aeronautic Publications is made up of Parts C and D of Section VIII of NavSup Publication 2002. Part C contains a listing of manual type publications, and Part D contains a listing of letter type technical directives.

Part C is divided into subject matter groups, and all publications within a group are then listed in numerical order. For example, all manuals in the 00 series are listed first, then followed by the 01, 02, 03, etc., through the 51 series.

Part D is further divided into a number of subsections. Some of these include general, aircraft/airframe, accessories, powerplants, and support equipment. Listed in the general section are Aircrew System Bulletins and Changes, Aviation Clothing and Survival Equipment Bulletins and Changes, Technical Orders, and Technical Notes. All Aircraft/Airframe Changes and Bulletins are listed in the aircraft/airframe section. The accessories section contains a listing of all Accessory Changes and Bulletins. Engine Bulletins and Changes are listed in the powerplants section. The support

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equipment section contains a listing of all Support Equipment Changes and Bulletins.

The basic index (NavSup Publication 2002, Section VIII, Parts C and D) is revised and reissued annually. A separate supplement covering each Part is issued bimonthly between issues. The revision to the basic index, as well as each supplement, is cumulative from the prior revision.

Equipment and Subject Applicability List

The Equipment and Subject Applicability List (NavAir 00-500A) contains an alpha numeric listing of all aeronautic equipment by model, type, or part number and indicates all manuals by code number that are applicable to each item of equipment. In addition, another section of this list contains an alphanumeric listing by model, type, or part number of all aeronautic equipment by category (accessories, armament, clothing and survival equipment, etc.) and indicates by number all letter type technical directives applicable to each item of equipment.

Publication numbers appear more than once in this list inasmuch as complete equipment systems and their respective major components are listed separately.

This list should be used when attempting to determine what publications are available on a particular item of equipment, and the class of equipment, model, type, or part number are known.

This list is revised and reissued semiannually, in March and September. It is kept current by the issuance of bimonthly supplements between each basic issue.

Aircraft Application List

The Aircraft Application List (NavAir 00-500B) contains a listing of all manuals grouped according to their application to an aircraft. This part of the index does not contain listings of any letter type publications, and all manuals are listed by publication code number only.

A list of basic numbering categories is provided in the front of the book. This list may be used in determining the general type of equipment covered in a publication. It may also be used to determine what manuals are available for a particular model of aircraft.

This list is revised and reissued semiannually, in March and September and is not supplemented between reissues.

Directives Application List by Aircraft Configuration

The Directives Application List by Aircraft Configuration (NavAir 00-500C) contains a listing of the active NavAirSysCom letter type technical directives with respect to their applicability to aircraft. The lists in this volume are arranged first by aircraft series, second by aircraft configuration, and third by Airframe/Aircraft Bulletin and/or Change numbers. NOTE: Configuration refers to modifications made to a basic aircraft model. For instance, F-4A, F-4B, RF-4B, F-4G, etc., are all different configurations of the F-4 aircraft model.

This list is revised and reissued semiannually, in January and July and is not supplemented between reissues.

TECHNICAL MANUAL SYSTEM

Manuals are published in a number of different general subject categories. The AZ supervising the operation of a technical library should be familiar with all the various categories of manuals; however, this and the following sections are primarily concerned with the manuals most often used or required in aircraft maintenance activities.

Technical manuals for an aircraft model, its components, and support equipment normally consist of Periodic Maintenance Requirements Manuals, Maintenance Instructions Manuals, Structural Repair Manuals, Illustrated Parts Breakdown Manuals, Overhaul Instructions Manuals, Operating and Service Instruction Manuals for support equipment, a Maintenance Planning Manual, General Engineering Series Manuals, Training Manuals, and Special-Purpose Manuals.

General Manuals (00 Series)

As indicated by the title, this series of manuals includes information of interest to all naval aviation personnel. In the final analysis, some publications in this series may not be considered as actual technical manuals; however, they furnish aircraft maintenance activities with valuable required information. Included are three parts of the Naval Aeronautic Publications Index (00-500A, 00-500B, and 00-500C, already discussed), Outfitting Lists and Allowance Lists, and Aviation Training Literature.

ALLOWANCE LISTS AND OUTFITTING LISTS (00-35Q SERIES).—Allowance Lists and Outfitting Lists consist of listings of the material and equipment necessary to place and maintain various activities in a material readiness condition. These allowances are based on known or estimated requirements or on available usage data.

Allowance Lists are identified by SECTIONS. Certain sections such as A, H, and K are issued as individual publications. Others such as B, R, and T appear as a series of publications, each of which is applicable to a specific model of equipment, model of aircraft, or type of activity.

Allowance Lists are reissued periodically. When new issues or reissues are published, they are listed in the next issue of NavSup 2002, Section VIII, Part C. All lists not appearing in the current issue or latest supplement to NavSup 2002 have been canceled.

For the most part, Allowance List and Outfitting List code numbers are NA 00-35Q plus the section identification letter and a dash number to identify a particular section in the series. For example, a Section G Allowance List for the S-2D aircraft is NA 00-35QG-007. This publication lists all the accountable general support equipment necessary for the Organizational maintenance of the S-2D aircraft and some related aircraft models. The foregoing Allowance List is used in conjunction with NA 00-35 QG-016, which lists all consumable general support equipment for all classes, types, and models of aircraft.

Allowance Lists are discussed in detail in chapter 7 of this training course.

TRAINING LITERATURE (00-80 SERIES).—This series of publications is issued by authority of the Deputy Chief of Naval Operations (Air). Included are various Air Safety Pamphlets and General Aviation Training Publications. All such publications listed in the current issue of NavSup 2002, Section VIII, Part C, are available at the publications supply point. All requests for 50 or more copies of a publication must be submitted to the Chief of Naval Operations, Flight Training Branch, Washington, D.C. 20350, with a statement of justification.

Aircraft Manuals (01 Series)

The following types of manuals are prepared and issued for each model of aircraft used by the Navy:

NATOPS (Naval Air Training and Operating Procedures Standardization Program) Flight Manual, herein referred to as Flight Manual.

Maintenance Instructions Manual.

Structural Repair Manual.

Illustrated Parts Breakdown.

Periodic Maintenance Requirements Manual, including related Maintenance Requirements Cards and Sequence Control Charts.

The NavAirSysCom also provides a series of General Engineering Manuals, applicable to all aircraft models, and available to aircraft maintenance activities. These publications are concerned with such subjects as Corrosion Control, Aircraft Structural Repair, Aircraft Hardware, and Aircraft Cleaning. As previously stated, these publications are of a general nature and are used in conjunction with the specific aircraft model manuals.

A maintenance Planning Manual is issued (for newer models) to serve as the maintenance officer's source of information on maintenance management with respect to the particular weapons system. It contains information on what the total maintenance plan for the weapons system is, what facilities, equipment, material, space, and personnel will be needed, and what resources, including technical information, services, training, supply support, etc., are available and how to obtain them.

FLIGHT MANUAL.—The Flight Manual contains complete operating instructions for the aircraft and its operational equipment. Emergency operating instructions as well as normal operating instructions are provided. Although Flight Manuals are issued primarily for the use of pilots and aircrewmen, they provide valuable operational information to maintenance personnel as well.

Two methods of updating Flight Manuals are by regular change notices and by interim manual changes. Regular change notices are issued periodically and cover routine changes and instructions. Interim manual changes cover vital operating instructions and are issued when immediate action is necessary.

Flight Manuals for newer aircraft models are identified by -1 in Part III of the publication code. For example, NA 01-40AVC-1 identifies a Flight Manual for the A-4E.

MAINTENANCE INSTRUCTIONS MANUAL.—The Maintenance Instructions Manual (MIM) contains most of the essential information required by aircraft maintenance personnel for service and maintenance of the complete

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aircraft. It includes the data necessary for troubleshooting and maintaining the powerplant, accessories, and all systems and components of the aircraft.

Instructions in the Maintenance Instructions Manual include such typical service and maintenance operations as the following:

1. Routine servicing.
2. Lubrication requirements.
3. Cleaning.
4. Adjustments.
5. Minor repairs.
6. Removal and replacement of components.
7. Testing.

The Maintenance Instructions Manual for all current production aircraft is made up in volumes, each volume being individually bound and issued separately. This permits each work center in an activity to have its own applicable volume, or volumes, at hand for ready reference.

Classified maintenance information is not included in the regular volumes of the Maintenance Instructions Manual. Essential classified information is contained in separate volumes or supplements of the Maintenance Instructions Manual which are classified "confidential." These volumes are usually bound in red in order that they may be readily identified and should be handled in accordance with the Department of the Navy Security Manual for Classfied Information.

The various volumes of the Maintenance Instructions Manual cover such areas as the following:

General Information and Servicing.
Airframe Group.
Powerplant and Related Systems.
Armament and Photographic Systems.
Electrical Systems.
Communication and Radio Navigation Systems.

The first volume, usually titled General Information and Servicing, is designated primarily for the plane captain; however, this volume contains a great deal of information important to all maintenance personnel. It contains a general description of the aircraft, all information pertaining to servicing the aircraft, and necessary information which is not contained in other specialized volumes.

Each of the specialized system volumes (airframe, powerplants, electrical, etc.) of the Maintenance Instructions Manual is further divided into four sections, as described in the following paragraphs.

Section I is the same in all volumes of a particular aircraft Maintenance Instructions Manual. This section provides an introduction to the manual and usually supplies a list of the changes applicable to the particular volume concerned.

Section II describes the system and components as well as their operation.

Section III provides such maintenance coverage as removal and installation procedures and troubleshooting charts for the Organizational level of maintenance.

Section IV provides component repair procedures for the Intermediate level of maintenance.

The different aircraft manufacturers may group the material in the various volumes of the Maintenance Instructions Manual under different titles. For example, the Survival and Environmental Systems MIM for one model aircraft may be contained in one volume; whereas, another model aircraft may have two or more volumes to cover the same subjects.

As previously stated, the complete MIM for an aircraft consists of several separately bound volumes. Each volume is assigned an individual publication code number for identification purposes. The complete MIM is divided into groups of volumes (categories) containing related data or related systems.

Maintenance Instructions Manuals are identified by -2 in Part III of the publication code. Additional dash numbers are used to identify the different groups or categories. Point numbers are used to identify subsystems or related data to these groups or categories. For example, NA 01-75PAA-2-2.2 is the code number for the P-3A MIM for the Airframe Group, and NA 01-75PAA-2-2.2 signifies the MIM for the Landing Gear System for the P-3A.

STRUCTURAL REPAIR MANUAL.—This manual is prepared primarily for personnel of the AM rating and is used as a guide in making structural repairs to the airframe. It contains general information such as airframe sealing, control surface rebalancing, general shop practices, damage evaluation and support of structure, and a description of the structure through the medium of indexed illustrations and repair drawings.

The Structural Repair Manual for most new aircraft is published in two volumes. This is not due to its size but is to suit its usage by

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Powerplant Manuals (02 Series)

Powerplant Manuals, commonly called Engine Manuals, are designed primarily for the use of personnel in the AD rating; however, other maintenance personnel may require the use of these manuals from time to time. The 02 series manuals are broken down as follows:

02 applies to General Aircraft Engine Manuals.

02A applies to Reciprocating Engine Manuals.

02B applies to Jet Propulsion Engine Manuals.

02F applies to Rocket Type Jet Engines.

Generally, each engine model is covered by three types of manuals—Service Instructions Manual, Overhaul Instructions Manual, and an Illustrated Parts Breakdown.

Parts I and II of the publication code for these manuals are basically the same as the Aircraft Series (01). Part III of the publication code normally consists of a-2 for the Service Instructions, -3 for the Overhaul Instructions, and -4 for the Illustrated Parts Breakdown.

SERVICE INSTRUCTIONS MANUAL.—This manual contains information necessary for the routine servicing and maintenance of the engine model covered. Also included are instructions for troubleshooting, dismantling, reassembling, and testing the engine.

OVERHAUL INSTRUCTIONS MANUAL.—This manual contains instructions for complete overhaul of the engine as performed by Naval Air Rework Facilities. Although it is published primarily for overhaul activities, it is also used by Organizational and Intermediate maintenance activities.

ILLUSTRATED PARTS BREAKDOWN.—This is a parts catalog containing listings of all the parts of the complete aircraft engine. It is broken down into an Introduction, Group Assembly Parts List, and a Numerical Index. This manual illustrates, lists, and describes all parts and special support equipment necessary to maintain the particular engine model.

Aircraft Components and Related Equipment Manuals

These manuals are not limited to but include Accessories Manuals, Instrument Manuals, Armament Manuals, and Electronics Manuals. The 03 series manuals cover all types of accessories; Instrument Manuals are covered in the 05 series; the 11 series manuals are concerned with Armament and related equipment; and the 08 and 16 series pertain to Electronics Manuals.

The manufacturer of each item of equipment (carburetor, altimeter, bomb rack, radar set, etc.) is required to provide adequate instructions for operating the item and maintaining it throughout its service life. These manuals therefore contain descriptive data; detailed instructions for installation, operation, inspection, maintenance, and overhaul; and an illustrated parts list. All manuals pertaining to these different items of equipment available for issue are listed in numerical order (by publications number) in the applicable section of Part C, Section VIII of NavSup Publication 2002. They are also listed in 00-500A, but in alphanumeric order according to part number. In 00-500B, these manuals are listed under the aircraft in which the item is installed.

Aircraft components and related equipment manuals are used to supplement information found in the aircraft Maintenance Instructions Manual. For example, when the Maintenance Instructions Manual does not give instructions for repairing a particular item, reference should be made to the applicable item manuals.

If a component or piece of equipment is relatively simple, all the necessary instructions may be contained in a single manual. More complex items may require two or more manuals. For example, one manual may cover operation, service, and overhaul instructions, while the parts breakdown is contained in a separate manual.

Support Equipment Manuals (17 and 19 Series)

The 17 and 19 series of technical manuals cover most types of support equipment. The manufacturer of each item of support equipment is required to furnish adequate instructions for operating the equipment and maintaining it throughout its service life. Like aircraft Maintenance Instructions Manuals, these publications, prepared by the manufacturer, are issued under the authority of the NavAirSysCom and are then official Navy publications.

Support Equipment Manuals are stocked, cataloged listed, and located in the same manner as aircraft components and related equipment manuals.

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Included in the 17 and 19 series of technical manuals are the Maintenance Requirements Cards for various ground support equipment.

Descriptive Data Sheets for
Aviation Support Equipment
(20 Series)

These sheets provide a consolidated source of descriptive information about individual items of aviation support equipment not available elsewhere.

The type of data furnished on these sheets includes the following:

Official nomenclature of the item.
Manufacturer and model/type number.
Functional classification.
Federal Stock Number.
A photograph or drawing of the item.
Functional description (purpose).
Reference data and literature available about the item.
Shipping data (size, weight, etc.).

LETTER TYPE TECHNICAL DIRECTIVES

BuWeps Instruction 5215.8 established a system to promote uniformity in technical directives. This system is limited to instructions of a technical nature which change or modify the affected aircraft or equipment. These instructions are disseminated in the form of Changes and Bulletins, or in special circumstances by Interim Changes or Interim Bulletins. NavSup Publication 2002, Section VIII, Part D, together with its latest cumulative supplement, provides a listing of all current letter type technical directives.

Changes and Bulletins are issued by technical personnel of the NavAirSysCom and are based on Contractor Service Bulletins, material defects submitted by field service activities, or other letters of recommendation of proposed modifications from field service activities.

Changes and Interim Changes are assigned numbers in a numerical sequence by the Technical Directives Control Center, located at the Naval Air Technical Services Facility (NATSF), Philadelphia, Pa. 19111. Bulletins and Interim Bulletins are numbered similarly in another number series. Since all Interim Changes are in one series and all Interim Bulletins in another, it is then possible to keep the same number for a formal Bulletin or Change when such is issued to supersede the interim directive.

Sometimes it is found that a Change or Bulletin is not the complete answer to a problem, and it is determined necessary to amend or revise an outstanding directive. An Amendment is used for minor changes in the original directive. A Revision is a completely new edition of an existing directive. Identification of revised or amended Changes and Bulletins is discussed in the following paragraphs.

The title of a Change or Bulletin for aircraft and powerplants is made up of four parts. Part one is the aircraft or powerplant model designation; part two, the appropriate title subject; and part three, the word "Change" or "Bulletin" and the sequential number. When applicable, the words "Rev. A," "Amendment 1," etc., follow the basic directive number.

The title of a change or Bulletin for equipment consists of only three parts—the title subject, the word "Change" or "Bulletin," and the sequential number.

Interim Changes and Bulletins are titled in the same manner as formal Changes and Bulletins with the exception that the word "Interim" is prefixed to the title. The title subject of a Change or Bulletin is one of the following, as appropriate:

Powerplant.
Propeller.
Airframe.
Avionics.
Accessory.
Aviation Armament.
Photographic.
Aircrew System.
Clothing and Survival Equipment.
Air Launched Missile.
Target Control System.

An Interim Change or Interim Bulletin is a directive issued to correct a safety or operational condition whenever it is considered too important to risk waiting for the issuance of the formal directive. Such directives are normally issued by message to insure speedy receipt by activities concerned. These directives may or may not contain the final solution to the condition being experienced.

Interim Changes and those Interim Bulletins which require continuing action are usually superseded by a formal Change or Bulletin with the same directive title and number within 90 days from the date of issue. Interim Bulletins

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TOPIC 3 - ALTERATION TECHNIQUES

Competencies

- Transfer markings of fitter for alteration.
- Pad out dressmaker's dummies to simulate figure problems.
- Adjust for fullness.
- Adjust neckline and facing to fit.
- Alter collars, neck, and neckfacings.
- Alter various kinds of sleeves.
- Alter shoulder line.
- Adjust fit of sleeve.
- Alter length of sleeve, jacket, coat, dress, skirt, and pants.
- Adjust back of garment.
- Alter lined garments.
- Correct waist line problems.
- Adjust waistband on skirts and pants.
- Alter hip line on skirt, dress, and pants.
- Fit and adjust crotch seam in pants.
- Alter cuffs.
- Make alterations on all types of fabric including suede, leather, fur, wool, vinyl, silk, and velvet.
- Establish good rapport with customer.

Motivating Procedure

Display on dressmaker's dummies a well fitting garment and a garment of the same style in need of alteration. Conduct a circular response on the desirability of correct fit and ways the poorly fitted garment may be altered.

Learning Experiences

- Demonstrate the principles of fitting with a garment on a dressmaker's dummy. Distribute Standards for Fitting Women's Clothes and have trainees evaluate the fit of garments worn by selected class members. See Appendix H.

of a single action nature are not superseded by a formal Bulletin.

Changes

A Change is a technical directive containing instructions and directions to accomplish a material change, modification, repositioning, or alteration in the physical appearance of an aircraft or equipment or the installation of different parts in subassemblies, assemblies, or components in aircraft or equipment. They may cover additions, omissions, or replacement of parts. They also cover any change in the material of which the parts are made. Airframe Changes are issued after delivery and acceptance of the aircraft by the Navy and are usually issued for the purpose of improving flight or safety conditions of the aircraft or equipment.

Changes are classified by various "action" categories. The assigned action category serves as a priority for compliance with the various directives.

The classification Immediate Action is assigned to directives which are issued to correct safety conditions, the uncorrected existence of which would probably result in fatal or serious injury to personnel, extensive damage, or destruction of property. These directives are identified by a border of red X's, broken at the top center of the page by the words IMMEDIATE ACTION.

The classification Urgent Action is assigned to directives which are used to correct safety conditions which, if uncorrected, could result in personnel injury or property damage. These directives are identified by the words URGENT ACTION at the top of the first page and a border of red diagonals around the cover page.

Routine Action directives are those concerned with equipment or procedural deficiencies of a material—mechanical, operational, or tactical in nature—the uncorrected existence of which could constitute a hazard. They are identified by the words ROUTINE ACTION printed at the top of the cover page.

Bulletins

A Bulletin is a technical directive containing instructions and directions to accomplish inspections, calibrations, tests, and adjustments, or additional instructions on standard rework, methods, limitations, and procedures which do not fall within the definition of a Change. A General Bulletin may be issued in instances in which the instructions and directions apply to a number of different powerplants, airframes, etc. Bulletins may be assigned an action classification like a Change, but this is not mandatory. A bulletin does not require the addition or deletion of parts. It may, however, require the replacement of the removed part with a new part of the same part number.

Instructions and Notices

Instructions and Notices are directives containing information and instructions concerning policy, administration, and air operations. As previously stated, Instructions and Notices are not listed in the Naval Aeronautic Publications Index. They are discussed further in chapter 3 of this training course.

MISCELLANEOUS AVIATION PUBLICATIONS

Several other publications of general interest to aviation personnel are available in most aircraft maintenance activities. A few of the most important are discussed in the following paragraphs.

Approach

Approach (NavAir 00-75-510), The Naval Aviation Safety Review, is published monthly by the Naval Safety Center and is distributed to all naval aeronautic organizations. It presents the most accurate information currently available on the subject of aviation accident prevention.

A large number of aviation maintenance accidents are maintenance induced; that is, they occur during preparation for, performance of, and securing from maintenance or as a result of sloppy or improper maintenance. For instance, a statistic reported in Approach revealed that in 9 accidents during a 15-month period, 9 aircraft were lost—9 million dollars lost due to the omission of 9 cents worth of cotter pins.

Digest of U.S. Naval Aviation Weapons Systems

The Naval Aviation Engineering Service Unit (NAESU), by direction of the Commander, Naval Air Systems Command, prepares and publishes

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a monthly magazine of interest and importance to aviation maintenance personnel. This magazine is published in two editions—Aeronautics (NavAir 08-1-504) and Avionics (NavAir 08-1-503).

The digest is sent to all naval aviation activities and other authorized agencies requiring information concerning current trends in naval aeronautical, electrical, and electronic equipments relative to operation, maintenance, installation, and supply. Both editions provide an excellent source of information dealing with new equipment and new ideas for older equipment. The articles in both editions are tailored to the needs of maintenance personnel.

The Aeronautics edition concentrates on subject matter that is maintenance oriented for aeronautical shops and work centers. Articles in this edition pertain to such subjects as powerplants, airframes, armament, and aviator survival equipment.

From the title, it is apparent that the Avionics edition is primarily devoted to the field of electronics. This edition gives the latest procedures for speeding the testing, calibration, and alignment of equipment, as well as new developments in avionics equipment and avionics maintenance problems.

Each activity should receive sufficient copies to provide at least one copy to each shop or maintenance work center. In addition, a file of back issues should be maintained in the technical library. Requests for additional copies, article reprints, and mailing list changes should be made directly to NAESU.

Naval Aviation News

The Naval Aviation News, NavAir 00-75-3, is published monthly by the Chief of Naval Operations and the Naval Air Systems Command. Its purpose is to disseminate data on aircraft training and operations, space technology, missile, rocket, and other aviation ordnance developments, aeronautical safety, aircraft design, powerplants, aircraft recognition, technical maintenance, and overhaul procedures.

As its name implies, this publication is essentially a news magazine. It enables readers to keep abreast of the latest unclassified developments in every facet of naval aviation. In addition, the coverage of fleet operations and the human interest articles on the noteworthy feats and accomplishments of individuals make the Naval Aviation News an entertaining as well as an informational periodical.

Crossfeed

Crossfeeds are "Official Use Only" publications issued by the Naval Safety Center. Each Crossfeed is in the form of a letter to the squadron aviation safety officer.

Crossfeeds often contain material extracted from Aircraft Accident Reports and reports from special investigations; therefore, they are not available for general distribution throughout an activity.

Generally, information concerning Maintenance Crossfeeds and General Crossfeeds will be passed on by the safety officer to those with an obvious need to know.

MICROFILM READER PRINTER

A relatively new concept in supplying maintenance activities with certain types of technical data has been accomplished by the use of microfilm. Microfilming is the photographic art of reproduction of text or pictures at ratios of reduction too great for reading or viewing without optical assistance. Microfilm is available as 16mm and 35mm filmstrip, mounted in individual frames on aperture cards and in cartridge form. A reader or some type of projector is required in order to enlarge the microfilm for reading.

The latest approach in this field has provided Intermediate maintenance activities with a microfilm reader printer which, as its name implies, enlarges the microfilm for reading or viewing and also has the capability of printing a permanent copy in a matter of a few seconds.

The quality assurance division, in conjunction with maintaining the technical library, is responsible for maintaining the reader printer. Therefore, the senior AZ assigned to the aeronautic technical library in an Intermediate maintenance activity may be concerned with the operation of the reader printer.

There are many different makes and models of microfilm readers and reader printers. Some have printing capabilities while others do not. Discussion of the operation of all the various models is not appropriate for this training course. The particular model discussed is widely used in the Navy.

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The Filmac 400C cartridge reader printer (fig. 6-1), manufactured by the Minnesota Mining and Manufacturing Company, provides a fast means of viewing 16mm cartridge microfilm and also prints a copy of the frame being viewed in a matter of seconds. This particular model is practically automatic; therefore, very little training is required to properly operate and maintain it. Like any delicate machine, the operating instructions provided by the manufacturer should be closely followed and the machine should not be abused.

As of this writing, the 400C reader printer is used primarily in the Component Repair Program; however, it is very possible that its usage will encompass other areas in the Naval Aircraft Maintenance Program. Cartridge sets of component repair data are provided to Intermediate level maintenance activities by NATSF. Subsequent updated microfilm cartridge sets are mailed to each user. Upon receiving updated cartridges, the user activity returns the outdated cartridges to NATSF for updating and reuse. Affixed to each cartridge is a label or index which provides information on the contents of that particular cartridge.

The 400C reader printer operates on standard 110-volt alternating current. It is controlled by an ON-OFF switch located above the viewing screen on the front of the machine. This switch controls the projection lamp, which illuminates the viewing screen and also the cooling blower.

This machine incorporates an automatic microfilm threading process; therefore, loading and threading microfilm is a simple task. Loading a cartridge of microfilm into the machine consists of inserting the cartridge into the holder with the open end toward the right. The cartridge is then pressed flat against the holder until the cartridge lock clicks. Threading is accomplished by turning the speed control knob counterclockwise and depressing the thread lever for approximately 2 seconds, or until images appear on the viewing screen. Microfilm advancement is stopped by returning the speed control knob to the center position.

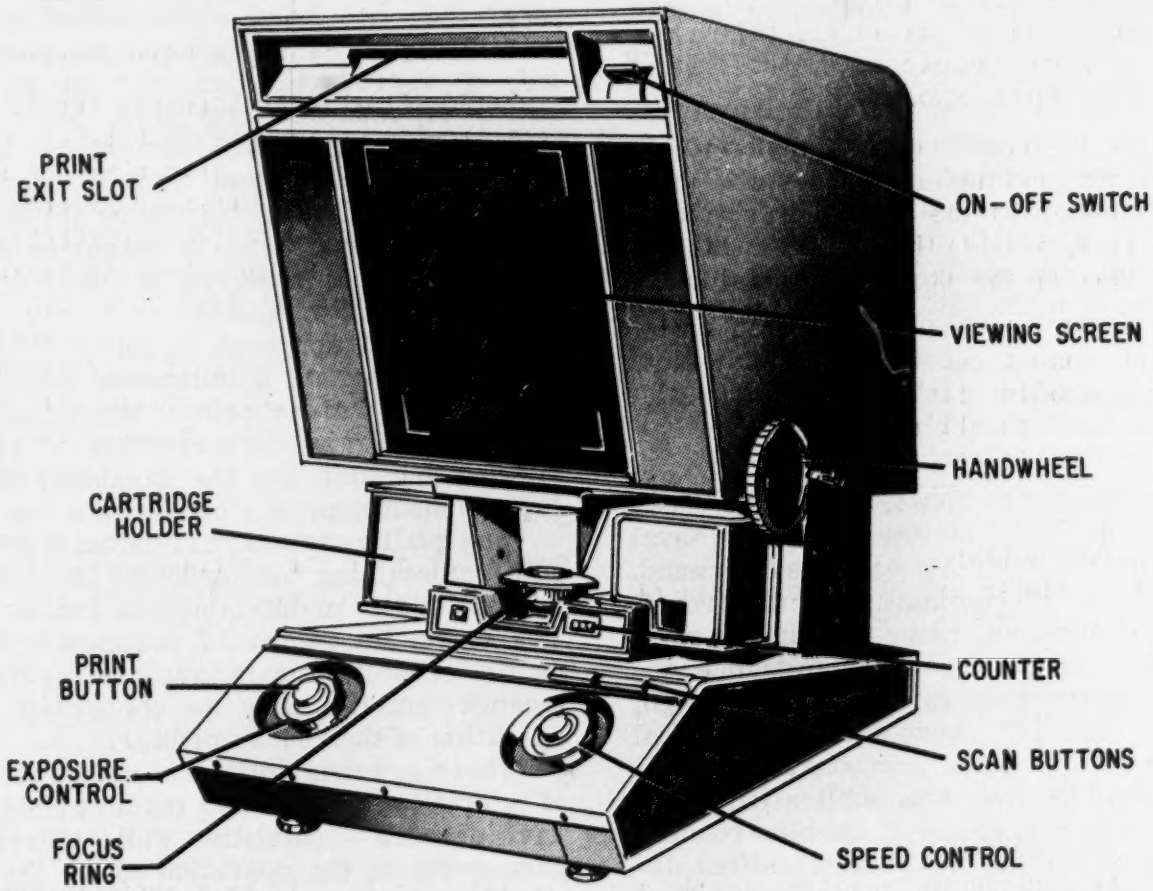

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Figure 6-1.—Microfilm reader printer.

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A counter registers the frames or images as they advance; therefore, by referring to the indexed cartridge, the approximate location of a frame can be determined and the microfilm rapidly advanced until this frame number corresponds to the counter reading. Rapid advancement of the microfilm is accomplished by turning the speed control knob counterclockwise—the farther the knob is turned, the faster the microfilm advances. The microfilm is wound back into the cartridge by turning the speed control knob clockwise.

Scanning a cartridge of microfilm in search of a specific frame can be accomplished by two different ways. One way is by the use of the handwheel located on the right-hand side of the reader printer. The other way is by use of the appropriate scan button. An arrow on each of the two scan buttons indicates the direction of microfilm travel. Once the desired frame is on the viewing screen, the focus ring is used to bring the image into sharp focus.

To make a print or copy of the frame of microfilm being viewed is a simple process. First of all, the image on the viewing screen should be centered and in proper focus. This can be accomplished by use of the handwheel and focus ring. Next, the exposure control knob must be set for proper exposure.

NOTE: Lower exposure control knob settings give light prints, and higher settings give dark prints. Experience with the reader printer will, for the most part, provide the operator with the setting to be used on the exposure control knob.

The print button is then pressed momentarily and the print comes out the print exit slot.

Prior to microfilm cartridge removal, the speed control knob should be rotated clockwise until all microfilm is wound back into the cartridge. To remove the cartridge, simply push back on the cartridge lock and remove the cartridge from the holder.

This reader printer uses a special type of copy paper and will not operate when the supply of copy paper is exhausted. It also uses an activator solution in the printing process. Under normal use, a bottle of activator solution is adequate for one roll of copy paper. It is a good practice to install a new bottle of activator solution each time a new roll of copy paper is installed. Th operator's instructions manual provided by the manufacturer gives complete details for loading both copy paper and activator solution. In addition, this manual gives instructions for routine cleaning and maintenance that can be performed by the operator.

TECHNICAL LIBRARY MANAGEMENT

As the Navy has become more and more dependent upon complex equipment, the need for technical information of all kinds has become more pressing. Aircraft maintenance activities cannot function properly without a considerable collection of technical reference material. While technical publications in smaller Organizational maintenance activities are not required on the same scale as larger Intermediate and Depot level activities, they are of sufficient importance that the squadron quality assurance division must maintain a fairly extensive library.

The aeronautic technical library is the central control point within aircraft maintenance activities which issures that the following requirements are met:

1. The full allowance of publications is on board.
2. They are readily available.
3. They are maintained current and up to date.
4. Security provisions are observed.

Senior Aviation Maintenance Administrationmen are frequently assigned duties as supervisors of technical libraries. In size, the libraries range from the small collections maintained by one part-time person to large libraries serving an aircraft maintenance department of a shore station. Any AZ may be called upon to set up a small library, or to revitalize an existing one which is not meeting the needs for which it was established. As personnel who work with technical material, they should know the basic principles of technical library maintenance whether or not they ever operate a large library.

A librarian must be a person who can assess needs for material and find means of acquiring and storing it. He must have an inquiring mind, be able to think constructively without following a blueprint, and be able to maintain balance in his operation. He must realize that the value of a technical library cannot be judged on the basis of how it compares in size with another library, but only on how well it meets the needs of the activity. A library expanded to provide an "empire," or one which grows indefinitely because the librarian feels he must maintain every item, is very bad and should be reduced to practical size.

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ORGANIZATION

Like other military units, the technical libary organization chart must make provision for responsibility and authority. Beyond this requirement, the organizational arrangements depend upon the size and function of the library.

An officer is usually designated, either by the department head or the commanding officer, as being in charge of the library. In most cases this will be the Quality Assurance Officer, and this duty is collateral to his primary duties. He determines the policies of operation and accepts responsibility for whatever classified material is maintained.

If the library is large enough to require the fulltime services of more than one enlisted person, the senior is designated as librarian, and is in charge of operating the library according to the policies established by the officer in charge. Publication clerks may be assigned as necessary to assist with the routine work.

PUBLICATIONS TO BE MAINTAINED

A few years ago, one may have been perfectly accurate in defining a library as a collection of books maintained in an orderly system, and a technical library as a collection of technical books. These definitions are now as obsolete as the saying that "what goes up must come down."

Large general libraries are likely to contain not only books, but films, tapes, prints, recorded music and books; as cultural repositories, libraries store information in whatever form is best suited to the material. Technical libraries have adopted this broader concept of a library, and have several different methods of storing the technical information needed by the users. A large technical library may include publications issued by many different government agencies, trade magazines and journals, microfilm files, commercially produced textbooks, and perhaps slides and filmstrips as well. It might, conceivably, contain a file of coded instruction tapes used to direct automatic machines in producing complex shapes or parts.

Before a librarian can get down to particulars and decide what he needs to keep in the library, there are two things he must determine: who will use the library and the nature of their work. These two factors will determine the range of the library by restricting the area to be covered. It is then a fairly simple matter to arrive at the individual publications to be procured.

As is the case of most technical libraries maintained in aircraft maintenance departments, they are used by maintenance personnel whose primary duties are repairing aircraft, and the publications required are those dealing with the details of repairing the applicable aircraft and all their component equipments, together with such catalogs as are needed to identify parts.

In most cases, the senior AZ will be responsible for the supervision of an established library and the bulk of the technical material will already be on hand. It might be well to review how these publications were received.

Newly commissioned and reactivated activities receive an initial outfitting of general publications automatically. They also automatically receive an outfitting allowance consisting of publications applicable to a particular model of aircraft. Revised publications were received by automatic distribution by use of Mailing List Requests for Aeronautic Publications. Still others were received by individual order on a one-time basis.

The Naval Aeronautic Publications Index provides valuable information for determining the various technical material required in aeronautic technical libraries. For example, the available technical manuals for a particular aircraft series can be found by using NavAir 00-500B. Likewise, the available letter type technical directives for a particular aircraft model are listed in NavAir 00-500C.

The various work center supervisors are another aid in determining technical information requirements. They should be consulted periodically to see if they have requirements for new or additional technical material. NavSup Publication 2002, Section VIII, Parts C and D, with its current supplement, should be reviewed regularly, as it provides a listing of new and revised publications as well as those canceled and superseded.

The quantity of publications required will depend on the size of the organization, number and location of work centers, number and different types of aircraft supported or maintained, etc. In any case, there should be sufficient quantities to meet the needs of the particular activity concerned. It should be kept in mind that all copies on hand must be maintained current, which requires considerable time; therefore, requests for publications should be

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carefully screened and it should be ascertained that they are required.

The optimum size and range for a technical library are therefore directly dependent upon the size and mission of the technical group using the library. The library should contain all of the technical information needed by the activities served, in whatever form or format is best suited for storing that particular kind of information.

TECHNICAL DATA PROCUREMENT

As has been previously mentioned, there are several different channels and methods for procuring material for a technical library. Most of the publications are available at no cost to local operating budgets. Commercially printed books, trade or technical magazines, and some material printed by the Government Printing Office must be paid for.

The majority of the technical publications required are published by direction of the Commander, NavAirSysCom. All of these publications are available at the aeronautic publications stock point, listed in front of the current NavSup Publication 2002, Section VIII, Part C; however, most publications received will be by automatic distribution through the use of NavWeps Form 5605/2. It should be remembered that Form 5605/2 provides for automatic distribution of revisions and changes to existing publications. If additional or different publications are required, they must be ordered separately on appropriate requisition documents, and a new Form 5605/2 must be completed and submitted to NATSF in order to automatically receive revisions and changes to any additional publications. The newly submitted Form 5605/2 will automatically supersede any previous form on file in NATSF in its entirety; therefore, it must include all publications desired on automatic distribution.

A recent change in the method of ordering individual NavAirSysCom manual publications on a one-time basis is by the use of a Single Line Item Requisition Document, DD Form 1348 (Series). This requisition document is prepared and submitted through the local supply channels. This form requires a stock number to be entered in the appropriate space. Stock numbers for manual publications are listed opposite the publication code in NavSup Publication 2002, Section VIII, Part C. Letter type technical directives listed in NavSup Publication 2002, Section VIII, Part D, should be ordered by title and number on the Requisition and Invoice/Shipping Document, DD Form 1149.

Although Interim Changes and Bulletins are listed in NavSup Publication 2002, Section VIII, Part D, they are not available for issue through the Publications Supply System. They are listed only for informational purposes.

In addition to the NavAirSysCom, other systems commands publish a variety of material which may be useful. There is no hard and fast rule for procurement of this material. If the item desired is not listed in the cognizance symbol I catalog and no other source is known, send the request by letter directly to the publishing command.

Fleet and type commanders publish a limited amount of material, normally relating to operational problems in their respective areas. This material is usually supplied automatically to activities on the standard mailing list. If other requirements exist, a letter request may be submitted to the applicable fleet or type commander.

Situations may arise in both Organizational and Intermediate levels of maintenance which require the use of engineering drawings. Technical information of this type is normally supplied to these levels of maintenance in the form of microfilm reproductions of the actual drawings. Engineering drawing reproductions provide all the necessary information to construct, assemble, and install a part or an assembly. Aircraft and equipment manufacturers provide NATSF and Naval Air Rework Facilities with engineering drawings for use by engineering and repair personnel. These activities are also provided with microfilm and Vandyke (blueprint) copies of engineering drawings. As previously discussed, some type of optical assistance is required to view microfilm; therefore, these activities have microfilm readers and reader printers for viewing and reproducing copies of the drawings.

For the most part, microfilm copies of engineering drawings are provided in filmstrip and in single frames mounted on aperture cards. Aperture cards are standard size EAM cards and have printed and keypunched identifying information concerning the frame of microfilm which they contain. It is conceivable that reproductions of engineering drawings may, in the future, be provided in cartridge form for use by the Filmac 400C reader printer previously discussed.

The senior AZ, supervising the operation of a technical library in an Organizational or Intermediate activity, may be required to procure

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microfilm. Naturally, microfilm would be of little or no value to maintenance personnel unless there is some type of reader available for viewing it.

Most aircraft and equipment IPB's contain manufacturer's engineering drawing numbers for various components. If microfilm of a particular drawing is required and the drawing number unknown, then the aircraft or equipment company technical representative should be consulted for this information.

In most cases the requirement for microfilm will be on an as-needed basis; therefore, large stocks will normally be maintained in the technical library of Organizational and Intermediate activities. The various work center supervisors will normally notify the person in charge of the technical library of their requirement for microfilm.

All requests for microfilm of engineering drawings should be forwarded to the Commanding Officer, U.S. Naval Air Technical Services Facility (EDD), 700 Robbins Avenue, Philadelphia, Pennsylvania 19111, on a DD Form 1149. When a complete set of drawings for an aircraft or equipment is requested, the individual drawings need not be listed; however, the request must be accompanied with a statement of justification. Requests for classified and unclassified drawings must be submitted on separate forms.

A file copy of each request should be maintained by the requesting activity as well as any correspondence relating to the request. Since approximately four and a half million drawings are available from NATSF, proper submission of requests for copies of these drawings is essential to avoid delay in receipt.

MAINTAINING PUBLICATIONS

A technical library may be filled with hundreds of volumes of interesting, important information; but if they cannot be located quickly, or are not current, they are of little use to anyone. There must be systematic filing and cross-referencing so that each item can be located. There must also be a constant program to keep every publication current.

All technical data received in the library should be promptly screened so that routing to appropriate divisions and branches can be accomplished. Naturally, material of an urgent nature should have priority over routine publications. The screening and the routing of technical publications are closely related to that of correspondence, discussed in chapter 3 of this training course. It should be kept in mind that the main reason for prompt screening and routing is to get the technical data in the correct hands so appropriate action, when required, can be taken. Should difficulties be encountered while screening technical publications, quality assurance division personnel should be consulted.

After screening and prior to routing the publication, a Catalog Card, OpNav Form 5070-11, should be prepared for the custody record file. The publication should also be marked with some identifying mark (preferable a rubber stamp) on the front cover and title page. Each publication should also contain a number. For example, if two copies of a particular publication are received or maintained, they would be numbered 1 and 2, respectively. Each time a publication is checked out the person to whom it is issued signs the Catalog Card. This system provides quick reference as to who has a particular publication in case it is needed. When the publication is returned, the librarian signs the card in the drawee's presence to show its return.

Sometimes, due to the size of the activity, location of divisions and branches, and type of publications concerned, it is not feasible for them to be routed. In this case the librarian may route a listing containing the titles of all new publications to inform all concerned of the new publications available in the technical library.

When changes are received, they should be entered in the appropriate publications as soon as possible. For those publications in the library, the changes must be entered by library personnel. For those publications checked out, deliver the changes to the holders of the publications along with a Change Entry Certification. The holder is responsible for entering the change and informs the librarian to this effect by signing the certification and returning it to the library, where it is filed.

An AZ who is familiar with the principles and uses of locator systems should have no difficulty establishing a workable system for a technical library. He should keep in mind that the library is much more likely to grow than to dwindle, and should use a locator system which can allow expansion without extensive changes.

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The locator file should be in two parts, one part alphabetical and the other numerical. The alphabetical file should include titles, major subject divisions, and authors if applicable, each on separate cards. Publications which are assigned numbers by the originating activity should also be listed under those numbers in the numerical section of the file. Every item in the library should be represented by at least one entry in the file, and many will require several reference cards. Such a file will require a little more work to set up, but the time saved in locating material will more than compensate for it.

Numbered shelves and a good locator file will make it unnecessary to shift everything in the library to add a few new volumes. By the very nature of the material, there will be many changes in library content. A system requiring constant reshuffling to make room for new material will likely break down from the amount of work required. A system based on arbitrary locations discourages casual browsing, but will allow new volumes to be placed in vacant spots in the shelves, regardless of where they occur. It is the same principle which applies to storing material; instead of spare parts, information is stored.

Except for the time involved, there is no particular problem in keeping technical publications current and up to date. If the library is on a mailing list, many of the changes are received automatically as they are issued. It is a simple matter to compare the dates given in the publications index with the dates on the numerical index cards, if these latter are annotated as changes are made.

To insure that a NavAirSysCom manual type publication is current, the date or latest revision date shown on the manual should be compared with the date listed opposite the manual title in NavSup Publication 2002, Section VIII, Part C, and its current supplement.

Publications issued by other activities are not so easily checked. If the publishing offices issue annual listings of current publications, these should be compared with publications maintained locally. Commercially published material, usually bound in hard covers, is not ordinarily revised annually and will be little trouble in this respect.

WORK CENTER PUBLICATIONS

All publications maintained by the technical library are not kept in the library. Production personnel require the regular use of technical publications; therefore, some of them should be readily available in the various work centers throughout the maintenance activity. This means that several volumes of the same manual may be required in a single maintenance activity. It is not feasible for each work center to have an individual copy of every publication that is used by the particular work center; however, they should have the publications most often used. These should include publications such as applicable volumes of the Maintenance Instructions Manual, Illustrated Parts Breakdown, and certain general manuals. The work centers also have requirements for some letter type technical directives. Regardless of the technical publications kept in the work centers, all should be checked out from the technical library. Catalog Cards, maintained in the library, should show the holders and location of all checked out publications. By using this system, the technical library maintains control of all work center publications and applicable revisions, and changes can be procured as necessary to keep these publications current.

The fact that a particular publication is kept in a work center does not mean that only one copy is required in the activity. A current copy of all technical publications required in the work centers should be maintained in the library.

It is the responsibility of the technical library supervisor to insure that the publications required and kept in work centers are current, as well as those kept in the library. When changes for a particular publication are received, it is a simple task to check the Catalog Card and find the location of the publication. If it is checked out, the change, together with a Change Entry Certification, should be forwarded to the holder for incorporation. Upon incorporation of the change, the certification is completed by the holder and returned to the library. This provides a record that the change has been incorporated in the applicable publication. It is suggested that a system be devised whereby there is a time limit for incorporation of changes. This would discourage the normal habit of "putting off" the incorporation. Numerous noncurrent publications have been used in completing maintenance tasks due to the fact that someone "put off" the incorporation of a change. Situations like this are a potential flight safety hazard and indicate substandard library supervision.

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Periodic spot checks of each work center's publications should be made to ascertain that the publications are being updated properly. Although this may appear to be a difficult task, it is actually a simple process. One method is by checking the changed or revised date of the publication against the Catalog Card, which should have all applicable change or revision dates listed.

Further spot checking is accomplished by the use of the List of Changed Pages, located in the publication. This list is on the back of the title page of the latest revision and should be the first page of the manual. It is identified by the letter A. Necessary additional pages are lettered B, C, etc. This list includes the number of each page changed/revised since the last basic issue of the manual plus the date it was changed/revised. Several changed/revised page numbers from this list should be selected and checked. The date on the bottom of those pages checked should correspond with those listed on the A page.

NOTE: That portion of the text affected by the current change or revision is normally indicated by a heavy vertical line in the outer margin of the page.

To check manuals which are updated by interim changes, it is necessary to compare the interim changes listed on the Catalog Card with those entered on the Flyleaf of the Interim Manual Change Summary of the manual.

REPORTING ERRORS IN TECHNICAL PUBLICATIONS

The NavAirSysCom has provided procedures for reporting of omissions and errors in aircraft and equipment technical publications, test tapes, and check lists. Discrepancies in the following technical manuals are reported using these established procedures:

1. Service Instructions Manuals.
2. Overhaul Instructions Manuals.
3. Maintenance Instructions Manuals.
4. Structural Repair Manuals.
5. Illustrated Parts Breakdown.
6. Periodic Maintenance Requirements Manuals, Maintenance Requirements Cards, and related Sequence Control Charts.

The report is prepared on the Unsatisfactory Material/Conditon Report (UR), NavAir Form 13070/5. The UR form is a four-page carbon interleafed set. Detailed instructions for preparing and submittal of the UR are printed on the cover of each set.

The original of the UR is forwarded to NATSF and a file copy should be retained by the originating activity for record purposes. The third (tag) copy is not required for this type of reporting.

The UR form is also used for submittal of specific information concerning failures, material defects, and other critical situations affecting naval aeronautic equipment which require prompt attention and corrective action. This includes hazards to flight safety and aeronautic equipment found discrepant as a result of design deficiency, faulty manufacture, faulty overhaul, or faulty preservation/packing.

SECURITY OF CLASSIFIED PUBLICATIONS

The problem of security of classified publications in the technical library is generally limited to ways and means of storing, using, accounting for, and disposing of such publications in accordance with existing directives. The basic Navy security directive relating to the safeguarding of classified information is the Department of the Navy Security Manual for Classified Information, OpNav Instruction 5510.1 (Series). Its provisions apply to all activities of the Navy. The application of security measures regarding technical library classified publications may be further influenced by locally issued directives which supplement the basic directives.

All personnel in the Navy are individually responsible for assuring that knowledge of classified information which they prepare or handle is made available only to persons who have clearly established a legitimate "need to know." Classified material is procured for the technical library because it is needed during the performance of some maintenance functions. Use of these publications by maintenance personnel should be anticipated and steps taken to procure security clearances for selected personnel most likely to require the information.

The technical library supervisor must initiate procedures that insure him positive control of all classified publications for which he is custodian. The first problem of custody is storage. Classified material may not be kept on

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open shelves accessible to unauthorized personnel. While large libraries sometimes need walk-in safes for classified material, most find that a few locking drawer files are adequate. The Navy Security Manual discusses storage containers of varying degrees of integrity. Also provided in the manual are specific requirements for safeguarding combinations and keys for locks, as these, to various extent, affect the protective capabilities of the different types of containers.

Classified publications which are no longer required in the library should be disposed of by approved methods.

Publications listed in NavSup Publication 2002, Section VIII, Parts C and D, are unclassified unless otherwise marked "1" (confidential) in the column headed "SC." The numerical Index is not classification authority. The supplements to the index contain information of classification action on a "when-occurring" basis.

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- Conduct a discussion on the factors to be considered before making alterations. Consider such aspects as fabric characteristics, seam allowances, darts, extent of alterations needed, time involved in making alteration, and effect of alteration on garment design.

- Show trainees the importance of retaining the grain line of various garment sections by using striped or plaid clothing on dressmaker's dummies. The dummies should be padded to create figure problems such as large hips, low bust, rounded shoulders, large abdomen, and short waist. See Appendix I. Use a pattern piece on an opaque projector to show how the garment part would be altered. Demonstrate the alteration on a readymade garment. See Appendix J.

- Demonstrate how garments are pinfitted and how markings are transferred to the wrong side of fabric. Have trainees practice these techniques.

- Invite a resource person to demonstrate methods for lengthening and shortening sleeves and skirt hems, changing waist and shoulder lines, altering bust darts and side seams, replacing zippers, and changing sleeve caps.

- Have trainees suggest solutions to alteration problems on many different types of garments and fabrics. Use padded dummies and/or class members for models.

- Have a committee make a survey of the types of alterations most often made on men's clothing. Analyze the list for competencies of class members and demonstrate unfamiliar procedures.

- Use slides or photographs to illustrate correct and incorrect fit of men's garments. Invite a person from a men's tailoring shop to discuss standards for proper fit of clothing and to demonstrate the basic alterations that are usually required.

- Have each trainee bring to class a pair of discarded men's trousers for practice in making such alterations as replacing a zipper, altering the waistline and crotch, replacing one pocket, replacing the tip of other pocket, cuffing one leg using marker, and cuffing other leg using formula.

- Have trainees make a reference notebook of procedures commonly used in alterations. Include such techniques as changing dart angles and hem lines, fitting slacks, correcting faulty necklines, and cuffing pants. See Appendix J.

- Plan a field trip to a place specializing in leather, suede, and fur garments. Ask alteration person to demonstrate procedures used in making alterations on these fabrics. Have trainees record procedures in their reference notebooks.

- Role play a series of customer-fitter situations which show interaction between customer and fitter. Have class note and discuss good and poor techniques used by fitter. See Appendix K.

Chapter 7

MATERIAL CONTROL

It has been said that "the only permanent thing in the supply field is change." This statement may be slightly exaggerated, but it is quite true at times. The important thing to remember is that changes in supply procedures are necessary to keep pace with the changing maintenance concepts of the modern Navy weapon systems. New systems are constantly under development to insure that supplies and materials are available in the right quantities, at the right place, and at the right time for the end user.

One of the functions of the senior AZ in a maintenance activity is to coordinate the material support for the worker actually performing maintenance tasks. To accomplish this function the AZ must have a working knowledge of the Navy supply system and its application to the maintenance of aircraft. It is also a responsibility of the senior Aviation Maintenance Administrationman to insure proper utilization of materials within his particular area of responsibility.

AVIATION SUPPLY

As Aviation Maintenance Administrationmen advance to first class and chief and occupy supervisory billets, they will become more involved in the details of rendering support for the man on the job. One of these detail areas is in the field of aviation supply.

Aviation supply personnel are vital members of the aircraft maintenance team; and the AZ, as well as the other aviation maintenance ratings, must work in close harmony with them if successful teamwork is to be achieved. The team must work so that a flow of materials is maintained from the manufacturer throughout the fleet. Although the AZ may not use parts and components as do some of the other maintenance ratings, a correct concept of supply's relationship to the entire organization is essential in the supervision of all aircraft maintenance functions.

The primary objective of the Navy supply system is to achieve a proper balance between the supply of materials and the material requirements of the Department of the Navy. The aviation supply system is designed to achieve this objective for the aeronautical material segment. It must be emphasized at this point that the aviation supply system is not separate and distinct, but is a segment of the integrated Navy supply system. The procedures and organization in this chapter are appropriate for the aviation segment, and in many instances are equally appropriate to other segments of the Navy supply system.

ORGANIZATION AND FUNCTION

The command exercising management control over the policies and procedures of the aviation supply organization is the Naval Supply Systems Command. The Commander, Naval Supply Systems Command is usually a rear admiral who is appointed by the President with the advice and consent of the Senate. He works with the delegated authority of the Secretary of the Navy, and all policies and procedures of the aviation supply organization emanating from him have the full force and effect of SecNav orders.

To better understand the relationship of the Naval Supply Systems Command to the aviation supply system, it might be well to quickly review the development of the Navy supply system.

Prior to 1842 the commanding officers of ships and stations were responsible for the procurement of their own supplies. They were furnished funds for this purpose by the Navy Department and were required to account for

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all expenditures. In addition to creating an intolerable burden of paperwork on the Navy Department, this procedure had the effect of forcing prices upward, especially when two commanding officers were bidding for some scare commodity.

In 1842 Congress approved the establishment of a Bureau of the Navy to take cognizance over all matters of naval supply. The primary responsibilities of this infant supply bureau were the procurement, maintenance of custody, and issuance of naval material. They are the primary responsibilities of the Naval Supply Systems Command today. Every function of the Naval Supply Systems Command is directly related to one or more of these responsibility areas.

In the early years of naval aviation when the Navy had few aircraft, the procurement of spare parts was much like the old system whereby commanding officers dealt directly with the sellers to fill the needs of each command. The pioneer naval aviation project directors had to deal directly with the manufacturers as parts were required.

By 1917 the Naval Aircraft Factory (NAF) in Philadelphia had come into existence and was assigned responsibility for the procuring of aircraft and spare parts. Other responsibilities assumed by NAF included the repair of aircraft, the manufacture of some spare parts, and eventually the manufacture of complete aircraft. There may still be a few aviators around today who earned their Navy wings in the old N3N, built by NAF.

In 1921 the Bureau of Aeronautics (BuAer) came into being and assumed the responsibility of procuring aircraft and aircraft engines. The responsibility for procuring spare parts and other aeronautical material remained with NAF, which until 1941 was the aviation supply center of the Navy.

The Aviation Supply Office (ASO) was established in 1941 under the technical control of BuAer and the management control of the Bureau of Supplies and Accounts. The function of ASO was the procurement, custody, and issuance of aeronautical spare parts and technical material. This is essentially the function of ASO today under the technical control of the Naval Air Systems Command. Management control of ASO is exercised by the Naval Supply Systems Command.

RESPONSIBILITIES OF THE NAVAL SUPPLY SYSTEMS COMMAND

The general functions of the Naval Supply Systems Command include many that are not related to aircraft maintenance, and not of primary interest to AZ personnel. Listed below are some of the more important general functions of the Naval Supply Systems Command:

1. Supervises the procurement, receipt, custody, warehousing, and issuance of Navy supplies and materials, exclusive of ammunition, projectiles, mines, explosives, and medical supplies.
2. Supervises and directs the operation of the supply phases of the Navy supply system and administers the redistribution program of excess personal property within the Department of Defense and the sale of Navy surplus property.
3. Authorizes and supervises the transportation of Navy property.
4. Prepares budget estimates and administers funds for the supply distribution system.
5. Renders an annual report to the Congress of money value of supplies on hand at the various stations at the beginning of each fiscal year, the disposition thereof, purchase and expenditure of supplies for the year, and balance on hand.
6. Coordinates the compilation and arranges for the printing of the Catalogs of Navy Material.

Some additional functions of the Navy Supply Systems Command that are of interest to AZ personnel are the general functions of ASO. These include the following:

1. Responsibility for overall determination of requirements, procurement, and distribution of standard aeronautical materials. (Certain materials excepted; such as complete aircraft and engines, complete electronic equipment, major photo equipment, nonstandard and experimental aerological equipment, and items of naval weapons ordnance equipment.)
2. Maintenance of a complete file of ASO and Naval Air Systems Command contracts, letters of intent, amendments, extensions, and change orders, and distribution of all necessary copies of documents to Navy field activities.
3. Stock control of aeronautical materials at all aviation supply facilities, including control of packing, preservation and distribution of material under ASO cognizance to, from, and between aviation supply facilities and major supply points.

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4. Maintenance of complete records of material on order and followup procedure necessary to effect timely deliveries for all material under ASO cognizance.

5. Maintenance of up-to-date records of existing storage facilities at depots, major supply points, and operating stations for aeronautical materials, and control of influx of materials in aviation supply channels so as not to exceed existing storage facilities.

6. Determination and disposition of obsolete and excess aeronautical material under NavAirSysCom cognizance.

7. Preparation and distribution of the Navy Stock List of ASO, including interchangeability data.

8. Compilation and distribution of some allowance lists subject to approval by NavAirSysCom.

9. Compilation of lists of spare parts to be salvaged from surveyed aircraft.

10. Followup on delivery, stock recording, reallocating as necessary, and distributing change material promulgated by NavAirSysCom.

11. Establishment and maintenance of a statistical unit which assembles, compiles, and analyzes usage data.

12. Maintenance of a representative at each aircraft manufacturer's plant who keeps ASO fully informed, as requested, as to all changes which affect spare parts under procurement.

13. Establishment of an inspection service which inspects aviation supply activities within established naval districts.

APPROPRIATIONS

At one time or another, almost everyone has had the frustrating experience of not being able to draw from supply some item needed immediately; the usual reason given being, "We do not have any money left." It takes only a short time to realize that the Navy does not operate with unlimited funds. This section and the following section, titled "Operating Budgets," are presented to further an understanding of the system whereby funds are made available at the user activity level for operating expenses.

The main money pool of the government is the General Fund of the Treasury. Funds come into the General Fund from such sources as income taxes, excise taxes, import-export taxes, etc. The only way for money to be expended from the General Fund is by congressional action, which has to be approved by the President. A bill passed by Congress which includes the expenditure of funds from the General Fund is called an appropriation.

An estimate of the amount of money required for the operation of the Defense Department during a given fiscal year is prepared by Department of Defense fiscal experts well in advance of the beginning of the fiscal year. The Congress studies the proposed budget in the light of world affairs, the current domestic economy, and such other considerations as they see fit, then acts upon it. Congress may increase the amount requested, decrease it, or pass it as is. After presidential action is completed, the money is made available to the Department of Defense to be spent during a specified year. This is known as an "annual" or "one-year" appropriation.

Congress and the President may also approve "no-year" appropriations for special projects such as large construction programs over an unspecified length of time.

Another form of appropriation is the "multipleyear" appropriation for projects which will be completed in a predictable length of time. An example of the use of this type of appropriation is the money appropriated to cover the expenses of the NROTC college programs for the next 4 years.

The appropriation by which the AZ is most affected is the "current-year" appropriation. After the appropriation or expenditure authorization is received in the Department of Defense, it is prorated among the services as a percentage of their previously submitted budget estimates. The Navy's share is prorated among the various systems commands and bureaus in essentially the same manner; that is, as a percentage of their estimated requirements for the coming fiscal year. The money to be spent for naval aviation is made available to NavAirSysCom. Here, part of the money is allocated to ASO for the purchase of aircraft spare parts and related equipment in quantities which past usage data has indicated will probably be sufficient for the coming year. These spare parts are furnished to the operating activities at no cost, since their usage has been anticipated and the items paid for in advance. The account from which money was spent to buy these items is known as the Appropriation Purchase Account (APA). Material received in the user activities from this account is known as APA material.

Another part of NavAirSysCom funds is made available to the operating activities in the form of operating budgets.

OPERATING BUDGETS

Funds available within a appropriation account for commitments, obligations, and expenditures are administered through the issuance of operating budgets. An approved operating budget is an authorization granted for the purpose of incurring commitments, obligations, and expenditures to accomplish the mission of an activity. Therefore, an approved operating budget is a subdivision of an appropriation which provides the funding authority for an official to accomplish a specific function or mission.

Approved operating budgets concerning naval aviation are authorizations by NavAirSysCom to the user activities to spend a certain amount of money during a given length of time for specified purposes. User activities are shore commands, which operate aircraft, and the major air type commanders.

Operating funds for stations, rework activities, etc., concerned with the operation and maintenance of aircraft and related equipment are allotted to them by the NavAirSysCom as an operating budget. Departments within these organizations normally submit their department budget to the station comptroller who reviews and combines the different department budgets into a recommended station budget. Senior AZ's may be called upon to assist in furnishing a realistic estimate of division operating expenses and future needs which the department head may use in formulating the department budget.

Since there is a relatively long period between budget submission and the subsequent receipt of funds, the necessity for accurate estimates of future requirements and strict management of materials for which allotted funds are expended cannot be overemphasized.

Operating funds for squadrons and units are apportioned to them by their type commander as an Operating Target (OPTAR). Routine nonaviation expenses for operating squadrons and units are absorbed by the ship or station to which assigned.

Operating Targets

Funds to finance the operation of aircraft are allotted by the NavAirSysCom to the air type commanders. Operating funds for squadrons, units, and ships are apportioned to them by their cognizant air type commander as an operating target (OPTAR). An OPTAR is a planned estimate which the air type commander allocates for the financing of aircraft operating costs during a given period of time. OPTAR's are issued on a quarterly basis and unused funds from the previously issued OPTAR revert to the control of the type commander as each new OPTAR is authorized. Type commanders provide OPTAR's to squadrons, units, and ships under their operational control, whether or not the user activity is based ashore.

There are several different types of OPTAR's issued by air type commanders for aviation purposes. Two that are of interest to AZ personnel are flight operations and aircraft maintenance funds. These are discussed in the following paragraphs.

Flight operation funds are used primarily for the purpose of financing actual flight operations; therefore, they have application at the Organizational level. These funds finance the following:

1. Aviation fuels and lubricants consumed in aircraft.
2. Liquid oxygen.
3. Aerial film for use in aircraft cameras.
4. Flight clothing and operational equipment authorized in NavAirSysCom Allowance List (NavAir 00-35QH-2).
5. Flight deck safety shoes.
6. Squadron administrative consumable office supplies.
7. Unit identification marks (shoulder patches) for initial issue to newly reported personnel.
8. Material and services required when located at an activity without Navy or Marine Corps Intermediate maintenance capability.

Aircraft maintenance funds are provided to Organizational and Intermediate maintenance activities to finance the cost of various supplies and materials consumed in the performance of aviation maintenance. These funds finance the following:

1. Repair parts, common hardware, lubricants, cleaning agents, cutting compounds, metals, and other materials incorporated into or expended in the performance of aviation maintenance of aircraft, engines, aeronautical components and subassemblies, and Navy maintenance of aviation maintenance support equipment.

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2. Fuels and lubricants consumed by aircraft engines in the performance of complete section repairs.

3. Pre-expended, consumable maintenance material.

4. Replacement of expendable or consumable allowance list items with material accountability codes B and C. (Allowance list and material accountability codes are discussed later in this chapter.)

MATERIAL IDENTIFICATION

In addition to the task of supervising lower rated AZ personnel in the performance of routine duties, senior AZ's may be assigned maintenance supervisor duties. In most cases, these duties will encompass the task of assisting in the procurement of material and parts used by production personnel. One important area of material procurement is the correct identification of the material and parts required.

There may be times when a part or some technical material is needed and the stock number is unknown. At other times some material may be on hand and its identity not positively known. A knowledge of the various methods of identifying material other than by stock number will often help speed the completion of a maintenance task. Certain data may be available which do not identify an item but which may lead to positive identification. The following sections discuss some methods of identifying material.

FEDERAL STOCK NUMBERING SYSTEM

The Defense Cataloging Standardization Act, passed by Congress in 1952, provided for a uniform system of identification, classification, and stock numbering throughout the Department of Defense. Prior to this time there were many stock numbering systems within the Department of Defense and within the Navy itself. It was possible for the same item to be stocked under different stock numbers as Navy general stores, Navy aviation stores, Air Force stores, Army quartermaster stores, and many others. There was no cross-reference system whereby an agency could determine if its excess material was the same as that which was in short supply in another agency.

The federal cataloging system eliminated this situation by placing all like items under a federal stock number bearing a common official government name. This system was made applicable to all agencies within the Department of Defense.

Under the federal cataloging system, federal stock numbers are required for all items that are subject to central inventory management within the Department of Defense. Each Navy item to be stocked under centralized inventory control is assigned a federal stock number which is used in all supply management functions. This federal stock number is listed in supply publications in which the item is referenced.

The Federal Stock Numbering System was intended to create and improve standardization of items of military supply in servicewide use and reduce excess inventories which, for the most part, were caused by lack of standardization. Also, the reduction of excess inventories eliminates substantial financial loss due to material obsolescence.

Federal Stock Number (FSN)

The FSN is an 11-digit number which furnishes positive identification of virtually all items of supply from purchase to final disposition. The 11 digits are uniformly arranged in groups of 4, 3, and 4 digits, with groups separated by hyphens. The 11 digits are made up of a 4-digit federal supply class (FSC) and a 7-digit federal item identification number (FIIN). In addition to the 11-digit number, the Navy supply system utilizes certain code prefixes and suffixes to aid in the performance of various management functions. These codes are of significance only within the Navy and are not used during interservice transactions. When the prefixes and suffixes are used, the FSN is known as a coded FSN.

Figure 7-1 describes the format of a coded FSN, including applicable management codes for an item of supply under the cogniznace of ASO.

The following paragraphs discuss the various parts of a coded FSN and frequent reference to figure 7-1 will assist in understanding the composition of coded FSN's.

A cognizance symbol consists of a 2-digit code prefixed to an FSN to identify and designate

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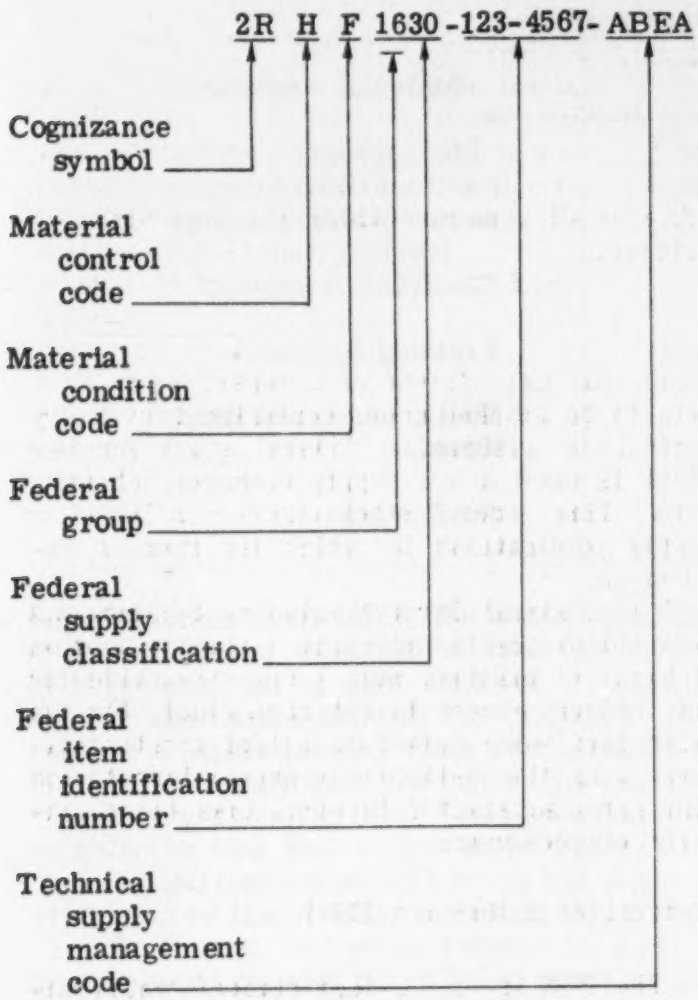

Figure 7-1.—Breakdown of a coded FSN.

the systems command, office, agency, or Navy inventory manager that exercises management control over specific categories of material. Although the cognizance smybol officially consists of two digits, it will be observed that publications and requisitioning procedures frequently drop the first digit for APA material, thus 2R is referred to as R, etc.

Listed in table 7-1 are some of the more common cognizance symbols, together with the type material controlled and the name of the cognizant command or office.

Material control codes divide inventories into segments reflecting similar demand, repairability or other characteristics. For example, some material control codes reflect either fast or slow moving demand characteristics while others denote whether the item is to be repaired by Intermediate or Depot level maintenance activities.

Material condition codes classify material in terms of readiness for issue and use, or to identify action underway to change the status of material. For example, one material condition code is used to indicate that a particular item is serviceable and ready for issue. If, after issue from the supply system and through use this item becomes unserviceable, its material condition code would be changed to reflect the requirement for rework, repair, etc. Naturally, upon completion of rework or repair the material condition code would be changed to show that the item is serviceable and ready for issue. Therefore, this code changes from time to time on a particular item depending on the condition of the material.

The federal supply classification class is the first four digits of the FSN and is used to group related commodities together. Each item of supply is classified in one, and only one, 4-digit FSC. The first two digits denote the group or major division of commodities, and the last two digits denote the class or subdivision of commodities within a group. Aircraft components and accessories are in group 16, therefore, in the FSC 1630 the 16 denotes an aircraft component or accessory and the 30 indicates a particular class within this group, which is aircraft wheel and brake systems. Other classes in group 16 are indicated as 1610—propellers, 1620—landing gear components, etc.

The federal item identification number consists of the last seven digits of the FSN. It serves to differentiate each individual item of supply from all other items of supply; that is, each individual item of supply (F-4B brake, P-3A brake; etc.) is assigned a separate FIIN. The FIIN in no way determines the position or sequence of the item in relation to other items.

The technical supply management code (TSMC) is a four-character code suffixing the FSN. As previously discussed, the FSC class classifies material by what it is. The TSMC groups material by associating supporting spare parts with their end assemblies.

NOTE: A recent change has replaced the four-character TSMC with a two-letter special material identification code (SMIC). However, like many areas where changes are made, a certain time element is involved; therefore, the TSMC will still be used for sometime on many coded FSN's. A SMIC is a management code added as a suffix to an FSN to indicate a primary weapon support item, specialized material, or general/common material. ASO has published a conversion guide which cross references the SMIC with the TSMC.

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Table 7-1.—Cognizance symbols.

Symbol	Cognizant activity	Material controlled
1E	Aviation Supply Office	Photographic material
2R	Aviation Supply Office	Aeronautical equipment
2V	Naval Air Systems Command	Aeronautical equipment (certain items only)
1N	Electronics Supply Office	Electronic equipment
20	Naval Training Devices Center	Training devices
1W	Fuel Supply Office	Fuels, lubes, and gases
1I	Naval Supply Depot, Philadelphia	Forms
0I	Naval Supply Depot, Philadelphia	Publications

Many variations of coded stock numbers will be encountered in maintenance work. These variations indicate material management responsibilities for the item; flag certain items as recoverable, consumable, high value, etc.; and identify the condition of the material if it is not ready for issue.

Becaues the variety of codes is so extensive and the trend to single service management of items has caused so many changes in recent years, a list of codes that might be prefixed or suffixed to a stock number would not be appropriate for this course. The primary things to keep in mind are that the basic stock number, consisting of three groups of numerals, identifies the item from a technical point of view and that the other codes identify material management characteristics.

STANDARDIZATION OF ITEM NOMENCLATURE

As part of the federal cataloging system, each item of supply is assigned an official government name. Maintenance personnel frequently refer to material by trade name or terminology other than the official government name. Alphabetical indexes in the various stock catalogs and other publications are sequenced by official name. To effectively utilize these publications, it is necessary to become acquainted with the proper nomenclature.

The assignment of names to stock items is practically as important as the assignment of FSN's. When items are inducted into the supply system, official government nomenclature must be assigned. Often this item name plus additional descriptive data will differ from names of items previously used. If difficulty is experienced in locating a familiar item in the catalog, it is quite possible that the name has been changed to conform to a more general usage. A few examples will show the importance of correct item nomenclature. It will be found that a "swab" is a small stick with a tiny wad of cotton on one end, and is used by the Medical Department. In order to clean the decks it will be necessary to think of another name for "swab." "Mops" will be found listed in the catalog, together with the correct FSN. Other examples are as follows; "Ceilometer" becomes "Projector, Cloud Height"; "Zipper" has become "Fastener, Slide Interlocking," etc.

NAVAL MATERIAL CATALOGS

Federal and naval material catalogs provide information necessary to identify and procure items of material for operation and maintenance of activities afloat and ashore. The catalog most commonly used by aviation personnel is the Federal Supply Catalog Navy Management Data List.

The Navy Management Data List (NMDL) consists of two separate sections. One section, the Fleet Ballistic Missile Weapons System Supplement, has application only to submarine forces and therefore is of little or no use to aviation maintenance personnel.

The other section, titled the Management Data List, includes basic management data necessary for preparing material requisitions. Also, it is the instrument for publishing data relative to stock number changes, unit of issue,

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unit price, shelf life of material, number of items contained in a package, and associated information.

The NMDL is designed to disseminate management type information as it relates to an FSN. It is not designed to act as a comprehensive catalog of material in the supply system, identify an item to an FSN, or serve as a shopping guide. Therefore, in order to get the necessary FSN or other needed information for making effective use of the NMDL, additional publications must be used in conjunction with the NMDL. These include the Deleted and Superseded FIIN List, the Consolidated Repairable Item List, and the Federal Supply Catalog Navy Master Cross Reference List.

The Deleted and Superseded FIIN List provides historical data of stock number deletions and supersessions. It should be remembered that the FIIN taken from this list is referred back to the NMDL for the requisitioning data.

The Consolidated Repairable Item List contains a listing of Navy managed mandatory turn-in repairable items. It is prepared to assist in identifying Navy managed mandatory turn-in repairable items and pertinent movement priority designators. Some repairable items under the cognizance of ASO and the NavAirSysCom are not included in this publication. These are listed in the ASO Master Repair List.

The Federal Supply Catalog Navy Master Cross Reference List provides the means of identifying an item from a reference number (part number, drawing number, etc.) to an FSN. The FSN found in this publication should be referenced back to the NMDL for all pertinent information required in requisitioning material.

IDENTIFICATION SOURCE DATA

As previously stated, positive identification of an item of supply has been accomplished when it is identified to its applicable FSN. For the most part, the FSN is not marked on material; however, most material has some type of data affixed to it that can be used for identification purposes. Certain data which do not identify an item but which aid in obtaining positive identification are discussed in the following paragraphs.

Manufacturer's Part Number

Normally, the manufacturers of parts stamp, etch, paint, or otherwise affix a part number on each item manufactured. The use of this manufacturer's part number and the knowledge of the part's application (that is, on what equipment it is used) normally lead to the positive identification of the part's nomenclature and FSN. The part number can be ascertained to be correct by reference to the appropriate Illustrated Parts Breakdown (IPB), and the FSN may be obtained by reference to the appropriate Federal and Naval Material Catalogs.

Drawing Number

A drawing number consists of letters, numbers, or a combination of both which are assigned to a particular drawing for identification purposes. The activity controlling the drawing (normally the manufacturer) assigns the number in conformance with their drawing number system. One drawing may apply to several items; thus, other distinguishing data may be necessary to identify the item on the drawing.

Drawing numbers may be used to identify the microfilm available in some technical libraries. Some large assemblies are illustrated in the appropriate Illustrated Parts Breakdown but are not broken down sufficiently to show identifying data for their component parts. By obtaining the drawing number of the larger item and cross-referencing it to the applicable microfilm, sufficient identifying information for the component part may be obtained.

Nameplates

Some aeronautical materials have nameplates attached which provide such information as the manufacturer's name or code, make or model number, serial number, size, voltage, phase, etc. Identification data taken from the nameplate of the old part can be very helpful in identifying and procuring a replacement. Nameplate data is particularly useful when requesting nonstandard material which is not subject to the federal cataloging system.

Markings and Measurements

Special coded markings, other than part numbers, and measurements often aid in the identification of some materials. For instance, compressed gas cylinders are color coded to identify the contents of the cylinders. Sheet metal is stamped with a significant identifying symbol which is repeated at intervals

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throughout the length of the sheet. This symbol includes the composition, temper, thickness, etc.

Flexible rubber hose is marked with a symbol which is repeated at intervals throughout the length of the hose. Bare wire is separated according to diameter. Tubing has two types of measurements—outside diameter, given in inches; and thickness of the wall, given in thousandths of an inch. Female fittings such as crosses, tees, and couplings are measured across the inside diameter of the threaded opening. The male fittings are measured across the outside diameter of the male threads.

Source Codes

Item Source Codes are symbols which indicate to a consumer a source of supply for an item required to maintain or repair aeronautical articles. Specifically, these codes indicate whether the item is to be requisitioned from the supply system; to be manufactured; to be obtained from salvage; not to be replaced since the next higher assembly is to be installed; or, due to failure, is in need of complete overhaul or retirement of the assembly or equipment from service.

Source codes are assigned to material at the time of provisioning. Known or anticipated usage is the primary factor in the assignment of source codes. The ability to manufacture an item within a naval activity is considered to be of secondary importance. In other words, items are normally source coded for purchase and stocking in the Navy supply system if usage is known or anticipated. Source codes for individual items may be revised as experience and usage develop.

Source codes are published as a column of the numerical index of the Illustrated Parts Breakdown, and in other publications as directed by the NavAirSysCom.

Source codes are provided in six series—P, M, A, N, X, and U.

Source code P series applies to items of supply system stock which are purchased in view of known or anticipated usage and which are relatively simple to manufacture within the Navy if necessary.

Source code M series applies to items which are not purchased but are capable of being manufactured at Navy fleet or overhaul activities. These items are normally manufactured upon demand and are not stock numbered.

Source code A series applies to assemblies which are not purchased.

Source code N series applies to items (nuts, bolts, screws, etc.) which do not meet established criteria for stocking and which are readily available from commercial sources. These items are purchased on demand.

Source code X series applies to items which, if damaged, would require uneconomical repair. The need for an item, or items, coded X will normally result in recommendation for retirement of that equipment from service.

Source code U applies to items which are not of supply or maintenance stocking significance.

Within each of the source code series, except U, there are one or more subcodes identified by a letter or number appended to the basic code number. These subcodes provide detailed information concerning the procurement or manufacture of various parts within the scope of the particular code series. The applicable Illustrated Parts Breakdown provides ready reference for each of the codes and subcodes as required.

The preceding sections have emphasized some of the many things that may be used to identify or aid in procurement or use of material. The senior AZ who is familiar witi the methods of identifying material is an asset to a maintenance organization, especially in performing maintenance supervisory duties.

AERONAUTICAL ALLOWANCE LISTS

This title is inclusive of publications identified as Allowance Lists (except advanced base lists), Initial Outfitting Lists, and Tables of Basic Allowances.

Naval Air Systems Command Allowance Lists, Initial Outfitting Lists, and Tables of Basic Allowances are prepared by the NavAirSysCom or the Aviation Supply Office. In nearly all instances ASO has the responsibility for preparation, but in all cases these lists are published by the direction of and approved by the NavAirSysCom. These lists contain the following:

1. The equipment and material (both consumable and nonconsumable) necessary to outfit and maintain units of the aeronautical organization in a condition of material readiness.

2. Substantially all items used with sufficient frequency to justify their issuance to all activities maintaining aircraft or equipment for which the lists are designed.

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3. Information concerning stock number, nomenclature, interchangeability, and supersedures.

4. A set of detailed instructions for the application and utilization of the publication.

5. A table of logistic data showing the total weight and cube of all material contained in the list.

In the final analysis, the equipment and spare parts listed in these publications are made available to aircraft operating and maintenance activities in accordance with assigned operational maintenance and logistics responsibilities through appropriate application of allowance lists and outfitting actions. The Aviation Supply Office has the responsibility for continually reviewing and updating the allowance lists.

INITIAL OUTFITTING LISTS

Initial Outfitting Lists are publications which indicate the range and quantities of maintenance spare parts considered necessary to support various aeronautical end items. These lists contain repair parts, such as airframe parts, electronic parts, engine parts, and general aeronautical equipment. The material covered by Initial Outfitting Lists is normally retained in supply department stocks until required for issue. This allowance of material is provided to ships or activities and is firm only at the time of initial outfitting. Increases and decreases in both range and/or quantities of material are based upon usage data of each activity concerned. Each series list is designed to support an aircraft, electronic equipment, or some other aeronautical article.

ALLOWANCE LISTS

These are publications which indicate the range and quantities of equipment and material considered necessary for maintenance support of assigned and/or supported aircraft. Generally, these items are inuse items required for daily or continual use, such as aircraft jacks, air compressors, and avionics test equipment.

TABLES OF BASIC ALLOWANCE

Publications listing equipment and material required by activities for performance of their assigned mission are known as Tables of Basic Allowance. They contain both shop equipment and common supporting spare parts. They cover allowances of tools and equipment required for use by such activities as Fleet Marine Force squadrons and target pilotless aircraft activities.

A complete listing of Aeronautical Allowance Lists, Initial Outfitting Lists, and Tables of Basic Allowance, with NavAirSysCom publication numbers and their effective dates, is contained in NavSup Publication 2002, Section VIII, Part C.

IDENTIFICATION AND TYPES OF ALLOWANCE LISTS

Allowance Lists and Initial Outfitting Lists are identified by the NavAirSysCom publication number 00-35Q (Series), while Tables of Basic Allowance are identified by the NavAirSysCom publication number 00-35T (Series). The following paragraphs discuss some of the various sections of allowance lists.

Section A, Standard Aeronautical Material and Naval Stock Account Material

Section a covers general material such as nuts, bolts, tubing, hose, paint, and other items common to the operation of all aircraft models. Both equipage and consumable supplies are shown in the Section A.

Section B, Aircraft Maintenance Parts

Section B contains airframe, engine, and accessories maintenance parts peculiar to each type of aircraft. A separate section B is issued for each model of aircraft.

Section C, Office Furniture and Laborsaving Devices

Section C lists the items and quantities of office furniture and laborsaving devices for the administrative support of deployable fleet air activities only.

Section G, General Support Equipment for All Types, Classes, and Models of Aircraft

Section G (Series) lists the quantities of handtools, handling and servicing equipment,

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Instructional Materials

- Dressmaker's dummies in various sizes
- Padding for dummies
- Copies of Information Sheet - Using the Dress Form (Appendix I)
- Men's and women's garments for demonstration and practice
- Various kinds of pattern pieces
- Guide sheets for evaluating fit of women's garments (Appendix H)
- Pictures or slides of correct and incorrect fit in men's clothing
- Sewing equipment and supplies

Instructor References

BOOKS

Beck, D. M. *Custom tailoring for homemakers*. Peoria, Ill. Chas. A. Bennett Co., Inc. 1964.

Bishop, E. B. & Arch, M. S. *The Bishop method of clothing construction;* rev. ed. Philadelphia, Pa. J. B. Lippincott Co. 1966.

_____ *Fashion sewing by the Bishop method*. Philadelphia, Pa. J. B. Lippincott Co. 1962.

Cozine, June, & others. *A pilot study for gainful employment in home economics*. Washington, D.C. U.S. Government Printing Office. 1968.

Johnson, Mary. *Mary Johnson's guide to altering and restyling ready-made clothes*. New York, N.Y. E. P. Dutton and Co., Inc. 1964.

Schwebke, P. W. & Krohn, M. B. *How to sew leather, suede, fur*. Milwaukee, Wis. The Bruce Publishing Co. 1966.

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and material which are made available for maintenance support of aircraft as may be assigned or supported.

Section H, Flight
Operational Material

Section H is applicable to air task group commanders and all Navy and Marine squadrons operating aircraft or having aircraft assigned. It contains items and quantities of flight operational material considered necessary to maintain the concerned activities in a continual condition of operational readiness.

Section K, Naval Aeronautical
Publications and Forms

Section K outlines the general types and classes of aeronautical technical and training publications and forms which are provided as a commissioning allowance for various Navy and Marine Corps aviation activities. It lists those publications and forms which are issued by the Deputy Chief of Naval Operations (Air) and by the Naval Air Systems Command, but does not include publications provided to aviation activities by other Navy Department systems commands and bureaus, by fleet commands, or by non-Navy offices.

Section R, Aeronautical
Electronics Material

Section R comprises Allowance Lists and Initial Outfitting Lists of electronic equipment and material required for the test and maintenance of aeronautical electronic equipments within the Naval Establishment.

Section T, Special Maintenance
Support Equipment

Section T is applicable to Navy and Marine aeronautical maintenance activities and lists the allowances of special support equipment required for maintenance support of assigned aircraft. A separate section T allowance is published for each manufacturer.

Section Z, Special Equipment
and Spare Parts

Section Z includes mobile electric powerplant spare parts and equipment and spare parts support for aircraft support equipment.

The foregoing section list breakdown includes only those sections of professional interest to the AZ. The complete list includes allowance lists for arresting gear and catapults, photographic, aerological, etc.

ACCOUNTABILITY CODES

The accountability codes used in allowance lists and most Illustrated Parts Breakdowns are known as Material Accountability Recoverability Codes (MARC). MARC's are assigned only to aeronautical provisioned items to reflect the accountability, recoverability, and repair policy determined for an item of equipment of material required for the maintenance, repair, or rework of an end item. MARC is a system whereby a letter of the alphabet is used as a guidepost by personnel working with aviation material. This system helps personnel to determine the proper method of the following:

1. Requisitioning material with regard to inventory control and fiscal accounting procedures.
2. Accounting for material while in use.
3. Turn-in or disposition of material.
4. Repair or overhaul.

The following list defines the various material accountability codes:

B—Exchange Consumables

Code B is applied to items which are consumable or expendable but normally require item-for-item exchange for issue after the initial outfitting. Such items may contain precious metals, may be highly pilferable, or may be high cost items.

C—Consumables

Code C is applied to all other consumable or expendable items which do not require item-for-item exchange for replacement.

D—Equipage, Support Type

Code D is applied to end items of support equipment which are economical and practical to repair on a scheduled basis through a major rework activity. Code D items are maintained on a custodial signature basis and must be surveyed when lost or missing or when beyond

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economical repair. After initial outfitting, Code D items require item-for-item exchange for replacement. Every effort should be made to repair Code D items locally or through fleet support activities prior to turning in the item to the supply system as non-RFI material.

E—Equipage, Locally Repairable, Support Type

Code E is applied to end items of support equipment which are to be repaired locally by the using or fleet support activity within their assigned maintenance responsibility. Code E items are maintained on a custodial signature basis when in use, require item-for-item exchange for replacement, and require surveying when lost or missing. The cognizant NavAirSysComRep may authorize repair of E items through customer service from a major rework activity in order to meet operational commitments.

R—Equipage

Code R is applied to repairable (except end items of support equipment) items which are economical and practical to repair on a programed basis through a major rework activity. Code R items are repaired by local activities when the extent of the required repair falls within the maintenance capability of the activity. After initial outfitting, these items are issued only on an exchange basis or when necessary to replace an item expended by approved survey.

L—Equipage, Locally Repairable

Code L is applied to repairable (except end items of support equipment) items which can be repaired by deployable squadrons within their assigned maintenance responsibility upon consideration of the following factors:

1. Manhours and skills required to perform the repair.
2. Total cost of providing necessary support equipment to perform the repair.
3. Total cost of providing necessary repair parts to perform the repair.

Items coded L are scrapped when economical repair is beyond local activity capabilities. After initial outfitting, issues of Code L items are made only when exchange procedures provide for turn-in of the replaced item or when necessary to replace an item expended by approved survey.

DEVIATIONS FROM ALLOWANCE LIST REQUIREMENTS

It is the policy of the NavAirSysCom to make available to each Navy activity the authorized equipment and repair parts necessary to insure operational readiness. Allowance list requirements are not mandatory and deviations are approved as pointed out in the following paragraphs.

Type, Force, and major operating commanders, or their subordinate logistics commanders, may authorize deviations from allowance list requirements including one-time in-excess issue of equipment for a requirement not considered generally applicable to other activities of the same type, or for independent operations of detached activities.

Organizational and Intermediate maintenance activities often have requirements for equipment which does not appear on existing allowance lists. In some cases the equipment is requested because it is considered superior to existing equipment or it may be the result of an entirely new requirement; that is, for rework of a component or to perform repairs or services for which no previous capability existed.

In order to assure that each request for deviation is properly reviewed and evaluated for validity and possible application to other maintenance activities, the originating activity should submit an official request to the Naval Air Systems Command Headquarters, via the chain of command (including the cognizant NavAirSysComRep). The following general procedures are followed in approval or rejection for a new piece of support equipment where no previous capability or need existed.

The request, together with complete justification, should be forwarded via the chain of command to the NavAirSysComHq. The request should not be made through supply system channels. The type commander normally identifies, on the forwarding endorsement, the Intermediate maintenance activity which will perform the equipment evaluation if different from the requesting activity.

The NavAirSysComRep normally investigates the request and indicates on the forwarding endorsement the availability of the requested equipment from existing resources. Upon review and approval, the NavAirSysComHq provides the activity concerned with the equipment is considered a prototype and is for

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evaluation. No additional equipment is normally procured until the validity of the need can be determined. During the evaluation, the type commander and cognizant NavAirSysComRep performs monitoring actions and provides additional assistance as required.

The completed documentation of the evaluation is forwarded via the chain of command to the NavAirSysComHq. In the forwarding endorsement, the type commander normally suggests a criteria for allocation of equipment to other activities. Upon review of the evaluation report, the NavAirSysComHq notifies all concerned of the action taken. In case of approval, this includes ASO so appropriate action may be taken to insure updating allowance lists.

AIRCRAFT MAINTENANCE MATERIAL READINESS LIST (AMMRL) PROGRAM

This program has provided for the development of data and documentation needed to determine and establish firm support equipment requirements and inventory control of aircraft maintenance support equipment. It provides for the construction of an Individual Material Readiness List (IMRL) for each aircraft maintenance activity, by name, prescribing items and quantities of aircraft maintenance material required for material readiness of that specific activity to which the list applies. This program also provides for the construction of material readiness lists to indicate the total quantities of each item authorized within stations, logistic areas, and major operating command areas.

Within the AMMRL program there are several material readiness lists; however, only two are discussed here.

The Application Data Material Readiness List (ADMRL) is used to specify the requirements for each item of aircraft maintenance support equipment against each level of maintenance and selected ranges of each aircraft, engine, propeller, and system for which each item is needed. This data is developed primarily from Aeronautical Allowance Lists. Through the use of electronic data processing machines this data is used to develop Individual Material Readiness Lists.

The IMRL specifies items and quantities of aircraft maintenance support equipment required for material readiness of the aircraft maintenance activity to which the list applies. As previously stated, this list applies to an activity by name. The NavAirSysComRep is responsible for the preparation of the IMRL for each activity in his cognizant area. It is prepared by extracting from the AMMRL those applicable portions which pertain to the specific aircraft and maintenance material assignments of the activity for which the list is developed.

The IMRL should be continually reviewed and up-dated by each activity to support current and anticipated changes in aircraft maintenance support equipment requirements. Because the IMRL is continually reviewed and updated and approved by the cognizant command, it is the firm mandatory material readiness list of the activity to which the list applies. The IMRL is actually a composite listing of the various allowance lists previously discussed.

MATERIAL ISSUE AND TURN-IN

As mentioned earlier in this chapter, the senior AZ performing supervisory duties in a maintenance activity has certain responsibilities for supporting the production personnel. These duties might include providing assistance in the areas of material requisitioning and turning in inoperative material. Material support has an important bearing on aircraft readiness; therefore, senior AZ's should be familiar with the local supply activity, material requisitioning, and material turn-in.

Probably one of the most abused areas in naval aviation is in the area of material procurement. This is true because most times when a part or some material is needed the user wants it immediately and does not care what procedures are used in its procurement; just so he gets the desired material. Standard requisitioning procedures and priorities have been established and these should be followed by all concerned if the supply system is to function properly.

SUPPLY ACTIVITY

The mission of the supply activity is to support the operational and maintenance efforts of the activity/ship. Stocks of aviation oriented material carried are tailored and replenished to this end. Positioning, replenishment, and control of stocks of material in maintenance areas are carried out as a result of joint decisions by the Supply and Maintenance Officers concerned. They determine the range, depth, and related procedures. The Navy

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Maintenance and Material Management System requires that the cost of material used in maintenance be determined and accumulated in such manner and detail that weapons system costing can be measured. Usage is finely defined as to stock number, within component, within system, within equipment/weapon/aircraft, in a particular squadron, located in a specific operational area, at a definite point in time. These data are used as an inventory management tool to determine geographic and strategic distribution of stocks of material. In addition, the data will be invaluable in establishing the material portions of work standards in maintenance.

Supply Support Center

Maintenance organizations have one point of contact with the supporting supply activity. This single supply contact point is the Supply Support Center (SSC), which responds to all material requirements of the maintenance organizations. The SSC is an internal organization of the local supply activity. It is made up of three sections—the Supply Response Section, the Component Control Section, and the Supply Screening Section.

Supply support is available consistent with the operating hours of the maintenance activities supported. If maintenance is being performed 24 hours a day, then supply support is available 24 hours a day.

The supply support center maintains rotatable pool material which consists of repairable ready-for-issue items reserved primarily to satisfy the requirements of Organizational level maintenance. Items maintained in the pool are capable of being repaired by the local Intermediate maintenance activity, have application relationship to weapon systems supported by local Intermediate maintenance activities, and have an average Organizational maintenance level removal rate of at least one per month. Defective components are turned in to Intermediate level maintenance for repair. The defective components repaired to an RFI condition are then returned to the rotatable pool to replace the components previously issued.

Generally, items included in a rotatable pool are repairable items of supply which are under the issue control of the local supply officer. However, instances may occur when it is desirable to position some items or assemblies (such as a pre-soaked carburetor, built-up wheel assembly, built-up prop, etc.) in the pool for use by Organizational and Intermediate maintenance activities. Pre-positioning of items of this nature is acceptable as long as they aid in decreasing NOR time.

The local supply officer and aircraft maintenance officers concerned determine the range and quantity of each item required in the rotatable pool. Two elements used in this determination are the local repair cycle time and the local removal rate. The local repair cycle time is the average total elapsed time between removal of a component and the complete local repair of the item into an RFI condition. The local removal rate is the average number of defective components removed over a 3-month period, for which replacement RFI components were required.

After the components and the quantity of each that will be included in the pool have been determined, the supply officer publishes an official list of pool items. This listing provides a ready reference for the components carried in the pool. RFI rotatable pool items are withdrawn from the pool by the local supply officer only under the following conditions:

1. When actual usage indicates the item/quantity can no longer be justified as a reservation, and the aircraft maintenance officer concurs.
2. When requested by the aircraft maintenance officer.
3. Only as a last resort to satisfy non-local system requirements.

In order for the rotatable pool to fully serve its intended purpose there must be complete cooperation between the maintenance and supply organizations. Organizational maintenance activities must expedite return of defective components to supply so that these components can be delivered to the Intermediate activity for repair. The Intermediate activity must complete repairs in an expeditious manner so that the repaired components can be returned to supply to be placed in the rotatable pool. Then, the supply organization is able to offer maximum support in the form of RFI components to insure maximum aircraft readiness.

Low value, fast moving consumable items are preexpended from supply. Such materials are located in the maintenance area; and the establishment, maintenance, and replenishment of pre-expended bins are the responsibility of the supply organization.

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SUPPLY RESPONSE SECTION.—The Supply Response Section (SRS) is responsible for preparing all necessary requisitions (DD Form 1348) and related documents required to obtain material for local maintenance use in direct support of weapon system maintenance. The maintenance organization verbally notifies the supply organization of the need of such material. When material is available locally, the time frame for processing and delivery is as follows:

Priority	Process/Delivery Time
1-3	1 hour
4-8	2 hours
9-20	24 hours

The SRS is responsible for receipt, storage, and issuance of all ready-for-issue pool components. It is responsible for physical delivery of RFI material to maintenance organizations, and the pickup of defective components from the Organizational maintenance activity and subsequent delivery to the Intermediate maintenance activity. Actual maintenance personnel are not involved in the physical movement of material between organizations.

This section also performs technical research in regard to completion of requisition documents as well as determining the status of outstanding requisitions and relaying this status to the customer upon request.

COMPONENT CONTROL SECTION.—The Component Control Section (CCS) maintains status records of all components being processed in the Intermediate maintenance activity. This section is also responsible for maintaining status records for all rotatable pool items.

SUPPLY SCREENING SECTION.—The Supply Screening Section (SSS) is responsible for initiating disposition action on components that cannot be repaired by the local Intermediate maintenance activity. Using listings and directives from inventory managers, screening personnel determine disposition of components in question, including prospective consignee and packaging and preservation requirements prior to movement of material.

MATERIAL CONTROL WORK CENTER

The material control work center in a maintenance activity performs a staff function, and as such provides support and services to the production divisions. It exists for the primary purpose of insuring that maintenance requirements for parts and materials are made known to the supply organization in a timely manner in order to prevent work stoppages and grounding aircraft. Material control insures that parts and materials made available to maintenance are systematically utilized and not allowed to accumulate or to become depleted. It serves as the single point of contact within the maintenance organization for the conduct of business with the supply organization.

The material control work center provides material support to their cognizant organization by accomplishing the following general functions:

1. Pass all requirements for material required for direct support of weapon system maintenance to the SSC. A material control register is maintained for these items.
2. Prepare documents for materials required for indirect support of weapon system maintenance. Examples of materials for which documents are to be prepared are aviation fuels and lube oils, rags, and flight jackets. A separate requisition record log is maintained for these items.
3. Maintain liaison with the supporting SSC on maintenance material matters to insure that material needs of the organization are satisfied.
4. Establish delivery points for all material and insure that material received is expeditiously routed to the applicable work center.
5. Furnish technical advice and information to the supply activity on the identity and quantity of supplies, spare parts, and materials required for maintenance actions.
6. Establish procedures to insure the periodic inventory of tools and the adequate accountability of material and equipment on custody to the cognizant organization.
7. Initiate surveys in the event of loss, damage, or destruction of accountable material.
8. Keep the maintenance control work center advised of the overall supply situation as it affects the activity.
9. Perform cost and allotment record accounting, charting, and budgeting of cost applicable to the cognizant organization.
10. Monitor the operation of toolrooms and maintain an updated IMRL.
11. Maintain inventory control of authorized allowances of material.

The material control work center is responsible for the coordination of material ordering, receipt, and delivery. This is done in such a manner as to insure that the correct material

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is ordered and that it reaches the work center within the specified time frame.

The foregoing functions of the material control work center apply to both Organizational and Intermediate level activities. Some of the functions which are applicable to one level only are listed in the following paragraphs.

Intermediate Level

An Administrative Screening Unit has been established in the material control work center of Intermediate maintenance activities. This screening unit does the following:

1. Positively identifies material and determines if it is within the repair capability of the Intermediate Maintenance Activity (IMA).
2. Insures that all required documentation is affixed to the component (that is, logs, records, MAF, etc.).
3. Notifies maintenance control of the receipt of defective components for scheduling into the IMA.
4. Transfers the defective components to the appropriate work center when directed by maintenance control.

All components received in the IMA material control receive screening to determine if the item is within the check, test, or repair capability of the IMA. As a result of this screening, components requiring maintenance within the IMA capability are reported to maintenance control as ready for induction. Items beyond IMA capabilities are returned to the Supply Support Center with appropriate recommendations for disposition. When work on components in the IMA has been completed, the components, together with required records, are returned to material control for appropriate routing back into supply organization.

Organizational Level

In addition to the general functions, the material control work center in Organizational level activities is responsible for the following:

1. Verification of NORS (Not Operationally Ready Supply) requisitions and maintenance of current NORS status records.
2. Inventory of aircraft upon receipt and transfer and maintenance of inventory records.

When removed components are generated as a result of the maintenance effort, material control insures that the SSC is notified to make a pickup. These components must be accompanied by record cards and logs, when applicable, plus the number two, three, and four copy of the Maintenance Action Form.

Material Control Register

The Material Control Register is used by Intermediate and Organizational level material control work center to record all material requested from the Supply Support Center in direct support of weapon system maintenance. Space is provided to record essential information considered necessary to monitor operating target (OPTAR) funds. This information includes part number, priority, quantity, price, date and time ordered, and date and time received. Maintenance control uses the time ordered and time received to help determine Not Operationally Ready Supply (NORS) time used in fulfilling readiness reporting requirements.

Material Requisitioning

The Military Standard Requisitioning and Issue Procedure (MILSTRIP) and Uniform Material Issue Priority System were developed by the Department of Defense to provide a common supply language and more effective supply system operations within the military establishment. This system standardizes forms, formats, codes, procedures, and the priority system.

MILSTRIP employs two forms for the requisitioning and issuing of material. The Single Line Item Requisition Document (Form DD 1348) is the basic request document submitted to the applicable supply echelon for material requirements. The issue document is the Single Line Item Release/Receipt Document (Form DD 1348-1). Form DD1348-1 is also used to return RFI material to the supply system. As previously stated, these forms will be prepared by the Supply Response Section of supply for all material requested in direct support of weapon system maintenance and by the material control work center for material requested in indirect support of weapon system maintenance.

Under the MILSTRIP priority system there is no decision to be made in assigning priorities. The urgency of need combined with the unit's military importance when applied to the priority number chart (table 7-2) indicate the proper priority number and no deviation is allowed.

The force/activity designators represent categories of activities in descending order of military importance, ranging from the combat forces under I to the miscellaneous activities under V. Every activity is assigned one of the five force/activity designations according to

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Table 7-2.—Priority number chart.

Force/activity designator	Urgency-of-need categories			
	A	B	C	D
I	1	4	11	16
II	2	5	12	17
III	3	6	13	18
IV	7	9	14	19
V	8	10	15	20

their military importance. These designations are as follows:

I—COMBAT—The highest order of military importance. This designator is not used in peacetime unless approved by the President or the Joint Chiefs of Staff.

II—POSITIONED—U.S. Forces positioned and maintained in a state of readiness for immediate combat or direct combat support.

III—READY—U.S. Forces maintained in a state of readiness to deploy for combat.

IV—RESERVE AND SUPPORT—U.S. active and selected reserve forces planned for employment in support of approved joint war plans. This category includes training units and units in training for scheduled deployment.

V—OTHERS—All units not otherwise assigned.

Force/activity designators are assigned by the Secretary of the Navy, the Chief of Naval Operations, and Commanders in Chief of Fleets. Authority to make assignments may be delegated to Fleet Commanders with the exception of I—COMBAT. Each activity is advised by the appropriate military commander of the assigned designator which governs the procurement of material for that activity.

The letters across the top of table 7-2 represent different degrees of urgency, in descending order of need, from an extremely serious need under A to routine stock replenishment under D. The urgency category is selected by the requesting activity. Definitions of the urgency-of-need categories for aviation units are as follows:

A—Material and equipment for immediate installation or use to effect emergency repairs or replacement for an aircraft mechanically incapable of flight, or an aircraft incapable of performing its primary mission.

B—Material required to effect emergency replacement or repairs without which the operational capability of the activity will be impaired and decreased effectiveness and efficiency in accomplishing assigned operational missions and tasks will result.

Material required to effect emergency replacement or repairs without which the activity can operate only temporarily as an effective unit in performing its assigned operational mission and tasks. This includes material required for aircraft overhaul work stoppage.

C—Material required for emergency repairs of replacement of specific units of inoperative equipment or systems not essential to the operational effectiveness or safety of the force/activity.

Material required for scheduled deployment.

D—Material required in preparation for operational readiness.

Material required for scheduled maintenance of a specific aircraft or system.

Material required for initial outfitting and filling of allowances.

All stock replenishment actions other than previously prescribed.

If a squadron or unit has been assigned force/activity designator III and a work center supervisor determines that a part or some material is needed which if not received will impair the capability of the aircraft to perform its assigned mission, then the priority assigned must be number 6. The only other priorities available to force/activity designated III units or squadrons are 3, 13, and 18.

There are two allowable exceptions to the force/activity designator governed priority number system. Medical or disaster supplies and essential clothing may be requisitioned under priorities 3 and 6, respectively, by any activity regardless of its force/activity designator.

Material Turn-In

There are two main reasons for turning in material—the first and most common is the turning in of a damaged, wornout, or otherwise inoperative part in exchange for a like RFI item; and second, returning of material for credit, such as excess material or material received in error.

When it is determined that a needed part is an exchange item, the old part should be cleaned of grease and dirt, drained, flushed, or purged as necessary before turning it in. It is the responsibility of the maintenance

personnel to attach aircraft equipment condition tags directly to the repairable item. An aircraft equipment condition label is applied to the exterior of the container. All turn-in material should be returned, if practicable, in the container in which the new item was received.

Activities placing items into shipping containers are responsible for the accuracy and completeness of information on the tag and the label, including the necessary obliteration of previous markings on the container which no longer apply. The primary reason for these tags and labels is to provide a means of identification and condition without disruption of packaging or preservation. These tags and labels indicate the required disposition to those processing the material through channels.

When a defective repairable item is turned in, the following forms are required: copies two, three, and four of the multicopy Maintenance Action Form and the Accessory and Component Service Record, when applicable. The supply department uses copy two of the MAF for bookkeeping purposes. Copies three and four of the MAF accompany the item to the Intermediate maintenance activity. When repair is completed by the IMA, copy four of the MAF is attached to the RFI item and the item is returned to the supply system.

If material being turned in is no longer required and is RFI, a Single Line Item Release/Receipt Document (DD 1348-1) is submitted with the item. RFI means ready for issue in all respects—preservation still intact and item in original or reusable container with seals unbroken.

Parts Kits

Supporting items and material for the maintenance, repair, and rework of selected repairable type items are procured, stocked, requisitioned, accounted for, and used on a kit basis as a single item. These parts kits should not be confused with Change Kits which are issued to perform a one-time modification of an item, nor with Interim Fleet Maintenance Support Kits which consist of a minimum range and quantity of parts and material to support the items until regular parts kits become available as a result of normal provisioning action.

A repair kit consists of a group of maintenance or overhaul parts that are bought, packaged, and stocklisted as a single item regardless of the supply classification of the items contained in the kit. Normally, these parts have either a very low unit cost or have a high replacement rate in overhaul or repair of the next higher assembly. Depending upon the complexity of the item to be repaired, there can be one or more kits needed for its repair. Repair parts kits are designed to serve three separate requirements as described in the following paragraphs.

C KIT (CURE-DATED OR SOFT GOODS).—This kit provides cure-dated items such as diaphragms, packings, and O-rings. The C kit may also contain soft goods not subjected to age controls such as gaskets and seals, plus metallic items such as screws, nuts, and washers required to be removed when cure-dated or soft goods type material are replaced. When mixed categories of cure-dated parts are packaged in a single container, the controlling cure-date of the package is that of the oldest cure-dated part in the package. If cure-dated kits become overaged due to the expiration of the storage limitations, the kit is administratively disposed of as excess material.

D KIT (OVERHAUL).—This kit contains hard good repair parts required at the time of overhaul. This kit does not contain cure-dated parts nor any metallic item which is placed in the C kits, thus both are required at the time overhaul maintenance is being performed.

F KIT (FLEET).—This kit provides those items that are required to be replaced at Intermediate and Organizational maintenance levels. Replacement of F kit items normally does not require special tools or equipment. This type kit does not contain cure-dated parts.

Part numbers for repair kits are listed in the applicable Illustrated Parts Breakdown and, in some cases, the Maintenance Instructions Manual.

SURVEYS

Rules and regulations concerning surveys and the responsibility connected with the accounting for government property are of primary importance to every man in the naval service. Personnel of the AK rating are considered the technical experts in matters pertaining to surveys; however, the senior AZ may be required to initiate or assist in the preparation of a request for survey.

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A survey is the procedure required by Navy Regulations when property must be reevaluated or expended from the records due to loss, damage, deterioration, or normal wear. The survey request provides a record showing the cause, condition, responsibility, recommendation for disposition, and authority to expend material from the records. The Survey Request, Report, and Expenditure (NavSup Form 154) is used to survey property, except when a survey is due to discrepancies incident to shipment of material. The Report of Survey (DD Form 46) is used in cases where property is surveyed due to discrepancies incident to shipment of material.

TYPES OF SURVEYS

A FORMAL survey is required for those classes of material or articles so designated by the systems command or office concerned, or when specifically directed by the commanding officer. A formal survey is made by either a commissioned officer or a board of three officers, one of whom, and as many as practicable, must be commissioned officers. The formal survey board is appointed by the commanding officer.

Neither the commanding officer, the officer on whose records the material being surveyed is carried, nor the officer charged with the custody of the material being surveyed, may serve on a survey board.

INFORMAL surveys are made by the head of the department having custody of the material to be surveyed. Informal surveys are used in all cases when a formal survey is not required or directed by the commanding officer. A formal survey can be directed by the commanding officer when circumstances are considered to warrant such action.

PREPARATION OF REQUEST FOR SURVEY

A request for survey may be initiated by a department, division, or section head or a designated subordinate as prescribed by local regulations. Normally, requests for survey are initiated in the department having custody of the material being surveyed. The initial survey request is made on a rough copy of NavSup Form 154. A statement by the originator is placed on or attached to the request for survey relative to the condition of material, including the following:

1. Cause or condition surrounding the loss, damage, deterioration, or obsolescence of material.
2. Responsibility for cause or condition of material or reason why responsibility cannot be determined.
3. Recommended disposition of material or action to be taken.

Upon receipt of the rough copy, the designated group or section prepares a sufficient number of smooth copies of the request for distribution in accordance with local regulations. It is then forwarded to the commanding officer who will determine whether the survey request is to be formal or informal. If formal, the survey request is forwarded to the designated surveying officer(s); if informal, it is forwarded to the head of department for survey action. The surveying officer(s) or department head, as appropriate, conducts the survey.

The statement by the originator as to cause, condition, etc., is attached to the smooth request for survey for evaluation by the surveying officer(s). After the survey has been completed by the head of department or surveying officer(s), it is returned to the commanding officer for review and action. After approval by the commanding officer, the survey is forwarded to the cognizant fleet command and/or systems command for final review and approval when so required. In the absence of specific instructions, surveys are not forwarded to the Naval Air Systems Command for final review and approval.

After approval, the supply officer expends and replaces items as directed by the approved survey. Requests for replacement of surveyed items must be accompanied by a certified copy of the approved survey request.

DISTRIBUTION OF SURVEYS

Copies of a survey are distributed as follows:

1. One copy to the originator of the survey request.
2. One copy to the surveying officer, board, or head of department.
3. The original and three copies to the officer carrying the surveyed material on his records, except when the original is forwarded to a systems command or office for approval. (See item 4.)
4. The original to the cognizant systems command or office when required for final

review and approval. The original is returned to the officer carrying the surveyed material on his records unless the systems command or the supply demand control point requires an information copy approved by the commanding officer. In such cases, a copy is returned to the officer carrying the surveyed material on his records.

5. Any additional copies as may be required by local regulations.

6. One copy (in addition to the regular distribution) to the shipping officer when material shipped on U.S. Government Bill of Lading (Standard Form 1103) is short or material is damaged. A copy is not sent to the shipping officer for material that was shipped under a commercial bill of lading since sufficient information is furnished on the delivering carrier's shipping papers or the Notice of Rejection (NavSup Form 160).

In all cases a certified copy of the approved survey must accompany requests submitted for replacement of surveyed material.

EMERGENCY DISPOSAL

The commanding officer may direct immediate disposition of surveyed material prior to the receipt of systems command or other approval if this action is considered necessary to safeguard the health or safety of his command.

CULPABLE RESPONSIBILITY

When a person in the naval service is found to be culpably responsible (deserving blame) by a surveying officer or board, the reviewing officer refers the entire matter to such a person for a statement. The reviewing officer must then take such disciplinary action as the circumstances require. He notes on the survey form the action taken and informs the Chief of Naval Personnel and the Bureau or systems command concerned as to the disciplinary action taken. In the case of officers, he must make recommendations as to the inclusion of a statement of the action taken in the record of the person concerned and inform such person of the final decision in the matter. Action on the survey in respect to the material involved is not withheld pending disciplinary action.

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TOPIC 4 - REPAIR TECHNIQUES

Competencies

- Alter, repair, and replace a zipper.
- Repair ripped seams by hand and machine.
- Replace and repair outside pockets.
- Replace inside pockets in a jacket or coat.
- Replace lining in a coat or jacket.
- Mend holes or tears.

Motivating Procedure

Have trainees describe personal and family clothing repairs that they have made recently. Discuss if the methods used would be satisfactory for a paying customer.

Learning Experiences

- Show trainees a variety of repair problems that were identified in the class survey. Use examples of repair techniques, wall charts, or duplicated materials to help trainees identify possible solutions to repair problems. Assign several repair jobs to each trainee and display and discuss completed work.
- Demonstrate how to make various kinds of patches and darns such as fringed patch, hemmed patch, chain stitch darn for knits, and french weaving. Have students practice and develop standards for finished products.
- Set up a repair clinic using garments from trainees' family wardrobe. Have trainees estimate cost of repair in terms of time, money, and wearability.

Instructional Materials

- Garments in need of repair
- Wall charts and duplicated material for student reference
- Examples of proper repair techniques
- Sewing equipment and supplies.

SCAI 1433

FILM LIST

MN-8725 Management Improvement—Its Your Business. (26 min.) Applicable to chapter 2.

SC-7432 Industrial Organization and Management—Internal Organization. (39 min.) Applicable to chapter 2.

FN-9433A Principles of Paperwork Management—Plain Letters. (13 min.) Applicable to chapter 3.

FN-9433F Principles of Paperwork Management—Records Disposal. (15 min.) Applicable to chapter 3.

FN-9433G Principles of Paperwork Management—the Navy Directives System. (18 min.) Applicable to chapter 3.

MN-3425B Supervision—Budgeting Time and Effort. (16 min.) Applicable to chapter 3.

MA-8199B Work Simplification in the Shop. (17 min.) Applicable to chapter 3.

MA-8892 Transmission Security. (30 min.) Applicable to chapter 3.

MN-8242 Security—Your Personal Responsibility. (16 min.) Applicable to chapters 3 and 6.

MA-8891 Introduction to Automatic Data Processing. (31 Min.) Applicable to chapter 5.

MN-9584 Quality Control in Maintenance of Naval Aircraft. (18 min.) Applicable to chapter 6.

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ABSTRACT - This booklet is one in a series of booklets of supplemental lessons in food and nutrition prepared by the Extension Service of the U.S. Department of Agriculture and is designed for use by trainer agents in on-the-job training of Extension aides to provide them with information about food needs of family members and with teaching methods to use in helping families. Lessons are: (1) Cultural Food Patterns, (2) Combating Food Misinformation, (3) Sizes of Servings, (4) Digestion and Absorption of Food, (5) Special Diets and How to Handle Them, (6) Weight Control, and (7) Food Needs of Infants, the Preschool Child, School Children, Teenagers, Pregnant and Lactating Women, and the Elderly. Purposes, presentation suggestions, learning activities, references, and audiovisual materials accompany each lesson. An introductory section provides additional suggestions for the trainer agent and lists recommended references. Related booklets are available as VT 012 841-VT 012 843, all in this issue. (SB)

VT 012 840

FOOD and NUTRITION...

supplemental lessons for training extension aides

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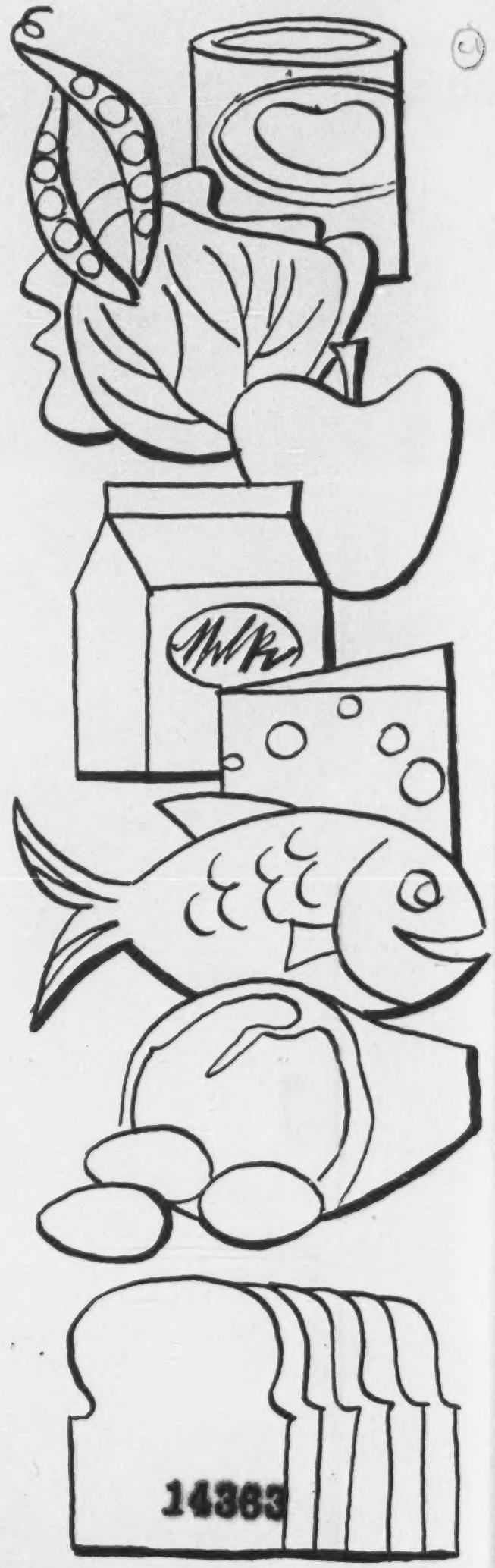

FOOD NEEDS OF FAMILY MEMBERS

VT012840
14363

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Food Needs of Family Members is one of a series of booklets of supplemental lessons in food and nutrition designed for use in on-the-job training of Extension aides. Purpose of these lessons is to give the aides more information about food needs of family members and to provide them with practical teaching methods that they can use in helping families.

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FOOD AND NUTRITION

Supplemental Lessons for Training Extension Aides

FOOD NEEDS OF FAMILY MEMBERS

Purpose

These lessons were written to help trainer agents prepare aides for work with families in the Food and Nutrition Education Program. They help the aides understand the more specific needs of family members of different ages and with varying dietary problems.

This series follows the 15 basic lessons in nutrition given in the initial training for aides and leaders and it enlarges lesson 6 - Food Needs Throughout Life - and Lesson 7 - Feeding Young Children. The information can be adapted by the aides for the families they work with. They can also be used in teaching groups of adults and youth.

The first lesson gives the aides information and makes them more aware of background such as cultural food patterns of the families. The next five tell how to combat food misinformation, what is meant by a serving, more about digestion and absorption of foods, and how to handle the problems of special diets and weight control. Lessons 7 through 12 take up the needs of the infant, preschool child, the school child, teenagers, pregnant and lactating women, and the elderly.

TRAINER AGENT'S RESPONSIBILITY

References are suggested for the agent's use with each lesson. The agent will find it helpful to assemble these references before starting the lessons and to use them in her preparation for teaching.

References are also suggested for the aide's use. The agent should be selective in the references she gives to aides. Order those selected well in advance.

Go over references thoroughly with the aides so that they know what is in each reference.

Professional people in related fields may be asked to participate in training meetings. Such participation should be planned well in advance.

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A working relationship with each aide should already be established as a result of the initial training period. Effective communication remains vital in teaching. Before teaching supplemental lessons, the trainer agent may wish to review purposes of the training and importance of aides' participation.

This suggested checklist will help to assure that all necessary preparations for the in-service training sessions have been made:

___Meeting place with necessary facilities has been obtained.

___All references needed to complete the lessons have been assembled.

___Local public health service and library have been checked for additional references.

___All visual materials and equipment needed to teach the lessons are on hand.

___All reference materials needed for the aides have been obtained.

___All lesson plans have been carefully studied so that the overall content of the course is fully understood.

___Sufficient time has been allowed to complete each lesson.

ADAPTING THE LESSONS TO YOUR AIDES

Guides used in teaching the basic lessons also should be followed in teaching the supplemental lessons.

Adapt training classes to meet the needs of your group. Here are some ideas to keep in mind:

1. Simplify. Do not try to cover too much material in one lesson. Pick out the most important points and emphasize them.

2. Use colorful visuals and a dynamic presentation to help make each lesson appealing.

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3. Emphasize good nutrition elements in the food the aides are now eating. Point out how small changes can often result in a more balanced diet.

4. Stress foods rather than nutrients.

5. Involve the aides in training meetings in as many ways as possible.

EXTENDING INFORMATION

The information given in the supplemental lessons may be effectively used in other ways, such as adaptation for use in training volunteer leaders or in newsletters or newspaper articles. A series of radio or television programs based on the lessons will extend to a larger audience the ideas that aides are promoting.

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Instructor References

BOOKS

Johnson, Mary. *Mary Johnson's guide to altering and restyling ready-made clothes.* New York, N.Y. E. P. Dutton and Co., Inc. 1964.

Pollard, L. B. *Experiences with clothing.* Boston, Mass. Ginn and Co. 1968.

Schwebke, P. W. & Krohn, M. B. *How to sew on leather, suede, fur.* Milwaukee, Wis. The Bruce Publishing Co. 1966.

PAMPHLETS

Cornell University. Cooperative Extension Service, New York State College of Home Economics. *Mending clothes and household fabrics,* by G. L. Butt. Ithaca, N.Y. The College. n.d. (Bulletin 871)

_____ *Sewing fabrics of man-made fibers,* by Janet Reed and Adaline Snellman. Ithaca, N.Y. The College. n.d.

_____ *Stretch in the wardrobe,* by Nancy Conklyn and Jean McLean. Ithaca, N.Y. The College. 1966.

U. S. Department of Agriculture. *Clothing repairs.* Washington, D.C. U. S. Government Printing Office. n.d. (Bulletin G 107)

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Recommended publications

For aides and leaders

Publications and visual materials are listed with each lesson. Make sure that adequate supplies of them are on hand before you begin teaching.

USDA

Bulk quantities of USDA pamphlets can be obtained through your State distribution officer.

Calories and Weight, G-153 (25¢)
Family Fare, G-1 (45¢)
Food and Your Weight, G-74 (15¢)
Food Guide for Older Folks, G-17 (10¢)
Nutritive Value of Food, G-72 (30¢)
*Feeding Young Children, PA-693 (5¢)
*How Food Affects You flipchart (in booklet form), 1970
32 pages, (60¢)
*Meal Planning Made Easy, PA-695 (5¢)
*Daily Food Guide Leaflet, F&NS-23 (35¢ for 10 copies)
Free illustrated F&NS Daily Food Guide leaflets are available for educational programs relating to U.S. Department of Agriculture's Family Food Assistance Programs through your regional Food and Nutrition Service Office.

*Publications NOT available free may be purchased from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, at the prices indicated. GPO offers a 25 percent discount for 100 or more copies.

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Answers to Questions That Are Often Asked About Diabetic Diets, No. 1847 (10¢)
Infant Care, Children's Bureau, No. 8, 1970 (20¢)
Prenatal Care, Children's Bureau, No. 4, 1970 (20¢)
When Your Baby Is on the Way, Children's Bureau, No. 391, 1969 (15¢)
Your Baby's First Year, Children's Bureau, No 400, 1968 (15¢)
Your Child From One to Six, No. 30 (20¢)

Copies of publications from Health, Education and Welfare may be obtained locally from the Public Health Service or purchased from the Superintendent of Documents.

National Dairy Council

A Boy and His Physique, B-10 (25¢)
A Girl and Her Figure, B-87 (25¢)
Feeding Little Folks, B-310 (15¢)
Feeding Your Baby at Your Breast, B-106 (8¢)
How Your Body Uses Food, B-77 (25¢)
Lower Cost Meals That Please, B-64 (15¢)
Source Book on Food Practices with Emphasis on Children and Adolescents, B-26 (15¢)
Weight Control Source Book, B-70 (15¢)
What Did You Have for Breakfast This Morning? Leader Guide, B-115 (20¢)
What to Eat Before You Are Pregnant, While You Are Pregnant, After the Baby Comes, B-103 (4¢)

A catalog listing available materials can be obtained. If you live in a city where there is an affiliated Dairy Council, requests for material should be directed to that office. If you are not served locally, send orders to National Dairy Council, 111 North Canal Street, Chicago, Illinois 60606.

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Recommended references

For trainer agents

Each lesson includes a list of recommended reference books and publications for trainer agents to use in preparing lessons. Make sure you have the references you need to do a good job.

Beware of "Health" Quacks, American Medical Association, 535 North Dearborn Street, Chicago, Illinois 60610.

Eating For Your Baby To Be, National Live Stock and Meat Board, 36 South Wabash Avenue, Chicago, Illinois 60603 (20¢).

"Eating Habits of Teenagers," Spindler, E. Food and Nutrition News, May 1968, National Live Stock and Meat Board, 36 South Wabash Avenue, Chicago, Illinois 60603.

Facts About Diabetes, ADA Forecast, Cookbook for Diabetics, American Diabetes Association, Inc., 18 East 48th Street, New York, New York 10017.

Feeding Your Baby and Child, Spock and Lowenburg, 1967 Affiliated Publishers, Inc., 630 Fifth Avenue, New York, New York 10020 (50¢).

Food, Yearbook of Agriculture, 1959. ($3.25) Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.

Food, A Key To Better Health, Nutrition Foundation, Inc. 1970. Order from Colson Company, 901 North Main Street, Paris, Illinois 61944 (25¢).

"Food Acceptance, A Challenge to Nutrition Education--A Review," Lamb, M. Journal of Nutrition Education, 1:2, 1969, Society for Nutrition Education, 119 Morgan Hall, University of California, Berkeley, California 64720. Single copies $1.50.

Food and Man, Lowenburg and others, John Wiley and Sons, Inc., 605 Third Avenue, New York, New York 10016, 1968 ($7.95).

Food and Nutrition---basic lessons for training extension aides, Extension Service, USDA.

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Food Facts Talk Back, American Dietetic Association, 620 North Michigan Avenue, Chicago, Illinois 60611.

Food For Us All, Yearbook of Agriculture, 1969 ($3.50). Superintendent of Documents, Government Printing Office, Washington, D.C., 20402.

Fundamentals of Normal Nutrition, Robinson, Corinne H., Macmillan Company, 866 Third Avenue, New York, New York 10022, 1968 ($7.95).

Introduction to Nutrition, Fleck, Henrietta and Munves, Elizabeth, Macmillan Company, 866 Third Avenue, New York, New York 10022, 1962 ($7.50).

Learning Better Nutrition: A Second Study of Approaches and Techniques, Ritchie, Jean A.S., FAO, Unipub, Inc., P.O. Box 433, New York, New York 10010, 1967 ($4.00).

Making Baby's Formula, Evaporated Milk Association, 228 North LaSalle Street, Chicago, Illinois 60601.

Mr. Peanut's Guide to Nutrition, 1970, Standard Brands Educational Service, P.O. Box 2695, Grand Central Station, New York, New York 10017.

Nutrition in Action, Martin, E.A., Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017, 1965. Teacher's guide ($6.50).

Principles of Nutrition, Wilson Eva D. and others, John Wiley and Sons, Inc., 605 Third Avenue, New York, New York 10016, 1965 ($8.50).

Recommended Dietary Allowances, 1968, National Research Council, 2101 Constitution Avenue, NW, Washington, D.C. 20037, ($1.75).

Understanding Food Patterns in the USA, 1969, American Dietetic Association, 620 North Michigan Avenue, Chicago, Illinois 60611.

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Visuals

Slide Sets

"Improving Teenage Nutrition" C-116 1963.
27 frames. $8.00.
"Oopsies" C-74 1960. 22 frames. $8.00.

USDA slide sets may be purchased from Photography Division, Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250.

Charts and Posters

How Food Affects You (flipchart in booklet form). 1970.
32 pages color (60¢) Superintendent of Documents.
*Daily Food Guide Poster, 22" x 28", 15¢ per copy.

National Dairy Council

What Did You Have for Breakfast This Morning? Chart
P-518 (35¢).

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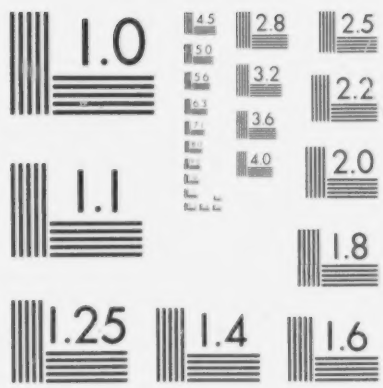

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

FOOD NEEDS OF FAMILY MEMBERS

Lesson 1: CULTURAL FOOD PATTERNS

PURPOSE

Trainer agent to help aides:

1. Understand factors that influence food patterns.

2. Recognize cultural subgroups in community and their food patterns.

PRESENTATION

- Have a food tasting party. Prepare some foods that are unfamiliar to the group as well as foods they know. Also, serve foods in an unfamiliar way (for example, pears or other locally grown fruits or vegetables cut into cubes). Observe reactions of the group to the foods.

- Discuss reactions to the food tasting. Point out positive and negative attitudes, influence of peer acceptance, and general reactions.

- Discuss some factors that influence foods a person eats. Refer to the listed references for background information. Ask the aides to give examples of how the following influence eating habits:

  - childhood habits
  - family members
  - peers
  - religion
  - status
  - security
  - culture or ethnic group

- Show the National Dairy Council poster "What Did You Have for Breakfast this Morning?" Ask the aides the following questions to stimulate discussion:

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- Do all of these children eat the same foods for breakfast? Why or why not?

- Does what we eat really matter?

Discuss the eating habits and related background information of ethnic groups in the community:

- nationality background
- location of ethnic groups in community
- family characteristics (extended family, size, etc.)
- religion
- occupations
- facilities for eating and cooking
- frequency of meals
- facilities for buying and obtaining food
- kinds and proportion of foods in diet
- methods of preparing and serving foods

. Using foods or pictures, have the aides show how the foods eaten by a particular ethnic group fit into the Daily Food Guide. Have the aides suggest additional foods so that some from all food groups are represented in the diet. (Aides may wish to use their own version of the Daily Food Guide made in Lesson 2 of Food and Nutrition...Basic Lessons.)

. Discuss this statement: Food habits, good or bad, are hard to change.

. Have aides understand food patterns of homemakers by studying several dietary recalls. Discuss food groups most lacking.

APPLICATION OF LESSON BY AIDES

Aides understand some of the factors which influence food patterns.

Aides recognize food patterns of ethnic groups among specific families in community, what food groups are represented, and what food groups need emphasis in the food patterns.

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REFERENCES FOR TRAINER AGENT

1. Understanding Food Patterns in the USA, 1969, American Dietetic Association

2. What Did You Have for Breakfast This Morning?, poster and leader guide, National Dairy Council

3. "Food Acceptance, A Challenge to Nutrition Education--A Review," Lamb, M. Journal of Nutrition Education 1:2, 1969, pp. 20-23

4. Learning Better Nutrition, FAO, pp. 28-70

5. Food and Man, Lowenburg and others, pp. 65-121

VISUALS AND EQUIPMENT

Pictures from labels, seed packets and catalogues

Food prepared by aides representing local ethnic tastes

Newsprint or chalkboard

What Did You Have for Breakfast This Morning?, poster, National Dairy Council

Daily Food Guide, F&NS-23, USDA

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FOOD NEEDS OF FAMILY MEMBERS

Lesson 2: COMBATING FOOD MISINFORMATION

PURPOSE

Trainer agent to help aides:

1. Identify some common food facts and fallacies.

2. Learn the dangers of food misinformation.

3. Recognize indications of food fads and fallacies.

4. Learn sources of reliable nutrition information.

PRESENTATION

- Give the true-false quiz on food facts and fallacies. Note the amount of misinformation among aides and discuss questions on quiz.

- Have aides tell and discuss other food fads or fallacies.

- Discuss the dangers of food fads and fallacies:

  - Essential nutrients are often lacking in a fad diet.

  - Medical attention to a serious ailment is often delayed while a food quack attempts to treat the condition. Emphasize that the physician is the only person qualified to diagnose and treat illness.

- Emphasize that, according to the American Medical Association, about 10 million Americans squander $500 million each year on food fads. The victims are found in all educational and economic levels. Chronically ill or aged persons are especially vulnerable. It is difficult to identify quacks because they often represent themselves as doctors and nutritionists. They lecture, write, and promote misinformation through advertising. Products include "miraculous" food as supplements, pills, gadgets, cooking equipment, service devices, treatments, or books.

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UNIT 4 - ELEMENTS AND PRINCIPLES OF DESIGN

Competencies

- Recognize those features of design which may be altered.
- Make alterations in garments that utilize the elements and principles of design.

Motivating Procedure

Exhibit two dummies, each dressed in an unbecoming style. Pad one dummy to simulate a short, stout figure and pad the other dummy to simulate a tall, slender figure. Have students identify the reasons for the poor visual efforts.

Learning Experiences

- Demonstrate fundamental principles of art and elements of design by using pictures, garments, fabrics, and silhouette kits. See Appendix L.
- Divide class into groups of two or three trainees. Have each group plan several garments of good design with the aid of a silhouette kit and then present their ideas to class using an opaque projector.
- Have trainees explain the elements and principles of design they need to consider when making various types of alterations.

Instructional Materials

- Dummies padded to simulate extreme figure types
- Pictures or actual garments and fabrics showing elements and principles of good design
- Silhouette kits (Appendix L)
- Clothing needing alterations
- Dresses for dummies

Instructor References

BOOKS

Craig, H. T. *Clothing, a comprehensive study;* annotated edition. Philadelphia, Pa. J. B. Lippincott Co. 1968.

McJimsey, H. T. *Art in clothing selection.* New York, N.Y. Harper and Row. 1963.

Milady Publishing Corporation. *Charm teachers' manual; section two, wardrobe planning.* New York, N.Y. The Corporation. 1966.

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- List indications of quackery:

  - guarantees of quick cures

  - claims of "special" or "secret" formulas that can cure one or more diseases

  - case histories or testimonials to promote products

  - products used to replace surgery, X-rays, or medically approved drugs

  - statements of disasters which may happen if products are not used

- List sources of reliable nutrition information:

  - individuals such as Extension home economists, home economics teachers, home economists employed by other agencies, physicians, dietitians with hospitals, medical clinics, school lunch programs, Extension nutritionists, and public health nutritionists

  - organizations and agencies such as the U.S. and State Departments of Agriculture, Food and Drug Administration, Public Health Service, State and American Medical Associations, State and American Dietetic Associations, State and American Public Health Associations, State and American Home Economics Associations, and Better Business Bureaus.

APPLICATION OF LESSON BY AIDES

Aides learn to recognize food misinformation.

Aides help homemakers understand differences between food facts and fallacies.

Aides encourage families to seek reliable nutrition information.

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REFERENCES FOR TRAINER AGENT

1. Food Facts Talk Back, American Dietetic Association

2. Beware of "Health" Quacks, American Medical Association

3. Nutrition in Action, Martin, 1965, pp. 231-238

4. Fact Sheets, Food and Drug Administration

VISUALS AND EQUIPMENT

Chalkboard or newsprint pad

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FOOD FADS QUIZ

Directions: Indicate whether the statement concerning foods and nutrition is true or false, circling T for true and F for false.

	True or False
1. Adults do not need milk.	T F
2. A good way to reduce is to omit breakfast.	T F
3. Milk should be included in a weight-reducing diet.	T F
4. Fish and celery are "brain" foods.	T F
5. Toast has fewer calories than untoasted bread.	T F
6. Margarine has fewer calories than butter.	T F
7. Omit meat, eggs and milk from the diet to cure arthritis.	T F
8. Citrus fruits are "acid forming" in the body.	T F
9. Milk causes constipation in adults.	T F
10. Grapefruit aids reducing.	T F
11. Dark bread has fewer calories than white bread.	T F
12. Fruit and vegetable juices contain calories.	T F

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13.	Vegetables and cereals produced in poor soil are of very low food value.	T F
14.	Food stored in an open can in the refrigerator is dangerous.	T F
15.	Wheat germ, yeast, and blackstrap molasses can prevent nervousness, correct baldness, and help digestion.	T F

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ANSWERS TO FOOD FADS QUIZ

1. False. Adults, as well as children, need the nutrients found in milk. It is the best and most reliable single source of calcium, which is needed by everyone. Milk is recommended for adults because it provides nutrients needed for maintenance of bones and teeth and for other body functions, such as normal clotting of the blood in healing, and regularity of the heart action. Milk is also a valuable source of good quality protein, riboflavin, and many other nutrients.

2. False. Reliable studies show that a reducing plan including a well-balanced breakfast is more successful than one which omits breakfast. The individual feels better, has less fatigue, is more alert, less hungry and less tempted to "nibble" before lunch time. Everyone, including "weight-reducers," needs to replenish the body with vitamins, minerals and protein, as well as energy, after a 10- to 12-hour fast. Surplus body fat can supply some of the energy, but not the other nutrients.

3. True. Because of its high content of protein, calcium and riboflavin, whole or skim milk usually should be included in any diet, reducing or otherwise.

4. False. No single food supplies all nutrients needed by any one part of the body.

5. False. Toasting does not reduce the number of calories. Toasting does slightly reduce the water content, and so weight for weight, a pound of toast actually has a few more calories than a pound of untoasted bread.

6. False. Margarine and butter have the same caloric value. Vegetable oils, from which margarine is made, have the same caloric content as animal fat.

7. False. There is no evidence that any food will either cause or cure this disease.

8. False. Citrus fruits are acid in their original state. After digestion and final use by the body cells, fruits are changed in chemical form and leave an alkaline residue in the blood and tissues. The body needs both acid-forming and alkaline-forming foods, which a mixed diet will supply.

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9. False. The only way milk may cause constipation is for a person to take it in such large quantities that he does not eat enough of other foods to give him the necessary bulk.

10. False. Grapefruit contains sugar, vitamins, minerals, and citric acid. None of these in any way removes or helps to remove fat from the body. Although grapefruit is not as high in caloric value as some fruits, it does contain calories.

11. False. Generally speaking there is very little difference in the caloric value of regular white bread and dark bread. Some dark breads containing raisins or made with molasses may have a few more calories than plain white bread.

12. True. Yes, they do. Fruit juices contain the natural sugars of the original fruit and may have sugar added before canning or freezing. A 6-oz. glass of orange juice contains 80 calories; if sweetened, it may have 100 or more.

    Vegetable juices contain fewer calories than unsweetened fruit juices but do contain some: 1 cup of tomato juice contains 50 calories, and if sweetened may contain as many as 75 calories.

13. False. Poor soil reduces yield rather than nutrient content of the food. Furthermore, people are not likely to eat food grown in only one type of soil. The various soil deficiencies here and there will not affect the average person.

14. False. It is safe to keep food in the original can after it has been opened. It is important to cover the can and to keep the food cool. A few acid foods may dissolve a little iron from the can, but this is not harmful or dangerous to health.

15. False. These so-called miracle foods have no unique virtues, no magical powers. Certain special foods, such as wheat germ, brewer's yeast, and blackstrap molasses, do contain a generous amount of some vitamins and minerals or other nutrients. But these nutrients are also found in many common foods and often in a more palatable form.

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FOOD NEEDS OF FAMILY MEMBERS

Lesson 3: SIZES OF SERVINGS

PURPOSE

Trainer agent to help aides:

1. Learn what constitutes a standard serving of common foods in each of the four food groups.

2. Learn the importance of amounts served.

PRESENTATION

- Have a bowl of cooked vegetables and paper plates available. Ask each aide to place a serving of a cooked vegetable on a plate. Measure the amount on each plate and compare this to a 1/2 cup standard serving.

- Review the Daily Food Guide. Ask aides to name a food group and tell the number of servings needed for adults and children, and the major nutrient in it.

- Give the following demonstrations:

  - Milk Group. Have various sizes of glasses and cups available. Pour liquids from glasses and cups into a standard measuring cup to illustrate difference in amounts. Exhibit the recommended servings for children, teenagers, and adults including pregnant women and nursing mothers.

    -- Show standard servings from the milk group:

    1 cup milk
    1/2 cup custard
    1/2 cup ice cream
    1/2 cup cottage cheese
    1 cup cocoa (made with milk)
    1 slice cheddar cheese (1 oz.)

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-- Exhibit a suggested day's intake from milk group.

- Meat group. Show standard servings from the meat group:

  2 and 3 ounces of cooked meat
  Foods which contain an equivalent amount of protein
  - 4 tablespoons peanut butter
  - 2 eggs
  - 1 cup cooked dry beans or peas

-- Exhibit a suggested day's intake from meat group.

- Fruit and vegetable group. Show standard servings from fruit and vegetable group:

  1/2 cup cooked or raw vegetables or fruit
  1 medium banana, apple, or orange
  1 medium potato
  1/2 grapefruit

-- Exhibit a suggested day's intake from fruit and vegetable group, including fruits and vegetables high in Vitamin A and Vitamin C.

- Bread and cereal group. Show standard servings from bread and cereal group:

  1 slice bread
  1 biscuit or roll
  1 ounce ready-to-eat cereal
  1/2 to 3/4 cup cooked cereal, grits, rice, macaroni

-- Exhibit a suggested day's intake from the bread and cereal group.

. Illustrate serving sizes for children. Two or three tablespoons make a serving for small children.

. Point out people should eat the size of serving they want. Serving size helps us judge the amount of food that is indicated by the Daily Food Guide.

. Discuss the value of teaching serving sizes to homemakers. Include these factors:

  - weight control
  - economy
  - nutritive value and variety.

- Have aides illustrate sizes of servings for adults and children.

- At the end of the lesson have aides place a standard serving of vegetable on a plate and compare with their serving selected at beginning of lesson.

APPLICATION OF LESSON BY AIDES

Aides understand the importance of learning the average sizes of servings from the food groups.

Aides will teach serving sizes when helping homemakers with food preparation.

REFERENCES FOR TRAINER AGENT

1. Nutritive Value of Foods, G-72, USDA

2. Family Fare, G-1, USDA

VISUALS AND EQUIPMENT

DAILY FOOD GUIDE, poster, F&NS-23, USDA

Foods and equipment for exhibits of sizes of servings

Bowl or pan of cooked vegetable

Small paper plates

Spoons

REFERENCE FOR AIDES

1. Daily Food Guide, leaflet, F&NS-23, USDA

2. Food - A Key to Better Health, Nutrition Foundation, p.3

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FOOD NEEDS OF FAMILY MEMBERS

Lesson 4: DIGESTION AND ABSORPTION OF FOOD

PURPOSE

Trainer agent to help aides:

1. Have a basic understanding of how foods are digested by the body.

2. Learn some factors that influence digestion and absorption of food.

PRESENTATION

. Introduce lesson by explaining that food must be changed by the body to become part of your cells and you. Protein, carbohydrates, and fats are broken down into smaller substances in a process called digestion. Show slides 1-13 of "How Food Becomes You" slide set to illustrate. Have aides refer to How Your Body Uses Food, National Dairy Council.

. Show a diagram of the digestive organs. Discuss how food changes in the mouth, stomach, small intestine, and large intestine.

. Point out these facts when discussing digestion in the mouth:

- Digestion begins in the mouth when food is mixed with saliva.

- Saliva contains a digestive enzyme which changes some of the carbohydrates (starch) into sugar. This process is aided by eating slowly and chewing food well.

- Other food is broken up by the teeth into smaller pieces so it can be digested further along the digestive tract.

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UNIT 5 - PREPARATION FOR EMPLOYMENT

Competencies

- Identify sources of employment.
- Show a positive attitude toward work.
- Follow acceptable practices when preparing for and during a job interview.
- Manage efficiently personal time, energy, and skills during working hours.
- Communicate effectively with others.

Motivating Procedure

Invite a new employee to discuss his satisfactions in being a part of the world of work.

Learning Experiences

- Invite local employers and an employment service representative to serve on a panel to discuss such topics as where to look for a job, how to apply for a job, conduct during an interview, and what the employer looks for in an applicant.
- Show trainees sample job application blanks using the opaque projector. Discuss unfamiliar terms and the information required. Give trainees job application blanks to complete. Conduct mock interviews with trainees and discuss the impressions made by the applicants and ways these impressions may be improved.
- Present case studies which illustrate situations where the attitudes or values of the employee influenced the action of the employer. Ask trainees to suggest the proper employee action and attitude for each situation.
- Ask trainees to collect newspaper advertisements of jobs related to garment alteration. Discuss qualifications in relation to trainee skills.

Instructional Materials

- Job application forms
- Case studies
- Newspaper advertisements

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- Discuss digestion in the esophagus. Food passes through the esophagus to the stomach.
- Explain the steps of digestion in the stomach:
  - The stomach wall contains many muscles which further mix food. The food is churned and partially digested.
  - Enzymes and a mild acid change proteins into smaller, more soluble parts.
  - The churned mass becomes a thick liquid and is passed from the stomach into the small intestine.
- Discuss digestion in the small intestine:
  - Fats are broken down into fatty acids and glycerol. They are absorbed through the intestinal wall into the bloodstream.
  - Partially digested proteins are changed into amino acids.
  - Partially digested carbohydrates (starches) are converted to simple sugars.
  - Amino acids and simple sugars are also absorbed through intestinal walls into the bloodstream.
- Explain the need for protein, carbohydrates, and fat in a balanced diet. Include the following information:
  - Carbohydrates provide quick energy.
  - Proteins build and repair cells.
  - Fat contributes energy and satiety value.
- Explain the steps of digestion in the large intestine:
  - The body cannot digest some substances, such as cellulose. This roughage and other waste products pass through the large intestine and out the body.

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REFERENCES FOR AIDES

1. How Your Body Uses Food, National Dairy Council

2. Mr. Peanut's Guide to Nutrition, Standard Brands

3. How Food Affects You, flip chart, pp. 12, 16, 25

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FOOD NEEDS OF FAMILY MEMBERS

Lesson 5: SPECIAL DIETS AND HOW TO HANDLE THEM

PURPOSE

Trainer agent to help aides:

1. Know sources of help for persons with special diets.

2. Understand procedures to be followed in helping families with special diets.

PRESENTATION

. Contact a local public health worker, dietitian or physician who is qualified to give aides information about special diets.

. Ask resource person to:

- Lead a discussion on understanding the nature of selected special diets, such as diabetic, low-salt, and cholesterol. Include overall principles of dietary treatment and kinds of foods that need to be altered or avoided in the diet.

- Stress that each special diet is different so the physician's recommendation must be followed.

- Respond to questions aides are often asked by homemakers, such as:

  Johnny is a diabetic, but he eats lots of candy. What should I do?

  Susie is on a special diet but fixing all that special stuff is too much trouble.

  Timmy is allergic to wheat, but I don't know what to do.

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- Discuss local agencies and other sources of information on special diets.

- Present the following guides for assisting with special diets:

  - Reemphasize that the aide should only reinforce the diet given by the physician.

  - Remind aide to check with supervising home economist before helping homemaker on a special diet.

  - Ask aides to tell of special diet problems they have encountered.

APPLICATION OF LESSON BY AIDES

Aides encourage families to follow physicians' advice for special diets and obtain help from proper sources.

Aides give out appropriate leaflets to homemakers.

REFERENCES FOR TRAINER AGENT

1. Introduction to Nutrition, Fleck & Munves, (1962) Chapter 30.

2. Facts About Diabetes, ADA Forecast, Cookbook for Diabetics, American Diabetes Association, Inc.

3. Answers to Questions That Are Often Asked About Diabetic Diets, U.S. Department of Health, Education and Welfare, Public Health Service.

14391

FOOD NEEDS OF FAMILY MEMBERS

Lesson 6: WEIGHT CONTROL

PURPOSE

Trainer agent to help aides:

1. Understand that body weight can be controlled by a balance of activity and food intake.

2. Identify the factors which contribute to overweight.

3. Become aware of the dangers of obesity.

4. Understand that all foods contribute calories to the diet in varying amounts.

PRESENTATION

. Show the slide set "The Oopsies."

. Discuss with aides:

- How many homemakers they visit would they consider to be grossly overweight. (A person who exceeds a desirable weight by 10 percent is considered overweight.)

- Approximately 40 percent of persons in the United States above 40 years of age are believed to be obese. (A person who exceeds his desirable weight by more than 20 percent is considered obese.)

- Children and adolescents who exceed 10 percent of their desirable weight are considered overweight and those who exceed their desired weight by 20 percent are considered obese.

- Discuss these factors which cause homemakers to be overweight or obese:

  - eating because they are bored or frustrated
  - eating too many high calorie foods
  - lacking exercise--refer to pages 3 and 4, Food and Your Weight
  - cultural food patterns
  - habitual eating pattern (developed in youth)
  - heredity
  - social eating
  - metabolic abnormalities (very small percentage of overweight is due to glandular disturbances)

- Ask aides to identify some of the problems related to obesity, such as:

  - difficulty in performing everyday activities--walking, climbing stairs, bending over, etc.
  - more frequent subjection than others to cardio-vascular diseases, diabetes
  - surgery more hazardous
  - pregnant women more prone to toxemia; more complications in delivery
  - higher mortality rate
  - physical appearance less attractive
  - more difficult to find jobs
  - social opportunities more limited

- Review the Daily Food Guide, pointing out that:

  - The minimum number of servings recommended by the Daily Food Guide will supply approximately 1200 calories, which would be a safe reducing diet for most women.

14393

- Show aides how to use calorie tables and serving sizes in booklet, Calories and Weight. Demonstrate calories in servings of common foods.

- List and discuss suggestions for reducers. Use as references Calories and Weight and Food and Your Weight.

- Emphasize these points:

  - Check with doctor first.

  - Take it slowly--a loss of one or two pounds a week is enough.

  - Plan meals around familiar foods.

  - Establish a pattern of eating that can be followed when desirable weight is attained.

  - Do not skip meals.

  - Follow a reliable food plan to be sure that meals are nutritionally adequate.

  - Choose lower calorie foods within each food group.

  - Season foods with spices, herbs, vinegar or tart fruit juices instead of fats, gravies, and other high calorie dressings.

  - Eat cereals or fruit without sugar.

  - Drink coffee and tea without sugar or cream.

  - Budget your calories to take care of special occasions.

  - Choose snacks wisely.

  - Keep busy to avoid eating foods not included in planned meals and snacks.

  - Take more exercise.

14394

APPLICATION OF LESSON BY AIDES

Aides encourage overweight individuals to lose weight by following the Daily Food Guide.

REFERENCES FOR TRAINER AGENT

1. Food for Us All, Yearbook of Agriculture, 1969, USDA, pp. 304-314

2. Calories and Weight, G-153, USDA

3. Food and Your Weight, G-74, USDA

4. Fundamentals of Normal Nutrition, Robinson, 1968, pp. 392-412

5. Nutrition In Action, Martin, 1965, pp. 191-201

6. Nutritive Value of Foods, G-72, USDA

7. Weight Control Source Book, National Dairy Council

VISUALS AND EQUIPMENT

"Oopsies," Slide set, USDA

Screen and projector

Chalkboard or newsprint

Daily Food Guide, F&NS-23, USDA

REFERENCES FOR AIDES

1. Calories and Weight, G-153, USDA

2. Food and Your Weight, G-74, USDA

3. Nutritive Value of Foods, G-72, USDA

4. Food, A Key to Better Health, Nutrition Foundation, pp. 16-18

14395

FOOD NEEDS OF FAMILY MEMBERS

Lesson 7: FOOD NEEDS OF INFANTS

PURPOSE

Trainer agent to help aides:

1. Understand the nutritional needs of infants.

2. Learn kinds and amounts of foods needed by infants.

3. Learn ways to help homemakers prepare food for infants.

PRESENTATION

- Discuss milk as a baby's first food. It contains nutrients which infants need for growth and development--protein, vitamins, calcium and other minerals. It also supplies food energy. By the time a child is one year old, he should be consuming foods from all four food groups in a 3- to 5-meal-a-day pattern.

- Enlist the help of a public health nutritionist, nurse or other qualified person to discuss infant feeding:

  - bottle vs. breast feeding
  - methods of bottle sterilization
  - additional nutrient needs of infants
    - liquid
    - vitamin and mineral supplements
  - introducing solid foods to infants
  - weaning the baby
  - coping with feeding problems

- Have aides prepare several foods suitable for feeding infants at different stages of growth:

  - diluted orange juice
  - pureed vegetables
  - mashed fruits
  - strained meats
  - egg yolk

14396

Instructor References

BOOKS

Corwen, Leonard. *Find your job and land it.* New York, N.Y. Arco Books, Inc. 1966.

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McDermott, I. E. & Norris, J. L. *Opportunities in clothing.* Peoria, Ill. Chas. A. Bennett Co., Inc. 1968.

PAMPHLETS

New York State. Department of Commerce. Women's Program. *Pointers on how to apply for that all-important first job,* by A. A. Babbidge. Albany, N.Y. The Department. 1969. (Job horizon series No. 1C.)

_____ Department of Labor, Division of Employment. *How the New York labor law protects you.* Albany, N.Y. The Division. 1966.

_____ *How to sell yourself to an employer.* Albany, N.Y. The Division. n.d.

1437

- Have aides practice bottle sterilization procedures.

- Discuss community agencies, clinics, and resources providing information and help for mothers with infants --for example, well-baby clinics.

APPLICATION OF LESSON BY AIDES

Aides understand principles of infant feeding.

Aides teach homemakers how to prepare food for infants.

Aides teach homemakers importance and methods of sterilizing equipment for feeding infants.

Aides inform homemakers of community resources available.

REFERENCES FOR TRAINER AGENT

1. Feeding Your Baby and Child, Spock and Lowenburg

2. Making Baby's Formula, Evaporated Milk Association

3. Feeding Your Baby at Your Breast, National Dairy Council

4. Materials available from local health department or Office of Child Development, U.S. Department of Health, Education and Welfare

REFERENCES FOR AIDES

1. Your Baby's First Year, Children's Bureau Publication No. 400, 1968, U.S. Department of Health, Education and Welfare

2. Food - A Key to Better Health, Nutrition Foundation, pp. 7-8

14397

FOOD NEEDS OF FAMILY MEMBERS

Lesson 8: FOOD NEEDS OF THE PRESCHOOL CHILD

PURPOSE

Trainer agent to help aides:

1. Understand the nutritional needs of the preschool child.

2. Know the kinds and amounts of food needed by preschool children.

3. Learn to help homemakers plan meals to meet the food needs of preschool children.

PRESENTATION

- Show slides 1-35 of "Feeding Young Children." Discuss the following:

  - Preschool children need the same foods as adults but in different amounts. Refer to the Daily Food Guide. Emphasize the recommended intake of the milk group in particular.

  - The growth rate is slower during the preschool years than during infancy. However, there is a continuous need for a well-balanced diet.

  - The amount of food a preschool child needs depends on age, rate of growth, size, and activity.

- Review with aides Lesson 7, Feeding Young Children from Food and Nutrition--Basic Lessons, and section on young children in Food, A Key to Better Health.

- Illustrate a possible meal pattern for a good daily diet for a preschool child. Stress sizes of servings for preschool children. Demonstrate appropriate serving sizes.

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- Discuss the importance of regular meals for preschool children. Children have small stomachs, and therefore may not be able to eat enough food at a meal to last for a long period. In addition to regular meals, snacks play an important role in the diet of a preschool child.

- Discuss nutritious snacks for children. Have aides suggest foods from the illustrated meal pattern that would be good snacks for preschool children. Suggest other foods that would provide valuable nutrients, rather than just empty calories.

- Ask aides to list some problems of homemakers in feeding preschool children. Have aides relate these problems to characteristics of this age group. Discuss how these problems can be handled.

APPLICATION OF LESSON BY AIDES

Aides prepare a low cost nutritious meal appropriate for a family with young children. Show how this meal can be adapted for a preschool child.

Aides help parents understand the importance of helping their children establish good food habits.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 283-302

2. Food For Us All, Yearbook of Agriculture, 1969, USDA, pp. 294-303

3. Feeding Young Children, Extension Service, USDA, PA-693

4. Feeding Your Baby and Child, Spock and Lowenburg, Chapter VI

5. Food and Nutrition--basic lessons for training extension aides, Extension Service, USDA

6. Your Child from One to Six, No. 30, U.S. Department of Health, Education and Welfare

14399

VISUALS AND EQUIPMENT

"Feeding Your Young Children," filmstrip, National Dairy Council

Newsprint

Projector and screen

Measuring equipment and food for illustrating serving sizes

Daily Food Guide, poster, F&NS-23, USDA

REFERENCES FOR AIDES

1. Feeding Young Children, PA-693, Extension Service, USDA

2. Feeding Little Folks, National Dairy Council

3. Food - A Key to Better Health, Nutrition Foundation, pp. 7-9

14400

FOOD NEEDS OF FAMILY MEMBERS

Lesson 9: FOOD NEEDS OF SCHOOL CHILDREN

PURPOSE

Trainer agent to help aides:

1. Understand food needs of school-age children (6 to 12 years).

2. Know the types and amounts of foods they need.

3. Learn more about the kinds of food programs available for them.

PRESENTATION

. Discuss characteristics of this age group which affect nutrient needs and food habit formation:

- From ages 7 to 10, growth usually is steady. For girls, growth is usually more rapid around 10 to 11, and for boys the growth spurt begins about 13 to 15.

- Nutrient needs are still high and calorie needs are increasing to provide building material for growth, furnish energy for vigorous physical activity, help maintain resistance to infection, and develop an adequate store of nutrients for growth and stresses during adolescence.

- Until age 9, boys and girls have similar nutrient needs. After 9, boys need more calories than girls because they are usually more active. Ask aides to identify and compare activities of boys and girls from 9 to 12 years old.

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- Emphasize that school children still look to adults for guidance:

  - Children, even though in school, need an example set for them at home to form good food habits. Have aides discuss ways that parents can set a good example.

  - Teachers and "heroes" may be influential outside the home in the formation of food habits.

- Point out that children have increasing responsibilities for making own food selections:

  - Changes in community life provide children with opportunities to eat more meals away from home. Have aides identify some of these changes, such as vending machines, school lunch, school breakfast, and day camps.

  - There are fewer chances for the family to be together for mealtime. Mother's work takes her out of the home. Children often have the responsibility for preparing their own breakfast.

  - There is increased snacking without supervision. Have aides discuss ways they can encourage homemakers to have nutritious snacks available in the home.

- Relate the Daily Food Guide to the food needs of the school-age child.

- Discuss the nutrients which need to be especially emphasized for the school-age child, using as a guide the USDA Food Consumption Studies in Food For Us All, pp. 269-270. Ask aides to identify snack foods for school children which would be high in these nutrients.

- Discuss school feeding programs using Food For Us All, pp. 73-74, 260-264, and 298-299, as a guide.

- Ask a school lunch supervisor to discuss the following points with the aides:

  - food requirements for participation in the National School Lunch Program or School Breakfast Program.

  - eligibility of children for free or reduced-price lunches or breakfasts.

  - attitudes of children toward the school lunch program.

14402

- List on the chalkboard the foods and amounts included in a school breakfast or school lunch. Have aides plan food for the remainder of the day to meet the recommendations in the Daily Food Guide. Collect school lunch menus printed in daily newspapers and have aides plan remaining meals and snacks for a day for a school-age child.

- Have aides use comparison cards to answer questions such as:

  My daughter won't drink orange juice; what should I do?

  My son doesn't drink milk, but he eats lots of ice cream; isn't that all right?

  Why do we often hear,"serve liver to your children"?

  My children love peanut butter and jelly sandwiches; is this all right?

APPLICATION OF LESSON BY AIDES

Aides encourage homemakers to consider the school lunch in planning food for the other meals and snacks.

Aides become alert to those who are eligible for free or reduced-price school lunches or breakfasts.

Aides encourage participation in school food programs where possible.

Aides encourage parents to set a good example for children in selecting nutritious food for meals and snacks.

REFERENCES FOR TRAINER AGENT

1. Food For Us All, Yearbook of Agriculture, 1969, USDA, pp. 73-74, 260-265, 269-270, 273-278, 298-299

2. Food, Yearbook of Agriculture, 1959, USDA, pp. 296-302

3. Principles of Nutrition, Wilson, Fisher, Fuqua, 1965 pp. 447-450

4. Source Book on Food Practices with Emphasis on Children and Adolescents, National Dairy Council

14403

VISUALS AND EQUIPMENT

Comparison cards, National Dairy Council

Chalkboards or newsprint

Daily Food Guide, poster, F&NS-23, USDA

School lunch menus from local newspapers

REFERENCES FOR AIDES

1. Daily Food Guide, leaflet, F&NS-23, USDA

2. Meal Planning Made Easy, Extension Service, PA-695, USDA

14404

FOOD NEEDS OF FAMILY MEMBERS

Lesson 10: FOOD FOR THE TEENAGER

PURPOSE

Trainer agent to help aides:

1. Understand food needs of teenagers.

2. Understand some of the reasons for teenagers' eating habits.

3. Develop techniques and methods to reach teenagers with nutrition information which may encourage them to make wise food choices.

PRESENTATION

- Review the four food groups and discuss different patterns of eating. Emphasize that it is the amount and kind of food eaten within a 24-hour period that counts and not just what is eaten at one meal.

- Show the slide set entitled "Improving Teenage Nutrition." Discuss social, emotional, and physical needs of teenagers and how these needs may affect their eating habits.

- Emphasize that:

  - Adolescence is an age of great activity.

  - It is period of rapid growth.

  - Eating snacks is a way of life for a busy teenager.

  - Many physical and emotional changes take place during adolescence.

  - Some foods, such as milk, are considered baby foods; others, like coffee, are grown-up foods. Refer to pages 299-301, 273-278, 1969, Yearbook of Agriculture <u>Food for Us All</u>.

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- Have aides suggest ways of providing nutritious foods for teenagers to fit their pattern of eating. List all suggestions on newsprint or chalkboard under nutrient headings.

- Review survey findings, using the charts provided in this lesson as a guide. What foods can be added, and how, to insure adequate intake of needed nutrients?

- Divide the aides into groups. Give each group a copy of A Girl and Her Figure and A Boy and His Physique. Ask them to talk over what they would emphasize to interest teenagers in wise eating practices. Have them report back to the total group.

- Have each aide tell the group how she plans to help homemakers understand why teenagers need to know how to make wise food choices.

APPLICATION OF LESSON BY AIDES

Aides help homemakers and teenagers understand the importance of eating a wide variety of foods.

REFERENCES FOR TRAINER AGENT

1. Food for Us All, Yearbook of Agriculture, 1969, pp. 273-278, 299-301, 319-324

2. "Eating Habits of Teenagers," Spindler, E. Food and Nutrition News, National Live Stock and Meat Board, May 1968

3. Nutritive Value of Foods, G-72, USDA

VISUALS AND EQUIPMENT

"Improving Teenage Nutrition," slide set, USDA

Slide projector and screen

14406

UNIT 6 - MANAGEMENT OF A GARMENT ALTERATION BUSINESS

Competencies

- Organize business and work area for efficiency and comfort.
- Plan work schedule effectively.
- Purchase and inventory sewing equipment and supplies.
- Maintain accurate financial and customer records.
- Analyze the cost of time and supplies required for an alteration.

Motivating Procedure

Present the findings of a local survey of charges made for various garment alterations. Discuss the reasons for any variation in prices.

Learning Experiences

- Take a field trip to one or more alteration facilities to observe the organization of the business and work areas, how work is scheduled, and the equipment used. Have students discuss observations in terms of their proposed employment.
- Have each trainee design a floor plan for a clothing alteration business and work area and make a detailed list of equipment and supplies required for this plan.
- Divide class into small groups and have each group interview a manager of some type of an alteration facility to determine the kinds of customer and financial records that are needed. Have students share experiences with the class. See Appendixes M and N.
- Present case studies involving garments needing alteration, including such items as time and supplies required to complete the job. Have trainees figure cost of alteration and fill out customer's bill. Discuss charges made for various alterations.
- Discuss the advantages and disadvantages of having an independent business in a private home, including such topics as convenience, facilities, speed and work standards, and customer relations.
- Have trainees interview dressmakers who have a business of their own to determine how customers are secured. Discuss advantages and disadvantages of such methods of advertising as the newspaper, bulletin board notices in public places, radio announcements, and word of mouth from satisfied customers.

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REFERENCES FOR AIDES

1. Food - A Key to Better Health, Nutrition Foundation, pp. 10-11

2. Daily Food Guide, F&NS-23, USDA

3. A Girl and Her Figure and A Boy and His Physique, National Dairy Council

14407

NUTRIENT INTAKE BELOW RECOMMENDED ALLOWANCE

IN HOUSEHOLDS WITH INCOMES UNDER $3,000

SEX-AGE (YEARS)	PROTEIN	CALCIUM	IRON	VITAMIN A VALUE	THIAMIN	RIBOFLAVIN	ASCORBIC ACID
MALE:							
9-11				★★	★		
12-14		★★★★	★★★	★★	★★		
15-17		★★★	★★	★	★		★★
18-19		★★★					
FEMALE:							
9-11		★★★★	★★★★		★		
12-14		★★★★	★★★★	★★★	★★		
15-17		★★★★	★★★★		★★		★★
18-19		★★★★	★★★★		★★	★★	★★★

BELOW BY: ★ 1-10% ★★ 11-20% ★★★ 21-29% ★★★★ 30% OR MORE

AVERAGE INTAKE OF GROUP BELOW RECOMMENDED DIETARY ALLOWANCE, NAS-NRC, 1968

U.S. DIETS OF MEN, WOMEN, AND CHILDREN, 1 DAY IN SPRING, 1965

14408

NUTRIENT INTAKE BELOW RECOMMENDED ALLOWANCE

SEX-AGE (YEARS)	PROTEIN	CALCIUM	IRON	VITAMIN A VALUE	THIAMIN	RIBOFLAVIN	ASCORBIC ACID
MALE:							
9-11		★					
12-14		★ ★	★ ★ ★		★		
15-17		★	★				
18-19							
FEMALE:							
9-11		★ ★ ★	★ ★ ★ ★		★		
12-14		★ ★ ★	★ ★ ★ ★	★	★		
15-17		★ ★ ★ ★	★ ★ ★ ★		★ ★		
18-19		★ ★ ★	★ ★ ★ ★	★	★		

BELOW BY: ★ 1-10% ★ ★ 11-20% ★ ★ ★ 21-29% ★ ★ ★ ★ 30% OR MORE

AVERAGE INTAKE OF GROUP BELOW RECOMMENDED DIETARY ALLOWANCE, NAS-NRC, 1968
U.S. DIETS OF MEN, WOMEN, AND CHILDREN, 1 DAY IN SPRING, 1965

14499

FOOD NEEDS OF FAMILY MEMBERS

Lesson 11: FOOD NEEDS FOR PREGNANT AND LACTATING WOMEN

PURPOSE

Trainer agent to help aides:

1. Become familiar with nutritional needs of pregnant and lactating women.

2. Learn about resources in the community where a mother can receive care for herself and her baby.

3. Learn how to help pregnant and lactating homemakers add additional foods to family meals to meet their requirements.

PRESENTATION

. Ask a qualified local public health worker to discuss:

- services available at local health department for pregnant and lactating women.

- the importance of good nutrition before and during pregnancy.

- increased food needs for mothers who breast feed their babies.

- individual differences in relation to pregnancy such as nausea, rate of weight gain, constipation, edema.

- questions aides may have encountered or wish to ask.

14410

Outline general guidelines for working with pregnant women:

- Every pregnant woman should eat the kinds and amounts of food recommended by the Daily Food Guide or the diet prescribed by her physician.

- In the early months of pregnancy the baby is very small and extra food is not needed.

- In later months the baby grows rapidly. To meet these extra growth demands the mother should have more food from the four food groups. At least 3 cups of milk a day is desirable.

- The teenage pregnant girl is going through two growth cycles--her own and her baby's. She should have foods sufficient to cover both growth needs.

APPLICATION OF LESSON BY AIDES

Aides help pregnant homemakers plan adequate diets.

Aides understand food needs of pregnant and lactating women and refer mothers to agencies which can help them.

REFERENCES FOR TRAINER AGENT

1. What to Eat Before You are Pregnant, While You Are Pregnant, After the Baby Comes. National Dairy Council.

2. Prenatal Care. Children's Bureau Publication No. 4, 1970, U.S. Department of Health, Education & Welfare

3. Infant Care. Children's Bureau Publication No. 8, 1970, U.S. Department of Health, Education & Welfare

4. Eating for Your Baby to Be. National Live Stock and Meat Board

5. Recommended Dietary Allowances, 1968. National Research Council

VISUALS AND EQUIPMENT

Daily Food Guide, poster, F&NS-23, USDA

14411

REFERENCES FOR AIDES

1. Food - A Key to Better Health, Nutrition Foundation pp. 14-15

2. When Your Baby Is on the Way. Children's Bureau Publication No. 391, 1969, U.S. Department of Health Education and Welfare

14412

FOOD NEEDS OF FAMILY MEMBERS

Lesson 12: FOOD NEEDS OF THE ELDERLY

PURPOSE

Trainer agent to help aides:

1. Understand the nutritional needs of older persons.

2. Identify some of the special problems that influence eating habits of the elderly.

3. Become aware of community agencies which may be helpful to older folks.

4. Assist the aging to make good food choices and to avoid food fads.

PRESENTATION

- Review the Daily Food Guide and relate it to the food needs of the elderly.
- Emphasize in your discussion that:

  - Older persons often need to be encouraged to eat a wider variety of foods. Ask aides to identify foods which seem to be popular and foods which are not generally eaten by the elderly with whom they visit. To which food groups do these foods belong?

  - Selection of foods from the four food groups will discourage food faddism to which many older persons are susceptible. Discuss briefly some of the reasons older persons may be particularly vulnerable to food faddism.

14413

- Fewer calories are needed because activity is less. Ask aides to describe the types of activities they observe in homes of older people and to compare these to activities in homes of young families. Have aides identify ways in which calories may be limited within each of the four food groups.

- Physiological changes may also call for some modification of diets.

. Discuss factors which influence food habits of the elderly. List on board as they are brought out in discussion.

. Include these points in your discussion:

- Food habits have been formed in earlier years.

- Some foods may cause physiological distress.

- Lack of proper dentures may limit food choices.

- Eating alone may make eating less enjoyable.

- Food preparation may be hindered by physical disabilities, lack of equipment and facilities for serving and storing food.

- Illness, disability and lack of transportation can make food shopping difficult.

- Income may be limited.

- Some elderly persons may be confused by the variety of items in stores.

. Have aides role-play a visit to the home of an elderly man who lives alone, whose income is limited and who walks with crutches. Help him plan food for a day.

. Have aides plan food for a day for an older person without dentures.

. Introduce Food Guide for Older Folks and Lower Cost Meals that Please. Discuss content.

. Explore available community resources for improving the nutrition of older persons living alone. Prepare a list of these for the aides.

14414

- Discuss:

  - What available educational programs relate to planning meals and to selecting, buying and preparing food?

  - What meal assistance programs are available through community agencies?

- Ask a representative from an agency that deals with some of the problems of older persons in your community to discuss the role of the agency, how it functions, the services it provides and how these services can be made available to those who need them. Allow time for aides to ask questions.

APPLICATION OF LESSON BY AIDE

Aides apply this information in teaching families with elderly members as well as older persons living alone.

REFERENCES FOR TRAINER AGENT

1. Food For Us All, Yearbook of Agriculture, 1969, USDA, pp. 277-278; 279-285; 301-303

2. Fundamentals of Normal Nutrition, Robinson, 1968, pp. 379-387

VISUALS AND EQUIPMENT

Daily Food Guide, F&NS-23, USDA

Chalkboard or newsprint

REFERENCES FOR AIDES

1. Daily Food Guide, leaflet, F&NS-23, USDA

2. Food Guide for Older Folks, G-17, USDA

3. Lower Cost Meals That Please, National Dairy Council

4. List of community agencies dealing with problems of the elderly (to be prepared by agent)

14415

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14416

Instructional Materials

- Catalogs of sewing equipment and supplies
- Various bill forms
- Newspaper advertisements
- Sample bulletin board notices
- Case problems

Instructor References

BOOKS

Lembeck, Ruth. *380 part-time jobs for women.* New York, N.Y. Dell Publishing Co., Inc. 1968.

McDermott, I. E. & Norris, J. L. *Opportunities in clothing.* Peoria, Ill. Chas. A. Bennett Co., Inc. 1968.

PAMPHLETS

New York State. Department of Commerce. *Nimble thimble shop.* Albany, N.Y. The Department. 1967.

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ABSTRACT - This booklet is one in a series of booklets of supplemental lessons in food and nutrition prepared by the Extension Service of the U.S. Department of Agriculture and is designed for use by trainer agents in on-the-job training of Extension aides to provide them with information about nutrients and with teaching methods to use in helping families. Purposes, presentation suggestions, learning activities, references, audiovisual materials, and equipment accompany these lessons: (1) Protein, (2) Carbohydrates, (3) Fat, (4) Calcium, (5) Iron, (6) Iodine, and (7) Vitamins A, B, C, and D. An introductory section provides additional suggestions for the trainer agent and lists recommended references. Related booklets are available as VT 012 840-VT 012 843, all in this issue. (SB)

VT 012 841

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FOOD and NUTRITION...

supplemental lessons for training extension aides

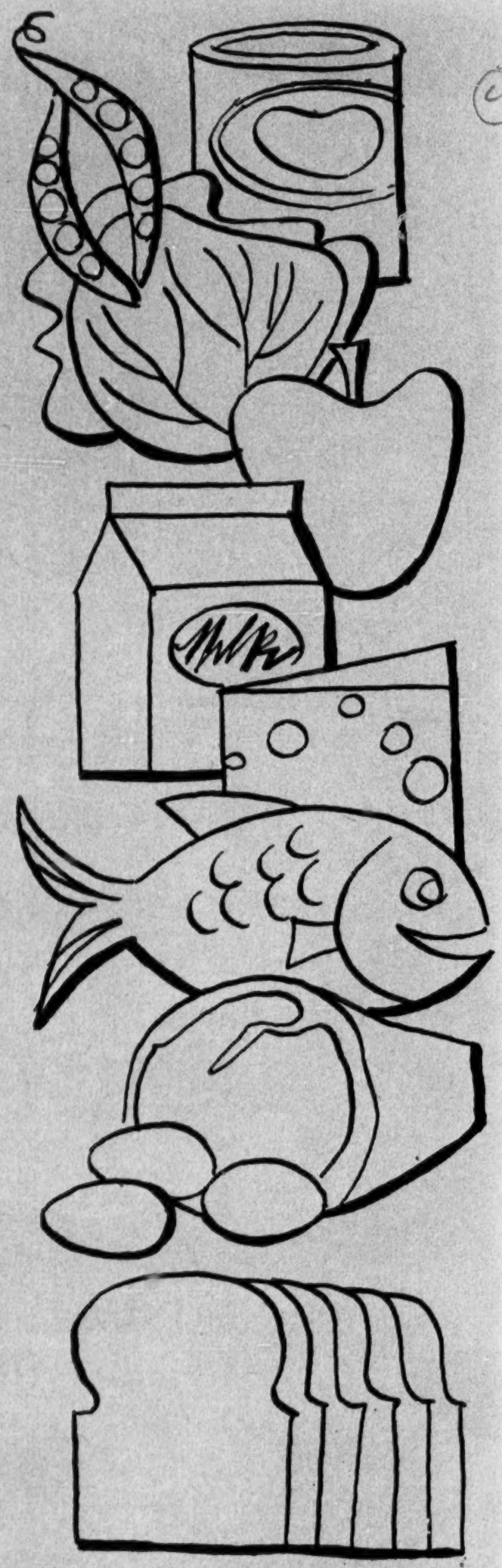

KEY NUTRIENTS

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LESSONS - KEY NUTRIENTS

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Key Nutrients is one of a series of booklets of supplemental lessons in food and nutrition, designed for use in on-the-job training of Extension aides. These lessons are not intended to be complete teaching units. The purpose is to enrich the aides' background in food and nutrition and to provide practical teaching methods that they can use in taking food and nutrition information to families. Since technical subjects in nutrition are simplified some of the generalizations may have exceptions.

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FOOD AND NUTRITION

Supplemental Lessons for Training Extension Aides

KEY NUTRIENTS

Purpose

These lessons were written to help trainer agents further prepare aides for work with families in the Food and Nutrition Education Program. It is the responsibility of the trainer agent to see that aides have a broad perspective of the importance of food to people, a basic understanding of nutrition and an understanding of how to teach this information to low-income families.

The series follows the 15 basic lessons in nutrition given in the initial training for aides and leaders and will help the trainer agent enlarge the background nutrition knowledge of the aides. The series is an expansion of Lesson 3 - Key Nutrients from Food and Nutrition--basic lessons for training Extension aides and should be applied to the problems the aides have identified. The information may be used by the aide as the occasion arises in her work with families and the lessons adapted by the aide for use with groups of youth or adults.

TRAINER AGENT'S RESPONSIBILITY

References are suggested for the agent's use with each lesson. The agent will find it helpful to assemble these references before starting the lessons and to use them in her preparation for teaching.

References are also suggested for the aide's use. The agent should be selective in the references she gives to aides. Order those selected well in advance.

Go over references thoroughly with the aides so that they know what is in each reference.

Professional people in related fields may be asked to participate in training meetings. Such participation should be planned well in advance.

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A working relationship with each aide should already be established as a result of the initial training period. Effective communication remains vital in teaching. Before teaching supplemental lessons, the trainer agent may wish to review purposes of the training and the importance of aides' participation.

Suggested check list to be sure that all necessary preparations for the in-service training sessions have been made:

___Meeting place with necessary facilities has been obtained.

___All references needed to complete the lessons have been assembled.

___Local public health service and library have been checked for additional references.

___All visual materials and equipment needed to teach the lessons are on hand.

___All reference materials needed for the aides have been obtained.

___All lesson plans have been carefully studied so that you fully understand the overall content of the course.

___Sufficient time has been allowed to complete each lesson.

ADAPTING THE LESSONS TO YOUR AIDES

Guides used in teaching the basic lessons should be followed in teaching the supplemental lessons also:

Adapt training classes to meet the needs of your group. Here are some ideas to keep in mind:

1. Simplify. Do not try to cover too much material in one lesson. Pick out the most important points and emphasize these.

2. Use colorful visuals and a dynamic presentation to help make the lesson more appealing.

3. Emphasize good nutrition elements in the food the aides are now eating. Point out how small changes can often result in a more balanced diet.

4. Involve the aides in the training meetings in as many ways as possible.

EXTENDING INFORMATION

The information given in the supplemental lessons may be effectively used in other ways, such as adaptation for use in training volunteer leaders or in newsletters or newspaper article. A series of radio or TV programs based on the lessons may help to extend to a larger audience the ideas that aides are promoting.

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Recommended publications

For aides and leaders

Publications and visual materials are listed with each lesson. Make sure that these supplies are on hand before you begin teaching.

USDA

Bulk quantities of USDA pamphlets are usually obtained through your State distribution officer.

Family Fare, G-1
Milk in Family Meals, G-127
Nutritive Value of Foods, G-72
*Key Nutrients, PA-691 (5¢)
*How Food Affects You (flipchart in booklet form) 1970. 32 pages. (60¢)
*Composition of Foods, Agricultural Handbook No. 8. $1.50.
*Daily Food Guide Leaflet, F&NS-23 (35¢ for 10 copies)
Food for Thrifty Family flyers, F&NS
Free illustrated F&NS flyers and the Daily Food Guide are available for educational programs relating to U.S. Department of Agriculture's Family Food Assistance Programs through your regional Food and Nutrition Service office.

HEW

The Food You Eat and Heart Disease, No. 537

Copies of publications from Department of Health, Education and Welfare may be obtained locally from the Public Health Service or purchased from the Superintendent of Documents.

*Publications NOT available free may be purchased from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, at the prices indicated. There is a 25 percent discount for 100 or more copies on all GPO orders.

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Recommended references

For trainer agents

Each lesson includes a list of recommended reference books and publications for trainer agents to use in preparing lessons. Make sure you have the references you need to do a good job.

Eat to Live, Wheat Flour Institute, 14 E. Jackson Blvd., Chicago, Ill. 60604. 1969. $1.00.

Food, USDA Yearbook of Agriculture, 1959. $3.25. Supt. of Documents, Government Printing Office, Washington, D.C. 20402.

Food, A Key to Better Health, Nutrition Foundation, Inc. 1970. Order from Colson Co., Paris, Ill. 61944. 25¢.

Food and Nutrition---basic lessons for training Extension aides. Extension Service, USDA.

Food Becomes You, Leverton, Ruth; Dolphin Books, Doubleday Co., Inc., 501 Franklin Ave., Garden City, N.J. 11530. 1961. $0.95. Hardcover edition: Iowa State Press, Ames, Iowa 50012. 1965. $4.95.

Food For Us All, USDA Yearbook of Agriculture, 1969, $3.50. Supt. of Documents, Government Printing Office, Washington, D.C. 20402.

Fundamentals of Normal Nutrition, Robinson, Corinne H.; Macmillan Co., 866 3rd Ave., New York, N.Y. 10022. 1968. $7.95.

Introduction to Nutrition, Fleck, Henrietta and Munves, Elizabeth; Macmillan Co., 866 3rd Ave., New York, N.Y. 10022. 1962. $7.50.

Learning Better Nutrition: A Second Study of Approaches and Techniques, Ritchie, Jean A.S.; FAO, Unipub, Inc., P.O. Box 433, New York, N.Y. 10010. 1967. $4.00.

Nutrition Handbook for Family Food Counseling, National Dairy Council, 111 North Canal St., Chicago, Ill. 60606. 30¢.

Nutrition in Action, Martin, E.A., Holt, Rinehart & Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. 1965. Teacher's Guide. $6.50.

Principles of Nutrition, Wilson, Eva D. and others; John Wiley and Sons, Inc., 605 3rd Ave., New York, N.Y. 10016. 1965. $8.50.

Teaching Nutrition, Eppright, E. and others; Iowa State Press, Ames, Iowa 50012. 1963. $4.95.

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Visuals

Slide Sets

"How Food Affects You," C-156. 1969. 48 frames. $8.00.
"Milk the Magnificent," C-161. 1969. 50 frames. $8.00.

USDA slide sets may be purchased from the Photography Division, Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250.

Charts and Posters

How Food Affects You (flip chart in booklet form). 1970. 32 pages color. 60¢. Superintendent of Documents.

*Daily Food Guide Poster, 22" x 28". 15 cents per copy.

National Dairy Council

Comparison Cards for Adults. B-43-A. $2.50 a set.
Food Models B-12. $3.00 a set.
Display for Food Models. G-100. $1.50.
Milk Made the Difference. Poster P-512. 30 cents.

A catalogue can be obtained listing available materials. If you live in a city where there is an affiliated Dairy Council Unit, requests for material should be directed to that office. If you are not served locally, send orders to National Dairy Council, 111 North Canal Street, Chicago, Ill. 60606.

Wheat Flour Institute

Wall chart on Wheat Kernels.

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KEY NUTRIENTS

Lesson 1: PROTEIN

PURPOSE

Trainer agent to help aides:

1. Learn how the body uses protein.

2. Learn food sources of protein.

3. Learn the importance of and methods for supplementing vegetable protein with animal protein.

PRESENTATION

- Review lesson 5 of Food and Nutrition---basic lessons for training extension aides by discussing the concept that foods may be classified as protein, carbohydrates, and fats. Most foods are a combination of nutrients. Vitamins, minerals and water are found in combination with these classes of food.

- Have aides identify parts of their body which are made of protein. You can see some of these parts--muscles, skin, hair, nails, eyes. Much of what you do not see is also made of protein--blood, heart, nerves, brain and others.

- Show aides how to use visuals in teaching the function of protein in the body. Use charts 4-8 from the booklet "How Food Affects You" or slides 16 and 17 of the set with the same title. Explain that protein:

  - Builds and maintains all tissues.

  - Forms an important part of enzymes. Enzymes are substances that break our food down so that it can be digested and used in the body.

  - Forms an important part of many hormones. Hormones regulate body processes.

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The Local Course of Study

The advisory committee and administrative staff can provide assistance relative to job opportunities for which training should be provided, course content, organization, and resources for the instructor. Suggestions for organizing and presenting a local course in the area of garment alterations are given in this section.

ORGANIZING A LOCAL COURSE

The local course of study should be based on the State outline. The following will help to provide a well organized local plan.

- Determine the length and units for the course from the chart Time Allocations for Course Units, found on the following page, by:
  - Identifying jobs for which the course will be designed
  - Selecting units and topics to be covered
  - Estimating time needed for course. For example, training for the job of dressmaker requires 84 hours and could be scheduled for two weeks for six hours a day or fourteen weeks for two, three hour sessions a week.

- Adjust and develop the materials given in the State course to meet local needs.

PLANNING A LESSON

It is the instructor's responsibility to prepare thoroughly for each class session. He must have full knowledge of the concepts and skills he will teach. A lesson can be planned to be completed in one session or extended over several class sessions. The following points may serve as guidelines for planning a lesson.

- Teach one thing at a time.

- Proceed from the simple to the complex.

- Prepare lesson content to meet needs of trainees.

- Make the practice experiences interesting and fruitful.

- Prepare for the class session by studying the lesson plan and collecting the required teaching materials such as audiovisual aids and equipment, instructional materials for distribution to trainees, books and other resources related to the lesson, and sewing equipment and supplies for demonstrations or trainee use.

- Forms an important part of body fluids. Next to water, protein is the most plentiful substance in the body.

- Supplies energy.

. Have aides identify food sources of protein. Use food models to group proteins into animal and plant sources:

Animal Sources	Plant Sources
lean meat	dry beans
poultry	peas
fish	nuts
seafoods	cereals
eggs	breads
milk	
cheese	

. Point out which of the four food groups contribute protein to the diet and which group makes the greatest contribution of protein. Refer to Daily Food Guide.

. Include these points in your discussion:

- Animal sources of protein are of better quality than plant sources.

- Protein is made up of smaller parts called amino acids. These are referred to as the building blocks of protein.

- Some amino acids can be made in the body from other amino acids. However, some amino acids cannot be made in the body, and therefore must be supplied in food. These are called essential amino acids.

- Animal protein sources contain more of the essential amino acids needed to build cells for the human body than plant protein sources do. Because animal protein has more amino acids needed by the body, it is of better quality than plant protein.

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- Plant protein eaten in combination with a small amount of animal protein improves the nutritional value of the diet.

- Use the Daily Food Guide to illustrate the recommended number of servings of meat or meat alternates. Point out that protein foods should be eaten throughout the day so that the essential amino acids may be most effectively utilized in the body. Explain that protein eaten in excess of body needs will be converted to fat in the body.

- Have aide list protein foods she eats. Have the aide suggest animal protein foods that can be eaten in small amounts in combination with those foods that are vegetable protein to improve the nutritional quality such as:

  - cereal and milk

  - beans and cheese

  - beef and rice

APPLICATION OF LESSON BY AIDES

Aides help homemaker recognize that there are many protein foods in addition to meat. Protein is supplied from vegetable sources and only small amounts of animal protein need be added to improve the quality.

Aides suggest combinations of animal and vegetable protein foods to homemakers.

Aides encourage homemakers to eat some protein foods at each meal.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 57-63.

2. Eat to Live, Wheat Flour Institute, p. 16.

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VISUALS AND EQUIPMENT

"How Food Affects You", slide set, C-156, USDA.

Projector and screen.

Daily Food Guide, F&NS 23, USDA.

Food Models, National Dairy Council.

How Food Affects You, flip charts, USDA.

REFERENCES FOR AIDES

1. How Food Affects You, flip charts, USDA.
2. Key Nutrients, PA-691, USDA.
3. Family Fare, G1, USDA, pp. 7-8.

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KEY NUTRIENTS

Lesson 2: CARBOHYDRATES

PURPOSE

Trainer agent to help aides:

1. Learn how the body uses carbohydrates.

2. Learn food sources of carbohydrates.

3. Understand the significance of empty-calorie foods.

PRESENTATION

- Review lesson 5 of Food and Nutrition---basic lessons for training extension aides by discussing the concept that all foods may be classified as protein, carbohydrates, and fats, and that all supply energy in varying amounts. Vitamins, minerals and water are found in combination with these classes of food.

- Show aides how to use visuals in illustrating the function of carbohydrates in the body. Show slides 32-33 from "How Food Affects You" or chart 28 from the flip charts. Emphasize that carbohydrates:

  - Supply food energy.

  - Help the body use fat efficiently.

  - Spare protein for purposes of body building and repair.

- Point out that carbohydrates are made up of sugar and starches. A starch is a complex made up of units of sugars.

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- Illustrate the food sources of carbohydrates using food models:

Sugars	Starches
honey	breads
molasses	cereals
syrup	corn
sugar	grits
	potatoes
	rice
	spaghetti
	macaroni
	noodles

- Point out the food groups that make the largest contribution of carbohydrates. Refer to the Daily Food Guide.

- Include these points in your discussion:

  - Carbohydrates are the main source of energy for the peoples of the world because they are found in plentiful and economical foods.

  - Many carbohydrate foods are empty-calorie foods. An example is sugar. Stress eating carbohydrate foods that contain other valuable nutrients.

  - A small amount of carbohydrates is stored in the body. However, if carbohydrates are eaten in great excess of energy needs, the excess will be stored as fat in the body.

- Have aides select several dietary recalls from their lists of homemakers. Evaluate the dietary intake of carbohydrates, watching for the inclusion of important nutrients -- protein, vitamins and minerals -- in the foods also.

APPLICATION OF LESSON BY AIDES

- Aides understand what empty-calorie foods are and how to substitute other nutritious foods for them.

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- Aides encourage homemakers to select carbohydrate foods that contain vitamins and minerals.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959,USDA, pp. 88-100.

VISUALS AND EQUIPMENT

"How Food Affects You," slide set, C-156, USDA.

Projector and screen.

Daily Food Guide, F&NS 23, USDA.

Food Models, National Dairy Council

How Food Affects You, flip charts, USDA.

REFERENCES FOR AIDES

1. How Food Affects You, flip charts, USDA.
2. Key Nutrients, PA-691, USDA.
3. Food - A Key to Better Health, Nutrition Foundation, p.5.
4. Family Fare, G1, USDA, p. 9.

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KEY NUTRIENTS

Lesson 3: FAT

PURPOSE

Trainer agent to help aides:

1. Learn the function of fat in the diet.

2. Learn food sources of fat.

3. Understand the meaning of polyunsaturated fats.

PRESENTATION

- Review lesson 5 of Food and Nutrition---basic lessons for training Extension aides by discussing the concept that all foods may be classified as protein, carbohydrates, and fats, and that all supply energy in varying amounts. Vitamins, minerals and water are found in combination with these classes of food.

- Discuss the function of fats in the body. Show slides 32-34 from "How Food Affects You" or chart 28 from flip charts, showing aides how to use visuals in teaching homemakers. Emphasize that fats:

  - Supply energy in compact form (weight for weight, fats supply twice as much energy as carbohydrates).

  - Supply some essential fatty acids.

  - Help the body use certain other nutrients. (Fats are carriers of fat soluble vitamins A and D.)

  - Add variety and flavor to many foods.

  - Protect the body from excessive loss of heat.

  - Support and protect vital organs.

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- Show a bottle of oil and a can of solid fat. Ask aides if they know the difference in these food items.

  - Both are fats.

  - Oils are liquid fats at room temperature, solid fats are solid at room temperature.

  - Liquid oils are generally made from vegetable sources. Most vegetable oils are highly polyunsaturated. This refers to the type of fatty acids in the oil.

  - Solid fats are predominately made from animal sources and contain mostly saturated fatty acids. However, many times polyunsaturated fats are added to solid fats.

- Have aides read several can and jar labels to see if polyunsaturated fatty acids are contained in the fat or oil.

- Briefly mention research that has shown there may be a relationship between a highly saturated fat (animal) intake and incidence of heart disease. There have been recommendations to increase the proportion of polyunsaturated fats in the diet for people with certain kinds of heart ailments.

- Discuss the function of fats in the body. Show slides 32-34 from "How Food Affects You" or chart 28 from the flip chart.

- Illustrate the food sources of fats using food models, pictures or cartoons:

  fat in meat
  lard
  cooking fats and oils (foods cooked in them)
  butter
  margarine
  salad dressings
  salt pork and bacon drippings

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- Point out that normal persons should have some animal and vegetable fat in the diet each day. Fats eaten in excess of body needs are stored as fat in the body.

- Have aides tell how they would teach homemakers the meaning of the term polyunsaturated found on the label from a can of shortening.

APPLICATION OF LESSON BY AIDES

Aides encourage homemakers to select fat foods that also contain vitamins and minerals.

REFERENCE FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 74-87.

2. Food for Us All, Yearbook of Agriculture, 1969, USDA, pp. 226-231.

3. The Food You Eat and Heart Disease, No. 537, U.S. Department of Health, Education and Welfare, Public Health Service.

VISUALS AND EQUIPMENT

"How Food Affects You" slide set, C-156, USDA.

Projector and screen.

Food Models, National Dairy Council.

Jars and cans of vegetable and animal oil and fats.

How Food Affects You, flip chart, USDA.

REFERENCES FOR AIDES

1. How Food Affects You, flip chart, USDA.

2. Key Nutrients, PA-691, USDA.

3. Food - A Key to Better Health, Nutrition Foundation, p. 5.

4. Family Fare, G1, USDA, p. 9.

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KEY NUTRIENTS

Lesson 4: CALCIUM

PURPOSE

Trainer agent to help aides:

1. Understand how the body uses calcium.

2. Learn the food sources of calcium and ways to get the recommended amounts each day.

PRESENTATION

. Review information, pointing up the need to emphasize calcium in teaching homemakers.

  - Refer to the review of the 1965 Food Consumption Study in Food For Us All, pp. 266-272.

. List on the board, the groups of people who are not likely to get the recommended amounts of calcium in their diets.

  - teenagers
  - adults
  - older folks

. Point out that calcium is a mineral. Minerals help build the body structure and help regulate many processes in the body. Calcium is the substance found in ordinary blackboard chalk, limestone, road rock, sea shells, and bones.

. Discuss the function of calcium in the body. Use illustrations in "How Food Affects You" flip charts, pages 8, 9 and 10, or slides 19 and 20 from series by same title. Ask the aides to review Key Nutrients for a summary of functions and sources of calcium.

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TIME ALLOCATION FOR COURSE UNITS

UNITS AND TOPICS	JOB TITLES AND APPROXIMATE HOURS†					
	Garment Ripper	Women's Garment Finisher	Seamstress	Tailor's Helper	Garment Fitter	Dressmaker
Use and Care of Fabrics	6	6	6	6	6	6
Selection, Use, and Care of Sewing Equipment	3*	3*	6	6	6	6
Techniques of Sewing						
• Pressing Techniques	3	3	3	3	3	3
• Construction Techniques	6*	6*	21	21	21	21
• Alteration Techniques			21	21	21	21
• Repair Techniques			9	9	9	9
Elements and Principles of Design					4	4
Preparation for Employment	6	6	6	6	6	6
Management of a Garment Alteration Business						8
Total hours	24	24	72	72	76	84

† Time has been allocated in two and three hour units so that the classes can be taught in evening or day sessions.

* Only selected portions of learning areas will be needed for these jobs.

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- Explain that:

  - Calcium is distributed unevenly in the body -- 99% is found in bones and teeth; 1% is found in the fluids and soft tissues.

  - Calcium helps in muscle contraction, nerve transmission, blood clotting, and beating of heart.

- Show pictures of animals from "Milk Made the Difference" and discuss. Show slides 4-12 from the "Milk the Magnificent" slide set. Show aides how to use visuals in working with homemakers.

- Point out that:

  - The best sources of calcium are milk and milk products. It is difficult to supply the amounts of calcium recommended unless milk in some form is used daily.

  - Ask aide to name the major nutrient contributions of the milk group. List them on board or newsprint:
    - calcium
    - protein
    - riboflavin

  - Milk products add variety to meals and snacks and can be used in place of some of the milk which would be drunk. Use comparison cards, food models, or actual food to show these calcium equivalents of one cup of fluid milk:

1 1/3 oz.	cheddar
1 1/3 cups	cottage cheese
1 cup	cocoa made with milk
1 cup	custard
1 1/2 cups	ice cream
3/4 cup	macaroni and cheese

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- Show amounts of milk recommended in the Daily Food Guide to help supply calcium:

Children under 9	2-3	8 oz.-cups or equivalent (or more)
Children 9-12	3	" " " "
Teenagers	4	" " " "
Adults	2	" " " "
Pregnant women	3	" " " "
Nursing mothers	4	" " " "

- Discuss other food sources of calcium such as:

  - dried peas and beans
  - collards, kale
  - dandelion, mustard, and turnip greens
  - canned salmon and mackerel
  - enriched breads made with milk or dry milk solids

- Emphasize that young children need calcium because their bones are growing. Older persons need calcium to keep their bones hard and strong.

- Ask aides to review a few of the food recalls from homemakers to evaluate the milk intake.

- Have aides role-play a visit with a homemaker who does not use milk because she believes it is too expensive.

- Have an aide prepare a flavored milk drink using dry milk. Serve this for refreshments. Suggest ways of adding dry milk to foods to increase calcium intake.

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- Have aides identify foods that are high in calcium from a list. Look up calcium content in Nutritive Value of Foods G-72 and report back. Suggested list:

  apple
  bacon
  dry beans
  green snap beans
  bread, enriched
  liver
  broccoli
  butter
  cabbage
  carrots
  cream cheese
  chocolate milk
  corn
  clams
  crab meat
  eggs
  ice cream
  skim milk
  oyster stew
  green pepper
  spinach
  canned salmon

APPLICATION OF LESSON BY AIDES

Aides encourage children to drink more milk by teaching their mothers to prepare flavored milk drinks and frozen snacks.

Aides use "How Food Affects You" flip charts and "Milk Made the Difference" pictures with homemakers to teach the importance of the milk group.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 112-118.

2. Principles of Nutrition, Wilson, Fisher, and Fuqua, pp. 134-155.

3. Nutrition in Action, Martin, pp. 88-102.

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4. Food For Us All, Yearbook of Agriculture, 1969, USDA, pp. 266-272.

5. Nutritive Value of Foods, G-72, USDA.

VISUALS AND EQUIPMENT

Food and materials for food preparation.

"How Food Affects You" slide series, C-156, USDA.

How Food Affects You flip charts, USDA.

"Milk the Magnificent" slide series, C-161, USDA.

"Milk Made the Difference" pictures from National Dairy Council.

Slide projector and screen.

Food or food models and comparison cards to show calcium equivalents, National Dairy Council.

Daily Food Guide, F&NS-23, USDA.

Various items containing calcium such as chalk, limestone, bones, sea shells.

REFERENCES FOR AIDES

1. Key Nutrients, PA-691, USDA.

2. How Food Affects You flip charts, USDA.

3. "Milk Made the Difference" pictures from National Dairy Council.

4. Food-A Key to Better Health, Nutrition Foundation, p. 4.

5. Family Fare, G1, USDA, p. 10.

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KEY NUTRIENTS

Lesson 5: IRON

PURPOSE

Trainer agent to help aides:

1. Understand how the body uses iron.

2. Learn food sources of iron and methods of including iron-rich foods in the diet.

PRESENTATION

. Review the importance of iron and its functions in the body. Emphasize that:

- Iron deficiency is the most prevalent nutritional disorder among children in the United States.

- Iron is a mineral like calcium or iodine that our bodies need to function properly.

- Iron combines with protein in our bodies to form hemoglobin, the red substance in our blood which carries oxygen from the lungs to all parts of our bodies. Body cells must be constantly supplied with oxygen to sustain life.

- Iron forms part of several enzymes in the body. Enzymes are substances that break food down so that it can be digested and used in the body.

- Iron is stored in the liver, bone marrow and spleen in the body.

. Point out that the best sources of iron are:

- liver and other organ meats

- dried peas and beans

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- egg yolks

- beef, pork, lamb and veal

. Emphasize that other good sources of iron are:

- enriched or whole-grain breads and cereals

- dark green leafy vegetables

- dried apricots, prunes, raisins

- molasses

. Point out that iron content of some food can be increased by cooking in cast iron utensils.

. Explain that egg yolk is one of the first solid foods added to an infant's diet because milk contains very little iron.

- Menstruating women require larger amounts of iron because of the periodic loss of blood.

- Iron-deficiency anemia, which can cause a tired feeling, is due to a lack of iron in the diet. A physician should be consulted to treat anemia.

. Have several aides use pages 12-14 of the flip chart "How Food Affects You" to discuss with the group how they might use this visual to teach homemakers that iron is a nutrient found in foods that our bodies need to function properly.

. Have aides prepare, or tell how they have prepared, one or two iron-rich foods, such as organ meat, molasses cookies, a dark green vegetable.

. Have aides share with the group how they would help homemakers introduce iron-rich foods into their family diets, such as having raisins available for afternoon snacks; using molasses cookies instead of plain cookies; or adding molasses to baked beans.

. Give aides several menus that lack or are low in foods containing iron. Let them suggest ways to include iron.

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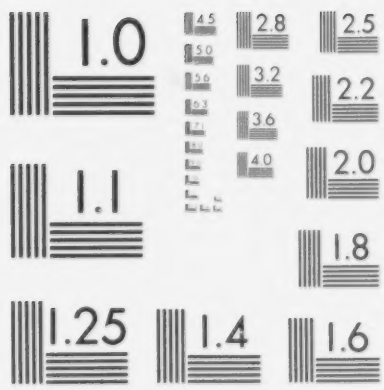

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

APPLICATION OF LESSON BY AIDES

Aides teach the importance of iron in the diet.

Aides explain ways to include foods containing iron in family diets.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 122-129.

2. Eat to Live, Wheat Flour Institute, pp. 20-21.

VISUALS AND EQUIPMENT

Foods and materials for food preparation.

How Food Affects You, flip charts, USDA.

REFERENCES FOR AIDES

1. How Food Affects You, flip charts, USDA.

2. Food - A Key to Better Health, Nutrition Foundation, p. 4.

3. Family Fare, G1, USDA, p. 11.

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KEY NUTRIENTS

Lesson 6: IODINE

PURPOSE

Trainer agent to help aides:

1. Understand how the body uses iodine.

2. To learn the food sources of iodine and the importance of using iodized salt.

PRESENTATION

. Review information pointing up the need to emphasize iodine in teaching homemakers. Emphasize that:

- Iodine is a mineral, like calcium and iron, that is necessary for our body. Although large amounts are toxic, small amounts of iodine are important for a balanced diet.

. Discuss the function of iodine in the body:

- Iodine forms part of the hormone thyroxine which regulates body processes. Thyroxine is made by the thyroid gland which is located in the neck. Thyroxine regulates the rate at which the body produces energy from food. If the activity of the thyroid gland is slow, the body tends to store up energy in fat. If the gland is over active, the body burns up food and body reserves too fast and tends to become thin. Both conditions affect physical and mental health, nerves, rate of heart beat and appetite.

- Iodine is necessary for maintenance of body processes throughout life.

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- Discuss food sources of iodine, such as:

  - iodized salt

  - shell fish

  - salt water fish

- Point out that the simplest way to be sure there is enough iodine in the diet is to use iodized salt. Ask how many aides use iodized salt. Compare the prices of iodized and regular salt in the local food stores. Show labels from boxes of both iodized and regular salt.

- Explain that some persons cannot use iodized salt because they have certain diseases. For those who are healthy, however, iodized salt is recommended.

- Emphasize that iodine is stored in the thyroid gland in the neck. A simple goiter, which is an enlargement of the thyroid gland, may be caused by insufficient iodine in the diet. Explain that the use of iodized salt is important in the prevention of simple goiter. Ask aides if they have ever known anyone with a goiter.

APPLICATION OF LESSON BY AIDES

Aides understand the importance of using iodized salt.

Aides check at local food stores for iodized salt.

Aides compare cost of iodized and regular salt.

Aides encourage homemakers to choose and use iodized salt instead of regular salt.

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- Use teaching aids frequently to enrich the classroom presentation. Use them to help trainees understand a concept or skill. Visual aids may be purchased, borrowed from companies, or made by the instructor. A list of the most common instructional aids include bulletin and flannel boards; shadow boxes; display windows; duplicated aids such as films, filmstrips, film loops, overhead transparencies, and opaque printed material; flip and data charts; and three dimensional aids such as actual parts, mockups, and models.

- Indicate the relation of this lesson to previous lessons and to the job.

- Emphasize the key points to be covered in the lesson.

- Use a variety of evaluative devices to check student progress in relation to job competencies. Some techniques that can be used include score cards, rating scales, progress charts, interviews, objective tests, and written or oral response to case problems.

PRESENTING A LESSON

A successful teacher is one who is aware of the feelings of others and has a contagious enthusiasm for work. He uses a well-modulated voice, is cheerful, courteous, and sympathetic. It is important that the instructor keep in mind the following principles of learning.

- All individuals do not learn at the same rate.

- Success encourages and failure disheartens. Nothing succeeds like success.

- Learning means a change in behavior.

- One learns best when he is ready to learn.

- A person learns by doing. The more he is involved the more he is likely to learn. He learns when he solves problems, looks up facts, asks questions, compares ideas, operates machines, and uses equipment.

- One learns best when he feels secure.

- Experiences are more meaningful when built upon step-by-step learning situations.

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REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 122-129.

2. Eat to Live, Wheat Flour Institute, pp. 21-23.

3. Principles of Nutrition, Wilson, Eva, and others, new edition, Chapter on Iron and Iodine.

VISUALS AND EQUIPMENT

Boxes of iodized and regular salt.

Pictures of goiter from nutrition texts.

REFERENCE FOR AIDES

1. Family Fare, G1, USDA, p. 11.

2. Food, A Key to Better Health, Nutrition Foundation, p. 5.

14446

KEY NUTRIENTS

Lesson 7: VITAMIN A

PURPOSE

Trainer agent to help aides:

1. Learn the importance of Vitamin A and how the body uses it.

2. Learn foods containing Vitamin A and how to include them in the diet.

PRESENTATION

. Present a brief overview of the functions and characteristics of vitamins. Emphasize these points:

- Vitamins are essential for body growth to resist infection, and to keep the body functioning properly.

- All vitamins needed for good health can be found in food.

- Vitamins may be classified as fat-soluble or water-soluble. Fat-soluble vitamins can be stored in the body. Water-soluble vitamins cannot be stored in the body to any significant extent. Therefore, foods containing water-soluble vitamins should be eaten every day.

. Point out the characteristics of Vitamin A. This vitamin is:

- Fat-soluble and can be stored in the body.

- Fairly stable to heat.

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- Discuss and show the specific functions of Vitamin A in the body. Refer to flip charts "How Food Affects You" pages 16-18 or slides 24 and 25 in slide set by same title, or to Key Nutrients leaflet.

- Emphasize that Vitamin A:

  - Helps the eyes adjust to dim light.

  - Helps keep the skin smooth.

  - Helps keep the lining of the mouth, nose, throat, and digestive track healthy and resistant to infection.

  - Promotes growth.

- Identify and discuss food sources of Vitamin A:

  - Animal sources are the only immediate sources of Vitamin A. Dark green, leafy, or deep yellow vegetables contain a substance called carotene, which is changed into Vitamin A by the body.

- Ask aides to identify animal sources of Vitamin A from the list of foods in Key Nutrients. Ask aides to explain why liver is high in Vitamin A.

- Display food sources of Vitamin A using pictures or food models such as:

  liver
  dark green leafy vegetables such as spinach
  broccoli, turnip greens, kale, collards
  deep yellow vegetables such as carrots,
  pumpkin, sweetpotatoes, winter squash
  apricots
  cantaloupe
  egg yolk
  butter and fortified margarine
  whole milk and cheese
  fortified milk and milk products

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- Compare the amounts of Vitamin A in light and dark green leafy vegetables; compare the amounts of Vitamin A in yellow and deep yellow vegetables. Show examples of these vegetables, such as lettuce and broccoli or corn and carrots.

- Indicate that dark green and deep yellow colors in vegetables usually indicate high Vitamin A value and that they add color and variety to meals.

- Point out that foods in the fruit and vegetable group are our main sources of Vitamin A. Illustrate with Daily Food Guide.

- Prepare two foods rich in Vitamin A such as a sweet-potato casserole or a salad made from greens.

- Have the aides select food recalls from several homemakers and evaluate the diets for Vitamin A content.

- Have the aides classify several recipes containing Vitamin A-rich foods into "good" and "fair" sources.

APPLICATION OF LESSON BY AIDES

Aides explain to homemakers the importance of Vitamin A in the body. Aides teach homemakers ways to include low-cost Vitamin A-rich foods in the diet.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 130-133.

2. Eat to Live, Wheat Flour Institute, p. 17.

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VISUALS AND EQUIPMENT

"How Food Affects You" slide series, C-156, USDA.

How Food Affects You flip charts, USDA.

Pictures or food models.

Daily Food Guide, F&NS-23, USDA.

Dark green and light green vegetables for comparison.

Dark yellow and light yellow vegetables for comparison.

Food and materials for food preparation.

REFERENCES FOR AIDES

1. How Food Affects You, flip charts, USDA.
2. Key Nutrients, PA-691, USDA.
3. Food - A Key to Better Health, Nutrition Foundation, p. 4.
4. Family Fare, G1, USDA, p. 12.

KEY NUTRIENTS

Lesson 8: B-VITAMINS

PURPOSE

Trainer agent to help aides:

1. Learn the function of three B-Vitamins: thiamine, riboflavin, and niacin.

2. Learn food sources of these B-Vitamins and ways of including them in the diet.

3. Understand the meaning of the terms "enriched" and "fortified" when used to describe food.

PRESENTATION

. Show pages 24-26 from flip charts "How Food Affects You." Point out that:

- Vitamin B, once believed to be a single nutrient, is now known to be composed of many vitamins. Thiamine, riboflavin, and niacin are three of these.

- B-Vitamins are water-soluble and therefore cannot be stored in the body. Foods containing these vitamins should be eaten every day.

. Discuss functions of B-Vitamins:

- Thiamine helps body cells obtain energy from food, helps keep nerves in healthy condition, and promotes good appetite and digestion.

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- Keep foods containing riboflavin away from the light. Do not leave milk on the doorstep in glass bottles or clear plastic containers.

- Use liquid from cooked meats and vegetables in soups, sauces, and gravies.

Have aides prepare a visual on enrichment that would be meaningful to a homemaker.

APPLICATION OF LESSON BY AIDES

Aides check local food stores for enriched and fortified products.

Aides help homemakers understand labels on enriched and fortified products.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 139-149.

2. Eat to Live, Wheat Flour Institute, pp. 18-19, 30-33.

VISUALS AND EQUIPMENT

How Food Affects You, flip charts, USDA.

Daily Food Guide, F&NS-23, USDA.

Labels from bread and cereal boxes, etc.

Wall chart on wheat kernel from the Wheat Flour Institute.

REFERENCES FOR AIDES

1. How Food Affects You, flip charts, USDA.

2. Key Nutrients, PA-691, USDA.

3. Family Fare, G1, USDA, p. 13.

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KEY NUTRIENTS

Lesson 9: VITAMIN C

PURPOSE

Trainer agent to help aides:

1. Learn how the body uses Vitamin C.

2. Learn food sources of Vitamin C and how to include Vitamin C food in the daily diet.

3. Learn how to help homemakers understand the importance of including Vitamin C in their diet each day.

PRESENTATION

- Have display of Vitamin C foods. Ask aides what nutrients are found in these foods.

- Mention that Vitamin C is also called ascorbic acid.

- Show slides 26 and 27 of the "How Food Affects You" slide set or pages 20-22 of the "How Food Affects You" flip charts to illustrate the following functions of Vitamin C in the body:

  - Helps hold body cells together and strengthens walls of blood vessels.

  - Helps in healing wounds.

  - Helps resist infection

- Have aides compare the ascorbic acid content of the following foods. Use Bulletin 72, Nutritive Value of Foods.

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brussel sprouts	oranges
collards	grapefruit
mustard greens	strawberries
green peppers	tomatoes
potatoes	cauliflower
turnip greens	cantaloupe
broccoli	cabbage

apples	pears
bananas	beets
watermelons	celery
peaches	corn

- Have aides group foods from both lists above into columns under these headings--best, good, and poor sources. This could be a reference for the aide to use with homemakers.

- Discuss precautions against loss of Vitamin C in cooking and storing.

- Use display of food to help aides determine low-cost sources of Vitamin C foods. Consider other foods: fruit drinks to which Vitamin C has been added, and fruits and vegetables in season.

- Have aides tell of other foods with which they are familiar that may be sources of Vitamin C.

- Have aides role-play ways of convincing homemakers to use low-cost Vitamin C foods.

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Appendix

APPENDIX A

SAMPLE PERFORMANCE PRETEST

This performance test consists of two parts. Part A involves pattern placement, cutting, and marking and should help the instructor to evaluate the applicant's understanding of commercial patterns, manual dexterity in using some cutting and marking equipment, and ability to follow directions accurately. Part B relates to construction procedures and should give the instructor some understanding of the quality of the applicant's workmanship and comprehension of construction terms. The instructor may wish to change the pretest and use full-scale pattern pieces and additional fabric.

Before administering the pretest be sure that applicant understands:

- What he is expected to do
- Time limits for the test
- Procedures to be used in evaluating and reporting test results

PART A - PATTERN PLACEMENT, CUTTING, AND MARKING

Materials required:

- Piece of fabric measuring 12 by 36 inches
- Set of pattern pieces - (examples on following pages)
- Sewing equipment
- Test instructions

Directions: Perform the following steps using the materials provided.

(1) Prepare the fabric so that it measure 12 by 36 inches. Fold it so there is a 12- by 12-inch square of single thickness and a 12- by 12-inch square of double thickness as shown in the drawing.

(2) Lay patterns A, B, C, and D on the section of double thickness as indicated on the drawing. Do not cut out patterns at this step.

(3) Place patterns E and F on the section of single thickness.

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APPLICATION OF LESSON BY AIDES

Aides help homemakers understand the importance of Vitamin C in the diet.

Aides select dietary recalls from several homemakers and evaluate for Vitamin C.

Aides plan with homemakers ways to include low-cost Vitamin C foods in families' diets.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 150-161.

2. Eat to Live, Wheat Flour Institute, p. 19.

3. Nutritive Value of Foods, USDA, G-72.

VISUALS AND EQUIPMENT

Foods for display.

"How Food Affects You" slide set, C-156, USDA.

Slide projector and screen.

REFERENCES FOR AIDES

1. How Food Affects You flip charts, USDA.

2. Key Nutrients, PA-691,USDA.

3. Nutritive Value of Foods, G-72, USDA.

4. Food - A Key to Better Health, Nutrition Foundation, p.5.

5. Family Fare, G1, USDA, p. 12.

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KEY NUTRIENTS

Lesson 10: VITAMIN D

PURPOSE

Trainer agent to help aides:

1. Learn the functions of Vitamin D in the body.

2. Learn sources of Vitamin D and how to obtain the recommended amounts.

PRESENTATION

. Refer to the leaflet Key Nutrients and discuss functions of Vitamin D in the body. Point out that:

- The first formation of bone is known as cartilage.

- Calcium and phosphorus are the minerals that cause the cartilage to harden into bone.

- When Vitamin D is not present in the diet, cartilage does not harden completely, resulting in soft curved bones, bowed legs, or knock knees. This disease is known as rickets.

. Show a picture of a child with rickets and point out deformities of bone structure.

. Show slides 30 and 31 from "How Food Affects You" slide set. Emphasize:

- Infants and children need Vitamin D for growth.

- Adults need small amounts of Vitamin D to keep bones and teeth healthy.

- Pregnant and lactating women need additional amounts to ensure healthy babies and to protect their own bodies.

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- Point out food sources of Vitamin D:

  - Salt water fish, herring, mackerel, and canned salmon and sardines are sources. Egg yolk and liver contain Vitamin D in varying amounts.

  - Milk is generally not a good source unless it is fortified with Vitamin D. Read labels for Vitamin D content.

  - Cod-liver oil and halibut-liver oil are excellent sources of both Vitamin A and Vitamin D.

  - Human skin contains a fat which is transferred into Vitamin D when it is exposed to the ultraviolet rays of direct sunlight. Clouds, fog, dust and clothes interfere with the absorption of these ultraviolet rays.

- Discuss amounts of Vitamin D needed. Vitamin D is required throughout the growth period. The amount recommended is 400 USP units per day from infancy through age 22. The requirement for pregnant and lactating women is the same as for growing children. Enough Vitamin D can generally be obtained by drinking amounts of milk recommended in the Daily Food Guide.

  - Since Vitamin D is fat-soluble and is stored in the body, excessive amounts can be harmful. Toxic effects, including loss of appetite, vomiting, diarrhea and drowsiness, appear in children consuming massive amounts. Toxic effects do not result from Vitamin D in foods.

  - Concentrated forms of all vitamins should be prescribed by a physician.

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APPLICATION OF LESSON BY AIDES

Aides check with young mothers to see if children are drinking Vitamin D milk and are being exposed to sunshine.

Aides visit local markets to determine availability of Vitamin D milk and report findings at later training meetings.

REFERENCES FOR TRAINER AGENT

1. Food For Us All, Yearbook of Agriculture, 1969, USDA, pp. 258-259.

2. Food, Yearbook of Agriculture, 1959, USDA. pp. 130-138.

3. Milk in Family Meals, G-127, USDA.

4. Principles of Nutrition, Wilson, Fisher and Fuqua, pp. 225-233.

VISUALS AND EQUIPMENT

Picture of a child with rickets.

"How Food Affects You" slide set, C-156, USDA.

Projector and screen.

Milk cans, boxes, and cartons.

REFERENCES FOR AIDES

1. Key Nutrients, PA-691, USDA.

2. Food - A Key to Better Health, Nutrition Foundation pp. 4-5.

3. Family Fare, G1, USDA, p. 12.

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VT 012 842
Foods and Nutrition--Supplemental Lessons for Training Extension Aides. Meal Planning.

Department of Agriculture, Washington, D.C. Extension Service.
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DESCRIPTORS - *HOME ECONOMICS EDUCATION; *TEACHING GUIDES; *COOKING INSTRUCTION; *NUTRITION INSTRUCTION; FOODS INSTRUCTION; *EXTENSION EDUCATION; ON THE JOB TRAINING; ADULT VOCATIONAL EDUCATION; BIBLIOGRAPHIES; FAMILY MANAGEMENT; SERVICE WORKERS; EXTENSION AGENTS

ABSTRACT - This booklet is one of a series of booklets of supplemental lessons in food and nutrition prepared by the Extension Service of the U.S. Department of Agriculture and is designed for use by trainer agents in on-the-job training of Extension aides to provide them with information about meal planning and with teaching methods to use in helping families. Purposes, presentation suggestions, learning activities, references, and audiovisual materials accompany these units: (1) Low-Cost Meals, (2) Planning for Snacks, (3) Planning for a Good Breakfast, (4) Quick and Easy Meals, (5) One-Burner Meals, (6) Casserole Meals Without a Recipe, (7) Meals for One or Two, and (8) Meal Planning to Include an Older Person, During Pregnancy, and When There Is a Weight Problem. Additional suggestions for the trainer agent and lists of recommended references are provided in an introductory section. Related booklets are available as VT 012 840-VT 012 843, all in this issue. (SB)

VT 012 842

FOOD and NUTRITION...

supplemental lessons for training extension aides

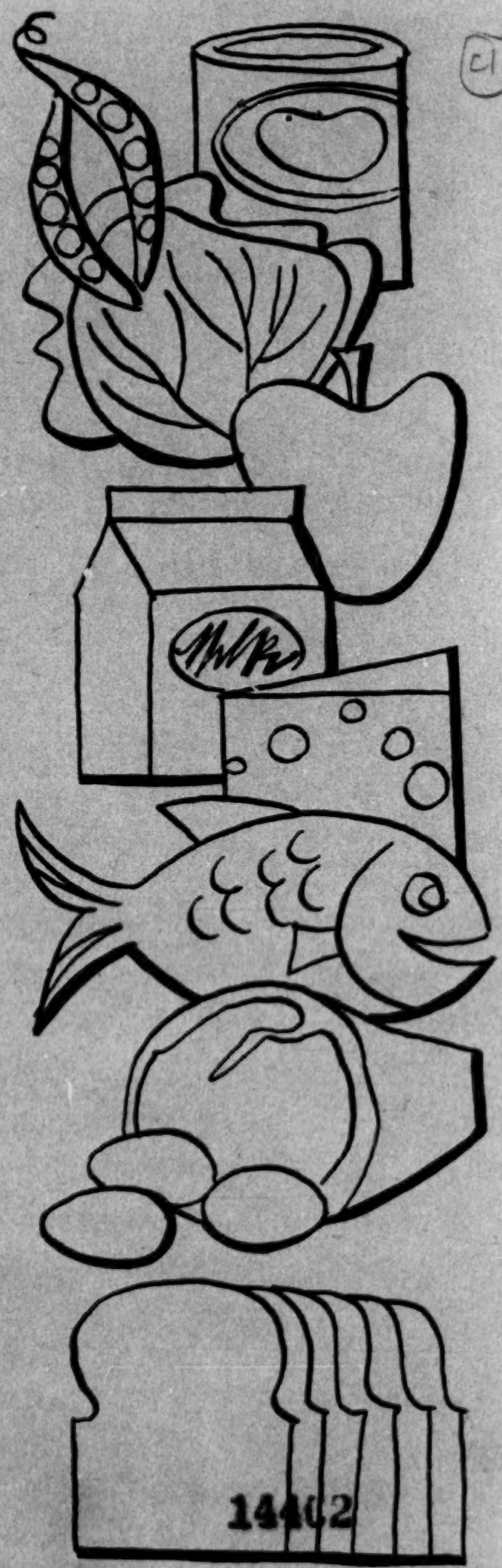

MEAL PLANNING

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Meal Planning is one of a series of booklets of supplemental lessons in food and nutrition, designed for use in on-the-job training of Extension aides. These lessons are not intended to be complete teaching units. The purpose is to enrich the aides' background in food and nutrition and to provide practical teaching methods that they can use in taking food and nutrition information to families. Since technical subjects in nutrition are simplified some of the generalizations may have exceptions.

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FOOD AND NUTRITION

Supplemental Lessons for Training Extension Aides

MEAL PLANNING

Purpose

These lessons were written to help trainer agents prepare aides for work with families in the Food and Nutrition Education Program. It is important that aides understand the principles of planning meals to include nutrition, family needs and preferences as well as cost.

The lessons are on expansion of Lesson 8 - Plan Meals to Meet Family Food Needs from Food and Nutrition---basic lessons for training Extension aides. The information can be adapted by the aides for the families they work with. It also can be used in teaching groups of adults or youth. This series should be used to supplement the initial training given aides and will help the trainer agent enlarge the food and nutrition knowledge of the aides.

TRAINER AGENT'S RESPONSIBILITY

References are suggested for the agent's use with each lesson. The agent will find it helpful to assemble these references before starting the lessons and to use them in her preparation for teaching.

References also are suggested for the aide's use. The agent should be selective in the references she gives to aides. Order those selected well in advance.

Go over references thoroughly with the aides so that they know what is in each reference.

Professional people in related fields may be asked to participate in training meetings. Such participation should be planned well in advance.

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A working relationship with each aide should already be established as a result of the initial training period. Effective communication remains vital in teaching. Before teaching supplemental lessons, the trainer agent may wish to review purposes of the training and the importance of aides' participation.

Suggested check list to be sure that all necessary preparations for the in-service training sessions have been made:

___Meeting place with necessary facilities has been obtained.

___All references needed to complete the lessons have been assembled.

___Local public health service and library have been checked for additional references.

___All visual materials and equipment needed to teach the lessons are on hand.

___All reference materials needed for the aides have been obtained.

___All lesson plans have been carefully studied so that you fully understand the overall content of the course.

___Sufficient time has been allowed to complete each lesson.

ADAPTING THE LESSONS TO YOUR AIDES

Guides used in teaching the basic lessons should be followed in teaching the supplemental lessons also:

Adapt training classes to meet the needs of your group. Here are some ideas to keep in mind:

1. Simplify. Do not try to cover too much material in one lesson. Pick out the most important points and emphasize them.

2. Use colorful visuals and a dynamic presentation to help make the lesson more appealing.

3. Emphasize good nutrition elements in the food the aides are now eating. Point out how small changes can often result in a more balanced diet.

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(4) Ask the instructor to check pattern layout. The instructor will tell you when you may cut out the pieces. Keep remaining fabric for use in Part B.

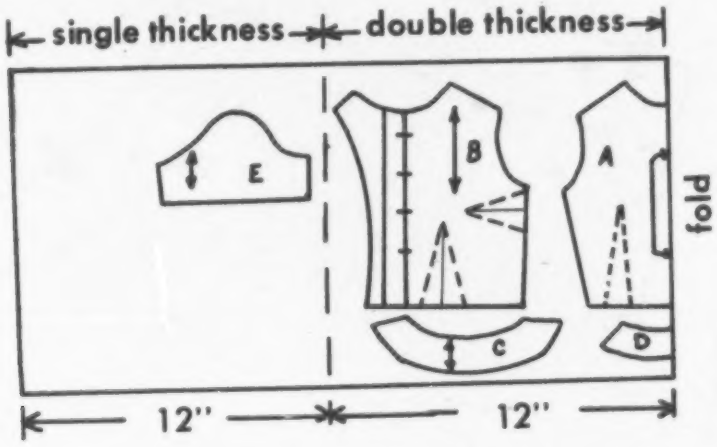

(5) After pieces are cut out, mark darts and sleeve markings with tracing paper and wheel. Mark center front line, fold line, and buttonholes with basting thread.

PART B - CONSTRUCTION PROCEDURES

Directions: Perform the following steps using the materials from Part A.

(1) Use the bodice front and back to illustrate the following:
Directional staystitching
Correctly sewn darts
Seam construction on shoulder using a $\frac{1}{4}$-inch seam

(2) Use the facing pieces, bodice, and sleeve to show how to:
Join neck facings
Finish outer edge of facings
Apply facings to neck edge and one armhole
Apply sleeve to the other armhole

(3) Put in two rows of machine stitches for gathering across one side of the 6-inch square. Use a $\frac{5}{8}$-inch seam allowance and put a lower row of stitching in the seam line. Do not pull the gathers.

(4) Hem the opposite side of the 6-inch square as in a gathered cotton skirt without seam binding. Turn under $\frac{1}{4}$ inch from the edge. Make a $1\frac{1}{4}$-inch hem. Sew hem by hand using a slip stitch or blind stitch.

(5) Construct the collar correctly. Do not put on bodice.

(6) Label the bodice, fabric square, and collar with your name and present to the instructor.

4. Involve the aides in the training meetings in as many ways as possible.

EXTENDING INFORMATION

Information given in the supplemental lessons may be effectively used in other ways, such as adaptation for use in training volunteer leaders or in newsletters or newspaper articles. A series of radio or TV programs based on the lessons may help to extend to a larger audience the ideas that aides are promoting.

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Recommended publications

For aides and leaders

Publications and visual materials are listed with each lesson. Make sure that supplies of them are on hand before you begin teaching.

USDA

Bulk quantities of USDA pamphlets are usually obtained through your State publications distribution officer.

Calories and Weight, G-153 (25¢)
Eat A Good Breakfast to Start A Good Day, L268 (5¢)
Family Fare, G-1 (45¢)
*Food and Your Weight, G-74 (15¢)
Food Guide for Older Folks, G-17 (10¢)
*Meal Planning Made Easy, PA-695 (5¢)
Money Saving Main Dishes, G-43 (30¢)
*Daily Food Guide Leaflet, C&MS-23 (35¢ for 10 copies)
Free illustrated Daily Food Guides are available for educational programs relating to U.S. Department of Agriculture's Family Food Assistance Programs through your regional Food & Nutrition Service office.

Cereal Institute, Inc.

Breakfast Source Book, pp. 7-14, Cereal Institute, Inc. 135 South LaSalle Street, Chicago, Ill. 60603.

*Publications NOT available free may be purchased from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, at the prices indicated. There is a 25 percent discount for 100 or more copies on all GPO orders.

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Florida Citrus Commission

Teen Temptations, Florida Citrus Commission, Institutional and School Marketing Dept., P.O. Box 148, Lakeland, Florida 33802.

Kellogg Company

Why Break the Fast?, Resource Kit, Kellogg Company, Battle Creek, Michigan 49016.

National Dairy Council

An Album of Snacktime Hits, B16 (3¢)
Easy Meals That Please, B33 (5¢)
What to Eat Before You Are Pregnant, While You Are Pregnant, After the Baby Comes, B103 (4¢)
Lower Cost Meals That Please, B64 (15¢)

A catalog can be obtained listing available materials. If you live in a city where there is an affiliated unit of the National Dairy Council, requests for material should be directed to that office. If you are not served locally, send orders to National Dairy Council, 111 North Canal Street, Chicago, Ill. 60606.

Quaker Oats Company

Budget Saving Recipes, Quaker Oats Company, Chicago, Ill. 60654.

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Recommended references

For Trainer agents

Each lesson includes a list of recommended reference books and publications for training agents to use in preparing lessons. Make sure you have the references you need to do a good job.

Consumers All, Yearbook of Agriculture, 1965. $2.75, Supt. of Documents, Government Printing Office, Washington, D.C. 20402.

Eat to Live, Wheat Flour Institute, 14 E. Jackson Blvd., Chicago, Ill. 60604 $1.00.

Food, Yearbook of Agriculture, 1959. $3.25, Supt. of Documents, Government Printing Office, Washington, D.C. 20402.

Food A Key to Better Health, Nutrition Foundation, Inc. 1970. Order from Colson Co., Paris, Ill. 61944. 25¢.

Food For Us All, Yearbook of Agriculture, 1969, $3.50, Supt. of Documents, Government Printing Office, Washington, D.C. 20402.

Meal Management, Kinder, Faye, Macmillan Co., 866 3rd Ave., New York, N.Y. 10022. 1968. $7.95.

Nutrition in Action, Martin, E.A., Holt, Rinehart & Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. 1965. Teacher's Guide $6.50.

Teaching Nutrition, Eppright, E. and others, Iowa State Press, Ames, Iowa 50012. 1963. $4.95.

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VISUALS

Slide Sets and Filmstrips

"Breakfast and the Bright Life" A-56, 1970, 60 frames, $9.00.
"Milk the Magnificent" C-161, 1969, 50 frames, $8.00; Filmstrip $5.50.
"Milk Basic to Good Nutrition" C-162, 1970, 50 frames, $8.00; Filmstrip $5.50.
"The 'Basic Four' Way to Good Meals" C-158, 1969, 50 frames, $8.00; Filmstrip $5.50.
"Weight Control (The Oopsies)," C-74, 1960, 22 frames, $8.00; Filmstrip $5.50.
"Food Value Stretchers" C-152, 1968, 50 frames, $8.00; Filmstrip $5.50.
"Good Meals for Busy Days" C-106, 1963, 57 frames, $9.00; Filmstrip $6.50.
"Non-Instant, Non-Fat Dry Milk" C-169, 1970, 49 frames, $8.00; Filmstrip $5.50.

USDA slide sets may be purchased from the Photography Division, Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250. Copies of the filmstrips may be ordered from Photo Lab., Inc., 3825 Georgia Ave., N.W. Washington, D.C. 20011.

Filmstrips

"Why Eat A Good Breakfast?" 30 frames, Cereal Institute, Inc., 135 South LaSalle Street, Chicago, Ill. 60606.

Charts and Posters

*Daily Food Guide Poster, 22" x 28", F&NS-13, 15¢.

National Dairy Council

Comparison Cards for adults, B43-A, $3.00 a set.

14470

MEAL PLANNING

Lesson 1: LOW-COST MEALS

PURPOSE

Trainer agent to help aides:

1. Identify low-cost food sources in the Daily Food Guide and ways they can be included in food plans for the day.

2. Develop skill in planning nutritious low-cost meals and snacks.

3. Learn ways to help homemakers include low-cost foods to improve the nutrition of the family.

PRESENTATION

. Ask aides to name low-cost foods under each of the four food groups which could be used in meals and snacks. List on chalk board.

- Milk Group

-- Nonfat dry milk and evaporated milk are cheaper than fresh milk.

-- Cream is expensive. Whipped evaporated or whipped nonfat dry milk usually can be used in place of whipped cream. They have more calcium and protein, less fat, and fewer calories than cream.

-- Less expensive cheese products such as processed cheese and cheese food are a good source of protein and calcium. More expensive cheeses may not provide more nutrients.

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- Meat Group

  -- Dried beans, peas, and peanut butter make hearty dishes. Use in combination with an animal protein to improve the quality of the vegetable protein.

  -- Eggs are usually a less expensive source of protein than most meats.

  -- The nutritive value of ground beef, liver, heart, and kidney is good for the money spent.

  -- Chicken and turkey are good buys when they are plentiful.

  -- Locally caught fresh fish, canned fish flakes (such as mackerel) and frozen fillets are usually good buys.

  -- Meat in combination with a white sauce or with macaroni, spaghetti, noodles or rice can reduce cost and extend the nutritive value of the pasta.

- Fruit-Vegetable Group

  -- Fresh vegetables that are in season and plentiful are better buys than those purchased at other times.

  -- Frozen spinach and other greens, chopped broccoli, squash, peas, and green beans may be good buys, as compared with the fresh vegetable.

  -- Cabbage, potatoes, and root vegetables such as carrots are usually good vegetable buys.

  -- Canned tomatoes are cheaper and often higher in vitamin C than raw tomatoes out of season.

  -- Canned greens, pumpkin, and green beans are usually economical buys.

  -- Canned vegetables usually cost less than frozen.

  -- During most seasons, frozen orange juice is cheaper and has about the same nutritive value as fresh.

14472

- Breads and Cereals

  -- Plain bread or rolls are lower in cost than sweet or fancy-shaped rolls.

  -- Enriched and whole grain breads and cereals supply more nutrients for the money than unenriched products.

  -- Day-old bread, which can be purchased at food stores or special outlets, costs less.

  -- Homemade bread and cookies are usually lower in cost than similar purchased items.

. Use Comparison Cards to compare nutritive values of low-cost foods with more expensive foods in the same food group.

. Plan a day's meals and snacks around some of the low-cost foods which have been listed. Use the Daily Food Guide in planning. Use pictures or food models to illustrate.

. Other points to consider when planning low-cost meals and snacks:

  - Use resources which are available.

    -- Food supply on hand.

    -- Leftovers.

    -- Food from the garden.

    -- USDA donated foods or food stamps, whichever is available.

    -- Specials at the grocery store -- some advertised foods may not be "specials."

  - Plan simple meals.

  - Use recipes that can be prepared without costly ingredients.

  - Make a shopping list.

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- Show filmstrip or slide set "The 'Basic Four' Way to Good Meals." Analyze meals for good nutrition and cost. Discuss ways in which meal costs could be lowered but still be nutritious. What adjustments could be made? Discuss with aides.

- Aides plan a day's meals and snacks around USDA donated foods if available to families. Include low-cost food items which need to be purchased, or:

- Aides plan a day's meals and snacks around "specials" which are currently being advertised in the local papers. Use the Daily Food Guide in planning.

- Make plans to prepare and serve one of the low-cost meals at a later training session.

APPLICATION OF LESSON BY AIDES

Aides apply lesson to their own family meal planning.

Aides apply information as they work with individual homemakers.

Aides use information when teaching small groups.

REFERENCES FOR TRAINER AGENT

1. Food for Us All, Yearbook of Agriculture, 1969, pp. 279-293.

2. Consumers All, Yearbook of Agriculture, 1965, pp. 416-423.

3. Food, Yearbook of Agriculture, 1959, pp. 577-588.

4. Meal Management. Kinder, 1968, pp. 253-311.

5. Eat to Live, Wheat Flour Institute, pp. 42-44.

VISUALS AND EQUIPMENT

Chalkboard or newsprint pad.

Filmstrip or slide set "The 'Basic Four' Way to Good Meals," USDA.

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Pictures of food or food models.

Comparison cards for adults, National Dairy Council.

Newspaper advertisements from grocery stores.

Daily Food Guide, poster, F&NS-13, USDA.

REFERENCES FOR AIDES - Select as needed

1. Daily Food Guide, leaflet, C&MS-23, USDA.
2. Meal Planning Made Easy, PA-695, ES-USDA.
3. Food A Key to Better Health, Nutrition Foundation, pp. 20-21.
4. Family Fare: Food Management and Recipes, G-1, USDA.
5. Easy Meals That Please, National Dairy Council.
6. Budget Saving Recipes, Quaker Oats.
7. Money Saving Main Dishes, G-43, USDA.
8. Ideas for Economy-Minded Families, PA-934, USDA.
9. Ideas for Families Using Donated Foods, PA-935, USDA.
10. Ideas for Leaders Working with Economy-Minded Families, PA-937, USDA.

14475

PATTERN PIECE FOR PRETEST

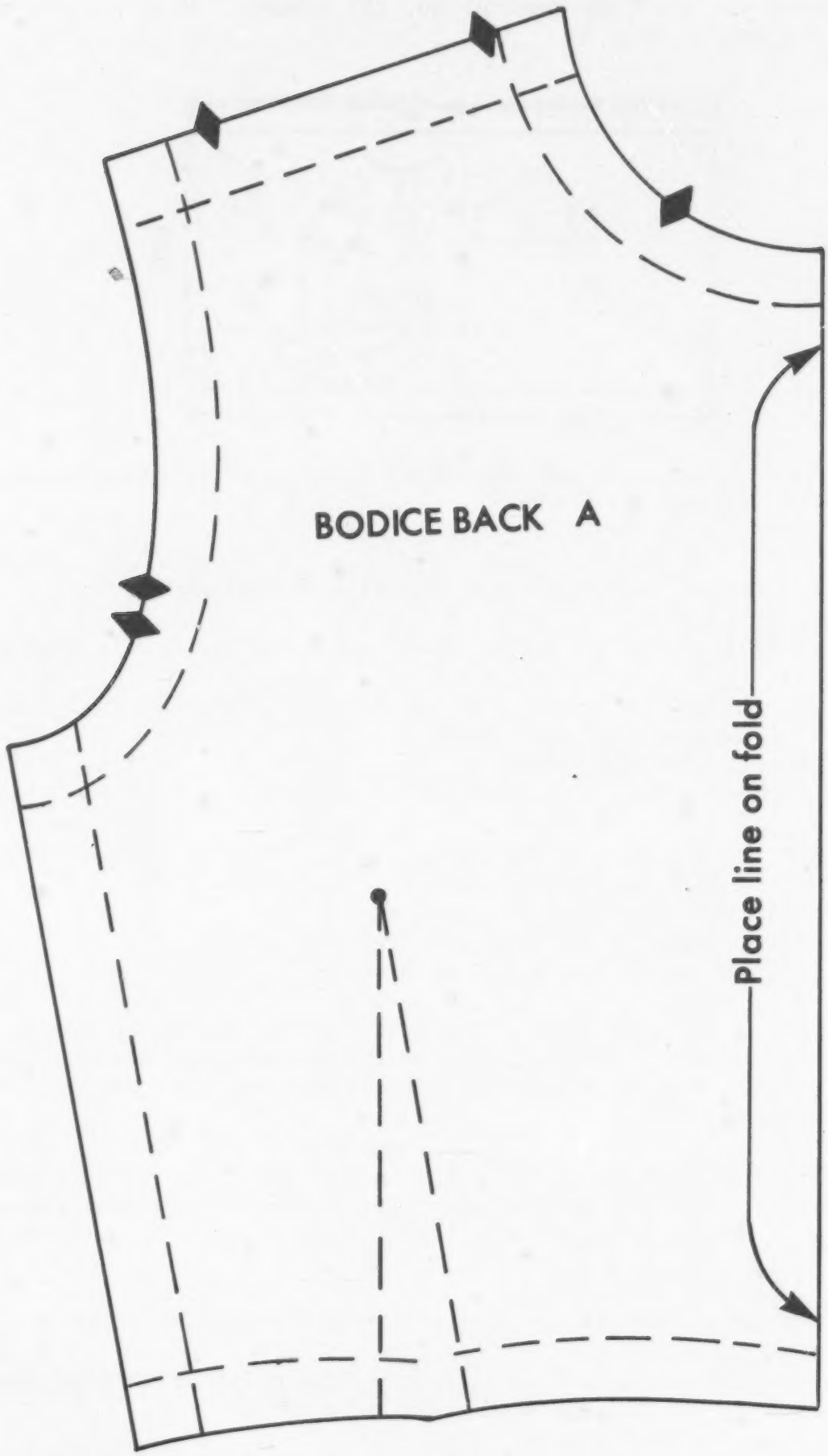

Bodice Back

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MEAL PLANNING

Lesson 2: PLANNING FOR SNACKS

PURPOSE

Trainer agent to help aides:

1. Understand how snacks help meet daily food needs.
2. Learn ways to help homemakers include nutritious, low-cost snacks in a daily food plan.

PRESENTATION

- Display some typical snack foods such as soft drinks, ice cream, candy, cake, cookies, potato chips, fruits, etc. Ask aides to group the foods according to the four food groups. Some will not fit into the four food groups. Discuss the food value and relative cost of the snacks using the comparison cards.

- Aides indicate the number of times they have eaten within the last 24 hours. Emphasize that snacks may provide a large portion of the day's food for many people.

  - What foods do aides and their own families eat between meals? List these foods in columns with the following headings: milk, meat and substitutes, fruits and vegetables, breads and cereals, and other foods.

  - Compare the nutritive value of these foods. Do most of these snacks fit into the four food groups or are they other foods?

  - What are advantages of selecting snacks from the four food groups?

- Are snacks good for us? Yes and no. It depends upon:

  - the time the snack is eaten. Sweet, rich foods eaten shortly before meal time dull the appetite for the next meal.

14476

- the amount of food eaten. Too much food eaten between meals may lessen the appetite for foods at meal time.

- kinds of food selected. Foods which contain little food value other than calories are generally poor choices. These are called empty calorie foods. Examples are soft drinks, candy and potato chips.

- relationship of the snack to the other foods eaten during the day. Snacks should help meet the food needs as recommended in the Daily Food Guide.

- the person who eats the snack. Many people may not get all of the food needs at mealtime so snacks can help meet these needs. Examples are: growing children, active teenagers, adults who do heavy work, and those who need to gain weight.

  -- It may be more satisfying for overweight people, who are losing weight, to eat smaller amounts of food but more frequently.

. Put guidelines for choosing snacks on chalkboard or newsprint.

  - Choose snacks from the four food groups in the Daily Food Guide.

  - Avoid empty-calorie foods. They are expensive for the nutrients supplied.

  - Select according to the needs of the individual.

  - Select good snack choices such as fresh fruit, vegetable nibblers, milk, fruit juice, plain cookie, and small open-faced sandwich.

. Aides divide into groups. Each group plan a day's meals with a morning and an afternoon snack. Ask them to use the USDA donated foods currently being offered in the community or low-cost foods. Examples of low-cost snack items might be cocoa made from nonfat dry milk, carrot nibblers, cornmeal, oatmeal, or peanut butter cookies.

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- Use low-cost nutritious snacks at training session. If time permits, have aides prepare one low-cost nutritious snack which they planned.

APPLICATION OF LESSON BY AIDES

Aides use information to help homemakers plan snacks which supplement their meals.

Aides use information in teaching small groups.

REFERENCES FOR TRAINER AGENT

1. Consumers All, Yearbook of Agriculture, 1965, pp. 393-397.
2. Food for Us All, Yearbook of Agriculture, 1969, pp. 264, 265, 273-278, 320.
3. Nutrition in Action, Martin, 1965, pp. 217-222.
4. Teaching Nutrition, 1964, Eppright, Pattison and Barbour, pp. 60-62, 70, 83, 92, 150, 151, 276.

VISUALS AND EQUIPMENT

Foods to illustrate typical snacks.

Chalkboard or newsprint.

Comparison Cards.

Daily Food Guide, poster, F&NS-13, USDA.

REFERENCES FOR AIDES

1. Daily Food Guide, leaflet, C&MS-23, USDA.
2. Food A Key to Better Health, Nutrition Foundation, p. 8.
3. Teen Temptations, Florida Citrus Commission, Lakeland.
4. An Album of Snacktime Hits, National Dairy Council.

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MEAL PLANNING

Lesson 3: PLANNING FOR A GOOD BREAKFAST

PURPOSE

Trainer agent to help aides:

1. Know the advantages of eating breakfast.

2. Learn the characteristics of a good breakfast.

3. Learn ways to help homemakers plan nutritious breakfasts to meet individual needs.

PRESENTATION

. Use poster What Did You Have For Breakfast This Morning? to open discussion about breakfast.

. Conduct a poll among aides regarding the following questions. Use responses as a basis for discussion.

- What does the word "breakfast" mean to you?

- Did you eat breakfast this morning?

- Did everyone in your family eat breakfast?

- What foods do you like for breakfast? As foods are mentioned, separate into the four food groups and other foods.

. Discuss why breakfast is important

- Show slides, "Breakfast and the Bright Life" or filmstrip "Why Eat A Good Breakfast." Review breakfast study reported in Breakfast Source Book.

- Studies show that a midmorning coffee break does not replace breakfast.

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- Body uses nutrients more efficiently when they are distributed throughout the day.

. Discuss why people skip or skimp breakfast. Aides role play or respond to these statements and suggest ways to cope with problems.

  - I don't eat breakfast. I'm on a diet.

  - I don't like eggs, bacon and cereal that are usually eaten at breakfast.

  - I'm just not hungry enough to eat breakfast right after I get up. I'd rather have a cup of coffee in the middle of the morning.

  - We don't have enough money to have food in the morning.

  - I'm too rushed in the morning. I'd rather sleep late and skip breakfast.

  - If anyone in our house eats breakfast, he just grabs something from the refrigerator.

  - I'm too busy fixing my hair and putting on makeup to bother with eating.

. Use Comparison Cards and food models or actual foods. e.g. Compare nutritive value and calories in a breakfast with empty-calorie snacks and heavy desserts.

. Review guidelines in Eat a Good Breakfast to Start a Good Day. A good breakfast:

  - gives protein, minerals, and vitamins.

  - provides fuel for energy.

  - tastes good.

. Show pictures of traditional and non-traditional breakfasts which meet the guidelines for a good breakfast.

14481

- Have aides plan a low-cost nutritious breakfast around these situations:

  - prepared without cooking.
  - without foods from the meat group.
  - featuring USDA donated foods if available.
  - low in calories.
  - featuring foods used by a local cultural group.

APPLICATION OF LESSON BY AIDES

Aides stress, with program families and groups, the importance of breakfast.

Help change attitudes and behavior regarding breakfast.

REFERENCES FOR TRAINER AGENT

1. Food For Us All. Yearbook of Agriculture, 1969, p.320.

2. Food. Yearbook of Agriculture, 1959, pp. 301, 323, 510.

3. Nutrition in Action. Martin, pp. 21, 22, 214, 215, 221, 222.

4. Breakfast Source Book. Cereal Institute, pp.7-14.

5. Why Break the Fast? Resource Kit. Kellogg Company, Battle Creek, Michigan.

VISUALS AND EQUIPMENT

"Breakfast and the Bright Life," slide set, A-56, USDA.

"Why Eat a Good Breakfast," filmstrip, Cereal Institute, Inc.

Screen and projector.

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Food models and Comparison Cards, National Dairy Council.

Pictures of foods.

Chalkboard or newsprint.

REFERENCES FOR AIDES

Eat a Good Breakfast to Start a Good Day, Leaflet 268, USDA.

Food, A Key to Better Health, Nutrition Foundation, p. 6.

EVALUATION

Several weeks after the lesson, ask aides to evaluate breakfasts which were eaten by the families they visited on one day. Also check number of aides now eating breakfast and compare with the poll.

14483

MEAL PLANNING

Lesson 4: QUICK AND EASY MEALS

PURPOSE

Trainer agent to help aides:

1. Learn ways to plan nutritious meals that can be prepared with a minimum of time, energy and skill.
2. Plan a day's food that a person with limited abilities could prepare.

PRESENTATION

- Review lesson 8 from Food and Nutrition...basic lessons for training extension aides and discuss the quality of the meals in terms of nutrition, color, texture, flavor and cost. Make up your own or use these menus:

- Write two menus on the board.

Menu 1	Menu 2
Scrambled Eggs	Poached Eggs
Buttered Canned Green Beans	Frozen Green Beans with Bacon
Sliced Tomatoes	Tossed Salad
Bread and Spread	Toast and Spread
Peanut Butter Cookies	Peanut Butter Cookies
Milk	Coffee

- Aides identify the menu which would be easiest to prepare and give reasons for their choice.

- Aides make suggestions for planning simple nutritious meals children could prepare for the family.

- Food preparation can be simplified by planning meals that:

  - limit the number of foods served.

- include foods which require little attention during preparation.

- require the simplest methods of food preparation.

- can be prepared from low-cost convenience foods which are partially or completely prepared.

    -- Canned foods and mixes simplify food preparation.

    -- Homemade biscuit, cookie, cocoa and pudding mixes are economical and simplify meal preparation.

- use foods prepared in advance.

    -- Fresh fruits and vegetables can be cleaned and refrigerated for later use.

    -- Eggs can be hard cooked and refrigerated for later use.

. Show slides or filmstrip "The 'Basic Four' Way to Good Meals."

    - Analyze the meals for nutrition, eye appeal and ease of preparation.

    - How can the menus be adjusted so that the meals could be simpler to prepare?

. Aides plan a quick breakfast, a carried lunch or a simple supper using the Daily Food Guide and the time-saving suggestions which have been discussed.

APPLICATION OF LESSON BY AIDES

Aides "child-test" the meals they planned for ease and simplicity in food preparation.

Aides use information with individual families and small groups.

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REFERENCES FOR TRAINER AGENT

1. Meal Management, Kinder, 1968, pp. 330-344.

2. Consumers All, Yearbook of Agriculture, 1965, pp. 468-471.

VISUALS AND EQUIPMENT

Chalkboard or newsprint.

Slides or filmstrip "The 'Basic Four' Way to Good Meals," USDA.

REFERENCES FOR AIDES

1. Daily Food Guide, leaflet, C&MS-23, USDA.

2. Meal Planning Made Easy, PA-695, Extension Service, USDA.

3. Eat A Good Breakfast to Start A Good Day, L-268, USDA.

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PATTERN PIECE FOR PRETEST

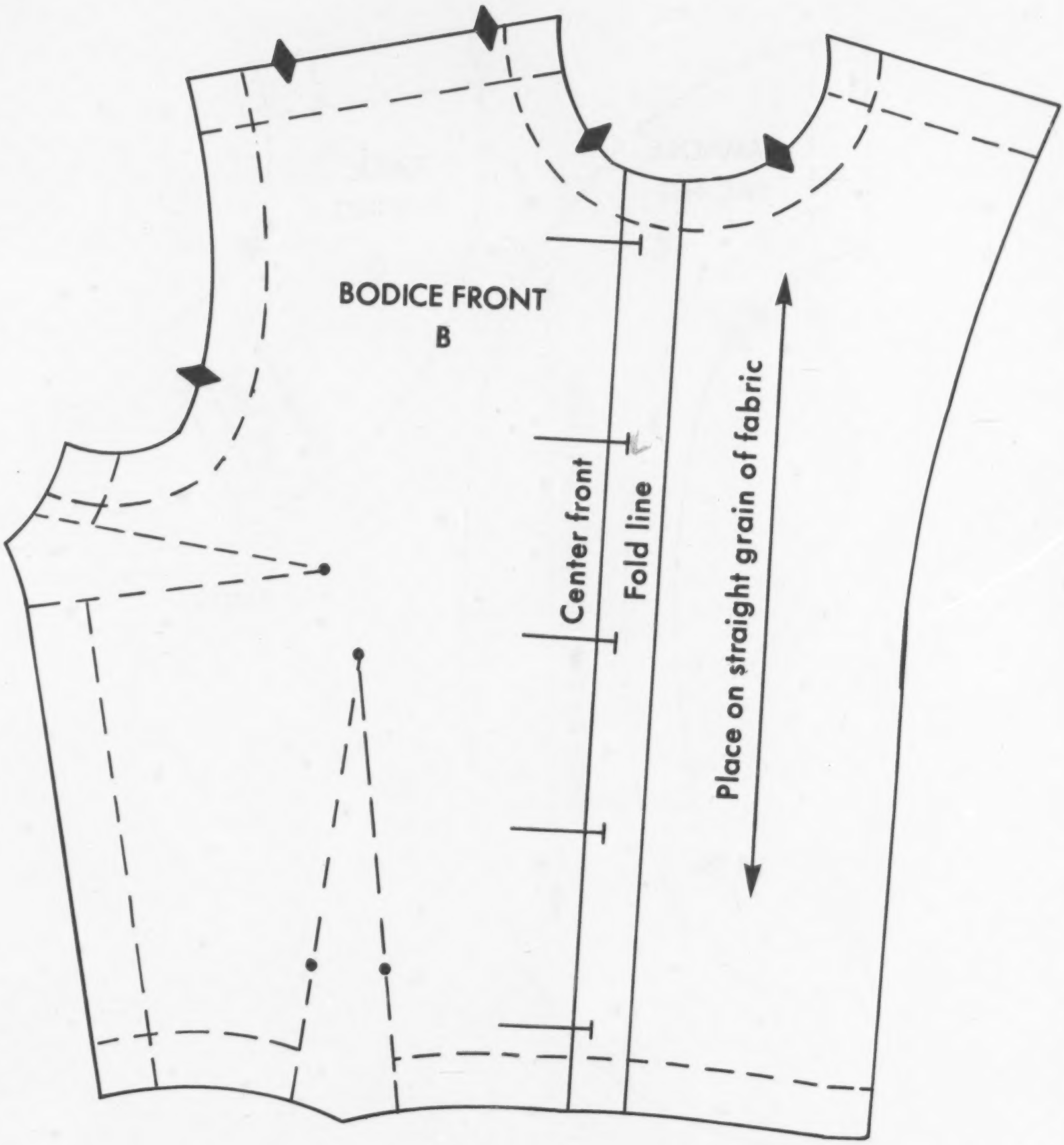

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MEAL PLANNING

LESSON 5: ONE-BURNER MEALS

PURPOSE

Trainer agent to help aides:

1. Assist homemakers to plan nutritious meals when cooking facilities are limited.

PRESENTATION

. Aides tell of situations they have known when cooking facilities were very limited.

- Limitations might include:

-- no oven

-- no refrigerator

-- poor storage space for staples

-- limited cooking equipment

- Examples of program families in which cooking facilities may be limited:

-- older people on limited incomes.

-- families living in poor housing.

-- families whose homes have been destroyed through disasters such as storms, floods, and fires.

. Discuss how to plan meals where cooking facilities are limited.

- Consider the situation:

-- Heat source. If there's only one gas or electric unit, plan for one dish meals, double-decker cooking using a double boiler and keeping food hot while another cooks.

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-- Refrigeration space. If there's no way to keep perishables cold, use canned foods and dry storage items such as dry milk and mixes. Plan amount of food needed so there will be no perishable leftovers.

-- Storage space for non-perishable foods. If storage is poor, use cans and jars with tight-fitting lids.

- Meal plan

-- Use simple menus. Limit number of foods served.

-- Use the Daily Food Guide in planning meals and snacks.

-- Plan to use some foods which require no cooking.

- Illustrate planning food for a day when there are limited cooking facilities. Write on board, illustrate with food models or pictures on a poster.

. Use the following example: Family - an elderly couple living in one room.

- Cooking facilities - hot plate, heavy skillet with lid, double boiler, mixing bowl, can opener, knife, cup, spoon, and limited refrigerator space.

- Meal Plan for A Day

Breakfast	Lunch
Tomato Juice	Beef Stew
Oatmeal with Milk	Hot Corn Bread with Spread
Milk	Cabbage Slaw
	Milk

Supper

Canned Chopped Meat and Potato Casserole
Corn Bread and Spread
Spinach
Carrot Strips
Custard
Coffee

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- Evaluate the meals using the Daily Food Guide.

- Ask aides to plan order of preparation of these foods and the equipment to be used.

APPLICATION OF LESSON BY AIDES

Aides plan low-cost food for a day using the following situation. Plan meals for a young family - mother, father, and two pre-school children. They have these things for cooking and storing food: Electric skillet, hot plate, saucepan, can opener, knife, spoon, fork, and containers with lids for storing staples.

Aides prepare one of these meals using the limited facilities described.

Aides use this experience as background information as they work with individual families or small groups.

REFERENCES FOR TRAINER AGENT

1. Recipe booklets which are developed by electric skillet manufacturers.

VISUALS AND EQUIPMENT

Chalkboard or newsprint.

Pictures of food or food models.

Daily Food Guide, poster, F&NS-13, USDA.

REFERENCES FOR AIDES

1. Daily Food Guide, leaflet, C&MS-23, USDA.
2. Meal Planning Made Easy, PA-695, ES-USDA.
3. Family Fare: Food Management and Recipes, G-1, USDA.
4. Food Guide for Older Folks, G-17, USDA.
5. Money Saving Main Dishes, G-43, USDA.

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MEAL PLANNING

Lesson 6: CASSEROLE MEALS WITHOUT A RECIPE

PURPOSE

Trainer agent to help aides:

1. Recognize advantages of using low-cost main dish casseroles in meals.

2. Learn the basic components of a main dish casserole.

PRESENTATION

- Discuss advantages of planning for main dish casseroles.

  - preparation can often be done in advance.

  - provides a way to use leftovers.

  - provides a way to extend meat.

  - provides a main dish to please the family.

  - enables homemaker to be creative.

- Write a main dish casserole recipe on the board. Indicate the food group to which each component belongs.

  - A main dish casserole may be made without a recipe using these suggestions:

    1 part protein food such as meat, fish, egg or cheese
    2 parts cooked starchy food such as noodles, rice or macaroni
    2 parts vegetables such as beans, peas, tomatoes, carrots, asparagus or celery
    sauce enough to moisten, such as gravy, white sauce, or canned cream soups
    a crunchy topping such as bread or cracker crumb seasoning
    bake at moderate temperature (350F)

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- Demonstrate the preparation of a casserole. One combination might be:

  1 cup cooked chopped beef
  2 cups cooked rice
  2 cups cooked green beans
  1 can condensed tomato soup
  1 chopped onion
  buttered bread crumbs

  This amount will make six servings.

- While demonstrating, give information concerning nutrition and meal planning.

  - Animal protein (beef) and cereal protein (rice) are combined in this casserole. Cereal protein is not as good quality as animal protein. When combined with animal protein, its quality is improved.

  - The amount of green beans in a serving of this casserole is not considered a serving of vegetables in the Daily Food Guide (1/2 cup is a serving).

  - Some ingredients in casserole recipes such as mushrooms, pimiento and olives usually increase cost but may make it more appealing.

- Give information concerning meal planning.

  - Suggest foods which can be added to complete this meal such as a carrot-raisin salad, cornbread, and milk.

  - Have aides help plan the remaining food for the day. Use Daily Food Guide.

- Aides make lists of low-cost protein foods, starchy foods, vegetables, sauces, and seasonings which might be used in preparing casseroles.

14491

APPLICATION OF LESSON BY AIDES

Aides apply information to their own meal planning by preparing and taste-testing a main dish casserole. Tell what other foods they served with the casserole.

Aides use information with individual families and small group meetings.

REFERENCES FOR TRAINER AGENT

1. Selected recipe books on casseroles or one-dish meals.

VISUALS AND EQUIPMENT

Chalkboard or newsprint.

Demonstration supplies and equipment.

Daily Food Guide, poster, F&NS-13, USDA.

REFERENCES FOR AIDES

1. Daily Food Guide, leaflet, C&MS-23, USDA.
2. Meal Planning Made Easy, PA-695, ES-USDA.
3. Family Fare: Food Management and Recipes, G-1, USDA.
4. Money-Saving Main Dishes, G-43, USDA.

MEAL PLANNING

Lesson 7: MEALS FOR ONE OR TWO

PURPOSE

Trainer agent to help aides:

1. Expand their knowledge related to planning meals for one or two.

2. Learn ways to help homemakers plan meals.

PRESENTATION

- Have aides tell group about persons with whom they are working who live alone or with another person. Keep a running record of:

  - approximate ages.

  - type of kitchen facilities they have.

  - types of food and nutrition problems already identified.

  - kinds of foods they most often fix for themselves.

  - evident health problems.

- Point out advantages of planning, preparing and serving meals for one or two people.

  - Fewer individual needs and preferences to consider.

  - Less work and time in preparation.

  - Can eat what and when they wish.

14493

- Discuss disadvantages when planning, preparing and serving meals for one or two. Consider ways to overcome their problems.

  - Lack of variety in foods may result in poor nutrition. To get more variety,

    -- Buy in small quantities.

    -- Include convenience foods in meal plan. Example: Frozen dinners served with other foods can make a nutritious meal.

    -- Use USDA food stamps or donated foods if available.

  - Lack of appetite may result in poor nutrition.

    -- Boredom contributes to poor appetite.

    -- Have meals with friends occasionally.

    -- Plan meals for eye and taste appeal. Include a variety of colors, flavors and textures in a meal.

    -- Vary place where meals are eaten. Eat in front of a window, on a balcony.

    -- Take walks to stimulate appetite.

  - Preparation of too much food may result in waste. To avoid waste:

    -- Use leftovers in a variety of ways.

    -- Exchange foods with friends occasionally.

- Display food in various can and box sizes and compare costs.

- Review bulletin, Food Guide for Older Folks.

- Use Daily Food Guide as an aid in planning. It gives the number of servings per day by age groups.

14494

APPLICATION OF LESSON BY AIDES

1. Aides make visuals of colorful and colorless meals.

2. Each aide plan low-cost meals for two days for one or two people. Show how food planned for first day can be used in meals or snacks for the second day.

3. Aides apply information to families of one or two with whom they work. Help families find solutions to problems.

REFERENCES FOR TRAINER AGENT

1. Food For Us All, Yearbook of Agriculture, 1969, pp. 301-303.

2. Food, Yearbook of Agriculture, 1959, pp. 322-324.

3. Nutrition in Action, Martin, 1965, pp. 200-202.

VISUALS AND EQUIPMENT

Chalkboard or newsprint.

Food items in various box or can sizes.

Pictures of foods.

REFERENCES FOR AIDES

Food Guide for Older Folks, G-17, USDA.

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Lesson 8: MEAL PLANNING TO INCLUDE AN OLDER PERSON

PURPOSE

Trainer agent to help aides:

1. Learn how the family's daily food plan can be adjusted to meet the needs of older folks.

2. Learn ways to help homemakers adjust family meals.

PRESENTATION

- Review lessons 6 "Food Needs Throughout Life" and 8 "Plan Meals to Meet Family Food Needs" in Food and Nutrition...basic lessons for training extension aides. Emphasize that older persons need:

  - fewer calories because of reduced activity.

  - the same nutrients as other family members, but in different amounts, and

  - amounts and kinds of food in the Daily Food Guide to supply the nutrients needed.

- Adjust family meals to meet the special needs of an older person. Discuss why changes are needed and how to make them.

  - Processes of digestion slow down, therefore--

    -- Use fewer rich fatty foods like pastry, whipped cream, fat meats, and gravies.

    -- Serve frequent small meals rather than large meals less often.

14496

PATTERN PIECES FOR PRETEST

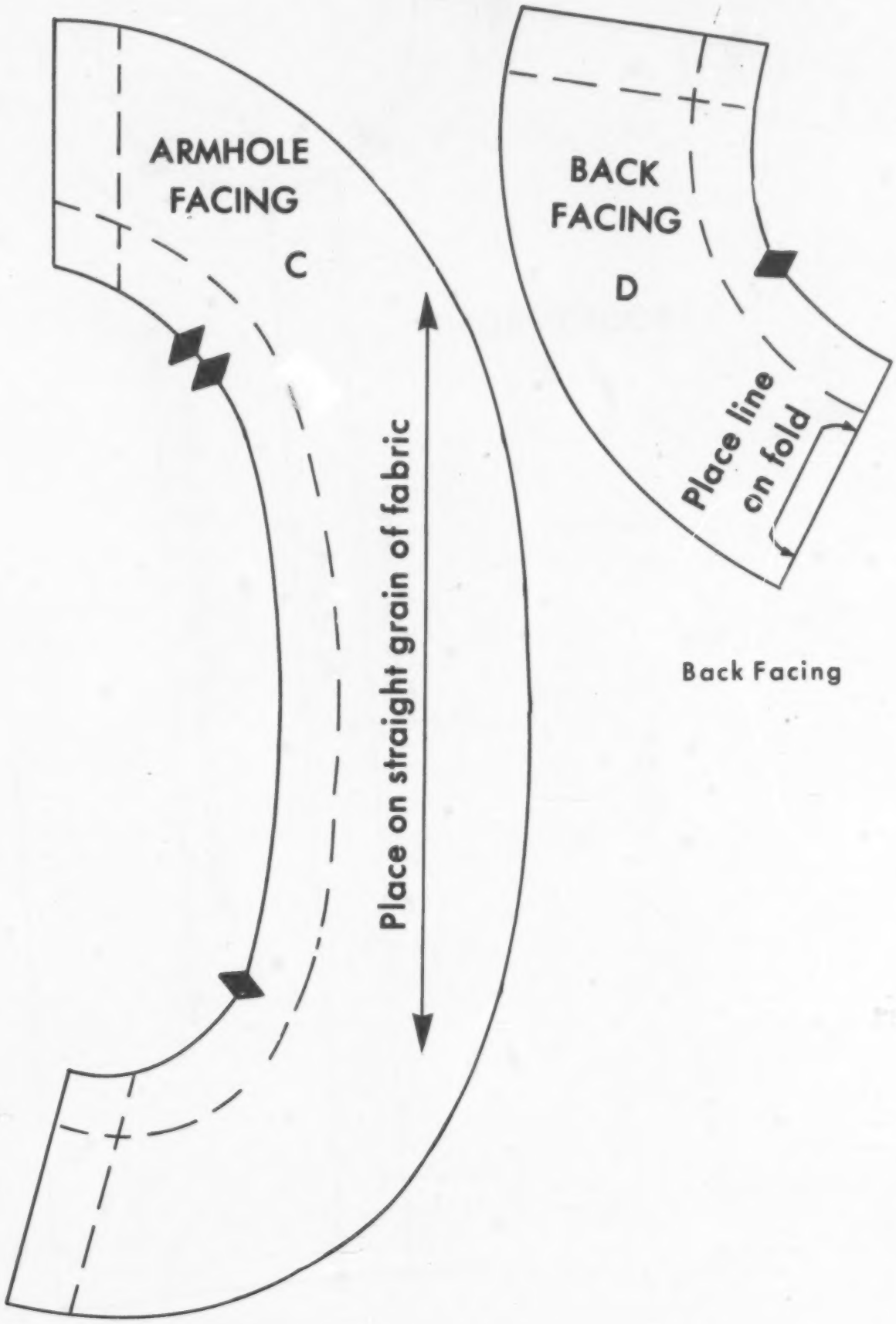

Back Facing

Armhole Facing

- Teeth are often missing or dentures poorly fitted so plan for foods which can be easily eaten.

    -- ground meats or chopped meats.

    -- soft foods.

    -- beverages which contain more than, calories.

    -- cream soups.

    -- chopped raw vegetables.

- Food likes and dislikes are well established.

    -- Know food likes and dislikes.

    -- Include well-liked nutritious foods often.

- Health problems may necessitate changes in diet. Follow instructions from physician.

- Older people need fewer calories. Avoid empty-calorie foods. Plan for smaller servings.

. Plan a suitable routine.

    - Have regular meals.

    - Serve an easily digetsed meal at night.

    - Plan from the Daily Food Guide.

    - Reserve part of the family meal for a mid-morning or mid-afternoon snack.

    - Include milk in meals and snacks.

. Have aides describe a program family in which there is an older person. Plan a day's meals and snacks for the family.

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APPLICATION OF LESSON BY AIDES

Aides make a list of appropriate in-between meal snacks for older people.

Aides apply information as they work with families including older people.

REFERENCES FOR TRAINER AGENT

1. Food for Us All, Yearbook of Agriculture, 1969, pp. 277-278, 303, 323.

2. Food, Yearbook of Agriculture, 1959, pp. 311-324.

3. Nutrition in Action, Martin, 1965, pp. 200-201.

VISUALS AND EQUIPMENT

Chalkboard or newsprint.

Pictures or food models.

Daily Food Guide, poster, F&NS-13, USDA.

REFERENCES FOR AIDES

1. Daily Food Guide, leaflet, C&MS-23, USDA.

2. Meal Planning Made Easy, PA-695, ES, USDA.

3. Lower Cost Meals That Please, National Dairy Council.

4. Food Guide for Older Folks, G-17, USDA.

EVALUATION

Make home visits and have conferences with aides to see how they use information with families including older people.

14498

14497

MEAL PLANNING

Lesson 9: MEAL PLANNING DURING PREGNANCY

PURPOSE

Trainer agent to help aides:

1. Understand the increased nutritional needs during pregnancy.

2. Learn how the family's food plan can be adjusted to meet the needs of the pregnant woman.

PRESENTATION

- Review Lesson 6, "Food Needs Throughout Life" in Food and Nutrition...basic lessons for training extension aides.

- Discuss section on food for pregnant women in Food, A Key to Better Health, pp. 14 and 15.

- List adjustments to be made in the food intake by the pregnant woman.

  - Increase intake to three cups of vitamin D milk.

  - Use more foods in the four food groups and less from the additional foods in meals and snacks.

  - Stress the importance of a balanced diet during pregnancy.

- Review the value of vitamin D fortified milk.

- Discuss ways the pregnant woman may get more milk into her diet as she plans family meals and snacks. List on board as aides contribute answers or illustrate with pictures or food models.

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- Use milk as mid-morning and mid-afternoon snack.

- Include more cheese in meals.

- Plan for more milk desserts -- ice cream, puddings, custards.

- Plan to use cottage cheese in main dish or in salads.

- Plan meals around soups made with milk. Suggest use of vitamin D fortified evaporated milk, dry skim and whole milk.

. Show and discuss one of the following slide sets or filmstrips: "Food Value Stretchers," "Milk the Magnificent," "The 'Basic Four' Way to Good Meals" or "Milk, Basic to Good Nutrition."

APPLICATION OF LESSON BY AIDES

Aides plan meals and snacks for the day for a program family including a pregnant woman. Evaluate the meals using the Daily Food Guide. Also, consider variety in flavor, color and texture. Calculate the amount of milk in the meals and snacks in this assignment to see if they include more for the pregnant woman.

Use as background to help pregnant homemakers plan meals.

REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, pp. 194-198, 273-282.

2. Food For Us All, Yearbook of Agriculture, 1969, pp. 295, 296, 313.

3. Nutrition in Action, E. Martin, 1965, pp. 70, 203-206.

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VISUALS AND EQUIPMENT

Chalkboard or newsprint.

Slide set or filmstrips: "Food Value Stretchers," USDA; "Milk the Magnificent," USDA; "Milk, Basic to Good Nutrition," USDA; or '"The 'Basic Four' Way to Good Meals," USDA.

Screen and projector.

Daily Food Guide, poster, F&NS-13, USDA.

REFERENCES FOR AIDES

1. Food, A Key to Better Health, Nutrition Foundation, pp. 14-15.

2. Daily Food Guide, C&MS-23, USDA.

3. Meal Planning Made Easy, PA-695, USDA.

4. What to Eat Before You Are Pregnant, While You Are Pregnant, After the Baby Comes, National Dairy Council.

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MEAL PLANNING

Lesson 10: MEAL PLANNING WHEN THERE IS A WEIGHT PROBLEM

PURPOSE

Trainer agent to help aides:

1. Learn to adjust the family's food plan to meet the needs of a member who has a weight problem.

PRESENTATION

- Review pages 16-19 in Food, A Key to Better Health.
  - Emphasize the chief reason for overweight is an imbalance of calories and activity.
  - Illustrate this balance with pictures or a poster.
  - Show selected slides from "The Oopsies."
  - Stress the need for encouragement by family members for the person trying to lose weight.
- Plan family meals so that the calorie counter can enjoy them, too.
  - Build meals around familiar well-liked foods. Crash diets will not change food habits. They are often monotonous and short-lived and ineffective.
  - Plan adequate meals and snacks with emphasis on the four food groups.
  - Show that the minimum number of servings recommended by the Daily Food Guide will supply approximately 1200 calories which, for most women, would be a safe reducing diet. Include kinds and amounts of food which will yield fewer calories. Draw these from the aides and list on the board:

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-- Trim fat from meat before cooking.

-- Keep servings small for the "calorie counter."

-- Serve sauces, gravies and dressings separately so they may be avoided.

-- Add butter to vegetables at the table.

-- Use skim milk rather than whole milk in cooking and drinking.

-- Use fruit, (fresh or cooked with little sugar) rather than pastries, cakes and cookies.

-- Plan to use more low-starch vegetables.

-- Prepare meat without added fat.

-- Bake, boil or broil rather than fry foods.

- Have aides identify starchy and non-starchy vegetables using pictures or food models.

- Show how a family's food plan can be adjusted to meet the needs of a person who is trying to lose or gain weight. Use suggested menus in Food and Your Weight as a guide.

APPLICATION OF LESSON BY AIDES

Aides use information as they work with program families who have a weight problem.

REFERENCES FOR TRAINER AGENT

1. Food For Us All, Yearbook of Agriculture, 1969, pp. 304-314.

2. Food, Yearbook of Agriculture, 1959, pp. 101-111.

3. Consumers All, Yearbook of Agriculture, 1965, pp. 398-402.

4. Food and Your Weight, G-74, USDA.

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VISUALS AND EQUIPMENT

Chalkboard or newsprint.

Slide set "Weight Control (The Oopsies)," USDA.

Slide projector and screen.

Pictures of food or food models.

Daily Food Guide, poster, F&NS-13, USDA.

REFERENCES FOR AIDES

1. Food, A Key to Better Health, Nutrition Foundation, pp. 16-19.

2. Daily Food Guide, leaflet, C&MS-23, USDA.

3. Meal Planning Made Easy, PA-695, USDA.

4. Calories and Weight, G-153, USDA.

EVALUATION

Make home visits and have conferences with the aides to see how they use the information.

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14505

VT 012 843
Food and Nutrition--Basic Lessons for Training Extension Aides.

Department of Agriculture, Washington, D.C. Extension Service.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - Apr70 65p.

DESCRIPTORS - *HOME ECONOMICS EDUCATION; *TEACHING GUIDES; *NUTRITION INSTRUCTION; *FOODS INSTRUCTION; COOKING INSTRUCTION; *EXTENSION EDUCATION; ON THE JOB TRAINING; ADULT VOCATIONAL EDUCATION; FAMILY MANAGEMENT; BIBLIOGRAPHIES; SERVICE WORKERS; EXTENSION AGENTS

ABSTRACT - Prepared by the Extension Service of the U.S. Department of Agriculture, this teaching guide is for trainee agents use in on-the-job training of Extension Aides and is designed to provide aides with the information they need to help families improve their diets. The information, which is to be provided during the initial three weeks training and later during weekly meetings, is organized in these lessons: (1) Food Makes the Difference, (2) Daily Food Guide, (3) Key Nutrients, (4) Foods Contain Different Amounts of Nutrients, (5) How Your Body Uses Food, (6) Food Needs Throughout Life, (7) Feeding Young Children, (8) Plan Meals to Meet Family Food Needs, (9) Get More for the Food Dollar, (10) Comparative Food Shopping, (11) Preparation of Milk, Milk Products, Vegetable, Fruit, Meats, Breads, and Cereals, and (12) How to Make a 24-Hour Dietary Recall. Purposes, presentation suggestions, learning activities, references, evaluation methods, supplemental lesson suggestions, audiovisual materials, and equipment accompany each lesson. An introductory section provides additional suggestions for the trainer agent and lists recommended references. Related booklets are available as VT 012 840-VT 012 842, all in this issue. (SB)

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VT 012 843

PATTERN PIECES FOR PRETEST

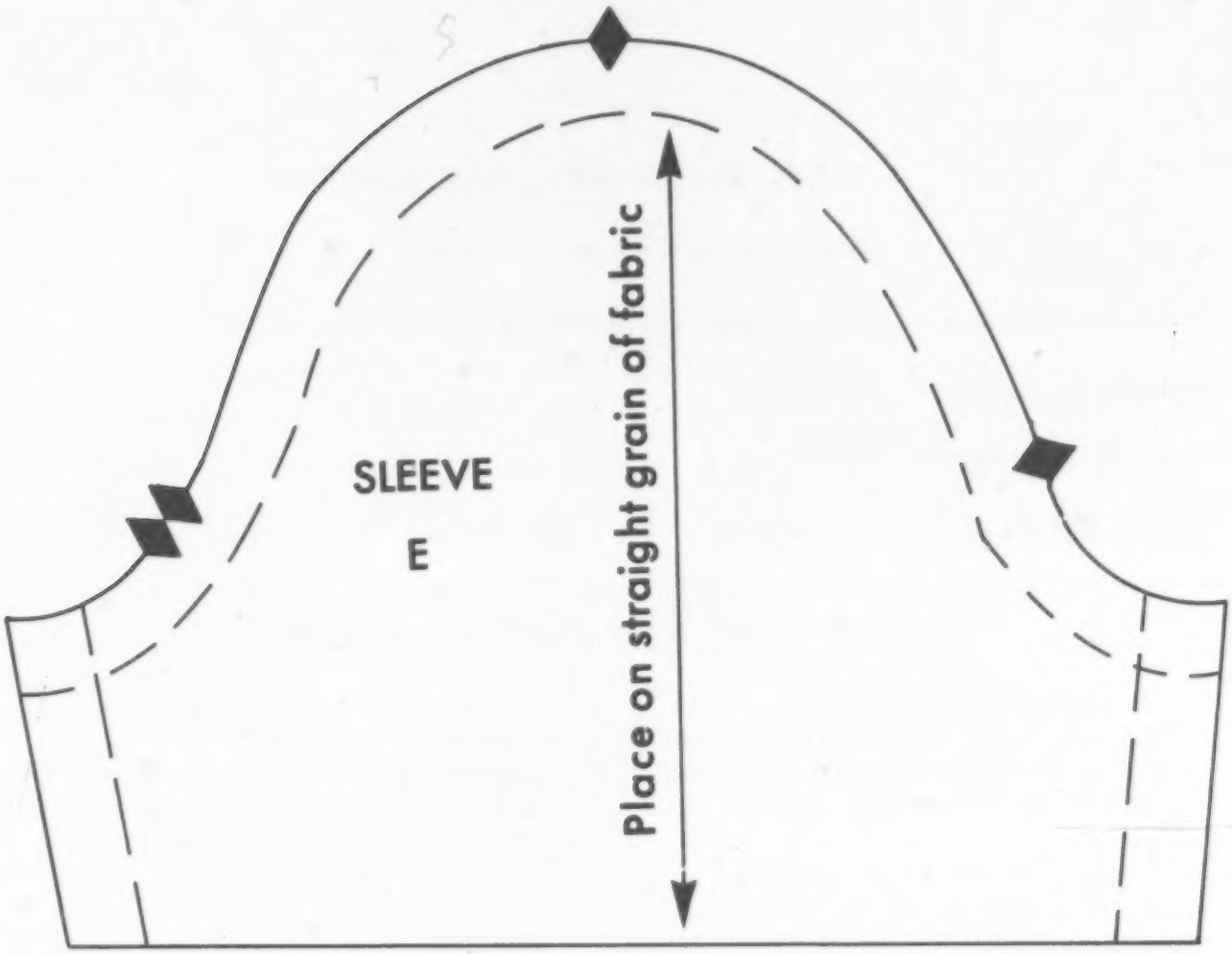

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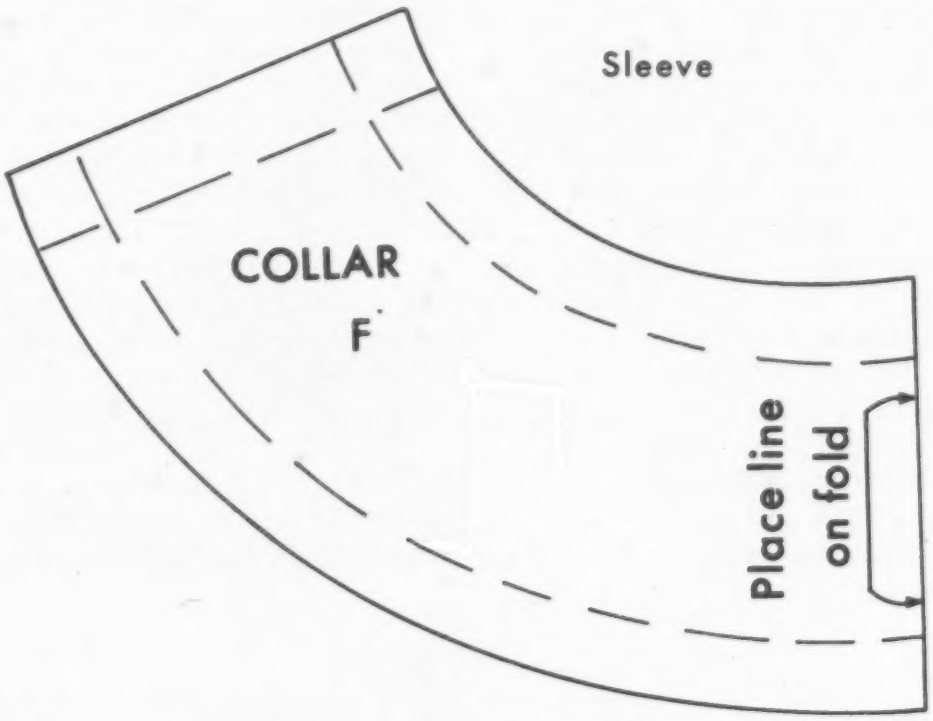

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Revision at Press

FOOD and NUTRITION... basic lessons for training extension aides

VT012843

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OFFICE OF EDUCATION
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Issued April, 1970

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FOOD AND NUTRITION...
basic lessons for training extension aides

Purpose of the lessons

These lessons were designed to help the trainer agent give aides the background in food and nutrition they will need for their work with low-income families.

In Extension's Food and Nutrition Education Program, trainer agents provide this background information to aides as part of the initial three weeks' training. After the aides start working with families, agents need to provide one half-day of training each week. At the weekly meetings, additional lessons are presented to help aides with the problems they encounter.

Volunteer leaders working with low-income youth and adults can also benefit from this training. Aides and volunteer leaders often work on the same type of program.

Scope of the lessons

Each lesson has a specific purpose. The 15 basic lessons provide aides with the information they need to begin the important job of helping families improve their diets. This initial training can also stimulate aides and leaders to want more information.

Lesson 1: Food Makes The Difference

Food's relationship to health and its meaning to people.

Lesson 2: Daily Food Guide

Daily Food Guide and how to use it.

Lesson 3: Key Nutrients

Important nutrients and their sources.

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Lesson 4: Foods Contain Different Amounts of Nutrients

Foods and the variation in the amounts of nutrients they contain.

Lesson 5: How Your Body Uses Food

Use of food in the body related to energy, growth, maintenance and repair of body cells.

Lesson 6: Food Needs Throughout Life

Amounts of nutrients needed vary according to age, activity, body size and stage of growth.

Lesson 7: Feeding Young Children

Relation of nutrition to child growth and development.

Lesson 8: Plan Meals To Meet Family Food Needs

Use of Daily Food Guide in planning meals and snacks.

Lesson 9: Get More For The Food Dollar

Wise food selection, use of a shopping list, and ways of keeping records of food costs.

Lesson 10: Comparative Food Shopping

Comparison of choices available to food shoppers.

Lesson 11: Preparation of Milk and Milk Products

Basic principles of milk cookery and how to apply them to preparation of milk and cheese dishes.

Lesson 12: Preparation of Vegetables and Fruits

Importance of fruits and vegetables in family meals. Understand and apply principles of vegetables preparation.

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Lesson 13: Preparation of Meats

Review the foods that make up the meat group. Learn basic principles of meat cookery.

Lesson 14: Preparation of Breads and Cereals

Identify foods in the bread and cereal group. Understand and apply the principles of bread and cereal cookery.

Lesson 15: How To Take A Twenty-Four Hour Dietary Recall

Meaning and purpose of the 24-hour dietary recall. The technique of taking a recall.

Ideas for supplemental lessons to follow the 15 basic lessons in nutrition are suggested with each lesson plan. These additional lessons increase the knowledge of aides and leaders. It will also be necessary to repeat the basic lessons during the weekly in-service training meeting and apply this information to the problems that aides have identified.

References are suggested for the trainer agent with each lesson. It is essential that these references be assembled before starting the course. References are also suggested for the aides. Plan to order these well in advance.

It is important that the trainer agent be selective in the references she gives to aides. Review contents before giving them to aides. Go over references thoroughly with aides so that they know what is in each one.

Professionally-trained people in related fields may be asked to participate in training meetings. For example, a public health nutritionist would be helpful in the lesson on feeding young children.

Adapting the lessons to your aides

Just as it takes time for aides to develop good working relationships with homemakers, trainer agents need time to get to know the aides with whom they work. During the initial training period, you are presenting material and you are also

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trying to establish a working relationship with each aide. Effective communications can be vital to the success of the program.

These classes may be a new situation for many aides. They might need help in understanding why classes are necessary. They may wonder how much they will be asked to participate. You can discuss these matters with the aides and make them feel more comfortable in the classroom situation.

Discuss training plans with the aides. Tell them what they will be learning during the next few weeks. It is important that the aides feel that this is their training and their program, not just yours.

Adapt training classes to meet the needs of your group. Here are some ideas to keep in mind:

1. Simplify. Do not try to cover too much material in one lesson. Pick out the most important points and emphasize these.

2. Use colorful visuals and a dynamic presentation to help make the lesson more appealing.

3. Demonstrate ways of preparing foods. This method may be especially good for creating interest and stimulating discussion.

4. Tasting foods provides aides with ideas that they can pass along to other homemakers. Make sure the aides know how to prepare and serve donated foods if they are available.

5. Emphasize the good nutrition found in the food the aides are now eating. Point out how small changes can often result in a more balanced diet.

6. Stress foods rather than just nutrients.

7. Involve the aides in the training meetings in as many ways as possible.

Trainer agent's responsibility for aide training

These 15 lesson plans were written primarily to help trainer agents prepare new aides for work with families in

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the Food and Nutrition Education Program. Aides must have a broad perspective on food and nutrition before they can begin to do their job. This is your responsibility.

Before the aides are trained and ready to go to work, trainer agents must develop working relationships with community agencies and organizations in relation to this program. Many low-income families have been in contact with agencies. These agencies and their field workers should know the Extension aide's function. If they believe that Extension aides can help families, they will be more apt to support the program and the aides. Community support is vital to the effectiveness of the Food and Nutrition Education Program.

Use this check list to make sure that you are ready to begin teaching:

___Meeting place with necessary facilities has been obtained.

___All the references you need to prepare the lessons have been assembled.

___Local public health service and library have been checked for additional references.

___All visual materials and equipment needed to teach the 15 lessons are on hand.

___All reference materials needed for the aides have been obtained.

___All lesson plans have been carefully studied so that you fully understand the overall content of the course.

___Sufficient time has been allowed to prepare each lesson.

Extend information

Much time and effort is involved in training aides. Make the most of the lessons you prepare by using this material in other ways. Use it to train volunteer leaders. Adapt it for use in newsletters or newspaper articles. A series of radio or TV programs based on the lessons could help to extend the ideas that aides are promoting to a larger audience.

Food recall information obtained from low-income families is used for reporting purposes. It should also be used to

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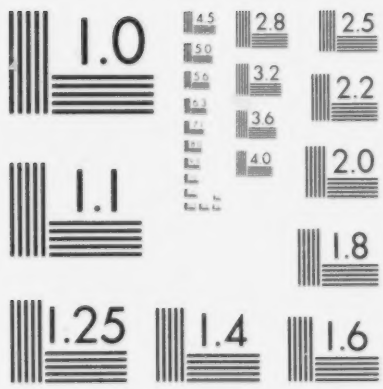

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

identify the food practices of families you are reaching, to evaluate the progress of your program, and to strengthen your aide training program.

Recognize achievement

Aides and leaders who complete the basic training course should be recognized. This is an achievement. A certificate gives aides something they can take home and show the family. Graduation dinners or special meetings are also a good idea.

Recommended publications, visual materials

For trainer agents, aides and leaders

Publications and visual materials are listed with each lesson. Make sure that these supplies are on hand before you begin teaching.

USDA

Single copies or bulk quantities of these USDA pamphlets can usually be obtained through your State distribution officer. USDA slide sets may be purchased from the Photography Division, Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250.

		Agents	Aides & Leaders
G-153	Calories and Weight	X	
G-74	Food and Your Weight	X	
L-424	Food For Fitness	X	X
GS-1	Nutrition--Food at Work For You	X	X
G-72	Nutritive Value of Foods	X	
G-1	Family Fare	X	X
G-43	Money-Saving Main Dishes	X	X
G-118	Beef and Veal in Family Meals	X	X
G-124	Lamb in Family Meals	X	
G-160	Pork in Family Meals	X	X
G-112	Cheese in Family Meals	X	X
G-127	Milk in Family Meals	X	X
G-105	Vegetables in Family Meals	X	X
G-5	Food For The Family With Young Children	X	
G-150	Cereals and Pasta in Family Meals	X	X
G-125	Fruits in Family Meals	X	X
HERR37	Family Food Buying Guide	X	

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		Agents	Aides & Leaders
	Visuals		
C-156	"How Food Affects You" slide set. 1969. 48 frames. $8.00.	X	
C-121	"Selecting & Buying Food For The Young Family" slide set. 1966. 36 frames. $8.00.	X	
	USDA		
	Order from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 at the prices indicated below.		
PA-681	Training Home Economics Program Assistants To Work With Low Income Families. 55¢	X	
PA-680	Handbook for Home Economics Program Assistants. (Free copies are available through your State publications distribution officer)		X
	Food For Young Families Series:		
PA-700	Guide for agent (15¢)	X	
	Six Leaflets:		
PA-691	Key Nutrients (5¢ each)	X	X
PA-692	Principles of Cookery (5¢ each)	X	X
PA-693	Feeding Young Children (5¢ each)	X	X
PA-694	Eat To Live Better (5¢ each)	X	X
PA-695	Meal Planning Made Easy (5¢ each)	X	X
PA-696	Selecting & Buying Food (5¢ each)	X	X
	(PA 691-696-S, Spanish leaflets, may be available from State distribution officer).		
	"How Food Affects You" flip chart (in booklet form). 1970. 32 pages. Color. 60¢	X	X
	Food For Thrifty Families (Packet B):		
	Complete kit of 29 publications... $1.50 per kit or $112.50 per 100 kits		X
	*Set of 21 illustrated flyers (C&MS 23-43) $1.00 per set or $75.00 per 100 sets		X
PA-743	Suggestions for Trainer Agent	X	

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APPENDIX B

PRESS RELEASE FOR COURSE PROMOTION

From: Centerville Central School

Contact Person: Carl Clum, Director of Adult Education

School Telephone: WH3-0001

Home Telephone: WO7-5464

Release Date: Immediate

EARN MONEY DOING GARMENT ALTERATIONS

Garment Alterations, a new course, will be offered by the adult education program of the Centerville Central School District.

The course will prepare individuals to alter ready-to-wear garments in a department store, specialty shop or their own business. Applicants must be able to use a sewing machine and a commercial pattern. Only persons with some basic sewing skills should apply due to the specific nature and limited time for training. Individuals should bring to the first class meeting a garment having a collar and set-in sleeves.

Instruction is designed to help each participant reach his full potential through group instruction and individual assistance.

Classes will begin Tuesday evening, September 24, at the Centerville High School and will run for fourteen weeks. Sessions will be held on Tuesday and Thursday evenings from 7 to 10 p.m.

Mrs. Evelyn Black, a home economist with many years of commercial experience in the clothing field, will be the instructor. Mrs. Black was recently chairman of the committee Expanding Job Potentials for Women sponsored by the Job Development Authority.

Enrollment will be limited to 15; therefore, prompt registration is necessary. A registration fee of $5.00 plus a materials fee of $3.00 will be charged.

To register or obtain further information, call Carl Clum, Director of Adult Education, at the school telephone number WH3-0001.

		Agents	Aides & Leaders
	Meat Identification Charts. Notebook size (8 1/2 x 11"). 1¢. Wall-size (25x 33"). 20¢.	X	
	"Beef...From Store To Table" filmstrip $2.00. 75 frames.	X	

NATIONAL DAIRY COUNCIL

If you live in a city where there is an affiliated Dairy Council Unit, requests for material should be directed to that office. If you are not served locally, send orders to National Dairy Council, 111 North Canal Street, Chicago, Ill. 60606.

B-26	A Source Book On Food Practices. 15¢.	X	
B-77	How Your Body Uses Food. 25¢.	X	X
B-60	Your Guide To Good Eating And How To Use It. 15¢.	X	
B-310	Feeding Little Folks. 15¢.	X	X
B-5	Food Before Six. 10¢.	X	
B-76	Guide to Good Eating (8 1/2" x11"). 4¢.		X
B-164	Guide to Good Eating (4x6"). 1¢. (In Spanish - B-164S)		X

Visuals

B-43-A	Comparison Cards for Adults. $2.50 per set.	X	X
B-12	Food Models. $3.00 per set.	X	
G-100	Display for Food Models. $1.50.	X	
F-9	"Feeding Your Young Children" filmstrip and guide. 60 frames. $2.00.	X	
F-6	"How Food Becomes You" filmstrip and guide. 56 frames. $2.00.	X	

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	Agents	Aides & Leaders
HEW		
Copies of publications from the U.S. Department of Health, Education and Welfare may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. On orders of 100 or more copies of any one publication sent to one address, a 25 percent discount is given. Copies of some publications may be obtained free by writing to the Office of Child Development, Distribution Section, Room G-024, South Building, HEW, Washington, D.C. 20201.		
No. 30 Your Child From One to Six. 20¢		X
OTHERS		
How To Be A Better Shopper, Consumer Relations Dept., Sperry & Hutchinson Company, 3003 East Kemper Road, Cincinnati, Ohio 45241		X
It's On The Label, Home Economics Dept., National Canners Association, 1133 20th St., N.W., Washington, D.C. 20036.	X	
New Treasury of Yeast Baking, Fleischmann's Educational Services, Box 2695, Grand Central Station, New York, N.Y. 10017.	X	
"Vegetable Treasure" filmstrip kit. Includes filmstrip, narration guide, worksheets for students, and two wall charts. $2.50. Order from Green Giant Company, Office Services Building, Le Sueur, Minn. 56058.	X	

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	Agents	Aides & Leaders
Budget Saving Recipes, The Quaker Oats Company, Chicago, Ill. 60654.	X	X

Recommended references

For trainer agents

Each lesson includes a list of recommended reference books and publications for trainer agents to use in preparing the 15 lessons. The following is a listing of the references recommended for agents' use. These items have a star (*) beside them. Additional references are also suggested. Make sure you have the references you need to do a good job.

Nutrition

*Food and Man, Lowenberg, M.E. and others, John Wiley and Sons, Inc., 605 3rd Ave., New York, N.Y. 10016. 1968. $7.95.

*Principles of Nutrition, Wilson, Eva D. and others, John Wiley and Sons, Inc., 605 3rd Ave., New York, N.Y. 10016. 1965. $8.50.

Eat to Live, Wheat Flour Institute, 14 E. Jackson Blvd., Chicago, Ill., 60604. 1969. $1.00.

Nutrition Science and You, Mickelsen, Olaf, National Education Association, Publication Sales Division, 1201 16th St., N.W. Washington, D.C. 20036. 1964. $0.50.

Nutrition in Action, Martin, E.A., Holt, Rinehart & Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. 1965. $7.95.

Fundamentals of Normal Nutrition, Robinson, Corinne H., Macmillan Co., 866 3rd Ave., New York, N.Y. 10022. 1968. $7.95.

Introduction to Nutrition, Fleck, Henrietta and Munves, Elizabeth, Macmillan Co., 866 3rd Ave., New York, N.Y. 10022. 1962. $7.50.

Food Becomes You, Leverton, Ruth, Dolphin Books, Doubleday Co., Inc., 501 Franklin Ave., Garden City, N.J. 11530. 1961. $0.95. Hardcover edition: Iowa State Press, Ames, Iowa 50012. 1965. $4.95.

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Nutrition Teaching

*Learning Better Nutrition: A Second Study of Approaches and Techniques, Ritchie, Jean A.S., FAO, Unipub, Inc., P.O. Box 433, New York, N.Y. 10016. 1967. $4.00.

Nutrition in Action. Martin, E.A., Holt, Rinehart & Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. 1965. Teacher's Guide. $6.50.

Teaching Nutrition, Eppright, E. and others, Iowa State Press, Ames, Iowa 50012. 1963. $4.95.

Nutrition Handbook for Family Food Counseling, National Dairy Council, 111 North Canal St., Chicago, Ill. 60606. 30¢.

Feeding Young Children

*Feeding Your Baby and Child, Spock, Benjamin and Lowenberg, Miriam, Pocketbooks, Inc. 1967. 75¢. Order from Simon and Schuster Publishers, 110 39th St., New York, N.Y. 10018.

Office of Child Development, U.S. Department of Health, Education and Welfare publications. Obtain free from State or County public health department OR Office of Child Development, Distribution Section, Rm. G-024, South Building, HEW, Washington, D.C. 20201.

Purchase from Superintendent of Documents, U.S.Government Printing Office, Washington, D.C. 20402.

Food Your Children Need (#14). (10¢).
Prenatal Care (#4). (20¢).
When Your Baby Is On The Way (#391). (15¢).
Mientras Su Bebe esta en Camino (#391). (15¢).
Infant Care (#8). (20¢).
Your Baby's First Year (#400). (15¢).
El Primo Ano de Vida de Su Bebe (#400). (15¢).
Your Child From 1 to 3 (#413). (20¢).
Su Hijo de 1 A 3 (#413). (20¢).
Your Child from 3 to 4 (#446). (25¢).
Your Child from 1 to 6 (#30). (20¢).
Your Child from 6 to 12 (#324). (25¢).

Food Preparation

*Handbook of Food Preparation, American Home Economics Association, 1600 Twentieth St., N.W. Washington, D.C. 20009. Rev. 1964. $1.00.

USDA publications for the consumer. Examples: Poultry in Family Meals, G-110, and Eggs in Family Meals, G-103, USDA. Order through your State distribution officer.

Our Daily Bread, Educational Services, Fleischmann's, Box 2695, Grand Central Station, New York, N.Y. 10017.

Conserving the Nutritive Value in Foods, G-90; Storing Perishable Foods In The Home, G-78, USDA. Order from your State distribution officer.

Let's Cook Fish, Bureau of Commercial Fisheries, P.O. Box 128, College Park, Md. 20740. $0.60.

Experimental Study of Foods, Griswold, Ruth M., Houghton Mifflin Co., 2 Park St., Boston, Mass. 02107. 1962. $8.95.

Meal Planning

*Meal Management, Kinder, Faye, Macmillan Co., 866 3rd Ave., New York, N.Y. 10022. 1968. $7.95.

Eat A Good Breakfast To Start A Good Day, L-268, USDA. Crder from State publication distribution officer.

Meal Planning Guide, Pet Inc., 400 S. 4th Street, St. Louis, Missouri 63166.

Selecting and Buying Food

*Money Management - Your Food Dollar, Money Management Institute, Household Finance Corporation, Prudential Plaza, Chicago, Ill. 60601. Reprinted 1968. 25¢.

*Food, Yearbook of Agriculture, 1959. ($3.25) and Consumers All, Yearbook of Agriculture, 1965. ($2.75), and Food For Us All, Yearbook of Agriculture, 1969, ($3.50), USDA, Supt. of Documents, Government Printing Office, Washington, D.C. 20402.

14521

How To Buy Series. One-page flyers describe use of USDA grades in buying food. Subjects include buying and storing information on poultry, nonfat dry milk, beef roasts, fresh vegetables, fresh fruits, cheese, eggs, and other foods.

Miscellaneous

*Composition of Foods, Agricultural Handbook No. 8, USDA, Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. $1.50.

Comparison Cards - Teenagers, National Dairy Council, 111 North Canal St., Chicago, Ill., 60606. $2.50 per set.

Visuals

"The Real You" filmstrip. 85 frames. (Nutrition for teenagers.) "The Power of Food" filmstrip. 75 frames. (Nutrition for elementary school age children.) In color. $2.00 each. National Live Stock and Meat Board, 36 South Wabash Avenue, Chicago, Ill., 60603.

"Breakfast and The Bright Life" filmstrip. Cereal Institute, Inc., 135 South LaSalle St., Chicago, Ill. 60603.

"Your Food--Chance or Choice?" Color filmstrip. 106 frames. $5.00. National Dairy Council, 111 North Canal Street, Chicago, Ill. 60606.

"How Hamburger Turns Into You." Film. Rent or purchase from Hank Newenhouse, Inc., 1825 Willow Road, Northfield, Ill. 60093.

USDA slide sets--order from Photography Division, Office of Information, USDA, Washington, D.C. 20250.

"Food Value Stretchers", C-152. 50 frames. 1968. Color. $8.00.

"The Basic 4 Way to Good Meals", C-158. (No. 1 of a series. Subject-milk cookery) 50 frames. 1969. Color. $8.00

14521

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USDA Filmstrips--Order from Photo Lab Inc., 3825 Georgia Avenue, N.W., Washington, D.C. 20011.

"Food Value Stretchers", C-152. 50 frames. 1968. Color. $5.50.

"The Basic 4 Way to Good Meals", C-158. (No. 1 of a series. Subject-milk cookery.) 50 frames, 1969. Color. $5.50.

14523

Lesson 1: FOOD MAKES THE DIFFERENCE

PURPOSE

Trainer agent to help aides:

1. Understand how food affects the way a person feels, looks, and acts.

2. Understand factors that affect the food a person eats.

3. Learn to write a 24-hour dietary recall.

PRESENTATION

. Discuss the meaning of food.

Write the word "food" on the board. Have each aide write down five words (adjectives or nouns) that describe food. Discuss the different meanings of food. Divide words into "negative" and "positive" connotations.

The fact that food means something different to each person is related to a difference in values.

. Discuss the social, psychological, and physiological aspects of food.

-- Food satisfies hunger and other needs.

-- An adequate diet helps us resist disease.

-- Food gives us energy and strength.

-- Food affects mental performance.

-- Food is a part of social functions.

-- Food is used to express feelings, relieve tension.

-- Food is sometimes used as a bribe.

-- Food is used to express creativity.

14524

- Write twenty-four hour dietary recall.

  Have each aide write down the foods she ate in the last 24-hour period, including all meals and snacks. Use standard dietary recall method (See Lesson 15).

  (Trainer agent will later summarize 24-hour recall of aides as basis for understanding their food habits. This information should be compared with findings from a second 24-hour dietary recall at end of initial training.)

- Discuss how food affects the way a person grows, feels, looks, and acts. Show "How Food Affects You" slide set.

  --Food affects growth, bones, teeth, muscles, nerves, blood, skin, and eyes.

  --Nutrients are substances necessary for life. Food is made up of many nutrients.

  --Nutrition is the food you eat and how your body uses it.

  --Nutrition is not the only factor that influences health.

- Introduce "How Food Affects You" flipchart to aide.

APPLICATION OF LESSON BY AIDES

This lesson is an introduction to a series of background nutrition lessons set up primarily for the aide's information.

The lesson is designed to help aides understand the different attitudes towards food that they will encounter in their work.

The lesson introduces aides to the 24-hour dietary recall which they will be taking from homemakers.

14525

FLYER FOR COURSE PROMOTION

$

NEED MONEY - EARN MONEY

Alter clothes for a department store
Sew in a specialty shop
Establish own alteration shop

IF YOU CAN

Use a sewing machine
Use a commercial pattern
Put a dress together
Apply a set-in sleeve
Sew on a collar
Hem a garment

COME

Centerville Central School
Classes begin September 24 for 14 weeks
Tuesdays and Thursdays, 7-10 p.m.
Fee $5. plus $3. for materials

For Information Call: WH3-0001 between 9 a.m. - 3 p.m.

1451 1450

REFEPENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, USDA, pp. 631-635.

2. A Source Book on Food Practices, National Dairy Council.

3. Principles of Nutrition, Wilson, Fisher, and Fugua, pp. 7-10.

4. Learning Better Nutrition, FAO, pp. 28-30.

5. Food and Man, Lowenberg et al, pp. 85-124.

VISUALS AND EQUIPMENT

"How Food Affects You", USDA slide set and flipchart,

Projector and screen.

Magazine pictures of children, teenagers, and adults, that show examples of the effects of good and bad nutrition, could be displayed to illustrate how food affects people.

REFERENCES FOR AIDES

Eat To Live Better, PA-694, USDA.

EVALUATION

Do aides understand 24-hour dietary recall? Compare this information with recall taken with Lesson 15.

IDEAS FOR SUPPLEMENTAL LESSONS

-- Cultural food patterns

-- Evaluating cultural food patterns

-- Superstitions about foods

-- Dietary recall

14526

Lesson 2: DAILY FOOD GUIDE

PURPOSE

Trainer agent to help aides:

1. Understand Daily Food Guide and how to use it.

2. Learn that all persons need foods from the four groups but in varying amounts.

3. Learn to evaluate food intakes.

PRESENTATION

- Give a quiz to determine nutrition knowledge of the aides. (See quiz, pp. 22-24.)

- Discuss the fact that no one food contains all the nutrients we need--a variety of foods is necessary.

- Explain the Daily Food Guide, using a mounted Daily Food Guide, flannelboard and food models.

  -- As each food group is discussed, have aides name foods in that group. Using the food models, place these on the flannelboard.

  -- Rearrange foods on the flannelboard to show the number of servings of each food group required daily. Discuss serving sizes. Actual portions of food could be shown. For example, a "glass" of milk using various size cups.

  -- Fats, salad dressings, etc., are "other" foods, not mentioned in the Daily Food Guide.

  -- Hand out notebook-size Daily Food Guide. Stress that this is easy method to help people plan meals so that everything the body needs is included.

14527

- Evaluate 24-hour dietary recall taken previously. Using Daily Food Guide, ask aides how they rated on the basis of:

  One serving from each food group.

  Recommended number of servings from each food group.

- Have available magazine pictures of various foods. Aides will group these into the four food groups. Place them on flannelboard and review each food group.

- Have aides role-play using the Daily Food Guide in a teaching situation.

- Review Eat To Live Better bulletin. Hand out Nutrition--Food at Work for You and briefly discuss.

APPLICATION OF LESSON BY AIDES

- Aides understand how to use the Daily Food Guide with homemakers.

- Aides may wish to make their own version of the Daily Food Guide using local foods. For example, a file folder can be divided into four parts. Magazine pictures of foods from the four food groups can then be placed in the appropriate sections for use in discussions with homemakers.

REFERENCES FOR TRAINER AGENT

1. Food for Fitness, L-424, USDA.

2. Your Guide to Good Eating and How to Use It, National Dairy Council.

3. Nutrition-Food at Work for You, GS-1, USDA.

VISUALS AND EQUIPMENT

Mounted poster-size Daily Food Guide (C&MS-23).

Flannel or magnetic board.

Food Models (National Dairy Council).

Pictures of food.

14527

14528

REFERENCES FOR AIDES

1. Daily Food Guide, C&MS-23, USDA.

2. Eat to Live Better, PA-694, USDA

3. Nutrition--Food at Work for You, GS-1, USDA.

EVALUATION

Observe aides using the Daily Food Guide in a teaching situation.

IDEAS FOR SUPPLEMENTAL LESSONS

Serving sizes

Food standards

14529

Lesson 2

NUTRITION QUIZ

Some statements about nutrition are given below. Please show whether or not you think each statement is correct or false. Circle "T" for true and "F" for false. If you don't understand a statement, ask your Trainer Agent about it. If you are completely unsure of the answer, circle both "T" and "F".

	True or False
1. Good eating habits are important to health.	T F
2. In a family, including a father, mother, 16-year old son and an 18-year old daughter, the father should have the largest serving of meat.	T F
3. Protein-rich foods, such as meat, milk and eggs, provide liberal amounts of several nutrients needed for the growth of small children.	T F
4. It is better not to include orange juice and milk in the same meal because orange juice causes the milk to curdle in the stomach.	T F
5. By the end of the first year, babies should have learned to use a variety of foods besides milk, as a milk diet may not allow for total growth and development.	T F
6. School age children need vitamin pills to ensure good health.	T F
7. The term "well-balanced" when applied to a day's diet means that all of the food groups in the daily plan are included in amounts recommended.	T F
8. A serious vitamin deficiency may affect many parts of the body.	T F
9. When children have enough food to satisfy their appetites, their diets are certain to be nutritionally adequate.	T F

14258

14530

10. A good nutritional practice is to eat a variety of foods each day. T F

11. Eggs can completely replace milk in the diet so far as nutrients are concerned. T F

12. Carbonated beverages are a desirable food for young children. T F

13. Skim milk contains the same amounts of body building minerals and protein as whole milk. T F

14. No reducing diet should contain bread or potatoes. T F

15. Most fat children and overweight adults have a glandular disturbance. T F

16. Milk is a food mainly for infants and growing children. T F

17. Apples are an excellent source of Vitamin C. T F

18. Foods that taste sour are generally not good for people. T F

19. Foods enriched with Vitamin D can help in the normal development of bones and the prevention of rickets. T F

20. All people should use a low-fat, low cholesterol diet to prevent heart disease and strokes. T F

21. If a person eats regular meals, he should be rated as having good food habits. T F

22. A "well-balanced" meal is one that is not too starchy or too fat. T F

23. The greater the percentage of polyunsaturated fats in a food, the greater the health-giving properties of that food. T F

24. The four groups of foods in the daily food guide are Dairy Foods, Meats, Citrus Fruits, and Cereals. T F

14531

25. Healthy, active, young children require some concentrated sweets in their diet each day for energy needs. T F

This material is based on a test developed by the Department of Food and Nutrition, Iowa State University, Ames, Iowa.

14531

14532

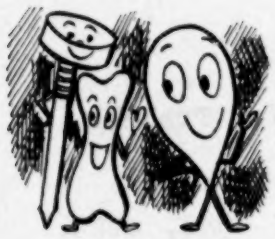

Lesson 3: KEY NUTRIENTS

PURPOSE

Trainer agent to help aides:

1. Define nutrients.
2. Understand the relationship of nutrients to health.
3. Become familiar with important food sources of the key nutrients.

PRESENTATION

- Explain the meaning of nutrients.
- Review the leaflet, Key Nutrients.
- Show flip chart and selected slides from "How Food Affects You" slide series.
- Give an over-all view of how nutrients relate to four food groups:
  - what does each nutrient do in the body?
  - what are good food sources of the nutrients?
  - what amounts of each food are needed to supply recommended nutrients?
- Have aides use food models or pictures to illustrate good food sources of each nutrient.

APPLICATION OF LESSON BY AIDES

Reproduce page 8, titled "What Good Foods Can Do For Us", from the leaflet Food for Families. Explain to aide how she can use this in teaching situations.

Show aides how they can relate nutrients to foods when they talk with homemakers.

14533

REFERENCES FOR TRAINER AGENT

1. Food for Families, Suggestions for Trainer Agent, PA-743, USDA.

2. Nutrition--Food at Work for You, GS-1, USDA.

VISUALS AND EQUIPMENT

Flannel board, food models, and pictures.

"How Food Affects You" slide series and flip chart, USDA.

Slide projector and screen.

REFERENCES FOR AIDES

Key Nutrients, PA-691, USDA.

EVALUATION

Use pictures of nutrients from How Food Affects You flip chart and have aides match to food pictures.

IDEAS FOR SUPPLEMENTAL LESSONS

Protein, carbohydrates, fats and water

Calcium and iron

Vitamins

14233

14534

Lesson 4: FOODS CONTAIN DIFFERENT AMOUNTS OF NUTRIENTS

PURPOSE

Trainer agent to help aides:

1. Learn that many nutrients are necessary to meet needs of the body.

2. Understand that nutritive values are different for each food.

3. Realize that nutrients for body needs are easy to obtain when a variety of foods are eaten.

PRESENTATION

- Use Comparison Cards for Adults (National Dairy Council) to show the differences in nutrient value of various foods.

- Comparison cards show the percentage of the daily requirement for key nutrients that various foods provide. Have aides divide cards into the four food groups and select foods and combinations of foods that will meet 100 percent of the daily requirement for that nutrient.

- Using comparison cards, show sources of protein, Vitamins A and C, calcium, and iron. For example, note the protein in meat, milk, breads, and cereals. The following question may be used to involve aides in the discussion: "If I needed to get more Vitamin A and ascorbic acid in my diet, which vegetable would be the best choice—green beans, potato or sweet potato?"

- Discuss other references containing information on nutritive value of foods. For example - Nutritive Value of Foods.

14536

14535

APPENDIX D

GUIDE SHEET FOR BURNING TEST†

Name_____ Date_____

Materials Required

- Matches
- Candle (food warmer)
- Small aluminum pie tin
- Strip of aluminum foil
- Tweezers
- Packet of fabric samples
- Information Sheet - Burning Fiber Characteristics

Directions

(1) Place all the equipment on the strip of aluminum foil.
(2) Place the candle in the small pie tin.
(3) Light the candle and using the tweezers, hold each fabric sample in the flame.
(4) Observe and record in the appropriate places the appearance of the flame, the odor, and the ash of each fabric.
(5) Identify each sample by comparing the recorded observations with the data given in the Information Sheet - Burning Fiber Characteristics.

FABRIC NUMBER AND DESCRIPTION	APPEARANCE OF FLAME	ODOR	ASH	YOUR IDENTIFICATION OF THE FIBER

† Adapted from Cozine, June, & others. *A pilot study for gainful employment in home economics.* Washington, D. C. U.S. Government Printing Office. 1968.

1451

APPLICATION OF LESSON BY AIDES

Aides understand how to use comparison cards in teaching situations to illustrate that foods contain different amounts of nutrients.

REFERENCES FOR TRAINER AGENT

1. Eat to Live Better, PA-694, USDA.
2. Nutritive Value of Foods, G-72, USDA.
3. Composition of Foods, Handbook No. 8, USDA.
4. Food For Us All, Yearbook of Agriculture, 1969, pp. 315-318, USDA.

VISUALS

Comparison Cards for Adults and Teaching Guide (National Dairy Council).

REFERENCE FOR AIDES

Comparison Cards for Adults (National Dairy Council).

EVALUATION

Observe aides' ability to solve the following problems:

1. Can cottage cheese take the place of milk? Can ice cream? What role do these foods play in menus?
2. If I want to serve eggs or cheese as an alternate for meat, how many eggs or how much cheese should I substitute for one serving of meat?
3. Why should an iron-rich food be included in the day's menu if cheese is used as a main dish?

IDEAS FOR SUPPLEMENTAL LESSONS

Meat and meat substitutes as sources of protein.

Fruits and vegetables rich in vitamins and minerals.

Breads and cereals for energy foods.

Dairy foods supply calcium, protein, and riboflavin.

14235

14536

Lesson 5: HOW YOUR BODY USES FOOD

PURPOSE

Trainer agent to help aides:

1. Review and gain additional knowledge of how the body uses food for energy, growth, maintenance, and repair of body cells.

2. Understand that all foods can be classified as protein, carbohydrates, or fat.

PRESENTATION

- Show the first 40 frames of "How Food Becomes You" filmstrip.

- Review and summarize all lessons covered previously, placing emphasis on the relationship of food to a healthy body.

- List and discuss how the body uses:

  - protein foods to build and repair the cells of the body.

  - carbohydrate foods for energy to live, work and play. Compare number of calories used in various activities; such as sleeping, eating, walking, and others.

  - fats for heat and energy.

  - minerals for formation of bones, teeth and many other functions.

  - vitamins for growth, to prevent disease, and to keep the body functioning properly.

  - water to regulate body temperature and to carry nutrients to cells.

14537

- Show that all foods may be classified as protein, carbohydrates, and fats and all supply energy in varying amounts. Vitamins, minerals, and water are found in combinations in these classes of food.

- Energy is expressed in terms of calories. Use Comparison Cards to show calories and nutrients in foods.

APPLICATION OF LESSON BY AIDES

This lesson is designed as background information for aides so that they can help homemakers understand the importance of eating a wide variety of foods.

REFERENCES FOR TRAINER AGENT

1. How Your Body Uses Food, National Dairy Council.

2. Food and Your Weight, G-74, USDA.

3. Calories and Weight, G-153, USDA.

VISUALS AND EQUIPMENT

"How Food Becomes You" filmstrip, National Dairy Council.

Comparison Cards For Adults, National Dairy Council.

Projector and screen.

REFERENCES FOR AIDES

How Your Body Uses Food, National Dairy Council.

EVALUATION

Have aides respond orally to questions taken from main points covered in first five lessons.

IDEAS FOR SUPPLEMENTAL LESSONS

Digestion and absorption of food in the body.

14237

14538

Lesson 6: FOOD NEEDS THROUGHOUT LIFE

PURPOSE

Trainer agent to help aides:

1. Understand that throughout life the same nutrients are needed but differences in age, activity, size, and stages of growth affect the amounts needed.

2. Know the food needs of people at different stages in life.

3. Understand that individual food needs vary.

PRESENTATION

- Show pictures illustrating people in the different stages of life. Ask aides to tell what foods they believe adult men and women, pregnant women, children at various ages, and older folks need.

- Use Daily Food Guide and discuss changes in food required for different activities and stages of growth:

  -- Adult men and women
  Amounts of foods recommended by the Daily Food Guide plus added foods for energy needs.

  -- Pregnant women
  Amounts of foods recommended by the Daily Food Guide plus additional milk and selection of additional foods from the four food groups. Additional calories are needed only in the second half of pregnancy.

  -- Children
  The foods recommended in the Daily Food Guide but smaller servings. Additional foods from the four food groups if needed for energy.

  -- Teenagers
  The foods recommended in the Daily Food Guide plus additional milk and additional foods from the four food groups to meet energy needs.

14540

14539

-- Older folks

The foods recommended in the Daily Food Guide. Fewer additional calories because activity is less.

REFERENCES FOR TRAINER AGENT

1. Food For Us All, Yearbook of Agriculture, 1969, "A Food Guide for the Ages, From Baby to Gramps," pp. 294-303, USDA.

2. Daily Food Guide, C&MS-23, USDA.

VISUALS AND EQUIPMENT

Flannelboard and blackboard or newsprint.

Pictures of persons at various stages in life.

Descriptions of people at various stages in life, written on slips of paper.

REFERENCES FOR AIDES

Food For Fitness, L-424, USDA.

EVALUATION

Trainer agent provides slips of paper describing people of different ages, body sizes, and activities. Aides are asked to draw a slip and give the food needs of that person.

IDEAS FOR SUPPLEMENTAL LESSONS

Food Needs At Different Ages

the infant and preschool child
the school age child
the teenager
the pregnant and nursing woman
older folks
other special food problems

14540

14539

Lesson 7: FEEDING YOUNG CHILDREN

PURPOSE

Trainer agent to help aides:

1. Understand that most food habits are formed during childhood.

2. Understand the relation of nutrition to growth and development of the child.

3. Encourage parents to help children develop desirable food habits.

PRESENTATION

- Show "Feeding Your Young Children" filmstrip.

- Review important points on blackboard or sheet of newsprint.

  -- Importance of food for growth and development

  All nutrients are in food.
  No food contains all nutrients.

  -- Characteristics of a well-nourished child.

  Body build and growth rate.
  Hunger and appetite.
  Desirable weight.

  -- Developing good food habits.

  Experiences with the wide variety of foods.
  Providing favorable conditions.
  Positive attitude of parents.
  Coping with eating problems.

- Introduce Feeding Young Children bulletin. Discuss content. Also introduce and discuss Your Child From One to Six, Feeding Little Folks and Food Before Six.

14541

- Acquaint aides with local resources that offer related services to children and parents. For example, school feeding programs, baby clinics, children and youth projects, crippled children's clinics, etc.

APPLICATION OF LESSON BY AIDES

Have aides share and discuss ways they see they could use this information in working with parents to help children develop desirable eating habits.

REFERENCES FOR TRAINER AGENT

1. Feeding Young Children, PA-693, USDA.

2. Folders available from local health department or Office of Child Development, U.S. Department of Health, Education and Welfare. For example: Your Child from One to Six - No. 30.

3. Feeding Little Folks and Food Before Six, National Dairy Council.

4. Feeding Your Baby and Child, Spock and Lowenberg, Chapter VI, "Setting the Stage for Children's Eating."

5. Food for the Family with Young Children, G-5, USDA.

VISUALS AND EQUIPMENT

"Feeding Your Young Children" filmstrip, National Dairy Council.

Listing of local resources.

Blackboard or newsprint.

Projector and screen.

REFERENCES FOR AIDES

1. Feeding Young Children, PA-693, USDA

2. Feeding Little Folks, National Dairy Council.

14541

14542

EVALUATION

Observe aides' attitude toward several of the following statements:

"Carrots will make you pretty." (False Reason)

"If you don't eat your egg, you can't have dessert." (Threat)

"A bite of food you like after the new foods helps." (Suggestion)

"You're getting along fine without any help." (Independence)

IDEAS FOR SUPPLEMENTAL LESSONS

Introducing new foods.
Kind and amount of food a child needs at different ages.
Coping with eating problems.

14543

Lesson 8: PLAN MEALS TO MEET FAMILY FOOD NEEDS

PURPOSE

Trainer agent to help aides:

1. Obtain an overview of planning food for family meals and snacks.

2. Appreciate the value of advanced planning.

PRESENTATION

- Introduce lesson by placing food models for a day's meals and snacks on a flannelboard. These meals may or may not be adequate. Have aides separate foods into the four food groups. If the meals do not meet the recommendations of the Daily Food Guide, ask the aides to suggest foods to add so that the day's intake in each of the four food groups is complete.

- Discuss the importance of eating a variety of foods spaced throughout the day in meals and snacks. There are physiological benefits. For example: breakfast eaters have been shown to be more alert, steadier, and more productive in the late morning hours than breakfast skippers.

- Discuss different patterns of eating. There are different patterns of eating that help us distribute the nutrients we need throughout the day. These patterns are only a guide and can be adjusted to suit different family situations. An example can be illustrated with food models on flannelboard.

Breakfast:	Fruit or juice, bread or cereal, milk, beverage.
Lunch:	Main dish, vegetable or fruit, bread, milk (a good time for adults to get milk).
Dinner:	Main dish, two vegetables, bread, beverage, dessert (fruit makes a good dessert).

14543

14544

- Snacks should help us meet our daily needs for nutrients.
  - -- Show how food in the three meal a day pattern can also be used as snacks.
  - -- Show how teenagers can get adequate servings from the milk group in snacks.
  - -- Choose snacks from the Daily Food Guide. Compare the food value in empty calorie snacks (candy and carbonated drinks) and nutritious snacks (fruit, milk, fruit juices.) Use Comparison Cards.
- Introduce and discuss Meal Planning Made Easy leaflet.
- Discuss value of advanced planning for food for the family.
  - -- Can help save time and money.
  - -- Makes it easier to follow the Daily Food Guide.
  - -- Makes it easier to provide variety in family meals and snacks.
- Discuss points to consider when planning meals.
  - -- Suit planning to your situation.
  - -- Have tools available to help -- paper, pencils, Daily Food Guide, meal patterns.
  - -- Plan food for a day as a unit.
  - -- Consider age and activity of family members.
  - -- Plan for color, texture, shape, and flavor. This will add interest to meals. Illustrate with actual foods or pictures.

APPLICATION OF LESSON BY AIDES

Aides understand how to use information in teaching situations and in own family meal planning.

14545

INFORMATION SHEET - BURNING FIBER CHARACTERISTICS			
FIBER	FLAME	ODOR	ASH
ACETATE	Flames quickly; material puckers, sputters, melts; drips like tar	Acid, like vinegar	Brittle black ash, difficult to crush with fingers
ARNEL	Flames quickly; sputters, melts; drips like tar	Acid, like vinegar	Like acetate
COTTON	Large yellow flame; burns quickly, leaves creeping ember	Like burned paper	Light, feathery, grayish ash; black ash denotes mercerized cotton
CRESLAN	Melts	Acrid	Hardens
DACRON FORTEL KODEL VYCRON	Melts before burning; burns slowly	Slightly sweetish, aromatic	Brittle, beady ash, creamy in color
DARVAN	Melts and burns		Hard black bead
DYNEL	Shrinks; will not support combustion	Disagreeable	Hardens; becomes brittle
FIBERGLASS	Will not burn; melts at temperature over 1,500° F.		Melts
LINEN	Like cotton; sometimes burns slower if yarn is heavier, leaves creeping ember	Like burned paper	Like cotton; sometimes heavier if yarn is thicker
METALLICS	Only other fibers in fabric burn		Metal ribbons
NYLON	Melts, shrinks from flame; bubbles as it burns	Pungent acrid odor	Hard round amber beads, cannot be crushed

†Adapted from Cozine, June, & others. *A pilot study for gainful employment in home economics.* Washington, D. C. U.S. Government Printing Office. 1968.

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REFERENCES FOR TRAINER AGENT

1. Food, Yearbook of Agriculture, 1959, pp. 510-518, USDA.

2. Food For Us All, Yearbook of Agriculture, 1969, pp. 279-293, USDA.

3. Meal Management, Kinder, pp. 223-336.

VISUALS AND EQUIPMENT

Food models (National Dairy Council).

Flannelboard.

Pictures or actual foods to illustrate ways of getting variety in meals.

Comparison Cards for Adults (National Dairy Council).

Daily Food Guide poster, C&MS-23, USDA.

REFERENCES FOR AIDES

Meal Planning Made Easy, PA-695, USDA.

Guide To Good Eating, National Dairy Council.

EVALUATION

Have each aide plan meals for her family for one day using the Daily Food Guide and meal patterns which are best for her situation.

IDEAS FOR SUPPLEMENTAL LESSONS

It's what you eat - not how or when.

Snacks as a part of your day's food plan.

Meal planning for young children.

Meal planning when a baby's on the way.

Meal planning when there's a calorie counter in the family.

Meal planning when older folks are with you.

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Lesson 9: GET MORE FOR THE FOOD DOLLAR

PURPOSE

Trainer agent to help aides:

1. Identify factors that influence food selection.
2. Learn the value of making shopping lists.
3. To learn how to keep simple food record costs and make use of this information.

PRESENTATION

. Discuss factors that influence food selection.

-- Money available.
-- Size, age, and activities of family members.
-- Storage and equipment.
-- Food likes and dislikes.
-- Season and locality.
-- Special diets.
-- Time for preparation.
-- Availability of stores in which to shop.

. Show "Selecting and Buying Food for the Young Family" slide series. As the slides are shown, look for some of these points.

-- Needs of different family members.
-- Steps in making a shopping list.
-- Ways to save money in shopping.
-- Ways to store food.
-- Family values.

. Discuss slide set.

-- What factors determine the food needs of different family members?

Sex
Activities
Age

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-- What steps were suggested for making a shopping list?

Think through meals to be prepared.
Check what is on hand.
Plan around the four food groups.

-- What ways were suggested for saving time?

Consider convenience foods.
Plan ahead.
Shop when store is not crowded.

-- What ways were suggested for saving money? Add ideas you have used.

Check newspaper ads.
Separate food from nonfood items.
Avoid impulse buying.
Consider specials.
Check price per serving.
Consider convenience foods.

-- How was it suggested that foods should be stored?

Frozen foods and ice cream -- in freezer if possible.
Meat and poultry -- loosely wrapped and put in coldest part of refrigerator.
Sugar, flour, rice, dry milk -- use canisters, cans, or jars with tight fitting lids to keep foods dry and free from insects.

. Discuss food cost records.

-- Ask aides how much money they think they spend for food.
-- Ask aides how they know how much money they spend.
-- Discuss ways shoppers can know how much money they spend for food.

Keep shopping list and cash register receipts. (Deduct nonfood items)
Allotment of certain amount of income for food.
From total money spent for food, subtract 25 percent for nonfood items.

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-- Discuss value of food cost record and how it can be used to get more for the food dollar.

. Introduce Family Fare bulletin. Discuss contents and use.

. Summarize lesson:

-- Selecting and buying food to nourish the family adequately for good health at a price she can afford is a big challenge for any homemaker. Keeping a record of money spent for food is a good starting point for studying food buying practices.

APPLICATION OF LESSON BY AIDES

Aide will use this knowledge in obtaining information for the Family Record - Part 2, and to help homemakers get more for their food dollar.

Improve food buying practices.

REFERENCES FOR TRAINER AGENT

1. Consumers All, Yearbook of Agriculture, 1965, pp. 416-423, USDA.

2. Family Fare, G-1, USDA.

3. Food for Us All, Yearbook of Agriculture, 1969, pp. 279-293, USDA.

4. Money Management - Your Food Dollar, Household Finance Corporation.

VISUALS AND EQUIPMENT

"Selecting and Buying Food for the Young Family" slide series, USDA.

Projector and screen.

Daily Food Guide poster, C&MS-23, USDA.

REFERENCES FOR AIDES

Selecting and Buying Food, PA-696, USDA.

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EVALUATION

Aides keep a food cost record so that it can be analyzed and discussed at a later time.

IDEAS FOR SUPPLEMENTAL LESSONS

Buying and storage of food.
Buying meats.
Buying fruits and vegetables.
Buying dairy products.
Buying cereals.

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Lesson 10: COMPARATIVE FOOD SHOPPING

PURPOSE

Trainer agent to help aides:

1. Become more aware of the way food items are grouped in different stores.

2. Learn how to read labels.

3. Compare cost, form, quality, and nutritive value of foods.

4. Become aware of special services provided by food stores.

PRESENTATION

Divide aides into groups of 2-4 to visit food stores. This can be done on the day before the meeting on Comparative Shopping, or it can precede the meeting. Assign these topics to groups. Ask them to compare cost per unit, cost per serving, form of food available and nutritive value.

-- Cereals - presweetened
cornflakes
highly fortified cereal
oatmeal - instant
old fashioned
quick.

-- Milk - fresh whole, 2% skim, non-fat dry, evaporated.

-- Cheese - mild, sharp, process, process cheese spread.

-- Eggs - size and grade.

-- Ground meat - ground beef
ground round
ground chuck.

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-- Vegetables - fresh, frozen, canned green beans.

- Aides will report on their visits to food stores.

- Trainer agent will bring food advertisements to class for aides to study. Discuss the following:

  Are advertised foods really a bargain?
  Why are some foods advertised as being on special?
  What information is given about specials?
  Where can you find food advertisements?
  What differences or similarities are found among food advertisements?

- Compare quality and cost of food. Examine contents of three different cans of green beans. Compare taste, texture, color. Note broken pieces, amount of liquid, discoloration. Compare cost.

- Discuss and study labels:

  a. Required information
  b. Other information
  c. How to use information on label

- Have aides report on special services found in stores visited. Discuss how stores are arranged for convenience and promotional products.

APPLICATION OF LESSON BY AIDES

Aides use information to help homemakers become better food shoppers.

REFERENCES FOR TRAINER AGENT

1. Consumers All, Yearbook of Agriculture, 1965, pp. 416-440, USDA.

2. Handbook of Food Preparation, pp. 9-20, American Home Economics Association.

3. Family Food Buying Guide, Research Report #37, USDA.

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4. It's on the Label, National Canners Association.

5. Food For Us All, Yearbook of Agriculture, 1969, pp. 45-50, USDA.

VISUALS AND EQUIPMENT

Cans of food, dishes for display.

Labels

Food advertisements

REFERENCES FOR AIDES

How to be a Better Shopper, Sperry and Hutchinson.

Family Fare, G-1, USDA.

EVALUATION

Ask aides to give two examples of good food buys they have made and tell why they were good buys.

IDEAS FOR SUPPLEMENTAL LESSONS

Buying selected food items.
Reading labels.
Tour of markets.
Selecting food for quality.

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Lesson 11: PREPARATION OF MILK AND MILK PRODUCTS

PURPOSE

Trainer agent to help aides:

1. Appreciate the need for milk at all ages.
2. Learn principles of milk cookery.
3. Apply principles in preparation of milk and cheese dishes.

PRESENTATION

- Review the importance of milk.
  - -- Everyone needs milk.
  - -- Children under 9 years of age need 2 to 3 cups a day. Some children do not have the capacity to drink this much. Some of it can be used in cooked foods.
  - -- Teenagers need four or more cups a day.
  - -- Adults of all ages need at least two cups a day. Older folks need milk to supply calcium for bone strength and protein for tissue repair. Milk is easily digested by most people.
  - -- Pregnant women need three or more cups.
  - -- Nursing mothers need four or more cups a day.
- Display different forms of milk and some popular types of cheese. Discuss.

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- Review the principles of milk cookery.

  Use low heat in cooking because milk scorches easily. Milk can be heated satisfactorily over low direct heat or over boiling water. (Demonstrate)

  Natural cheese should be heated at a low temperature to prevent it from getting stringy or tough. (Demonstrate) Processed cheese melts more easily and is less likely to get stringy when heated at high temperatures because an emulsifying agent has been added.

- Discuss storage:

  -- Fresh dairy products are highly perishable. Keep them clean, cold, and tightly covered.

  -- Refrigerate fresh milk, cream, and milk products as soon as possible after purchase. If milk stands in the sunlight, riboflavin is lost and the flavor changes.

  -- The numbers of bacteria increase as milk ages or stands at room temperature. Milk which has been taken from the carton should not be returned to it.

  -- Keep unopened cans of evaporated milk at room temperature or in a cool place. Once opened, refrigerate.

  -- Store cheese covered in the refrigerator. Cheese mold is not harmful.

  -- Store nonfat dry milk in tightly covered containers in a cool place. After dry milk is reconstituted, treat it as fresh milk.

- Demonstrate uses.

  Dry milk can be used in two ways. It may be reconstituted and used as fresh fluid milk or it may be mixed with dry ingredients. Demonstrate both.

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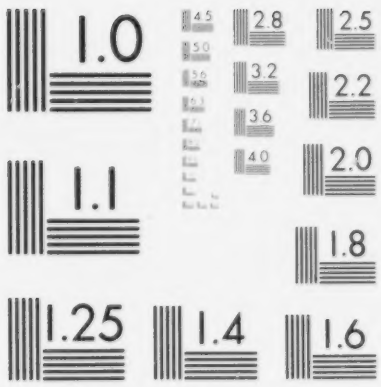

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

List some ways milk and milk products can be used for soup, main dishes, desserts, beverages, and snacks.

Divide aides into small groups and prepare low cost milk and cheese dishes. Plan a meal around these foods.

Demonstrate whipped toppings for desserts made with dry and evaporated milk.

APPLICATION OF LESSON BY AIDES

Aides encourage families to use more milk and milk products.

Aides apply principles of milk cookery in teaching situations.

REFERENCES FOR TRAINER AGENT

1. Food for Us All, Yearbook of Agriculture, 1969, pp. 146-159, USDA.

2. Consumers All, Yearbook of Agriculture, 1965, pp. 437-440, USDA.

3. Milk in Family Meals, G-127, USDA.

4. Cheese in Family Meals, G-112, USDA.

VISUALS AND EQUIPMENT

Food and equipment for demonstration.

REFERENCES FOR AIDES

1. Milk in Family Meals, G-127, USDA.

2. Cheese in Family Meals, G-112, USDA.

EVALUATION

Have aides prepare a list of dishes made with milk or cheese that they could suggest to homemakers.

IDEAS FOR SUPPLEMENTAL LESSONS

Prepare other foods using milk and dairy products.
Discuss further uses of nonfat dry milk.
Prepare milk drinks.

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Lesson 12: PREPARATION OF VEGETABLES AND FRUITS

PURPOSE

Trainer agent to help aides:

1. Review the importance of fruits and vegetables in family meals.

2. Understand and apply the principles of vegetable preparation.

PRESENTATION

. Show place of vegetables and fruits in Daily Food Guide.

-- All fruits and vegetables supply vitamins and minerals but in varying amounts. Use slides 19-29 from "How Food Affects You" slide series to illustrate.

-- Most dark green and deep yellow vegetables are inexpensive sources of Vitamin A. For example: greens, pumpkin, squash, sweet potatoes, and carrots. They are also sources of Vitamin C.

-- Many of them are low in calories. Raw vegetables are a low-calorie between-meal snack.

-- Dry peas and beans are high in protein. This is the reason they are placed in the meat group of the Daily Food Guide.

-- The Daily Food Guide recommends four or more servings of fruits and vegetables per day. Show serving size.

. Discuss principles of vegetable cookery.

-- Suggestions for preparation

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. Wash vegetables before cooking

. Trim and pare thinly to avoid excessive loss of nutrients

. Some vegetables may be cooked in their skins.

-- Basic methods of cookery

. Boiling - To insure the best flavor, color, texture, and food value, cook only until tender. Vegetables cooked in skins retain most nutritive value. To shorten cooking time, cut, slice, dice, or coarsely shred vegetables. Cooking in small amounts of water conserves nutrients.

. Baking - Bake in a hot oven (400-450°) so vegetable cooks in a short time. Moderate oven may be used but longer cooking time is needed.

. Frying - Vegetables may be pan-fried in small amount of fat or cooked in deep fat. Using the correct temperature for frying prevents the absorption of large amounts of fat.

-- Demonstrate the three methods. Discuss the advantages and disadvantages in relation to cost, time, color, flavor, texture, and nutritive value.

-- Have aides list as many ways as possible to prepare several low-cost vegetables such as potatoes, leafy greens, and corn.

-- Show selected frames from "Vegetable Treasure" filmstrip.

APPLICATION OF LESSON BY AIDE

Aides encourage families to use more fruits and vegetables.

Aides apply principles of vegetable cookery in teaching homemakers.

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REFERENCES FOR TRAINER AGENT

1. Food for Us All, Yearbook of Agriculture, 1969, pp. 174-195, USDA.

2. Consumers All, Yearbook of Agriculture, 1965, pp. 454-456, USDA.

3. Vegetables in Family Meals, G-105, USDA.

4. Fruits in Family Meals, G-125, USDA.

VISUALS AND EQUIPMENT

Daily Food Guide poster, C&MS-23, USDA

"How Food Affects You" slide series, USDA.

"Vegetable Treasure" filmstrip, Green Giant Company. (Selected frames)

Projector and screen.

Food and equipment for vegetable preparation.

Comparison cards for adults, National Dairy Council.

REFERENCES FOR AIDES

1. Vegetables in Family Meals, G-105, USDA.

2. Fruits in Family Meals, G-125, USDA.

3. Principles of Cookery, PA-692, USDA.

4. Family Fare, G-1, USDA.

EVALUATION

Have aides try a new vegetable or cooking method and report to the group.

IDEAS FOR SUPPLEMENTAL LESSONS

Making salads with fruits and vegetables.
Preparing vegetable soup.
Cooking vegetables in tempting ways.
Using raw vegetables as snacks.

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Lesson 13: PREPARATION OF MEATS

PURPOSE

Trainer agent to help aides:

1. Review the variety of foods included in the meat group.

2. Learn principles of meat cookery.

PRESENTATION

- Aides review the variety of foods included in the meat group: poultry, fish, eggs, dry beans and peas, peanut butter and meat. (Fat back, salt pork, and bacon are considered fats rather than meat.)

- Review the nutrients of foods included in the meat group.

- Identify the least costly sources of protein. Discuss extending food dollar by using eggs, cheese, milk, cereals, and vegetables.

- Discuss basic meat cooking methods.

  --Roasting
  --Broiling
  --Pan broiling
  --Pan frying
  --Braising
  --Cooking in liquid

- Review factors which affect the method selected: tenderness, size, thickness, amount of bone, desired flavor, available time and cooking facilities.

  Beef - Thick blocky cuts from the rib, loin, and sirloin usually are roasted. Choice grades chuck, round or rump can be oven-roasted. Lower grades make excellent pot roasts. Thin steaks usually are best pan broiled or pan fried; thick steaks are best broiled. Braising

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or cooking in liquid are generally recommended for less tender cuts. Commercial meat tenderizers are best used with meats to be fried or broiled.

Pork - Selection of a cooking method for pork depends on the cut. Pork should be cooked medium or well done. Generally thick cuts are roasted, braised or simmered; thin cuts are pan broiled, pan fried, or braised.

Poultry - Age of the bird usually determines the method selected. Broilers and fryers are usually tender.

Variety meats (liver, kidneys, heart, tongue, and tripe). Type of cooking depends on how tender the particular meat is. These meats are usually cooked well done.

- Demonstrate several methods of cookery using low cost cuts of meat.

- Discuss storage - Fresh meat is highly perishable and must be refrigerated. Cooked meat should be covered, chilled and used as soon as possible.

APPLICATION OF LESSON BY AIDE

Aides use information in talks with and demonstrations for homemakers.

REFERENCES FOR TRAINER AGENT

1. Lessons on Meat, National Live Stock and Meat Board

2. Money Saving Main Dishes, G-43, USDA.

3. Beef and Veal in Family Meals, G-118, USDA.

4. Lamb in Family Meals, G-124, USDA.

5. Pork in Family Meals, G-160, USDA

VISUALS AND EQUIPMENT

Meat Identification Charts, National Live Stock and Meat Board.

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"Beef...From Store to Table" filmstrip, National Live Stock and Meat Board.

Pictures of meat cuts.

Filmstrip projector and screen.

REFERENCES FOR AIDES

1. Beef and Veal in Family Meals, G-118, USDA.

2. Pork in Family Meals, G-160, USDA.

3. Money-Saving Main Dishes, G-43, USDA.

EVALUATION

Show filmstrip or pictures of meat cuts and ask aides to identify and suggest ways of cooking.

Encourage aides to check with homemakers to see if new meat cuts or methods of cookery have been used.

IDEAS FOR SUPPLEMENTAL LESSONS

Cooking variety meats.
Cooking beans, peas and lentils.
Use of peanut butter.
Meat-stretching ideas.

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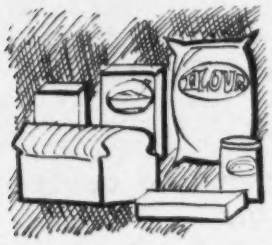

Lesson 14: PREPARATION OF BREADS AND CEREALS

PURPOSE

Trainer agent to help aides:

1. Review the foods in the bread and cereal group.
2. Learn some principles of bread and cereal cookery.
3. Know a variety of ways to prepare breads and cereals.

PRESENTATION

- Describe foods in the bread and cereal group. Illustrate using magazine pictures and flannelboard. Emphasize value of enriched and whole grain breads and cereals.
  - -- Breads can be divided into three general classes: unleavened, those leavened with yeast and those leavened with baking powder. Yeast breads are usually allowed to rise before they are baked whereas the carbon dioxide from doughs made from baking powder is released in the oven.
  - -- Cereals fall into three general classes: Those that are cooked and eaten hot, "instantized" cereals that only require the addition of boiling water, and those that are ready-to-eat as they come from the package.
- Explain some of the basic principles of bread preparation.
  - -- Yeast, a living plant, is easily injured by high temperatures. Liquids used to soften yeast must be at the required temperature.

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-- Flour provides the proteins that develop into gluten to form the cells, crumb and framework of breads.

-- Gluten develops with kneading, producing cells which then contain the leavening gas. Not all yeast-leavened breads must be kneaded. In batters and soft doughs, beating or stirring develops the gluten.

-- During the rising period, carbon dioxide gas and alcohol are formed by the yeast cells. Elastic gluten strands trap this leavening gas, allowing the dough to double or triple its bulk. Time needed for rising depends on the temperature, the amount of yeast used, the richness of the dough and the kind of flour used.

-- Too hot an oven can cause the crust of breads to form too fast. This limits the expansion of the leavening gas and the volume of the baked product.

-- If oven temperature is too low, breads do not rise quickly enough to set the gluten structure before water evaporates. This limits volume and allows the leavening gas to escape too soon, sometimes causing the bread to fall.

. Explain some of the principles of starch cookery.

-- In making gravy and sauces, the starch mixture should be heated long enough for the starch grains to take up water and swell, causing the thickening process to take place.

Prolonged boiling may cause starch paste to become thin because some of the starch converts to simple sugars.

Separate starch grains before heating by mixing with cold liquid, creamed or melted fat or sugar, to avoid forming lumps of cooked starch.

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- Explain some of the basic principles of cereal cookery.

  -- In cooking cereals, the most important nutrient loss is thiamine, which is subject to destruction by heat and is also soluble to water. Except for macaroni products, it is best to cook cereals and rice so that the water will be completely absorbed. Macaroni requires more water.

  -- Packaged cereals requiring cooking should not be washed. Washing once before cooking can cause a thiamine loss of 10 percent in brown and converted white rice and 25 percent in regular rice. Rinsing rice after cooking should also be discouraged.

- Demonstrate different ways to prepare and serve breads.

- Demonstrate a variety of ways to prepare and serve cooked cereals.

APPLICATION OF LESSON BY AIDE

Aides understand some basic principles of bread and cereal cookery.

Aides know a variety of ways to prepare breads and cereals.

Aides understand how to use this information in talks with homemakers.

REFERENCES FOR TRAINER AGENT

1. Food for Us All, Yearbook of Agriculture, 1969, pp. 205-225, USDA.

2. New Treasury of Yeast Baking, Fleischmann's.

3. Cereals and Pasta in Family Meals, G-150, USDA.

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Information Sheet - Burning Fiber Characteristics (Continued)

FIBER	FLAME	ODOR	ASH
OLEFIN (Polypropylene, Polyethylene)	Fuses, shrinks, curls away from flame; melts as it burns	Polypropylene - faint asphalt Polyethylene - burning parafin	Hard, tough tan round bead
ORLON	Melts; burns like acetate; yellow flame, black smoke	Acrid	Hard black bead
RAYON	Ignites quickly, like cotton	Like burned paper	Like cotton
ROIME JUTE	Yellow flame, smolders with creeping ember	Burning paper	Small fluffy gray ash
SARAN	Melts, shrinks from flame; not flammable		Hard bead
SILK (Pure dye)	Burns slowly; ceases flaming when withdrawn from flame	Animal odor, less pronouned than wool	Round, crisp, shiny black beads, easily crushed with fingers
SILK (Weighted)	No flame; burned part becomes incandescent and chars	Same as pure silk	Screenlike skeleton of original sample
SPANDEX	Fuses but does not shrink away from flame; burns with melting	Musty	Leaves a soft fluffy, gummy ash
VEREL	Melts; shrinks from flame	Acrid	Hard black ash
VICARA	Somewhat like wool	Burning chicken feathers	Small bead, easily crushed
WOOL	Small, slow flickering flame; sizzles and curls	Strong animal odor like burning feathers or hair	Crisp dark ash, irregular shape, easily crushed with fingers
ZEFRAN	Flames; sputters slightly	Acrid	Black ash, easily crushed

VISUALS AND EQUIPMENT

Flannelboard

Magazine pictures

Food demonstration supplies

REFERENCES FOR AIDES

1. Enriched Rice, C&MS-30, Enriched Corn Grits, C&MS-31, Enriched Cornmeal, C&MS-32, Whole Grain or Enriched Breads and Cereals, C&MS-34, Donated Rolled Wheat, C&MS-35, USDA.

2. Budget Saving Recipes, Quaker Oats Company.

3. Cereals and Pasta in Family Meals, G-150, USDA.

EVALUATION

Ask aides to demonstrate how they will use this information in teaching situations.

IDEAS FOR SUPPLEMENTAL LESSONS

Baking breads with limited equipment.
Preparing cooked cereals for children.

Cost comparisons: baking homemade breads vs. buying breads for a family.

Cost comparisons: serving cooked cereals vs. ready-to-eat cereals.

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Lesson 15: HOW TO TAKE A TWENTY-FOUR HOUR DIETARY RECALL

PURPOSE

Trainer agent to help aides:

1. Know the meaning of a 24-hour dietary recall.

2. Understand the purpose of the 24-hour dietary recall.

3. Learn the basic steps in taking 24-hour dietary recall.

4. Develop effective interview techniques which can result in accurate reports.

PRESENTATION

. Discuss the reasons why a 24-hour dietary recall is needed.

-- To identify individual food practices which will later contribute towards providing important information on group food practices.

-- To establish a benchmark for future teaching.

-- To measure progress with families.

Define the 24-hour dietary recall.

-- It is a record of the foods eaten by the person being interviewed during the previous 24 hours. This includes all meals, snacks and beverages and the recall begins with the meal eaten prior to the interview.

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Stress need for obtaining first recall as soon as possible after family enters program--before much teaching has been done.

Emphasize need for establishing good communication with family before attempting recall.

Explain the basic steps required to get a 24-hour dietary recall.

-- Aide should ask homemaker to tell what she has eaten during the last 24 hours, starting with the meal before the interview. Answers should be written down in a note pad, not on an official form.

-- All meals, snacks and beverages eaten at home or elsewhere, are to be reported.

-- Example: An aide is getting recall information in the afternoon. She begins by asking, "What did you have to eat and drink at noon today?" Then she asks, "Did you have anything between breakfast and lunch?" Next she finds out what the homemaker ate for breakfast. Then, she asks, "Did you eat or drink anything between the time you ate supper last night and the time you went to bed?" Following this, she asks, "What did you eat and drink for supper last night?" And then she asks what the homemaker had between supper and lunchtime yesterday.

-- Questions such as, "What did you drink with your lunch?" or "What kind of sandwich or soup did you have?" help to provide a complete recall.

-- Questions that suggest answers, such as "Did you have a dark green or yellow vegetable today? should be avoided.

-- When taking the recall, aides should not show, by their expressions or comments, any approval or disapproval of the foods reported.

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-- If, for religious or ethnic reasons, a family's food habits are different on holidays or at other times, the 24-hour dietary recall should not be taken at this time.

-- Some factors affecting accuracy of the recall.

Number of times a 24-hour dietary recall has been taken.

People eat differently at different times.

Different interviewers have different effects on people.

Aide's ability to write down what the homemaker tells her--not what she thinks the homemaker means.

Demonstrate and practice 24-hour dietary recall interviews.

-- Trainer agent and aide show other aides the basic technique.

-- Aides practice with each other. Trainer agent should evaluate records obtained.

APPLICATION OF LESSON BY AIDES

Aides understand how to get a 24-hour dietary recall from homemakers and how to apply this information to a teaching situation.

REFERENCES FOR TRAINER AGENT

1. Training Home Economics Program Assistants to Work with Low-Income Families, PA-681, USDA.

2. Instruction Guide For Family Record and Aides List of Families reports.

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REFERENCE FOR AIDES

Handbook for Home Economics Program Assistants, PA-680, USDA.

Copy of Aides List of Families report (buff sheet).

Copy of Family Record - Part 2 (buff sheet).

EVALUATION

Trainer agent should compare aides' 24-hour dietary recall with recall information obtained during first lesson. Note changes; discuss with aides in group meeting or individual conferences.

Observe aides' ability to interview other aides. Set up additional practice sessions as needed.

Once the aides are working in the field and 24-hour dietary recall information is being brought in, try to answer questions as they arise. Review basic 24-hour dietary recall techniques with aides when necessary.

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ABSTRACT - This curriculum guide was developed by an NDEA Industrial Arts-Science Curriculum Committee and an NDEA Industrial Arts-Science Editorial Committee during workshops conducted in California and it is designed for instructor use in preparing or revising power mechanics courses in junior or senior high school industrial arts. The material complies with the objectives of the industrial arts programs in California schools, and the content applies the principles relating to power, energy, and force. Sections are: (1) Natural Power, (2) Mechanical Power, (3) Steam Power, (4) Thermal Power, (5) Electrical Power, (6) Hydraulic Power, and (7) Pneumatic Power. Course outlines for power and automotive mechanics, battery terminology, and assignment sheets are appended, and selected references are included. (GEB)

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Industrial Arts
POWER MECHANICS

Applying Scientific Principles Relating to POWER • ENERGY • FORCE

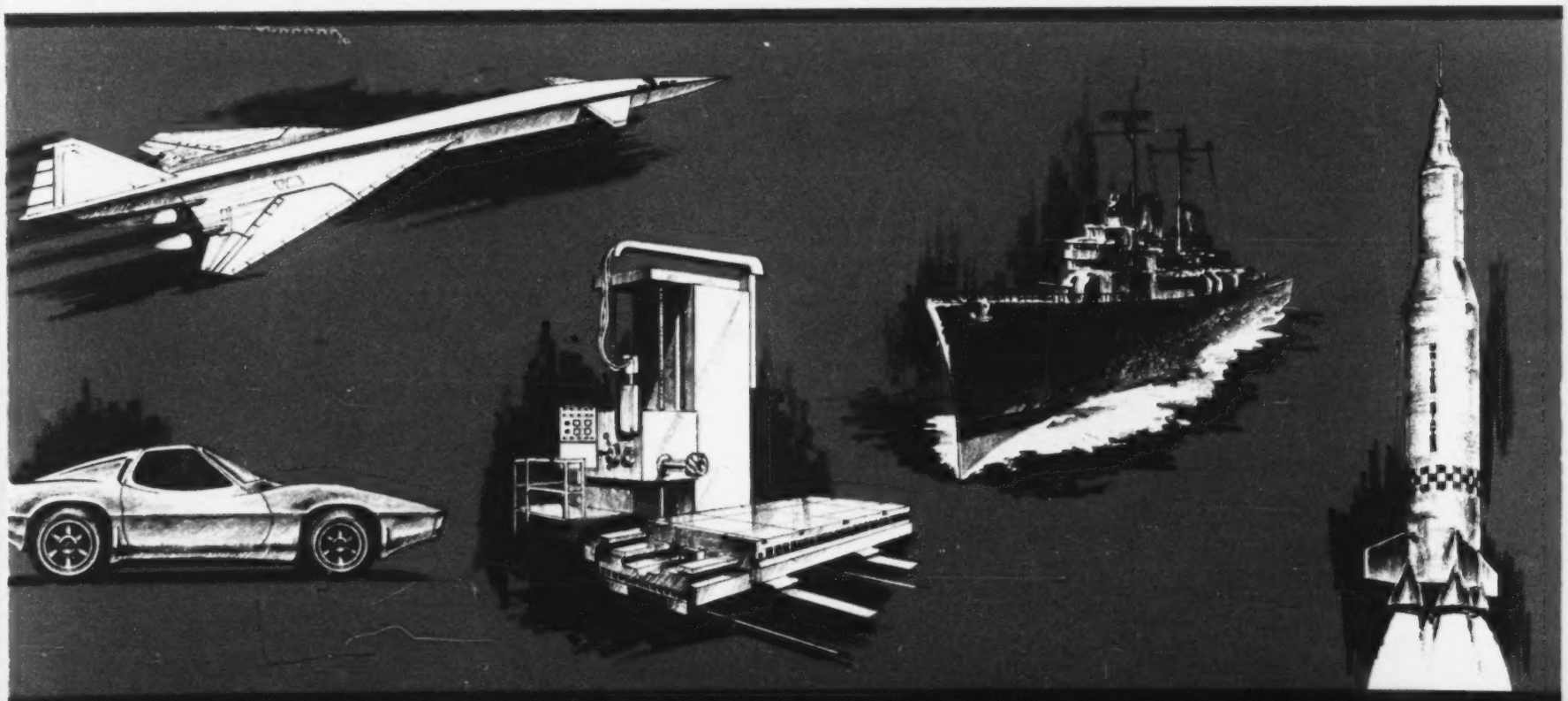

LIFORNIA STATE DEPARTMENT OF EDUCATION Max Rafferty – Superintendent of Public Instruction Sacramento, 1970

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Instructional Units

Industrial Arts
POWER MECHANICS
Applying Scientific Principles to POWER • ENERGY • FORCE

Robert L. Woodward and Norman L. Myers
Consultants in Industrial Arts Education
Project Coordinators

Project Conducted Under National Defense Education Act of 1958, Public Law 864 of the 85th Congress

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INFORMATION SHEET - PRESSING GARMENTS

Equipment Required

- Ironing board
- Needle, sleeve, and seam boards
- Point presser
- Steam iron and distilled water
- Variety of pressing clothes and hams
- Pressing mitt
- Pounding block or clapper
- Stiff brush
- Machine pressing equipment

Safety Practices

- Follow manufacturer's instructions.
- Avoid flowing garments and large pockets.
- Avoid long hair.
- Turn off machines when not in use.

Precautions

- Use directional pressing to retain garment shape.
- Test fabrics for water spotting.
- Use pressing cloth, iron sleeve, sock, or brown paper to avoid iron shine.
- Avoid making a crease in sleeve.
- Avoid pressing sharp hem line on silks and similar fabrics.

Preliminary Steps

- Remove basting whenever possible before pressing.
- Finish seam edge before pressing.
- Remove pins before pressing.
- Cut darts open on heavy fabrics.

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FOREWORD

Courses in industrial arts power mechanics are designed to provide opportunities for students to make applied use of technical information and scientific principles pertaining to power, energy, and force. Students are thus given the types of experiences that will make their knowledge of technical and scientific information meaningful and useful to them and that will cause them to acquire and use proficiently the skills involved in industrial arts power mechanics. These achievements will in turn intensify the students' interest in industrial arts, science, and technology.

Two studies conducted by the California State Department of Education were concerned with the scientific content in automotive/power mechanics courses offered by California high schools. These studies produced information that was used to develop instructional material for the industrial arts area of power mechanics. This information was used by members of the NDEA Industrial Arts-Science Curriculum Committee and the NDEA Industrial Arts-Science Editorial Committee during workshops conducted under the provisions of the National Defense Education Act in the preparation of the material for an experimental edition of *Industrial Arts Power Mechanics.*

A copy of the experimental edition of *Industrial Arts Power Mechanics* and a questionnaire were sent to each automotive/power mechanics teacher in the high schools of California and to selected industrial arts leaders in other states. The educators were asked to review the publication and complete and return the questionnaires. Suggested changes listed in the returned questionnaires were used in revising the material presented in the experimental edition.

The instructional units in this publication provide a sound basis for the preparation of courses of study/instruction in (1) power mechanics per se; (2) power mechanics which serve as introductory courses to industrial arts automotive mechanics, electronics, and metals in grades nine through twelve; and (3) automotive mechanics which make use of the elements of power mechanics.

I am certain that the information presented in *Industrial Arts Power Mechanics* will be of great value in the development of power mechanics courses with the breadth and depth of content that is needed and in which sound, efficient, and effective instructional procedures are emphasized.

Max Rafferty

Superintendent of Public Instruction

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NDEA COMMITTEES

NDEA Industrial Arts-Science Curriculum Committee

The specialists in automotive/power mechanics from the ten California colleges with accredited industrial arts teacher-education programs and the teachers, supervisors, and teacher educators who prepared the instructional units for *Industrial Arts Power Mechanics* during a work session held at Fresno State College, December 19-23, 1966, are as follows:

Leslie L. Aldrich, Fresno State College; John C. Davis (retired), Fresno City Unified School District; Raymond E. Fausel, California State College at Los Angeles; Frank J. Irgang, San Diego State College; Richard E. Johnston, Washington High School, Fremont (formerly at Chico State College); Frank H. Jolly, Humboldt State College, Arcata; Mark Jones, Tustin Union High School District; Angus J. MacDonald, San Jose State College; Ted A. McCoy, Hanford High School; Burton A. Pontynen, Pacific Union College, Angwin; Ernest J. Rawson, California State College at Long Beach; James E. Rice, California State Polytechnic College, San Luis Obispo; Frank E. Schroeter, Fresno State College; and Gerald Valente, formerly at San Francisco State College.

NDEA Industrial Arts-Science Editorial Committee

The members of the teams of specialists in science and specialists in industrial arts who, at work sessions in Los Angeles, Sacramento, and San Diego, on December 18-22, 1967, edited and augmented the material for *Industrial Arts Power Mechanics* prepared by the NDEA Industrial Arts-Science Curriculum Committee, are as follows:

O. Bruce Akers, Burbank Unified School District; Ralph C. Bohn, San Jose State College; Joseph E. Freeland, Sacramento City Unified School District; Serafino L. Giuliani, San Diego City Unified School District; Harold L. Marsters, San Diego State College; Richard L. Miller (retired), Los Angeles Unified School District; Jack E. Reynolds, Sacramento City Unified School District; William B. Steinberg, San Diego City Unified School District; and David O. Taxis, Office of the Los Angeles County Superintendent of Schools.

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PREFACE

Industrial Arts Power Mechanics presents a set of instructional units derived from the results of two studies, a series of work sessions, and an evaluation of an experimental edition.

Members of the Central California Automotive Technical Committee, who prepared the material for the experimental edition of *Industrial Arts Automotive Mechanics* which was published by the California State Department of Education in 1964, requested the Department to conduct a study to determine the extent to which scientific principles are being applied in present industrial arts automotive/power mechanics courses and the ways in which these principles can be applied to a greater extent in all courses in this area of industrial arts. The Department responded by conducting two studies, one in 1964 and the other in 1965.

The first study was conducted by having teachers of automotive/power mechanics in the high schools of California complete a questionnaire that was designed to secure their reactions to the way in which scientific principles were employed in *Industrial Arts Automotive Mechanics.* All the automotive/power mechanics teachers who responded favored the covering of applicable scientific principles in the automotive publication. The second study was conducted by having teachers of automotive/power mechanics in the high schools of California complete a questionnaire that was designed to report if the teachers applied a given set of scientific principles in their courses and, if so, how. In both studies the teachers indicated a need for curriculum material that would set forth ways of applying scientific principles and provide instructional units covering the broader area of power mechanics.

A series of work sessions for the development of instructional material in industrial arts power mechanics which would apply scientific principles relating to power, energy, and force was financed by funds provided under provisions of Title III of the National Defense Education Act.

The first work session was held at Fresno State College on December 19-23, 1966. Specialists in automotive/power mechanics from the ten colleges in California with accredited industrial arts teacher-education programs were assisted by supervisors and representatives of the Central California Automotive Technical Committee in preparing instructional units in power mechanics. These participants, listed as members of the NDEA Industrial Arts-Science Curriculum Committee in this publication, used the data obtained from the two studies, information presented in the California State Department of Education publications *Industrial Arts and Science* and *Mathematics and Industrial Arts Education,* and science textbooks used in the school systems located near the ten colleges represented at the work session to develop the instructional material.

Additional work sessions were held in Los Angeles, Sacramento, and San Diego on December 18-22, 1967, to augment and edit the power mechanics material developed at the Fresno State College work session. Each work-session team was composed of a specialist in science, a specialist in automotive/power mechanics, and a specialist in industrial arts. The participants in these work sessions are listed as members of the NDEA Industrial Arts-Science Editorial Committee in this publication.

Copies of the experimental edition of *Industrial Arts Power Mechanics* and questionnaires for evaluating the publication were distributed in September, 1968, to automotive/power

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mechanics teachers and industrial arts supervisors and teacher educators in California and to selected industrial arts teachers and supervisors in other states. Those who evaluated the experimental edition and responded to the questionnaire became members of the National Power Mechanics Review Committee. Changes suggested by them were taken into consideration in revising the material.

The NDEA project was coordinated by Robert L. Woodward and Norman L. Myers, Consultants in Industrial Arts Education, California State Department of Education.

The education profession in California, and particularly those members working in the area of industrial arts automotive/power mechanics, are greatly indebted to all the teachers, supervisors, and teacher educators who participated in the work sessions and studies which resulted in *Industrial Arts Power Mechanics.*

Industrial Arts Power Mechanics should be of invaluable assistance in the preparation of detailed courses of study/instruction in power mechanics, in the revision of present courses of study/instruction in automotive mechanics, and in the improvement of instruction in California junior high schools and high schools.

J. WILLIAM MAY
Acting Chief,
Division of Instruction

MITCHELL L. VOYDAT
Chief, Bureau of Elementary
and Secondary Education

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CALIFORNIA'S INDUSTRIAL ARTS PROGRAM

The industrial arts program in California schools is an integral part of the total program of education and is designed specifically to help prepare students to meet the requirements of an industrial-technological culture. In this program, which involves study, experimentation, and application, students learn through participation in activities in which they use industrial-technical tools, machines, materials, and processes, as well as English, mathematics, science, and social sciences, in solving meaningful problems.

The four major purposes of industrial arts are to provide opportunity for each student to develop (1) insight and understanding of industry and its place in our society; (2) talent in industrial-technical fields; (3) problem-solving ability related to the materials, processes, and products of industry; and (4) skill in the proficient and safe use of tools and machines. These purposes are furthered by a program in which emphasis is placed on helping students acquire the knowledge and skills basic to many careers.

In kindergarten and grades one through six, the industrial arts program furthers the established educational objectives and enriches the experiences pupils have in attaining such objectives. The industrial arts activities employed for this purpose emphasize planning and construction that is required in meeting needs that arise as the pupils participate in experiences relating to English, mathematics, science, and social sciences. The regular classroom teacher has responsibility for conducting the elementary school industrial arts program.

In grades seven and eight of elementary schools and grades seven, eight, and nine of junior high schools, the industrial arts program is an integral and often required part of the total program of education for all youth. Students are usually guided through a series of introductory experiences in a variety of industrial arts areas. Included in the program are courses which provide instruction in the broad areas of drafting, electricity/electronics, graphic arts, industrial crafts, metals, power mechanics, and woods. In a large school each of these areas of instruction is often taught in a different shop/laboratory; in a small school, several are taught in one shop/laboratory. In each instance the courses are taught by teachers with special preparation in the field of industrial arts and in specially designed and equipped facilities. In these grades emphasis and attention are given to helping students discover and further their aptitudes, abilities, and interests. Provision is made for students to acquire a variety of skills and to profit from participation in creative activities.

In grades nine through twelve and ten through twelve, the industrial arts program provides opportunity for the high school student, regardless of his major, to choose the industrial arts courses he believes will be of the greatest value to him in attaining the goal he is seeking. Included in the program are elective courses which provide instruction in the broad areas of automotive mechanics, drafting, electronics, graphic arts, industrial crafts, metals, photography, plastics, power mechanics, and woods. These courses are taught by teachers with special preparation in the field of industrial arts and in specially designed and equipped facilities. The advanced techniques developed in these courses approach the procedures used in industry. At this level emphasis is given to practices and requirements of occupations and professions relating to each industrial arts area. Challenging opportunities are provided for scientifically and mathematically oriented students to work and experiment with new materials, processes, ideas, and designs.

Knowledge and skills acquired and the experience gained in the industrial arts program assist individuals to select careers wisely and to participate successfully in programs of education and training offered by institutions of higher learning, industry, and government which provide further preparation needed for the chosen careers.

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INTRODUCTION

Industrial Arts Power Mechanics is designed to apply scientific principles relating to power, energy, and force. The words *power, energy,* and *force* often have different meanings when used in everyday language than when used in a scientific sense. In a scientific sense these words are defined as follows:

- *Power* is the time rate of doing work.
- *Energy* is the capacity to do work.
- *Force* is a push or a pull.

Industrial arts power mechanics is the study of the generation and conversion of energy to power and the transmission, control, and use of this power. Power mechanics includes the study of (1) the development of power for industrial and home use; (2) the control and measurement of power; (3) the transmission of power through mechanical, fluid, and electrical means; and (4) the use of power to accomplish work.

Each unit in *Industrial Arts Power Mechanics* presents a broad coverage of the topic indicated by its title, covers the scientific principle involved, suggests methods of application of the technical and scientific information, and lists selected references to further technical and scientific information. These references are keyed by numbers in parentheses to the complete list of selected references immediately preceding the appendices. The page numbers listed after each keyed number give further direction for locating pertinent information.

Appendix A of this publication presents a relatively brief course outline for industrial arts power mechanics; Appendix B presents a comprehensive course outline for industrial arts automotive mechanics. The outline on power mechanics is keyed to the instructional units contained in the text and to certain sections of the automotive mechanics outline. Appendix C contains terminology on the storage battery, and Appendix D contains assignment sheets.

One of the purposes of *Industrial Arts Power Mechanics* is to assist in the preparation of courses of study/instruction in (1) power mechanics specifically; (2) power mechanics which serve as introductory courses in other areas of industrial arts; and (3) automotive mechanics which also cover the broader aspects of power mechanics. Another purpose is to demonstrate the interrelationships of the instructional content of industrial arts power mechanics with that of science.

Courses in power mechanics provide an instructional program that is much broader in content than the conventional automotive mechanics courses. In fact, power mechanics employs a selective coverage of many sources of energy and their application.

Knowledge and skills relating to power mechanics may be used in grades seven and eight to augment courses in other areas of industrial arts; however, it is recommended that courses in power mechanics not be provided below grade nine. Introductory courses in power mechanics may be offered in grade nine of junior high schools or four-year high schools. It is recommended that courses in power mechanics be provided at the high school level. Power mechanics may be offered at the high school level as an introduction to courses in the industrial arts areas of automotive mechanics, electronics, and metals.

Today's industrial technology requires knowledge and skills that are not adequately covered in conventional automotive mechanics courses. It is recommended that these conventional courses be more selective in content relating to automotive mechanics and include the broader aspects of power mechanics.

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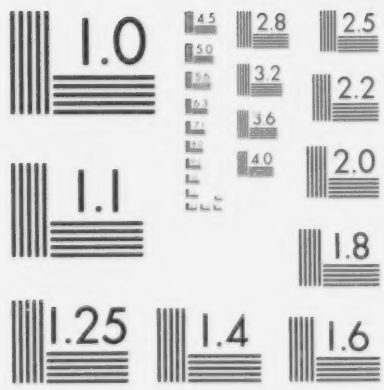

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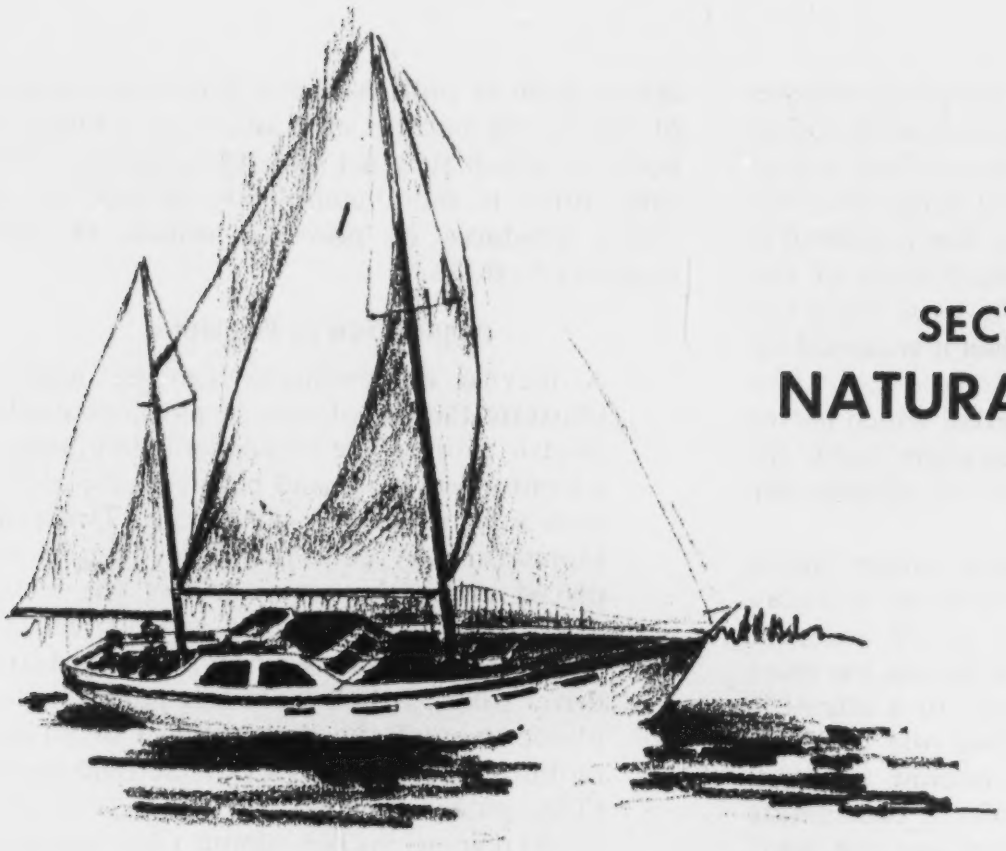

SECTION I
NATURAL POWER

Unit 1 — MUSCLE POWER

The only power available to primitive man was his own muscle. This muscle power made it possible for him to travel, seek food, make simple tools, and fight his enemies. The lever was used by man during this early period. However, relatively great sources of power were available only when the muscles of many men were brought to bear upon a single object. Later, other simple machines were used by man to multiply his muscle power. These were the wheel and pulley, the inclined plane, the wedge, and the screw. (Refer to Unit 6, "Simple and Compound Machines.")

When man learned to domesticate and harness animals, another source of muscle power became available. However, human and animal muscles applied to simple machines limited man's power output. This limitation made it necessary for him to seek other sources of energy. Among the sources of energy to be employed were water and wind, which were used to turn waterwheels and windmills. Today, many sources of energy are used by man. Even though modern man has countless labor-saving devices and makes use of many sources of power, he still depends on muscle power for a great number of daily activities.

It should be understood that simple machines are devices to increase man's strength (muscle). However, such machines cannot increase man's ability to do work, which is defined as the product of the force and the distance through which it moves. Machines merely allow the trade of distance for "quick" force. For example, the wrench used to loosen a nut is a form of lever. If the nut is stuck tightly, it may be necessary to use a longer wrench to increase the leverage. Actually, the work accomplished is not reduced, because the wrench handle is moved a longer distance than the nut moves. The same amount of work has been done, but in a different, more gradual manner. Either speed can be sacrificed to gain force, or force can be sacrificed to gain speed. Because force is required to move the parts of a machine and to overcome friction in the machine, the actual mechanical advantage is never as great as the theoretical mechanical advantage. Thus the efficiency of a machine is always less than 100 percent.

Scientific Principles Involved: Work, Power, Energy, Force

In everyday language the term *work* is used to describe any activity in which muscular or mental effort is exerted. In a scientific sense, however, *work* has a very special meaning: *Work is done*

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- Trial press on a scrap of fabric or on an inconspicuous area of garment to determine best method.
- Place strip of paper between seam and garment before pressing if fabric will mark through to outside.

Factors and Methods that Control Pressing Results

- Pressure - Lean on iron or use pounding block.
- Heat - Use amount of heat required by the fabric.
- Moisture - Use a steam iron or dry iron with a damp pressing cloth or a wet sponge.

Techniques During Construction

- Place seams together at back of pressed or unpressed pleats.
- Put waistline seams together toward bodice.
- Place yoke seams together away from gathers.
- Put armhole seam together into the sleeve, over the sleeve cap.
- Do not press underarm seam
- Arrange vertical darts and tucks toward the center front or back unless otherwise indicated.
- Place horizontal darts and tucks down unless otherwise indicated.
- Flatten a bulky edge by:
  1. Steaming fabric
  2. Pounding surface flat
  3. Steaming again to set edge
- Place curved area over shaped surface.
- Press each section of garment as it is sewn.

Techniques for Final Pressing

- Follow procedures used during construction.
- Press from outside using pressing cloth if fabric will shine.
- Press plackets closed.
- Remove basting from pleats.

when a force acts on matter and changes its motion or when force moves an object against an opposing force. No matter how long a 50-pound load is held on a person's shoulder, work is not being done in a scientific sense; the upward force that is exerted is merely counteracting the downward force of the load. Work is done in a scientific sense when the load is raised to the shoulder, when it is carried up a flight of stairs, or when it is dragged across the floor. In these cases a force is exerted which moves the object. Expressed in an equation, *work (in foot-pounds) = force (in pounds) × distance (in feet).*

Like the term *work,* the term *power* has a scientific meaning that differs from its everyday meanings. When it is said that a person has great power, it usually means that the person has great strength or wields great authority. In a scientific sense, however, *power is the time rate of doing work.* A man does the same amount of work whether he climbs a flight of stairs in one minute or in one hour, but he does not use the same amount of power.

Matter acquires energy when work is done against gravity in raising matter to an elevated position or when work is done to set matter in motion. The energy thus acquired can be used to do work. In mechanics there are two kinds of energy, kinetic energy and potential energy. *Kinetic energy is energy due to motion of a mass.* A moving automobile, a bullet leaving the muzzle of a gun, a spinning flywheel, a rolling ball, and falling or running water all possess kinetic energy. *Potential energy is stored energy.* The water impounded behind a dam has potential energy. This energy becomes kinetic when it is used to turn a waterwheel or turbine. The coiled mainspring of a watch has potential energy because work was done in winding it. Its potential energy becomes kinetic as the spring unwinds.

Force is directly related to work and energy. *Force is a push or a pull.* However, forces do not always push or pull an object. Some combinations of forces just balance each other; as a result, the body on which they act remains stationary. Therefore, force is more completely defined as that which produces or prevents motion or has a tendency to do so.

Application of Principles

1. A bicycle dynamometer can be made to illustrate the use of muscle power to produce electric power. The bicycle is held upright by a front-wheel block and balancing supports on each side of the rear-wheel axle. Two rollers (approximately four inches in diameter) are placed under the rear wheel of the bicycle. The front roller is the idler, and the rear roller is the driver. A pulley wheel is attached to the driver roller. A belt from this pulley wheel is placed around the pulley wheel of an automobile alternator with a variable field control. (The pulley selected should permit about 1,000 revolutions per minute.) All supports of parts should be attached to a plywood base/floor. The generated current is fed to a 12-volt storage battery for stabilizing voltage. A bank of lights or other electrical load can be employed to use up the electricity produced by the alternator. Meter readings can be made and horsepower computed.
2. Simple machines among the tools and machines in a facility can be identified and demonstrated by students. (Refer to Unit 6, "Simple and Compound Machines.")

Selected References

***Note:** The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.*

(9), pp. 80, 486-87; *(13),* pp. 58-64; *(16),* p. 148; *(22),* p. 49; *(24),* pp. 452-55; *(26),* pp. 1-16; *(27),* pp. 42-49, 120-42; *(36),* pp. 8-13; *(37),* pp. 298-99; *(63),* pp. 493-97; *(66),* pp. 1-8.

Unit 2 — WATERWHEELS

The waterwheel, sometimes called a gravity wheel, is a simple mechanical device to convert water power to mechanical power (rotary motion) against a resistance at the axle of the wheel. The three general types of waterwheels are the undershot wheel, the overshot wheel, and the breast wheel. The undershot wheel was one of the first engines designed to do work. It was introduced over 2,000 years ago by the Egyptians and the Persians. Undershot waterwheels are made so that

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when the paddles at the bottom of the wheel are dipped into a stream or river, the current of water exerts a force against the paddles and turns the wheel. Overshot wheels make use of water that is directed at the top of the wheel on the downward side. Breast waterwheels, which are similar to the undershot wheels, are rotated by directing water above the center of the wheel on the downward side. The early waterwheels were constructed of wood; iron parts became common during the Renaissance.

With the introduction of hydraulic turbines in the early part of the nineteenth century, the importance of waterwheels decreased. Today, they are limited to small power plants.

The modern water turbine has a wheel or rotor with a series of blades or vanes. Instead of being placed in an open stream or river, these rotors are enclosed in a housing. Water under pressure is directed to them through pipes and nozzles. Usually, the pressure of the water is built up by damming a water source.

Scientific Principle Involved: Water Pressure

At sea level the pressure of air from all directions is 14.7 pounds per square inch (psi). Water also has pressure. For about every 34 feet below the surface of water, the pressure is multiplied by 14.7 pounds per square inch (the amount of pressure at the surface). The pressure of deep water must be taken into consideration when designing huge dams. The thickness of the base and the strength of the concrete must be such that they will withstand the pressure of the water held back. It is this water pressure that turns the rotors of the water turbines found in the electrical power plants located at the base of dams.

The force of the water strikes against the paddles at the bottom of the undershot waterwheel (left) and at the top on the downward side of the overshot waterwheel (right).

Application of Principle

1. A model waterwheel can be constructed. Water conducted by a tube from a faucet can be directed on the blades of the waterwheel to demonstrate the three types of wheels: undershot, overshot, and breast.
2. The pressure of water can be demonstrated by pouring two quarts of water into a cellophane bag. If the bag is lifted and four holes are punched vertically (near the bottom, about an inch apart) on two sides of the bag, the water will spurt farthest from the holes nearest the bottom of the bag.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 509-12; *(16)*, pp. 153-54, 161; *(26)*, pp. 8-13; *(27)*, pp. 214-17; *(46)*, pp. 395, 398-99.

The U.S. Navy's hydrofoil gunboat is powered by water jet and is capable of speeds in excess of 40 knots. Water is drawn through rear struts into centrifugal pump and is then jetted through nozzles near the stern (Boeing Company, Seattle, Washington).

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Unit 3 — WINDMILLS

Windmills consist of a rotating element or wheel driven by the wind that causes the turning of a shaft connected to equipment to perform useful work. Windmills are practical when intermittent power is required, as in pumping water to storage tanks and generating electrical power for charging storage batteries in power-supply systems.

The windmill was one of the earliest devices used to obtain power from natural sources. Some records indicate that windmills were in existence prior to the seventh century. The windmill was in use in Persia during the tenth century and in Western Europe near the close of the twelfth century.

During the sixteenth century the general form of the Dutch windmill was stabilized. No essential changes were made until the start of the twentieth century, when research showed the way for significant improvements in the form of sails or windmill arms. Modern windmills have tended toward high-speed designs or types possessing wheels rotating at a large number of revolutions per minute for maximum efficiency in operation.

Present types of windmills are the multivane, the propeller, and the S rotor. The multivaned wheel, though the least efficient of the modern windmills, has the most numerous applications in the United States. The multivaned and propeller windmills possess rotors that revolve about a horizontal shaft, and hence it is necessary to orient the rotors into the wind through the use of a vertical vane or rudder. Since the S-rotor type of wheel is mounted on a vertical shaft, it is possible to take advantage of the current of wind without swinging the entire unit on a vertical axis.

Scientific Principle Involved: Horsepower Output of Windmill

The available power in a current of wind is due to the kinetic energy of the mass of air flowing through a given area per unit of time. In a windmill the area concerned is the frontal area swept out by the rotating element. At sea-level conditions of air pressure and temperature, the available horsepower per unit of area is given by the equation $Hp = 0.00000214 \times V^3$, where V is the wind velocity in feet per second. This equation gives the results of horsepower output of a windmill (area 100 square feet, efficiency 30 percent) as follows:

Wind speed in feet per second	10	20	30	40	50	100
Wind speed in miles per hour	6.8	13.6	20.4	27.2	34.0	68.0
Windmill horsepower ..	0.06	0.5	1.7	4.1	8.0	64.0

Application of Principle

1. A windmill can be constructed for demonstration and use in generating electrical power for charging storage batteries.
2. A cup-type anemometer can be used or constructed to check wind speed.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 228-32; *(16)*, pp. 152-53; *(26)*, pp. 13-15.

Unit 4 — HEAT COLLECTORS

It is safe to assume that the earth's supply of fossil fuels will last for at least one and one-half centuries and that the supply of uranium will last for a century beyond the fossil fuels. However, these fuels are lmited, and energy sources which are not presently being used must be put to efficient use in the future.

The energy of the sun is the most obvious source of energy. The daily supply is tremendous. In two days the sun provides the United States with energy equal to all our remaining fossil fuel reserves. Much of this energy is lost, however, because of clouds and other forms of energy dispersion. Yet the energy reaching the earth is still far greater than our needs. If only 1 percent of available ground area were used for solar power plants, these plants would have a theoretical capability to produce more power than all the steam and hydroelectric power plants in the world.

There are two major problems in making practical use of solar energy – collecting it and using it at low intensity. Heat energy at normal earth temperatures is difficult to put to practical use. More research and study are needed before solar energy becomes a major source of controlled power.

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Some current uses, though small, are noteworthy. They are as follows:

1. Solar cells convert solar energy to electricity. Even though the output is low, solar cells are used to power satellites and provide power for remote telephone boosters.
2. Solar evaporation of seawater has been a major source of salt and other ocean minerals for centuries. Also, the evaporation and condensation of seawater as a source of fresh water have been effective in small and experimental installations.
3. Solar cooking units have been designed and manufactured for use in areas having a substantial amount of available sunshine.
4. Solar heating of homes has been successful in regions where there is an abundance of sunshine.

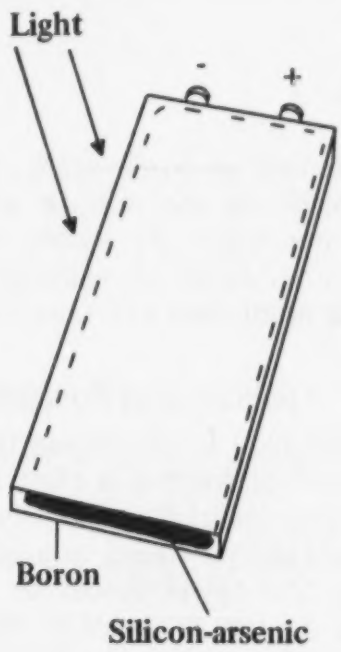

A solar cell is composed of a wafer of silicon-arsenic coated with boron.

Scientific Principle Involved: Heat

The temperature of a body is the measure of the motion of its molecules. Molecules of all substances possess kinetic energy, which may be expressed by the formula $KE = 1/2MV^2$ where KE is kinetic energy, M is mass, and V is velocity. As the temperature of a substance rises, the kinetic energy and, therefore, the velocity of the motion of its molecules increases.

Heat is transferred by conduction, by convection, or by radiation:

1. *Conduction:* Through motion, kinetic energy is transferred from one atom or molecule to other atoms or molecules adjacent to it. In this way heat travels through a body by conduction. Metals are good heat conductors; nonmetallic substances are poor conductors.
2. *Convection:* The increased molecular motion, due to a rise in temperature, causes substances to expand, thereby reducing their density. When any portion of a gas or liquid is heated to a higher temperature than the remaining fluid, it becomes lighter and floats upward. The resulting movement is a convection current. Heat is distributed in gases and liquids by these convection currents.
3. *Radiation:* Heat in the form of radiant energy travels in straight lines through space and transparent materials. Radio waves, infrared light, visible light, ultraviolet light, and x-rays are all forms of radiant energy. When radiant energy, particularly that of the infrared portion of the spectrum, strikes an opaque object, some of it is reflected back into space and some is absorbed. The absorbed portion increases the kinetic energy of the atoms or molecules that make up the substance, thus increasing its temperature.

All opaque bodies radiate some heat, depending on their temperature, and all such bodies absorb some of the radiant energy that strikes them. The amount of absorption or radiation depends mainly on the surface and color of the body. Rough, dark-colored surfaces absorb and radiate more heat. Smooth, light-colored surfaces absorb and radiate less heat.

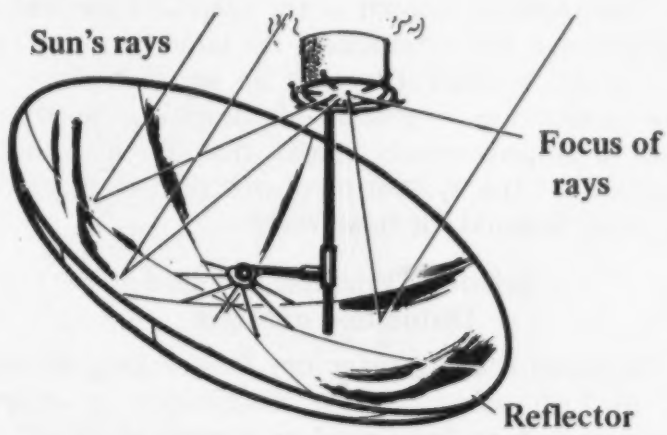

Solar cooking can be demonstrated by using a concave mirror or bright metallic surface to convert the sun's rays to heat for power.

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Application of Principle

1. A simple heat collector can be made from a box which is painted a dark color, preferably black. A second collector box, painted white, should also be made. A thermometer should be placed in each box and the boxes placed in bright sunlight. The temperature readings of each thermometer should be recorded at periodic intervals. An appropriate graph can be plotted.

2. Solar cooking can be demonstrated by using a concave mirror or bright metallic surface. A match or small pieces of wood can be ignited at the focal point of the mirror or reflector. A larger unit, designed to roast hot dogs or cook other foods, can be built with a bright, concave, metallic surface as a reflector. Care should be exercised since very high temperatures are possible.

3. The conversion of solar energy to electricity can be illustrated through the use of solar cells. A solar motor assembly can be built which consists of a pair of solar cells wired to a small motor. The motor will operate whenever the cells are exposed to sunlight.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(14), pp. 160-70; *(16)*, pp. 177, 217-18; *(26)*, pp. 339-40; *(46)*, pp. 128, 398, 400, 401; *(54)*, pp. 552-53; *(59)*, p. 274; *(66)*, pp. 174-81; *(83)*, pp. 71-78, 182-85, 193.

Unit 5 — SOLAR STILLS

The available supply of fresh water may soon be inadequate for many cities and countries in the world. Many islands, such as the Virgin Islands, have inadequate supplies of fresh water for drinking and for irrigating crops. As a result, considerable effort has been expended to extract ocean water that can be used as fresh drinking water.

One method, often recommended for survivors at sea, involves the evaporation and condensation of seawater. During evaporation the water goes into the air in the container, leaving the salt and other minerals behind. When the water is condensed, it is fresh and free of salt and other minerals.

This method, known as the solar still method, is inexpensive but impractical for large quantities of water. It is currently used as an emergency or low-production method of desalting seawater. Future improvements might find it or a modification of the system more practical to meet the growing demand for fresh water.

Scientific Principle Involved: Distillation of Water

Seawater is not satisfactory for drinking because of its high saline content. Distillation or evaporation has long been used as a method to obtain pure water. The process consists of evaporating or boiling water to form water vapor or steam, which is then condensed to liquid again. The condensation takes place on any surface which is cooler than the water vapor or steam. All suspended matter and any dissolved material which has a higher boiling point than water are left behind.

Application of Principle

A solar still may be developed through the use of a large, clear plastic bag, a black towel, or other dark, absorbent material, and a collector tray. The plastic bag should be rigged as a canopy over the black towel. The towel should be soaked in salt water. When the unit is placed in the sun, the solar energy will be absorbed by the towel and the water will be heated and evaporated. The water vapor will rise to the inside of the canopy. Since the air is cooler within the canopy than at the towel, the water will condense on the inner surface of the clear plastic bag. A collector tray along the edge of the canopy should be used to collect the small quantities of condensed fresh water.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(8), pp. 147-49; *(13)*, pp. 213, 336; *(14)*, pp. 169-70; *(43)*; pp. 172-73, 186-89.

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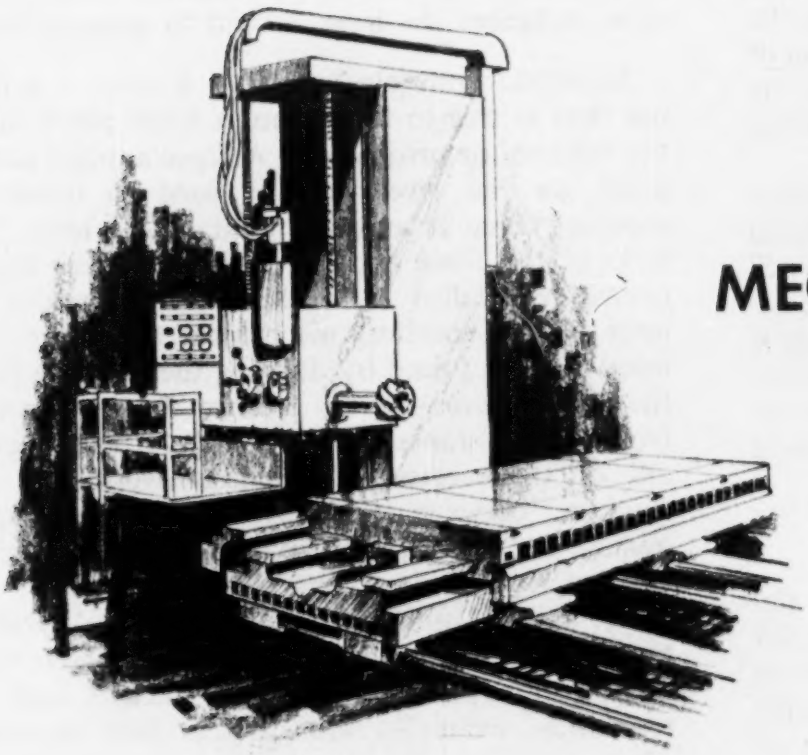

SECTION II
MECHANICAL POWER

Unit 6 — SIMPLE AND COMPOUND MACHINES

Machines are used to transform energy, transfer energy, multiply force, multiply speed, and change the direction of a force. A generator transforms mechanical energy into electrical energy. A steam or gas turbine transforms heat energy into mechanical energy. Machines are used to transfer energy from one place to another; for example, in an automobile the connecting rods, crankshaft, drive shaft, and rear axle transfer energy from the combustion in the cylinders to the rear wheels. Machines are used to multiply force; thus, an engine can be lifted out of an automobile by using a system of pulleys. The pulley system makes it possible to raise the engine by exerting a force which is smaller than the weight of the engine. However, this smaller force must be exerted over a greater distance than the height through which the engine is raised, and the engine moves more slowly than the chain which is pulled. A machine, therefore, produces a gain in force, but only at the expense of speed. Machines are also used to multiply speed; for example, a bicycle is used to gain speed, but only by exerting a greater force. No machine can be used to gain both force and speed at the same time. And machines are used to change the direction of a force, as when a single pulley at the top of a flagpole enables one end of the rope to exert an upward force on the flag as a downward force is exerted on the other end.

Mechanical Advantage

When a chain hoist is used to lift a car engine, the chain moves several feet to raise the engine a few inches. When a vise is tightened, the end of the handle is moved (turned) further than the jaw of the vise is moved. When the lever of a paper cutter is pulled down, the hand of the operator moves farther than any point on the cutting edge. In each of these cases and in countless others, a lesser force is exerted to gain a greater force at the expense of having to exert the lesser force over a longer distance. Each of these machines provides mechanical advantage.

Scientific Principle Involved

By the use of simple or compound machines, a person is able to multiply the force that his muscles are capable of exerting. When a 20-pound force is exerted through a pulley arrangement of a chain hoist to lift a 200-pound engine, the effort of a person is multiplied ten times. Mechanical advantage equals weight supported *(W)* divided by the force applied *(F)* in any mechanical device; or, to put it another way, mechanical advantage equals

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W/F. The mechanical advantage then is ten. With the vise the mechanical-advantage principle is the same except that it is achieved by a combination of two simple machines, the wheel and axle and the screw or inclined plane. Likewise, the paper cutter combines the lever and the wedge.

The mechanical advantage of force of a machine is termed theoretical or actual. Theoretical mechanical advantage is the ratio of the distance the effort force moves to the distance the resistance force moves. Actual mechanical advantage is the ratio of the resistance force to the effort force. The efficiency of any machine is the ratio of its actual mechanical advantage to its theoretical mechanical advantage converted to a percent.

Simple Machines

There are six simple machines. These are the lever, the pulley, the wheel and axle, the inclined plane, the screw, and the wedge. Other machines are either modifications of one of these simple machines or a combination of two or more of them. The pulley and the wheel and axle are fundamentally levers, while the wedge and screw are modified inclined planes. Many complicated machines are combinations of simple machines. A combination of two or more simple machines is called a compound machine. A drill press is an example of a compound machine. Many of the simple machines are found in the drill press.

Lever

The lever was one of the first simple machines known to man. In making use of leverage, he found that the turning effort exerted depended on (1) the amount of force applied; and (2) the length of the lever arm. The same form of simple lever is still used to move heavy objects. In modern machines many other more complex forms of this simple machine are used in gaining mechanical advantage or speed of movement. Some examples of tools (machines) that use the lever principle are tire jacks, scissors, hammers, bolt cutters, pliers, tin snips, crowbars, vise handles, wrenches, hand-lever punches, paper cutters, drill presses (feed handles), and squaring shears (treadles). Pushing, pulling, raising, or lowering of handles on most tools are applications of the principle of the lever. Moving the accelerator, clutch, brake pedals, turn-indicator levers, and manual gearshift levers are examples of the application of the lever in automobiles. Operating cranks and kick starters are examples of the application of the lever principle found in other units driven by internal-combustion engines. In most instances the lever is used to increase force.

Scientific principle involved. A lever is a rigid bar that is free to turn about a fixed point called the fulcrum or pivot point. A force applied to one point on the lever may be used to overcome resistant force at another point on the lever. The ratio of the force applied to the resistance that is overcome is called the mechanical advantage of the lever. The theoretical mechanical advantage of a lever may be found by dividing the distance from the effort (force) to the fulcrum by the distance from the resistance (load) to the fulcrum. Levers are of three classes. First-class levers have the fulcrum between the forces; some examples include tin snips, pliers, and scissors. Second-class levers have the load or resistance between the effort and the fulcrum; paper cutters and welding tank trucks are examples. Third-class levers have the effort applied between the fulcrum and the resistance; examples are calipers and tweezers. These tools are familiar examples of the use of levers. Levers may be used to increase force, distance, or speed. If the resistance force is greater than the effort force, then the effort force must

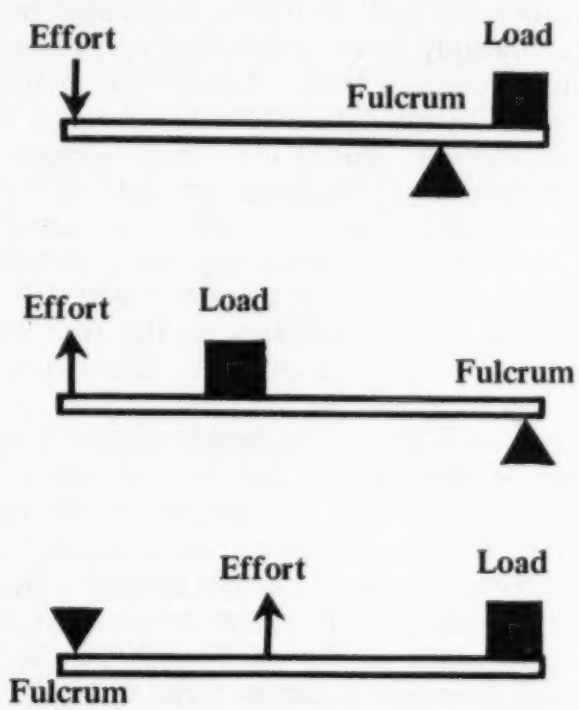

A first-class lever (top) has the fulcrum between the effort applied and the load (e.g., prying with a crowbar); a second-class lever (center) has the load between the effort applied and the fulcrum (e.g., moving a wheelbarrow); and a third-class lever (bottom) has the effort applied between the fulcrum and the load (e.g., using a broom).

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move through a greater distance (faster) than the resistance. The work done by the lever can, therefore, never be greater than the amount of work produced by the effort on the lever. If the work done by the lever were greater than that put in, the lever would be an energy-creating or perpetual-motion machine.

Wheel and Axle

The wheel serves a number of purposes. Like a fixed pulley, a road wheel on an automobile supports a load and permits it to move in a direction parallel to the road surface. When power from the engine causes the rear axle to turn, the rear wheels act as levers to move the load they support. The wheels also function as levers when the brakes are applied. Gears, sprockets, pulleys, windlasses, and winches are examples of the wheel and axle.

Scientific principle involved. When in motion, the wheel is a continuously rotating lever. The center of the wheel is the fulcrum. A wheel that, like a front wheel on a car, merely rolls and supports a load has a mechanical advantage of one. Drive wheels on powered vehicles usually have a mechanical advantage of less than one. And wheels with brakes have a similar mechanical advantage. The amount of mechanical advantage depends on the wheel radius, rear axle ring-gear radius, brake drum, or disk radius. A cable or rope windlass is a wheel and axle with a mechanical advantage greater than one. The amount of mechanical advantage gained by a windlass depends on the diameter of the drum and the length of the driving handle.

Inclined Plane

The inclined plane is a great help to workmen because of the mechanical advantage it provides. Oil drums and other heavy objects can be raised or lowered by means of an incline. The same principle is involved in the grading of roads and mountain trails and in the ascent and descent of winged aircraft in flight.

Scientific principle involved. An inclined plane consists of a plane surface with one end or side higher than a plane parallel to the earth's surface. Mechanical advantage is gained when an object is moved up a slanted surface rather than when it is lifted vertically. As an example, a 300-pound drum can be rolled up a 12-foot incline that rises 4 feet at one end by a calculated force of 100 pounds.

Wedge

Man has found many applications of the principle of the wedge. The great force that can be exerted by this simple machine makes it useful in (1) separating or forcing one thing away from another (by the use of axes, chisels, knives, splitting wedges, and wedges used to lift heavy objects); and (2) locking or holding objects together (by the use of wedges in hammer handles; pegs, nails, and other fasteners that are driven into materials; corks in bottles; and gears or wheels that are pressed on the ends of shafts).

Scientific principle involved. The wedge is an object that has a greater cross section at one end than at the other. As a wedge is moved in the direction of its smaller cross section, a greater force is exerted at right angles to this motion by its sides. The wedge is a form of the inclined plane, and its mechanical advantage is gained in the same manner. If a wedge has a length of 6 inches and its cross section increases from zero to 2 inches, it will have a calculated mechanical advantage of three.

Pulley

Pulleys and belts, as well as sprockets and chains, are used in driving all types of equipment. The drill press, lathe (wood and metal), jig saw, milling machine, chain hoist, block and tackle, and many other devices would be rendered useless without the simple machine known as the pulley. The pulley provides a means of transmitting mechanical power from a single driving source to one or more driven mechanisms. The pulley, as used with a chain hoist, provides a mechanical advantage; it makes easier the lifting of a heavy object, such as an automobile engine. Pulley and belt combinations, as found in the drill press, are used for obtaining desired speeds. Pulleys and belts are used to transmit power from internal-combustion engines to drive electric generators and fans of vehicles and stationary units.

Scientific principle involved. A pulley, which is a wheel that turns readily on an axle, provides a means of transferring power through a belt or chain from one location to another. With this transfer of power, it is possible to accomplish work at a location removed from the source of power. In the lifting or moving of an object, a single fixed pulley merely changes the direction of force. In a pulley system with one movable pulley, the force moves twice as fast as the load. A combination of

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pulleys of varying sizes may be used to increase or decrease speeds beyond the speed of the driving source. The law governing this principle is that the ratio of the speeds at which the pulleys turn is inversely proportional to the diameters of the pulleys. As an example, an 8-inch pulley at the driving source will make one revolution for every two revolutions of a 4-inch driven pulley.

Screw

Certain devices are regulated with adjusting screws. As adjusting screws are turned, force is applied to control the space between the parts or to provide the resistance that may regulate the flow of gas, liquids, or electricity. The correct setting is determined by the amount the adjusting screw is turned and, in some cases, can be checked with an electronic instrument or a pressure gauge. A few devices that use adjusting screws are oxyacetylene regulators, padding capacitors, paint-spray guns, automobile carburetors, micrometers, and compasses. Clamps and vises make use of the simple machine known as the screw. A common clamping operation is holding material firmly in a drill-press vise while the stock is being drilled. The handle of the vise acts as a lever, multiplying the mechanical advantage of the screw. The total mechanical advantage of such a device is the product of the mechanical advantages of the two simple machines.

Scientific principle involved. A machine screw is a cylindrical body with a helical (spiral) groove cut into its surface. For practical purposes a screw may be considered an inclined plane in the form of a helix. The screw must resist tension (strain) and shearing (cutting). In its application as a simple machine, the screw is machined to precision accuracy in both fit (correct size) and pitch (distance between threads). The fit of the screw determines how much friction will take place as the screw is turned. With too much friction, the screw is difficult to adjust; with too little friction, the screw is difficult to keep adjusted. The pitch of the screw thread determines how finely a particular instrument can be adjusted. If the fit and the pitch are not correct, the effectiveness of the adjusting screw is decreased.

Compound Machines

An engineer designing a steering system for an automobile must devise a set of levers and gears that provides enough mechanical advantage to turn the front wheels easily yet requires a minimum number of turns of the steering wheel for the convenience of the operator. Consideration must be given to the diameter of the steering wheel, which is rigidly attached to the steering shaft; to the ratio of the gears in the steering gear box; and to the length of the levers, which move the wheels at their pivot points. Power assistance (power steering) is often built into an automobile to assist the driver in exerting greater force in turning the wheels.

Scientific Principle Involved

The function of a machine is to convert energy to useful work. The steering system of an automobile is a machine that enables a person to multiply the force produced by his muscles. The lever is a rigid bar that is free to turn about a fixed point. The arm or end to which force is applied is the effort arm; the arm that moves the load is the resistance arm. The mechanical advantage, which depends on the lengths of the two arms, may be increased by lengthening the effort arm or shortening the resistance arm. The gear is a form of lever. It is a series of levers around a circle used to transmit continuous force to another gear. One gear of a pair may be the resistance arm and the other the effort arm. The wheel rigidly attached to an axle is also a form of lever. The rim of the wheel is like a series of levers and is more convenient to use than a single lever. A combination of two or more simple machines, such as the lever, gears, and wheel with axle, is a compound machine. In almost all cases the total mechanical advantage of a compound machine is the product of the mechanical advantages of the simple machines of which it is composed.

Application of Principles

Examples of simple and compound machines can be identified among the hand tools and components of machines in the facility as well as in the systems of internal-combustion engine units. Simple and compound machines can be demonstrated by using (1) a yard or meter stick as a lever to lift weights; (2) weights, levers, and spring scales to show mechanical advantage and torque; (3) brake pedals on automobiles to illustrate classes of levers by disconnecting the brake pedal from the master cylinder and connecting a spring scale or torque wrench to the pedal; (4) a spring scale

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connected to the rim of a steering wheel to measure the force necessary to steer the vehicle; (5) input and output transmission shafts to determine gear ratios; (6) the rolling of a grease drum up a ramp to demonstrate the inclined plane; and (7) a wood or metal wedge to secure tool heads.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 436-53; *(22)*, pp. 448-516; *(24)*, pp. 132-46; *(26)*, pp. 5-6; *(27)*, pp. 131-42, 353; *(36)*, pp. 9-13; *(37)*, pp. 312-32; *(55)*, pp. 3-30; *(66)*, pp. 104-10; *(69)*, Chapter 10, Chapter 15.

Unit 7 — LUBRICATION

For the proper lubrication of a four-cycle internal-combustion engine, the oil used must prevent rotating and sliding metal surfaces from coming into contact while under heavy shock loads and widely varying temperatures. Internal liquid resistance to flow prevents oil from being squeezed from between moving metal surfaces of bearings, cylinder walls, and valve trains. This property of oil is commonly referred to as viscosity.

Viscosity of Oils

Viscosity of oils must be discussed in terms of (1) body, or the resistance of the oil film to puncture; and (2) fluidity, or the ease with which oil flows through distribution lines and coats metal surfaces. These characteristics can be considered opposites since the more fluidity an oil shows, the less body it has. Modern engines require an oil with great fluidity because of close tolerance but with body resistive to breakdown under the heavy loads and temperatures imposed by high horsepower output.

The viscosity of an oil can be determined by a device called a viscosimeter. The viscosimeter determines the time it takes a measured quantity of oil at a certain temperature to flow through a metered orifice.

Temperature affects oils by increasing their viscosity as the temperature drops and decreasing their viscosity as the temperature rises. According to the viscosity rating system of the Society of American Engineers (SAE), lower numbers indicate a thinner oil, higher numbers a thicker oil. Winter grade oils have a *W* after the SAE number to indicate that the oil was tested at zero degrees F. and 210 degrees F. The three automotive winter grades are SAE5W, SAE10W, and SAE20W. Automotive oil not tested at zero degrees F. is rated as SAE20, SAE30, SAE40, or SAE50. Oils can have multiple ratings, such as SAE10W-30. This number means that the oil can be substituted for grades SAE10W, SAE20W, and SAE30.

The American Petroleum Institute (API) has devised a system for classifying motor oils according to *engine service requirements.* This classification system provides six service ratings, three for gasoline engines and three for diesel engines. The first letter in each designation indicates the type of engine: *M* for the gasoline and LPG engine, and *D* for the diesel engine. The second letter in each designation indicates the type of service. The three service ratings for gasoline or spark-ignition engines are (1) *MS* for severe service; (2) *MM* for medium service; and (3) *ML* for light service.

A Viscosity Index (VI) evaluates oil in terms of viscosity change caused by variations in temperature. The adopted VI rating scale goes as high as 300. The higher the VI number indicated, the less the oil viscosity varies with temperature. In a very cold climate, the viscosity index is very important. It may be necessary, for example, to start an engine at below zero degrees F., but in a few minutes have oil temperature within the engine at 200 degrees F. In this situation the oil must not be so thick at starting that it prevents cranking, but not so thin at operating temperature that engine damage results.

Oil companies blend oil with additives to give the proper viscosity index for the type of service for which the oil is intended. Multiviscosity oils, in wide use now, are premium oils that have a high VI rating. The viscosity of an oil used in an automobile engine has much to do with the life of that engine. Manufacturers' recommendations should be followed carefully in selecting and using oil.

With the development of improved lubricating oils and more efficient oil and air filters, automotive manufacturers have liberalized their recommendations for oil changes. When favorable operating conditions exist, some manufacturers recommend that oil should be changed every two months or after 4,000 miles of operation, which-

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Suggestions for Specific Types of Fabrics

- Use needle board for pressing pile fabrics.
- Use only warm iron on man-made fibers and silk.
- Press fabrics with a raised design face down on softly padded board.
- Press lace from wrong side on ironing board covered with terry cloth.
- Set iron for the fabric on the side which is being pressed when using a bonded fabric.
- Leave wool fabrics on board until dry to avoid stretching.
- Use dry iron on all sheer fabrics except cotton.
- Do not press synthetic fur or vinyl fabrics.

Solutions to Pressing Problems

- Use stiff brush when nap becomes flattened.
- Remove shine by pressing over with a very damp cloth.
- Remove scorching by sponging with hydrogen peroxide to which sodium perborate has been added (1 teaspoon per pint). Rinse well. Test on colored fabric first in an inconspicuous place.
- Reshape curved area by pressing with steam over shaped surface.
- Use steam machine or steam iron to revive flattened pile surfaces.

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ever occurs first. Other manufacturers favor an oil change every two months or after 6,000 miles, whichever occurs first. All recommend that for more adverse driving conditions, such as start-and-stop driving, cold-weather driving, or driving through dusty areas, the oil should be changed more frequently.

Scientific Principle Involved:
Fluid Friction and Viscosity

When a liquid (fluid) is set in motion, internal structures (molecules) move at different velocities. Friction is involved as these structures slide over or rotate around each other. This friction is known as viscosity.

A liquid is made up of molecules in motion which are of different sizes for different liquids. Liquids with large molecules tend to have a higher viscosity than liquids with small molecules. This phenomenon might be explained by comparing the larger molecules to rocks and the smaller molecules to fine sand. It is much easier to force a pile of sand to flow than a pile of rocks because rocks tend to pile up and resist motion. Liquids with different-sized molecules can be mixed to obtain a desired viscosity. The smaller molecules can be thought of as little bearings that fit in with the larger molecules to provide a "ball-bearing" effect to reduce the resistance to flow of the larger molecules.

The molecular structure of a liquid is always in motion; how active the molecules are is determined by temperature. The lower the temperature, the slower and closer together are the molecules. The higher the temperature, the more rapidly and farther apart the molecules move. The more activity displayed by the molecules, the less is the energy that will be necessary to cause the liquid to flow. The opposite is true for lower temperatures. If the temperature is raised too high, the molecules tend to get so far apart that, for all practical purposes, the viscosity of the liquid may disappear.

Application of Principle

1. Obtain several different SAE grades of oil. Provide a funnel with a small metering orifice. Heat measured quantities to a given temperature (such as 200 degrees F.) and time the flow through the funnel. Cool the same samples in dry ice or in a refrigerator to a given temperature (such as 32 degrees F.). Compare the rates of flow.
2. Show the effect of cold on the cranking of an engine by cooling a small gasoline engine with dry ice. Compare how difficult this engine is to start with different grades of engine oil in the crankcase.
3. Compare the viscosity of various oils by a simple device. Place oils to be tested in plugged test tubes, each of which contains a small steel ball. Place the test tubes in a rack so that all can be rotated at the same time. The more viscosity an oil has, the longer will it take for the oil to reverse in the test tubes and for the steel ball to settle to the bottom.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), p. 37; *(20)*, pp. 260-90; *(21)*, pp. 338-45; *(22)*, pp. 174-75; *(27)*, pp. 225-26; *(66)*, pp. 39-43; *(69)*, Chapter 5, p. 5; *(75)*, Chapter 10, pp. 1-2.

Functions of Lubricating Oil

Lubricants are used to slow down wear and to reduce friction between two moving surfaces. The lubricating oil used in the four-cycle internal-combustion engine performs at least seven functions. It (1) lubricates moving parts to reduce wear; (2) reduces friction and power loss; (3) prevents spot overheating by absorbing heat as it circulates; (4) seals piston rings, pistons, and cylinder walls to prevent loss of gases on the power stroke; (5) absorbs shock in bearings; (6) dissolves lacquerlike substances and suspends other by-products of broken-down oil and worn metal through the use of detergents and the oil-filter action (helps keep engine clean); and (7) neutralizes acids (formed in the breakdown of oil by heat which would damage metal parts) through the use of additives.

Cylinder walls, pistons, and piston rings are exposed to the high heat of the burning fuel-air mixture (particularly on the power stroke). This heat will evaporate some of the oil coating on pistons and cylinder walls. The oxygen from the unused air in the fuel-air mixture together with the high temperature will partially burn part of the oil coating the exposed surfaces, leaving carbon. The heat also "cracks" some of the oil molecules, causing the formation of additional carbon.

Lubrication of the two-cycle engine is quite different from the lubrication of the four-cycle engine. Since the fuel mixture must travel through

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the crankcase, a reservoir of oil cannot be stored there. The lubricating oil is mixed with the gasoline and is then put into the gas tank. (Two-cycle engine manufacturers are now developing and marketing engines with oil-metering devices that eliminate the need for premixing the oil and gasoline.) The lubricating oil for all crankcase parts enters the crankcase as part of the fuel mixture. Millions of tiny oil droplets suspended in the mixture of gasoline and air settle on the moving parts in the crankcase, providing lubrication.

Scientific Principle Involved:
Effect of Heat on Hydrocarbon Molecules

Heat is one form of energy and has the capacity of doing work (both useful and destructive). High temperature is used in petroleum refineries to break large hydrocarbon molecules into smaller ones (cracking) in order to obtain more gasoline. The carbon and hydrogen atoms of the hydrocarbon molecules are held together by chemical bonds. When heat is added and the temperature is thereby raised, the atoms begin to vibrate, stretching the bonds (very much like bouncing a ball tied to a rubber band). When the vibration becomes too violent, the bonds begin to break.

Application of Principle

1. Demonstrate the effect of heat on lubricating oil by dipping one end of a 1-foot welding rod in oil, holding the rod with pliers, and heating the opposite end with a torch. The heat travels along the rod, and the oil begins to smoke (evaporate). Continued heating produces a black, sticky coating on the rod from the oil (carbon and lacquerlike substances). Test and compare various brands and viscosities of oils. Also test used oils (crankcase drainings).
2. Check the acid content of used oil by placing a small quantity of crankcase drainings on a piece of metal.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 36-42; *(21)*, pp. 299, 302; *(22)*, pp. 172-79; *(27)*, pp. 68, 225-26; *(36)*, pp. 111-12; *(66)*, pp. 102-3; *(69)*, Chapter 5, pp. 2-7; *(75)*, Chapter 10, pp. 1-10.

Dry, Greasy, and Viscous Friction

Friction is a force which resists motion and converts the energy of motion into heat. The "drag" due to friction depends on the roughness of the surfaces in contact, the amount of surface, and the force holding them together. Friction is both a help and a hindrance in the operation of an automobile. It helps a person to hold and turn the steering wheel. Without friction the brakes would not work and the tires would not have traction. The steering wheel, brakes, and the tire tread are all designed to increase the effectiveness of this helpful friction.

However, friction in the automobile engine and along the power train wastes energy and causes wear. The use of machined and polished moving parts, bearings, and proper lubrication all help to decrease the amount of friction. They enable the engine (and power train) parts to last longer and the automobile to perform more efficiently.

There are three types of friction: dry, greasy, and viscous. Dry friction occurs when two dry surfaces rub together. The friction between the brake lining and the brake drum is one example of dry friction. Greasy friction occurs when a small quantity of oil or grease is applied between the two contacting surfaces. Grease is applied to automobile door latches and the front wheel suspension system. Viscous friction occurs between the layers of a liquid. The lubricating oil in an automobile engine is forced between the moving metal surfaces. Viscous friction is thus substituted for sliding friction.

Scientific Principle Involved:
Dry, Greasy, and Viscous Friction

Atoms and molecules make up solids, liquids, and gases. They all behave as though they were very tiny balls. The surfaces of highly polished solids appear to be perfectly smooth. However, photographs of these surfaces, taken with an electron microscope, show "hills and valleys." The "hills" of one contacting solid surface tend to fit into the "valleys" of the other, causing friction (resistance to movement) between solid surfaces. The molecules of greases are larger and move about more slowly than those of oils (at the same temperature). The constant movement of the molecules prevents the formation of permanent "hills and valleys" between layers of greases and oils. Friction in both oils and greases should be, and is, less than solid friction, and oil (viscous) friction is less than greasy friction.

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Application of Principle

1. Measure relative friction by using several blocks of the same size (but of different materials), a spring balance, a long, flat surface, grease, and lubricating oil. Tie a string to each block in order to attach the spring balance. Test each block for all three types of friction (dry, greasy, viscous). Place a block on the long, flat surface with the spring balance attached to the block. Pull the spring balance steadily until the block begins to move. Read and record this "starting force" (pull). (The difference between the starting and moving force is the friction.) Test the blocks for dry friction and record the date of testing in a table. Coat each block with grease and repeat the experiment. Observe and record the starting force and the moving force for each block. Cover the long, flat surface with oil and repeat the experiment. Again observe and record the starting force and moving force for each block.
2. Measure the force needed on the steering wheel of an automobile to turn the front wheels. Place different surfaces under the front tires.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 440-41, 445-46; *(14)*, pp. 81-82, 95-98; *(22)*, pp. 49-51; *(27)*, pp. 225-26; *(66)*, pp. 38, 86; *(69)*, Chapter 5, pp. 2-3.

Unit 8 — SPRINGS

Mechanical energy can be stored in a spring and used in many ways in machinery, engines, watches, toys, and other devices. A spring has the capacity to store energy and release it when needed. Springs are made of steel or brass. One of the most frequent uses of springs is to supply motive power in a mechanism. A good example of this is found in the windup toy. When the toy has been wound up and the lever has been activated, the toy moves about, releasing the stored energy of the wound spring. The valve springs in an automobile engine are also used to supply motive power or energy. The spring pushes or holds the valve firmly in the valve seat of the engine until the rotating cam mechanism of the engine forces the valve lifter to open the valve. When the lifter stops pushing on the valve, the spring then pushes the valve back into the valve seat.

Another use for a spring is to return displaced mechanisms to their original position. Examples are a door-closing spring or the spring on a cam follower. The coil or leaf spring on the car frame is connected to the axles of an automobile and is used to keep the body at a certain level with respect to the road. As the automobile moves along a highway and irregularities move the car body up and down, the springs help return the body to its original position. These same springs act as shock absorbers on the automobile so that the bouncing effect is absorbed by the springs and is not transmitted to the rider in the car. In modern automobiles hydropneumatic devices are used to limit the speed of the spring action.

Springs are classified according to their shapes. The three main types of springs are the flat or leaf spring, the helical spring, and the spiral spring. The flat or leaf spring, which is made of plates or leaves, has the special advantage of both pushing or

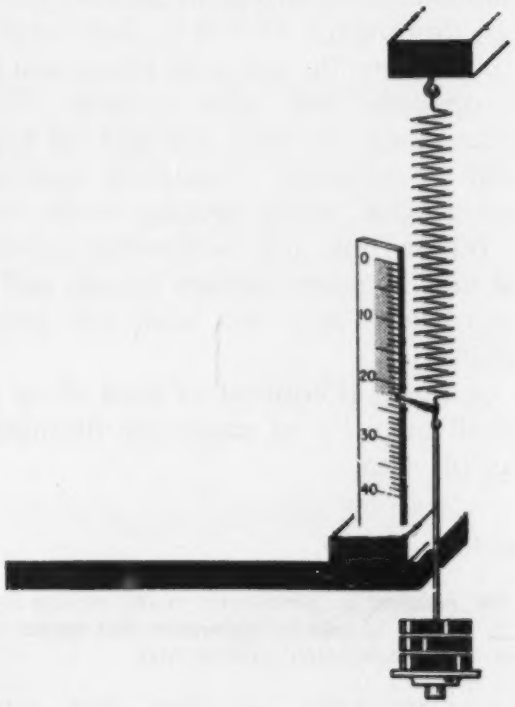

If the pointer attached to the spring returns to the zero mark after the weight is removed, the spring is perfectly elastic.

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pulling at right angles. The helical spring consists of a wire wound in a helix. It can be used for compression, such as a valve spring, or for tension, such as a brake spring. The spiral spring is a wire or band wound in a spiral that produces a torque, such as the spring found in a recoil device used in a lawnmotor starter.

Scientific Principle Involved: Elasticity

When a force is applied to a solid body, distortion of the body occurs. The greater the force, the greater is the deformation. In an elastic substance the displacement of the atoms and molecules of the substance under stress sets up forces of attraction and repulsion which resist the distorting force and tend to restore the body to its original size and shape. A substance is said to be perfectly elastic if the restoring force, called "elastic recoil," is equal and opposite to the force causing the distortion. If the body does not resume its normal shape and size on removal of the distorting force, its "elastic limit" has been exceeded. Certain metals, such as steel and brass, which possess desirable elastic properties, are used for making springs of various shapes and sizes to withstand the forces of compression, tension, and torsion for which they are designed.

Hooke's law states that *within the limits of perfect elasticity, strain is directly proportional to stress.* This is the principle upon which a spring balance operates: the amount the spring is stretched (or compressed) is directly proportional to the force applied. Thus, if 600 pounds will compress a coil spring 3 inches, 1,200 pounds will compress it twice as far, or 6 inches.

From the standpoint of conservation of energy, the spring is practically 100 percent efficient because it can return practically all of the energy stored in it on distortion if its elastic limit is not exceeded.

Application of Principle

1. Employ springs as a means of absorbing, storing, and imparting mechanical energy. Activities involving the measurement of the energy in springs might include the following:
   a. Test the tension of a screen door spring with a scale and record the pounds pull at various lengths as the spring is stretched.
   b. Test compression springs, such as internal-combustion engine valve springs, on a valve-spring tester, again noting the force required to compress the spring and the change in the length or height of the spring.
   c. Check the torque on a torsion bar with either a scale and lever or a torque wrench.
2. Pursue the method by which the spring is actuated. Some of the methods are as follows:
   a. Use a cam (like that used in the internal-combustion engine) to actuate the valve.
   b. Apply pressure, either hydraulic or pneumatic, to push on a valve (for example, check valves in a fuel pump).
   c. Use a twisting effort, such as the torsion bar or curtain roll, to demonstrate spring action.
3. Gather a variety of springs and identify them as to type (helical, spiral, or leaf); function (to absorb, store, or impart energy); or force which they counteract or react to (compression, tension, or torsion).

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 133-37; *(22)*, pp. 517-31; *(27)*, pp. 190-91; *(69)*, Chapter 15, pp. 7-16; *(75)*, Chapter 16, p. 7, Chapter 39, p. 1, Chapter 40, p. 4, Chapter 42, p.3.

Unit 9 — CLUTCHES

The purpose of a clutch is to permit the coupling or uncoupling of a power source (engine or motor) and the drive unit. In an automobile with a standard (not automatic) transmission, the clutch makes it possible to transmit the power from the engine through the power train to the wheels. The clutch utilizes the scientific principle of friction. When the clutch is in a coupled position (engaged), it provides the link which allows power to flow from the engine to the rear wheels. In the uncoupled position (disengaged), it does not permit power to flow. When the clutch is disengaged, the gear may be shifted easily. When the clutch is gradually engaged, with the automobile in gear, the vehicle moves smoothly in the selected direction.

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Classifications of clutches and examples of each include (1) the disk clutch, used in automobile transmission couplings; (2) the cone clutch, used in standard transmission synchronizers and engine-lathe controls; (3) the overrunning clutch, used in starter drives and automatic transmissions; (4) the sprag clutch, used in automatic transmissions; (5) the ratchet-dog clutch, used in automobile bumper jacks; and (6) the centrifugal clutch, used in motorcycles, lawnmowers, and go-carts.

All automobile clutches are similar in construction and operation; they are classified as single- or multiple-disk. The single disk is most widely used. Frictional contact in the clutch is made between two smooth, metallic driving surfaces and facings riveted to a driven disk. Pressure springs hold the flywheel, pressure plate, and the friction disk together. The hub of the friction disk is splined to the transmission shaft. Depressing the clutch pedal releases the spring presure, and uncoupling takes place. The flywheel, pressure plates, and the friction disk then turn independently. Releasing the clutch pedal engages the units, and the vehicle moves.

Scientific Principle Involved: Sliding Friction

One scientific principle involved in the operation of a clutch is sliding friction. This friction acts parallel to the surfaces which are sliding over one another and in the direction opposite to that of the motion. The degree of friction depends upon the materials and their surfaces. Sliding friction occurs between the brake lining and the brake drum on a

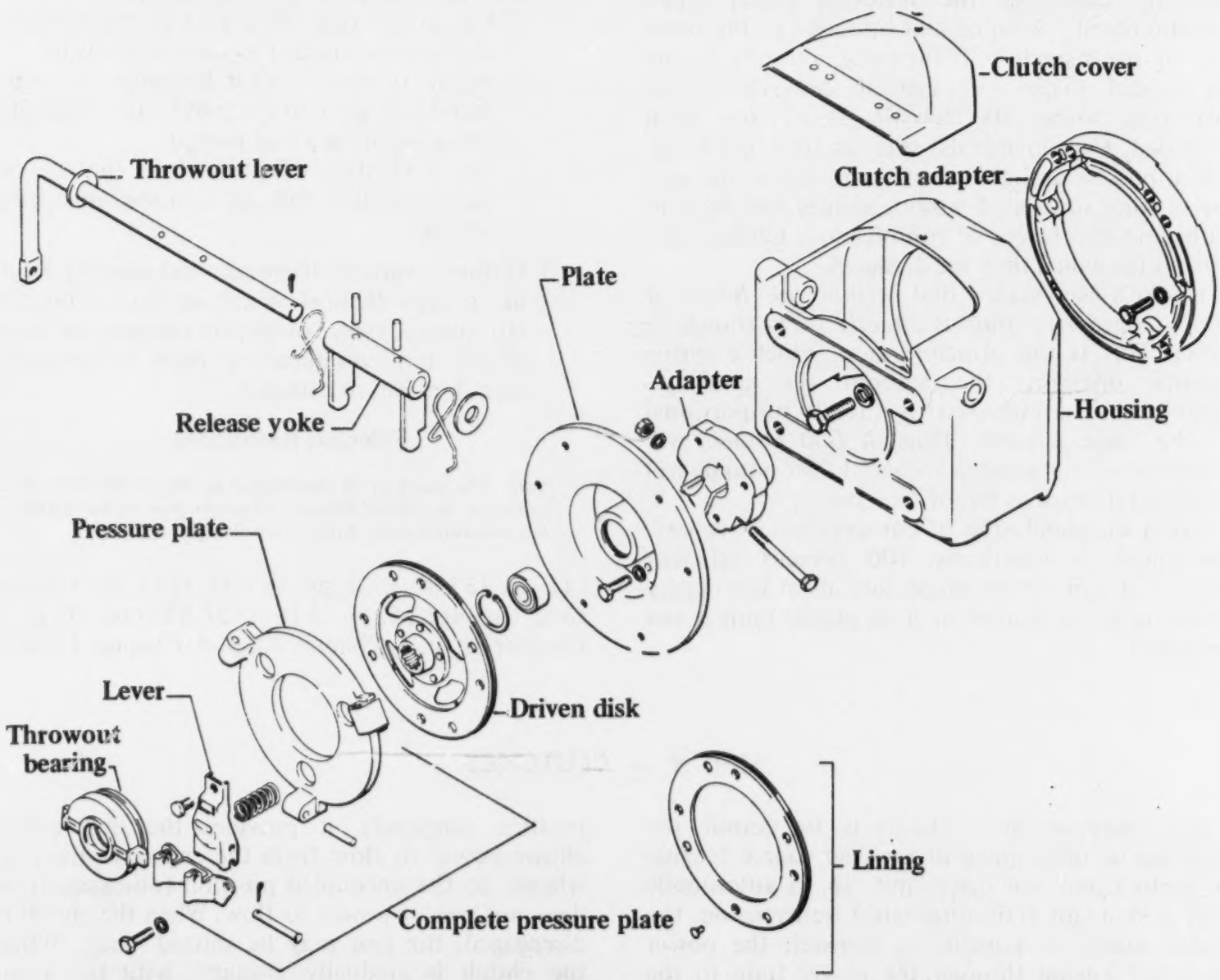

The illustration presented above gives an exploded view of the clutch unit used in the three-wheel Cushman gasoline truckster (Cushman Motors, Lincoln, Nebraska).

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car. It also occurs when two facings on the clutch are pressed between the flywheel and the pressure plate. When the friction becomes great enough between the two surfaces, slippage is almost nil. The two most important factors in this frictional force are the nature of the surfaces involved and the force pressing the surfaces together. Clutch efficiency is, therefore, dependent on the clutch's ability to transmit power from the driver to the driven through friction and, conversely, on its ability to separate the driven from the driver and avoid friction.

Application of Principle

1. Raise an automobile with a bumper jack. Examine the ratchet-dog clutch and observe it as it operates in the jack.
2. Check the operation of a coaster brake on a bicycle; this overrunning clutch stops the bicycle as increasing pressure is applied by the rider's foot on the pedal.
3. Turn the tuning knob on a radio to either the extreme left or extreme right position; continue turning the knob and note the slippage that occurs. (This is an application of the friction-clutch principle.)
4. Check cone-clutch assemblies on engine and woodworking lathes.
5. Examine, disassemble, and reassemble an automobile clutch assembly. Identify the various parts and study their functions.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 155-56; *(22)*, pp. 391-405; *(27)*, pp. 64-66; *(39)*, pp. 17-18; *(55)*, pp. 38-45; *(60)*, pp. 49-50; *(66)*, pp. 104-5; *(78)*, pp. 356-63.

Unit 10 — DYNAMOMETERS

The dynamometer is a device for determining the actual horsepower (hp) or torque (twisting in foot-pounds) that is available at the crankshaft of an internal-combustion engine or at the driving wheels of a vehicle. Dynamometers may be grouped as follows according to the three methods used to provide load: (1) the use of an electrical generator, using an electrical load; (2) the use of liquids under pressure, using a hydraulic load; and (3) the use of a mechanical shoe or disk brake, using a frictional load.

For the testing of automotive-type equipment, the electrical-load dynamometer has proven most practical. This unit is constructed to measure the power available at the driving wheels of the vehicle. Floor-mounted rollers connected to an electrical generator are driven by the wheels of the vehicle. The voltage and amperage (wattage) output of the generator circuit is instrumented to indicate the horsepower and torque at any given horsepower or engine revolutions per minute (rpm) according to the formula $Hp = volts \times amperes \div 746$, or $watts \div 746$, 1 horsepower equaling 746 watts.

In this testing it is necessary to take into consideration that the power actually measurable at the crankshaft of the engine would be much greater than at the driving wheels because of the power losses in the power-transmission train.

Electrical-load dynamometers and, occasionally, hydraulic-load dynamometers, are available that couple the engine unit directly to the dynamometer for very accurate engine evaluation.

The frictional and hydraulic-load dynamometers couple the crankshaft of the engine to a lever arm that bears on a weighing scale. The engine is placed under load at a given rpm by the frictional-brake unit or hydraulic pump while the lever is pressing on the scale. The torque in foot-pounds is determined by the simple formula which states that torque (in foot-pounds) equals lever arm length in feet, scale reading in pounds. Thus, $Hp = torque \times rpm\ of\ engine \div 33{,}000$. (The figure 33,000 comes from James Watt's determination, based on careful measurement, that a strong horse can do about 33,000 foot-pounds of work per minute.)

Scientific Principle Involved: Horsepower

Work can be accomplished by sliding, rolling, lifting, or rotating anything having mass. Work is done when a force acts on matter and changes its motion. A force (energy) can be supplied by a natural phenomenon (such as wind) or by a mechanical device (such as an engine or an electrical motor). In relation to power output, a force

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must have a time factor or rate of doing work. Power represents a mass being displaced over a distance in a certain period of time. Power is a function of the time it takes to accomplish work (force X distance moved). For the use of science and industry, it has been established that a horsepower represents the lifting of 33,000 pounds 1 foot in 1 minute. The formula is expressed as *Hp = weight in pounds X distance moved in feet ÷ 33,000 X time in minutes.*

Application of Principle

1. A simple dynamometer for small gasoline engines of about 1 horsepower can be constructed from a typical 12-volt automotive alternator or direct-current generator with a regulator. A variable resistor or carbon pile of .1 or 1 ohm capable of dissipating at least 1,500 watts should be provided for the generator load circuit. A tachometer suitable to the engine should be provided with an accurate voltmeter and ammeter. At a given rpm the load should be adjusted to give a slight drop in voltage with a maximum ampere indication.
2. A hydraulic dynamometer can be constructed by driving a hydraulic pump or water pump with a small engine and measuring the pressure and flow developed through an orifice at a given rpm.
3. A frictional dynamometer can be constructed from an automobile brake and a scale. Measure the foot-pounds of torque produced at a given rpm.
4. An experimental or demonstration dynamometer for small engines can be constructed similar to the one illustrated.

When this type of dynamometer is used, the engine must be started with no load on the generator. Once the engine is operating at peak performance, the electrical load is thrown into the circuit. The students can (a) record the voltage and amperage; (b) multiply these readings to determine the wattage output of the engine-generator; and (c) divide this product (wattage) by 746 to determine the horsepower.

In one high school the students calculate the actual horsepower of automobiles and test the performance of "tuned" and "untuned" engines by making use of a highway going over a hill of known elevation. By knowing the height of the hill, the total weight of the vehicle, and the time required to accomplish this run, the students figure the total foot-pounds of work accomplished per minute; by dividing the total foot-pounds of work per minute by 33,000, the students figure the average horsepower actually developed.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), p. 33; *(11)*, pp. 98-100; *(20)*, pp. 371-74; *(22)*, pp. 54, 253-54; *(26)*, p. 304; *(27)*, p. 125; *(47)*, pp. 82-83, 171-72; *(66)*, p. 86; *(76)*, pp. 34-37; *(78)*, pp. 52-54.

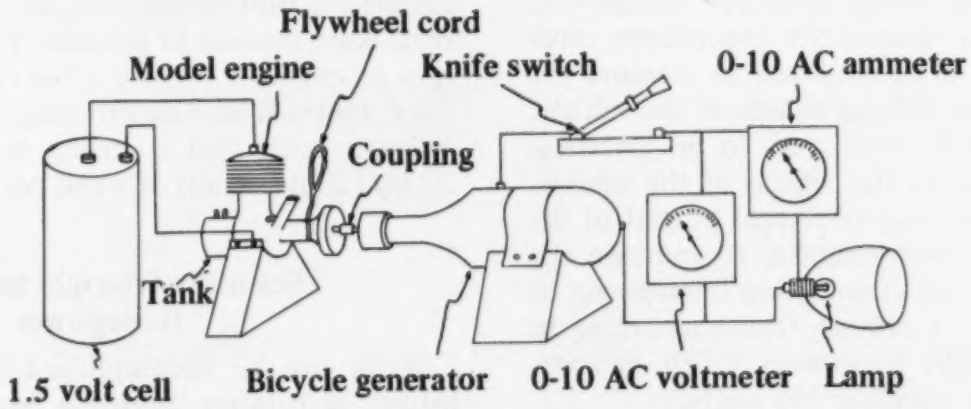

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SECTION III
STEAM POWER

Unit 11 — STEAM ENGINES AND TURBINES

When water is boiled and changed into steam, water expands about 1,700 times. If this steam is collected in a closed container and is not permitted to expand to its full volume, the pressure (and the boiling temperature of the water) will increase. When this pressure is released, it has the potential to do work. In this way heat energy (used to boil the water) can be converted into mechanical energy. The steam can be used to drive the piston of a steam engine or to drive the blades of a steam turbine. Since the generation of steam is usually done by burning the fuel outside the engine, most steam engines and steam turbines are external-combustion engines. Wood, coal, or oil is used as fuel. Nuclear power plants use heat from a nuclear reactor to produce steam.

The steam turbine has become one of man's most important sources of power. Approximately 80 percent of all electricity used in the United States is generated by steam turbines. Many ships use steam turbines to drive their giant propellers.

In a large steam turbine, the two main parts are the rotor and the stator. The rotor is a long shaft on which are mounted wheels containing a large number of sets of blades. The stator, which encases the rotor, contains a large number of fixed nozzles. Steam from the nozzles exerts pressure against the sets of blades, causing the rotor to turn. The diameters of both the rotor and the stator are larger near the outlet end to allow for the expansion of the steam. The pitch and size of the blades vary throughout the length of the turbine so that the expansive force of the steam is used efficiently.

Steam also has other valuable functions. It can be used to heat buildings and clean automotive or

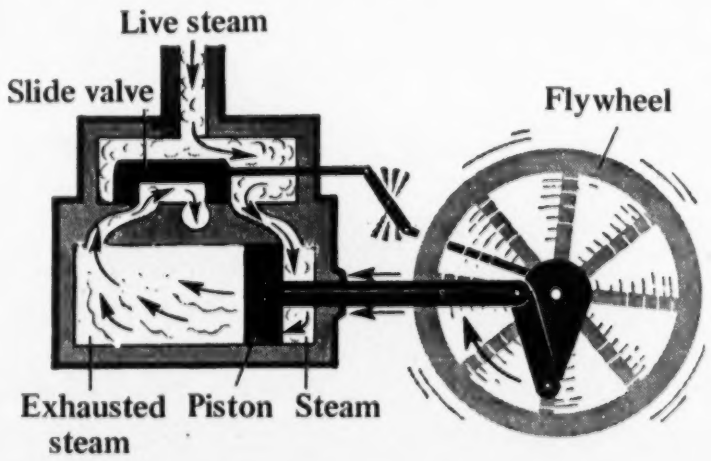

In the steam engine of James Watt, the steam pushes the piston first on one end, then on the other end, so that there is power when the piston slides forward as well as when it slides backward.

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industrial equipment. At one time the steam engine was the source of power used in automobiles. At present, in an effort to use fuel more efficiently and reduce smog, experiments are being conducted to develop a compact steam engine or turbine that can serve as a source of power for the automobile.

Scientific Principle Involved: Conversion of Heat

Whenever a gas is trapped in a confined container and the temperature is increased, the pressure increases. This pressure can be used to apply a force which can move pistons, rotate blades, or provide force for other purposes. Steam engines and turbines are heat engines using external combustion. They are able to change heat energy to mechanical energy.

Application of Principle

1. Demonstrate that the energy of steam can move an object. Punch holes diagonally from each other near two corners of a metal (spice) can. (These holes should be about one-half inch above the bottom and just around the corner on the broad surface of the can.) Put about two tablespoonfuls of water in the can and close the opening in the top. Hang the can by a thread. Apply heat to the bottom of the can.
2. Construct a simple steam turbine by using a pressure cooker or a tin can to generate steam. Fasten a small tube to the pressure cooker outlet or outlet of the constructed boiler and direct the steam to the blades of a turbine. (The turbine can consist of a few blades mounted on a small shaft or a squirrel-cage-type blower.)

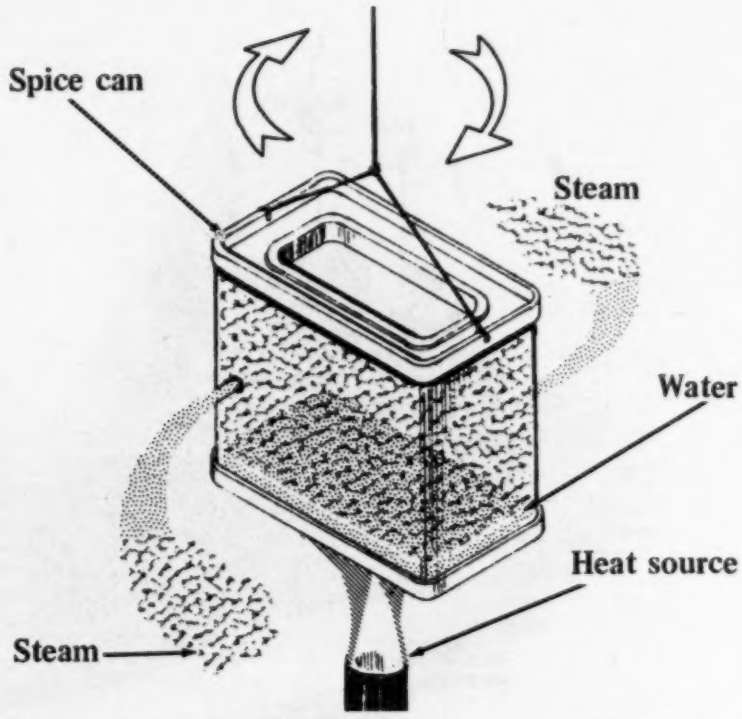

The energy of steam can be made to move an object.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(16), pp. 154-61; *(26)*, pp. 11-22, 73-88; *(27)*, pp. 271-76; *(36)*, pp. 15-18; *(37)*, pp. 347-53; *(43)*, pp. 144-69; *(44)*, pp. 74-101; *(66)*, pp. 142-48; *(73)*, pp. 14-20.

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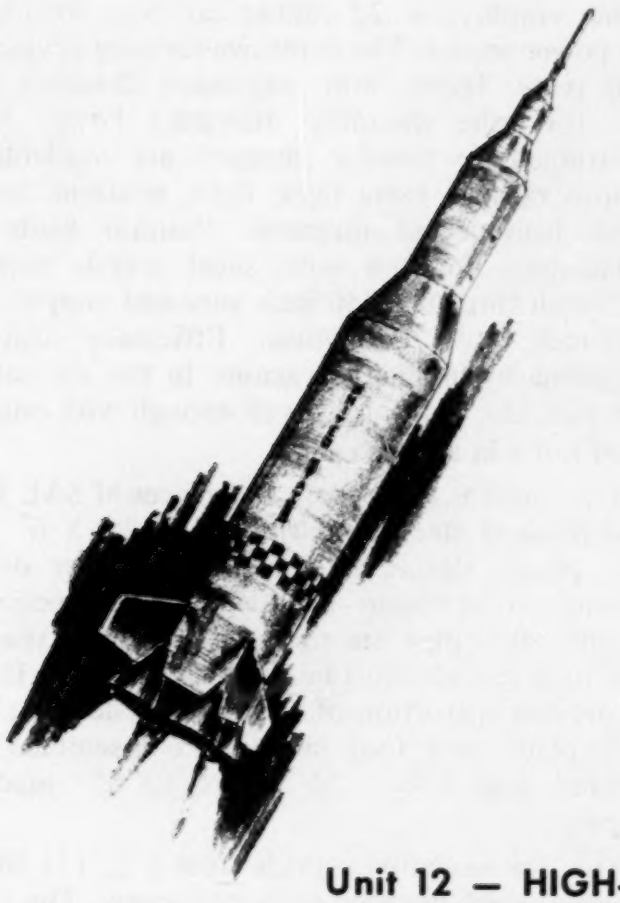

SECTION IV
THERMAL POWER

Unit 12 — HIGH-ENERGY RATE FORMING

High-energy rate forming has developed from an interesting curiosity to a metalworking reality. There are extensive possibilities for the application of this process in a wide variety of industries. High-energy rate forming of metals now includes the operations of forming, sizing, flanging, engraving, compacting, welding, hardening, and controlled cutting. Some of these operations are used commercially; others are still in the experimental stage. The material used in these operations may be in bulk, plate, sheet, or powder form. There are four methods of high-energy rate forming: explosive, electrohydraulic, electromagnetic, and pneumatic-mechanical.

Low and high explosives are used in *explosive forming.* Low-explosive powders do not actually explode but burn at a rate of several hundred feet per second and are accompanied by the rapid evolution of gas. Expansion of the gas, through either air or some other medium, such as water or a hydraulic plunger, forces the blank to the contour of the die. Low explosives are used in a closed chamber. High explosives detonate in a few millionths of a second and produce shock waves whose magnitude is in millions of pounds per square inch (psi). The charge is suspended in a medium over the material to be formed. The medium used to conduct the shock waves is usually air or water, but oil, plastics, powdered talc, and clay are also used. The charge may be shaped to direct the shock waves to specific areas of the blank. Explosive forming is used in extruding, forging, shearing, and blanking. Metal and ceramic powders have been successfully compacted by the technique of explosive forming.

Electrohydraulic forming is sometimes referred to as hydrospark forming or electric-discharge forming. The discharge of an electric spark under water produces a shock wave with sufficient energy to form metal parts. Forces equal to 6,000 horsepower (hp) within 40 millionths of a second are possible at present. The equipment used in electrohydraulic forming consists basically of a high-voltage power supply, capacitors for storing the charge, a discharge switch, and a coaxial electrode. The force can be varied by changing the voltage. The advantages of electrohydraulic forming over many other forming processes are greater safety, more precise control, and lower cost.

Another concept in high-energy forming is *magnetic forming.* Electrical energy produces magnetism which acts as the forming force. The magnetic pulses, lasting only six millionths of a second, exert pressure up to 560,000 pounds per

APPENDIX G

SCORE CARD FOR EVALUATING SEWING TECHNIQUES

Name _____ Date _____

Directions: Evaluate sewing techniques during a construction project and record by checking in appropriate column.

TECHNIQUES	SCORE	
	Acceptable	Needs Improvement
PATTERN PLACEMENT, CUTTING, AND MARKING FABRIC		
Fabric folded properly and evenly.	_____	_____
Pins placed correctly.	_____	_____
Pieces cut evenly on cutting line.	_____	_____
Center front and buttonholes marked correctly. .	_____	_____
Darts marked correctly	_____	_____
SEWING DARTS		
Stitching follows dart line.	_____	_____
Stitch size correct for fabric	_____	_____
Appropriate end finish	_____	_____
Pressed correctly.	_____	_____
ATTACHING FACING		
Facing in correct position	_____	_____
Seams clipped and trimmed properly	_____	_____
Understitching even.	_____	_____
Facing pressed to lie flat	_____	_____
Facing edge finished neatly.	_____	_____
BUTTONHOLES AND BUTTONS		
Space between buttonholes equal.	_____	_____
Buttonhole correct length for button	_____	_____
Buttonhole in correct position	_____	_____
Buttonhole straight relative to fabric grain . .	_____	_____
Stitching even and smooth.	_____	_____
Threads fastened and clipped properly.	_____	_____
Button sewed on properly	_____	_____
APPLYING ZIPPER		
Seam below zipper $\frac{5}{8}$" wide and pressed open . . .	_____	_____
Seam finished appropriately.	_____	_____
Stitching straight and appropriate width	_____	_____
Seam covers zipper from outside.	_____	_____

square inch. Magnetic forming has three classifications of forming: compression, expansion, and hammer. This forming method has the distinct advantage of forming material without marring or scratching the surface, thus eliminating further finishing operations. It can perform as many as 600 forming operations per hour. Magnetic forming is used to (1) form tubing into precise and difficult shapes; (2) expand tubing into bushings, hubs, and split dies; (3) swage inserts, fittings, and terminals into many different parts, including rope, cables, and other parts; and (4) coin, shear, and blank.

The Hyge machine, built by Convair and used for *pneumatic-mechanical forming,* is actuated by 2,000 pounds per square inch of nitrogen. When the compressed gas is suddenly released from its storage chamber, it drives a piston-column assembly at high velocity into a liquid medium which acts against the blank in the die. The machine also has been used to extrude tungsten, forge ferrous and nonferrous alloys, and compact ceramic and metal powders. Advantages of pneumatic-mechanical forming over many other forming processes are the elimination of explosives as the power source and the high repeatability of the operation.

Scientific Principles Involved: Work, Power, Energy, Force

The four methods of high-energy rate forming covered in this unit deal primarily with the scientific principles relating to energy, force, power, and work. Energy is defined as the ability to do work (or the capacity for doing work). In mechanics there are two forms of energy, kinetic and potential. Kinetic energy is energy due to the motion of a mass. A moving automobile, exploding gunpowder leaving a shell, compressed gas released from a storage chamber, and an electrical charge leaving a capacitor all have kinetic energy. Potential energy is stored energy. A coiled mainspring of a watch and a charged capacitor have potential energy. Force produces or prevents motion. It is also defined as a push or pull. Work is done when force acts on matter and changes its motion or when force moves an object against an opposing force. Power is the rate of doing work. In high-energy rate forming, the work accomplished depends upon the energy which produces the force.

Application of Principles

High-energy rate forming can be demonstrated through the use of an explosive-forming device which employs a .22 caliber cartridge (blank) as the power source. The explosive-forming device has four parts: frame, bolt, explosion chamber, and die. (See the assembly drawing.) Power loads (cartridge-type powder charges) are available in various ratings: extra light, light, medium, heavy, extra heavy, and magnum. Medium loads are satisfactory for use with sheet metals such as .015-inch tinplate, .030-inch annealed copper, and .035-inch soft aluminum. Efficiency can be increased by pulling a vacuum in the die cavity; however, the unit works well enough with only air relief holes in the die cavity.

The frame is made from two pieces of SAE 1020 cold-finished steel measuring $\frac{5}{8}'' \times 2'' \times 6''$. The two pieces should be clamped together during drilling to maintain alignment. Four pieces of $\frac{3}{8}$-inch steel pipe are used for the frame spacers. The four spacers must be precisely the same length to prevent distortion of the frame. The top plate, base plate, and four spacers are assembled and secured with four $\frac{3}{8}''$ (16 NC) $\times$ 5″ machine screws.

The bolt assembly is made from a $\frac{5}{8}''$ (11 NC) $\times$ 3″ alloy steel hexagon-head cap screw. The firing pin and firing pin retainer are made from an oil-hardened drill rod and both are heat-treated to 52Rc (Rockwell). If heat-treating facilities are not available, parts 1 and 2 may be made from heat-treated SAE 4140 steel. This material is machinable and tough enough to serve the purpose well. The firing pin retainer also serves as the bolt handle. The die-centering pin at the bottom of the frame is a modified $\frac{3}{8}''$ (16 NC) $\times \frac{1}{2}''$ round-head machine screw and keeps the die centered in the frame.

The explosion chamber is made from 1020 steel. It is important to maintain reasonable concentricity in all machined parts and to leave the cartridge chamber undersize for later reaming by a gunsmith. The die cavity is also made from 1020 steel. The size of the air relief holes is determined by experimentation.

When all parts have been completed and before heat treatment of the firing pin and firing pin retainer (if a drill rod is used), the unit should be assembled, and the assembly should be checked by a qualified gunsmith. In particular he should check the firing pin length, check the head space, and ream the chamber for .22 caliber. The charge for this service varies, but generally is less than the cost of a chambering reamer.

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The material to be formed should be cut to 2¼-inch diameter and placed between the explosion chamber and the die. A power load should then be inserted into the chamber, this assembly should be placed in the frame, and the bolt should be turned down securely.

For safety the unit is so designed that the explosion chamber is recessed into a counterbore in the die cavity, and the bolt enters a counterbore in the explosion chamber. It is practically impossible to discharge a power load unless all parts have been securely and properly assembled.

The power load is discharged by striking the firing pin sharply but *lightly* with a small hammer. The expended power load may be extracted with a 6-inch piece of ⅛-inch brazing rod.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 436-50; *(16)*, p. 91; *(27)*, pp. 120-31; *(45)*, pp. 1-884; *(61)*, pp. 133-45.

Note: A 60-page book, *High-Energy Rate Forming and Testing*, (No. R-96), can be purchased from the *American Machinist*, Reader's Service Department, 330 West 42nd Street, New York, N.Y. 10036, for $2.00.

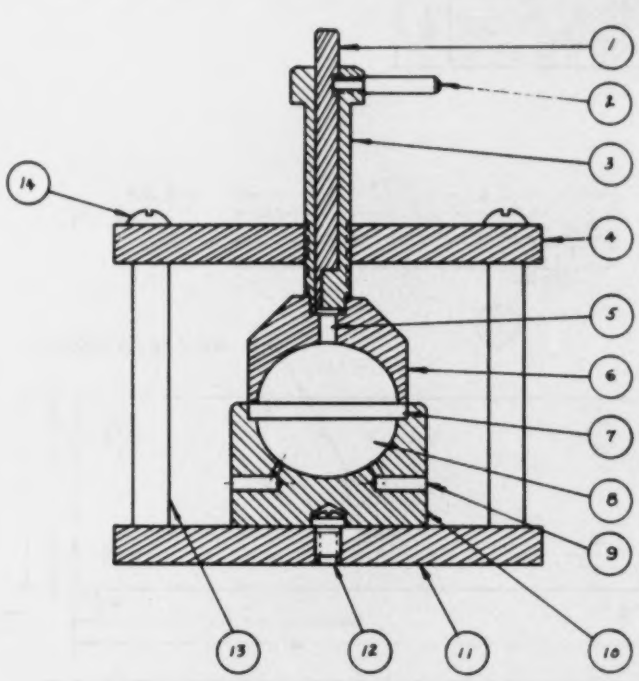

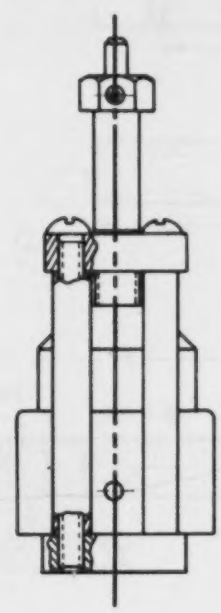

Caution: Place explosive-forming device behind wireglass screen or in metal or wood container before firing.

NO	PART NAME	REQ	MATERIAL
14	3/8 X 5 MACHINE SCREW	4	STEEL
13	3/8 DIA PIPE	4	GAL.
12	FILLISTER HEAD CAP SCREW	1	STEEL
11	BASE PLATE	1	CF1020
10	LOWER CASING	1	CF1020
9	AIR RELIEF HOLES	2	———
8	DIE CAVITY	—	———
7	MATERIAL TO BE FORMED	—	———
6	UPPER CASING	1	CF 1020
5	FIRING CHAMBER	—	———
4	TOP PLATE	1	CF 1020
3	HEX HEAD CAP SCREW	1	STEEL
2	FIRING PIN RETAINER	1	STEEL
1	FIRING PIN- HEAT TREAT	1	DRILL ROD

EXPLOSIVE-FORMING DEVICE

DESIGNED BY F. ACCURSO — SCALE 3/4" = 1"

DR BY STERLING C. LOWE — SHEET 1 of 2

Developed by
Frank P. Accurso, Merritt College
Peralta Junior College District, Oakland

Drawings by
Sterling C. Lowe, Encina High School
San Juan Unified School District, Carmichael

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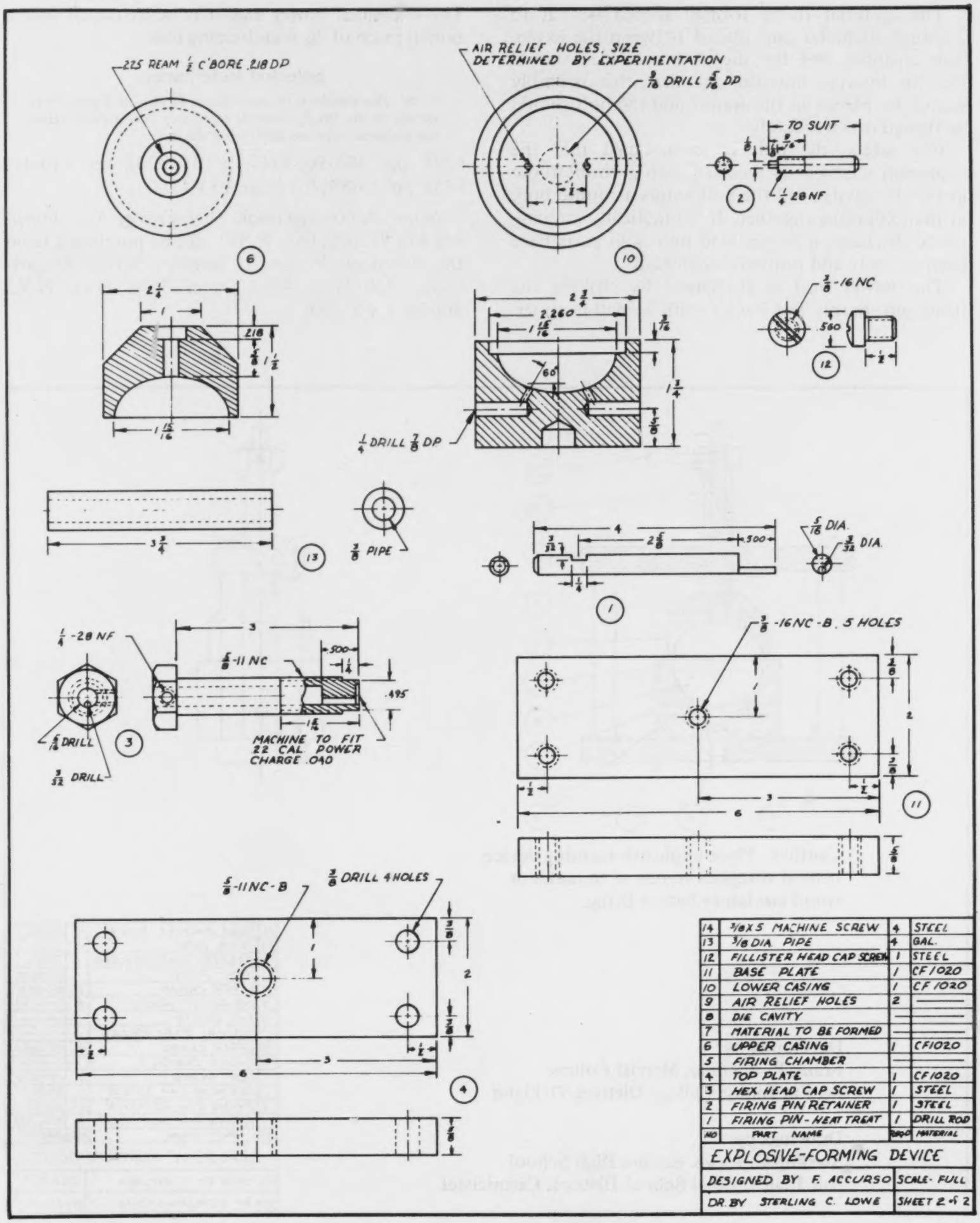

NO	PART NAME	REQ	MATERIAL
14	3/8 X 5 MACHINE SCREW	4	STEEL
13	3/8 DIA. PIPE	4	GAL.
12	FILLISTER HEAD CAP SCREW	1	STEEL
11	BASE PLATE	1	CF 1020
10	LOWER CASING	1	CF 1020
9	AIR RELIEF HOLES	2	———
8	DIE CAVITY	—	———
7	MATERIAL TO BE FORMED	—	———
6	UPPER CASING	1	CF1020
5	FIRING CHAMBER	—	———
4	TOP PLATE	1	CF 1020
3	HEX HEAD CAP SCREW	1	STEEL
2	FIRING PIN RETAINER	1	STEEL
1	FIRING PIN - HEAT TREAT	1	DRILL ROD

EXPLOSIVE-FORMING DEVICE

DESIGNED BY F. ACCURSO — SCALE - FULL

DR. BY STERLING C. LOWE — SHEET 2 of 2

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Unit 13 — POWDER-ACTUATED TOOLS

Among the most interesting of the recently developed tools are powder-actuated tools. These tools use energy from the firing of a powder charge to drive a fastener into concrete or steel. Many attempts were made to use explosive energy for this purpose as early as the turn of the century, but not until 1945 was a method developed that was commercially practical. Today, labor on hundreds of fastening jobs is greatly reduced by powder-actuated tools. This method makes use of a stud-driving tool, a powder charge, and a fastener (stud). Powder-actuated tools have two primary functions. First, they set threaded studs into concrete and steel for fastening removable installations. Second, they drive nail-like studs through materials into concrete and steel for making permanent installations.

Since powder-actuated tools make use of the high-pressure gases developed by the confined burning of powder (nitrocellulose propellant), they are potentially as dangerous as any other form of explosive. However, improvements in these tools since they were first introduced have made them relatively safe to operate as long as the prescribed precautions are observed. Because safety is such an important factor in operating powder-actuated tools, all operators must be certified before they may fire an explosive tool. To obtain a certificate, an operator must pass a written test on the safe operation and care of the tool.

The first safety practice to be observed is to read and understand the instruction manual provided for the particular powder-actuated tool before attempting to operate the tool. These manuals describe the components of the stud-driver, the loading and firing cycle of the tool, the parts list and parts numbers, the use of the extension, the use of the shield, the proper maintenance of the tool, and the particular precautions to be observed. All of the safety precautions presented in a manual are important and must be observed in order to prevent injury to the operator or to a bystander. Certain of these precautions take precedence over others. The general sequence of importance of these precautions is indicated in the safety instructions that follow:

1. Use a positive guide to insure alignment when setting a fastener through a previously prepared hole in steel.
2. Always fire from a fully shielded position as protection against ricochet.
3. Use an extension only when the safety control rod is accurately set to prevent firing at an angle.
4. Make sure before firing that the fastener does not have sufficient power to drive completely through the material.
5. Always set the fastener 3 inches or more from the edge of concrete.
6. Always set the fastener ½ inch or more from the edge of steel.
7. Use only a factory-recommended fixture for any special fastening as described in the manufacturer's instruction manual.
8. Allow at least 30 seconds before removing a tool from the work surface in the event it does not fire; then remove the powder charge and dispose of it safely.
9. Be sure the tool is unloaded when not in use. If an operator decides not to fire the tool, he must unload it.
10. Never fire into cast iron, tile, high carbon steel, or other hard or brittle materials.

Despite the many hundreds of applications performed daily by a powder-actuated tool, there are only a few simple basic rules that govern the system and make it possible for the operator to do good work. These rules are as follows:

1. Know the material to be penetrated. If a common nail can be hammered into the base material, don't use a powder-actuated tool.
2. Select the proper fastener for the job. Consider only the section of the fastener that is to be imbedded under the work surface of the material since the section above the work surface of the material will be determined by application requirements. When selecting a fastener for concrete, choose one that will penetrate into the concrete a minimum distance of eight times the diameter of the shank of the fastener. A light-duty fastener with a shank diameter of 5/32 inch must penetrate 1 ¼ inches; a heavy-duty fastener with a shank diameter of ¼ inch must penetrate 2 inches. When selecting a fastener for steel, remember that the whole point of the fastener must appear through the reverse side of the steel plate.

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3. When selecting a powder charge to set a fastener into either steel or concrete, or when determining how far to insert the stud into the barrel, always use the weakest powder charge or insert the stud a fair distance into the barrel for the first fastening. Learn the color codes some manufacturers have placed on the powder charges, for the different colors designate powder charges of varying intensity. The colors should be memorized for immediate recognition. The power of the charge is indicated by the color of the wads in the mouth of the cartridge case as well as on the box or container in which they are packed.
4. Know the holding power of the fastener. A powder-actuated tool is designed to maintain a balance in the relationship of the power of the cartridge to the length and diameter of the fastener shank. If a fastener is selected within the proper limits – that is, eight diameters into concrete or the whole point through the reverse side of steel – the correct holding powers will generally result.

Scientific Principle Involved: Expansion of Gases

The propelling force of the powder charge (nitrocellulose, the successor to gunpowder/black powder) results from the rapid burning and evolvement of hot gases that exert a sustained forward force or pressure on the missile or projectile. The rapid conversion of the powder charge into hot gases that have a larger volume than the volume of

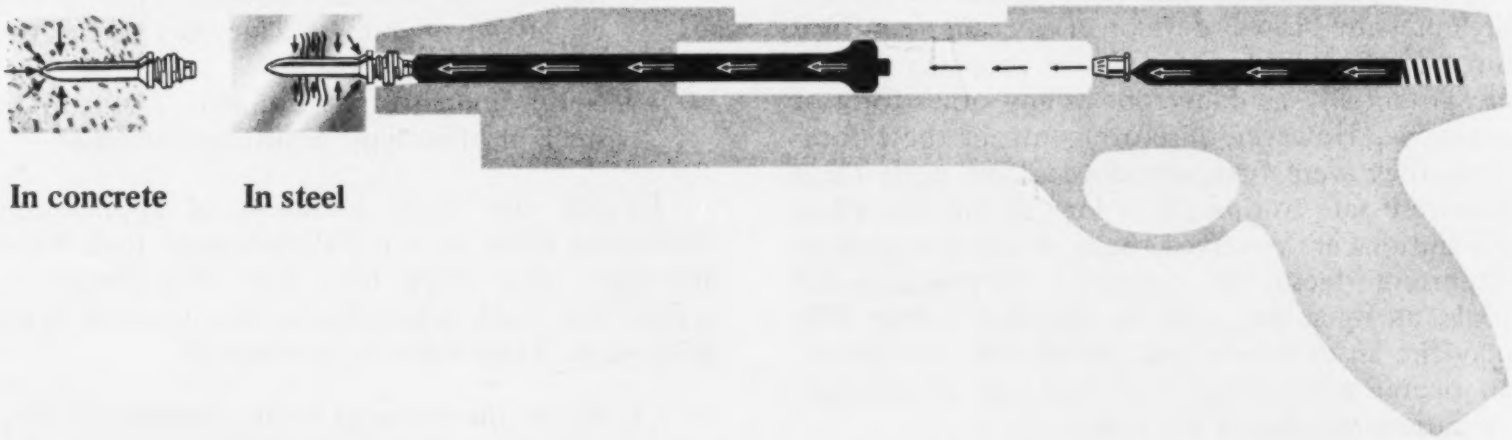

In concrete In steel

The powder-actuated tool (above) utilizes the energy from a power source to set threaded studs or drive pins through materials into concrete or steel (USM Fastener Company, Shelton, Connecticut).

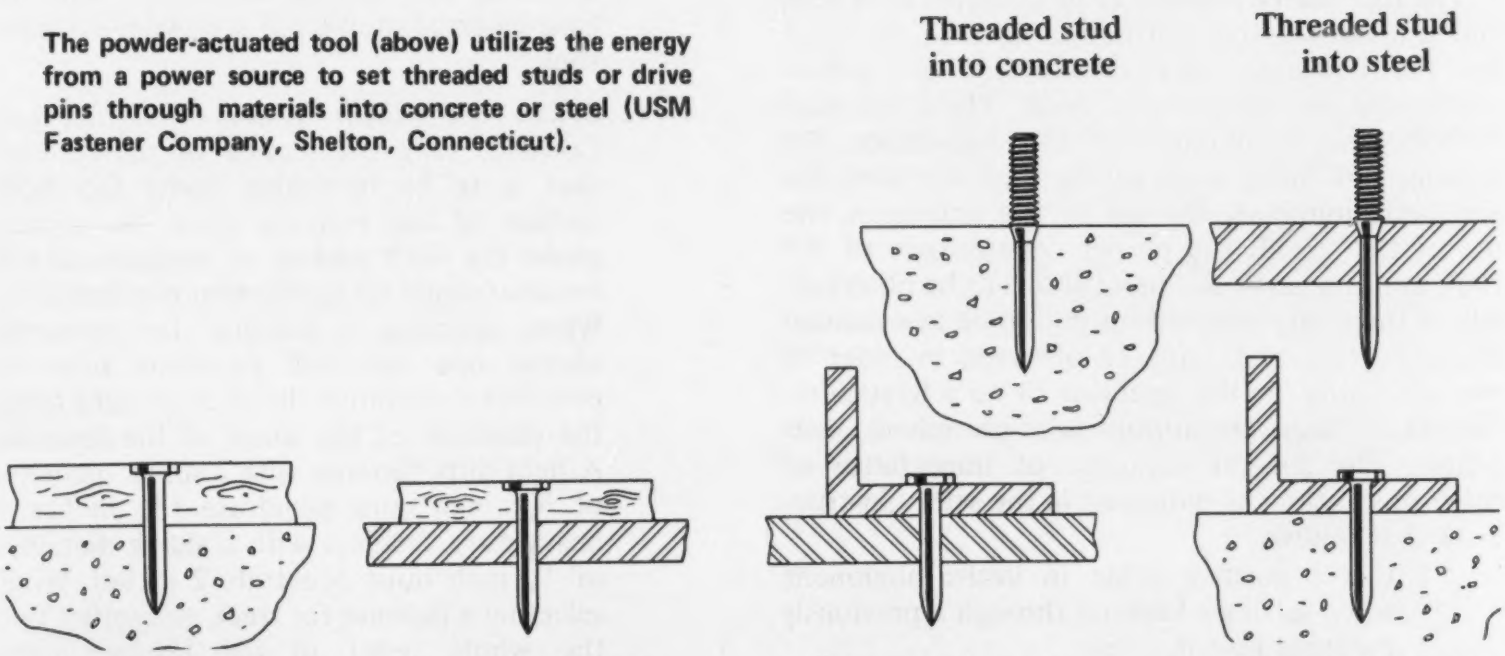

Drive pin through wood into concrete

Drive pin through wood into steel

Drive pin through steel into steel

Drive pin through steel into concrete

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the original charge overbalances the restraining pressure of the surrounding matter.

Application of Principle

Since the powder charge and fastener are potentially as dangerous as ammunition, the powder-actuated tool must be operated by a person with an operator's certificate. A qualified teacher, construction worker, or manufacturer's representative should demonstrate the use of this tool. The explosive-forming device (referred to in Unit 12, "High-Energy Rate Forming") can be used to demonstrate the propelling force of a powder charge.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(16), p. 91; *(18)*, Article 27; *(27)*, pp. 237-38; *(61)*, pp. 133-45.

Note: Operators' manuals published by the manufacturers of Drive-it, Ramset, and Remington powder-actuated tools can be obtained from local suppliers of industrial equipment and concrete fasteners.

The caseless "power-cap" (right) is used in a newly developed powder-actuated tool to drive pins and studs into concrete and steel. It reduces fastening-cycle time; burns cleaner, with no residue; and eliminates cartridge case ejection. It works as follows (see below): (1) cap in position, firing pin armed; (2) firing pin releases, squeezing cap against anvil; (3) heat transfer begins; and (4) cap is completely consumed, energy is ported through anvil into barrel, activating piston ram (USM Fastener Company, Shelton, Connecticut).

Eight times actual size

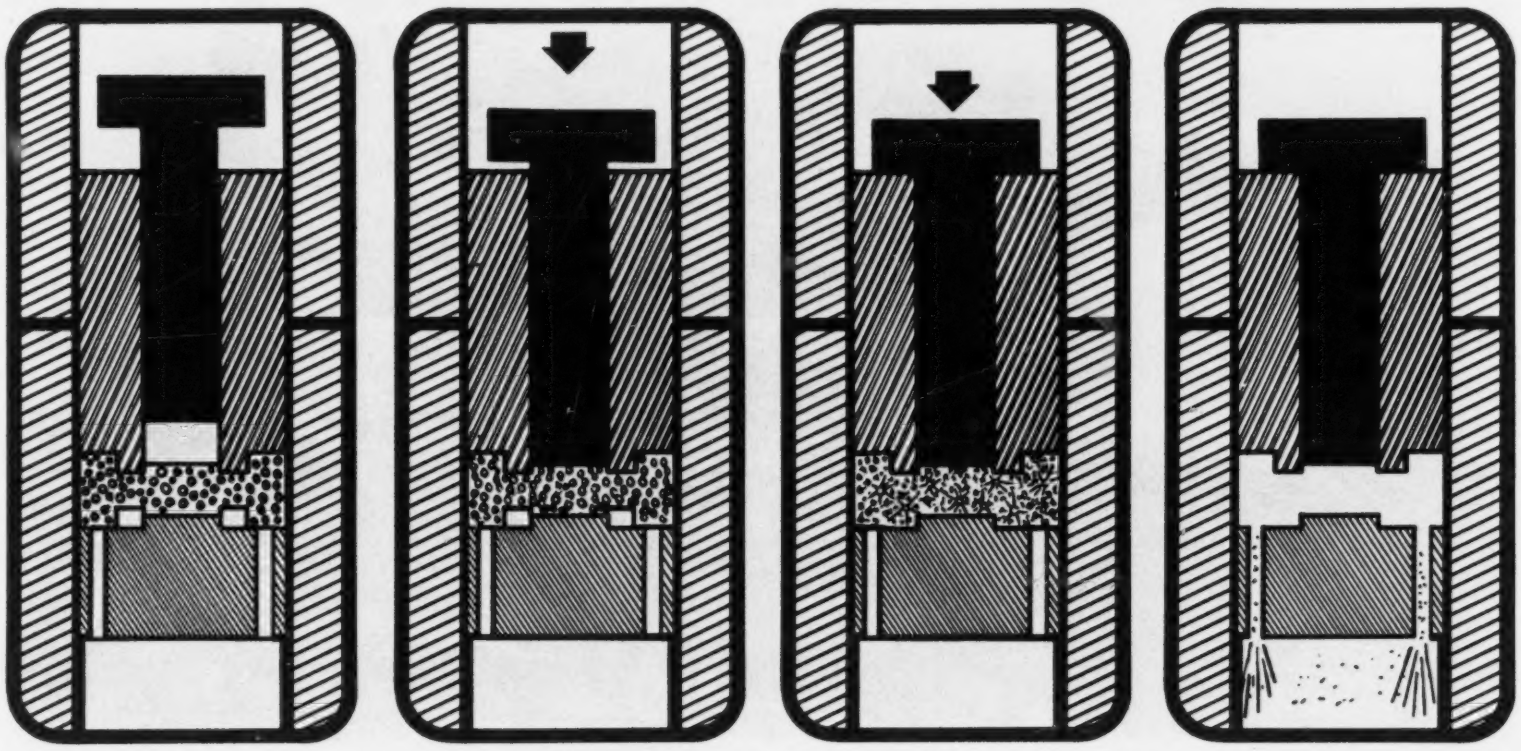

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Unit 14 — JET AND ROCKET ENGINES

Jet and rocket engines are internal-combustion engines. They operate through the application of Newton's third law of motion: *For every action there is an equal and opposite reaction.* Burned gases leave the engines with great force. The opposite reaction is an equal thrust in a forward direction. As a result the jet or rocket engine is pushed (thrust) forward, carrying the plane or rocket with it.

Jet and rocket engines operate identically in relation to Newton's law. However, they differ in the way their fuel is prepared for combustion. A jet engine sucks in air from the atmosphere and mixes it with the fuel for burning. A rocket carries its own air in the form of an oxidizer and operates in space, where there is no atmosphere.

The jet engine is defined further as one which propels itself by the same gases that convert the fuel's thermal energy into mechanical work — turning the air compressor turbine.

There are three types of jet engines using the same basic principles of operation: the turbojet, the turbofan, and the ramjet engines. They are described as follows:

1. The *turbojet or gas turbine engine* is thought of as a "pure" jet engine because it most closely follows the above description. In the turbojet engine, air is brought into the front of the engine by a compressor. The compressor forces the air into the center section of the engine, where fuel is added and ignited. The burning fuel increases the temperature and the pressure in the chamber. The gases, therefore, exert a heavy force in all directions. The compressor prevents the gas from escaping out the front. As the gas escapes out the rear, it drives a turbine. The only function of the turbine is to drive the compressor. As the gases escape out the exhaust, a forward push is given to the engine. This push is called thrust, which is measured in pounds. Thrust is, therefore, the forward push (force) resulting from the pressure in the combustion chamber. In the turboprop engine the combustion gas turns a propeller as well as a compressor. Propulsion power in this case comes from the propeller. The exhausting gas, depleted of most of its energy in operating the prop and the turbine, adds little thrust to the turboprop engine.
2. The *turbofan engine,* one of the most widely used engines, modifies the operation of the

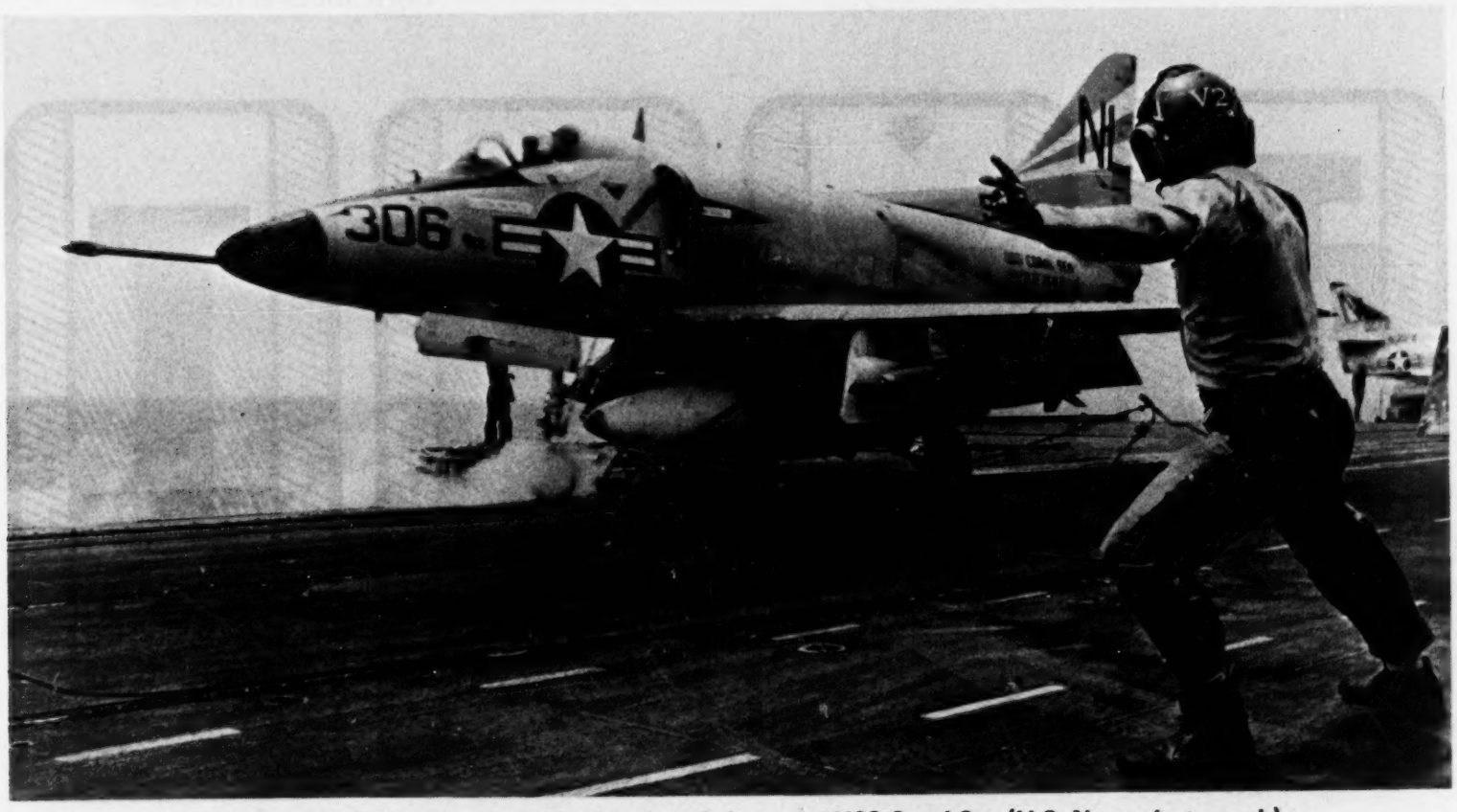

A steam catapult is used to launch a jet aircraft from the USS Coral Sea (U.S. Navy photograph).

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turbojet engine. The turbofan engine is able to process greater quantities of air, provide increased thrust, and operate at lower temperatures. This improvement is accomplished by providing a bypass around the combustion chamber for a portion of the incoming air. This air is shunted to the rear of the engine, where it combines with the heated gases. The mixing of the gases makes more efficient use of the available heat, producing greater thrust.

3. The *ramjet engine* does not even use a compressor, has no moving parts, and requires high speed before it can operate; it cannot be started from rest. The forward motion of the engine brings in the air. The shape of the combustion chamber prevents the air already in the chamber from being compressed by the incoming air. Fuel is added and ignited, and thrust is produced in the same manner as in the turbojet engine. The incoming rush of air prevents the forward exhaust of the burned gas. At high speeds the ramjet engine is more efficient and trouble free than the turbojet engine; however, the ramjet engine cannot be used when the plane is standing still or is traveling at slow speeds. Future jet engines may take advantage of both turbojet and ramjet features. A combination engine called a turboramjet engine has been proposed. It would take off and operate as a turbojet engine. When sufficient speed is reached, it would operate as a ramjet.

The rocket engine uses the same principles of operation which control the jet engine. However, it operates independent of air, carrying a supply of both fuel and oxidizer. Since the "reaction principle" of motion does not require atmosphere, the rocket engine operates effectively in space. In operation, oxidizer and fuel are ignited in a combustion chamber. The resulting gases are heated to a very high temperature, producing a high pressure. As the gases escape from the rear of the engine, a strong forward thrust propels the rocket.

The same principle of operation that is applied to the turboprop engines of planes can be applied to gas turbine engines in automobiles. In these engines nearly all of the force of the escaping gas is absorbed by the turbine. The turbine serves a dual function. Part of the energy is used to drive the compressor bringing in the air needed for combustion. However, the larger portion of the energy is used to rotate the airplane propeller when the turboprop engine is used or to rotate the wheels of the automobile when the gas turbine is used.

Scientific Principle Involved: Newton's Laws

Gas confined within a container exerts pressure equally in every direction. As long as the container is sealed, the forces resulting from the pressure are in balance. If the pressure is relieved at any point, however, the force at that point will drop. As a result the force opposite the reduced force will cause movement or apply an unbalanced force in a direction opposite that of the relieved pressure. This same principle can be identified in a different manner: for every action there is an equal and opposite reaction. In the case of gas pressure, relief of the pressure (by opening the chamber at that point, exhausting the gas) produces an opposite and equal reaction. The reaction is a push away from the point at which the pressure is released.

Application of Principle

1. Newton's third law of motion (for every action there is an equal and opposite reaction) can be demonstrated by filling a toy balloon with air and releasing the balloon. The balloon goes forward (reaction) with a force equal and opposite to the force of the escaping air.
2. The principle of jet and rocket propulsion can be taught by constructing a small rocket, using a CO_2 cartridge as the engine. The rocket can be operated on a string on the school grounds. The most important consideration for a good flight is to get a hole punched in the cartridge and the rocket released before much of the CO_2 escapes.
3. The thrust of a CO_2 cartridge can be measured by attaching the cartridge to a bicycle wheel and checking the movement of the wheel with a dynamometer.

Selected References

***Note:** The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.*

(1), Volume 5, pp. 918-25, Volume 7, pp. 1237-39, Volume 10, pp. 1859-62; *(7)*, pp. 13-14; *(9)*, pp. 119-20; *(13)*, pp. 192-99, 519; *(22)*, pp. 75-77; *(24)*, pp. 238-43; *(26)*, pp. 233-88; *(37)*, pp. 383-91; *(54)*, pp. 507-14; *(55)*, pp. 81-108.

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Unit 15 — GASOLINE TESTING

Two tests used in comparing the power of gasolines are the Full Load Power Test and the Fixed RPM Power Test. The units used in the measurement are foot-pounds of torque (fpt).

A single-cyclinder engine is generally used in testing the power of gasolines. The engine fuel-supply system must be equipped with a quick-change system, which can be made by fitting the fuel line with a glass jar lid in a way that will permit the person performing the test to rapidly interchange jars containing samples of different gasolines.

The engine is equipped with a tachometer, and the load is applied by a dynamometer. Readings of the revolutions per minute (from the tachometer) and foot-pounds of torque (from the dynamometer) are made and recorded for each sample of gasoline for full load power and fixed rpm power.

Directions for performing the tests are as follows:

1. *Full Load Power Test.* Adjust the throttle and dynamometer until maximum readings for both rpm and fpt are observed. Record these readings.
2. *Fixed RPM Power Test.* Adjust the throttle to maintain 2,000 rpm while increasing the load on the engine with the dynamometer. Record the highest fpt reading which can be obtained without dropping below 2,000 rpm.

Today's best gasoline engines reach an efficiency of 25 to 30 percent. Higher efficiency of the engine is obtained by increasing the pressure (compression) of the fuel-air mixture in the cylinder just before it is ignited. However, high compression raises some difficult practical problems, such as making pistons and valves fit perfectly. Also, when the pressure on the gasoline vapor is suddenly increased by the compression of a piston, the gas gets hot. In fact, under high compression the fuel mixture gets hot enough to explode before the spark ignites, causing engines to knock. Chemists have developed a gasoline that can be highly compressed without exploding too soon. High-octane gasoline is highly resistant to knock; low-octane fuel knocks easily. A gasoline is rated by the use of an octane-rating number (ONR). Iso-octane is given a rating of 100 because it is very resistant to knocking. Another fuel, heptane, is given a rating of zero because it knocks easily. A mixture of half iso-octane and half heptane (by volume) has a rating of 50. Iso-octane and heptane are reference fuels used to test and rate unknown fuels.

Scientific Principle Involved: Conversion of Energy

Gasoline (chemical energy) is useful as a fuel for internal-combustion engines because it is easily evaporated and very flammable. A mixture of gasoline vapor and air provided by the carburetor enters the cylinder, the piston moves up to compress it, and an electric spark ignites the compressed mixture. The burning is a fast chemical reaction that produces carbon dioxide (CO_2), water vapor, and a large amount of heat (heat energy). The heat produced expands the CO_2 and water vapor, forcing the piston down. The downward movement of the piston (mechanical energy) turns the crankshaft.

The dynamometer makes use of friction to measure the torque (twisting rotational force) produced by an engine. Force is a push or a pull which tends to produce movement. Friction is the resistance to movement which is observed when two surfaces make contact.

Application of Principle

1. Samples of various grades and brands of gasoline should be given the Full Load Power Test and the Fixed RPM Power Test. The recorded readings should be compared to determine what significant differences of power have been demonstrated, and the various differences in automobile engine design and conditions which affect its fuel requirements should be discussed. Some of the factors which should be in the discussion are compression ratios, carburetors, gasoline octane ratings, spark coils, capacitors, distributor points, spark plugs, and ignition wires. *Note:* Poisonous carbon monoxide is present in the exhaust gases of a running engine. Good ventilation is a "must" to prevent carbon monoxide poisoning whenever an engine is being operated indoors.
2. A fractionating tower can be assembled to distill petroleum. *Note:* It is unsafe to heat petroleum with an open flame above 75 degrees C. Rubber tubes must be connected from the fractionating tower to the collecting bottles. Petroleum warmed to 40 degrees C.

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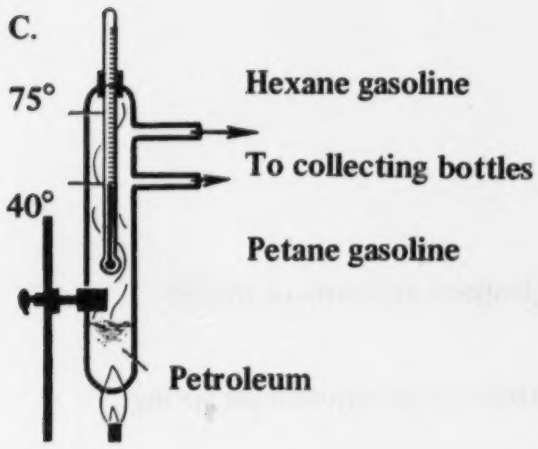

will produce a vapor that when condensed will be pentane gasoline; to 75 degrees C., hexane gasoline.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(16), pp. 100-101, 166-67; *(22),* pp. 49-59, 165-77; *(69),* Chapter 6, pp. 1-38; *(75),* Chapter 20, pp. 1-8.

Unit 16 — CARBURETION

Most American internal-combustion engines use gasoline as fuel. Gasoline is obtained from petroleum and is composed primarily of hydrogen and carbon compounds. By the mixture of correct amounts of gasoline and air and the ignition of this mixture in an engine, power is produced to drive a vehicle. The mixing of gasoline and air in controlled amounts is known as carburetion. The device on automobiles and other units driven by internal-combustion engines that performs this function is called a carburetor. The carburetor performs several specialized functions. The names and brief descriptions of these functions are as follows:

1. *Float circuit.* The major function of the float circuit is to keep the bowl filled with gasoline. As the level of gasoline approaches full, the float rises and cuts off the ingress feed; when the float drops, the valve is opened, allowing the ingress feed to open.
2. *Idle and low-speed circuit.* This circuit operates when the throttle is closed or nearly closed. At this time only a small amount of air can flow through the carburetor air horn (air intake), causing a limited mixture to be supplied to the engine.
3. *High-speed, part-load circuit.* As the throttle is opened for high speed, it moves past the low-speed port in the carburetor and allows air to pass the air horn in a sufficient quantity to furnish a mixture adequate for the demanding conditions.
4. *High-speed, full-power circuit.* This circuit is designed to do what its title suggests. The mixture supplied is satisfactory for engine operation from partly open to nearly wide-open throttle. When the throttle is opened wide, a metering rod and jet assembly allow more gasoline to pass a point and provide an enriched mixture.
5. *Accelerating pump circuit.* This circuit carries the engine through the closed throttle to open-throttle transition period. The transition period is ofter referred to as a "flat spot" in engine performance.
6. *Choke circuit.* This circuit is designed to cause the carburetor to deliver great amounts of fuel for starting when the engine is cold. The circuit can be controlled electrically, thermostatically, or manually.

A great deal of air passes through the carburetor and engine. Air is likely to contain a great amount of dust and grit. These impurities, if they entered the engine, could cause serious engine damage. All air entering the engine through the carburetor must first pass through an air cleaner. Air cleaners contain filter material (fine-mesh metal threads or ribbons, special paper, cellulose fiber, or polyurethane) or oil reservoirs to remove dust and grit from the incoming air.

Scientific Principle Involved: Bernoulli's Principle

When a fluid is undergoing a change in velocity, the pressure, measured at right angles to the direction of flow, is lowest at the point of highest velocity. A venturi is built in the air tube leading to the jets in a carburetor. The air moves through the venturi, causing a low pressure as it reaches the area of the tube, where the diameter is less

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APPENDIX H

STANDARDS FOR FITTING WOMEN'S CLOTHES†

Name _____ Fitter _____

ITEMS TO CHECK	GENERAL APPEARANCE		
	Good	Poor	Correction Necessary
GENERAL APPEARANCE			
Enough ease to provide comfort, yet not sloppy.	____	____	____
Blouse or bodice hangs gracefully and smoothly from shoulder seams	____	____	____
Skirt hangs smoothly and gracefully from waistline	____	____	____
Key grain lines in place on figure.	____	____	____
Garment is in perfect balance on figure	____	____	____
SHOULDER SEAM			
Shoulder seam lies along the center of top of shoulder, not noticeable from either back or front (in normal figure).	____	____	____
Shoulder seam begins at about 1 inch behind earlobe and extends to shoulder tip at right angles to armhole	____	____	____
Shoulder seam area is smooth without pulling, straining, or wrinkling	____	____	____
NECKLINE SEAM			
Normal neckline fits curve at base of neck, crossing center back on most prominent vertebrae when head is tilted forward and crossing center front at pit of the neck just above the collar bone.	____	____	____
Neckline does not ride up, pull away, or stand out	____	____	____
UNDERARM SEAM			
Underarm seam falls in vertical line beneath arm, starting from center of underarm and dropping in perpendicular line to floor . . .	____	____	____
Underarm seam of bodice meets side seam of skirt	____	____	____
Underarm seam divides back and front when viewed from side.	____	____	____
Underarm seam is not obvious when viewed from back or front	____	____	____

†Adapted from Cozine, June, & others. *A pilot study for gainful employment in home economics.* Washington, D.C. U.S. Government Printing Office. 1968.

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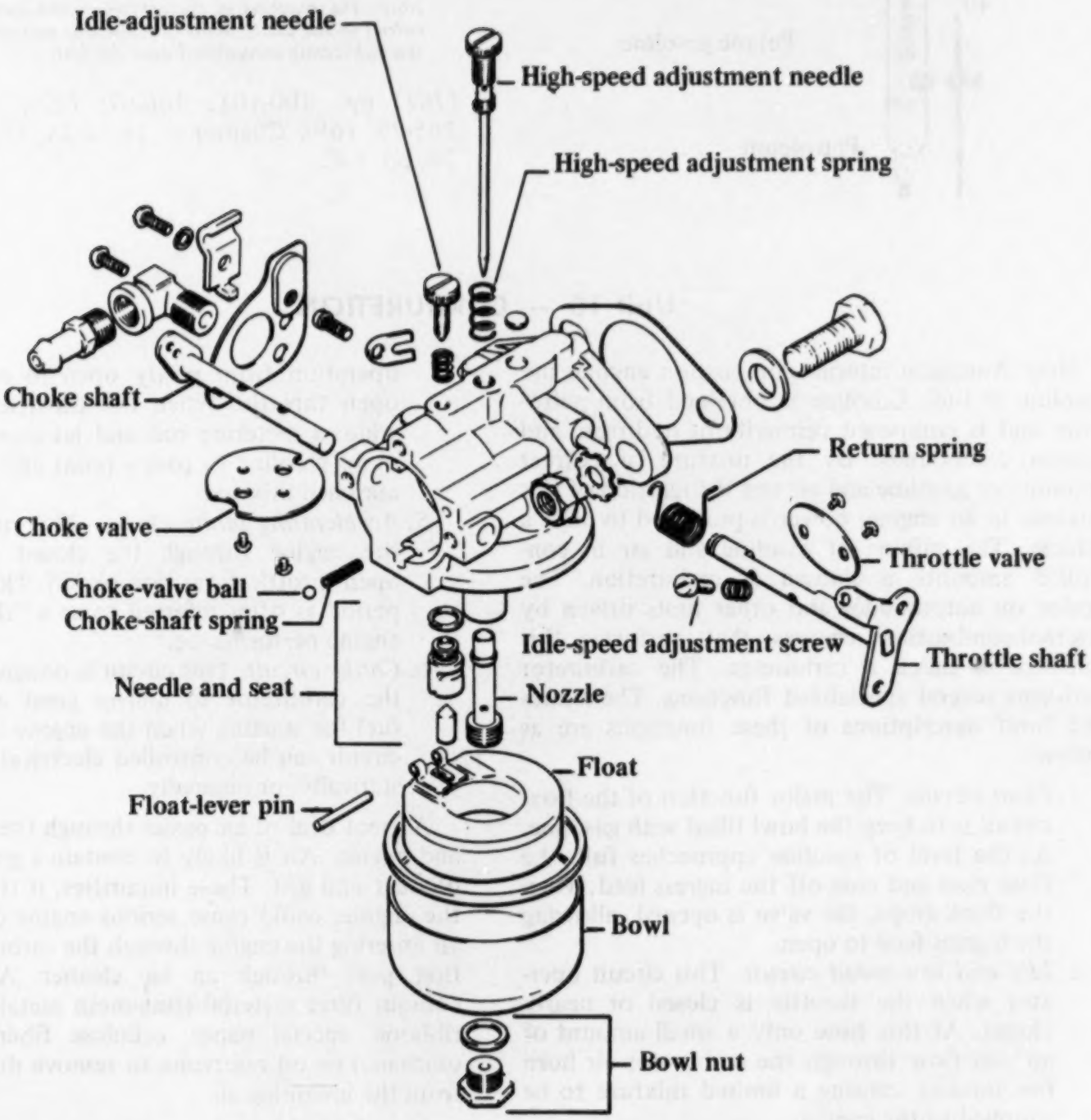

The illustration presented above gives an exploded view of the carburetor used in the three-wheel Cushman truckster and haulster (Cushman Motors, Lincoln, Nebraska).

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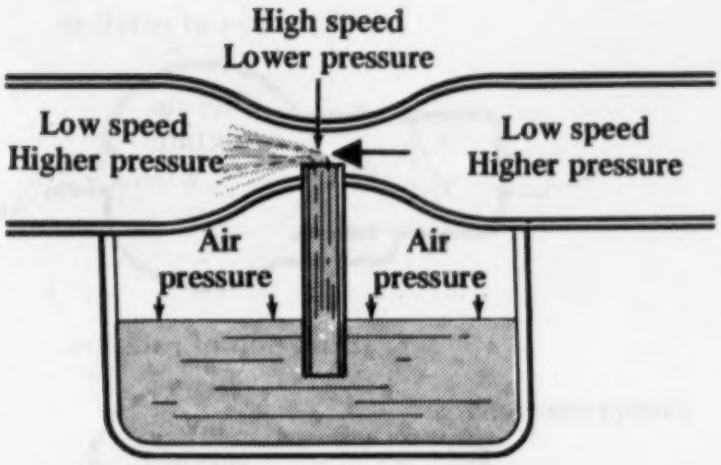

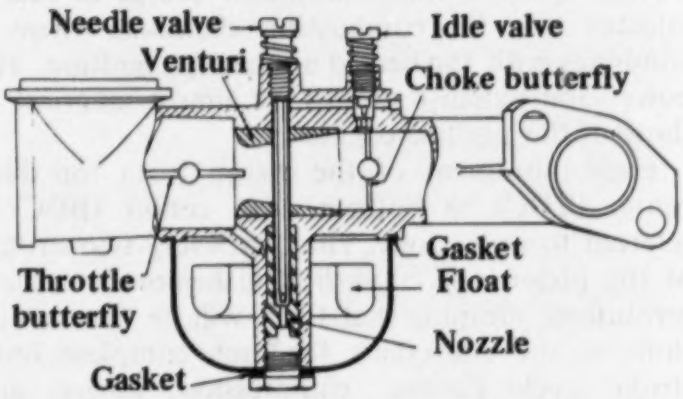

The venturi (left) is a constricted tube which causes the velocity of the air to increase and the pressure to decrease. A carburetor (right) illustrates the use of the venturi (Briggs & Stratton Corp., Milwaukee, Wisconsin).

(constricted). The air pressure in the liquid container (bowl) forces the gas to flow into the tube and mix with the air, where it becomes atomized.

Application of Principle

1. Small, single-cylinder engines lend themselves well to experimentation involving the degree of combustion efficiency and its effect on the engine's operating conditions. Students can vary (a) the throttle-valve setting; (b) the choke-valve setting; and (c) the mixture setting. They can then observe the results in smoothness of operation speed and the quantity and color of exhaust smoke.
2. Students can construct a miniature wind tunnel to measure static and dynamic pressures in the venturi.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(20), pp. 244-57; *(22),* pp. 127-71; *(27),* pp. 224-25; *(36),* pp. 113-16; *(69),* Chapter 6, pp. 1-40; *(75),* Chapter 21, pp. 1-16; *(78),* pp. 193-214.

Unit 17 — TWO- AND FOUR-CYCLE ENGINES

The source of power for internal-combustion, reciprocating engines is heat-formed by the burning of a combustible mixture of petroleum products and air. In a reciprocating engine this burning takes place in one or more closed cylinders, each containing a piston. Expansion resulting from the heat of combustion applies pressure on the piston. This pressure forces the piston down, turning a shaft by means of a crank and a connecting rod.

In the gasoline engine the fuel is ignited by a spark; in the diesel engine, by the heat of compression. The series of events that takes place to run the engine may occur in one revolution of the crankshaft (two-stroke cycle) or in two revolutions of the crankshaft (four-stroke cycle). The operating cycle consists of the following parts:

1. *Intake.* The mixture of fuel and air is drawn or forced into the cylinder by reducing the cylinder pressure to less than atmospheric pressure or by applying an initial, higher pressure to the fuel charge.
2. *Compression.* The mixture is reduced in volume, or compressed.
3. *Power.* The mixture is ignited by a timed electric spark (gasoline engine) or by the heat of compression (diesel engine). The burning fuel-air mixture expands, forcing the piston down and thus converting the generated chemical energy into mechanical energy.
4. *Exhaust.* The burned gases are exhausted from the cylinder so that a new cycle can begin.

The diesel engine differs from the gasoline engine in that in the diesel engine air alone is drawn into the cylinder during the intake stroke and is then compressed to a much higher degree.

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The air is heated by compression. Instead of an electric spark, a finely atomized charge of fuel is injected into the combustion chamber, where it combines with the heated air, causing ignition. The power and exhaust strokes are almost identical to those of the gasoline engine.

Each movement of the piston from top dead center (TDC) to bottom dead center (BDC) is referred to as a stroke. Thus, for every two strokes of the piston, the crankshaft makes one complete revolution, meaning that there will be two revolutions of the crankshaft for each complete four-stroke cycle (intake, compression, power, and exhaust). For the purpose of intake and exhaust, valves are installed in the combustion chamber. The opening and closing of the valves must be synchronized with the movement of the piston on appropriate strokes.

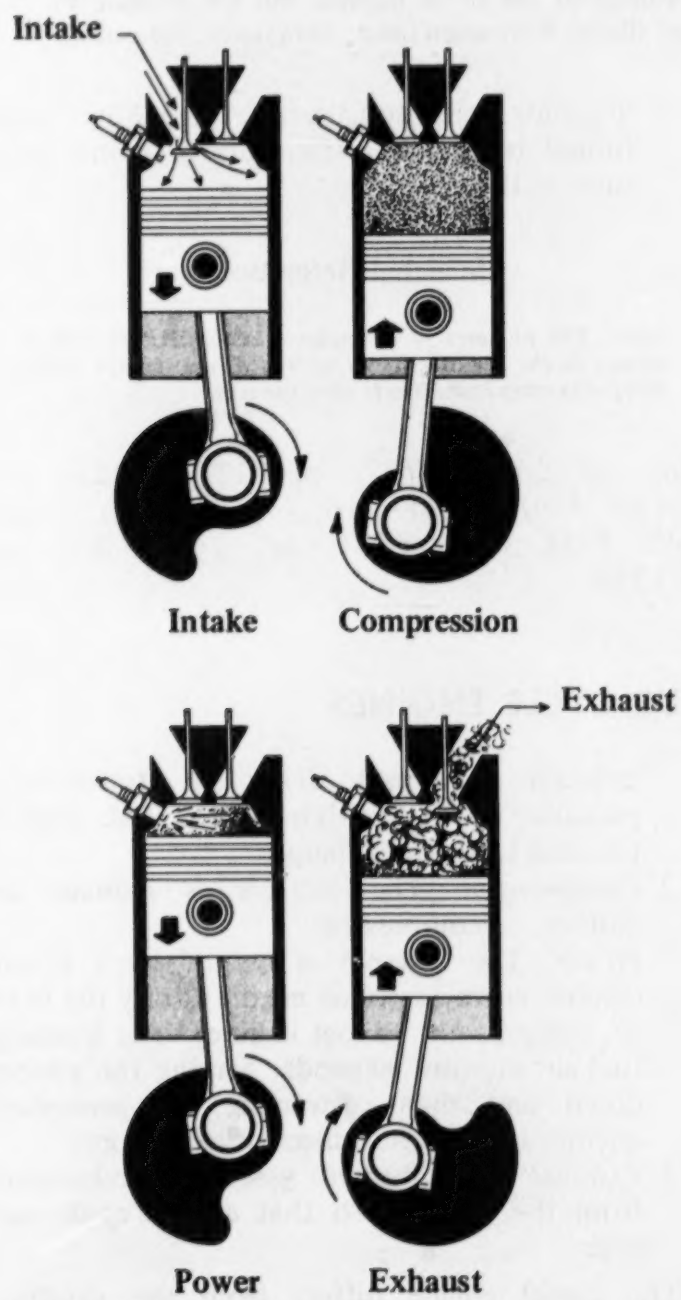

The four-stroke cycle of an internal-combustion engine takes two revolutions of the crankshaft.

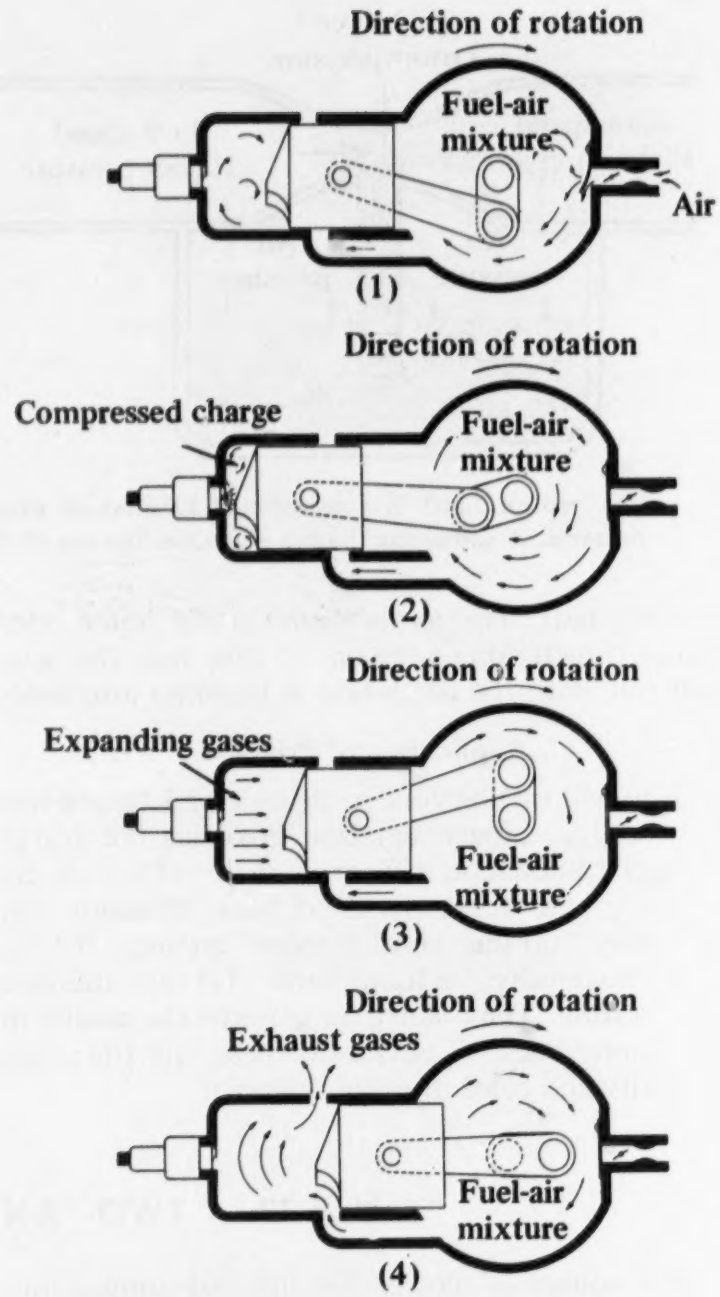

The two-stroke cycle of an internal-combustion engine takes one revolution of the crankshaft.

In a two-stroke-cycle engine, the four events take place in two strokes of the piston or one revolution of the crankshaft. Thus, a compressed fuel charge is fired each time a piston reaches TDC; each downward stroke is a power stroke. The incoming fuel-air mixture must be somewhat higher in pressure than the lowest pressure existing in the cylinder. The piston is used as an air pump

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for this purpose; the engines are called "crankcase-scavenged."

Scientific Principle Involved: Expansion of Gases

A very important principle in the operation of the two- or four- cycle engine is the expansion of gases or the conversion of chemical energy to heat energy to mechanical energy. Energy is defined as the capacity to do work. The energy is stored in the molecules of gasoline. When the fuel is ignited, energy is released and produces heat, which increases the pressure of the gases above the piston. The piston is pushed down in the cylinder. The downward movement of the piston turns the crankshaft.

Application of Principle

1. Have students do as follows:
   a. Disassemble and assemble two- and four-cycle engines.
   b. Draw on engine schematics (provided by teacher) the flow of air-fuel and exhaust on each of the engine types.
   c. Identify valves, ports, pistons, rods, and other internal parts.
   d. Determine the firing order of an engine.
   e. Find the compression ratio of an engine by using actual measurements.
   f. Determine engine displacement by measuring the bore and stroke.
2. Calculate actual pressure on the top of a piston as a result of the expanding gases.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 27-29; *(13)*, pp. 464-66; *(22)*, pp. 38-48; *(26)*, pp. 113-18; *(27)*, pp. 271-72; *(36)*, pp. 19-20; *(56)*, pp. 3-12; *(66)*, pp. 17-19; *(67)*, pp. 17-20; *(69)*, Chapter 1, pp. 7-22; *(72)*, pp. 4-31; *(75)*, Chapter 4, pp. 1-12.

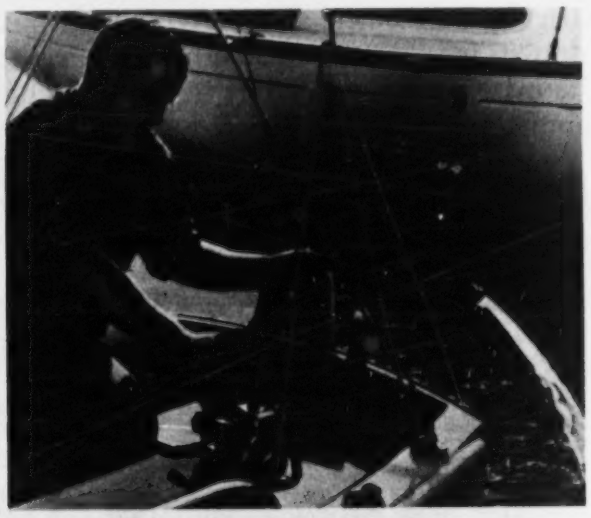

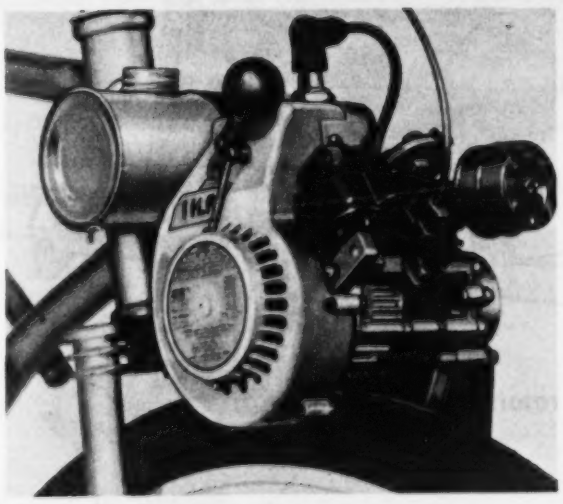

Single-cylinder, air-cooled, two-cycle engines are used to power a saw, pump, bicycle, and spray-gun compressor (Orline Products, Los Angeles, California).

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Unit 18 — WANKEL ENGINES

The recently developed Wankel internal-combustion engine is relatively small, lightweight, and inexpensive to manufacture. It is extremely versatile: there is almost no limit on compression ratio, maximum revolutions per minute, type of fuel feed, and method of cooling. The Wankel engine is capable of running at high speeds for long periods of time. It is very successful in cutting down friction by a reduction in the number of moving parts.

As the rotor "piston" of the Wankel engine turns, it forms chambers between the three sides of the rotor and the wall of the housing. The shape, size, and position of the chambers are constantly being altered by the rotor's rotation. Cycles of intake, compression, power, and exhaust are going on simultaneously around the rotor when the engine is running. There are three power impulses for each rotor revolution.

As the rotor opens the intake port, which has no speed-restricting valve mechanism, the fuel-air mixture is drawn in. The rotor continues turning, closing the intake port by passing beyond it. Then the compression begins, followed by ignition, combustion, and expansion for the power stroke until the exhaust port is uncovered. The exhaust cycle then takes place, again with no speed-restricting valve mechanism. The entire operation cycle is thus completed.

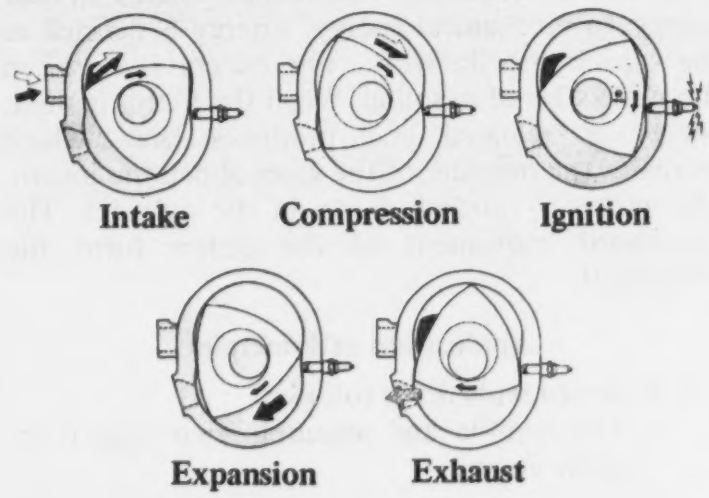

During the combustion cycle the rotor of the Wankel engine turns and forms chambers between the three sides of the rotor and the wall of the housing (Curtiss-Wright Corp.).

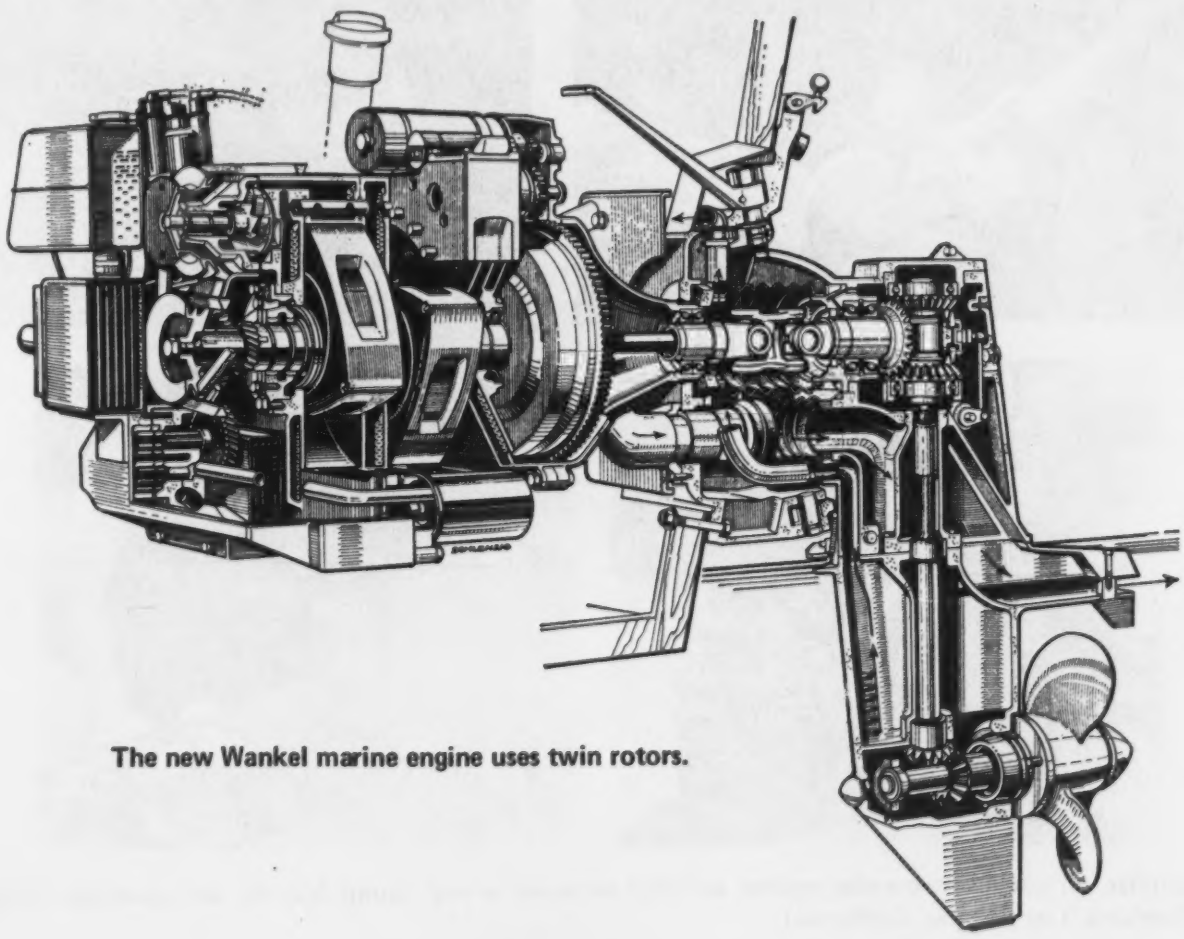

The new Wankel marine engine uses twin rotors.

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Scientific Principle Involved: Movement of Inertia

A body continues in its state of rest or uniform motion unless an unbalanced force acts on it (Newton's first law of motion). A wheel mounted on an axle will not start to rotate unless a torque is applied to the wheel. A wheel which is spinning will continue to spin at constant angular velocity unless a torque acts on it. In both cases the wheel is in equilibrium. Thus, Newton's first law of motion also applies to rotary motion.

A rotating flywheel helps maintain a constant angular velocity of the crankshaft of a Wankel or conventional internal-combustion engine. The moment of inertia of a flywheel is large. Torques acting on it do not produce rapid changes in its angular momentum. As the torque from the combustion in each chamber or cylinder tends to accelerate the crankshaft, the flywheel provides a torque which resists this action. But as the torques from each chamber or cylinder where compression is occurring tend to decelerate the crankshaft, the flywheel provides a torque which resists this action also. The flywheel tends to maintain a uniform rate of crankshaft rotation.

Application of Principle

The Wankel engine, which has not been adopted for use in any American vehicle, is being used in NSU sports cars and marine engines manufactured in Germany. Several companies have been licensed to manufacture the engine, including Curtiss-Wright in the United States, Daimler-Benz and others in Germany, Perkins in England, and Kogyo in Japan. Most of these companies will provide drawings and photographs on request.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(22), pp. 78-80; *(26)*, pp. 209-12; *(27)*, pp. 88-89, 108-9; *(46)*, p.86.

Unit 19 — THERMOSTATS

A thermostat is a device that is used to control temperature. It responds directly to a change in temperature and is usually set so that it maintains a desired temperature level. Most thermostats are used to open or close electrical circuits or to control the flow of liquids or gases.

Thermostats are used in the home to control the temperatures of heating systems, air conditioners, refrigerators, electric irons, stove ovens, and electric blankets. In the automobile a thermostat restricts the flow of the coolant in the radiator until the correct temperature of the engine is reached. The automobile heater, as well as the refrigeration system, uses the thermostat as a temperature-control device.

One of the most common thermostats uses a bimetallic strip that operates on the expansion and contraction of two different metals. When the temperature changes, the two metals expand or contract unequally. This causes the bimetallic strip to bend in the form of an arc. The bending of the strip can be used to open or close a circuit.

In a home-heating system the thermostat is set to open or close the circuit controlling the valve that turns the heater on or off at the desired temperature. A similar unit is used in the electric iron so that the circuit is broken and the iron is shut off when the proper temperature is reached. If the iron becomes too cool, the thermostat closes the electrical circuit and the iron heats up again.

In the automobile engine the thermostat is placed in the top of the block to close off the flow of coolant when the engine is cold. This closure causes the engine to reach operating temperature more quickly. The thermostat operates a valve so that, when the engine warms the coolant to the set temperature of the thermostat, the valve opens to permit normal circulation. Coolant thermostats are of various types which normally use the expansion of a liquid or wax to control the engine temperature. One type, called a bellows thermostat, contains a liquid that evaporates with increasing temperature and causes the pressure inside the bellows to expand and push the valve open. Another type, called a butterfly thermostat, uses a wax pellet, which also expands with increasing temperature to open the valve to permit the coolant to flow through the radiator.

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Scientific Principle Involved: Thermal Expansion

Heat is the kinetic energy of randomly moving molecules. Adding heat to a substance causes the molecules to move more rapidly and produce a greater tendency for the molecules to overcome their mutual attracting forces and to move farther apart. Different solids have individual rates of expansion and different melting points because they are composed of unrelated molecules which are bonded together in different ways. Liquids also have various expansion rates and boiling points; but liquids in general expand more than solids under the same changes in temperature since liquid molecules move more freely. The molecules of gases are so far apart and free to move that the thermal expansion rates for gases are many times greater than those for liquids or solids.

Thermostatic controls in the form of spiral springs, such as those used to actuate the heat-riser valve in the automobile exhaust system, depend on the expansion of the metal in the coil to relax the tension of the spring.

Since brass expands about twice as much as steel, bimetallic bars made of these inexpensive metals, bonded together, make sensitive thermostatic controls which can also conduct electricity and withstand high temperatures.

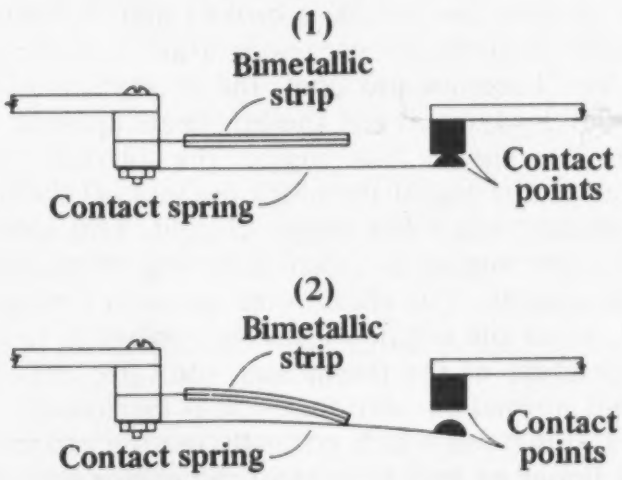

The two different metals in the thermostat expand unequally when the temperature rises, causing the closed contact points (1) to open (2).

Thermostatic controls which operate on the principle of thermal expansion of liquids and gases are generally more sensitive than those dependent on solids because of their high expansion rates. Gases and vapors are particularly useful in thermostats because their molecules, which are uniformly distributed, exert their pressure equally in all directions to all parts of the sealed container.

Application of Principle

1. Secure one or more thermostats from automobiles, a container for boiling water, a thermometer, and a heat source. Suspend the thermostat and thermometer in the container of water and increase the temperature of the water. Note the action of the thermostat as the temperature of the water approaches the temperature stamped on the thermostat. Record the temperature at which the thermostat begins to open, continue to observe the action of the thermostat, and record the temperature at which it is fully open. Discuss the thermostat as a means of control in the cooling system of the internal-combustion engine.

2. Conduct the same type of experiment by using the spiral spring found on the heat riser in the exhaust system of the automotive-type internal-combustion engine. Note that the application of heat to this spring will cause it to actuate the control valve, an action that can be readily observed when heating the spiral spring in the automatic choke on a carburetor. Observe that when heat is applied to this spring, the choke valve moves from the closed to the open position.

3. Note other applications of thermostats in electric irons, circuit breakers, and many other heat-controlled appliances. Obtain the thermostat from an electric iron or a circuit breaker from an automobile electrical system and either connect these units into an electrical circuit with a sufficient load to actuate them or apply heat directly and observe their action.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(22), pp. 194-95, 349; *(26)*, pp. 146-47; *(27)*, pp. 233-38; *(46)*, pp. 211-12; *(47)*, pp. 267-71; *(66)*, p. 47; *(69)*, Chapter 4, pp. 9-11.

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Unit 20 — WELDING PROCESSES

Welding is the process of joining metal parts by directing heat to melt and fuse parts together. When heat alone is used, the operation is called fusion welding. In some welding processes pressure is used to help join the metals. Many welds require that extra metal be added to the weld by melting a metal rod into the molten puddle.

Industry uses welding to fasten parts together permanently and to make repairs on broken equipment. Many buildings, bridges, and ships are fabricated by welding. The automobile has parts that are welded together; in "tooling up" for an automobile, the manufacturer spends considerable time in arranging for special welding equipment to fabricate many of its parts. As a means of fabrication, welding has proven fast, dependable, and flexible. It has made possible the simplification of design and the elimination of costly machining processes. The three most common methods of welding are gas, arc, and resistance welding.

Gas welding is accomplished by mixing oxygen and acetylene in the body of a welding torch and then lighting the gaseous mixture at the tip. The oxygen-acetylene flame produces a temperature of 6,300 degrees F. After properly adjusting the flame, the welder heats the metal part by holding the flame near the metal until a molten puddle forms. Then he applies the welding rod to build up the weld. One of the advantages of gas-welding equipment is that through the use of a special torch the flame can be used to cut metals.

In arc welding the electric power comes from either an electric generator or a transformer. One cable from the source of power is connected to the metal objects to be welded, and the other is connected to the holder that clamps the electrode. The welder strikes an arc by touching the metal part to be welded with the electrode. The arc produces a temperature of about 9,000 degrees F. The operator feeds the electrode into the joint, forming a bead as it is moved along the surface.

Spot welding, which is usually a method of resistance welding, is employed a great deal in industry to join sheet-metal parts. The pieces of metal are placed together and clamped under pressure between the tips of two electrodes. A large amount of current passes between the electrodes and fuses the metal pieces together at the point where the current passes through the metal.

Brazing, involving the use of gas-welding equipment, is not considered a method of welding. It is called hard soldering since the piece to be brazed is not melted. Instead, the brazing rod is melted into the edges of the pieces to be joined. This process is used in repairing broken parts because there is very little danger that any of the original parts will be damaged.

Safety Instructions

1. Obtain permission from your teacher before using welding equipment.
2. Make sure you have ample ventilation.
3. Be sure that you wear welding goggles while using oxygen-acetylene welding equipment. All assistants and observers must also wear welding goggles.
4. Wear a helmet with a proper observation window, a pair of treated gauntlet gloves, and a treated leather apron while using electric welding equipment. All assistants and observers must also wear this equipment.
5. Keep your sleeves and pants cuffs rolled down and wear a leather jacket while using electric welding equipment.
6. Make sure that welding equipment is working properly and that it is used correctly.

Scientific Principle Involved: Kinetic Molecular Theory

Heat is the kinetic energy of moving molecules. Chemical energy released on the burning of acetylene in the oxyacetylene torch is the source of energy used in gas welding. In the electrical-arc weld, the heat energy is produced by the acceleration of electrons and ions in the electrical field; in the resistance weld the heat is due to the resistance to the movement of electrons in the metal. The purpose of using heat in welding is to increase the temperature of the metals to the point where the kinetic energies of the molecules and atoms of the metals are sufficient to break the bonds which hold these particles together in the crystalline structure of the solid. When these bonds are broken, the metal fuses and the particles move more freely in the liquid state. On cooling, the particles lose kinetic energy and resume relatively fixed positions in the solid state. When these effects occur on the local heating of pieces of metal held closely together, as in spot or seam welding, the result is a strong, solid bond without the addition of more metal. Addition of molten metal, such as in gas and arc welding, allows bonds to form between the

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added metal and the fused metal from the surface being welded. The molten metal flows into small spaces between the metal surfaces by capillary action caused by intermolecular forces of cohesion.

In brazing, a different metal with a lower melting point is used as the bonding material. The metals to be brazed are preheated (but not to the melting point) in order to increase the molecular motion, which promotes better penetration of the molecules of the solid metal surfaces by the molecules of the molten metal. The bonds in solids between unlike molecules (adhesion) can be as strong as or stronger than the bonds between like molecules (cohesion). The molten metal used in brazing flows into the small spacing between the metal pieces by capillary action, which is due both to the strong attraction (adhesion) between the molten metal and the solid metal surface and to the high surface tension (cohesion) of the molten metal.

Application of Principle

1. The most effective approach to the application of welding and brazing is to learn the basic technical information and acquire the skills involved in the welding and brazing process.
2. A demonstration of both the gas- and arc-welding processes should include the setup and adjustments necessary for each particular welding operation.
3. An aid which will allow the development of the necessary manipulative skills without the actual use of electrodes, welding or brazing rods, or oxygen and acetylene is a 1-inch dowel or stick approximately 14 to 16 inches in length. A hole is drilled in which an ordinary graphite pencil will fit snugly. The hole should be at an angle which approximates the position of the welding torch or electrode. By an adjustment of the length of the pencil to correspond to either a torch or an electrode, the basic patterns and strokes may be practiced on a piece of paper.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(34), pp. 27-41, 237-51; *(47)*, pp. 276-79, 342; *(87)*, pp. 30-33.

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SECTION V
ELECTRICAL POWER

Unit 21 — DRY CELLS: PRIMARY CELLS

One of the most common sources of electrochemical energy is the dry cell (primary cell). Electrical devices such as flashlights, portable radios, and warning flashers on the highways are usually powered by dry cells, which are convenient and flexible power suppliers. Regardless of size a zinc-carbon single dry cell produces 1.5 volts of direct current (DC). The cell is most often made from (1) zinc, which is one of the electrodes and serves as the shell or container; (2) a carbon rod, which is the other electrode and extends through the center of the cell; and (3) an ammonium chloride paste, which is the electrolyte. The top of the cell is sealed to prevent evaporation of the moisture in the electrolyte, and the zinc shell is usually encased in steel or heavy paper. Proper care and intermittent use extends the life of this source of electrical energy.

In recent years the dry cell has been improved. One of these improvements is the so-called mercury cell. The negative electrode of this cell is made of an amalgam of powdered zinc and mercury, pressed into shape. The depolarizer is composed of mercuric oxide and graphite powder. The zinc-mercury amalgam cuts down local action, and the graphite helps reduce the internal resistance of the cell. Mercury cells have a considerably longer life than the ordinary zinc-carbon-ammonium chloride dry cell.

Scientific Principle Involved: Conversion of Energy

The dry cell produces an electric current by converting chemical energy into electrical energy. The conventional dry cell consists of a negative electrode (zinc case) and a positive electrode (carbon rod). Electrons must pass from the negative to the positive electrode (external circuit) before electrical energy is produced. A chemical substance (ammonium chloride) in the zinc container reacts with the zinc, forming zinc ions and liberating electrons. This reaction is very slight until the positive and negative electrodes are connected together in a circuit. When the circuit has been completed, the chemical reaction increases, and the electrons steadily move from the negative to the positive electrode through the external circuit. At this time hydrogen bubbles attempt to form a coating on the carbon electrode. Another chemical (manganese dioxide) is provided to dispose of these hydrogen bubbles in order that the chemical reaction may continue. The movement of electrons will continue until most of the zinc is consumed by the reaction.

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Standards for Fitting Women's Clothes (Continued)

ITEMS TO CHECK	GENERAL APPEARANCE		
	Good	Poor	Correction Necessary
DARTS			
Front bodice and bust darts are in line with crown of bust, but end 1 or 2 inches from it.	___	___	___
Fabric at end of darts is smooth.	___	___	___
Similar darts are balanced in noticeable length on both sides of the figure	___	___	___
Darts are in line with no puckering along the line of stitching	___	___	___
Hip darts stop short of fullest part of hips. .	___	___	___
TUCKS, DART TUCKS, AND GATHERS			
Tucks, dart tucks, and gathers direct fullness toward fullest part of figure	___	___	___
ARMHOLE SEAM			
Armhole seam forms smooth curve over top of shoulder.	___	___	___
Armhole seam falls perpendicularly to the floor from tip of shoulder to point at which it begins to curve under the arm	___	___	___
Shoulder seam does not droop down onto the arm in a plain sleeve	___	___	___
Armhole falls about 1 inch below arm pit. . . .	___	___	___
SLEEVE			
Crosswise grain is parallel to floor above the elbow	___	___	___
Lengthwise grain is perpendicular to the floor above the elbow	___	___	___
Plain sleeve is eased into armhole with no obvious gathers	___	___	___
Sleeve cap is wide enough to enclose arm with ease.	___	___	___
Dart or fullness placed at elbow in long sleeves	___	___	___
Long sleeves extend to where hand ends and wrist begins.	___	___	___
WAISTLINE			
Waistline seam falls at natural waistline when garment is so designed.	___	___	___
Waistline seam fits snugly, but is not tight. .	___	___	___
BUTTONS AND BUTTONHOLES			
One buttonhole placed at the level of the bustline on a fitted garment.	___	___	___
One buttonhole placed at natural waistline on suits and jackets	___	___	___

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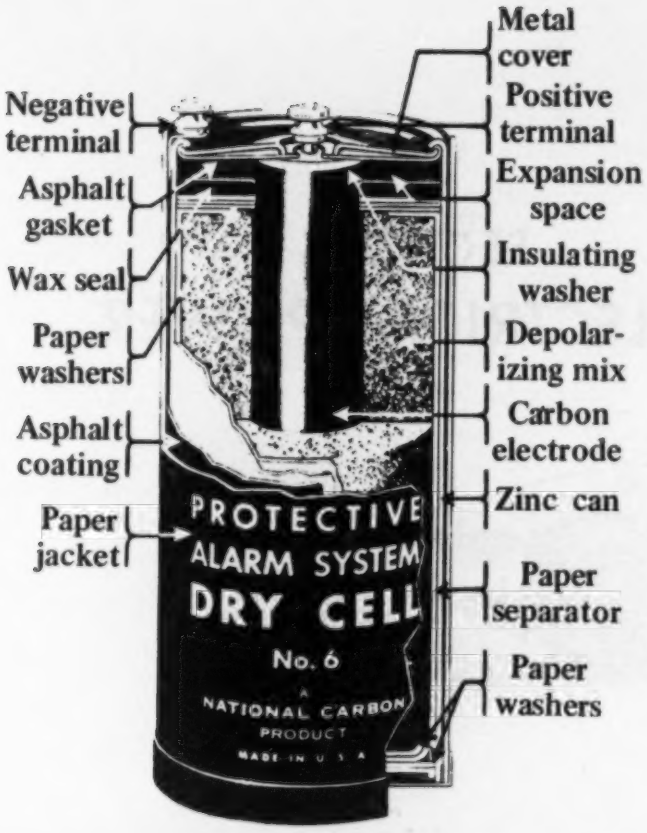

A cross-sectional view of a zinc-carbon-ammonium chloride dry cell shows the components (National Carbon Company, Inc.).

Application of Principle

1. Fresh dry cells and cells that are in various states of deterioration can be given an approximate test by connecting them in a circuit with a 1.5-volt light bulb and observing the intensity of the light. A more accurate test can be made with a battery tester which measures volts and amperes. Zinc-carbon cells, regardless of their size, deliver 1.5 volts. However, larger cells deliver more current. A fresh No. 6 dry cell delivers about 25 amperes, a penlight cell about three amperes. The ammeter test should be made only when necessary, and then as quickly as possible, because the drain of the current reduces the life of the cell. *Note:* Deteriorated cells are likely to expand or leak. They should be removed from flashlights and other devices. When dry-cell-powered equipment is stored, the batteries should be removed. A dry cell should be put into use before the expiration date that is stamped on the label.
2. The chemical action of a supposedly dead cell may be restored temporarily by punching a number of holes in the case and letting it stand in water for a short time. However, cells restored in this manner are of little practical use because they are only partially restored, their life is short, and they leak.
3. Dry cells in various states of deterioration may be displayed, attention being directed to swelling, perforation of the container, and corrosion. Cells may be cut in half to show their internal structure.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 481-82; *(14)*, pp. 212-14; *(26)*, pp. 292, 297; *(27)*, pp. 458, 461, 465-66; *(36)*, p. 50; *(47)*, pp. 228-30; *(49)*, Volume 3, 276-79; *(54)*, pp. 331-32; *(65)*, pp. 41-42; *(66)*, pp. 155-56; *(86)*, pp. 40-41.

Unit 22 — STORAGE BATTERIES: SECONDARY CELLS

The storage battery is an electrochemical device for converting chemical energy into electrical energy. It consists of a number of storage cells connected in series. A storage cell is a secondary or voltaic cell that can be restored or recharged repeatedly. Storage cells of three types are now in general use: the lead-acid cell, the Edison cell, and the nickel-cadmium cell. The lead-acid storage cell, used in the batteries of automobiles, airplanes, trucks, motorcycles, and other equipment requiring a portable source of electrical energy, is by far the most widely used type. The electromotive force (emf) of each lead-acid cell is approximately 2.2 volts.

Lead-Acid Battery

Active materials within the lead-acid battery react chemically to produce direct current (DC) whenever lights, radio, starting (cranking) motor, or other current-consuming devices are connected to the battery circuit. This current is produced by the chemical reaction between the active materials of the plates and the sulfuric acid of the electrolyte.

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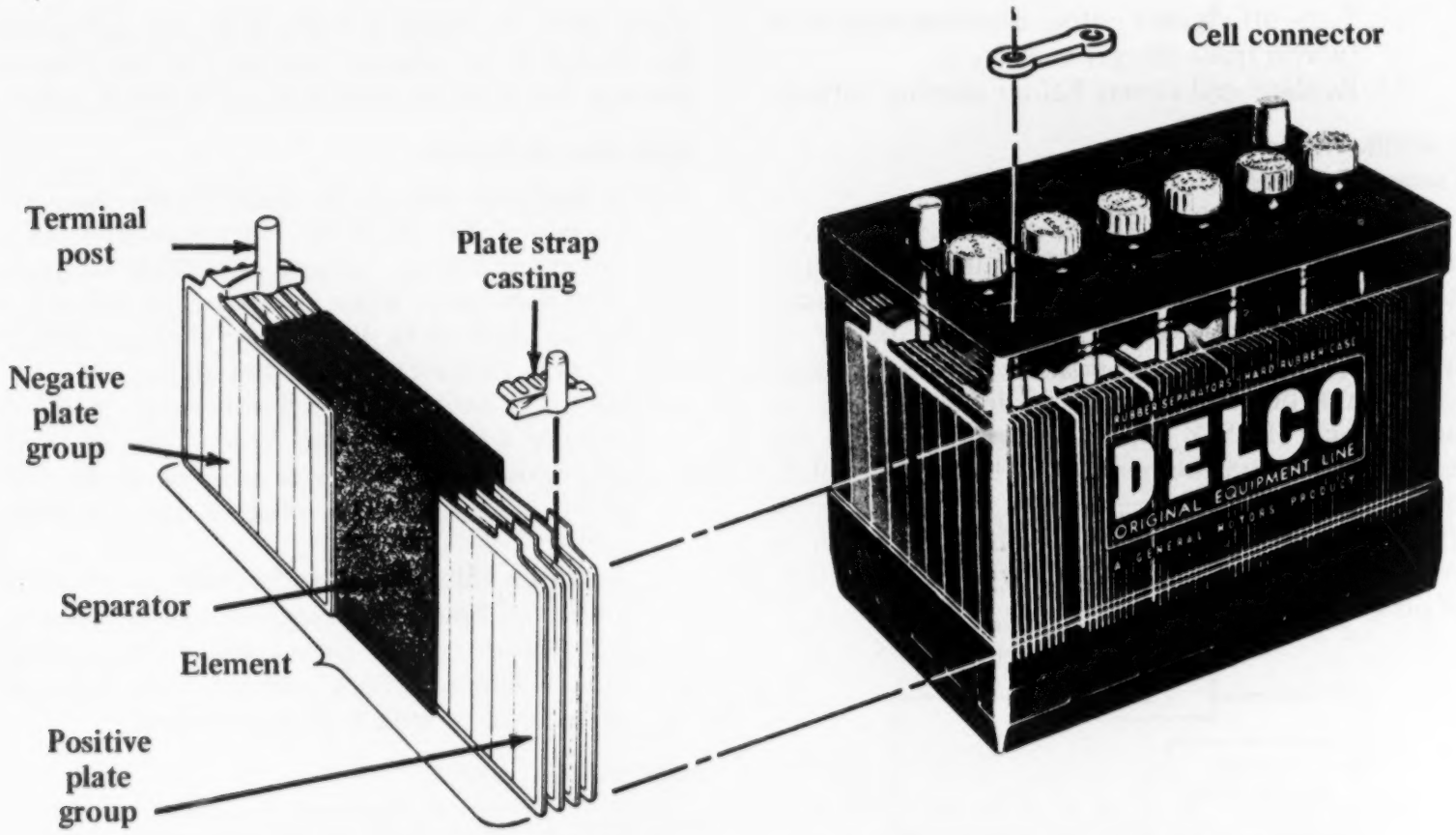

An interior-construction view of a typical 12-volt lead-acid storage battery illustrates internal cell connections (Delco-Remy Division, General Motors Corp.).

The battery performs three functions in automotive applications. First, it supplies electrical energy for the starting motor and for the ignition system as the engine is started. Second, it intermittently supplies current for the lights, radio, heater, and other accessories when the electrical demands of these devices exceed the output of the alternator. Third, the battery acts as a voltage stabilizer in the electrical system. Satisfactory operation of the vehicle is impossible unless the battery performs each of these functions.

The internal construction of a lead-acid storage battery is such that a highly reliable power source is provided. Two types of plates, one positive and the other negative, are the basic units. These plates consist of chemically active materials contained in grids. The grids are flat, rectangular, lattice-like castings. Each grid is designed specifically to hold the active materials. Once the grids have been pasted with the active materials, they are called plates. During the manufacturing process these plates are then said to be "charged." Charged negative plates contain sponge lead (Pb), which is gray in color. Charged positive plates contain lead peroxide (PbO_2), which has a dark brown color.

Safety Instructions

1. Obtain permission from your teacher before servicing or charging a storage battery.
2. Use proper instruments for testing a storage battery.
3. Avoid overfilling a battery, especially if it is to be charged.
4. Use water and baking soda (a neutralizer) to clean off the top of a battery.
5. Remove and transport a battery with a battery lifter.
6. Handle battery or acid with care. Wash immediately any part of your body or clothing that comes in contact with acid.
7. Wash hands immediately after handling a battery.
8. Wear goggles when using a charger.
9. Provide ample ventilation when using a charger.
10. Remove cell covers before charging a battery, unless the covers have other instructions upon them.
11. Keep open flames and sparks away from a battery being charged.

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12. Turn off charger before disconnecting leads (wires) from charger to battery.
13. Replace cell covers before moving battery.

Scientific Principle Involved: Conversion of Energy

Electromotive force (emf) can result from the immersion of certain pairs of dissimilar materials into the proper electrolyte. The lead-acid storage battery is a combination of negative plates of sponge lead (Pb) and positive plates of lead peroxide (PbO_2) immersed in an electrolyte of sulfuric acid (H_2SO_4) and water (H_2O). When the terminal posts are connected to form a complete circuit, a movement of electrons will result from the chemical action. This chemical reaction is between the active materials of two different kinds of plates and the electrolyte.

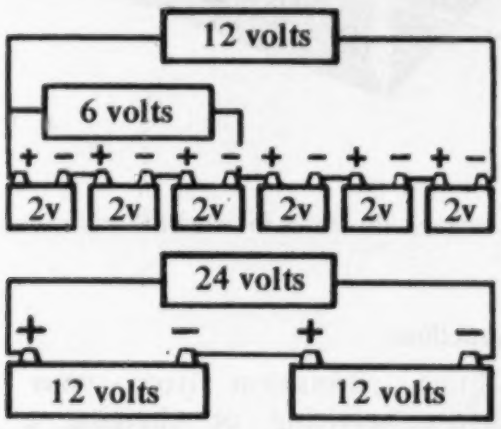

Each cell in a lead-acid storage battery has a potential of approximately 2 volts (actual potential is 2.2 volts per cell). Batteries containing three cells connected in series are 6-volt batteries; six cells connected in series are 12 volt. Applications requiring higher voltages use combinations of batteries, such as two 12-volt batteries connected in series to obtain a 24-volt system.

During the chemical reaction the oxygen (O_2) of the lead peroxide (PbO_2) of the positive plates combines with the hydrogen (H_2) of the sulfuric acid (H_2SO_4) to form water (H_2O); the sulfate (SO_4) from the sulfuric acid (H_2SO_4) combines with part of the lead (Pb) of the lead peroxide to form lead sulfate ($PbSO_4$). Also, a chemical change takes place at the negative plates. The lead (Pb) of the negative plate combines with the sulfate (SO_4) of the sulfuric acid (H_2SO_4) in the electrolyte to form lead sulfate ($PbSO_4$), which is the same material as the positive plates. The excess electrons transferred from the positive plates to the negative plates cause an imbalance which is corrected when the circuit is completed and the electrons move through the external circuit to the positive plates.

Application of Principle

1. A lead-acid cell can be made by placing parts of two plates (positive and negative) from a discarded storage battery in a dilute solution of sulfuric acid. When the plates are immersed in the electrolyte, little or no chemical action occurs. However, when the plates are connected in series with a 1.5-volt lamp, chemical activity will take place. *Note:* The use of an acid-resistant container of glass or plastic will make it possible to observe the chemical activity.
2. A simple voltaic cell can be made by inserting a strip of brass and a strip of galvanized iron (or a clean copper penny and a silver dime) into a lemon. Check current flow between strips or coins with a galvanomenter.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(7), pp. 37-39; *(9)*, pp. 229-30; *(13)*, pp. 481-82; *(16)*, pp. 244-47; *(22)*, pp. 200-204; *(27)*, pp. 466-69; *(33)*, pp. 24-27; *(37)*, p. 415; *(47)*, pp. 233-42; *(65)*, pp. 44-47; *(66)*, pp. 155-57; *(69)*, Chapter 19, pp. 9-14; *(86)*, pp. 45-49; *(87)*, p.53.

Electrolysis

Electrolysis is the decomposition of a chemical compound by means of electrical energy. Electrolysis has been put to many useful purposes in industry, such as in the manufacturing of chlorine and fluorine gases, in electroplating, and in the extracting of aluminum and certain other metals from their ores. However, electrolysis can occur where it is not desirable; for example, during the charging of a storage battery. If the rate during charging (amperage rate of current flow) is too high, the battery will heat, producing an excessive amount of explosive gas (a mixture of hydrogen and oxygen) by electrolysis. These gases are also produced when the battery is overcharged (when charging is continued after the battery has a full charge). When a storage battery is being charged, the manufacturer's recommended charging rate should be followed; the charging should be done in a well-ventilated area, away from heat, sparks, and open flame.

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Refer to the safety instructions previously mentioned in this unit.

Scientific Principle Involved:
Electrolysis

When an electrolytic cell (cell of a storage battery) is connected to a direct-current source, such as a battery charger, the cathode (negative plate) becomes negatively charged and the anode (positive plate) positively charged. Positive ions move to the cathode, where they acquire electrons from the cathode and are discharged. Negatively charged ions move to the anode and are discharged by giving up electrons to the anode. The loss of electrons by the cathode and the acquisition of a like number of electrons by the anode is, in effect, the conduction of electricity through the cell. The conduction of electricity through an electrolyte, together with the resulting chemical changes, is called electrolysis.

Application of Principle

The explosive nature of the hydrogen and oxygen gases produced through electrolysis when a storage battery is charged can be demonstrated by capturing the gases and igniting them in a safe manner. The demonstration can be conducted as follows:

1. A "cannon" can be constructed to demonstrate the potential hazard of a spark igniting gas given off from a storage battery being charged. An 18-inch length of 1½-inch pipe is capped at one end. The cap is drilled and tapped for a 14mm spark plug. This unit can be mounted on a stand. One terminal of a storage battery is connected by a length of No. 12 wire to a primary terminal of a 12-volt ignition coil and the cannon barrel (pipe). The other battery terminal is connected with No. 12 wire through a push-button starter switch to the other primary terminal of the ignition coil. The high-tension terminal is connected to the spark plug. Then the cannon barrel is placed for about five minutes over a cell opening of a battery that is charging and gassing freely. The cannon is then removed and placed at a demonstration location. The starter button is pressed to ignite the accumulated gas.

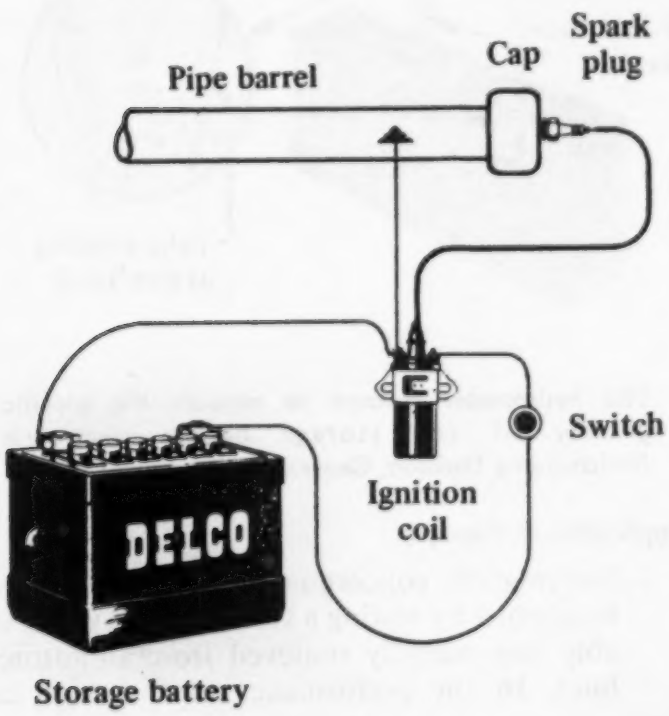

2. A simple means of capturing the gases produced during the charging of a storage battery is to insert in the cell openings of the battery rubber stoppers (with a hole in the center of each stopper for a glass elbow for the end cell and T joints for the others). The glass tubes are connected in series by the use of pieces of rubber tubing. This series hookup is then connected by a rubber tube that leads to a shallow pan partly filled with water. If all tubing connections are tight and the battery is charging, gas will bubble slowly from the submerged end of the tubing. After sufficient time has elapsed (ten minutes to half an hour) for the gases from the battery to replace the air in the tube, gas samples may be collected in small jars or wide-mouth bottles (2 to 8 ounces in capacity) by water displacement. So that the gas can be burned or exploded safely, the inverted jar is lifted from the pan, covered with a glass plate, and placed right side up on a table. At arm's length from the jar, the glass plate is removed and a burning match is thrust into the mouth of the jar. Pure hydrogen pops, then burns quietly with an almost invisible flame. Hydrogen mixed with oxygen or air explodes with a pop or a shriek, depending on the composition of the mixture. *Note:* Use only a small, wide-mouth bottle or jar for this demonstration. Do not collect gas in a large container and do not explode gas in a confined space, such as a bottle with a narrow neck or a bottle with a stopper. Do not attempt to light the gas at the end of the rubber tube.

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Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(9), pp. 46-47; *(13)*, pp. 280-81; *(27)*, pp. 498-506; *(37)*, p. 294.

Hydrometer Test

Each cell of a lead-acid storage battery contains balanced quantities of positive active material, negative active material, and sulfuric acid. The sulfuric acid is diluted with water, and the solution is called the electrolyte. When the cell is fully charged, the active materials are free of sulfate, and the strength of the electrolyte is at its maximum. When a cell discharges, the active materials react with the sulfuric acid in the electrolyte, and lead sulfate is formed on the plates. This reaction gradually lowers the strength of the electrolyte. Since the strength of the electrolyte varies directly with the state of the charge of the cell, this strength offers a convenient basis for estimating the state of the charge. To determine approximately the state of charge and how much energy is available from a battery, one needs only to measure the specific gravity of the electrolyte.

Specific gravity can be measured by means of a battery hydrometer. In the taking of a specific gravity reading, it is important that the float be freely suspended in the liquid, not touching the walls, top, or bottom of the barrel. It is important also that the eye be approximately at the liquid level when the reading is taken. Specific gravity readings are affected by temperatures; 80 degrees F. is the accepted standard. For every 10 degrees of electrolyte temperature *above* 80 degrees F., four gravity points (.004) must be *added* to the gravity reading. This addition compensates for the loss of gravity caused by expansion of the liquid as its temperature increases. For every 10 degrees of electrolyte temperature *below* 80 degrees F., four gravity points must be *subtracted* from the gravity reading. This subtraction compensates for the gain in gravity caused by the contraction of the liquid as its temperature decreases.

Refer to the safety instruction previously listed in this unit.

Scientific Principle Involved:
Specific Gravity

All liquids have weight; some weigh more than others. The weight of a unit volume (e.g., cubic centimeter) of a liquid is called its density. When the density of one liquid is compared to a standard, the relationship is called the liquid's specific gravity. All liquids are compared to water, which is given a specific gravity of 1.000. If it is found that 1 cubic centimeter of iron weighs 7.6 times as much as 1 cubic centimeter of water, it is said that the specific gravity of iron is 7.6. An object placed in a container of liquid is buoyed or lifted by an amount equal to the weight of the liquid it displaces; this is called Archimedes' principle. The denser the liquid, therefore, the greater is its buoyant force on the object. For example, as sulfuric acid is denser than water, a mixture containing more acid, as in a fully charged battery, will buoy a floating object higher than a mixture containing less acid, as in a discharged battery. A hydrometer uses a calibrated (specifically marked) float that measures the density or specific gravity of a liquid compared to pure water. Thus, this instrument will measure how much acid is mixed with the water in a battery by weighing the mixture – that is, more acid makes the float rise higher and less acid lets the float sink deeper. The markings on the calibrated float give the specific gravity of the mixture compared to pure water.

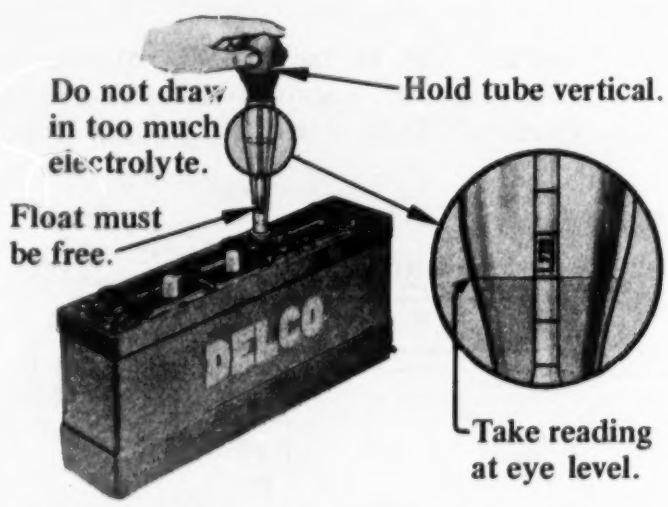

The hydrometer is used to measure the specific gravity of the storage battery electrolyte (Delco-Remy Division, General Motors Corp.).

Application of Principle

1. Information concerning the hydrometer can be applied by testing a storage battery (preferably one recently removed from an automobile). In the performance of the test, care

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must be taken to avoid spilling the electrolyte because it contains sulfuric acid, which can burn a person's skin or destroy his clothing. If spilling should occur, the acid should be washed off with plenty of water. The hands should always be washed immediately after a storage battery has been handled.

2. A hydrometer can be used to measure/test antifreeze solutions and crude oil.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(7), p.39; *(22)*, pp. 357-58; *(27)*, p. 207; *(47)*, p. 237; *(71)*, p. 28; *(86)*, p. 48.

Battery Installation and Servicing

A storage battery is designed to withstand normal operating conditions; however, excessive mechanical abuse will lead to early failure. Mechanical abuse often occurs during installation. So that a battery might be properly installed, recommendations for installation are given as follows:

1. Before installing the battery, check for proper battery polarity with respect to the vehicle's specifications. "Ground" polarity is usually indicated. Avoid reversed polarity during installation by marking cables as to their polarity when removing the old battery since reversed battery polarity may cause serious damage to the electrical system. Remember that the positive battery terminal post is larger than the negative terminal post. *Note:* When installing batteries, disconnect the "grounded" cable at the battery terminal first and reconnect it last to avoid damage to the battery and wiring by accidental "grounds."
2. Be sure that the battery carrier and hold-down device are clean and that the new battery rests level when installed.
3. Tighten the hold-down device until it is snug; however, do not draw it tight enough to distort or crack the battery case.
4. Be sure that the cables are in good condition and that the terminal clamps are clean.
5. Clean the battery terminals with a wire brush before attaching the cable clamps. Do not pound the clamps onto the battery terminals. When tightening cable nuts, use the wrench carefully to avoid twisting and damaging the cell cover.
6. Make sure that the cable terminals are clean and tight at the engine or frame and also at the cranking motor switch and solenoid.

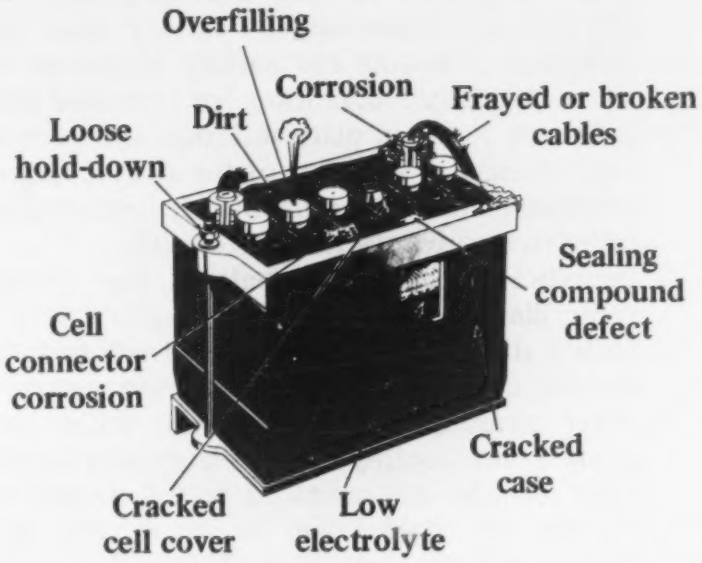

The importance of periodic battery service cannot be overemphasized. With a reasonable amount of attention and care, the useful life of the battery can be greatly extended; neglect and abuse, however, will shorten its life. Any servicing and maintenance program should include the following points:

1. Inspect the battery thoroughly for defective cables, loose connectors, corrosion, cracked cases and covers, and loose hold-down devices.
2. Check the electrolyte level periodically, particularly in hot weather, and add pure water if necessary to bring the liquid to the required level in each cell. Overfilling should be avoided, as this will cause the loss of electrolyte, resulting in excessive corrosion, reduced battery performance, and shorter battery life. Allowing the electrolyte level to drop below the tops of the plates will cause the exposed plate material to become dry and chemically inactive. Also, the high concentration of electrolyte remaining in the battery will cause permanent damage on the plate area below the electrolyte level, causing poor battery performance and shorter life.

   If the battery requires the addition of an excessive amount of water in normal service, an overcharged condition is indicated. Some water usage is normal, usually 1 to 2 ounces per battery per 1,000 miles of service, depending on the type of service and prevailing temperatures. If the water usage becomes

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excessive, high battery temperatures or a high voltage-regulator setting should be suspected as the most likely causes. If very little water is used over three or four thousand miles of service, an undercharged battery may be indicated. Allowing the battery to remain in an undercharged condition for excessive periods may result in plate sulfation and permanent damage. The cause of the undercharged condition should be immediately corrected in order to insure optimum battery life.

3. Periodically, clean the battery top, posts, cable clamps, carrier, and hold-down device with a diluted ammonia or soda solution to remove corrosion and other foreign material. After cleaning, flush with clean water and apply a thin coating of petroleum jelly to the cable clamps and posts to retard corrosion. Tighten the hold-down device so that the battery will not shake in the carrier, but avoid over-tightening to avoid possible damage to the battery case.

Refer to the safety instructions previously listed in this unit.

Scientific Principle Involved:
Corrosion and Oxidation

The term corrosion may be used to denote the chemical change which takes place when a metal combines with oxygen. (Examples include the formation of an oxide scale on steel heated in air and of hydrous oxide rust on iron exposed to water or damp air.) Chemical change also occurs when metal comes into contact with an acid. The heat given off by an internal-combustion engine, moisture in the air, and the spilling or spraying of an electrolyte cause the corrosion of battery terminals, cable clamps, and holders.

Application of Principle

Skills can be applied and knowledge extended through the installation and servicing of storage batteries. Servicing can be made of batteries installed in automobiles or recently removed from them.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 110-11; *(22)*, pp. 359-63; *(69)*, Chapter 19, pp. 13-14; *(71)*, p. 28; *(75)*, Chapter 36, pp. 19-24, *(78)*, pp. 247-57.

Battery Testing

The storage battery may be tested to determine if it is in good condition or if it is defective or worn out and must be replaced. Before the performance of any electrical checks, a visual inspection should be made to reveal any obvious defects. If the case or covers are cracked or if the battery has unusual odors or is otherwise damaged, the battery should be replaced.

The light-load test and the hydrometer test (which was explained earlier in this unit) should be performed on batteries having individual cell covers. The light-load test is simple, quick, and accurate; it should be applied to batteries before they are charged. Otherwise, defective cells may pass the test and cause a false diagnosis. An expanded scale voltmeter (one that has .01 volt per scale division) is needed for this test.

To check the electrical condition of battery cells using the light-load test, first check the electrolyte level in each cell. If necessary, raise it to the proper level by adding pure water. Then, if the battery is in the vehicle, place a load on the battery by holding the starter switch on for three seconds or until the engine starts. If the engine starts, turn off the ignition immediately. If the battery is out of the vehicle, place a 150-ampere load on it for three seconds. Next, turn on the headlights (low beam); or, if the battery is out of the vehicle, place a 10-ampere load on the battery. After one minute, with lights still on or the 10-ampere load still connected, read the voltage of each battery cell with a voltmeter, noting the exact voltages. It is necessary to remember only the highest and lowest cell voltages.

The condition of the battery can be determined by noting the difference in voltage readings between the individual cells as follows:

1. If any cell reads 1.95 volts or more and there is a difference of .05 volt (five divisions) or more between the highest and lowest cell, the battery is defective, damaged, or worn out and should be replaced.
2. If any cell reads 1.95 volts or more and the difference between the highest and lowest cell is less than .05 volt (five divisions), the battery is good and sufficiently charged.
3. If cells read both above and below 1.95 volts and the difference between the highest and lowest cell is less than .05 volt (five divisions), the battery is good but requires charging.

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If all cells read less than 1.95 volts, the battery state of charge is too low to test accurately. Boost-charge and repeat the light-load test. Boost-charge all 12-volt batteries rated at 100 ampere-hours or less at 50 amperes for 20 minutes (1,000 ampere-minutes). Charge all other batteries, both 6-and 12-volt, at 60 amperes for 30 minutes (1,800 ampere-minutes). If none of the cells comes up at 1.95 volts after the first boost charge, the battery should be given a second boost. Batteries which do not come up after a second boost charge should be replaced. If the charger being used will not give the rate specified, charge for an equal number of ampere-minutes at the next lower rate available. For purposes of the light-load test, do not boost a battery more than the amount indicated. If the battery is found to be good after boosting, it should be fully recharged by the slow-charge method before being placed in service.

The "421" test, the specific-gravity cell-comparison test, and the hydrometer test (which was explained earlier in this unit) may be used on batteries. In the specific-gravity cell-comparison test, the specific gravity of each cell, regardless of state of charge, is measured and interpreted. If specific gravity readings show a difference between the highest and lowest cell of .050 (50 points) or more, the battery is defective and must be replaced.

The "421" test is a specific, programmed test procedure consisting of a series of timed discharge and charge cycles that will determine the condition of the battery with a high degree of accuracy in a very short period of time. The "421" testers, which are manufactured by a number of different suppliers, automatically subject the battery to the programmed "421" test. The "421" testers, when used in the procedure as outlined in the chart that follows, will in two or three minutes accurately determine the condition of any 12-volt unit regardless of size, in or out of the vehicle, in any state of charge, and at any temperature.

EXAMINATION OR TEST	WHAT TO LOOK FOR	ACTION
1. VISUAL INSPECTION NOTE: If no visual defects are found proceed to Test 2.	a. Cracked cases and covers	REPLACE BATTERIES
	b. Electrolyte level below top of plates.	Low electrolyte level may cause permanent damage to batteries. Fill with water to proper level and proceed with careful testing of battery, to determine if damage has occurred. Low electrolyte level indicates that the battery has been neglected for an extended period of time and/or the battery is being subjected to overcharge in which case the charging system should be checked for correct voltage setting.
	c. Other abuse.	REPLACE BATTERIES—If terminals are loose or bent, sealing compound removed, cell covers damaged, plates or separators damaged by insertion of probes, tools, etc.
2. "421" TEST NOTES: A. *Do not charge units* prior to making test. B. "421" testers are produced by a number of different manufacturers—follow the directions for tester operation. C. Be certain to obtain clean and tight connections before performing this test. D. All meter readings must be made immediately after indicator light comes "ON"	Batteries designated as *Bad* by tester.	REPLACE BATTERIES
	Batteries designated as *Good* and with no owner complaint or indication of poor performance.	RETURN TO SERVICE— Posts, cables and top should be clean and batteries should be in at least a 75% state-of-charge.
	Batteries designated as *Good* by tester, but are still questionable because of owner complaint or age of battery.	Proceed to Step 3.
3. SPECIFIC GRAVITY (HYDROMETER) TEST NOTE: DO NOT charge battery prior to making test.	a. 50 points or more variation between highest and lowest cells.	REPLACE BATTERIES
	b. Less than 50 points variation between highest and lowest cells.	RETURN TO SERVICE— Posts, cables and top should be clean and the battery should be in at least 75% state-of-charge.

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Refer to the safety instructions previously listed in this unit.

Scientific Principle Involved:
EMF and Capacity Rating

The lead-acid storage battery for automobiles with 6-volt electric systems is three 2.2-volt cells connected in series. The emf is approximately 6.6 volts. Six cells are connected in series to make up the battery for 12-volt systems.

The quantity of chemical energy stored in a battery depends on the magnitude (greatness) of the charging current and the time the current flows to bring it to a fully charged state. The capacity of a battery is usually rated in ampere-hours. One having a capacity rating of 90 ampere-hours could supply a current of 1 ampere for 90 hours, 2 amperes for 45 hours, 3 amperes for 30 hours, and so on.

Application of Principle

The procedures provided in this section can be used in testing storage batteries installed in vehicles or recently removed from them.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(22), p. 204; *(26)*, pp. 298-99; *(27)*, pp. 469-72; *(33)*, p. 26; *(47)*, pp. 234-35; *(65)*, p. 198; *(86)*, pp. 46-47.

Battery Charging

There are two basic methods of recharging batteries. One is the slow-charge method and the other is the fast-charge method. As the names imply, the methods differ in the length of time the battery is charged and in the amount of charging current supplied. Before any battery is recharged, the cells should be checked and water added if necessary to bring the electrolyte to the proper level. Periodically during the charging process, the temperature of the electrolyte should be measured; and if the temperature exceeds 125 degrees F., the charge rate must be reduced or temporarily halted to avoid damage to the battery. The electrolyte temperature should never be allowed to exceed 125 degrees F.

The slow-charge method supplies the battery with a relatively low charging rate for a long period of time. The charging rate should be 7 percent of the ampere-hour rating of the battery. *Example:* If the ampere-hour rating is 60 a.h., the charge rate should be 4.2 amperes or, for all practical purposes, 4 amperes. If the ampere-hour rating of the battery is unknown, the charge rate should be 5 amperes for passenger-car type batteries and 9 amperes for heavier batteries. Charging periods of 24 hours and more may be needed to bring the battery to full charge. The battery is fully charged when the cells are gassing freely and no change in specific gravity occurs over a one-hour period. Sulfated batteries (that is, batteries which have stood in a discharged condition for long periods of time without recharging) may require three or four days of slow charging in order to bring the battery to a fully charged condition. Batteries which are permanently sulfated can never be restored to a normal operating condition, regardless of the rate of charge or the length of time the charge is applied.

The fast-charge method supplies the battery with a high charging rate for a short period of time. Charging rates of 40 to 70 amperes are common, with charge periods varying from 1½ to 3 hours, depending on battery type and size. The high charging rate may be continued for as long as there is no electrolyte loss and the electrolyte temperature does not exceed 125 degrees F. Because of the short charging period and the high charging rate, the plates are not fully converted to lead peroxide (PbO_2) and sponge lead (Pb). This deficiency means that a battery cannot be fully recharged by the fast-charge method although it can be substantially "boosted" or recharged. For the complete recharging of the battery, the fast-charge procedure should be followed with a slow charge for a few hours. When fast chargers are used, the safeguards built into the charger by the manufacturer should never be ignored or circumvented as these safeguards are intended to protect the battery from damage. It is important to remember that an explosive mixture of hydrogen and oxygen gases is formed when any battery is being charged. As the mixture escapes through the battery vents, normal air circulation usually carries the explosive mixture away. But if circulation is poor or if the battery is being heavily charged, the explosive mixture may accumulate near the battery. Since a spark or flame can ignite the mixture and cause an internal battery explosion, care should be taken to avoid sparks and flame near the battery.

Refer to the safety instructions previously listed in this unit.

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Scientific Principle Involved: Chemical Change

The sulfuric acid electrolyte contains both hydrogen ions (H+) and sulfate ions (SO_4-). The negative plate, which is sponge lead, reacts with the sulfate ions in the electrolyte to produce a deposit of lead sulfate. During this reaction electrons are released; they move through the external circuit to provide electric power for the starter, lights, and other electrical equipment of the internal-combustion engine unit. The lead peroxide of the positive plate reacts with the hydrogen and sulfate ions of the electrolyte to form water and a deposit of lead sulfate.

When the external circuit is open, the movement of electrons is interrupted, causing both chemical reactions to stop. If the circuit is closed for a long period of time without the benefit of a charging current, the reactions will continue until the plate surfaces are covered with lead sulfate and most of the hydrogen and sulfate ions are removed from the electrolyte. The sponge lead of the negative plate and the porous lead peroxide of the positive plate provide greater internal surface areas for chemical change and collection of the lead-sulfate deposit.

Certain chemical reactions that produce a movement of electrons can be reversed if the movement of electrons is reversed. All rechargeable cells depend on a reaction of this type. When a lead and sulfuric acid battery is connected to a charger, the reactions are reversed. When charging is complete, both plates are restored to their original composition, and the electrolyte is restored to its original concentration of sulfuric acid (hydrogen and sulfate ions). This process is illustrated in a formula as follows:

$$PbO_2 + Pb + 2H_2SO_4 \underset{\text{Charging}}{\overset{\text{Discharging}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O$$

Application of Principle

Charge lead-acid storage batteries and make tests covered under "Hydrometer Test" and "Battery Testing" in this unit.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 105, 111; *(7)*, pp. 39-40; *(9)*, pp. 229-30; *(22)*, pp. 362-63; *(26)*, pp. 172-73; *(27)*, pp. 466-67; *(33)*, pp. 24-25; *(47)*, pp. 240-42; *(54)*, pp. 332-33; *(65)*, pp. 45-46; *(75)*, Chapter 36, pp. 21-23; *(78)*, pp. 242-43; *(86)*, pp. 46-49.

Unit 23 — GENERATION OF ELECTRICITY

This unit deals with (1) magnetos; (2) direct-current generators and alternators; (3) alternating-current rectifiers; and (4) generator regulation.

Magnetos

A magneto is a device which generates and distributes electricity for igniting the compressed fuel-air mixture in the combustion chamber of internal-combustion engines used to operate vehicles and portable or stationary equipment (for example, lawn mowers, motorcycles, chain saws, portable lighting systems, and outboard motorboats).

The magneto generates the electricity, steps up the low voltage to a high-tension voltage, and distributes it to the cylinder (or cylinders) at the correct instant. These operations are done without the aid of a storage battery. Certain magnetos are low-tension types; they generate a low voltage, which is then stepped up to a high voltage by means of a separate coil. High-tension magnetos produce voltage of sufficient value to jump the spark-plug gap without the use of a separate coil.

The difference between a magneto and a generator is that while the generator has an electromagnetic field requiring an outside source of electricity to excite it, the magneto uses permanent magnets for this field. Magneto ignition systems have certain advantages over the battery-demanding systems. The magneto systems are more portable and lighter, and they provide a spark that is hotter as the engine speed increases.

There are two types of magnetos, the low-tension type and the high-tension type. Magnetos are classified further according to the part of the magneto which is revolved. A magneto that has its windings on a rotor which is revolved in a magnetic field is known as a shuttle-wound magneto. In the

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Standards for Fitting Women's Clothes (Continued)

ITEMS TO CHECK	GENERAL APPEARANCE		
	Good	Poor	Correction Necessary
SKIRT			
Center front and center back lines hang perpendicular to floor	____	____	____
Side seams hang perpendicular to floor.	____	____	____
Hipline allows room to move and sit	____	____	____
Pleats hang straight, closed, and perpendicular to floor.	____	____	____
Waistband remains flat without wrinkling. . . .	____	____	____
Hem is an even distance from floor.	____	____	____
Skirt is at most flattering length for figure and within the fashion range.	____	____	____

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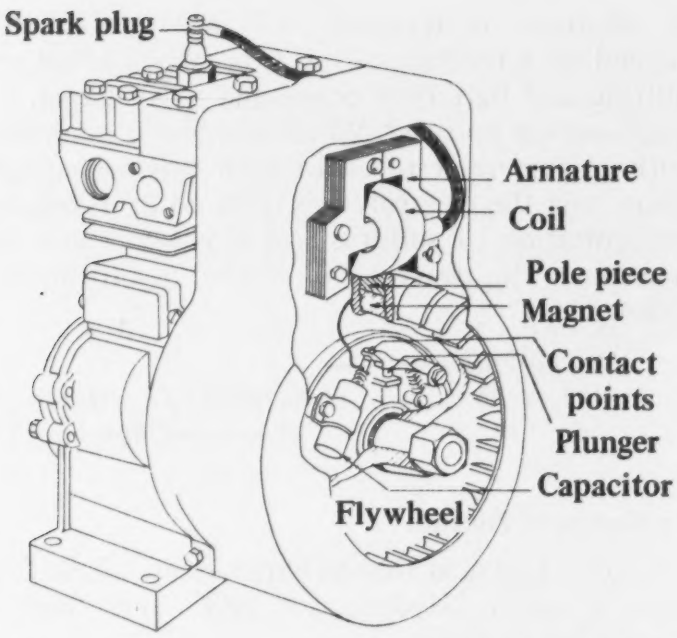

The magneto of a small engine produces electricity when the flywheel is rotated by the pulling of a rope wound around a pulley attached to the crankshaft (Briggs and Stratton Corp.).

inductor-type magneto both the coil and the magnet are mounted in stationary positions; movement of the magnetic field is obtained by making and breaking the magnetic field. A newly developed magneto, known as a revolving magnetic design, has been made possible by new types of magnets. The coil of the magneto is mounted in a stationary position, and one or more magnets are revolved between the pole pieces of the magneto.

A magneto, in a sense, consists of two simple circuits; one is called a primary circuit and the other a secondary circuit. Both circuits have windings which surround the same iron core, and the magnets in the flywheel or rotor act on both circuits. Current can be induced in each circuit by changing the magnetism in or around the coils. The primary circuit, which has relatively few turns of heavy wire, includes a set of breaker points and a capacitor. The secondary circuit, which has a coil with many turns of lighter wire wound around the outside of the primary winding, includes a spark plug. A permanent magnet is mounted in the flywheel or rotor; as the flywheel rotates, the magnet is brought into proximity with the coil and core.

Scientific Principle Involved:
Magnetism

Every magnet has a north pole and a south pole. Like poles repel each other (two north poles or two south poles); unlike poles attract each other (a north pole and a south pole). The reason for this phenomenon is that a magnetic force (or field) exists between the opposite poles of a magnet. This magnetic field is composed of invisible lines of force (magnetic flux).

There are two types of magnets, permanent magnets and temporary magnets (electromagnets). The earliest type of permanent magnet was the natural one of ore and was used as a compass in navigation. It was called a lodestone (lead stone). Now, permanent magnets are manufactured. Two common shapes of manufactured magnets are the bar magnet, which has a pole at each end, and the horseshoe magnet, which is a bar magnet that has been bent into a **U** shape so that the poles are close together. Originally, manufactured magnets were made of high carbon steel. Now, high quality permanent magnets are manufactured from alloys of steel and tungsten, chromium, and cobalt; from alloys of nickel and chromium; and from ceramics. These magnets not only are stronger but retain their magnetism for much longer periods.

The movement of electrons (flow of current) can be caused by revolving a coil of wire in a

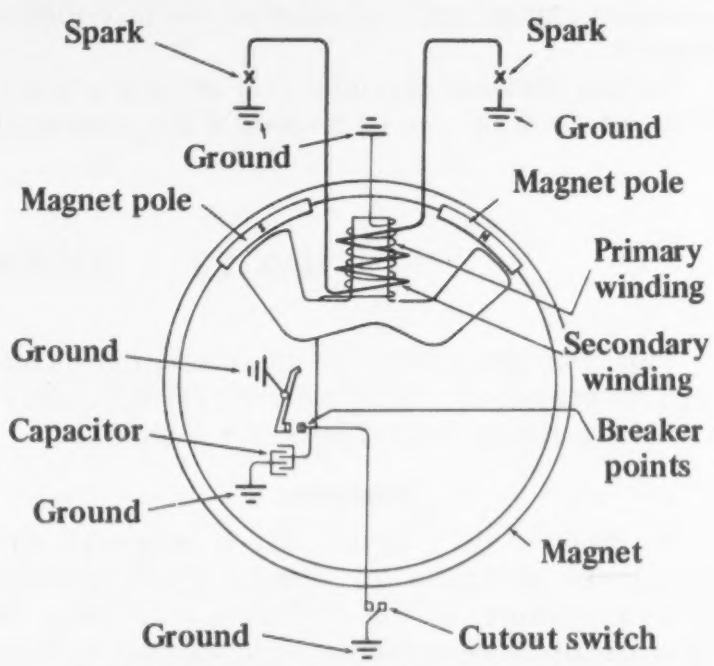

The schematic diagram given above presents the components of a flywheel-type magneto used in an outboard motor (Evinrude Motors).

magnetic field. In a conventional generator the magnetic field is produced by passing current through the field coils, which in turn produce the magnetic field (electromagnets). In the case of the magneto, the magnetic field is produced by means of permanent magnets. Magneto ignition systems

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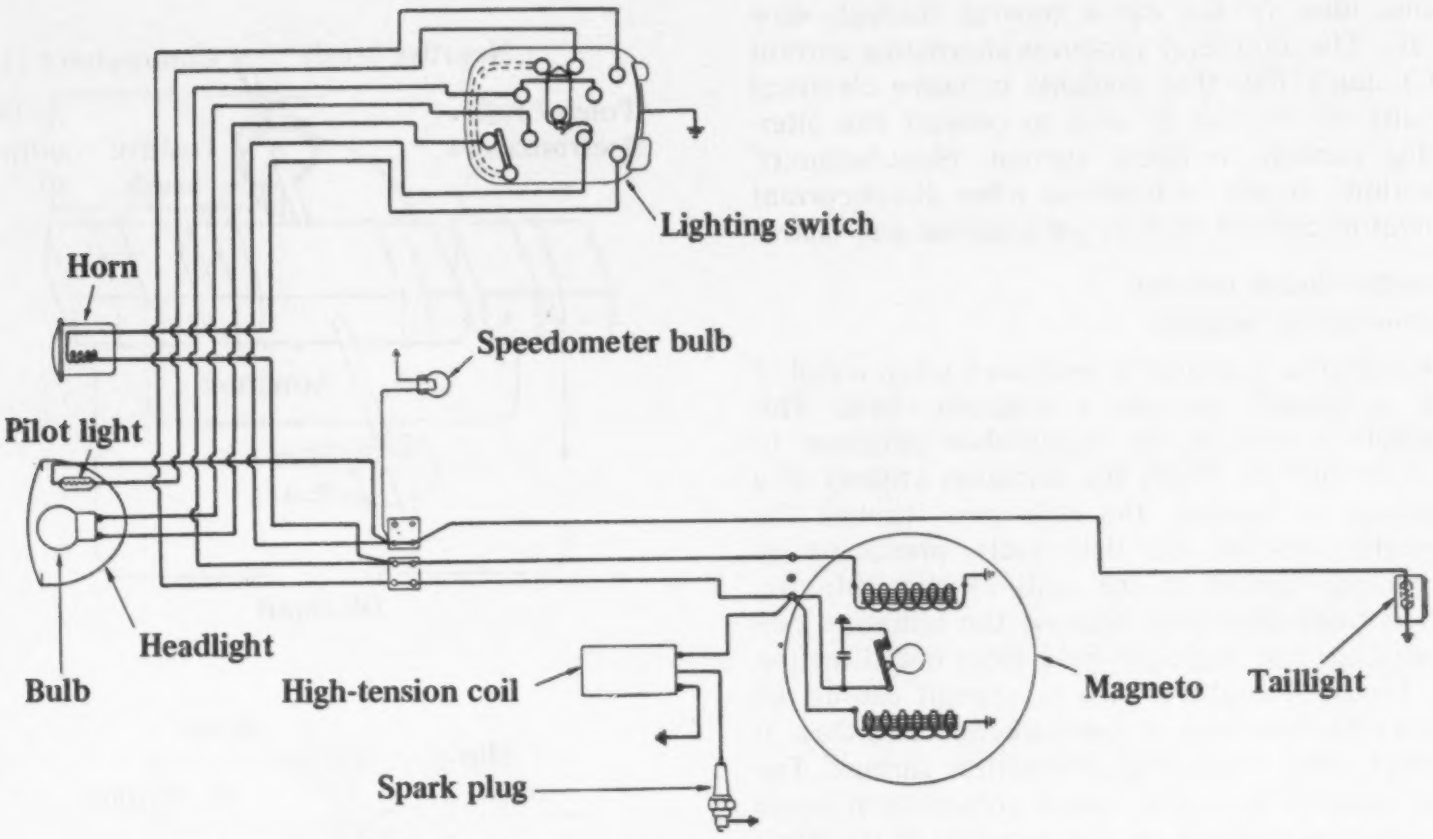

A flywheel magneto provides electrical current needed to operate the engine and the electrical components shown in the motor-scooter wiring diagram (Lambretta: Innocenti Motor Division).

have distinct advantages. They do not require any storage battery or other source of current, and the intensity of the generated voltage does not decrease but increases with the engine speed. Magnetos are particularly popular for internal-combusion engines where a storage battery is not needed for starting or lighting. The recent development of permanent magnets of greatly increased strength has improved their performance.

Application of Principle

1. Place a magnet under a sheet of glass or a piece of cardboard. Sprinkle iron filings on the glass or cardboard and tap lightly. The iron filings will show the form of the magnetic field.
2. Locate permanent magnets used in the components of small engines and automobiles (magneto, radio speaker, and compass).
3. Check the permanent magnet in a speedometer.
4. Service or repair a magneto.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 482-90; *(15)*, pp. 13-22; *(19)*, pp. 28-33; *(26)*, pp. 159-61, 306-9; *(27)*, pp. 510-32; *(29)*, Section VII, pp. 1-3; *(32)*, pp. 15-18; *(33)*, pp. 55-58; *(47)*, pp. 57-61, 188-89; *(52)*, pp. 5, 9; *(53)*, pp. 19, 85-86; *(54)*, pp. 293-94; *(57)*, pp. 193-204; *(62)*, pp. 68-77; *(65)*, pp. 20-29; *(69)*, Chapter 3, pp. 18-21; *(75)*, Chapter 35, pp. 23-29, Chapter 36, p. 27; *(79)*, p. 20; *(81)*, pp. 25-27; *(84)*, pp. 46-47; *(85)*, Appendix; *(86)*, pp. 12-19, 104.

Direct-Current Generators and Alternators

The automobile must have some source of direct current (DC) to operate the starter, ignition, lights, and electrically operated accessories. A storage battery will furnish this electrical energy for a limited time. A direct-current generator, which converts mechanical energy provided by the engine to electrical energy, has been used for a number of years to keep the battery charged. Demands of the electrical system of modern automobiles have placed a heavy strain on the generator. For this reason the direct-current generator has been replaced in many vehicles by the alternator (alternating-current generator), which has the advantage of producing current at low speeds even when the

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engine idles or the car is moving through slow traffic. The alternator produces alternating current (AC) much like that available in home electrical circuits. A rectifier is used to convert this alternating current to direct current. Manufacturers' directions should be followed when direct-current generators and alternators are installed and tested.

Scientific Principle Involved: Electromagnetic Induction

An electric potential is produced when a coil of wire is passed through a magnetic field. This principle is used in the automobile generator to produce current. When the armature (rotor) of a generator is turning, the coils pass through the magnetic flux of the field coils, producing an alternating current in the coils of the armature. The current alternates because the armature coil approaches the magnetic field from one direction and leaves in another. This movement causes the current to flow first in one direction and then in another, thus producing alternating current. The direct-current generator uses a commutator made of segments arranged on the armature so that they contact the brushes at the proper times during the rotation. This contact causes the pulsating current to flow in only one direction in the external circuit. The alternator uses slip rings and collects the alternating current, which is then converted to direct current with a rectifier. Unlike the magneto, which uses permanent magnets, these generators use field coils, which are electromagnets (temporary magnets). The electromagnets produce the

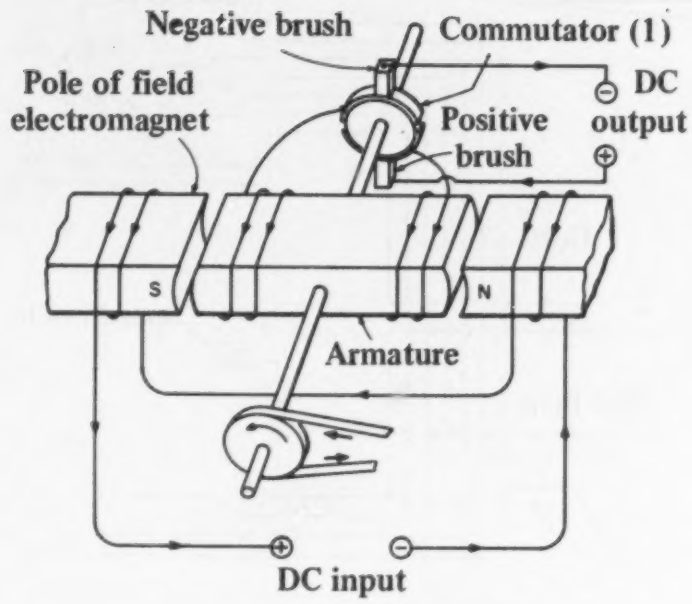

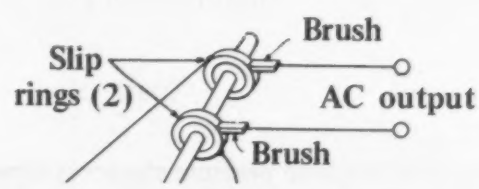

A basic direct-current generator is identical to a basic alternating-current generator except that one has a commutator and the other has slip rings. If the commutator (1) is replaced by the slip rings (2), the generator's output will become alternating current instead of direct current.

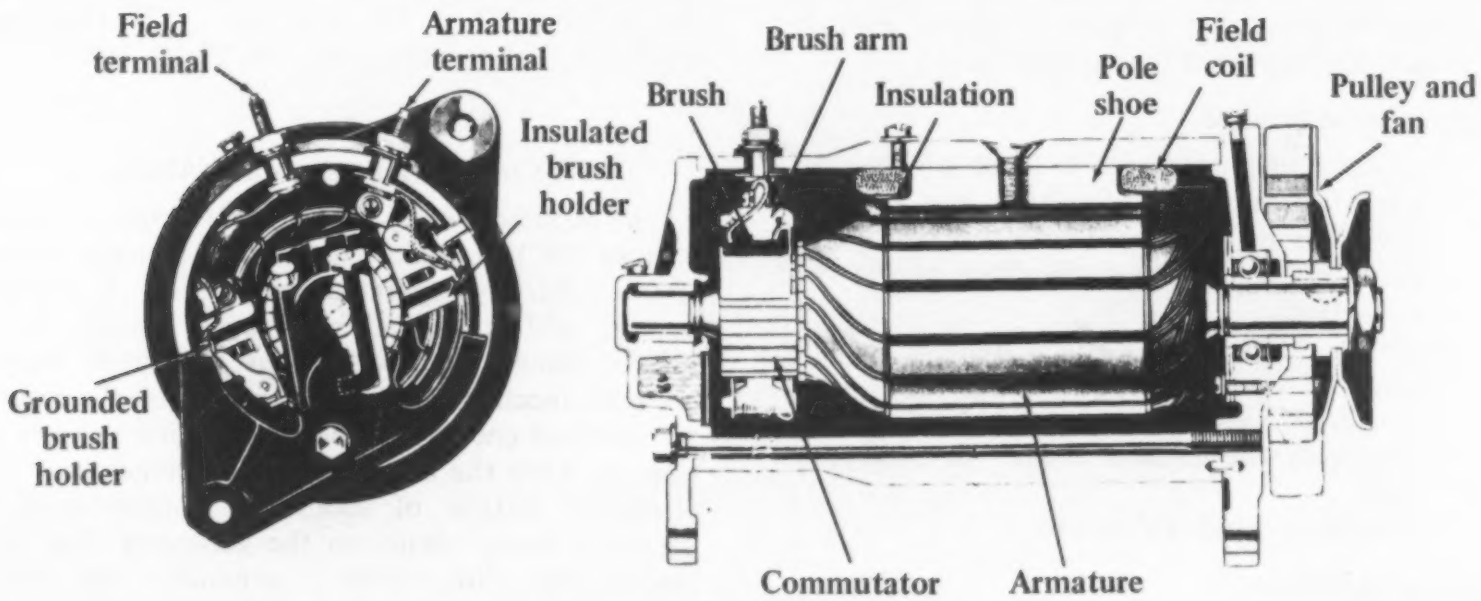

The illustrations presented above give an end view and a sectional view of a direct-current passenger-car generator (Delco-Remy Division, General Motors Corp.).

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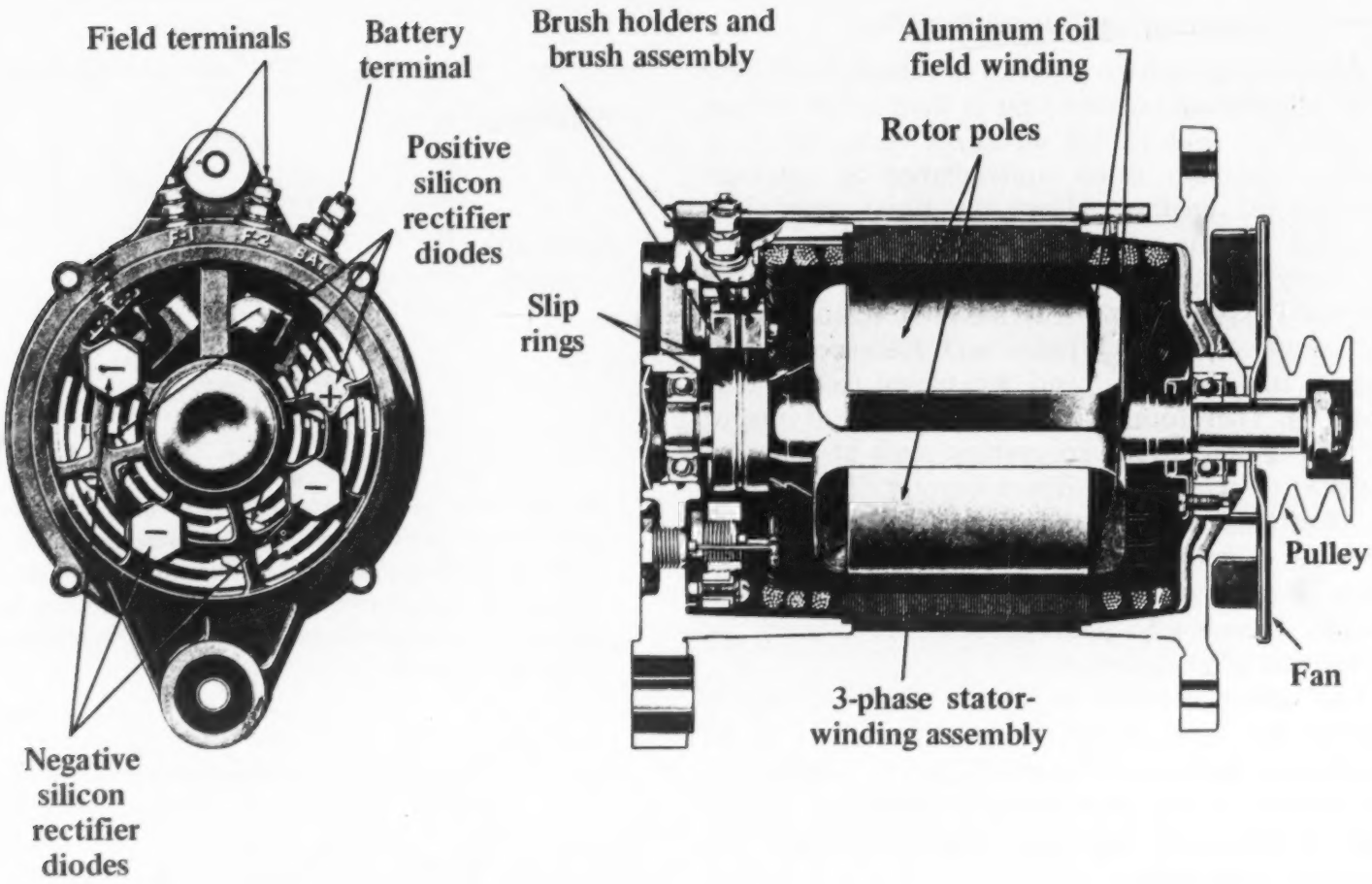

The illustrations presented above give an end view and a sectional view of an alternating-current generator (alternator) (Delco-Remy Division, General Motors Corp.).

properly oriented magnetic field when direct current is sent through the field coils as part of the direct current produced by the generator is supplied to these coils.

Application of Principle

1. The relationship of the field strength to the generator output can be shown by placing a variable resistor in the field circuit and regulating the amount of direct current supplied to the field.
2. A generator can be designed, constructed, and operated by a group of students.
3. Generators can be checked, serviced, and repaired.
4. A 6- or 12-volt light bulb can be connected to each end of a generator field coil; when the coil is lowered into the field of an operating growler, the bulb will light up.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(10), pp. 7, 12-21, 24; *(13)*, pp. 482, 490; *(22)*, pp. 215-25, 377-83; *(24)*, pp. 15, 172-73; *(26)*, pp. 173-79, 316; *(27)*, pp. 539-49; *(33)*, pp. 71-85; *(38)*, pp. 152-53; *(47)*, pp. 189-213, 218-22; *(51)*, pp. 5-11; *(54)*, pp. 321-26; *(62)*, pp. 111-17; *(65)*, pp. 200-201; *(66)*, pp. 158-59; *(69)*, Chapter 19, *pp. 17-24;* (86), *pp. 105-8.*

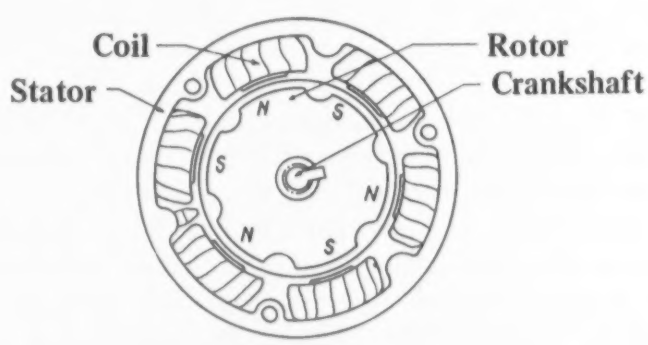

The rotor-type alternating-current generator used in motorcycles is composed of a stator with coils which are wound around iron cores and a rotor made of permanent magnets which is attached to the crankshaft (Honda Motor Company, Ltd.).

Alternating-Current Rectifiers

Alternating-current generators (alternators) produce alternating current that is used in the home, in industry, and in the electrical components of automobiles and other units driven by internal-combustion engines. However, direct current is required for the operation of certain components of many electric/electronic devices, such as the electrical systems of internal-combustion-engine units, the circuits of radio and television transmitters and receivers, and measuring instruments (meters). Therefore, the alternating-current output of alternating-current generators must at times be changed or rectified to direct current. This change or rectification is accomplished by the use of selenium, silicon, magnesium-copper sulphide, or copper-oxide rectifiers or electron tubes, which furnish a one-way path for electric current or movement of electrons.

The silicon rectifier or silicon diode rectifier is one of the most recent types of rectifiers to be developed. Because of its small size, it is built into the frame of the automobile's alternator. Plate-type rectifiers are relatively large in size and are mounted externally.

Single-phase alternating current would result in a pulsating current. To provide a much smoother flow of current, alternators are built with three stator circuits which, in effect, give overlapping pulses of alternating current. When these pulses are rectified through diodes, a comparatively smooth flow of direct current is obtained.

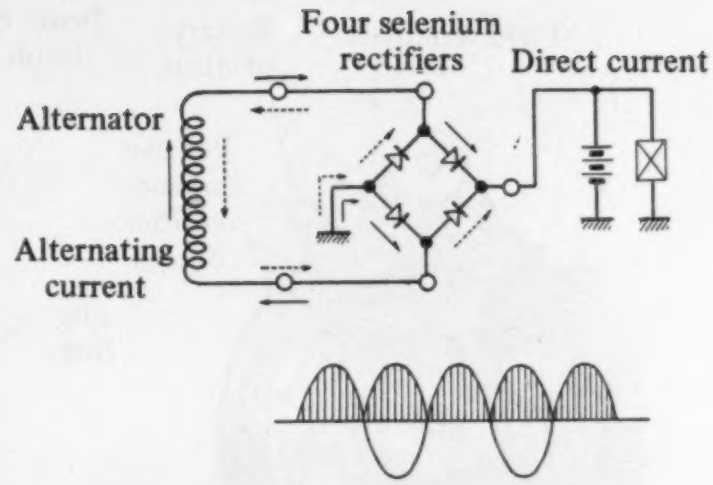

A full-wave or bridge rectifier is used to rectify alternating current produced by alternators. In the diagram presented above, four selenium rectifiers are interconnected to provide direct current during both halves of the alternating-current cycle (Honda Motor Company, Ltd.).

Scientific Principle Involved: Rectification

The process of changing alternating current to direct current is called rectification. When a silicon diode rectifier is placed in series with a load (electrical device) in a circuit and is supplied with an alternating current, the current is allowed to flow in only one direction. This type of rectifier, which is called a half-wave rectifier, provides pulsating direct current. For one half of each cycle of alternating current, the current flows through the rectifier and load. During the other half-cycle, the current cannot flow through the rectifier so that no current flows through the circuit. Capacitors can be used to smooth out the pulsating current; however, full-wave or bridge rectifiers, which use both halves of each cycle, or three-phase alternators produce a smoother direct-current output.

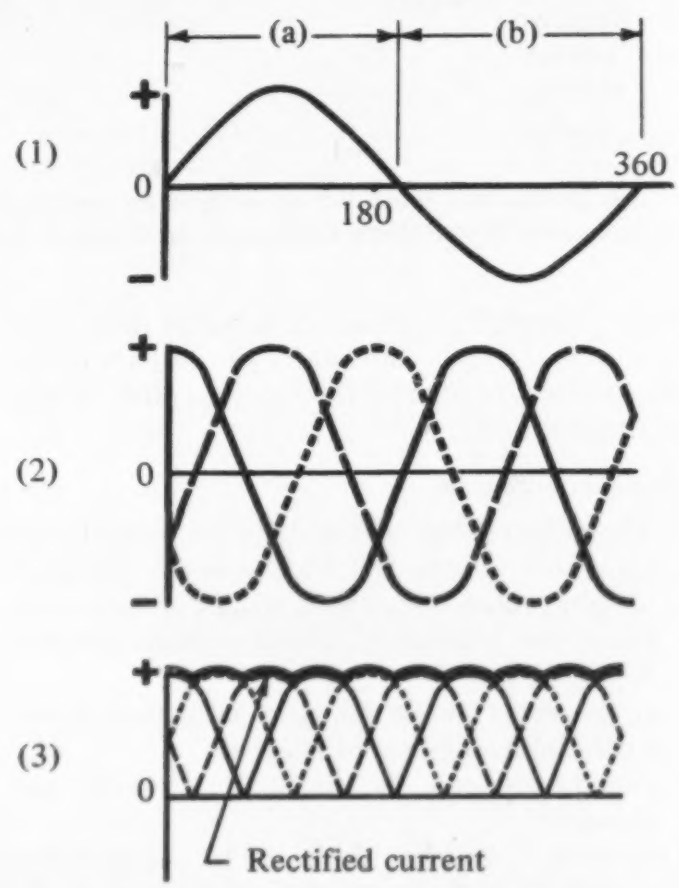

In the diagram of a single-phase alternating current (1), the positive half wave is represented by (a), the negative half wave by (b). In the three-phase alternating current (2), the phase outputs overlap but do not coincide. The three-phase alternating current depicted in (2) is shown as rectified direct current in (3).

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Application of Principle

1. Locate rectifiers in the generator circuit of automobiles and other units driven by internal-combustion engines.
2. Disassemble, clean, check, and, if necessary, repair generators used in the electrical system of internal-combustion-engine units.
3. Mount a ½-horsepower, single-phase motor, a 35-ampere alternator, a regulator, and a storage battery on a piece of plywood. Charge the battery by driving the alternator with the motor.
4. Use an ohmmeter to demonstrate how a silicon diode rectifier will have low resistance in one direction and high resistance in the other.
5. Demonstrate magnetic fields by placing several coils around a cardboard tube and pulling a piece of iron through the tube by turning on each coil in turn.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(5), pp. 1-15; *(13)*, pp. 489-90; *(22)*, pp. 217-22, 381-83; *(24)*, pp. 195-99; *(26)*, pp. 174-75; *(27)*, pp. 645-48; *(33)*, pp. 81-83, 177-80; *(38)*, pp. 152-56; *(47)*, pp. 172-78, 409; *(51)*, pp. 21-23; *(53)*, pp. 23-25; *(65)*, pp. 285-90; *(69)*, Chapter 19, pp. 25-29; *(75)*, Chapter 31, pp. 1-22; *(86)*, pp. 135-36.

Generator Regulation

Both alternating-current and direct-current generators require a regulator which prevents the generator from producing excessive voltage/current. Without regulation, a generator would continue to increase its output as speed increased until it would be producing so much current that it would overheat and burn up. If an unregulated generator were connected to the electric circuit of an automobile or to other units driven by an internal-combustion engine, the storage battery would be greatly overcharged and the electrical devices could be damaged. The direct-current generator uses an external resistance to control voltage and amperage output. Various devices are used to regulate alternating-current generators by placing resistance in the generator field circuit. Cutout relays (circuit breakers) are a part of the regulation system of direct-current generators and some alternating-current generators. The cutout relay closes the circuit between the generator and battery when the generator is producing current; it opens this circuit so that the battery cannot discharge through the generator when the generator slows or stops. Certain alternating-current generators, because their design makes them self-limiting, have no cutout relays and no current regulators. The rectifying diodes or transistors in the circuit (transistor systems) prevent reverse current or discharge of the battery through the generator.

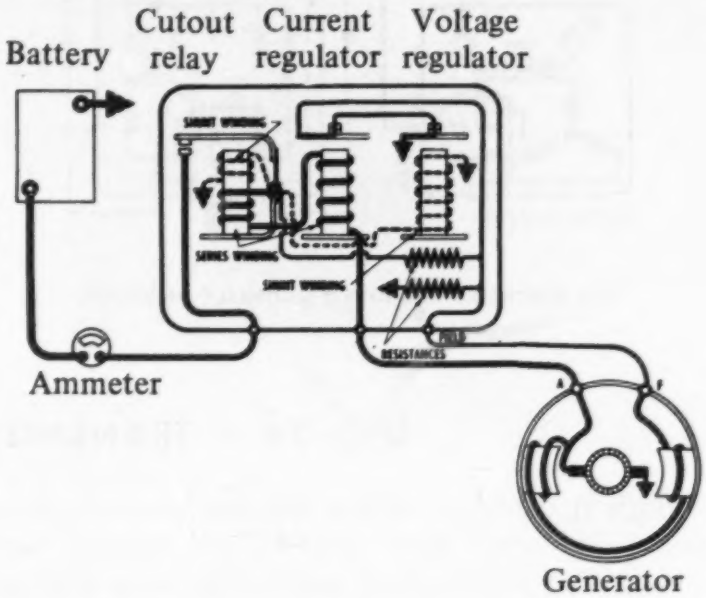

A conventional three-unit regulator is used with a generator.

Scientific Principle Involved: Electromagnetic Switch

The cutout relay, voltage regulator, and current regulator are switches operated by an electromagnet. The cutout relay consists of two windings (coils) around a core and a flat steel armature, mounted on a hinge above the core. A contact point on the armature is positioned just above a stationary contact point that is connected to the battery. When the generator is not operating, a spring holds the two points apart, keeping open the circuit between the generator and battery. When the generator begins to operate, current flows through one winding, induces voltage in the other winding, and creates a magnetic field around the core. The armature is pulled by the electromagnet and the contact points come together (close). This action completes the circuit between the generator and the battery. When the generator stops, current begins to flow from the battery to the generator.

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This reversal of current flow creates a reverse magnetic field in one winding which bucks the magnetic field in the other winding. The weakened magnetic field can no longer hold the armature down and keep the contact points together. When the armature springs up, the circuit between the battery and the generator opens.

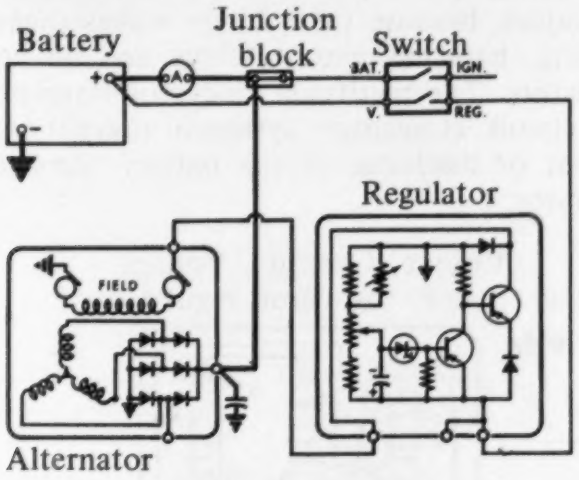

The alternator employs a transistor regulator.

Application of Principle

1. Locate regulators in the generator circuit of automobiles and other units driven by internal-combustion engines.
2. Clean, check, and, if necessary, repair regulators (cutout relays, voltage regulators, current regulators, and transistor systems).

Selected References

***Note:** The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.*

(4), pp. 124-27; *(5)*, pp. 1-15; *(7)*, pp. 42-44; *(13)*, pp. 486-87; *(19)*, pp. 226-37; *(22)*, pp. 215-32; *(26)*, pp. 309-11; *(27)*, pp. 519-24; *(33)*, p. 60; *(36)*, pp. 85-96; *(47)*, pp. 321-29; *(65)*, pp. 198-202; *(66)*, pp. 154-55; *(69)*, Chapter 19, pp. 20-23; *(75)*, Chapter 33, pp. 1-23; *(78)*, pp. 286-329.

Unit 24 — TRANSMISSION OF ELECTRIC POWER

Both the storage battery and the electric generator (alternator) have positive and negative terminals. The positive terminal, which has a shortage of electrons, attracts electrons. The negative terminal, which has an excess of electrons, repels electrons. When a circuit is completed between the terminals, electrons move through the circuit. They will move as long as there is a complete circuit and as long as the electromotive force is maintained. The original electrons that start out displace electrons in the next atoms, and so on along the length of the circuit. The movement of electrons is called an electric current.

The modern automobile has an alternator and a storage battery to supply the electrical system. Electrons move (or current flows) through wires to the ignition and lighting systems and through cables to the storage battery and the starting (cranking) motor. The internal current flow in the electrolyte is a movement of positive and negative ions in opposite directions.

Scientific Principle Involved:
Electromotive Force

A device such as a storage battery or an electric generator provides the electromotive force which removes electrons from one end of a wire and piles them up at the other end. When the number of electrons at one end of a wire exceeds the number at the other end, an electric field is set up between the ends of the wire. This field causes free electrons in the wire to move from the negative end to the positive one. This movement of electrons is the flow of electric current; it is the electromotive force (voltage) that creates the electric pressure that causes the current to flow.

Application of Principle

1. Use a proper meter to check the electromotive force (voltage) of a storage battery and a generator.
2. Use a proper meter to determine the positive and negative terminals of a dry cell and a storage battery.

Note: An ammeter must always be connected in series with the circuit. To make a series connection requires breaking the circuit to connect the meter. A voltmeter is always connected in parallel or across the circuit. The circuit does not have to be broken so that voltage can be measured. Use direct-current meters to measure direct currents and voltages. Direct-current meters must always be connected with the correct polarity. Use alternat-

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ing-current meters to measure alternating currents and voltages.

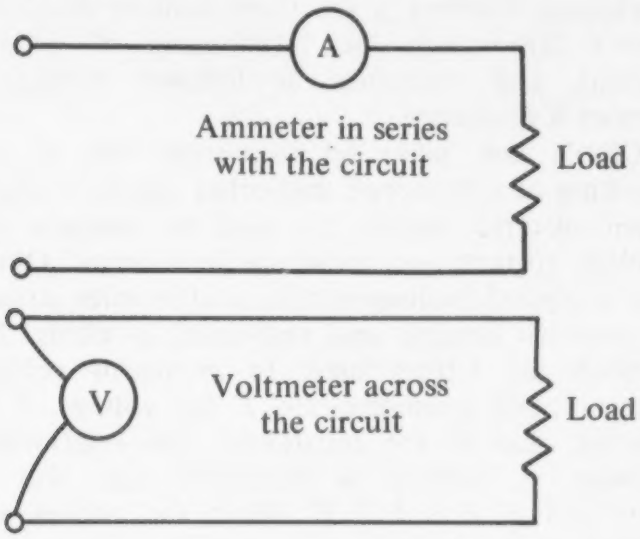

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 490-91; *(22)*, p. 201; *(26)*, p. 296; *(27)*, pp. 463, 560-61; *(33)*, pp. 152-64; *(47)*, pp. 22-23, 34-35; *(62)*, pp. 15-19; *(66)*, pp. 150-52.

Conductors and Insulators

A conductor is a material that readily allows a flow of electrical current (movement of electrons). Metals are good conductors of electricity. Silver is the best conductor; copper and aluminum follow, in that order. For this reason wires, cables, straps, and bars used in transmitting electric power are made of copper or aluminum, and silver is used in the manufacture of many electronic parts. Solutions of salts, acids, and bases are fairly good conductors.

An insulator is a material that will not readily conduct electricity (resisting the movement of electrons). Rubber, glass, porcelain, mica, amber, oils, and sulfur are good insulators. Rubber and plastic serve as insulating shields around wires used to conduct electricity. Power lines are attached to insulators made of glass or porcelain. Pure water is an insulator, but water from a faucet is not because it usually contains small amounts of dissolved impurities.

The movement of electrons can be stopped by an open circuit (a switch in the "off" position or a break in a conductor) or shorted or grounded by a conductor that is not a part of the intended circuit.

Scientific Principle Involved: Electron Theory

An atom is composed of particles of matter called protons, neutrons, and electrons. The protons and neutrons form the nucleus, which is the center of the atom. The electrons are arranged outside the nucleus in an orderly manner. Each atom has an equal number of protons and electrons. The proton carries a positive (+) electric charge, the neutron carries no electric charge, and the electron carries a negative (–) electric charge. A normal atom has no electric charge because the positive charge of the protons in the nucleus is canceled or neutralized by the negative charge of the electrons outside the nucleus.

The protons in the nucleus cannot easily be moved; however, the electrons can be disturbed and even pulled away from the atom. When this occurs and electrons are taken away from a neutral atom, the atom has a positive charge and becomes a positive ion; that is, the atom has more positively charged protons than negatively charged electrons. Conversely, if extra electrons are added to a neutral atom, the atom has a negative charge and becomes a negative ion.

Some atoms hold their electrons very tightly. Substances made up of atoms of this type are known as insulators; electrons do not move through them easily. These substances are usually nonmetallic. Other atoms have electrons that are held very loosely. Some of these electrons jump rapidly from atom to atom as "free electrons." Substances made up of atoms of this type are called conductors; electrons move through them easily. The best conductors are metals, such as silver, copper, and aluminum. When electrons are taken from atoms in a conductor, the atoms become charged positively, and the electrons from nearby atoms are attracted to them, moving into spaces left by the departed electrons. This action is repeated along the entire length of the conductor. A positive charge placed on any part of the conductor causes a movement of electrons from atom to atom within the conductor. This movement of electrons is called an electrical current.

Application of Principle

1. Check the amperage of circuits using an ammeter, a 1.5-volt dry cell, and the types and lengths of wires that follow:
   a. Five feet each of No. 22 copper, aluminum, and nichrome wire, connected separately in circuits

b. Five feet of No. 18 copper wire, and then five feet of No. 28 copper wire
c. One foot of No. 28 copper wire and then a ten-foot piece of No. 28 copper wire

2. Attempt to operate the starting (cranking) motor of an automobile by connecting a small gauge conductor, such as a length of No. 16 copper wire, between storage battery and starter.
3. Inspect the electrical systems of a small engine unit and an automobile.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), p. 491; *(27)*, pp. 430-31; *(33)*, pp. 16-17; *(47)*, pp. 10, 25; *(54)*, pp. 316-19; *(62)*, pp. 59-67; *(63)*, pp. 162-67; *(65)*, pp. 96-101; *(69)*, Chapter 2, pp. 5-7, Chapter 19, pp. 4-5; *(75)*, Chapter 30, p. 2, Chapter 36, pp. 4-12; *(81)*, pp. 17-18; *(86)*, pp. 5, 53.

Voltage, Current, and Resistance

Voltage (E) or electromotive force (emf) is electrical pressure that will cause electrons to move (current to flow) in a closed circuit. The force is the repelling force caused by a surplus of electrons and the attracting force caused by a deficiency of electrons. Electrical pressure or potential difference is measured in volts. It is the voltage which causes the flow of current in a closed circuit to provide heat and light and operate electrical equipment.

Current (I) is the rate of the electron movement. Current may be simply described as the rate of movement of electrons in a circuit. The basic unit of measurement for current is the ampere. Electrons move from negative to positive in a circuit.

Resistance (R) is opposition to the movement of electrons (flow of current) and is measured in ohms. All components in a circuit, including wires, have some resistance. Electric motors, appliances, and other electrical devices have resistance. Resistance is the property limiting the flow of current in a closed circuit.

Scientific Principle Involved: Ohm's Law

The movement of electrons in an electrical circuit occurs when voltage overcomes resistance, causing current to flow. Voltage is the pressure that causes the flow of current (movement of electrons). Resistance is the opposition offered by the circuit to the flow of current (movement of electrons). Current is the movement of electrons. Ohm's law states the relationship of voltage, current, and resistance as follows: *Voltage = current × resistance.*

Ohm's law plays an important role in the checking of automotive and other electric circuits. When electric meters are used to measure the voltage, current, and resistance in a circuit, Ohm's law is applied. Voltage is measured in volts, current in amperes (amps), and resistance in ohms. The symbols or letters used to represent voltage, current, and resistance are E for voltage, I for current, and R for resistance. The relationship *Voltage = current × resistance* can also be expressed as $E = I \times R$. When the voltage and resistance are known, the amount of current is found by using $I = E \div R$; when the voltage and current are known, the resistance is found by using $R = E \div I$. Some practical examples are given as follows:

1. A headlight has a resistance of 4 ohms. When it is connected to a 12-volt battery, how much current will it draw?

   $I = E \div R; I = 12 \div 4; I = 3$ *amperes*

2. A 12-volt battery delivers 100 amperes to a starting motor. What is the total resistance of the starting circuit?

   $R = E \div I; R = 12 \div 100; R = .12$ *ohms*

3. A poorly connected battery cable has a resistance of 1 ohm. How much voltage will be required to push 300 amperes through this bad connection?

   $E = I \times R; E = 300 \times 1; E = 300$ *volts*

Application of Principle

1. Voltmeters, ammeters, and ohmmeters can be used to measure electrical conditions in circuits. An ohmmeter is used to measure the resistance of an open circuit. A voltmeter is used to measure the voltage drop between two points in a closed circuit and the total circuit voltage. An ammeter is used to measure current flow in a closed circuit.
2. A proper meter should be used to determine sources of resistance in the starting circuit of an automobile, including (a) corroded terminals; (b) broken insulation; and (c) frayed or broken wires.

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3. Determine the resistances of resistors by reading the color codes and checking with an ohmmeter.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 490-91; *(26)*, pp. 299-303; *(27)*, p. 473; *(33)*, pp. 36-38; *(47)*, pp. 31-32; *(58)*, pp. 15-59; *(62)*, pp. 15-16; *(65)*, pp. 70-95; *(86)*, pp. 53-71.

Series and Parallel Circuits

Electrons move (current flows) from a high-potential point (excess of electrons) to a low-potential point (deficiency of electrons). The path or paths followed by the electrons or current is called the electric circuit. All circuits must contain a source of electromotive force to bring about the difference of potential that causes electrons to move (current to flow). This source may be an electric cell, a mechanical generator, or another device that provides electric power. All paths of the circuit lead from the high-potential (negative) end of the electromotive source to its low-potential (positive) end.

The electrons (or current) in a circuit follow paths provided by solid conductors, liquids, gases, vacuums, or any combinations of these. Its path may include electric lights, heaters, motors, or any other of the many devices requiring electricity.

The three general types of electric circuits are (1) the series circuit, which provides a single, continuous path for electrons to move (current to flow) from the negative side of the electromotive-force source to the positive side; (2) the parallel circuit, which provides two or more parallel paths for electron movement (current flow) from negative to positive; and (3) the series-parallel circuit, a combination of the other two.

Scientific Principle Involved: Direct-Current Circuit

In a series circuit the current flow is the same in all parts of the circuit; the total resistance is equal to the sum of the individual resistances; and voltage is equal to the sum of the potential differences across each of the individual resistances. In a parallel circuit the voltage is the same across all resistances; the total current is equal to the sum of the currents through its branches; and the total resistance is equal to the voltage across the resistances divided by the total current in the circuit.

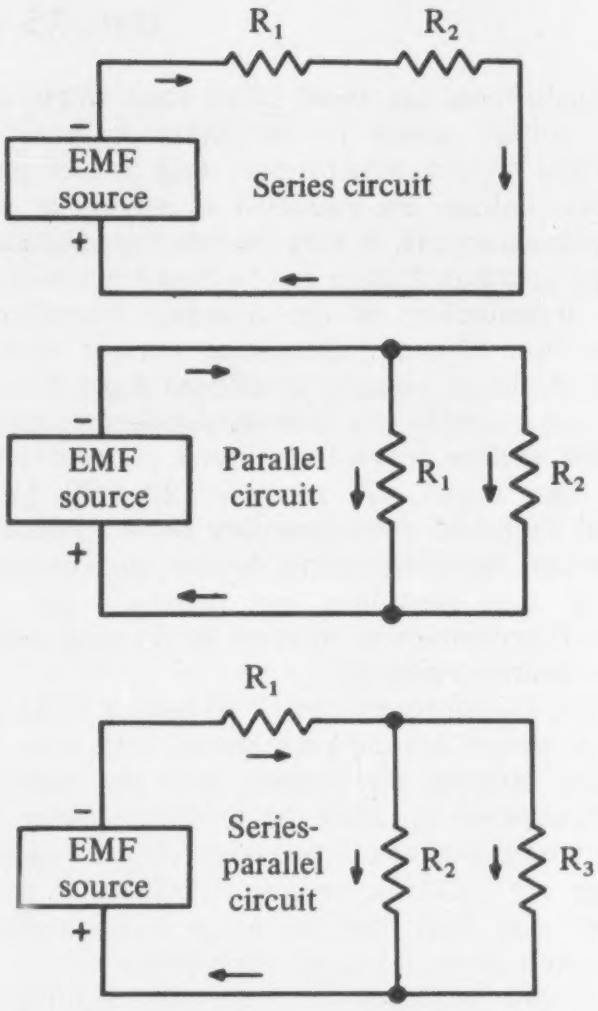

Electrons move from the negative side of the power source (EMF) through the resistances and back to the positive side of the source. In the series circuit the electrons move through resistors R^1 and R^2 (load); in the parallel circuit, through R^1 and R^2; and in the series-parallel circuit, through R^1 (in series) and then through R^2 and R^3 (in parallel).

Application of Principle

1. Trace, check, and measure circuits in electrical systems and devices.
2. Hook up series, parallel, and series-parallel circuits by using lengths of wire and light bulbs or other resistances to prove the relationships between voltage, current, and resistance in these circuits.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 493-94; *(19)*, pp. 19-22; *(26)*, p. 303; *(27)*, pp. 454-91; *(33)*, pp. 44-49; *(47)*, pp. 40-48; *(62)*, pp. 21-46; *(65)*, pp. 114-19; *(66)*, pp. 152-53; *(86)*, pp. 55-57.

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Unit 25 — TRANSFORMERS

Transformers are most often used where electrical voltage needs to be either increased or decreased. Power transformers used to increase or decrease voltage are classified as step-up or step-down transformers. A very common application of a step-down transformer can be found in the model train transformer or the doorbell transformer, where the 120-volt alternating current used in home electrical circuits is reduced from 8 to 24 volts. An example of a step-up transformer used to increase voltage is the transformer connected to a neon sign which will increase 120 volts to the several thousand volts necessary for the operation of the sign. Many electronic devices, such as radios, stereos, tape recorders, and television sets, use power transformers to increase or decrease voltage to the desired amounts.

Power transformers consist of two or more coils of wire wound around a laminated metal core. The winding carrying the current from the source of electrical power is called the primary winding. The other winding or windings which carry the induced voltage are called secondary windings. A transformer may have one or more secondary coils which step up or step down the voltage.

The two leads of the primary winding are connected to the source of power, which must be an alternating current or an interrupted direct current. The current through the secondary coil or coils is known as the induced current, and its voltage is known as the induced voltage. If the number of turns of wire in the secondary coil equals the number of turns in the primary coil, the induced voltage will be the same as the voltage applied to the primary coil. If the number of turns in the secondary coil is less than the number in the primary coil, the voltage will be reduced; and if the number of turns in the secondary coil is greater than the number in the primary coil, the voltage will be increased. Thus, the ratio of the voltage induced in the secondary coil or coils to the voltage applied to the primary coil is the same as the ratio of the number of turns of wire in the secondary coil to the number in the primary coil.

Scientific Principle Involved: Electromagnetic Induction

An electric current flowing in a wire produces a magnetic field around the wire; the greater the movement of electrons, the greater is the strength of the magnetic field. A coil of insulated wire carrying an electric current becomes an electromagnet whose strength is determined in direct proportion to the amount of current and the number of turns of wire in the coil. Using a permeable steel core also greatly increases the strength of the electromagnet because the core itself becomes a strong temporary magnet. Reversing the movement of electrons in the coil reverses the magnetic field of the coil.

Moving a magnet perpendicular to a wire produces the movement of electrons along the wire. Moving a magnetic field through a coil of wire induces an electromotive force in the coil. The strength of the electromotive force is in direct proportion to the rate of change of the magnetic field and to the number of turns of the coil. Reversing the magnetic field reverses the direction of the induced voltage.

In a power transformer the changing magnetic field that is produced by the alternating current in the primary induces an alternating electromotive force of the same frequency in the secondary. Since the rate of change of magnetic flux is the same for both the primary and secondary windings, the voltage ratio is the same as the ratio of turns of wire in the coils.

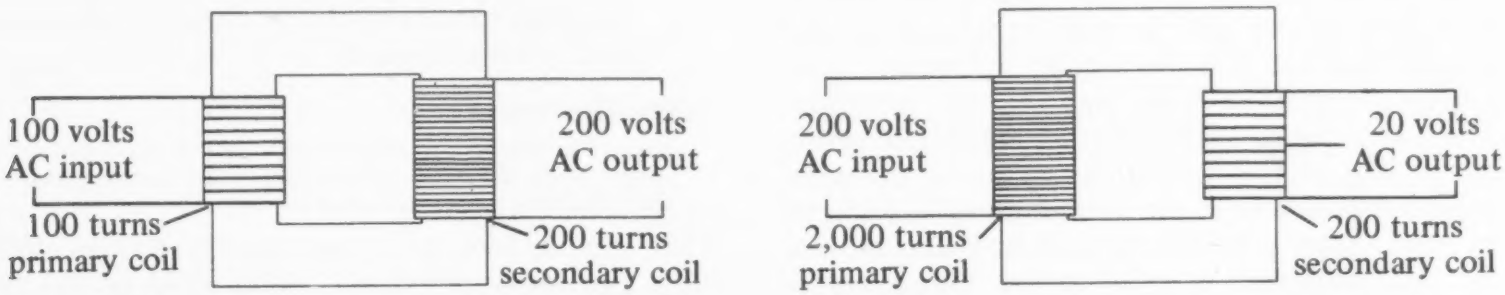

The step-up transformer (left) and the step-down transformer (right) show the direct relationship of the number of turns of the coils to the voltage.

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In an ignition coil of an automobile, the voltage (6 or 12 volts) of the storage battery is transformed or stepped up to the high voltage required to make the current jump the spark-plug gap. The ignition coil has a primary circuit made up of a winding of a few hundred turns of relatively heavy wire and a secondary circuit made up of a winding of many thousands of turns of fine wire. When the distributor contact points close and current flows in the primary circuit, a magnetic field builds up. When the distributor contact points open and the current stops flowing, the magnetic field collapses. The collapsing magnetic field induces high voltage in the secondary winding. This induction creates the high-voltage surge that is conducted through the distributor rotor and cap to a spark plug.

The increase in voltage in the step-up transformer and the automobile ignition coil is accompanied by a corresponding decrease in current so that the power output (volts X amperes) cannot be greater than the power input. These devices are highly efficient (95 percent or better) since losses of energy are relatively small in the form of heat due to resistance of the windings, eddy currents, and hysteresis in the laminated and highly permeable core.

Application of Principle

1. Electromagnetic induction can be demonstrated by connecting a coil of wire to a galvanometer and moving a permanent magnet past or through the coil of wire. Induced voltage increases as the speed of the magnet is increased, and the direction of current flow (indicated by the deflection of the needle) changes as the direction of the magnet is changed.
2. A graphic illustration of how an electromagnet will develop a magnetic field can be obtained by connecting the ignition coil of an automobile to a battery and the high tension lead to a spark plug. A spark appears at the spark-plug gap as the flow of electricity is interrupted. An automotive ignition capacitor placed across the switch changes the spark as it arcs the gap. This change demonstrates an increase in voltage.
3. The following procedure can be used to illustrate a decrease in voltage: first, connect a doorbell transformer to the ordinary 120-volt house current; then connect a voltmeter across the output terminals and observe the voltage, which should be approximately 15 volts (depending on the specific transformer used).

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 82-85, 104; *(12)*, p. 379; *(13)*, pp. 491-93; *(15)*, pp. 13-22; *(22)*, p.239; *(25)*, p. 200; *(26)*, pp. 324-29; *(27)*, pp. 559-60; *(33)*, pp. 91-98; *(36)*, pp. 56, 92, 102-3; *(47)*, pp. 337-52; *(53)*, pp. 85-88; *(54)*, pp. 325-27; *(65)*, pp. 135-49; *(66)*, p. 53; *(69)*, Chapter 3, p.3.

Unit 26 — SPARK PLUGS

Spark plugs, which produce high-voltage sparks to ignite combustible fuel mixtures, are found in devices such as furnaces, heating units of steam cleaners, and internal-combustion engines. The spark plug consists of a steel shell in which is fastened a porcelain insulator. (An insulator is a nonconductor, a material through which electricity will not pass.) An electrode runs through the center of this insulator and another electrode extends out from the bottom of the steel shell to a position close to the center electrode. When the spark plug is used in the ignition system of an automobile, the shell is screwed into the cylinder head, and the wire from the distributor is connected to the top of the center electrode. The electricity (the voltage boosted by the coil) travels down the center electode and jumps the gap to the other electrode. Then it travels to the engine block and back to the coil through "ground." The fuel mixture is ignited when the electric spark jumps the gap between the electrodes at the proper time near the end of the compression stroke.

Spark plugs are classified according to a heat range which indicates their ability to transfer heat from the firing tip of the insulator to the cooling system of the engine. The rate of heat transfer is controlled basically by the distance the heat must travel to reach the cooling medium. A "cold" plug, which has a relatively short insulator nose, transfers heat very rapidly into the engine's cooling

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system. Such a plug is used in heavy-duty or continuous, high-speed operation to avoid overheating. A "hot" plug, which has a much longer insulator nose, transfers heat more slowly away from its firing end. Thus it runs hotter and burns off combustion deposits which might tend to foul the plug during prolonged idle or low speed operation. Because the operating temperatures of spark plugs vary in different engines and under different engine service conditions, the plugs are made in several heat ranges.

Scientific Principle Involved: Ionization of Gases

Dry air at atmospheric or higher pressures is such a poor conductor of electricity that it can for practical purposes be considered an insulator for low voltages. The atoms that compose the molecules of any gas occasionally lose an electron and become positive ions. Thus, there are always a few positive ions and free electrons present in the air. A higher percentage of these electrically charged particles is normally present in heated gases, such as the compressed fuel-air mixture in the combustion chamber of a gasoline engine. The high voltage of the ignition coil produces strong electrical forces on the electrically charged particles in the gap between the electrodes. Free electrons accelerating rapidly toward the positive electrode collide with molecules of the gases, causing further ionization and a movement of electrons across the gap. Rapid interactions among the ions and molecules of the gases result in the release of heat, light, and sound energy in a spark discharge similar, but on a smaller scale, to the discharge of lightning between a cloud and the earth. This energy released in the gap of the spark plug is sufficient to ignite the fuel-air mixture in the combusion chamber.

Application of Principle

Compare the test results obtained on a spark plug cleaning and testing machine, using a new and a used spark plug. Remove, test, clean, and reinstall spark plugs according to the procedures that follow:

1. Loosen the plugs for one or two turns with a spark-plug wrench or a deep-socket wrench.
2. Blow the dirt out of spark-plug ports.
3. Remove the plugs the rest of the way, keeping them in their respective order.
4. Analyze visually the condition of the spark plug (normal, oil-fouled, too hot, too cold).
5. Clean the exterior of the plugs in solvent to remove grease and dirt. Allow to dry.
6. Clean with the spark plug cleaning machine.
7. Open the spark-plug electrode gap and file the electrodes to obtain clean, bright sparking surfaces.
8. Reset the spark-plug gap to proper specifications, using the wire-type gauge and bending the side electrode only.
9. Use a spark plug cleaning and testing machine. Compare sparking efficiency with a new plug.
10. Place the spark plugs (with new gaskets) back in the engine, tightening them to the recommended torque.

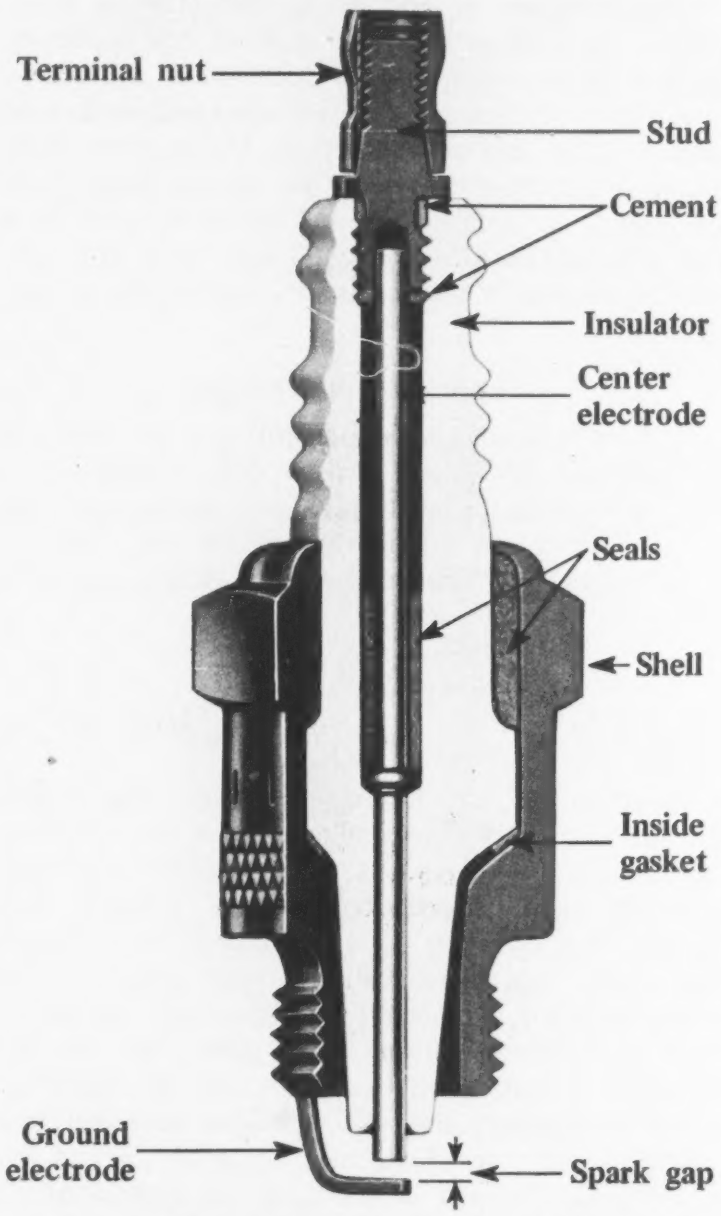

It is essential that the spark plugs be the right type for the engine in which they are used (Champion Spark Plug Company, Toledo, Ohio).

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Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(2), pp. 1-35; *(4)*, pp. 80-81; *(22)*, pp. 237-38, 386-88; *(27)*, pp.441-42; *(47)*, p. 25; *(56)*, p. 40; *(66)*, pp. 60-61; *(69)*, Chapter 3, pp. 9-12; *(75)*, Chapter 35, pp. 15-23; *(78)*, pp. 336-38; *(81)*, pp. 285-92.

Unit 27 — IGNITION SYSTEMS

The purpose of the ignition system is to develop and deliver high-voltage electricity so that the spark plugs in the engine cylinders can deliver a high-voltage spark to ignite the air and gasoline mixture at the proper time. The ignition system consists of a battery, ignition switch, ignition coil, distributor, spark plugs, and wiring.

The very high voltage needed to jump the gap of the spark plugs is obtained from the ignition coil. This coil is a step-up transformer that steps up the voltage to over 20,000 volts. The battery supplies the voltage to the primary circuit of the ignition coil. However, since pure direct current cannot be used to induce a voltage in the secondary of a transformer, it is necessary to start and stop the battery current.

The starting and stopping or opening and closing of the primary circuit of the ignition coil is done by the distributor, which is usually driven by the engine camshaft. The distributor has a set of contact points that are opened and closed by a rotating cam which has the same number of lobes as the engine has cylinders. The camshaft, which is driven by the engine, rotates at one half the speed of the crankshaft. This opening and closing of the contact points by the cam starts and stops the current flow in the primary of the ignition coil so that voltage is induced into the secondary coil. A capacitor (condenser) is placed across the points to prevent the burning of the contact points and to reduce arcing.

The distributor delivers the high voltage produced by the secondary of the ignition coil to the correct spark plug at the proper time. This delivery is accomplished by the rotor in the distributor. The rotor attached to the distributor shaft is connected directly to the output of the ignition coil. As the rotor turns in the distributor, it moves from one contact point to the next in the distributor cap. Each of the contacts in the cap is connected by a high-tension cable to a different spark plug. Thus, as the rotor turns, it distributes the high-voltage surges first to one spark plug, then to another, and so on, according to the engine firing order.

High-compression engines require a higher voltage at high speeds for efficient ignition of the fuel. In the conventional system the points open and close quickly, and the primary coil does not have time to build up to a very high voltage. Other defects found in this system are the limited life of the points and capacitor, along with the maintenance necessary to keep these units in working condition.

The transistorized ignition system eliminates these defects and provides far more dependable service than could be obtained from the conventional system. The transistor, which is capable of handling large amounts of current, switches the primary circuit on and off so that the points carry only a very small current. Since the points carry

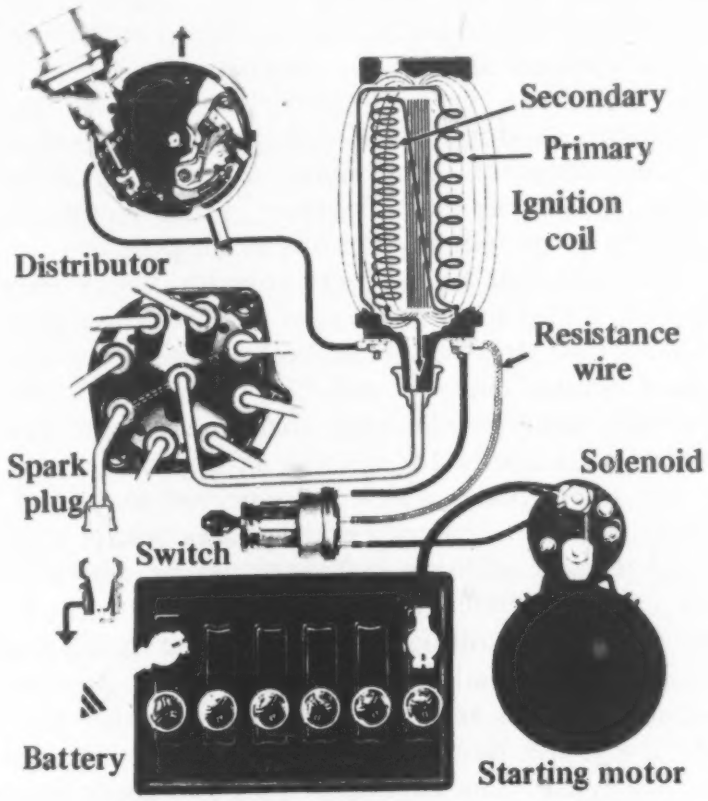

The ignition coil in a typical ignition circuit is shown schematically, with the magnetic lines of force indicated (Delco-Remy Division, General Motors Corp.).

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such a small portion of the total current, arcing between them is eliminated and a capacitor is not required. However, a special coil with a higher turns ratio and current rating must be used.

Some transistorized ignition systems do not use a contact point in the primary circuit. Instead, a magnetic pickup coil is used to time the transistor current flow for the primary circuit. A permanent magnet ring is mounted on the top of the distributor shaft. This magnet has the same number of teeth as there are cylinders in the engine. Inside of the permanent magnet is a pickup coil that is wound around a steel core, which also has teeth. Each time the teeth align, the magnetic lines of force from the permanent magnet cut through the turns of wire in the pickup coil. This activity produces the same effect in the primary circuit as does the opening of the contact points. The specialized transistorized circuit connected to the pickup coil acts as a current amplifier and switch to turn the primary coil circuit off and on.

Scientific Principle Involved: Electromagnetic Energy

When the primary circuit of the ignition coil is interrupted by the opening of the points in the distributor, the magnetic field produced in the core of the ignition coil collapses rapidly. The change in flux induces a high electromotive force in the secondary winding, whose voltage ratio, compared to the voltage of the primary, is the same as the ratio of the number of turns in the secondary winding to the number of turns in the primary.

The capacitor (condenser) consists of two conducting plates separated by an electrical insulator, usually two strips of metal foil separated by wax paper wound into a roll. It operates on the principle that an electrical charge placed on one plate of the conductor induces an opposite charge in the other plate, which is connected to ground. These opposite charges on the plates attract each other so that additional charges can be added to the charging plate. When the primary current to the induction coil is interrupted, the collapsing magnetic field induces a current in the primary winding as well as in the secondary. Rather than arc across the points, the primary current charges the capacitor. The capacitor then discharges back through the primary coil when the points are again on the make.

The high voltage on the center electrode of the spark plug produces a high rate of ionization of the gases in the fuel-air mixture in the combusion chamber. Sufficient force is supplied to the charged particles (ions) by the electric field to produce enough energy in the spark discharge across the gap to ignite the mixture, producing heat energy in the expanding gases as a result of the chemical reaction in the burning fuel.

The magnetic pickup coil used in some transistorized ignition circuits operates on the principle of electromagnetic induction, which produces an electromotive force whenever the flux through the coil changes. However, since this current is relatively small, timed voltage pulses are used to vary the bias on the transistor base to control the amplitude of the current through the primary circuit.

Ignition systems used on internal-combusion engines may be categorized as (1) the hot-tube or glow-plug types used on model airplane and diesel engines; (2) the magneto type; (3) the transistorized ignition; (4) the capacitor-discharge type; (5) the pulse pickup type; and (6) the conventional automotive-type ignition system. There are many other applications for ignition systems which employ the same basic principle; an example is the ignition system used for automatically fired gas furnaces, heaters, or steam cleaners.

Application of Principle

The students can do the following things:

1. Measure the voltage in the primary cirucit (approximately 6 to 12 volts in the automobile) and compare it to the measured secondary voltage (approximately 25 to 30 thousand volts, as measured with an oscilloscope).
2. Measure the voltage in as many ignition systems as are available and compare their primary and secondary voltages.
3. Measure the amperage flowing in the primary and secondary circuits of the conventional, transistorized, and magneto-ignition systems. Compare the amperage flowing in the primary of each system and discuss the implications of this comparison.
4. Demonstrate glow-plug ignition by connecting a model airplane glow plug to a 6-volt battery and observing the small coil of wire as it becomes red hot.
5. Examine and repair various ignition systems and their individual components.

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Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 80-95; *(12)*, pp. 436-43; *(15)*, pp. 15-22; *(16)*, pp. 249-53; *(19)*, pp. 397-429, 461-64; *(22)*, pp. 233-43; *(26)*, pp. 112-13, 117, 163-65; *(27)*, pp. 620-24; *(33)*, pp. 268-79; *(36)*, p. 110; *(47)*, pp. 353-54; *(66)*, pp. 99-101, 111; *(81)*, pp. 243-311.

Unit 28 — ELECTRIC MOTORS

An electric motor is a device that converts electrical energy into mechanical energy. Because of its ease of operation, efficiency, convenience, and economy of operation, it is used extensively in industry, in business, in the home, and in the automobile. Electric motors range in size from very small motors used to run electric clocks to very large motors used to operate industrial conveyor-belt systems.

Electric motors have a variety of characteristics, each of which is selected to meet the requirements that it must fulfill. The automobile has several different types of direct-current motors. One starts (cranks) the engine, another operates the blower of the heating/refrigeration system, and another raises and lowers the windows.

The motor used to start the engine in an automobile is a series-wound motor in which the field coils are connected in series with the armature coils. Series-wound motors have the advantage of developing a tremendous torque, which is essential when starting an automobile engine. Shunt-wound motors, which have the field coil connected in parallel with the armature coil, are used where constant speed is desired, such as for blowers. Another direct-current motor is called a compound-wound motor since it has one field coil in series with the armature and another in parallel with it. The compound-wound motor combines the starting torque of the series-wound motor with the constant speed of the shunt-wound motor. A rheostat is used to control the current flow in order to vary the speed of a direct-current motor.

The alternating-current motor is used extensively in the home and in industry, where alternating current is readily available. Alternating-current motors are usually classified as induction, universal, and synchronous motors.

The induction motor is the most common type used to operate industrial equipment such as drill presses, lathes, and grinders. Household equipment, such as washing machines, dryers, refrigerators, and disposals also uses induction motors. These motors are trouble-free and do not use the commutators or brushes found in direct-current motors. Induction motors require a starting system in order to get them rotating. There are a number of different systems used for this purpose. One of the most common methods of starting an induction motor is through the use of two sets of stationary windings. One winding is called the running winding and the other the starting winding. The starting winding is automatically disconnected from the circuit after the motor is in motion.

The universal motor is used where variable speeds are desired; it can be found in electric mixers and sewing machines. A rheostat is used to control the speed of a universal motor. The synchronous motor is used where constant speed is desired. The electric clock, which uses a synchronous motor, has a stator and a rotor with multiple poles.

Scientific Principle Involved: Electromagnetic Induction

An electric current flowing in a wire produces a magnetic field around the wire. If the wire is placed at right angles to a magnetic field, the interaction of the two magnetic fields produces a force on the wire, tending to move the force across the magnetic field. The amount of the force is directly proportional to the strength of current in the wire, the strength of the magnetic field in which it is placed, and the length of the wire. The direction of the force is determined by the direction of the movement of the electrons in the wire and the direction of the magnetic field in which the wire is placed. This interaction between magnetic fields is the underlying principle for the operation of all electric motors, where the attractions and repulsions between the magnetic fields of the armature (rotor) windings and the field (stator) produce the torque which turns the motor. The torque of the motor depends on the strength of the current, the number of windings in the armature, the number of turns in each winding, and the

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strength of current and number of turns in the field coils. All direct-current motors utilize a commutator and brushes to change the direction of current flow in the armature coils at just the right instant during the cycle in order to maintain the rotation. Direct-current motors may be reversed in the direction of rotation by reversing the current in either the armature or in the field windings, but not in both. The series-wound direct-current motor can be operated on alternating current because both the armature and the field windings change polarity simultaneously in step with the alternations in the current.

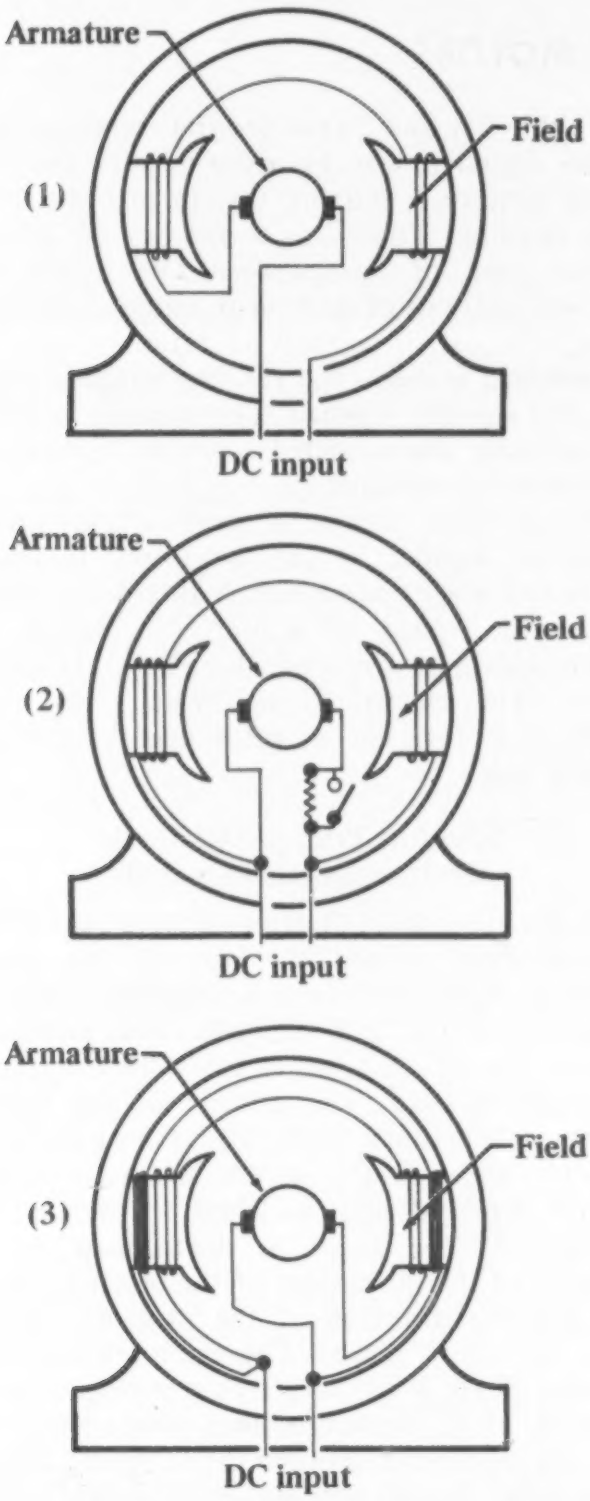

The diagrams show the wiring of (1) a direct-current series-wound motor; (2) a direct-current shunt-wound motor; and (3) a direct-current compound-wound motor.

The induction motor operates on alternating current only because the motor depends on the alternating magnetic field produced by the current in the stator to induce an alternating current in the rotor conductors. The current induced in the rotor is opposite in direction to the stator current; therefore, their fields are in direct opposition to each other. However, since a torque is necessary to produce rotation, the starting coil must have a current which is out of phase with the stator current. This change of phase of the stator coil is accomplished by either a capacitor or an induction coil, which causes the current to either lead or lag the impressed voltage. When the rotor approaches near-synchronous speed, the stator current is interrupted, and the alternations in the main stator coil which are out of phase with the induced current in the rotor will continue to supply torque to maintain the rotor at near-synchronous speed. The synchronous motor is a constant-speed motor because its speed of rotation is determined by the frequency (cycles per second) of the alternating-current power supplied to the stator and the number of poles on the rotor, in accordance with the formula $rpm = f \times 120 \div p$, where f = frequency of alternating current in cycles per second and p = number of poles.

Variable speeds are obtained in direct-current and universal alternating-current/direct-current motors by controlling the amount of current with a rheostat.

Since the electric motor is similar in construction to the electric generator, the rotating motor produces a current which opposes that being supplied to the motor. This opposition accounts for the fact that more current is required for starting an electric motor than for operating it at its designed speed.

Application of Principle

1. Laboratory activities involving all of the various types of electric motors would be virtually impossible. However, a list could be made identifying electrical motors by their type and utilization, such as AC, DC, induction, synchronous, series, shunt, and others;

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and the advantages and disadvantages of each could be discussed. Skills could be applied and the understanding of technical information extended through disassembly, testing, and study of the various circuits involved.

2. A simple demonstration which indicates the relationship between the amount of current required and the load applied to the motor is obtained by connecting to a battery an internal-combustion-engine starter motor which has been removed from the engine, and measuring the amperage required by the free-running starter motor. Next, the ammeter is connected to a starter motor which is installed on an engine, the engine is started, and the amperage required to turn the starting motor now that the load of the engine has been added is noted. The two amperage readings are compared and their implications are discussed.
3. Another common application involves varying the speed of electric motors. Sewing machines, as well as automobile-heater and air-conditioning blower-motors, utilize a motor which requires a varying speed. The circuits of such motors could be analyzed and discussed, such points being discussed as the necessity for variable speed and the precise means of accomplishing such speed. The various components, such as the brushes, commutators, and rheostats, which make possible the varying of the speed of an electric motor, can be physically examined.
4. Opposed to an electric motor, which must operate at an infinite number of revolutions per minute, the synchronous motor must maintain continuous revolutions per minute. The rpm of the synchronous motor is controlled by the frequency of the alternating current and the number of poles in the motor. An example of a synchronous motor which should be examined is an electric clock.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 120-23; *(13)*, pp. 497-98; *(22)*, pp. 205-14, 366-68; *(24)*, pp. 193-94; *(26)*, pp. 183-84; *(27)*, pp. 549-55; *(33)*, pp. 136-51; *(47)*, pp. 356-403; *(54)*, pp. 397-99; *(65)*, pp. 186-92; *(69)*, Chapter 19, pp. 31-32; *(75)*, Chapter 34, pp. 3-15; *(86)*, pp. 108-12.

Unit 29 — FUEL CELLS

Scientists are working constantly to find new methods for generating electrical power. One method that has great promise is the fuel cell. This cell has been used to develop electrical power inside spacecraft that have carried astronauts into outer space.

Fuel cells produce a continuous flow of electricity by means of chemical action. These cells create electric energy with greater efficiency than do most other electrical generators. A fuel cell can produce electricity as long as it is fed fuel along with oxygen or air. Dry-cell batteries work on a similar principle but cannot be fed continuously with fuel.

The fuel cell consists of electrodes; an electrolyte; a fuel, such as hydrogen gas; and an oxidizing agent, such as oxygen. In the hydrogen-oxygen fuel cell, catalytic nickel is used for electrodes, and the electrolyte is potassium hydroxide. Oxygen is fed to the positive electrode and hydrogen to the negative electrode. The result of the chemical action in the cell is the production of water, which must be removed to maintain the proper electrolyte concentration. The voltage output is approximately 1 volt per fuel cell. Because of the high cost of producing a fuel cell, its use is limited at the present time.

In Gemini spacecraft the smallest active element of the fuel-cell battery is the thin individual fuel cell, which is 8 inches long and 7 inches wide. Each cell consists of an electrolyte-electrode assembly with associated components for gas distribution, current collection, heat removal, and water control. In the fuel-cell battery for the Gemini, 32 cells are series-connected to form a module. Terminal plates installed on the ends of the two outside cells in the module serve as electrical connectors for the external circuitry. Each module has its own hydrogen and coolant manifold as well as its own water-oxygen separator. Three modules containing a total of 96 single fuel cells are installed in a cylindrical container to form a compact fuel-cell

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battery. The three modules are electrically independent and are connected in parallel through connections to the main electrical bus. The fuel-cell batteries may also be connected in parallel with the reentry batteries. Fuel cells are highly efficient; they have an overall thermal efficiency of more than 50 percent. They are capable of producing more electricity per pound of fuel than all but nuclear devices. The fuel-cell batteries are silent, fumeless, and operable without moving parts.

Scientific Principle Involved: Electrochemical Effect

The fuel cell is an electrochemical cell in which the energy of the chemical reaction between oxygen and a gaseous fuel such as hydrogen, natural gas, or carbon monoxide is converted directly into low-voltage, direct-current electrical energy. In the hydrogen-oxygen cell, hydrogen gas passes through the porous nickel electrodes and reacts with the hydroxide ions of the electrolyte. This reaction forms water and gives up electrons to the electrode. When an external circuit is completed to the oxygen-fed electrode, these electrons move to this electrode and enter into the chemical reaction, where the oxygen reacts with water to form negatively charged hydroxide ions. These ions replace those which were used up at the hydrogen-fed electrode. The net result of these reactions is the combination of hydrogen and oxygen to form water in the cell and the movement of electrons from the hydrogen-fed cathode to the oxygen-fed anode. In addition to acting as an electrical conductor, the porous nickel in the electrodes serves as a catalyst by breaking down molecules of the hydrogen and oxygen gases into separate atoms, helping to speed up the chemical reactions at the electrodes. Since the electrodes do not enter into the chemical reaction in this cell, they do not deteriorate as in the conventional electrochemical cell.

In Gemini spacecraft, ion-exchange membrane fuel cells convert the energy of the chemical reaction of hydrogen and oxygen directly into electricity. Unlike conventional batteries, fuel-cell batteries will continue to operate as long as hydrogen and oxygen are fed from an external source. The structure of the fuel cell contains an anode and cathode, which are in contact with a solid plastic electrolyte (ion-exchange membrane) that permits the exchange of hydrogen ions between electrodes. In the presence of a metallic catalyst, hydrogen gives up electrons to the load (where they do useful work as an electric current) while releasing hydrogen ions, which migrate across the electrolyte to the cathode. There the ions combine with oxygen and electrons from the load circuit to produce water, which is carried off by wicks to a collection point. Ribbed metal current-carriers are in contact with both sides of the electrodes to conduct the produced electricity. The fuel batteries and the fuel and oxidant supply are located in the spacecraft-equipment section. Total consumption is approximately 0.9 pound per kilowatt hour. Fuel and reactant flow is regulated to delivery pressure by a dual pressure regulator and relief valve. By-product water from the fuel-

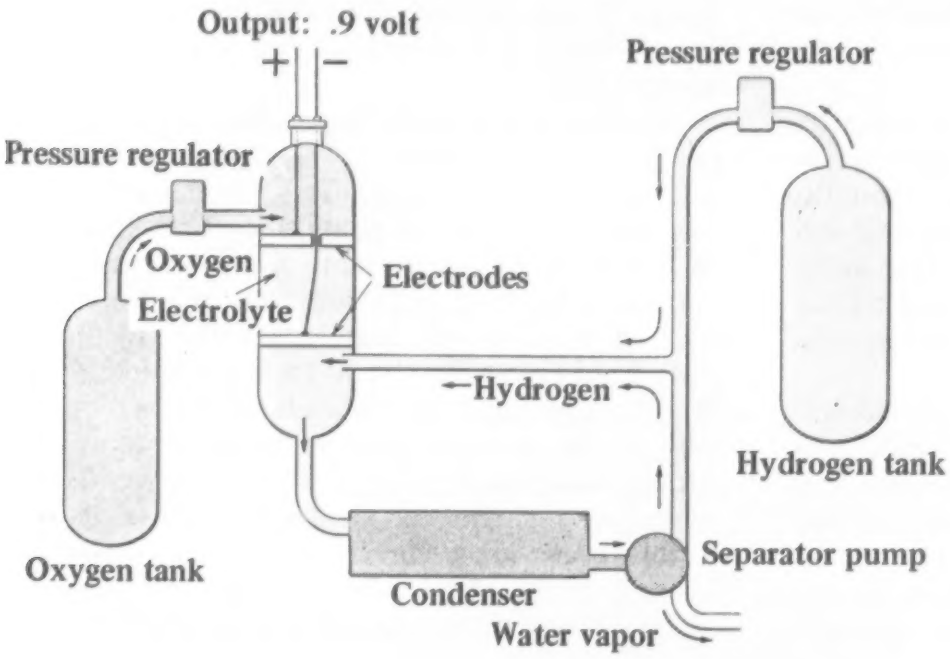

The hydrogen-oxygen fuel cell uses catalytic nickel electrodes and an electrolyte of potassium hydroxide.

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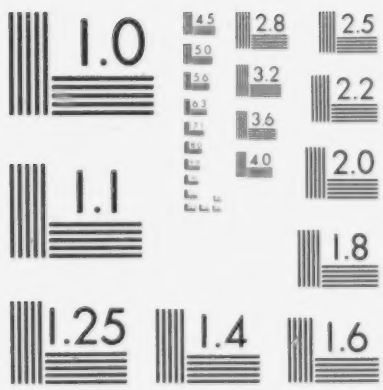

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

ILLUSTRATIONS OF PATTERN ALTERATION TECHNIQUES

The drawings on the following pages illustrate how pattern pieces can be altered to correct various fitting problems. These may be used with an opaque projector or prepared as transparencies with overlays for use with an overhead projector.

A basic bodice pattern is used for the diagrams. Each example includes a drawing of a garment area in need of a specific alteration and a diagram of the associated pattern pieces showing the needed adjustments.

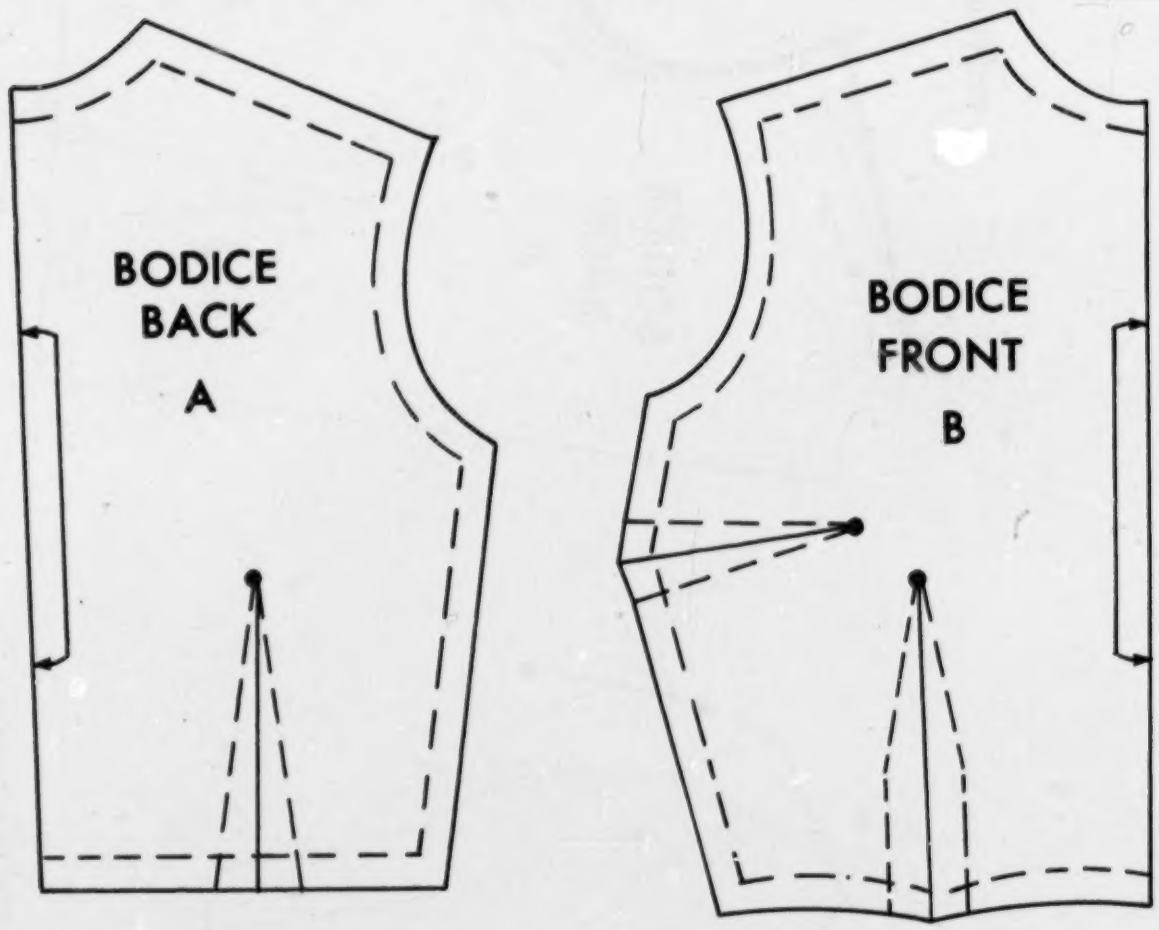

Basic Bodice Pattern Pieces

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cell battery provides a pressure reference for the reactant gases.

Application of Principle

Fuel cells are classified as one of the more exotic power sources in use today. Most of the fuel cells produced are used for scientific experimentation and military or specialized industrial applications. One source of information concerning laboratory activities relating to various types of fuel cells is contained in the laboratory manual (pp. 135-40) for the following book, which was written by Joseph W. Duffy: *Power: Prime Mover of Technology* (First edition). Bloomington, Ill.: McKnight & McKnight Publishing Co., 1964.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(26), pp. 331, 336-39; *(27)*, pp. 468-69; *(36)*, pp. 82-85; *(64)*, p. 81; *(66)*, pp. 186-89.

Unit 30 — PHOTOELECTRIC CELLS

Some modern automobiles have automatic headlight dimmers and automatic light switches. These devices are operated by a photoelectric cell, which is used to convert radiant energy into a flow of electric current.

The first photoelectric cells used the photoelectric vacuum tube as the control device. The photoelectric tube can provide electric current for operating devices that will turn on burglar alarms, open doors, pick up sound in the sound motion-picture projectors, and control a variety of devices. Certain materials (such as potassium, sodium, selenium, and cesium) will give off small quantities of electrons when held in ordinary light. When light is focused on the material in the vacuum tube, a positive anode will attract the electrons which are emitted. The current flow in the phototube, which is very small, is usually increased by an amplifier. The output of the amplifier can be connected to a relay that will turn a circuit on or off.

Most present-day photoelectric cells use solid-state materials in which a small voltage can be produced when light shines on the material. These solar cells, called photovoltaic cells, use two types of material which generate a voltage at a junction between the material when light shines on the surface. A good example of such a device is the light meter used in photographic meters where the output of the cell is connected to a sensitive galvanometer. The stronger the light, the greater is the voltage produced by the cell. The increase or decrease of the cell voltage is determined by reading the needle movement in the galvanometer.

The automatic headlight switch used in the automobile turns the car lights on or off according to the light level. As evening approaches and daylight is reduced to the point where lights are needed, the photoelectric cell turns the car lights on. The photoelectric cell, which is mounted behind the windshield, is exposed to the light. This cell is connected to a transistor amplifier circuit which operates a sensitive relay. This relay is connected to a power relay that turns on the car lighting system.

Scientific Principle Involved: Photoelectric Effect

Photoelectric devices depend on the absorption of incident light (infrared through ultraviolet) by electrons in the sensitive material to alter the electric characteristics of the material. According to the quantum theory of light, photons are the small bundles of energy or quanta associated with light radiation. Since the energy of the photon depends on the frequency of the light wave, photons of ultraviolet light (higher frequency) have more energy than visible and infrared light. When an electron in a material absorbs a photon of radiant energy, it may be released from its bonds within the material, and its energy of motion will depend on how much energy it absorbs from the

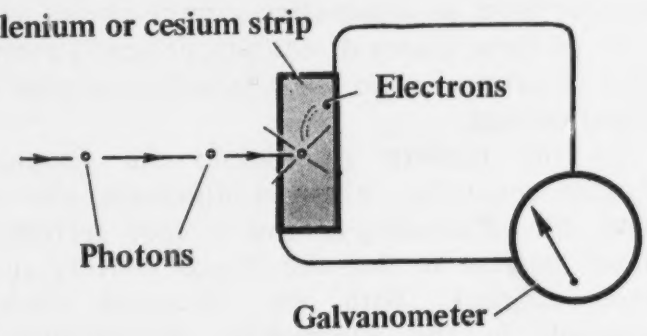

Light falling on certain metals, such as selenium or cesium, produces an electric current.

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photon and how much of that energy was used in breaking the bonds. The magnitude of the photoelectric effect is determined by the intensity (number of photons) of radiation absorbed.

In the vacuum or gas-filled phototube, the sensitive element (cathode) is coated with a metal, such as potassium or cesium, which emits electrons from the surface when subjected to incident light. These photoelectrons are accelerated toward a positive anode in the same way as in the conventional electron tube.

Photocells which use a single semiconducting material, such as selenium or cadmium sulfide, depend on the photoelectric effect to produce pairs of free electrons and positive holes within the material. This increase in the number of free electrons and positive holes results in the proportional increase of conductance of the cell in the battery-powered circuit.

Photovoltaic cells, such as the solar cell, use two different semiconducting materials in contact with each other to form an N-P barrier. In the N-type material, such as selenium- silicon, conduction is due to excess free electrons; in the P-type material, such as boron-silicon, conduction is due to the excess positive holes. This separation of electrical charges produces an electrical field across the barrier. When light is absorbed at the barrier region, new pairs of free electrons and positive holes are produced by the photoelectric effect. The increase in the number of free electrons in the P-type material allows the more energetic electrons to move across the barrier into the N-type material, where they are free to move and deliver electrical power in the external circuit.

Application of Principle

1. Demonstrate the characteristics of photovoltaic cells by connecting a cell (silicon, selenium, or the like) to a milliammeter. Expose the cell to ordinary light and observe the action of the milliammeter (0-1). Vary the intensity of the light and note the meter readings also vary in direct proportion to the intensity of light striking the photovoltaic cell.
2. Use an ordinary lightmeter to measure the available light when taking photographs. Record the readings as the meter is exposed to direct and indirect light in varying degrees. Also note the change in the meter reading as the color of the subject or background changes.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(9), p. 152; *(13)*, pp. 576, 577; *(16)*, pp. 307-8; *(26)*, pp. 339-42; *(27)*, pp. 333-34, 352, 458; *(33)*, pp. 27, 281-83; *(37)*, p. 513; *(47)*, pp. 39, 253-57, 405, 459; *(54)*, pp. 431, 448; *(65)*, pp. 64-65; *(86)*, p. 7.

Unit 31 — SEMICONDUCTOR POWER RECTIFIERS

In certain electronic circuits it is desirable to convert alternating current into direct current. Such devices as radio receivers, television sets, stereos, and tape recorders all require a source of direct current. To obtain the necessary direct current from an alternating-current power source, each of these pieces of equipment uses a rectifier. The rectifier changes the alternating current into direct current.

In the modern automobile the alternating-current generator, called an alternator, also must have the alternating-current output rectified to direct current so that the storage battery can be kept charged. With the increased electrical demands in the automobile, the alternator is replacing the direct-current generator because of its efficiency and generating capabilities at low speeds.

Vacuum tubes can be used as rectifiers, but in many devices they are being replaced by solid-state semiconductors. These semiconductors, called diodes, will permit current to flow through the conducting material quite easily in one direction. When the current is reversed, the semiconductor offers a great deal of resistance to the flow of current. Thus, the semiconductor diode will permit current to flow in one direction only; and when connected in an alternating-current circuit, the output from the diode is direct current.

The early semiconductor power rectifiers – copper oxide, copper sulfide, and selenium – were known as dry rectifiers. At the present time germanium or silicon are being used for solid-state rectifiers, which are usually mounted in the slip-ring end of the alternator.

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When a single diode is used as a rectifier in an alternating-current circuit, the output, after passing through the diode, will be pulses of direct current. Direct current will flow only during half of the alternating-current cycle since the diode will permit current flow in one direction only. So that a much smoother direct current can be obtained, it is possible to design a circuit called a full-wave rectifier that will rectify both halves of the alternating cycle. The output provides a much smoother flow of current since two pulses of direct current are produced for each cycle of alternating current. Such a circuit, called a bridge-rectifier system, uses four diodes.

In the automobile it is very desirable to have a fairly smooth direct current for charging purposes. Three stator windings are, therefore, used in the alternator and are connected in either a "Y" connection or a "delta" connection. This arrangement enables the generator to produce a three-phase alternating current which provides overlapping cycles of alternating current. The output of the three-phase current is connected to six solid-state diodes so that the output from the rectifiers is a fairly constant direct current. Since diodes produce heat when they are conducting current, it is necessary to use special devices called heat sinks to absorb this energy. The diodes are placed inside the alternator, and the heat sinks have large radiating surfaces to allow the heat to be radiated into the air surrounding the generator.

Scientific Principle Involved: Rectification with Semiconductors

Silicon and germanium are quite similar in their structure and chemical behavior. The atoms of both elements have four electrons bound in the same way in their respective crystals. In its transistor functions germanium is the more versatile semiconductor. Germanium acquires the diode property of rectification and the transistor property of amplification through the presence of certain impurities in the crystal structure. Two types of impurities are important; one is known as a donor, the other as an acceptor.

Arsenic and antimony are typical donor elements. When minute traces of antimony are added to germanium, each antimony atom donates one electron to the crystal structure. Four of the five electrons are paired, but the fifth electron is relatively free to wander like the free electrons of a metallic conductor. The detached electron leaves behind an antimony atom with a unit positive charge. Germanium with this type of crystal structure is called N-type, or electron-rich germanium. N-type germanium consists of germanium to which are added equal numbers of free electrons and bound positive charges so that the net charge is zero.

Atoms with three electrons, such as those of aluminum and gallium, will act as acceptors. When minute traces of aluminum are added to germanium, each aluminum atom accepts a single electron from a neighboring germanium atom, leaving a hole in the electron-pair bond from which the electron is acquired. This hole is the equivalent of a positive charge since it acts as a trap into which an electron can fall. As an electron fills the hole, it leaves another hole behind into which another electron can fall. In effect, then, the hole (positive charge) detaches itself and becomes free to move, leaving behind the aluminum atom with a unit negative charge. Germanium with this crystal structure is called P-type, or hole-rich germanium. P-type germanium consists of germanium to which is added an equal number of free positive holes and bound negative charges so that the net charge is zero.

Both P-type and N-type crystals are good conductors, and each will conduct equally well in either direction. When the two types are joined together, however, an electric barrier is established where their surfaces meet. The plane at which the P-type crystal meets the N-type crystal is called the P-N junction. The free holes of the P crystal cannot pass through the electric barrier at the P-N junction to reach the N crystal; the free electrons of the N crystal cannot cross the P-N junction to reach the P crystal.

A small potential difference impressed across the pair enables the free electrons to cross the junction

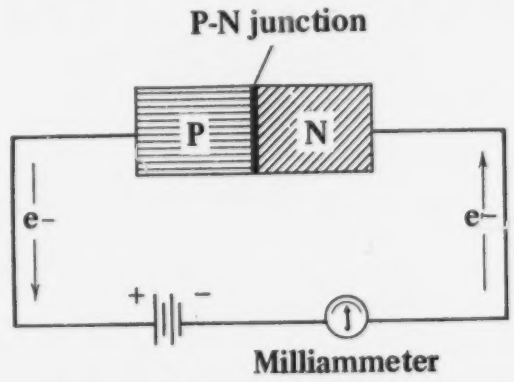

A small potential difference impressed across the P-type and N-type crystals enables the free electrons to cross the junction and pass into the P-crystal.

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and pass into the P crystal. Similarly, the holes cross into the N crystal. The apparent movement of holes is in the opposite sense to the actual movement of electrons which fall in the holes of the P-type crystal. Thus, an electron movement is established across the P-N junction and in the external cirucit.

If the battery connections are reversed, the free electrons in the N crystal and the free holes of the P crystal are attracted away from the P-N junction. The junction region is left without current carriers; consequently, there is no conduction across the junction and no current in the circuit.

It is the junction which has the distinctive property of permitting electron movement in one direction with ease when a small voltage is applied in the proper sense. Thus, the P-N junction is the rectifying element of semiconductor crystals.

Application of Principle

A characteristic of solid-state rectifiers, such as the diodes used in automobile alternators, is that they will allow current to flow in one direction only. This characteristic may be demonstrated, and at the same time the diode may be checked for opens and shorts, by using an ohmmeter.

1. Select a diode, either positive or negative case, from an alternator. If a negative-case diode is selected, connect the negative lead of the ohmmeter to the case of the diode. Next, connect the positive lead of the ohmmeter to the positive lead of the diode. Reverse the connections when checking a positive-case diode. Although there may be a wide variation in the resistance of different diodes, the ohmmeter reading should be consistently above 300 ohms. If the reading is below 300 ohms, the diode has probably been shorted and should be replaced.
2. Check an open circuit in a negative-case diode by connecting the negative lead of the ohmmeter to the positive lead of the diode and the positive lead to the negative case of the diode. Reverse the connections when checking a positive-case diode. If an infinite resistance is indicated by the ohmmeter, the diode has an open circuit and should be replaced. *Note:* If the diode is good, there will be no current flow when the ohmmeter is connected as indicated previously. However, reversing the connections on the diode will cause a current to pass through the diode.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(22), p. 220; *(26)*, pp. 348-49; *(27)*, pp. 621-23; *(33)*, pp. 269-70; *(47)*, pp. 433-39; *(65)*, pp. 268-70; *(75)*, Chapter 31, pp. 7-8.

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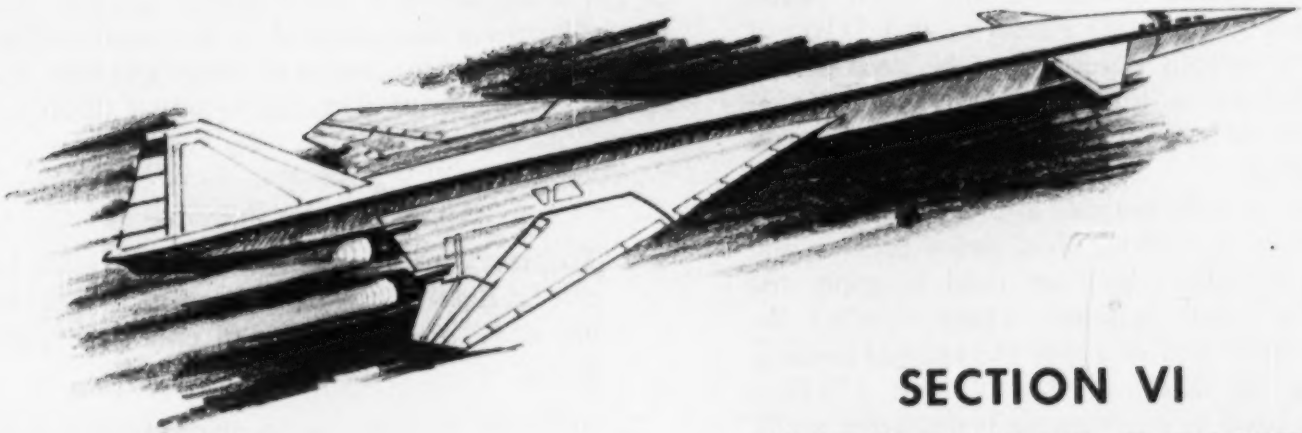

SECTION VI
HYDRAULIC POWER

Unit 32 — JACKS AND PRESSES

Through the use of hydraulics, the strength (muscle power) of a person can be multiplied thousands of times. For example, it is possible through the use of hydraulic jacks for a person to lift a part or all of a house. Hydraulic tools are used extensively in the automotive industry. Whenever a heavy force must be applied or a heavy weight lifted, a hydraulic tool has been designed to provide the means.

A hydraulic jack or press consists of large and small cylinders connected at their base by a small tube or internal passage. A piston fits into each cylinder. When a force is applied to the handle at the small piston, a pressure is developed in the small cylinder. The pressure developed depends on the area of the small piston and the force applied. This pressure is carried through the hydraulic line to the large cylinder. In this cylinder the pressure is applied to the large piston, forcing it to move.

In the simplified diagram of a hydraulic press, a lever is attached to the small piston. As the small piston is pushed down, some of the liquid from the small cylinder (1) is forced into the large cylinder (2). This pressure raises the large piston a small amount. As the lever is worked up and down, it pumps the liquid from the reservoir and forces it into the cylinder (2). When the pressure is to be

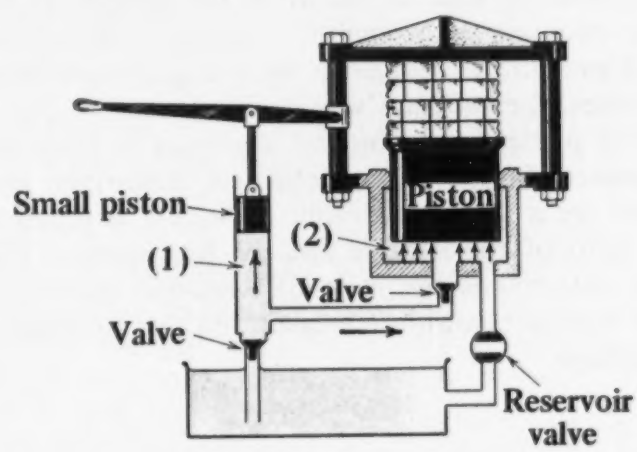

released, the reservoir valve is opened to let the liquid flow from the cylinder (2) back into the reservoir.

The force is determined by the pressure and the area of the pistons. For example, the small piston has an area of 1 square inch and is connected directly to the larger piston, which has an area of 100 square inches. If a force of 200 pounds is applied to the small piston, a pressure of 200 pounds per square inch is developed. This pressure is transmitted to the larger cylinder, which has a piston area of 100 square inches. This piston is, therefore, pushed with a force of 20,000 pounds (100 sq. in. X 200 lbs. per sq. in.) This gain in

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force (from 200 to 20,000 pounds) is made at the expense of distance moved. If the small piston moved 5 inches, the large piston moved 5/100 of an inch. The output force could be doubled by decreasing the size of the small piston and cylinder to ½ square inch. However, the distance moved would be halved.

The force of 200 pounds applied to the small cylinder is easy to obtain. Most jacks, presses, and cranes have handles which are used to apply the force to the small cylinder. These handles are arranged as levers and multiply the applied force at the expense of distance. The 10-ton (20,000-pound) jack used as an example is relatively small, but 60- and 80- ton jacks are available. The output force is very high; however, movement is quite slow because of the tremendous mechanical advantage needed to multiply a 50- to 100-pound force to an 80-ton force.

Scientific Principle Involved: Pascal's Principle

A hydraulic pump or set of cylinders does not "pump" pressure. It merely produces a flow of hydraulic fluid. Pressure is generated only when a restriction or load is placed in the circuit. If the flow encounters negligible resistance, the developed pressure is negligible. As the resistance force increases, the pressure within the system produced by the pump (or cylinders) increases to meet the resistance force. The mechanical advantage produced by a set of hydraulic cylinders is equal to the ratio of the surface area of the pistons. This ratio determines the ratio of distances moved by each cylinder, another measure of the mechanical advantage.

Pressure applied anywhere on a confined liquid or gas is transmitted undiminished in every direction. The force thus exerted by the confined liquid or gas acts at right angles to every portion of the surface of the container and is equal upon equal areas (Pascal's principle).

Application of Principle

1. The mechanical advantage of hydraulic jacks can be determined by measuring and comparing the distance the small and large pistons move.
2. Different weights can be placed on the jack to show that a resistance is necessary to produce a mechanical advantage. A comparison of force applied to the weight lifted can also be calculated by operating the jack handle through a spring scale. The efficiency of the jack can be shown by a comparison of the theoretical mechanical advantage and the actual mechanical advantage.
3. Hydraulic devices can be disassembled and assembled to assist in understanding the operation of each part. The exact theoretical advantage of the hydraulic parts can be provided by the measurement of piston sizes.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(6), pp. 3-6; *(27)*, pp. 200-202; *(36)*, pp. 54-60; *(69)*, Chapter 18, p.2; *(75)*, Chapter 51, pp. 4-5; *(80)*, pp. 463-72.

Unit 33 — MACHINE TOOLS

Many machine tools use hydraulic systems to control the movement of machining operations. Hydraulic systems provide rapid, accurate, and efficient control of intricate machine functions. Hydraulic power, as applied to tools and machines, relies on the principle that liquids can't be compressed. Liquids under pressure transmit the pressure throughout all parts of the fluid. This basic property allows the use of a liquid to transmit power from its source to the desired point of application by means of transmission lines (pipes or tubes).

In many applications hydraulic systems are more efficient than mechanical linkage or a train of gears. In addition, hydraulic systems are more flexible in terms of load, speed, and mechanical advantage. The basic system consists of an electric motor driving a hydraulic pump and other rotating parts of the machine. The hydraulic pump operates a hydraulic system consisting of control valves, cylinders, and gauges or sensing devices. Both vertical and horizontal motion of tables and machine platforms can be operated and controlled by the hydraulic system.

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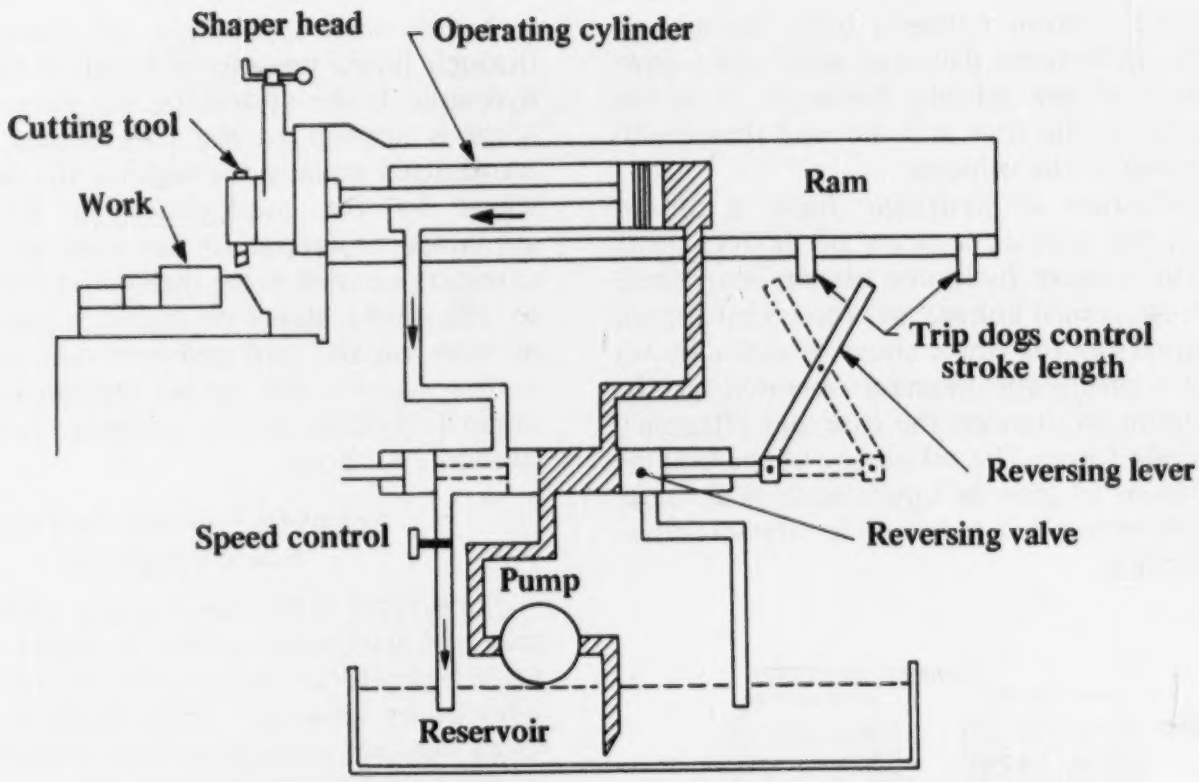

Simple valving permits accurate control of a hydraulically actuated shaper.

Scientific Principle Involved: Pressure Transmission by Liquid

Liquids, when subjected to pressure changes, transmit the pressure change to all parts of the fluid undiminished (Pascal's principle). This principle may also be stated as follows: Pressure applied anywhere on a confined fluid is transmitted undiminished in every direction. The force thus exerted by the confined fluid acts at right angles to every portion of the surface of the container and is equal upon equal areas. Note that fluids may be either liquids or gases; Pascal's principle applies to both of these states of matter.

Application of Principle

Devices in which liquids are used to transmit pressure, such as hydraulic presses, lifts, and brakes, can be examined, tested, and operated. Pressure gauges can be placed in the system to determine the system's pressure. Cylinders can be measured and the pressure converted to force to determine the force being used to produce a particular motion. Machines can be adjusted as follows to demonstrate the hydraulic principles:

1. The speed of the machine can be changed by restricting liquid flow.
2. An increase in pressure can be demonstrated by increasing the work load.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(6), pp. 3-6; *(27)*, pp. 200-202; *(36)*, pp. 54-58; *(69)*, Chapter 18, p.2; *(80)*, pp. 463-72.

Unit 34 — BRAKING SYSTEMS

Devices for retarding or stopping motion are found in many pieces of equipment. The basic type of braking operation is a band tightened around or a pad pressed against a wheel in motion. Braking can be assisted by regulating the movement of fluids (liquids or gases), controlling the flow of electric current, reversing the rotation of ship propellers, reversing the pitch of airplane propellers, closing the clam-shell doors of jet engines, or pressing a disk against the face of a wheel.

In the braking systems of vehicles that move on wheels (such as automobiles, motorcycles, and

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scooters), the friction between brake drums and brake shoes or between pads and metal disks slows the rotation of the wheels; however, it is the friction between the tires and the road that results in the stopping of the vehicles.

The application of hydraulic force is almost universal in the braking systems of modern automobiles. The modern hydraulic system is a combination of mechanical linkage and force transmitted through liquids to the brake shoes or disks. Power brakes use a pneumatic cylinder operated by the engine vacuum to increase the ease and efficiency of the braking force. The efficiency of the braking force continues to grow in importance as automobile speed increases and automobile safety receives greater attention.

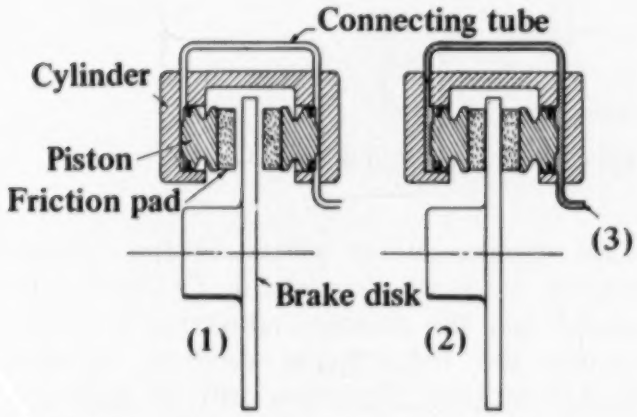

In sectional view (1) the disk brake is in a released position; in (2), the brake is in an applied position because of the hydraulic pressure (3) from the master cylinder.

A practical application of force distribution through liquid pressure is found in the four-wheel hydraulic brake system of the automobile. When force is applied to the foot pedal, a pressure is transmitted equally throughout the system to each wheel by the employment of the mechanical advantage of levers. At the road wheel hydraulic cylinders convert force through mechanical linkage to the brake shoes or friction pads. Release of pressure on the foot pedal reduces liquid pressure in the system, and spring tension returns to the original position all components, such as pistons, springs, and shoes.

Scientific Principle Involved: Pascal's Principle

Total force is the force acting against the entire area of a particular surface. A liquid exerts a total force against the entire area of the bottom and sides of its container. Since liquid pressure equals force per unit area, total force equals the product of the average pressure on the area times the entire area.

The principle of the transmission of force by a liquid can be illustrated as follows: If a force of 50 pounds were applied to a piston at a master cylinder whose area was 2 square inches, the 50 pounds of pressure would be distributed equally so that each square inch would produce 25 pounds of force. The force applied at each wheel cylinder would be 25 pounds if the cylinder had an area of one square inch. Force can be increased by enlarging the diameter of the output cylinder or by increasing the pressure per square inch (psi).

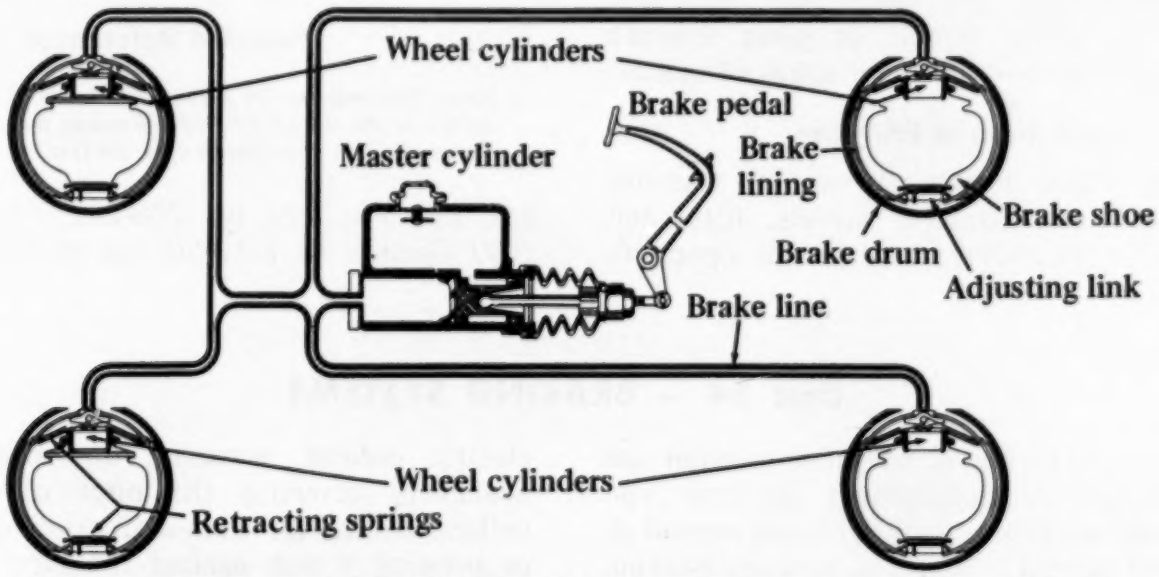

A schematic of a typical hydraulic system shows how brake shoes are activated to press the brake lining against the brake drums.

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Application of Principle

Instruction relating to basic hydraulic principles can be furthered through activities involving the service and repair of automotive hydraulic brake systems. Some of the activities students can perform are as follows:

1. Measure the pressure developed in a brake system.
2. Calculate the force developed at each brake shoe.
3. Service and repair automotive brakes.
4. Determine the compressibility of air as compared to brake fluid by allowing air to be admitted into the system.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 146-50; *(90)*, pp. 108-11; *(22)*, pp. 571-80, 587-94; *(27)*, pp. 200-202; *(36)*, pp. 54-60; *(63)*, p. 658; *(69)*, Chapter 18, pp. 1-10; *(75)*, Chapter 41, pp. 1-14, Chapter 51, pp. 1-5, *(78)*, pp. 504-18.

Unit 35 — FUEL PUMPS

The fuel pump is a simple example of the hydraulic pump used in almost all hydraulic applications. Power steering in the automobile is another application of the hydraulic pump. Many machines, jacks, and automobile lifts use hydraulics as their principal form of power. Production processes in industrial plants make extensive use of hydraulics.

The hydraulic fuel pump is designed to supply gasoline to the carburetor of an internal-combustion engine at a constant low pressure. It is a positive displacement pump using a diaphragm driven by a spring to develop and maintain pressure on the outlet side. In operation the diaphragm of the fuel pump is pulled back on the intake stroke by the action of the engine camshaft. As the diaphragm moves back on the intake stroke, a partial vacuum is produced in the fuel chamber. Atmospheric pressure acting on the fuel in the tank pushes it through the fuel lines, past the inlet valve, and into the fuel pump chamber. When the diaphragm is released, a spring located behind the diaphragm pushes the diaphragm forward, placing a pressure of approximately 6 pounds per square inch on the fuel in the chamber. This pressure forces the fuel against the inlet valve, closing it. When the carburetor needle valve opens, relieving the pressure in the line between the fuel pump and carburetor, the diaphragm moves forward, pushing fuel through the outlet valve and into the carburetor. The spring and diaphragm maintain an almost constant pressure on the fuel, thereby providing a continuous supply of fuel to the carburetor.

An electric fuel pump is used on some heavy-duty equipment, such as trucks and buses. This fuel pump contains a flexible metal bellows that is operated by an electromagnet.

Certain internal-combustion engines make use of the fuel-injection system. Instead of a carburetor this system uses a series of injection nozzles and a high-pressure fuel pump to spray the fuel into the air entering the engine cylinders.

Scientific Principle Involved: Atmospheric Pressure

Liquids will always flow to balance a pressure differential. When the pressure within the fuel pump chamber is reduced below atmospheric pressure (14.7 pounds per square inch) by the action of the diaphragm, atmospheric pressure within the gasoline tank pushes the gasoline from the tank into the fuel pump chamber, balancing the pressure within the tank and fuel pump chamber at atmospheric pressure.

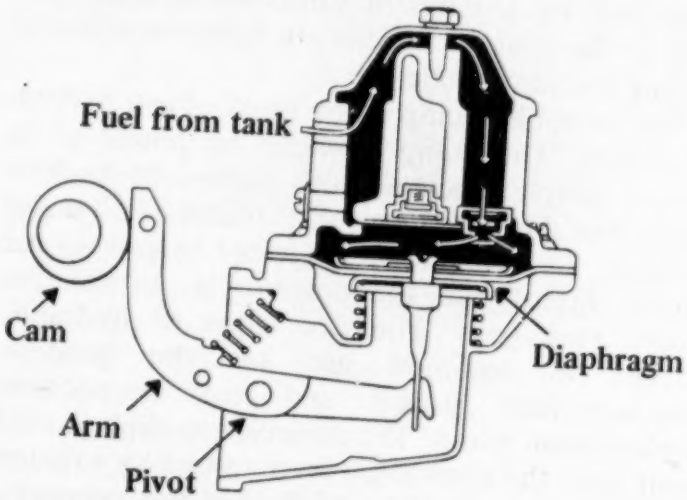

The illustration presented above shows a typical fuel pump in which the movement of the diaphragm produces a partial vacuum.

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Application of Principle

1. Disassemble and assemble a fuel pump, studying the operation of each component part. Determine the operating characteristics of the total pump and the contribution of each part to the operation of the pump.
2. Test the fuel pumps in three ways – for volume, vacuum, and pressure – as follows:
   a. Conduct the volume test by disconnecting the outlet line of the fuel pump and pumping gasoline into a measured container. Run the engine at idle speed on the fuel remaining in the carburetor. In a specified time compare the output with the manufacturer's specifications.
   b. Conduct the vacuum test by attaching a vacuum gauge to the inlet side of the fuel pump. Operate the fuel pump and compare the obtained vacuum with the manufacturer's specifications.
   c. Conduct the pressure test by attaching a pressure gauge to the outlet side of the fuel pump. Operate the fuel pump and compare the obtained pressure with the manufacturer's specifications.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 61-64; *(22)*, pp. 127-32; *(27)*, pp. 200-202; *(54)*, pp. 222-24; *(69)*, Chapter 6, pp. 1-10; *(75)*, Chapter 26, pp. 1-4, Chapter 51, pp. 1-5; *(78)*, pp. 180-81.

Unit 36 — POWER STEERING

Steering an automobile by moving the steering wheel manually has become more difficult because of increased weights and the use of wide, low-pressure tires. Ratios between the steering wheel and road wheels have been increased to compensate for the greater force needed to turn the automobile. A method of obtaining additional force to turn the wheels is the power-steering assembly. Power steering is a hydraulic system designed to assist the driver in turning the wheels of the automobile. During the past years a number of systems have evolved. Each, however, consists of a hydraulic pump driven by the automobile engine. The hydraulic fluid, under pump pressure, is controlled by a series of valves which direct the fluid to the proper chambers to assist the driver in turning the automobile.

The hydraulic pump is the heart of any hydraulic system. The pump develops no power of its own; it simply converts work applied to its drive shafts into the movement of a volume of oil under pressure. The volume is expressed in gallons per minute (gpm) and the pressure in pounds per square inch (psi). The two types of hydraulic pumps in common use are the positive-displacement pump and the nonpositive-displacement pump. The nonpositive-displacement pump uses the centrifugal force caused by rotation to move large quantities of fluid at low pressures. The automotive-engine water pump is of this design. When permitted to operate freely, it moves large quantities of water through the cooling system. If the system is restricted, as it is when the engine is cold and the thermostat is closed, the pump will simply rotate without movement or displacement of water.

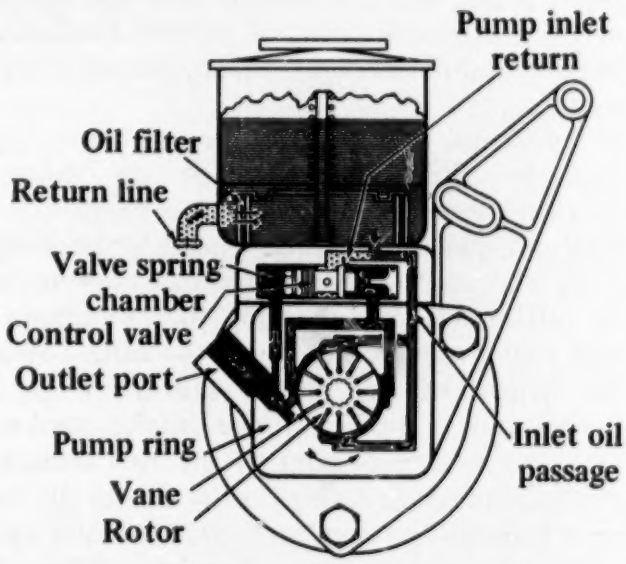

The vane-type power-steering pump provides additional force to assist in turning the wheels of an automobile (Ford Motor Co.).

All power-steering systems use a positive-displacement pump. For each revolution of the pump shaft, a specific quantity of fluid is displaced; i.e., pumped into the outlet line. Positive-displacement pumps have the advantage of (1) capability for pumping high pressures;

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PATTERN ADJUSTMENT FOR SQUARE SHOULDERS

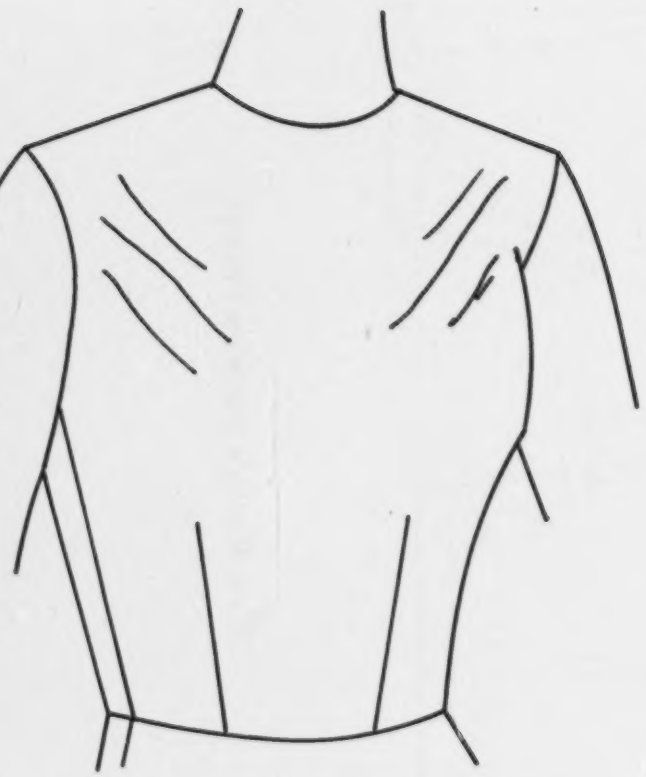

Diagram shows wrinkles and distortion of grain line on front of ill fitted garment caused by square shoulders.

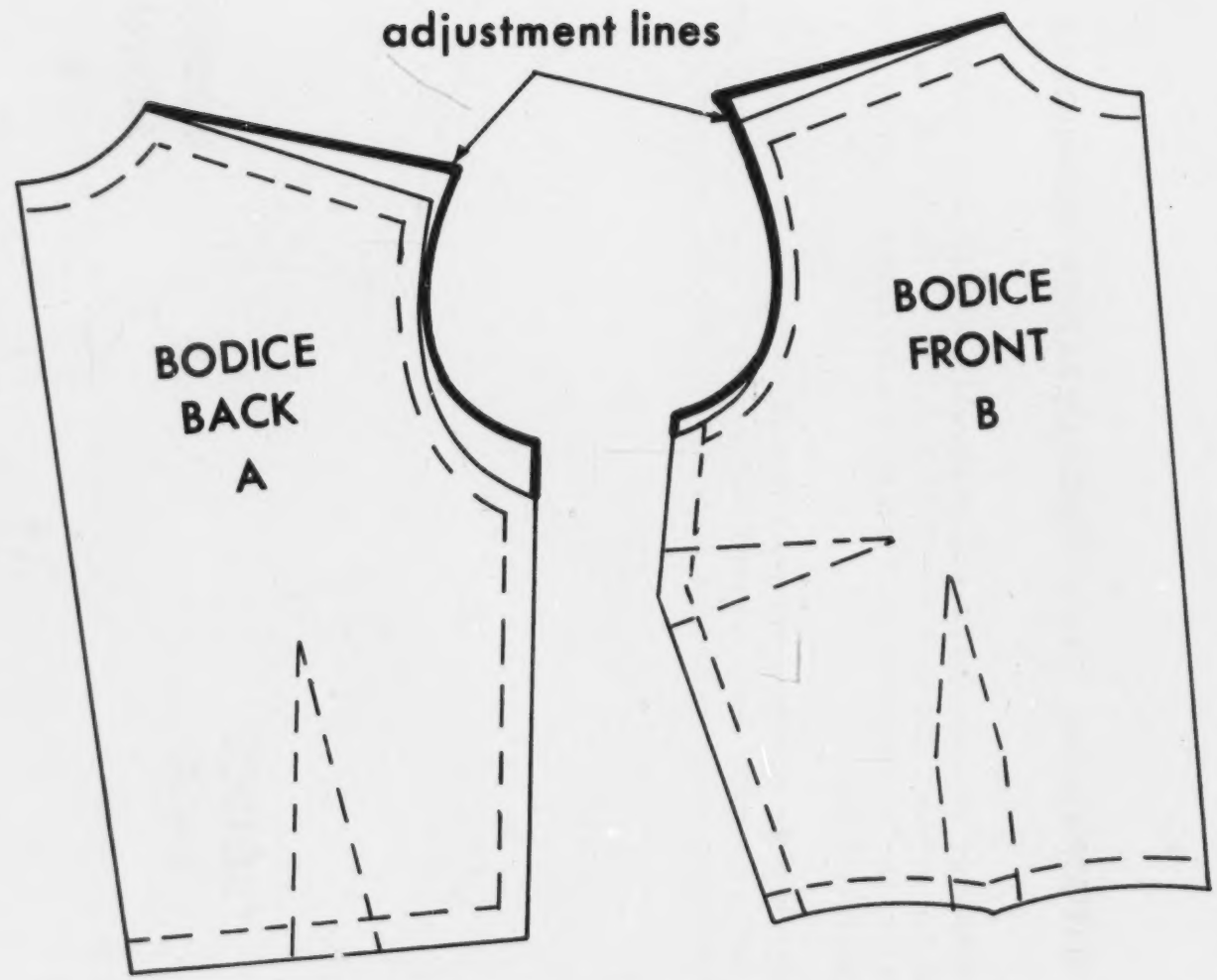

Diagram shows bodice back and front pattern pieces with needed adjustment lines indicated.

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(2) minimum size; (3) relatively high volumetric efficiency; (4) relatively small change in efficiency throughout the pressure range; and (5) great flexibility of performance. Most power-steering pumps on today's vehicles are based on a vane design or a modification of this design.

Some power-steering systems use a simple hydraulic cylinder connected to the steering linkage to assist the turning. In these systems fluid under pressure is pumped to one side of the cylinder. The pressure of the fluid in the cylinder forces the piston to move within the chamber. Since the piston is connected to the steering linkage, the movement of thepiston helps turn the automobile wheels. In some cases the piston is stationary and the cylinder is connected to the linkage. In this case the movement of the cylinder assists turning.

Scientific Principle Involved: Pressure Transmission by Liquids

Hydraulic fluids under pressure exert a force in every direction within a closed container. The force resulting from the pressure is determined by the pressure and the surface area on which the pressure is applied. When the pressure is applied to a movable piston (or stationary piston and movable cylinder), the resultant force is equal to the pressure per square inch (psi) times the area of the piston, measured in the same units (square inches).

Application of Principle

1. Power-steering systems can be tested on the automobile for operating pressure, flow (gpm), and relief-valve setting – maximum system pressure. By the installation of an engine tachometer, a decrease in engine speed will be noted when the pump is operating at maximum pressure.
2. Through the use of selected power steering components or purchased hydraulic pumps, motors, and cylinders, a number of devices can be constructed as follows:
   a. A drill-press vise can be made to operate hydraulically by the use of a hydraulic cylinder and pump.
   b. A hydraulically operated can crusher can be built through the use of a hydraulic cylinder and pump in addition to a chamber to hold the can being crushed.
   c. A pencil sharpener can be operated hydraulically through the use of a hydraulic pump and a motor.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(6), pp. 3-6, 21-24, 45-48; *(22)*, pp. 190-91, 546-60; *(27)*, pp. 200-202; *(36)*, pp. 54-68; *(63)*, p. 37; *(69)*, Chapter 17, pp. 21-24; *(75)*, Chapter 11, pp. 3-4, Chapter 39, pp. 10-14, Chapter 51, pp. 1-5; *(78)*, pp. 464-71.

Unit 37 — AIR CONDITIONERS

Automobile air conditioners are designed to make the interior climate of the automobile comfortable during summer driving. This comfort is attained by removing both heat and water vapor from the air automatically. As the temperature of the air is lowered, the ability of the air to hold water decreases. The air reaches its coldest temperature in the car and air conditioner when it passes over the cooling coils (evaporator). Water vapor in the air condenses and is deposited on the cooling coils. The water is collected at the bottom of the coils, and a hose carries the condensed water to the ground under the automobile.

The automobile air conditioner uses the same principle of operation as that used by most home refrigeration units and industrial air conditioners. These systems use the principle that when a liquid changes to a gas, heat energy is required. The heat for this change of state comes from the surrounding materials and air. The change takes place at a constant temperature. The temperature at which this change of state takes place is, however, dependent upon the pressure placed above the liquid. As the pressure increases, the temperature at which the change of state occurs increases.

Freon-12, an odorless and nontoxic chemical consisting of carbon, fluorine, and chlorine, is the most common liquid used as a refrigerant in automobile air conditioners. At atmospheric pressure Freon-12 (F-12), boils at 21.7 degrees F.

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below zero. At a pressure of 42 pounds per square inch, F-12 boils at 45 degrees F., which is a more practical temperature for air conditioning. Each pound of F-12 which changes to a liquid removes 70 British thermal units of heat. The heat comes from the surrounding air. Since heat is a form of energy, the removal of this energy from the air lowers the temperature of the air.

In this process the refrigerant is changed from a liquid to a gas. The gas is carried to a compressor, where the pressure is raised to 150 to 160 pounds per square inch. The boiling temperature is, therefore, increased to 115 to 120 degrees F. This temperature is above the normal air temperature. The high-pressure, high-temperature gas is pumped to a condenser next to the automobile radiator. At normal summer temperatures of 85 to 100 degrees F., air passes over the radiator, removing heat from the condenser and gas. As heat is removed, the refrigerant changes back into a liquid. If the outside temperature is higher than noted, the condensing pressure will increase to maintain a temperature of 20 to 30 degrees F. above the outside temperature.

When the gas is condensed into a liquid, the liquid flows back to the evaporator inside the automobile. Through the use of a valve or restrictor, the pressure is reduced to around 45 pounds per square inch. The refrigerant can again evaporate and remove more heat from the interior of the automobile. The air-conditioning cycle is continuous; the refrigerant is changing state in both the evaporator and condenser at all times during operation. Since the refrigerant is just "a carrier of heat energy," it is never expended. It need be replaced only if the system develops a leak.

The heat pump, sometimes used for home heating, is a reversal of the air-conditioning cycle. The evaporator is outside and takes heat from the outside air and discharges it through a condenser

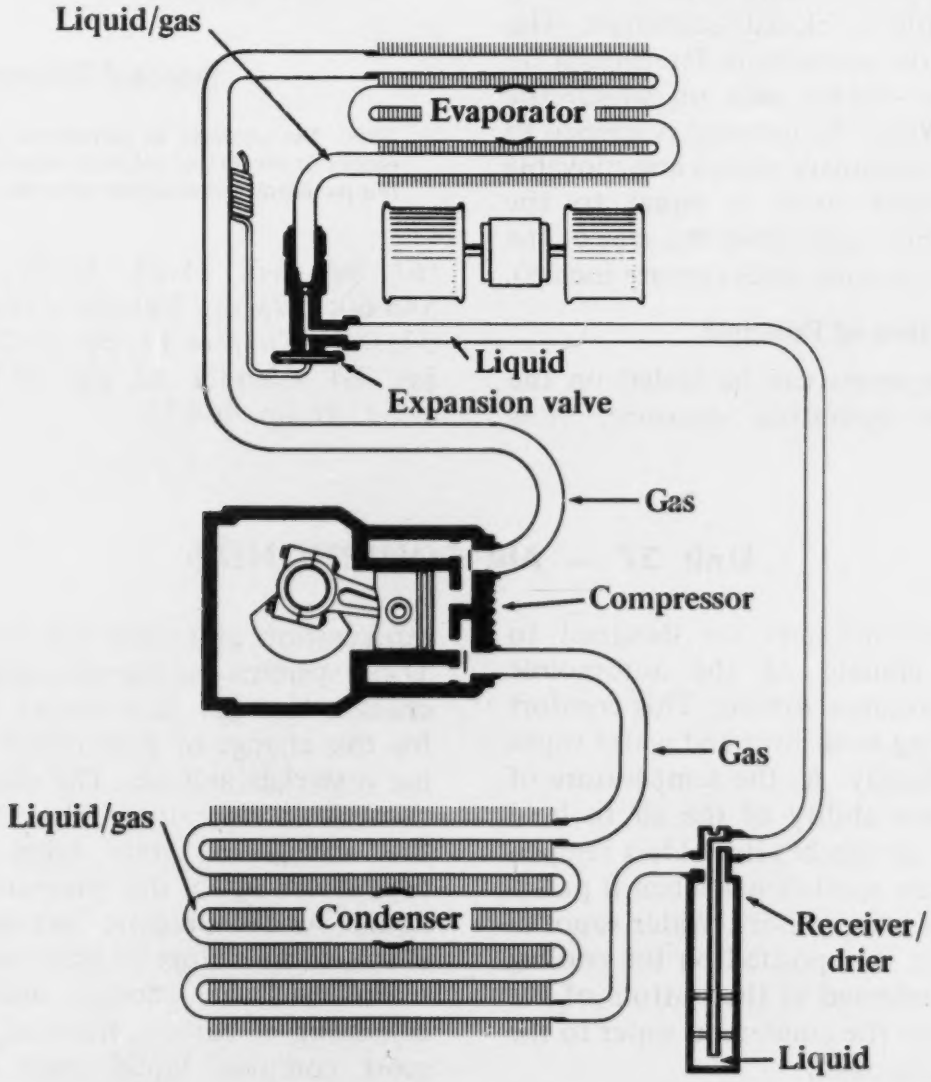

The state of the refrigerant at certain points in the air-conditioner unit is indicated in the diagram.

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into the home. In the summer the system can be reversed through the use of valves to cool the home.

Scientific Principle Involved: Heat Transfer

During the change of state of a liquid, heat energy is either absorbed or expended at a constant temperature. This form of heat transfer is called "latent heat of vaporization." The amount of heat being removed or added depends upon the substance. Water has a higher latent heat of vaporization than any other common substance. It takes 970.4 British thermal units of heat to change one pound of water to one pound of steam. Water would make an excellent refrigerant except that in order to get water to boil at air-conditioning temperatures of 40 to 60 degrees F., the water must be under a vacuum of more than 20 inches of mercury. This pressure is inefficient since a very large compressor would be required to operate the system.

Application of Principle

1. An automobile air conditioner can be used for student demonstration and activities. Also, a teaching system can be developed by obtaining a refrigeration or air-conditioning system and providing it for student use.
2. Gauges can be put on both the high and low sides of the unit to determine the operating pressures and temperatures at which the change of state is taking place in the evaporator and condenser.
3. Possible leaks can be checked through the use of a leak detector or a solution of soap and water on all joints.
4. A compressor can be disassembled and assembled and the operation of the compressor studied.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(13), pp. 263-65; *(22)*, pp. 602-4; *(27)*, pp. 279-80; *(28)*, pp. 1-369; *(36)*, pp. 68-74; *(54)*, pp. 555-58; *(69)*, Chapter 20, pp. 1-12; *(75)*, Chapter 48, pp. 1-9.

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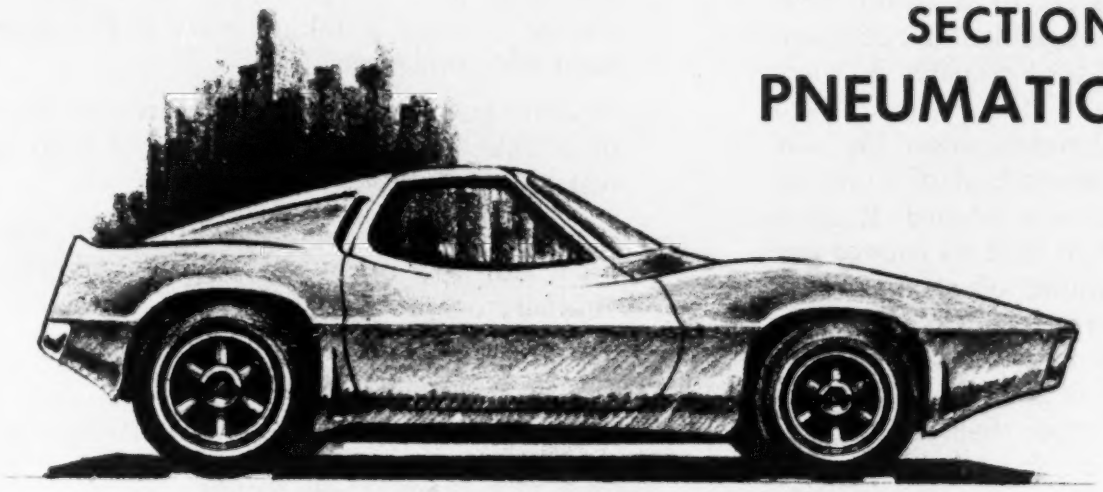

SECTION VII
PNEUMATIC POWER

Unit 38 — AIR-POWERED TOOLS

Air-powered (pneumatically operated) tools are particularly useful because they are relatively light and small, run cool, and have variable speed and torque. A few of the operations that can be performed by air-powered tools are drilling, sanding, grinding, chipping, tightening, and hammering. Other devices commonly found in industrial arts that depend on compressed air for their operation are spray guns, automatic feeds on printing presses, lubrication equipment, lifts, and jacks. In order that this flexible source of power can be used, an adequate supply of compressed air is needed, and hose connections should be conveniently located in the facility.

Air motors in air-powered tools require a pressure of approximately 90 pounds per square inch for efficient operation. A satisfactory source for obtaining this air pressure is the compressor in the automotive or woodworking facility; the compressor usually provides a pressure of 150 pounds per square inch. An air-powered tool is comprised of an air motor, housing, valve with lever, gears, spindle, and attachment to do the work. Motion in air-powered tools is produced in several ways. One method makes use of high-velocity air directed at a paddle or turbine wheel. The forced air causes the wheel to rotate like a waterwheel. Another method makes use of the relationship between pressure and volume. This second method is used to operate piston and rotary-vane motors, the two most common types of motors used in air-powered tools. These tools use reciprocating parts to accomplish work. Examples of these tools are the sheet-metal nibbler and the impact wrench used to tighten or loosen lug nuts on automobile wheels.

Scientific Principle Involved: Mechanical Properties of Gases

Two types of motors used to power air tools are the rotary type and the percussion or reciprocating type. In the first type a rotor with vanes is surrounded by a housing, usually made of cast aluminum. Air enters the housing, pushes on the vanes, and rotates a central shaft. The drill chuck or grinding wheel is fastened to the end of the central shaft. In the second type compressed air enters a cylinder and moves a piston that is connected to or strikes another part such as a chisel or riveting hammer. The pressure of compressed air and gases is frequently measured in atmospheres. One atmosphere of pressure is equal to 14.7 pounds per square inch (standard atmospheric pressure). When air is under a pressure of several atmospheres, it can exert a great expansive

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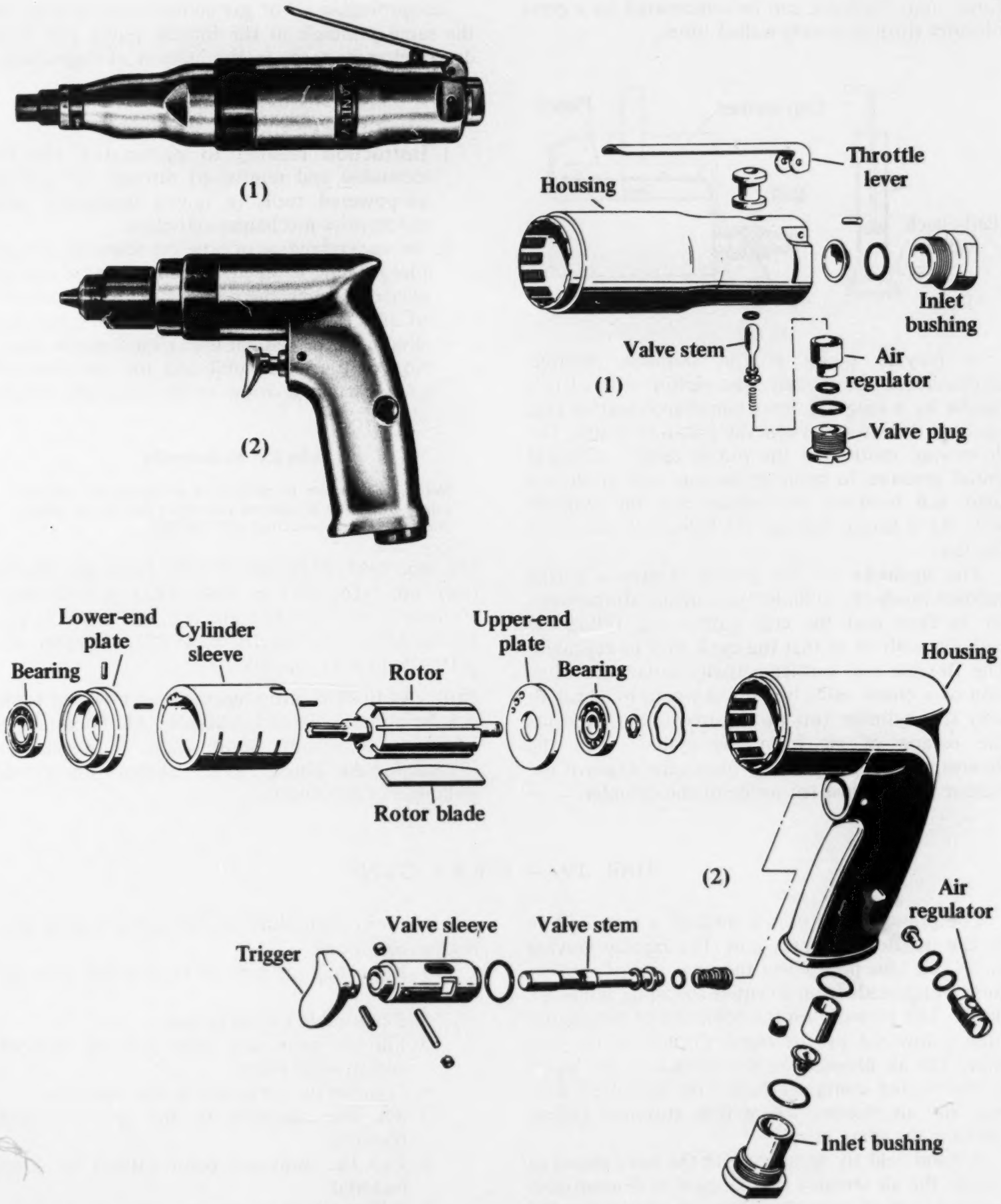

Photographs and exploded views illustrate units and components of air-powered tools (screwdrivers, nutsetters, and drills): (1) lever handle and (2) pistol handle (Stanley Air Tools).

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force, and this force can be transmitted for a great distance through strong-walled tubes.

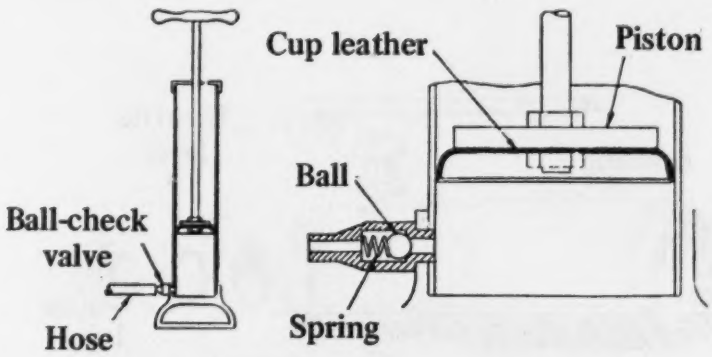

A bicycle pump is the simplest positive-displacement compressor. The piston, secured to a handle by a long rod, has a cup-shaped leather face opening downward when the pump is in use. The downward motion of the piston causes sufficient initial pressure to open up the cup and produce a tight seal between the leather and the cylinder wall. Air is forced through the ball-check valve into the tire.

The upstroke of the piston creates a partial vacuum inside the cylinder, permitting atmospheric air to flow past the cup leather and filling the cylinder with air so that the cycle may be repeated. The flexible cup leather actually serves the function of a check valve because it opens to admit air into the cylinder (on the upstroke) but prevents the escape of air from the cylinder (on the downstroke) as air pressure forces the edges of the leather tight against the inside of the cylinder.

Reciprocating air or gas compressors operate on the same principle as the bicycle pump but with design changes made in the interest of ruggedness, efficiency, and durability.

Application of Principle

1. Instruction relating to pneumatics can be extended and reinforced through the use of air-powered tools in power mechanics and automotive mechanics activities.
2. An understanding of how the scientific principles relating to pneumatics are applied can be gained through the disassembly and assembly of air motors or air-powered tools. Emphasis should be placed on understanding the function of the entire unit and the operation of each part in relation to the complete assembly.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(3), pp. 1-47; *(13),* pp. 277-78; *(25),* pp. 20-49; *(31),* pp. 1-16; *(41),* p. 1941; *(42),* p. 972; *(49),* Volume 1, p. 143; *(54),* pp. 211, 233-34; *(63),* pp. 16-46; *(69),* Chapter 18, p. 1; *(75),* Chapter 50, p.19, Chapter 51, pp. 6-8.

Note: Additional information on air-powered tools can be obtained from (1) Stanley Air Tools, 4525 Firestone Boulevard, South Gate, California; or (2) Stanley Air Tools, 30520 Lakeland Boulevard, Willowick, Ohio 44095.

Unit 39 — SPRAY GUNS

Compressed air is passed through a tube leading to the nozzle of a spray gun. The rapidly moving air in this tube passes over the open end of another tube which leads from a vented container holding a liquid. The pressure on the open end of the second tube is lowered by the rapid air flow in the first tube. The air pressure on the surface of the liquid in the vented container forces the liquid to flow into the air stream, where it is atomized before reaching the spray nozzle.

A hand-held fly sprayer (with the hand pump to supply the air stream) can be used to demonstrate the principle of operation. The tube supplying the liquid from the vented container is easily seen just in front of the opening from the air pump.

An orderly procedure for the use of a spray gun is given as follows:

1. Inspect all the parts to be sure that they are clean.
2. Reassemble the spray gun.
3. Fill the paint cup with properly thinned and strained paint.
4. Connect the spray gun to the regulator.
5. Set the regulator to the recommended pressure.
6. Test the spray-gun paint pattern on scrap material.
7. Adjust the paint-control valve and air pressure as needed.
8. Hold the nozzle 6 to 12 inches from work.

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9. Spray the paint with even, overlapping strokes.
10. Empty the spray gun of unused paint and thoroughly clean the gun and parts in paint thinner.

Scientific Principle Involved: Bernoulli's Principle

When a fluid (gas or liquid) is undergoing a change in velocity, the pressure (measured at right angles to the direction of flow) is lowest at the point of highest velocity. A venturi (constriction) is built into the air tube leading to the nozzle of a spray gun just before the top of the tube from the spray pot. The air must speed up to flow through the venturi, causing a very low pressure as it reaches the top of the paint tube. The air pressure in the vented paint pot forces paint to flow up the paint tube into the air stream, where it is atomized.

Another application of Bernoulli's principle is found in the carburetor of the internal-combustion engine. The air passage through a carburetor is partially constricted at the point where gasoline is mixed with air. This constriction increases the speed of air, lowers its pressure, and permits more rapid evaporation of the gasoline.

Application of Principle

The student will gain valuable experiences and skill in the actual use of a spray gun.

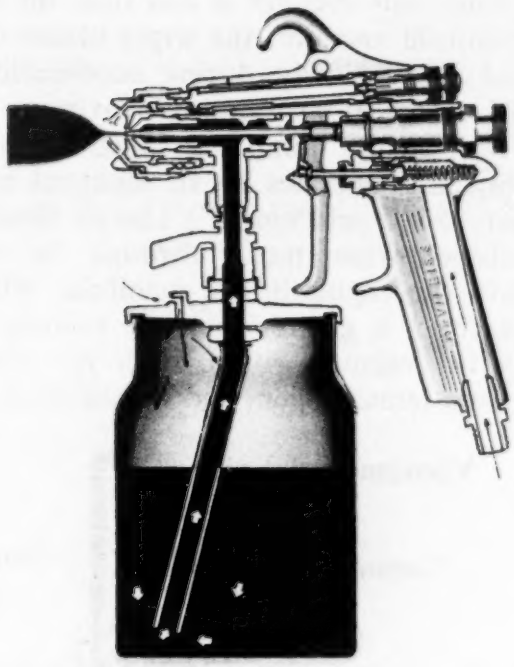

When the trigger of the spray gun is pulled, compressed air travels from the compressor, through the hose and spray gun, and out the nozzle. The air passing through the gun is at its highest velocity at the point where it meets the liquid from the tube of the container. The air pressure at the point where the air and liquid meet is lower than the air pressure in the container. This difference in pressure causes the liquid to rise in the tube and to enter into the air stream. The liquid is atomized and then expelled from the nozzle (DeVilbiss Co.).

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(9), p. 100; *(13)*, pp. 516-17; *(26)*, p. 151; *(27)*, pp. 223-25; *(49)*, Volume 1, pp. 155-56, Volume 10, p. 580; *(75)*, Chapter 50, pp. 21-28.

Unit 40 — VACUUM PUMPS

Pneumatic power can be produced through the use of compressed air (as explained in Unit 38, "Air-Powered Tools") or a vacuum pump and atmospheric pressure. A vacuum is a positive form of power. The source of this power is the weight of air, which is 14.7 pounds per square inch (psi). To use this power, a vacuum pump must remove the air from one end of a piston so that the air pressure can act on the other end to force it to do work. Vacuum pumps are used in the operation of windshield wipers, power brakes, power clutches, and door locks in the automobile.

Atmospheric pressure is used in the operation of many automotive windshield wipers. The wiper blades are moved by an air-powered motor which uses the pressure differential between the atmospheric pressure and the engine's intake-manifold vacuum for operation. The vacuum is decreased whenever the engine is rapidly accelerated or put under a heavy load. When these conditions occur, the pressure differential disappears, and the air-powered motor no longer has a pressure differential for operation. So that a continuous differential can be provided, a vacuum pump is placed between the windshield-wiper motor and the intake manifold. The vacuum pump maintains a sufficient vacuum (11 inches of mercury; i.e., $5\frac{1}{2}$ pounds below atmospheric pressure) to operate the wiper

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motor. Since this vacuum is less than the normal intake-manifold vacuum, the wiper blades operate somewhat more slowly during acceleration and under other conditions requiring maximum engine power. The vacuum pump is an integral part of the fuel pump and operates in an identical manner. (See Unit 35, "Fuel Pumps.") The air flows from the windshield-wiper motor through the vacuum pump into the engine intake manifold. When the engine vacuum is greater than the vacuum developed by the vacuum pump, both the inlet and outlet valves remain open, and the air flows freely from the wiper motor to the manifold. When the manifold vacuum drops, as it does during open throttle and full power operation, the pump acts as a booster, maintaining a minimum vacuum for windshield wiper operation.

Pneumatic systems may be used to multiply a force developed by a man or a machine. An excellent example of a pneumatic power booster is the automobile power-brake system. As vehicle weight, power, and speed are increased, the effort needed to stop the automobile is also increased. The variable factor used to determine the rate of

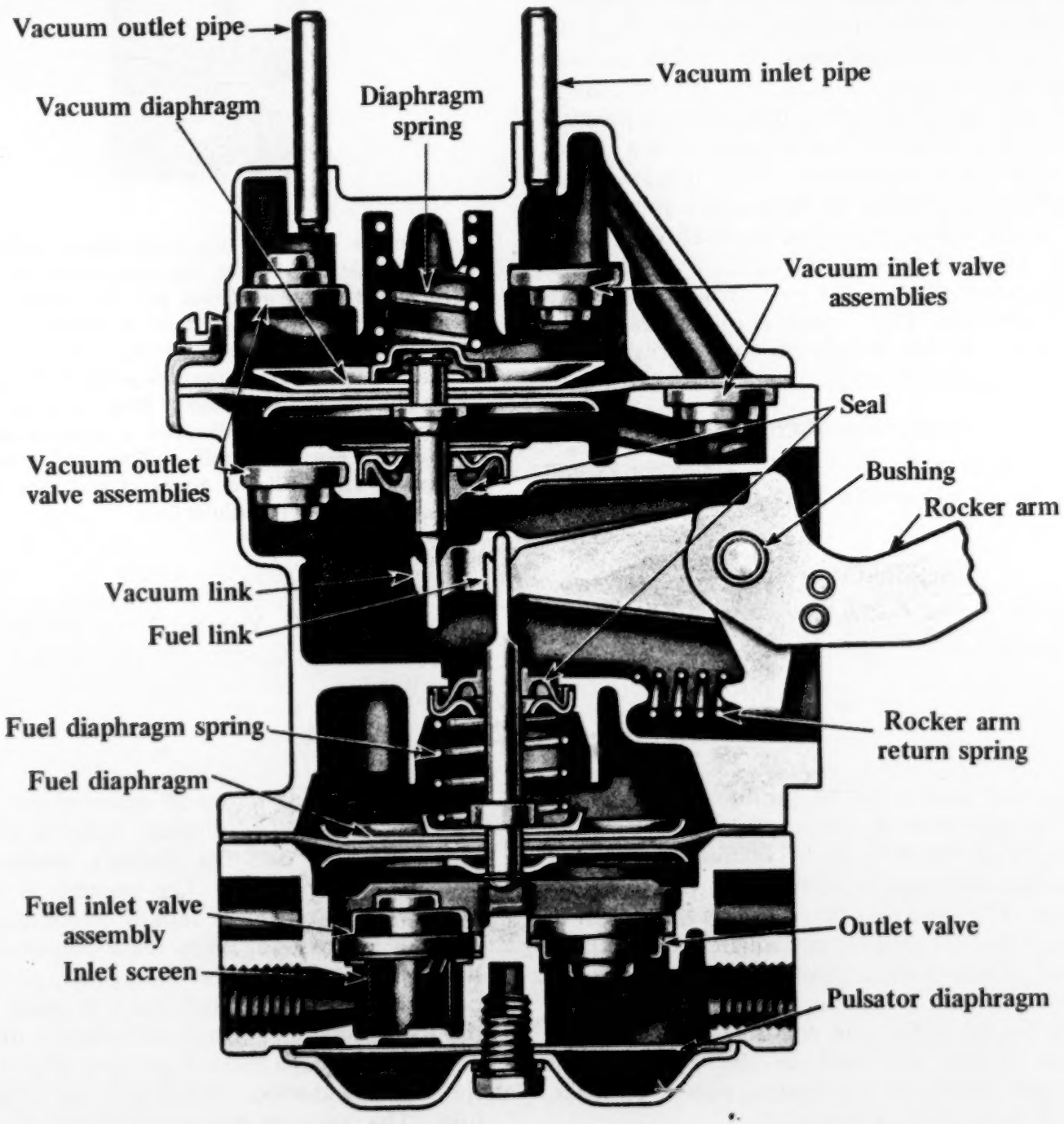

A combination fuel and vacuum pump shares a common housing and rocker arm (General Motors Corp.).

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deceleration is the pressure applied on the brake pedal. So that quicker braking can be done with less movement of the pedal, a pneumatic booster has been added to the system. This booster multiplies the braking force applied to the brake pedal. As a result, a small force applied to the brake pedal provides a high pressure on the hydraulic fluid in the master cylinder that rapidly brings the car to a stop. The power-brake system uses the pressure differential developed by the intake manifold. The booster consists of a chamber, valves, and a piston or diaphragm. Atmospheric pressure is admitted on one side of the diaphragm by the movement of the brake pedal. The intake manifold vacuum on the other side produces a pressure differential on the diaphragm so that the diaphragm moves toward the vacuum. Since the diaphragm is connected directly to the master cylinder, this motion operates the brakes and stops the vehicle. Valves are used to control the braking pressure and to balance the pressure on both sides of the diaphragm when the brakes are released.

Scientific Principle Involved: Atmospheric Pressure

The vacuum pump uses the principle that gas flows from high to low pressure in an attempt to balance the pressure. Atmospheric pressure will pass into the windshield-wiper air motor in its effort to balance the vacuum. The air will then travel to the chamber of the vacuum pump since the action of the diaphragm has reduced the pressure below atmospheric pressure. When the diaphragm moves up on the exhaust stroke, the pressure is increased; thus, a flow of air is produced from the chamber.

Application of Principle

1. A vacuum pump can be disassembled and assembled to determine the principle of operation, the flow of air through the pump, and the function of each part of the pump.
2. Pump operation can be demonstrated by attaching an inflated balloon on the intake side and a deflated baloon on the outlet side. When the pump is operated, the air will move from one balloon to the other.

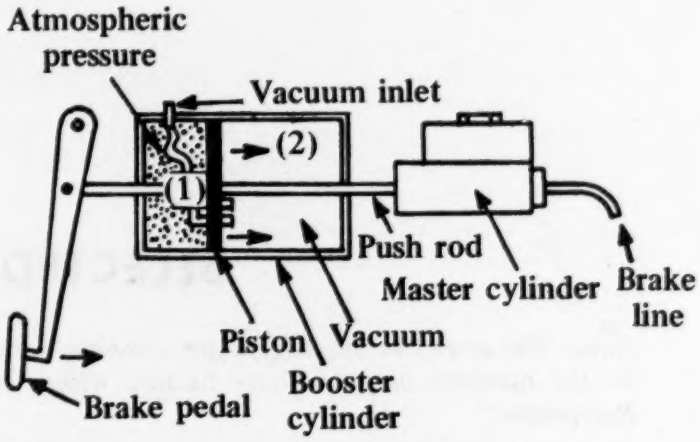

The schematic of a power brake shows how the control valve (1) can apply either engine vacuum or atmospheric pressure to section (2) of the booster cylinder.

3. Pump operation can be measured by attaching a vacuum gauge to the inlet side of the pump. As the pump is operated by hand, the pressure will drop (the vacuum will increase) to a pressure which counterbalances a mercury column approximately 11 inches high.
4. The force resulting from the operation of a power-brake unit can be determined for a number of different pressure differentials. This determination will require disassembly (or the use of a cutaway). Calculations may also include the mechanical advantage of the master and wheel cylinders in order to determine the available stopping force.
5. A power-brake booster assembly can be disassembled and assembled to determine the function and operation of each part as it contributes to the operation of the power-brake booster assembly.

Selected References

Note: The numbers in parentheses in this section refer to entries in the list of selected references that appear within this publication immediately after the text.

(4), pp. 62, 150; *(9)*, p. 98; *(13)*, p. 223; *(22)*, pp. 131, 582-86; *(26)*, p. 157; *(27)*, pp. 214-17; *(36)*, pp. 56-57; *(37)*, p. 24; *(54)*, p. 207; *(69)*, Chapter 6, p.10, Chapter 18, pp. 17-24; *(75)*, Chapter 26, pp. 1-3, Chapter 41, pp. 15-19, Chapter 51, pp. 6-9; *(78)*, pp. 519-24.

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PATTERN ADJUSTMENT FOR SLOPING SHOULDERS

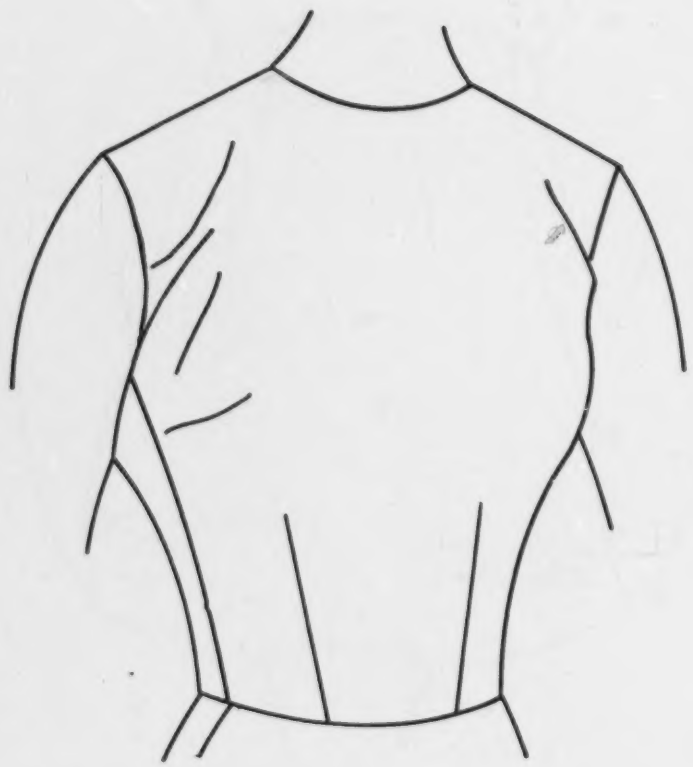

Diagram shows wrinkles and a distortion of grain line on front of ill fitting garment caused by sloping shoulders.

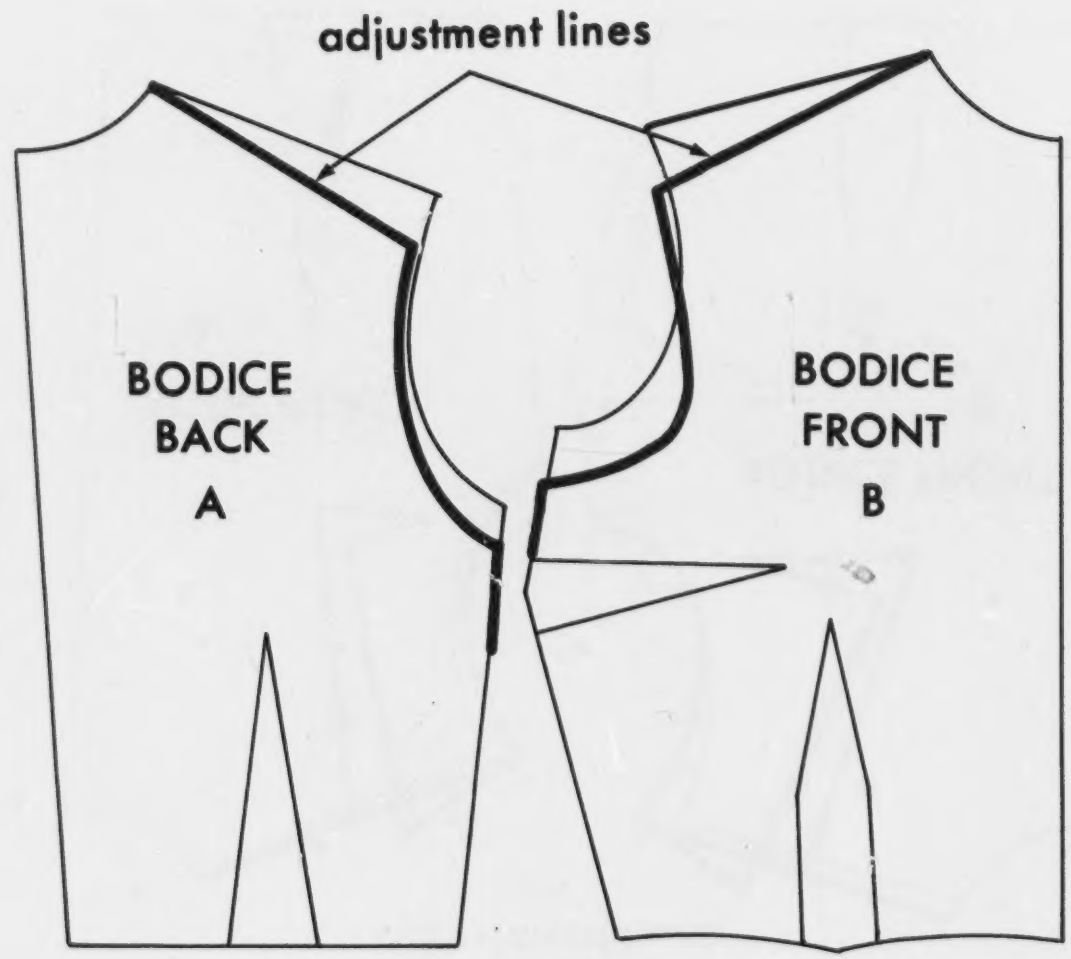

Diagram shows bodice back and front pattern pieces with needed adjustment lines indicated.

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APPENDIX A

POWER MECHANICS COURSE OUTLINE

In the following relatively brief course outline for industrial arts power mechanics, the topics, where appropriate, are keyed to the instructional units presented in this publication – for example, under "II. A. Muscle Power (Unit 1)"; and to the comprehensive course outline for industrial arts automotive mechanics in Appendix B – for example, under "I. A. Shop/Laboratory Safety (Refer to Appendix B. Section 1, I.)" This power mechanics course outline, when used for a specific course/program, can be expanded by including (1) additional points covered in the designated units; (2) topics presented in the automotive mechanics outline; and/or (3) information from the publications listed under "Selected References" at the end of each unit.

I. Shop/Laboratory Orientation
- A. Shop/Laboratory Safety
  (Refer to Appendix B, Section 1, I.)
  1. General causes of accidents
  2. Personal causes of accidents
  3. Safety instruction
- B. Tools and Equipment
  (Refer to Appendix B, Section 1, II.)
  1. Appreciation of tools
  2. Care of tools
  3. Classification of tools

II. Natural Power
- A. Muscle Power (Unit 1)
  1. Introduction to simple machines
  2. Work, power, energy, force
- B. Waterwheels (Unit 2)
  1. Types: undershot, overshot, breast
  2. Water pressure
- C. Windmills (Unit 3)
  1. Types: multivane, propeller, "S" rotor
  2. Horsepower output of windmill
- D. Heat Collectors (Unit 4)
  1. Conversion of solar energy to electricity
  2. Nature of heat
- E. Solar Stills (Unit 5)

III. Mechanical Power
- A. Simple and Compound Machines (Unit 6)
  1. Mechanical advantage
  2. Lever, wheel and axle, inclined plane, wedge, pulley, screw
  3. Compound machines
- B. Lubrication (Unit 7)
  (Refer to Appendix B, Section 6, I-XVI.)
  1. Viscosity of oils
  2. Lubricating oil functions
  3. Dry, greasy, and viscous friction
- C. Springs (Unit 8)
  (Refer to Appendix B, Section 16, V.)
  1. Classification of springs
  2. Elasticity: Hooke's law
- D. Clutches (Unit 9)
  (Refer to Appendix B, Section 11, I-X.)
  1. Six classifications of clutches
  2. Sliding friction
- E. Dynamometers (Unit 10)
  1. Methods of providing load
  2. Horsepower

IV. Steam Engines
- A. Steam Engines and Turbines (Unit 11)
- B. Conversion of Heat Into Work

V. Thermal Power
- A. High-Energy Rate Forming (Unit 12)
  1. Four methods of forming
  2. Work, power, energy, force
- B. Powder-Actuated Tools (Unit 13)
  1. Precautions to be observed
  2. Expansion of gases
- C. Jet and Rocket Engines (Unit 14)
  1. Types of jet engines
  2. Newton's laws of interactions
- D. Gasoline Testing (Unit 15)
  (Refer to Appendix B, Section 8, IX.)
  1. Power tests
  2. Conversion of chemical energy to heat energy to mechanical energy
- E. Carburetion (Unit 16)
  (Refer to Appendix B, Section 8, VII.)
  1. Carburetor functions
  2. Bernoulli's principle
- F. Two- and Four-Cycle Engines (Unit 17)
  (Refer to Appendix B, sections 3, 4, 5.)
  1. Four-stroke cycle
  2. Two-stroke cycle
  3. Expansion of gases
- G. Wankel Engines (Unit 18)
  1. Rotor-type engine
  2. Moment of inertia

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H. Thermostats (Unit 19)
(Refer to Appendix B, Section 7, VIII.)
1. Types and purposes
2. Thermal expansion

I. Welding Processes (Unit 20)
1. Gas, arc, and resistance welding
2. Kinetic molecular theory

VI. Electrical Power

A. Dry Cells: Primary Cells (Unit 21)
1. Zinc-carbon and mercury cells
2. Conversion of chemical energy into electrical energy

B. Storage Batteries: Secondary Cells (Unit 22)
(Refer to Appendix B, Section 9, IV.)
1. Conversion of chemical energy into electrical energy
2. Electrolysis
3. Hydrometer test
4. Specific gravity
5. Battery installation and servicing
6. Corrosion and oxidation of metals
7. Battery testing
8. Capacity rating of batteries
9. Battery charging
10. Chemical change in lead-acid storage cell

C. Generation of Electricity (Unit 23)
1. Magnetos
2. Magnetism
3. Direct-current generators and alternators
4. Electromagnetic induction
5. Alternating-current rectifiers
6. Rectification of current
7. Generator regulation
8. Electromagnetic switch

D. Transmission of Electric Power (Unit 24)
(Refer to Appendix B, Section 9, III.)
1. Electromotive force
2. Conductors and insulators
3. Electron theory
4. Voltage, current, and resistance
5. Ohm's law
6. Series and parallel circuits
7. Direct-current circuits

E. Transformers (Unit 25)
1. Types: step-up, step-down
2. Electromagnetic induction

F. Spark Plugs (Unit 26)
(Refer to Appendix B, Section 9, IX.D.)
1. Heat-range classification
2. Ionization of gases

G. Ignition Systems (Unit 27)
(Refer to Appendix B, Section 9, IX.)
1. Conventional and transistorized systems
2. Electromagnetic energy

H. Electric Motors (Unit 28)
(Refer to Appendix B, Section 9, V.)
1. Motors: series and shunt wound
2. Electromagnetic induction

I. Fuel Cells (Unit 29)
1. Use in spacecraft
2. Electrochemical effect

J. Photoelectric Cells (Unit 30)
1. Types and uses
2. Photoelectric effect

K. Semiconductor Power Rectifiers (Unit 31)
1. Types of rectifiers
2. P- and N-type semiconductors

VII. Hydraulic Power

A. Jacks and Presses (Unit 32)
1. Hydraulic pump components
2. Pascal's principle

B. Machine Tools (Unit 33)
1. Efficiency of hydraulic systems
2. Pressure transmission by liquids

C. Braking Systems (Unit 34)
(Refer to Appendix B, Section 20, I-VII.)
1. Devices for retarding or stopping motion
2. Pascal's principle

D. Fuel Pumps (Unit 35)
(Refer to Appendix B, Section 8, VI.)
1. Positive displacement pump
2. Atmospheric pressure

E. Power Steering (Unit 36)
(Refer to Appendix B, Section 17, VII.)
1. Advantage of power steering
2. Pressure transmission by liquids

F. Air Conditioners (Unit 37)
1. Types of air conditioners
2. Heat transfer

VIII. Pneumatic Power

A. Air-Powered Tools (Unit 38)
1. Piston and rotary-vane motors
2. Mechanical properties of gases

B. Spray Guns (Unit 39)
1. Operation and procedure for use
2. Bernoulli's principle

C. Vacuum Pumps (Unit 40)
1. Windshield wipers
2. Power brakes
(Refer to Appendix B, Section 20, IV.)
3. Balancing effect of atmospheric pressure

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APPENDIX B

AUTOMOTIVE MECHANICS COURSE OUTLINE

Section 1: Shop/Laboratory Practice

I. Automotive Shop/Laboratory Safety
- A. General Causes of Accidents
  1. Improper attitude
     - a. Disregard for rules of safety
     - b. Recklessness
     - c. Laziness
     - d. Uncooperativeness
     - e. Fearfulness
     - f. Impatience
     - g. Lack of consideration
     - h. Immaturity
  2. Lack of knowledge or skill
     - a. Lack of understanding what is to be done
     - b. Lack of conviction of need for following prescribed procedures
- B. Personal Causes of Accidents
  1. Operating equipment without permission
  2. Neglecting to secure assistance when needed
  3. Failing to warn other people about unsafe practices or equipment
  4. Operating equipment at unsafe speeds
  5. Working too fast
  6. Neglecting to use safety devices
  7. Using hands instead of equipment for holding material
  8. Assuming an unsafe position or posture
  9. Working unsafe equipment
  10. Distracting, teasing, abusing, and startling others
  11. Failing to use proper clothing and protective gear
- C. (Refer to *Industrial Arts Safety Instruction*, published by the California State Department of Education, as well as safety instructions issued by the offices of county superintendents of schools and by school districts.)

II. Automotive Tools and Power Equipment
- A. Appreciation of Tools
  1. Development
  2. Value to society
- B. Care of Tools
  1. Storage of tools
  2. Maintenance
     - a. Sharpening
     - b. Lubricating
     - c. Repairing

  (Report tools in need of repair.)
- C. Classification of Automotive Tools
  1. Chisels
     - a. Cape
     - b. Cold
     - c. Diamond-point
     - d. Half-round
     - e. Roundnose
  2. Drilling tools
     - a. Hand drill
     - b. Electric drill
     - c. Twist drill
     - d. Reamers
  3. Files
     - a. Mill
     - b. Taper
     - c. Square
     - d. Round
     - e. Half-round
     - f. Breaker-point
     - g. Vixen-cut (body)
  4. Hammering tools
     - a. Ball peen hammer
     - b. Rawhide-faced mallet
     - c. Plastic-tipped mallet
     - d. Brass mallet
     - e. Rubber mallet
     - f. Sledgehammer
     - g. Dinging hammer
  5. Measuring tools
     - a. Feeler gauges
     - b. Micrometers
     - c. Steel rules
  6. Pliers
     - a. Slip-joint (combination)
     - b. Diagonal (cutting)
     - c. Long-nose (needle-nose)
     - d. Round-nose
     - e. Pump-type (channel-lock)
     - f. Side-cutting (electrician's)
     - g. Vise-grip
     - h. Brake-spring
     - i. Hose-clamp
  7. Punches
     - a. Aligning
     - b. Center
     - c. Pin
     - d. Starting
  8. Hacksaw

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9. Screwdrivers
   a. Standard-tipped
   b. Phillips
   c. Clutch
   d. Offset
   e. Setscrew driver (Allen wrench)
10. Shearing tools
   a. Straight shears
   b. Combination shears
   c. Duckbill shears
   d. Multileverage (aviation) shears
11. Soldering tools
   a. Soldering copper
      (1) Standard
      (2) Electric
   b. Fluxes
12. Threading tools
   a. Taps
      (1) Taper
      (2) Plug
      (3) Bottoming
      (4) Machine screw
   b. Dies
13. Wrenches and handles
   a. Open-end wrench
   b. Box-end wrench
   c. Socket wrench
      (1) Standard
      (2) Deep
      (3) Universal
   d. Torque wrench
   e. Adjustable-end wrench
   f. Monkey wrench
   g. Pipe wrench
   h. Handles
      (1) Speed (spinner)
      (2) Ratchet
      (3) Flex (break-over)
      (4) Tee
   i. Extensions
14. Specialized tools
   a. Pneumatic
   b. Hydraulic
   c. Electrical testing
   d. Engine and accessories' testing
   e. Body and fender
15. Power equipment
16. Welding equipment

Section 2: Automobile Components

I. Automobile Components
   A. Engine
   B. Framework
   C. Power Train
   D. Body
   E. Accessories

II. Engine
   A. Purpose
   B. Types
      1. Internal combustion
      2. External combustion
   C. Systems
      1. Fuel system
         a. Purpose
         b. Components
            (1) Fuel tank and lines
            (2) Fuel filter
            (3) Air cleaner (wet and dry)
            (4) Fuel pump
            (5) Carburetor
            (6) Fuel injectors
            (7) Intake manifold
            (8) Fuel-level indicator
      2. Ignition system
         a. Purpose
         b. Components
            (1) Battery (6 or 12 volts)
            (2) Distributor
            (3) Magneto
            (4) Coil
            (5) Spark plugs
            (6) Ignition switch
            (7) Wiring
      3. Lubrication system
         a. Purpose
         b. Components
            (1) Oil pump
            (2) Oil filter
            (3) Oil galleries and passages
            (4) Oil-pressure indicator
            (5) Crankcase
            (6) Crankcase ventilator
      4. Cooling system
         a. Purpose
         b. Types
            (1) Liquid-cooled
            (2) Air-cooled
         c. Components
            (1) Radiator
            (2) Fan blade
            (3) Water pump
            (4) Water jackets and passages
            (5) Thermostat
            (6) Temperature indicator
      5. Electrical system
         a. Purpose
         b. Components
            (1) Battery
            (2) Regulator
            (3) Generator/alternator
            (4) Starting motor
            (5) Wiring
            (6) Switches
            (7) All activated components

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III. Framework
- A. Purpose
- B. Construction
  - 1. Box type
  - 2. X-type
  - 3. Unitized type
- C. Units Attached to Framework
  - 1. Engine
  - 2. Suspension system (front and rear)
    - a. Springs
      - (1) Purpose
      - (2) Types
        - (a) Coil
        - (b) Laminated leaf
        - (c) Single leaf
        - (d) Torsion bar
        - (e) Air suspension
    - b. Shock absorbers
      - (1) Purpose
      - (2) Type: direct-acting, telescoping
    - c. Steering system: purpose
    - d. Brakes
      - (1) Purpose
      - (2) Types
        - (a) Mechanical
        - (b) Hydraulic
        - (c) Pneumatic
        - (d) Electric
        - (e) Rigid or independent
      - (3) Components
        - (a) Brake-pedal assembly
        - (b) Master-cylinder assembly
        - (c) Brake lines
        - (d) Wheel-cylinder assemblies
        - (e) Wheel-brake assemblies
        - (f) Hand brake
      - (4) Principle of operation
      - (5) Power brakes
    - e. Tires
      - (1) Purpose
      - (2) Types
        - (a) Tube-type
        - (b) Tubeless
      - (3) Classification
        - (a) Size
        - (b) Plies
        - (c) Material

IV. Power Train
- A. Purpose
- B. Components
  - 1. Clutch
    - a. Purpose
    - b. Types commonly used
      - (1) Single dry disk
      - (2) Fluid coupling
  - 2. Transmission
    - a. Purpose
    - b. Types
      - (1) Standard: manual shift
      - (2) Automatic
      - (3) Overdrive
  - 3. Propeller shaft: purpose
  - 4. Differential
    - a. Purpose
    - b. Gear ratio
  - 5. Rear axles
    - a. Purpose
    - b. Types
      - (1) Live: rear
      - (2) Dead: front

V. Body
- A. Purpose
- B. Design (streamlining)
- C. Construction
  - 1. Pressed-steel panels
  - 2. Reinforcing members
  - 3. Attaching brackets
  - 4. Attaching bolts (rubber-mounted)
- D. Components
  - 1. Firewall assembly
  - 2. Instrument-panel assembly
  - 3. Floor assembly
  - 4. Roof assembly
  - 5. Doors- and center-pillar assembly
  - 6. Rear-quarter assemblies
  - 7. Rear-end assembly
  - 8. Front fenders, hood, and grill assembly
  - 9. Windshield and glass assemblies
  - 10. Seats
  - 11. Body-ventilating system
  - 12. Headlining assembly
  - 13. Exterior molding and trim
- E. Finishes
- F. Body Styles
  - 1. Sports coupe and sedan
  - 2. Convertible
  - 3. Sedans
  - 4. Station wagons
  - 5. Sports cars
  - 6. Compacts
  - 7. Sports wagons (buses, others)
  - 8. Pick-up trucks, trucks (assorted sizes and uses)

VI. Accessories
- A. Definition
  - 1. Comfort/convenience
  - 2. Safety and safety belts
- B. Examples
  - 1. Radio
  - 2. Heater, defroster, air conditioner
  - 3. Windshield wiper
  - 4. Clock
  - 5. Back-up lights
  - 6. Spotlight

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7. Courtesy light
8. Automatic light-dimmer

Section 3: Types of Engines

I. Purpose of Engine Classification
   A. To Differentiate Between Engines for Clear Communication
   B. To Categorize Engines by Common General Features
   C. To Describe Engines for Information and Possible Application

II. Criteria for Engine Classification
   A. Types of Fuel
      1. Gasoline (high and low compression)
      2. Fuel oil (diesel, Hesselman)
      3. Liquefied petroleum gas (LPG)
   B. Cycling
      1. Four-stroke cycle
      2. Two-stroke cycle
   C. Cooling
      1. Liquid-cooled
      2. Air-cooled
      3. Combined
   D. Valve Arrangement
      1. L-head (flat head)
      2. I-head (overhead valve)
      3. F-head (combination L- and I-head)
      4. T-head
   E. Cylinders
      1. Number of cylinders
      2. Arrangement of cylinders
         a. Inline
            (1) Vertical
            (2) Inverted
            (3) Slant or tilt
         b. Vee
            (1) Vertical
            (2) Inverted
            (3) Variable angle
         c. Opposed (pancake)
         d. Radial
            (1) Single bank
            (2) Multibank
         e. Rotary Wankel
   F. Use
      1. Passenger car
      2. Truck or bus
      3. Agricultural machinery
      4. Construction equipment
      5. Aircraft
      6. Motorcycles
      7. Railroad engines
      8. Marine
      9. Stationary
      10. Specialized use
   G. Identification
      1. Manufacturer's name
         a. Real manufacturer: Ford, General Motors, others
         b. Application manufacturer: International Harvester, Gillig, Euclid, others
      2. Designer's name
         a. Individual designer: Diesel, Wankel, others
         b. Multiple designer: Pratt and Whitney, others
      3. Series number (390, F100, 300G, others)
   H. Additional Types and Innovations
      1. Turbojet
      2. Ramjet
      3. Gas turbine
      4. Free piston
      5. NSU-Wankel
      6. Rocket
      7. Fuel cell
      8. Solar
      9. Electric
      10. Steam

Section 4: Engine Operation and Measurement

I. Physical Principles Related to Engine Operation
   A. Definition of Physical Principles
   B. Structure of Matter
      1. Atoms
         a. Size
         b. Structure
            (1) Electrons
            (2) Protons
            (3) Neutrons
      2. Elements
      3. Molecules
         a. Structure
         b. Chemical reaction
   C. States of Matter
      1. Liquids
      2. Solids
      3. Gases
   D. Combustion
      1. Definition
      2. Products of combustion
         a. Heat
         b. Light
         c. By-products
   E. Heat
   F. Change of State
      1. Definition
      2. Method of accomplishment
         a. Application of heat
         b. Application of cold
   G. Expansion of Matter
      1. Liquids: thermometer
      2. Solids: thermostat
      3. Gases: combustion chamber

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H. Pressure Increase
  1. Cause
  2. Results
    a. Temperature increase
    b. Compression
I. Gravity
  1. Definition
  2. Measurement: weight
J. Atmospheric Pressure
  1. Definition
  2. Weight of air
  3. Pressure exerted
K. Vacuum
  1. Definition
  2. "Partial vacuum"

II. Engine Operation
A. Cylinder Design
  1. Description
  2. Sealing
    a. Head
    b. Valves
B. Piston
  1. Description
  2. Piston fit
  3. Materials used
  4. Piston action
    a. Combustion
    b. Heat
    c. Pressure increase
C. Piston Rings
  1. Purpose
  2. Location
  3. Types
D. Valves
  1. Type
  2. Purpose
  3. Ports
    a. Intake
    b. Exhaust
  4. Valve operating mechanism
    a. Camshaft
    b. Cam followers or lifters
    c. Pushrods
    d. Valve spring
    e. Rocker arm
E. Crankshaft
  1. Purpose
  2. Description
  3. Rotary motion
F. Action in Cylinder
  1. Definition of "stroke"
    a. BDC to TDC
    b. TDC to BDC
  2. Four-stroke cycle
    a. Two crankshaft revolutions
    b. Four strokes
      (1) Intake
      (2) Compression
      (3) Power
      (4) Exhaust
  3. Two-stroke cycle
  4. Diesel engines
G. Flywheel
  1. Description
  2. Purpose

III. Forces
A. Work
  1. Definition
  2. Illustrations
  3. Measure in terms of distance and force
  4. Formula: $Work = f \times d$
B. Energy
  1. Definition
  2. Potential
  3. Kinetic
C. Power
  1. Definition
  2. High-powered machine
  3. Low-powered machine
  4. Horsepower
    a. Definition
    b. Formula: $Hp = \frac{force \times distance}{33{,}000 \times time}$
D. Inertia
  1. Definition
  2. Evidence of inertia at work
E. Torque
  1. Definition
  2. Method of measure (foot-pounds)
  3. Formula: *Torque = force × distance (lever arm)*
F. Friction
  1. Definition
  2. Types
    a. Dry
    b. Viscous
    c. Greasy

IV. Engine Measurements
A. Bore
  1. Definition
  2. Method of determination
B. Stroke
  1. Definition
  2. Method of determination
C. Piston Displacement
  1. Definition
  2. Formula: $Displacement = \frac{\pi D^2 L}{4}$
  3. Multicylinder total displacement × number of cylinders
D. Compression Ratio
  1. Definition
  2. Clearance volume
  3. Formula: *Cylinder volume @ BDC ÷ clearance volume*
  4. Problem related to higher compression ratios

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a. Power increase
b. Predetonation more acute (knocking)

V. Engine Power Output
A. Brake Horsepower (bhp)
1. Definition
2. Prony brake test
B. Indicated Horsepower (ihp)
1. Definition
2. Oscilloscope test
C. Friction Horsepower (fhp)
1. Definition
2. Method of determination
D. SAE Horsepower
1. Definition
2. Purpose
E. Engine Torque
1. Definition
2. Method of determination

VI. Engine Efficiency
A. Mechanical Efficiency
1. Relationship between bhp and ihp
2. Formula: *ME = bhp ÷ ihp (answer in percent)*
B. Thermal Efficiency
1. Relationship between power output and energy in fuel burned
2. Heat losses
a. Cooling by water and oil (35 percent)
b. Lost in exhaust gases (35 percent)
3. Limitations to thermal efficiency
a. Excessive heat
b. Breakdown in lubrication system
C. Volumetric Efficiency
1. Relationship between amount of fuel-air mixture actually entering cylinder and amount that could enter
2. Factors affecting volumetric efficiency
a. Engine rpm
b. Temperature of fuel-air mixture

VII. Overall Efficiency
A. Rolling Resistance
B. Air Resistance
C. Acceleration (overcoming of inertia)

Section 5: Engine Construction

I. Manifolds
A. Methods of Manufacture
1. Materials used
2. Design
B. Intake Manifold
1. Purpose
2. Types
3. Location
C. Exhaust Manifolds
1. Purpose
2. Types
3. Location
4. Manifold heat-control valve
D. Manifold Inspection
1. Check for warpage
2. Check for cracks
3. Check surface
4. Check heat-control valve for freeness

II. Cylinder Head
A. Methods of Manufacture
1. Materials used
2. Design
B. Types
1. Valve-in-head
2. Flat head
C. Purpose
1. Combustion chamber
2. Water jackets
3. Intake and exhaust ports and passages
D. Rocker-Arm Cover

III. Oil Pan
A. Methods of Manufacture
1. Materials used
2. Design
B. Purpose
1. Baffles
2. Oil troughs
3. Nozzles
4. Drain plug
5. Seals
C. Oil Pump
1. Purpose
2. Types
a. Gear
b. Dual rotor
3. Location
4. Oil intake
5. Screen

IV. Valve Train
A. Camshaft
1. Methods of manufacture
2. Purpose
3. Types
a. Stock
b. Other grinds
4. Location
5. Components
a. Cam lobes
b. Fuel pump eccentric
c. Distributor drive gear
d. Bearing journals
e. Thrust plate
6. Camshaft timing gear or sprocket
7. Timing chain
B. Valve Lifters (Tappets)
1. Purpose
2. Location
a. I-head

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PATTERN ADJUSTMENT FOR BROAD SHOULDERS

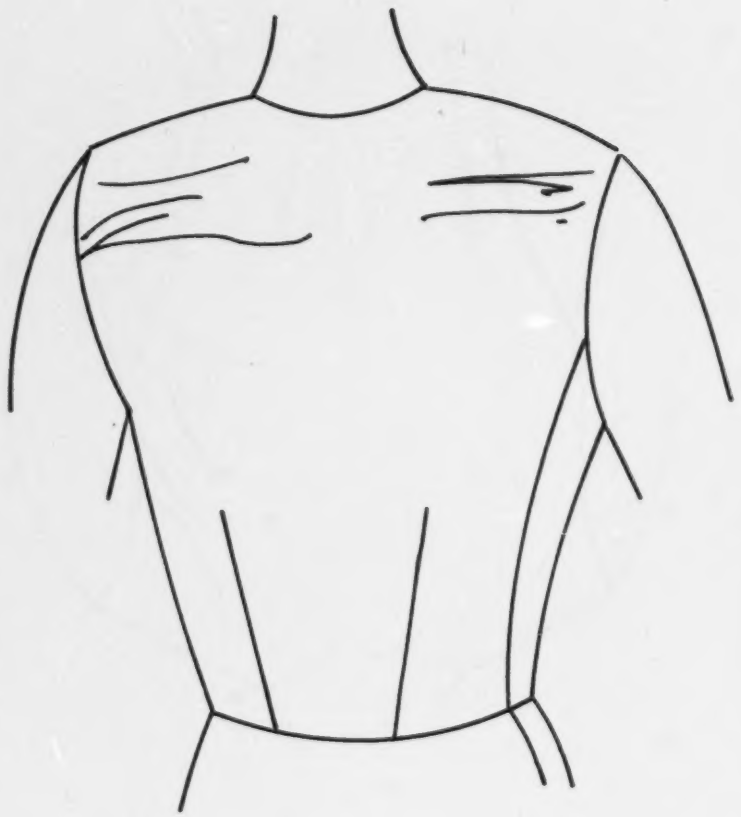

Diagram shows wrinkles and distortion of grain line on back of ill fitting garment caused by narrow shoulders.

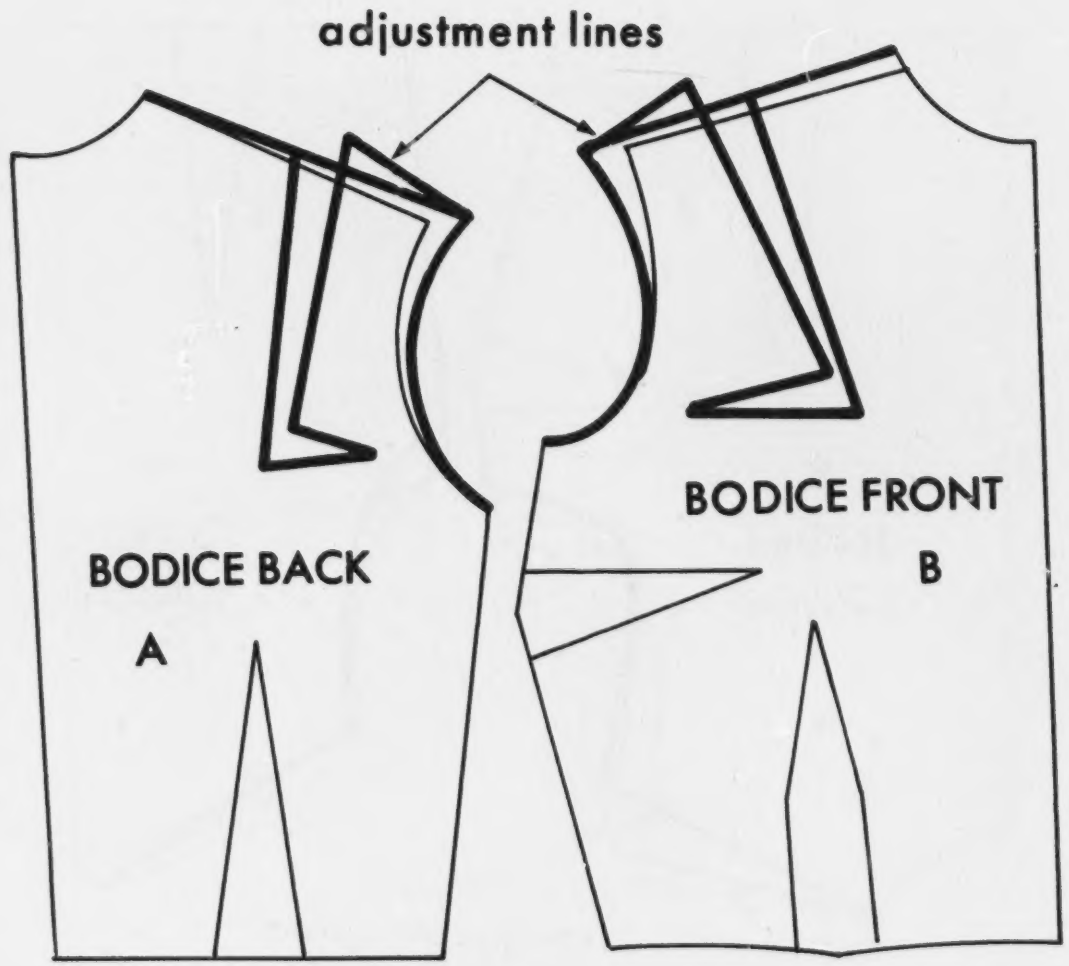

Diagram shows bodice back and front pieces altered by splitting and spreading patterns at shoulder to create new shoulder and armscye lines.

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b. L-head
c. F-head
3. Types
a. Solid
b. Adjustable
c. Hydraulic

C. Push Rod
1. Purpose
2. Location
3. Types
a. Tubular
b. Solid

D. Rocker Arm and Shaft
1. Purpose
2. Rocker-arm types
a. Cast
b. Forged
c. Stamped steel
3. Rocker-arm shaft
a. Location
b. Purpose

E. Valve Guides
1. Purpose
2. Location
3. Types
a. Pressed in
b. Slip in
c. Integral
4. Lifter guides

F. Valves
1. Methods of manufacture
2. Purpose
a. Intake
b. Exhaust
3. Types (past and present)
a. Rotary
b. Sliding-sleeve
c. Poppet or mushroom
4. Parts of poppet valve
a. Head
b. Margin
c. Face
d. Neck
e. Stem
f. Spring-retainer lock groove
g. Tip
5. Valve cooling
a. Purpose
b. Method
(1) Water jackets
(2) Water-distributing tube
c. Sodium valves
6. Valve seat
a. Purpose
b. Types
(1) Direct
(2) Inserts

G. Valve Springs
1. Purpose
2. Types
a. Single
b. Double
3. Retainers
a. Stationary
b. Free type
c. Positive type
4. Retainer locks (keepers)
a. Conical
b. Pin
c. Horseshoe

H. Relationship of Parts in L-Head Engine
I. Relationship of Parts in I-Head Engine
J. Relationship of Parts in F-Head Engine

V. Piston and Connecting Rod Assembly

A. Piston
1. Methods of manufacture
2. Purpose
3. Parts of piston
a. Head
b. Ring grooves
c. Ring lands
d. Pin boss and bushing
e. Skirt
(1) Major thrust face
(2) Minor thrust face
4. Expansion control
a. Steel rings
b. Struts
c. Slots
d. Cam ground pistons

B. Piston Rings
1. Methods of manufacture
2. Purpose
a. Seal compression
b. Control oil
3. Types
a. Compression
(1) Plain
(2) Tapered
(3) Grooved
b. Oil control
4. Ring joints
a. Types
(1) Butt
(2) Angle
(3) Lap
b. Ring gap
5. Ring expanders
a. Purpose
b. Location
6. Coated rings
7. Chrome-plated rings

C. Piston Pin
1. Purpose

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2. Types
   a. Center-lock
   b. End-lock
   c. Slotted
   d. Press-fit
   e. Floating
D. Connecting Rod
   1. Purpose
   2. Method of manufacture
   3. Parts
      a. Rod
      b. Little end (bushing)
      c. Big end
      d. Rod cap
      e. Oil holes
      f. Rod nuts
         (1) Safe wire
         (2) Self-locking
         (3) Cotter pin
         (4) Palnut
      g. Tongue and groove
   4. Rod stretch and reconditioning
   5. Alignment of oil holes

VI. Bearings
A. Methods of Manufacture
B. Purpose
C. Types
   1. Bushings
   2. Sleeve
   3. End thrust
   4. Poured
   5. Semi-fitted
   6. Precision insert: types of metal overlays
   7. Roller
   8. Ball
D. Location
   1. Main bearings
   2. Connecting-rod bearings
   3. Camshaft bushings
   4. Piston pin bushings
   5. Clutch pilot-bushing or -bearing
   6. Camshaft thrust plate
E. Oil Clearance
F. Requirements
   1. Load-carrying capacity
   2. Fatigue resistance
   3. Embeddability
   4. Conformability
   5. Corrosion resistance
   6. Low wear rate

VII. Crankshaft
A. Methods of Manufacture
   1. Materials used
   2. Design
B. Purpose
   1. Connecting rod throws
   2. Main bearing journals
   3. Counterbalances
   4. Oil passages
   5. Oil slinger/thrust pad
C. Flywheel
   1. Purpose
      a. Supplies inertia to crankshaft
      b. Engages with starter motor
      c. Driving member of clutch
   2. Location
D. Crankshaft Timing-Gear or Sprocket
E. Vibration Damper
   1. Purpose
   2. Construction
   3. Location

VIII. Cylinder Block
A. Methods of Manufacture
   1. Materials used
   2. Design
B. Purposes
   1. Cylinders
   2. Water jackets
   3. Welch plugs (soft plugs)
   4. Intake and exhaust ports and passages
   5. Valve-lifter chamber
   6. Oil galleries
   7. Pressure relief valve
C. Engine Serial Number Location

IX. Gaskets
A. Materials Used
   1. Soft metal
   2. Fiber
   3. Rubber
   4. Neoprene
   5. Cork
   6. Leather
B. Purpose
C. Types and Location
   1. Cylinder head
   2. Oil pan
   3. Push-rod cover
   4. Valve cover
   5. Manifolds
   6. Timing-gear cover and seal
   7. Main bearing seal

X. Miscellaneous Components
A. Bell Housing
   1. Purpose
   2. Dust cover
B. Engine Mounts

Section 6: Engine Lubrication System

I. Purpose of Lubrication System
A. Lubricate Moving Parts to Prevent Wear
B. Lubricate Moving Parts to Reduce Power Loss from Friction
C. Act as Cooling Agent

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D. Absorb Shock Between Bearings and Other Moving Parts
E. Form Seal Between Piston Rings and Cylinder Walls
F. Act as Cleaning Agent

II. Theory of Lubrication
A. Friction Bearings
B. Antifriction Bearings
C. Oil Passages
1. Circulation
2. Location
a. Internal
b. External

III. Source of Oil
A. History and Development
1. Discovery
2. Early uses
3. Oil and automobile
B. Modern Processes
1. Modern oil fields
2. Refining

IV. Properties of Oil
A. Viscosity
1. Body
2. Fluidity
B. Viscosity Ratings
1. Viscosimeter
2. Temperature
C. Viscosity Index
D. Resistance to Carbon Formation
E. Additives
1. Oxidation inhibitors
2. Antifoam agents
3. Detergents
4. Antiwear additives
5. Acid inhibitors
6. Varnish inhibitors
7. Sludge inhibitors

V. Water Sludge Formation
A. Process of Formation
B. Prevention of Sludge
1. Types of car opefation
2. Temperature
3. Crankcase ventilating system

VI. Service Ratings of Oil (API)
A. MS
B. MM
C. ML
D. DS
E. DG

VII. Oil Changes
A. Purpose
1. Replace contaminated oil
2. Keep engine clean
3. Drain oil
a. From below
b. From above
B. Oil Change Interval
1. Factory recommendations
a. For engine with oil filter
b. For engine without oil filter
2. Other recommendations

VIII. Oil Consumption
A. Causes
1. Engine condition
2. Driving conditions
3. Mixture of oil types
B. Corrections

IX. Types of Lubrication Systems
A. Splash
B. Pressure Feed
C. Combination of Splash and Pressure Feed

X. Oil Pumps
A. Purpose: Circulation
B. Location
1. Internal
2. External
C. Types
1. Gear
2. Dual rotor
3. Vane
4. Plunger
D. Theory of Operation
1. Capacity
2. Priming
E. Method of Drive
1. Distributor
2. Cam gear
3. Crankshaft gear
F. Parts
1. Camshaft gear
2. Shaft
3. Body
4. Drive gear
5. Idler gear
6. Cover
7. Intake
8. Outlet
9. Screen

XI. Relief Valves
A. Purpose
B. Types
1. Plunger
2. Ball
C. Location
1. Block
a. Internal
b. External
2. Pump
D. Operation

XII. Oil Filters
A. Purpose
B. Location

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C. Types
  1. By-pass
  2. Full-flow
D. Theory of Operation
E. Change Interval

XIII. Oil Coolers
A. Purpose
B. Types
C. Location
D. Operation
E. Transference of Heat

XIV. Oil-Pressure Indicators
A. Purpose
B. Location
  1. Dash unit
  2. Engine sender unit
C. Types
  1. Bourdon tube
  2. Electric
    a. Balancing coil
    b. Bimetal
    c. Warning light

XV. Crankcase Ventilation
A. Purpose
B. Types
  1. Standard
  2. Positive
C. Operation
D. Smog Control

XVI. Oil-Level Indicators
A. Purpose
B. Location

Section 7: Engine Cooling System

I. Purpose of Engine Cooling System
A. Maintain Efficient Engine Operating Temperature
B. Regulate Engine Operating Temperature to Driving Conditions
C. Maintain Temperature Limits
  1. Results of overheating
    a. Breakdown of lubrication oil
    b. Damage to bearing and moving parts
    c. Warpage and cracking of cylinder head
    d. Loss of coolant
    e. Stoppage of water circulation
    f. Changes in clearance
  2. Results of overcooling
    a. Loss of engine thermal efficiency
    b. Excessive consumption of fuel
    c. Dilution of engine oil
    d. Formation of sludge
      (1) Lubrication failure
      (2) Corrosive acids
    e. Changes in clearance

II. Types of Cooling Systems
A. Air-Cooled
  1. Cooling fins
  2. Circulation of air
B. Liquid-Cooled
  1. Thermosyphon
    a. Gravity
    b. Natural laws of water circulation (convection)
  2. Forced circulation
    a. Method of circulation
    b. Circulation under pressure

III. Four Essentials of Cooling System
A. Absorption
B. Circulation
C. Radiation
D. Control

IV. Water Jackets
A. Cylinder Block
B. Cylinder Head
C. Water-Distribution Tubes
D. Water Nozzles
E. Soft Plugs (Welch Plugs)

V. Water Pump
A. Purpose
B. Type Used
C. Location
D. Parts
  1. Housing
  2. Water inlet
  3. Water outlet
  4. Impeller
  5. Shaft
  6. Seals
  7. Pulley
  8. Bearings
E. Theory of Operation
F. Method of Drive

VI. Engine Fan
A. Purpose
B. Location
C. Method of Drive

VII. Radiator
A. Purpose
B. Compartments
  1. Air passages
  2. Water passages
C. Radiator Types
  1. Ribbon cellular
  2. Tube and fin
D. Radiator Parts
  1. Radiator shell
  2. Radiator core
    a. Top header
    b. Water tubes
    c. Air fins

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3. Fan shroud
4. Shell attaching bolts
5. Water inlet
6. Water outlet
7. Upper tank
8. Lower tank
9. Connecting hoses
10. Drain cock

E. Draining Radiator
1. With pressure cap
2. Without pressure cap

VIII. Thermostats
A. Purpose
B. Location
1. Water-cooled
2. Air-cooled
C. Types
1. Bellows
2. Bimetallic
3. Solid expansion
D. Thermostat Parts
1. Case
2. Bellows or spring
3. By-pass valve
4. Air-bleed hole
E. Principles of Operation
1. Temperature ranges
2. Water circulation: cold
3. Water circulation: hot

IX. Radiator Pressure Cap
A. Purpose
1. Improve cooling efficiency
2. Prevent evaporation
3. Prevent surge losses
B. Physical Principles
1. Pressure increase
2. Boiling-point effects
C. Pressure Cap Parts
1. Vacuum valve
2. Blowoff valve
3. Overflow pipe
D. Pressure Cap Capacities

X. Temperature Indicators
A. Purpose
B. Location
1. Dash unit
2. Engine unit
C. Indicator Types
1. Vapor pressure
2. Electrical
a. Balancing coil
b. Bimetal thermostat

XI. Antifreeze Solutions
A. Purpose
B. Physical Principles
1. Freezing: expanding force
2. Prevention of freezing
C. Requirements for Good Antifreeze Solution
1. Mixes readily with water
2. Circulates freely
3. Must not damage system by corrosion
4. Must not freeze
D. Inadequate Antifreeze Solutions
1. Salt solutions
2. Sugar solutions
3. Oil products
4. Kerosene
5. Glycerin
E. Temporary Antifreeze Solutions
1. Alcohol
2. Alcohol base materials
a. Low boiling point
b. Evaporation
F. Permanent Antifreeze Solutions
1. Ethylene glycol materials: percentages
2. Methanol materials: percentages

XII. Radiator Additives
A. Cooling System Cleaners
B. Sealer
C. Acid and Rust Inhibitor

XIII. Special Features
A. Surge Tank
B. Radiator Covers
C. Radiator Screens

XIV. Hot-Water Car Heater
A. Purpose
B. Parts
1. Heater radiator
2. Fan motor
3. Fan blades
4. Connecting hoses
C. Theory of Operation

Section 8: Engine Fuel System

I. Purpose of Engine Fuel System
A. Store Fuel
B. Deliver Fuel to Engine
C. Mix Fuel and Air to Proper Proportions

II. History and System Types
A. Gravity Feed System
1. Tank located higher than carburetor
2. System used about 1900 to 1931
B. Vacuum System
1. Vacuum tank located higher than carburetor
2. Intake-manifold vacuum applied to vacuum tank
3. Gravity from vacuum tank to carburetor
4. System invented about 1920
C. Pressure System
1. Fuel tank under 2 to 4 pounds higher pressure than atmospheric
2. Hand pump on dash for starting

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3. Engine pump used after running
4. System used in some higher-priced cars about 1915

D. Propane and Butane Systems
1. Creates own pressure
2. Stored as a liquid
3. Released as a vapor
4. Used in localities where readily available
5. Used now on some installations

E. Pump System
1. Draws from tank by vacuum
2. Forces to carburetor by pressure
3. Now standard type of installation

III. Fuel Tanks
A. Purpose
B. Location
C. Structure
1. Metal: spark proof
2. Corrugation
3. Baffles
4. Filler pipe
5. Filler cap
6. Vent
7. Gauge sending-unit location
8. Fuel line
9. Filter screen
10. Drain plug

IV. Fuel-Level Indicators
A. Purpose
B. Types
1. Stick
2. Hydrostatic
3. Mechanical
4. Electric
a. Bimetal type
b. Balancing coil type

V. Fuel Lines
A. Purpose
B. Types
1. Steel
2. Copper
3. Flexible
C. Fittings
1. Compression
2. Flared
D. Location
1. Vibration
2. Sharp edges
3. Heat

VI. Fuel Pumps
A. Purpose
B. Location
C. Diaphragm Types
1. Bellows
2. Plunger
3. Impeller
4. Combination
D. Operation

VII. Carburetion
A. Carburetor Fundamentals
1. Purpose of carburetor
2. Physical principles
a. Atmospheric pressure
b. Vacuum
c. Evaporation
d. Atomization
B. Carburetor Basic Parts
1. Air horn
2. Venturi
3. Fuel nozzle
4. Throttle valve
C. Fuel Mixtures
1. Rich
a. Ratio
b. Conditions when needed
2. Lean
a. Ratio
b. Conditions when needed
D. Float Circuit
1. Purpose
2. Operation
3. Fuel-pump control
a. Leverage
b. Hydraulics of surface areas
4. Concentric
a. Horseshoe float
b. Dual-float assembly
5. Dual-float circuits
6. Float-bowl vent
a. Balanced
b. Unbalanced
7. Air bleed: purpose
8. Adjustment
a. Fuel level too low
b. Fuel level too high
E. Idle- and Low-Speed Circuit
1. Purpose
2. Operation
a. Air-horn conditions
b. Idle circuit
c. Low-speed circuit
d. Air bleeds
3. Adjustment
a. Idle speed
b. Idle mixture
F. High-Speed Part-Load Circuit
1. Purpose
2. Operation
a. Mechanical (metering rod)
b. Vacuum (power valve)
G. High-Speed Full-Power Circuit
1. Purpose

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2. Operation
   a. Mechanical (metering rod)
   b. Vacuum (power valve)
   c. Combination mechanical and vacuum

H. Accelerator-Pump Circuit
1. Purpose
2. Operation
   a. Plunger
   b. Diaphragm
3. Adjustment

I. Choke Circuit
1. Purpose
2. Manual operation
3. Vacuum operation
4. Electric
5. Adjustment

J. Other Carburetor Features
1. Throttle cracker
2. Fast idle
3. Antipercolator
4. Throttle-return checks
   a. Dashpot
   b. Diaphragm
5. Distributor-vacuum circuit
6. Starter switches
7. Kick-down switches
8. Governors

K. Carburetor Types
1. Fuel entry to manifold
   a. Downdraft
   b. Updraft
   c. Side draft
2. Barrels
   a. Single barrel
   b. Two barrel
   c. Four barrel
      (1) Primaries
      (2) Secondaries
      (3) Progressive linkage
      (4) Circuit variations from single and two barrel
3. Multiple carburetors
   a. Two two-barrels
   b. Three two-barrels
   c. Two four-barrels
      (1) Unison linkage
      (2) Progressive linkage
      (3) Vacuum-controlled linkage
4. Fuel injection
   a. Combustion chamber
   b. Intake manifold

VIII. Air Cleaners
A. Purpose
B. Oil-Bath Type
1. Operation
2. Service
C. Dry Type
1. Operation
2. Service

IX. Fuels
A. Fuels in General Use
1. Gasoline
2. Benzene
3. Benzol
4. Alcohol
5. Natural gas
6. Fuel oil
7. Propane and butane

B. Physics of Carburetion and Combustion of Gasoline
1. Combustion
2. Compression
3. Fuel knock (detonation and preignition)
   a. Heat on irregular surfaces
   b. Compression ratio
   c. Ignition timing
   d. Rapid burning
      (1) Antiknock value
      (2) Measurement of antiknock value
      (3) Chemical control
      (4) Weight of air
      (5) Vaporization
         (a) Spraying
         (b) Heat
         (c) Vacuum
      (6) Volatility
         (a) Starting
         (b) Vapor lock
         (c) Warm-up
         (d) Acceleration
         (e) Economy
         (f) Crankcase dilution
         (g) Evaporation during nonoperation
         (h) Atmospheric conditions
         (i) Blend
      (7) Harmful chemicals and gum

Section 9: Electrical System

I. Purpose of Electrical System
A. Cranks Engine for Starting
B. Helps Create High-Voltage Surge for Ignition
C. Provides Electrical Current for Electrically Operated Devices

II. Components of Electrical System
A. Storage Battery
B. Cranking Motor
C. Generator/Alternator
D. Regulators
E. Ignition Distributor (Timer)
F. Magneto
G. Coil
H. Spark Plugs
I. Wiring
J. Switches
K. Accessory Units

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III. Fundamentals of Electricity
- A. Characteristics
  1. Atoms
     a. Electrons: negative (–)
     b. Protons: positive (+)
  2. Attraction of opposite charges
  3. Repulsion of like charges
  4. Accumulation of electrons: electric charge
  5. Accumulation of electrons by generators and batteries
- B. Principles of Electric Current
- C. Conductors
  1. Example: copper
  2. Free movement of electrons
- D. Insulators
  1. Example: rubber
  2. Few free electrons
  3. Prevention of loss of electrons from conductors
- E. Electrical Terms
  1. Voltage
     a. Electric pressure
     b. Pressure measured in volts
  2. Amperage
     a. Current flow
     b. Flow measured in amperes
  3. Resistance
     a. Resistance to electrical pressure
     b. Resistance measured in ohms
- F. Ohm's Law
- G. Circuits
  1. Series
     a. Current flow same in all parts of circuit
     b. Total resistance equal to sum of individual resistances
     c. Voltage equal to sum of potential differences across each of individual resistances
  2. Parallel
     a. Voltage same across all resistances
     b. Total current equal to sum of currents through branches
     c. Total resistance equal to voltage across resistances divided by total circuit current
  3. Series-parallel
     a. Certain components in series
     b. Certain components in parallel
- H. Magnetism
  1. Magnets: characteristics
  2. Lines of force
     a. Stretch between magnetic poles
     b. Tend to be parallel (do not cross)
- I. Electromagnetism
  1. Lines of force produced by current flow
  2. Electromagnets: combined magnetic field
  3. Permeability
     a. Iron core in coil
     b. Increased magnetic field

IV. Storage Battery
- A. Purpose
- B. Construction
  1. Container
  2. Plates
     a. Positive: lead peroxide
     b. Negative: sponge lead
  3. Separators
  4. Post straps
  5. Terminal posts
  6. Cell covers
  7. Cell connectors (internal and external)
  8. Vent plugs
  9. Sealing compound
- C. Principles of Chemical Activity
- D. Battery Ratings
  1. Definition
     a. Total area
     b. Volume of active plate material
     c. Amount of electrolyte
     d. Strength of electrolyte
  2. Methods of rating
     a. Ampere-hour capacity
     b. Cold rating

V. Cranking Motor
- A. Purpose
- B. Principles of Motor Operation
  1. Magnetic field around conductor
  2. Conductor in magnetic field
  3. Lines of force action
  4. Current flow
- C. Construction of Cranking Motor
  1. Basic elements
     a. U-shaped conductor
     b. Contacts
     c. Brushes
     d. Magnets
     e. Battery
  2. Components of cranking motor
     a. Armature
     b. Field-frame assembly
     c. Commutator end-head assembly
     d. Brushes
     e. Drive housing
     f. Drive mechanism
     g. Solenoid assembly
     h. Shift-lever assembly
- D. Cranking-Motor Drives
  1. Purpose
  2. Types
     a. Overrunning clutch
     b. Inertia
        (1) Bendix drive
        (2) Dyer drive
        (3) Folo-thru drive
     c. Principles of operation

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E. Cranking-Motor Controls
  1. Purpose
  2. Manual operation
  3. Automatic control: solenoid
  4. Methods of operation
F. Simple Wiring Diagram

VI. Direct-Current Generator
A. Purpose
B. Principles of Generator Operation
  1. Conductor moving through magnetic field
  2. Current flow
  3. Magnetic lines of force
  4. Rate of cutting lines of force
C. Construction of Generator
  1. U-shaped conductor
  2. Contacts
  3. Brushes
  4. Field coils
  5. Drive unit
D. Components of Generator
  1. Frame assembly
    a. Frame
    b. Field coil
    c. Pole shoes
    d. Terminals
  2. Armature
  3. Commutator end frame
  4. Brushes
  5. Drive end frame
  6. Fan
  7. Pulley
E. Output control
F. Wiring diagram

VII. Generator Regulators (Conventional and Transistorized)
A. Purpose
B. Cutout Relay (Circuit Breaker)
  1. Purpose
  2. Construction
    a. Two windings
      (1) Current
      (2) Voltage
    b. Core
    c. Armature
    d. Contacts
    e. Spring
  3. Operation
    a. Voltage buildup
    b. Magnetic field produced
    c. Spring tension overcome
    d. Armature closes
    e. Generator current flowing
      (1) Current flows to battery from generator
      (2) Magnetic field buildup
      (3) Points held closed by current
    f. Generator current flowing
      (1) Current flows from battery to generator
      (2) Magnetic fields reversal-weakened
      (3) Contact points separate
      (4) Circuit opens
C. Voltage Regulator
  1. Purpose
    a. Prevents excessive voltage
    b. Maintains constant voltage
  2. Operation
D. Current Regulator
  1. Purpose
    a. Regulates current to battery
    b. Protects battery
  2. Operation

VIII. Alternating-Current Generator System (Alternator)
A. Wiring Diagram of Alternator Circuit
B. Function of Alternating-Current Generator (Alternator)
C. Construction and Description of Parts
D. Principles of Alternator Operation

IX. Ignition System (Conventional and Transistorized)
A. Purpose
B. Components
  1. Battery
  2. Switch
  3. Resistor
  4. Coil
  5. Distributor
  6. Spark plugs
  7. Wiring
  8. Switch
  9. Timer
C. Distributor
  1. Purpose
    a. Closes and opens circuit between battery and coil
    b. Distributes high-voltage surge to spark plugs
  2. Location
  3. Construction
    a. Housing
    b. Drive shaft
      (1) Breaker cam
      (2) Advance mechanism
    c. Breaker plate
    d. Contact points
    e. Rotor
    f. Cap
  4. Operation
  5. Spark advance mechanisms
    a. Purpose
    b. Types and operation
      (1) Centrifugal
      (2) Vacuum
      (3) Combination
      (4) Full vacuum
D. Spark Plugs
  1. Purpose
  2. Location

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3. Construction
   a. Shell
   b. Insulator
   c. Electrodes
      (1) Center
      (2) Ground
   d. Terminal
   e. Sealing methods
   f. Threads
4. Heat ranges
   a. Heat path
   b. Hot
   c. Cold
5. Spark gap
6. Operation

E. Ignition Coil
1. Purpose
2. Location
3. Construction
   a. Case
   b. Coils (wire)
      (1) Primary
      (2) Secondary
   c. Iron core
   d. Insulating materials
   e. Terminals
      (1) Primary
      (2) Secondary
4. Operation
   a. Creating magnetic field
   b. Collapsing magnetic field: primary
   c. Collapsing magnetic field: secondary
   d. Capacitor (condenser) effect

F. Ignition Switch
1. Purpose
2. Operation

G. Wiring Diagram
1. Primary circuit
2. Secondary circuit

H. Ignition Timing Marks
1. Purpose
2. Location

X. Electrical Circuits
A. Horn
B. Lights (Internal)
C. Running Lights
1. Headlights
2. Taillights
3. Stop lights
4. Back-up lights

D. Directional Signals
E. Accessories

XI. Relays
A. Purpose
B. Uses
1. Lighting
2. Horn

Section 10: Engine-Trouble Diagnosis

I. Engine Failure
A. Compression Loss
B. Failure of Engine to Turn Over
C. Ignition Troubles
D. Carburetion Troubles

II. Compression Loss
A. Causes
1. Cylinder bore wear
2. Improper valve timing
3. Improper valve seating
4. Cylinder-head gasket
5. Cracks

B. Trouble Checklist
1. Crank engine; diagnose compression noises
2. Make compression test
3. Observe valve action
4. Check valve adjustment

III. Failure of Engine to Turn Over
A. Causes
1. Piston and ring fit
2. Bearing clearances
3. Valve action
4. Lubrication system
5. Cooling system
6. Starting system

B. Trouble Checklist
1. Check lubricating oil
2. Check water
3. Turn crankshaft by hand, if possible
4. Observe valve action
5. Diagnose abnormal knocks and noises

IV. Carburetion Troubles
A. Causes
1. Carburetor circuits
   a. Float
   b. Idle
   c. Part throttle
   d. High speed
   e. Accelerator pump
   f. Choke
2. Fuel pump
3. Fuel tank
4. Fuel lines
5. Manifold and exhaust system

B. Trouble Checklist
1. Check fuel level in tank
2. Check accelerator action
3. Remove carburetor fuel line; crank engine
4. Check fuel pump
5. Test fuel lines
6. Check air cleaner

V. Ignition Troubles
A. Causes
1. Primary system
   a. Battery

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PATTERN ADJUSTMENT FOR NARROW SHOULDERS

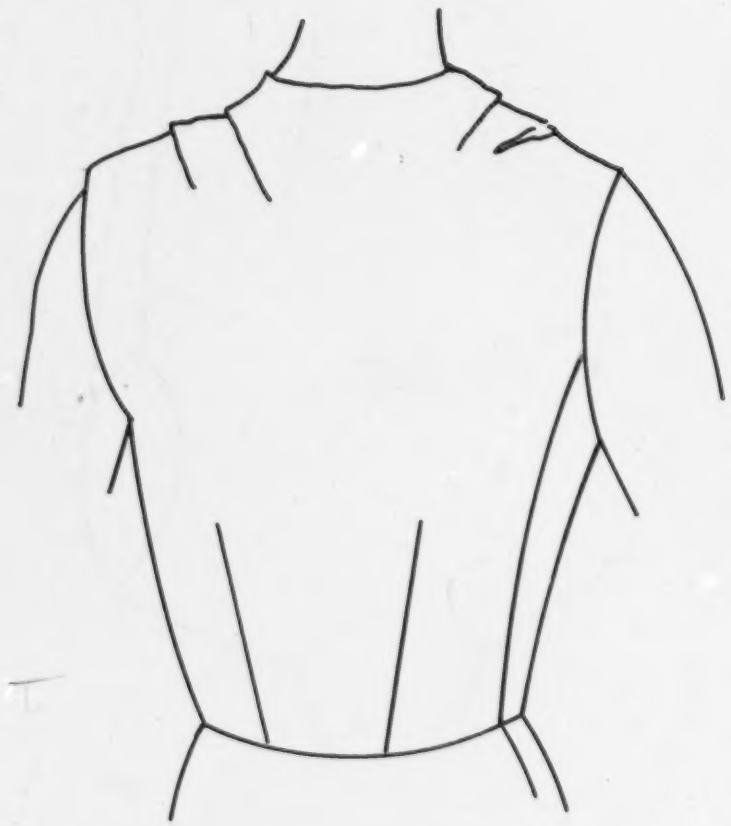

Diagram shows wrinkles and distortion of grain line on ill fitting garment caused by narrow shoulders.

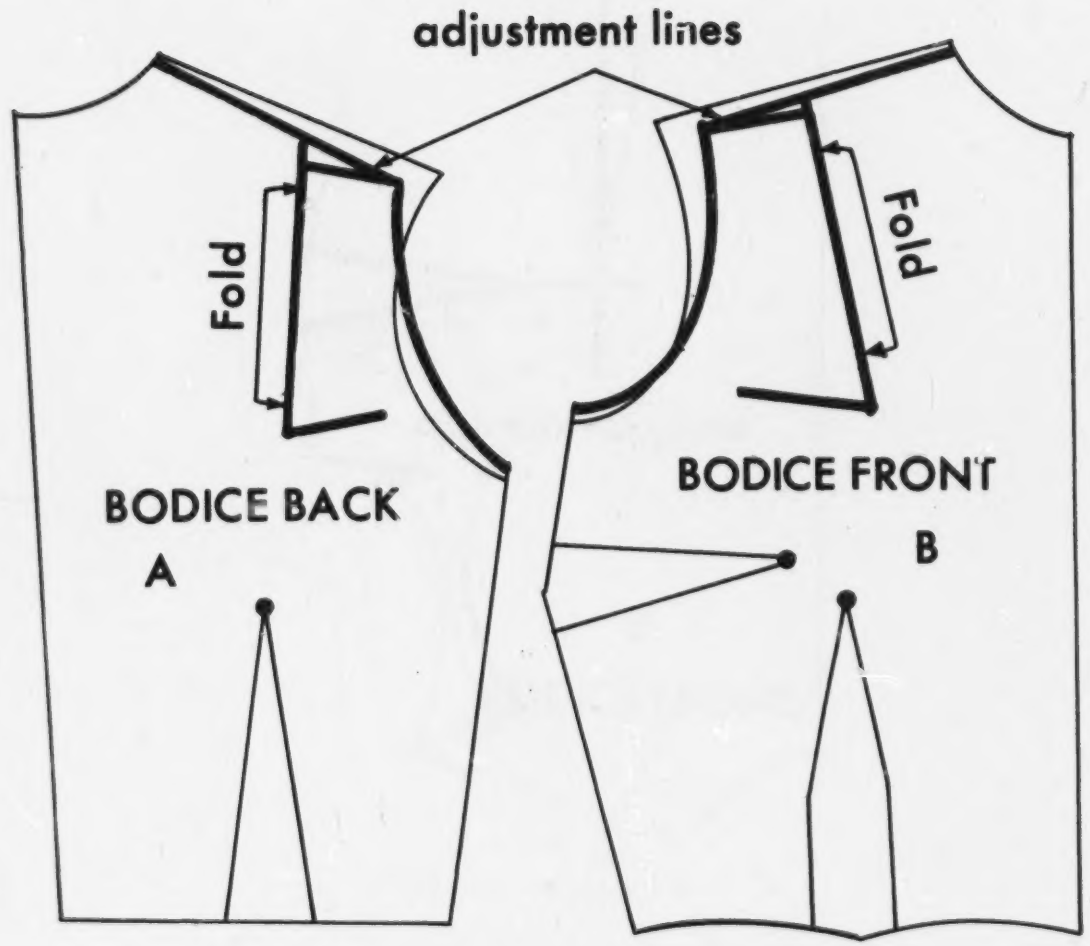

Diagram shows bodice back and front pattern pieces altered by taking a tuck in pattern at shoulder to create new shoulder and armscye line.

Fig. 1
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b. Switch
c. Primary winding
d. Connections
e. Voltage-dropping resistor
f. Coil primary-winding
g. Distributor points
h. Capacitor (condenser)
i. Ground return to battery

2. Secondary system
a. Coil secondary-winding
b. Distributor rotor
c. Distributor cap
(1) Broken
(2) Moisture
d. High-tension wiring
e. Spark plugs
f. Ground return through part of primary system

B. Trouble Checklist (Use of Jumper Wire and Voltmeter)
1. Remove coil wire from distributor
a. Crank engine
b. Check spark
2. Check battery side of coil
a. Check switch
b. Inspect wiring and battery connections
3. Check distributor side of coil
a. Check points
b. Inspect wiring and connections
c. Check capacitor (condenser)
4. Check ignition timing

Section 11: Clutches

I. Purpose of Clutch
A. Used with Standard Transmissions
B. Couples or Uncouples Engine and Transmission
1. Coupled position (normal running)
a. Power to transmission
b. In gear: power to rear wheels
2. Uncoupled position
a. Allows gears to be shifted easily
b. Allows engine to run with transmission in gear
C. Provides Gradual but Positive Application of Engine Power to Power Train
1. Minimizes shock
2. Provides comfortable starts

II. Principles of Operation
A. Frictional Contact Made Between Two Smooth Metallic Driving Surfaces and Facings Riveted to Driven Disk
1. Flywheel and pressure plate: driving surfaces
2. Friction disk: driven plate
B. Flywheel, Pressure Plate, and Friction Disk Held Together by Pressure Springs
C. Hub of Friction Disk Splined to Clutch Shaft
D. Clutch Uncoupled by Release of Spring Pressure on Pressure Plate by Operation of Clutch Pedal
E. Flywheel and Pressure Plate Permitted to Turn Independently of Friction Disk

III. Types of Clutches
A. All Similar in Construction and Operation
1. Expanding clutches
2. Contracting clutches
3. Cone clutch
4. Dry-disk clutches
a. Coil pressure-spring type
b. Diaphragm-spring type
c. Crown pressure-spring type
5. Multiple dry-disk clutches
6. Oil-bath disk clutches
a. Multiple disk
b. Single disk
B. Most Commonly Used Clutch: Single Dry-Disk

IV. Friction Disk
A. Hub Assembly
1. Splined hub
a. Splined to clutch shaft
b. Allows movement lengthwise
c. Forces hub to turn with clutch shaft
d. Must fit snugly yet without drag or bind
2. Torsional springs
a. Placed between drive washers
b. Absorbs torsional vibration from engine
c. Absorbs some engaging shock
3. Hub flange
4. Drive washers
5. Molded friction washer
a. Located between hub flange and drive washer
b. Prevents oscillation between hub flange and drive washer
6. Movement of hub flange limited by stop pin
B. Disk Assembly
1. Friction rings or clutch facings
a. Made of frictional material
(1) Asbestos main part of composition
(2) Heat-resistant materials
b. Provides proper amount of slipping when starting
c. Provides positive nonslipping drive when engaged
d. Usually riveted to cushioning springs
2. Cushioning springs
a. Provide cushioning effect as clutch is engaged
b. Produce smoother engagement
c. Consist of waved cushion springs
d. Waves compress when engaged

V. Pressure-Plate Assembly
A. Pressure Plate and Flywheel
1. Both driving surfaces
2. Surfaces smooth, parallel
3. Friction disk between driving surfaces
B. Clutch Cover
1. Bolted to flywheel
a. Becomes part of flywheel

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b. Rotates with flywheel
c. All parts of pressure-plate assembly attached to clutch cover
2. Houses pressure spring arrangement
3. Houses clutch release mechanism

C. Pressure Springs
1. Coil
a. Contains three to nine springs
b. Spring loads friction disk between pressure plate and flywheel when coupled
c. Clutch released by compression of springs
2. Diaphragm (tapering-finger type)
a. Provides spring pressure to pressure plate
b. Acts as release levers
c. Reacts similarly to bottom of oil can when depressed
(1) Tapered fingers depressed
(2) Diaphragm pivots on pivot ring
(3) Outer edge raises
(4) Works against retracting spring to pressure plate
(5) Pressure plate pulled away from friction disk
d. Clutch engaged by built-in spring tension of diaphragm
3. Crown
a. Variation of diaphragm type
b. Diaphragm formed of single corrugated plate of spring metal
c. Action (same as in V.C.2.c.)

D. Release Levers
1. Purpose: to disengage clutch by relieving spring pressure to pressure plate
a. Coil-spring type
(1) Usually three levers
(2) Adjustable
(a) Adjustment screws
(b) Uniform pressure
b. Diaphragm-spring type
(1) Tapered fingers
(2) Nonadjustable
c. Crown-spring type
(1) Corrugated edge release
(2) Nonadjustable
2. Release levers depressed by throw-out bearing

VI. Throw-Out Mechanism
A. Clutch-Shaft Bearing Retainer and Sleeve
1. Front transmission bearing retained
2. Clutch shaft covered by sleeve
B. Throw-Out Collar
1. Slides on clutch shaft sleeve
2. Holds throw-out bearing
C. Clutch-Release Fork
1. Pivots on flywheel housing: ball stud
2. Moves throw-out bearing and collar forward
D. Throw-Out Bearing
1. Sealed ball bearing
2. Mounted on throw-out collar
3. Moved forward against release levers
4. Turns with the release levers
5. Depresses release levers, disengaging clutch

VII. Clutch Pedal and Linkage
A. Effects of Depressing Clutch Pedal
1. Clutch pedal arm depressed
2. Rotation of clutch pedal shaft
3. Adjusting link pushed or pulled
4. Rotation of cross shaft (if included)
5. Forward movement of throw-out fork
a. Forward movement of throw-out bearing
b. Release levers depressed
c. Pressure plate pulled away from friction disk
B. Effects of Releasing Clutch Pedal
1. Return of clutch pedal arm (assisted by return spring)
2. Clutch fork pulled back by linkage
3. Throw-out bearing pulled away from release levers
4. Return of release levers
5. Pressure plate, friction disk, and flywheel compressed by pressure springs
C. Hydraulically Clutch Operated

VIII. Clutch Shaft Support
A. Crankshaft End of Clutch Shaft Supported in End of Crankshaft or Center of Flywheel by Bushing, Roller, or Ball Bearing
B. Shaft to Be in Perfect Alignment (Will not "Whip")

IX. Semicentrifugal Clutch
A. Clutch Similar in Construction to Coil-Pressure-Spring Clutch
B. Weights Placed on Outer Ends of Release Levers
C. Added Pressure on Pressure Plate Exerted by Release Levers Because of Increased Speed
D. Centrifugal Action When Clutch Begins to Revolve

X. Clutch Trouble Diagnosis
A. Slipping
B. Chattering or Grabbing
C. Spinning or Dragging
D. Noises (When Engaged, Disengaged)
E. Pedal Pulsation
F. Friction-Disk Facing Wear

Section 12: Standard Transmissions and Overdrives

I. Purpose of Transmission
A. Provides Means of Varying Gear Ratios Between Engine and Rear Wheels
1. Ratios between engine and rear wheels (approximately)
a. Low gear ..... 12 to 1
b. Second gear ..... 8 to 1
c. High gear ..... 4 to 1
d. Reverse gear ..... 12 to 1
2. Ratios between clutch shaft and transmission main shaft
a. Low gear ..... 3 to 1

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b. Second gear ..... 2 to 1
c. High gear ..... 1 to 1
d. Reverse gear ..... 3 to 1

B. Provides Reverse Gear for Backing Car

II. Transmission Gears
A. Relative Speed of Rotation (Gear Ratio)
1. Speed determined by number of teeth
a. Same number of teeth
(1) Turn at same speed
(2) Gear ratio: 1 to 1
b. Different number of teeth
(1) Smaller gear turns faster
(2) Large gear 24, smaller gear 12; gear ratio: 2 to 1
2. Number of teeth of driven gear divided by number of teeth of driving gear to determine ratio
B. Direction of Rotation
1. Turn in opposite directions (when two gears mesh)
2. Idler gears
a. Change direction of rotation
b. Do not change gear ratio between driving gear and driven gear
C. Types of Gears
1. Spur gear
2. Helical gear
3. Bevel gear
4. Skew-bevel gear
5. Worm gear
6. Rack gear
7. Pinion gear
8. Planetary gears
a. Internal or ring
b. Planetary
c. Sun
d. Spider or planet carrier

III. Torque (Transmission)
A. Change of Torque According to Gear Ratio
B. Torque in Any Turning Shaft or Gear
1. Torque applied to crankshaft
2. Torque supplied by crankshaft to gears in transmission so that gears turn
3. Torque carried through power train to rear wheels, causing rear wheels to turn
C. Torque on Gears Measured as Straight-Line Force at Distance from Center of Gears
D. Torque Ratio Opposite to Gear Ratio
E. Torque Increase Caused by Reduction of Gear Speed

IV. Basic Standard Transmission
A. Gears
1. Clutch or main drive gear
2. Cluster gear or countershaft gears
a. Countershaft drive gear
b. Countershaft second gear
c. Countershaft low gear
d. Countershaft reverse gear
3. Main-shaft low and reverse sliding gear
4. Main-shaft second and high sliding gear
5. Reverse idler gear
B. Shafts
1. Clutch or pilot shaft
2. Countershaft
3. Transmission main shaft
4. Reverse idler gear shaft
C. Thrust Washers
1. Countershaft
2. Main shaft
3. Reverse idler shaft
D. Bearings
1. Clutch gear bearing
2. Main-shaft rear bearing
3. Front pilot bearing
4. Countershaft bearings
5. Reverse idler bearing
E. Bearing Retainers
1. Clutch gear bearing retainer and throw-out bearing sleeve
2. Main-shaft bearing retainer
F. Transmission Case
G. Shifting Mechanism
1. Shifting forks
2. Shifting levers (side mount)
3. Cover

V. Operation of Basic Standard Transmission
A. Neutral
B. Low Gear
C. Second Gear
D. High Gear
E. Reverse Gear

VI. Gearshift Lever (Transmission)
A. H-Pattern
B. Two Separate Motions
1. Selection of gear assembly
2. Movement of gear assembly

VII. Transmission Synchronizing Device (Synchromesh)
A. Gears About to Mesh Made to Rotate at Same Speed
1. Mesh without clashing of gears
2. Easier shifting
3. Less wear on transmission parts
B. Synchromesh Types
1. Cone-clutch type (Ford)
2. Pin type (Dodge)

VIII. Constant-Mesh Transmission
A. Main-Shaft and Countershaft Second Gears Always in Mesh
B. Constant Mesh Used in Conjunction with Synchromesh
C. Principles of Operation

IX. Selector and Shifter (Transmission)
A. Types of Selector and Shifter Devices
B. Steering-Column Gearshift Mechanism
C. Floor-Shift Mechanism

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X. Transaxle Units: Similar in construction and operation to other standard transmissions

XI. Purpose of Overdrive
- A. Establish More Favorable Gear Ratio
- B. Reduce Engine Speed at High Car Speed
- C. Provide More Economical Operation
- D. Lessen Engine and Accessory Wear Per Car Mile
- E. Drop Engine Speed About 30 Percent

XII. Method of Operation (Overdrive)
- A. Automatic
  1. Operation automatic at about 30 miles per hour
  2. Selective
     - a. Direct drive
     - b. Into overdrive: foot to be raised from accelerator
     - c. Out of overdrive
       - (1) Accelerator to be depressed "wide open"
       - (2) Throttle switch actuated
- B. Two Separate Controls
  1. Centrifugal device (governor)
  2. Electrical control (solenoid)

XIII. Freewheeling Mechanism (Overdrive)
- A. Coupling Between Two Shafts in Line with Each Other (Overrunning Clutch)
  1. Inner shell
  2. Outer shell
  3. Rollers between
- B. Solid Drive When Power Delivered to Input Shaft
- C. Output Shaft Overrun Because of Slowdown of Input Shaft
  1. Uncoupling of clutch
  2. Free turning of output shaft
  3. Input shaft on transmission
  4. Output shaft on propeller shaft
- D. Mechanical Principles of Operation

XIV. Planetary-Gear System (Overdrive)
- A. Components
  1. Outer ring gear (internal gears)
  2. Three planet pinions
  3. Planet-pinion cage
  4. Planet-pinion shafts
  5. Sun gear
  6. Sun-gear shaft
  7. Ring-gear shaft
- B. Principles of Operation
  1. Speed increase (sun gear stationary)
     - a. Planet-pinion cage turning
     - b. Sun gear stationary
     - c. Planet-pinion shafts carried around with cage
     - d. Planet pinions
       - (1) Rotate on shafts
       - (2) "Walk around" stationary sun gear
       - (3) Cause ring gear to rotate
  2. Speed increase (ring gear stationary)
     - a. Ring gear stationary
     - b. Planet-pinion cage turning
     - c. Sun gear rotating faster than cage
     - d. Driven member turning faster than driving member
  3. Speed reduction (ring gear turning)
     - a. Ring gear turning
     - b. Sun gear stationary
     - c. Planet-pinion cage turning slower than ring gear
     - d. Driven member turning slower than driving member
  4. Speed reduction (ring gear stationary)
     - a. Ring gear stationary
     - b. Sun gear turning
     - c. Planet pinions
       - (1) Turn on shafts
       - (2) "Walk around" ring gear
       - (3) Planet-pinion cage rotates
     - d. Cage rotating slower than sun gear
     - e. Driven member turning slower than driving member
  5. Reverse (planet-pinion cage stationary)
     - a. Planet-pinion cage stationary
     - b. Ring gear turning
     - c. Planet pinion
       - (1) Acts as reverse idlers
       - (2) Causes sun gear to turn in reverse direction to ring gear
     - d. Sun gear turning faster than ring gear
  6. Reverse (planet-pinion cage stationary)
     - a. Planet-pinion cage stationary
     - b. Sun gear turning
     - c. Ring gear turning opposite to and slower than sun gear
  7. Direct drive
     - a. Any two members locked together: then entire planetary-gear system locked, and input and output shafts turn at same speeds
     - b. No member held stationary and no two members locked together: system will not transmit power at all
- C. Application to Overdrive
  1. Ring gear attached to output shaft
  2. Planet-pinion cage splined to transmission main shaft
  3. Sun gear
     - a. May be permitted to turn free
     - b. May be locked in stationary position
       - (1) Ring gear (output shaft) forced to turn faster than transmission main shaft
       - (2) Transmission main shaft "overdriven" by output shaft

XV. Nomenclature (Overdrive)
- A. Clutch Cam
- B. Transmission Main Shaft
- C. Sun Gear
- D. Pinion-Cage Assembly
- E. Ring Gear
- F. Pinions

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G. Output Shaft
H. Output-Shaft Bearing
I. Clutch-Cam Rollers
J. Control Shaft and Lever
K. Shift Fork
L. Solenoid Assembly
M. Control Rod
N. Sun-Gear Pawl
O. Blocker Ring
P. Sun-Gear Plate
Q. Governor

XVI. Overdrive Operation
A. Going into Overdrive
1. Car speed approaching 18 to 20 miles per hour
2. Sun-gear pawl retracted
3. Governor closing electrical contact
4. Solenoid energized
a. Spring loading solenoid pawl
b. Pawl held away by blocker ring
5. Accelerator pedal momentarily released by driver
a. Engine speed dropping
b. Freewheeling mechanism going into action
c. Output shaft overrunning transmission main shaft
(1) Sun gear slowing and reversing direction
(2) Moving blocker ring
(3) Pawl moving inward
(a) Registers with notch on sun-gear control plate
(b) Locks control plate: stationary
(c) Locks sun gear: stationary
6. Driver accelerating and engine speed increasing: car going into overdrive (See XIV.B.1.)
B. Coming Out of Overdrive: Accelerator Pedal Depressed
1. Operates kick-down switch
2. Produces two actions
a. Opens solenoid circuit
(1) Attempts to withdraw pawl
(2) Considerable pressure against pawl
b. Grounds out ignition circuit
(1) Prevents engine from delivering power
(2) Relieves driving thrust on sun gear
(3) Pawl pulled back by solenoid
(4) Ignition circuit reopened by solenoid
C. Locking Out of Overdrive: Control Knob Pulled
1. Actuates control rod
2. Moves shift fork
a. Sun gear meshing with ring gear
b. Sun gear and ring gear locking
3. Locks sun-gear pawl
D. Reversing
1. Overdrive to be locked out (shaft mechanism reversed by transmission)
2. Overdrive control rod moved to lockout position when reverse shift is made

XVII. Overdrive Electrical Components
A. Battery
B. Ignition Switch
C. Relay
D. Kick-down Switch
E. Governor Switch
F. Ignition Coil and Distributor
G. Solenoid
1. Ground-out contact
2. Pull-in and hold-in winding
H. Wiring

Section 13: Automatic Transmissions

I. Main Sections of Automatic Transmission
A. Clutch Coupling or Torque Converter
B. Planetary Gear Box

II. Fluid Coupling (Torus)
A. Fluid Coupling Theory
1. Two fans facing each other
2. Oil coupling driving and driven torus (straight vanes in both torus units)
B. Engine Flywheel to Torus Cover Drive
C. Torus Cover to Driving Torus
D. Driven Torus and Input Shaft
E. Acts as Clutch

III. Torque Converter
A. Torque Converter Theory
1. Two fans facing each other
2. Stator redirecting oil at different angle to turbine
3. Torque multiplied
B. Engine Flywheel to Torque Converter Cover
C. Pump (Impeller) to Stator to Turbine
D. Turbine to Stator, Where Oil Is Returned to Pump
1. Turbine driving input shaft
2. Spiral vanes on turbine
E. Three Jobs of Stator
1. As stationary member for oil to push against
2. Redirects oil to pump
3. Overruns (like a bicycle coaster brake) when car reaches cruising speed
F. Torque Conversion Ended at Cruising Speed, with Coupling Taking Place

IV. Planetary Gears
(Review Section 12 of this outline.)

V. Automatic Transmission Operation
A. Oil Pump (to Supply Pressure)
B. Pressure Regulator Maintaining Constant Pressure
C. Shift Valve Directing Oil to Band-Servo or Clutch-Piston Action
D. Manual Valve Turning Oil Pressure On or Off
E. Governor
1. Operated by centrifugal force to make shifts occur automatically
2. Attached to transmission output shaft and thus sensitive to car speed

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F. Throttle Valve
   1. Operated by accelerator pedal position to time shifts
   2. Works in opposition to governor pressure and thus sensitive to engine speed

VI. Automatic Transmission Maintenance
   A. Checking Oil Level
   B. Changing Oil

Section 14: Drive Lines

I. Purpose of Drive-Line Assembly
   A. Transfers Power from Transmission to Differential
      1. Change in angle
      2. Change in length
   B. Absorbs Rear-End Torque

II. Components of Drive Line
   A. Universal Joints
   B. Slip Joints
   C. Propeller Shaft
   D. Torque Tube
   E. Universal Ball Joint
   F. Supporting Members

III. Universal Joints
   A. Purpose
   B. Types
      1. Cross and Yoke
         a. Yoke
         b. Spider
         c. Trunnions
         d. Needle bearings
      2. Ball and trunnion
         a. Propeller shaft
         b. Pin
         c. Body
         d. Ball
         e. Needle bearings
         f. Centering button
         g. Grease cover
      3. Constant velocity
         a. Reasons for
         b. Construction
            (1) Body
            (2) Balls
   C. Operation
      1. Cross and yoke
      2. Ball and Trunnion
      3. Constant velocity
         a. Bendix
         b. Double cross and yoke

IV. Slip Joints
   A. Purpose
   B. Types
      1. Splines
      2. Built-in (ball and trunnion)

V. Types of Drive
   A. Torque-Tube Drive
      1. Construction
         a. Propeller shaft enclosed
         b. Universal joints
            (1) Type used
            (2) Number
         c. Universal ball joint
         d. Slip joints
         e. Support members
      2. Rear-end torque absorption
      3. Push delivered to front section of chassis
   B. Hotchkiss Drive
      1. Construction
         a. Propeller shaft exposed
         b. Universal joints
            (1) Type used
            (2) Number
         c. Slip joints
         d. Support members
      2. Rear-end torque absorption
      3. Push delivered to rear section of chassis
   C. Curved Flexible Shaft
      1. Construction
         a. Three-inch bow
         b. Ball-bearing pillow blocks
         c. No slip joints
         d. No universal joints
      2. Rear-end torque absorption
      3. Push delivered to rear section of chassis

Section 15: Rear Axles and Differentials

I. Purpose of Differential
   A. Transmits Rotary Power Through Right Angle
   B. Allows Different Rear-Axle Speed
      1. Prevents skidding in turns
      2. Improves steering control

II. Types of Differentials
   A. Conventional
   B. Nonslip (Limited Slip)
   C. Transaxle

III. Differential Components (Major)
   A. Differential-Side Gears
   B. Differential-Pinion Gears
   C. Differential-Pinion Shaft
   D. Differential Case
   E. Ring Gear
   F. Drive Pinion
   G. Drive-Pinion Carrier and Caps
   H. Differential-Bearing Adjusters
   I. Differential Bearing (Cone and Rollers)
   J. Axles (Axle Drive Shafts)

IV. Differential Power Flow
   A. Drive Pinion Driven by Propeller Shaft
   B. Drive Pinion Meshed with Ring Gear
   C. Ring Gear Bolted to Differential Case, Causing Case to Turn (Rotate)
   D. Differential-Pinion Shaft Mounted in Case

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E. Differential-Pinion Gears Mounted on Shaft
F. Differential-Pinion Gears Meshed with Side Gears
G. Differential-Side Gears Splined to Axles

V. Differential Gear Action
A. Straight Ahead
1. Differential-pinion gears not rotating
2. Equal pressure exerted on side gears
3. Both wheels turning at same speed
B. Turning
1. Two pinion gears rotating on shaft
2. More turning movement exerted to outer side gear with same amount of torque
3. Outside wheel turning more rapidly

VI. Nonslip Differential
A. Similar in Construction to Conventional Type
B. Incorporates Two Sets of Clutch Plates (or Cones) Between Side Gears and Case
C. More Power Instead of Less Applied to Drive Wheel Hard to Turn

VII. Differential Gearing
A. Manner of Gear Reduction
B. Variance of Ratios According to Make and Application
1. Passenger cars (3.36:1 to 5:1)
2. Heavy- duty applications (9:1 by double reduction)
C. Calculation of Gear Ratio
D. Types of Gears
1. Spur (obsolete)
2. Spiral bevel (nearly obsolete)
a. More gear tooth contact
b. Even wear
c. Quieter operation
3. Hypoid
a. Similar to spiral bevel
b. Drive pinion lowered
c. Wiping action
d. Needs special lubricant
E. Nomenclature of Gears
1. Toe
2. Heel
3. Flank
4. Face
5. Pitch line
F. Gear Measurements
1. Clearance
2. Backlash

VIII. Rear Axles
A. Purpose
B. Types
1. Dead
2. Live
a. Semifloating
b. Three-quarter floating
c. Full-floating

IX. Differential Trouble Diagnosis
A. Noises Mistaken for Gear-Axle Noises
1. Road noise
2. Tire noise
3. Front-wheel bearing noises
4. Engine and transmission noises
B. Rear-Axle Bearing
1. Wheel bearing
2. Side gear and pinion
3. Pinion bearing
4. Ring and pinion noise
a. Drive
b. Coast
c. Float
d. Drive, coast, and float
5. Nonslip differential chatter

Section 16: Suspension Systems

I. Purpose
A. Support Weight of Front End of Car
B. Permit Steering of Car: Provide Safer Steering Control
C. Absorb Shock Through Springs
D. Provide Ride Control

II. Types of Front Suspension
A. Rigid Axle
B. Independent Front Suspension

III. Rigid Axle
A. Applications
1. Heavy-duty trucks and buses
2. Industrial vehicles
3. Early model autos
B. Construction
1. Beam
2. Steering knuckle
3. Kingpin
4. Leaf spring
C. Characteristics
1. Both front wheels affected by any surface change
2. Gyroscopic effect of tilted wheels

IV. Independent Front Suspension
A. Construction
1. Upper control arm
2. Lower control arm
3. Steering-knuckle support
4. Steering knuckle
5. Spring
6. Stabilizer shaft or sway bar
7. Shock absorber
B. Operating Characteristics
1. Wheels completely independent of each other
2. Better ride control
3. Smoother ride
C. Variations in Design of Independent Front Suspension
1. Coil spring
2. Transverse leaf spring

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3. Torsion-bar spring
4. Ball-joint front suspension
   a. Replaces steering knuckle and support
   b. Uses spherical joints
   c. Uses fewer moving parts

V. Springs
A. Purpose
B. Operating Characteristics
   1. Rate
   2. Frequency
C. Types
   1. Leaf
   2. Coil
   3. Torsion bar
   4. Air suspension
D. Leaf Spring
   1. Common types
      a. Semielliptic
      b. Quarter elliptic
   2. Installation
      a. Transverse
      b. Longitudinal
   3. Construction
      a. One or more leaves
      b. Master leaf
      c. Spring seat
      d. Center bolt
      e. U-bolt
      f. Rebound clips
      g. Spring eye
      h. Spring hanger
      i. Spring shackle
      j. Bushings
E. Coil Spring
   1. Operating characteristics
      a. Free of friction
      b. Requires efficient shock absorber
   2. Installation
      a. Requires linkage to support vehicle thrust
      b. Used primarily in front suspension
F. Torsion-Bar Spring
   1. Operation
      a. Twisting action
      b. Free of friction
      c. Provision for adjustment
      d. Lightweight
   2. Construction
      a. Spring-steel round shaft
      b. Linkage
      c. Adjustable anchor
G. Air Suspension
   1. Operation
   2. Construction
      a. Air-bag or air-spring assembly
      b. Air compressor
      c. Leveling valves

VI. Shock Absorbers
A. Purpose
   1. Dampen spring oscillations
   2. Keep wheels on pavement
   3. Provide better control
   4. Provide smooth ride
B. Types
   1. Hydraulic
      a. Direct-acting
      b. Opposed-cylinder
      c. Parallel-cylinder
      d. Rotating-vane
   2. Friction
C. Theory of Operation
   1. Hydraulic principles
   2. Forcing liquid through orifice
D. Testing

VII. Front-End Geometry
A. Definition
B. Purpose
   1. Provide steering ease
   2. Provide steering stability
   3. Provide maximum tire life
   4. Provide ride quality
C. Classifications
   1. Camber
      a. Positive
      b. Negative
   2. Kingpin inclination
   3. Caster
      a. Positive
      b. Negative
   4. Toe-in
   5. Include angles
   6. Toe-out on turns
D. Methods of Adjustment

Section 17: Steering Systems

I. Purpose of Steering System
A. Guide Car
B. Provide Easy Steering

II. Early Steering Systems
A. Tiller
B. Fifth-Wheel Steering

III. Ackerman Steering System
A. Front Wheels Supported on Pivots
B. Front Wheels Linked to Steering Wheel by Gears and Levers

IV. Classification of Steering Systems
A. Manual
B. Power
   1. Integral or hydraulic
   2. Linkage or mechanical

V. Manual Steering Gears
A. Recirculating Ball and Nut

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B. Worm and Roller
C. Cam and Lever

VI. Steering Linkage
A. Steering Wheel
B. Steering Shaft
C. Steering Gear
D. Pitman Arm
E. Drag Link or Steering Connecting Rod
F. Tie Rod(s)
G. Relay Rod
H. Steering Arms
I. Steering Knuckles
1. Knuckle support
2. Kingpin
J. Ball Joints
K. Spindle
L. Wheel Bearings

VII. Power-Steering Operation
A. Hydraulic
1. Power-steering pumps
a. Construction
b. Operation
c. Location
2. Power-operating mechanism
a. Valve operation
b. Power cylinders
B. Mechanical
1. Construction
2. Operation
3. Location

Section 18: Tires and Tubes

I. Purpose of Tires
A. Provides Cushion
1. Absorbs shock
2. Tire flexes
B. Provides Frictional Contact
1. Minimizes skidding on turns
2. Provides for quick stops

II. Casing Construction
A. Plies (Variable Number)
B. Bead
C. Sidewall
1. Black
2. White
3. Colored
D. Curb Bead
E. Shoulder
F. Tread
1. Design
2. Purpose
a. Provide traction
b. Reduce surface area
c. Cool tire

III. Types of Tires
A. Solid
B. Pneumatic
1. Tube
2. Tubeless
3. Puncture-sealing
C. Materials
1. Natural rubber
2. Synthetic rubber

IV. Tire Sizes
A. Rim Size
B. Thickness at Sidewalls
1. Inflated
2. No load

V. Inner Tubes
A. Materials
1. Rubber
2. Synthetic
B. Air Valve
1. Stem
2. Core
3. Cap
C. Special Tubes
1. Puncture-sealing
2. Safety tube

VI. Tire Inflation
A. Proper Inflation
B. Low Pressure
1. Hard steering
2. Front-wheel shimmy
3. Steering kickback
4. Side of tread worn
5. Excessive flexing
a. Heat
b. Ply separation
6. Rim bruises
C. Excessive Pressure
1. Center of tread worn
2. Hard ride
3. Fabric rupture
D. Uneven Pressure (Pulls to Side)

VII. Tire Rotation
A. Purpose
B. Procedure

VIII. Causes of Tire Wear
A. Excessive Speed
B. Improper Inflation
C. Improper Front-Wheel Alignment
1. Excessive camber
2. Excessive toe-in or toe-out
D. Improperly Adjusted Brakes
E. Unbalanced Wheels
F. Incorrect Steering-Linkage Adjustment

IX. Recapping and Regrooving Tires

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Section 19: Wheel Balance

I. Purpose of Wheel Balance
  A. Provide Ease of Steering
  B. Provide Comfortable Ride
  C. Provide Maximum Tire Mileage

II. Problems of Balancing Wheels
  A. Centrifugal Force
  B. Making Wheel Run True (Must Be Round)
  C. Flexing of Tire on Wheel
  D. Wheel Tramp (Bounce and Wobble)

III. Types of Wheel Imbalance (Out of Balance)
  A. Static
    1. Lies in plane of wheel rotation
    2. Causes front and rear wheels to bounce
  B. Dynamic
    1. Lies in zone on either or both sides of plane of rotation
    2. Causes front wheels to wobble as well as bounce

IV. Types of Balance
  A. Static
    1. Balanced wheel assembly, when on spindle, remains in fixed position regardless of how placed on the spindle
    2. Weight added or subtracted for equal distribution of wheel weight around its axis of rotation
  B. Dynamic
    1. Wheel rotation true, without wobble or shake
    2. Distribution of corrective weights on both sides of wheel

V. Tire Balance Marks
  A. Symbols Used for Marking Tires
  B. Markings to Line Up with Valve Stem Hole in Rim
  C. Less Accurately Balanced Assembly Marked by Red Dot

VI. Types of Wheel Run-Out
  A. Lateral
    1. Wheel alternately moves in and out from center of vehicle while rotating on its spindle
    2. Causes dynamic imbalance (out of balance)
    3. Checked by pointer near side wall
    4. Run-out not to exceed ⅛ inch
    5. Corrected by remounting tire on wheel or straightening wheel
  B. Eccentric or Radial
    1. Amount of spindle deviation from its center during wheel rotation
    2. Causes static and dynamic imbalance (out of balance)
    3. Checked by pointer near tire tread
    4. Corrected by shaving tread

Section 20: Automotive Brakes

I. Friction
  A. Definition
    1. Dry
    2. Greasy
    3. Viscous
  B. Factors Affecting Friction
    1. Pressure applied or load
    2. Roughness of surface
    3. Type of materials
  C. Types
    1. Static friction (at rest)
    2. Kinetic friction (in motion)
  D. Cause: Surface Irregularities
  E. Application
    1. Brake shoe and brake drum friction
      a. Slows wheel rotation
      b. Stops wheel rotation
    2. Tires to road surface friction
      a. Sliding stop (kinetic)
      b. Rolling stop (static)
    3. Front brakes larger than rear

II. Hydraulics
  A. Definition
  B. Physical Principles of Liquids
    1. Not compressible
    2. Transmit motion
      a. Act as solids under pressure
      b. Action and reaction
    3. Transmit pressure
      a. Pressure equal throughout system
      b. Pressure equal in all directions
      c. Output force equals pressure times area
      d. System pressure equal to input force divided by piston area

III. Hydraulic Brake Fluid
  A. Chemically Inert (Must Not Affect Metal and Rubber Parts)
  B. Must Not Vaporize at High Temperature
  C. Must Remain Fluid at Low Temperature
  D. Must Act as Lubricant
  E. Must Mix Readily With Other Hydraulic Fluids

IV. Types of Brakes
  A. Mechanical
  B. Hydraulic (Four-Wheel)
    1. Shoe
    2. Disk
    3. Caliper or spot
  C. Electric
  D. Air
  E. Vacuum

V. Components of Brake System
  A. Master-Cylinder Assembly
    1. Brake pedal
    2. Brake-pedal linkage
    3. Master cylinder
      a. Body
        (1) Reservoir
        (2) Cylinder

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DART LINE ADJUSTMENT FOR LOW BUST

Diagram shows wrinkles and distortion of grain line on ill fitting garment caused by low bust.

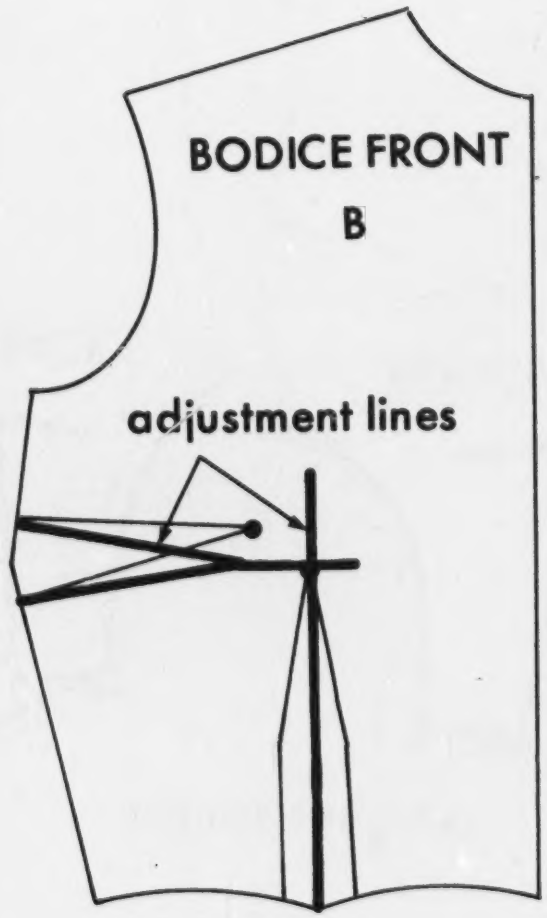

Diagram shows bodice front pattern piece with dart line altered for low bust line.

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b. Piston
(1) Primary cup
(2) Secondary cup
c. Piston return spring
d. Head nut
e. Check-valve assembly
f. Push rod
g. End boot
4. Dual Master Cylinder
B. Wheel Brake Mechanism
1. Wheel cylinder
a. Cylinder body
b. Pistons
(1) Piston cup
(2) Piston spring
c. Boots
d. Activating spring
e. Bleeder valve
2. Brake-shoe assembly
a. Backing plate
b. Brake shoes
(1) Friction material
(2) Primary shoe
(3) Secondary shoe
c. Anchor pin
d. Hold-down spring
e. Brake-shoe return spring
f. Adjusting mechanism
C. Hydraulic Brake Lines
1. Special type
2. Steel pipe
3. Fittings
4. Flexible hose
a. Front wheel connection
b. Rear axle connection

VI. Hydraulic Brake Operation
A. Application
1. Brake pedal depressed
2. Master-cylinder piston moving forward
a. Compensating port covered
b. Hydraulic fluid trapped in system
(1) Fluid moving in system
(2) Fluid under pressure
3. Wheel cylinder pistons moved outward
a. Activating pin moved outward
b. Brake shoes forced against drums
c. Frictional contact
(1) Heat
(2) Dragging effect
d. Slows wheel rotation
B. Release
1. Release brake pedal
2. Master-cylinder piston returns
3. Brake-shoe return spring activated
4. Brake shoes pulled from drums
5. Wheel cylinder pistons forced inward
6. Liquid returning to master cylinder
a. Pressure dropping
b. Check valve closing
(1) Maintains some pressure in system
(2) Keeps fluid in
(3) Keeps air out

VII. Accessories
A. Hand Brake
1. Drive shaft
2. Rear wheel
B. Power Brakes
1. Purpose
2. Basic principles of operation
C. Self-Adjusting Mechanism
1. Purpose
2. Method of operation
D. Hill Holder
1. Purpose
2. Method of operation
E. Stoplight Switch
1. Mechanically operated
2. Hydraulically operated

Section 21: Purchasing Automotive Parts

I. Make of Automobile
A. Model
B. Year

II. Engine Type
A. Number of Cylinders
B. Cylinder Arrangement
C. Valve Arrangement
D. Cubic-Inch Piston Displacement
E. Horsepower Rating

III. Exact Part to Be Purchased
A. Location
B. Casting Number (if available)
C. Part Number (if available)
D. Design
1. Type
2. Size
3. Description

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APPENDIX C

BATTERY TERMINOLOGY

Amperage	The rate of flow of electric current (movement of electrons) in a closed circuit measured in amperes
Battery	A unit (two or more cells connected together) that consumes chemical energy to produce electric energy when needed
Electrolyte	A solution of salts, bases, or acids in water in which the negative and positive plates are immersed
Grid	A framework made of an alloy of lead and antimony that holds an active material
Hydrometer	An instrument used to measure the specific gravity of a liquid
Lead-acid cell	A secondary cell that can be recharged
Negative plate	A grid filled with sponge lead (Pb)
Overcharging	Passing a direct current through a battery that has already been charged to maximum
Positive plate	A grid filled with lead peroxide (PbO_2)
Primary cell	A cell that cannot be recharged
Secondary cell	A cell that can be recharged
Separator	An insulating material made of wood, glass, or rubber that separates the positive and negative plates
Specific gravity	The weight of any volume of a liquid divided by the weight of an equal volume of water or the ratio of the density of a substance to the density of a standard
Sulfation	A process in which lead sulfate coats the plates of a lead-acid battery that has been allowed to remain partially charged
Sulphuric acid and water	The electrolyte of a lead-acid battery
Voltage	Electric pressure, electromotive force (emf) that causes current flow (movement of electrons) when the external circuit is closed

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APPENDIX D

ASSIGNMENT SHEETS

Unit 17: Four-Cycle Engines

Explain briefly what takes place during the following strokes:

Intake: _____

_____

_____

_____

_____

Compression: _____

_____

_____

_____

_____

Power: _____

_____

_____

_____

_____

Exhaust: _____

_____

_____

_____

_____

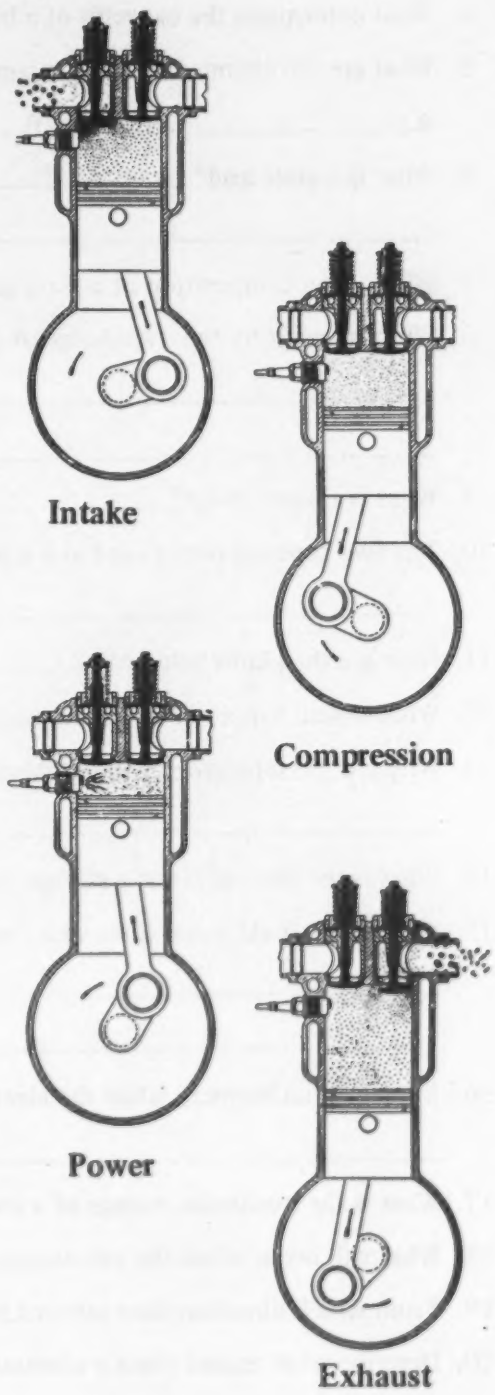

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Unit 22: Storage Battery

1. What is the purpose of a storage battery? _____
2. What is the major difference between a storage battery and a cell? _____
3. What is meant by the capacity of a battery? _____
4. What determines the capacity of a battery? _____
5. What are the chemicals used in a conventional automobile battery?

   A. _____ B. _____ C. _____
6. What is a plate grid? _____
7. What is the composition of a plate grid? _____
8. What is meant by the overcharge of a battery? _____
9. What is a plate group? _____
10. The two types of plates used in a lead-acid cell are:

    A. _____ B. _____
11. How are the plates held apart? _____
12. What would happen if the plates touched? _____
13. Why are the separators made of wood, glass, or rubber? _____
14. What is the electrolyte of a storage battery? _____
15. Describe first aid procedures when an electrolyte is spilled on a person: _____
16. Explain what happens when the electrolyte is added to a dry-charged storage battery: _____
17. What is the maximum voltage of a storage battery cell? _____
18. What will occur when the two terminals of a battery are connected through an external circuit? _____
19. From which direction does internal current flow in a battery? _____
20. Describe what occurs when a continuous supply of current has been used from a battery: _____

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Unit 23: Magneto and Generator

1. What is a permanent magnet? _____

2. How is a magnet identified? _____
3. What makes up the external magnetic field between the two poles of a magnet? _____
4. In what direction do magnetic lines of force move? _____
5. What are two characteristics of lines of force?

   A. _____

   B. _____
6. What will happen when unlike poles of a magnet are brought together? _____
7. What is magnetic repulsion? _____
8. What is formed around a wire when current is flowing through it? _____
9. How can the magnetic lines of force around a wire be demonstrated? _____
10. State the left-hand rule: _____
11. What is an electromagnet? _____
12. Explain briefly what happens to the magnetic lines of force around two parallel wires that have electric current flowing through them: _____
13. What is the purpose of a magneto? _____
14. How is a magneto driven? _____
15. What is the purpose of a generator? _____
16. How is a generator driven? _____

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17. Describe a simple magneto: _____

18. What is the meaning of a "load" in a generator circuit? _____

19. Explain the major difference between a simple direct-current generator and an alternator: _____

20. How is current generated in the windings of an armature? _____

21. What is the source of the current that flows through the field windings? _____

22. What effect does the current flow have on the field of an electromagnet? _____

23. What kind of current is produced in the armature of a direct-current generator? _____

24. How is the generator made to produce more current when its load is increased? _____

25. The three basic parts of a generator are: _____

_____, _____

26. What are slip rings? _____

27. What is a commutator? _____

28. What is the function of brushes in a generator? _____

29. Where are the generator brushes located? _____

30. Why must the output of the generator be controlled? _____

31. What two devices must be used in controlling the output of the generator?

A. _____ B. _____

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Unit 23: Rectification and Regulation

1. What is rectification of current? _____

2. Describe a silicon diode rectifier: _____

3. What is half-wave rectification? _____

4. What is full-wave rectification? _____

5. Describe pulsating current: _____

6. What is another name for a cutout relay? _____

7. What device made it possible to adapt alternators for use in automobiles? _____

8. Where is the cutout relay located in the electrical system? _____

9. What are two functions of the cutout relay?

   A. _____

   B. _____

10. Describe a cutout relay: _____

11. When the direct-current generator is in operation, what allows current to flow to the storage battery? _____

12. When the alternator is not operating, what prevents current from flowing from the battery through the generator? _____

13. What causes the contact points of the regulators to close? _____

14. What causes the contact points of the regulators to open? _____

15. Give two results that will cause damage if the generator output is not regulated:

    A. _____

    B. _____

16. What is the purpose of the voltage regulator? _____

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17. Does the generator always charge the battery at the same rate? _____

    Explain: _____

    _____

18. To which generator circuit is the voltage regulator connected? _____

    _____

19. As the battery approaches a charged condition, what happens to the voltage applied to the field coils? _____

    _____

20. What is the effect on the magnetic field around the armature as the voltage applied to the field coil changes? _____

    _____

21. What happens when a predetermined voltage is reached at the output terminals of a generator circuit? _____

    _____

22. Describe what happens in the voltage regulator when the output voltage of the generator drops below a predetermined voltage: _____

    _____

23. Why is a voltage regulator referred to as a vibrating voltage regulator? _____

    _____

24. Are current regulators similar to voltage regulators? _____ What is the basic difference? _____

    _____

25. Why is a current regulator described as a vibrating current regulator? _____

    _____

26. Where are the diodes installed in an automobile alternator? _____

    _____

27. Is a cutout relay needed in a transistorized regulator system? _____

    _____

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Unit 24: Electricity/Electronics

1. What is the nucleus of an atom? _____
2. A proton in the nucleus of an atom has a _____ charge, and the electron outside the nucleus has a _____ charge.
3. When free electrons collect in one place, a _____ is formed.
4. When these free electrons move from one place to another, it is called _____
5. What two devices in the automotive electric system provide emf?
   A. _____ B. _____
6. What terminals are found on an automobile battery or alternator? _____
7. What substances allow electrons to move freely? _____
8. How is the negative (-) terminal determined? _____
   _____ Positive (+) terminal? _____
9. Why is copper wire a good conductor? _____
10. Why is rubber a good insulator? _____
11. What normally covers a conductor? _____
12. Define voltage: _____
13. If the voltage is increased, what will be the results on the electron movement? _____
14. How is voltage measured? _____
15. What is amperage? _____
16. How is amperage measured? _____
17. What is meant by resistance? _____
18. Why is there more resistance in a small wire than in a large wire? _____
19. Why is the resistance less in a short wire than in a long wire? _____
20. How is resistance measured? _____
21. State Ohm's law (in words): _____

DART LINE ADJUSTMENT FOR HIGH BUST

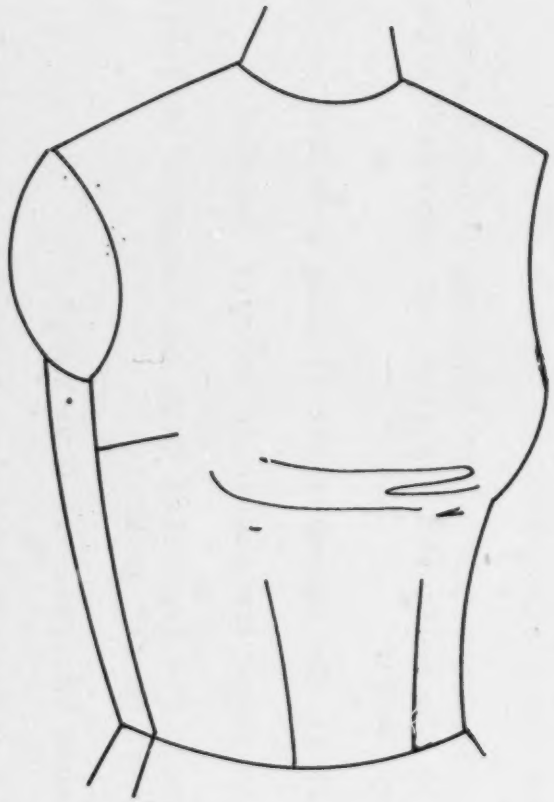

Diagram shows wrinkles and distortion of grain line on ill fitting garment caused by high bust.

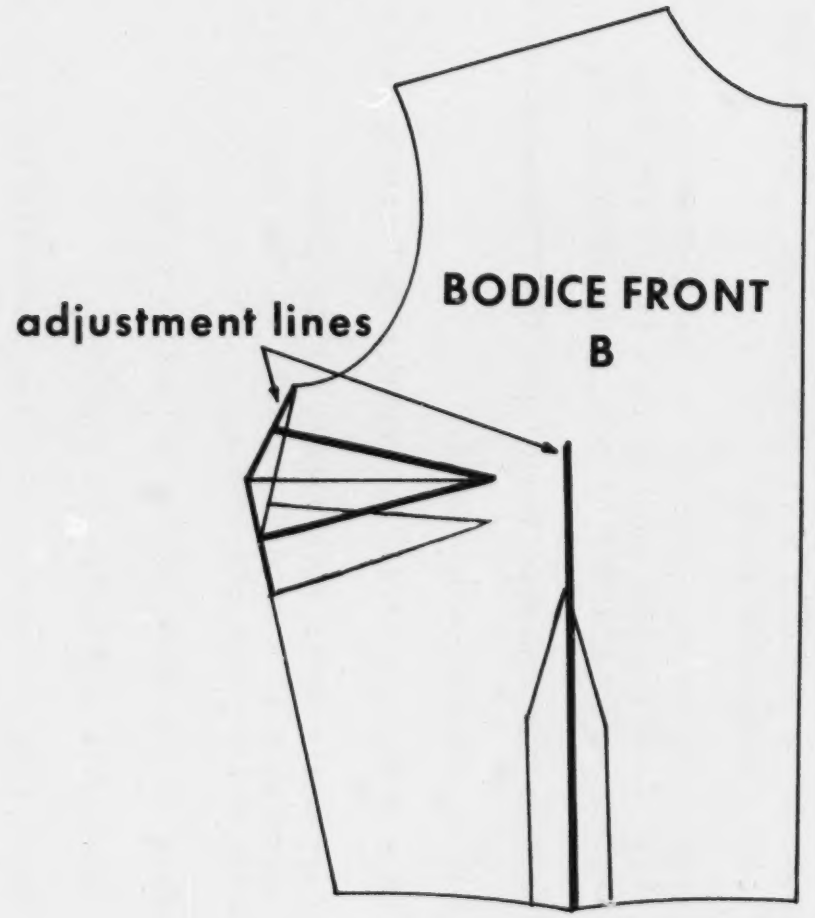

Diagram shows bodice front pattern piece with dart line altered for high bust line.

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CAA1

22. What is the basic formula for Ohm's law? _____

23. In the formula, what instruments are used to measure each of the following? _____

E = _____ , I = _____ , R = _____

24. Using Ohm's law, how much voltage is required to force 8 amperes of current through a resistance of 4 ohms? _____

_____

25. Describe a series circuit: _____

_____

26. Describe a parallel circuit: _____

_____

27. What is the advantage of a parallel circuit when a number of units are involved? _____

_____

28. How are switches wired into a circuit? _____

29. What happens to the voltage as it travels through a circuit? _____

_____

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ACKNOWLEDGMENTS

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ABSTRACT - Prepared by educators in Warren County schools of New Jersey in cooperation with the Vocational-Technical Laboratory of Rutgers University, this is the first of two laboratory manuals for teacher and student use in teaching the fundamentals of electronics. The contents are designed to challenge prospective electronics technicians through problem-solving techniques concerning basic D-C circuits. The 21 experiments, for use with a basic electronics or electricity textbook, include objectives, material or equipment required, procedure, conclusions, and questions. A materials list, instructions for writing reports, report format, and an accessory kit list are included. Part two is available as VT 012 901, also in this issue. (GEB)

VT 012 900

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STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL EDUCATION

ELECTRONICS LABORATORY MANUAL - 1

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WASHINGTON, NEW JERSEY

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Division of Vocational Education

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January 1971

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DIVISION OF VOCATIONAL EDUCATION

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CURRICULUM LABORATORY

RUTGERS – THE STATE UNIVERSITY

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FOREWORD

This Laboratory Manual is written in an attempt to challenge the intellect of the prospective electronics technician. This is accomplished by using the problem-solving technique. The ability to solve problems is a vital prerequisite to the fulfillment of the job classification.

This Laboratory Manual was written to be used in conjunction with a basic electricity or electronics textbook.

Some of the experiments include introductions, as some textbooks do not relate the material content of the theory to a working (laboratory) knowledge of experimentation.

The experiments are arranged in a spiraling order. This provides an increasing level of skill and knowledge each time the general topic is presented.

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BASIC D. C.

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APPENDIX K

CASE PROBLEMS ON GARMENT ALTERATIONS

The following problems may be utilized as the basis for role-playing situations as a means of stimulating discussion or as part of an evaluation lesson. Each situation presents a fitting problem. Answer the questions in relation to the information given.

1. The seam lines on the skirt do not hang perpendicular to the floor. The skirt wrinkles and the hem line is not parallel to the floor. The customer says all her clothes hang the same way.

   - What is the probable reason for the fitting problem?
   - Can an alteration be made?
   - What steps are needed to correct the fitting problem?

2. The customer's dress fits except in the armhole and shoulder area. The appearance is marred by ripples in the upper sleeve and the shoulder droops onto the arms.

   - What is the cause of the fitting problem?
   - Should the alteration be made?
   - What steps are needed to correct the fitting problem?

3. A customer's skirt fits at the waist and across the hips in the front but the back has ripples at the end of the darts.

   - What is the cause of the fitting problem?
   - What steps are needed to correct the fit?

4. A very slender "flat" young Miss has a dress with a skirt that is loose in the waist and hip area and she would like the dress to fit more snugly.

   - What is the cause of the fitting problem?
   - What steps are needed to improve the fit?

5. A customer has requested that you lengthen an A-line shift on a "permanent press" garment.

   - Should the alteration be made?
   - What steps are needed to make the alteration?

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056 238

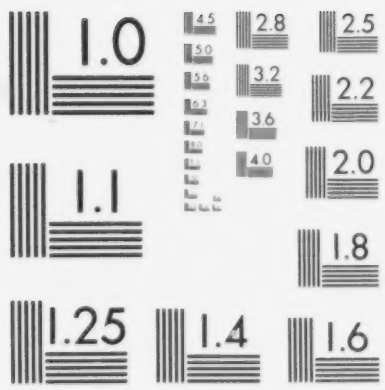

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

19. Bridge Circuits--D.C..... 78

20. Inductance--Self and Mutual..... 84

21. Introduction to Capacitors and Time Constant..... 87

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Materials List

The following equipment is required:

Electronic Fundamentals Accessory Kit

Breadboard-Circuit patching unit

Variable power supply

Multimeter Experiment board

Vacuum Tube voltmeter

Acknowledgement

I wish to acknowledge the assistance of the following men who contributed to the preparation of this manual:

Frederick Spencer - Drafting Department - Warren County Technical School

Michael Fichera - New Jersey State Department of Education

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REPORTS

ALL REPORTS ARE TO BE SUBMITTED USING THE FOLLOWING FORMAT:

COURSE TITLE:_____

Experiment Nos._____

TITLE:

DATE PERFORMED
CLASS NO.
INSTRUCTOR

TECHNICAL REPORT SUBMITTED BY:_____

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INSTRUCTIONS FOR TECHNICAL REPORT WRITING

I. GENERAL

The following instructions are given to assist the student in making an orderly presentation of the results of the tests performed.

Every laboratory report is to be written with the idea of providing a permanent and complete record of an experiment. Properly prepared reports are of great value for future reference and are to be retained by the student, subject to future inspection. Reports should be completely understandable to another person unfamiliar with your work. They should also be clear to you, long after you have forgotten the details of the work. Sufficient details should be included to enable you or another person to exactly duplicate the experiment.

Reports should be printed in ink or typewritten. Use one side ONLY of 8½" x 11" white quadruled paper (¼" squares) for all needs except graphs. For graphs use standard 8½ " x 11" plotting (graph) paper.

The individual pages of the report should be properly correlated, numbered, and assembled.

The front page must be a standard college title sheet. All information required must be filled in. Names of all members of the laboratory team or group must appear on this page.

II. SKETCHES - DIAGRAMS:

Sketches and diagrams should be in ink. Colored pencil may be used for accenting certain features of the sketches, if desired.

III. CURVES:

Curve sheets must be drawn in ink. Each of the individual curves must be suitably designated. The individual scales on the ordinate and abscissa must be suitably spaced. The units adopted should be clearly designated. The ordinate and abscissa scales should be chosen so that the limits of the ordinate and the abscissa are well within the margins of the curve sheet. The legend on the curve sheet should include:

1. The title of the curve
2. The student's name
3. The date

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Coordinate scales should be indicated by heavy lines and suitably designated.

All points of plot should be indicated on the curve sheet.

All curves are drawn as smooth curves. The curves follow the general trend of the points, but do not necessarily pass through all points.

Curves should never be drawn freehand. Always use a straight-edge and/or french curves.

It should be remembered that curves depict the results of the experiment. They are then, necessarily, one of the most important elements of a laboratory report. Precision and care should be used in the choice of scales, location of the points of plot, and the drawing of the curve.

IV. ENGLISH:

Correct English must be used in all report writing. This includes correct spelling and punctuation as well as the proper use of engineering terms. (All reports MUST be written so as to be legible.) Reports will be returned for rewriting if not acceptable.

Personal pronouns such as I, we, etc. should not be used.

V. GRAPHICAL PRESENTATION OF DATA:

1. The overall appearance must be neat and attractive.

2. The graph is to occupy substantially the whole ruled paper.

3. A complete descriptive title is to be lettered more prominently than other items and underlined.

4. The lettering is to be in ink.

5. The lettering must be uniform in size, spacing, and use of capitals or small letters.

6. The minimum height of letters is one space.

7. Plot the independent variable horizontally and the dependent variable vertically.

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8. Name the variable and specify all units alongside each axis. Use guide lines for lettering.

9. Use subdivisions of 1, 2, 5, and 10 when choosing scales.

10. Show all points with a cross. Make the cross with a sharp pencil or ball-point pen.

11. If there is more than one set of points, enclose like points with distinguishing marks.

12. The curve or characteristic is the average of the plotted points. It should be smooth, uniform, and continuous. It should have no sharp changes in slope and should be drawn in ink.

13. If more than one curve is plotted on the same graph sheet, they are distinguished by use of color or by dotted or dashed lines.

14. The name of the student and the date should appear in the bottom right-hand corner.

VI. REPORT FORM:

The report must be arranged in the following form:

STATEMENT OF PROBLEM: The object or purpose of the experiment should be a brief, concise statement, usually included in the Laboratory Manual.

CONCLUSIONS: This is a very important portion of the report. It is in this portion of the report that the student makes an analysis of the results obtained and draws any conclusions which are warranted. The results obtained in this report should be compared with other information which is available in trade publications, textbooks, operating manuals, etc. If the results deviate from those which were expected, the student should determine, if possible, the reasons for such variations and include this in this section.

DISCUSSION: A complete analysis of the curves obtained should be made. A satisfactory explanation of the significance of the shape of the curve is required. This should include a comparison between the curves obtained and those expected as well as reasons for deviation, if any.

The student should, at the end of this section, in a brief and concise manner present in numerical sequence, if possible, the conclusions he is able to draw as the results of this report.

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METHOD: This should be a brief summary, using the student's own words, of the method actually used in performing the test. It should not be copied from the experiment sheets because of the excessive detail used.

SAMPLE COMPUTATIONS: Show sample calculations, suitably arranged and designated, so that the entire process is clearly indicated. Where several computations of an identical nature have been made, only one (or a sample) need be included.

REFERENCE: The identification of the apparatus, equipment, and materials used in the test should be listed. All data must be properly referenced to Engineering Notebook and must specify Notebook Number and data page.

VII. SUBMISSION OF REPORTS:

Reports are to be completed and handed personally to the instructor during the last laboratory period assigned for the experiment.

It is expected that all reports will be handed in on time.

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ACCESSORY KIT COMPOSITION

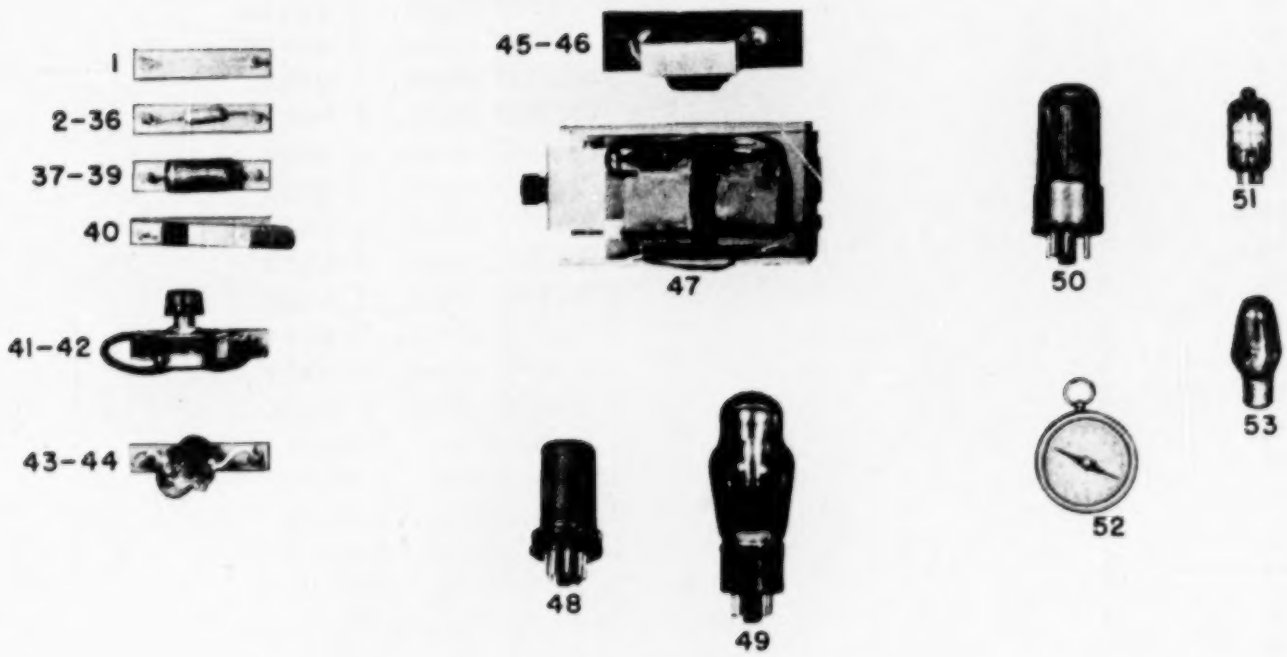

ITEM	QTY	DESCRIPTION
1	6	Shorting Strip
2	1	Resistor, 1 ohm, 1 watt, 1%
3	1	" 2.2 ohms, 1 watt
4	1	" 10 ohms, 1 watt, 1%
5	1	" 10 ohms, 1 watt, 5%
6	1	" 15 ohms, 1 watt
7	1	" 16 ohms, 1 watt, 5%
8	1	" 25 ohms, 5 watts
9	4	" 27 ohms, 1 watt
10	1	" 56 ohms, 1 watt
11	1	" 150 ohms, 1 watt
12	1	" 160 ohms, 1 watt, 5%
13	1	" 470 ohms, 1 watt
14	1	" 560 ohms, 1 watt
15	1	" 1000 ohms, 1 watt
16	2	" 1000 ohms, 5 watts
17	1	" 1500 ohms, 1 watt
18	2	" 2200 ohms, 1 watt

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ITEM	QTY	DESCRIPTION
19	1	Resistor, 3300 ohms, 1 watt
20	1	" 4700 ohms, 1 watt
21	1	" 5100 ohms, 7 watts
22	1	" 5600 ohms, 2 watts
23	1	" 10,000 ohms, 1 watt
24	1	" 15,000 ohms, 2 watts
25	1	" 18,000 ohms, 1 watt
26	1	" 22,000 ohms, 1 watt
27	1	" 47,000 ohms, 1 watt
28	1	" 56,000 ohms, 1 watt
29	3	" 100,000 ohms, 1 watt
30	1	" 150,000 ohms, 1 watt
31	1	" 300,000 ohms, 1 watt, 5%
32	1	" 470,000 ohms, 1 watt
33	1	" 1 megohm, 1 watt
34	1	" 1.2 megohms, 1 watt
35	1	" 2.2 megohms, 1 watt
36	1	" 4.7 megohms, 1 watt
37	2	Capacitor, .01 µf, 400 V
38	1	Capacitor, .1 µf, 400 V
39	2	Capacitor, 1.0 µf, 200 V
40	1	Key Switch
41	1	Resistor, Variable, 500 ohms, 1 watt
42	1	Resistor, Variable, 2500 ohms, 1 watt
43	1	Lamp, 7 watts
44	1	Bulb, Neon, NE-2
45	1	Inductor, 4 henrys
46	1	Inductor, 7 henrys
47	1	Mutual Inductance Demonstration Assembly
48	1	Vacuum Tube, Type 6SJ7
49	1	Gas Tube, Type OA3
50	1	Vacuum Tube, Type 6J5GT
51	1	Vacuum Tube, Type 6AL5
52	1	Compass, Magnetic
53	1	Lamp, Pilot, 7 watts

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SILHOUETTE KIT

Suggestions for Using Silhouette Kit

The kit includes five basic figure types, some basic clothing silhouette patterns for the medium build figure, five basic face shapes along with neckline and collar styles to fit the basic dress pattern for the medium figure, and illustrations showing the effect of line on figure types. Some ideas for using the kit are given below.

- Make basic clothing silhouettes for each figure type. Some ideas are provided for the medium figure type.
- Duplicate materials from the kit for each trainee to use for individual projects.
- Use figure types and clothing silhouettes on opaque projector for class discussion.
- Have trainees determine the styles most suited to each figure type by using clothing silhouettes.
- Apply design principles by using skirts, jackets, bodices, collars in different combinations on all figure types.
- Have trainees experiment with figure types by cutting clothes from fabric or wallpaper of different size stripes, figures, and plaids. Show results to class on opaque projector.
- Study the neckline best suited to face shapes by changing faces and necklines on the medium build figure wearing the basic dress.
- Demonstrate the effect of line on various figure types by using colored gummed tape on the basic dress.
- Develop a bulletin board or display case by tracing the figures onto poster board or paper. Costumes can be cut from fabric or wallpaper and tabbed at the shoulders.
- Add felt, flannel, or sandpaper to figures for use on flannel board.

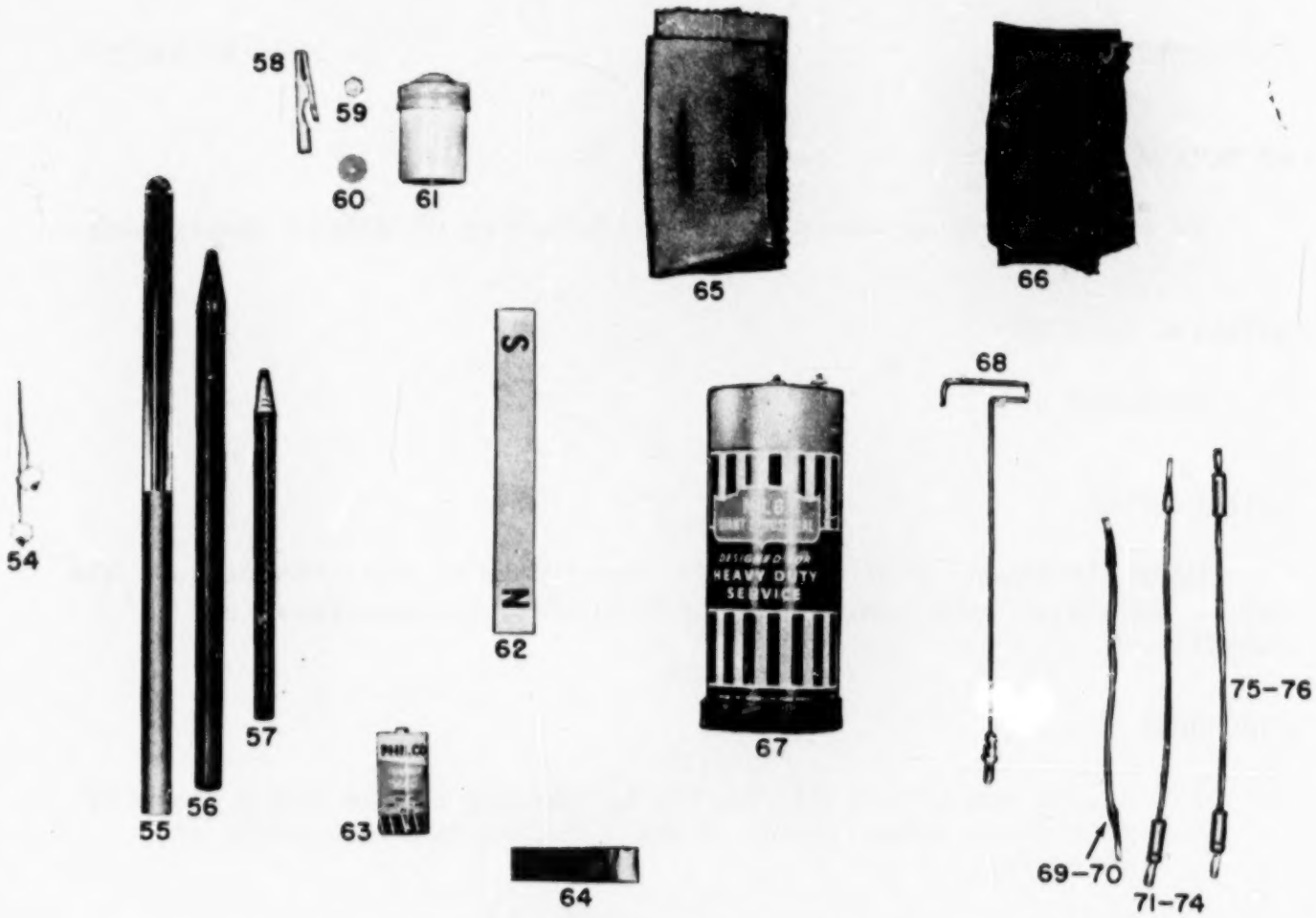

ITEM	QTY.	DESCRIPTION
54	2	Pith balls
55	1	Rod, glass
56	1	Rod, hard rubber
57	1	Pencil, china-marking (black)
58	2	Clip, alligator
59	4	Nut, hexagonal, 6-32
60	4	Post, banana
61	1	Iron filings, 2 oz. package
62	2	Magnet, bar type
64	1	Wire, No. 38 nichrome, 14 inches long
65	1	Cloth, wool
66	1	Cloth, silk
68	1	Stand assembly
69	9	Clip-lead, interconnecting, 5 inches long (black)
70	2	Clip-lead, interconnecting, 10 inches long (black)
71	1	Clip-lead, interconnecting, 12 inches long (black)
72	1	Clip-lead, interconnecting, 12 inches long (red)
73	1	Clip-lead, interconnecting, 30 inches long (black)
74	1	Clip-lead, interconnecting, 30 inches long (red)
75	5	Lead, interconnecting, 8 inches long (black)
76	2	Lead, interconnecting, 8 inches long (red)

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EXPERIMENT #1 ELECTROSTATICS

OBJECTIVE

To become aware of the effects and behavior of static electricity.

MATERIAL REQUIRED

Acessory kit

INTRODUCTION

Many electronic devices use the principles of electrostatics. The most common are: the electrostatic voltmeter, loudspeakers, and capacitors.

PROCEDURE

1. Attach one pith-ball string to the top of the stand assembly so that it hangs freely about 4 inches from the point of attachment.

2. Attach the other pith ball on the stand three to four inches to the side of the first ball.

3. Rub a glass rod on the silk cloth, then touch the rod to one pith ball. This charges the pith ball. Now charge the second pith ball.

4. Try to move the two balls together. Notice the effect. Record the result and explain the theory behind your observation.

5. Charge the second ball again, but use a rubber rod rubbed across a wool cloth.

6. Try to bring the balls together. Notice the effect on the balls under these conditions. Record as in step #4.

7. Touch the two balls together, then charge both to the same polarity by repeating step #3. Record your observation as in previous steps.

8. Replace all materials in the accessory kit.

CONCLUSION

Summarize your conclusions.

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QUIZ

1. State the Law of charges.

2. What are positive and negative charges?

3. What is an electrostatic field?

4. Write a paragraph concluding the results of the experiments using your own judgment.

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EXPERIMENT #2

ELECTRICAL COMPONENTS
AND RESISTOR COLOR CODE

OBJECTIVE

To become familiar with components used in electronic circuits.
To learn to read the Resistor Color Code.

EQUIPMENT REQUIRED

Accessory kit

INTRODUCTION

Before any experimentation work can be started, the student must be capable of recognizing the components used in electronic circuits.

PROCEDURE

1. Select from the accessory kit one of each of the following. Use the Accessory Kit Composition information from pages 5 and 6 as a guide. Go to your text to find any symbols you do not know.

   a. Resistor

   b. Capacitor

   c. Variable resistor

   d. Lamp

   e. Neon bulb

   f. Inductor

   g. Transformer

   h. Vacuum tube

   i. Dry Cell

   Describe the part by marking down the numbers, color, or other marking. Example: Resistor, wirewound, 100,000 ohms.

2. Complete a short paragraph on each of the above components stating its particular characteristics which should include: use in a circuit, construction, symbol, etc.

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3. It may be helpful to recognize the physical size of resistors in proportion to their power rating (ability to dissipate heat). The following chart is for your convenience.

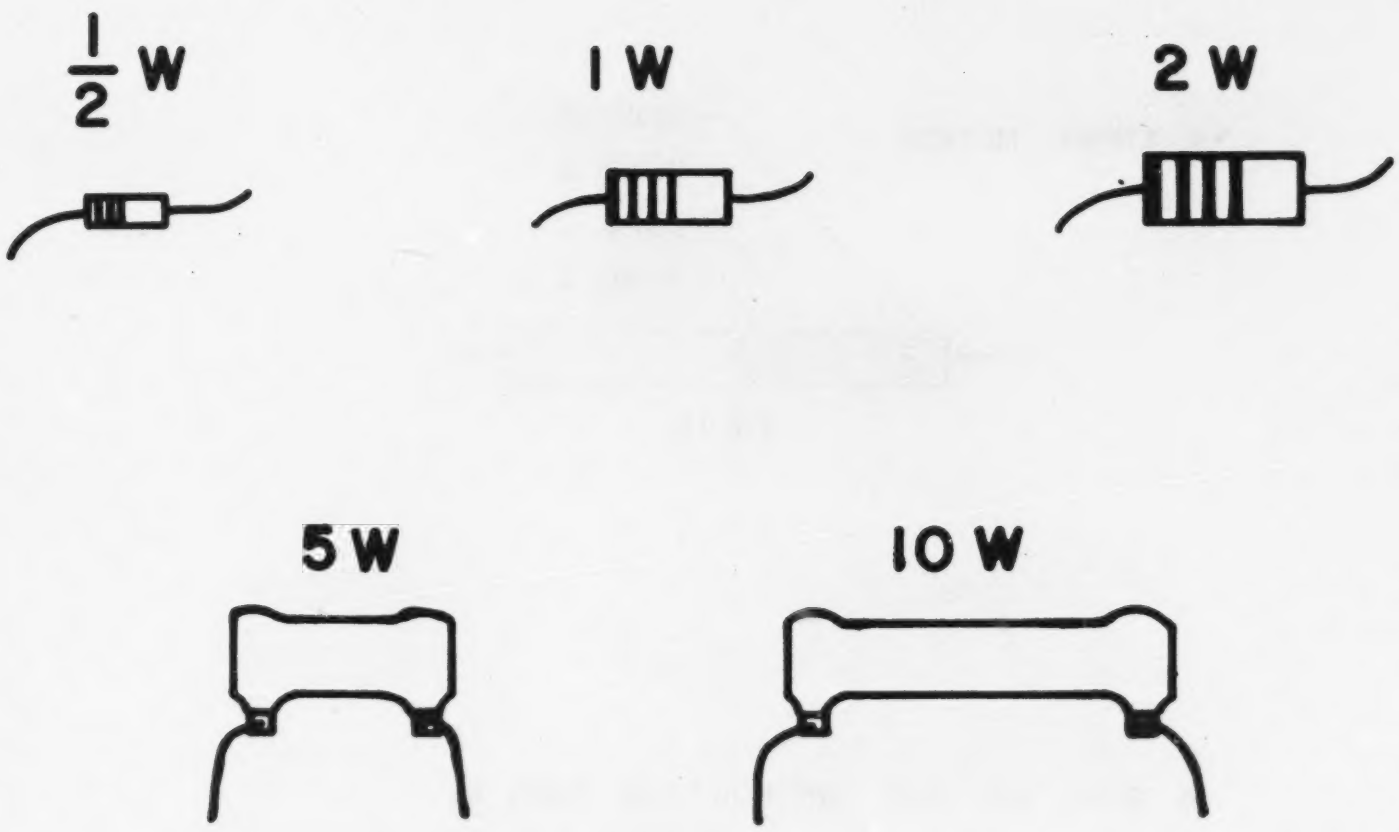

FIG. 1A

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4. The following figure shows the various methods of color-coding resistors. Refer to Figure D below to learn how to read the values.

A. STRIPE METHOD

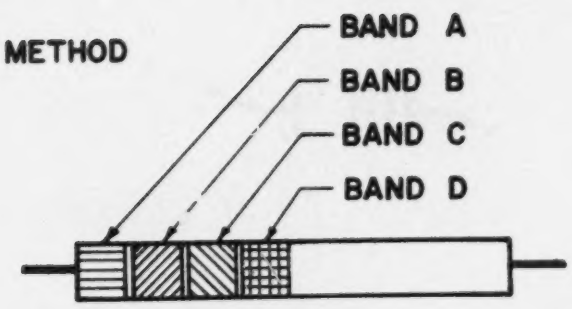

FIG. 1B

B. BODY AND DOT METHOD (NO BAND D)

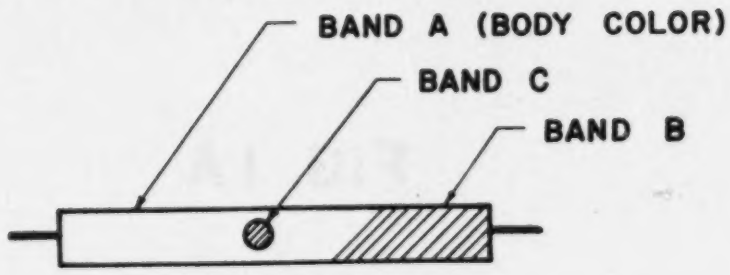

FIG. 1C

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C. Color Code:

COLOR	1ST NUMBER	2ND NUMBER	MULTIPLIER	TOLERANCE (PERCENT)
BLACK	0	0	1	
BROWN	1	1	10	
RED	2	2	100	
ORANGE	3	3	1,000	
YELLOW	4	4	10,000	
GREEN	5	5	100,000	
BLUE	6	6	1,000,000	
VIOLET	7	7	10,000,000	
GRAY	8	8	100,000,000	
WHITE	9	9	1,000,000,000	
GOLD			0.1	5
SILVER			0.01	10
NONE				20
	BAND 1	BAND 2	BAND 3	BAND 4

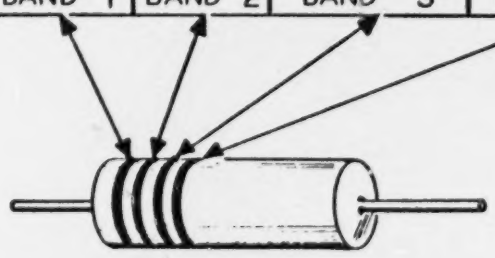

Fig. 1D

D. Example:

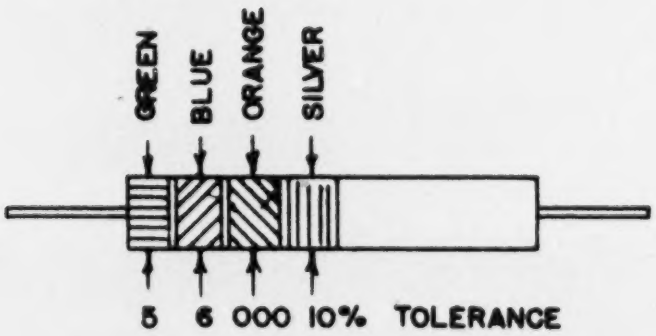

Fig. 1E

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QUIZ

1. Select 20 different resistors from the accessory kit that use the stripe method of identification. Write the colors down in the order given, then identify the value and tolerance of each.

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EXPERIMENT #3 BASIC CIRCUIT DIAGRAMS

OBJECTIVE

To be able to recognize the physical and electrical arrangement of components, in this case, resistive in nature.

EQUIPMENT REQUIRED

Accessory Kit
Breadboard - circuit patching unit

INTRODUCTION

All components and equipment are designed to function both electrically and physically in an orderly arrangement. Recognition of the three basic arrangements is a prerequisite to circuit-building, troubleshooting and repair.

PROCEDURE

1. Construct this circuit on the breadboard.

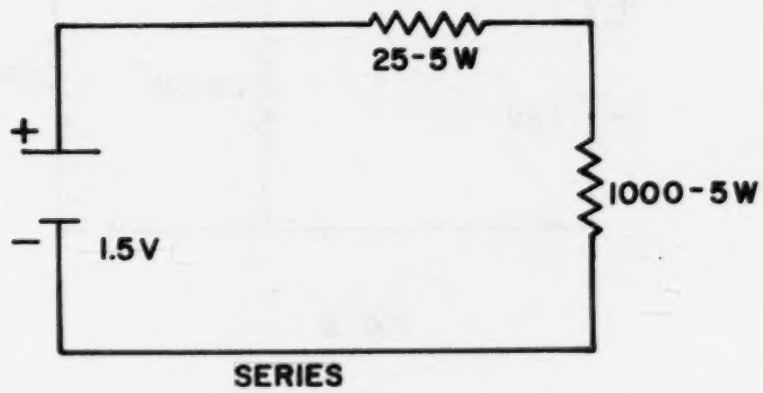

FIG. 2 A

2. Have your instructor check this circuit and initial your report.

3. Draw a pictorial (picture) diagram of your setup.

4. State the characteristics of the circuit constructed in Step #1.

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5. Construct the circuit below and repeat steps 2 through 4.

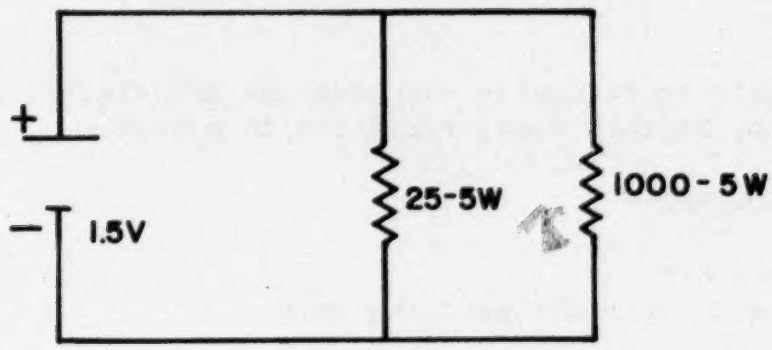

FIG. 2B

6. Do the same with the circuit below.

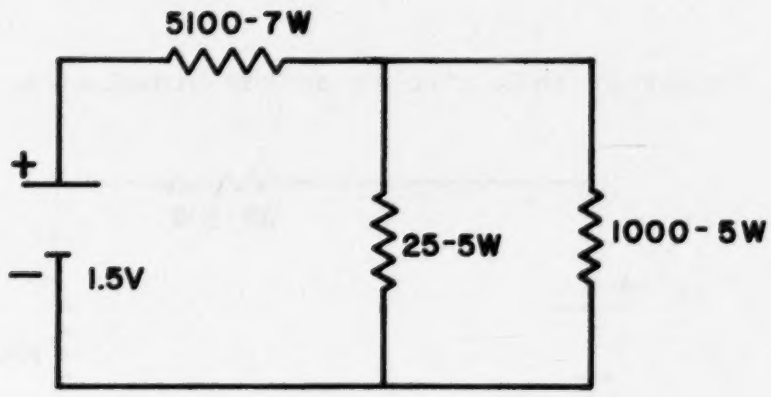

FIG. 3

CONCLUSION

The diagrams shown are basic. A series circuit may have some 20 to 30 components. A good idea of what to look for in a series, parallel,or combination circuit is necessary.

QUIZ

1. Have another student arrange a circuit on the breadboard. Draw a pictorial of the setup, then a schematic from this. Have your instructor check to see if they agree. Make sure the battery is not connected in this "prototype" arrangement.

2. Do the same as in step #1 but use other components with the resistors such as: capacitors, coils, bulb, etc.

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BASIC FIGURE TYPES

The five basic figure patterns illustrate women with figures that are medium, short and thin, short and heavy, tall and thin,and tall and heavy. These figure types can be used to design various styles of garments. Suggested garment silhouettes for the medium figure are included.

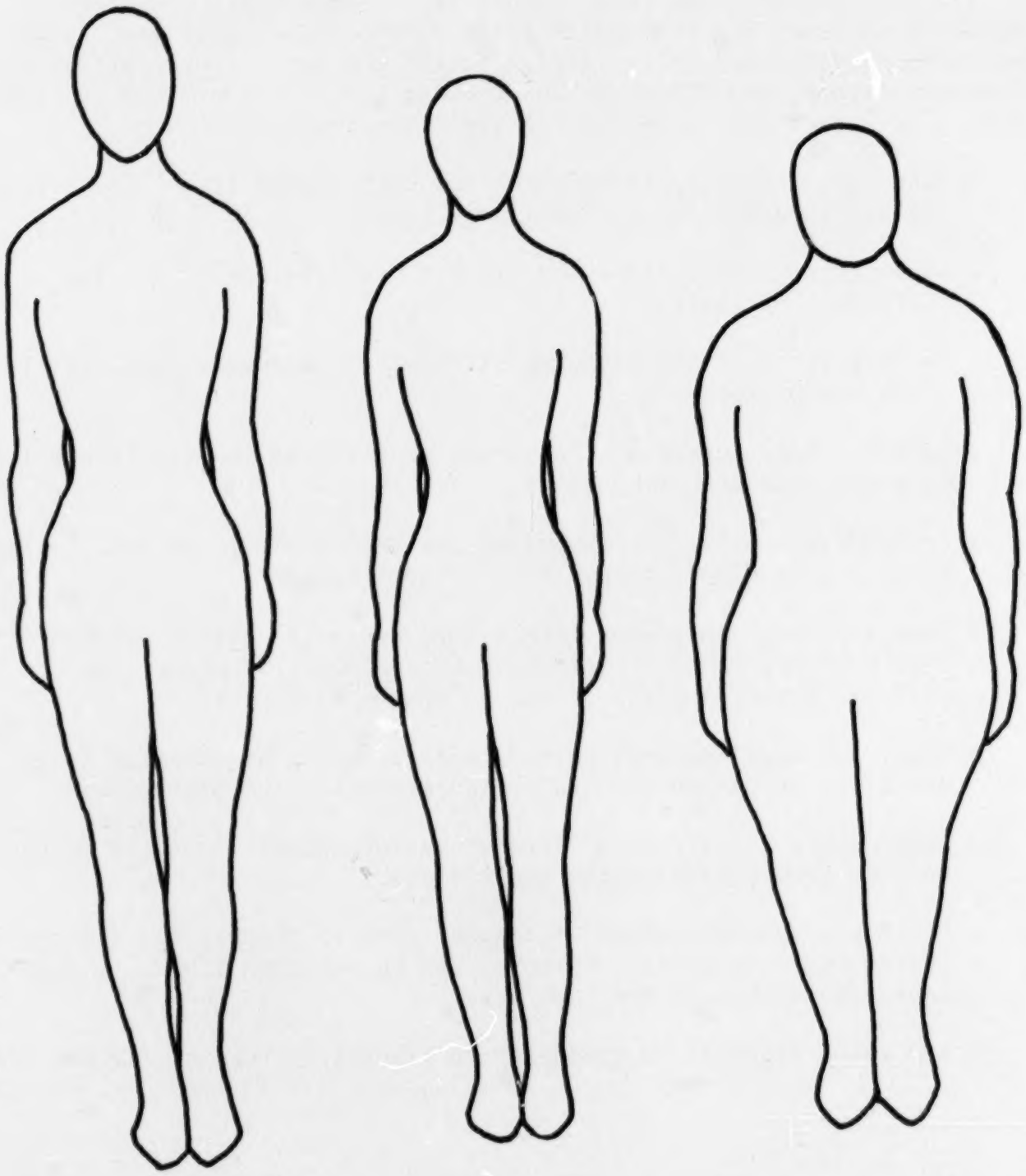

Medium | Short and Thin | Short and Heavy

0781 1471

EXPERIMENT #4 POWER SUPPLY FAMILARIZATION

OBJECTIVE

To become familar with electronic power supplies.

EQUIPMENT REQUIRED

Variable ac, dc power-supply chassis

INTRODUCTION

Safety Note: Do not plug ac line-cord into line power unless told to.

This supply provides both fixed and variable ac and dc voltages to equipment and units under test. Alternating current is delivered to the T_1 and T_3 primaries through the one-ampere line fuses F_1 and F_2. T_1 is commonly called a "variac" since it varies the voltage of the power delivered to the T_2 primary. The ac voltage available from the primary is 0 to 117 volts. This voltage is controlled by the setting of T_1.

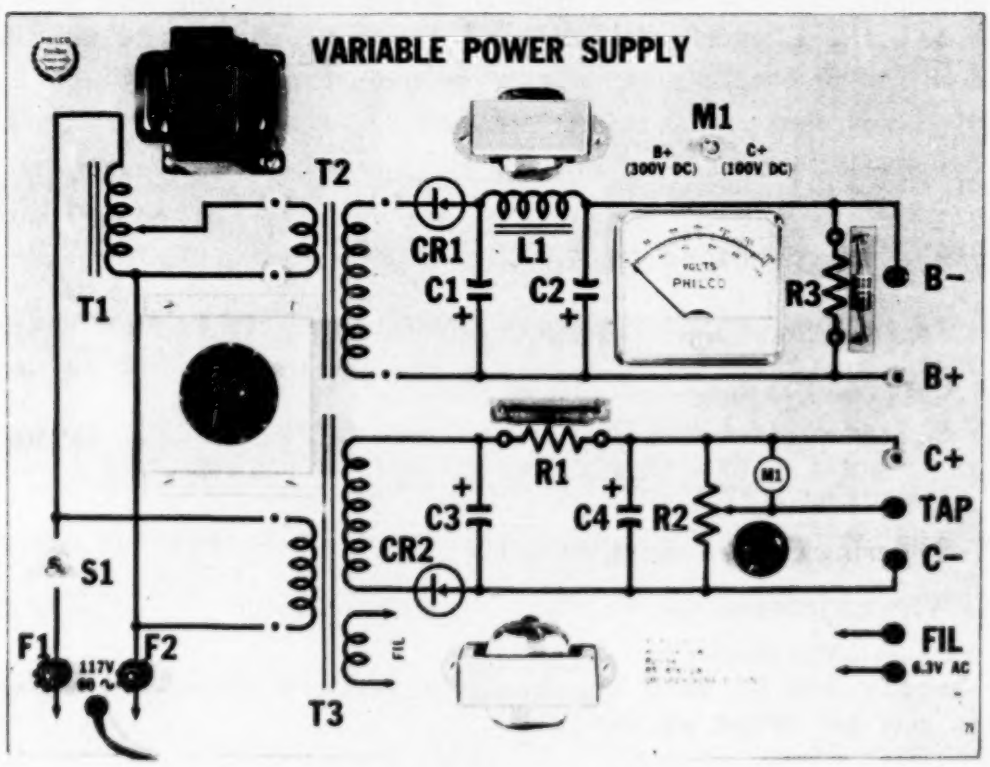

Fig. 4

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Where it is necessary to have a fixed 117-volt ac supply, you plug into the primary.

Where it is necessary for potentials higher than 117 volts ac, the secondary of T_2 is used (secondaries are normally the right-side windings). The connections to the secondary of T_2 are the two white female banana jacks. This secondary is variable to approximately 330 volts ac, using T_1 as the control.

A low fixed ac voltage of 6.3 volts is obtained from the filament winding of T_3 (FIL). The connections are at the right-hand bottom side of the board. When it is necessary to use high or low direct-current potentials, a semi-conductor (Cr_1 or Cr_2) is used to change ac to dc. This dc potential is available at either (depending on the requirements) the B+, B-, or C- and tap. By switching the M_1 switch to B+ (300 volts) a varying dc potential of 0 to 300 volts will be found available at B+, B- jacks. This voltage will then vary with the T_1 control and read direct on M_1 as to voltage available.

It might be well to note at this time that R_1 and R_3 must always be plugged into the board when working with any dc current.

By switching M_1 to the right side (C + 100 volts dc) and varying R_2, low dc voltages are made available at jacks C+ or C- and the tap.

PROCEDURE

1. After checking the fuses of the power supply, insert the ac plug into the line. Turn on S_1 and vary T_1 (M_1 on B+) until readings are obtained on M_1.

2. Turn T_1 fully counter-clockwise, switch M_1 to C+ and vary R_2 until M_1 responds, indicating the bottom circuit is workable.

3. Turn S_1 off, wait 1 minute, then remove R_3 and R_1. Repeat steps 1 and 2. <u>BE CAREFUL and DO NOT RUSH THIS STEP</u>.

4. Turn off S_1, wait 5 minutes, then replace R_1 and R_3.

CONCLUSION

A power supply can be used to obtain a variety of ac and dc voltages. These voltages may be fixed or variable.

QUIZ

1. Which circuits do the fuses protect and what size are the fuses? What does the fuse size indicate?

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2. The available voltages from your unit are:

a_____			ac fixed
b_____			ac "
c_____	to	_____	ac variable
d_____	to	_____	ac variable
e_____	to	_____	dc variable
f_____	to	_____	dc variable
g_____	to	_____	dc variable

3. To the best of your present knowledge, state the functions of each component of the power-supply unit.

Example: F_1 - fuse - protect the circuit from overload.

14745

EXPERIMENT #5

VOLTOHMMETER (VOM)
FAMILARIZATION

OBJECTIVE

To become familar with a meter capable of measuring ac, dc volts, ohms, and dc current.

EQUIPMENT REQUIRED

Power-supply chassis
VOM
Accessory kit
Breadboard

INTRODUCTION

A thorough knowledge of the instrument is a prerequisite to the mastery of that test or measuring device. The following specifications are basic to all VOMs, but apply specifically to the R.C.A. WV38A.

VOLT-OHM-MILLIAMMETER

Type WV-38A

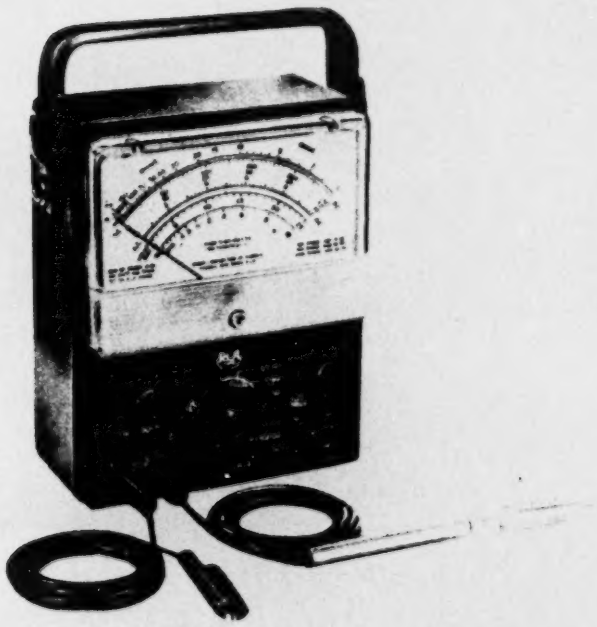

14746

SAFETY PRECAUTIONS

For proper operation, the ground (black) lead of the WV-38A should be connected to the ground of the equipment under test before any connections are made. An important point to remember is that there is always danger inherent in testing electrical equipment. The operator should thoroughly familiarize himself with the equipment under test before working on it. Bear in mind that high voltages may appear at unexpected points in defective equipment.

Experience has shown the following additional precautions to be necessary:

1. It is a good practice to remove the power before connecting test leads to high-voltage points. If this is impractical, be very careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock injury.

2. Filter capacitors may store a charge large enough to be lethal. Discharge all filter capacitors before attaching test leads.

3. Remember, leads with broken insulation provide an additional hazard at exposed points along the leads. Check your test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect the test leads immediately after the test is completed.

5. Remember, the risk of severe shock is only one of the possible hazards. Even, a minor shock can place the operator in jeopardy of more serious injury, such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

The RCA WV-38A is a lightweight, compact, rugged, all-purpose ac measuring instrument. It is designed to measure the rms values of sine-wave voltages from 0.1 volt to 5000 volts, dc voltage from 0.005 volt to 5000 volts, dc current from 1 microampere to 10 amperes, resistance values from 0.2 ohm to 20 megohms, and decibels from -20 DB to + 50 DB.

14747

SPECIFICATIONS

Electrical

DC Voltmeter (at full scale):

Ranges . . . . . 0 to .25, 1.0, 2.5, 10, 50, 250, 1000, 5000 volts
Input resistance 20,000 ohms per volt
Circuit loading 50 microamperes bleeder
Accuracy ±3%

AC Voltmeter (at full scale):

Ranges . . . . . 0 to 2.5, 10, 50, 250, 1000, 5000 volts
Input Resistance 5000 ohms per volt
Circuit loading 200 microamperes bleeder current
Accuracy ±5%
Frequency Response (reference 1000 cps) flat within 1/2 db from 10 cps to 50 kc on the 25-, 10-, and 50-volt ranges.

DC Current (at full scale):

Ranges . . . . . 0 to 50 microamperes
0 to 1 milliampere
0 to 10 milliamperes
0 to 100 milliamperes
0 to 500 milliamperes
0 to 10 amperes

Insertion Loss 0.25 volt
Accuracy ±3%

DC Ohms:

Ranges	Scale Ends	Center Scale	Full-Scale Currents
R x 1	2,000	12 ohms	120 ma
R x 100	200,000	1200 ohms	1.2 ma
R x 10,000	20,000,000	120,000 ohms	0.006 ma

Accuracy ±3% of pointer position for exact value

Internal Batteries:

R x 1 1 1/2 volt D Cell
R x 100 1 1/2 volt D Cell
R x 10,000 4 Penlite Cells in series with D cell, 7 1/2 volts

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AF Output (at full scale):

Ranges	0 to 25, 10, 50, 250 volts
Input Resistance	5000 ohms per volt
Circuit Loading	200 microamperes
Accuracy	± 5%

Note:

An internally connected .01 µf blocking capacitor permits output measurements in presence of dc voltages. If measurements are made in high-impedance circuits (e.g. electron-tube plates) very little error results. Where measurements have to be made in low-impedance circuits, with dc voltage present, an electrolytic capacitor of 10 µf or higher should be connected externally in series, and the measurement made as a regular ac voltage.

Decibel Levels (Zero DB is 1 milliwatt in 600 ohms):

2.5 V range	-20 to + 10 db
10 V range	- 8 to + 22 db
50 V range	+ 6 to + 36 db
250 V range	+ 20 to + 50 db

(May be read on Output or AC positions)

METER MOVEMENT

The WV-38A has a large 5 ¼ inch, extended-view meter housed in a clear plastic case. The case is sealed to prevent foreign matter from entering the meter and interfering with its operation.

SCALES

There are five separate scales on the meter. The top black scale is used when measuring ohms. The second black scale is used to read dc voltages and currents. The two red scales are used when measuring ac voltages, the lower one being used only for the 25-volt range. The bottom scale on the meter is used for decibel measurements. A chart, located at the lower right-hand corner of the scale, is used when making decibel measurements.

RANGE SWITCH

The Range Switch, located at the center of the control panel, has 12 positions. The Range Switch may be turned in either direction to obtain the function and range desired.

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AC-DC SWITCH

The AC-DC Switch, located at the upper left-hand corner of the control panel, has three positions. It should be set in the AC position for all ac and Output voltage measurements. For all other measurements it is normally set in the DC position. The DC position is used to reverse the polarity of the test leads when the black lead is plugged into the COMMON jack.

The AC-DC Switch does not function when the +25V 50μa or +1V 50 μa jacks are being used, nor does it function in the -10A or +10A positions.

PANEL JACKS

There are nine jacks located on the control panel. The jacks are designed for trouble-free, low-resistance connections. The test leads must be inserted into the proper jacks to obtain the circuit and range desired for each function of the WV-38A.

OPERATING SECTION

Zero Setting of Pointer

The pointer of the meter must indicate zero when the WV-38A is in the normal operating position. If the pointer does not indicate zero, the adjustment screw, located at the lower center of the meter cover, should be readjusted.

USE OF RANGE AND METER SCALES

The meter scales on the WV-38A have been designed to provide ease of operation and quick readability over a wide range of measurements. The scales have been grouped according to the type of measurement for which they are used.

Because of the wide number of measurement ranges provided on the WV-38A, it is often possible to take voltage or resistance readings on two ranges and scales. For the greatest accuracy in voltage and current measurements, always use the range which will provide an on-scale reading which is nearest to the full-scale point. For example: 48 dc volts can be read from either the 50-volt or the 250-volt range. Because the 50-volt range will provide a reading nearest the full-scale point, the 50-volt range should be used. This general rule applies to all ac and dc voltage ranges. For resistance measurements, however, the range selected should be the one which provides the reading nearest the center of the scale. The WV-38A provides the most accurate ohms-readings at mid-scale points.

14750

For some measurements it will be necessary to use a multiplying factor with the scale to obtain the correct reading. The required multiplication is indicated by the setting of the range switch. For example: when the range switch is set to the 100-V position for voltage measurement, the 0 to 10 scale is used, but the reading is multiplied by 100.

CAUTION

When making voltage or current measurements, it is a good practice to make a trial measurement at a higher range setting than is considered necessary. Repeated overload may destroy the meter movement or impair the accuracy of indications.

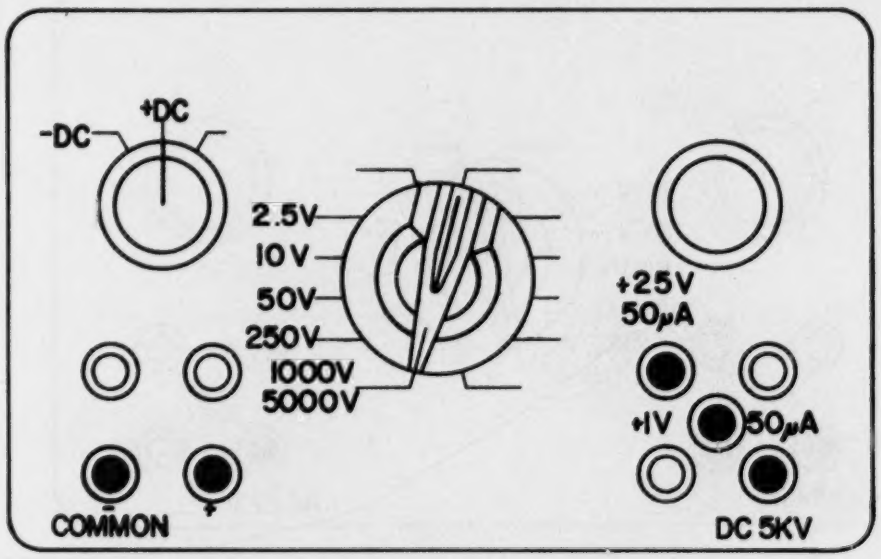

FIGURE 4. D-C VOLTAGE MEASUREMENT

DC Voltage Measurement (See Fig. 4)

1. Set the AC-DC Switch to the "+DC" or "-DC" position as required.
2. Set the Range Switch to a position considerably higher than the voltage to be measured.
3. Plug the black test lead into the "COMMON" jack on the control panel.
4. Plug the red test lead into the "+" jack on the control panel when the 2.5V, 10V, 50V, 250V, or 1000V range is used.
5. Connect the test leads to the voltage source to be measured.
6. Reset the Range Switch to a position which gives a suitable pointer deflection.
7. Read the dc voltage from the scale corresponding to the range selected.

14751

For the .25 Volt, 1 Volt, and 5000 Volt Ranges:

Note: When using the .25V and 1 V jacks, the Function Switch must be set to the "+DC" position. Meter polarity must be observed by applying the red test lead to the positive circuit point and the black test lead to the negative circuit point.

8. To use the .25-volt range, set the Range Switch to the 2.5 V position and plug the red test lead into the "+.25 V/50 µA" jack.
9. To use the 1-volt range, set the Range Switch to the 1.0 V position, and plug the red test lead into the "+1 V" jack.
10. To use the 5000-volt range, set the Range Switch to the 5000 V position, and plug the red test lead into the "DC 5 KV" jack.

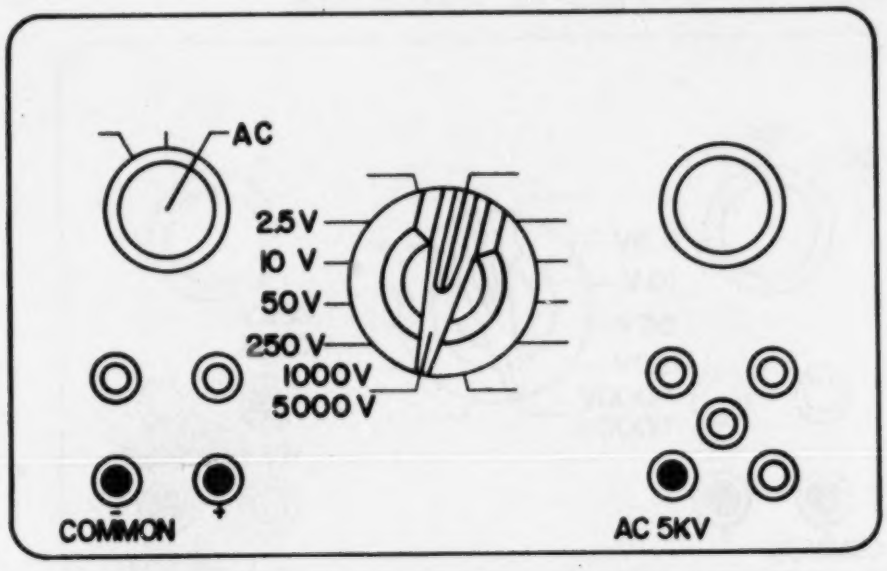

FIGURE 5. A-C VOLTAGE MEASUREMENTS

AC Voltage Measurement (See Fig. 5.)

1. Set the AC-DC Switch to the AC position.
2. Set the Range Switch to a position considerably higher than the voltage to be measured.
3. Plug the black test lead into the COMMON Jack on the control panel.
4. Plug the red test lead into the + jack on the control panel when the 2.5 V, 10V, 50V, 250V, or 1000V range is used. When the 5000V range is used, the red test lead must be plugged into the "AC 5 KV" jack.
5. Connect the test leads in series with the current flow to be measured.
6. Reset the Range Switch to a position which gives a suitable deflection point.
7. Read the ac voltage from the scale corresponding to the range selected.

14752

BASIC FIGURE TYPES

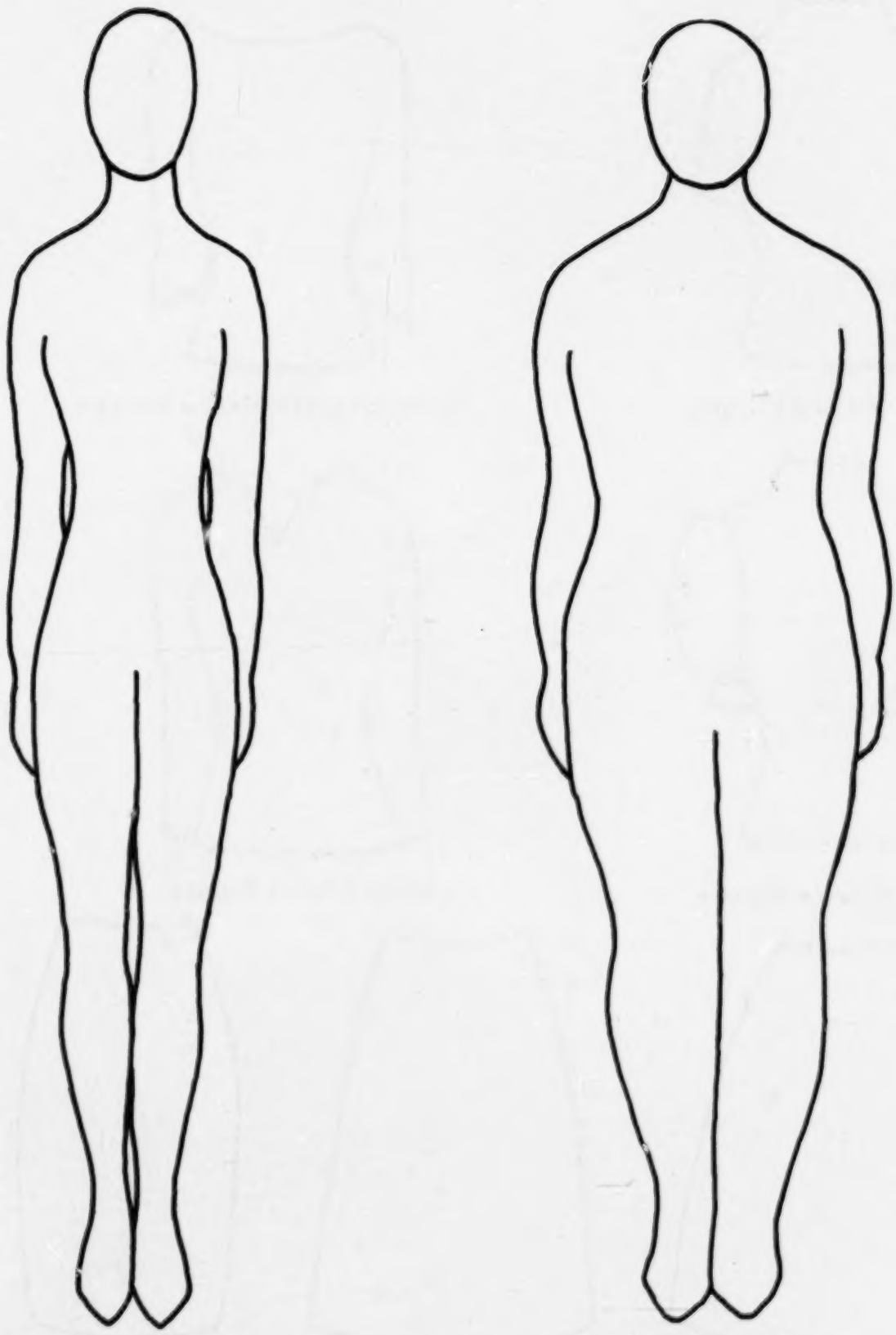

Tall and Thin

Tall and Heavy

1472

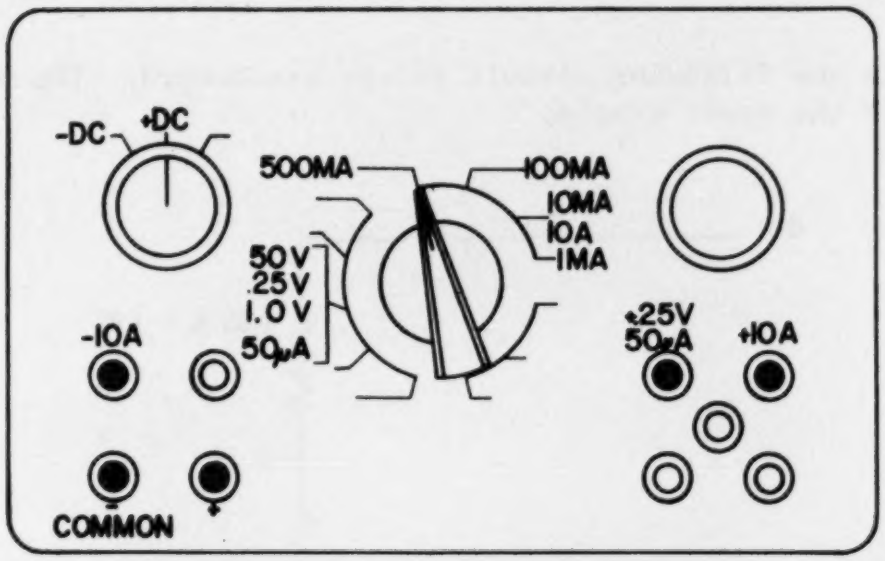

FIGURE 6. D-C CURRENT MEASUREMENTS

DC Current Measurement (See Fig. 6)

1. Set the AC-DC Switch to the +DC or -DC position as required.
2. Set the Range Switch to a position considerably higher than the current to be measured.
3. Plug the black test lead into the COMMON jack on the control panel. This is for all ranges with the exception of the 10 AMPS range.
4. Plug the red test lead into the + jack on the control panel for all ranges with the exception of the 10A and 50μA ranges.
5. Connect the test leads in series with the current-flow to be measured.
6. Reset the Range Switch to a position which gives a suitable point deflection.
7. Read the dc current from the scale corresponding to the range selected.
8. To use the 50μA range, set the Range Switch to the 50 μA position and the Function Switch to +DC position. Plug the red test lead into the +25 V/50μA jack. The meter polarity must be observed by applying the red test lead to the most positive current connection and the black lead to the less positive (negative) connection.
9. To use the 10 A range, plug the black test lead into the -10A jack and the red test lead into the +10A jack. On this current range the AC-DC Switch must be set to the +DC position, and the Range Switch set to the 10A position. Meter polarity must be observed by applying the red test lead to the most positive circuit connection and the black lead to the other circuit connection.

14753

PROCEDURE

1. Assemble the following circuit on the breadboard. (Do not energize the power supply.)

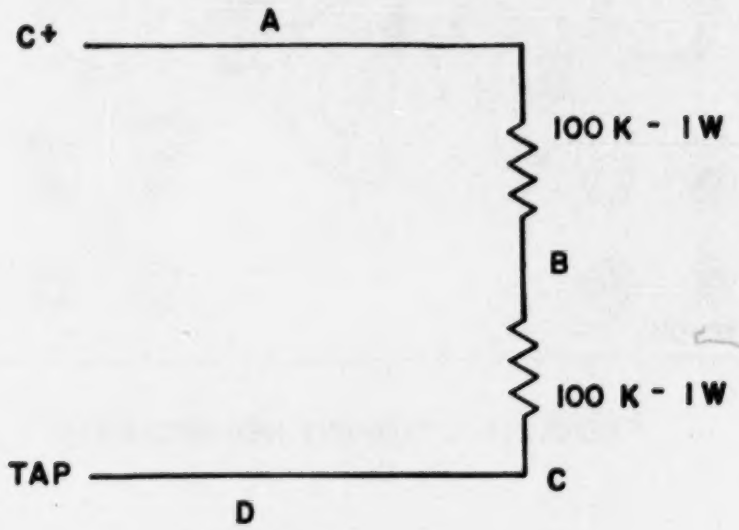

FIG. 7

2. Set R_2 counterclockwise, M_1 to CT (Makes the bottom scale of M_1 applicable, 0-100).
3. Turn on S_1, adjust R_2 until M_1 reads 10 volts (1/10 of full scale).
4. Measure (VOM) the dc voltage present between points A and D. The Tap is negative. If the VOM does not read at all, call your instructor. If it reads either slightly high or low, adjust R_2 until the VOM reads 10 volts precisely.
5. Each resistor, being the same value, should develop 5 volts, for a total of 10 volts. Measure points A to B and B to C. Knowing that the negative side of the VOM should always be connected to the "Low" side of a circuit, and that the Tap is Low, make sure that the lowside of the meter is connected to B then C in the order of checking. Record all pertinent information.
6. Calculate the meter resistance (Rm) at this voltage.
7. Turn S_1 off and assemble the following circuit on the breadboard.

14754

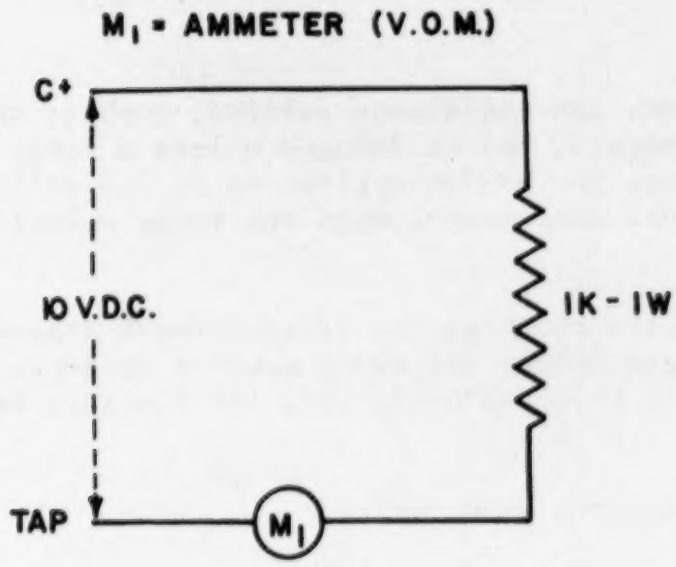

FIG. 8

8. Place the VOM on a scale capable of reading about 10 milliamperes dc.
9. Turn on S_1 making sure that M_1 still holds at 10 volts dc. Readjust if necessary.
10. Record the current through the ammeter.
11. When using the VOM as an ohmmeter (measuring the value of dc resistance), there are certain conditions to be met. The circuit or component being measured must be de-energized (no ac or dc power applied). Internal batteries in the VOM furnish all the power necessary to measure the component or circuit.
12. Procedure for ohms measurement.
    a. Set the Function Switch to the +DC position.
    b. Set the Range Switch to the appropriate position.
    c. Plug the black test lead into the COMMON jack on the control panel.
    d. Plug the red test lead into the + jack on the control panel.
    e. Short the test leads together and adjust the ZERO OHMS control until the pointer indicates "0" (full scale clockwise).
    f. Connect the test leads to the resistance to be measured.
    g. Reset the Range Switch if necessary to a position which gives a suitable pointer deflection. If this is necessary, repeat steps e and f before proceeding with step h.
    h. Read the resistance from the OHMS scale, and multiply by the range factor.

14755

CAUTION:

Low-current, low-resistance devices, such as thermocouples and meter movements, may be damaged unless a range above "R x 1" is used, because the WV-38A applies up to 1.5 volts across the resistance under measurement when the range selector is set at "R x 1".

To facilitate checking the front-to-back resistance ratio of electrolytic capacitors and semiconductor devices, the test lead polarity can be reversed by setting the Function Switch to the DC position.

13. Assemble the circuit shown below.

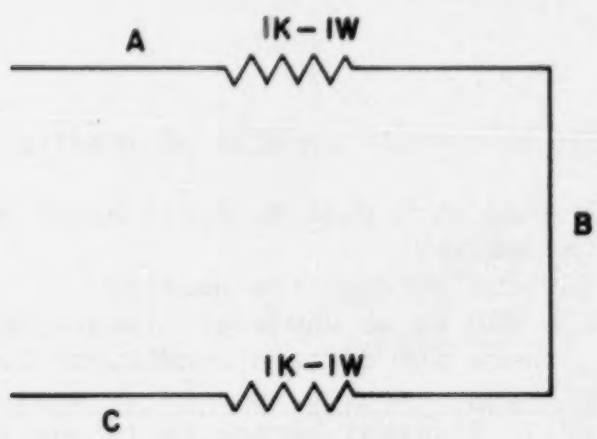

FIG. 9

14. After "Zeroing" your ohmmeter on the range you expect the reading to fall into, measure and record points A to B, B to C, and A to C.
15. Try changing the Range Switch to some other range. Record the range used and accuracy obtained in comparison to step #14 readings.

Always zero the meter after switching ranges.

Ex. R x 1 to R x 100 to R x 1000

14756

CONCLUSION

The VOM is a versatile instrument with several functions.

It can be used to measure most voltages and resistances with a good degree of precision.

QUIZ

1. Which range would be used when measuring:

   a. 60 volts dc
   b. 3 volts dc
   c. 8 ma
   d. 300 ma
   e. 2.7K ohms
   f. 56K ohms

2. Explain "meter sensitivity".
3. When measuring a particular value of resistance, it was found that the meter's pointer did not move from the static position. List the possible causes of this condition in their order of probability.

14757

14758

EXPERIMENT #6 OHM'S LAW - SERIES

OBJECTIVES

To establish the fundamental relationship of Ohm's Law in a series circuit.

To gain a working knowledge of series circuit characteristics.

EQUIPMENT REQUIRED

Power supply
Breadboard
Accessory kit
VOM

PROCEDURE

1. Construct the following circuit on your breadboard. (Leave S_1 off.)

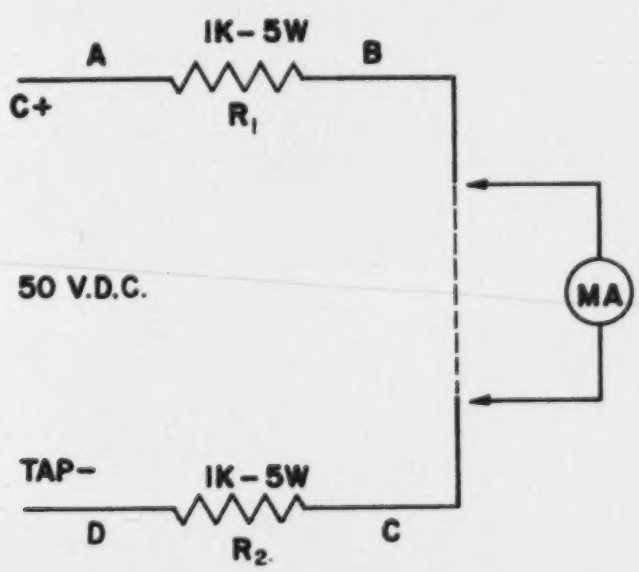

FIG. 10

2. Calculate E R_1, E R_2, I R_1, I R_2, I_1 and R_T.
3. Turn on S_1 and adjust R_2 to assure 50 volts output.
4. Measure E R_1 and E R_2.
5. Disconnect power (S_1 off) and open the circuit between points B and C. Insert a milliammeter.
   (All current measuring devices are called ammeters. It is not wrong to call a milliammeter an ammeter even though ma current is expected). Make doubly sure that the Range is sufficient, as per your calculations.

14758

6. Apply power; measure and record I_T.
7. Explain the differences found between the theoretical and the actual currents.
8. Construct the following circuit and make a full report as per step 1 to 7.

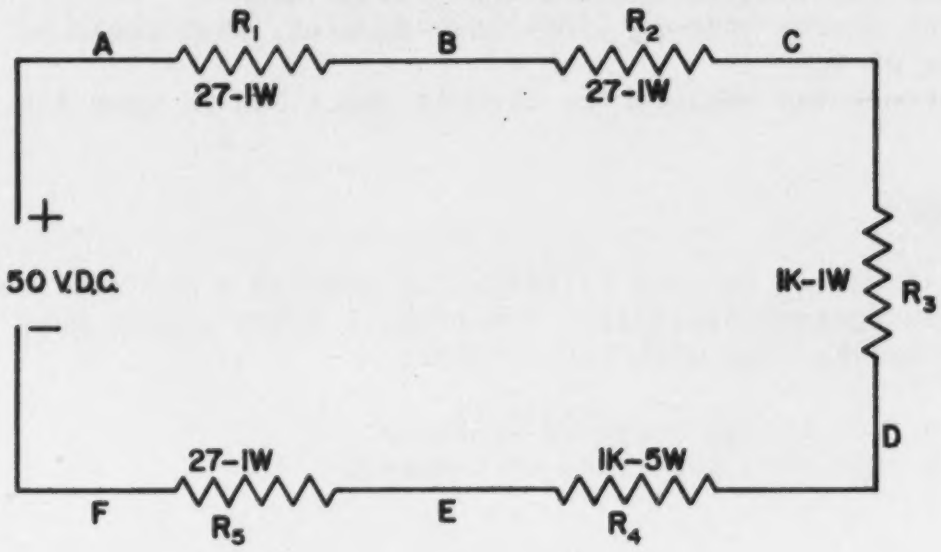

FIG. 11

9. Calculate E R_1 through E R_5, I R_1 through I R_5, and R_T.
10. Measure all calculated values of step 9.
11. Record any differences, if significant.
12. Calculate Total Power, as well as P R_1 through P R_5.
13. Which of the resistors, if the circuit were overloaded, would most probably overheat and burn open first?
14. Does $R_T = E_T/I_T$?
15. State Ohm's Series Circuit Laws, using the short form. Ex: $R_1 = R_2 = R_3$ etc.
16. Calculate the value of R_T for the following circuit.

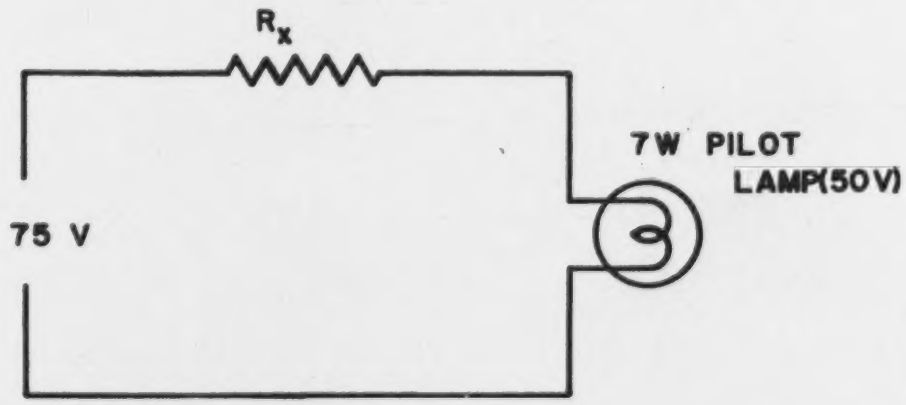

FIG. 12

14759

17. Construct the circuit, combining resistances to "make up" the value of R_x. Insure, through calculations, that PR_x is sufficently high.
18. Measure ER_x, E bulb, and I_T.
19. Do the theoretical and measured values agree?
20. If the source voltage (50V) were doubled, what would be the new value of R_x?
21. Construct and measure the circuit described in step #20.

CONCLUSIONS

Most loads or devices in circuitry require a minimum and maximum of power to operate properly. Sometimes a power source must be divided correctly or the load will have either:

a. not enough power to operate;
b. too much power and be damaged.

QUESTIONS

1. Explain how the 7-watt load would function if R_x were accidently shorted out or burned open.
2. What would be the function of the components (resistors) in the circuit if the 7-watt lamp were a 7-watt transistor amplifier?

14760

EXPERIMENT #7 OHM'S LAW - PARALLEL

OBJECTIVES

To achieve a workable knowledge of parallel circuit connections and circuit laws.

MATERIAL REQUIRED

Power Supply
Breadboard
Accessory Kit
VOM

PROCEDURE

1. Construct the following circuit:

R_1 = 1K - 5W
R_2 = 1K - 5W
R_3 = 100K - 1W

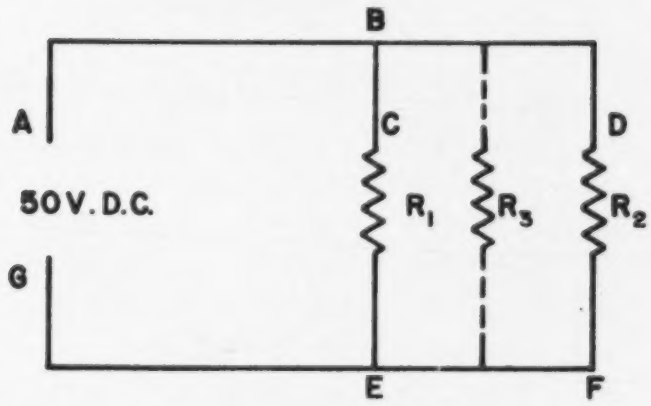

FIG. 13

2. Calculate R_T, I_T, I R_1, I R_2, E R_2, and PR.
3. Measure and record all but P_T, explaining any significant differences noted.
4. State the parallel circuit laws in short form.
5. Remove R_2 and replace with a 10K-1W resistor.
6. Calculate and measure the new circuit conditions.
7. Add R_3, then repeat step #6.
8. Review your findings, using any pertinent information gained through the experiment.
9. Design a parallel circuit with one branch containing a 7-watt light bulb and the other branch using 5 watts of power.
10. Build and test the circuit in #9.

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CONCLUSIONS

Parallel circuits are widely used. Some of the most elaborate equipment (radar, machine logic control, computers, T.V. and radio) use many of their control and power output sections in parallel (or shunt) due to the advantages. DO NOT proceed to the next experiment until you have a full understanding of the series and parallel circuit.

QUESTIONS

1. What determines the maximum total power parallel branches may use?
2. State the formulas that can be used when calculating total resistance in a parallel circuit. Which would be most commonly used?
3. What would be the result, in a well-designed circuit, if the source voltage were doubled on R_T?
4. If, in a parallel circuit, it was thought that one of the resistive branches was not passing any current, what method could be used to find this trouble? Explain your answer in detail.
5. What would be the effect on the circuit parameters if one branch were to short out? Explain your reasoning.

14762

BASIC CLOTHING SILHOUETTES FOR MEDIUM FIGURE

Basic clothing silhouettes for the medium figure are illustrated below. Similar silhouettes can be made for other basic figure types. The silhouettes can be used to illustrate the principles of good garment design in relation to figure type.

Short Sleeve Blouse

Three-quarter Sleeve Blouse

Puff Sleeve Blouse

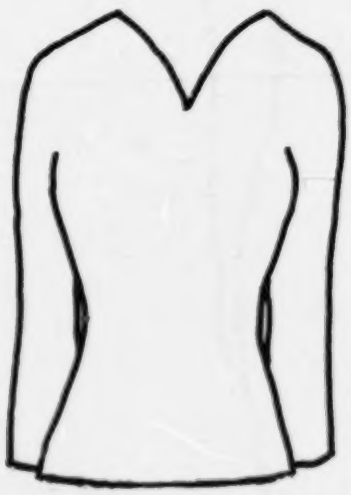

Long Sleeve Blouse

Flared Skirt

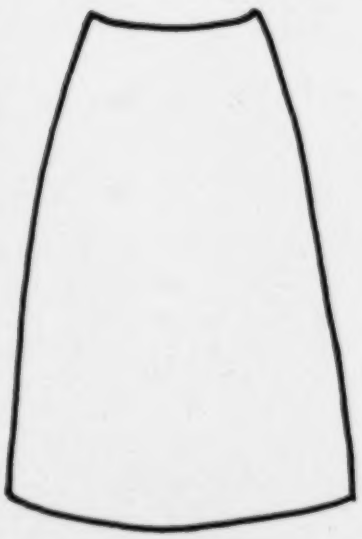

A-line Skirt

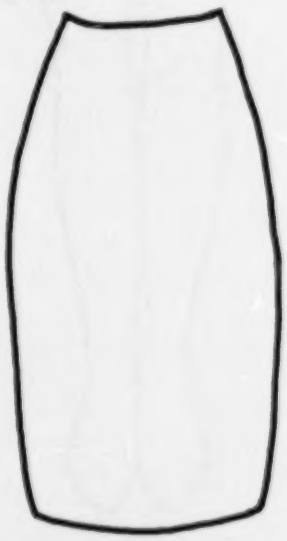

Straight Skirt

STAT 1473

EXPERIMENT #8 OHM'S LAW - COMPLEX I, II, AND III

OBJECTIVES

Most pieces of elaborate equipment use both series and parallel circuit arrangements, in what is called complex circuits. By applying both circuit laws to the individual branch or string, a reasonable understanding of the circuit can be realized.

MATERIAL REQUIRED

Power supply
Breadboard
Accessory kit
VOM

PROCEDURE PART I

1. Construct the following circuit.

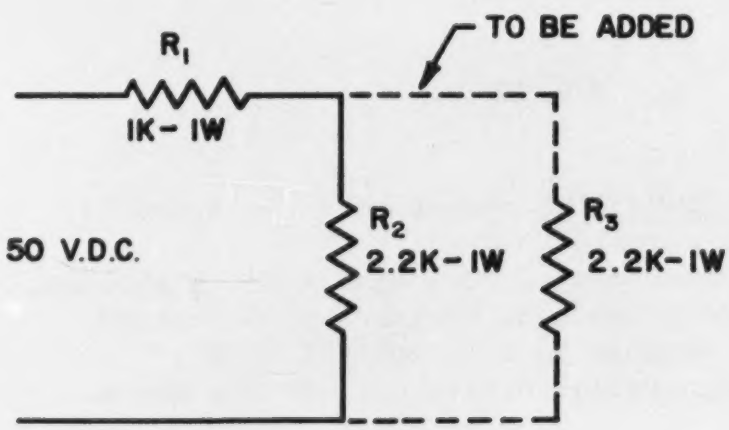

FIG. 14

2. Calculate and measure E R_1, E R_2, I_T, and R T_2.
3. Add R_3, then calculate and measure E R_1, E R_2, E R_3, I R_1, I R_2, I R_3, I_T, and R_T.
4. Make a comparison between steps 2 and 3, explaining the effect on the circuit of the addition of R_3.
5. Change R_3 to a 1K ohm-1 watt resistor and compare the values of the circuit with the original values.
6. Do the circuit laws agree with the actual findings? To what extent?

14763

PART II (Turn in as a separate experiment)

1. Construct the following circuit.

$R_1, R_6 = 1K - 5W$ $R_3 = 1K - 1W$

$R_2 = 560 - 1W$ $R_4, R_5 = 2.2K - 1W$

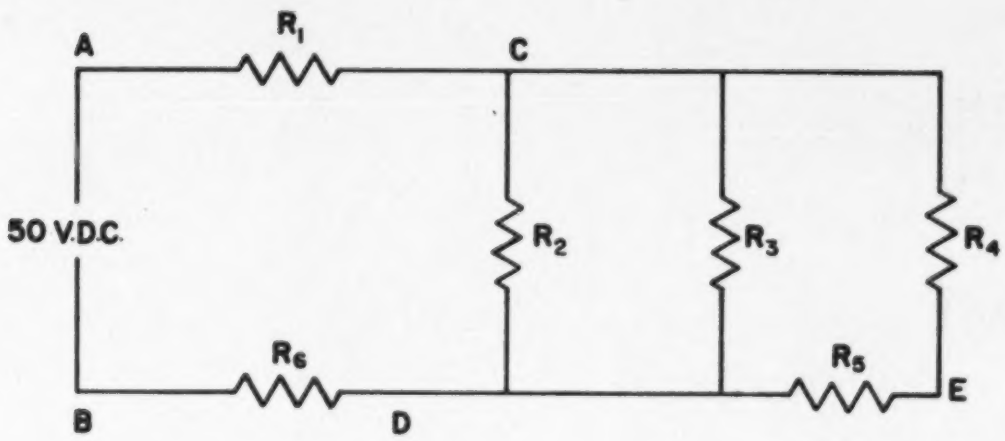

FIG. 15

2. Calculate ALL INDIVIDUAL values of E, I, R, and P.
3. Measure all measurable values.
4. Calculate R_T from point C to E with A to B shorted.
5. Measure R_T from point C to E with A to B shorted.
6. Calculate and measure R_T from point E to D.
7. Explain any significant differences in the above.

14764

PART III (Turn in as a separate experiment)

1. Construct the following voltage divider.

R_1=1K-5W	R_5=4.7K-1W
R_2=2.2K-1W	R_6=15K-1W
R_3=5.6K-2W	R_7=18K-1W
R_4=10K-1W	R_8=22K-1W

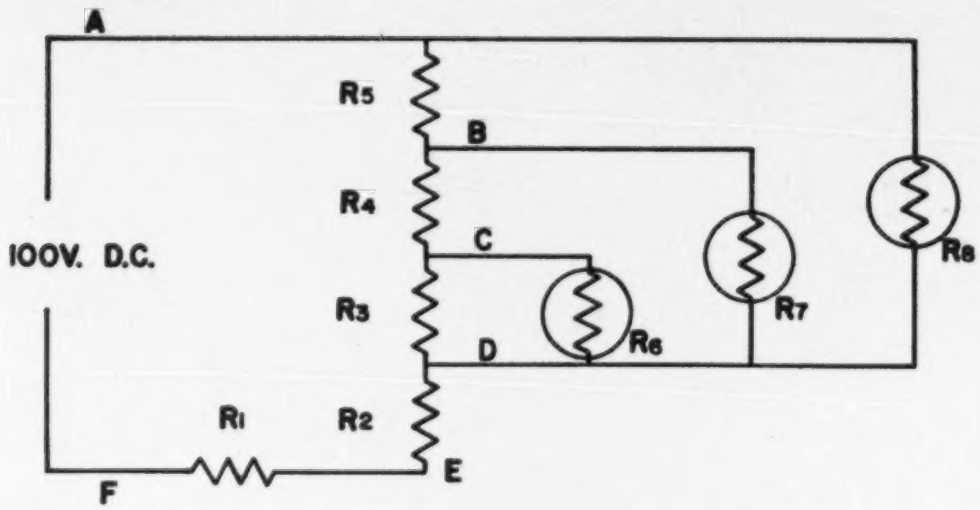

FIGURE 16

2. R_6, R_7, and R_8 represent power-consuming units or devices such as transistor or vacuum-tube circuits.
3. Calculate and measure all values of E, I, and R_T. Calculate all PRs and P_T.
4. Measure all circuit potentials from the reference point D to all other points. Explain the negative readings.
5. Repeat step #4 for point F.

CONCLUSIONS

By a predetermined arrangement of components, it is possible to "bleed" a source value (such as 100 V) down to values required by specific units, delivering both positive and negative values that some loads require. By changing the reference point or the source, a new set of conditions exists. Part III is one of the most useful yet complicated dividers used. A good working knowledge of complex circuits must be gained to advance. Do not proceed unless you understand this unit.

14765

QUESTIONS

1. In Part III, by moving the reference to point E, what is the voltage across R_8? Why is this true?
2. In Part III, by moving the reference to point A, what happens to the polarity of R_1 through R_5?

14766

EXPERIMENT #9 ELECTROMAGNETIC FORCE

OBJECTIVE

To observe the effects of a magnetic field produced by a current carrier.

MATERIAL REQUIRED

Accessory kit
Test leads

PROCEDURE

1. Breadboard the following circuit.

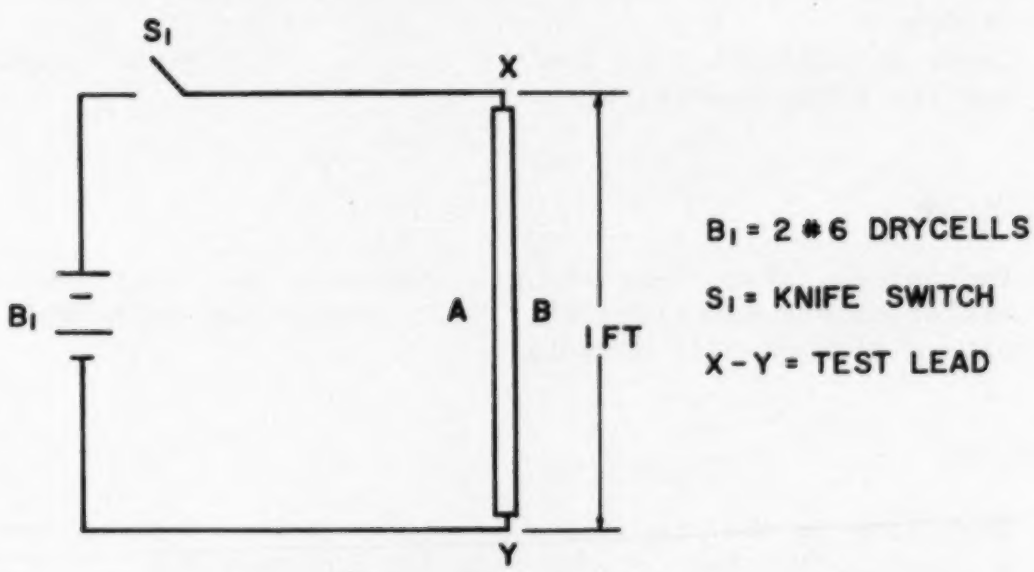

FIG. 17

2. Position a compass at point A so that the needle and X Y are parallel. (Keep S_1 open)
3. Close S_1 and note the direction the compass is deflected. Explain.
4. Open S_1 and position the test lead 90° to the compass needle.

14767

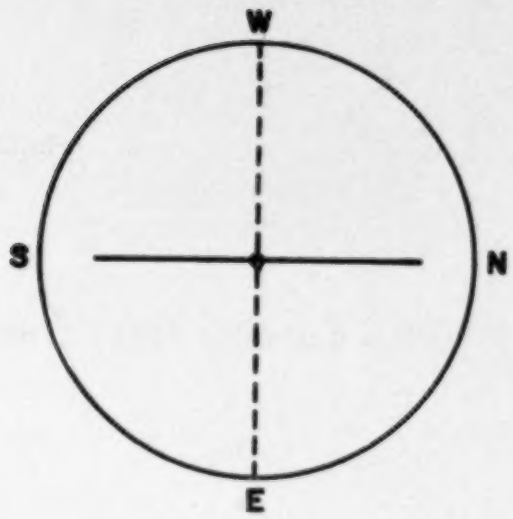

FIG. 18

5. Close S_1 and observe the results.
6. Take a sheet of paper and scatter some iron filings over the inner third of the paper. Lay the 1 foot test lead over the filings.
7. Close S_1 lift the test lead up slowly. Observe and explain the results after opening S_1.

CONCLUSION

The passage of current along a conductor has many side effects, some useful, others deterimental. Most present-day generators and alternators work on this principle.

QUESTIONS

1. What form do the lines of force take when current passes through a conductor? (Refer to your text for information)
2. If the current in a conductor rises, does the amount and/or the strength of the lines of force increase or decrease?

14768

EXPERIMENT #10 AMMETERS - DC

OBJECTIVES

To develop the skills necessary to use ammeters.
To learn the electrical make-up of an ammeter.
To learn to construct an ammeter in an emergency, using a basic meter movement.

MATERIAL REQUIRED

Basic multimeter circuit board
Accessory kit
VOM (DC, ma)
4 - #6 dry cells (E_{bb})

PROCEDURE

1. Set up the basic circuit on the multimeter board, making sure that R_2 is set to minimum resistance before the battery is engaged.

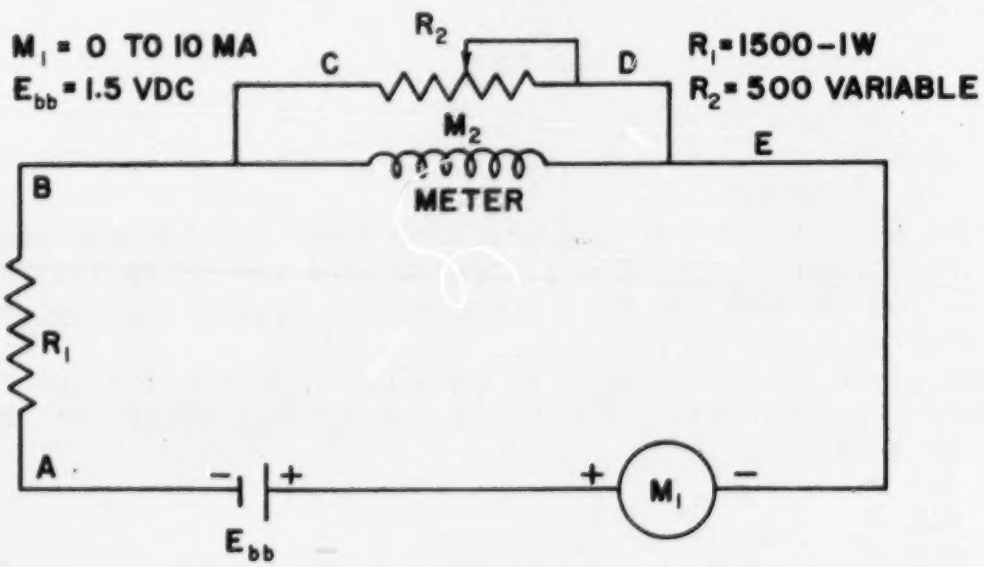

FIG. 19

2. Adjust R_2 until the meter M_2 reads full scale. Disconnect E_{bb}.

14769

3. Without moving the R_2 slider, remove R_2 from the circuit and measure its finite value. Record as R_m.
4. Place R_2 back into the circuit then explain why this variable should be called R_m (M = meter).
5. Divide the M_1 reading by two. Call this I_m and record. Why?
6. Connect the following circuit.

R_1=1.5K-1W E_{bb}=3V DC

R_2=500 VARIABLE M_1= 0 TO 10 MA

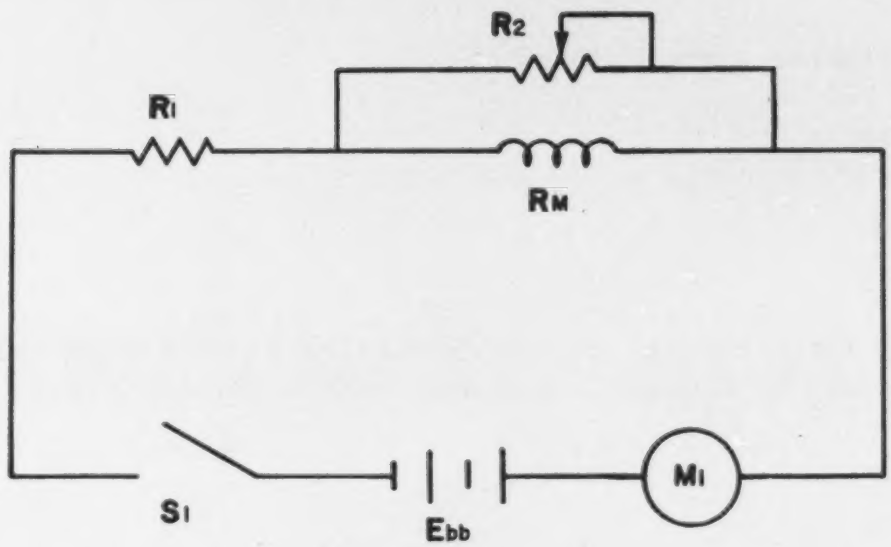

FIG. 20

7. Before closing S_1, calculate the total possible current in this circuit (Exclude R_2).
8. Calculate the value of R_2 necessary to limit the current through R_m to the maximum "safe" point. Record and set R_2 to this value.
9. Close S_1 and observe the R_m's indication. Record and explain any variations observed.
10. From the above investigation, it should be obvious that as E_{bb} increases, I_T increases. Calculate the R_2 (R_x) value for the following sources:
    a. 4.5 v
    b. 6.0 v
    c. 9.0 v
11. Substitute the R_x values on the schematic that will make the meter capable of reading:
    A = 0 to 1 amp
    B = 0 to 100 ma
    C = 0 to 10 ma
    D = 0 to 1 ma

14770

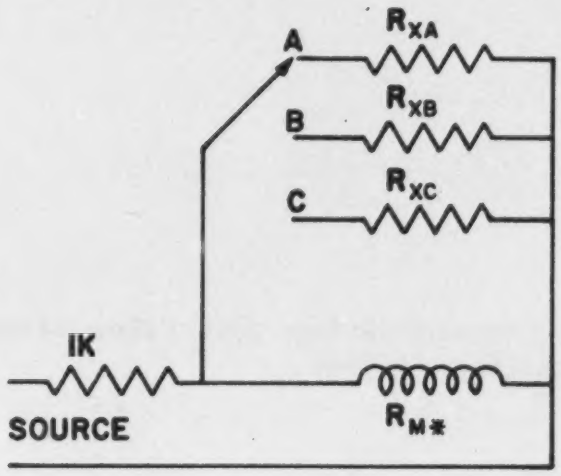

* USE THE VALUE OF R_M FROM THE PREVIOUS INFORMATION

FIG 21

12. If I_m was doubled, for a full-scale deflection:

    R_{xa} = _____
    R_{xb} = _____
    R_{xc} = _____

13. Give the schematic of a circuit for a meter movement that takes 50μ (micro) amperes for full-scale deflection. This should be capable of switching to:

    0 to 50 μa, 500 μa, 1 ma, 10 ma, and 1 ampere.

CONCLUSION

A meter must have a circuit to divide the current if it is to be used to measure currents greater than the meter movement can carry.

QUIZ

1. What type of meter movement is used in the multimeter board?
2. What is a meter-movement shunt?
3. Explain why movements generally "rob" the circuit of some power when placed in series. Would they or could they be placed in parallel?

14771

BASIC CLOTHING SILHOUETTES FOR MEDIUM FIGURE

V-neck Dress

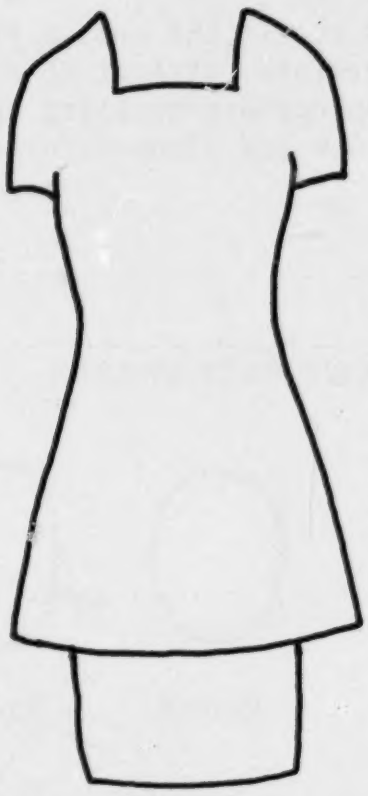

Square Neck Tunic Dress

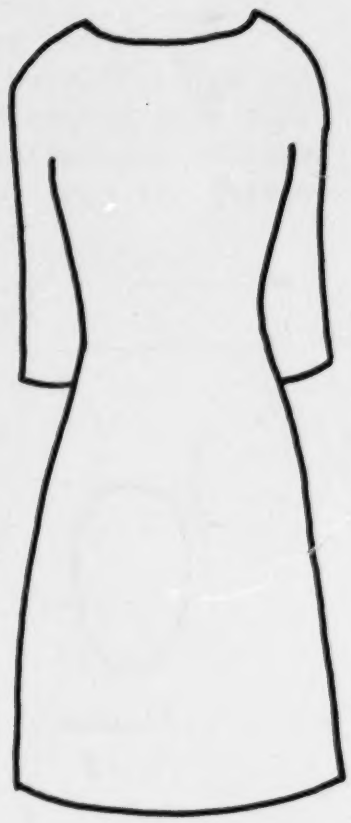

Basic Dress

Eisenhower Jacket

Bertha Collar Jacket

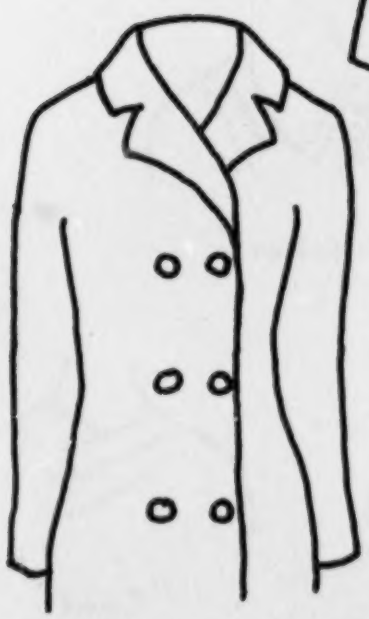

Double-breasted Coat

Double-breasted Jacket

1474

CONCLUSIONS

The experiment should have proven that a unidirectional meter-movement will measure alternating current if a device is used or switched into the circuit that converts ac into dc.

QUIZ

1. Why is R_1 placed in the circuit?
2, How could this meter be extended to measure 63v, 630v or .63v?

14773
14773

EXPERIMENT #12 VOLTMETERS

OBJECTIVE

To gain a better working knowledge of voltmeters by investigating the relationship between sensitivity and multipliers.

MATERIAL REQUIRED

Multimeter panel
Power supply
Breadboard
VOM
Accessory kit

PROCEDURE

1. Construct the following circuit. Leave S_1 off and R_3 slider at minimum resistance. (It must be determined how much current will cause full-scale deflection of M_1 and what E_m is at this time.)

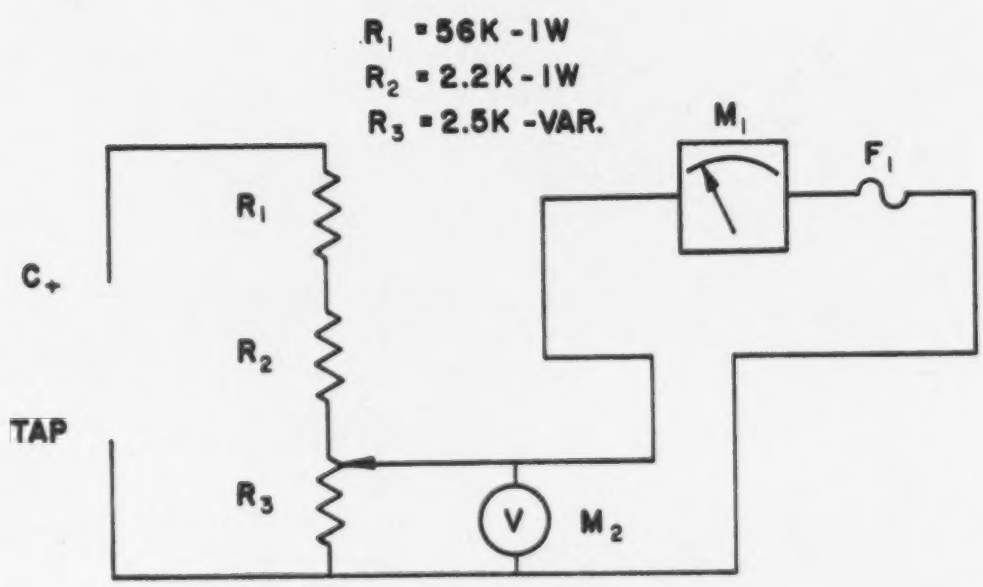

FIG. 22

2. Place M_2 on the 2.5v dc scale (observe polarity) and turn on S_1 power.

14774

3. Adjust R_2 (power supply chassis) until M_1 (P.S.) reads 100 volts dc.
4. Adjust R_3 until M_1 (Multimeter panel) reads full scale.
5. Read and record M_2 voltage. (External voltmeter). This is E_m full scale.
6. Calculate the multimeter-panel voltage-sensitivity rating from previous data.

$$SR = \frac{R_m}{E_m}$$

where SR is the amount of resistance necessary to limit the current through the meter to full-scale reading with one volt applied.

Placement example:

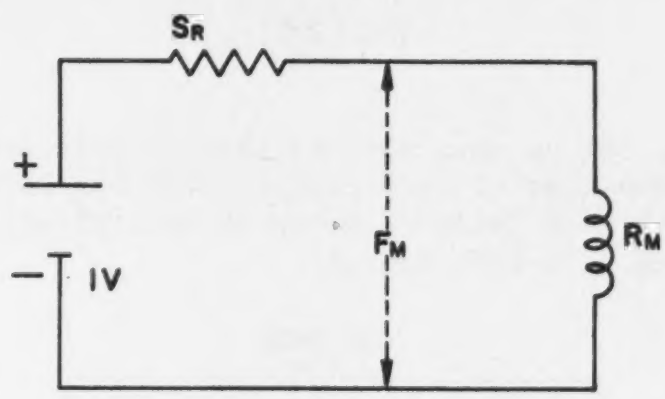

FIG. 23

7. In determining the value of multiplier resistors, calculate the value necessary to extend the voltmeter to 10v

$$R\ mult = \frac{E\ full\ scale}{I\ full\ scale} - R_m$$

8. Consider the multiplier resistor, using the "black box" method.

14775

Example

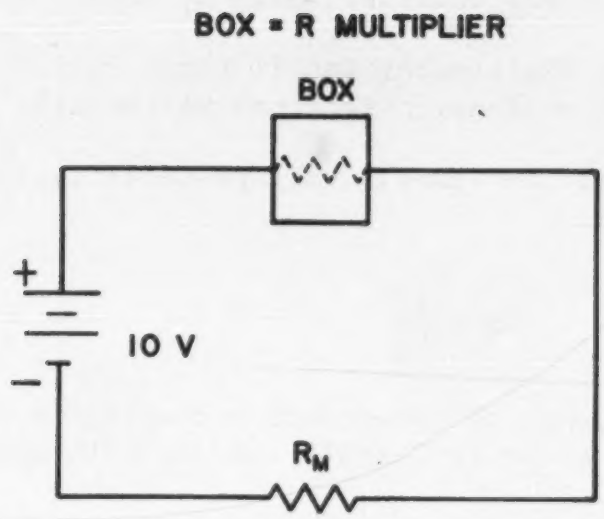

FIG. 24

If R_m can develop, let us say, no more than .1 volt across it, while passing no more than 1 ma of current, the black box must develop 9.9v, or 10.0v minus .1v. The value of R box (R multiplier) is $R + \frac{E}{I}$, or 9.9K when used with a 10-volt source.

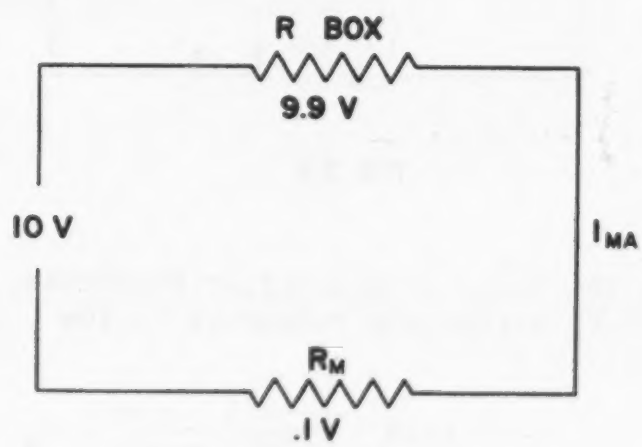

FIG. 25

9. Calculate R multiplier necessary to extend the meter to read:

A.	50v	C.	500v	E.	5v
B.	100v	D.	1000v	F.	25v

14776

10. Construct the following circuit to verify our theory.

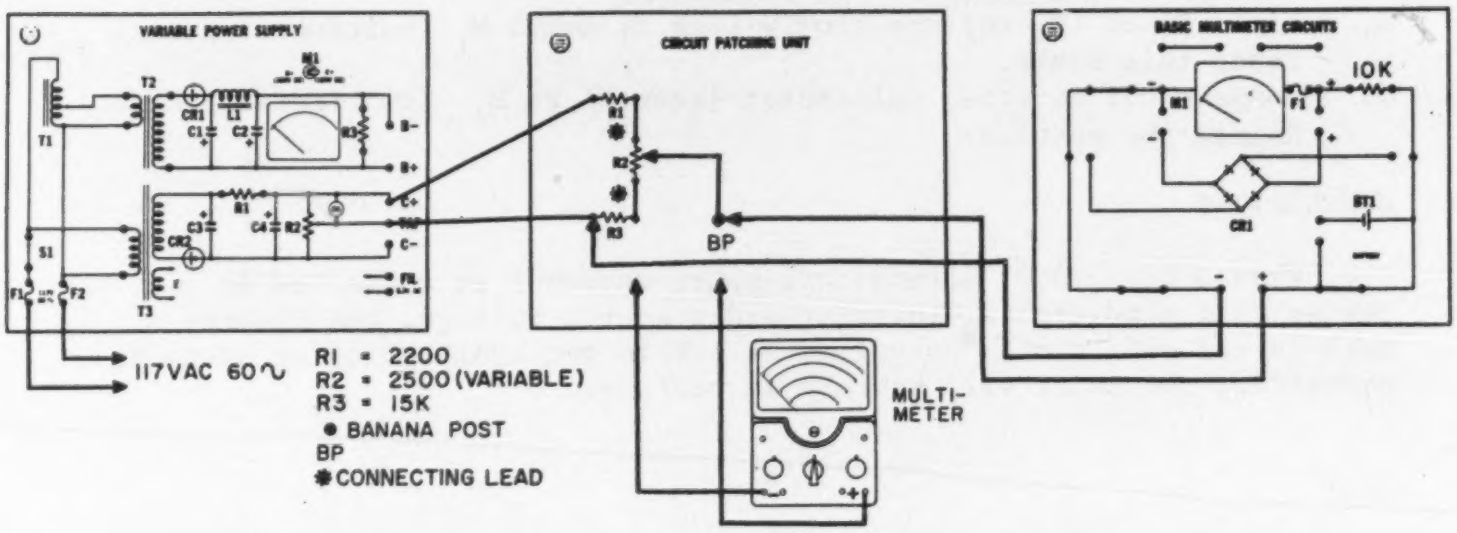

Fig. B

11. After turning the R_2 slider (patching unit) to the bottom position, adjust R_2 (+) for a power supply reading of 100 v.
12. Adjust R_2 (patching unit) until M_1 (multimeter panel) reads maximum.
13. Measure E_m and E source (external multimeter - BP to R_3 bottom).
14. Compare these readings to your calculations.

AC MEASUREMENTS

1. Construct the following circuit, but do not apply power.

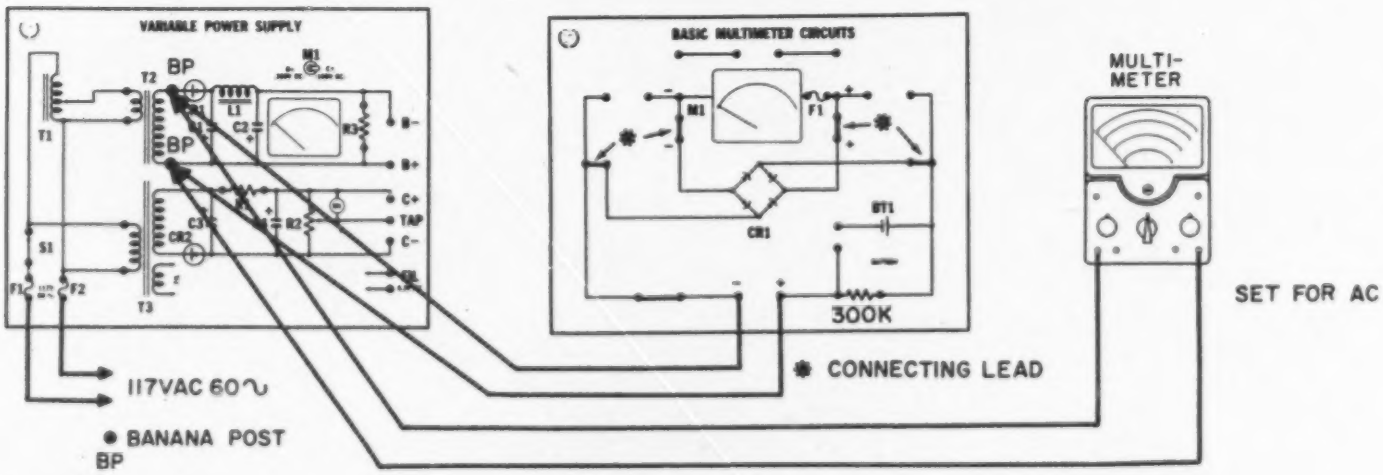

Fig. C

2. Calculate the multiplier resistor needed to produce a 0-300 volt ac voltmeter. If the calculated size is not 300K, replace the 300K resistor with your calculated value.

14777

3. Set T_1 variac, fully counterclockwise.
4. Apply power (S_1 on) and slowly turn T_1 until M_1 (multimeter panel) reads full scale.
5. Compare the external multimeter (source) to M_1 (multimeter panel). Record the results.

CONCLUSIONS

When a basic D.M. moving-coil meter movement is connected in series with a multiplier resistor and a source voltage, the instrument is called a series dc voltmeter. With the addition of an ac-to-dc converter, the meter will measure ac voltages.

QUIZ

1. A 30-volt dc voltmeter has a terminal resistance of 10K. What is the amount of current necessary for a 50% scale deflection? A full-scale deflection?
2. Why is a voltmeter scale linear?
3. Why must ac be converted to dc when used in most meter movements?

14778

EXPERIMENT #13 OHMMETERS

OBJECTIVE

To construct the two basic types of ohmmeters, testing resistances to measure the validity of the meter.

MATERIAL REQUIRED

Multimeter (VOM)
Multimeter panel
Patching unit
Accessory kit

PROCEDURE

1. Construct the following circuit (series ohmmeter).

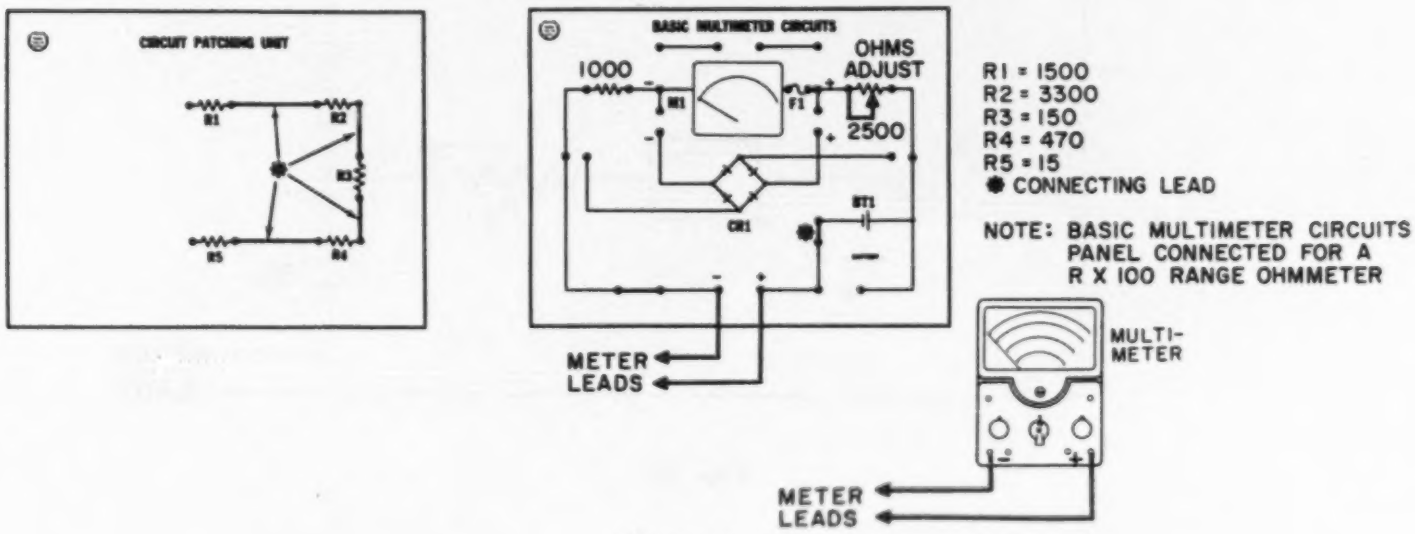

Fig. D

2. Be sure that BT_1 (1.5v) is properly polarized, then calculate R_T and I_T of the circuit, using 2500 ohms as the value in your calculations.
3. If I_m does not exceed 1 ma, momentarily touch the panel meter leads together, adjusting "ohms adjust" until M_1 reads maximum. (Do not move this potentiometer from this position, as the circuit is now calibrated.)
4. Remove BT_1 from the circuit, and measure the 1K resistance and the ohms-adjust separately. Do not measure across the meter, or it will burn out. Now add R_m to the combined series resistance and divide this value into the BT_1 voltage. This should be I_m, which was found in preceding experiments.

14779

5. Replace B T_1, then take the panel meter leads and place them across R_1 on the breadboard. I_m should be half the previous I_m. This should prove that R_T has now been doubled, indicating half current.

6. Measure and record the readings obtained when measuring across: (Refer to the circuit patching unit diagram on previous page)

R_2 = _____
R_4 through R_2 = _____
R_3 through R_4 = _____

7. Construct the following circuit.

R_S = 160 R_2 = 2.5K VAR.
R_1 = 1K BT_1 = 1.5 V

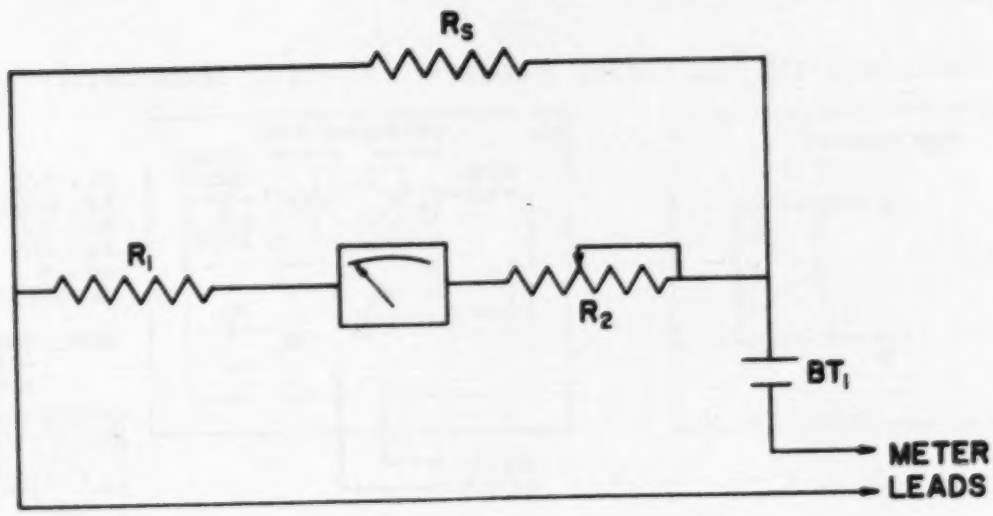

FIG. 26

8. Figure 26 is an alternate method of constructing a series ohmmeter using a meter shunt. This allows I_T to double while I_m remains constant. Adjust R_2 for full-scale deflection with the meter leads touching. Release.

9. Calculate the R_T and I_T of the circuit (consider the leads connected).

10. By calculation it is found that with the addition of R_5, in this case 160 ohms, the basic meter has been extended to read M x 10 ($160 \approx 1/10\ R_T$).

11. Measure all the previous points covered in step #6. Multiply all readings by the range multiplier (x10) to determine the actual resistance.

14780

12. Replace the 160-ohm resistor with a 16-ohm resistor. Zero the meter in as in step #3.

13. Read R_3, R_4, and R_5. The meter is on the Rx1 scale.

R x .1 = 1.6 ohm
R x 1 = 16
R x 10 = 160
R x 100 = 1600
R x 1000 = 16K
etc.

CONCLUSION

The ohmmeter is a direct-reading device but may be extended to read <u>any</u> value with the use of proper shunt or series resistances. The meter is also capable of applying power to the part or circuit under test. Never work an ohmmeter into a "live" circuit.

QUIZ

1. Compute the current-limiting resistance required to produce a full-scale deflection for a series ohmmeter having a 1 milliampere meter movement, R_m = 100 ohms, with a source of 6 volts rather than 1.5v.
2. Calculate the shunt resistance necessary when using a 50 μv (MICROAMP) movement with R_m = 100 and a source of 3v (B T_1).

14781

EXPERIMENT #14 CELLS

OBJECTIVES

To determine the condition of a primary cell by measurement of its internal resistance.

To learn how to combine cells for a variety of potentials.

MATERIAL REQUIRED

Multimeter
Accessory kit

PROCEDURE

1. Set the VOM on the 2.5-volt scale and measure the E_{NL} (no-load voltage) of a No. 6 dry cell. Record.
2. Connect a 2.2-ohm resistor "across" this cell and measure E_L (loaded voltage). (Disconnect as soon as possible because the current will approach 1 ampere.)
3. Calculate R_I (internal resistance of the battery), using the formula below.

$$R_I = R_L \left(\frac{E_{NL} - E_L}{E_L}\right)$$

4. Repeat steps 1 to 3 for at least three other cells.
5. Compare the resistances by placing them in a chart form.
6. Select, in order, the most efficient cells, using R_I as the determinant. (Bad cell, R_I = infinity)
7. Connect the 4 cells in series, in parallel, and then in combination as shown in figure E.
8. Record all measurable information.
9. Sum up all characteristics of series-connected, parallel-connected, and combination-connected cells.
10. Design a circuit which has the ability to supply power to a 1-watt lamp rated at 3 volts, dc. Four 1½-volt batteries are available, each capable of delivering 100 milliamperes.

CONCLUSION

Cells are combined to form batteries capable of delivering either high-output voltage and low current or low-output voltage and high current, depending on the requirements of the load circuit.

14782

BASIC FACE SHAPES, NECKLINE STYLES, AND COLLAR STYLES

Face shapes are designed to fit the medium figure type. An oval face is considered ideal; therefore, attempt to create this illusion for other face shapes by using appropriate neckline and collar styles. Various neckline and collar styles given are planned for the medium figure pattern wearing the basic dress.

BASIC FACE SHAPES

NECKLINE STYLES

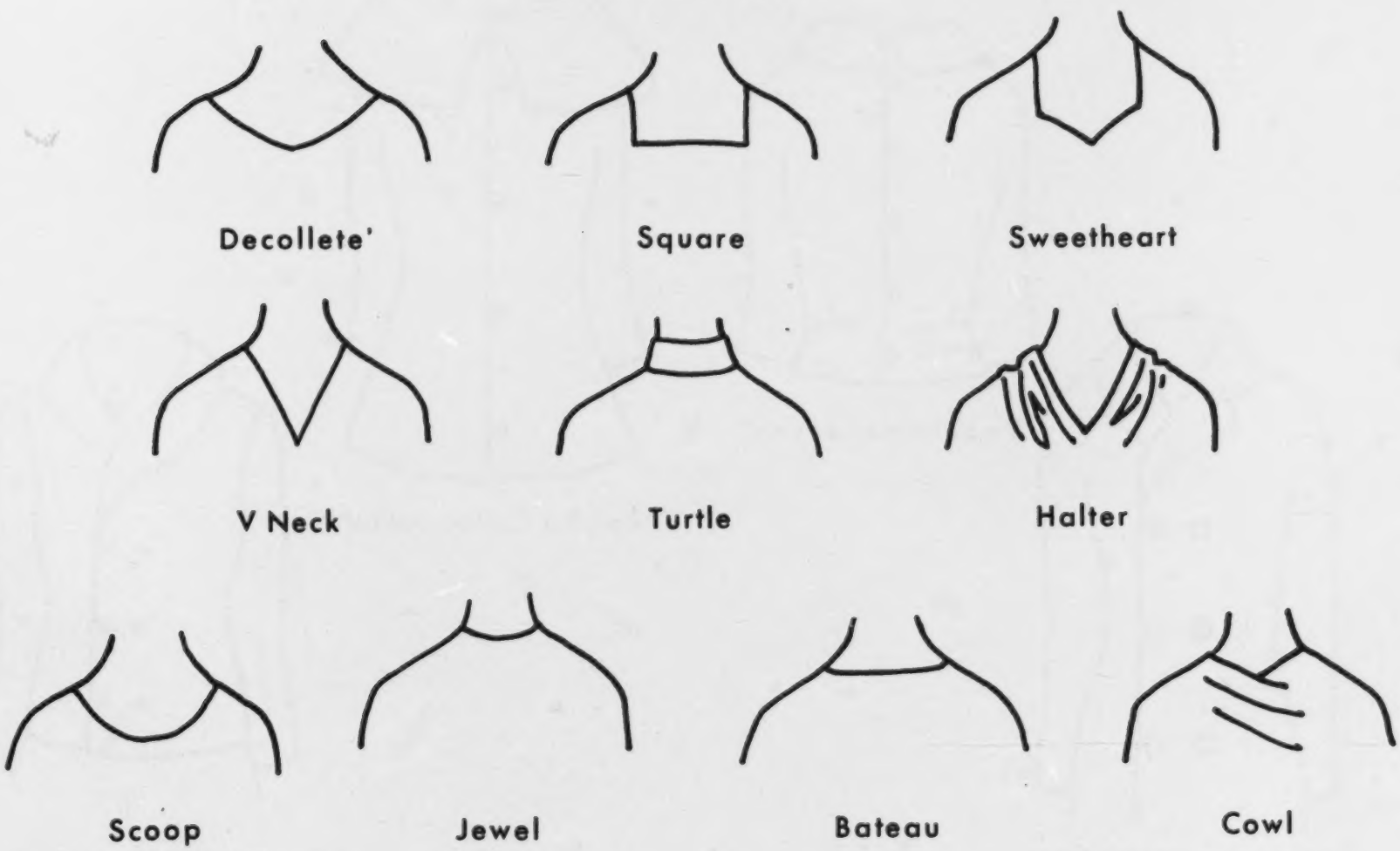

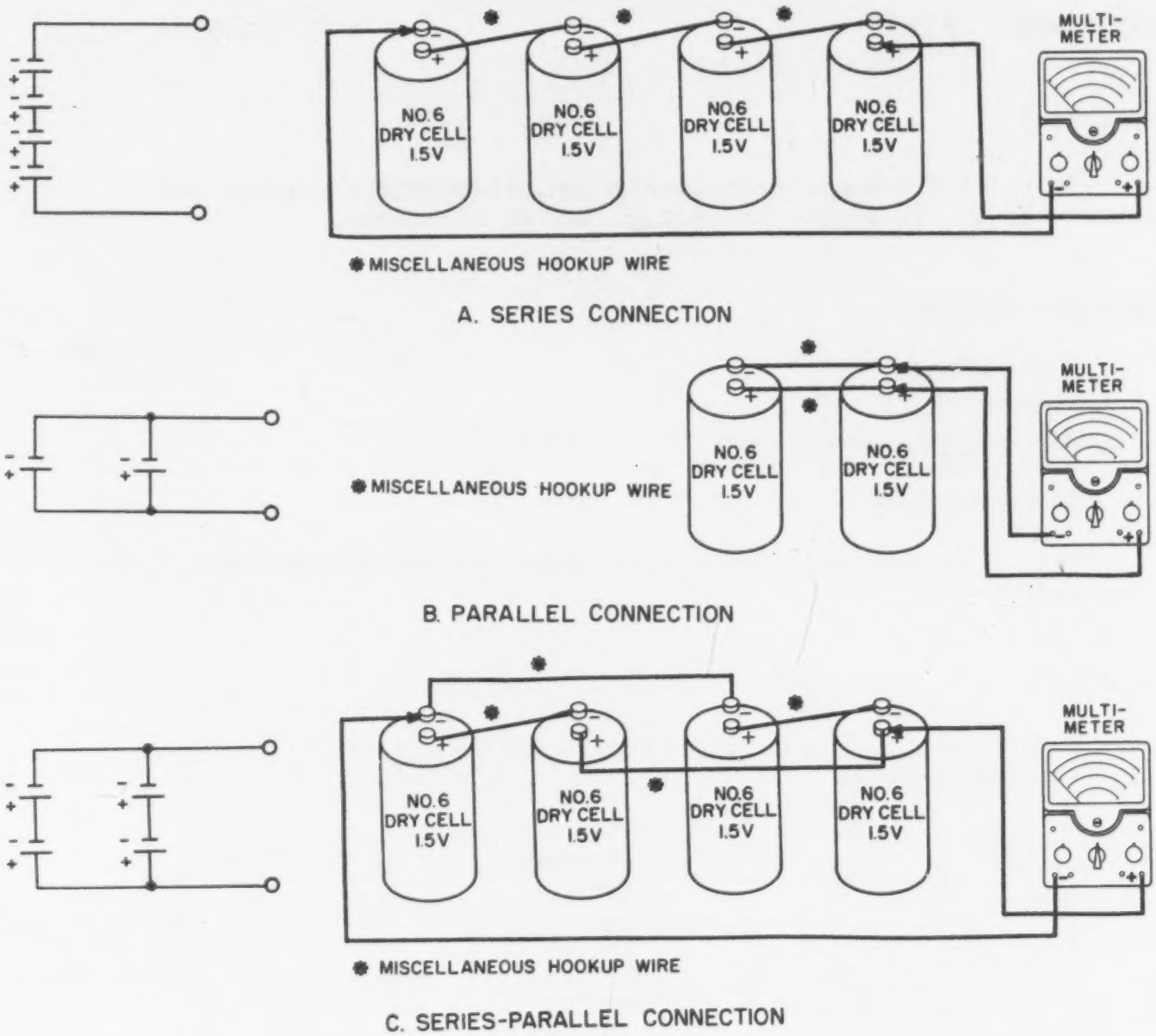

Fig. E

QUIZ

1. If two cells, one 1½v and the other 3 volts, are connected in parallel, what would a voltmeter measure when placed across these two batteries? 1½, 3, or 4½ volts?
2. Define polarization. How can it be decreased?
3. Why does a primary cell have a limited "shelf" life?
4. What is a battery?

14783

EXPERIMENT #15 KIRCHHOFF'S LAW

OBJECTIVE

To verify, through experimentation, Kirchhoff's voltage and current laws. To apply the voltage law in circuitry.

MATERIAL REQUIRED

Power supply
Breadboard
Multimeter
*VTVM (Vacuum tube voltmeter)
Accessory kit

*Read manufacturer's instruction sheet before attempting to use this instrument.

PROCEDURE

1. Construct the following circuit, with S_1 off and T_1 and R_2 fully counterclockwise.

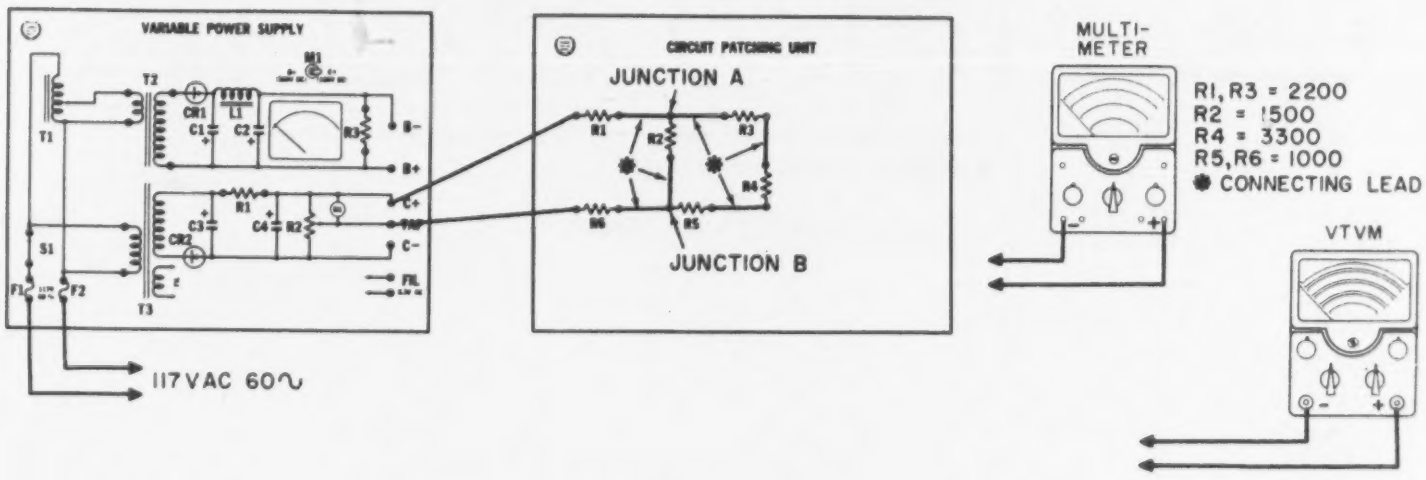

Fig. F

2. Turn on S_1 and adjust R_2 until C+ = 45v.
3. Measure and record the voltage drop across R_1, R_2, and R_6. Do these add up to give the applied voltage?
4. Measure the voltage developed across R_1, R_3, R_4, R_5 and R_6. Together they make up a closed loop. Explain how Kirchhoff's voltage law applies to a closed loop such as mentioned in steps 3 and 4.
5. Use a VTVM to test the two closed loops, comparing it to the VOM readings.

14784

6. Measure $I\ R_6$, $I\ R_2$, and $I\ R_5$ with the VOM.
7. If $I\ R_6$ is the current to junction "B", does $I\ R_2 + I\ R_5$ add up to $I\ R_6$?
8. Measure $I\ R_1$ through $I\ R_3$. Does $I\ R_2 + I\ R_3$ add up to $I\ R_1$? Explain how Kirchhoff's Current Law applies in this step.
9. Using the circuit built on the patch panel, write the algebraic current and voltage sign path.

Ex:

$$-I\ R_1 + I\ R_2 + I\ R_3 = 0$$
$$-10 + 5 + 5 = 0$$

CONCLUSION

Kirchhoff's voltage and current laws use deductive reasoning in analyzing complex circuitry by other means than Ohm's law. Ohm's law is <u>never</u> incorrect, but sometimes it is a slow method of analysis.

QUIZ

1. In what direction is current assumed to flow, when using the laws?
2. A voltage traced in the direction of assumed current-flow is preceded by a _____ sign, whereas a voltage drop traced against the assumed direction of current-flow is preceded by a _____ sign.

14785

EXPERIMENT #16 SUPERPOSITION THEOREM

OBJECTIVE

To solve complex circuits involving two or more sources of voltage or current.

MATERIAL REQUIRED

Breadboard
Power supply
VOM
Accessory kit

INTRODUCTION

In any resistive network containing several power sources, the current through any resistor can be determined by algebraically adding individual currents caused by each source acting alone. During the individual determinations all other power sources are considered "shorted out."

EXAMPLE:

$R_1 = 10$ $R_4 = 40$

$R_2 = 20$ $R_5 = 50$

$R_3 = 30$

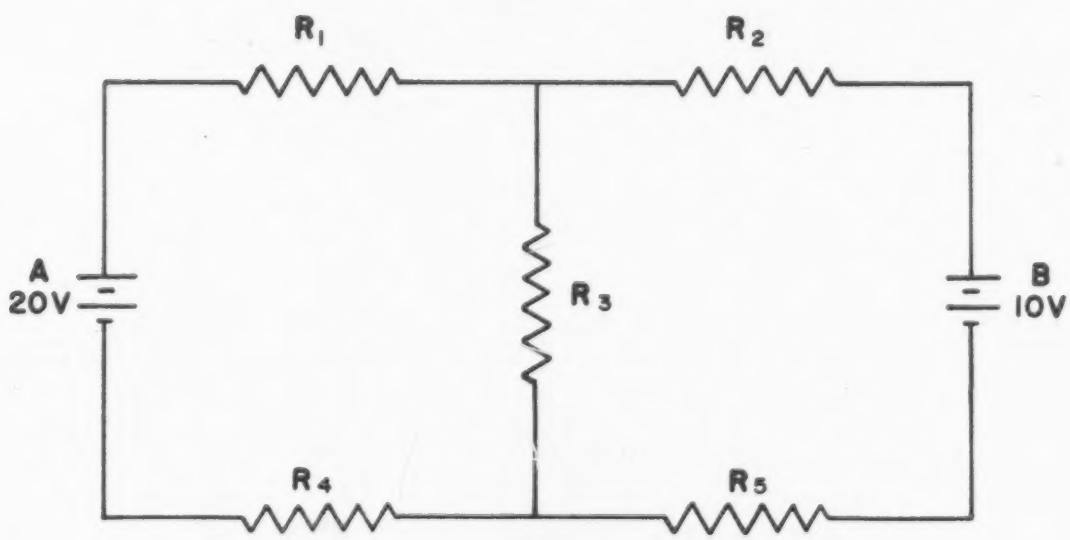

FIG. 27

14786

A. First we short out one source, arbitrarily picking "B." Now we have a simple combination circuit.

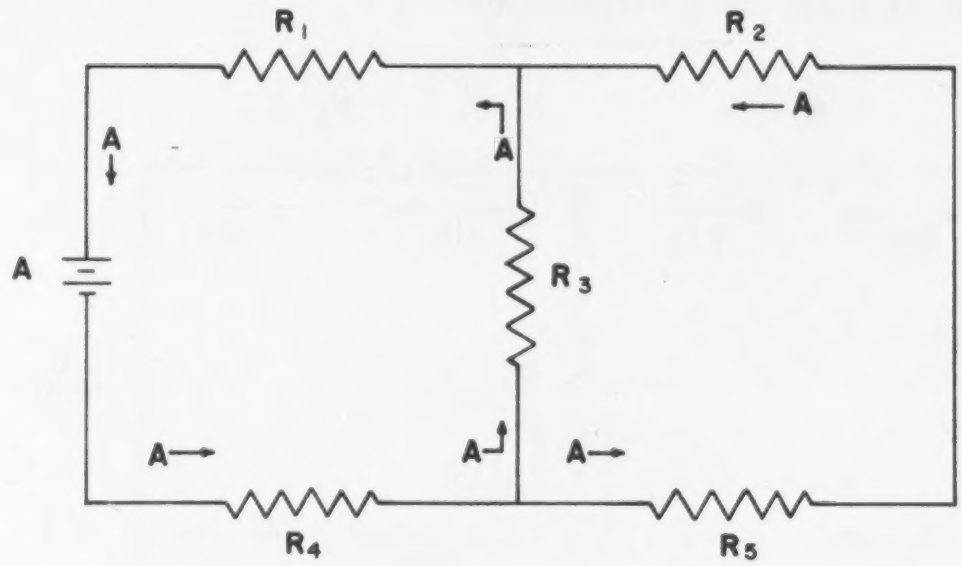

FIG. 28

B. Calculate R_1, and I R_1 through I R_5. Label your answers I_{1a} through I_{5a}.

C. Replace the "B" source and short out the "A" source.

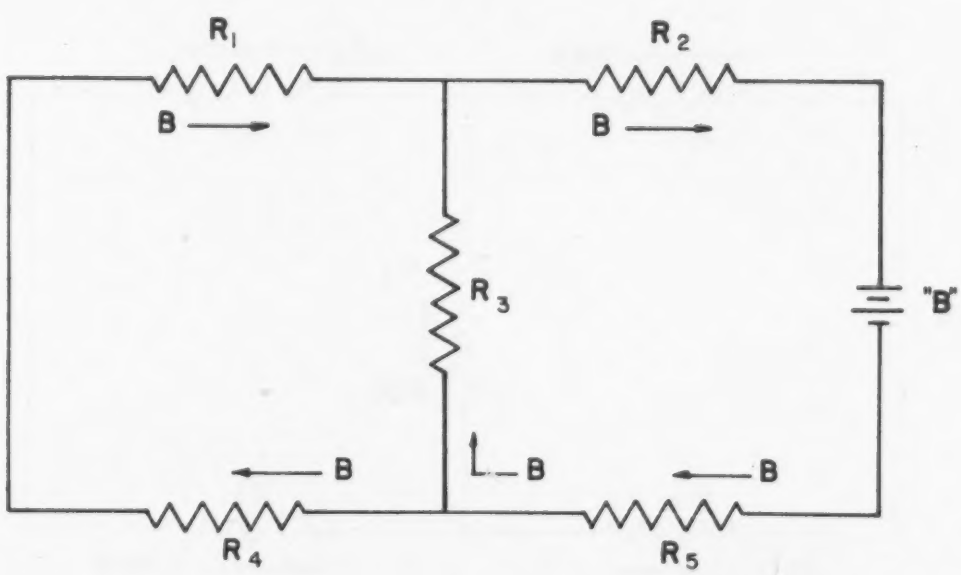

FIG. 29

14787

D. Calculate R_T and I R_1 through I R_5. Label the answers I_{1b} through I_{5b}.

E. Redraw the combined circuit, labeling "A" current "Diamond" and "B" current "Arrows," as in Figure 30.

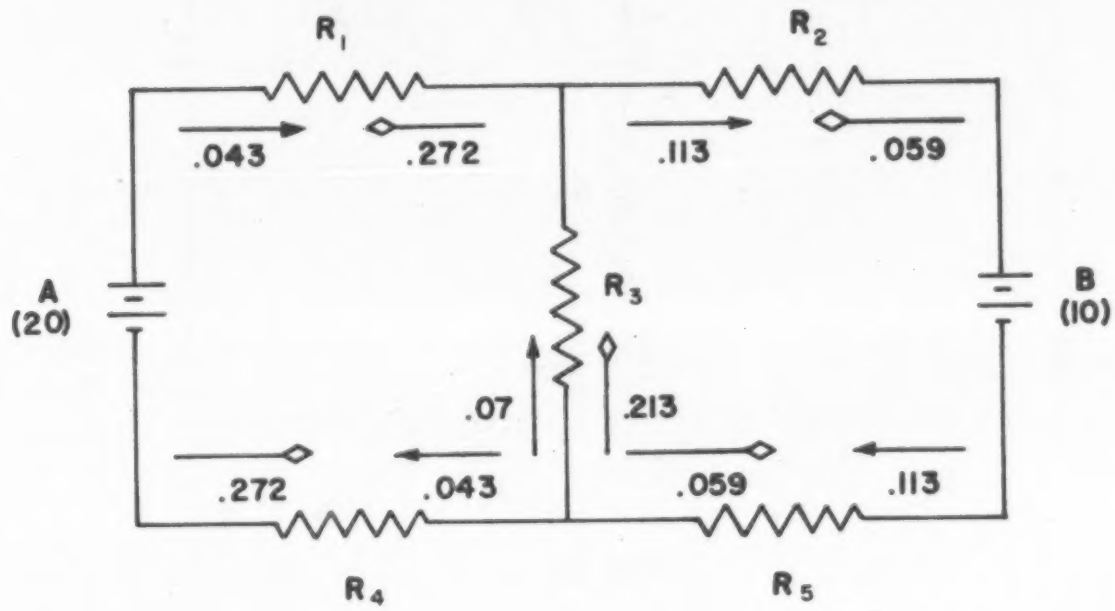

FIG. 30

F. Enter the algebraic sums, using the subtractive method, and showing the direction with an arrow, as in Figure 31.

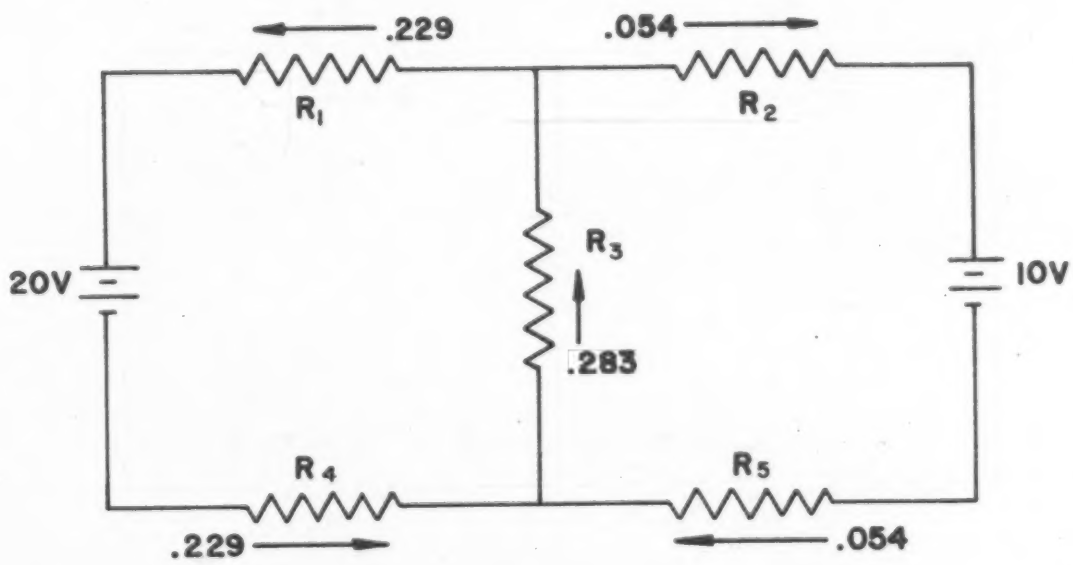

FIG. 31

14788

G. Using Ohm's Law, we find E R_3 to be 8.49v, in the direction shown by the arrow. All other values can be easily found.

H. Current sources would be worked out similarly, using an open circuit instead of a short.

EXAMPLE:

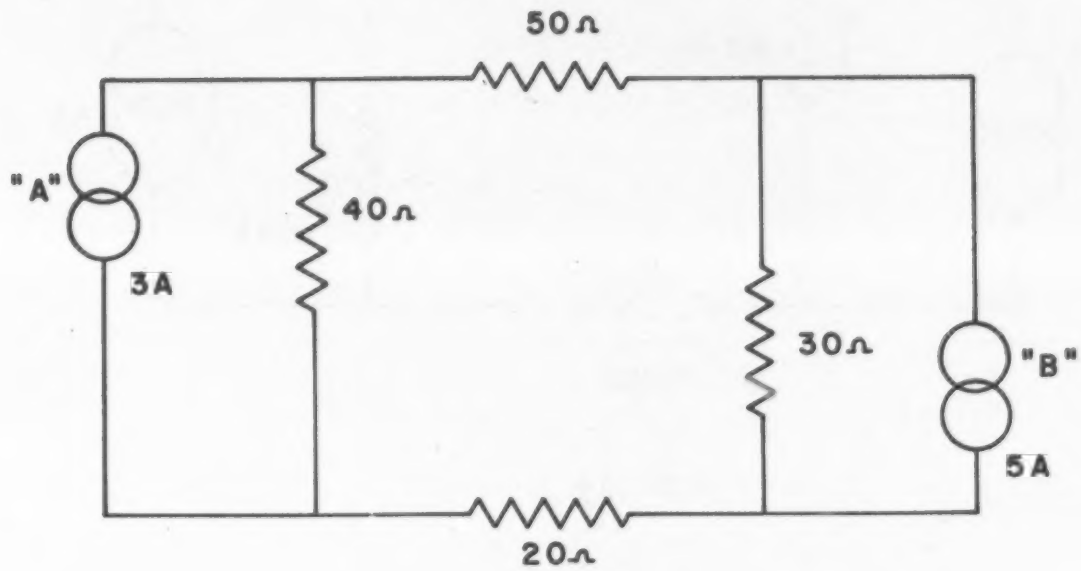

FIG. 32

Open one source and calculate the needed values, as in Figure 33.

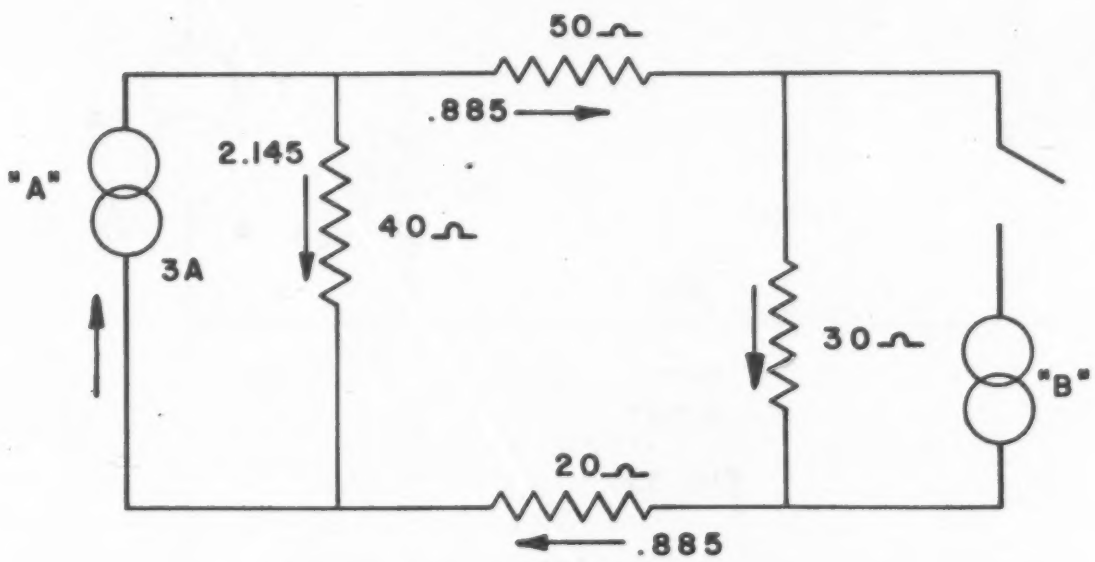

FIG. 33

14789

Open the other source and calculate the needed values, as in Figure 34.

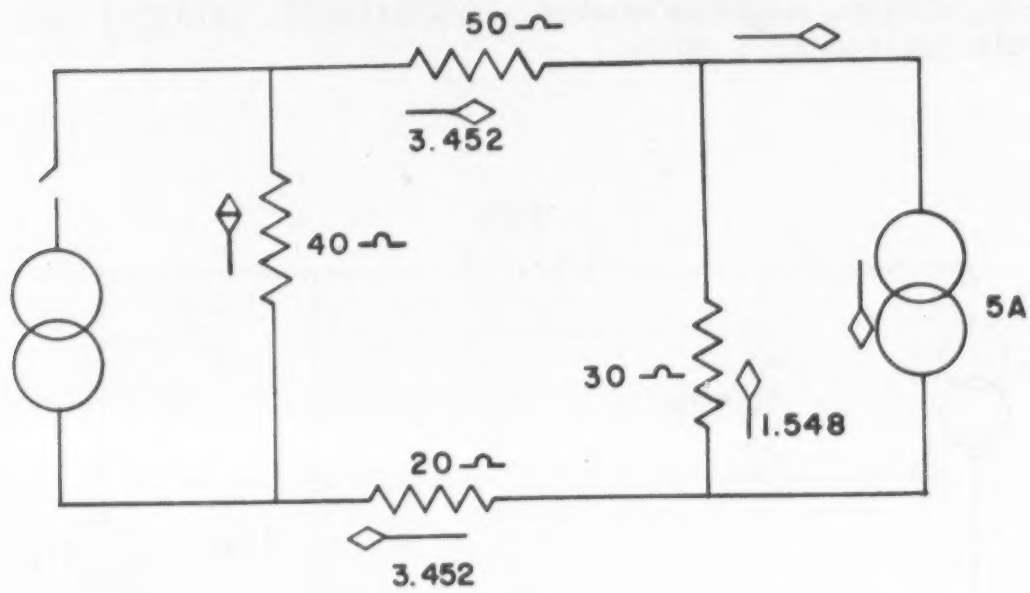

FIG. 34

Combine algebraically as in Figure 35.

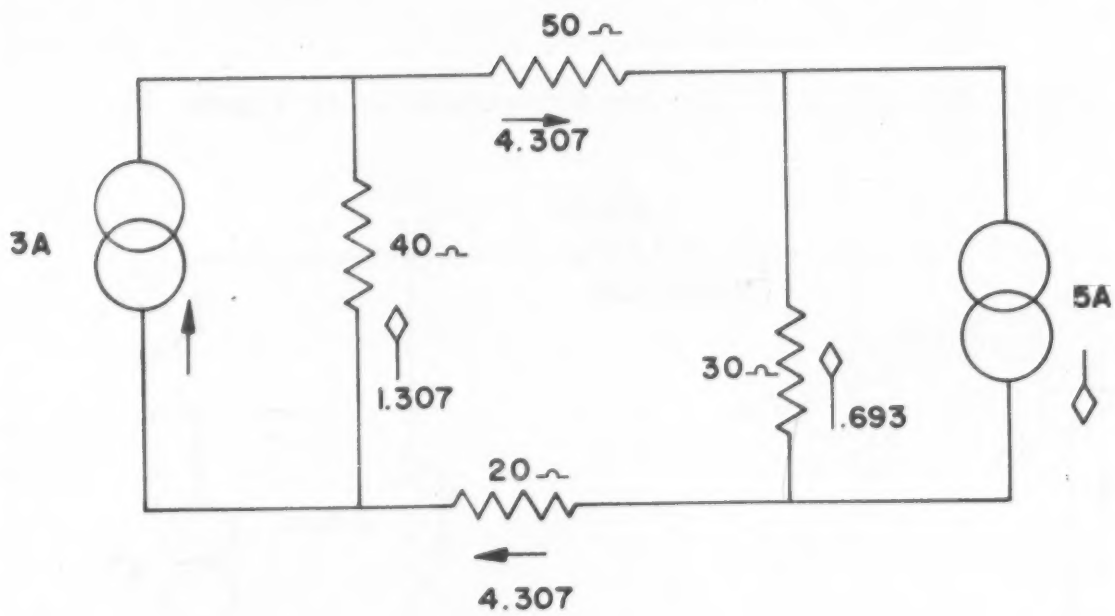

FIG. 35

I. Ohm's Law will now resolve all voltages and powers.

14790

PROCEDURE

1. Construct the following circuit on the patch panel.

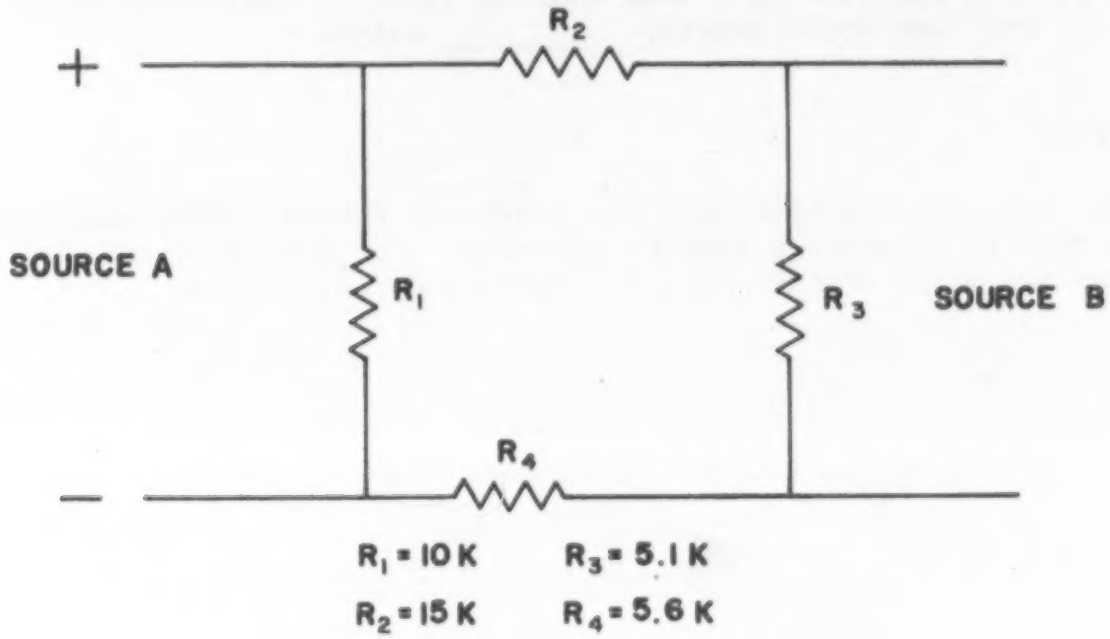

FIG. 36

2. Connect source "A" to CT and Tap. Adjust for 20v output.
3. Connect source "B" to BT and B-. Set to 25v output.
4. Calculate and then measure all voltages and currents, noting all significant differences.
5. Construct the following circuit on the patch panel.

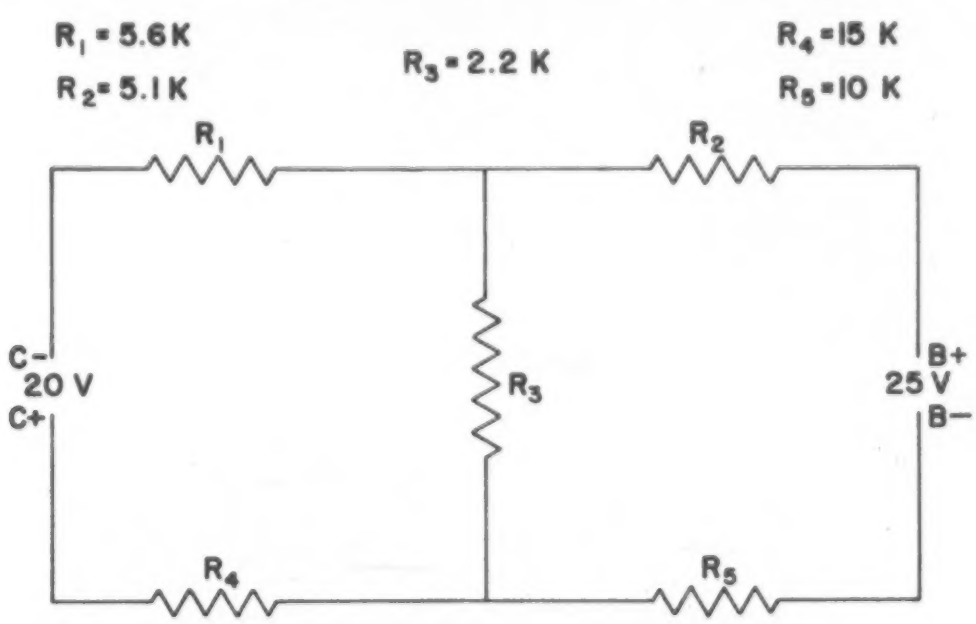

FIG. 37

14791

6. Calculate, then measure all currents and voltages. (Indicate direction.)
7. If R_3 were replaced by a lamp with an internal resistance of 2.2K, the lamp would develop _____ watts.

CONCLUSIONS

Many circuits use more than one source of energy. Step analysis reduces them to relatively simple circuits. You must know and understand the two major methods used -- closed and open sources.

14792

COLLAR STYLES

Peter Pan

Button-down

Pointed-club

Tuxedo

Tie

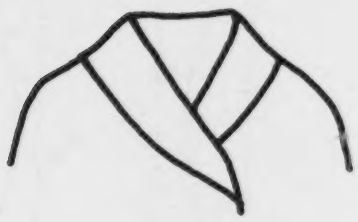

Shawl

Bandeau

Mandarin

Cape

1476

EXPERIMENT #17 THEVENIN'S THEOREM

OBJECTIVE

To simplify complex circuits by reducing them to simple circuits where Ohm's Law may be used.

MATERIAL REQUIRED

Patching panel
VOM and VTVM
Power supply
Accessory kit

INTRODUCTION

Thevenin's Theorem states: Any two-terminal circuit can be replaced by a simple series circuit consisting of an equivalent voltage source and resistance where:

A. The equivalent source is the voltage that would be present at the load terminals with the load removed.
B. The equivalent series resistance is the resistance that would be measured at the load terminal with the source replaced by its internal resistance and the load removed.

The theorem takes into consideration that the source voltage must be held constant.

EXAMPLE:

To find I R_3 and E R_3:

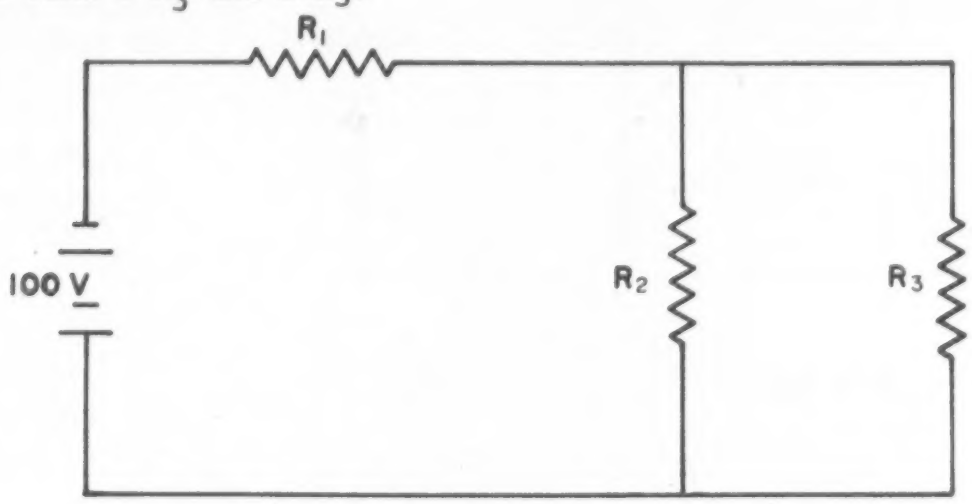

R_1 = 10K R_2 = 20K R_3 = 20K (LOAD)

FIG. 38

14793

213 OF 327

ED

056 238

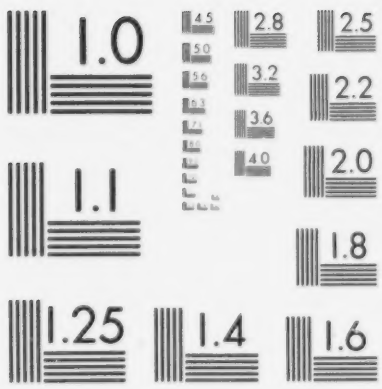

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

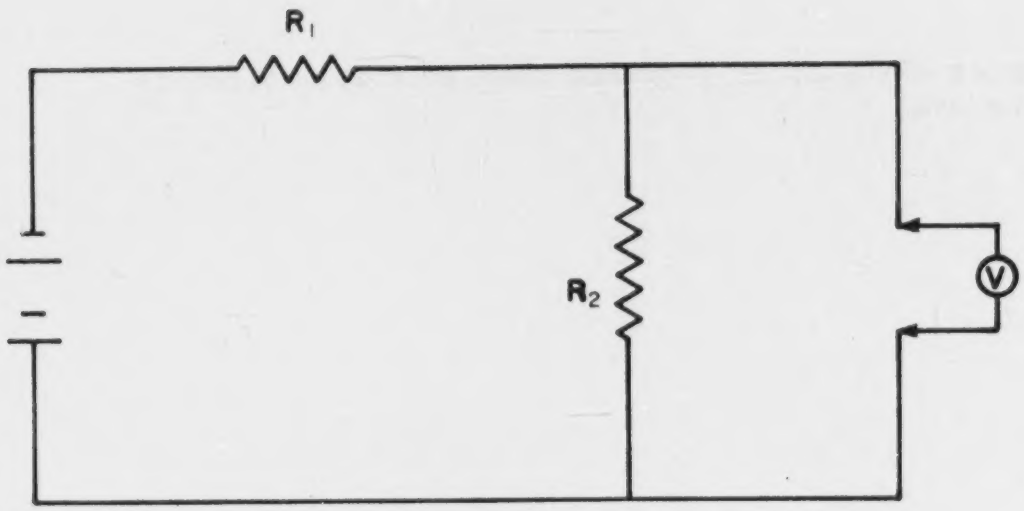

Remove the load. Calculate E_{TH} (equivalent voltage) at the load point (67v)

FIG. 39

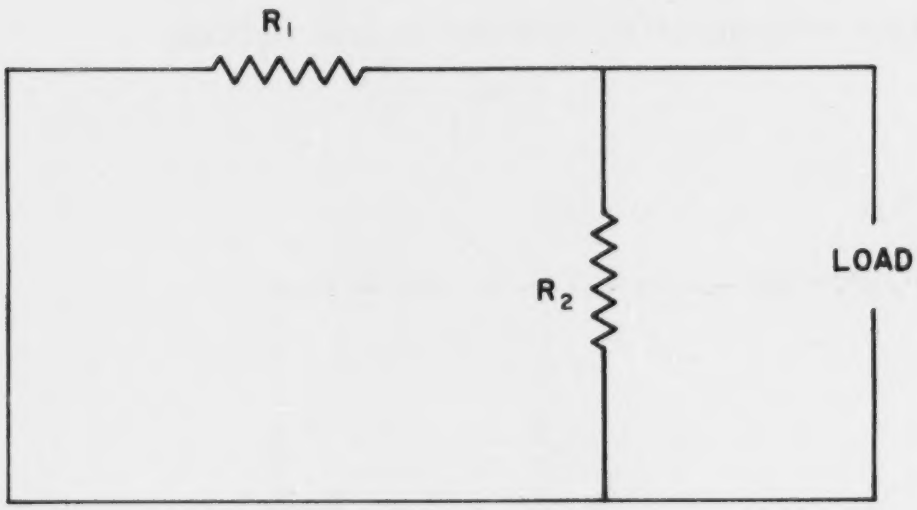

Replace the source by a short (assuming source resistance is low).

FIG. 40

14794

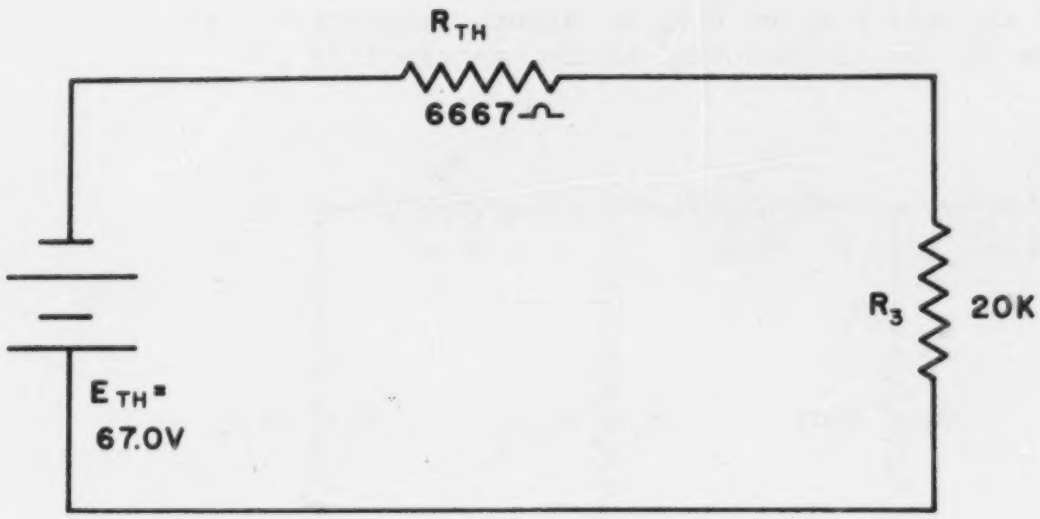

Looking back from the load, R_1 and R_2 are in parallel. Lump and call them R_{TH}.

FIG. 41

The circuit can now be solved by Ohm's Law. The I_T in this circuit is 2.5 ma; hence the IR_3 is also 2.5 ma because of the series-circuit arrangement. The ER_3 is 50 volts. This is a very simple circuit, but the principle may be applied to the most complex circuit. The circuit often can be resolved by visual inspection.

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EXAMPLE #2

It is not easy to find I R_6 or E R_6 by visual inspection. If we apply the theorem to the circuit (twice) we can simplify it.

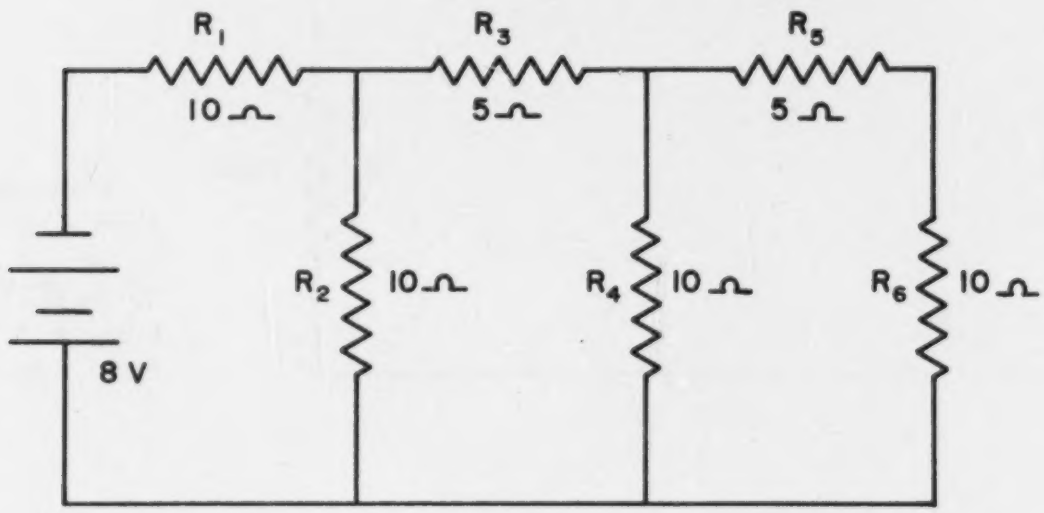

FIG. 42

Regard everything beyond R_3 as the load. This places R4, R5 and R6 as the load. It also places R_1, R_2 and R_3 in the source circuit.

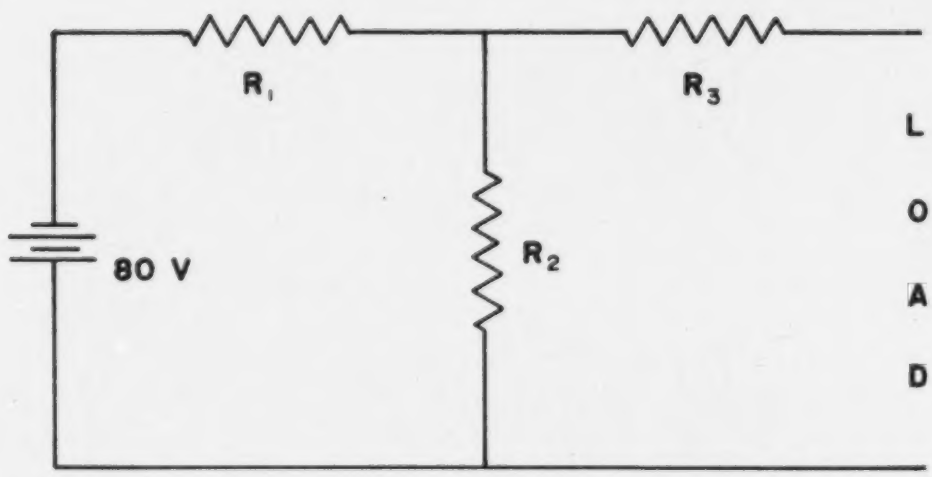

FIG. 43

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The circuit has the load removed. Determine E_{TH} by looking back from the load terminals. Notice that R_3 has no voltage developed, as there is no current-path through it. The source voltage divides equally between R_1 and R_2. This means that E_{TH} = 40v. To find R_{TH}, replace the 80v battery with a short, placing R_1 and R_2 in parallel but still in series with R_3. R_{TH} = 10 ohms: R_1 and R_2 in parallel produce an equivalent 5 ohms, which is in series with R_3, a 5-ohm resistance, for a total of 10 ohms.

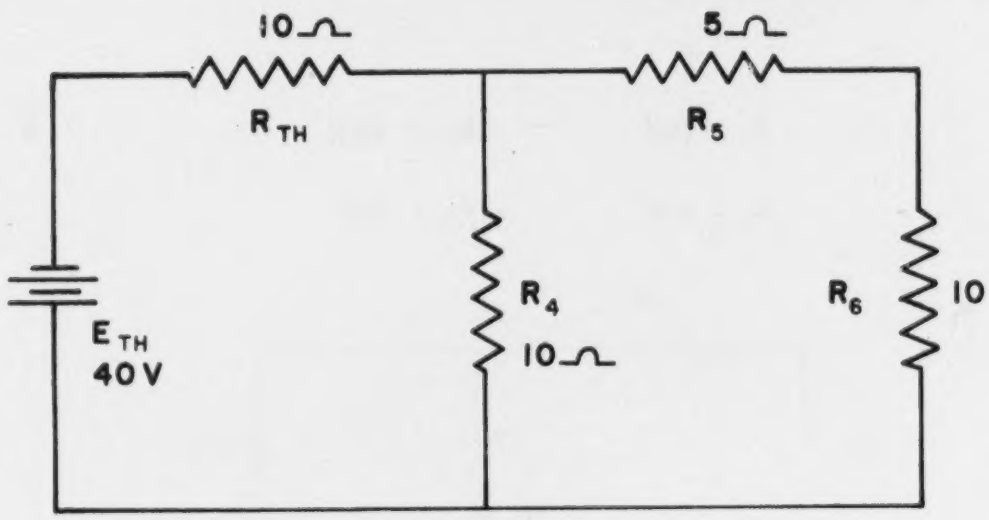

FIG. 44

Introduce the load circuit, designating R_6 as the load, and remove it again to determine E_{TH} and R_{TH}. Calculate E_{TH} = 20v and R_{TH} = 10 ohms.

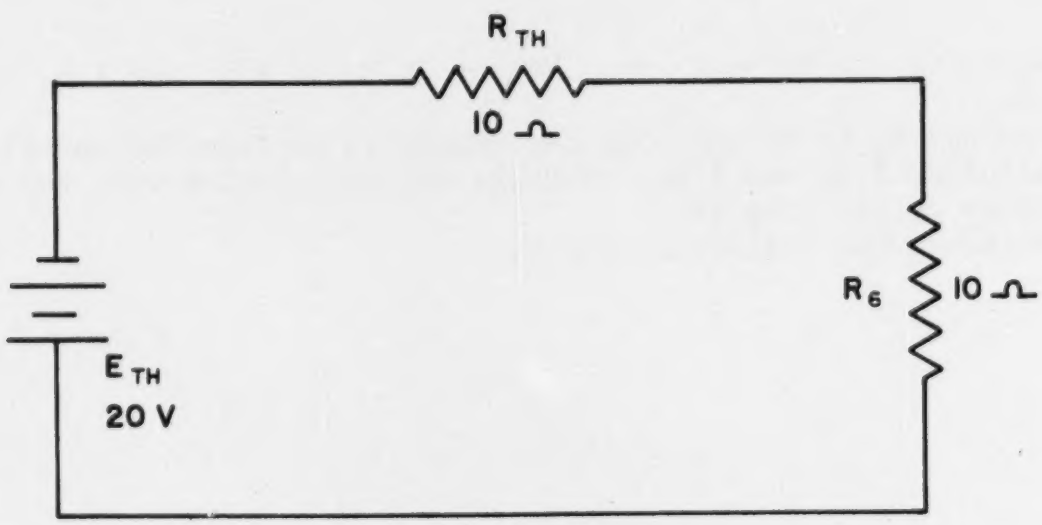

FIG. 45

14797

Reconnecting the circuit, we find the simplified circuit, the equivalent circuit of the 6 original resistors, much easier to analyze.

PROCEDURE

1. Construct the following circuit.

R_1 = 15K R_3 = 22K

R_2 = 10K R_4 = 18K

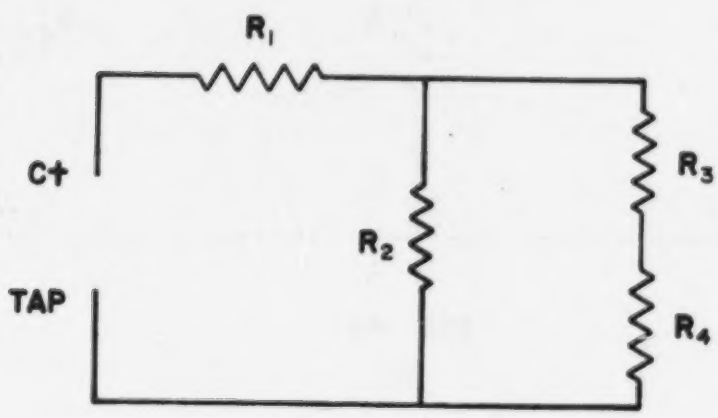

FIG. 46

2. Adjust C+ to 15 volts dc. Measure E R_1 to ER_4 and I R_1 to I R_4.
3. Consider R_4 to be the load resistance to be found by calculation.
4. Calculate E R_4 and I R_4. Compare the calculation with the measured values as per step #2.
5. Construct the following circuit.

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R_1 = 47K R_4 = 56K

R_2 = 22K R_5 = 5.6K

R_3 = 18K R_6 = 15K

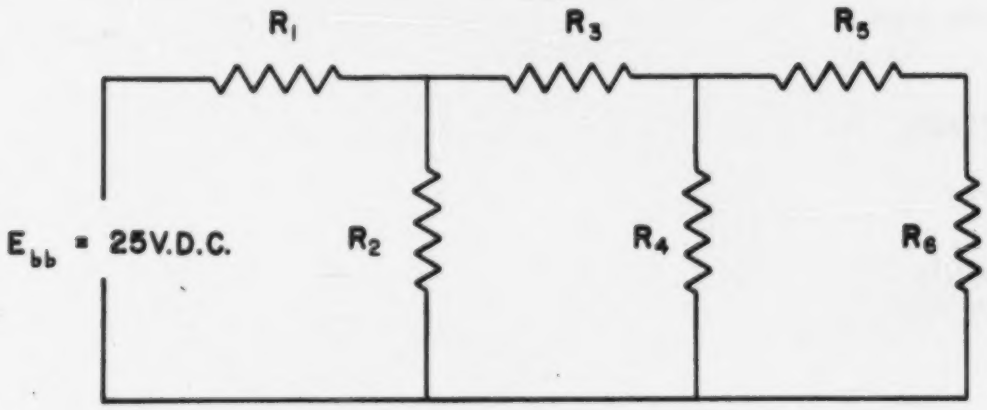

FIG. 47

6. Consider R_6 as the load, and calculate the values, using Thevenin's Theorem; then measure I R_6 and E R_6. Compare all results.

CONCLUSIONS

Beginning with a very complex circuit, we can make use of several repetitions of Thevenin's Theorem to calculate a simple equivalent circuit, readily solved. The theorem is widely used in research to analyze semi-conductor circuitry.

QUIZ

1. In which of the circuits discussed or calculated in this experiment is maximum power dissipated by the designated load? Explain your answer.
2. What effect do the component values have on the value of Thevenin's equivalent resistance?
3. Using Ohm's Law, calculate any of the circuits constructed. Compare this solution with the Theorem method. List any advantages noted when using Thevenin's Theorem.

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EXPERIMENT #18 WYE-DELTA NETWORK

OBJECTIVE

To learn to reduce complex circuits, which often cannot be reduced by Ohms Law.

MATERIAL REQUIRED

Breadboard
VOM
Power Supply
Accessory Kit

INTRODUCTION

The Delta and Wye are types of circuit connections.

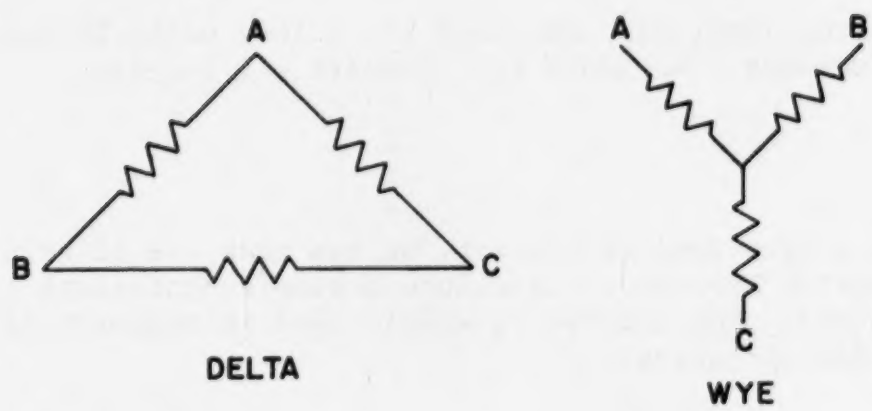

FIG. 48

An example of a Delta-Wye conversion

14800

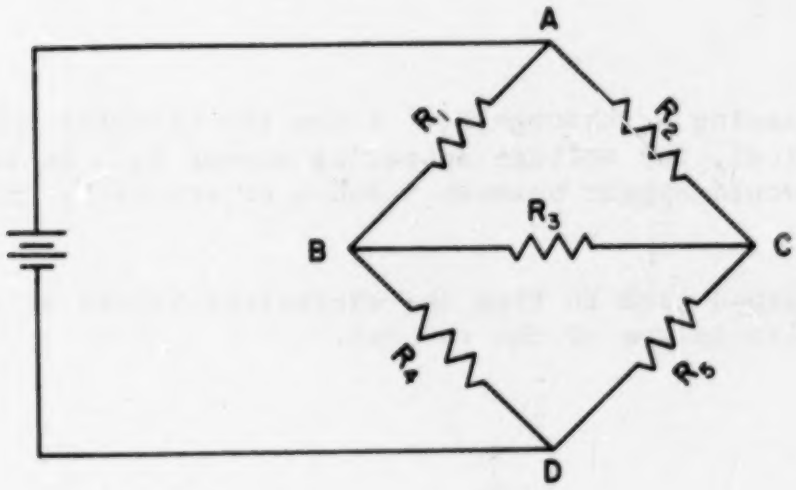

FIG. 49

The circuit in Figure 49 contains a bridge network across a source. If R_T were to be determined by Ohm's Law, it would be a difficult task. Between points A, B, and C a delta network is formed. If the network were replaced by a Wye at these points, as in Figure 50, Ohm's Law could resolve the circuit.

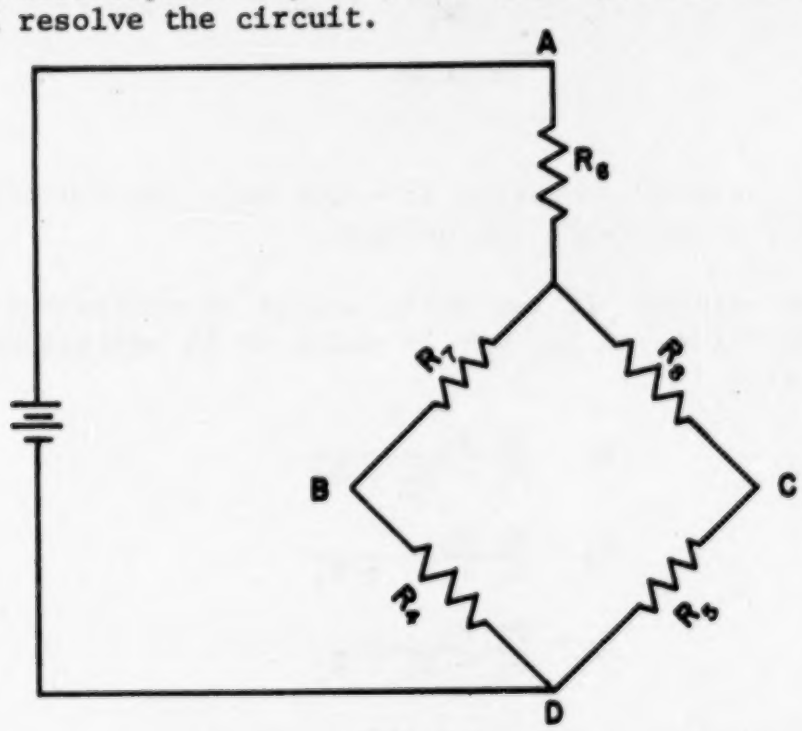

FIG. 50

Figure 50 shows the delta replaced by a wye with

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ILLUSTRATIONS SHOWING THE EFFECT OF LINE ON FIGURE TYPES

Optical illusions may be created for various figure types by using lines such as horizontal, vertical, curved, and diagonal. Vertical lines give the illusion of height; panels, of width; and tapered panels, of slenderness. The use of the vertical line is shown below.

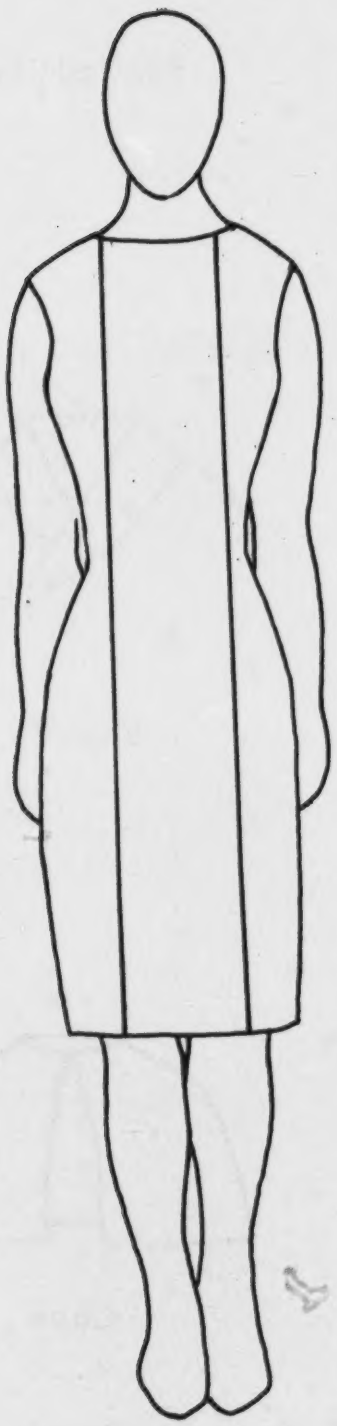

Medium

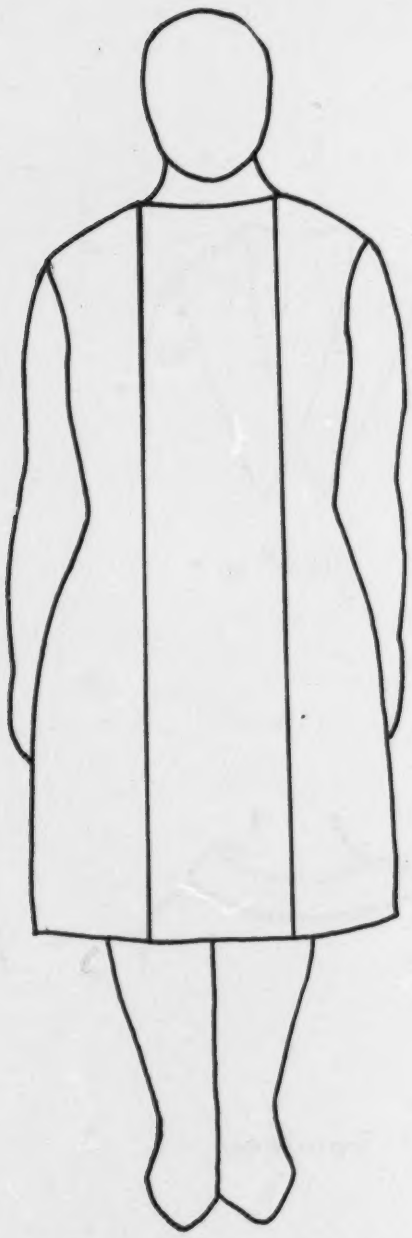

Short and Heavy

1477

R_6 through R_8 replacing R_1 through R_3. Since the circuits would be electrically identical, the voltage appearing across R_3 in the original circuit would appear between B and C, or across R_7 and R_8 in Figure 50.

This is one method used to find the equivalent values of resistance, converting from delta to wye or the reverse.

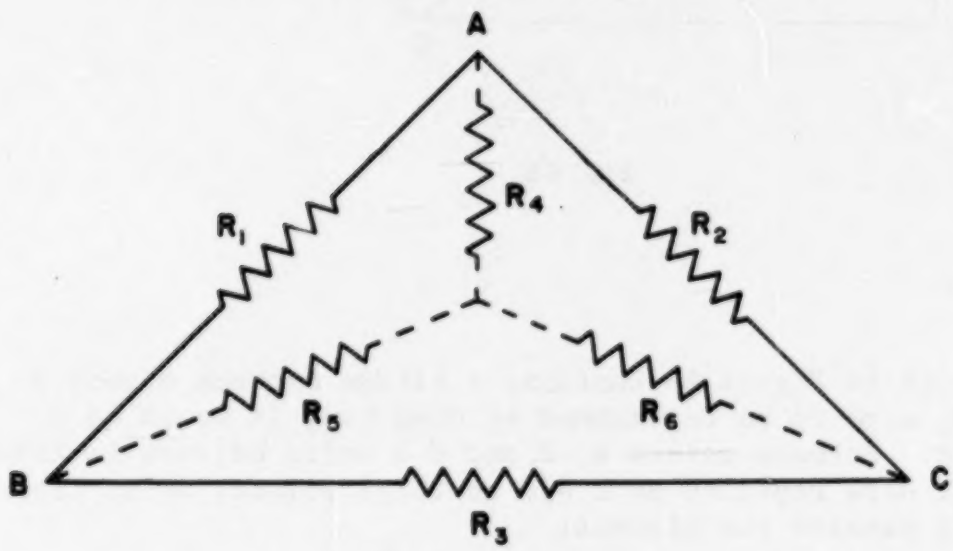

FIG. 51

The circuit could be converted to a wye with the substitution of R_4 through R_6, thereby simplifying the network.

The question arises: If the delta values of resistance are known what would be the values of the wye in order to <u>BE</u> equivalent? The conversion tables:

$$R_4 = \frac{R_1 \; R_2}{R_1 + R_2 + R_3}$$

$$R_5 = \frac{R_1 \; R_3}{R_1 + R_2 + R_3}$$

$$R_6 = \frac{R_2 \; R_3}{R_1 + R_2 + R_3}$$

In a similar manner, a wye-to-delta conversion:

$$R_1 = \frac{R_4 \; R_5 + R_4 \; R_6 + R_5 \; R_6}{R_6}$$

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$$R_2 = \frac{R_4 R_5 + R_4 R_6 + R_5 R_6}{R_5}$$

$$R_3 = \frac{R_4 R_5 + R_4 R_6 + R_5 R_6}{R_4}$$

More elaboration on bridge circuits will follow in Experiment #19.

PROCEDURE

1. Construct the circuit below on your patch panel.

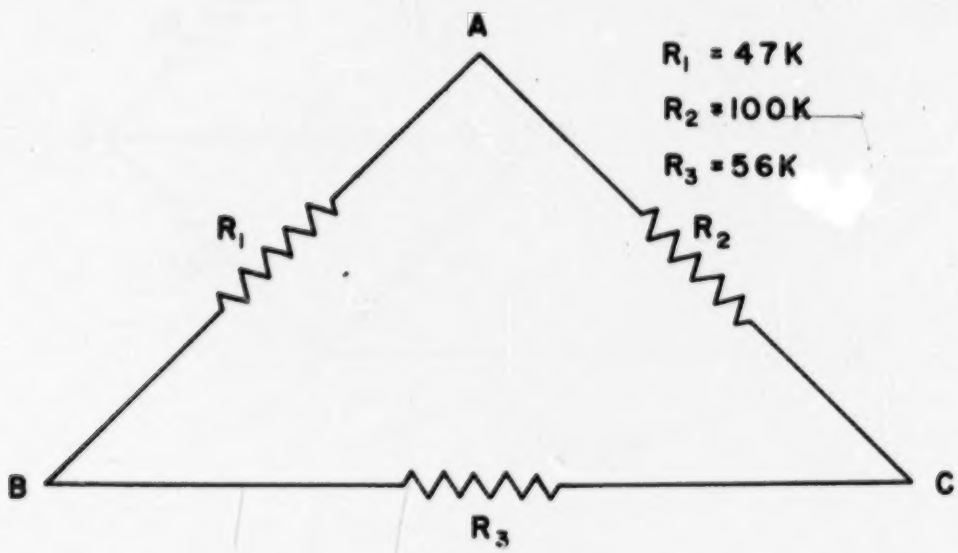

FIG. 52

2. Measure R between points.

   A to B = _____
   A to C = _____
   B to C = _____

3. Connect Ct to point A, tap to B, and adjust for 10 volts dc.
4. Measure and record the voltage between A - C and B - C.
5. Move the power supply to point C (Ct) and -B (tap).
6. Measure and record the voltage from point A - B and A - C.
7. Convert the delta network to a wye.
8. Select 3 resistors that are close to the calculated values in step 7. Wire on the patch panel.
9. Measure and record the resistance between A - B, A - C, and B - C on the wye network. How do these resistances compare to points A to B, A to C, and B to C in the delta arrangement in step 2?
10. Connect a 10v supply between points A and B .

14803

11. Measure and record the voltage between points A - C and B - C. Compare these voltages to previous readings of the delta network.
12. Connect a 10v supply between A - C on the wye patch. Measure and record the voltage between points A - B and B - C.
13. Connect the 10v supply between B - C on the wye patch. Measure the voltages between A - B and A - C.
14. Construct the following circuit.

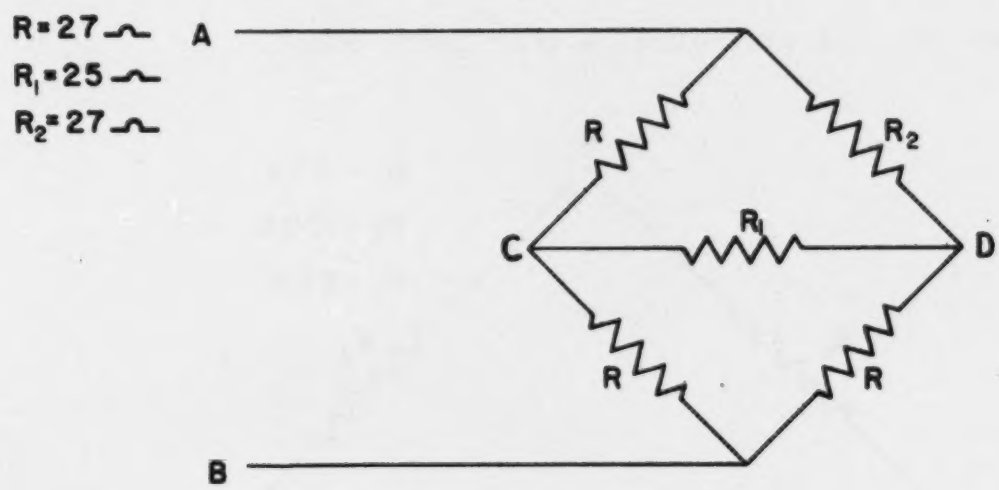

FIG 53

15. Measure R_T between points A - B and C - D.
16. Convert the delta (top section) to wye, calculating the R_T. Compare step 15 to 16.
17. Measure the resistance between points C and D.
18. Change R_2 to 160 ohms. Measure the resistance between points C and D.
19. Now change R_2 to 10 ohms. Measure resistance between points C and D.
20. Compare steps 17 through 19.

CONCLUSION

After learning how to convert delta circuits to wye circuits, the solution of complex networks can be obtained using Ohm's Law.

14804

EXPERIMENT #19 DC BRIDGE CIRCUITS

OBJECTIVES

To gain a working knowledge of bridge circuits.

To construct an experimental voltage or resistance bridge used in testing precision measurements.

MATERIAL REQUIRED

Breadboard
VOM (2 Reqd.)
Accessory kit
4 #6 dry cells (Because of the current regulation required, batteries are used as the power supply in this experiment.)

INTRODUCTION

One of the most widely used instruments in quality-control testing is called the resistance bridge. This bridge is used in very low tolerance circuits where .1 ohm is critical. A dc bridge circuit is shown below in Figure 54.

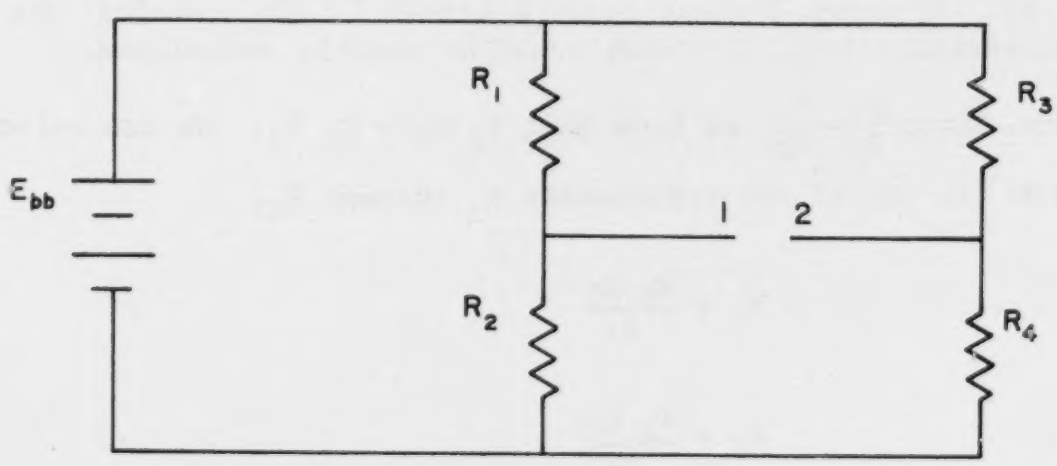

FIG 54

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This is more commonly drawn as in Figure 55.

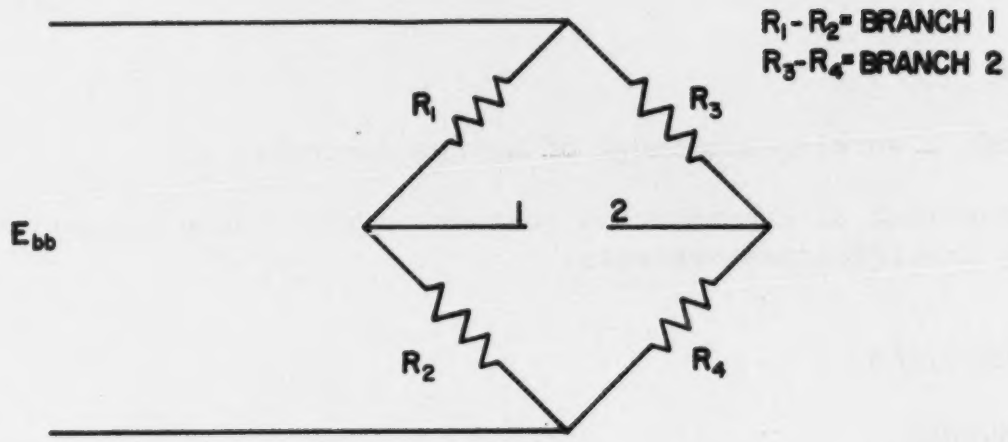

FIG. 55

It is worth noting that $R_1 - R_2$ and $R_3 - R_4$ are each in series across E_{bb} and act as voltage dividers. Point 1 voltage is determined by the $R_1 - R_2$ resistance ratio. Conversely, point 2 value is determined by $R_3 - R_4$ resistance relationship. A meter inserted between points 1 and 2 (M_1) would indicate the emf existing between those points. For example if R_2 and R_4 are in the same proportion as R_1 and R_3, M_1 would read zero, as no current would flow through the meter movement. Hence the name "balanced bridge". This type of bridge can be used to measure either voltage or resistance. For example, if R_4 were unknown and R_3 were variable (a calibration resistor), varying R_3 until M_1 indicated zero would indicate that I R_4 and I R_3 were in the same proportion as I R_2 and I R_1. R branch 1 would equal R branch 2. By reading the calibration resistor (R_3), R_4 value could be readily calculated.

From the ratio $\frac{R_1}{R_3} = \frac{R_2}{R_4}$, we know that $R_1 R_4 = R_2 R_3$. We can solve this equation for any of the resistances R_1 through R_4.

$$R_4 = \frac{R_2 R_3}{R_1}$$

$$R_3 = \frac{R_1 R_4}{R_2}$$

$$R_2 = \frac{R_1 R_4}{R_3}$$

$$R_1 = \frac{R_2 R_3}{R_4}$$

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Normally R_1 and R_3 are fixed precision resistors with predetermined ratios. The value of R_2 is read on a calibrated dial and multiplied by a simple ratio R_3/R_1 which may be 1:10, 1:1, 10:1, etc.

If R_1 and R_3 are 1:1, R_2 and R_4 (the unknown) will also be 1:1. Normally, a special meter called a center-zero meter is used. The pointer has the ability to move either left or right from a static position. Normal meters usually have their static position on the left side or the right side(ohmmeter). This center zero protects the meter, since the current may flow in either direction from the zero position. A VOM meter movement can usually be adjusted "off" normal zero by moving the mechanical zero-adjustment screw which sets the pointer off the left-or right-hand edge. This can be set to some even number of the scale, which would then equal static zero. The setting can be 10, 20, or 50, etc. with the range switch set to a high range. The range is then reduced until it accommodates the maximum swing.

PROCEDURE

1. Obtain a piece of cardboard 2" x 2". Set its extremes on the potentiometer as shown and mark in percentages as shown in Figure 56.

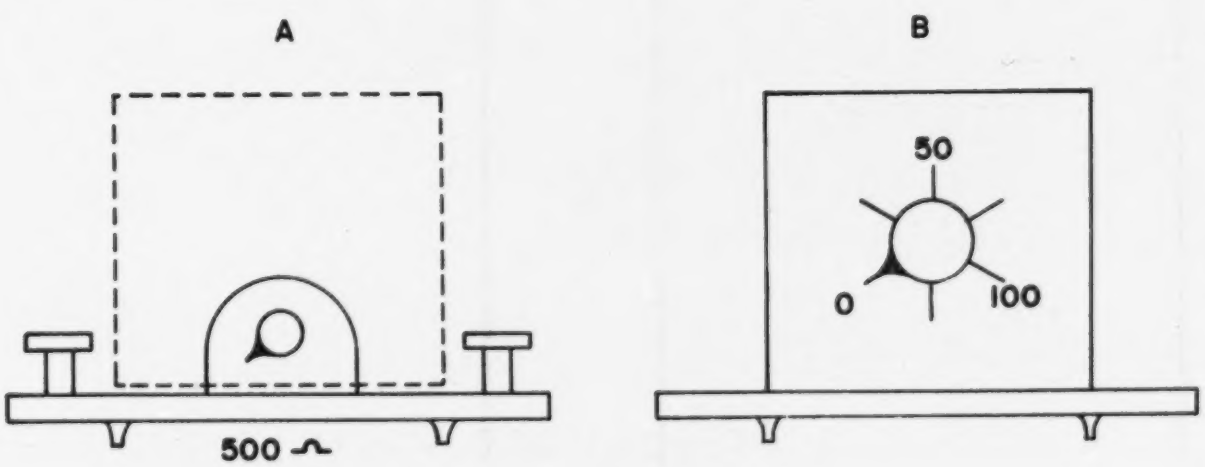

FIG. 56

2. Remove the knob and nut from the potentiometer and mount the cardboard under the nut. Assemble, making sure that the knob extremes are at 0 and 100.
3. Construct the following circuit. (R_3 is the potentiometer.)

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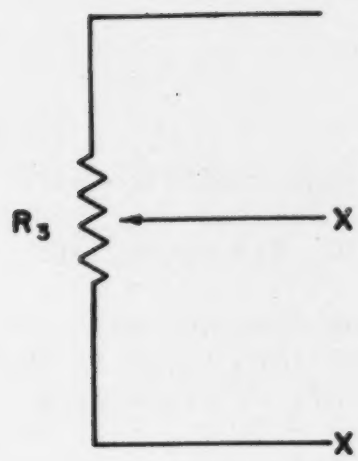

R_3 = 500 OHM

CALIBRATION POT

FIG. 57

4. Connect an ohmmeter to terminals X. Turn R_3's knob so that the pointer reads exactly at zero (as per your drawing on the cardboard). Read the ohmmeter and record the obtained value in the chart, Figure 58. Set the potentiometer for each of the scale points listed on the calibration chart and record the resistance readings for each setting.

SCALE	RESISTANCE	SCALE	RESISTANCE
0		55	
5			
10			
50		100	

FIG 58

5. Using the data in the chart, Figure 58, plot a resistance curve for your potentiometer. Use Figure 59. This curve will show the resistance of the 500-ohm potentiometer for any setting of the dial.

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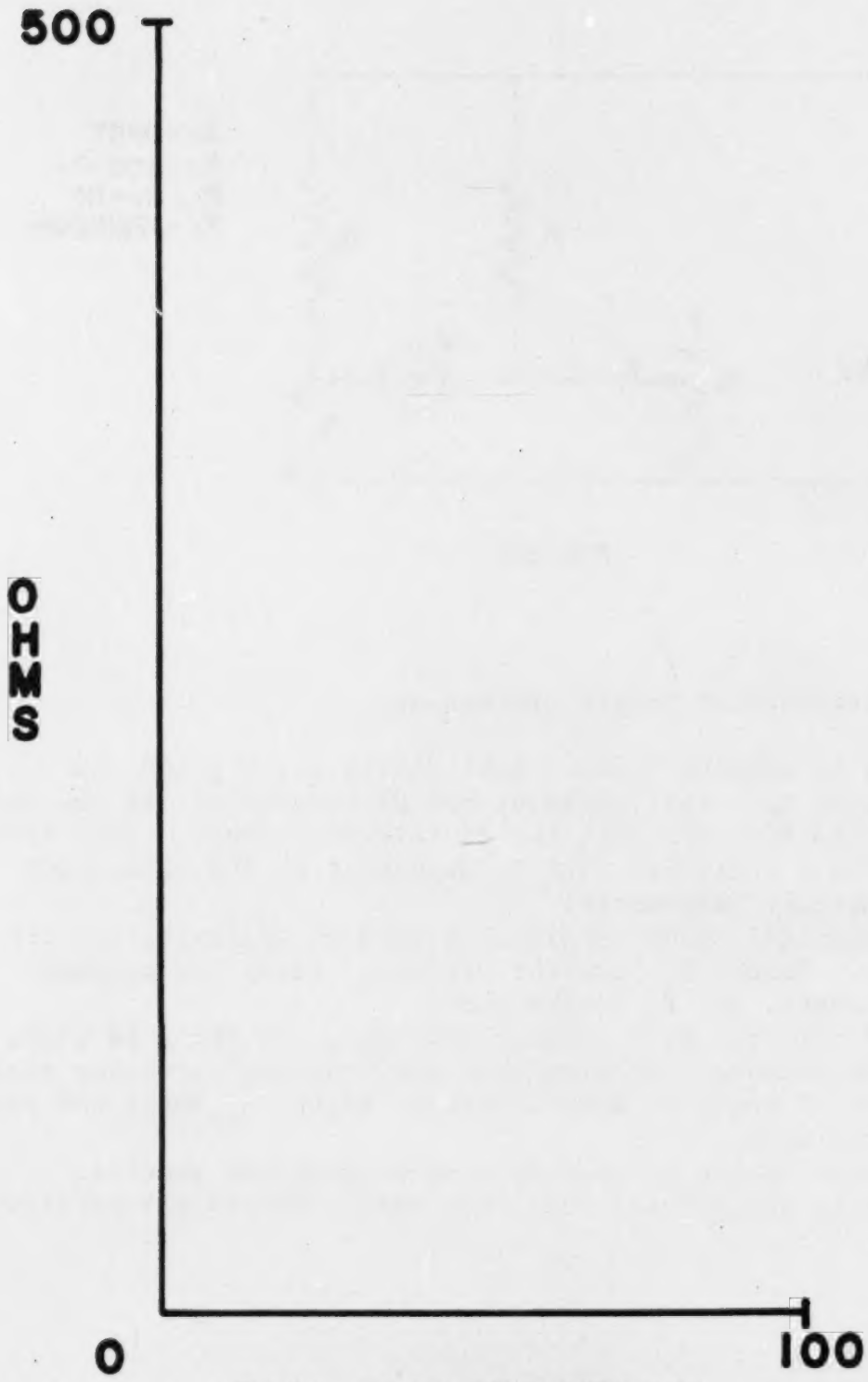

FIG 59

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6. Construct the following circuit:

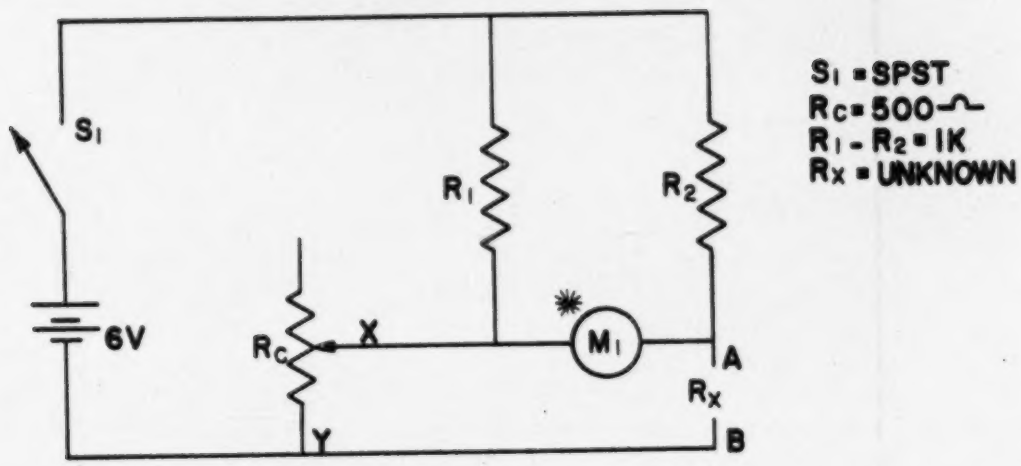

FIG. 60

*Read the introduction before proceeding.

7. Assume R_x is an unknown value. Arbitrarily place a 160 ohm - 1 W resistor at R_x. This resistor has 5% tolerance. It can read between 152 and 168 ohms with the 5% tolerance range. The bridge will read with a tolerance that is dependent on the tolerances of all its circuit components.
8. M_1 (off; mechanical zero) should be placed on approximately the 100 ma scale. Insert M_1 into the circuit. Using the graphed calibration chart, set R_c to 160 ohms.
9. Close L_1 and note the M_1's pointer movement. If there is none, the bridge is balanced, proving that the "unknown" resistor really is 160 ohms. If there is some movement, adjust R_c until the pointer returns to the zero.
10. Lower the range switch to provide a more sensitive reading. Adjust R_c until the pointer indicates zero. Record all pertinent information.

QUIZ

1. If a potentiometer is to be used in a bridge, why must the resistance be accurately known for each setting?
2. Is the resistance of R_c linear? Would it be desirable in this application?
3. Does the accuracy of R_1 and R_2 affect the unknown resistance's theoretical value?

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EXPERIMENT #20 INDUCTANCE (Self and Mutual)

OBJECTIVES

To observe the effects of self and mutual inductance.

MATERIAL REQUIRED

Power Supply
Breadboard
Accessory Kit
VOM and VTVM

INTRODUCTION

Inductance is the property of a component which tends to keep a changing current constant. An inductance is determined by the equation:

$$L = \frac{R^2 N^2}{9R + 10I} \quad \text{(Air core-single layer)}$$

Where
L = inductance in μ-henries
R = Radius in inches
N = Number of turns
I = Length of coil in inches

A henry is equal to a change in current of one ampere per second, inducing an emf of one volt.

When two coils are positioned where the flux from one coil cuts turns of another coil, a voltage is developed in the second coil. (secondary). This is called transformer action. The energy in the second coil is dependant upon a factor called the coefficient of coupling (K).

The second coil can then draw current, due to the induced emf, and may either aid (+) or oppose (-) the originating source. This additional inductance developed by the originating coil (primary) is called mutual inductance (M). $M = K\sqrt{L_1 L_2}$ where the coils are connected in series, with mutual inductance. The total series inductance is:

$$L_T = L_1 + L_2 \pm 2M$$

+2M if the coils' flux fields add
-2M if fields oppose

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EFFECT OF LINE ON FIGURE TYPES

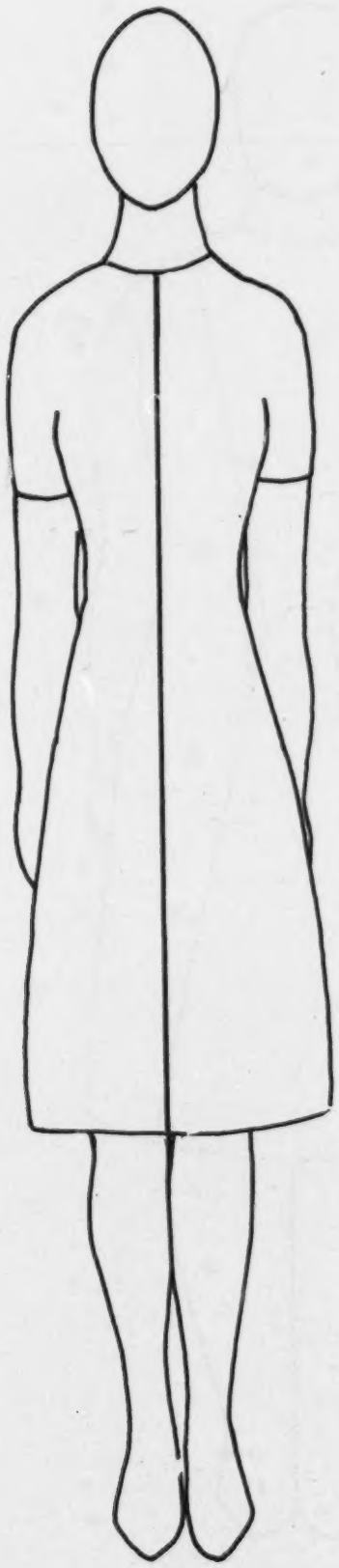

Tall and Thin

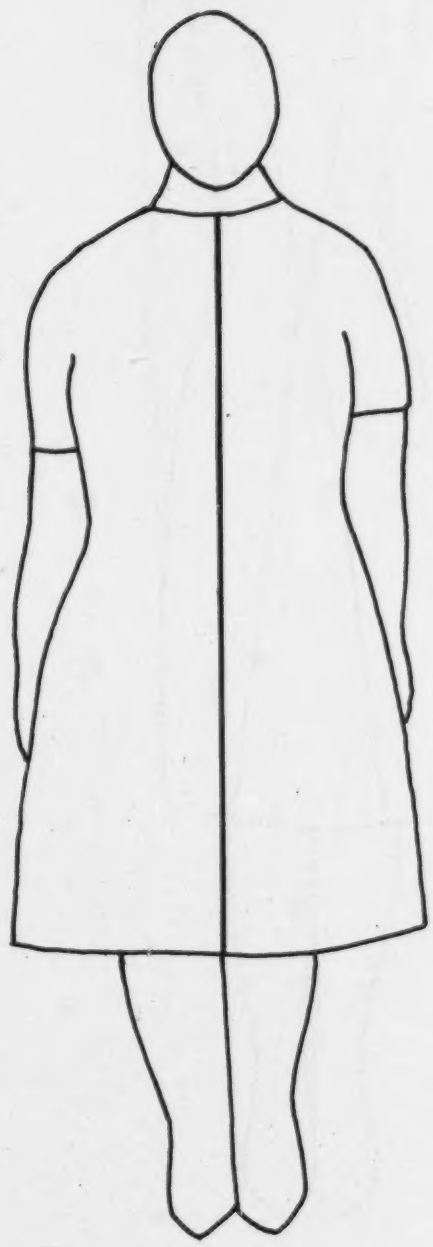

Short and Heavy

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The formula for parallel inductance is:

For Aiding Fields $\frac{1}{L} = \frac{1}{L_1+M} + \frac{1}{L_2+M}$

For Opposing Fields $\frac{1}{L} = \frac{1}{L_1-M} + \frac{1}{L_2-M}$

PROCEDURE

1. Set up the circuit shown below:

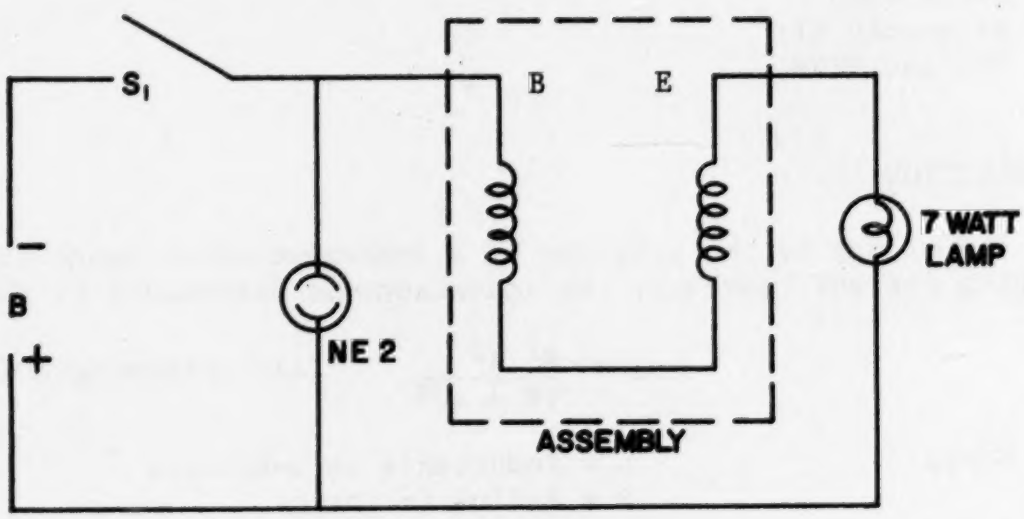

FIG. 61

2. Set B+ to 80 volts dc. Keep the coils close to each other.
3. Depress S_1 and note the results on NE_2 and the 7-watt lamp.
4. Release S_1 and note the momentary flash of NE_2(counter-emf of T_1) and the gradual diminishing of the lamp.
5. Short out points B and E. Depress S_1 and note the effect on NE_2 and the lamp.
6. Open S_1 and note the effect of "No" inductance in the circuit and the action of the bulbs.
7. Compare step 3 and step 5, inductance in and out of the circuit.
8. Wire the following circuit:

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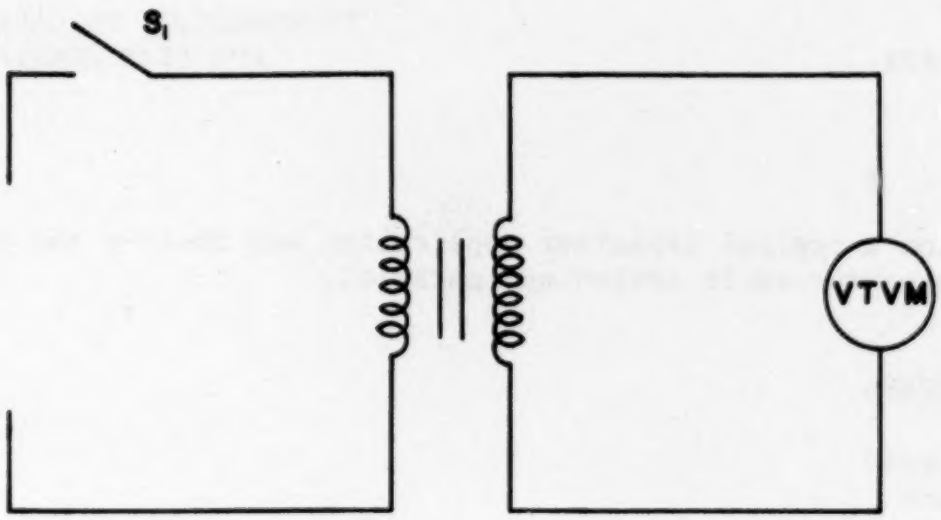

FIG. 62

9. Position $coil_1$ and $coil_2$ as far apart as possible.
10. Adjust C+ (VOM) for 2 volts dc.
11. Adjust the VTVM for a zero-center scale on the 5-volt dc scale.
12. Close S_1 and note the effect on the VTVM.
13. Open S_1, slide coils 1 and 2 together. Now repeat steps 10 to 12.
14. Move the coils apart, one quarter inch at a time, repeating step #12 each time.

CONCLUSIONS

Self inductance is the result of energy storage and release into the circuit, whenever current changes. It is possible to transfer some of this stored energy to another coil brought in proximity to the original coil.

QUIZ

1. List the factors that contribute to an inductor's ability to store energy.
2. Does an inductor oppose current? How can you prove this?
3. Why does the secondary voltage decrease if coils 1 and 2 are pushed apart?
4. How does an iron core contribute to the amount of mutual inductance or transfer of energy?
5. Is it possible, with 2 volts applied to $coil_1$, to have much more than 2 volts induced into $coil_2$? Why?
6. What is unity coupling and how can it be achieved?

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EXPERIMENT #21

INTRODUCTION TO CAPACITORS AND TIME CONSTANT

OBJECTIVE

To examine a typical capacitor application and observe the effect of capacitors connected in series and parallel.

MATERIAL REQUIRED

Power Supply
Breadboard
VTVM
Accessory Kit

INTRODUCTION

Types and Construction

Aside from the resistor, a capacitor is the most frequently used component in any circuit. Because of the capacitor's constant use, it is necessary for an electronics technician to become familiar with many types of capacitors.

It can be said that a capacitor is constructed of two conductors, with a dielectric or insulating material between them. If a battery were connected across the plates of a capacitor, it would place a negative charge on one of the plates and a positive charge on the other plate. This means that there is an emf across the capacitor. After disconnecting the battery the capacitor will remain charged. If a wire were used to connect the two plates, the excess of electrons on the negatively charged plate would flow toward the positively charged plate because of its deficiency of electrons. Thus current would flow through the wire.

It is necessary to understand the various types of capacitors, their special uses, their special construction, and polarity observations. The unit of measuring capacity is related to the physical size of a capacitor.

Paper Capacitors

The construction of a paper capacitor is relatively simple. It is comprised of two layers of metal foil sandwiched between the layers of waxed paper alternately placed, as illustrated in Figure 63A. The plates are the foil, which is capable of holding the charge, and the waxed paper acts as the insulating material (dielectric) between the plates. In some cases the whole capacitor is impregnated, or soaked, with oil.

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Soaking the capacitor with oil has two advantages: it enables the capacitor to have a higher breakdown voltage and also protects it against corrosion. A paper capacitor has no polarity as far as negative and positive terminals are concerned. However, its construction (Figure 63A) makes it necessary that one plate cover or engulf the other plate. This foil plate is referred to as the outer foil. The lead coming from the outer foil is usually identified by a ring or dot at that end of the capacitor or a ball of solder at the base of the lead. Figure 63B illustrates the three common methods of identification. One purpose of identifying the outer foil lead is as follows:

> If a blocking capacitor in the grid circuit is connected to the grid by the outer foil lead, then the whole outer foil will act as an antenna. This antenna will pick up and pass on any interference to the tube.

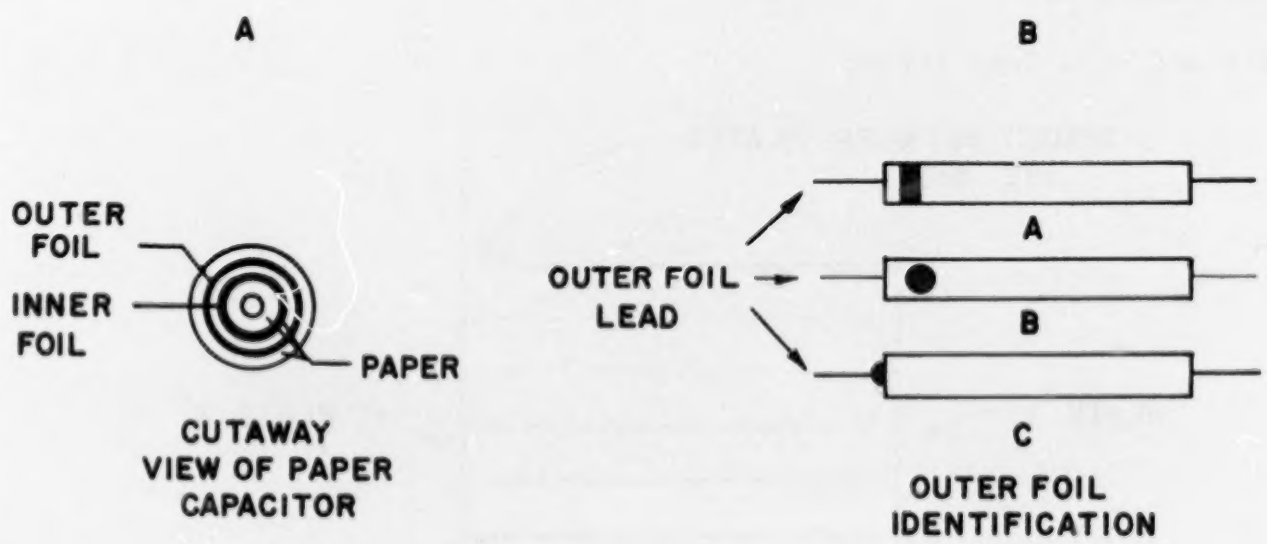

FIG 63

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Electrolytic Capacitors

Electrolytic capacitors work on the same principle as a paper capacitor. The major difference is that an electrolytic capacitor has a definite prearranged polarity. It is constructed so that only one side, or plate, is capable of being charged negatively. This is due to the type of dielectric used between the plates. This condition is accomplished by having a borax solution between the plates. When the capacitor is first assembled, a slight dc voltage is applied across the plates and is gradually increased. At the end of this process an aluminum oxide has formed on one of the plates, and this comprises the dielectric. Thus it can be seen that if, when using the capacitor in a circuit, the polarity of the applied voltage was connected backward, the oxide coating would break down and the dielectric would be destroyed. CAUTION: ALWAYS OBSERVE THE POLARITY OF AN ELECTROLYTIC CAPACITOR. Also, due to this type of dielectric, an electrolytic capacitor has a certain amount of leakage between the plates. This leakage is present in all electrolytic capacitors. The aluminum oxide dielectric is not a good insulator and allows a slight current flow between the plates. However, this disadvantage is compensated for by the fact that an electrolytic capacitor has much more capacity than other capacitors of like physical size. The resistance for an electrolytic capacitor rated at 200 volts should not be under 200K, and a capacitor rated at 450 volts should not have a resistance of less than 1 M.

Ceramic and Mica Capacitors:

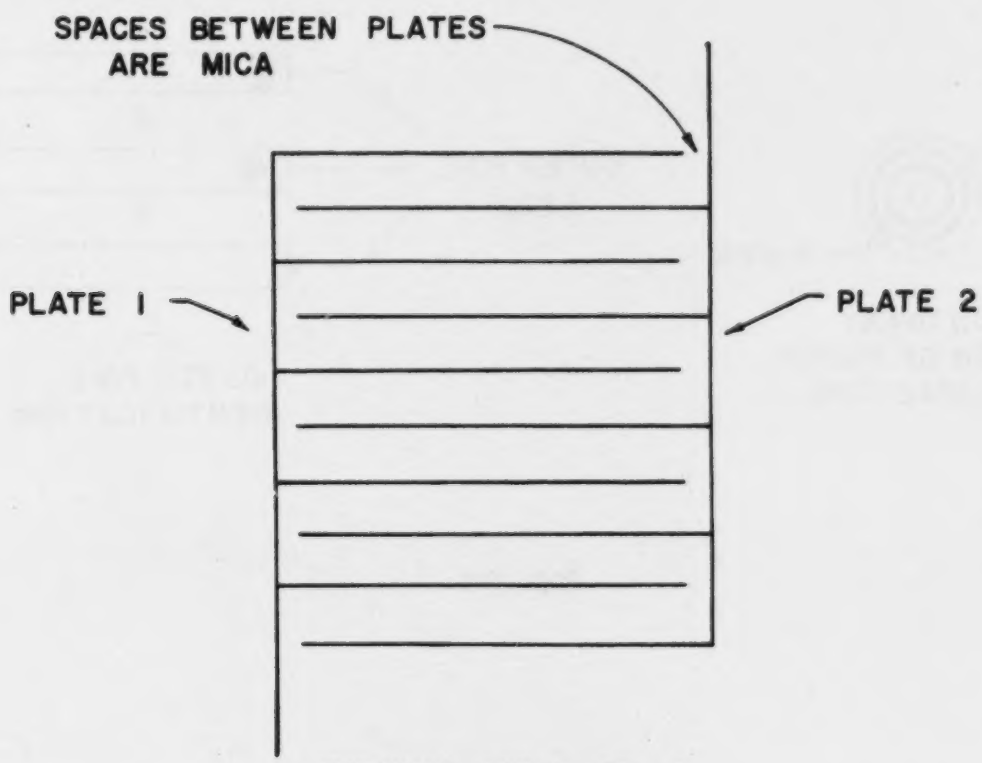

CUTAWAY VIEW OF A MICA CAPACITOR

FIG 64

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A problem arises when a capacitor is used in a high-frequency circuit. A paper or an electrolytic capacitor absorbs a portion of the charge during the positive half of the ac cycle and does not fully discharge during the negative half of the cycle. In other words, if you were to charge a paper capacitor and then discharge it, a few minutes later you could discharge it again. This is caused by the dielectric's retaining some of the charge and not giving it up. The ceramic and mica capacitors were developed to overcome this problem. These capacitors have the ability to quickly and completely discharge, enabling them to follow a very high frequency. They have this special ability because they use a ceramic or mica dielectric, which absorbs very little of the charge applied to the capacitor. Figures 64 and 65 illustrate the construction of a mica and ceramic capacitor.

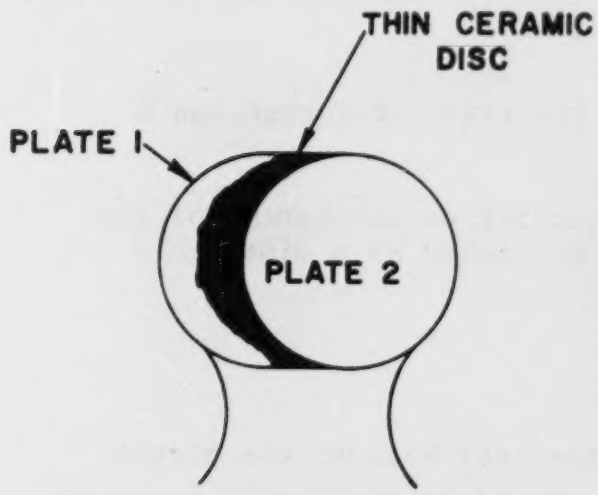

OPEN VIEW OF A DISC-TYPE CERAMIC CAPACITOR

FIG 65A

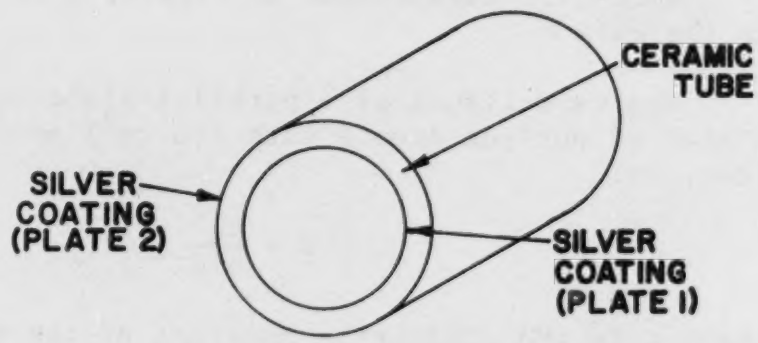

CUTAWAY VIEW OF A TUBULAR-TYPE CERAMIC CAPACITOR

FIG 65 B

Checking a capacitor may appear to be a simple and unimportant job. However, experience will show that in order to find the trouble in a piece of electronic equipment quickly and accurately, you must be able to check a capacitor with speed and precision. A technician should develop his methods of checking capacitors so that when troubleshooting a particular circuit he will definitely know whether a capacitor is good or bad.

Capacitors Connected in Series and Parallel

When two or more capacitors are series connected, the total capacitance (C_T), always has a value smaller than the smallest capacitance in the series string. Parallel-connected capacitors add

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directly. This is just the reverse of resistors connected together. The formulas for calculating combined capacitance, then, are the resistance formulas with the correct symbols and applications.

Series connections $C_T = \frac{C_1 C_2}{C_1 + C_2}$ or $C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$, etc.

Parallel connections $C_T = C_1 + C_2 + \ldots\ldots\ldots\ldots C_n$

Two other formulas are used in capacitive circuits:

$$C = \frac{Q}{E}$$

Where C = capacitance in farads, Q is the ratio of charge, and E is the emf.

The capacitance of a parallel-plate capacitance consisting of two plates of surface area A each (in cm^2) and separated by a distance d (cm), is:

$$C = \frac{KA}{4\pi d}$$

where K is the dielectric constant of the material between the plates and C is the capacitance in farads.

PROCEDURE

1. Construct the following circuit:

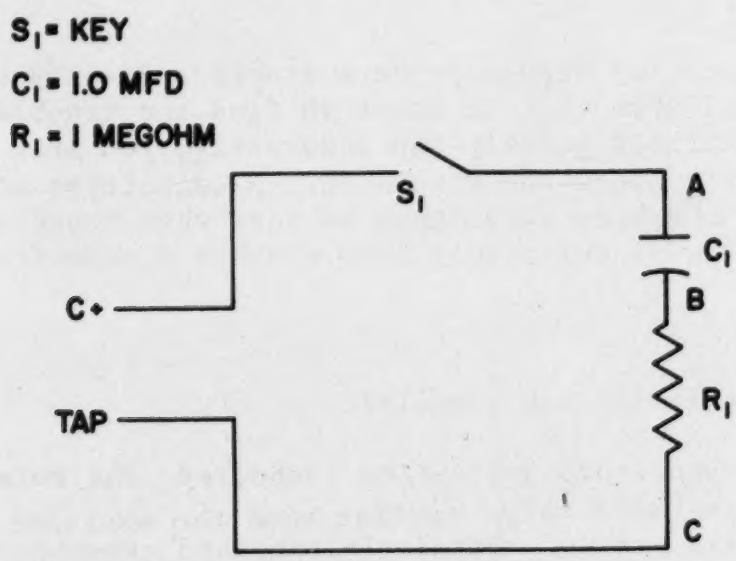

FIG. 66

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2. Adjust T-C+ to 40 volts
3. Connect a VTVM from points A to B, using the 0 to 50 volts dc range.
4. Close S_1, noting the rate at which C_1 charges. Calculate the time constant from the following equation:

$$T_C = RC$$

where T = Time in seconds
R = Resistance in ohms
C = Capacitance in farads

Multiply T_C x 5 for 100% charge.

5. After experimenting with the charge time, open S_1 and short out A to C. Record the discharge time (when VTVM reads 0 volts).
6. Place a second 1 µf capacitor between A and B.
7. Repeat steps 4 and 5.
8. Replace R_1 with a 4.7 M ohm resistor. Repeat steps 4 and 5.
9. Add .1 µf capacitor in series with C_1.
10. Repeat steps #2 through #5.
11. Record all pertinent data.

CONCLUSIONS

Five RC time constants is the charge or discharge time of capacitors regardless of the size of R or C. A thorough understanding of T=RC is a prerequisite for workers in the electronics field.

QUIZ

1. What percentage does a capacitor charge to in 1 T_C, 2, 3, 4 and 5 + C?
2. What is the percent of discharge in each of the above?
3. How do capacitors in series and parallel affect the time constant?
4. How does Kirchhoff's Law apply to this circuit consisting of R and C? Expand upon your explanation.

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Geitzenauer, William
Electronics Laboratory Manual--II.

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Rutgers, The State Univ., New Brunswick, N.J. Curriculum Lab.
New Jersey State Dept. of Education, Trenton. Div. of Vocational Education

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ABSTRACT - Prepared by educators in Warren County Schools of New Jersey in cooperation with the Vocational-Technical Laboratory of Rutgers University, this is the second of two laboratory manuals for teacher and student use in teaching the fundamentals of electronics. Contents are designed to challenge prospective electronics technicians through problem-solving techniques concerning A-C circuits. The 16 experiments, for use with a basic electronics or electricity textbook, include objectives, introduction, material or equipment required, procedure, conclusions, and questions. A list of electronic symbols is appended. Part one is available as VT 012 900, also in this issue. (GEB)

VT 012 901

ED0 56238

STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION
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ELECTRONICS LABORATORY MANUAL - 2

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EFFECT OF LINE ON FIGURE TYPES

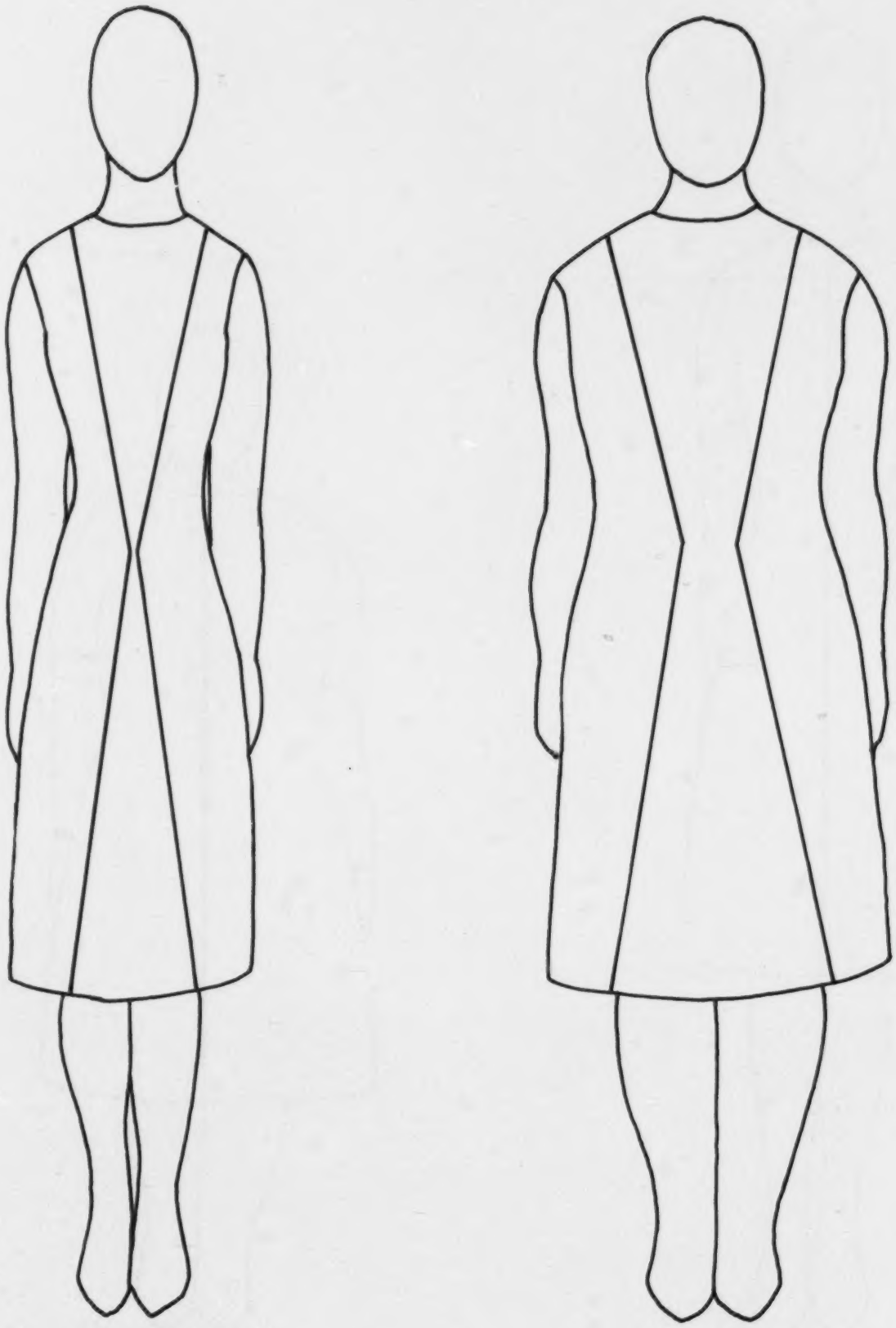

Tall and Thin

Tall and Heavy

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State of New Jersey
Department of Education
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ELECTRONICS LABORATORY MANUAL - II

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FOREWORD

This Laboratory Manual is written in an attempt to challenge the intellect of the prospective electronics technician. This is accomplished by using the problem-solving technique. The ability to solve problems is a vital prerequisite to the fulfillment of the job classification.

This Laboratory Manual was written to be used in conjunction with a basic electricity or electronics textbook.

Some of the experiments include introductions, as some textbooks do not relate the material content of the theory to a working (laboratory) knowledge of experimentation.

The experiments are arranged in a spiraling order. This provides an increasing level of skill and knowledge each time the general topic is presented.

EXPERIMENT #1

INTRODUCTION AND APPLICATION OF THE OSCILLOSCOPE

OBJECTIVE

To develop the knowledge and skill required in using an oscilloscope.

INTRODUCTION

Model 460
DC - Wide Band
Oscilloscope

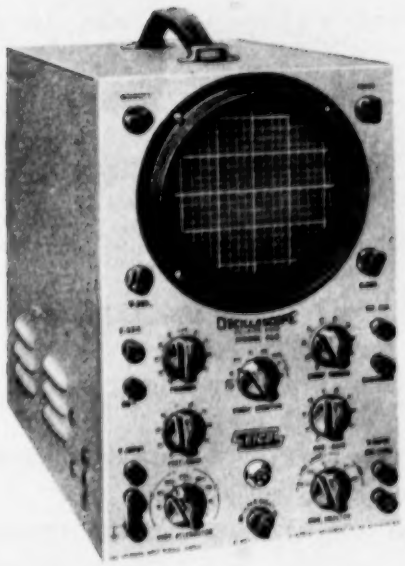

Cathode-Ray Tube

Type	5UP1
Accelerating Potential	1200 volts (2nd anode with respect to cathode)
Illuminated Scale	Engraved, illuminated plexiglass scale over face of tube; dimmer control provided on front panel.
Filter Bezel	Special green acetate matches screen phosphor. Standard 5" CET bezel fits standard photographic equipment.

Vertical Channel

Sensitivity (at full gain)	25 millivolts rms/inch
Undistorted Deflection	greater than 4 inches
Frequency Response (sinusoidal)	
Direct Coupling	Flat (+1, -3 dB) from dc to 4.5 mc
[redacted]pacitive Coupling	Flat (+1, -3 dB) from 1 cps to 4.5 mc

[redacted]

Transient Response	
Rise time	0.06 microseconds max.
Overshoot	8% max.
Input voltage (maximum)	
Unbalanced (either coupling)	600 volts (dc plus peak ac)
Balanced	1 volt p-p
Input Coupling	Capacitive or direct
Attentuation (switch-type)	By factors of 1, 10, 100, and 1000± 5% as selected by VERT. ATTENUATOR selector; frequency compensated so that there is no visible change in waveshape at any attenuator position.
Input Impedance	
Single-ended (unbalanced)	3 megs shunted by 35 mmf
Balanced	6 megs shunted by 20 mmf
Positioning	± 2 inches; permits centering on screen of any portion of trace expanded vertically to 4" peak-to-peak.

Horizontal Channel

Sensitivity	0.6 rms volts per inch
Frequency Response	Flat (± 1dB) 1 cps to 400 kc
Input Impedance	Approximately 5 megs shunted by 35 mmf (at 1 kc).
Expansion	To 2 times full-screen diameter without distortion.
Positioning	So any portion of expanded trace may be examined on screen.
Horizontal Inputs	Linear time base with choice of synchronization described below, phase-controlled 60 cps input, or external input.

Linear Time-Base Generator (Recurrent)

Frequency Range	10 to 100,000 cps sawtooth in 4 ranges plus EXTERNAL CAPACITOR position. A sweep range down to 1 cps may be obtained by connecting an appropriate capacitor between EXT. CAP. terminal and ground. Special TV-V and TV-H positions provide 30 cps and 7875 cps sweeps respectively for convenience in TV servicing.
Synchronization	"+" internal, "-" internal, 60 cps (phase controlled), or external.

Intensity Modulation Circuit (Z Axis)

Input Impedance	Approximately 0.1 meg at medium intensity setting.
Sensitivity	Approximately 3 volts rms for blanking the beam.
Polarity	Beam intensity increased on positive excursion of signal.

Calibration Voltage

Availability	Switched to input of vertical amplifier by setting VERT. ATTENUATOR selector to CAL.
Waveshape	Sinusoidal
Frequency	60 cps
Amplitude	400 millivolts peak-to-peak
Accuracy	± 5% factory-adjusted; add accuracy of meter used for initial adjustment in kit instruments.
Useful range	With calibrated graph screen and calibrated vertical attenuator provided, permits voltage measurement over range of 100,000 to 1.

Sawtooth Output

Availability	Front-panel terminal
Amplitude	15 volts peak-to-peak max. (Varies with hor. gain control).
Polarity	Positive
Frequency	Same as linear time-base generator
Impedance	Approximately 300 ohms.

60 CPS Output

Availability	Front-panel terminal
Amplitude	3 volts rms.

General

Sync Voltage	Amplifier limiter circuit provides automatic control; no sync voltage adjustment required.
Phasing Control	Provides fully controlled phase shift for 60 cps sweep application.
Power Supplies	One high voltage, one low voltage; both transformer rectifier type with RC filter systems.

Tube Complement	2-6AU8, 2-6CB6, 2-6J6, 1-12AU7, 1-6AX5, 1-1V2.

Physical Specifications

Shipping Weight	30 lbs.
Overall Dimensions	14 3/4" high, 8 1/2" wide, 16 1/2" deep
Cabinet	Steel; grey wrinkle finish
Panel	Heavy gauge aluminum; brushed satin finish; etched rub-proof legends.

Cop 1482[illegible]

MATERIAL REQUIRED

6" oscilloscope
Audio Signal generator

PROCEDURE

Follow the succeeding instructions with the use of an oscilloscope, preferably an EICO 460.

FUNCTIONS OF CONTROLS AND TERMINALS

The oscilloscope controls and terminals are easy to use once their functions are understood.

If the controls are divided into specific groups, for purposes of explanation, it will be easier to understand and keep in mind just what these functions are.

The INTENSITY and FOCUS knobs together control the appearance of the trace. The INTENSITY knob controls the brightness of the trace and the FOCUS knob controls the sharpness or definition of the trace on the scope screen. Proper adjustment of these controls should give a trace formed from a thin bright line or an undeflected spot of light that is tiny, round, and bright. (1)* These controls interact to an extent; that is, adjustment of the FOCUS knob is usually necessary when the setting of the INTENSITY knob is changed. (2)

The V-POS (Vertical-Position) and H-POS (Horizontal-Position) knobs control the location of the trace on the screen. Turning the H-POS knob shifts the trace left or right (3) and turning the V-POS knob moves the trace up or down. (4) (5)

The VERTICAL ATTENUATOR provides a choice of no attenuation or three decade steps of frequency-compensated attenuation (6) of the input voltage fed to the vertical amplifier. Each attenuation is obtainable with either direct coupling provided to the vertical amplifier (positions under the dc arc on the dial), or capacitive coupling to the vertical amplifier (positions under the ac arc on the dial). At either "1" position, the amplitude of the signal voltage is unchanged (no attenuation). At either of the "10", "100", "1000" positions, the amplitude is attenuated by a ratio of 10:1, 100:1, and 1000:1 respectively. At the CALibrator position, a 0.4 volt peak-to-peak sine wave at power-line frequency is fed to the vertical amplifier. (7) (8)

The VERTICAL GAIN control allows continuous adjustment of the vertical amplifier gain. (9) It is used with the VERT. ATTENUATOR selector to adjust trace height to the desired value.

The HOR. SELECTOR combines the functions of sync selector for the internal sweep and input selector for the horizontal amplifier. At any of the four most counterclockwise positions (under the SYNC-SWEEP arc on dial) the internal linear sweep is fed to the horizontal amplifier. These four positions permit selection of sync voltages for the sweep oscillator. At the "+" and "-" positions, the synchronizing voltage is taken internally from the vertical amplifier. At "-", the sweep trace flyback starts during the negative-going excursion of the voltage applied to the vertical amplifier. (10) At the "EXT." position, an external synchronizing voltage applied between the H-INPUT/EXT. SYNC.

* Notes begin on page 101.

terminal and ground is fed to the sweep oscillator. (11) At the 60 cps position, an ac signal of power-line frequency is taken from the power supply and applied to the sweep oscillator to sync it at line frequency. The PHASING control is effective in the 60 cps SYNC position and permits phase adjustment of the 60 cps sync voltage to shift the starting point of the waveform display to any desired point on the waveform. (12)

At either of the two most clockwise positions of the HOR. SELECTOR (under HOR arc on dial), the sweep oscillator is disabled. At the 60 cps HOR. position, an ac signal of power-line frequency is taken from the power supply and applied to the input of the horizontal amplifier. The PHASE knob controls the phase shift of the line frequency voltage used for sinusoidal sweep. (13) At the EXT. HOR. position, an external signal voltage fed between the H-INPUT/EXT. SYNC. terminal and ground is applied to the input of the horizontal amplifier. The HOR-GAIN control is effective in both the 60 cps HOR. and EXT. HOR. positions.

The SWEEP FREQUENCY band selector selects the frequency band over which the SWEEP VERNIER (fine sweep-frequency control) can be varied for frequency adjustment of the internal linear sweep. The numbers on either side of the markers are the upper and lower limits of the band (approximately). The four positions, reading from left to right are 10-100 cps, 100 cps-1 kc, 1-10 kc, 10-100 kc. The EXT. CAP position is used when it is desired to obtain a linear sweep below 10 cps down to approximately 1 cps. A 0.5 mf external capacitor (rated at least 200 wvdc) must be connected between the EXT. CAP and SAWTOOTH terminals for sweeps down to 1 cps. (14)

The V & H positions (under the TV arc on the dial) are designed to eliminate the need for repeated readjustment of the SWEEP VERNIER in TV work. If, with the SWEEP SELECTOR set at the TV-V position, the SWEEP VERNIER is set to display two full cycles of a 60 cps signal to obtain a sweep frequency of 30 cps, turning the SWEEP SELECTOR to TV-H will result in a sweep frequency of 7875 cps without readjustment of the SWEEP VERNIER. (15)

The V-INPUT terminals provide for connection of external signals to the vertical amplifier. An external jumper must always be used to short the lower of the two terminals to ground for conventional single-ended input. Remove the jumper for balanced input. (No attenuation may be derived from the vertical step attenuator on balanced input because this attenuator affects only input signals fed to the upper of the two V-INPUT terminals.) See NOTES ON CONTROLS & TERMINALS for use of balanced input. (16)

An external voltage for purpose of intensity (Z-AXIS) modulation may be applied between the Z-AXIS binding post and ground. Never apply an intensity modulating signal that is large enough to swing the grid of the cathode ray tube positive, or the life of the tube may be greatly shortened. Positive grid swing is indicated by noticeable defocusing of the trace during the positive phase of the intensity modulating signal.

APPENDIX M

CUSTOMER RECORD†

Name _____ Date _____

Address: (Home) _____ (Business) _____

_____ _____

Phone: (Home) _____ (Business) _____ Pattern Size _____

LOCATION	MEASUREMENTS		ADJUSTMENTS + or -	FINISHED GARMENT
	Customer	Pattern		
Bust				
Over				
Under				
Waist				
Back waist length				
Front waist length				
Dress Length				
Skirt front length				
Skirt back length				
Sleeve Length				
Shoulder to elbow				
Elbow to wrist				
Around upper arm				
Around lower arm				
Around wrist				
Hemline to Floor				
Dart Adjustment				

†Adapted from Cozine, June, & others. *A pilot study for gainful employment in home economics.* Washington, D.C. U.S. Government Printing Office. 1968.

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A test voltage of power-line frequency is available between the 60 cps terminal and ground. The amplitude of this voltage varies with load.

A sawtooth voltage from the output of the sweep circuit oscillator is available between the SAWTOOTH terminal and ground. The frequency of the sawtooth is, of course, variable by the SWEEP SELECTOR and SWEEP VERNIER controls. The amplitude is variable by the HOR-GAIN control.

The AC POWER switch is ganged with a dimmer control for the lamp which edge-lights the plexiglass scale.

NOTES ON CONTROLS AND TERMINALS

1. Proper trace definition will be obtained only if the astigmatism control is correctly adjusted (See Maintenance) and the scope is not operated in strong fields such as are found near transformers, transmitters, and power generating equipment, etc., which may distort the electron beam that produces the trace.

2. A sharply focused short line or a small spot of high intensity should not be permitted to remain stationary on the screen for any considerable length of time (more than ½ minute) or the screen will be burned. A trace of excessively high intensity will burn the screen in 3 to 5 minutes. These burned portions of the screen will no longer fluoresce and are useless for observation. If it is required to have a fixed trace on the screen for a long period, reduce the intensity of the trace to a minimum.

3. A trace can be expanded vertically beyond full-screen width without distortion. This is particularly important in dealing with sweep waveforms. The range of horizontal positioning is several times full screen to permit examination of any part of the expanded trace.

4. A trace can not be expanded vertically beyond full-screen width without distortion. Vertical positioning beyond the ±2 inches obtainable is, however, useful, since this range of positioning will permit bringing the top or bottom of any trace expanded vertically to full-screen width into the central region of the screen where screen curvature will not cause blurring of these portions of the trace.

5. When the VERT.-ATTENUATOR control is set at one of the positions under the DC (direct-coupled) arc on the dial, the dc component of any signal fed to the vertical amplifier will be amplified along with the ac component of the signal and be reflected on the screen by a proportional vertical movement of the trace. The direction of the trace movement depends on the polarity of the dc component. Therefore, when going from observation of a pure ac wave to one containing dc or vice versa, it may be necessary to use the V-POS control to bring the trace back to center screen. The dc component of a signal has no effect at the AC (capacitive-coupled) positions of the VERT.-ATTENUATOR.

6. Trimmer capacitors C2, C3, and C4 are used for compensating the vertical step attenuator at the 1000, 100, and 10 positions respectively. See MAINTENANCE section for procedure.

7. See OPERATION section for use of CALibration position.

8. Potentiometer R6 is used to set the peak-to-peak value of the calibrating voltage to the prescribed value. See MAINTENANCE section for procedure.

9. Potentiometer R16 is the dc balance adjustment. When R16 is adjusted properly, there will be no shifting up or down of the trace on turning the VERT. GAIN control from minimum to maximum with no input signal to the vertical amplifier.

10. The +(INT.) and -(INT.) positions allow the synchronization of any type of non-sinusoidal waveform.

11. The EXT. sync. position is for use with generators or other devices which have sync. outputs.

12. The PHASING control action in the "60 CPS" HOR. position permits use of sweep generators that do not have phase-controlled 60 cps sinusoidal sweep outputs or dispensing with connections to such outputs when they are available.

14. Large-valued capacitors will give lower sweep frequencies (approximately 1 mf for a sweep as low as 0.5 cps). However, good results below a few cps can not be assured.

15. Trimmer C22 must be adjusted initially in kit instruments to display two full cycles of a 15750 cps signal at the TV-H position after the SWEEP VERNIER has been set to display two full cycles of a 60 cps signal at the TV-V position. See MAINTENANCE section.

16. Use of the balanced input to the vertical amplifier makes it possible to reject any common-made signal (in-phase signal applied to both inputs) while at the same time passing and amplifying the balanced input signal. In this way, noise pickup in the test leads or in the equipment under test can be greatly reduced. Balanced input is obtained by removing the jumper between the lower of the two V-INPUT terminals and ground, setting the VERT. ATTENUATOR at the "1" position under the DC arc and feeding the signal to be observed between the two upper V-INPUT terminals. Use of the balanced input is limited by the fact that no step attenuation is possible because there is only one step attenuator in the instrument and therefore only one of the inputs could be attenuated. Therefore, with balanced input, full-scope sensitivity is obtained and the maximum amplitude of signal that can be observed without distortion due to overloading is 1 volt p-p.

17. The maximum undistorted output voltage of the vertical amplifier generally does not produce vertical deflection in excess of 5". Maximum deflection of 4" will provide adequate utilization of the screen area.

18. A slight overshoot or ringing may be evident with high-frequency square-wave inputs. This effect should not exceed 8%. Keep in mind, however, that sometimes the square-wave generator may be at fault and this should be checked before attributing the effect to the scope.

19. At maximum gain settings, the sensitivity of the amplifiers is very high. Under these conditions stray pickup may produce patterns on the screen when no signal source is connected to the vertical input terminals. This is normal and does not interfere with the scope operation.

OPERATION

NOTE: To obtain proper results with your "scope", it is advisable to become acquainted with the functions and correct use of the panel controls and terminals by making some simple tests. These tests will also serve to assure you that the instrument is in proper working condition. Do not attempt this procedure with kits before all final checks have been completed and all initial adjustments have been made as described in the MAINTENANCE section.

1. Set the INTENSITY, VERT. GAIN, and HOR. GAIN controls at their furthest counterclockwise positions.

2. Set the FOCUS, V-POS, and H-POS, controls at the center of their ranges. All other controls may be set at any position.

3. Insert the power cord into a 105-125 volt, 50-60 cycle ac outlet.

WARNING: This instrument will not operate, or will operate improperly and even be seriously damaged if connected to any other type of power line (such as dc, 25-cycle ac, or an ac line above 125 volts).

4. Turn the POWER control clockwise (on). The pilot lamp should light. (Note scale-illumination control by potentiometer attached to POWER switch.) Allow the unit to warm up for about one minute. Then gradually turn the INTENSITY control clockwise until a spot appears somewhere on the screen of the cathode ray tube (CRT). If the spot does not appear, adjust the V-POS and H-POS controls slightly, as it may be off screen.

NOTE 2: At low sweep frequencies, flickering of the pattern is normal due to the slow writing speed at the spot and the persistance of the screen, which together are insufficient to cause the motion to blend into a fixed image.

10. With the single sine wave pattern locked in, switch the HOR. selector from +(INT.) to -(INT.). The same wave-form should appear, but displaced by 180°.

11. With the single sine wave pattern locked in, switch the HOR. SELECTOR to the 60 CPS SYNC position. Turn the PHASING control and note the shift in starting point of the displayed waveform.

12. Set up the "scope" controls as in paragraph 8, adjusting the PHASING control for a broad ellipse. Then set the INTENSITY control at minimum. From an audio oscillator, apply about 3 volts at 300 cps between the INT. MOD. binding post and ground, and then gradually advance the INTENSITY control until a broken-line ellipse is seen on the screen. Carefully adjust the frequency until the broken lines stand still. Note that there are 5 such lines. This indicates that the ratio between the frequency applied to the INT. MOD. binding post and the frequency applied to the V. INPUT binding post (60 cps) is 5. The INT. MOD. binding post may be used for inserting timing markers on a trace or determining the frequency of an unknown signal.

CAUTION: In any application where a signal is applied to the INT. MOD binding post, the INTENSITY control should first be set at minimum and then advanced until the desired intensity is obtained.

13. TO OPERATE the internal calibrator for measuring peak-to-peak voltage, use the following procedure: (p-p is an abbreviation for peak-to-peak.)

MEASUREMENT OF P-P VOLTAGES: (a) Set the VERT. ATTEN. at CAL. This operation injects a 0.4 volt p-p sine wave of power-line frequency into the vertical input circuit at a point following the vertical step attenuator but preceding the vertical gain control. (b) Set the HOR. SELECTOR at "+" and the HOR. GAIN control at zero (so that the pattern on the screen is simply a vertical line). (c) Adjust the VERT. GAIN and VERT. POS. controls until the vertical line extends exactly 4 major divisions (a division is 1 inch) on the calibrated screen.

You have now standardized the sensitivity of the vertical amplifier to permit direct p-p voltage measurements. Do not touch the VERT. GAIN controls while voltage measurements are being made, as any disturbance of the setting makes it necessary to recalibrate the vertical amplifier.

The p-p amplitude of a signal voltage applied to the V. INPUT terminals may be read as follows. Set the VERT. ATTEN. selector at a position that gives a pattern under 4 inches in height, without touching

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the VERT. GAIN control. Use the VERT. POS. control to place the bottom of the pattern on the lowest graduation of the calibrated scale. If the VERT. ATTEN. selector is at the 1 position, full scale is 0.4 volts p-p (4 inches). At the 100 position, full scale is 400 volts p-p.

MEASUREMENT OF P-P VOLTAGES ABOVE 400 VOLTS : Steps a and b are the same as when measuring voltages under 400 volts p-p. In step c, however, the VERT. GAIN control is adjusted for a deflection that is a convenient fraction of full scale. At most, this deflection should be as many times smaller than full scale as the expected value of the unknown voltage is larger than 400 volts p-p. The VERT. ATTEN. is then set at 1000 and the p-p deflection of the unknown signal is read off the calibrated screen.

The ratio of this deflection to the deflection set at calibration is then multiplied by 400 to obtain the amplitude of the unknown signal in volts p-p. EXAMPLE: The deflection set at calibration is 10 divisions or 2 inches. With the VERT. ATTEN. set at 1000, the p-p deflection of the unknown signal is 20 divisions or 4 inches. The amplitude of the signal is equal to (20/10) X 400 = 800 volts p-p.

NOTE: If the signal under observation is a sine wave (only), the rms value of the amplitude may be obtained by dividing the p-p value by 2.8.

APPLICATIONS

General: The oscilloscope is an instrument designed for viewing electrical oscillations and transients. Phenomena having a repetition rate from a few cycles per second to several megacycles per second may be displayed on a scope.

Waveform Investigation: When the output of the internal sweep generator is fed to the horizontal channel, the pattern on the screen is actually a graph showing the variation with time of the instantaneous amplitude of the signal applied to the vertical channel. The sweep frequency is usually a sub-harmonic of the signal frequency, so that several complete cycles of the signal are displayed on the screen.

Display of Waveforms: Displaying a waveform means obtaining a picture that shows how the amplitude of the signal under observation varies with time. It is generally most convenient to use a time-base signal that varies linearly with time, so that equal intervals of time are represented on the screen by equal intervals of distance along the same axis. The sawtooth output of the sweep generator gives such a time-base on the horizontal axis, the time (in seconds) represented by the overall horizontal deflection being equal to the reciprocal of the sweep frequency (in cycles per second).

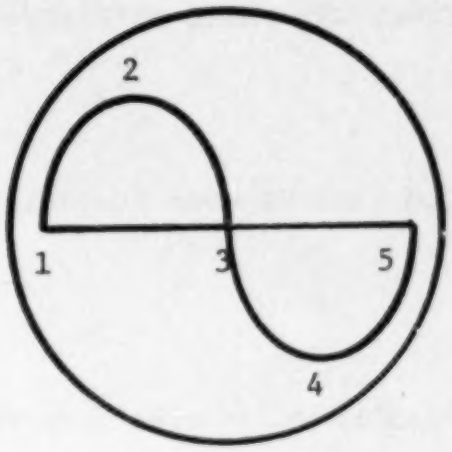

Figure A

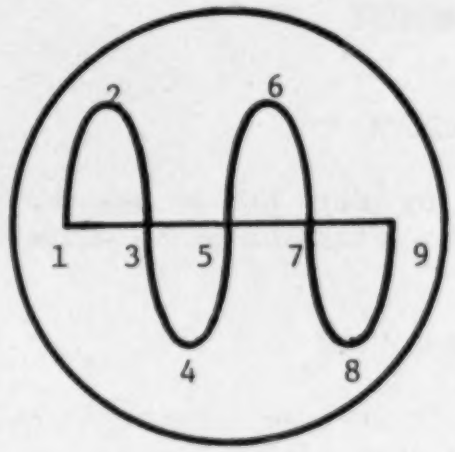

Figure B

If the frequency of the observed signal is equal to the sweep frequency, one complete cycle will be observed on the screen. If the frequency of the applied signal is twice the sweep frequency, two complete cycles will be obtained on the screen, and so on. Figure A is a drawing of a sine wave applied to the vertical plates and a sawtooth wave of the same frequency applied to the horizontal plates. Figure B is a drawing showing the resultant pattern when the frequency of the sawtooth is one-half that employed in Figure A. Changing the frequency of the sawtooth causes the display of two waveforms.

In these figures, points that occur simultaneously are numbered the same. The circle represents the tube screen. If simultaneous projections were drawn from every point on each wave, the intersections would trace out the sine waves shown in the circles. The sections of the sawtooth between 1 and 4 in Figure A and between 1 and 9 in Figure B are the sweep sections during which the displays are produced. The sections of the sawtooth between 5 and 1 in Figure A and between 9 and 1 in Figure B are the sections during which the beam is returned very rapidly to the starting point at the left-hand side of the screen. The return trace appears on the screen as a fine horizontal line.

CONCLUSIONS

For all phases of electronics it is absolutely necessary that the operator be thoroughly familiar with the operation of the oscilloscope and be skillful in using it. Review this experiment several times until you have become accustomed to using and adjusting the "scope."

QUIZ

1. Make a list containing all the controls associated with the 430. State the specific function of each.
2. What is a Lissajous pattern and where is it used?
3. Explain several practical applications of an oscilloscope.

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EXPERIMENT #2 FREQUENCY AND PHASE DETERMINATION

OBJECTIVE

To learn how to use the oscilloscope to find unknown frequencies and to determine phase differences.

INTRODUCTION

It must be remembered that ac has basically three characteristics. These are:

a. Amplitude or magnitude
b. Frequency (repetition with time)
c. Phase relationship

Conventionally the term ac is applied to both current and voltage. A typical sinusoidal alternating waveform is shown below:

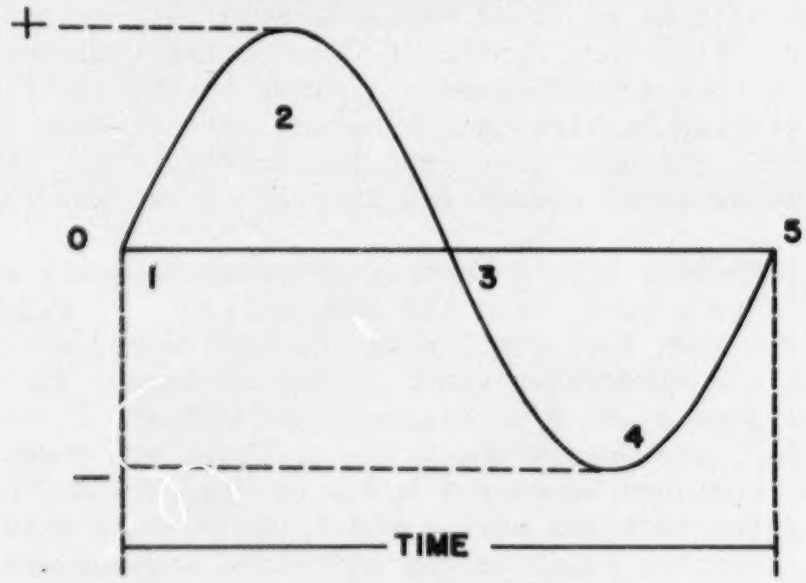

FIG. 1

Beginning at point 1, the amplitude rises at a sine-wave rate (sinusoidal) where it reaches its positive peak ($C + E_{max}$); from this point it then decreases to its NO power point (3) and then proceeds to its second maximum power point ($-E_{max}$), returning to zero at (5); this then repeats. T is 360° rotation, a full cycle consisting of two alternations, points 1 to 3 and 3 to 5. The time required to complete one cycle is equal to T.

$$T = \frac{1}{f}$$

where T = time in seconds
f = frequency in cycles/second

EXAMPLE:

60 cycles per second power line in every household:

$$T = \frac{1}{f}$$

$$T = \frac{1}{60}$$

$$T = .0167 \text{ second or } 16.7\ \mu\text{sec}$$

One alternation would be .5T, or 8.35 μsec

Lissajous Patterns: Another type of fundamental pattern is obtained when both the vertical and horizontal deflection voltages are sine waves that are related in frequency as follows: one frequency is a whole-number multiple of the other; one frequency is a simple fraction of the other. When one or the other of these conditions is fulfilled, stationary closed-loop patterns are obtained. These patterns are called Lissajous figures after the 19th century French scientist. They are particularly useful in determining the frequency ratio between two sine-wave signals. If the frequency of one signal is known, the frequency of the other signal can easily be determined from the frequency ratio. Usually the known signal is applied to the horizontal channel and the unknown signal to the vertical channel. The shape of the pattern changes with the phase relationship between the known and unknown signals. For example, all the patterns shown in Figure 2 (and those intermediate) are possible with a frequency ratio of 1:1 if the phase differences indicated exist.

Fig. 2

In general to determine the frequency ratio from the Lissajous figure, count the number of points of tangency to horizontal and vertical lines, drawn or imagined (See Figure 3). Points of tangency at the top of the figures result from the unknown frequency applied to the vertical channel. Those at the side of the figure result from the known frequency applied to the horizontal axis. The following relationship holds true in all cases:

$$\frac{\text{V axis freq.}}{\text{H axis freq.}} = \frac{\text{V pts. of tangency}}{\text{H pts. of tangency}}$$

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As an example, take Figure 3 C, which shows four points of tangency at the top and one point at the side. This indicates that the unknown frequency applied to the vertical axis is four times the known frequency. In Figure 3 F, one point of tangency at the top and four at the side indicate that the unknown frequency is one-fourth the known frequency.

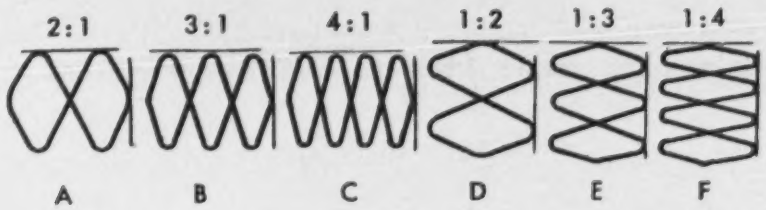

Fig. 3

MATERIAL REQUIRED

Oscilloscope
Audio Signal Generators (2)
Accessory Kit

PROCEDURE

1. Place the vertical input selector on internal calibrate and obtain a 2-inch sine-wave pattern.
2. Through the use of the frequency selector control, stabilize the trace until one wave is present. (This is always the ac line frequency 60 hz)
3. Without touching the frequency range or fine frequency control, place the vertical control off calibration or line to vertical input. Connect the audio signal generator (A.S.G.) into the vertical input jack.
4. Tune the A.S.G. until one wave is observed on the oscilloscope's face. Read the calibrated A.S.G. frequency. It should be at 60 hz.
5. Tune the A.S.G. to 120 hz and note the number of waves that appear on the face during the same time as the 60 hz appeared. This shows that, if a period of time is calibrated on the oscilloscope, other "unknown" frequencies can be read from the face of the oscilloscope.
6. Repeat step #5 for 180, 240, 300 and 360 hz.
7. Set up the following pictorial.

CUSTOMER FINANCIAL RECORD

One method of keeping efficient financial data is a customer file. All available information should be recorded so that there is an accurate record on which to base charges.

Customer's Name _____ Phone _____

Address _____

Job received _____ _____
(Description) (Date)

Hours worked _____

Materials supplied _____ Cost $ _____

_____ $ _____

_____ $ _____

Total $ _____

Bill rendered _____ Paid _____ $ _____
(Date) (Date) (Amount)

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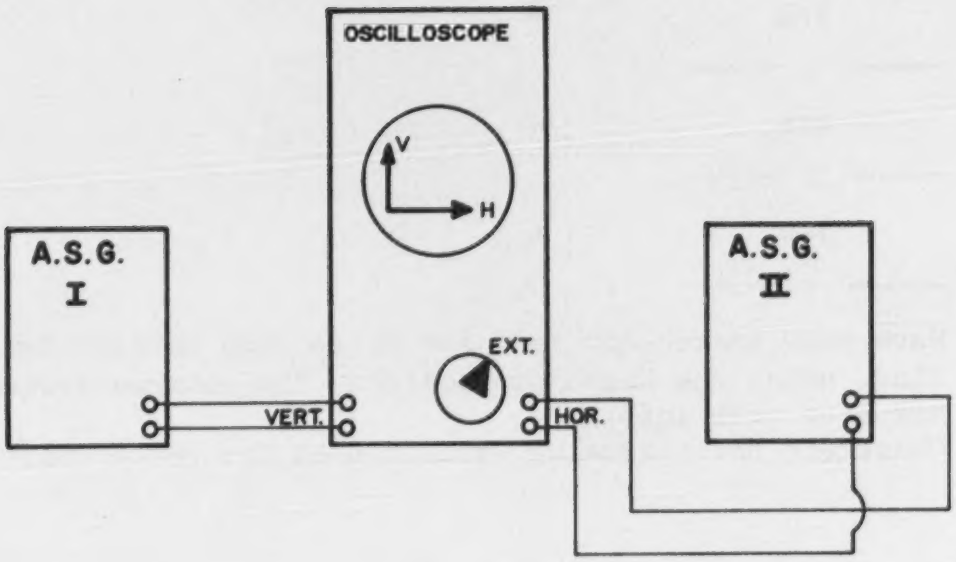

FIG. 4

8. Lissajous patterns are used in checking phase or frequency differences between known and unknown frequencies. Set the A.S.G. to a frequency of 100 hz sine-wave output.
9. Adjust the vertical gain to obtain a 1½ inch deflection.
10. Adjust the second A.S.G. to a frequency of 200 hz by means of the pattern. Refer to Figure 3.
11. Set up the following Lissajous ratios and draw the resultant oscilloscope traces.

V:H::1:2 =

(100 : 200)

1:3 =

_____ : _____

1:4 =

_____ : _____

2:1 =

_____ : _____

3:1 =

_____ : _____

4:1 =

_____ : _____

2:3 =

_____ : _____

3:2 =

____ : ____

4:5 =

____ : ____

5:4 =

____ : ____

12. Have your instructor turn A.S.G. to some unknown frequency. Find, using the Lissajous pattern, the unknown frequency. Instructor will initial.
13. Construct the following circuit, used for phase shifting.

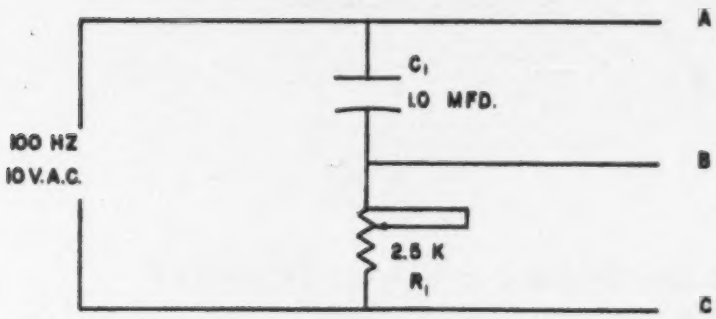

FIG. 5

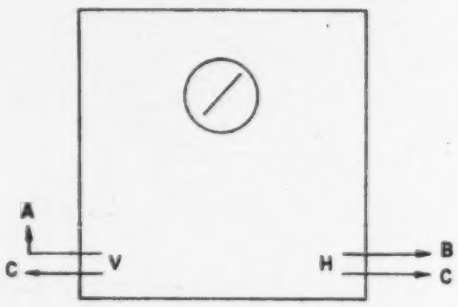

FIG. 6

14. Refer to Figure 2's traces, then slowly adjust R_1 on Figure 5 from minimum to maximum. Observe the trace, starting the phase-shift approximately at maximum and 50% resistance.
15. Change the input frequency to 500, 1000, 5000, and 10K repeating step #14 for each of the frequencies.

CONCLUSIONS

Frequency determination is widely used in industry when adjusting trap and filter circuits.

It is often necessary to inspect the phase of the voltage in respect to the current in an inductive or capacitive circuit, to view the degree of lead or lag.

14843

EXAMPLES:

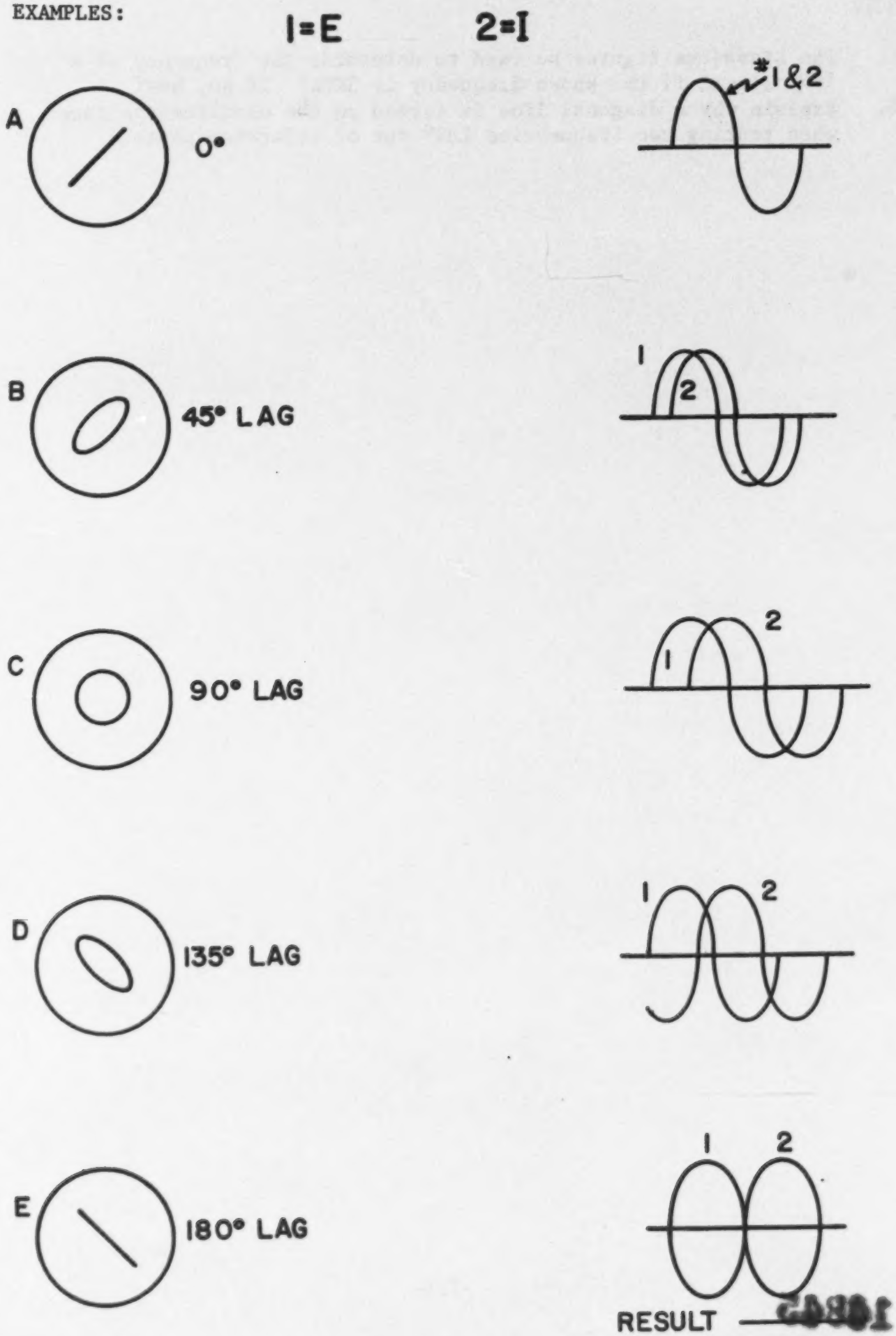

FIG 7

14844

QUIZ

1. Can Lissajous figures be used to determine the frequency of a 1KHZ signal if the known frequency is 3KHZ? If so, how?
2. Explain why a diagonal line is formed on the oscilloscope face when testing two frequencies 180° out of reference phase.

16845

EXPERIMENT #3 AC VOLTAGE (RMS, PEAK, AND PTP)

OBJECTIVES

To understand the relationship between the effective value (RMS) and the peak-to-peak value of voltage and current in an ac circuit.

To develop a working knowledge of alternating and direct current.

INTRODUCTION

Root mean square (RMS), or effective value, is the most common method used to measure ac sources. The 115-volt ac house outlet power is a common RMS value. When an electric heater consumes 2000 watts at 20 amps., the 20 amps is an RMS value. Normally any 110-volt ac voltage or current that has no designation is assumed to mean an RMS value.

By the use of higher order mathematics, it is found that the RMS value is .707 of maximum. Conversely, RMS times 1.414 equals maximum. When using an oscilloscope presentation, it will be especially useful to be able to convert to RMS value.

EXAMPLE: (two methods)

PTP = 20v (maximum to maximum) as measured on an oscilloscope.

A. 20 X .5 X .707 = 7.07 volts RMS

B. 20 X .3535 = 7.07 volts RMS

MATERIALS REQUIRED

Audio frequency signal generator
Power supply
Breadboard
Accessory kit
VTVM

PROCEDURE

1. Set up the equipment as shown in Figure 8.

2. Adjust the A.S.G. to 3.5 volts RMS, or approximately 10v peak-to-peak at 1000 hz.
3. Adjust the oscilloscope for two complete cycles, 2 divisions high (2 inches). Do not move the vertical gain control again, as the scope is now calibrated; 1 inch = 5 volts P.T.P. or 1.75 volts RMS.
4. With the oscilloscope measure both the RMS and P.T.P. value across each resistor on the breadboard.
5. Recalibrate the oscilloscope by inserting 6.3 volts ac RMS into the oscilloscope from the power supply (Fil.).
6. Place the 6.3 volts across R_1 through R_3.
7. Repeat step #4.
8. Add all resistor P.T.P. readings and all RMS values. Do they keep the same relationship of .707 $volts_{peak}$ = RMS?

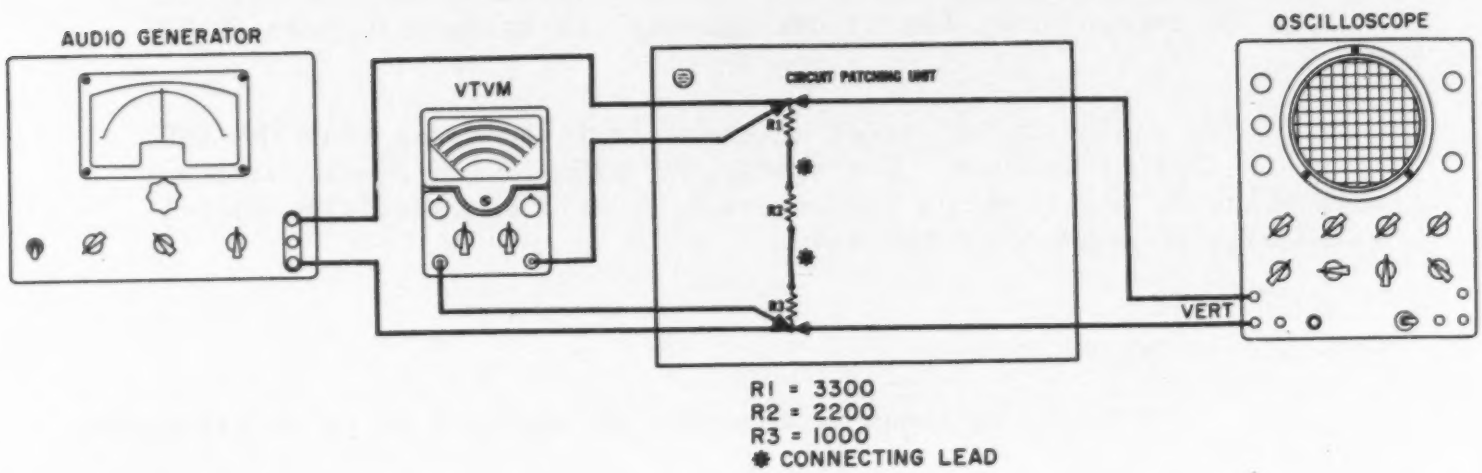

Fig. 8

CONCLUSION

Although an oscilloscope displays all voltages or currents maximum to maximum, it can be calibrated to measure peak or RMS values with ease.

QUIZ

1. An oscilloscope is accurate within 5% when reading voltages and currents. If the oscilloscope measured 25 volts P.T.P., which was then converted to RMS, on paper, what would a no-tolerance, ac RMS meter read, minimum and maximum, and still be correct?
2. Point out any differences detected during calculation and observation when running this experiment.

EXPERIMENT #4

INDUCTANCE, INDUCTIVE REACTANCE, AND IMPEDANCE

OBJECTIVE

To observe the effect of inductance in an alternating current circuit.

INTRODUCTION

A coil of wire possesses inductance (L) and inductive reactance (X_L). Inductive reactance is measured in ohms and is dependent on the applied frequency and the inductance.

$$X_L = 2\pi fL$$

The amount of X_L (ac opposition to a changing current) has a great influence on circuit current and tends to filter or smooth it.

Inductive reactance never appears alone in a circuit. Any coil that has inductance must also contain wire resistance. The combined opposition, X_L and R, is known as impedance (Z) and is found generally by:

$$Z = \sqrt{R^2 + X_L^2}$$

or

$$Z = \frac{E}{I}$$

Inductive reactance is directly proprotional to frequency. That is, inductive reactance (X_L) increases with frequency, as is illustrated in Figure 9.

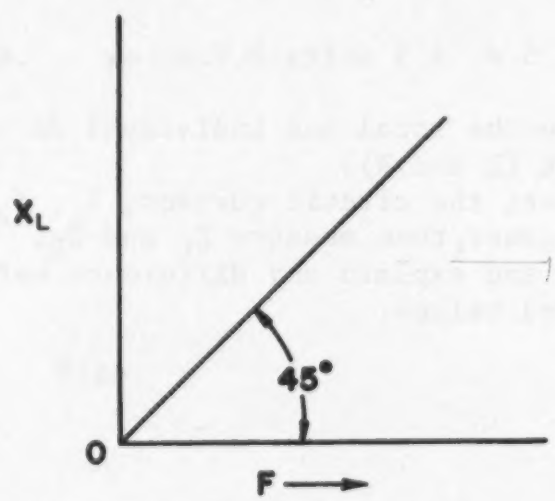

FIG. 9

14848

MATERIAL REQUIRED

Breadboard
Accessory kit
A.S.G.
Oscilloscope
VTVM and VOM

PROCEDURE

1. Set up the equipment for observing voltage, current, and impedance relationships in a series L-R circuit.

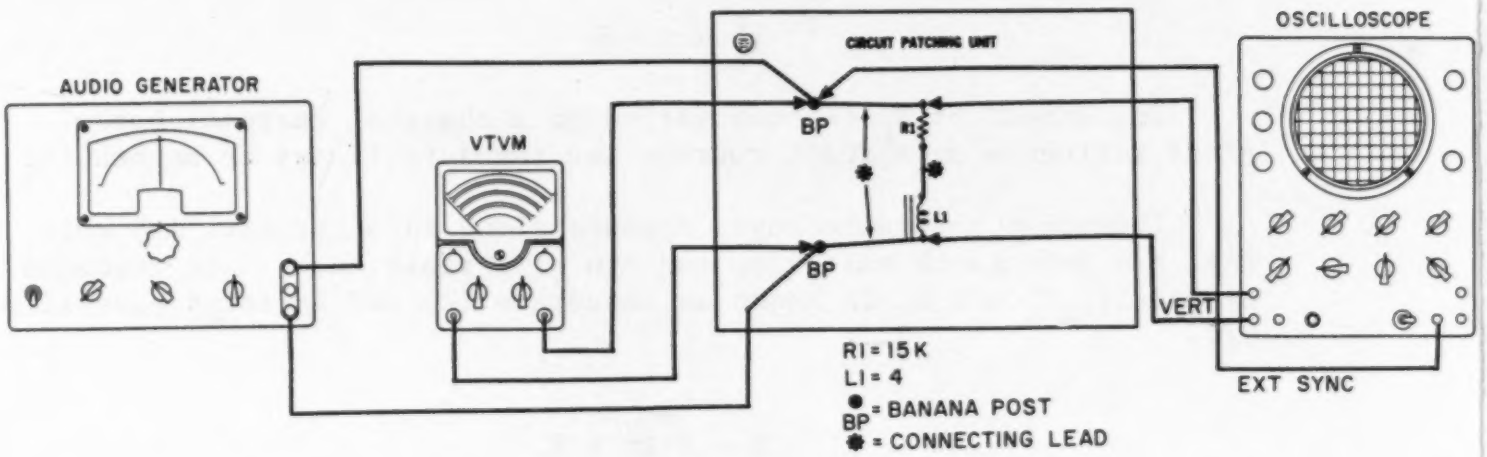

Fig. 10

2. Adjust the A.S.G. for 1200 hz and 3.5 volts RMS (10v P.T.P.).
3. Calibrate the scope for .5 volts P.T.P. = 1 small scale division. This is done by adjusting the vertical gain for 20 small scale divisions whereby:

20 = 10	volts P.T.P. or	3.5	volts RMS
10 = 5	volts P.T.P. or	1.75	volts RMS
5 = 2.5	volts P.T.P. or	.875	volts RMS

4. Measure the total and individual dc resistances present in the circuit (L and R).
5. Calculate the circuit current, I_L, I_R, E_L, and E_R.
6. Apply power; then measure E_L and E_R.
7. Record and explain any difference between the calculated and measured values.

8. Calculate X_L, then plug it into the formula for total opposition, Z.
9. Transpose the formula for impedance, $Z = \frac{E}{I}$; calculate the circuit current I.
10. Knowing total I series, calculate E_R and E_L.
11. Connect the oscilloscope across each component and measure each P.T.P. (Note the phase-shift between the components).
12. Draw a vector diagram of the voltage phase relationship of the circuit, using the circuit current as a horizontal zero time reference.
13. Replace the 15K resistor with a 47K resistor and repeat steps #2 through #12.

CONCLUSIONS

The effect of ac introduced into a circuit, differs significantly from the effect of dc. The inductive reactance of the circuit limits the change of the current in the circuit and it cannot follow the ac voltage source. The current actually lags the circuit voltage by up to 90°, dependent on the relationship between L and R. It may be said— the voltage in an inductive circuit <u>leads</u> the current (E.L.I.).

QUIZ

1. Would you expect the inductance to rise or fall if the frequency to the circuit were increased?
2. If the frequency were increased, what would happen to X_L? Z?
3. A coil has 10 ohms resistance and a reactance of 13 ohms at 60 hz. What is the circuit current with 30 volts dc applied?
4. In a circuit having 100 ohms X_L and 100 ohms R, what will be the phase angle of the current with reference to the voltage?
5. What is the Z of a series circuit containing X_L = 10 henry, R_1 = 10 ohms and R_2 = 100 ohms?

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EXPERIMENT #5 PARALLEL L-R CIRCUIT ANALYSIS

OBJECTIVE

To observe parallel L-R circuits in a practical environment.

INTRODUCTION

A parallel L-R circuit is similar to parallel-connected resistors in dc circuits. In resistor circuits the voltages present across each branch are equal and in phase with each other. However, in an ac circuit which has an inductor in parallel with R, the current in the "L" branch lags the branch voltage as well as all other resistive branch voltages. This results in the inductor-branch current lagging the voltage in the inductive branch, the current in the resistive branch, and the source voltage by up to 90° (theoretical).

MATERIAL REQUIRED

Audio frequency generator
Oscilloscope
Breadboard
Accessory kit
VTVM and VOM
Table of Trignometric Functions

PROCEDURE

1. Set up the equipment for analysis of parallel L-R circuits.

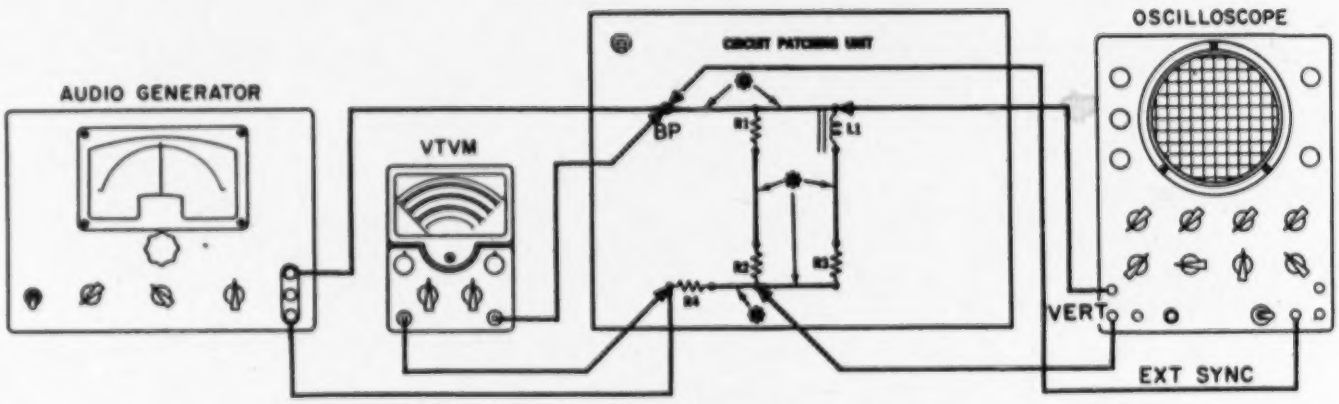

Fig. 11

R_1 = 5.1K
R_2, R_3 = 1K
R_4 = 560
L_1 = 4H

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2. Adjust the signal generator to 400 hz and maximum output voltage.
3. Adjust the oscilloscope for 2 cycles of presentation.
4. Calculate X_L and R in series to find Z. (Branch 2)
5. Calculate R—branch #1.
6. Calculate I—branch 2 and I—branch #1.
7. Draw a vector diagram consisting of I-Branch #1 versus I-Branch #2. Work out the line current.
8. Illustrate, on the vector diagram, the relationship of I-line to I-Branch #1 and I-Branch #2.
   EX: I_{Line} leads $I_{Branch\ 1}$ by 30° and lags $I_{Branch\ 2}$ by 60°.
9. Calculate the total Z by the use of Ohm's Law and the impedance formula. This should be less than either branch. Record.
10. Set up the equipment shown below.

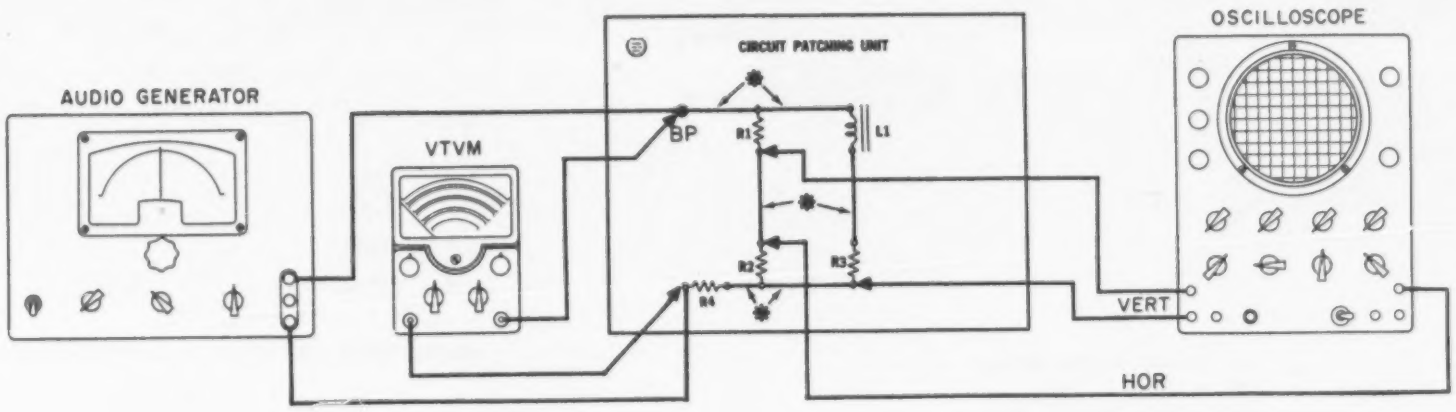

Fig. 12

R_1 = 5.1K
R_2, R_3 = 1K
R_4 = 560
L_1 = 4H

11. Adjust the oscilloscope controls for an in-phase Lissajous pattern.
    Note for part A of Figure 13:
    The line (Lissajous Pattern) is 45° when both horizontal and vertical deflections are equal.

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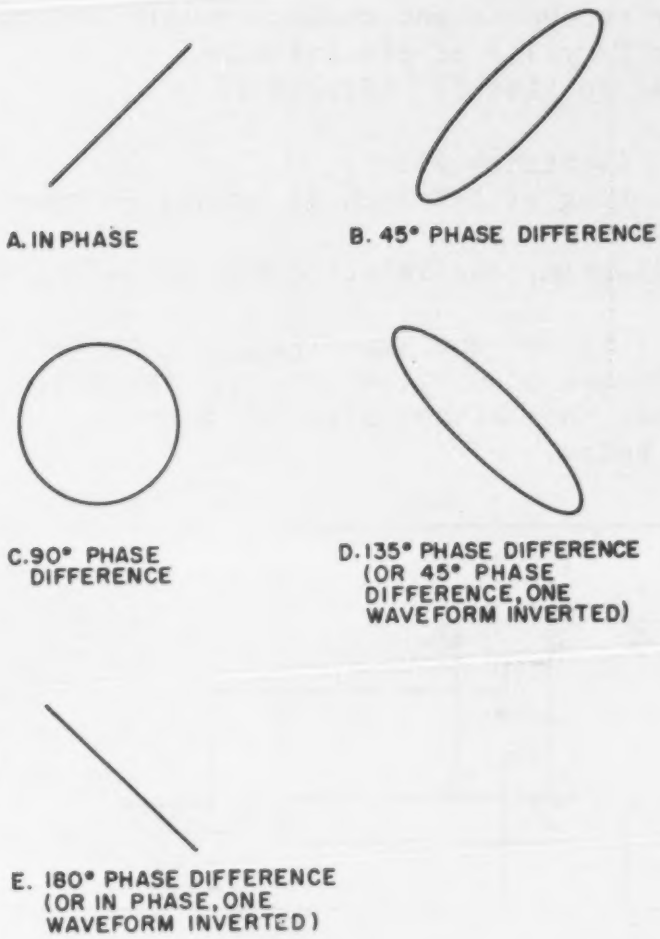

Fig. 13

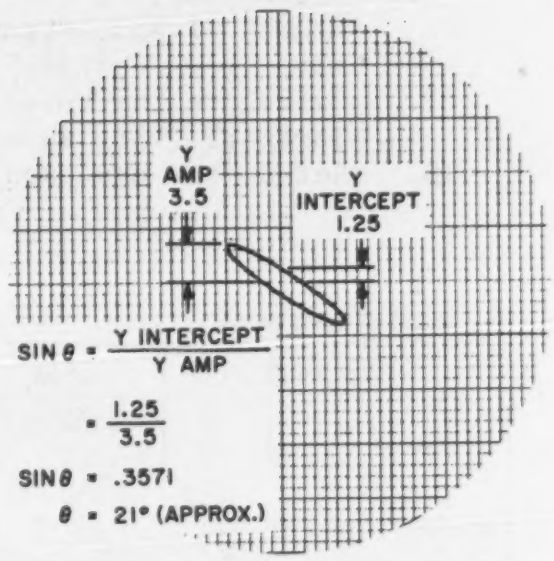

NOTE: THIS PATTERN IS SHIFTED 180°

Fig. 14

12. Move the horizontal input lead to the top of R_3 and adjust the oscilloscope gain controls for a 90° phase-difference Lissajous Pattern (part C). Recall that the phase of the resistive branch is the same as the applied voltage; therefore the vertical input is a sample of the voltage applied to the circuit.
13. Move the horizontal input lead to the left terminal of R_4. This samples the phase of the line-current in respect to the applied voltage. Note: Because of the placement of the oscilloscope ground reference lead, the horizontal-input wave-form is 180° out of phase from the vertical-input wave-form.
14. Draw the oscilloscope pattern accurately and find the phase angle by using the Y-intercept over Y-amplitude method to determine the sine trignometric function.
15. Compare this to your calculated value.

CONCLUSIONS

In a parallel circuit the voltage is the same across each branch and is used as the reference when analyzing such circuits. The current through the resistive branch is in phase with the reference voltage, and the current through the inductive branch lags the reference voltage. The line current, which is the vector sum of the branch currents, is greater than either branch current and lags the applied voltage. The total impedance is less than the opposition of either branch.

14853

QUIZ

1. An R.F. choke coil has a dc resistance of 1000 ohms with an inductance of 500 millihenrys. This coil is paralleled with a 2K ohm resistor. When 50-volt ac is applied at 1 megahertz, the line current is _____ amperes with a current lag of _____° behind E_{line}.
2. Why is the phase of a parallel or series L-R circuit important?
3. A coil with a reactance value of 50 ohms is connected across a 100-volt source. A dc resistor of 10 Ω is in series with the coil. A 20-ohm resistor is in parallel with this combination. What is circuit Z, I_T, and E_R for the 10-ohm resistor?

EXPERIMENT #6 COMPLEX L-R CIRCUITS

OBJECTIVE

To reinforce the knowledge gained in Experiment #5, using Inductance in alternating-current circuits.

INTRODUCTION

Although an inductor has the same properties when placed into a series or parallel ac circuit, the circuit effect differs in both cases. In analysis they must be treated electrically as individual circuits. Combining the two into one complex circuit will further alter the concept.

MATERIAL REQUIRED

Audio frequency signal generator
Vacuum-tube voltmeter (VTVM)
Breadboard
Accessory kit
VOM

PROCEDURE

1. Construct the following circuit.

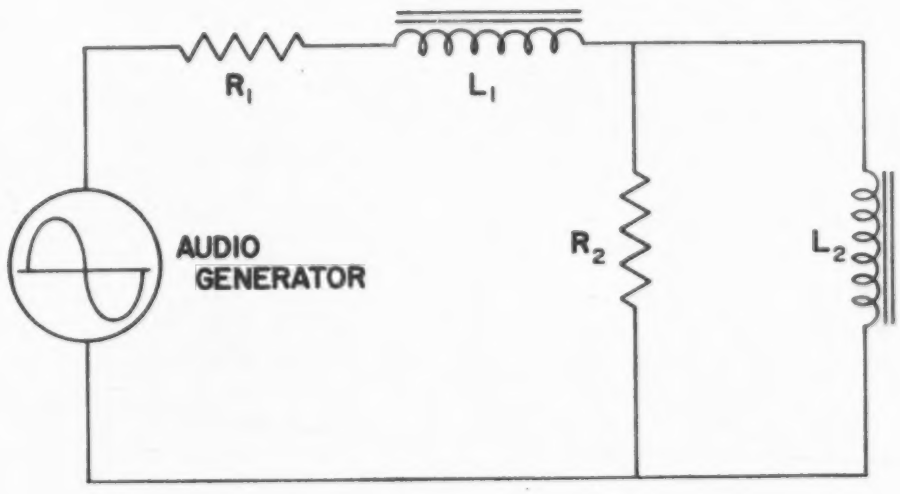

$R_1 = 15K$ $L_1 = 4H$
$R_2 = 5.1K$ $L_2 = 7H$

FIG. 15

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2. Calculate Z_T, I_T, E_{R1}, E_{R2}, I_{L2}.
3. Apply 1 Khz at maximum output power to this combination circuit.
4. Measure all measurable values and compare them with the calculated values.
5. Draw a vector diagram using the line voltage as the reference.
6. Change the line frequency to 10 Khz.
7. Repeat steps #2 to #6.
8. Analyze the effect of varying the frequency on this circuit, by raising and lowering the input frequency 500 hz.

CONCLUSION

In the series portion of the circuit, X_L varies linearly with frequency, consequently line current varies inversely with frequency. The parallel portion is characterized by the opposite of the series L-R circuit characteristics.

QUIZ

Review the circuit under question, in its entirety. Design your own circuit if necessary to complete your synopsis.

14856

EXPERIMENT #7 R-C SERIES CIRCUITRY

OBJECTIVE

To observe the effects of capacitance in a series R-C circuit.

INTRODUCTION

The property of a capacitor is to try or tend to keep the voltage (either ac or pulsating dc) at a constant value. The nature of capacitance, however, causes the voltage present in this circuit to do the opposite of inductance, or to lag the current. It might be well to remember this little memory-aid:

ELI - ICE - MAN

This refers to the current/voltage relationship in an inductive and capacitive circuit. E (L) I: voltage leads current in an inductive circuit. I (C) E: current leads voltage in a capacitive circuit.

The amount of opposition a capacitor offers to alternating current is measured in ohms and symbolized as X_C. The basic formula used to find the amount of X_C is:

$$X_C = \frac{1}{2\pi fC} \quad \text{or} \quad \frac{.159}{fC}$$

In a series circuit containing both R and C, an increase in the frequency (rate of change of the input) will cause a decrease in X_C and a consequent increase in the line current.

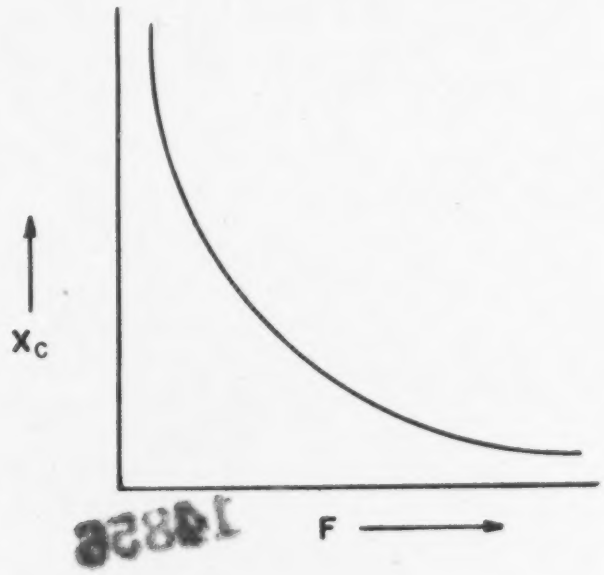

FIG. 16

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An increase in capacitance will have the same effect on the circuit current. It will also decrease the phase-lag between E and I. Z is found by:

$$Z = \sqrt{R^2 + X_C^2}$$

MATERIAL REQUIRED

A.S.G.
Breadboard
Oscilloscope
Accessory kit
VTVM
VOM

PROCEDURE

1. Construct the following circuit:

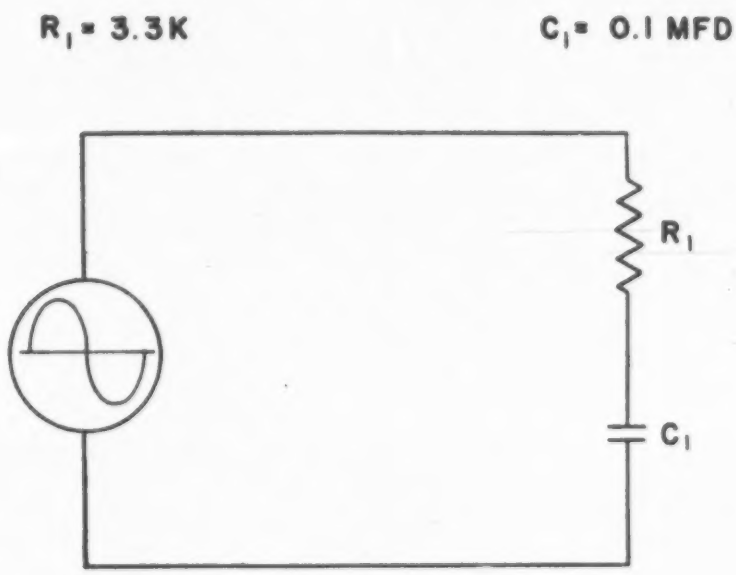

FIG. 17

2. Set the A.S.G. to 480 hz and maximum output.
3. Set the oscilloscope trace for several cycles of ac and a height, when placed across the A.S.G., of 4 inches. Record the P.T.P. ACROSS EACH COMPONENT.
4. Calculate X_C, Z , I , E_{R1} and E_{C1}.

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5. Measure all measurable values.
6. Calculate the amount of voltage lag in this circuit.
7. Parallel a 1-emf capacitor across C_1.
8. Repeat steps #2 to #6.
9. Change the input frequency 10% and measure all effects observable.

CONCLUSION

In a series R-C circuit the most probable major influence is the input frequency, determining X_C and Z. It must be remembered: AT ALL TIMES E and I are in phase in a pure resistance, regardless of its circuit placement. Inductance or capacitance may cause the phase to shift.

QUIZ

1. A .001 mf capacitor is 45° out of phase with a shunt resistor, 10K. What is the input frequency?
2. In a 1 Khz circuit, a capacitor opposes the change in voltage by 750 ohms. What size is the capacitor?

EXPERIMENT #8 PARALLEL R-C CIRCUITRY

OBJECTIVE

To observe the effect of alternating voltage and current in a parallel R-C circuit.

INTRODUCTION

A resistor and a capacitor wired in parallel have the combined properties of both components. The capacitive reactance, being inversely proportional to frequency, will pass more current as the input frequency is raised. This rise is non-linear or exponential in nature. The branch voltages, as in ALL parallel circuits, are equal and in phase with each other. As with other capacitive circuits, the current in the capacitive branches leads the branch voltage by up to 90°.

MATERIAL

A.S.G.
VTVM and VOM
Breadboard
Accessory kit

PROCEDURE

1. Set up the equipment as shown below:

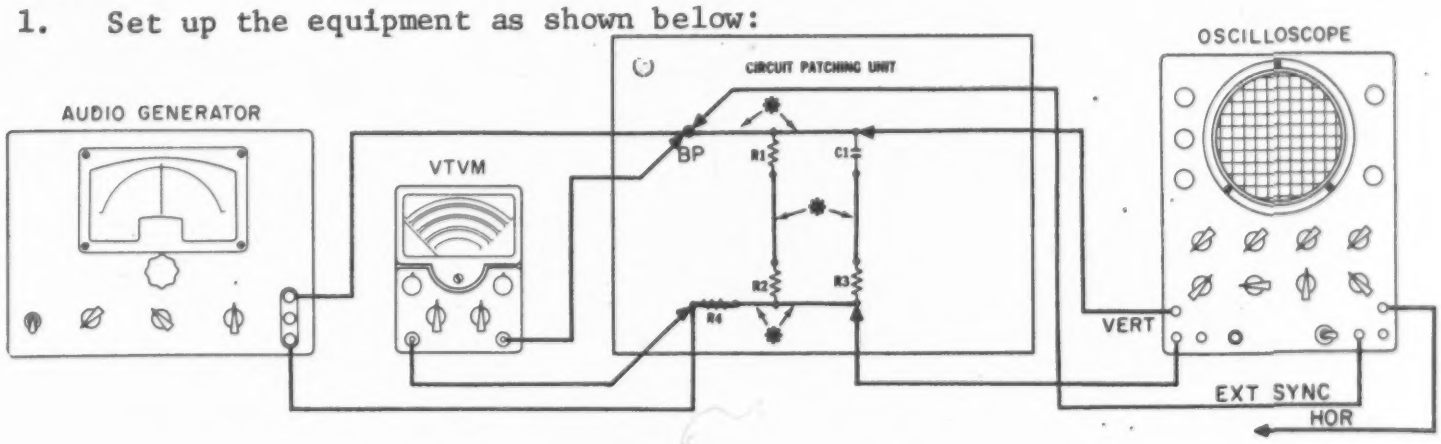

Fig. 18

R_1 = 3.3K
R_2, R_3 = 1K
R_4 = Jumper
C_1 = 0.1 mfd

2. Set the A.S.G. to 1Khz and maximum output.

3. Calculate X_{C1}, Z, I, E_C and E_{R3} of the capacitance branch.
4. Calculate E_{R1}, E_{R2}, I_{R1}, and R_T of the resistive branch.
5. Calculate the total L, Z, and the phase angle of the circuit.
6. Measure all measurable values calculated.
7. Compare in chart form all calculated and measured values. Explain any differences.

CONCLUSION

In a parallel R-C circuit the voltage is the reference in the circuit, due to parallel-circuit characteristics. The resistive branch current is in phase with the total voltage (combined R_1 and R_2 voltage). The total Z in the circuit will be less than either branches R or C, due to the reciprocity of the component placement arrangement.

QUIZ

1. If C_1 is doubled, what happens to Z_T? I_T?
2. If the frequency is changed 20%, the total Z will change _____ ohms. Is it a linear change?
3. What effect has a change in the resistive circuit's ohmic value on the total circuit current?
4. Where is the circuit Z greater, at the lower frequency line current or the higher?

14861

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1483

EXPERIMENT #9 R-C COMBINATION CIRCUITRY

OBJECTIVE

To analyze a circuit containing parallel R-C components in series with each other.

INTRODUCTION

By incorporating both the series and parallel R-C circuit laws independently, a complex circuit can be reduced to an understandable circuit.

MATERIAL REQUIRED

A.S.G.
Breadboard
Accessory kit
VOM and VTVM
Oscilloscope

PROCEDURE

1. Construct the following circuit:

R_1 = 1K C_1 = .1 MFD
R_2 = 1K C_2 = .01 MFD

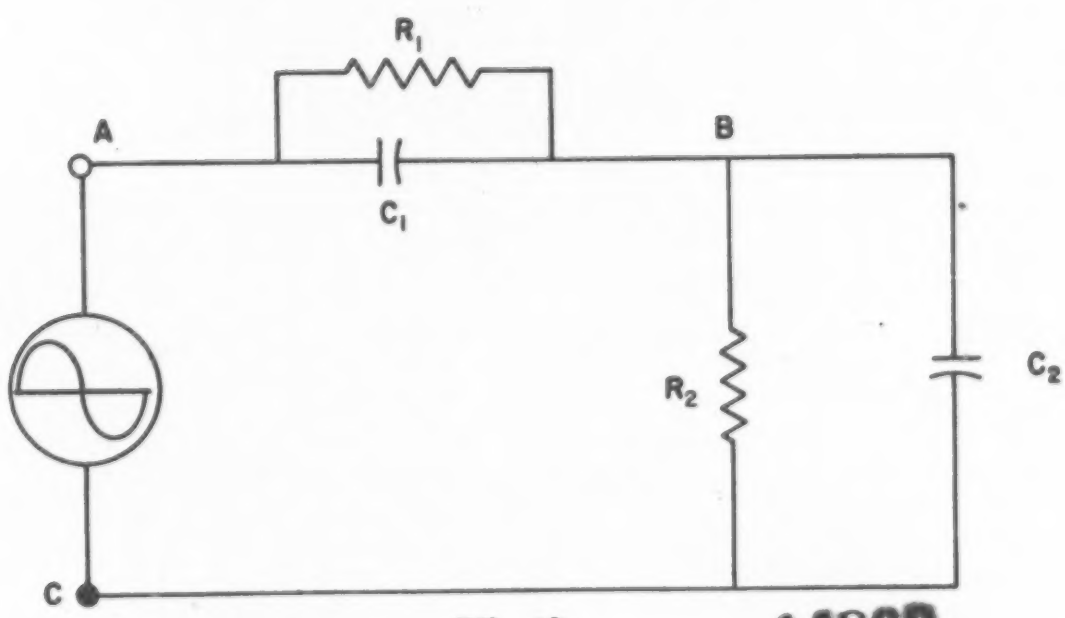

FIG 19

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2. Set the A.S.G. to 150 hz and maximum output. NOTE: Monitor the output power from the A.S.G. as it may change due to the shorting effect of capacitance at the higher frequencies.
3. Calculate all possible values, including the voltage-divider action of R_1 - C_1 and R_2 - C_2 combinations. (RMS value)
4. Measure all measurable values, including the RMS from B to C.
5. Open the circuit at point B and measure the current at this point. Calculate .707 of this value.
6. Vary the A.S.G. above and below 150 hz until the above calculated values are reached. Record.

CONCLUSION

In R-C circuits, as the frequency increases, the phase angle (which in reality is a comparison between the ac and dc circuit resistance) will decrease. This is due to the shunting effect of capacitance as the frequency changes. There are many advantages to be gained from either series or parallel circuits using capacitance. They are used commonly as filters and ac voltage-divider circuits.

QUIZ

1. Design a voltage-divider circuit using two capacitors in series across the 110-volt ac line, so the voltage across one of the capacitors is 11 volts ac.
2. Repeat #1 but have one of the capacitors 8 mf.

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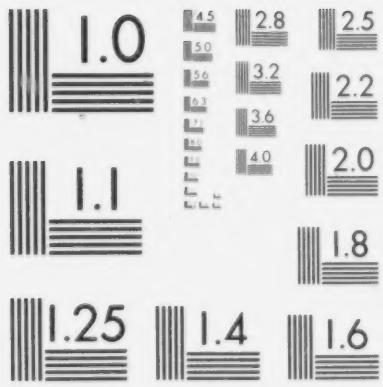

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

EXPERIMENT #10 SERIES R-L-C CIRCUITRY

OBJECTIVE

To observe the effects of resistance, inductance, and capacitance in a series circuit.

INTRODUCTION

Series R-L-C circuits find their greatest application as resonant circuits and phase-shifting circuits. In all circuits of this type, the reference phase will be "I" line.

MATERIAL REQUIRED

A.S.G.
Breadboard
VTVM and VOM
Oscilloscope
Accessory kit

PROCEDURE

1. Construct the following circuit:

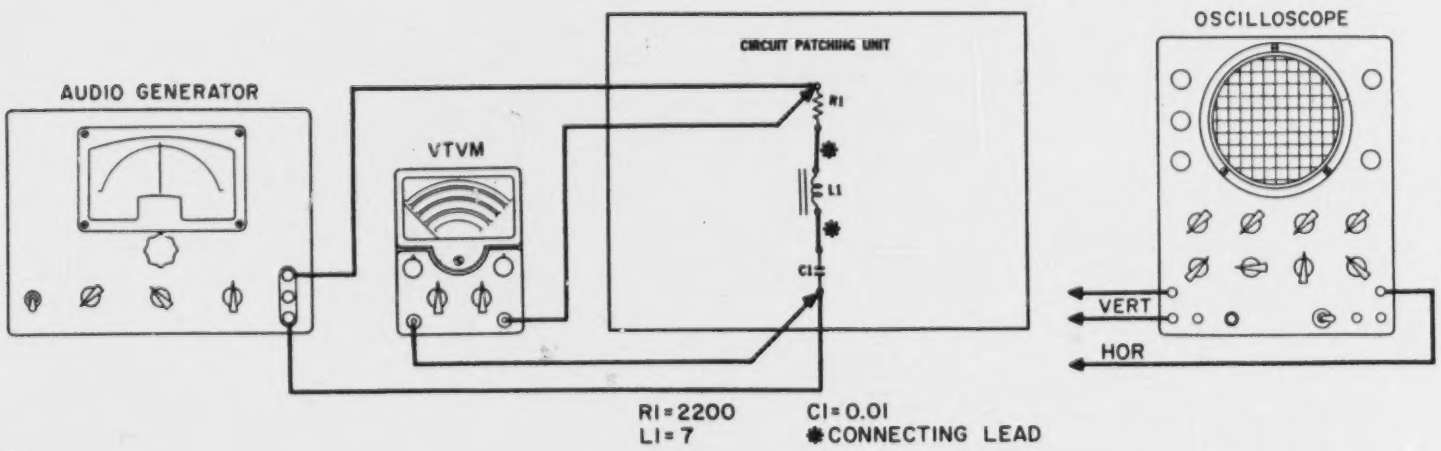

Fig. 20

2. Set the signal generator to 500 hz at 3.5 volts RMS. Monitor this voltage throughout the experiment to assure constant output voltage.
3. Calculate X_L, X_C, R, Z, and I_T.

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4. Measure all measurable values at the 500 hz input frequency.
5. Calculate E_{R1}, E_{L1}, and E_{C1}.
6. Measure with the oscilloscope all calculated values from step #5.
7. Compare all measured and calculated values.
8. Change the input frequency to 1400 hz.
9. Repeat steps 3 to 7.

CONCLUSION

Series-circuit laws still apply, but the reactances must be dealt with in a different manner due to ELI - ICE - MAN. If each is out of phase by up to 90° from a dc resistance, one leading and one lagging, they are in direct opposition to each other. If the oppositions are equal they may neutralize each other.

QUIZ

1. Draw a vector diagram containing R, X_C, X_L at both 500 and 1400 hz.
2. What is the phase relationship between circuit current and source voltage?
3. Between circuit current and E_C?
4. What would be the effect on the circuit current, source voltage, and I_c if R_1 were removed?

14865

EXPERIMENT #11 PARALLEL R-C-L CIRCUITRY

OBJECTIVE

To acquaint the student with the usefulness of R-C-L parallel circuits as filter networks.

INTRODUCTION

In a circuit of this type the impedance changes line and branch currents considerably as the line frequency changes. Depending upon the direction of the line frequency change, the circuit may look either capacitive, inductive, or resistive in nature. The net reactance is the difference between the reactive components.

MATERIAL REQUIRED

A.S.G.
Breadboard
VTVM and VOM
Oscilloscope
Accessory kit

PROCEDURE

1. Construct the following circuit.

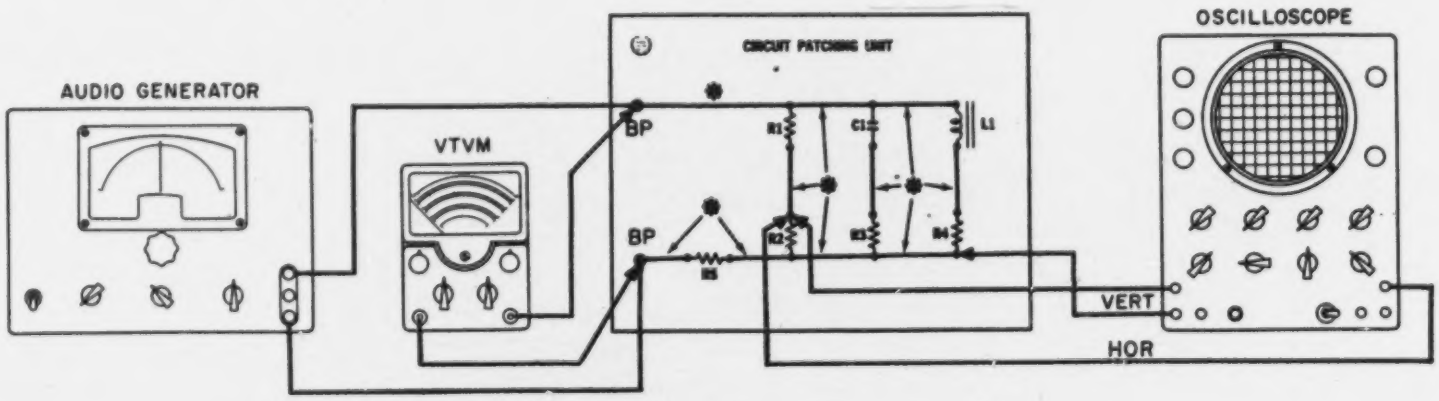

Fig. 21

R_1 = 22K
R_2, R_3, R_4 = 1K
R_5 = 25 Ω

L_1 = 4H
C_1 = .01 mfd

14866

2. Adjust the signal generator output for 1 Khz at 10 volts P.T.P. output.
3. Calculate all values, including lead or lag of the E source - I source relationship.
4. Measure all measurable values.
5. Compare (in chart form) the results obtained in steps 3 and 4.
6. Change the input frequency to 500 hz and 1500 hz (output 10 volts P.T.P.)
7. Repeat steps #3 to #5 for each of the new frequencies.

CONCLUSIONS

In a parallel reactive circuit, current is controlled by the component having the least reactance.

QUIZ

1. The controlling component in the experimental circuit at low frequencies is the _____.
2. If the input frequency were raised to 5 Khz, would the circuit look capacitive or inductive? Why?
3. The generator output drops to 5 volts P.T.P. but the frequency stays the same. State the circuit and component effects that would take place.

14867

EXPERIMENT #12 SERIES RESONANCE

OBJECTIVE

To determine the operating characteristics of a series-resonant circuit at and off resonance.

INTRODUCTION

Resonant circuits are used extensively in electronics as frequency-discrimination circuits. By selecting one frequency or a narrow band of frequencies from the total spectrum, we can tune a radio or TV station. Resonant circuits are generally used at RF (radio-frequency) rather than AF, but will be used in this experiment at the lower frequencies.

MATERIAL REQUIRED

A.S.G.
VTVM and two VOM's
Oscilloscope
Breadboard
Accessory kit
Graph paper
Multimeter panel

PROCEDURE

1. Construct the following circuit.

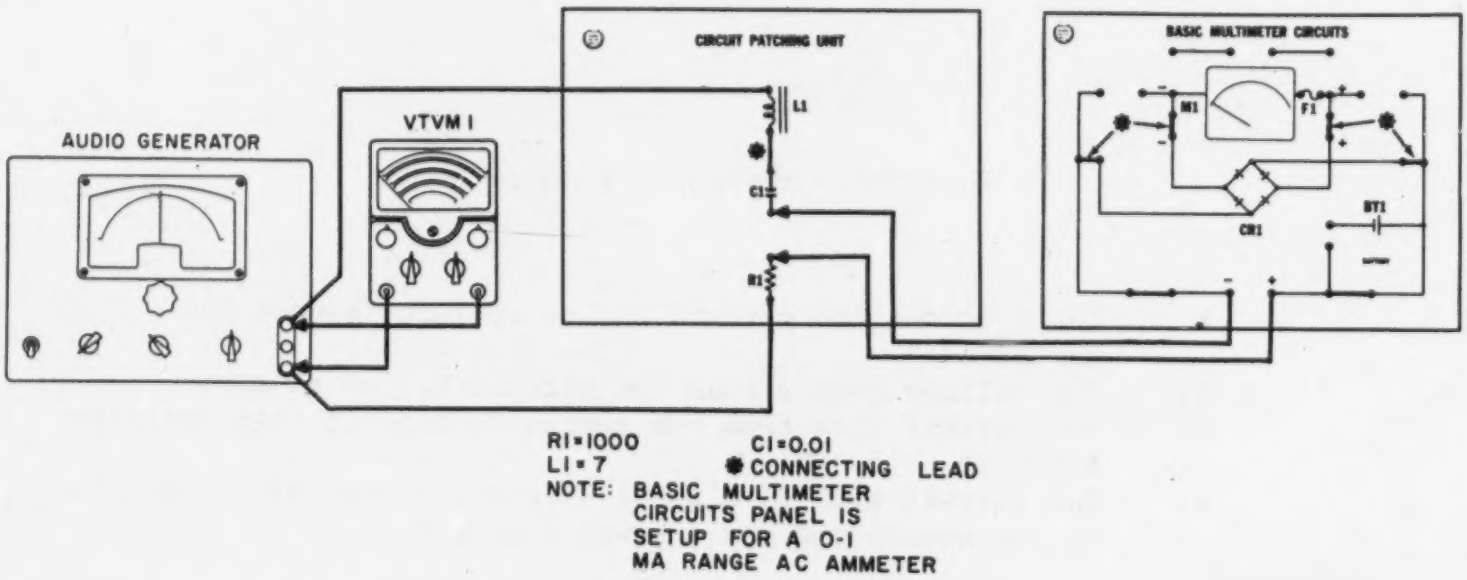

Fig. 22

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2. Connect a VOM across both L_1 and C_1 (ac volts).
3. Set the signal generator to 10 volts P.T.P. and adjust the frequency until E_{L1} and E_{C1} read the same. (May be at or near zero)

   NOTE: The VTVM must monitor the 10-volt P.T.P. throughout this experiment.

4. Calculate X_L, X_C, Z, I_T, E_R, E_{C1}, and E_{L1} at this frequency.
5. Measure all calculated values.
6. Compare steps #4 and #5.
7. Adjust the signal generator to both a higher and lower frequency until the upper and lower half-power points are reached. (70.7%I_T) Record the generator frequency at each of these points.
8. Determine the bandwidth and bandpass of this circuit.
9. Calculate the circuit Z.
10. Change R_1 to 10 ohms. Repeat steps #7 through #9.
11. Change R_1 to 10 K.
12. Repeat steps #7 through #9.
13. Make a graph for each of the three trials (10Ω, 1K, and 10K) of impedance versus frequency.

CONCLUSION

Characteristics of all series circuits at resonance:

A. $X_L = X_C$

1. $X_L = 2\pi FL$
2. $X_C = \frac{1}{2\pi FC}$
3. $2\pi FL = \frac{1}{2\pi FC}$
4. $FR = \frac{1}{2\pi\sqrt{LC}}$

   Where FR = resonance frequency

B. The Z across the circuit is low or zero (equals the resistance).
C. The voltage drop across the circuit is low or zero.
D. The current flow from the source is high or theoretically infinite. (R = 0)
E. The circuit acts as a purely resistive (no reactance) load to the source and has a power factor = 1.

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F. The voltage drop across either reactance is equal to E = IZ and may be greater than the source voltage.

G. The phase angle of the current and voltage as seen by the source is 0°, or in phase.

The bandwidth is the frequency range that the current is passing above the half-power points.

EX: FR = 1000 hz, L.S.B. = 800 hz,
U.S.B. = 1200 hz, B.W. = 400 hz

Circuit bandpass is the actual frequencies that the circuit is working, or capable of working, at the values given.

EX: FR = 1000 hz, L.S.B. = 800 hz,
U.S.B. = 1200, B.P. = 800 to 1200 hz

QUIZ

1. A 7.5-ohm resistor is connected in series with a 150-microhenry coil and a 169 mmf capacitor to a 1-volt variable-frequency source. Determine F, I_T, X_L, X_C, Q, E_R, and E_C at the resonant frequency.
2. The voltage drop across the coil or capacitor is _____ times greater than the applied voltage in question #1.
3. Why does the impedance increase on both sides of resonance?
4. In a series R-L-C resonant circuit operating above resonance (FR), the voltage developed across C drops. Why is this?
5. The resistance in a series resonant circuit cannot be changed. However, it is possible to raise the Q, narrow the B.W., and keep the same resonant frequency (FR) by increasing the L-to-C ratio. Explain.

14870

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EXPERIMENT #13 PARALLEL RESONANCE

OBJECTIVE

To analyze a practical parallel resonant circuit and observe its resonant characteristics.

INTRODUCTION

Parallel resonant circuits are used for the same purpose as series resonant circuits, frequency discrimination. However, the circuit characteristics differ quite distinctly from the series resonant circuit.

Example of Z and I:

Theoretical

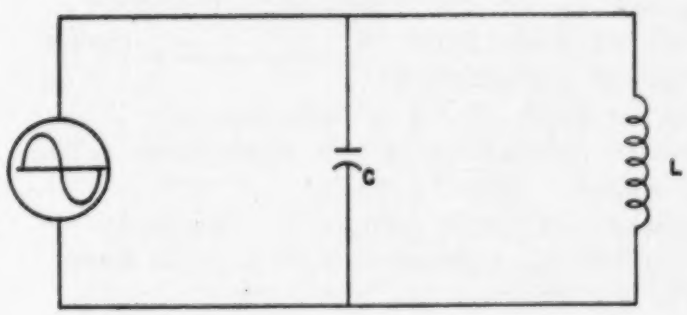

FIG 23

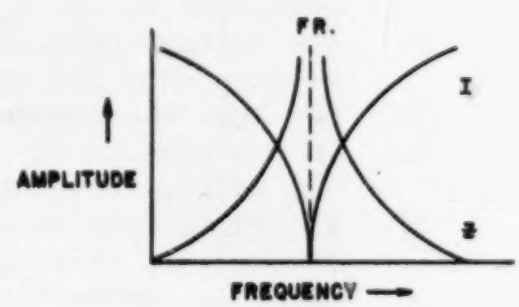

FIG. 24

Practical

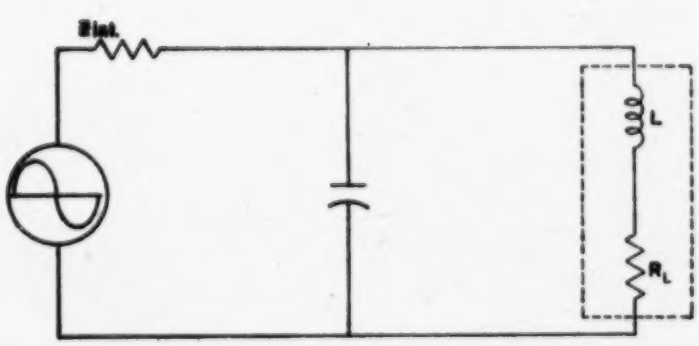

FIG. 25

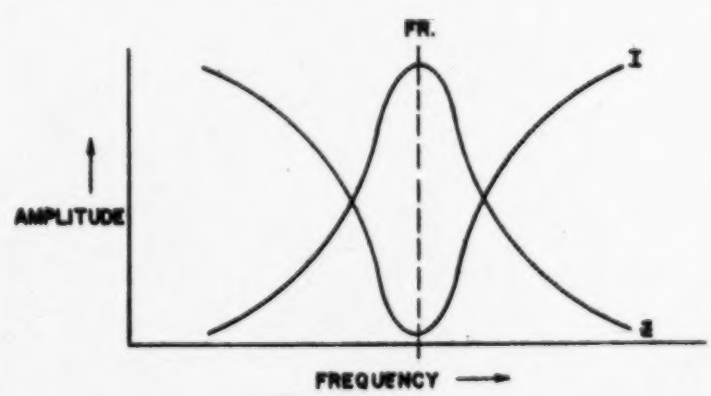

FIG. 26

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MATERIAL REQUIRED

A.S.G.
VTVM and two VOM's
Oscilloscope
Breadboard
Accessory kit
Graph paper

PROCEDURE

1. Construct the following circuit.

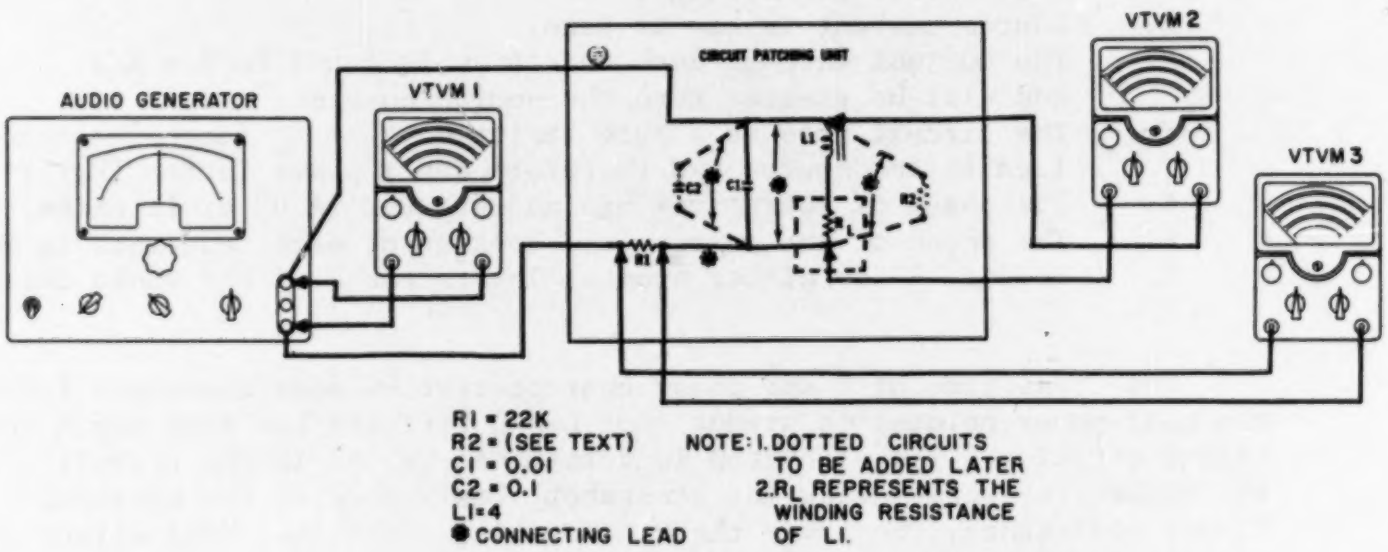

Fig. 27

NOTE: VTVM-2 and -3 may be VOM's (20K ohms/volt)

2. Adjust the signal generator to a frequency where meter 3 reads minimum. At this frequency set the generator amplitude at 10 volts P.T.P. or at maximum if 10 volts P.T.P. cannot be achieved. (Keep this constant throughout the experiment.)
3. Calculate X_L, X_C, Z_1, and I_T at this frequency. Include R_1 and R_L in your calculations for Z_1 and I_T.
4. Calculate .707 of Z_T for the USB and LSB cut-off points.
5. Calculate I_T at the cut-off points.
6. Adjust the generator to each of these points, by monitoring the line current. Record FUSB and FLSB.
7. Calculate B.W., B.P., and circuit Q.
8. Change C_1 to a 0.1 mf capacitor.
9. Repeat steps #2 to #7. Compare the new results.

14872

10. Add R_2 and repeat steps #2 to #7. Compare the effect on the circuit with the addition of R_2.
11. Use the oscilloscope in all applications where voltage readings are required.

CONCLUSIONS

The characteristics of a theoretically "pure" parallel resonant circuit are:

A. $X_L = X_C$
B. The Z across the circuit is maximum.
C. The voltage drop across the circuit is equal to or less than the source voltage.
D. Source current is Low or Zero.
E. The current through each reactance is equal to I = E/X and will be greater than the source current.
F. The circuit acts as a pure resistive $X_C = X_L$ (zero reactance) load to the source and therefore has a power factor (P.F.)= 1.
G. The phase of source voltage and current is 0° or in phase.
H. The phase of the current and voltage of each reactance is 90°.
I. Adding "R" to either branch, lowers the Z of the whole circuit.

The transition of Z and phase characteristics near resonance (above the half-power points) is gradual for Low-Q circuits but more rapid for high-Q circuits. The circuit Q is determined by "R" in the circuit: the higher the series line (or generator) resistance, or the parallel (load) resistance, the lower the Q. However, resistance does affect circuit Q and hence the impedance. It is precisely because of the opposite effect of frequency change upon the reactances that the characteristic variations of impedance (and phase angle) occur.

QUIZ

1. A 160-microhenry coil in series with a 20-ohm resistor is connected in parallel with a 250 mm capacitor and placed across a 20v, variable frequency source. Find FR, Q, Z_T, I_T, and the branch currents at resonance.
2. Which of the following are true about a parallel R-L-C circuit operating at resonance? (theoretically)

   A. I_C cancels out I_L.
   B. The current in the inductor is 180° out of phase with the line current.
   C. The power dissipated in R_L (series with L) is greater (E source constant) than at any other frequency.

14873

D. The circuit acts purely resistive.
E. The current in L and C are greater than at any other frequency.
F. The phase angle of the applied voltage and current is zero degrees.
G. The capacitive and inductive voltages are in phase.
H. The capacitive voltage completely cancels the inductive voltage.

3. A variable capacitor has a minimum capacitance of 20 mmf and a maximum capacitance of 300 mmf. If connected across a 100 μh coil, what is the (a) highest frequency (b) lowest frequency, to which it can be made resonant?

EXPERIMENT #14 TRANSFORMER THEORY

OBJECTIVE

To analyze the principle of transformer action.

INTRODUCTION

A transformer consists of two or more inductances in proximity to each other. Current flowing in one inductor induces a voltage into another. Normally, the coil that is receiving the source power is called the primary (E_P) and the coil receiving this energy is called a secondary coil (E_S). Examples of schematic layout of a power transformer and its common wire color code are shown in Figures 28 and 29.

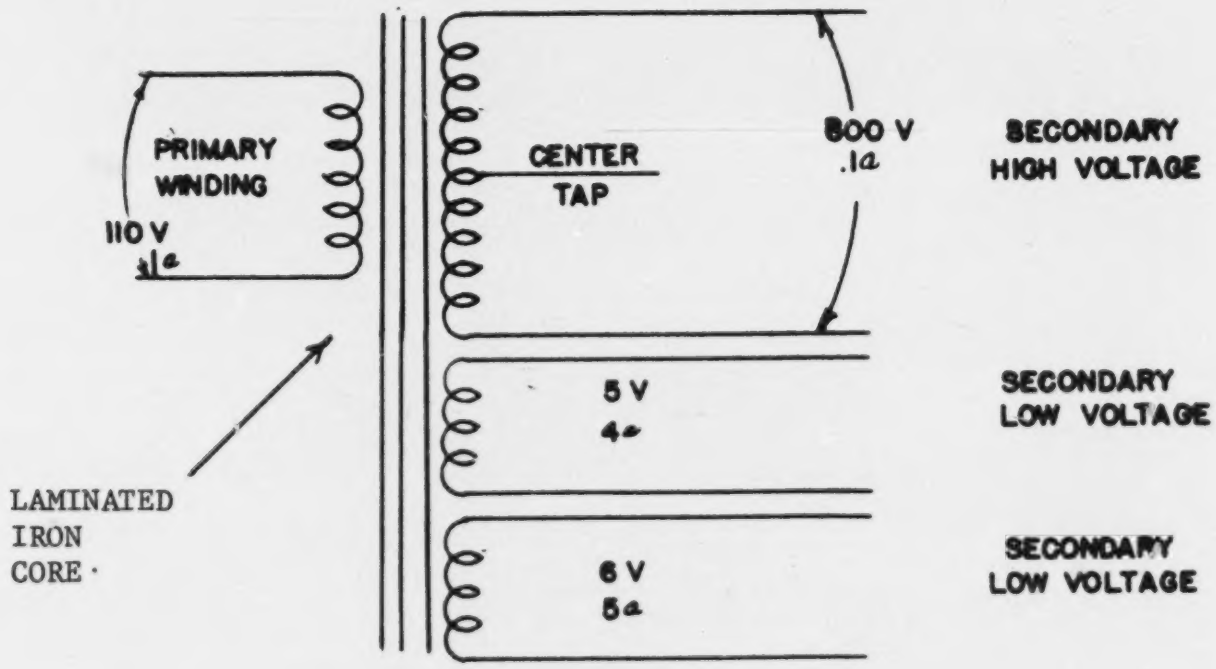

Fig. 28

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As shown, a single primary winding can supply several secondary windings, but it must be remembered that at best the total secondary power can never exceed the primary power.

COLOR	WINDING
BLACK	PRIMARY
RED	HIGH VOLTAGE
RED AND BLACK	HIGH VOLTAGE CENTER TAP
YELLOW	5 VOLT FILAMENT
GREEN	6 VOLT FILAMENT
GREEN AND YELLOW	6 VOLT CENTER TAP

Fig. 29

The primary and secondary windings may be wound on different types of cores to increase magnetic coupling and efficiency. The most commonly used core is laminated iron. This is used at low and audio frequencies, but at higher frequencies (RF) either powdered iron or no core is used.

The parallel dotted or solid lines between the primary and secondary coils indicate the presence of an iron core.

Some more commonly used formulas for calculating turns ratio, voltages, or currents are as follows:

A. $N = \frac{\text{Secondary turns}}{\text{Primary turns}}$ (Step-up)

B. $N = \frac{\text{Primary turns}}{\text{Secondary turns}}$ (Step-down)

C. $E_s = N \times E_p$ or $E_s = \frac{E_p}{N}$

D. $I_s = \frac{I_p}{N}$ or $I_s = NI_p$

E. $\frac{Z_p}{Z_s} = \frac{N_p}{N_s}^2$

14876

F. % efficiency $= \frac{P_s}{P_p} \times 100$

G. $\frac{T_p}{T_s} = \frac{E_p}{E_s}$ or $\frac{T_p}{T_s} = \frac{I_s}{I_p}$

H. Combining, $\frac{I_p}{I_s} = \frac{E_s}{E_p} = \frac{N_s}{N_p} = \sqrt{\frac{Z_s}{Z_p}}$

When a load is connected across the secondary of a transformer, many things happen:

a. The source emf produces primary current.
b. I_p produces a counter emf, E_c, in the primary.
c. I_p also produces a secondary voltage, E_s.
d. E_s produces I_s, through the load.
e. I_s produces its own magnetic field, which cuts the primary coil.
f. The expanding secondary field produces a counter emf, E_{cc}, in the primary (opposite to E_c but in phase with the primary source voltage).
g. E_{cc} partially cancels out E_c.
h. I_p tends to increase, due to the E_c decrease.

14877

MATERIAL REQUIRED

A.S.G.
VTVM
Oscilloscope
Breadboard
Accessory kit

PROCEDURE

1. Set up the equipment as shown below:

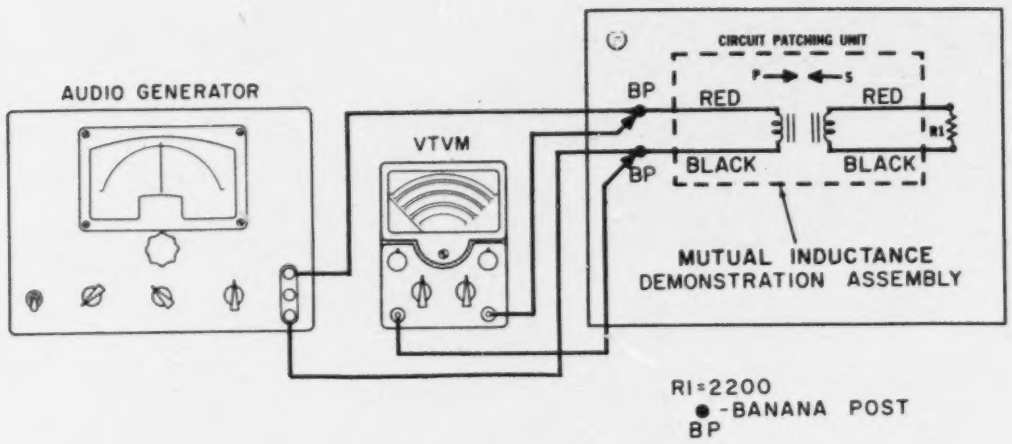

Fig. 30

2. Push the coils together (tight coupling) and adjust the audio generator for an output of 1 Khz at 10 volts P.T.P., or maximum if 10v cannot be realized. Measure E_{R1}.
3. Push the coils apart in steps of .25 inches, recording E_{R1}.
4. Set up the equipment as shown below.

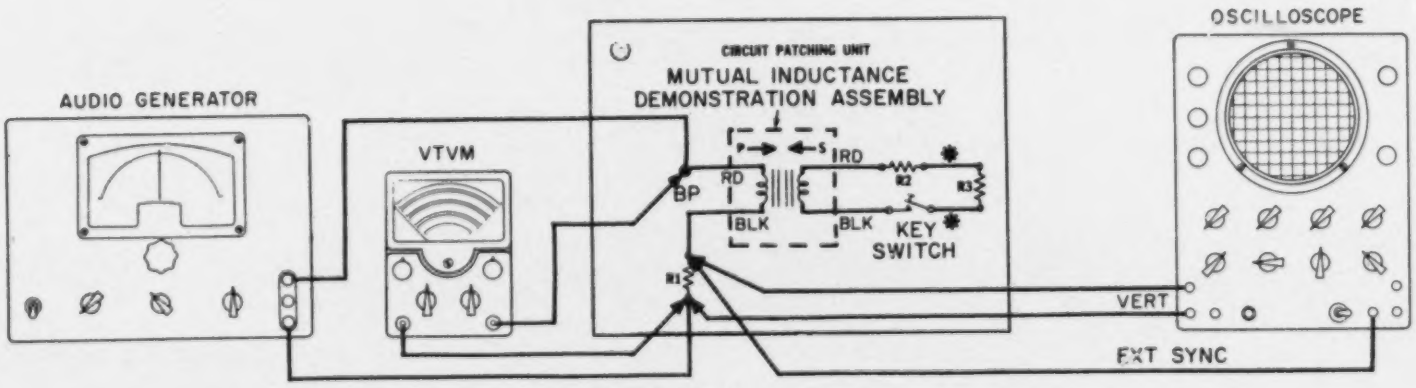

Fig. 31

R_1, R_2 = 2.2K
R_3 = 1.5K

14878

CONCLUSION

There are three types of coupling in transformers: tight, optimum, and loose. This in effect governs the amount of induced power into secondary coils and is usually fixed during manufacture.

With a pure resistive load in the secondary, the E and I are in phase with each other and 180° out of phase with the primary voltage. Reversing the secondary leads causes an in-phase condition to exist.

QUIZ

1. What would be the result on the primary voltage if the secondary load were inductive? Capacitive?
2. Name two uses for a transformer with a 1:1 turns ratio.
3. What is the result of decreasing the secondary load resistance on the primary current? Why?
4. Can either winding of a two-winding transformer be used for the primary? Why?

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EXPERIMENT #15

TRANSFORMER
E, I, AND Z TURNS RATIO

OBJECTIVE

To observe the relationship between primary and secondary E, I, and Z.

INTRODUCTION

The relationship between the number of primary turns and secondary turns is called the turns ratio of the transformer. When the turns ratio is known, along with the voltage, current, or impedance of one winding, the other coil's E, I, or Z can be found.

MATERIAL REQUIRED

Multimeter
Power supply
Breadboard
Accessory kit
Multimeter panel

PROCEDURE

1. Set up the equipment shown below.

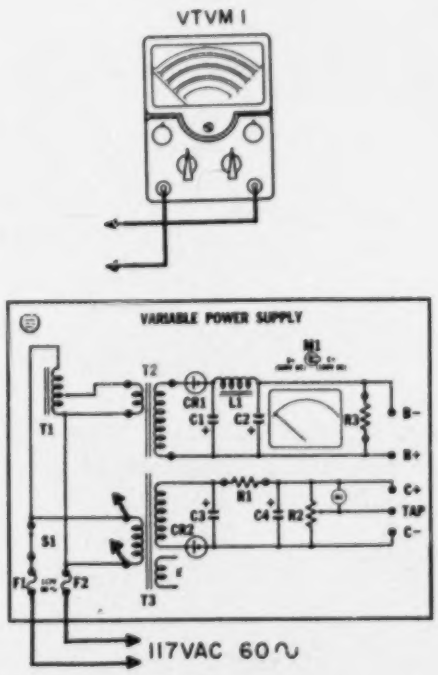

Fig. 33

14380

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1485

2. Connect the VOM across the primary of T_1 (measured at the primary of T_3). Record this voltage.
3. Set T_1 dial at 25 and measure across the primary of T_2. (T_1's output)
4. Calculate the turns ratio of T_1 with the above information.
5. Set the powerstat to 50. Repeat Steps #3 and #4.

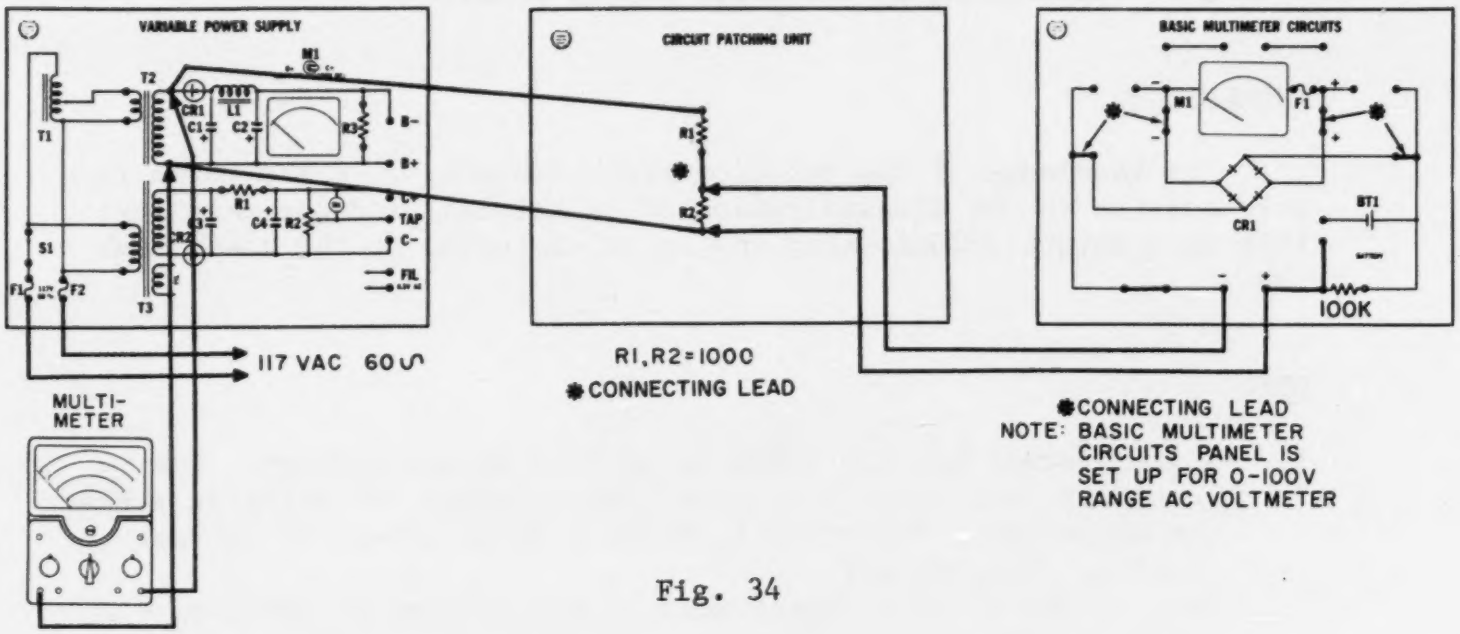

Fig. 34

1. Connect the VOM across R_1 (Breadboard) and record this voltage.
2. Calculate the turns ratio of T_3.
3. Remove R_3 from the variable power supply.
4. Adjust T_1 for 165 volts across the T_2 secondary.
5. Measure T_2 primary.
6. Calculate T_2's turns ratio.
7. Record the secondary current as indicated on the multimeter panel.

NOTE: The meter panel is set on the 100 volts ac scale and indicates one volt for each ma of secondary current.

8. Calculate I_p (T_2) from the turns ratio and secondary current.
9. Calculate T_1 primary current from the T_1 - T_2 turns ratio and T_2 secondary current (previously calculated).
10. Substitute a 5.1K resistor for the 1K resistor at R_1 on the breadboard.
11. Repeat Steps #4 through #9, part II.

14881

12. Leave the 5.1K resistor at R_1 on the breadboard. (Refer to note in Step #7, part II.)
13. Adjust the Rheostat (T_1) for 135v across the T_2 secondary.
14. Calculate the turns ratio of T_1 and T_2 as a combination.
15. The secondary "Z" is approximately 6.1K. Calculate Z_p of T_1, using the turns ratio from Step #15.
16. Substitute a 1K resistor for the 5.1K at R_1 on the breadboard and repeat Steps #14 through #16.
17. Replace R_3 on the power supply panel.

CONCLUSION

The knowledge of the relationship between E, I, Z, and turns is a prerequisite to the classification of technician, aide, or engineer. This is a unique relationship and is an expansion of the basic Ohm's Law.

QUIZ

1. A transformer has 120 volts ac applied to its primary. The secondary load circuit is open, yet measures 360 volts ac across the secondary. Measuring I_p shows a small amount of current flowing. Explain why.
2. What is the E_s of a transformer if the primary is 100v, T_p = 200 and T_S = 40?
3. If a power transformer has a step-up voltage ratio of 1:5, under load, what will be the approximate ratio of I_P to I_S?
4. A power transformer has E_P = 4400v and E_S = 220v. The efficiency of the transformer is 98% when delivering 23a of I_S. What is the value of I_P?
5. What would happen if a transformer designed for 400 hz were connected to a 60-hz line? 60 hz, to a 400-hz line? Elaborate.

14882

EXPERIMENT #16

TRANSFORMER
TYPES AND APPLICATIONS

OBJECTIVES

To examine basic types of transformers.

INTRODUCTION

The three main types of transformers are: power transformers, audio frequency transformers, and radio frequency transformers. Power transformers are used to step up or step down voltages, or both. Audio transformers are used at low frequencies (less than 20 Khz), mainly as impedance matching devices, which transfer maximum power to a load. RF transformers serve a similar function at the higher frequencies. (20 Khz to infinity)

Applications:

A. Power transformer

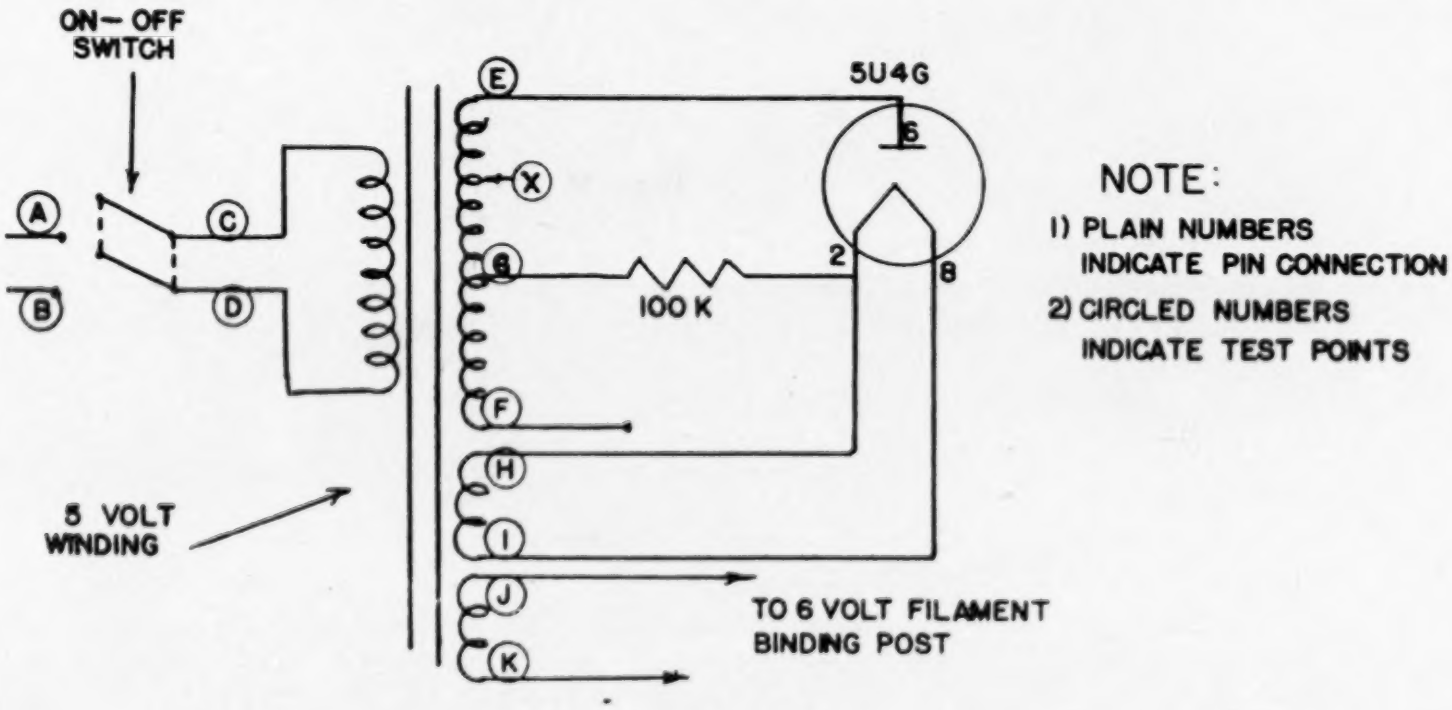

Fig. 35

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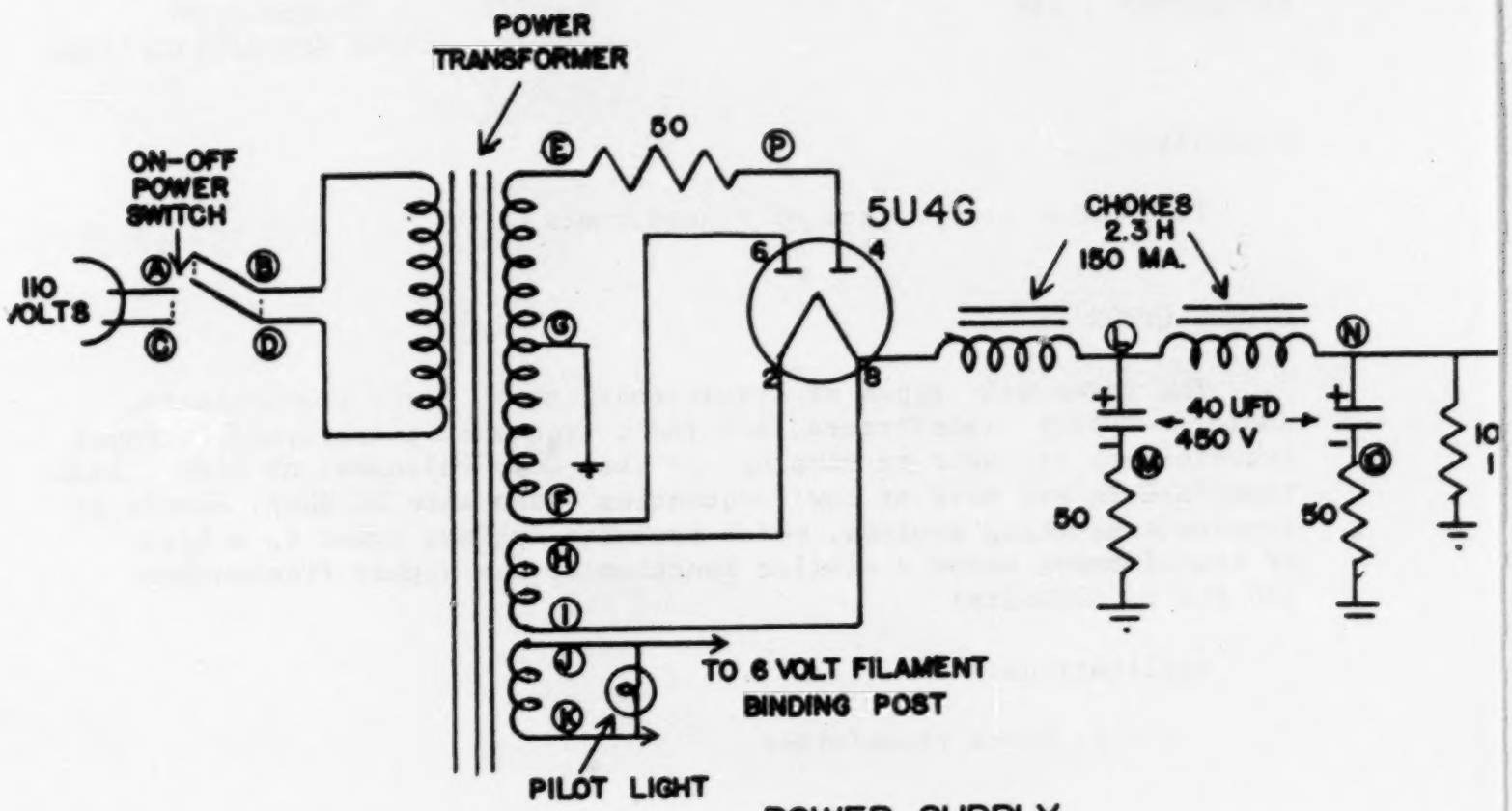

POWER SUPPLY

Fig. 36

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B. Audio Transformers

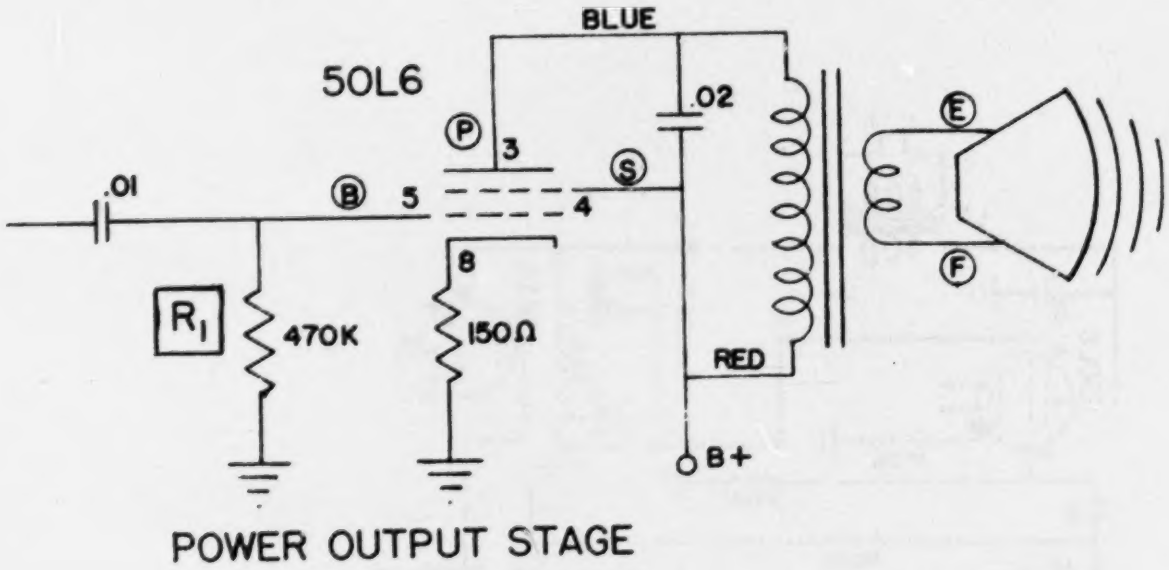

Fig. 37

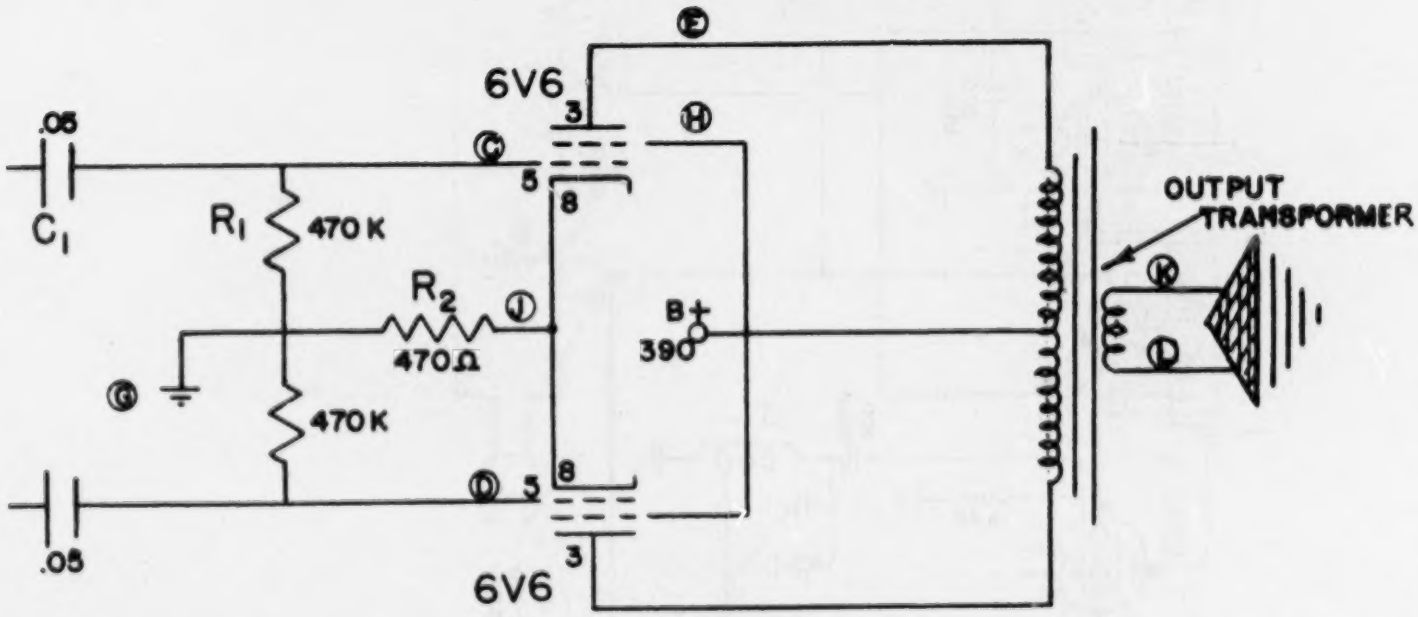

Fig. 38

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C. RF transformer (T_1 and T_2)

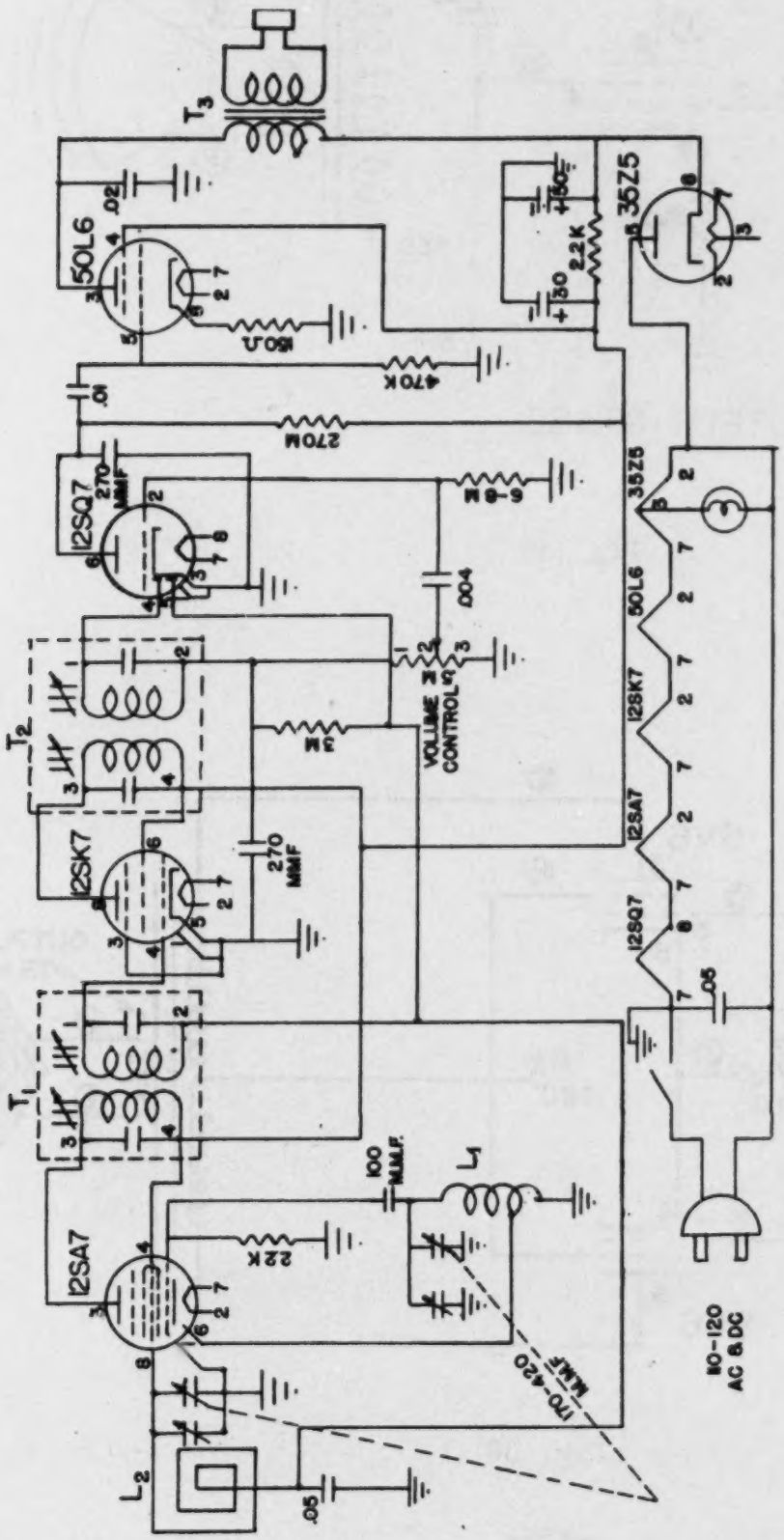

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Fig. 39

MATERIAL REQUIRED

VOM
Power supply

PROCEDURE

1. On the variable-power-supply (V.P.S.) panel, measure the line voltage (T_3 primary).
2. Adjust the powerstat (T_1) until the line voltage reads 50% of maximum.
3. Notice that the transformer is now effectively center-tapped, with equal voltages across each half.
4. The entire winding of T_1 is used as the primary of the auto-transformer, and only that portion below the adjustable arm is used as the secondary.
5. Connect the VOM across the secondary winding of the auto transformer.
6. Adjust R_1 for 70 volts ac.
7. Calculate the turns ratio, noticing the action of T_1, a step-down transformer.
8. Adjust R_1 for 100 volts ac.
9. Repeat Step #7.
10. Adjust R_1 for maximum and repeat Step #7. (Note that R_1 in step #10 is a 1:1 transformer)

CONCLUSIONS

Although many different types of transformers are used in electronic equipment, such devices have two functions: to transfer E or I, or to match impedance.

QUIZ

1. Is it possible to connect the primary and secondary of a conventional power transformer together to form an autotransformer? Illustrate if necessary to explain your answer, whether it be yes or no.
2. Draw the schematic symbol for:

   a. Power transformer--center tapped
   b. Audio output transformer--tapped primary
   c. RF transformer--tapped primary

14887

ELECTRONICS SYMBOLS

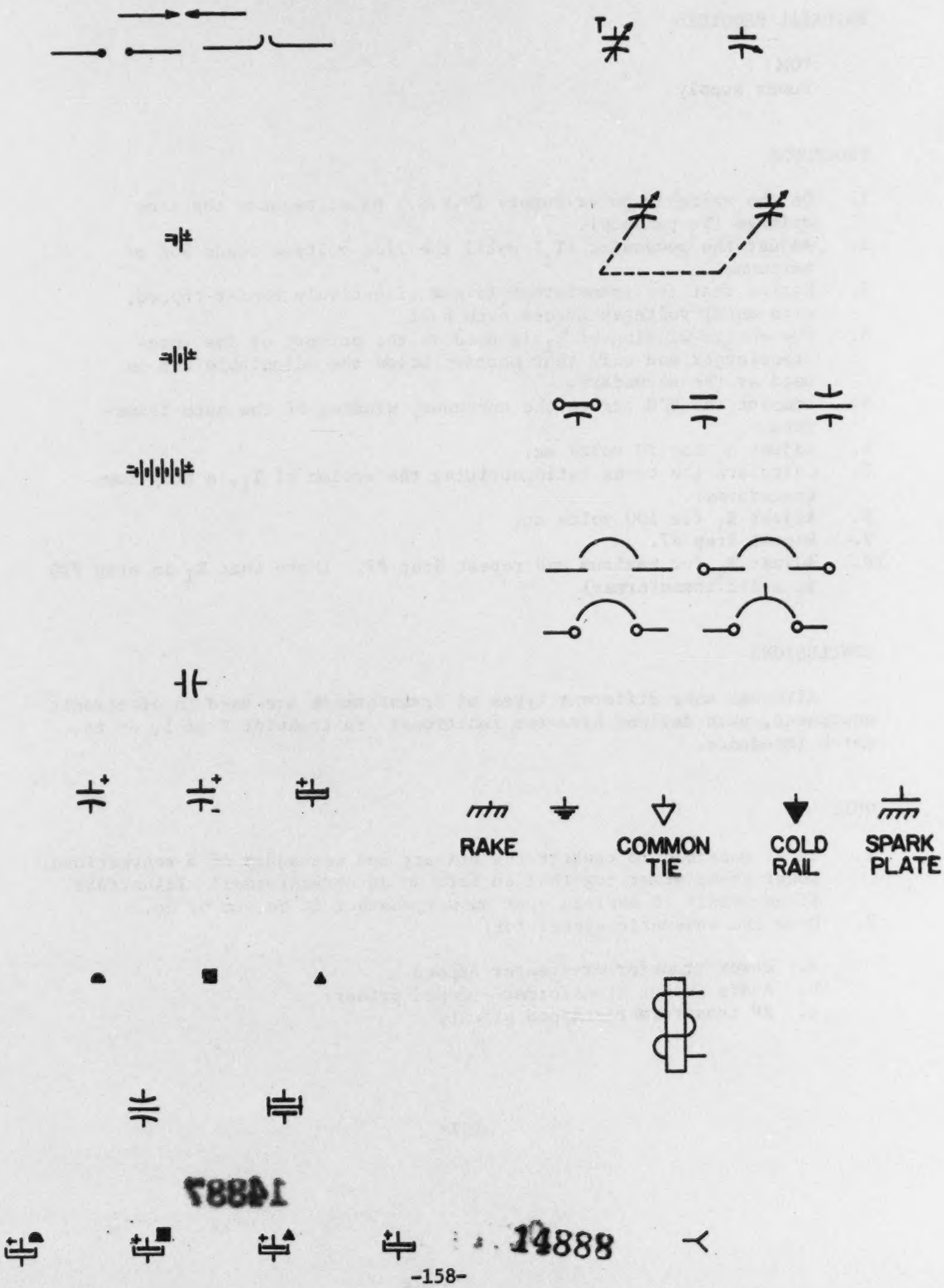

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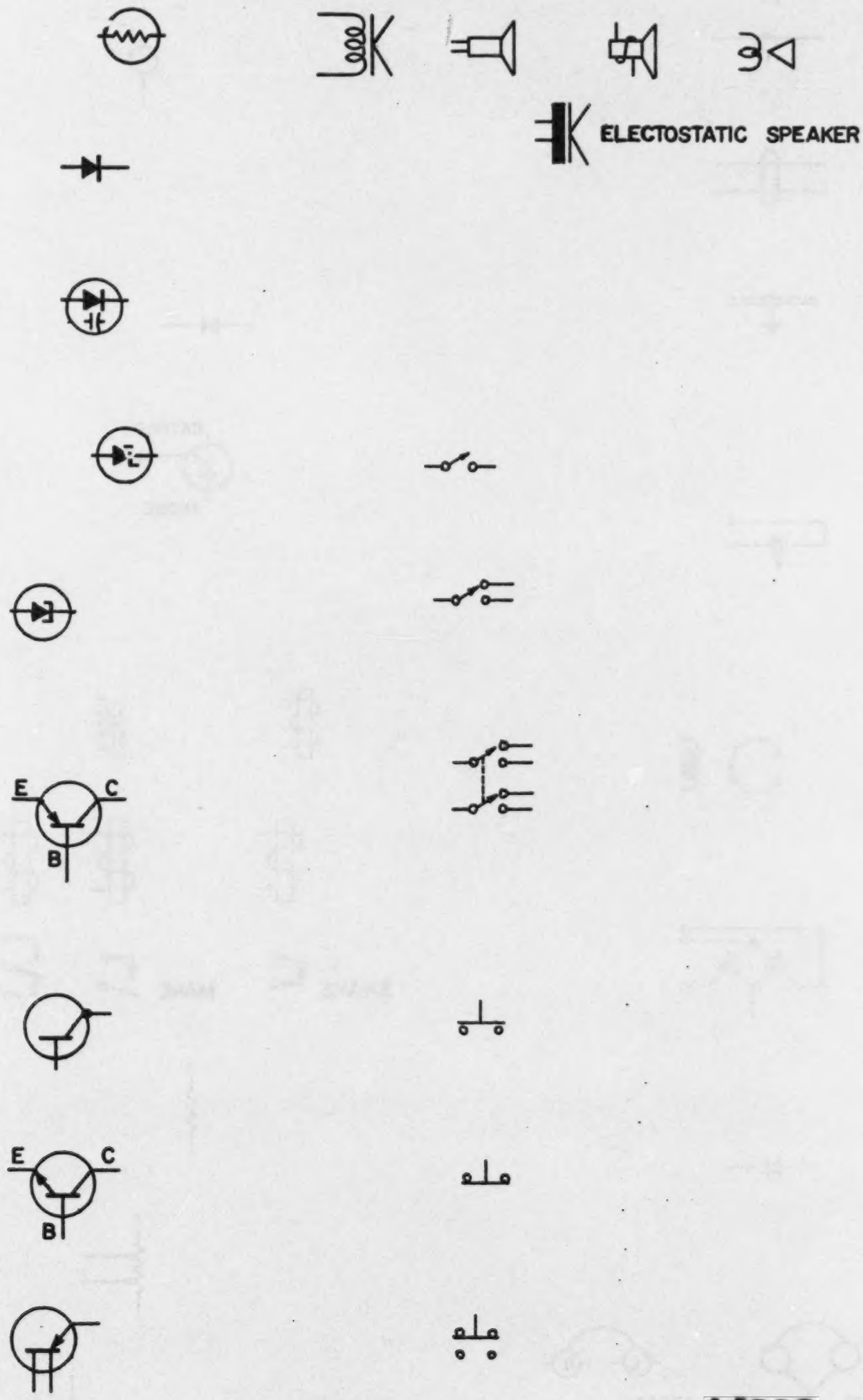

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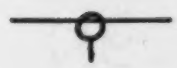

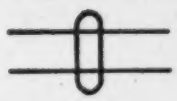

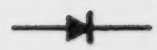

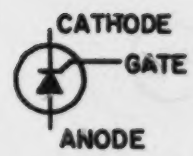

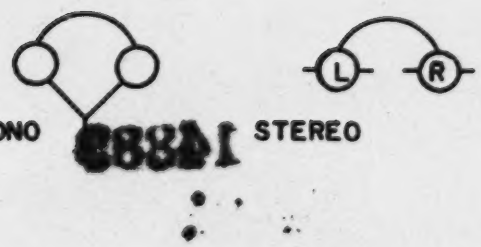

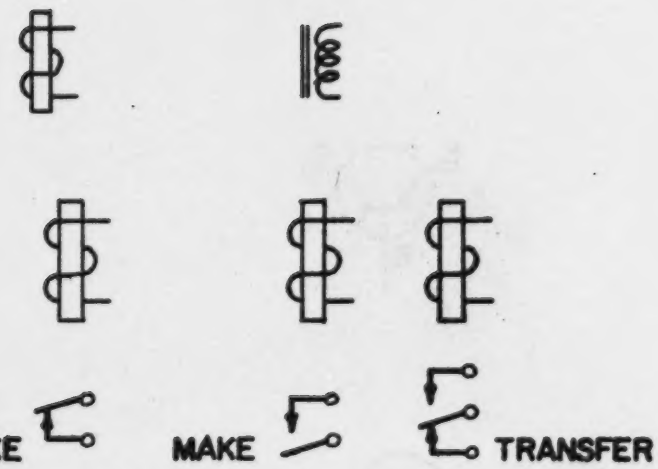

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VT 011 267
Modular Instruction. Automobile Mechanics Vocational Training.

United States Reformatory, Petersburg, Va.
MF AVAILABLE IN VT-ERIC SET.
U.S. Bureau of Prisons, Education and Training Division, 101 Indiana Avenue, N.W., Washington, D.C. 20537 (no charge).
PUB DATE - ND 130p.

DESCRIPTORS - *STUDY GUIDES; *TEACHING GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *AUTO MECHANICS; *AUTO MECHANICS (OCCUPATION); BEHAVIOR; VOCATIONAL EDUCATION; CORRECTIONAL REHABILITATION; CORRECTIONAL EDUCATION; SCHEDULE MODULES; INSTITUTIONAL SCHOOLS

ABSTRACT - This modular instructional guide was developed for use in the automobile mechanics vocational training program at the United States Reformatory in Petersburg, Virginia. The contents are arranged in modular order so that revisions can be made without interrupting the entire procedure and students can work at individual rates. Major units are: (1) Introduction, (2) Tools, (3) Fuel System, (4) Electrical System, (5) Engine, (6) Cooling System, (7) Brake System, (8) Power Flow, (9) Chassis, (10) Servicing, and (11) Trouble Shooting and Tuneup. Specific performance objectives, references, conditions, and behavior expectancies are presented for each unit. Students are expected to select pertinent information materials to aid them in the course. A training progress report chart is appended. (Not recommended for hard copy reproduction due to marginal legibility of original document.) (GEB)

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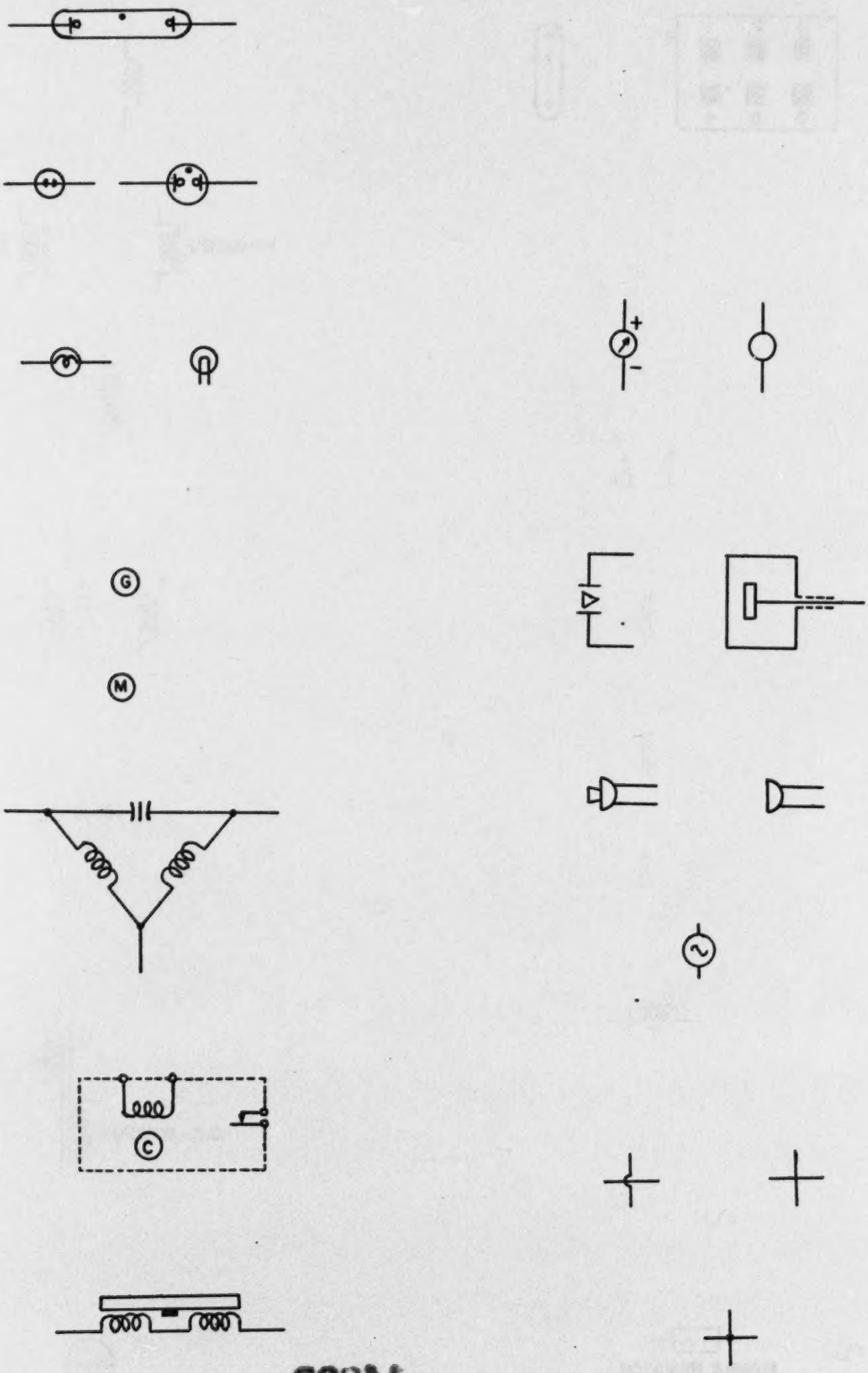

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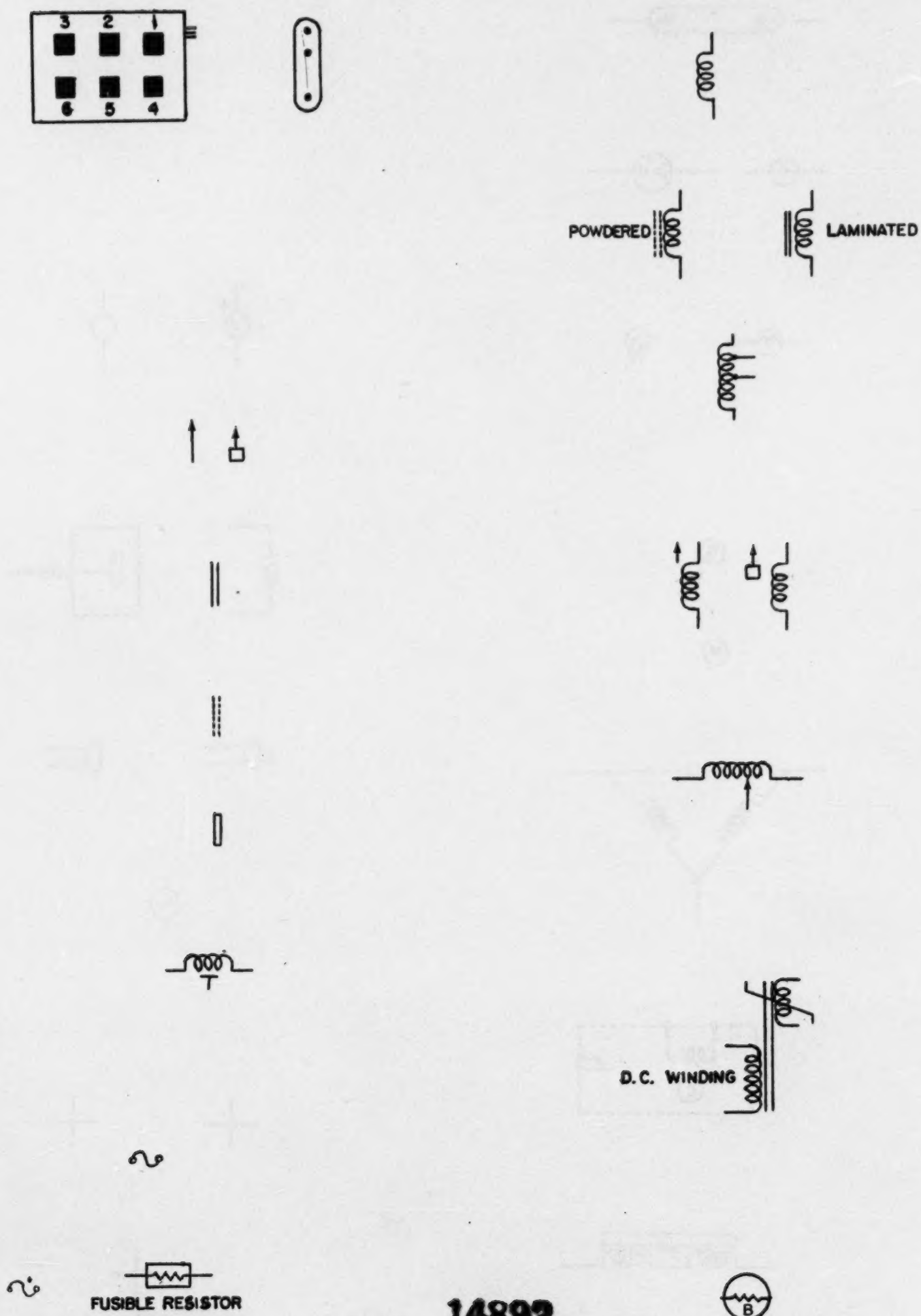

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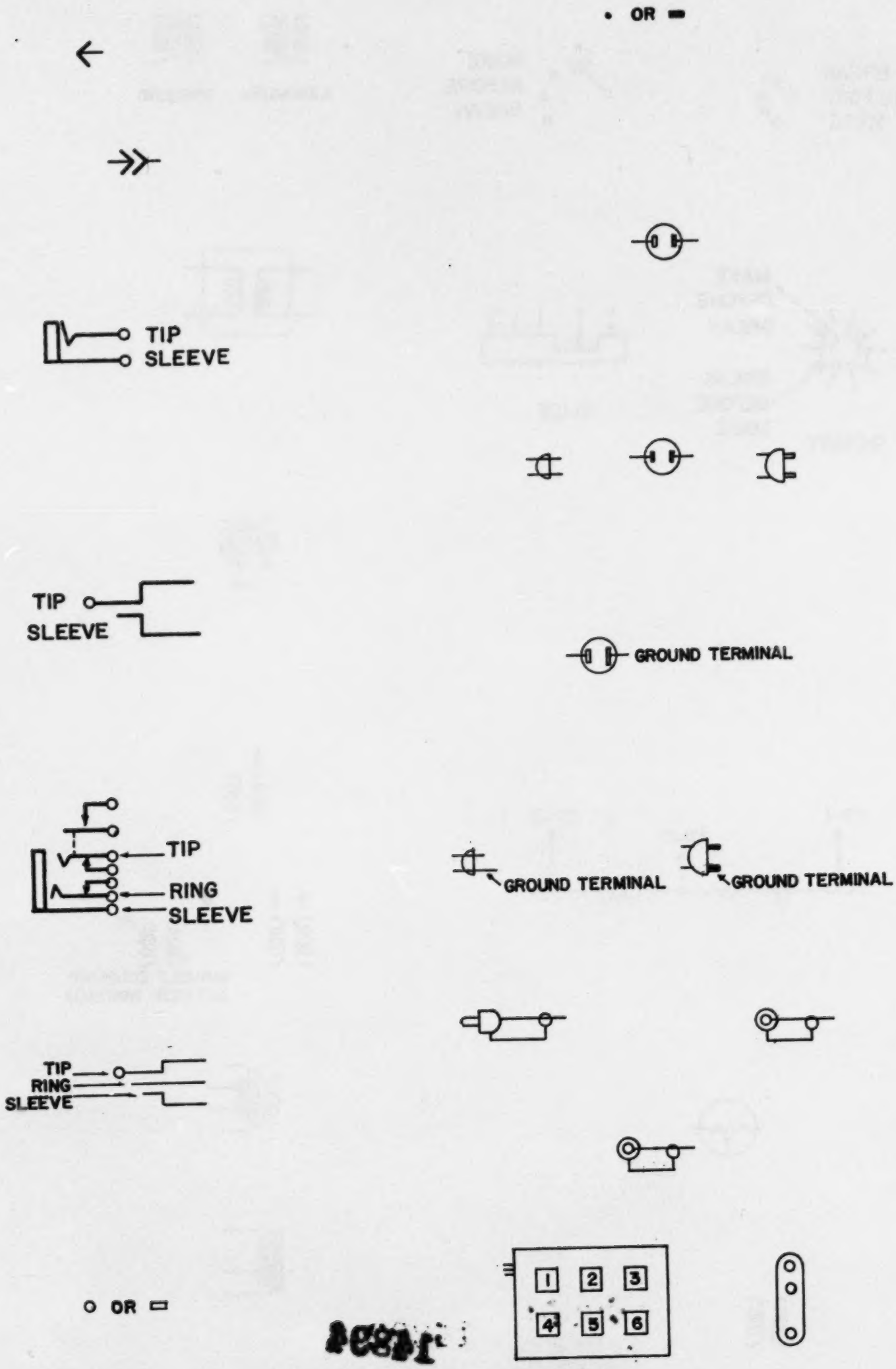
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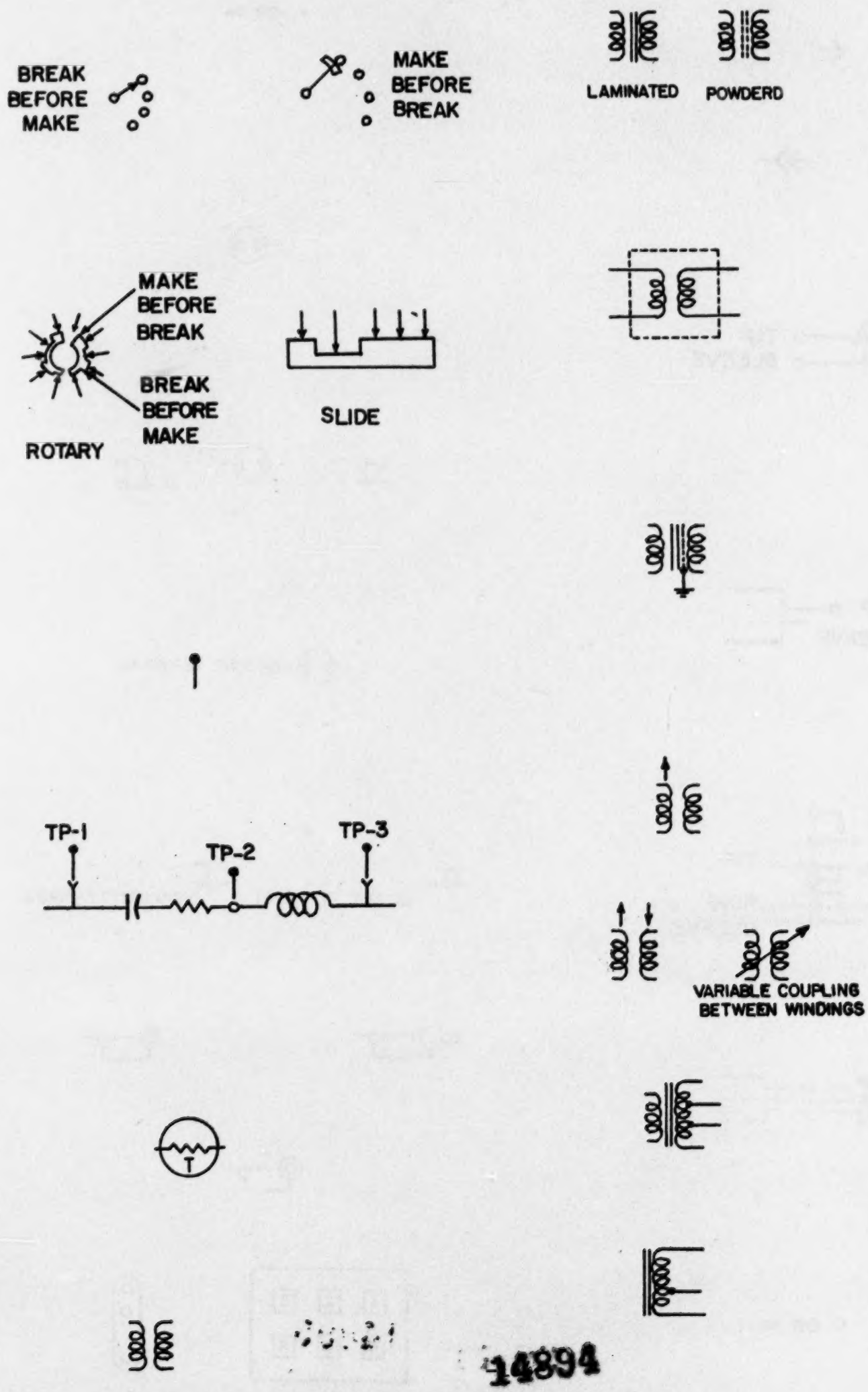
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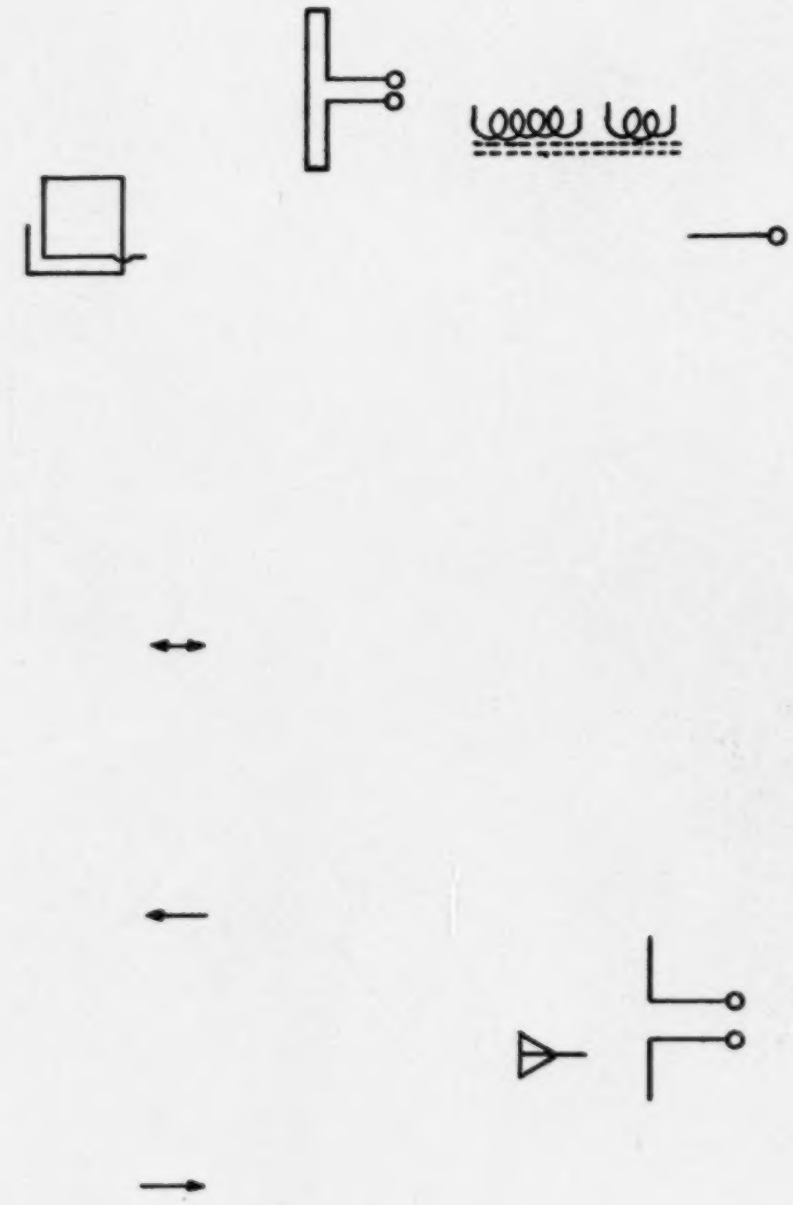

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VT 012 902
Jones, Glenn C.
Introduction to Electronics for Electrical and Electronics Students, Part I.

Camden County Vocational and Technical High Schools, Sicklerville, N.J.
Rutgers, The State Univ., New Brunswick, N.J. Vocational-Technical Curriculum Lab.
New Jersey State Dept. of Education, Trenton. Div. of Vocational Education
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Vocational-Technical Curriculum Laboratory, Rutgers University, 4103 Building, Kilmer Campus, New Brunswick, New Jersey 08903 ($2.00).
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DESCRIPTORS - *TEACHING GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *ELECTRICITY; *ELECTRONICS; INDUSTRIAL ARTS; INSTRUCTIONAL MATERIALS; ADULT VOCATIONAL EDUCATION; SECONDARY GRADES; ACHIEVEMENT TESTS; VOCATIONAL EDUCATION

ABSTRACT - Developed by electronics teachers in Camden County vocational and technical schools of New Jersey in cooperation with the Vocational-Technical Laboratory of Rutgers University, this is the first of two guides designed for teacher and student use in introducing the basic principles of electricity and electronics. Units, each consisting of three or more lessons, cover the following topics: (1) Safety, (2) Tools, (3) Atoms, Electrons, and Electricity, (4) Current and Conductors, (5) Voltage and Potential, (6) The Battery, (7) Resistance and Resistors, (8) The Metric System and Powers of Ten, (9) Reading Scales, (10) The Slide Rule, (11) Ohm's Law, and (12) Reading the Meters. The lessons contain explanatory information, assignments, questions, illustrations, and diagrams. Achievement tests are included. A continuation of this course is included in a related document, available as VT 012 903, also in this issue. (GEB)

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VT 012 902

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STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL EDUCATION

C-1

INTRODUCTION TO ELECTRONICS

FOR ELECTRICAL AND ELECTRONICS STUDENTS

PART I

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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GLENN C. JONES, INSTRUCTOR
CAMDEN COUNTY VOCATIONAL AND TECHNICAL HIGH SCHOOLS
STRATHMERE, NEW JERSEY

State of New Jersey
Department of Education
Division of Vocational Education

INTRODUCTION TO ELECTRONICS

For Electrical and Electronics Students

Part 1

Prepared by
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Donald C. Springle, Superintendent
Camden County Vocational and Technical High Schools
Sicklerville, New Jersey

Vocational-Technical
Curriculum Laboratory
Rutgers - The State University
Building 4103 - Kilmer Campus
New Brunswick, New Jersey

September, 1970

14808

WELCOME

Welcome to the study of electricity and electronics. This study - this course - will be like a new friend, and it will probably be the best friend of your life. For the next several years you will be learning of the properties of electricity, which are now considered by a large majority of the people on earth to be deep mysteries. Millions even consider them to be magic. You will have the satisfaction of knowing and understanding these secrets. You will be building circuits and commanding powerful forces of electricity to do your bidding.

These forces are either furnishing the power or are operating the controls of machines which produce the many thousands of things that we need or enjoy in our daily life. They are needed in the giant locomotives which transport people and necessities from city to city. They are needed in the ships which transport people and necessities from country to country; and they are needed in the space ships which explore the regions of outer space.

Tomorrow's electrician will work hand-in-hand with the scientists and engineers who will create new products, machines, and luxuries undreamed of today. The electronics technician will be interpreting the engineer's language to the producers and will be guiding their hands in the manufacturing of those wonders-to-come.

It is good to know, too, that the need for electricians and electronics men is becoming greater and greater. This situation means that salaries will be higher in this field of work.

The industrial electrician is becoming more and more respected as a highly skilled technician. His job is demanding higher skills. He is now finding that he must have a knowledge of electronics, since he is expected to service and repair many manufacturing controls that are of electronic design.

If you will inquire, you will probably find that electronic controls connected to the boilers in your school are responsible for maintaining constant heat in your classrooms.

The industrial electrician, then, is a skilled man in a technical field. He receives a salary which permits him to bring up his family in a good neighborhood where he is respected as a citizen contributing to the growth of our country.

The electronics technician perhaps lives next door to the industrial electrician. He works under most desirable conditions - often in research laboratories - and contributes in a large way toward the technical progress of our nation. These laboratories must be clean and air conditioned.

14900

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MODULAR INSTRUCTION

AUTOMOBILE MECHANICS VOCATIONAL TRAINING

U. S. Reformatory

Petersburg, Virginia

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The surroundings are pleasant, and his fellow-workers are intelligent and capable. There is usually plenty of work to be done, but he is seldom rushed; moreover, the work is interesting. When the day is over he is not generally weary, as are most of the people doing factory work in our area. The technician is the man we see engaged in civic work or in some pleasant recreation during the evening hours.

14901

PREFACE

This book contains the material taught to the beginning students of the Electronics and Electrical courses in the Camden County Vocational and Technical Schools. After this introduction to Electricity and Electronics, these students continue in their respective trade studies. The following years of course, find them going deeper into the theory of the work that they are then studying.

It is believed that this text will also be found of value in any high school or junior high school teaching electricity or electronics.

There are many people I would like to thank for their help in preparing some of the illustrations, particularly Steve Logeren, a student in the Printing course at this school for the hours he spent in the photographing and offset printing of some of the illustrations.

Glenn C. Jones

September 1970

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UNIT I - SAFETY

Lesson No. I — Dangerous Hidden Charges

"It is better to be safe than sorry." This is so true. The words seem trite, perhaps; and it is possible that to some of you they may be only words. If you will stop and think, it is possible that you know someone who has lost an arm or a hand through a preventable accident. When he came out of the hospital with only one hand he was sorry - real sorry that he had not been just a little more careful.

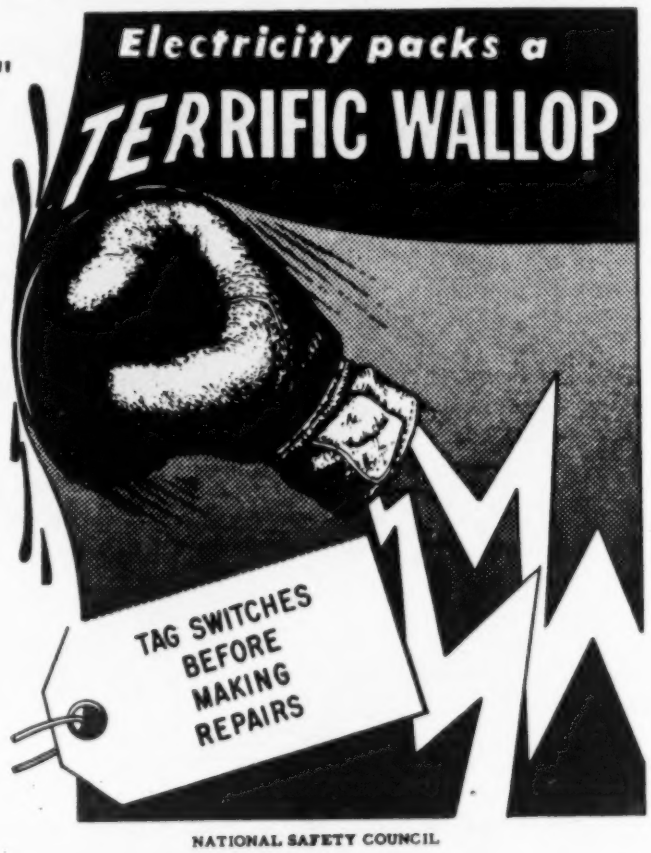

Always Be Careful

There are many machines in this school which, if misused, may prevent you from every operating any kind of machine. Let us guard our lives, our eyes, our limbs, and our health.

You will be working with voltages at times which are lethal. Lethal is not a bad-sounding word as far as words go, but a lethal voltage can reduce your body to a cinder, can bring sorrow to many members of your family, and can make your loved ones experience the sadness of seeing you lowered into a grave. Lethal means capable of bringing death. REMOVE LETHAL VOLTAGES FROM ALL EQUIPMENT BEFORE MAKING REPAIRS.

Capacitors are incorporated in the circuitry of many pieces of electrical or electronic equipment. These capacitors have the ability to store electrical charges. The equipment may have been removed from the source of voltage for hours and yet remain lethal. These capacitors must be discharged before touching the equipment. This may be done with a shorting bar such as this:

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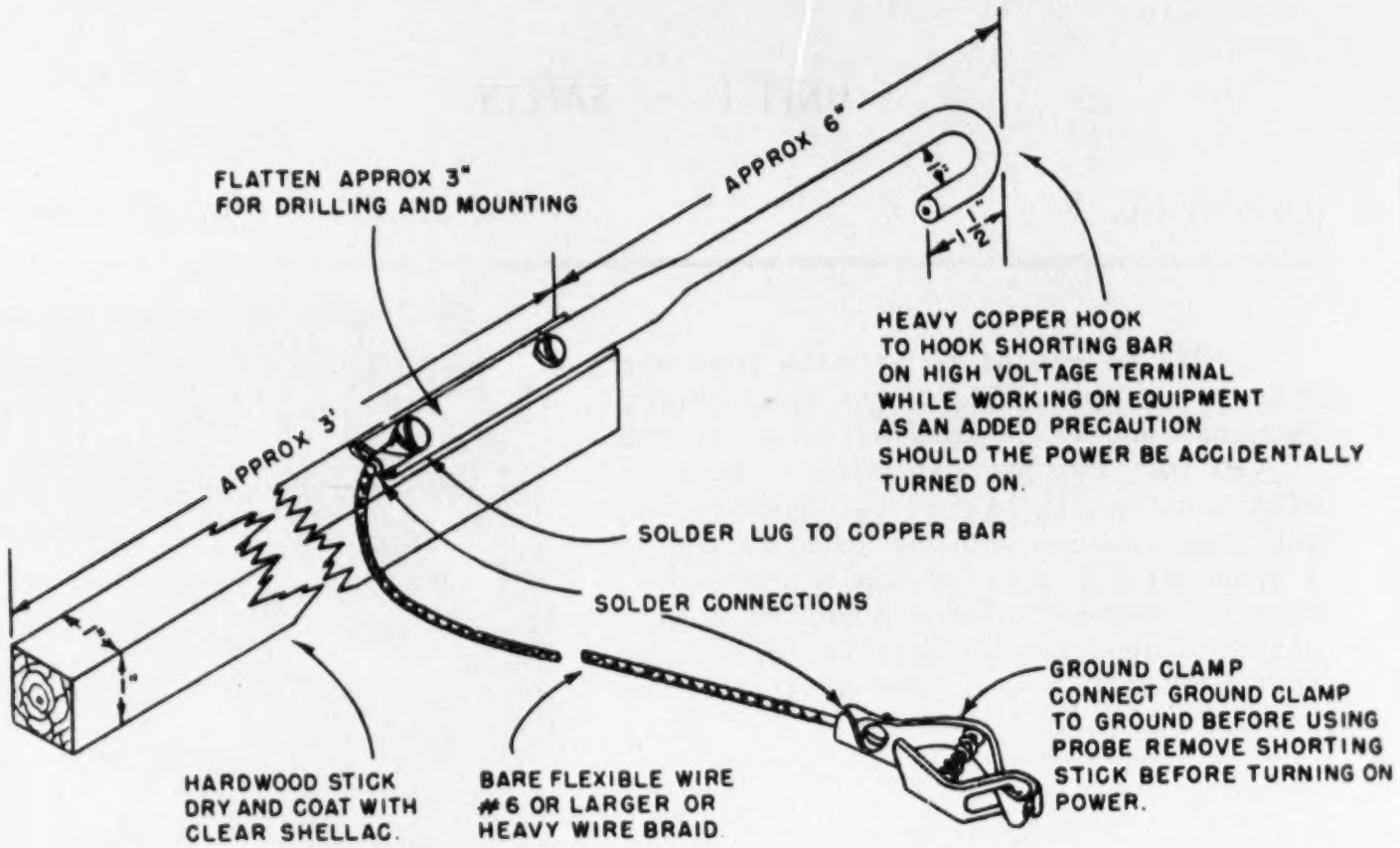

Fig. I-1-1

Quite a few men have been killed by capacitor charges. The use of a shorting bar like the one shown could have prevented all of these deaths. The dimensions of the parts will vary with the amount of charge it is designed to short out. The handle may be three or four feet long if it is designed for the man working with high-power radio transmitters or similar electrical equipment.

The large clip on the end of the wire is connected to a good ground connection. Then the curved portion is touched to all parts of the circuit where high voltages could exist.

A smaller or much less elaborate arrangement may be used to discharge potentials in low-power equipment such as communications receivers.

14906

ASSIGNMENT:

1. Is it possible to receive a dangerous electric shock from a piece of electronic or electrical equipment after it is disconnected from its source of electricity?

2. What is the definition of the word lethal?

3. Copy Fig. 1 in your notebook, and give a description of its use.

14907

UNIT I - SAFETY

Lesson No. 2 Safety Practices

Whenever you are working on any electrical equipment make sure you know where the circuit breakers are. Never work around high voltages while alone. If it is necessary to work around high voltages, never use more than one hand. Keep the other hand in your pocket if possible and make sure that you are standing on a good insulating material. Insurance companies and labor unions require that electrical workers stand on rubber mats when working with high voltages.

Wherever you might be working, always know where the fire extinguishers are located. Know how to operate them. A careful worker will even check the inspection tags on the extinguishers to be sure that they have been serviced and inspected according to standards of safety. In school or at work, make sure that you know where you are supposed to go when there is a fire drill. Never use a soda-and-acid extinguisher on an electrical fire. Water, too, should never be used on such fires. On an electrical fire, use a CO_2 (carbon dioxide) extinguisher or some dry type of extinguisher.

It is good policy never to use carbon tetrachloride for cleaning. Breathing fumes from this chemical is much more dangerous than many people suspect. That little amount of poison that you breathe today remains in your body tissues to be added to that which you might breathe tomorrow or next week, and when enough is added to your system, sickness or even death can be the result.

Small cuts and puncture wounds, if not treated, can provide a seat for serious infection.

Use safety belts and every other possible safety precaution if it is necessary to work in high places where you might fall.

14908

When storing equipment on high shelves, be sure that there is plenty of room for it, and that the shelf is strong enough to hold the weight. Do not place anything on a high shelf if there is a possibility that vibration may cause it to fall.

ASSIGNMENT:

1. Why should one never use water to extinguish an electrical fire?

2. Why should one stand on a rubber mat or on something well-insulated from the ground while working with high voltages?

3. Give two reasons why you should know the location of the circuit breakers.

4. Where is the nearest fire extinguisher to your workbench?

5. Where is the next nearest fire extinguisher?

6. Where is the nearest fire-alarm box?

7. What precautions should you take when putting materials on shelves?

14909

UNIT I - SAFETY

Lesson No. 3 Safety Practices-2

The preservation of life is man's greatest instinct. Second only to the preservation of our lives should come the preservation of our sight. Life is difficult enough for those who are born blind, but to become blind after reaching the teens through a preventable accident is sheer tragedy.

Whenever you are using a grinding wheel, a drill press, or doing any work which may result in flying particles capable of causing eye damage, wear goggles or some other type of eye or face guard. One small particle from an ordinary grinding wheel can, in a second, cause the loss of sight.

If you find yourself working in the vicinity of acids or other strong chemicals, you should always wear the goggles recommended to shield your eyes against such chemicals.

You have probably been told never to look at an electric arc or an acetylene arc. This can be extremely dangerous to your vision.

The throwing of any objects in school shops is strictly forbidden. The chance of causing eye damage or loss of sight is greatly increased by such foolish actions. Many types of seemingly harmless horseplay can lead to blindness.

As you grow up, you form habits, and these habits may determine whether or not you are saddled with the miseries of illness in later life. Good posture while working will permit your lungs and other vital organs to perform their work in keeping your body healthy. Never slump while working or studying. Practice good posture. A healthy worker is an alert worker and a safe worker.

MODULAR INSTRUCTION

AUTOMOBILE MECHANICS VOCATIONAL TRAINING

U.S. Reformatory

Petersburg, Virginia

Need for more systematic training and maximum effective use of physical facilities and instructional services has dictated the construction of vocational training and on-the-job training courses comprised of modular instruction and the use of appropriate work or training stations.

Automobile mechanics modular instruction consists of eleven modules comprised of thirty-four performance objectives. Modular course construction allows additions, deletions and revisions to be made with comparative ease. Expansion of certain phases of automobile mechanics, such as brake repair, is simplified by addition of more comprehensive skill and related training in a separate booklet and the addition of a suffix letter to the module number (VII-A).

Module I (Introduction, which contains only one Performance Objective) is included in the form in which all Performance Objective instructions are presented to the trainee. On the left of the booklet are the related studies he must complete prior to beginning the skill training listed on the right. Each sheet is encased in a document protector to avoid grease stains and to prevent tearing of the sheets. Because of the variety of

Loose clothing, necklaces, and fetishes hanging around your neck should never be worn in the shop. This practice is dangerous even if you do most of your work away from moving machinery, because it is easy to forget the danger when going to a machine for a short, unexpected job. Most necklaces are made of metals which are good conductors of electricity. They make excellent electrodes for an electrocution.

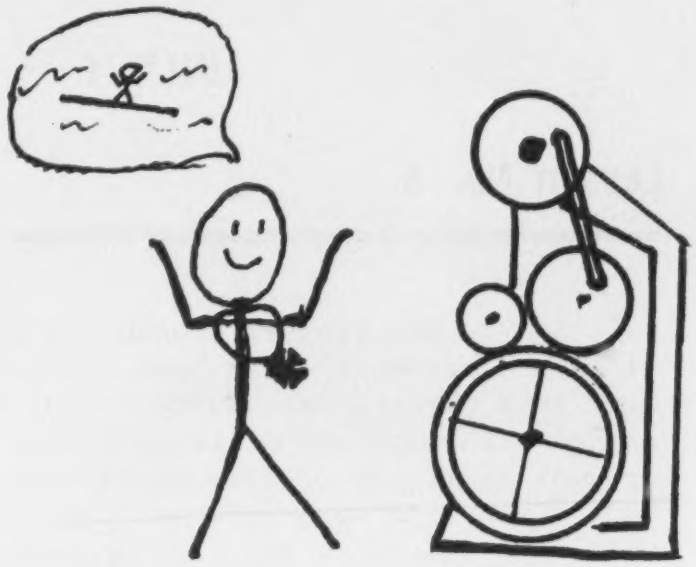

The wearing of rings on the fingers can also be dangerous when working around high voltages. Men have been electrocuted by accidently touching their wedding rings to charged wires or components.

So remember: NO NECKLACES AROUND THE NECK. NO RINGS ON THE FINGERS. NO LONG NECKTIES (BOWTIES ARE OK). WEAR SHORT SLEEVES AND NO DANGLING OR LOOSE CLOTHING AROUND MOVING MACHINERY.

ASSIGNMENT:

1. Why would life be more difficult for one who loses his sight in his youth than it is for one who is born blind?

2. Think of three kinds of horseplay that you have seen around school, and then think how blindness could result from such "playing around."

3. What two kinds of dangers arise from the wearing of necklaces around machinery?

4. List all the safety practices included in this lesson.

14911

UNIT I - SAFETY

Lesson No. 4 Safety in Your Home Workshop

If you are truly a student of electricity or of electronics, you will be experimenting at home. You will probably be getting in trouble with your parents for cluttering up your room or the basement or the garage with your wires, transformers, radios, and transmitters. A good student is likely to draw reprimands, especially from his mother, unless he keeps a neat work area at home. You can minimize this if you are neat with your work and if you return all tools to their proper places after using them. Not only will your parents appreciate this, you will be observing one of the most important safety precautions.

A cluttered workbench is an unsafe place to work. On the workbench you should have only the bare necessities to do the job at hand.

Good lighting is also necessary for safe working conditions. If there isn't enough light over your workbench, let the installation of good light be your first project.

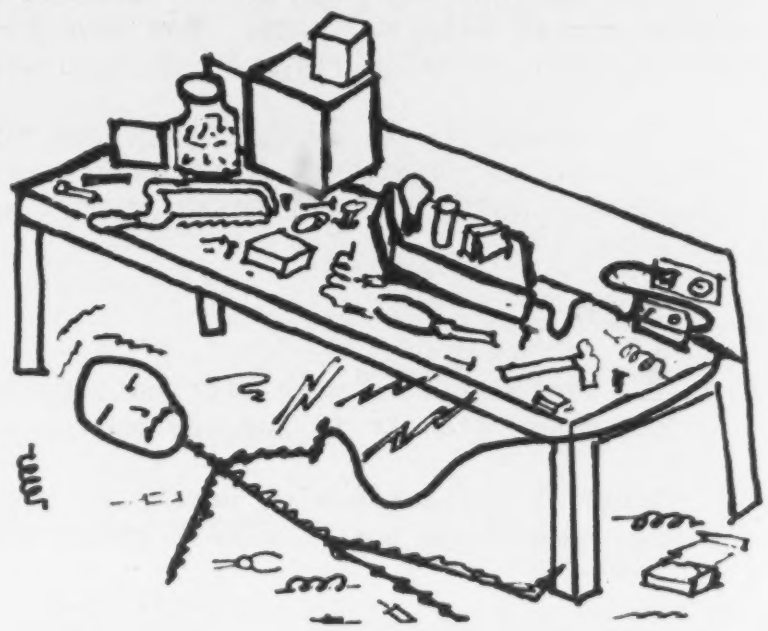

Never work on high voltages without someone's being in the room with you - someone who knows where the main switch is and who knows something about first aid in case of electrical shock. If your workshop is on a concrete floor, make sure that you are standing on a rubber mat when working with dangerous voltages. Never work on projects having dangerous voltages after you become sleepy. The 110 volts in your house service can bring death. Even if your shop has a good, dry, hardwood floor, it is still good practice to have a rubber mat upon which to stand.

14912

Regardless of how safe you feel your light switch is, never touch it (or anything else connected to electricity) while in contact with a water pipe, a sink, a spigot, or anything in electrical contact with the ground.

Never work with electricity if you are wet, and use extreme care even if you are slightly damp with perspiration. Stand on a rubber mat, keep one hand in your pocket, and use rubber gloves when possible.

Remember: a great percentage of fatal accidents in this country happen at home.

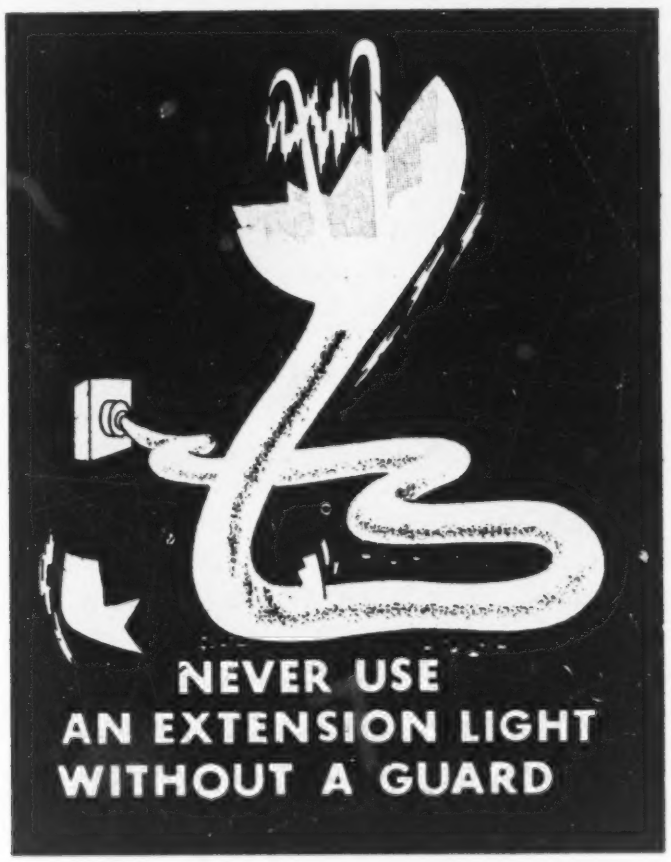

ASSIGNMENT:

1. Think of three ways one could have an accident working at an overcrowded workbench.

2. How does the returning of tools to their proper places have a bearing on safety?

3. Why is it dangerous practice to touch a light switch while in contact with a water pipe?

4. How does being wet with perspiration add to the danger of working with electricity?

14913 14914

UNIT II - TOOLS

Lesson No. I — Your Tools

The workman who carefully selects and takes pride in his tools is almost always the workman who can be trusted to do a good job. Workmen who do good jobs, of course, are the ones who receive good pay. With an inquiring mind, a sound body, and the proper tools of his trade, a young man beginning the study of his trade is almost assured success.

Would you put up with conditions which would allow rain to get into the gasoline tank of a car, or grit to get into the oil and ruin the bearings? No, you would take better care of a good old jalopy which faithfully carries you around. Would you neglect the simple care required to keep your tools in good shape - the tools which will help you make the money to buy the things you want in life?

If you had a job of tightening screws and were paid according to the number you tightened, would you spend 50 cents more for a screwdriver which would make it possible to tighten five percent more screws each day? Surely, you would. It would not take you long to see that the better tool would mean more money for you. Well, then, would you go to a junk store and buy a cheap soldering iron which would do a job only half as well as a good iron, and take twice as long to do it? You surely wouldn't; that would be false economy. It is possible that the lack of a good soldering iron for just a few days could set a student back far enough to prevent his moving into the next area of achievement, and could make him lose out on a necessary portion of the work of his trade.

There is an old saying about a horseshoe nail. "For the lack of a nail, the shoe was lost. For the lack of the shoe, the horse was lost. For the lack of the horse, the rider was lost. For the lack of the rider, the battle was lost. For the loss of that battle, a kingdom was lost."

It is entirely possible to compare that horseshoe nail with a soldering iron, and that kingdom with your success in life. Buy a good soldering iron. You could, in one evening, throw away more money in a soda shop than the difference in price between a cheap soldering iron and a good one.

There are several good makes to select from. There are the American Beauty, the Unger, and the Weller lines that can be depended upon.

14914

The Unger soldering iron shown here

comes with various sizes and shapes of tips.

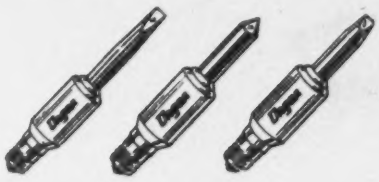

This iron is excellent for the work you will be doing in the electronics shop. It is suggested that you get the 47½ - watt tip.

You should also obtain a tool box about the size of a small fishing-tackle box. In fact, tackle boxes make very good tool boxes. Besides the tool box and soldering iron, you will need a roll of rosin-core solder, a 5" or a 6" adustable wrench,

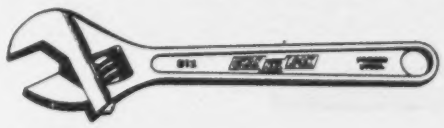

several screwdrivers of assorted sizes,

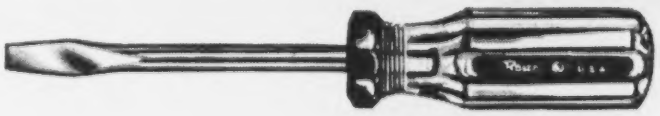

including a medium and a small Phillips screwdriver,

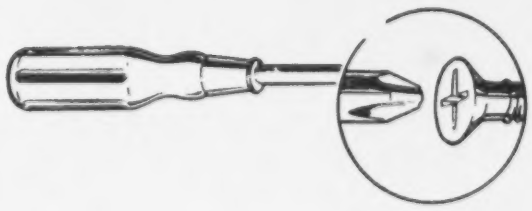

14915

a pair of 5" long-nose pliers,

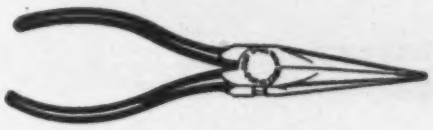

a pair of 5" or 6" slip-joint pliers,

a pair of 5" diagonal cutters,

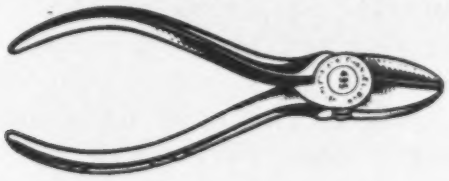

one medium-size file,

one pair of 36" meter test leads, one with a test probe,

the other with an alligator clip—

both with phone tips.

14916

You will need:

2 24" test leads (alligator clips on both ends)

2 36" test leads (alligator clips on both ends)

1 pair of safety goggles

Here is a picture of the tools belonging to a typical freshman in the electronics course.

The student in the electric shop will need a tool kit like the one shown below, containing one each of the following:

6" electrician's side-cutting pliers

6" slip-joint pliers

7" water-pump pliers

5" or 6" long-nose pliers

5" diagonal cutter

Folding carpenter's rule (wood)

Medium screwdriver, approx. 8"

Medium Phillips screw-driver, approx. 7"

Small spirit level

Roll electrician's tape

Roll friction tape

Linesman's tool pouch (the type which attaches to the belt)

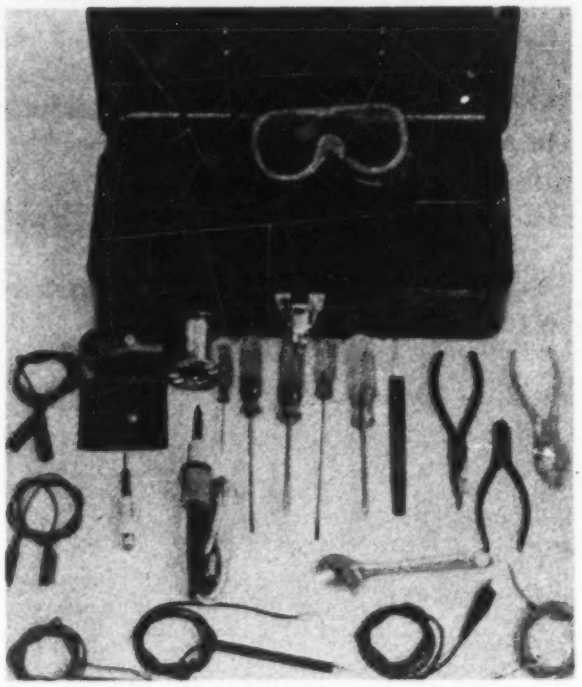

Fig. II - 1 - 1

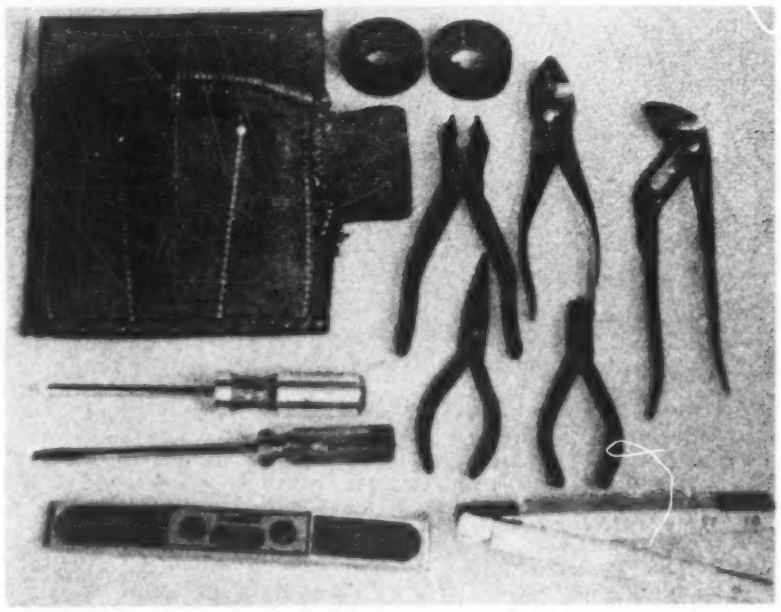

Fig. II - 1 - 2

14918

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ASSIGNMENT:

1. Name the tools needed by the electronics students

2. Why does the electrical student need a different method of carrying his tools?

3. Give three reasons for not buying a cheap soldering iron.

4. Why don't skilled craftsmen buy their tools from the so-called bargain stores?

14918

UNIT II - TOOLS

Lesson No. 2 Care and Use of Your Tools

The tool which you will probably use more than any other is the screwdriver, and the tool which is more abused than any other is the screwdriver.

The untrained worker will be found using screwdrivers as chisels, pinchbars, levers, and test probes. You will never see a top-ranking, highly paid workman abusing screwdrivers. The skilled worker is careful with all his tools. He keeps them clean and in good repair. He uses the proper tool for the job, and he returns it to its proper place when the job is finished.

(Some companies will discipline workers found with tools in bad repair - even his own tools and will give such workers "time off" without pay.)

The right size screwdriver must be used. It must fill the slot of the screwhead. If the blade of the screwdriver is too small, it will be hard to keep it in the slot while turning it. In jumping out, the too-small screwdriver will not only damage the screwhead (giving a sloppy appearance to the job), it may also suffer damage itself.

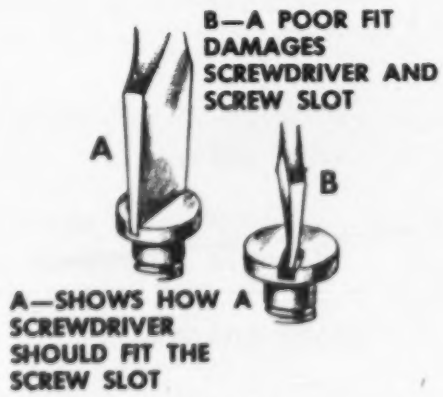

Fig.: II-2-1

If the screwdriver is used as a lever or as a pinchbar, the shank will very often be bent. Once the shank is bent, it is almost impossible to straighten it. Trying to use a screwdriver with a bent shank can lead not only to poor work; serious accidents can result.

14919

When using the screwdriver, make sure that the shank is alined with the axis of the screw; otherwise it may slip from the slot and cause damage.

When it seems that more power is needed to turn the screwdriver, never remedy this by using pliers on the shank. Get a heavier and better-suited screwdriver.

Pliers are made in many sizes and shapes, for many different kinds of jobs. Anything that might change the shape can make them no longer suitable for their intended use. Good pliers are made of good, tempered steel and should never be subjected to heat. High temperatures can ruin the temper, and the steel will become soft.

Never use your delicate long-nose pliers to do a heavy job that calls for gas pliers or perhaps even a wrench. Unskilled workmen have ruined many good pliers in this manner. Do not use pliers as a wrench to tighten or loosen nuts and bolts. Not only will this ruin the milled jaws of the pliers, it will round the corners on the nut or the bolthead.

Your adjustable wrench was not designed for rough service. If extreme force is required to remove a nut or a bolt, you should get an open end wrench.

The adjustable wrench should be kept clean, and the moving parts should have an occasional touch of light oil.

When using a wrench of any type, you should be in a position to pull instead of pushing. If it is necessary to push, do so with caution and apply the force with the palm of your hand. This can prevent hand injuries and bruised knuckles.

Regardless of what kind of wrench you are using, make sure that it fits the nut or bolt that you are turning; and if you are using the adjustable wrench, make sure that you turn it the right way.

14920

automobiles, engines, transmissions and other automotive components, and the variety of test equipment used, it is not feasible to list manuals, charts, test equipment instructions, and other aids needed in performing the skill operations. This requires the student to select pertinent informational materials and to use them as he would in an actual employment situation.

Four areas of related study are utilized although all four are not required for all performance objectives. These areas are: Related Information classes, Programmed Instruction classes, Resource Materials Center, and Trade Theory (Shop Instructor). Related Study has been carefully analyzed to eliminate extraneous materials, thus limiting classroom instruction to the essentials required for efficient skill training of the affected performance objectives. A fifth instructional source is available in Special Education and Remedial classes when a student requires specialized remedial academic instruction to aid him in assimilating related instruction.

Although analysis of related study materials might appear to lessen the teaching load of the related instructors it provides for more individualized instruction for the trainees and provides for greater flexibility in time spent by the trainee in the shop and in the classrooms. Flexibility of movement of students between related classes and the resource materials center is also attained allowing more effective correlation of related subject presentation.

Figure 3 shows the right way to turn the adjustable wrench.

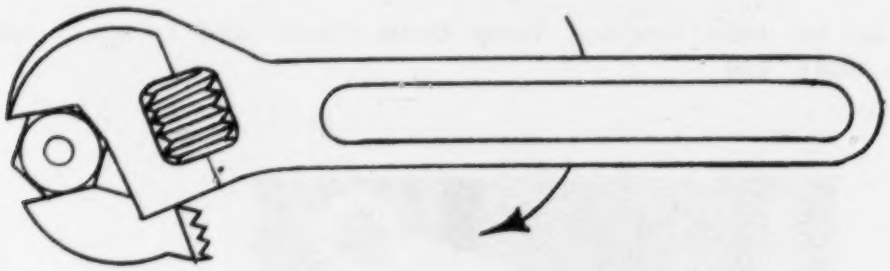

RIGHT DIRECTION

If you turn it in the wrong direction, the wrench can be damaged or can slip off the nut, causing damage to your hand and the job.

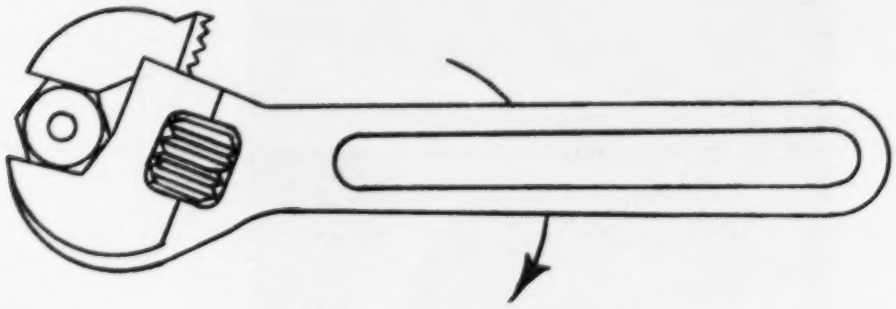

WRONG DIRECTION

A poorly ground screwdriver is possibly worse than no screwdriver at all. Study the illustration below and you will see that when it is ground wrong it can easily slip out of the slot. The angle shown here actually would force the blade out of the slot.

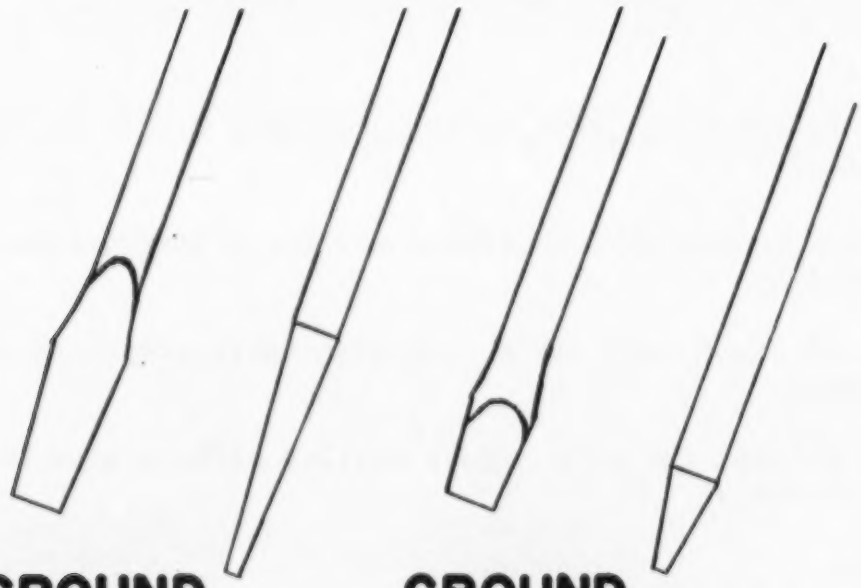

SSCI-1

14921

Take pride in your tools. Keep them clean and in good condition. And know where they are.

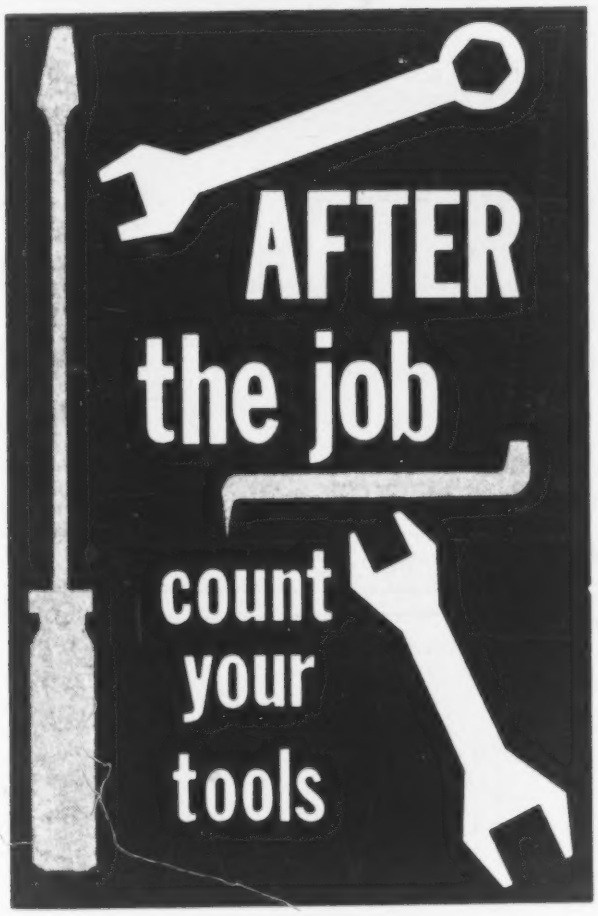

ASSIGNMENT:

1. Why is it important to turn an adjustable wrench in the proper direction?

2. Give two reasons why you should not use a screwdriver too small for the job.

3. Which can stand more force, the adjustable wrench or the open-end wrench?

4. Why is it that the more highly skilled workers give more care to their tools?

14922

UNIT II - TOOLS

Lesson No. 3 Using the Soldering Iron

Whether you intend to be an electrician,

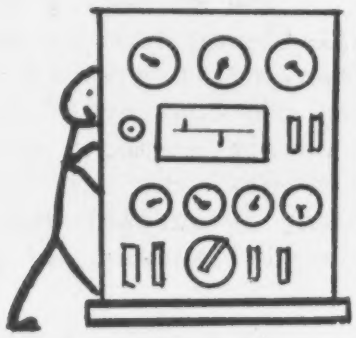

an electronics technician,

or a radio and TV repairman,

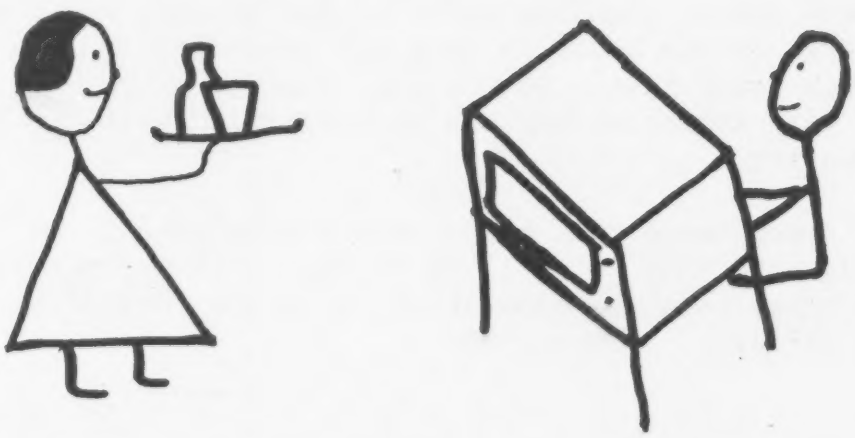

there will be many occasions when you will find it necessary to use a soldering iron.

14923

Practice is needed to attain skill, but there are a few facts with which you must become acquainted first.

The first thing to remember is that the connection to be soldered must be clean. Sometimes a material may look clean but may be covered with an oily or resinous coating which may not be seen by the eye. Steel wool, crocus cloth, a file, or a scratchbrush may be used to clean foreign substances from metal surfaces.

The soldering iron tip must be clean and well tinned. A well-tinned iron is one whose tip is coated with solder and has a clean, silvery appearance. The iron may be cleaned with a dry rag. When the coating of solder is gone, or if the iron has been filed to obtain a smooth tip, it may be retinned. Allow the iron to heat until the bare copper is just beginning to turn color (yellow, brown, or purple) and apply a good rosin-core solder to the tip. This will spread and give the tip a good tinning.

An acid-core solder should never be used on electrical connections. Never use any flux-core solder unless it is rosin-core or one that is recommended by a reputable manufacturer for radio or electrical soldering.

There are three principle types of solder sold in stores supplying the electrical and electronics trade - 40/60, 50/50, and 60/40. Let us look at the first, the most commonly used. This solder is made of a tin-lead alloy containing 40% tin and 60% lead. This is most commonly used because it does a reasonably good job and is less expensive to buy. It will become completely liquid at 460° F.

The 50/50 solder becomes molten at a noticeably lower temperature - 414° F. This solder cost more, however, because it has a greater tin content, and tin is an expensive metal which must be imported from other countries. The 60/40 solder becomes completely liquid at 370° F. This solder is more desirable in most jobs, but, of course, costs still more. The 60/40 solder leaves a shinier job - much neater than the 40/60 solder leaves, but a more important advantage of the 60/40 is that the connection can be soldered at a much lower heat - 90° F. less than with the common 40/60. This is very important because so many components can be ruined by overheating.

A flux is a substance that helps metals form a bond. In the normal wiring jobs that you will be doing, it is not necessary to use any flux other than the flux which is in the core of a good rosin-core solder.

14924

The flux performs two duties. It chemically cleans the surface of oxidations which may escape the eye, and of oily films which might be there from being touched by your fingers. The flux also reduces the surface tension of the molten solder, permitting it to spread and wet like soapy water. This is called wetting. If a soldered connection is properly wetted, the solder has completely covered the entire junction and has run to a thin, feathery edge.

After making sure that both wire and terminal are clean, wrap wire 1 1/2 turns as shown, remembering that the contact must be made between the wire and the terminal - not through the solder. Solder is only for holding. Wrap tightly, and crimp!

Fig. II-3-1

Heat the connection as shown. The soldering iron tip should be against both terminal and wire. Experience will tell you when there is enough heat to make the solder flow properly.

Fig. II-3-2

Some authorities say to apply the solder only to the wire; some say that it may be applied to the tip of the iron and allowed to flow down on the connection. The position of the work will make the difference. If possible, it is best to apply the solder directly to the wire, letting it flow down and around, then feathering out on the terminal.

Fig. II-3-3

14925

The finished job should look like this, with no more solder than is necessary to hold the wire tight on the terminal. Too much solder makes a sloppy job which will get you neither a passing mark in school nor a job in industry.

Fig. II-3-4

It is most important that there be no movement between the wire and the terminal during the time that the molten solder is hardening. If there is movement, a cold-solder joint may result. Most cold-solder joints may be recognized by a dull, powdery appearance, but often cold-solder joints may escape casual inspection. Therefore, it is necessary to carefully examine each soldered connection before accepting it.

Before starting a soldering job it is well to remember the following:

1. Make sure everything the solder is to touch is clean.

2. The soldering tip must be clean and well tinned.

3. Arrange, if possible, for a support to prevent movement while the solder is hardening.

4. Use only enough solder to hold the mechanical connection.

5. Never use an acid-core solder. Use only a rosin flux.

6. Have a dry rag handy to keep the tip clean.

QUESTIONS:

1. What is the percentage of lead in 40/60 solder?

2. What is meant by <u>tinning</u> a soldering-iron tip?

3. Which solder takes a higher temperature to melt, 40/60 or 60/40?

4. What two functions are performed by a flux?

5. What is meant by <u>wetting</u>?

6. In what kinds of electrical wiring jobs is an acid-core solder required?

7. Does a higher tin or a higher lead content in a solder produce the shinier appearance?

14926

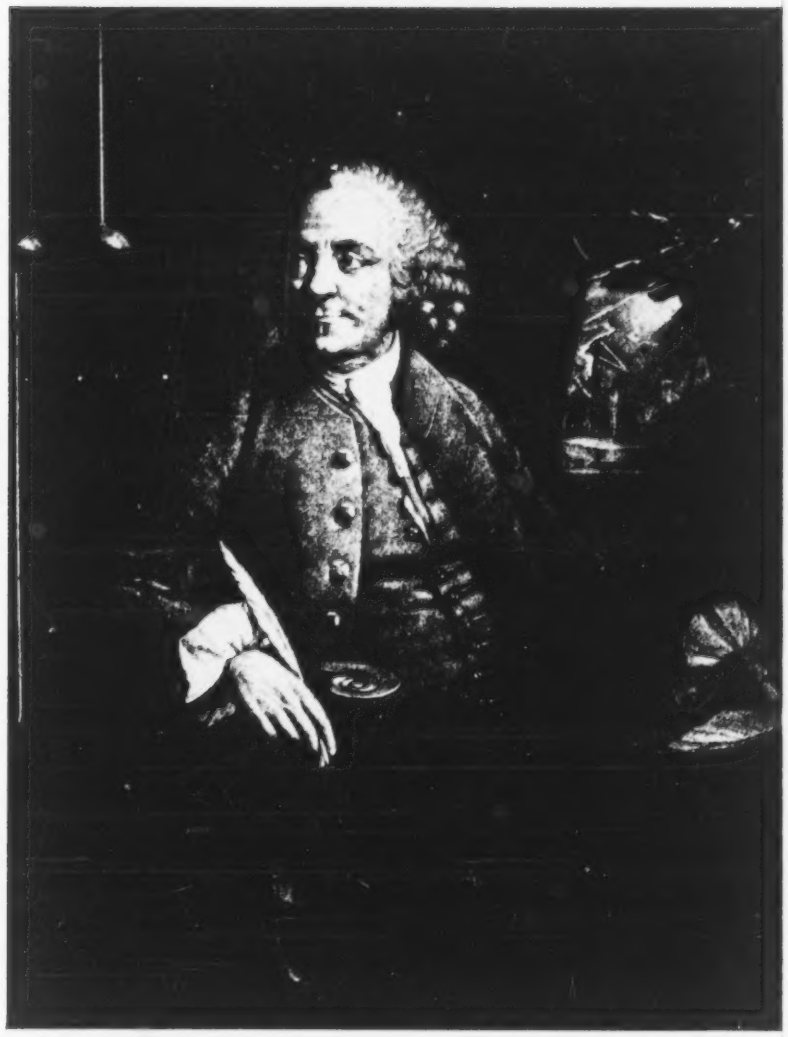

BENJAMIN FRANKLIN (1706–1790).

Famous American statesman, scientist, and author; born in Boston; printer and publisher by occupation; made scientific studies in electricity as a diversion rather than as a profession. Introduced the terms positive and negative electricity; proved the identity of lightning and electricity by flying a kite in a thunderstorm; invented the lightning rod; originated the one-fluid theory of electricity.

14927

UNIT III - ATOMS, ELECTRONS, AND ELECTRICITY

Lesson No. I — Electricity

The dictionary tells us that the word electricity is a noun, and comes from the Greek word "elektra," meaning "amber" (a yellowish resin material). Man first produced electricity by rubbing amber. You can see why the name was used.

The first experiences with electricity took place about 600 B.C. The elektra caused some interesting things to happen. For instance, have you ever rubbed a piece of paper against your desk until it stuck, or noticed a quick shock when you touched a door knob in cold, dry weather? Yes, you have shown the same general interest that man has always had in electricity.

More than two thousand years later some men (now called scientists) had formed the habit of examining and organizing their experiences with nature. They learned that the electricity obtained from amber was a "standing" charge. They used the word "static" to describe this charge. ("Static" means standing, still, or stationary. The word "static" was in common use then.) Although the electricity stayed in one place, as on the amber rod, they found that the charge could be transferred to another object, such as a ball made of pith, by touching the ball to the rod.

These early experimentors also found other materials that produced static electricity, such as glass. They also made some mistakes. They had noticed that when a pith ball charged from an amber rod was brought near a pith ball charged from a glass rod, the two attracted each other. Two pith balls charged from the same rod repelled each other.

"UNLIKES" ATTRACT

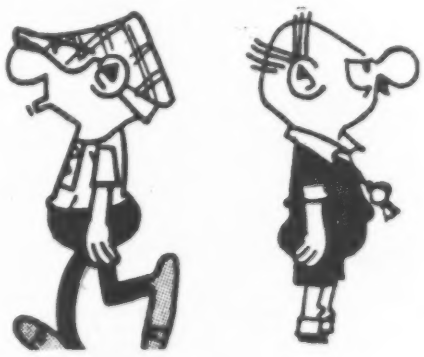

"LIKES" REPEL

14928

This led them to conclude that there were two different kinds of electricity. The one was called vitreous for glass. Later the word "positive" was used. The other type of electricity was called resinous for the resinous amber rod. Later the word "negative" was used. Despite their error, which you will learn more about in another lesson, the names have stuck - to cause students to have unhappy moments. The experienced person now thinks of positive electricity as merely being less negative. You will see why as you learn more about electricity.

It was in the 19th century that Michael Faraday, the famous English scientist, discovered that the shape of a body has much to do with its holding or releasing a charge. This was just one of his discoveries. Faraday discovered that a hollow metal ball has no removable electrical charge on the inside, and that it has an evenly distributed charge on the outside. He also discovered that if there are points on a charged body, the charge will tend to escape at these points. It is on this principle that spark plugs are designed. Lower voltages may be used on plugs if the electrodes are pointed. (One must realize, however, that the sharper the point, the quicker it will be burned down, effectively widening the gap.)

What seemed to be another kind of electricity was discovered by Count Alessandro Volta, an Italian physicist (1745-1827). This was named voltaic electricity and later came to be known as current electricity. As the word "current" indicates, this electricity involves a flow (or current) of electricity. Currents are produced in various ways: by chemical action in a cell, by movements of a conductor in a magnetic field, by heating the junction of two dissimiliar metals, and by the inductive action of a varying current in one conductor placed near a second conductor.

At this point, let us remember that the word "electricity" is a noun, and that electricity is a form of energy. The word "electric" is an adjective which describes the noun. You never say "Our electric was cut off." The word "electric" is used to describe a motor, a drill, a light, etc.

QUESTIONS:

1. What is the Greek word for amber?

2. How far back in history can the knowledge of electricity be traced?

3. What is the difference between static electricity and voltaic electricity?

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4. Early scientists referred to two kinds of electricity, vitreous and resinous. What did they mean?

5. Use the word <u>electric</u> in three different sentences.

6. Use the word <u>electricity</u> in three different sentences.

7. What kind of electricity is that which causes lightening?

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As each trainee proceeds through a performance objective in the shop he is guided and assisted by the trainee who immediately preceded him in that operation. This plan provides assistance to the initiate and further training and learning for the student who has completed the objective. This procedure becomes increasingly more valuable as the more complex and intricate performance objectives are reached.

Each instructor, including the shop instructor, records each student's progress in his phase of training on his Training Progress Report (Appendix I) by initialing the block indicating completion of the work required for the appropriate performance objective and module. He then completes the slip referring to his phase of training (Appendix II) and forwards it to the Vocational Training Program Coordinator who is responsible for disseminating this information to the other instructors and for its entry into the trainee's master training record.

UNIT III - ATOMS, ELECTRONS, AND ELECTRICITY

Experiment No. I — Static Charges

OBJECTIVE: To demonstrate static charges.

MATERIAL
- 2 Iron stands
- 2 Pith balls
- 1 Glass rod
- 1 Hard-rubber rod
- 1 Silk cloth
- 1 Wool cloth

PROCEDURE, Part A:

1. Tie a pith ball to each of the iron stands with a light thread about a foot in length.

2. Rub the hard-rubber rod briskly with the wool cloth. (Rod becomes negatively charged.

3. Touch the rod to one of the pith balls. (This will charge the ball negatively.)

4. Rub the glass rod briskly with the silk cloth. (The rod will take on a positive charge.)

5. Touch the glass rod to the other pith ball. (This ball will take on a positive charge.)

6. Bring stands close enough together for the balls to react to each other. (In the above case they will attract each other.)

QUESTIONS:

What happens to the silk cloth when it rubs the glass rod?

What happens to the hard-rubber rod when it is rubbed by the wool cloth?

Give some examples of electrostatic attraction and repulsion that you have seen.

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PROCEDURE, Part B:

1. Repeat steps 1, 2, and 3 of the previous procedure.

2. Rub the hard-rubber rod again with the wool cloth.

3. Touch it to the other pith ball. (This ball will also take on a negative charge.)

4. Again place the stands so the balls are close to each other.

5. Observe that the balls will repel one another.

QUESTIONS:

Why do the balls now repel each other?

Give as many examples that you may recall where like charges repel.

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UNIT III - ATOMS, ELECTRONS, AND ELECTRICITY

Lesson No. 2 — The Atom

Before you can begin to understand the basic nature of either static or current electricity, you must have some knowledge of the structure of atoms.

All matter is made up of atoms. There are 102 kinds of atoms. Each kind of atom is called an element and has a name. Copper and lead are two examples of elements. There are about twenty elements that you see or use daily. The other elements are a little less common and a few are very rare. Six of the 102 have been made by man from other elements.

Just as all matter is composed of atoms, all atoms are, in turn, made up of three parts: protons, neutrons, and electrons. The different elements just have different amounts of these parts. For electrical purposes we can forget the neutrons. Neutrons are not involved in electricity. However, the protons and electrons are very important. They are electricity.

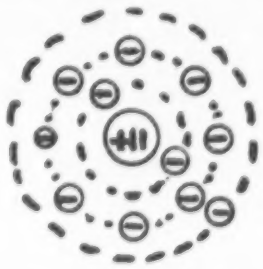

Fig.: III-2-1
A representation of an atom

The atom looks much like a tiny solar system. These tiny solar systems are so small that thousands of them could be put on the very point of a pin. To be specific, the point of a pin is made up of thousands of atoms. The atoms are so much like small solar systems that some scientists have come to believe that all of nature is made up of different-sized solar systems.

At the center of the atom solar system is a solid part called the nucleus. The nucleus is the heaviest part of the atom, just as the sun is the biggest and heaviest part of our solar system. This is where the protons are. Protons are relatively heavy positively charged particles (solids). Each proton with its single positive charge is tightly bound to the nucleus. This gives us an atom with the positive charge bound in the center.

Whirling around the nucleus as the planets whirl around the sun are the electrons. Each electron carries a negative charge.

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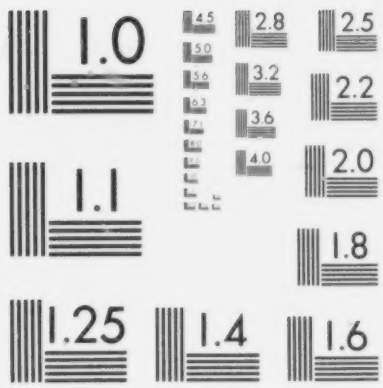

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

This charge is exactly equal to the positive proton charge but opposite in nature. The electrons are much lighter than protons. Each electron weighs about 1/2000 as much as a proton.

Again like the planets of our solar system, electrons whirl around at various but definite distances from the nucleus. No one can predict exactly where an electron will be during a given instant. But we can predict that a given pair of electrons will stay a certain average distance from the nucleus. While we do not know the reason, we also know that the electrons group in levels. Each level can hold a certain number of electrons, and this number has a great influence on the electrical nature of atoms. A later lesson in this unit will deal with electron distances from the nucleus in more detail.

To summarize: an atom has a heavy, positive central nucleus. Whirling around at various distances from the nucleus are bands or levels of electrons. If it were large enough to be seen, the outer appearance of the atom would be like a little globe.

To get a true appreciation for the atom, you must also understand that electrons of different atoms cannot get any closer than the outermost electrons of each atom. That is, the atoms cannot penetrate each other.

There is a great deal of empty space in an atom. This is just like our solar system, isn't it? Less than 1/10 of one percent of an atom is made up of solid particles. The rest of the atom's volume is empty space. An example will give you an idea of the amount of space. If the nucleus of a "large" atom were the size of a basketball and located in the center of the United States, the outermost electrons would not fit between the Mexican and Canadian borders of the United States!

QUESTIONS:

1. What are all the atoms of one kind called?

2. Name the three parts of an atom.

3. Give your idea of the size of an atom.

4. What kind of electrical charge does the proton have?

5. What kind of charge does the electron have?

6. Where is the proton located?

7. Where are the electrons in an atom?

8. Can you name some elements you come into contact with every day?

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UNIT III - ATOMS, ELECTRONS & ELECTRICITY

Lesson No. 3 — The Positive Charge

The last lesson introduced the parts of the atom and mentioned that each element had a different number of those parts.

Through the years scientists have had different views of how the whole pattern of atomic knowledge fits together. The chart on the next page shows the most up-to-date version of that pattern. The chart is organized the way it is because it contains several kinds of information. It is necessary to focus your attention on each point of interest as you go.

First, you will notice that there is a letter symbol in each box. This symbol is an abbreviation for the name of each element (in Greek). For example, H stands for hydrogen and Cu for copper.

Immediately beneath the symbol is a whole number. This is the atomic number of the element. It identifies the element as much as the element's name. The atomic number is the number of protons in the nucleus of the element. This number is always the same for any given element. If you change the number of protons, you have a different element. This different element would have the characteristics of the element of the new atomic number.

Protons cannot be removed or added to an atom by normal electrical means, however. The number of protons can only be changed in an atomic reactor. The process takes an enormous amount of energy.

Thus for practical everyday electrical purposes we cannot move the protons with their positive charges. As a result, we must depend upon the movement of electrons for any practical electrical purpose.

This does not mean that we cannot use a positive charge. The positive charge is always present as a fixed quantity, but in an electrically neutral object, it is exactly balanced by the negative electrons. To get the effect of the positive charge, we need only to remove some of the electrons. Since even a positive electrical charge is generated by moving electrons, it is easier to think of electricity in terms of electrons. Protons are still important. But, since we cannot work with protons for everyday electrical purposes, we ignore them except to appreciate the need for them and their fixed positive charge.

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PERIODIC TABLE OF THE ELEMENTS

METALS | NONMETALS

	I	II	III	IV	V	VI	VII	Noble gases VIII
1	1.00797 H 1							4.0026 He 2
2	6.939 Li 3	9.0122 Be 4	10.811 B 5	12.01115 C 6	14.0067 N 7	15.9994 O 8	18.9984 F 9	20.183 Ne 10
3	22.9898 Na 11	24.312 Mg 12	26.9815 Al 13	28.086 Si 14	30.9738 P 15	32.064 S 16	35.453 Cl 17	39.948 Ar 18
4	39.102 K 19	40.08 Ca 20	44.956 Sc 21	47.90 Ti 22	50.942 V 23	51.996 Cr 24	54.9380 Mn 25	55.847 Fe 26
	58.9332 Co 27	58.71 Ni 28	63.54 Cu 29	65.37 Zn 30	69.72 Ga 31	72.59 Ge 32	74.9216 As 33	78.96 Se 34
	79.909 Br 35	83.80 Kr 36						
5	85.47 Rb 37	87.62 Sr 38	88.905 Y 39	91.22 Zr 40	92.906 Nb 41	95.94 Mo 42	[99*] Tc 43	101.07 Ru 44
	102.905 Rh 45	106.4 Pd 46	107.870 Ag 47	112.40 Cd 48	114.82 In 49	118.69 Sn 50	121.75 Sb 51	127.60 Te 52
	126.9044 I 53	131.30 Xe 54						
6	132.905 Cs 55	137.34 Ba 56	Lanthanide Series: 174.97 Lu 71	178.49 Hf 72	180.948 Ta 73	183.85 W 74	186.2 Re 75	190.2 Os 76
	192.2 Ir 77	195.09 Pt 78	196.967 Au 79	200.59 Hg 80	204.37 Tl 81	207.19 Pb 82	208.980 Bi 83	[210*] Po 84
	[210] At 85	[222] Rn 86						
7	[223] Fr 87	[226] Ra 88	Actinide Series: [257] Lw 103					

TRANSITION ELEMENTS

RARE EARTH ELEMENTS

Lanthanide Series	138.91 La 57	140.12 Ce 58	140.907 Pr 59	144.24 Nd 60	[147*] Pm 61	150.35 Sm 62	151.96 Eu 63	157.25 Gd 64	158.924 Tb 65	162.50 Dy 66	164.930 Ho 67	167.26 Er 68	168.934 Tm 69	173.04 Yb 70	
Actinide Series	[227] Ac 89	232.038 Th 90	[231] Pa 91	238.03 U 92	[237] Np 93	[242] Pu 94	[243] Am 95	[247] Cm 96	[249*] Bk 97	[251*] Cf 98	[254] Es 99	[253] Fm 100	[256] Md 101	[254] 102	

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QUESTIONS:

1. What is an atomic symbol?

2. What determines which element you have?

3. What is the atomic number?

4. Can we move the protons from the nucleus? How?

5. How can we produce a positive charge?

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UNIT III - ATOMS, ELECTRONS, & ELECTRICITY

Lesson No. 4 Electron Levels

Atoms are usually neutral. Under normal or ground-state conditions, an atom has one electron for each proton. These electrons are not just lumped together in a solid blob, as you know.

Each electron orbits around the nucleus at some average distance. You might be interested to know that different electrons have different orbital paths. Some are perfectly round and others are elongated, eccentric orbits, coming quite close to the nucleus at one point and going well away at a far point. These orbits use the nucleus to swing around, just as our rockets use the earth and moon to swing around. As a result, they can be just as variable as our rocket orbits.

You should first understand that we still cannot predict exactly where an electron orbit will carry it around the nucleus at a given instant. But by studying optical effects, we can predict probable orbit positions. You may be interested in studying those effects in the future. It is sufficient for now that you know that these same optical effects have convinced scientists that electrons always have an average energy level. For convenience here we will think of all orbits as round, since the shape of the orbit doesn't affect electrical or electronic characteristics.

The electrons of atoms arrange themselves in two patterns. There is a major pattern of seven levels. The electrons of the atom group themselves in one or several bands or shells. These bands are separated by relatively large distances.

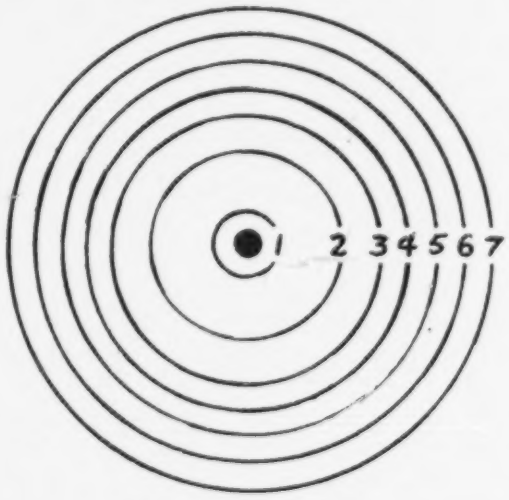

Fig. III-4-1

Note that for convenience the circles represent average energy levels and not actual orbits. These narrow shells of widely separated energy levels are numbered 1 through 7, with 1 - the lowest energy level - next to the nucleus and 7 on the outer edge. Of course you realize that not every atom has seven shells of electrons. The

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smallest atom, hydrogen, has only one electron, and it is in the first level. Each shell can hold only a certain number of electrons. If an atom has more electrons, they then go into the next shell until all the electrons are in some shell. (Note: An older convention of naming shells uses the letters K through Q instead of the numbers 1 through 7.)

Each shell is in turn divided into sublevels. There are four possible sublevels. These are called s, p, d, and f sublevels. The letters are abbreviations for optical properties caused by the different sublevels.

The first sublevel, the s sublevel, can hold only two electrons. These electrons have the same amount of energy and orbit at the same distance. The s sublevel is the lowest energy level in any shell and it always fills first. The 1 shell has only the s sublevel and can therefore hold only two electrons in all.

The second sublevel is the p sublevel, and it can hold six electrons. Each p electron in this sublevel has the same energy. All p sublevels can hold a maximum of six electrons. The first p sublevel appears in the 2 shell. It is always the second sublevel to fill as each shell gets more electrons. The p sublevel completes the 2 shell, which can therefore hold a total of 8 electrons. Shell 1 is the only shell that cannot have a p sublevel.

The third sublevel is the d sublevel. The d sublevel can hold ten electrons. As is the case with all other sublevels, all the electrons in the sublevel have the same average energy. The d sublevel first appears in the 3 shell, giving a maximum shell size of 18 electrons. The d sublevel can appear in shells 3 through 7.

The fourth sublevel is the f sublevel. The f sublevel can hold 14 electrons. The f sublevel first appears in the fourth shell. It can occur in shells 4 through 7, bringing the maximum of electrons in those shells to 32.

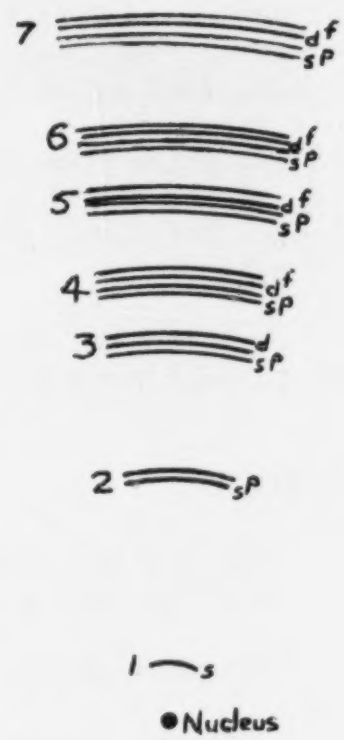

Electron Sublevels
Fig. III-4-2

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COURSE CONTENTS

MODULE		PERFORMANCE OBJECTIVES
I	Introduction	1. Introduction to Automotive Mechanics
II	Tools	1. Identification and Use of Tools
III	Fuel System	1. Remove, Overhaul, Replace, and Test Fuel Pump
		2. Remove, Disassemble, Reassemble, Replace, and Test Carbureter. (1 bbl.)
		3. Remove, Disassemble, Reassemble, Replace, and Test Carbureter. (2 bbl.)
IV	Electrical System	1. Remove, Clean, Test, and Replace Storage Battery
		2. Remove, Disassemble, Reassemble, Replace, and Adjust Distributor
		3. Remove, Test, and Replace Secondary Wiring
		4. Remove, Disassemble, Reassemble, Replace, and Test Starting Motor
		5. Remove, Disassemble, Reassemble, Replace and Test Generator
		6. Remove, Disassemble, Reassemble, Replace, and Test Alternator
		7. Remove, Replace, and Test Voltage Regulator

We are not very concerned with the d and f sublevels, because we cannot readily remove electrons from those sublevels. The s and p sublevels are very important for two reasons. First, these are the electrons that are easily removed or added. These are the electrons that move to provide an electrical current.

The s and p sublevel electrons are also important for another reason. These electrons help determine the nature of the elements. For instance, look at the atomic chart on page 32. You will see true metals in the two left-hand columns. If you look on the right side of each block, you will see a column of numbers; these tell you the number of electrons in each level. The bottom number is the outside level of electrons. All the elements in the first column have one s sublevel electron in the outermost shell. The elements in the second column all have two s sublevel electrons in the outermost shell. A little thought will lead you to the conclusion that s sublevel electrons form metals. If you look around the chart you will find other elements that have only one or two electrons in their outer shells. Yes, these are s sublevel electrons. You will also recognize some of these elements as metals. Except for the first series of elements consisting of only hydrogen and helium, whenever the outer shell of electrons is an s sublevel, the substance is a metal.

Metals are electrical conductors. Non-metallic elements are used to make insulators.

ASSIGNMENT:

1. How does an atom become "charged"? Give an example of both a positive and a negative charge.

2. How many shells of electrons can an atom have?

3. Give the letter for each sublevel.

4. What causes an atom to be a metal?

5. Where do the electrons come from when we have an electric current?

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UNIT III - ATOMS, ELECTRONS, AND ELECTRICITY

Lesson No. 5 Atoms, Molecules, and Matter

By this time you know that an atom is made up of a nucleus (the center) and electrons orbiting around this nucleus. These electrons, as you have learned, circle at different distances from the center core (the nucleus). Atoms with many electrons have them circling in a variety of orbits, each a different distance or position from the nucleus. These positions, as you know, are called levels or shells. The copper atom, for example, has four levels.

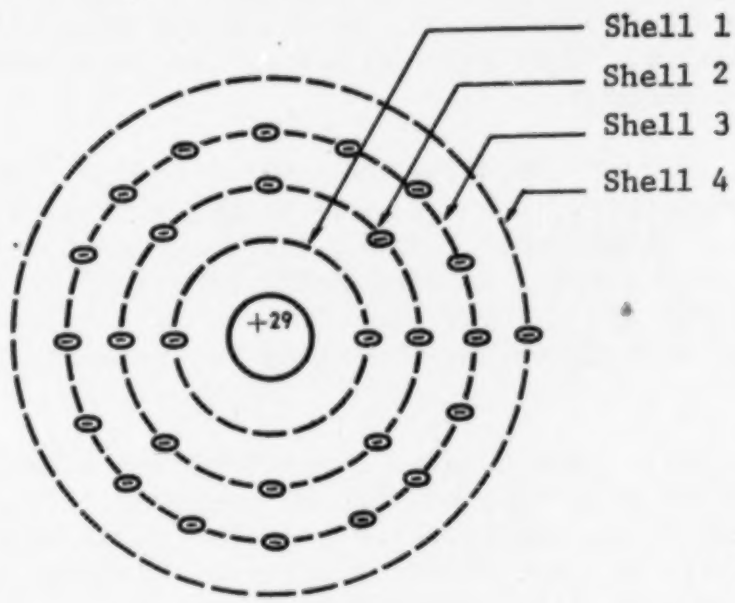

Fig.: III - 5 - 1 Schematic diagram of an atom of copper

We can see from the diagram that copper has 29 electrons and 29 protons. The atomic number is 29.

All electrons are alike, no matter what kind of atom they might be in. It is the combination of electrons, protons, and neutrons that make a material what it is. The copper atom is actually a sub-microscopic piece of copper. If you put enough copper atoms together, you would have copper with all its characteristics.

If you could read all the 102 symbols on the table of elements, you would not find brass there, or bronze, or steel, or water, salt, or any of countless other substances. These materials are not elements.

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Iron is an element. Steel is not. Iron is an element because it can be broken down to its atoms, and each atom will still be iron. Similarly, all the atoms in copper are copper atoms. Steel, on the other hand, is made up of a number of different elements. High-carbon steel is made up principally of iron and carbon. Manganese steel is made of iron, carbon, and manganese, etc. Bronze is made of copper and tin; brass, of copper and zinc. Water consists of hydrogen and oxygen. Common table salt is a combination of sodium and chlorine.

Would you say that water is a mixture of hydrogen and oxygen, or that the salt is a mixture of sodium and chlorine? No. They are compounds. In water, two atoms of hydrogen combine with one atom of oxygen. They don't just rest next to each other; they combine to make a molecule of a substance quite different from either of the combining atoms. This is a compound.

You may mix water, sugar, and lemon juice together and you know what you will get - lemonade. Is lemonade a compound? No, it is a mixture. Here the molecules of the different materials are just resting next to each other. They are not joined together chemically, as are the atoms in compounds.

What are alloys? An alloy is a metal made of two or more other metals mixed together. This is done to get a metal with a different characteristic. Sometimes it is to get a stronger metal, a lighter metal, or one with a lower melting point, like solder. Solder is an alloy of lead and tin. Stainless steel is an alloy of different kinds of steel mixed with chromium. An alloy may be a mixture or it may be a compound.

Alloys usually have greater electrical resistance than any of the individual materials in the mixture or compound. This property is utilized in manufacturing the wire for electrical heating elements. The heating coils in most of our electrical heating applicances are made of nichrome, an alloy of nickel, chromium, and iron.

QUESTIONS:

1. What is an element?

2. What is an alloy?

3. What is a compound?

4. Name three compounds.

5. What is the difference between a compound and a mixture?

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UNIT IV - CURRENT AND CONDUCTORS

Lesson No. I — Moving Electrons

By this time you understand that there is constant movement in an atom. The electrons are moving around the nucleus of the atom, in levels or shells. The largest atoms have as many as seven shells.

You will recall that the shell closest to the nucleus is known as the 1 shell; then next to it is the 2 shell, and so on through 7. The first shell cannot have more than two electrons; the second cannot have more than eight; the 3 shell, 18; the 4 shell, 32; and the 5 shell, 32. The number of electrons in the next two shells is uncertain.

If an atom has three shells, the outer shell of that atom may have as many as eighteen electrons. This does not mean that it must have eighteen electrons. Suppose the atom has an atomic number of 13. The 1 shell will have two electrons; the 2 shell will have eight, leaving only three for the 3 shell. Those three electrons are rather loosely held to the nucleus. They are sometimes called free electrons. Certain impulses will cause these electrons to leave the outer shells of their own atoms and enter the outer shells of neighboring atoms. These neighboring atoms, after receiving these electrons, will have too many electrons and will then throw excess electrons on to other atoms.

Impulses such as light, on some materials, strong magnetic fields, or chemical action may set up this condition of exchanging electrons. This is what happens in the conduction of electricity. This action can happen more readily in good conductors than in poor conductors. In the perfect insulator it could not happen at all.

This action of electrons will go down a wire 186,000 miles in one second. Therefore 186,000 miles per second is the speed of electricity. This is also the speed of light.

To help you visualize what happens when a current flows, Figure 1 is a schematic picture of a battery.

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You can see that there is a large concentration of electrons around the negative terminal. In fact, there are too many electrons in this area. They are trying to get to that positive area where there is a deficiency of electrons, but they need a good path - a good conductor. A good piece of copper wire will provide that path.

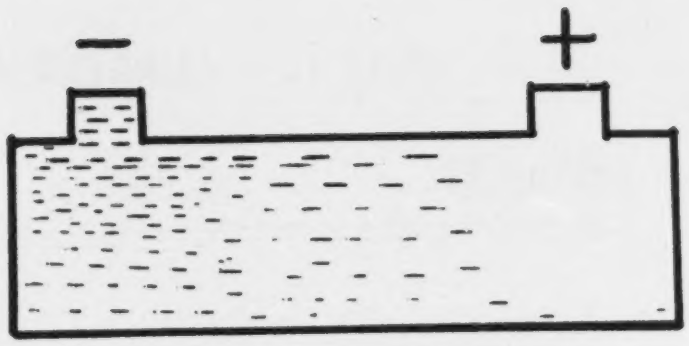

Fig. IV-1-1

If you will connect a piece of wire as shown in Figure 2, the atoms at the negative terminal of the battery will throw some electrons into that end of the wire. This will, of course, begin that chain reaction through the entire length of the wire.

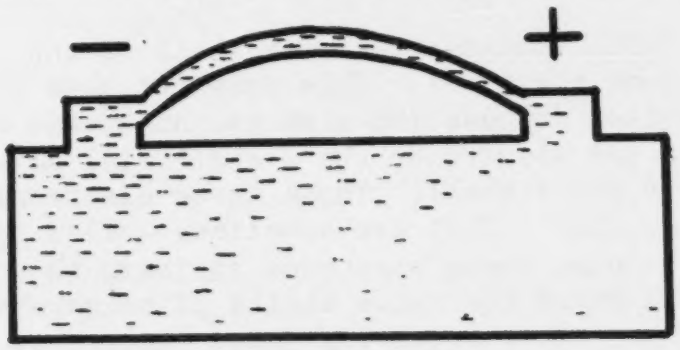

Fig. IV-1-2

This exchange of electrons - all going in the same direction, from negative terminal to positive terminal - is called current flow, electric current, or just plain <u>current</u>.

ASSIGNMENT:

1. How many shells can there be around an atom?

2. What is the speed of electric current?

3. Explain the flow of electric current through a circuit.

4. In which direction do electrons move through a conductor?

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UNIT IV - CURRENT AND CONDUCTORS

Lesson No. 2 Conductors

A good conductor (carrier of electric current) is made of a material whose atoms have lots of free electrons.

Copper is the most commonly used material for conductors of electricity. Copper has an atomic number of 29. A copper atom has its electrons in four shells, as shown in Figure IV - 2 - 1.

The first shell has its greatest number of electrons -- 2. The second shell has its greatest number -- 8. The third shell has its greatest number -- 18. The three shells together can hold and do hold 2 + 8 + 18 = 28 electrons.

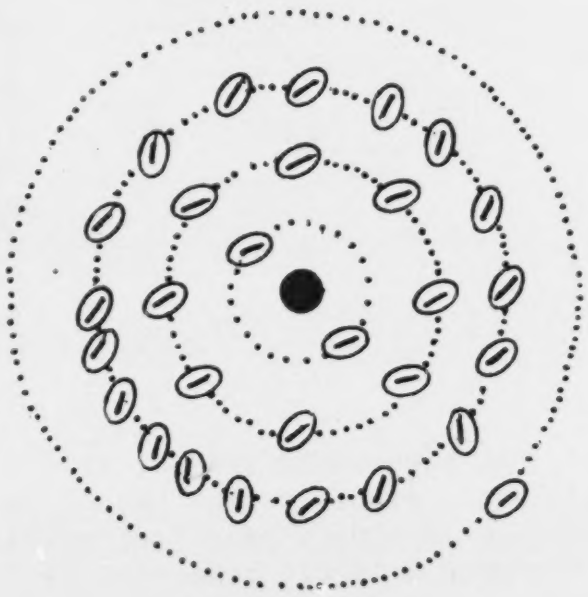

Fig.: IV-2-1

If the atom of copper has 29 as its atomic number, it has 29 electrons. So, there must be only one electron left for its outermost shell (the 4 shell), which can hold as many as 32 electrons. This one little electron is there, way off by itself, relatively speaking, barely held by the attraction of the nucleus. Just a little attraction from another body will take that electron.

After this electron leaves its orbit, the atom is left in a state of imbalance, and the atom has a positive charge while in this state. It is during the beginning of this action - this sudden change - that this atom will more or less jerk an electron from the outer shell of a neighboring atom.

If you have two conductors of the same material, one with a larger diameter than the other, it stands to reason that the larger

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one will carry more current, because it has more atoms and more electrons in it.

The more free electrons a material has, the better conductor that material will be.

Silver has been found to be the best conductor of electricity, and it is used in some applications where only small amounts are needed and where the need outweighs the cost. While silver is the best conductor, copper is the next best. In order of conductivity, conductors run like this:

Silver
Copper
Gold
Aluminum
Tungsten
Zinc
Brass
Platinum
Iron
Nickel
Tin
Steel
Lead
Mercury
Nichrome
Carbon

As previsouly stated, silver is the best conductor, but its cost ordinarily prohibits the use of this metal. Copper is the most practical. Aluminum is a very practical metal, cost-wise, to use as a conductor, but it is only a little more than half as good a conductor as copper. So, taking everything into account, there is nothing like copper as a good, all-around, practical conductor of electricity.

ASSIGNMENT:

1. Must a good conducting material have lots of free electrons or few free electrons?

2. What is the most commonly used material for conductors?

3. What are free electrons?

4. If an atom has lost an electron, does this affect its charge?

5. Which is the better conductor of electricity, silver or copper?

6. Why is copper so universally used as a conductor of electricity?

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UNIT IV - CURRENT AND CONDUCTORS

Lesson No. 3 Conductance and Resistance

In all groups, societies, or circles, sooner or later it becomes necessary to compare one thing with another. For this purpose there must be some kind of measurement.

In spite of our civilized approach and our democratic teachings, within a group of boys it is known who is the strongest, the best with his fists, or the smartest. It is usually known that Mike can whip Charlie, but Craig can whip Mike, etc. We might give Mike a rating of 1. On this basis, Charlie might have a rating of 3/4, Craig might rate 1 1/2, and so on.

Since copper is universally used as a conductor of electricity, it is considered as the standard conductor and is assigned the figure 1 for relative conductance. If there were a material twice as good as copper, it would have a relative conductance of 2. If it were only half as good as copper, it would have a relative conductance of 0.5.

Relative conductance is the reciprocal of the relative resistance. The reciprocal of a number is the number 1 divided by that number. For example, the reciprocal of 2 is 1/2; the reciprocal of 10 is 1/10; etc.

Again, copper has the number 1 assigned as its relative resistance. Since the reciprocal of 1 (1 divided by 1) equals 1, therefore we again get the number 1 as copper's relative conductance.

Tests show silver to be only 92% as resistive as copper, making 0.92 the relative resistance of copper. To find the relative conductance, you find the reciprocal of 0.92.

$$\frac{1}{0.92} = 0.92\,\overline{)\,1.00} = 92\,\overline{)\,100.00} = 1.08 \text{ (rel. conductance)}$$

$$\begin{array}{r} 1.08 \\ 92\overline{)\,100.00} \\ \underline{92} \\ 8\,00 \\ 7\,36 \end{array}$$

Therefore, if you take a copper wire of a given size and length and a silver wire of the same size and length, the silver wire will be capable of conducting (carrying) 1.08 times the current that the copper wire will carry.

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If you were to use a wire the same size as the copper but made of a material having a relative conductance of 0.75, that wire would carry only three-fourths as much current as the copper wire would carry.

To give you an idea as to how different conductive materials compare, the following table of relative resistances and conductances is given.

Material	Relative Resistance	Relative Conductance
Silver	0.92	1.08
Copper	1.00	1.00
Gold	1.38	0.725
Aluminum	1.59	0.629
Tungsten	3.20	0.312
Zinc	3.62	0.275
Platinum	5.80	0.172
Iron	6.67	0.149
Nickel	7.73	0.129
Tin	8.20	0.121
Steel	8.62	0.116
Lead	12.76	0.081
Nichrome	60.00	0.0166
Carbon	2030.00	0.0004

ASSIGNMENT:

1. Which is the better conductor, zinc or lead?

2. Which material has more resistance, silver or gold?

3. What is the reciprocal of 1? of 3? of 1.59?

4. If a copper conductor will carry 10 amperes, how much current will a nickel conductor of the same size carry when the voltage source and load are the same?

5. Which is the better conductor, zinc or carbon?

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UNIT IV - CURRENT AND CONDUCTORS

Lesson No. 4 Insulators

Electrically speaking, materials may be put into two general classes, conductors and insulators.

A conductor must offer little resistance to the flow of electric current. An insulator must offer very, very high resistance to the flow of electric current.

The unit of resistance is the ohm. The perfect conductor would have no resistance - 0 ohms.

The perfect insulator would have extremely high resistance - ∞ ohms. The symbol ∞ means "infinity" - without any limit.

There is no such thing as a perfect conductor or a perfect insulator.

While cost limits us to copper and aluminum for conductors, there are many good insulators. Glass is a very inexpensive material and is an excellent insulator for those situations where glass insulators may be used. The choice of insulators depends on circumstances. In some applications, flexibility ("bendability") may be of great importance. Insulation for hook-up wires and power cords for small applicances fall into this category.

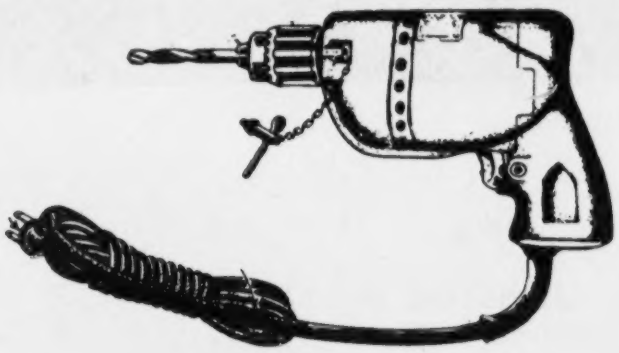

You would want the insulation on the power cord on this drill to last a long time before getting brittle and cracking.

Fig.: IV - 4 - 1

Besides having very high resistance to electric current, there is another quality that is important in an insulator. That property is DIELECTRIC STRENGTH. The dielectric strength of an insulator is its strength against breakdown under electric stress.

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IV	Electrical System (Cont.)	8. Remove, Replace, Test, and Adjust Head Lamp Assembly
V	Engine	1. Disassemble, Check, Make Measurements, and Reassemble Engine
		2. Reface Valves and Grind Seats
VI	Cooling System	1. Remove and Replace Radiator, Hoses, Thermostat. Flush Radiator and Engine
		2. Remove and Replace Water Pump
VII	Brake System	1. Remove and Replace Brake Shoes and Overhaul Wheel Cylinder
		2. Overhaul Master Cylinder
VIII	Power Flow	1. Remove, Test, Replace, and Adjust Clutch
		2. Disassemble, Check, and Reassemble Standard Transmission
		3. Remove and Replace Automatic Transmission
		4. Disassemble, Check, and Reassemble Automatic Transmission
		5. Remove Drive Shaft, Remove, Test, and Replace Universal, Replace Shaft
		6. Remove, Disassemble, Check, Reassemble, and Replace Differential

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The dielectric strength of the paper insulation between the foil strips in this capacitor must be great enough to retain its insulating properties without breaking down under the voltage applied to it.

Fig.: IV - 4 - 2

Many insulators must possess great strength. The insulators you see holding the long heavy wires on high-voltage transmission lines must be very strong to withstand the weight, wind, ice, and changes in temperature.

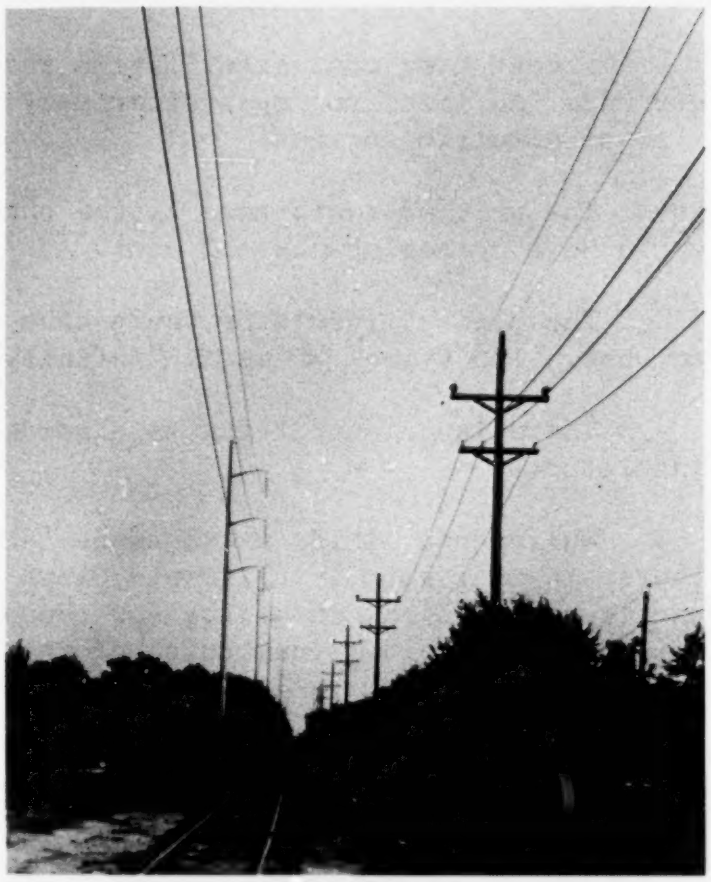

Fig.: IV -4 - 3

Electrical insulators are physically classified as solids, liquids, gases, plastics, varnishes, and lacquers. Vacuum, too, is a good insulator and has high dielectric strength.

Insulators are made of molecules with tightly held electrons which are very reluctant to leave their orbits.

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ASSIGNMENT:

1. Name as many insulating materials as you can.

2. Into what physical classifications may insulators be put?

3. What is the main difference between a conductor and an insulator?

4. What is meant by <u>dielectric strength</u>?

5. What would happen to a capacitor if the dielectric strength of the insulating material between the plates or strips of foil was too low for the voltage applied?

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UNIT IV - CURRENT AND CONDUCTORS

Lesson No. 5
Experiment — Insulators and Conductors

OBJECTIVE: To demonstrate the varying values of resistance found in conductors and nonconductors.

MATERIAL:
1 Ohmmeter with leads
2 Pieces of sheet metal, approximately 2" x 4"
1 Small glass of water
1 Teaspoonful of table salt
1 Blotter
1 Nichrome heating element
1 5' length of copper wire (#22 or #24)

PROCEDURE:

1 - Place dry blotter between the pieces of sheet metal. Connect ohmmeter leads, one to each metal plate. Measure resistance.

2 - Dip the blotter in water and replace between the plates. Again, measure and record resistance.

3 - Dissolve the salt into the water.

4 - Soak the blotter in the salt-water solution, and measure and record the resistance as in steps 1 and 2.

5 - Place the leads to each end of the nichrome heating element. Measure and record resistance.

6 - Replace the nichrome element with 5' length of copper wire and measure the resistance.

QUESTIONS:

1 - After observing the difference in resistance in steps 1 and 4, ask yourself what this tells you about working with electrical circuits when they are wet or damp.

2 - Why is the resistance lower in step 6 than in step 5?

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UNIT IV - CURRENT AND CONDUCTORS

Lesson No. 6 — The Edison Effect

When an electric current goes through a conductor, heat is produced. This effect is often used for man's benefit. Usually, however, the heat is not wanted. Great problems have come from excessive heat in electrical and electronic circuits. Before the coming of transistors, there was a heating problem in the design of computers. The many, many vacuum tubes gave off so much heat that the components had to be spaced so far apart that it required several rooms to house some of the early computers.

It was the heating effect of a current that made Thomas Edison's invention of the incandescent lamp possible. "Incandescent" means glowing with light. When a metal approaches 1800° Fahrenheit, it will give off a red light. Thereafter it will become brighter and brighter until it gives off a nearly white light. Edison's problem in the beginning was to keep the wire (the filament) at this high temperature without having it burn up. He found that he had to have it in a vacuum - away from oxygen - so that it would not deteriorate from oxidation (burning). Then he had to find a material which would hold up under the extreme heat.

Edison, America's most celebrated inventor, was also probably the first to observe an electronic effect. One might say that in his discovery of the Edison Effect he had the key to the field of electronics in his hand, but failed to know what was behind the door. He discovered this effect in 1883, just 3 years after he presented the incandescent lamp (the common light bulb) to the world. He constructed a different kind of light bulb this time, in which he placed a small metal plate some distance from the filament. While experimenting with this lamp, he discovered that an electric current would pass between the filament and this little plate. This would happen only when the lamp was burning. Current was actually flowing through space without a visible conductor. This became known as the Edison Effect.

Being a practical inventor, rather than a true scientist, Edison probably left this discovery to give his time and attention to something more practical at that time. More than 17 years later (after the beginning of this century) John A. Fleming, an English electrical engineer, employed Edison's discovery in his creation of the first radio tube. This phenomenon, the Edison Effect, led to the breakthrough into a new field of science. Fleming first used it in his diode vacuum tube to detect radio signals and to rectify alternating current.

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Some science writers say that Edison pointed the way to electronics. It is possible that he knew that an entire new world in the use of electricity lay in that direction, but was too busy with problems in another direction to grasp the vast possibilities of that new field.

ASSIGNMENT:

1. Who constructed the first radio tube? For what two purposes was that first tube used?

2. Who discovered that an electric current will pass through a vacuum without a visible conductor? When was this discovery made?

3. If oxygen gets into a light bulb or a vacuum tube, what will happen?

4. What is an incandescent lamp?

5. What was Edison's main problem in developing the incandescent lamp?

6. Can you explain how the Edison Effect made possible a few of the conveniences you now enjoy?

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UNIT V - VOLTAGE AND POTENTIAL

Lesson No. I — Potential

Before we talk about potential and voltage, it will be wise for us to review a few of the facts that you have learned about energy. Let us remember that all energy comes from the sun originally - whether it be heat energy, electrical energy, chemical energy, nuclear energy, or mass energy.

The sun's heat may evaporate water from the sea and carry it to higher levels as clouds. Then the water is returned to the earth in the form of rain. Some of this rain may then be stored in lakes. While it is resting in the lake, it has potential energy. The dictionary tells us that "potential" is something that "can be, but has not yet come into being." All this water has potential, potential to turn wheels which, in turn, may perform many thousands of operations. (Of course, you know that energy in motion is kinetic energy.) This stored energy in the lake is potential energy, it can someday do something, but it has not yet done it.

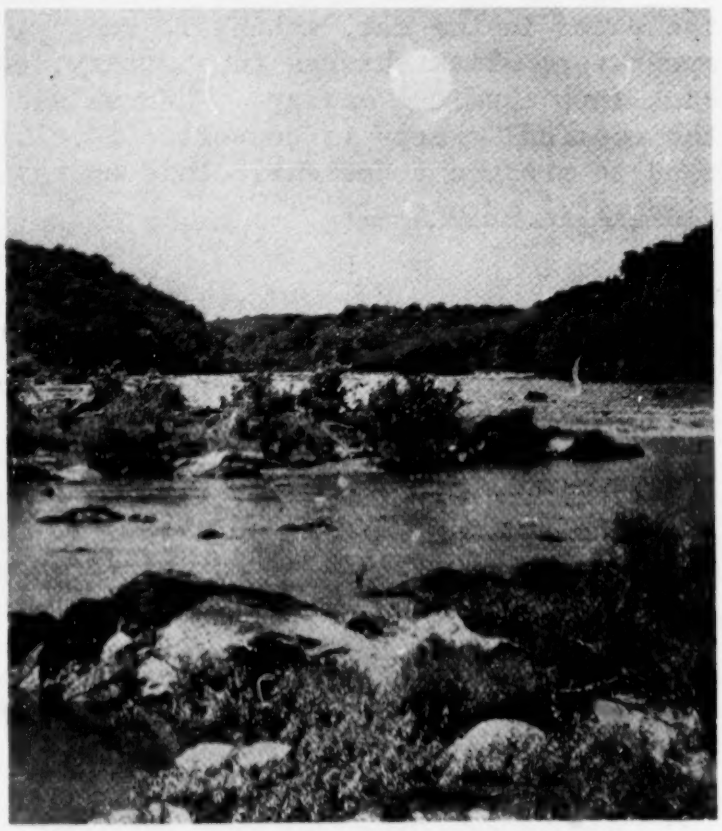

Fig.: V-1-1

If you are sitting under a shelf which has a heavy box poorly placed on the shelf - ready to fall off - the potential is there to put a knot on your head. You could say that there exists a potential danger.

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When your father goes to start his automobile in the morning, there must be some kind of potential energy existing to turn the starter. What kind of potential is this? Surely you have already guessed -- CHEMICAL POTENTIAL. There is a potential energy stored in the battery, and this is called chemical energy, or chemical potential.

Let's trace just the high points of the journey of this potential energy from the sun to the automobile battery.

Many millions of years ago the sun supported chemical energy which caused the growth of jungle trees, vines, shrubs, etc. These plants grew, died, and decayed. During the millions of years since, this matter has changed form. It has liquified. It has become liquid petroleum. It is pumped from the ground, and from this material gasoline is made.

It is obvious now that the energy of exploding gasoline turns the motor in the car, making it run. The motor also turns the generator, which charges the battery, converting the rotary motion back into chemical energy. When we use (or discharge) the battery, the chemical energy is converted to electrical energy, which can be used to produce a current. This energy can therefore be called <u>electrical potential</u>.

When you go to the filling station for gasoline, you are concerned about how much gas you are getting. Therefore, there must be a system of measurement. Gasoline and nearly all of our liquids are measured in gallons. When you buy meat, you buy it by the pound. So, just as it is necessary to have a system for measuring gasoline and meat, it is necessary to have a measuring system for potential. Electrical potential is measured in volts.

When one says that a student has the potential to become a great engineer, one means that the student has all the abilities required to

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make a good engineer. He "can be, but has not yet come into being."

You have probably heard someone say of a building, "That building is a potential fire trap." He means that everything is favorable for a fire to spread rapidly - lots of rubbish, paper, exposed woodwork, drafty corridors, etc. Fire could race through the building, but one has not yet started. The potential is there.

QUESTIONS:

1 - What is potential energy?

2 - What is kinetic energy?

3 - From what does all energy come originally?

4 - What kind of energy is necessary to turn a starting motor?

5 - Write three sentences using the word "potential."

6 - If a battery has a high potential, does it mean that it is going to do work?

7 - If a student has the potential to become a successful businessman, does it mean that he will become a successful businessman?

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UNIT V - VOLTAGE AND POTENTIAL

Lesson No. 2 Electromotive Force

Before talking about electromotive force, it will be best if we first understand potential difference.

Do you remember when you rubbed some of the electrons off the car seat onto the seat of your trousers? What happened? You remember that there was an imbalance created in the atoms of the material in the car seat, and there was an imbalance in the atoms of the material in your clothing. One material had taken some of the electrons from the atoms of the other material. Neither of the materials was left in its original neutral condition. They were both charged - one negatively, and the other positively. There was a difference. We call this difference in charge potential difference. We measure this potential in volts.

When a potential difference exists, there is the potential to return to the original, neutral state. If the potential to change is there, then there must be some kind of force to cause the change. We call this force electromotive force, or e.m.f. Electromotive force, depending on its quantity and rate that it is being expended, is doing most of the work that is being done in the world today. Many other forces are converted to electromotive force before being used. The force of water or of steam is changed to electromotive force in order to distribute it more efficiently and to use it with greater ease.

When you stand by a railroad and see a train being pulled by a diesel-electric engine, you may not realize it, but the wheels are being turned by electromotive force. The mechanical force created by the diesel engine does not drive the wheels directly. Instead the engine drives electric generators, which drive the wheels. This is done because of the increased ease of control and for increased efficiency of fuel.

In the armed forces, there are radio receivers and radio transmitters that are powered by hand-turned generators. Again, this is mechanical force being changed into electromotive force.

There are certain powerful chemicals which have the potential to corrode, burn, eat metal, or to cause change. This chemical energy (this potential to cause change) may be used to produce electromotive

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force. This possibility of using chemical energy to produce electromotive force is utilized in the manufacture of batteries - flashlight batteries, radio batteries, automobile batteries, etc.

Electromotive force is measured in volts.

QUESTIONS:

1 - What kind of force drives the wheels of a diesel-electric locomotive?

2 - What kind of force is used to create the force which drives the wheels of the diesel locomotive?

3 - What kind of energy is used to create the electromotive force found in a flashlight battery?

4 - What is potential energy?

5 - In what units of measurement do we measure electromotive force?

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IX	Chassis	1. Disassemble, Check, and Reassemble Steering Gear Assembly
		2. Remove, Replace, and Adjust Front Suspension
		3. Alignment
		4. Changing Tires
X	Servicing	1. Changing Oil and Grease
		2. Repacking Front Wheel Bearings
		3. Remove and Replace Muffler and Tail Pipe
XI	Trouble Shooting and Tune-Up	1. Creating Malfunctions, Finding, and Correcting

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UNIT V - VOLTAGE AND POTENTIAL

Lesson No. 3 Electrical Pressure

After becoming familair with potential difference and electromotive force, and after learning just what a volt is, we should now become aware that in the electrical trade electromotive force is referred to as electrical pressure. Sometimes you may hear an electrician refer to e.m.f. as pressure.

When you take another look at electromotive force, it is easy to understand why it may be referred to as pressure. We may use air pressure or water pressure to help us understand electromotive force.

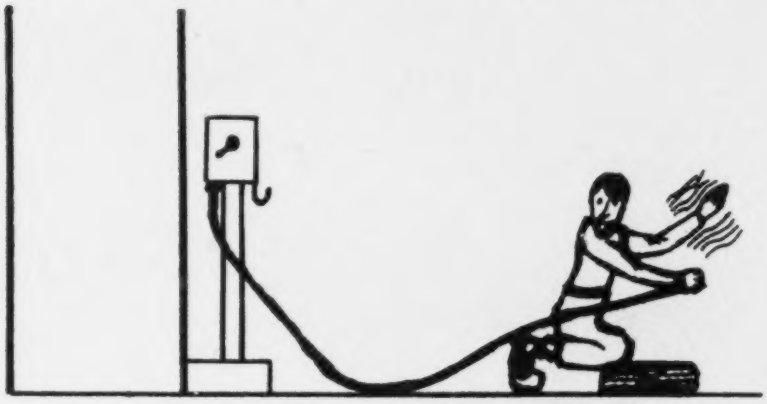

If there is nct enough pressure in the air tank at the filling station, you will never be able to get as much air in your tire as you need.

If there is not enough water in the water tank or standpipe providing the water supply in your community, there will not be enough pressure to send a stream strong enough to wash the mud and dirt off your car.

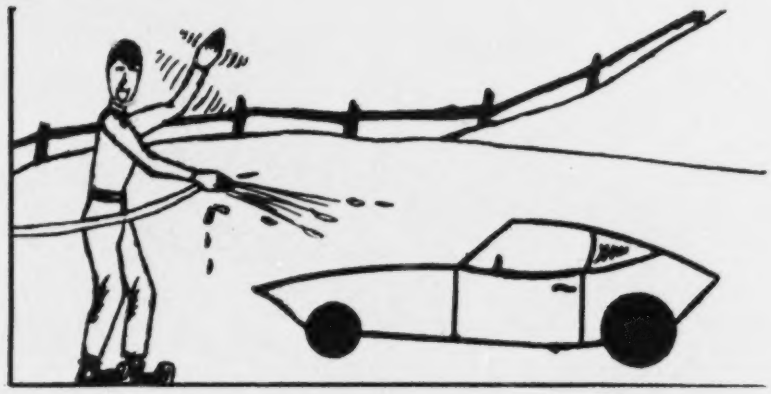

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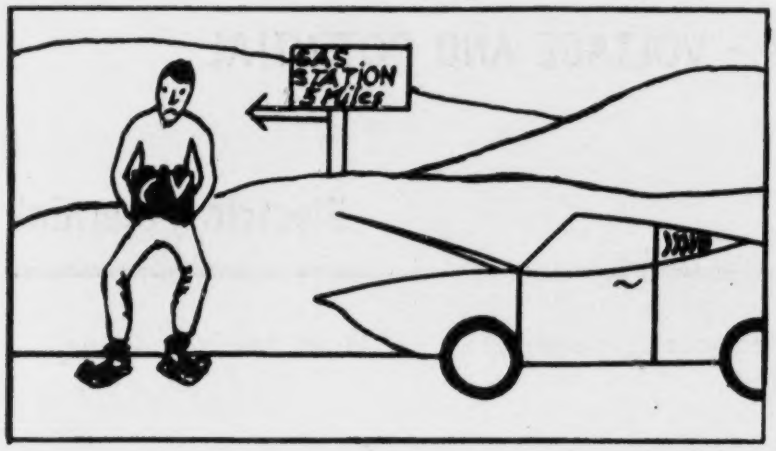

If you were to have someone, by mistake, put a 6-volt battery in a car which is designed for a 12-volt battery, you are not likely going to take your girl for a ride until you get a battery with enough pressure to crank the motor.

Pressure exerts force, and force does work. Water pressure turns turbines. Air pressure sometimes is used to exert the force needed to run certain small motors and to do various jobs, besides pumping up tires. Some technicians and engineers do not like to use the term pressure when referring to e.m.f. This lesson is not especially designed to encourage you to use this word, but if it helps you to better understand electrical potential, then go ahead and think of it as pressure.

QUESTIONS:

1 - How may you explain electromotive force as pressure?

2 - Give as many examples of pressure as possible, relating each to electromotive force.

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4 - Connect as shown below:

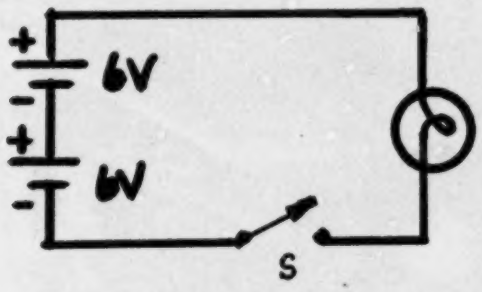

Fig.: V-4-2

5 - Close the switch. Is the light now burning as it should be burning? Is the light as bright as it should be? What is the quantity of potential? Why did the lamp not burn before closing the switch? Was there any potential before closing the switch?

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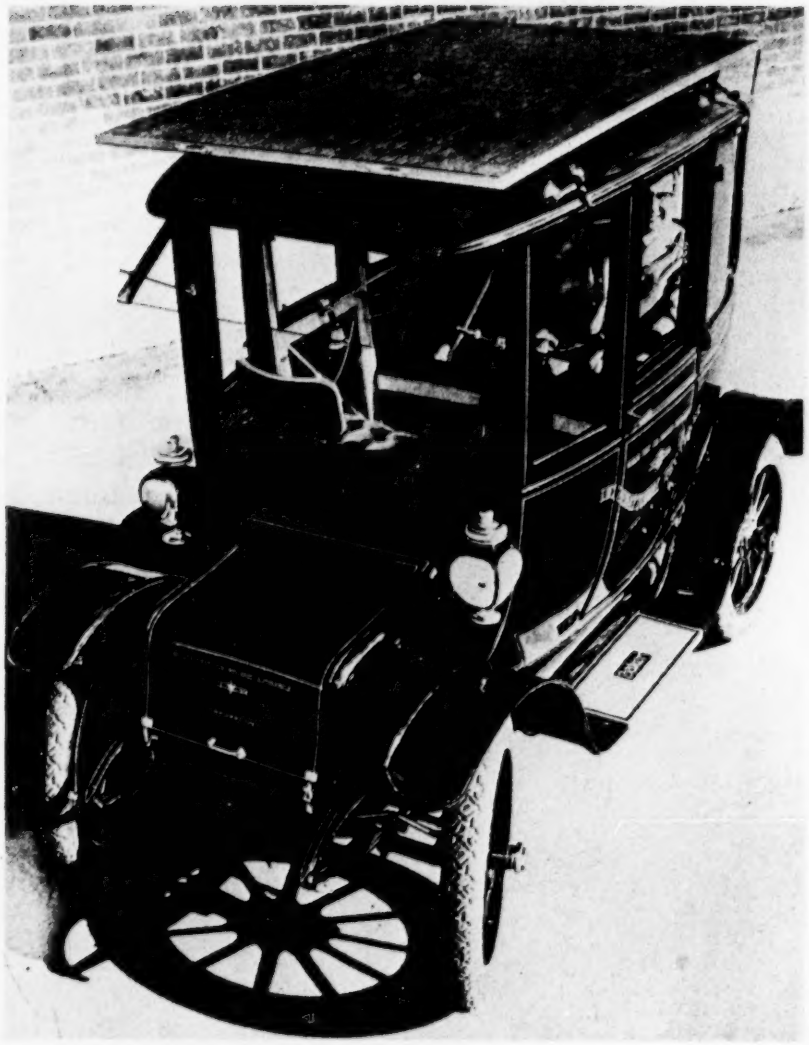

An old Baker Electric Automobile actually running on the power of the sun. A battery of solar cells mounted on the top of the car charges the batteries which furnish the power for the car. This car does not pollute the air.

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UNIT VI - THE BATTERY

Lesson No. I History and Classification

It is often difficult to find who the real discoverers or inventors were of many of the things that science has given to us, since all inventors build upon the knowledge that others have discovered before them. From about 1725 to the end of that century, many men were working with electricity in their laboratories. In the year 1745, Benjamin Franklin's scientific papers were read at the Royal Society in London. In 1746 and 1747 Franklin was doing experimental work in electricity with Thomas Hopkinson, Philip Syng, and Ebenezer Kinnersley in Philadelphia. In April 1751, a collection of Franklin's papers was published as Experiments and Observations on Electricity. This 80-odd page book made Franklin famous throughout Europe. Just as this great American refused to patent his famous heating stove, wishing others to benefit from his genius, he made public his findings in electrical science. Many scientists in England and all over Europe read his papers, sought his acquaintance, and nearly all benefited from his experiments.

Until the time of Franklin and his contemporaries, the study of electricity had not advanced much beyond man's acquaintance with static charge. This was interesting, but had little practical use. It was in the 18th century that man was to harness and store electricity.

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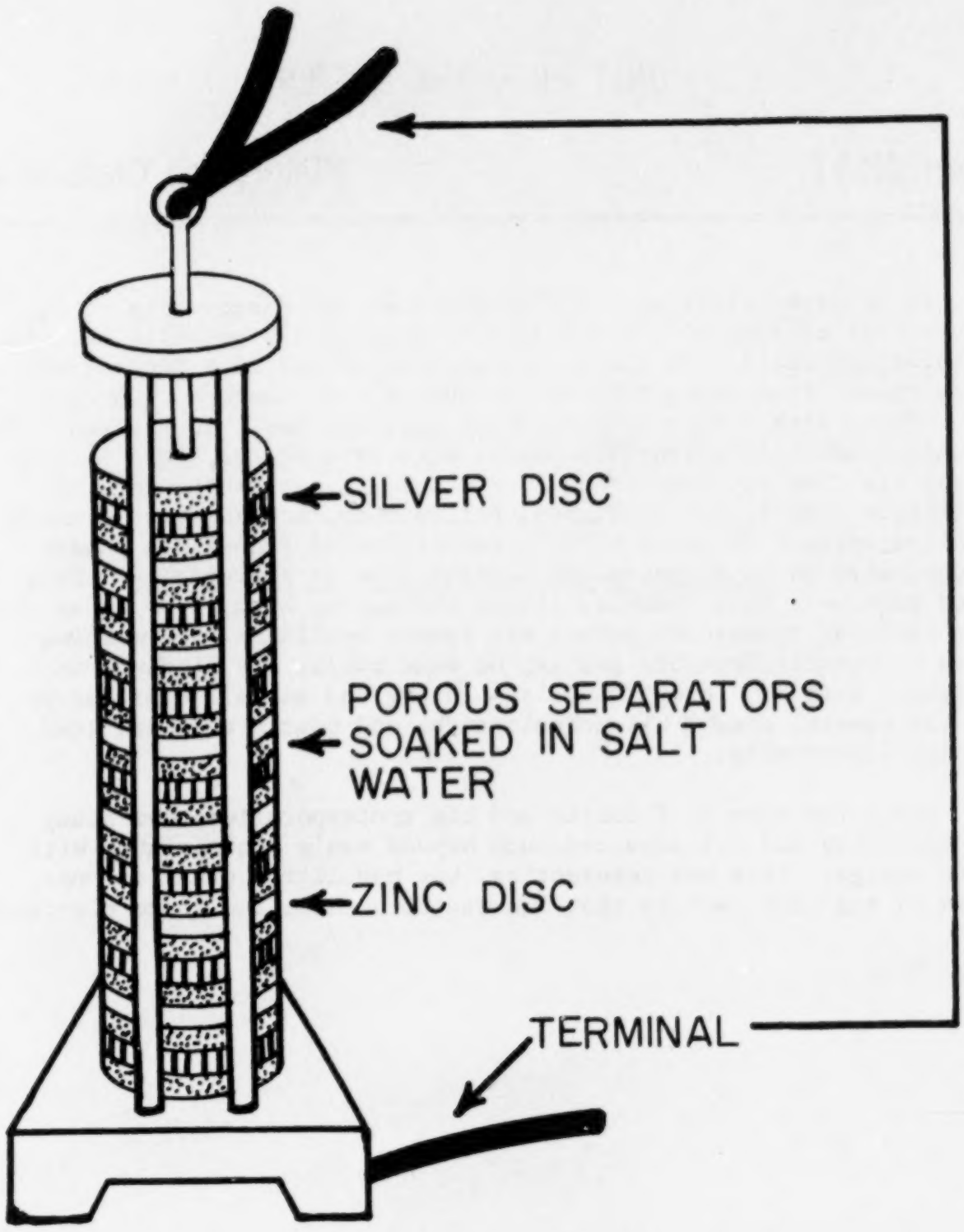

Fig: VI-1-1

The first usable source of electricity was the chemical battery. The process of producing electromotive force by chemical means was discovered by a famous Italian scientist, Luigi Galvani (1737-1798), and the first chemical battery was constructed by another famous Italian, Allesandro Volta (1745-1827). The first chemical battery was known as a voltaic pile.

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In 1839, twelve years after the death of Volta, the great French physicist, Georges Leclanché, was born. Most of the batteries that you have handled are based on his invention and are named in his honor. All carbon-zinc dry cells are called Leclanché cells. He was given a patent on this type of cell in 1868 - just three years after the ending of the War Between The States.

Strictly speaking, a battery consists of two or more cells connected together to supply an electric current. The word is also used loosely, however, to mean a single cell that supplies a current.

Batteries are divided into two main groups, primary cells and the secondary cells. The difference between the two groups is that secondary cells are rechargeable, while primary cells are not rechargeable.

The primary-cell group may be divided into three principle classifications: (a) Leclanché cells, (b) alkaline primary cells, and (c) mercury cells.

There are many kinds of secondary cells. Until recently, most secondary cells were wet cells and had to be handled very carefully in order not to spill the electrolyte. The increasing need for rechargeable batteries has caused battery manufacturers to boost research and development to such an extent that we now have two excellent dry secondary cells. These new dry secondary cells are the nickel-cadmium cells and the alkaline secondary cells. Of course they aren't really dry, but are so sealed that they will not spill or leak.

Alkaline cells may be either primary or secondary cells, but you can not recharge the alkaline primary cells.

ASSIGNMENT:

1 - Explain the difference between primary and secondary cells.

2 - Who were Volta and Galvani? When were they born?

3 - What is a Leclanché cell?

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UNIT VI - THE BATTERY

Lesson No. 2 — The Electrolytic Cell

Primary and secondary cells work on the same principle. The difference between the types of cells is only one of rechargeability.

A cell works because of the tendency of metals to dissolve in most liquids. For instance, whenever a piece of copper is placed in water it will start to slowly dissolve. This is also true of all other metals, such as iron, lead, and mercury. Some metals, such as sodium, dissolve explosively and would not be satisfactory for manufacturing cells.

The dissolving of metals is a chemical action. Chemical actions are electrical in nature. Thus whenever a given metal is placed in a liquid, such as water, the tendency to dissolve causes a small electromotive force (e.m.f. voltage) between the metal and the liquid. This is an internal e.m.f. We need an external e.m.f., one that will push electrons through a wire.

A usable e.m.f. calls for a different arrangement. Two different metals are placed in a solution that will readily conduct electricity. A solution that will readily conduct electricity is called an electrolyte. Any electrolyte will work, but some electrolytes are better than others for certain metals. A look at Fig. VI-2-1 shows that the electrolyte takes the place of a wire to complete the circuit.

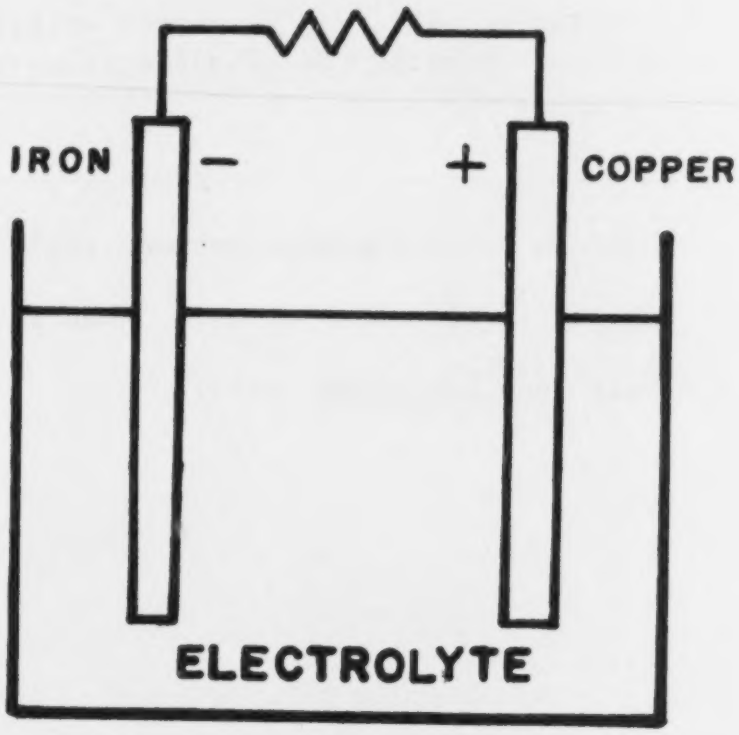

Fig.:VI-2-1

Both metals tend to dissolve in the electrolyte. This causes an internal e.m.f. on each of the metals. Since the metals are different, one e.m.f. is always bigger than the other. A chemist can predict which, but you would have to experiment with a meter. When the two metals are connected by a conductor, as shown in the diagram, the two e.m.f.'s oppose each other. The larger overcomes the smaller. The difference between the e.m.f.'s is the e.m.f. or voltage of the cell. Thus, both metals desire to go into solution, but only the stronger one can do so.

The two metals are called electrodes. One is positive, the other is negative. The electrode that goes into solution is always the negative one. The wires are connected at the terminals of the electrodes. The electrode that dissolves is more negative than the one that doesn't, and that electrode has the negative terminal. The other terminal is less negative and is called the positive terminal, even though it is not really positive.

As the cell is used to produce a current, the negative electrode continues to dissolve. When the terminal is completely dissolved, or when it completely coats the other electrode, the cell is "dead". A primary cell is discarded when dead. With flashlight D cells, the negative electrode is the zinc case and frequently developes leaks before the battery becomes dead.

A secondary cell is recharged with a slightly greater reverse e.m.f. This reverses the chemical process, and the metal of the negative electrode is redeposited during charging until it is back as it was at the start.

QUESTIONS:

1 - What are the 3 essential parts of an electrolytic cell?

2 - What would you say is the basic physical process that makes a cell capable of producing a current?

3 - What makes one electrode the positive terminal, and the other the negative?

4 - What is the negative electrode in an ordinary dry cell?

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: I. INTRODUCTION

MILESTONE: I. INTRODUCTION

PERFORMANCE OBJECTIVE NO: 1 TITLE: Introduction to Automotive Mechanics

CONDITIONS: Introduction to, and familiarization with, the course of training, related instruction and skill development required, shop facilities, and personal conduct

LEARN	REFERENCE	SOURCE
1. Manner in which course is conducted	1. Lecture	1. Shop Instructor
2. Shop layout and facilities available	2. Shop tour	2. Shop Instructor
3. "A Car is Born"	3. Filmstrip	3. Resource Materials Center

The following picture shows the structure of a typical dry cell:

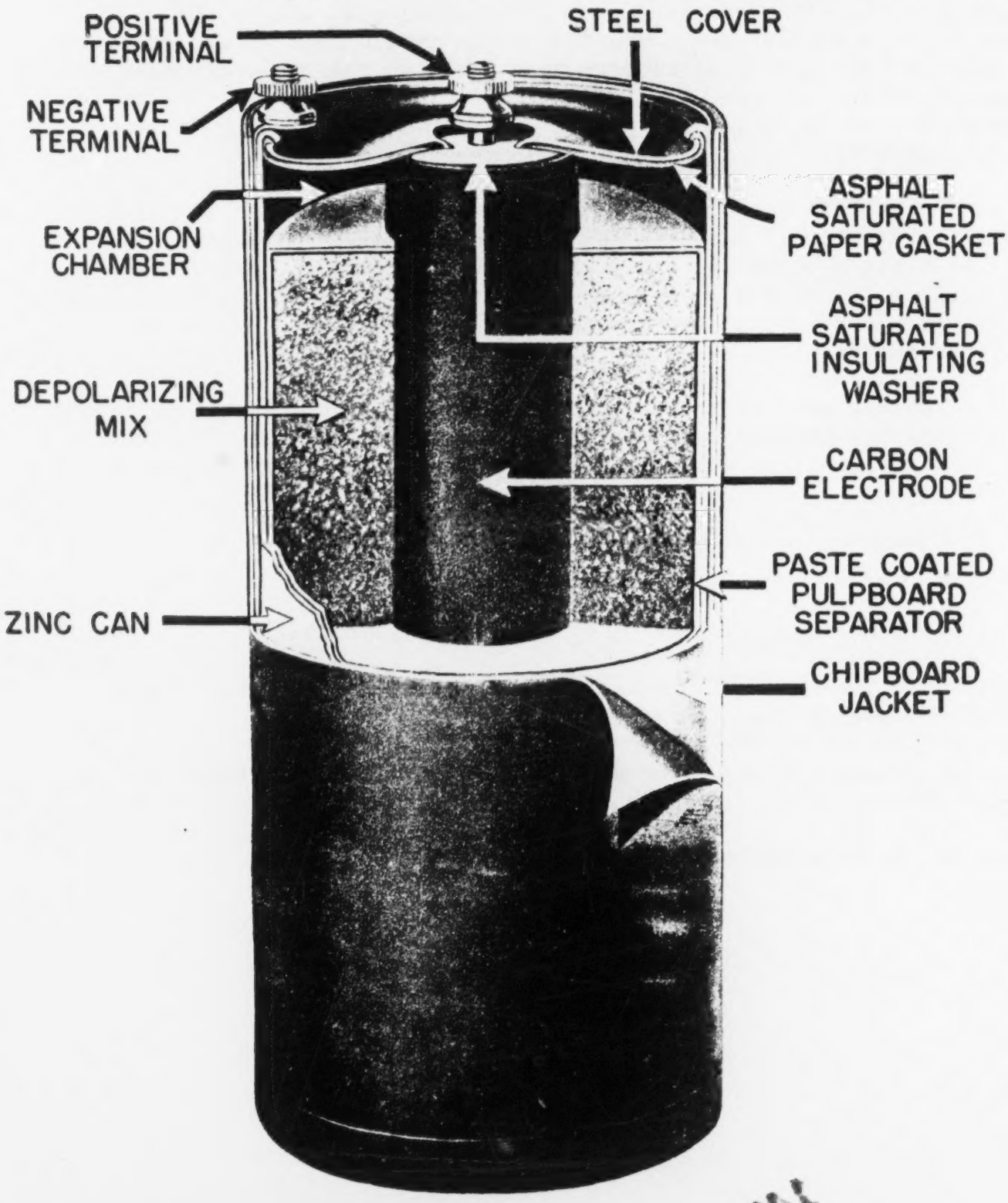

Fig.: VI-3-1

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What we call a dry cell really isn't a dry cell, because the mixture inside is not dry. It must be moist in order to function as a source of electricity. When it is really dry, it is dead.

We also call it a battery, but strictly speaking, it is not a battery. It is a cell. It takes more than one cell to make a battery. The word "battery" means a number of similar articles connected together. This little object which we call a battery is also called a battery by many manufacturers. Many cells are called batteries right on their labels. The label of one declares it to be a "1.5-volt Dry-Cell Battery." So, you are not too wrong if you call it a battery; you are just falling in line with a change in the language. Sometimes these changes are good, sometimes bad. In this case it is not too bad as long as there is no misunderstanding about what you mean.

The 9-volt battery in your transistor radio is a true battery. It is made up of a number of cells which are connected in series and put into a case, with the positive and negative terminals brought to the outside of the battery container.

The common dry cell, like the one shown in the illustration, has a potential of approximately 1.5 volts. Dry cells are electrolytic cells. They produce an e.m.f. as the zinc dissolves in the electrolyte (the pasty material within the cell). As it does so, it leaves some electrons on the zinc case. It is these electrons that produce the current.

The electrons flow to the carbon electrode, where they are removed by chemical action with hydrogen in the electrolyte, resulting in the formation of hydrogen gas.

Dry cells are not rechargeable regardless of the many so-called dry-cell battery chargers on the market. These devices do, however, depolarize the cells (eliminate the hydrogen bubbles from the surface of the carbon electrode). This tends to increase the useful life of the cell.

When the cell is in use, the process called electrolysis is going on inside it, and bubbles of hydrogen are collecting around the carbon electrode. These bubbles are not very good conductors of electricity, so an internal resistance is built up in the battery, making it seem weak or dead.

A depolarizing agent, manganese dioxide, is usually added to the electrolyte to help prevent the formation of bubbles. Time, also, makes a difference. A comparatively new battery which has been polarized through a period of too-long use can sometimes be used again after a rest period. This will give the carbon electrode time to depolarize itself.

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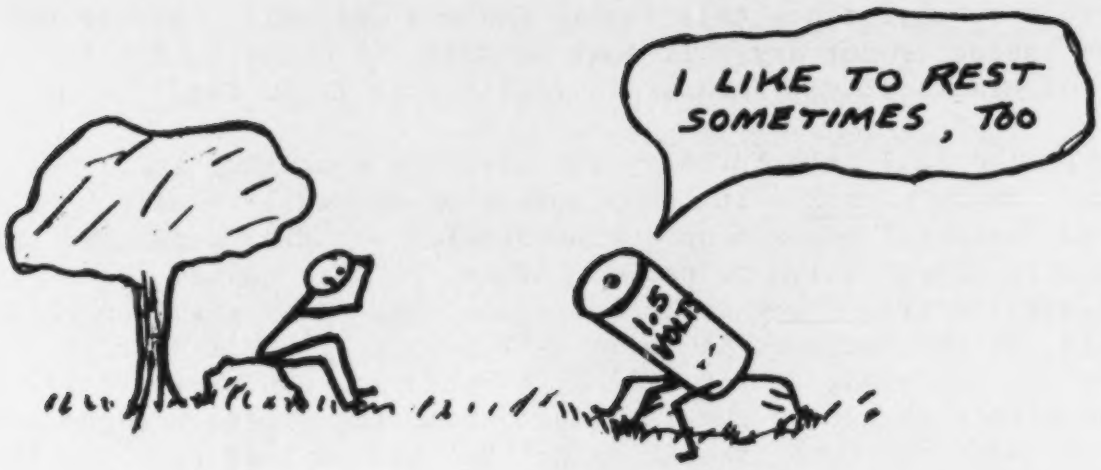

These cells are inexpensive to manufacture. This makes them practical for flashlights, portable radios, self-powered model cars and planes, and many other similar applications.

They should not be used for continuous operation or at more than 0.25 amperes. They should never be left in equipment for long periods of time, because after their energy is used up, they sometimes start leaking and exude corrosive chemicals which can ruin the equipment around the battery holder or case. They should never be subjected to high temperatures or stored near steam pipes or heaters.

The word "flashlight" comes from the original, prudent use of the batteries. Flashlights were not originally intended for continuous use. They were intended to be used intermittently (with rest periods). Better design and better materials now make it possible to draw continuous current for longer periods of time. The batteries have to be replaced more often that way, however. Many people are willing to do this if they need the convenience of a continuous light.

ASSIGNMENT:

1 - What are the connection-points on a battery called? What does this word mean? (Study the word in the dictionary.)

2 - Why do batteries sometimes perform better after a rest?

3 - What is meant by <u>depolarization</u>?

4 - What is electrolysis?

5 - Is a flashlight battery really a battery? If not, what is it?

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6 - What is the active chemical in the electrolyte of the common dry cell?

7 - Are dry cells considered rechargeable?

8 - Is the carbon rod in the dry cell the positive or the negative electrode?

9 - Of what material is the negative electrode in the dry cell made?

10 - What does the depolarizing agent do in the dry cell?

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UNIT VI - THE BATTERY

Lesson No. 4 Secondary Cells

Secondary cells produce an electromotive force, just as primary cells do. The main difference is that secondary cells are rechargeable while primary cells are not. In primary cells, some of the materials are consumed (used up) during discharge. In secondary cells, instead of the materials' being consumed, they are merely exchanged from one part of the cell to another part. The battery may be returned to the charged condition by forcing a current back through the cell in the opposite direction from its discharging direction.

> NOTE: The above statement does not mean that you would connect opposite poles to a battery charger. You connect the +terminal of the charger to (+) on the battery, and the -terminal of the charger to the (-) on the battery in order to charge it. This forces the current into the cell in a direction opposite to that when it was discharging.

Most of us think of an automobile battery when we think of rechargeable secondary cells. Some people even refer to secondary cells as "wet" cells. Actually, there are some secondary cells which look very much like "dry" cells.

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The cell shown here, for instance, is a secondary cell which looks like a primary cell. These are very popular now in many small electrical appliances. They can be recharged over and over; and often they have been known to last longer than the appliance itself. They are found in electric toothbrushes, photo-flash units, electric carving knives, electric shavers, electric clothes brushes, etc.

Fig.: VI-4-1

The lead-acid storage battery - the one you see in automobiles - is one of the most widely used batteries at this time because it is capable of providing large quantities of electrical energy. The voltages may be low, but this type of battery is capable of delivering moderate currents for long periods of time and large amounts of current for short periods of time.

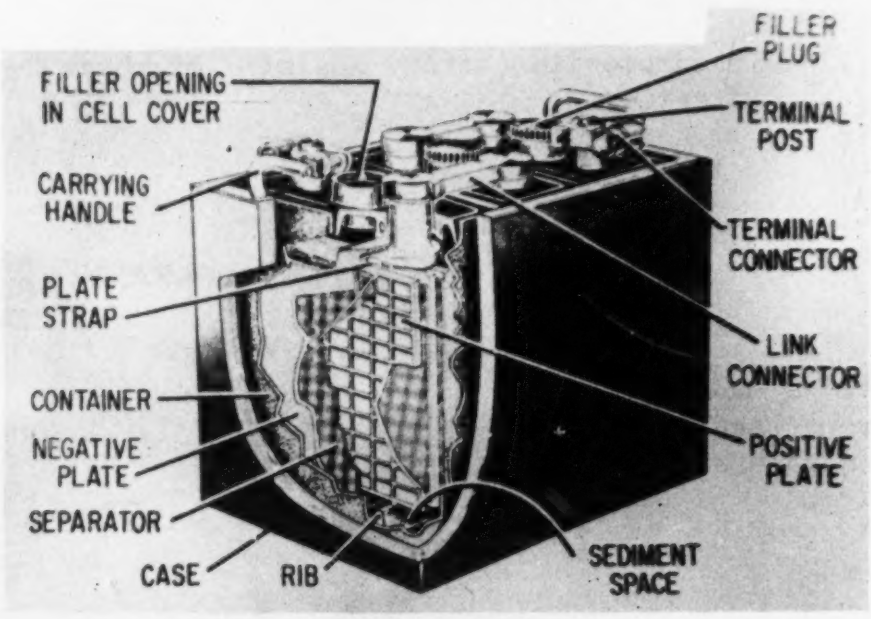

Fig.: VI-4-2

Eight flashlight cells will give you approximately the same voltage that you would have in an ordinary 12-volt automobile battery, but will they start an automobile? No. They cannot deliver the current necessary to turn the starter.

The lead-acid cell has, when charged, a potential of approximately 2 volts while under load - slightly more when there is no load on it.

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A 6-volt battery has three of these cells connected in series (+terminal to -terminal) like this:

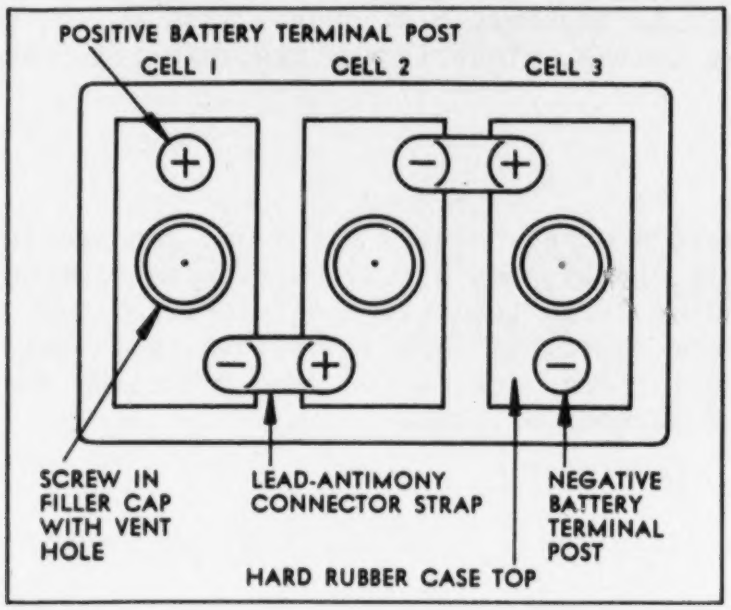

Fig.: VI-4-3

The modern 12-volt automobile battery has six of these 2-volt cells connected in series.

Each cell is made up of numerous lead plates and separators, as shown here.

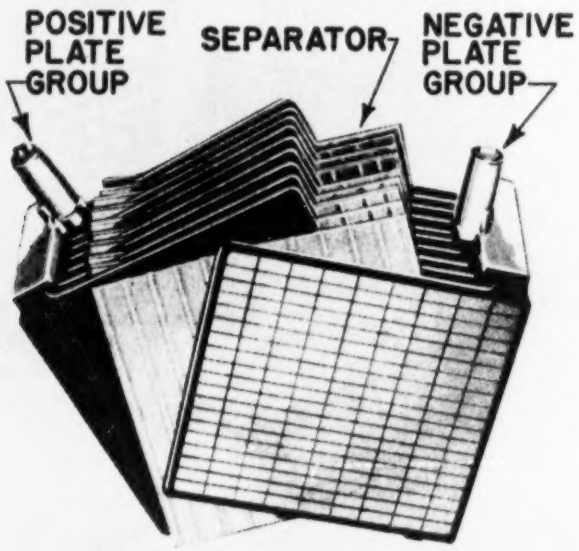

Fig.: VI-4-4

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When the cell is in the charged condition, half of the plates are of lead peroxide (PbO_2) and the other half are composed of sponge lead (Pb). In the charged condition the electrolyte solution consists of pure sulphuric acid in water.

When the cell is in a discharged condition, all of the plates (the positive group and the negative group) contain lead sulphate ($PbSO_4$). Some of the sulphate (SO_4) has left the electrolyte to combine with the lead, and the solution contains less sulphuric acid (H_2SO_4).

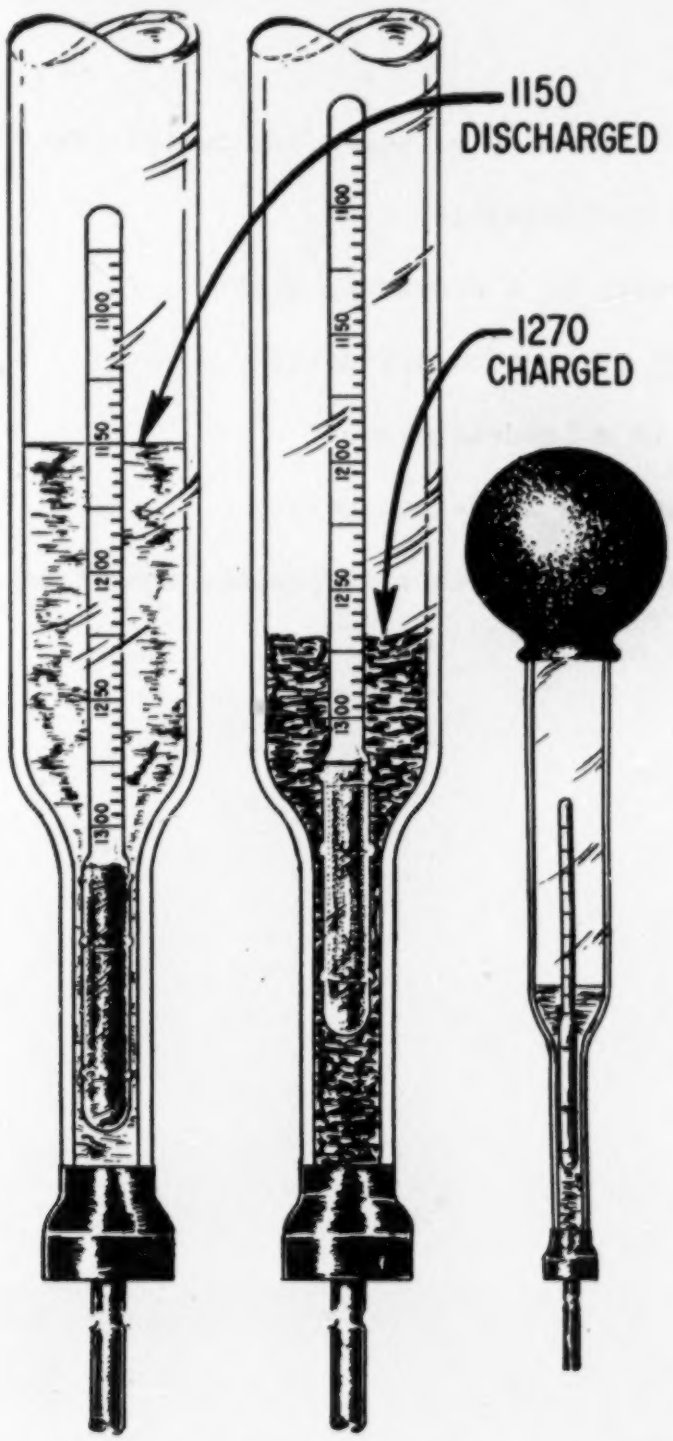

Fig.: VI-4-5

When the electrolyte is less acid, it is not as heavy as when it contained more acid. The hydrometer will show this. Some of the solution from the battery is drawn up into it. When the solution is heavy with acid, the float in the hydrometer will rise higher, and when the solution is lighter (the acid content reduced due to discharging) the float will sink lower into the solution. It is in this manner that we can know the condition of a battery by finding the <u>specific gravity</u> of the electrolyte with the hydrometer.

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When a discharged lead-acid cell is connected to a battery charger or to a charging generator, the process of electrolysis reverses the chemical action which took place during discharge, and the sulphates (SO_4) are drawn from the plates back into the solution.

The charging and discharging processes may be repeated many times in a good storage battery without wearing out the plates. Before the manufacturers developed better separators, the plates often outlasted the separators. It is important that the battery be kept in the charged condition and that the level of the solution be kept above the tops of the plates.

ASSIGNMENT:

1 - Are automobile batteries made of primary or secondary cells? Why?

2 - Is an ordinary flashlight cell rechargeable?

3 - Is a nickel-cadmium cell a primary or a secondary cell?

4 - Is a carbon-zinc cell a primary or a secondary cell?

5 - What makes up the electrolyte in a lead-acid cell?

6 - What is the approximate voltage of a lead-acid cell?

7 - What are two precautions one may take which will prolong the life of an automobile battery?

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UNIT VI - THE BATTERY

Lesson No. 5 — Batteries in Series and in Parallel

You may connect two 1.5-volt penlight cells in series (+ terminal of one to - terminal of the other). Then connect three larger 1.5-volt D-cells in parallel (+ terminals to + terminals, and - terminals to - terminals). Now measure them like this:

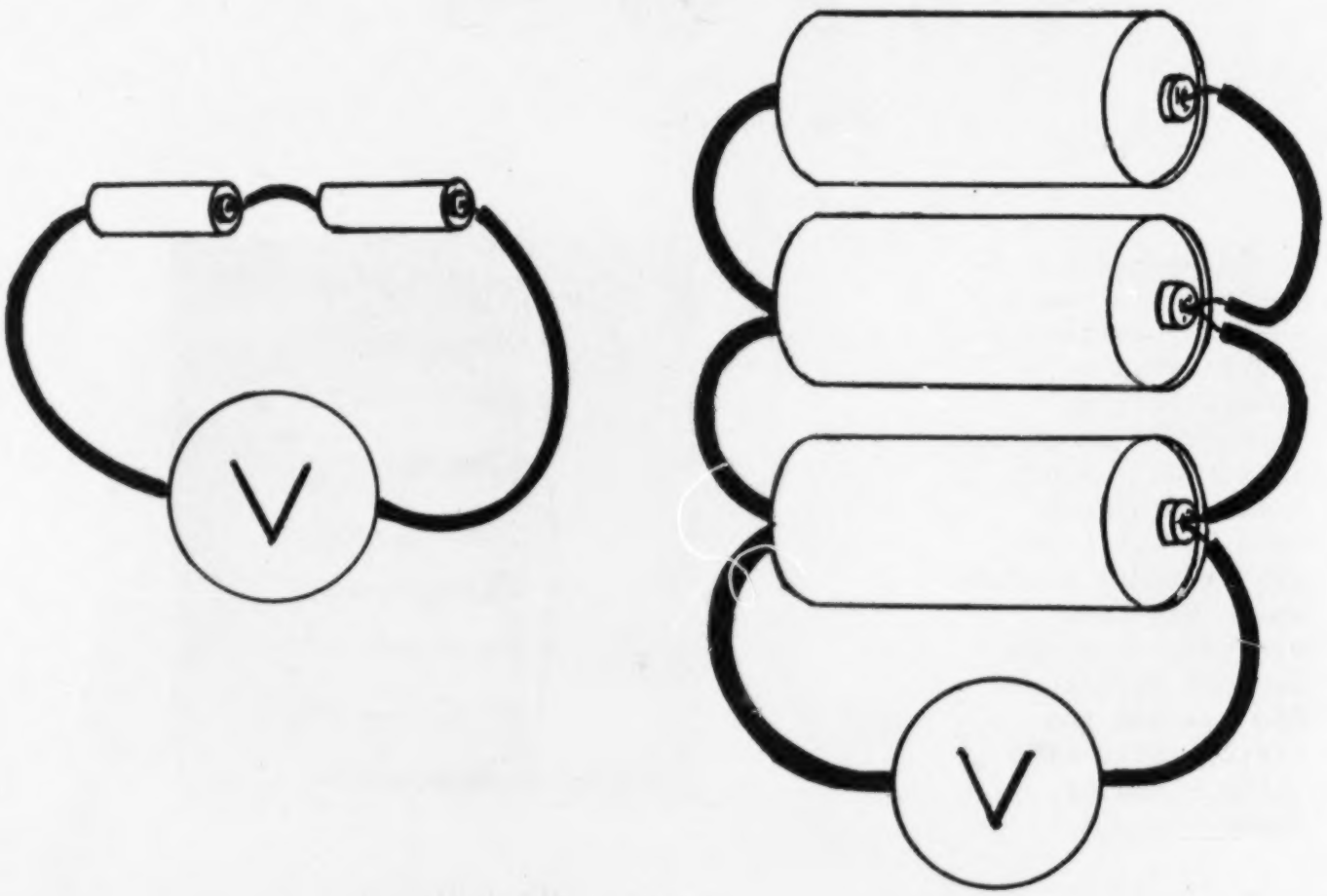

Fig.: VI-5-1

If you don't already know what the voltage measurements will be, you are likely to get a surprise. The two little batteries in series will show a greater voltage than will the three larger batteries connected in parallel.

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SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: I. INTRODUCTION

MILESTONE: I. INTRODUCTION

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Introduction to Automotive Mechanics

CONDITIONS:

Upon arrival of the trainee, the instructor will approach the trainee and welcome him into the course. A conversation about general topics will be carried on between the instructor and the trainee until the instructor feels that the new man is at ease in the shop environment.

BEHAVIOR:

1. Instructor explains to the trainee the contents and objectives of the course and how it is conducted
2. Instructor explains opportunities of the trade
3. Instructor explains to the trainee what is expected of him and how he is to conduct himself during the course
4. The trainee observes all phases of the training being conducted in the shop

PERFORMANCE CRITERIA:

No performance criteria

When you put cells in series, the voltages are added. When you parallel them - no matter how many - the voltage remains the same as if there were only one cell.

Paralleling the cells is the same as increasing the size. It does not matter how large you make a carbon-zinc cell, the voltage will still be only about 1.5 volts.

The cells shown in the following picture all have the same voltage value. The larger ones, though, can deliver a larger current for a longer period of time than can the smaller ones.

Fig.: VI-5-2

In dry-cell batteries of more than 1.5 volts, there are a number of 1.5-volt cells connected in series. Study this photograph of a 9-volt transistor-radio battery which has been opened so you can see the structure. You can see the little wafer-like cells - six of them.

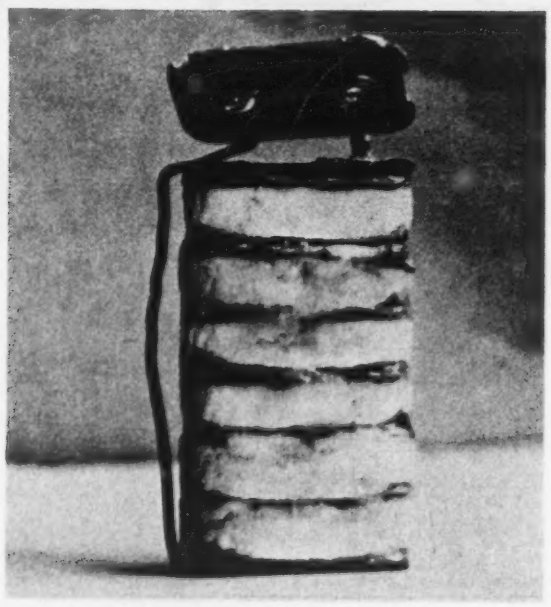

Fig.: VI-5-3

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Even though you can't follow the connections in the photograph, they are connected in series - positive to negative, etc.

Suppose your transistor radio required a higher current than that required by ordinary transistor radios (the larger transistor radios do require more current). You may get this higher current by paralleling two 9-volt batteries. This will give you twice as much current for the same amount of time. If you put three of them in parallel you could draw three times as much current.

Let's assume that you went to the Army Surplus store and bought a piece of surplus electronic equipment which required a working voltage of 18 volts and demanded twice as much current as an ordinary 9-volt transistor radio. How could you combine regular 9-volt batteries to supply this equipment?

You could first put two of the 9-volt batteries in series, making 18 volts. Then you could parallel this series combination with another just like it.

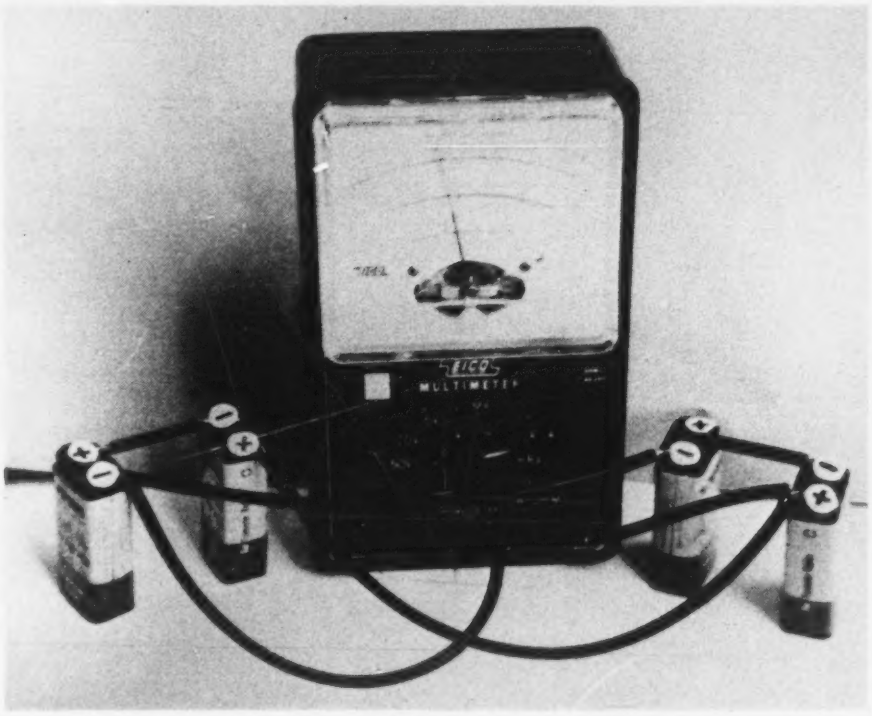

Fig.: VI-5-4

Now you have <u>twice</u> the voltage <u>and</u> <u>twice</u> the current-capability of one battery.

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ASSIGNMENT:

1 - If you connect ten 1.5-volt dry cells in series, how many volts could you measure from the combination?

2 - If you connect twenty 1.5-volt dry cells in parallel, how many volts could you measure from the combination?

3 - If you connect ten cells (1.5-volt carbon-zinc) in series and then parallel them with the ten-cell combination in Question No. 1, how many volts could you measure across the combination?

4 - How do you connect batteries when there is a larger current requirement?

5 - If you had a supply of 1.5-volt carbon-zinc cells capable of sustaining 0.25 amperes, how would you connect them to supply a demand for 6 volts at 1.5 amperes? Draw the diagram.

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UNIT VI - THE BATTERY

Lesson No. 6 Demonstration

Batteries in Series-Parallel

OBJECTIVE: To demonstrate voltages obtained from series, parallel, and series-parallel circuits.

EQUIPMENT: 6 No. 6 dry cells

2 Volt-ohmmeter with leads

10 Short-clip leads

1 Potentiometer (1 megohm)

PROCEDURE:

1 - Connect all six cells in parallel. Measure the voltage of this parallel circuit.

2 - Connect three cells in series and the other three in parallel. Measure each arrangement. Now connect the series combination in series with the parallel combination, and measure the voltage across this circuit.

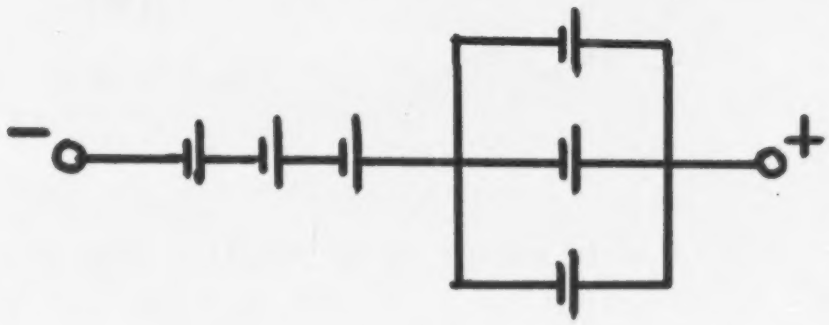

Fig.: VI-6-1

3 - Connect all six cells in series and measure the voltage across the combination.

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4 - Make connections shown in circuit A. Adjust the variable resistor until the current meter shows maximum current.

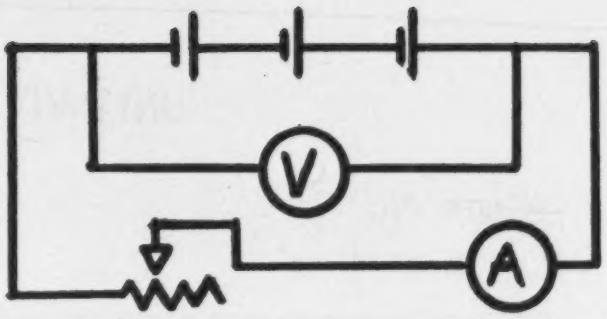

(A)

Fig.: VI-6-2

5 - Make the connections shown in circuit B. Adjust the variable resistor until the current meter shows maximum current.

Why is it that the two batteries in (B) will give more current than the three batteries in (A)?

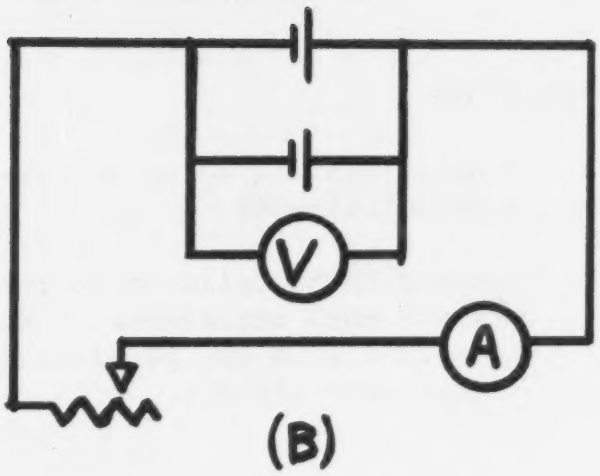

(B)

Fig.: VI-6-3

QUESTIONS:

1 - Do you connect batteries in series or in parallel when you want a higher voltage?

2 - If you need higher current, how may you combine batteries?

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UNIT VI - THE BATTERY

Lesson No. 7 — Charging Batteries

You recall that secondary cells may be charged by forcing a current back through the cells in the direction opposite the direction of discharge.

It is done like this.

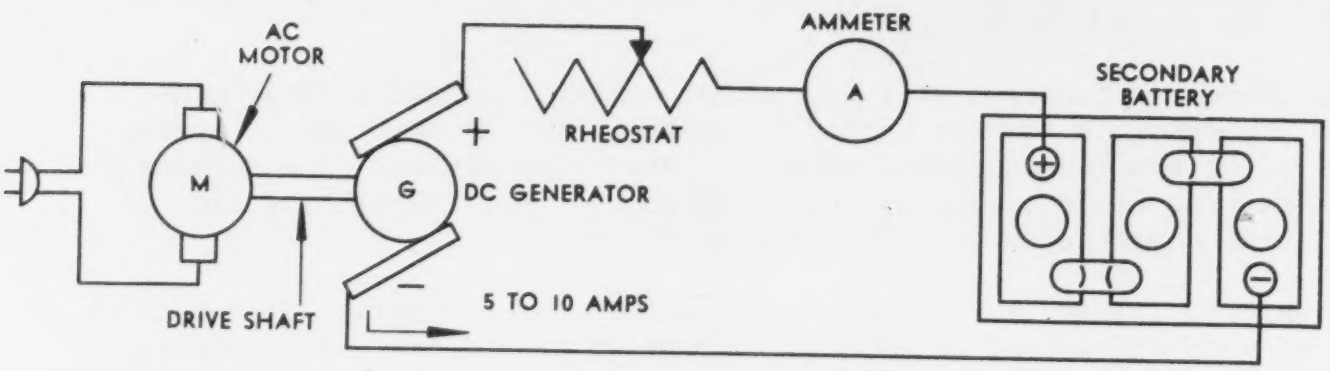

Fig.: VI-7-1

The motor-generator charger in the diagram could be replaced by a heavy-duty dry-rectifier type, or even by one using vacuum tubes or mercury-vapor tubes. Note the ammeter connected in series with the circuit. This is to show the rate of charge.

It is better to charge a battery at a slow rate (between 5 and 10 amperes). There are many so-called "fast chargers" which may get your battery charged within an hour or two, so that you may continue on your way, but this quick charge can be dangerous to your battery. High currents cause heating, and overheating will often buckle the plates in a battery.

Another precaution you should remember if you ever need to have an automobile battery recharged: NEVER PERMIT ANYONE TO ADD EXTRA ACID TO YOUR BATTERY. This will, of course make the hydrometer show a higher specific gravity reading, but it is a false reading for indicating the condition of your battery. The only time that acid should be added to a battery is if the electrolyte has been spilled out of the battery.

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There are little chargers that can be bought for charging nickel-cadmium cells used in small appliances and radios. If you measure the output voltage of these chargers before the battery is connected, the voltage will seem too high, but when the battery is connected, the load of the battery will bring the voltage down to slightly above the rated battery voltage.

The output voltage of a charger, when the battery is connected to the charger, must be slightly more than the battery's voltage. The safe charging voltage for a 6-volt battery is approximately 7.5 volts.

There are numerous kinds of chargers. Perhaps you have heard of the "trickle" charger. You will often see these advertised in the newspapers. A trickle charger is designed to keep stored batteries in a fully charged condition while they are out of service. They are not designed to recharge batteries that are discharged. If you want to buy a charger to recharge an automobile battery, don't buy one unless it can deliver as much as 6 amperes.

A lead-acid battery (your automobile battery) should receive some care. The specific gravity should be occasionally checked and of course, the level of the liquid should always be above the plates. The terminals should be kept clean and properly tightened, so that the battery can receive the charging current from the generator.

Specific gravity is the ratio (comparison) of the weight of something compared with the weight of an equal amount of pure water. The specific gravity of pure water is 1.000. Something with a specific gravity of 1.5 weighs 1.5 times as much as water. The specific gravity of the electrolyte in a charged battery may be between 1.270 and 1.300. If it is ever below 1.200, the battery needs immediate attention.

ASSIGNMENT:

1 - Is it safe to give a fast charge to a battery?

2 - What is the specific gravity of pure water?

3 - Is a lead-acid battery considered charged if the specific gravity is 1.200?

4 - What is the specific garvity of a fully charged automobile battery?

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UNIT VI - THE BATTERY

Lesson No. 8 Other D. C. Sources

There are many occasions when d.c. sources are necessary and regular a.c. line voltage will not do the job. A.C. can be changed to d.c., however, in several different ways. You will learn later of several ways to "rectify" a.c. It can also be done by driving a d.c. generator by an a.c. motor. This was shown in the battery charger.

In today's space vehicles there is a great need for d.c. The transmitters and receivers are powered by d.c., and so are many of the instruments used for making hundreds of measurements. The d.c. supply is almost as sophisticated as the vehicles themselves. Fuel cells are used. On present space capsules they are mounted on the outer bulkhead, just behind the astronauts. Electrical energy is obtained as it is needed. This system produces water as a by-product while it is producing energy. The fuel cell seems to meet most of the requirements for space travel so well that some people have suggested them for electric automobiles.

A practical source of d.c. for automobiles is considered very important at this time. Most of us have become so aware of the dangers of air pollution that automobile manufacturers are now making major efforts to produce an electric automobile which will be practical. Pictured here is a 1967 electric model produced in England.

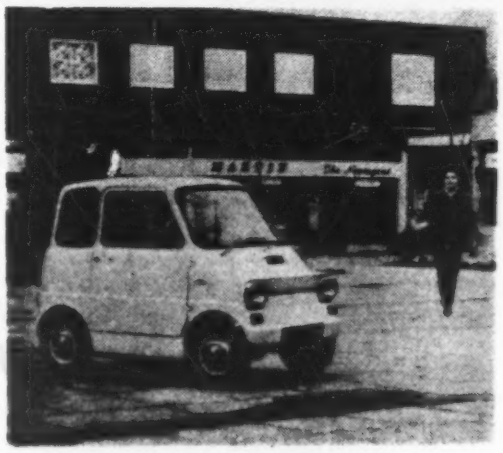

Fig.: VI-8-1

Many people in this country are now employed in research toward producing an electric car that will win the acceptance of the American people. This means that eventually they will attain this goal, and many more electricians and electronics people will be needed in the manufacturing and servicing of these cars.

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Here is a picture of the Westinghouse Markette, still in the experimental stage when this picture was taken.

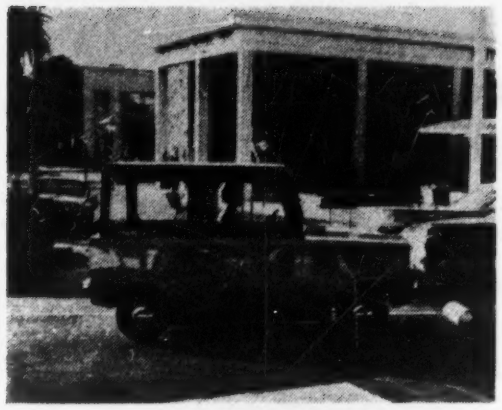

Fig.: VI-8-2

About fifty years ago, an electric car was manufactured in this country. In it were many Edison storage batteries. There were so many that they weighed about as much as the car. Edison cells were expensive, too. There is a lot of nickel in them. The positive electrodes are made of nickel, the negative electrodes are made of iron, and the electrolyte consists of potassium hydroxide and water. The Edison cell has a much longer life than the lead-acid cell, but it does not perform as well at low temperatures.

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Vast quantities of alkaline batteries are now being produced for those who want a longer-life disposable battery.

Fig.: VI-8-3

The electrolyte in alkaline batteries is made of alkaline chemicals which are, in a way, the opposite of acids, since they will neutralize each other when combined. Weak alkaline solutions have a slippery feel to the fingers, where an acid solution has a rough feel. Either, if strong enough, can damage the tissues of the body as well as many electrical components if they are carelessly allowed to spill.

Mercury cells are primary cells made for uses where the battery must be smaller than the carbon-zinc type. Modest amounts of current can be drawn from a mercury cell for a longer period of time than can be drawn from a carbon-zinc cell of the same size. Mercury cells also tend to hold their rated voltage longer than other types, instead of gradually tapering off to low voltages.

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: II TOOLS

MILESTONE: 1. TOOL IDENTIFICATION AND USE

PERFORMANCE OBJECTIVE NO: 1 TITLE: Identification and Use of Tools

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Identification and use of common hand tools	1. "ABC's of Hand Tools" (Pamphlet and 16mm motion picture)	1. Resource Materials Center
2. Identification and use of common hand tools	2. "Basic Tools for Young Mechanics" (Continuous film loop # 8355)	2. Resource Materials Center
3. Fasteners and tools	3. Automotive Mechanics, by Crouse. pp. 11 through 37. Automotive Tools Workbook, by Crouse. Jobs 5 through 14	3. Related Informati
4. Tools, measuring instruments, and fasteners	4. Teaching machine cards 1A through 1G	4. Teaching Machine (Shop)

They come in many sizes and shapes.

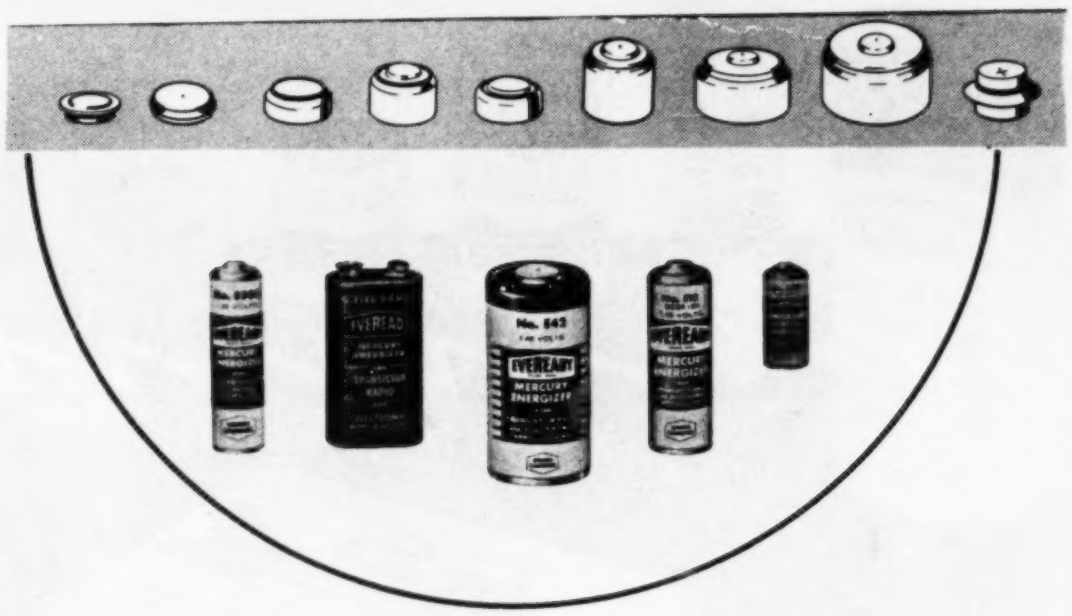

Fig.: VI-8-4

A silver-zinc battery has been developed for guided missiles. It has a high power-to-weight ratio, and can be discharged at a higher rate than most conventional batteries. Voltage remains constant during discharge instead of tapering off. This silver-zinc battery is stored in a dry state until time of use and has a very high "shelf" life. It also operates during extreme changes in temperatures, as is necessary for missiles. It is also ideal for emergency use in lifeboats and liferafts carried on aircraft.

ASSIGNMENT:

1 - What is the main advantage of a mercury cell?

2 - Is the mercury cell rechargeable?

3 - Why do people pay higher prices for alkaline cells?

4 - Name two ways one can get d. c. from an a. c. source.

5 - Give two outstanding properties of the silver-zinc cell.

14990

UNIT VII - RESISTANCE AND RESISTORS

Lesson No. 1 About Resistors

George S. Ohm was a German electrician who lived from 1787 to 1854. He found that, when the size or shape of a conductive material was changed, a given voltage would force different amounts of current through the material. He already knew that different materials permitted different amounts of current to pass when the same voltage was applied. So Ohm concluded that the resistance to current flow was determined not only by the kind of material in which it was flowing, but also by the size and shape of the conductor.

There is no such thing as a perfect conductor. All materials have some resistance, even though it might be extremely small.

What is resistance? If your friend decides to take your girl friend to a movie, you will probably say something or commit some act to dissuade him. Whatever you say or do to slow down his budding friendship with your girl can be termed as resistance on your part. If someone tries to do something and someone else does something to prevent it, then he is resisting, or putting up resistance. It is the same with electricity. Resistance can be put into a circuit where it will cut down the flow of electricity - and the more resistance you put there, the less will be the current flow.

There are many instances in electricity and electronics where the flow of electric current needs to be lessened, and in these cases resistors are placed in the lines of current flow.

14991

Resistors come in many sizes and shapes, as you can see in Fig. VII-1-1.

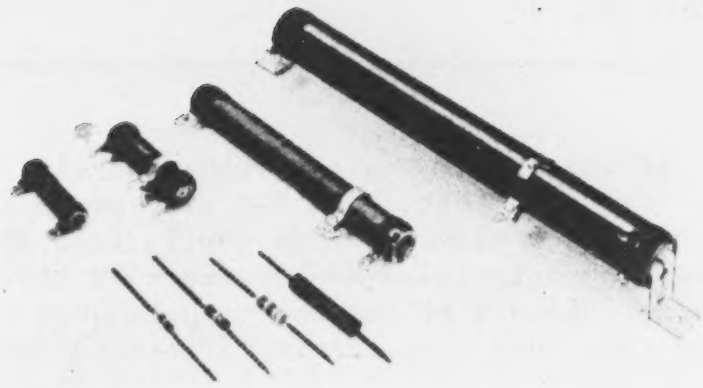

Fig.: VII-1-1

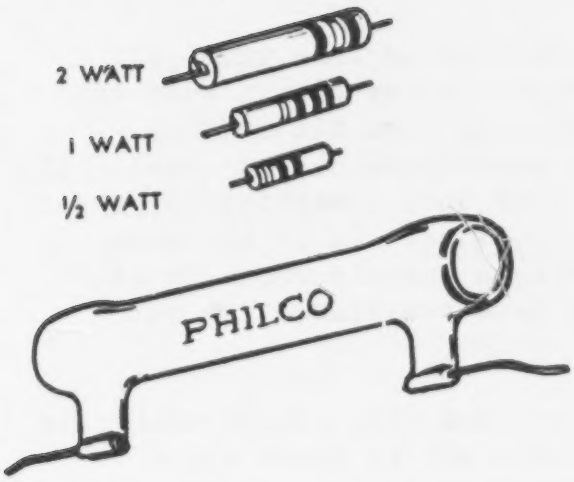

Fig. VII-1-2

Some resistors are of fixed values, and are called <u>fixed resistors</u>. These are fixed resistors.

The symbol for a fixed resistor is drawn like this:

Fig.: VII-1-3

14992

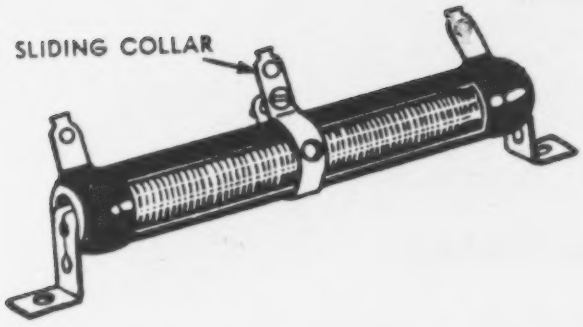

Fig.: VII-1-4

There are adjustable resistors such as this.

The symbol for an adjustable resistor is drawn like this:

Fig.: VII-1-5

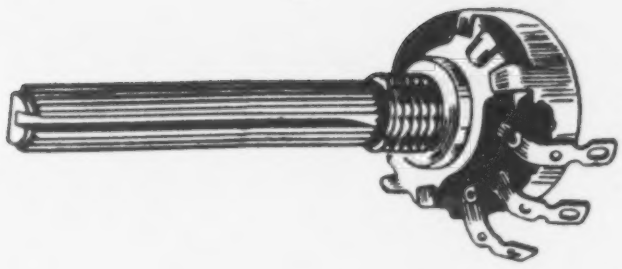

Fig.: VII-1-6

There are variable resistors like this. Perhaps you have already seen these resistors and thought of them as volume controls. This type of resistor is used in the volume-control circuits of radios and television sets. These variable resistors may be known as potentiometers or "pots." They may also be used in such a way that they will be called rheostats.

If one is connected in a circuit like this, it will be called a rheostat.

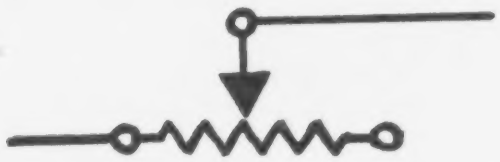

Fig.: VII-1-7

If it is connected in a circuit like this, it will be called a potentiometer or a "pot."

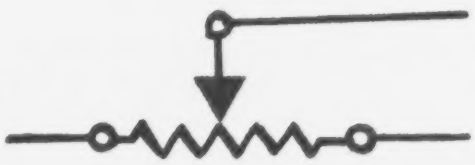

Fig.: VII-1-8

There are large resistors and there are small resistors. The amounts of current and voltage dictate the size. More will be said about this later when we are discussing power.

QUESTIONS:

1 - What is a potentiometer?

2 - How does a rheostat differ from a potentiometer?

3 - In electrical and electronics terms, what is a "pot?"

14994

UNIT VII - RESISTANCE AND RESISTORS

Lesson No. 2 Resistance in Conductors

The ideal wire for conducting electric current would be one without any resistance. As it has been stated before, this is impossible. There is resistance in all conductive materials, and the smaller the size of the wire, the greater will be the resistance.

Wire sizes vary from the fine, hair-like 40-gauge, which is just a little over three one-thousandths of an inch in diameter, up to the large 0000 gauge (four-ought) which is a half inch in diameter. It is obvious that the four-ought gauge would carry large amounts of current, while the resistance of the 40-gauge would be so high that only small amounts of current can pass without burning out the wire.

For measuring wire, the inch is divided into a thousand parts. Each of these parts is called a mil. Therefore, a mil is $\frac{1}{1000}$ inch.

The table on the next page will enable you to compare the characteristics of the different sizes of annealed copper wire. This table will be valuable later when you will be making other comparisons of wire sizes.

ACEA 14995

AMERICAN WIRE GAUGE (B&S) FOR ANNEALED COPPER WIRE

Gauge No.	Diameter in Mils at 20°C	Cross Section at 20°C		Ohms per 1000 Feet		Allowable Current Capacity	
		Circular Mils	Sq. In.	0°C (32°F)	20°C (68°F)	Rubber Insulation	Other Insulation
0000	460.0	211,600.0	0.1662	0.04516	0.04901	225	325
000	409.6	167,800.0	0.1318	0.05695	0.06180	175	275
00	364.8	133,100.0	0.1045	0.07181	0.07793	150	225
0	324.9	105,500.0	0.08289	0.09055	0.09827	125	200
1	289.3	83,690.0	0.06573	0.1142	0.1239	100	150
2	257.6	66,370.0	0.05213	0.1440	0.1563	90	125
3	229.4	52,640.0	0.04134	0.1816	0.1970		
4	204.3	41,740.0	0.03278	0.2289	0.2485	70	90
5	181.9	33,100.0	0.02600	0.2887	0.3133		
6	162.0	26,250.0	0.02062	0.3640	0.3951	50	70
7	144.3	20,820.0	0.01635	0.4590	0.4982		
8	128.5	16,510.0	0.01297	0.5788	0.6282	35	50
9	114.4	13,090.0	0.01028	0.7299	0.7921		
10	101.9	10,380.0	0.008155	0.9203	0.9989	25	30
11	90.74	8,234.0	0.006467	1.161	1.260		
12	80.81	6,530.0	0.005129	1.463	1.588	20	25
13	71.96	5,178.0	0.004067	1.845	2.003		
14	64.08	4,107.0	0.003225	2.327	2.525	15	20
15	57.07	3,257.0	0.002558	2.934	3.184		
16	50.82	2,583.0	0.002028	3.700	4.016	6	10
17	45.26	2,048.0	0.001609	4.666	5.064		
18	40.30	1,624.0	0.001276	5.883	6.385	3	5
19	35.89	1,288.0	0.001012	7.418	8.051		
20	31.96	1,022.0	0.0008023	9.355	10.15		
21	28.45	810.1	0.0006363	11.80	12.80		
22	25.35	642.4	0.0005046	14.87	16.14		
23	22.57	509.5	0.0004002	18.76	20.36		
24	20.10	404.0	0.0003173	23.65	25.67		
25	17.90	320.4	0.0002517	29.82	32.37		
26	15.94	254.1	0.0001996	37.61	40.81		
27	14.20	201.5	0.0001583	47.42	51.47		
28	12.64	159.8	0.0001225	59.80	64.90		
29	11.26	126.7	0.00009953	75.40	81.83		
30	10.03	100.5	0.00007894	95.08	103.2		
31	8.928	79.70	0.00006260	119.9	130.1		
32	7.950	63.21	0.00004964	151.2	164.1		
33	7.080	50.13	0.00003937	190.6	206.9		
34	6.305	39.75	0.00003122	240.4	260.9		
35	5.615	31.52	0.00002476	303.1	329.0		
36	5.000	25.00	0.00001964	382.2	414.8		
37	4.453	19.83	0.00001557	482.0	523.1		
38	3.965	15.72	0.00001235	607.8	659.6		
39	3.531	12.47	0.000009793	766.4	831.8		
40	3.145	9.888	0.000007766	966.5	1049.0		

14996

Wire gauges are available for measuring unknown sizes of wire. Fig.: VII-2-1 shows a popular gauge found in many electrical and electronics shops. Ask your instructor to let you use one. Get a few known sizes of wire and "get the feel" of the gauge.

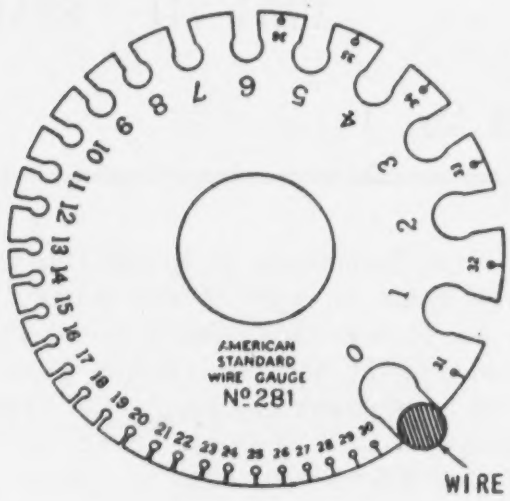

Wire gage

Fig.: VII-2-1

QUESTIONS:

1 - How many mils are in a half-inch?

2 - Using the table, find the resistance in 2000 ft. of 24-gauge annealed copper wire.

3 - From the table find the diameter in mils of three-ought wire.

4 - What is the resistance of 5000 ft. of one-ought wire?

5 - What is the resistance of 500 feet of 40-gauge wire?

UNIT VII - RESISTANCE AND RESISTORS

Lesson No. 3 — Resistance Color Code

If manufacturers printed the resistance value on all resistors, it would make it easier for some of us to read them - if they were always in a position where we could see those printed values. Unfortunately, it is not always possible to have them placed in a piece of equipment so that one side of the resistor would always be visible. It has been found that color-coded bands running all around the resistors make it much easier to read their values when they are in close places. Color-coding is very helpful in trouble-shooting, since locating certain resistors can save time in locating a particular area in a circuit.

Most resistors have four bands around them. Some have only three. Starting from one end of the resistor, the first band indicates the first "significant figure" in the resistance value of that resistor. (The first significant figure means the first figure, so long as it is not an initial zero following a decimal point. For example the first significant figure in the number .078 is 7.)

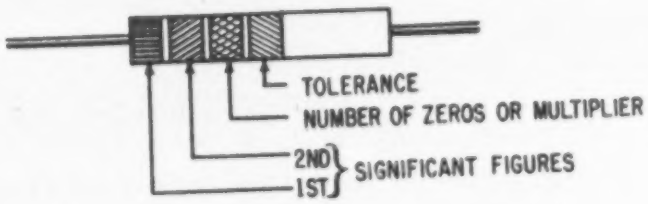

RESISTOR COLOR CODE

Fig.: VII-3-1

The second band represents the second significant figure and the third band tells us by what number to multiply the first two figures to obtain the total value of resistance of that resistor. The fourth band lets us know the tolerance of the resistor.

Let us study the tolerance band first. You will note in the color-code table (page 95) that if the fourth band is of gold, the tolerance is 5%. That means that if, for example, it is a 100-ohm resistor, its resistance can range between 95 ohms and 105 ohms and still be considered acceptable.

If you need a 100-ohm resistor "five-percenter" and go to the radio-supply store and tell the man behind the counter that that is what you want, he will give you one with a brown, black, brown, gold set of color bands on it. The gold band (the fourth band) tells you that this resistor has a 5% tolerance. If, when you get home, you measure the value of this resistance with your ohmmeter

14998

and find that it is only 95 ohms, don't think that you were given the wrong resistor. The resistor is within 5%, since 95 ohms is 95% of 100. It could have been 105 ohms, and you would still have a "five-percenter."

If, instead of a gold band, you had a silver band for tolerance, the 100-ohm resistor could be anywhere between 90 and 110 ohms and still be within the tolerance range. If there is no tolerance band on the resistor, it is a "twenty-percenter" - that is, its actual resistance could be anywhere between 80 ohms and 120 ohms.

Some electrical circuits require components of very close tolerances if the circuit is to operate properly. There are other electrical circuits where the tolerances are not as close. When the tolerances are not too close, we can use resistors with 10% and even 20% tolerances. Circuits such as those that are not too critical can be manufactured at less expense than those of close tolerances. It is more costly for the manufacturers of resistors to test and sort five-percenters than twenty-percenters; therefore the five-percenters must sell for a higher price.

Study the Resistor Color-Code table, and you will be able to understand how a resistor color-coded RED RED RED GOLD would be read 2200 ohms + 5%. The first band, being red, tells you that the first figure is a 2. The next band, being red, tells you that the second figure is another 2. The third band (the multiplier band), being red, tells you that the first and second figures are to be multiplied by 100. So, you have 22 X 100 = 2200

Color	1st Digit	2nd Digit	Multiplier	Tolerance (Percent)
Black	0	0	1	
Brown	1	1	10	
Red	2	2	100	
Orange	3	3	1,000	
Yellow	4	4	10,000	
Green	5	5	100,000	
Blue	6	6	1,000,000	
Violet	7	7	10,000,000	
Gray	8	8	100,000,000	
White	9	9	1,000,000,000	
Gold			.1	5
Silver			.01	10
No Color				20

Resistor Color - Code Table

If you have a resistor that has three bands around it - BROWN BLACK BLACK it is a 10-ohm resistor of 20% tolerance.

BROWN	BLACK		BLACK		(NO TOLERANCE BAND)	
1	0	X	1	=	10	20%

14399 12000

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: II. TOOLS

MILESTONE: I. TOOL IDENTIFICATION AND USE

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Identification and Use of Tools

CONDITIONS:

Student will be provided the opportunity to open racks and study tools under the supervision of the shop instructor. The teaching machine is available for use by the student when and where necessary.

BEHAVIOR:

After the satisfactory completion of all related studies:

1. Tool modules should be run on the teaching machine
2. Open tool board and identify each tool, its use and proper method of use
3. Repeat steps #1 and #2 until you can identify all tools and their use

PERFORMANCE CRITERIA:

To be able to identify all automobile mechanics tools.

Learning time: 3 hours

QUESTIONS:

What are the resistance values of the resistors color-coded as follows:

1.	WHITE	BLACK	ORANGE	GOLD
2.	BROWN	WHITE	RED	GOLD
3.	GREEN	ORANGE	ORANGE	
4.	GRAY	BLACK	BLACK	SILVER
5.	BROWN	BROWN	BROWN	GOLD
6.	BLUE	YELLOW	YELLOW	
7.	VIOLET	YELLOW	RED	
8.	GREEN	RED	ORANGE	SILVER
9.	GRAY	ORANGE	ORANGE	GOLD
10.	RED	RED	RED	

Color	1st Digit	2nd Digit	Multiplier	Tolerance (Percent)
Black	0	0	1	
Brown	1	1	10	
Red	2	2	100	
Orange	3	3	1,000	
Yellow	4	4	10,000	
Green	5	5	100,000	
Blue	6	6	1,000,000	
Violet	7	7	10,000,000	
Gray	8	8	100,000,000	
White	9	9	1,000,000,000	
Gold			.1	5
Silver			.01	10
No Color				20

Resistor Color - Code Table

(Questions continued on next page.)

15000

11.	ORANGE	ORANGE	ORANGE	
12.	BROWN	RED	YELLOW	
13.	BROWN	GRAY	ORANGE	
14.	BROWN	VIOLET	RED	
15.	YELLOW	YELLOW	YELLOW	
16.	YELLOW	BROWN	BLACK	
17.	YELLOW	RED	RED	
18.	YELLOW	BLACK	BLACK	GOLD
19.	BLUE	ORANGE	ORANGE	SILVER
20.	BLUE	BLACK	BROWN	
21.	GREEN	RED	RED	
22.	GREEN	ORANGE	ORANGE	GOLD
23.	GREEN	BROWN	YELLOW	SILVER
24.	BROWN	BLACK	BLUE	
25.	BLACK	BROWN	GOLD	GOLD

Color	1st Digit	2nd Digit	Multiplier	Tolerance (Percent)
Black	0	0	1	
Brown	1	1	10	
Red	2	2	100	
Orange	3	3	1,000	
Yellow	4	4	10,000	
Green	5	5	100,000	
Blue	6	6	1,000,000	
Violet	7	7	10,000,000	
Gray	8	8	100,000,000	
White	9	9	1,000,000,000	
Gold			.1	5
Silver			.01	10
No Color				20

Resistor Color - Code Table

15001

15002

UNIT VII - RESISTANCE AND RESISTORS

Lesson No. 4 — Resisting Electrons in a Vacuum Tube

It does not matter whether little Mike is pulling back on the wagon or pushing back from the front, he is still resisting Bobby's effort to pull the wagon forward.

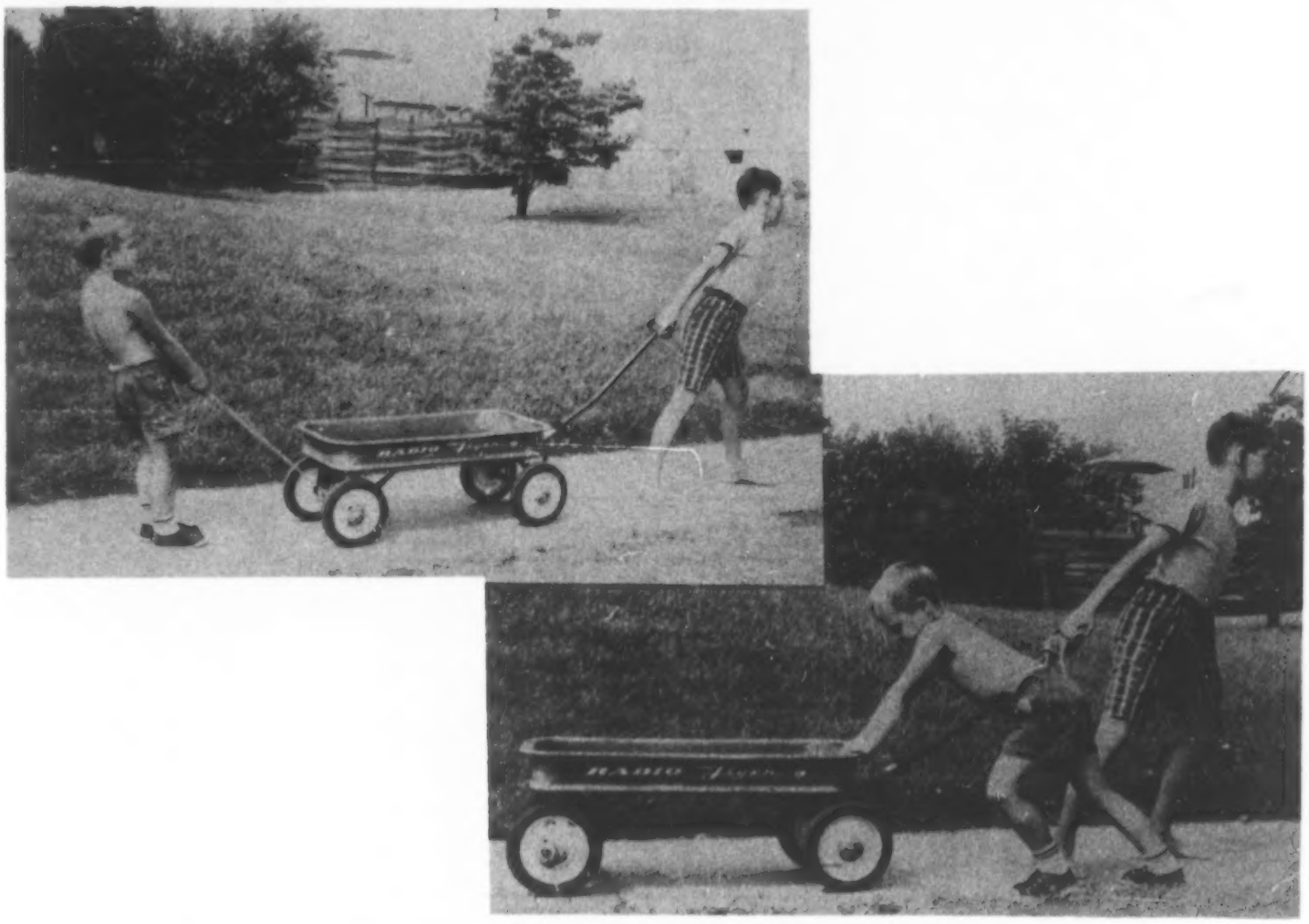

15002

To "resist" is to oppose, to hinder, to check, to hold back, or to obstruct. To "repel" is to push back, drive away, oppose. Anything that opposes or repels the flow of an electric current may be considered as resistance.

Let us look at the diagram of a vacuum tube - a simple triode vacuum tube.

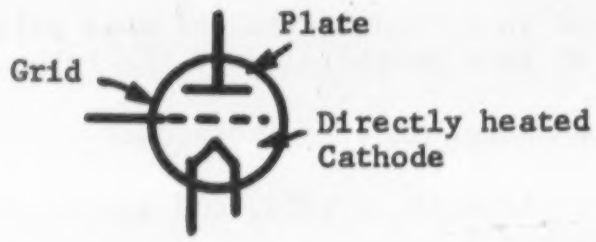

Fig.: VII-4-1

When the filament (called "cathode" in the diagram) is heated, it will emit (or boil off) electrons. A positive charge on the plate will attract them, causing a current to flow. If, however, a negative charge is put on the grid which is placed between the filament and the plate (the "anode"), the negatively charged electrons will be repelled by this negative charge. REMEMBER, ELECTRONS ARE ALWAYS NEGATIVELY CHARGED. THERE IS NO SUCH THING AS A POSITIVE ELECTRON.

The higher the negative charge is on the grid, the smaller the current will be. All tubes have a cut-off point, at which the flow of current between the cathode and the plate will stop.

If you will study the following curve, you will see that increasing the negative charge on the grid of a vacuum tube gradually cuts down the flow of current until it is completely cut off.

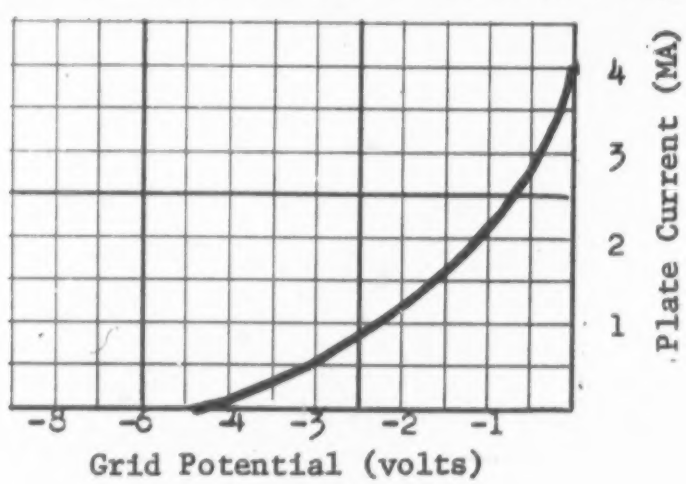

15003

216 OF 327

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056 238

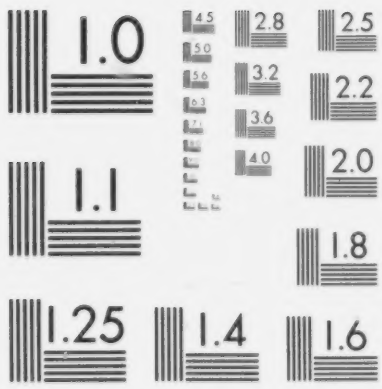

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Look at the curve and you will see that, with no potential on the grid, four milliamperes of current will flow. If a negative charge of 1 volt is applied to the grid, only about two milliamperes will flow. When -5 volts is on the grid, the current is completely cut off. This curve is called a characteristic curve. All tube types have characteristic curves which may be referred to in designing electronic circuits.

QUESTIONS:

1 - Define resistance, giving three different kinds of resistance.

2 - If current is to flow in a vacuum tube, at what polarity must the plate be? And at what potential must the cathode be?

3 - Which element in the vacuum tube is the anode?

4 - If a tube has only a filament, a grid, and a plate, which of these electrodes is the cathode?

5 - In your notebook, draw the diagram of a triode vacuum tube and label each electrode.

15001

12003

216

ELECTRONICS MEN CREATED THIS TELETYPE MACHINE.
ELECTRONICS TECHNICIANS DO ROUTINE SERVICING.

15005
12006

UNIT VIII - THE METRIC SYSTEM AND POWERS OF TEN

Lesson No. 1 The English and the Metric Systems

Can you imagine how your ancestors measured distance, weight, and volume 10,000 years ago? Well, if the distance happened to be ten or twelve miles, he probably called it a day's walk - that is, if he lived on flat land. Had he been in mountainous country, he probably would have called it a three or four-day journey, depending on the ruggedness of the land. Firewood was probably measured by the armful - and this would vary from man to man, depending on how long his arms were. You can use your imagination and perhaps guess what units he used for weight.

During the years covered by biblical writings there was a standard of length called the cubit. There was also a measurement called Ezekiel's reed, which was supposed to have been six cubits. Another unit was called a schaenus. For many hundreds of years, while man was becoming more and more civilized, he did not have a practical system of measurement.

The first successful effort to standardize a system of weights and measurements was made by the English in 1266, just a little more than 200 years before Columbus made his famous voyage to America.

In the English system, the yard is used as the standard unit of length, while the pound is the standard unit of weight. In spite of the difficulties of dealing with numbers like 36 and 16, and the awkward fractions that result, we still use some of that system in our country.

Over 500 years after the adoption of the English system, the National Assembly of France proposed, in 1793, a much more convenient system, the metric system, which they made legal six years later. Since then, most of the advanced countries of the world have adopted the metric system; in this country we use it in our scientific work. It is called the metric system because the unit of length is the meter.

The unit of weight, in the metric system, is the gram. Heavy objects are weighed in kilograms, and very light objects, in milligrams. We can convert (change) grams to kilograms or milligrams merely by moving the decimal. This is impossible in the English system.

15006

1 kilogram = 1000 grams

1 centigram = 0.01 gram

1 milligram = 0.001 gram

Can you do this with ounces, pounds, tons, etc.?

The meter is the basic unit of length in the metric system. One kilometer is one thousand meters, and one millimeter is 1/1000 of a meter. You may know that in France and in numerous other European countries, speedometers in cars are read in kilometers instead of miles.

Let's look at a meter stick. Perhaps you have seen one and thought that it was a yard stick. If you will compare one with a yardstick, you will see that the meter stick is a little longer than the yard stick. In fact, it is 3.37 inches longer. Let's look at that meter stick again and visualize a thousand of them lying end-to-end. That distance would be one kilometer.

KILO MEANS ONE THOUSAND

If you don't have a gram, a kilogram, and a milligram weight, send someone to the chemistry or the physics department in your school to borrow one of each and compare them. Hold the gram weight in one hand and the kilogram weight in the other. Remember that the kilogram weight is a thousand times as heavy as the gram weight. You may have trouble finding a milligram weight, but probably you will be able to locate a 50-milligram weight. With that you will be able to understand that a milligram is a thousand times lighter than the gram. So let us remember that, in the metric system,

MILLI MEANS ONE THOUSANDTH

QUESTIONS:

1 - What is the unit of weight in the English system?

2 - How long ago was the English system devised?

3 - What is the unit of weight in the metric system?

15007

4 - Where did the metric system get its name?

5 - What is the unit of length in the metric system?

6 - What is the unit of length in the English system?

7 - What does kilo mean?

8 - What does milli mean?

15008

1498

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III FUEL SYSTEM

MILESTONE: I FUEL PUMP

PERFORMANCE OBJECTIVE NO: 1 TITLE: Remove, Overhaul, Replace, and Test Fuel Pump

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Fuel pumps*	1. Automotive Mechanics, by Crouse. pp. 336 & 337. Automotive Mechanics Workbook, by Crouse. Job 37	1. Related Information Class
2. Fuel pumps	2. Teaching machine cards 2A, 2B, 2C	2. Teaching Machine (Shop)
3. Fuel Pumps	3. The Fuel System, by Ford Motor Co. pp. 16 through 33	3. Programmed Instruction Class
4. Fuel pumps	4. Appropriate Shop Manual*	4. Shop Library

* NOTE: Student will be required to select the shop manual or manuals pertaining to the automobile he is using and to find for himself the relevant information for the performance objective assigned. He will do this throughout the entire course.

UNIT VIII - THE METRIC SYSTEM AND POWERS OF TEN

Lesson No. 2 — Prefixes

You have learned that kilo means one thousand times the unit and that milli means one thousandth (1/1000) of the unit. Now, what part of a dollar is a cent? Of course you know that it is one hundredth. So it is reasonable to assume that a centigram is one hundredth (1/100) of a gram. Also, you should recognize that 1/100 of a gram may be written .01 gram or, better, 0.01 gram.

There will be many occasions when you will be expected to know the metric units of weight and length during your career in electricity or electronics. So get a good start today and learn these two simple tables.

1 millimeter	=	0.001 meter	=	1/1000	meter
1 centimeter	=	0.01 meter	=	1/100	meter
1 decimeter	=	0.1 meter	=	1/10	meter
1 decameter	=	10 meters			
1 hectometer	=	100 meters			
1 kilometer	=	1000 meters			

1 milligram	=	0.001 gram	=	1/1000	gram
1 centigram	=	0.01 gram	=	1/100	gram
1 decigram	=	0.1 gram	=	1/10	gram
1 decagram	=	10 grams			
1 hectogram	=	100 grams			
1 kilogram	=	1000 grams			

You now have prefixes from thousandths to thousands. There are two other prefixes you should learn at this time. They are meg or mega and micro. Meg or mega indicates one million, while micro means one millionth.

Resistance is often measured in millions of ohms, or megohms. Capacitance is often measured in millionths of farads, or microfarads. Capacitance is even measured millionths of millionths, or micromicrofarads. You will also see a relatively new term - pico - used for micromicro. A micromicrofarad (one millionth of a millionth of a farad) may be called a picofarad.

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You can see now, with science and technologies growing each day, that we can find new ways to help ease the burdens in learning and working. So scientists asked, "Why use a word a block long when a short word will do just as well?" So we have pico instead of micro-micro.

If you will look at the table you will see that there are a thousand millimeters in a meter. That must be so, must it not, since 1 millimeter equals 0.001 meter or 1/1000 of a meter.

How many millimeters, then, would there be in a centimeter? Look at the decimal fractions 0.001, 0.01, and 0.1. Each time the decimal is moved one space to the right, you are multiplying by 10. One millimeter equals 0.001 meter, while one centimeter equals 0.01 meter. We get the centimeter length by multiplying the millimeter length by 10. So, there must be 10 millimeters in a centimeter. Again, there will be 10 centimeters in a decimeter and 10 decimeters in a meter, making 10 x 10 x 10 or 1000 millimeters in a meter.

QUESTIONS:

1 - How many centimeters are there in a decameter?

2 - How many centimeters are there in a meter?

3 - How many milligrams are there in a gram?

4 - How many centigrams are there in a decigram?

5 - How many grams are there in a kilogram?

6 - How many millimeters are there in a meter?

7 - How many picofarads are there in a farad?

8 - How many ohms are there in a megohm?

9 - How many microfarads are there in a farad?

10 - How many micromicrofarads are there in a farad?

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UNIT VIII - THE METRIC SYSTEM AND POWERS OF TEN

Lesson No. 3 — Converting from One Unit to Another

If you want to tell someone the weight of a package that contains 50 4-ounce switches, you do not tell him it will weigh 200 ounces. You tell him it will weigh 12 1/2 pounds. You converted the number of ounces to pounds by dividing:

$$\frac{\text{number of ounces}}{16} = \text{number of pounds}$$

$$\frac{200 \text{ ounces}}{16} = 12\ 1/2 \text{ pounds}$$

Converting from one unit to another in the metric system is much easier, since any unit may be changed to any other merely by moving the decimal point.

Move the decimal point to the right to multiply; move the decimal point to the left to divide.

Move the decimal point one place to multiply or divide by 10; 2 places, by 100; 3 places, by 1000, etc.

For example, to change 2.43 centimeters to millimeters, we must multiply 2.43 by 10 (since there are 10 millimeters in a centimeter). We do this very simply by moving the decimal point one place to the right.

2.43 cm. x 10 = 24.3 mm.

Suppose we wish to change 256 centimeters to meters. We must divide by 100, since there are 100 centimeters to a meter.

Where is the decimal point in the number 256? There is none. But we know that when there is no decimal point in a number, we can understand a decimal point as coming after the number.

256 = 256.

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Therefore to divide 256 by 100, we move the "understood" decimal point two places to the left.

256. ÷ 100 = 2.56

256 centimeters = 2.56 meters

Let us change 24 milligrams to centigrams. We must move the decimal point one place to the left in order to divide by 10. We understand the decimal point to be to the right of the number.

24 mg. = 24. mg.

24. ÷ 10 = 2.4 centigrams

Students sometimes are puzzled as to whether to divide or multiply when converting one unit to another. If you have a large unit (like miles or kilometers) to change to a small unit (like yards or meters), you multiply. You need to end up with <u>more</u> of the small unit than of the large unit.

No. of miles x 1760 = No. of yards.

5 miles x 1760 = 8800 yards

No. of kilometers x 1000 = No. of meters

5 kilometers x 1000 = 5000 meters

Conversely, to change from a small unit to a large unit, you want to end up with a <u>smaller</u> amount of the large unit, so you divide.

No. of ounces ÷ 16 = No. of pounds

200 ounces ÷ 16 = 12 1/2 pounds

No. of centigrams ÷ 100 = No. of grams

500 centigrams ÷ 100 = 5 grams

How many meters in 45 centimeters? We must divide by 100. Understanding the decimal point to be after the number, we move it

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two places to the left and get 0.45 meters.

How many meters in 45 millimeters? We need to move the decimal point three places to the left.

But there are only two places to the number. So we must indicate the third place by a zero. We get

45 mm. ÷ 1000 = .045 meters

How many milligrams are there in 8 grams? Here again, we will have to add zeros.

8 grams = 8. grams

8. x 1000 = 8000 milligrams

Show how 2.5 kilometers equals 2500 meters.
Show how 68 milligrams equals .068 grams.
Show how .79 kilometers equals 790 meters.
Show how 800 centimeters equals 8 meters.

QUESTIONS:

1 - Express the following numbers in centimeters:
1 meter 3.5 meters 257 meters .5 meters
3000 millimeters 250 millimeters 10 millimeters
.06 meters 6795 millimeters .265 meters 1 kilometer

2 - Express the following numbers in meters:
1 kilometer 27 kilometers 200 centimeters 56 centimeters
265 millimeters .098 kilometers 3657 centimeters
20 kilometers 2987 millimeters 42.5 centimeters .5 kilometers

3 - Express the following numbers in milligrams:
1 gram 8.7 grams 200 grams .054 grams
65 centigrams 18 centigrams 2.9 centigrams 300 centigrams
10 grams .398 grams .016 grams .0025 centigrams

4 - Express the following numbers in grams:
10 centigrams 367 milligrams 2400 centigrams 7.5 centigrams
1 kilogram 590 centigrams 20,000 milligrams 30 kilograms

5 - Can you think of any system of measures in our country that uses a decimal system to convert from one unit to another?

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UNIT VIII - THE METRIC SYSTEM AND POWERS OF TEN

Lesson No. 4 — Powers of Ten

Isn't it a lot easier to write 10^6 than to write 1,000,000? Well 10^6 is 1,000,000. That little 6 standing to the right and above the 10 is called an <u>exponent</u> or a <u>power</u> of ten. It is like the 2 in 10^2 meaning 10 x 10 and the 3 in 10^3 meaning 10 x 10 x 10. When we write 10^6 it means 10 x 10 x 10 x 10 x 10 x 10 or 1,000,000. Not only is it easier to write large numbers this way, it is easier to multiply and divide when we write them in this way.

Suppose you wish to multiply a million by a million. Until now you probably did it like this, by adding 6 zeros to 1,000,000.

$$\begin{array}{r} 1{,}000{,}000 \\ \times \quad 1{,}000{,}000 \\ \hline 1{,}000{,}000{,}000{,}000 \end{array}$$

It is much easier to do it this way:

$$10^6 \times 10^6 = 10^{12}$$

10^{12} is a million million. You will notice that the multiplication was done by merely <u>adding</u> the exponents. 10^{12} means 1 with twelve zeros to the right.

10^2 = 100 (1 with two zeros to the right)

10^3 = 1,000 (1 with three zeros to the right)

10^9 = 1,000,000,000 (1 with nine zeros to the right)

Suppose we have to multiply a billion by a thousand

1,000,000,000 x 1,000 = $10^9 \times 10^3 = 10^{12}$ or 1,000,000,000,000.

You can certainly see that it is much easier to give the answer as 10^{12}.

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Powe s of ten are a kind of shorthand for mathematics.

Let's look at these multiplications:

$40{,}000 = 4 \times 10^4$

$40{,}000 \times 300{,}000 = 4 \times 10^4 \times 3 \times 10^5 = 12 \times 10^9$

$15{,}000{,}000 = 15 \times 10^6$ or 1.5×10^7

$360{,}000 = 3.6 \times 10^5$

$19{,}000{,}000 \times 42{,}000 = 1.9 \times 10^7 \times 4.2 \times 10^4 = 7.98 \times 10^{11}$

ASSIGNMENT:

Multiply

1. $6 \times 10^6 \times 2 \times 10^3$
2. $3 \times 10^3 \times 1 \times 10^4$
3. $1 \times 10^6 \times 12 \times 10^6$
4. $2.5 \times 10^3 \times 4 \times 10^{11}$
5. $18 \times 10^4 \times 2 \times 10^7$
6. $5 \times 10^3 \times 3 \times 10^8$
7. $6 \times 10^3 \times 2.5 \times 10^6$
8. $8 \times 10^2 \times 3 \times 10^{14}$
9. $15 \times 10^9 \times 2 \times 10^4$
10. $50 \times 10^3 \times 0.5 \times 10^3$

Express as powers of 10 and multiply

11. 17,000 x 2,000,000
12. 300,000 x 240,000
13. 780,000 x 30,000,000
14. 40,000 x 160,000
15. 35,000,000 x 290,000

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UNIT VIII - THE METRIC SYSTEM AND POWERS OF TEN

Lesson No. 5 — Negative Exponents

You know that $10^3 = 1{,}000$. What would you think 10^{-3} would be? Suppose you look at the following little table.

10^{-3}	=	0.001	=	1/1,000
10^{-2}	=	0.01	=	1/100
10^{-1}	=	0.1	=	1/10
10^{0}	=	1		
10^{1}	=	10		
10^{2}	=	100		
10^{3}	=	1,000		

This table shows you that when the exponent has a negative sign in front of it the number is <u>less</u> than <u>one</u>, and the <u>larger</u> that negative exponent, the <u>smaller</u> a part of one it will be.

Let's examine a few examples involving numbers which are all <u>less than one</u>.

$2 \times 10^{-3} = 2 \times 0.001 = 0.002$

$2 \times 10^{-3} \times 4 \times 10^{-3} = 8 \times 10^{-6} = 8 \times 0.000001 = 0.000008$

$3 \times 10^{-2} \times 2 \times 10^{-1} = 6 \times 10^{-3} = 6 \times 0.001 = 0.006$

IT IS IMPORTANT THAT YOU REMEMBER THAT WHEN A NUMBER STANDS ALONE WITH NO DECIMAL EITHER IN FRONT OR IN BACK OF IT, IT IS UNDERSTOOD THAT THERE IS A DECIMAL IN THE BACK OF IT - THAT IS, TO THE RIGHT.

This (6) is the same as this (6.)

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Now if you want to express 6×10^{-3} in decimal equivalent, you start from the decimal, which you know is to the right of the 6, and count three places to the left:

0.006

and show it in this manner. Of course, you read it as six one-thousandths, or simply six thousandths.

One more thing. Suppose you had to add -2 to +5? You know from algebra that -2 +5 = + 3. Similarly, +6 + (-4) = +2.

If you are multiplying negative and positive powers of 10, the exponents need only to be added algebraically.

$10^{-2} \times 10^{-5} = 10^{-7}$

$10^{-5} \times 10^{3} = 10^{-2}$

$3 \times 10^{-2} \times 2 \times 10^{6} = 6 \times 10^{4}$

$3 \times 10^{-4} \times 3 \times 10^{18} = 9 \times 10^{14}$

$2 \times 10^{-3} \times 2 \times 10^{9} = 4 \times 10^{6}$

$4 \times 10^{-12} \times 3 \times 10^{3} = 12 \times 10^{-9}$

$2 \times 10^{-4} \times 3 \times 10^{6} \times 10^{-12} \times 3 \times 10^{4} = 18 \times 10^{-6}$

ASSIGNMENT:

Multiply

1. $2 \times 10^{3} \times 2 \times 10^{-3}$
2. $3 \times 10^{4} \times 2 \times 10^{-9}$
3. $4 \times 10^{2} \times 2.5 \times 10^{-8}$
4. $5 \times 10^{-9} \times 2 \times 10^{6}$
5. $1.5 \times 10^{3} \times 4 \times 10^{-9}$
6. $25 \times 10^{-12} \times 3 \times 10^{6}$
7. $19 \times 10^{8} \times 1 \times 10^{-3}$
8. $9 \times 10^{12} \times 3 \times 10^{-5}$
9. $6 \times 10^{-15} \times 6 \times 10^{12}$

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UNIT VIII - THE METRIC SYSTEM AND POWERS OF TEN

Lesson No. 6 — English and Metric Conversions

There are many occasions when you will find it necessary to convert from one system of measurements to the other. Suppose you bought a European automobile whose nuts and bolts were made according to metric measurements, and you wanted to know how many inches the metric measurements came to. Suppose you happened to be visiting in some European country and wanted to buy some cloth to send to the girl friend so she could make a dress. If you asked for five yards of the material, the man behind the counter might ask you how many meters there are in your yard. This happened to the author of this book in a department store in a small town in Portugal.

Not only is it a nice thing to be able to know the relationships and to be able to make the conversions, but it is necessary that you, going into the electrical or the electronics trade, be able to convert from one system to the other. Study the following table of comparisons and conversions.

1 foot	=	0.3048 meters
1 foot, cubic	=	0.0283 cubic meters
1 foot, square	=	0.0929 square meters
1 inch	=	0.0254 meters
1 inch	=	2.54 centimeters
1 mile	=	1.6093 kilometers
1 pint, liquid	=	0.4732 liters
1 pound	=	0.4536 kilograms
1 yard	=	0.9144 meters
1 yard, cubic	=	0.7646 cubic meters
1 yard, square	=	0.8361 square meters

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SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: I. FUEL PUMP

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Overhaul, Replace, and Test Fuel Pump

CONDITIONS:

Assignment will be performed on complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective cover on front seat of automobile
2. Move automobile into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper tools and materials
6. Select proper manual and turn to appropiate chapter
7. Disconnect fuel line and any other attached accesories
8. Remove fuel tank cap and blow fuel from line to prevent siphoning
9. Remove attaching bolts from pump
10. Remove pump from engine and place on work bench
11. Disassemble pump following steps as outlined in manual
12. Identify all parts of the pump and the function of each
13. Reassemble the pump following steps as outlined in the manual

PERFORMANCE CRITERIA:

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1 centimeter	=	0.3937 inches
1 gram	=	0.0353 ounces
1 kilogram	=	2.2046 pounds
1 kilometer	=	0.6214 miles
1 liter	=	2.1134 liquid pints
1 meter	=	3.2808 feet
1 meter	=	39.37 inches
1 meter	=	1.0936 yards

Just for fun, let's imagine that you were visiting a friend in Argentina and wanted to help him out by doing a job for him. In the Argentine, the peso is the unit of money; and there are 100 centavos in a peso just as we have 100 cents in our dollar. Suppose that, at the present exchange rate, one American dollar is worth four Argentine pesos, and you wish to buy 250 feet of insulated wire from a store in Buenos Aires. The price there is 12.5 centavos per meter. How much American money would you have to pay for the 250 feet of wire?

From the table find that 1 ft. = 0.3048 meter

You need 250 X 0.3048 = 76.2 meters of wire

76.2 X 0.125 = 9.525 (nine pesos and fifty-two and half centavos)

$\frac{9.525}{4}$ = $2.38 (American money)

QUESTIONS:

1 - How many meters are there in 6.5 yards?

2 - Convert 10 inches into centimeters.

3 - Convert 3.5 meters to inches.

4 - Convert 1 kilometer to feet.

5 - How many kilograms are there in 1.5 pounds?

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ELECTRONIC ENGINEERS DESIGNED AND CREATED THIS TELEVISION RECEIVER.

ELECTRONICS TECHNICIANS KEEP IT OPERATING.

15019

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UNIT IX - READING THE SCALES

Lesson No. I — The Rule and The Yardstick

You can read the scale on an ordinary twelve-inch rule. You should be able to find halves and quarters. Perhaps you can even read eighths and sixteenths. You should also be able to read the scale on a yardstick - that is, if you understand the scale on the rule.

Suppose we look at just an inch section on the rule. We will pretend that this is an inch. (It is actually much longer, so that it will be easier to see the divisions.)

Halfway between the left end of the rule and the 1 we see a large line. This stands for 1/2 inch.

If you will look at your rule again, you will see that these halves are halved, by smaller lines. These halves of halves are <u>quarters</u>.

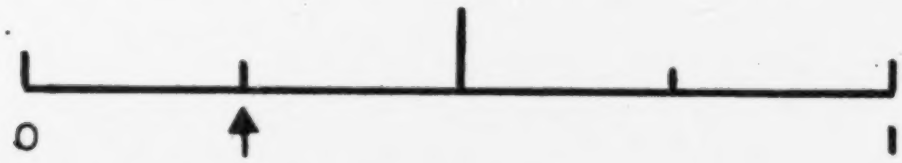

The arrow above indicates 1/4 inch.

The <u>quarters</u> are halved, making eighths.

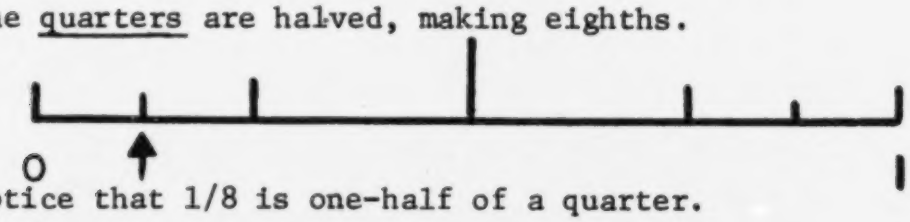

Notice that 1/8 is one-half of a quarter.

Now, if you halve the eighths you will have sixteenths.

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Machinists and some other craftsmen carry steel rules they call scales where the sixteenths are halved into thirty-seconds, and these thirty-seconds are halved again to make sixty-fourths of an inch. For making measurements accurate to smaller parts than sixty-fourths, they usually use a precision instrument called a micrometer, with which they can measure in thousandths of an inch.

ASSIGNMENT:

Using a pencil with a hard lead and a fine point, indicate the following points:

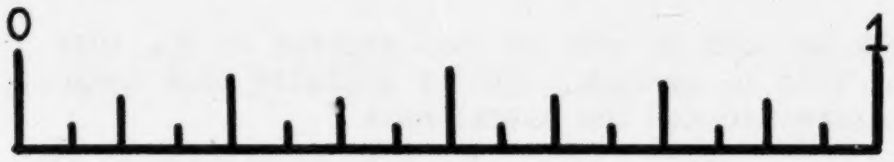

a. 15/16 inch

b. 3/16 inch

c. 1/8 inch

d. 3/4 inch

e. 5/8 inch

f. 3/8 inch

g. 9/16 inch

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UNIT IX - READING THE SCALES

Lesson No. 2 — The Inch vs. the Centimeter

Compare a meterstick with a yardstick. Of course you will find that the meterstick is more than three inches longer than the yardstick. The important difference, however, is that it is divided into tenths, hundredths, and thousandths instead of thirds, quarters, eighths, sixteenths, etc.

Let us compare an inch with a centimeter.

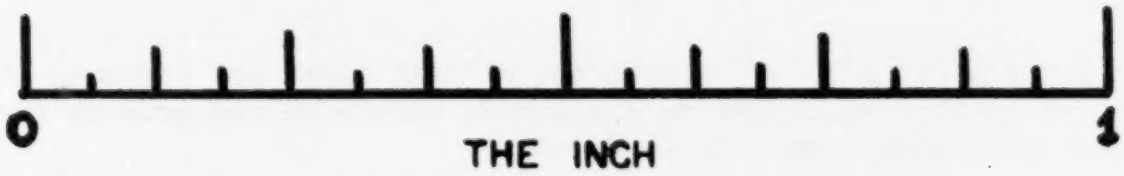

THE INCH

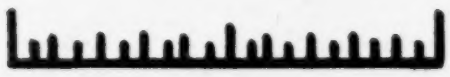

THE CENTIMETER

In scientific fields, nearly all measurements are made in units, tenths, hundredths, hundreds, thousandths, thousands, etc. Many measurements are also made in percentages. In other words, scientists and technicians use the decimal system. It is so easy just to move a decimal point back and forth to divide or multiply.

On the centimeter scale below, the arrow indicates 0.7 centimeter, or 70% of a centimeter. You will see that the centimeter is divided into ten equal portions (millimeters). So all you have to do is to indicate the line at the seventh division.

Where would 0.4 centimeter be? 0.9 centimeter?

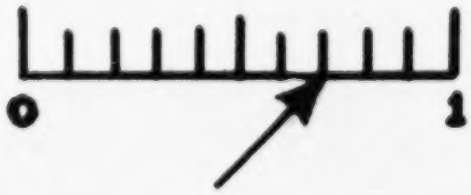

Can you find 0.7 inch or 70% of an inch? Or 0.2 inch? You will find this very difficult.

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The word decimal comes from the Latin word decimus meaning tenth, from decem, meaning ten. Perhaps no one really knows where the Latins got the word.

Let's look at the number 1.

When it stands alone, it is understood that there is a decimal point to the right.

1 means 1.

If we put a decimal point in front of it, it becomes one-tenth or 1/10.

.1

Going back to 1, if we move the decimal point one place to the right, it will be necessary to add a zero before we can move it one place in that direction. So it becomes

10.

Now you can see why we call a scale like the following a decimal scale. From it we can read directly in units, tenths, and sometimes even hundredths.

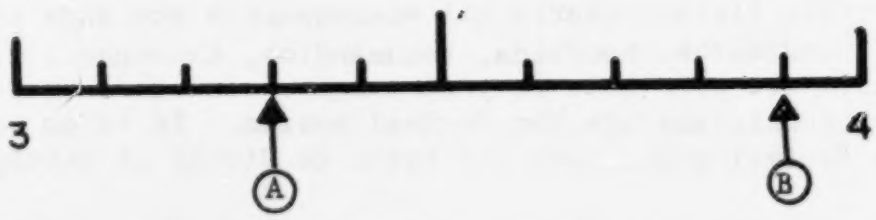

There are ten equal portions between the 3 and the 4. If we look at arrow A, we read 3.3, since it is 3/10 of the distance between 3 and 4. Likewise, arrow B is 9/10 of the distance between 3 and 4, making that point 3.9.

15024

ASSIGNMENT:

The diagram below represents a centimeter. Draw arrows to the points requested. (Use a hard lead and a sharp point.) Label each arrow.

a.	0.7	d.	0.9
b.	0.5	e.	0.1
c.	0.2	f.	0.4

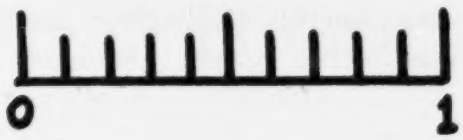

150 2 2 0 1

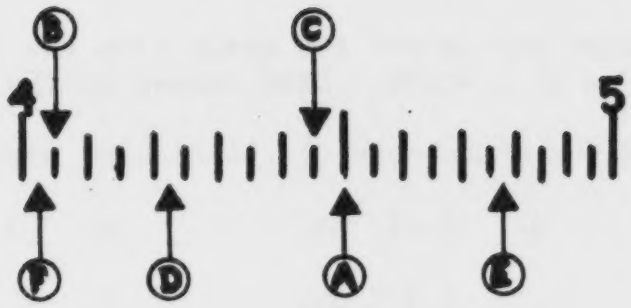

Fig.: IX-3-3

In Figure 3,

A points to 4.5	D points to 4.225
B points to 4.05	E points to 4.775
C points to 4.45	F points to 4.025

The following diagram represents a centimeter.

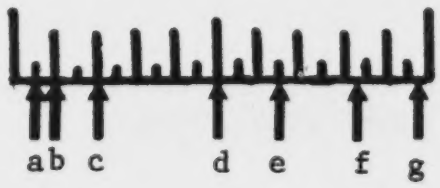

Fig.: IX-3-4

(a) indicates 0.05 centimeter or 0.5 millimeters
(b) indicates 0.1 centimeter or 1 millimeter
(c) indicates 0.2 centimeter or 2 millimeters
(d) indicates 0.5 centimeter or 5 millimeters
(e) indicates 0.65 centimeter or 6.5 millimeters
(f) indicates 0.825 centimeter or 8.25 millimeters
(g) indicates 0.975 centimeter or 9.75 millimeters

Study the above very carefully before going into the assignment.

15027

ASSIGNMENT:

1 - The diagram below represents the space from the 3- to the 4-centimeter marks on a scale. Draw arrows to the points requested.

(Use a hard lead and a sharp point.) Label each arrow.

a.	3.5 cm.	d.	3.25 cm.	g.	3.925 cm.
b.	3.75 cm.	e.	3.375 cm.	h.	3.65 cm.
c.	3.15 cm.	f.	3.225 cm.	i.	3.875 cm.

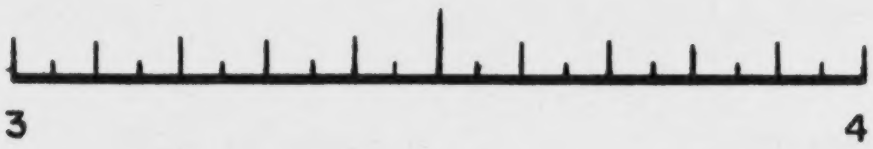

Using a hard, sharp pencil, draw arrows to the following points on the above scale. Label each arrow.

a.	1.5	f.	2.75	k.	5.7
b.	1.9	g.	5.25	l.	7.55
c.	7.2	h.	6.05	m.	2.5
d.	4.8	i.	2.05	n.	6.45
e.	3.0	j.	4.35	o.	3.95

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SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: I. FUEL PUMP

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Overhaul, Replace, and Test Fuel Pump

CONDITIONS:

BEHAVIOR:

14. Install fuel pump on engine following steps as outlined in manual
15. Make all connections
16. Re-check all steps to assure that none have been missed
17. Start engine and test pump following procedure as outlined in manual
18. If pump is satisfactory, clean and replace tools and materials to proper place
19. Close hood
20. Replace fender covers
21. Return automobile to proper parking area
22. Remove seat covers and store in proper place
23. Clean work station for next project

PERFORMANCE CRITERIA:

Satisfactorily remove, disassemble, replace, and test fuel pump in $1\frac{1}{2}$ hours (depending on make and model)

Learning time: 3 hours

3 -

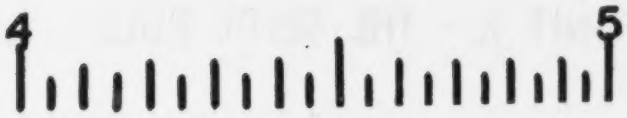

Draw arrows to the following points, as before.

a.	4.5	e.	4.15	i.	4.025
b.	4.8	f.	4.675	j.	4.05
c.	4.25	g.	4.40	k.	5.00
d.	4.95	h.	4.825	l.	4.575

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UNIT X - THE SLIDE RULE

Lesson No. I — Description and History

In the first quarter of the seventeenth century - 1600 to 1625 - the English-speaking man was experiencing an unusually active era. In this short 25-year span of time in the English world, future generations were given the mathematical tools that make possible most of the calculations in electricity. It was during this time that the Mayflower Compact was made; it and the Virginia Assembly of 1619 are recognized as the foundation stones of American institutions and the model of democracy for the rest of the world. It was during this time that the great English scientist and theologian, Rev. Edmund Gunter, discovered the importance of certain trigonometric ratios, compiled them into tables, and put them into use in solving problems in navigation and astronomy. He made a two-foot rule of tables called Gunter's scale. That and Gunter's line, which followed, was the forerunner of today's slide rule.

The slide rule is a marvelous instrument that will let you make calculations very quickly - even when they involve large or complicated numbers.

During this course - this year - you will be expected to learn only a few operations on the slide rule. Next year you will learn more. Of course, some of you will wish to go farther than the instructions of this book will cover. In that case, you will have the manual which came with your slide rule.

This year you will learn to use the C scale, the D scale, and the CI scale. Please note that the CI scale is not the C-one scale, but the C-I (I as in Iowa) scale. The CI scale is often called the reciprocal scale. You will use it for finding reciprocals, which you will need to do on many occasions. You will also use it in multiplying on many occasions to eliminate extra moves of the slide.

Let's look at just one scale of the slide rule. Let us examine the D scale, for example. You will notice that there is less distance between 8 and 9 than there is between 7 and 8, and less between 7 and 8 than there is between 6 and 7. Between 1 and 2 there is so much distance that the tenths are numbered. This gives much greater accuracy when working in this area than when working with higher numbers.

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For instance, let's find the place for the number 1,265.

Now let's read another four-digit number, this time between 9 and 10, at the end of the scale. Let's try to point out 9,575. There is so little space here that accuracy must suffer to some degree.

ASSIGNMENT:

1 - Who was Rev. Edmund Gunter?

2 - Which scale on the slide rule is called the reciprocal scale? What is a reciprocal?

3 - On your slide rule, find the following locations:

a. 25	f. 225	k. 46
b. 35	g. 135	l. 735
c. 15	h. 575	m. 895
d. 175	i. 1355	n. 1755
e. 95	j. 62	o. 9755

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UNIT X - THE SLIDE RULE

Lesson No. 2 — Logarithms And The Scales

Look at your slide rule. You will see that the C and D scales are identical. The only difference is that the C scale is on the part which slides in and out of the rule (called the slide), and the D scale is on the larger part (called the rule). The D scale is directly under the C scale. These two scales are adjacent (right next to each other) because they are the most-used scales. They are the ones that we shall study now.

In the previous lesson you learned that Rev. Gunter used two pieces of apparatus called Gunter's scale and Gunter's line to find answers to mathematical problems. Let us see how he did that.

You have heard of logarithms, but you still haven't had to study them in school. You know by now that $10^2 = 100$ and that $10^3 = 1{,}000$. The little 2 or 3, placed behind and slightly higher than the 10, is called an exponent. The 10 is called the base. These exponents are sometimes called logarithms, especially when they are used to shorten long mathematical problems.

Logarithms are usually to one of two standard bases. When 10 is used as the base, the logarithms are called common logarithms. In the more complex problems in electrical engineering, natural (or Napierian) logarithms are used. Natural logarithms are to a base which has a numerical value of 2.71828. This figure is represented by the Greek letter epsilon which looks very much like our letter "e", and often, in print, when there is no type for the Greek letter, we use our letter "e". We should never call this "e" when we are speaking of it, however, because 2.71828 is epsilon.

When we see a notation like this:

$$e^{3.7687}$$

The figure 3.7687 is a natural logarithm.

When we see a notation like this:

$$10^3$$

The figure 3, besides being an exponent, is also a common logarithm.

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The nice thing about logarithms is the fact that we can make long mathematical problems into short ones by using them. Let us look at a very simple example, just to give you an idea of what logarithms are all about.

Instead of saying 1,000 X 1,000, and going through the process of multiplying them in the old-fashioned way, we may set the problem up in this manner:

$$10^3 \times 10^3 = 1{,}000{,}000 \text{ or } 10^6$$

If you can set up your numbers as powers of the base 10 (and this can be done easily, with tables), then to multiply numbers, you simply add the exponents.

The slide rule is based on logarithms. We multiply on the slide rule by adding!

Let us see, now, why the progression of the numbers on the scales of the slide rule are not <u>linear</u>, as they are on an ordinary meterstick or yardstick, but nonlinear - that is, the spacings between no two numbers are the same.

Let's use the number 2 as a base, and use consecutive numbers for exponents.

$$2^1 = 2$$

$$2^2 = 4$$

$$2^3 = 8$$

$$2^4 = 16$$

$$2^5 = 32$$

Now, see how these numbers look on a graph.

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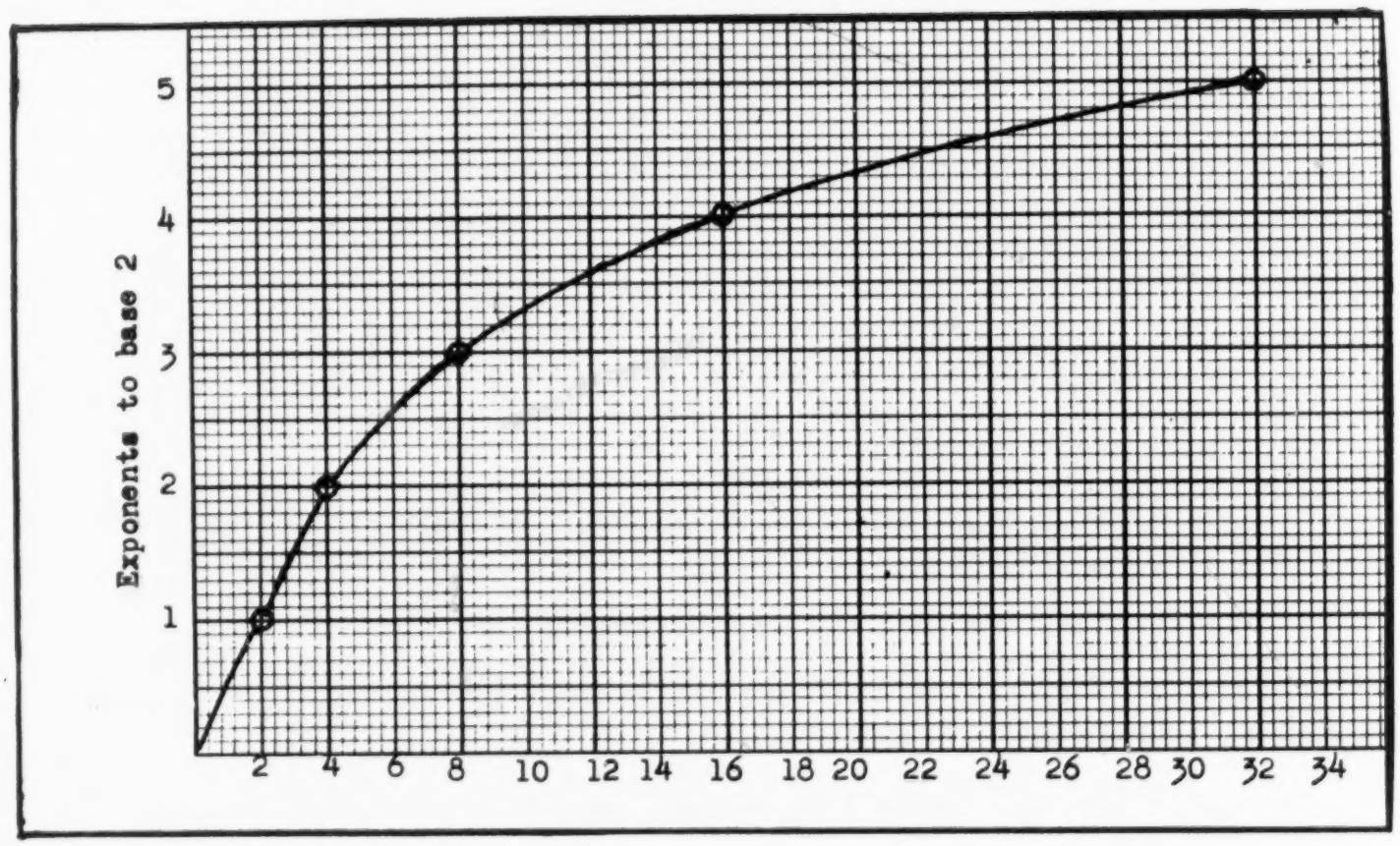

Fig.: X-2-1

The word linear means "in a straight line." See how nonlinear the graph is. This run of numbers (2, 4, 8, 16, etc.) is a logarithmic or exponential progression.

Logarithms are a wonderful tool for calculating. For exact figures, we can use tables of logarithms; for approximate figures, obtained very quickly, we use the slide rule instead.

In multiplying with the slide rule, all we are doing is adding logarithms. In dividing with the slide rule, we are subtracting logarithms.

ASSIGNMENT:

1 - In the expression 10^4, which number is the base and which is the exponent?

2 - What is the difference between an exponent and a logarithm?

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3 - What are natural logarithms?

4 - What is the base of common logarithms?

5 - When we see "e" used as a base for logarithms, what do we call the "e"?

UNIT X - THE SLIDE RULE

Lesson No. 3 — Slide Divisions

Since there are varying distances between all the divisions on the slide rule, it is necessary for us to stop at this time and become familiar with those divisions. We shall examine that portion of the scale between the 1 and the 2, and point out the correct reading of figures which fall between these divisions.

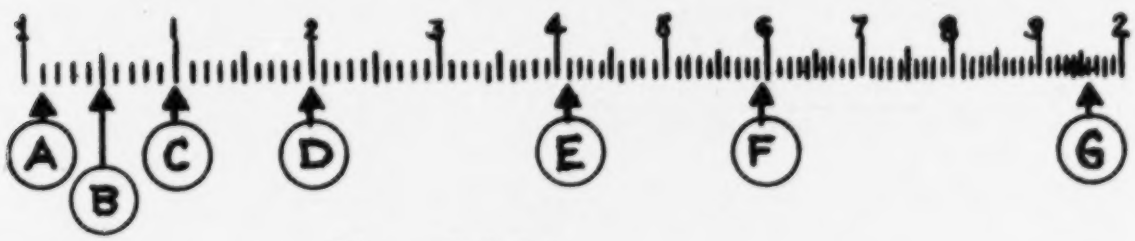

Fig.: X-3-1

A	points to	101	E	points to	141
B	points to	105	F	points to	1595
C	points to	11	G	points to	196
D	points to	12			

Of course, you must understand that at A, the 101 could mean 1.01 or 10.1 or 1010 or 0.0101 or even 101,000,000. The slide rule gives only <u>significant figures</u>. It is necessary for the operator to place the decimal. The 196 in G can mean 0.196 or 1.96 or 19.6 or 1960 or even 196,000,000.

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There is less space between the 2 and the 3 than between the 1 and the 2, and the divisions are quite different. Each division stands for two-tenths of the distance between the larger lines, so special care is needed in reading numbers on this part of the scale.

Fig.: X-3-2

A	points to	21	E	points to	262
B	points to	218	F	points to	276
C	points to	232	G	points to	287
D	points to	241	H	points to	295

The scale between the 3 and the 4 is just like the scale from 2 to 3 except that the spaces are smaller. The scale between the 4 and the 5 may be similar to these, or it may be like the remaining portions of the slide rule.

The spaces between 5 and 6, 6 and 7, 7 and 8, 8 and 9, and 9 and 10 are divided into the same kinds of divisions. Let us examine one type of scale between 4 and 5.

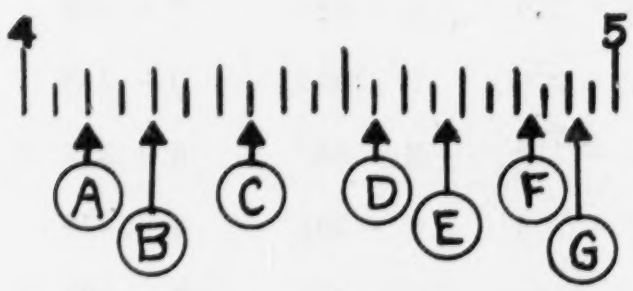

Fig.: X-3-3

A	points to	41	E	points to	4675
B	points to	42	F	points to	4825
C	points to	435	G	points to	492
D	points to	455			

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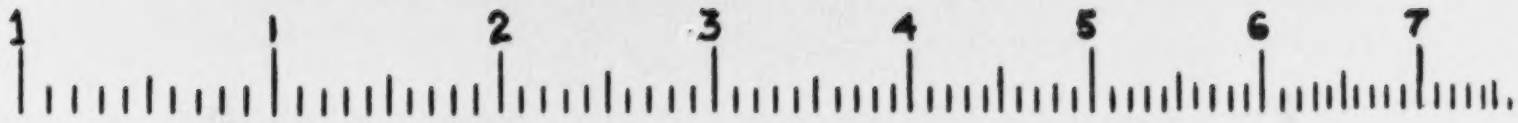

1 - On the above scale, point out, as before, the following values:

A - 123	F - 1605	K - 1700
B - 159	G - 1225	L - 1095
C - 110	H - 1358	M - 1202
D - 105	I - 1405	N - 1650
E - 1365	J - 1015	O - 1154

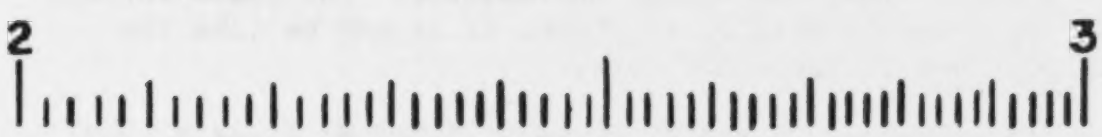

2 - On the above scale, point out:

A - 250	F - 219	K - 283	P - 249
B - 290	G - 270	L -2065	Q - 258
C - 210	H - 272	M - 247	R - 287
D - 212	I - 275	N - 291	S -2475
E - 216	J -2200	O - 223	T - 201

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CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III FUEL SYSTEM

MILESTONE: II CARBURETOR - SINGLE BEARREL (Cont.)

PERFORMANCE OBJECTIVE NO: 2 TITLE: Remove, Disassemble, Reassemble, Test and Adjust Carburetor

CONDITIONS:

LEARN	REFERENCE	SOURCE
7. "Servicing Automatic Chokes"	7. Continuous Film Loop # 8367	7. Resource Materials Center
8. Carburetion and Fuel System	8. Teaching Machine cards 2D, 3A, 3B, 3C, and 3D	8. Teaching Machine (Shop)

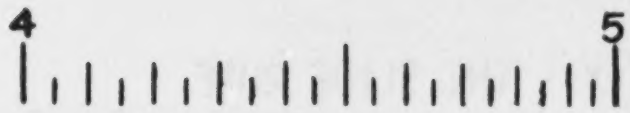

3 - On the above scale, point out:

A - 42	D - 447	G - 476
B -4200	E - 434	H - 429
C - 455	F - 401	I - 461

UNIT X - THE SLIDE RULE

Lesson No. 4

Multiplying

Now we will learn to multiply on the slide rule. For example, 2 X 3.

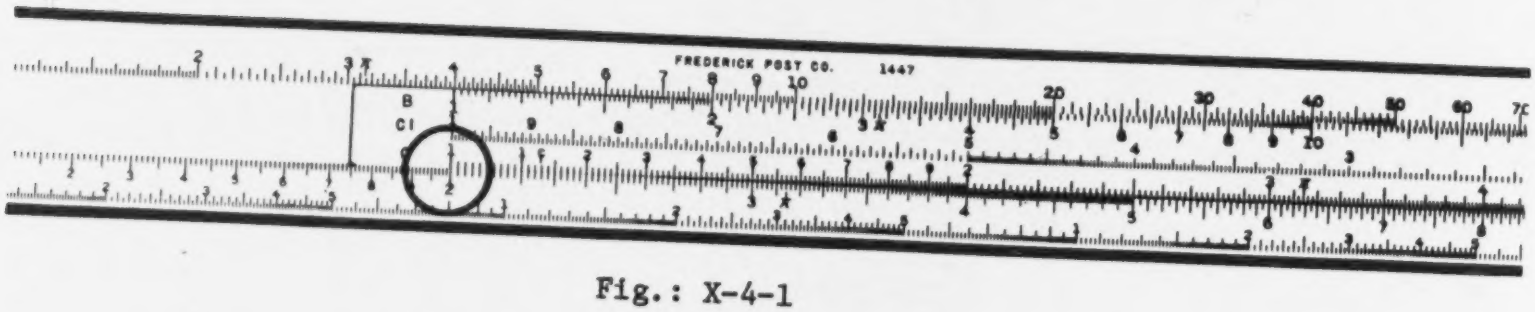

Fig.: X-4-1

Place the left index (the 1 on the C scale) over 2 on the D scale.

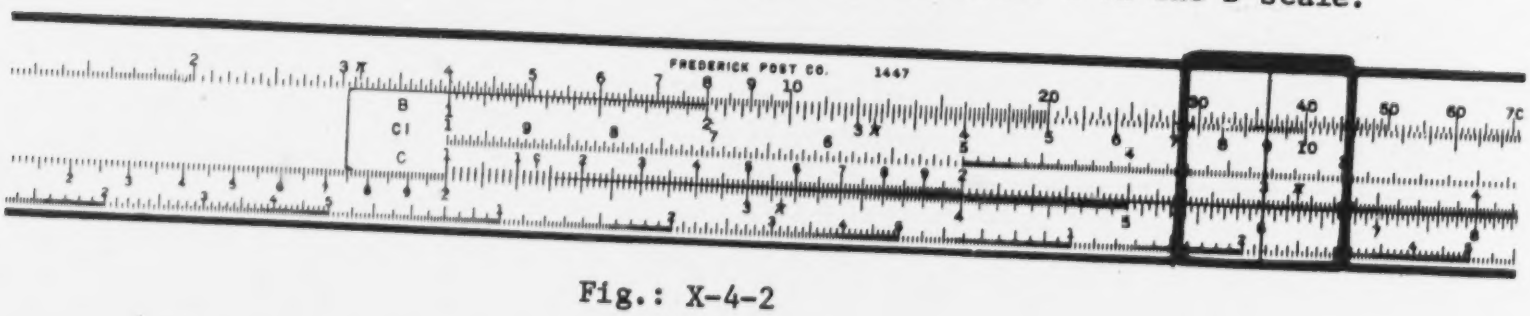

Fig.: X-4-2

Slide the cursor to the right until the hairline is over the 3 on the C scale. Look under the hairline on the D scale and observe the answer - 6.

Now multiply 3 X 2. Place the left index over the 3 on the D scale. Move the cursor until the hairline is over the 2 on the C scale. Observe the answer, 6, on the D scale under the hairline. Note that it doesn't matter which way you multiply - 2 X 3 or 3 X 2 - you may suit your own convenience.

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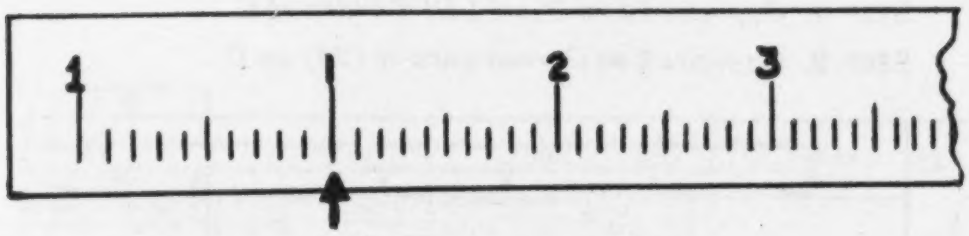

Fig.: X-4-3

Examine the left end of the C and D scales and the number 2. The extreme left end is 1. You will also notice another 1 near the left end, but if you examine more closely you will see that that is a one-tenth (1/10) division between the end and the 2 (or between 1 and 2). So this is not 1, but 11.

Later when you understand the placement of the decimal point, you will see that it could also be 1.1, 0.11, 0.011, 0.0011, or even 11,000 or 11,000,000.

In the figure below, the index is above the number 14 on the D scale. This could mean 14 or 1.4 or 0.14 or 0.014 or even 14,000.

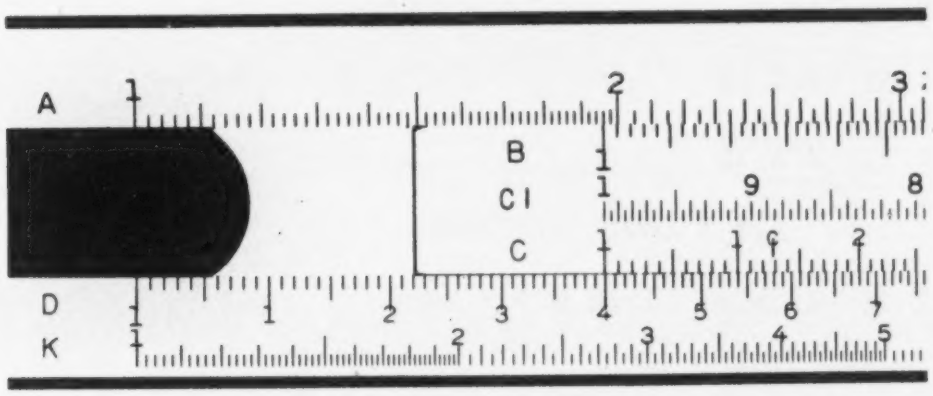

Fig.: X-4-4

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Now let us multiply 14 X 2. Follow these steps.

STEP 1. *Opposite 14 on D, set LEFT index of C.*

STEP 2. *Opposite 2 on C, read answer (28) on D.*

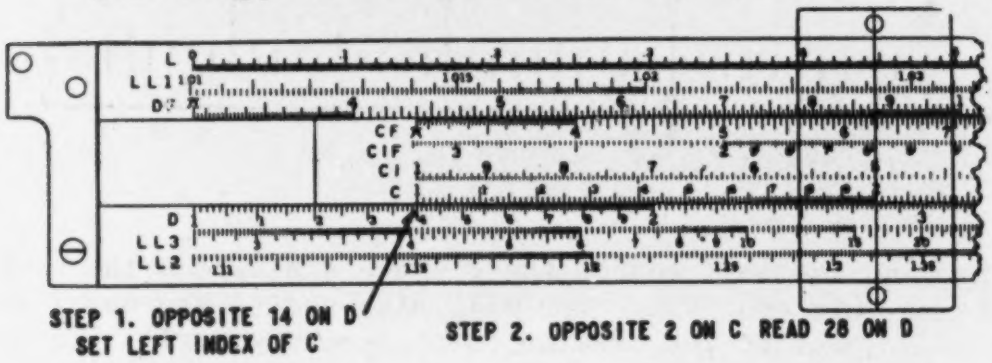

Fig.: X-4-5

Had the problem been 1.4 X 2, the answer would have been 2.8. Had the problem been 14 x 20, the answer would have been 280.

ASSIGNMENT:

Multiply the following with your slide rule:

1 - 1.3 X 2; 13 X 2

2 - 2 X 1.5; 2 X 15

3 - 2 X 2.5; 2 X 25

4 - 2.5 X 1.6; 2.5 X 160; 2.5 X 16

5 - 1.5 X 3; 15 X 3; 15 X 0.3

6 - 1.25 X 20; 125 X 2

7 - 17 X 2; 1.7 X 20

8 - 1.75 X 2; 175 X 2

9 - 2.5 X 2; 26 X 2; 27 X 2; 28 X 2

10 - 2.5 X 12; 2.5 X 1.2

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UNIT X - THE SLIDE RULE

Lesson No. 5 Using The Right Index

With your slide rule, multiply 8 X 7. Do this before you read any farther.

If you tried to multiply 8 X 7, you found that it was impossible to move the cursor to 7 after you placed the left index over 8 on the D scale - that is, if you used the left index, as you have been doing up to this point. So now is the time to learn that the slide rule has two indexes - the right as well as the left. The right end of the slide is the right index, and it is this index that you must use to multiply 8 X 7.

Place the right index over 8 on the D scale, and move the cursor until the hairline is over 7 on the C scale. Then, under the hairline on the D scale, you will find the answer, 56.

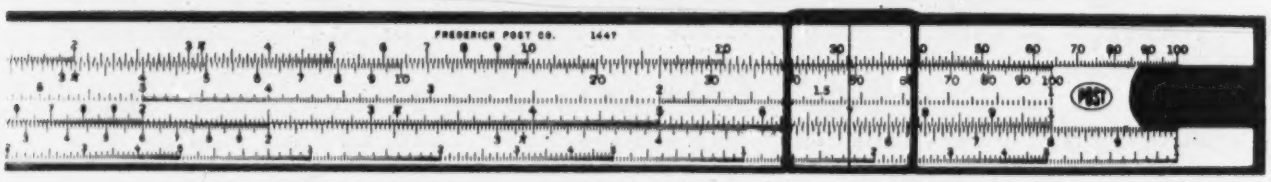

Fig.: X-5-1

ASSIGNMENT:

With your slide rule, multiply the following:

1 - 9 X 8; 9 X 5; 9 X 11

2 - 8 X 5; 8.5 X 4; 5 X 8

3 - 5 X 9; 7 X 5; 5 X 7.2

4 - 4 X 9; 8 X 12; 8 X 12.5

5 - 8.5 X 11; 8.5 X 2; 4 X 8.5

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UNIT X - THE SLIDE RULE

Lesson No. 6 Placing the Decimal (I)

We have been repeating, over and over, that a figure on the slide rule may have the decimal point placed anywhere. For instance, 6 on the slide rule could be 6 or it could be 0.6 or even 6,000 or more or less.

Multiply 220 X 400

Your slide rule will give you 88. You know, of course, that the answer must be much greater, and, with a little time, you can place the decimal by a careful consideration of the two given numbers. We can't always spare that time. We use the slide rule because we need to conserve time. There are two rules which are very simple; and these two rules will always tell us just where the decimal belongs.

The number 220 is the same as 220. (with a decimal point). Any time a figure stands without a decimal point, it is understood that there <u>is</u> a decimal point to the right of the figure. For example, 1 is 1. or 1.0 or 1.000 (with as many zeros as you might wish to have following the decimal point - they do not change the value of the number).

An INTEGER is anything complete or whole.
An INTEGRAL DIGIT is a whole number - one which does not have a decimal <u>before</u> it.

240.5

The 2, the 4, and the 0 in the above figure are all <u>integral digits</u>. The 5 which follows the decimal point is not an integral digit, because it is not a whole number. Following the decimal point, it must be less than 1.

Now, if you add the integral digits in the expression 220 X 400, you have 6; and if you subtract 1, leaving 5, you have the number of integral digits in the answer.

220 X 400 = 88,000

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It was necessary to add three zeros behind the 88 to bring the integral digits to 5 in the answer.

Multiply 124.5 X 22.5

Your slide rule reads approximately 280.

124.5 has three integral digits. 22.5 has two integral digits. The total number of integral digits in the expression, minus 1, equals 4. So, the answer must have 4 integral digits. Since you can read no more than three digits here for your answer, it is necessary for you to add a zero. The answer is 2,800. If you work it out on paper, however, the correct answer is 2801.25, but 2,800 is considered within slide-rule accuracy. In most electrical calculations, slide-rule accuracy is acceptable.

Multiply 0.0018 X 2,000

Your slide rule reads 36.

0.0018 has two zeros <u>after</u> the decimal. These two zeros are negative in their effect on the number of integral digits in the expression. The number 2,000 has 4 integral digits, and the number 0.0018 could be said to have -2 integral digits. Therefore, you subtract the 2 negatives from the 4, leaving 2. Now we must, according to the rule, subtract another 1, so that the answer will have only 1 integral digit. The answer, then, is 3.6.

Multiply 0.0018 X 20

This time the two negative zeros completely cancel the two integrals in 20. We must again subtract 1, so that will leave us with a net of -1 integral digits, and we will have to place a zero in front of our answer, .036 (or, as this is generally written, 0.036).

If you will go back and repeat the work we have done in this lesson, you will see that in each problem we moved the slide to the right and used the left index in our operation. If we had had to move the slide to the left, using the right index, we would not have used the above rule, which we will call Rule 1.

R U L E 1: When you move the slide to the right, add the number of integral digits in the multiplier to those in the multiplicand and then subtract one; the result will be the number of integral digits in the answer.

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Read again the rule which you have just studied and examine each of the problems shown below. Make sure you understand just how the correct answers were reached.

160 X 24	=	3,840
1,500 X 30	=	45,000
240 X 25	=	6,000
0.35 X 200	=	70
0.035 X 200	=	7
0.0035 X 200	=	0.7
0.0035 X 20	=	0.07
0.0035 X 2	=	0.007

ASSIGNMENT:

Do the following problems, place the decimals, and give the answers within slide-rule accuracy.

1. 21 X 3.000
2. 190 X 421
3. 18 X 0.003
4. 180 X 3,000
5. 2.5 X 0.2
6. 250 X 0.02
7. 2,500 X 0.02
8. 2,400 X 4,000
9. 215 X 0.42
10. 235 X 3.34
11. 0.0019 X 26,500
12. 1,860 X 0.444
13. 18.6 X 44.4
14. 222 X 3,330
15. 315 X 2,920
16. 3.15 X 2,920,000,000
17. 0.00315 X 2,920,000
18. 0.0315 X 0.00292
19. 28 X 0.000186
20. 200 X 2,000

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UNIT X - THE SLIDE RULE

Lesson No. 7 Placing the Decimal (II)

R U L E 2: When the slide is moved to the left, add the number of integral digits in the multiplier to those in the multiplicand. The sum will be the number of integral digits in the answer.

Notice that when the slide is moved to the left, the 1 is not subtracted from the sum of the integral digits, as was done when the slide was moved to the right.

Multiply 850 X 400

There are 6 integral digits shown above.

Your slide rule shows 34 when you perform the multiplying operation, so your answer is 340,000. You must add the four zeros so that your answer will contain the six integral digits.

Multiply 0.480 X 5

Your slide rule gives you an answer of 24.

The 0.480 contains no integral digits, since the decimal point is to the left, so 0.480 does not count in placing the decimal. The number 5 has one integral digit - the only integral digit in the problem, so the answer must have just one integral digit, and will be 2.4.

Study the following problems and answers.

Apply the rules and make sure that the answers are right.

90 X 8,000	=	720,000
0.9 X 8,000	=	7,200
840 X 50	=	42,000
840 X 0.002	=	1.68
0.096 X 0.003	=	0.000288
0.088 X 0.05	=	0.0044

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ASSIGNMENT:

Solve the following problems, making sure that the decimals are correctly placed.

1. 48 X 950
2. 840 X 625
3. 290 X 0.9
4. 540 X 0.08
5. 630 X 5.5
6. 825 X 4.25
7. 0.92 X 0.004
8. 23 X 0.000196
9. 860 X 2,460,000
10. 0.546 X 3,400
11. 775 X 885
12. 262 X 0.194
13. 843 X 72
14. 94.2 X 0.7
15. 7.2 X 0.4
16. 0.6 X 0.005
17. 65 X 58
18. 24 X 3600
19. 36.5 X 55.4
20. 0.173 X 0.0162

15048

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III FUEL SYSTEM

MILESTONE: II CARBURETOR - SINGLE BARREL

PERFORMANCE OBJECTIVE NO: 2 TITLE: Remove, Disassemble, Reassemble, Test and Adjust Carburetor

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Fractional measurements	1. Measurements, by Du Pont. Unit A. Panels A1 through A3	1. Programmed Instruction Class
2. "The Carburetor"	2. Filmstrip	2. Resource Materials Center
3. "Fuel Feed Systems"	3. Filmstrip	3. Resource Materials Center
4. Carburetors	4. The Fuel System, by Ford Motor Co. pp. 34 through 77	4. Programmed Instruction Class
5. Carburetion	5. Automotive Mechanics, by Crouse. pp. 337 through 341. Automotive Mechanics Workbook, by Crouse. Jobs 35 and 36	5. Related Information Class
6. "Carburetor Idle Adjustment"	6. Continuous Film Loop # 8366	6. Resource Materials Center

UNIT X - THE SLIDE RULE

Lesson No. 8 — Dividing (I)

You will quickly see that dividing on the slide rule, just as in arithmetic, is very much the opposite of multiplying. Suppose you have a problem like this:

$$6 \div 3 \quad \text{or} \quad 6/3$$

State it as <u>6 divided by 3</u> instead of saying <u>3 into 6</u>, as is often done. This will lend itself very conveniently to doing division problems as the reverse of multiplying with the slide rule. If you have 6 divided by 3, take the first number first.

1. Place hairline over 6 on the D scale.
2. Slide 3 on the C scale under hairline.
3. Read answer on the D scale under the index.

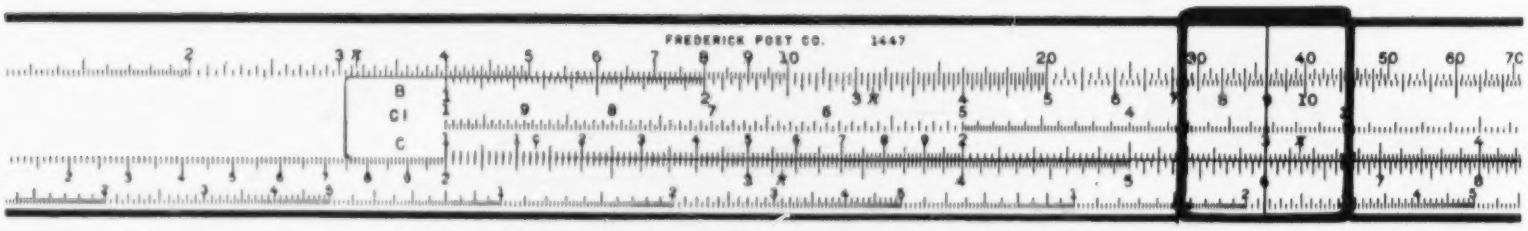

Fig.: X-8-1

The answer is always read on the D scale, the same as with multiplication. The answer here, of course, is 2.

Division problems can also be worked in another way, but we will follow this way.

EXAMPLE 2: $277 \div 25$ or $277/25$

Place hairline over 277 on the D scale, move the slide so that 25 on the C scale will also be under the hairline. The significant part of the number of the answer will be seen under the index - 111.

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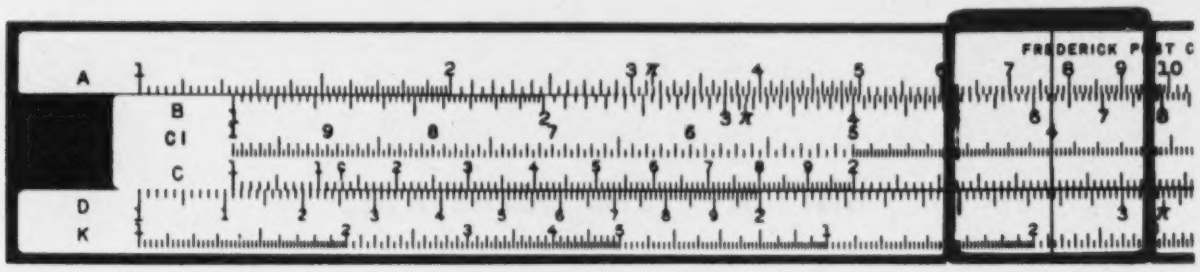

Fig.: X-8-2

Certainly you know that the answer is not 111. There couldn't be 111 24's in 277 - so it must be 11.1. This is done through "common sense" placement of the decimal. If the answer is such that it is not this easy, you can use the following rule.

RULE: IN DIVISION, WHEN YOU MOVE THE SLIDE TO THE RIGHT, SUBTRACT THE NUMBER OF INTEGRAL DIGITS IN THE DIVISOR FROM THE NUMBER OF INTEGRAL DIGITS IN THE DIVIDEND AND THEN ADD 1. THIS WILL GIVE YOU THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

In Example 2, the dividend (277) has three integral digits and the divisor (25) has two integral digits. Following the rule, we subtract 2 from 3 and add 1. This gives us 2. There are two integral digits in the answer - 11.1.

ASSIGNMENT:

Find the answers to the following:

1. $9 \div 3$
2. $90 \div 30$
3. $25 \div 12.5$
4. $50 \div 25$
5. $\frac{600}{2.5}$
6. $\frac{45}{19}$
7. $\frac{555}{185}$
8. $\frac{9.45}{2.1}$
9. $\frac{83.5}{35}$
10. $\frac{5,100}{204}$

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UNIT X - THE SLIDE RULE

Lesson No. 9 — Dividing (II)

If we have to divide 1955 by 387

$$1955 \div 387 \quad \text{or} \quad \frac{1955}{387}$$

we do just as we did in the last lesson. We place the hairline over the dividend (1955) on the D scale and then move the slide until the divisor (387) on the C scale is under the hairline also. Under the index you will read the significant numbers of the answer - 505. Is the answer 505, or is it 50.5, 5.05, or even 0.505?

For this example we have another rule, because we moved the slide to the <u>left</u> instead of to the <u>right</u>.

RULE: IN DIVISION, WHEN YOU MOVE THE SLIDE TO THE LEFT, SUBTRACT THE NUMBER OF INTEGRAL DIGITS IN THE DIVISOR FROM THE NUMBER OF INTEGRAL DIGITS IN THE DIVIDEND AND THIS WILL GIVE YOU THE NUMBER OF INTEGRAL DIGITS IN THE ANSWER.

What difference did you notice between this rule and the one given in the last lesson, for cases where you move the slide to the right? It is the same except here, when you move the slide to the <u>left</u>, you <u>don't add 1</u>.

So in the example above, the divisor (387) has 3 digits. The dividend (1955) has 4 digits. 3 from 4 = 1, so the answer must be 5.05.

EXAMPLE 2:

$$195.5 \div 3.87 \quad \text{or} \quad \frac{195.5}{3.87}$$

Place hairline over 195.5 on D scale. Move slide until 3.87 is also under hairline. Note that the index rests over 505 on the D scale.

1 (the number of integral digits in the divisor) from 3 (the number of integral digits in the dividend) equals 2. There are two integral digits in the answer; so the answer must be 50.5.

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ASSIGNMENT:

1. $8 \div 6$

2. $9 \div 3$

3. $6 \div 2$

4. $95 \div 4.75$

5. $8500 \div 42.5$

6. $45 \div 9$

7. $465 \div 517$

8. $1545 \div 38.7$

9. $17650 \div 50.5$

10. $\frac{405}{5.06}$

11. $\frac{3675}{3.70}$

12. $\frac{20.6}{9.5}$

13. $\frac{455}{7.04}$

14. $\frac{5.65}{0.9}$

15. $\frac{8.15}{0.7}$

16. $\frac{7.7}{8.2}$

17. $\frac{8350}{9550}$

18. $\frac{23}{35}$

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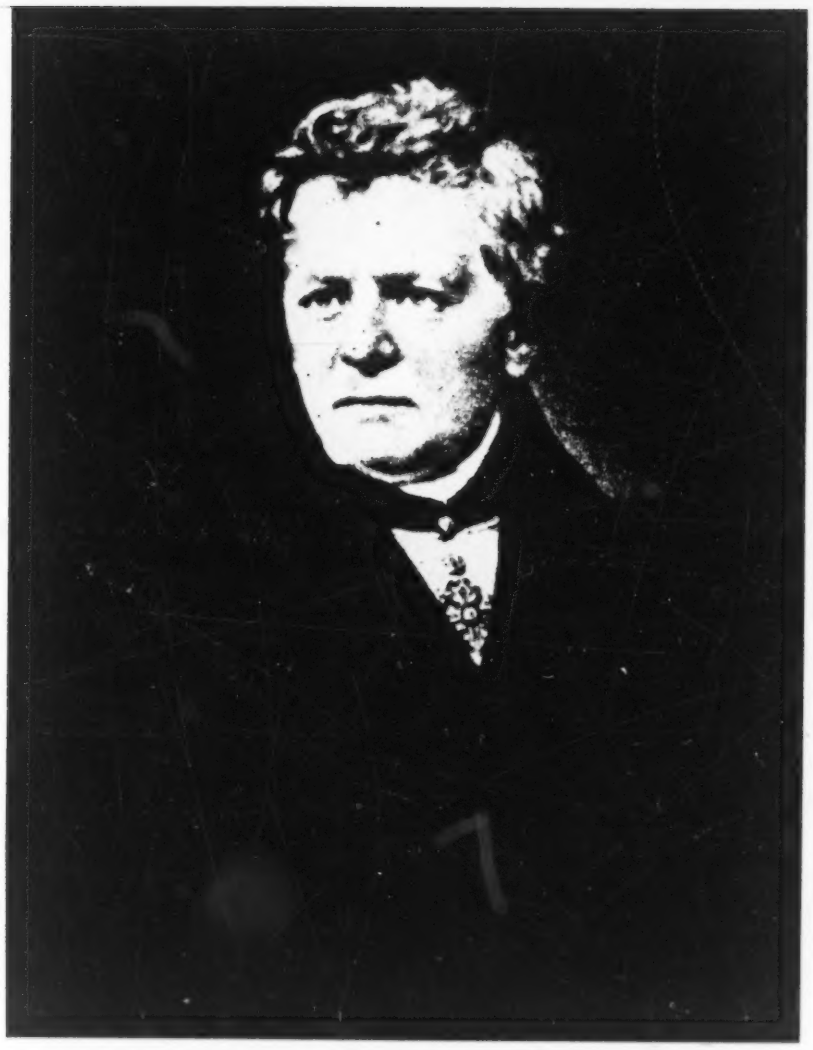

GEORG SIMON OHM (1787–1854).

German physicist and discoverer of the famous law in electricity bearing his name. In 1826, while teaching mathematics at a gymnasium in Cologne, he published his famous paper on the experimental proof of his law. At the time of his death he was professor of experimental physics in the university at Munich.

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UNIT XI - OHM'S LAW

Lesson No. 1 George S. Ohm

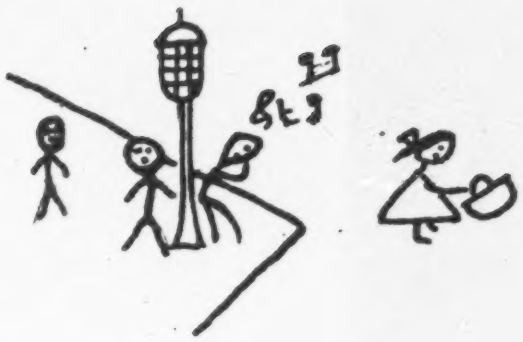

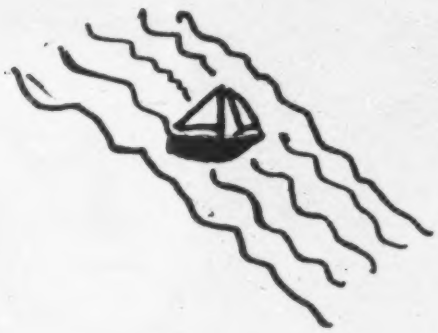

In the summer of 1787, big things were doing in Philadelphia. A few young fellows were standing on the corner of Market and Fourth watching the girls go by. There were certainly fewer young men in the Camden-Philadelphia area then than now, but we can be assured that they were discussing the same topics being discussed on the same corner today. One of the bolder ones gave a low whistle when a young girl with ribbons in her hair came walking by. She was carrying a basket containing several pounds of butter covered neatly by a freshly laundered doily. She was hurrying home for supper. Her mother had taken in several guests who were in Philadelphia to attend the Philadelphia Convention. It was at this convention, you remember, that our Constitution had the breath of life and reality put into it.

Yes Philadelphia was alive. The nation was new. Great men were building the foundations of our society. The cool breezes off the Delaware gave a sparkling feeling to one's blood. The girls were beautiful, and the boys knew it.

Over in Germany, a loud, bellowing baby was born that same year. His lungs were good, and his father's ringing ears could testify to that. Mr. and Mrs. Ohm, his parents, named him George; and it is said that, upon being told about the Philadelphia Convention, Mr. Ohm said that it was good that the Atlantic Ocean separated Germany from America, for otherwise the delegates would not be able to hear one another because of little George's bellowing.

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Little George Simon Ohm grew up, learning to love sauerkraut, pig knuckles, and knockwurst. He also became a professor of mathematics, and was heard across the Atlantic Ocean - across the Pacific, and all the other oceans of the world. There is no country where Ohm's Law is not known.

This is Ohm's Law:

$$I = \frac{E}{R}$$

I equals E over R. Remembering this simple rule (or equation) gives you the key which opens the door to the knowledge of electricity.

This was not known until George Ohm discovered that "the current in a circuit is equal to the applied voltage divided by the total resistance in the circuit." We could expand the above formula to read: current (in amperes) = $\frac{\text{EMF (in volts)}}{\text{Resistance (in Ohms)}}$

The sumbol Ω (the Greek letter omega) is used for ohms.

It is like this:

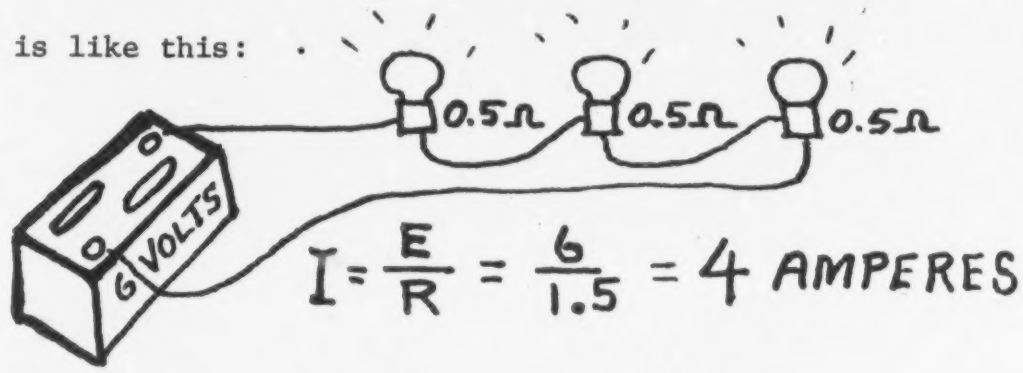

Some people use this magic triangle:

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By covering that which is wanted, the formula for finding it is shown. Suppose you want to find E (the voltage). Place your finger over E, and the triangle shows that E equals I·R.

If you wish to find R, place your finger over R, and the triangle tells you that R equals E over I - or the voltage divided by the current.

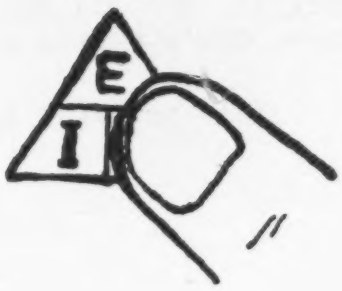

It will be entertaining and beneficial to you if you will substitute other values for voltage and resistance for the battery and lamps shown above and solve the problem for I, for E, and for R.

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UNIT XI - OHM'S LAW

Lesson No. 2 — Resistors in Series

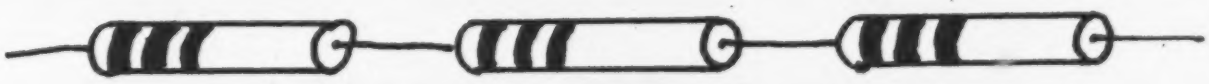

When resistors are connected like this they are connected in series. The above is a pictorial diagram--or a picture of the connection. Below is the schematic diagram of the same series resistors.

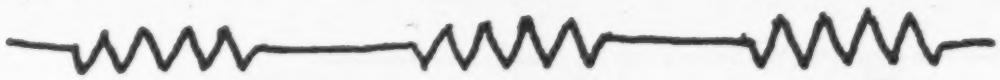

To find the total resistance of a circuit when the resistors above are connected in series, one may simply add the individual resistances like this:

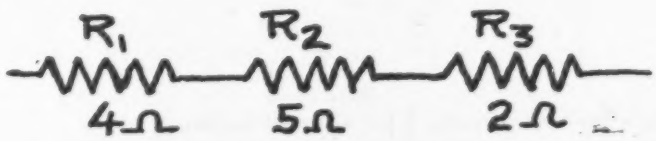

R_t (total resistance) = $R_1 + R_2 + R_3$

$R_t = 4 + 5 + 2 = 11$

It does not matter how many resistors you add to the series circuit, each resistor adds to the total resistance; and the more resistive the circuit becomes, the less the current will be, as long as the applied voltage remains the same.

If you increase the voltage applied to a series circuit, the current will increase; and that increase will be in direct proportion to the increase in the applied voltage. That is, as the voltage increases, the current will increase.

Problem: How much current will flow in a series circuit consisting of three resistors of 1, 3, and 1 ohms, if the applied voltage is 10 volts?

$R_t = R_1 + R_2 + R_3 = 1 + 3 + 1 = 5$ Ohms

$$I_t \text{ (total current)} = \frac{E_a \text{ (applied voltage)}}{R_t}$$

$$I_t = \frac{10}{5} = 2 \text{ Amperes}$$

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PROBLEMS

1.

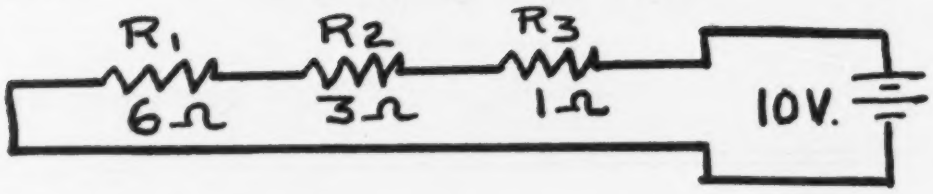

Find: R_t, I_t

2.

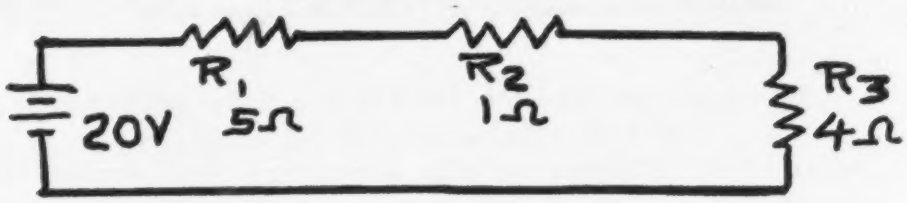

Find: R_t, I_t

3.

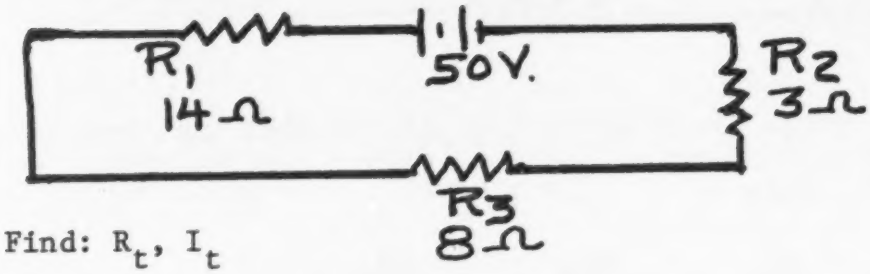

Find: R_t, I_t

4.

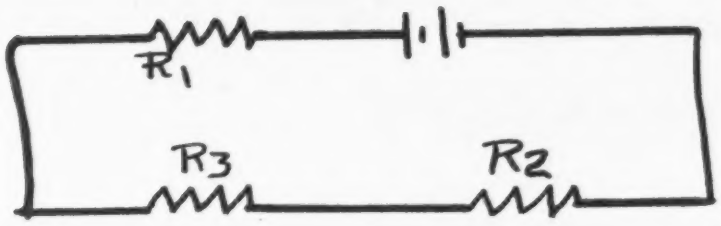

I_t = 1 Ampere, R_t = 90 Ohms. Find $E_{applied}$.

5.

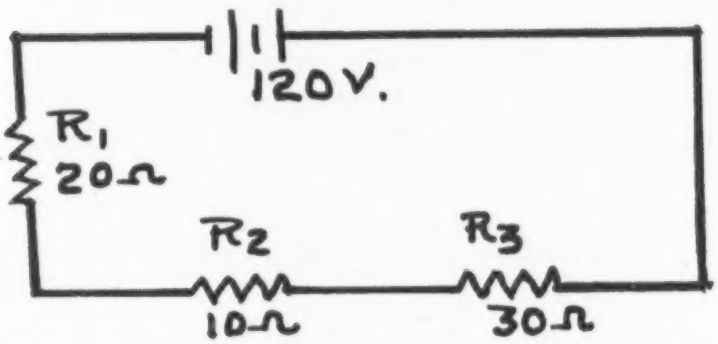

Find the voltage drops across each of the resistors, E_{R_1}, E_{R_2}, and E_{R_3}.

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SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: II. CARBURETOR-SINGLE BARREL

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Carburetor

CONDITIONS:

Assignment is to be performed on complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective cover on front seat of automobile
2. Move vehicle into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper manual and turn to appropiate chapter
6. Select proper tools and materials
7. Disconnect crankcase vent line from air breather
8. Remove air breather assembly
9. Disconnect fuel line
10. Disconnect vacuum line
11. Disconnect throttle linkage
12. Disconnect automatic choke tube
13. Remove nuts attaching carburetor to manifold
14. Remove carburetor from manifold
15. Disassemble carburetor following steps as outlined in the manual

PERFORMANCE CRITERIA:

6. 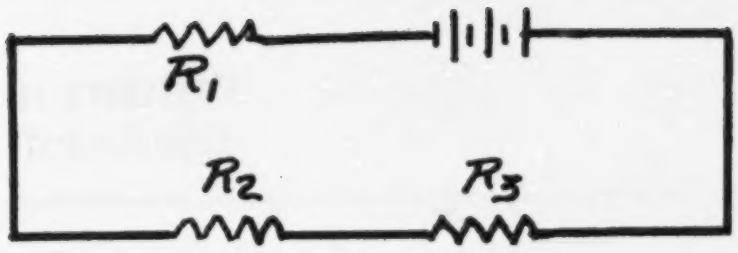

E_a = 150 volts, I_t = 25 Amperes
Find R_t

7. 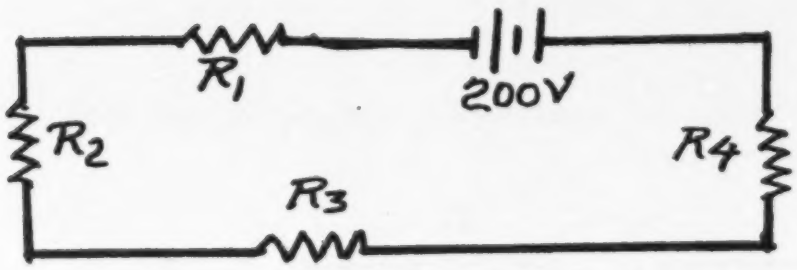

R_1 = 20 Ohms, R_2 = 10 Ohms, R_3 = 15 Ohms,
R_4 = 5 Ohms.
Find E_{R_1}, I_{R_4}, I_{R_2}.

8. 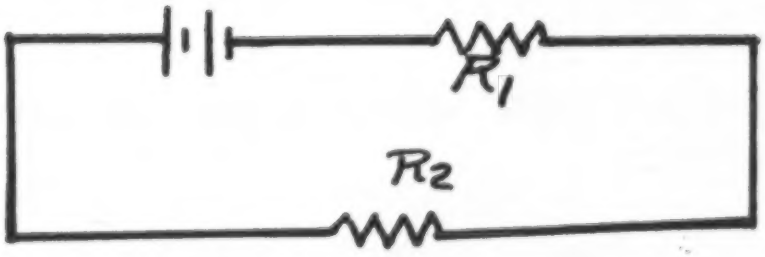

E_{R_1} = 50 Volts, R_1 = 25 Ohms, E_{R_2} = 30 Volts
Find R_t and $E_{applied}$.

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UNIT XI - OHM'S LAW

Lesson No. 3 — Resistors in Series Experiment

OBJECTIVE: To better understand resistors in series and to compare actual measurements with mathematical calculations.

MATERIALS:
- 1 2.2K resistor
- 2 1K resistors
- 1 D-C power supply, variable, 0-50 V. or higher
- 1 Vacuum tube voltmeter
- 1 Volt-ohm meter

Connect as follows, and measure E_{R_1} (using vacuum tube voltmeter "VTVM"). Calculate I_t.

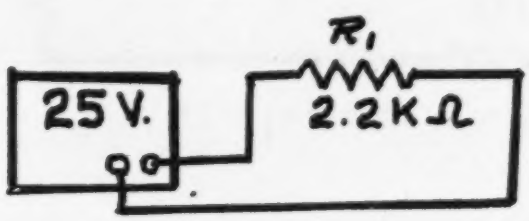

Connect the VOM (volt-ohm meter) in series with the circuit. Measure the current and compare that value with the calculated value of I_t.

Measure the voltage drop across the VOM and calculate the resistance of the meter. Add the meter resistance to the 2.2K ohms and calculate the total current again.

Connect the circuit as follows. Measure R_t with one lead disconnected from power supply.

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Connect the power supply and re-check for 25 volts. Place VOM in series with the circuit and measure the circuit current, I_t. With the VOM still in the circuit, measure (with VTVM) the voltage drops across each of the resistors and across the VOM. Calculate I_t and compare it with the value indicated on the VOM.

Connect as shown below:

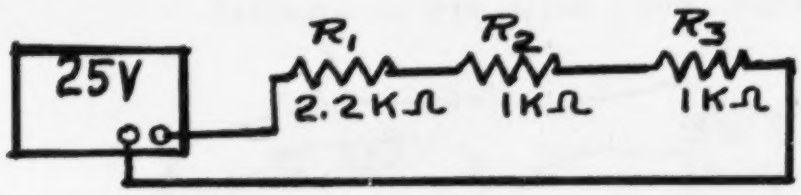

With power disconnected from circuit, measure total resistance. With VTVM, measure voltage drop across each resistor.

Calculate I_t.

Measure I_t with VOM in series with the circuit. Compare the value of the current as measured with the VOM with that value derived through calculation. Is there any difference? Why is there (or is there not) a difference?

QUESTIONS:

If three resistors, each valued at 1,000 ohms, are connected in series, what is the total value of resistance?

What would be the value of total resistance if another resistor valued at 1,500 ohms were connected in series with the three resistors mentioned above?

If a 90-volt battery is connected in series with the above circuit, how much current would flow through the resistors?

Why is a VOM wired in parallel and never in series?

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UNIT XI - OHM'S LAW

Lesson No. 4 — Resistors in Parallel

The resistors shown below are in parallel.

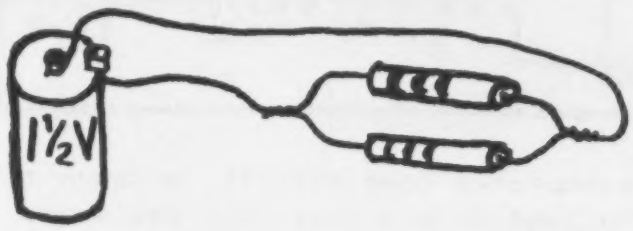

The following also are in parallel.

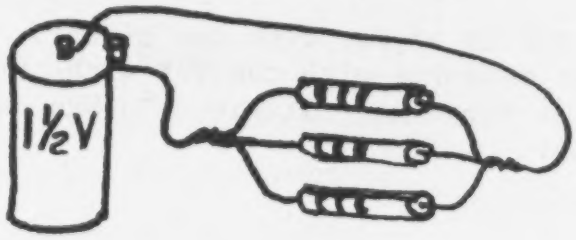

In the circuit shown below, R_2 and R_3 are in parallel, and the combined R_2 and R_3 are in series with R_1.

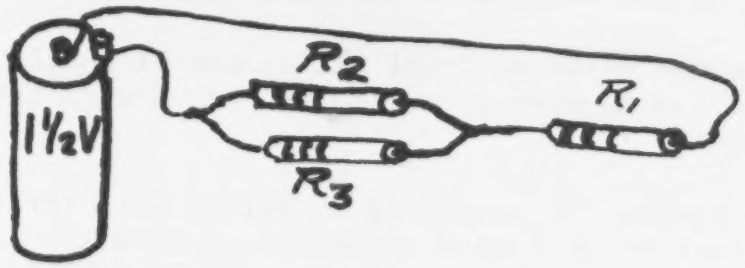

Let us calculate the total resistance in the circuit shown below.

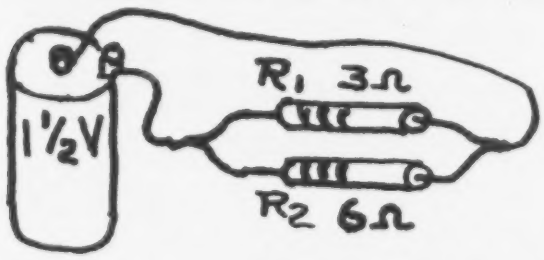

The easiest way to find the total resistance when only two resistors are in parallel is to use the method known as the <u>product-over-the-sum</u> method.

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$$\frac{R_1 \times R_2}{R_1 + R_2} = \frac{3 \times 6}{3 + 6} = \frac{18}{9} = 2 \text{ ohms}$$

Note that R_t is less than the resistance of either single resistor.

How can the total resistance be less than one resistance? Let us imagine that each resistance is a one-foot piece of copper wire. From what you know of wire you would say that the 6-ohm resistance is half the diameter of the 3-ohm resistance. Now if we were to roll both wires and make them into one, wouldn't you expect a wire of greater diameter than the 3-ohm resistance? Therefore, you would expect that two resistances in parallel would form a resistor with less resistance than either single resistance. This is what happened.

Electrically, of course, it is merely a case of having the same e.m.f. across both resistances, and we know that they must obey Ohm's Law to give a combined resistance that is effectively less than either resistor.

If there are three or more resistors in parallel, another method can be used to calculate the total resistance - the <u>reciprocal</u> method. This uses the equation:

$$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$$

For example, if $R_1 = 2$ ohms, $R_2 = 3$ ohms, and $R_3 = 4$ ohms, find the total resistance of the circuit if all three resistors are connected in parallel.

$$R_t = \frac{1}{\frac{1}{2} + \frac{1}{3} + \frac{1}{4}}$$

The LCD (lowest common denominator) of 2, 3, and 4 is 12. Then

$$R_t = \frac{1}{\frac{6 + 4 + 3}{12}} = \frac{1}{\frac{13}{12}}$$

$$= 1 \times \frac{12}{13} = \frac{12}{13} \text{ ohms}$$

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ASSIGNMENT:

In the four following circuits, solve for R_T, I_T, and the current through each resistor.

1.

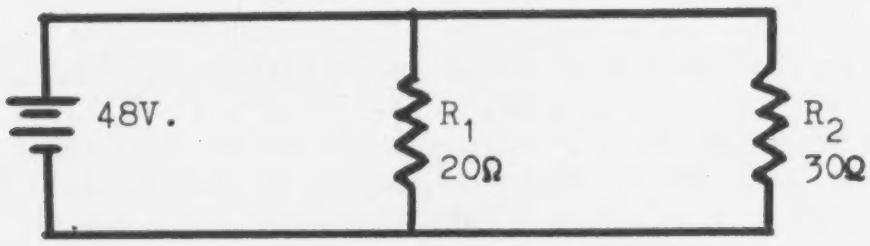

2.

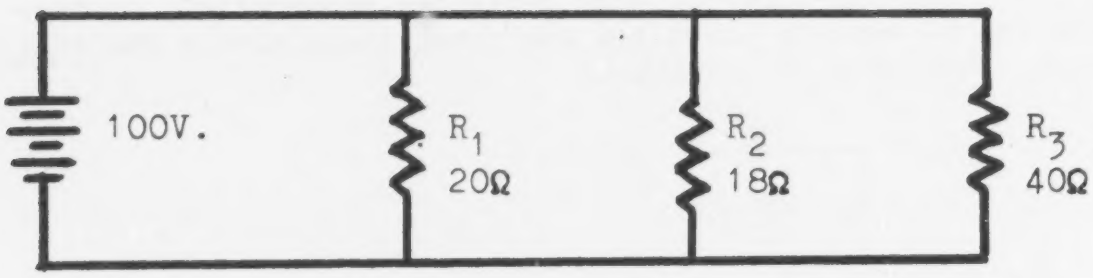

3.

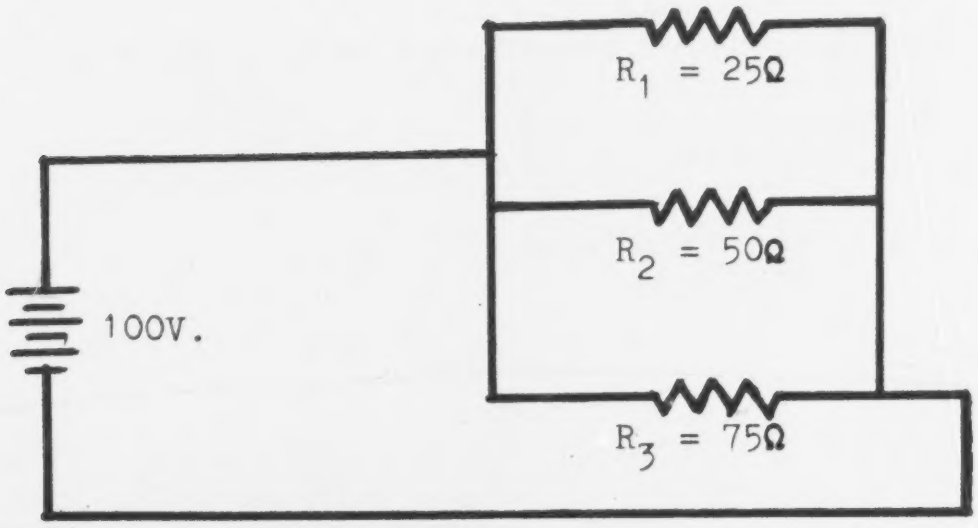

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4.

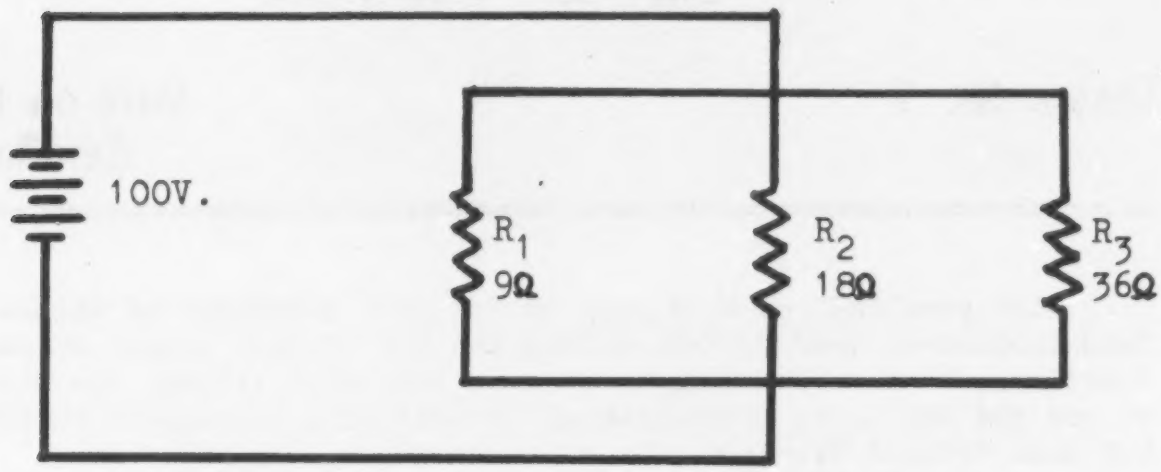

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UNIT XI - OHM'S LAW

Lesson No. 5

More on Parallel Resistors

The problems you have seen so far have resistors of values that lend themselves readily for finding the LCD (lowest common denominator). Sometimes, if the LCD seems to go into very high values, you might wish to use the following method, which is still the reciprocal method, but uses decimal fractions where we previously used the LCD.

For example:

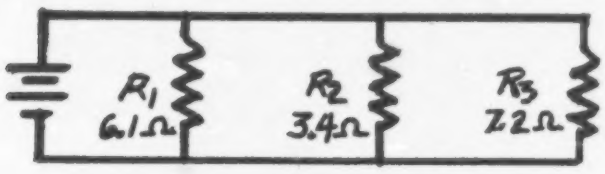

$$R_t = \frac{1}{\frac{1}{6.1} + \frac{1}{3.4} + \frac{1}{7.2}}$$

Instead of finding the LCD, find the reciprocals of 6.1, 3.4, and 7.2. That is, divide 1 by 6.1 for the reciprocal of 6.1; divide 1 by 3.4 for the reciprocal of 3.4, etc.

```
                    .163
6.1 ) 1.00   =   61 ) 10.000   =   0.163 57/61   =   0.164
                      6 1
                      3 90
                      3 66
                        240
                        183
                         51
```

After finding the reciprocals of the other two values we have:

$$R_t = \frac{1}{0.164 + 0.294 + 0.139} = \frac{1}{0.597}$$

```
                                  1.67
= 0.597 )1.000   =   597 ) 1000.00   =   1.67 ohms
                            597
                            403 0
                            358 2
                             44 80
                             41 79
                              3 01
```


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This could have been done by a double use of the product-over-the-sum method.

In this method R_1 and R_2 can be reduced to the effect of a single resistor.

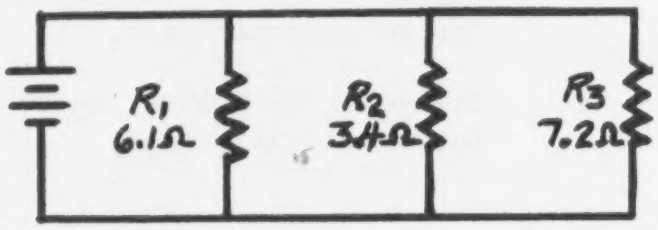

(A) $\frac{6.1 \times 3.4}{6.1 + 3.4} = \frac{20.74}{9.5} = 2.2$ ohms

(B) This reduces the problem to one like this:

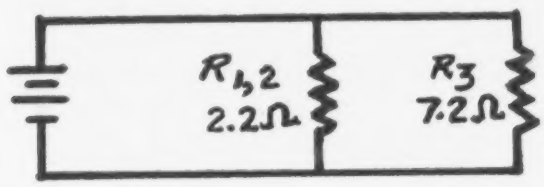

(C) $\frac{2.2 \times 7.2}{2.2 + 7.2} = \frac{15.8}{9.4} = 1.7$ ohms

R_t = 1.7 ohms, approximately the same value as found by the reciprocal method.

After becoming better acquainted with your slide rule, you will find the method shown above to be the most convenient way of finding the total resistance of three or four resistors that are in parallel.

ASSIGNMENT:

Follow steps A, B, and C (as explained above) and find R_t in the following:

1. 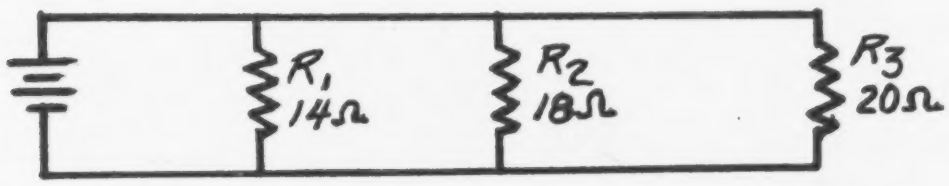

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2. Change R_1 to 18 ohms, R_2 to 20 ohms, R_3 to 22 ohms and solve for total resistance.

3. Change R_1 to 8 ohms, R_2 to 16 ohms, R_3 to 30 ohms and solve for total resistance.

4. Change R_1 to 14 ohms, R_2 to 16 ohms, R_3 to 32 ohms and solve for total resistance.

5. Change R_1 to 23 ohms, R_2 to 17 ohms, R_3 to 36 ohms and solve for total resistance.

15068

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: II. CARBURETOR-SINGLE BARREL

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Carburetor

CONDITIONS:

BEHAVIOR:

16. Identify all parts and the function of each
17. Reassemble carburetor following steps as outlined in the manual
18. Make all bench adjustments as outlined in manual
19. Clean all gasket material from base of carburetor and intake manifold
20. Install new carburetor - manifold gasket
21. Install carburetor on manifold
22. Secure carburetor to manifold with nuts
23. Reconnect fuel line
24. Reconnect vacuum line
25. Reconnect automatic choke tube
26. Reconnect throttle linkage
27. Start automobile and immediately check for leaks
28. Make all adjustments as outlined in manual
29. Recheck all steps in installation and adjusting
30. Install air breather assembly
31. Reconnect crankcase vent

PERFORMANCE CRITERIA:

1504

UNIT XI - OHM'S LAW

Lesson No. 6 — Series-Parallel Resistors

The circuit shown below is a series-parallel circuit.

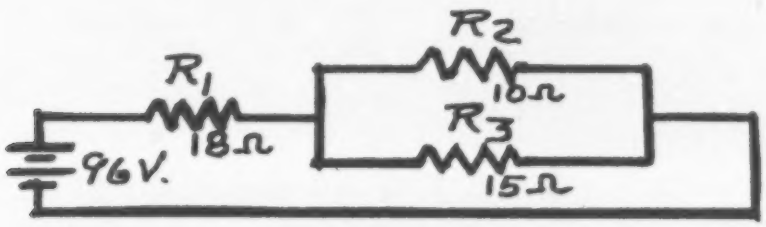

The equivalent resistance resulting from paralleling R_2 and R_3 equals 6 ohms. The product-over-the-sum method, as shown below, is the easiest way to calculate this.

$$R_{2,3} = \frac{R_2 \times R_3}{R_2 + R_3} = \frac{10 \times 15}{10 + 15} = \frac{150}{25} = 6$$

We may now reduce the circuit to show only two resistors in series.

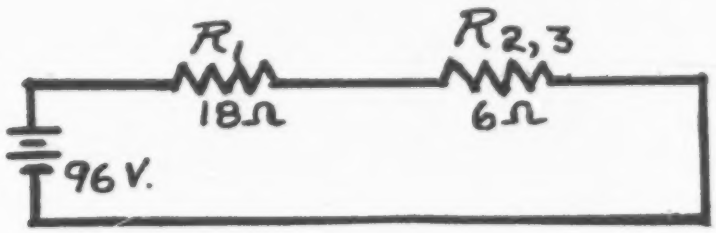

In the above diagram, $R_{2,3}$ represents the equivalent resistance that we computed for those two resistors in parallel.

Since we now have only two resistors to work with, and since they are in series, we may add them and show them in a schematic like the following:

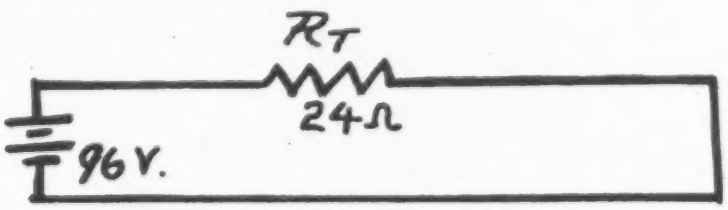

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REMEMBER THIS: The voltage drop across R_2 is the same voltage drop that appears across R_3. It is not just equal to the voltage drop across R_3; it is the same, the identical drop. This is important to understand at this point, because we shall be thinking like Mr. Kirchhoff in finding the various values in the circuit. We'll be using his law, which states that in a closed loop the sum of all the voltage drops will equal the applied voltage.

Looking at the diagram, we see that the resistance of R_2 and R_3 combined is 6 ohms. R_1 is 18 ohms, and R_t is 24 ohms.

So

$$I_t = \frac{E_{applied}}{R_t} = \frac{96}{24} = 4 \text{ amperes}$$

Now

$$E = I \times R$$

$$E_{R_{2,3}} = I \times R_{2,3} = 4 \times 6 = 24 \text{ V}$$

$$E_{R_1} = I_{R_1} \times R_1 = 4 \times 18 = 72 \text{ V}$$

We know that these values are correct, because 72 V + 24 V = 96V, the total voltage drop in the circuit.

While there is only one voltage drop across a combination of parallel resistors, the current through each of these parallel resistors will be of different values unless each of them has the same value of resistance.

In this case, $I_{R_2} = \frac{E_{R_2}}{R_2} = \frac{24}{10} = 2.4$ amperes,

and $I_{R_3} = \frac{E_{R_3}}{R_3} = \frac{24}{15} = 1.6$ amperes.

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It can readily be seen that, if the current divides when it gets to these parallel resistors, part will go through one and the remainder of the current will go through the other. The total of these two currents must equal the total line current. If they do, this proves that the calculations were correct.

PROBLEMS:

In the circuits shown below, find R_t and I_t.

1.

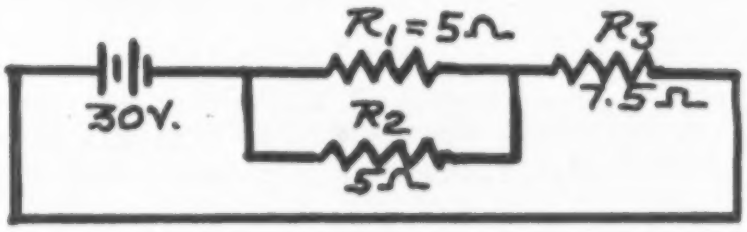

2.

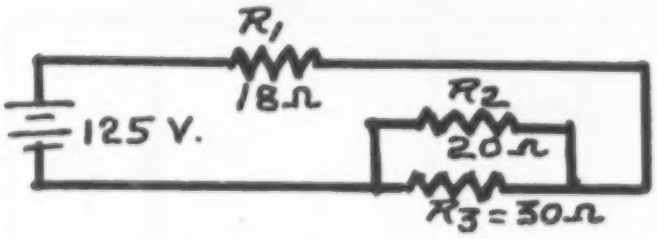

3.

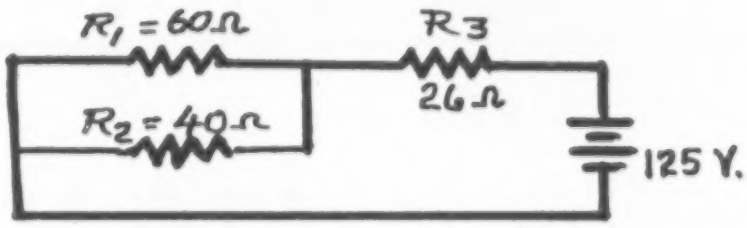

15071

UNIT XI - OHM'S LAW

Lesson No. 7 — Analysis of A Complex Circuit

If you have a circuit like Fig. 1 shown below, and wish to do a complete circuit analysis - that is, to obtain the values of all the voltage drops and currents in the circuit - it is necessary to do some simplifying.

Notice that the circuit is composed of three distinct portions: a group of resistors in parallel, from A to B; a single resistors R_5, from B to C; and a pair of resistors in parallel, from C to D.

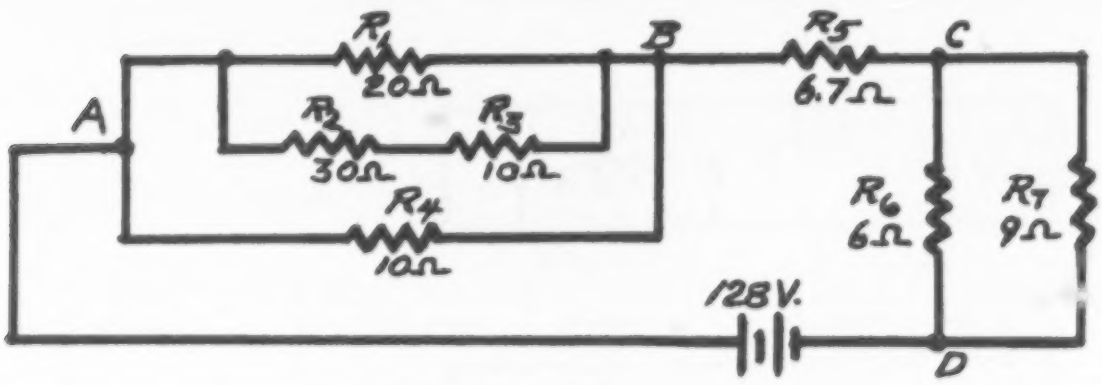

Fig.: X1-7-1

It is first obvious that R_2 and R_3 are in series. We can add the values of these two resistors for the sake of simplicity. We obtain a value of 40 ohms for $R_{2,3}$, which is in parallel with R_1 and R_4. This is shown in Fig. 2:

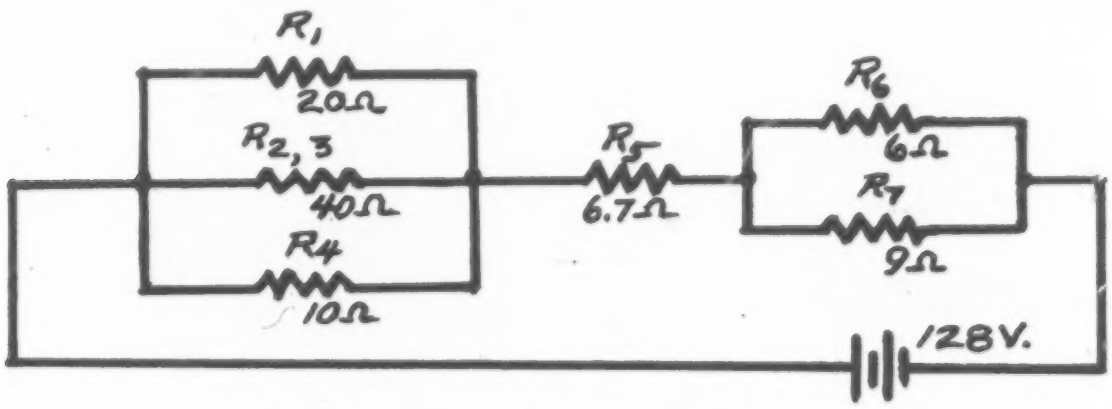

Fig.: X1-7-2

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R_1, R_4, and $R_{2,3}$ may now be reduced to one resistance value by using the reciprocal method.

$$R_{1,2,3,4} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_{2,3}} + \frac{1}{R_4}} = \frac{1}{\frac{1}{20} + \frac{1}{40} + \frac{1}{10}} = \frac{1}{\frac{2}{40} + \frac{1}{40} + \frac{4}{40}}$$

$$= \frac{1}{\frac{7}{40}} = 1 \times \frac{40}{7} = \frac{40}{7} = 7\overline{)40.0} = 5.7 \text{ ohms.}$$

Using the same method, R_6 and R_7 can be reduced to one value of 3.6 ohms. Actually, the product-over-the-sum method would be better than the reciprocal method since there are only two resistors involved.

We can now reduce the original circuit to an equivalent series circuit, as shown in Fig. 3.

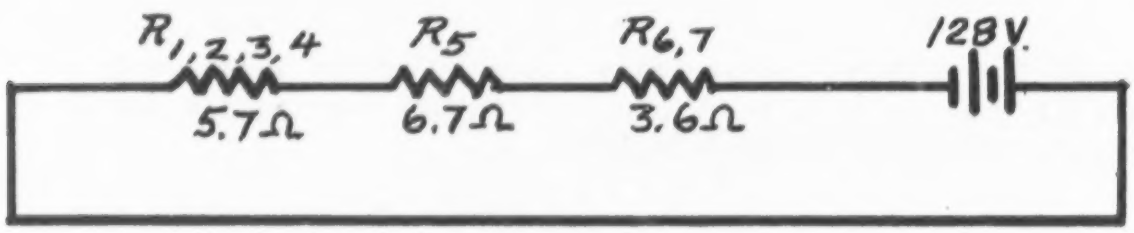

Fig.: X1-7-3

We may now further reduce Fig. 3 to Fig. 4.

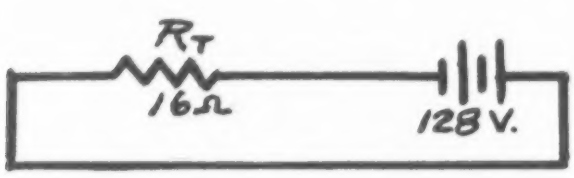

Fig.: X1-7-4

This shows the total resistance of the circuit to be 16 ohms. Next, we shall find the total circuit current.

$$I_t = \frac{E_t}{R_t} = \frac{128}{16} = 8 \text{ A}$$

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217 OF 327

ED

056 238

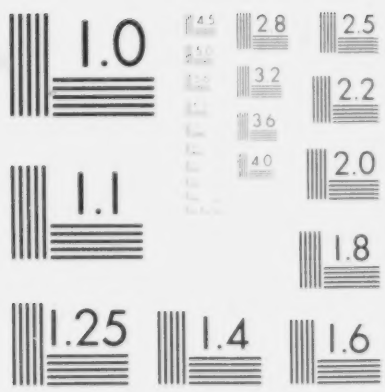

MICROCOPY RESOLUTION TEST CHART

In Fig. 3, we reduced the voltage drops to three major divisions. Let us look at this circuit again and obtain the values of the voltage drops.

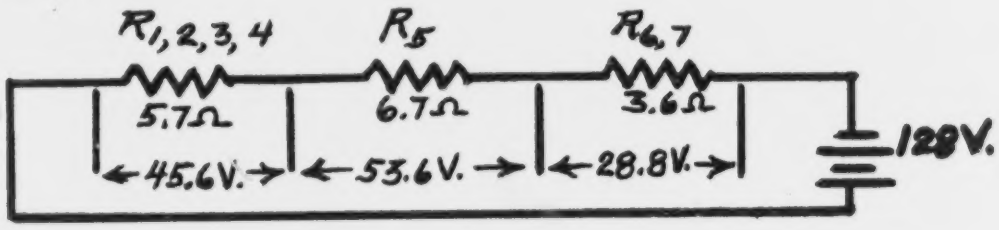

Fig.: XI-7-5

$$E_{R_{1,2,3,4}} = I \times R = 8 \times 5.7 = 45.6 \text{ V}$$

$$E_{R_5} = I \times R = 8 \times 6.7 = 53.6 \text{ V}$$

$$E_{R_{6,7}} = I \times R = 8 \times 3.6 = 28.8 \text{ V}$$

TOTAL 128.0 V.

The addition of the total voltage drops results in a total equal to the applied voltage. This proves that the figures for E are correct. This is Kirchhoff's law.

Going back to Fig. 1, we find that there are three paths for current-flow from Point A to Point B. We have now found that the voltage drop across this combination is 45.6 V, and we know the value of the total resistance in this parallel combination.

To find the value of I_{R_1}, we use:

$$I_{R_1} = \frac{E_{R_1}}{R_1} = \frac{45.6}{20} = 2.28 \text{ A}$$

Similarly, $I_{R_4} = \frac{E_{R_4}}{R_4} = \frac{45.6}{10} = 4.56 \text{ A}$

Since R_2 and R_3 are in series, 45.6 volts is not the voltage drop across either <u>one</u> resistor, but across both. So, for better understanding, we'll say

$$I_{R_{2,3}} = \frac{E_{R_{2,3}}}{R_{2,3}} = \frac{45.6}{40} = 1.14 \text{ A}$$

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We know that these three currents should now add up to the value of I_t. This is one way to check the accuracy of our calculations.

$$I_{R_1} = 2.28 \text{ A}$$

$$I_{R_{2,3}} = 1.14 \text{ A}$$

$$I_{R_4} = \underline{4.56 \text{ A}}$$

$$\text{TOTAL} \quad 7.98 \text{ A}$$

This is close enough to 8 amperes for us to accept.

This still leaves us without knowing the value of the voltage drops across the individual resistors R_2 and R_3. We know now that a current of 1.14 A flows through each of these resistors, so finding the voltage drops is simple, using Ohm's Law $E = I \times R$.

$$E_{R_2} = I_{R_2} \times R_2 = 1.14 \times 30 = 34.20 \text{ V}$$

$$E_{R_3} = I_{R_3} \times R_3 = 1.14 \times 10 = 11.4 \text{ V}$$

checking, $E_{R_2} + E_{R_3} = 45.6 \text{ V}$

Let us review how we can solve a complicated problem such as this.

(1) Examine the circuit carefully and decide what distinct portions it consists of.

(2) Reduce the resistances in each portion to a single, equivalent value.

(3) Redraw the circuit in the simplest form possible.

(4) Calculate the value of the total resistance.

(5) Calculate the value of the total circuit current.

(6) Calculate the voltage drops over each portion of the circuit.

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(7) Going back to the original problem, calculate the current through each resistance, based on the figures for E and I that you have found.

Check your figures as you work them out.

PROBLEMS:

1. In the circuit shown, find R_t, I_t, E_{R_2}, I_{R_3}, and E_{R_4}.

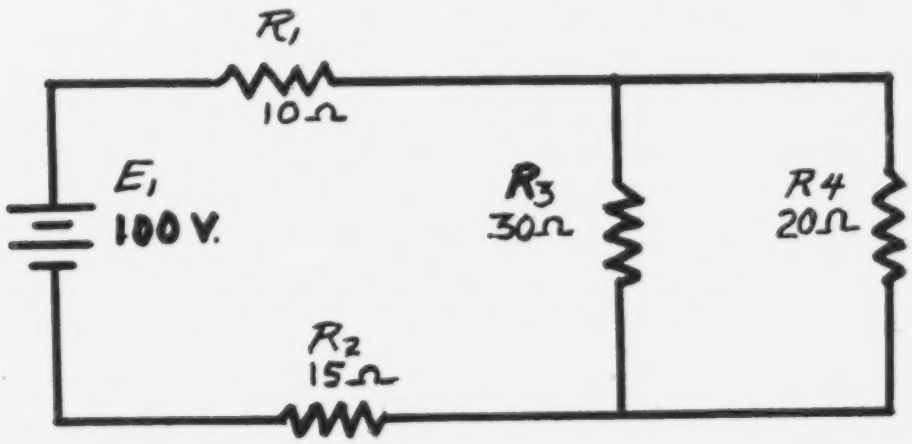

2. In the circuit shown below find I_{R_2}, I_{R_3}, E_{R_2}, E_{R_3}.

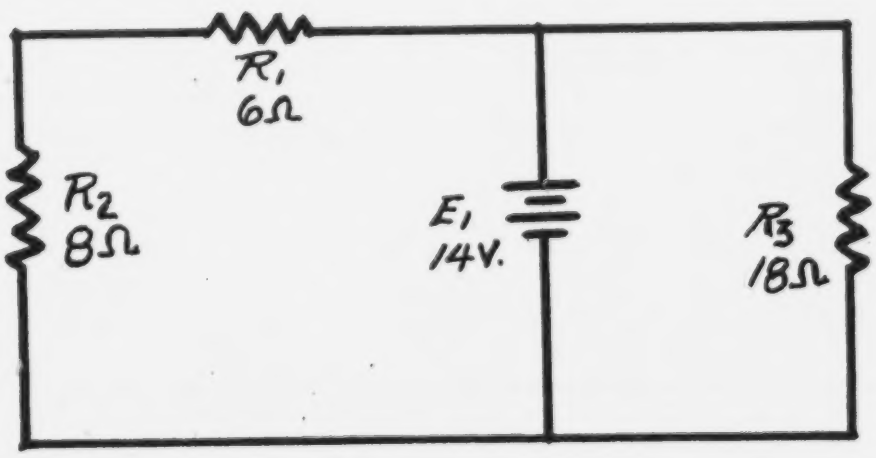

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3. In the following circuit find the values of E_{R_3}, I_{R_3}, E_{R_2}, I_{R_2}, E_{R_5}.

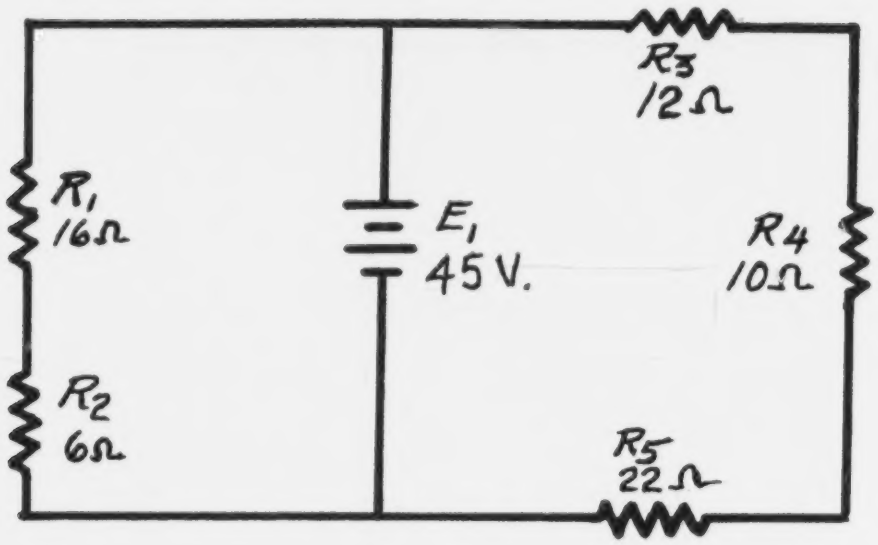

4. Find I_{R_1}, I_{R_2}, I_{R_3}, I_{R_4}, I_{R_5}, E_{R_1}, E_{R_2}, E_{R_5}, and E_{R_6}.

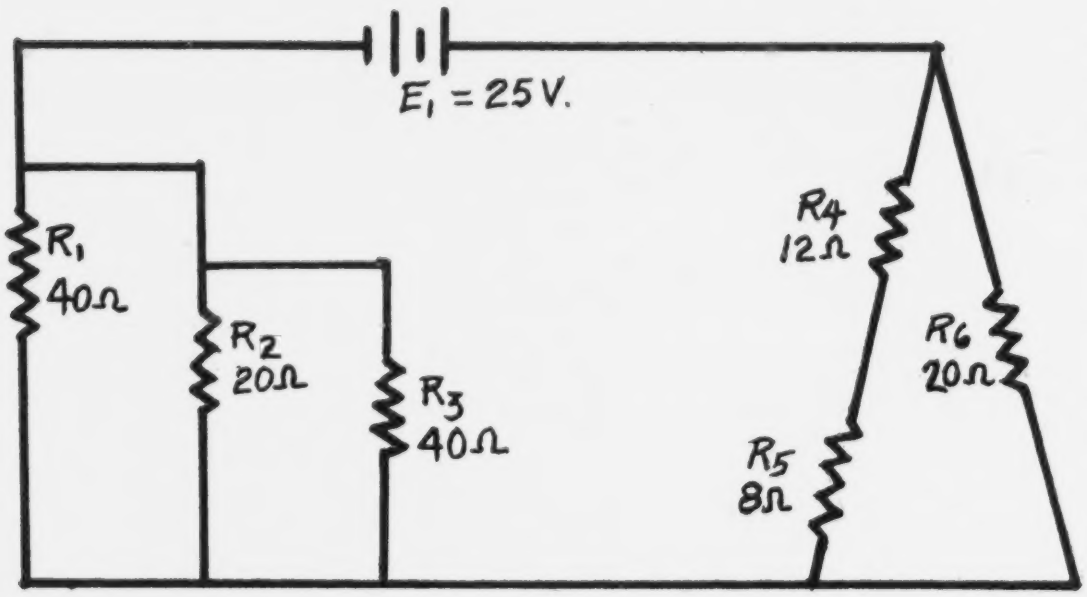

15079

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: II. CARBURETOR-SINGLE BARREL

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Carburetor

CONDITIONS:

BEHAVIOR:

32. If carburetor is satisfactory, clean and replace tools and materials to proper place
33. Remove and store fender covers
34. Close hood
35. Return automobile to proper parking area
36. Remove seat covers and store in proper place
37. Clean work stall for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, overhaul, replace, and test a single barrel carburetor in 2½ hours.

Learning time: 6 hours

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5. Find I_{R_1}, I_{R_2}, I_{R_3}, I_{R_4}, I_{R_5}, E_{R_1}, E_{R_2}, and E_{R_3}.

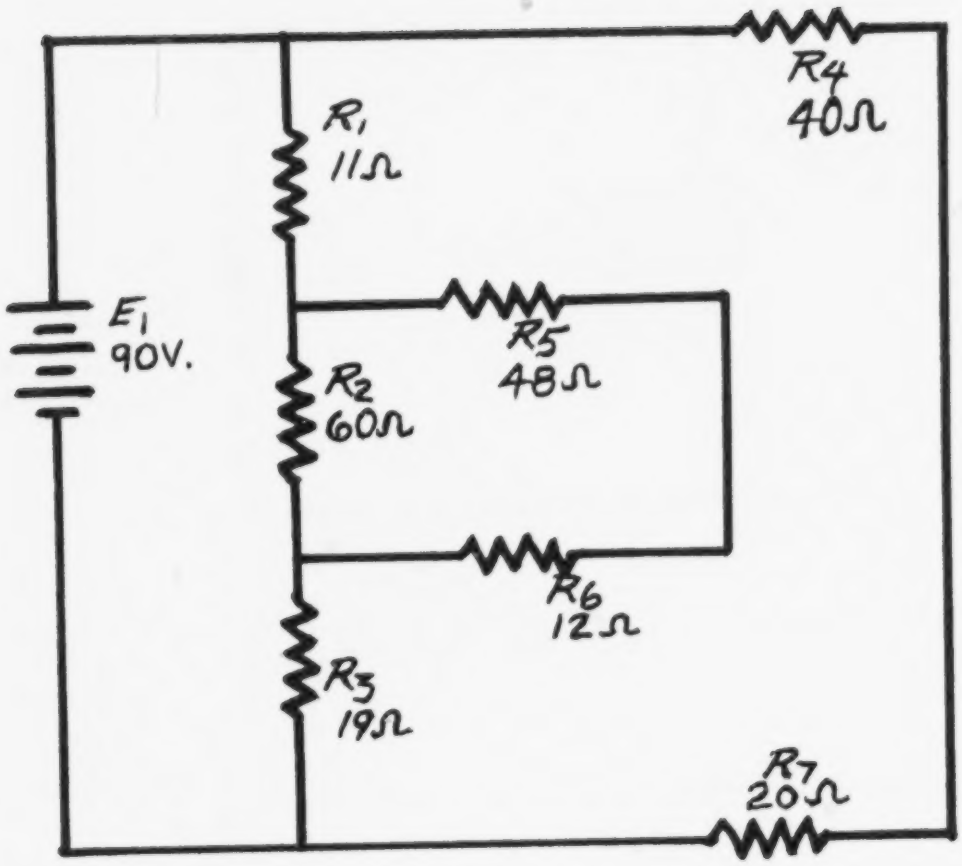

15081

UNIT XII - READING THE METERS

Lesson No. 1 Reading Voltages

There are numerous multimeters, or VOM's, available in this country. They vary in size, shape, sensitivity, the arrangement of the scales on the meter face, and in the number of functions possible. Once you learn how to read one, however, you will find it easy to read any of them, after a little study of their ranges, functions, and scales.

A single multimeter may be used to measure voltage, resistance, or current - and each of these over a wide range of values. In order to properly read off the particular value we are trying to measure, we must first connect our leads properly and then turn the switches on the meter to the proper positions. The needle will move to a certain position, and we must read this point on the proper scale. Sometimes we will have to mentally move the decimal point as well - but after a while this will become easy.

The FUNCTION SWITCH is the switch which changes the multimeter from an a-c meter to a d-c meter. (See Figure XII-1-1.) Some meters also have a position labeled output. This gives the same circuit conditions as the a-c position, but is there for making special a-c output measurements under special test arrangements. When the switch is on a-c it is set for all a-c measurements. However, many VOM's do not measure alternating current. In those meters, the a-c position measures a-c volts only.

When the function-switch is turned to d-c, the meter may be used as a d-c voltmeter, a d-c ammeter, or an ohmmeter, depending on where the range-switch is set.

The RANGE SWITCH (See Figure XII-1-1) is a rotary switch which lets us select different ranges for measuring voltage, amperage, and resistance with accuracy. Imagine how little accuracy there would be in measuring 3 volts on a 500-volt range. Also, imagine how much more accurately you can read 30 ohms on a range that goes up to 1000 ohms than on a range that goes to 100 K-ohms. Some meters have a range in megohms.

The different positions of the range-switch tell us the maximum amount that the meter will measure with the switch in that position. For example, if the switch points to 50V, that means it can measure from zero up to 50 volts. If the range-switch points to 10 MA, that means that the meter will measure from zero to 10 milliamperes.

15082

Let's connect our test leads (the red one to the positive jack, the black one to the common jack) and make a d-c voltage measurement. We know that we are measuring a d-c voltage, but we don't know how much. So we start at the highest range and, if the needle shows practically no movement, we drop down to the next lower range, and then on down until the needle gives us a good reading - not too near either end of the scale.

Suppose the function-switch, the range-switch, and the needle-indicator look like Fig. XII-1-1.

What are we measuring? Well, we know it is a d-c voltage because the function-switch is on DC. Since the range-switch is on 5V, we know it is less than 5 volts - 5 volts being the maximum voltage on that range.

Where is the 5-volt range? You won't see a 5-volt range, but, looking on the center scale, you will see a 50-volt range. Find it. If the range-switch is on 5V, then the 50 is read 5.0 V.

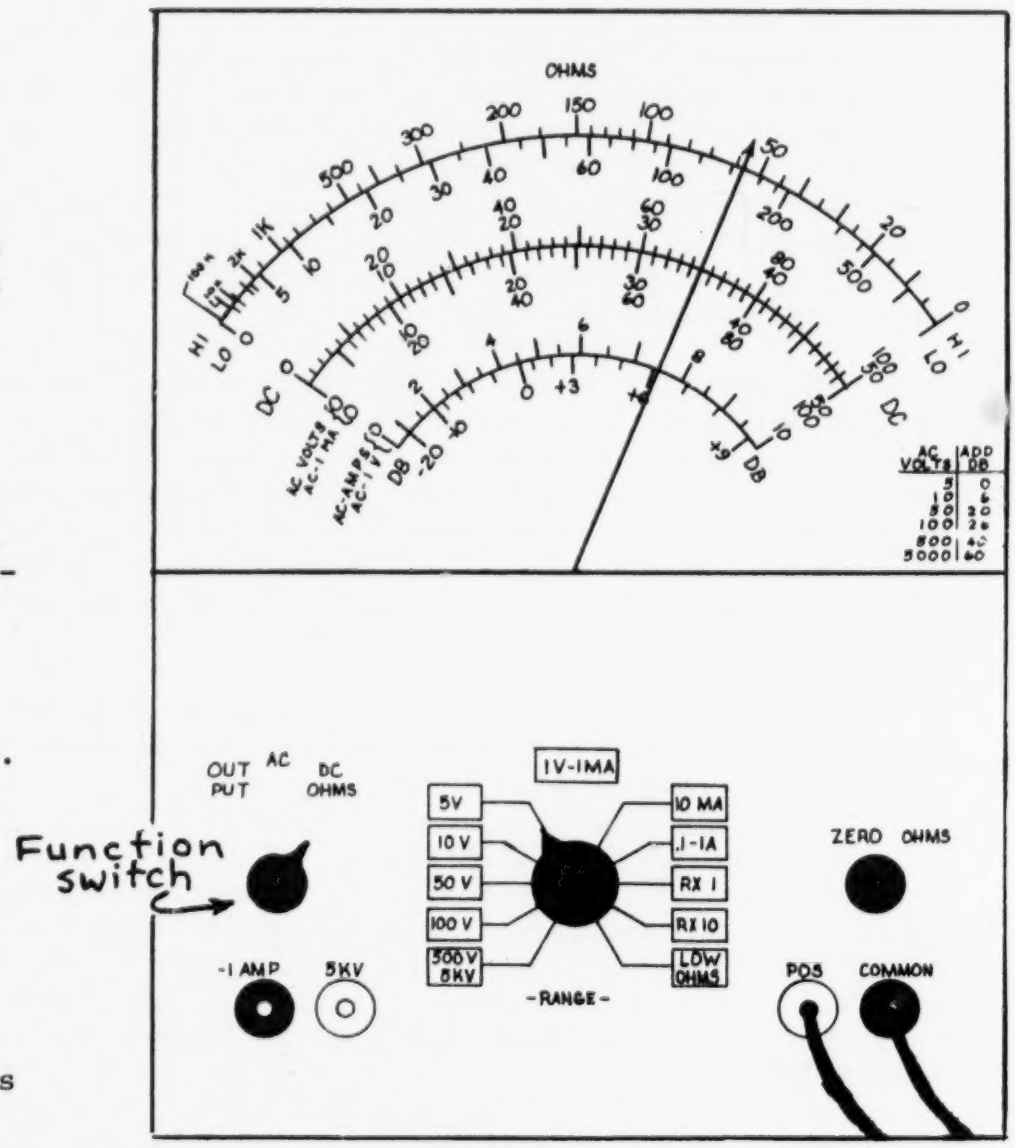

Fig.: XII-1-1

15084

You will see now that the needle is exactly halfway between 30 and 40 (or 3.0 and 4.0 on this range). Therefore the voltage we are reading is 3.5 volts d-c.

Had the needle rested here when the range-switch was on 50V, the voltage would have been read directly as 35 volts. Had the range-switch been on 500V, the voltage would have been 10 x 35, or 350 volts. Had the needle rested at the same position, while the red lead was connected to the 5KV jack instead of the positive jack, the voltage would have been 3,500 volts.

All of this sounds very difficult, but it is simply a matter of moving a decimal point. If a scale goes up to 100 and we are operating in a range going up to 1, we simply divide our reading by 100 - that is, move the decimal point two places to the left. This makes the maximum reading correct at 1.00. If the needle pointed to 40, the reading would become 0.40 (volts or amps as the case might be).

Similarly, if we are using a scale that goes up to 50V and we are operating in a range that goes up to 500V, we move our decimal point one place to the right. The maximum becomes 500V and our reading of 35V becomes 350V.

Look at the scale opposite the large arrow on Figure XII-1-2. D-c voltage values are read above the curved line, and a-c values are read below the line.

You will note that the values of a-c voltage do not correspond exactly to the d-c values. This is due to the fact that a-c must be brought in through a rectifier and that reactance is involved. You will understand this after you have learned more about electricity.

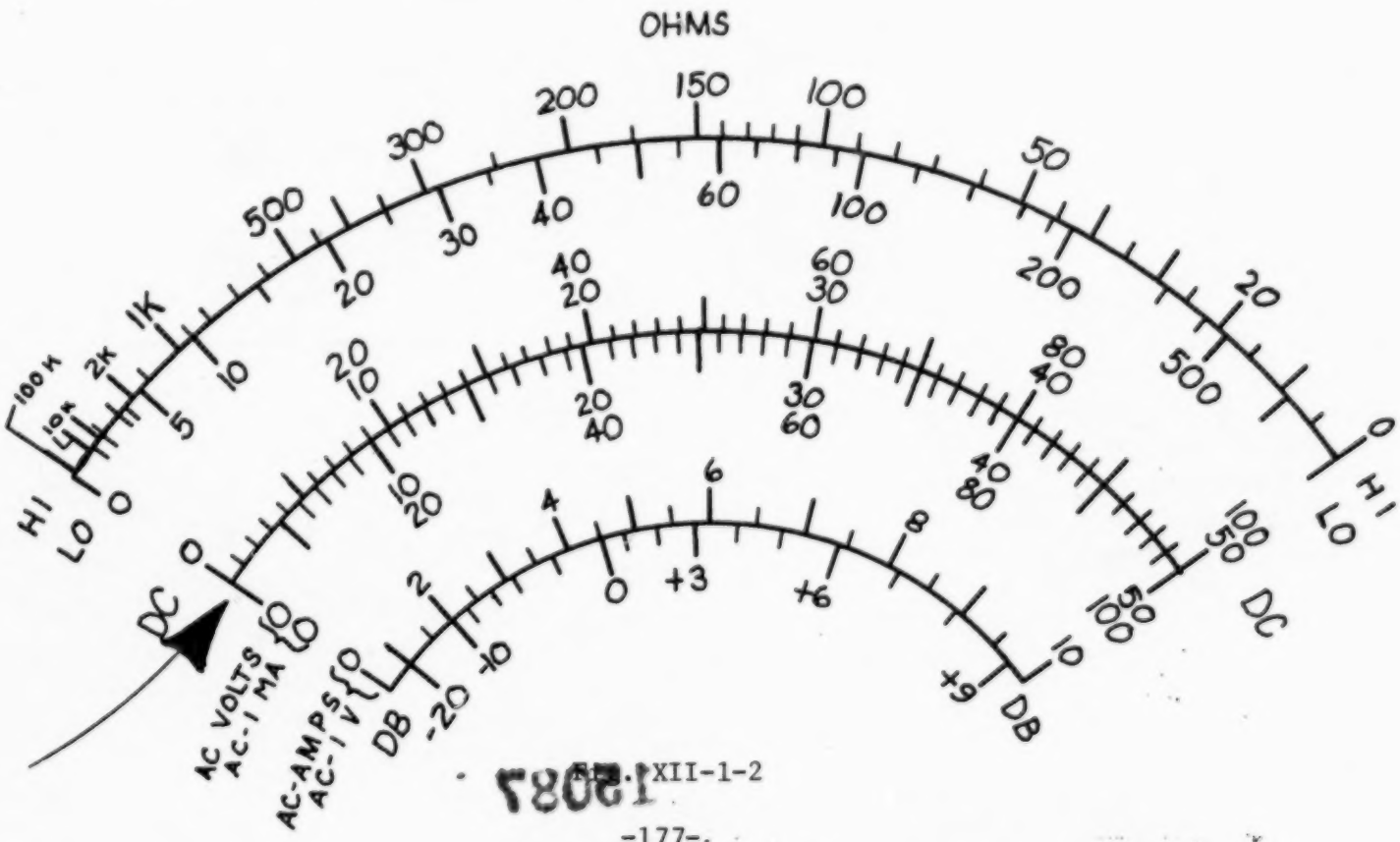

FIG. XII-1-2

15085

Look again at the range opposite the arrow. Note that, at 50 volts, the a-c reading is the same as the d-c reading, but at 10 volts, the a-c reading is lower on the scale than the d-c reading.

As a-c voltages become lower and lower, they are farther and farther from the corresponding d-c voltage readings.

Look at Fig. XII-1-3. You will see that we are reading a-c, since the function-switch is on AC. The range-switch indicates 1 volt. In this case, we do not use the 50-volt (center) scale. For readings of less than 1-volt a-c, we use the 1-volt scale. Find it. The needle rests on 2 on this scale. But since the full-scale reading is only 1 volt (and not the 10 marked on it), this reading must be 0.2 volts. Now look at the 1-volt d-c scale. (The 1-volt d-c scale is the one indicating 100 at full-scale reading. The 100 is read as 1.00 volt when the range-switch is on 1V.) We see that the needle is indicating 12 volts on the d-c range or 0.12 volts on the scale we are using. Here you can see the need for a separate scale for low a-c voltages.

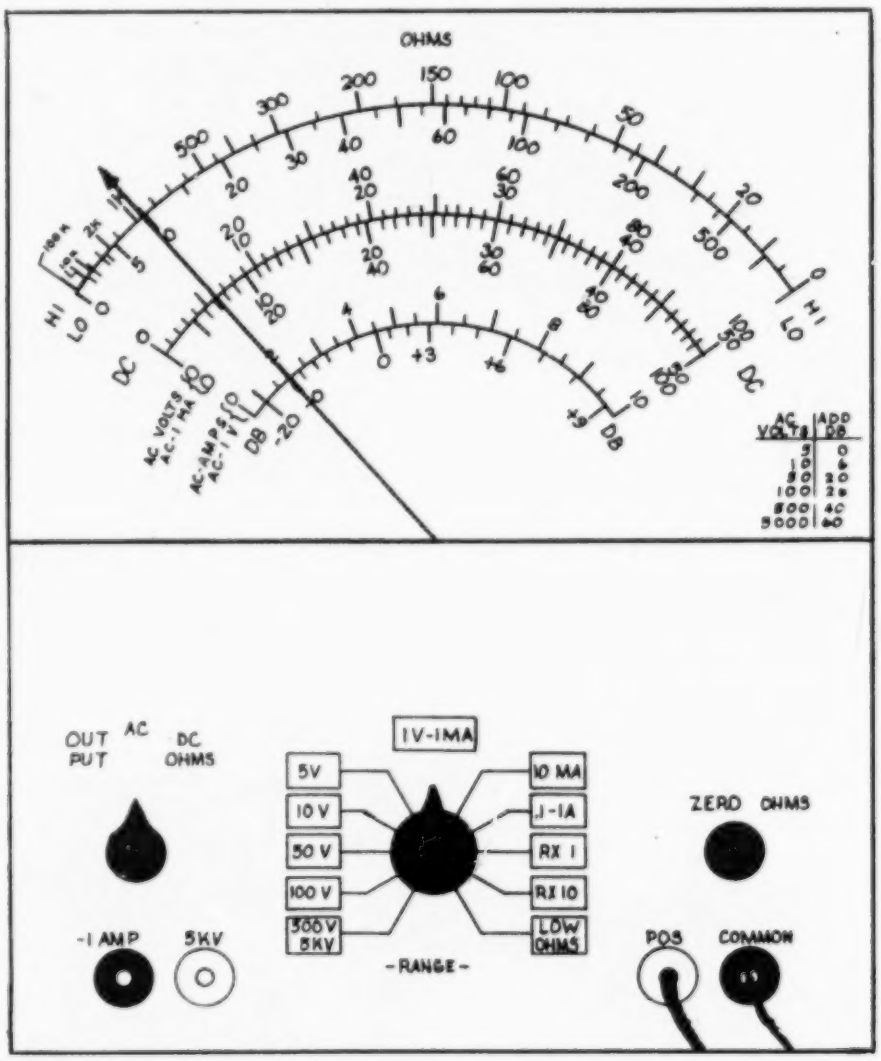

Fig. XII-1-3

15087

ASSIGNMENT:

1. What is the function of the function-switch?

2. What is the purpose of the range-switch?

3. Why isn't the needle deflected as far for 0.2 volts a-c as it is for 0.2 volts d-c?

4. Using the first line below as an example, supply the missing numbers for the other lines.

Your range-switch points to:	Your meter scale goes up to:	The needle points to:	This is read as:
10	100	30	
5	50	24	
500	50	24	
100	100	72	
1	100	72	
1	10	6	
10	100	62	
50	50	43	
1	10	8	
5K	50	22	

5. Use a hard-lead pencil and, very lightly, mark the leads, switches, and the four meter faces indicating (a) 40 volts d-c, (b) 2.5 volts d-c, (c) 75 volts a-c, (d) 0.7 volts a-c on the four meter-face diagrams on the next page.

12030

15088

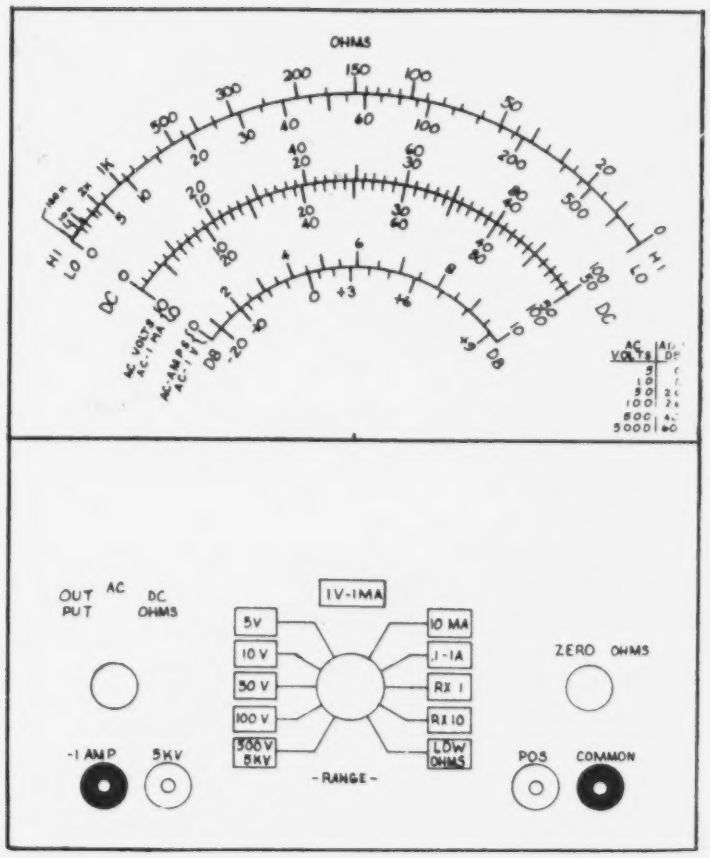
OHMS
DC
AC VOLTS
AC-AMPS
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

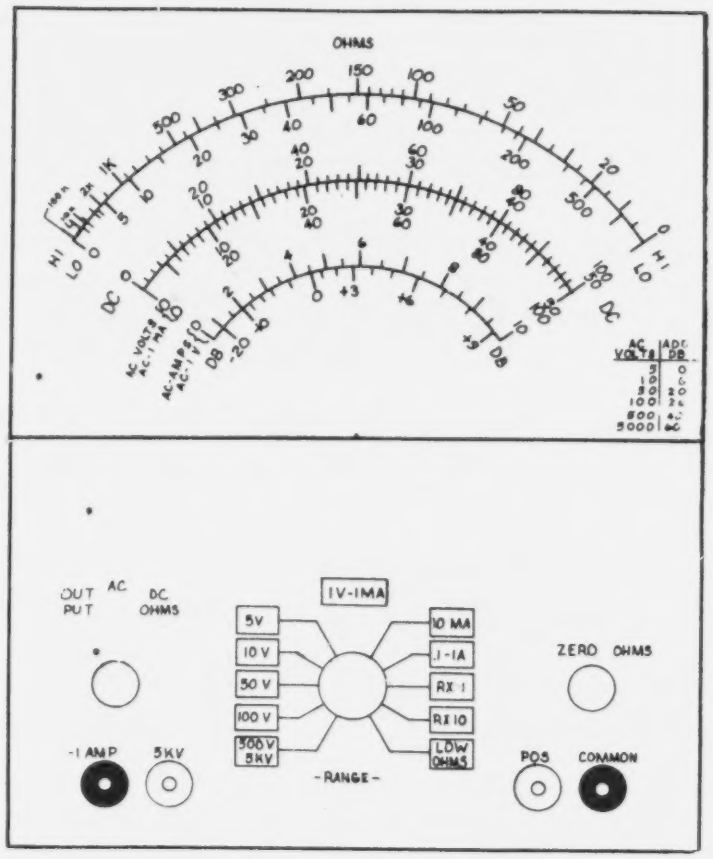
OHMS
DC
AC VOLTS
AC-AMPS
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

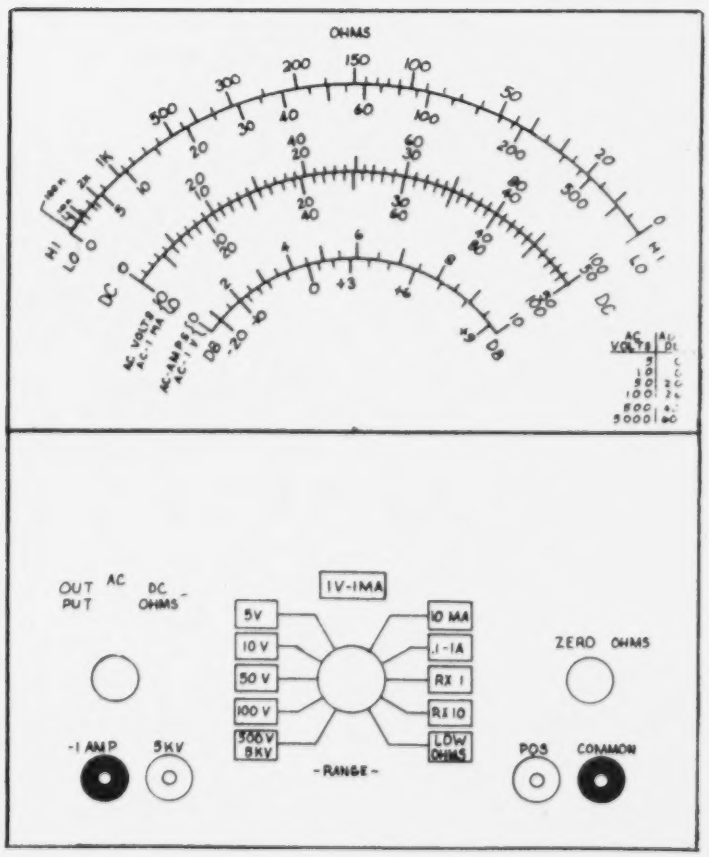
OHMS
DC
AC VOLTS
AC-AMPS
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

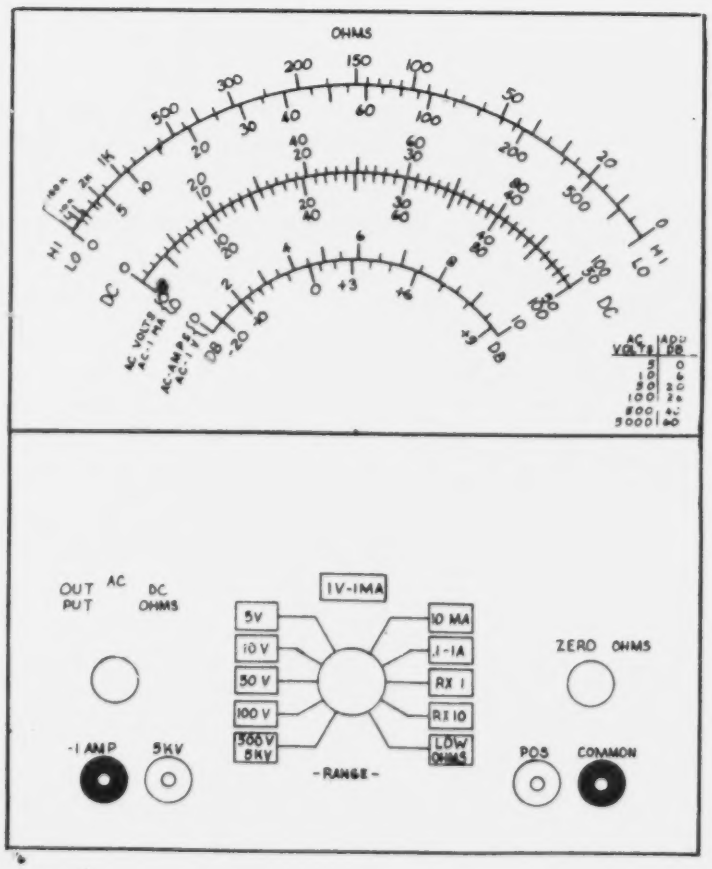
OHMS
DC
AC VOLTS
AC-AMPS
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

15090

12088

UNIT XII - READING THE METERS

Lesson No. 2 — Reading Resistance

Some meters have more resistance ranges than others. The one we are using in this lesson has only three ranges, as you will see if you look toward the right of the range-switch. With the switch on the R x 1 range, the resistance is read directly on the scale; with the switch on the R x 10 range, we multiply the scale-reading by 10. The LOW OHMS range is read on its separate scale, just below the other scale.

Look at Figure 1. If the meter is set up and reads like this, we are reading 50 ohms. (Note the position of the switches.) Should the needle be in the same position but with the range-switch on R x 10, then we would be reading 50 x 10 or 500 ohms.

The LOW OHMS range actually gives us another type of ohmmeter, and you will notice that 0 ohms is on the opposite end of the scale. This is because, when the range-switch is on LOW OHMS, we switch in a shunt-type ohmmeter instead of the series-type we have when we are switched to either the R x 1 or the R x 10 range.

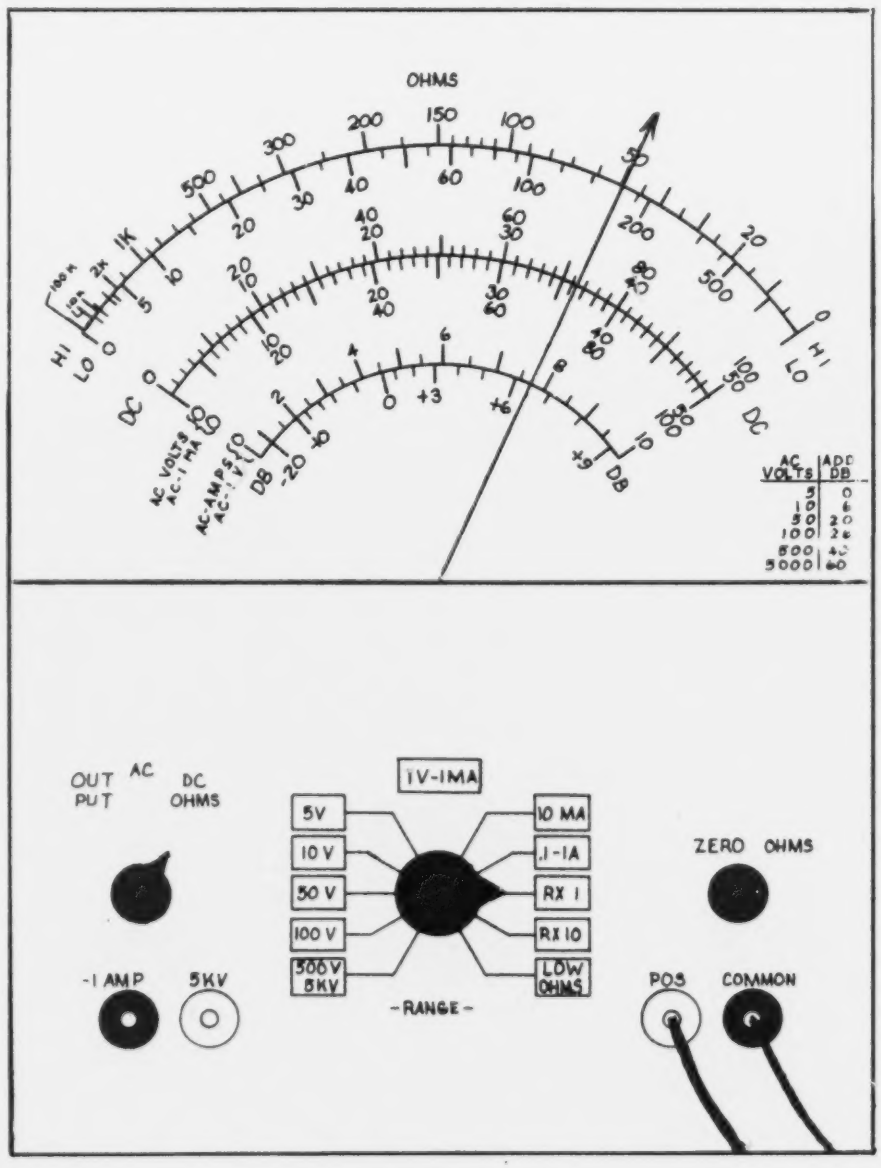

Fig.: XII-2-1

15091

When you learn about shunt ohmmeters, you will learn that current is drawn continuously through them. Therefore, when this meter is switched to LOW OHMS, if left in this position the battery in the meter will soon be exhausted. Use the low-ohms range only for measuring low values of resistance.

There is a slightly greater degree of accuracy in measuring small-resistance values on the low-ohm range. Compare the distance between 0 and 20 on each scale and you will see that there is more distance (giving greater reading accuracy) on the low-ohms scale than on the regular ohms scale.

ASSIGNMENT:

On the following four figures, indicate (very lightly, with a hard-lead pencil) the following values. Show the leads coming from the proper lead jacks, the position of the switches, and the position of the needle.

1. 20KΩ
2. 750Ω
3. 5KΩ
4. 120Ω (on the low-ohms scale)

15093

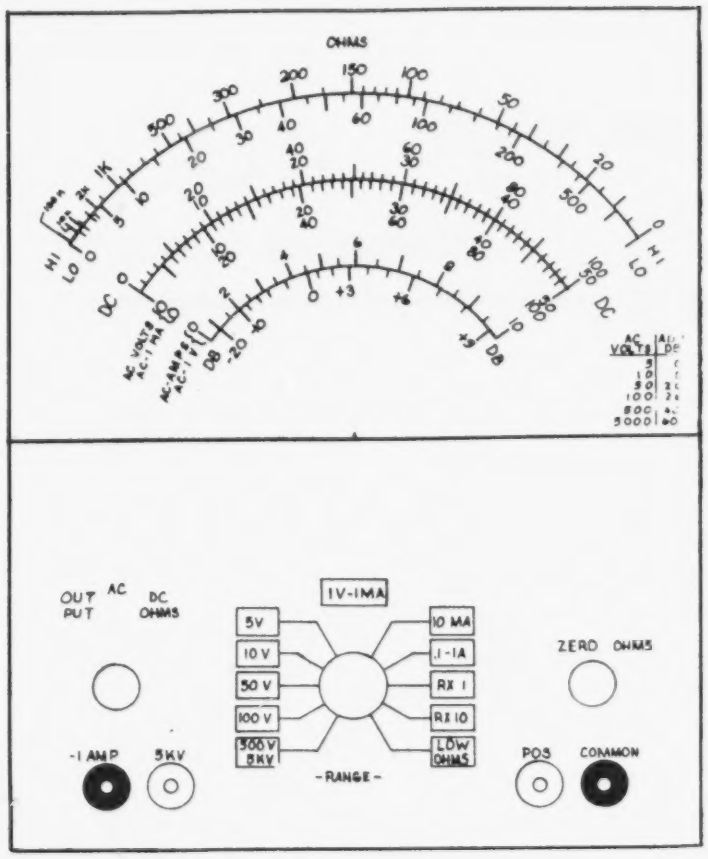
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

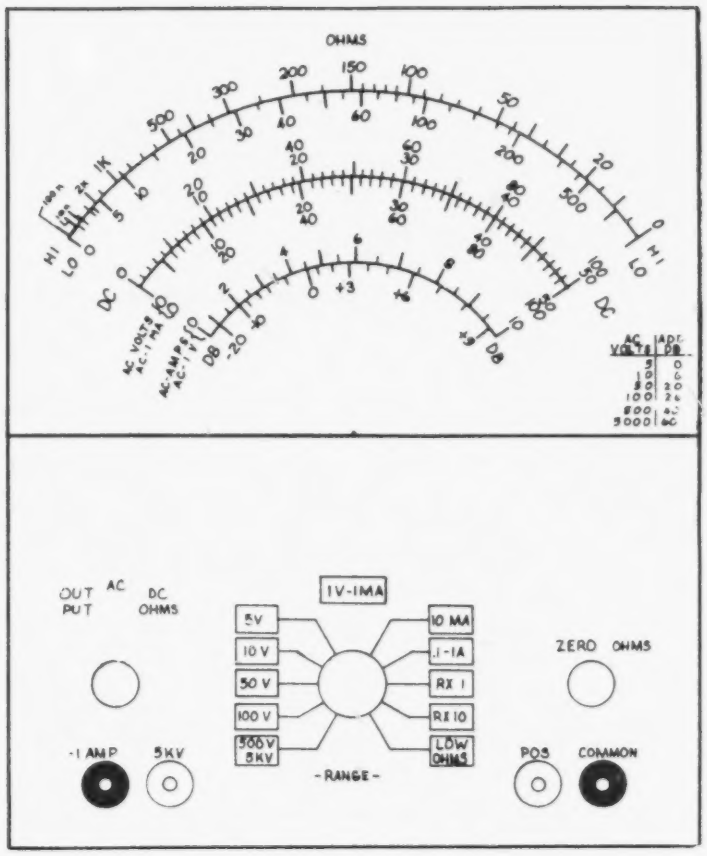
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

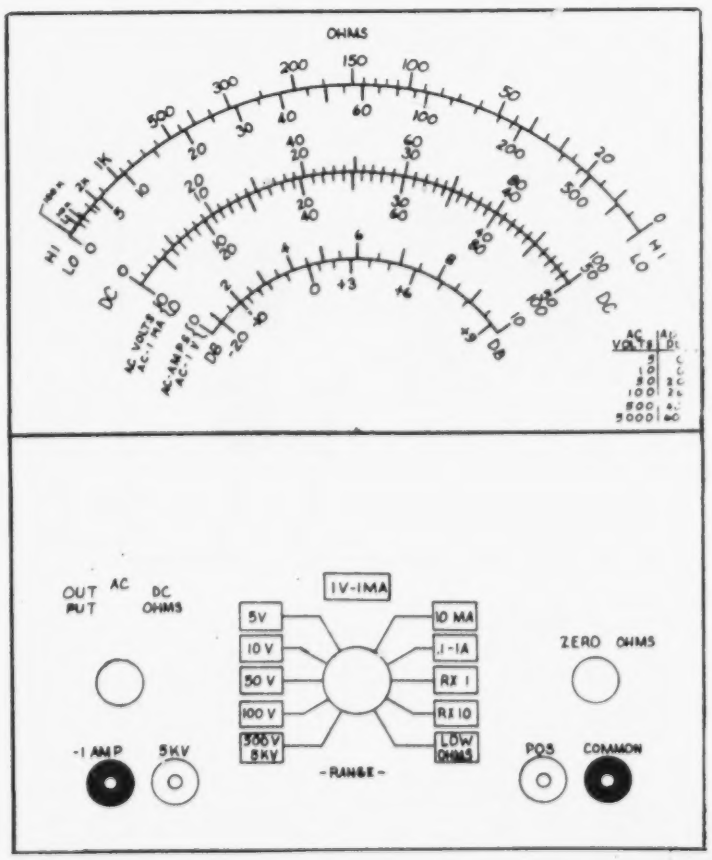
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

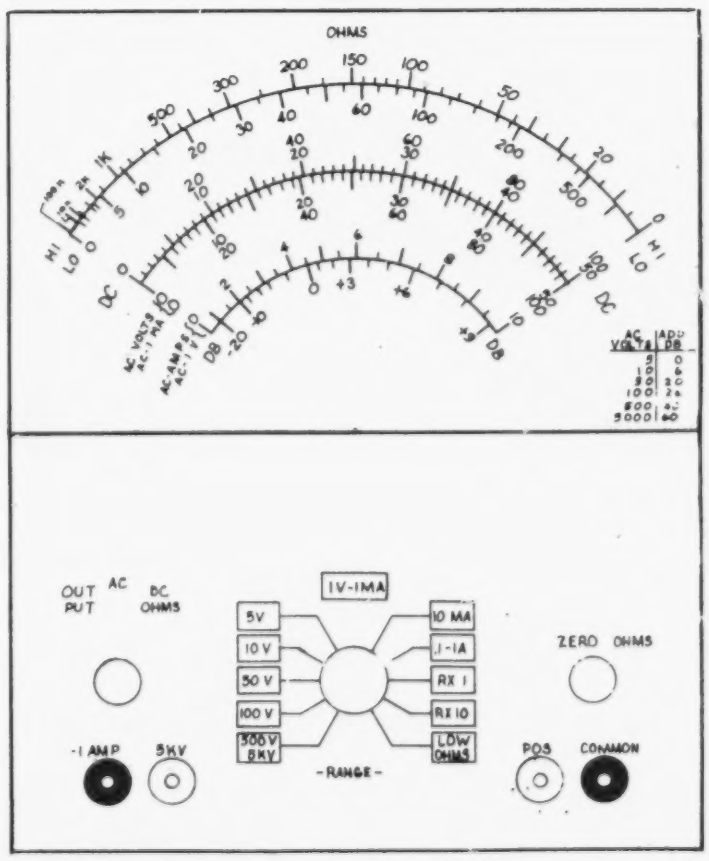
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
-1 AMP
5KV
POS
COMMON

1208
15094

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III FUEL SYSTEM

MILESTONE: III CARBURETOR - TWO BARREL

PERFORMANCE OBJECTIVE NO: 3 TITLE: Remove, Disassemble, Reassemble, Test and Adjust Carburetor

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Two barrel carburetors	1. Automotive Fuel, Lubrication, and Cooling Systems, by Crouse. pp. 136 through 140	1. Related Information Class

UNIT XII - READING THE METERS

Lesson No. 3 — Measuring Current

Let's look at the meter shown in Figure 1. The function-switch is on d-c; the range-switch is on 10 MA. You will see that the needle lies across 40 on the 100 d-c scale.

How many MA's does this represent? We must read the 100 scale as 10.0 MA when we use the 10 MA range. So the 40 means 4 milliamperes.

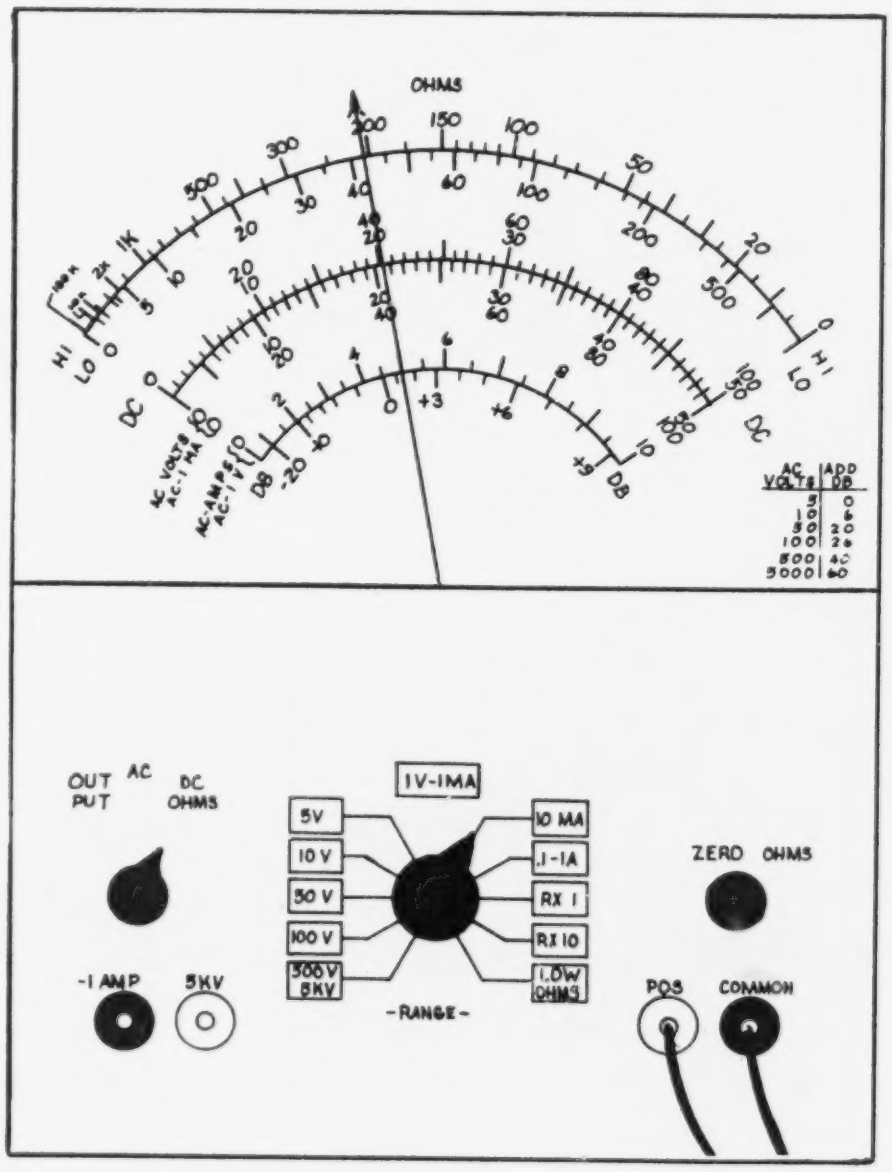

Fig.: XII-3-1

15096

If we have our meter in series with a circuit, what would we be measuring on the meter shown in Figure 3?

First, note that the function-switch is on a-c. Now since we have the meter in series with the circuit, we are reading current. (A connection across the circuit would be for measuring volts.)

The range-switch is on the 1 MA range since we are reading current, so we must be reading less than 1 MA. Look at the AC - 1 MA scale. The needle is on 14, but the scale goes to 100. Converting this to 1.00, we convert the 14 to .14. Thus we are reading 0.14 MA, a-c.

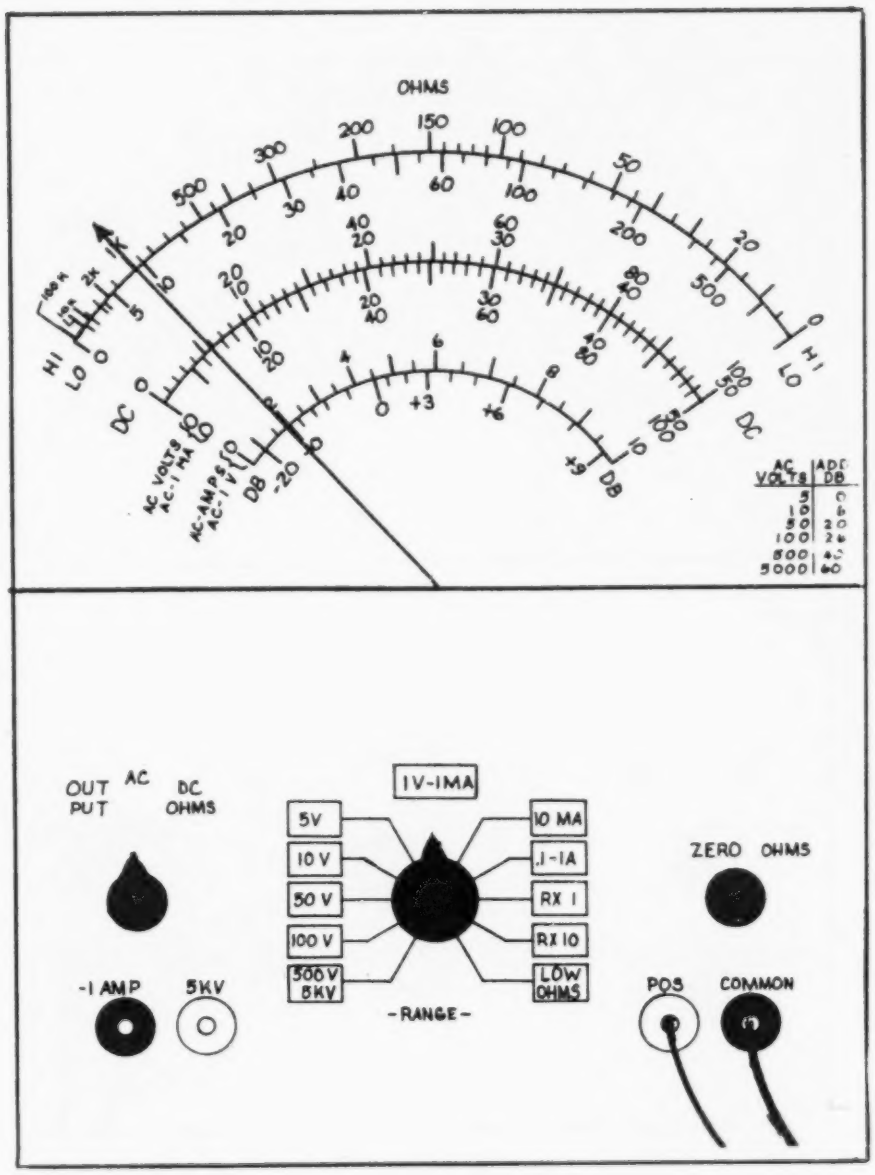

Fig.: XII-3-3

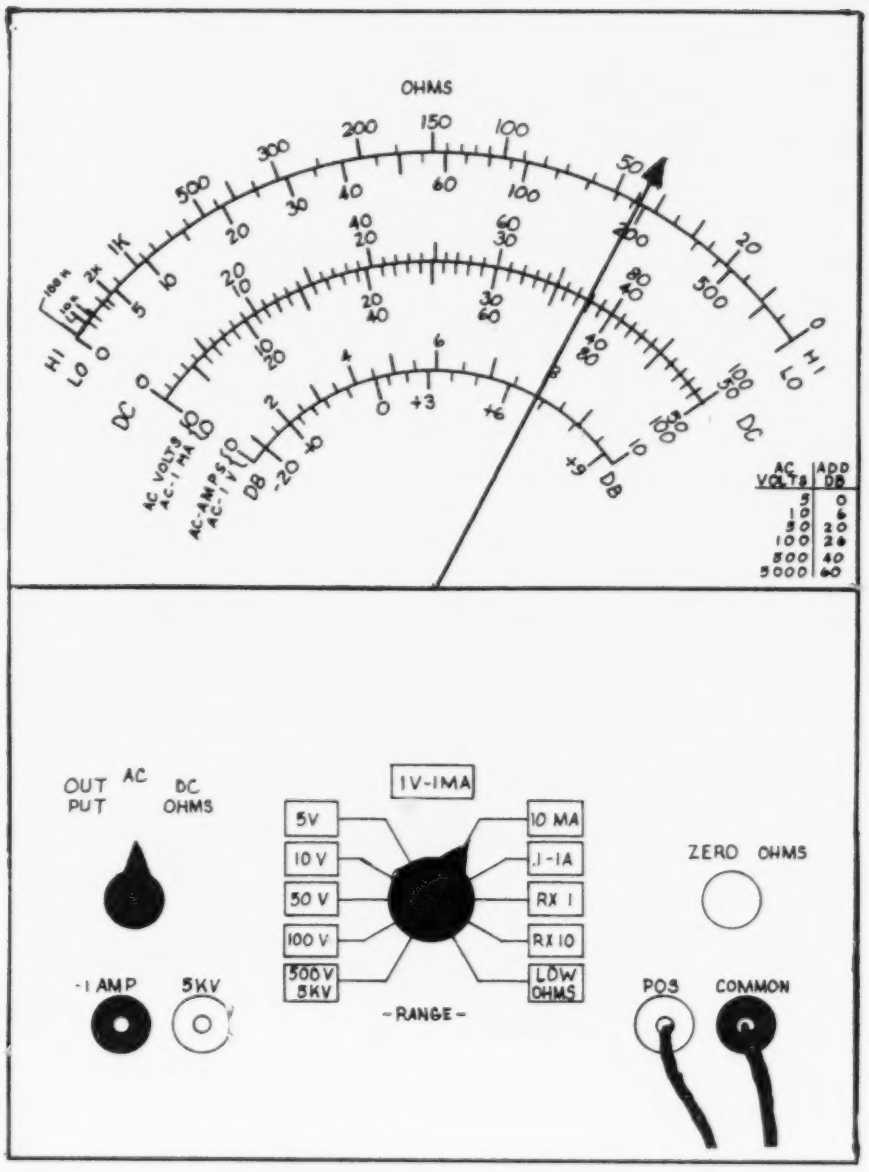

Fig.: XII-3-4

Figure XII-3-4 shows a VOM indicating a measurement of 8 MA, a-c. Make sure you see that the needle is on 8 on the AC - AMPS scale, that the function-switch is on a-c and the range-switch is on 10 MA. What would you be reading if the function-switch were on d-c and the range-switch were on 10V?

REMEMBER: Just as you do in measuring voltages, if you don't know the general range of the current you are about to measure, start with the high ranges so that you will not ruin the meter.

15100

ASSIGNMENT:

On the following four meter-face diagrams, draw the leads, switch settings, and needles to have them indicate the following values:

1. 0.6MA, d-c
2. 0.1MA, a-c
3. 2 MA, a-c
4. 2 MA, d-c

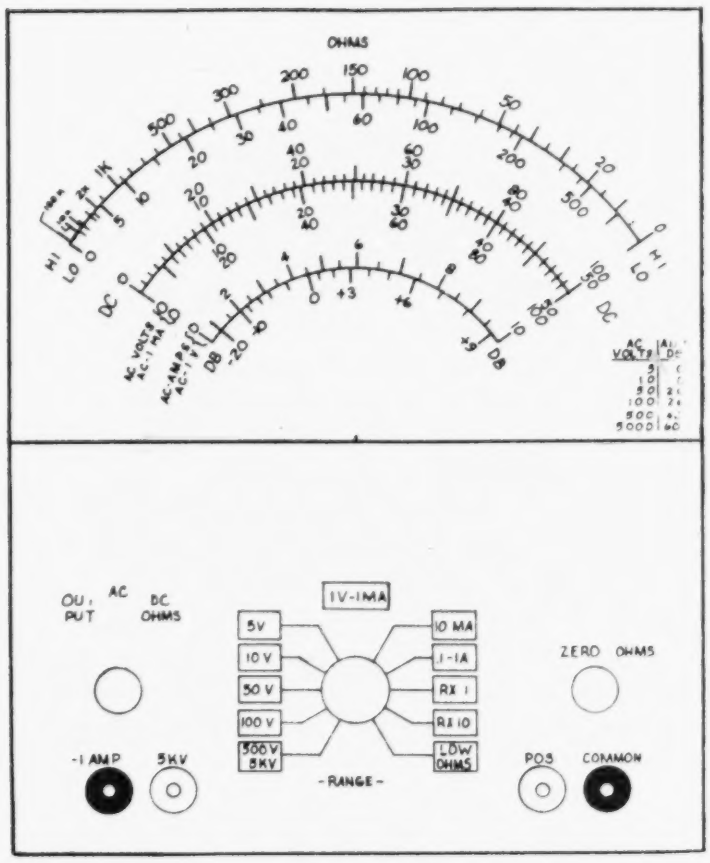

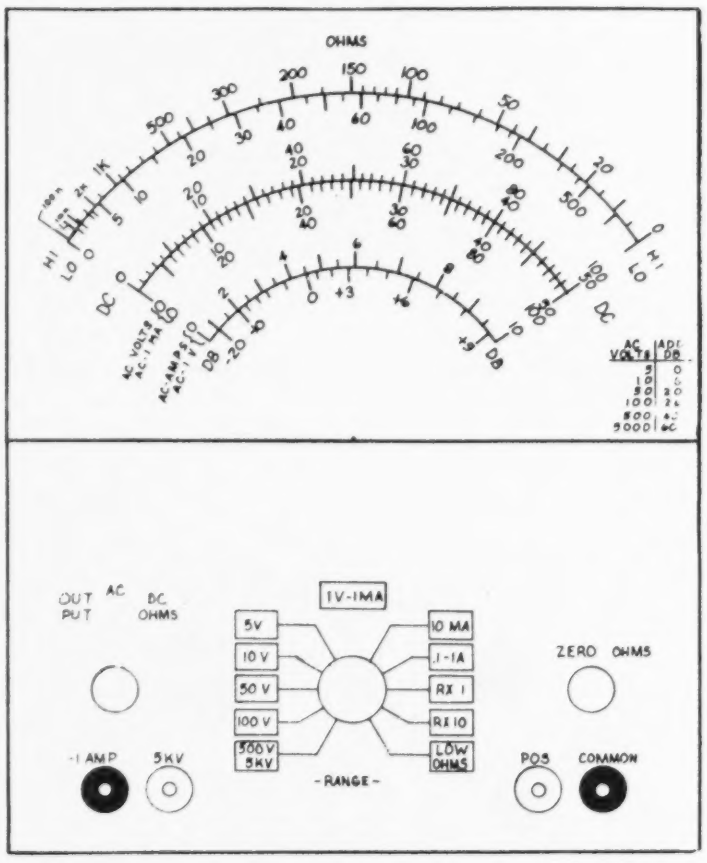

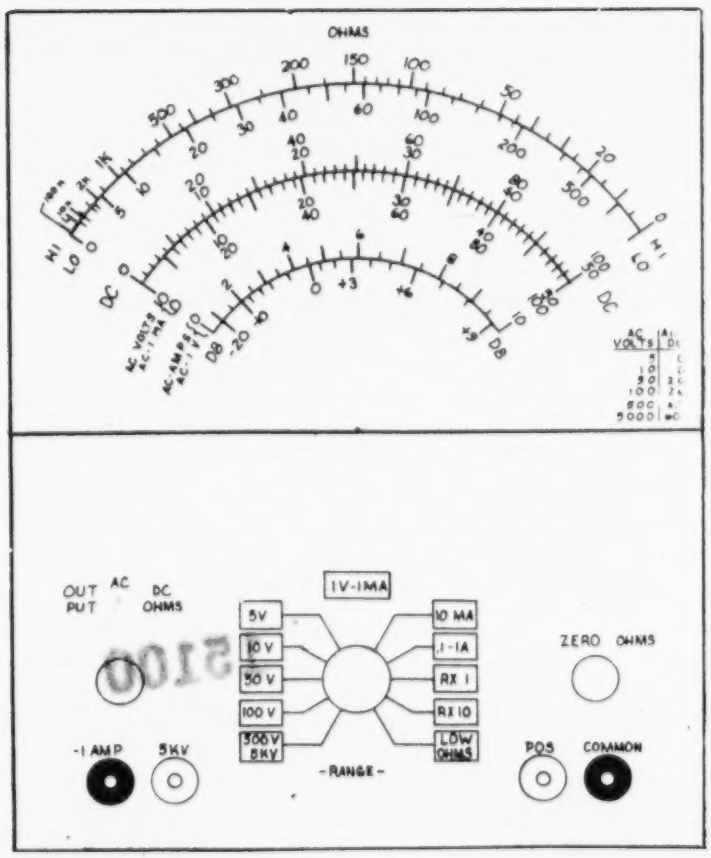

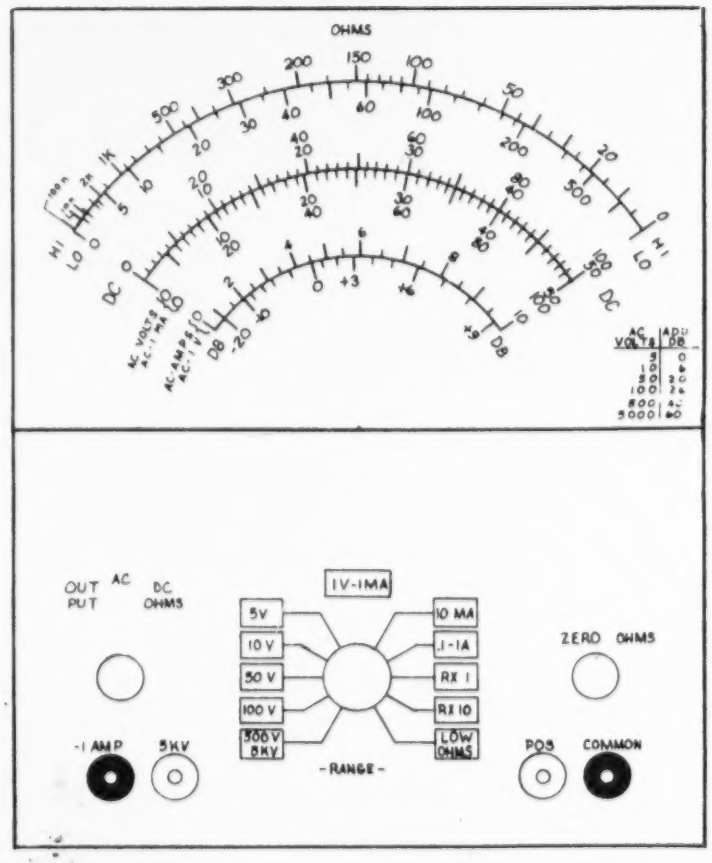

15102

UNIT XII - READING THE METERS

Lesson No. 4 — The High-Voltage Jack

The voltage range is extended in some meters by having a high-value dropping resistor in the meter, leading to a separate jack for one of the test leads. It is necessary to have physical separation of the leads to prevent arcing at the higher voltages.

To read in the 5 KV range: we connect the test lead to the 5 KV jack, set the range-switch to 5 KV, and use the 50 V scale. However we must multiply our reading by 100 (50 V x 100 = 5000 V or 1 KV).

If you connect the leads as shown in Figure 1, and the needle indicates as shown, you would be measuring 4,600 volts d-c.

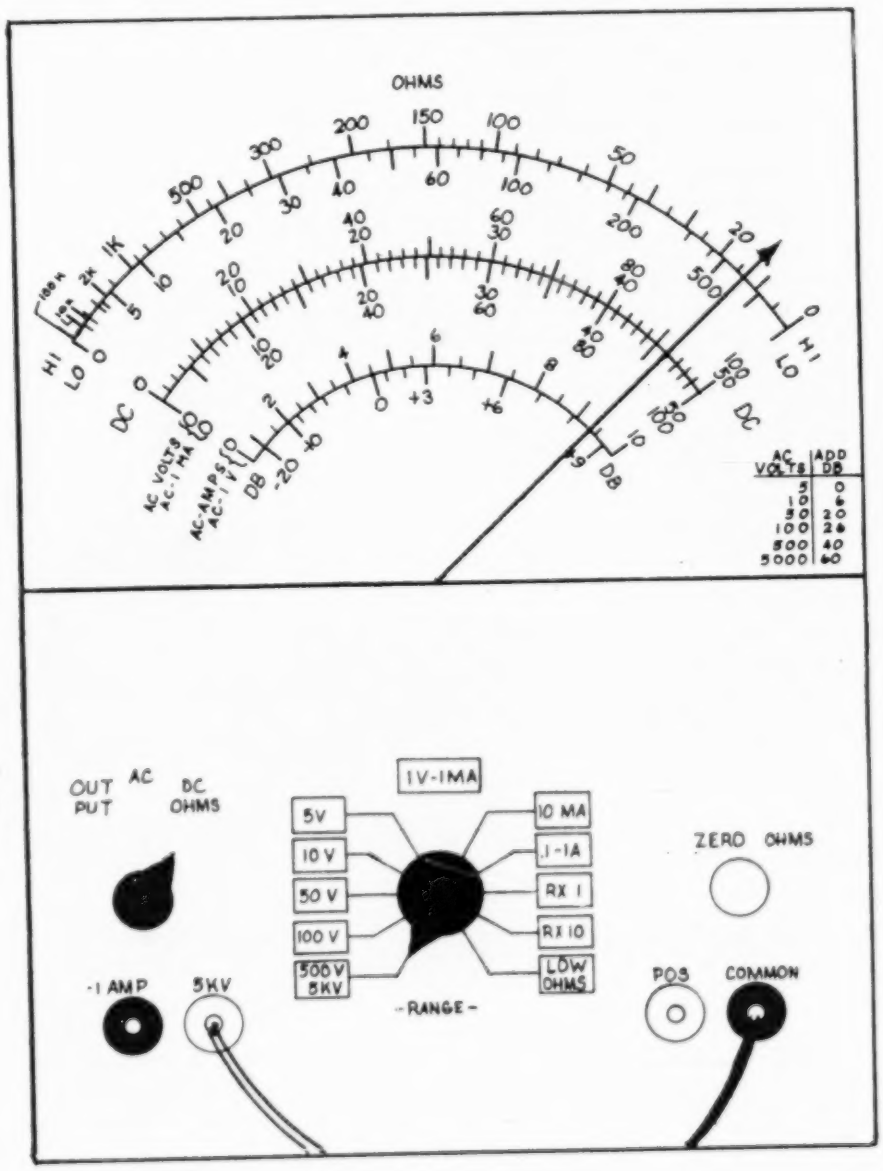

Fig.: XII-4-1

Study the meter in Figure 2 and you will see that you are reading 1000 volts a-c. Note that the function-switch is on a-c, one of the test leads is in the 5 KV jack, the range-switch is on 5 KV, and the needle is on 10 on the a-c volts scale.

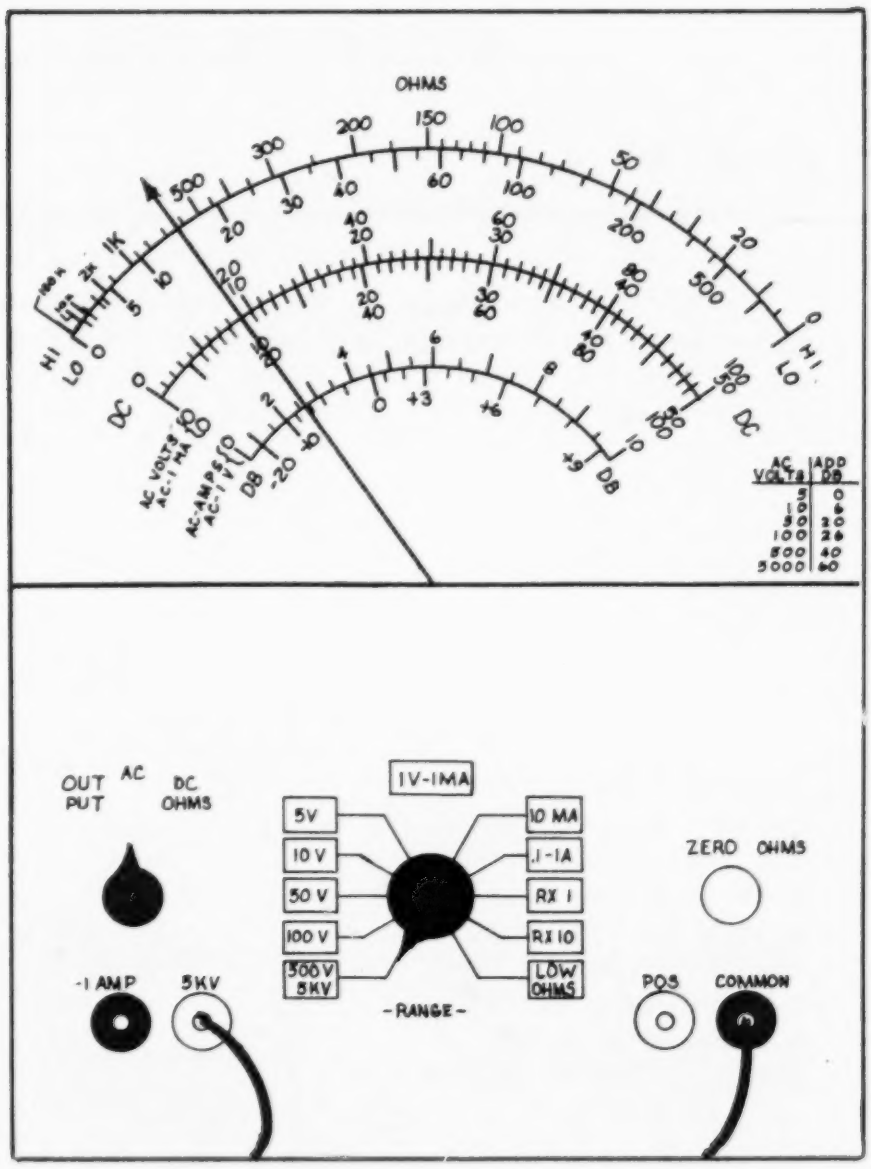

Fig.: XII-4-2

15105

WARNING! If there is any possibility that the voltage you are about to measure is more than 5 KV, it will be necessary to use a special high-voltage probe. The high-voltage probe has another range-extending resistor in it.

Now study the following four readings and determine what the meters are reading.

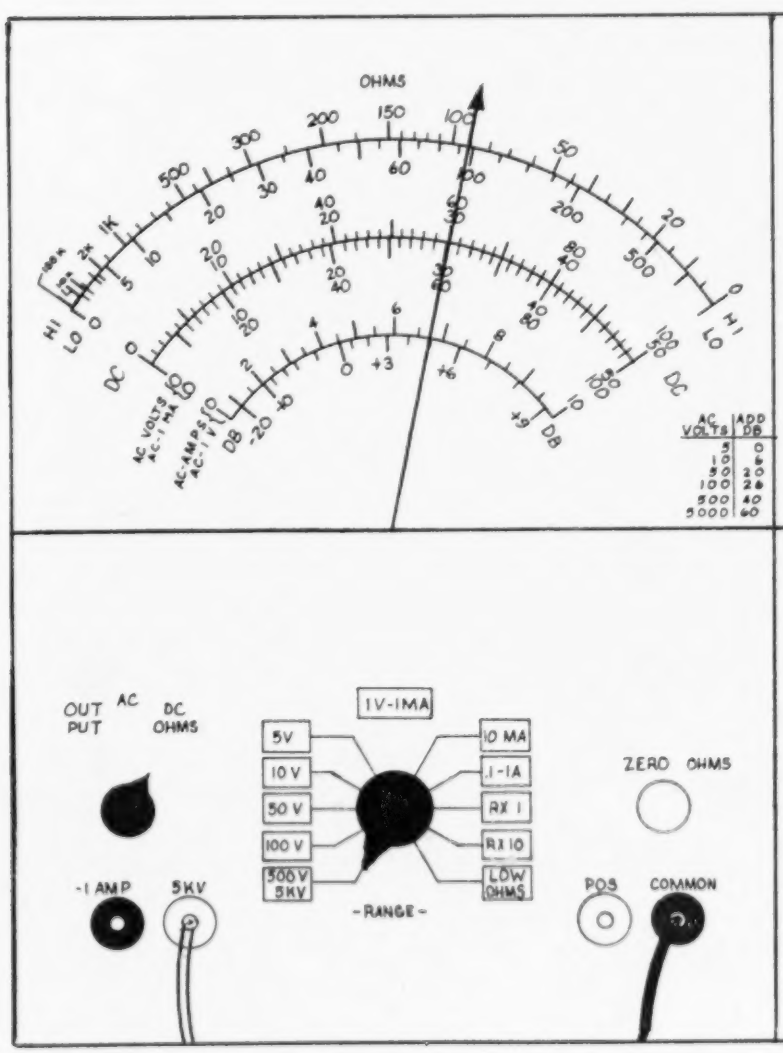

Fig.: XII-4-3

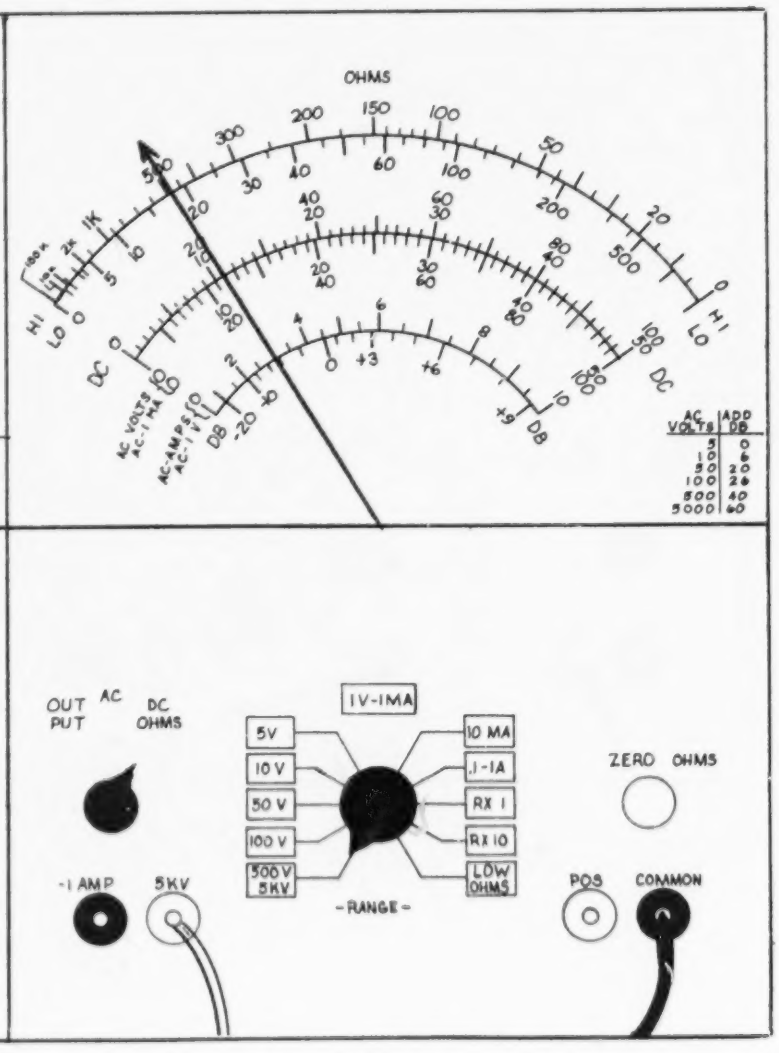

Fig.: XII-4-4

15106

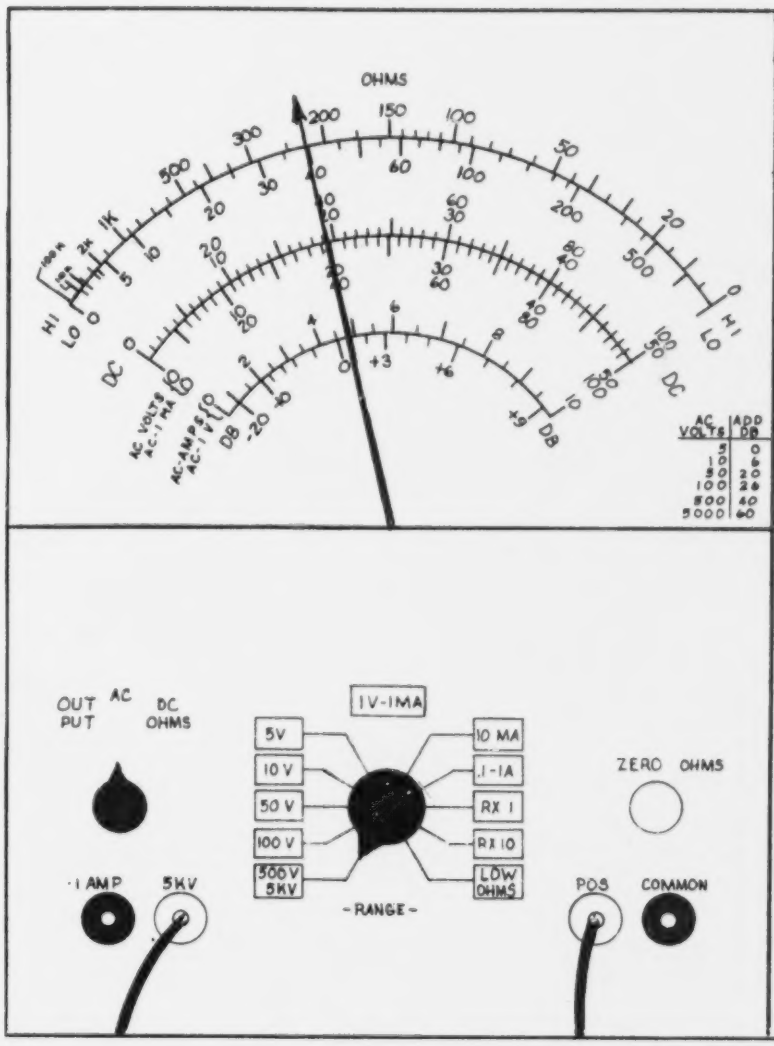

Fig.: XII-4-5

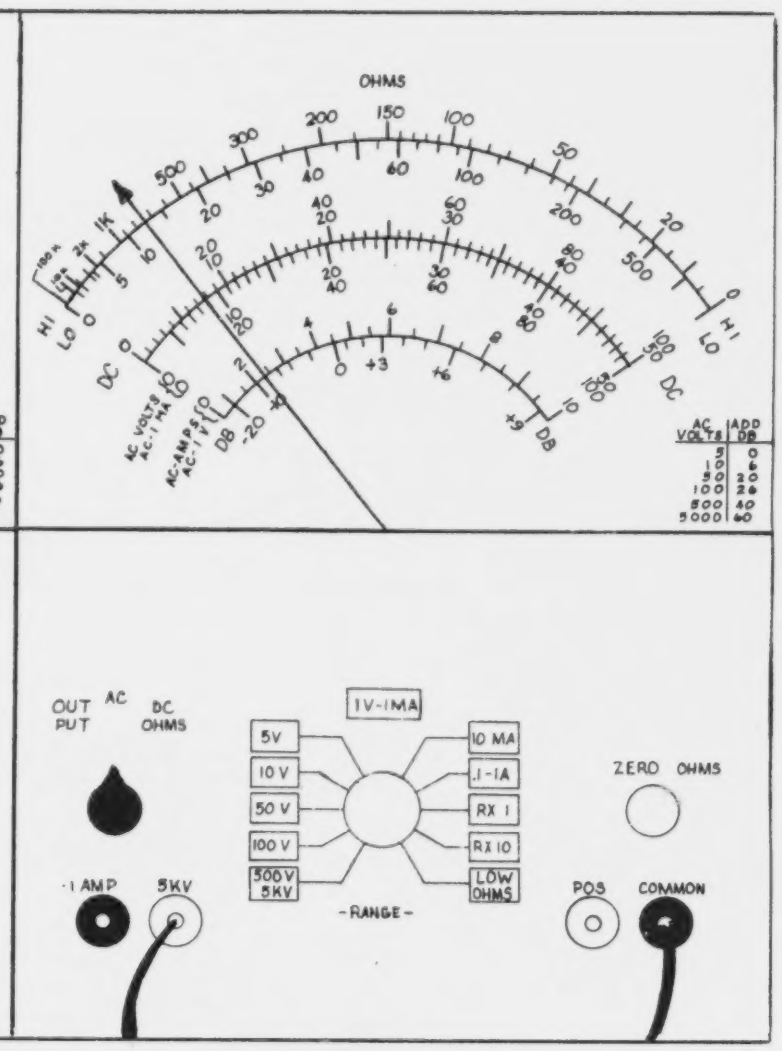

Fig.: XII-4-6

15106
5108

ASSIGNMENT:

Use a hard lead pencil and indicate the following readings on the four following figures. Make sure the range and function-switches are pointed correctly and that the needle indicates the proper reading.

1. 1200 V d-c
2. 4700 V a-c
3. 3500 V d-c
4. 2000 V a-c

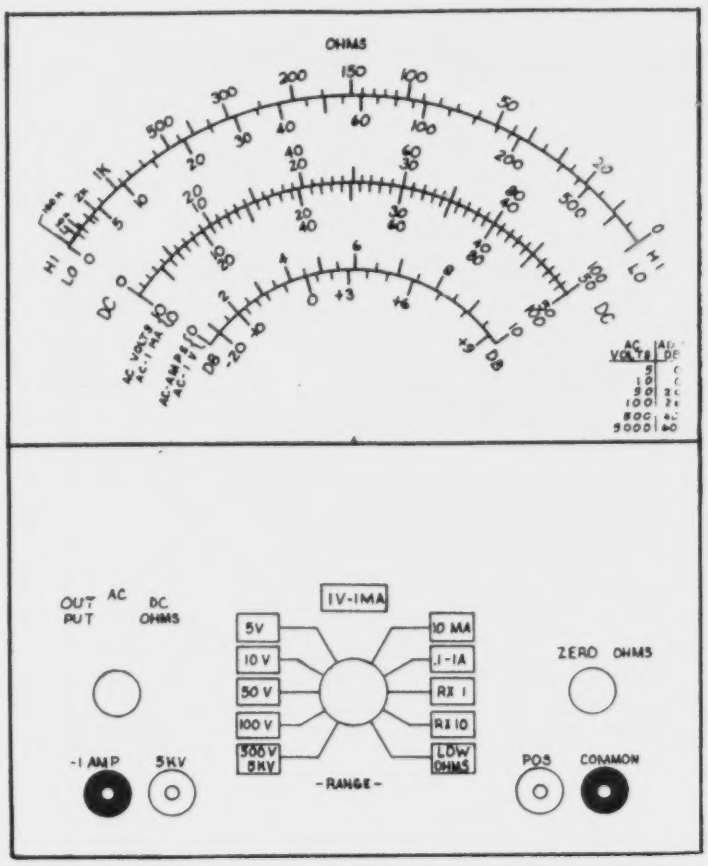

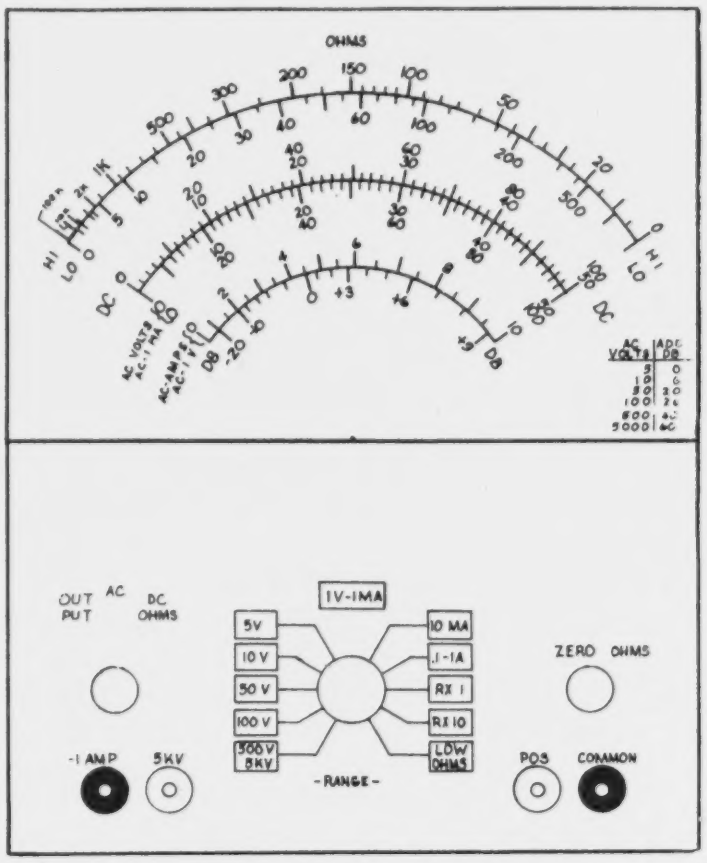

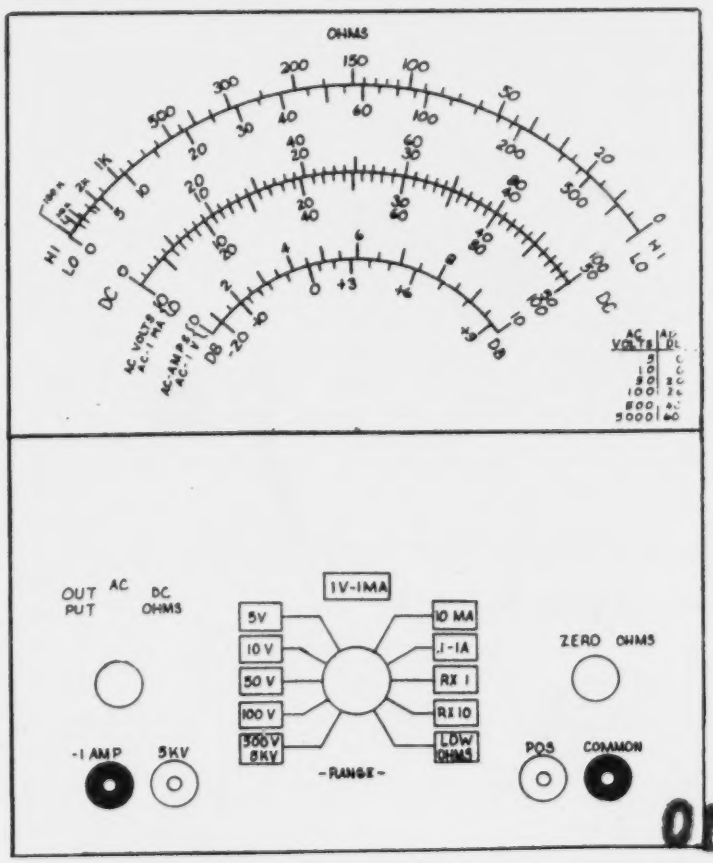

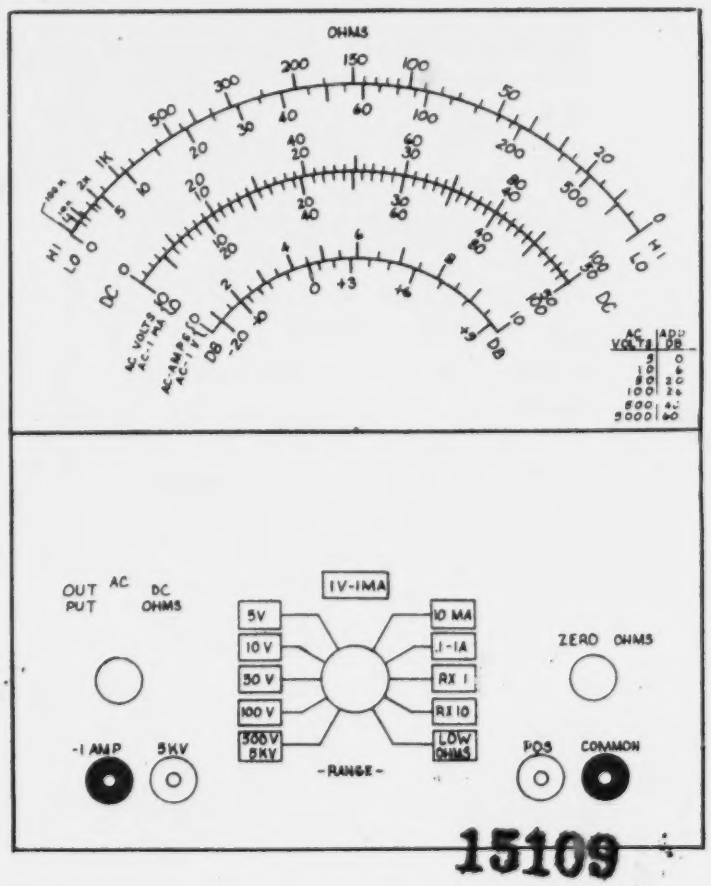

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: III. CARBURETOR-TWO BARREL

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Two Barrel Carburetor

CONDITIONS:

This assignment will be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective cover on front seat of automobile
2. Move automobile into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper manual and turn to appropiate chapter
6. Select proper tools and materials
7. Disconnect crankcase vent line from air breather
8. Remove air breather assembly
9. Disconnect fuel line
10. Disconnect vacuum line
11. Disconnect throttle linkage
12. Disconnect automatic choke tube
13. Remove nuts attaching carburetor to manifold
14. Remove carburetor from manifold
15. Disassemble carburetor following steps as outlined in the manual

PERFORMANCE CRITERIA:

1507

UNIT XII - READING THE METERS

Lesson No. 5 — The High-Current Jack

There is an extra-low-value shunt resistor placed in some meters so that higher values of current may be measured.

Figure 1 indicates that a d-c current of 0.9 amperes (or 900 MA d-c) is being measured. How do we reach this figure?

(1) The black lead is in the -1AMP jack.

(2) The function-switch is on d-c.

(3) The range-switch is on .1 - 1A position, giving us a 1A maximum current range, since the (-) lead is in the -1A jack.

(4) Look at the 100 d-c range. The needle is at 90. Call the 100, 1.00A. This changes our reading of 90 to 0.90A, as we mentioned above.

NOTE: It is the placement of the leads that make the range either .1A or 1A.

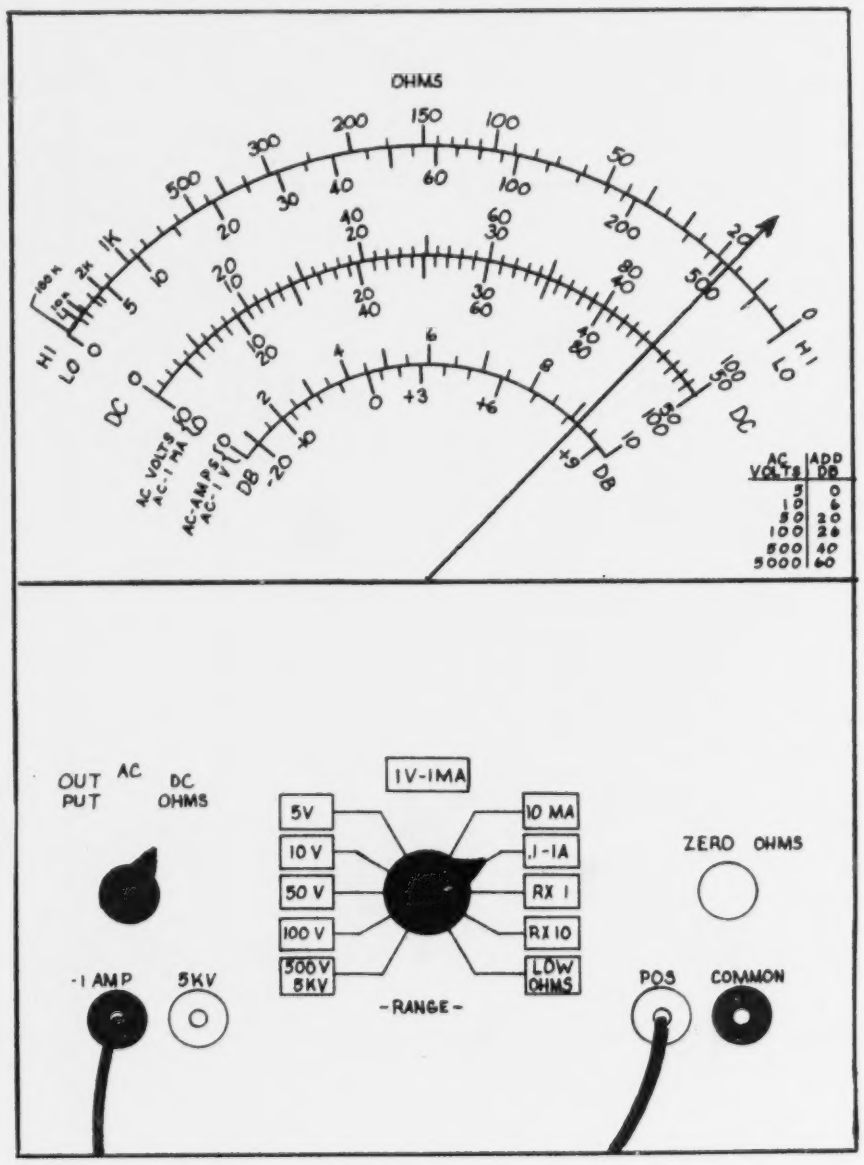

Fig.: XII-5-1

15110

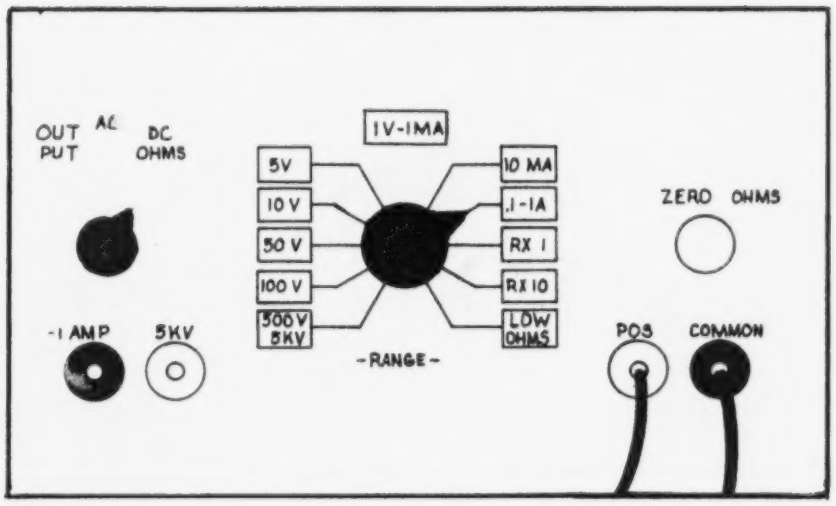

If the leads are connected as shown on Figure XII-5-2, then we are on the .1 A range.

Fig.: XII-5-2

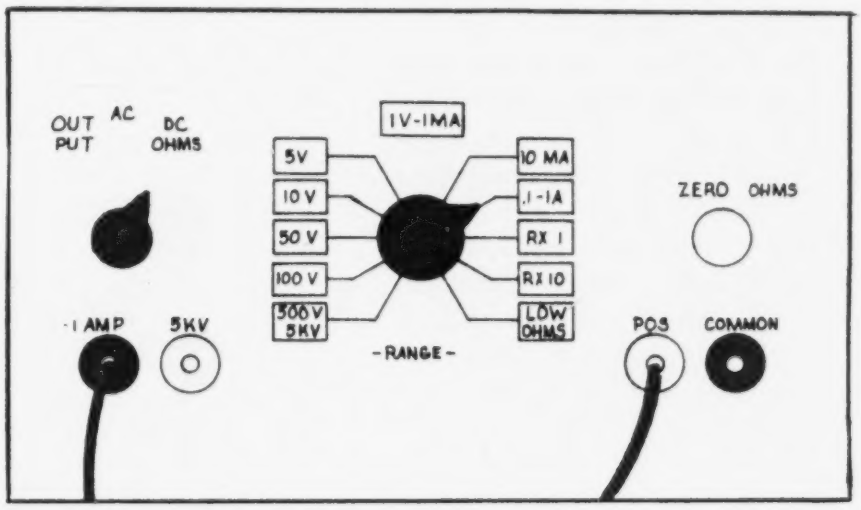

If the leads are connected to the meter as shown in Figure XII-5-3, it will be on the 1A range.

Fig. XII-5-3

15111

What is the meter reading in Figure XII-5-4?

Since the function-switch is on a-c and the range-switch is on a current range, we know that we are reading an a-c current. The leads come from the "POS" jack and the 1A jack, so we know that the <u>.1 - 1A</u> that the range-switch is pointing to is the 1A range instead of the .1A range. Now on the AC -AMPS scale we read 7. We know that, since the scale reads 10A maximum rather than 1 amp, we read the 10A as 1.0A and the 7 amps becomes 0.7 amps. The 0.7A, of course, may be stated as 700 milliamperes.

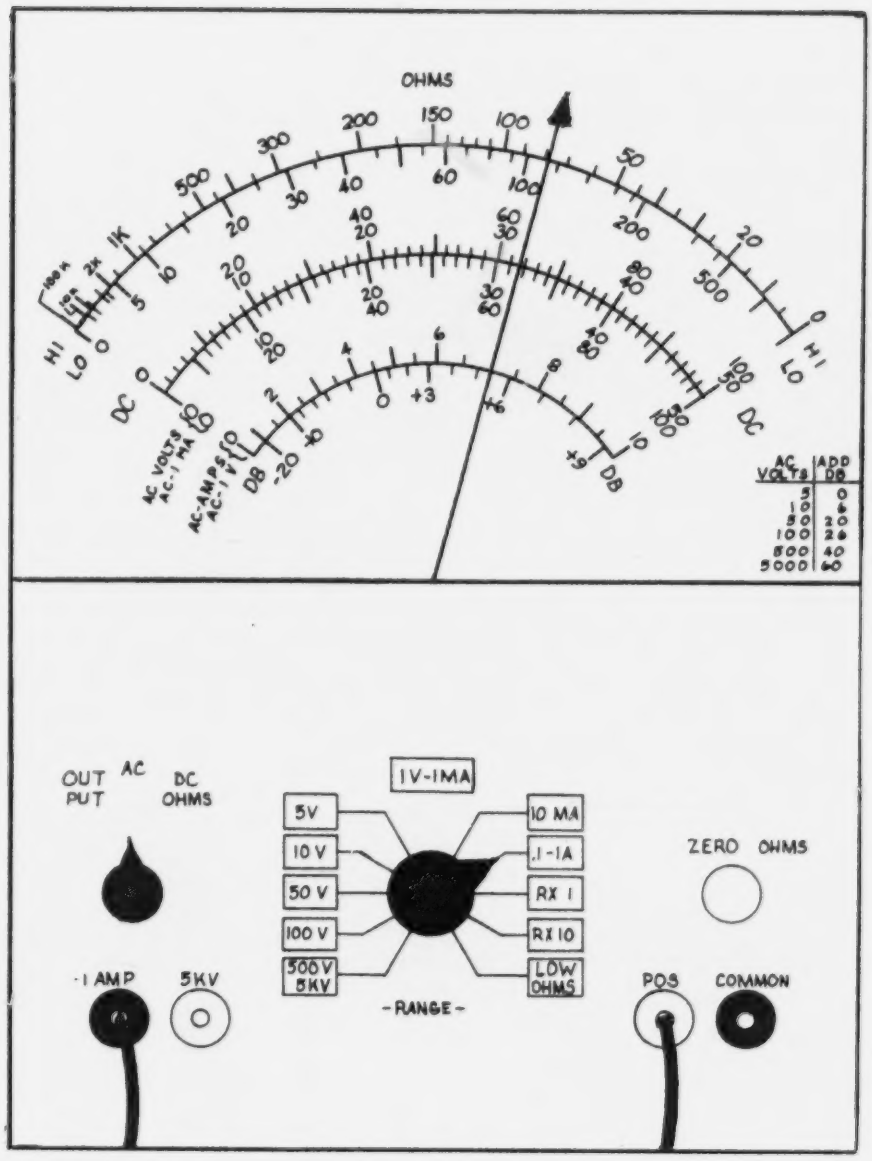

Fig.: XII-5-4

Study figures 5 through 8 on the next page and tell what each meter is indicating.

15113

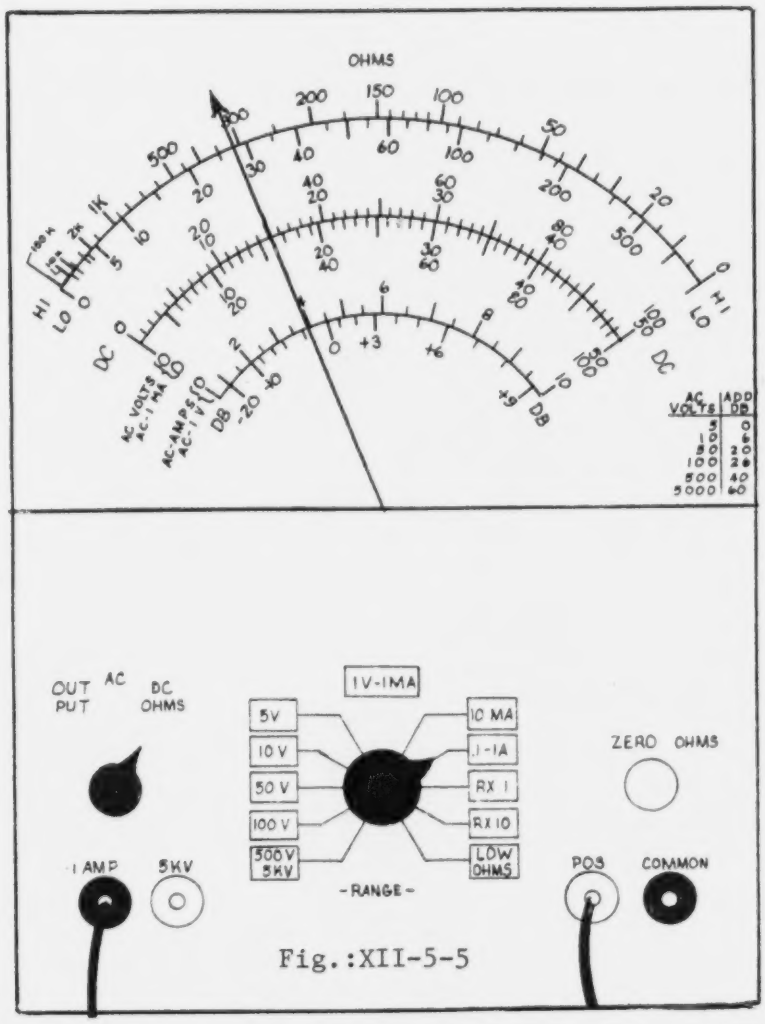

Fig.:XII-5-5

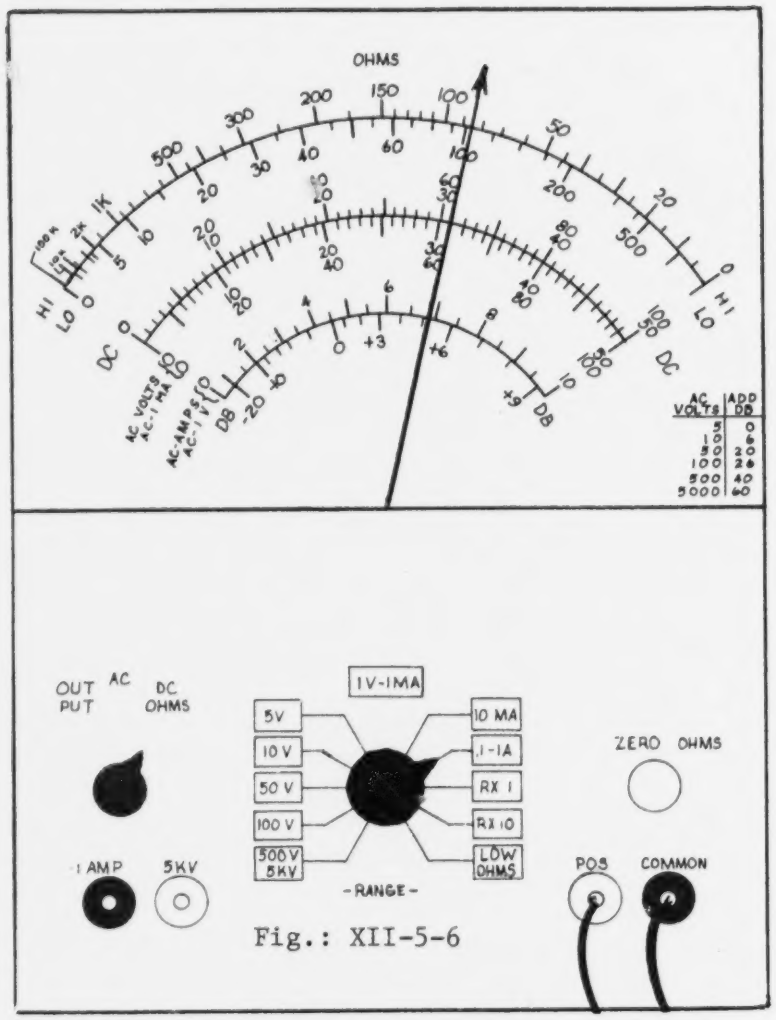

Fig.: XII-5-6

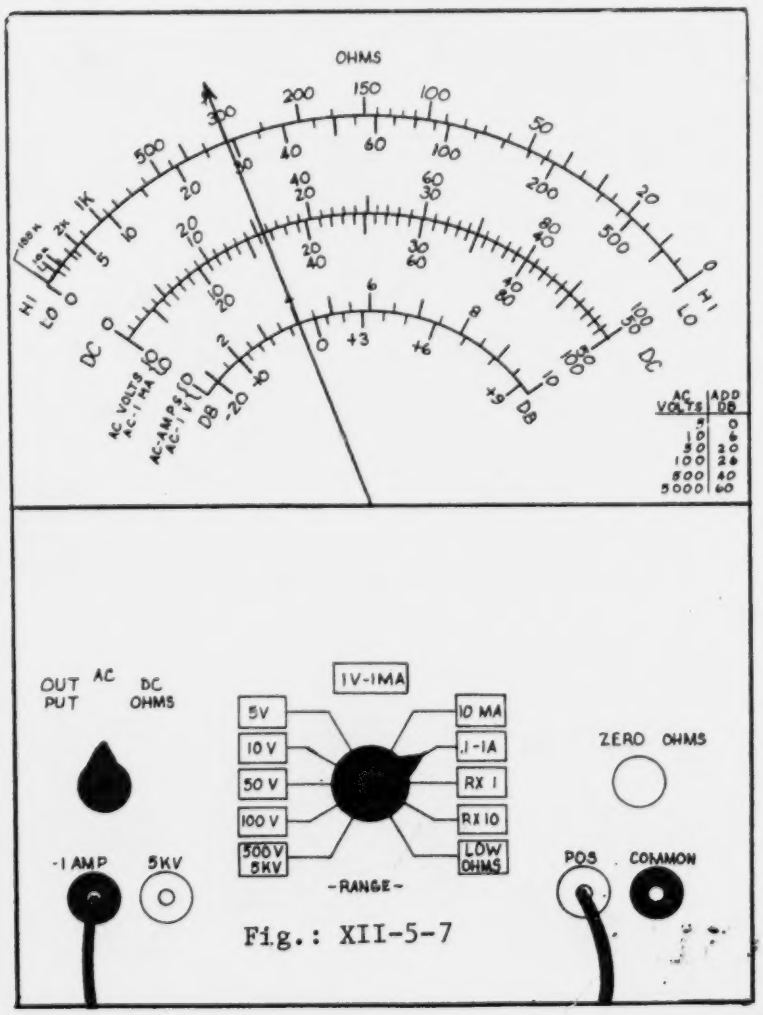

Fig.: XII-5-7

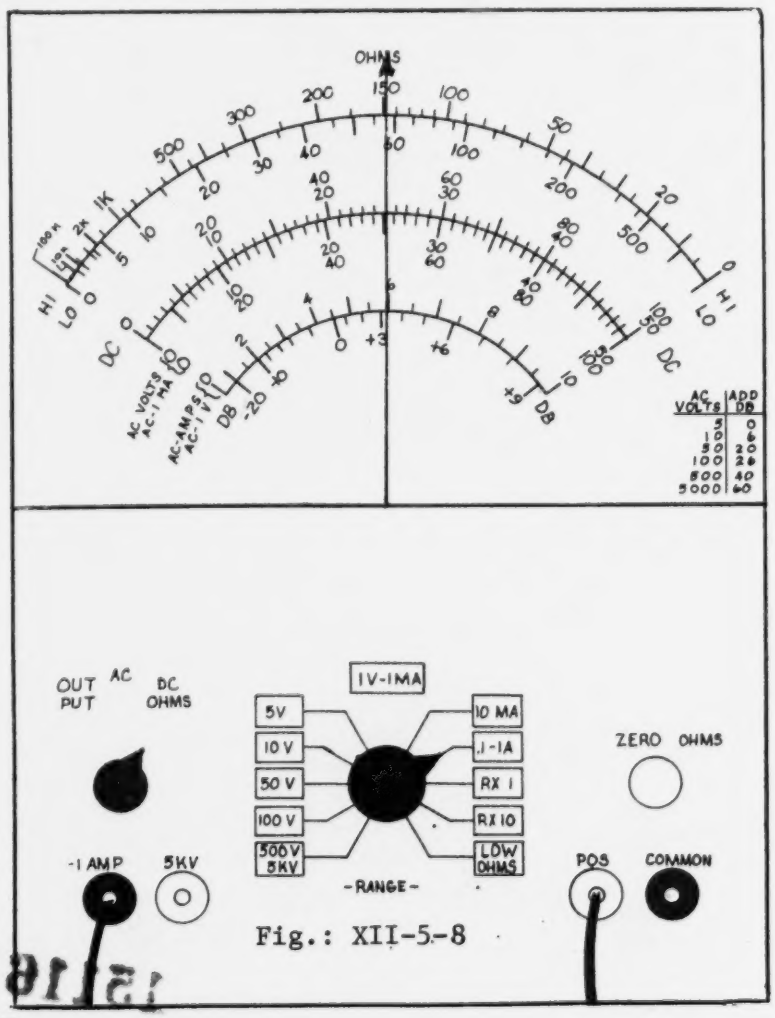

Fig.: XII-5-8

15114

ASSIGNMENT:

On the four following meter figures indicate the following readings.

1. 700 MA DC
2. 0.7A AC
3. 300 MA AC
4. 0.3A DC

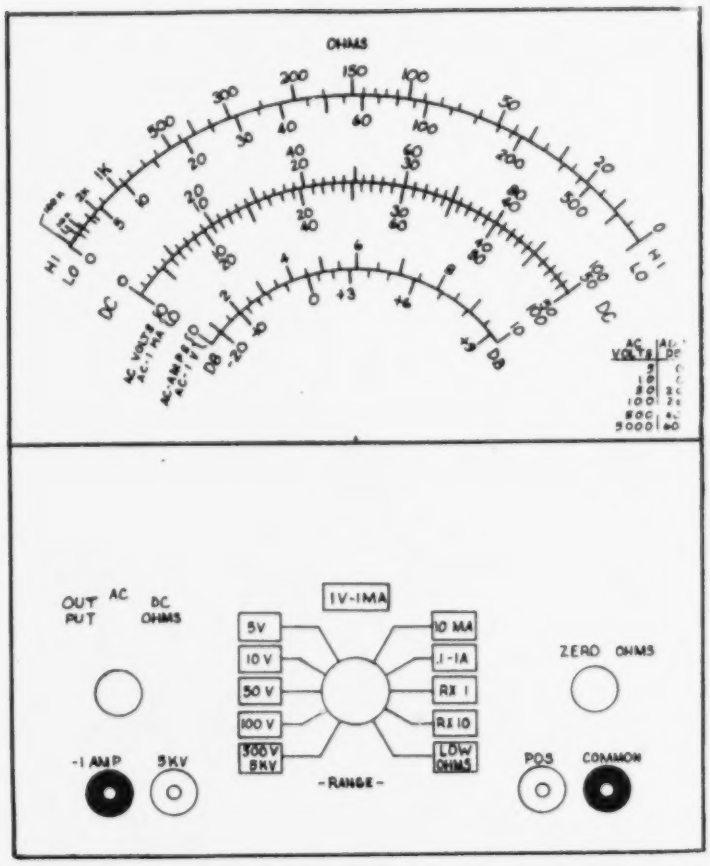

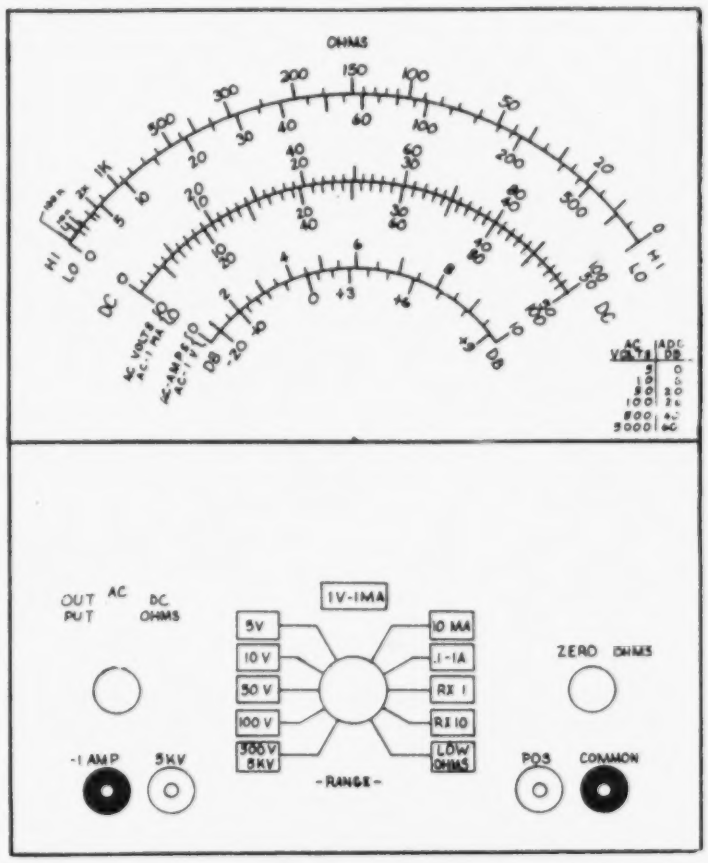

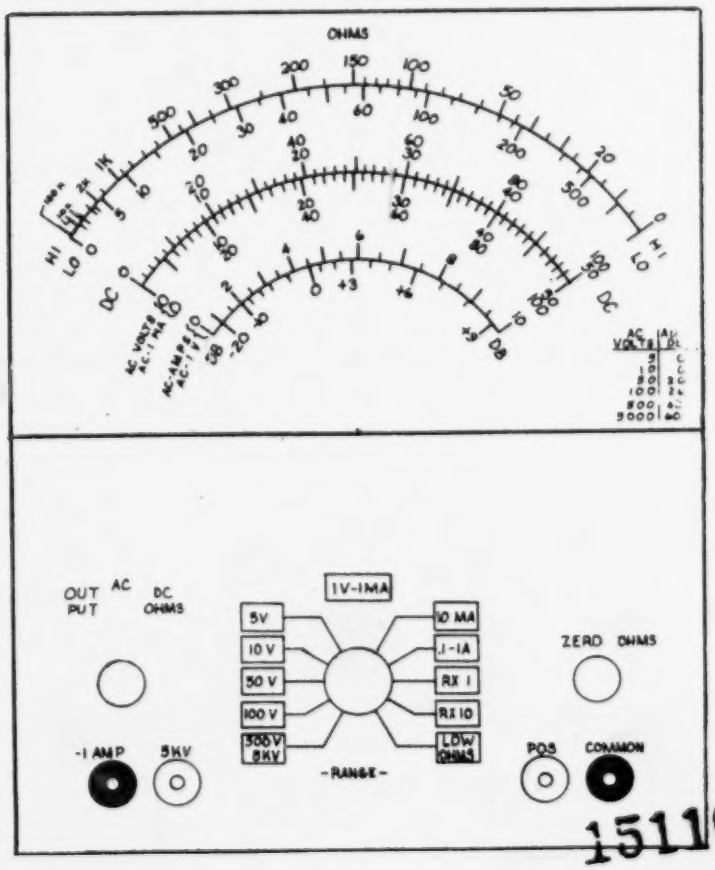

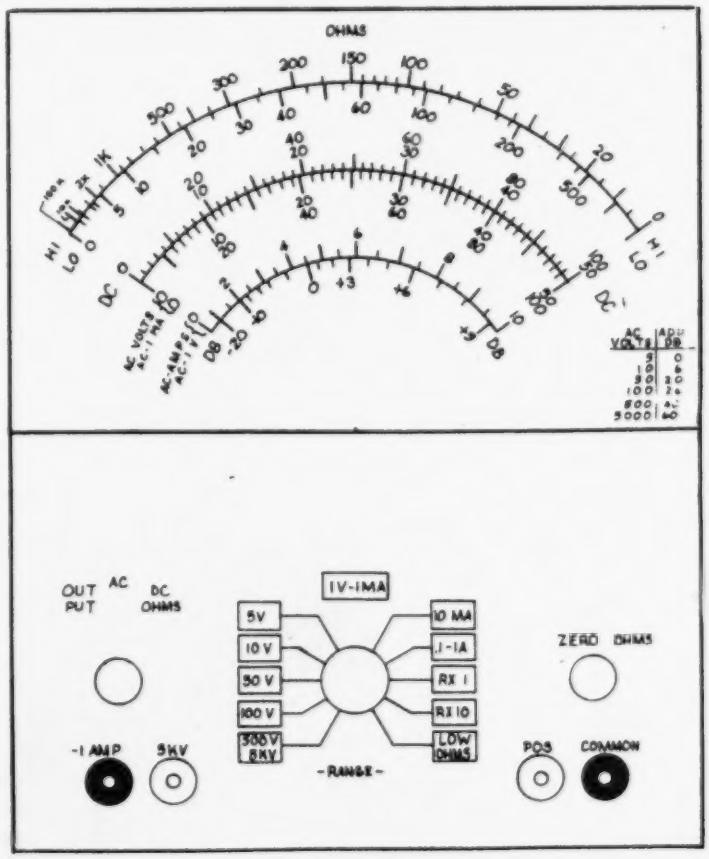

15116

15114

UNIT I

ACHIEVEMENT TEST

1. One should never use carbon tetrachloride in cleaning anything because _____

   _____

2. For what purpose is a shorting bar used? _____

   _____

3. Of what should the handle of a shorting bar be made? _____

   _____

4. What does the word lethal mean? _____

   _____

5. What type of fire extinguisher should you use on an electrical fire? _____

6. Where are the circuit breakers in the lines coming to your workbench? _____

   _____

   _____

7. How may untreated cuts and puncture wounds contribute to unsafe conditions? _____

   _____

   _____

8. Why should the preservation of students' good health be important in maintaining a safe shop? _____

   _____

   _____

15117

UNIT II

ACHIEVEMENT TEST

1. Name three reputable manufacturers of dependable soldering irons.
2. Name at least two brands of high-quality pliers.
3. Name at least two dealers in your locality who sell high-quality tools.
4. Why is buying cheap tools a false economy?
5. How can you keep your tools in proper repair?
6. For how many different kinds of jobs is the screwdriver designed?
7. What is 40/60 solder?
8. If you want a real bright, shiny appearance to your soldered connections, what kind of solder would you use?
9. What is meant by tinning a soldering iron?
10. Why is acid-core solder not used in soldering electronic equipment?

15118

UNIT III

ACHIEVEMENT TEST

1. What is the Greek word for amber?

2. How far back in history can the knowledge of electric attraction be traced?

3. What is the difference between static electricity and voltaic electricity?

4. Early scientists referred to two kinds of electricity, vitreous and resinous. What did they mean?

5. Use the word <u>electric</u> in three different sentences.

6. Use the word <u>electricity</u> in three different sentences.

7. Do all the electrons of an atom circle the nucleus in the same orbit? If not, tell how they do circle the nucleus.

8. Is the electricity produced in generators static electricity or voltaic electricity?

9. Is the electricity produced by walking over a nylon carpet voltaic or static?

10. What kind of electricity is that which causes lightning?

11. Give an example to explain the difference between an element and a compound.

12. Give an example of an alloy in common use in electrical applications.

13. Why don't the electrons fly away from the nucleus of an atom?

14. It has been said that an atom is mostly open space. Would you agree or disagree? Explain.

15. Why are the s and p electrons so important to electricians?

15119

UNIT IV

ACHIEVEMENT TEST

1. Describe the structure of an atom, either in words or with a diagram. Include: nucleus, protons, electrons, shell, atomic number.

2. What is electric current flow?

3. How fast does an electric current travel?

4. In what direction does electric current flow?

5. Name three good conductors.

6. How does a conductor differ in atomic structure from an insulator?

7. Why is copper the most commonly used conductor?

8. If an atom loses an electron, how does this affect the electrical charge of the atom?

9. Which is a better conductor, gold or copper?

10. Who made the first electric light bulb? the first radio tube?

15120

UNIT V

ACHIEVEMENT TEST

1. Name two examples where mechanical energy is employed to produce electromotive force.

2. Define the word potential.

3. The volt is the unit of measurement of what?

4. What is the difference between force and energy?

5. Is electrical pressure a universal term?

6. What is electrical pressure?

7. In what units is e.m.f. measured?

8. Where do we find chemical energy employed in producing electromotive force?

9. In what units is potential difference measured?

10. Why do we use the word difference in potential difference?

15121

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: III. CARBURETOR-TWO BARREL

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Two Barrel Carburetor

CONDITIONS:

BEHAVIOR:

16. Identify all parts and the functions of each
17. Reassemble carburetor following all steps as outlined in the manual
18. Make all bench adjustments as outlined in the manual
19. Clean all gasket material from base of carburetor and intake manifold
20. Install new carburetor-manifold gasket
21. Install carburetor on manifold
22. Secure carburetor to manifold with nuts
23. Reconnect fuel lines
24. Reconnect vacuum lines
25. Reconnect automatic choke tube
26. Reconnect throttle linkage
27. Start automobile and immediately check for leaks
28. Make all adjustments as outlined in the manual
29. Recheck all steps in installation and assembly
30. Install air breather assembly
31. Reconnect crankcase vent

PERFORMANCE CRITERIA:

1508

UNIT VI

ACHIEVEMENT TEST

1. What were the nationalities of: Franklin, Volta, Leclanché, and Galvani?

2. Compare the alkaline cell with the nickel-cadmium cell as to uses; as to primary-secondary type; as to advantages and disadvantages.

3. What is the voltage of four 1.5-volt cells connected in parallel?

4. Are common dry cells rechargeable? Why does <u>resting</u> sometimes seem to build up a dry cell which seemed burned out?

5. What is the electrolyte in a storage battery? What does it consist of?

6. How can you tell when a storage battery needs recharging?

7. Give two rules for getting the greatest possible service from a dry cell.

8. Give two rules for getting the greatest possible service from a lead-acid storage battery.

9. How would you connect 1.5-volt carbon-zinc cells, each capable of sustaining .25 amperes, to obtain a 6-volt supply at .75 amperes?

10. Draw a diagram showing a circuit containing a resistance and 6 dry cells - 2 paralleled groups, each consisting of 3 series-connected cells.

UNIT VII

ACHIEVEMENT TEST

1. What kind of charge will repel electrons?

2. How many mils are in ½ inch?

3. Is 10-gauge wire heavier or lighter than 20-gauge wire?

4. Do different kinds of metal conductors have different electrical resistances?

5. What is a "pot," and where do you often see them?

6. What are the resistance values of the resistors color-coded as follows:

a.	RED	RED	RED	GOLD
b.	ORANGE	YELLOW	BROWN	SILVER
c.	WHITE	YELLOW	ORANGE	
d.	WHITE	GRAY	YELLOW	GOLD
e.	VIOLET	WHITE	RED	SILVER
f.	BLUE	BLACK	BLACK	GOLD
g.	BROWN	BLACK	BLACK	
h.	GRAY	WHITE	RED	SILVER
k.	BLUE	RED	ORANGE	
m.	ORANGE	ORANGE	ORANGE	

15123

UNIT VIII

ACHIEVEMENT TEST

I. In what system are the following units used?

1. Mile
2. Inch
3. Centimeter
4. Ounce
5. Foot
6. Centigram
7. Pound
8. Liter
9. Kilogram
10. Yard
11. Ton
12. Quart

II. Change to grams:

(a) 200 centigrams
(b) 2 kilograms
(c) 550 milligrams
(d) 49 milligrams
(e) 1.9 kilograms

III. Change to millimeters:

(a) 25 centimeters
(b) 4 meters
(c) 3 centimeters
(d) 360 centimeters
(e) 97 millimeters

IV. Express the following in powers of ten:

1. 100
2. 1,000
3. 0.01
4. 0.001
5. 200,000
6. 22,000
7. 0.002
8. 1,200

V. When and where was the metric system first used?

VI. How many grams are there in (a) a kilogram (b) a milligram (c) a microgram?

15124

VII. How many ohms are there in one megohm?

VIII. Multiply and leave answer in powers of 10.

1. $3 \times 10^4 \times 2 \times 10^5$
2. $4 \times 10^{-2} \times 3 \times 10^{-3}$
3. $5 \times 10^{-4} \times 2 \times 10^6$
4. $170{,}000 \times 2{,}000{,}000$
5. $22{,}000 \times 3 \times 10^{-6}$

12124

UNIT IX

ACHIEVEMENT TEST

1. Here is a representation of an inch. By using arrows and the given letters, indicate the following points:

a. 6 1/4"	e. 6 1/8"	i. 6 9/16"
b. 6 7/8"	f. 6 5/16"	j. 6 3/16"
c. 6 1/16"	g. 7"	
d. 6 3/4"	h. 6 1/2"	

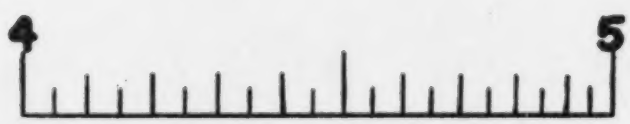

2. Here is a representation of a centimeter. By using arrows and the given letters, indicate the following points:

a. 4.7	e. 4.475	i. 4.65
b. 4.55	f. 4.3	j. 4.225
c. 4.05	g. 4.875	
d. 4.925	h. 4.025	

15125

UNIT X

ACHIEVEMENT TEST

You must make all the calculations given below through the use of the slide rule only. Do not multiply or divide by arithmetic computation.

1. 2.25 x 3.75
2. 6.7 x 1.95
3. 2,350 x 1,945
4. 8.45 ÷ 2.25
5. 950 ÷ 0.75
6. 260 x 176
7. 2,500 x 531
8. 365 x 0.87
9. 0.55 x 8,000
10. 0.955 ÷ 0.5
11. 25 x 0.7
12. $\frac{26}{11}$
13. $\frac{465}{5}$
14. $\frac{9,500}{0.75}$
15. $\frac{225}{9}$
16. $\frac{0.143}{2}$
17. $\frac{28}{10}$
18. $\frac{0.00075}{275}$
19. $\frac{9,500}{26}$
20. $\frac{21}{0.2}$

15126

UNIT XI

ACHIEVEMENT TEST

1. Find the reciprocals of (a) 5, (b) 2, (c) 4, (d) 9, (e) 23.

2. There are three resistors in parallel. R_1 = 12 ohms, R_2 = 4 ohms, and R_3 = 32 ohms. Solve for R_t.

3. Use another method for finding R_t in the problem given above.

4. In the circuit below find R_t, I_t, E_{R_1}, and E_{R_2}.

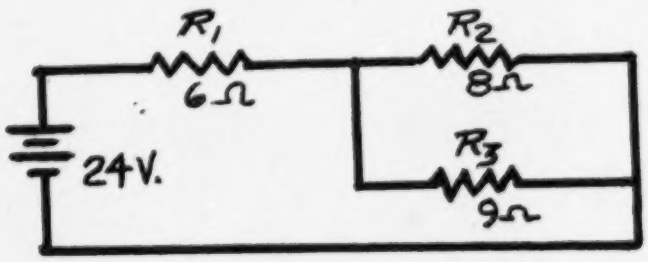

5. In the circuit below find I_{R_1}, I_{R_2}, I_{R_3}, I_{R_4}, I_{R_5}, I_{R_6}, I_{R_7}; E_{R_1}, E_{R_2}, E_{R_3}, E_{R_4}, E_{R_5}, E_{R_6}, and E_{R_7}.

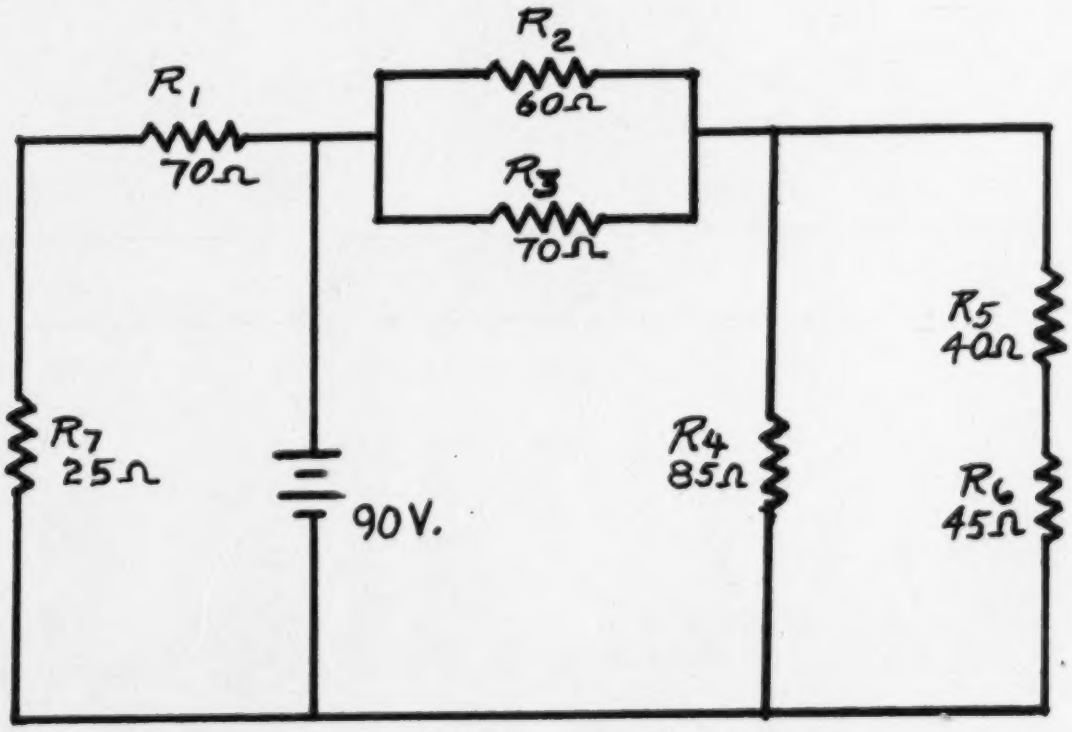

15127

UNIT XII

ACHIEVEMENT TEST

On the following twelve meter figures, draw the necessary lines and pointers to make them indicate the following values. Be sure to write the value at the bottom of each one.

1. 3.5V d.c.
2. 2,000 Ω
3. 0.4V d.c.
4. 70 MA d.c.
5. 0.2 MA a.c.
6. 3,000V a.c.
7. 600 Ω
8. 10 Ω
9. 6MA a.c.
10. 0.5 MA d.c.
11. 900 MA a.c.
12. 4,600V a.c.

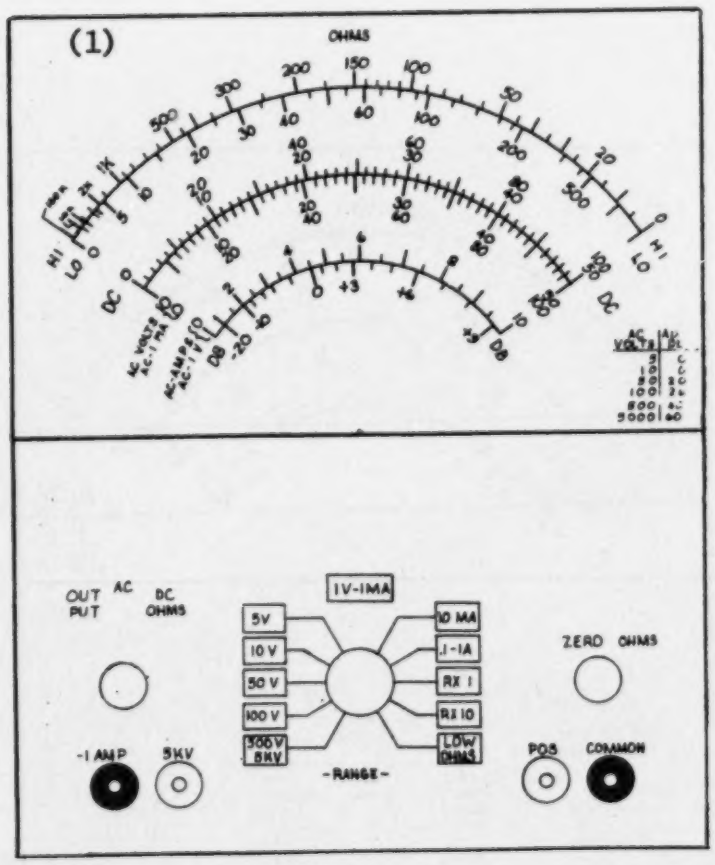

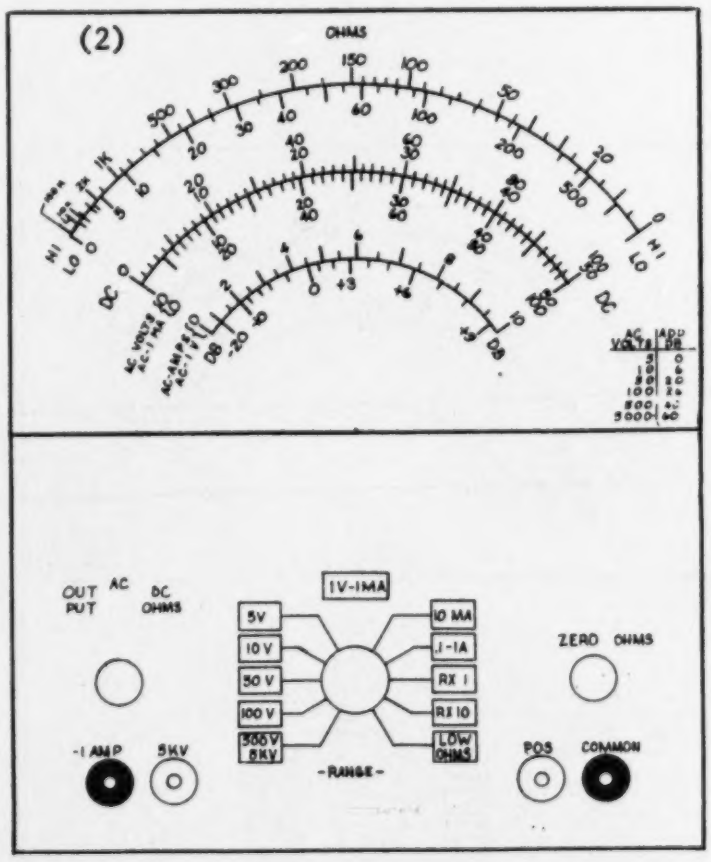

15128

(3)

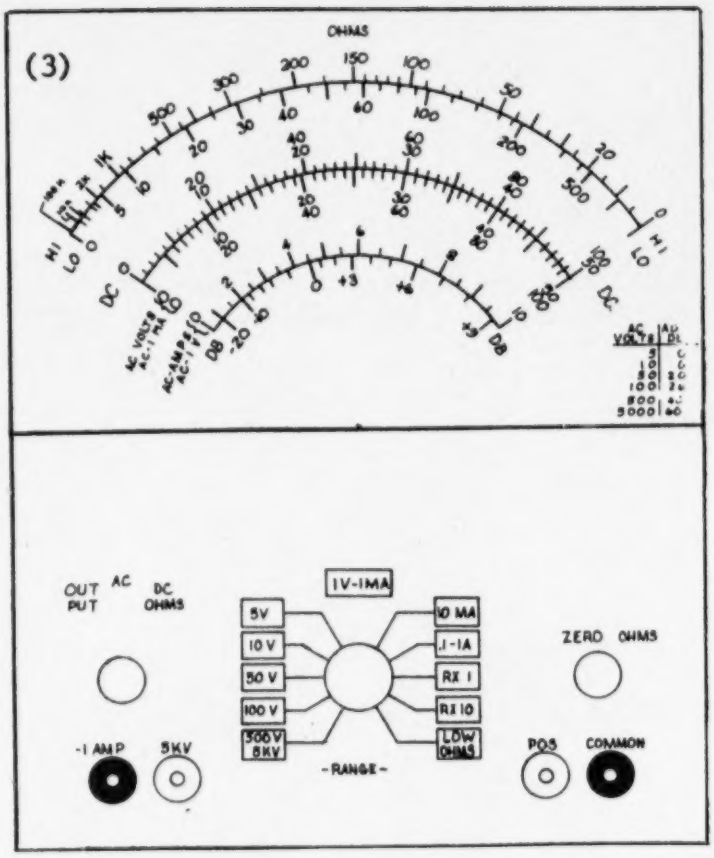
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
-1 AMP
5KV
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
POS
COMMON

(4)

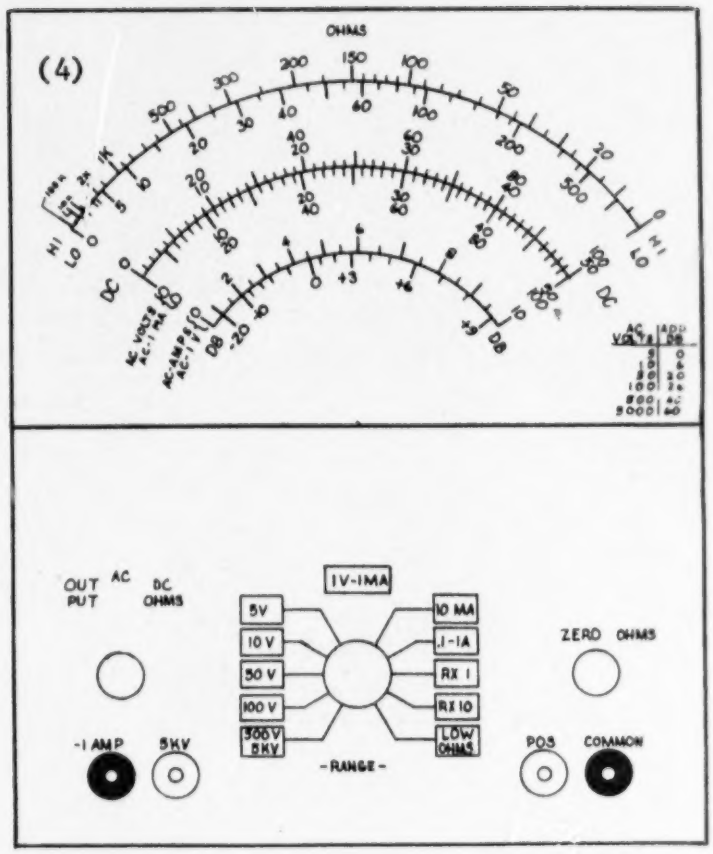
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
-1 AMP
5KV
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
POS
COMMON

(5)

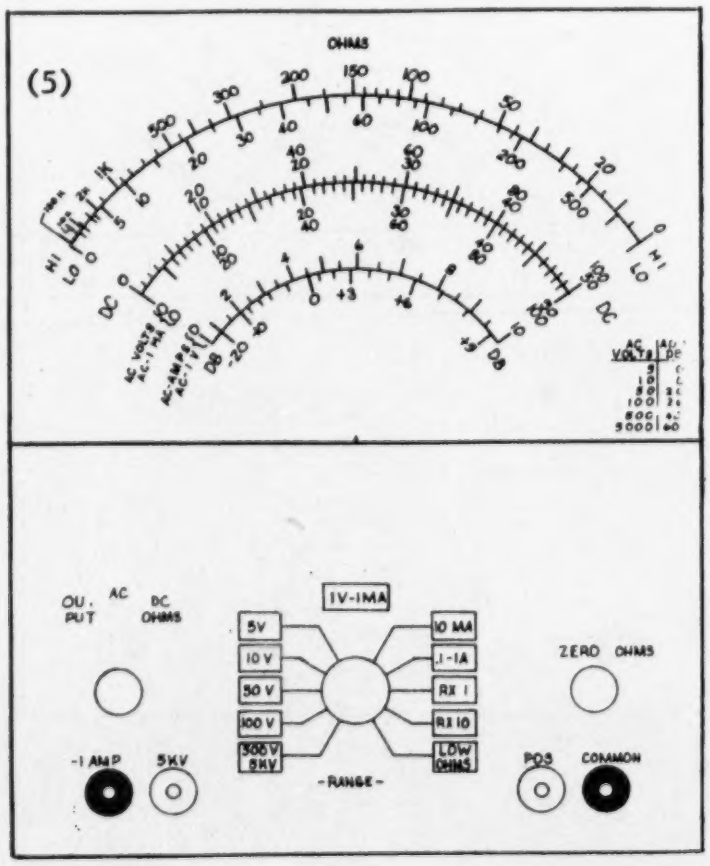
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
-1 AMP
5KV
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
POS
COMMON

(6)

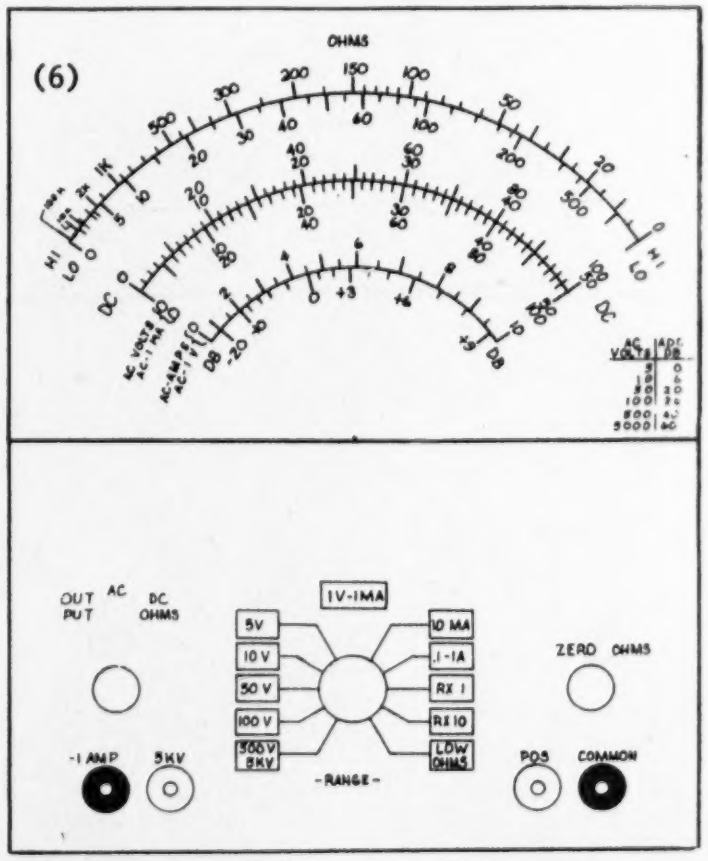
OHMS
DC
AC VOLTS
AC-1 MA
AC-AMPS
AC-1 V
DB
OUT PUT
AC
DC OHMS
-1 AMP
5KV
1V-1MA
5V
10 V
50 V
100 V
500V 5KV
10 MA
.1-1A
RX 1
RX 10
LOW OHMS
-RANGE-
ZERO OHMS
POS
COMMON

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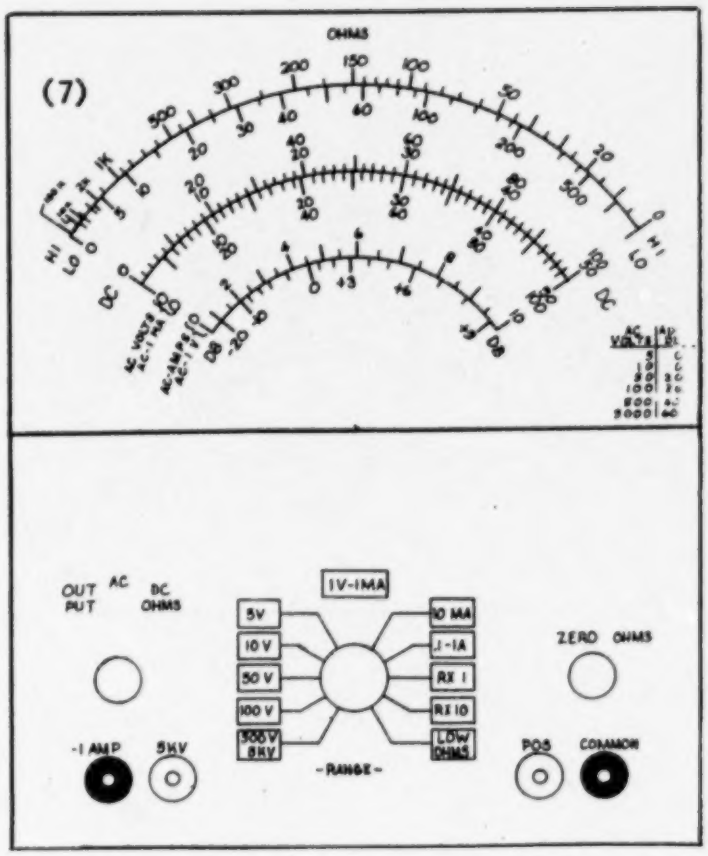

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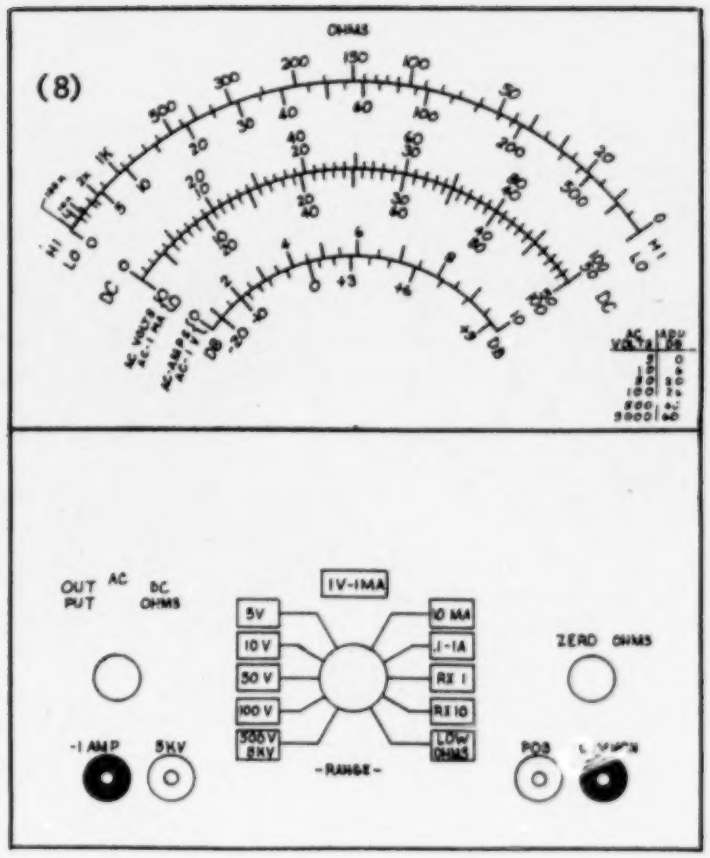

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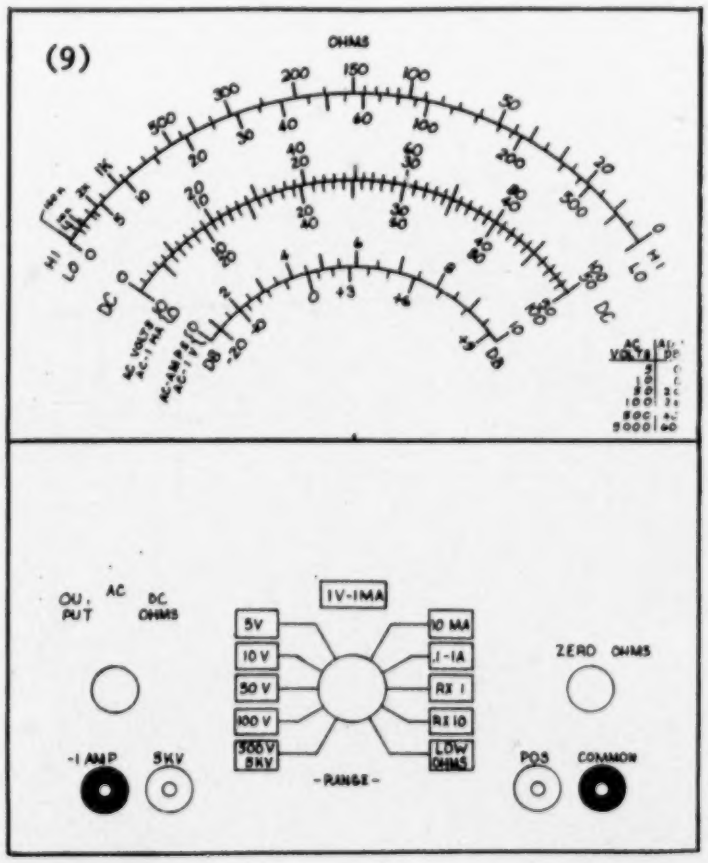

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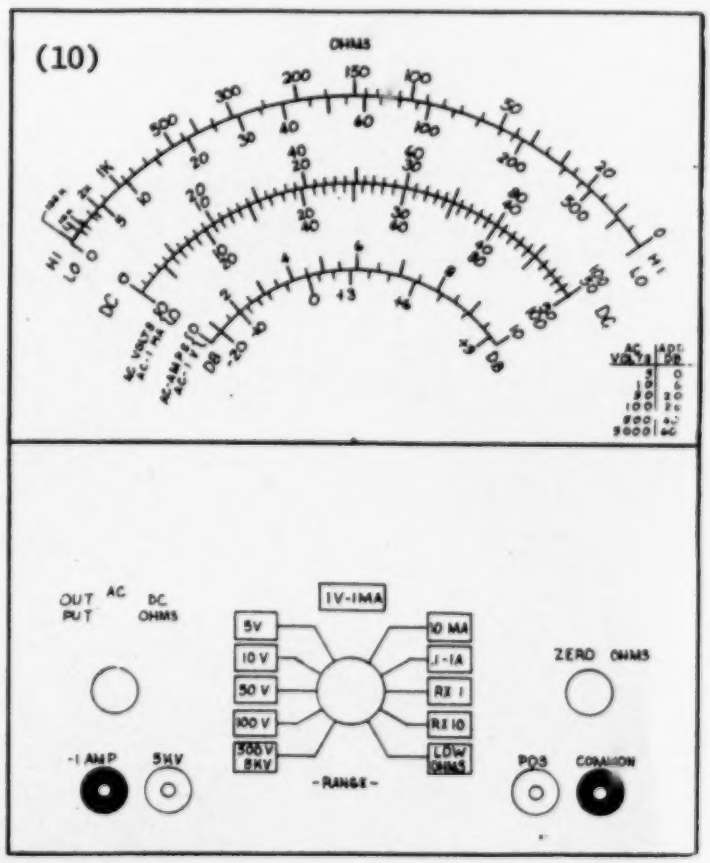

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/PERFORMANCE OBJECTIVE STATEMENT/

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: III. FUEL SYSTEM

MILESTONE: III. CARBURETOR-TWO BARREL

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Two Barrel Carburetor

CONDITIONS:

BEHAVIOR:

32. If carburetor satisfactory, clean and replace tools and materials in proper place
33. Remove and store fender covers in proper place
34. Close hood
35. Return automobile to proper parking area
36. Remove seat cover and store in proper place
37. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to remove, disassemble, reassemble, replace, and test a two barrel carburetor in 3 hours.

Learning time: 6 hours

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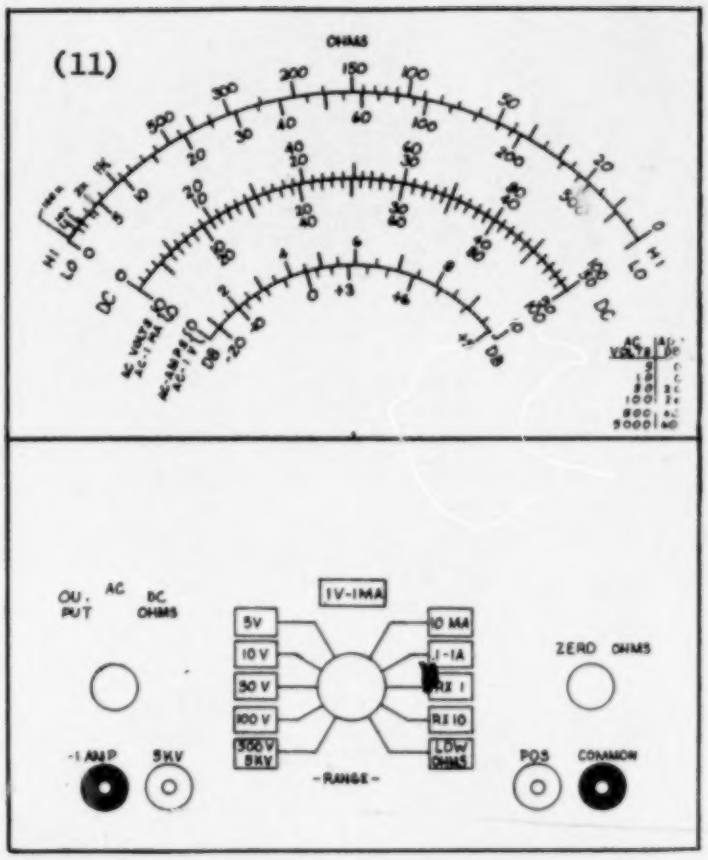

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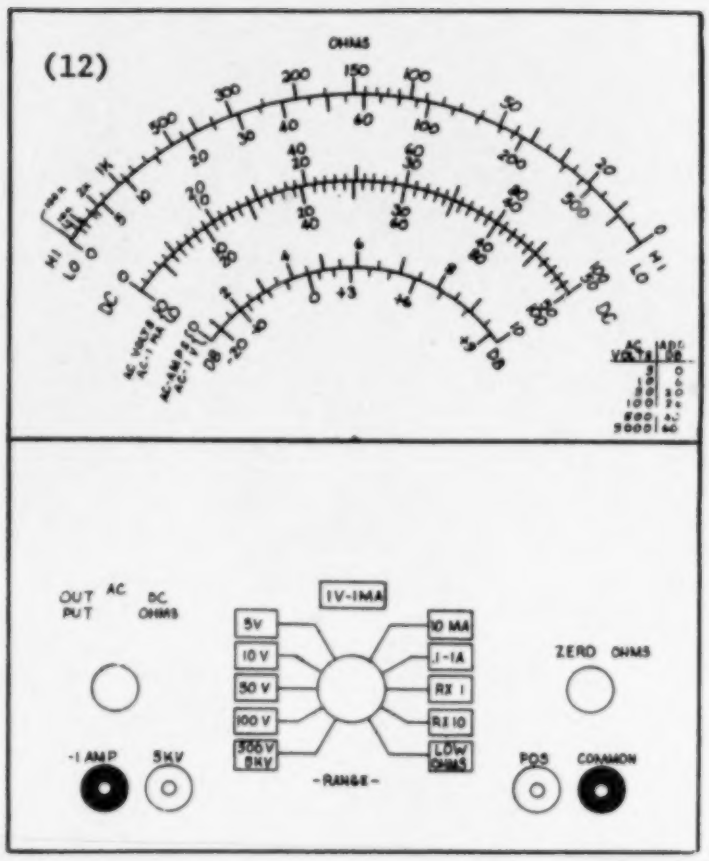

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ABSTRACT - Developed by educators in Camden County Vocational and Technical Schools of New Jersey in cooperation with the Vocational-Technical Laboratory of Rutgers University, this is the second of a 2-part guide designed for teacher and student use in introducing the basic principles of electricity and electronics. Eight units, each consisting of three or more lessons, cover the following topics: (1) Kirchhoff's Laws, (2) Magnetism, (3) Meter Movements, (4) Multimeters, (5) Amateur Radio Licensing, (6) Alternating Current, (7) Effects of Capacitance and Inductance, and (8) Power Supplies. Other than background and explanatory information, the lessons contain assignments, questions, and illustrations. A glossary, an explanation of electrical symbols, and achievement tests are included. Part 1 of the guide is available as VT 012 902, also in this issue. (GEB)

VT012 903

ED0 56238

STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL EDUCATION

INTRODUCTION TO ELECTRONICS

FOR ELECTRICAL AND ELECTRONICS STUDENTS

PART 2

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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VT012903

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State of New Jersey
Department of Education
Division of Vocational Education

INTRODUCTION TO ELECTRONICS

For Electrical and Electronics Students

Part 2

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Curriculum Laboratory
Rutgers - The State University
Building 4103 - Kilmer Campus
New Brunswick, New Jersey

March, 1971

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DIVISION OF VOCATIONAL EDUCATION

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BUILDING 4103 –KILMER CAMPUS

NEW BRUNSWICK, NEW JERSEY

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UNIT XIII - KIRCHHOFF'S LAWS

Lesson No. 1 — Positive and Negative Numbers

If I have no money, one might say my assets are zero. If I have no money and if I owe Jim $2.00 and Bob $5.00, one might say that my assets are $7.00 below zero — or minus (-) $7.00. If, however, Charlie owes me $5.00 and Dan owes me $10.00, my assets are actually worth $8.00.

Let's look at the money owing to me as positive values and that which I owe as negative values.

Then	-2	that which I owe Jim
	-5	that which I owe Bob
	+5	that which Charlie owes me
	+10	that which Dan owes me
	+ 8	my actual worth

This is called algebraic addition. Algebraic addition involves negative as well as positive numbers. Examine the following examples:

+2	+4	-6	-3	+5	+7
-5	-3	+2	-5	+1	-8
-3	+1	-4	-8	+6	-1

How did we get these answers? "By common sense" you may say. But problems aren't always so simple, and a couple of rules will come in handy.

(1) In adding algebraically, if the signs are alike, add the numbers and use the same sign on your answer.

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+2	-2	+7	-7
+3	-3	+1	-1
+5	-5	+9	-9
		+17	-17

(2) If the signs are unlike, subtract the smaller number from the larger and use the sign of the larger.

-2	+2	+13	-4	+4
+7	-7	- 4	+13	-13
+5	-5	+ 9	+ 9	- 9

In the examples above the numbers are arranged in a vertical position. They may also be arranged horizontally for algebraic addition, like this:

-5 -2 +3 = -4

-5 +3 -2 = -4

-2 +3 -5 = -4

In working such problems, it is usually simplest to add all the negative numbers, add all the positive numbers, and then combine the two results. In each of the above cases, this method would lead us to -7 +3, which of course equals -4.

Here are several more examples:

1. -5 +2 -1 = -4

2. -5 +2 -1 +2 = -2

3. -2 +4 +3 -1 = +4

4. +7 +2 -3 = +6

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In examples 3 and 4, the answers should be written simply as 4 and 6, leaving off the plus sign preceding the numbers, because a number standing alone (without any sign) is understood to be positive.

In example 4, the first digit, +7, should have been written simply as 7, since the plus sign is not needed there. If the first number is negative, as in examples 1, 2, and 3, the negative sign is needed to indicate that those numbers are not positive numbers.

Note that we can write the sum of 7 and -2 in two ways: either vertically or horizontally:

$$\begin{array}{r} 7 \\ \underline{-2} \\ 5 \end{array} \qquad \text{or} \qquad 7 \quad -2 \quad = \quad 5$$

For the second form we can also write: 7 - 2 = 5
The spacing here tells us that we are subtracting a +2 from a +7, but it works out to the same answer as adding a -2. So for convenience we often use a centered plus or minus sign.

10 - 3 - 9 + 2 = 0

PROBLEMS:

Find the algebraic sums of the following.

1. -4 - 10 + 2 - 3
2. -3 + 6 + 4 - 7 + 2
3. -6 - 3 + 2 + 9 - 4
4. 8 - 5 + 9 - 3 + 2 + 6
5. 20 + 2 - 8 + 3
6. -25 + 4 - 8 + 15
7. -4 + 35 - 5 - 10 + 40
8. 25 + 5 - 15 - 10 + 5 + 15
9. 4 - 7 + 9 - 4 - 6 - 2 - 5 - 3
10. -2 + 8 + 4 - 6 + 8 + 4 - 2 + 6

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRICAL SYSTEM

MILESTONE: I STORAGE BATTERY

PERFORMANCE OBJECTIVE NO: 1 TITLE: The Storage Battery

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. The Storage Battery	1. Automotive Electrical Equipment, by Crouse. pp. 45 through 73	1. Related Information Class
2. Battery Maintenance	2. Automotive Electrical Equipment, by Crouse. pp. 74 through 109	2. Related Information Class
3. Battery Maintenance	3. Automotive Electrical Equipment Workbook, by Crouse. Jobs 10 through 15	3. Related Information Class
4. Hydrometer testing		4. Shop Instructor
5. Voltage testing		5. Shop Instructor

UNIT XIII - KIRCHHOFF'S LAWS

Lesson No. 2 Multiplication

You have seen how positive and negative numbers may be added algebraically. Let's see now how these positive and negative signs affect answers when the numbers are multiplied.

We know that $2 \times 4 = 8$

or $(2) \times (4) = 8$

The 2 and the 4 are positive numbers since they are without signs in front of them. If one of the numbers has a negative sign in front of it while the other is positive, the answer will be negative.

$(2) \times (-4) = -8$

or $(-2) \times (4) = -8$

If both numbers are negative, however, the answer will be positive.

$(-2) \times (-4) = 8$

RULES:

Negative x negative = Positive

(-) x (-) = (+)

Positive x positive = Positive

(+) x (+) = (+)

Negative x positive = Negative

(-) x (+) = (-)

Positive x negative = Negative

(+) x (-) = (-)

15141

In algebra, we use parentheses ( ) to show that two or more numbers are to be considered as one unit. Any operation performed on one of the numbers must be performed on the others. No doubt you have met up with this idea before.

For example, 2 times (7 - 5) might be written 2(7 - 5). If we were to perform the operation of multiplication, we would get (2 x 7) - (2 x 5) = 14 - 10 = 4. This is obviously correct, since 2 times (7 - 5) is actually 2 times 2.

Let us use the letters a, b, and c to stand for numbers - any numbers at all.

If b plus c are multiplied by a, like this: $a(b + c)$, the answer is $ab + ac$. That is, $a(b + c) = ab + ac$.

If you multiply b plus c by 4, like this

$$4(b + c)$$

the answer is $4b + 4c$. Then $4(b + c) = 4b + 4c$.

If you multiply a + b by -4, like this

$$-4(a + b)$$

the answer is $-4a - 4b$. Then $-4(a + b) = -4a - 4b$.

If you multiply a - b by -4 like this

$$-4\ (a - b)$$

the answer is $-4a + 4b$. Then $-4(a - b) = -4a + 4b$.

As you know, in electricity we work with many different letters, each standing for a particular value.

EXAMPLES:

$$4\ (R_1 + R_2) = 4R_1 + 4R_2$$

$$-10(I_1 + I_2) = -10I_1 - 10I_2$$

$$8(I_1 - I_2) = 8I_1 - 8I_2$$

$$-6(I_1 - I_2) = -6I_1 + 6I_2$$

15142

Another thing we must learn now if we are to be able to figure out circuits - which parts of an algebraic "expression" we can combine, and which we cannot.

If I told you to add 10 volts and 3 ohms, you would say - "It can't be done; they are different types of things." But if I said, "add 10 volts and 3 ohms and 2 volts and 4 ohms," you would be able to at least add the volts together and add the ohms together. The answer might not mean much, but it could be done.

$$10V + 3\Omega + 2V + 4\Omega = 10V + 2V + 3\Omega + 4\Omega = 12V + 7\Omega$$

In algebra, similarly, we cannot add different types of things, that is, different letters.

$$6a + 2b = 6a + 2b$$

But we can add (or subtract) similar types of things.

$$4a + 2a = 6a$$

$$6V - 1V = 5V$$

We might find ourselves with an expression like this:

$$2a - 4b + 3c + 6a - 2c$$

We can combine the similar parts:

$$2a + 6a - 4b + 3c - 2c$$

We get: $8a - 4b + 1c$, which is written $8a - 4b + c$. (That is, $1c$ is written as c.)

Here is something you might come across in electricity:

$$3I_1 + 4I_2 + 3I_1 - 18 = 0$$

You can combine the two I_1's but not the I_1's with the $4I_2$ or the plain number 18. They are different things. So you would write this as

$$3I_1 + 3I_1 + 4I_2 - 18 = 0$$

$$6I_1 + 4I_2 - 18 = 0$$

15143

Here is another:

$$-4I_1 - I_1 + 5I_2 - 20 = 0$$

$$-5I_1 + 5I_2 - 20 = 0$$

PROBLEMS:

Multiply:

1. $4(I_1 + I_2)$
2. $-3(b - c)$
3. $-16(I_1 + I_2)$
4. $-14(a + b - c - d + e)$

Combine:

5. $2I_1 + 3I_1 + 6I_2 + 5I_2$
6. $4a + 2b - c - 3a - 7c$
7. $10I_1 - 4I_2 + 3I_2$
8. $13x - 10y + 2z + 6y - 2z$

Multiply and combine:

9. $-2(a - b) + 12(a + b)$
10. $4(I_1 - I_2) - 2I_1 + 3I_2$
11. $-3(I_2 - I_1) - 10(I_1 - I_2)$
12. $5(I_1 - I_2) - 4I_1 + 7I_2 - 2I_2$

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UNIT XIII - KIRCHHOFF'S LAWS

Lesson No. 3 Law No. 1

There are two Kirchhoff laws. The first one states:

> The algebraic sum of the currents at any junction in an electrical circuit is equal to zero.

You could also state this by saying that, "The total of all the currents leaving a junction is equal to all the currents coming into it."

Suppose we have a condition like this:

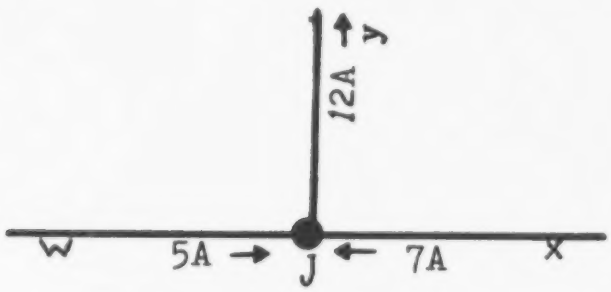

Fig.: XVIII-3-1

Wire w is carrying 5 amperes of current into junction J. Wire x is carrying 7 amperes of current into junction J. Since there is only one more wire at that junction (wire y), it must be carrying away all of that current -- all 12 amperes.

Now if you want to go back and relate this situation to the first of Kirchhoff's laws, in algebraic terms, you can apply + signs to the currents coming into the junction and a - sign to the current going out and state it like this:

$$-12 + 5 + 7 = 0$$

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Let's look at this junction and its currents:

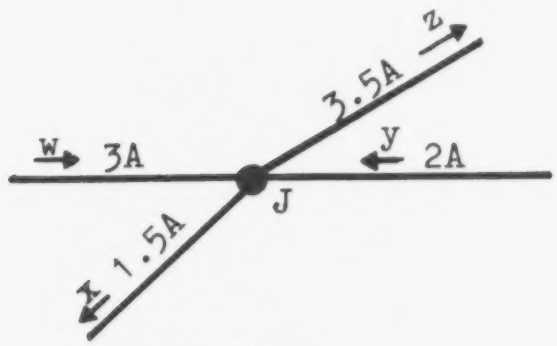

Fig.: XIII-3-2

We must have a starting place, so let's start with conductor w and go around the junction in a counterclockwise direction, giving + values to currents going toward the junction and - values to those leaving the junction.

$$3 - 1.5 + 2 - 3.5 = 0$$

Add them. Don't the + values cancel out all of the - values? Therefore their algebraic sum does equal zero, and these current values do follow Kirchoff's law.

This is a simple law - simple in that it is so logical. It is like saying, "All that goes up must come down." All the currents going into a junction must leave that junction.

Follow the currents in the following circuit:

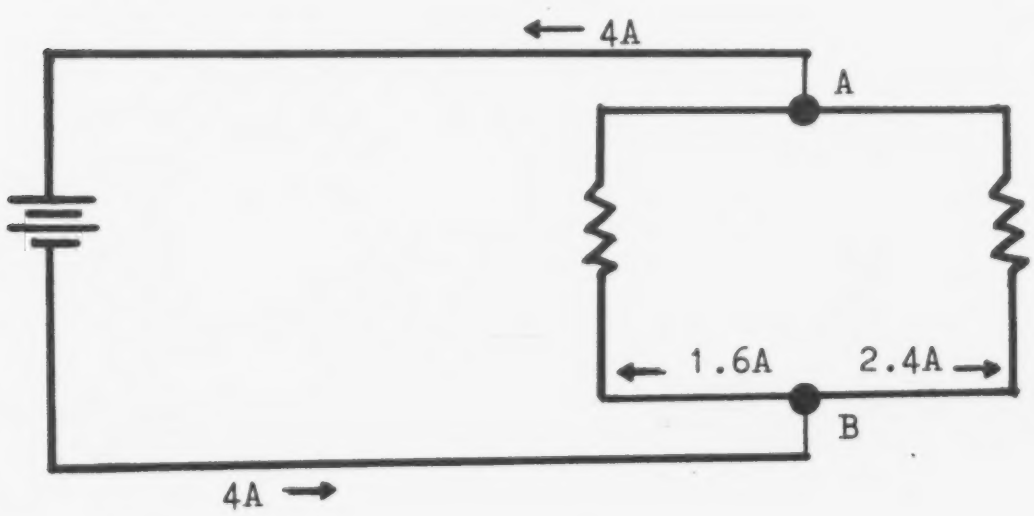

Fig.: XIII-3-3

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How much current is going into junction A? How much is leaving junction A? How much is going into junction B? How much is leaving junction B?

The algebraic equation showing Kirchhoff's first law for junction B is:

$$4 - 2.4 - 1.6 = 0$$

The equation for junction A is:

$$1.6 + 2.4 - 4 = 0$$

ASSIGNMENT:

Write the algebraic equations (demonstrating Kirchhoff's first law) for the currents at the junctions shown below.

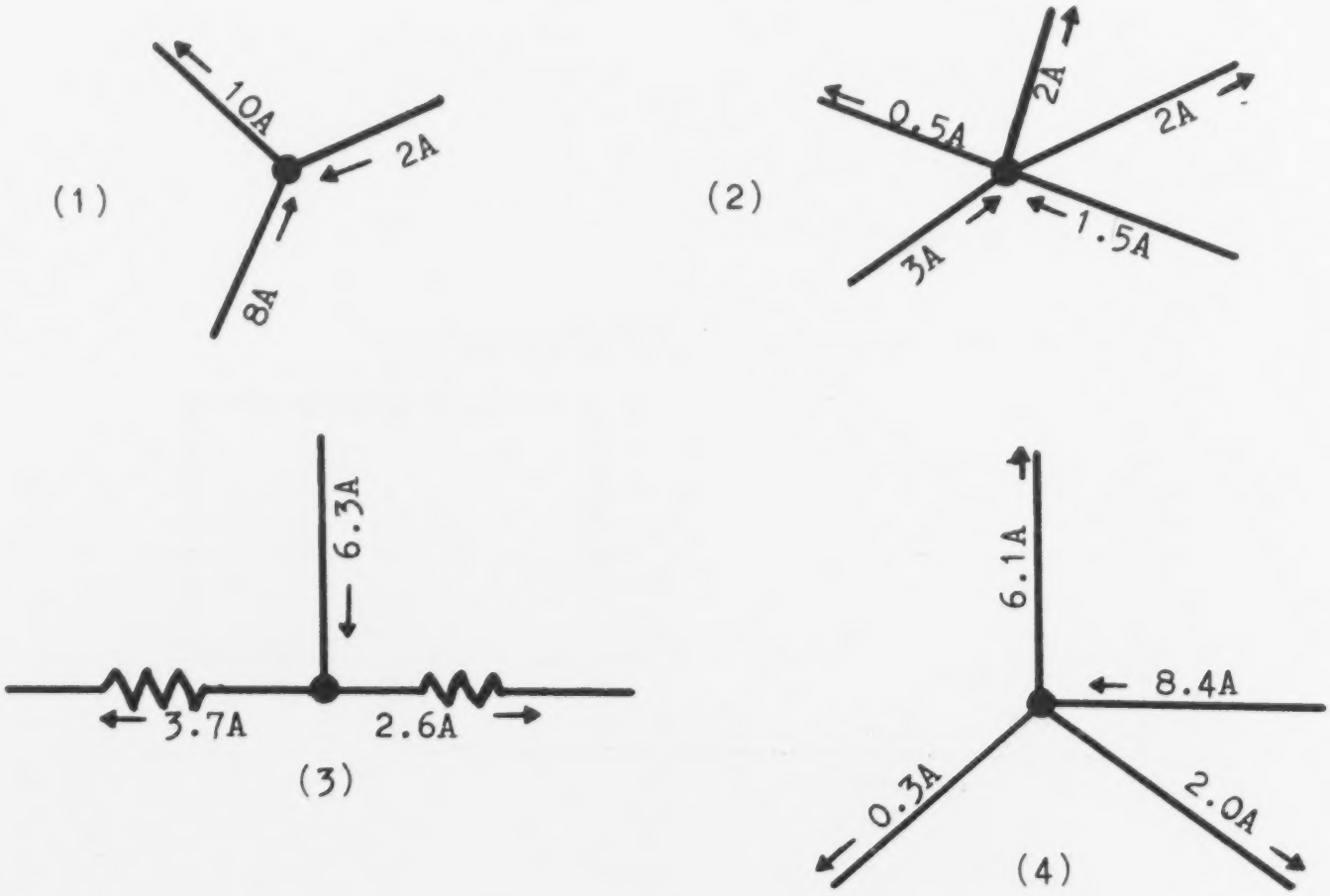

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UNIT XIII - KIRCHHOFF'S LAWS

Lesson No. 4 Law No. 2

Kirchhoff's second law states that:

> The algebraic sum of the electromotive forces and the voltage drops around any closed electrical loop is zero.

This may also be stated as, "The sum of all the voltage drops in a closed electrical loop is equal to the applied e.m.f."

Look at this circuit:

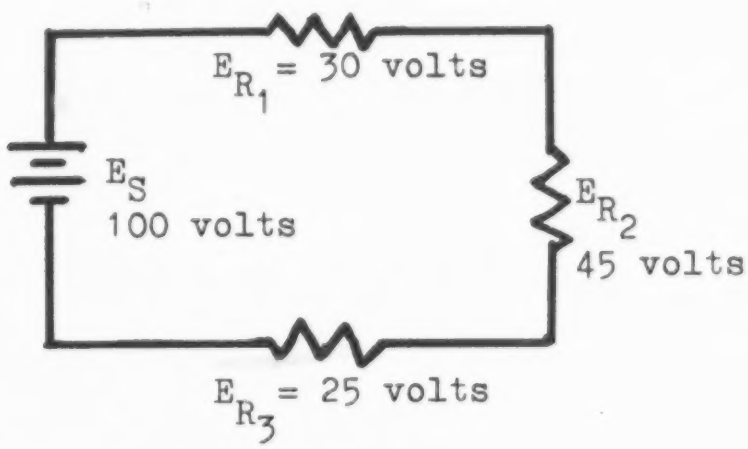

Fig.: XIII-4-1

When you add the voltage drops 30 + 45 + 25 you will get 100 - the same as the applied e.m.f. (the source voltage).

The fact that the sum of their voltage drops equals the source voltage is Kirchhoff's Law No. 2.

This can be used in many ways. Perhaps you will most often use it this way:

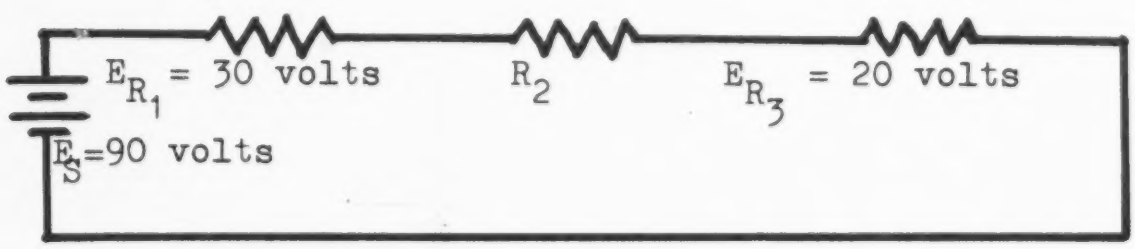

Fig.: XIII-4-2

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The value of R_2 is not given. According to Kirchhoff's voltage law, the three drops must equal 90 volts. We can see voltage drops totaling 50 volts. Now we know that the other 40 volts must be dropped across R_2, since there is no other resistance in the circuit to cause this drop.

Consider this circuit:

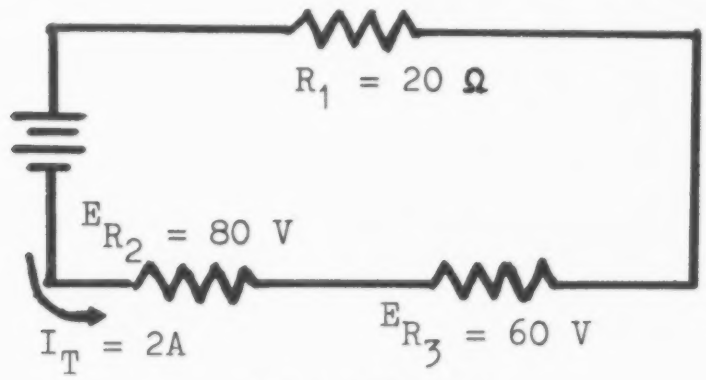

Fig.: XIII-4-3

What is the value of the applied voltage?

We know that the sum of the voltage drops equals the applied voltage. Only two of the voltages are given. E_{R_1} is not given, but the resistance value of R_1 is given and we have the total current given. I_T flows through R_1, so:

$$E = I \times R$$

$$E_{R_1} = 2 \times 20 = 40 \text{ volts}$$

Now we have all the voltage drops. E_{R_1} = 40 volts, E_{R_2} = 80 volts, and E_{R_3} = 60 volts.

$$40 + 80 + 60 = 180$$

So the applied voltage must be 180 volts.

ASSIGNMENT:

1. Find E_{R_1}

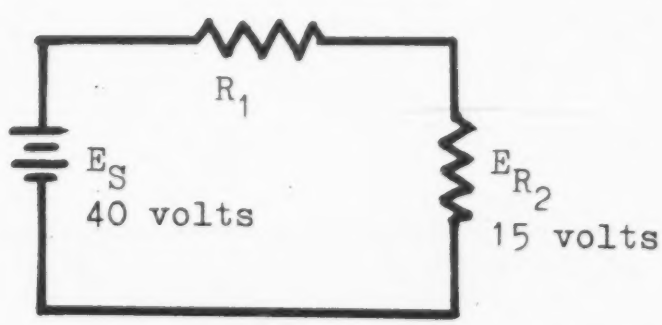

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2. Find the value of the source voltage.

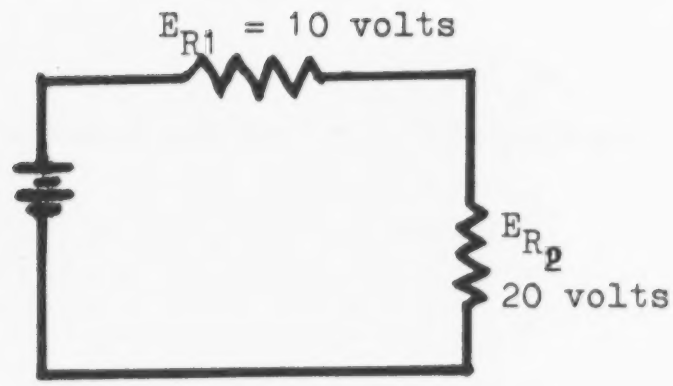

3. Find $E_{applied}$.

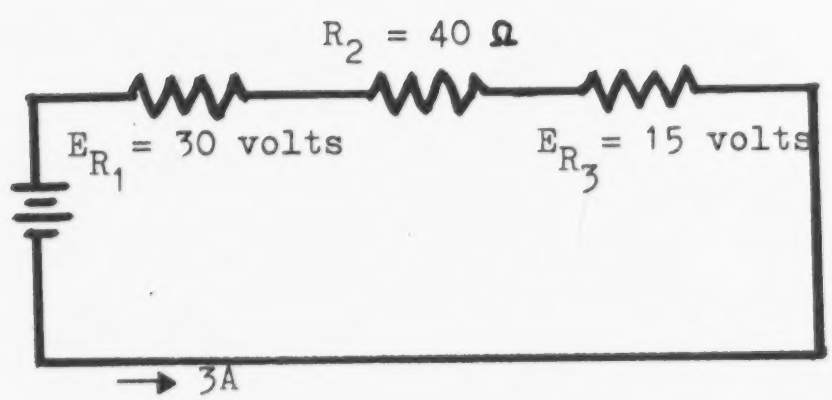

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: I. STORAGE BATTERY

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Clean, Test, and Replace Storage Battery

CONDITIONS:

This assignment will be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective cover on front seat of automobile
2. Move automobile into proper work station
3. Raise hood on automobile
4. Place protective covers on fenders
5. Select proper manual and turn to appropiate chapter
6. Select proper tools and materials
   (Before proceeding, obtain one pound of bicarbonate of soda and a water can filled with water. Keep these items handy and use to neutralize acid or corrosion. Do not get acid on clothing or skin. If you do, immediately neutralize acid with soda water solution.)
7. Remove cables from battery
8. Submerge cable terminals in soda water solution
9. Remove battery hold-down bracket

PERFORMANCE CRITERIA:

1511

UNIT XIII - KIRCHHOFF'S LAWS

Lesson No. 5 Forming Equations

An equation is the sort of thing we have been dealing with in the past couple of lessons - an algebraic statement where one thing equals another. For example, here are some equations:

$$3 + 4 - 2 = 5$$

$$2I + 6I = 8I$$

$$E = I \times R$$

(When we speak of the two sides of an equation, we mean the parts to the left and the right of the = sign.)

An equation, as we said, is a statement. It is a short way of writing down the relationship between different things.

How would you say (in words)

$$E = IR \ ?$$

We must learn how to set up an equation for a circuit in a manner which will help us solve problems we will meet in the future. Consider the following circuit and the equation that goes with it:

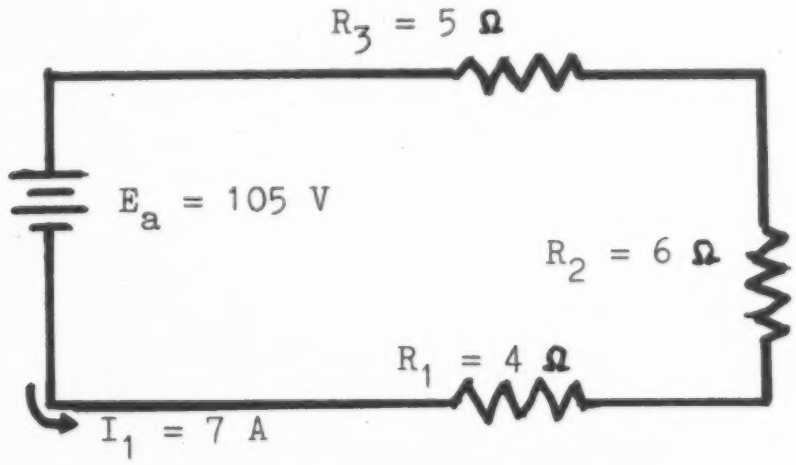

Fig.: XIII-5-1

15151

We know that $E_{R_1} + E_{R_2} + E_{R_3} = E_{applied}$, or that

$$E_{R_1} + E_{R_2} + E_{R_3} - E_{applied} = 0$$

Let's review now that $E_{R_1} = I_{R_1} \times R_1$. We also know that $I_1 = I_{R_1}$ as well as the value of current through the other resistors in this series circuit.

If $E_{R_1} = I_{R_1} \times R_1$ then $E_{R_1} = 7(4)$ (that is, 7 x 4)

and $E_{R_2} = 7(6)$

and $E_{R_3} = 7(5)$

We must have polarities to these voltage drops, so let's establish them by starting at the negative terminal of the battery and going in a counterclockwise direction. That is the direction of the electron-flow, you will recall. This would make the end of R_1 nearest to the battery <u>negative</u>, wouldn't it? The polarities, then, would be like this.

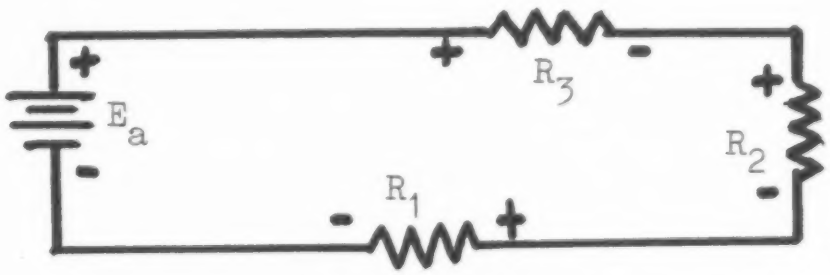

Fig.: XIII-5-2

Let's start the equation.

$$-E_{R_1} - E_{R_2} - E_{R_3} + E_{applied} = 0$$

$$\text{or } -I_1 (R_1) - I_1 (R_2) - I_1 (R_3) + E_{applied} = 0$$

Where did we get the minus signs? You will notice that, starting at the negative terminal of the battery and going around the circuit in a counterclockwise direction, and stopping when we get back to where we started, we give the polarity we find at the <u>near</u> end of the voltage drops and at the applied voltage. Let's look at it again while studying the circuit - and knowing what each figure represents and why the sign is as it is.

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$$-I_1(R_1) - I_1(R_2) - I_1(R_3) + E_a = 0$$

$$-7(R_1) - 7(R_2) - 7(R_3) + E_a = 0$$

$$-7(4) - 7(6) - 7(5) + 105 = 0$$

$$-28 - 42 - 35 + 105 = 0$$

In writing the equation, you can start anywhere you please and go in either direction. It is best, however, to be consistent in starting points; and, if possible, make your starting point at the negative terminal of the source voltage. Forming this habit will be helpful later on when you will be writing equations for more complex circuits.

To illustrate how you can start at another place and go in the other direction, let's do just that with the circuit we have just studied.

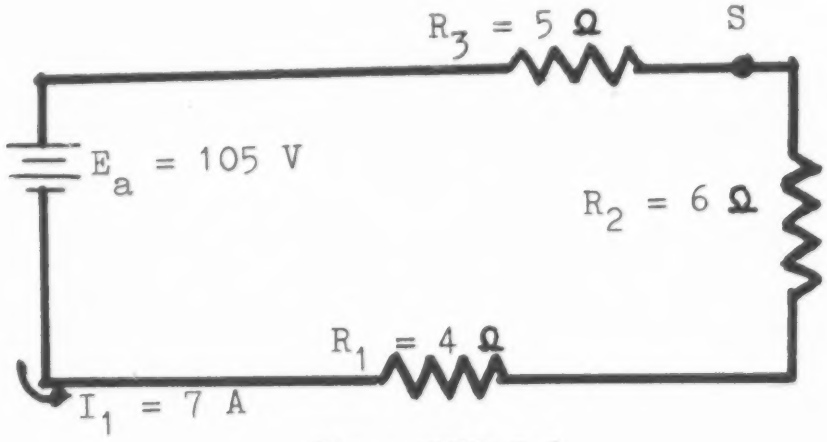

Fig.: XIII-5-3

Let's start at point S and go in a clockwise direction.

$$I_1(R_2) + I_1(R_4) - E_a + I_1(R_3) = 0$$

$$7(6) + 7(4) - 105 + 35 = 0$$

$$42 + 28 - 105 + 35 = 0$$

$$105 - 105 + 0$$

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ASSIGNMENT:

Write the Kirchhoff's-Law equations for the following circuits.

1

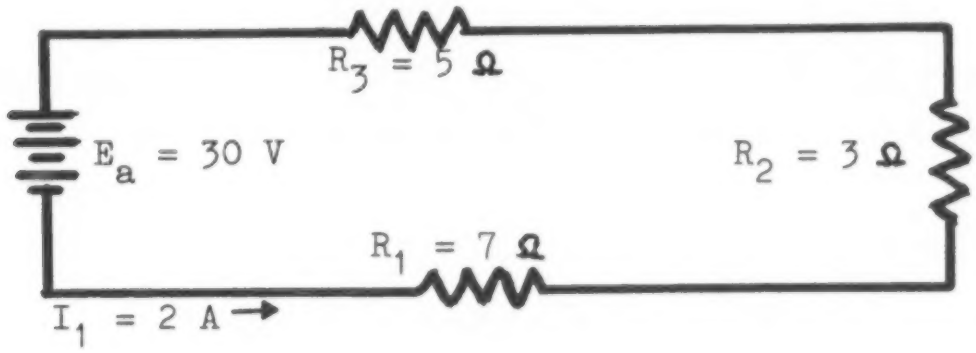

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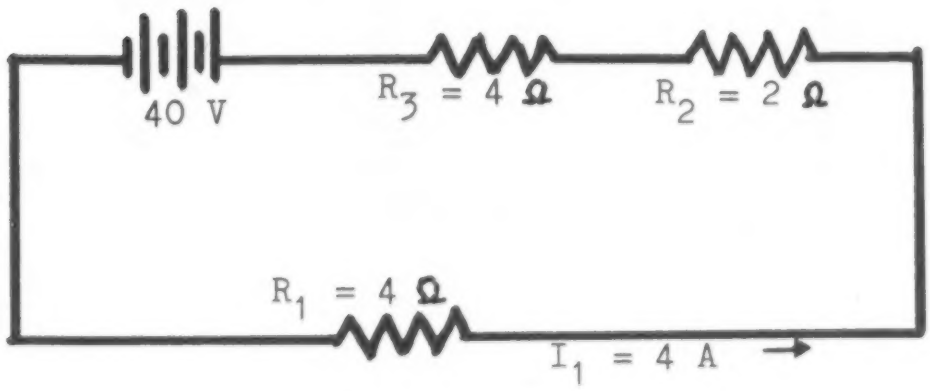

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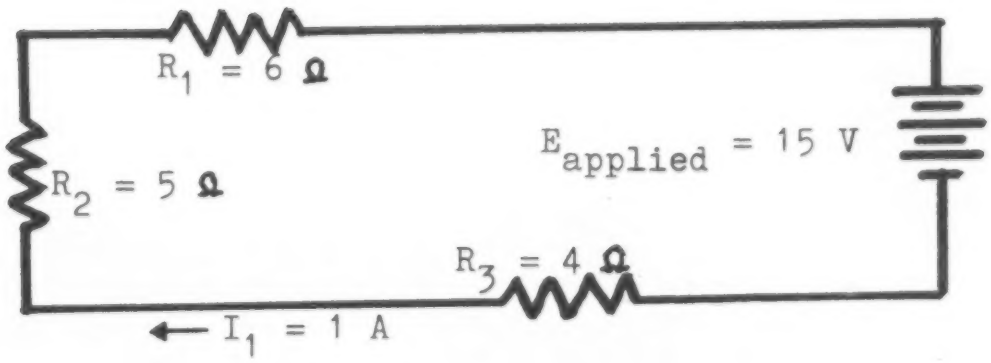

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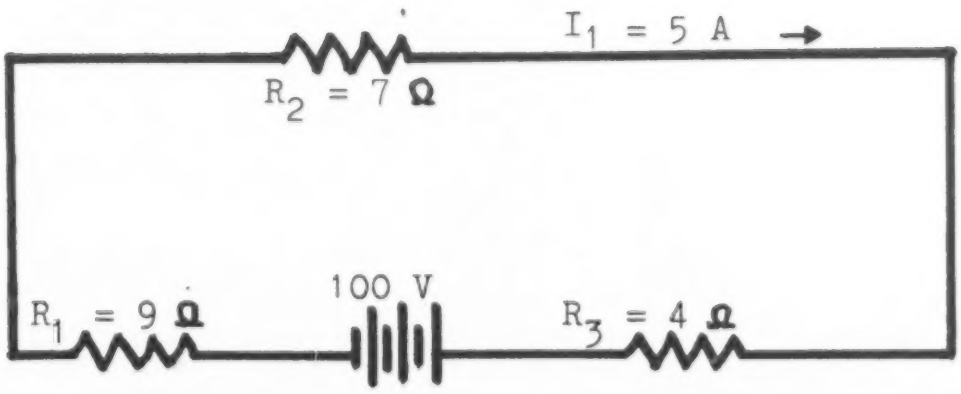

UNIT XIII - KIRCHHOFF'S LAWS

Lesson No. 6 — Two Voltage Sources

There will be occasions in your electrical work when you will run into circuits having two different voltage sources. Study the one below and see if you can solve for I_1, I_2, and I_3, using Ohm's Law.

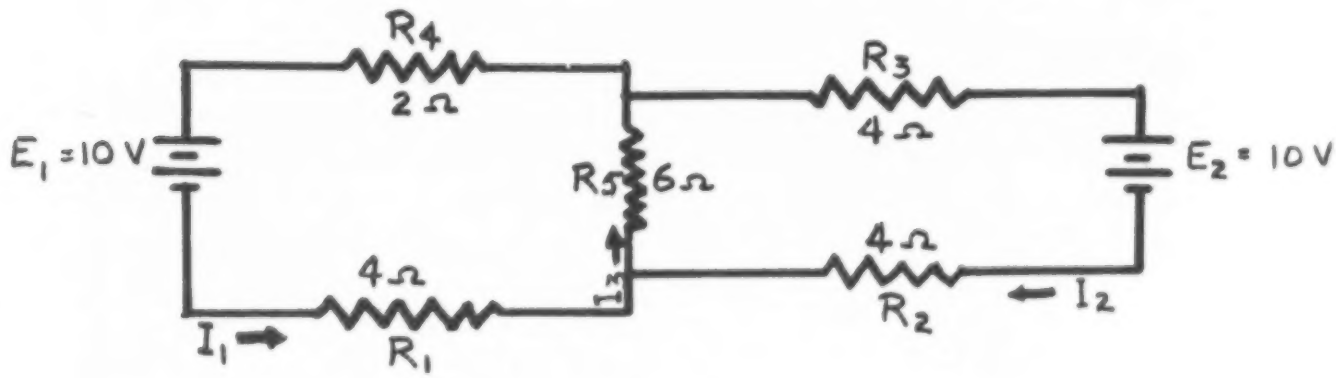

Fig.: XIII-6-1

Now that you have learned that Ohm's Law will not help you get the answers, let's see how it can be solved.

There are three different currents in this circuit. We shall first study the one from E_1 going through R_1, R_5, and R_4 back through E_1, and we'll call it I_1. Similarly, E_2 can force a current through R_2, R_5, and R_3. We'll call this current I_2.

Have you noticed that both I_1 and I_2 go through R_5? We'll call the sum of these two currents I_3, and remember that $I_3 = \Sigma\ (I_1 + I_2)$.
I_1 may be going in one direction while I_2 could be going in the other direction. This is why we add the two currents <u>algebraically</u>. The Greek letter sigma (Σ) means the <u>algebraic sum of</u>.

For example, if $I_1 = 5A$ and $I_2 = -3A$, I_3 could be found like this:

$$I_3 = \Sigma\ (I_1 + I_2)$$
$$I_3 = 5 + (-3)$$
$$I_3 = 5 - 3$$
$$I_3 = 2A$$

Let's write the equation for the left side of the above circuit.

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$$-E_{R_1} - E_{R_5} - E_{R_4} + 10 = 0$$

$$-I_1 (R_1) - I_3 (R_5) - I_1 (R_4) + 10 = 0$$

Don't forget that the current going through R_5 is I_3 and $I_3 = \Sigma (I_1 + I_2)$

$$- I_1 (4) - (I_1 + I_2) 6 - I_1 (2) + 10 = 0$$

$$- 4I_1 - 6 I_1 - 6I_2 - 2 I_1 + 10 = 0$$

We can combine all the I_1's. We get

$$\text{(A)} - 12I_1 - 6I_2 + 10 = 0$$

That is all we can do with this equation at this time, so let's call it <u>Equation A</u> and leave it for now while we go back and develop the equation for the right side of the circuit.

$$-E_{R_2} -E_{R_5} -E_{R_3} + 10 = 0$$

$$-I_2R_2 - I_3R_5 - I_2R_3 + 10 = 0$$

$$-I_2(4) - (I_1 + I_2) 6 - I_2(4) + 10 = 0$$

$$-4I_2 - 6I_1 - 6I_2 - 4I_2 + 10 = 0$$

Combining all the I_2's, we get

$$\text{(B)} -6I_1 - 14I_2 + 10 = 0$$

If we had a simple equation like

$$5I_1 - 10 = 0$$

by the rules of algebra it would be easy to find out the value of our unknown quantity, I_1. First we would add 10 to each side of the equation. (This does not change the truth of the equation.)

$$5I_1 - 10 + 10 = 0 + 10$$

or $$5I_1 = 10$$

There is another trick we can perform now, to help us find I_1. It doesn't change the truth of the equation either. We divide both sides of the equation by the number 5.

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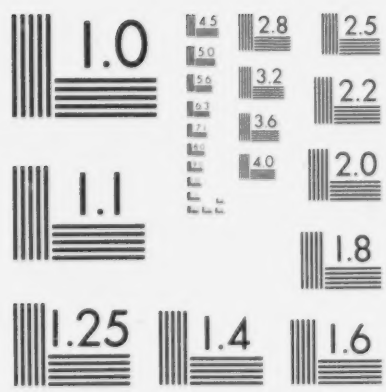

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

$$\frac{5I_1}{5} = \frac{10}{5}$$

or $$I_1 = 2$$

That is how we would go about solving a simple equation that has one unknown quantity in it.

If we look at equations A and B, however, we find that each contains <u>two</u> unknown quantities-- I_1 and I_2. Neither equation, taken by itself, can enable us to find their values. However, we can work with these two equations together, and find the unknown quantities. When we work with two equations in this manner, they are called <u>simultaneous equations</u>, because we work with both at the same time - or <u>simultaneously</u>.

Let's place one of these equations over the other, as if to add them.

(A) $$-12I_1 - 6I_2 + 10 = 0$$

(B) $$-6I_1 - 14I_2 + 10 = 0$$

If we had the same number of I_1's or I_2's in each equation, we could perform a simple trick to find one or the other - we could add or subtract the two equations. This would leave us with only one unknown quantity, which would make a solution possible.

So let us multiply equation B by -2. This will not change the truth of the equation. That will give us $+12I_1$ which will cancel out the $-12I_1$ if we add equation B to equation A.

But remember, if you multiply equation B by -2, you must multiply the <u>entire</u> equation — everything on both sides of the = sign — so that it is still true.

$$(-2) \times -6I_1 - 14I_2 + 10 = 0$$

will give $$+12I_1 + 28I_2 - 20 = 0$$

Now add the two equations, A and the new form of B.

$$\begin{array}{lrrrl} (B) \times (-2) & \cancel{12I_1} & + 28I_2 & - 20 & = 0 \\ (A) & \cancel{-12I_1} & - 6I_2 & + 10 & = 0 \\ \hline & & 22I_2 & - 10 & = 0 \end{array}$$

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$$+22I_2 = +10 \text{ (adding 10 to both sides)}$$

$$I_2 = \frac{10}{22} \text{ (dividing both sides by 22)}$$

$$\text{or} \quad I_2 = 0.454\text{A}$$

We could take this newly found value of I_2 and substitute it for I_2 in either equation, A or B. That would leave I_1 as the only unknown value in the equation, making it possible to solve for I_1. This method is called the substitution method.

To be sure and safe, however, it is best to solve for I_1 just as we solved for I_2.

If we multiply equation A by 7 and equation B by -3, it will give values of I_2 in the two equations which will cancel out when the two equations are added.

(A) $-12I_1 - 6I_2 + 10 = 0$; x(7) gives $-84I_1 - \cancel{42I_2} + 70 = 0$

(B) $-6I_1 - 14I_2 + 10 = 0$; x(-3) gives $+18I_1 + \cancel{42I_2} - 30 = 0$

$$-66I_1 \qquad + 40 = 0$$

(Subtracting 40 from both sides) $-66I_1 = -40$

(Multiplying both sides by -1) $66I_1 = 40$

(Dividing both sides by 66) $I_1 = \frac{40}{66}$

$$\text{or} \quad I_1 = 0.606\text{A}$$

Now let's go back and solve for I_1 by the substitution method.

I_2 was found to be 0.454 A.

Let's plug this numerical value of I_2 into equation B. It will work, however, in either equation A or equation B.

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(B) $-6I_1 - 14I_2 + 10 = 0$

$-6I_1 - 14(0.454) + 10 = 0$

$-6I_1 - 6.356 + 10 = 0$

$-6I_1 + 3.644 = 0$

$-6I_1 = -3.644$ (subtracting 3.644 from both sides)

$I_1 = \frac{3.644}{6} = 0.607$ Ampere (Dividing through by -6)

It proves, doesn't it? It always will, if you are careful with your signs and watch your decimals.

Finding I_3 is now simple.

$$I_3 = \Sigma(I_1 + I_2)$$

$$I_3 = 0.606 + 0.454 = 1.060 \text{ amperes}$$

I_3 is the current we would have to use to find the value of E_{R_5}.

$$E_{R_5} = I_3 \times R_5$$

$$E_{R_5} = 1.06 \times 6 = 6.36 \text{ volts}$$

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: I. STORAGE BATTERY

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Clean, Test, and Replace storage Battery

CONDITIONS:

BEHAVIOR:

10. Carefully remove battery from automobile
11. Thoroughly clean battery with soda water solution
12. Inspect battery for cracks
13. Check electrolyte level in each cell
14. Test specific gravity of each cell with hydrometer
15. Check battery voltage
16. Place on charger
17. Clean battery terminals with terminal cleaning tool
18. If battery is found to be satisfactory, carefully replace battery in automobile
19. Clean hold down bracket and install on battery
20. Clean and dry battery terminals
21. Put cables back on proper battery terminal (observe polarity)
22. Tighten cables
23. Coat battery post and terminals with vasoline
24. Start automobile and observe charge indicator light or gauge - Light should go out - Gauge should indicate charge

PERFORMANCE CRITERIA:

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ASSIGNMENT:

Find the values of I_1, I_2, and I_3 in the following circuits.

1.

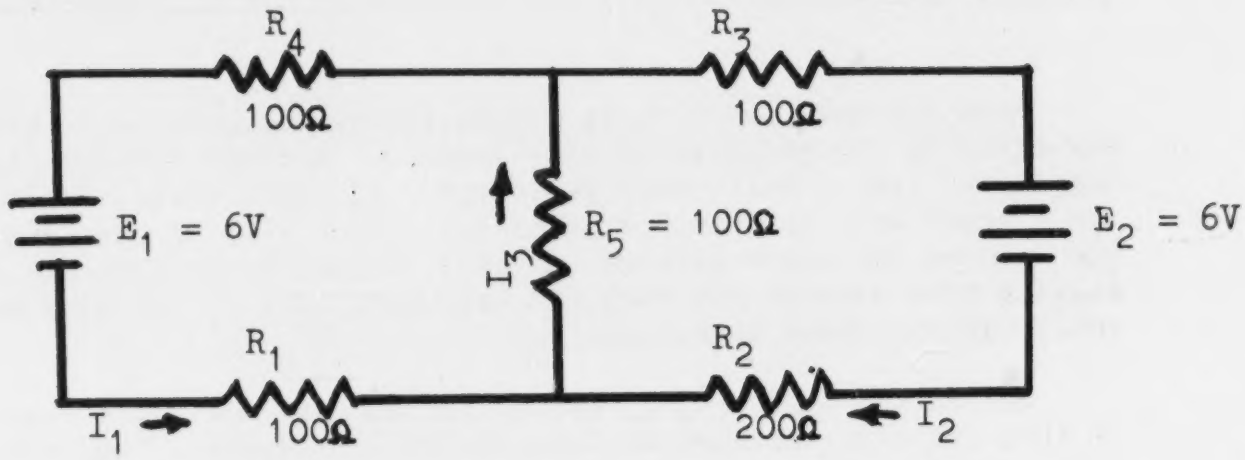

2.

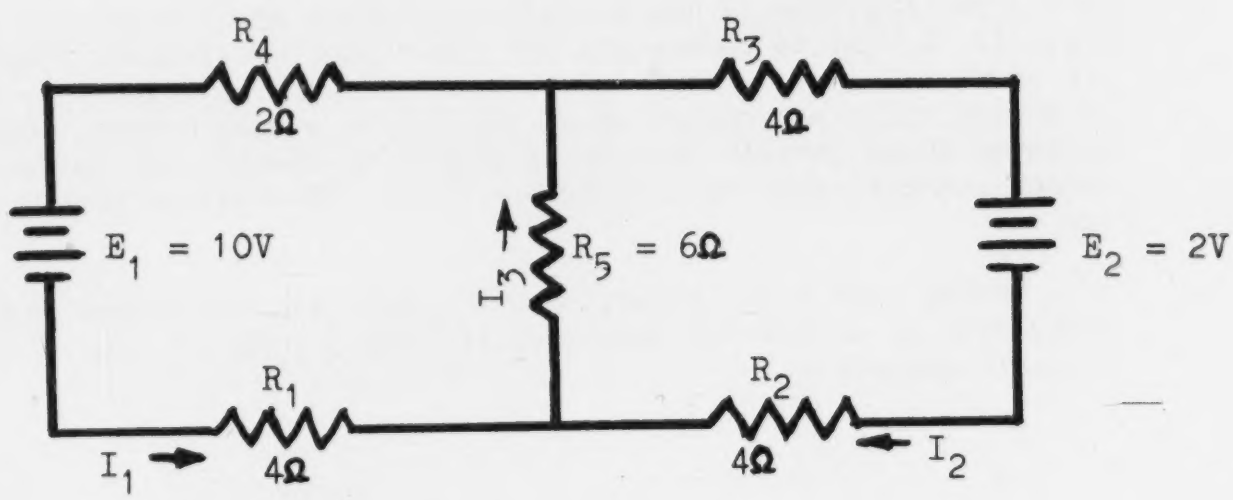

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UNIT XIV - MAGNETISM

Lesson No. 1 — Legend, the Earth, the Compass

When you were quite young - even before you started to kindergarten- you probably enjoyed playing with magnets. Perhaps you had little magnetized toys. Well, many years ago - in fact, thousands of years ago - grown men, gray-headed scholars, played with magnets and pondered the reasons for their strange actions. Today, scientists are still playing with magnets and they are unlocking some of the many secrets still unknown about magnetism.

Before the beginning of the Christian era, men found small pieces of iron ore near the town of Magnesia in Asia Minor. They found that this peculiar ore would attract pieces of iron. The ore (or stone) was called magnetite because it was discovered near Magnesia, and the name magnet comes from magnetite.

You can imagine what a strange thing a magnet was in that day when a man had none of the marvels of science and electricity around him. It is easy to understand how these people let their imaginations run away with them. Today we can read the stories which they made up during their excitement about the powers of magnetism. They made up tales about certain islands of magnetite drawing the nails out of ships, reducing them to nothing but boards floundering around on the sea!

It was many years later, however, when man discovered that he could make an artificial magnet by rubbing a strip of iron with a piece of magnetite.

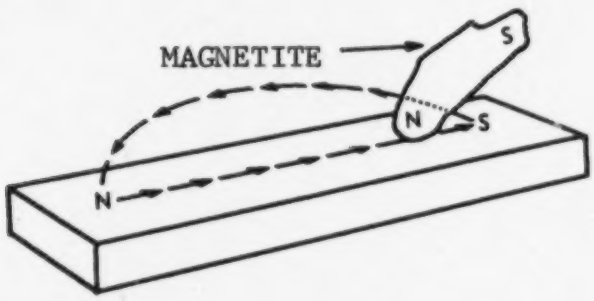

Fig.: XIV-1-1

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Still more years later, man learned that if he suspended a bar magnet on a string, it would come to rest with a certain end pointing to the north and the other end toward the south.

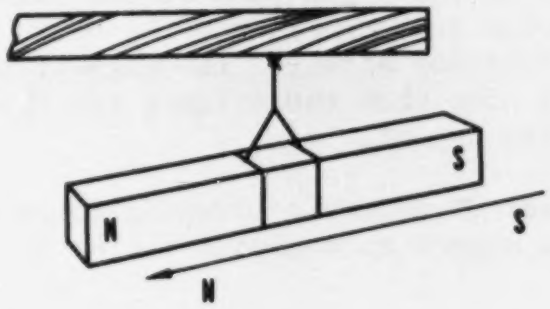

Fig.: XIV-1-2

He already knew that magnets had "poles" - that is, ends which were opposite to each other in their force. If he had two bar magnets, the end of one would attract one end of the other and would repel the other end. It seems logical, then, that he came to the conclusion that the earth was something like a magnet itself. This discovery was perhaps one of the greatest in the history of mankind, because of its aid to sea navigation.

To avoid confusion, the poles of a magnet are labeled. One end always seeks the north pole of the earth, and so it is called the north pole of the magnet. The other end (that seeks the south) is called the south pole of the magnet.

If a bar magnet is placed under a piece of glass, and iron filings sprinkled on top of the glass, these filings will line up as shown in the following photograph.

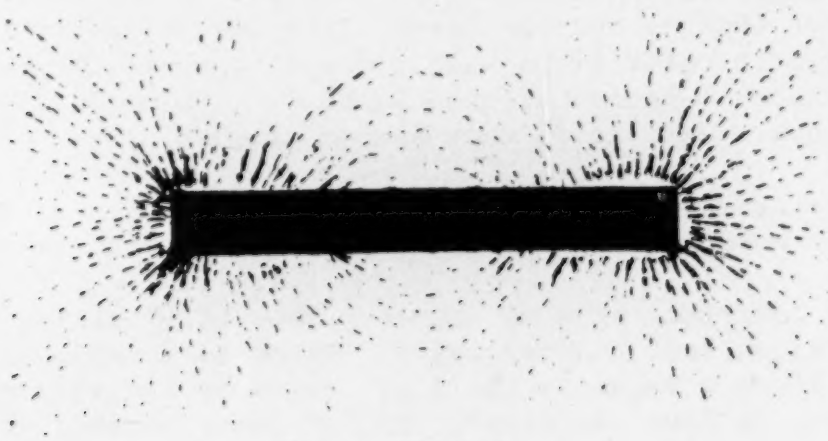

Fig.: XIV-1-3

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We know that there is power here which can force particles of iron to move, and it is seen here that this force is concentrated in lines. Therefore it remains to decide in which direction these lines travel. Scientists have agreed to accept the direction as running from the north pole to the south pole of the magnet outside the magnet (and continuing inside the magnet from the south pole to the north). So we can say now that the stronger the magnet, the more lines of force we will have; also that these lines run from the north pole to the south pole of the magnet.

The total number of magnetic lines of force through a given cross section (of a magnet or magnetic field) is called the magnetic flux.

It has been found that the magnetic lines of force never cross.

Magnetic lines of force are always in closed loops. They seem to form complete circuits outside and inside the magnet, through its poles.

Magnetic lines coming from the same pole tend to repel one another. Another way of saying this is that lines of force traveling in the same direction (convention assumes they move) repel one another.

Magnetic lines will pass through all kinds of materials, whether they are magnetic materials or not. So there cannot be a magnetic insulator.

Knowing the above four facts, along with the knowledge that like poles repel and unlike poles attract, scientists have been able to employ magnetism in the performance of many duties.

Magnetism possesses secrets yet unsolved. Scientists have not fully explained this mysterious force. The modern theory of magnetism is that a magnetic material becomes a magnet when the atoms in that material are made to become aligned instead of being in their original random positions. What makes them become aligned?

The magnetic alignment is caused by the electrons of the magnetic material. The movements of electrons always create magnetic fields.

Magnetic materials have an uneven number of electrons in certain orbits. Electrons tend to form pairs. These pairs spin in opposite directions. Since a magnetic field is caused by the spin movement, their magnetism is thus cancelled. But an uneven number of electrons does not allow one electron to form a pair. The unbalanced spin of that electron causes an atom to have a magnetic field.

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When an external magnetic field, such as a bar magnet, is brought into contact with the randomly arranged atomic fields, the atomic fields rearrange themselves so that they are parallel with the stronger external field.

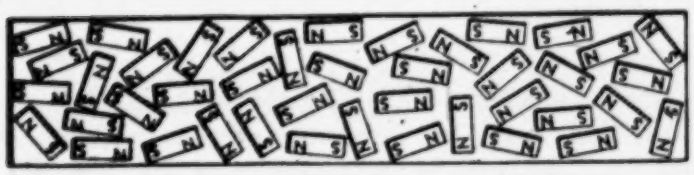

A representation of randomly arranged atoms in an unmagnetized substance.

Fig.: XIV-1-4

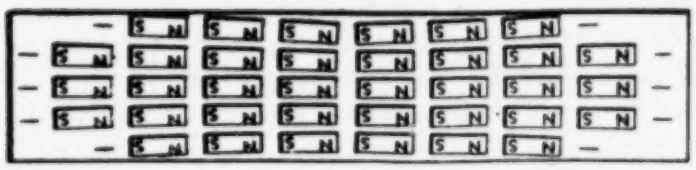

A representation of aligned atoms in a magnetized substance.

Fig.: XIV-1-5

Iron and metals containing considerable proportions or iron are among the better magnetic materials - materials that can be attracted by magnets and can themselves be made into magnets. Soft iron can be easily magnetized and can also be easily demagnetized. Such materials are known as temporary magnets when they are magnetized. Many of our so-called "permanent" magnets are made of steel. One of the strongest is known as Cast Alnico V, which contains aluminum, nickel, cobalt, copper, and iron. Permanent magnets have many uses in electricity and electronics. Practically all loudspeakers today have strong permanent magnets in them.

Magnets should never be heated or dropped. Heat or a sharp jarring knocks the molecules out of line, and the material returns to its original condition with random-positioned molecules. Horseshoe-type magnets should be kept with a "keeper" across the open poles. This keeper can be made of any piece of iron or steel.

QUESTIONS:

1. What is magnetite?

2. How did the magnet get its name?

3. Give three precautions for preserving the strength of a permanent magnet.

4. What is the molecular theory of magnetism?

5. What are the metals in Cast Alnico V?

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UNIT XIV - MAGNETISM

Lesson No. 2 Electromagnetism

In 1777, the year after the signing of the Declaration of Independence, Hans Cristian Oersted was born in Copenhagen, Denmark. By the age of 12 he was assisting his father in his apothecary, where he became interested in chemistry. He entered the University of Copenhagen at the age of 17 and received a medical degree after 6 years of study. He did not practice medicine for long. Six years after graduation he was back at the university, this time as a professor of physics. On a certain day in 1819, when he had been teaching there 14 years, he was lecturing to a class when he by chance placed a wire carrying an electric current parallel to a compass needle. Much to his surprise, the needle swung around and pointed at the wire. When he reversed the current, the needle turned around so that its other end was pointing toward the wire!

It was on that day that man learned that there is a direct connection between electricity and magnetism. In time it became clear that there are lines of magnetic force around a conductor when it is conducting an electric current, and that the direction of the current determines the direction of the magnetic force.

In order to understand diagrams illustrating the direction of current flow, we must consider that we are looking at a cross section, or the end of the wire. If it has a cross on it like this

it means that the current is going <u>away</u> from the reader. (Think of the cross mark as the tail end of an arrow - the tail feathers.) If the end of the wire is shown with a dot in the center like this

it means that the current is coming <u>toward</u> the reader. (The dot represents the tip of the arrowhead, coming toward you.)

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The information you have learned in this lesson was thousands of years coming to man. Great scientists lost much sleep in pondering over the forces of magnetism and electricity, trying to decipher the puzzles - while you have learned this tremendous relationship in just a few minutes!

This relationship is vital to the study of electricity, because it forms the basis for the generation of electricity for commercial uses. It is important, too, in the understanding of motors, as well as thousands of other electrical and electronic components. You may not see the connection right now, but before long you will.

You know now that if a current flows through a conductor, a magnetic field will be created around that conductor. It is appropriate at this time to learn also that if a conductor is moved through a magnetic field, a voltage will be generated in the conductor, which can cause a current to flow if the circuit is complete. The experiment which follows this lesson demonstrates this interesting fact.

An important sidelight was postulated by Lenz and is now called Lenz's Law. This law states that when a current is induced in a conductor by a magnetic field, that current will flow in such direction that its magnetic field will oppose its inducing field. Using this law we can always find the direction of an induced current by using the left-hand rule.

QUESTIONS:

1. Who was Hans Christian Oersted?

2. What great discovery did Oersted make?

3. Was Oersted actually seeking the fact which he discovered?

4. Draw arrows indicating the direction of magnetic flux around this conductor.

5. Here are two conductors parallel to each other. Current is flowing through the left-hand one. Indicate the direction of the induced current and the induced magnetic field of the right-hand conductor.

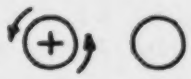

6. Explain Lenz's law in your own words.

15167

UNIT XIV - MAGNETISM

Lesson No. 3 (Experiment) — Creating a Current-Flow with Magnetism

OBJECTIVE: To demonstrate (1) that moving a conductor through a magnetic field produces a voltage and (2) that there is a definite relationship between the direction of magnetic lines of force and the direction of current flow.

MATERIALS REQUIRED:

1 Galvanometer

1 3-ft. length of wire (meter lead or similar)

1 Strong horseshoe or similar permanent magnet

PROCEDURE:

1. Connect the 3-foot wire across the galvanometer terminals and bring that conductor down between the poles of the magnet, observing the direction of the needle's deflection on the meter.

2. Bring the wire back up through the magnetic field. Observe the direction of the needle's deflection again.

3. Increase the speed of movement through the magnetic field. Observe for change in maximum voltage.

4. At the same speed, cut through the magnetic field at an angle. Observe the difference in voltage magnitude.

5. Make several turns in the conductor and repeat steps 2 and 3, observing magnitude of the induced voltages.

15168

QUESTIONS:

1. Is there any difference in voltage magnitude when the conductor passes through the magnetic field at a faster rate of speed?

2. Why did the galvanometer needle deflect in the opposite direction when the lead was brought back up through the field in step 3?

3. Establish the direction of the current in the conductor when it came down through the magnetic field. Does it agree with what you have already learned about the direction of the lines of force?

4. In your notebook draw a picture of the magnet showing the direction of the lines between the poles. Show the conductor coming down through the field, and indicate the direction of current-flow through the conductor.

5. Repeat step 4, but showing the conductor going <u>up</u> through the field.

15169

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYATEM

MILESTONE: I. STORAGE BATTERY

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Clean, Test, and Replace Storage Battery

CONDITIONS:

BEHAVIOR:

25. If performance is satisfactory, clean and replace tools and materials
26. Remove fender covers and store in proper place
27. Close hood
28. Return automobile to proper parking area
29. Remove front seat covers and store in proper place
30. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to service battery in 1 hour.

Learning time: 2 hours

1513

UNIT XIV - MAGNETISM

Lesson No. 4 Units

This is not the time for you to be given an entire course in magnetism, but if you progress in the field of electricity it will be necessary for you to eventually have a very good knowledge of magnetism. There are numerous formulas, ratios, and units represented by various Greek letters. This year, if you just get a basic understanding of only a small part of this study, you will find when you go on that you will have a good background on which to build your knowledge. So, be sure that you fully know the few things that are brought out in today's lesson.

MAGNETOMOTIVE FORCE (m.m.f.) is comparable to electromotive force in Ohm's-law formulas. The practical unit of m.m.f. is the ampere-turn abbreviated At. (In many physics books and engineering texts you will find another unit used - the gilbert, named in honor of Dr. William Gilbert, 1544-1603, scientist and physician. The gilbert is designated by the letter G, and is equal to .7958 ampere-turns.)

If 2 amperes of current are sent through a coil made up of 50 turns, the m.m.f. (magnetomotive force) will be 100 ampere-turns. If 8 amperes of current are sent through a coil made up of 100 turns, the m.m.f. will be 800 ampere-turns.

Magnetomotive force is the force set up by the current flowing through the coil. IT IS NOT A MEASUREMENT OF THE POWER OF THE ELECTRO-MAGNET. The strength of the magnet will depend also on the material in the core and its permeability.

PEAMEABILITY (μ) is a measure of a material's relative ability to conduct magnetic lines of force. When we say <u>relative</u> ability, we are comparing the material's ability to the ability of air to conduct those magnetic lines. Air is given a permeability of 1. Permeability is designated by the Greek letter <u>mu</u> (μ).

FLUX DENSITY (B) is the number of lines of magnetic flux per square centimeter. In some of the larger units it is the number per square meter or per square inch. Basically, however, flux density is the number of magnetic lines per square centimeter. The basic unit for flux is called <u>gauss</u>. The gauss is the cgs (centimeter-gram-second) unit. The term <u>tesla</u> has recently been given to the MKS (meter-kilogram-second) unit. The English unit is <u>kilolines per square inch</u>. Flux density is designated by the letter B.

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FIELD INTENSITY (H) is the magnetizing force per unit of length. It is the number of gilberts per centimeter of length of the material conducting the flux lines. This force is designated by the letter H. Sometimes it is just spoken of as magnetizing force.

The relationship of μ, B, and H can be seen in the mathematically expressed ratio

$$\mu = \frac{B}{H}$$

This formula can be re-arranged just as in Ohm's-law formulas.

$$\text{If } \mu = \frac{B}{H}, \text{ then } H = \frac{B}{\mu}, \text{ and } B = \mu H$$

ASSIGNMENT:

1. Who was William Gilbert? (It is suggested that you refer to a good encyclopedia and learn something about this man.)

2. Of what is the gilbert the unit of measurement?

3. In the study of magnetism, what does the letter B denote?

4. What does H denote?

5. What is an ampere-turn?

6. If a coil of 200 turns has 6 amperes flowing through it, what is its magnetomotive force?

5.71

15170

UNIT XV - METER MOVEMENTS

Lesson No. 1 — The Basic Movement

When most young men learn to drive automibiles, they do so before they learn what makes the car go. They know how to start the engine. They get the feel of the steering wheel, and learn the functions of the instruments and controls, but at first few of them know the functions of the valve lifters or the high-speed jet. You have recently learned how to make measurements with a VOM. By now, surely, your curiosity is demanding that you know what is inside the meter case.

The heart of the meter is the meter movement. It may be an ohmmeter, a d-c voltmeter, an a-c voltmeter, or an ammeter, and still have the same kind of basic meter movement.

In your study of magnetism you learned that, by moving a conductor through a magnetic field, you can produce an electric current. It is also true that, if an electric current is flowing through a conductor that is free to move in a magnetic field, the conductor will move due to its own magnetic flux set up by that current flow. It works both ways, you remember: a moving conductor can cause a current-flow, and a current-flow can cause a conductor to move.

In applications of both of these principles, coils of wires are used rather than simple conductors. In the first situation mentioned above, the more turns the coil of wire has as it moves through the magnetic field, the more current will be produced. Also, on the other hand, a given amount of current can cause greater movement of a coil with many turns than of a coil with only few turns.

If current is run through a coil which is wound on a rotatable drum placed between the poles of a permanent magnet, the drum will turn in an attempt to line up the turns with the flux between the poles of the magnet.

15172

Figure XV-1-1 shows how a conductor tends to line up with the magnetic lines of force.

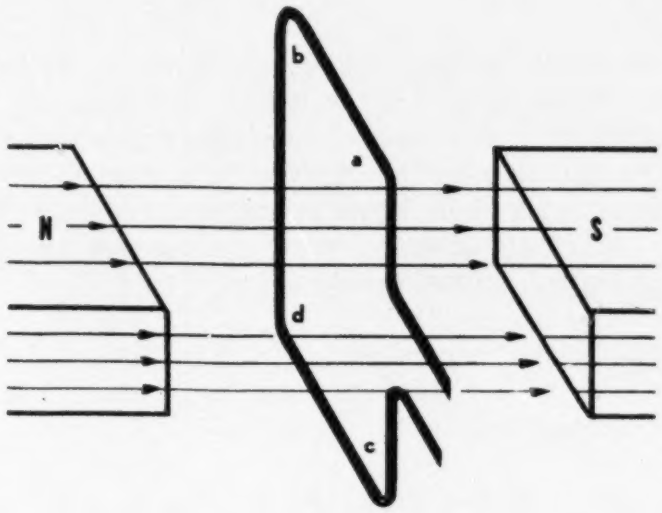

Fig.: XV-1-1

A. Current flowing through coil sets up magnetic flux opposing flux of permanent magnet.

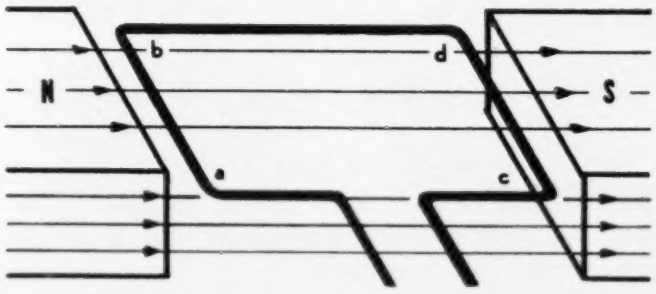

B. Coil rotates toward unopposed position.

If a pointer is connected to a coil of wire - or to the drum or cylinder upon which the coil is wound, it will point to any value printed on any scale placed under the pointer. If you constructed such a piece of apparatus with the correct number of turns and the magnetic field of such strength that the pointer would point to its maximum position when one milliampere of current was flowing through the coil, you would have a one-milliampere meter movement. If you ran a weaker current through the coil and the pointer came to rest at a point exactly midway on the scale, you would know that there was half as much current as that one milliampere which gave full-wave deflection. So the new current would be 0.5 ampere.

15173

The most commonly used meter movement is constructed basically in this manner, and is called a moving-coil movement or a D'Arsonval movement. Many of our present movements are called Weston movements. This movement is simply a slightly modified D'Arsonval movement.

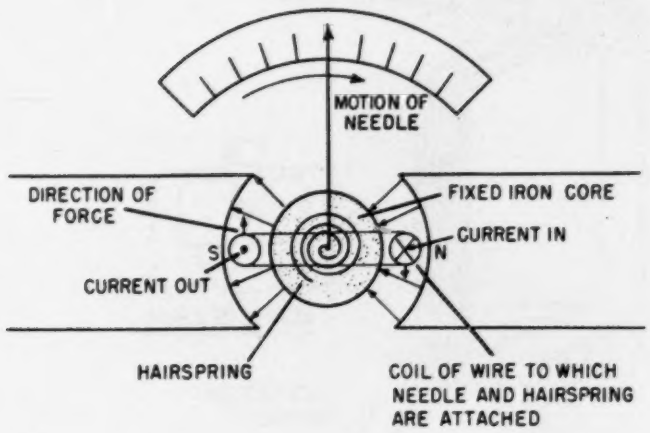

D'Arsonval Movement Fig.: XV-1-2

15174

Figure 3 shows more detail in the construction of the basic D'Arsonval movement, and Figure 4 shows the movement's location within the meter.

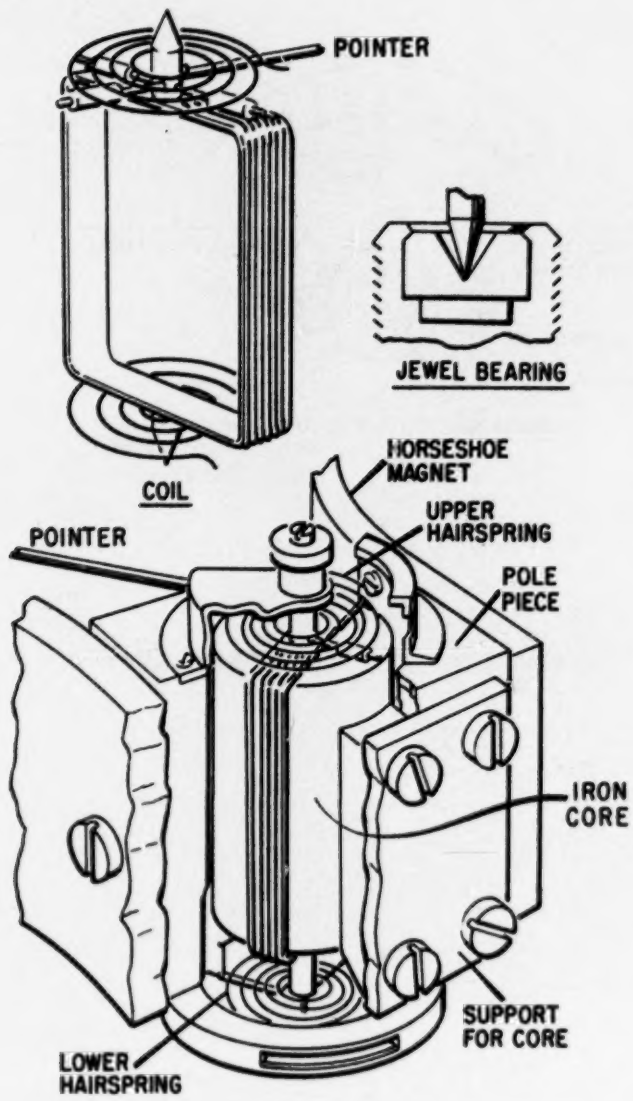

Details of Basic D'Arsonval Movement

Fig.: XV-1-3

15175

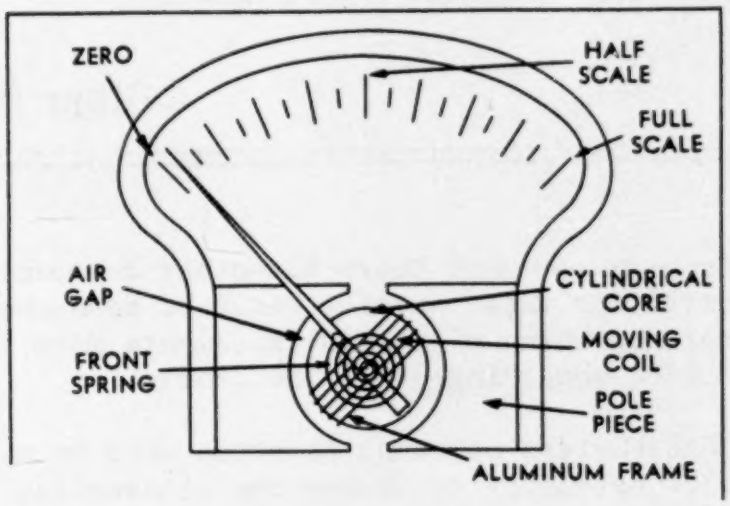

D'Arsonval Movement in Case with Scale

Fig.: XV-1-4

Note that the spring holds the pointer at the zero position.

QUESTIONS:

1. The moving-coil movement is known by two other names. What are they?

2. Is the basic moving-coil meter movement used in voltmeters, in ohmmeters, or in ammeters?

3. When there is no current flowing in the coil of the basic meter movement, which way are the turns of the coil in respect to the magnetic flux from the poles of the magnet - parallel to the lines of force or at an angle to them?

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UNIT XV - METER MOVEMENTS

Lesson No. 2 Other Movements

Besides the D'Arsonval movement there are other movements. Some of them are better suited for their special kinds of measurements; and even though we shall be using D'Arsonval movements more than any other kind, we should know something about the others.

The ELECTRODYNAMOMETER-type movement is often used in a.c. measurements. It is not necessary to change the alternating current to direct current to activate this movement, as must be done in the D'Arsonval movement.

Where the D'Arsonval movement had a single coil moving in the magnetic field of a permanent magnet, the electrodynamometer-type movement has another coil. In fact, there are four coils - two movable coils arranged so as to be able to rotate between two fixed coils. Here again the principle is that which causes two conductors with magnetic fields to tend to align themselves.

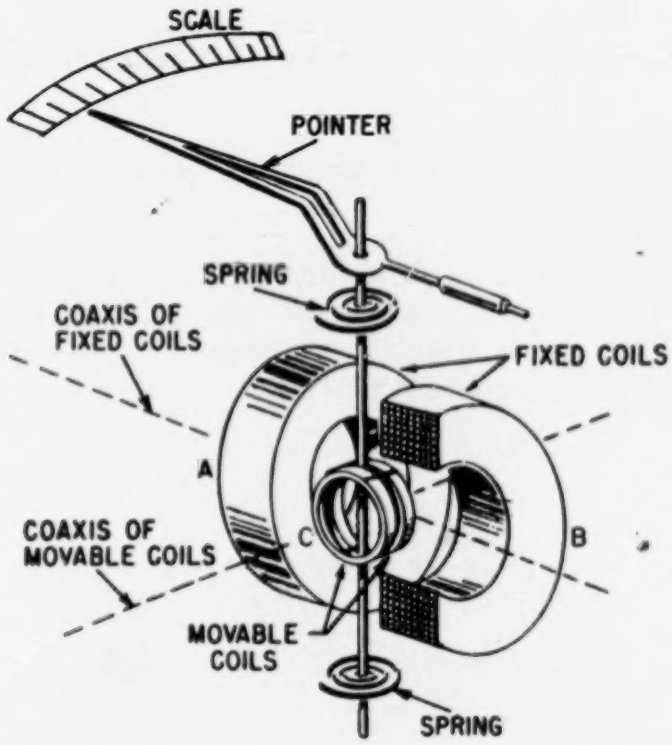

Inside construction of an electrodynamometer.

Fig.: XV-2-1

15177

Figure 2 shows the circuit arrangement of the electrodynamometer-type meter.

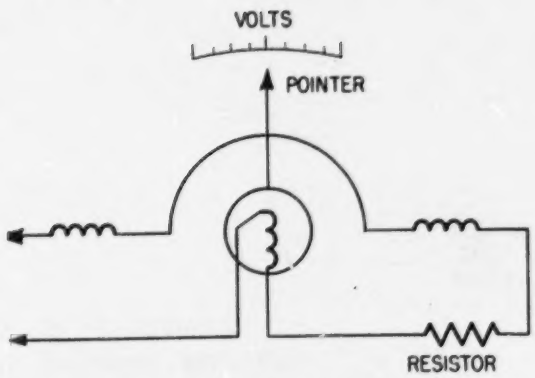

Circuit arrangement of electrodynamometer type meter

Fig.: XV-2-2

The dynamometer-type movement is less sensitive than the moving-coil-type (the D'Arsonval) movement. However, it is very accurate, and is used in a.c. applications.

THE IRON-VANE-TYPE MOVEMENT

If two pieces of soft iron are placed in a coil through which an electric current is flowing, the two pieces of iron will become magnetized - each having its south pole next to the south pole of the other, and its north pole next to the north pole of the other. Since unlike poles attract and like poles repel, the pieces of iron are going to push away from each other, as is shown in Figure 3.

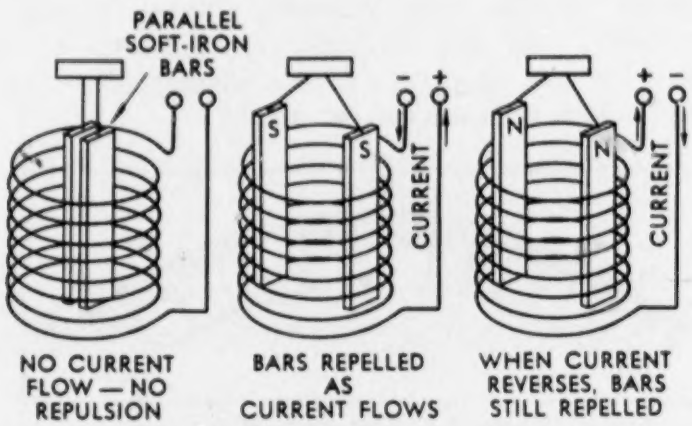

Principle of Iron-Vane Meter Movement Operation

Fig.: XV-2-3

15178

You will notice that, regardless of the direction of current flow, the action will be the same. This means, of course, that this meter movement will operate with a.c. without its having to be changed to d.c.

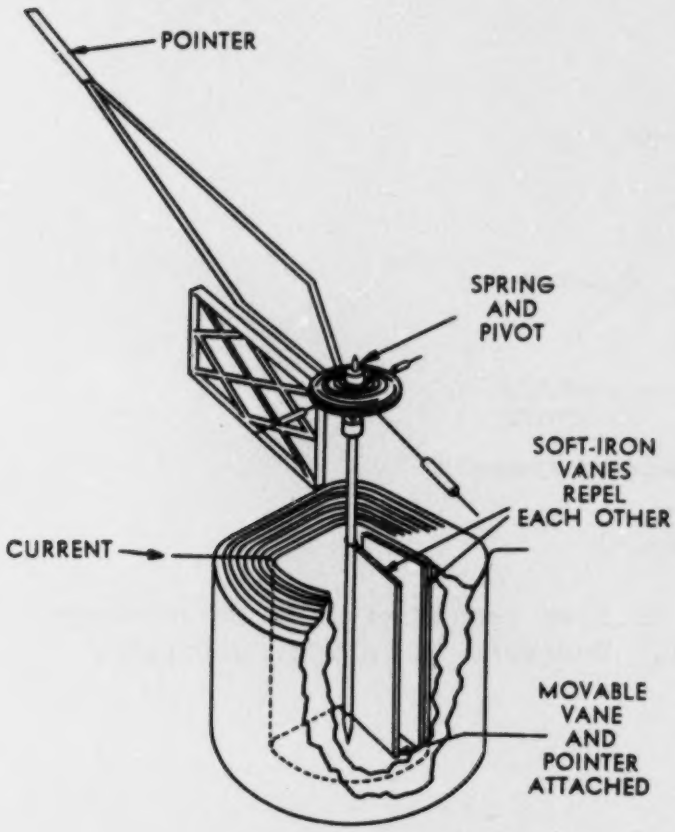

Figure 4 is a simple illustration of one type of iron-vane meter movement.

Fig.: XV-2-4

The pointers on most meter movements move in proportion to the amount of current flowing through them. The scales are linear - that is, each time the current is increased by a particular amount, the movement will increase by the same amount. This is not so with the iron-vane-type movement. As the current is increased, the pointer deflection increases by the square of the amount of current increase. This type scale is called a square-law scale.

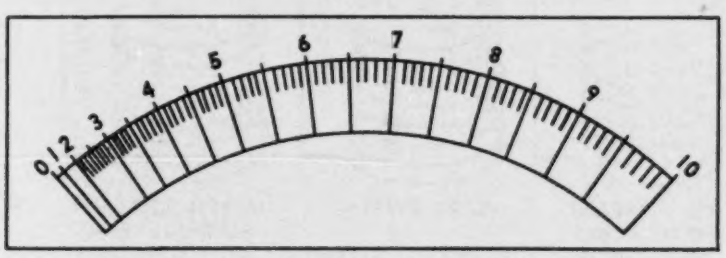

Typical Square-Law Iron-Vane Meter Scale

Fig.: XV-2-5

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRICAL SYSTEM

MILESTONE: II IGNITION SYSTEM - DISTRIBUTOR

PERFORMANCE OBJECTIVE NO: 2 TITLE: Remove, Overhaul, Replace and Adjust Distributor (Cont.)

CONDITIONS:

LEARN	REFERENCE	SOURCE
8. "Adjusting the Distributor Cam Angle"	8. Continuous film loop # 8359	8. Resource Materials Center
9. "Timing an Engine"	9. Continuous film loop # 8358	9. Resource Materials Center
10. "Ignition Systems"	10. Filmstrip	10. Resource Materials Center
11. "Ignition Trouble"	11. Filmstrip	11. Resource Materials Center
12. The Distributor	12. Ignition Systems - The Distributor, by Ford Motor Co. pp 40 through 84	12. Programmed Instruction Class
13. The Ignition System	13. Teaching machine card 4 B	13. Teaching Machine (Shop)
14. The Distributor	14. Teaching machine card 4 C	14. Teaching Machine (Shop)

QUESTIONS:

1. Is it necessary to have a rectifier in a meter utilizing the electrodynamometer movement?

2. How many coils are there in the electrodynamometer movement?

3. Is the D'Arsonval movement as sensitive as the electrodynamometer movement?

4. Is the electrodynamometer movement current-operated or it is voltage-operated?

5. Is the electrodynamometer an accurate movement?

6. What is the principle of the operation of the iron-vane-type meter movement?

7. How does the scale of the iron-vane-type movement differ from that of the common D'Arsonval movement?

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UNIT XV - METER MOVEMENTS

Lesson No. 3 Other Movements (II)

Sometimes it is necessary to measure very high voltages, like those found in television picture tubes and the anode voltages in x-ray tubes. Sometimes it is necessary to have as much as 100,000 volts present in x-ray tubes. To measure these high voltages we often find ELECTROSTATIC voltmeters used.

In the study of electrostatics it was noted that when two pith balls are given like charges, they repel each other, and when given unlike charges they attract each other. The electrostatic voltmeter operates on this principle. The main operating parts in this type of movement are the two plates which are connected to the potential differences - that is, one plate is connected to one terminal of the voltage to be measured and the other plate is connected to the other terminal. The plates are arranged so that one is stationary while the other is permitted to move according to the force of the charge. The movable plate is so connected to the pointer that it will indicate the voltage on a scale. Figure 1 demonstrates the action of this meter movement.

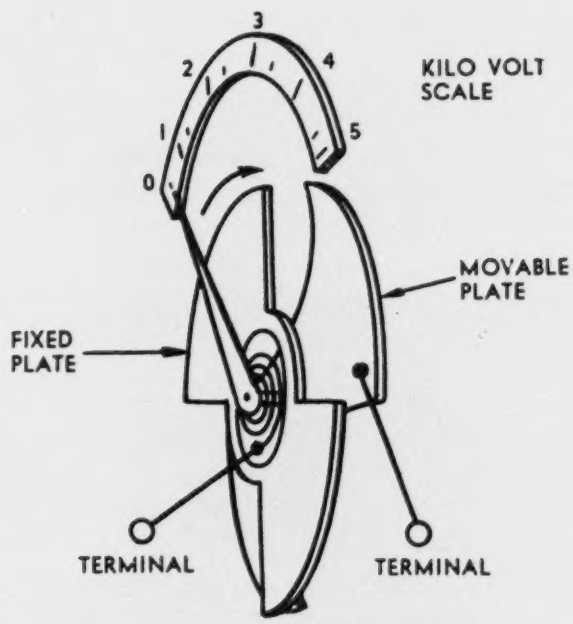

Principle of Electrostatic Voltmeter with Non-Linear Scale

Fig.: XV-3-1

Since there is no electrical connection between the plates in this meter, it is ideal for measuring voltages where the drawing of current would load the circuit. This type of movement is different from all others in that is is voltage-operated rather than current-operated.

The scale of the electrostatic movement is non-linear.

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Another type of meter should be discussed here. It is known as the THERMOCOUPLE AMMETER. ("Thermo" means heat and "couple" is a linking together) The basic movement is the D'Arsonval movement. This type of meter works on two principles:

1. Heat is produced by the flow of electric current.

2. When certain dissimilar metals are joined together and heated, a voltage is produced.

There are several physical arrangements of thermocouple and heater elements used. Figure 2 shows the way this meter works.

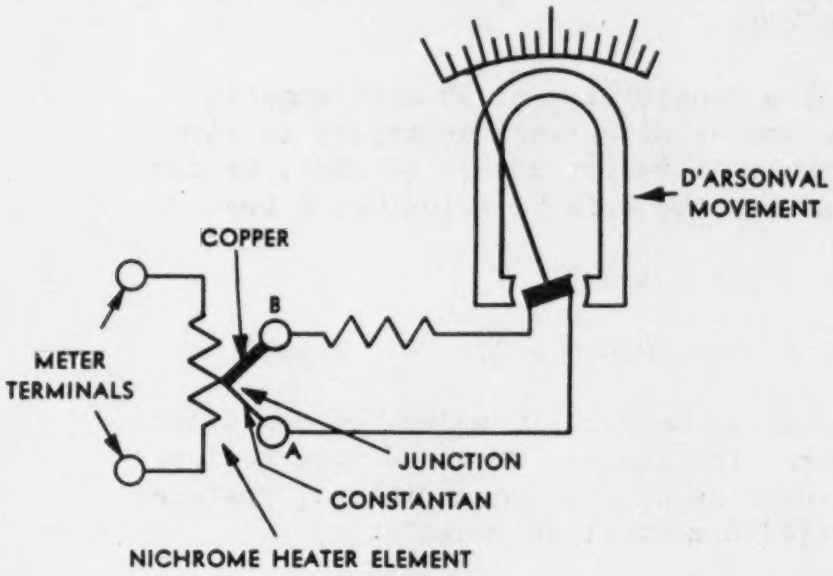

Fig. XV-3-2

The heat produced within the nichrome resistance element by the current heats the junction of a copper bar and a constantan bar. Constantan, an alloy often used in thermocouples, consists of 60% copper and 40% nickel.

These heat-activated meters are often used in measuring very high frequency voltages, such as in radio transmitters and in radar. You may hear them called <u>bolometers</u> or sometimes <u>barretters</u>.

QUESTIONS:

1. Where would it be practical to use an electrostatic voltmeter?

2. What is a bolometer?

3. Is the electrostatic voltmeter a current-operated device?

4. Is the thermocouple ammeter a current-operated device?

5. Does the electrostatic voltmeter have a linear scale?

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UNIT XV - METER MOVEMENTS

Lesson No. 4 — The Voltmeter

The moving-coil-type meter movement, as you know, is a current-operated device. On the other hand, it is known that the coil in that movement has a certain amount of resistance, and when current flows through a resistance, a voltage is developed across it. There is a direct relationship between the meter's pointer deflection and that voltage drop across the coil.

If a meter movement has a sensitivity of 50 milliamperes (0.050 amperes), that is the amount of current necessary to give full-scale deflection. If the coil resistance is 20 ohms, we can find the voltage developed across the coil by using Ohm's Law:

$$E = I \times R$$

$$E = 0.050 \times 20 = 1 \text{ volt}$$

If we wish that movement to measure 10 volts, we could not apply it right across the meter terminals. We would have to lose 9 volts somewhere. This is done by placing an additional resistor in the circuit. This is called a multiplier resistor.

To know what value of multiplier resistor is needed, the first information needed is just how much <u>total</u> resistance is desired in the circuit. To find R_t, the following formula is used:

$$R_t = \frac{E_{full\ scale}}{I_{full\ scale}}$$

$$R_t = \frac{10}{0.05} = 200 \text{ ohms}$$

If R_t is 200 ohms, and the moving coil itself has 20 ohms, it is simple to understand that all one has to do now is to subtract the meter resistance from the total resistance. We would have

$$R_{multiplier} = R_t - R_{meter\ movement}$$

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Perhaps it would be better to write all of it in one formula:

$$R_{multiplier} = \frac{E_{full\ scale}}{I_{full\ scale}} - R_{meter\ movement}$$

A multirange voltmeter can be constructed by placing a number of multiplier resistors in the circuit and making arrangements to switch from one to another, as shown in Figure 1.

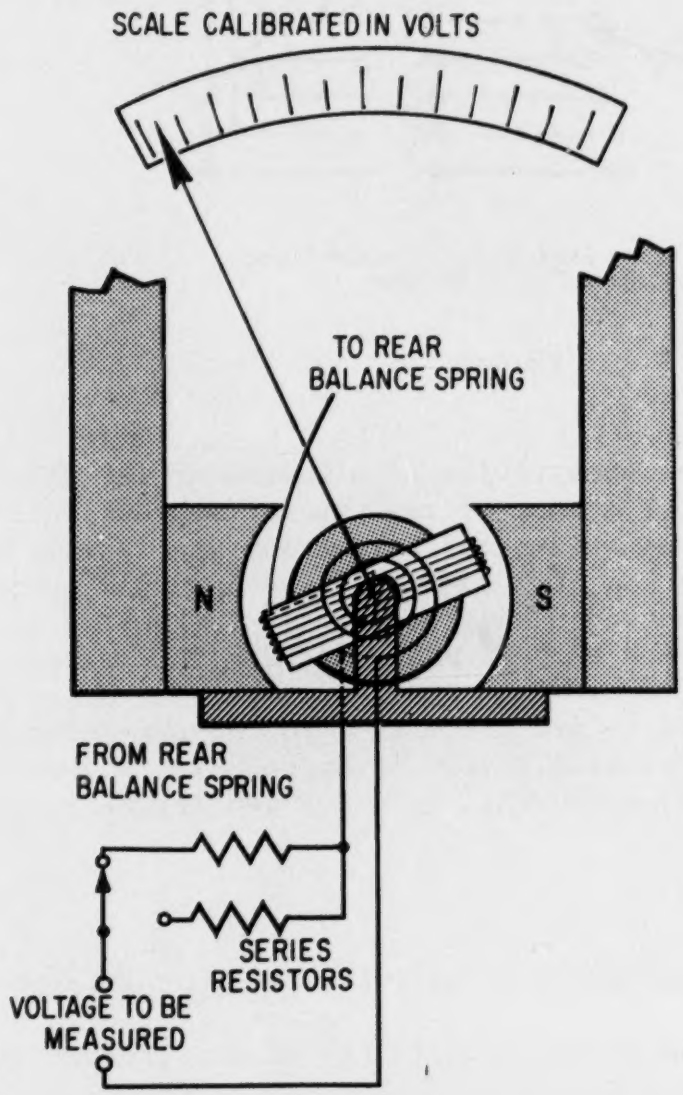

Simplified voltmeter circuit.

Fig.: XV-4-1

15184

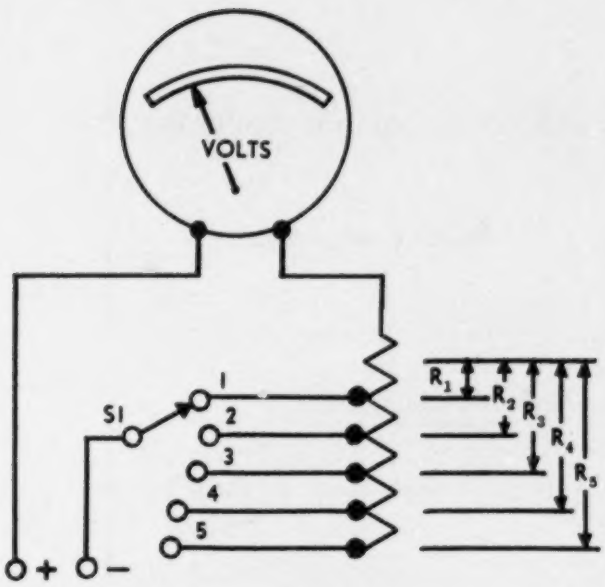

Multirange Voltmeter Using Fixed-Tapped Resistor

Fig.: XV-4-2

A multirange voltmeter can also be constructed by using various taps on a single resistor, as shown in Figure 2.

The sensitivity of a voltmeter is rated in ohms per volt. This is the amount of resistance (in ohms) necessary to have the needle show full-scale deflection when 1 volt is applied. A good voltmeter has high sensitivity. A 5000-ohms-per-volt voltmeter is not considered a very good meter for making certain measurements. A meter such as this has a decided loading effect and can result in lowering the voltage by measuring it. In purchasing a voltmeter, it is best to get one with a 20,000-ohm-per-volt sensitivity. Where even higher sensitivity is needed, it is best to use a vacuum tube voltmeter, which will be discussed later.

QUESTIONS:

1. How is the sensitivity of a meter movement rated?

2. How is the sensitivity of a voltmeter rated?

3. Why is it best to use voltmeters of high ohms-per-volt rating?

4. What is a multiplier resistor?

5. If you have a meter movement which has an internal resistance of 50 ohms and a sensitivity of 25 milliamperes, and you want to design a voltmeter which will measure 10 volts, what would be the value of the multiplier resistor?
   Make this calculation and draw the circuit in your notebook.

6. Suppose you wish this meter to have both a 10-volt range and a 100-volt range. Make the calculation for the multiplier resistor and draw the diagram of this two-range meter in your notebook.

UNIT XV - METER MOVEMENTS

Lesson No. 5 — The Ammeter

A simple meter movement is an ammeter in itself. A 50-microampere movement will measure currents from 0 to 50 microamperes. On an ordinary moving-coil movement, 25 microamperes would deflect the pointing needle halfway across the scale on a 50-microampere movement. A current of 100 microamperes would probably damage the movement mentioned above. Suppose, then, you wanted to measure currents up to 100 microamperes. Doesn't it stand to reason that if you bypass half of this current, 100 microamperes would then show full-scale deflection on the meter (since it would have only half of the 100 microamperes going through the meter)?

If you are bypassing half of the current in the above meter arrangement, and you cut the 100 microamperes down to 50 microamperes, that will permit 25 microamperes to pass through the movement and show half-scale deflection.

When you wish to measure the current flowing in a circuit, you place the meter in series with the circuit as shown here:

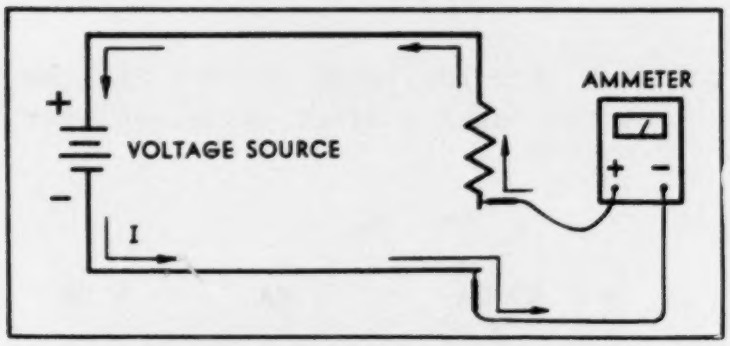

Connection of Ammeter to Circuit

Fig.: IV-5-1

15'86

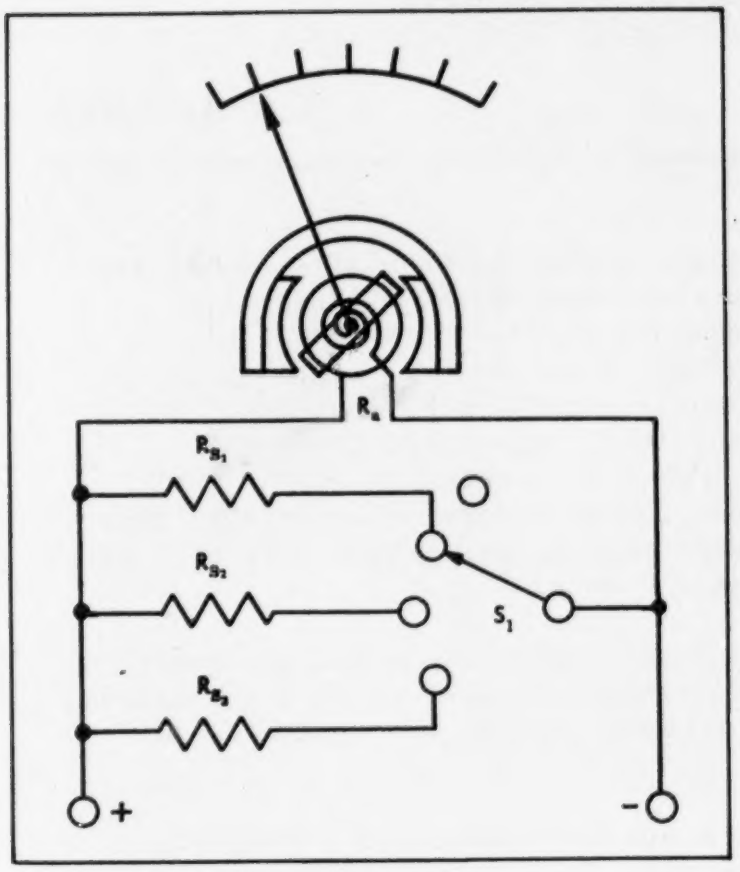

Basic Multirange Ammeter

Fig.: XV-5-2

Instead of having to connect the bypass (shunt) resistors on the outside of the meter case, it (or they) can be placed inside the case and switched in and out as the need for different ranges occurs. Figure 2 shows such an arrangement.

If you had a meter movement with a sensitivity of 1 milliampere and an internal resistance of 50 ohms and wanted to be able to measure currents up to 10 milliamperes, you would use this equation to calculate the shunt resistance:

$$R_s = \frac{E_s}{I_s}$$

First you need to find the value of the shunt current (I_s).

$$I_s = I_t - I_m$$

This is easy, since you know that the total current will be 10 milliamperes, and you know that the meter current cannot be over 1 milliampere. So

$$I_s = I_t - I_m$$

$$= 10 \text{ MA} - 1 \text{ MA} = 9 \text{ MA}$$

Next you need to find E_s. This is the voltage across the shunt resistor which, of course, must be the voltage across the meter movement—since they are in parallel. So

$$E_s = E_m = I_m \times R_m$$

$$= 0.001 \times 50$$

Now that you have the values for E_s and for I_s, you can plug them into the first formula:

$$R_s = \frac{E_s}{I_s} = \frac{0.001 \times 50}{0.009} = 5.55 \text{ ohms}$$

15187

ASSIGNMENT:

1. In your notebook draw a diagram showing an ammeter placed in a circuit in such a way that the current in the circuit may be measured.

2. Draw another diagram showing a meter movement in a circuit where it is measuring current, and in this diagram show a shunt resistor.

3. Suppose the meter movement in No. 2 has an internal resistance of 45 ohms and has a sensitivity of 1 milliampere. Find the value of the shunt resistor (R_s) if it is desired to measure up to 100 milliamperes.

15188

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UNIT XV - METER MOVEMENTS

Lesson No. 6 — The Ohmmeter

The ohmmeter consists of a meter movement (usually the D'Arsonval movement), a battery, and a known value of resistance. Basically, a series ohmmeter operates in the manner indicated in the following schematic diagram:

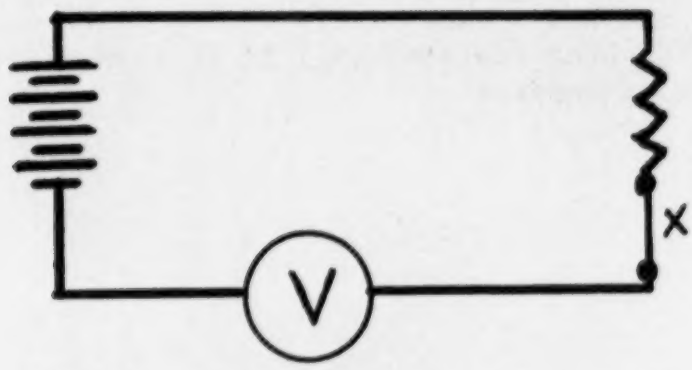

Schematic drawing of a series ohmmeter

Fig. XV-6-1

Let us assume that the battery produces 1 volt and that the resistance is 1000 ohms.

$$I = \frac{E}{R} = \frac{1}{1000} = 0.001 \text{ A} = 1 \text{ MA}$$

The meter movement being a 1-milliampere movement, 1 milliampere will cause full-scale deflection. Any value of resistance placed at point X will be in series with the 1 K-ohm known resistance, and will increase the total resistance of the circuit and lessen the current. If another 1 K-ohm resistor is placed at point X, the overall resistance will be 2 K-ohms. What will the current be?

$$I = \frac{E}{R} = \frac{1}{2000} = 0.5 \times 10^{-3} = 0.5 \text{ MA}$$

The current will be just half the original, and the needle will deflect to half-scale.

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRICAL SYSTEM

MILESTONE: II IGNITION SYSTEM - DISTRIBUTOR

PERFORMANCE OBJECTIVE NO: 2 TITLE: Remove, Overhaul, Replace and Adjust Distributor

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Adding decimal fractions	1. Mathematics for the Automotive Trades, by Delmar. pp. 28 through 31	1. Related Information Class
2. Angles and degrees	2. Measurements, by Du Pont. pp. B1 through B25. Panels B1 through B8	2. Programmed Instruction Class
3. Cam dwell	3.	3. Shop Instructor
4. Adjusting point spring tension	4.	4. Shop Instructor
5. Adjusting GMC points	5.	5. Shop Instructor
6. Using the timing light	6.	6. Shop Instructor
7. "Replacing Ignition Points"	7. Continuous film loop # 8376	7. Resource Materials Center

Let us look at the results. In the original condition, where there was no resistance placed at point X and the indicating needle was at full-scale, the resistance at point X was 0 ohms. So we can label the full-scale position "0".

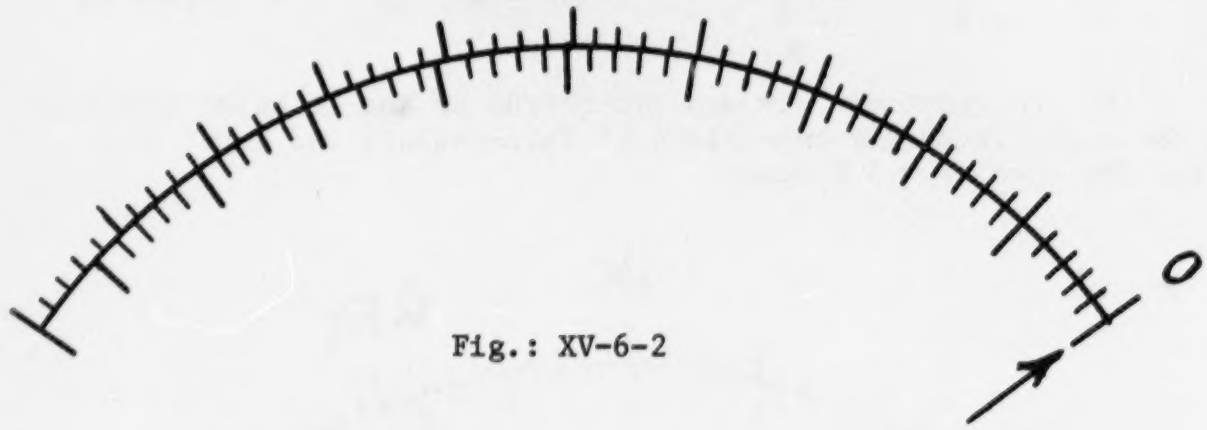

Fig.: XV-6-2

The point X represents where the test leads are connected across a resistance in the circuit. So we can now say <u>when we connect the test leads to a 1 K-ohm resistor, the needle deflects half-scale</u>. We can label this point "1 K-ohm".

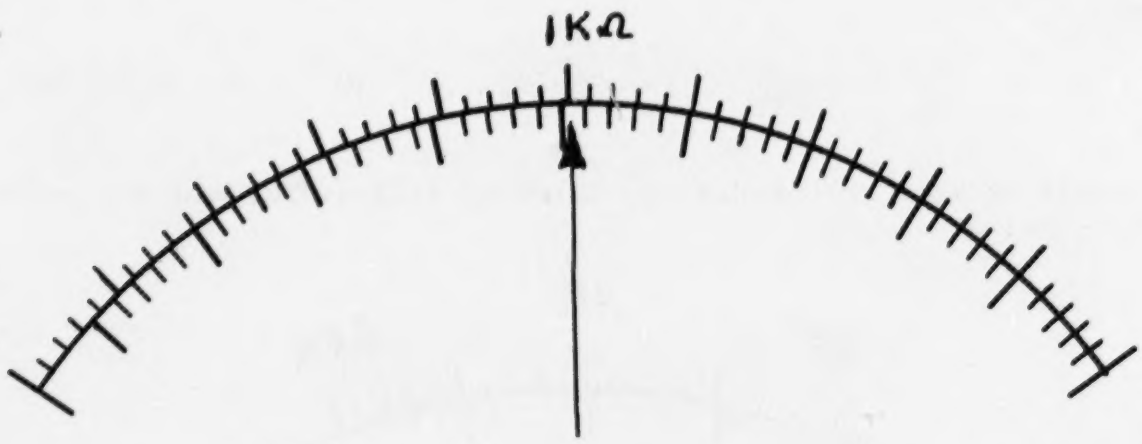

Fig.: XV-6-3

15190

Suppose we put the probes across a 500-ohm resistor instead of the 1 K-ohm resistor. This will add 500 ohms in series to the original 1 K-ohm resistance in the circuit, making the total resistance 1500 ohms.

$$I = \frac{E}{R} = \frac{1}{1500} = 0.666 \times 10^{-3} = 0.666 \text{ MA}$$

We can count off six and two-thirds of the 10 major divisions on the scale (actually two-thirds of full-scale), and label this point 500 ohms or 0.5 K-ohms.

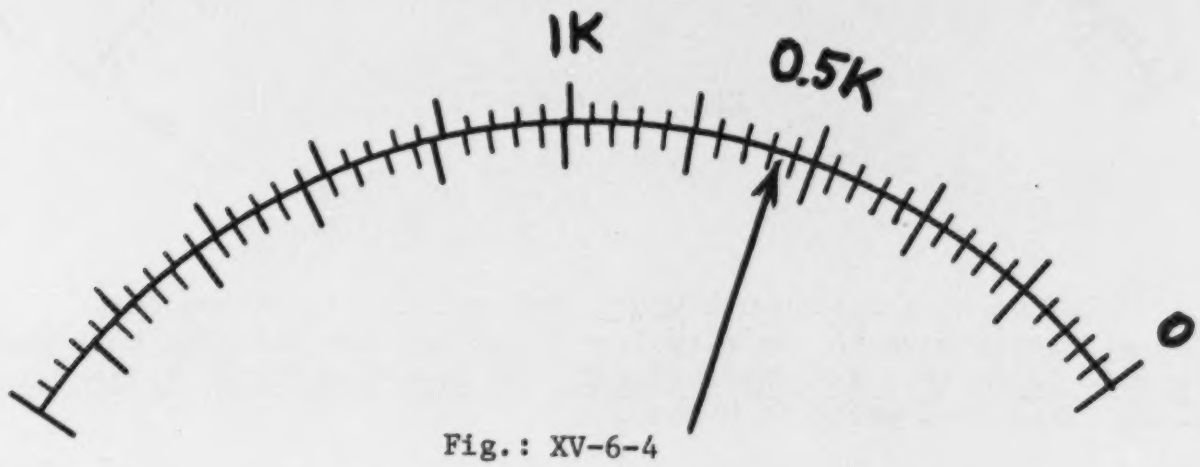

Fig.: XV-6-4

Now let's replace the 500-ohm resistor with a 2000-ohm resistor. (Remember, we still have the 1000-ohm resistor in the circuit.)

$$I = \frac{E}{R} = \frac{1}{3000} = 0.333 \times 10^{-3} = 0.333 \text{ MA}$$

This would deflect the needle one-third of full-scale, and the point can be labeled 2 K-ohms.

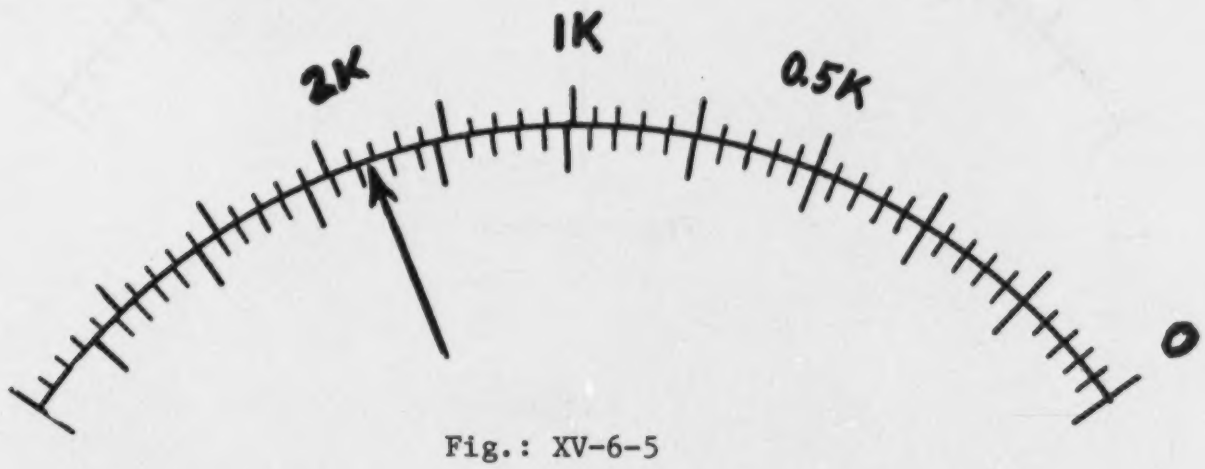

Fig.: XV-6-5

15191

Study the scale we have just completed. You can see that the distance between 0 and 1 K-ohm is greater than the distance between 1 K-ohm and 2 K-ohms. (The higher the resistance-values go on the scale, the shorter will be the distance between each succeeding step. This goes on and on into infinity. That is the nature of electrical resistance of materials. Remember, there is no such thing as a perfect insulator. A perfect insulator would reduce the current to zero. Note that the high-resistance end of the scale ends with the sign of infinity—∞.

The following scale is the completed scale for one type of ohmmeter. Resistances, like voltages, can be measured on meters using various scales. Additional resistance can be put into the internal circuit to make it possible to measure high values of resistance with greater accuracy.

One value of resistance may be calculated so that the scale can be multiplied by 10, another by 100, 1000, and even up to 1,000,000.

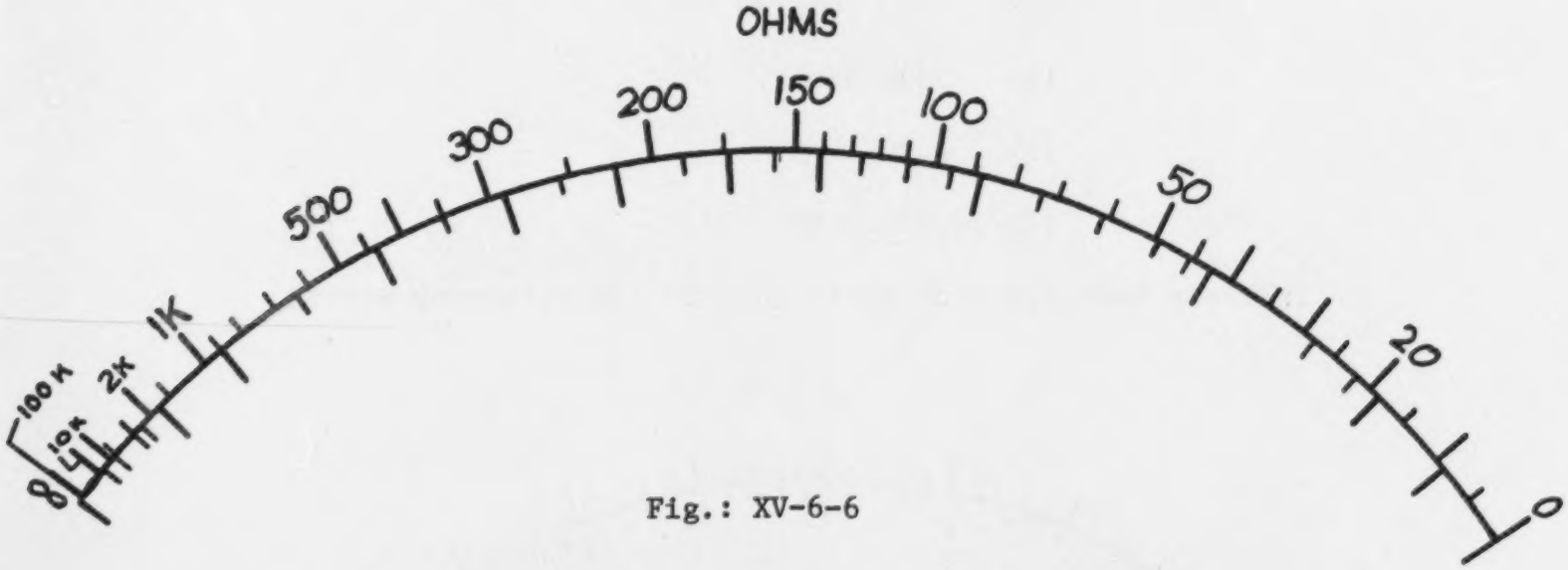

Fig.: XV-6-6

By looking at the above, it is easy to see how a resistance near the 100 K-ohm end of the scale could be measured far more accurately if the scale had a R X 1000 multiplier. The needle would then be near 100 instead of being at the extreme high end of the scale, where just a hair's breadth would represent a much greater difference than at 100.

15192

QUESTIONS:

1. Is the scale on an ohmmeter linear?

2. Is the ohmmeter a current-operated or a voltage-operated device?

3. Why is it necessary to have a battery in an ohmmeter?

4. Calculate the currents that would flow through a 10 MA meter movement from a 1-volt battery when the following resistances are in the circuit: (For practical purposes you may forget that there is any resistance in the meter movement.)

   (a) 1000 ohms

   (b) 1500 ohms

   (c) 2000 ohms

   (d) 3000 ohms

   (e) 4000 ohms

   (f) 10,000 ohms

Indicate each value of resistance on the following scale.

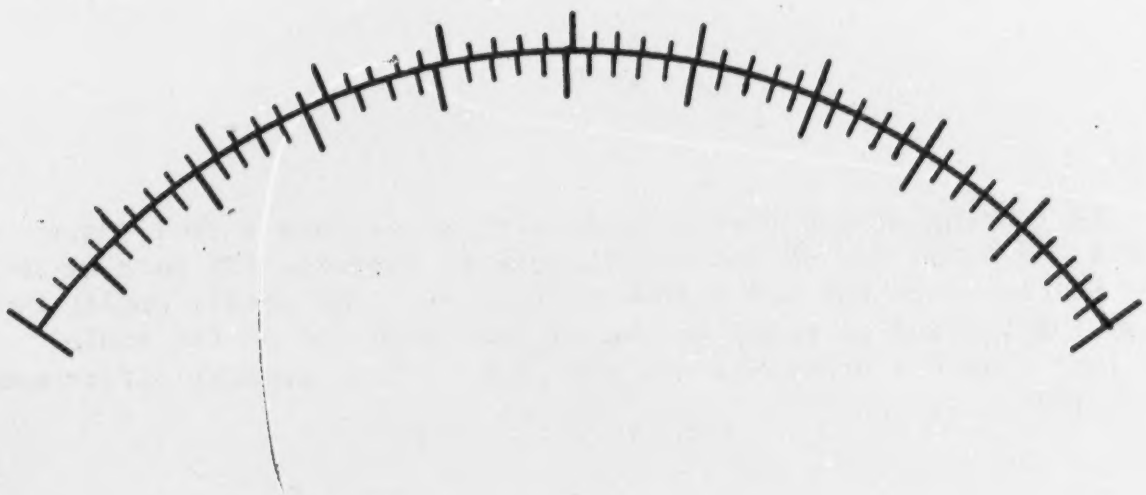

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UNIT XV - METER MOVEMENTS

Lesson No. 7 — The Shunt Ohmmeter

On some of the voltohmmeters you will see around the shop, you will see a "Low Ohms" position on the function switch. You have already been told that you are never to leave the switch on this position. From this lesson you will understand why.

First, let us look at the schematic diagram of the shunt-type ohmmeter. This is the circuit made within your VOM when you switch it to "Low Ohms."

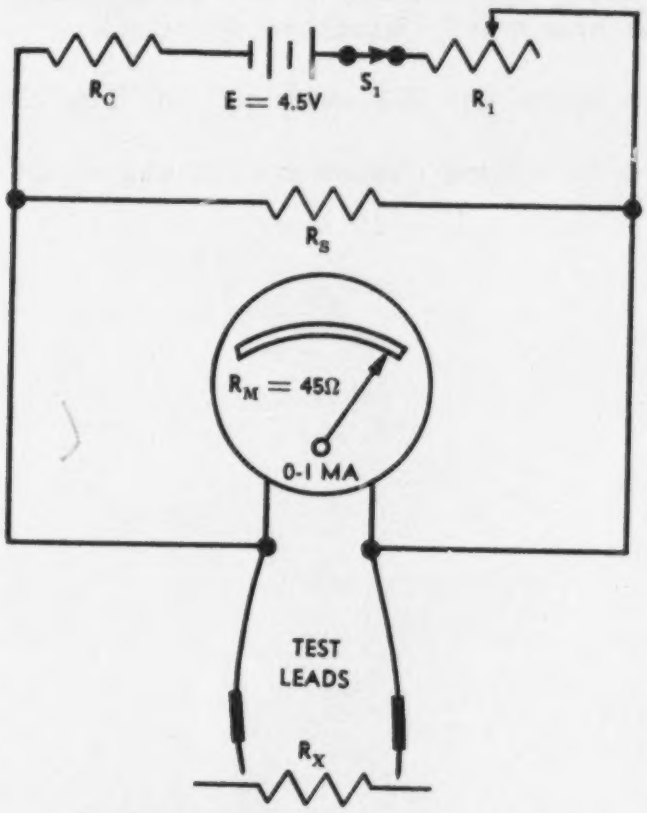

Typical Shunt-Type Ohmmeter Circuit

Fig.: XV-7-1

It can be seen that, with nothing across the test leads, there is current flowing in the circuit. Part of it is going through R_S, and the rest of it is going through the meter movement. If a resistor to be measured (R_X) is placed across the test leads, another path is made for current flow. Therefore, less current will flow through the meter movement.

15194

In the series ohmmeter, the movement carried maximum current when the resistor being measured was of minimum value. Therefore the scale was read from right to left. In the shunt-type ohmmeter, the movement carries maximum current when the resistor being measured is of maximum value. Therefore the shunt-type ohmmeter is read from left to right. Just to remember these differences is not enough. Study the two circuits and understand why one is read in one direction and the other is read in the opposite direction.

The shunt ohmmeter is usually used for measuring low values of resistance.

ASSIGNMENT:

1. If the test leads are not connected to anything, will the needle of the shunt-type ohmmeter deflect?

2. Why do we not leave the VOM switched to "Low Ohms"?

3. Compare the series-type ohmmeter with the shunt-type.

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UNIT XV - METER MOVEMENTS

Lesson No. 8 — The Galvanometer

There are times when it is necessary to detect small values of electrical current and to determine the direction of those currents. The instrument used for this is the galvanometer, named in honor of Luigi Galvani, that Italian scientist of the 18th century who devoted much of his time to the study of electricity.

There are numerous types of galvanometers - from the rather inexpensive charge-discharge indicators one often finds on the instrument panels of sports cars to the very delicate and expensive beam-of-light types used in research laboratories.

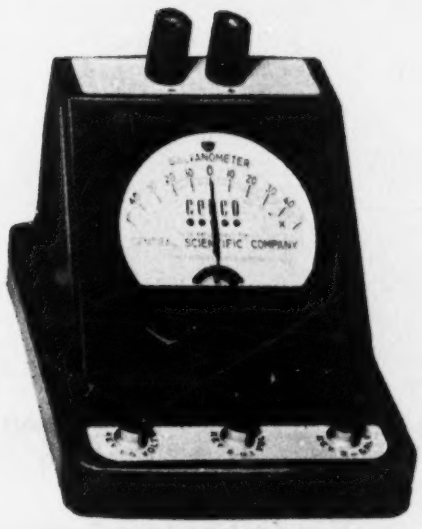

Student galvanometer

Galvanometer for classroom demonstrations

Fig.: XV-8-1

15196

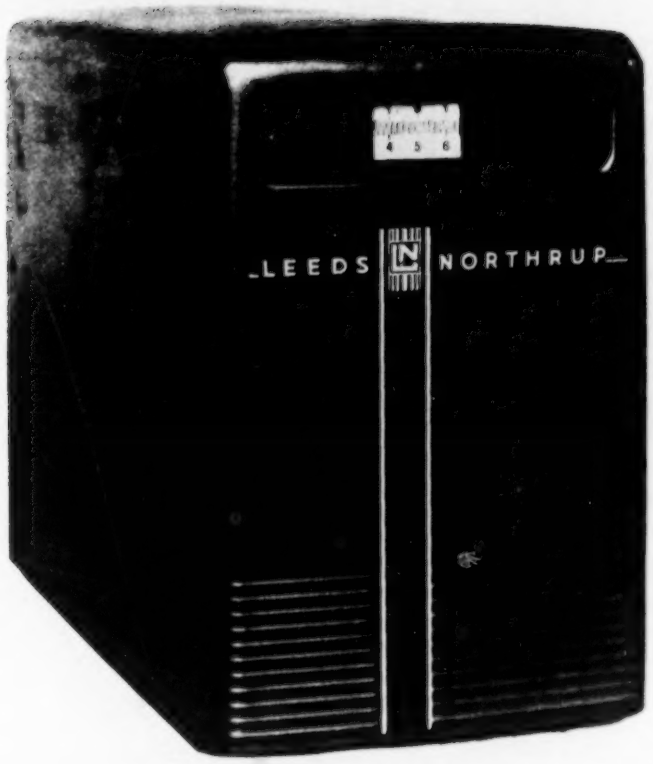

Research galvanometer

Fig.: XV-8-2

Most galvanometers have the conventional D'Arsonval movement. Shown above is an illustration showing one of the more sensitive galvanometers. Instead of the moving coil being supported by bearings or jewels, this type is suspended on flat ribbons of phospher bronze. There is practically no friction loss in this type. Losses are further reduced by eliminating the indicator needle with its spring. A small beam of light is reflected from a small mirror that turns with the coil assembly.

15197

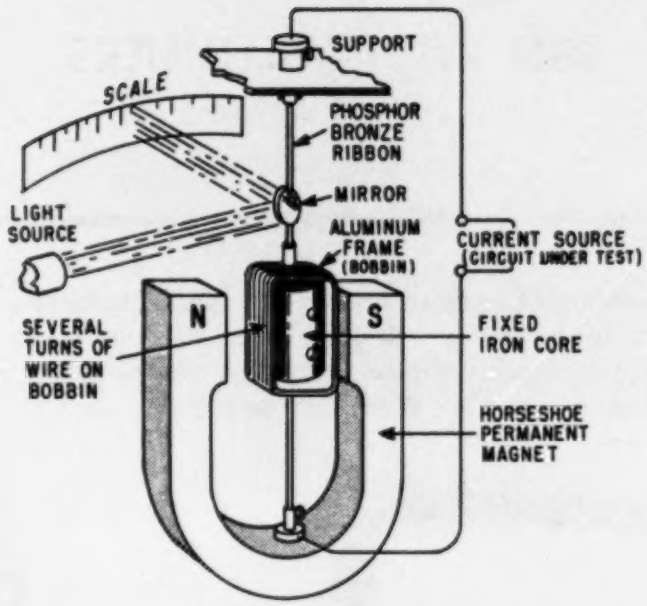

Simplified diagram of a galvanometer

Fig.: XV-8-3

Most definitions of the galvanometer state that it indicates the direction of current. There is one special type, however, that is used for a.c. This is a very special type which is termed a galvanometer by a limited number of technicians and scientists.

QUESTIONS:

1. What type movement is usually found in galvanometers?

2. What is the advantage in using the beam of light and a mirror in galvanometers?

3. Give your definition of a galvanometer.

15198

UNIT XVI - MULTIMETERS

Lesson No. 1 Principles

There are many different kinds of multimeters. Many different manufacturers produce them. Regardless of how many sizes, shapes, or colors you might find, those used by servicemen and technicians fall into two classes - the VOM and the VTVM.

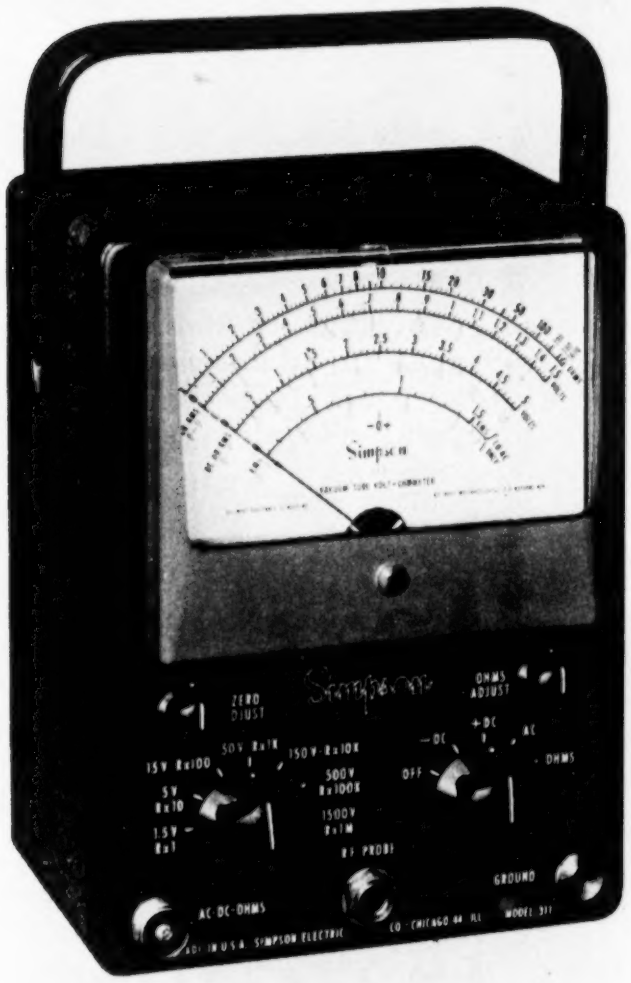

Vacuum-Tube Voltmeter
(VTVM)

Volt-Ohmmeter
(VOM)

Volt-Ohmmeter
(VOM)

Fig.: XVI-1-1

15199

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: II. IGNITION SYSTEM- DISTRIBUTOR

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Disassemble, Reassemble, Replace, and Adjust Distributor

CONDITIONS:

This assignment will be performed on a complete automobile.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective cover on front seat of automobile
2. Move automobile into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper manual and turn to appropiate chapter
6. Select proper tools and materials
7. Disconnect battery ground cable
8. Remove air breather assembly
9. Disconnect vacuum line from distributor
10. Disconnect primary laed wire at coil
11. Unfasten distributor cap retaining clips and lift off the distributor cap
12. Rotate engine until distributor rotor is pointing towards center of engine fan
13. Mark this point on distributor housing and engine block (This is the reference points for installing the distributor

PERFORMANCE CRITERIA:

1510

The multimeter is several meters in one case, and there is a switch which permits switching from one meter to the other. It is done like this:

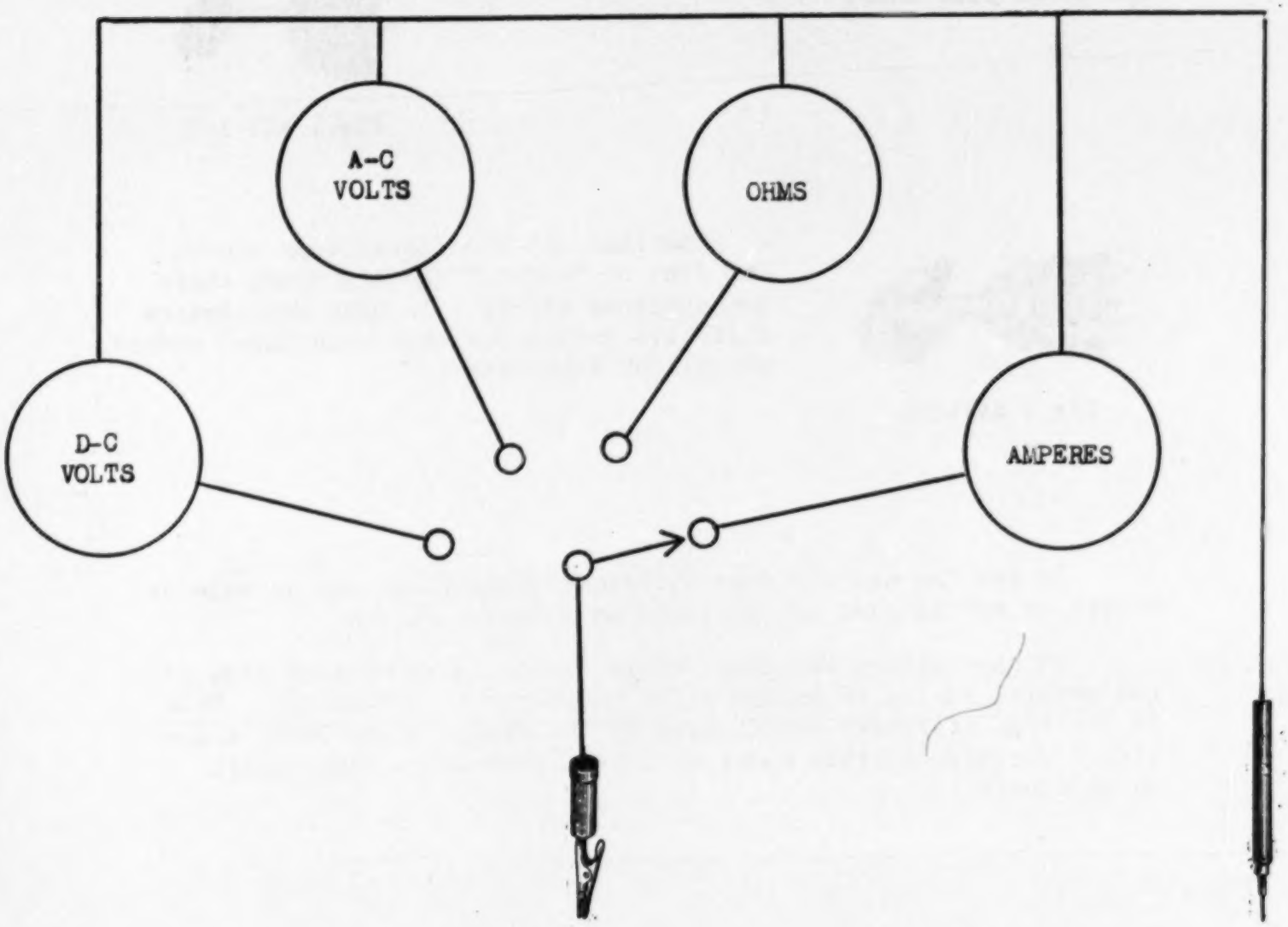

Fig.: XVI-1-2

Besides switching from one meter circuit to the other, special switching is done so that the same components may be used in more than one meter circuit; and, of course, the ranges must be changed to the range needed at the time. Rotary switches are used to do these jobs. A rotary switch usually has many connecting terminals

15200

and looks like this.

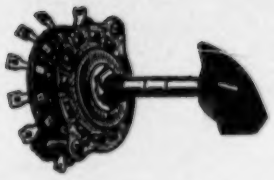

Fig.: XVI-1-3

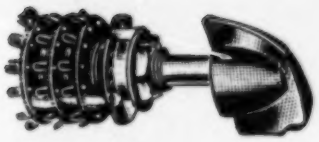

Fig.: XVI-1-4

Sometimes all the connections are on one deck or "wafer," and sometimes there are numerous wafers. In many multimeters there are rotary switches with three wafers, which look like this.

So you can see how many different connections may be made or broken by moving just one position on a rotary switch.

On some rotary switches, there are contacts on each side of the wafers, making it possible for one wafer to act as two. This is the type of rotary switch used by the Philco Model 7005; individual circuits of this model will be discussed in some detail in this unit.

12500

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The d.c. voltmeter cirucit is rather conventional and follows the principles you have already studied. Study the function of all the components in this circuit (Fig. XVI-1-5) and be prepared to discuss them in class.

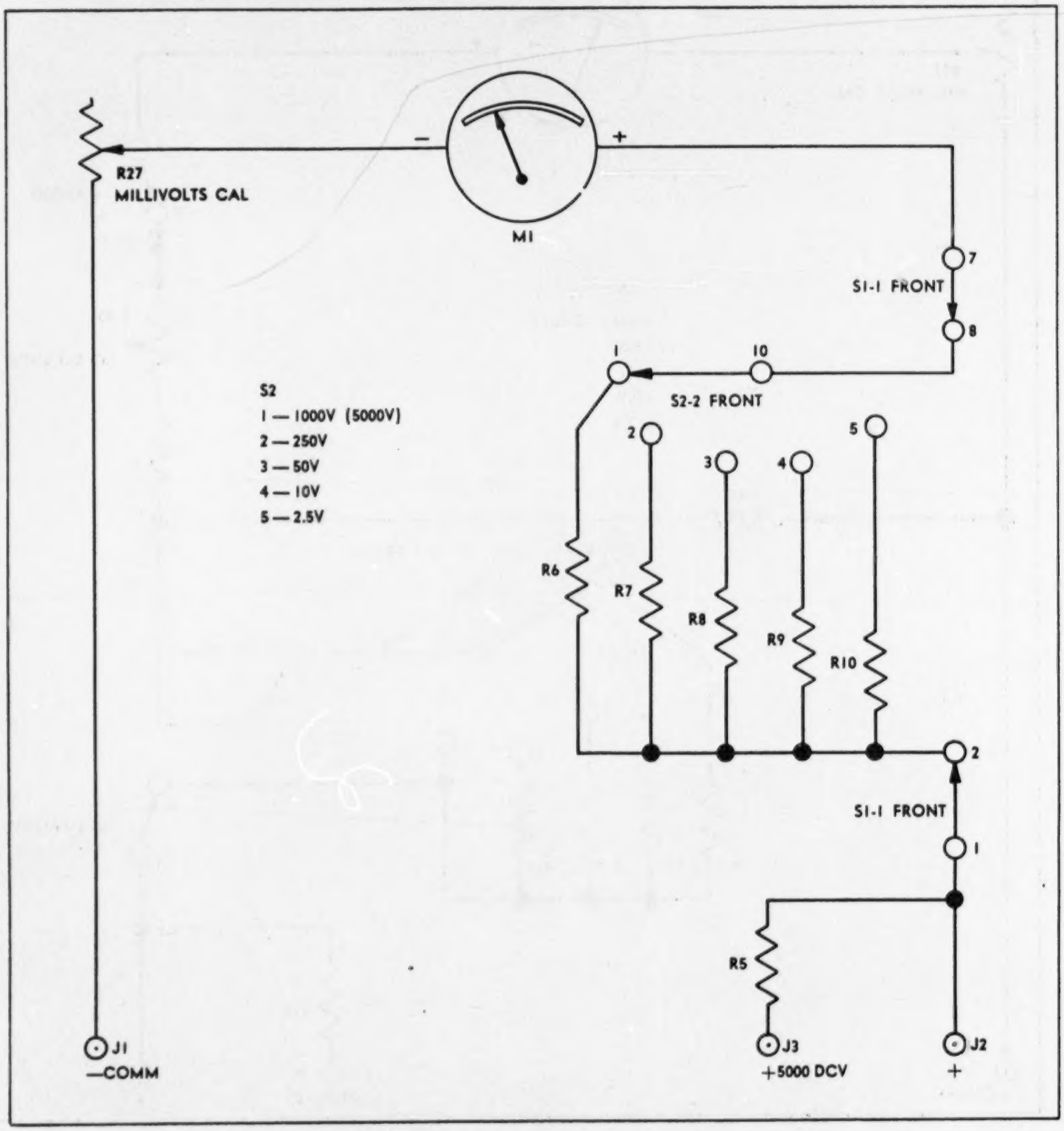

Fig.: XVI-1-5 *D-C Voltmeter Circuit*

15202

If you will now study the diagram of the a.c. voltmeter circuit (Fig. 6), you will find that it has a rectifier (CR-1) in series with

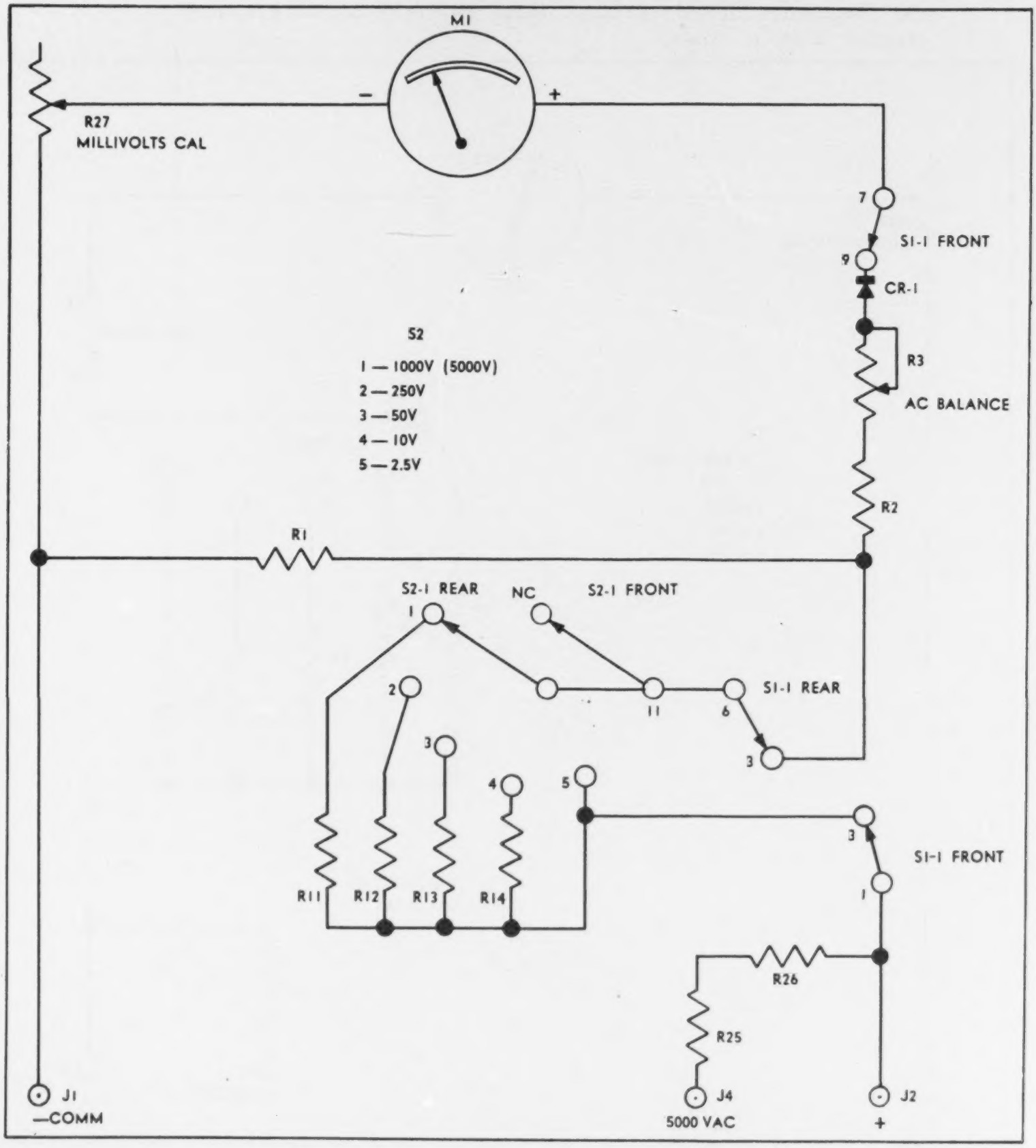

Fig.: XVI-1-6 *A-C Voltmeter Circuit*

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the line to the meter movement. The movement (the D'Arsonval, in most cases) is operated by direct current. Alternating current would cause the needle to try to go first in one direction and then in the other, at the frequency of the current. With ordinary house current - 60 cycle a.c. - the needle would try to change direction 120 times per second. The rectifier will pass the current in one direction only, so, actually, the current is flowing in the meter for only half the time. The circuit is so designed and the time that the current is off is so short that the needle remains steady and indicates the correct voltage.

Ask your shop instructor to show you several different types of rotary switches. Ask him to include one which has at least one wafer which has contacts on both sides. Examine these carefully, especially the wipers (the moving contacts). You will find that some of them are double, some make contact with more than one of the stationary contacts at the same time, and some of them may have more than two separate moving contacts.

Also, ask your instructor to show you a meter rectifier and compare it with other rectifiers.

ASSIGNMENT:

On a large piece of paper draw the schematic for the d.c. voltmeter and the a.c. voltmeter. With a writing implement of another color, draw in a switch connecting to test jacks and switched into such a position as to have the jacks connected to the a.c. voltmeter.

15204

UNIT XVI - MULTIMETERS

Lesson No. 2 — The VOM

If you take the two circuits that we studied in the last lesson and add an ohmmeter and another circuit for measuring current you will have a voltohmmeter, or a VOM. Let us study the following ohmmeter circuit.

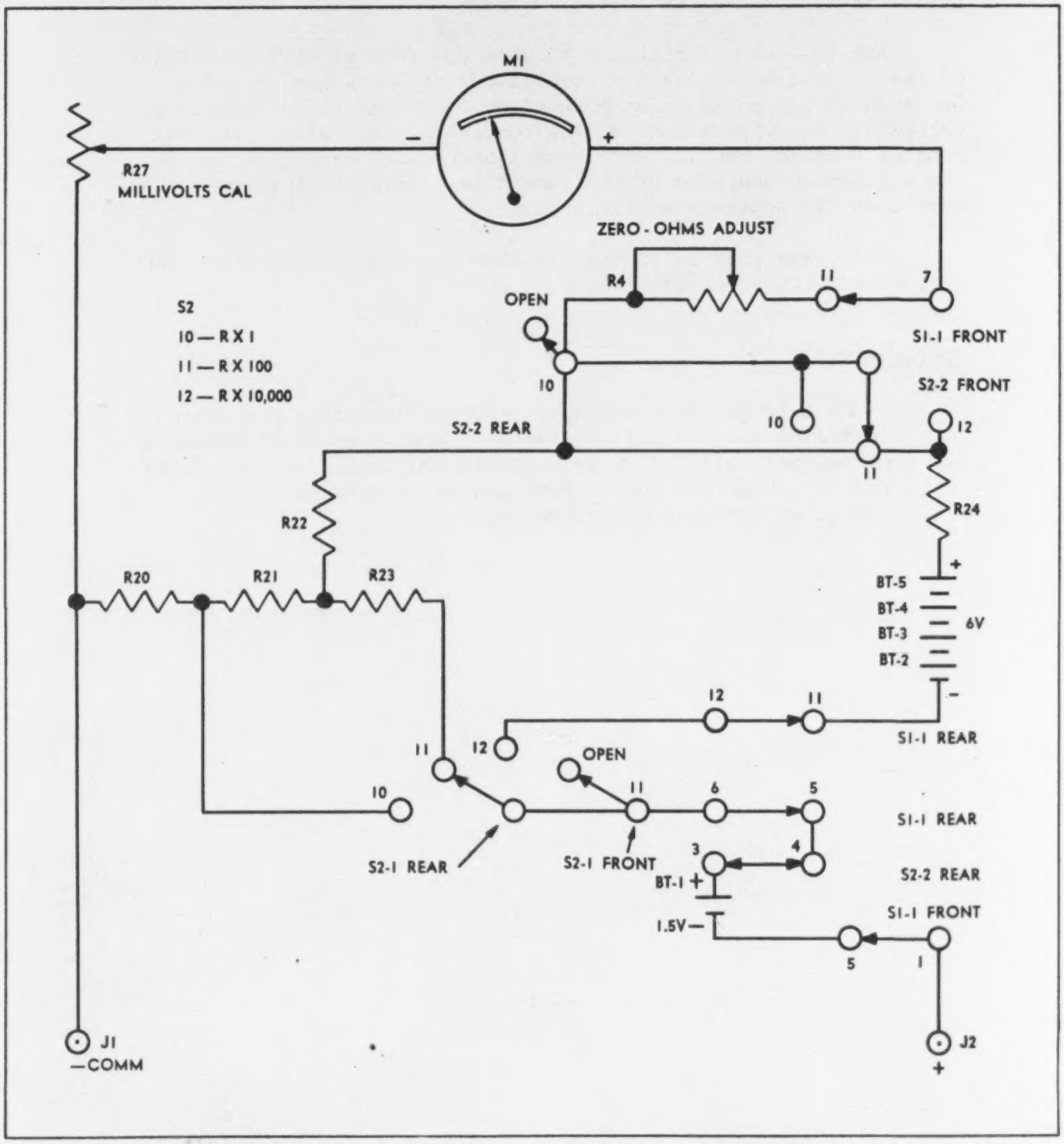

Fig.: XVI-2-1 *Ohmmeter Circuit Shown on the Rx100 Range*

15205

Why is R4 in the circuit? Just what does it do? If you cannot answer this, go back to the lesson on ohmmeters and study it again. Also, make sure you know what R21 and R23 do in the circuit.

Study the d.c. ammeter circuit shown in Fig. 2 You will notice that switching S2 from positons 6 through 9 puts different shunt resistors across the meter, changing it from 100 microamperes to 500 milliamperes in four steps. If you will redraw the circuit as a 100 MA meter, leaving out all components through which no current flows, it will help you understand this circuit. If you do not then fully understand, it is suggested that you draw it for the other three ranges, each time omitting those components which are not in use.

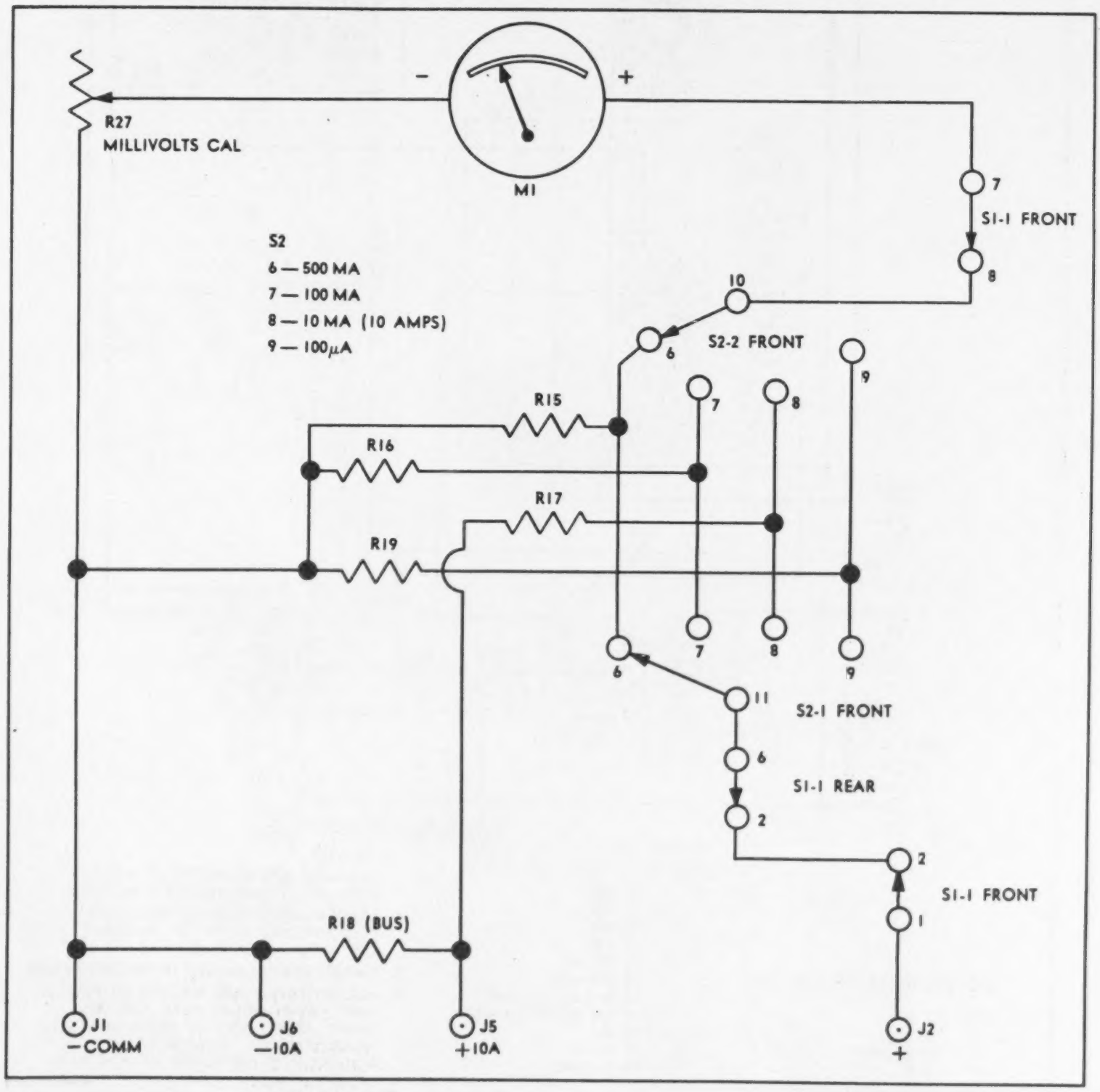

Fig.: XVI-2-2 *D-C Ammeter Circuit*

15206

The following circuit (Fig. 3) combines all four of the previously described circuits shown in this unit. All switches are shown in Position #1, making it a 1000-V d.c. voltmeter. It will be of great help to you if you will draw a schematic of this circuit, under these conditions, omitting all components not being used for this circuit. (See next page for a suggestion.)

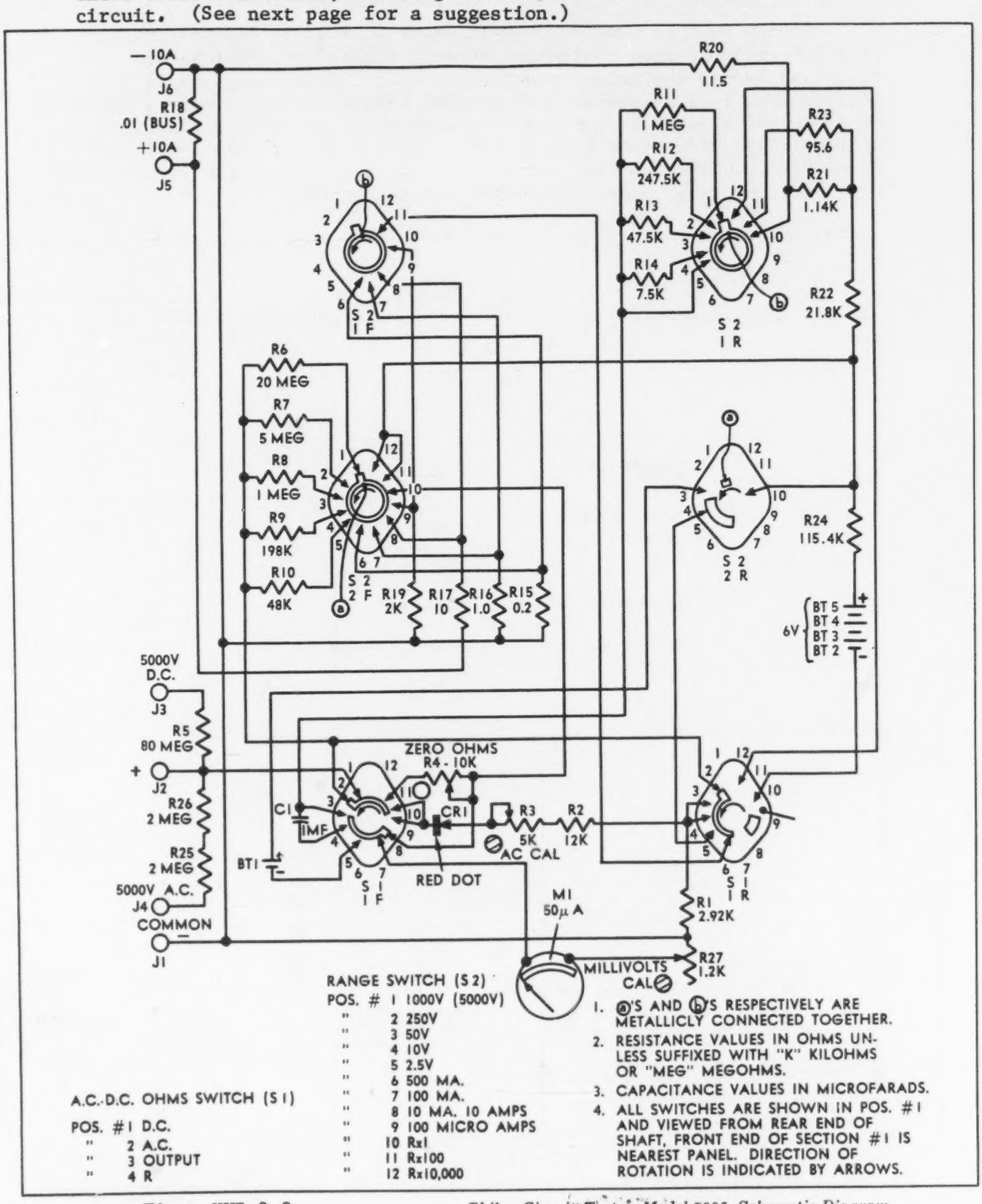

Fig. XVI-2-3 *Philco Circuit Tester, Model 7005, Schematic Diagram*

(Hint: Trace the circuit on the schematic first. With a pencil, very lightly indicate that part of the circuit in use. Then draw your simplified circuit.)

The following is a picture of the meter containing all of the circuitry studied in this unit. It is one of the better voltohmmeters.

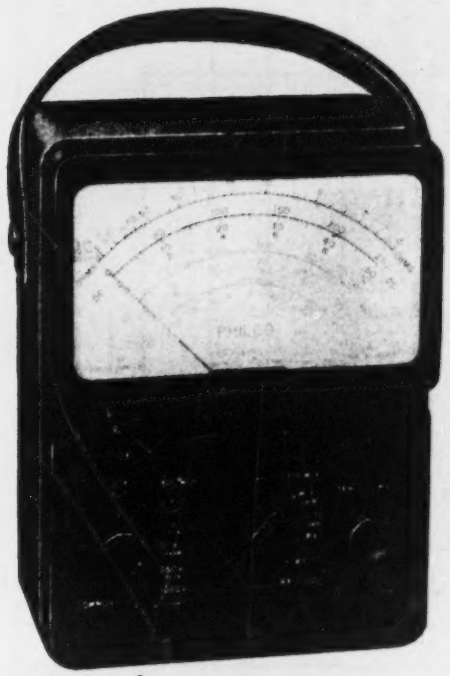

Typical Multimeter (Philco Circuit Tester; Model 7005)

Fig.: XVI-2-4

ASSIGNMENT:

The following 3 schematics of the Philco Model 7005 voltohmmeter are included for you to use in tracing the different circuits with a pencil. See the instructions below each one.

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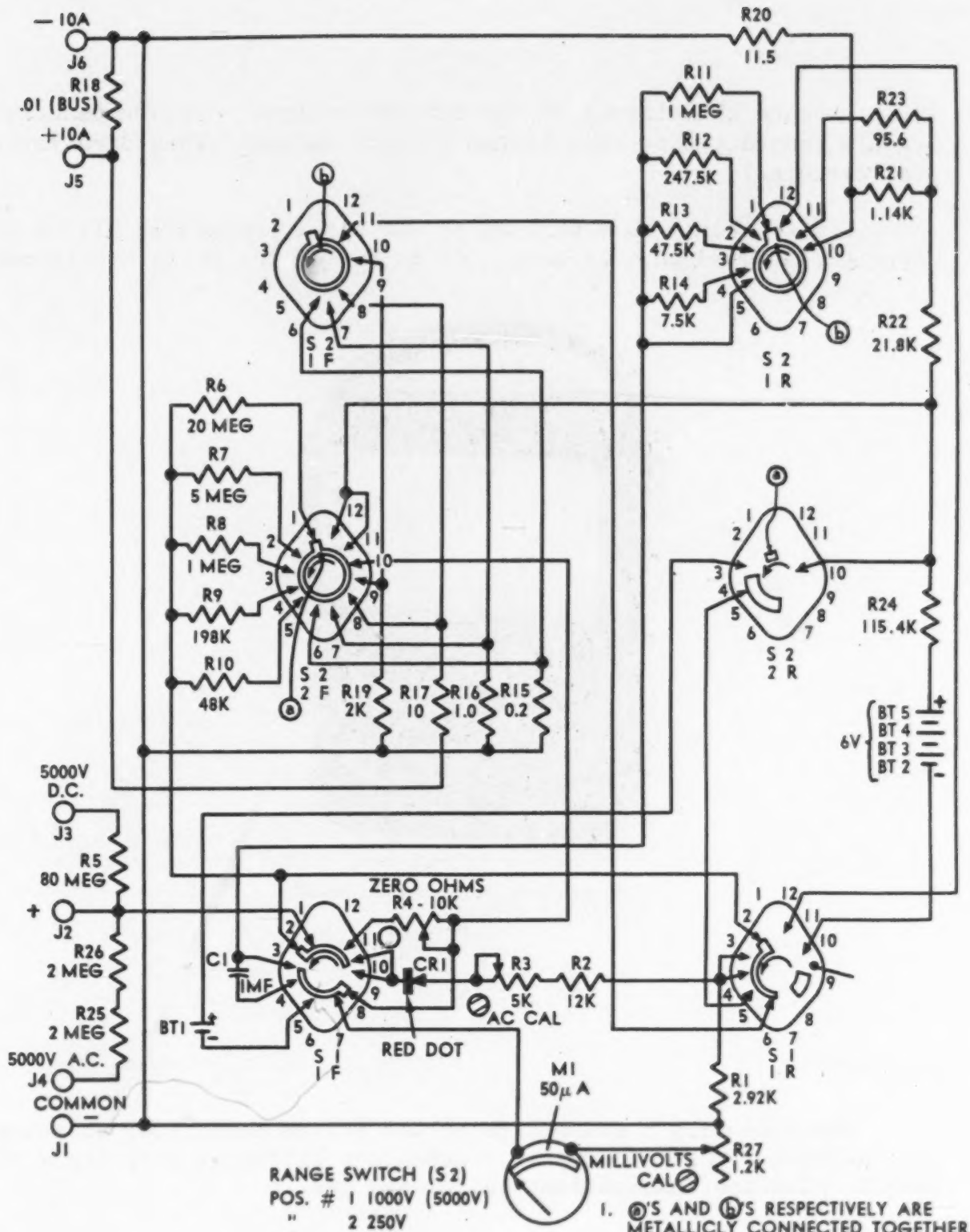

RANGE SWITCH (S 2)

POS. #	1	1000V (5000V)
"	2	250V
"	3	50V
"	4	10V
"	5	2.5V
"	6	500 MA.
"	7	100 MA.
"	8	10 MA. 10 AMPS
"	9	100 MICRO AMPS
"	10	Rx1
"	11	Rx100
"	12	Rx10,000

A.C.-D.C. OHMS SWITCH (S 1)

POS. #	1	D.C.
"	2	A.C.
"	3	OUTPUT
"	4	R

1. ⓐ'S AND ⓑ'S RESPECTIVELY ARE METALLICLY CONNECTED TOGETHER.
2. RESISTANCE VALUES IN OHMS UNLESS SUFFIXED WITH "K" KILOHMS OR "MEG" MEGOHMS.
3. CAPACITANCE VALUES IN MICROFARADS.
4. ALL SWITCHES ARE SHOWN IN POS. #1 AND VIEWED FROM REAR END OF SHAFT, FRONT END OF SECTION #1 IS NEAREST PANEL. DIRECTION OF ROTATION IS INDICATED BY ARROWS.

1. Trace the circuit for the 250-V a.c. volt range; then draw a simplified schematic showing only those components that are in use.

15209

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: II. IGNITION SYSTEM - DISTRIBUTOR

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Disassemble, Reassemble, Replace, and Adjust Distributor

CONDITIONS:

BEHAVIOR:

14. Remove distributor hold down clamp and screw
15. Lift distributor out of engine
16. Disassemble distributor following steps as outlined in the manual
17. Identify all parts and the functions of each
18. Reassemble distributor following steps as outlined in the manual
19. Make bench adjustments
20. Test distributor on distributor tester
21. Install distributor in engine (Observe reference marks and rotor position)
22. Replace battery cable
23. Secure distributor leaving screw loose enough to allow distributor to be rotated
24. Rotate engine until #1 piston is on top dead center (TDC) (Rotor button should point to #1 spark plug distributor terminal)

PERFORMANCE CRITERIA:

1517

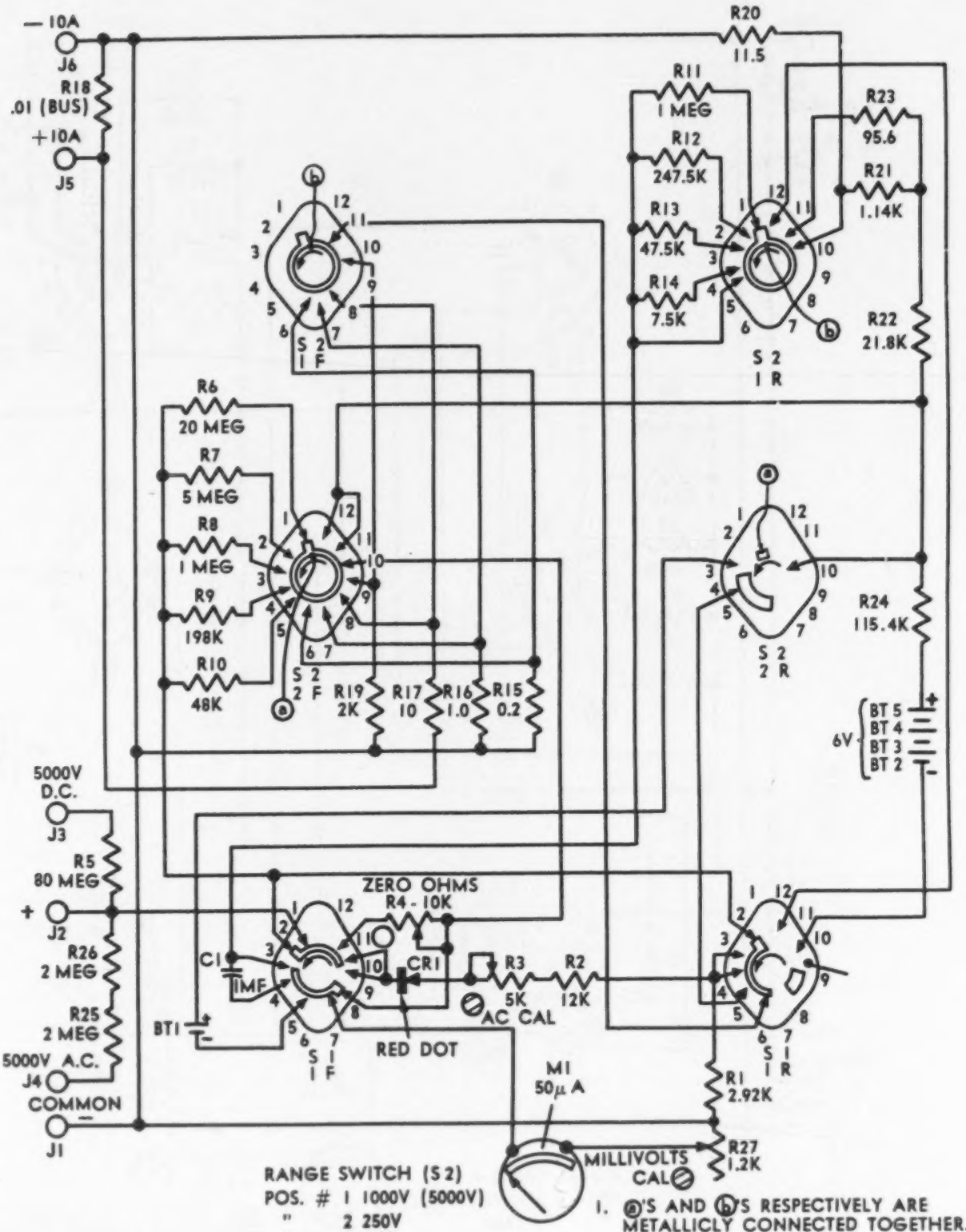

2. Trace the circuit for the R x 100 range; then draw a simplified schematic, as before.

15210

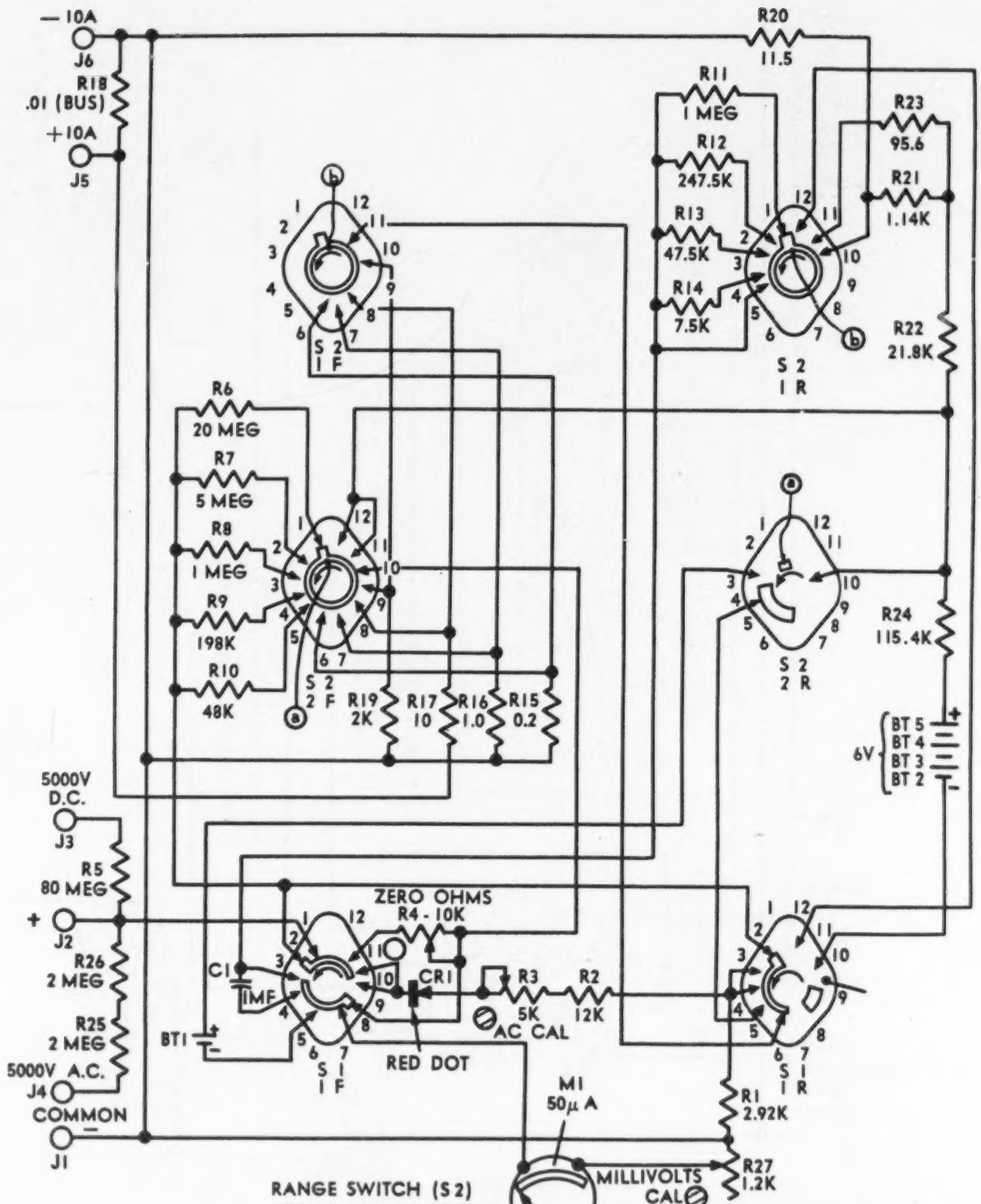

RANGE SWITCH (S 2)

POS. #	1	1000V (5000V)
"	2	250V
"	3	50V
"	4	10V
"	5	2.5V
"	6	500 MA.
"	7	100 MA.
"	8	10 MA. 10 AMPS
"	9	100 MICRO AMPS
"	10	Rx1
"	11	Rx100
"	12	Rx10,000

A.C.-D.C. OHMS SWITCH (S 1)

POS. #	1	D.C.
"	2	A.C.
"	3	OUTPUT
"	4	R

1. ⓐ'S AND ⓑ'S RESPECTIVELY ARE METALLICLY CONNECTED TOGETHER.
2. RESISTANCE VALUES IN OHMS UNLESS SUFFIXED WITH "K" KILOHMS OR "MEG" MEGOHMS.
3. CAPACITANCE VALUES IN MICROFARADS.
4. ALL SWITCHES ARE SHOWN IN POS. #1 AND VIEWED FROM REAR END OF SHAFT, FRONT END OF SECTION #1 IS NEAREST PANEL. DIRECTION OF ROTATION IS INDICATED BY ARROWS.

3. Trace the circuit for the 100-MA d.c. range; then draw a simplified schematic, as before.

15211

12510

UNIT XVI - MULTIMETERS

Lesson No. 3 The Vacuum-Tube Voltmeter

If you need to read voltages present on household applicances, power-supply voltages in radio equipment, and the majority of potential differences, you will find the common VOM (volt-ohm-meter) not only satisfactory but the best, since you do not have to plug this meter into an a.c. outlet. No voltage is needed to operate the voltmeter circuit except the voltage being measured; and it has its own self-contained battery to operate its ohmmeter circuit.

There are voltages, however, that cannot be measured by the VOM. Some voltage sources are so weak that they cannot force any appreciable amount of current. The signal voltage on the grid of a radio detector, for instance, is so feeble that if you were to connect a VOM to it, the voltage would become much lower due to the load of the meter. The vacuum-tube voltmeter is the instrument needed to measure such voltages. No electronics serviceman's workbench should be without one. It does not overload the circuit being tested because the meter movement is not put across it. The meter movement is powered by another source of voltage. The voltage being measured is simply present on the grid of a vacuum tube, as Fig. 1 shows.

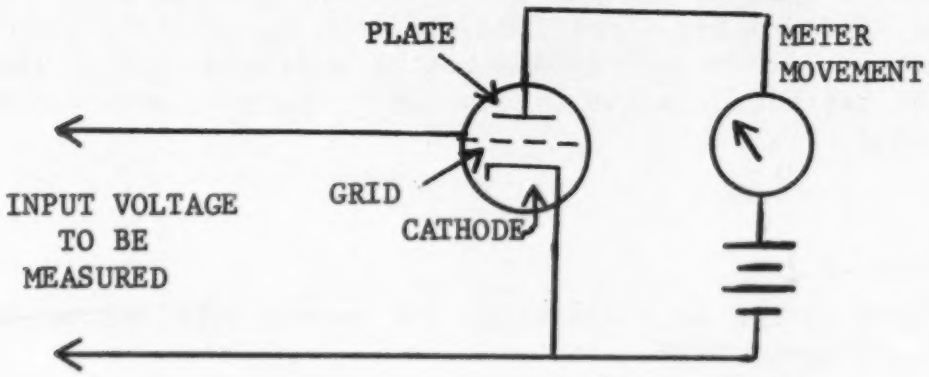

Fig.: XVI-3-1

Let us assume we are testing for a voltage. When there is no input voltage present, electron-current will flow from the negative terminal of the battery through the vacuum tube from the cathode to the plate. From the plate it goes through the meter and back into the battery. The more current flows through the meter, the more it will deflect.

If the grid is made more negative than the cathode, the current through the tube will be lessened. (Remember, electrons are negative charges. Like charges repel. So if the grid becomes negative, it

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will tend to drive the electrons back toward the cathode, reducing the current-flow through the tube and the meter.)

On the other hand, if the grid is made more positive in respect to the cathode, it will attract electrons. In doing this it actually accelerates the electrons. Since it is attracting the electrons, it is reasonable for you to first think that the grid will absorb them. This is not true, however. The grid is actually a fine wire wound around the cathode (but not touching it). The electrons must pass between these windings before reaching the plate. There is so much more space between the turns of the grid wire than the space occupied by the wire itself that the electrons shoot right by the grid and are drawn to the plate by the high positive plate voltage. Therefore the current will increase through the tube and through the meter.

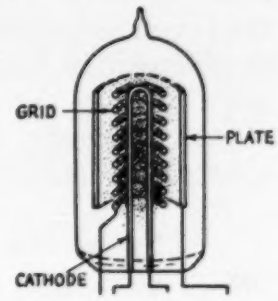

Fig.: XVI-3-2

REMEMBER: If the grid voltage is positive in respect to the cathode, plate current will increase. If the grid voltage is negative in respect to the cathode, the current will become less; and if this negative potential becomes great enough, it will stop the flow of current through the tube altogether.

A schematic diagram of the Eico Model 232 vacuum-tube voltmeter is included (Fig. 3) for the more ambitious student who wishes to spend a little extra time in tracing the circuitry for its different functions. Doing this, and drawing simplified diagrams of the individual circuits will certainly help anyone gain a better understanding of the VTVM. (HINT: The instructor might even be able to give some extra credit for this kind of work.)

QUESTIONS:

1. What is the main advantage the vacuum-tube voltmeter has over the common VOM?

2. How does the applied voltage (the voltage being measured) cause the needle of the meter movement to deflect?

3. From what electrode to what electrode in the vacuum tube do the electrons flow?

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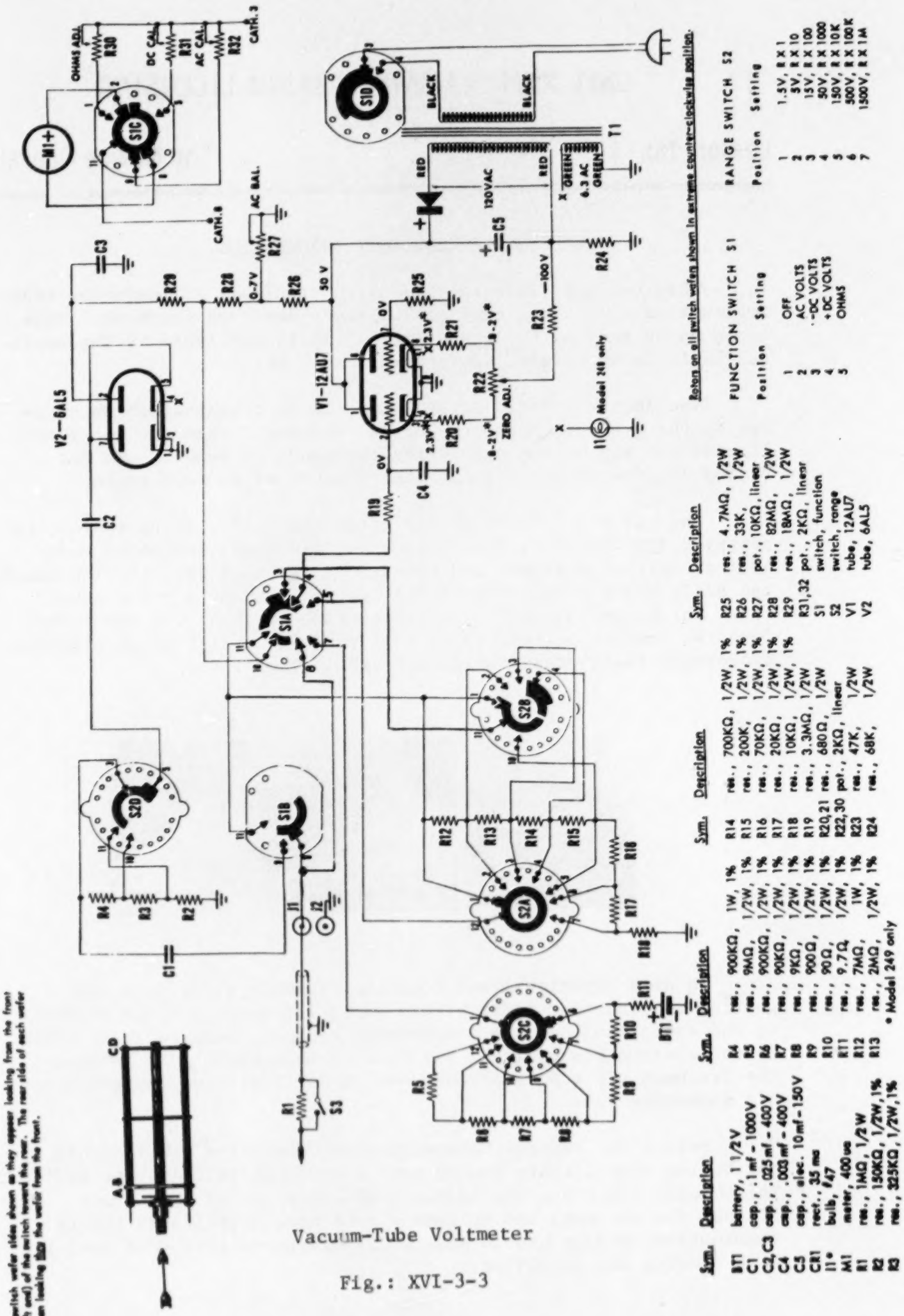

All switch wafer sides shown as they appear looking from the front (shaft end) of the switch toward the rear. The rear side of each wafer is seen looking thru the wafer from the front.

Relays on all switch wafers shown in extreme counter-clockwise position.

Sym.	Description
BT1	battery, 1 1/2 V
C1	cap., .1 mf - 1000 V
C2, C3	cap., .025 mf - 400 V
C4	cap., .003 mf - 400 V
C5	cap., elec. 10 mf - 150 V
CR1	rect., 35 ma
I1*	bulb, #47
M1	meter, 400 ua
R1	res., 1MΩ, 1/2 W
R2	res., 150KΩ, 1/2W, 1%
R3	res., 325KΩ, 1/2W, 1%
R4	res., 900KΩ, 1W, 1%
R5	res., 9MΩ, 1/2W, 1%
R6	res., 900KΩ, 1/2W, 1%
R7	res., 90KΩ, 1/2W, 1%
R8	res., 9KΩ, 1/2W, 1%
R9	res., 900Ω, 1/2W, 1%
R10	res., 90Ω, 1/2W, 1%
R11	res., 9.7Ω, 1/2W, 1%
R12	res., 7MΩ, 1W, 1%
R13	res., 2MΩ, 1/2W, 1%
R14	res., 700KΩ, 1/2W, 1%
R15	res., 200K, 1/2W, 1%
R16	res., 70KΩ, 1/2W, 1%
R17	res., 20KΩ, 1/2W, 1%
R18	res., 10KΩ, 1/2W, 1%
R19	res., 3.3MΩ, 1/2W
R20, 21	res., 680Ω, 1/2W
R22, 30	pot., 2KΩ, linear
R23	res., 47K, 1/2W
R24	res., 68K, 1/2W
R25	res., 4.7MΩ, 1/2W
R26	res., 33K, 1/2W
R27	pot., 10KΩ, linear
R28	res., 82MΩ, 1/2W
R29	res., 18MΩ, 1/2W
R31, 32	pot., 2KΩ, linear
S1	switch, function
S2	switch, range
V1	tube, 12AU7
V2	tube, 6AL5

* Model 249 only

FUNCTION SWITCH S1

Position	Setting
1	OFF
2	AC VOLTS
3	-DC VOLTS
4	+DC VOLTS
5	OHMS

RANGE SWITCH S2

Position	Setting
1	1.5V, R X 1
2	5V, R X 10
3	15V, R X 100
4	50V, R X 1000
5	150V, R X 10K
6	500V, R X 100K
7	1500V, R X 1M

Vacuum-Tube Voltmeter

Fig.: XVI-3-3

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UNIT XVII - AMATEUR RADIO LICENSING

Lesson No. 1 — The Novice Operator

HELPFUL INTRODUCTORY INFORMATION

When one goes into the ham shack of almost all American radio amateurs he will see a copy of The Radio Amateurs Handbook. This is known by many as the ham's bible. It is published by The American Radio Relay League, Newington, Conn., 06111.

The American Radio Relay League is an organization which is run by the amateur operators who are members. When you get your license you may become one of the thousands of members who are united to advance the art and the pleasure of amateur radio.

The handbook covers nearly every phase of amateur radio — receivers, transmitters, radio-teletype, sideband, frequency modulation, antenna systems, and general electronics theory. The American Radio Relay League (the ARRL) publishes about a dozen other books which you should find of interest. If this list cannot be found in your shop, the League will send you a list of information concerning their organization and publications.

In some vocational and technical schools it is felt that getting into amateur radio brings added interest to those students in the electrical and the electronics courses, especially to those in the electronics courses. In fact, some schools require that the freshman get a Novice Radio Amateur's license before going into his sophomore year.

Before the Federal Communications Commission (FCC) opened the Novice class, there was no easy way to get into Amateur Radio. The General class was the lowest class, and to get this class license the newcomer had to pass a much more complicated theory examination, and he had to pass a 13-word-per-minute code test in both sending and receiving.

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Now a beginner can get a Novice license by being able to send and receive 5 words per minute, along with passing an examination which will prove that he knows enough about communications laws and radio theory to operate a Novice radio station.

Any radio amateur, 21 years of age or older, who possesses a General class amateur license or higher, may give the code test to one who wants to take the Novice test. This volunteer examiner then writes to the Federal Communications Commission, 334-36 York Street, Gettysburg, Pennsylvania, 17325 and requests the examination forms. The examination is sent to the volunteer examiner, who supervises the applicant's taking the examination. When the applicant finishes the examination, he is to furnish the volunteer with an envelope and postage stamp for mailing the examination back to Gettysburg, where it is checked. If the applicant passes the examination, that information is passed on to Washington from Gettysburg. His license will be sent from Washington, D. C. If the examination is failed, the notification comes from Gettysburg, Pennsylvania.

The Novice Class license is good for only two years, whereas the higher class licenses are permanent (though requiring renewal every five years). The Novice Class license can never be renewed, because it was given only to help the beginner get into the field of amateur radio more easily than before the creation of this class of license. It is generally considered that if the Novice is not ready for a higher class license after two years, he isn't the person who would advance himself enough to operate in the crowded Amateur frequency bands anyway.

In order to lessen the likelihood that the Novice operator might cause interference where he shouldn't, he is limited in power to 75 watts, and his transmitting frequencies must be crystal controlled. The General Class operator, and those above that class, may operate at input powers up to 1,000 watts. The Novice is held to 75 watts because of the dangers of transmitting harmonics of the transmitting frequency. The General Class operator may use a variable-frequency oscillator, which permits him to move from one frequency to another by merely turning a dial. The Novice may not use a variable-frequency oscillator (a VFO) because, being less skilled, he is more likely to move outside of the permitted band of frequencies. Therefore, the Novice operator must control his frequency with a crystal, which is not variable.

QUESTIONS:

1. What is the highest input power a Novice operator is permitted to use?

2. Why are the Electronics students in some schools required to obtain a Novice Class Amateur Radio license?

3. With what must the Novice operator control his operating frequency?

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UNIT XVII - AMATEUR RADIO LICENSING

Lesson No. 2 — Novice Frequencies

The Novice Class operator is allotted frequencies in the 80-meter, the 40-meter, the 15-meter, and the 2-meter Radio Amateur bands. In the 80-meter band he may operate from 3700 kc. to 3750 kc. In the 40-meter band he is permitted to operate from 7150 kc. to 7200 kc. In the 15-meter band he may operate from 21.1 mc. to 21.25 mc. In the 2-meter band he may operate from 145 mc. to 147 mc.

From the beginning of the Novice Class license until fairly recently, the Novice operator had been permitted to operate "voice" in the 2-meter band. Now, however, all operations must be A1 Emission (telegraphy, continuous wave). Again, this rule change was for the benefit of the Novice. If the beginner is permitted to go on radio-telephone operation, it is possible that he might never bring his code-speed up to the 13-word-per-minute requirement for the General Class license.

In 1964, American electronics manufacturers began using the term hertz for cycles per second. In most of the other countries of the world this term was already in use. It honored H. R. Hertz, the German scientist who was the first to demonstrate wireless communication. Hertz is abbreviated Hz. Kilohertz is abbreviated KHz, and megahertz is MHz.

	1 hertz (Hz)	=	1 cycle per second
	1 kilohertz (KHz)	=	1,000 cycles per second
	1 megahertz (MHz)	=	1,000,000 cycles per second
Also	1 cps	=	1 Hz
	1 kc	=	1 KHz
	1 mc	=	1 MHz

Let's look at the Novice frequencies again as they are given in the different units.

The 80-Meter Band (Novice)

	3700	-	3750 kc
or	3.7	-	3.75 mc
or	3.7	-	3.75 MHz

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The 40-Meter Band (Novice)

	7150	-	7200 kc
or	7.15	-	7.2 mc
or	7.15	-	7.2 MHz

The 15-Meter Band (Novice)

	21,100	-	21,250 kc
or	21.1	-	21.25 mc
or	21.1	-	21.25 MHz

The 2-Meter Band (Novice)

	145	-	147 mc
or	145	-	147 MHz

QUESTIONS:

1. Why is radiotelephone operation being terminated for the Novice operator in the 2-meter band?

2. Express 3700 kc in MHz.

3. Express 7160 kc in MHz.

4. Express 21,100 kc in mc.

5. Express 147 mc in MHz.

6. Name the different bands that the Novice Class operator may use to transmit radiotelegraph signals.

7. What is A1 emission?

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UNIT XVII - AMATEUR RADIO LICENSING

Lesson No. 3 — Legal Transmitter Power

It has previously been mentioned that the Novice Class radio amateur operator may not use more than 75 watts. This is a very important fact, and it is one of those facts that the FCC is particularly careful in testing an applicant about before a license is issued to him. You must know how to measure your power.

The FCC regulations are on <u>input</u> power, not <u>output</u> power. To measure it, you must be able to know the voltage on the plate or plates of the final amplifier as well as the plate current. Power is calculated by multiplying the plate voltage by the plate current.

EXAMPLE: If the plate voltage (Ep) = 1,000 volts, and the plate current (I_p) = 75 MA (0.075A),
P = I x E = 0.075 x 1,000 = 75 watts.

Suppose there are two tubes in the final stage of amplification drawing 40 milliamperes each, at a plate voltage of 500 volts. The total plate current is the sum of the currents the two tubes are drawing, or 2 x 40, or 80 milliamperes. Then the input power is 500 x 0.080 = 40 watts.

How can you determine your plate voltage and your plate current? Plate voltage is measured between the plate and the cathode of the tube. Since there is negligible voltage drop across the final tank coil, the voltage may be measured at the low end of the coil if it is more convenient.

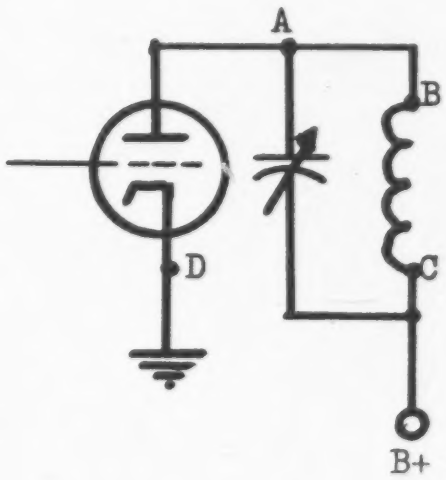

Fig.: XVII-3-1

In the diagram shown here, plate voltage may be read between A and D, A and Ground, B and D, B and Ground, C and D, or C and Ground.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: II. IGNITION SYSTEM - DISTRIBUTOR

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Disassemble, Reassemble, Replace, and Adjust Distributor

CONDITIONS:

BEHAVIOR:

25. Rotate distributor in direction of firing order until the rubbing block on the contact points passes completely over the #1 distributor lobe
26. Move distributor against rotation until points start to open on the #1 lobe
27. Tighten hold-down clamp screw finger tight
28. Install distributor cap
29. Attach primary lead wire to coil
30. Recheck installation steps
31. Connect power timing light to #1 spark plug (Do not remove spark plug wire - use proper adapter)
32. Start engine and run at idle speed
33. Rotate distributor until pointer and timing marks indicate correct timing as given in specifications
34. Stop engine
35. Tighten distributor hold down screw
36. Start engine and recheck time - If timing remained the same, stop the engine

PERFORMANCE CRITERIA:

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Referring back to the diagram, the plate current may be measured by placing the milliammeter in series with the plate circuit or in series with the cathode circuit.

Suppose you are operating a transmitter in which you have 700 volts on the plate of the final amplifier tube. What is the maximum plate current you may be permitted to have?

First, you must remember that maximum P = 75 watts. You have E = 700 volts. All you have to do is use the formula P = I x E or I x E = P.

If I x E = P

then $I = \frac{P}{E} = \frac{75}{700}$ = 0.107 amperes or 107 milliamperes.

QUESTIONS:

1. What is the maximum power that the Novice Class operator is permitted to run?

2. Is the above <u>input</u> or <u>output</u> power?

3. If E_p = 900 volts and I_p = 60 MA, what is the input power?

4. If you have 1,200 volts on the plate of your Novice transmitter, how much current may you draw through the tube?

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WHO MAY OPERATE AN AMATEUR RADIO STATION

The Federal Communications Commission states that an amateur radio station may be operated only by a person holding a valid amateur operator's license. Such station may be operated by the licensee only in the manner and to the extent provided in his amateur operator's license. Persons other than the station licensee, when operating such station, may operate it "only to the extent and in the manner authorized to the licensee of the station and not exceeding the operating authority of such person's own amateur operator license." In other words, a General Class operator may operate a Novice station but only on the Novice frequencies. A Technician Class operator is not permitted to operate on the Novice frequencies for which he is not licensed. Under the old Novice licenses, when 2-meter phone operation was permitted, the Technician could operate 2-meter phone on the Novice station. Your Novice Class license, however, will not permit radiotelephone operation and, therefore, no Technician Class operator will be legally permitted to operate your station on any band.

A written record of transmissions, called a log, must be kept at each station. It must show:

1. The date and time of transmission
2. The call letters of the station called
3. The frequency band used
4. The type of emission used
5. The location of the station at the time of transmission
6. Message traffic handled (if any)
7. The signature of each licensed operator operating the equipment and the name of any person not holding a license who speaks over a radiotelephone transmitter directly or by recording, or who operates a teleprinter keyboard.

The log must be preserved for at least two years after the final entry is made in it. Also, all message traffic must be preserved for at least one year after it is handled.

When transmitting on frequencies below those in the 2-meter band, spurious radiations must be reduced in accordance with good engineering practice, and must not cause interference to near-by receivers of good engineering design not tuned to the transmitter. Voice modulation of a transmitter must not cause spurious emissions; the maximum modulation percentage is 100. Simultaneous frequency modulation and amplitude modulation is not permitted. The frequency of the signal transmitted must be as constant as the "state of the art"

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permits. If you feel that you might be transmitting spurious radiations or unwanted harmonics, the best way to check is to have someone about two miles away monitor your transmission and search for the suspected, unwanted emissions. Someone living very close to you cannot give you an honest report, because your transmitter could possibly be overloading his receiver. Also, very weak harmonics may be detected there that would not reach the receiver two miles away.

Even though the Novice Class transmitter must have crystal frequency control, there must be means of measurement of the frequency at the station. These means must be independent of the means used to control the transmitting frequency and must be of sufficient accuracy to ensure operation within the frequency band used. The ideal piece of equipment for this purpose is a crystal calibrator, which is used in conjunction with the receiver. This calibrator, by the way, should be checked for accuracy against the frequency of the Bureau of Standards' radio station WWV.

QUESTIONS:

1. What is the log and how long must it be kept?

2. If you are a licensed Novice Class operator, who besides yourself may operate your station?

3. What records must be kept in the log?

4. What are the FCC regulations concerning measurement of frequencies used in amateur transmission?

UNIT XVII - AMATEUR RADIO LICENSING

Lesson No. 5 — Quality of Signals

Most amateur radio transmitters are powered primarily from commercial a.c. power lines, so it is necessary that this a.c. voltage be rectified and filtered into pure d.c. before it is applied to the plates of the tubes in the transmitter. The rectifier changes the voltage from a.c. to a pulsating d.c.; from

this:

Fig.: XVII-5-1

to this:

Fig.: XVII-5-2

It is obvious that the voltage behind the rectifier is no longer going negative, but it is changing amplitude at the frequency of the a.c. if half-wave rectification was used, and at twice the frequency of the a.c. if full-wave rectification was used. This rapid change in amplitude is called ripple, and it can cause hum in any circuit where it is used on the plates of the tubes. The output from the rectifier must be smoothed by a filter network made up of inductance and capacitance. A good filter will give a B+ output like this:

Fig.: XVII-5-3

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The output from a battery with its pure d.c. would give the same pattern on the oscilloscope.

When operating on all bands below 144 mc, the FCC requires that the plate voltages be pure d.c. This is to give a constant carrier, and one which will give a pure d.c. note.

If the output signal from a radiotelegraph transmitter is pure, then there can be no "chirp." The signal seems to chirp when there is a rapid change in the transmitter frequency upon keying, i.e. when the key is closed and opened. Keying the oscillator instead of following stages can cause chirp. Other causes may be feedback of r-f energy from the final amplifier to the oscillator, or poor regulation at the power supply, causing frequency shift.

Chirp can most often be prevented by (1) building the transmitter with a buffer amplifier stage between the oscillator and the final amplifier; (2) building the oscillator from a design which has high stability; (3) providing B+ voltages from a power supply with good regulation; (4) employing voltage regulation at the oscillator; (5) shielding the oscillator so that energy cannot feed back from later stages of amplification.

Just as overmodulation can cause spurious sidebands that are not tolerated by the FCC, key clicks can also cause spurious radiations on either side of the transmitter frequency. These radiations interfere with signals from other transmitters - possibly even signals from commercial and government stations. Key-click filters are used to prevent such spurious radiations.

QUESTIONS:

1. What is chirp?

2. Give 5 methods of preventing chirp.

3. What kind of voltage is found between the rectifier and the power supply's filter?

4. Why must the output of the rectifier-power-supply be filtered?

5. Why is a key-click filter used?

6. What is ripple?

7. The FCC is very particular about the purity of signals on what frequencies?

8. What are key clicks?

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UNIT XVII - AMATEUR RADIO LICENSING

Sample Test No. I

1. In the language of Amateur Radio, a cipher is

   a. a form of arithmetic
   b. a secret code
   c. the International Morse Code
   d. modulated cw

2. Radio amateurs are permitted to

   a. broadcast music
   b. make regular political speeches for their parties
   c. send, receive, and deliver commercial message traffic
   d. discuss electronic technicalities and weather

3. Persons permitted to operate a radio station licensed to a Novice are

   a. any other radio amateur
   b. qualified Army or Navy radio operators
   c. any radio amateur except the advanced extra class license holder
   d. any amateur radio operator except those holding Technician Class licenses

4. Under ordinary operating procedure (excluding short transmissions and tests) the operator must identify his station every

   a. ten minutes
   b. five minutes
   c. fifteen minutes
   d. half-hour

5. Twenty-one megacycles is which harmonic of seven megacycles?

   a. first
   b. second
   c. third
   d. fourth

6. A rectifier is used to

   a. filter ripple from d.c.
   b. change d.c. to a.c.
   c. vary amplitude of a carrier
   d. change a.c. to d.c.

7. If you are going to operate <u>portable</u> away from your base station, you must

   a. notify the FCC engineer-in-charge of the inspection district that your base station is in if you plan to operate more than 48 hours while away from the base station.

b. notify the above official if you plan to operate more than 12 hours
c. notify the FCC engineer-in-charge of the inspection district in which you intend to operate if you plan to operate more than 12 hours
d. notify the FCC engineer-in-charge of the inspection district in which you intend to operate if you plan to operate more than 48 hours.

8. What is the relationship between a kilocycle and a megacycle?

a. 1 megacycle = 100 kilocycles
b. 1 megacycle = 1×10^{-3} cycles
c. 1 megacycle = 1×10^{-6} cycles
d. 1 megacycle = 1,000 kilocycles

9. The instrument used to measure electrical potential is the

a. ammeter
b. voltmeter
c. ohmmeter
d. wattmeter

10. $I = \frac{E}{R}$ expresses

a. Krauses' Law
b. Thevenin's Theorum
c. Ohm's Law
d. Lenz's Law

11. An applicant who fails the Novice examination may take another examination

a. after 10 days from the date he failed the examination
b. after 20 days from the date he failed the examination
c. after 30 days from the date he failed the examination
d. after 60 days from the date he failed the examination

12. A modulator is used to

a. vary the amplitude, frequency, or phase of a transmitter for the purpose of transmitting information
b. change a.c. into d.c.
c. make big signals from small signals
d. pass a.c. and hold back d.c.

13. An oscillation not essential to the operation of the equipment and usually occurring on a frequency considerably removed from the operating frequency is called

a. a harmonic
b. an integral multiple
c. key clicks
d. a parasitic oscillation

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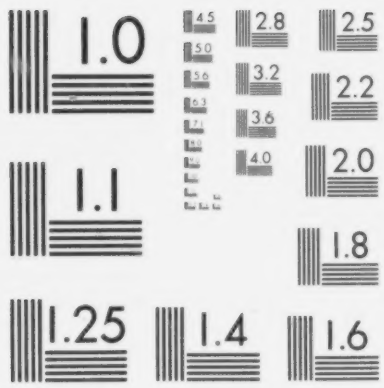

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

14. A capacitor

a. passes direct current and rejects alternating current
b. passes both a.c. and d.c.
c. effectively passes alternating current
d. rejects pulsating frequencies

15. The FCC limits antenna height because of

a. excessive power radiation
b. hazards to air navigation
c. neighborhood appearance
d. interference to marine navigation

16. You may not communicate with some countries because of

a. strained relations with those governments, war, etc.
b. differences in technical arrangements, frequencies, etc.
c. power inputs in the transmitters of their stations
d. communications laws in those countries

17. A Novice station running full power has 1200 volts on the plates of a pair of tubes in the final amplifier. How much current is being drawn by the plates of each tube?

a. 62 mA
b. 31 mA
c. 620 mA
d. 920 mA

18. Frequencies between 3700 and 3750 kc are found in the

a. 80-Meter band
b. 40-Meter band
c. 10-Meter band
d. 2-Meter band

19. If a Novice station at full power has 40 mA of I_p on the plate of the final amplifier, E_p is

a. 1875 volts
b. 300 volts
c. 3000 volts
d. 187.5 volts

20. If the signal input voltage to a transistor amplifier is 0.2 volts and the output voltage of the amplifier is 5 volts, the amplification factor is

a. 25
b. 10
c. 7
d. 1

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UNIT XVII - AMATEUR RADIO LICENSING

Sample Test No. 2

Since the FCC examinations are given in the multiple-choice form, the following multiple-choice questions should give the student an idea as to how he will be questioned on those examinations.

1. A radio-frequency choke

   a. opposes currents of radio frequencies and passes d.c. currents
   b. passes currents of radio frequencies and opposes a.c. currents
   c. passes audio frequencies and opposes radio frequencies
   d. passes radio frequencies and opposes direct current

2. Amplification is

   a. the process of modulation by controlling the amplitude at the rate of the modulator's frequency
   b. the process of increasing the amplitude or power level of a signal
   c. attenuation of the signal at audio frequencies
   d. any multiple of the fundamental

3. If a tube does not heat up when the filament voltage is turned on, it is caused by

   a. the plate voltage being off
   b. the center tap of the high-voltage secondary being disconnected
   c. probably the filament pins of the tube are not making contact at the tube socket
   d. the filament voltage having ripple

4. The plate voltage of the final amplifier tube in a transmitter may be measured between

   a. the cathode and B+ end of the RF choke in the plate circuit
   b. the plate and the B+ end of the RF choke in the plate circuit
   c. the grid and the B+ end of the RF choke in the plate circuit
   d. the cathode and the screen grid

5. The Novice frequencies in the 40-meter band are those between

   a. 3700 and 3750 kc
   b. 7.150 and 7.200 mc
   c. 21.1 and 21.25 mc
   d. 7.15 and 7.2 kc

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: II. IGNITION SYSTEM - DISTRIBUTOR

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Disassemble, Reassemble, Replace, and Adjust Distributor

CONDITIONS:

BEHAVIOR:

37. Remove timing light
38. Connect vacuum control line
39. Recheck all wires and connections
40. Replace air breather assembly
41. If distributor functions satisfactorily, clean and replace tools and materials
42. Remove fender covers and store in proper place
43. Close hood
44. Return automobile to proper parking area
45. Remove seat cover and store in proper place
46. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, disassemble, reassemble, replace, and adjust distributor in 2 hours and 30 minutes.

Learning time: 6½ hours

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14. A filter choke is used for

a. passing RF and rejecting AF
b. smoothing RF signals
c. smoothing the d.c. output of a rectifier
d. none of the preceding

15. Ohm's law states that

a. Power equals voltage multiplied by current.
b. For finding current, resistance is inversely proportional to voltage.
c. For finding current, resistance is directly proportional to voltage.
d. For finding resistance, the current is directly proportional to voltage.

16. To make an amateur radio station safe, one should

a. make sure all power supplies have bleeder resistors
b. install interlock switches on lids and panel openings of all high-voltage equipment
c. have the cabinets of all components in the station connected to a good common ground
d. use all of the above precautions

17. There are two tubes in the final amplifier of a transmitter. E_p = 500 V and each tube is drawing 0.05A. Input power is

a. 25 watts b. 250 watts c. 50 watts d. 500 watts

18. A frequency multiplier is

a. a device that delivers output power at integral multiples of the frequency
b. a device that delivers frequencies at integrals of the applied frequency
c. a device that amplifies the oscillator signal at integral multiples
d. a device to be avoided because it can put your signal outside the bands of frequencies permitted by the FCC

19. Wavelength (in meters) may be found by

a. dividing 300,000,000 by the frequency (in Hz)
b. dividing 186,000 by the frequency (in c.p.s.)
c. multiplying the frequency (in c.p.s.) by 300,000,000
d. multiplying the frequency (in Hz) by 186,000

20. One method of correcting harmonic radiation is to

a. lower the plate voltage
b. use lower-C interstage circuits
c. use higher-C interstage circuits
d. increase grid drive

21. in the diagram shown below, the block designated by the letter B is

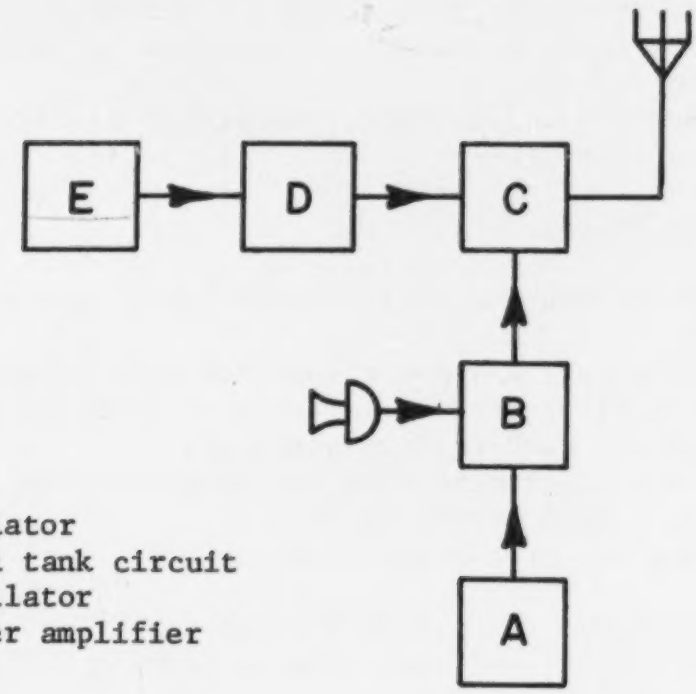

a. the modulator
b. the final tank circuit
c. the oscillator
d. the buffer amplifier

22. Also, in the diagram shown above, the block designated by the letter A is

a. the power supply
b. the oscillator
c. the final amplifier
d. the buffer amplifier

23. In the same diagram, the block designated by C is

a. the modulator
b. the oscillator
c. the final amplifier
d. the buffer amplifier

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24. A key-click filter is used in a transmitter design for

a. safety purposes
b. limiting spurious emissions
c. protection to the tubes
d. the elimination of sidebands in the radiotelephone transmitter

25. In the diagram at the right, R_T is equal to

a. 76Ω
b. 2Ω
c. 14Ω
d. 28Ω

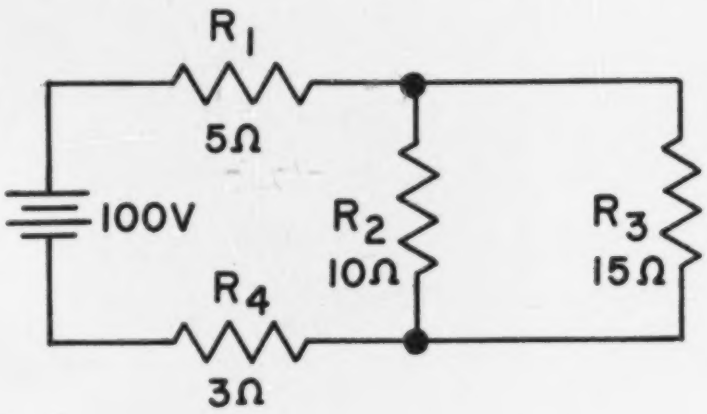

26. In the above diagram, I_{R_4} is equal to

a. 2 A b. 3 A c. 5 A d. 7.15 A

27. 1 μμF is equal to

a. 1×10^{-12} farads
b. 1×10^{-6} μF
c. 0.000000000001 farads
d. all of the above

28. The instrument which is used to measure electrical energy is

a. the voltmeter
b. the wattmeter
c. the watt-hour meter
d. the galvanometer

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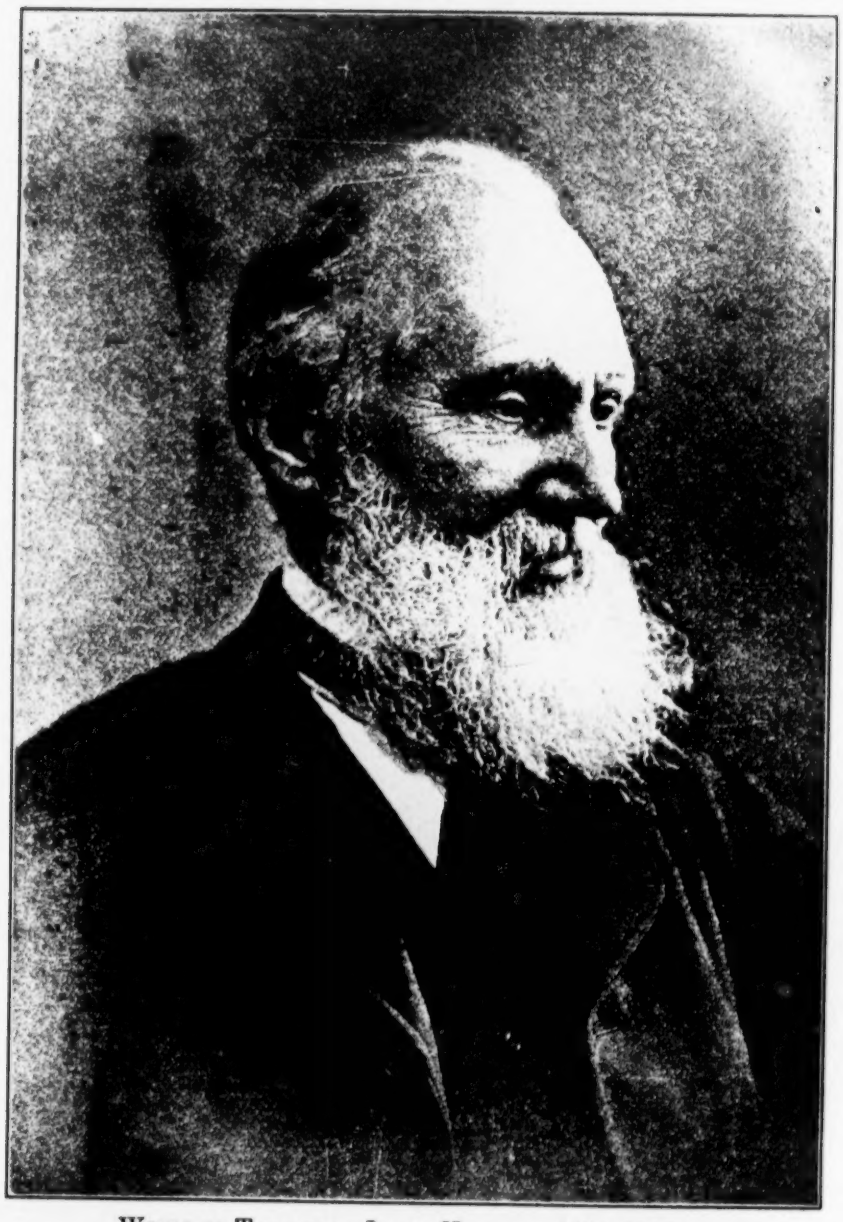

WILLIAM THOMSON, LORD KELVIN (1824–1907).

A British physicist and electrical engineer; born in Belfast, Ireland; for more than fifty years professor of physics in Glasgow University, Scotland; invented the mirror galvanometer used in cable signaling; developed an improved form of mariners' compass. His work in thermodynamics is of the greatest value. He was one of the first to appreciate the principle of CONSERVATION OF ENERGY.

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UNIT XVIII - ALTERNATING CURRENT

Lesson No. I — What is AC?

There are basically two different kinds of electric currents - DC and AC. You have been studying d.c. and, of course, understand that it flows in one direction. Alternating current switches direction constantly, the number of times per second depending upon the frequency. If it is a 60-cycle current (the frequency of house current) the direction changes to the opposite and then back 60 times per second. In a 60-cycle current, therefore, there are actually 120 direction changes in a second.

If you turn on an electric light in your home, the instant you turn it on the current may be flowing in the direction of the arrow shown in the upper illustration.

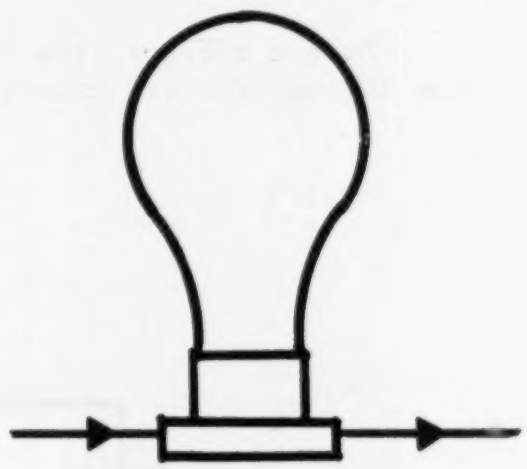

Fig.: XVIII-1-1

In a small fraction of a second, the current will be flowing in the opposite direction. It will change directions 120 times each second, making 60 complete cycles each second.

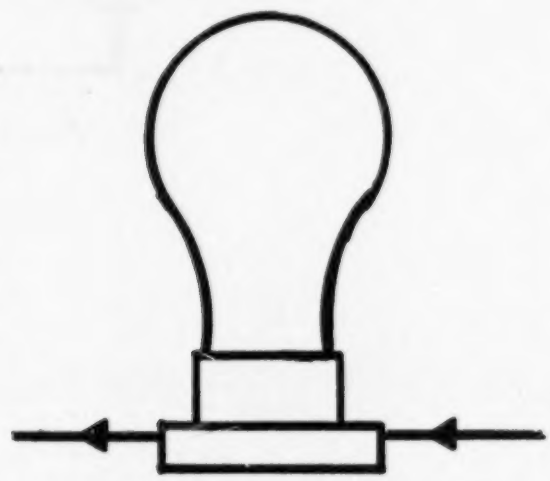

Fig.: XVIII-1-2

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TO COMPLETE THE CYCLE, THE CURRENT MUST RETURN TO THE ORIGINAL DIRECTION. THEREFORE, THERE ARE TWO CHANGES IN EACH CYCLE - FROM ONE DIRECTION TO THE OPPOSITE, AND THEN BACK AGAIN.

Resistance is the only impeding force that d.c. (direct current) meets. In a-c (alternating current) circuits, though, there are other forces which tend to hold back or lessen the current-flow. These forces are called reactances, and when all the reactances, along with the resistance, are combined, we call the composite force impedance.

There are two kinds of reactance. One is called capacitive reactance (X_C). Capacitive reactance is the resistance to a current due to a capacitor or the capacitance effect of the wires themselves. The other is inductive reactance (X_L). Inductive reactance is the resistance to a-c current due to inductance. This inductance may be caused by the wires or by a coil designed for that purpose.

Direct current from the battery in the circuit below will not flow through the capacitor.

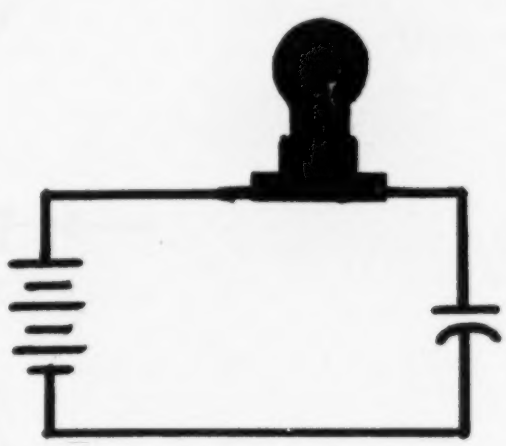

Fig.: XVIII-1-3

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Alternating current, however, will effectively flow through a capacitor.

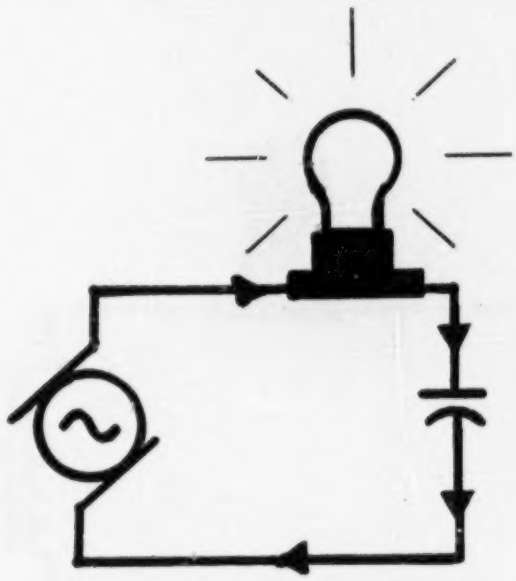

Fig.: XVIII-1-4

The capacitor does not allow all of the a.c. through. It has an impeding force — a holding-back force — which varies in strength according to the value of the capacitance and the frequency of the a.c. This reactance is called capacitive reactance and is designated "X_C."

Let's study the diagram shown below. If there is no d.c. resistance in the coil, it will offer no opposition to the flow of d.c. coming from the battery.

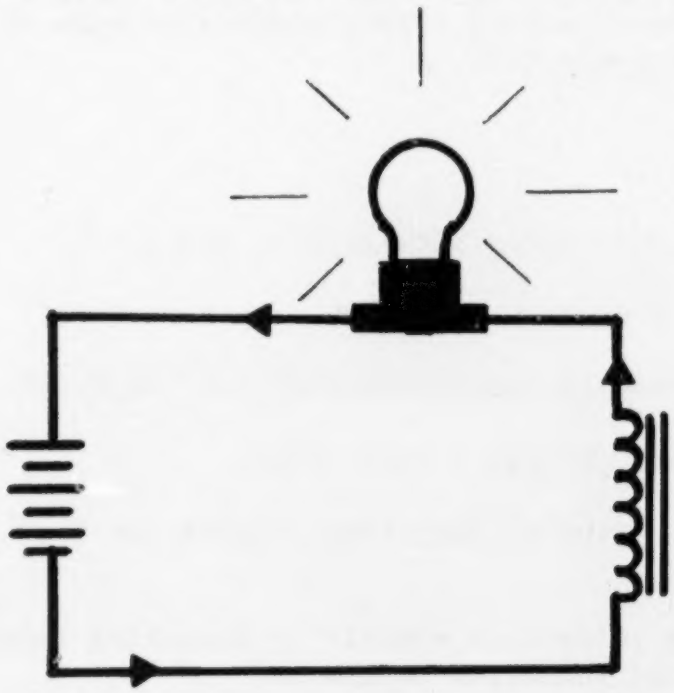

Fig.: XVIII-1-5

If, however, a source of a.c. replaces the battery, this a.c. will find an impeding force in the coil which will tend to hold it back.

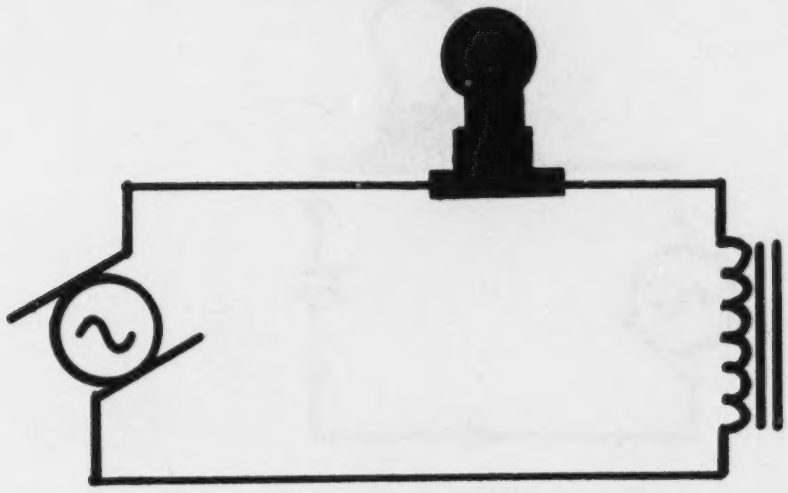

Fig.: XVIII-1-6

The impeding force which holds back the flow of a.c. is known as inductive reactance (X_L). The strength of this reactance will be governed by the inductance in the coil <u>and</u> the frequency of the alternating current.

In a-c circuits, we may be faced with these opposing forces - capacitive reactance (X_C), inductive reactance (X_L), and also resistance (R). These opposing forces combine to make up a resistance force known as <u>impedance</u> (Z).

ASSIGNMENT:

1. What is the difference between a.c. and d.c.?

2. What is the frequency of ordinary house current?

3. Does an automobile battery furnish a.c. or d.c.?

4. Will a.c. pass through a capacitor?

5. Will a coil having no resistance oppose the flow of alternating current?

6. What are the letters or symbols representing impedance, capacitive reactance, and inductive reactance?

7. What is the effect of inductive reactance on the flow of direct current?

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UNIT XVIII - ALTERNATING CURRENT

Lesson No. 2 Generation of AC

You remember that if a conductor moves between the north and south poles of a magnet, cutting the lines of magnetic flux, a current is made to flow in that conductor if it is in the form of a loop; and the direction of this current-flow is determined by the direction the conductor is moving through the magnetic lines. You should also remember that the number of lines being cut in a certain time (a unit of time) determines the amount of e.m.f. generated. The stronger the magnet (the more lines of flux), the greater will be the voltage.

Look at Figure 1 below. It shows in a simplified form how an alternating current is generated by the movement of a coil of wire. The positions (A) through (E) show the position of a loop of wire (which is going to carry off the current produced) in relation to the poles of a magnet. The curved line below is a graph of the e.m.f. produced by one complete rotation of the loop. One complete rotation is 360°; a half rotation is 180°.

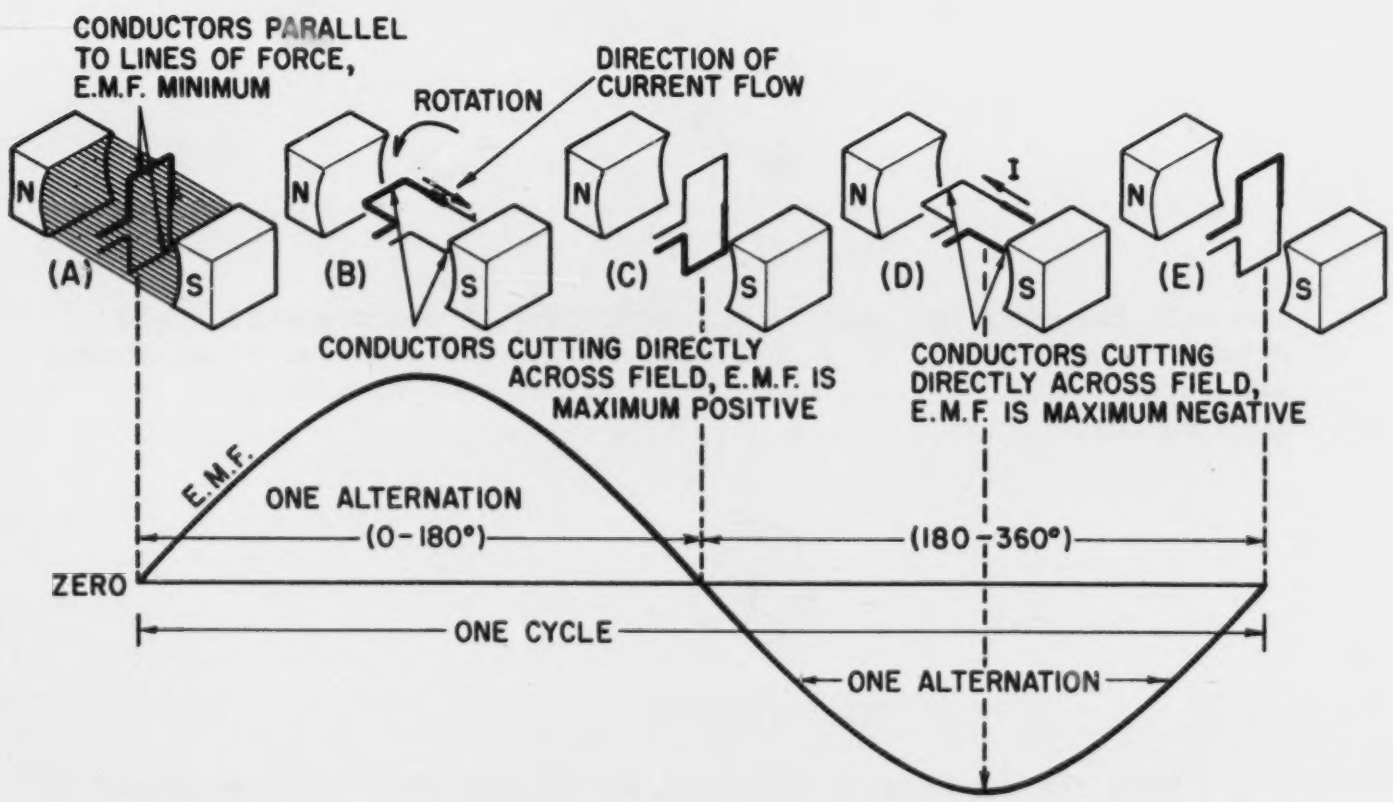

Basic alternating-current generator.

Fig.: XVIII-2-1

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRICAL SYSTEM

MILESTONE: III IGNITION SYSTEM - SECONDARY WIRING

PERFORMANCE OBJECTIVE NO: 3 TITLE: Remove and Replace Secondary Wiring (Cont.)

CONDITIONS:

LEARN	REFERENCE	SOURCE
5. "Spark Plug Service"	5. Continuous film loop # 8357	5. Resource Materials Center
6. Spark Plugs	6. Automotive Electrical Equipment, by Crouse. p. 413, pp. 453 through 456 Automotive Electrical Equipment Workbook, by Crouse. Job 43	6. Related Information Class
7. Ignition Coils, Secondary Wiring, and Spark Plugs	7. Ignition Systems, by Ford Motor Co. pp. 12 through 39 and 85 through 97	7. Programmed Instruction Class
8. Coil Construction	8. Delco-Remy Training Aid	8. Shop Library
9. Locating Ignition Malfunctions	9. Ignition Simulator in conjunction with Sun Ignition Tester. Sun Manual	9. Shop

If you will look at position A in the figure, you will be able to tell that the conducting loop is cutting no lines at that position. The movement of the conductors is practically parallel with the lines. When the conductors are at the position B or D, they are cutting more lines in a unit of time than they would be cutting at any other position.

Now, bearing in mind that the conductors are rotating at an even speed, think how many lines they would be cutting when at a position halfway between A and B. Concentrate on this until you fully understand why the current or voltage would be higher at B than at C or E. Make sure that you understand this. Your shop instructor will explain it to you more than once, if necessary, because he knows that this is a basic idea that you must understand before you can proceed to an understanding of alternating current.

You understand how the current increases and decreases, or how the voltage rises and falls according to the position of the conductors in the magnetic field of an a-c generator. The next thing that you need to understand is how the current alternates its direction — that is, goes one way and then back the other way. Let's look at the heavy-lined part of the conductor in Figure B. The arrow indicates that this portion of the loop is moving down through the lines of flux. Now, if you remember your lessons in MAGNETISM you can visualize the conductor wrapping the lines around it in this manner.

Fig.: XVLII-2-2

You will remember too that if the direction of the magnetic field around a conductor is in a counterclockwise direction as shown above, the current will be going away from you and will be indicated in this manner.

Fig.: XVIII-2-3

When the conductors come back up through the field, as shown in D, the current will be reversed, as shown. Now, if you will, in your imagination follow the heavy end of that coil as it rotates. You can understand how - looking into the end of the conductor - the current will go first in one direction and then in the other during one full rotation. This is one cycle - to an opposite condition and then back to the original.

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If the direction is changed, but does not come back to the original direction, that is an alternation. There are two alternations in each cycle in alternating current. There are 120 alternations per second in 60-cycle current.

Notice the form of the curve in Figure XVIII-2-1. It is called a sine curve or sine wave (from the "sine" of an angle, in trigonometry). You will come across this form of curve many, many times in your study of electricity. In this case it shows how the e.m.f. varies as the coil turns through a right angle (90°), a straight angle (180°) and back to the original position (360°).

ASSIGNMENT:

1. Draw the symbol used for an a.c. supply of e.m.f. Tell what the curve in it means.

2. The conductor shown in the diagrams below represents a single turn of an armature winding.

Observe the position of the armature winding as it is in the magnetic field, and match armature position to the instantaneous value on the sine wave (the correct number on the curve).

A ___ B ___ C ___ D ___

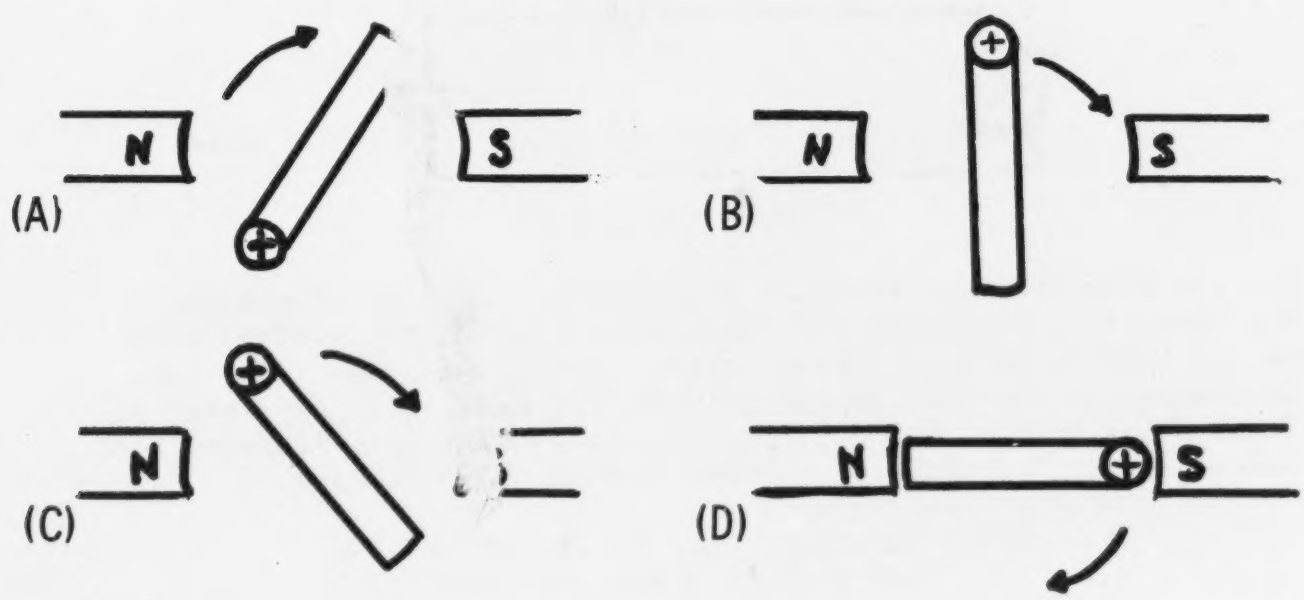

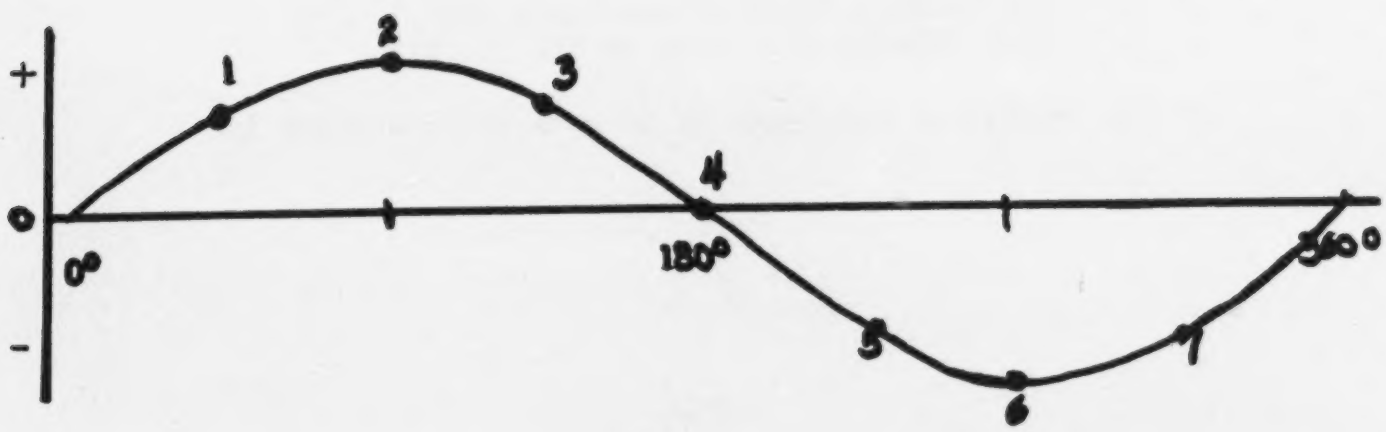

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UNIT XVIII - ALTERNATING CURRENT

Lesson No. 3 Reactance and Impedance

In the first lesson in this unit you learned that there are "holding back" forces in a-c circuits other than just resistance. You learned that a coil can resist a.c., yet it will permit d.c. to pass. You also learned that d.c. will not pass through a capacitor while an alternating current seems to pass through it. These forces are called reactances. Reactance is indicated by the letter "X". The subscripts "C" and "L" indicate whether the reactance is capacitive or inductive. X_C stands for that force in a capacitor which tends to hold back some of the flow of a.c. X_L stands for that force in an inductor which tends to hold back some of the flow of a.c. The relationship of those forces to one another is one of the interesting aspects in the study of alternating current.

You may have a circuit like this

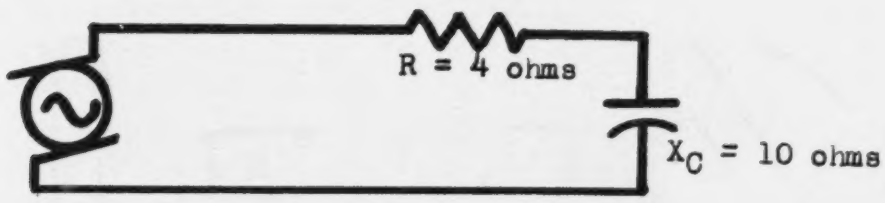

Fig.: XVIII-3-1

and you know that the resistor will lessen the value of current. You know, too, that when the capacitor is added, the current will be cut down to an even smaller value. The interesting fact, now, is that it is possible to add another component which one would at first think would cut the current even more, and this component (an inductor) can increase the current instead of decreasing it.

IT IS IMPORTANT THAT YOU DO NOT GET THE IDEA THAT THIS IS ALWAYS THE CASE. IT IS ONLY WHEN THE INDUCTOR CAN REDUCE THE OVERALL VALUE OF REACTANCE THAT MORE CURRENT WILL FLOW IN THE CIRCUIT.

If the capacitive reactance is 10 ohms and you place an

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inductor with 13 ohms inductive reactance in series with the circuit like this,

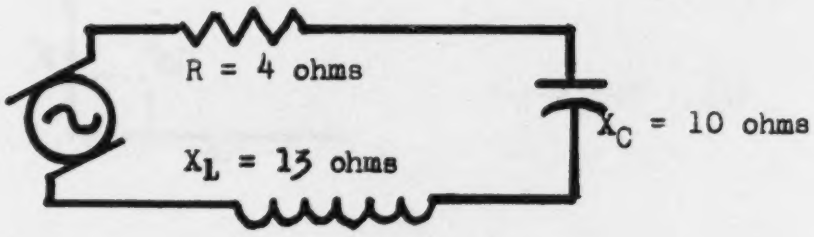

Fig.: XVIII-3-2

the two reactances "buck" each other and leave the circuit with an overall reactance of 3 ohms. So far as the passage of total current goes, the circuit will "look like this" to the current.

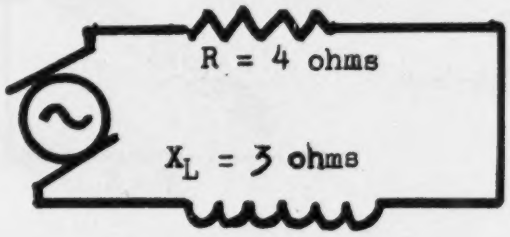

Fig.: XVIII-3-3

This is because inductive reactance and capacitive reactance are one half-cycle (180°) out of phase with each other. Inductive reactance and capacitive reactance in series affect one another like this:

(a) A capacitive reactance of 2 ohms in series with an inductive reactance of 9 ohms results in an inductive reactance of 7 ohms.

(b) A capacitive reactance of 9 ohms in series with an inductive reactance of 5 ohms results in a capacitive reactance of 4 ohms.

(c) A capacitive reactance of 4 ohms in series with an inductive reactance of 4 ohms cancel each other and leave the circuit with no reactance at all. It is as if neither were in the circuit.

Opposing forces (180° out of phase) pull against one another like this

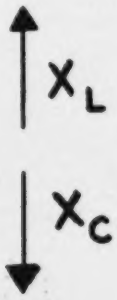

Fig.: XVIII-3-4

Reactance is also 90° out of phase with resistance. They oppose one another like this

Fig.: XVIII-3-5

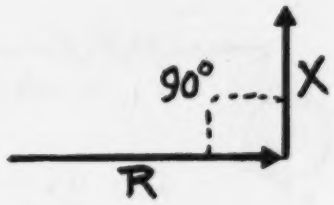

If a circuit has 4 ohms of resistance and 3 ohms of inductive reactance, these quantities may be shown graphically like this

Fig.: XVIII-3-6

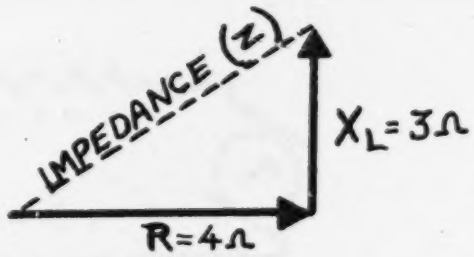

When the reactance is placed at the end of the line representing resistance in such a way as to make a right angle (90°), a right triangle may be formed by closing it in with the hypotenuse. The value of the hypotenuse will be the value of the impedance (Z). All of the forces which tend to hold back alternating current go to make up impedance in this manner.

Just in case some of you have forgotten how to find the value of the hypotenuse of a right triangle, let's go through one. Suppose a circuit has 4 ohms of inductive reactance and has 3 ohms of resistance. What is the value of the impedance?

$$Z = \sqrt{R^2 + X^2} = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5 \text{ ohms}$$

If there is more than one inductive reactance (X_L) or capacitive reactance (X_C), the like reactances can be added before calculating the impedance. That is, X_L can first be added to any other X_L's or X_C can first be added to any other X_C's.

SP 15243

ASSIGNMENT:

1. Find the value of the hypotenuse in each of the following triangles.

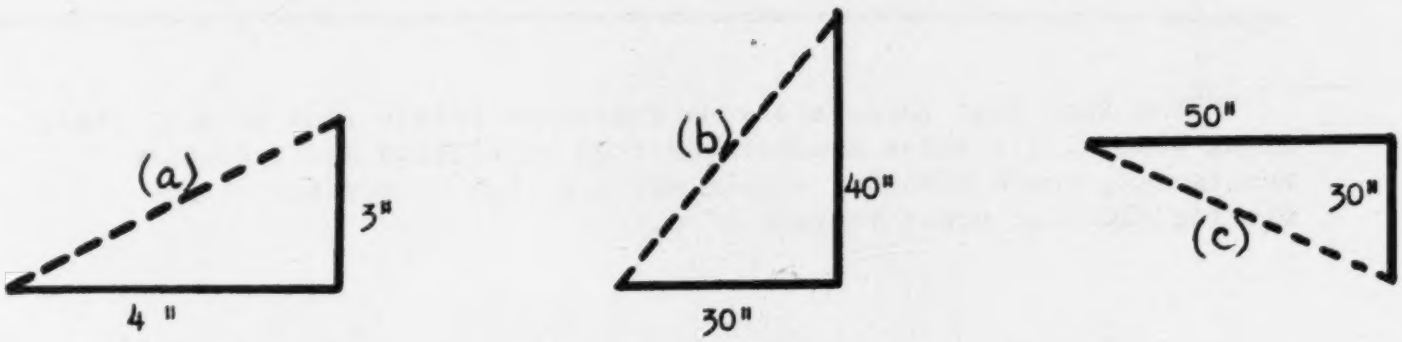

2. If a circuit has a capacitor which produces 15 ohms of capacitive reactance in series with 8 ohms of inductive reactance, what is the overall reactance? Is it capacitive or inductive?

3. Suppose the circuit in No.2 has a 10-ohm resistor added in series with it, what will be the value of the impedance of the circuit?

UNIT XVIII - ALTERNATING CURRENT

Lesson No. 4 AC Power Transmission

The fact that there are some radiation losses from an a.c. line, along with difficulties encountered from capacitive and inductive reactances, could make one wonder why d.c. isn't used for transmitting electric power instead of a.c.

If it were not for the fact that it is so easy to step up a.c. to high-voltage levels by means of transformers and then back down again, we probably would have d.c. coming into our homes today. Thomas A. Edison was very much against a.c. power transmission when Nikola Tesla influenced the construction of the original power plant at Niagara Falls.

There was much indecision until Lord Kelvin was consulted. This great British scientist agreed with Tesla and George Westinghouse, and the plant was designed to produce alternating current for public consumption.

If you will examine a 5-ampere fuse and a 1-ampere fuse, you will see that the conductors in the 5-ampere fuse are considerably larger than in the 1-ampere fuse. Bear in mind that it takes a large conductor to carry high currents. You know that the formula for power is $P = I \times E$, that is

Power (in watts) = I (in amperes) X E (in volts).

Perhaps you can imagine how large the long-distance conductor would have to be in order to supply the power needed in even a small village if the line voltage were 110 volts instead of, say, 44,000 volts.

Remember, now, it is not commercially practical to alter d.c. in such a way as to make transformer action practical. So d.c. would have to be transmitted to the village at the voltage level at which it is to be used.*

---

*During the writing of this book, a power company in California was erecting a system for the transmission of high voltage d.c. with modern methods of converting to a.c. at the distribution points. They point out that in the long run, this cheaper due to the savings on insulators. As you know, a.c. needs insulation at its peak voltage, whereas d.c. needs insulation for only 70.7% of that value. The effective value of a.c. is only 0.707% times its peak value.

15245

EXAMPLE: Suppose there are 500 homes in a village, and each is burning ten 100-watt light bulbs and consuming another 1,000 watts in household appliances. This makes 2,000 watts of power being used in each house. If you multiply this by 500, you will see that the village is consuming 1,000,000 watts. Now, how many amperes of current from a 110-volt source would it take to produce a million watts?

If $P = I \times E$, then $I = \frac{P}{E}$

$$I = \frac{P}{E} = \frac{1,000,000}{110} = 9,100 \text{ amperes}$$

Now if the line voltage of the transmission line going into the village is 44,000 volts, how much current will the line have to carry?

$$I = \frac{P}{E} = \frac{1,000,000}{44,000} = 22.7 \text{ A}$$

There is a lot of difference between 22.7 amperes of current and 9,100 amperes of current! Again, look at the 5-ampere fuse and the 1-ampere fuse and again think how large the power transmission lines would have to be if they carried over 9,000 amperes of current.

Remember, in transmitting power - the higher the voltage, the lower the amperage may be to deliver the power.

ASSIGNMENT:

1. A transmission line carries power at 132,000 volts. How much current must it carry if it is supplying a community which is using 2.5 million watts of electric power?

2. A line carrying 15 amperes is supplying 3,300 watts of electric power. What is the voltage of this line?

3. Why is a.c. used instead of d.c. in the transmission of electric power?

UNIT XVIII - ALTERNATING CURRENT

Lesson No. 5 — Wavelength

"Wavelength" is a term you have probably heard for a long time. Perhaps you have formed ideas as to what wavelength really is. Let's see how close you have been to understanding wavelength.

First, let's remember that electricity and light travel at a speed of 300,000,000 meters per second (186,000 miles per second). Try to visualize a radio transmitter operating at a frequency of 30 megacycles - thirty million cycles per second.

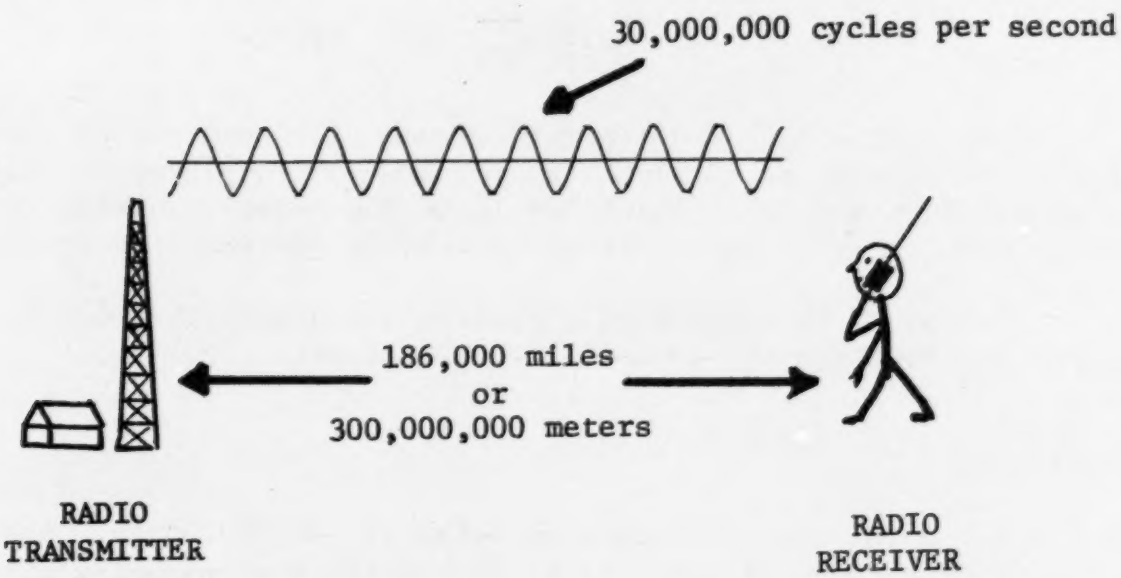

In one second the oscillator in the transmitter has changed the polarity of the voltage to the antenna from + to - and back to + 30,000,000 times! This being a radio frequency, the signals, when sent to a properly constructed antenna, will leave the antenna and radiate many miles through the air.

If there are 30 million oscillations per second between the transmitter and the receiver, then there must be a certain measurable distance between those oscillations.

If there are 30,000,000 in a distance of 300,000,000 meters, the distance between two peaks of the wave must be

$$\frac{300,\cancel{000},\cancel{000}}{30,\cancel{000},\cancel{000}} = 10 \text{ meters}$$

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The distance between two adjacent (next-to-each-other) peaks is called the wavelength. The symbol for wavelength is the Greek letter lambda (λ).

The formula for finding wavelength is

$$\lambda = \frac{300,000,000}{f}$$

where f = frequency in cycles per second.

EXAMPLE: What is the wavelength if the frequency is 30 megacycles?

$$\lambda = \frac{300,000,000}{f} = \frac{300,000,000}{30,000,000} = 10 \text{ meters}$$

Of course, the answer is in <u>meters</u> since the figure 300,000,000 is the distance given in meters per second.

Just in case you should ever forget the formula, you can always refresh your mind and check it by remembering that 30 megacycles is in the 10-meter amateur radio band.

If you are interested in amateur communications, you should also know that 50 megacycles is in the 6-meter band. Let's see if the formula proves that.

$$\lambda = \frac{300,000,000}{50,000,000} = 6 \text{ meters}$$

It is possible that sometimes you may know a wavelength and need to know the frequency. From algebra, you know that the formula is still true if you exchange λ with f.

$$\text{from} \quad \lambda = \frac{300,000,000}{f} \quad \text{to} \quad f = \frac{300,000,000}{\lambda}$$

Let's go back to the 6-meter example and see if 50 megacycles falls into the 6-meter band.

$$f = \frac{300,000,000}{\lambda} = \frac{300,000,000}{6} = 50,000,000 \text{ cycles per second}$$

While talking about frequency and wavelength, perhaps now would be a good time to know which are the VHF (very high frequency) bands and which are the UHF (ultra high frequency) bands.

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RELATED INSTRUCTION

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRICAL SYSTEM

MILESTONE: III IGNITION SYSTEM - SECONDARY WIRING

PERFORMANCE OBJECTIVE NO: 3 TITLE: Remove and Replace Secondary Wiring

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Determining firing sequences	1.	1. Shop Instructor
2. Secondary wiring	2. Automotive Electrical Equipment, by Crouse, pp. 413 and 414 Automotive Electrical Equipment Workbook, by Crouse, Job 39	2. Related Information Class
3. Coils	3. Automotive Electrical Equipment, by Crouse, pp. 405 through 413 Automotive Electrical Equipment Workbook, by Crouse, Job 40	3. Related Information Class
4. "Installing Spark Plug Wire Terminals"	4. Continuous film loop # 8377	4. Resouce Materials Center

The FCC (Federal Communications Commission) has classified them as follows:

Frequency	Classification	Abbreviation
10 to 30 kc.	Very low frequencies	v.l.f.
30 to 300 kc.	Low frequencies	l.f.
300 to 3000 kc.	Medium frequencies	m.f.
3 to 30 Mc.	High frequencies	h.f.
30 to 300 Mc.	Very high frequencies	v.h.f.
300 to 3000 Mc.	Ultrahigh frequencies	u.h.f.
3000 to 30,000 Mc.	Superhigh frequencies	s.h.f.

What are microwaves? "Micro," as you know, is used for something very, very small. The term microwave is rather loosely used. It is applied to those wavelengths that have frequencies above 1,000 megacycles. So, actually, the upper half of the UHF range could be called microwaves. The actual UHF television frequencies do not quite fall into the microwave classification, however, because the top UHF television frequency is 890 megacycles.

ASSIGNMENT:

1. If a transmitter is operating at a frequency of 1500 kc., what is the wavelength of its signal?

2. What is the frequency of a 40-meter signal?

3. What are microwaves?

4. If a transmitter is operating at 40 Mc., is it in the medium, high, veryhigh or ultrahigh frequencies?

5. What is wavelength?

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UNIT XIX - EFFECTS OF CAPACITANCE AND INDUCTANCE

Lesson No. 1 — Capacitors

To understand a capacitor, it is best to look at one in its simplest form - nothing but two metal plates separated by a thin layer of material called a dielectric.

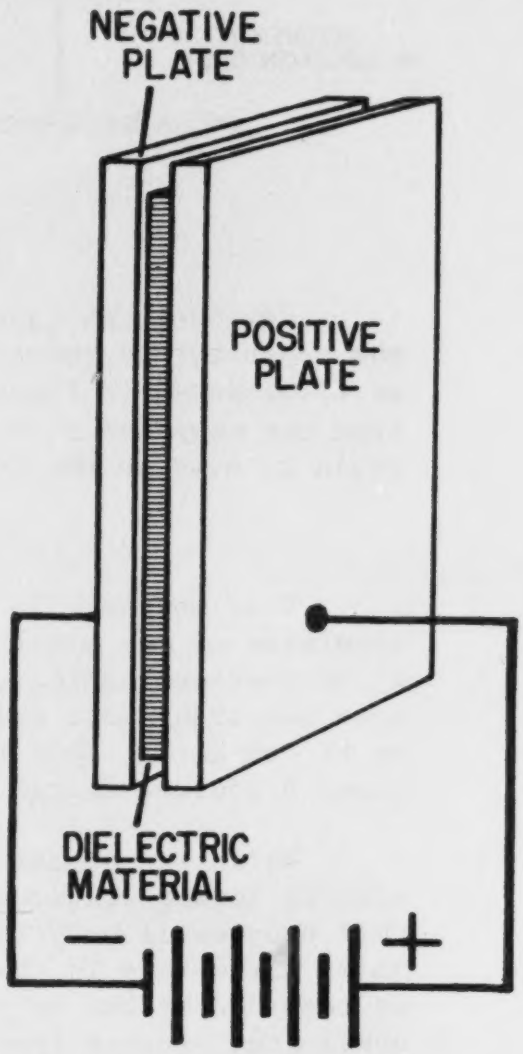

Fig.: XIX-1-1 Simple capacitor.

The dielectric can be any of many types of insulating material, including air. Whatever the composition of the dielectric, it must prevent electrons from moving through the capacitor at the rated voltage. The dielectric determines the rated voltage of a capacitor. As the capacitor is charged, the two opposite charges on the plates distort the electron orbits of the dielectric. When the charge is great enough, it will remove one or more electrons from atoms of the dielectric and cause a weak spot, if not a hole. The capacitor then leaks - and must be replaced. This is why we must never use a capacitor above its rated voltage.

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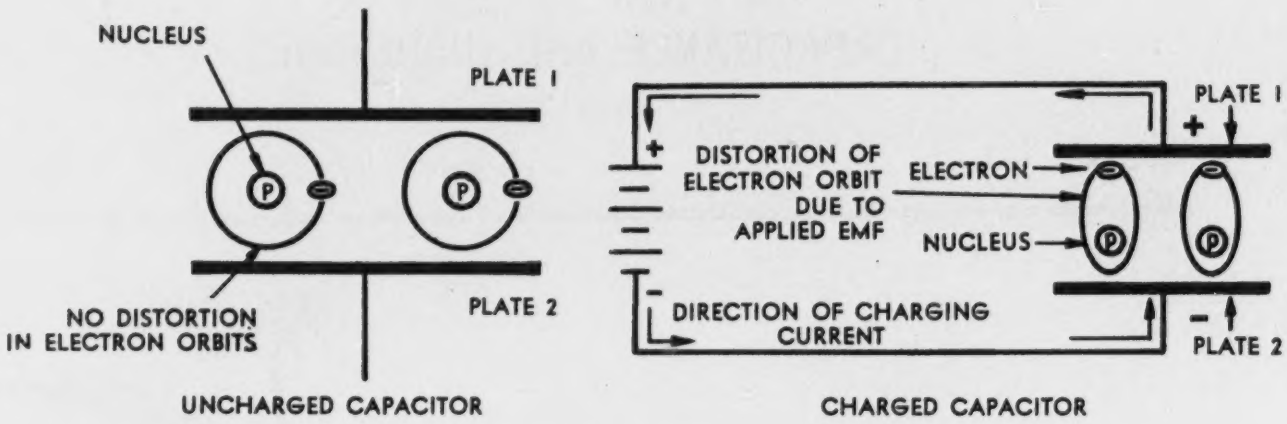

Fig.: XIX-1-2

How does the capacitor work? When the capacitor is connected in a circuit, as illustrated in Figure 3, the electrons from the negative side of the power supply begin to move to the negative plate.

Fig.: XIX-1-3

This movement is almost immediately retarded by the mutual repulsion of the electrons on the plate. The charging continues at an ever-decreasing rate until the applied e.m.f. can no longer move electrons onto the plate. The capacitor is then as charged as it can get at that voltage. An increased e.m.f. (voltage) could cause a greater charge.

While the negative side is gaining electrons, the positive side is losing electrons to the positive side of the power supply. This process is much the same as that on the negative plate. The major difference is that on the positive plate the loss of electrons is retarded by the increasing positive charge due to more and more unbalanced protons (positive charges), rather than more and more unbalanced electrons.

You could now remove the capacitor from the circuit and you would remove the charge with it. The capacitor could be discharged, causing a current to flow until the capacitor was fully discharged.

How quickly can a capacitor charge? This depends upon the size of the capacitor and the circuit, but most capacitors charge in extremely small fractions of a second. The larger the capacitor, the longer it takes to charge in any given circuit.

The charging of a capacitor involves a transfer of current. At the instant a capacitor is connected into the circuit, it has practically no resistance. At that instant we could apply Ohm's law

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to the rest of the circuit and determine the current flow. As soon as the electrons begin to charge the capacitor, however, its resistance increases. This resistance increases sharply as the capacitor first charges, and the increase tapers off toward the end of the charge period. The rate of resistance increase is termed exponential (logarithmic). Thus, whenever we have a capacitor in a circuit, it will tend to make the current follow an exponential waveform, with a constant decrease until the current is zero when the capacitor is fully charged. Figure 4 is a graph showing how the charging affects various important characteristics.

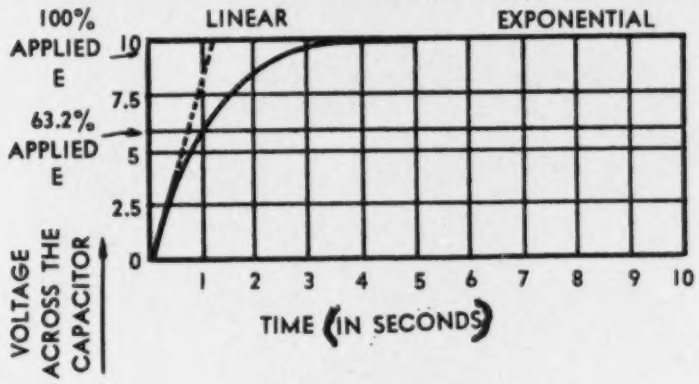

Rise of Voltage in a Practical Capacitor
Fig.: XIX-1-4

When a capacitor is discharged, the process is just the reverse, as shown in Figure 5.

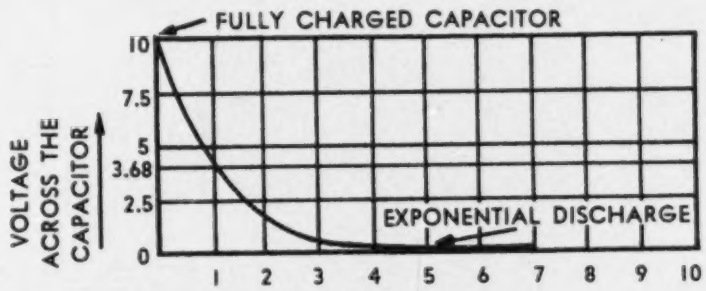

Fig.: XIX-1-5

The charge-discharge-rate characteristic is very important. In many applications capacitors are used to make time-constant circuits. You can see why it is important that we know the time constant. It is also important to remember that increased circuit resistance can increase the time constant. Increased circuit resistance, of course, decreases the applied e.m.f. across the capacitor. Without further discussion at this point, also remember that a.c. is a constantly changing applied e.m.f.

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ASSIGNMENT:

1. What does a capacitor do?

2. What is a dielectric?

3. What happens to the atoms in the dielectric when a capacitor takes on a charge?

4. Does a capacitor charge at a linear rate?

5. Explain the difference between a linear rate of change and an exponential rate of change.

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UNIT XIX - EFFECTS OF CAPACITANCE AND INDUCTANCE

Lesson No. 2 — Units and Behavior

Like almost everything else, there is a need for some way of measuring capacitance. Before learning how capacitance is measured, though, let us find out what a coulomb is. A coulomb is a unit of charge. Actually, an absolute coulomb is defined as "the amount of electrical charge which crosses a surface in one second if a steady current of one absolute ampere is flowing across the surface." The unit of capacitance is called the farad in honor of Michael Faraday. It is the amount of capacitance which permits a capacitor to take on a charge of one coulomb when one volt is applied.

The farad is a very large unit - much larger than we normally encounter. The values we work with are much smaller. They are usually on the order of millionths of farads, or millionths of millionths. You have heard the term microfarad. It is 1/1,000,000 or 1×10^{-6} farad. Perhaps you have also heard of the micro-microfarad. It is one millionth of one millionth or 1×10^{-12} farad, often written as 1 μμf and sometimes called the picofarad.

1 farad = 10^6 microfarads
1 farad = 10^{12} micro-microfarads
1 microfarad = 10^{-6} farad
1 micro-microfarad = 10^{-12} farad

Fig.: XIX-2-1

Study this table and learn the different ways of noting capacitance values and their relationships to each other.

The values of ceramic, mica, and paper capacitors are often shown in color-code. The colors represent the same numbers that they do on resistors. There are several methods of placing these colors on capacitors, however. Some are given in Figure 2.

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CAPACITANCE

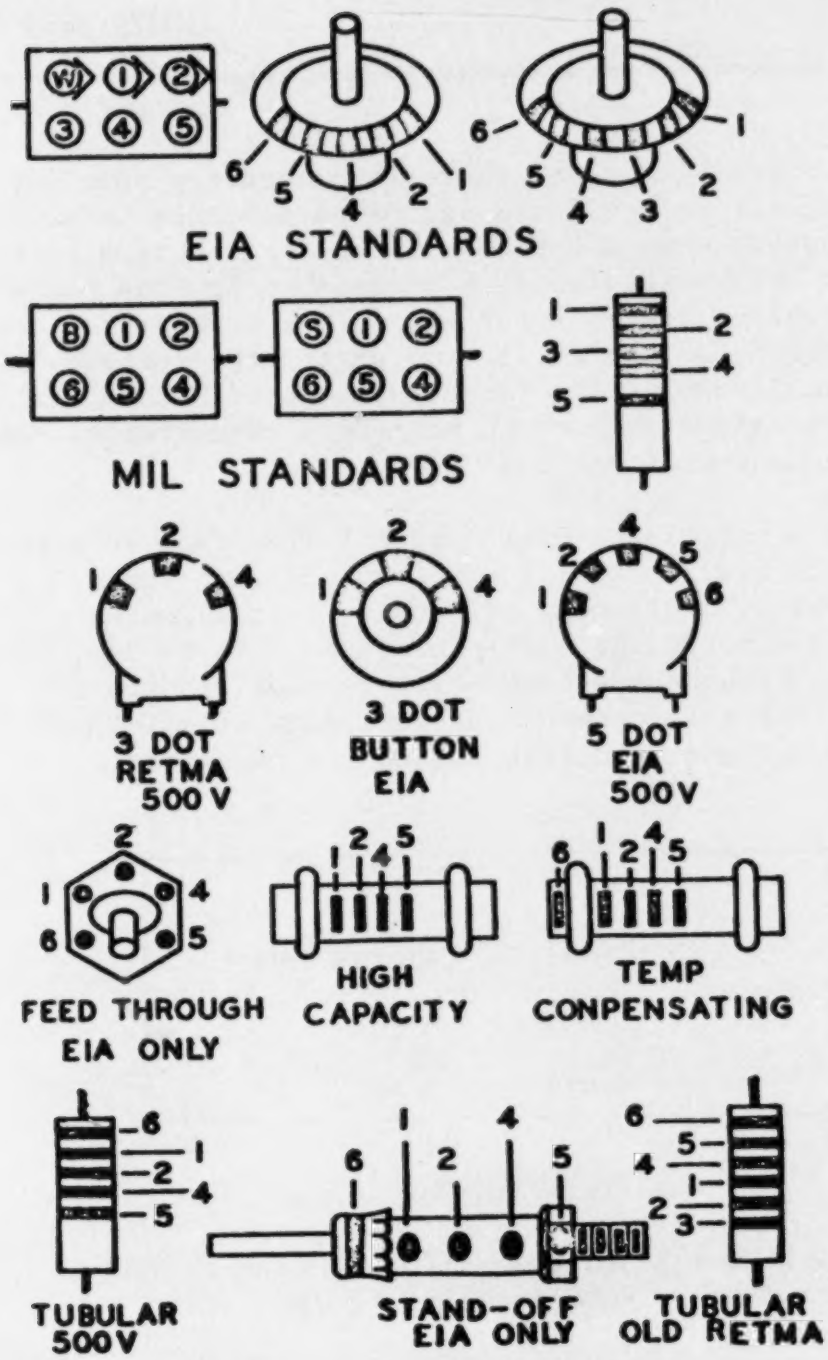

W = WHITE MEANS MICA EIA ONLY

B = BLACK MEANS MICA MIL ONLY

S = SILVER MEANS PAPER

1 = FIRST DIGIT

2 = SECOND DIGIT

3 = THIRD DIGIT

4 = MULTIPLIER

5 = TOLERANCE

6 = CHARACTERISTIC

VOLTAGE RATING IS INDICATED BY DIMENSION RATHER THAN COLOR CODE

Fig.: XIX-2-2

It is said that capacitors "pass" a.c. This is actually what happens:

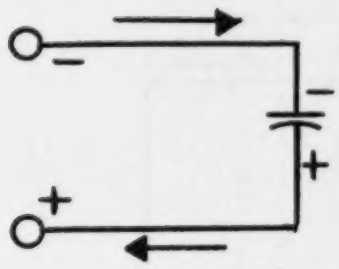

The capacitor charges as shown here when a voltage is applied.

Fig.: XIX-2-3

When the applied voltage reverses polarity, the capacitor discharges the charge just taken on and becomes charged with reversed polarity.

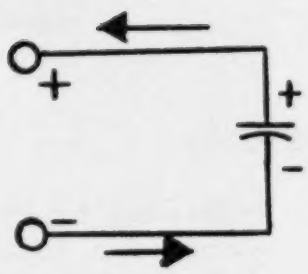

Fig.: XIX-2-4

At the beginning of each alternation, the capacitor charges, and there is current in the circuit during this time. When the input polarity reverses, the capacitor will discharge, causing current to flow in the opposite direction. This goes on and on - back and forth - but the current never really goes through the capacitor. Even though the current does not go through it, the effect is the same, since there is a flow of alternating current in the circuit. So you can say that a.c. effectively passes through a capacitor.

Let's review:

1. A microfarad is one one-millionth of a farad. The Greek letter mu (μ), meaning in electronics one one-millionth or 1×10^{-6} is often used like this — 1 μf. 1 μf = 1 microfarad.

2. One micro-microfarad is one millionth of a millionth of a farad. It may also be noted as 1 μμf or 1×10^{-12} farads. A micro-microfarad is also called a picofarad.

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Color	1st Digit	2nd Digit	Multiplier	Tolerance (Percent)
Black	0	0	1	
Brown	1	1	10	
Red	2	2	100	
Orange	3	3	1,000	
Yellow	4	4	10,000	
Green	5	5	100,000	
Blue	6	6	1,000,000	
Violet	7	7	10,000,000	
Gray	8	8	100,000,000	
White	9	9	1,000,000,000	
Gold			.1	5
Silver			.01	10
No Color				20

Resistor Color - Code Table

ASSIGNMENT:

1. Referring to the capacitance color chart, what would be the value of a mica-type capacitor if the colors are WHITE RED GREEN ORANGE BROWN SILVER?

   (HINT: Do not worry about characteristics. They aren't used enough for you to consider them at this time. They are used in military electronics, generally, to designate test methods and sometimes temperature coefficients.)

2. Referring to the capacitance color chart, what would be the value of a capacitor (also mica) if the colors are BLACK YELLOW GREEN BLACK GOLD BROWN?

3. How many microfarads are 35,000 micro-microfarads?

4. How many μμf are 100 μf?

5. What is a picofarad?

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UNIT XIX - EFFECTS OF CAPACITANCE AND INDUCTANCE

Lesson No. 3 — Capacitive Reactance

Capacitors, as you know, effectively pass a.c., but there can be a "holding back" force which will lessen the flow of a.c. This "holding back" force in a capacitor is called capacitive reactance. It is noted as (X_C). The letter "X" stands for reactance. The subscript "C" stands for capacitance. So X_C stands for reactance found in capacitance.

The higher the frequency of the applied voltage (that is, the faster it changes from positive to negative and then back), the easier it is for a.c. to effectively pass through the capacitor. Also, the higher the value of capacitance, the easier it will be for the alternating current to pass.

We must remember now that high currents can pass only when there is small reactance.

Since reactance is a "holding back" force, a resistance, it is measured in ohms.

The formula for finding capacitive reactance is

$$X_C = \frac{1}{2\pi f C}$$

π = 3.14, and C = number of cycles

EXAMPLE: Suppose there is a 1 μf capacitor in series with a 60-cycle a.c. circuit. What is the value of the capacitive reactance?

$$X_C = \frac{1}{2\pi f C} = \frac{1}{6.28 \times 60 \times 1 \times 10^{-6}} \overset{*}{=} \frac{1 \times 10^{6}}{377}$$

$$= 377\overline{)1{,}000{,}000}^{\,2{,}653} = 2{,}653 \text{ ohms}$$

* Remember, when you carry powers of ten across the fraction bar, the sign of the exponent changes. Thus, when the 10^{-6} was carried up to the top, the numerator became 1×10^{6} or 1,000,000.

Let's assume that the frequency is double that in the problem we just worked. How would doubling the frequency affect the capacitive reactance?

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SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: III. IGNITION SYSTEM - SECONDARY WIRING

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove, Test, and Replace Secondary Wiring

CONDITIONS:

This assignment will be performed on a complete automobile.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective cover on seat of automobile
2. Move automobile into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper manuals and turn to appropiate chapter
6. Select proper tools and materials
7. Disconnect battery ground cable
8. Remove air breather assembly
9. Mark #1 spark plug wire terminal in distributor cap
10. Unsnap the two retainer clips and lift distributor cap free of distributor
11. Remove secondary coil wire from center of coil
12. Remove secondary wire from spark plugs
13. Remove clamps holding secondary wires to engine
14. Lift distributor cap and secondary wiring assembly from engine

PERFORMANCE CRITERIA:

$$X_C = \frac{1}{2\pi f C} = \frac{1}{6.28 \times 120 \times 1 \times 10^{-6}} = \frac{1{,}000{,}000}{753}$$

$$= 753\overline{)1{,}000{,}000}^{\,1{,}328} = 1{,}328 \text{ ohms}$$

NOTE: When we doubled the frequency, we halved the capacitive reactance.

Since X_C becomes less when either the frequency or the capacitance increases, the capacitive reactance is said to be <u>inversely proportional</u> to the value of capacitance or of frequency.

ASSIGNMENT:

Solve for the value of capacitive reactance in each of the following circuits.

A

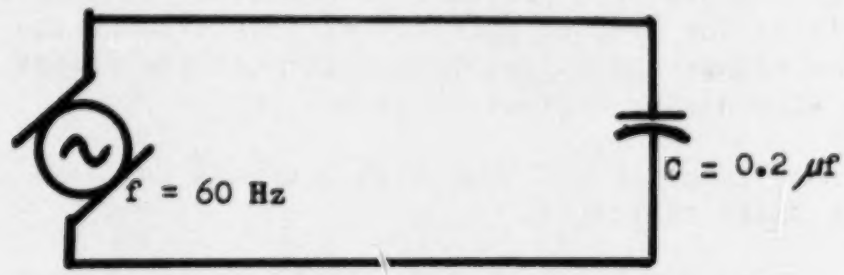

B

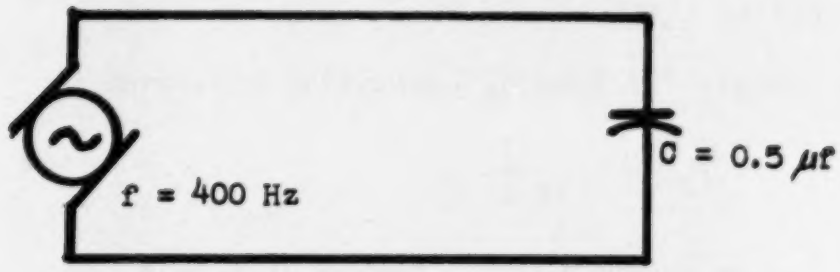

C

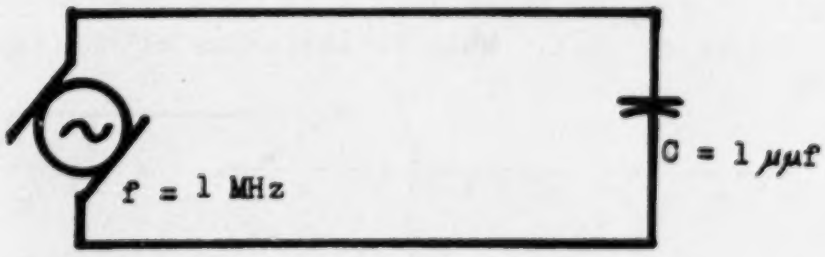

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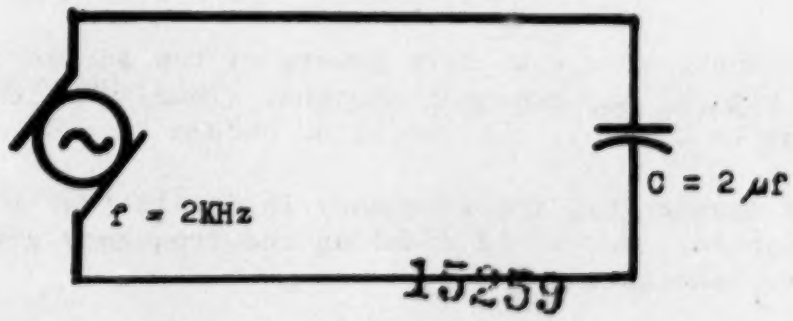

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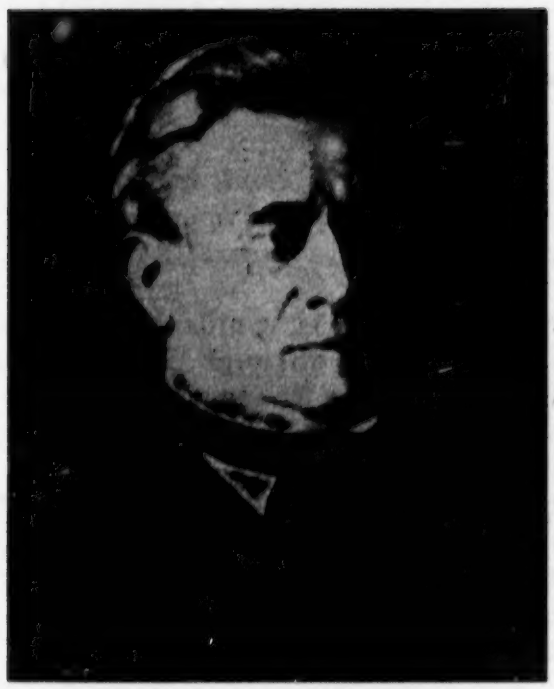

Joseph Henry (1797-1878)

Joseph Henry was born in Albany, N. Y. in 1797. (This was not too long after our nation became independent). He attended a country school, and later attended the Albany Academy. Being very interested in electricity, he spent most of his time in the study of its action. His experiments and discoveries formed the basis for the development of the telegraph, telephone, radio, and the electric motor. He was the discoverer of self-induction in electrical conductors. He later became professor of natural philosophy at Princeton University, and in 1842 Congress appointed him to be the first secretary of the Smithsonian Institution. He founded the U. S. Weather Bureau - one of the many scientific advancements he inaugurated for our country. He was considered the leading American physicist of his time. The unit of inductance is named in his honor.

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UNIT XIX - EFFECTS OF CAPACITANCE AND INDUCTANCE

Lesson No. 4 Inductance

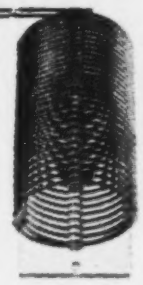

An inductor is nothing but a coil of wire. These coils come in many sizes and shapes, as you can see from the pictures on this page.

What does an inductor do? It tends to oppose any change in the current going through it. At any instant that the current flowing in an inductor is increasing in value, the inductance will be tending to hold back that current. If at any instant the current happens to be decreasing in value, the inductance will tend to increase the current. This is in accordance with Lenz's law. Lenz's law states that an induced magnetic field will be in such direction as to oppose the inducing field.

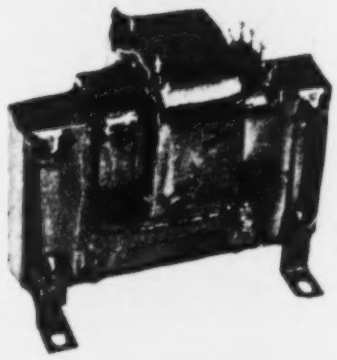

If a battery is connected to a lamp through long straight wires, the lamp will immediately light. There will be no lag in the current. If an inductor is placed in series with the lamp - of if the line is wound in enough turns - the lamp will take some time in reaching its full brilliancy. This is due to back e.m.f. or the effect of induction. Back e.m.f. is caused by the fact that each turn in a coil induces a voltage in its neighboring turns, which will cause a current in direct opposition to that coming from the source voltage. This is called <u>self-induction</u>.

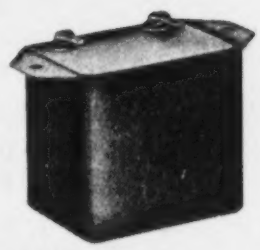

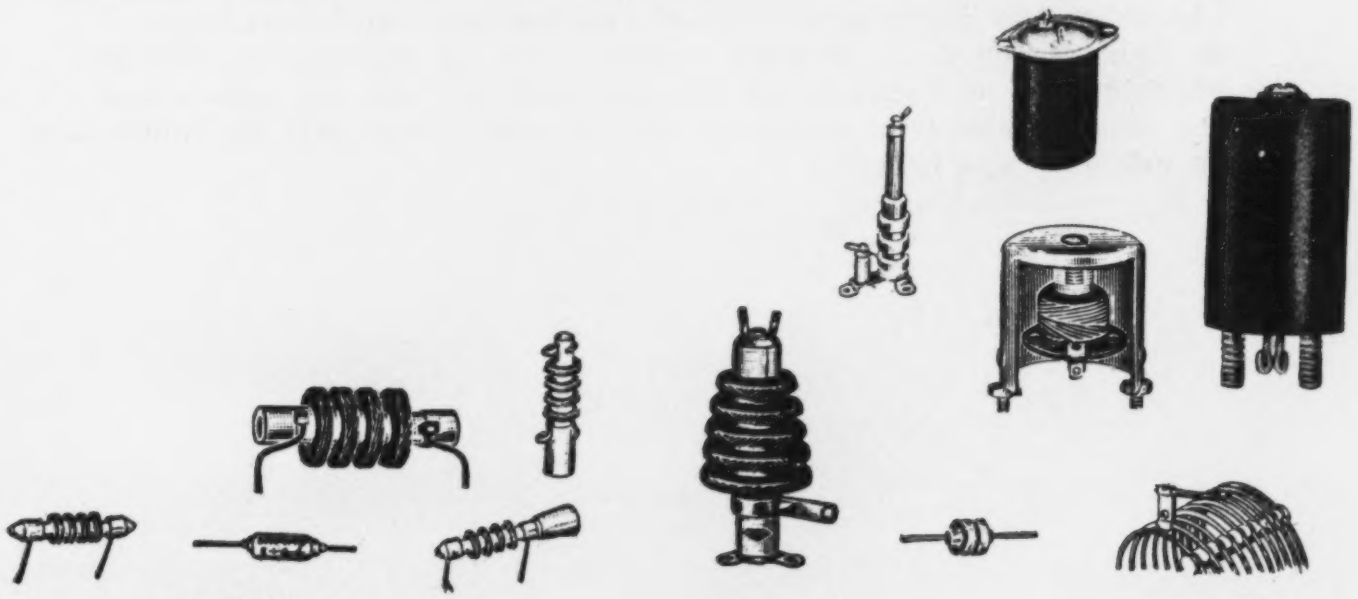

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Fig.: XIX-4-1

Joseph Henry, the American physicist, and the English scientist Michael Faraday were both working with coils at the same time. Henry demonstrated back e.m.f. from self-induction. We can demonstrate it in the following manner.

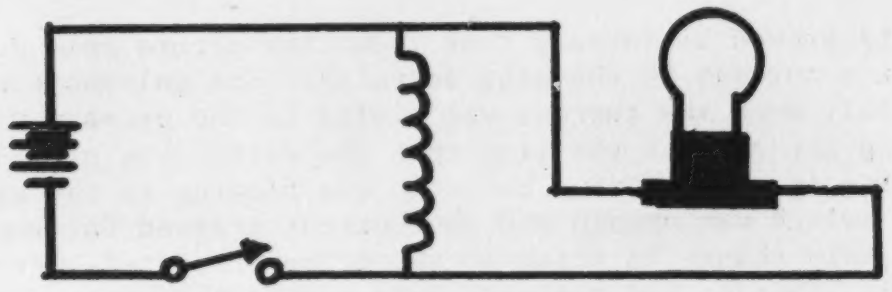

Fig.: XIX-4-2

When the switch is closed, the light flashes brightly for just an instant and then grows dim. When the switch is opened, the lamp goes out, but before going out it again gives a bright flash.

When the switch was closed, back e.m.f. prevented the current from reaching a maximum through the coil; but when the back e.m.f. ceased, the coil then relieved the lamp of some of its current. This is why the lamp grew dim. When the switch was opened, cutting off the current from the battery, the collapsing field in the inductor induced an e.m.f., and the current from this self-induced e.m.f. discharged through the lamp, bringing it again to maximum brilliancy.

Faraday was early in reporting his findings. He made some of them known to the scientific world through his report to the Royal Society in 1831. One of his most outstanding experiments was the one where he wrapped two closely-wound coils around a wooden core, connecting a battery and a galvanometer in the following manner.

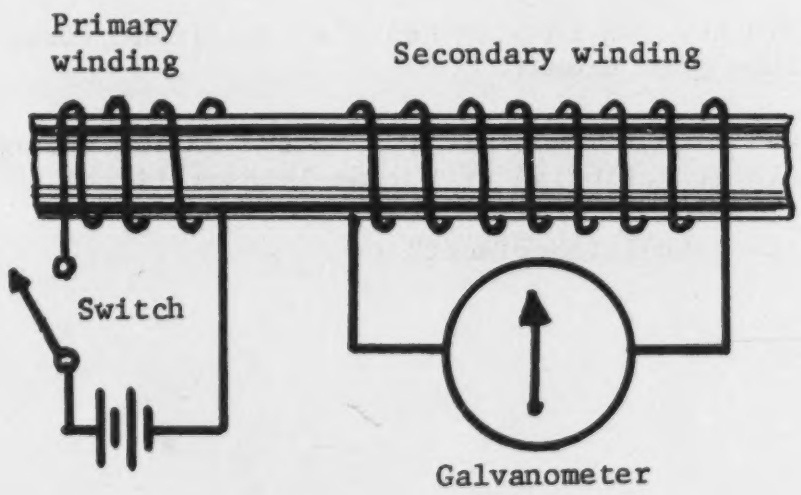

Fig.: XIX-4-3

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When he closed the switch, the needle would indicate a current-flow in one direction. When he opened the switch, the needle would show a momentary flow of current in the opposite direction. Once the switch was closed, and after the galvanometer had indicated a flow of current for just an instant, no more current was indicated in the secondary coil.

This proved to Faraday that induction occurs only during the time that a current is changing in value. The galvanometer indicated current only when the current was rising in the primary winding. All during the rest of the time that the switch was closed, current was flowing in the primary, but none was flowing in the secondary. When the switch was opened and the current started falling in the primary, this change in value in the primary induced current into the secondary. Faraday had not only proven that induction occurs only during a change in amplitude of a current, but here he had demonstrated mutual inductance. Mutual inductance occurs when the expanding and collapsing field of one coil is close enough to an entirely separate coil to induce electrical energy into that coil.

When Faraday reported this to the Royal Society, he probably did not know that this would lead not only to big factories making transformers (which this really was), but also to the transmission of electromagnetic waves through the air, making possible that which we call radio.

ASSIGNMENT:

1. Give as many reasons as you can as to why inductors are manufactured in so many shapes and sizes.

2. Who was Michael Faraday?

3. Who was Joseph Henry?

4. Explain why the lamp in Henry's experiment first lit brightly and then grew dimmer.

5. Why did it not immediately go out when the switch was opened? Why did it get brighter for an instant first?

6. What is mutual inductance?

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UNIT XIX - EFFECTS OF CAPACITANCE AND INDUCTANCE

Lesson No. 5 R-L Time Constants

The current flowing through a coil does not immediately reach full value when a voltage is applied. Counter-e.m.f. fights the incoming current, but due to the fact that counter-e.m.f. (c.e.m.f.) exists only during the rise or fall of the incoming current, it always loses in the end, and the applied current will reach full value.

There is a formula for finding the time it takes an applied current to rise.

$$t = \frac{L}{R}$$

t = the time (in seconds) it takes the current to reach 63.2% of its full value. This time is called the <u>time constant</u>.

L = the inductance (in henrys)

R = the resistance (in ohms)

Suppose we have a circuit like this.

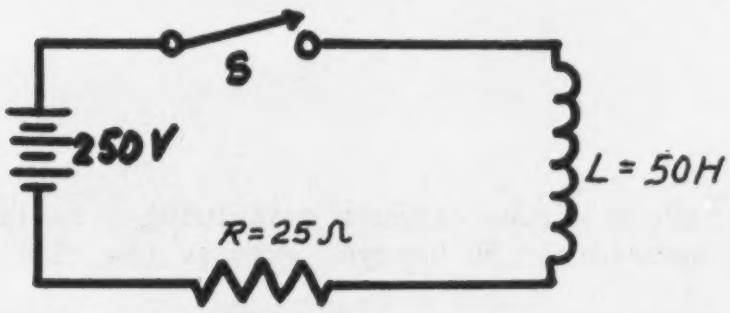

Fig.: XIX-5-1

You know immediately (from your knowledge of Ohm's Law) that the current in this circuit will be 10 amperes. It will take some time for it to reach 10 amperes, however, because of the effect of inductance. Let's see how long it will take for the current to rise to 63.2% of 10 amperes.

$$t = \frac{L}{R} = \frac{50}{25} = 2 \text{ seconds}$$

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We know that in 2 seconds the current is 6.32 amperes (6.32 is 63.2% of 10). The current must still rise to get to 10 amperes.

In another time constant, the current will increase 63.2% of the remainder, or 63.2% of (10 - 6.32) - or 63.2% of 3.68.

63.2% of 3.68 = 2.33, so at the end of 4 seconds (2 time constants) the current is 6.32 A + 2.33 A, or 8.65 amperes.

There is now a difference between 8.65A and the full 10A. In another time constant, the current will be that at 4 seconds plus 63.2% of the difference between 8.65 and 10.

10 - 8.65 = 1.35

63.2% of 1.35 = 0.85

8.65 + 0.85 = 9.5

The current has risen to 9.5 amperes at the end of 3 time constants (6 seconds). Following the same procedure, you will find the current to be 9.8 amperes at 4 time constants, and 9.9 amperes at the end of 5 time constants.

For all practical purposes the current is considered at full value at the end of 5 time constants.

Study this carefully. Make sure you know how the values were found at each time constant, and then see how they have been plotted on the curve on the next page (Figure 2). You will notice, too, that this curve is an exponential curve.

ASSIGNMENT:

1. If you have a series circuit containing a resistor of 20 ohms and an inductor of 30 henrys, what is the time constant?

2. If the above circuit has 100 volts d.c. applied to it, calculate I_T.

3. How long after the voltage is applied can it be considered that full current is passing through the inductor?

4. How much current is flowing at the end of 1 time constant?

5. How much current is flowing at the end of the second and third time constants?

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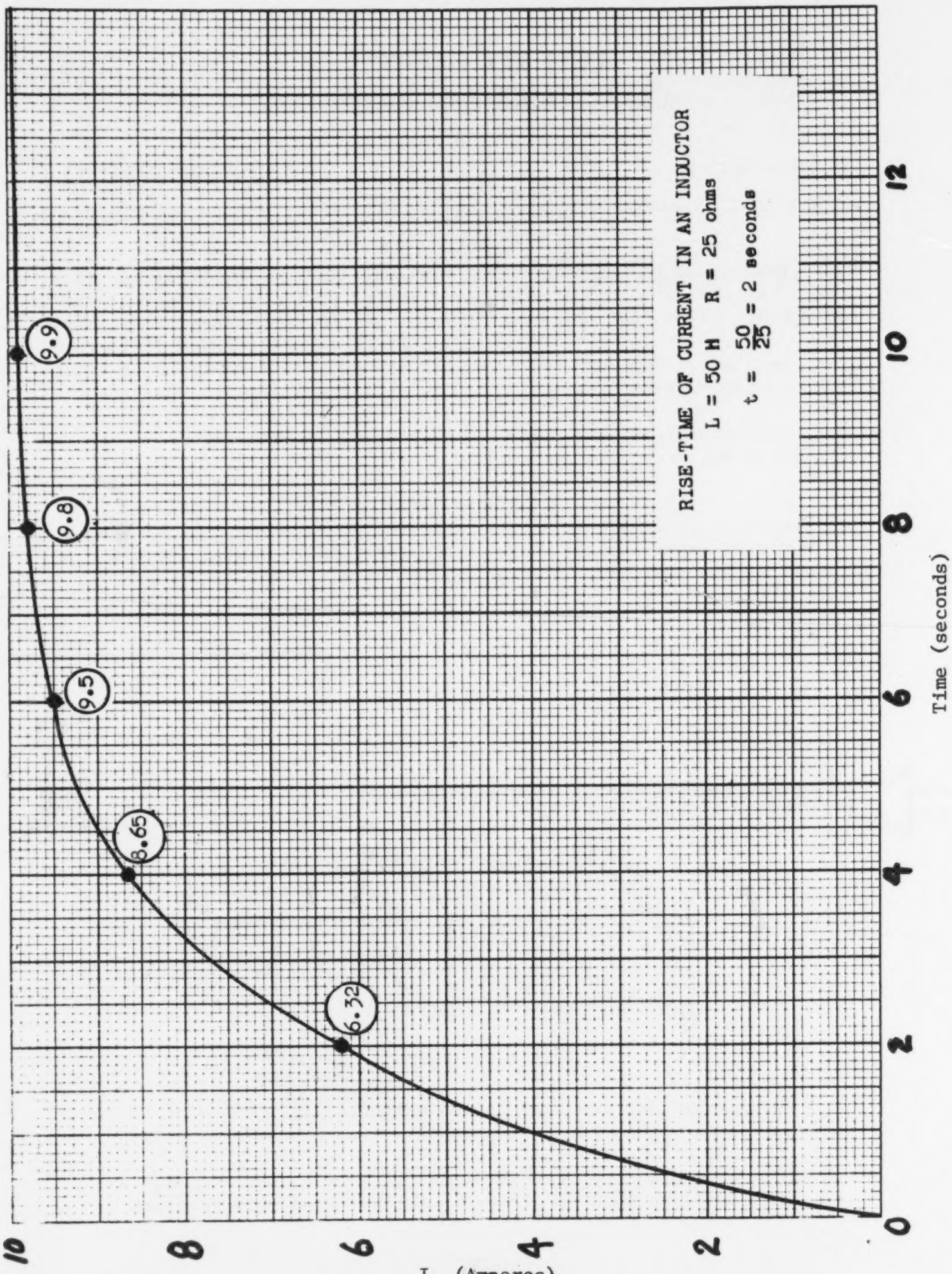

Fig.: XIX-5-2

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UNIT XIX - EFFECTS OF CAPACITANCE AND INDUCTANCE

Lesson No. 6 Inductive Reactance

Inductance can be changed by changing the core material in the coil. Any material which provides a better path for the circulation of magnetic lines of flux will cause a coil to have higher inductance. Iron provides a better path for the flow of magnetic lines of force than does air. Therefore, if iron is placed in the center of a coil, the inductance will increase - and so will the inductive reactance.

Inductive reactance is that property of an inductor which reacts against the flow of a.c.

If you connect a coil of many turns of wire in the line of an electric light bulb which is being fed a.c., there will be little if any difference noticed in the brightness of the bulb. If you insert an iron core into the center of the coil, however, the light will dim.

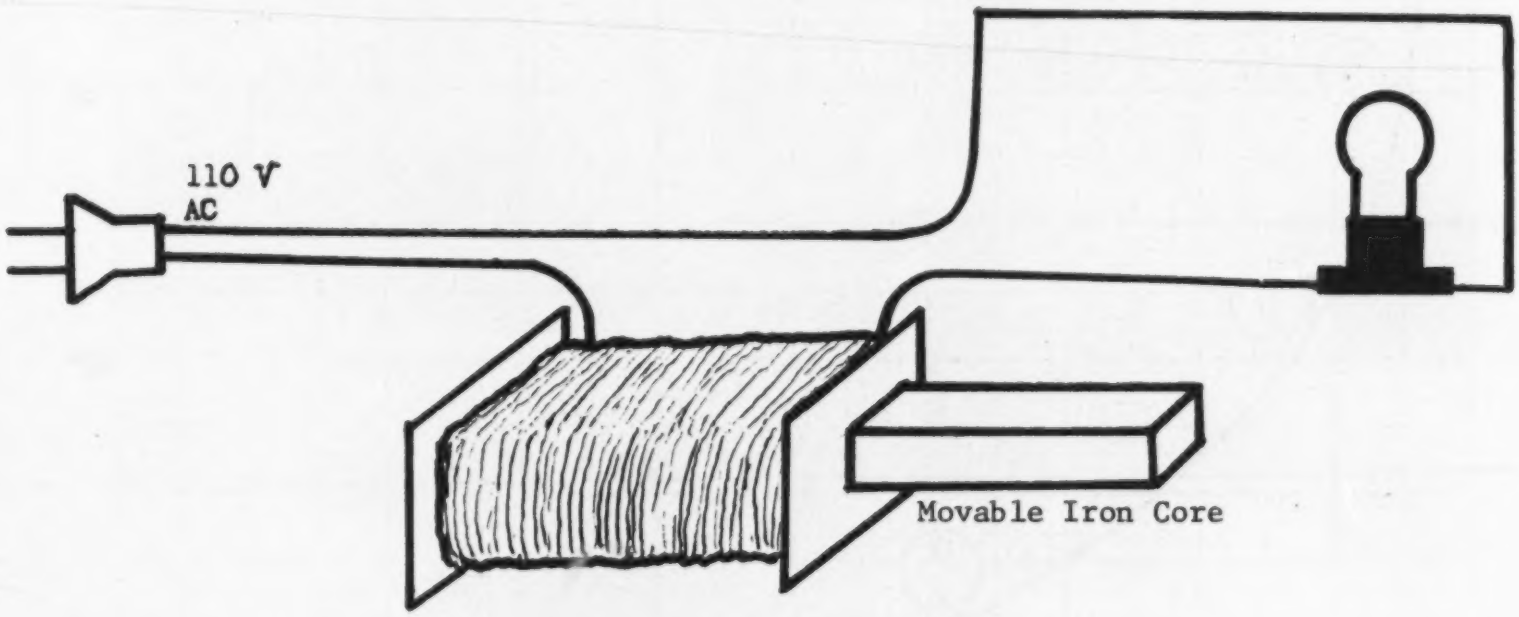

Fig.: XIX-6-1

This is because the iron passes magnetic lines of force better than air does. It is said to have higher permeability than air.

If you connect 110 volts from a d.c. source, the movement of the iron core will have no effect on the brilliance of the lamp.

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This inductive reactance (X_L) varies according to the frequency of the current and according to the value of inductance. The formula for finding inductive reactance is

$$X_L = 2\pi fL$$

Inductive reactance is directly proportional to both frequency and inductance. The unit of inductive reactance is the ohm.

ASSIGNMENT:

1. Which material has higher permeability, iron or air?

2. What is permeability?

3. What is inductive reactance?

4. What is the inductive reactance of a 0.5 henry inductor in a 400-Hz circuit?

5. Inductive reactance is directly proportional to the value of inductance. What is meant by directly proportional?

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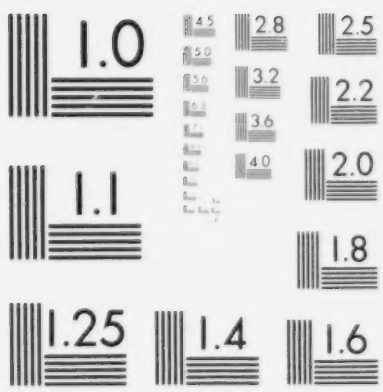

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

UNIT XX - POWER SUPPLIES

Lesson No. I — Applications

In the early days of radio, when your great-grandfather put aside his crystal set with its catswhisker for a new and modern vacuum-tube set, he had to go to town and buy A batteries, B batteries, and C batteries. The A battery was the battery which furnished the current for heating the tubes. The B battery was the one used for amplifying weak signals into strong signals and for providing the power for his headphones - or maybe even a loud-speaker. The C battery was for furnishing a bias voltage on the grids of the vacuum tubes. The A batteries didn't last very long. Some people used automobile storage batteries for the A battery, and when they became weak they were often carried to the service station to be recharged. Some had their own battery chargers then, but not many.

After a few years of hauling the storage batteries back and forth between home and the service station, someone developed a battery eliminator with wet rectifiers. The radio could now be plugged into the house circuit. Behind the radio were many jars filled with corrosive solutions, which caused many disputes between Grandma and Grandpa about the "looks of the room" or the safety of the children. This went on for quite some time before the dry rectifier was invented. Then Grandpa got rid of his many jars and cleaned up the table where he displayed his radio.

This dry rectifier was actually the forerunner of today's semiconductor of which you hear so much. A rectifier effectively changes alternating current into direct current - that is, a.c. to d.c.

Those old power supplies were used on most radios for quite a number of years - 40 or more - and even now, many receivers still have power supplies incorporated in their circuitry. The majority of radio receivers made now, however, are transistorized and are powered by batteries. The new batteries are light and inexpensive. The heavy A batteries are no longer needed, because transistors do not need heating.

During the development of radio, electronics grew as a new field of industry. This industry started with the improvements and developments in radio, and then came all sorts of navigational equipment for helping those in airships and ships at sea to know where they are. Radar was developed during World War II to detect enemy aircraft. The range of radar was greatly increased and it is being used in many peacetime applications. Atomic energy opened new fields in medical electronics.

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We could spend hours discussing the many applications of electronics. In each application we would find that there is some sort of d-c power supply. Some supplies are designed for high voltages and high currents, some for medium power, and some for low power.

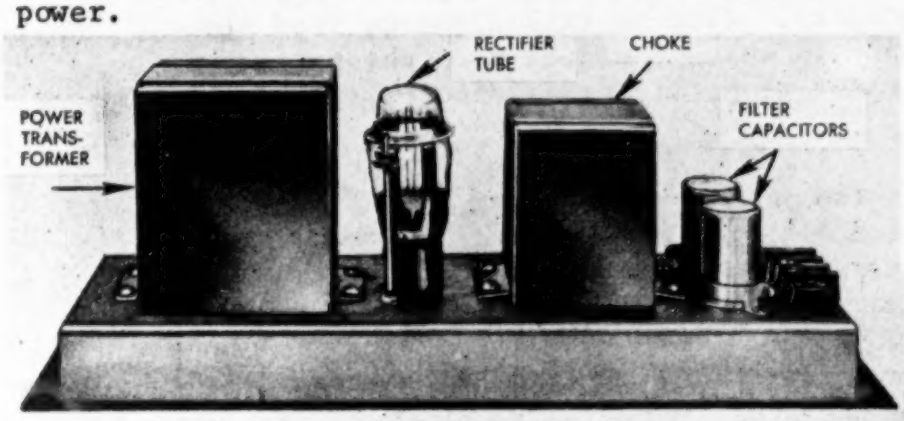

LOW

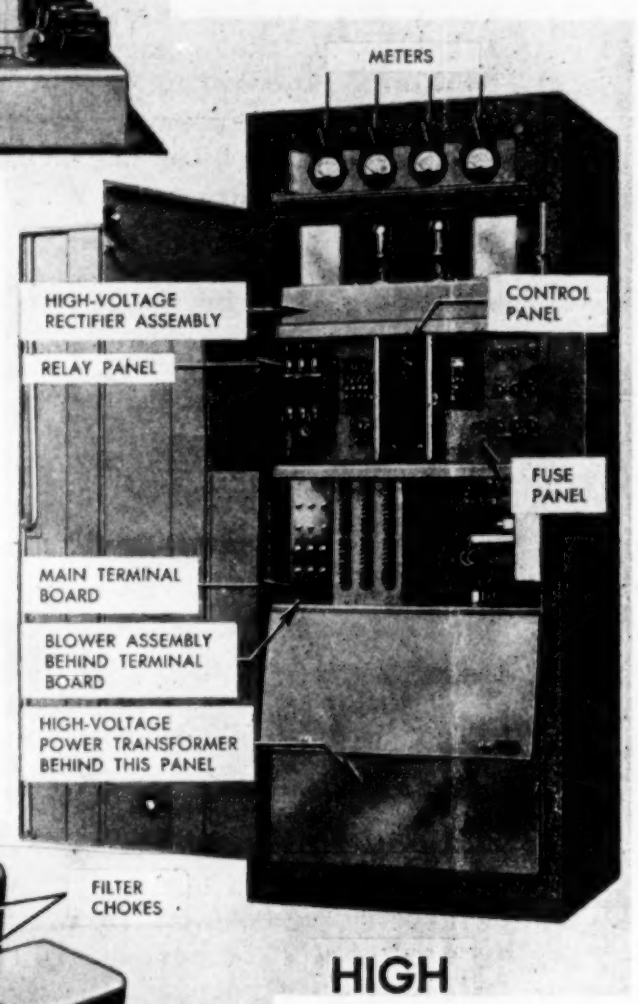

HIGH

Fig.: XX-1-1

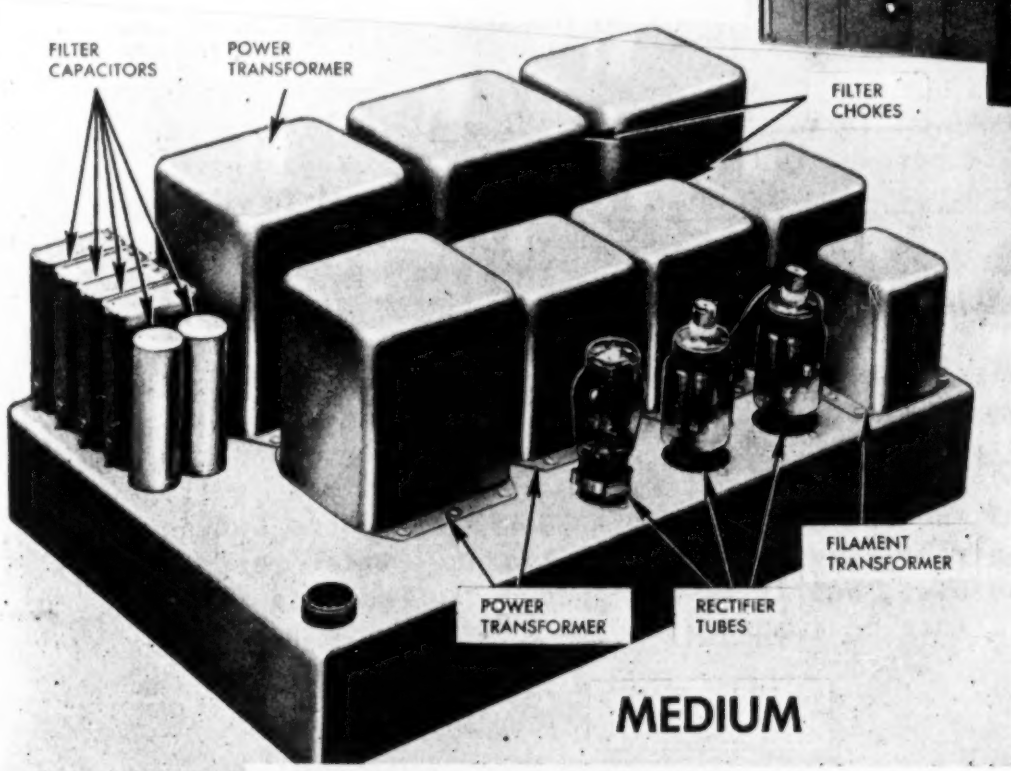

MEDIUM

Examples of low-, medium-, and high-voltage power supplies.

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Power supplies fall into three categories according to their source of primary power.

1. BATTERY SOURCES. The use of batteries, as previously explained, falls into this category. Also in this class we find the vibrator power supply in which the d.c. from the battery is chopped by the vibrator to permit transformer action in raising the voltage.

   Then, too, there is the dynamotor, which is a d-c motor and generator built together in the same housing. The motor is powered by a battery or batteries and turns the generator amature, which is on the same shaft. Some of the windings are wound together or wound one on top of the other. These dynamotors are designed to develop various voltages and currents.

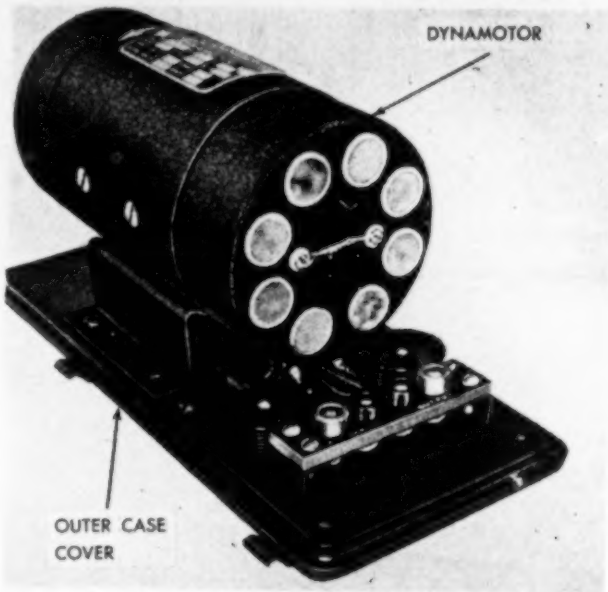

DYNAMOTOR

Fig.: XX-1-2

2. COMMERCIAL POWER SYSTEMS. This is the kind of power supply we will be talking about in this unit. This is the system where we use the voltages from commercial power lines - the lines which furnish electrical energy to our homes and to our schools. We take this current, rectify it, and filter it so that we can have reasonably pure d.c. at whatever voltage we might need for any particuliar application.

3. ELECTROMECHANICAL SYSTEMS. These are the systems with which some of you will become well acquainted. Into this category fall the many gasoline-powered motor-generators used in military field equipment. Then there are the hand-driven generators. You really hold your transmission time to a minimum when the transmitter is powered by one of the hand-cranked generators!

   The power supply is made up like this: First, the input voltage must be brought to the desired level. This is done with a transformer which can either step up the voltage or step it down. Second, the voltage is then rectified - that is, a d-c voltage is taken out of the rectifier after an a-c voltage is put into it. Third, the rectified voltage is filtered. After rectification, we have d.c., but it is not pure d.c. There is ripple on it, and this must be smoothed.

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ASSIGNMENT:

1. What is a power supply?

2. Why are power supplies needed in electronic equipment?

3. What is the function of the rectifier in the power supply?

4. Why is the filter section needed in the power supply?

5. What is a dynamotor?

6. What does the vibrator do in a vibrator power supply?

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UNIT XX - POWER SUPPLIES

Lesson No. 2 — Rectifiers

We say that a rectifier changes a.c. to d.c. If you wanted to get fussy, you might dispute this as a literal definition. But this we know: If we put a.c. into it, we can get d.c. out of it. A rectifier will pass a current in only one direction. This means its output is in only one direction. A current which flows in only one direction is called <u>direct current</u> or <u>d.c.</u>

This is the schematic symbol for a rectifier. The arrow head points in the direction of conventional current flow (positive to negative). The arrow head is called the anode, because it is to this end that the positive terminal is connected if current is to pass. The negative terminal is connected to the cathode.

Fig.: XX-2-1

Some manufacturers and writers have made changes in the polarity-symbols. Electrical current is now thought of as flowing from negative to positive (the direction of electron movement). Some manufacturers have changed to the newer convention. It is a good idea to check diodes against their symbol mark with an ohmmeter, so that you will know the direction of current-flow.

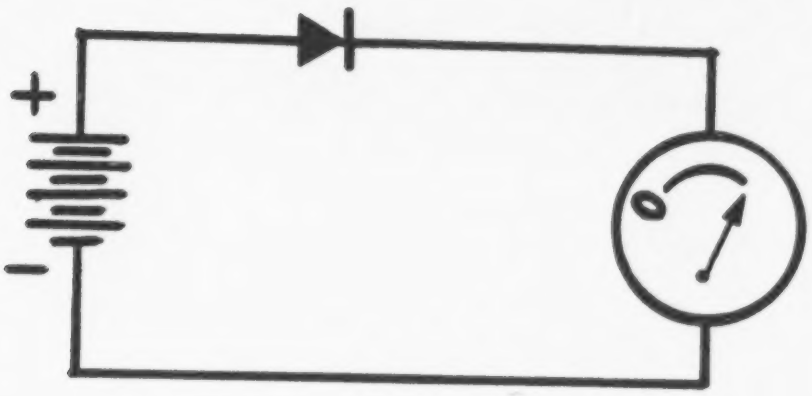

If d.c. is applied to a rectifier in the correct direction, current will flow and the meter will indicate voltage.

Fig.: XX-2-2

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If the battery's polarity is reversed, no current will flow and the meter will indicate no voltage.

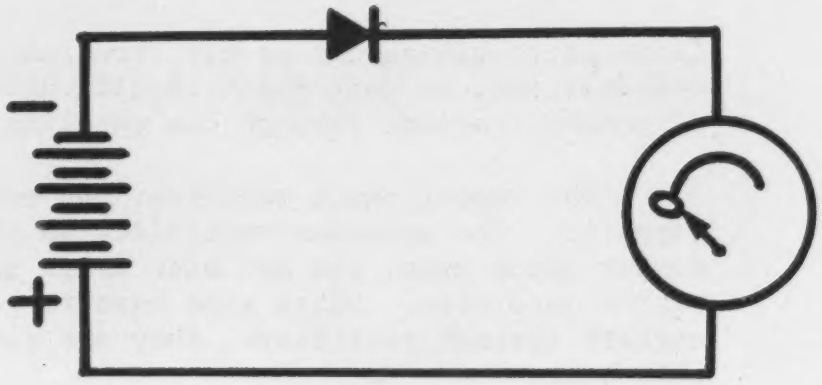

Fig.: XX-2-3

If 60 c.p.s. alternating current is applied, the current will flow during one-half of each cycle and will not flow during the other half. Sixty times during a second the current will flow, and the current will be cut off sixty times during that second.

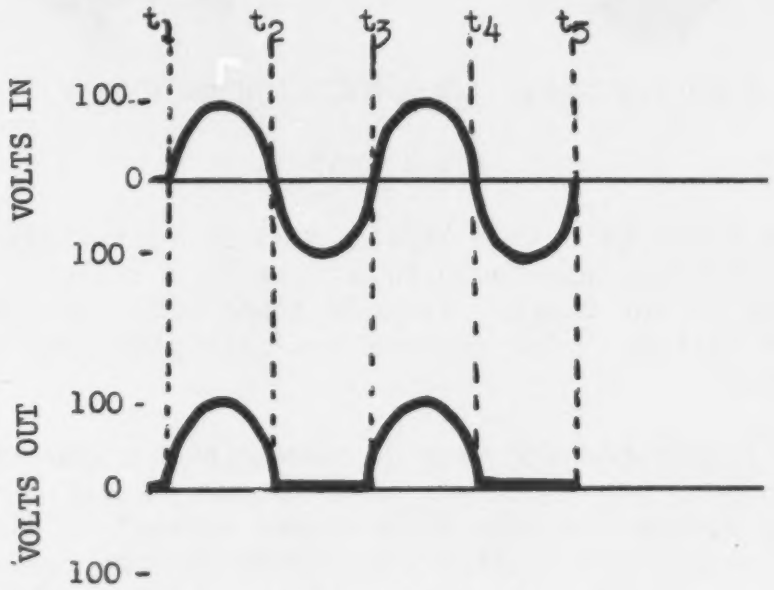

Fig.: XX-2-4

Note carefully that no current flows during one-half of each cycle. This is important for you to remember, because this is called half-wave rectification. The term "half-wave" is very well selected, don't you think?

Later we shall study full-wave retification, but at this time, let's just look at some of the different types of rectifiers.

You will later learn that radio detectors are really nothing but rectifiers of a special sort. Some rectifiers are made of oxides of metals. Iron rust is an oxide, and it can act as a rectifier under certain conditions. Perhaps you have heard of bed springs and rusty

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fence gates giving off sounds from radio stations. That was detection, demodulation, or just plain rectification of the very strong signals of nearby stations through the metallic oxides in these objects.

The copper oxide rectifier has seen much service in many power supplies. The selenium rectifier, which often looks just like the copper oxide type, has had wide usage and is still found in some television receivers. Since some heat is generated by the passage of current through rectifiers, they are constructed with fins to dissipate this heat.

A COPPER OXIDE AND A SELENIUM RECTIFIER

Fig.: XX-2-5

Vacuum tubes were also widely used as rectifiers. You have already learned that electrons will flow from a heated cathode in a vacuum tube to the plate. But electrons will not flow from the plate to the cathode. Can you see how this principle can be used as a rectifier?

Gas-filled tubes are used in many applications where high power is needed. Gas tubes are used because there is very little voltage-drop across the tube while heavy current is flowing. In vacuum-tube rectifiers there is considerable voltage-drop across the tube when current is flowing, and it varies as the current varies.

Today, we use many rectifiers which are so small that they have to be viewed through a microscope. These are on the modern integrated circuit boards. We also have rectifier tubes used in high-power applications that are several feet high and have to be cooled by running water.

Most of the vacuum-tube rectifiers as well as many of the oxide-type rectifiers are now being replaced with solid-state devices. The telephone company and many plants have already replaced bulky rectifiers with much smaller diodes. A diode the size of your index finger can replace a tube-type rectifier the size of your head.

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The diode shown below in actual size can replace a vacuum-tube rectifier about the size of a 100-watt light bulb.

Fig.: XX-2-6

ASSIGNMENT:

1. What is a diode?

2. What is a rectifier?

3. What is half-wave rectification?

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UNIT XX - POWER SUPPLIES

Lesson No. 3 Transformers

We have been talking about transformers for some time, but we haven't actually studied the transformer.

You know that expanding and receding lines of magnetic force from one conductor will induce a voltage in another conductor if the second conductor is close enough to be cut by the expanding and receding lines. A simple transformer is made of two coils, usually one wound on top of the other, and an iron core placed in the center. The ends of the core are joined to more iron like that in the core. This iron core is a good conductor of magnetic lines of force, and, therefore, gives more efficiency to the transformer. (It is suggested here that you get an old transformer and take it apart so that you can see the segmented core material).

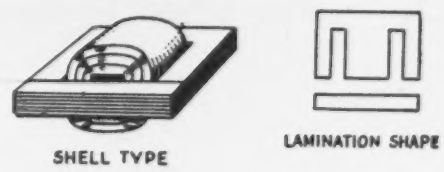

Fig.: XX-3-1

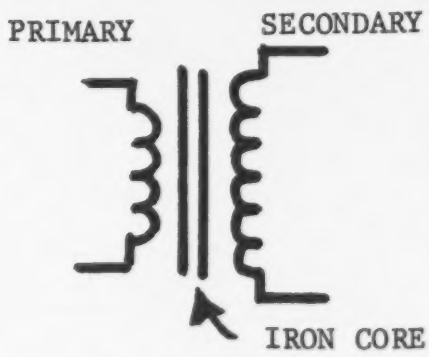

Fig.: XX-3-2

In the simple two-coil transformer, the coil which is connected to the input voltage is called the primary. The coil which delivers the output is called the secondary.

If the primary has 100 turns and the secondary has 200 turns, the output voltage will be twice that of the input. If the primary has 200 turns and the secondary has 100 turns, the output voltage will be half that of the input. The transformer shown in Figure 2 is an iron-core transformer. This is indicated by the vertical lines between the primary and secondary. A symbol for a transformer which does not have these lines is an air-core transformer. Iron-core transformers are used for low frequencies, for power transformers, and audio transformers. Transformers designed for radio frequencies are air-core. A compressed powdered iron core is now being used for frequencies considerably higher than the audio range. These transformers are especially useful where frequencies are above the audio range and where space is at a premium.

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Many transformers have several secondary windings so that several different voltage levels may be had from the same transformer. Some transformers have tapped primaries so that the transformer may be used with different values of input voltage.

Most transformers that are used in radio and television have the leads color-coded. Figure 3 shows a commonly used color code.

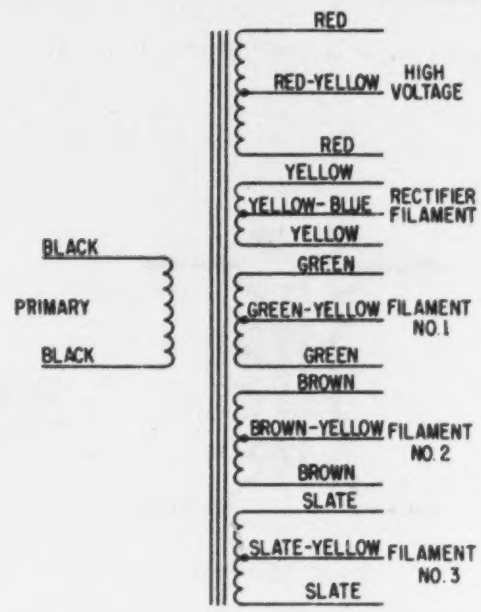

Fig.: XX-3-3

The output leads, being a.c., will have polarity changes 120 times each second. For instance, for one-half of one cycle (1/120 second) the output will have polarity like this.

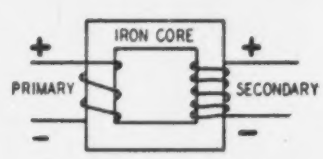

Fig.: XX-3-4

During the other half cycle the polarity will be reversed. You will notice that the top lead of the primary and the top lead of the secondary have the same polarity. This will hold true (with this transformer) at all times. This isn't always the way it is. The direction of the secondary turns in relation to the direction of the primary turns determines the polarity of the leads.

In many applications it is not necessary to know the phasing of the leads, but in others it is very important. When the phase-relationship is important, it is equally important that our schematic diagrams show it - and that the transformers themselves show it.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: III. IGNITION SYSTEM - SECONDARY WIRING

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove, Test, and Replace Secondary Wiring

CONDITIONS:

BEHAVIOR:

15. Make thorough inspection and test as outlined in the manual
16. Remove all wires from distributor cap - observe rotation of removal and mark each wire for reassembly
17. Make other tests and inspections as outlined in the manual
18. Rewire distributor cap - observing rotation and identification marks
19. Place wiring assembly on engine and rebolt clamps to engine
20. Place distributor cap on engine making sure that the cap is properly positioned as outlined in the manual
21. Reclip cap to distributor
22. Reconnect each plug wire in accordance to distributor rotation and firing order of the engine
23. Insert coil secondary wire into coil
24. Check all wires to be sure they are firmly in place and that insulating covers are pushed back down on distributor towers and plug insulators

PERFORMANCE CRITERIA:

1523

Figure 5 shows how we represent opposite-direction windings of the two coils. This would indicate that the polarities are out of phase - that is, the two top leads would have opposing polarities.

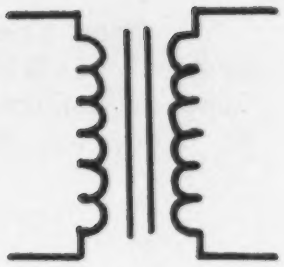

Fig.: XX-3-5

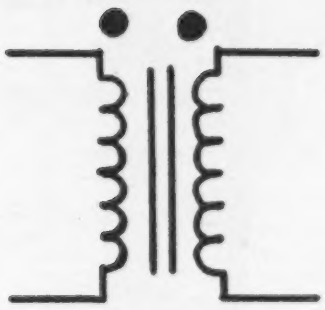

Fig.: XX-3-6

If you wanted to show this same diagram as an in-phase diagram, you could do it by placing dots as in Figure 6;

or you could reverse the direction of the secondary coil so that both windings would be going in the same direction, as in Figure 7.

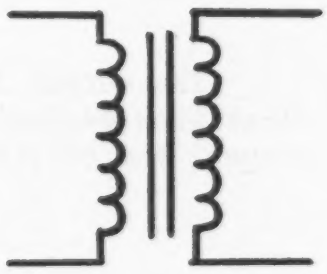

Fig.: XX-3-7

Suppose you saw a diagram like this.

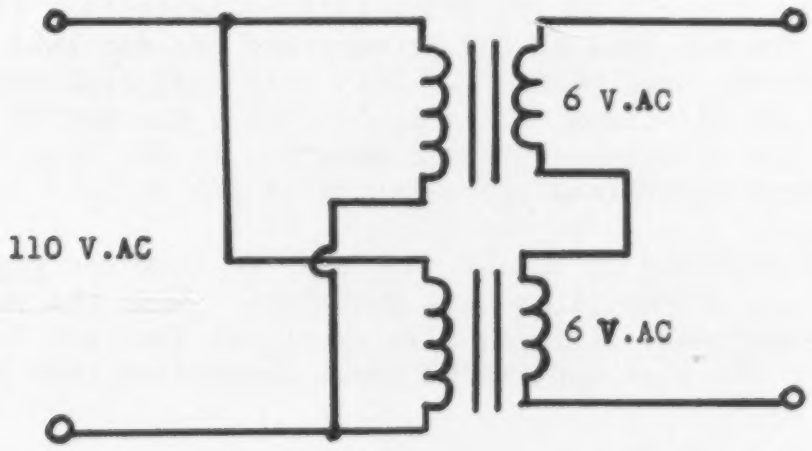

Fig.: XX3-8

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What would be the value of the output voltage? It would be 0 volts, because reversed polarities have been connected in series. It could be compared to connecting two flashlight cells like this.

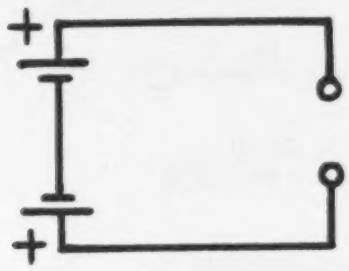

Fig.: XX-3-9

The two voltages cancel each other, making the output equal to 0 volts.

There is much more to be learned about transformers before you finish this course. If you want to get "one step ahead," you might go further into the subject before your next year's course. Your instructor will direct you toward good sources of information.

Another type of transformer you should be able to recognize before going any further is the autotransformer ("auto" means "self," or "same.")

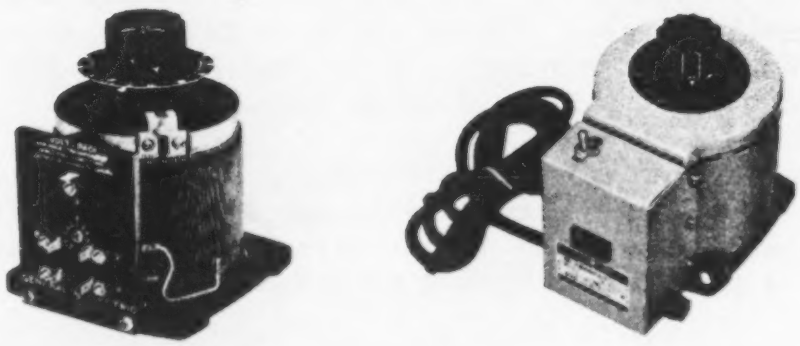

Autotransformers
Fig.: XX-3-10

15281

The autotransformer has only one winding, which is both the primary and the secondary. This is the way the connections are made.

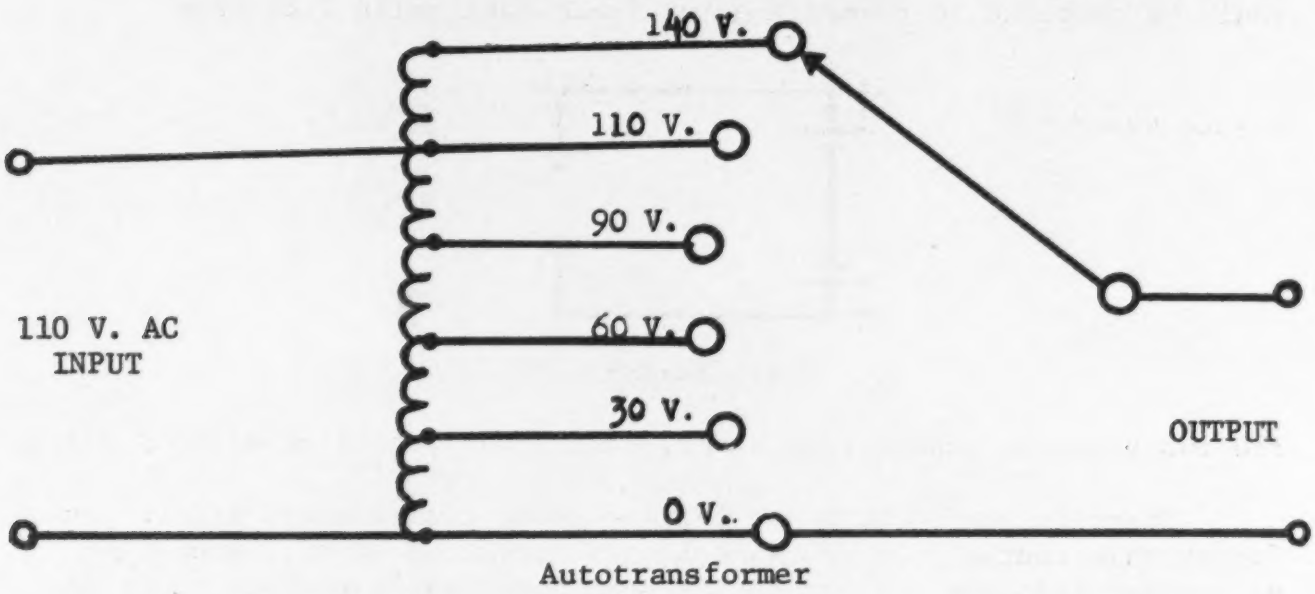

Fig.: XX-3-11

The voltage applied to the primary portion of the coil induces voltage into the rest of the coil which adds to the input voltage. A transformer of this type will give a variety of output levels, from 0 volts to approximately a 35% or 40% higher voltage than the input. As a rule, the secondary voltage is seldom more than 35% greater than the input voltage.

There are various sizes and shapes of autotransformers made by numerous manufacturers. One is called a Variac; another company calls its product the Powerstat. It is possible that you will see autotransformers called by other trade names.

Autotransformers are ideal for making adjustments to line voltages when they vary. One disadvantage is that the circuit following the autotransformer is not isolated from the outside line, as it is when a transformer with a separate secondary winding is used.

ASSIGNMENT:

1. Study the diagram of Faraday's demonstration to the Royal Society (Unit XIX, Figure 4-3) and explain its relationship to the study of transformers.

2. Explain mutual inductance.

3. Draw a schematic diagram showing three 6-volt filament transformers connected to give an 18-volt output. Indicate phase in your diagram.

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UNIT XX - POWER SUPPLIES

Lesson No. 4 — The Automotive Ignition Coil

Do you recognize the transformer shown in this diagram?

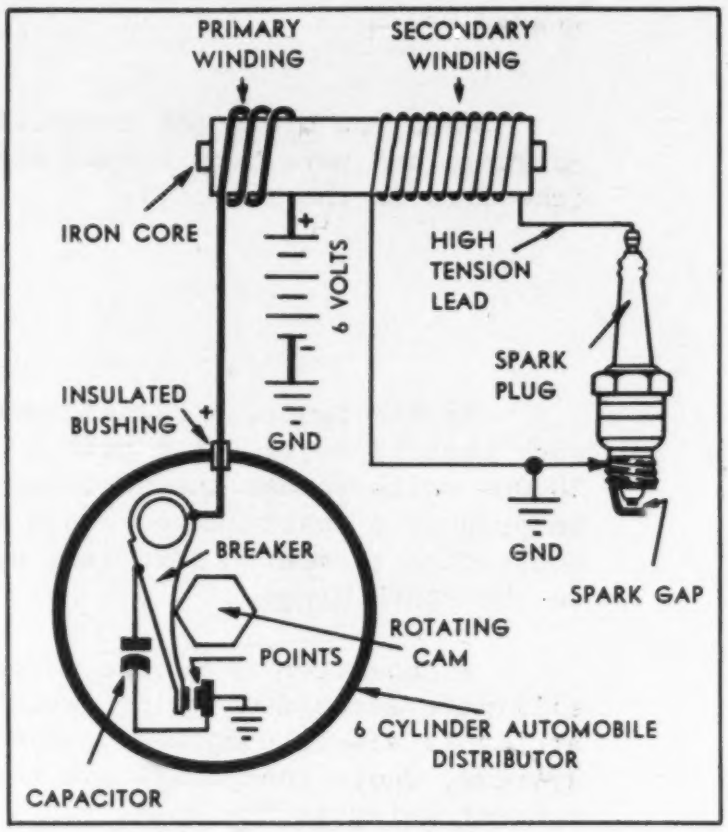

Automobile Ignition System

Fig.: XX-4-1

You have always called this transformer a coil, haven't you? Well, the coil in the ignition system of an automobile is really a transformer.

The battery of a car can supply only d.c. Now how do we get transformer action when we apply d.c.? We have been told that we cannot get transformer action with d.c. This is true. If we put a battery across the primary and hold it there, we will get no continuous voltage from the secondary. (In fact, we might burn out the primary winding.)

If you have a voltmeter across the secondary and apply d.c. to the primary, you will see the needle jump when you first make contact, but it will go back to zero until you break the connection; then it will jump in the opposite direction. It is only while the lines of magnetic flux are cutting the secondary turns that we have a voltage induced.

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When you make the connection, the magnetic lines of flux start from the conductor and spread out.

Fig.: XX-4-2

When you break the connection, the lines collapse and move back toward the conductor (the wire in the primary).

Fig.: XX-4-3

In the ignition transformer (the coil), the turns-ratio is such that 12 volts (or 6 volts) on the primary will produce about 20,000 volts across the secondary. This high voltage is necessary to produce a spark large enough to ignite the fuel mixture in the combustion chamber. Some cars have between 25,000 and 30,000 volts on the spark plugs.

A capacitor is placed across the switch (the points) to eliminate excessive arcing, which burns out the points. This arcing is almost completely eliminated in the transistorized ignition systems, where the points are not required to make and break the current going to the coil. In these systems, the points merely switch a low-current voltage on and off the transistor, which switches the coil current on and off.

ASSIGNMENT:

1. What do the points do in an ignition system?

2. Why are the points necessary?

3. What is the potential supplied to the spark plugs?

4. Why is it necessary to have such high voltages on the spark plugs?

5. How is this high voltage developed?

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UNIT XX - POWER SUPPLIES

Lesson No. 5 — Full-wave Rectification

You have been taught to think of current as going from negative to positive. There are several reasons for this which you understand by now. During the study of crystal diodes, however, it is better to think in terms of conventional current flow (positive to negative), since the research scientists who did pioneering in crystals think in conventional directions. These are the men who created the symbols which you see in schematic diagrams with their arrowheads pointing from positive to negative.

As you know, when a diode is placed in an a.c. circuit, current can flow during only one-half of the cycle.

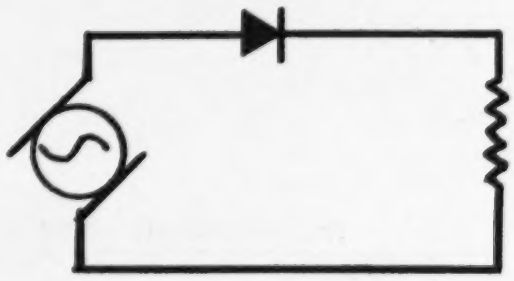

Fig.: XX-5-1

During the other half-cycle, when the polarity of the a.c. input is reversed, the current will not flow, due to the fact that the diode will pass the current in only one direction. This is half-wave rectification, and with this type of rectification, in a 60 c.p.s. line, current will flow for 1/120 second and be off during the next 1/120 second.

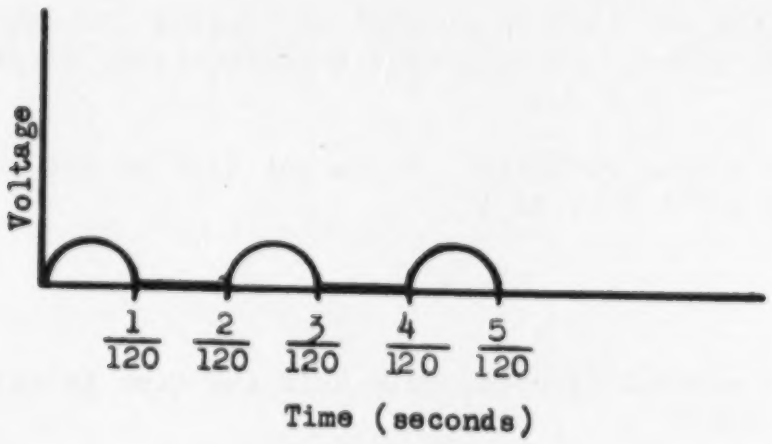

Fig.: XX-5-2

It doesn't take too much reasoning to understand that there must be some advantage in having the current flow during these "no current" times. For one thing, it greatly reduces the ripple of the current. This can be arranged by using another diode. This is called full-wave rectification.

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Let's study the following diagram.

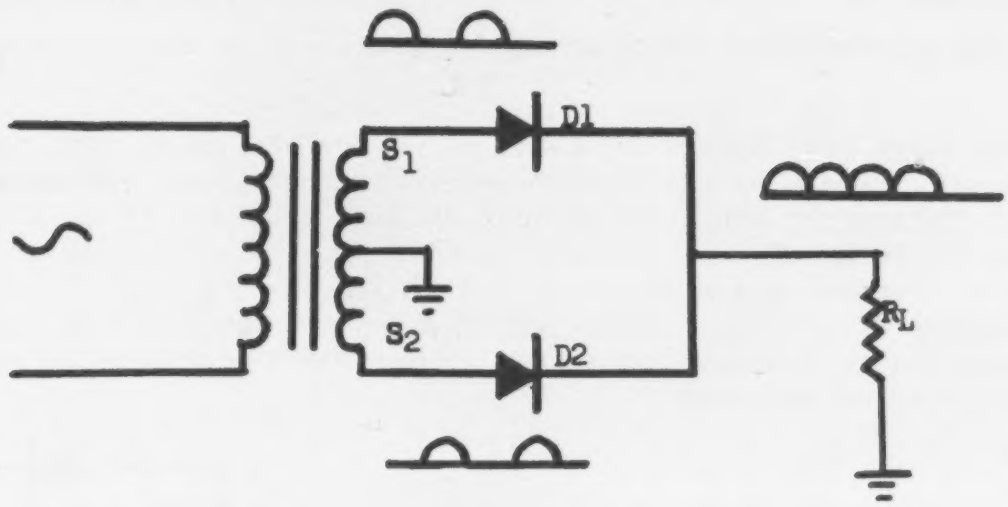

Fig.: XX-5-3

As you know, when S_1 is positive, S_2 will be negative, and during the next half-cycle this will be reversed. Any time S_1 is positive, the center tap will be negative in respect to S_1; and any time S_2 is positive, the center tap will be negative in respect to S_2.

Let's assume now that S_1 is positive. Current will flow through D1, then through R_L to ground and from ground to the center tap, completing the circuit. On the next half-cycle, S_2 will be positive, so the current will flow through it, through R_L to ground; and then from ground it will flow to the center tap, completing the circuit during this half-cycle.

Now you can see how the current is flowing through the load resistor at all times. In half-wave rectification, it flows only half the time.

Note the output waveform. It is not flat on the top exactly like d.c. from a battery, is it?

ASSIGNMENT:

1. Why does current flow for only half the time in half-wave rectification?

2. What is full-wave rectification?

3. Draw a half-wave rectifier.

4. Draw two full-wave rectifiers (one for each half-cycle) and show the path of current-flow in each.

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UNIT XX - POWER SUPPLIES

Lesson No. 6 — Filters

You saw in the previous lesson that the waveform as it comes from the rectifier is not flat, as it would be when coming from a battery. The varying current is d.c., though, because it goes in one direction only. However, there is ripple on it. Let's look at this ripple again.

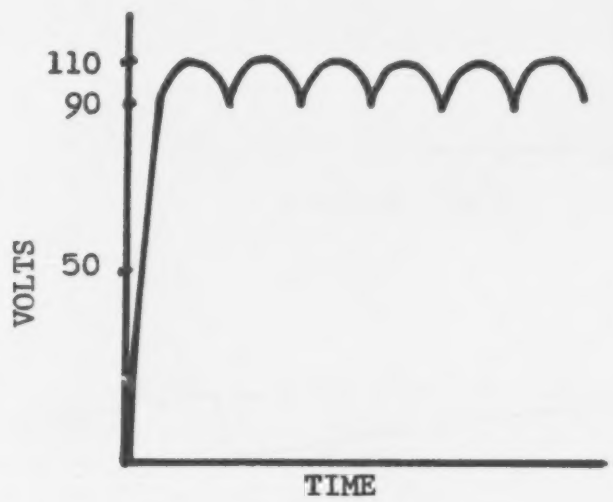

Fig.: XX-6-1

You can see that you have a positive voltage, but it is varying in value from +90 volts to +110 volts. (Note: a simple rectifier would vary from 0V to 110V). These are the tops of the full-wave peaks — 120 per second. If you place a capacitor across the output,

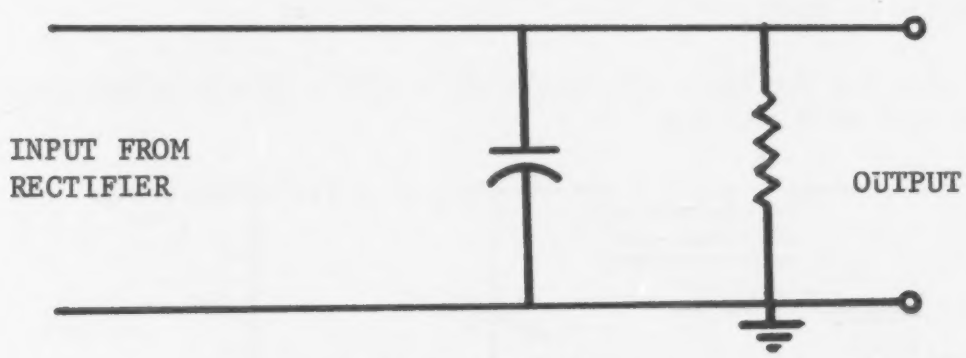

Fig.: XX-6-2

15287

it will charge to 110 volts when the output voltage is at its peak, and will try to hold that voltage during the time that the voltage is 90 volts. Instead of being like part A of Figure 3, we will have something like part B.

Fig.: XX-6-3A

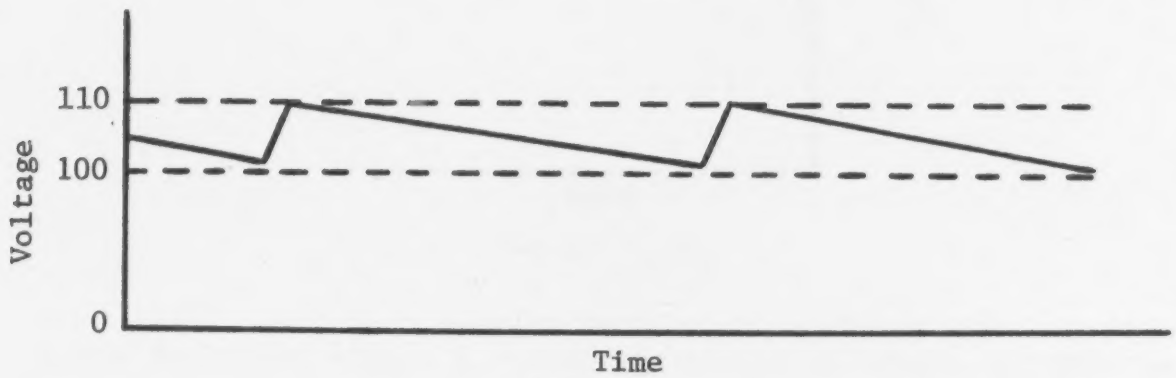

Fig.: XX-6-3B

You can see that the capacitor is keeping the voltage from dropping below 100 volts now.

If you put an inductor (called, in this application, a filter choke) in series like this

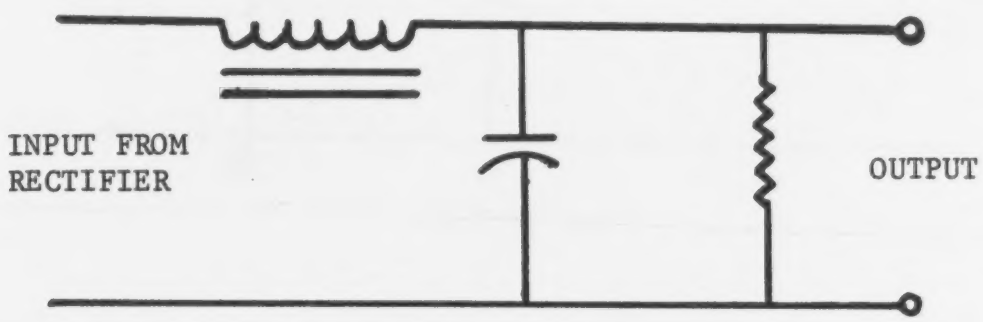

CHOKE-INPUT FILTER
Fig.: XX6-4

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the output voltage will be smoother still. You remember that an inductor resists changing current. This ripple frequency — changing, in this example, from 90 to 110 volts — causes a corresponding change in the current, so the choke smoothes a little more of the ripple out of the output voltage. Some better filter circuits have two chokes and two capacitors in what is called a double-section filter, as shown in Figure 5.

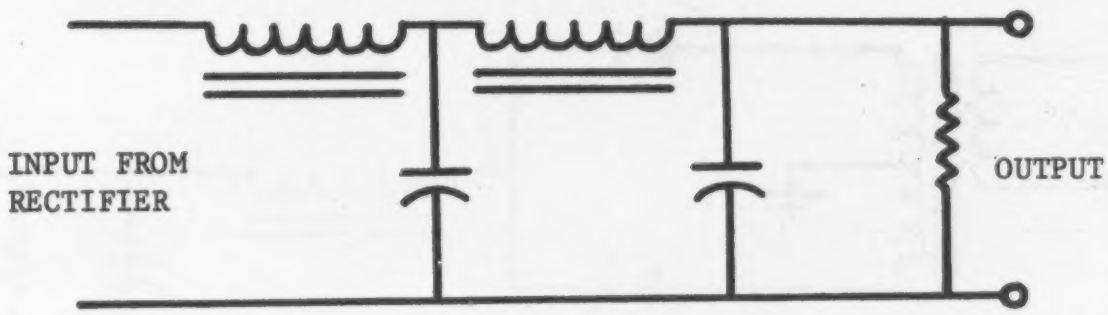

Fig.: XX-6-5

Filters such as this, when the proper values of inductance and capacitance are used, deliver d.c. outputs of almost battery-quality d.c.

If a filter is connected as in Figure 6,

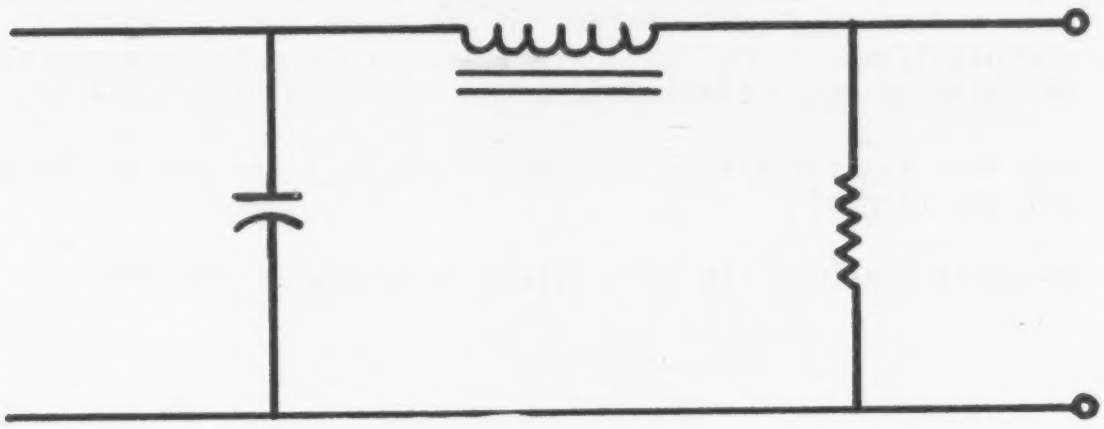

CAPACITIVE-INPUT FILTER

Fig.: XX-6-6

it is known as a capacitive-input type and has the disadvantage of having poor regulation — that is, dropping in voltage as load is applied. If it is a choke-input filter, as shown in Figure 4, the voltage will be slightly lower, but the regulation will be better.

In the choke-input type, the choke tends to resist changes in current values (due to back e.m.f. in the inductor) and reduces the peaks before the capacitor gets a chance to store them.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: III. IGNITION SYSTEM - SECONDARY WIRING

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove, Test, and Replace Secondary Wiring

CONDITIONS:

BEHAVIOR:

25. Check to make sure engine compartment is clean of rags, tools, materials, etc.
26. Start engine
27. Make tests and inspections as outlined in the manual
28. If engine performs satisfactorily, replace air breather assembly
29. Clean and replace tools and materials
30. Remove fender covers and store in proper place
31. Close hood
32. Return automobile to proper parking area
33. Remove seat covers and store in proper place
34. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, test, and replace secondary wiring in $1\frac{1}{2}$ hours

Learning time: 3 hours

1524

In the capacitive-input type, regulation is poor because of the capacitor's inability to hold the complete charge until the next half-cycle when it is charged again. Therefore, where good regulation is required, it is best to use the choke-input-type filter.

Figure 7 shows a typical full-wave power supply with filter.

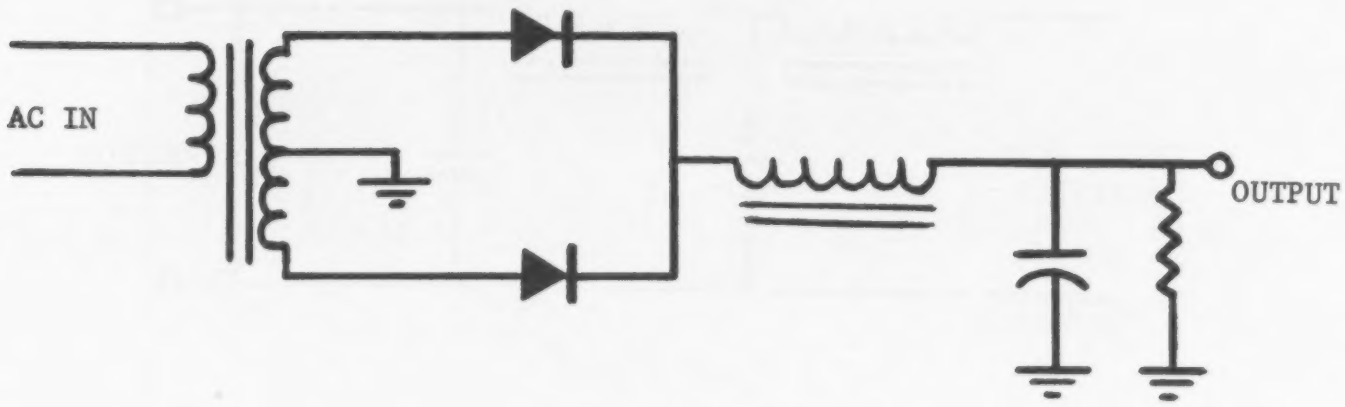

Fig.: XX-6-7

ASSIGNMENT:

1. Draw two schematic diagrams of a typical center-tap-type full-wave rectifier power supply. On one trace the conventional current-flow for one half cycle, and on the other diagram show the path of the current during the following half cycle.

2. How does capacitance in the power-supply filter aid in filtering out the ripple?

3. Describe the part the choke plays in filtering ripple.

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UNIT XX - POWER SUPPLIES

Lesson No. 7 — The Bridge Rectifier

The full-wave power supply described in Lesson 6 utilized a center-tapped secondary like this.

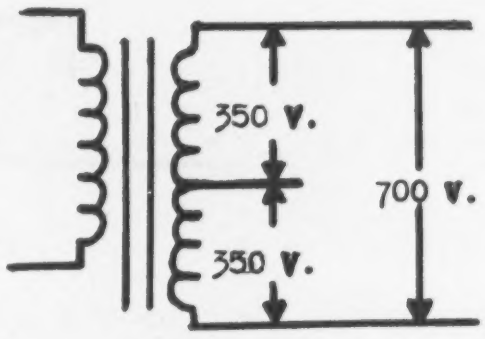

Fig.: XX-7-1

Only a half of the secondary winding is used at any one time, as you remember. In a secondary like the one above, only 350 volts can be obtained. There is another type of circuit which makes it possible to get the full 700 volts from the secondary. That is the <u>bridge type</u>. With the bridge you will get an output of twice the voltage, but only half as much current may be drawn as in the center-tapped circuit (where you get half the voltage).

If a transformer's maximum output with the center-tapped circuit is 350 volts at 200 MA, that means that the maximum power is 350 x 0.2, which gives us 70 watts. If you were to draw the same current at 700 volts, that would be 140 watts. If 70 watts is the maximum power, then it is impossible to draw 140 watts, isn't it?

Now that we know that you can get twice the voltage but only half the current when we use a bridge circuit instead of a center-tapped circuit, let's look at the bridge circuit.

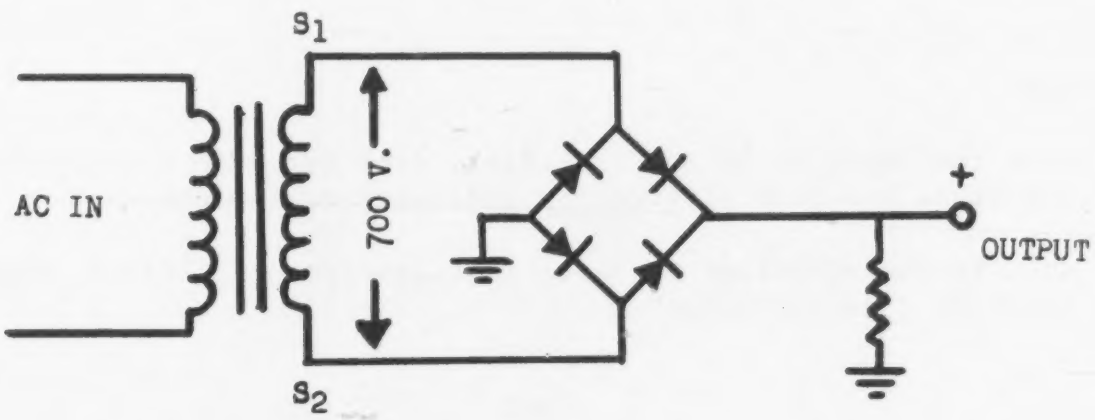

Fig.: XX-7-2

15291

The top terminal is negative and the bottom terminal is positive, as shown in Figure 3. *Remember we are thinking in terms of conventional current flow.*

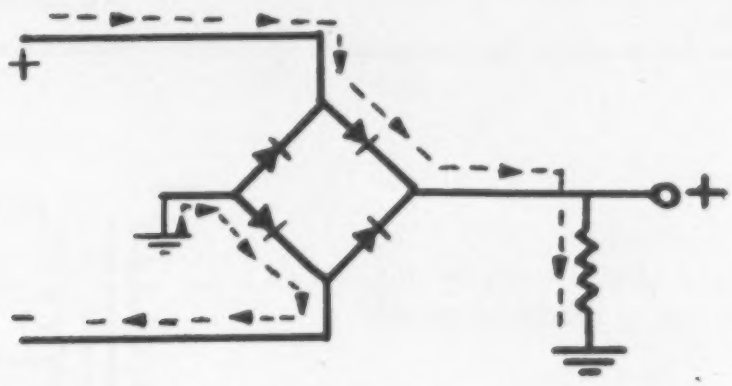

Fig.: XX-7-3

The small arrow heads point out the path as well as the direction of current flow. In Figure 4, the polarities are reversed. Follow the path and the direction now.

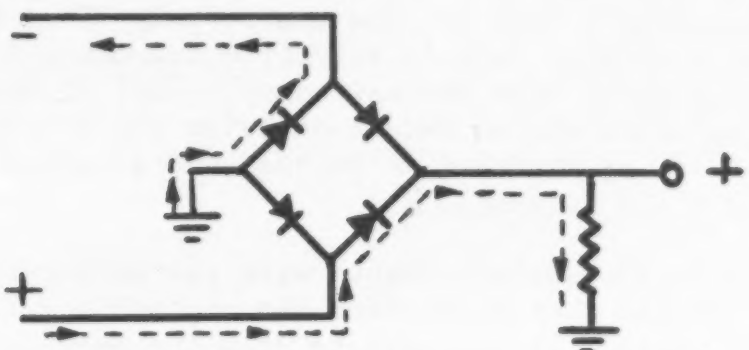

Fig.: XX-7-4

The bridge-type full-wave rectifier is most convenient in giving higher voltages when modest amounts of current are needed. This type of rectifier circuit also needs a filter, just as the center-tap full-wave rectifier does, and the same filter considerations are required.

ASSIGNMENT:

1. Draw two separate bridge rectifiers (one for each half-cycle) and trace the path of electron current flow through each.

2. What is the advantage in using a bridge-type rectifier? What could be a disadvantage?

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GLOSSARY

ACCELERATION The speeding up of velocity. The speeding up of electrons by an accelerating anode in a cathode-ray tube. Electrons are usually focused by the first anode in a CR tube and then are accelerated when they go through the opening in the second anode.

ADJACENT Adjoining, next to. *His property was adjacent to the park. A current was induced into the adjacent turn of the coil.*

ADJUSTABLE Capable of being adjusted or changed. *He is using an adjustable wrench. He changed the voltage by moving the collar on the adjustable resistor.*

ALGEBRAIC Pertaining to algebra. *He wrote an algebraic equation. Algebraic equations and algebraic addition are used in solving problems by Kirchhoff's laws.* In algebraic addition, the numbers may have either positive or negative signs. Example: -2 +4 -7 = -5

ALKALI (pl. alkalis or alkalies) A substance which, chemically, is the opposite of an acid. Lye and soda-ash are alkalis. They may be neutralized by acids or they may, on the other hand, neutralize acids. (The adjective form of the word is ALKALINE. *The soil in your yard may be alkaline or it may be acid.)*

ALTERNATION A change to the other condition. In electricity, the changing from positive to negative or from negative to positive. An alternation is a single change. If the change is from positive to negative and then back to positive, this is a cycle. There are two alternations in a cycle.

AMMETER An electrical meter for measuring electric current.

AMPLIFICATION Making something larger or greater.

ANALYSIS The act of finding the nature, value, or function of something by thorough examination of its parts.

ATOMIC Pertaining to atoms, or referring to something very small.

ATTRACTION The mutual action by which bodies or particles tend to come together.

AUDIO 1.Pertaining to electromagnetic waves that correspond to sound waves that are within the range of hearing (15 to 20,000 cps). 2. In television broadcasting, that portion of the signal which carries the sound rather than the picture.

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CAPACITOR An electrical device consisting of two or more plates of a conductive metal separated by an insulating material called a dielectric. This device, sometimes called a condenser, stores an electric charge.

CENTIGRAM A unit of weight equal to 1/100 gram; abbrev. cg.

CHEMICAL A substance used in a chemical operation or produced by such an operation.

CHEMISTRY The science dealing with the composition and properties of different kinds of materials.

COMMUNICATION Giving and receiving information by audible, visual, or electrical means.

COMPLEX Complicated; not simple. Also (noun), a whole thing made up of a great number of related parts.

COMPONENT A part of a whole. *A transformer is one of the components of a power supply.*

CONDUCTOR In electricity, a substance or material that readily transmits electricity. There are other conductors, such as those materials which conduct heat, sound, etc.

D'ARSONVAL MOVEMENT A type of meter movement, also called the moving-coil-type movement. This movement is commonly used in most multimeters and test equipment.

DIELECTRIC An insulating material between the plates of a capacitor. Air, mica, paper, and oil when so used are dielectrics.

DISCHARGE To relieve of a charge, to fire off, to give forth, emit. Also (noun), the release of stored energy.

DYNAMO A machine for converting mechanical energy into electrical energy; an electric generator. Sometimes loosely used for a machine that converts electrical energy into mechanical energy.

DYNAMOMETER An apparatus for measuring force. The term is now used for numerous testing devices - some very elaborate systems - for testing machines under operating conditions.

EFFICIENCY The ratio of output to input. In electrical and mechanical technology, this term is the ratio of the output to input power, expressed in percentage. If 100 units of a quantity goes in and only 50 units come out, the efficiency is 50/100 or 50%.

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FILAMENT A threadlike object; the wire which glows in an electric light or which heats a radio tube.

FREQUENCY The number of times a thing is repeated in a given unit of time. Example: The current in a circuit reverses its direction and then returns to its original direction (two changes) sixty times per second (120 changes). *Its frequency is 60 cycles per second, or 60 Hz.* Symbol, f.

GENERATOR In electricity, any machine by which mechanical energy is changed into electrical energy; a dynamo, especially a large one.

HENRY The basic unit of electrical inductance.

IGNITION Act of igniting (setting fire to something); also, means of ignition.

INDUCE 1. To bring on or about. 2. To produce by induction, as an electric current.

INDUCTION The process by which an electrical conductor becomes electrified in the presence of an electrically charged body or a magnetic field. A magnetizable body can similarly be magnetized by induction by being in a magnetic field.

INDUCTOR A part of an electrical apparatus which acts on another part, or is itself acted on, by induction. A coil of wire is an inductor, since it acts upon alternating current with inductive reactance.

INSTRUMENT A device for doing work or producing an effect.

INVERSE Opposite in order, relation or effect; reversed; inverted. Example: $X_C = \frac{1}{2\pi f C}$. Frequency (f) is inversely proportional to X_c, because, as f increases, X_c decreases, and as f decreases, X_c increases.

ISOLATE To set apart from others; place alone. *In electricity, the secondary of a transformer is isolated from the primary as far as d.c. is concerned.*

JUNCTION A place of joining, a place where an electrical connection is made to another part of the circuit or to another circuit.

KILOMETER A unit of length or distance, equal to 1,000 meters or approximately 5/8 mile. This unit is used in continental Europe.

MAGNITUDE Greatness of size, importance, influence. *We use meters, in electricity, to learn the magnitude of the resistance or current or voltage.*

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MANUFACTURER A person or organization of persons engaged in the making of a product.

MERCURY A heavy, silvery metallic element which is liquid at ordinary temperatures. It is sometimes called quicksilver. The chemical symbol is Hg. It is used in thermometers. Dentists mix it with other metals for filling teeth.

MEGOHM 1,000,000 ohms

MICROFARAD A unit of measurement of electrical capacitance equal to 1/1,000,000 farads or 1×10^{-6} farads.

MILLIHENRY A unit of measurement of electrical inductance equal to 1/1,000 henry or 1×10^{-3} henry.

MODULATE In radio, to vary the frequency, phase, or amplitude of a radio wave according to an audio frequency. Or, to apply sound-wave signals to change some characteristic of a transmitted radio wave.

MODULATION In radio, the variation of a radio frequency by applying audio frequency.

MOLECULAR Pertaining to, consisting of, or produced by molecules.

MOLECULE The smallest particle of an element or compound that can exist in the free state and still have the characteristics of that substance.

MULTIMETER A meter for measuring more than one of the quantities of electricity or electrical effect. Example: a meter which measures volts, amperes, and ohms.

MUTUAL Having a similar effect, one on another. *A mutual dislike; mutual induction.*

NUCLEUS A central thing or part around which other parts or things are grouped. In chemistry and physics, the central part of an atom, containing practically all the mass (weight) of the atom. *Electrons are usually pictured as rotating about the nucleus of the atom.*

OHM The unit of electrical resistance, equal to the resistance of a circuit in which an electromotive force of one volt maintains a current of one ampere.

OSCILLATOR In electronics, a circuit which causes variations between maximum and minimum values of current and voltage. These variations may alternate between maximum positive and maximum negative. The frequency may be very low or very high. The RF carrier signal of a transmitter originates in an oscillator. Oscillators, both audio frequency (AF) and radio frequency (RF), are used in many test applications, and are sometimes called signal generators.

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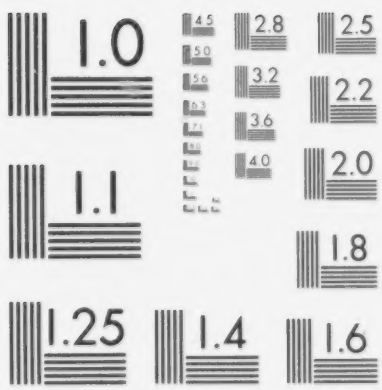

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OSCILLOSCOPE A device that shows periodic changes in an electric quantity on the fluorescent screen of a cathode-ray tube. These presentations may then be studied for shape, frequency, magnitude, etc.

PARALLEL Extending in the same direction and at a constant distance apart.

PERMEABILITY In electricity, the ability to concentrate magnetic flux. *Soft iron has high permeability because it is very effective in concentrating magnetic lines of force.*

PHYSICS The science dealing with the properties, changes, interaction, etc. of matter and energy.

PITH The soft, spongy tissue in the center of certain plant stems.

POLAR In electrical science, having polarity. Having two opposite natures, directions, etc. (Literally, on or near the North or South Pole.) *In checking the polarity of the current, I found that I had accidentally attached the positive wire to the negative terminal.*

POLARIZATION The producing or acquiring of polarity, as the inducing of north and south poles into a bar of iron.

POTENTIAL 1. That which can be but has not yet come into being; possibliity. 2. In electricity, the relative voltage between two points in an electrical circuit.

POTENTIOMETER A three-terminal variable resistor.

PREFIX One or more letters or syllables added at the beginning of a word to modify its meaning. For example, meg in megohm changes the word ohm to a word meaning one million ohms.

PRIMARY First in order of development, time, or intention. Electricity: In a transformer, the word refers to the coil into which the input current flows.

PRINCIPLE A fundamental or general truth. A general or settled rule of action.

PROTON Positive particle in an atom. The smallest quantity of positive electricity that can exist in a free state.

PYTHAGOREAN Of or pertaining to Pythagoras, a Greek philosopher. The Pythagorean theorum, Hyp = $\sqrt{h^2 + b^2}$, gets its name from Pythagoras.

RADAR (RAdio Detection And Ranging) A device for locating an object by measuring the time for the echo of a radio wave to return from it, and the direction from which it returns.

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: IV STARTING MOTOR

PERFORMANCE OBJECTIVE NO: 4 TITLE: Remove, Overhaul, Replace and Test Starter Motor

CONDITIONS:

LEARN	REFERENCE	SOURCE
7. Using Ammeters and Voltmeters	7.	1. Shop Instructor
8. "Cutting a Generator Armature"	8. Continuous film loop # 8371	2. Resource Materials Center
9. "Replacing Generator Brushes"	9. Continuous film loop # 8370	3. Resource Materials Center
10. The Starter	10. Teaching machine cards 5A & 5B	4. Teaching Machine (Shop)

RATIO One value divided by another of like kind; usually expressed as a fraction. It tells the relationship between numbers. *The ratio of 75 to 100 is the same as the ratio of 3 to 4.*

REACTANCE In electrical circuits, reactance is the opposition of inductance and capacitance to alternating current. The symbol for reactance is X. Reactance is measured in ohms.

RECTIFICATION In electricity, the conversion of alternating current into one-directional current by means of a rectifier.

REPULSION Mechanical force tending to separate bodies having like electrical charges or like magnetic polarity.

RESISTANCE Property of a conductor which determines the amount of current that will flow as a result of the application of a given electromotive force.

RHEOSTAT A resistor whose value can be varied.

SCHEMATIC DIAGRAM Circuit diagram in which component parts are represented by simple, easily drawn symbols. Sometimes simply called the schematic.

SECONDARY Next below the first in importance; one in a subordinate place. In electricity, the output coil in a transformer.

SELENIUM Chemical element having marked photosensitive properties and a resistance that varies inversely with illumination. Selenium is also used in contact with iron to form the selenium rectifier.

SENSITIVITY Least input capable of causing a desired output.

SERIES A number of similar things or events standing or following each other in order. In electricity, the method of arranging the components in a circuit by connecting them end to end to provide a single path for current.

SHUNT To turn to one side. Electricity: 1. A precision, low-value resistor placed across the terminals of an ammeter to increase its range. 2. Any part connected in parallel with some other part. Or the act of connecting a part in parallel with some other part.

SIMULTANEOUS At the same time.

SOURCE Origin; first cause. *A battery is the source of electricity in some circuits.*

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STATIC Not changing, lacking movement. Electricity: 1. Referring to the electricity of charged bodies. 2. Interference in a circuit. Static may come from either natural disturbances, such as lightning or northern lights, or from nearby electrical equipment, usually due to some fault. 3. A fixed, non-varying condition, as those used to make certain tests known as static tests.

SUPERHETERODYNE RECEIVER A radio receiver in which a local oscillator creates a signal to be mixed with the incoming signal to produce another signal of a lower frequency. This new signal, called the IF signal, is the result of heterodyning or beating the two signals together. The IF signal undergoes high amplification in the IF amplifier stages and is then fed into a detector (the second detector) for demodulation. The signal from the second detector is then usually further amplified for power.

TECHNICIAN One highly skilled in the basics of a certain technical field and often highly trained in the physics and mathematics of that field. In industry, the technician interprets the engineer's language and directives to the production personnel.

TERMINAL Last, end, final. The final station in a radio relay system is called the terminal station. In electricity, a fitting to which electrical connections are made.

THEORY A general principle offered to explain certain facts.

TOROIDAL Shaped like a doughnut.

TRANSFORMER An electrical device, without moving parts, which by electromagnetic induction transfers electric energy from one or more circuits to one or more other circuits at the same frequency, usually with changed values of voltage and current.

TRANSMISSION 1. The transfer of electric power from one location to another through conductors. 2. The dispatching of a signal by wire or wireless.

TRANSISTOR A minute electronic device, used like an electron tube, which controls current-flow by means of a semiconductor, such as germanium.

VARIABLE Changing, changeable.

WHEATSTONE BRIDGE A null-type resistance-measuring circuit in which resistance is measured by direct comparison with a standard resistance. This circuit was devised by Samuel H. Christie, 1784-1865, English scientist and mathematician, and was introduced to the scientific world by Sir Charles Wheatstone, 1802-1875, English scientist and inventor.

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ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

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RESISTOR		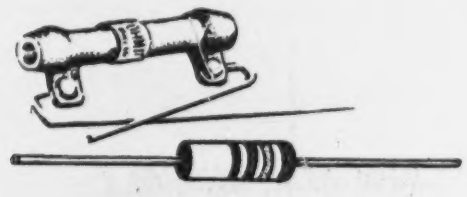
VARIABLE RESISTOR	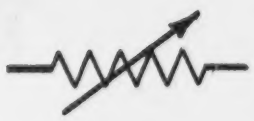	
TAPPED RESISTOR		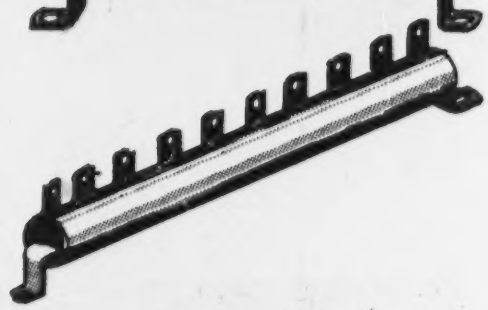
POTENTIOMETER	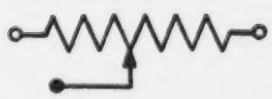	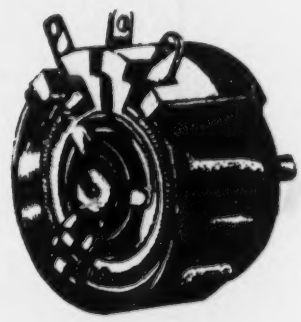
RHEOSTAT		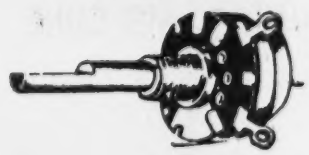
CAPACITOR, FIXED	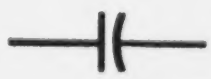	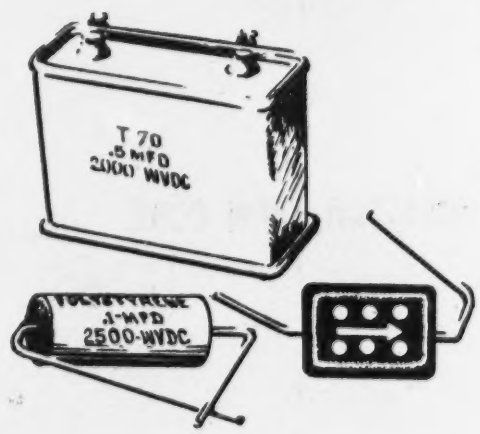

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ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

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CAPACITOR, VARIABLE		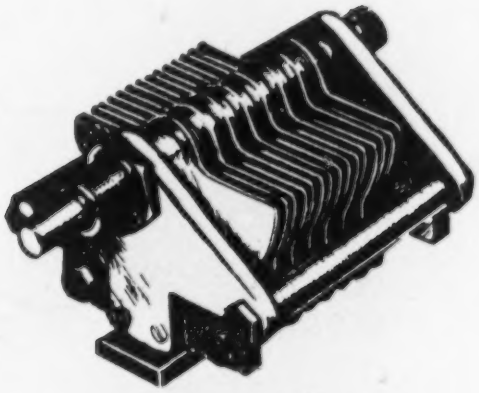
CAPACITOR, GANGED	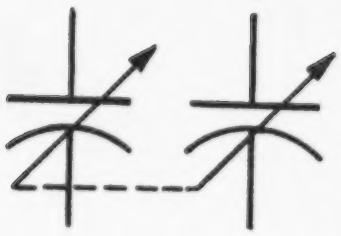	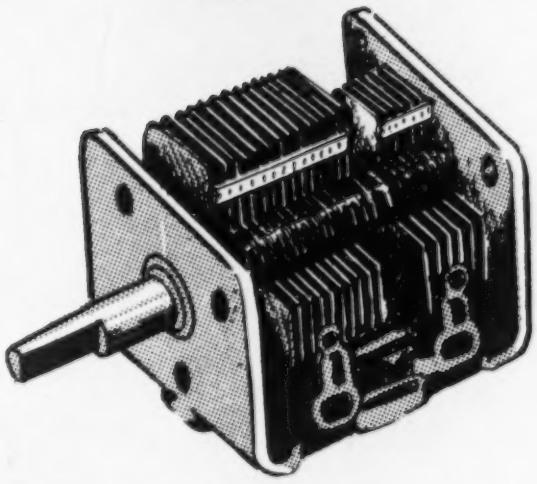
INDUCTOR, AIR CORE		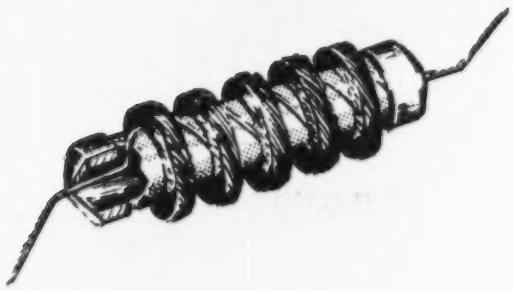
INDUCTOR, IRON CORE		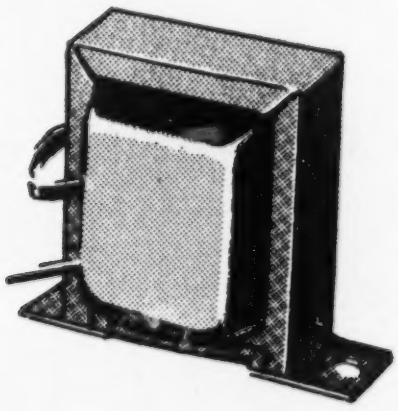

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ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

Name	Symbol	Picture
BATTERY		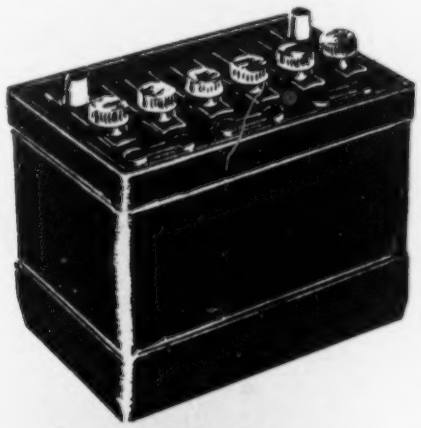
GENERATOR (MAY BE A-C OR D-C, DEPENDING ON HOW LABELED)		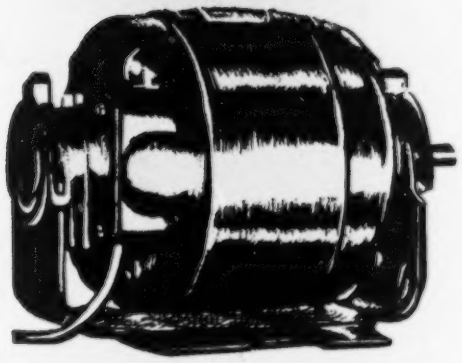
MOTOR (MAY BE A-C OR D-C DEPENDING ON HOW LABELED)		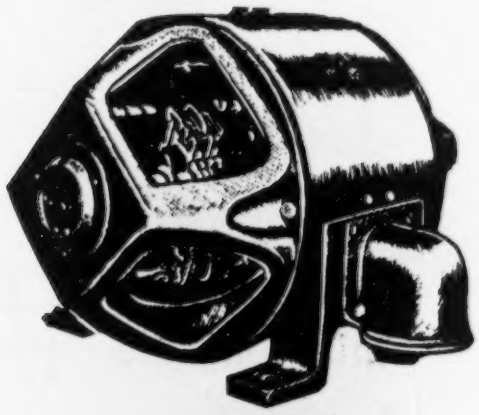
RECTIFIER	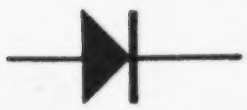	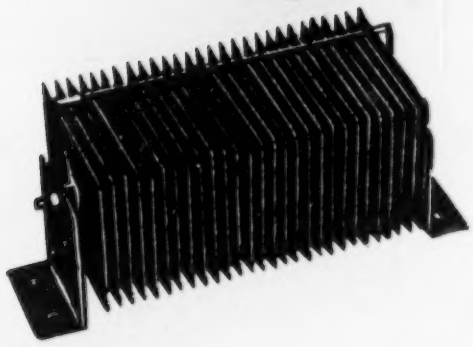

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ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

Name	Symbol	Picture
TRANSFORMER, AIR CORE		
TRANSFORMER, IRON CORE		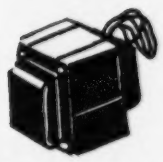
RELAY COIL WITH CONTACTS	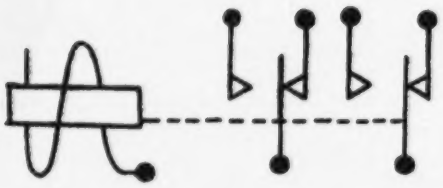	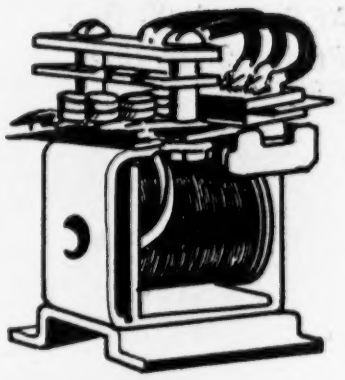
PIEZOELECTRIC CRYSTAL UNIT		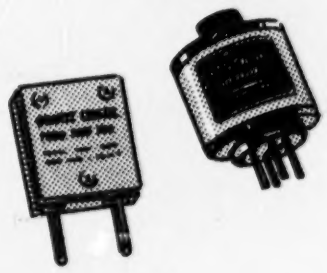

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ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

Name	Symbol	Picture
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NO CONNECTION	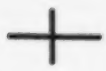	
GROUND		
TWO-CONDUCTOR CABLE		
SHIELDED TWO-CONDUCTOR CABLE		
COAXIAL CABLE		
SINGLE POLE SINGLE THROW SWITCH		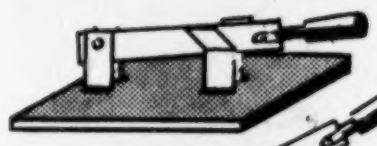
SINGLE POLE DOUBLE THROW SWITCH		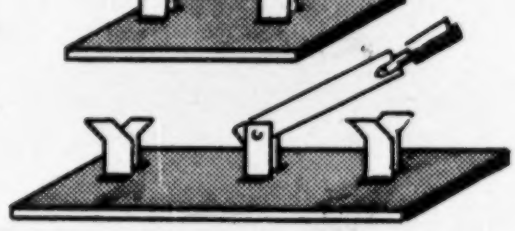
DOUBLE POLE SINGLE THROW SWITCH	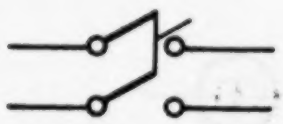	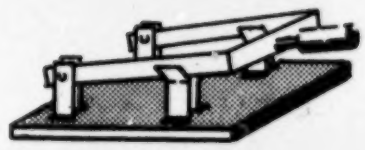
DOUBLE POLE DOUBLE THROW SWITCH		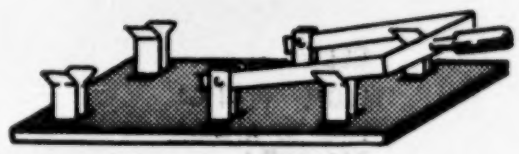

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ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

Name	Symbol	Picture
SWITCH CIRCUIT BREAKER		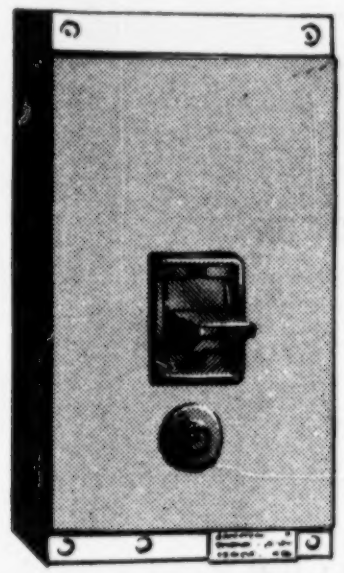
PUSH CIRCUIT BREAKER		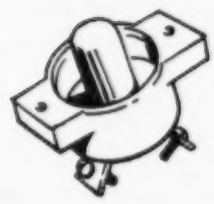
PUSH-PULL CIRCUIT BREAKER		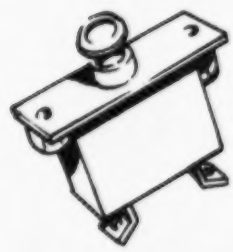
FUSE		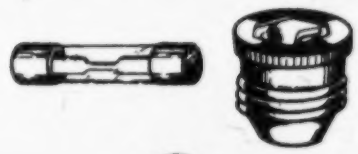
LAMP		
CELL (LONG VERTICAL LINE IS ALWAYS POSITIVE)		

15306

15303

ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

Name	Symbol	Picture
THERMAL RESISTOR (BALLAST LAMP)		
VOLTAGE REGULATOR OR GLOW TUBE (d-c TYPE)		
GLOW LAMP (COLD CATHODE) a-c TYPE		
SYNCHRO TRANSMITTER RECEIVER OR CONTROL TRANSFORMER		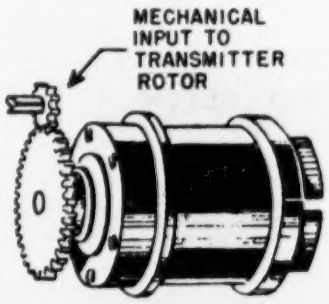
DIFFERENTIAL TRANSMITTER OR RECEIVER		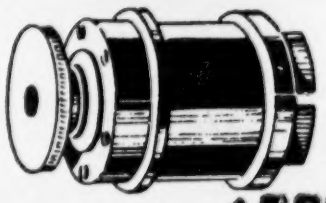

15307

15307

ELECTRICAL SYMBOLS

WITH ILLUSTRATIONS OF TYPICAL DEVICES

Name	Symbol	Picture
HEADPHONES		
MICROPHONE	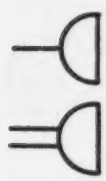	
LOUDSPEAKER		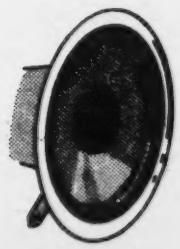
VOLTMETER		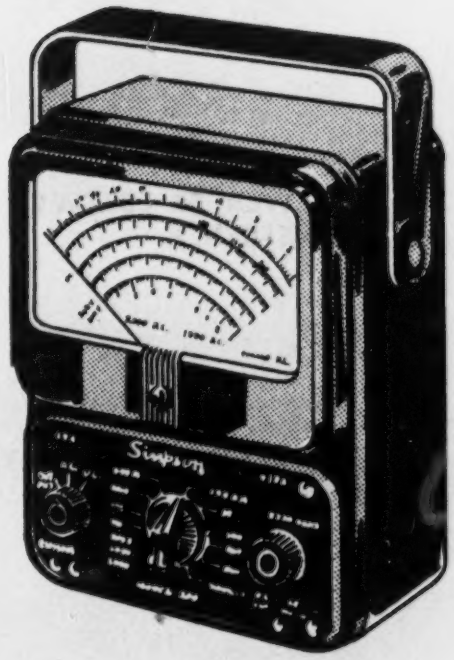
AMMETER		
OHMMETER		

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1528

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: IV STARTING MOTOR

PERFORMANCE OBJECTIVE NO: 4 TITLE: Remove, Overhaul, Replace and Test Starter Motor

CONDITIONS: Student will learn the related information listed below

ITEM	REFERENCE	SOURCE
1. Fundamentals, Construction, and Controls of a Starting Motor	1. Automotive Electrical Equipment, by Crouse. pp. 110 through 144 Automotive Electrical Equipment Workbook, by Crouse. Jobs 16 through 22	1. Related Information Class
2. "Current Electricity"	2. Filmstrip	2. Resource Materials Center
3. "The Starting Motor"	3. Filmstrip	3. Resource Materials Center
4. Using the armature lather	4.	4. Shop Instructor
5. Using the growler	5.	5. Shop Instructor
6. Principles of Ammeters and Voltmeters	6. Automotive Electrical Circuits, by Ford Motor Co. pp. 21 through 67	6. Programmed Instruction Class

UNIT XIII

ACHIEVEMENT TEST

1. Write the equations for I_1 and I_2 in the following circuit.

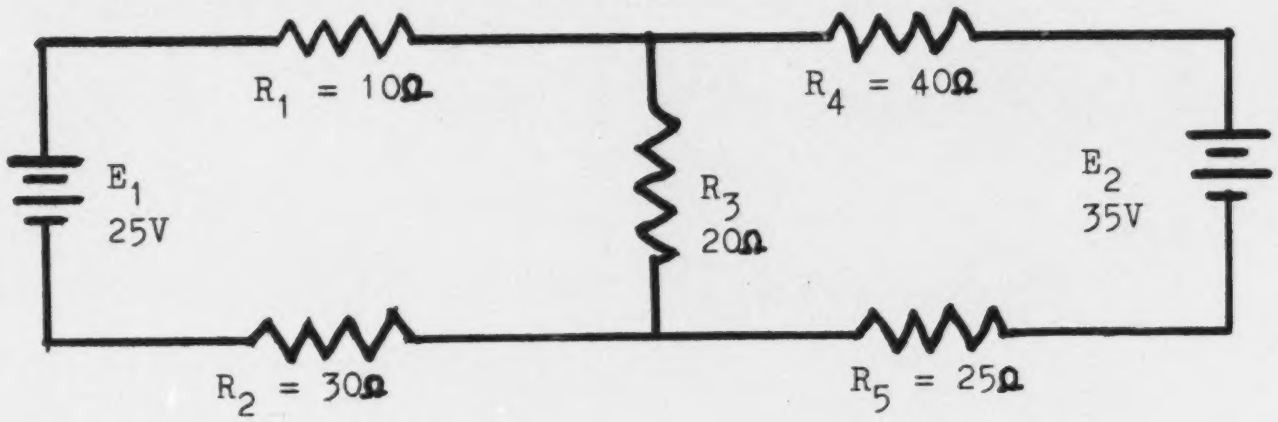

2. From the following two equations, find the value of I_1.

$$20I_1 + 30I_1 + 30I_2 + 60I_1 - 50 = 0$$

$$30I_2 + 10I_2 + 10I_1 + 20I_2 - 80 = 0$$

3. From the following two equations, find the value of I_1.

$$30I_1 + 20I_2 - 90 = 0$$

$$60I_1 + 10I_2 - 30 = 0$$

4. From the equations in problem 3, find the value of I_2.

5. State Kirchoff's first law in your own words.

15309

UNIT XIV

ACHIEVEMENT TEST

1. How did the magnet get its name?

2. What is Alnico?

3. If a coil of 1200 turns has a current of 3 amperes flowing through it, what is its magnetomotive force?

4. Explain in your own words the molecular theory of magnetism.

5. Who was Hans Christian Oersted? What did he do?

6. Draw a cross section of a wire, indicate the direction of an electric current going through it, and show the direction of magnetic flux around it.

7. What does the letter H denote?

8. What is a gilbert?

9. Give three precautions for preserving the strength of a permanent magnet.

10. What is field intensity?

15210

UNIT XV

ACHIEVEMENT TEST

1. What type of meter movement is the most commonly used?

2. Give another name for the movement mentioned above.

3. Is the movement mentioned above a current-or voltage-operated device?

4. How many coils are there in the electrodynamometer movement?

5. How does the electrodynamometer movement compare with the commonly used movement mentioned in No. 1 in (a) sensitivity, (b) accuracy?

6. Explain the principle of operation of the iron-vane type of meter movement.

7. What are the principles on which the thermocouple-ammeter works?

8. For what types of measurements is the bolometer usually used?

9. Is the electrostatic voltmeter a current-or voltage-operated device?

10. What type of meter movement does not have a linear scale?

11. How is the sensitivity of an ammeter rated?

12. How is the sensitivity of a voltmeter rated?

13. Name the two purposes for which the galvanometer is used.

15311

UNIT XVI

ACHIEVEMENT TEST

1. Why are meter rectifiers placed in voltohmmeters?

2. Is the rectifier needed in the d.c. voltmeter circuit?

3. Why are multiwafer rotary switches used in voltohmmeters?

4. What is the principle difference between a d.c. voltmeter and an a.c. voltmeter?

5. Why is there a battery in a VOM?

6. Generally speaking, how are the resistors placed in the ammeter circuit?

7. How many different kinds of measurements can one accomplish with a VOM?

8. Why should every electronics technician have a VTVM?

9. What do the letters in VTVM stand for?

10. In a vacuum tube, what controls the flow of electrons?

15312

UNIT XVIII

ACHIEVEMENT TEST

1. What is reactance?

2. How are capacitive reactance and inductive reactance related to each other?

3. Will d.c. pass through a capacitor?

4. How does inductive reactance affect the flow of d.c.?

5. If a 2-henry inductor is placed in series with a 60-cps circuit, what is the X_L?

6. If an electric heater draws 5 amperes from a 110-volt line, how much power is it consuming?

7. Explain why power transmission lines carry a.c. rather than d.c.

8. How much current is being drawn by a 150-watt light bulb when it is connected to its rated voltage of 110 volts?

9. In the field of electronics, what does the Greek letter lambda stand for?

10. What is the frequency of a 20-meter radio signal?

15313

UNIT XIX

ACHIEVEMENT TEST

1. Draw a rough graph showing two different progressions, one linear and the other exponential.

2. Explain what a dielectric is and what happens to the atoms of the dielectric when a capacitor is holding a charge.

3. What is a capacitor? What kind of functions does it perform, and what does it do in performing its functions?

4. What is the unit of capacitance?

5. What part of a farad is a microfarad?

6. What is a micro-microfarad?

7. What is a picofarad?

8. What is capacitive reactance?

9. In what units is inductance measured?

10. In what units is inductive reactance measured?

11. What is the X_L of a 60 Hz circuit which has inductance amounting to 1.18 henry?

12. If the above circuit also has capacitance amounting to 6 μf, what is the overall reactance?

15314

UNIT XX

ACHIEVEMENT TEST

1. What are power supplies? Why are they needed?
2. What does a rectifier do?
3. Name two kinds of rectifiers - the devices, not the circuits.
4. How does a vibrator power supply operate?
5. What is half-wave rectification? Explain and draw a circuit.
6. What is a semiconductor material?
7. Draw the symbol for an autotransformer and explain how it works.
8. What is full-wave rectification?
9. What is regulation?
10. Draw a bridge-type full-wave rectifier.

15315

VT 012 916
The Supervision and Training of Case Aides. A Reading Reference for Supervisors and Staff Trainers.

California State Human Relations Agency, Sacramento. Dept. of Social Welfare.
MF AVAILABLE IN VT-ERIC SET.
Training Aid No. 39B
PUB DATE - Aug70 32p.

DESCRIPTORS - *SUPPLEMENTARY READING MATERIALS; *SUPERVISORY TRAINING; *CASEWORKERS; *SUBPROFESSIONALS; *SOCIAL SERVICES; VOCATIONAL EDUCATION; WELFARE SERVICES; JOB TRAINING; SUPERVISOR ACTIVITIES

ABSTRACT - This supplementary material was prepared by the Training Bureau of the Human Relations Agency, California State Department of Social Welfare and is to be used by supervisors and staff trainers as a reference to and summary of principles relating to the supervision and training of case aides and their role in the public welfare system. References accompany the textual material, and the material is keyed to the training sessions in VT 012 920 also in this issue. (SB)

VT 012 916

ED0 56238

TRAINING AID

Number 39B

THE SUPERVISION AND TRAINING OF CA

A Reading Reference for Supervisors and St

August 1970

STATE OF CALIFORNIA
HUMAN RELATIONS AGENCY
DEPARTMENT OF SOCIAL WELFARE
Robert Martin – Director

TRAINING BUREAU
B. R. Becker – Chief

VT012916

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TRAINING AID

Number 39B

THE SUPERVISION AND TRAINING OF CASE AIDES

A Reading Reference for Supervisors and Staff Trainers

August 1970

STATE OF CALIFORNIA
HUMAN RELATIONS AGENCY
DEPARTMENT OF SOCIAL WELFARE

Robert Martin – Director

TRAINING BUREAU

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15318

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: IV. STARTING MOTOR

PERFORMANCE OBJECTIVE NO.: 4 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Starting Motor

CONDITIONS:

This assignment is to be performed on a complete automobile.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper manual and turn to appropiate chapter
6. Select proper tools and materials
7. Disconnect battery ground cable
8. Disconnect battery to solenoid cable from battery
9. Position support arms under automobile and carefully raise automobile with floor lift to desired working height
10. Remove starter terminal nut and remove starter cable
11. Remove starter to clutch housing bolts
12. Remove starter by bringing forward until bendix drive clears starter ring gear then lower fron under automobile

PERFORMANCE CRITERIA:

1527

TRAINING AID
Number 39B

THE SUPERVISION AND TRAINING OF CASE

A Reading Reference for Supervisors and St

August 1970

State of California
Human Relations Agency
Department of Social Welfare

Robert Martin - Director

Training Bureau

B. R. Becker - Chief

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TRAINING AID
Number 39B

THE SUPERVISION AND TRAINING OF CASE AIDES.

A Reading Reference for Supervisors and Staff Trainers

August 1970

State of California
Human Relations Agency
Department of Social Welfare

Robert Martin - Director

Training Bureau

B. R. Becker - Chief

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References

Finch, Wilbur, The Training of Welfare Aides in Providing Services to Clients. Oregon Public Welfare Division, Staff Development Section, June 1969.

THE SUPERVISION AND TRAINING OF CASE AIDES IN PUBLIC WELFAR

Introduction

A major effort is currently being undertaken by a number of agencies to restructure job assignments so as to achieve tw comes from a recognized need to enrich and expand social se stresses the need for an expanded use of different classifi providing agency program services to clients. The second g recognition that large groups of individuals, and particula tofore been denied access to employment in the human servic meaningful job opportunities, which provide training and ca nities for welfare recipients and other poor persons, place upon the human services field to define meaningful employme opportunity for such persons to enter employment through ag The unique skills of the professional, in short supply, can priately used to maximum benefit when those tasks he now pe or utilize his education, are delegated to other staff who performing these as members of an agency service team. In which preprofessional staff members can perform which have vided to agency clients due to a lack of sufficient staff t

The purpose of this reference is to look more closely at th Aide in public welfare, and particularly to summarize from ture, the knowledge and some of the principles which have be to the training and supervision of these new staff members, services field, in general, as well as in public welfare it and supervision of Case Aides in public welfare is likely t of whether this opportunity to employ preprofessionals wil adding new and necessary dimensions to the agency's program question of the ability of preprofessionals to contribute t based upon the experiences of many other agencies in recent

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PERVISION AND TRAINING OF CASE AIDES IN PUBLIC WELFARE

uction

r effort is currently being undertaken by a number of governmental and private
es to restructure job assignments so as to achieve two major goals. The first
from a recognized need to enrich and expand social services to clients and
es the need for an expanded use of different classification levels of staff in
ng agency program services to clients. The second goal comes from increased
tion that large groups of individuals, and particularly the poor, have here-
been denied access to employment in the human services. The need to open
gful job opportunities, which provide training and career advancement opportu-
for welfare recipients and other poor persons, places heavy responsibility
e human services field to define meaningful employment tasks, and to provide
nity for such persons to enter employment through agencies like public welfare.
que skills of the professional, in short supply, can only be said to be appro-
y used to maximum benefit when those tasks he now performs, which do not require
ize his education, are delegated to other staff who are equally capable of
ning these as members of an agency service team. In addition, there are services
reprofessional staff members can perform which have not been previously pro-
o agency clients due to a lack of sufficient staff time and resources.

pose of this reference is to look more closely at the new role of the Case
public welfare, and particularly to summarize from the professional litera-
e knowledge and some of the principles which have been developed in relation
training and supervision of these new staff members, within the broader human
s field, in general, as well as in public welfare itself. Because the training
ervision of Case Aides in public welfare is likely to be the prime determinent
her this opportunity to employ preprofessionals will truly provide a means of
new and necessary dimensions to the agency's program - for there can be little
n of the ability of preprofessionals to contribute to such an achievement,
pon the experiences of many other agencies in recent years - the line

References

supervisor must assume an important teaching role, nec
meaningful place for the Case Aide as a member of an a
ble for the provision of defined program services to a

Social Welfare Manpower Needs

Although major efforts have been made since 1962, to i
of professional schools of social work, primarily thro
leave stipends, public welfare agencies have increasin
efforts alone will not solve the "manpower crisis" in
most continuously involved since 1962. Obviously, the
must be found elsewhere. To some extent, the employme
reate degrees to provide public welfare program servic
administrative realization that sufficient professiona
would probably never be available to fill all social s
agency. More recently, many persons have asked whethe
in the best of possible worlds, to employ MSW's to f
Obviously, it would not because many public welfare se
persons with less education. However, the analysis of
in achieving program goals has yet to be accomplished,
of the tasks to be performed by the MSW, the baccalaur
case aide classifications can be identified. The prim
problems in public welfare, as in other human service
found in the creation of a continuum of classification
sibilities clearly differentiated at each level of pro
system wherein the expertise of each employee is recog

Lally, Winifred A., "The Public Service Career Program: Its Implication for Client, Agency, and Community."

By relieving professional workers with an MSW or a bac
that do not require professional education at either a
level for their performance, the agency will be openin
and effective use of professional staff time and an im
the provision of program services. Thus, the differen
reflected in the new careers for the poor concept must

15325

ervisor must assume an important teaching role, necessary to the preparation of a ningful place for the Case Aide as a member of an agency team which is responsi- for the provision of defined program services to a specific group of clients.

ial Welfare Manpower Needs

hough major efforts have been made since 1962, to increase the number of graduates professional schools of social work, primarily through provision of educational ve stipends, public welfare agencies have increasingly come to realize that these orts alone will not solve the "manpower crisis" in which the agency has been al- t continuously involved since 1962. Obviously, the solution of manpower problems t be found elsewhere. To some extent, the employment of workers with baccalau- te degrees to provide public welfare program services to clients earlier reflected inistrative realization that sufficient professional manpower, with an MSW degree, ld probably never be available to fill all social service positions within the ncy. More recently, many persons have asked whether the agency would want, even the best of possible worlds, to employ MSW's to fill many of these positions. iously, it would not because many public welfare services can be provided by sons with less education. However, the analysis of various tasks to be performed achieving program goals has yet to be accomplished, so that clearer delineation the tasks to be performed by the MSW, the baccalaureate degree worker and various e aide classifications can be identified. The primary solution to manpower blems in public welfare, as in other human service agencies, must ultimately be nd in the creation of a continuum of classification levels of staff, with respon- ilities clearly differentiated at each level of professional development - a tem wherein the expertise of each employee is recognized and fully utilized.

relieving professional workers with an MSW or a baccalaureate degree of tasks t do not require professional education at either a graduate or undergraduate el for their performance, the agency will be opening the door to a more efficient effective use of professional staff time and an improved level of practice in provision of program services. Thus, the differential use of staff which is lected in the new careers for the poor concept must, if it is to be fully realized,

References

Public Welfare, The Journal of the American Public Welfare Association, Vol. XXVII, No. 2 (April 1969).

Pearl, Arthur and Riessman, Frank - New Careers for The Poor. The Free Press, New York, 1965. (See Chapter 1, Poverty and New Careers for Nonprofessionals.)

eventually result in new careers for the professional
role of the social service worker, when several employ
taneous contact with an individual client, must necess
his previous responsibilities for sole relationship in
placing emphasis on a larger purview of the helping re
reciprocal influence of auxiliary helping roles. Thus
social service worker of the need for skill in the use
require him to sharpen his perception of his own role
purposefully with the client, the total agency work gr
staff designated as carrying specific service function
leadership role in the delivery of program services.

The New Career Concept and Its Implication for Public

As proposed and developed by Pearl and Riessman, the "
with the premise that there is a need to create new jo
and that these jobs will involve the assignment of a n
to more highly-educated professional or technical staf
relatively unskilled, inexperienced persons, and assig
recruited from among recipient groups. Hiring the poo
a fundamental and logical approach to the problem of p
society, partly because these jobs are less likely to
and partly because of the need to provide vastly impro
those members of our society who are in need of agency
identified needs which social agencies have been unabl
of current manpower resources. Preprofessionals can,
needed manpower resources and contribute to expanding
in an automated and industrial age.

Providing jobs for the poor which they can perform mus
steps taken in implementing a new career concept. The
they must become a meaningful and intricate part of th
provide opportunity for advancement through a multi-le
ment through a series of positions requiring the perfo
and more responsible tasks of a related nature is to b
might eventually provide a continuum of positions rang

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ntually result in new careers for the professional as well. For example, the e of the social service worker, when several employees have direct and simul- eous contact with an individual client, must necessarily differ markedly from previous responsibilities for sole relationship in the helping process - instead cing emphasis on a larger purview of the helping relationship by adding the iprocal influence of auxiliary helping roles. Thus, rather than relieving the ial service worker of the need for skill in the use of relationship, it will uire him to sharpen his perception of his own role and to use his skills more posefully with the client, the total agency work group and those members of ff designated as carrying specific service functions. It will center him in a dership role in the delivery of program services.

New Career Concept and Its Implication for Public Welfare

proposed and developed by Pearl and Riessman, the "new career concept" begins h the premise that there is a need to create new jobs within the human services; that these jobs will involve the assignment of a number of tasks normally allotted more highly-educated professional or technical staff, but which can be performed by atively unskilled, inexperienced persons, and assigning these to preprofessionals, ruited from among recipient groups. Hiring the poor to serve the poor is certainly undamental and logical approach to the problem of poverty within a highly automated iety, partly because these jobs are less likely to be automated out of existence partly because of the need to provide vastly improved and enriched services for se members of our society who are in need of agency intervention. There are many ntified needs which social agencies have been unable to meet within the limitations current manpower resources. Preprofessionals can, especially in these areas, provide ded manpower resources and contribute to expanding the vast array of services required an automated and industrial age.

viding jobs for the poor which they can perform must be only the first of a number of os taken in implementing a new career concept. These jobs must be made permanent; y must become a meaningful and intricate part of the agency system; and they must vide opportunity for advancement through a multi-level lattice of positions. Advance- t through a series of positions requiring the performance of increasingly complex more responsible tasks of a related nature is to be an agency goal. Such a lattice nt eventually provide a continuum of positions ranging from nonskilled entry level

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: IV. STARTING MOTOR

PERFORMANCE OBJECTIVE NO.: 4 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Starting Motor

CONDITIONS:

BEHAVIOR:

13. Disassemble starter following steps as outlined in manual
14. Make all tests and checks as outlined in manual
15. Reassemble starter following steps as outlined in manual
16. Make all final bench tests as outlined in manual
17. If all tests and checks are satisfactory, proceed as follows;
18. Return starter to position underneath automobile and insert into starter hole in flywheel housing, observing all precautions as outlined in manual
19. Position starter so that bolt holes line up
20. Install starter to flywheel housing bolts and tighten
21. Connect starter cable and tighten nut
22. Remove all tools, materials, etc. from underneath the automobile
23. Release lock on floor lift
24. Release air and lower automobile to floor
25. Connect battery to solenoid cable
26. Connect battery ground cable

PERFORMANCE CRITERIA:

References

Elston, Patricia, "Public Welfare: The Breath of Change." Up From Poverty. ed. by Frank Riessman and Hermine I. Popper, Harper and Row Publishers, New York, 1968.

assignments, continuing through intermediate nor
position (two years of college plus experience)
college plus experience), and finally terminatir
tion (requiring graduate education). Thus, if
one will eventually see the development of separ
vice, within income maintenance, and within spec
opportunity for vertical advancement, as well as
where an individual's skills can most effective
one to which he is currently assigned.

The new career concept and its application with
tually involve the adoption and implementation
any one of which will individually determine whe
meaningful use of staff will succeed or fail.
include:

1. The employment, training, and use of p
job assignments to perform social serv
on redefined social service goals.

2. The total restructuring of job assignm
of staff, to assure maximum use of pro
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3. Adoption of a social service team appr
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ties to meet this).

4. Expansion of the opportunities for upw
including the planned use of both inse
of educational leave.

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signments, continuing through intermediate nonprofessional functions, an assistant sition (two years of college plus experience), a worker position (four years of llege plus experience), and finally terminating in a recognized professional posi-on (requiring graduate education). Thus, if this concept is to be fully implemented, e will eventually see the development of separate career ladders within social ser-ce, within income maintenance, and within specialized technical functions, with an portunity for vertical advancement, as well as horizontal transfer in those situations ere an individual's skills can most effectively be developed in an area other than the e to which he is currently assigned.

e new career concept and its application within the public welfare system must even-ally involve the adoption and implementation of four major administrative strategies, y one of which will individually determine whether the agency's goal of a differential aningful use of staff will succeed or fail. Briefly, these four strategies will clude:

1. The employment, training, and use of preprofessional staff in newly created job assignments to perform social service tasks and functions which are based on redefined social service goals.

2. The total restructuring of job assignments at various classification levels of staff, to assure maximum use of professional education at both a graduate and undergraduate level, and employment experience.

3. Adoption of a social service team approach wherein several members of staff. will work together to achieve the social service goal for and with the client (and in variance with past emphasis upon the single social service worker's assessing client need and performing all necessary agency activi-ties to meet this).

4. Expansion of the opportunities for upward mobility of all staff members, including the planned use of both inservice training and part-time use of educational leave.

References

Gertrude S. Goldberg, "Nonprofessionals in Human Services," Charles Grosser, William E. Henry and James G. Kelly, eds., Jossey-Bass Inc., San Francisco, 1969.

*Ibid. p. 19.

Training Bureau, An Orientation and Induction Training Course for Case Aides. California State Department of Social Welfare, April 1969. pp. 2-3 (Included in the introduction of this training aid is a list of the more common tasks assigned to Case Aides in California county public welfare departments.)

The Use of Case Aides in the Human Services

Because of the relative newness of preprofessionals as
of social services, there are yet no clearly defined b
aide activites should occur. Instead, each agency ha
preprofessional responsibilities in terms of its own p
while differentiating case aide functions from those t
fication levels of staff. Because of the wide range o
experiences with which case aides come to the agency,
and particularly the early tasks which they are asked
determined by the specific abilities of the individua
program definitions of functions which have been iden

Studies which have been done in the area of social se
that most tasks performed by preprofessionals can be g
gories of responsibility:

1. Direct service responsibilities usually invo
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with clients through common language or styl
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county public welfare departments in Califor
responsibilities have frequently taken the f
and advising clients on such matters as food
household management, and budget planning.

2. Joint responsibilities, ancillary to the pro
services, usually aim more specifically at b
service into more productive contact. Withi
departments in California, such joint respon
Case Aide in securing information from clien
worker) in determining or redetermining elig
tance; or in escorting a hesitant client (wh
service worker) to, from and through the use
resource already determined to be needed by

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The Use of Case Aides in the Human Services

Because of the relative newness of preprofessionals as team members in the delivery of social services, there are yet no clearly defined boundaries within which case aide activites should occur. Instead, each agency has faced the task of defining preprofessional responsibilities in terms of its own program of services to clients, while differentiating case aide functions from those to be performed by other classification levels of staff. Because of the wide range of skill, education, and life experiences with which case aides come to the agency, their specific assignments, and particularly the early tasks which they are asked to perform, will largely be determined by the specific abilities of the individual aide, within the broader program definitions of functions which have been identified.

Studies which have been done in the area of social service task assignments suggest that most tasks performed by preprofessionals can be grouped under four broad categories of responsibility:

1. Direct service responsibilities usually involve aspects of counseling, remediation, job development, tutoring and teaching. Such assignments tend to make maximum use of preprofessional skills in specific areas and attitudes, such as "enthusiasm, spontaneity, ability to communicate with clients through common language or style, empathy, and ability to help clients to negotiate the complexities of the ghetto."* Within county public welfare departments in California, such direct service responsibilities have frequently taken the form of showing, demonstrating, and advising clients on such matters as food preparation and buying, household management, and budget planning.

2. Joint responsibilities, ancillary to the provision of other agency services, usually aim more specifically at bringing the client and the service into more productive contact. Within county public welfare departments in California, such joint responsibilities may involve the Case Aide in securing information from clients, needed (by an eligibility worker) in determining or redetermining eligibility for financial assistance; or in escorting a hesitant client (who is being seen by a social service worker) to, from and through the use of a specific community resource already determined to be needed by the client.

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References

Nixon, Russell A., "Congressional Actions." Nonprofessionals in the Human Services, Grosser, Charles; Henry, Wm. E.; and Kelly, James G., eds., Jossey-Bass Inc., San Francisco, 1969.

Pearl, Arthur and Riessman, Frank, New Careers for the Poor. The Free Press, New York, 1965.

3. Bridging responsibilities involve a
agency to a larger target populatio
client. For example, in California
such activities may take the form o
(or groups of clients) on the use o
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4. Recruitment and follow-up responsib
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county public welfare departments s
Aide in advising and assisting a pa
request for agency social services.

Legislative Trends

The use of preprofessionals in the provision
There is precedent for such programs, previo
recently in numerous experimental and demons
institutions have made use of different clas
care and services to their client population
social agency has tended to move somewhat sl
bution of preprofessionals to direct service
the Economic Opportunity Act of 1964 has con
new careers concept, because of its emphasis
and the involvement of the consumer of servi
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other, in defining this concept, has provide
planning and implementing new careers progra

In 1966, the first major legislation was pas
program. In amendments to the Economic Oppo
(Title II, Sec. 205, e) to prepare low-incom

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3. Bridging responsibilities involve activities which help to relate the agency to a larger target population, rather than to an individual client. For example, in California county public welfare departments, such activities may take the form of explaining and advising clients (or groups of clients) on the use of resources within the county department; or locating and meeting with established neighborhood groups which have neighborhood improvement goals, to provide information about the agency.

4. Recruitment and follow-up responsibilities involve activities which aim at locating potential clients or potential users of a specific program from among an already identified client group. For example, in California county public welfare departments such activities may involve the Case Aide in advising and assisting a particular client to make an initial request for agency social services.

Legislative Trends

The use of preprofessionals in the provision of social services is not a new idea. There is precedent for such programs, previously during World War II, and more recently in numerous experimental and demonstration projects. For many years, institutions have made use of different classification levels of staff in providing care and services to their client population, even if the more traditional community social agency has tended to move somewhat slower in recognizing the potential contribution of preprofessionals to direct service activities. Probably the enactment of the Economic Opportunity Act of 1964 has contributed most to the development of a new careers concept, because of its emphasis upon maximum participation by the poor, and the involvement of the consumer of services in planning and deciding how such services are to be provided. The following year saw the publication of Arthur Pearl's and Frank Riessman's book, New Careers for the Poor. This publication, more than any other, in defining this concept, has provided the needed direction necessary to planning and implementing new careers programs.

In 1966, the first major legislation was passed directly implementing a new careers program. In amendments to the Economic Opportuity Act, a new program was established (Title II, Sec. 205, e) to prepare low-income persons to enter career employment in

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References

public services. This "Scheuer Amendment" marked congressiona
idea that "new careers for the poor" was to be a major thrust
employment opportunities for those previously denied access to
cupations. In the 1967 amendments to this same act, the langua
provisions were further strengthened and, in congressional rep
made of the need to assure job opportunities for those who are
Senate report stated:

United States Congress, Senate Report No. 563, Committee on Labor and Public Welfare, Economic Opportunity Amendments of 1967, Sept. 12, 1967, p. 25.

> "The new careers program is too new for evaluation. Howe
> committee notes that while the early emphasis is upon tra
> is proper, it appears that not enough attention is being
> assure that 'new career' jobs, paid by other funds, will
> at the completion of training. It will not be easy to br
> traditional barriers, such as civil service regulations a
> sional 'standards', which block the disadvantaged from mo
> public service occupations, but considerable effort must
> this regard if the program is to succeed."

Nixon, Russell A., op. cit., pp. 206-227.

It was of surprise to very few persons when, in the Social Sec
1967, this same commitment to a new career concept was specifi
public welfare. At this time, the training, employment and us
in the provision of the public welfare program services became
ment upon the various states who administer the categorical ai
as upon their county welfare departments, if federal matching
claimed for administrative costs in the provision of social se
Similar directions in legislation were taken by Congress in th
Act Amendments of 1967, the Vocational Education Act of 1968, t
Rehabilitation Act Amendments of 1968, the Intergovernmental M
to mention only some of the more noticeable pieces of legislat
new career goals. There can be little question of the governm
the creation of employment opportunities for the poor in publi
to implement a program of meaningful job opportunities is now
the agency. A commitment has been made to participate in this
tions to broader social ills, while strengthening and enrichin
those whom the agency is committed to serve.

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lic services. This "Scheuer Amendment" marked congressional commitment to the a that "new careers for the poor" was to be a major thrust toward creation of loyment opportunities for those previously denied access to public service oc- ations. In the 1967 amendments to this same act, the language as well as its visions were further strengthened and, in congressional reports, stress was e of the need to assure job opportunities for those who are trained. The ate report stated:

> "The new careers program is too new for evaluation. However, the committee notes that while the early emphasis is upon training, which is proper, it appears that not enough attention is being given to assure that 'new career' jobs, paid by other funds, will be available at the completion of training. It will not be easy to break down traditional barriers, such as civil service regulations and profes- sional 'standards', which block the disadvantaged from moving into public service occupations, but considerable effort must be made in this regard if the program is to succeed."

as of surprise to very few persons when, in the Social Security Amendments of , this same commitment to a new career concept was specifically implemented in ic welfare. At this time, the training, employment and use of preprofessionals he provision of the public welfare program services became a federal require- upon the various states who administer the categorical aid programs, as well pon their county welfare departments, if federal matching funds are to be med for administrative costs in the provision of social services to clients. lar directions in legislation were taken by Congress in the Higher Education Amendments of 1967, the Vocational Education Act of 1968, the Vocational bilitation Act Amendments of 1968, the Intergovernmental Manpower Act of 1967 - ention only some of the more noticeable pieces of legislation which have furthered career goals. There can be little question of the governmental commitment to creation of employment opportunities for the poor in public welfare. The task mplement a program of meaningful job opportunities is now a responsibility of agency. A commitment has been made to participate in this program to seek solu- s to broader social ills, while strengthening and enriching social services to e whom the agency is committed to serve.

References

	Federal and State Regulations
Department of Health, Education, and Welfare, Social and Rehabilitation Service, Interim Policy Statement No. 15, August 5, 1968.	In implementation of the 1967 Amendments to th training and effective use of subprofessional federal regulations require each state's plan effective use of subprofessional staff as com or full-time employment of persons of low inc ients...." These regulations specify five mi the purpose intended by this legislation. Th "1. Such methods of recruitment and sele full-time or part-time employment of educational achievement, including e adults, older persons, and the physi of recipients; "2. an administrative staffing plan to i of which subprofessional staff are a "3. a career service plan permitting per subprofessional level and, according experience, preservice and inservice with pay, progress to positions of i "4. an organized training program, super subprofessional staff; and "5. annual progressive expansion of the numbers of subprofessional staff as appropriate number and proportion of staff are achieved to make maximum operation."
Ibid., pp. 1 and 2.	

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Federal and State Regulations

In implementation of the 1967 Amendments to the Social Security Act, relating to the training and effective use of subprofessional staff as community service aides, federal regulations require each state's plan to provide for the "training and effective use of subprofessional staff as community service aides through part-time or full-time employment of persons of low income, and where applicable, of recipients...." These regulations specify five minimum requirements needed to meet the purpose intended by this legislation. These include:

"1. Such methods of recruitment and selection as will offer opportunity for full-time or part-time employment of persons of low income and low-educational achievement, including employment of young and middle-aged adults, older persons, and the physically and mentally disabled...and of recipients;

"2. an administrative staffing plan to include the range of service personnel of which subprofessional staff are an integral part;

"3. a career service plan permitting persons to enter employment at the subprofessional level and, according to their abilities, through work experience, preservice and inservice training and educational leave with pay, progress to positions of increasing responsibility and reward;

"4. an organized training program, supervision and supportive services for subprofessional staff; and

"5. annual progressive expansion of the plan to assure utilization of increasing numbers of subprofessional staff as community service aids, until an appropriate number and proportion of subprofessional staff to professional staff are achieved to make maximum use of subprofessionals in program operation."

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: IV. STARTING MOTOR

PERFORMANCE OBJECTIVE NO.: 4 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Starting Motor

CONDITIONS:

BEHAVIOR:

27. Make a thorough check of all connections
28. Remove all tools, materials, etc. from engine compartment
29. Remove coil to distributor secondary wire from center of distributor cap and ground to engine
30. Crank engine to determine starter cranking speed (Check battery state of charge)
31. Make all checks and tests as outlined in manual
32. If all tests and cranking speed check satisfactory, replace coil wire to center terminal of distributor
33. Remove all testing equipment, tools, etc. from engine compartment
34. Start engine and stop engine several times
35. If everything checks satisfactory, return all tools and materials to proper place
36. Remove fender covers
37. Close hood
38. Return automobile to proper parking area
39. Remove seat covers and store in proper place
40. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to remove, disassemble, reassemble, replace, and test starting motor in 3 hours.

Learning time: 6 hours

References

California SDSW Manual Regulations 10-203.7

California State Department of Social Welfare Manual Reg
objectives for the agency's planned employment and use o
stresses the potential enrichment of county department's
clients; a second, which emphasizes the improvement in s
a third identifies the need to provide employment opport
families within the human services. By no later than Ju
staffing plan is expected to provide for the employment,
use of Service Aides in both Adult, and Family and Chil
tion,these regulations stress that the county staffing p

1. An organized training program which includes th
facilities, community colleges and other approp
tutions;

2. Provide annually for progressive expansion in
assigned to the services system, until maximum
Aides is assured;

3. Assignment of responsibility for the ongoing de
the use of Aides to a specific member of the c

4. Supervision of the individual Services Aide by
services staff.

Similarly, county departments are encouraged to also pr
and use of case aides within the income maintenance fun

Preassignment Training for Case Aides

Emanual Rallowitz, Issues and Strategies in the Use of Nonprofes-sionals. A paper pre-sented at the NASW Sym-

The use of the preprofessional, whose attributes and co
for him to serve the poor, not in the same way that the
way which is still helpful and which brings the poor an
closer touch with each other, is a primary goal to be s
effectiveness and competencies of the preprofessional ar

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lifornia State Department of Social Welfare Manual Regulations identify three jectives for the agency's planned employment and use of case aides: one, which resses the potential enrichment of county department's program of services to ients; a second, which emphasizes the improvement in services to the poor and third identifies the need to provide employment opportunities to low-income nilies within the human services. By no later than July 1, 1969, each county affing plan is expected to provide for the employment, training and effective e of Service Aides in both Adult, and Family and Children's programs. In addi-on, these regulations stress that the county staffing plan shall include:

1. An organized training program which includes the use of adult education facilities, community colleges and other appropriate educational institutions;

2. Provide annually for progressive expansion in the number of Aides assigned to the services system, until maximum utilization of Service Aides is assured;

3. Assignment of responsibility for the ongoing development and expansion of the use of Aides to a specific member of the county department staff; and

4. Supervision of the individual Services Aide by a member of the social services staff.

nilarly, county departments are encouraged to also provide for the development d use of case aides within the income maintenance function.

eassignment Training for Case Aides

e use of the preprofessional, whose attributes and competencies make it possible r him to serve the poor, not in the same way that the professional does but in a y which is still helpful and which brings the poor and the professional into oser touch with each other, is a primary goal to be sought through training. The fectiveness and competencies of the preprofessional are based upon natural skills

References

posium, National Conference on Social Welfare, San Francisco, May 25, 1968 (unpublished manuscript).

Arthur Pearl and Frank Riessman, New Careers for the Poor. The Free Press, New York, 1965. p. 156.

Pauline R. Coggs and Vivian R. Robinson, "Training Indigenous Community Leaders for Employment in Social Work." Social Casework, Family Service Association of America, Vol. XLVII, No. 5 (May 1967).

Training Bureau, An Orientation and Induction Training Course for Case Aides. Training and OOA, State Department of Social Welfare, April 1970.

acquired not through education but through lif
training is to help the Case Aide to further d
rather than to teach him a new or different wa

Nothing will undermine an agency's planned use
services to clients so much as to allow new Ca
with clients with the mistaken notion that mer
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Although it will be important for the line sup
Aide's lack of professional education and expe
what can be expected realistically of him in h
important to remember that many of the abiliti
social worker are a result of personality deve
the Case Aide may also have access. Within hi
Aide can develop competencies, if his developm
thoughtful supervisory training in the perform
For this reason, the line supervisor must assu
whatever broader program of training and educa

Wherever the use of Case Aides has been succes
kind of preservice or preassignment training h
county public welfare departments, this perio
accomplish five basic tasks:

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ed not through education but through life experience. The task then of
ng is to help the Case Aide to further develop his natural ways of helping,
than to teach him a new or different way of helping clients.

g will undermine an agency's planned use of preprofessionals in providing
es to clients so much as to allow new Case Aides to perform meaningful work
lients with the mistaken notion that merely their poverty background and life
ences are sufficient qualifications for helping others. The training of Case
to assume beginning positions within the agency, is both the crux of a new
s concept as well as the prime determinate of whether the agency's planned
different classification levels of staff will be successful. He must be
specific skills necessary to performing his job assignment; he must be
how to relate both to clients as well as to other members of staff with
e will be working; he must be helped to acquire a feeling of belonging
agency team in order to identify with the agency's superior purposes
ms; and, lastly, he must, in the course of his training, acquire a feel-
fulfillment which comes from performing meaningful and necessary activi-
ith increasing skill and confidence in his own abilities.

gh it will be important for the line supervisor to recognize that the Case
lack of professional education and experience will result in limitations in
an be expected realistically of him in his work with clients, it is equally
ant to remember that many of the abilities of the professionally educated
worker are a result of personality development and life experiences to which
se Aide may also have access. Within his specific job assignments, the Case
an develop competencies, if his development is consciously planned and involves
tful supervisory training in the performance of individual but related tasks.
is reason, the line supervisor must assume a core role of facilitator in
er broader program of training and education is ultimately developed.

er the use of Case Aides has been successfully demonstrated, the need for some
f preservice or preassignment training has been identified. In California
public welfare departments, this period of orientation essentially seeks to
lish five basic tasks:

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References

1. It should familiarize the new Case Aide with
bilities as an employee as well as the beginn
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tensive learning process which aims at helpin
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5. It should introduce the new Case Aide to some
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It should be noted that orientation training is consci
period of preassignment training in order to avoid arc
these new employees. Thus, by the time the Case Aide
following a one-week period of orientation training, h
understanding of his new role, the kinds of tasks he w
expectations of him as an employee, the agency progran
helping clients, and the other classifications of sta
work. The line supervisor, at this point, must help h
ning knowledge as he is given his first assignments.

. It should familiarize the new Case Aide with his rights and responsibilities as an employee as well as the beginning expectations which the agency holds for him. As such, orientation will begin a more extensive learning process which aims at helping the Case Aide to achieve identification with this new role of "employee." For many, this may involve the more difficult shift from a previous role as "client."

. It should familiarize the new Case Aide with some of the beginning tasks he will perform as a Case Aide, and the broader role to be played by the Aide, as a team member, concerned with providing meaningful services to clients. With such knowledge, the new Case Aide can begin to weigh and consider how he can draw upon his own life experiences in helping others.

. It should review major parts of the agency's program, to help the new Case Aide gain awareness of his own knowledge of public welfare and begin providing new information about portions of the program with which he is not familiar.

. It should introduce some beginning ways in which the Case Aide will work with clients, particularly on his early assignments, and provide some opportunity to practice these beginning skills.

. It should introduce the new Case Aide to some of the other classification groups of staff with whom he will be working, providing some understanding of what their role and function will be in relation to his own.

uld be noted that orientation training is consciously limited to a one-week of preassignment training in order to avoid arousing undue anxiety among new employees. Thus, by the time the Case Aide begins his job assignment, ing a one-week period of orientation training, he should have acquired some tanding of his new role, the kinds of tasks he will be performing, the agency's ations of him as an employee, the agency programs within which he will be g clients, and the other classifications of staff with whom he will jointly The line supervisor, at this point, must help him to make use of this begin- nowledge as he is given his first assignments.

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References

George Brager, "The Indigenous Worker: A New Approach to the Social Work Technician." Social Work, The Journal of the National Association of Social Workers, Vol. 10, No. 2 (April 1965).

Dorothea Cudaback, Case Sharing in the AFDC Program: The Use of Welfare Service Aides. University of California School of Social Welfare Research Projects Office and the Alameda County Welfare Department, October 1967.

The "Style" of the Case Aide

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Cudaback describes this style in one of her m
ences in the Alameda County Welfare Departmen

> "Our Aides' communication with their cli
> personal. They usually address each oth
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> common ground by mentioning their own ex
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> other hand, if they think the client can
> open, direct and authoritative. They ma
> visit that she should take more baths, o
> tend to show emotions freely, expressing
> affection openly."

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'Style" of the Case Aide

bly no area dealing with the employment of Case Aides has received wider tion from professional writers than the "style" with which preprofessionals with clients, primarily because their ways of working with clients should and ffer markedly from the ways in which a social service worker will work with ts. With awareness that any discussion of style must ultimately represent alizations - as there will likely be as many exceptions to what is said as are similarities - it might still be helpful to look more closely at some of ways in which Case Aides have been characterized as working differently from social service worker counterpart on the agency team.

pproach which an Aide will take and the ways in which a Case Aide will work clients have variously been described by such words as honesty, frankness, tance, directness, informality and practicalness. In contrast to his social ce worker counterpart, the Case Aide is more likely to respond to the immedi- tated concerns and tangible needs of her client with immediate action. Dorothea ack describes this style in one of her many papers, based upon project experi- in the Alameda County Welfare Department. She says:

'Our Aides' communication with their clients is casual, friendly, and personal. They usually address each other by first names, or might easily substitute 'honey' or 'sweetie'. Aides quickly establish a common ground by mentioning their own ex-client status and openly dis- cuss their own personal experiences as mothers, homemakers, etc., to make a point. They take time to just talk to clients; even on routine contacts (i.e., picking up a completed application form) they might spend up to an hour in relaxed conversation. If they think clients might be resistant to service, they spend several visits just getting acquainted, before they move to the purpose of the referral. On the other hand, if they think the client can take it, they can be alarmingly open, direct and authoritative. They may tell a client on the first visit that she should take more baths, or keep her house cleaner. They tend to show emotions freely, expressing anger, pleasure, warmth, and affection openly."

References

*George Brager, op. cit., p. 37.

The Case Aide will most often give his prime attention
external life situation, as opposed to internal influen
uncommon for a social service worker to see a client as
Case Aide will view this same client as "reacting to th
which she lives."* Perhaps these differences in their w
perceiving of clients, which the supervisor will want t
describe why a Case Aide can be most successful in help
of problems. His own economic deprivations and life ex
with coping skills which derive themselves from, and ar
environment from which he has come. Thus his abilities
considerable, are more likely to be within the grasp of
abilities to stretch leftover food, to manage on surplu
bargains in unusual places, and to deal with the more e
systems, may be highly developed - even though he is no
skills in planning and handling his own life situation.
it is inevitable that the success of the Case Aide wil
upon such factors as the line supervisor's ability to e
develop his own "styles" of helping; the degree to whi
supervisory instruction primarily by what is helpful to
preconceived notions about how help "should be provide
supervisory-worker environment can foster discovery of
the Aide's individual helping skills. Case Aides will
However, these will not ordinarily be serious or irrep
provided the freedom to err as well as the opportunity
the gains for both the client and the Aide will be of

Because of past life experiences, the Case Aide may al
feelings to this new job assignment which are dissiden
to assume. For example, because of his prior dependen
having to live, as a recipient, on less than adequate
surprised occasionally to find a new Case Aide coming
toward and fearfulness of the agency. If recognized
malized training and supervisory instruction can help

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Case Aide will most often give his prime attention to factors in the client's ernal life situation, as opposed to internal influences. Thus, it will not be ommon for a social service worker to see a client as "neglectful," while the e Aide will view this same client as "reacting to the terrible conditions in ch she lives."* Perhaps these differences in their ways of working with and ceiving of clients, which the supervisor will want to encourage, most graphically cribe why a Case Aide can be most successful in helping clients with certain kinds problems. His own economic deprivations and life experiences have provided him n coping skills which derive themselves from, and are characteristic of, the ironment from which he has come. Thus his abilities and attainments, while siderable, are more likely to be within the grasp of impoverished clients. His lities to stretch leftover food, to manage on surplus commodities, to locate gains in unusual places, and to deal with the more established institutional tems, may be highly developed - even though he is not always conscious of these lls in planning and handling his own life situation. Under such circumstances, is inevitable that the success of the Case Aide will depend in large measure n such factors as the line supervisor's ability to encourage him to further elop his own "styles" of helping; the degree to which he can be guided in ervisory instruction primarily by what is helpful to the client rather than conceived notions about how help "should be provided"; and the extent which the ervisory-worker environment can foster discovery of ways to further develop Aide's individual helping skills. Case Aides will make frequent mistakes. ever, these will not ordinarily be serious or irreparable, and if the Aide is vided the freedom to err as well as the opportunity to learn from his mistakes, gains for both the client and the Aide will be of far greater value.

ause of past life experiences, the Case Aide may also bring some attitudes and lings to this new job assignment which are dissident to the helping role he is assume. For example, because of his prior dependency upon the agency and ing to live, as a recipient, on less than adequate income, one should not be prised occasionally to find a new Case Aide coming with feelings of hostility ard and fearfulness of the agency. If recognized and planned for, both for- ized training and supervisory instruction can help the Aide to move beyond

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: V GENERATOR

PERFORMANCE OBJECTIVE NO: 5 TITLE: Remove, Overhaul, Test and Replace Generator (Cont.)

CONDITIONS:

LEARN	REFERENCE	SOURCE
5. "Replacing Generator Brushes"	5. Continuous loop film # 8370	5. Resource Materials Center
6. "Cutting a Generator Armature"	6. Continuous loop film # 8371	6. Resource Materials Center
7. Generators and Regulators	7. Teaching machine cards 6A, 6B, 6C, 6D	7. Shop

References

these initial feelings in assuming his employee-hel
Dissident attitudes may be expressed in other areas
more common problems which have been found with the
include:

1. Some Case Aides may be sensitive to what th
differential treatment of clients on the pa
service workers. When this occurs, they ma
some clients, becoming hostile toward case
to them, to be punitive in dealing with the
Case Aide will need special supervisory he
perceptions, and the effects of his reactio

2. Some Case Aides may come to the agency wit
professional" as being a person who is deta
unconcerned about his clients. As with any
need to be repeatedly handled until the Cas
helping role with clients which is mutually
service worker activities.

3. Some Case Aides may initially see little d
skills and those of the social service work
belief that, having been poor, they are be
with and understand the needs of their cli
help in understanding the expertise of each
and the different ways in which each can be

4. Some mothers who have been on AFDC may come
position with noticeably hostile feelings
in general, which can, if not constructive
their ability to work with some families.

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these initial feelings in assuming his employee-helping role with clients. Dissident attitudes may be expressed in other areas as well. Several of the more common problems which have been found with the employment of Case Aides include:

1. Some Case Aides may be sensitive to what they perceive to be differential treatment of clients on the part of various social service workers. When this occurs, they may over identify with some clients, becoming hostile toward case workers who appear, to them, to be punitive in dealing with them. At such times, the Case Aide will need special supervisory help to understand his perceptions, and the effects of his reactions upon the client.

2. Some Case Aides may come to the agency with an image of "the professional" as being a person who is detached, unfeeling, and unconcerned about his clients. As with any stereotype, this may need to be repeatedly handled until the Case Aide can assume a helping role with clients which is mutually supportive with social service worker activities.

3. Some Case Aides may initially see little difference between their skills and those of the social service worker because of their belief that, having been poor, they are better able to communicate with and understand the needs of their clients. They will need help in understanding the expertise of each member of the team, and the different ways in which each can be of help to clients.

4. Some mothers who have been on AFDC may come to their Case Aide position with noticeably hostile feelings toward AFDC fathers, in general, which can, if not constructively handled, limit their ability to work with some families.

References

George Brager, "The Indigenous Worker: A New Approach to the Social Work Technician" Social Work, the Journal of the National Association of Social Workers, Vol. 10, No. 2 (April 1965).

Thus, as with any group of new staff members, cha
can be identified. However, the agency skill nee
pate these in the planning of both formalized tra
conferences. Attitudinal changes are an importan
whereby any new employee achieves identification
All new employees, no matter what their classific
with some stereotyped attitudes, which may or may
goals. If new Case Aides will differ markedly fr
it is more likely to be in the way they express t
fact that they have them. The Aide will more lik

In shifting from a client to an employee role, sp
to the fact that the Case Aide will be concerned
and will need supervisory help in making this tr
may complain about poor working conditions, for e
centrate upon the job at hand. Nevertheless, th
can be of critical importance to many, including
to immobilization, if not considered in the prior
supervisor in anticipation of the new employee's

In summary then, the Case Aide's "style" or manne
and will be different from that of the social se
these differences might best be seen in the foll
Case Aide characteristics:

1. In his work with clients, the Case Aide
direction - he "decides," "announces" a
vice worker, on the other hand, is more

2. In the Case Aide's contact with clients
ably less formal. He may hug clients,
share first names.

Thus, as with any group of new staff members, characteristic kinds of problems can be identified. However, the agency skill needed is the ability to anticipate these in the planning of both formalized training as well as supervisory conferences. Attitudinal changes are an important part of any induction process whereby any new employee achieves identification with the agency's superior aims. All new employees, no matter what their classification, will come to the agency with some stereotyped attitudes, which may or may not be compatible with program goals. If new Case Aides will differ markedly from new social service workers, it is more likely to be in the way they express these attitudes, rather than the fact that they have them. The Aide will more likely present these for others to see.

In shifting from a client to an employee role, special recognition must be given to the fact that the Case Aide will be concerned about his place as an employee, and will need supervisory help in making this transition. New social service workers may complain about poor working conditions, for example, but still be able to concentrate upon the job at hand. Nevertheless, the working and environmental conditions can be of critical importance to many, including Case Aides, and for some, contribute to immobilization, if not considered in the prior planning which is done by the supervisor in anticipation of the new employee's arrival.

In summary then, the Case Aide's "style" or manner of working with clients should and will be different from that of the social service worker. In particular, these differences might best be seen in the following list of frequently observed Case Aide characteristics:

1. In his work with clients, the Case Aide frequently will provide active direction - he "decides," "announces" and "insists." (The social service worker, on the other hand, is more likely to "suggest" and "enable.")

2. In the Case Aide's contact with clients, he is more likely to be considerably less formal. He may hug clients, accept (and repay) hospitality, and share first names.

References

Martin L. Birnbaum and Chester H. Jones, "Activities of the Social Work Aides." Social Casework, Family Service Assoc. of America, Vol. XLVIII, No. 10 (December 1967). p. 630.

Dorothea Cudaback, Training and Education of New Careerists in Public Welfare. Circular Letter No. 2408, State Department of Social Welfare - January 27, 1970.

3. Mutuality of interest and shared
Aide and the client may be more e
made to "we" blacks.

4. The Case Aide is less likely to b
role" and thus is more likely to

5. The Case Aide is more likely to
need and his most visible problem

Perhaps one last problem, stemming from th
tioned. This is the possibility of overi
It would be very easy to encourage and rev
in a Case Aide. One supervisor in a fami
scribes this skillful role which is requi
of Aides.

> "I had to understand this danger and,
> desire to 'move upward,' remember th
> enable them to continue to look back
> income community.... The supervisor
> so well that this relationship betwe
> level cannot be a one-sided affair i

Thus, the "style" of the Case Aide is an
helping skills as well as a reflection of
will be contained the very important expe
in order to enrich its program of service

The Supervision of Case Aides

Implementating a new careers concept with
the specific tasks which are to be assig
department's program of services to clien
ingredients: (1) the Case Aide's backgro

3. Mutuality of interest and shared group loyalties between the Case Aide and the client may be more evident. Thus, comments may be made to "we" blacks.

4. The Case Aide is less likely to be unencumbered by a "professional role" and thus is more likely to express himself openly and frankly.

5. The Case Aide is more likely to respond to the clients's stated need and his most visible problem.

erhaps one last problem, stemming from these characteristics, should be mentioned. This is the possibility of overidentification with the professional. t would be very easy to encourage and reward professional kinds of behavior n a Case Aide. One supervisor in a family service agency most clearly describes this skillful role which is required of the supervisor in his training f Aides.

> "I had to understand this danger and, while not discouraging the Aide's desire to 'move upward,' remember that a major goal of training is to enable them to continue to look back at how life really is in the low income community.... The supervisor must be willing to learn. We know so well that this relationship between supervisee and supervisor on any level cannot be a one-sided affair if it is to be meaningful."

hus, the "style" of the Case Aide is an important and initial part of his elping skills as well as a reflection of his life experience. Within it ill be contained the very important expertise for which the agency searches n order to enrich its program of services to clients.

he Supervision of Case Aides

mplementating a new careers concept within public welfare, will mean that the specific tasks which are to be assigned to a Case Aide, within the county epartment's program of services to clients, must make use of three essential ngredients: (1) the Case Aide's background, which is indigenous to the

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References

population served by the agency; (2) the specific know
the Case Aide has gleaned from life experiences in the
being a recipient of agency services; and (3) the Case
develop his natural ways of helping, rather than to lea
others. The supervisor's task then, is to maximize ea
in his day-to-day instruction of the Aide.

Because of the nature and kinds of assignments which t
given, and because it is his life experiences and skil
hopes to capitalize, supervisory teaching will want to
and techniques from those used more frequently in teac
degree worker. In addition, teaching must reflect rec
different ways in which Case Aides will learn. Two ma
to underscore any more detailed consideration of the s
First, the Case Aide, coming as he will from more disa
the community, is likely to bring to this new assignme
feelings toward the power structure which are common
sents. Because the supervisor will, especially in his
Case Aide, represent agency authority he will want to
flicting attitudes and feelings with which the new Aid
overcome, in developing a meaningful use of supervisio
Aide will work with clients in ways which are differen
worker's methods of helping, it may be difficult for t
quish initial fears that the Aide will not do a qualit
However, if such fears are not relinquished, the resul
be a proliferation of ways to control and direct this
thus hampering the establishment of the creative envir
development of personal and individual skills.

As county departments have acquired experience in supe
Aides, certain patterns have emerged reflecting the k
needed in supervision, to help these new staff members
helping role. Three such factors which have been stre

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erved by the agency; (2) the specific knowledge and skills which de has gleaned from life experiences in the poverty area and in pient of agency services; and (3) the Case Aide's need to further natural ways of helping, rather than to learn a new way of helping supervisor's task then, is to maximize each of these ingredients o-day instruction of the Aide.

he nature and kinds of assignments which the Case Aide will be ecause it is his life experiences and skills upon which the agency italize, supervisory teaching will want to utilize different methods es from those used more frequently in teaching the baccaulaureate r. In addition, teaching must reflect recognition of some of the ys in which Case Aides will learn. Two major factors would seem e any more detailed consideration of the specifics of teaching. ase Aide, coming as he will from more disadvantaged groups within y, is likely to bring to this new assignment the same strong ard the power structure which are common to the group he repre- use the supervisor will, especially in his initial work with the epresent agency authority he will want to recognize the many con- itudes and feelings with which the new Aide must cope, and possibly developing a meaningful use of supervision. Second, because the rk with clients in ways which are different from the social service hods of helping, it may be difficult for the supervisor to relin- l fears that the Aide will not do a quality job with clients. such fears are not relinquished, the result is all too likely to ration of ways to control and direct this new worker's activities, ng the establishment of the creative environment needed for the of personal and individual skills.

partments have acquired experience in supervising and teaching Case in patterns have emerged reflecting the kinds of modifications pervision, to help these new staff members to assume their agency . Three such factors which have been stressed include:

References

1. The supervisor's (and a
dictory messages to Cas
to speak out about what
ularly where his observ

2. The supervisor's need t
conferences, where this
employment, and probabl
in his supervisory conf
"tell about his interes
problems he is having i
conception can frequent
rather than an individu

3. The supervisor's need t
that he is supervising
which which the Aide is
should be left free to
with the opportunity to

As has been implied in all that
which the line supervisor establ
need to differ markedly from a m
these new employees may have exp
experiences in school and prior
to respond positively to this mo
formalized training sessions mus
role for the participant and, in
visory conference will want to p
through-doing activities. Where
with "showing how" and "practice
a particular assignment. Servic
tasks, and the time taken to ass
of each step to be involved in c
by-doing is the primary method t
quickly and thoroughly be learne

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1. The supervisor's (and agency's) need to avoid the giving of contradictory messages to Case Aides. For example, encouraging the Aide to speak out about what he sees with other members of staff, particularly where his observations will not be welcomed.

2. The supervisor's need to make combined use of group and individual conferences, where this is possible. In the beginning of the Aide's employment, and probably for considerable time following, emphasis in his supervisory conferences should be upon asking the Aide to "tell about his interesting cases" rather than "tell about the problems he is having in his cases." Common areas of error and misconception can frequently be handled more successfully on a group, rather than an individual basis.

3. The supervisor's need to constantly and continually remind himself that he is supervising the worker, and not the individual case which which the Aide is working. Whenever possible, the Aide should be left free to accept or reject advice, providing him with the opportunity to err and to learn from his own mistakes.

s has been implied in all that has previously been said, the teaching role ich the line supervisor establishes in relation to the new Case Aide will ed to differ markedly from a more traditional academic approach. Many of ese new employees may have experienced unhappy and unsuccessful learning periences in school and prior job experiences, and thus are not as likely respond positively to this more traditional approach. For these reasons, rmalized training sessions must be planned so as to provide a more active le for the participant and, in similar fashion, teaching through supersory conference will want to place much greater emphasis upon learningrough-doing activities. Where possible, "telling" should be replaced th "showing how" and "practice" of what steps will be involved in completing particular assignment. Service activities must be broken down into simpler sks, and the time taken to assure understanding on the part of the Case Aide, each step to be involved in completing a particular task. Again, learning--doing is the primary method through which the job assignment will most ickly and thoroughly be learned.

References

Robert Becker, the Selection and Training of New Careerists. (Unpublished draft manuscript.) November 1969.

Within whatever ways the line supervisor finall
visory teaching of the new Case Aide, the follo
in the teaching which occurs:

1. Teaching must make maximum use of verb
assignments, written exercises, lectur
a give and take between the supervisor
the practical steps involved in perfor
of illustrations and examples, and enc
his own life experiences in seeking he

2. Emphasis in supervisory conferences sh
ticular steps involved in performing a
the information and knowledge needed t

3. Learning should primarily occur throug
followed by discussion within which th
dom to learn from his experiences, inc
make. Such teaching methods as role p
cussion appear to provide the more act
in the training of Aides.

4. Information which the Aide will need i
should be provided in simple, easily u
opportunity to question and identify e
experience in seeking more complete un

5. The many questions which the Case Aide
learning should be responded to direct
with an opportunity for the Aide to di

6. When the Case Aide is participating in
visor will want to plan opportunity fo
work with clients, the use of those sp
each training session.

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ever ways the line supervisor finally decides to plan her super-
hing of the new Case Aide, the following factors should be reflected
hing which occurs:

aching must make maximum use of verbal communication - not reading
signments, written exercises, lectures, etc. Discussion, involving
give and take between the supervisor and the Aide(s) should emphasize
e practical steps involved in performing a task, make frequent use
illustrations and examples, and encourage the learner to draw upon
s own life experiences in seeking helping solutions.

phasis in supervisory conferences should be on specifying the par-
cular steps involved in performing an assigned task, and acquiring
e information and knowledge needed to perform the task with skill.

arning should primarily occur through active, doing activities,
llowed by discussion within which the Aide will be given the free-
m to learn from his experiences, including the mistakes he will
ke. Such teaching methods as role playing, observation and dis-
ssion appear to provide the more active learning role to be sought
the training of Aides.

formation which the Aide will need in performing his job assignment
ould be provided in simple, easily understandable terms providing
portunity to question and identify examples from his own life
perience in seeking more complete understanding.

e many questions which the Case Aide will have in the process of
arning should be responded to directly, honestly and informally,
th an opportunity for the Aide to disagree being provided.

en the Case Aide is participating in formalized training, the super-
sor will want to plan opportunity for the Aide to practice, in his
rk with clients, the use of those specific content areas taught in
ch training session.

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References

In planning and scheduling conferences du
Aide's employment, brief daily conference
conferences. In this way, individual ass
assessed before additional assignments ar
ferences around single assignments, oppo
to performing the task is most likely to

Similarly, early assignments should invol
services which can be completed in one or
success has been achieved with this kind
of client contacts may be introduced.

The Use of Adult Learning Theory in the T

The fact that adults differ in the way th
fact to most supervisors. The experience
teaching of adult social service workers
group, markedly different learning patter
from the previous discussion, it is equal
ever varying patterns to tax the teaching
would,therefore,be useful to review some
have been identified as being of particul
professionals. Of paramount importance to
ever conscious of the fact that learning
any group, requires a change in behavior.
It must result from a consciously planned
training which aims at achieving clearly

Seven principles of learning appear in a
describe their experiences in training p

1. That learning must meet a need.

2. That learning should be active.

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ning and scheduling conferences during the initial months of the Case
employment, brief daily conferences are frequently preferred over weekly
nces. In this way, individual assignments can be made and the experience
d before additional assignments are made. By planning these early con-
s around single assignments, opportunity to discuss each step necessary
orming the task is most likely to be provided before it is to be performed.

ly, early assignments should involve the provision of concrete kinds of
s which can be completed in one or two client contacts. When sufficient
has been achieved with this kind of activity, services involving a series
nt contacts may be introduced.

of Adult Learning Theory in the Training of Case Aides

t that adults differ in the way they learn is a well accepted and known
most supervisors. The experienced supervisor has also learned, in his
g of adult social service workers, that even among this more homogeneous
markedly different learning patterns and styles are readily evident. Thus,
e previous discussion, it is equally evident that the Case Aide will bring
rying patterns to tax the teaching skills of the supervisor. Perhaps it
herefore, be useful to review some of the principles of adult learning which
en identified as being of particular value and use in the training of pre-
ionals. Of paramount importance to the supervisor is the need to remain
nscious of the fact that learning for this group of new employees, as with
up, requires a change in behavior. Such a change will not occur by accident.
result from a consciously planned, thoughtfully implemented, program of
g which aims at achieving clearly defined and measurable changes in behavior.

rinciples of learning appear in a variety of forms as various authors
e their experiences in training preprofessionals. Simply stated, these are:

That learning must meet a need.

That learning should be active.

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References

Richard W. Hallstein, "We Know Where to Start." Training and Development Journal, July 1969.

3. That learning tasks and experiences shoul
sequence, with each subsequent session bu
experience.

4. That learning should be broken down into
learner can comprehend the various parts

5. That learning should include repetition a
to practice the skill being taught.

6. That learning should include a knowledge
the opportunity for learning from experie

7. That learning experiences must be readily
related by the Case Aide. In other words,
the particular content being taught is di
usable in his work with clients.

In addition to these basic principles, the experien
departments have clearly identified other factors w
training of Case Aides, particularly in their early
Of critical importance is the fact that a variety o
more likely to achieve the results desired. Thus,
sions must be joined together with observational ex
on-the-job training, forming a well-planned, meanin
ience. For this reason, learning must and should t
and in the Case Aides' early job assignments. Wher
various learning experiences will:

1. Build upon the specific knowledge and skil
brings to the job assignment.

2. Take advantage and utilize the Case Aide's
and upon these build new skills needed in

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3. That learning tasks and experiences should be arranged in a logical sequence, with each subsequent session building upon the preceding experience.

4. That learning should be broken down into its parts, so that the learner can comprehend the various parts which comprise the whole.

5. That learning should include repetition and sufficient opportunity to practice the skill being taught.

6. That learning should include a knowledge of results, to maximize the opportunity for learning from experiences.

7. That learning experiences must be readily recognized as being job-related by the Case Aide. In other words, he will need to see how the particular content being taught is directly related to and usable in his work with clients.

addition to these basic principles, the experiences of various county artments have clearly identified other factors which should guide the ining of Case Aides, particularly in their early months of employment. critical importance is the fact that a variety of teaching methods are e likely to achieve the results desired. Thus, formalized training ses- ns must be joined together with observational experiences and supervisory the-job training, forming a well-planned, meaningful total learning exper- ce. For this reason, learning must and should take priority in supervision in the Case Aides' early job assignments. Where this is done, these ious learning experiences will:

1. Build upon the specific knowledge and skill which each Case Aide brings to the job assignment.

2. Take advantage and utilize the Case Aide's own life experiences, and upon these build new skills needed in his job assignment.

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3. Take advantage of the unique l
Case Aide.

4. Assure assignment of only thos
Aide's capacity - physically,

5. Provide the Case Aide with hel
in some situations from one as

6. Provide the supportive help wh
Aide role (covered more fully

Clearly, to be successful, training mus
meaningful role for the Case Aide in pu
seminar conducted by Sidney Fine, for r
departments from the Western States, he
defined the task of the supervisor when

> "A person learns from being what he
> him in the process of becoming."

One Approach for Viewing the Ways in Wh

One calculated risk in suggesting a mod
which Case Aides will work with clients
guidelines for the "one right way" to w
important to stress, at the beginning,
is a very basic and beginning step in t
more precisely, a meaningful role which
providing services to clients. Future
modifications and adaptations, and even
even totally different way of viewing '
However, for the present, this model ma
making sense" out of this new part of t
services to clients.

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advantage of the unique learning patterns and styles of the Aide.

e assignment of only those tasks which are within the Case s capacity - physically, emotionally, and psychologically.

de the Case Aide with help in preparing for a shift in roles, me situations from one as "client" to one of "employee."

de the supportive help which he will need to assume his Case role (covered more fully in a later section).

successful, training must be the cornerstone for building a e for the Case Aide in public welfare. In a recent workshop/ ted by Sidney Fine, for representatives of public welfare rom the Western States, he probably most clearly and succinctly sk of the supervisor when he said:

learns from being what he is. Your task is to involve e process of becoming."

for Viewing the Ways in Which a Case Aide Will Work With Clients

d risk in suggesting a model within which to view the ways in des will work with clients, is that it may appear to establish r the "one right way" to work with clients. Therefore, it is stress, at the beginning, that the specific model to be described ic and beginning step in the long process of seeking to clarify, y, a meaningful role which these new staff members are to play in vices to clients. Future agency experience is likely to provide and adaptations, and even possibly result in the development of an different way of viewing "what a Case Aide will do with clients." the present, this model may offer, to some, a scheme or map "for out of this new part of the agency's system for delivering social lients.

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From the kinds of tasks which are being assigned to Cas
direct service functions, in county departments, it is
series of three possible levels of helping techniques
functions which might be performed by the Case Aide as
helping skills. Within such a scheme, the beginning C
primarily by:

1. Providing material and concrete assistance fo

2. Providing information about, and help to use,
to the client.

3. Teaching through action and example, ways of
which threaten or prevent family functioning.

As the Case Aide would gain in experience and expand h
additional techniques could be taught, adding further
might help clients. Thus, he might additionally help

1. Acting as teacher-model (in his dealing with
those kinds of behavior and methods used in s
social problems.

2. Supporting positive client actions in problem

Sometime in the future, when further differentiation o
is possible, and when delineation of the ways in which
with his baccalaureate degree and master's degree in s
with clients, it is also possible to conceive of a th
which would, perhaps, have some overlapping functions
service worker. Thus, the very experienced Case Aide
two additional helping techniques to his repertoire.
help clients by:

1. Assisting the client to perceive and apprais
tives and to anticipate consequences through

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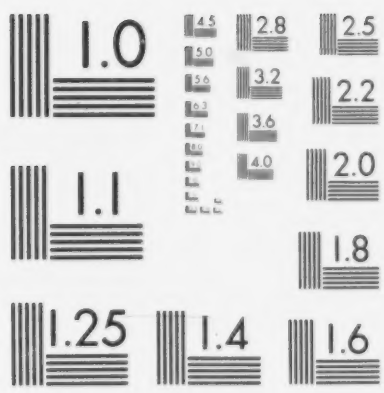

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: V. GENERATOR

PERFORMANCE OBJECTIVE NO.: 5 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Generator

CONDITIONS:

This assignment will be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper manual and turn to appropiate chapter
6. Select proper tools and materials
7. Disconnect battery ground cable
8. Check manual and follow steps necessary to remove any accessories which prevent removal of generator
9. Remove battery and generator field leads from generator. (If generator has ground wire disconnect it too)
10. Remove bolt from adjusting arm
11. Remove bolts from generator bracket (those securing generator to bracket only)
12. Carefully remove fan belt and lift generator from engine compartment

PERFORMANCE CRITERIA:

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nds of tasks which are being assigned to Case Aides within the area
vice functions, in county departments, it is possible to identify a
three possible levels of helping techniques - a continuum of overlapping
which might be performed by the Case Aide as he develops and expands his
lls. Within such a scheme, the beginning Case Aide might help clients
by:

roviding material and concrete assistance for and with the client.

roviding information about, and help to use, resources available to
the client.

aching through action and example, ways of managing situations
ich threaten or prevent family functioning.

Aide would gain in experience and expand his helping skills, some
techniques could be taught, adding further to the ways in which he
clients. Thus, he might additionally help clients by:

ting as teacher-model (in his dealing with the client), displaying
ose kinds of behavior and methods used in solving environmental-
cial problems.

pporting positive client actions in problem solving.

the future, when further differentiation of various Case Aide levels
, and when delineation of the ways in which the social service worker
ccalaureate degree and master's degree in social work will each work
s, it is also possible to conceive of a third Case Aide level, one
, perhaps, have some overlapping functions with a beginning social
ker. Thus, the very experienced Case Aide might be taught to add
nal helping techniques to his repertoire. He would then additionally
s by:

sisting the client to perceive and appraise reality, to see alterna-
ives and to anticipate consequences through logical discussion.

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2. Expressing his opinion and makin
decisions, where the client neec
of acting on his own.

While imperfect, this continuum of overla
to trainers by offering one way of perce
of helping,which a Case Aide might emplo
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The "Helper Therapy Principle"

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for them. (2) As the nonprofession
ing roles, they may actually become
provide more help to others at a ne

Frank Riessman, "The 'Helper' Principle." Social Work, The Journal of the National Association of Social Workers, Vol. 10, No. 2 (April 1965).

Ibid. p. 28.

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2. Expressing his opinion and making recommendations in guiding client decisions, where the client needs permission to act or is fearful of acting on his own.

While imperfect, this continuum of overlapping functions may be of some help to trainers by offering one way of perceiving of the differing levels or ways of helping,which a Case Aide might employ as he gains in agency experience and knowledge, and possibly participates in outside educational opportunities.

The "Helper Therapy Principle"

A principle of increasing interest to many social workers, is one which has been termed the "Helper Therapy Principle" - the use of people with a specific problem to help other people with a similar problem. With the addition of preprofessionals, as social service staff members within public welfare, the possible relatedness of this helper principle to the use of Case Aides, becomes more evident. Such a conscious use of people with specific problems to help others is not a new or very revolutionary idea, having already been a basic means of helping within such organizations as Alcoholics Anonymous and other similar groups. However, much of the writing on the use of such a principle has tended to focus primarily upon its potential benefit for the person being helped. In his more recent article, Frank Riessman suggests that emphasis is being placed upon the wrong person. The addition of Case Aides as members of a helping team, he believes, suggests a need to also focus our attention upon the person who is providing the help, because "frequently it is he who improves." Thus, Riessman identifies at least two important implications of the "Helper Therapy Principle" for the nonprofessional of lower socioeconomic background.

> "(1) Since many of the nonprofessionals to be recruited are former delinquents, addicts, AFDC mothers, and the like, it seems quite likely that placing them in a helping role can be rehabilitative for them. (2) As the nonprofessionals benefit from their new helping roles, they may actually become more effective workers and thus provide more help to others at a new level."

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Carried still further, the helper principle could well pr
development of new leadership roles within agency organiz
within the culturally disadvantaged groups from which pre
Thus, one might say that "leadership can develop through
the helper role would provide such an opportunity to many
the helper role contribute to the development of helping
are suggested, including:

Ibid. p. 31.

1. That the process of advocating or persuading oth
position, frequently results in a greater person
to this same position.

2. That in the process of helping, the helper is gi
ful part in the system. This contributes to a g
task, bringing about the further development of
help others.

Thus, the conscious use of a "Helper Therapy Principle" m
value in a wider distribution of the helper role, a poten
ership training, and especially, as an educational tool i
sionals to assume their Case Aide role. Certainly one co
less conscious use of this principle has been operative a
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with others in the helping professions, have not achieved
from their helping role, much more than has generally bee

Developing and Using a Team Concept

The incorporation into the public welfare system of diffe
of social service staff (or within the separated financia
formed by the agency) raises questions around what kind o
appropriately deploy manpower in service delivery, assuri
the discovery and development of human resources within b
sons. The traditional model that the agency has used whi

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ill further, the helper principle could well provide opportunity for the t of new leadership roles within agency organizations, and more importantly, culturally disadvantaged groups from which preprofessionals are recruited. might say that "leadership can develop through the process of leading," and role would provide such an opportunity to many of these persons. How can role contribute to the development of helping skills? Several mechanisms ted, including:

hat the process of advocating or persuading others about a specific osition, frequently results in a greater personal self-commitment o this same position.

hat in the process of helping, the helper is given a stake or meaning-ul part in the system. This contributes to a greater commitment to the ask, bringing about the further development of their own abilities to elp others.

conscious use of a "Helper Therapy Principle" might suggest possible wider distribution of the helper role, a potential use of it in lead-ining, and especially, as an educational tool in training preprofes-assume their Case Aide role. Certainly one could question whether a ious use of this principle has been operative already within social or many years. Who is to say that social workers themselves, along s in the helping professions, have not achieved some personal benefits helping role, much more than has generally been recognized or accepted.

and Using a Team Concept

oration into the public welfare system of different classification levels service staff (or within the separated financial assistance functions per-the agency) raises questions around what kind of agency structure can most ely deploy manpower in service delivery, assuring maximum opportunity for ery and development of human resources within both agency and client per-traditional model that the agency has used which links the client to the

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agency via "his" caseworker mu
cient and creative fulfillment
differential use of staff. Th
and a volunteer, a case aide,
a similar array of possible pe
department), for example, requ
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less the various activities of
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The use of a team concept or a
goals might be accomplished.
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social service team therefore
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competency, a team approach wou
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The adoption or use of such an
is directed towards the same go
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whom the client will have direc
group." Within social services
responsibility with the client
might exist within the assistan
occurs, would comprise a part o
a part. What would be the comm
characteristics can readily be

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agency via "his" caseworker must now be viewed as questionable design for the efficient and creative fulfillment of those agency goals being sought through a maximum differential use of staff. The possible face-to-face interaction between the client and a volunteer, a case aide, a social service worker, a homemaker (not to mention a similar array of possible persons within financial assistance parts of the county department), for example, requires considerable thought as to how the functions and tasks performed by each of these staff members is to be defined and organized. Unless the various activities of these persons, with an individual client, achieve some uniformity of purpose and goal, the result is all too likely to be that recently described by one client who, when asked who her worker was, responded, "I don't know, I think it's a committee."

The use of a team concept or approach suggests a different means by which agency goals might be accomplished. As implied in the use of the word "team," emphasis would be placed upon the relationship of the service giving staff to each other (or the financial assistance giving staff within their part of the county department) and to the client in the course of delivering agency program services. The social service team therefore would be composed of those staff persons engaged in face-to-face interaction with the client. Thus, while each person would have an individually assigned function (or basic job) for which he possesses a special competency, a team approach would seek to join these persons together into a mediating staff unit through which all of the program services of the agency are available to a given set of clients.

The adoption or use of such an approach must assume that the entire agency staff is directed towards the same goal of "helping" the client to cope more successfully with his life situation. Thus, in a broad sense, each staff person with whom the client will have direct interaction will be a part of an agency "work group." Within social services, they become a "social service team" that assumes responsibility with the client in a goal directed service plan. A similar team might exist within the assistance portions of the county department, and when this occurs, would comprise a part of a still larger work group of which the client is a part. What would be the common characteristic of a social service team? Five characteristics can readily be identified, including:

Robert Barker and Thomas Biggs, The Differential Use of Social Work Manpower. National Association of Social Workers, New York City, 1968.

Elliott Studt, "Fields of Social Work Practice: Organizing our Resources for More Effective Practice." Social Work, The Journal of the National Association of Social Workers, Vol. 10, No. 4 (October 1965).

1. The team members would share responsibility fo program relevant to the needs of a specific, a

2. They would comprise the primary group through responsive to individual client needs.

3. They would share commonly defined goals with e they jointly work.

4. They would be the agency in action for the cli

5. The team would be comprised of a group of spec expertise in his own right that can be brought solution of client problems.

As is readily evident in these characteristics, the mem team must share the same goal with the client. They mu cating well and collaborating in the solution of daily job to be done. Lastly, the various team members must the client in implementing a goal-directed service plan various client contacts, acceptance of the client as a

Clearly, if one is to utilize a team approach in organi staff functions and activities in relation to a given c and role implications for staff will be profound. For role in such a staff group becomes one of leadership in than solely one of unilateral representation of upper a of activities of various team members becomes a necessa Ordinarily, a supervisor would not perform direct activ in concert with the social service worker, must assure activity to other members of the team, each accordinn t and abilities.

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1. The team members would share responsibility for making the agency program relevant to the needs of a specific, assigned group of clients.

2. They would comprise the primary group through which the agency can be responsive to individual client needs.

3. They would share commonly defined goals with each client with whom they jointly work.

4. They would be the agency in action for the client.

5. The team would be comprised of a group of specialists - each with expertise in his own right that can be brought into action in solution of client problems.

readily evident in these characteristics, the members of a social service nust share the same goal with the client. They must be capable of communi- well and collaborating in the solution of daily problems related to the be done. Lastly, the various team members must assume responsibility with lient in implementing a goal-directed service plan, and demonstrate, in their us client contacts, acceptance of the client as a person of worth and value.

y, if one is to utilize a team approach in organizing various social service functions and activities in relation to a given client, the administrative le implications for staff will be profound. For example, the supervisory n such a staff group becomes one of leadership in program adaptation, rather solely one of unilateral representation of upper authorities. An orchestration ivities of various team members becomes a necessary supervisory function. arily, a supervisor would not perform direct activities with a client, but he, ncert with the social service worker, must assure appropriate assignment of ty to other members of the team, each according to his knowledge, expertise ilities.

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The Necessity of Providing Supportive Services

The employment of Case Aides in public welfare will
to provide some supportive services to this new emp
not clearly defined within the county department fo
vices. Certainly, it is important to recognize tha
to this new job assignment with personal and family
their ability to assume this new helping role. Car
or compound these problems in the employment settin
assist the Aide in overcoming these problems which
his performance of assigned tasks.

Thus, it will be necessary for supportive help to b
ing groups as well as individual supervisory confer
tation and induction, the mutual aid system establi
has been used effectively in some county department
initial anxieties, problems with role change, and i
outside or personal influences which impinge upon t
employee role. For example, one Case Aide whose to
been in domestic work, initially had much difficult
did not pay her transportation to and from work - a
previous employment. The group could, in several m
her to see that employment in this setting does not
the responsibilities which she must assume in under
member. In addition to expected difficulties in ro
problems may require the supervisor's help, either
where brief or short-term help can eliminate a more
referral to a resource who can assist the Aide with
problems as day care for children, illness of a fam
parent-child discord, etc., may each find their way

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: V. GENERATOR

PERFORMANCE OBJECTIVE NO.: 5 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Generator

CONDITIONS:

BEHAVIOR:

13. Disassemble generator following steps as outlined in manual
14. Make all tests and checks as outlined in manual
15. Reassemble generator following steps as outlined in manual
16. Make all final bench checks as outlined in manual
17. If all tests and checks are satisfactory, proceed as follows;
18. Return generator to engine compartment
19. Bolt generator to bracket but do not tighten
20. Put fan belt on generator (check condition of fan belt and replace if necessary)
21. Bolt generator to adjusting arm
22. With proper tool, move out on generator until proper belt tension is obtianed
23. Tighten generator adjusting bolts and generator to engine bracket bolts
24. Connect battery field and ground wires following steps as outlined in manual

PERFORMANCE CRITERIA:

ity of Providing Supportive Services

ment of Case Aides in public welfare will require the line supervisor some supportive services to this new employee, if other means are y defined within the county department for the provision of such ser- rtainly, it is important to recognize that some Case Aides will come w job assignment with personal and family problems which could impair ity to assume this new helping role. Care must be taken not to add to d these problems in the employment setting and, where possible, to Aide in overcoming these problems which may directly impinge upon mance of assigned tasks.

ill be necessary for supportive help to be provided through both train- as well as individual supervisory conferences. In his initial orien- induction, the mutual aid system established within the training group sed effectively in some county departments, by its members, in handling xieties, problems with role change, and in some incidences, in handling personal influences which impinge upon the Aide's adaptations to the ole. For example, one Case Aide whose total employment experience had mestic work, initially had much difficulty understanding why the agency y her transportation to and from work - a consistent pattern to her mployment. The group could, in several meetings, quite effectively help that employment in this setting does not include such practices, and sibilities which she must assume in undertaking her new role as an agency n addition to expected difficulties in role change, specific personal ay require the supervisor's help, either through direct intervention f or short-term help can eliminate a more concrete problem, or through o a resource who can assist the Aide with more long-term help. Such s day care for children, illness of a family member, marital conflict, ld discord, etc., may each find their way into an employment setting.

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In addition to the need for supportive serv
weigh the possible impact of and seek solut
which can result merely from the Aide's pre
consideration will need to be given to answ

1. How will the confidentiality of re
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financial assistance?

2. What problems should be anticipate
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worker, whom he sees in a "client"

Wherever questions of this kind arise, it wi
sought so that the roles and responsibilitie
clearly understood by all.

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ition to the need for supportive services, each county department must the possible impact of and seek solution to, other areas of difficulty can result merely from the Aide's presence in the agency. Therefore, eration will need to be given to answering such questions as:

. How will the confidentiality of records be assured when the Aide has previously been a recipient of county department services or financial assistance?

. What problems should be anticipated when an employee is simultaneously a recipient of financial assistance?

. Where an employee simultaneously has a service worker in the department, what kinds of guidelines will be needed in determining the Aide's supervisor's involvement in providing supportive help, and the responsibilities of her worker in these same areas?

. Should a Case Aide work jointly in helping clients with the worker, whom he sees in a "client" role?

er questions of this kind arise, it will be important that answers be so that the roles and responsibilities of each staff member remain y understood by all.

VT 012 917
An Orientation and Induction Training Course for Case Aides.

California State Human Relations Agency, Sacramento. Dept. of Social Welfare.
MF AVAILABLE IN VT-ERIC SET.
Training Aid 38-A
PUB DATE - Jul70 134p.

DESCRIPTORS - *TEACHING GUIDES; VOCATIONAL EDUCATION; *CASEWORKERS; *SOCIAL SERVICES; *WELFARE SERVICES; JOB TRAINING; *SUBPROFESSIONALS; OCCUPATIONAL INFORMATION; JOB SKILLS; ANNOTATED BIBLIOGRAPHIES

ABSTRACT - This 2-part training guide was prepared for teachers by the Training Bureau of the Human Relations Agency, California State Department of Welfare, and outlines major areas of content necessary to adequately prepare case aides to perform job duties. The 88-hour training program consists of a 1-week orientation period (40 hours) of planned group instruction and observational experiences, which is followed by a 1 to 3-month induction training period (48 hours) of planned group instruction in combination with supervised on-the-job training. Part 1 provides a series of 17 orientation training sessions and accompanying lesson plans, references, and suggested content and teaching methods, and Part II provides 23 induction training sessions organized in a similar manner. Both parts are preceded by an outline of the sessions and a brief description of the content in each session. An annotated bibliography and an exercise in team training are appended. A related workbook is available as VT 012 918 also in this issue. (SB)

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VT 012 917

ED0 56238

AN ORIENTATION AND INDUCTION TRAINING

FOR CASE AIDES

July 1970

State Department of Social Welfare — Human Resources
Phoenix, Arizona — Arizona

TRAINING DIVISION

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EDUCATION & WELFARE
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TRAINING AID

Number 38-A

AN ORIENTATION AND INDUCTION TRAINING G

FOR CASE AIDES

July 1970

State Department of Social Welfare - Human Rel
Robert Martin - Director

TRAINING BUREAU
B. R. Becker - Chief

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TRAINING AID

Number 38-A

AN ORIENTATION AND INDUCTION TRAINING COURSE FOR CASE AIDES

July 1970

ate Department of Social Welfare - Human Relations Agency
Robert Martin - Director

TRAINING BUREAU
B. R. Becker - Chief

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PREFACE AND ACKNOWLEDGEMENTS

The training, employment and use of preprofessionals in public
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prepare Training Aid 38A, An Orientation and Induction Training
Case Aides, and its companion workbook, Training Aid 38B, A Wor
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Special recognition must be given to the county departments wit
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have provided me on their unique and individual ways of using C
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have individually contributed help in the preparation of this m
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Wilbur Fin

Wilbur Finch,
Training Consultant

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Wilbur Finch

Wilbur Finch,
Training Consultant

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: V. GENERATOR

PERFORMANCE OBJECTIVE NO.: 5 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Generator

CONDITIONS:

BEHAVIOR:

25. Observe all safety precuations
26. Install all accessories removed following steps as outlined in manual
27. Connect battery ground to battery terminal
28. Inspect all wires and connections and remove all tools, materials, etc. form engine compartment
29. Start engine and make tests as outlined in manual
30. If all checks and tests are satisfactory, stop the engine and proceed as follows;
31. Remove all tools, testing equipment, etc. and place in proper place
32. Remove covers from fenders and store in proper place
33. Close hood
34. Return automobile to proper parking area
35. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to remove, disassemble, reassemble, replace, and test generator in 3 hours.

Learning time: 6 hours

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INTRODUCTION

A recent manpower innovation within the human services has been the devel careers concept" and its resulting movement towards an expanded use of pr team members, in the provision of services to clients. The Scheurer Amen Opportunity Act, in 1966, provided initial commitment of the federal gove through the establishment of New Careers Programs, whose purpose was to d programs for persons from poverty areas, to prepare them for new employme created. The 1967 Amendments to the Social Security Act moved further to career concept" within public welfare itself. This legislation required ment and use of preprofessionals in the provision of public welfare servi

The implementation of a "new careers concept" within public welfare has f of two program goals. The first reflects a desire to expand and enrich s clients, by expanding the agency's use of different classification levels reflects the agency's desire to provide meaningful job opportunities for previously denied access to public welfare employment because of educatio a result of this legislation and its incorporation into federal regulatio ments have already moved to employ Case Aides to perform tasks within b and social service programs. This training aid has been developed in res of this new personnel classification. It is intended for use by county w their orientation and induction training of new Case Aides.

The addition of Case Aides, as members of an agency team, requires admini preparation, of which training comprises one very important part. It is orientation and induction training of these new staff members will build administrative planning:

1. A clear identification of the tasks, roles and responsibilities levels of staff within the county department.

2. An understanding on the part of all employees of the role and r Case Aide and his relationship to the Social Service Worker, th and other classifications of staff with whom he will be working

3. A differentiation of the training responsibilities to be assign members, and a clear understanding of the role of each of these teaching the Case Aide.

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bers, and a clear understanding of the role of each of these staff members in
ching the Case Aide.

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From the various job specifications for Case Aides, developed
can identify a number of tasks more commonly used in these sta
for this training aid. These tasks are grouped under four are
function:

1. Direct Service Functions:

   a. Shows, demonstrates and advises clients on such
      buying, household management, budget planning

   b. Briefly cares for children so that a mother ca
      first days at school, clinic appointment, etc.

   c. Locates and escorts client through the use of
      resource.

   d. Talks with client to identify material needs (
      suitable laundry facilities, etc.) hampering a
      effective home management.

   e. Suggests the cooperation and joining together
      and advises group in planning cooperative proj
      problems (i.e., the pooling of transportation
      appointments, the sharing of babysitting servi

   f. Visits isolated clients to ask if material nee

2. Joint Functions:

   a. Secures specific information from clients need
      eligibility for financial assistance.

   b. Escorts hesitant client to, from and through t
      resource.

   c. Demonstrates how to secure and assist client t
      suitable housing, the location of some special

   d. Surveys the receptiveness and possible use of
      summer camps for children).

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job specifications for Case Aides, developed by county welfare departments, one mber of tasks more commonly used in these statements and which serve as a basis aid. These tasks are grouped under four areas descriptive of their major

Service Functions:

ows, demonstrates and advises clients on such matters as food preparation and ying, household management, budget planning and child rearing.

iefly cares for children so that a mother can accompany a fearful child to his rst days at school, clinic appointment, etc.

cates and escorts client through the use of a neighborhood and/or community source.

lks with client to identify material needs (repair of stove, location of more itable laundry facilities, etc.) hampering achievement of more efficient or fective home management.

ggests the cooperation and joining together of a group of individual clients, d advises group in planning cooperative projects towards solution of common oblems (i.e., the pooling of transportation resources to maintain clinic pointments, the sharing of babysitting services, etc.).

sits isolated clients to ask if material needs are being met.

Functions:

ecures specific information from clients needed in determining or redetermining ligibility for financial assistance.

scorts hesitant client to, from and through the use of a specific community esource.

emonstrates how to secure and assist client through the process of locating ultable housing, the location of some special need item, etc.

urveys the receptiveness and possible use of special programs by clients (i.e., ummer camps for children).

e. Shows clients how to complete selected forms.

3. Bridging Functions:

a. Explains and advises clients (or groups of clients) on the use o in the county department.

b. Gathers specific information from neighborhood people or groups, door canvassing, etc.

c. Visits and talks with school personnel, community agency staff n secure specific information needed.

d. Locates and meets with established neighborhood groups which hav improvement goals, to provide information about the agency.

4. Recruitment and Follow-up Functions:

a. Asks client questions to determine why he has been unable to fol contacting or using a specific resource.

b. Asks client questions to determine why agency appointment was no

c. Advises and assists client in making initial request for agency for special need items, etc.

To the various tasks listed above, each county welfare department has identifie unique to the specific needs and programs of the county, which should be added the administrative planning of orientation and induction training for Case Aide

The Purpose of the Training Aid

The purpose of this training aide is to provide, in outline form, major areas o necessary to adequately prepare Case Aides to perform those tasks more commonly classifications of staff; to suggest methods of teaching this content; and to o where additional information can be secured. To this, the county department wi additional content relating to those more unique tasks which have not been list which take advantage of the specific background and skills of an individual aid

ws clients how to complete selected forms.

Functions:

ains and advises clients (or groups of clients) on the use of resources with-
he county department.

ers specific information from neighborhood people or groups, does door-to-
canvassing, etc.

ts and talks with school personnel, community agency staff members, etc., to
re specific information needed.

tes and meets with established neighborhood groups which have neighborhood
ovement goals, to provide information about the agency.

nt and Follow-up Functions:

client questions to determine why he has been unable to follow through in
acting or using a specific resource.

client questions to determine why agency appointment was not kept.

ses and assists client in making initial request for agency social services,
special need items, etc.

s listed above, each county welfare department has identified other tasks, more
fic needs and programs of the county, which should be added to the list in
planning of orientation and induction training for Case Aides.

Training Aid

training aide is to provide, in outline form, major areas of content
tely prepare Case Aides to perform those tasks more commonly assigned to such
staff; to suggest methods of teaching this content; and to offer references
formation can be secured. To this, the county department will want to add
relating to those more unique tasks which have not been listed above and/or
e of the specific background and skills of an individual aide.

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The Training Model Used

The experiences of county departments to date has shown that spe the methods and techniques used in training Case Aides, as they learn from many of the adults upon whom county department have p training time. For example, the Case Aide is more likely to hav or experience which was limited to the assignment of specific ro as each was performed. Thus, he may not have developed a way of application of more generalized material to a variety of assigne explicit instruction and guidance, particularly in the early mon county department.

A number of general principles can be identified which should gu Case Aides, and which have influenced the specific model of orie used in this training aid. These include:

1. Group training and initial on-the-job training assign edge and skills which the Case Aide brings to his new

2. Training will be most effective where planned group t supervisory conferences build upon experience-based d and concepts are introduced at appropriate points wit examples.

3. Orientation and induction training must provide oppor cuss and prepare for a shift in roles, in some cases of employee.

4. Training must take advantage of the learning patterns In doing so, it will provide opportunities to learn b ing methods (discussion, role playing, etc.) which st can be seen and experienced concretely.

The model proposed in this training aid provides for a brief on the agency, comprising forty hours of preassigned training, whi planned observational experiences. The purpose of this period familiarize the Case Aide with agency organization and operatio training will provide knowledge of the background, basic philos and the opportunity to develop enough basic skills to begin wor immediately followed by a one- to three-month period of inducti hours of planned group [illegible]on, in combination with supervi

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: VI ALTERNATORS

PERFORMANCE OBJECTIVE NO: 6 TITLE: Remove, Overhaul, Replace and Test Alternator

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Alternator Fundamentals	1. Automotive Electrical Equipment, by Crouse. pp. 204 through 206 and pp. 218 through 223 Automotive Electrical Equipment Workbook, by Crouse. Jobs 33 through 35	1. Related Information Class
2. Alternators	2. Fundamentals of Electricity, by Ford Motor Co. pp. 76 and 77	2. Programmed Instruction Class
3. Alternators	3. Teaching Machine card 7A and 7B	3. Teaching Machine (Shop)

Used

county departments to date has shown that special thought must be given to chniques used in training Case Aides, as they will differ in the ways they the adults upon whom county department have previously focused much of their example, the Case Aide is more likely to have had no prior work experience; was limited to the assignment of specific routine tasks, explicitly taught, ned. Thus, he may not have developed a way of learning which required the generalized material to a variety of assigned tasks. He may need more on and guidance, particularly in the early months of his employment with the

principles can be identified which should guide the planned training of ich have influenced the specific model of orientation and induction training ing aid. These include:

aining and initial on-the-job training assignments must build upon the knowl- skills which the Case Aide brings to his new agency assignment.

will be most effective where planned group training sessions and individual ory conferences build upon experience-based discussion, and generic principles epts are introduced at appropriate points with simple, clearly related .

ion and induction training must provide opportunity for the Case Aide to dis- prepare for a shift in roles, in some cases from one of "client" to one yee.

must take advantage of the learning patterns and styles of the participants. so, it will provide opportunities to learn by doing and utilize those teach- ods (discussion, role playing, etc.) which stimulate verbalization around what een and experienced concretely.

in this training aid provides for a brief one-week period of orientation to sing forty hours of preassigned training, which combines group instruction with nal experiences. The purpose of this period of orientation training is to se Aide with agency organization and operation. In addition, orientation ide knowledge of the background, basic philosophy and purpose of the agency, y to develop enough basic skills to begin work. Orientation training is ed by a one- to three-month period of induction training, comprising forty-eight roup on, in combination with supervised, on-the-job training. This

instruction, provided in small groups and making maximum use of discussion m
upon the further development of specific skills needed to perform assigned t
include more general knowledge required in the provision of human services,
standing of why people behave in the way they do, social problems, and the e
lems commonly encountered within the work situation.

This total of eighty-eight hours of training (excluding individual superviso
should be completed within the first three months of a Case Aide's employmen
minimum of training time needed to adequately prepare the Case Aide. Additi
group sessions to cover specific areas of identified learning need should be
out on a continuing ongoing basis.

The content areas covered in this training aid have been selected because th
more common and frequently identified tasks listed in county welfare departm
tions, which have been developed and used in hiring Case Aides and related p
groups of employees. Because of this, individual county departments may fin
some more unique tasks which they assign to this classification of employee,
area needed is not included or that one which is included may or may not be
such cases, the county department will want to modify the overall plan to in
content areas unique to the specific needs of their Case Aides. In any even
substitutions will not reduce the overall period of training needed by these

The Content and Organization of the Training Aid

This training aid consists of two major parts and an appendix of supplementa
Part I consists of a series of seventeen orientation training sessions, orga
columns. The "Reference" column lists books and articles of use to the trai
tion for conducting the training session. The center column contains teach
"lesson plans", listing the main points to be covered in each session. The
"Comments, Suggestions" offers information about the content and suggests te
its presentation.

Part II consists of a series of twenty-three induction training sessions orga
way as the previous section. Both are preceded by an outline of the session
description of the content to be covered in each session. An appendix to the
tains an annotated bibliography of selected materials on the training, emplo
preprofessionals in the human services; as well as an exercise in team train
induction training session number eighteen.

in small groups and making maximum use of discussion methods, will focus
opment of specific skills needed to perform assigned tasks; as well as
nowledge required in the provision of human services, such as an under-
behave in the way they do, social problems, and the exploration of prob-
red within the work situation.

ight hours of training (excluding individual supervisory conferences)
thin the first three months of a Case Aide's employment. This represents a
ne needed to adequately prepare the Case Aide. Additional content and
specific areas of identified learning need should be planned and carried
going basis.

red in this training aid have been selected because they represent the
tly identified tasks listed in county welfare department class specifica-
developed and used in hiring Case Aides and related pre-professional
ecause of this, individual county departments may find that, because of
which they assign to this classification of employee, a specific content
uded or that one which is included may or may not be appropriate. In
department will want to modify the overall plan to include specific
the specific needs of their Case Aides. In any event, such changes and
reduce the overall period of training needed by these new employees.

ation of the Training Aid

sts of two major parts and an appendix of supplemental information.
ries of seventeen orientation training sessions, organized in three
e" column lists books and articles of use to the trainer in his prepara-
training session. The center column contains teaching outlines or
the main points to be covered in each session. The column headed
offers information about the content and suggests teaching methods for

eries of twenty-three induction training sessions organized in the same
tion. Both are preceded by an outline of the sessions and a brief
ent to be covered in each session. An appendix to the training aid con-
iography of selected materials on the training, employment and use of
human services; as well as an exercise in team training, for use in
ion number eighteen.

A second training aid, 38B, A Workbook for Case Aides in Orienta been developed for use by the trainee participating in these ori sessions. This aid contains a series of "learning by doing" exe ments for use by the Case Aide in relation to individual trainir a place for the participant to keep class notes is provided.

Suggestions for Use of The Training Aid

The training of Case Aides may, in some county departments, be staff members and demands upon staff time may be eased through lesson plan briefly outlines the content to be taught and empha be covered by the instructor. However, in using this material, ment, broaden and expand this basic outline, making those modif necessary to assure that each session is relevant to the learni participating in training, and to the specific tasks which they department. It is not important that all of the points outline covered in the training session. What is important is that the presented in a tangible and useable manner. Teaching should ma assumptions explicit, and concepts which are introduced should practical use in work with clients. The Case Aides own life ex for group discussion as well as the introduction of new content discussion should be a primary method of instruction. Wherever responsibility should be assigned to a single person who can pr orientation and induction training, although other persons may group for specific instructional purposes.

Particularly during the period of orientation training, the tra questions and anxieties which these new Case Aides bring, and, developed prior to their arrival, it is important that the con guided by the learning needs of the specific aides in training cover the content he has planned in this week period, but he i reordering parts of the material to the readiness of his group his new assignment, the Case Aide must first see himself as an an agency team. Identification with this new role of "employe the agency are therefore important elements of orientation tra

Because this plan combines planned group sessions with observa training, the planning of these latter experiences become an i process. Care must be exercised in selecting the employee who

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, 38B, A Workbook for Case Aides in Orientation and Induction Training, has
e by the trainee participating in these orientation and induction training
ontains a series of "learning by doing" exercises and brief reading assign-
Case Aide in relation to individual training sessions planned. In addition,
cipant to keep class notes is provided.

f The Training Aid

Aides may, in some county departments, be the responsibility of a number of
ands upon staff time may be eased through use of this training aid. Each
utlines the content to be taught and emphasizes the most important points to
tructor. However, in using this material, the teacher will want to supple-
and this basic outline, making those modifications in content which are
hat each session is relevant to the learning needs of Case Aides who are
ning, and to the specific tasks which they will be performing in the county
t important that all of the points outlined in a specific lesson plan be
ng session. What is important is that the major concepts and principles be
le and useable manner. Teaching should make use of many illustrations, make
and concepts which are introduced should be explicitly related to their
with clients. The Case Aides own life experiences should serve as a basis
as well as the introduction of new content. For this reason, small group
a primary method of instruction. Wherever possible, primary training
be assigned to a single person who can provide continuity throughout
tion training, although other persons may be asked to join the teaching
structional purposes.

he period of orientation training, the trainer should focus upon the many
es which these new Case Aides bring, and, although a plan is proposed and
eir arrival, it is important that the content and sequence be adapted and
g needs of the specific aides in training. Thus, the skillful teacher may
has planned in this week period, but he is equally capable of changing and
he material to the readiness of his group. Before being able to undertake
he Case Aide must first see himself as an agency employee and as a member of
tification with this new role of "employee" and with the superior aims of
fore important elements of orientation training.

mbines planned group sessions with observational experiences in orientation
g of these latter experiences become an important part of the total learning
e exercised in selecting the employee who will provide this experience and,

ideally, the person will, in his work with clients, express the q
person. In most of the observations planned, an experienced Case
model to provide this early learning experience, although a Socia
(where a Case Aide is not available) if the differences in his wa
Case Aide, is clearly differentiated and the service functions he
in part, to the kinds of tasks the Case Aide will be performing.
the fact that the Case Aide will be fulfilling a defined role in t
of this role in achieving agency program objectives.

Induction Training combines the use of formalized group training s
ing. For maximum effectiveness, the activities of the trainer, wh
sessions each week, must be coordinated with on-the-job training n
supervisor, if the Case Aide is to be provided with opportunity to
provided in group sessions.

During the first three months of employment, the tasks assigned by
selected on the basis of learning needs. Thus, they should:

1. Be within the capacity of the Case Aide; physically, emo

2. Provide an opportunity to practice what is being taught i
sessions;

3. Provide an opportunity to learn one new task at a time an

4. Early assignments should involve the provision of concret
be provided by the Case Aide in one or two client contact
success has been achieved in this type of activity, servi
tacts can be introduced.

The formalized group training sessions planned during the introduct
for four hours each week in either one block period of time, or in
sessions are to be oriented towards meeting the educational needs o
develops in his job assignment. Because the content of these sessio
task assignments for beginning Case Aides, identified by county depa
to reorder the sequences of specific sessions, depending upon the sp
use of Case Aides. Following each group session, an opportunity to
assignment is to be planned by the line supervisor, and coordination
responsibility of the trainer.

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person will, in his work with clients, express the qualities desired in a helping
ost of the observations planned, an experienced Case Aide is a most appropriate
ide this early learning experience, although a Social Service Worker can be used
Aide is not available) if the differences in his way of working, from that of a
clearly differentiated and the service functions he performs are related, at least
he kinds of tasks the Case Aide will be performing. It will be important to stress
the Case Aide will be fulfilling a defined role in the agency, and the importance
in achieving agency program objectives.

ining combines the use of formalized group training sessions with on-the-job train-
imum effectiveness, the activities of the trainer, who plans and conducts group
week, must be coordinated with on-the-job training now being provided by the line
f the Case Aide is to be provided with opportunity to use the content being
roup sessions.

rst three months of employment, the tasks assigned by the line supervisor should be
he basis of learning needs. Thus, they should:

within the capacity of the Case Aide; physically, emotionally, and educationally;

vide an opportunity to practice what is being taught in his weekly group training
sions;

vide an opportunity to learn one new task at a time and in a sequential manner;

ly assignments should involve the provision of concrete kinds of services, which can
provided by the Case Aide in one or two client contacts. Later, when sufficient
cess has been achieved in this type of activity, services involving a series of con-
ts can be introduced.

d group training sessions planned during the introduction period should be scheduled
s each week in either one block period of time, or in two, two-hour sessions. These
to be oriented towards meeting the educational needs of the Case Aide as he
is job assignment. Because the content of these sessions was developed from common
nts for beginning Case Aides, identified by county departments, the trainer may want
e sequences of specific sessions, depending upon the specific county plan for the
ides. Following each group session, an opportunity to use this content on his job
to be planned by the line supervisor, and coordination of this planning should be a
of the trainer.

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The orientation and induction training of Case Aides will c
the training planned for other groups of staff. This will
problems that are brought by the aide to the job setting ar
well. The mutual aid system established within the trainir
handling initial anxieties, problems with role change, and
outside or personal influences which may infringe upon the
Such a supportive function is an appropriate training role
Aide's employment, particularly until he is able to utiliz
seeking such help.

In planning his training sessions, the trainer will want t
ing Aid 38B, to decide the use which he plans to make of i
training curriculum. Although specific suggestions for th
relation to many of the sessions, these can be used in a v
prior to and in preparation for a particular session, they
session, or, in some cases, they can be completed followin
finally decides to make of these assignments, as a part of
tant to provide an opportunity for participants to discuss
completing assignments should be provided. It is suggeste
for group discussion and that they be "corrected" only by
orientation training, and again at the end of induction tr
to assist the trainer in assessing the degree to which lea

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on and induction training of Case Aides will differ, in one important respect, from planned for other groups of staff. This will involve the need to handle personal are brought by the aide to the job setting and, thus, to the training situation as tual aid system established within the training group can be used by its members in ial anxieties, problems with role change, and, in some incidences, the handling of rsonal influences which may infringe upon the aide's adaptation to an employee role. tive function is an appropriate training role in these early months of the Case ment, particularly until he is able to utilize the superivsory-aide relationship in help.

is training sessions, the trainer will want to carefully review the workbook, Train- to decide the use which he plans to make of individual assignments, as a part of the iculum. Although specific suggestions for the use of assignments are offered in any of the sessions, these can be used in a variety of ways. They can be completed in preparation for a particular session, they can be completed as a part of the in some cases, they can be completed following a session. Whatever use the trainer es to make of these assignments, as a part of his training plan, it will be impor- de an opportunity for participants to discuss each completed assignment. Time for signments should be provided. It is suggested that assignments be used as a basis cussion and that they be "corrected" only by the participant himself. At the end of raining, and again at the end of induction training, an evaluation form is included trainer in assessing the degree to which learning objectives have been achieved.

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PART I

ORIENTATION TRAINING SESSIONS

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: VI. ALTERNATOR

PERFORMANCE OBJECTIVE NO.: 6 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Alternator

CONDITIONS:

This assignment is to be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Raise hood
4. Place protective covers on fenders
5. Select proper manual and turn to appropiate chapter
6. Select proper tools and materials
7. Disconnect the battery ground cable
8. Check manual and follow steps as outlined to remove any accessories which prevent removal of alternator
9. Remove Alternator battery and alternator field leads from alternator - If alternator has ground wire, disconnect it
10. Remove bolt from adjusting arm
11. Remove bolts from alternator bracket (those bolts securing alternator to bracket)

PERFORMANCE CRITERIA:

The Purpose of Orientation Training

The purpose of orientation training sessions essentially is on
to the agency and his job assignment. As such, it should unde
agency organization and operation and provide him with the nec
the agency, including the basic philosophy and purposes for wh
orientation training should provide an opportunity for the new
skills in order to begin his specific job assignment.

In order to achieve the above, the orientation sessions in thi
broad areas of content including:

1. What are the rights, responsibilities and expectatio
welfare department employee?

2. What tasks will he be performing as a Case Aide?

3. What are the agency programs within which he will be

4. How will he work with clients?

5. What other classifications of staff will he be worki

Certainly, it will not be possible to cover these five content
of orientation training. However, by the end of this orientat
acquired a perception of his new role of "employee" and an und
as a Case Aide within the county welfare department.

An Outline of Orientation Sessions

Session 1 - INTRODUCTION AND ORIENTATION TO TRAINING PROGRA

An informal group session designed to introduce
gram, to review the learning experiences planne
and to begin an establishment of a sense of "we
cussion of employee rules and regulations are a
beginning session.

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pose of Orientation Training

pose of orientation training sessions essentially is one of introducing the new Case Aide agency and his job assignment. As such, it should undertake to familiarize him with the organization and operation and provide him with the necessary background information about ncy, including the basic philosophy and purposes for which the agency exists. In addition, tion training should provide an opportunity for the new Case Aide to develop enough basic in order to begin his specific job assignment.

to achieve the above, the orientation sessions in this training aid seek to cover five reas of content including:

What are the rights, responsibilities and expectations of the Case Aide as the county welfare department employee?

What tasks will he be performing as a Case Aide?

What are the agency programs within which he will be performing Case Aide tasks?

How will he work with clients?

What other classifications of staff will he be working with?

ly, it will not be possible to cover these five content areas totally during this one week ntation training. However, by the end of this orientation training period, he should have d a perception of his new role of "employee" and an understanding of how he will function se Aide within the county welfare department.

ine of Orientation Sessions

1 - INTRODUCTION AND ORIENTATION TO TRAINING PROGRAM - 2 hours

An informal group session designed to introduce the Case Aides to the training program, to review the learning experiences planned, the objectives to be achieved, and to begin an establishment of a sense of "we-ness" among participants. A discussion of employee rules and regulations are also an important part of this beginning session.

Session 2 - A TOUR OF COUNTY DEPARTMENT, INTRODUCTIONS, ETC. - 2 hours

A tour of the county department to physically orient the new
ting they will be working in and to introduce them to key pe
will later be working.

Session 3 - WHAT DO CASE AIDE'S DO? - 2 hours

A discussion of the need for Case Aides in public welfare,
appropriate case aide tasks and functions and appreciation
be made by aides in achieving agency goals.

Session 4 - OBSERVATIONAL EXPERIENCE - 2 hours

An individual observation, preferably with an experienced C
basis for participants to expand and clarify their percepti
Case Aide, and to compare the various helping tasks which t
prior conceptions of this role.

Session 5 - WHAT IS PUBLIC WELFARE?- 2 hours

Beginning with participant perceptions, the purpose and obj
welfare programs are discussed, with emphasis upon categori
with whom case aides will initially be working.

Session 6 - A DISCUSSION OF VARIOUS PUBLIC WELFARE PROGRAMS, SERVICES,

The reasons why services are provided in addition to assist
and the kinds of service resources available in the agency
prior use of these services by participants can contribute
cussion to consideration of ways to help clients make maxim

Session 7 - OBSERVATIONAL EXPERIENCE - 4 hours

An individual observational experience where interpretation
service or resource, or an information service is provided,
aide with an example of how one can interpret the use of a

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NTY DEPARTMENT, INTRODUCTIONS, ETC. - 2 hours

county department to physically orient the new Case Aides to the set-
l be working in and to introduce them to key persons with whom they
working.

AIDE'S DO? - 2 hours

of the need for Case Aides in public welfare, identification of
ase aide tasks and functions and appreciation of the contribution to
des in achieving agency goals.

EXPERIENCE - 2 hours

observation, preferably with an experienced Case Aide, will provide a
ticipants to expand and clarify their perceptions of the role of a
d to compare the various helping tasks which they have observed with
ions of this role.

C WELFARE?- 2 hours

h participant perceptions, the purpose and objectives of public
ams are discussed, with emphasis upon categorical programs of clients
e aides will initially be working.

OF VARIOUS PUBLIC WELFARE PROGRAMS, SERVICES, AND RESOURCES - 2 hours

hy services are provided in addition to assistance will be reviewed,
of service resources available in the agency discussed. The possible
these services by participants can contribute to expansion of the dis-
nsideration of ways to help clients make maximum use of such resources.

EXPERIENCE - 4 hours

observational experience where interpretation of a public welfare
esource, or an information service is provided, will provide the case
example of how one can interpret the use of a resource to a client.

Session 8 - THE QUALITIES OF A HELPING PERSON - 2 hours

Identification of these factors which will create confidence in the
the part of clients, and a discussion of the importance of understan

Session 9 - HOW DOES A CASE AIDE HELP? - 2 hours

The characteristic ways of helping, use by Case Aides, are discussed
ways of establishing rapport, preparing for an interview, hints on i
and ending the interview.

Session 10 - OBSERVATIONAL EXPERIENCE - 4 hours

An individual observation is provided for each Case Aide, preferably
ienced aide providing a service to a client. The Case Aide can iden
and characteristics utilized by the helping person for comparison, i
with previously identified qualities and characteristics in Sessions

Session 11 - THE PUBLIC WELFARE TEAM - 2 hours

The public welfare team is defined, its characteristics identified a
and functions of the various agency employees who comprise the team
in this session.

Session 12 - CASE PRESENTATION AND DISCUSSION - 2 hours

A case presentation by an Eligibility Worker and Social Service Work
with emphasis upon their differing roles and responsibilities with t
serve as a basis for discussing the ways in which the case aide will
a member of a team, in helping the client.

Session 13 - OBSERVATIONAL EXPERIENCE - 4 hours

An observational experience of an Eligibility Worker and/or Social S
will provide opportunity for the participant to further clarify his
entiate this from those roles of other team members.

OF A HELPING PERSON - 2 hours

n of these factors which will create confidence in the Case Aide, on lients, and a discussion of the importance of understanding others.

SE AIDE HELP? - 2 hours

istic ways of helping, use by Case Aides, are discussed, including: lishing rapport, preparing for an interview, hints on interviewing, e interview.

EXPERIENCE - 4 hours

observation is provided for each Case Aide, preferably of an exper- roviding a service to a client. The Case Aide can identify qualities stics utilized by the helping person for comparison, in discussion, y identified qualities and characteristics in Sessions 8 and 9.

LFARE TEAM - 2 hours

fare team is defined, its characteristics identified and the (roles) of the various agency employees who comprise the team are discussed on.

TION AND DISCUSSION - 2 hours

cation by an Eligibility Worker and Social Service Worker is planned, upon their differing roles and responsibilities with the client, to sis for discussing the ways in which the case aide will contribute, as team, in helping the client.

EXPERIENCE - 4 hours

nal experience of an Eligibility Worker and/or Social Service Worker opportunity for the participant to further clarify his role and differ- from those roles of other team members.

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Session 14 - SOME CONCEPTS USED IN THE HELPING SERVICES - 2 hours

Selected concepts of social work practice - confidentiali
dignity and worth of the individual, rights and responsib
presented and discussed in terms of Case Aide functions.

Session 15 - EXPECTATIONS AND RESPONSIBILITIES - 2 hours

A review of expectations, rights and responsibilities of
personnel policies affecting employees and future trainin
encourage the Case Aide's continued development is planne

Session 16 - REVIEW OF WEEKS ACTIVITIES AND GROUP EVALUATION - 2 hours

A review of the week orientation, content areas covered,
ples discussed, and a discussion of these experiences in
has occurred.

Session 17 - A MEETING WITH INDIVIDUAL SUPERVISORS - 2 hours

A brief conference between the Case Aide and his ongoing
which the purpose of supervision can be briefly introduce
for introduction to persons he will be working with, wher
following Monday, and the location of his desk can be cov

SOME CONCEPTS USED IN THE HELPING SERVICES - 2 hours

Selected concepts of social work practice - confidentiality, self-determination, the dignity and worth of the individual, rights and responsibilities of clients - are presented and discussed in terms of Case Aide functions.

EXPECTATIONS AND RESPONSIBILITIES - 2 hours

A review of expectations, rights and responsibilities of all public welfare employees, personnel policies affecting employees and future training programs designed to encourage the Case Aide's continued development is planned.

REVIEW OF WEEKS ACTIVITIES AND GROUP EVALUATION - 2 hours

A review of the week orientation, content areas covered, major concepts and principles discussed, and a discussion of these experiences in terms of learning which has occurred.

A MEETING WITH INDIVIDUAL SUPERVISORS - 2 hours

A brief conference between the Case Aide and his ongoing supervisor is planned, in which the purpose of supervision can be briefly introduced; and ample time exists for introduction to persons he will be working with, where he is to report on the following Monday, and the location of his desk can be covered.

15414

References	1. Introduction and Orientation Session
	A. Objective To identify and discuss the objectives of orientation training, the content to be covered, and employee rules and procedures to be followed.
"Planned Learning Activities", SDSW, October, 1961. "Using Informal Methods", Adult Leadership, March, 1955.	B. Introduction 1. Leader to group. 2. Participants to each other and to leader. 3. Participants to setting: physical arrangements, time schedule, and other housekeeping details.
	C. Purpose and Objectives of Training Program 1. Why orientation? 2. What you will be learning. a. With whom and where you will be working. b. Some of the tasks you will be doing as a Case Aide. c. The ways in which public welfare helps people. d. What the Eligibility Worker and Social Service Worker do. e. Some ways in which you can help people.

15415

I. Introduction and Orientation Session	Comments, Suggestions
A. <u>Objective</u> To identify and discuss the objectives of orientation training, the content to be covered, and employee rules and procedures to be followed.	
B. <u>Introduction</u> 1. Leader to group. 2. Participants to each other and to leader. 3. Participants to setting: physical arrangements, time schedule, and other housekeeping details.	A. Name tags should be available for use by the leader and participants. An informal atmosphere is essential for learning. A circle or semi-circle seating arrangement is most likely to invite the group interaction desired.
C. <u>Purpose and Objectives of Training Program</u> 1. Why orientation? 2. What you will be learning. a. With whom and where you will be working. b. Some of the tasks you will be doing as a Case Aide. c. The ways in which public welfare helps people. d. What the Eligibility Worker and Social Service Worker do. e. Some ways in which you can help people.	B. The purpose and objectives of the training program should be presented in informal discussion, providing participants with an opportunity to raise questions, express anxieties, and suggest specific areas of interest and concern for later emphasis. Where appropriate, the differing role of the volunteer and homemaker should also be considered.

15416

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: VI. ALTERNATOR

PERFORMANCE OBJECTIVE NO.: 6 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Alternator

CONDITIONS:

BEHAVIOR:

12. Carefully remove fan belt and lift alternator from engine compartment
13. Disassemble alternator following steps as outlined in manual
14. Make all tests and checks as outlined in manual
15. Reassemble alternator following steps as outlined in manual
16. Make all final bench checks as outlined in manual
17. If all final tests and checks are satisfactory, proceed as follows;
18. Return alternator to engine compartment
19. Bolt alternator to bracket but do not tighten
20. Put fan belt on alternator (check condition of fan belt and replace if necessary)
21. Bolt alternator to adjusting arm
22. With proper tool, move out on alternator until proper belt tension is obtained
23. Tighten alternator adjusting bolts and alternator to engine bracket bolts

PERFORMANCE CRITERIA:

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f. How you will work with the Social Serv and Eligibility Worker.

g. County department rules and procedures followed by all employees.

D. Content

1. Outline of content.

2. Training schedule.

3. Employee rules and procedures.

E. Distribution of the Workbook

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15417

1. Introduction and Orientation Session	Comments, Suggestions
f. How you will work with the Social Service and Eligibility Worker. g. County department rules and procedures followed by all employees. Content 1. Outline of content. 2. Training schedule. 3. Employee rules and procedures. Distribution of the Workbook	C. If the workbook schedule is not used, a schedule should be reproduced and discussed in detail to be sure that each participant understands where he is to be and with whom. Employee rules and procedures discussed at this time should be limited to beginning essentials. (i.e., working hours, coffee breaks, where employees park their automobiles, etc.) If the workbook is to be used by the trainer, it can be distributed and its purpose briefly explained. Time to read the introduction should be provided and its use for note taking reviewed. Confidentiality, which is covered in Session 14, may need to be included earlier in some county departments.

15418

15417

A. Objective

To identify and locate significant persons with
he will be working, and employee-related facilit
which he will be using.

B. Content to be covered.

1. The physical relationship of various office
each other.

2. Meeting significant persons with whom the C
Aide will later be working, including:

a. His supervisor.

b. His department or division head.

c. Other persons in the unit to which he
assigned.

3. Employee-related facilities.

a. The door which employees use.

b. The restroom and lunch facilities.

c. Where employees hang their coats, keep
purses, etc.

d. Where employees park their cars.

e. How employees sign in or out, who they
obtain materials, and what supplies are
available for them.

15419

2. A Tour of County Department

Comments, Methods

A. Objective

To identify and locate significant persons with whom he will be working, and employee-related facilities which he will be using.

B. Content to be covered.

1. The physical relationship of various offices to each other.

2. Meeting significant persons with whom the Case Aide will later be working, including:

   a. His supervisor.

   b. His department or division head.

   c. Other persons in the unit to which he will be assigned.

3. Employee-related facilities.

   a. The door which employees use.

   b. The restroom and lunch facilities.

   c. Where employees hang their coats, keep their purses, etc.

   d. Where employees park their cars.

   e. How employees sign in or out, who they see to obtain materials, and what supplies are available for them.

The tour of the county department office is for the purpose of orienting the participants to the physical environment in which they will be working. Special attention should be given to:

1. Meeting the immediate supervisor with whom the participant will later be working, as well as other significant people.

2. Locating where and with whom he will be working.

3. Identifying facilities used by employees.

Emphasis upon their employee status and what employees do is important.

Ask participants to complete their workbook assignment on page 4, for the next session. Class time may need to be allowed for this.

15420

3. What do Case Aides do?	Comments, Suggestions
<u>Objective</u> To identify some of the major tasks he will be performing as a Case Aide. <u>The Need For Case Aides in Public Welfare</u> 1. The need to enrich social services to clients. 2. Many tasks can be performed by a Case Aide. 3. Better utilization of the skills of all staff. 4. More jobs are made available for persons in the helping services. 5. The need to provide career development opportunities for all staff members.	This session can begin with a discussion of the workbook assignment on page 4, and a review of the questions listed in relation to this example.
<u>Examples of Case Aide Functions and Tasks</u> 1. Direct Service Functions, such as: a. Advised clients on food preparation and buying. b. Demonstrates for clients how to purchase food more carefully. 2. Joint Functions, such as: a. Shows client how to complete a specific form. b. Escorts hesitant client to and through a family planning clinic.	Participants should be encouraged to draw upon their own experiences in identifying possible Case Aide tasks under each category. Use a blackboard to list tasks, adapting participant suggestions and filling in areas which are omitted. The trainer will want to modify examples to be compatable with specific tasks being assigned to aides in the county department.

3. Bridging Functions, such as:

   a. Advises clients on the use of a resource w in the county department.

   b. Gathers specific information on a neighbor through door-to-door canvassing.

4. Recruitment and Follow-up Functions, such as:

   a. Asking a client why he was unable to follo through in contacting or using a specific resource.

   b. Assisting a client to make a request for agency social services.

D. The Contribution to be Made by the Case Aide

1. The Case Aide has an important contribution to make in planning for agency clients.

2. The Case Aide comes with special knowledge and client experience that can ease his communicat with and appreciation of clients with whom he work.

3. The Case Aide can serve as a liaison between t client with whom he works, and the agency whic he represents.

4. The Case Aide can offer interpretation of clie and neighborhood behavior.

5. The Case Aide can offer some special and uniqu services to clients.

New Careers: The Community/Home Health Aide Trainers Manual. National Institute of New Careers, University Research Corporation. Washington, D. C., October 1968.

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3. What do Case Aides do?	Comments, Suggestions
3. Bridging Functions, such as:	
a. Advises clients on the use of a resource within the county department.	
b. Gathers specific information on a neighborhood through door-to-door canvassing.	
4. Recruitment and Follow-up Functions, such as:	
a. Asking a client why he was unable to follow through in contacting or using a specific resource.	Case Aides should be encouraged to identify specific skills and experiences they have had which they feel now are helpful to a client.
b. Assisting a client to make a request for agency social services.	
D. <u>The Contribution to be Made by the Case Aide</u>	
1. The Case Aide has an important contribution to make in planning for agency clients.	
2. The Case Aide comes with special knowledge and client experience that can ease his communication with and appreciation of clients with whom he will work.	
3. The Case Aide can serve as a liaison between the client with whom he works, and the agency which he represents.	
4. The Case Aide can offer interpretation of client and neighborhood behavior.	
5. The Case Aide can offer some special and unique services to clients.	

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References

4. Observational Experience

A. Objective

To identify and describe in detail one way in which Case Aide helped a particular client.

B. Suggested Guidelines for Planning the Observational Experience

The purpose of this first observational experience is to provide the learner with an opportunity to observe an experienced Case Aide performing an appropriate agency helping function with a client.

1. The function should be representative of one earlier considered in group discussion.

2. The tasks performed should be relatively simple ones, similar to the kind a new Case Aide will b assigned in the coming weeks.

3. The Case Aide should be told something about the observational experience, including:

   a. Information about the family they will be visiting.

   b. The problem with which the aide is planning to help the family.

   c. What he plans to do.

   d. How she and the client were brought togeth (how the referral of this family came to h

   e. What he will do with any additional inform tion he obtains at the visit.

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15426

4. Observational Experience

Comments, Suggestions

A. <u>Objective</u>

To identify and describe in detail one way in which a Case Aide helped a particular client.

B. <u>Suggested Guidelines for Planning the Observational Experience</u>

The purpose of this first observational experience is to provide the learner with an opportunity to observe an experienced Case Aide performing an appropriate agency helping function with a client.

1. The function should be representative of one earlier considered in group discussion.

2. The tasks performed should be relatively simple ones, similar to the kind a new Case Aide will be assigned in the coming weeks.

3. The Case Aide should be told something about the observational experience, including:

   a. Information about the family they will be visiting.

   b. The problem with which the aide is planning to help the family.

   c. What he plans to do.

   d. How she and the client were brought together (how the referral of this family came to him).

   e. What he will do with any additional information he obtains at the visit.

A social service worker may be used where an experienced Case Aide is not available, but care must be taken to distinquish between Case Aid and Social Service tasks performed.

Ask participants to complete their workbook assignment, following their observation, on page 6.

Opportunity for participants to discuss this observational experiences in the learning group should be planned immediately following the experience, or at the next planned group session.

Ask participants to complete the workbook assignment on page 7, in preparation for the next session.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: VI. ALTERNATOR

PERFORMANCE OBJECTIVE NO.: 6 TITLE: Remove, Disassemble, Reassemble, Replace, and Test Alternator

CONDITIONS:

BEHAVIOR:

24. Connect battery field and ground wires following steps as outlined in manual
25. Install all accessories removed following steps as outlined in manual
26. Connect battery ground to terminal
27. Inspect all wires and connections and remove all tools, materials, etc. from engine compartment
28. Start engine
29. Make all checks and tests as outlined in manual
30. If all tests and checks are satisfactory, stop the engine and proceed as follows;
31. Remove all tools, materials, etc. and place in proper place
32. Remove covers from fenders and store in proper place
33. Close hood
34. Return automobile to proper parking area
35. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to remove, disassemble, reassemble, replace, and test alternators in 3 hours.

Learning time: 6 hours

References

5. What is Public Welfare?

A. Objective

To identify and discuss the three broad pu
public welfare, and differentiate between
categorical aid programs through which fin
assistance is provide to clients.

B. The Purpose of Public Welfare

Public Welfare Seeks to:

1. Support and maintain financially need
by

a. Providing money and/or vendor pa

b. Certification of eligibility

through

a. Categorical Aid programs

b. General Assistance program

c. Food Stamp program

d. Medi-Cal program

In order to

Enable financially needy people to su
level compatible with health and dece
despite their best efforts, they cann
themselves.

2. Conserve the human resources of peopl

by

Eligibility and Assistance Manual, Vol. I, SDSW.

Social Security Program in the United States, The Schottland, Charles I., Merdith Publishing Company, New York, 1963.

15427

5. What is Public Welfare?

Comments, Suggestions

A. <u>Objective</u>

To identify and discuss the three broad purposes of public welfare, and differentiate between the various categorical aid programs through which financial assistance is provide to clients.

(Some Trainers may prefer to schedule sessions 5 and 6 prior to session 3.)

B. <u>The Purpose of Public Welfare</u>

Public Welfare Seeks to:

1. Support and maintain financially needy persons <u>by</u>
   a. Providing money and/or vendor payments
   b. Certification of eligibility

   <u>through</u>

   a. Categorical Aid programs
   b. General Assistance program
   c. Food Stamp program
   d. Medi-Cal program

   <u>In order to</u>

   Enable financially needy people to subsist at a level compatible with health and decency when, despite their best efforts, they cannot support themselves.

2. Conserve the human resources of people

   <u>by</u>

Discussion will draw upon the perceptions of Public Welfare which participants bring to their new job assignment. Summarize the case example in the workbook on page 7 and discuss the questions which Case Aides answered in completing this assignment.

These purposes can be graphically represented on a blackboard to serve as a basic model of Public Welfare upon which later discussion can build.

Participants should develop a list of examples for each of these broad program areas.

istance
W.

gram in the
Schottland,
Publishing
1963.

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Social Services Standards
SDSW.

providing Social Services

through

a. Work with financially needy individuals an families

b. Work with children

c. Work with aged, disabled or blind adults

to

a. Increase earning capacity and realize thei full potential for productive, independent living

b. Protect those who, because of age, physica or mental condition, cannot act effectivel for themselves.

3. Protect the Public

by

Licensing

through

a. Establishing standards for the care of children and aged persons

b. Inspection of public agencies and facilitie serving children and aged persons.

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5. What is Public Welfare?	Comments, Suggestions
viding Social Services	Specific examples of each broad program area should be offered.
ough	
Work with financially needy individuals and families	
Work with children	
Work with aged, disabled or blind adults	
Increase earning capacity and realize their full potential for productive, independent living	
Protect those who, because of age, physical or mental condition, cannot act effectively for themselves.	
otect the Public	
censing	
rough	
Establishing standards for the care of children and aged persons	
Inspection of public agencies and facilities serving children and aged persons.	

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	to a. Provide assurance to the public that ag and facilities serving children and adu meet appropriate standards. b. Protect the public against irregular ch placement practices.
Eligibility and Assistance Manual, Vol. 1, SDSW	C. The Categorical Aid Programs 1. Old Age Security (OAS) For persons 65 years of age or older. 2. Aid to Families with Dependent Children (AFDC AFDC-U) a. Aid to dependent children who are in nee lack parental support and care because o death, continued absence from the home, incapacity of one or both parents. b. Aid to children whose need stems from the unemployment of the father, or under limi circumstances, the mother. 3. Aid to the Blind (AB) and Aid to the Potential Self-Supporting Blind (APSB) a. A minimum age of 16 years b. A definition of economic blindness (1/10t of normal eyesight or less)

Comments, Suggestions

to

a. Provide assurance to the public that agencies and facilities serving children and adults meet appropriate standards.

b. Protect the public against irregular child placement practices.

The Categorical Aid Programs

1. Old Age Security (OAS)

   For persons 65 years of age or older.

2. Aid to Families with Dependent Children (AFDC and AFDC-U)

   a. Aid to dependent children who are in need and lack parental support and care because of death, continued absence from the home, and incapacity of one or both parents.

   b. Aid to children whose need stems from the unemployment of the father, or under limited circumstances, the mother.

3. Aid to the Blind (AB) and Aid to the Potentially Self-Supporting Blind (APSB)

   a. A minimum age of 16 years

   b. A definition of economic blindness (1/10th of normal eyesight or less)

The brochure Public Assistance and Welfare Services in California can serve as reading and reference material for participants.

The purpose of this overview is not to teach detailed eligibility requirements for these various programs. Instead, emphases should be on providing sufficient information to assure an awareness of potential agency resources.

Emphasis and more detailed information will need to be included on those categorical aid programs with which the case aide may be working.

4. Aid to the Needy Disabled (ATD)

   a. A person with a physical or mental di
   which probably will continue for life
   prevents engagement in paid employmen
   homemaker duties.

   b. At least 18 years of age.

5. General Relief (GR)

   a. To meet the needs of people not eligi
   under one of the previous categorical
   programs.

   b. Financed and administered under count
   auspices.

D. Related Agency Program Resources

1. The Food Stamp Program

   The purchase of food stamps at a discount
   increase the food purchasing power and imp
   the nutrition of financially limited perso
   families.

2. Medical Services

   The purchase of selected medical benefits
   persons eligible with a full choice of doc
   and facilities used for such services.

3. State Preschool Program

   A planned child development activity whic
   to prepare disadvantaged children from ec
   ly and/or culturally deprived families fo
   success in the formal educational system.

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5. What is Public Welfare	Comments, Suggestions
4. Aid to the Needy Disabled (ATD) a. A person with a physical or mental disability which probably will continue for life and prevents engagement in paid employment or homemaker duties. b. At least 18 years of age. 5. General Relief (GR) a. To meet the needs of people not eligible under one of the previous categorical aid programs. b. Financed and administered under county auspices.	
. Related Agency Program Resources 1. The Food Stamp Program The purchase of food stamps at a discount to increase the food purchasing power and improve the nutrition of financially limited persons and families. 2. Medical Services The purchase of selected medical benefits for persons eligible with a full choice of doctors and facilities used for such services. 3. State Preschool Program A planned child development activity which seeks to prepare disadvantaged children from economically and/or culturally deprived families for later success in the formal educational system.	Local examples of each of these resources should be identified and discussed. A comparison of the Food Stamp Program with surplus commodities may be useful in lessening misconceptions of participants. Ask participants to complete the workbook assignment on page 10, in preparation for the next session.

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References

6. A Discussion of Public Welfare Programs, Se

A. Objective

To identify and differentiate betwe
social services provided by the age

B. Some Reasons Why Social Services ar

1. To broaden a person's ability t

2. To expand each person's range o
can use in determining his futur

3. To protect people from neglect,
exploitation.

4. To make available additional res

5. To help people to utilize agency
resources more fully in the solu
problems.

6. To help people more clearly expr
and needs to the agency as well
resources.

C. Specific Programs, Services and Resou

1. Required Services:

a. Information and Referral Serv

b. Protective Services

(1) for adults

(2) for children

Social Services Standards, SDSW.

15435

Discussion of Public Welfare Programs, Services and Resources	Comments, Suggestions
A. <u>Objective</u> To identify and differentiate between the major kinds of social services provided by the agency to clients.	The purpose of this session is to expand the Case Aide's beginning knowledge of agency programs and resources.
B. <u>Some Reasons Why Social Services are Provided</u> 1. To broaden a person's ability to manage his life. 2. To expand each person's range of choices, which he can use in determining his future. 3. To protect people from neglect, abuse or exploitation. 4. To make available additional resources to clients. 5. To help people to utilize agency and community resources more fully in the solution of their problems. 6. To help people more clearly express their problems and needs to the agency as well as other community resources.	Participants should be encouraged to draw upon their wealth of prior experience in identifying why services are provided to clients. The specific reasons listed here are only some of the more often suggested ones - Case Aides will think of many additional ones. Specific examples of each should be offered in illustration of the reasons and purposes for providing social services.
C. <u>Specific Programs, Services and Resources</u> 1. Required Services: a. Information and Referral Services b. Protective Services (1) for adults (2) for children	Discussion can be stimulated by asking participants to identify the kinds of services they have received or know of other persons receiving.

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: VII VOLTAGE REGULATORS

PERFORMANCE OBJECTIVE NO: 7 TITLE: Remove, Replace and Test AC and DC Voltage Regulators

CONDITIONS:

LEARN	REFERENCE	SOURCE
5. Checking Generator Regulator Systems	5. Automotive Electrical Equipment, by Crouse. pp. 263 through 276	5. Related Information Class
6. Checking Alternator Regulator Systems	6. Automotive Electrical Equipment, by Crouse. pp. 308 through 326	6. Related Information Class

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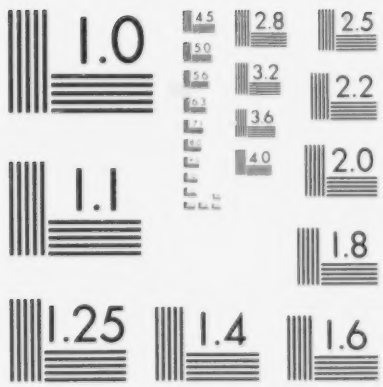

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

c. Employment and Social Rehabilitation Servi

d. Services to Strengthen Individual and Fami Life

e. Out-of-Home Services

(1) for adults

(2) for children

f. Day Care Services

g. Health Care Services

h. Family Planning Services

i. Homemaker Services - for adults

2. Recommended Service Programs

a. Adoption Services

b. Licensing Services

c. Educational Training Program

d. Homemaker Services - for children

Discussion of Public Welfare Programs, Services and Resources	Comments, Suggestions
c. Employment and Social Rehabilitation Services d. Services to Strengthen Individual and Family Life e. Out-of-Home Services (1) for adults (2) for children f. Day Care Services g. Health Care Services h. Family Planning Services i. Homemaker Services - for adults 2. Recommended Service Programs a. Adoption Services b. Licensing Services c. Educational Training Program d. Homemaker Services - for children	In discussion of these agency programs, the following questions should be answered in relation to each: (1) What is the program or service and why is it provided? (2) To whom is it available and under what circumstances? (3) Who provides the service? (4) How is the client and the program or service brought together? (5) What possible role might the Case Aide play in relation to the particular service? This session can be summarized, using the workbook assignment on page 10 as a basis for discussion. Before the session ends, ask participants to complete the workbook assignment on page 13 before the next session, and review how this is to be completed.

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References

7. An Observational Experience

A. Objective

To identify and discuss in detail, how one employee explains and/or interprets the use of an agency res to a client.

B. The Observational Experience to be Planned

The purpose of this experience is to provide each C Aide with an opportunity to observe an experienced employee (preferably a Case Aide) explain and/or interpret the use of an agency resource to a client.

In this observation, the participant will want to se answers to the following questions:

1. What did the client want or need to know?

2. How was the subject of the resource introduced i the interview?

3. How was the resource explained?

7. An Observational Experience

Comments, Suggestions

Objective

To identify and discuss in detail, how one employee explains and/or interprets the use of an agency resource to a client.

The Observational Experience to be Planned

The purpose of this experience is to provide each Case Aide with an opportunity to observe an experienced employee (preferably a Case Aide) explain and/or interpret the use of an agency resource to a client.

In this observation, the participant will want to seek answers to the following questions:

1. What did the client want or need to know?

2. How was the subject of the resource introduced in the interview?

3. How was the resource explained?

Ask participants to answer the questions on page 12 of their workbook following their observational experience.

A discussion of these experiences should be planned immediately following the observation, which focuses upon answering these questions.

Ask participants to complete their workbook assignment which begins on page 13, in preparation for their next session.

8. The Qualities of a Helping Person

References		Com
Common Human Needs. Towle, Charlotte, National Association of Social Workers, New York, 1965.	A. Objective To identify and discuss the qualities of a helping person and how these qualities will be expressed in their work with clients. B. Some Basic Factors Which Will Create Confidence in the in the Case Aide on the Part of Clients: 1. Confidence that he is understood. a. He experiences a warm, friendly interest. b. He is allowed to tell his story in his own way. c. He is helped to tell it by the Case Aide's questions (to be distinguished from probing). d. His personal feelings are accepted and appreciated (but this does not necessarily imply agreement). e. He is not judged as a good or bad person. 2. Confidence that he is respected. a. He learns what help he can have. b. He is asked for his opinion. c. He is not hurried or rushed in discussing his request. d. Where possible, he is offered more than one course of action. e. He is allowed to decide what he wants to do.	Dra in tio ask pre tra a b cha tho res con

15441

. The Qualities of a Helping Person	Comments, Suggestions
fy and discuss the qualities of a helping d how these qualities will be expressed in their clients.	Drawing upon their own experiences in seeking help in everyday situations, participants should be asked to list those qualities they prefer in a helping person. The trainer can develop two lists, on a blackboard, one for helping characteristics and another for those characteristics which are resented, create distrust or block communication.
c Factors Which Will Create Confidence in the se Aide on the Part of Clients:	
dence that he is understood.	
He experiences a warm, friendly interest.	
He is allowed to tell his story in his own way.	
He is helped to tell it by the Case Aide's questions (to be distinguished from probing).	
His personal feelings are accepted and appreciated (but this does not necessarily imply agreement).	
He is not judged as a good or bad person.	
idence that he is respected.	
He learns what help he can have.	
He is asked for his opinion.	
He is not hurried or rushed in discussing his request.	
Where possible, he is offered more than one course of action.	
He is allowed to decide what he wants to do.	

f. His questions are answered frank
answer is not known, he is refer
who can answer the question (or
attempts to obtain the informati

C. An Exercise in Helping

1. Situation: A Case Aide has been aske
Mrs. Smith, an ADC recip
asked for help in learni
food more wisely on her

2. Situation: Mr. Jones, an OAA recipie
in a very isolated part
has increasingly had diff
ing his food and other es
his check arrives. The
been asked to visit Mr. J
mine whether he has been
these essentials for the

D. The Importance of Understanding Others:

1. Each person is unique. He has his ow
strengths, weaknesses, attitudes, etc

2. Emotional needs are as important as p

3. It is important to be interested in t
client. If a mother is concerned abou
health problem, rather than purpose o
listen to her concerns before proceed
purpose of your visit.

4. Differences in the way a person respo
result of different perception (one's
the outside world).

Selected Social Work Concepts for Public Welfare Workers. Tanner, Virginia, USDHEW, Bureau of Family Services, Washington, D. C.

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	Comments, Suggestions
f. His questions are answered frankly or, if the answer is not known, he is referred to someone who can answer the question (or the Case Aide attempts to obtain the information for him).	
C. <u>An Exercise in Helping</u> 1. Situation: A Case Aide has been asked to visit with Mrs. Smith, an ADC recipient, who has asked for help in learning to purchase food more wisely on her budget. 2. Situation: Mr. Jones, an OAA recipient, lives in a very isolated part of the county and has increasingly had difficulty purchasing his food and other essentials when his check arrives. The Case Aide has been asked to visit Mr. Jones to determine whether he has been able to acquire these essentials for the month.	Assign one person to the role of "Case Aide" and ask that he respond as he would on the job. A second person is to be assigned the role of "client" and follows the situation described. Divide the remaining group in half. Ask one group to observe the client and the other the Case Aide. After about five minutes of role playing, ask the "Case Aide" and "client" each how he feels he did. General discussion can follow around what each observer saw.
D. <u>The Importance of Understanding Others</u>: 1. Each person is unique. He has his own values, strengths, weaknesses, attitudes, etc. 2. Emotional needs are as important as physical needs. 3. It is important to be interested in the "whole" client. If a mother is concerned about a child's health problem, rather than purpose of your visit, listen to her concerns before proceeding with the purpose of your visit. 4. Differences in the way a person responds may be the result of different perception (one's awareness of the outside world).	Discussion can begin with a review of the workbook assignment on pages 13 and 14. How each participant would respond to the situations can reflect the points here to be taught, and serve as a basis of identifying why it is important to understand the client.

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Remember:

a. No two persons perceive the same thing in the same way.

b. Despite your best of intentions, the client m not perceive you as a helping person.

c. Do not be defensive. Instead, attempt to understand why he responds as he does.

5. Be aware of one's own preconceptions. These are a product of one's own background and experiences.

6. Many clients are noticeably fearful and may be easily upset by problems and difficulties they ar experiencing. Recognize the client's fearfulness

7. Clients may react to a Case Aide differently now that he is a representative of the agency, becaus

   a. They may resent their dependency upon the age

   b. They may resent having to live on a less than adequate income.

   c. They may be fearful that they will not conti to be eligible for financial assistance.

   d. Past contacts with the agency may not always have been positive or helpful, from the clie point of view.

   e. They may have felt that they were discrimina against by this or some other agency or institution.

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/ RELATED INSTRUCTION /

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: VII VOLTAGE REGULATORS

PERFORMANCE OBJECTIVE NO: 7 TITLE: Remove, Replace and Test AC and DC Voltage Regulators

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Current and Voltage Regulation	1. Filmstrip	1. Resource Materials Center
2. Regulator Fundamentals	2. Automotive Electrical Equipment, by Crouse. pp. 226 through 230	2. Related Information Class
3. DC Regulators	3. Automotive Electrical Equipment, by Crouse. pp. 230 through 244 Automotive Electricity Workbook, by Crouse. Jobs 30 and 31	3. Related Information Class
4. AC Regulators	4. Automotive Electrical Equipment, by Crouse. pp. 244 through 259 Automotive Electricity Workbook, by Crouse. Jobs 36 and 37	4. Related Information Class

8. The Qualities of a Helping Person

Comments, Suggestions

Remember:

a. No two persons perceive the same thing in the same way.

b. Despite your best of intentions, the client may not perceive you as a helping person.

c. Do not be defensive. Instead, attempt to understand why he responds as he does.

5. Be aware of one's own preconceptions. These are a product of one's own background and experiences.

6. Many clients are noticeably fearful and may be easily upset by problems and difficulties they are experiencing. Recognize the client's fearfulness.

7. Clients may react to a Case Aide differently now that he is a representative of the agency, because:

a. They may resent their dependency upon the agency.

b. They may resent having to live on a less than adequate income.

c. They may be fearful that they will not continue to be eligible for financial assistance.

d. Past contacts with the agency may not always have been positive or helpful, from the client's point of view.

e. They may have felt that they were discriminated against by this or some other agency or institution.

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References	8. The Qualities of a Helping Person	Com
	f. They may not have always felt that the agency understood them. g. Such perceptions will most often be overcome by your demonstration of the helping qualities previously discussed. h. The client may resent the Case Aide's job and salary.	Ask wor ind dis pre

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8. The Qualities of a Helping Person	Comments, Suggestions
f. They may not have always felt that the agency understood them. g. Such perceptions will most often be overcome by your demonstration of the helping qualities previously discussed. h. The client may resent the Case Aide's job and salary.	Ask participants to complete the workbook assignment on page 16, indicating whether they agree or disagree with each statement, in preparation for the next session.

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References

Riessman, Frank, "The Revolution in Social Work: The New Nonprofessional," Transaction. Washington University, St. Louis, Mo., Vol. 2, No.1, Nov-Dec, 1964.

New Careers: The Community/Home Health Aide, National Institute for New Careers, University Research Corporation. U. S. Department of Labor, Washington, D. C., October 1968.

9. How Does a Case Aide Help?

A. Objective

To identify the ways in which Case Aides work with clients and discuss how they can establish rapport w clients.

B. The Ways in Which Case Aides Work with Clients are Frequently Characterized by Such Qualities as:

1. Honesty.
2. Acceptance.
3. Directness.
4. Informality.
5. A practical approach.

C. Ways of Establishing Rapport

1. Introduce yourself and state the reason for you visit.
2. Express a desire to assist the client.
3. Observe the client for indications of acceptanc rejection. If rejection, try to discover his r for not wanting your help. If acceptance, purs interview.
4. Informal conversation can help to put the clien ease.
5. Show interest in the client's problems as he se them.

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9. How Does a Case Aide Help?

A. Objective

To identify the ways in which Case Aides work with clients and discuss how they can establish rapport with clients.

B. The Ways in Which Case Aides Work with Clients are Frequently Characterized by Such Qualities as:

1. Honesty.
2. Acceptance.
3. Directness.
4. Informality.
5. A practical approach.

C. Ways of Establishing Rapport

1. Introduce yourself and state the reason for your visit.
2. Express a desire to assist the client.
3. Observe the client for indications of acceptance or rejection. If rejection, try to discover his reasons for not wanting your help. If acceptance, pursue the interview.
4. Informal conversation can help to put the client at ease.
5. Show interest in the client's problems as he sees them.

Comments, Suggestions

Discussion can begin with a review of the assignment completed in the workbook on page 16. From a discussion of whether they agree or disagree with these statements, the characteristic ways of working, for a Case Aide, can be developed. It should be recognized that while these questions may be beyond the capacity of the learner, and that in reality they cannot always be answered easily, they are intended only for use in stimulating discussion.

Ask participants to practice on each other. This can be done by having one person assume the role of "Case Aide" and another the role of "client." The Case Aide can be given the assignment of introducing himself and putting the client at ease. Group discussion can follow in which these factors are identified and listed on a blackboard.

6. Clarify your role in assisting him and enco to seek the help of his Social Service Work Eligibility Worker with problems appropriat areas of responsibility.

C. How to Prepare for a Visit

1. Why are you going to see the client?

2. What is to be accomplished?

3. Telephone or write a letter to the client t schedule the appointment.

4. Gather the information and materials you wi for the interview - forms, list of question pencils, etc.

5. Be as prompt as possible for your interview

D. Some Useful Hints in Talking With Clients

1. Introduce yourself and greet the client by (Names are important).

2. Encourage the client to talk freely.

3. Listen to all that he says.

4. Be sure that you speak so the person can he and use words he will understand.

5. Determine how fast the client can discuss t with you and adjust your speed accordingly.

6. Observe nonverbal communication. (The clien reactions, expressions, concentration on t conversations, etc.)

Interviewing: Its principles and methods, Garrett, Annette, Family Service Association of America, New York, 1942.

Essentials in Interviewing. Harper and Brothers, New York, 1952., Fenalson, Anne A.

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Comments, Suggestions

6. Clarify your role in assisting him and encourage him to seek the help of his Social Service Worker and an Eligibility Worker with problems appropriate to their areas of responsibility.

C. How to Prepare for a Visit

1. Why are you going to see the client?

2. What is to be accomplished?

3. Telephone or write a letter to the client to schedule the appointment.

4. Gather the information and materials you will need for the interview - forms, list of questions, pencils, etc.

5. Be as prompt as possible for your interview.

D. Some Useful Hints in Talking With Clients

1. Introduce yourself and greet the client by name. (Names are important).

2. Encourage the client to talk freely.

3. Listen to all that he says.

4. Be sure that you speak so the person can hear you and use words he will understand.

5. Determine how fast the client can discuss the matter with you and adjust your speed accordingly.

6. Observe nonverbal communication. (The client's reactions, expressions, concentration on the conversations, etc.)

Some Casework Concepts for the Public Welfare Worker. Keith-Lucas, Alan, The University of North Carolina Press, Chapel Hill, 1957.

7. Pause from time to time so that the per comment or ask questions. Be sure that understands what you have said so far.

8. Encourage a relaxed, informal atmosphere interview.

9. Notice if the client becomes tired in t (this may mean you should continue some

10. Make sure that the client is comfortabl or may not require privacy.

11. When possible, place sensitive question end, rather than the beginning of the int

E. Ending Your Conversation

1. Summarize what you and the client have

2. Review what you and what the client are as a result of the interview (if appropr

3. If a follow-up interview is planned, sc for your return.

4. Thank the person for his time.

F. After You Have Seen the Client

1. Jot down notes of what you discussed wi (particularly important to remember is information and details that can be easi

2. Ask yourself some questions.

a. Did the interview achieve its purpos why not?

Comments, Suggestions

7. Pause from time to time so that the person can comment or ask questions. Be sure that he understands what you have said so far.

8. Encourage a relaxed, informal atmosphere in your interview.

9. Notice if the client becomes tired in the interview (this may mean you should continue sometime later.)

10. Make sure that the client is comfortable. This may or may not require privacy.

11. When possible, place sensitive questions nearer the end, rather than the beginning of the interview.

E. Ending Your Conversation

1. Summarize what you and the client have discussed.

2. Review what you and what the client are going to do as a result of the interview (if appropriate).

3. If a follow-up interview is planned, schedule a time for your return.

4. Thank the person for his time.

F. After You Have Seen the Client

1. Jot down notes of what you discussed with the client (particularly important to remember is factual information and details that can be easily forgotten).

2. Ask yourself some questions.

a. Did the interview achieve its purpose? If not, why not?

b. What did I learn about the client that I did not previously know?

c. How did I help? How did the client respond to my help?

d. If a return visit is planned, what will be its purpose?

e. What information did I obtain that would help the Social Service Worker and Eligibility Worker in their work with this client?

f. What questions do I have as a result of this interview?

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: VII. VOLTAGE REGULATOR

PERFORMANCE OBJECTIVE NO.: 7 TITLE: Remove, Replace, and Test Voltage Regulator

CONDITIONS:

This project is to performed on a complete automobile.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Raise hood
6. Place protective covers on fenders
7. Disconnect battery ground cable
8. Disconnect wires from voltage regulator following steps as outlined in manual
9. Remove screws which attach regulator to engine compartment
10. Remove voltage regulator from engine compartment
11. Make all checks and tests as outlined in manual
12. If all checks and tests are satisfactory, place regulator in original position in engine compartment
13. Attach regulator to engine compartment with screws

PERFORMANCE CRITERIA:

9. How Does A Case Aide Help?	Comments, Suggestions
b. What did I learn about the client that I did not previously know?	
c. How did I help? How did the client respond to my help?	
d. If a return visit is planned, what will be its purpose?	
e. What information did I obtain that would help the Social Service Worker and Eligibility Worker in their work with this client?	
f. What questions do I have as a result of this interview?	

A. Objective

To identify and describe how a specific servic provided to a client.

B. Suggested Guidelines for the Experience

The purpose of this observational experience i vide each learner with the opportunity to obse experienced Case Aide in providing a specific, service to a client. The specific service sho selected because it will involve the aide's us interviewing skills as well as doing skills.

The learner should be asked to answer the foll questions:

1. Did the interview achieve its purpose? If not?

2. What did you learn about the client that y previously know?

3. If a return visit is planned, what will be purpose?

4. What information did you obtain that would Social Service Worker and/or Eligibility W in their work with this client.

5. What questions do you have as a result of interview.

Prior to this observational experience it is that the Case Aide who is being observed, shal information she has about this family and the of this contact.

10. Observational Experience	Comments, Suggestions
A. <u>Objective</u> To identify and describe how a specific service is provided to a client.	Ask the Case Aides to complete their workbook assignment on page 18, following this observational experience. The questions they will be answering should be reviewed, to assure that they are understood.
B. <u>Suggested Guidelines for the Experience</u> The purpose of this observational experience is to provide each learner with the opportunity to observe an experienced Case Aide in providing a specific, concrete service to a client. The specific service should be selected because it will involve the aide's use of interviewing skills as well as doing skills. The learner should be asked to answer the following questions: 1. Did the interview achieve its purpose? If not, why not? 2. What did you learn about the client that you did not previously know? 3. If a return visit is planned, what will be its purpose? 4. What information did you obtain that would help the Social Service Worker and/or Eligibility Worker in their work with this client. 5. What questions do you have as a result of this interview. Prior to this observational experience it is important that the Case Aide who is being observed, share what information she has about this family and the purpose of this contact.	A group discussion should be planned immediately following the observational experience to discuss individual reactions and their answers to these questions.

References

Differential Use of Social Work Manpower. Barker, Robert and Biggs Thomas, NASW, New York, 1968.

"Fields of Social Work Practice: Organizing Our Resources for More Effective Practice." Elliott Stutt, Social Work, NASW, Vol. 10, No. 4, (October 1965).

11. The Public Welfare Team

A. Objective

To identify the characteristics of a public
and discuss its purpose and function in wor
clients.

B. Definition

A public welfare team is a group of agency
are functionally significant to the provisi
services and financial assistance to a grou
for which they are jointly responsible.

C. The Characteristics of a Public Welfare Tea

1. They share responsibility for making the
gram relevant to the needs of specific

2. They are the primary group in the agenc
be responsive to him.

3. They share commonly defined goals with
with whom they jointly work.

4. They are the agency in action for the c

5. The team comprises a group of specialis
expertise in his own right that can be
action in solution of client problems.

D. The Composition of the Team

1. The team comprises each agency employee
direct contact with the client.

2. Any team member may involve other membe
the client is in need of their expertis

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II. The Public Welfare Team	Comments, Suggestions
A. <u>Objective</u> To identify the characteristics of a public welfare team and discuss its purpose and function in work with clients.	The concept of a "team" will not be a new concept for Case Aides. From discussion of their own ideas of what a "team" is, these characteristics can be identified and listed on a blackboard.
B. <u>Definition</u> A public welfare team is a group of agency employees who are functionally significant to the provision of social services and financial assistance to a group of clients for which they are jointly responsible.	
C. <u>The Characteristics of a Public Welfare Team</u> 1. They share responsibility for making the agency program relevant to the needs of specific clients. 2. They are the primary group in the agency which can be responsive to him. 3. They share commonly defined goals with each client with whom they jointly work. 4. They are the agency in action for the client. 5. The team comprises a group of specialists - each with expertise in his own right that can be brought into action in solution of client problems.	
D. <u>The Composition of the Team</u> 1. The team comprises each agency employee who has direct contact with the client. 2. Any team member may involve other members whenever the client is in need of their expertise.	Ask participants to turn to page 19 of their workbook, for discussion of team members.

3. The team members and their role.

   a. The Social Service Worker.

   b. The Eligibility Worker.

   c. The Case Aide.

   d. The Volunteer.

   e. The Receptionist.

   f. The Homemaker.

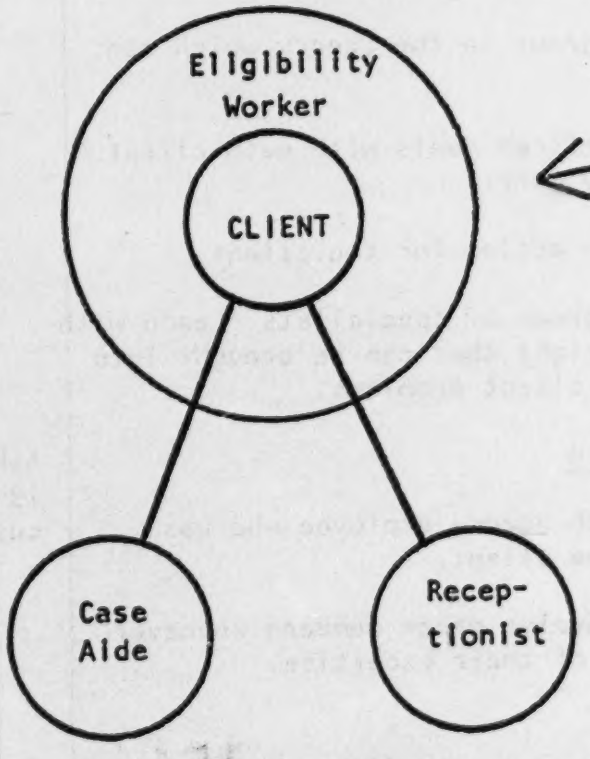

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Comments, Suggestions

3. The team members and their role.

   a. The Social Service Worker.

   b. The Eligibility Worker.

   c. The Case Aide.

   d. The Volunteer.

   e. The Receptionist.

   f. The Homemaker.

Define the major functions and tasks performed by each team member.

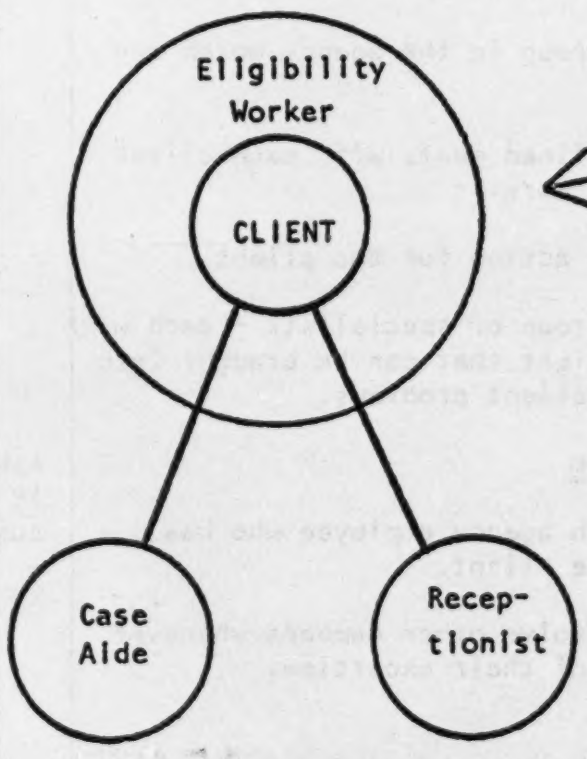

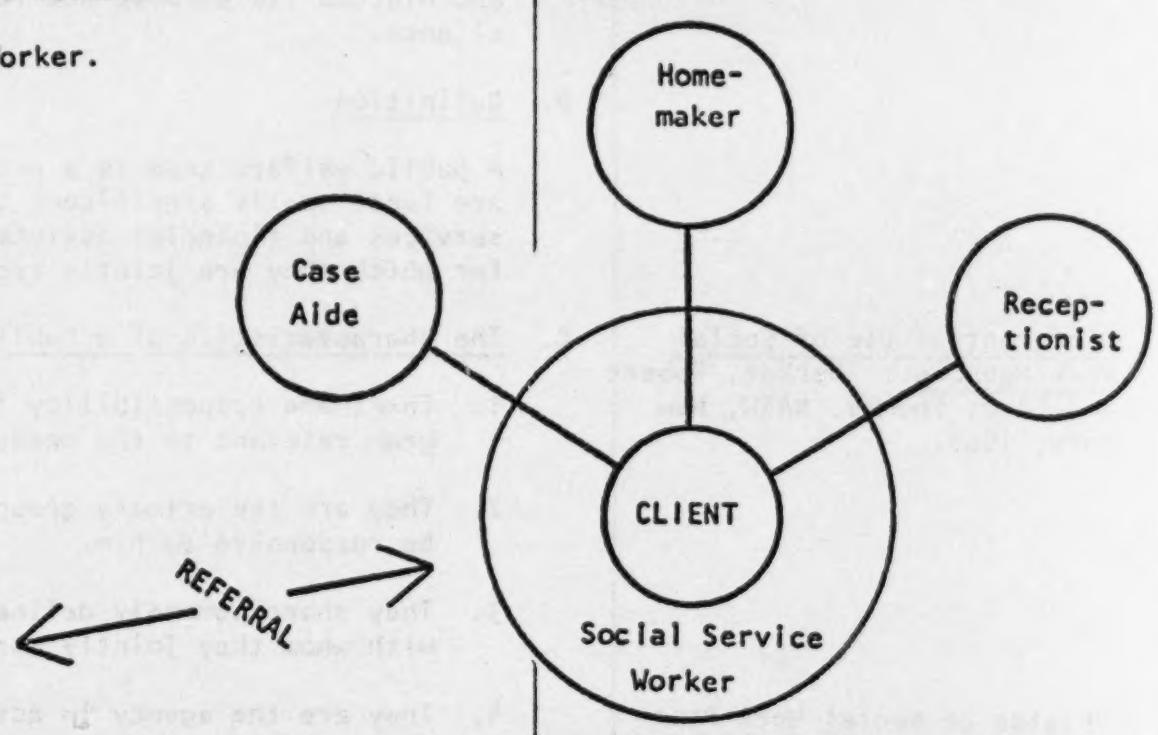

This diagram lends itself to emphasizing:

1. The client as the central focus of agency concern.

2. The orchestrational role of the Social Service Worker and Eligibility Worker.

3. The mutuality of effort needed to maximize the benefits of agency services for the client.

D. A Team Approach Requires:

1. That the Social Service Worker, the El
Worker, the Case Aide and other team m
the same goal.

2. That they communicate well with each o
between agency teams.

3. That they understand each other's cont
resources.

4. That they collaborate in the solutions
problems related to the job to be done

5. That the various team members assume r
with the client in implementing a goal
service plan.

6. That all team members demonstrate an a
the client as a person of value and wo

7. That each team member have a clear und
of his own role and its limitations.

Comments, Suggestions

D. A Team Approach Requires:

1. That the Social Service Worker, the Eligibility Worker, the Case Aide and other team members share the same goal.

2. That they communicate well with each other and between agency teams.

3. That they understand each other's contributions and resources.

4. That they collaborate in the solutions of daily problems related to the job to be done.

5. That the various team members assume responsibility with the client in implementing a goal-directed service plan.

6. That all team members demonstrate an acceptance of the client as a person of value and worth.

7. That each team member have a clear understanding of his own role and its limitations.

References

12. Case Presentation and Discussion

A. Objective

To differentiate between the roles and tasks perf by various agency employees working with a speci client.

B. Suggested Guidelines for Case Presentation

A joint case presentation should be planned, invo an Eligibility Worker, Social Service Worker and pertinent staff who have had contact with a spec client (Case Aide, Homemaker, Volunteer, etc.). Social Service Worker can be assigned responsibi leader-coordinator and present information on:

1. Family history, including the length of time family has been known to the agency.

2. The genesis of the problem(s) and the need f financial assistance and social services.

3. The timing and involvement of the various st members who have worked with the family.

4. The overall case plan for services.

Each member of the team will then describe his r activities in relation to the family, including:

1. How they became acquainted with the family.

2. Their role as a team member and the activiti have performed in relation to this client.

3. How these activities have contributed to the plan.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: VII. VOLTAGE REGULATOR

PERFORMANCE OBJECTIVE NO.: 7 TITLE: Remove, Replace, and Test Voltage Regulator

CONDITIONS:

BEHAVIOR:

14. Connect wires to regulator
15. Connect battery ground cable
16. Start engine and make all checks and tests as outlined in the manual
17. If all checks and tests are satisfactory, return tools, and materials to proper place
18. Remove covers from fenders and store in proper place
19. Close hood
20. Return automobile to proper parking area
21. Remove seat covers and store in proper place
22. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, replace, and test voltage regulator in 1 hour.

Learning time: 2 hours

12. Case Presentation and Discussion	Comments, Suggestions
<u>Objective</u> To differentiate between the roles and tasks performed by various agency employees working with a specific client. <u>Suggested Guidelines for Case Presentation</u> A joint case presentation should be planned, involving an Eligibility Worker, Social Service Worker and other pertinent staff who have had contact with a specific client (Case Aide, Homemaker, Volunteer, etc.). The Social Service Worker can be assigned responsibility as leader-coordinator and present information on: 1. Family history, including the length of time this family has been known to the agency. 2. The genesis of the problem(s) and the need for agency financial assistance and social services. 3. The timing and involvement of the various staff members who have worked with the family. 4. The overall case plan for services. Each member of the team will then describe his role and activities in relation to the family, including: 1. How they became acquainted with the family. 2. Their role as a team member and the activities they have performed in relation to this client. 3. How these activities have contributed to the case plan.	The persons presenting the case should be selected because of their ability to work together and because they are representative of the qualities earlier identified as being characteristic of a "team." Participants should be asked to answer the questions listed on page 21 of their workbook. Question and discussion should be encouraged.

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References

13. Observational Expe

A. Objective

To compare and contrast the way anoth
team member works with clients from t
will work with clients.

B. Suggested Guidelines For Planning The
Experience

The purpose of this planned experience
each Case Aide with the opportunity to
standing of the roles of other members
Welfare Team" through observation of a
In planning this experience, care must
someone whose work examplifies the dif
of working, from those of a Case Aide,
tionship to Case Aide functions should
Ideally, the observational experience
with whom the aide will later be workin

Specific areas to be observed include:

1. What does the specific employee do

2. How does this differ from what I wi

3. Were any possible Case Aide functio
being needed by the client?

4. How can a Case Aide support what thi
trying to do with the client?

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13. Observational Experience

Comments, Suggestions

A. Objective

To compare and contrast the way another public welfare team member works with clients from the way a Case Aide will work with clients.

B. Suggested Guidelines For Planning The Observational Experience

The purpose of this planned experience is to provide each Case Aide with the opportunity to expand his understanding of the roles of other members of the "Public Welfare Team" through observation of another team member. In planning this experience, care must be taken to select someone whose work examplifies the differences in ways of working, from those of a Case Aide, although a relationship to Case Aide functions should be identifiable. Ideally, the observational experience will be of someone with whom the aide will later be working.

Ask the participants to complete the workbook assignment on page 22.

The Case Aide should be given sufficient information about the client to understand the purpose of the interview and why the contact is planned.

Specific areas to be observed include:

1. What does the specific employee do in the interview?
2. How does this differ from what I will be doing?
3. Were any possible Case Aide functions identified as being needed by the client?
4. How can a Case Aide support what this employee is trying to do with the client?

A group discussion should be planned immediately following the experience(s) to discuss these questions.

References	14. Some Concepts Used in the Helping Servic
New Careers: The Community/ Home Health Aide. Trainer's Manual, National Institute for New Careers, U. S. Department of Labor, Washington, D. C., April 1969.	A. Objective To describe the use of the concepts of confidentia respect for a person's worth, and client self-dete tions in his work with clients. B. The Meaning of Confidential Information 1. Definition: The sharing of information, secur it will be used only to understand and help. 2. The reasons for confidentiality. a. To establish and maintain a helping relati built on trust and mutual confidence. b. The agency's responsibility for protecting client from the misuse of personal informa c. The ability of the agency to help, which c from its understanding of the client's nee d. Freedom to share inner thoughts as well as material wants. 3. Variations in using information a. Between client - agency representatives. (team). b. Between aide - trainer/supervisor. c. Betweeen aide - other agency staff. d. Within the department or agency.

14. Some Concepts Used in the Helping Services	Comments, Suggestions
A. Objective To describe the use of the concepts of confidentiality, respect for a person's worth, and client self-determinations in his work with clients.	
B. The Meaning of Confidential Information 1. Definition: The sharing of information, secure that it will be used only to understand and help. 2. The reasons for confidentiality. a. To establish and maintain a helping relationship built on trust and mutual confidence. b. The agency's responsibility for protecting the client from the misuse of personal information. c. The ability of the agency to help, which comes from its understanding of the client's needs. d. Freedom to share inner thoughts as well as material wants.	A brief presentation and frank discussion of the meanings of these concepts. The trainer will want to support positive attitudes and point to ways in which they are beneficial in working with clients.
3. Variations in using information a. Between client - agency representatives. (The team). b. Between aide - trainer/supervisor. c. Betweeen aide - other agency staff. d. Within the department or agency.	Specific examples should be identified for each such situation.

e. Between this agency - anothe agency and/or institution.

f. Within training group sessio

4. The Case Aide must treat all inf to him while performing his duti between himself and his trainer/

a. What information he is to sha Eligibility Worker.

b. What information he is to sha Service Worker?

5. Careless divulging of informatio affect the relationship between t agency.

C. Respect for a Person's Worth

1. Every individual has human dignit

2. Respect is the basic element of a ship.

3. One must respect self in order to

4. The rights of each agency client

a. To apply for public assistanc services.

b. To be given financial assista eligible, promptly and withou

Comments, Suggestions

e. Between this agency - another social welfare agency and/or institution.

f. Within training group sessions.

4. The Case Aide must treat all information that comes to him while performing his duties as confidential between himself and his trainer/supervisor.

a. What information he is to share with the Eligibility Worker.

b. What information he is to share with the Social Service Worker?

5. Careless divulging of information may seriously affect the relationship between the client and the agency.

The ramifications of confidentiality might be pertinent here.

C. Respect for a Person's Worth

The participants should be asked for personal examples where they believe a helping person expressed or did not express such an attitude towards them.

1. Every individual has human dignity.

2. Respect is the basic element of a helping relationship.

3. One must respect self in order to respect others.

4. The rights of each agency client

a. To apply for public assistance and/or social services.

b. To be given financial assistance, if he is eligible, promptly and without discrimination.

c. To be advised of why the agency may take specific action.

d. To spend the financial assistance he rece the way he wishes.

e. To have information regarding rules and pr of the agency which may affect him or his

f. To agency time, to question facts and cont actions, and to discuss these.

5. The responsibility of the Case Aide to respec client he may meet and work with.

D. Responsibilities of the Client

1. With each right he must assume a responsibili

2. The Case Aide's role in helping a client fulf responsibilities.

a. As an agent, representing the total agenc

b. As a member of an agency team.

c. As a helping person to the client.

d. The client's right to appeal.

"The Principle of Client Self-Determination." Biestek, Felix P., S.J., Social Casework, November 1951.

E. The Client's Right of Self-Determination

1. To determine his own destiny.

2. To accept or reject agency help.

3. To participate in shaping his own destiny.

4. To success or failure.

5. To plan his life on the basis of sufficient i tion being available to him.

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Comments, Suggestions

c. To be advised of why the agency may take a specific action.

d. To spend the financial assistance he receives in the way he wishes.

These rights might be listed on one side of a blackboard and their comparable responsibility listed when material in the following section is discussed.

e. To have information regarding rules and procedures of the agency which may affect him or his family.

f. To agency time, to question facts and contemplate actions, and to discuss these.

5. The responsibility of the Case Aide to respect each client he may meet and work with.

D. Responsibilities of the Client

1. With each right he must assume a responsibility.

2. The Case Aide's role in helping a client fulfill his responsibilities.

The positives of helping the client fulfill responsibilities should be stressed.

a. As an agent, representing the total agency.

b. As a member of an agency team.

c. As a helping person to the client.

d. The client's right to appeal.

See examples on page 44 which deal with these issues.

Self- E. The Client's Right of Self-Determination

A question to stimulate group discussion might be:

"How will this influence the ways in which you work with clients?"

1. To determine his own destiny.

2. To accept or reject agency help.

3. To participate in shaping his own destiny.

4. To success or failure.

5. To plan his life on the basis of sufficient information being available to him.

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References

15. Expectations and Responsibilitie

A. Objective

To identify and discuss employee rules and pro under which Case Aides will function, their re bilities as team members, and future developme opportunities available to them.

B. A Review of the Responsibilities and Expectati the Case Aide as an Employee

1. Office hours.

2. Dress

3. The use of sick leave.

4. The use and accruement of vacation leave.

5. Specific county rules and procedures follo (including the claiming of expenses).

C. Responsibilities of the Case Aide as a Member Agency Team

Four case examples for discussion?

1. A client you have visited several times t she does not like her social service worke she is cold and disinterested.

2. When visiting a client to discuss budgeti client tells you she is working half time told her social worker because she does n welfare grant discontinued.

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SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: VIII LIGHTING - HEADLAMPS

PERFORMANCE OBJECTIVE NO: 8 TITLE: Remove, Replace Headlamp Assembly, Test and Adjust Aim (Cont.)

CONDITIONS:

LEARN	REFERENCE	SOURCE
7. Lighting Systems	7. Teaching Machine cards 8A, 8B, 8C, 8D, 8E.	7. Teaching Machine (Shop)
8. Use of Headlight Testers	8. Headlamp Tester	8. Shop Instructor
9. "Testing Headlight Aim"	9. Continuous loop film # 8362	9. Resource Materials Center
10. Headlights	10. Automotive Electrical Equipment by Crouse. pp. 494 through 499	10. Related Information Class
11. "Headlight Intensity and Replacement"	11. Continuous loop film # 8363	11. Resource Materials Center

15. **Expectations and Responsibilities**	Comments, Suggestions
A. Objective To identify and discuss employee rules and procedures under which Case Aides will function, their responsibilities as team members, and future developmental opportunities available to them.	
B. A Review of the Responsibilities and Expectations of the Case Aide as an Employee 1. Office hours. 2. Dress 3. The use of sick leave. 4. The use and accruement of vacation leave. 5. Specific county rules and procedures followed (including the claiming of expenses).	Although these items were initially covered in session one, it is important to review and clarify the rules and procedures under which they will operate as employees.
C. Responsibilities of the Case Aide as a Member of an Agency Team Four case examples for discussion? 1. A client you have visited several times tells you she does not like her social service worker because she is cold and disinterested. 2. When visiting a client to discuss budgeting, the client tells you she is working half time but has not told her social worker because she does not want her welfare grant discontinued.	Participants should be encouraged to discuss what they would do or say under circumstances described in each of the examples.

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3. After seeing a client several times approached the social service worke special need amount be put in the c cover the cost of repairing her was Such repair would greatly improve t home situation as she would not hav hours away trying to do her washing social service worker says he will addition to the grant because, "The wouldn't use these funds for this p

4. A client tells you that she and her the verge of a separation and asks provide "marital counseling" to the to save the marriage.

D. Career Development Opportunities

1. Career advancement opportunities wi department.

2. Resources available for completing its equivalency.

3. Part-time educational leave opportu county department and the participa county in the cost of attending out during and after working hours.

4. Community Service Aide curriculums local junior and/or community coll

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15. **Expectations and Responsibilities**	Comments, Suggestions
3. After seeing a client several times, you have approached the social service worker to recommend a special need amount be put in the client's grant to cover the cost of repairing her washing machine. Such repair would greatly improve the client's home situation as she would not have to spend long hours away trying to do her washing elsewhere. The social service worker says he will not approve this addition to the grant because, "The client probably wouldn't use these funds for this purpose anyway."	
4. A client tells you that she and her husband are on the verge of a separation and asks if you would provide "marital counseling" to them in an attempt to save the marriage.	
D. Career Development Opportunities	
1. Career advancement opportunities within the county department.	
2. Resources available for completing high school or its equivalency.	
3. Part-time educational leave opportunities within the county department and the participation of the county in the cost of attending outside courses during and after working hours.	
4. Community Service Aide curriculums available through local junior and/or community colleges.	

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E. Future Training Planned for Case Aides

1. Induction training:

   a. Schedule and frequency of planned ses

   b. Subjects to be covered.

   c. Methods and procedures to be used.

2. Ongoing training.

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15. Expectations and Responsibilities	Comments, Suggestions
E. <u>Future Training Planned for Case Aides</u> 1. Induction training: a. Schedule and frequency of planned sessions. b. Subjects to be covered. c. Methods and procedures to be used. 2. Ongoing training.	It is important that detailed planning of induction training be completed by this time so that continuity is achieved.

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References

16. Review of Week's Activities and G

A. Objective

To identify and discuss his learning ach
those sessions which he believes were mo

B. A Review of Orientation Content

1. The tasks performed by a Case Aide.

2. The purpose of public welfare and it
financial assistance and social serv

3. The responsibilities and roles of th
Worker, Social Service Worker, the H
the volunteer.

4. Major ways of helping as a Case Aide
remember when interviewing a client.

5. Department rules and expectations wh
employee, will be expected to follow

C. Group Evaluation of the Training Session

Group task: Evaluate this training prog
and make recommendations which the group
important.

D. Written Evaluation and Assessment of Tra

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16. Review of Week's Activities and Group Evaluation

	Comments, Suggestions
A. Objective To identify and discuss his learning achievements and those sessions which he believes were most beneficial.	
B. A Review of Orientation Content 1. The tasks performed by a Case Aide. 2. The purpose of public welfare and its programs of financial assistance and social services. 3. The responsibilities and roles of the Eligibility Worker, Social Service Worker, the Homemaker and the volunteer. 4. Major ways of helping as a Case Aide - things to remember when interviewing a client. 5. Department rules and expectations which he, as an employee, will be expected to follow and meet.	Participants may be assigned responsibility of summarizing parts of the earlier training in which they have participated.
C. Group Evaluation of the Training Sessions to Date Group task: Evaluate this training program you are in and make recommendations which the group thinks are important.	Group evaluation can be achieved by a free discussion with the trainer. Another method which can be used:
D. Written Evaluation and Assessment of Training	Ask the group to select its own leader and as a group, to evaluate the orientation training they have now completed. The group should be given at least 30 minutes to seek group consensus and to complete this task. Notes on the evaluation and recommendations should be kept and given to the trainer.

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References

16. Review of Week's Activities and Group Evalua

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16. Review of Week's Activities and Group Evaluation	Comments, Suggestions
	Ask participants to complete the evaluation form in their workbooks. Their names should not be put on forms so that they will be free to offer their frank opinions.

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/ RELATED INSTRUCTION /

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: VIII LIGHTING - HEADLAMPS

PERFORMANCE OBJECTIVE NO: 8 TITLE: Remove, Replace Headlamp Assembly. Test and Adjust Aim

CONDITIONS: Student will learn related information listed below

LESSON	REFERENCE	SOURCE
1. Electrcical Circuits	1. Automotive Electrical Circuits, by Ford Motor Co. pp. 1 through 17, pp. 30 through 67, pp. 68 through 85, pp. 508 through 511	1. Programmed Instruction Class
2. Basic Electricity	2. Automotive Electrical Equipment, BY Crouse. pp. 10 through 28	2. Related Information Class
3. "Current Electricity"	3. Filmstrip	3. Resource Materials Center
4. "Electrical Systems"	4. Filmstrip	4. Resource Materials Center
5. Circuits	5. Automotive Electricity Workbook, by Crouse. Jobs 1 through 7	5. Related Information Class
6. Checking the Electrical System	6. Automotive Electricity Workbook, by Crouse. Job 45	6. Related Information Class

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17. A Meeting With Individual Supervisors	Comments, Suggestions
In terminating this first week of orientation, this last two-hour period should be left free for a meeting of participants with their line supervisor. The purpose of this meeting is to lessen anxiety of opportunity for them to become acquainted with their line supervisor, to learn the location of their desk, to meet people with whom they will be working and/ perhaps, to learn any specific rules or procedures to be followed in the specific unit to which they are attached. When the participants leave work, they should clearly know where they are to report on the following Monday and, possibly, what their beginning work assignment will be.	This session might be planned to start as a brief group meeting followed by individual conferences, or the total time can be spent individually with their line supervisor.

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PART II

INDUCTION TRAINING SESSIONS

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The Purpose of Induction Training

The purpose of induction training is to provide the new Case Aide skills to performing those tasks assigned to this classification focus upon helping the Case Aide to develop and expand his natura rather than to teach him a new or different way of helping client sessions contained in this training aid have been developed from assigned to Case Aides in county public welfare departments, and these staff members will need to perform these tasks. Four broad

1. Specific techniques and aids in performing their job ass
2. The methods used by Case Aides in helping clients.
3. Additional knowledge about the agency and its clients.
4. Knowledge needed in performing specific helping tasks.

Each county welfare department will want to add additional content Case Aides, related to the specific tasks assigned to these new em in this training aid. Specific sessions have been left open for t

An Outline of Induction Training Sessions

Session 1 - USING THE TELEPHONE EFFECTIVELY - 2 hours

Principles of effective telephone usage are introdu use of these principles, within the group is provid

Session 2 - SOME THINGS TO HELP YOU IN YOUR WORK - 2 hours

This session offers specific help with the mechanic including keeping a log of their work and writing.

Session 3 - A FRAMEWORK FOR HELPING - 2 hours

This session introduces one approach to work with c the steps involved in such an approach. The concept and techniques used to support this concept are disc

pose of Induction Training

pose of induction training is to provide the new Case Aide with sufficient knowledge and beginning to performing those tasks assigned to this classification of staff. As such, this training will pon helping the Case Aide to develop and expand his natural skills and ways of helping people, than to teach him a new or different way of helping clients. The content of the induction training s contained in this training aid have been developed from the more common tasks which have been d to Case Aides in county public welfare departments, and represents the beginning content which taff members will need to perform these tasks. Four broad areas are covered, including:

Specific techniques and aids in performing their job assignment.
The methods used by Case Aides in helping clients.
Additional knowledge about the agency and its clients.
Knowledge needed in performing specific helping tasks.

unty welfare department will want to add additional content areas to the induction training of des, related to the specific tasks assigned to these new employees which have not been anticipated training aid. Specific sessions have been left open for this purpose.

ine of Induction Training Sessions

1 - USING THE TELEPHONE EFFECTIVELY - 2 hours

Principles of effective telephone usage are introduced and an opportunity to practice the use of these principles, within the group is provided.

2 - SOME THINGS TO HELP YOU IN YOUR WORK - 2 hours

This session offers specific help with the mechanics of the job performed by the Case Aide, including keeping a log of their work and writing.

3 - A FRAMEWORK FOR HELPING - 2 hours

This session introduces one approach to work with clients, used by Case Aides, and examines the steps involved in such an approach. The concept of "self-help" is also introduced and techniques used to support this concept are discussed.

Session 4 - HELPING AS A CASE AIDE - 2 hours

This session focuses upon the major aims of Case Aid
the four major ways in which a Case Aide helps clien
and concrete assistance; (2) acting as a model-teach
actions; and (4) providing information about and hel
resources.

Session 5 - UNDERSTANDING AND TALKING WITH CLIENTS - 2 hours

Factors which influence the way in which people comm
the various types of communication and some of the b
self-understanding in order to help other persons is

Session 6 -- COMMUNITY RESOURCES - 2 hours

Major groupings of community resources are presented
ing and discussing specific community resources avai
upon the various needs which these resources are des
for these services.

Session 7 -- HELPING A CLIENT TO USE A RESOURCE - 2 hours

This session focuses upon the various ways in which a
resource together; factors which the Case Aide will w
resource; and discussion of the various steps to be t
and use a community resource.

Session 8 - PLANNED VISITS TO COMMUNITY RESOURCES - 4 to 8 hours
available to clients within the county.)

Planned visits to community resources used by clients
direct knowledge about each such resource, in prepara
in work with clients.

Session 9 - POVERTY: ITS CAUSES AND EFFECTS - 2 hours

Consideration of the nature of poverty, its character
Case Aide in his work with clients, is offered in bro
be viewed.

LPING AS A CASE AIDE - 2 hours

is session focuses upon the major aims of Case Aide activities, the helping process and e four major ways in which a Case Aide helps clients, including: (1) providing material d concrete assistance; (2) acting as a model-teacher; (3) supporting positive client tions; and (4) providing information about and helping the client to use available sources.

DERSTANDING AND TALKING WITH CLIENTS - 2 hours

ctors which influence the way in which people communicate provide a basis for considering e various types of communication and some of the basic needs of people. The need for lf-understanding in order to help other persons is stressed in this session.

MMUNITY RESOURCES - 2 hours

jor groupings of community resources are presented and serve as a framework for identify- g and discussing specific community resources available to clients. Emphasis is placed on the various needs which these resources are designed to meet, and who is eligible r these services.

LPING A CLIENT TO USE A RESOURCE - 2 hours

is session focuses upon the various ways in which a Case Aide might bring a client and source together; factors which the Case Aide will want to consider in selecting a source; and discussion of the various steps to be taken in helping a client to get to d use a community resource.

ANNED VISITS TO COMMUNITY RESOURCES - 4 to 8 hours (depending upon the resources ailable to clients within the county.)

anned visits to community resources used by clients will provide the Case Aide with rect knowledge about each such resource, in preparation for his later use of these work with clients.

VERTY: ITS CAUSES AND EFFECTS - 2 hours

nsideration of the nature of poverty, its characteristics and its implications for the se Aide in his work with clients, is offered in broadening the way in which poverty may viewed.

Session 10 - SOME MYTHS ABOUT PUBLIC WELFARE AND ITS CLIENTS - 2 hou

Some common myths about public welfare and its clients
common misunderstandings about the agency and to handle
attitudes of individual members.

Session 11 - NUTRITION - 2 hours

An introduction to the principles of nutrition and the
comprise the elements of a balanced diet is provided an
of the factors which influence and affect what and how

Session 12 - MEAL PLANNING AND BUYING - 2 hours

This session focuses upon the factors which influence me
method for planning and buying food. Through discussion
Aides, can be identified to maximize their use with a va

Session 13 - HOUSEHOLD MANAGEMENT - 2 hours

One approach to household management is presented and se
sion in which participants can share their own ideas and
generalized for wider use with a variety of clients.

Session 14 - FAMILY BUDGETING - 2 hours

One approach to family budgeting is offered in helping p
the skills which they have already developed in managing

Session 15 - SOME PRINCIPLES OF CHILD CARE AND CHILD REARING - 2 hour

Some principles of child care are presented and the grou
characteristics or tasks to be accomplished by a child a
These principles are then discussed in relation to their

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HE MYTHS ABOUT PUBLIC WELFARE AND ITS CLIENTS - 2 hours

ne common myths about public welfare and its clients provide a means by which to clarify mmon misunderstandings about the agency and to handle, in the learning group, non-helping titudes of individual members.

TRITION - 2 hours

introduction to the principles of nutrition and the various groupings of food which nprise the elements of a balanced diet is provided and serves as a basis for discussion the factors which influence and affect what and how much a person eats.

AL PLANNING AND BUYING - 2 hours

s session focuses upon the factors which influence meal planning, and suggests one thod for planning and buying food. Through discussion, other methods, used by Case les, can be identified to maximize their use with a variety of clients.

SEHOLD MANAGEMENT - 2 hours

approach to household management is presented and serves as a basis for group discus-n in which participants can share their own ideas and their specific examples can be eralized for wider use with a variety of clients.

ILY BUDGETING - 2 hours

approach to family budgeting is offered in helping participants to identify and discuss skills which they have already developed in managing on a limited budget.

E PRINCIPLES OF CHILD CARE AND CHILD REARING - 2 hours

e principles of child care are presented and the group is asked to identify major racteristics or tasks to be accomplished by a child at various stages in his development. se principles are then discussed in relation to their use in work with clients.

Session 16 - AN EXERCISE IN TEAMWORK - 2 hours

An exercise in teamwork is planned to reinforce th
delivery of social services to clients.

Session 17 through 22 - SUGGESTIONS FOR CONTENT IN SIX SESSIONS -

Suggestions of a number of content areas are offer
can select and plan the remaining six sessions.

Session 23 - REVIEW AND EVALUATION OF INDUCTION TRAINING - 2 ho

A review of induction training sessions, the conte
identified, serve as a summary of training to date
evaluation of these learning experiences.

AN EXERCISE IN TEAMWORK - 2 hours

An exercise in teamwork is planned to reinforce the concept of a team approach in the delivery of social services to clients.

ugh 22 - SUGGESTIONS FOR CONTENT IN SIX SESSIONS - 12 hours

Suggestions of a number of content areas are offered, from which county welfare departments can select and plan the remaining six sessions.

REVIEW AND EVALUATION OF INDUCTION TRAINING - 2 hours

A review of induction training sessions, the content areas covered and major principles identified, serve as a summary of training to date and a basis for group and individual evaluation of these learning experiences.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: VIII. LIGHTING - HEAD LAMPS

PERFORMANCE OBJECTIVE NO.: 8 TITLE: Remove, Replace, Test, and Adjust Head Lamp Assembly

CONDITIONS:

This assignment is to be performed on a complete automobile.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Remove right and left head lamp rim following steps as outlined in manual
6. Remove each head lamp retainer ring being careful not to drop head lamp
7. Unplug wires from head lamp and remove head lamp bulb
8. Repeat step #6 and #7 on each head lamp
9. Make checks and tests as outlined in the manual
10. Plug head lamp bulb to wires following steps as outlined in manual
11. Replace head lamp retainer ring
12. Repeat steps #10 and #11 for each head lamp

PERFORMANCE CRITERIA:

References

The customer service department of your local telephone company has a number of useful teaching aids, and may be willing to provide a trainer to cover this content area. They can also vide you with a number of brochures and publications that can be used by trainees.

I. Using The Telephone Effectively

A. Objective

To identify and discuss at least three principles proper telephone usage.

B. What do you do when the telephone rings?

1. First impressions are lasting impressions.

2. A prompt and courteous handling of telephone creates a helping environment for agency work

3. When a caller has to wait on the line through rings he is apt to be annoyed. Always answer phone promptly

   a. A situation to consider:

      You are working with some materials acros room when the telephone rings. The phone several times before you can answer. You the telephone and say what?

   b. A response for the situation:

      "Mr. Smith speaking. I'm sorry to have k waiting; I was not at my desk when the ph began to ring."

4. Use please and thank you liberally in your co sation - this helps to make a good impression

5. Always identify yourself when answering the phone.

I. Using The Telephone Effectively

	Comments, Suggestions
A. <u>Objective</u> To identify and discuss at least three principles of proper telephone usage.	
B. <u>What do you do when the telephone rings?</u>	
1. First impressions are lasting impressions.	This session can begin with a review and discussion of the exercise on page 31 of the workbook.
2. A prompt and courteous handling of telephone calls creates a helping environment for agency work.	
3. When a caller has to wait on the line through several rings he is apt to be annoyed. <u>Always answer the phone promptly</u>	
a. A situation to consider:	
You are working with some materials across a room when the telephone rings. The phone rings several times before you can answer. You answer the telephone and say what?	Ask the group to offer possible responses and select the one which seems the best response.
b. A response for the situation:	
"Mr. Smith speaking. I'm sorry to have kept you waiting; I was not at my desk when the phone began to ring."	
4. Use please and thank you liberally in your conversation - this helps to make a good impression.	
5. Always identify yourself when answering the telephone.	

C. Talking on the telephone

1. Don't talk too fast or too slowly. Adjust your speed to the pace set by the person you are talking with.

2. Be careful not to speak in a monotone. Use the many inflections of which your voice is capable.

   a. A situation to consider:

      "Mr. Smith, I'm so glad you called."

   b. It should sound better when "Mr. Smith" and "so" are emphasized (or "Mr. Smith" and "glad").

3. Speak in a normal conversational tone. Don't shout or let your voice drop to low.

4. Pronounce your words clearly.

D. What to say and what not to say

1. Maintain a focus on the purpose of the telephone call.

2. Answer the caller's questions.

3. Volunteer any information he may need.

4. Listen carefully to what he has to say.

5. Maintain conciseness and politeness, but don't be so brief as to sound discourteous.

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1. Using The Telephone Effectively	Comments, Suggestions
<u>Talking on the telephone</u>	
1. Don't talk too fast or too slowly. Adjust your speed to the pace set by the person you are talking with.	
2. Be careful not to speak in a monotone. Use the many inflections of which your voice is capable.	
a. A situation to consider:	Ask the members of the group to try different voice inflections.
"Mr. Smith, I'm so glad you called."	
b. It should sound better when "Mr. Smith" and "so" are emphasized (or "Mr. Smith" and "glad").	
3. Speak in a normal conversational tone. Don't shout or let your voice drop to low.	
4. Pronounce your words clearly.	
<u>What to say and what not to say</u>	
1. Maintain a focus on the purpose of the telephone call.	You may want to discuss the two examples contained in the workbook on page 31, at this point. Which conversation is the most effective and why?
2. Answer the caller's questions.	
3. Volunteer any information he may need.	
4. Listen carefully to what he has to say.	
5. Maintain conciseness and politeness, but don't be so brief as to sound discourteous.	

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E. When taking telephone calls for someone else

1. Find out who is calling

You might say: (1) May I tell Mr. Jones w calling, please?

(2) Mr. Jones would like t who is calling.

(3) Could you tell me who ing, please, so that I announce your call to

2. If you are screening telephone calls, you m to find out what the person wants.

You might say: (1) Perhaps I can help you

(2) May I tell Mr. Jones w calling about, perhaps be able to help.

F. Some do's and don'ts:

1. If you are taking a message, jot down the m important words - then complete writing the as soon as you hang up the telephone.

2. Don't start anyone on a wild goose chase. are not sure who should handle the call, dor transfer it. Instead, offer to call the per and then find out who has the information he

3. If you get someone who has been traveling fr extension to the next, do not transfer the c again, even if you know who would have the i tion. This person may not be at their desk: offer to have that person telephone them bac

4. Remember to return telephone calls, respond messages, and follow through.

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1. Using The Telephone Effectively	Comments, Suggestions
E. When taking telephone calls for someone else	
1. Find out who is calling	
You might say: (1) May I tell Mr. Jones who is calling, please?	Ask participants which response they believe is most appropriate?
(2) Mr. Jones would like to know who is calling.	
(3) Could you tell me who is calling, please, so that I can announce your call to Mr. Jones?	
2. If you are screening telephone calls, you may want to find out what the person wants.	
You might say: (1) Perhaps I can help you.	
(2) May I tell Mr. Jones what you're calling about, perhaps I might be able to help.	
F. Some do's and don'ts:	
1. If you are taking a message, jot down the most important words - then complete writing the message as soon as you hang up the telephone.	
2. Don't start anyone on a wild goose chase. If you are not sure who should handle the call, don't transfer it. Instead, offer to call the person back and then find out who has the information he wants.	
3. If you get someone who has been traveling from one extension to the next, do not transfer the call again, even if you know who would have the information. This person may not be at their desk. Instead, offer to have that person telephone them back.	
4. Remember to return telephone calls, respond to messages, and follow through.	

References

2. Some Things to Help You in Your Work

A. Objective

To identify and discuss the written procedures followe by Case Aides in the county department, their purpose the information which is to be included.

B. Keeping a log of your work

You will want to remember

1. The date.
2. What you were to do.
3. How the client participated (and reacted).
4. Your assessment of what happened.
5. What are the next steps planned.
6. Specific information and requests to be shared wi other team members.

C. Writing About What You Do

1. Serves two purposes
   a. To refresh your memory and let you view what have done and learned about a client over a period of time.
   b. To let others know what is happening.
2. Some points to remember.
   a. Keep your recording as short as possible but include all pertinent information.
   b. Keep records current and up to date.

Speak When You Write, Connecticut Mutual Life Insurance Company, Hartford, Connecticut, 1961.

2. Some Things to Help You in Your Work	Comments, Suggestions
A. <u>Objective</u> To identify and discuss the written procedures followed by Case Aides in the county department, their purpose and the information which is to be included.	
B. <u>Keeping a log of your work</u> You will want to remember 1. The date. 2. What you were to do. 3. How the client participated (and reacted). 4. Your assessment of what happened. 5. What are the next steps planned. 6. Specific information and requests to be shared with other team members.	Where appropriate, specific county procedures should be substituted wherever specified steps and procedures which are to be followed in the county department.
C. <u>Writing About What You Do</u> 1. Serves two purposes a. To refresh your memory and let you view what you have done and learned about a client over a period of time. b. To let others know what is happening. 2. Some points to remember. a. Keep your recording as short as possible but include all pertinent information. b. Keep records current and up to date.	Many county departments have some kind of a reporting form or some similar procedure which can be specifically taught at this point.

3. Information which is normally in
write.

a. The date(s) of client contac

b. The goal or goals to be achi

c. Facts surrounding the proble

d. How the problem(s) were hand

e. Why this particular method w

f. What the client and case aid
subsequently.

g. Your assessment of the conta

D. Writing Letters:

1. Keep letters short and to the po

2. Use simple, clear sentences.

3. Use proper titles.

4. Write clearly so others can reac

5. Avoid using big or technical wo

6. Follow procedures and methods o
department.

3. Information which is normally included in what you write.

   a. The date(s) of client contact(s).

   b. The goal or goals to be achieved.

   c. Facts surrounding the problems.

   d. How the problem(s) were handled.

   e. Why this particular method was chosen.

   f. What the client and case aide plan to do subsequently.

   g. Your assessment of the contact(s).

D. Writing Letters:

   1. Keep letters short and to the point.

   2. Use simple, clear sentences.

   3. Use proper titles.

   4. Write clearly so others can read.

   5. Avoid using big or technical words.

   6. Follow procedures and methods of the county department.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: VIII. LIGHTING SYSTEM - HEAD LAMPS

PERFORMANCE OBJECTIVE NO.: 8 TITLE: Remove, Replace, Test, and Adjust Head Lamp Assembly

CONDITIONS:

BEHAVIOR:

13. Adjust head lamp focus with head lamp unit following steps in manual and also the instructions on the testing and adjusting unit being used
14. Install head lamp rims
15. Recheck focus and brilliancy with test unit
16. If test is satisfactory, return tools and materials to proper place
17. Return automobile to proper parking area
18. Remove front seat covers and store in proper place
19. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to remove, replace, test, and adjust head lamp assembly in 1 hour

Learning time: 2 hours

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E. Suggestions in taking notes:

1. Listen for the main thought.

a. Sometimes a title helps.

b. Ask yourself

(1) Is the speaker for or against the

(2) Does he keep repeating something?

(3) Does he summarize what he is sayin

2. Listen with a pencil in hand.

a. Write down important words.

b. Don't try to write it all down.

c. Copy down what the speaker puts on the board.

3. Listen to what you can use.

a. Try to find things that will help you job.

b. Listen for things that will help you a

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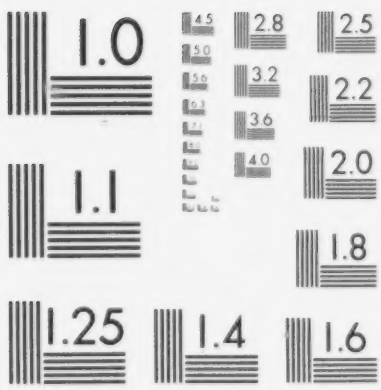

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

2. Some Things to Help You in Your Work	Comments, Suggestions
E. <u>Suggestions in taking notes:</u> 1. Listen for the main thought. a. Sometimes a title helps. b. Ask yourself (1) Is the speaker for or against the subject? (2) Does he keep repeating something? (3) Does he summarize what he is saying? 2. Listen with a pencil in hand. a. Write down important words. b. Don't try to write it all down. c. Copy down what the speaker puts on the blackboard. 3. Listen to what you can use. a. Try to find things that will help you in your job. b. Listen for things that will help you as a person.	Ask participants to complete the assignment on page 34 of their workbook, in preparation for their next session.

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References

Training Manual for Human Service Technicians Working with Older Persons, Part II (Trainees), Dr. Lewis Lowy, Ph. D., United Community Services of Metropolitan Boston, Boston, Massachusetts 1968.

3. A Framework For Helping

A. Objective

To identify and discuss the steps which are usually taken by a case aide in helping clients.

B. Introduction

In order to help a person, the Case Aide must know and understand the client, including:

1. Who the client is.
2. The kind of problems with which the Case Aide may be helping.
3. The resources available for use in the solution of the problem.
4. What the Case Aide will do with the client and how they will, together, seek a solution to the problem.
5. Evaluate the outcome of this helping activity with his supervisor.

C. The Case Aide enables the client to accept and benefit from help through the mutual trust and respect that each develop for the other.

D. The framework:

1. Identifying the problem:

   a. Who is your client? Who are his family? Where does he live and under what circumstances?

3. A Framework For Helping

	Comments, Suggestions
A. <u>Objective</u> To identify and discuss the steps which are usually taken by a case aide in helping clients.	
B. <u>Introduction</u> In order to help a person, the Case Aide must know and understand the client, including: 1. Who the client is. 2. The kind of problems with which the Case Aide may be helping. 3. The resources available for use in the solution of the problem. 4. What the Case Aide will do <u>with</u> the client and how they will, together, seek a solution to the problem. 5. Evaluate the outcome of this helping activity with his supervisor.	This session can begin with a discussion of the workbook assignment on page 34. What do they need to know about Mrs. Sanchez in order to be of help to her?
C. The Case Aide enables the client to accept and benefit from help through the mutual trust and respect that each develop for the other.	
D. The framework: 1. Identifying the problem: a. Who is your client? Who are his family? Where does he live and under what circumstances?	Use actual examples to illustrate.

b. What is the problem as the client
family sees it; and as his socia
sees it?

c. How has the client tried to hand
problems? How successful was he

d. What strengths and weaknesses wi
client's ability to solve this p

e. What does the client expect of t
the agency?

2. Deciding what should be done?

a. What resources are available to
client himself, his family, his
his community)?

b. Based upon what you know, make a
which you and the client can fol

c. Is the client in agreement with

d. Does he have the ability to fol

e. Is the plan realistic in terms
resources, your time, etc.?

f. Is the plan in agreement with t
plan?

3. Implementing the plan:

a. Establish a base of mutual resp

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3. A Framework for Helping	Comments, Suggestions
b. What is the problem as the client sees it; as his family sees it; and as his social service worker sees it?	
c. How has the client tried to handle previous such problems? How successful was he?	
d. What strengths and weaknesses will influence the client's ability to solve this problem?	
e. What does the client expect of the Case Aide and the agency?	
2. Deciding what should be done?	
a. What resources are available to help (within the client himself, his family, his neighborhood and his community)?	It is important to clarify that the case aide "does" reflect his concern for the client's more immediate, tangible problems, and that his is not casework practice.
b. Based upon what you know, make a plan of action which you and the client can follow.	
c. Is the client in agreement with this plan?	
d. Does he have the ability to follow such a plan?	
e. Is the plan realistic in terms of available resources, your time, etc.?	
f. Is the plan in agreement with the agency's case plan?	
3. Implementing the plan:	
a. Establish a base of mutual respect and trust.	The material presented in Orientation Session 8 may here be reviewed.

b. Encourage and help the client to ac

(1) Recognize when he and his situa change.

(2) Encourage the client to do wha himself.

(3) First, help him to do something can be successful.

(4) Encourage him in seeking solut immediate, tangible problems wh

(5) Recognize and accept the diffi have participating in the plan

4. Evaluate the outcome of your work with visor.

E. The Concept of Self-Help:

1. A helping person seeks to help people their own problems.

a. He allows them to decide their own

b. He helps them to expand their rang

c. Through successful problem-solving their ability to handle future pro

2. How is the technique of Self-Help used

a. Point out alternatives.

b. Offer suggestions rather than defi direction.

3. A Framework for Helping	Comments, Suggestions
b. Encourage and help the client to accept help. (1) Recognize when he and his situation can change. (2) Encourage the client to do what he can himself. (3) First, help him to do something in which he can be successful. (4) Encourage him in seeking solutions to more immediate, tangible problems which he faces. (5) Recognize and accept the difficulty he may have participating in the plan.	The client's right to accept or reject services should also be weighed, as should what the case aide does with the client, be compatible and a part of an overall plan of service.
4. Evaluate the outcome of your work with your supervisor.	
E. <u>The Concept of Self-Help</u>:	
1. A helping person seeks to help people in solving their own problems.	
a. He allows them to decide their own destiny.	
b. He helps them to expand their range of choices.	
c. Through successful problem-solving, he increases their ability to handle future problems.	
2. How is the technique of Self-Help used.	Participants might practice by suggesting the kinds of responses most likely to encourage self-help.
a. Point out alternatives.	
b. Offer suggestions rather than definite direction.	

References

3. A Framework

c. Don't take over

d. Encourage self-action

e. Involve the client in
making.

f. Wherever possible, do
than <u>for</u> the client.

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV ELECTRIC SYSTEM

MILESTONE: IX LIGHTING - TAIL, STOP, AND SIGNAL

PERFORMANCE OBJECTIVE NO: 9 TITLE: Remove, Test, and Replace Bulbs in Taillights and signal lights

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Directional Signals and Switches	1. Automotive Electrical Equipment, by Crouse. pp. 478 through 483, and p. 503	1. Related Information Class
2. Lighting Circuits	2. Teaching machine card 8F	2. Teaching Machine (Shop)
3. Wiring Diagrams	3. Automotive Electrical Circuits, by Ford Motor Co. pp. 68 through 85	3. Programmed Instruction Class

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	Comments, Suggestions
c. Don't take over	
d. Encourage self-action	
e. Involve the client in planning and in decision making.	Ask participants to complete the assignment on page 36 of their workbook, in preparation for the next session.
f. Wherever possible, do <u>with</u> the client, rather than <u>for</u> the client.	

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References

4. Helping as a Case Aide

A. Objective

To compare and contrast the four major ways i
case aides help clients and discuss the proce
such helping can occur.

Socialization: a concept and method of Casework practice for Public Assistance. State of Washington, Department of Public Assistance, May 1969.

B. The Case Aide's ability to help a client will
upon:

1. His ability to build a base of mutual tru
confidence.

2. His ability to communicate clearly and co
with the client.

3. His ability to support positive actions a
havioral changes.

4. His ability to teach - to show and demons
to achieve a specific goal.

5. His ability to focus first upon meeting t
stated need.

C. The major aims of Case Aide activities:

1. To make available to the client, county c
and community resources to meet his needs

"The Socialization of Parents," McBroom, Elizabeth, Child Welfare, Child Welfare League of America, March 1967.

2. To provide opportunities for clients to
to cope more effectively with his enviro

3. To provide a model, through action and e
managing situations in his life which he
unsatisfactory.

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4. Helping as a Case Aide

	Comments, Suggestions
A. <u>Objective</u> To compare and contrast the four major ways in which case aides help clients and discuss the process by which such helping can occur. B. <u>The Case Aide's ability to help a client will depend upon:</u> 1. His ability to build a base of mutual trust and confidence. 2. His ability to communicate clearly and concisely with the client. 3. His ability to support positive actions and behavioral changes. 4. His ability to teach - to show and demonstrate how to achieve a specific goal. 5. His ability to focus first upon meeting the client's stated need. C. <u>The major aims of Case Aide activities:</u> 1. To make available to the client, county department and community resources to meet his needs. 2. To provide <u>opportunities</u> for clients to <u>learn</u> how to cope more effectively with his environment. 3. To provide a model, through action and example, for managing situations in his life which he finds unsatisfactory.	Use discussion of Case Aide's experiences to date as a basis for adding detail and examples of what is being taught.

4. To enlarge the client's understanding o over his environment.

D. Questions to be answered:

1. What can be done now to ease the pressu client?

2. What are his choices?

3. Does he know about them?

4. When he knows, does he want to use them

5. Which one(s) does he want to use?

6. After some of the immediate pressures a what other needs might be met?

E. The helping process

1. Establish clear and explicit communicat client.

a. Understand how goals can be achieve county department rules, regulatio cedures.

b. Identify and respond to the client need.

(1) Listen purposefully

(2) Observe what is happening.

(3) Give information needed clearl

"Helping AFDC Families: A comparative study." McBroom, Elizabeth, Social Service Review, University of Chicago Press, December 1965.
(Note: although developed from socialization theory, considerable adaptations for

Comments, Suggestions

4. To enlarge the client's understanding of and control over his environment.

D. Questions to be answered:

1. What can be done now to ease the pressures upon the client?

2. What are his choices?

3. Does he know about them?

4. When he knows, does he want to use them?

5. Which one(s) does he want to use?

6. After some of the immediate pressures are lessened, what other needs might be met?

E. The helping process

1. Establish clear and explicit communication with the client.

a. Understand how goals can be achieved within county department rules, regulations, and procedures.

b. Identify and respond to the client's stated need.

(1) Listen purposefully

(2) Observe what is happening.

(3) Give information needed clearly and honestly

use by Case Aides has been made in this material.)

(4) Find out from the client enc so you understand what he wa expects and how he would lik

2. Agree upon a goal for immediate acti

a. Determine with the client who wi when and how it is to be done.

b. Be sure that the client understa upon the goal to be undertaken.

3. Direct helping activity:

a. Material and concrete assistance

(1) Focuses upon meeting the cli needs first.

(2) A tangible way of demonstrat to help.

(3) Involves providing for and w with emphasis upon your mutu to work together.

(a) May involve doing for th tacting a landlord, the agency, etc.) at first.

b. Acting as a model-teacher:

(1) Displaying (in his dealings those kinds of behavior and problem-solving.

Comments, Suggestions

(4) Find out from the client enough information so you understand what he wants, what he expects and how he would like to proceed.

2. Agree upon a goal for immediate action.

a. Determine with the client who will do what, when and how it is to be done.

b. Be sure that the client understands and agrees upon the goal to be undertaken.

3. Direct helping activity:

a. Material and concrete assistance:

(1) Focuses upon meeting the client's material needs first.

(2) A tangible way of demonstrating your desire to help.

(3) Involves providing <u>for</u> and <u>with</u> the client with emphasis upon your mutual responsibility to work together.

(a) May involve doing <u>for</u> the client (contacting a landlord, the school, another agency, etc.) at first.

b. Acting as a model-teacher:

(1) Displaying (in his dealings with the client) those kinds of behavior and methods used in problem-solving.

Summarize the various examples on page 36 of the workbook as a basis for discussing the four major ways in which a case aide helps clients.

(2) Teach through actions and examples, w
managing situations which are threate
prevent family functioning.

(3) Utilize the Case Aide's unique skills
specific problem-solving endeavors as
his understanding and use of various
agency resources.

c. Supporting positive client actions:

(1) Requires recognition of the client's
strengths and his efforts at problem-
solving.

(2) Complimenting the client on his achie
(commenting on his efforts to clean h
house, to keep medical appointments,

(3) Accentuating the positive:

d. Providing information about and helping t
resources available to the client and, in
situations, providing specific resources
supplies.

(1) Direct provision of material items (s
times from supplies maintained by age

(2) Using knowledge of agency to be sure
client receives what he is eligible t
receive.

(3) Developing and finding new resources
coordinating their use by clients.

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Comments, Suggestions

(2) Teach through actions and examples, ways of managing situations which are threatening or prevent family functioning.

(3) Utilize the Case Aide's unique skills in specific problem-solving endeavors as well as his understanding and use of various social agency resources.

c. Supporting positive client actions:

(1) Requires recognition of the client's strengths and his efforts at problem-solving.

(2) Complimenting the client on his achievements (commenting on his efforts to clean his house, to keep medical appointments, etc.)

(3) Accentuating the positive:

d. Providing information about and helping to use resources available to the client and, in some situations, providing specific resources or supplies.

(1) Direct provision of material items (sometimes from supplies maintained by agency.)

(2) Using knowledge of agency to be sure that client receives what he is eligible to receive.

(3) Developing and finding new resources and coordinating their use by clients.

References

(4) Performing acti
principles and

F. Strengthening the base of m

1. The need to view each c
future contacts.

2. To support the "team co
of others in the agency

3. Specific ways of buildi

(a) Individualization

(b) Acceptance of client

(c) Responding to stated

(d) Understanding the cl

(e) Nonjudgemental.

(f) To determine his own
is to do.

(g) Respecting what he sa

G. Periodic review of progress w
sharing of pertinent informat

H. Discussion of examples from C

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: IX. LIGHTING - TAIL, STOP, & SIGNAL

PERFORMANCE OBJECTIVE NO.: 9 TITLE: Remove, Test, and Replace Light Bulbs

CONDITIONS:

This assignment is to performed on a complete automobile.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Remove tail light lens following steps as outlined in manual
6. Remove bulbs by pushing in and turning - Bulb will align with slots and can be pulled from socket
7. Make tests and checks as outlined in the manual
8. Install bulb
9. Make necessary tests and checks following steps as outlined in manual
10. If all tests and checks are satisfactory, install tail light lenses as outlined in manual
11. Recheck lights and if still satisfactory, return tools and materials to proper place

PERFORMANCE CRITERIA:

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Comments, Suggestions

(4) Performing activities within social welfare principles and helping concepts.

F. Strengthening the base of mutual trust and acceptance

1. The need to view each client contact as a base for future contacts.

2. To support the "team concept" - the helping roles of others in the agency with whom the client works.

3. Specific ways of building trust

(a) Individualization

(b) Acceptance of client as a person of worth.

(c) Responding to stated need.

(d) Understanding the client's point of view.

(e) Nonjudgemental.

(f) To determine his own future and choose what he is to do.

(g) Respecting what he says - Confidentiality.

G. Periodic review of progress with your supervisor and the sharing of pertinent information with other team members

H. Discussion of examples from Case Aide's assignments

Ask participants to complete the assignment on page 38 of their workbook, in preparation for their next session.

References

5. Understanding and Talking with Cl

A. Objective

To identify the basic reasons for human beha
ways in which people communicate, and discus
importance of knowing oneself in order to he

B. How one interacts with those around him

1. The five senses:

   a. taste

   b. touch

   c. smell

   d. hearing

   e. sight

2. Factors which influence the way in which
communicate:

   a. Preoccupation

   b. Perceptions

   c. Misconceptions - prejudices

   d. Illness

   e. Language

   f. Cultural influences

   g. Social and environmental influences

5. Understanding and Talking with Clients

	Comments, Suggestions
A. Objective To identify the basic reasons for human behavior, the ways in which people communicate, and discuss the importance of knowing oneself in order to help others.	
B. How one interacts with those around him 1. The five senses: a. taste b. touch c. smell d. hearing e. sight	
2. Factors which influence the way in which we communicate: a. Preoccupation b. Perceptions c. Misconceptions - prejudices d. Illness e. Language f. Cultural influences g. Social and environmental influences	Ask the participants to offer examples of each of these factors as well as suggest additional factors.

3. Types of communication:

a. Verbal Communication

(1) Speaking and listening to what a

(2) Formal and informal communicatio
Case Aide is more comfortable wi
modes of communication rather th
structured environment.)

(3) Informal communication is two-wa
munication.

b. Nonverbal communication.

(1) movements, attentiveness, postur
expressions, hyperactivity.

(2) Behavior

(3) Some common reactions:

(a) Tension

(b) Blushing

(c) Excitement

(d) Avoidance

(e) Crying

(f) Nervousness

	Comments, Suggestions
3. Types of communication: a. Verbal Communication (1) Speaking and listening to what a person says. (2) Formal and informal communication. (The Case Aide is more comfortable with informal modes of communication rather than a structured environment.) (3) Informal communication is two-way communication.	A review of the assignment on page 38 of the workbook can serve as a basis for discussing the various types of communication.
b. Nonverbal communication. (1) movements, attentiveness, posture, facial expressions, hyperactivity. (2) Behavior (3) Some common reactions: (a) Tension (b) Blushing (c) Excitement (d) Avoidance (e) Crying (f) Nervousness	One way in which nonverbal communication can be taught is to show the beginning few minutes of the film, Interviewing (use the film which includes thoughts as well as comments of actors), without sound, and ask participants to describe what they think people are reacting to. Later replay sequence with sound so that observations can be tested. Discuss the possible meanings of these reactions. What do they tell you about the client?

(4) The importance of nonverbal co
especially for infants, the il
the elderly, etc.

(5) Nonverbal communication is usu
difficult to interpret.

(6) Nonverbal communication must b
in relation to verbal communic

c. Written communication.

(1) Makes a permanent record.

(2) Does not allow for immediate i

(3) One way of confirming verbal c

C. Understanding Why People Behave as They do

1. Some needs of people

a. Need for recognition

b. Need for love

c. Need to be liked

d. Need for security

e. Need to belong

f. Need to be useful

g. Need to be accepted by others

Comments, Suggestions

(4) The importance of nonverbal communication especially for infants, the ill person and the elderly, etc.

(5) Nonverbal communication is usually more difficult to interpret.

(6) Nonverbal communication must be considered in relation to verbal communication.

c. Written communication.

(1) Makes a permanent record.

(2) Does not allow for immediate interpretation.

(3) One way of confirming verbal communication.

C. <u>Understanding Why People Behave as They do</u>

Discuss how these needs are expressed.

1. Some needs of people

a. Need for recognition

b. Need for love

c. Need to be liked

d. Need for security

e. Need to belong

f. Need to be useful

g. Need to be accepted by others

2. Ways of helping to meet needs:

   a. Finding satisfying ways of meeti

   b. Developing better feelings towar whom the client has contact.

   c. Encouraging new contacts with th

   d. Recognizing the need to enjoy on

   e. Finding ways to succeed.

   f. Giving recognition.

   g. Developing talents and skills.

   h. Acquiring new attitudes and feel others.

D. Communication in interpersonal relationsl

1. All relationships involve interactio people.

2. Both the case aide and client commun and nonverbally.

3. Communication frequently expressing meet basic needs.

4. Two kinds of interpersonal relationsh and impersonal.

	Comments, Suggestions
2. Ways of helping to meet needs:	
a. Finding satisfying ways of meeting needs.	Identify specific examples.
b. Developing better feelings towards others with whom the client has contact.	
c. Encouraging new contacts with the community.	
d. Recognizing the need to enjoy oneself.	
e. Finding ways to succeed.	
f. Giving recognition.	
g. Developing talents and skills.	
h. Acquiring new attitudes and feelings towards others.	
D. <u>Communication in interpersonal relationship</u>	
1. All relationships involve interaction between people.	
2. Both the case aide and client communicate verbally and nonverbally.	
3. Communication frequently expressing the search to meet basic needs.	
4. Two kinds of interpersonal relationships - personal and impersonal.	

E. The Case Aide's need for self-knowledge

1. Attitudes and perceptions which col to others.

2. Prejudices and misconceptions about groups of people.

3. The need to accept people as they a

4. The ability to recognize and accept really are.

5. The ability to accept disappointme vs. defeatism.)

6. Over identification vs. under iden client problems.

7. Acceptance and use of authority.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IV. ELECTRICAL SYSTEM

MILESTONE: IX. LIGHTING - TAIL, STOP, & SIGNAL

PERFORMANCE OBJECTIVE NO.: 9 TITLE: Remove, Test, and Replace Light Bulbs

CONDITIONS:

BEHAVIOR:

12. Return automobile to proper parking area
13. Remove seat covers and store in proper place
14. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, test, and replace tail and signal light bulbs in 1 hour.

Learning time: 2 hours

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5. Understanding and Talking With Clients	Comments, Suggestions
E. The Case Aide's need for self-knowledge 1. Attitudes and perceptions which color our responses to others. 2. Prejudices and misconceptions about individuals or groups of people. 3. The need to accept people as they are. 4. The ability to recognize and accept things as they really are. 5. The ability to accept disappointments (over optimism vs. defeatism.) 6. Over identification vs. under identification with client problems. 7. Acceptance and use of authority.	Ask participants to complete the assignment on page 41 of their workbook, in preparation for the next session.

Directories of resources and county department resource files.

A. Definitions:

1. Resources: Sources of supply, support or ai

2. Community Resources: Those resources, eithe or informal, which mee financial, health, emp cultural, social or sp needs of the members o community.

B. Major groupings of resources:

1. Public or Tax Supported Programs.

2. Private or voluntary agencies.

3. Religious or sectarian agencies or programs.

4. Commercial services.

5. Informal services - frequently the result of alliance between neighbors or groups of pers join together in response to a need or to me particular problem.

C. Identification of Formalized Community Resources specific need

Resources designed to meet:

1. Economic needs

2. Housing needs

3. Employment needs

6. Community Resources	Comments, Suggestions
A. <u>Definitions</u>:	
1. Resources: Sources of supply, support or aid	This session can begin with a discussion of the workbook assignment on page 41, and why they have selected specific resources.
2. Community Resources: Those resources, either formal or informal, which meet the financial, health, employment, cultural, social or spiritual needs of the members of a community.	
B. <u>Major groupings of resources</u>:	
1. Public or Tax Supported Programs.	Explain how each of these differ.
2. Private or voluntary agencies.	
3. Religious or sectarian agencies or programs.	
4. Commercial services.	
5. Informal services - frequently the result of an alliance between neighbors or groups of persons who join together in response to a need or to meet a particular problem.	
C. <u>Identification of Formalized Community Resources to meet specific need</u>	In discussing major community resources, each should be identified and discussed in relation to: (1) who is eligible to use this service; (2) under what conditions is it available; (3) how is the service provided.
Resources designed to meet:	
1. Economic needs	
2. Housing needs	
3. Employment needs	

4. Nutritional needs
5. Health needs (both physical and em
6. Social, Recreational needs
7. Employment needs
8. Educational needs
9. Spriritual needs

D. Informal Resources

6. Community Resources	Comments, Suggestions
4. Nutritional needs 5. Health needs (both physical and emotional) 6. Social, Recreational needs 7. Employment needs 8. Educational needs 9. Spriritual needs	A specific list of major community resources should be developed and distributed to participants which provides sufficient information to clearly identify the functions served by each resource. Focus should be upon the specific needs met by each resource.
D. <u>Informal Resources</u>	The Case Aides should be encouraged to offer examples of resources they know about and which might be used in working with clients. Ask participants to complete the workbook assignment on page 44, in preparation for the next session.

References

7. Helping a Client to Use a Resour

A. Objective

To identify and discuss the steps involved in
client to use a community resource and the va
in which this is accomplished.

B. The purpose in using a resource

To bring together a person with a specific ne
agency, institution or other resource, capabl
that need.

1. Using a resource may involve writing a le
agency informing them of the need of a pa
client.

2. It may involve a telephone call to anothe
and to a client, directing each to the ot

3. It may involve taking a client to some ag
resource, and showing him how to use it.

C. Whatever method is used, it should reflect th
considerations:

1. It should be fast enough to meet the need
specific client, avoiding undo delay.

2. It should be personal enough to assure th
client will be comfortable in using the r

3. It should be simple enough so that the cl
understand how he can use the resource an
will have sufficient information about th
in order to help him.

7. Helping a Client to Use a Resource

Comments, Suggestions

A. <u>Objective</u>

To identify and discuss the steps involved in helping a client to use a community resource and the various ways in which this is accomplished.

B. <u>The purpose in using a resource</u>

To bring together a person with a specific need and an agency, institution or other resource, capable of meeting that need.

1. Using a resource may involve writing a letter to an agency informing them of the need of a particular client.

2. It may involve a telephone call to another agency and to a client, directing each to the other.

3. It may involve taking a client to some agency or resource, and showing him how to use it.

C. <u>Whatever method is used, it should reflect the following considerations:</u>

1. It should be fast enough to meet the need of the specific client, avoiding undo delay.

2. It should be personal enough to assure that the client will be comfortable in using the resource.

3. It should be simple enough so that the client will understand how he can use the resource and the agency will have sufficient information about the client in order to help him.

A brief presentation, describing the kinds of agencies and/or resources that case aides will be helping clients to use can serve as a basis for discussion of the steps usually taken in helping clients to use a community resource.

4. It should be planned sufficiently to as meeting of the client's need.

D. When is another resource used?

1. Whenever the county welfare department vide the services needed by the client specific problem.

2. Whenever the resource being used prefer procedures be used in directing people services.

3. Whenever the client would prefer agency tacting a potential resource.

E. The steps to be taken in using a resource

1. Determine whether a specific need exist client, and if he wishes help in using

2. Can the client meet this need? Can the this need? If not, is there another ag resource who can meet this need.

3. Determine the requirements of the agenc the client will be referred and whether eligible to obtain their help.

4. Determine how to best help the client c use the resource.

5. Clear with the source for a specific t place where the client can seek their h possible obtain the name of the person the client will speak.

Comments, Suggestions

4. It should be planned sufficiently to assure a prompt meeting of the client's need.

D. When is another resource used?

1. Whenever the county welfare department does not provide the services needed by the client to meet his specific problem.

2. Whenever the resource being used prefers specific procedures be used in directing people to its services.

3. Whenever the client would prefer agency help in contacting a potential resource.

E. The steps to be taken in using a resource

1. Determine whether a specific need exists for the client, and if he wishes help in using a resource.

2. Can the client meet this need? Can the agency meet this need? If not, is there another agency or resource who can meet this need.

3. Determine the requirements of the agency and to whom the client will be referred and whether he would be eligible to obtain their help.

4. Determine how to best help the client contact and use the resource.

5. Clear with the source for a specific time, date and place where the client can seek their help. If possible obtain the name of the person with whom the client will speak.

Through discussion of examples, participants should be encouraged to identify these steps. Review the workbook assignment on page 44, as a basis for discussing what next steps a case aide might take.

6. Find out if the time is convenien and determine help he may need in appointment.

7. Provide the client with specific needs and be sure that he underst what way that the resource will h

8. Find out whether the client has t that he understands where to go.

9. If his appointment is in the futu client of the appointment a few d go.

F. What should the case aide do after us

1. The Case Aide assumes responsibil its use by and benefit to the cli

2. Find out whether the client was a appointment.

3. If appointment was not kept (and try to eliminate the reason for h keep the last appointment.

4. If the resource was contacted by out if the need continues and the the resource was able to help the

5. If the client will continue conta source, is there anything you can benefit for the client.

6. What, if any, next steps might be

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V ENGINES

MILESTONE: I ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO: 1 TITLE: Disassemble Engine, Check and Make Measurements, Reassemble and Run

CONDITIONS:

LEARN	REFERENCE	SOURCE
4. "Operating Principle of the 4-stroke Internal Combustion Engine	4. Filmstrip	4. Resource Materials Center
5. "The 4-stroke Internal Combustion Engine	5. Filmstrip	5. Resource Materials Center
6. Plain Bearings	6. Plain Bearings, by Du Pont	6. Programmed Instruction Class
7. Anti-friction Bearings	7. Anti-friction Bearings, by Du Pont	7. Programmed Instruction Class
8. "Bearings"	8. Filmstrip	8. Resource Materials Center
9. The Engine	9. Teaching Machine card 9A, 9B, 10A, 10B, 10C, 11A, 11B, 11C, 12A, 12B, 13A, 13B	9. Teaching Machine (Shop)
10. "Engine Lubricating Systems"	10. Filmstrip	10. Resource Materials Center

Comments, Suggestions

6. Find out if the time is convenient for the client and determine help he may need in keeping the appointment.

7. Provide the client with specific instructions he needs and be sure that he understands how and in what way that the resource will help him.

8. Find out whether the client has transportation and that he understands where to go.

9. If his appointment is in the future, remind the client of the appointment a few days before he is to go.

F. <u>What should the case aide do after using a resource?</u>

1. The Case Aide assumes responsibility for assessing its use by and benefit to the client.

2. Find out whether the client was able to keep his appointment.

3. If appointment was not kept (and need continued) try to eliminate the reason for his inability to keep the last appointment.

4. If the resource was contacted by the client, find out if the need continues and the extent to which the resource was able to help the client.

5. If the client will continue contacts with the resource, is there anything you can do to maximize its benefit for the client.

6. What, if any, next steps might be taken.

Have participants practice various steps to take in helping a client use a resource by considering a specific case situation and deciding what they would do in this specific situation.

References

8. Planned Visits to Community Resource

A. Objective

To identify and discuss community resources avai
clients, when the specific resource would be use
how he can help clients to use it.

B. Suggested guidelines in planning visits to commu
resources

The purpose of this session is to provide case a
with the opportunity to visit several community
available for clients. Those selected for a vis
should be representative of major community resc
used by clients. Participants should be asked t
identify the following information on their visi

1. What is the resource?

2. To whom and under what circumstances can it

3. In what ways does it help people?

4. What methods of help are used?

5. How does the resources prefer to have a ref
made?

An opportunity for discussion and assessment of
possible use of each resource visited should be
following these visits.

8. Planned Visits to Community Resources

	Comments, Suggestions
A. <u>Objective</u> To identify and discuss community resources available to clients, when the specific resource would be used, and how he can help clients to use it.	
B. <u>Suggested guidelines in planning visits to community resources</u> The purpose of this session is to provide case aides with the opportunity to visit several community resources available for clients. Those selected for a visit should be representative of major community resources used by clients. Participants should be asked to identify the following information on their visit. 1. What is the resource? 2. To whom and under what circumstances can it be used? 3. In what ways does it help people? 4. What methods of help are used? 5. How does the resources prefer to have a referral made? An opportunity for discussion and assessment of the possible use of each resource visited should be planned following these visits.	Participants can be divided into smaller groups with each sub-group visiting different agencies and institutions and later sharing what they have learned with the others. In this way a wider range of resources can be visited and what is learned can be used by all participants. Ask participants to complete the workbook assignment on pages 46 and 47, on the specific resources visited. A discussion of the resources should be planned immediately following these visits. Ask participants to complete the workbook assignment on page 48, in preparation for this next session.

15546

15547

9. Poverty: Its Causes and Effects

Comments, Suggestions

y in the
asie, Robert
ds.
r Social
ncy Preven-
n Studies
s, Ca., 1964

A. Objective

To identify major causes of poverty and discuss how he, as a case aide, can help to lessen its effect upon clients.

B. Some definitions

1. Poverty is a condition of being in which one's past and future meet in the present - and go no further. (Ira Goldenberg)

2. A member of a four-person family with a total annual income of not more than $2,500. (Joint Economic Committee of Congress)

C. The nature of poverty

1. A design of living which influences a person's perceptions of the world around him.

2. It has its own styles and distinctive social and psychological consequences.

3. One must distinquish between impoverishment and being caught in a cycle of poverty.

D. Poverty can be influenced by:

1. Income:

a. The level of income.

b. The stability or regularity of income.

c. The source of income (employment or welfare).

This session can begin by discussing the workbook assignment on page 48, and the various perceptions of poverty offered in these quotations.

References	
	2. Feelings and attitudes: a. Marginality. b. Helplessness. c. Dependency. d. Not belonging. 3. Environmental conditions E. Characteristics of poverty: 1. Economic: a. A constant struggle for survival. b. Unemployment and underemployment c. Marginal income. d. Absence of savings. e. A chronic shortage of cash. f. The absence of food reserves in the home. g. Borrowing at high rates of interest.
About The Poor: Some Facts and Some Fictions. Herzog, Elizabeth, U. S. D.H.E.W., Social and Rehabilitation Service, Children's Bureau, Washington, D.C., 1967.	

Comments, Suggestions

2. Feelings and attitudes:

   a. Marginality.

   b. Helplessness.

   c. Dependency.

   d. Not belonging.

3. Environmental conditions

Additional characteristics should be added by participants.

E. Characteristics of poverty:

1. Economic:

   a. A constant struggle for survival.

   b. Unemployment and underemployment

   c. Marginal income.

   d. Absence of savings.

   e. A chronic shortage of cash.

   f. The absence of food reserves in the home.

   g. Borrowing at high rates of interest.

The Other American: Poverty in the United States. Harrington, Michael, Penguin Books, 1964.

2. Some social and psychological character

   a. Living in crowded quarters.

   b. A lack of privacy.

   c. More frequent resort to violence in of quarrels.

   d. An increase in one-parent families.

   e. Emphasis upon family solidarity - a rarely achieved.

   f. Present time orientation.

   g. Authoritarianism

   h. A sense of resignation and fatalism the realities of the life situation

   i. A belief that existing institutions their interests and needs.

F. The cycle of poverty: (one example):

   1. The poor become sick more often because live under unhygienic conditions.

   2. They are more likely to remain sick lon they lack money for medical care, an a balanced diet, confidence in physicians standing of their medical needs.

   3. As a result, they are less capable of the next time around.

Comments, Suggestions

2. Some social and psychological characteristics:

   a. Living in crowded quarters.

   b. A lack of privacy.

   c. More frequent resort to violence in the settling of quarrels.

   d. An increase in one-parent families.

   e. Emphasis upon family solidarity - an ideal rarely achieved.

   f. Present time orientation.

   g. Authoritarianism

   h. A sense of resignation and fatalism based upon the realities of the life situation.

   i. A belief that existing institutions do not serve their interests and needs.

F. The cycle of poverty: (one example):

   1. The poor become sick more often because they may live under unhygienic conditions.

   2. They are more likely to remain sick longer, because they lack money for medical care, an adequate, balanced diet, confidence in physicians, and understanding of their medical needs.

   3. As a result, they are less capable of facing illness the next time around.

Additional examples of the vicious circle which the poor frequently find themselves caught in, can be developed by the group. Ask questions like: What effect will such an environment have on children? What kind of persons are they likely to become?

G. The implications of "a cycle of poverty" for wh
Case Aide does:

1. The Case Aide will want to be concerned wi
economic, social, and psychological factors
influence families. (Helen Harris Perlman
"Man cannot live by bread alone, but he ca
by guidance and counseling alone either."
concern must be sought.)

2. One important way of breaking the cycle of
is to help people to want and to seek new

3. The Case Aide will help interpret the inte
needs of clients.

4. Wherever possible, the Case Aide will want
the energy which clients must devote to su
constantly trying to "make do" with string
rope is needed - by bringing the client to
resources that can help him.

H. Some principles of helping:

1. Clients need a Case Aide who will encourag
try, to hope, to believe in their futures,
selves and in their abilities.

2. A Case Aide who will try to understand the
and the culture within which he lives.

3. A Case Aide's ability to help will be base
her feelings towards the client. They mu
trust and faith in each other.

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V ENGINES

MILESTONE: I ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO: 1 TITLE: Disassemble Engine, Check and Make Measurements, Reassemble and Run

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Fundamentals of Engine Operation	1. Cutaway Engine Training Aid	1. Shop
2. Engines	2. Automotive Engines, by Crouse. pp. 65 through 104, 170 through 210, 212 through 275, 476 through 517, 520 through 552 Automotive Engines Workbook, by Crouse. Jobs 1 through 3, 4 through 15, 24 through 32	2. Related Information Class
3. Engine Operation	3. How the Internal Combustion Engine Operates, by Du Pont.	3. Programmed Instruction Class

Comments, Suggestions

G. The implications of "a cycle of poverty" for what a Case Aide does:

1. The Case Aide will want to be concerned with the economic, social, and psychological factors which influence families. (Helen Harris Perlman has said: "Man cannot live by bread alone, but he cannot live by guidance and counseling alone either." A balanced concern must be sought.)

2. One important way of breaking the cycle of poverty is to help people to want and to seek new goals.

3. The Case Aide will help interpret the interest and needs of clients.

4. Wherever possible, the Case Aide will want to lessen the energy which clients must devote to survival - constantly trying to "make do" with string where rope is needed - by bringing the client together with resources that can help him.

H. Some principles of helping:

Discussion might be stimulated by asking the question, "In what ways might a case aide help clients caught in a cycle of poverty?"

1. Clients need a Case Aide who will encourage them to try, to hope, to believe in their futures, in themselves and in their abilities.

2. A Case Aide who will try to understand the client and the culture within which he lives.

3. A Case Aide's ability to help will be based upon her feelings towards the client. They must have trust and faith in each other.

4. A Case Aide will want to learn the difference in perceptions by which he and the client view things.

5. The degree to which the client can undertake new action and accept new goals will depend upon and be influenced by his family and friends.

6. A Case Aide can serve as a model - an example of one person who is succeeding.

	Comments, Suggestions
4. A Case Aide will want to learn the difference in perceptions by which he and the client view things.	
5. The degree to which the client can undertake new action and accept new goals will depend upon and be influenced by his family and friends.	
6. A Case Aide can serve as a model - an example of one person who is succeeding.	Ask participants to complete the workbook assignment on pages 51 and 52, in preparation for their next session.

References

10. Some Myths About Public Welfare and its Clients

A. Objectives

To identify common myths abut public welfare and its clients, and clarify the reasons for these misconceptions.

B. Some Examples of Common Myths

1. Most recipients could work if they only had the ambition to do so.

   a. About 90% of the persons receiving public assistance are unable to work.

   b. Aged, blind, disabled and children.

2. Fathers in AFDC-U families should be forced to work and support their families.

   a. Unemployed fathers are required to register for employment.

   b. They frequently face many problems in finding employment (lack of education, discrimination, lack of skills, etc.).

   c. Even when employed, not all men can earn an income which is adequate to support their family.

3. Public welfare grants provide an adequate income for families.

   a. Such grants rarely reflect more recent rises in cost of living.

   b. Not all items considered "essential" by individuals will be included in such a grant.

10. Some Myths About Public Welfare and its Clients

Comments, Suggestions

A. Objectives

To identify common myths abut public welfare and its clients, and clarify the reasons for these misconceptions

Have the participants read and discuss the workbook assignment on pages 51 and 52. Through discussion other myths can be identified.

B. Some Examples of Common Myths

1. Most recipients could work if they only had the ambition to do so.

   a. About 90% of the persons receiving public assistance are unable to work.

   b. Aged, blind, disabled and children.

2. Fathers in AFDC-U families should be forced to work and support their families.

   a. Unemployed fathers are required to register for employment.

   b. They frequently face many problems in finding employment (lack of education, discrimination, lack of skills, etc.).

   c. Even when employed, not all men can earn an income which is adequate to support their family.

Encourage participants to develop their own answers to these myths, where this is possible. The learning group itself can be used in clarifying misconceptions on the part of participants.

3. Public welfare grants provide an adequate income for families.

   a. Such grants rarely reflect more recent rises in cost of living.

   b. Not all items considered "essential" by individuals will be included in such a grant.

c. Public welfare grants do not provide f
pected emergencies.

d. Even the most skilled of homemakers wo
difficult, at times, to manage on such

4. People who receive welfare grant spend the
foolishly.

a. Many recipients are very skilled at ma
their welfare grant.

b. Some lack the skills needed for carefu
budgeting, etc. The agency is concern
helping them to develop such skills.

c. Differences exist in how we each perce
important.

5. Most people on public assistance lie about
sources of income they receive and therefo
guilty of fraud.

a. Administrative error is one reason why
are sometimes not correctly figured.

b. Some clients, because of their lack of
about assistance, actually receive les
they are eligible for.

c. Some clients do not understand that th
report income, nor do they know that t
will allow them to keep some of this i
before subtracting the remainder from
grant. This is an important area in w
Case Aide can help them.

Comments, Suggestions

c. Public welfare grants do not provide for unexpected emergencies.

d. Even the most skilled of homemakers would find it difficult, at times, to manage on such a grant.

4. People who receive welfare grant spend their money foolishly.

   a. Many recipients are very skilled at managing on their welfare grant.

   b. Some lack the skills needed for careful shopping, budgeting, etc. The agency is concerned with helping them to develop such skills.

   c. Differences exist in how we each perceive what is important.

5. Most people on public assistance lie about other sources of income they receive and therefore are guilty of fraud.

   a. Administrative error is one reason why grants are sometimes not correctly figured.

   b. Some clients, because of their lack of knowledge about assistance, actually receive less than they are eligible for.

   c. Some clients do not understand that they are to report income, nor do they know that the agency will allow them to keep some of this income before subtracting the remainder from their grant. This is an important area in which a Case Aide can help them.

6. The majority of children on AFDC are illegitimate.

   a. The majority of children are not illegitimate.

   b. Those who are need the special help of the agency.

7. If welfare checks were kept as low as possible, this would force clients to find other means of supporting themselves.

   a. The majority of people on assistance are incapable of working or finding a means of support beyond what they currently have.

   b. Helping people becomes almost impossible when they are subject to severe economic deprivation.

   c. Low assistance grants keep people on assistance by providing no way to escape through training, having adequate clothing to find a job, etc.

8. Welfare mothers frequently have more children in order to boost their grant.

   a. The amount of increase received in a grant with an additional child is always less than what it will cost to raise that child.

   b. In some cases, the addition of a child can mean even more deprivation for the rest of the family.

   c. Not all welfare mothers know about the ways available to them to plan when to have a child and to avoid having a child when they do not want one.

Ask participants t
workbook assignmer
Be sure to provide
food allowance acc
standards.

10. Some Myths About Public Welfare and Its Clients	Comments, Suggestions
6. The majority of children on AFDC are illegitimate. a. The majority of children are not illegitimate. b. Those who are need the special help of the agency.	
7. If welfare checks were kept as low as possible, this would force clients to find other means of supporting themselves. a. The majority of people on assistance are incapable of working or finding a means of support beyond what they currently have. b. Helping people becomes almost impossible when they are subject to severe economic deprivation. c. Low assistance grants keep people on assistance by providing no way to escape through training, having adequate clothing to find a job, etc.	
8. Welfare mothers frequently have more children in order to boost their grant. a. The amount of increase received in a grant with an additional child is always less than what it will cost to raise that child. b. In some cases, the addition of a child can mean even more deprivation for the rest of the family. c. Not all welfare mothers know about the ways available to them to plan when to have a child and to avoid having a child when they do not want one.	Ask participants to complete the workbook assignment on page 55. Be sure to provide a maximum daily food allowance according to county standards.

New Careers: the Community/ Home Health Aide. Trainer's Manual. National Institute for New Careers, U. S. Department of Labor, Washington D. C., April 1969.

A. Objective

To identify the major grouping o
a balanced diet, and discuss tho
fluence what and how much a pers

B. Some definitions:

1. Food: Any nourishing substa
tain life, provide en
etc.

2. Nutrition: The study of wha
sustain life, pr
growth, etc.

3. Diet: Food considered in te
composition and its e

C. Factors which affect a person's
eats

1. Economics: the amount of mo
chasing food.

2. Food supply: Where, in what
circumstances

3. Customs: religious and cult
what a person can
the way in which i

4. Social: the environment in
food and eats, thos

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: I. ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Disassemble, Check, Make Measurements, and Reassemble Engine

CONDITIONS:

Operations are to be performed on a live engine mounted on a stand. This operation requires removal of engine from stand to a universal work stand for certain phases of disassembly ans reassembly.

BEHAVIOR:

After satisfactory compltеion of all related training, proceed as follows:

1. Select proper manual and turn to appropiate chapter
2. Obtain engine specifications sheet from instructor
3. Select proper tools and materials
4. Move parts rack to area and position in a convenient location but in a location which would not obstruct free movement in the shop. Store all parts in a neat, orderly manner.
5. Start engine
6. Determine engine condition by following all steps as outlined in the manual
7. Fill out first section of specification sheet
8. Disconnect and remove battery - store battery on battery rack
9. Drain radiator and engine block
10. Remove radiator base clamp and remove radiator hoses - store on rack

PERFORMANCE CRITERIA:

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11. Nutrition

Comments, Suggestions

A. Objective

To identify the major grouping of food sources needed in a balanced diet, and discuss those factors which influence what and how much a person eats.

B. Some definitions:

1. Food: Any nourishing substance that is eaten to sustain life, provide energy, promote growth, etc.

2. Nutrition: The study of what people eat in order to sustain life, provide energy, promote growth, etc.

3. Diet: Food considered in terms of its qualities, composition and its effect upon health.

C. Factors which affect a person's perceptions of what he eats

1. Economics: the amount of money available for purchasing food.

2. Food supply: Where, in what form and under what circumstances food is obtained.

3. Customs: religious and cultural influences upon what a person can eat, "should eat", and the way in which it is prepared.

4. Social: the environment in which a person prepares food and eats, those with whom he eats, etc.

A home economist or staff member with such an educational background might be an appropriate person to teach this session.

Encourage participants to share their knowledge of nutrition and use their terms, while trying to eliminate misunderstandings or misconceptions.

References	11. Nutrition	Comments
Nutrition and Healthy Growth U.S. D.H.E.W., Welfare Administration, Children's Bureau, Washington, D.C., 1965.	D. Factors which influence what and how much a person should eat: 1. Age 2. Sex 3. Body build 4. Health factors 5. Activity E. Daily food needs: 1. Protein foods 2. Vitamins 3. Minerals 4. Energy foods F. Five basic foods sources:	
New Careers: The Community/ Home Health Aide. Trainer's Manual National Institute of New Careers, U. S. Department of Labor, Washington, D. C., April 1969.	1. Fats a. Sources: Butter, animal and vegetable oils, bacon, pork, mayonnaise, etc. b. Excessive amount may result in obesity or excessive weight: related to some heart conditions, diabetes, etc.	Use the 55, as specif These in cha referen

		Comments, Suggestions
rowth Admin- ureau,	D. Factors which influence what and how much a person should eat: 1. Age 2. Sex 3. Body build 4. Health factors 5. Activity E. Daily food needs: 1. Protein foods 2. Vitamins 3. Minerals 4. Energy foods F. Five basic foods sources: 1. Fats a. Sources: Butter, animal and vegetable oils, bacon, pork, mayonnaise, etc. b. Excessive amount may result in obesity or excessive weight: related to some heart conditions, diabetes, etc.	
ity/ er's ute of artment D. C.,		Use the workbook assignment on page 55, as a basis for discussing specific examples. These various groupings can be put in chart form for more ready reference and use in discussion.

c. Insufficient amounts may result in a lack of energy, tiredness, etc.

2. Carbohydrates:

a. Sources:

Flour, potatoes, sugar, bananas, dates, oatmeal etc.

b. Excessive amounts may result in increased blood sugar, obesity, liver diseases, etc.

c. Insufficient amounts may result in a lack of energy, tiredness, problems of elimination, etc.

3. Proteins

a. Sources:

Lean meats, poultry, fish, dry beans, cheese, milk, eggs, cereals, breads, etc.

b. Insufficient amounts may result in pellagra, retarded growth of children, weaknesses, tiredness, etc.

4. Minerals

a. Sources:

(1) Calcium - milk, cheese, many green vegetables, dry beans, citrus fruits, eggs, etc.

(2) Iron - liver, dry beans, some green vegetables, dried fruits, eggs, some cereals.

Comments, Suggestions

c. Insufficient amounts may result in a lack of energy, tiredness, etc.

2. Carbohydrates:

a. Sources:

Flour, potatoes, sugar, bananas, dates, oatmeal, etc.

b. Excessive amounts may result in increased blood sugar, obesity, liver diseases, etc.

c. Insufficient amounts may result in a lack of energy, tiredness, problems of elimination, etc.

3. Proteins

a. Sources:

Lean meats, poultry, fish, dry beans, cheese, milk, eggs, cereals, breads, etc.

b. Insufficient amounts may result in pellagra, retarded growth of children, weaknesses, tiredness, etc.

4. Minerals

a. Sources:

(1) Calcium - milk, cheese, many green vegetables, dry beans, citrus fruits, eggs, etc.

(2) Iron - liver, dry beans, some green vegetables, dried fruits, eggs, some cereals.

(3) Iodine - iodized salt, some sea foods, etc.

b. Insuffucient amounts may result in rickets, weakness of bones, poor teeth, anemia, poor skin, thyroid condition, etc.

5. Vitamins

a. Sources:

(1) Vitamin A - liver, dark green leafy vegetables, deep yellow vegetables, fruits, butter, butter, cream, egg yolk, whole milk, etc.

(2) Thiamine - pork, enriched and whole grain cereal products, liver, milk, etc.

(3) Other vitamins - Milk, cheese, liver, poultry, fish, peanuts, other meats, leafy green vegetables, etc.

(4) Ascorbic acid - citrus fruit, strawberries, cantaloupe, tomatoes, potatoes, greens, etc.

b. Insufficient amounts may result in a lower resistance to infection, poor eyesight, muscle pain, mental deterioration, diarrhea, scurvy, etc.

Food Stamp Program: Education Letters. SDSW, Food Stamp Bureau, May 1969.

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II. Nutrition	Comments, Suggestions
(3) Iodine - iodized salt, some sea foods, etc.	
b. Insuffucient amounts may result in rickets, weakness of bones, poor teeth, anemia, poor skin, thyroid condition, etc.	
5. Vitamins	
a. Sources:	
(1) Vitamin A - liver, dark green leafy vegetables, deep yellow vegetables, fruits, butter, butter, cream, egg yolk, whole milk, etc.	
(2) Thiamine - pork, enriched and whole grain cereal products, liver, milk, etc.	
(3) Other vitamins - Milk, cheese, liver, poultry, fish, peanuts, other meats, leafy green vegetables, etc.	
(4) Ascorbic acid - citrus fruit, strawberries, cantaloupe, tomatoes, potatoes, greens, etc.	
b. Insufficient amounts may result in a lower resistance to infection, poor eyesight, muscle pain, mental deterioration, diarrhea, scurvy, etc.	Ask participants to complete the workbook assignment on page 57, in preparation for their next assignment. Be sure that release time from their job assignment is provided for this purpose.

(A large variety of publications on skillful buying are available for use.)

Sidney Margolious. How to Make the Most of Your Money. Meredith Press, New York, 1966.

A. Objective

To identify and discuss principles of food
these can be used in helping clients.

B. Factors which influence meal planning:

1. Likes and dislikes.
2. Meals which members eat away.
3. Food budget.
4. Food storage facilities.
5. Buying practices.
6. Special diets.
7. Range of foods used.
8. Resources for food preparation.
9. Sanitation.

C. A knowledge of nutrition is a first step
food expenses for a family

1. Many clients have a knowledge of low-c
methods but may misunderstand how nutr
shopping must play a part in planning

2. Some people believe that some low-cost
margarine, dry nonfat milk or lower g
not as nutritious.

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12. Meal Planning and Buying

	Comments, Suggestions
A. <u>Objective</u> To identify and discuss principles of food buying and how these can be used in helping clients.	
B. <u>Factors which influence meal planning:</u> 1. Likes and dislikes. 2. Meals which members eat away. 3. Food budget. 4. Food storage facilities. 5. Buying practices. 6. Special diets. 7. Range of foods used. 8. Resources for food preparation. 9. Sanitation.	This session can begin with a discussion of the workbook assignment on page 57 and participant experiences in completing this. Did they learn anything that was not previously known?
C. <u>A knowledge of nutrition is a first step in lessening food expenses for a family</u> 1. Many clients have a knowledge of low-cost cooking methods but may misunderstand how nutrition and shopping must play a part in planning. 2. Some people believe that some low-cost foods like margarine, dry nonfat milk or lower grade meats are not as nutritious.	Encourage Case Aides to identify specific skills they have developed and to generalize these so as to maximize their use in a variety of client situations.

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3. Planful shopping cannot be done quickly - it wil take some time and planning.

D. One way of planning meals and buying:

1. Plan meals around specials.

a. Read newspaper ads and plan your meals aroun each week's specials. Compare specials offe by several stores.

b. Meat is the item most often featured and you largest food expense. Start with this item.

c. Specials offer reductions, on the average, o

d. Other frequently listing feature items can a secured. (Canned and packaged products, cof soaps, etc.)

e. Plan your menus before you shop, not afterwa Modifications can later be made but pre-plan will help you to not forget items you will b needing.

2. Buy according to nutritive value.

a. Some foods which seem inexpensive are not, i were to measure their nutritional value.

b. People frequently use cold cuts or frankfurt in the belief that these are cheap. From a nutritious point of view, these are much mor costly than regular meat.

Food For Groups of Young Children Cared for During the Day. Hille, Helen M. U.S. D.H.E.W., Social and Rehabilitation Service, Children's Bureau, Washington, D.C., 1968.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: I. ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Disassemble, Check, Make Measurements, and Reassemble Engine

CONDITIONS:

BEHAVIOR:

11. Lift radiator free of engine stand and store in parts room
12. Remove air breather assembly and dtore on rack. (Note: All parts other than radiator will be neatly stored on rack)
13. Remove fuel lines
14. Remove fuel pump
15. Remove carburetor
16. Remove secondary wires
17. Remove primary ignition wires
18. Remove distributor
19. Remove generator and bracket
20. Remove starting motor
21. Remove rocker arm covers
22. Remove intake manifold dollowing steps as outlined in manual
23. Remove rocker arms and push rods following steps as outlined in the manual

PERFORMANCE CRITERIA:

Comments, Suggesitons

3. Planful shopping cannot be done quickly - it will take some time and planning.

D. <u>One way of planning meals and buying:</u>

1. Plan meals around specials.

a. Read newspaper ads and plan your meals around each week's specials. Compare specials offered by several stores.

b. Meat is the item most often featured and your largest food expense. Start with this item.

c. Specials offer reductions, on the average, of 20%.

d. Other frequently listing feature items can also be secured. (Canned and packaged products, coffee, soaps, etc.)

e. Plan your menus before you shop, not afterwards. Modifications can later be made but pre-planning will help you to not forget items you will be needing.

2. Buy according to nutritive value.

a. Some foods which seem inexpensive are not, if one were to measure their nutritional value.

b. People frequently use cold cuts or frankfurters in the belief that these are cheap. From a nutritious point of view, these are much more costly than regular meat.

These notes contain some of the more common shopping principles used.

A study of calorie count for various items is one way of viewing nutritional value.

c. Home-cooked items tend to be less costly for sandwiches and lunches than are cold cuts and prepared luncheon items available for purchas

3. Buy the lowest suitable grade.

a. Lower grade items have the same nutritional value. Grade A items are usually selected fo their size and shape over grades B and C, not their food value.

b. Meats are usually graded according to "Choice "Good" and "Standard." The amount and type o fat usually determines the grade, although ea can be tender.

4. Read the ingredients.

a. Check the list of ingredients each package is required to carry.

b. On prepared foods where no standard has been set, the label must list the ingredients in t order of their amount. (the first example represents the most nutritious buy. It conta the most meat).

For example, one can of beef stew can read:

"beef, potatoes, tomatoes," etc.

A second brand can read:

"beef, water, potatoes", etc.

A third brand can read:

[redacted] beef, potatoes", etc. [redacted]

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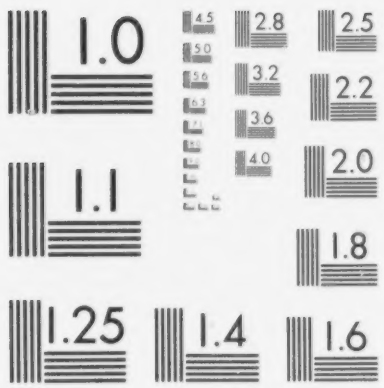

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Comments, Suggestions

c. Home-cooked items tend to be less costly for sandwiches and lunches than are cold cuts and prepared luncheon items available for purchase.

3. Buy the lowest suitable grade.

a. Lower grade items have the same nutritional value. Grade A items are usually selected for their size and shape over grades B and C, not their food value.

b. Meats are usually graded according to "Choice", "Good" and "Standard." The amount and type of fat usually determines the grade, although each can be tender.

4. Read the ingredients.

a. Check the list of ingredients each package is required to carry.

b. On prepared foods where no standard has been set, the label must list the ingredients in the order of their amount. (the first example represents the most nutritious buy. It contains the most meat).

For example, one can of beef stew can read:

"beef, potatoes, tomatoes," etc.

A second brand can read:

"beef, water, potatoes", etc.

A third brand can read:

[redacted], beef, potatoes", etc.

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c. Don't judge a package by its siz
weight of the contents.

5. Evaluate convenience vs. cost of var

a. A point to remember: each addit
processing adds additional cost

(1) Block cheese usually costs

(2) Chicken parts usually cost
chicken.

b. Ready-to-eat items have become p
they are time-saving. For examp
cost more than cereals you cook

6. Buy in bulk.

a. Families sometimes believe that s
save waste. But, possible savin
planning how to use larger quanti
is possible.

b. Largest savings are on the larges

c. Similarly, fresh milk is cheaper
by the half gallon than in quart

7. Whenever possible use lower cost alte

a. Dry nonfat milk has all the value
(except Vitamin A).

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c. Don't judge a package by its size. Look at the weight of the contents.

5. Evaluate convenience vs. cost of various items.

a. A point to remember: each additional step in processing adds additional cost to an item.

(1) Block cheese usually costs less than sliced.

(2) Chicken parts usually cost more than a whole chicken.

b. Ready-to-eat items have become popular because they are time-saving. For example: dry cereals cost more than cereals you cook yourself.

6. Buy in bulk.

a. Families sometimes believe that smaller sizes save waste. But, possible savings make it worth planning how to use larger quantity, when this is possible.

b. Largest savings are on the largest packages.

c. Similarly, fresh milk is cheaper if purchased by the half gallon than in quart containers.

7. Whenever possible use lower cost alternatives.

a. Dry nonfat milk has all the value of whole milk (except Vitamin A).

b. Evaporated milk can also good for cooking.

c. Margarine has as much fo does not turn rancid as

d. Extend your meat by comb expensive protein food (cereals).

8. In buying fruits and vegetabl looks

a. Take advantage of lower p or smaller fruits and veg

b. Buy fruits and vegetables season, when their cost i

9. Watch your spending on snacks

a. Two of the most expensive is on snack type food and

b. Potato chips, corn chips, the pound) exceedingly hig various types of foods, pc pare yourself is the least the most costly if you pur cooked.)

	Comments, Suggestions
b. Evaporated milk can also save and is especially good for cooking.	
c. Margarine has as much food value as butter (and does not turn rancid as quickly).	Encourage participants to locate and use the many free materials published by government agencies and food companies on buying and preparing foods.
d. Extend your meat by combining it with less expensive protein food (cheese, eggs, beans and cereals).	
8. <u>In buying fruits and vegetables, buy value and not looks</u>	
a. Take advantage of lower prices on irregular sizes or smaller fruits and vegetables.	
b. Buy fruits and vegetables while they are in season, when their cost is less.	
9. Watch your spending on snacks.	
a. Two of the most expensive items in many budgets is on snack type food and soft drinks.	Ask participants to complete the workbook assignment on page 59, in preparation for their next session.
b. Potato chips, corn chips, etc. tend to cost (by the pound) exceedingly high amounts. Of these various types of foods, popcorn, which you prepare yourself is the least costly. (it can be the most costly if you purchase it already cooked.)	

References

13. Household Mar

Peg Bracken, The I Hate to Housekeep Book. Fawcett Crest Books, New York, 1962.

A. Objective

To identify principles of househo
cuss specific ways in which they
management problems.

B. As much as it is possible, plan y

1. Begin with that day you do yo
will be on the day in which w
in your newspaper.

2. List the other major cleaning
ning one or two major tasks e
cleaning, washing, etc.).

3. Be sure to plan around other
ities you may have.

C. Organize your home in a manner wh
find useful

Heloise, Heloise's Kitchen Hints, Cardinal Pocket Books, New York, 1966.

1. Arrange your kitchen shelves
applesauce to Z for zucchini)
meat to Green for spinach).

2. In cleaning, don't cover thing
absolutely necessary. It will
two things to clean the next t

3. Each time you clean, start wit

4. Set up a clutter depot.

5. Establish one permanent place
leaving messages.

13. Household Management

		Comments, Suggestions
to Crest	A. <u>Objective</u> To identify principles of household management and discuss specific ways in which they can help clients with management problems. B. <u>As much as it is possible, plan your schedule</u> 1. Begin with that day you do your food shopping. This will be on the day in which weekly "specials" appear in your newspaper. 2. List the other major cleaning and household, planning one or two major tasks each day (ironing, cleaning, washing, etc.). 3. Be sure to plan around other non-housekeeping activities you may have. C. <u>Organize your home in a manner which you understand and find useful</u> 1. Arrange your kitchen shelves by alphabet (A for applesauce to Z for zucchini) or by color (Red for meat to Green for spinach). 2. In cleaning, don't cover things up unless it's absolutely necessary. It will just mean you have two things to clean the next time around. 3. Each time you clean, start with a different room. 4. Set up a clutter depot. 5. Establish one permanent place in your home for leaving messages.	Group discussion Participants should be encouraged to carry major responsibility for planning and carrying this session. The content offered lists one approach to household management. There are many other approaches which can work equally well. The group should use this session to identify and share their own ideas. The leader can help to generalize specific examples for possible wider use with a variety of clients. Thus, the major purpose of this session is to identify what they already know and how they can use this with clients.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: I. ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Disassemble, Check, Make Measurements, and Reassemble Engine

CONDITIONS:

BEHAVIOR:

24. Remove water pump and fan following steps as outlined in the manual
25. Remove cylinder heads following steps as outlined in the manual
26. Remove drain plug from oil pan and drain oil
27. Replace oil drain plug in pan
28. Remove oil pan following steps as outlined in the manual
29. Position engine hoist over engine and bolt lifting chain to engine block following steps as outlined in the manual
30. Remove bolts from engine mounts and lift engine and transmission assembly from stand
31. Remove transmission from engine following steps as outlined in the manual
32. Bolt engine assembly to universal stand
33. Disassemble engine block assembly following steps as outlined in the manual
34. Make all measurements, checks, etc. as outlined in the manual and record on engine specification sheet

PERFORMANCE CRITERIA:

D. Some helpful hints for housekeeping

1. Keep burn ointment near the stove, not i
room medicine cabinet. (Who ever gets b
bathroom?)

2. Sift your flour from the sack right into
canister. Then you won't need to sift i
bake.

3. A chopped raw apple added to oatmeal gre
the oatmeal.

4. In trying to remove stains from clothing
of thumb to follow is: (a) first try colc
if this doesn't work, (b) try hot water.

5. Excess soap suds can be reduced by shakin
them.

6. You can make window shades out of table c
Just remove the old shade and tuck the oi
on the same roller.

7. To keep flies away from the garbage can,
bottom of your can with oil drained from

8. If you see a line of ants coming through
kitchen door, draw a chalk line on the fl
some reasons, ants, don't like to cross c

9. When you buy a box of soap-filled pads, cu
fourths with your scissors. A fourth of
just enough to clean one or two pans and
having to keep used pads around for a seco
third use.

Comments, Suggestions

Some helpful hints for housekeeping

1. Keep burn ointment near the stove, not in the bath room medicine cabinet. (Who ever gets burned in the bathroom?)

2. Sift your flour from the sack right into your flour canister. Then you won't need to sift it when you bake.

3. A chopped raw apple added to oatmeal greatly improves the oatmeal.

4. In trying to remove stains from clothing a good rule of thumb to follow is: (a) first try cold water, and if this doesn't work, (b) try hot water.

5. Excess soap suds can be reduced by shaking salt on them.

6. You can make window shades out of table oilcloth. Just remove the old shade and tuck the oilcloth back on the same roller.

7. To keep flies away from the garbage can, coat the bottom of your can with oil drained from a car.

8. If you see a line of ants coming through the kitchen door, draw a chalk line on the floor. For some reasons, ants, don't like to cross chalk.

9. When you buy a box of soap-filled pads, cut them in fourths with your scissors. A fourth of a pad is just enough to clean one or two pans and you avoid having to keep used pads around for a second and third use.

Discussion can begin by reviewing the workbook assignment on page 59.

10. A small rug can be kept from sliding by sewing rubber jar rings to the back of it. A rubber ring glued on the bottom of a dog dish will keep this from sliding.

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13. Household Management	Comments, Suggestions
10. A small rug can be kept from sliding by sewing rubber jar rings to the back of it. A rubber ring glued on the bottom of a dog dish will keep this from sliding.	Ask participants to complete the workbook assigment on page 61, in preparation for their next session.

References

Institute of Life Insurance, A Discussion of Family Money: How Budgets Work and What They Do. Women's Division, Institute of Life Insurance, New York, April 1964.

14. Family Budgeting

A. Objective

To identify and discuss principles of family budg which can be used in helping clients.

B. One approach to budgeting:

1. Estimate how much money your family can expec receive as income.

2. Determine all your fixed obligations (rent, p on loans, taxes, installments on articles whi have been purchased).

3. Set aside a small emergency fund to meet the expected.

4. Determine your living expenses (what are your expenses for food, clothing, home upkeep, tra tation, recreation and so on).

   a. Some people find it helpful to figure liv expenses on the basis of each family memb

   b. What is left, if anything is, can be used special needs as they arise or to purchas future needs when specific items are on s

C. Some other approaches:

1. The envelope system - putting so much each mo a number of envelopes, each for a specific fa need of expense.

2. Plan the use of credit buying so that you can the current month's income and not begin to s next month's check. How much can you afford each month on such an account?

14. Family Budgeting

	Comments, Suggestions
A. <u>Objective</u> To identify and discuss principles of family budgeting which can be used in helping clients.	
B. <u>One approach to budgeting</u>: 1. Estimate how much money your family can expect to receive as income. 2. Determine all your fixed obligations (rent, payments on loans, taxes, installments on articles which have been purchased). 3. Set aside a small emergency fund to meet the unexpected. 4. Determine your living expenses (what are your weekly expenses for food, clothing, home upkeep, transportation, recreation and so on). a. Some people find it helpful to figure living expenses on the basis of each family member. b. What is left, if anything is, can be used for special needs as they arise or to purchase for future needs when specific items are on sale.	Group discussion Ask Case Aides to assume some responsibility for planning this session. Its purpose is to identify and use the skills which the Case Aides already have in managing on a limited budget. The teaching notes present one approach to be used in stimulating discussion.
C. <u>Some other approaches</u>: 1. The envelope system - putting so much each month in a number of envelopes, each for a specific family need of expense. 2. Plan the use of credit buying so that you can live on the current month's income and not begin to spend next month's check. How much can you afford to pay each month on such an account?	

D. Discussion of other methods used by Case Aides

E. Helping Clients with their buying

	Comments, Suggestions
D. Discussion of other methods used by Case Aides E. Helping Clients with their buying	Discuss the workbook assignment on page 61, focusing upon how a case aide might help clients to avoid such situations.

References

15. Principles of Child and Child Rear

Witmen and Kotinsky, Personality in The Making.

A. Objective

To identify some of the major developmental a ments of children and discuss how principles development can be used in work with clients.

B. The Family:

"a unit composed not only of a child, but of an occasional animal and a common cold." (Ogc

1. To produce children and provide them with of supporting affection.

2. To induct them, from infancy on, into the values of their culture and of society.

3. To give them their initial identity withi community.

C. Some principles of child development and chil inuluence the helping services

1. The family is the most significant single in the development of the child.

2. The child's basic attitudes are formed pr within the family.

3. A significant function of the family is t the child with acceptance and value produ confidence.

4. Parental training is not made effective m the setting of high standards.

15. Principles of Child and Child Rearing

Comments, Suggestions

A. Objective

To identify some of the major developmental accomplishments of children and discuss how principles of child development can be used in work with clients.

B. The Family:

"a unit composed not only of a child, but of men, women, an occasional animal and a common cold." (Ogden Nash)

1. To produce children and provide them with a setting of supporting affection.

2. To induct them, from infancy on, into the ways and values of their culture and of society.

3. To give them their initial identity within the community.

C. Some principles of child development and child care which inuluence the helping services

1. The family is the most significant single influence in the development of the child.

2. The child's basic attitudes are formed principally within the family.

3. A significant function of the family is to provide the child with acceptance and value producing self-confidence.

4. Parental training is not made effective merely by the setting of high standards.

A discussion of the workbook assignment on pages 63 and 64, and the reasons why participants answered these questions as they have, can serve as a basis for identifying principles of child development. List these on the blackboard as they are identified for later group reference and use.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: I. ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Disassemble, Check, Make Measurements, and Reassemble Engine

CONDITIONS:

BEHAVIOR:

35. Reassemble engine block assembly following steps as outlined in the manual
36. Using hoist, remove engine block assembly from universal stand
37. Couple engine and transmission assembly together following steps as outlined in the manual
38. Position engine and transmission assembly on engine stand and connect engine to motor mounts
39. Disassemble cylinder heads following steps as outlined in the manual
40. Make all measurements, checks, tests, etc. as outlined in the manual
41. Clean but do not grind valves on these heads or head unless instructor tells you to do so
42. Reassemble cylinder heads following steps as outlined in the manual
43. Install cylinder heads push rods and rocker arm assembly following steps as outlined in the manual

PERFORMANCE CRITERIA:

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5. It is important for a child to have
learn through experience.

6. Consistency is an important factor i
development.

7. The setting of realistic standards c
child with a sense of security.

8. New habits are most effectively taug
through encouragement, recognition, a
performance pleasurable.

9. Punishment is not an effective means
misbehavior over an extended period o

D. Major developmental characteristics of ch

1. The end of the first year of life.

a. Physical growth

b. Beginning control of his movement
with help, pick up and throw obje
etc.

c. He can speak a few words - "mama"

d. Contacts with the world are throug
and primarily the mother.

e. Recognizes the meaning of "no no."

Comments, Suggestions

5. It is important for a child to have the opportunity to learn through experience.

6. Consistency is an important factor in achieving normal development.

7. The setting of realistic standards can provide a child with a sense of security.

8. New habits are most effectively taught to children through encouragement, recognition, and making their performance pleasurable.

9. Punishment is not an effective means for eliminating misbehavior over an extended period of time.

D. Major developmental characteristics of children

To stimulate discussion, ask participants what major characteristics they have observed for these various age groups.

1. The end of the first year of life.

   a. Physical growth

   b. Beginning control of his movements - he can stand with help, pick up and throw objects, crawl, sit, etc.

   c. He can speak a few words - "mama" and "dada."

   d. Contacts with the world are through the parents and primarily the mother.

   e. Recognizes the meaning of "no no."

2. By age 2 1/2 years (the toddler)

   a. He learns to walk.

   b. A world of action - learns mastery of himsel (in climbing, walking, jumping, etc.)

   c. He is learning language - to offer help and parental commands.

   d. A preoccupation with exploration.

   e. Most of his play involves individual activit

3. The Preschool child:

   a. His attention is increasing focused upon the neighborhood.

   b. His individuality will become more pronounce

   c. Mastery of toilet training.

   d. Learning may include drawing, coloring and st telling.

   e. Begins to form relationships with neighborhoo children and adults.

   f. He will be able to share much information abo himself - describe events and activities.

   g. Two important emotions - aggression and sympa

2. By age 2 1/2 years (the toddler)

   a. He learns to walk.

   b. A world of action - learns mastery of himself (in climbing, walking, jumping, etc.)

   c. He is learning language - to offer help and refuse parental commands.

   d. A preoccupation with exploration.

   e. Most of his play involves individual activity.

3. The Preschool child:

   a. His attention is increasing focused upon the neighborhood.

   b. His individuality will become more pronounced.

   c. Mastery of toilet training.

   d. Learning may include drawing, coloring and story telling.

   e. Begins to form relationships with neighborhood children and adults.

   f. He will be able to share much information about himself - describe events and activities.

   g. Two important emotions - aggression and sympathy.

4. The child from age 6 to age 12.

   a. Peer groups assume greater significance

   b. Begins to question adult reasoning.

   c. Testing of authority.

   d. Formation of groups along sex lines.

   e. An increasing use of symbols.

   f. Becomes aware of his place in time, the of other people's experiences, and deve of self criticism.

   g. Can assume more responsibility for the himself and perform some chores.

5. The adolescent:

   a. The need to decide upon and prepare for vocation.

   b. A freeing of himself from his parents.

   c. Joining with a larger society outside t

   d. Seeking satisfying relationships with opposite sex.

   e. The trying out of new roles.

   f. The further development of a sense of

Comments, Suggestions

4. The child from age 6 to age 12.

   a. Peer groups assume greater significance.

   b. Begins to question adult reasoning.

   c. Testing of authority.

   d. Formation of groups along sex lines.

   e. An increasing use of symbols.

   f. Becomes aware of his place in time, the sharing of other people's experiences, and development of self criticism.

   g. Can assume more responsibility for the care of himself and perform some chores.

5. The adolescent:

   a. The need to decide upon and prepare for a vocation.

   b. A freeing of himself from his parents.

   c. Joining with a larger society outside the home.

   d. Seeking satisfying relationships with the opposite sex.

   e. The trying out of new roles.

   f. The further development of a sense of self.

Charlotte Towle, Common Human Needs. National Association of Social Workers, New York, 1957.

E. What needs do these characteristics express?

1. The infant's need for love, care, protection.
2. The toddler's need to learn.
3. The preschool child's need to begin making some decisions for himself.
4. The school age child's need for creative activity and for attainment of mental and physical skills.
5. The adolescent's need for self-identification and preparation for independent living.

Comments, Suggestions

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4. The school age child's need for creative activity and for attainment of mental and physical skills.

5. The adolescent's need for self-identification and preparation for independent living.

Instrumented Training: A Tool for Developing Teamwork in New Career Agencies. Paniagua, Lita and Gould, Richard, New Careers Training Laboratory, Frank Riessman, Director, New York University, April 1969.

A. Objective

To identify and discuss how teamwork can be

B. The purpose of the exercise

In orientation training sessions, emphasis w
upon the Case Aide's role as a member of a "
Team." By this time, he has had experience
ever developing skills with clients, and in
the activities of the Social Service Worker,
ity Worker, etc. It is therefore important
the concept of a "team approach" in the deli
agency services to clients, and the various
played by the members of this most important

The purpose of this exercise is to reinforce
develop job-related interpersonal skills whi
to achieve the mutuality of effort needed by
team in order to maximize their potential be
client. In other words, the team members sh
being a team.

C. Guidelines for the Exercise

Each Case Aide should invite a Social Servic
an Eligibility Worker with whom she regularl
works, to participate in this particular tra
with her. The exercise will be a learning e
all involved, and its purpose is to teach te

1. Explain the training exercise to the tot

   a. That each team will be given an assi
      they are to jointly complete. (See

1084
15602

16. An Exercise in Teamwork

	Comments, Suggestions
A. <u>Objective</u> To identify and discuss how teamwork can be strengthened.	
B. <u>The purpose of the exercise</u> In orientation training sessions, emphasis was placed upon the Case Aide's role as a member of a "Public Welfare Team." By this time, he has had experience in using his ever developing skills with clients, and in concert with the activities of the Social Service Worker, the Eligibility Worker, etc. It is therefore important to reinforce the concept of a "team approach" in the delivery of agency services to clients, and the various roles to be played by the members of this most important team. The purpose of this exercise is to reinforce and further develop job-related interpersonal skills which are needed to achieve the mutuality of effort needed by this agency team in order to maximize their potential benefit to the client. In other words, the team members should practice being a team.	See Appendix 2 (Page 133) for a teamwork exercise which can be used.
C. <u>Guidelines for the Exercise</u> Each Case Aide should invite a Social Service Worker and an Eligibility Worker with whom she regularly and jointly works, to participate in this particular training session with her. The exercise will be a learning experience for all involved, and its purpose is to teach teamwork.	Other members of a team may also be added where appropriate.
1. Explain the training exercise to the total group.	Provide the entire group with some ground rules, e.g., (1) you are to function as a team; (2) each group will need to designate a leader; etc.
a. That each team will be given an assignment which they are to jointly complete. (See Appendix.)	

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: I. ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Disassemble, Check, Make Measurements, and Reassemble Engine

CONDITIONS:

BEHAVIOR:

44. Install intake manifold following all steps as outlined in the manual
45. Install water pump and fan
46. Install distributor following all steps as outlined in the manual
47. Install carburetor
48. Install fuel pump and line
49. Install ignition primary wiring
50. Install ignition secondary wiring
51. Install generator and connect wires
52. Install starter
53. Install radiator
54. Install radiator hoses and hose clamps
55. Tighten oil pan plug and fill engine to proper level with oil
56. Check fluid level in transmission and fill to proper level
57. Fill radiator with water and check for leaks
58. Make all preliminary adjustments as outlined in the manual

PERFORMANCE CRITERIA:

1558

b. A time limit is set for its completion.

c. The members of each team must jointly work out among themselves a solution to the problems pose in the assignment.

d. Each team will evaluate their activity at the en of the work session, and will return the complet evaluation form to the trainer.

e. Each team will return to the larger group at the end of the teamwork session, and one member of each team will report on the problem-solving results achieved by his team.

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15605

16. An Exercise in Teamwork	Comments, Suggestions
b. A time limit is set for its completion.	
c. The members of each team must jointly work out among themselves a solution to the problems posed in the assignment.	Provide entire group with some ground rules, e.g., you are a team.
d. Each team will evaluate their activity at the end of the work session, and will return the completed evaluation form to the trainer.	Each group will need to designate a "leader" for the exercise and assign roles of recorder, etc.
e. Each team will return to the larger group at the end of the teamwork session, and one member of each team will report on the problem-solving results achieved by his team.	Using the reports of each team, the trainer will conduct a general discussion of the assignment. This might be done by asking each group to present its task. The evaluation form on page 124 might be put on the bulletin board and the total group encouraged to assess team accomplishments. Evaluation of team functioning should be accomplished in total group participation.

References

17. through 22. Suggestions for Co

Six sessions, covering a period of twelve hours to be added by the county department in complet tion training of new Case Aides. The trainer w select content needed by the Case Aides in the assignment, and these six sessions have been le content covering the more unique uses of Case A individual county departments which cannot be a Some of the particular content areas to be cove clude the following:

1. The development of new community or ne resources.
2. The special needs of older clients, th or children.
3. The use of specific forms.
4. More detailed information on eligibili
5. Assessing the suitability of housing.
6. The use of surplus foods.
7. The location and recruitment of client
8. Work with specific minority groups.
9. Educational games for children.
10. Participation in client groups.

17. through 22. Suggestions for Content	Comments, Suggestions
Six sessions, covering a period of twelve hours, will need to be added by the county department in completing the induction training of new Case Aides. The trainer will want to select content needed by the Case Aides in their specific job assignment, and these six sessions have been left open for content covering the more unique uses of Case Aides in individual county departments which cannot be anticipated. Some of the particular content areas to be covered might include the following: 1. The development of new community or neighborhood resources. 2. The special needs of older clients, the handicapped, or children. 3. The use of specific forms. 4. More detailed information on eligibility requirements. 5. Assessing the suitability of housing. 6. The use of surplus foods. 7. The location and recruitment of clients. 8. Work with specific minority groups. 9. Educational games for children. 10. Participation in client groups.	

References

23. A Review and Evaluation of Induction Traini

A. A summary and review of material covered in ind
training sessions.

B. Group evaluation of the induction training sess

1. Group Task: Evaluate induction training a
recommendations which the gro
are important.

C. Written evaluation and assessment of training.

23. A Review and Evaluation of Induction Training Sessions

	Comments, Suggestions
A. A summary and review of material covered in induction training sessions.	
B. Group evaluation of the induction training sessions: 1. Group Task: Evaluate induction training and make recommendations which the group thinks are important.	Group evaluation can be done through an open discussion with the trainer. Another approach which can be used is to ask the group to select its own leader and, as a group, to evaluate induction training they have now completed. Allow at least 30 minutes to seek group consensus and ask that notes on recommendations be kept and turned into the trainer.
C. Written evaluation and assessment of training.	Ask the participants to complete the evaluation form in their workbooks on pages 65 through 68.

APPENDIX NUMBER

An Annotated Bibliography of Selected A
The Training, Employment and Use of Preprof

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APPENDIX NUMBER 1

Annotated Bibliography of Selected Articles and Publications on
aining, Employment and Use of Preprofessionals in the Human Services

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15612

15613

AN ANNOTATED BIBLIOGRAPHY OF SELECTED ARTICLES AND PUBLICATIONS ON
HE TRAINING, EMPLOYMENT AND USE OF PREPROFESSIONALS IN THE HUMAN SERVICES

t T. and Briggs, Thomas L., Differential Use of Social Work Manpower: An Analysis
tion Study. National Association of Social Workers, New York, 1968.

s the nature of the manpower crisis, the extent of the problem, its effect
rofession and clients served, and alternative courses of action. The authors
an analytical framework within which the profession can proceed to more
t manpower utilization, and describes a study demonstrating the use of a team
in the delivery of social services to clients.

d and O'Reilly, Charles, "What About the Manpower Crisis in Social Welfare?"
e, The Journal of the American Public Welfare Association, Vol. XXVII, No. 4,
).

r discusses the need for a manpower pool of many different levels of education and
, so that each can use his talents and abilities fully and appropriately.

tin L.; Harm, Mary G.; and Ortof, Selma B.; The Content for Training in Project
d Study Association of America, New York, 1967.

ument is the result of efforts to develop a model curriculum from the experiences
ing, learning and program implementation in Project ENABLE. The material may be
revised, adapted or developed in further training programs directed toward the use
education as a means of involving parents in community and institutional improve-
d change. The syllabus represents narrative condensation of the major teaching
in national and regional institutes and in supervision of local programs.

tin L. and Jones, Chester H., "Activities of the Social Work Aides." Social
ly Service Association of American, Vol. XLVIII, No. 10, (December 1967)

s the selection, training and use of indigenous, nonprofessional social work aides in
Enable, a one-year community action program sponsored by Child Study Association,
ague and [illegible]rvice Association of America.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: I. ENGINE OVERHAUL

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Disassemble, Check, Make Measurements, and Reassemble Engine

CONDITIONS:

BEHAVIOR:

59. Connect battery cables following steps outlined in the manual - observe polarity
60. Re-check steps to make sure none have been omitted
61. Start engine and run at speed and length of time specified in the manual
62. Make all tests, checks, and adjustments as outlined in the manual
63. Stop engine
64. Re-torque bolts
65. Start engine and run until temperature is stabilized
66. Re-adjust valves as outlined in the manual
67. Adjust carbureter
68. Stop engine and fill out balance of specifications sheet
69. Install air breather and other accessories
70. Start engine
71. If engine meets tests and performs satisfactorily, return all tools, materials, test equipment, parts rack, etc., to proper storage places
72. Clean area for next project

PERFORMANCE CRITERIA:

To be able to disassemble, check, make measurements, and reassemble engine in 15 hours

Learning time: 35 hours

1557

Blum, Arthur, "Differential Use of Manpower in Public Welfare." Soc
National Association of Social Workers, Vol. II, No. 1, (January 196

Discusses manpower shortage in social welfare as necessitating
tional structure and manpower utilization. The author stresses
how best to serve client needs, not on present professional rol
tional patterns. A possible model for maximum utilization of m
using treatment teams is presented.

Brager, George. "The Indigenous Worker: A New Approach To The Soci
Social Work, the Journal of the National Association of Social Worke
(April 1965).

A description of the unique contribution of indigenous workers
ways of working with clients.

Byars, Lloyd L., and Schwefel, Linda, "Training the Hard-Core Unempl
and Experiences." The Training and Development Journal, American So
July 1969.

Offering a business perspective to the problems of employing th
background to this current movement is offered as a basis for c
(1) motivating the unemployed, and (2) the special training nee
ployed. A summary of several such training programs are offere

Calnan, Wilfrid M., "Differential Use of Manpower." Public Welfare,
Public Welfare Association, Vol. XXV, No. 1 (January 1967).

The differential use of manpower as a most important considerat
social services and as an essential solution to long-term manpo
is discussed. The indigenous worker is viewed as the hitherto
and the people needing help.

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, "Differential Use of Manpower in Public Welfare." Social Work, Journal of the ociation of Social Workers, Vol. II, No. 1, (January 1966).

es manpower shortage in social welfare as necessitating basic changes in organiza- structure and manpower utilization. The author stresses that changes must be based on t to serve client needs, not on present professional role definitions and organiza- patterns. A possible model for maximum utilization of manpower in public welfare treatment teams is presented.

ge. "The Indigenous Worker: A New Approach To The Social Work Technician." the Journal of the National Association of Social Workers, Vol. X, No. 2 .

iption of the unique contribution of indigenous workers to social work, and their working with clients.

L., and Schwefel, Linda, "Training the Hard-Core Unemployed: Some of the Problems nces." The Training and Development Journal, American Society of Training Directors,

ng a business perspective to the problems of employing the hard-core poor, a brief ound to this current movement is offered as a basis for discussing such factors as tivating the unemployed, and (2) the special training needs of the hard-core unem- . A summary of several such training programs are offered as examples.

frid M., "Differential Use of Manpower." Public Welfare, The Journal of the American are Association, Vol. XXV, No. 1 (January 1967).

fferential use of manpower as a most important consideration in the administration of services and as an essential solution to long-term manpower problems in social work cussed. The indigenous worker is viewed as the hitherto "missing link" between service e people needing help.

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Christmas, June Jackson. "Group Methods In Training And Action: Nonprofessi
Personnel In A Deprived Community." American Journal of Orthopsychiatry, Vol
(April 1966).

This paper describes the author's work as a psychiatrist at the Harlem H
indigenous nonprofessional, mental health aides for such functions as ca
expediters, leaders in group discussions, observer recorders for groups
families in poverty areas.

Coggs, Pauline R. and Robinson, Vivian R., "Training Indigenous Community Lea
in Social Work." Social Casework, The Family Service Association of America,
(May 1967).

Describes the use of social work aides in the Milwaukee Public School Sy
these indigenous workers.

Cowne, Leslie J., "Approaches to the Mental Health Manpower Problem." Mental
No. 2 (April 1969).

A review of the literature dealing with the mental health manpower probl
experimental programs in the training and use of nonprofessionals.

Cudaback, Dorothea, Training and Education of New Careerists in Public Welfar
of Social Welfare, Circular Letter 2408, (January 1970).

The importance of building a "new careers" concept into an agency progra
of preprofessionals in public welfare is stressed as the author discusse
the triad of work-training-education needed, and the educational methods
these new staff members to provide social services to clients.

Cudaback, Dorothea, "New Careerists in Public Welfare." Public Welfare, The
American Public Welfare Association, Vol. XXVI, No. 2 (April 1968).

This article describes the use of clients in public welfare agencies as
helping social workers to improve and extend services to clients. The a
the author's experiences as Director of the Aide Training Project, Alame
Department, and very clearly describes the use of these preprofessionals
project.

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on. "Group Methods In Training And Action: Nonprofessional Mental Health
ed Community." American Journal of Orthopsychiatry, Vol. XXXVI, No. 3

ibes the author's work as a psychiatrist at the Harlem Hospital Center using
ofessional, mental health aides for such functions as case interviewers,
ers in group discussions, observer recorders for groups and liaison to
rty areas.

Robinson, Vivian R., "Training Indigenous Community Leaders for Employment
ial Casework, The Family Service Association of America, Vol. XLVIII, No. 5,

e of social work aides in the Milwaukee Public School System and the training of
workers.

proaches to the Mental Health Manpower Problem." Mental Hygiene. Vol. 53,

literature dealing with the mental health manpower problem, including
grams in the training and use of nonprofessionals.

raining and Education of New Careerists in Public Welfare. State Department
rcular Letter 2408, (January 1970).

f building a "new careers" concept into an agency program for the employment
als in public welfare is stressed as the author discusses the new careerist,
k-training-education needed, and the educational methods used in preparing
members to provide social services to clients.

New Careerists in Public Welfare." Public Welfare, The Journal of the
re Association, Vol. XXVI, No. 2 (April 1968).

cribes the use of clients in public welfare agencies as full-time employees,
orkers to improve and extend services to clients. The article is based upon
eriences as Director of the Aide Training Project, Alameda County Welfare
very clearly describes the use of these preprofessionals as a part of this

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Gartner, Alan, "The Use of the Paraprofessional and New Directi
Agency." Public Welfare The Journal of the American Public Wel
No. 2, (April 1969).

The already considerable use of paraprofessionals in the so
ing significance of their presence, serves as a basis for
to social services. Considered are (1) the demand of para
work, career advancement training, and education; (2) a gro
of new careerists; (3) the changing role of the public serv
impact of the 1967 Social Security Amendments and other soc
demand from the consumer for quality service, responsive to
to the community.

Grosser, Charles F., "Community Development And The Urban Poor.
National Association of Social Workers, Vol. X, No. 3, (July 19

Describes the use of indigenous leadership in community or

Grosser, Charles; Henry, William E.; Kelly, James G., editors,
Services. Jossey-Bass Inc., San Francisco, 1969.

Papers presented at a conference on Nonprofessional Mental
the American Psychological Association and the National As
held in Washington in May 1967. These papers deal with is
the poor in the helping services, implications for the pro
manpower development programs, and the implications for so

Hallstein, Richard W., "We Know Where to Start." The Training
Society of Training Directors, July 1969.

Principles of learning applied to training the disadvantag

Harvey, Mrs. Harold D., Chairman, Conference on Individualized
Social Workers, October 1966.

The minutes of a discussion of the use of the nonprofessio
issues and questions raised by the employment and use of n
for discussion of the viewpoint and experiences of Public
and a private sectarian agency, in using nonprofessionals.

lan, "The Use of the Paraprofessional and New Directions for the Social Service Public Welfare The Journal of the American Public Welfare Association, Vol. XXVII, ril 1969).

lready considerable use of paraprofessionals in the social welfare field and the grow- ignificance of their presence, serves as a basis for discussing five issues relating cial services. Considered are (1) the demand of paraprofessionals for meaningful career advancement training, and education; (2) a growing development of organization w careerists; (3) the changing role of the public service workers' unions; (4) the t of the 1967 Social Security Amendments and other social legislation; and (5) the d from the consumer for quality service, responsive to their needs, and responsible e community.

harles F., "Community Development And The Urban Poor." Social Work, The Journal of the ssociation of Social Workers, Vol. X, No. 3, (July 1965).

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s presented at a conference on Nonprofessional Mental Health Work, jointly sponsored by merican Psychological Association and the National Association of Social Workers, and in Washington in May 1967. These papers deal with issues raised by the employment of oor in the helping services, implications for the profession, the task of defining jobs, wer development programs, and the implications for social work education.

Richard W., "We Know Where to Start." The Training and Development Journal, American Training Directors, July 1969.

ples of learning applied to training the disadvantaged.

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nutes of a discussion of the use of the nonprofessional in a variety of settings. The and questions raised by the employment and use of nonprofessionals serve as a basis scussion of the viewpoint and experiences of Public Welfare, Veterans Administration private sectarian agency, in using nonprofessionals.

Jones, Betty Lacy, D.S.W., "Nonprofessional Workers in Professional
Child Welfare, the Journal of the Child Welfare League of America,

A report of a research study which focused upon answering three
assignments to nonprofessionals requiring work with clients and
policies and supervisory controls that are different for nonpro
fessionals' work that is considered satisfactory. Findings are
fessional framework and four different jobs are suggested for n

Kidneigh, John C., "Restructuring Practice for Better Manpower Use."
of the National Association of Social Workers, Vol. 13, No. 2 (April

The author suggests one possible solution for manpower problems
on the division of work. A scale for measuring the levels of c
in duties is proposed. The scale consists of five subscales me
initiative, judgment, independence, expressive requirements, in
with persons. The article is concerned primarily with social w
preprofessional functions, but contributes one approach to the
differential use of staff in social work practice.

Kurzman, Paul A., "The New Careers Movement and Social Change." Soc
Association of America, Vol. 51, No. 1, (January 1970).

New careers programs, along with offering expansion of services,
having the potential to curtail social action defect social refo
to be aware of dangers and limitations inherent in new careerism
help paraprofessionals to maintain their identity as residents o
their commitment to neighborhood defined needs.

Lally, Winifred A., "The Public Service Career Program: Its Implicat
Community." Public Welfare, The Journal of the American Public Welfar
No. 2, (April 1969).

The development of the public service career movement, as a resu
to the Economic Opportunity Act, is reviewed and serves as a bas
major methods used in developing career models. These can be de
down the job by task and separating out the simpler tasks, or by
first identifying service needs and then defining the tasks to m

15622

acy, D.S.W., "Nonprofessional Workers In Professional Foster Family Agencies." the Journal of the Child Welfare League of America, Vol. XLV, No. 6 (June 1966).

of a research study which focused upon answering three questions: the kinds of ts to nonprofessionals requiring work with clients and foster parents; agency and supervisory controls that are different for nonprofessionals; and nonpro- s' work that is considered satisfactory. Findings are analyzed within a pro- framework and four different jobs are suggested for nonprofessionals.

C., "Restructuring Practice for Better Manpower Use." Social Work , The Journal l Association of Social Workers, Vol. 13, No. 2 (April 1968).

r suggests one possible solution for manpower problems in social welfare focusing ivision of work. A scale for measuring the levels of complexity and responsibility is proposed. The scale consists of five subscales measuring originality and e, judgment, independence, expressive requirements, intensity and level of contact sons. The article is concerned primarily with social worker functions, as opposed to ssional functions, but contributes one approach to the broader issues of the ial use of staff in social work practice.

A., "The New Careers Movement and Social Change." Social Casework , Family Service f America, Vol. 51, No. 1, (January 1970).

ers programs, along with offering expansion of services, need to be recognized as e potential to curtail social action defect social reform. Stressed is the need are of dangers and limitations inherent in new careerism, and the need to plan to aprofessionals to maintain their identity as residents of the neighborhood and mmitment to neighborhood defined needs.

ed A., "The Public Service Career Program: Its Implication for Client, Agency, and ublic Welfare, The Journal of the American Public Welfare Association, Vol. XXVII, 1969).

lopment of the public service career movement, as a result of the Scheurer Amendment conomic Opportunity Act, is reviewed and serves as a basis for discussing the two thods used in developing career models. These can be developed either by breaking job by task and separating out the simpler tasks, or by a developmental approach, entifying service needs and then defining the tasks to meet those needs. The author

15622

suggests that the real test facing public welfare is wheth
effectiveness against its goals and objectives, and on the
modify, expand or abandon old programs and strategies and c

Levinson, Perry and Schiller, Jeffry, "Role Analysis of the
Work, Journal of the National Association of Social Workers

A review of past use of auxiliary personnel in social
proposing a conceptual framework and raising basic re
welfare activity. A helpful evaluation of the often c
indigenous worker is expected to play.

Levitt, Louis, "Case Aides and Administrative Realities."
American Public Welfare Association, Vol. XXVIII, No. 1, (J

A presentation which deals with the practical applicat
bureaucratic structure, the author discusses the need
at all levels in the delivery system within urban ghet
questions raised by the implementation of a case aide

Lowenberg, Frank, "Social Workers and Indigenous Nonprofessi
Social Work, Journal of the National Association of Social W

This article examines the experiences of some professio
in innovative settings. It identifies problems encount
new role model for workers and services and new structu

Lowy, Dr. Louis, Training Manual For Human Service Technicia
Part I, Trainers, United Community Services of Metropolitan

A manual for trainers, this publication contains guideli
out a training program as well as curricular material to
plan a training program. The content includes informati
environment, the trainee, selecting training objectives,

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the real test facing public welfare is whether it is prepared to measure its against its goals and objectives, and on the basis of critical analysis, to or abandon old programs and strategies and create new ones.

and Schiller, Jeffry, "Role Analysis of the Indigenous Nonprofessional." Social of the National Association of Social Workers, Vol. 11, No. 3, (July 1966).

of past use of auxiliary personnel in social welfare agencies provides a basis for a conceptual framework and raising basic research issues in the area of social ctivity. A helpful evaluation of the often conflicting and ambiguous roles the s worker is expected to play.

"Case Aides and Administrative Realities." Public Welfare, The Journal of the c Welfare Association, Vol. XXVIII, No. 1, (January 1970).

ation which deals with the practical application of a systems approach in a large tic structure, the author discusses the need for participation of nonwhite staff vels in the delivery system within urban ghettos as well as a number of policy raised by the implementation of a case aide program.

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for trainers, this publication contains guidelines for those who design and carry ining program as well as curricular material to be selected by the trainer as they aining program. The content includes information on the trainer, the training nt, the trainee, selecting training objectives, content and methods.

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V ENGINES

MILESTONE: II VALVE REFACING AND GRINDING

PERFORMANCE OBJECTIVE NO: 2 TITLE: Reface Valves and Grind Valve Seats

CONDITIONS: Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Valves	1. Automotive Engines, by Crouse. pp. 412 through 473 Automotive Engines Workbook, by Crouse. Jobs 16 through 23	1. Related Information Class
2. Valves	2. Teaching Machine card 13A	2. Teaching Machine (Shop)
3. Using the Valve Grinder	3. Valve Grinder	3. Shop Instructor
4. Using the Valve Refacer	4. Valve Refacer	4. Shop Instructor
5. "Modern Valve Reconditioning"	5. Filmstrip	5. Resource Materials Center

Lowy, Dr. Louis, Training Manual for Human Service Technicians Worki
Part II, Trainees, United Community Services of Metropolitan Boston,

This manual is designed for possible use in two ways: (1) as cu
trainers for teaching; (2) as curriculum content material by tr
on aging and the aged which is essential to performing helping
includes information on the major problems of aging; the develo
strengths of aging; resources to meet the needs of older adults
with older persons.

MacLennan, Beryce and Klein, William "Utilization of Groups in Job
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A description of the training of nonprofessionals for service
organization, family counseling, recreation and education.

Mandville, Paul F. and Maholick, Leonard T., "Changing Points of Em
Community's Natural Counselors." Mental Hygiene. Vol 53, No. 2, (

This paper describes the theoretical and philosophical conside
the analysis of an ongoing training program for the community'
the revisions in emphasis and procedures that followed.

National Committee on Employment of Youth, Subprofessionals -- From
N.C.E.Y., 1967 (pp 105-109).

A description of several programs where new jobs have been dev
specifically to provide a new type of service to the community

National Institute for New Careers, University Research Corporation
Home Health Aide Trainer's Manual. U. S. Department of Labor, Manp
Training and Employment Service, Washington, D. C., October 1968.

One of a series of manuals, designed to be used in training Co
who will be assuming subprofessional positions at the entry le
introduction to the program, provides suggestions for present
Careers training program, and outlines a basic (core) curricu

aining Manual for Human Service Technicians Working With Older Persons. United Community Services of Metropolitan Boston, Boston, Massachusetts, 1968.

designed for possible use in two ways: (1) as curriculum content material by eaching; (2) as curriculum content material by trainees to obtain information he aged which is essential to performing helping services. The content mation on the major problems of aging; the developmental process, needs and ging; resources to meet the needs of older adults; and approaches to working sons.

nd Klein, William "Utilization of Groups in Job Training." International ychotherapy, Vol. XV, No. 4, (October 1965).

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and Maholick, Leonard T., "Changing Points of Emphasis in Training the Counselors." Mental Hygiene. Vol 53, No. 2, (April 1969).

cribes the theoretical and philosophical considerations that helped generate f an ongoing training program for the community's natural counselors, and in emphasis and procedures that followed.

on Employment of Youth, Subprofessionals -- From Concepts to Careers. 105-109).

of several programs where new jobs have been developed by agencies, o provide a new type of service to the community.

for New Careers, University Research Corporation, New Careers: The Community/ ainer's Manual. U. S. Department of Labor, Manpower Administration, U.S. ment Service, Washington, D. C., October 1968.

s of manuals, designed to be used in training Community/Home Health workers suming subprofessional positions at the entry level. This manual provides an o the program, provides suggestions for presenting and implementing a New ing program, and outlines a basic (core) curriculum for health service trainees.

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National Institute for New Careers, University Research Corporation, New Ca
Health Aide Trainee's Manual. U. S. Department of Labor, Manpower Administ
and Employment Service, Washington, D. C., October 1968.

A manual for use by trainees participating in the core training progra
above publication. Each unit of learning includes an exercise for the
Specific instructions for its use are to be given verbally by the inst

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New Careers Agencies. New York University, April 1969.

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for use of training (team training). This training technique is inten
of human service agencies now involved in adding preprofessionals as t
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The employment, training and use of preprofessionals in public welfare
method for improving quality of services to clients. Also discussed a
by the addition of these new staff members, and the creation of a care

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Discusses the new careers concept and identifies problems and issues in
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No. 4, (October 1968).

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of new careers programs. The theoretical sources of the obstacles are
well as the specific forms they take. Tactical maneuvers to modify th
are suggested.

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for use by trainees participating in the core training program described in the lication. Each unit of learning includes an exercise for the trainee to complete. instructions for its use are to be given verbally by the instructor.

and Gould, Richard, Instrumented Training: A Tool for Developing Teamwork in encies. New York University, April 1969.

developed by the staff of the New Careers Training Laboratory which presents method f training (team training). This training technique is intended for use with staff service agencies now involved in adding preprofessionals as team members in the of social services to clients.

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yment, training and use of preprofessionals in public welfare is proposed as one r improving quality of services to clients. Also discussed are the problems posed dition of these new staff members, and the creation of a career ladder.

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separately or in combination, influence the mental health attitudes of p
This research offers evidence that certain mental health attitudes are a
through training, but that others are not. Findings suggest that traini
mental health attitudes in a positive direction if the attitudes to be c
associated with the amount of mental health knowledge the attendant has.
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a short-term conventional training program.

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professional Personnel." Social Work, Journal of the National Association o
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A training manual and workbook for preprofessional workers in the huma

Distefano, M. K.; and Marr, Larry W.; "Attitude Changes in Psychiatric Experience and Training." Mental Hygiene, Vol. 53, No. 2, (April 1969).

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"A Theoretical Scheme for Determining Roles of Professional and Non- el." Social Work, Journal of the National Association of Social Workers, ober 1966).

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book prepared for use by welfare aides, containing a number of short readings and
ng-by-doing exercises.

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ed by this county department in preparing these preprofessionals for work in the human
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The success or failure of the most carefully planned, the most adeq
tional programs, the author suggests, may depend solely on the natu
between pupils and teachers. Hidden feelings and prejudices in the
as much as de facto lack of respect for individual differences in t
written in relation to the education of children, this article has
the trainer in public welfare who is responsible for teaching prepr

USDHEW, Welfare Administration, Utilization of Auxiliary Staff in the Pr
in Public Welfare, Washington, D. C., 1965.

Discusses the development of various types of jobs auxiliary to adr
work functions, in providing services in public assistance programs
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USDHEW, Welfare Administration, Utilization of Social Work Staff with D
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Outlines and discusses the need to establish two careers lines for
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Wiley, Wretha, Designing Jobs and Careers in Model Cities Program. New
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Paper describes the problems involved in simplistic approaches to
fessionals, and illustrates a "developmental approach" to job and
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March, 1970:W.F.

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failure of the most carefully planned, the most adequately financed educa- s, the author suggests, may depend solely on the nature of the encounter and teachers. Hidden feelings and prejudices in the teacher impair success facto lack of respect for individual differences in the classroom. Although ation to the education of children, this article has particular relevance for public welfare who is responsible for teaching preprofessional staff.

inistration, Utilization of Auxiliary Staff in the Provision of Family Services Washington, D. C., 1965.

development of various types of jobs auxiliary to administrative and social , in providing services in public assistance programs. Provides illustrative ions for auxiliary personnel with less than college education.

inistration, Utilization of Social Work Staff with Different Levels of Education in Public Welfare and Selected Illustrative Job Specifications for Local ashington, D. C., 1965.

iscusses the need to establish two careers lines for family services in public r personnel with a master's degree in social work and one for personnel with degree whose social work training is provided primarily within the agency.

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s the problems involved in simplistic approaches to job development for nonpro- d illustrates a "developmental approach" to job and career design, drawing upon systems analysis and functional job analysis.

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/ PERFORMANCE OBJECTIVE STATEMENT /

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: II. VALVE GRINDING & REFACING

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Reface Valves and Grind Seats

CONDITIONS:

Operation is to be performed on cylinder head obtained from store room. Occasionally this operation is performed on a live engine.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Obtain one cylinder head from the parts room
2. Select proper manual and turn to appropiate chapter
3. Obtain from the instructor the operating instructions for the grinding equipment to be used
4. Select proper tools and equipment
5. Remove all valves from cylinder head following steps as outlined in the manual
6. Remove all deposits from combustion chambers, valve parts, and valves
7. Make all tests and checks as outlined in the manual
8. Using the instruction book and with the assistance of the instructor, set up valve grinding equipment
9. After demonstration on 1st valve by instructor, grind remaining valves
10. After demonstration on 1st valve seat, grind remaining seats

PERFORMANCE CRITERIA:

APPENDIX NUMBER 2

An Exercise on Teamwork

AN EXERCISE ON TEAMWORK

A most useful tool to use in the training of team members has bee
cation published by the New York University School of Education f

Possible Topics for the Team Training Exercise

1. A case study situation, descriptive of the kind of situation

   Example

   The case aide has found, in her work with a particular clien
   her social service worker about many of her everyday problem
   the case aide about these and several of these problems dire
   social service worker is attempting to help Mrs. Smith. For
   worker has been working with Mrs. Smith around problems she
   behavior of her son, John, who is now entering adolescence.
   ances at school with increasing frequency. Today, she told
   son is to have to go to school dressed so differently than t
   suspects that this is why he is frequently truant or why he
   does attend.

   Each team will develop a strategy that might resolve this pr

2. An exercise which lists the ways in which a helping person e
   sought in a helping person.

   Example

   Employees in the human services are said to require "sensiti
   As a team, list ten ways in which a social service worker an
   this quality in working with clients.

* Reissman, Frank, Instrumented Training: A Tool for Developing
  New York: New York University, April 1969.

AN EXERCISE ON TEAMWORK

eful tool to use in the training of team members has been suggested in a recent publi-
blished by the New York University School of Education for New Careers.*

Topics for the Team Training Exercise

se study situation, descriptive of the kind of situation existing in the work setting.

ble

case aide has found, in her work with a particular client, that Mrs. Smith avoids telling
social service worker about many of her everyday problems. However, she does talk with
case aide about these and several of these problems directly relate to areas in which the
l service worker is attempting to help Mrs. Smith. For example, the social service
r has been working with Mrs. Smith around problems she is having in controlling the
vior of her son, John, who is now entering adolescence. He has been creating disturb-
at school with increasing frequency. Today, she told her case aide how embarrassed her
s to have to go to school dressed so differently than the other children and, she
cts that this is why he is frequently truant or why he does not behave himself when he
attend.

team will develop a strategy that might resolve this problem.

ercise which lists the ways in which a helping person expresses a specific characteristic
t in a helping person.

le

yees in the human services are said to require "sensitivity" in their work with clients.
team, list ten ways in which a social service worker and a case aide would demonstrate
quality in working with clients.

, Frank, Instrumented Training: A Tool for Developing Teamwork in New Careers Agencies.
: New York University, April 1969.

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Example

As a team, list ten ways in which social service workers work with c
case aides work with clients. In what ways are these similar and in

Ideas For Evaluation Tools As A Basis For Total Group Discussion:

1. For Evaluation of the Group.

Rating Scale:

Very Much

How much discussion was there about ideas presented?

Were suggestions constructive?

Were group members tolerant about suggestions of others?

How well did members listen to others?

Did group members keep to the subject?

2. Behavior to be evaluated - Team Behavior.

Which of the following describes the relations between group member

___Cooperation ___Equal status ___C

___Hostility ___Submission to one person ___S

___Friendliness ___Free exchange of ideas ___A

___Equal roles ___Sharing opinions

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n ways in which social service workers work with clients, and ten ways in which
th clients. In what ways are these similar and in what ways are they different?

ols As A Basis For Total Group Discussion:

the Group.

Rating Scale:

	Very Much	Some	Little
n was there about ideas			
onstructive?			
tolerant about suggestions			
rs listen to others?			
keep to the subject?			

luated - Team Behavior.

wing describes the relations between group members when solving the problem?

___Equal status ___Controlling idea exchange

___Submission to one person ___Support for each other

___Free exchange of ideas ___Attacking each other

___Sharing opinions

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3. For Evaluation of Individuals.

(Rate each member including yours

	Very Little 1	2	Little 3	4	Some 5	6	Much 7
Interest in discussion							
Contribution to discussion							
Listening with understanding							
Helping group stay on subject							

Behavior - Leadership

Rank each person. First indicates least tendency to behave in way des

1. Tendency to impose opinions. (Use initials)
2. Tendency to get angry.
3. Tendency to praise others.

n of Individuals.

(Rate each member including yourself)

	Very Little 1	2	Little 3	4	Some 5	6	Much 7	8	Very Much 9
iscussion									
to discussion									
n understanding									
stay on subject									

adership

son. First indicates least tendency to behave in way described.

to impose opinions. (Use initials)

to get angry.

to praise others.

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VT 012 918
A Workbook for Case Aides in Orientation and Induction Training.

California State Human Relations Agency, Sacramento. Dept. of Social Welfare.
MF AVAILABLE IN VT-ERIC SET.
Training Aid 38-B
PUB DATE - Jul70 77p.

DESCRIPTORS - *WORKBOOKS; VOCATIONAL EDUCATION; STUDY GUIDES; *SUBPROFESSIONALS;*CASEWORKERS; *SOCIAL SERVICES; *WELFARE SERVICES

ABSTRACT - This workbook was prepared by the Training Bureau of the Human Relations Agency, California State Department of Social Welfare, to assist in the training of case aides. The 33 exercises are keyed to the orientation and induction training sessions found in the training manual, available as VT 012 917 also in this issue. (SB)

VT 012 918

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ED0 56238

TRAINING AID

Number 34-B

A WORKBOOK FOR CASE AIDES IN ORIENTATION AND INDUCTION TRAINING

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
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July 1970

State Department of Social Welfare -- Human Relations Agency
Robert Martin -- Director

TRAINING BUREAU
B. R. Becker -- Chief

ED 056238

T R A I N I N G A I D

Number 38-B

A WORKBOOK FOR CASE AIDES

IN ORIENTATION AND INDUCTION TRAINING

July 1970

State Department of Social Welfare - Human Relations Agency
Robert Martin - Director

TRAINING BUREAU
B. R. Becker - Chief

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: V. ENGINE

MILESTONE: II. VALVE GRINDING & REFACING

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Reface Valves and Grind Seats

CONDITIONS:

BEHAVIOR:

11. Make all tests and checks as outlined in the manual
12. Replace valves following all steps as outlined in manual
13. If all steps are satisfactory, return cylinder head to the store room
14. Clean tools and equipment and store in proper place
15. Clean work station and prepare for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, grind, and replace valves in the cylinder head in 3 hours.

Learning time: 6 hours

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PREFACE

One Case Aide, speaking for her class of trainees at their graduation said:

> "On February 3, 1967, at 8:30 a.m., we five women met for the first time. Nervous, apprehensive, not really knowing what to expect or what was expected of us. We felt like five squares in a world full of circles. Our one common bond was the burning desire to be free; free of public assistance, of social workers, of the rules and regulations governing our lives.
>
> "It was a way out, the ... weeks ahead were simply to be gotten through, the price we must pay for that precious freedom. These were our thoughts.
>
> "I can truly speak for all of us when I say it took only one day, one day to realize that we couldn't have been more mistaken. This was not something meant just to make us self-supporting and thus cutting down the State's expense. We were needed, and for some of us it was the first time we had felt needed outside our families for a long time. The social workers needed us. The clients needed us."[1/]

Yes, you are needed as members of a very important team - one that you will be learning more about in the coming weeks. But, before we discuss the part you will play on this team, a very sincere and special welcome. We are glad that you have chosen to join us as an employee of this county welfare department.

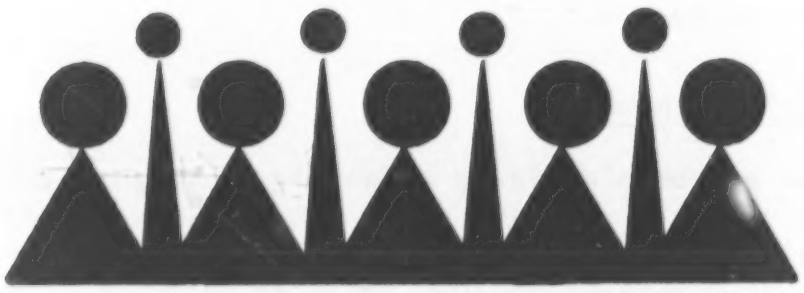

1/ Reprinted from A Firsthand View of New Careerists in Public Welfare, by Dorothea Cudaback, Director of the Aide Training Project, Alameda County Welfare Department.

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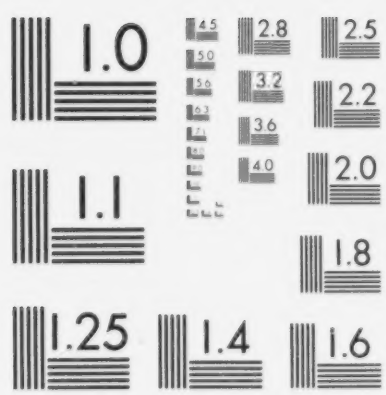

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

INTRODUCTION

This workbook is designed to help you in your new job as a Case Aide in this county welfare department. You are now about to begin a period of orientation and induction training that will continue through your third month of employment. We don't expect you to arrive on this, your first day of work, capable of performing your new job. No one can begin a Case Aide job with such knowledge. This is why we have planned a series of training sessions - so that you will have the opportunity to learn how to do your new job and what is expected of you as an employee in the county welfare department.

Orientation Training

Beginning today, you will start a one-week period of orientation to the county welfare department and to your new job assignment. During this week, you will have an opportunity to begin learning about the agency and enough about its operation in order to begin your job. You will also have an opportunity to observe more experienced staff work with clients. Thus, you will be able to see how experienced staff use their knowledge in helping people.

As you can see, we are planning a number of ways in which to help you to learn how to be a Case Aide. It is our sincere hope that you will not only learn how to be of help to people on your job, but that just learning this new job will be an enjoyable experience as well.

Induction Training

Induction training will begin next week, after you have begun your job, and will continue for several months. In these coming months, your supervisor will be helping you with your new job, and to apply what you have learned in group-training sessions to your work with individual clients. You will also be attending additional group-training sessions. Not only will you be offered new information of use to you in your job, in these sessions, but you will be able to discuss this information, together with other Case Aides, in our search for still further ways of being of help to people.

Purpose of This Workbook

This workbook has been designed as an aid to you in your training sessions and on your job assignment. It includes a variety of classroom materials that you will be using. Your trainer will help you to use this book as he discusses various subjects with you. For each session, there is a place for you to jot down notes for your later reference and use on your job. Feel free to write in your workbook. It is your own personal copy and our way of introducing you to your new job. Many of these exercises are designed to serve as a bases for discussion and therefore do not necessarily contain all the information you will want. For example, the exercise on page 16 asks you to make some judgments which will not be as easily made in your work with clients. However, we hope this will stimulate you to ask additional questions about your new job assignment.

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ORIENTATION TRAINING SESSIONS

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YOUR SCHEDULE FOR ORIENTATION

MONDAY	Introduction to Training Time: _____ Place: _____ _____	A Tour of the County Office Time: _____ Place: _____ _____	**What Do Case Aides Do?** Time: _____ Place: _____ _____	Observation With: _____ Time: _____ Place: _____ _____
TUESDAY	What is Public Welfare? Time: _____ Place: _____ _____	Welfare Programs, Services & Resources. Time: _____ Place: _____ _____	Observation With: _____ Time: _____ Place: _____	
WEDNESDAY	The Qualities of a Helping Person Time: _____ Place: _____ _____	How Does a Case Aide Help? Time: _____ Place: _____ _____	Observation With: _____ Time: _____ Place: _____	
THURSDAY	The Public Welfare Team Time: _____ Place: _____ _____	Case Presentation Time: _____ Place: _____ _____	Observation With: _____ Time: _____ Place: _____	
FRIDAY	Some Concepts Used in the Helping Services Time: _____ Place: _____ _____	Expectations & Responsibilities Time: _____ Place: _____ _____	A Review of Orientation Time: _____ Place: _____ _____	Meet With Your Supervisor Time: _____ Place: _____ _____

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Some things I will want to remember:

1. Who are the people with me in this training session?

   My trainer is:_____

   The participants are:_____

   _____ _____

   _____ _____

   _____ _____

   _____ _____

2. What will I be learning in orientation?

   _____

   _____

   _____

   _____

   _____

   _____

3. What rules and procedures will I be following as an employee?

   _____

   _____

   _____

   _____

   _____

   _____

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A TOUR OF THE COUNTY DEPARTMENT OFFICE

In your first few weeks on your new job, you will be meeting a number of people with whom you will later be working. To help you in remembering who each person is, perhaps you might begin a list of their names and what their jobs are:

I have met the following persons:	Their job in the county department is:

Some things I will want to remember about the county department: _____

_____

_____

_____

_____

_____

_____

_____

AN EXERCISE ON WHAT CASE AIDES DO

One Case Aide in discussing her work with a multi-problem family said:

> "The roach situation is very bad. They are going all across the wall and nobody is stopping to knock them down, you know. It's hard for me to sit there and I got into this - 'well why don't we remove these roaches because the children are around and it might be bad for the children.' I wrote on a piece of paper the name of an insecticide and about how much it would cost and said I would like to see him spray. He did. He followed my instructions. The next time I was out he had two cans of insecticide. Because I had been thinking in terms of these roaches I stopped on my way to their home at an Army surplus store and picked up a spray gun; the man let me have it for 25¢. I find that there are more fluid ounces in a can of insecticide rather than the aerosol can - it's larger but it's for the pressure in it. So I didn't need the spray gun but I do have other clients with roaches, so I will give my spray gun to them. He did spray the roaches; on this he followed my instructions to the letter."*

Answer the following questions:

1. What do you think about the way this Case Aide handled the problem of roaches with this family?

   _____

   _____

   _____

2. Do you think it is important for the Case Aide to be concerned about the amount of fluid ounces in a can of insecticide rather than an aerosol can?

   _____Yes _____No

   Explain: _____

   _____

3. List three or four more ways in which a Case Aide might help a family:

   _____

   _____

   _____

*Reprinted from A Firsthand View of New Careerists in Public Welfare, by Dorothea Cudaback, Director of the Aide Training Project, Alameda County Welfare Department, p. 5.

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VI. COOLING SYSTEM

MILESTONE: I. RADIATOR, ENGINE, HOSES, AND THERMOSTAT

PERFORMANCE OBJECTIVE NO: 1 TITLE: Remove and Replace Radiator, Hoses, and Thermostat. Flush Radiator and

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Fundamentals of Cooling System	1. Automotive Fuel, Lubricating, and Cooling Systems, by Crouse. pp. 394 through 400, 406 through 410, 418 through 434. Automotive Engines Workbook, by Crouse. Jobs 38 through 40.	1. Related Information Class
2. "Servicing the Radiator Pressure Cap"	2. Continuous loop film # 8365	2. Resource Materials Center
3. "Testing a Thermostat"	3. Continuous loop film # 8374	3. Resource Materials Center
4. "Replacing a Thermostat"	4. Continuous loop film # 8375	4. Resource Materials Center
Cooling System	5. Teaching Machine cards 15A, 15B, 15C	5. Teaching Machine (Shop)

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4. The next time you go shopping, write down the price of two brands of insecticide for roaches:

Brand Name: _____ Fluid ounces in a regular can: _____

Cost:_____ Fluid ounces in an aerosol can:_____

Cost:_____ Brand Name: _____ Fluid ounces in a regular

Can:_____ Cost: _____ Fluid ounces in an aerosol can:

_____ Cost:_____

Which is the best buy?_____ Why?_____

_____

What did you learn from this exercise?_____

_____

- -

Some notes from class:_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

15655

SOME NOTES ON MY FIRST OBSERVATIONAL EXPERIENCE: (Answer these questions after you have observed an experienced Case Aide in working with a family.)

1. How may people are there in this family? _____adults

   _____children.

2. What was the problem that the Case Aide was trying to help this family with?

   _____

   _____

   _____

3. What did the Case Aide do to help the family?_____

   _____

   _____

   _____

4. What was the family's response?_____

   _____

   _____

5. Can you suggest another way or a different way in which you, as a Case Aide, might help this family with the same problem?

   _____

   _____

   _____

   _____

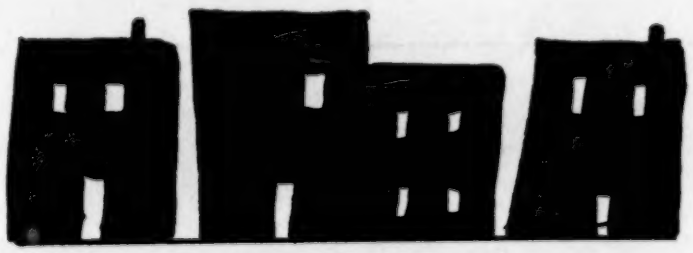

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WHAT IS PUBLIC WELFARE?*

A forty-year-old woman, whose sole income came from her AFDC grant, described public welfare in the following way:

> "The main thing, too, is that from the very word go the income is based on the barest necessities. There is no such thing as an extra income, so say something - an accident or something else - happens that you've got to have extra transportation money; there's no such thing as there being a fund that can be an emergency fund that can be sent to you, you know, on the spur of the moment.
>
> "Like, for instance, if you get a check on the first of the month, okay, that's our rent, utilities, phone, and so forth, and the kids have to have shoes. Then the next one is for the fifteenth - we get a little groceries on the first, enough that'll hold us until the fifteenth - then we do our heavy shopping. But you still got another bill or the kids need something or something is going on somewhere. You better believe there's always something, especially when it gets cold weather. And we can't live without necessities for ourselves - our personal necessities and our house necessities. Like I told my worker, my children have to take baths, my children have to have clean clothes to put on -- and I can't clean up the house with the food I eat. All you can buy is food, and you can't buy much of a meal anyway because of the prices you got to pay.
>
> "And another thing is that the caseworkers is falling under such a caseload that they don't have the time to give to the personal problems of people that they're dealing with. They don't have time to listen a lot of times. This is where it is - a person will have a problem or a person will have a particular need to know something, and his social worker is sometimes his only contact with professional, educated-type people that could give him advice, and he's busy, he's had a lot of cases like this, he's tired, he's cranky, he doesn't want to be bothered. This causes quite a hassle, quite a feeling of insecurity."*

Answer the following questions:

1. How did you feel after reading this statement by a client?

   ___Mad ___Sad ___Indifferent ___Other Feelings

   Why did you feel this way?_____

   _____

   _____

*Reprinted from Prelude to Riot: A View of Urban America From the Bottom, by Paul Jacobs, Vintage Books, New York, 1966, pp. 64-65.

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2. Do you think that this client is typical of most clients in how she views public welfare?

_____Yes _____No

3. List those things that this woman looks to public welfare for:

_____

_____

_____

_____

_____

_____

_____

- -

Some things I will want to remember from class:

1. What are the purposes of public welfare:

_____

_____

_____

_____

_____

2. What are the programs through which help is given?

_____

_____

_____

_____

_____

_____

_____

_____

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People who work in public welfare frequently use abbreviations in referring to various aid programs. The following is a list of abbreviations you will want to learn.

OAS = Old Age Security.

AFDC = Aid to Families With Dependent Children.

AFDC-U = Aid to Families With Dependent Children - Unemployed.

AB = Aid to the Blind.

APSB = Aid to the Potentially Self-Supporting Blind.

ATD = Aid to the Needy Disabled.

GR = General Relief.

* * * * * * * * * * * * * * * * * * *

Some Suggested Readings on Public Assistance Programs, prepared by the State of California, Human Relations Agency, Department of Social Welfare (available free in limited quantities from the publication section, State Department of Social Welfare, 744 P Street, Sacramento):

Aid to Unemployed Families

Aid to Families With Dependent Children

Aid to Needy Disabled Program

Complaints and Fair Hearings in Public Assistance Programs

Food Stamp Program

Important Notice on Civil Rights

Keep Us Posted

Old Age Security

Social Welfare Programs for the Blind

State Services for the Blind in California

Public Assistance and Welfare Services in California

PUBLIC WELFARE PROGRAMS, SERVICES AND RESOURCES

Some definitions of words that you will need to know:

1. PUBLIC WELFARE - An agency set up by law to provide financial assistance and social services for selected groups of persons.

2. PUBLIC ASSISTANCE - Financial aide provided to persons determined by defined standards, to be in need.

3. SOCIAL WELFARE - Society's concern for the well-being of people in their personal daily lives.

4. SOCIAL WORK - A body of knowledge, skill and ethics, professionally employed in the administration of social services and in development of the programs of social welfare.

5. SOCIAL WORKER - A person with graduate education in social work or an undergraduate major in social welfare and who uses special skills and knowledge to help people with personal and family problems and interpersonal relationships.

6. SOCIAL SERVICES - The ways in which men translate into action their sense of obligation to contribute to the well-being of others through development of planned ways of contributing to that well-being.

7. SOCIAL SERVICES WORKER - An agency employee responsible for the providing of agency social services to clients and for the coordination of the agency's service activities in order to maximize their potential benefit to the client.

8. ELIGIBILITY WORKER - An agency employee responsible for determining the client's eligibility for financial assistance and for continued eligibility for assistance programs.

9. VOLUNTEER - A person who although not an agency employee volunteers his time to the agency to perform needed tasks.

How much do you remember? See if you can complete the following paragraph by filling in the appropriate word:

_____ is a community agency concerned with the well-being of people. It provides _____ to needy persons in order that they can live at a level compatible with health and decency. In addition, it is concerned with the many problems which clients may face and attempts to help them with these problems by providing a wide range of _____. Among the agency staff with whom a client

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will have contact are the _____ who are primarily concerned with helping them with personal and social problems; the _____ who determines the amount of the grant to which they are entitled; and the _____ who, although not an agency employee, may be asked to assist a client with a specific problem. Public Welfare is only one of a number of community agencies that are concerned with the _____ of people. Many of these agencies employ _____ who, because of their special knowledge and skill, are able to help people to overcome problems which prevent them from achieving their potential for productive, independent living.

You should have one word left over which you did not use in this paragraph.

- -

Some notes from class discussion:

1. Why are social services provided by the agency?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

-15661

2. What are the public welfare programs, services and resources we have discussed?

_____

_____

_____

_____

A SECOND OBSERVATIONAL EXPERIENCE (Answer the following questions after you have observed the interview.)

1. What did the client want or need to know?_____

_____

_____

_____

2. How was the subject of the resource introduced in the interview?

_____

_____

_____

3. How was the resource explained?_____

_____

_____

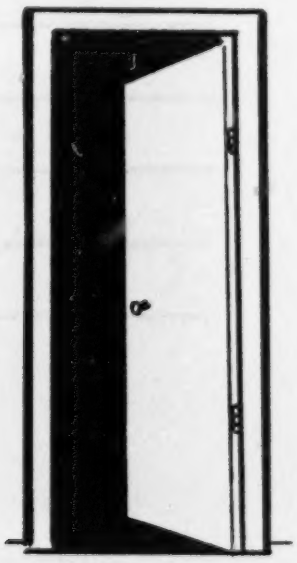

4. Did the client appear to understand the resource? If not, why not?

_____

_____

_____

5. Was anything done to help the client in using the resource?

_____

_____

_____

THE QUALITIES OF A HELPING PERSON

Being a helping person requires more than just experience. It requires practice as well. As a Case Aide, what might your immediate response be to a client who made the following comments to you?

1. Client: "Mrs. Smith, my social service worker, said that you could help me to find another place to live. I've been evicted from here."

   Your immediate response might be: _____

   _____

2. Client: "Moving isn't going to solve anything for me. That is really the least of my problems and I can't really spend my time looking for another place now, even if I have to move by the end of the month."

   Your immediate response might be: _____

   _____

   _____

3. Client: "I suppose I should have paid my rent as soon as I got my welfare check and I sure wish now that I had. However, I felt that I had to get the television fixed - its the only way that I can keep the children occupied while I try to fix dinner."

   Your immediate response might be: _____

   _____

   _____

4. Client: "I suppose you are in a hurry for us to start looking for a place to live. I know you are a busy person and can't waste your time on me."

Your immediate response might be: _____

_____

_____

5. Client: "Even though I know there are places to rent in the south end of town, I absolutely refuse to live there."

Your immediate response might be: _____

_____

_____

Some notes from class discussion:

1. What are the characteristics of a helping person?

_____

_____

_____

_____

_____

_____

_____

_____

_____

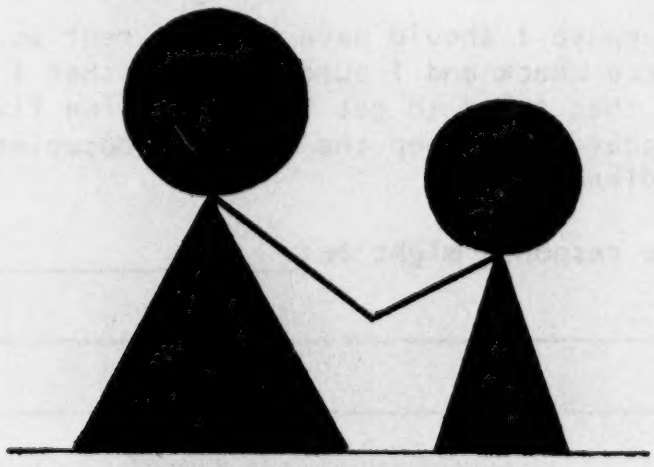

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VI. COOLING SYSTEM

MILESTONE: I. RADIATOR, ENGINE, HOSES, AND THERMOSTAT

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove and Replace Radiator, Hoses, Thermostat, Flush Radiator and Engine

CONDITIONS:

This assignment is to be performed on a complete automobile.

BEHAVIOR: After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropriate chapter
4. Select proper tools, materials, etc.
5. Raise hood
6. Place protective covers on fenders of automobile
7. Drain cooling system
8. Remove radiator and heater hoses following all steps as outlined in the manual
9. Make all checks and tests as outlined in the manual
10. Replace radiator and heater hoses following all steps as outlined in the manual
11. Remove top radiator hose from radiator
12. Remove bottom radiator hose from water pump
13. Reverse flush radiator following all steps as outlined in the manual

PERFORMANCE CRITERIA:

2. What do I need to remember in understanding others?

Before you finish this session, turn back to the responses you suggested on the previous page. Do they reflect the qualities of a helping person that you have identified in class discussion?

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HOW DOES A CASE AIDE HELP?

Answer each of the following questions by making an X under the word "yes" if you agree with the statement, and under the word "no" if you do not agree with the statement.

YES	NO		
		1.	I should tell a client that I have been on public assistance in order for him to know that I can understand how he feels.
		2.	I have often suggested a way in which I have solved a similar problem, thinking that perhaps the client might be able to use a different way of handling it.
		3.	I usually avoid telling clients about particular stores in which I shop, because it is important that they learn to shop wisely for themselves.
		4.	Sometimes a client can learn more when I show them how to use a resource, rather than when I just tell them about it.
		5.	I know that there are some clients that I will not be able to help as much as I would like.
		6.	If at all possible, I try to find another resource for the client to use, when the agency cannot meet a specific financial need which he has.
		7.	It is important to help clients understand the policies and procedures of our agency.
		8.	I try to avoid telling people that I don't know the answer to their question.
		9.	Although it is difficult to say "no" to requests, it is sometimes necessary to do so.
		10.	I prefer to maintain a business-like relationship with clients who try to tell me about their personal troubles.
		11.	It is important to listen to the client's concerns, even if they differ from the reason for my visit.
		12.	I believe it is important to explain to the client how I, his social service worker, and eligibility worker, are each available to help him, but in different ways and with different things.

Some notes from class discussion:

1. Some ways of establishing rapport.

2. How to prepare for an interview.

3. Some hints on interviewing.

4. Ending the interview.

5. What should I do following the interview?

A THIRD OBSERVATIONAL EXPERIENCE (Answer the following questions after you have observed the interview)

1. Did the interview achieve its purpose? If not, why not?

_____

_____

_____

2. What did you learn about the client that you did not previously know?

_____

_____

_____

_____

3. If a return visit is planned, what will be its purpose?

_____

_____

_____

_____

_____

4. What information did you obtain that would help the Social Service Worker and Eligibility Worker in their work with this client?

_____

_____

_____

_____

_____

5. What questions do you have as a result of this interview?

_____

_____

_____

_____

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THE PUBLIC WELFARE TEAM

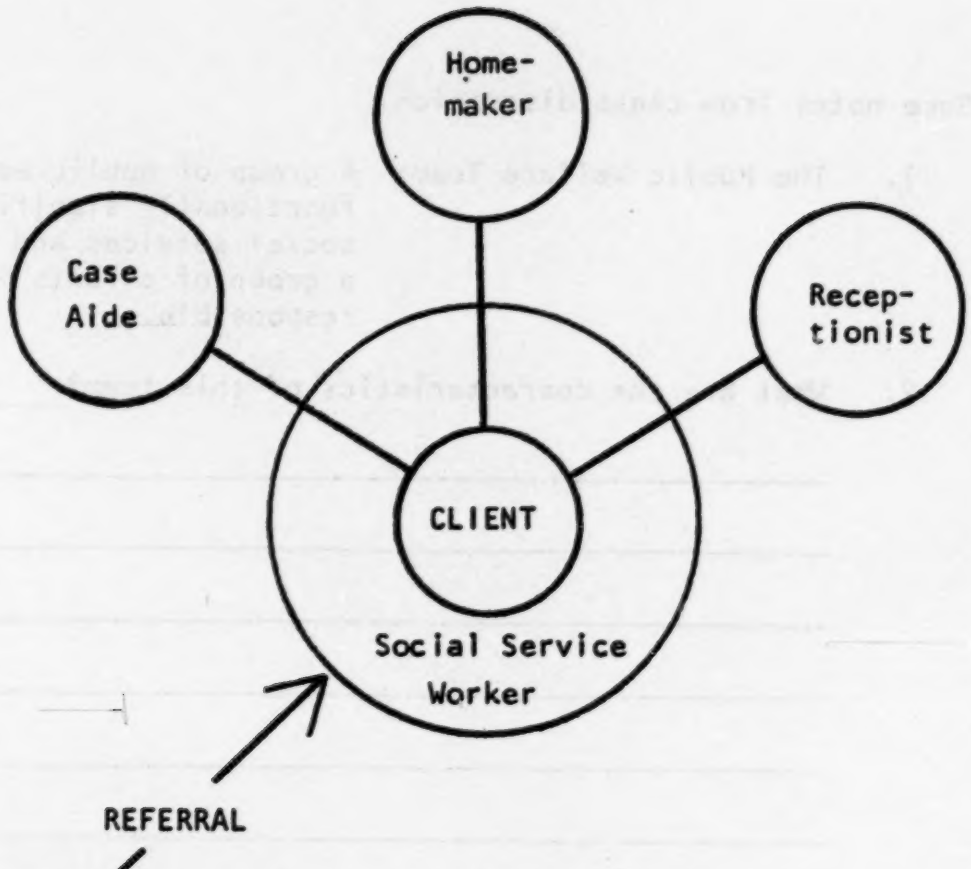

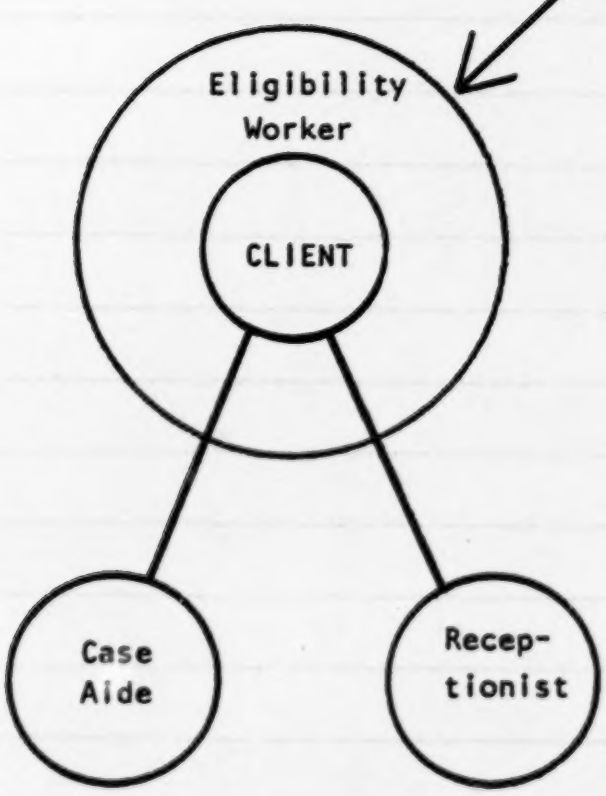

What does this diagram describe?

_____

_____

_____

_____

_____

_____

_____

_____

_____

*(Reprinted with modification from a Workbook for Case Aides, by Sister Anne Paula, Welfare Aide Training Consultant, Staff Development Section, Oregon Public Welfare Division, January 1970.)

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Some notes from class discussion:

1. The Public Welfare Team: A group of public welfare employees who are functionally significant to the provision of social services and financial assistance to a group of clients for which they are jointly responsible.

2. What are the characteristics of this team?_____

3. Who are the members of this team?_____

4. What does a team approach require?_____

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A CASE PRESENTATION AND DISCUSSION Can you answer the following questions from this case presentation?

1. What did I learn about this family that helped me understand their situation?

_____

_____

_____

_____

2. What problems were the family and the agency trying to solve together?

_____

_____

_____

_____

_____

_____

_____

3. Who were the team members involved and what did each member do to help this family?

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

e. _____

_____

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YOUR FOURTH OBSERVATIONAL EXPERIENCE: (Answer the following questions after you have observed the interview.)

1. What did the worker do for, and with the client?_____

_____

_____

_____

_____

2. How is this similar to what a Case Aide will do?_____

_____

_____

_____

_____

3. How does this differ from what a Case Aide would do?_____

_____

_____

_____

_____

4. What might I do as a Case Aide to help this client, that would also help this worker to achieve his goal with the client?

_____

_____

_____

_____

_____

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SOME CONCEPTS USED IN THE HELPING SERVICES

Some things to remember from class discussion:

1. What does confidentiality mean? _____

_____

_____

_____

_____

2. How can I demonstrate respect for a person's worth? _____

_____

_____

_____

_____

3. How can I help a client to fulfill his responsibilities to himself and to the agency? _____

_____

_____

_____

_____

4. How can I help a client to exercise his right of self-determination?

_____

_____

_____

_____

_____

15673

EVALUATION OF TRAINING:

We are interested in knowing how you feel about the orientation course you are now completing. We hope to improve it as we go along. Therefore, would you please answer each of the following questions and help us by being frank in your opinions.

DO NOT PUT YOUR NAME ON THIS FORM.

---

1. Please complete each of the following sentences in relation to how you feel about this orientation course.

   Of all of the areas we have discussed, I found most helpful ...

   The area I found least helpful was ...

   I would recommend changing ...

   I hope you will not change ...

   I believe the trainer should ...

   I hope that the trainer will not ...

   My observational experiences have been ...

2. Considering your past experiences and knowledge, as well as what you have learned during this week of training, list four ways in which you believe you are presently most ready to begin helping clients.

   (1) _____

   _____

   (2) _____

   _____

   (3) _____

   _____

   (4) _____

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VI. COOLING SYSTEMS

MILESTONE: I. RADIATOR, ENGINE, HOSES, AND THERMOSTAT

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove and Replace Radiator, Hoses Thermostat, Flush Radiator and Engine

CONDITIONS:

BEHAVIOR:

14. Remove thermostat and thermostat housing
15. Remove thermostat from housing and perform all checks and tests as outlined in the manual
16. Reverse flush block following all steps as outlined in the manual
17. Replace thermostat and housing
18. Connect radiator hoses
19. Fill cooling system with coolant
20. Perform all tests and checks as outlined in the manual
21. If all tests and checks are satisfactory, remove protective covers from fenders and store in proper place
22. Return all tools and materials to proper location
23. Close hood making sure it is securely latched
24. Return automobile to proper parking area
25. Remove protective covers from front seat of automobile and store in proper place
26. Clean work area

PERFORMANCE CRITERIA:

To be able to satisfactorily flush radiator and engine, and to satisfactorily remove and replace radiator, hoses, and thermostat in 4 hours.

Learning time; 6 hours

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ASSESSMENT OF WHAT YOU HAVE LEARNED

We are also interested in finding out what you have learned in your training sessions. Would you help us to do this by answering the following questions. Again, you need not put your name on this form.

- - - -

		Agree			Disagree
(5)	It is the county department's major responsibility to give as little money as it can to clients.	1	2	3	4
(6)	The use of food stamps or surplus food is one important resource for clients because it is a way of expanding their food budget.	1	2	3	4
(7)	Agency clients are not eligible for medical care, except in cases of emergency.	1	2	3	4
(8)	Social services are provided by the agency in order to help clients overcome personal and family problems.	1	2	3	4
(9)	Public welfare is not concerned about day care for children.	1	2	3	4
(10)	In planning your interview it is important to know what the purpose of your interview is, before you see the client.	1	2	3	4
(11)	It is not always necessary or important for the Case Aide to work closely with other agency staff who are seeing the client.	1	2	3	4
(12)	Confidentiality means that the Case Aide never shares information about her client with other agency staff.	1	2	3	4
(13)	There will frequently be times when a Case Aide must decide what is best for a client and tell him exactly what he is to do.	1	2	3	4
(14)	Not all clients should be given welfare, especially when they do not spend their money wisely.	1	2	3	4
(15)	As a Case Aide, I am responsible for helping a client report any income to his Eligibility Worker.	1	2	3	4
(16)	I do not believe that a Case Aide should ever let a client do something that will hurt him, even if he is adamant about wanting to do it.	1	2	3	4

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D. Client: "I have been doing ironing for my neighbor and earning about $10.00 a month. Please don't tell Mr. Jones, my Eligibility Worker, because he would stop my check.

Response:

1. Did you know that Mr. Jones can allow you to earn some money before subtracting some of it from your check?

2. Perhaps you should tell Mr. Jones. He will know how to figure this so that you will have every advantage possible.

3. I will have to report this to Mr. Jones.

4. I won't tell anyone about this.

When you have answered all of the questions, remove this evaluation from your workbook and give it to your trainer. Thank you for your help with this evaluation.

If you would like to make any additional comments about the training sessions, and what you have learned, please do so on the remainder of this page.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Date:_____ County department: _____

15678

Induction Training Sessions

15679 12618

YOUR SCHEDULE OF INDUCTION TRAINING SESSIONS

1. **Using the Telephone Effectively** Time: _____ Date: _____ Place: _____ _____	2. **Some Things to Help You in Your Work** Time: _____ Date: _____ Place: _____ _____	3. **A Framework For Helping** Time: _____ Date: _____ Place: _____ _____
4. **Helping As A Case Aide** Time: _____ Date: _____ Place: _____ _____	5. **Understanding and Talking With Clients** Time: _____ Date: _____ Place: _____ _____	6. **Community Resources** Time: _____ Date: _____ Place: _____ _____
7. **Helping a Client to Use a Resource** Time: _____ Date: _____ Place: _____ _____	8. **Visiting Community Resources** Time: _____ Date: _____ Place: _____ _____	9. **Poverty: Its Causes and Effects** Time: _____ Date: _____ Place: _____ _____
10. **Some Myths About Public Welfare** Time: _____ Date: _____ Place: _____ _____	11. **Nutrition** Time: _____ Date: _____ Place: _____ _____	12. **Meal Planning and Buying** Time: _____ Date: _____ Place: _____ _____

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YOUR SCHEDULE OF INDUCTION TRAINING SESSIONS (continued)

13. **Household Management** Time: _____ Date: _____ Place: _____ _____	14. **Family Budgeting** Time: _____ Date: _____ Place: _____ _____	15. **Some Principles of Child Care and Child Rearing** Time: _____ Date: _____ Place: _____ _____
16. **An Exercise in Teamwork** Time: _____ Date: _____ Place: _____ _____	17. Rearing Time: _____ Date: _____ Place: _____ _____	18. Time: _____ Date: _____ Place: _____ _____
19. Time: _____ Date: _____ Place: _____ _____	20. Time: _____ Date: _____ Place: _____ _____	21. Time: _____ Date: _____ Place: _____ _____
22. Time: _____ Date: _____ Place: _____ _____	23. Review and Evaluation of Induction Training Time: _____ Date: _____ Place: _____ _____	

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USING THE TELEPHONE EFFECTIVELY:

Answer the following questions about using a telephone:

1. Do you ever pick up the receiver of a ringing telephone, and say "Hello?" Yes: _____ No: _____

2. Ask a caller to wait while you get information; then stay away from the telephone so long that he hangs up? Yes: _____ No: _____

3. Have you ever received a call for someone who isn't in the office and then forgot to tell him about it? Yes: _____ No: _____

4. Have you ever transferred a telephone call to someone else, when you were not sure they could help? Yes: _____ No: _____

5. Do you ever chat with a friend who calls you during working hours as though you were at home? Yes: _____ No: _____

Here are two examples of how two Case Aides handled similar telephone calls. What one do you think does the better job.

Mrs. Smith handled it this way:

"Mr. Jones' desk; Mrs. Smith speaking."
"Mrs. Smith, this is Mr. Johnson."
"How are you, Mr. Johnson? And the wife and children?"
"All in good health - now what I was calling about was my appointment with Mr. Jones' tomorrow at 2:00 p.m."
"Oh yes, Mr. Johnson, i can see from Mr. Jones' schedule that he does have an appointment with you tomorrow. I hope the weather is better tomorrow when you come in."
"Well, what I was calling about, was that I'd like to postpone my appointment until about 3:00 p.m. I have a job appointment earlier in the afternoon and I doubt if I can get to your office any earlier."
"Oh what a shame, Mr. Johnson. I'm sure Mr. Jones will be disappointed, I can have Mr. Jones telephone you later this afternoon to let you know if he can see you at 3:00. Will that be satisfactory, Mr. Johnson."
"Yes, thank you. Goodbye."

Mrs. Brown handled it in this way:

"Mr. Jones' desk, Mrs. Brown speaking."
"This is Mr. Johnson, Mrs. Brown."
"May I help you, Mr. Johnson."
"I'd like to postpone my appointment with Mr. Jones tomorrow from 2:00 to 3:00 p.m. I have a job appointment earlier in the afternoon and I doubt if I can get to your office earlier."
"I'm not sure whether Mr. Jones has that time open on his schedule, but I can have him telephone you later this afternoon and tell you if he can see you at 3:00 p.m. Will that be satisfactory, Mr. Johnson."
"Yes, thank you. Goodbye."

15682

Which person do you think handled this situation better?

Mrs. Smith: _____ Mrs. Brown: _____

Explain why you think so: _____

_____

_____

* * * * * * * * * * * * * * * * * *

Some things to remember from class discussion:

1. What to do when the telephone rings?

_____

_____

_____

_____

_____

_____

_____

2. How to talk on the telephone?

_____

_____

_____

_____

3. When taking telephone calls for someone else?

_____

_____

_____

_____

_____

4. Some do's and dont's.

_____

_____

_____

_____

15683

SOME THINGS TO HELP ME IN MY WORK

Some things to remember from class:

15684

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VI. COOLING SYSTEM

MILESTONE: II. WATER PUMP

PERFORMANCE OBJECTIVE NO: 2 TITLE: Remove and Replace Water Pump

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Water Pumps	1. Automotive Fuel, Lubticating, and Cooling Systems, by Crouse pp. 400 through 401, 434 through 442 Automotive Engines Workbook, by Crouse Job 41	1. Related Information Class
2. "Cooling System"	2. Filmstrip, Kit A - films #7 & #8	2. Resource Materials Center
3. Water Pump	3. Teaching Machine cards 15D, 15E	3. Teaching Machine (Shop)

1564

A FRAMEWORK FOR HELPING

Following is a brief description of a case situation involving a visit of a Case Aide with a client. What would you do in a situation like this?

The Alice Sanchez Case

A Social Service Worker asked me to visit with Mrs. Sanchez. At the time of her last visit to the home, the worker had found Mrs. Sanchez to be very tired, her home was a mess and, yet, she claimed that "everything was fine."

Mrs. Sanchez and her three children, Bob, John and Mary, live in an old house on Vista Road. It is beyond the city limits and therefore has no sidewalk in front of the home. There is no lawn for the children to play on and the yard is used mostly for discarded items no longer of use to the family.

Mrs. Sanchez answered the door and seemed surprised to see me, although I had written her a letter about my planned visit. She wore a houserobe and her hair was still in curlers - she appeared to be sleepy and perhaps had not been up very long.

I told Mrs. Sanchez that her Social Service Worker, Mrs. Jones, had asked me to visit her because she seemed so very tired when she last visited. Mrs. Jones had thought that perhaps I could be of help to her. She invited me into her home and we sat in her living room. Mrs. Sanchez said that everything was really alright, although she had not been able to manage her house very well because the children had all been sick with colds. There didn't seem anything else for us to talk about, so I asked her about Mary, who I could see sleeping in the next room. She told me that Mary did not seem to be getting over her cold. She seems so hot all of the time and has eaten only a very little food in the past two days. Sometimes when she is awake she doesn't seem to know me, Mrs. Sanchez said, beginning to cry as she spoke about Mary's illness.

I said to Mrs. Sanchez...

What would you do next with Mrs. Sanchez? List the various things you might do on this visit, based upon what you know so far.

_____

_____

_____

_____

_____

_____

_____

What else, if anything, would you want to know from Mrs. Sanchez in order to help?

_____

_____

_____

_____

_____

_____

_____

Some Things to Remember From Class:

1. A framework for helping.

_____

_____

_____

_____

_____

_____

_____

_____

_____

2. How can I use a "self-help" concept in my work with clients?

_____

_____

_____

_____

_____

_____

HELPING AS A CASE AIDE

Four different examples of helping:

1. It was very early in the morning when Mary Smith, a Case Aide, arrived at the Allen home. Mrs. Allen had telephoned Mrs. Smith the previous evening, saying that she was without food for her children and was obviously upset, being afraid of sending the children to school the following morning without breakfast. After their telephone conversation, where Mrs. Smith had determined that there was just enough food left for the family dinner, she telephoned several churches in the neighborhood. One minister offered enough food from church supplies to tide Mrs. Allen over for a few days until her welfare check would arrive. Mrs. Smith then arranged to pick up this food early the next morning from the church so that she could bring it to the Allen home in time for the children to eat before going to school.

2. Mrs. Johnson, a Case Aide, has been visiting with Mrs. Dunbar for several weeks in an effort to help her with household management problems. Even before ringing the doorbell this morning, Mrs. Johnson could notice a major change in the home. Someone had put brightly colored, cheerful curtains on the windows which had previously been barren. As Mrs. Dunbar answered the door, Mrs. Johnson enthusiastically commented upon change in appearance of the room with curtains. Mrs. Dunbar was obviously proud that her effort had been noticed, and the two spent the first part of their conversation talking about how much better the room now looks with curtains in the window, and the time it must have taken Mrs. Dunbar to make them.

3. One Case Aide described her work with a father whose neglect of his daughter's personal hygiene and dress had caused her to be ostracized by the other children at school.

> "I told him I expected him to keep her clothing clean, including the underclothing. I told him to make good soapy water and let her put them in and soak them while she is at school. Then I told the little girl she is to wash these panties and slip and hang them where they will get dry by the next morning. This way every day you will have clean underclothing to put on until we can get some more. The father was surprised because she opened up completely to me and answered all my questions. So I went into the bathroom and ran a tub of water, dumped soap flakes into the water, and said you get undressed now and get in the tub while I am talking with your father. I want you to take a bath. I came out and closed the door... you know I'm a stranger and I don't want her to get shy. I talked to the father about overseeing the fact that she did take a bath two or three times a week this same way with soap. He said okay. I shampooed her hair while she was in the tub and showed her how to wash herself. I pressed her hair. I had on a scarf and I tied it around her head so she wouldn't have to worry about combing it the next morning." *

4. Mrs. Benetez had been on public assistance for several years and Mrs. Lucas, her Case Aide, was very surprised to learn that she had not heard of or was seemingly unaware of the Food Stamp Program and its possible benefits to her. No doubt the fact that she spoke Spanish and could neither read or write, has kept Mrs. Benetez from learning about such resources and using them to expand her welfare grant. Because she is usually very shy and hesitant to use resources which are unknown to her, Mrs. Lucas explained the advantages of Food

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Stamps and later took Mrs. Benetez to the food stamp center, helping her apply for and purchase some stamps. Afterwards they went shopping together so that Mrs. Lucas could show her how these stamps are used in place of money, and what items could be purchased with the stamps.

Briefly summarize the ways in which Case Aides offer help to clients in each of these four examples:

1. _____

2. _____

3. _____

4. _____

<u>Some things to remember from class</u>:

What is the Case Aide's ability to help based upon? _____

_____

_____

What kinds of questions should I seek answers for? _____

_____

_____

_____

How does a Case Aide help? _____

_____

_____

_____

_____

Additional information to remember: _____

_____

_____

* Reprinted from "A Firsthand View of New Careerists in Public Welfare" by Dorothea Cudaback

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UNDERSTANDING AND TALKING WITH CLIENTS

Read the following description of how one husband and wife communicate.

"He can be quiet for long stretches of time, obviously and moodily quiet. His wife finds his silences hard to bear. She doesn't know what they will 'lead to.' Every day she asks her husband whether there is anything 'special' he wants to eat - even though they both know there isn't much they can afford but the daily mainstays -- bread, coffee, doughnuts, crackers, some thin stew, potatoes, homemade jam, biscuits. Mrs. McCaslin defers to her husband, though; one way is to pay him the courtesy of asking what he wants. I have often heard them go back and forth about food, and as if for all the world they were far better off, with more choices before them:

'Anything special you want for supper?'

'No. Anything suits me fine. I'm not too hungry.'

'Well, if that's it then I'd better make you hungry with something special.'

'What can do that?'

'I thought I'd fry up the potatoes real good tonight and cut in some onions. It's better than boiling, and I've got some good pork to throw in. You wait and see.'

'I will. It sounds good.'

He hurts and she aches for him. His back has its 'bad spells,' and she claims her own back can 'feel the pain that goes through his.' They don't touch each other very much in a stranger's presence, or even, I gather, before their children, but they give each other long looks of recognition, sympathy, affection, and sometimes anger or worse. They understand each other in that silent, real, lasting way that defies the gross labels that I and my kind call upon. It is hard to convey in words -- theirs or mine -- the subtle, delicate, largely unspoken, and continued sense of each other (that is the best I can do) that they have. In a gesture, a glance, a frown, a smile they talk and agree and disagree.

'I can tell what the day will be like for Hugh when he first gets up. It's all in how he gets out of bed, slow or with a jump to it. You might say we all have our good days and bad ones, but Hugh has a lot of time to give over to his moods, and around here I guess we're emotional, you might say.'"*

*Reprinted from "Life in Appalachia - The Case of Hugh McCaslin," by Robert Coles. Trans-action, Washington University, St. Louis, Mo., Vol. 5, No. 7, June 1968.

15589

Can you list eight different ways in which Mr. and Mrs. McCaslin communicate with each other. In other words, how do they each know what the other one is thinking, feeling or wanting?

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

* * * * * * * * *

Some things to remember from class:

1. How does one interact with his surroundings? _____

_____

_____

2. What kinds of things influence the way in which we communicate with other people?

_____

_____

_____

_____

3. How do we communicate? _____

_____

_____

_____

_____

4. What influences the way a person acts? _____

_____

_____

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5. What do I need to know about myself in order to help people? _____

_____

_____

_____

_____

_____

_____

* * * * * * * * *

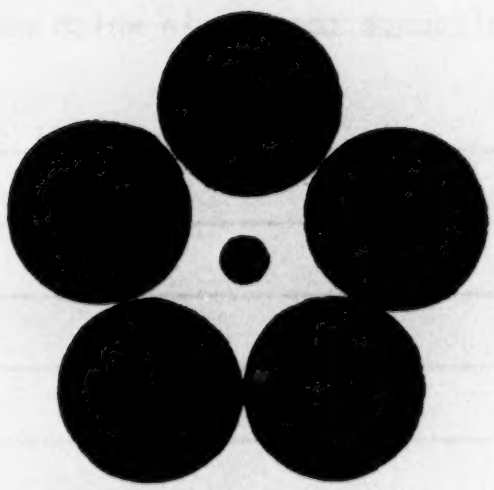

15691

COMMUNITY RESOURCES

What is a community resource?

"Those resources, either formal or informal, which meet the financial, health, employment, political, cultural, social or spiritual needs of the members of the community."

Some examples to look at:

1. The Jones family have a son stationed in Viet Nam, from whom they have not heard for over three months. Letters to him have not been answered and Mrs. Jones has become quite upset, afraid that her son may be missing in action. Check where you might refer them for help.

   _____ To a Social Service Worker.

   _____ To their minister.

   _____ To the local Red Cross office.

   _____ Not enough information upon which to decide.

   Explain why you chose the particular resource: _____

   _____

2. Mrs. Smith has become increasingly concerned about her son, Michael, who does not eat well and has had one cold after another during the past several months. Check where you might refer Mrs. Smith for help with Michael.

   _____ To a Social Service Worker.

   _____ To the county hospital.

   _____ To the county health department office.

   _____ To her Eligibility Worker.

   _____ Not enough information upon which to decide.

   Explain why you have chosen this particular resource: _____

   _____

15692

3. Mrs. Harris had been without electricity for two days, when her service was stopped by the utility company because she had not paid her bill. The Eligibility Worker has said that the agency cannot provide additional funds to pay this bill because Mrs. Harris had already received money for her utilities in her welfare check. Check where you might refer Mrs. Harris.

_____ To her Social Service Worker.

_____ To the minister at her church.

_____ To a loan company.

_____ To the utility company.

_____ Somewhere else. Specify: _____

_____ Not enough information upon which to decide.

Explain why you have chosen this particular resource: _____

_____

4. Mrs. Landau is desperate about finding winter coats for her two older children who are presently without sufficiently warm coats to attend school on cold days. Check where you might refer her.

_____ To her Eligibility Worker.

_____ To the Goodwill or Salvation Army store.

_____ To her local church.

_____ To her relatives or neighbors.

_____ Not enough information upon which to decide.

Explain why you have chosen this particular resource: _____

_____

Some things to remember from class:

_____

_____

_____

_____

_____

_____

A list of the resources discussed in class:

Name of the Resource	Available to Meet What Need	The Kind of Help Given

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VI. COOLING SYSTEM

MILESTONE: II. WATER PUMP

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove and Replace Water Pump

CONDITIONS:

This assignment is to performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Raise hood
6. Place protective covers on fenders
7. Drain engine block and radiator
8. Remove parts and accessories following all steps as outlined in the manual
9. Remove water pump following all steps as outlined in the manual
10. Perform all tests and checks as outlined in the manual
11. Install water pump following all steps as outlined in the manual

PERFORMANCE CRITERIA:

1565

HELPING A CLIENT TO USE A RESOURCE

Read the following brief description of a case situation involving a Case Aide.

The Amy Harris Case:

Amy Harris and her two children, Mary (age 6) and Michael (age 3), have been receiving assistance for the past two years under the Aid to Families of Dependent Children Program. During these two years, she has continued to live in a small rented house on the edge of town. Although never in very good condition, in the past year this home has been plagued with a number of problems, and the landlord has refused to make needed repairs. The steps at the front door are rotting away, the plumbing in the bathroom is frequently out of order, and the cost of heating the home has markedly increased as a result of a broken window (which is covered only with cardboard) and the open spaces around the doors. With the more recent influx of rats, Mrs. Harris has reluctantly decided that she can no longer tolerate these living arrangements and must find more adequate housing for her family.

When Mrs. Harris asked the agency to help her in locating more suitable housing, this case was assigned to a Case Aide. The Case Aide, being familiar with housing resources, is aware that there is very limited low-cost housing available for Mrs. Harris to consider. A government housing project, not far from where she presently lives, would offer the most benefit for Mrs. Harris insofar as space and the conditions of the building are concerned. With this knowledge in mind, the Case Aide has scheduled an appointment to talk with Mrs. Harris about her housing needs and to make a referral to the housing authority office that runs this project.

Based upon the information available to you in this case situation, list the steps you might take in helping Mrs. Harris to the housing authority office.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

Would you want any additional information in order to decide whether this was an appropriate resource? If so, what would you like to know?

_____

_____

_____

_____

15695

Some things to remember from class:

What should I consider in using a resource? _____

_____

_____

_____

When should a resource be made? _____

_____

_____

_____

What steps should be taken in helping a client use a resource? _____

_____

_____

_____

_____

_____

What should a Case Aide do after the client and the resource have been brought together?

_____

_____

_____

_____

_____

_____

_____

_____

_____

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VISITING COMMUNITY RESOURCES

Complete the following form on each community resource you visit.

Name of resource: _____

Address: _____

Telephone: _____

Who is eligible to use this resource? _____

_____

_____

In what ways does this resource help clients? _____

_____

_____

_____

_____

What methods does the resource use to help clients? _____

_____

_____

_____

How should a referral be made to this resource? _____

_____

_____

_____

_____

What other information about the resource that I will want to remember? _____

_____

_____

_____

_____

Name of resource: _____

Address: _____

Telephone: _____

Who is eligible to use this resource? _____

_____

_____

In what ways does this resource help clients? _____

_____

_____

_____

_____

What methods does the resource use to help clients? _____

_____

_____

_____

How should a referral be made to this resource? _____

_____

_____

_____

_____

What other information about the resource that I will want to remember? _____

_____

_____

_____

_____

POVERTY: ITS CAUSES AND EFFECT

Many people talk about poverty, but too often, each of us views poverty in a little different way. Therefore, let's see if you can decide what poverty means to different people by looking at several descriptions.

One mother described her poverty in this way:

> "They say we're lazy and we don't pay much attention to the law, and sure enough I have two boys to prove it and one to disprove it, so it's two to one against us in this family. But I'd like to tell people why I think my two boys went bad.
>
> I preached and hollered at all three the same. Those older boys were good boys just like the little one, and I remember when they wanted to study and be somebody, just like him. But they never had a chance. They were born too soon...
>
> They went to school until it didn't make any sense to stay there, because we had no money and they thought they should try to get jobs. So they left school and tried. They tried and tried and there wasn't anything for them.
>
> I wonder, do people who never have to worry about work know what happens to you when you keep on knocking your head on a stone wall and there's still no work? I'll tell you what, your head bleeds, and you get tired; you get so tired that you give up. Then you have all those hours and whatever you can figure out to do with them...
>
> ...Now, it's all right if you're an older woman like me and you have children; you keep busy with them. But if you're a man, you don't have kids to occupy you. So what can you do? I'll tell you what happens, you just fold up and die....
>
> I watched my boys go bad like milk you know is standing too long; there's no use for it, so it gets sour...*

Another mother writes about the amount of money allowed her family for rent:

> "How can a welfare recipient have safe, healthful housing when the rent allowance is so low that it covers only about one-half of what he is now paying for rent - unless he lives in a housing project, and there, everytime he gets an increase in his budget the rent is raised. He cannot afford to move to a better residence because then he would use the food allowance - he can't afford the amount of rent he is now paying for the high-rent, run-down house or apartment he's in now,

---

*Reprinted from "There's Sinew in the Negro Family." Background paper for White House Conference "To Fulfill These Rights," by Robert Coles. Washington, D.C., November 1965.

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designed for three or four people, which he has to stick three or four children into each bedroom or bed, and if he's lucky, he ends up in the living room - if he is not lucky he sleeps in the bath tub or maybe the family sleeps in shifts... How! How can you rent a three or four bedroom house on a NO-bedroom allowance - $55 per month (monthly rent allowance for most welfare recipients - some even less). This large amount will get you an unfurnished single on the lower east side - NO CHILDREN - but CATS allowed; because the RATS come pretty BIG and the CATS aren't allergic to RAID and BLACK FLAG used to try to kill the roaches. How can a sardine-can be safe and healthful????? For a sardine - you - but he's dead and nothing matters then anyway...*

A writer has said:

"Poverty is many different things - a sick old man on welfare, a drunk beating his wife, cockroaches in the kitchen and the stench of urine in the corridor, a dirt farmer fighting an unwilling soil, an unwanted Negro boy sitting on a stoop, a miner with nothing to do. All of these conditions - and more - are suggested in the statistics on poverty. But numbers are abstractions and people are real. It takes more than numbers to reach the state of knowledge that **e. e. cummings** described so well:

Now the ears of my ears awake and
Now the eyes of my eyes are opened.**

Can you think of five ways in which you might help people like this?

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

*Reprinted from Prelude to Riot: A View of Urban American From the Bottom by Paul Jacobs. Vintage Books, New York, 1966, pp. 67-68.
**Reprinted from Poverty: American Style, edited by Herman P. Miller. Wadsworth Publishing Company, Inc., Belmont, California, 1968, p. 119.

Total
15700

Some things to remember from class:

1. What things influence poverty?

2. What are the characteristics of poverty?

3. What can I do as a case aide to lessen the effects of poverty upon clients?

15701

SOME MYTHS ABOUT PUBLIC WELFARE AND ITS CLIENTS

Have you ever taken time to read the "letters to the editor" column in your local newspaper? The following are several such letters for you to consider.

1. "Sir: The other day I read a letter from a party in San Diego who stated there is no corruption in welfare. I would like to have him explain this: In the town where I live, there is a woman we have complained about several times, and we even circulated a petition signed by at least 15 people. She is on relief and has six dogs that bother the people all night. She just bought two St. Bernards at $150 apiece, on the tax money we pay. Complaints to the sheriff's office and to the animal control have had no effect at all. Welfare is surely misused here. Let him explain that."*

   Do you think that this client should be allowed to keep her dogs?

   YES _____ NO _____

   Explain your answer: _____

   _____

   _____

2. Editor: "I believe the only way that hunger in the United States can be controlled is by handing out food to the poor.

   "People today don't know how to use the money that they get to feed and house themselves with. I know one lady that has three cars and she doesn't work, so I don't know why she needs them. She just bought a $35 dog when she already has two dogs." **

   Do you agree that handing out food would be a better way to combat hunger?

   YES _____ NO _____

   Explain your answer: _____

   _____

   _____

* Reprinted from the Sacramento Bee, February 19, 1970.
** Reprinted from the Sacramento Union, January 28, 1970.

CORBI 15702

3. "Sir: The three point system to curb the population explosion given in one of your letters on January 15 should be put to a vote by the people of California. The third point - compulsory sterilization of mothers on welfare after the second child - should be certainly put in force.

" The strongest point against this action is taking away a freedom of people on welfare, when in actuality they are taking away our freedom to spend our hard-earned wages the way we want, instead of supporting them to a way of life equal to ours, without having to work for it, leaving them their freedom to propagate at will.

"The strongest point for this action would be less people on welfare, eventually, as the children grew older and the mother could work. It would discourage the absentee husband, now the practice of the majority of large family welfare recipients."*

Do you agree or disagree with this person's point of view?

Agree _____ Disagree _____

Explain your answer: _____

_____

_____

4. "Sir: My heart just bleeds for the poor family who got their welfare check in November in time for a nice turkey for Thanksgiving Day, but failed to receive their December check in time for a big Christmas.

"No wonder so many people are on welfare if they spend their check for one big blowout and moan their hard luck when the next check doesn't arrive in time for another big show.

"I don't recall having a turkey for Thanksgiving and Christmas in my childhood, and I don't recall that it was such a sad day. We were thankful to the Good Lord for what we did have. And what we had was earned the hard way. Perhaps that is why we were grateful for what we did have." **

Do you think that many welfare families spend their money for one big "blow-out"?

YES _____ NO _____

Explain your answer: _____

_____

_____

* Reprinted from the Los Angeles Times, January 24, 1970.
** Reprinted from the Sacramento Bee, January 19, 1970.

SUWL 15703

Some things to remember from class:

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VI. COOLING SYSTEM

MILESTONE: II. WATER PUMP

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove and Replace Water Pump

CONDITIONS:

BEHAVIOR:

12. Install parts and accessories following all steps as outlined in the manual
13. Fill cooling system with coolant
14. Perform all checks and tests as outlined in the manual
15. If all checks and tests are satisfactory, remove protective covers from fenders and store in proper place
16. Return all tools and materials to proper place
17. Close hood
18. Return automobile to proper parking area
19. Remove protective covers from front seat and store in proper place
20. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove and replace the water pump in 2 hours.

Learning time: 3 hours

1566

A GUIDE TO GOOD EATING

Use daily . . . .

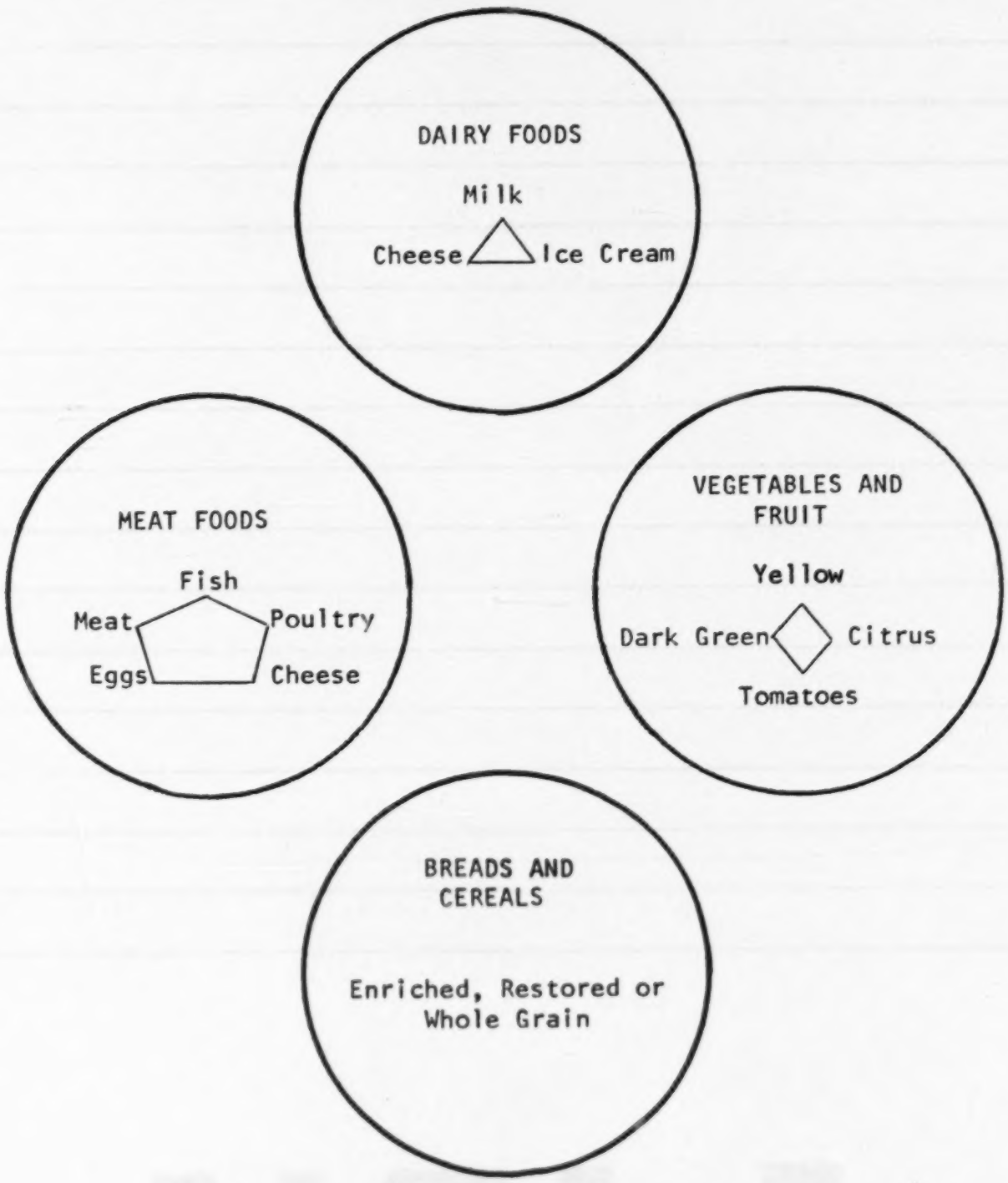

. . . for a balanced diet.

15705

NUTRITION

A Case Example:

Mr. and Mrs. Jones and their two children, John (age 3) and Mary (age 7) have recently been assigned to you for help with their food planning. Mrs. Jones has found it hard to manage on her food allowance and to provide her family with nutritious meals. Using the chart on the previous page as a guide, would you develop a one-week menu which the Jones family might follow. Remember, they will be able to spend only $ a day for food.

	BREAKFAST	LUNCH	DINNER
MONDAY			
TUESDAY			
WEDNESDAY			
THURSDAY			
FRIDAY			

15706

Some things to remember from class

1. Some definitions:

   Food: Any **nourishing** substance that is eaten to sustain life, provide energy, promote growth, etc.

   Nutrition: The study of what people eat in order to sustain life, provide energy, promote growth, etc.

   Diet: Food Considered in terms of its qualities, composition, and its effect upon health.

2. Some factors which influence what and how much a person should eat:

   _____

   _____

   _____

   _____

   _____

   _____

3. Basic food sources:

   a. Fats: _____

   _____

   b. Carbohydrates: _____

   _____

   c. Proteins: _____

   _____

   d. Minerals: _____

   _____

   e. Vitamins: _____

   _____

-56 15707

MEAL PLANNING AND BUYING

An exercise in shopping:

The following are a number of items found on one client's shopping list and are similar to many items which people on a limited income would frequently be buying. In order to get the most for your money, shopping in various stores can sometimes result in marked savings so that some of the client's income is used to meet other needs. Using this client's list, would you go to three stores and write down the price of each item. Enter the size of the item at the first store so that a similar size is priced at each store, although you may select a different brand, if the item is cheaper in any one of the stores.

Select the following kinds of food stores to collect your prices:

1. A small, neighborhood grocery store, preferably in an area where clients live.

2. A large chain grocery store.

3. A food discount store, if one is available in your area.

Ask your trainer for help in selecting the specific stores you will visit, if you are not sure which ones to choose.

LOOK FOR THE BEST BUYS IN FOOD

ITEM	SIZE	SMALL STORE $	CHAIN STORE $	DISCOUNT STORE $
1 Chicken				
2 lbs Ground Beef				
2 lbs Carrots				
1 lb Spinach				
5 lbs Potatoes				
3 pkge Bread				
1 pkge Spaghetti				
1 pkge Rice				
1 pkge Powdered Milk				
1 box Dry Cereal				
5 lbs Sugar				
1 jar Peanut Butter				
1 can Tomatoes				
1 can Corn				
2 qts Milk				
1 box Washing Soap				
1 jar Ammonia				
4 roles Toilet Paper				
1 box Oat Meal				
TOTAL COST				

15708

Some things to remember from class:

1. One way of meal planning and buying.

2. Some other ideas which the case aides have found useful.

HOUSEHOLD MANAGEMENT

Taking care of a home - cleaning, shopping, planning and preparing meals, washing and ironing - can be a most difficult job for any person. Most people have learned some ways of making this job a little easier, although they may not often stop to think about them. The following are several examples of ways in which individual persons have found to make their work easier.

One woman reported that:

> "I have found that if I plan my washing several times a week, rather than once a week, I don't seem to get so far behind in my ironing, and the children are more likely to have something clean to wear when they need it."

A second woman reported that:

> "I have found that if I add a little apple to the children's oatmeal when I cook it, they are much more likely to finish their breakfast."

A third woman said:

> "One way to avoid scrubbing bathtub rings, she learned, is to put a small amount of liquid detergent in the children's bath water - and the children like the bubbles."

These ideas may or may not be of use to other persons but each represents one person's way of making her job just a little easier.

Give some thought to the things that you have learned to do. See if you can list five ideas below, which might also be of help to a client.

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

IrvA6710

Some things to remember from class:

What should be considered in planning your schedule? _____

_____

_____

_____

Some ideas in organizing your home in a more useful way: _____

_____

_____

_____

_____

_____

Some helpful hints that can help make housekeeping easier: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

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FAMILY BUDGETING

A definition of budgeting: An itemized plan of how a family will spend its income.

Family budgeting is a difficult task for most persons, but the more limited a person's income is, the more complicated becomes the task. Each of us budgets our expenses, even when we do not take the time to do so carefully. The decision whether we should buy a magazine to read, some special treat for the children, or an item of clothing, must be weighed in terms of its possible later consequence - what might we then have to do without.

Some examples of poor buying:

1. "I saw a TV ad for a $29 sewing machine, so I wrote to the company and they sent down a salesman who demonstrated it for me. It shook the whole house, but I wanted to buy it anyway. But he kept saying it would disturb all the neighbors by being so noisy, and went out into the hall and brought in another model costing $185....

   "I actually had to pay $220. He promised if I paid within a certain amount of time I would get $35 back. But since my husband was out of work, we couldn't pay within the time period, so I didn't get the refund... I was taken in by the high-pressure sales talk."*

2. "In March ..., a peddler knocked at my door and insisted so much that I said I'd take a lamp for $29. I gave him a $3 deposit. When he came back with the account book the next week, the price had gone up to $42. I said I wouldn't pay it. So he took away the lamp, but he never gave me back the $3."

3. "We've spent more money repairing the TV than it cost. The store sent a different one than we asked for and it didn't look new. We complained to the store and they offered a trade for $25 on another one."*

If you were asked to help any one of these three families in budgeting, so that they could better know how much of their money they could spend on items, what would you suggest they do?

_____

_____

_____

* Reprinted from "How the Poor Are Bilked" by David Caplouitz. Poverty American Style, ed. Herman P. Miller, Wadsworth Publishing Company, Inc., Belmont, California, February 1968, pages 144-145.

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Some things to remember from class:

What is one approach to budgeting: _____

What other approaches have participants used and found helpful? _____

PRINCIPLES OF CHILD CARE AND CHILD REARING

Some thing to think about:

1. Mary has only one arm. She is 18 months old. She wants to feed herself but cannot hold the dish still.

   Mrs. B. says she should have a dish that has a suction cup on it that will not move. Then she can learn to feed herself.

   Mrs. R. says that because she has only one arm, she should be fed by another person until she is older.*

   Who is right? _____

   Why? _____

   _____

   _____

2. John is six years old. He has just started school. He is doing very well at school. Each day his mother checks with the teacher. She asks if John did well. If he did, she buys him something at the store.*

   Is this a good idea? _____

   Why or why not? _____

   _____

   _____

3. Alice is three years old and a very active youngster. In order to keep her from getting dirty, Mrs. H. keeps her in her crib most of the day, until she can finish her housework and spend time with her.

   Do you think this is a good idea? _____

   Why or why not? _____

   _____

   _____

4. Michael is sixteen years old. His mother, Mrs. L., makes him come home immediately after school each day and rarely allows him to attend school activities in the evening. Mrs. L. has seen so many other boys get into trouble in the neighborhood and she is determined to avoid her son turning "out bad."

   Do you think that Mrs. L is right? _____

---

* Reprinted from a Workbook for Welfare Aides by Sister Anne Paula. Oregon Public Welfare Division, Staff Development Section, January 1970.

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: I. BRAKE SHOES AND WHEEL CYLINDER

PERFORMANCE OBJECTIVE NO: 1 TITLE: Remove and Replace Brake Shoes, and Overhaul Wheel Cylinder

CONDITIONS:

LEARN	REFERENCE	SOURCE
6. "Hydraulic Brakes"	6. Filmstrip	6. Resource Materials Center
7. "Power Brakes"	7. Filmstrip	7. Resource Materials Center
8. Brakes	8. Teaching Machine cards 16A, 16B, 16C	8. Teaching Machine (Shop)

Why? _____

_____

_____

5. Linda grew up in a home with little love. She is now eight years old and is in a foster home. She has a six-year-old foster sister named Mary. When Linda does not get what she wants, she hits Mary. The foster parents do not punish Linda. They talk with her. They try to be very patient and loving. They try to help Mary understand and give her extra attention too.*

   Is this a good way to help Linda? _____

   Why or why not? _____

   _____

   _____

* * * * * * * * * * *

Some things to remember from class:

What are some common principles used in the helping services? _____

_____

_____

_____

_____

What are some of the major developmental characteristics of children? _____

_____

_____

_____

_____

_____

What needs do these characteristics express? _____

_____

_____

_____

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EVALUATION OF TRAINING

We are interested in knowing how you feel about this induction training course you are now completing. We hope to improve it as we go along. Therefore, would you please answer each of the following questions and help us by being frank in your opinions.

DO NOT PUT YOUR NAME ON THIS FORM.

- -

1. Please complete each of the following sentences in relation to how you feel about this orientation course.

   Of all of the areas we discussed, I found most helpful ...

   The area I found least helpful was ...

   I would recommend changing ...

   I hope you will not change ...

   I believe the trainer should ...

   I hope the trainer will not ...

   I believe that future Case Aides attending this course would most like ...

   The opportunity to use the content of sessions in my job assignment was ...

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ASSESSMENT OF WHAT YOU HAVE LEARNED

We are also interested in finding out what you have learned in your training sessions. Would help us to do this by answering the following questions. Again, you need not put your name on this form.

- -

1. We would like to know whether you agree or disagree with the following statements. Circle number 1, 2, 3, or 4 following each statement.

   For each statement:

   1 means you totally agree
   2 means you kind of agree
   3 means you kind of disagree
   4 means you totally disagree

	Agree - - - - - - -			Disagree
a. A major problem faced by many poor people is their feeling of hopelessness.	1	2	3	4
b. There is little anyone can do to eliminate poverty.	1	2	3	4
c. A major step in helping a client involves convincing the client to see things the way you do.	1	2	3	4
d. In making a referral, one should first be sure that the client is ready to use the resource	1	2	3	4
e. "Self-help" means telling the client what to do but not doing it for him.	1	2	3	4
f. Pointing out alternatives is one way of helping a client to find new solutions to his problems.	1	2	3	4
g. Clients are sometimes referred to other agencies in order to reduce the workload of public welfare.	1	2	3	4'

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	Agree			Disagree
h. The easiest and most helpful way of making a referral is just to tell the client about the resource and where he should go to get help.	1	2	3	4
i. Once a referral has been made, the Case Aide's job is done.	1	2	3	4
j. The only important thing to consider in food planning is how hungry a person is.	1	2	3	4
k. Children should have milk and fruits to eat, but adults do not need these.	1	2	3	4
l. Food buying is best done in a careful and planned manner.	1	2	3	4
m. It is usually cheaper to buy in larger quantities.	1	2	3	4
n. Grade A items are better for a person to eat than are grades B or C.	1	2	3	4
o. Teaching a client usually means showing him how to use something and not just telling him about it.	1	2	3	4
p. Giving information and teaching are the two major ways in which a Case Aide can help clients.	1	2	3	4
q. Clients should be discouraged from having any fun if it means they must spend some of their welfare check to do so.	1	2	3	4
r. One should not compliment people who accomplish something because then they will not want to try to overcome other problems.	1	2	3	4

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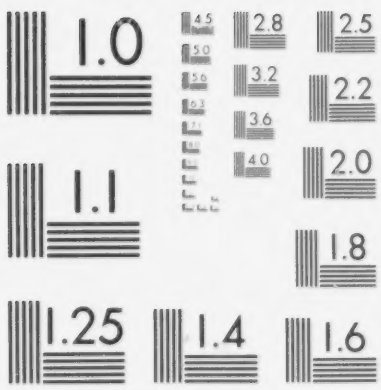

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

2. Read each of the following brief descriptions of a client situation and answer the questions that are asked about each statement.

a. You have been asked to explore the interest of several clients in forming a group to seek solution of transportation problems which they have in common. Mrs. R. says that, as group leader, you should decide ahead of time how this problem is to be solved and tell the group members at their first meeting what each person is to do.

Do you agree with Mrs. R? _____

Why or why not? _____

_____

_____

_____

b. Mrs. Smith has undertaken a program of training which means she must plan for her youngest child's care while she is attending class. Mrs. Smith leaves her youngest child, Mary (age 2), with whoever in the neighborhood is willing to care for her during the time that she is gone.

Do you think this is a good idea? _____

Why or why not? _____

_____

_____

_____

c. Mrs. Brown is an 80-year-old woman who lives alone. A Case Aide, Mrs. Adams, visits her from time to time to be sure that she has been able to purchase needed groceries with her welfare check. Mrs. Adams has found that Mrs. Brown likes flowers. She occasionally brings her a flower out of her own yard.

Do you think this is a good idea? _____

Why or why not? _____

_____

d. Mrs. Allen buys the food she needs each day for her family. In this way, she does not have to worry about how and where it will be stored.

Do you think this is a good idea? _____

Why or why not? _____

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_____

_____

_____

e. Mrs. Kennedy has two children, Sean (age 2) and Mary (age 5). Living on a welfare check creates many problems in planning her food expenditures. Would you make a one-day menu, using low-cost foods, that Mrs. Kennedy might use?

Breakfast	Lunch	Dinner

3. Now that you have had experience in working with clients, and in performing a number of different kinds of jobs, would you list those areas in which you believe further training could help you to do a better job.

(1) _____

(2) _____

(3) _____

(4) _____

(5) _____

When you have answered all of the questions, remove this evaluation from your workbook and give it to your trainer. Thank you for your help with this evaluation.

If you would like to make any additional comments about the training sessions, please do so on the remainder of this page.

_____

_____

_____

_____

_____

_____

Date: _____ County department: _____

15720

VT 012 920
A Training Course on the Supervision of Case Aides.

California State Human Relations Agency, Sacramento. Dept. of Social Welfare.
MF AVAILABLE IN VT-ERIC SET.
Training Aid No.39A
PUB DATE - Aug70 40p.

DESCRIPTORS - *TEACHING GUIDES; VOCATIONAL EDUCATION; *SUPERVISORY TRAINING; *CASEWORKERS; *SUBPROFESSIONALS; *SOCIAL SERVICES; WELFARE SERVICES; SUPERVISOR ACTIVITIES; PROBLEM SOLVING; STUDENT CHARACTERISTICS; JOB TRAINING

ABSTRACT - This teaching guide was prepared by the Training Bureau of the Human Relations Agency, California State Department of Social Welfare and contains six 2-hour sessions designed to prepare line supervisors to assume responsibility for new case aides. Sessions are: (1) Introduction, (2) Role of the Case Aide in Providing Services to Clients, (3) "Style" of the Case Aide and His Ways of Learning, (4) Seeking Solutions to Problems, (5) Planning for the Case Aide's Arrival and His Ongoing Supervision, and (6) Organizing and Managing the Delivery of Services. Brief descriptions, learning objectives, and a content outline accompanied by references, comments, and suggestions are provided for each session. An introductory section describes the purpose, content, organization, training model, and ways to use the guide. Related documents are available as VT 012 916 and VT 012 917 also in this issue. (SB)

VT 012 920

ED0 56238

TRAINING AID

Number 39A

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EDUCATION & WELFARE
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A TRAINING COURSE ON THE SUPERVISION OF CASE AIDES

VT012920

August 1970

STATE OF CALIFORNIA
HUMAN RELATIONS AGENCY
DEPARTMENT OF SOCIAL WELFARE
Robert Martin – Director

TRAINING BUREAU
B. R. Becker – Chief

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TRAINING AID

Number 39A

A TRAINING COURSE ON

THE SUPERVISION OF CASE AIDES

August 1970

STATE OF CALIFORNIA
HUMAN RELATIONS AGENCY
DEPARTMENT OF SOCIAL WELFARE
Robert Martin – Director

TRAINING BUREAU
B. R. Becker – Chief

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: I. BRAKE SHOES AND WHEEL CYLINDER

PERFORMANCE OBJECTIVE NO: 1 TITLE: Remove and Replace Brake Shoes, and Overhaul Wheel Cylinder

CONDITIONS:

Students will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Fundamentals and Servicing of Brake System	1. Automotive Chassis and Body, by Crouse. pp. 387 through 434, 436 through 509 Automotive Chassis Workbook, by Crouse. Jobs 20 through 25	1. Related Information Class
2. "Replacing Bendix Brake Shoes"	2. Continuous film loop # 8353	2. Resuorce Materials Center
3. "Reburling Brake Wheel Cylinder"	3. Continuous film loop # 8354	3. Resource Materials Center
4. "Bleeding Hydraulic Brakes"	4. Continuous film loop $ 8373	4. Resource Materials Center
5. "Brake Operating Linkage"	5. Filmstrip	5. Resource Materials Center

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TRAINING AID
Number 39A

A Training Course On

The Supervision of Case Aides

August 1970

State of California
Human Relations Agency
Department of Social Welfare

Robert Martin - Director

Training Bureau

B. R. Becker - Chief

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PREFACE AND ACKNOWLEDGEMENT

Jerome S. Bruner has said: "Knowledge is like a rope, each strand
inches along its length, all being intertwined to give a solidity
public welfare is to carry greater responsibility for the successf
his line supervisor. For it is to be the major task of this ag
the various strands which are to comprise, ultimately, the knowled
composed of life experiences, education, agency training and super
visor faces is one of determining how these specific strands of kn
way as to result in a case aide whose unique expertise will still
to look back at how life really is in the low-income community, an
life experiences in working with clients.

In many ways this same challenge has influenced my developing this
Training Aid 39B, as I have attempted to build upon the orientatio
ly released by the Training Bureau, defining the supervisor's assi
interrelated role within the total program of training to be provi
degree to which the case aide can be provided an opportunity to ap
and supervisory on-the-job training, to his actual work with clien
which the agency may ultimately be able to enrich its social servi
the use of different classification levels of staff to provide a b

While it is important to acknowledge the most valuable help and co
the development of this training aid series, and particularly my c
ing aid on "The Supervision of Case Aides" ought to trigger many r
aid in teaching as well as those who will be participating in this
have so much to learn about the use of case aides, their training
their many contributions towards an enriched and more effective pr
sincerely hope that these materials will stimulate our further dev
aides, based on the knowledge we are currently and will continue a
should realistically be viewed as an overture - for the various ro
county department staff in their ongoing work with clients.

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PREFACE AND ACKNOWLEDGEMENTS

said: "Knowledge is like a rope, each strand of which extends no more than a few
th, all being intertwined to give a solidity to the whole." Probably no one person in
carry greater responsibility for the successful and meaningful use of case aides than
For it is to be the major task of this agency person to help guide the weaving of
hich are to comprise, ultimately, the knowledgeable and skillful case aide- strands
riences, education, agency training and supervision. The challenge which the super-
determining how these specific strands of knowledge can be woven together in such a
case aide whose unique expertise will still allow him the opportunity and ability
ife really is in the low-income community, and to draw upon his special knowledge and
orking with clients.

e challenge has influenced my developing this training aid, and its companion volume,
I have attempted to build upon the orientation and induction training course previous-
aining Bureau, defining the supervisor's assignment as involving a continuous
hin the total program of training to be provided for case aides. Certainly, the
ase aide can be provided an opportunity to apply what he will learn in group sessions
e-job training, to his actual work with clients, will represent the same degree to
ultimately be able to enrich its social services to clients - our primary goal in
classification levels of staff to provide a broader range of social services to clients.

to acknowledge the most valuable help and contributions made by many agency persons to
is training aid series, and particularly my colleagues in the Training Bureau, a train-
vision of Case Aides" ought to trigger many responses from those who will now use this
ll as those who will be participating in this training. Because we in Public Welfare
about the use of case aides, their training and supervision and, most importantly,
ons towards an enriched and more effective program of social services to clients, I
hese materials will stimulate our further development of skill needed in using case
nowledge we are currently and will continue acquiring. Perhaps these training materials
be viewed as an overture - for the various roles of the play are now to be written by
ff in their ongoing work with clients.

Wilbur Finch

Wilbur Finch, Training Consultant

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An Outline of Supervisory Training Sessions . . . . . .

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Session 2 - The Role of the Case Aide in Providing Services

Session 3 - The "Style" of the Case Aide and His Ways of Lea

Session 4 - Seeking Solutions to Problems. . . . . .

Session 5 - Planning for the Case Aide's Arrival and His Ong

Session 6 - Organizing and Managing the Delivery of Service

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INTRODUCTION

The introduction of case aides as employees in public welfare who will, in conjun
tion levels of staff, be performing either financial assistance or social service
have profound impact upon the ways in which these various client contacts are to
For this reason, the line supervisor is to play a key role in achieving the agenc
meaningful place for the case aide, within a larger team of agency staff persons,
work in concert with the client in achieving a common goal. Primarily because of
teaching, which is to be the cornerstone in the agency's attempt to build and imp
different classification levels of staff in the provision of social services and
clients, the line supervisor must now be asked to assume an expanded teaching res

This training aid is the second in a series of training aids, developed in respons
new personnel classification, the case aide. It is intended for use by county pu
their training of line supervisors who are to be assigned responsibility for the
of these new staff members. As such, it will need to be viewed in the context of
related to the previous aids which have been developed and focus specifically on
training of case aides themselves.

THE PURPOSE OF THE TRAINING AID

The purpose of this training aid is to provide, in outline form, the content nece
line supervisors who are to be assigned responsibility for the supervision of cas
for teaching this content; and to offer references where additional information
county department will want to add additional content relating to the planned use
new staff members within its own program of services and financial assistance to
the specific responsibilities which are to be assigned to and carried by various
otherwise preparing these new case aides to assume their role as an agency emplo

THE TRAINING MODEL USED

The experiences of county welfare departments in planning and preparing for the
providing services to clients, (or in performing financial assistance functions)
need to prepare more than just the new case aide to assume his job assignment.
and understand the different ways in which these new staff members will work wit
consideration must be given to the broader impact which the case aide's presence
which other classification levels of staff will work with clients as well. Simi
Worker, the Eligibility Worker, and any other classification levels of staff who
the case aide, will need to participate in planning training which will provide
of the role and functions which the case aide will perform with clients, and the
their own responsibilities with the client.

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case aides as employees in public welfare who will, in conjunction with other classifica-
f, be performing either financial assistance or social service functions with clients, will
t upon the ways in which these various client contacts are to be organized and managed.
e line supervisor is to play a key role in achieving the agency's goal to define a
r the case aide, within a larger team of agency staff persons, who are to be assigned to
h the client in achieving a common goal. Primarily because of the importance of supervisory
to be the cornerstone in the agency's attempt to build and implement its planned use of
ation levels of staff in the provision of social services and financial assistance to
upervisor must now be asked to assume an expanded teaching responsibility.

s the second in a series of training aids, developed in response to the creation of this
ification, the case aide. It is intended for use by county public welfare departments in
ine supervisors who are to be assigned responsibility for the supervision of one or more
members. As such, it will need to be viewed in the context of its larger purpose and
ious aids which have been developed and focus specifically on the orientation and induction
des themselves.

TRAINING AID

training aid is to provide, in outline form, the content necessary for the preparation of
o are to be assigned responsibility for the supervision of case aides; to suggest methods
ontent; and to offer references where additional information can be secured. To this, the
ill want to add additional content relating to the planned use which is to be made of these
ithin its own program of services and financial assistance to clients; as well as identify
sibilities which are to be assigned to and carried by various staff members in teaching and
these new case aides to assume their role as an agency employee.

USED

county welfare departments in planning and preparing for the addition of case aides in
to clients, (or in performing financial assistance functions), has clearly demonstrated the
e than just the new case aide to assume his job assignment. The line supervisor must know
different ways in which these new staff members will work with clients; and careful
be given to the broader impact which the case aide's presence will have upon the ways in
ication levels of staff will work with clients as well. Similarly, the Social Service
lity Worker, and any other classification levels of staff who will be working directly with
need to participate in planning training which will provide them with needed understanding
ctions which the case aide will perform with clients, and the relatedness of these tasks to
ilities with the client.

The model proposed in this training aid provides for six trai
hours of training. Such sessions can be scheduled in a conti
over a period of time (for example, two-hour sessions each we
of these training sessions is to prepare line supervisors for
aides by providing them with knowledge of why case aides are c
and to assist them in anticipating needs and thus, preparing
which is more likely to meet their more unique learning needs
These training sessions should also provide the line supervis
understand the role which the new case aide is to play in pro
services to clients; and the possible impact of his presence
by other classifications of staff with whom he will be workin

THE CONTENT AND ORGANIZATION OF THE TRAINING AID

This training aid consists of two major parts, in addition to
a series of six training sessions, organized in three columns
of possible use to the trainer in his preparation for conduct
contains content, listing the main points to be covered in ea
Suggestions" offers information about the content and suggest

Part B is a separate narrative document for the trainer's use
with a readily available reference to and summary of some of
relative to the supervision and training of case aides, and t

The trainer should also refer to and make use of Training Aid
Career for Case Aides. Of particular help may be the "Annota
Publications on the Training, Employment, and Use of Preprofe
located in the Appendix of this training aid.

SUGGESTIONS FOR USE OF THE TRAINING AID

The training of line supervisors, in some county departments,
members, and demands upon staff time may be eased through use
outlines the con ent to be taught and emphasizes the most imp
However, in planning for the use of this content, within any
should supplement, broaden and expand this basic outline, mak
assure that training is relevant to the learning needs of ind

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oposed in this training aid provides for six training sessions, comprising a total of twelve ining. Such sessions can be scheduled in a continuous block of time or can be scheduled d of time (for example, two-hour sessions each week for a period of six weeks). The purpose ining sessions is to prepare line supervisors for assumption of responsibility for new case viding them with knowledge of why case aides are currently being employed in public welfare; t them in anticipating needs and thus, preparing a plan of training for these new staff members e likely to meet their more unique learning needs and utilize their individual learning patterns. ng sessions should also provide the line supervisor with a broader perspective within which to he role which the new case aide is to play in providing either financial assistance or social clients; and the possible impact of his presence upon the tasks performed and functions fulfilled ssifications of staff with whom he will be working.

AND ORGANIZATION OF THE TRAINING AID

g aid consists of two major parts, in addition to the Introduction. Part A contains lesson plans for six training sessions, organized in three columns. The "Reference" column lists books and articles use to the trainer in his preparation for conducting each training session. The center column tent, listing the main points to be covered in each session. The column headed "Comments, offers information about the content and suggests teaching methods for its presentation.

separate narrative document for the trainer's use. Its primary purpose is to provide the trainer ly available reference to and summary of some of the principles contained in the literature, the supervision and training of case aides, and their application in this public welfare system.

should also refer to and make use of Training Aid 38A, An Orientation and Induction Training ase Aides. Of particular help may be the "Annotated Bibliography of Selected Articles and on the Training, Employment, and Use of Preprofessionals in the Human Services," which is he Appendix of this training aid.

FOR USE OF THE TRAINING AID

of line supervisors, in some county departments, may be the responsibility of several staff demands upon staff time may be eased through use of this training aid. Each lesson plan briefly con ent to be taught and emphasizes the most important points to be covered by the instructor. planning for the use of this content, within any individual county department, the instructor ement, broaden and expand this basic outline, making those modifications in content to training is relevant to the learning needs of individual supervisors participating, and that it

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relates directly to the more individual and unique uses of case aides which is
programs of financial assistance and social services. Although greater emphasi
use of the case aide in providing social services to clients, in outlining this
easily be adapted and related to assignments of aides within the income mainten
of additional examples and illustrations.

It is not important that all of the points outlined in a specific training sess
important is that the major concepts and principles be introduced and, in the p
participants be provided an opportunity to relate these in a usable manner to t
supervising and teaching aides. The use of short "mini" type lectures, in comb
discussion, will probably prove the more efficient method to use in covering th
gested, within a period of 12 hours. Also, although it has not been stressed i
county departments should, where they have not already done so, provide spec
visors relating to the content which new case aides will be provided in their c
training, identifying the specific responsibilities which the supervisor will c
aide to use, in his work with clients, the content he will be provided in this

Training Aid 38A, An Orientation and Induction Course for Case Aides and Trai
Case Aides in Orientation and Induction Training, are both recommended as refer
participating in this training course. Therefore, a copy of these training aid
each participant for ready reference in this training course as well as for his
Although the supervisors may not be totally responsible for the orientation and
case aides, except in relation to his on-the-job supervision, much of this co
and continued teaching through his ongoing supervision of the aide.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: I. BRAKE SHOES AND WHEEL CYLINDER

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove and Replace Brake Shoes and Overhaul Wheel Cylinder

CONDITIONS:

This assignment is to be performed on all wheels, front and rear, on a complete automobile. Institutional regulations prohibit road tests.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Position lift arms under automobile frame and raise automobile to a comfortable working height
6. Remove wheels, front and rear, following all steps as outlined in the manual
7. Remove brake drums following all steps as outlined in the manual
8. Remove brake shoes following all steps as outlined in the manual
9. Disassemble wheel cylinders following all steps as outlined in the manual
10. Make all checks, tests, and inspections as outlined in the manual

PERFORMANCE CRITERIA:

individual and unique uses of case aides which is planned within the department's ance and social services. Although greater emphasis has been placed upon the iding social services to clients, in outlining this material, this content can d to assignments of aides within the income maintenance system, through the use llustrations.

of the points outlined in a specific training session be covered. What is concepts and principles be introduced and, in the process of training, that opportunity to relate these in a usable manner to their anticipated task of es. The use of short "mini" type lectures, in combination with more extensive ove the more efficient method to use in covering the amount of content sug- 2 hours. Also, although it has not been stressed in the content of these sessions, where they have not already done so, provide specific information to super- nt which new case aides will be provided in their orientation and induction ecific responsibilities which the supervisor will carry in helping the case h clients, the content he will be provided in this training.

ation and Induction Course for Case Aides and Training Aid 38B, A Workbook For d Induction Training, are both recommended as reference material for supervisors ing course. Therefore, a copy of these training aids should be available to reference in this training course as well as for his later use in supervision. not be totally responsible for the orientation and induction training of new ion to his on-the-job supervision, much of this content will need reinforcement gh his ongoing supervision of the aide.

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Lesson Plans for A Training Course on

THE SUPERVISION OF CASE AIDES

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LEARNING OBJECTIVES

By the time the line supervisor completes this training course, he wi

1. To identify the major reasons for the addition of case aide and the possible implications that this will have for the a clients.

2. To differentiate between the various ways in which a case a methods more commonly used by the social service worker in

3. To identify the various patterns of learning, which are mor how to use these in planning his teaching.

4. To anticipate some of the problems which may result from th determine ways in which such problems might more effectivel

5. To identify and take necessary steps in planning for the c supervision.

6. To identify and determine ways of helping the case aide to

AN OUTLINE OF SUPERVISORY TRAINING SESSIONS

Session 1 - AN INTRODUCTION TO THE TRAINING COURSE AND DISCUSSION OF EMPLOYED IN PUBLIC WELFARE - TWO HOURS

This introductory session is designed as a way of revie training course, and the content to be covered. In add reasons which have motivated the agency to add case aid terms of the possible implications which the presence o program of services to clients.

Session 2 - THE ROLE OF THE CASE AIDE IN PROVIDING SERVICES TO CLIE

Beginning with the role which has been defined for case field, participants will weigh and consider the more ch

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ine supervisor completes this training course, he will be able:

tify the major reasons for the addition of case aides as staff members in public welfare, possible implications that this will have for the agency's program of services to .

erentiate between the various ways in which a case aide will work with clients, from those more commonly used by the social service worker in helping clients.

tify the various patterns of learning, which are more characteristic of case aides, and use these in planning his teaching.

cipate some of the problems which may result from the addition of case aides, and ne ways in which such problems might more effectively be managed.

tify and take necessary steps in planning for the case aide's arrival, and for his ongoing sion.

tify and determine ways of helping the case aide to participate as a team member.

ERVISORY TRAINING SESSIONS

NTRODUCTION TO THE TRAINING COURSE AND DISCUSSION OF THE REASONS WHY CASE AIDES ARE TO BE OYED IN PUBLIC WELFARE - TWO HOURS

introductory session is designed as a way of reviewing the purposes and objectives of the ning course, and the content to be covered. In addition, background information on the sons which have motivated the agency to add case aides will be presented and discussed in s of the possible implications which the presence of these aides will have upon the agency's ram of services to clients.

ROLE OF THE CASE AIDE IN PROVIDING SERVICES TO CLIENTS - TWO HOURS

nning with the role which has been defined for case aides within the larger human services d, participants will weigh and consider the more characteristic ways in which case aides will

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work with clients, comparing these with the ways in whi
clients. Stressed will be the importance of the superv
"natural ways of helping," rather than his learning a n

Session 3 - THE "STYLE" OF THE CASE AIDE AND HIS WAYS OF LEARNING -

This session will focus upon the ways of learning which
and the implication that this will have for supervisory
be reviewed and guidelines for supervisory teaching pre

Session 4 - FINDING SOLUTIONS TO PROBLEMS - TWO HOURS

The focus of this session will be upon the anticipation
from the case aide's presence, and discussion of possib

Session 5 - PLANNING FOR THE CASE AIDE'S ARRIVAL AND FOR HIS ONGOIN

This session will involve a review of the supervisory m
arrival, in determining his learning needs, and in plan
emphasis will be upon adapting these methods to meet th

Session 6 - ORGANIZING AND MANAGING THE UTILIZATION OF CASE AIDES I

This session will consider some of the possible implica
other social service (or financial assistance) staff, a
and managing their contacts with clients. Also conside
case aides will work with clients. A review and evalua
planned.

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th clients, comparing these with the ways in which the social service worker works with
. Stressed will be the importance of the supervisor **helping the aide to develop his**
l ways of helping." rather than his learning a new or different way of helping.

YLE" OF THE CASE AIDE AND HIS WAYS OF LEARNING - TWO HOURS

ssion will focus upon the ways of learning which are more characteristic of the case aide,
implication that this will have for supervisory teaching. The goals of supervision will
ewed and guidelines for supervisory teaching presented.

SOLUTIONS TO PROBLEMS - TWO HOURS

us of this session will be upon the anticipation of possible problems which may result
e case aide's presence, and discussion of possible solutions.

G FOR THE CASE AIDE'S ARRIVAL AND FOR HIS ONGOING SUPERVISION - TWO HOURS

ssion will involve a review of the supervisory methods used in planning for a new employee's
, in determining his learning needs, and in planning ongoing supervisory teaching. However,
s will be upon adapting these methods to meet the case aide's needs.

ING AND MANAGING THE UTILIZATION OF CASE AIDES IN THE DELIVERY OF SERVICES - TWO HOURS

ssion will consider some of the possible implications of the case aide's presence upon
ocial service (or financial assistance) staff, and discussion of one means of organizing
aging their contacts with clients. Also considered will be one model for viewing how
des will work with clients. A review and evaluation of the training course will also be
.

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References	Session 1 - AN INTRODUCTION TO THE TRAINING COURSE AND T WHY CASE AIDES ARE BEING EMPLOYED IN PUBLIC W
	A. An Introduction to the Training Course
	1. Introductions
	a. The leader to the group
	b. The participants to each other
	2. The purposes and objectives of the traini course
	3. The content to be covered
	a. The outline of content to be covered
	b. The training schedule (agenda) to be
	B. Why Case Aides Are to be Employed in Public We
Lally, Winifred A., "The Public Service Cover Programs: Its Implication for Client, Agency, and Community." Public Welfare, The Journal of the American Public Welfare Association, Vol. XXVII, No. 2, (April 1969).	1. Manpower issues in public welfare
	a. The 1962 Amendments to the Social Se Act which stressed:
	(1) Provision of program services t
	(2) The need to increase the number employees with graduate educati social work.
	(3) Required the provision of stipe employees wishing to seek gradu education in social work.

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References	
	(4) Identified the need for a comprehensiv plan of continuous training for all employees responsible for providing social services to clients.
	b. Agency efforts have resulted in recognition that:
	(1) Workers with a baccalaureate degree can provide meaningful services to clients.
	(2) Persons with less than college education can contribute to an important enrichment of the agency's program of services to clients.
	(3) Helping in specific areas sometimes requires knowledge and expertise which comes from life experiences rather tha education.
Pearl, Arthur and Riessman, Frank, New Careers for the Poor. The Free Press, New York, 1965.	2. The New Career Concept and its implication for public welfare
	a. The New Career Concept - its element includes:
	(1) Recognition that there is a need to create new jobs within the human services.

	Comments, Suggestions
(4) Identified the need for a comprehensive plan of continuous training for all employees responsible for providing social services to clients.	
b. Agency efforts have resulted in recognition that:	
(1) Workers with a baccalaureate degree can provide meaningful services to clients.	
(2) Persons with less than college education can contribute to an important enrichment of the agency's program of services to clients.	
(3) Helping in specific areas sometimes requires knowledge and expertise which comes from life experiences rather than education.	
2. The New Career Concept and its implication for public welfare	This concept has been sufficiently used in professional literature that the group itself may be able to participate in its definition.
a. The New Career Concept - its element includes:	
(1) Recognition that there is a need to create new jobs within the human services.	

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: I. BRAKE SHOES AND WHEEL CYLINDER

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove and Replace Brake Shoes and Overhaul Wheel Cylinder

CONDITIONS:

BEHAVIOR:

11. Reassemble wheel cylinders following all steps as outlined in the manual
12. Replace brake shoes following all steps as outlined in the manual
13. Replace brake drums following all steps as outlined in hte manual
14. Replace wheels, front and rear, following all steps as outlined in the manual
15. Make initial brake adjustment following all steps as outlined in the manual
16. Lower the automobile to the floor
17. Raise hood
18. Place protective cover on fender over which you will be working
19. Remove filler cap from master cylinder
20. Connect the pressure bleeder to master cylinder following instructions on unit being used
21. Pressurize pressure bleeder
22. Raise automobile and bleed air from each wheel cylinder

PERFORMANCE CRITERIA:

References

(2) That case aide jobs will involve
assignment of a number of tasks
normally allotted to more highly
educated professional staff, but
can be performed by relatively un
skilled, inexperienced persons, a
assigning these to such preprofes
staff.

(3) The need to create jobs within th
human services for persons (the p
previously denied access because
educational requirements.

(4) The ability to expand and enrich
services by using persons recruit
from client groups to provide ser
not now available through agencie
(i.e., escorting, teaching, or ad
services).

b. Why does The New Careers Concept make

(1) New jobs created within the human
services are less likely to be au
out of existence.

(2) There is uniform agreement that a
expansion and enrichment of servi
is needed by clients.

(3) That the case aide, recruited fr
among the recipient group can br
special and unique skills which
derived from his life experience
and, therefore, useful to other
with similar experiences.

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Comments, Suggestions

(2) That case aide jobs will involve the assignment of a number of tasks normally allotted to more highly educated professional staff, but which can be performed by relatively unskilled, inexperienced persons, and assigning these to such preprofessional staff.

(3) The need to create jobs within the human services for persons (the poor) previously denied access because of educational requirements.

(4) The ability to expand and enrich agency services by using persons recruited from client groups to provide services not now available through agencies (i.e., escorting, teaching, or advising services).

b. Why does The New Careers Concept make sense?

(1) New jobs created within the human services are less likely to be automated out of existence.

(2) There is uniform agreement that an expansion and enrichment of services is needed by clients.

(3) That the case aide, recruited from among the recipient group can bring special and unique skills which are derived from his life experiences and, therefore, useful to other persons with similar experiences.

Ask the group to develop these ideas and list them on the blackboard. The ideas offered may be similar to the points listed and additions can be offered by the leader where the group does not identify the particular point.

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References	
	(4) They are capable of learning how t perform some tasks now performed b social services workers, thus free more educated staff to use their p fessional skills more fully.
Elston, Patricia, "Public Welfare: The Breath of Change." Up From Poverty. Edited by Frank Riessman and Hermini I. Popper. Harper and Row Publishers, New York, 1968.	c. What will be involved in implementing New Careers Concept?
	(1) The creation of permanent job assi ments for the case aide.
	(2) Identifying how this job is to be meaningful part of a continuum of service job assignments.

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	Comments, Suggestions
(4) They are capable of learning how to perform some tasks now performed by social services workers, thus freeing more educated staff to use their professional skills more fully.	
c. What will be involved in implementing a New Careers Concept?	Explain what the county department is now doing to develop career advancement opportunities for case aide employees.
(1) The creation of permanent job assignments for the case aide.	
(2) Identifying how this job is to be a meaningful part of a continuum of social service job assignments.	A review of specific State Regulations 10-203 should be planned for the purpose of understanding the philosophy and objectives behind the agency's addition of case aides. The trainer will want to encourage the expression of attitudes and feelings of individual participants towards these regulations.

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References	
State Department of Social Welfare, Administrative Planning Workshop on the Use of Case Aides. December 15-18, 1969. (Circular Letter No. 2446)	A. The Emerging Role of the Case Aide in the Human Services: As case aides have been employed in increasing n in social agencies, specific areas of services, which they can skillfully be involved, have emer 1. The case aide can be involved in the mainte or strengthening of a client's adaptive pat a. By providing directive, educational an daily living services which aim at mai nance of family functioning. b. By providing a variety of environmenta services (for example, helping the cli locate more suitable housing). c. By directly helping the client to deve more effective skills in maintaining h family role (i.e., child care, househo management, budgeting, etc.). d. By fact finding in relation to specifi program areas. 2. The case aide can respond to many kinds of inquiries by clients, helping them to obta and use more fully the various resources o agency. 3. The case aide has been able to make routin referrals, particularly in the use of comm and neighborhood resources which are frequ less known to other agency staff.

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Session 2 - THE ROLE OF THE CASE AIDE IN PROVIDING SOCIAL SERVICES TO CLIENTS

	Comments, Suggestions
The Emerging Role of the Case Aide in the Human Services: As case aides have been employed in increasing numbers in social agencies, specific areas of services, for which they can skillfully be involved, have emerged. 1. The case aide can be involved in the maintenance or strengthening of a client's adaptive patterns a. By providing directive, educational and daily living services which aim at maintenance of family functioning. b. By providing a variety of environmental services (for example, helping the client locate more suitable housing). c. By directly helping the client to develop more effective skills in maintaining his family role (i.e., child care, household management, budgeting, etc.). d. By fact finding in relation to specific program areas. 2. The case aide can respond to many kinds of initial inquiries by clients, helping them to obtain and use more fully the various resources of the agency. 3. The case aide has been able to make routine type referrals, particularly in the use of community and neighborhood resources which are frequently less known to other agency staff.	Involve the group in identifying specific examples of jobs which case aides might perform in each of these areas.

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References	
	4. The case aide can bridge gaps in communic particularly with the client who, because fearfulness or distrust, cannot yet avail of many more formalized services.
	B. The More Specific Tasks and Functions Perform Case Aides in California County Public Welfar Departments
See the Introduction of Training Aid 38A for a more complete listing of tasks which have been identified by California county departments.	1. Direct service functions, such as: a. advises clients on food preparation buying; b. demonstrates how to purchase food m carefully.
	2. Joint functions, such as: a. shows client how to complete a spec b. escorts hesitant client to and thro family planning clinic.
Goldberg, Gertrude S., "Nonprofessionals in Human Services," from Nonprofessionals in Human Services, edited by Charles Grosser, William E. Henry and James G. Kelly, Jossey-Bass Inc., San Francisco, 1969.	3. Bridging functions, such as: a. advises clients on the use of a spe resource within the county departme b. gathers specific information in a n hood through door-to-door canvassin
	4. Recruitment and follow-up functions, suc a. asks a client why he is unable to f through in contacting and using a s resource;

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	Comments, Suggestions
4. The case aide can bridge gaps in communication, particularly with the client who, because of fearfulness or distrust, cannot yet avail himself of many more formalized services.	
The More Specific Tasks and Functions Performed by Case Aides in California County Public Welfare Departments	
1. Direct service functions, such as: a. advises clients on food preparation and buying; b. demonstrates how to purchase food more carefully.	The trainer will want to expand this list, including those specific tasks which are to be assigned to case aides in his individual county department.
2. Joint functions, such as: a. shows client how to complete a specific form; b. escorts hesitant client to and through a family planning clinic. 3. Bridging functions, such as: a. advises clients on the use of a specific resource within the county department; b. gathers specific information in a neighborhood through door-to-door canvassing. 4. Recruitment and follow-up functions, such as: a. asks a client why he is unable to follow through in contacting and using a specific resource;	Ask participants to consider the kinds of tasks listed on pages 2 and 3 of Training Aid 38A, which represent the more common tasks and functions being assigned to case aides by various county public welfare departments in California. Pose questions: How do these tasks compare with those you have perceived for the case aide? In what additional ways might a case aide be used?

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b. assists a client to make a request for agency social services.

C. The Importance of Assigning Tasks Which Will Capit Upon The Case Aides Specific Skills

1. They should build upon his life experiences a recipient of agency financial assistance and social services.

2. They should allow opportunity for the case ai to utilize the attainments and abilities he h acquired in managing on a less than adequate income.

3. They should draw upon the specific knowledge which the case aide has of the poverty (or cl community, and the less known resources avail to and used by persons living in this area.

4. They should utilize the case aides natural wa of helping, capitalizing on his ability to communicate and utilize a similar life style with recipients.

5. They should draw upon the skills he has acqui in working with established agencies and ins tutions, and his specific knowledge of how t secure their help and assistance.

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Comments, Suggestions

b. assists a client to make a request for agency social services.

The Importance of Assigning Tasks Which Will Capitalize Upon The Case Aides Specific Skills

Pose Question: What are some of the ways in which we can capitalize upon the unique background and experiences of the case aide?

1. They should build upon his life experiences as a recipient of agency financial assistance and social services.

2. They should allow opportunity for the case aide to utilize the attainments and abilities he has acquired in managing on a less than adequate income.

3. They should draw upon the specific knowledge which the case aide has of the poverty (or client) community, and the less known resources available to and used by persons living in this area.

4. They should utilize the case aides natural ways of helping, capitalizing on his ability to communicate and utilize a similar life style, with recipients.

5. They should draw upon the skills he has acquired in working with established agencies and institutions, and his specific knowledge of how to secure their help and assistance.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: I. BRAKE SHOES AND WHEEL CYLINDER

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove and Replace Brake Shoes and Overhaul Wheel Cylinders

CONDITIONS:

BEHAVIOR:

22. (continued) following steps as outlined in the manual
23. Release pressure from pressure bleeder
24. Readjust brake following steps as outlined in the manual
25. Lower automobile to floor
26. Disconnect pressure bleeder
27. Check fluid level in master cylinder and fill to proper level
28. Check brake pedal for proper travel and firmness
29. Make all tests and checks following all steps as outlined in the manual
30. If all tests and checks are satisfactory, remove fender cover and store in proper place
31. Return all tools and materials to proper place
32. Close hood
33. Return automobile to proper parking area
34. Remove seat cover and store in proper place
35. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove brake shoes, overhaul wheel cylinders, and reassemble in 4 hours.

Learning time: 6 hours

References	
Cudaback, Dorothea, Training and Education of New Careerists in Public Welfare. State Department of Social Welfare, Circular Letter No. 2408 (January 1970).	D. The Case Aide's Ways of Working With Clients Probably no area has received greater attenti result of the addition of case aides to publi than has their more characteristic ways of wo with clients and how these will differ marked the methods of helping employed by the social worker. 1. Specific words used to describe the case way of working with clients have include a. Honesty, particularly in the way in frequently will raise the obvious f discussion. b. Frankness, particularly in the way quently will share his opinion with c. Acceptance, particularly in his abi respond warmly to the client, accep him as he is. d. Directness, particularly in the way he sometimes will authoritatively d the client to take steps in overcom particular difficulty he faces. e. Informality, particularly in the wa respond to the client on a first na readily share his feelings (pleasur etc.) as well as share personal exp as a mother, homemaker, etc., to ma point.

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	Comments, Suggestions
D. The Case Aide's Ways of Working With Clients	
Probably no area has received greater attention as a result of the addition of case aides to public welfare than has their more characteristic ways of working with clients and how these will differ markedly from the methods of helping employed by the social service worker.	Encourage the participants to suggest other characteristics they know of or have read about. A brief presentation describing the more characteristic ways in which case aides will work with clients can serve as a basis for stimulating discussion.
1. Specific words used to describe the case aide's way of working with clients have included:	
a. Honesty, particularly in the way in which he frequently will raise the obvious for discussion.	
b. Frankness, particularly in the way he frequently will share his opinion with clients.	Consider the examples of helping found on pages 4, 36 and 37 of Training Aid 38B.
c. Acceptance, particularly in his ability to respond warmly to the client, accepting him as he is.	
d. Directness, particularly in the way in which he sometimes will authoritatively direct the client to take steps in overcoming some particular difficulty he faces.	
e. Informality, particularly in the way he will respond to the client on a first name basis, readily share his feelings (pleasure, anger, etc.) as well as share personal experiences as a mother, homemaker, etc., to make a point.	

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References	Session 2 - THE ROLE OF THE CASE AIDE IN PROVIDING SOCIAL SERVICES TO CLIENTS
	f. Practicalness, particularly in the wa will usually respond to the client's tangible needs and to his external li situation.
George Brager, "The Indigenous Worker: A New Approach To The Social Work Technician." Social Work, The Journal of the National Association of Social Workers, Vol. 10, No. 2 (April 1965).	2. The importance of helping the case aide to develop further his "natural ways of helpi
	a. Because his own economic deprivation life experiences have provided him wi coping skills, more likely within the of the client with whom he works;
	b. Because these "natural ways of helpin the basic enrichment of agency servic which is sought through the addition aides;
	c. Because the case aide's major contrib to agency services is to be found in ability to look back at how life real in the low-income community.
	3. Implications for supervisory teaching
	a. The need to encourage the case aide t further develop his "natural ways of helping," rather than to teach (as we to social service workers) a differen of helping.
	b. The need to be guided in the teaching case aides more by what is helpful to client, rather than preconceived idea about the way in which help "should" provided.
	c. The allowing of sufficient freedom of activity to foster the further develo of individual helping skills and inno

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Comments, Suggestions

f. Practicalness, particularly in the way he will usually respond to the client's tangible needs and to his external life situation.

2. The importance of helping the case aide to develop further his "natural ways of helping."

a. Because his own economic deprivation and life experiences have provided him with coping skills, more likely within the grasp of the client with whom he works;

b. Because these "natural ways of helping" are the basic enrichment of agency services which is sought through the addition of case aides;

c. Because the case aide's major contribution to agency services is to be found in his ability to look back at how life really is in the low-income community.

3. Implications for supervisory teaching

a. The need to encourage the case aide to further develop his "natural ways of helping," rather than to teach (as we do to social service workers) a different way of helping.

b. The need to be guided in the teaching of case aides more by what is helpful to the client, rather than preconceived ideas about the way in which help "should" be provided.

c. The allowing of sufficient freedom of activity to foster the further development of individual helping skills and innovation.

References

Department of Social Services. Public Service Career Program: Case Aide Trainees. The City of New York. March 1968.

A. The Contrasting Techniques (and Materials) I
Training and How These May Differ in Teachin
Case Aide

1. Lecture

PROFESSIONALS	CASE AIDES
Understands academic language	Not familiar wit language
Takes relevant notes	Considerable nee written outlines and dramatic emp key explicit ref to examples
	Lacks note takin
Tends to ask pertinent questions	Often reluctant questions
Can follow implicit logic of talk and digressions	Needs to underst immediate useful what is being ta
Can condense main point from extensive verbal elaboration	
Will often sustain attention during lengthy discussion of theoretical material	Uncomfortable wi theoretical acad discussions

Session 3 - THE "STYLE" OF THE CASE AIDE
AND HIS WAYS OF LEARNING

Comments, Suggestions

A. The Contrasting Techniques (and Materials) Used in Training and How These May Differ in Teaching the Case Aide

1. Lecture

PROFESSIONALS	CASE AIDES
Understands academic language	Not familiar with academic language
Takes relevant notes	Considerable need for written outlines, graphic and dramatic emphasis of key explicit references to examples
	Lacks note taking skills
Tends to ask pertinent questions	Often reluctant to ask questions
Can follow implicit logic of talk and digressions	Needs to understand the immediate usefulness of what is being taught
Can condense main point from extensive verbal elaboration	
Will often sustain attention during lengthy discussion of theoretical material	Uncomfortable with theoretical academic discussions

Drawing upon their own experiences, the participants should be asked to list characteristics under each of these teaching methods. The trainer can develop two lists on the blackboard for later reference and use in identifying their implications for supervisory teaching.

The importance of this comparison is that it brings out the contrast in certain operating assumptions with regard to training aides and professionals. Once the contrast is established supervisors begin to understand that aides cannot be taken for granted and trained in the usual manner.

Consider the brief forms of note taking planned for in Training Aid 38B. For example, on page 18, questions guide the case aide in deciding the kind of information he will want to remember.

References

2. Books or Manuals

PROFESSIONALS	CASE AIDES
Will do assigned readings	May have only simple r ing habits or low read level
Tends to analyze and summarize key chapters, paragraphs, or sections	May have literacy prob
Will refer to reading materials for later use	Lacks sophisticated analytical procedures, e.g., summarizing, abstracting
Seeks criticism of reading materials from others	May have no experience outside reading, secon reading, independent research
Understands organization, outline and and division of book (e.g., foreword, appendix, footnote references, etc.)	Looks for information is immediately relevan and applicable for con problem
Can grasp graphs, charts, technical references	
Has no problem of literacy, slow reading level, etc.	

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Comments, Suggestions

2. Books or Manuals

PROFESSIONALS	CASE AIDES
Will do assigned readings	May have only simple reading habits or low reading level
Tends to analyze and summarize key chapters, paragraphs, or sections	May have literacy problems
Will refer to reading materials for later use	Lacks sophisticated analytical procedures, e.g., summarizing, abstracting
Seeks criticism of reading materials from others	May have no experience of outside reading, secondary reading, independent research
Understands organization, outline and and division of book (e.g., foreword, appendix, footnote references, etc.)	Looks for information which is immediately relevant and applicable for concrete problem
Can grasp graphs, charts, technical references	
Has no problem of literacy, slow reading level, etc.	

3. Case References

PROFESSIONALS	CASE AIDES
Develops understanding from extensive or detailed reading or references from other professionals	Points are better understood if aides role-play (i.e., act out) events of a particular case
Points can be extracted and learned from examples taken from a variety of agencies, experiences, places; understanding arrived at through verbal exchange	Responds best to short one-page listing of four or five agency or case problems

4. Group Discussion

PROFESSIONALS	CASE AIDES
Tends to follow framework or agenda outline by discussion leader	Not accustomed to leading discussion groups or taking notes
Observes rules of order or sense of protocol	Not familiar with formal protocol
Individuals follow through on written or reading assignments	May be initially reluctant to follow through without help or direction

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Comments, Suggestions

3. Case References

PROFESSIONALS	CASE AIDES
Develops understanding from extensive or detailed reading or references from other professionals	Points are better understood if aides role-play (i.e., act out) events of a particular case
Points can be extracted and learned from examples taken from a variety of agencies, experiences, places; understanding arrived at through verbal exchange	Responds best to short one-page listing of four or five agency or case problems

Consider the brief examples of helping on pages 36 and 37 of Training Aid 38B, as one method of teaching case aides. These four examples specifically describe the ways of helping contained in the teaching notes in Training Aid 38A, pages 66 and 67. Note the different ways in which this material has been written for the trainer and for the case aide.

4. Group Discussion

PROFESSIONALS	CASE AIDES
Tends to follow framework or agenda outline by discussion leader	Not accustomed to leading discussion groups or taking notes
Observes rules of order or sense of protocol	Not familiar with formal protocol
Individuals follow through on written or reading assignments	May be initially reluctant to follow through without help or direction

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: II. MASTER CYLINDER

PERFORMANCE OBJECTIVE NO: 2 TITLE: Overhaul Master Cylinder

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Master Cylinders	1. Automotive Chassis and Body, by Crouse. pp. 395 through 397, 400, 484 through 486 Automotive Chassis Workbook, by Crouse. Job 25	1. Related Information Class
2. "Reburling the Master Cylinder"	2. Continuous film loop # 8352	2. Resource Materials Center

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References

PROFESSIONALS	CASE AIDES
Talk flows without extended or difficult pauses	
Recorded minutes	
Substitutes available for role of discussion leader, note-taker, et al	

B. What Are the Implications for Teaching?

1. Lecture:

   a. Not useful as a teaching technique.

   b. Can be improved by recourse to simple language and brevity.

   c. Case aides can be encouraged to help cho topics and participate in presentations.

   d. Major points can be repeated and written in some form (i.e., on blackboard, outli etc.).

   e. The need to avoid excessive qualifying statements.

   f. Where used, it should be relaxed, atten to questions, and tempered with easy flowing humor.

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Session 3 - THE "STYLE" OF THE CASE AIDE
AND HIS WAYS OF LEARNING

Comments, Suggestions

PROFESSIONALS	CASE AIDES
Talk flows without extended or difficult pauses	
Recorded minutes	
Substitutes available for role of discussion leader, note-taker, et al	

<u>What Are the Implications for Teaching?</u>

1. Lecture:

   a. Not useful as a teaching technique.

   b. Can be improved by recourse to simple language and brevity.

   c. Case aides can be encouraged to help choose topics and participate in presentations.

   d. Major points can be repeated and written in some form (i.e., on blackboard, outlined, etc.).

   e. The need to avoid excessive qualifying statements.

   f. Where used, it should be relaxed, attentive to questions, and tempered with easy flowing humor.

Encourage participants to draw these implications from the lists which have been completed.

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References

2. Books and Manuals:

   a. Should be condensed and summari

   b. Stress should be placed upon th simplified language, illustrati simple exercises.

   c. Materials used in the county de will need some modification for and ready use by case aides in

3. Case References:

   a. Case material should be develop or two-page designs with short, responses.

   b. Short case examples are useful trating key understanding of pr concept being taught and can be letting case aides act out agen protocol and skills. Role-play the aide to understand what to which is fast and most effectiv

4. Group discussion:

   a. A more effective teaching techn

   b. The supervisor will want to see of belonging, confidence and in

   c. Different group roles can be ro leader, note-taker, observer, e

   d. Information can be discussed th and learned in depth.

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	Comments, Suggestions
2. Books and Manuals: a. Should be condensed and summarized. b. Stress should be placed upon the use of simplified language, illustrations and simple exercises. c. Materials used in the county department will need some modification for reference and ready use by case aides in training.	Consider the summarized way in which public welfare's program is presented in the teaching notes on pages 19, 20 and 21 of Training Aid 38A.
3. Case References: a. Case material should be developed in one- or two-page designs with short, open-ended responses. b. Short case examples are useful in illustrating key understanding of principles and concept being taught and can be used by letting case aides act out agency problems, protocol and skills. Role-playing helps the aide to understand what to do in a way which is fast and most effective.	Note the use made of case material on page 38 of Training Aid 38B. Participants might consider how they can teach nonverbal communication using this example: For an example of role playing, discuss the example on page 30 of Training Aid 38A.
4. Group discussion: a. A more effective teaching technique. b. The supervisor will want to seek a sense of belonging, confidence and involvement. c. Different group roles can be rotated (e.g., leader, note-taker, observer, et al). d. Information can be discussed thoroughly and learned in depth.	

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References	
	e. Provides case aides with the to further develop verbal ski
	C. Some Principles of Supervisory Teaching
State Department of Social Welfare, Administrative Planning Workshop in The Use of Case Aides. December 15-18, 1969, (Circular Letter No. 2446).	1. Play down the academic and instead spontaneity in learning.
	2. Teach by doing. Use observation a learning situations to teach. Obs experienced case aides has been a technique.
Russman, Frank, Strategies Against Poverty. Chapter IX, Random House, New York, 1969.	3. Use demonstration, such as role-pl the case aide see and "feel" how t be done.
	4. Be clear and explicit. Give frequ trations, examples, explanations. teaching of tasks down into its pa
	5. Use condensed and simplified read as well as lists of steps case aid in performing an assigned task.
	6. Use a small group approach in the case aides wherever this is possi appropriate.

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	Comments, Suggestions
e. Provides case aides with the opportunity to further develop verbal skills.	
C. <u>Some Principles of Supervisory Teaching</u>	
1. Play down the academic and instead encourage spontaneity in learning.	Use actual examples to illustrate.
2. Teach by doing. Use observation and experience learning situations to teach. Observing more experienced case aides has been a most useful technique.	
3. Use demonstration, such as role-playing. Let the case aide see and "feel" how the job is to be done.	Ask each participant to select a particular job or assignment which a case aide might do, and to prepare a brief 10 minute demonstration of how this assignment might be taught, using these principles. Plan to allow sufficient time for these presentations at the beginning of the next session. In discussing these demonstrations, the various ways in which these principles are applied should be identified and stressed.
4. Be clear and explicit. Give frequent illustrations, examples, explanations. Break the teaching of tasks down into its parts.	
5. Use condensed and simplified reading materials, as well as lists of steps case aide will take in performing an assigned task.	
6. Use a small group approach in the teaching of case aides wherever this is possible and appropriate.	

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References	Session 4 - SEEKING SOLUTIONS TO PR
State Department of Social Welfare, Administrative Planning Workshop on The Use of Case Aides. December 15-18, 1969 (Circular Letter No. 2446).	A. Problems to be Anticipated The addition of case aides, or for tha new group of staff, will create some p agency, as it struggles to create a me for them. 1. Some of the early difficulties wh have experienced in their new rol a. Because of their prior depen agency and having had to liv ients, on a less than adequa case aides may come with hos or fearfulness of the agency b. Some case aides may be sensi they perceive to be the diff ment of clients on the part social service workers. Thu overidentify with some clien hostile toward social servic appear, to them, to be punit with clients. c. Some case aides may, initial difference between their ski of the caseworker because of that he has more concrete, d and, therefore, more usable of what it means to be poor. d. Some case aides are confused by professional attitudes, j which they do not understand

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Session 4 - SEEKING SOLUTIONS TO PROBLEMS	Comments, Suggestions
A. <u>Problems to be Anticipated</u> The addition of case aides, or for that matter any new group of staff, will create some problems for the agency, as it struggles to create a meaningful place for them.	Presentation and discussion of individual assignments made in the previous session should precede this content.
1. Some of the early difficulties which case aides have experienced in their new role of "employee"	Discussion can begin with a review of the content discussed in the previous session as a basis for anticipating problems.
a. Because of their prior dependency upon the agency and having had to live, as recipients, on a less than adequate income, some case aides may come with hostility toward or fearfulness of the agency.	Consider the four examples on pages 44 and 45 of Training Aid 38A. Pose question: How might you teach a case aide to handle such situations?
b. Some case aides may be sensitive to what they perceive to be the differential treatment of clients on the part of various social service workers. Thus, they may overidentify with some clients and become hostile toward social service workers who appear, to them, to be punitive in dealing with clients.	
c. Some case aides may, initially, see little difference between their skills and those of the caseworker because of their belief that he has more concrete, down to earth, and, therefore, more usable understanding of what it means to be poor.	Participants should be encouraged to discuss how they might handle such problems.
d. Some case aides are confused and isolated by professional attitudes, jargon, etc., which they do not understand.	

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e. He may initially perceive of supervi a means of accounting for performanc a relationship through which learnin be derived from work experiences.

f. He may be easily impatient with proc which appear to limit his ability to help to clients.

g. Some mothers who have been on AFDC f quently bring noticeable hostile fee toward AFDC fathers, in general, whi can, if not handled, limit their abi to work with some families.

2. Some of the difficulties faced by the soc service worker as a result of the case ai presence.

a. The social service worker enjoys a c status in the agency. When the case does not meet his expectations, his reaction might be expressed in feel of anxiety and resentment.

b. There is a tendency to exert an und amount of control over what the cas does, because of a preoccupation wi the case aide can or cannot do. Su control is likely to stifle the aid ability to use natural ways of help

c. There is an uncomfortableness with aides more active, immediate, spont response to the client's needs. Th very different from the problem-sol approach used in social work practi

Comments, Suggestions

e. He may initially perceive of supervision as a means of accounting for performance, not a relationship through which learning can be derived from work experiences.

f. He may be easily impatient with procedures which appear to limit his ability to be of help to clients.

g. Some mothers who have been on AFDC frequently bring noticeable hostile feelings toward AFDC fathers, in general, which can, if not handled, limit their ability to work with some families.

2. Some of the difficulties faced by the social service worker as a result of the case aide's presence.

a. The social service worker enjoys a definite status in the agency. When the case aide does not meet his expectations, his reaction might be expressed in feelings of anxiety and resentment.

Consider the chart on page 36 of Training Aid 38A, and the orchestrational role suggested for the social service worker and eligibilit worker.

b. There is a tendency to exert an undue amount of control over what the case aide does, because of a preoccupation with what the case aide can or cannot do. Such control is likely to stifle the aides ability to use natural ways of helping.

c. There is an uncomfortableness with the aides more active, immediate, spontaneous response to the client's needs. This is very different from the problem-solving approach used in social work practice.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: II. MASTER CYLINDER

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Overhaul Master Cylinder

CONDITIONS:

This assignment is to be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Raise hood
6. Place protective cover on fender over which you will be working
7. Disconnect hydraulic lines and other accessories from master cylinder following all steps as outlined in manual
8. Remove master cylinder following all steps as outlined in the manual
9. Disassemble master cylinder following all steps as outlined in the manual
10. Make all tests and checks as outlined in the manual
11. Reassemble master cylinder following all steps as outlined in the manual

PERFORMANCE CRITERIA:

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Martin L. Birnbaum and Chester H. Jones, "Activities of the Social Work Aides." Social Casework, Family Service Association of America, Vol. XLVIII, No. 10 (December 1967), p. 627.

d. The social service worker's us
tions can be misunderstood by
(One aide has been reported to
remarked, "That slum you keep
is my home." "Another wanted
clients were people - perhaps
irony. The use of such expres
'you people' usually awakened
in the aides. One aide stated
thought an indigenous person w
who had some kind of health pr

3. Anticipating problems through plann

a. Accept your responsibilities f
a meaningful place and role fo
aide.

b. Avoid giving contradictory mes
example, encouraging staff to
but responding negatively to t
suggestions when these are ope

c. Involve social service staff i
for the arrival of the case ai
defining the role which the ca
jointly fulfill with them in w
clients.

d. Communicate the desirability o
case aide in performing meanin
with clients.

e. Clearly define and write a "jo
which will guide you as well a
service staff in understanding
be played by the case aide, at
the early months of his assign

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d. The social service worker's use of abstractions can be misunderstood by the case aide. (One aide has been reported to have remarked, "That slum you keep talking about is my home." "Another wanted to know if clients were people - perhaps not without irony. The use of such expressions as 'you people' usually awakened some hostility in the aides. One aide stated that she thought an indigenous person was someone who had some kind of health problem.")

3. Anticipating problems through planning

a. Accept your responsibilities for creating a meaningful place and role for the case aide.

b. Avoid giving contradictory messages (for example, encouraging staff to speak out but responding negatively to their suggestions when these are openly offered).

c. Involve social service staff in planning for the arrival of the case aide, and in defining the role which the case aide will jointly fulfill with them in working with clients.

d. Communicate the desirability of using the case aide in performing meaningful tasks with clients.

e. Clearly define and write a "job description" which will guide you as well as the social service staff in understanding the role to be played by the case aide, at least in the early months of his assignment.

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f. Involve the social service
training of the case aide,
through ways in which he ca
a helping approach to clien

g. Clarify your expectations o
aide.

h. Be guided by what is helpfu
rather than how help "shoul

i. Raise, for discussion, prob
affect staff ability to wor
helping the client.

B. The Necessity of Providing Supportive

1. Case aides may bring personal, f
problems with them to the job as
child care problems, health prob
conflict, etc.).

a. The job assignment should n
enhance problems which do e

b. Supportive services may fre
needed and is an appropriat
role.

c. Supportive services can als
for through the group sessi
case aides.

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f. Involve the social service worker in the training of the case aide, particularly through ways in which he can demonstrate a helping approach to clients.

g. Clarify your expectations of the new case aide.

h. Be guided by what is helpful to the client, rather than how help "should" be provided.

i. Raise, for discussion, problems which can affect staff ability to work together in helping the client.

3. <u>The Necessity of Providing Supportive Services</u>

1. Case aides may bring personal, family or social problems with them to the job assignment (i.e., child care problems, health problems, family conflict, etc.).

   a. The job assignment should not compound or enhance problems which do exist.

   b. Supportive services may frequently be needed and is an appropriate supervisory role.

   c. Supportive services can also be provided for through the group sessions planned for case aides.

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References	Session 4 - SEEKING SOLUTIONS TO PROBLEMS
	2. Some questions to resolve. a. How will the confidentiality of rec assured when the aide has previousl recipient of county department serv financial assistance? b. How will case assignments be planne to eliminate the case aide's workin someone she already knows on a pers basis? c. Where a case aide may simultaneousl a service worker in the department be an agency client), what kinds of lines will be needed in determining supervisor's involvement in providi supportive services, and the respon ities of her worker in these same a d. Should a case aide work jointly in clients with the social service wor (or eligibility worker) whom he see "client" role?

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Session 4 - SEEKING SOLUTIONS TO PROBLEMS	Comments, Suggestions
2. Some questions to resolve. a. How will the confidentiality of records be assured when the aide has previously been a recipient of county department services or financial assistance? b. How will case assignments be planned so as to eliminate the case aide's working with someone she already knows on a personal basis? c. Where a case aide may simultaneously have a service worker in the department (and be an agency client), what kinds of guidelines will be needed in determining the supervisor's involvement in providing supportive services, and the responsibilities of her worker in these same areas? d. Should a case aide work jointly in helping clients with the social service worker (or eligibility worker) whom he sees in a "client" role?	These four questions are frequently a source of problems, particularly in the early use of case aides. The county director might be asked to join the group for this discussion, providing him with the opportunity to share with the group the specific administrative procedures which are to be used in such situations. The participants can also be divided into four smaller groups. Each group would be assigned one question to resolve, and to report back to the larger group the specific ways in which this question could be answered.

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References

A. Some Early Questions to Ask in Planning for the
Aide's Arrival

1. What tasks do the agency define for the ca
aide?

2. How will I plan to use the case aide, init
in my unit?

3. What will be the case aide's relationship
other staff members?

4. How can I involve other staff in the unit
planning and preparing for the case aide's
arrival?

5. How will referrals from social service st
screened in making early assignments for
case aide?

6. What must I do to prepare for the case ai
arrival (including assignment and locatio
a desk and other equipment, introductions
staff, initial assignments, supplies, etc

B. Preparing A Plan of Training Which Will Includ
Case Aide's Early Job Assignments

1. Some principles to remember

a. Early assignments should build upon
knowledge and skills which the case
brings to the job assignment.

b. The case aide should be provided wit
opportunity to observe others and "d
before undertaking assignments on hi

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Session 5 - PLANNING FOR THE CASE AIDE'S ARRIVAL AND FOR HIS ONGOING SUPERVISION

	Comments, Suggestions
Some Early Questions to Ask in Planning for the Case Aide's Arrival 1. What tasks do the agency define for the case aide? 2. How will I plan to use the case aide, initially, in my unit? 3. What will be the case aide's relationship to other staff members? 4. How can I involve other staff in the unit in planning and preparing for the case aide's arrival? 5. How will referrals from social service staff be screened in making early assignments for the case aide? 6. What must I do to prepare for the case aide's arrival (including assignment and location of a desk and other equipment, introductions to staff, initial assignments, supplies, etc.)?	Discussion can be used to identify the various factors which will need to be considered in answering these questions.
Preparing A Plan of Training Which Will Include the Case Aide's Early Job Assignments 1. Some principles to remember a. Early assignments should build upon the knowledge and skills which the case aide brings to the job assignment. b. The case aide should be provided with opportunity to observe others and "do with" before undertaking assignments on his own.	

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References

c. In the teaching of initial t
should be broken down into t
that the aide clearly unders
steps he will be expected to

d. Learning should primarily oc
activities followed by discu
will reinforce the learning

e. Information which the case a
in performing his job assign
provided in simple, easily u
terms, providing opportunity
and identify examples from h
experiences in seeking more
understanding.

2. Some guidelines to early training

a. Plan frequent, short confere
each task to be assigned. I
opportunity for the case aid
the individual steps involve
the task and, after its peri
discussing the experience.

b. Early assignments must take
and use a specific skill wh
aide has brought to the age
assignment must be within h
physically, emotionally, and

c. Early assignments should in
vision of concrete kinds of
can be completed in one or
contacts. Later, once succe
in this kind of activity, s
involving a series of conta
introduced.

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	Comments, Suggestions
c. In the teaching of initial tasks, they should be broken down into their parts, so that the aide clearly understands what steps he will be expected to take.	Teaching the case aide how to talk with clients (see Training Aid 38A, pages 31 and 32) can be used to consider how this task might be broken into its various parts.
d. Learning should primarily occur through activities followed by discussion which will reinforce the learning experience.	
e. Information which the case aide will need in performing his job assignment should be provided in simple, easily understandable terms, providing opportunity to question and identify examples from his own life experiences in seeking more complete understanding.	Consider the use of an observational experience on page 25 of Training Aid 38A, as one example of "teaching by example."
2. Some guidelines to early training	
a. Plan frequent, short conferences around each task to be assigned. Provide an opportunity for the case aide to discuss the individual steps involved in performing the task and, after its performance, discussing the experience.	Use actual examples to illustrate. Encourage participants to consider how these guidelines will be used in their actual teaching of case aides.
b. Early assignments must take advantage of and use a specific skill which the case aide has brought to the agency; and the assignment must be within his capacity - physically, emotionally, and educationally.	
c. Early assignments should involve the provision of concrete kinds of services which can be completed in one or two client contacts. Later, once success is achieved in this kind of activity, services involving a series of contacts can be introduced.	

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VII. BRAKE SYSTEM

MILESTONE: II. MASTER CYLINDER

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Overhaul Master Cylinder

CONDITIONS:

BEHAVIOR:

12. Install master cylinder following all steps as outlined in the manual
13. Connect hydraulic lines and accessories following all steps as outlined in the manual
14. Fill master cylinder reservoir and bleed system following all steps as outlined in the manual
15. Make all tests and checks as outlined in the manual
16. If all tests and checks are satisfactory, remove fender cover and store in proper place
17. Return all tools and materials to proper place
18. Close hood
19. Return automobile to proper parking area
20. Remove seat covers and store in proper place
21. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satidfactorily remove, overhaul, and replace master cylinder in 1½ hours.

Learning time: 3 hours

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References	
Training Aid 38A, An Orientation and Induction Training Course for Case Aides.	d. Assignments should be specific so as to build upon the conten being provided in training ses will provide the case aide wit opportunity to practice what h being taught. e. It is important that early ass viewed as a training rather th function. In this way, tasks assigned will be specifically a learning opportunity and giv sequential manner.
State Department of Social Welfare, Administrative Planning Workshop on The Use of Case Aides. December 15-18, 1969 (Circular Letter No. 2446).	C. Deciding What Job Assignments Are Suitab Case Aide 1. Assignments must be screened befor to the case aide to a. Identify the client problem. aide provide the service which b. Establish an initial service c. Determine method of service n d. Determine the risks involved. 2. Tasks should involve primarily tec can be taught briefly through on-t training. 3. Method of approach can be defined

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	Comments, Suggestions
d. Assignments should be specifically planned so as to build upon the content which is being provided in training sessions. This will provide the case aide with planned opportunity to practice what he is being taught.	Ask participants to identify what kinds of assignments can help the case aide to use the content provided him in induction training sessions on "helping as a case aide" (page 64) and "household management" (page 97).
e. It is important that early assignments be viewed as a training rather than a job function. In this way, tasks to be assigned will be specifically planned as a learning opportunity and given in a sequential manner.	
C. <u>Deciding What Job Assignments Are Suitable for Which Case Aide</u>	
1. Assignments must be screened before being given to the case aide to	
a. Identify the client problem. Can a case aide provide the service which is needed?	
b. Establish an initial service goal.	
c. Determine method of service needed.	
d. Determine the risks involved.	
2. Tasks should involve primarily techniques that can be taught briefly through on-the-job training.	
3. Method of approach can be defined in advance.	

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References

D. Areas to Consider in Planning for the Ongoing Supervision and Training of the Case Aide

1. What is the motivation of the case aide? example:

   a. Why and under what circumstances ha chosen to join the county department

   b. How strong is his wish to help peopl

   c. How much self-confidence and hope do have? Does he see himself moving f up a career ladder, beyond his prese classification?

   d. What are his perceptions of what a c aide will do and will not do?

2. What is his motivation in learning? For example

   a. Why is he interested in learning thi

   b. How does he perceive and use supervi

   c. How does he use his fellow aides (an other staff members) in learning?

3. How does the case aide learn? For exampl

   a. In what ways does he appear to learn easily?

   b. What of his own life experiences and can he draw most readily upon in hel clients?

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	Comments, Suggestions
D. <u>Areas to Consider in Planning for the Ongoing Supervision and Training of the Case Aide</u> 1. What is the motivation of the case aide? For example: a. Why and under what circumstances has he chosen to join the county department staff? b. How strong is his wish to help people? c. How much self-confidence and hope does he have? Does he see himself moving further up a career ladder, beyond his present job classification? d. What are his perceptions of what a case aide will do and will not do? 2. What is his motivation in learning? For example a. Why is he interested in learning this job? b. How does he perceive and use supervision? c. How does he use his fellow aides (and other staff members) in learning? 3. How does the case aide learn? For example: a. In what ways does he appear to learn more easily? b. What of his own life experiences and skills can he draw most readily upon in helping clients?	Pose questions: What will you need to know in planning the ongoing supervision and training of case aides? Discussion should emphasize why this information is needed and how it will direct supervisory teaching.

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References

c. Does he raise questions and under what circumstances?

d. How does he appear to learn best (throug doing, seeing, discussing, etc.)?

4. How does he carry out the helping process?

a. How does he respond to the client's stated need?

b. Does he perceive of the client and his situation appropriately?

c. Can he draw upon his own life experience and skills in helping the client?

d. Can he secure the information he needs from the client?

e. Does he know what questions to ask in securing information?

f. When helping a client to use resources, does he select an appropriate resource in relation to the client's need?

5. How does he respond to differences in people

a. What effect do client situations which differ from his own life experiences ha upon his ability to help?

b. How comfortable is he in working with people of other ethnic background?

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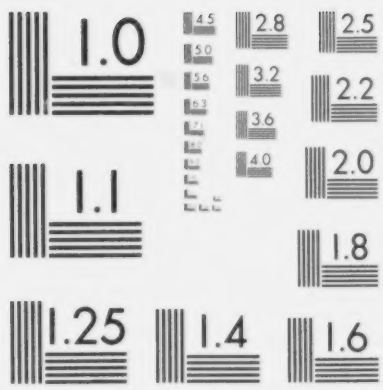

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Comments, Suggestions

c. Does he raise questions and under what circumstances?

d. How does he appear to learn best (through doing, seeing, discussing, etc.)?

4. How does he carry out the helping process?

a. How does he respond to the client's stated need?

b. Does he perceive of the client and his situation appropriately?

c. Can he draw upon his own life experiences and skills in helping the client?

d. Can he secure the information he needs from the client?

e. Does he know what questions to ask in securing information?

f. When helping a client to use resources, does he select an appropriate resource in relation to the client's need?

5. How does he respond to differences in people?

a. What effect do client situations which differ from his own life experiences have upon his ability to help?

b. How comfortable is he in working with people of other ethnic background?

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References	
	c. Can he work with peopl behavioral patterns?
	6. How does he report his work
	a. Can he report what the says accurately?
	b. Does he remember to fo what he agrees to do w
	c. Can he share informati other staff members wh the client?

	Comments, Suggestions
c. Can he work with people who have different behavioral patterns?	
6. How does he report his work?	
a. Can he report what the client needs or says accurately?	
b. Does he remember to follow through on what he agrees to do with a client?	
c. Can he share information needed by the other staff members who are working with the client?	

References	
Studt, Elliott, "Fields of Social Work Practice: Organizing our Resources for More Effective Practice." Social Work, NASW, Vol.10, No. 4, (October 1965).	A. The Problems Resulting From Using Different Classification Levels of Social Service Staff The possibility of face-to-face interaction betwee the client and a volunteer, a case aide, a social service worker, and a homemaker, for example, requires considerable thought as to how the variou functions and tasks performed by these various persons are to be defined and organized. For the activities of these various persons to be successful, it will be necessary that: 1. The various social service staff members shar a common purpose and goal with the client. 2. They must be capable of communicating well an collaborating in solution of daily problems. 3. They assume responsibility with the client in implementing a goal directed service plan. B. A Team Approach - The importance of staff particip as members of an agency team in their work with clients. 1. Definition: As it is here considered, an age team would be composed of those staff members engaged in interaction with the clien 2. What would be their characteristics? a. The team members would share responsibil for making the agency program relevant t the needs of a specific, assigned group clients.

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: I. CLUTCH

PERFORMANCE OBJECTIVE NO: 1 TITLE: Remove, Test, Replace, and Adjust Clutch

CONDITIONS:

Student will learn the related information listed below

LESSON	REFERENCE	SOURCE
1. Fundamentals and Service of the Clutch	1. Automotive Mechanics, by Crouse. pp. 391 through 400, 401 through 405 Automotive Chassis Workbook, by Crouse. Jobs 1 through 3	1. Related Information Class
2. "The Clutch" part 1 & 2	2. Filmstrip	2. Resource Materials Center
3. The Clutch	3. Teaching Machine cards 17A, 17B, 17C	3. Teaching Machine (Shop)

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	Comments, Suggestions
e Problems Resulting From Using Different assification Levels of Social Service Staff	
e possibility of face-to-face interaction between e client and a volunteer, a case aide, a social rvice worker, and a homemaker, for example, quires considerable thought as to how the various nctions and tasks performed by these various rsons are to be defined and organized. For the tivities of these various persons to be success- l, it will be necessary that: The various social service staff members share a common purpose and goal with the client. They must be capable of communicating well and collaborating in solution of daily problems. They assume responsibility with the client in implementing a goal directed service plan.	Present this problem for considera- tion and discussion. Consider the training session offered to case aides in orientation training (Training Aid 38A, pages 35 - 37) on "The Public Welfare Team." Pose questions: What can the supervisor do to improve individual participation on the team? What will administration need to do?
Team Approach - The importance of staff participating members of an agency team in their work with ients. Definition: As it is here considered, an agency team would be composed of those staff members engaged in interaction with the client. What would be their characteristics? a. The team members would share responsibility for making the agency program relevant to the needs of a specific, assigned group of clients.	

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References	
	b. While each of these service sta would have an individually assi function (or basic job) for whi possesses special competence an a team approach would join thes into a mediating staff unit thr program services are available set of clients.
	c. They would become the "service" "assistance") agency in action client.
	d. They would be comprised of a gr specialists - each with experti his own right that can be broug action in solution of client pr
	e. They would share commonly defin with each client with whom they work.
State Department of Social Welfare, Administrative Planning Workshop on the Use of Case Aides, December 15-18, 1969, (Circular Letter No. 2446).	3. The advantages of a team approach
	a. Avoids role diffusion.
	b. Reduces social distance of leve
	c. Creates consistency in concepts management.
	d. Enhances growth of all team mem
	e. Avoids assignment traps.
	f. Provides means of predicting ca complexities and length of serv

Personal

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Comments, Suggestions

b. While each of these service staff members would have an individually assigned function (or basic job) for which he possesses special competence and expertise, a team approach would join these persons into a mediating staff unit through which program services are available to a given set of clients.

Where appropriate, a specific county model to be used should be sutstituted.

c. They would become the "service" (or "assistance") agency in action for the client.

d. They would be comprised of a group of specialists - each with expertise in his own right that can be brought into action in solution of client problems.

e. They would share commonly defined goals with each client with whom they jointly work.

3. The advantages of a team approach

a. Avoids role diffusion.

b. Reduces social distance of levels of staff.

c. Creates consistency in concepts and treatment management.

d. Enhances growth of all team members.

e. Avoids assignment traps.

f. Provides means of predicting case complexities and length of service.

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4. Implications for supervision

   a. Leadership in program adaptation.

   b. The orchestration of the activities of
      members.

   c. Appropriate assignment to activities to
      individual team members or units of sta
      each according to his knowledge, exper
      and abilities.

C. <u>One Approach for Viewing the Ways in Which a Cas
Will Work With Clients</u>

1. In teaching the case aide how to work with
   stress must be placed upon:

   a. A working relationship rather than a t
      peutic relationship.

   b. Rapport: an exchange and interchange
      wherein feelings are interexpressed.

   c. Working with people around reeducation
      reintegration, rather than casework pr

   d. Giving rather than taking.

2. Some basic concepts of helping to be taught

   a. Listening and hearing.

   b. Offering of sympathy as contrasted wit
      empathy.

   c. Respect for the person.

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	Comments, Suggestions
4. Implications for supervision a. Leadership in program adaptation. b. The orchestration of the activities of team members. c. Appropriate assignment to activities to individual team members or units of staff, each according to his knowledge, expertise and abilities.	Pose the question: Who is going to fulfill this coordination function? The specific county plan of coordination should here be discussed. Consider the induction training session on "An Exercise in Teamwork" (Training Aid 38A, page 107. Pose question: Can this same idea be adapted to and used in supervision?)
<u>One Approach for Viewing the Ways in Which a Case Aide Will Work With Clients</u> 1. In teaching the case aide how to work with clients stress must be placed upon: a. A working relationship rather than a therapeutic relationship. b. Rapport: an exchange and interchange wherein feelings are interexpressed. c. Working with people around reeducation and reintegration, rather than casework practice. d. Giving rather than taking. 2. Some basic concepts of helping to be taught. a. Listening and hearing. b. Offering of sympathy as contrasted with empathy. c. Respect for the person.	Review the major points discussed in Sessions 3 and 4 as a basis for considering how the supervisor will teach work with clients.

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d. Holding out expectations for

e. Advice giving.

f. Use of appropriate language
open communication.

g. Knowledge of how to accept p

3. Two levels of helping techniques
functions which might be performe
aide.

a. The beginning case aide

(1) Providing material and
tance for and with the

(2) Providing information a
use resources available

(3) Teaching through action
ways of managing situati
threaten or prevent func

b. The case aide with experience
skills

(1) Acting as a teacher-mode
dealings with the client
those kinds of behavior
used in solving environm
problems.

(2) Supporting positive clie
problem-solving.

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Comments, Suggestions

d. Holding out expectations for behavior.

e. Advice giving.

f. Use of appropriate language with simple and open communication.

g. Knowledge of how to accept people.

3. Two levels of helping techniques involving functions which might be performed by the case aide.

a. The beginning case aide

(1) Providing material and concrete assistance for and with the client.

(2) Providing information about and help to use resources available to the client.

(3) Teaching through action and example, ways of managing situations which threaten or prevent functioning.

b. The case aide with experience and expanded skills

(1) Acting as a teacher-model (in his dealings with the client), displaying those kinds of behavior and methods used in solving environmental-social problems.

(2) Supporting positive client actions in problem-solving.

The four examples on page 36 of the case aide workbook (Training Aid 38B) might be used to illustrate examples of the helping functions listed here.

References	
	D. <u>Evaluation of Training</u> 1. A review of content covered. 2. Group task: Evaluate this training course and make recommendations which the group thinks are important. 3. Written assessment.

	Comments, Suggestions
D. <u>Evaluation of Training</u> 1. A review of content covered. 2. Group task: Evaluate this training course and make recommendations which the group thinks are important. 3. Written assessment.	Group evaluation can be achieved by a free discussion with the trainer. Limit discussion to ten or fifteen minutes. A written assessment of the training course should also be developed and used to determine the degree to which the learning objectives listed on page 4 have been achieved.

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VT 012 948
Ground Instructor Examination Guide. Basic-Advanced.

Federal Aviation Administration, Washington, D.C.
MF AVAILABLE IN VT-ERIC SET.
AC-143-1B
Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (TD4.408:G91, $1.00).
PUB DATE - 67 64p.

DESCRIPTORS - *AVIATION TECHNOLOGY; *STUDY GUIDES; *INSTRUCTIONAL MATERIALS; *TRADE AND INDUSTRIAL EDUCATION; RESOURCE MATERIALS; *TESTS; INDIVIDUALIZED INSTRUCTION; MAPS; MAP SKILLS

ABSTRACT - Prepared by the Flight Standards Service of the Federal Aviation Administration, this study guide is an aid in preparing for the Basic or Advanced Ground Instructor Written Examination. Included in the guide are: (1) recommended study materials and outline, (2) a sample examination, (3) weather information, (4) a daily weather map, (5) aircraft description and performance data, and (6) sample exam-o-grams. Also included are the answers and related explanations for the sample examination. World Aeronautical Chart (405-Gila River) is intended for use with this guide. (JS)

VT 012 948

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: I. CLUTCH

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Test, Replace, and Adjust Clutch

CONDITIONS:

This assignment is to be performed on a complete automobile - manual shift, three or four speed.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Position lift arms under frame of automobile
6. Raise automobile to proper working height
7. Remove drive shaft following all steps as outlined in the manual
8. Disconnect shift linkage from transmission following all steps as outlined in the manual
9. Disconnect other parts and accessories following all steps as outlined in the manual
10. Remove transmission following all steps as outlined in the manual
11. Remove clutch fork and throw-out bearing following all steps as outlined in the manual

PERFORMANCE CRITERIA:

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AC 143-1B

ED0 56238

Ground Instructor Examination Guide

Basic-Advanced

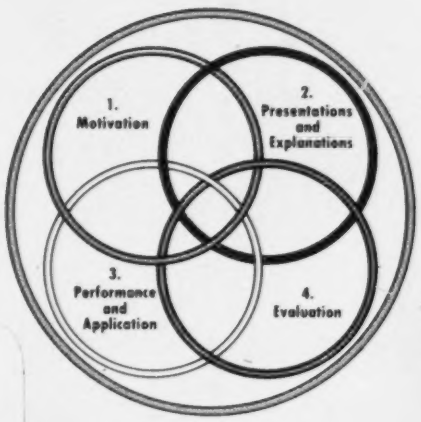

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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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GROUND INSTRUCTOR EXAMINATION GUIDE
BASIC—ADVANCED

Introduction

This study guide was prepared by the Flight Standards Service of the Federal Aviation Administration to assist applicants who are preparing for the Basic or Advanced Ground Instructor Written Examination. It is not offered as a quick and easy way to gain the knowledge necessary for passing the written examination. Knowledge and understanding are seldom gained quickly or easily. This is particularly true in the diversified field of aviation ground instruction. There can be no substitute for diligent study to attain basic knowledge, unremitting effort to develop competence, and continuous review to remain current in the many areas where technological change is the rule rather than the exception.

The purpose of this guide is to provide guidance for the serious student by outlining the scope of knowledge required. Thus, the student is better able to intelligently direct his study plan.

Nature of the Examination

Much of the information and knowledge required of the instructor in aviation ground subjects is essentially the same today as it was many years ago, yet there has been a gradual and definite change in some areas. Technological advancements and refinements in today's aircraft, plus the increased use made of their capabilities by the general flying public, have outmoded the practice of testing for memory alone. Of course, basic knowledge is still necessary but it must be related to the operationally realistic situation. An aircraft's primary commercial use is to provide safe, speedy, and efficient transportation and all civilian training, flight or ground, is directed toward this end. For this reason, knowledge must be related to skill, and skill is inextricably interwoven with knowledge. Therefore, written examinations today require the ability to use basic knowledge in practical situations as well as in answering questions based on theoretical problems.

For this reason, this examination guide will deal with questions that test for knowledge alone as well as questions that test for the ability to apply and use this knowledge in a realistic environment. Some of the questions will deal with specific subjects (navigation, radio navigation, meteorology, Federal Aviation Regulations, aircraft and powerplants) and test for basic knowledge and grasp of theory in regard to fundamentals of instructing. Other questions will require the ability to combine and synthesize knowledge in two or more of the specific subject areas.

The FAA Written Examinations your students will take are of similar format and nature with regard to requiring competence at practical application of theory and knowledge. Knowing this should enable you to organize course material and direct classroom efforts so that your students will be well prepared for their examinations.

Type of Examination Questions

The examination questions are of the objective, multiple-choice type as illustrated by questions in the sample examination. Each question can be answered on a special answer sheet with a pencil mark. To preclude the possibility of an applicant's receiving a failing grade because of a mistake in grading, all tests scored below passing are rechecked by trained personnel.

Taking the Examination

The equipment that the applicant will need for taking the examination includes a pro-

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tractor or plotter and a computer. It is also desirable to have a pair of dividers. The applicant is allowed the following number of hours to complete the Ground Instructor Examination:

A. Basic ..... 4 hours
B. Advanced ..... 5 hours
C. Fundamentals of Instructing. 2 hours
(It is not necessary to take this on the same day as the Basic or Advanced Examinations.)

While it may be possible to complete in less time, it would be unwise to plan on this. If it becomes necessary to hurry in order to finish the exam, it will only increase the probability of mistakes.

Always bear in mind the following facts when you are taking the examination:

1. The questions are not trick questions. Each statement means exactly what it says. Do not look for hidden meanings. The statement does not concern exceptions to the rule; it refers to the general rule.

2. Always read the statement or question first—before you look at the answers listed below it. Be sure you read the entire question carefully. Avoid "skimming" and hasty assumptions. This can lead to a completely erroneous approach to the problem or failure to consider vital words.

3. Only *one* of the alternate answers given is completely correct. Other answers may be correct as far as they go, but are not complete or are answers based on erroneous assumptions, misconceptions, or incorrect procedures and interpretations. *Understand* the question or statement. *Then work out your* answer before choosing from the list of alternate answers the response which you consider to be the best.

4. Do not spend too much time on a question which you cannot solve or on one where you have considerable doubt as to the correct answer. By so doing you deprive yourself of the opportunity to mark all those questions which you can promptly solve or answer. You may always go back to the questions you skipped after you are through with all those which you can readily answer. Many times you could have answered 5 or 10 questions during the time you work with one that is difficult. The procedure which will enable you to make maximum use of time available can well mean the difference between a passing and failing score.

5. In working problems which require computations or use of the plotter and computer, select the answer which is closest to the result you get. Due to slight differences in individual computers and many small errors you may make in measuring distances, true courses, etc., it is possible that you will not get an exact agreement every time. However, sufficient spread is provided between right and wrong answers so that the selection of the answer closest to your solution will be the right choice, *providing* you have used correct technique and reasonable care in making your computations.

NOTE: When the test is constructed, the correct answers are "double-checked" by several types of computers. Any of the several types of computers which are commonly used throughout the country should prove satisfactory.

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RECOMMENDED STUDY MATERIALS

Aeronautical Charts

World Aeronautical Charts. (25 cents each)

Sectional Aeronautical Charts. (30 cents each)

Enroute Low Altitude Radio Navigation Charts. (25 cents each). This particular chart is not used on either the Basic or Advanced Examination, but instructor applicants and certificated instructors should be familiar with its format and use.

Flight Information

Airman's Information Manual. This publication presents, in three Parts, information necessary for the planning and conduct of flights in the U. S. airway system. Besides providing frequently updated airport and navaid data, the AIM includes instructional and procedural information, and is designed for use in the cockpit. Each Part is available on a separate annual subscription.

Part 1. *Basic Flight Manual and ATC Procedures.* ($2.00 domestic; $2.50 foreign — GPO) : combines the former Sections I and II and will be issued quarterly.

Part 2. *Airport Directory.* ($2.00 domestic; $2.50 foreign — GPO) : a revised version of former Section IV, expanded to include the physical description of those airports formerly shown only in Section IV-A. Will be issued semiannually.

Part 3. *Operational Data and Notices to Airmen.* ($9.00 domestic; $11.25 foreign—GPO) : presents former Sections III, III-A and IV-A every 28 days, supplemented by Section III-A (*Notices to Airmen*) every 14 days, midway of the 28-day cycle.

Handbooks and Technical Manuals

Private Pilot's Handbook of Aeronautical Knowledge. 1965. AC 61-23 ($2.75—GPO.) This handbook contains essential, authoritative information used in training and guiding private pilots. All subject areas in which an applicant may be tested are covered in the handbook. It tells how to use the Airman's Information Manual and the data in FAA approved airplane flight manuals, as well as basic instruments for airplane attitude control.

Personal Aircraft Inspection Handbook. Revised 1964. AC 20-9. (50¢—GPO). This is a general guide for inspection of aircraft; Part I deals with the fundamentals of inspection, and Part II covers a typical inspection in detail. As reliable inspection comes only with experience, it is emphasized that the use of this handbook by the novice does not qualify him to make final determinations regarding the airworthiness of the aircraft. This Handbook supersedes TM-101 dated 1950.

Flight Instructor's Handbook. 1964. AC 61-16. (60¢—GPO). This revised handbook is one of the primary sources of information and guidance for pilots preparing for the flight instructor written examination. It is basically a book which explains accepted theories and practices applicable to teaching and the learning process. Therefore, it will also prove most useful to those preparing for the Fundamentals of Instructing section of the Ground Instructor Written Examination.

Flight Training Handbook. AC 61-21. (70¢—GPO). This text deals with certain basic flight information such as load factor principles, weight and balance, and related aerodynamic aspects of flight, as well as principles of safe flight. The balance of the book provides information and direction in the introduction and performance of training maneuvers. Thus it serves primarily as a text for student pilots, for pilots improving their qualifications or preparing for additional ratings, and for flight instructors; however, it can also be useful to the ground instructor.

Navigation and Weather

Practical Air Navigation. 9th Edition, 1963. ($4.00). This is the revised commercial edition of CAA Bulletin No. 24. It provides a very comprehensive coverage of all subjects and areas dealing with navigation whether it be pilotage, dead reckoning, or radio and celestial navigation. Any student who understands the material avail-

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able in this highly recommended text will have no serious trouble with the navigation problems on his examination. This text may be obtained from many book dealers or from the publisher, Jeppeson & Co., 8025 East 40th Ave., Denver, Colorado 80209.

Aviation Weather. 1965. AC 00-6. ($2.25—GPO). This joint FAA/Weather Bureau publication supersedes and replaces "Pilot's Weather Handbook, TM-104," and provides an up-to-date and expanded text for pilots and flight operations personnel. It gives the pilot a practical understanding of those meteorological principles important to aviation and essential to his effective use of current weather and weather forecast information.

Weather Services for Pilots. 1962. (10 cents). This publication should do much to explain the weather services available through U. S. Weather Bureau stations and FAA Flight Service Stations. It explains in considerable detail weather reports and forecasts available and useful to pilots.

Federal Aviation Regulations

Part 1—Definitions and Abbreviations. (25 cents). This lists abbreviations and definitions to be used with the new Federal Aviation Regulations.

Part 61—Certification: Pilots and Flight Instructors. (50 cents). The applicant is responsible for the items in this Part which pertain to competency in all those areas which fall within the scope of knowledge required for his certification as a ground instructor.

Part 71—Designation of Federal Airways, Controlled Airspace and Reporting Points. (20 cents). The applicant will be directly concerned with this Part of the Federal Aviation Regulations dealing with airspace.

Part 91—General Operating and Flight Rules. (60 cents). It is imperative that the applicant be thoroughly familiar with the material contained in this Part, except those which pertain to Instrument Flight Rules.

Part 141—Pilot Schools. (25 cents). Although this Part of the Federal Aviation Regulations deals with pilot schools, it includes the regulations pertaining to ground schools with which the applicant should be familiar. General knowledge of various aspects of pilot school requirements will be of considerable value to the applicant.

Part 143—Ground Instructors. (15 cents). This short Part to the Regulations prescribes the requirements for issuing ground instructor certificates and associated ratings, and the general operating rules for the holders of those certificates and ratings.

National Transportation Safety Board

Safety Investigation Regulations, Part 320. May 18, 1966. (5 cents). This publication deals with procedures required in dealing with accidents and lost or overdue aircraft in the United States, its territories, and possessions.

Training Aids

Commercial Pilot Examination Guide. 1966. AC 61-25 (75 cents). This guide gives detailed information on the scope and depth of knowledge required of the commercial pilot applicant.

How to Obtain Study Materials

All study material, except charts and *Practical Air Navigation* may be obtained by remitting check or money order to:

Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

Charts may be obtained at most local airports, or by remitting check or money order to:

Coast and Geodetic Survey
ESSA
Rockville, Maryland 20852

In many instances, the above materials may be obtained at airports or from book stores.

In addition, there are many other excellent commercially prepared textbooks, audio-visual training aids, and other instruction materials which may be helpful in preparation for the examination.

NOTE: The items listed were available or in preparation at the time this publication went to press.

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STUDY OUTLINE FOR THE GROUND INSTRUCTOR WRITTEN EXAMINATION

The study outline which follows is the framework for basic aeronautical knowledge that the prospective ground instructor must know; *every question* on the FAA examination can be *directly* related to one or more of the topics contained in this outline. This subject matter is predicated on both theoretical questions in specific areas and on operationally realistic airman activity, and encompasses the knowledge requirements specified in Federal Aviation Regulations.

Section 1 — Fundamentals of Instructing

I. The Ground Instructor — Desirable Qualities.
   A. Good attitude toward teaching.
      1. Desire to do a competent job.
      2. Ability to develop and improve.
      3. Sincerity, enthusiasm, and patience.

II. The Pattern for Instruction—How to Guide the Learning Process.
   A. *Understand* the factors, conditions, and principles which guide the learning process.
      1. Establish clear objectives.
      2. Provide for student participation.
      3. Develop understanding and insight.
      4. Develop ability to think and reason through use of known facts.
      5. Use of motivation, presentation, trial performance and evaluation.

III. Planning—Vital to Teaching Success.
   A. Diagnose present student ability and ability desired upon completion of course.
   B. Arrange teaching sequence to "make sense".
      1. Proceed from the known to the unknown.
      2. Proceed from the easy to the difficult.
      3. Plan so student will see necessity and logic of each succeeding step.
      4. Use a lesson plan—know its advantages.

IV. Presentation—Procedure to Follow.
   A. Plan.
      1. Student-instructor relations — establish an atmosphere of cooperation.
      2. Direct and explain.
      3. Discuss.
         a. Get *all* students to participate.
         b. Keep discussion moving toward goal.
         c. Emphasize important points.
         d. Keep explanation short, clear, and to the point.
      4. Question technique—its use and importance.
      5. Use analogies as a link between known and unknown.
      6. Use instructional aids.

V. Performance, Practice, and Application.
   A. Steps to follow.
      1. Start with the easy and work toward the difficult.
      2. Make performance realistic.
      3. Guide student's efforts.
      4. Get each student to participate.
      5. Relate performance to previous explanations and directions.
      6. Provide adequate practice but guard against blind "trial and error".

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7. Evaluate student progress.

VI. Motivation--Basic to All Learning.
- A. Reward—use and limitations.
- B. Immediate and long-range goals and their relative usefulness.
- C. Arousing interest.
  1. Use of student's background.
  2. Use of your own experience and background.
  3. Use of anecdotes and stories.
- D. Conditions detrimental to good motivation.
  1. Self-consciousness.
  2. Antagonism.
  3. Impatience.
  4. Worry.
  5. Physical discomfort.
  6. Boredom.

VII. Teaching Methods and Techniques.
- A. Telling—sometimes called the "lecture" method.
  1. Does not permit student participation.
  2. Can be combined with other methods to make it more effective.
- B. Discussions—techniques of.
  1. Develop cooperative spirit.
  2. Clarify problems.
  3. Encourage participation.
  4. Avoid dominating discussion.
  5. Summarize frequently.
- C. Demonstrations or showing.
  1. Must be combined with telling.
  2. Advantages.
     - a. Makes explanations concrete.
     - b. Aids student understanding.
     - c. Saves learning time.
     - d. Effective with large groups.
     - e. Gives students over-all perspective.
     - f. Appeals to several senses.
     - g. Has dramatic appeal.
- D. Performing or Doing—Essential to the Learning Process.
  1. Techniques.
     - a. Plan the performance.
     - b. Prepare the student for performance.
     - c. Guide the performance.
     - d. Give individual attention.
     - e. Evaluate the performance.
     - f. Have the student evaluate the performance.
     - g. Practice the performance.
     - h. Supervised study—a form of performance.
       - (1) Survey — student must get a picture of the problems.
       - (2) Assign reading material.
       - (3) Student must practice self-questioning.
       - (4) Recite.
       - (5) Review — necessary to develop and firmly fix learning and improve weakness revealed by recitations.
       - (6) Critique — an analysis of performance.
- E. Test Administration Procedures — Preceding, During, and After Student Participation.
  1. Preceding.
     - a. Be on time.
     - b. Check tests for errors.
     - c. Give clear instructions.
     - d. Create relaxed atmosphere.
  2. During.
     - a. Avoid distractions.
     - b. Limit student discussions.
     - c. Be alert to student need for permissible assistance.
  3. After.
     - a. Review.
     - b. Permit constructive student criticism—written and oral.
- F. Evaluation — The measure of Success of the Teaching Program.
  1. What to test.
     - a. Understanding.
     - b. Actual performance—ability to apply knowledge to realistic problems is the only positive assurance of mastery of subject.
  2. Characteristics of Good Evaluation Devices.
     - a. Validity — does it measure what it is supposed to measure?

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: I. CLUTCH

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Test, Replace, and Adjust Clutch

CONDITIONS:

BEHAVIOR:

12. Remove pressure plate and clutch following all steps as outlined in the manual
13. Perform all checks and tests as outlined in the manual
14. Replace pressure plate and clutch disc following all steps as outlined in the manual
15. Replace clutch fork and throw-out bearing following all steps as outlined in the manual
16. Replace transmission following all steps as outlined in the manual
17. Reconnect all parts and accessories following all steps as outlined in the manual
18. Reconnect shift linkage following all steps as outlined in the manual
19. Replace drive shaft following all steps as outlined in the manual
20. Perform all tests, checks, and adjustments following all steps as outlined in the manual
21. Lower automobile to the floor

PERFORMANCE CRITERIA:

b. Reliability — are the results consistent?
c. Objectivity — limit personal judgments.
d. Differentiate — test must measure small but significant differences in achievement.
e. Comprehensive — provide adequate sampling.

3. Types of tests.
a. Multiple-choice.
b. Matching.
c. True-False.
d. Completion.
e. Essay.

G. Instructional Aids—Choose the Aid that Fits the Learning Situation.

1. Usual types of aids.
a. Films, strips, slides.
b. Training graphics — diagrams, charts, pictures, etc.
c. The blackboard.
d. Training devices—mockups, schematics, operational, sectionalized, and exploded.
e. Training literature.
f. Field trips.

2. Caution in the use of instructional aids.
a. Contribute little unless they develop student understanding.
b. Don't expect them to do your teaching.

VIII. Student-Instructor Relationship.

A. Establish receptive, cooperative working relationship.
1. Be natural, enthusiastic, and helpful.
2. Realize you are dealing with men, not machines.
3. Be a guide, not a driver.
4. Treat students as adults — do not talk down to them.
5. Be fair, firm, and friendly.

B. Additional suggestions for establishing atmosphere conducive to learning.
1. Show no partiality or favoritism.
2. Never try to bluff.
3. Never harshly criticize in front of others.
4. Acknowledge your own mistakes.
5. Act decisively.
6. Keep student headed toward his objective.
7. Be interested in your pupils as individuals.
8. Be courteous.
9. Recognize and reward excellence.
10. Encourage class participation.
11. Encourage initiative and self-reliance.

Section 2 — Aeronautical Knowledge

I. Preflight — Activities Relating to the Proposed Cross-Country Flight.
During the preflight portion of the examination you will be required to perform most of the following activities which are directly related to the proposed cross-country flight:

A. Lay out the proposed route on the aeronautical chart provided with the examination.
1. Follow the instructions given in the examination and draw the course lines for the proposed route.
2. Determine the true courses with a protractor and measure distances, *using the mileage scale at the bottom of the chart.* For accurate measurement, use the center of the airport symbols—not the edge.
3. Study the area along your proposed route and note the locations of the following:
a. *Prominent* checkpoints.
b. Radio aids to navigation (VOR, nondirectional radio beacons, and L/MF range stations). Be certain to

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check this data against current information in the *Airman's Information Manual.*

c. High terrain (particular attention should be made to note the elevations—heights above sea level — of the higher ridges and peaks along the routes that traverse rough or mountainous country).

d. Obstructions (note the elevations of high obstructions enroute and in the vicinity of destination landing fields).

e. Control areas, control zones, and airport traffic areas.

f. Prohibited, restricted, caution, and warning areas.

B. Check the weather. Consult your local Weather Bureau Airport Station, or an FAA Flight Service Station for flight weather briefings. Be able to read and interpret the following data:

1. Surface weather map. (Identify fronts, air masses, and read station model data, using the key furnished in the examination.)
2. Area forecasts.
3. Terminal forecasts.
4. Winds-aloft forecasts.
5. SIGMETS (significant meteorological developments) and AIRMETS (formerly designated "Advisories for Light Aircraft", they include weather phenomena of less severity than that covered by SIGMETS).
6. Hourly Sequence Reports.

C. Review the important data in the flight planning publication — *the Airman's Information Manual.* Be familiar with and able to use the information pertaining to:

1. Communication frequencies: control towers, approach control, primary traffic control, ground control, departure control, Flight Service Stations.
2. Navigation aid frequencies: VOR Stations, nondirectional radio beacons, L/MF Range Stations, VHF/DF, Radar.
3. NOTAMS (Notices to Airmen).
4. Special Notices: list of Military Climb Corridors and Oil Burner Routes, good operating practices, and other helpful information.
5. Airport data: location, runway information, availability of fuel and service, availability of UNICOM and weather reporting facilities, etc., lighting.
6. Review pertinent information on:

a. Enroute Cruising Altitudes.

b. Airport Traffic Control procedures.

c. Light Gun Signals.

d. Radio-telephone phraseology and techniques.

e. Complete list of VOR receiver checkpoints.

f. Enroute communications.

g. U. S. Aircraft Emergency procedures, search and rescue procedures, emergency SCATANA rules (Security Control of Air Traffic and Air Navigation Aids).

h. U. S. Weather Bureau telephone numbers.

i. FAA Flight Standards District Office telephone numbers.

j. Aircraft accident reporting.

D. Check your aircraft equipment and records, and your personal qualifications to see that regulations have been met.

1. Check to see that your aircraft—

a. Has the required documents aboard.

b. Has had the necessary in-

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spections within the required time.

c. Is properly equipped for flight (including operations at night and operations in and out of airports on which United States Government-operated control towers are located).

2. Check your pilot qualifications to ascertain that—

a. You have the proper pilot and medical certificates.

b. You have complied with recency of experience requirements for carrying passengers (day and night).

E. Select your cruising altitudes, taking into consideration—

1. Regulations with regard to the hemispherical rule (semi-circular rule).
2. Enroute terrain and obstruction elevations.
3. VFR cloud separation requirements.
4. Winds aloft.
5. Restricted areas such as Military Climb Corridors. (For additional information concerning ing prohibited, restricted, caution, and warning areas, see reverse side of your chart.)

F. Review your *Airplane Flight Manual* and *Owner's Handbook*.

1. Understand the difference between normal and utility category.
2. Consult the weight and balance data and determine that the aircraft is properly loaded. Know how to compute empty weight, useful load, gross weight, and moments.
3. Check on the grade and quantity of fuel and oil required.
4. Review flight load factor limitations and airspeed limitations.
5. Check your performance charts as required for—

a. Takeoff data (*Airplane Flight Manual* or *Owner's Handbook* charts or Denalt Performance Computer.

b. Climb data.

c. Landing distance data.

d. Cruise performance data (cruise power settings, approximate true airspeeds, fuel consumption rate).

e. Airspeed calibration table.

f. Stall speed vs. angle of bank table.

G. Compute navigation data for the flight based on selected cruising altitudes, cruise performance data from the *Airplane Flight Manual* or *Owner's Handbook*, and the appropriate winds aloft.

1. Convert the forecast winds aloft which are given in knots to miles per hour (also convert, when required, temperatures given in Centigrade to Fahrenheit or vice versa). Interpolate for winds (and temperatures) at intermediate altitudes.
2. Compute true headings and convert to magnetic headings by applying the appropriate magnetic variation corrections. Convert magnetic headings to compass headings by applying correction for deviation.
3. Compute estimated groundspeeds and estimated times enroute.
4. Compute estimated fuel required for flight based on estimated times enroute and the aircraft cruise performance charts.
5. Compute normal range and maximum range based on Cruise Performance Charts. Compute range with reserve allowance.
6. Make a thorough visual inspection. During this inspection, drain a generous amount of fuel from your fuel supply (fuel strainer and wing tank sump

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drains), and inspect for evidence of water contamination. If ice, snow, or frost is on the aircraft, remove completely.

H. Follow the recommended procedures in filing your VFR flight plan.

NOTE: Except for knowledge and interpretation of instruments in relation to *attitude control* of the airplane, the Basic and Advanced Ground Instructor Written Examinations will deal only with flight under VFR conditions.

II. Preflight—Basic Aeronautical Knowledge Indirectly Related to the Proposed Cross-Country Flight.

During the preflight portion of the examination, you will be questioned on additional aeronautical subjects. Some of these subjects may not directly relate to the proposed cross-country flight, but they are germane to the various airman certificates and ratings. These subject areas include:

A. Weather. As a ground instructor, you should demonstrate a broad understanding of weather. You should be familiar with—
   1. Basic concepts of the earth's atmosphere and the composition of air.
   2. Types of clouds and associated weather phenomena.
   3. General circulation patterns (winds).
   4. Air masses.
   5. Low and high pressure centers.
   6. Frontal weather (weather conditions generally associated with cold fronts, warm fronts, occluded fronts, etc.).
   7. Thunderstorms.
   8. Ice and turbulence.
   9. Fog and other visibility obscurations.
   10. Meteorological terminology (definitions).

B. Navigation. You should understand the following:
   1. The earth and its coordinates of latitude and longitude.
   2. Chart projections used for air navigation (with emphasis on the properties of the Lambert Conformal Conic Projection).
   3. Map reading.
   4. Dead reckoning.
      a. Wind triangle (vector) problems.
         (1) Determine true course and groundspeed.
         (2) Determine true heading and groundspeed.
         (3) Determine wind direction and velocity.
         (4) Determine true heading and true airspeed.
         (5) Off-course corrections.
      b. True course to compass heading.
      c. Compass heading to true course. (Application of wind, variation, and deviation corrections.)
      d. Speed—time—distance problems.
      e. Knots—m.p.h. conversions.
      f. Nautical — statute conversions for both speed and distance.
      g. Rates of climb and descent computations.
      h. Airspeed and altitude corrections.
      i. Centigrade—Fahrenheit conversions.
      j. Estimated time of arrival (ETA), estimated time enroute (ETE), and arrival scheduling.
      k. Cruise control.
      l. Use of flight log (preflight and in-flight).
   5. Radio navigation as it pertains to VFR flight. (See item E.)
   6. Navigation terminology (definitions).
   7. The vital relationship between weather phenomena and problems of navigation.

C. Aerodynamics and Principles of

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Flight. You should demonstrate a knowledge of—

1. Forces acting on an aircraft.
2. Principles of basic maneuvers.
3. Aircraft performance and factors affecting performance (with emphasis on the effect of density altitude on aircraft performance).
4. Static and dynamic stability (longitudinal and lateral).
5. V_y and V_x speeds.
6. Terminology and definitions.

D. Airframe and Powerplant. You should have a working knowledge of—

1. Aircraft structures.
2. Airframe components and control surfaces.
3. Fuel and fuel systems.
4. Oil and oil systems.
5. Electrical system fundamentals.
6. Reciprocating engine principles and components.
7. Carburetion and fuel injection.
8. Ignition.
9. Propellers.
10. Engine instruments.
11. Engine controls (throttle, propeller, mixture, carburetor heat, cowl flaps, etc.).
12. Relationship between r.p.m. and manifold pressure.
13. Brake mean effective pressure (BMEP), and its significance.

E. Radio Equipment. You should understand the basic characteristics, operations, frequency ranges, advantages, and limitations of—

1. VHF Communications Equipment. Understand the "line of sight" range of transmissions. Understand that an operative transmitter and receiver are all that are required to use VHF Direction Finding Service and radar assistance from ground stations. (In some instances, assistance may be available even when all radios are out if proper procedures are followed.)
2. VOR Equipment.
   a. Understand principle of VOR operation. Be able to recognize a usable signal.
   b. Know the components of your VOR receiver and the importance of proper tuning.
   c. Understand that a radial is a line of magnetic bearing extending *from* a VOR.
   d. Understand how to utilize receiver checkpoints to establish receiver accuracy.
   e. Be able to work a VOR orientation. Understand how to determine your approximate position relative to the station by interpreting the setting of the omni-bearing selector, the position of the LEFT-RIGHT needle, and the indication of the TO-FROM indicator. Understand the importance of correct "sensing".
   f. Know and understand the procedures for VOR off-course navigation and for solving time and distance problems.

*3. L/MF Range and ADF.
   a. By referring to your chart, be able to determine the magnetic direction of the four legs of low frequency ranges and the relative position of the "A" and "N" quadrants.
   b. Know how range legs are numbered, why average quadrant bisectors are used, and how they are obtained.
   c. Know the types of markers used with the L/MF range and their functions.
   d. Understand nondirectional beacons—their use, classification and range.

* Applicable primarily to Ground Instructor-Advanced Examination.

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e. Understand how to interpret bearing information when using your ADF for tracking inbound and outbound and for track interception.
(1) Relative Bearings.
(2) Magnetic Bearings.
(3) True Bearings.

F. Flight Instruments. You should understand the basic principles of operation and characteristics of all flight instruments.

1. Understand the basic similarity between visual and instrument flying with regard to control of aircraft attitude.
2. Be able to interpret the pitch-and-bank attitude of your aircraft by reference to the flight instruments.
3. Understand the bowl-type magnetic compass.
   a. Know the method of making turns by referring to the magnetic compass to determine the lead point at which to begin rolling out.
   b. Understand the following errors of the bowl magnetic compass:
      (1) Deviation.
      (2) Oscillation error.
      (3) Magnetic dip error. Dip error is responsible for:
         (*a*) *Northerly turn error* which is most pronounced on northerly and southerly headings; and
         (*b*) *Acceleration error* which is most pronounced on easterly and westerly headings.
4. Thoroughly understand the altimeter (sensitive altimeter adjustable for changes in barometric pressure).
   a. Know the effect of nonstandard temperature and pressure on the indications of the altimeter.
   b. Understand how to apply altimeter settings to the altimeter setting window of the altimeter.
   c. Be able to interpret the indications of the altimeter.
   d. Know how to determine pressure altitude.
5. The Airspeed Indicator. Know the eight airspeed ranges and limitations that are reflected by the standard marking system on the face of the airspeed indicator (white, green, and yellow arcs, and the red line).
   a. Flap operating range.
   b. Normal operating range.
   c. Caution range.
   d. Power-off stalling speed with the wing flaps and the landing gear in the landing position (V_{so}).
   e. Power-off stalling speed "clean"——wing flaps up and landing gear retracted (V_{s1}), if equipped with a retractable landing gear.
   f. Maximum flap extended speed (V_{fe}).
   g. Maximum structural cruising speed (V_{no}).
   h. Never-exceed speed (V_{ne}). (See fig. 27 in appendix.)

III. Prestarting Inspections.

A. Exterior Visual Inspection. Understand the importance of—

1. The use of a checklist in establishing good habit patterns.
2. Allowing sufficient time for a thorough and complete walk-around inspection as recommended by the aircraft manufacturer.
3. The emphasis placed on checking for, and adequate drainage of, possible fuel contamination.
4. Checking the pitot tube and static pressure orifice.
5. Ice, snow, and frost removal from the aircraft.

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IV. Starting, Taxiing, and Engine Runup.

A. Understand the need for—

1. Following a checklist based on manufacturer's recommendations.
2. Familiarity with emergency procedures with regard to engine or induction system fires.
3. Ground control or tower contacts where applicable for taxi clearance.
4. Careful observance of the oil pressure/temperature, and magneto checks; and where applicable, check on fuel pressure, cylinder head temperature, r.p.m., manifold pressure, flaps, trim, and full control travel in the proper direction.
5. Courtesy in control of propeller blast in taxiing and runup where proximity of other aircraft, buildings, and personnel are involved.

V. Takeoff.

A. Use your checklist.

B. Contact tower for takeoff clearance but check traffic carefully yourself. You are still responsible for the safety of your operation.

C. Activate any VFR flight plan by reporting time off to appropriate facility.

D. Be certain you clearly understand tower instructions.

E. Follow tower instructions without deviation except when cleared to do so, or in an emergency.

F. Check density altitude/performance.

G. Use takeoff performance charts. (See fig. 12 in the appendix.)

VI. In-Flight.

A. Climb to your selected altitude and complete your level-off procedures. Take necessary precautions to ensure accuracy when making readings from the bowl magnetic compass. Reset the gyro-driven heading indicator to the magnetic compass frequently.

B. Comply with FAR 91, *General Operating and Flight Rules*, at all times. Maintain a constant vigilance for other traffic.

C. Compute estimated true airspeeds and true altitudes. Be forever alert to density altitude, etc.

D. Determine time between checkpoints and compute groundspeed. Compute ETA over various checkpoints and destination. Keep log of time over various points.

E. Use good fuel management procedures. Keep close check on fuel consumption rate. Maintain proper fuel/air mixture setting appropriate to cruising altitude through proper use of mixture control.

F. If the winds-aloft forecast proves inaccurate, or if you drift off your flight-planned course, compute new headings and groundspeeds to destination from your present position.

G. Make periodic VFR position reports to Flight Service Stations. Give PIREPS (Pilot Reports) on unusual weather or erratic operation of radio navigation aids. Request weather information if necessary.

H. Be able to follow L/MF Range Legs and VOR radials.

I. Know how to tune in and identify a radio range or VOR station. Understand how to utilize an air navigation radio aid, i.e., VOR radial, L/MF range leg, and ADF bearing.

J. Have a working knowledge of the procedures for requesting radar vectors, D/F steers and associated enroute emergency navigation assistance.

K. Monitor appropriate stations for 15 minutes after the hour (area) and 45 minutes after the hour (airway) weather broadcasts. Maintain a continuous listening watch for possible in-flight weather safety advisories (SIGMET or AIRMET).

L. When operating in the vicinity of a large aircraft, be on the alert for wing-tip vortices (wakes of ex-

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treme turbulence behind aircraft). Take recommended action if you inadvertently encounter wing-tip vortices.

M. Avoid bad weather. Do not get trapped above an overcast. When necessary, use the 180° turn, but this device is reliable only when you have not waited too long to make the decision to turn.

N. Avoid turbulent air if possible. If you encounter severe turbulence, slow the aircraft to at least the recommended maneuvering speed.

O. Keep a continuous watch of all engine instruments. Be able to recognize symptoms of carburetor icing. Remember that, on aircraft equipped with constant speed propellers, the initial loss of power will be reflected by decreased manifold pressure, not by loss of r.p.m. due to action of propeller governor.

P. When making in-flight power adjustments, sequence your throttle and propeller controls in the correct order. Remember BMEP tolerances.

Q. Be prepared for in-flight emergencies—equipment failure, loss of orientation, or unexpected weather. Have alternate plans of action.

R. If you cross a Military Climb Corridor, be sure to fly at an altitude appropriate to the segment crossed.

S. If you take off or land at an airport located within an airport traffic area, follow applicable Regulations.

T. Know the official sunset time for the area over which you are flying. Turn your navigational lights on at the required time. Be familiar with airport lighting, runway lighting, and taxiway lighting.

U. Prior to starting your letdown, check to see that fuel selector is on the appropriate tank, and mixture control is in proper position. Take necessary precautions to avoid possible carburetor icing during prolonged letdowns at reduced power settings.

V. When approaching your destination, contact the tower for landing instructions. Be able to interpret instructions. (For example, if you are instructed to land on "RUNWAY 22 RIGHT TRAFFIC", you should understand you are to land on a runway with magnetic direction of 220°, using a right-hand traffic pattern.)

W. Use standard practice when entering traffic. Watch for light gun signals from the tower, in the air, or on the ground if your radio receiver becomes inoperative. Maintain a constant vigilance for other traffic. Be alert for segmented marker system or flashing amber light as indications of non-standard traffic.

X. Run a complete prelanding check, *using your checklist.*

Y. Understand the purpose and use of the Visual Approach Slope Indicator (VASI).

Z. After landing, switch to the appropriate ground control frequency if applicable (*after* turning off the active runway), and exercise extreme caution while taxiing back to ramp.

VII. Post-Flight Activities.

A. Turn off all switches and secure the controls.

B. Close your flight plan with the appropriate facility if you have not done so.

C. Refuel the aircraft in order to reduce condensation in the tanks and possible water contamination of the fuel.

D. If applicable, arrange for hangar space or tie-downs.

E. Understand procedures for notification and reporting of aircraft accidents and overdue aircraft as specified in Safety Investigation Regulation Part 320.

F. Record your flight time. (Not mandatory except to verify recent experience or to substantiate claim to experience necessary for grade of certificate or rating sought.)

THE SAMPLE EXAMINATION

The following test items are included for one purpose—to familiarize you with the type of questions you may expect to find on FAA examinations. Keep in mind that these few sample items do not include all of the topics on which you will be tested in the FAA examination. For this reason you should concentrate on the section entitled "Study Outline for the Ground Instructor Written Examination." A KNOWLEDGE OF ALL THE TOPICS MENTIONED IN THIS OUTLINE—NOT JUST THE MASTERY OF THE SAMPLE TEST ITEMS — SHOULD BE USED AS THE CRITERION FOR DETERMINING THAT YOU ARE PROPERLY PREPARED TO TAKE THE FAA WRITTEN EXAMINATION.

The appendix of this booklet contains the supplementary materials which will be required from time to time during the sample examination. These materials include weather information, aircraft description and performance data, the flight planning data (excerpted information from the *Airman's Information Manual,* diagrams, charts, and illustrations).

This examination is divided into two sections. The first section tests for basic knowledge in *Fundamentals of Instructing.* It is necessary that an applicant for a Ground Instructor certificate pass a written examination dealing with the conditions, techniques, and principles which control the learning process. This examination is separate from, and in addition to, the written examination on subjects which pertain to the rating he seeks (Basic, Advanced or Instrument). The applicant may, if he chooses to do so, take this written examination on the same day that he takes the examination on the subjects covered by the rating sought. However, he may take it on another date before taking the written examination on subjects pertaining to the rating sought. Regardless of his choice as to when he takes this examination, *both* sections must be passed by an applicant. It is *not* necessary, however, to take the examination on *Fundamentals of Instructing* for each additional rating sought. For example, if an applicant for the Basic Ground Instructor rating passes both the section on *Fundamentals of Instructing* and the section pertaining to Navigation, Meteorology, Federal Aviation Regulations, Aircraft and Engines, it is not necessary for him to again pass the section on *Fundamentals of Instructing* to obtain either the Advanced Ground Instructor rating or the Instrument Ground Instructor rating. He only needs to pass an examination on the subject matter pertaining to the rating he seeks.

The second section of the sample examination is based on an operational realistic cross-country flight where general knowledge must be applied to practical situations. Answers and explanations to the questions which follow may be found on page 25 through page 30.

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SAMPLE EXAMINATION

Section 1 — Fundamentals of Instructing

1. Test reliability refers to the
   1——characteristic of a test which indicates consistent results for a test over a period of time.
   2——measure of temporary variations influenced by chance errors.
   3——accuracy with which an examination identifies the superior students.
   4——exactness with which a test measures what it is supposed to measure.
2. If an instructor wishes to do an effective job of teaching, the most important requirement is that he master
   1——only teaching methods.
   2——only his subject matter.
   3——both teaching methods and subject matter.
   4——public speaking technique.
3. One of the most significant sources of information for an instructor with regard to the need to develop new and better ways of improving his teaching effectiveness lies in
   1——noting whether a comparison between his methods and those used by successful teachers is favorable or unfavorable.
   2——the observations and suggestions made by supervisors and other instructors.
   3——the observation and evaluation of the difficulties which his students are having.
   4——listening to student's suggestions.
4. Good instruction techniques involve many important elements. Select the answer which includes only those items important to good instruction.
   A. Evaluate the student and recognize his difficulties as an individual.
   B. Instruct each class in exactly the same manner so as to assure a constant level of student proficiency.
   C. Set specific goals.
   D. Avoid setting standards of performance lest failure to meet them prevents progress.
   E. Acquaint the student with his progress only if he seems concerned about the matter.
   F. Keep student informed of his progress.
   G. Allow the student to participate in the class session and demonstrate his ability, but anticipate mistakes, and if possible correct them before they occur.
   H. Use a teaching sequence that "makes sense" from the learner's point of view.
   I. Improve motivation through use of negative incentives.
   J. Use oral questions in the classroom to evaluate progress and level of learning.
   K. Use a lesson plan even if it is inadequate.
   L. Emphasize the lecture method of instruction.
   M. Limit classroom practice as much as possible since it consumes too much time.
   1——A, C, F, H, J, K.
   2——B, D, E, G, I, L, M.
   3——A, D, E, H, L.
   4——C, F, G, H, K.
5. True comprehension and understanding of a subject is the very essence of any learning. The best way to determine if a student really understands a subject is to
   1——accept a high grade average as evidence of such understanding.

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: I. CLUTCH

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Remove, Test, Replace, and Adjust Clutch

CONDITIONS:

BEHAVIOR:

22. Make final tests and adjustments following all steps as outlined in the manual
23. If final tests and checks are satisfactory, return tools and materials to proper place
24. Return automobile to proper parking area
25. Remove covers from front seat and store in proper place
26. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, test, replace, and adjust clutch in 3 hours.

Learning time: 4 hours

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2——give examinations which require high levels of retention in order to make a good grade.

3——ascertain that the student can actually apply his knowledge to all the problems covered in the classroom program.

4——test the student's ability to apply his knowledge toward solving new and difficult situations.

Section 2 — Aeronautical Knowledge

This part of the examination is based on a flight from Gallup, New Mexico, to Holbrook, Arizona, to Flagstaff, Arizona, and to Williams, Arizona.

Although this is a hypothetical cross-country, the weather data is authentic. The airplane you are assumed to be flying is a late model, 4-place, single-engine airplane. It is equipped with retractable, tricycle landing gear and a constant speed propeller. It is typical of several models currently being produced by various manufacturers. This airplane is designated as DAEDALIAN DART 2468–W. It is to be flown in accordance with FAA-approved Airplane Flight Manuals and placards that appear in the airplane.

PROPOSED CROSS-COUNTRY FLIGHT DATA

You are a professional pilot employed by an engineering corporation whose home office is in Gallup, New Mexico. You are scheduled for a flight originating in Gallup, New Mexico, and terminating in Williams, Arizona, with intermediate stops at Holbrook, Arizona, and Flagstaff, Arizona.

You will carry three corporation executives who are conducting a business survey. You have established your tentative route on WAC Chart 405 as follows:

LEG I

McKinley County Airport, Gallup, New Mexico, to Holbrook Municipal Airport, Holbrook, Arizona, via direct route.

LEG II

Holbrook Municipal Airport, Holbrook, Arizona, to Flagstaff Municipal Airport, Flagstaff, Arizona, via direct route to Winslow, Arizona, VORTAC; thence direct route to Flagstaff Airport.

LEG III

Flagstaff Municipal Airport, Flagstaff, Arizona, to Williams Municipal Airport, Williams, Arizona via direct route.

Except for Gallup, New Mexico, the places named can be located in respect to the closest town by reference to the excerpt from the *Airman's Information Manual,* figure 18, in the appendix.

Your preflight activities include:

1. Any necessary review of the *Airplane Flight Manual, Operation Placards,* and *Owner's Handbook,* with particular emphasis on operating speeds, power and mixture settings, weight and balance considerations, and emergency procedures.
2. A study of pertinent information in the *Airman's Information Manual.*
3. A review of your map with emphasis on the relationship between your route and airway structure, terrain and obstruction elevations, and all airport facilities available enroute in event of emergency.
4. A review of radio checkpoints and facilities.
5. Thorough check of all available weather information.
6. Filing a flight plan.
7. Preflight check of the airplane.

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1. Federal Aviation Regulations require careful preflight planning

1——only on flights that are conducted off-airways.

2——on all cross-country flights.

3——only on flights for hire.

4——only on flights which carry passengers.

2. According to the 0700 Hourly Sequence Report (see fig. 5 in the appendix),

1——PHX reports a ceiling of 12,000 feet.

2——PRC reports a pressure of 906.4 millibars.

3——TUS reports an altimeter setting of 39.83 inches.

4——GNT reports calm surface winds.

3. The 0800 Hourly Sequence Report at Phoenix, Arizona, (see fig. 5) indicates that

1——the ceiling is 10,000 feet.

2——the ceiling is 1,200 feet.

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3——the ceiling is 12,000 feet.
4——there is no reported ceiling at Phoenix.

4. You plan to depart at 0830 MST and a study of all the Hourly Sequence Reports in figure 5 permits you to conclude that

1——you have no weather problem with regard to the flight.
2——you can anticipate frontal activity between *0700* MST and *0800* MST.
3——ceilings will decrease along the route.
4——you are unable to ascertain what the weather is likely to do in the next few hours.

5. A study of *all* the weather information *available* to you before you start the flight (see figs. 3, 4, and 5 of the appendix) will allow you to deduce that

1——it is not possible to estimate what the weather is likely to do in the next few hours.
2——turbulence and surface winds are likely to be your principal enroute weather problems.
3——scattered thunderstorms will probably occur along your route before *1200* MST.
4——it would be best to fly as low as terrain and obstruction clearance will permit because of more favorable winds.

6. Your World Aeronautical Chart 405 is based on the Lambert Conformal Conic Projection, a chart projection which is much used for aeronautical charts because

1——scale errors are small, so for all practical purposes, scale may be considered constant over a single sheet.
2——it affords a simple and satisfactory solution for all problems of navigation, both rhumb line and great circle.
3——its directions conform very closely to directions on the earth.
4——all of the above are true.

NOTE: See figure 22 in the appendix for a diagram of this projection.

7. Pressure altitude and indicated altitude are approximately the same at 5,000 feet *above the ground* over Tucson, Arizona. Indicated airspeed is 170 m.p.h. If you use the TUS FD (Winds-Aloft Forecast) given in figure 4 of the appendix, you determine that

1——TAS is approximately 197 m.p.h.
2——TAS is approximately 183 m.p.h.
3——TAS is approximately 190 m.p.h.
4——there is not enough information available to find true airspeed.

NOTE: Assume CAS (Calibrated Airspeed) to be identical to IAS.

8. The statements listed below concerning the 1:00 a.m. EST surface weather map (see fig. 6 of appendix) may or may not be correct.

A. Tropical maritime air is south and east of the fronts while polar maritime air lies NW of the N–S front.
B. The front which extends eastward from Salt Lake City is an occluded front.
C. The front which extends eastward from Salt Lake City is a stationary front.
D. The isobar of lowest pressure that can be identified is the 1004.0-millibar line.
E. The isobaric pattern is such that the surface winds over the area pictured should be moderately strong (25 to 30 knots).
F. The surface wind at Winslow, Arizona, is from the north.
G. The surface temperature is 67° F. and dewpoint is 29° F. at Winslow, Arizona.

In selecting all the correct statements from the preceding, you would include items

1——A, B, E, and G.
2——A, C, D, and G.
3——C, D, and G.
4——B, E, and F.

9. Your weight .....165 lbs.
Front seat passenger weight ..150 lbs.
Rear seat passenger weight ..365 lbs.
Fuel .....Full
Oil .....Full
Baggage .....150 lbs.

Using the above information, together with data from the Aircraft Description in figure

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8, you are able to determine through use of the Loading Graph and Center of Gravity Envelope Graph (fig. 10 of the appendix) that

1——your gross weight and balance requirements are both within limits.
2——your weight is in excess of maximum gross limit and until it is within limits it would be a waste of time to attempt to evaluate the center of gravity condition.
3——both weight and balance conditions are outside of established limits.
4——it is not possible to determine if the weight and balance conditions are within limit on the basis of information supplied.

10. If you were to drain 21 gallons of fuel from your tanks, you will

1——be within all placarded limitations.
2——still exceed placarded baggage limitations.
3——still exceed gross weight and balance limitations.
4——still be unable to figure your weight and balance problems because there is not enough information.

Your flight is comparatively short with two intermediate stops, so you decide to drain 21 gallons of gas and readjust your load in order to provide for better aircraft performance as well as allow for other important considerations.

11. You plan to remain VFR at all times, and to avoid turbulence as much as possible, you plan to fly more than 3,000 feet above the ground enroute. Your enroute altitude

1——would be indeterminable until you compute the magnetic heading.
2——should be odd thousand plus 500 feet from Gallup, New Mexico, to Holbrook, Arizona.
3——should be odd thousand plus 500 feet.
4——should be even thousand plus 500 feet.

12. Concerning Airport Traffic Area Rules as required by Federal Aviation Regulations, which of the following statements apply?

A. An Airport Traffic Area is defined as the space included within a 5-statute-mile horizontal radius of the geographical center of an airport and extending up to (but not including) 2,000 feet above the surface of the airport at which an operative traffic control tower is located.

B. Aircraft, when operating to or from an airport having a tower operated by the United States, shall normally maintain two-way radio communication with that tower while in the Airport Traffic Area.

C. The basic VFR minimums when operating in an Airport Advisory Service Area are 5 miles visibility and 1,500-foot ceiling.

D. Unless he receives subsequent instructions to the contrary, a pilot who has been authorized by the tower to taxi "TO" a designated runway may cross any runways that intersect or cross his taxi route.

1——A, B, D.
2——A, B, C, D.
3——B, C.
4——A, B, C.

13. Refer to the *Airman's Information Manual* data in figures 14, 15, 16, 17, 18, and 19 of the appendix, and determine which of the following statements are ACCURATE.

A. The Holbrook Municipal Airport, Holbrook, Arizona, has only one runway.

B. The longest runway at Holbrook Municipal Airport is between 4,970 and 5,069 feet in length.

C. A Flight Service Station is located on the Tucson Municipal Airport, Tucson, Arizona.

D. Neither the Holbrook nor the Flagstaff Airport has UNICOM facilities.

E. Both the Holbrook and the Flagstaff Airports have the proper fuel for your airplane.

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F. At Prescott, Arizona, Runway 3–21 is closed for takeoff and landing until further notice.

1——A, B, D, E.
2——C, E.
3——B, C, E.
4——B, D, F.

14. Of the airports where you intend to land along your route of flight, only the Winslow Municipal Airport, Winslow, Arizona, is within a control zone. If you were to land here, your basic VFR minimums would

1——be the same as for the other airports where you intend to land.
2——require 5 miles visibility and a ceiling of 1,500 feet.
3——require 3 miles visibility and a ceiling of 1,200 feet.
4——require 3 miles visibility and a ceiling of at least 1,000 feet.

LEG I

15. If you were to select 10,500 feet MSL as your cruising altitude on the first leg of your flight, and at that indicated altitude found your pressure altitude to be 10,000 feet, your approximate compass heading and true airspeed should be

1——230° and 180 m.p.h.
2——229° and 173 m.p.h.
3——251° and 173 m.p.h.
4——251° and 179 m.p.h.

NOTE: Use an indicated airspeed of 150 m.p.h., outside air temperature of 10° C and the Winslow Winds Aloft Forecast (fig. 4). You need not interpolate the winds. (See fig. 9 for compass correction card.)

16. Assuming a gross weight of 2,900 lbs., together with a surface temperature of 73° F. and an estimated surface wind of 13 knots, your approximate takeoff distance to clear a 50-foot obstacle at Gallup, New Mexico, is

1——1,955 feet.
2——1,638 feet.
3——1,817 feet.
4——1,390 feet.

NOTE: Refer to the performance charts (fig. 12 of the appendix).

17. After your takeoff from Gallup, New Mexico, at 0830 MST, you notice as you climb out on course that you are passing through 8,800 feet. Which of the altimeter illustrations in figure 23 of the appendix indicates this altitude?

1——A.
2——B.
3——C.
4——D.

18. Assume that you have 33 gallons of usable fuel remaining after you reach 10,500 feet. Approximately how long can you fly with a power setting of 2200 r.p.m. and 19 inches of manifold pressure if you retain a 30-minute fuel reserve?

1——2 hours and 52 minutes.
2——5 hours and 6 minutes.
3——3 hours and 21 minutes.
4——None of the above are correct.

NOTE: Refer to the 10,000-ft. Cruise Performance Chart in the appendix, figure 13.

*19. While enroute to Holbrook, Arizona, you use ADF to tune in and properly identify the Winslow, Arizona, low frequency navigation aid. The proper setting for the function switch when warming up and tuning the ADF is

1——loop position.
2——antenna (receiver) position.
3——compass position.
4——aural null position.

*20. You are able to read the coded identifier for the Winslow L/MF facility satisfactorily, but repeated trials prove that there are neither "A" nor "N" quadrant signals, nor on-course signals. After a careful check of your equipment, the chart, and the Airport/Facility Directory of the *Airman's Information Manual* (figure 17 of the appendix), you decide

1——the L/MF ground facility is not functioning properly.
2——you have lost your sensing antenna.
3——your function switch was on the aural null position.
4——the Winslow L/MF navigation aid is no longer an L/MF radio range station.

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LEG II

21. If you select 10,500 feet as your cruising altitude on the flight from Holbrook, Arizona, to Flagstaff, Arizona, and use an estimated indicated airspeed of 170 m.p.h., an outside air temperature of +15° C. and the Winslow Winds-Aloft Forecast (fig. 4 in the appendix), you compute your estimated average groundspeed for this leg to be approximately

1——187 m.p.h.
2——175 m.p.h.
3——150 m.p.h.
4——None of the above.

NOTE: You need not interpolate winds. Assume pressure altitude and indicated altitude to be the same.

22. Assume that on this leg of the flight, conditions are favorable for carburetor icing. To properly cope with this condition, you should know that

A. in your airplane, the first evidence of carburetor icing would be a decrease in r.p.m., followed by engine roughness.
B. the first indication of carburetor icing is engine roughness, followed by loss of engine r.p.m.
C. in your airplane the first evidence of carburetor icing would most likely be a decrease in manifold pressure.
D. it is best to use carburetor heat as a preventive measure rather than as a measure to cure the icing condition.
E. it is best to wait until there is some evidence of carburetor icing before application of carburetor heat since application of heat when no ice is present will result in a lean mixture and possible detonation.

In selecting correct statements from the above list, you would include items

1——A and D.
2——B and E.
3——C and E.
4——C and D.

23. As you approach the Winslow, Arizona, VORTAC, you note that your course will cause you to cross the path of a four-engine jet. This crossing will be approximately 3 miles behind and slightly below the jet. If you are familiar with hazards involving turbulence in the wake of large aircraft, you would select which of the following as correct statements?

A. The main source of the disturbance or turbulence is the "jet wash" or "prop wash".
B. The main source of the disturbance or turbulence is the vortex created by the wing tips.
C. Large, heavy, slow flying aircraft produce the most violent turbulence or vortices.
D. The violent, compact, tornado-like air masses associated with this phenomena can cause loss of aircraft control or even structural failure.
E. Under the circumstances described, you are too far from the jet to be affected by this invisible hazard.
F. If you encounter this hazard in cruising flight, you should decrease speed as fast as possible, avoid "fighting the controls", and if possible change altitude.
G. If taking off or landing behind large aircraft, fly up-wind of their track, KEEP PLENTY OF DISTANCE, and request delay from the tower on takeoffs and landings if in doubt about wake turbulence or spacing.
H. Helicopters can create conditions of vortex turbulence similar to that produced by fixed-wing aircraft and you should stay above their flight path.

1——B, C, D, F, G, and H.
2——A, D, E, F, and G.
3——A, C, D, E, and G.
4——B, E, F, and H.

24. If, for some reason, you were to lose your visual references while taking evasive action with regard to the jet, and a check of your instruments showed the readings pictured in figure 25 in the appendix, which of the following statements are true? You are in a

A. coordinated, descending turn to the right, and should first reduce power and bank to return to level flight.

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B. coordinated, descending turn to the right, and should first add power and increase back pressure to return to level flight.

C. skidding, climbing turn to the left.

D. nose-high attitude.

E. nose-low attitude.

F. 20° bank, approximately.

G. standard rate turn.

1——A, D, F, and G.

2——B, E, F, and G.

3——A, E, F, and G.

4——C and D only.

25. Assume that you now find yourself in a coordinated level turn with a 40° bank. Your present gross weight, when in straight and level flight, is 2,800 pounds. Referring to the illustrations in figure 26 in the appendix, which of the following statements are correct?

A. In the situation depicted in illustration A, your approximate effective gross weight is 3,668 pounds.

B. Your rate of turn is the same for situation A, B, and C, but the radius of turn increases as the speed increases.

C. The radius of turn remains constant for situations A, B, and C, but the rate of turn will increase as the speed increases.

D. The radius of turn is less, but the rate of turn is greater in situation A than in either B or C.

E. The load factor increases as the speed increases.

1——B and C.

2——A, C, and D.

3——A, B, and D.

4——A and D.

26. Soon after leveling off on-course, you encounter moderate turbulence and quickly you check your airspeed indicator which appears in figure 27 of the appendix. If you wished to remain at or below maximum structural cruising speed, you could not exceed

1——252 m.p.h.

2——10 m.p.h. less than red line speed.

3——210 m.p.h.

4——None of the above are correct.

*27. In the vicinity of Winslow, Arizona, you decide to combine ADF navigation and pilotage. You tune in and identify the Winslow low frequency radio aid to navigation. You next place the ADF function switch on COMP. After the ADF needle holds a steady indication, you check your magnetic heading and the ADF readings. Their indications are shown in figure 28 in the appendix. This means you have a

1——magnetic bearing of 45° to the station and that you are southwest of the station.

2——relative bearing of 45°, but your bearing to the station cannot be determined with the information supplied.

3——magnetic bearing of 315° to the station, and that you are southeast of the station.

4——magnetic bearing of 45° to the station and that you are southeast of the station.

NOTE: Assume a nonrotatable azimuth dial on the ADF.

28. You are ready to land on Runway 21 at Flagstaff, Arizona, Municipal Airport, after a total flying time of 1 hour and 5 minutes since leaving Gallup, New Mexico. Fuel consumption has been at the rate of 10 gallons per hour. Surface wind is 20 knots from 210°, and surface temperature is 75° F. You will use 40° of flaps for the landing. Referring to the landing table in figure 12 of the appendix, your landing distance for clearing a 50-foot obstacle is approximately

1——834 feet if the temperature were standard at your altitude.

2——973 feet regardless of the temperature.

3——1,390 feet.

4——645 feet.

NOTE: Interpolate weight to the closest 500 pounds, altitude to the closest 500 feet, and wind to the closest 6 m.p.h. Assume takeoff gross weight was 2,900 pounds.

LEG III

29. It is 1700 MST before your clients are ready to take off for Williams, Arizona. A check of the *latest* area forecast, terminal forecast, and in-flight weather advisories in

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figures 3, and 4, of the appendix indicates that there should be

1——only scattered clouds at 8,000 feet above the ground, and turbulence should remain about the same as the evening progresses.

2——increasing turbulence and decreasing clouds as the evening progresses.

3——no ceilings below 10,000 feet MSL, and turbulence should gradually decrease.

4——scattered clouds at 8,000 feet, broken clouds 12,000 — 15,000 above ground, and gradually decreasing turbulence.

30. After departing Flagstaff, Arizona, you wish to "dog-leg" your direct route so as to stay away from the Restricted Area (R–2302), 7 miles west of Flagstaff, and yet stay close to the highway and railroad to Williams. You tune in and identify the Winslow VORTAC with the omni bearing selector set on 270°. If you did not know your position and used *only* your omni, which reads as illustrated in figure 29 in the appendix, you would know that you are

1——on the 90° radial and flying toward the station.

2——on the 270° radial and flying away from the station.

3——unable to determine at the moment where you are going, but you are on the 270° radial.

4——unable to determine *anything* about where you are, or where you are going.

31. Assume that in taxiing to the flight line at the Williams Municipal Airport, Williams, Arizona, your nosewheel collapses causing damage in excess of $300.00. If you were unsure about accident reporting procedures, you could find the necessary information in

1——Part 61, Federal Aviation Regulations.

2——Part 67, Federal Aviation Regulations.

3——Part 1, Federal Aviation Regulations.

4——Civil Aeronautics Board, Safety Investigation Regulations Part 320.

32. Usually the first measure appropriate for control of detonation on takeoff in an aircraft with constant speed propellers is the

1——reduction of manifold pressure.

2——reduction of r.p.m.

3——adjustment of mixture to a leaner setting.

4——application of carburetor heat.

* Indicates questions that are applicable primarily to the Ground Instructor—Advanced Examination.

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ANSWERS AND EXPLANATIONS

Section 1 — Fundamentals of Instructing

1. (1) Alternate #2 is incorrect because it refers only to one of the factors which affect reliability, not the complete evaluation of reliability. Alternate #3 has nothing to do with reliability of a test. Alternate #4 is the definition for validity.

2. (3) Alternates #1 and #2 are not complete. Alternate #4, while useful, is not as essential to success in teaching as item #3.

3. (3) All of the other responses are means of effecting improvement, not clues to determining the need for improvement.

4. (1) The statements made in this question cover a broad range of items; however, the correct response may be found in *Flight Instructor's Handbook*, AC 61–16. Response #2 is incorrect because every item included in it is incorrect. Response #3 is incorrect because items D, E, and L are incorrect. Response #4 is incorrect because it includes item G.

5. (4) All other responses will test for rote memory on ability to deal with familiar problems which, in themselves, will not effectively prove that the student *understands* what he knows.

Section 2 — Aeronautical Knowledge

1. (2) FAR 91.5, *Preflight Action*, states: "Each pilot in command shall, before beginning a flight, familiarize himself with all available information concerning that flight. This information must include, for a flight under IFR or a flight not in the vicinity of an airport, available weather reports and forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which he has been advised by ATC."

2. (4) The 0700 Sequence Report for GNT shows the letter "Ø Ø Ø Ø" in the space denoting surface wind which designates a calm wind condition.

3. (4) The reported layer of *thin* broken clouds at 12,000 feet does not constitute a ceiling. (Reference *Aviation Weather* AC 00–6, and Part 1 of the Federal Aviation Regulations.)

4. (4) The study of hourly sequence reports *only* will not furnish sufficient information to make a route forecast of your own. (Reference *Aviation Weather* AC 00-6.)

5. (2) The terminal forecasts call for surface winds in this area to be 20 to 30 knots. The in-flight advisory calls for light to moderate turbulence below 14,000 feet until at least 1900M. Area forecasts covering the period between 0600 MST and 1800 MST call for light to moderate turbulence with locally severe turbulence in some areas. The 1245Z Pilot Report Summary supports the Terminal and Area Forecasts and In-Flight Advisory.

6. (4) The first three statements are all true. (Reference p. 16–28, *Practical Air Navigation*, 9th edition.)

7. (1) Using a pressure altitude of 7,630 (5,000 feet plus ground elevation at TUS), and a forecast temperature of +20° C., (you must interpolate the temperature between 5,000 feet and 10,000 feet) your computer should indicate approximately 197 m.p.h. TAS opposite a CAS of 170 m.p.h. Normally the indicated airspeed should be corrected for instrument and installation errors to calibrated airspeed. This can be done through the use of an airspeed correction table as shown in figure 33. Remember, calibrated airspeed (CAS) is the same as true indicated airspeed (TIAS).

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8. (2) The air mass to the south and east of the front is composed of tropical maritime air as represented by the symbol "MT" located in the Texas Panhandle. The air mass to the northwest of the front is composed of maritime polar air as represented by the symbol "MP" located in Northern California. (Reference *Aviation Weather* AC 00-6.) The portion of the front extending eastward from Salt Lake City is stationary as indicated by a combination of the warm front and cold front symbols and their placement (opposing) on the frontal line. (Reference *Aviation Weather* AC 00–6.)

Isobars are lines connecting points of equal pressure. The line curving into Nevada from Cedar, Utah, and back to the front at a point north of Salt Lake City, Utah, represents a pressure of 1004.0 millibars as indicated by the figure "1004." (Reference *Aviation Weather* AC 00–6.)

The figure "67" at the 10 o'clock position and the figure "29" at the 8 o'clock position on the Winslow station model represent a temperature of 67° F. and a dewpoint of 29° F. respectively. (See the specimen station model in fig. 6.)

9. (2) The empty weight, including unusable fuel, is 1839 lbs. (figs. 8 and 11). The empty weight moment is approximately 65,900 pound-inches (empty weight X empty C.G.).

LOADING PROBLEM

	Weight in Pounds	*Moment in Thousand Pound-Inches*
Airplane (empty)	1839	65.9
Pilot and Front Seat Passenger	315	11.5
Rear Seat Passengers ..	365	25.4
Fuel (55 gal. @ 6 lbs. per gal., fig. 9)	330	15.8
Oil (3 gal. @ 7.5 lbs. per gal., fig. 11)	22.5	−.4
Baggage	150	14.1*
TOTAL	3021.5	132.3

*Extrapolated From Loading Graph, Figure 10.

In this particular instance it is not possible to state with absolute certainty that the airplane is not within safe balance limits even though it exceeds weight limits. The moment of 132.3 does lie within the extended lines on the chart which delineate the forward and rearward C.G. limits. In reality, the question becomes rather academic since you could not legally take off with a gross weight of 3021.5 pounds, regardless of the situation with regard to C.G. Your gross weight is 121.5 pounds in excess of the maximum allowable gross weight; therefore, you must reduce the load to 2900 pounds or less and recompute the center of gravity. (Reference figures 10 and 11, and *Flight Training Handbook*, AC 1–21.)

10. (2) The draining of 21 gallons (126 lbs.) of fuel would reduce the gross weight below the maximum allowable, but the baggage weight still would exceed maximum allowable weight of 125 pounds in the baggage compartment. (Reference fig. 8.)

11. (4) When an aircraft is operated in level cruising flight at 3,000 feet or more above the surface, the cruising altitudes . . . shall be observed:

(a) "Below 18,000 feet. At an altitude appropriate to the magnetic course being flown as follows:
  (1) ". . ."
  (2) "180° to 359° inclusive, at even thousands plus 500 (4,500; 6,500; etc.)." (Reference FAR 91.109.)

12. (1) Statements A, B, and D are correct. (Reference FAR 1, *Definitions*, for Statement A; FAR 91.87, *Operation at Airports with Operating Control Towers*, for Statements B and D.

13. (3) Statements B, C, and E are accurate and may be verified by referring to figures 14, 15, 16, 17, and 18 in the appendix. A careful analysis of figures 14, 15, 16, 17, 18, and 19 will reveal that statements A, D, and F are erroneous.

14. (4) Regulations pertaining to *basic* VFR minimums state that an aircraft shall not be flown within a control zone beneath the ceiling if the ceiling is less than 1,000 feet. Neither shall any person operate an aircraft in flight within a control zone when the flight visibility is less than 3 miles. When ground visibility is less than 3 miles no person shall take off or land an aircraft, or enter

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the traffic pattern of an airport within a control zone. Study FAR 91.105.

15. (1) Given Indicated Airspeed
——150 m.p.h.
Given Pressure Altitude
——10,000 Feet
Given Outside Air Temperature
—— +10° C.
Computed True Airspeed
——180 m.p.h.
Plotted True Course
——243°
Figure 4—Wind
——230°/29 m.p.h. (25 knots)
Computed Wind Correction Angle
—— −2°
Computed True Heading
——241°
Chart Magnetic Variation
——14° E.
Computed Magnetic Heading
——227°
Figure 9 (intermediate) compass deviation
—— +3°
Computed Compass Heading
——230°

16. (2) The elevation of McKinley County Airport at Gallup, New Mexico, is 6,467 feet. Referring to the takeoff data chart in figure 12, you will note that interpolation between the 5,000-foot and 7,500-foot column will be necessary. Enter the chart at the 2900 lb. gross weight block and read across (right) on the 15 m.p.h. (13 knots) line to:

5,000 ft.—1,200′ to clear 50′ obstacle
7,500 ft.—1,580′ to clear 50′ obstacle
Difference—380′
Interpolate for 6,467 feet—59% of 380′ plus 1,200 feet (in actual practice 60% would probably be more desirable)
6,467 feet—1,424′ to clear 50′ obstacle (*with standard temperature*)
Interpolated standard temperature for 6,467 feet is +36° F. Current temperature of +73° F. will necessitate increasing the takeoff distance by 15% (current temperature is 37° higher than standard).

Final Computed Takeoff Distance at Gallup is *1,638* feet.

17. (2) The altitudes indicated by the four altimeters are as follows:

A. 880 feet.
B. 8,800 feet.
C. 18,800 feet.
D. 7,880 feet.

18. (1) Figure 13 in the appendix shows a fuel consumption of 9.8 gal./hr. at 10,000 feet with a power setting of 2200 r.p.m. and 19 inches of manifold pressure. Subtracting the 30-minute fuel reserve from the total of 33 gallons leaves 28.1 gallons of fuel (33 gallons—4.9 gallons). Burning 28.1 gallons of fuel at the rate of 9.8 gallons per hour would permit 2 hours 52 minutes of flying. Study the charts until you understand their use.

19. (2) When tuning a radio compass, the set should be allowed to warm up with the switch in the "Ant" or "Rcvr" position.

20. (4) A careful check of the excerpt from the *Airman's Information Manual,* figure 17, shows that the Winslow low frequency facility is now classified as RBN H-SAB. From the information in figure 17, we find that this means it is a non-directional radio beacon providing automatic transcribed weather service (TWEB). The WAC Chart is not current in the information it provides with regard to this radio navigation aid. This illustrates one of the reasons why some of the information which appears on charts must be cross-checked against appropriate supplemental sources of information. *Use* the *Airman's Information Manual* in planning and conducting flights. Study chapter 4 of *Practical Air Navigation.* Note in particular the last paragraph on page 58.

21. (1) You must first correct indicated airspeed to true airspeed. An indicated airspeed of 170 m.p.h. at 10,500 feet and +15° C. results in a true airspeed of 207 m.p.h. To compute the average groundspeed you could either use an average true course and apply the wind to this or apply the wind to each segment of the leg and average the resulting groundspeeds. It should be noted that technically this procedure is not abso-

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: II. TRANSMISSIONS - STANDARD, MANUAL SHIFT

PERFORMANCE OBJECTIVE NO: 2 TITLE: Disassemble, Check, and Reassemble Standard Transmission

CONDITIONS:

Students will learn the related information listed below

ITEM	REFERENCE	SOURCE
1. Fundamentals and Servicing Standard Transmissions	1. Automotive Mechanics, by Crouse. pp. 405 through 426, 438 through 439, 441 through 445 Automotive Chassis Workbook, by Crouse. Jobs 4 through 7	1. Related Information Class
2. "The Transmission"	2. Filmstrip	2. Resource Materials Center
3. "The 4 - Speed Transmission"	3. Filmstrip	3. Resource Materials Center
4. "The Synchro-mesh Transmission"	4. Filmstrip	4. Resource Materials Center
5. Transmissions	5. Teaching Machine cards 17C, 18A, 18B, 18C	5. Teaching Machine (Shop)

lutely accurate since it is 10 miles more from the INW to Flagstaff than from Holbrook Airport to INW VORTAC. However, the difference in groundspeeds over the two segments is negligible; therefore, the time difference would be slight. The INW winds aloft forecast shows the wind at 10,000 feet is from 230° true, at approximately 29 m.p.h. Whether you apply this wind to an average true course of 279° or to the exact true course for each segment and average the resulting groundspeeds, the answer is the same—187 m.p.h.

22. (4) In aircraft with constant speed propellers, loss of power is first reflected in the manifold pressure reading since the propeller governor will maintain the r.p.m. setting made with the propeller control. Engine roughness generally does not develop to a noticeable degree until icing has progressed beyond the point where it could have been recognized by loss of manifold pressure. It is far easier and safer to prevent the formation of carburetor ice than to remove it after it has formed. Study chapter 18 of *Private Pilot's Handbook of Aeronautical Knowledge.*

23. (1) This problem is covered in detail in Exam-O-Gram No. 3 and Advisory Circular 90–23, *Wake Turbulence* (information available at General Aviation District Offices or through the FAA, Washington, D. C. 20590). You should study both of these publications carefully.

24. (3) The quality of a turn (slipping, skidding, coordinated) is indicated by the position of the ball in the turn-and-bank indicator. If the ball is in the center between the two reference markers, the turn is coordinated. The aircraft is in a nose-low attitude since the attitude indicator (artificial horizon) shows the nose below the horizon and the other instruments show a descent. Even if the attitude indicator were malfunctioning, it is scarcely possible to be in other than a nose-low attitude in your airplane with the airspeed, vertical speed, and altimeter indicating as illustrated. The attitude indicator shows a 20° bank to the right (each of the small graduations on the scale at the top of the instrument is for 10°). The turn needle also indicates a turn to the right at a standard rate. Reduce power, decrease bank, and then apply back pressure as necessary to recover when the nose is low and the airspeed is increasing. This is much safer than adding back pressure first which might well increase the load factor beyond safe limits.

25. (4) The load factor for a 40° bank is determined by using the graph in figure 26. This graph gives a load factor of approximately 1.31 for a 40° bank. Multiplying 2800 by 1.31 results in an effective gross weight of 3,668 lbs. In order to maintain a given rate of turn, the angle of bank must be varied with the TAS. If, for example, you wish to hold a standard rate turn of 3° per second at a true airspeed of 100 m.p.h., your angle of bank will be 13.5°. The bank required to produce this same rate of turn at 200 m.p.h. TAS is nearly double the bank required at 100 m.p.h. It now becomes 25.6°; therefore, the rate of turn must decrease if the TAS increases while the bank remains constant. It then follows that any given bank at slow speed provides a higher rate of turn and results in a smaller radius of turn than the same degree of bank at higher speeds.

26. (3) Maximum structural speed (V_{no}) is the maximum speed for normal operation. It is located at the juncture point of the lower limit of the yellow arc (caution), and the upper limit of the green arc (normal operating range) on the face of the airspeed indicator. Study Exam-O-Gram No. 8 and FAR 23.1545.

27. (3) The magnetic bearing to the station is the magnetic heading ± the relative bearing. 270°, the magnetic heading, plus 45°, the relative bearing, is 315°, the magnetic bearing *to* the station. If the magnetic bearing to the station is 315°, then the magnetic bearing *from* the station is the reciprocal of this, or 135°. A magnetic bearing of 135° from the station places you southeast of the station. Because of meridian convergence and possible difference in variation values between the location of the station and the location of the aircraft, certain errors are inherent to the use of radio bearings. Therefore, the serious student should study carefully chapters 11 and 14 of *Practical Air Navigation* (9th Edition).

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28. (1) Flying for 1 hour 5 minutes burning fuel at the rate of 10 gallons per hour would mean a gross weight reduction of approximately 65 pounds. Interpolating weight to the closest 500 pounds would mean using a weight of 2,900 pounds for the following computation:

(a) A 20-knot headwind equals 23 m.p.h.

(b) 24 m.p.h. means a 40% reduction in landing distance.

(c) Field elevation of Flagstaff is 7,012 feet; thus the closest 1,000-ft value is 7,000 feet.

(d) Interpolating on the chart, with a gross weight of 2,900 lbs. at 7,000 feet and standard temperature, the landing distance to clear a 50′ obstacle is *1,390* feet.

(e) A 40% reduction of 1,390 feet is 556 feet.

(f) Subtracting 556 feet from 1,390 feet equals 834 feet.

(g) This figure is valid only if the temperature is standard at 7,000 feet.

29. (3) The latest weather information in figures 3 and 4, pertaining to those items mentioned in the question are:

*FA 1845Z
*FT 2245Z
*FL 2320Z

Area forecasts report heights of cloud bases above mean sea level, not the ground, unless stated to the contrary. Cloud bases on terminal forecasts are reported in feet above the ground. A check of the terminal and area forecasts reveals that in both instances clouds are forecast to be above 10,000 feet MSL. The 2320Z AIRMET indicates that the moderately turbulent conditions existing below 14,000 feet in northern New Mexico and Arizona should decrease to light turbulence by 1900 MST. Study Chapter 17, *Aviation Weather*.

30. (3) With the information supplied, you cannot fix your location by use of omni alone, but under the circumstances given here you can only determine that you are on the 270° radial. At any given moment, omni alone tells you only where you are and *not* where you are going. Only by relating the course selector value and the TO-FROM indication to the magnetic compass reading can you determine whether you are actually going TO the station or FROM the station on the selected radial or simply crossing that radial. Even after you have determined which radial you are on you can determine your position or "fix" along this radial only by use of geographical landmarks, or an accurate groundspeed estimate, or by a cross-bearing from another station. For a more detailed explanation of omni (VOR) and its use, study chapter 28 of the 1965 edition of the *Private Pilot's Handbook of Aeronautical Knowledge*, chapter 13 of the 9th edition of *Practical Air Navigation*, and Exam-O-Grams 15 and 16.

31. (4) Figure 21 gives an explanation of how to report an accident and refers to the Regulation which pertains to this requirement.

32. (1) Horsepower is a function of both torque and r.p.m. That is, an engine can deliver the same brake horsepower (b.h.p.) at different combinations of crankshaft r.p.m. and crankshaft torque. The pilot, through adjustment of throttle and r.p.m., exercises control over these factors. One of the basic limitations placed on engine operation is the amount of pressure developed within a cylinder as controlled by combination of torque and r.p.m. values. An increase in these values will increase pressure and pressure will increase power. It will also increase the loads imposed on the engine, and if they are not controlled or kept within limits, it can ultimately result in engine failure. Power is therefore limited by the pressures developed within the cylinders. The most convenient way of estimating cylinder pressure is through the index of Brake Mean Effective Pressure (BMEP).

The limits of operation within which the accepted degree of reliability can be obtained are known as engine ratings. Takeoff power

* See figure 2 for meaning of code.

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generally approaches the limits of these ratings for an engine. If detonation should occur on takeoff, the throttle should be retarded in order to reduce the cylinder pressure. If the RPM is reduced *first* it will cause an *increase* in BMEP, and only aggravate the condition. Adjustments of mixture may produce just the opposite of results desired if the cause of the detonation is improperly evaluated. Application of carburetor heat with full power setting will tend to cause or increase detonation.

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APPENDIX

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WEATHER INFORMATION

ABQ—Albuquerque, New Mexico
FMN—Farmington, New Mexico
FLG—Flagstaff, Arizona
GNT—Grants, New Mexico
INW—Winslow, Arizona
PHX—Phoenix, Arizona
PRC—Prescott, Arizona
SAF—Santa Fe, New Mexico
TUS—Tucson, Arizona
ZUN—Zuni, New Mexico

FIGURE 1. *Station identifiers.*

1. FT1—12-hr. Terminal Forecasts
2. FT2—24-hr. Terminal Forecasts
3. FA—Area Forecasts
4. FD—Winds Aloft Forecasts
5. FL—In-Flight Advisory
   a. SIGMET—Weather significant to safety of all aircraft.
   b. AIRMET—Weather phenomena of operational interest to all aircraft, but potentially hazardous to aircraft of limited capability.
6. UA—Pilot Report Summary
7. SA—Hourly Sequence Report
8. WW—Severe Weather Forecasts
9. AC—Severe Weather Outlooks

FIGURE 2. *Letter designators for reports and forecasts.*

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WEATHER INFORMATION

Albuquerque Area Forecast

FA ABQ 111245Z
ø6M–18M FRI (0600 MST—1800 MST FRI)
NRN ARIZ NRN NEW MEX
CLDS AND WX. MOSTLY CLR WITH OCNL –⦶ ABV 18ø MSL. SCTD CU DVLPG OVR MTNS BCMG 14ø–15ø⦶ MSL DURG THE AFTN WITH A FEW HIGH LVL SHWRS OVR THE MTNS. SFC WNDS W OF CONTDVD LCLY UP TO 1825G BY 11øøM
ICG. LGT ICGIC. FRZG 135–145
LGT TO MDT TURBC. MDT TURBC TO 15ø DVLPG BY LATE MRNG WITH LCL SVR TURBC VCNTY HIER MTNS AND NEAR SHWRS
OTLK 18M FRI–06M SAT. NO RSTV WX

FA ABQ 111845Z
12M FRI–øøM SAT (Noon Friday—Midnight Friday)
NRN ARIZ NRN NEW MEX
CLDS AND WX. ERN PLAINS OF NRN NEW MEX 11ø–12ø⦶MSL CLRG AFT 22øøM. NRN ARIZ AND RMNDR NRN NEW MEX 13ø⦶MSL WITH ABV 15ø⦶V⊕MSL BRFLY 12ø⦶ MSL IN FEW SHWRS DURG EVE HRS. AFT 21M ABV 15ø⦶V⦶MSL
ICG. NONE. FRZG LVL 12ø–135 MSL
TURBC. MDT FOR LGT ACFT DCRG DURG EVE BCMG LGT AFT 2øM
OTLK øøM–12M SAT. CLR OR ABV 15ø⦶ MSL DURG MRNG HRS. AFT 12M SCTD CU BASES 12ø MSL BRFLY BRKN OVR MTNS IN FEW SHWRS

FIGURE 3. *Albuquerque area forecasts.*

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Albuquerque Terminal Forecasts

FT1 30 111045Z
ø4M–16M FRI (0400 MST—1600 MST)
INW ○. 12øøM 9øⓁ 2325
PRC ○. 2ø12. 1øøøM 8øⓁ+1øøⓁ 2ø2ø
FLG ○. 1øøøM 7øⓁ+1øøⓁ 2ø2ø
FMN ○. 12øøM 9øⓁ 232ø
ABQ ○. 13øøM 1øøⓁ OCNLY 2325
FT1 30 112245Z
16M FRI–ø4M SAT (1600 MST FRI—0400 MST SAT)
INW 8øⓁ+1øøⓁ OCNLY 2525G. 19øøM +1øøⓁ
PRC 8øⓁC+12øⓁ 232øG3ø. 19øøM C+15øⓁ. 22øøM +15ø–Ⓛ
FLG 8øⓁC+12øⓁ 2ø2øG. 19øøM C+12øⓁ 2325G. 22øøM+1øø–Ⓛ
FMN C8øⓁ 232ø OCNLY 7øⓁ BRF RW—VCNTY. 2øøøM C+1øøⓁ
ABQ 8øⓁ+1øøⓁ 2ø2ø OCNLY C8øⓁ 2525G3ø. 19øøM+1øøⓁ

NOTE: FMN (Farmington, New Mexico) is approximately 180 Statute Miles N. E. of Winslow, Arizona.

Winds Aloft Forecasts (FD)

03M–15M (0300 MST—1500 MST)

LVL	3000	5000–FT	7000	10000FT	15000FT	20000FT
INW			2020	2325+12	2730+03	2740−10
PHX	1915	1920+24	2025	2030+13	2040+02	2140−10
TUS		2715+25	2720	2830+15	2940+05	3040−10

Albuquerque In-Flight Weather Advisories

FL ABQ 111345Z
0645M—1045M FRI
AIRMET ALPHA 1. NRN ARIZ AND W OF CONTDVD IN NWN NEW MEX LGT TO LCLY MDT TURBC BLO 80 MSL WITH STNG DOWNDRAFTS OVER LEE SLPS
FL ABQ 112320Z
1620M–1900M FRI
AIRMET ALPHA 2. NRN ARIZ NRN NEW MEX MDT TURBC BLO 140 MSL DCRG BCMG LGT BY 1900M

FIGURE 4. *Albuquerque forecasts and in-flight weather advisories.*

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Albuquerque Pilot Report Summaries

ABQ UA 111245Z
GNT—40 W GNT MDT TURBC 105 BN35. FLG AREA LGT TURBC SFC TO 105 PA23.
50 E PRC LGT MDT TURBC 105 PA24. ZUN—INW MDT TURBC 9500 C 310
ABQ UA 111625Z
ZUN V-62 SAF MDT TURBC 120 C 182
INW—PRC MDT OCNLY SVR TURBC 105 PA22
ZUN-GNT MDT TURBC ICRG 9500 C 172

Hourly Sequence Weather Reports
07M

SA33 111400Z
PRC 14Ø-◐2Ø+Ø64/6Ø/32/181Ø/985
FLG 12Ø-◐15+ Ø55/55/18/1812G18/993
INW 1ØØ◐6Ø Ø45/55/26/181Ø/998
ZUN 12Ø◐2Ø+ Ø7Ø/55/3Ø/2ØØ5/995
GNT 12Ø-◐35 Ø65/55/31/ØØØØ/ØØ1
PHX 9Ø◐12Ø-◐45 Ø75/7Ø/3Ø/27Ø4/HK ALQDS
TUS E15Ø◐/◐5Ø Ø6Ø/75/35/181Ø/983

Hourly Sequence Reports
08M

SA33 111500Z
PRC 13Ø◐45 Ø67/68/31/2718/991
FLG 12Ø◐2Ø+ Ø65/6Ø/3Ø/2Ø15/993
INW 1ØØ◐6Ø+ Ø47/65/31/1815/989
ZUN 1ØØ-◐25 Ø65/6Ø/33/231Ø/999
GNT 12Ø◐/-◐35 Ø6Ø/65/32/181ØG15/ØØØ
PHX 1ØØ◐12Ø-◐35 Ø82/75/33/27Ø5/HK ALQDS
TUS E15Ø◐U⊕7Ø Ø75/75/32/2315/985

FIGURE 5. *Albuquerque pilot report summaries and hourly sequence reports.*

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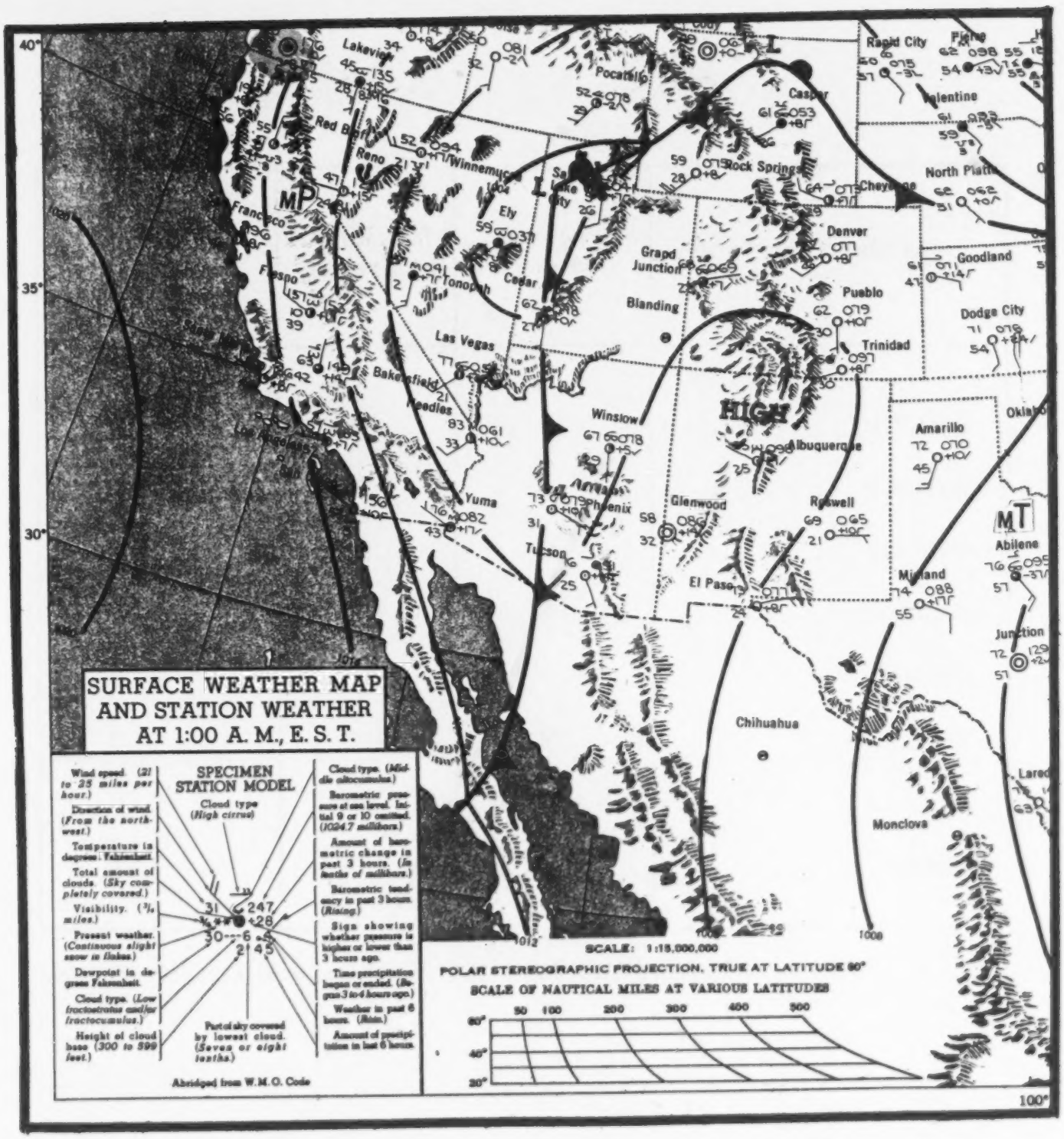

FIGURE 6. *Daily weather map excerpt—1:00 a.m. EST.*

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Standard time zone	Letter designator	Meridian (degrees)	To convert to GMT, add (hours)--
Atlantic	. . . . .	60	4
Eastern	E	75	5
Central	C	90	6
Mountain	M	105	7
Pacific	P	120	8
Yukon	Y	135	9
Alaskan	A	150	10
Bering.	B	165	11

FIGURE 7. *Meridians of standard time zones and conversion to Greenwich (Z) time.*

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/ PERFORMANCE OBJECTIVE STATEMENT /

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: II. TRANSMISSIONS - STANDARD, MANUAL SHIFT

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Disassemble, Check, and Reassemble Standard Transmission

CONDITIONS:

This assignment will be performed on a transmission obtained from the parts storage room. Under performance checks and tests, perform only bench checks and tests on this unit.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Obtain a transmission from the parts storage room
2. Select proper manual and turn to appropiate chapter
3. Select proper tools and materials
4. Disassemble the transmission following all steps as outlined in the manual
5. Identify all parts and their function
6. Perform all tests and checks as outlined in the manual
7. Reassemble transmission following all steps as outlined in the manual
8. Perform all bench tests and checks as outlined in manual
9. If all tests and checks are satisfactory, return transmission to storage area
10. Return tools and materials to proper place
11. Clean area for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily disassemble, check, and reassemble 3 speed manual shift transmission in 3 hours

Learning time: 4 hours

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AIRCRAFT DESCRIPTION
PLACARDS IN THE AIRPLANE

THIS AIRPLANE MUST BE OPERATED AS A NORMAL CATEGORY AIRPLANE. NO ACROBATIC MANEUVERS (INCLUDING SPINS) APPROVED

IDENTIFICATION: N 2468W.

MAXIMUM GEAR OPERATING SPEED: 135 mph, CAS.

MANEUVERING SPEED: 130 mph, CAS.

MAXIMUM ALLOWABLE WEIGHT IN BAGGAGE COMPARTMENT: 125 lbs.

The following information is excerpted from the AIRPLANE FLIGHT MANUAL.

ENGINE OPERATION LIMITATION: Power and Speed 260 bhp at 2625 rpm.

FUEL SYSTEM: The engine is approved for 100/130 fuel only. Fuel is supplied from 2 tanks of 32.5 gallons total capacity each.

Separate electric gauges indicate the quantity in each tank. The gauges read empty when the level is down to 5 gallons since the last 5 gallons in each tank are unusable. The airplane is equipped with an electrically-driven auxiliary fuel pump for standby use in the event the engine-driven pump fails.

OIL: The engine uses a wet-sump, full-pressure oil system. The oil capacity is 12 quarts.

For temperature above 40° F use SAE 50; below 40° F use SAE 30.

PROPELLER: The propeller is a single-acting, hydraulic constant-speed type with two forged aluminum blades, controlled by an engine-driven governor.

HYDRAULIC SYSTEM: The landing gear and flaps are extended and retracted by hydraulic actuators, powered by an engine-driven hydraulic pump and a pressure accumulator.

ENGINE INSTRUMENT MARKINGS:

Oil Pressure Gauge	
Idling	10 psi (red line)
Normal Operating Range	30–60 psi (green arc)
Maximum Pressure	100 psi (red line)
Manifold Pressure Gauge	
Normal Operating Range	15–24 in. Hg (green arc)
Cylinder Head Temperature	
Normal Operating Range	300–460° F (green arc)
Do Not Exceed	460° F (red line)
Tachometer	
Normal Operating Range	2200–2450 rpm (green arc)
Maximum (Engine-rated speed)	2625 rpm (red line)
Fuel Quantity Indicators	
Less than one-quarter tank remaining	red arc to red line
Empty (includes 5 gallons each tank unusable)	E (red line)

EMPTY WEIGHT: 1839 lbs.

MAXIMUM GROSS WEIGHT: 2900 lbs.

FLIGHT LOAD FACTORS:

Flaps Up	+3.8, − 1.52
Flaps Down	+3.5

EMERGENCY PROCEDURES:

Emergency Gear Extension Procedure.

When the landing gear will not extend hydraulically, it may be extended manually as follows:

(1) Place the gear handle in the full down position.

(2) Pull the auxiliary pump handle out its full extension.

(3) Operate the auxiliary pump handle up and down until the green gear-down light comes on.

* * * * *

FIGURE 8. *Aircraft description, placards, and excerpts from* Airplane Flight Manual.

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RADIO EQUIPMENT

1. VHF transmitter ..... 118.1 mc to 126.8 mc.
2. VHF receiver with OMNI ..... 108.1 mc to 126.8 mc.
3. ADF receiver ..... 200 kc to 1750 kc.

COMPASS CORRECTION CARD												
FOR(MH)	0	30	60	90	120	150	180	210	240	270	300	330
STEER(CH)	0	28	56	88	120	151	183	216	240	268	296	328

FIGURE 9. *Radio equipment and compass correction card.*

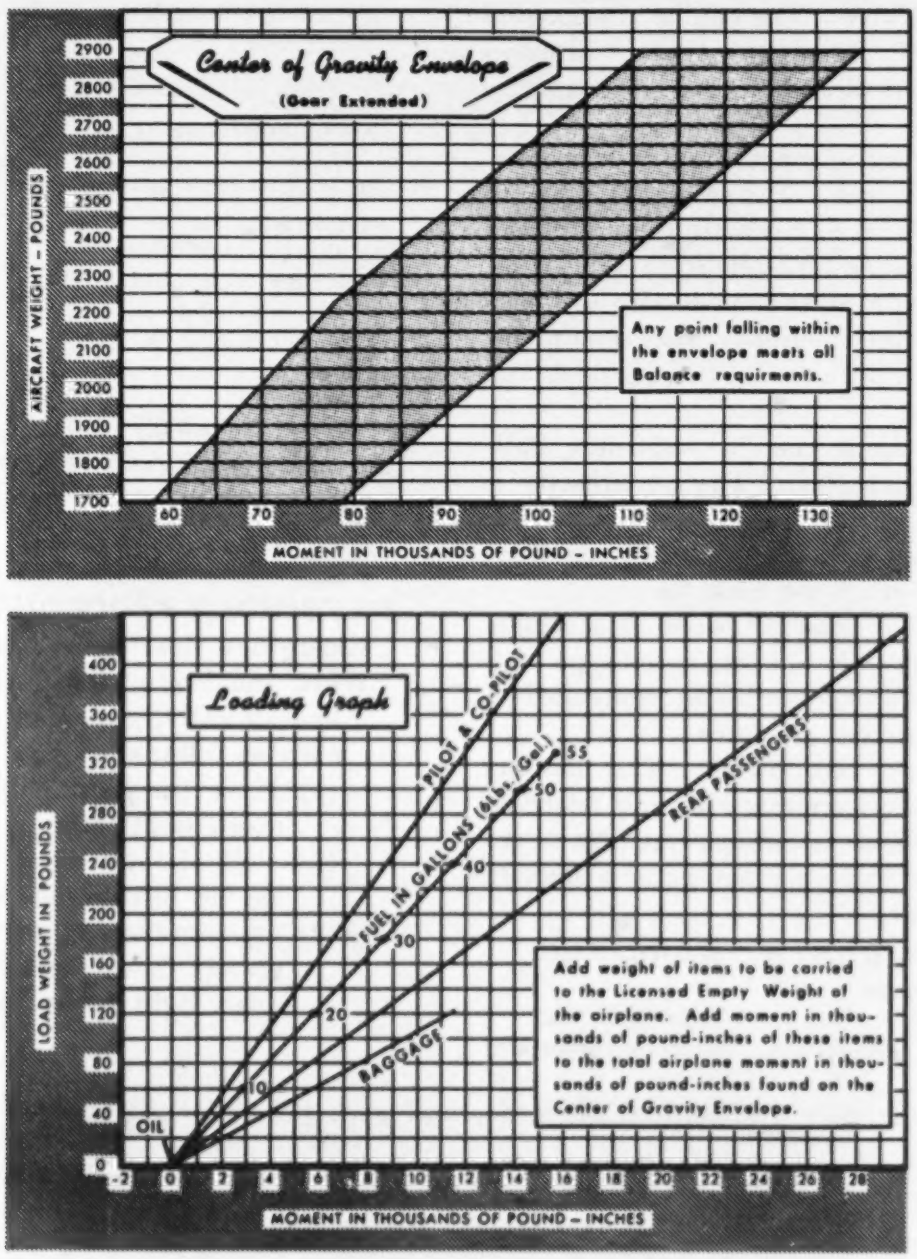

FIGURE 10. *Loading graph and center of gravity envelope.*

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WEIGHT AND BALANCE

All airplanes are designed for certain limit loads and balance conditions. These limits for your aircraft are shown on the graphs for Figure 10.

An individual weight and balance report and equipment list is furnished with each airplane; these documents list the empty weight and empty weight center of gravity of the individual airplane as equipped when it left the factory. *Changes in equipment which affect the empty weight and empty weight center of gravity must be entered in the aircraft maintenance records in accordance with Federal Aviation Regulations.*

To determine that your gross weight and center of gravity for a given flight are within limits, use the following procedure:

(1) From the weight and balance report or the latest entry pertaining to weight and balance in the aircraft maintenance record.

(2) Determine the weights and moments of your disposable load items, using the loading graph.

(3) Add these items, as shown in the sample problem.

(4) Plot the totals on the center of gravity envelope graph.

EXAMPLE PROBLEM

Example for an airplane with a licensed empty weight of 1839 pounds and a moment of 65,873 pound-inches: (Empty weight of 1,839 lbs. multiplied by the number of inches the empty C. G. is from the datum—in this airplane 35.82 inches. The figure thus obtained is arbitrarily divided by 1,000, the moment in pound inches.)

	Weight Pounds	*Moment (lb-in) 1000*
Empty Weight (licensed)	1839.0	65.9
Oil (12 qts.)	22.5	−0.4
Pilot and Front Seat Passenger	340.0	12.2
Rear Seat Passengers	340.0	23.8
Full Fuel (55 gal.)	330.0	15.8
Baggage	28.5	2.7
TOTAL	2900.0	120.0

Locate this point (2900 – 120.0) on the center of gravity envelope graph. Since the point falls within the envelope the above loading meets all the balance requirements.

FIGURE 11. *Weight and balance instructions.*

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LANDING DISTANCE TABLE

GROSS WEIGHT LBS.	APPROACH IAS MPH	AT SEA LEVEL & 59°F		AT 2500 FT & 50°F		AT 5000 FT & 41°F		AT 7500 FT & 32°F	
		GROUND ROLL	TO CLEAR 50' OBSTACLE	GROUND ROLL	TO CLEAR 50' OBSTACLE	GROUND ROLL	TO CLEAR 50' OBSTACLE	GROUND ROLL	TO CLEAR 50' OBSTACLE
2300	68	415	1015	445	1070	480	1130	520	1190
2600	72	470	1105	505	1165	545	1230	590	1300
2900	76	520	1190	560	1260	605	1330	655	1405

NOTE: REDUCE LANDING DISTANCES 10% FOR EACH 6 MPH HEADWIND. FLAPS 40° AND POWER OFF.

CLIMB DATA

GROSS WEIGHT LBS.	AT SEA LEVEL & 59°F			AT 5000 FT. & 41°F			AT 10000 FT. & 23°F			AT 15000 FT. & 5°F			AT 20000 FT. & -12°F		
	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	FROM S.L. FUEL USED
2300	97	1770	2.0	94	1415	3.0	91	1065	4.0	88	715	5.1	85	370	6.3
2600	100	1510	2.0	98	1150	3.1	95	875	4.4	92	560	5.8	89	250	7.5
2900	104	1300	2.0	101	1010	3.3	98	720	4.8	96	430	6.7	94	140	9.2

NOTE: THROTTLE, 2625 RPM, MIXTURE AT RECOMMENDED LEANING SCHEDULE-FLAPS AND GEAR UP. FUEL USED INCLUDES WARM-UP AND TAKE-OFF ALLOWANCE.

TAKE-OFF DATA

TAKE-OFF DISTANCE WITH 20° FLAPS FROM HARD-SURFACED RUNWAY

GROSS WEIGHT LBS.	IAS AT 50 FT. MPH	HEAD WIND MPH	AT SEA LEVEL & 59°F		AT 2500 FT. & 50°F		AT 5000 FT. & 41°F		AT 7500 FT. & 32°F	
			GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE
2300	58	0	435	695	515	805	615	950	740	1145
		15	285	465	320	545	390	650	480	800
		30	135	270	170	330	215	400	270	505
2600	62	0	570	885	680	1040	815	1250	985	1550
		15	360	605	435	720	530	880	655	1105
		30	195	365	240	445	305	560	385	725
2900	65	0	740	1135	880	1355	1055	1655	1285	2155
		15	480	790	580	950	705	1200	875	1580
		30	270	500	335	615	425	795	540	1080

NOTE: INCREASE DISTANCES 10% FOR EACH 25°F ABOVE STANDARD TEMPERATURE FOR PARTICULAR ALTITUDE.

FIGURE 12. *Takeoff, climb, and landing performance tables.*

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CRUISE PERFORMANCE 10000

NORMAL LEAN MIXTURE

Standard Atmosphere
Zero Wind

Gross Weight - 2900 Pounds
55 Gallons - No Reserve

10,000 FEET

RPM	MP	% BHP	Fuel Press.	MPH TAS	Gal/ Hour	Endurance Hours	Range Sta. Miles
2450	20	65	7.5	184	12.2	4.5	830
	19	60	6.8	179	11.4	4.8	860
	18	56	6.2	174	10.6	5.2	900
	17	52	5.6	169	9.9	5.6	940
2300	20	59	6.5	177	11.0	5.0	885
	19	55	6.0	172	10.4	5.3	910
	18	51	5.5	167	9.7	5.7	950
	17	47	5.1	162	9.1	6.0	975
2200	20	55	5.9	172	10.3	5.3	915
	19	51	5.5	168	9.8	5.6	940
	18	48	5.1	163	9.1	6.0	985
	17	44	4.8	157	8.6	6.4	1005
2100	20	50	5.3	165	9.5	5.8	955
	19	47	5.0	161	9.0	6.1	980
	18	43	4.7	156	8.5	6.5	1010
	17	40	4.4	151	8.0	6.9	1035
	16	37	4.2	145	7.6	7.2	1050
	15	34	4.0	138	7.1	7.8	1070
	14	30	3.8	129	6.6	8.3	1075

FIGURE 13. *Cruise performance chart.*

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AIRPORT FACILITY DIRECTORY LEGEND

LOCATION

The airport location is given in nautical miles (to the nearest mile) and direction from center of referenced city.

ELEVATION

Elevation is given in feet above mean sea level and is based on highest usable portion of the landing area. When elevation is sea level, elevation will be indicated as "00". When elevation is below sea level, a minus sign (–) will precede the figure.

RUNWAYS

The runway surface, length, reciprocal headings, and weight bearing capacity are listed for the longest instrument runway or sealane, or the longest active landing portion of the runway or strip, given to the nearest hundred feet, using 70 feet as the division point, i.e., 1468 feet would be shown as "14"; 1474 feet would be shown as "15." Runway lengths prefixed by the letter "H" indicates that runways are hard surfaced (concrete; asphalt; bitumen, or macadam with a seal coat). If the runway length is not prefixed, the surface is sod, clay, etc. The total number of runways available is shown in parenthesis. (However, only hard surfaced runways are counted at airfields with both hard surfaced and sod runways.)

RUNWAY WEIGHT BEARING CAPACITY

Add 000 to figure following S, T, TT and MAX for gross weight capacity, e.g., (S–000).

S–Runway weight bearing capacity for aircraft with single-wheel type landing gear. (DC–3), etc.

T–Runway weight bearing capacity for aircraft with twin-wheel type landing gear. (DC–6), etc.

TT–Runway weight bearing capacity for aircraft with twin-tandem type landing gear. (707), etc.

Quadricycle and twin-tandem are considered virtually equal for runway weight bearing considerations, as are single-tandem and twin-wheel.

A blank space following the letter designation is used to indicate the runway weight bearing capacity to sustain aircraft with the same type landing gear, although definite figures are not available, e.g., (T–).

MAX–Maximum runway gross weight bearing capacity for all aircraft.

Omission of weight bearing capacity indicates information unknown. Footnote remarks are used to indicate a runway with a weight bearing greater than the longest runway.

SEAPLANE BASE FACILITIES

A number preceding the parenthetical designation, indicates the number (quantity) available.

Beaching gear, consisting of the quantity and type of beaching gear available.

The number (quantity) if available, of Mooring Buoys (MB) and Crash Boats (CB) available. MB & CB indicates details of quantity are not available.

LIGHTING

B: Rotating Light (Rotating beacon). Green and white, split-beam and other types.) Omission of **B** indicates rotating light is either not available or not operating standard hours (sunset-sunrise).

NOTE.–Code lights are not codified, and are carried in Remarks.

L: Field Lighting (when code **L4–7** is indicated, lighting **4, 5, 6, 7** is available). An asterisk (*) preceding an element indicates that it operates on prior request only (by phone call, telegram or letter). Where the asterisk is not shown, the lights are in operation or available sunset to sunrise or be request (circling the field or radio call). **L** by itself indicates temporary lighting, such as flares, smudge pots, lanterns.

1–Strip lights or portable runway lights (electrical)
2–Boundry
3–Runway Floods
4–Low Intensity Runway
5–Medium Intensity Runway
6–High Intensity Runway
7–Instrument Approach (neon)
8A, B, or C–High Intensity Instrument Approach

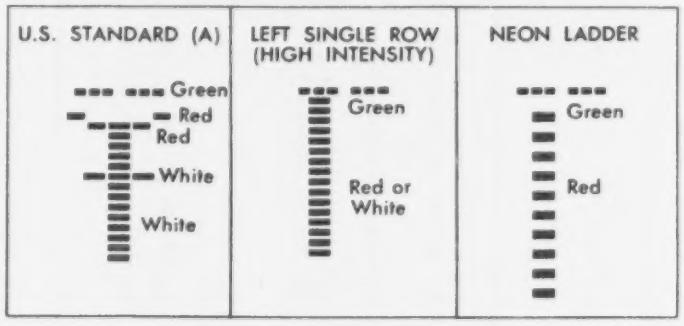

9–Sequence Flashing Lights (3,000' out unless otherwise stated)
10–Visual Approach Slope Indicator (VASI)
11–Runway end identification lights (threshold strobe) (REIL)
12–Short approach light systems (SALS)

FIGURE 14. *Airport Facility Directory Legend.*

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AIRPORT FACILITY DIRECTORY

Lighting (Con't)

13–Runway alignment lights (RAIL)
14–Runway centerline
15–Touchdown zone

Because the obstructions on virtually all lighted fields are lighted, obstruction lights have not been included in the codification.

SERVICING

S1: Storage.
S2: Storage, minor airframe repairs.
S3: Storage, minor airframe and minor powerplant repairs.
S4: Storage, major airframe and minor powerplant repairs.
S5: Storage, major airframe and major powerplant repairs.

FUEL

F1 80 oct., at least.
F2 80/87 oct., or lower
F3 91/96 oct., or lower
F4 100/130 performance rating, or lower.
F5 115/145 performance rating, or lower.

TURBINE FUELS

TP–1 650 turbine fuels for civil jets.
JP–1 (Kerosene), JP–3, JP–4, JP–5.

DAYLIGHT SAVING TIME

An airport located in a geographic area which normally converts to daylight saving time will be so identified by use of a code.

The two most common time periods during which daylight time is in effect in the conterminous United States are April 25–September 26 and April 25–October 31, and these are indicated as DT 1 and DT 2 respectively. The code "DT" by itself indicates that daylight time is in effect but not on the common time periods of DT 1 or DT 2. In such cases the applicable time period is footnoted in the airport remarks section.

Reference to daylight time will remain in the Airport Directory continuously.

OTHER

AOE–Airport of Entry.
VASI–Visual Approach Slope Indicator, applicable runway provided.
RVV–Runway visibility, applicable runway provided.
RVR–Runway Visual Range, applicable runway provided.
TPA–Traffic Pattern Altitude–This information is provided only at those airports without a 24–hour operating control tower or without an FSS providing Airport Advisory Service. Directions of turns are indicated only when turns of the pattern(s) are to the right (non-standard). TPA data are related to the runway listed under the tabulated airport information. Generally, only one altitude is listed; however, at some airports two altitudes have been established; one for conventional aircraft and one for high performance aircraft. They are shown in this manner, TPA 8/15–R (increments of 100 feet). The higher figure being the higher performance aircraft altitude.
FSS–The name of the controlling FSS is shown in all instances. When the FSS is located on the named airport, "on fld" is shown following the FSS name. When the FSS can be called through the local telephone exchange, (Foreign Exchange) at the cost of a local call, it is indicated by "(LC)" (local call) with the phone number immediately following the name of the FSS, i.e., "FSS: WICHITA (LC481-5867)." When at Intephone line exists between the field and the FSS, it is indicated by "(DL)" (direct line) immediately following the name of the FSS, i.e., "FSS: OTTO (DL)".

AIRPORT REMARKS

"FEE" indicates landing charges for private or nonrevenue producing aircraft. In addition, fees may be charged for planes that remain over a couple of hours and buy no services, or at major airline terminals for all aircraft.

"Rgt tfc 13–31" indicates right turns should be made on landings and takeoffs on runways 13 and 31.

Limited–intended for private use, but use by public is not prohibited.

Remarks data is confined to operational items affecting the status and usability of the airport, traffic patterns and departure procedures.

Obstructions.–Because of space limitations only the more dangerous obstructions are indicated. Natural obstructions, such as trees, clearly discernible for contact operations, are frequently omitted. On the other hand, all pole lines within at least 15:1 glide angle are indicated.

COMMUNICATIONS

Clearance is required prior to taxiing on a runway, taking off, or landing at a tower controlled airport.

When operating at an airport where the control tower is operated by the U.S. Government, two-way radio communication is required unless otherwise authorized by the tower. (When the tower is operated by someone other than the U.S. Government, two-way radio communication is required if the aircraft has the necessary equipment.)

Frequencies transmit and receive unless specified as: T–Transmit only, R–Receive only, X–On request. Primary frequencies are listed first in each frequency grouping, i.e., VHF, LF. Emergency frequency 121.5 is available at all TOWER, APPROACH CONTROL and RADAR facilities, unless indicated otherwise by a crossout: ~~121.5~~

Radar available is listed under "RADAR SERVICES" Radar beacons are indicated by "(BCN)" after "RADAR SERVICES", when available.

VOICE CALL

The voice call for contact with the traffic control services listed at each airport is the airport name followed by the call of the particular service desired, i.e., "LAGUARDIA TOWER." In these instances, only the name of the service is listed. When the voice call of the facility is not the same as the airport name, the complete voice call is listed.

FIGURE 15. *Airport Facility Directory Legend.*

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AIRPORT FACILITY DIRECTORY

SERVICES AVAILABLE

(See ATC Operations and Procedures, Section II)

TOWER

Clearance Delivery (CLRNC DEL).
Approach Control (APP CON) Radar and Non-Radar.
Departure Control (DEP CON) Radar and Non-Radar.
VFR Advisory Service (VFR ADV) Non-Radar.
Traffic Information Service (TFC INFO) Radar.
Surveillance Radar Approach (ASR).
Precision Radar Approach (PAR).
Ground Control (GND CON).
VHF Direction Finding (VHF/DF).

RADAR APPROACH PROCEDURE MINIMA

Weather minima for precision and surveillance radar approaches (PAR/ASR) specify only the lowest straight-in authorized for the approach.

FLIGHT SERVICE STATION (FSS)

Airport Advisory Service (AAS).
Island, Mountain and Lake Reporting Service.

UNICOM

Private aeronautical station, operates same hours as the airport, transmits and receives on one of the following frequencies:
U-1-122.8 mc (at airports without a control tower).
U-2-123.0 mc (at airports with a control tower).

SAMPLE

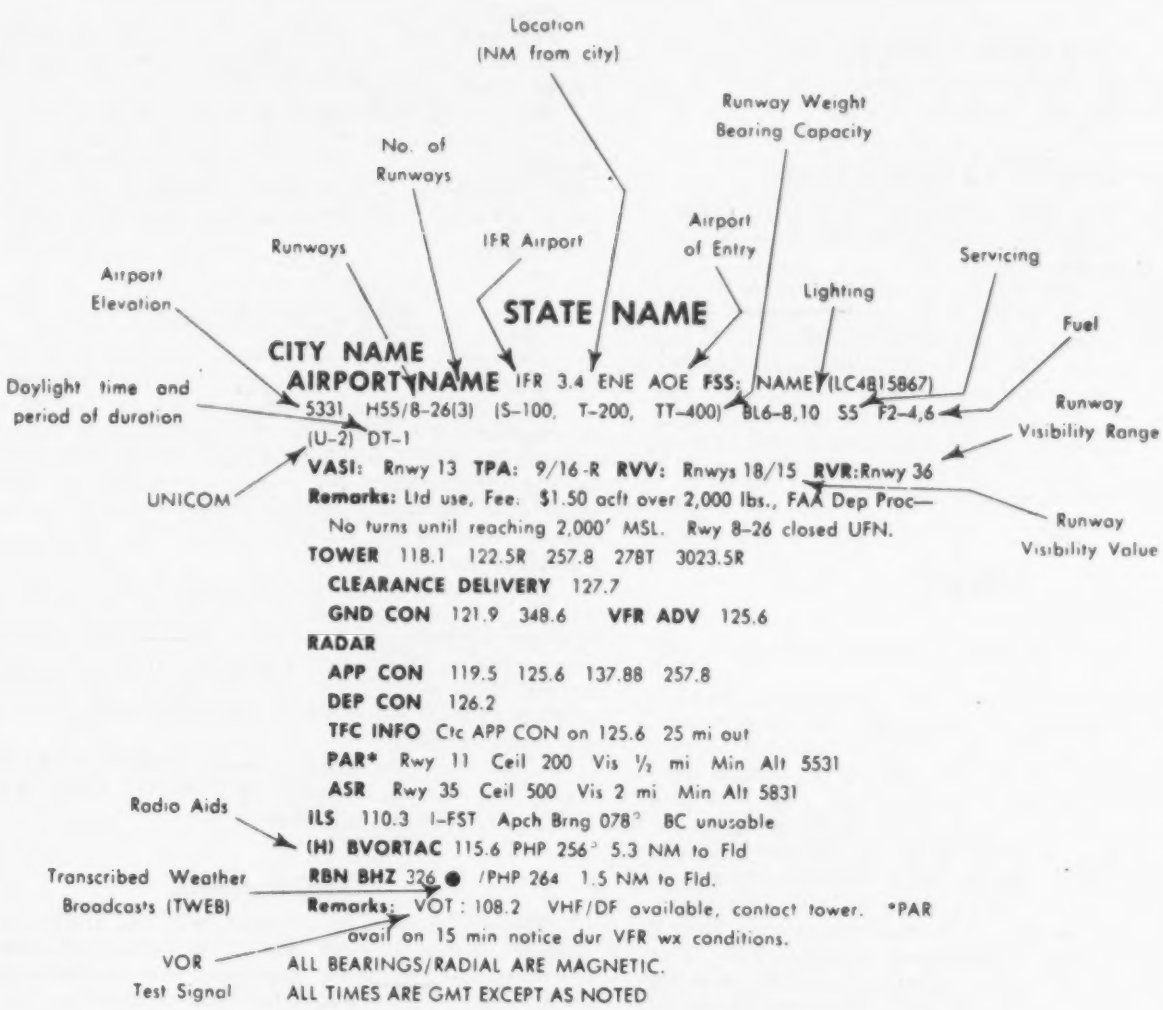

FIGURE 16. *Airport Facility Directory Legend.*

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RADIO CLASS DESIGNATIONS

Identification of VOR/VORTAC/TACAN Stations by Class (Operational Limitations):

Class	Normally Anticipated Altitude Service	Normally Anticipated Interference Free Distance Service
H	Up to 45,000 MSL	149.75 smi (130 nmi)
	Above 45,000′ MSL	115.2 smi (100 nmi)
L	Up to 18,000′ MSL	46.06 smi (40 nmi)
T	Up to 12,000′ MSL	28.79 smi (25 nmi)

H=High L=Low T=Terminal

NOTE: An H facility is capable of providing L and T service volume and an L facility additionally provides T service volume.

The term VOR is, operationally, a general term covering the VHF omnidirectional bearing type of facility without regard to the fact that the power, the frequency-protected service volume, the equipment configuration, and operational requirements may vary between facilities at different locations.

AB ..... Continuous automatic transcribed broadcast service.

B ..... Scheduled Broadcast Station (broadcasts weather at 15 and 45 minutes after the hour; Air Force Broadcasts, generally, 29 minutes).

DME ..... UHF standard (TACAN compatible) distance measuring equipment.

H ..... Non-directional radio beacon (homing), power 50 watts to less than 2,000 watts.

HH ..... Non-directional radio beacon (homing), power 2,000 watts or more.

H-SAB ..... Non-directional radio beacons providing automatic transcribed weather service.

ILS ..... Instrument Landing System (voice on localizer channel).

LMM ..... Compass locator station when installed at middle marker site.

LOM ..... Compass locator station when installed at outer marker site.

MA ..... Range (adcock, vertical raditors), power less than 50 watts.

MH ..... Non-directional radio beacon (homing) power less than 50 watts.

ML ..... Range (loop radiators), power less than 50 watts.

MRA ..... Range (adcock, vertical radiators), power 50 watts or more but less than 150 watts.

MRL ..... Range (loop radiators), power 50 watts or more, but less than 150 watts.

RA ..... Range (adcock, vertical radiators), power 150 watts or more.

RL ..... Range (loop radiators), power 150 watts or more.

S ..... Simultaneous range, homing signal and/or voice.

SABH ..... Non-directional radio beacon having limited navigational use. Provides automatic weather broadcasts.

TACAN ..... UHF navigational facility—omnidirectional course and distance information.

VOR ..... VHF navigational facility—omnidirectional, course only.

VOR/DME ... Collocated VOR navigational facility and UHF standard distance measuring equipment.

VORTAC ... Collocated VOR and TACAN navigational facilities.

W ..... Without voice facilities on range frequency.

Z ..... VHF station location marker at a LF range station.

NOTES

1. All FAA MH facilities operate continuously unless otherwise cited.
2. All FAA ranges operate continuously. Those which are not manned continuously are cited in the remarks with hours of operation in parentheses, e.g., (0600–2400).
3. LMF and VHF ranges listed at the same location are controlled by the same FSS.
4. Military navigational facilities which are not part of the common system are not listed in this publication.

AIRPORT/FACILITY DIRECTORY

ARIZONA

BUCKEYE (L) BVOR 110.6/BXK **FSS:** PHOENIX
Remarks: To be BVORTAC Sept. 30.

CASA GRANDE (L) BVOR 114.8/CZG **FSS:** PHOENIX

PHOENIX
SKY HARBOR MUNI *IFR* 3E **FSS:** PHOENIX on Fld
1122 H103/8R-26L(2) (S-170, T-300, TT-595) BL4,10 S5 F5 JP1 U2 **VASI:** Rnwy 8R
Phoenix Tower 118.7 122.5R 120.9
Clrnc Del 120.4 **Phoenix Gnd Con** 121.9
Phoenix App Con 118.1 122.5R 115.6T
Phoenix (H) BVORTAC 115.6/PHX 256° 5.3NM to fld.
Phoenix RBn BHZ 326/PHX 264° 1.5NM to fld.
Remarks: VOT: 109.0

ARIZONA—*Continued*

TUCSON INTL *IFR* 6S AOE **FSS:** TUCSON on Fld
2630 H120/12L-30R(3) (S-100, T-200, TT-360) BL4 S5 F5, JP1, JP4 U2
Remarks: 5649′ avbl lndg rnwy 3, 6000′ avbl rnwy 21. Jet arresting gear rnwy 12L-30R.
Tower: 118.3 122.5R **Gnd Con** 121.9
Radar Services: (BCN)
App Con 118.5 134.1 126.2 125.9 125.1 122.5R
Dep Con 125.9 **Tfc Info** ctc App Con 25 mi out.
ASR Rnwy 12, 30 Ceil 400 Vsby 1 mi Min Alt 3030.
(H) BVORTAC 117.1/TUS 254° 6.1NM to fld.
RBn H-SABZ 338●/TUS 083° 10.6NM to fld.

WINSLOW (H) BVORTAC 112.6/INW **FSS:** PRESCOTT
RBn H-SAB 266●/INW

FIGURE 17. *Radio Class Designations and Airport/Facility Directory.*

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AIRPORT DIRECTORY

*** ARIZONA ***

AGUILA
AGUILA FARMS 2 N
2204 44 (1) FSS: PHOENIX
Remarks: Unattended. *Livestock on strip.

BISBEE
BISBEE MUNI 5 SE
4780 39 (3) *L4 F2 FSS: DOUGLAS

DOUGLAS INTL See DOUGLAS-BISBEE

CASA GRANDE
CASA GRANDE MUNI 4 NW
1462 H38 (4) BL4 S3 F4 FSS: PHOENIX
Remarks: P-line S, E.

DEER VALLEY See PHOENIX

ELOY
CASA GRANDE IMPERIAL VALLEY CATTLE COMPANY OF ARIZONA 2 7 WSW
1525 52 (1)
Remarks: P-line E.

FLAGSTAFF
PULLIAM 4 S
7012 H70 (1) BL4 S5 F4 U-1 FSS: PRESCOTT

GILA BEND 2 SE
800 32 (2) L4 S3 F4 FSS: PHOENIX (LC 261-4295)

HOLBROOK MUNI 2 NE
5245 50 (2) BL4 S3 F4 FSS: ZUNI
Remarks: Rnwy 11-29 rolling.

KAYENTA 2 SE
5810 58 (1)
Remarks: 80 87 Fuel avbl emgcy. P-line SW end. Livestock and vehicles on rnwy.

LUKEVILLE Adj W
1416 22 (1)
Remarks: N, S apchs hazardous.

MARANA
MARANA ARPK 5 NW
1891 H68 (6) L4 S4 F5 U-1 FSS: TUCSON

NICKSVILLE Adj NE
4810 33 (1)
Remarks: Rnwy 4 apch restricted by acft in tie downs, P-line.

PHOENIX
DEER VALLEY 15 N
1450 H104 (1) (S30 T-45 TT 60) BL4 S5 F4 U-1
FSS: PHOENIX (DL)
Remarks: E 5200′ clsd except special permission.

ARIZONA—*Continued*

QUARTZITE Adj SW
894 31 (1) FSS: BLYTHE
Remarks: Cactus apch rnwy 7.

ROLL
ANTELOPE RANCH 2 SW
250 27 (1) F3 FSS: YUMA
Remarks: P-line E & W. Occasionally clsd for irrigation.

SCOTTSDALE
THUNDERBIRD ACADEMY 8 N
1465 H48 (1) L4 S5 F4 FSS: PHOENIX (LC 261-4295)
Remarks: P-line W. Clsd Sat.

TUCSON
DOWNTOWN TUCSON 1 S
2490 43 (2) S5 F4 FSS: TUCSON (LC 294-1463)
Remarks: P-lines SE, W & NW. Use E side 16/34.

FREEWAY 4 NW
2290 45 (1) L4 S5 F4 U-1 FSS: TUCSON (LC 294-1463)

RYAN FLD 14 SW
2413 H40 (2) BL4 S5 F4 FSS: TUCSON (LC 294-1463)
Remarks: P-line SSE.

TUCSON INTL See Section IV-A

VALLE
ARIZONA STATE 2 E
6001 57 (3) FSS: PRESCOTT
Remarks: Use cntr of strips. P-line S.

WICKENBURG
FLYING E RANCH 3 SW
2417 2 9(1) L5 F2 FSS: PHOENIX
Remarks: Only central 2250′ is lgtd.

WICKENBURG MUNI 12 W
2380 36 (1) FSS: PHOENIX

WILLIAMS MUNI 4 N
6700 H40 (2) BL4 S5 F4 JP1 U-1 FSS: PRESCOTT
Remarks: Muddy when wet.

WINSLOW MUNI *IFR* 2 SW
4937 H75 (2) BL4, 12 S5 F5 FSS: PRESCOTT (DL)
Remarks: P-line ENE. Attended on call after 9:00 PM. Rnwy 22 threshold displaced 1237′.

YUMA
MARSH 1 E
130 33 (1) S5 F4 FSS: YUMA (LC 725-2601)
Remarks: Rgt tfc N. Ditch N end. Muddy when wet.

YUMA MCAS/INTL See Section IV-A

FIGURE 18. *Airport Directory.*

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RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII, POWER FLOW

MILESTONE: III, AUTOMATIC TRANSMISSIONS

PERFORMANCE OBJECTIVE NO: 3 TITLE: Remove and Replace Automatic Transmission

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Removing and replacing automatic transmissions	1. Automotive Transmissions and Power Trains, by Crouse. pp. 94 htrough 95 Automotive Chassis Workbook, by Crouse. Job 6	1. Related Information Class
2. Removing and replacing automatic transmissions	2. Teaching Machine card 18C	2. Teaching Machine (Shop)

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Section III–A—NOTICES TO AIRMEN

This section is issued every 14 days and is primarily designed to supplement Section III of the AIM. It contains appropriate notices from the daily NOTAM Summary, Airmen Advisories, new or revised Oil Burner Routes and other items considered essential to flight safety.

NOTE: Data preceded by a checkmark (✓) are considered permanent and will usually be cited only once. Such information should be noted on charts and records. Temporary information is continuously cited until the condition is no longer in effect.

NOTE: Data are arranged in alphabetical order by State (and within the State by City or locality).

NEW OR REVISED DATA: New or revised data are indicated by underlining the first line of the affected item. The new information is not necessarily limited to the underlined portion, which is used only to attract attention to the new insert.

ALABAMA

BAYOU LA BATRE, BAY VIEW ARPT: Paved 3000′ drag strip 75′S and parallel to turf rnwy. P-line each side of drag strip and wire across strip 75′ from E end. N/S turf rnwy under constr, covered with stumps not to be used for acft operns.

BRANTLEY MUNI ARPT: Clsd UFN.

MOBILE, BATES FLD: Rnwy 18–36 restricted to acft of GWT 12,500 lbs or less for tkoffs and lndgs except in emgcy.

SELMA, SELFIELD ARPT: Rnwy 18–36 clsd until aprxly July 1966. VFR acft ctc Craig Twr on 126.2 for tfc and lndg advisories.

ARIZONA

BOUSE ARPT: Clsd until aprxly Nov. 1965.

GRAND CANYON NATIONAL PARK ARPT: Clsd for constr.

MARICOPA: CAUTION—DO NOT MISTAKE FOR LANDING AREA. Space Surveillance Stn at lat 33°06′31″, long 112°01′46″ aprxly 4 mi N. 1200′ W and parallel to hwy. Site is strip 300′ x 1800′ with paved portion lengthwise thru cntr 100′ in width and studded with 6′ steel posts. This permanent hazard lctd 22 nmi S Phoenix-Sky Harbor Arpt.

NOGALES INTL ARPT. Rnwy 3–21 clsd for resurfacing. Use parallel txwy for lndgs dalgt hrs.

PAYSON, BIRCH MESA ARPT: Clsd.

PRESCOTT MUNI ARPT: NW 1500′ of rnwy 12–30 clsd UFN. 2903′ avbl lndg and tkof both directions. Med intensity rnwy lgts serving rnwy 3–21 oper dusk-until aprxly 0315Z thereafter on request by radio to FSS or circling arpt.

WICKENBURG, REMUDA RANCH ARPT: Clsd.

ARKANSAS

CLARKSVILLE MUNI ARPT: First 125′ both rnwy ends clsd for constr UFN.

EL DORADO, GOODWIN FLD: Rnwy 13–31 clsd days.

HOPE MUNI ARPT: Drag racing being conducted the 2nd and 4th Sunday of each month. Rnwy 10–28 will be clsd Sat and Sun on those weekends. Rnwy 16–34 open for tfc use caution.

MENA MUNI ARPT: Clsd until aprxly Oct 1, 1965.

TEXARKANA MUN ARPT: Daily demolition activity, lctd aprxly 18 mi W, Mon thru Fri from 1200 CST to 1330 CST and 1500 CST to 1615 CST. Shrapnel and shock waves up to 3000′.

CALIFORNIA

BAKER ARPT. Clsd for repairs UFN.

BAKERSFIELD, MEADOWS FLD: Voice feature on LMM will be decmsnd Oct 16, 1965.

BLUE CANYON ARPT: Clsd for indefinite period.

BORREGO SPRING, BORREGO VALLEY-SAN DIEGO COUNTY ARPT: Rotating bcn inop until aprxly Oct 1, 1965.

CONCORD, BUCHANAN FLD: Marked 2000′ of txwy A has been designated as a tmpry parallel rnwy 1R–19L.

CORNING MUN ARPT: Clsd

DOS PALOS, EAGLE FLD: Clsd to all operns, til aprxly Oct 30, due major rnwy repairs.

FRAZIER PARK, LINCOLN SKY RANCH ARPT: Closed for unknown duration.

HANFORD MUNI ARPT: Rnwy under constr until aprxly Oct 4, for 400′ extension on N end.

HAWTHORNE ARPT: REIL and txwy lgts will be inop 2300–0700 nightly UFN.

HYAMPON ARPT: Clsd UFN due flood.

LINCOLN MUN ARPT: Rnwy 6–24 clsd for repairs. Glider operns week-ends; ctc on unicom. Arpt restricted to acft with less than 20,000 lbs GWT.

MONTAGUE, SISKIYOU CO ARPT: Apch lgtg inop UFN.

NEEDLES-RIVERVIEW ARPT: Clsd to public UFN.

OAKLAND-METROPOLITAN OAKLAND INTL ARPT: Rnwy 9L–27R clsd until aprxly Nov 9 for reconstr.

OAKLAND-METROPOLITAN OAKLAND INTL ARPT TWR: ILS glide slope (rnwy 27R) will be shut down Oct 4 til aprxly Oct 13 for mod.

FIGURE 19. *Notices to Airmen (NOTAMS).*

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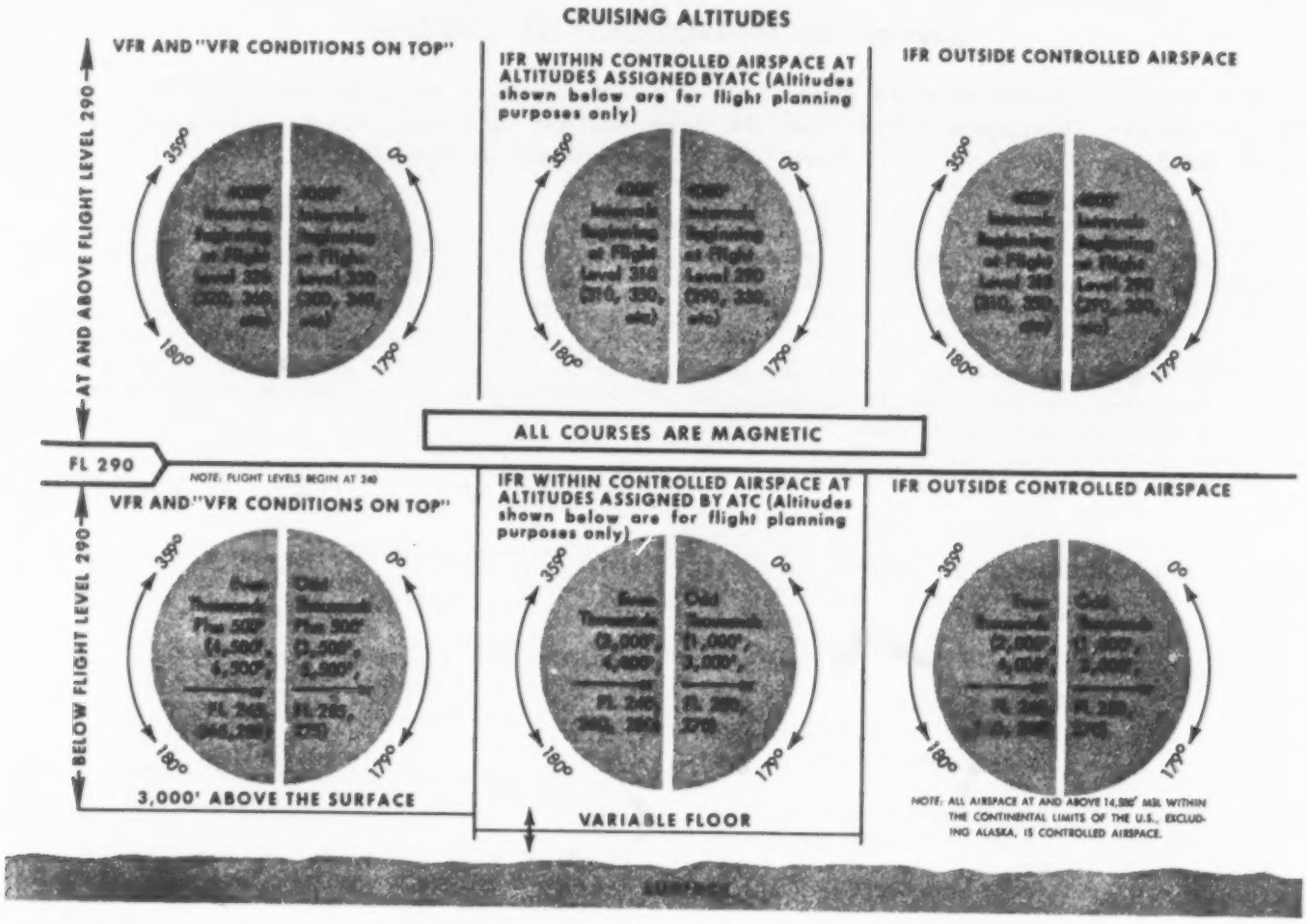

FIGURE 20. *Cruising altitudes.*

How to Report an Accident

Notification Requirements

The pilot, or operator, of an aircraft of U.S. registry *must immediately* notify the FAA of any aircraft accident which:

(a) Is known or believed to have been caused by structural failure of the aircraft, engine, or propeller.
(b) Involves midair collision of two or more aircraft.
(c) Results in serious injury to any person, or fatal injury to any person not an occupant of the aircraft.
(d) Involves fire in any of the components or systems on board the aircraft regardless of the extent of injury to the occupants or damage to the aircraft.

The pilot, or operator, shall notify the nearest FAA Flight Service Station, or General Aviation District Office informing them of:

1. Location.
2. Date.
3. Time of day.
4. Number of persons involved.
5. Injuries to each.
6. Aircraft registration number.
7. Aircraft make and model.
8. Names of crewmembers and operator.
9. The circumstances surrounding the accident.

Reporting Requirements

The pilot, or operator, of an aircraft of U.S. registry must, as soon as possible, after the accident, complete a written report to the FAA if the accident involved:

(a) Serious or fatal injury to a nonoccupant of the aircraft, or
(b) Estimated repair cost of $300 or more.

The written report must be submitted in triplicate on Form FAA-916 and mailed or delivered to the nearest FAA General Aviation District Office or Regional Office, or to the State aviation official or investigator, where applicable. (CAB Safety Investigation Regulations, Part 320, Subch. II.)

FIGURE 21. *How to report an accident.*

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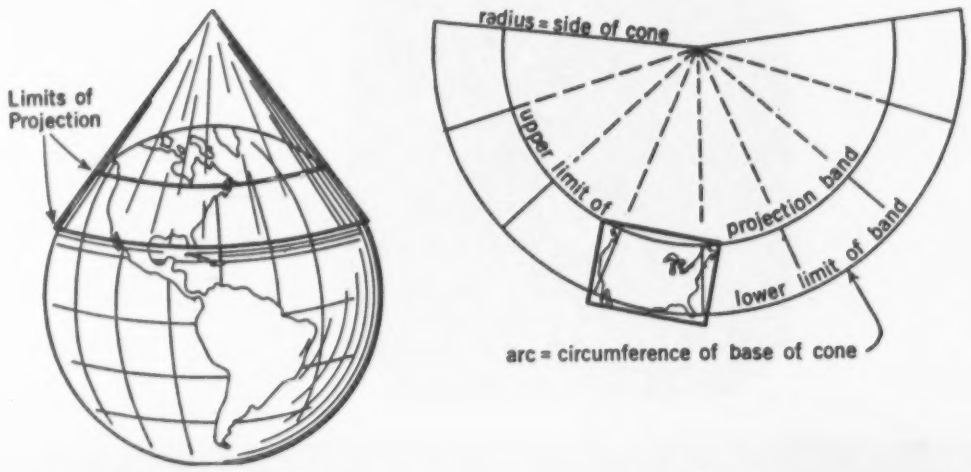

FIGURE 22. *The Lambert conformal chart projection.*

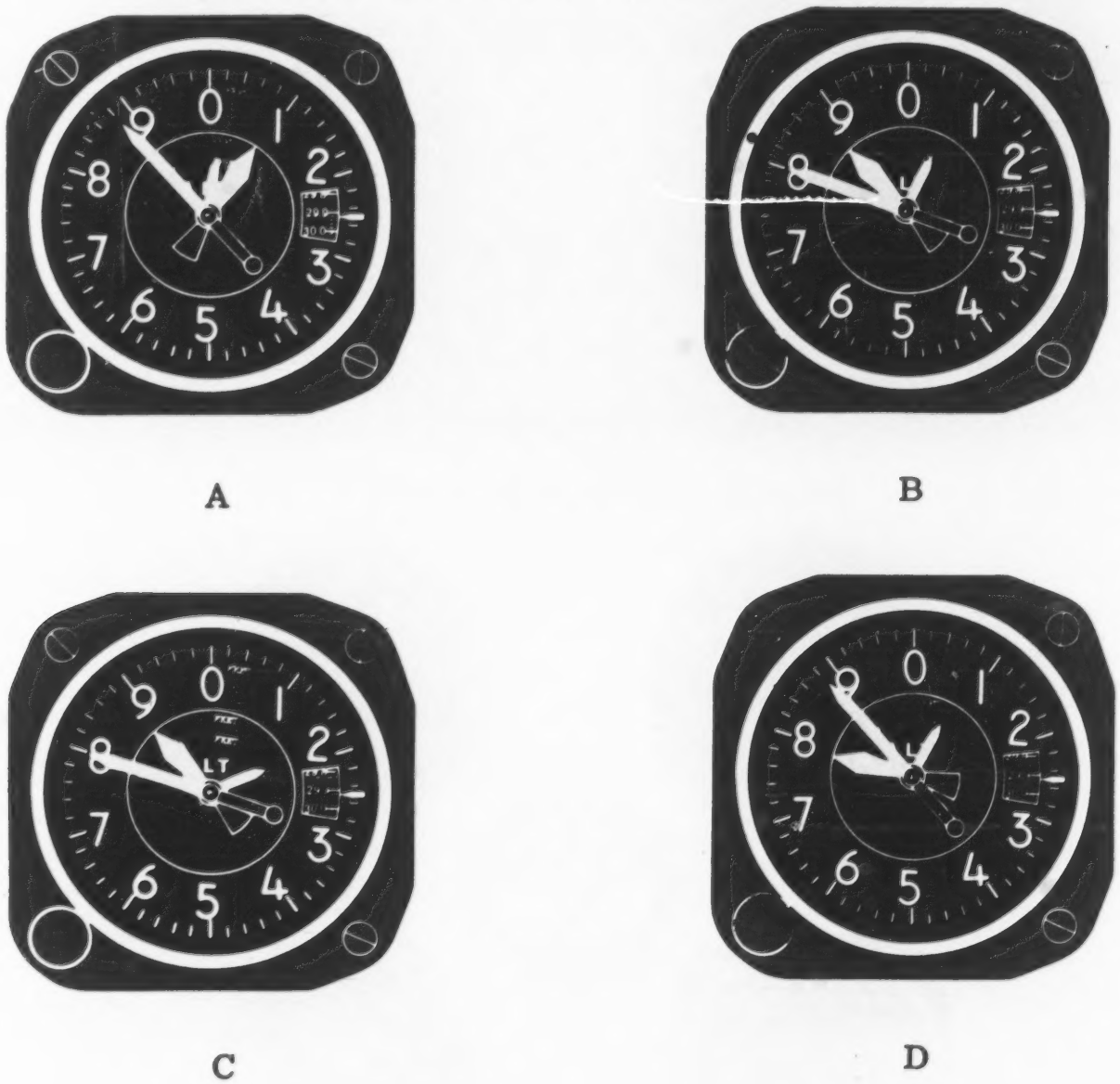

FIGURE 23. *Altimeter readings.*

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FIGURE 24. *Radio compass (ADF).*

FIGURE 25. *Instrument grouping.*

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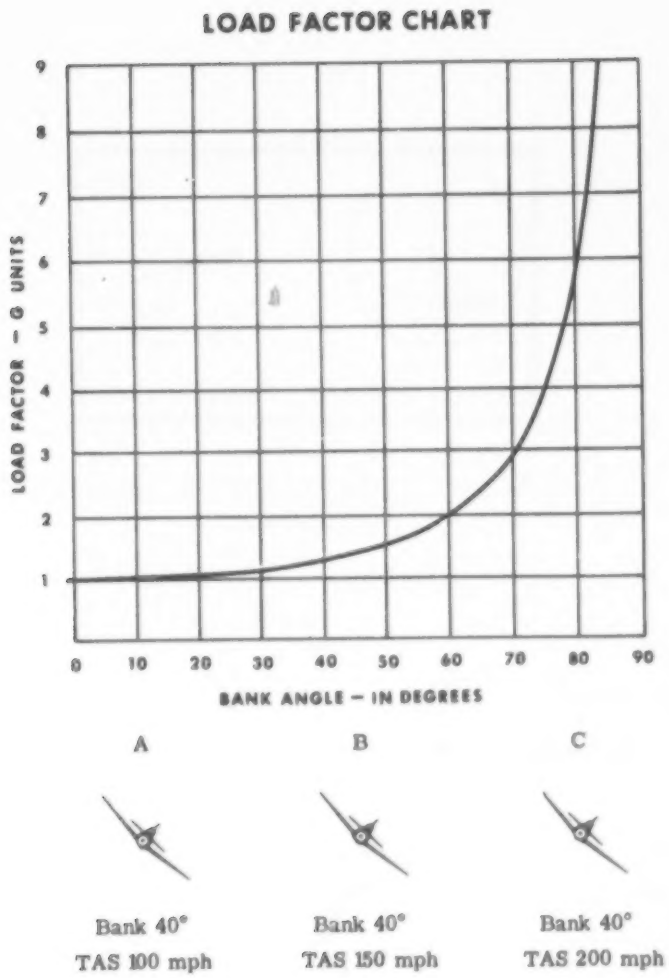

FIGURE 26. *Load factors, speeds and rates of turn.*

FIGURE 27. *Airspeed Indicator*

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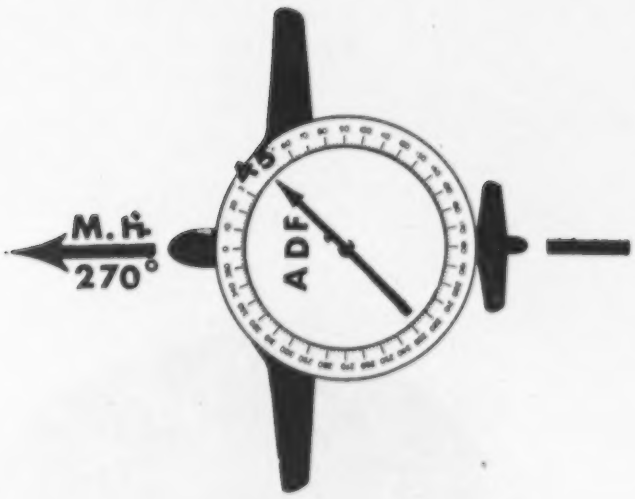

FIGURE 28. *ADF indications.*

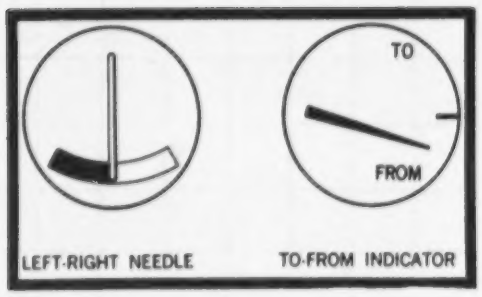

FIGURE 29. *VOR navigation receiver indications.*

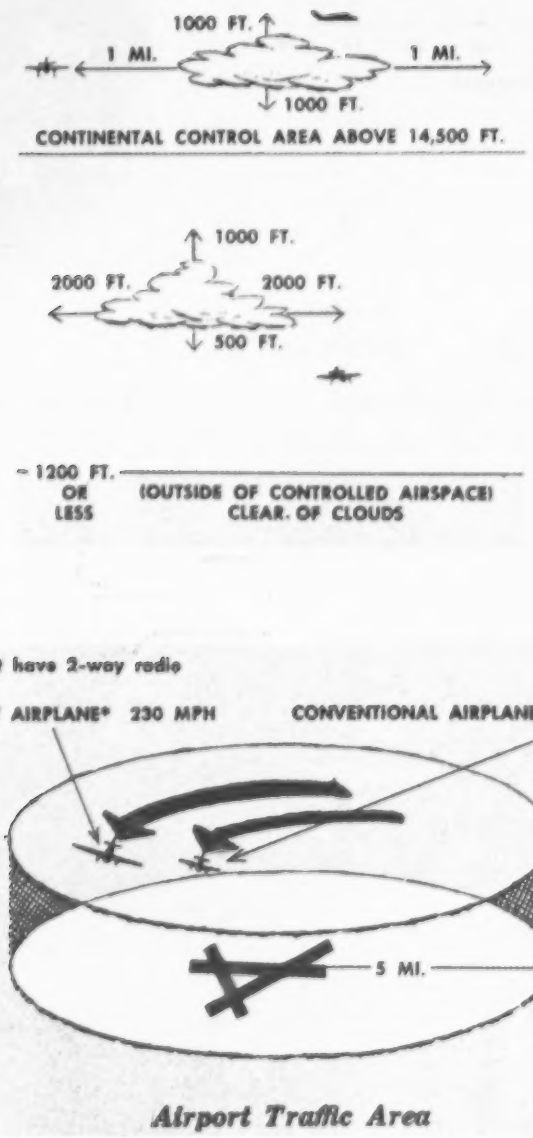

FIGURE 30. *Minimum VFR distance from clouds; airport traffic area.*

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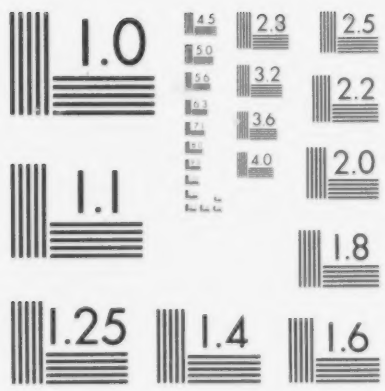

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

FEDERAL AVIATION AGENCY

FLIGHT PLAN

FORM APPROVED
BUDGET BUREAU NO. 04-R072.2

1. TYPE OF FLIGHT PLAN	2. AIRCRAFT IDENTIFICATION	3. AIRCRAFT TYPE	4. TRUE AIRSPEED	5. DEPARTURE TIME PROPOSED (Z)	5. DEPARTURE TIME ACTUAL (Z)
☐ FVFR ☒ VFR ☐ IFR ☐ DVFR	N 2468 W	DAEDALIAN DART	180 KNOTS	1530	

6. INITIAL CRUISING ALTITUDE	7. POINT OF DEPARTURE	8. ROUTE OF FLIGHT
10,500	GALLUP, NEW MEX.	DIRECT HOLBROOK, DIRECT WINSLOW VOR, DIRECT FLAGSTAFF, DIRECT WILLIAMS MUN.

9. DESTINATION (Name of airport and city)	10. ESTIMATED TIME EN ROUTE HOURS	10. MINUTES	11. FUEL ON BOARD HOURS	11. MINUTES	12. ALTERNATE AIRPORT(S)
WILLIAMS MUN. WILLIAMS, ARIZ.	2	20	3	20	

13. REMARKS
WILL GIVE TIME OFF TO ZUN FSS WHEN AIRBORNE; INTERMEDIATE STOPS AT HOLBROOK AND FLAGSTAFF WILL CANCEL WITH PRS FSS

14. PILOT'S NAME	15. PILOT'S ADDRESS OR AIRCRAFT HOME BASE	16. NO. OF PERSONS ABOARD
C. BREESE	McKINLEY COUNTY AIRPORT GALLUP, NEW MEX.	4

17. COLOR OF AIRCRAFT	18. FLIGHT WATCH
SILVER RED TRIM	

FAA Form 398 (7-64) USE PREVIOUS EDITION — **CLOSE FLIGHT PLAN UPON ARRIVAL** — GPO : 1964 OF—739-500 SEE REVERSE (7233)

FIGURE 31. *Example of VFR flight plan with flight following service requested.*

Color and type of signal	On the ground	In flight
Steady green	Cleared for takeoff	Cleared to land.
Flashing green	Cleared for taxi	Return for landing (to be followed by steady green at proper time).
Steady red	Stop	Give way to other aircraft and and continue circling.
Flashing red	Taxi clear of landing area (runway) in use.	Airport unsafe—do not land.
Flashing white	Return to starting point on airport.	
Alternating red and green.	General warning signal—exercise extreme caution.	

FIGURE 32. *Light gun signals used in airport traffic control.*

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AIRSPEED CORRECTION TABLE

FLAPS 0°								
IAS - MPH	60	80	100	120	140	160	180	200
TIAS - MPH	66	80	97	117	137	158	178	198
FLAPS 20°								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	59	62	67	73	81	91	101	111
FLAPS 40°								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	58	62	66	73	82	92	102	112

FIGURE 33. *Airspeed correction table.*

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EXAM-O-GRAM NO. 12
THE MAGNETIC COMPASS

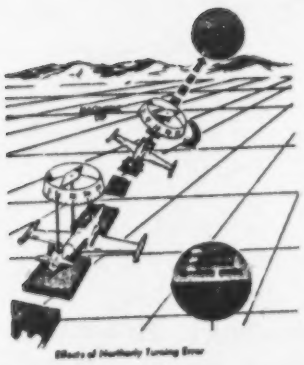

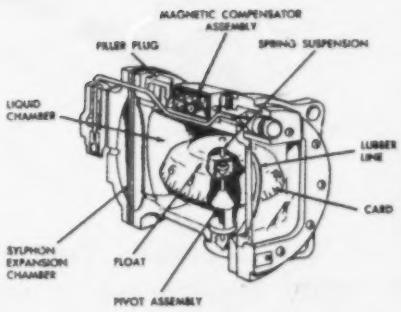

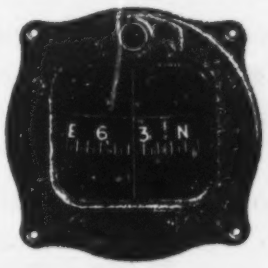

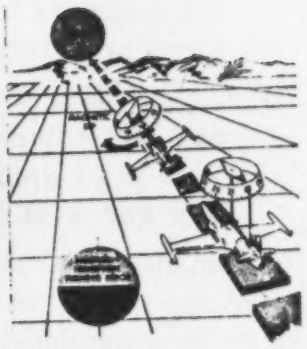

The Magnetic Compass

The magnetic compass, in terms of its errors, limitations, and in-flight characteristics, is one of those aeronautical subjects in which consistently large numbers of pilots fare poorly on FAA written examinations. There is evidence that this veteran instrument—it was one of the first to be installed in an aircraft—is one of the least understood instruments in the cockpit of today's modern general aviation aircraft. Many pilots seem to operate on the premise that it is easier to ignore this instrument's errors than it is to learn them. However, it should be remembered that (1) this is the only directional-seeking instrument in the cockpit of most general aviation aircraft, and (2) it is mechanically a simple, self-contained unit (independent of external suction or electrical power for its operation) that is likely to remain reliable at all times—reliable, that is, if the pilot understands its inherent errors.

WHAT ARE SOME OF THE COMPASS ERRORS THAT THE PILOT SHOULD UNDERSTAND?

The pilot should understand:

I. VARIATION—This is the angular difference between *true north* and *magnetic north* which is plotted on charts in *degrees east or west.* The pilot should understand perfectly *which to add and which to subtract* when converting from true headings or courses to magnetic headings or courses and vice versa. (Many pilots find such memory aids as "east is least and west is best" helpful in remembering that *east is subtracted* and *west is added* when going from *true* to *magnetic.*)

II. DEVIATION—This is the deflection of the compass needle from a position of magnetic north as a result of local magnetic disturbances in the aircraft. To reduce this deviation, the compass has a compensating device consisting of small adjustable magnets. The compass should be checked and compensated periodically. The errors remaining after "swinging" the compass should be recorded on a compass correction card which should be installed in the cockpit within the view of the pilot. (NOTE: Avoid placing metallic objects such as metal computers, flashlights, etc., on top of the instrument panel near the magnetic compass as this practice may induce large amounts of deviation and seriously affect the instrument's accuracy.)

In addition to these errors, the pilot should have a *working knowledge* of the following in-flight errors:

III. OSCILLATION ERROR — The erratic swinging of the compass card which may be the result of turbulence or rough pilot technique.

C015862

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: III. AUTOMATIC TRANSMISSION

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove and Replace Automatic Transmission

CONDITIONS:

This assignment will be performed on a complete automobile. Under tests and checks, all tests and checks will be performed, omitting only the road test.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Raise hood
6. Place protective covers on fenders
7. Disconnect or remove all parts and accessories which must be disconnected or removed when working over fender
8. Position hoist lift arms to correct position under automobile frame and raise automobile to comfortable working height
9. Remove drive shaft
10. Disconnect or remove parts and accessories required for transmission removal following all steps as outlined in the manual

PERFORMANCE CRITERIA:

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IV. MAGNETIC DIP—The tendency of the magnetic compass to point down as well as north in certain latitudes. This tendency is responsible for:

A. Northerly Turn Error—*This error is the most pronounced of the in-flight errors.* It is most apparent when turning to or from headings of north and south.

B. Acceleration Error—An error that can occur during airspeed changes. It is most apparent on headings of east and west.

As a quick refresher on this instrument's in-flight dip error, we invite you to accompany us on a simulated demonstration flight around the compass rose. Unless otherwise noted, we will limit our bank during turns to a gentle bank. Also, we will assume that we are in the northern hemisphere because the characteristics which we will observe would not be present at the magnetic equator, and would be reversed in the southern hemisphere.

DEMONSTRATION NO. 1 (Heading—North; Error—Northerly Turn Error)

As we start a turn in either direction from this heading, we notice that momentarily the compass *gives an indication of a turn opposite the direction of the actual turn.* (While the compass card is in a banked attitude, the vertical component of the earth's magnetic field causes the north-seeking end of the compass to dip to the low side of the turn, giving the pilot an erroneous turn indication.) If we continue the turn toward east or west, the compass card will begin to indicate a turn in the correct direction, *but will lag behind the actual turn*—at a diminishing rate—until we are within a few degrees east or west. One additional demonstration which we will cover before leaving north is the Slow Turn Error. If, while holding a compass indication of north, we sneak into a very gradual and shallow banked turn—say 3° or 4° of bank—it is possible to change the actual heading of the aircraft by 20° or more *while still maintaining an indication of north by the compass.*

DEMONSTRATION NO. 2 (Heading—East; Error—Acceleration Error)

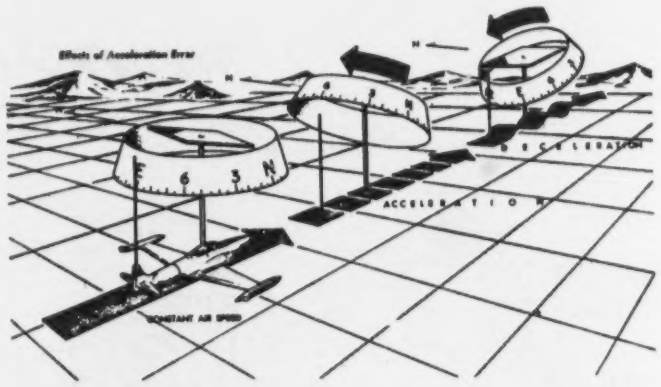

The Northerly Turn Error that we previously experienced is not apparent on this heading (or on a west heading). However, let's see what happens when we accelerate and decelerate by changing the airspeed. With the wings level, we will *increase* the airspeed by increasing the power setting or by lowering the nose, or both. Result—although we are holding the nose of the aircraft straight ahead, our compass card erroneously indicates a turn toward *north.* On the other hand, if we decrease the airspeed by reducing the power setting or raising the nose of the aircraft, or both, the compass will give an erroneous indication of a turn toward *south.* (Because of the pendulous-type mounting, the end of the compass card, which the pilot sees, is tilted upward while accelerating and downward while decelerating during changes of airspeed. This momentary deflection of the compass card from the horizontal, results in an error that is most apparent on headings of east and west.)

DEMONSTRATION NO. 3 (Heading—South; Error—Northerly Turn Error)

Again we are presented with the Northerly Turn Error problem that we encountered in Demonstration No. 1. Although the same set of forces that caused the erroneous indication when we banked the aircraft while on a north heading will likewise be working against us on this heading, the compass indications will appear quite different. For example, as we roll into a turn in either direction, the compass gives us an indication of a turn in the *correct direction*

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but at a *much faster rate than is actually being turned.* As we continue our turn toward west or east, the compass indications will continue to precede the actual turn—but at a diminishing rate—until we are within a few degrees of west or east. (It might be noted that the Acceleration Error is not apparent on this heading or on a north heading.)

DEMONSTRATION NO. 4 (Heading—West; Error—Acceleration Error)

On this heading we encounter the exact same errors that we have previously covered on a heading of east in Demonstration No. 2. If we *increase the airspeed,* we will get an erroneous indication of a *turn toward north.* If we *decrease the airspeed,* we will get an erroneous indication of a *turn toward south.* (A memory aid that might assist you in recalling this relationship between airspeed change and direction of the error is the word ANDS—Accelerate-North, Decelerate-South.)

WHAT ARE THE MAIN POINTS THAT SHOULD BE REMEMBERED CONCERNING THESE FOUR DEMONSTRATIONS?

The points we are trying to get across are these: (1) WHEN TAKING READINGS FROM THE MAGNETIC COMPASS WHILE ON A NORTHERLY OR SOUTHERLY HEADING (for establishing a course, setting the gyro-driven heading indicator, etc.), REMEMBER THAT IT IS ESSENTIAL TO HAVE THE WINGS PERFECTLY LEVEL FOR SEVERAL SECONDS PRIOR TO TAKING THE READING. (2) IF YOU ARE ON AN EASTERLY OR WESTERLY HEADING, IT IS IMPORTANT THAT THE AIRSPEED IS CONSTANT IN ORDER TO GET AN ACCURATE READING. (3) ON AN INTERMEDIATE HEADING, BOTH OF THE ABOVE CONDITIONS SHOULD BE MET. (Note: If your aircraft is equipped with a gyro-driven heading indicator, check it frequently with your magnetic compass.)

TURNS TO HEADINGS BY REFERENCE TO THE MAGNETIC COMPASS

For the pilot who would like a general set of rules for determining his lead point for making turns by reference to the Magnetic Compass, the following is submitted:

(NOTE: The angle of bank should not exceed 15° in order to minimize dip error.)

1. *When turning to a heading of north you must allow, in addition to your normal lead, a number of degrees approximately equal to the latitude at which you are flying. Example:* You are making a left turn to a heading of north in a locality where the latitude is 30°N. You have previously determined your normal lead to be approximately 5° for this particular angle of bank. In this case, you should start your rollout when the compass reads approximately 35°.
2. *When turning to a heading of south, you must turn past your normal lead point by a number of degrees approximately equal to the latitude at which you are flying. Example:* You are making a right turn to a heading of south in a locality where the latitude is 30°N. You have previously determined your normal lead to be approximately 5° for this particular angle of bank. In this case, you should turn past your normal lead point of 175° (180° — 5°) by 30°, and start your rollout when the compass reads approximately 205°.
3. *The error is negligible when turning to east or west; therefore, use the normal amount of lead when turning to an east or west heading.*
4. *For intermediate headings that lie between the cardinal headings, use an approximation based on the heading's proximity to north or south, the direction of the turn, and your knowledge of the compass's lead and lag characteristics in these areas.* In other words, use an "educated guesstimate".

We won't guarantee you that the above method will roll you out on the exact heading every time—at best, it is an approximate method. But it will get you reasonably close to your desired heading, and this beats having no method at all.

KNOW YOUR MAGNETIC COMPASS

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How to Obtain EXAM-O-GRAMS

Many EXAM-O-GRAMS for Private, Commercial, and Instrument Pilots have been published, and as the need arises, more will be made available. Some EXAM-O-GRAMS are intended to provide specific, detailed information on those subjects that seem to cause applicants the most difficulty on examinations. Other EXAM-O-GRAMS deal with items of vital importance to the pilot, but available information may not adequately cover the subject for various reasons. All of the EXAM-O-GRAMS should prove most useful on any training program.

EXAM-O-GRAMS are distributed free to ground school operators, flight school operators, ground instructors, flight instructors, etc. Any individual in these classifications who wishes to be placed on the EXAM-O-GRAM mailing list should address his request to:

FAA Aeronautical Center
Flight Standards Technical Div.
Operations Branch, AC–240
P.O. Box 25082
Oklahoma City, Oklahoma 73125

NOTE: Normally, only single copies are distributed to each operator or instructor. Sufficient quantities are not available to supply all pilots and participants in ground school classes. However, they may be reproduced by recipients in any way desired.

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★ U.S. GOVERNMENT PRINTING OFFICE : 1987 O—264-976

VT 013 005
Dairy. Unit (Module): Managing the Dairy Herd.

Kentucky Univ., Lexington. Instructional Materials Lab.
MF AVAILABLE IN VT-ERIC SET.
Instructional Materials Laboratory, Room 151, Taylor Education Building, University of Kentucky, Lexington, Kentucky 40506 (one copy free on request from State Directors of Agricultural Education).
PUB DATE - Oct69 19p.1969 Revision.

DESCRIPTORS - *AGRICULTURAL EDUCATION; *CURRICULUM GUIDES; *DAIRYMEN; ANIMAL SCIENCE; *SKILL DEVELOPMENT; LIVESTOCK; *AGRICULTURAL PRODUCTION; SKILLS; FARMERS;

BIBLIOGRAPHIC CITATIONS; COURSE CONTENT; TRANSPARENCIES; INSTRUCTIONAL MATERIALS

ABSTRACT - Developed by the Instructional Materials Laboratory at the University of Kentucky, this instructional unit is designed to develop abilities needed in managing dairy herds. Seven competency areas are presented with suggested teaching time, suggested references, and suggested instructional materials for each area. References, transparency masters, and major features of three common dairy herd testing programs are appended. A related document in this issue is available as VT 013 006. (GB)

VT 013 005

ED0 56238

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DAIRY

UNIT (MODULE): MANAGING THE DAIRY HERD

Major Teaching Objective

To develop the effective ability to manage the dairy herd

Suggested Learnings (Competencies) To Be Developed

1. To take proper care of the dairy herd
2. To plan a good record system
3. To cull the dairy herd properly
4. To provide replacements to the dairy herd
5. To use labor efficiently
6. To provide adequate facilities for the dairy
7. To market high quality dairy products

Revised by

Wilson Glenn Collins
Instructional Materials Laboratory
Division of Vocational Education
College of Education
University of Kentucky

October, 1969

VT013005

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UNIT (MODULE): MANAGING THE DAIRY HERD

Suggested Teaching Time

Number of class periods for group teaching:

In classroom, at school . . . . . _____
Outside classroom, at school . . . . . _____
Field Trips (away from school) . . . . . _____

Total . . . . . _____

Month(s) _____

Place of the Unit in the Course of Study

This is the fifth unit dealing with dairying, for use in high school vocational agriculture classes. The other four units are: (1) "Getting Started in Dairying," (2) "Selecting and Breeding Dairy Animals," (3) "Feeding Dairy Cows," and (4) "Controlling Parasites and Diseases." This unit deals with managing the dairy herd. Learnings in breeding, feeding, and disease and parasite control are not dealt with in this unit because they are covered in units 2, 3, and 4. The learnings found in units 2, 3, and 4, may also be secured from specific application of learnings found in the General Farm Animal Units (HS-33, HS-34, HS-35, and HS-36).

If dairy cattle is not in the course of study, this unit should not be used. If dairying is in the course of study, then this unit should probably be used in the sophomore, junior, or senior year. This could be an essential part of an advanced Dairying course. Regardless of where it is found, it should develop in the student the ability to properly manage dairy animals in order to secure the most efficient production.

Suggestions for Introducing the Unit

In introducing this unit, the importance of good management in dairying should be pointed out. Many farmers do a poor job of managing the dairy enterprise, and poor management results in inefficiency and low profits or no profits.

After sufficient interest has been created, the boys should be led to suggest the phases of management which needs to be considered. Any learning previously dealt with in another unit should be omitted. All seven of the learnings may prove helpful in developing managerial skills. This unit may require from ten to fourteen days to secure these learnings. One or two field trips may prove helpful. One trip to see a good dairy herd may be valuable. Another trip to visit good facilities and a good milking operation using labor saving equipment might prove valuable in relating learnings to the specific application.

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c. Use good milking procedures

-- Remove milker at the proper time
-- Avoid excessive vacuum
-- Keep milking parlor and equipment clean
-- Clean the cow's udder properly before milking

d. Try "Challenge Feeding" on the cows to boost production
e. Feed grain on the basis of production
f. Provide an adequate amount of a good-quality pasture in the summer and good quality roughage in the winter

Feeding and breeding are discussed in other units

Proper care of cows during dry period

a. Give cows a 6 to 8-week rest period
b. Feed cows enough concentrates to prevent excessive loss of flesh
c. If cows are in poor flesh, feed some concentrates each day (see feeding unit).
d. Dry cows should have access to succulent pasture or high-quality roughages.
e. Feed a laxative concentrate at least 2 weeks before calving (wheat bran and oats)

Caring for the herd bull (If you do not use artificial breeding)

a. Don't over-breed young bulls
b. Train the bull to lead while he is a calf
c. Bulls should be dehorned as a calf
d. Keep the bull in a pen large enough to get adequate exercise
e. Put a ring in the bull's nose when he is 8 months to 1 year of age.
f. Feed enough grain, minerals, and roughages to keep the bull in good breeding condition (not fat)

Grooming the cow

a. Regular grooming is necessary
b. Keep the cow's feet properly trimmed
c. Clip the cow's udder and surrounding areas
d. Grooming helps keep cows gentle

<u>Suggested Teaching-Learning Activities</u>

a. Suggested problem: How take proper care of the dairy herd?
b. A field trip to see a good dairy operation may be a good way to summarize this learning. A talk with the herd manager may prove very helpful in making concrete the experience.
c. Use transparency HS-51-1 with the learning.

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Suggested References and Instructional Materials

Books

Dairy Production	pp. 186-198
Dairy Cattle Feeding and Management.	pp. 205-207
Approved Practices in Dairying	pp. 79- 94
Introduction to Livestock Production	pp. 584-591
Livestock and Poultry Production	pp. 345-350

Publications

"Dairy Production," (Mississippi)	pp. 146-153, 175-179, 211-214
"Making Your Dairy Pay" (Southern States).	Chapter 8, pp. 79-87, 99-102, 131-133

Transparencies

HS-51-1 (The Dairyman's Cost)

2. To plan a good record system

Records to keep

a. Production -- DHIA plan, owner-sampler plan, and WADAM plan
b. Feeding -- kind of feed, amount of feed being fed, etc.
c. Breeding -- breeding and calving date, the bull used, sex of calf, etc.
d. Health -- record of vaccinations, tests, and treatments for various diseases.

Reasons for keeping records

a. The dairy herd cannot be profitably managed unless records are kept.
b. Adequate records remove much of the uncertainty in the operation of a dairy farm.
c. Good records cause greater profits, better feeding practices, increased production, improvement in quality of cattle kept, and more efficient use of labor.
d. Production records make it much easier to decide which animals should be culled.

Keeping records

a. Records must be kept accurately, but they need not be elaborate.
b. They should be complete and up-to-date.
c. The person keeping the record may carry a small notebook and record information at the time an event occurs.
d. Transfer the records to a permanent record book at the end of each day or week.
e. Record system should be handy (record book kept in a convenient place).

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Suggested Teaching-Learning Activities

a. Suggested problem: How keep records on our dairy herd?
b. Involving the students in this learning is a must if any desirable learning is to take place. Ask the students to compare the recordkeeping systems, and decide which one they would prefer to use, and explain why.
c. Use transparency HS-51-2 with this learning.

Suggested References and Instructional Materials

Books

Dairy Cattle Feeding and Management . . . . . Chapter 24
Dairy Production . . . . . pp. 101-110
Introduction to Livestock Production . . . . . pp. 583-586
Approved Practices in Dairying . . . . . Chapter 12
*Dairy Science . . . . . Chapter 36

Publications

"Dairy Production," (Mississippi). . . . . .Chapter 12
Farmers Bulletin 2132 . . . . . .pp. 8-11
Kentucky Leaflet 271 . . . . . .Entire
"Making Your Dairy Pay" (Southern States). . . . .pp. 16, 87-88

Transparencies

HS-51-2 (Major Features of Three Common Dairy Herd Testing Programs)

3. To cull the dairy herd properly

Reasons for culling

a. High-producing cows mean higher returns for your labor.
b. Fewer cows to house and care for
c. Production costs are lower
d. The receipts from the sale of a cull cow can buy a good heifer in her place.

Cows to cull

a. Cows with diseased udders
b. Shy breeders
c. Slow, hard milkers
d. Non breeders
e. Cows producing below the herd average
f. Brucellosis reactors
g. The tempermental cow
h. A cow that has become so badly crippled that she has difficulty getting around

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: III. AUTOMATIC TRANSMISSION

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove, and Replace Automatic Transmission

CONDITIONS:

BEHAVIOR:

11. Remove transmission following steps as outlined in manual
12. Perform all tests and checks following all steps as outlined in the manual
13. Make all bench adjustments following all steps as outlined in the manual
14. If all tests, checks, and adjustments are satisfactory, install transmission in automobile following all steps as outlined in the manual
15. Reconnect and install parts and accessories (under the automobile connections) as outlined in the manual
16. Install drive shaft
17. Check all work up to this point and if it is satisfactory, lower automobile to the floor
18. Connect all parts and accessories (over the fender connections) as outlined in the manual
19. Make all tests, checks, and adjustments as outlined in the manual
20. If all tests, checks, and adjustments are satisfactory, return tools and materials to proper place

PERFORMANCE CRITERIA:

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When to cull

a. Sell a cow when she will no longer make you money
b. Sell poor first-calf heifers

Suggested Teaching-Learning Activities

a. Suggested problem: How should we cull our dairy herd?
b. Use transparency HS-51-3 with this learning.

Suggested References and Instructional Materials

Books

Dairy Production . . . . . pp. 33-34
Dairy Cattle Feeding and Management. . . . . pp. 317-318
Approved Practices in Dairying . . . . . pp. 72-73

Transparencies

HS-51-3 (High Producers Pay)

Publications

Farmers Bulletin 2132 . . . . . pp. 3-4

4. To provide replacements

Things to consider in selecting cows and heifers

Type -- general appearance, dairy character, body capacity, and mammary system
Pedigree
Production records
Health
Vigor
Mammary development in heifers
Size

Things to consider in selecting the herd bull (Much of this needs to be done if breeding artifically as well)

Type (as shown on score card)
Production increase of the daughter over the dam
Consistency of increase
Proven sire--the records of ten daughters or more compared with the records of their dams
Healthy
Vigorous
Strong
Large

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Growing replacements

a. Whether to produce own replacements
b. Number of heifers to keep
c. Kind of heifers to keep

Buying replacements

a. Appearance
b. Production records
c. Age
d. Diseases
e. Know your source of supply

Suggested Teaching-Learning Activities

a. Suggested problem: How provide good replacements for our dairy herd?
b. Bringing in a good dairy heifer and discussing her good characteristics with the students may prove helpful with this learning.
c. Use transparency HS-51-4-1 and HS-51-4-2 with this learning.
d. Take advantage of all possible labor-saving devices (feed carts, silo unloaders, pipe-line milkers, bulk tank, elevated milking parlor, and others).

Suggested References and Instructional Materials

Books

Dairy Production	Chapter 4
Dairy Cattle Feeding and Management	pp. 172-186, Chapter 15
Introduction to Livestock Production	pp. 577-579
Dairy Science	pp. 286,306,310-311
Livestock and Poultry Production	Chapter 19

Publications

"Dairy Production," (Mississippi)	pp. 51-66
Farmers Bulletin 1998	pp. 16-19
"Making Your Dairy Pay," (Southern States)	Chapter 4,5

Transparencies

HS-51-4-1 - Front of Dairy Cow Unified Score Card
HS-51-4-2 - Back of Dairy Cow Unified Score Card

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5. <u>To use labor efficiently</u>

Need for using labor efficiently

a. Under average conditions between 90-150 man hours each year are needed to take care of a dairy cow.
b. Feed is the only other cost that is higher than labor.
c. Save labor -- increase income

Present labor-use situation on our farm

a. There is a wide range in the time requirements on dairy farms (each boy should decide how efficient he is in the use of labor).
b. If the present situation requires 150 or more hours per cow, improvement needs to be made.
c. Each boy should make a survey of his use of labor, and strive for efficiency.

Ways of saving labor

a. Careful and complete planning of the housing
b. Replace hand work with machinery whenever possible
c. Arrange the barn so that labor-saving equipment may be used in cleaning out the manure
d. Arrange the feed in a convenient location
e. The housing and equipment should be planned to reduce the time required to care for the cow.
f. Take advantage of all possible labor-saving devices (feed carts, silo unloaders, pipe-line milkers, bulk tank, elevated milking parlor, and others).

Scheduling work

a. Plan for one job to end where another begins
b. Schedule work for the total enterprise and not for one single phase
c. Make the needed changes in the dairy enterprise to save labor or to use labor more efficiently
d. Make an over-all plan for efficient use of labor

<u>Suggested Teaching-Learning Activities</u>

a. Suggested problem: How should we use our labor to get the best results from the dairy operation?
b. A field trip to a dairy farm to see the facilities would provide a good opportunity to mention efficiency in labor. (Field trip recommended in Learning 6.)

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Suggested References and Instructional Materials

Books

Dairy Production	Chapter 11
Dairy Cattle Feeding and Management	Chapter 16
Introduction to Livestock Production	p. 581
Approved Practices in Dairying	pp. 234-235

Publications

Kentucky Leaflet 218	Entire
Kentucky Circular 505.	pp. 3-13

6. To provide adequate facilities

Housing

a. Type of barn

-- Loose housing system
-- Stanchion system

b. Location of barn
c. Lighting conditions
d. Milk room

-- Location
-- Ventilation
-- Health precautions

e. Feed storage area
f. Maternity quarters
g. Bull facilities

-- Shelter
-- Fencing
-- Size of lot

h. Calf pens

Equipment

a. Feeding equipment

-- Self-feeding hay racks
-- Silo
-- Mechanical feeders

b. Milking equipment

-- Varies from seamless covered milk pail, milk strainer, milk can and cooler, to elaborate pipe-line milkers
--

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c. Cooling equipment

-- Bulk cooler (if grade A milk is produced)
-- Can cooler (if milk is produced for manufacturing purposes)

d. Cleaning equipment

-- Manure loader
-- Brooms, shovels, waterhose, etc.

e. Miscellaneous

-- Scales
-- Truck (1/2 or 3/4 ton)
-- Tractor

Suggested Teaching-Learning Activities

a. Suggested problem: What facilities do we need in our dairy business?
b. A field trip to a good dairy operation would be very helpful here. The herdsman could discuss the efficiency of the business, as well as how the equipment and facilities meet the needs of the farm.

Suggested References and Instructional Materials

Books

Dairy Cattle Feeding and Management	Chapter 31, 32
Dairy Production	Chapter 11
Approved Practices in Dairying	pp. 218-250
Livestock and Poultry Production	pp. 350-357

Publications

"Dairy Production," (Mississippi)	Chapter 9, 10
Kentucky Circular 249	pp. 5,8-11
Kentucky Leaflet 218	Entire
Kentucky Circular 505	pp. 5-12
Kentucky Miscellaneous 332.	Entire
Kentucky Miscellaneous 333	Entire
Kentucky Miscellaneous 334	Entire
"Making Your Dairy Pay" (Southern States)	pp. 81-88, 149-153

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7. To market high quality dairy products

Marketing during high prices

Plan to market much of the milk produced when milk is selling at a high price (usually in fall and winter months).

Forms

a. Fluid milk (Grade A is best)
b. Milk for manufacturing purposes

Butterfat content -- high or low percent of butterfat - breeds, feed, etc.

Quality

a. From healthy cows (TB-free herd, Bang's-free herd)
b. Bloody, stringy, and other abnormal milk produced from cows with mastitis shall be excluded.
c. Dirt in milk undesirable
d. Bacteria in milk kept to a minimum

-- Clean cow's udder properly at milking time
-- Have barn lot well drained and clean
-- Keep milking equipment in good shape and clean
-- Milkhouse properly equipped with pure water (hot & cold), proper wash and rinse racks, and a good cooling tank

e. Keep antibiotics and pesticides out of milk

Suggested Teaching-Learning Activities

a. Suggested problem: How should we market our milk?
b.

Suggested References and Instructional Materials

Books

Dairy Production	Chapter 13
Dairy Cattle Feeding and Management	pp. 391-396
Introduction to Livestock Production	Chapter 41
Approved Practices in Dairying	pp. 251-264
Livestock and Poultry Production	Chapter 20

Publications

Kentucky Miscellaneous 256-F	Entire
Kentucky Leaflet 202	Entire
Kentucky Circular 249	Entire
"Making Your Dairy Pay"	Chapter 10, pp. 84-87

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Evaluation of Unit

This unit may best be evaluated in terms of its usefulness in securing the significant learnings with the students. On your farm visits you will have opportunity to see what changes are taking place in the students and their farming program. The students, who earlier listed good practices in management, may now be led to compare those practices with those they are using in their farm experience program. If there is a significant difference help them to see the need to carry out the practices they listed earlier.

Evaluate with the students the teaching of the unit. Ask the class how the unit could have been improved. How could it have been made more interesting? Were the field trips and visual aids helpful?

REFERENCES

Books

*Dairy Science, Second Edition; Petersen (J.B. Lippincott Company, Chicago - 1950), 686 pp.

Dairy Production, Second Edition; Diggins and Bundy (Prentice-Hall, Inc., Englewood Cliffs, New Jersey - 1961), 341 pp.

Approved Practices in Dairying, Second Edition; Juergenson and Mortenson (The Interstate, Danville, Illinois - 1960), 296 pp.

Livestock and Poultry Production, Third Edition; Bundy and Diggins (Prentice-Hall Inc., Englewood Cliffs, New Jersey - 1968), 723 pp.

Dairy Cattle Feeding and Management, Fifth Edition; Reaves and Henderson (John Wiley and Sons, Inc., New York - 1963), 448 pp.

Introduction to Livestock Production, Second Edition; Cole (W.H. Freeman and Company, San Francisco, California, 1966), 827 pp.

Publications

*"Dairy Production" - Published by State Board for Vocational Education, Jackson, Mississippi. (Write for a single copy.)

"Making Your Dairy Pay" - Published by Southern States Cooperative Feed Service, Richmond, Virginia. (Copies supplied free by local Agency.)

USDA, Farmer's Bulletin 2132 - Improving Your Dairy Herd

USDA, Farmer's Bulletin 1998 - Selecting Dairy Cattle

Kentucky Circular 505 - How to Reduce Labor, Steps and Costs in Dairying.

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Kentucky Circular 249 - Producing Milk of Good Quality

Kentucky Leaflet 271 - Electronic Dairy Records

Kentucky Leaflet 218 - Milking the Easy Way

Kentucky Leaflet 202 - Clipping Dairy Cattle for Quality Milk Production

Kentucky Miscellaneous 256-F - Insecticide Recommendations for Lactating Dairy Animals - 1969

Kentucky Miscellaneous 332 - Teat Cup Operation and Use

Kentucky Miscellaneous 333 - Vacuum Lines

Kentucky Miscellaneous 334 - Milk Lines for Milking Machine

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*Teacher Reference only

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THE DAIRYMANS COST

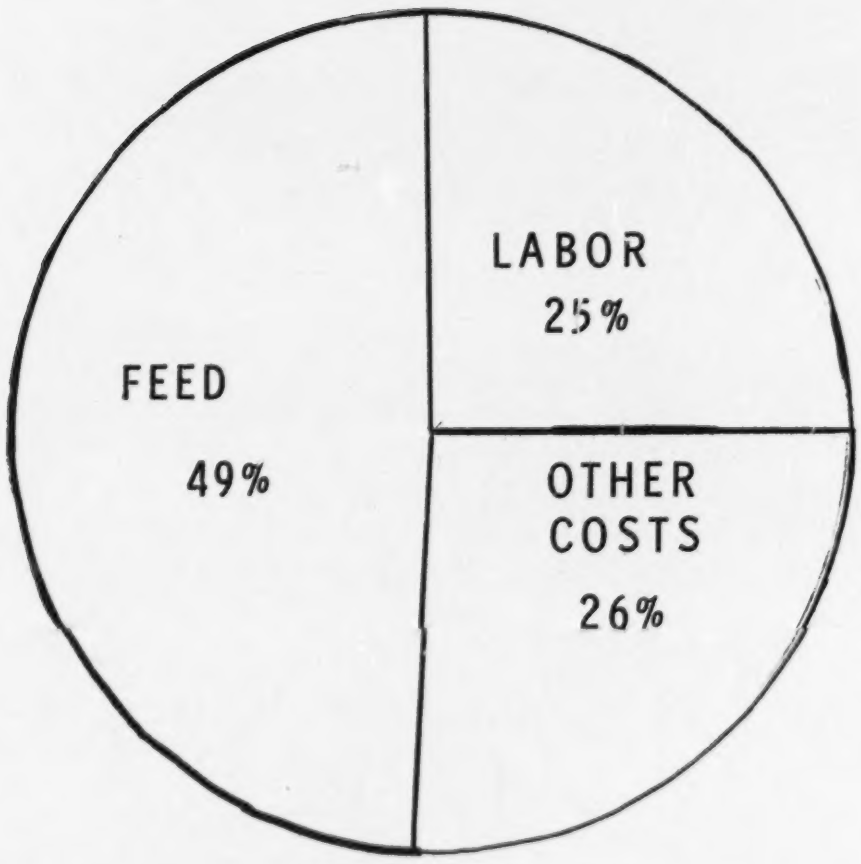

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MAJOR FEATURES OF THREE COMMON

DAIRY HERD TESTING PROGRAMS

DHIA - DAIRY HERD IMPROVEMENT ASSOCIATION

a. Complete milk and butterfat production figures on cows, plus herd averages

b. Gives feed consumption and returns over feed costs

c. Records are accepted as official, a disinterested party (DHIA Supervisor) weighs milk, records information, and performs butterfat tests

OS - OWNER-SAMPLER

a. Provides <u>exactly</u> the same information as DHIA

b. Not considered official because herd owner weighs milk; and DHIA Supervisor performs butterfat tests

c. Less costly than DHIA

WADAM - WEIGH-A-DAY-A-MONTH

a. Least costly program available

b. Provides milk production information for individual cows only, no butterfat tests are performed.

c. Excellent for culling and feeding based on milk production

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: III. AUTOMATIC TRANSMISSION

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove and Replace Automatic Transmission

CONDITIONS:

BEHAVIOR:

21. Remove covers from fenders and store in proper place
22. Close hood
23. Return automobile to proper parking area
24. Remove seat covers and store in proper place
25. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to remove and replace automatic transmission in 3 hours.

Learning time: 6 hours

HIGH PRODUCERS PAY

HERD AVERAGE POUNDS OF MILK	AVERAGE PER COW				
	FAT TEST	FAT, POUNDS	TOTAL FEED COST	INCOME OVER FEED COST	FEED COST PER CWT. MILK
13,321 #	3.95	526	$268	$423	$2.01
11,136 #	3.93	438	$235	$338	$2.11
9,078#	3.99	362	$209	$259	$2.30
6,885#	3.99	275	$181	$170	$2.63

Based on Pennsylvania DHIA Records, 1958

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DAIRY COW UNIFIED SCORE CARD

Copyrighted by The Purebred Dairy Cattle Association, 1943. Revised, and Copyrighted 1957
Approved — The American Dairy Science Association, 1957

Breed characteristics should be considered in the application of this score card		Perfect Score
Order of observation		
1. GENERAL APPEARANCE		30
(Attractive individuality with, feminity, vigor, stretch, scale, harmonious blending of all parts, and impressive style and carriage. All parts of a cow should be considered in evaluating a cow's general appearance)		
BREED CHARACTERISTICS — (see reverse side)	10	
HEAD — clean cut, proportionate to body; broad muzzle with large, open nostrils; strong jaws; large, bright eyes; forehead, broad and moderately dished; bridge of nose straight; ears medium size and alertly carried		
SHOULDER BLADES — set smoothly and tightly against the body	10	
BACK — straight and strong; loin, broad and nearly level		
RUMP — long, wide and nearly level from **HOOK BONES** to **PIN BONES**; clean cut and free from patchiness; **THURLS**, high and wide apart; **TAIL HEAD**, set level with backline and free from coarseness; **TAIL**, slender		
LEGS AND FEET — bone flat and strong, pasterns short and strong, hocks cleanly moulded. **FEET**, short, compact and well rounded with deep heel and level sole. **FORE LEGS**, medium in length, straight, wide apart, and squarely placed. **HIND LEGS**, nearly perpendicular from hock to pastern, from the side view, and straight from the rear view	10	
2. DAIRY CHARACTER		20
(Evidence of milking ability, angularity, and general openness, without weakness; freedom from coarseness, giving due regard to period of lactation)		
NECK — long, lean, and blending smoothly into shoulders; clean cut throat, dewlap, and brisket **WITHERS**, sharp. **RIBS**, wide apart, rib bones wide, flat, and long. **FLANKS**, deep and refined. **THIGHS**, incurving to flat, and wide apart from the rear view, providing ample room for the udder and its rear attachment. **SKIN**, loose, and pliable	20	
3. BODY CAPACITY		20
(Relatively large in proportion to size of animal, providing ample capacity, strength, and vigor)		
BARREL — strongly supported, long and deep; ribs highly and widely sprung; depth and width of barrel tending to increase toward rear	10	
HEART GIRTH — large and deep, with well sprung fore ribs blending into the shoulders; full crops; full at elbows; wide chest floor	10	
4. MAMMARY SYSTEM		30
(A strongly attached, well balanced, capacious udder of fine texture indicating heavy production and a long period of usefulness)		
UDDER — symmetrical, moderately long, wide and deep, strongly attached, showing moderate cleavage between halves, no quartering on sides; soft, pliable, and well collapsed after milking; quarters evenly balanced	10	
FORE UDDER — moderate length, uniform width from front to rear and strongly attached	6	
REAR UDDER — high, wide, slightly rounded, fairly uniform width from top to floor, and strongly attached	7	
TEATS — uniform size, of medium length and diameter, cylindrical, squarely placed under each quarter, plumb, and well spaced from side and rear views	5	
MAMMARY VEINS — large, long, tortuous, branching	2	
"Because of the natural undeveloped mammary system in heifer calves and yearlings, less emphasis is placed on mammary system and more on general appearance, dairy character, and body capacity. A slight to serious discrimination applies to overdeveloped, fatty udders in heifer calves and yearlings."		
Subscores are not used in breed type classification.	**TOTAL**	100

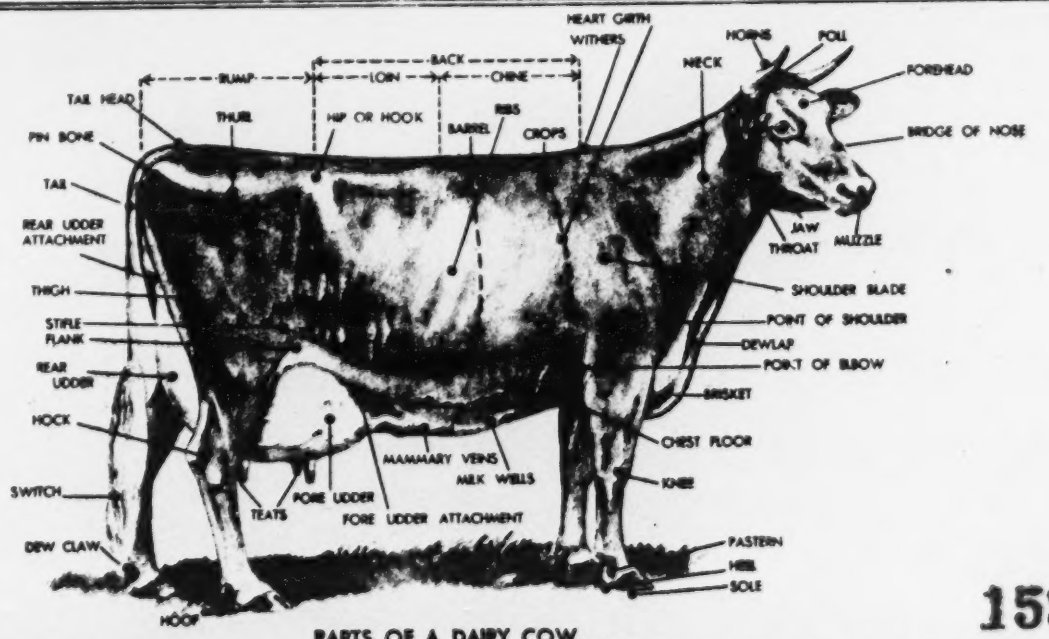

PARTS OF A DAIRY COW

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Courtesy - American Dairy Science Association

HS 51-4-1

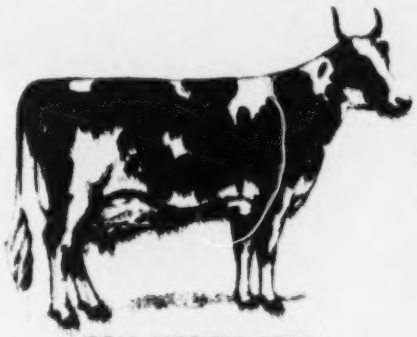

IDEAL AYRSHIRE COW

IDEAL BROWN-SWISS COW

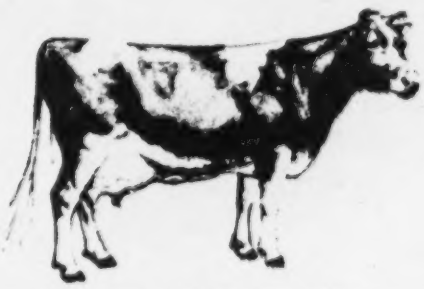

IDEAL GUERNSEY COW

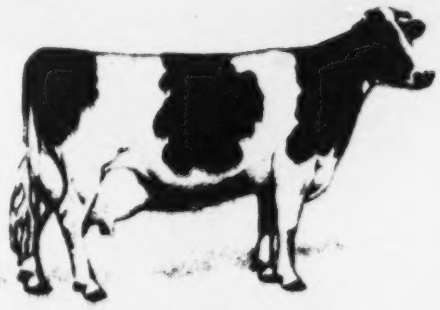

IDEAL HOLSTEIN-FRIESIAN COW

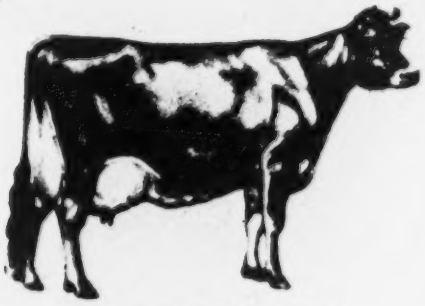

IDEAL JERSEY COW

BREED CHARACTERISTICS

AYRSHIRE

Strong and robust, showing constitution and vigor, symmetry, style and balance throughout, and characterized by strongly attached, evenly balanced, well-shaped udder.

COLOR—Light to deep cherry red, mahogany, brown, or a combination of any of these colors with white, or white alone, distinctive red and white markings preferred, black or brindle objectionable.

SIZE—A mature cow in milk should weigh at least 1200 lbs.

HORNS—Inclining upward, refined, medium length and tapered toward tips. No discrimination for absence of horns.

GUERNSEY

Size and strength, with quality and character desired.

COLOR—A shade of fawn with white markings clearly defined. Skin should show golden yellow pigmentation. When other points are equal, a clear (buff) muzzle will be favored over a smoky or black muzzle. A bright golden yellow pigmentation on the nose, around the eyes, in the ears, in the escutcheon, around the udder and at the point of tail is favored.

SIZE—A mature cow in milk should weigh at least 1100 lbs. "In milk" means normal condition after having been in milk from 3 to 6 months.

HORNS—No discrimination for absence of horns.

JERSEY

Sharpness with strength indicating productive efficiency.

COLOR—A shade of fawn, with or without white markings.

SIZE—A mature cow in milk should weigh about 1000 lbs.

HORNS—Incurving, refined, medium length and tapering toward tips. No discrimination for absence of horns.

BROWN SWISS

Strong and vigorous, but not coarse. Size and ruggedness with quality desired. Extreme refinement undesirable.

COLOR—Solid brown varying from very light to dark. White or off-color spots objectionable. Females with any white or off-color markings above the underside of the belly or with white core in switch do not meet color standards of the Brown Swiss breed, and shall be so designated when registered. Pink noses and light streaks up the side of the face objectionable.

SIZE—The minimum weight for mature cows should be about 1400 lbs.

HORNS—Incurving and inclining slightly up. Of medium length, lacking coarseness, tapering toward tips. Polled animals not barred from registry. No discrimination for absence of horns.

HOLSTEIN

Rugged, feminine qualities in an alert cow possessing Holstein size and vigor.

COLOR—Black and white markings clearly defined. Color markings that bar registry are solid black, solid white, black in switch, black belly, black encircling leg touching hoof head, black from hoof to knee or hock, black and white intermixed to give color other than distinct black and white.

SIZE—A mature cow in milk should weigh at least 1500 lbs.

HORNS—No discrimination for absence of horns.

EVALUATION OF DEFECTS

In a show ring, disqualification means that the animal is not eligible to win a prize. Any disqualified animal is not eligible to be shown in the group classes. In slight to serious discrimination, the degree of seriousness shall be determined by the judge.

EYES
1. Total blindness: *Disqualification.*
2. Blindness in one eye: *Slight discrimination.*
3. Cross-eyes: *Slight discrimination.*

WRY FACE
Slight to serious discrimination.

CROPPED EARS
Slight discrimination.

PARROT JAW
Slight to serious discrimination.

SHOULDERS
Winged: *Slight to serious discrimination.*

TAIL SETTING
Wry tail or other abnormal tail settings: *Slight to serious discrimination.*

LEGS AND FEET
1. Lameness — apparently permanent and interfering with normal function: *Disqualification.*
   — apparently temporary and not affecting normal function: *Slight discrimination.*
2. Bucked knees: *Slight to serious discrimination.*
3. Evidence of arthritis, crampy hind leg: *Serious discrimination.*
4. Boggy hocks: *Slight to serious discrimination.*

ABSENCE OF HORNS
No discrimination.

LACK OF SIZE
Slight to serious discrimination.

UDDER
1. Blind quarter: *Disqualification.*
2. Abnormal milk (bloody, clotted, watery): *Possible disqualification.*
3. Udder definitely broken away in attachment: *Serious discrimination.*
4. A weak udder attachment: *Slight to serious discrimination.*
5. One or more light quarters, hard spots in udder, obstruction in teat (spider): *Slight to serious discrimination.*
6. Side leak: *Slight discrimination.*

DRY COWS
Among cows of apparently equal merit: *Give strong preference to cows in milk.*

FREEMARTIN HEIFERS
Disqualification unless proved pregnant.

OVERCONDITIONED
Slight to serious discrimination.

TEMPORARY OR MINOR INJURIES
Blemishes or injuries of a temporary character not affecting animal's usefulness: *Slight discrimination.*

EVIDENCE OF SHARP PRACTICE
1. Animals showing signs of having been operated upon or tampered with for the purpose of concealing faults in conformation, or with intent to deceive relative to the animal's soundness: *Disqualification.*
2. Uncalved heifers showing evidence of having been milked: *Serious discrimination.*

Courtesy - American Dairy Science Association HS 51-4-2 15883

VT 013 006
Dairy. Unit (Module): Getting Started in Dairying.

Kentucky Univ., Lexington. Instructional Materials Lab.
MF AVAILABLE IN VT-ERIC SET.
Instructional Materials Laboratory, Room 151, Taylor Education Building, University of Kentucky, Lexington, Kentucky 40506 (one copy free upon request from State Directors of Agricultural Education).
PUB DATE - Oct69 18p. 1969 Revision.

DESCRIPTORS - *AGRICULTURAL EDUCATION; *CURRICULUM GUIDES; *ANIMAL SCIENCE; LIVESTOCK; *DAIRYMEN; *SKILL DEVELOPMENT; SKILLS; AGRICULTURAL PRODUCTION; BIBLIOGRAPHIC CITATIONS; TRANSPARENCIES; INSTRUCTIONAL MATERIALS

ABSTRACT - Developed by the Instructional Materials Laboratory at the University of Kentucky, this instructional unit is designed to develop abilities needed to get started in dairying. Six contemporary areas are presented with suggested teaching time, suggested references, and suggested instructional materials for each area. References, transparency masters, and comparison data of dairy cows are appended. A related document in this issue is available as VT 013 005. (GB)

VT 013 006

ED0 56238

HS 47

DAIRY

Unit (Module): Getting Started in Dairying

Major Teaching Objective

To develop the effective ability to get started in dairying

Suggested Learnings (Competencies) To Be Developed

1. To evaluate dairying as a possible major livestock enterprise on our farms
2. To decide whether the home farm is suitable for dairying
3. To determine the probable returns from a dairy cow
4. To determine the size herd that should be on the home farm
5. To select dairy animals
6. To secure dairy animals

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Revised by

Wilson Glenn Collins
Instructional Materials Laboratory
Division of Vocational Education
College of Education
University of Kentucky

October, 1969

VT013006

15887

UNIT (MODULE): GETTING STARTED IN DAIRYING

Suggested Teaching Time

Number of class periods for group teaching:

In classroom, at school . . . . . _____
Outside classroom, at school . . . . . _____
Field trips (away from school) . . . . . _____
Total . . . . . _____

Month(s) _____

Place of the Unit in the Course of Study

This unit is for use in high-school classes of vocational agriculture. It is the first of five units in dairying. The other four units are: (1) Breeding, (2) Feeding Dairy Cows, (3) Controlling Parasites and Diseases, and (4) Managing the Dairy Herd.

This unit probably should not be used unless dairying is in the teacher's course of study. If dairying is in the course of study, this unit probably should be used in the sophomore year. The primary purpose of this unit is to develop the effective ability to get started in dairying.

Suggestions for Introducing the Unit

In introducing this unit, the students should realize the importance of getting a good start in the dairy business. If students select dairying as their major livestock enterprise, they need to do a good job of getting started in the business to make a good income.

The first four learnings are useful in helping the student decide whether he should select dairying as his major livestock enterprise. Once that decision has been made, learnings five and six should prove helpful in selecting and securing the dairy animals needed to carry out his plans. Perhaps eight to ten days might be needed to fully secure the learnings in this unit. A field trip to see a good dairy farm operation may prove helpful during or after the unit has been completed. Good supervisory visits by the teacher are essential in getting the students' decisions which were made as a result of having the unit, carried out.

Suggested Learnings (Competencies) To Be Developed

1. To evaluate dairying as a possible major livestock enterprise on our farms

Importance of dairying

15888

a. Dairying is one of the most important farm enterprises in Kentucky
b. The sale of dairy products ranks second only to the sale of cattle and calves.
c. Milk is a remarkable combination of food elements.

Opportunities in dairying

a. In selling milk

-- Grade A milk
-- Milk for manufacturing purposes

b. In purebred dairying

-- Registered cattle are used.
-- The production cost is high.
-- The initial cost is high.
-- Gross income is usually higher than from other types of dairying.

c. In replacement heifers

-- Labor involved in milking is eliminated.
-- Cheap feed can be used.
-- Areas where milk markets are not available can be used.

d. In cow pools

-- Make for larger business
-- Command a better sales outlet
-- Afford the use of better bulls

Personal interest

a. To be successful, we must have enthusiastic interest in our work.
b. Enjoy working with dairy cows
c. It must be enjoyable work as well as a means of making a living.
d. Interested in developing an efficient herd

Ability to do a good job

a. Are you good enough a feeder and manager to average 9000 pounds of milk per cow for the lower testing breeds or its equivalent for high-testing breeds?
b. To do a good job in dairying requires close supervision and attention to details.
c. Do you have sufficient finances to get started?
d. Do you have sufficient labor available?
e. Labor should be qualified labor (of a high quality.)

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Advantages of dairying

a. Dairying fits well in diversified farming programs.
b. Cows are efficient consumers of roughages.
c. Dairying provides a stable income.
d. Dairy products improve the family diet.
e. Aids in maintaining soil fertility.

Disadvantages

a. A great deal of labor is required
b. Considerable capital is required.
c. There are many hazards in dairy production.
d. Substitutes for dairy products are affecting the dairy business.

Suggested Teaching-Learning Activities

a. Suggested problem: How evaluate dairying as a possible major livestock enterprise on our farms?
b. Discuss this learning well. A problem form may not be necessary if good class participation occurs.

Suggested References and Instructional Materials

Books

Approved Practices in Dairying, pp. 17-23
Introduction to Livestock Production, pp. 575-579
Livestock and Poultry Production, pp. 293-300
Dairy Production, Chapter 2
Dairy Cattle Feeding and Management, Chapter 1

Publications

"Making Your Dairy Pay, the Southern States Way," pp. 13-14
*"Dairy Production," (Mississippi), pp. 21-33

2. To decide whether the home farm is suitable for dairying

Size of farm

a. The farm should be large enough to produce most of the feed for the number of cows the labor on the farm can support.
b. As a general rule, it requires 3 to 4 acres of fairly good land per cow.
c. One hundred to 200 acres of good land is good size for a one-family dairy farm; 160 to 300 acres is good size for a farm using two fulltime men.
d. Dairy farming is rapidly becoming a big business.
e. Dairy herds are becoming larger and larger.

*Teacher Reference Only

15890

Kind of land

a. Dairying is adapted to farms where pasture is the basic feed crop.
b. Most Kentucky land is suitable for dairying.
c. The kind, quality, and amount of feed produced on a farm depends on the soil

Available markets

a. A good market is very important.
b. The future in the dairy business in in the marketing of high-quality whole-milk products.
c. The market will pay a premium for doing a good job.
d. Sharp competition for milk is good.
e.

Available labor

a. Dairying requires skilled labor.
b. Dairying requires a large amount of labor, distributed quite evenly through the year.
c.

Facilities

a. Barn

1. Feed-storage areas
2. Maternity quarters
3. Milk parlor
4. Milk room
5. Bull lot
6. Calf pens
7. Loafing area
8.

b. Equipment

1. Feeding
2. Milking
3. Cooling
4. Cleaning
5. Miscellaneous

Suggested Teaching-Learning Activities

a. Suggested problem: Should we have dairying on our farm?
b.

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Suggested References and Instructional Materials

Books

Dairy Production, Chapter 11
Introduction to Livestock Management, pp. 575-577
Farming Programs, pp. 104-105

Publications

*"Dairy Production" (Mississippi), pp. 33-34, Chapter 9, 10.

3. To determine the probable returns from a dairy cow

Items of receipts

a. Closing inventory
b. Fluid-milk sales
c. Calf
d. Manure

Items of expenses

a. Beginning inventory
b. Grain
c. Supplement
d. Hay
e. Silage
f. Pasture
g. Minerals
h. Interest on investment
i. Breeding
j. Housing and equipment
k. Electricity
l. Taxes
m. Insurance
n. Hauling milk
o. Veterinarian expense

*Teacher Reference Only

15892

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: IV. AUTOMATIC TRANSMISSIONS

PERFORMANCE OBJECTIVE NO: 4 TITLE: Disassemble, Check, and Reassemble Automatic Transmission

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Automatic Transmissions	1. Automatic Transmissions and Power Trains, by Crouse. pp. 209 through 335, 339 through 546 Automotive Chassis Workbook, by Crouse. Jobs 5 through 7 Automotive Mechanics, by Crouse. pp. 448 through 501	1. Related Information Class
2. "Power Transmission Trouble"	2. Filmstrip	2. Resource Materials Center
3. Automatic Transmissions	3. Teaching Machine card 18D	3. Teaching Machine (Shop)

1585

FORM FOR FIGURING
PROBABLE RETURNS PER COW FROM LABOR

Item of Receipts	Quantity	Price Per Unit	Total
Closing inventory (cow)			
Fluid milk			
Calf			
Manure			
	TOTAL		

Items of Expense	Quantity	Price Per Unit	Total
Beginning inventory (cow)	1		
Corn	30 bu.		
Supplement	300 pounds		
Alfalfa hay	2 tons		
Silage	3 tons		
Pasture	8 mos.		
Minerals	50 pounds		
Interest on investment	5 percent of value of cow		
Breeding	1		
Housing) Equipment)	10 percent of the value of building (or portions of buildings) and equipment used by the dairy enterprise divided by the total number of cows		
Electricity	$1.00 per month		
*Taxes ($1.50 per $100 assessed value - The assessed value is usually 1/3 of actual value.)			
*Insurance	$1.00 per $100 value of animal		
Hauling milk	$ .35 to $ .40 per 100 pounds		
Miscellaneous	$20 per cow		
Veterinarian expense	1 cow		

*For the herd, these are approximately 2 percent of the value of the cows.

12835

15893

Suggested Teaching-Learning Activities

a. Suggested problem: What returns should we expect from a dairy cow?
b. This learning lends itself to a "blackboard solution" or to a completion on an overhead transparency, with the boys helping to find the answers.
c. Use Transparency - HS-47-3 with this learning.

Suggested References and Instructional Materials

Books

Farming Programs, pp. 128-135.

Publications

*"Dairy Production" (Mississippi), pp. 68-70.

4. To determine the size herd that should be on the home farm

Production requirements for dairy cattle

a. Pasture, acres
b. Hay, tons
c. Silage, tons
d. Grain, bushels fo corn
e. Labor, hours
f. Barn room, square feet
g. Capital, dollars
h. Other costs

Consider the production requirements available for dairy cattle on the boy's home farm.

a. Acres of pasture
b. Tons of hay
c. Tons of silage
d. Tons of bedding
e. Amount of labor
f. Square feet of housing

Possible size dairy on our farms (cows)

Economical size herd for Kentucky

a. There is a best size herd for every farm.
b. A 35-cow herd is the minimum size for an economical unit.
c. Above 50 cows the cost of production per unit levels off greatly.
d.

15894

Number of replacement heifers needed

a. The average productive life of a cow is 3.9 years.
b. We need .4 heifer and .35 calf each year to replace each producing cow.
c. For 35 producing cows, we need 13 to 15 heifers and 12 to 13 calves each year.

Suggested Teaching-Learning Activities

a. Suggested problem: What size dairy herd should we have on the farm?
b. Use Transparency - HS-47-4 with this learning.

Suggested References and Instructional Materials

Books

Approved Practices in Dairying, pp. 50-56.
Farming Programs, pp. 91-92, 97-105.

Publications

"Vocational Agriculture" Notebook, pp. 8-9.

5. To select dairy animals

Type

a. General appearance
b. Body capacity
c. Dairy Character
d. Mammary development

Pedigree

a. A description of the sire and dam may be very helpful.
b. Study carefully the pedigree of an animal (before adding the animal to the herd).
c.

Production

a. The most reliable basis for selecting a cow is her record of production.
b. Care should be taken to find out the conditions under which the record was made.
c.

15895

Health and vigor

a. Be sure the tests have been made recently for tuberculosis, Bang's disease, and mastitis.
b. Buy only disease-free animals.
c. Seven percent of the animals in herds are sold annually because of diseases.

Size

a. A dairy cow should be above average in size for the breed.
b. Large enough to consume a large amount of feed
c. The cow should be large enough to consume an adequate amount of feed for good production.

Mammary development

a. A good cow must have a good udder.
b. The udder should be large.
c. An udder with good texture is soft and pliable.
d. The teats should be squarely placed on the udder.
e. The four quarters should be of equal size.
f. Mammary veins should be large, prominent, long, and tortuous.
g. Heifer's mammary glands develop in a definite pattern
h. Udder should be well attached.

Defects

a. Irregular teat placement
b. Poor eyesight
c. Poor teeth
d. Poor front or rear udder attachment
e.

Reliable source

a. Honest breeders will stand behind their products.
b. The fanciest barns, highest priced livestock, and good salesmen do not necessarily have the best stock available for the money.
c. Before we buy animals, we should see them under normal conditions on the farm.
d. The buyer should observe conditions under which the production records were made.

Suggested Teaching-Learning Activities

a. Suggested problem: What kind of dairy animals should we select?
b. A field trip to see a good dairy farm operation and some good animals would be helpful at this point. Be sure that the factors in selecting dairy animals are made clear to the students.
c. The use of Transparencies - HS-47-5-1, 2, 3, and 4 may prove useful.

15896

Suggested References and Instructional Materials

Books

Approved Practices in Dairying, pp. 36-42.
Dairy Production, Chapter 4
Dairy Cattle Feeding and Management, Chapter 20
Introduction to Livestock Management, pp. 272-283.
Farming Programs, pp. 108-113.
Livestock and Poultry Production, Chapter 17.

Publications

"Making Your Dairy Pay the Southern States Way," pp. 16-19.

6. To secure dairy animals

Partnership with parents

a. The son may be a partner with the father in carrying out the dairy enterprise.
b. In this case, each should share in the income according to what he contributes.
c. The father's advice is helpful to the son.
d. The father will furnish the farm, buildings, and most of the equipment.
e. The boy will furnish most of the labor.
f. The father and son share in the ownership of the animal(s). This should involve a trade agreement.

-- It should be written and handled in a businesslike manner.
-- The agreement should be fair.
-- The terms of the contract should be stated.
-- It should be simple and complete.

Self-financing

a. It is sound business to self-finance as much as possible.
b. Self-financing requires no outlay of interest money.
c.

Using borrowed money

a. Borrow from one of the following sources:

1. Bank
2. Production Credit Association
3. Parents
4. Other people
5.

15897

b. Make proper plans before borrowing money.

1. Make plans for borrowing money.
2. Plan for paying off the loan as soon as possible.
3.

Suggested Teaching-Learning Activities

a. Suggested problem: How should we secure our dairy animals?
b. It may be desirable for the teacher to help the boy in selecting and making arrangements for the purchase of the livestock.

Suggested References and Instructional Materials

Books

Dairy Production, Chapter 4.
Farming Programs, pp. 125-134, 154-155.

Publications

Kentucky Circular 563
Kentucky Circular 538-D, pp. 3-7.

Evaluating the Unit

This unit should be evaluated in terms of the teachers' objectives, and the decisions made by the students. As the teacher visits the students, he should try to evaluate the effectiveness of the teaching in terms of the quality of the dairy project the student initiates.

Evaluate with the class the teaching of the unit. All aids, techniques, and materials should be carefully evaluated after the unit has been completed.

15898

References

Books

Approved Practices in Dairying; Second Edition; Jurgenson and Mortenson (The Interstate, Danville, Illinois, 1960) 296 pp.

Dairy Production; Second Edition, Diggins and Bundy (Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1961), 341 pp.

*Dairy Science; Second Edition, Petersen (J. B. Lippincott Company, Chicago, 1950), 686 pp.

Dairy Cattle Feeding and Management, Fifth Edition, Reaves and Henderson (John Wiley and Sons, Inc., New York, 1963), 448 pp.

Livestock and Poultry Production; Third Edition, Bundy and Diggins (Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968), 723 pp.

Introduction to Livestock Production; Second Edition, Cole (W. H. Freeman and Company, San Francisco, California, 1966), 827 pp.

Farming Programs for Students in Vocational Agriculture, Hammonds and Binkley (The Interstate, Danville, Illinois, 1961), 314 pp.

Publications

*"Dairy Production," (Published by the State Board for Vocational Education, Jackson, Mississippi, 1958), 319 pp. (Write for a single copy.)

"Making Your Dairy Pay the Southern States Way," (Southern States Information-Publications Service, Richmond, Virginia, 1967.) 154 pp. (Copies can be secured from local agency.)

Kentucky Circular 583--"A Guide to Father-Son Farming Arrangements"

Kentucky Circular 538-D--"Property Rights"

"Vocational Agriculture" Notebook (Published by the Interstate, Danville, Illinois)

*Teacher Reference

15899

Returns Over Feed Costs at Various Production Levels

No. Herds	Lbs Milk	Lbs Grain Fed	Feed Cost	Return Over Feed Cost
		Per Cow		
5	15,200	7500	$367	$442
26	13,700	6500	333	402
74	13,100	5500	294	395
127	11,600	4500	245	377
149	10,200	3500	214	336
44	8,700	2500	172	315
4	7,900	1500	154	264

All Kentucky cows 6,580

Kentucky DHIA 1967

15900

NEEDED REPLACEMENTS IN DAIRYING

Percent of Total Number of Cows in the Herd	30 Cow Herd
Number of replacement heifers (12 to 27 months) on hand should usually equal to 40 to 27 percent of number of cows	12 to 14 heifers
Number of calves (1 to 12 months) on hand should usually equal 35 to 40 percent of number of cows	11 to 12 calves
Total number of replacements on hand	23 to 26 head

Source: Agricultural Economics Department, University of Kentucky

15901

15900

MAMMARY GLAND DEVELOPMENT OF HEIFERS

BIRTH TO 1 MONTH
TUBULAR STAGE

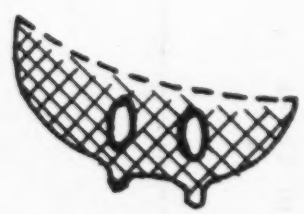

1 TO 2 MONTHS
ENLARGEMENT
STAGE

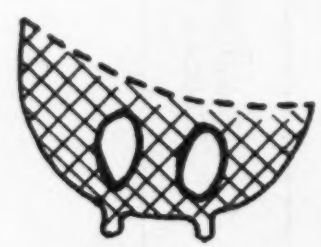

2 TO 3 MONTHS
QUARTER
STAGE

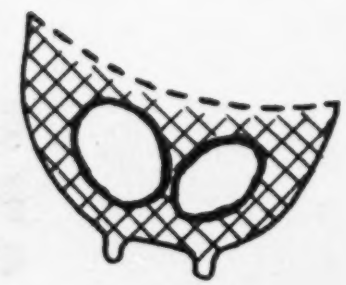

3 TO 4 MONTHS
QUARTER
STAGE

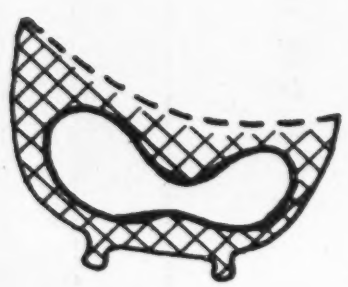

4 TO 5 MONTHS
HALF STAGE

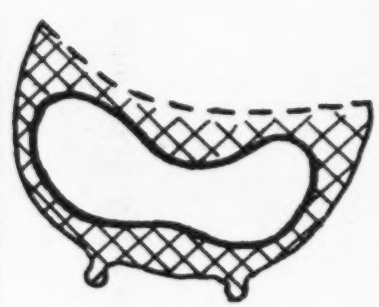

5 TO 6 MONTHS
HALF STAGE

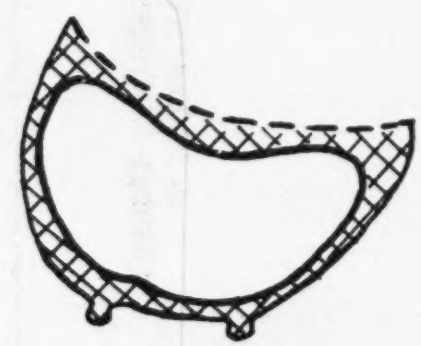

OVER 6 MONTHS
HALF STAGE

R. GILMORE, INST. MATL. LAB. U.K.
15903
15902
HS-47-5-1

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: IV. AUTOMATIC TRANSMISSION

PERFORMANCE OBJECTIVE NO.: 4 TITLE: Disassemble, Check, and Reassemble Automatic Transmission

CONDITIONS:

This assignment will be performed on a transmission obtained from the parts storage room. Under performance checks and tests, perform only bench tests and checks on this unit.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Obtain transmission from parts storage room
2. Select proper manual and turn to appropiate chapter
3. Select proper tools and materials
4. Disassemble transmission following all steps as outlined in the manual
5. Identify all parts and their functions
6. Perform tests and checks following all steps as outlined in the manual
7. Reassemble tranmission following all steps as outlined in the manual
8. Perform all bench checks and tests following all steps as outlined in the manual
9. If all tests and checks are satisfactory, return transmission to storage room
10. Return tools and materials to proper place
11. Clean work area for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily disassemble, check, reassemble, and bench test automatic transmission in 8 hours.

Learning time: 20 hours

A COMPARISON OF AVERAGE PRODUCTION PER COW
BETWEEN KENTUCKY DHIA HERDS AND ALL KENTUCKY HERDS

Year	DHIA HERDS (Pounds of Milk)	ALL KENTUCKY HERDS (Pounds of Milk)
1966	10,921	6,540
1968	11,300	6,800

There is usually over 4000 pounds difference between these two average figures.

Source: Kentucky DHIA - 1968

AVERAGE KENTUCKY DAIRY COW HERD SIZES

DHIA Herds	43 Cows
All Kentucky Herds	10-12 Cows (estimated)

Source: Dairy Science Department, University of Kentucky - 1969

15903

15903

DAIRY COW SCORE CARD

Based on Order of Observation	Perfect Score	Cow A	Official Score	Cow B	Official Score
1. General Appearance	30				
Breed Characteristics					
Head					
Shoulder blades					
Back					
Loin					
Rump					
Hips					
Thurls					
Pin bones					
Tail head					
Tail					
Legs					
Hind legs					
Feet					
2. Dairy Character	20				
Neck					
Withers					
Ribs					
Flank					
Thighs					
Skin					
3. Body Capacity	20				
Barrel					
Heart girth					
4. Mammary System	30				
Udder					
Texture					
Teats					
Mammary Veins					
TOTAL	100				

15904

Courtesy - Purebred Dairy Cattle Ass'n.
(This form may be duplicated and used on a field trip.)

VT 013 031
A Business Education Individualized Continuous Progress Research Curriculum Development Study. Volume I.

Weber County School District, Utah.
Utah State Board of Education, Salt Lake City.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 70 121p.

DESCRIPTORS - *BUSINESS EDUCATION; *INSTRUCTIONAL MATERIALS; BOOKKEEPING; TYPEWRITING; OFFICE MACHINES; *INDIVIDUALIZED INSTRUCTION; TESTS; *ASSIGNMENTS; ACCOUNTING; *PROGRAMED MATERIALS; SECONDARY EDUCATION; BEHAVIORAL OBJECTIVES; COURSE CONTENT

ABSTRACT - With the support of school administrators, several business education teachers developed this package of individualized curriculum materials. These materials are arranged in three parts which pertain to beginning typewriting, beginning and advanced business machines, and bookkeeping. Following the continuous progress approach, this color-coded document includes assignments and quizzes for each of the above units as based on selected textbooks. Behavioral objectives for the student and instructions for the teacher are also included. A second volume for shorthand, transcription, and secretarial procedures is available as VT 013 032, also in this issue. (JS)

VT 013 031

ED0 56238

Weber County Schools

BUSINESS CURRICULUM

INDIVIDUALIZED CONTINUOUS PROGRESS

TYPEWRITING (FIRST-YEAR COURSE)
BUSINESS MACHINES
BOOKKEEPING ACCOUNTING)

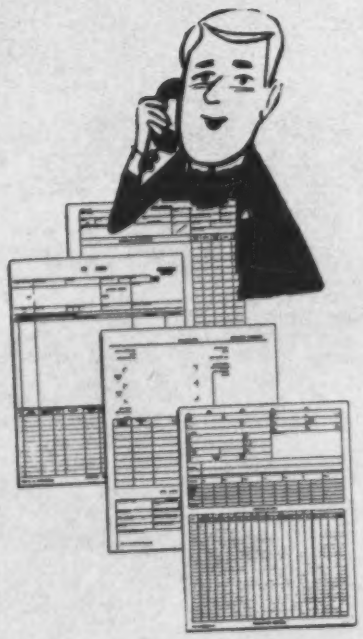

VT013031

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15906

VOLUME I

1970

A BUSINESS EDUCATION INDIVIDUALIZED CONTINUOUS PROGRESS RESEARCH CURRICULUM DEVELOPMENT STUDY, REPORTED IN TWO VOLUMES.

VOLUME I

PART ONE

A GENERAL INTRODUCTIVE COURSE TO BEGINNING TYPEWRITING USING THE INDIVIDUALIZED CONTINUOUS PROGRESS APPROACH.

PART TWO

AN INTRODUCTIVE COURSE IN BEGINNING AND ADVANCED BUSINESS MACHINES USING THE INDIVIDUALIZED CONTINUOUS PROGRESS APPROACH.

PART THREE

A COMPREHENSIVE COURSE IN BOOKKEEPING (ACCOUNTING) USING THE INDIVIDUALIZED CONTINUOUS PROGRESS APPROACH.

SUPPORTED BY: Utah State Board of Education Vocational Research and Experimentation Funds, Project No. D-235.

Weber County School District.

15907

ACKNOWLEDGEMENTS

Weber County School District

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INSTRUCTIONS FOR THE TEACHER

Typewriting

These sample packets are not intended to be used as an ideal method of instruction for every classroom. Each situation would demand some type of modification to meet the needs of scheduling, students, and text material available. Most of these packets were developed from the text, 20th Century Typing, 9th Edition, by Lessenberry, Crawford, and Erickson. The packets are developed in four stages. They are:

STAGE I: TECHNIQUES OF TYPEWRITING. This packet covers approximately nine weeks of instruction. The class period should be no longer than 45 minutes and the students should meet daily.

This stage covers the keyboard introduction and a few simple centering problems. After the teacher makes a short introduction of the lesson the students are then instructed by a commercial tape that corresponds with the lesson. This frees the instructor to work individually with those students who might be having difficulty with techniques. Transparencies are also used to aid the student in correct finger positions and posture.

The papers are turned in daily; however, no letter grade evaluation is made on them. The instructor may look at each paper to help him determine which students need more individual help the following day.

If the classroom has been wired for multiple channeling, the

instructor may want to take those students that seem to be learning at a slower pace and have them go through some lessons twice.

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The student has to make a choice at the completion of Stage I. He must decide if he wants to take Stage II A, Accuracy and Speed Building, which would prepare him for Stage III, Business Type, or if he wants to take Stage II B, Personal Type.

STAGE II A - ACCURACY AND SPEED BUILDING, The students in this stage should have a 45 minute class period and meet four or five days a week. The number of days would depend on the schedule.

The instructor will now have at least two groups of students in the classroom. To free the instructor to spend some time with the students in Stage II B, drills for speed and accuracy may be put on tape for the Stage II A students. Drills that have been put on transparencies are also good to use with these students.

At least one day a week and preferrably two days should be teacher directed drills and timed tests. The tests should be 5 minute test and the students should keep a personal chart of total speed and errors so he will always be aware of his increase.

The student would be kept in this stage until he reaches a given increase in speed, approximately 10 wpm above his speed at the completion of Stage I, and a maximum number of errors of approximately no more than seven errors on a five minute timing.

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STAGE II B - PERSONAL TYPE. This packet has been designed for the students to meet daily for one hour for approximately nine weeks.

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The students work at their own pace on this packet. Some may be able to finish before the nine weeks, some may take longer. No credit is given until completion. Guidelines should be set so they will know approximately where they should be in the packet at certain times through the term.

The jobs are brought to the instructor as each one is completed so the instructor can look at it with the student. If there has been an error in placement it can be brought to the students attention at that time. If the instructor feels the job should be redone the student can be told at that time.

Individual jobs are not given a letter grade. The students are graded on the production tests and three minute timed writing tests. One day a week should be used for drill and timings.

Transparencies are available to help the stedents in understanding how to set up letters and forms.

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STAGE III - BUSINESS TYPE. This packet has been broken into eight units which the student should be able to complete in 80 to 100 hours of typewriting. The time would depend on the skill the student has when entering the stage. It is suggested that the student be given four days a week to work on production packets, and the fifth day be spent on teacher directed drill and 5 minute timed writings. Those students who work ahead on the production packets may be released one day a week if the schools schedule will allow it. The instructor may want to give a mini-test on the fifth day along with drills. This would consist of a short production problem that all students have covered. It would be timed and then class discussion would be held to

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go over all points. The student would correct his own work. No grade would be given, however, all papers would be handed in. The problem might be put on a transparency so all students could look at the correct form while it is being discussed.

15912

11231

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII, POWER FLOW

MILESTONE: V. DRIVE SHAFTS AND UNIVERSAL JOINTS

PERFORMANCE OBJECTIVE NO: 5 TITLE: Remove Drive Shaft, Remove, Test, and Replace Universal Joint, Replace Drive Shaft

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Drive shafts and universal joints	1. Automotive Mechanics, by Crouse. pp. 502 through 507 Automotive Transmissions and Power Trains, by Crouse. pp. 557 through 566 Automotive Chassis Workbook, by Crouse. Job 11	1. Related Information Class
2. "Repacking a Universal"	2. Continuous film loop	2. Resource Materials Center
3. "Completeing the Transmission od Power"	3. Filmstrip	3. Resource Materials Center
4. Drive shafts	4. Teaching Machine cards 19A, 19B	4. Teaching Machine (Shop)

TECHNIQUES OF TYPEWRITING.

TYPING STAGE I

Performance Criteria

At the completion of this stage you will be able to type at the rate of 20 words a minute or more with an accuracy limit of no more than two errors per minute. You will be able to correctly set up and type a centering problem.

1. The speed and accuracy rate given above must be reached on at least three 3-minute timings before credit can be earned.
2. The centering problems must be satisfactorily completed before credit can be earned.
3. You will be given two objective tests to determine your knowledge of machine parts and spacing rules. To receive credit for these tests you must receive a score of 75% or higher. If you do not receive a score of 75% or higher you will be required to have a conference with your instructor to do additional assignments, and to take another test. A typewritten test will be given as the last assignment in this packet. It will consist of three vertical and horizontal centering problems. A time limit for this test is given on the last page of this packet.

SUPPLIES

You will need the following supplies for this typing stage:

type paper 8½ by 11 inches
folder to keep assignment packets in
pencil and pen

ASSIGNMENTS

All assignments should be identified in the upper right hand corner with the following items:

Name
Date
Lesson Number and class section

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1. Listen to and follow the directions given on tape #1. You will learn the control of a few parts of the typewriter (carriage return, cylinder know, carriage release, line space regulator, margin set, paper guide, paper bail, cylinder), correct position of the fingers on the home keys (a,s,d,f,j,k,l,;), and correct stroking of the home keys. If class time remains at the completion of the tape you should continue to practice on 1F page 4.

   Remember
   1. Sit up straight, practice good posture.
   2. Strike the keys with a firm, sharp stroke, and release quickly.
   3. Return the carriage with a wuick wrist and hand motion.
   4. Keep your eyes on the book.
   5. Never strike over a mistake.
   6. At the end of each class period get your work station ready for the next student.

   FORM THESE GOOD HABITS NOW !!!!!

2. Listen to and follow the directions given on tape #2. This lesson will teach you the correct finger reaches for the keys h, e, and Left Shift Key. You should begin to type at a slow and controlled rate. At this point do not be concerned about misstrokes. Continue typewriting with as little interruption as possible and without looking up to check to see if you have or have not typed without error. At the completion of the tape if there is alass time left you will practice on 2E page 6.

3. Listen to and follow the directions given on tape #3. You will learn the correct finger reaches for the letters i, t, and . (period), You will also learn the difference in pica and elite type. Pica type is a larger type and has 10 spaces to the horizontal inch; its centering point is 42. Elite type is a smaller type and has 12 spaces to the horizontal inch; its centering point is 50. (You are typing on an elite machine). The steps in getting ready to type are repeated in slightly briefer form in this lesson, but the activities are essentially the same. Remember, you should never begin to type until you have checked and adjusted the typewriter. While making reaches to new keys be sure to keep a guide finger on the home row to guide you back into position. Notice the spacing rule under 3E.

4. Listen to and follow directions given on tape #4. This lesson will integrate the three previous lessons and give you more time to practice on the keys that have been presented. You should read carefully section 4B of this lesson. It has information that you must know to complete this stage. If time remains at the end of the tape you should practice on 4F page 10. This instruction will not

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be repeated. Your instructor expects you, at the end of each tape, to find a section in your book that you need practice on and type until the end of the period.

5. Listen to and follow instructions for tape #5. In this lesson you will learn the reaches for the keys u, c, and Right Shift Key. Remember to always have a guide finger in home position to guide you back into position. Strike all keys without looking at your fingers or keyboard. Notice the new spacing rule in 5C.

6. Double letters often become speed traps for typists who are trying to increase their stroking rate. On the manual typewriter, double letters can be typed in "half time," that is, without lifting the finger enough for the key to return to its normal position before typing it the second time. Instead, two short and quick strokes will give the double letters without producing jerky or spasmodic stroking if the typing is done in rhythm--but not with the same time lapse between all strokes.

7. Follow the instrutions on the previous page for lessons 6 through 11. Learn to backspace and tabulate without taking your eyes from the books.

8. Listen to and follow instructions given on tape #12. Your best timing on section 12D will be recorded. At the end of the tape you will be given a 25 point objective test. This test will cover the machine parts taught to this point, the spacing rules, and the difference in pica and elite type. You will be given 15 minutes for this test.

9. Listen to and follow instructions given on tapes 13-20. There will be no new keys introduced in these lessons. You will improve typing motion and build continuity in typewriting. You will learn how to proofread. You should look for the following types of errors; failing to space, omitted letter, period for comma, faulty spacing, omitted word, strike over, misstrokes, transposition, added letter. Count only one error per word; circle the entire word. Your 3-minute timings will be recorded.

10. Listen to and follow instructions given on tapes #21-30. These lessons will teach you the proper finger reaches for the fingers with as much ease as you do the alphabet. Remember to keep your eyes on the copy when typing the alphabet and figures.

11. You will take two 3-minute speed tests and a 50 point objective test. You will be given 25 minutes for this test.

12. Each day after you have checked your machine you will have a 5-minute warmup practice on the section that will be on the board. These warm-ups will be handed in each Friday.

15916 15915

13. Study and type 35B. These are the steps in adjusting your machine for typing a line in centered form. You will always follow these steps before typing a horizontally centered problem. On the same paper, but below 35B you will type 35C. This is a drill on horizontaly centering. If you have any questions on this drill be sure to get help from your instructor before going on.

14. Complete the problem 35D. Bring the problem to your instructor for approval. After approval complete 35E.

15. Do problem 37B. You underscore with the shift of the 6 key.

16. Follow directions and type problems 36D and 37C. These will be done on separate half sheets of paper. The letters 'TS' mean to triple space. To do this you will return the carriage three times. This will leave two blank spaces between lines of writing.

17. Do drills 37E and 38B on drill paper.

18. Do problem 38C. Follow directions carefully. Notice the spacing at different points of the problem

19. Read and follow the directions for 38D. Follow the rules step by step and you should have no problems. If you have difficulty, ask your instructor for assistance before going on to the next assignment.

20. Do problem 39B and 39C. The steps for vertical centering are given in 38D.

21. Do problems 39D and 40D.

22. Type drill 38B. This drill is on typing outside the margins. Read your directions carefully before typing.

23. Type the bell cue drill given below. Type at a slow, even pace and listen for the ringing of the bell to know when to return the carriage at the end of the line. (You will not type the copy line for line.) If you are typing a word when the bell rings, complete the word. If the carriage locks before you complete the word, depress the margin release and type the rest of the word. Type once using a 50 space line, Double Space, type again on a 70 space line.

Most typing paper is 11 inches long. We count 6 lines to the inch, so a full-size sheet of paper has 66 lines. A half sheet is 5½ inches long and has 33 lines. To have the top margin exactly 1½ inches (9 lines), space down 10 times from the top of the page to type on the tenth line, leaving 9 lines for a top margin.

15916

24. You will take three 1-minute speed tests, three 2-minute speed tests, and three 3-minute tests.

25. You will complete three centering problems for test III. Ask your instructor for a rough draft of the problems you are to complete. If these problems are not completed satisfactorily, you will be given additional ones to practice on, and then will be given another test.

Evaluation

It is recommended this stage be completed by the end of one term, however, more time will be given if needed to reach the standards set for stage one.

The following grading scale will be used for the speed grade for stage one:

20-24 C
25-29 B
30-up A

Centering problems will be graded as follows:

0 errors	A
1-2 errors	B
3-4 errors	C
5 or more	redo the problem
strike over	redo the problem

Errors that will be marked are: Improper form or style, misspelled words, transposed words, improper margins, failure to capitalize correctly, and improper punctuation.

Test III Time Limit:

31-35 mins.	C
26-30 mins	B
25-under	A

15917

PERSONAL TYPE
Stage 11 - B

This course is designed for the student who intends to use type only for his personal use and as an aid in college.

Performance Criteria

At the completion of this course the student will be typing at a minimum rate of 30 words a minute, and will have an accuracy rate of no more than 1 error per minute. He will also have the knowledge to type for his own personal use: announcements, memorandums, postal cards, letters, reports, manuscripts, and personal data sheets.

1. The speed and accuracy rate must be reached on at least three 3-minute timed writings.
2. All production problems must be completed and approved by your instructor. If a problem is not approved it must be retyped.
3. You will be given two type tests. You must accurately complete at least 80% of these tests in order to receive credit for them. If you do not complete 80% of the test you will be given additional assignments, and will be given another test. The first test will consist of a memorandum, an announcement, a postal card, and two letters. A maximum of 45 minutes will be given for this test. The second test will contain a table with columnar heads, a manuscript with footnotes, and a title page. You will be given 40 minutes for this test.

Supplies

You will need the following supplies for this stage:

Type paper 8½ by 11 inches
folder to keep the assignment packet in
pencil or pen
type eraser
carbon paper.

1. You will type from the test job 53C page 90, and job 54C page 92. Study carefully the correction symbols given in these jobs. Many times in typing you will need to type a copy of your material, correct it with pen or pencil (this is called a rough draft), and then type your corrected copy as your final draft. You will use symbols in your rough draft.

15918

2. Type the rough draft on page 1A of this packet.

3. Compose a half page article at the typewriter entitled "My Future Plans". Mark any errors with proofreaders marks, and type a corrected final draft. Turn both copies in.

Typing From Script

4. In your personal typing you will often have to type from a copy that is written in pencil or pen. This is called typing from script. Do jobs 31D, 32B, and 34D group 3.

5. Write a half page article using the title "No Man Is An Island". Type a final copy from the script copy. Turn both copies in.

Erasing

6. The errors that you make in themes, personal notes, and other papers you wish to use should be corrected. You must, therefore, learn how to erase typing errors. The instructions for erasing typing errors correctly are given in the problem on page 1B of this packet. Always follow these procedures when erasing. You will be told in each assignment if you are to erase and correct errors. Type the paragraph outline on page 1B. Single space the lines of the paragraph. Be sure to align the Roman numerals at the right. Use the margin-release key and backspace to the desired point. Use a 60 space line.

Typing Announcements

7. Follow the directions and type 41B and 42C. Correct errors.

Number and Capitalization Guides

8. Do 86C and 87C. This will be returned to you for your personal reference. Erase and correct errors.

9. Do 91B, 92D, 93C, 95B. This will be returned to you for your personal reference. Erase and correct errors.

Typing Memorandums

10. Type job 44C problem 1. The information given in this problem will aid you in a future assignment when typing postal cards.

11. Type the two memorandums on page 1C of this packet. They are each to be typed (1) on a half sheet of paper, (2) with a 70 space line, (3) with SS, but DS between paragraphs, (4) with a 1 inch top margin, (5) with 3 blank spaces after the date. Erase and correct errors. Personal titles (Mr., Mrs., Dr., etc.), salutations, complimentary close, and formal signature are omitted.

Typing Postal Cards

12. Ask your instructor for two postal cards. Type job 44C problem 2.

13. Ask your instructor for a postal card. Type the problem on page 1D of this packet. Erase and correct errors.

Personal letters.

14. Type 50C problem 1 and 2. This is a personal business letter typed in modified block style with mixed punctuation. In a modified block style letter the return address, date, complimentary close, and writer's name are typed at the horizontal center of the paper; the other letter parts begin at the left margin. With mixed punctuation a colon follows the salutation and a comma follows the complimentary close. There is an example on page 2A of this packet. Erase and correct errors.

15. Type job 51B problem 1 and 52C. If you have any difficulty setting these letters up refer to page 2A of this packet. Notice in problem 2 of 52C the inside address is omitted. Erase and correct errors.

16. Another letter style that is common is the block style. This letter style has all letter parts starting at the left margin. There is also another punctuation that is often used. Open punctuation means that there is no punctuation after the salutation and complimentary close. There is an example on page 2B of this packet. Type the letters on page 1E and 1F of this packet. These are to be typed in block style, open punctuation, 50 space line, and with the date on line 15. Erase and correct errors.

17. In all our letters we have had 3 blank spaces between the date and the inside address. To make your letter appear more evenly spaced on the sheet of paper you may want to type it as the example on page 2C of this packet. Type the letter on page 1G in modified block style, open punctuation, using a 50 space line, and the vertical spacing given in example 2C. Erase and correct errors.

18. On page 2D of this packet you will find an example of a letter typed on a half sheet of paper, 5½ by 8½, and in modified block style with indented paragraphs. Study this example and type the letter on page 1H (1) on paper 5½ by 8½. (2) Use a 40 space line Start the return address on line 10. Leave three blank spaces after the date. (3) Indent the paragraphs 5 spaces. Erase and correct errors.

15920

19. "It is often desirable to make one or more copies of the material you are preparing. To make carbon copies, place the carbon paper, with the glossy side down, on a sheet of plain paper. The paper on which you will prepare the original is then laid on top of the carbon paper, and all the sheets are inserted into the typewriter. The dull surface of the carbon sheet should be toward you when the sheets have been rolled into proper position for typing.

When you wish to erase carbon copies, turn the sheets up a few spaces and move the carriage either to the right or to the left so that eraser crumbs will not fall into the machine. Place a small card between the original copy and the carbon sheet, directly under the letter or word to be erased. Make the erasure on the original.

Remove the card, pull the original copy and carbon sheet forward, and then erase on the carbon copy. If you are making more than one carbon copy, use the small card in the manner directed above on all copies except the last to keep from smudging the copies."

Retype assignment 15 preparing one carbon for each letter. Erase and correct errors.

20. You will ask your instructor for test I. You will be given 45 minutes to type a memorandum, an announcement, a postal card, and two letters. Correct all errors.

21. Review the rules for centering in jobs 35C and 38D. Do the problem on page II of this packet. Center the problem vertically on a half sheet of paper. Leave 6 blank spaces between columns. Single space the entries in each column. Triple-space after the heading.

22. Do drill 164B. Do problem 164C problem 1 and 2. Correct errors

23. Do drill 43E and 44D. Do problem 165C. Correct errors.

24. Type 165C problem 2 and 3

Manuscripts

25. Do job 65C problem 1 and 77D problem 1.

26. Do job 68D and 74C problem 2.

27. Do job 91D, 92C, 93D, 94C, and 98C. The three problems in 98C will be inserted into job 94C in the proper places and they will be stapled together. Erase and correct errors.

15921

28. You will take test II. You should be able to type a table with columnar heads, a manuscript with footnotes, and a title page.

Evaluation

The grading scale for speed and accuracy will be as follows:

27-30 C
31-34 B
35 up A

Your problems that are to be corrected will be graded as follows:

C errors - A
If the problem has any errors - redo
redo until correct - C

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: V. DRIVE SHAFTS AND UNIVERSAL JOINTS

PERFORMANCE OBJECTIVE NO.: 5 TITLE: Remove Drive Shaft; Remove, Test, and Replace Universal, Replace Shaft

CONDITIONS:

This assignment is to be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Position hoist arms and raise automobile to a comfortable working height
6. Remove drive shaft
7. Disassemble universal joint following all steps as outlined in the manual
8. Make all tests and checks as outlined in the manual
9. Reassemble universal joint following all steps as outlined in the manual
10. Make bench tests and checks as outlined in the manual
11. If all tests and checks are satisfactory, install drive shaft in autobile

PERFORMANCE CRITERIA:

PERSONAL TYPE
Stage II B
1 A Page 6

ROUGH DRAFT

all caps → FLARE for wit

Triple Space →

There are but two kinds of clever people in this world.. one group thinks of a ~~smark~~ witty remark in time to make it, and the other in time not to make it.

Genuine ~~True~~ wit is an art all right. It comes from saying the unexpected at the right time to the right people. Learn how to use it.

The next ~~thing~~ best to being witty yourself is ~~to be~~ being able to quote another's wit. Never be clever, though, ~~with~~ at the expense of someone else. This is always poor in taste.

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ERASING PROCEDURES

I. Move the carriage to the extreme right or left so that the eraser particles will not fall into the typewriter.

II. If the error occurs on the upper portion of your paper, roll the paper up two or three spaces to give yourself working room. If the erasure is to be made on the lower third of the paper, turn the cylinder backward to keep the paper from slipping.

III. When you erase, be sure that your hands and the eraser are clean to prevent smudges on the copy. An eraser shield is sometimes used to protect the writing that is not to be erased.

IV. Hold the paper firmly against the cylinder with your finger tips. Erase the error carefully so as not to make a hole in the paper. Brush or blow the eraser particles away from the typewriter.

V. Return the paper to typing position. Make the correction by striking the keys lightly. Restrike the letters, if necessary, to make the stroking even.

15924

1. MEMORANDUM IN ARRANGED COPY

Current date

TO: Typing Students

FROM: Procedures Committee

SUBJECT: Horizontal Centering

Centering headings and other typed materials so that there will be equal left and right margins is called horizontal centering.

The first step in centering material horizontally is that of checking the placement of the paper quide. Then, move the carriage to the center point of the paper.

The last step is to backspace once for each 2 spaces in the line to be centered. If one letter remains, disregard it. Begin to type at the point where the backspacing is completed.

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2. MEMORANDUM IN UNARRANGED COPY

Current date TO: John R. Douglas
FROM: Ronald E. Karleen SUBJECT:
Kayser Project
Congratulations to you and to the men in your department ofr developing an excellent program for use in the Kayser Project. I have just learned that the State Department has authorized an additional $750,000 for use in this project.

When including this addition the budget, be sure to follow the procedures outlined by the State Dept. Call Tom Oliver for further instructions. He has all the necessary forms that need to be completed.

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POSTAL CARD

(current date)

Dear Ted

At last we are settled in our Tucson home. Our address is
10293 Glen Arden Drive
and I hope you will write me soon and often. You know how much I miss you and other friends "back home". Tucson is a wonderful place, but it isn't home to me--yet!

Affectionately

(sign your own name)

Address the postal card to:

Linda Swenson
1560 Brandon Street
St. Paul 16, Minnesota

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BLOCK STYLE WITH OPEN PUNCTUATION

364 West 20th Street
Sioux City, Iowa 51104
December 20, 19--

3 blank

Mr. Thomas J. Briggs
West High School
6809 Franklin Blvd.
Cleveland, Ohio 44102

DS

Dear Mr. Briggs

DS

If you have several competent typists who are ready for office work, ask them to call for an interview with me.

DS

Before the interview, each applicant should complete an application form in ink. If the writing is neat and legible, I am impressed. If it has "messy" corrections, I am prejudiced against the applicant even before the interview is begun.

DS

Our Employment Test includes English, spelling, arithmetic, and typewriting. Competence in these areas is necessary, but we consider attitudes just as important as aptitudes and use the job interview to evaluate the applicant's attitudes.

DS

We expect to have two or three positions open for beginning office workers early next month.

DS

Sincerely yours,

3 blank

Albert N. Tomasson
Personal Director

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BLOCK STYLE WITH OPEN PUNCTUATION

260 Ridge Road Cleveland, Ohio 44102 June 24, 19--
Mr. Thomas J. Briggs Business Teacher West High
School Cleveland, Ohio 44102 Dear Mr. Briggs
Now I know how unprepared I was for the job interview
you sent me on a few days ago. I hadn't given enough
thought to my real interests and even less to my job
competence.
I didn't have my social security card or number. Because
I didn't have these with me for the interview, I was
at a disadvantage from the start.
The test went fairly well, I thing; but I need to
review my English, spelling, and arithmetic and must
practice my typing before another interview. I'll do
this, too.
I won't let you down when I go for the next interview,
I promise. Sincerely Earle Caldwell

PERSONAL TYPE
Stage II B
Page 12 1G

MODIFIED BLOCK WITH OPEN PUNCTUATION

1234 Indiana Avenue Kokomo, Indiana 46901 October 15, 1969

Mr. Lloyd Bartholome 141 Bedford Court Mansions Adeline Place
London, W.C. 1, England

Dear Mr. Bartholome

It was a great pleasure for me to meet you during my recent visit to London, and I would like to express my sincere thanks for your warm and generous hospitality.

I greatly enjoyed our evening at the Paladium. The convivial company, delightful music, and entertainment brought back pleasant memories of previous visits to your city.

Please extend my kindest regards to Mrs. Bartholome Sincerely

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056 238

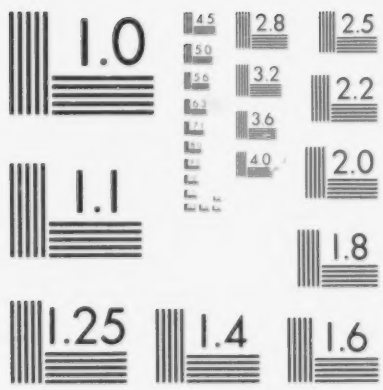

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PERSONAL TYPE
Stage II B
Page 13 1H

HALF SHEET OF PAPER
MODIFIED BLOCK WITH INDENTED PARAGRAPHS

(Use your own home address) (Current date)
Mr. John C. Gibson 3059 Mapleview Drive Frankfort, Kentucky 40601

Dear Mr. Gibson I am genuinely pleased to be able to write to you that arrangements have been made to offer Tchaikovsky's The Nutcracker Ballet during the coming Christmas Season. Three evening performances will be offered during the week of December 26.

The production has been completely redesigned; striking new sets and decor with add immeasurably to the dazzling impression. All the young at heart, from seven to seventy, will want to see and hear The Nutcracker Ballet !!

Next week, I shall be mailing your complimentary tickets.

Very cordially yours, Lawrence L. Davis, General Manager

15930
12358
229

THREE-COLUMN TABLE ON HALF SHEET

FOUNDING DATE AND LOCATION OF SOME AMERICAN UNIVERSITIES

California	Los Angelos	1919
Columbia	New York	1954
Dartmouth	Hanover	1769
Delaware	Newark	1743
Georgia	Athena	1785
Harvard	Cambridge	1636
Hawaii	Honolulu	1907
Pennsylvania	Philadelphia	1740
Pittsburgh	Pittsburgh	1787
Princeton	Princeton	1746
Rutgers	New Brunswick	1766
Vermont	Burlington	1791
William and Mary	Williamsburg	1693
Yale	New Haven	1701

15931

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: V. DRIVE SHAFTS AND UNIVERSAL JOINTS

PERFORMANCE OBJECTIVE NO.: 5 TITLE: Remove Drive Shaft; Remove, Test, and Replace Universal, Replace Shaft

CONDITIONS:

BEHAVIOR:

12. Make final tests and checks and if they are satisfactory, return tools and materials to proper place
13. Lower automobile to the floor
14. Return automobile to proper parking area
15. Remove seat covers and store in proper place
16. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to remove drive shaft, remove universal joint, test, and replace universal joint, and replace drive shaft in 1½ hours.

1589

Learning time: 3 h

PERSONAL TYPE
Stage II B
Page 16 2B

BLOCK STYLE
OPEN PUNCTUATION

15933

PERSONAL TYPE
Stage II B
Page 17 2C

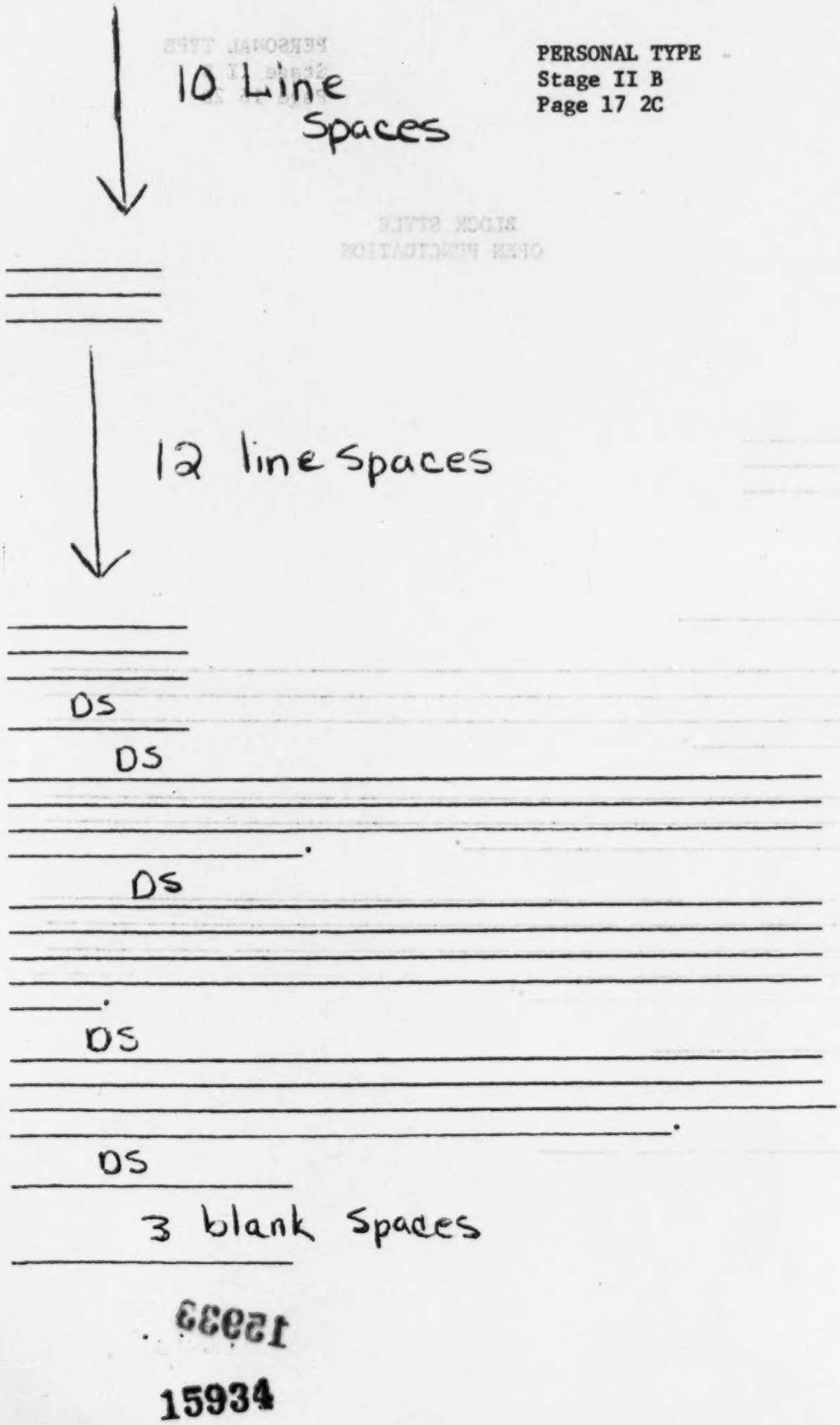

15934

PERSONAL TYPE
Stage II B
Page 18 2D

HALF PAGE

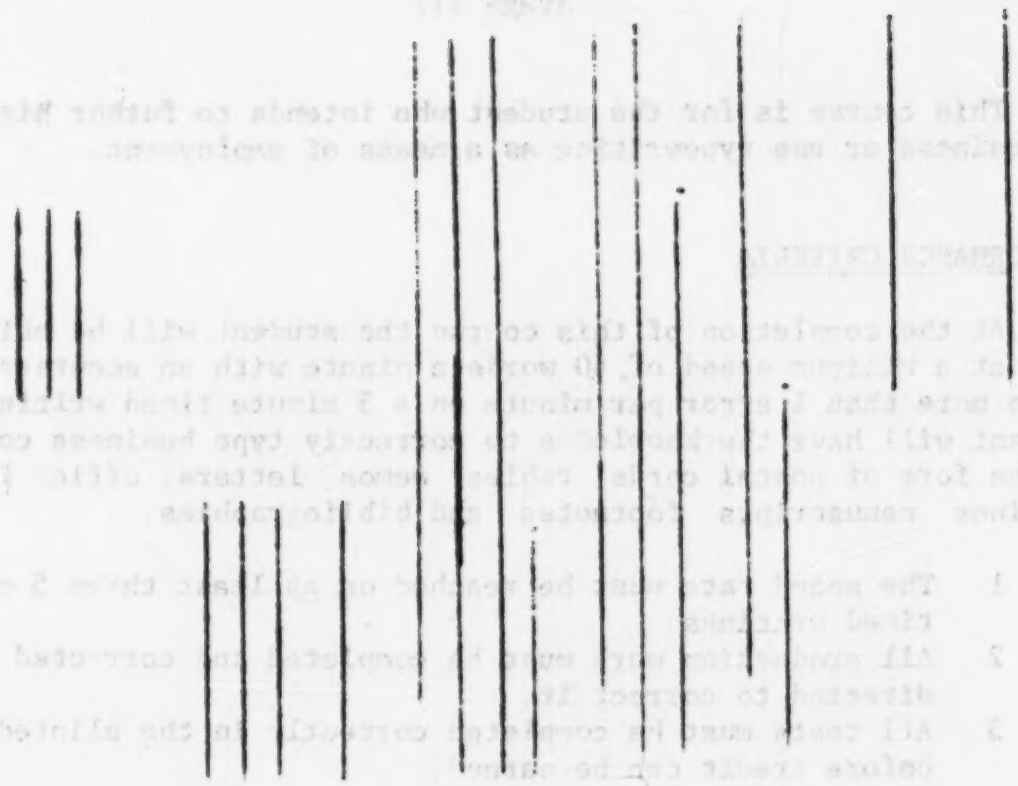

15935

BUSINESS TYPE
Stage III

This course is for the student who intends to futher his education in business or use typewriting as a means of employment.

PERFORMANCE CRITERIA

At the completion of this course the student will be able to type at a minimum speed of 40 words a minute with an accuracy rate of no more than 1 error per minute on a 5-minute timed writing. The student will have the knowledge to correctly type business correspondence in the form of postal cards, tables, memos, letters, office forms outlines manuscripts footnotes and bibliographies.

1. The speed rate must be reached on at least three 5-minute timed writings.
2. All production work must be completed and corrected if you directed to correct it.
3. All tests must be completed correctly in the alloted time before credit can be earned.

SUPPLIES

You will need the following supplies for this stage.

type paper 8½ by 11 inches
folder to keep your assignment packet in
type eraser
carbon paper
pen or pencil

EVALUATION

The following scale will be used for your speed and accuracy grade.

1st term		2nd term	
35-39	C	40-44	C
40-44	B	45-49	B
45-up	A	50-up	A

Each production test will be graded according to the scale on each individua

15936

STAGE III UNIT 1
ROUGH DRAFT AND SCRIPT

ASSIGNMENTS

1. You will type from the text job 53C page 90, and job 54C page 92. Study carefully the correction symbols given in these jobs. Many times you will need to type a copy of your material correct it with pen or pencil (this is called a rough draft), and then retype from your corrected copy for your final draft. You will use the symbols in these jobs in your rough draft.

2 You may often have to type from a copy that is written in pencil or pen. This is called typing from script. Do three times each, jobs 31D and 32B.

3. Ask your instructor for unit sheet 2. Give your instructor unit sheet 1.

12938
15937

STAGE III -- UNIT 2
ANNOUNCEMENTS & NOTES

ASSIGNMENTS

1 Type job 41B. Follow your spacing directions very carefully. Remember that the letters TS mean to triple space or return the carriage 3 times leaving 2 blank spaces. The letters DS mean to double space or return the carriage twice, leaving 1 blank space. Review pages 61 and 66 for centering rules.

2 Do drill 41C on centering on special size paper. If you do not throughly understand this drill ask your instructor for assistance.

3. Type job 42C. In this job you are taught what mixed punctuation is. Remember this for all future correspondence. Mixed punctuation means that a colon is typed after the salutation and a comma is typed after the complimentary close.

4 Type job 43D. The red lines indicate where the carriage should be returned.

5 Do drill 43E. Ask your instructor for assistance in this drill if you are unable to draw the line and type on it properly.

6 Type job 47D problems 1 and 2.

7 Ask your instructor for unit 3. Give your instructor unit sheet 2.

15938
15937

STAGE III - UNIT 3
POSTAL CARDS

ASSIGNMENTS

1. Read job 44C problem 1. You need to remember the dimensions given in this job when typing postal cards.

2. Ask your instructor for two postal cards. Type job 44C problems 2 and 3.

3. Do drill 44D. Get assistance from your instructor if you need it.

4. Type job 45D. Ask your instructor for 2 postal cards.

5. Do drill 45E. Follow directions carefully. If you need assistance ask your instructor.

6. Type job 47D problem 3. Ask your instructor for 1 postal card.

7. Ask your instructor for type test 1. You will be given an announcement, a personal note and a postal card in unarranged form. You will be required to set these problems up and type them in correct form in 30 minutes or less. The grading scale for this test will be as follows

Time Limit		Error Limit	
26 30 min. typing time	C	3-4 errors per problem	C
21-25 min. typing time	B	1-2 errors per problem	B
20 or less	A	0 errors per problem	A

15939

TYPING STAGE III - UNIT 4
LETTERS

ASSIGNMENT

1. Type job 50C problems 1 and 2. Notice what is meant by modified block style and mixed punctuation.

2. Type job 51B problems 1 and 3.

3. Type job 52C problems 1 and 2.

4. Type job 53B. This is a business letter and has no return address. It has a typed signature as well as a hand written signature and reference initials. Leave 3 blank spaces between the complimentary close and the typed signature to allow room for the handwritten signature. You will always put reference initials on business letters typed in this class unless you compose the business letter and put your name as the signature. By reference initials we mean your first and last initial (no periods after initials) placed usually a DS below the closing lines and at the left margin.

5. Read the top of page 91 on carbon copies.

6. Type job 54B.

7. Ask your instructor for 3 small envelopes and 3 large envelopes. Address these envelopes using the addresses given at the bottom of page 93. Three line addresses should be double spaces and four or more line addresses should be single spaced. Start the address 5 spaces from the left of the center of the envelope and on line 12 from the top of a small envelope and line 13 from the top of the large envelopes. Return addresses are always single spaced and placed on the second or third line from the top and on the second space from the left edge of the envelope.

8 Ask your instructor for letter test 2. You will be given three letters which you will be required to correctly set up and type in 30 min. or less. The letters will be modified block style with mixed punctuation, and each will have an envelope to be addressed.

9. Do drill 60D. A grade students erase properly. For all other assignments in this unit and future units you will erase errors and correct them if you are directed to do so in your instructions.

15940

STAGE III UNIT 4 cont.

10 Read the top of page 162 on business letter placement. You may need to refer back to this table for future assignments.

11 Type job 101D.

12. Type job 102C, letter 1. Correct errors.

13. Type job 104C, problems 1 and 3. correct errors

14 Type job 105C

15. Type job 106D. This is a block style letter all lines start at the left margin. Open punctuation is used no punctuation after the salutation or complimentary close.

16. Type job 109C, problem 1.

17. Type job 203C problem 1 and 2. This is a new style letter the AMS letter. It is a simplified style with no salutation or complimentary close. This style letter is always typed in block style. Read the letter before typing it. It contains information about typing this style letter.

18. Type job 204C problem 1 and 2. This is also a new style letter with inverted paragraphs. Notice that each line of the paragraph is indented 5 spaces except the first. Read the letter before typing it

19. Type job 205C problem 1 and 2. Read the letter before typing it.

20. Ask your instructor for test 3. This test will contain three letters which you will be required to correctly set up and type (correcting all errors) and address an envelope for each letter in 35 minutes or less. Be sure you know what is meant by modified block style, block style, and AMS style letters, and mixed and open punctuation.

21. Ask your instructor for unit sheet 5. Return unit sheet 4 to your instructor.

15941
SPECI

RELATED INSTRUCTION

HOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

URRICULUM: VOCATIONAL

STER: AUTOMOTIVE

RAM: AUTOMOBILE MECHANICS

DULE: VIII. POWER FLOW

LESTONE: VI. DIFFERENTIAL

FORMANCE OBJECTIVE NO: 6 TITLE: Remove, Disassemble, Check, Reassemble, and Replace Differential

ITIONS:

Student will learn the related information listed below

	REFERENCE	SOURCE
Differential construction and use	1. Automotive Transmissions and Power Trains, by Crouse. pp. 568 through 606 Automotive Chassis Workbook, by Crouse. Jobs 8 through 10	1. Related Information Class
"The Differential"	2. Filmstrip	2. Resource Materials Center
"Rear Axles"	3. Filmstrip	3. Resource Materials Center
"Full-floating Rear Axle"	4. Filmstrip	4. Resource Materials Center
Differential	5. Teaching Machine cards 20A, 20B, 20C	5. Teaching Machine (Shop)

1590

TYPING STAGE III UNIT 5
TABULATION

1. Do drill 57B. Follow each step carefully. Get help from your instructor if you need it.

2. Type job 57C.

3. Do drill 58B. You will have a DS between the main heading and the secondary heading, and a TS between the secondary heading and the columns.

4. Read vertical Centering Mathematical Method at the top of page 98. Below is an example of this type of centering.

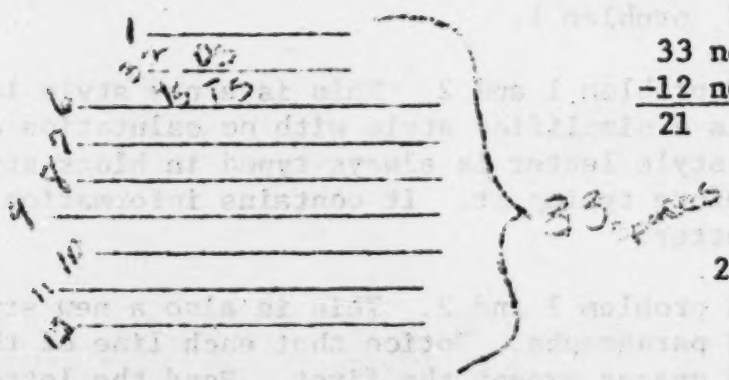

33 no. of lines available
-12 no. of lines needed
21

10 Top margin
2/21

5. Do drill 59B. Remember to space once after each letter and three times after each word on a spread heading.

6. Type job 59C. If you have difficulty remembering what the proofreaders marks mean turn back to pages 90 and 92. Correct errors.

7. Do drill 60B.

8. Type job 60C. Notice that you have a new proofreaders mark. Correct errors.

9. Type job 61C. You will have a DS before and after the tabulation problem in the letter.

10. Type job 64C problems 1 and 2. Correct errors.

11. Read job 114C. This will give you information on the Backspace from Center method of tabulating. You will use this method in future problems.

12. Type jobs 114D 116C 117C, and 119 problems 1 and 3.

14071
15942

STAGE III -- UNIT 5 cont.

13. Type job 120D problems 1 and 2. Read at the bottom of the page about LEADERS. Ask your instructor for help in typing leaders if you need assistance.

14. Type job 121C.

15 Ask your instructor for Test 4 . This test will contain three tabulation problems which you will be required to correctly set up and type (correcting errors) in 30 minutes or less.

16. Ask your instructor for unit sheet 6. Return unit sheet 5 to your instructor.

STAGE III - UNIT 6
OFFICE FORMS

ASSIGNMENTS

1. Type job 126E, problems 1 through 14. Study each illustration carefully and space your problems as shown in the illustrations. Ask your instructor for printed forms for these problems. Problem 11 is to be timed for 3 minutes. Ask your instructor to time you. Correct errors.

2. Type job 134D. Ask your instructor for a form.

3. Do drill 138D.

4. Type job 140C. You will be given another itinerary to type in a future job so pay close attention to the spacing of this one.

5. Type job 186C problems 1 and 2. Ask your instructor for 2 bill of lading forms.

6. Type job 219D problem 1. There should be 2 blank spaces between the two vertical columns of figures.

7. Ask your instructor for test 5. This test will contain a memo, a telegram, an invoice, a voucher check, and a bill of lading which you will be required to correctly set up and type (correcting errors) in 45 minutes or less.

8. Ask your instructor for unit sheet 7. Return unit sheet 6 to your instructor.

159407

STAGE III - UNIT 7
OUTLINES, MANUSCRIPTS, & REPORTS

1. Type job 65C. Note the two sentences above this job. They explain the spacing rules for outlines and how to set your tab. There will be two blank spaces after the period following the Roman numeral letters and numbers.

2. Do drill 65E.

3. Type job 66D problem 1. Every letter that is underscored three times should be capitalized.

4. Ask your instructor to aid you in the use of a page line gauge 66E.

5. Do drill 67D.

6. Type jobs 68C and 68D. Use your page line gauge for these jobs. Notice that your footnotes are single spaced with a double space between footnotes.

7. Ask your instructor for test 6. You will be required to type a one-page manuscript with footnotes, and one outline which will be given to you in rough draft form, one letter, and one tabulated item. You will be given 45 minutes to complete the test and correct all errors.

8. Type job 91D and 92C. Correct errors.

9. Type job 94C and 98C. These two problems will be bound together at the left. Allow correct margins for this. Correct errors.

10. Type job 217D - an unbound manuscript.

11. Type job 218D a topbound manuscript.

12. Ask your instructor for test 7. You will be required to type a one page leftbound manuscript, a one page topbound manuscript and a one page unbound manuscript. You will be required to know the margins for each different manuscript, and to correct all errors. You will be given 35 minutes for this test.

13. Ask your instructor for unit sheet 8. Return unit sheet 7 to your instructor.

15945

STAGE III - UNIT 8
JOB TYPING

No test will be given for this unit. Instead, you will receive a grade on each assignment. You will keep all the jobs for one assignment until they are all completed, then you will turn the entire assignment in at once. Each job should be turned in without error. Neat erasers are acceptable on all jobs except those mentioned in the last assignment.

ASSIGNMENTS

1 EMPLOYMENT APPLICATION- Type job 146C. When you type problem 3 make sure each statement about yourself is true.

2. TYPING IN A GENERAL SERVICE OFFICE- Type the 7 jobs found in applied typing lessons 252-256. For job 3 you will be required to type letters to the people holding index cards #191, 192, 197 and 198 only.

3. TYPING IN A SALES DEPARTMENT Type the following jobs found in lessons 258-263. Jobs 1,4,5,6,7 (letters 1 & 5) and 8 (letters 1,3,5,7)

4. TYPING IN A FINANCIAL DIVISION Type the following jobs found in lessons 265-268 Jobs 1,2,3,4 (only a model copy of each letter) 5 (only one letter- to the first addressee on the list whose account is between 46-60 days past due), 6 (only one letter- to the first addressee on the list whose account is more than 60 days past due), 8, and 9.

5. TYPING IN AN EXECUTIVE OFFICE Type the 7 jobs found in lessons 270-273.

6. TYPING IN A GOVERNMENT OFFICE- Type the following jobs found in lessons 277-280 Jobs 1,2 and 4.

7. TYPING IN A LEGAL OFFICE Type the following jobs found in lessons 282-285 Jobs 1 2 4 (put the endorsement on the back of job 2) and 6. No erasers are allowed on jobs 1 2 and 4. Everything must be perfect on these three jobs.

15946

TO THE INSTRUCTOR

The following individualized procedures are used in connection with the 20th Century Bookkeeping and Accounting, 23d edition, First-Year Course by Boynton - Carlson - Forkner - Swanson.

Work sheets and instructions are issued by the instructor or the Lab Assistant. The student works at his own rate of progress, checking the completed materials into his personal file folder which is evaluated to meet his needs or/and periodically with him.

Major emphasis is placed on performance of the learner his neatness accuracy amount of work completed by outlined completion dates. Detailed instructions are found on the pages that follow.

15947

PERFORMANCE CRITERIA:

At the end of each unit, the student must have completed all of the assigned work and application problems. These problems are to be completed with neatness--error corrections are acceptable if done in the prescribed manner. Errors made in the assigned problems will be classified as major*1 and minor. *2Minor errors will not reduce points allowable on the assignment unless there are too many.

1. All assignments must be completed before being evaluated.
2. The completed work will be graded as follows:
   a. Three points will be awarded the assignment if there are no errors made.
   b. Two points will be awarded if there are no more than five minor errors or one major error.
   c. One point will be awarded if there are no more than ten minor errors or two major errors.
   d. No points will be given for those assignments with eleven or more minor errors or three major errors.
   e. Students doing the bonus assignments will receive one point for doing the work and two points if the assignment is correct.
3. Quizes are given after each unit of work. Up to ten points are given for each quiz.
4. Tests will be given periodically with a possible score of 100 pts.
5. Quiz, test, and assignment scores are added together and divided by the total number possible to arrive at a grade. Grades will be determined as follows:

   A - 93-100%
   B - 85-92%
   C - 75-84%

*1 Major errors are classified as:
   a. leaving out journal entries
   b. an addition or subtracting error
   c. totals not balancing
   d. entries not posted correctly
   e. improper closing of ledgers
   f. inaccurate reports.

15948

THE COURSE WILL CONSIST OF THE FOLLOWING UNITS:

1. Starting a bookkeeping system.
2. Debits and credits of business transactions.
3. Journalizing, posting and proving accuracy by trial balance .
4. Six column work sheet.
5. Preparing income statement and balance sheet.
6. Closing the ledger.
7. Buying and selling merchandise on account; and payment and receipts of cash.
8. Keeping a checking account and reconciliation of the bank statement.
9. Completing an eight column work sheet.
10. a. Preparing financial reports for business.
    b. Recording and posting of adjusting and closing entries.
11. Completing the business cycle using the five special journals.
12. The combination journal.
13. Sales and purchase returns.
14. Payroll records, taxes, and reports; depreciation and disposing of fixed assets and bad debts.
15. Special bookkeeping cycle.
16. Introduction to data processing.

15049

UNIT I

OBJECTIVE:

At the end of this unit the student will know how to open the books of a business by preparing the beginning balance sheet, recording the opening entry, and posting to the general ledger.

ASSIGNMENT I

a. Read material in text, pages 3-9
b. Do study questions, page 10 and Cases 1,2, and 4, pages 10-11
c. Complete Drill 1-A and 1-B, Workbook page 3
d. Complete problems 1-1, 1-2, and 1-B, Workbook pages 3-4
e. Extra credit 1-S and Study Guide
(Optional for extra credit)

If the extra credit problems are done, forms will have to be made by the individual student.

Self Checking after completing the assignment; check the accuracy and the completeness of the work by asking these questions:

1. Is each of the three items in the heading centered on each line?

2. Is the heading of each section centered within the body of the balance sheet?

3. Are the assets, liabilities, and proprietorship listed immediately below the appropriate heading without skipping a line?

4. Is there a blank line between the Liabilities section and the Proprietorship section to separate these two sections?

5. Is the amount of the total assets at the bottom of the left-hand side of the balance sheet on the same line as the amount of the total liabilities and proprietorship at the bottom of the right-hand side?

6. Are the two totals at the bottom of the balance sheet the same amounts?

7. Are the single and double lines drawn across the amount columns only?

ASSIGNMENT 2

a. Read text material pages 15-19. Notice particularly the style in which the entry is recorded in the journal.

15950

b. Do Cases 1 and 2, page 20 of text.
c. Complete Study Guide, Workbook pages 5-6.
d. Complete Drill 2-A, Workbook page 7.
e. Complete problems 2-1, 2-2, and 2-B, Workbook pages 7-8
f. Extra credit problem 2-8, text page 23.

Ask for Quiz #1

INSTRUCTIONS: Upon completion of Assignments 1,2, and 3, review the work and study for a quiz. After studying ask for Quiz #1.

When Quiz is completed, request an evaluation conference with the teacher. If the quiz has been passed with 75% or better accuracy, proceed to Unit 2. If, however, the score is less than 75%, supplemental work and a different quiz must be completed.

*This procedure will be followed on all unit work, quizes and tests.

SUPPLEMENTAL ASSIGNMENT I-A

a. Complete problems 1-A, 1-B, page 637.
b. Complete problems 2-A, page 637
c. Complete problems 3-A, page 638.

Make own forms on loose leaf paper.

SUPPLEMENTAL ASSIGNMENT I-B

See attached sheet.

15951

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: VI. DIFFERENTIAL

PERFORMANCE OBJECTIVE NO.: 6 TITLE: Remove, Disassemble, Check, Reassemble, and Replace Differential

CONDITIONS:

This assignment will be performed on a complete automobile.

BEHAVIOR: After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to the appropriate chapter
4. Select proper tools and materials
5. Position hoist lift arms to correct position under the automobile frame
6. Raise automobile to comfortable working height
7. Disconnect parts and accessories required for differential removal following all steps as outlined in the manual
8. Place safety jacks in correct position underneath differential and lower automobile enough to cause safety jacks to support the differential
9. Remove bolts holding differential following all steps as outlined in the manual

PERFORMANCE CRITERIA:

SUPPLEMENTAL ASSIGNMENT
I-B

A. Prepare a balance sheet, dated October 31, current year, for C.N. Harvey. His assets and his liabilities are listed below.

Assets		Liabilities	
Cash	385.00	Allen Grocery	88.00
Automobile	2000.00	Jones Bros.	95.00
Furniture	3748.00	Hansen Dairy	12.00
House	17000.00		

B. Prepare a balance sheet, dated December 31, current year, for Ideal Laundry. M. T. Weber is the proprietor and manager. The assets and the liabilities are:

Assets		Liabilities	
Cash	973.50	J. M. Greens	120.00
Office Equipment	124.60	Hunt Supply Co.	56.80
Delway Equipment	970.00		
Machinery	5304.00		

C. Thomas Bostwick is an attorney with the following business assets and liabilities: Cash, 612.24; Supplies, 37.50; Law Library, 475.00; Office Furniture, 725.00; Office Equipment, 375.00. He owes Avery Book Company 55.25 and Hagan Equipment Company 465.00.

Instructions:
1. Prepare a balance sheet date June 1 of the current year.
2. Record the opening entry in a General Journal.

D. The balance sheet of the Bauman Repair Shop, owned by Merline Bauman, on July 31 of the current year is shown below:

Bauman Repair Shop
Balance Sheet
July 31, 1969

Assets		Liabilities	
Cash	412.00	Jarger Equip.	197.00
Parts	375.00	Davel & Son	32.00
Office Equip.	310.00	Total Liabilities	229.00
Shop Equip.	3500.00	Proprietorship	
		Merlin Bauman, Cap.	4368.00
Total Assets	4597.00	Total Liab. & Prop.	4597.00

Make an opening entry in the journal and post properly to the ledger.

15952

QUIZ I

1. The bookkeeping equation is _____.

2. The business paper from which an opening entry in the journal is made is called a _____.

3. The opening entry is obtained from the _____ and is recorded into the _____.

4. The steps of recording the opening entry in the journal are:
   a.
   b.
   c.
   d.

5. The steps of posting the opening entry to the ledger are:

   a.
   b.
   c.
   d.
   e.

6. Make an opening entry in the journal from the following information and post properly to the ledger.

Bauman Repair Shop
Balance Sheet
July 31, 1969

Assets		Liabilities	
Cash	412.00	Jaeger Equip. Co.	197.00
Parts	375.00	Davel and Son	32.00
Office Equipment	310.00	Total Liabilities	229.00
Shop Equipment	3,500.00	Proprietorship	
		Merlin Bauman, Cap.	4,368.00
Total Assets	4,597.00	Total Liab, and Prop.	4,597.00

15953 12324

QUIZ 1-A

1. The term asset is defined as _____;
   Liabilities is _____; and proprietorship is
   _____.

2. If a business' assets are $11,000 and its liabilities totaled $4,500, the proprietorship must be _____.

3. The claims against assets are sometimes called _____.

4. The source document for the opening entry is the _____.

5. Explain the steps in posting from the journal to the ledger.

6. When an error is made in journalizing and posting, the correct way to mak a correction is _____.

7. Make an opening entry in the journal from the following information and post properly to the ledger.

Hilltop Motel
Balance Sheet
August 1, 1969

Assets		Liabilities	
Cash	665.00	Apex Plumbing Co.	300.00
Housekeeping Sup.	650.00	Motel Equip. Co.	1200.00
Furniture & Fixtures	5600.00	Total Liabilities	1500.00
Office Equip.	595.00		
		Proprietorship	
Total Assets	7510.00	Charles Martin, Cap.	6010.00
		Total Liab. & Prop.	7510.00

15954 15923

QUIZ I-B

1. Assets = Liabilities + Proprietorship is the _____ equation.

2. What a business owns is knows as an _____, what is owed is a _____, and what a business is worth is the _____.

3. A source document for an opening entry in the general journal is _____.

4. Equities are claims against _____.

5. The five steps in posting are:
   1.
   2.
   3.
   4.
   5.

6. A diagram that shows all the steps involved in a particular activity or procedure is called a _____.

7. Make an opening entry in the journal and post properly to the ledger.

Roy High School Athletic Department

Assets		Liabilities	
Cash	234.00	Abel Supply Co.	325.00
Baseball Equip.	638.00	Cloe Printing Co.	47.00
Basketball Equip.	985.00	Martin Drug Co.	79.00
Football Equip.	2137.00	Total Liabilities	451.00
Track Equip.	475.00		
		Proprietorship	
Total Assets	4469.00	R. H. S. Athletic Dept.	4018.00
		Total Liab. & Prop.	4469.00

15955

UNIT 2

OBJECTIVE:

At the end of this unit the student should be able to analize, classify, and place into debit or credit all transactions affecting assets, liabilities, proprietorship, income and expense accounts.

ASSIGNMENT 4

a. Read text material, pages 39-46. Study carefully the T-accounts on page 46.
b. Answer study questions, text page 47.
c. Answer case 2, text page 47.
d. Complete Study Guide, Workbook pages 17-18.
e. Complete Drill 4-A, 4-B, and 4-C, Workbook page 49.
f. Complete problems 4-1, 4-2, 4-3, pages 20-22.
g. Bonus problems 4-S, 4-B, pages 23-24.

Self Checking:

1. What classification of account has its balance side on the debit side?
2. What classifications of accounts have their balance side on the credit side?
3. What classifications of accounts has all increases written on the debit side?
4. What classifications of accounts have all increases written on the credit side?
5. What classifications of accounts have all decreases written on the debit side?
6. What classification of account has all decreases written on the credit side?

Turn work in for evaluation.

ASSIGNMENT 5

a. Read carefully pages 53-58. Notice T-accounts on page 58.
b. Answer Cases 1, 2, 3, 4, text page 59.
c. Complete Study Guide, Workbook pages 25-26.
d. Complete Drill 5-A, 5-B, Workbook page 27.
e. Complete problems 5-1, 5-2, and 5-3, Workbook page 28.
f. Bonus problems 5-3, 5-B, Workbook pages 31-32.

Self Checking:

1. What two classification of account have their balances on the debit side?
2. What three classifications of accounts have their balances on the credit side?

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3. What two classification of accounts have each increase recorded on the debit side?

4. What three classifications of accounts have each increase recorded on the credit side?

Turn work in for evaluation.

INSTRUCTIONS: After Assignment 5 has been completed ask the teacher for Quiz 2. Follow instructions at the end of Unit 1.

SUPPLEMENTAL PROBLEM 2-A

a. Complete Appendix problem 4-A, pages 638-639.
b. Complete Appendix problem 5-A, pages 639-640.

SUPPLEMENTAL PROBLEM 2-B.

See attached sheet

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SUPPLEMENTAL PROBLEM 2-B

Mr. Ronald Radtke operates a real estate agency. His ledger contains the following accounts: cash; automobile; office furniture; office machines; office supplies; Holmes Equipment Company; Johnson Supply Company; Ronald Radtke, Capital; Commissions Income; advertising expense; automobile expense; entertainment expense and rent expense.

Analysis each of the following transactions using T-accounts.

1. Received cash, $37.00 for the sale of old office furniture.

2. Paid cash, $50.00 to the Johnson Supply Company in part payment of the amount owed them.

3. Received cash, $60.00 as commission for renting a house.

4. Paid cash, $150.00 for rent of office for November.

5. Paid cash, $10.50 for entertaining a customer.

6. Received cash, $65.00 as commission for serving as agent in securing a tenant for a house.

7. Paid cash, $9.75 for advertising.

8. Paid cash, $7.50 for gas and oil used in operating the automobile on business.

9. Paid cash, $12.25 for gas and oil used in operating the automobile on business.

10. Received cash, $550.00 as commission on the sale of a house.

11. Paid cash, $25.00 for office supplies.

12. Paid cash, $95.00 to Holmes Equipment Company in part payment of amount owed to them.

13. Paid cash, $8.00 for advertising.

14. Paid cash, $225.00 for new typewriter to be used in the business.

15. Received cash, $490.00 as commission on the sale of a house.

16. Paid cash, $100.00 for a new desk.

QUIZ 2

1. The two sides of all ledger accounts consist of _____ and _____.

2. The balance of any asset account is decreased by posting the amount to the _____ side.

3. Any proprietorship account balance is increased on the _____ side.

4. All expense accounts are increased by placing the amount to the_____ side.

5. Income account balance is increased by _____ the account.

6. An increase in proprietorship that results from the operation of the business is called _____. A decrease in proprietorship that results from the operation of a business is called an _____.

7. A liability account is decreased when the amount is placed on the _____ side.

8. The three classifications of accounts that the balances are increased by a credit are _____, _____ and _____.

9. The classifications of accounts that are decreased by a credit are _____ and _____.

QUIZ 2-A

1. Complete the following:

   a. An asset is increased by a _____ and decreased by a _____.

   b. A liability is increased by a _____ and decreased by a _____.

   c. Proprietorship is increased by a _____, and decreased by a _____.

   d. Income is increased by a _____ and decreased by a _____.

   e. Expenses are increased by a _____ and decreased by a _____

2. The classifcation accounts, income and expense, affect the _____ account of the balance sheet.

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3. The two accounts with debit balances are _____ and _____.

4. The three accounts with credit balances are _____, _____, and _____.

QUIZ 2-B

1. The debit side of any asset account is the balance on _____ side.

2. All increases in any account are always recorded on the _____ side.

3. The balance side of any liability account is the _____ side.

4. The side opposite the balance side of any liability is the _____ side.

5. The debit side of the Proprietorship account is the _____ side.

6. The increase or balance side of a Proprietorship account is the _____ side.

7. The balance side of any income account is the _____ side.

8. The decrease side of an income account is the _____ side.

9. The classification account, expenses, decreases the _____ account. This is done by _____ the expense account.

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UNIT 3

OBJECTIVE:

At the completion of this unit the student will be able to make journal entries, post to the ledger, and prove the accuracy of his journalizing and posting.

ASSIGNMENT 6

a. Read pages 65-78 of text material.
b. Answer questions page 79 of text
c. Complete Study Guide, Workbook pages 33-34
d. Complete Drill 6-B, Workbook page 36
e. Complete problems 6-1, 6-2, and 6-S, Workbooks pages 37-38
f. Extra credit problems, Drill 6-A, Workbook page 35 and problem 6-B, Workbook page 40.

Self Checking - After work is completed ask these questions:

1. Are all transactions recorded in the journal?

2. Does the cash accounts agree with the actual amount in the bank?

3. Do the debit columns equal the credit columns?

4. Were the total amounts of each column footed and proved before writing in large figures?

5. Were double lines drawn under the totals correctly?

INSTRUCTIONS: At this point a 100 point test covering Assignments 1-6 will be taken by the student. If the score is 75% or higher, proceed to Assignment 7. If the score is less than 75% then request from the teacher a special conference where he will review all the material missed on the test. Supplemental work will be given and a supplemental test taken. A score of 75% or greater must be attained before going ahead. Study carefully!

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: VI. DIFFERENTIAL

PERFORMANCE OBJECTIVE NO.: 6 TITLE: Remove, Disassemble, Check, Reassemble, and Replace Differential

CONDITIONS:

BEHAVIOR:

10. Raise automobile cautiously making sure that the differential is resting firmly on the safety stands
11. Remove differential from underneath the automobile
12. Perform all tests and checks as outlined in the manual
13. Disassemble the differential following all steps as outlined in the manual
14. Identify all parts and their functions
15. Perform all tests and checks as outlined in the manual
16. If the tests and checks are satisfactory, reassemble the differential following all steps as outlined in the manual
17. Make final tests, checks, and adjustments following all steps as outlined in the manual
18. Place the differential on safety stands under the automobile and position so that when the automobile is lowered, the differential will align with the support brackets
19. Lower automobile cautiously making necessary adjustments to align differential

PERFORMANCE CRITERIA:

ASSIGNMENT 9

a. Project 1, text pages 117-120 and Workbook pages 59-64

Turn in for evaluation

INSTRUCTIONS· After Assignment 9 is completed ask for Quiz 3. Follow instructions at the end of Unit 1.

SUPPLEMENTAL ASSIGNMENTS 3-A

a. Complete problem 6-A, pages 640-641
b. Complete problem 7-A, pages 642-643
c. Complete problem 8-A, pages 643-644

Turn in for evaluation.

QUIZ 3

1. The source document for all cash received is a _____.

2. The source document for all cash payments is the _____.

3. Double entry bookkeeping is recording the _____ and the _____ of each transaction.

4. The five divisions of most ledgers are 1._____ 2._____ 3._____ 4._____ and 5._____

5. How do you indicate that the totals of the general debit and general credit columns are not posted?

6. If the cash debit column total were $3,249.00, the cash credit total were $762.00, and the beginning balance was $565.00, the amount of cash account balance would be _____.

7. If the totals of the trial balance do not agree but can be divided by 9, this means that the bookkeeper made a _____ error.

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QUIZ 3-A

1. A receipt is given to each customer either in the form of a written paper or cash register tape. These items are a source document for all _____.

2. A check stub is a source document for all _____.

3. The five main divisions of most ledgers are: _____, _____, _____, _____, _____.

4. A check mark under the totals in the cash journal indicate that _____.

5. If the cash debit total was $4560.00, cash credit total was $1,620.30, and beginning balance was $780.00, then the cash account balance would be _____. This must agree with the total cash _____.

6. Recording the debit part and the credit part of each transaction is know as the _____ bookkeeping system.

7. A transpassing error can be determined by finding the difference of the trial balance totals and dividing by _____.

QUIZ 3-B

1. The source documents for all cash receipts and cash payments are _____, _____, and _____.

2. What is the cost on hand if the beginning balance was $565.00, cash debit $2,684.00 and cash credit $762.00?

3. Why is a check mark placed in the account title column when journalizing a transaction showing income from gross sales?

4. What is meant by the equality of debits and credits?

5. The five divisions of most ledgers are _____, _____, _____, _____, _____.

6. Why are the individual amounts in the cash debit and cash credit columns not posted?

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7. In a cash journal three of the five columns are posted. They are _____, _____ and _____.

8. Proving the accuracy of the ledger is usually done by footing each ledger account and finding the balance, then taking each balance and recording it into a _____.

UNIT 4

OBJECTIVE:

At the completion of this unit the student should be able to complete a six column worksheet and determine if a net income or loss occurred during the fiscal period.

ASSIGNMENT 10

a. Read text material pages 121-125
b. Complete Study Guide, Workbook pages 65-66
c. Do Drill 9-A, Workbook page 67
d. Do problems 9-1 and 9-B, Workbook pages 68, 70
e. Extra Credit problem 9-S, Workbook page 69

Self Checking:

1. Are all accounts listed in numerical order on the worksheet?

2. Were all assets, liabilities, and proprietorship accounts transferred to the balance sheet debit or credit columns?

3. Were all income and expense accounts transferred to the income statement debit or credit columns?

4. Were the words, 'net income' or 'net loss' written in the account titles column?

5. Do the totals of the trial balance equal?

6. After determining net income, was the amount written in the debit column of the income statement and credit column of the balance sheet; or if net loss, a credit in the income statement and debit in the balance sheet?

7. Do the totals of the income statement balance after net income or net loss is added?

8. Do the totals of the balance sheet balance after net income or net loss is added?

Turn in work for evaluation.

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INSTRUCTIONS: Ask for Quiz 4 and follow instructions of Unit 1.

SUPPLEMENTAL ASSIGNMENT 4-A

a. Complete problem 9-A, pages 664-665

Turn in for evaluation.

SUPPLEMENTAL ASSIGNMENT 4-B

a. Complete the following problem:

The account balances in the ledger of Bill Stevens an optometrist, on November 30 of the current year, the end of a fiscal period of one month were:

Cash	1,278.45
Automobile	2,950.00
Equipment	5,275.00
Office Furniture	987.10
Baxter Company (creditor)	349.25
Sawyer Optical Supplies (creditor)	95.50
Bill Stevens, capital	9,304.00
Professional Fees	1,304.00
Miscellaneous Expense	34.80
Rent Expense	150.00
Salary Expense	275.00

Turn in for evaluation
Complete a work sheet.

QUIZ 4

1. Complete a work sheet using the following information:

Berry Parcel Service
Work Sheet
for Month Ending June 30, 1969

		dr.	cr.
Cash	11	1,175.60	
Delivery Equipment	12	6,357.00	
Office Equipment	13	822.00	
Edger Gas & Oil Co.	21		1,320.00
Marathon Motors	22		182.50
Carl Berry, Capital	31		5,380.81
Fees Income	41		4,328.50
Heating Expense	51	273.20	
Labor Expense	52	1,380.81	
Miscellaneous Exp.	53	263.40	
Rent Expense	54	307.00	
Truck Expense	55	686.61	
		11,211.81	11,211.81

QUIZ 4-A

Complete a work sheet using the following information:

Dr. Michael R. Wunsch
Work Sheet
for Month Ended October 31, 1969

Cash	11	588.20	
Equipment	12	3,950.00	
Office Furniture	13	1,455.00	
Athens Equip. Co.	21		425.90
Michael R. Wunsch, Cap.	31		4,544.75
Fees Income	41		1,504.00
Miscellaneous Exp.	51	66.45	
Rent Exp.	52	140.00	
Salary Exp.	53	275.00	
		6,474.65	6,474.65

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QUIZ 4-B

Complete a work sheet using the following information:

A. J. Price
Work Sheet
For Quarter Ended December 31, 1969

Cash	11	2,654.45	
Automobile	12	3,940.00	
Equipment	13	7,625.00	
Office Furniture	14	1,610.00	
Baxter Company	21		795.45
Sawyer Applied Supplies	22		154.50
A. J. Price, Capital	31		9,500.00
Fees Income	41		6,009.30
Miscellaneous Expense	51	54.80	
Rent Expense	52	200.00	
Salary Expense	53	375.00	
		16,459.25	16,459.25

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UNIT 5

&

OBJECTIVE:

At the end of the unit the student should be able to complete an Income Statement and Balance Sheet by using information found on the work sheet.

ASSIGNMENT II

a. Read text material, pages 131-136
b. Study Questions, text page 137
c. Do Drills 10-A and 10-B, Workbook page 73
d. Do problems 10-1, 10-2, 10-S, Workbook
e. Extra credit, Workbook 10-B

Self Checking - Ask yourself these questions:

1. Did you center each line of the heading of your income statement?

2. Did you place the headings of the two sections of the income statement, income and expenses, close to the vertical red line at the left of the wide column?

3. Did you keep an even indention for all the account titles listed on your income statement?

4. Did you rule a double line under the amount of the net income to show completion of the work?

5. Did you center each of the three lines of the heading of your balance sheet?

6. Did you center the heading of each of the three main sections of the balance sheet: Assets, Liabilities, and Proprietorship?

7. Is the amount of the total assets at the bottom of the left-hand side of the balance sheet on the same line as the amount of the total liabilities and proprietorship at the bottom of the right-hand side?

8. Did you neatly rule the double lines across the amount columns only, under the two proving totals of your balance sheet?

Turn in for evaluation.

INSTRUCTIONS: Ask for Quiz 5. Follow instructions of Unit 1.

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SUPPLEMENTAL ASSIGNMENT 5-A

Complete problem 10-A, page 645

Turn work in for evaluation.

SUPPLEMENTAL ASSIGNMENT 5-B

See attached sheet

QUIZ 5

1. The report that shows the financial progress of a business over a period of time is _____.

2. The report which shows the financial condition of a business on a specific date is _____.

3. The information for preparing the income and expense sections of the income statement is obtained directly from the _____ and _____ columns of the work sheet.

4. The information used to complete the balance sheet items are obtained from the _____ and _____ columns of the work sheet.

5. If the Proprietor's beginning balance is $3400, the net income is $1300, then the new Proprietorship is _____.

6. Complete an income statement using the following information:

Commissions Income	2012.00
Advertising Expense	122.00
Automobile Expense	36.00
Entertainment Expense	14.00
Rent Expense	135.00

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QUIZ 5-A

1. Two financial reports that are taken from the work sheet are the _____ and the _____

2. If the proprietor's beginning balance was $6450.00; the net income for the month was $1700; what would the new proprietorship be?

3. Double lines are ruled under the final totals of each column of a report to indicate that _____.

4. Using the following information, prepare an Income Statement:

Admissions Income	2304.00
Advertising Expense	130.00
Electricity Expense	105.75
Film Rental Expense	925.00
Maintenance Expense	64.00
Projection Expense	33.00
Rent Expense	200.00
Water Expense	35.50

5. From the following information prepare a balance sheet:

Cash	2873.50
Air Conditioning Equip.	3375.00
Projection Equipment	8900.00
Sound Equipment	878.50
Film Producers, Inc.	50.00
International Studios	114.00
Majestic Films	28.00
Midwest Sound Service	60.00
National Supply Company	34.25
Frank Peck, Capital	14931.00
Net Income	809.75

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QUIZ 5-B

1. The work sheet probides information for the bookkeeper to prepare two financial reports. These are _____ and _____.

2. Find the net income of a business if the income accounts has a balance of $3500, the various expense accounts have a combined balance of $1754.50. _____

3. If the proprietorship's beginning balance totals $14,350, the net income figures to $1,745.60; what is the new proprietorship figure? _____.

4. Prepare an income statement from the following details.

Sales	468.25
Delivery Expense	248.85
Labor Expense	450.00
Miscellaneous Expense	41.10
Power Expense	140.00
Supplies Expense	70.20

5. Prepare a balance sheet using the following information:

Cash	1655.15
Delivery Equipment	3000.00
Machinery	17478.50
Office Equipment	892.10
Labor Equipment Company	3450.00
Zenith Supply Company	532.90
Paul Calvert, Capital	19608.80
Net Loss	565.80

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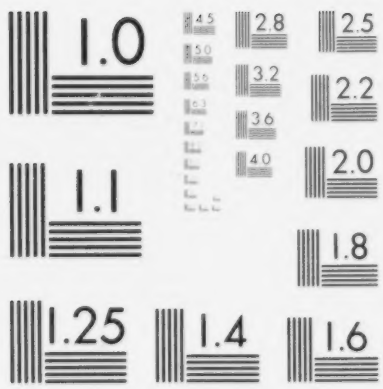

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

UNIT 6

OBJECTIVE:

At the completion of this unit the student should be able to close all Income and Expense accounts in the ledger; balance and rule the assets, liabilities, and proprietorship's accounts; and take a post closing trial balance.

ASSIGNMENT 12

a. Read pages 143-155 of text
b. Do cases 1, 2, 3; text pages 156-157
c. Complete study guide, Workbook pages 79-80
d. Do drill 11-A, 11-B; Workbook page 81
e. Complete problems 11-1, 12-2, 11-3; Workbook pages 82-88
f. Prepare a chart illustration the business cycle. (See text page 155 for an example) If chart is done on poster paper, up to 5 extra points may be earned.

Self Checking: After completing assignment ask these questions:

1. Are all income and expense accounts closed with double lines drawn correctly?

2. Have the new balances of each asset, liability, or proprietorship account been carried forward to the next month or year?

3. Does the post closing balance sheet have equal amounts in each column?

Turn in work for evaluation.

INSTRUCTIONS: After assignment 12 has been completed, ask for Quiz 6 from the instructor. Follow same procedure as in Unit I.

QUIZ 6

1. The account to which each income account and expense account is transferred is the _____ account.

2. To close the income account, the _____ account is credited.

3. To close each expense account in the ledger the _____ account is debited and each _____ account is credited.

4. To transfer net loss to the capital account the _____ account is credited.

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5. To transfer net income to the proprietorship account, the _____ account is credited.

6. The process of transferring the balances of the income and the expense accounts through a summary account to the proprietorship capital account is called _____.

QUIZ 6-A

1. The income and expense account is a summary account to which all _____ and _____ accounts are transferred.

2. The entry to close the income account is _____.

3. The entry to close the expense accounts is _____.

4. The entry to transfer net income to capital is _____.

5. The entry to transfer net loss to capital is _____.

6. Closing the ledger is the process of transferring all _____ and _____ accounts through a summary account to the _____ account.

QUIZ 6-B

1. From the following information make the three closing entries in a general journal.

Room Sales	2012.00
Advertising Exp.	122.00
Automobile Exp.	36.00
Entertainment Exp.	13.00
Miscellaneous Exp.	14.00
Rent Expense	135.00
Net Income	1692.00

2. After all accounts have been closed, only the _____, _____, and _____ have balances which are left open.

3. These balances are then taken and placed into a final report to check the accuracy of journalizing, posting, and reporting called the _____ _____ _____ _____

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SUPPLIMENTAL ASSIGNMENTS

6-A

a. Complete problem 11-A, page 646.

Turn work in for evaluation.

ASSIGNMENT 13

Complete project 2; Workbook pages 89-98.

Turn in for evaluation.

INSTRUCTIONS: After this assignment has been completed ask your teacher for test No. 2, a 100 point test. If the test score is 75% or higher proceed on to Unit 7, Assignment 14. If the score is less than 75%, ask the teacher for a conference where the problems will be discussed and a supplimental test be given.

UNIT 7

OBJECTIVE:

At the end of this unit the student will be able to record the purchasing and selling of merchandise on account, the payment and receiving of cash, the correction of errors, purchase of other items on account, the withdrawal of merchandise by the proprietor in special journals.

ASSIGNMENT 14

a. Read text material pages 165-180
b. Complete study questions: text page 181
c. Do drill 12-A; Workbook pages 101-102
d. Complete problems 12-1, 12-2, 12-B; Workbook pages 103-110.
e. Extra credit complete study; Workbook pages 99-100
Do problem 12-S; text page 184-185.

Check your work.

Turn in for evaluation.

ASSIGNMENT 15

A. Read material from text pages 187-203
b. Answer study questions; pages 203-204
c. Complete study guide; Workbook pages 111-112
d. Do drill 13-A; work book page 113

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e. Complete problems 13-1, 13-2, 13-13: Workbook pages 114-120
f. Extra credit 13-S; text page 207

Check work for completeness.

Turn in for evaluation.

INSTRUCTIONS: Ask the teacher for Quiz 7. Proceed as per instructions at Unit I.

QUIZ 7

1. A special journal to record merchandise which is bought on account is a _____.

2. When posting the information from this journal all individual amounts are posted to a subsidiary ledger. The name of this ledger is _____. These will have a _____ balance.

3. The totals of this journal are posted to the _____ accounts as a debit and _____ account as a credit in the general ledger.

4. The payment of all cash is recorded in a special journal called _____ journal.

5. The source document used to record the purchasing of merchandise on _____ account is the _____. The source document used to record cash payments is the _____.

6. When merchandise is purchased with cash it is recorded in the cash payments journal by debiting _____ and crediting _____.

QUIZ 7-B

1. The columnar headings of a single column purchases journal are _____ and _____.

2. The name of the separate ledger in which an account is kept for each creditor is a subsidiary ledger or _____ _____ ledger.

3. An account in the general ledger that summarizes all the account balances in a subsidiary ledger is called a _____ account.

4. A purchase _____ is the source document for the purchases journal. The _____ is the source document of all cash payments.

5. The _____ account and _____ account are debited and _____ is credited when a payment on account is made to a creditor.

6. The amount of each cash payment is not posted individually as a credit to the cash account because _____ _____.

ASSIGNMENT 16

a. Read pages 211-224 or text
b. Answer study questions, page 225 of text
c. Do drill 14-A, 14-B; Workbook page 123
d. Complete problems 14-1, 14-2, 14-B; Workbook pages 124-128, 130
e. Extra credit problem 14-S; Workbook page 129

Turn in work for evaluation.

ASSIGNMENT 17

a. Read pages 233-252 of text
b. Complete study guide; Workbook pages 133-134
c. Complete drill 15-A, 15-B; Workbook page 135
d. Complete problem 15-1, 15-2, 15-B; Workbook pages 136-138, 141-142
e. Extra credit problem 15-S; text page 142

Turn in work for evaluation.

INSTRUCTIONS: Ask for Quiz 7-C. Proceed as per instructions of Unit I

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QUIZ 7-C

1. The source document from which information is obtained for recording a sale of merchandise on account is _____.

2. The sale of merchandise _____ is the only business transaction recorded in a sales journal.

3. The _____ account is debited and the _____ account is credited in the general journal when the total of the sales journal is posted.

4. The individual entries in the sales journal are posted frequently to customers' accounts in the _____ ledgers.

5. An entry written in the account credited column that is not to be posted is called a _____ entry.

6. A _____ received from a customer, and the cash register _____ which records daily cash sales are the source documents to obtain the information to record in the cash receipts journal.

7. _____ is debited and _____ is credited when recording a cash sale in the cash receipts journal.

8. When a customer pays on his account, the amount is posted to his account in the accounts receivable ledger as a _____.

QUIZ 7-D

1. _____ is the source document for recording the sale of merchandise on account in the sales journal.

2. The sale of merchandise _____ is recorded in the sales journal only.

3. The two headings of the sales journal are _____ debit and _____ credit.

4. The subsidiary ledger to which each individual account is posted from the sales journal is the _____ ledger.

5. A _____ entry is written on the first line of a cash receipts journal in the accounts credited column.

6. Two source documents used to record cash received are a _____ and the _____.

7. When a cash sale is recorded in the journal _____ is debited and _____ is credited.

8. At the end of the month, the amount columns of the cash receipts journal are proved and totaled, and the totals of the special amount columns are posted. True or False.

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QUIZ 7-E

1. A sales slip is the source document for recording a sale of merchandise _____ in the sales journal.

2. A cash register tape is the source document used to record a cash _____ in the cash receipts journal.

3. A check is a source document to record money received from a customer who usually orders now and pays later. True or False.

4. Only merchandise sold _____ is recorded in a sales journal.

5. The double heading of a single column sales journal are _____ debit and _____ credit.

6. When a cash sale is made _____ is debited and _____ credited in a cash receipts journal.

7. If a check was received from William Poole on account, _____ would be debited and _____ credited in the general ledger, while the account _____ would be credited in the accounts receivable ledger.

ASSIGNMENT 18

a. Read pages 259-269 of text
b. Do study questions pages 269-270
c. Do case 1, page 270
d. Complete study guide; Workbook pages 143-144
e. Do drill 16-A; Workbook pages 145-146
f. Complete problems 16-1, 16-S; Workbook pages 147-149
g. Extra credit problem 16-B; text page 274

Turn in for evaluation.

INSTRUCTIONS: Ask the teacher for Quiz 7-F. Follow instructions of Unit 1.

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QUIZ 7-F

1. The following transactions are some which you might come acress when doing bookkeeping. Place a check mark in front of those which are miscellaneous entries, and make the general journal entry.

   a. Sold merchandise on account to Bill Tines, $500.00
   b. John McCann, the proprietor, withdrew merchandise for personal use, at cost, $150.00
   c. Purchased merchandise on account from Steves Supply, $1200.00
   d. Wayne Hunter, a customer, reported that on the statement he received, there is a $352.00 charge to his account for merchandise that he had not ordered nor received. Upon investigation this should have been charged to Raymond Holland.
   e. Bought store supplies on account from Swarty Supply Company, $112.50
   f. Received $500.00 from Bill Tines as partial payment of account
   g. Paid $250.00 for monthly rent.
   h. Purchased an office machine from Morgan Typewriter on account $300.00
   i. Sold an extra typewriter to George Stone on account $150.00.

QUIZ 7-G

The following transactions are some which you migh come across when doing bookkeeping. Place a check mark in front of those which are miscellaneous entries, and make the general journal entry.

a. Sold an extra typewriter to George Stone on account $150.00

b. Purchased an office machine fron Morgan Typewriter on account $300.00

c. Paid $250.00 for monthly rent.

d. Received $500.00 from Bill Times as partial payment of account.

e. Bought store supplies on account from Swarty Supply Company, $112.00

f. Wayne Hunter, a customer, reported that on the statement he received, there is a $352.00 charge to his account for merchandise that he had not ordered nor received. Upon investigation this should have been charged to Raymond Holland.

g. Purchased merchandise on account from Steve's Supply, $1200.00

h. John McCann, the proprietor, withdrew merchandise for personal use, at cost, $150.00

i. Sold merchandise on account to Bill Times, $500.00

45979

QUIZ 7-H

The following transactions are some which you might come across when doing bookkeeping. Place a check mark in front of those which are miscellaneous entries, and make the general journal entry.

a. John McCann, the proprietor, withdrew merchandise for personal use, at cost, $150.00.

b. Sold merchandise on account to Bill Times, $500.00

c. Wayne Hunter, a customer, reported that on the statement he received, there is a $352.00 charge to his account for merchandise that he had not ordered nor received. Upon investigation this should have been charged to Raymond Holland.

d. Purchased merchandise on account from Steve's Supply, $1200.00

e. Received $500.00 from Bill Times as partial payment of account.

f. Bought store supplies on account from Swarty Supply Company, $112.00

g. Purchased an office machine from Morgan Typewriter on account $300.00.

h. Paid $250.00 for monthly rent.

SUPPLEMENTAL ASSIGNMENTS

7-A

a. Problem 12-A, page 646
b. Problem 12-B, pages 646-647
c. Problem 13-A, pages 647-648

7-B

See attached sheet

7-C

a. Problem 14-A and 14-B, text pages 649-650
b. Problem 15-A, text pages 650657

Turn work in for evaluation

7-D

Problem 14-A, text pages 649-650

7-E

Complete problem 16-A, pages 651-652 of text

7-F

See the attached sheet

Turn work in for evaluation.

INSTRUCTIONS: After Quiz 7-E, F, and G have been passed satisfactorily ask the teacher for Test 3. Follow the instructions of previous tests.

7-B

A. The following purchases on account were made by the Avenue Book Store during November of the current year:

Nov. 2. Morrison School Supplies, $246.90
9. Perkins Paper Company, $125.80
11. Miller Publishing Company, $320.40
16. Morrison School Supplies, $180.20
20. Alton Book Company, $133.40
24. Miller Publishing Company, $220.60
24. Welton Greeting Card Company, $98.40
27. Morrison School Supplies, $220.80
27. Alton Book Company, $227.60

Instructions: 1. Record each purchase on page 11 of a purchases journal number invoices beginning with No. 621.
2. Total and rule the purchases journal.

B. The creditors of the Avenue Book Store and the amounts owed to each in November 1 of the current year were:

Alton Book Company, 1296 Prairie Avenue, Chicago 46	$278.00
Miller Publishing Company. 5101 Madison Road, City	------
Morrison School Supplies, 2624 Third Street, City	126.00
Perkins Paper Company, 247 Harbor Street, Duluth 24	115.20
Welton Greeting Card Company, 1240 Market Street, City . .	68.20

Instructions: 1. Open accounts for the creditors in an accounts payable ledger with balance-column ruling. Record the balance of each account. Allow four lines for each account.

2. In a general ledger open Account No. 21 for Accounts Payable and Account No. 51 for Purchases. Allow four lines for each account. In the accounts payable account record the credit balance of $537.40, dating this balance November 1 of the current year.

3. Post the entries in the purchases journal prepared in Exercise A to the proper accounts in the accounts payable ledger.

4. Post the total of the purchases journal to accounts in the general ledger.

C. The creditors of Richard Burton a wholesale china dealer, and the amounts owed to them on September 30 of the current year are as follows:

Lynn China Company, 347 State St., Weston	$230.20
Marshall Potteries, Charleston	260.00
Monticello China Company, 7863 Marburg Ave., Clinton . . .	415.60
Zanesville Pottery Company, Zainesville	281.20

Instructions: 1. Open accounts in an accounts payable ledger with balance-column ruling for the creditors listed above. Allow five lines for each account. Record the balance in each account. Date the balance Sept. 30 of the current year.

15981

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: VIII. POWER FLOW

MILESTONE: VI. DIFFERENTIAL

PERFORMANCE OBJECTIVE NO.: 6 TITLE: Remove, Disassemble, Check, Reassemble, and Replace Differential

CONDITIONS:

BEHAVIOR:

20. Replace attaching bolts following all steps as outlined in the manual
21. Raise automobile to a comfortable working height
22. Remove safety jacks and store in the proper place
23. Connect all parts and accessories following steps as outlined in the manual
24. Make all tests and checks as outlined in the manual
25. If all tests and checks are satisfactory, return tools and materials to proper location
26. Lower automobile to the floor
27. Return automobile to proper parking area
28. Remove protective seat covers from front seat and store in the proper place
29. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, disassemble, check, reassemble, and replace the differential assembly in 6 hours.

Learning time: 8 hours

7-B
Page 2

2. In a general ledger open the following accounts needed in this exercise. Allow four lines for each account. Record the balance for each account for which a balance is given. Date the balance September 30 of the current year.

Acct. No.	Account Title	Balance
11	Cash	$4,124.20 (Dr.)
21	Accounts Payable	1,187.00 (Cr.)
32	Richard Burton, Drawing	
51	Purchases	
63	Miscellaneous Expense	
64	Rent Expense	
65	Salary Expense	

The cash payments and purchases transactions completed by Richard Burton during October of the current year are given below.

Instructions: 3. Record the cash payments in a cash payments journal. All payments are made by check. Number the checks consecutively beginning with No. 110.

Record the purchases in a purchases journal. Number the purchases consecutively beginning with 81.

Oct. 2. Paid $180.00 for the October rent.
3. Purchased merchandise on account from Monticello China Company, $628.30
4. Paid $415.60 to Monticello China Company on account.
5. Purchased merchandise on account from Lynn China Company, $764.30
7. Paid $230.20 to Lynn China on account
14. Paid $324.00 for semimonthly payroll.
15. Purchased merchandise on account from Zaneville Pottery Company, $380.40
17. Paid $281.20 to Zanesville Pottery Company on account.
21. Paid $16.80 for electricity bill. (Misscellaneous Expense)
22. Purchased merchandise on account from Marshall Potteries, $520.30
23. Paid $260.00 to Marshall Potteries on account.
26. Paid $16.25 for October telephone bill. (Misscellaneous Expense)
28. Withdrew $350.00 for personal use.
31. Paid $325.00 for the semimonthly payroll.

Instructions: 4. Post the entries from the purchases journal and the cash payments journal to the proper accounts.
5. Total and rule the purchases journal. Post the total to the purchases account and to the accounts payable account in the general ledger.
6. Foot, prove, total, and rule the cash payments journal.
7. Post the totals of the special columns in the cash payment journal.
8. Prepare a schedule of accounts payable from the account payable ledger.

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18661

7-F

George Beacom, a retail clothing merchant, decided to open a new set of books on July 1 of the current year. His balance sheet on Jun 30 was as follows:

George Beacom
Balance Sheet
June 30, 1969

Assets		Liabilities	
Cash	2,280.20	Accounts Payable	927.80
Accojnts Receivable	780.60		
Mdse. Inventory	2,420.40	Proprietorship	
Supplies	93.60		
Prepaid Insurance	80.80	George Beacom, Capital	4,727.00
Total Assets	5,654.80	Total Liab. and Prop.	5,654.80

INSTRUCTIONS:

1. Record the opening entry in a two column general journal.

2. Record the following selected transactions in the general journal:

July 5. A. L. Benton reported that he was charged $48.30 for merchandise that he had not purchased. The sale as such was made to A. L. Bender.
12. Purchased supplies on account from the Wright Supply Co., $41.95; invoice dated July 11.
18. Took from stock for personal use one suit that cost $62.40
25. Donald Marvin reported that he was charged $82.35 for merchandise he had not purchased. The sale was made to D. A. Martin.

UNIT 8

OBJECTIVE:

At the completion of this unit the student will be able to complete the check stud, write checks correctly, and reconcile the bank statement.

ASSIGNMENT 19

a. Read text material pages 275-288
b. Complete study guide: Work book pages 149-150
c. Do drill 17-A, 17-B, 17-C; Workbook pages 151-152
d. Do problem 17-1, 17-2, 17-3; Workbook pages 153-154
e. Complete the following by:

1. Filling out the check stub
2. Writing the check
3. Reconciling the bank statement

INSTRUCTIONS: Ask instructor for Quiz 8. Follow instructions of Unit 1

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QUIZ 8

1. Placing cash with a bank is called a _____.

2. The one in whose name cahs is deposited is called a _____.

3. An account with a bank that permits the depositor to order payments to others from his bank balance is called a _____.

4. The signature on the stamp of the depositor on the bank of a check is called an _____.

5. Three kinds of endorsements illustrated in the text are _____, _____, and _____.

6. Before a check is written the _____ must be completely filled out.

7. When a mistake has been made on a check it should not be thrown away but the word _____ should be written on the check and check stub.

8. The bank sends a letter to each checking customer usually each month that has the following information: (1) the depositor's beginning bank balance; (2) the amounts of each check paid during the period; (3) the bank service charge; (4) the amounts deposited; (5) the depositer bank balance at the end of the period. This letter is called a _____.

QUIZ 8-A

1. One who places money in his account is a _____

2. The money being placed into an account is a _____.

3. An account with a bank on which a bank pays interest to the depositor is a _____. The account which usually requires the depositor to pay a service charge is a _____.

4. Endorsements are required to be written on the back of a check in order for it to be cashed. Three such endorsements illustrated in the text are _____, _____, _____.

5. The _____ must be filled out before the check is written

6. The word _____ is written on a check when an error has been made.

7. The bank sends a _____ to each banking customer usually each month which summarizes all the banking transactions carried on by the bank.

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QUIZ 8-B

1. Making a deposit is placing cash _____ for safe keeping.

2. A depositor is the one who _____.

3. The report that the bank makes to a depositor showing his deposits, withdrawals, and bank account balance is called a _____.

4. A checking account is an account with the bank that permits the depositor to _____.

5. A savings account is an account for which a bank pays _____ to the depositor.

6. An endorsement that consists only of the name of the endorser is called a _____.

7. An endorsement that states to whom the check is to be paid, together with the name of the endorser, is called an _____

8. An endorsement that limits the receiver of the check as to the use he can make of the funds collected is a _____.

9. When a check has been cancelled or an error made on it, the word _____ is written on the face of the check and check stub.

10. The(check, check stub) is filled out first by the maker of the check.

SUPPLEMENTAL ASSIGNMENT

8-B

On August 1 of the current year, the Allen Hardware Store, owned and operated by M. A. Allen, received from the First National Bank the bank statement of July.

INSTRUCTIONS: Prepare a reconciliation of the bank statement using the following data:

a. The checkbook balance on July 31 was $2,498.20

b. The July 31 balance on the bank statement was $2,693.70

c. Two charge slips accompanied the bank statement showing that the bank had made the following charges against the account of the Allen Hardware Store:
   1. A slip showing a service charge of $2.00
   2. A slip showing a charge of $1.50 for collecting a note for the Allen Hardware Store.

d. The following checks were found to be outstanding: No. 91, $36.10; No. 93, $42.90; and No. 96, $120.00.

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UNIT 9

OBJECTIVE:

At the end of this unit the student should be able to complete an eight-column work sheet making adjustments to merchandise inventory, supplies, and prepaid insurance.

ASSIGNMENT 20

a. Read pages 305-322 of text
b. Do cases 1, 2, 3 pages 323-324 of text
c. Complete study guide; Workbook pages 155-156
d. Do drill 18-A, 18-C; Workbook 157-158
e. Complete problem 18-1, 18-S; Workbook pages 159-160
f. Extra credit 18-B; textbook page 238

Turn in for evaluation.

INSTRUCTIONS: Ask the teacher for Quiz 9. Follow instructions of previous units.

QUIZ 9

1. The formula for finding the merchandise sold is: cost of goods sold = _____, _____, _____

2. To make an adjustment entry to transfer the beginning merchandise inventory to the summary account the _____ account is debited and the _____ is credited.

3. To make an adjustment entry to transfer the ending merchandise inventory to the summary account _____ is debited and _____ is credited.

4. The entry to make an adjustment for supplies _____ is debited and _____ is credited.

5. The entry to make an adjustment on prepaid insurance _____ is debited and _____ is credited.

15986

QUIZ 9-A

1. At the end of a fiscal period two inventories might be taken. An actual count of the items on hand is called a _____. An inventory record that shows changes in the amounts on hand as the changes occur is called a _____.

2. Make the adjustments for the following:

	Debit	Credit
Merchandise Inventory		
Supplies		
Prepaid Insurance		
Income and Expense Summary		
Insurance Expense		
Supplies.		
a. Beginning Merchandise Inventory	6245.00	
b. Ending merchandise Inventory	6310.00	
c. Supplies Used	125.00	
d. Insurance Expired	31.00	

QUIZ 9-B

1. Beginning merchandise inventory + purchases - ending merchandise inventory = _____.

2. Name the two kinds of inventories that are taken by businesses.
_____ and _____

3. Make the adjustments on the following:

a. Beginning merchandise inventory	7295.00
b. Ending merchandise inventory	6140.00
c. Supplies used	220.00
d. Insurance expired	35.00

	Debit	Credit
Merchandise Inventory		
Supplies		
Prepaid Insurance		
Income and Expense Summary		
Insurance Expense		
Supplies Expense		

SUPPLEMENTAL ASSIGNMENT

9-A

a. Do problem 18-B, page 653

b. See attached sheet.

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SUPPLEMENTAL ASSIGNMENT 9-A
Part 2

On June 30 of the current year, the end of a fiscal period of one month, the accounts and their balances in the general ledger of the Langer Auto Sales Agency, owned and operated by R. A. Langer, and the list of inventories were as follows:

Account Titles	Acct. No.	Balance
Cash	11	$ 3,067.20
Accounts Receivable	12	7,250.80
Merchandise Inventory	13	22,000.00
Supplies	14	360.20
Prepaid Insurance	15	340.00
Accounts Payable	21	7,210.40
R. A. Langer, Capital	31	25,209.50
R. A. Langer, Drawing	32	600.00
Inc. and Exp. Summary	33	
Sales	41	17,960.60
Purchases	51	14,241.10
Gas and Oil Expense	61	350.20
Insurance Expense	62	
Miscellaneous Expense	63	190.60
Rent Expense	64	300.00
Salary Expense	65	1,680.40
Supplies Expense	66	

Inventories, June 30, 19--
Merchandise inventory, $22,140.00
Supplies inventory, $265.40
Value of insurance policies, $320.00

INSTRUCTIONS: Prepare an eight-column work sheet.

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UNIT 10

OBJECTIVE:

At the end of this unit the student will be able to prepare financial reports for a business from the work sheet and to record and to post an adjusting and closing entries prior to closing the ledger.

ASSIGNMENT 21

a. Read text material pages 329-342
b. Define the following words:
   1. Cost of merchandise sold
   2. Gross profit on sales
   3. Net loss
   4. Capital statement
   5. Report form of balance sheet
   6. Supporting schedule
   7. Income statement
   8. Balance sheet
c. Answer study questions page 343; #1,3,5,6,8,9,10
d. Complete drills 19-A, 19-B, 19-C; Workbook pages 163-164
e. Do problems 19-1, 19-S; Workbook pages 167-169, 170
f. Extra credit: study guide; Workbook pages 161-162 problems 19-B; text page 347

Turn work in for evaluation.

ASSIGNMENT 22

a. Read text material pages 349-363
b. Complete study guide; Workbook pages 171-172
c. Do drill 19-A, 19-B, 19-C; Workbook page 173
d. Do problem 20-1; Workbook pages 174-182
e. Extra credit; answer study questions text page 363

Turn in work for evaluation.

INSTRUCTIONS: Ask the teacher for Quiz 10. Follow instructions of Unit 1.

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QUIZ 10

Write the letter in the blank preceding the statement that represents the statement correctly answering the following:

a. Adjustment entires
b. Closing entries
c. Account form of balance sheet
d. Assets
e. Capital statement
f. Cost of merchandise available for sale
g. Cost of merchandise sold
h. Expenses
i. Gross profit on sales
j. Income
k. Income statement
l. Liabilities
m. Net income
n. Net loss
o. Proprietorship
p. Report form of balance sheet
q. Schedule of accounts payable
r. Schedule of accounts receivable.

_____ 1. The income that a merchandising business earns from operations before expenses are deducted is called . . .

_____ 2. When the total liabilities are subtracted from the total assets, the remainder is called . . .

_____ 3. The entries recorded in the general journal to make the necessary changes in the general ledger accounts at the end of a fiscal period are. . .

_____ 4. When the total expenses are subtracted from the gross profit on sales, the difference is called. . .

_____ 5. When the expenses of a business are greater than the gross profit on sales, the difference is called . . .

_____ 6. A financial report that summarizes the changes in the proprietor's capital during a fiscal period is called . . .

_____ 7. The entries recorded in the general journal to clear all income, cost, and expense accounts by transferring the balances to a summary account and to bring the proprietor's capital account up to date is . . .

_____ 8. A list of all customers that shows the balance to be collected from each customer and the total amount to be collected from all customers is called a . . .

_____ 9. Beginning merchandise inventory plus purchases equals . . .

_____ 10. A list of all creditors that shos the balance owed to each creditor and the total amount owed to all creditors is called a . . .

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QUIZ 10-A

Write the letter in the blank preceeding the statement that represents the statement correctly answering the following:

a. Adjustment entries
b. Closing entries
c. Account form of balance sheet
d. Assets
e. Capital statement
f. Cost of merchandise available for sale
g. Cost of merchandise sold
h. Expenses
i. Gross profit on sales
j. Income
k. Income statement
l. Liabilities
m. Net income
n. Net loss
o. Proprietorship
p. Report form of balance sheet
q. Schedule of accounts payable
r. Schedule of accounts receivable

_____ 1. When the total liabilities are subtracted from the total assets the remainder is called . . .

_____ 2. A financial report that summarizes the changes in the proprietor's capital during a fiscal period is called a . . .

_____ 3. The entries recorded in the general journal to make the necessary changes in the general ledger accounts at the end of a fiscal period are . . .

_____ 4. Beginning merchandise inventory plus purchases equals . . .

_____ 5. When the total expenses are subtracted from the gross profit on sales, the difference is called . . .

_____ 6. The income that a merchandising business earns from operations before expenses are deducted is called . . .

_____ 7. When the expenses of a business are greater than the gross profit on sales, the difference is called . . .

_____ 8. A list of all creditors that shows the balance owed to each creditor and the total amount owed to all creditors is called a . . .

_____ 9. A list of all customers that shows the balance to be collected from each customer and the total amount to be collected from all customers is called a . . .

_____ 10. The entries recorded in the general journal to clear all income, cost, and expense accounts by transferring the balances to a summary account and to bring the proprietors capital account

15991

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IX. CHASSIS

MILESTONE: I. STEERING GEAR ASSEMBLY

PERFORMANCE OBJECTIVE NO: 1 TITLE: Disassemble, Check, and Reassemble Steering Gear Assembly

CONDITIONS:

Students will learn the related information listed below

	REFERENCE	SOURCE
Fundamentals and servicing of steering gear assembly	1. Automotive Chassis and Body, by Crouse. pp. 100 through 159, 184 through 192, 266 through 384 Automotive Chassis Workbook, by Crouse. Jobs 13 through 14, and 19	1. Related Information Class
"Front Axles and Steering Gear"	2. Flimstrip	2. Resource Materials Center
Front end and steering gear	3. Teaching Machine cards 13A, 21A, 21B	3. Teaching Machine (Shop)

1904

up to date is . . .

QUIZ 10-B

Write the letter in the blank preceding the statement that represents the statement correctly answering the following.

a. Adjustment entries
b. Closing entries
c. Account form of balance sheet
d. Assets
e. Capital statement
f. Cost of merchandise available for sale
g. Cost of merchandise sold
h. Expenses
i. Gross-profit on sales
j. Income
k. Income statement
l. Liabilities
m. Net income
n. Net loss
o. Proprietorship
p. Report form of balance sheet
q. Schedule of accounts payable
r. Schedule of accounts receivable

_____ 1. A list of all customers that shows the balance to be collected from each customer and the total amount to be collected from all customers is called a . . .

_____ 2. When the expenses of a business are greater than the gross profit on sales, the difference is called . . .

_____ 3. When the total liabilities are subtracted from the total assets, the remainder is called . . .

_____ 4. Beginning merchandise inventory plus purchases equals . . .

_____ 5. A financial report that summarizes the changes in the proprietor's capital during a fiscal period is called a . . .

_____ 6. The entries recorded in the general journal to make the necessary changes in the general ledger accounts at the end of a fiscal period are . . .

_____ 7. The income that a merchandising business earns from operation before expenses are deducted is called. . .

_____ 8. A list of all creditors that shows the balance owed to each creditor and the total amount owed to all creditors is called a . . .

15992

_____ 9. The entries recorded in the general journal to make the necessary changes in the general ledger accounts at the end of a fiscal period are . . .

_____ 10. When the total expenses are subtracted from the gross profit on sales, the difference is called.....

SUPPLEMENT ASSIGNMENT

10-A

a. Complete problem 19-A, pages 653-654

b. Complete problem 20-A, pages 654-655

10-B

a. Complete problem 18-A on the attached sheet.

b. Complete problem 19-A on the attached sheet.

INSTRUCTIONS: Ask the teacher for Test 5. Follow instructions of Test 1.

15993 12394

SUPPLEMENTAL ASSIGNMENT
10-B Part B - 19-A

On January 31 of the current year, the end of a monthly fiscal period, the account balances in the ledger of Burton Electric Supply, owned and operated by W. M. Burton, and the list of inventories were as follows:

Account Titles	Acct. No.	Balance
Cash	11	$ 3,460.00
Accounts Receivable	12	2,101.45
Merchandise Inventory	13	11,310.00
Supplies	14	504.00
Prepaid Insurance	15	540.00
Accounts Payable	21	1,780.00
W.M. Burton, Capital	31	15,018.40
W.M. Burton, Drawing	32	450.00
Inc. and Exp. Summary	33	---------
Sales	41	8,545.15
Purchases	51	4,870.20
Delivery Expense	61	485.45
Insurance Expense	62	---------
Miscellaneous Expense	63	361.25
Rent Expense	64	361.25
Salary Expense	65	300.00
Supplies Expense	66	---------

Inventories, January 31, 19--
Merchandise inventory, $12,210.50
Supplies inventory, $315.00
Prepaid insurance, $520.00

INSTRUCTIONS: 1. Prepare an eight-column work sheet.

2. Prepare the income statement and the balance sheet.

3. Record the adjusting and the closing entries in the general journal.

15994

UNIT 11

OBJECTIVE

At the end of this unit the student will be able to record in the different journals, post to the general and subsidiary ledgers, prepare the financial cycle for a fiscal period of one month.

ASSIGNMENT P 1

Complete practice set entitled "Spencer Athletics Goods."

Note This is to be obtained from the instructor.

INSTRUCTIONS

a. Open instruction envelope No. 1. Read it carefully.
b. Proceed by going from one instruction to the next. Complete each instruction before going on. As each envelope is completed bring the completed information to the instructor to be checked for possible errors. Then proceed on to the next envelope.
c. When the practice set has been completed, ask for test 4. Answers for the test will be obtained from the practice set.
d. Turn in both the completed practice set and the test together for evaluation.

UNIT 12

OBJECTIVE

At the completion of this unit the student will be able to record in a combination journal all the business transactions that take place during a fiscal period.

ASSIGNMENT 23

a. Read pages 405-416 of text
b. Compelte study guide Workbook pages 205-206
c. Do problems 23-1 23-2, 23 S Workbook pages 207-211
d Extra credit 23-B Workbook page 211

Turn work in for evaluation.

INSTRUCTIONS Ask the teacher for Quiz 12. Do as instructions of past units.

15995

QUIZ 12

1 The five journals that are combined to form the combination journal are _____, _____, _____, _____ and _____.

2. The cash on hand is recorded on line _____ of the combination journal.

3 Each amount in the _____ debit column and _____ credit columns are posted to the general ledger.

4. Each amount in the _____ debit and credit column is posted individually to a customer's account in the accounts receivable ledger.

5 Each amount in the _____ debit and credit columns is posted individually to the creditor's account in the accounts payable ledger.

6 The title of the customer's and creditor's accounts are given in the _____ column.

7. An amount of cash kept on hand and used for making small payments is called a _____.

8. In establishing a fund used to pay small amounts of cash for expenses the account _____ is debited and the account _____ is credited in the journal.

QUIZ 12A

1 A _____ is used to record cash receipts, cash payments purchases, sales, and miscellaneous entries into one book of original entry.

2. A memorandum entry is recorded on line _____ of a journal.

3 Each amount of the general debit and credit columns of a journal is posed to the _____ ledger.

4. Each individual amount of the accounts payable columns is posted to the separate accounts of the creditor in the _____ ledger.

5 Each individual amount of the account receivable columns is posted to the separate account of each customer in the _____ ledger.

6 A petty cash fund is _____.

7. To establish the petty cash fund in the journal, the account _____ is debited and the account _____ is credited.

15996

SUPPLEMENTAL ASSIGNMENT
12-B

INSTRUCTIONS 1. Record on page 6 in a combination journal the following transactions completed by R. H. Holt during the month of May of the current year

May 1. Issued Check No. 133 for $50 to establish a petty cash fund.
1. Received $78.67 from Paul Jones on account.
2. Issued Check No. 134 for $150 for the May rent.
3. Sold merchandise on account to Henry Jackson, $23.98
3. Cash sales for May 1-3 were $206.80
5. Purchased merchandise on account from Lamb & Sons, $361.25
6. Issued Check No. 135 for $427.47 to Norton Mfg. Co. on account.
7. Received $113.50 from Thomas Lucas on account.
9. Issued Check No. 136 for $75 for a cash purchase of merchandise.
10. Cash sales for May 5-10 were $488.55
12. Received $25 for an old display table. (Store Equipment)
13. Sold merchandise on account to Fred Piper, $103.75
15. Issued Check No. 137 for $141.36 to Baker Bros. on account.
16. Issued Check No. 138 for $300 to Mr. Holt for a withdrawal for personal use.
17. Cash sales for May 12-17 were $516.71
19. Purchased merchandise on account from Beaver & Bent, $735.15.
21. Issued Check No. 139 for $33 advertising. (Advertising Expense)
23. Sold merchandise on account to Robert Coyne, $45.
24. Cash sales for May 19-24 were $538.95
26. Issued Check No. 140 for $67.89 for a cash purchase of merchandise.

INSTRUCTIONS 2. Assume at this point of the problem you have reached the bottom of the page. Total all columns and forward to the next page of the combination journal. Then continue to journalize the following transactions

May 27. Issued Check No. 141 for $505.40 to Boswell Company on account.
29. Issued Check No. 142 for $73.15 for utility bills for the month. (Miscellaneous Expense)
31. Issued Check No. 143 for $38.45 for delivery expense.
31. Issued Check No. 144 for $330 for the payroll. (Salary Expense)
31. Issued Check No. 145 for $41.80 to replenish the petty cash fund. Advertising Expense, $7.50, Delivery Expense, $1.50 and Misc. Expense, $14.60.
31. Cash sales for May 26-31 were $471.10.

INSTRUCTIONS 3. Foot all columns of the combination journal and prove the equality of debits and credits.
4. Total and rule the combination journal.

15998

UNIT 13

/

OBJECTIVE

At the end of this unit the student will be able to record the entries for sales returns, purchases returns, payrolls, and payroll taxes.

ASSIGNMENT 24

a. Read text material pages 421 432
b. Complete study guide Workbook pages 213-214
c. Do drill 24 A Workbook page 215
d. Complete problems 24-1 24-2, 24 B Workbook pages 216-223
e. Extra credit problem 24 S; text page 438

Turn in for evaluation.

ASSIGNMENT 25

a. Read text material pages 439-453
b. Complete study quide Workbook pages 225-226
c. Do problems 25-1, 25-2, 25-3, 25-4
d. Extra credit 24-S, 24-B

Turn in for evaluation

ASSIGNMENT 26

a. Read text material pages 459-470
b. Do study guide Workbook pages 235-236
c. Complete problems 26-1 26-2, 26-3

INSTRUCTIONS At this point ask the teacher for test No. 6. Follow the instructions that have been given for other tests.

ASSIGNMENT 27

Complete Project 3 Workbook pages 243-264

INSTRUCTIONS Ask the teacher for Quiz 13. Follow procedure of previous units.

230 OF 327

ED

056 238

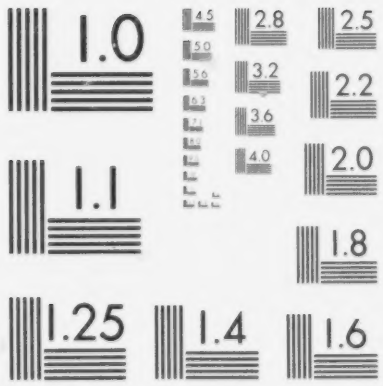

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

QUIZ 13

1. The source document for recording a transaction related to sales returns and allowances is _____.

2. _____ is debited and _____ and _____ are credited by the seller to record a transaction in which merchandise is returned by a charge customer.

3. _____ and _____ are debited and _____ is credited by the buyer to record a transaction in which credit is received for merchandise returned to a creditor.

4. When a buyer issues a check to a creditor to pay an invoice and a discount is allowed _____ and _____ are debited and _____ and _____ are credited.

5. When a seller receives cash on account from a charge customer and a discount is allowed _____ and _____ are debited and _____ and _____ are credited

6. The source document for journalizing the payroll information for each payroll period is _____.

QUIZ 13A

Make a journal entry to record the following payroll information obtained from the payroll register.

a. Issued check No. 90 for $1,351.98 in payment of the weekly payroll of $1,607.00 less deductions of $70.72 for FICA taxes, $170.80 for Employees Income tax, $3.50 for Community Chest Donations and $10.00 for U.S. Savings Bonds.

b. Recorded the employers payroll tax liabilities using the following FICA taxes $70.71 State Unemployment taxes, $43.39 and Federal Unemployment taxes $6.43.

16000

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IX. CHASSIS

MILESTONE: I. STEERING GEAR ASSEMBLY

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Disassemble, check, and Reassemble Steering Gear Assembly

CONDITIONS:

This assignment will be performed on a steering gear assembly obtained from the parts storage room.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Obtain steering gear assembly from parts storage room
2. Select proper manual and turn to appropiate chapter
3. Select proper tools and materials
4. Disassemble steering gear assembly following all steps as outlined in the manual
5. Identify all parts and their function
6. Perform all checks and tests as outlined in the manual
7. If all checks and tests are satisfactory, reassemble the steering gear assembly
8. Make final check, test and adujustments following all steps as outlined in the manual
9. If final checks, tests, etc. are satisfactory, return steering gear assembly to parts storage room
10. Return tools and materials to proper place
11. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily disassemble, check, and reassemble a steering gear assembly in 1½ hours

Learning time: 3 hours

c. Received a check from A. J. Fox in payment of our invoice of May 20. The terms of the sale were 1/20, n/30. The original amount of the invoice was $340.00

d. Received a credit memorandum for $40.00 from F. R. Rhodes for merchandise returned to them.

e. Issued a credit memorandum for $8.00 to A. R. Wells for merchandise returned by them on our invoice of June 14.

QUIZ 13B

1. A credit memorandum is a source document for recording a transaction relating to _____.

2. _____ is debited _____ and the deptor are credited to record a transaction in which merchandise is returned by a charge customer.

3. _____ and the creditor are debited and _____ is credited by a buyer to record transactions in which credit is received for merchandise returned to a _____.

4. When a seller receives cash on account from a charge customer, and a discount is allowed cash and _____ are debited and accounts receivable and the _____ are debited.

5. When a buyer issues a check to a creditor to pay an invoice, and a discount is allowed accounts payable and the _____ are debited and _____ and cash are credited.

16001

SUPPLEMENTAL ASSIGNMENT

13 A

a. Do problem 24-A, page 664.

b. Do problem 25-A, page 665

c. Do problem 26 A, pages 665-666

13 B

a. See the attached sheet.

b. See the attached sheet

c. See the attached sheet

SUPPLEMENTAL ASSIGNMENT
13 B Part A

INSTRUCTIONS 1. Record the following selected transactions which were completed by John Murphy during the month of June, in a combination journal like the All purchases and sales are made on account.

June 2. Received a check for $174.54 from B. C. Porter for our invoice of May 23 for $176.30 less a 1% discount of $1.76.

3. Purchased merchandise amounting to $463.81 from McHenry Bros.
4. Sold merchandise amounting to $113.66 to T. B. Baxter.
6. McHenry Bros. allowed us credit for $11.50 for defective merchandise.
6 Issued Check No 224 for $463.69 to Peyton & Co. in payment of their invoice of May 29 for $473.15 less a 2% discount of $9.46.
9 Issued a credit memorandum for $7.96 to T. B. Baxter for merchandise returned.
11. Issued Check No. 230 for $443.26 to McHenry Bros. in payment of the balance of $452.31 on their invoice of June 3 less a 2% discount of $9.05.
The amount of the invoice of June 3 was $463.81, but a credit of $11.50 was received on June 6. The balance of the invoice to which the discount applied was therefore $452.31, and the discount was 2% of this amount.
12 Sold merchandise amounting to $364.50 to A. D. King.

16001

16002

13. Issued Check No. 235 for $43.60 to Red Arrow Lines for delivery expense on merchandise sold.
14. Received a check for $104.65 from T. B. Baxter and gave him credit for that amount plus $1.06, a 1% discount.
    The amount of the invoice of June 4 was $113.66. A credit of $7.95 was given on June 9. The balance of the invoice to which the discount applies was therefore $105.71.
17. Purchased merchandise amounting to $611.44 from the Clyde Co.
22. Received a check for $360.85 from A. D. King for our invoice of June 12 for $364.50 less 1% discount of $3.65.
24. Sold merchandise amounting to $183.25 to B. F. Vance.
26. Issued Check No. 255 for $599.21 to the Clyde Co. in payment of their invoice of June 17 for $611.44 less a 2% discount of $12.23.
27. Purchased merchandise amounting to $534.65 from Knight & sons.
30. Issued Check No. 264 for $51.80 to Red Arrow Lines for delivery expense on merchandise sold.
30. Received a credit memorandum for $21.30 from Knight & Sons for merchandise returned by us.
30. Issued Check No. 266 for $46.21 to replenish the petty cash fund. The payments were as follows: Supplies, $12.14 Misc. Expense $17.32 Delivery Expense, $16.75

INSTRUCTIONS 2. Foot, prove and rule the combination journal.

SUPPLEMENTAL ASSIGNMENT
13 B Part B

The following table gives the hours worked and the hourly rate for ten employees. Each employee is paid his regular hourly rate for a maximum of 8 hours for Monday through Friday. If he works more than 8 hours on any of these five days, he receives time and a half for the overtime. He also receives time and a half for Saturday.

Name	Hours Worked						Hourly Rate
	M	Tu	W	Th	F	S	
Henry A. Abbott	8	8	8	8	8	4	$1.40
Robert C. Barton	8	8	8	8	10		1.60
Marvin Easton	8	10	8	8	8		1.70
Laurence Hershey	8	8	8	8	8	3	1.30
William Morton	8	8	8	0	8		1.95
Richard Parker	8	10	8	8	8		2.20
Raymond R. Ridge	8	8	8	8	10		2.00
Frank O. Sutto	8	8	8	8	8	4	2.00
Martin Tucker	8	8	8	8	8	2	1.80
David M. Weber	8	10	8	8	8		2.10

Determine the earnings for the week for each employee and the total earnings for all employees.

SUPPLEMENTAL ASSIGNMENT
13-B Part C

The Caldwell Print Shop completed the payroll transactions given below during the period January 1 to February 5. The Caldwell Print Shop is liable for payroll taxes at the following rates FLCA taxes, 3 1.3% state unemployment taxes, 2.7% and federal unemployment taxes 18% It is also liable for the purchase of U.S. Savings Bonds as the accumulated withholdings for each particular employee reaches the necessary amount.

INSTRUCTIONS 1. Open the following accounts in the general ledger and record the balances as of January 1 of the current year

Acct. No.	ACCOUNT TITLE	Credit Balance
22	Employees Income Taxes Payable	$253.60
23	FICA Taxes Payable	152.48
24	State Unemployment Taxes Payable	178.75
25	Federal Unemployment Taxes Payable	210.60
26	U.S. Savings Bonds Payable	98.00
63	Federal Unemployment Taxes	-------
66	FICA Taxes	-------
68	Salary Expense	-------
69	State Unemployment Taxes	-------

INSTRUCTIONS 2. Record the following selected transactions in a combination journal.

3. After each entry is journalized, post the tiems recorded in the General Debit and General Credit columns.

Jan 10. Issued Check No. 18 for $515.54 in payment of the weekly payroll of $610 less deductions of $63.40 for income taxes $19.60 for FICA taxes, and $12 for U.S. savings Bonds deductions.

10. Recorded the employer's payroll tax liabilities.

12. Issued Check No. 23 for $406.08 in payment of the liabilities for employees income taxes and FICA taxes for December.

12. Issued Check No. 24 for $178.75 in payment of the liability for state unemployment taxes for the last quarter of the previous year.

12. Issued Check No. 25 for $210.60 in payment of the liability for federal unemployment taxes.

12. Issued Check No. 26 for $18.75 to purchase one U.S. savings Bond for an employee.

17. Essued Check No. 36 to $515.54 in payment of the weekly payroll of $610 less deductions of $63.40 for income taxes, $19.06 for FICA taxes, and $12 for U.S. Savings Bond deductions.

17. Recorded the employer's payroll tax liabilities.

24. Issued Check No. 49 for $457.42 in payment of the weekly payroll of $540 less a deduction of $55.20 for income taxes, $16.88 for FICA taxes, and $10.50 for U.S. Savings Bond deductions.
24. Recorded the employer's payroll tax liabilities.
31 Issued Check No. 61 for $457.42 in payment of the weekly payroll of $540 less a deduction of $55.20 for income taxes, $16.88 for FICA taxes and $10.50 for U.S. Savings Bond deductions.

QUIZ 14

1. The amount of depreciation on fixed assets is a/an (fixed expense operating expense, other expense).

2. In the adjustment columns of the work sheet the estimated depreciation is recorded as a debit to _____ and credited to _____.

3. Equipment is classified as a (fixed asset current asset) on a balance sheet.

4. Three ways of disposing of a fixed asset are _____ _____, and _____.

5. The adjustment entry to record the estimated depreciation of a fixed asset is _____ as a debit and _____ as a credit.

6. A gain on the sale of a fixed asset is recorded as (other expense, other income) on the income statement. A loss is (other expense other income).

7. The adjustment entry to record the estimated bad debts is a debit to _____ and a credit to _____.

QUIZ 14 A

1 Most fixed assets are worth less than their purchase price after they have been used for a fiscal period because _____ _____.

2. The accumulated depreciation account is called a valuation account or minus asset account because _____ _____.

3. _____ is debited and _____ is credited when the estimated depreciation of a fixed asset is recorded.

4. _____ and discarding are three ways of disposing of a fixed asset.

5. Gain on fixed assets is listed on the Income Statement under the heading _____.

6. Loss on fixed assets is listed on the Income Statement under the heading _____.

7. An account receivable becomes a bad debt when the account becomes _____ due.

8 Allowance for bad debts is _____ and the customers account is written off as a bad debt.

ASSIGNMENT 31

a. Read text material pages 531 545.
b. Complete study questions page 545 of text.
c Complete study guide pages 305-306
d. Do problems 30 1 30 2, and 30 3

INSTRUCTIONS Ask the teacher for test 7. Follow the same procedure as with the other tests.

16007

UNIT 14

Objective At the completion of this unit the student will be able to record the entries for depreciation, disposition and trading of fixed assets estimating the amount from bad debts, the writing off of a bad dept account and the cash register tape.

Assignment 28

a. Read pp 481-493 of text.
b. Complete study guide workbook pp 265-266
c. Do drills 27-a 27-b workbook p 267
d. Complete problems 27-1, 27-2 27-s, 27-b

Turn in for evaluation

Assignment 29

a. Read pp 499-510 of text.
b. Complete study guide workbook pp 275 276
c. Do problems 28 1, 28-2, 28 3 28-b workbook pp 277-282
d. Extra credit problem 28-s text p. 512.

Turn in for evaluation

Assignment 30

a Read pp 515 526 of text
b. Complete study guide workbook pp 283-284
c. Do drill 29 A workbook p 285
d. Complete problems 29-1, 29 2 29-s workbook pp 286-287
e Extra credit 29-b workbook p 304

Turn in for evaluation

INSTRUCTIONS Ask the teacher for quiz 14. Follow procedure of other units of work.

16008

QUIZ 14

1. The amount of depreciation on fixed assets is a/an (fixed expense operating expense other expense).

2. In the adjustment columns of the worksheet, the estimated depreciation is recorded as a debit to _____ and credited to _____.

3. Equipment is classified as a (fixed asset current asset) on a balance sheet.

4. Three ways of disposing of a fixed asset are _____, _____, and _____.

5. The adjustment entry to record the estimated depreciation of a fixed asset is _____ as a debit and _____ as a credit.

6. A gain on the sale of a fixed asset is recorded as (other expense other income) on the income statement. A loss is (other expense other income).

7. The adjustment entry to reocrd the estimated bad debts is a debit to _____ and a credit to _____.

QUIZ 14 A

1. Most fixed assets are worth less than their purchase price after they have been used for a fiscal period because _____ _____.

2. The accumulated depreciation account is called a valuation account or minus asset account because _____ _____.

3. _____ is debited and _____ is credited when the estimated depreciation of a fixed asset is recorded.

4. _____ and discrading are three ways of disposing of a fixed asset.

5. Gain on fixed assets is listed on the Income Statement under the heading _____.

6. Loss on fixed assets is listed on the Income Statement under the heading _____.

7. An account receivable becomes a bad debt when the account becomes _____ due.

8. Allowance for bad debts is _____ and the customers account is written off as a bad debt.

16009
16010

QUIZ 14 B

1. The entry to record the purchase of a fixed asset for cash is _____ debited and _____ credited.

2. The entry to record the purchase of a fixed asset on account is _____ debited and _____ and the creditor's account credited.

3. The entry to record the estimated depreciation of a fixed asset is _____ debited and _____ credited.

4. The entry to record the selling of a fixed asset for more than its book value is cash and _____ debited and fixed asset and _____ credited.

5. The entry to record the selling of a fixed asset for less than its book value is cash, accumulated depreciation - equipment, and _____ debited and _____ credited.

6. The entry to record the discarding of a fixed asset with no book value is _____ debited and _____ credited.

7. The entry to record the discarding of a fixed asset with book value is _____ and loss or fixed asset debited and _____ credited.

8. The entry to record the trading of a fixed asset for another fixed asset is Delivery Equipment and _____ debited and cash and _____ credited.

9. The entry to record the estimated bad debts is _____ _____ debited and _____ credited

10. The entry to record the writing off of a bad debt for J. R. West is _____ debited and J. R. West and _____ _____ credited.

SUPPLEMENTAL ASSIGNMENT

14 A

A. Complete problems 27-A, 28-A, and 29-A, pages 667 669 of text.

14-B

Do the assignment on the attached sheet.

ASSIGNMENT 31

a. Read text material pages 531-545.
b. Complete study questions page 545 of text.
c. Complete study guide, pages 305-306
d. Do problems 30-1, 30-2, and 30-3

INSTRUCTIONS: Ask the teacher for test 7. Follow the same procedure as with the other tests.

16010

RELATED INSTRUCTION

HOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

URRICULUM: VOCATIONAL

LUSTER: AUTOMOTIVE

OGRAM: AUTOMOBILE MECHANICS

DULE: IX. CHASSIS

ILESTONE: II. FRONT SUSPENSION

ERFORMANCE OBJECTIVE NO: 2 TITLE: Remove, Replace, and Adjust Front Suspension

ITIONS:

Student will learn related information listed below

N	REFERENCE	SOURCE
Front suspension	1. Automotive Chassis and Body, by Crouse. pp. 47 through 96, 193 through 216 Automotive Chassis Workbook, by Crouse. Jobs 12, 13, 15, 16	1. Related Information Class
. "Springs"	2. Filmstrip	2. Resource Materials Center
. "Shock Absorbers"	3. Filmstrip	3. Resource Materials Center
. Front suspension	4. Teaching Machine cards 13A, 22A, 22B	4. Teaching Machine (Shop)

1596

SUPPLEMENTAL ASSIGNMENT
14 B Part A

R. J. Gifford purchased the following items of equipment during the first three years that he was in business.

Fixed Asset	Date of Purchase	Initial Cost	Annual Rate of Depreciation
1	January 4, 1960	$2,400	25 %
2	June 30, 1960	250	20 %
3	January 6, 1961	6,000	5 %
4	September 6 1961	60	12 %
5	April 1 1962	3,300	6 2/3 %
6	December 3 1962	72	16 2/3 %

INSTRUCTIONS 1. Record the adjusting journal entry for the total depreciation expense for (a) the year ended December 31, 1960, (b) the year ended December 31, 1961 and (c) the year ended December 31, 1962

2. Find the book value as of December 31, 1962 of each item of equipment.

---

14 B Part B

Joseph Egan, a retail shoe merchant, maintains in his general ledger accounts with Equipment, Allowance for Depreciation of Equipment, and Depreciation Expense.

INSTRUCTIONS 1. Record in a combination journal the following transactions selected from those completed by Mr. Egan during the current year.

Jan. 2 Issued Check No. 3 for $410 for a new electric typewriter.
Mar 31 Recorded the estimated depreciation of equipment for the quarter ended March 31 $162.50
Apr 1 Discarded two chairs for which there was no further use and which could not be sold. The chairs cost $75 and had a book value of $10 at the time they were discarded.
Jun 30 Recorded the estimated depreciation of equipment for the quarter ended June 30, $165.30
July 1 Sold an old office desk to a secondhand dealer for cash, $20. The desk cost $60 and had a book value of $12 when it was sold.
Aug 15 Issued Check No. 261 for $125 for new display shelves.
Sept.30 Recorded the estimated depreciation of equipment for the quarter ended September 30, $164.55
Oct. 1 Bought a new typewriter for $155 cash (Check no. 301) and an old typewriter. The old typewriter cost $145 and had a book value of $50 at the time of the trade in.

Nov 1 Sold an old adding machine for cash, $35. The adding machine cost $180 and had a book value of $46 after depreciation was recorded on September 30. The depreciation rate was $3 a quarter. (a) Record depreciation for October.

16011

15 B Part B

(b) Record the sale of the adding machine.

Dec 31. Recorded the estimated depreciation of equipment for the quarter ended December 31, $164.12.

INSTRUCTIONS 2 Foot, prove, and record the totals in the combination journal.

SUPPLEMENTAL ASSIGNMENT
14 B Part C

The Upsom Lumber Company maintains accounts with Bad Debts Expense and Allowance for Bad Debts. At the beginning of the current year the balance of the allowance for bad debts was $216.60

In this exercise you are given transactions taken from those completed by the Upsom Lumber Company during the current year.

INSTRUCTIONS 1. Record the following transactions in a combination journal.

Feb. 13 Decided that the past due account of Garry Fuller, $76.60 was uncollectable. Wrote off his account as bad debt.

Mar. 27 C. W. Lee, a charge customer became insolvent. Wrote off his account of $43 as a bad debt.

Mar. 31 (Ended of first quarterly fiscal period.) Increased the allowance for bad debts by making the necessary adjusting entry. The estimated bad debts expense for each quarterly fiscal period was 1 1/4% (.0125) of the total charge sales. The charge sales for the quarterly fiscal period ended March 31 were $11 650

May 15 R. W. Bunker, a charge customer, became insolvent. Wrote off his account of $86.50

June 30 The total charge sales for the second quarterly period ended June 30 were $9,990.80. Increased the allowance for bad debts 1 1/4% (.0125) of that amount.

Aug. 21 Decided that the past due account of Karl Hess, $123.80 was uncollectable. Wrote off his account as a bad debt.

Sept. 30 The total charge sales for the third quarterly fiscal period ended September 30 were $10 060.75 Increased the allowance for bad debts 1 1/4% (.0125) of that amount.

Dec. 31 Decided that the past due accounts of the following charge customers were uncollectible: Albert Beem $82.98; Joseph Harris, $160.30; R. B. Bough, $30. Wrote them off as bad debts in one combined entry, debiting Allowance for Bad Debts for the total.

16012
11031

Dec. 31 The total charge sales for the fourth quarterly fiscal period ended December 31 were $12 444.50. Increased the allowance for bad debts 1 1/4% (.0125) of that amount.

INSTRUCTIONS 2. Foot, prove, and record the totals in the combination journal.

Jan 31 Recorded the employer's payroll tax liabilities.

Feb. 1 Issued Check No. 63 for $37.50 to purchase U.S. Savings Bonds (2 at $18.75) for employees.

5. Issued Check No. 70 for $380.96 in payment of the liabilities for employees income taxes and FICA taxes for January.

UNIT 15

OBJECTIVE

At the end of this unit the student will be able to complete a business cycle using the combination journal, making the proper adjustments to accounts, preparing financial reports, and closing the ledger, and opening up the books for a new fiscal period.

ASSIGNMENT P 2

Complete practice set entitled "Tayler Hardware". This can be obtained from your instructor.

INSTRUCTIONS.

1. Open instruction envelope 1 and read it carefully.
2. Proceed by going from one instruction to the next completing each instruction before going on. As each envelope is complete, bring the journals, ledgers, and other papers to the instructor to be checked for possible mistakes.
3. Proceed then to the next envelope until completed. After completion ask for Test 9. Turn both the practice set and the test in together for evaluation.

Jan 31 Recorded the employer's payroll tax liabilities.

Feb 1 Issued Check No. 63 for $37.50 to purchase U.S. Savings Bonds (2 at $18.75) for employees.

5 Issued Check No. 70 for $380.96 in payment of the liabilities for employees income taxes and FICA taxes for January.

The introduction to the keyboard is called Bombing . It precedes the drill work and daily assignments. A Gregg publication entitled Basic Machine Exercises by J. H. Dool is used for the hub of the year's work Weekly tests are given to determine accuracy, speed and mastery. One important objective of the class is to help the learner develop a marketable skill on machines. It is recommended that from 3 to 5 hours work be completed each week. Credit may be awarded upon completion of the units either ¼ for a quarters work or ½ for a semester. The work may be completed in less than a quarter or spread out for as long as one year depending on released time and interest. Former students who have completed the work are recruited as Lab Assistants for credit These people add much to the program in interest and motivation especially if they are members of the Future Teachers of America.

Another objective is to give definite training to the left hand on the machine leaving the right hand free to write. Instructions are held to a minimum with drill being emphasized to the maximum. From the very beginning the operator is taught to self audit or double check each problem at the time it is run by adding downward, then up the column and comparing the totals. If they agree, then one can be reasonably sure they are correct This quick audit is the key to confident, meaningful mastery and quickly corrects faulty fingering techniques before they become habituated.

The Ten Key Machine is one of the most useful and popular machines in the business office today. Some are hand operated but most are electric.

16015

The instructor will point out and demonstrate the different machine parts and uses such as

The tape and its adjustments to the roller knobs etc.

The paper release for changing or adjusting paper.

How to change a ribbon.

The digit indicator shows the number of keys struck.

A credit balance is shown if the number subtracted is larger than the one added in-o the machine.

The use of the non add repeat clear, and multiplication keys.

Position the learner comfortably at the machine moderately erect with feet flat on the floor. Clear the machine by striking the total key before beginning a problem. Some machines must be struck twice to completely clear them. After establishing a pattern of good work habits and learning the four basic processes of adding subtracting multiplying and dividing on a ten-key machine, it is relatively easy to learn other types of business machines with complete confidence.

The paper tape will show all errors as well as all correct work completed and time spent. The tapes are to be handed in each day to be checked by a lab assistant. The operator is to keep a record of his individual scores. Fold the tapes as you would fold the hem on a blanket to about 12 inches long. Number each problem on the tape by using the non add key (23 <)

Sample illustration of data needed on each tape.

DATE & TIME _____
NAME _____

PAGE & JOB _____

1<

16016
C1081

BOMBING IDEAS

CHALLENGE TO THE LEARNER (You are to use the left hand on the machine leaving the right hand free to hold a pencil).

CORRECT THINKING NECESSARY

Be enthusiastic be excited about machine know how .

Imagine that you are a bombing pilot on an aircraft carrier. You must drop your bomb and return immediately to the carrier 6,5 4 and make a perfect landing on the deck or you will be lost in the drink as the pilots say. Your fingers are the bombs and the keys are the targets. They are all numbered and the bombs must strike the correct target

USE THE LEFT HAND

1st bomber (thumb) hits targets + and T

2nd bomber (finger) hits targets 3 6,9,00 (only)

3rd bomber (big finger) is to hit targets 2 8 5,0 (only)

4th bomber (ring finger) is to hit targets 1,4,7 (only)

READY FOR ACTION follow your problem with the left hand -- read the three numbers softly aloud and BOMB!!!

A flier who wishes to become an expert bomber should bomb each target as recommended (bomb down and up it, then bomb up and down again so that you have 4 identical strikes (correct answers) in a row before trying the next target (problem).

Combinations may be used with any text or drill book.

160008

ADDING AND CALCULATING MACHINES

Page 4

BOMBING RECORD

NAME _____ Class _____ Time _____

Bombing Mission	Targets Bombed	Targets Missed	Direct Hits	Bombing Mission	Targets Bombed	Targets Missed	Direct Hits
1				26			
2				27			
3				28			
4				29			
5				30			
6				31			
7				32			
8				33			
9				34			
10				35			
11				36			
12				37			
13				38			
14				39			
15				40			
16				41			
17				42			
18				43			
19				44			
20				45			
21				46			
22				47			
23				48			
24				49			
25				50			

160181

BOMBING MISSION #1 - Bomb the home keys (Targets 6,5,4)

FLIGHT PLAN: (Eyes on the target - don't peek at hands). Fly down the first column bombing as you fly - 4,5,6, + " " " 546 + T = 4824. Fly back up 456+456+465+654+654+564+564+546+ T =4824 - Continue to bomb up and down until you get 4 direct hits in a row then write the answer once with a 4 beneath it to report a successful bomb run. (Mission accomplished)

#1	#2	#3	#4	#5
456	444	566	454	655
456	555	554	545	564
465	666	455	465	644
465	666	456	565	654
654	444	566	646	556
654	555	566	646	445
564	555	664	664	664
564	444	664	446	645
546	456	456	456	456
4824	4785	4947	4887	5283

BOMBING MISSION #2 - Bomb two new keys (2,8)

FLIGHT PLAN: (Eyes on the targer - slowly feel out each key - then BOMB! IT! and quickly jerk the big finger back and rest it on 5)

#6	#7	#8	#9	#10
55	88	528	528	5285
58	55	555	582	2528
52	52	585	555	8252
55	55	522	882	2852
25	25	255	228	5225
22	28	252	852	8225
28	52	222	258	5588
55	82	888	528	2255
22	22	828	825	8285
82	55	528	888	8582
88	58	825	222	5555
542	-	5988	-	62632

BOMB THE KEYS !*
BLAST THE TARGET !*

*Number ten may be re-bombed under the supervision of thelab-assistant with the keys covered for 10 extra points toward a higher grade level or 30 minutes of released time which can accumulate in the bank of released time for you at a later date.

Total correct ans. _____ PAGE _____ Date _____ Name _____ Class _____

160195

BOMBING MISSION #3 - Bomb two more new keys (1,7,)

(Eyes on the target - feel out the new keys - Bomb!! Then jerk the finger back to position on the carrier deck where it should always rest when not flying on a bombing mission).

#11	#12	#13	#14	#15
44	41	414	777	1144
41	41	141	111	1177
47	47	171	444	1474
41	47	717	717	4174
44	44	411	414	4741
17	14	417	171	4477
14	17	444	141	4141
71	71	777	144	7417
74	74	744	441	7447
41	71	747	177	4714
17	17	114	771	45650
481	484	5097	4308	

BOMBING MISSION #4 - Bomb two more new keys (3,9)
(Eyes on the target - feel ! Bomb! Jerk your finger back to base!

#16	#17	#18	#19	#20
66	33	336	639	3399
33	33	363	369	6633
66	66	366	963	6369
33	66	663	936	3639
99	99	636	993	9339
36	99	633	339	3999
99	36	969	696	6339
63	63	939	396	9636
69	69	933	399	9396
96	96	993	663	3996
93	39	996	699	9339
36	93	393	339	6963
789	792	8220	7431	79047

Total correct ans. _____ PAGE _____ Date _____ Name _____ Class _____

16020103!

BOMBING MISSION: #7 - Bomb the triple zero (000)
(Eyes on the target! Use the thumb or the appropraate finger.

#31	#32	#33	#34	#35
1000	10001	14000	100012	783000
4000	40004	17000	400045	592000
7000	70007	25000	700078	183000
2000	20002	28000	300032	753000
5000	50005	36000	600065	951000
8000	80008	39000	900098	456000
3000	30003	19000	700037	157000
6000	60006	37000	200091	953000
9000	90009	18000	500086	759000
6000	70007	34000	800084	486000
9000'	40004	28000	600064	351000
60000	5600056	295000	5800692	6424000

BOMBING MISSION: #8 - Bomb more zeros.

Make four runs up and down each target - Fly by instrument !

#36	#37	#38	#39	#40
400	2115	500	6000.10	25.00
135	1550	30009	1200.74	109.30
305	6090	22030	750.00	4007.38
120	7500	45047	110.90	5600.00
670	1002	7865	50.00	2000.00
100	3440	35040	5000.72	7801.00
145	6160	98900	1770.04	9040.20
730	9200	30000	7009.50	6006.00
500	4003	50505	4.00	8000.00
905	5780	78000	3500.10	10500.00
4010	46840	397896	25396.10	53088.88

*Enter #39 and #40 on the tape as if the numbers were dollars and cents.

Total correct ans. _____ PAGE _____ Date _____ Name _____ Class _____

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IX. CHASSIS

MILESTONE: II. FRONT SUSPENSION

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Replace, and Adjust Front Suspension

CONDITIONS:

This assignment will be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Position hoist arms and raise automobile to comfortable working height
6. Remove front wheels and drums following steps as outlined in the manual
7. Remove upper control arm assemblies, spindles, srings, lower control arms, and other parts necessary for complete removal of front suspension, following all steps as outlined in the manual
8. Identify all parts and their function
9. Perform all tests and checks as outlined in the manual

PERFORMANCE CRITERIA:

BOMBING MISSION: #5 - Bomb one more new key (0)

#21	#22	#23	#24	#25
40	101	170	450	1707
10	707	140	120	1404
70	404	250	780	2505
20	202	280	320	2808
50	505	360	650	3909
80	808	390	980	3606
30	303	190	730	3070
60	606	370	910	1090
90	909	180	860	5030
70	707	340	840	6040
80	808	280	640	9030
600	6060	2950	7280	40199

Fly at night by instrument - (Don't peek at your hands).

BOMBING MISSION: #6 - Bomb the double zero (00)
Make four runs over each target - Go slowly, don't look!

#26	#27	#28	#29	#30
400	4004	1700	10012	78300
100	1001	1400	40045	59200
700	7007	2500	70078	18300
200	2002	2800	30032	75300
500	5005	3600	60065	95100
800	8008	3900	90098	45600
300	3003	1900	70037	15700
600	6006	3700	20091	95300
900	9009	1800	50086	75900
600	7007	3400	80084	48600
900	4004	2800	60064	35100
6000	56056	29500	580692	642400

Total correct ans. _____ PAGE _____ Date _____ Name _____ Class _____

16022

16021

BOMBING MISSION: #9 - Random targets - Don't hurry, take careful aim!

#41	#42	#43	#44	#45
41	595	1597	10000	3785
42	171	7530	10009	4159
43	383	8043	70033	80000
44	939	4009	15900	10203
45	159	1600	70053	9873
46	951	7009	36080	96952
47	753	1009	78900	43489
48	819	2493	10056	50913
49	357	6607	42809	30007
50	468	3120	34100	95010
51	372	1003	50030	42780
52	167	1590	90000	17570
558	6134	45610	517970	484741

BOMBING MISSION: #10 Important targets - Must be wiped out.
Tricky approach, add 0's to #46 and keep in column.

#46	#47	#48	#49	#50
.30652	652.30	568.03	687.50	50687
.551833	1833.55	1343.40	502.70	70502
.399	9.93	513.75	1146.75	751146
.22005	225.00	21.35	901.40	40901
.460025	2500.46	3.25	400.70	70400
.50580	55.80	3800.21	11.00	1001
.16004	106.40	8000.80	800.00	10008
.70002	200.07	605.25	658.88	86588
.390004	4000.93	96.47	1238.92	921238
.8000127	1278.00	343.46	8606.80	808606
.21172	112.72	40.09	670.08	86007
.8017	71.08	7.32	2779.43	297734
5.5067247	11046.24	15343.38	18404.16	3194818

Total correct ans. _____ PAGE _____ Date _____ Name _____ Class _____

Basic Machine Exercises
by J. H. Dool

ADDING & CALCULATING MACHINES
Page 10

FIRST QUARTER RECORD = 1/4 cr.

Date	Page	Correct	Test Score	Date	Page	Correct	Score
-	1	-	-	-	35	-	-
-	3	-	-	-	37	-	-
-	5	-	-	-	39	-	-
-	7	-	-	-	41	-	-
-	9	-	-	-	43	-	-
-	11	-	-	-	45	-	-
-	13	-	-	-	47	-	-
-	15	-	-	-	49	-	-
-	17	-	-	-	51	-	-
-	19	-	-	-	53	-	-
-	21	-	-	-	55	-	-
-	23	-	-	-	57	-	-
-	25	-	-	-	59	-	-
-	27	-	-	-	61	-	-
-	29	-	-	-	63	-	-
-	31	-	-	-	-	-	-
-	33	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-		-	-	-	-	-	-

First Quarter Total _____ _____ av.

_____ NAME _____ CLASS

Lab Asst. to initial each completed job.

16024

BUSINESS MACHINE EXERCISES by J. H. Dool

2nd Quarter Record = ¼ Credit

Date	Page	Correct	Test Score	Date	Page	Correct	Test Score
	65				95		
	67				97		
	69				99		
	71				101		
	73				103		
	75				105		
	77				107		
	79				109		
	81				111		
	83				113		
	85				115		
	87				117		
	89				119		
	91				121		
	93				123		

SEMESTER TOTAL _____ TEST AV. _____

Lab Asst. to initial each no. _____ _____ _____
(Name) (Date) (class)

16025

BUSINESS MACHINE EXERCISES by J. H. Dool

3rd Quarter Record = ¼ Credit

Date	Page	Correct	Test Score	Date	Page	Correct	Test Score
	2				36		
	4				38		
	6				40		
	8				42		
	10				44		
	12				46		
	14				48		
	16				50		
	18				52		
	20				54		
	22				56		
	24				58		
	26				60		
	28				62		
	30						
	32						
	34						

QUARTER TOTAL _____ TEST AV _____

Lab Asst. to initial each no. _____ (Name) _____ (Date) _____ (class)

16026

BUSINESS MACHINES EXERCISES by J. H. Dool

4th Quarter Record = ¼ Credit

Date	Page	Correct	Test Score	Date	Page	Correct	Test Score
	66				102		
	68				104		
	70				106		
	72				108		
	74				110		
	76				112		
	78				114		
	80				116		
	82				118		
	84				120		
	86						
	88						
	80						
	92						
	94						
	96						
	98						

SEMESTER TOTAL _____ TOTAL AV. _____

Lab Asst to initial each no. _____ _____ _____
(Name) (Date) (Class)

VT 013 032
A Business Education Individualized
Continuous Progress Research Curriculum
Development Study. Volume II.

Weber County School District, Utah.
Utah State Board of Education, Salt Lake City
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 70 272p.

DESCRIPTORS - *BUSINESS EDUCATION; *INSTRUCTIONAL MATERIALS; *INDIVIDUALIZED INSTRUCTION; TESTS; *ASSIGNMENTS; *PROGRAMED MATERIALS; SECONDARY EDUCATION; BEHAVIORAL OBJECTIVES; COURSE CONTENT; TYPEWRITING; STENOGRAPHY; OFFICE PRACTICE

ABSTRACT - With the support of school administrators, several business educators developed this package of individualized curriculum materials. These materials are arranged in four parts which pertain to shorthand I and II, typewriting and transcription, and secretarial procedures. Following the continuous progress approach this color-coded document also includes assignments and quizzes for each of the above units as based on selected textbooks. Instructions for the teacher are also included. A related volume on bookkeeping, typewriting, and business machines is available as VT 013 031, also in this issue. (JS)

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VT 013 032

ED0 56238

Weber County Schools

(C1)

BUSINESS CURRICULUM

INDIVIDUALIZED CONTINUOUS PROGRESS

SHORTHAND I

TYPE AND TRANSCRIPTION

SHORTHAND II

SECRETARIAL PROCEDURES

VT013032

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EDUCATION & WELFARE
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VOLUME II

1970

A BUSINESS EDUCATION INDIVIDUALIZED CONTINUOUS PROGRESS RESEARCH CURRICULUM DEVELOPMENT STUDY, REPORTED IN TWO VOLUMES

VOLUME II

PART ONE

A GENERAL INTRODUCTION COURSE
IN GREGG SHORTHAND I USING THE
INDIVIDUALIZED CONTINUOUS PROGRESS APPROACH

PART TWO

A GENERAL COURSE IN TYPE AND TRANSCRIPTION
CORRELATED WITH SHORTHAND I USING THE
INDIVIDUALIZED CONTINUOUS PROGRESS APPROACH

PART THREE

A GENERAL COURSE IN GREGG SHORTHAND II
USING THE
INDIVUDUALIZED CONTINUOUS PROGRESS APPROACH

PART FOUR

A GENERAL COURSE IN SECRETARIAL PROCEDURES
USING THE
INDIVUDUALIZED CONTINUOUS PROGRESS APPROACH

SUPPORTED BY: Utah State Board of Education Vocational Research an
Experimentation Funds, Project No. D-235

Weber County School District

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16031

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IX. CHASSIS

MILESTONE: II. FRONT SUSPENSION

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Remove, Replace, and Adjust Front Suspension

CONDITIONS:

BEHAVIOR:

10. Install upper control arm assemblies, spindles, springs, lower control arms, and other parts removed in step #7 following all steps as outlined in the manual
11. Install front wheels and drums following all steps as outlined in the manual
12. Make final tests, checks, and adjustments as outlined in the manual
13. If all tests, checks, and adjustments are satisfactory, return tools and materials to proper place
14. Lower automobile to the floor
15. Return automobile to proper parking area
16. Remove front seat covers and store in proper place
17. Clean work station for next project

If possible, use this automobile for your next project, which is wheel alignment.

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, replace, and adjust the front suspension in 6 hours.

Learning time: 12 hours

INTRODUCTION

The philosophy of the continuous progress individualized instruction business curriculum of the Weber School District is to enable the student to progress at his own rate according to his ability.

Behavioral objectives are established for each course and unit within the course. Performance standards, based on the norms of average ability which have been derived from past experience in traditional teaching and recommendations from the Business and Marketing Education Guide for the Utah State Board of Education, have been set. Each student must reach this criterion before he is allowed to progress to the next unit in each course. If a student does not reach the standard, he is given supplemental material and help from the teacher to reinforce his learning and bring him to the standard established; thus, enabling him to move to the next unit. In this manner a student is able to proceed at his own rate and ability.

Instructional material has been developed so that the course is equivalent to one semester. The student receives the material as he proceeds successfully from one unit to another. Upon the successful completion of any specific individualized course, the student is awarded credit and a letter grade.

In this program, an accelerated student has the opportunity to complete a semester's work in less than 18 weeks, enabling him to complete more than one course during a year's time. On the other hand, if a student needs more time to complete the semester's work, he may take the time necessary and still receive credit and a letter grade upon

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completion instead of experiencing failure for not being able to "keep up" with the class.

At the end of the quarter no letter grade is given to the student. A progress report is issued so that the parent can see exactly where his child is at the end of the quarter in relation to the required work for the course with an indication on the report of where the student should be at that time. The student also keeps a progress sheet of his own so that he can keep his record.

It is important that no grade or credit be issued until the student has completed the requirements for the course.

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INSTRUCTIONS FOR THE TEACHER

Shorthand I is set up to take one-hour's time daily of a two-hour block with Type and Transcription. If the two-hour block is not scheduled, the course can be a daily one-hour class. However, it is suggested that the students who are registered for shorthand should also be registered for a type class during the same semester.

The lessons in Chapter 1 are introduced to the class as a group. After successfully completing Chapter 1, the students begin to progress at their own rate according to the standards that have been determined. The students are encouraged to complete at least four lessons a week to be able to complete the course in the prescribed time. Inasmuch as each lesson must be presented individually during the first semester, it necessitates the teacher introducing several lessons during a class period. Homework can readily be checked off before each lesson is introduced during the first semester. Second semester's homework is checked off before giving the chapter test. A paper should be available in a convenient place where the student can indicate which lesson, test, or take is needed.

The tests for the first semester's chapters should be duplicated. Alternate tests should be made for those students who do not pass the test the first time. Because some students move ahead rapidly, all tests should be ready at the beginning of the school year. (A sample test is included.) The tests given during the second semester should be dictated. Dictation speed should not exceed the minimum requirement for the first semester. NOTE: The first score the student receives on a test is the one that should be used in determining his grade.

Weekly "takes" should be given after a student has completed Lesson 20. It is suggested that one day a week be designated as "take" day. All students should take them on this day.

Shorthand Dictation A B C's by Allien R. Russon, University of Utah, 1963, is used for daily dictation and weekly "takes" during the first semester. This material is correlated with the Gregg shorthand book. No student should be given one of the "takes" that is beyond the lesson he is working on in his text.

A teacher's guide has been included which indicates the correlation of the lessons introduced with material to be dictated from the A B C book. The word lists indicated in the teacher's guide should be taken from the previous day's assignment. It is to be noted that tapes are introduced at the beginning of Chapter 9. The students should be encouraged to take dictation from these tapes at least ten minutes per day. If tapes aren't available, the teacher should give "live" dictation daily.

SHORTHAND I
(First Semester)
NAME_____

PROGRESS REPORT

This report lists the minimum required assignments for first semester Shorthand I.

Completion of each assignment is indicated. The suggested term goals are given in red. However, this is just a guide. Progress beyond the suggested goal is encouraged.

The semester goal must be reached before the semester letter grade and credit is given.

ASSIGNMENT	COMPLETED
Chapter Tests (words, paragraphs, and brief forms from each chapter.)	
1. ____ ____ ____	6. ____ ____ ____
2. ____ ____ ____	7. ____ ____ ____
3. ____ ____ ____	8. ____ ____ ____
4. ____ ____ ____	9. ____ ____ ____
5. ____ ____ ____	10. ____ ____ ____
*Brief Form Tests (50-word test with at least 95% accuracy--after Chapter 9)	
1.	_____
*100-word Theory Tests (100 words from complete theory of shorthand with at least 80% accuracy--after Chapter 8)	
1.	_____
*Transcription (From homework notes transcribed on the typewriter)	
1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____
7.	_____
8.	_____
9.	_____
10.	_____
Dictation "Takes" (At least 3 at 40 words per minute for 3 minutes, transcribed on the typewriter with at least 95% accuracy)	
1.	_____
2.	_____
3.	_____

*Will be completed second term.

Parent's Signature_____

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SHORTHAND I
(Second Semester)
NAME_____

PROGRESS REPORT

This report lists the minimum required assignments for second semester Shorthand I.

Completion of each assignment is indicated. The suggested term goals are given in red. However, this is just a guide. Progress beyond the suggested goal is encouraged.

The semester goal must be reached before the semester grade and credit is given.

ASSIGNMENT

Chapter Tests (Words and paragraphs taken from each chapter. Each word test must have at least 85% accuracy, and the paragraphs should have at least 7 points out of 10.)

1. _____ _____
2. _____ _____ _____
3. _____ _____ _____
4. _____ _____ _____
5. _____ _____ _____
6. _____ _____ _____
7. _____ _____
8. _____ _____
9. _____ _____
10. _____ _____
11. _____ _____

Brief Form Tests (50-word test with at least 95% accuracy)

1._____
2._____

100-Word Theory Tests (100 words from complete theory of shorthand with at least 85% accuracy)

1._____
2._____

Transcription (From homework notes or dictated letters transcribed on the typewriter.)

1._____ 6._____ 11._____
2._____ 7._____ 12._____
3._____ 8._____ 13._____
4._____ 9._____ 14._____
5._____ 10._____ 15._____

Dictation "Takes" (At least 3 at 60 words per minute for 3 minutes, transcribed on the typewriter with at least 95% accuracy)

1._____
2._____
3._____

Parent's Signature_____

16032 16036

Name_____

Shorthand I
First Semester

CHAPTER I

1.
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Phrases

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Name_____

Shorthand I
First Semester
Transcription Test #1

CHAPTER 1

Transcribe the following at the bottom of this page:

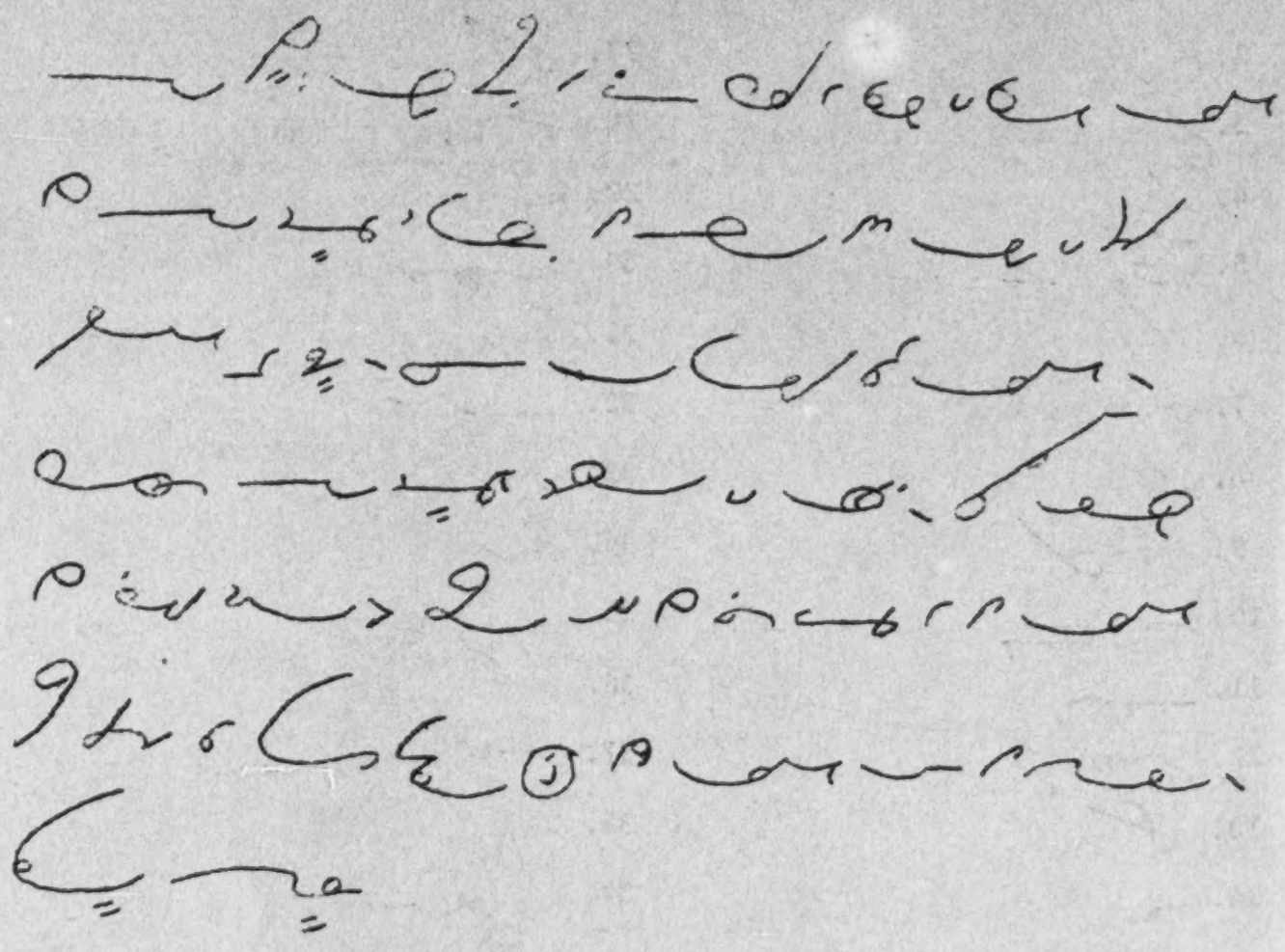

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Shorthand I
First Semester

TEACHER'S GUIDE

This guide is to correlate the introduction of lessons with dictation material from Shorthand Dictation A B C's. It also indicates at what point various phases of Shorthand I are introduced. Brief forms should, of course, be reviewed throughout the semester. Additional dictation and writing practice material can be taken from the shorthand book.

Chapter I

Lessons 1-5 Introduce each lesson at the board to the entire class. Each day the previous lesson should be reviewed.

Lesson 6 Introduce writing. Go back to Lesson 1 and review.

Test on Chapter I (after Lesson 6)
Duplicated test on theory (50 words)
Duplicated test for transcription by hand (a paragraph from the chapter)

If the student does not pass the test according to the standard set up, he should review theory. Check with him to help where needed.

A time limit should be set for the tests. It is suggested that a 20-minute limit be set on each duplicated test, 10 minutes for 50-word brief form tests, and 20 minutes for 100-word theory tests.

Chapter II

Dictation from new material will begin in this chapter. Preview words are given in the assignments on the student's instruction sheets so that they can be practiced before the material is dictated.

Lesson 7 Write, review rules, etc.
Lesson 8 Write, review rules, etc.
Lesson 9 Write, review rules, etc.
Lesson 10 Begin dictation on new material from Shorthand Dictation A B C's (page 5 - 4th day)
Lesson 11 A B C (page 5 - 5th day)
Lesson 12 A B C (page 5 - 1st day)

Test on Chapter II (after Lesson 12)
Duplicated test on theory (50 words)
Duplicated test for transcription by hand (a paragraph from the chapter)
Brief Form test (25 words - dicatated)

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Chapter III

Lesson 13	Practice preview words before giving ABC dictation (page 6 - 2nd day)
Lesson 14	A B C (page 6 - 3rd day)
Lesson 15	A B C (page 6 - 4th day)
Lesson 16	A B C (page 6 - 5th day)
Lesson 17	A B C (page 7 - 1st day)
Lesson 18	A B C (page 7 - 2nd day)

Test on Chapter III (after Lesson 18)
Duplicated test on theory (50 words)
Duplicated test for transcription by hand (a paragraph from the chapter)
Brief Form test (25 words - dictated)

Chapter IV

Lesson 19	A B C (page 7 - 3rd day)
Lesson 20	A B C (page 7 - 4th day)
	At this point, the student will begin "takes." One "take" will be given a week on a designated day. A student should never take a "take" that is beyond the point where he is in the shorthand book.
Lesson 21	A B C (page 9 - 1st day)
Lesson 22	A B C (page 9 - 2nd day)
	At this point the student should be reminded to review brief forms. For quick review the student should use the brief forms listed on the back page of the text.
Lesson 23	A B C (pages 9 and 10 - 3rd day)
Lesson 24	A B C (page 10 - 4th day)

Test on Chapter IV (after Lesson 24)
Duplicated test on theory (50 words)
Duplicated test for transcription by hand (a paragraph from chapter)
Brief Form test (25 words - dictated)

Chapter V

Lesson 25	Preview words and dictate A B C (page 12 - 1st day)
Lesson 26	A B C (page 12 - 2nd day)
Lesson 27	A B C (page 12 - 3rd day)
Lesson 28	A B C (page 13 - 4th day)
Lesson 29	A B C (page 15 - 1st day)
Lesson 30	A B C (page 15 - 2nd day)

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From this point on the tests will be transcribed on the typewriters. Instruction should be given as to how this is to be done. On the theory tests, the transcription should be typed in the space provided on the form. On the transcription tests, the transcription should be typed at the bottom of the paper on which the test has been duplicated. Brief form tests should be taken on the forms that have been duplicated for the theory tests.

Test on Chapter V
- Duplicated test on theory (50 words)
- Duplicated test for transcription (a paragraph from the chapter)
- Brief Form test (25 words)

Chapter VI

Begin word lists with this chapter. Dictate 10 to 25 words at the beginning of the class. These words should be taken from the previous lesson. Allow from one minute to two minutes for transcription. Transcription will be by hand unless dictation is given at the typewriter.

Lesson 31	Preview words and dictate A B C (page 16 - 3rd day)
Lesson 32	Introduce punctuation (commas) A B C (page 16 - 4th day) Word list (10 words) from Lesson 31
Lesson 33	Word list (10 words) from Lesson 32 A B C (Page 19 - 1st day)
Lesson 34	Word list (10 words) from Lesson 33 A B C (page 19 - 2nd day)
Lesson 35	Word list (10 words) from Lesson 34 A B C (pages 19 & 20 - 3rd day)
Lesson 36	Word list (10 words) from Lesson 35 A B C (page 20 - 4th day)

Test on Chapter VI
- Duplicated test on theory (50 words)
- Duplicated test for transcription (a paragraph from the chapter)
- Brief Form test (25 words)

Chapter VII

Lesson 37	Preview words and dictate A B C (page 23 - 1st day)
Lesson 38	Word list (10 words) from Lesson 37 A B C (page 24 - 2nd day)
Lesson 39	Word list (10 words) from Lesson 38 A B C (24 - 3rd day)
Lesson 40	Word list (10 words) from Lesson 39 A B C (pages 24 & 25 - 4th day)
Lesson 41	Word list (10 words) from Lesson 40 A B C (page 28 - 1st day)
Lesson 42	Word list (15 words) from Lesson 41 A B C (page 28 - 2nd day)

16041

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IX. CHASSIS

MILESTONE: III. FRONT SUSPENSION

PERFORMANCE OBJECTIVE NO: 3 TITLE: Alignment

CONDITIONS:

Student will learn related information listed below

LEARN	REFERENCE	SOURCE
1. Aligning front end	1. Automotive Chassis and Body, by Crouse. pp. 228 through 262 Automotive Chassis Workbook, by Crouse. Job 17	1. Related Information Class
2. Front end alignment	2. Teaching Machine card 17B	2. Teaching Machine (Shop)

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Test on Chapter VII
Duplicated test on theory (50 words)
Duplicated test for transcription (a paragraph from the chapter)
Brief Form test (50 words) Allow ten minutes for transcription.

Chapter VIII

Lesson 43	Preview words and dictate A B C (page 28 - 3rd day)
Lesson 44	Word list (15 words) from Lesson 43 A B C (page 29 - 4th day)
Lesson 45	Word list (15 words) from Lesson 44 A B C (page 33 - 1st day)
Lesson 46	Word list (15 words) from Lesson 45 A B C (page 33 - 2nd day)
Lesson 47	Word List (15 words) from Lesson 46 A B C (page 34 - 3rd day)
Lesson 48	Word list (15 words) from Lesson 47 A B C (page 34 - 4th day)

Test on Chapter VIII
Duplicated test on theory (50 words)
Duplicated test for transcription (a paragraph from the chapter)
Brief Form test (50 words) Allow 10 minutes for transcription

At this point the student may begin to take 100-word theory tests. At least one of these tests must be passed with 80% accuracy or above to complete the requirements for the semester's work. Just the transcription is to be checked; however, a misspelled word is counted as an error. Students are allowed to use their dictionaries.

Chapter IX

Tapes are introduced at this point. Students are to spend at least 10 minutes during the class period to take dictation from tapes. These are to be speed-development tapes. The students should be encouraged to take the speed that is a little higher than the one they can take comfortably to push their speed up.

The lessons in Chapter IX do not have to be introduced individually inasmuch as they are review. Brief forms and their derivatives are reviewed. Students should complete the assignments in this chapter on their own.

Test on Chapter IX
Dictate letter from chapter at 40 words per minute. Two points off for each error. Spelling is counted as an error.
Brief Form and derivative test (50 words) Allow 10 minutes for transcription.

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Chapter X

There is no test for this chapter. The students are to complete the assignments as instructed on their chapter guide sheet.

At this point if the student has already completed the semester's requirements for transcription from homework notes, it is not necessary that he transcribe the following paragraphs. Each lesson, however, should be completed as a homework assignment.

Lesson 57 - 502, 499
Lesson 58 - 508, 509
Lesson 59 - 514, 515
Lesson 60 - 520, 521
Lesson 61 - 524, 527
Lesson 62 - 530, 534
Lesson 63 - 541, 542
Lesson 64 - 548
Lesson 65 - 554
Lesson 66 - 558, 561
Lesson 67 - 568
Lesson 68 - 574
Lesson 69 - 580

Each student must pass a 100-word theory test with at least 80 per cent accuracy to complete the first semester's requirements.

16043

GENERAL INSTRUCTIONS FOR SHORTHAND I AND II

Supplies

Each student should have the following supplies for his own use at all times:

1. Pen (this need not be an expensive fountain pen--a good ballpoint is sufficient.)
2. Pencil (you should have one with you at all times to use as a spare in case your pen does not write). A pencil will also be used for checking your work and for certain markings.
3. Typing paper (carbon paper will be supplied for you). Have your own.
4. Typing eraser--be sure to have your own. There will be no borrowing of erasers.
5. Shorthand notebooks (one for homework, and one for classroom work).
6. Dictionary (each student must have his own dictionary). This need not be expensive. A paperback edition which costs about 50 cents is very good for your use in class.
7. A folder in which to keep your type paper and assignments. A folder with side pockets is good because it helps keep your papers and work organized.
8. Your textbooks will be furnished. Take good care of them because you will be responsible for them. If they are lost, you will be required to pay for them, and if they are damaged in any way, you will have to pay the cost of repair.
9. Mark all of your own supplies with your name in case you leave them in the classroom. With your name on them they could be returned to you.

Instructions on the Use of Notebooks

1. Keep two notebooks--one for classroom dictation, and the other for homework lessons. Bring both notebooks to class with you each day.
2. In your homework notebook, make certain that you identify each lesson. Also, circle the number of each paragraph as you copy your lesson. This is necessary for reference when you are called upon to transcribe or read from your homework notes.

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3. When writing in your notebooks, be sure to go completely through the book on one side of the paper, then turn your notebook over and go completely through it on the other side of the paper. In this way you do not waste paper and it saves time during dictation. When the notebook is filled, keep it for at least one week before throwing it away. You may be called upon to transcribe from your notes that have been written two or three days previously.

4. Keep your notebooks in a definite place on your desk. Then you will be ready to take dictation at a moment's notice, assuming, of course, that you keep a pen and pencil with your notebook at all times.

5. Keep a rubber band around the <u>used</u> portion of your notebook.

6. Place the date and lesson number at the bottom of the first page of the day's dictation or homework lesson.

7. Draw a line through each letter as soon as you transcribe it.

8. When you are interrupted in transcribing a letter, mark your place with a pencil.

9. Leave a space at the beginning of each letter dictated for mailable transcription for special instructions such as mailing directions, multiple carbons, and so on.

10. Write out unfamiliar names in longhand. (Do not do this when taking "takes.")

11. When the boss (or teacher) is interrupted during dictation, use the time to read your shorthand notes, improving outlines and inserting punctuation.

12. Indicate the end of each item in some way such as by a wavy line.

13. When it is necessary to take dictation on loose paper, fasten the notes in the proper place in the notebook for later reference.

14. Learn to turn pages in your notebook while taking rapid dictation.

<u>Timed Writings</u>

Timed writings will be given at least once a week as a class to measure your typing speed and accuracy. Additional timed writings will be given individually as requested.

Your papers should be set up as follows:

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1. Type the following in the upper left corner of your paper:*

*(Shorthand I Students)	*(Shorthand II Students)
Name	Name
Type and Transcription	Shorthand II
Semester 1 or 2	Semester 1 or 2
Timed Writings	Timed Writings

2. Start your timed writing about an inch and an half from the top of your paper.

3. Set your machine for double spacing, 70-space line unless given other instructions by your teacher.

4. Record your words per minute and number of errors at the top of your paper in this manner: 55/4

5. To pass a timed writing, you must not have more than one error per minute.

6. Circle the entire word where an error appears.

7. Hand in "passing" timed writings only. A certain number (shown on your instruction sheets) will be required each semester.

Tapes

Tapes at various speeds are available to help you increase your speed in taking dictation. Regular dictation practice is necessary. You should allow yourself at least 10 minutes a day for dictation.

You will each be given a set of ear cushions for your own use. These should be kept in an envelope, stapled to your folder so that you will have them when you need them. If you lose them, you will be charged twenty cents for a new set. You must use your own set always.

All of the equipment involved in using taped material is expensive. If you are careless with this equipment, it might throw the entire system out and penalize all of the students until repairs are made. Please use the equipment with care.

If at any time your set does not work properly, be sure to report the trouble to your teacher immediately.

Dial the channel for the speed that will help you the most. You should practice at a speed that is a little beyond your ability to write at that time.

Brief Forms

It is necessary for you to know how to write brief forms without

hesitation. Brief forms are words that are used often and have an abbreviated way of writing them. If you do not know these, you will have to write them out according to sound and this, of course, would take too much time. Learn your brief forms well. They are introduced in small groups to enable you to memorize them. You should review brief forms often throughout your study of shorthand to help you increase your ability to take dictation.

One way to help you automatize your writing of brief forms is suggested by Charles Swen, a champion shorthand writer. As a list of brief forms is presented, you take a piece of paper and copy the brief forms in one column. Then transcribe the brief forms by writing the transcription along side the shorthand symbol. After doing this, fold the paper under so that the shorthand forms do not show and then write new shorthand forms along side the longhand transcription. Next, fold the longhand words under and transcribe the shorthand forms. Continue this process until you have used the entire sheet. By the time you have written the brief forms and transcribed them a number of times you will have learned them.

When brief form tests are given, they will be dictated "live" or on tape. The special form to use for these tests will be provided. Transcription will be done on the typewriter. On brief form tests, both the shorthand forms and the transcription will be checked.

Word Lists

Word lists are used as a daily homework theory check. Fifteen to twenty-five words will be dictated by your teacher and should be transcribed on your typewriter.

Type your name in the upper left corner of your paper. Set your machine for double spacing, and set your left margin at 15. Words should be typed one under another in a column. If you cannot transcribe a word, leave the space--you may be able to transcribe it after you have completed the list. If you misspell a word while transcribing, do not erase or "x" out the mistake, just use the space bar and space once and retype the word correctly. You will be timed on your transcription and so you do not want to waste any time. Misspelled words will be counted as errors.

Always have a piece of paper in your machine with your name typed in the upper left corner.

Theory Tests

Tests will be given to test your knowledge of shorthand theory at the end of each chapter. The tests may be transcription from shorthand plates, "live" dictation, or "taped" dictation.

When taking a theory word test from "live" dictation or from "tape" a special form will be provided. You will write the shorthand symbol

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as the words are dictated and then be given a time limit for transcription. The transcription should be typed next to the shorthand form. Care should be taken in transcribing these words inasmuch as a misspelled word is counted as an error.

When a 100-word theory test is given, you will need two of the provided forms. These sheets should be stapled together before handing them in, and your name should appear on each page.

Takes

"Takes," three-minute timed dictation at various speeds, will be given at least once a week to help you measure your progress.

The material will be unpreviewed and will be dictated "live" or on tape. You will be allowed twenty minutes to transcribe and the transcription will be on the typewriter.

These "takes" are given to measure your ability to take dictation at a certain speed. Ninety-five per cent accuracy is required to pass a "take." A record of your achievement will be posted on the bulletin board, and you will be required to pass three takes at a certain speed before moving on to the next speed. Each "take" that is transcribed should be handed in to be recorded regardless of whether it is "passing" or not. A record will be kept of the number of errors made so that you will be able to see your progress. Word for word transcription will be required.

Directions for Transcribing "Takes"

1. Type your name, and the speed of your "take" in the upper left corner of your paper.

2. Use a 70-space line with five spaces for paragraph indention.

3. Set your machine for double spacing.

4. Type the salutation on one line followed with a colon:

5. Type the complimentary closing on a separate line followed with a comma. Start the closing at 50.

6. Erasers may be used for corrections.

7. When transcribing, if there is an outline you cannot transcribe at the time, leave a space. When you have completed the transcribing of the letter, if you can fill in the work or words that have been omitted, use the blank space that you have left. If you did not leave enough space for the word or words that were omitted, use the blank space between lines for the insertion.

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Name _____

1	26
2	27
3	28
4	29
5	30
6	31
7	32
8	33
9	34
10	35
11	36
12	37
13	38
14	39
15	40
16	41
17	42
18	43
19	44
20	45
21	46
22	47
23	48
24	49
25	50

16049

SHORTHAND I
(First Semester)

BEHAVIORAL OBJECTIVE

At the end of the first semester:

1. The student will have completed the theory of Gregg shorthand and be able to pass a theory test consisting of 100 words with at least 80% accuracy. The words will be dictated in no more than 10 minutes and should have been transcribed in 20 minutes. Words transcribed incorrectly and misspelled words will be counted as errors. Only the transcription will be checked. The words used will cover all phases of shorthand theory.

2. The student will be able to pass a 50-word brief form test with 95% accuracy. The words will be dictated at the rate of one every 1 1/2 seconds and transcribed with a 10-minute time limit. Shorthand and transcription will be checked--each will be worth one point. Misspelled words will be counted as errors.

3. The student will be able to transcribe, on the typewriter, paragraphs from homework notes. She should be able to transcribe each shorthand outline accurately. The transcription should be set up on type paper using a 60- or 70-space line with double spacing and indented paragraphs. Transcription from homework notes will consist of one letter. A maximum or three errors an assignment will be allowed to pass. A minimum or ten transcriptions will be required.

4. The student will be able to transcribe a theory test at the completion of each chapter. This test will consist of 50 words taken from each chapter. Eighty percent accuracy will be required to pass. There will be a 20-minute time limit. The student also will be able to transcribe a paragraph (or letter) from each chapter. Eighty per cent accuracy will be required to pass in a 20-minute time period.

5. The student will be able to read from shorthand plates in the book without hesitation on studied material. She should be able to read new words through spelling the shorthand form using the shorthand alphabet.

6. The student will be able to take dictation at 40 words per minute for three minutes on new, unpreviewed material and transcribe the dictation with 95% accuracy in a time limit of 20 minutes. Actual word for word transcription will be required.

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CHAPTER I

Objective: The student will be able to spell and read aloud without hesitation to the teacher the words of the recall chart in Lesson 6, Chapter I. The student will then be able to transcribe a 50-word test including words, brief forms, and phrases with a maximum of ten errors in 20 minutes. The student will also be able to transcribe a paragraph chosen by the teacher from practiced material in Lesson 6 with a maximum of ten errors.

The teacher will present on the board the shorthand alphabet letters presented in Lesson 1 and the punctuation marks. You will spell and read aloud as the teacher presents.

Assignment I. Spell and read aloud to yourself all words in lesson 1 at least three times. Cover the longhand with your hand or paper while you read the shorthand characters. You must be able to read page 20 without hesitation.

The teacher will review the alphabet strokes of Lesson 1 on the board, having you spell and read aloud. She will review all of Lesson 1 with you and the other students reading in concert. The teacher will then present the new strokes of Lesson 2 on the board, having you spell and read aloud.

Assignment 2. Spell and read aloud Lesson 1 and 2, covering the longhand. Be able to read page 23 without hesitation.

The teacher will review all alphabet strokes learned so far on the board. The first brief forms will be presented and an explanation given about them. The new alphabet strokes in Lesson 3 will be presented on the board with you spelling and reading from the board.

Assignment 3. Sight read brief forms three times, covering up the longhand with a piece of paper. Spell and read aloud three times all of the words in Lesson 3. Spell and read all of the connected matter in Lesson 3 three times or until it can be read without hesitation.

A complete review and drill of Lessons 1, 2, and 3 will be given by the teacher with you participating.

Assignment 4. Spell and read all words and all connected matter in Lessons 1, 2, and 3. You must be able to sight read the brief forms on page 24 without hesitation.

The teacher will review and drill all alphabet strokes learned thus far. The new strokes of Lesson 4 will be presented on the board to you.

Assignment 5. Spell and read three times all theory in Lesson 4, covering up the longhand. Read all the sentences aloud in the reading practice, spelling out each outline that you cannot read immediately. Do this until you can read these sentences without hesitation.

16051

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IX. CHASSIS

MILESTONE: III. FRONT SUSPENSION

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Alignment

CONDITIONS:

This assignment will be performed on a complete automobile, using a drive-on type aligning equipment.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Obtain instruction manual on equipment to be used
5. Select proper tools and materials
6. Set camber following all steps as outlined in the manual
7. Set caster following all steps as outlined in the manual
8. Set toe end following all steps as outlined in the manual
9. Recheck all settings and if they are satisfactory, return tools and materials to proper place
10. Return automobile to proper parking area
11. Remove front seat covers and store in proper place
12. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily align the front suspension in 3 hours.

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Learning time: 7 hours

The teacher will review and drill all shorthand strokes and brief forms learned thus far. The new strokes and brief forms in Lesson 5 will be presented to you.

Assignment 6. Spell and read three times all theory in Lesson 5 covering up the longhand. Memorize the brief forms in paragraph 27 until you can sight read them without hesitation. Read all of the reading practice aloud in Lesson 5 until you can read without hesitation. Spell out each outline you cannot read immediately.

The teacher will review and drill all strokes and brief forms learned thus far. Rules in Lesson 6 will be discussed and a presentation of the recall chart, No 39 will be given. The teacher will introduce writing.

Assignment 7. Write all theory (words) three times each that have been presented in Lessons 1 through 5. Spell and read aloud all words in the recall chart, page 38, and sight read brief forms and phrases. Read all the connected matter once. Hand your assignment to the teacher at the beginning of the next class.

The teacher will review the recall chart in Lesson 6 and the reading practice.

Assignment 8. Write the recall chart, page 38, (words, brief forms, and phrases) each once and transcribe them on longhand. Be able to read all the reading practice in Lesson 6 without hesitation. Hand in your assignment. Be prepared for a test on Lesson 6.

At this point a test will be given to you on Lesson 6, consisting of theory vocabulary transcription and paragraph transcription.

If you were able to pass this test in 20 minutes with no more than ten errors, you are ready to proceed with Chapter II.

16052

Shorthand I
(First Semester)

CHAPTER II

Objective: The student will be able to transcribe 50 words taken from the brief forms, words, phrases and amounts of the recall chart in Lesson 12 with a maximum of 10 errors in 30 minutes. The student will also be able to transcribe a paragraph chosen by the teacher from Lesson 13 with a maximum of ten errors in 20 minutes. The student will also be able to pass a brief form test on all brief forms covered up to Lesson 13 with 95% accuracy in five minutes.

The teacher will introduce Chapter II and Lesson 7. She will present the new theory and discuss the business vocabulary terms.

Assignment:

1. Spell and read the theory. Write the theory at least three times or until you can write it without looking at the book.

2. Read all of the reading and writing practice. If you come to a word you cannot read, spell it in shorthand. If you still cannot read it, write the word on a piece of paper. When you have completed this reading, check with the teacher for the meaning of the words you cannot read.

3. Copy #48 and #52. (Keep in mind that while you are copying this shorthand you should be able to read your own notes.)

When you have completed Lesson 7, have the teacher check your notebook. She will test you to know how well you know this material.

The teacher will introduce Lesson 8. She will present the new theory and the new brief forms. She will also discuss and explain #56, Business Vocabulary Builder.

Assignment:

1. Spell and read the theory. Write all of the theory at least three times or until you can write it without looking at the book. Sight read the brief forms. Learn the brief forms so that you can say them and write them without hesitation.

2. Read all of the reading and writing practice. If you come to a word you cannot read or spell out in shorthand, write it on a piece of paper. When you complete this lesson, ask the teacher for the meanings of the outlines you cannot read.

3. Copy #57, 58, 59, 60, and 61 of Lesson 8.

When you have completed this lesson, have your teacher check your notebook. She will test you as to how well you know this material.

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The teacher will review and dictate the brief forms. She will also review and dictate some material from Lesson 8. The theory of Lesson 9 will be presented to you.

Assignment:

1. Write the theory at least three times or until you can write it without looking at the book.

2. Review the Business Vocabulary Builder, #66.

3. Spell and read all of the reading and writing practice. Remember and follow the previous instructions on words you cannot immediately spell and read.

4. Copy #67,68,69, and 70.

5. Be prepared at any time to read to your teacher from this lesson or any previous lesson.

6. Practice and know how to write the following words.

day he me go ship

When you have completed this lesson, check with your teacher.

The teacher will review the theory of Lesson 9. She will present the theory of Lesson 10. Some new matter dictation will be introduced to you at this time.

Assignment:

1. Write the theory at least three times or until you can write it without looking at the book.

2. Review the Business Vocabulary Builder, #74.

3. Spell and read all of the reading and writing practice. Any words you cannot immediately spell and read, write them on a piece of paper.

4. Copy #75,76,77,78, and 79.

5. Be prepared at any time to read to your teacher any material from this lesson or any previous lesson.

6. Practice and know how to write the following words:

day Ray open I will be to go will not be he

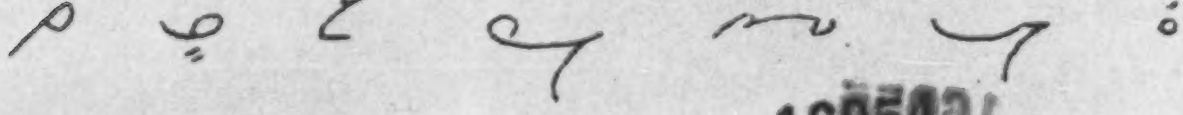

160541

ship store right he will not have I am going

will not be it will be

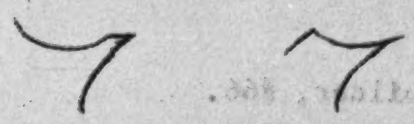

The teacher will review some material from Lesson 10. Brief forms will also be reviewed. The theory of Lesson 11 will be presented to you. The new brief forms will be introduced. The teacher will dictate from a paragraph from lesson 10 and also dictate some new matter dictation.

Assignment;

1. Write the theory at least three times or until you can write it without hesitation.

2. Review the Business Vocabulary Builder, #85.

3. Read all of the reading and writing practice.

4. Copy #86, 87, 88, and 89.

5. Be prepared at any time to read to your teacher from any material presented up to this time.

6. Be able to write the following words:

data day team need sailing here or go

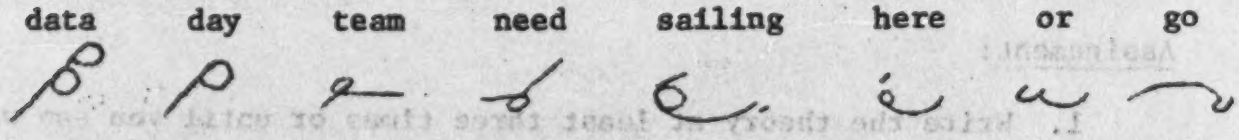

The teacher will review and dictate the brief forms to you. Dictation from a paragraph in Lesson 11 will be given. Lesson 13 will be introduced. New matter dictation will be given.

Assignment:

1. Read #95, Recall Chart. Write each shorthand outline once and transcribe it into longhand at the side of the shorthand outline.

2. Read all of the reading and writing practice.

3. Copy #97, 98, 99, and 100.

4. Review the Business Vocabulary Builder, #96.

5. Be prepared for a test on Lesson 13 and also a test on all brief forms covered up to this time.

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At this point a test will be given to you on Lesson 12 consisting of theory vocabulary transcription and connected matter. A brief form test will also be given at this time. The brief form test will be dictated and both shorthand outline and transcription will be checked.

If you were able to pass the theory vocabulary transcription in 20 minutes with no more than 10 errors, the transcription of the connected matter in 20 minutes with no more than 10 errors, and the brief form test with 95% accuracy in 5 minutes, you are ready to proceed with Chapter III.

16056

CHAPTER III

Objective: The student will be able to transcribe 50 words taken from the brief forms, words, phrases and amounts of the recall chart in Lesson 18 with a maximum of 10 errors in 30 minutes. The student will be able to transcribe some connected matter chosen by the teacher from Lesson 18 with a maximum of 10 errors in 20 minutes. The student will be able to take from dictation a brief form test of 25 words and transcribe it in 5 minutes with 95% accuracy.

The teacher will introduce Chapter III and Lesson 13. She will present the new theory and the brief forms. New Matter dictation will be given. Be able to write the following words:

Ray day May he will not be it will if you can

he go ship right please

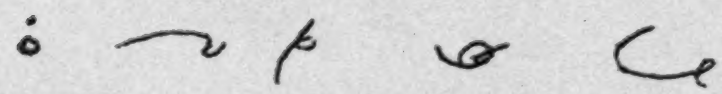

Assignment:

1. Write all of the theory at least three times or until you can write it without looking at the book. Memorize the brief forms so that you can write them without hesitation.

2. Review the business Vocabulary Builder, #104.

3. Read all the reading and writing practice. Spell any words that you cannot immediately sight read. Write the words you cannot spell and read on a piece of paper.

4. Copy #105, 106, 107, 108, 109, and 110.

Be prepared to read to your teacher at any time from this lesson or any previous lesson.

5. Practice and know how to write the following:

day May 5 o'clock or before it will not be

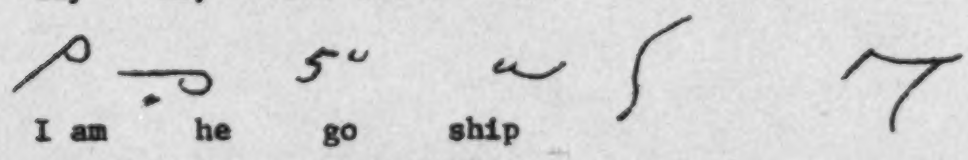

I am he go ship

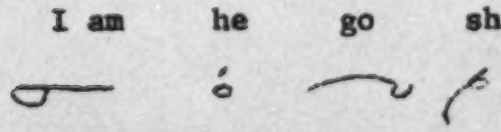

The teacher will review and dictate brief forms to you. She will also review the theory of Lesson 13. Some dictation from your lesson may be given at this time. The teacher will present Lesson 14 and some new matter dictation will be given.

16028

16057

Assignment:

1. Write all theory at least three times or until you can write it without looking at the book.

2. Review the Business Vocabulary Builder, #115.

3. Read all of the reading and writing practice, spelling all words you cannot sight read.

4. Copy #116, 117, 118, and 119.

5. Transcribe #116.

6. Be prepared to read to your teacher any material covered up to the present time.

7. Practice and be able to write the following words:

May here get goods me Erie pay pleased

pleased my your letter you should have I desire

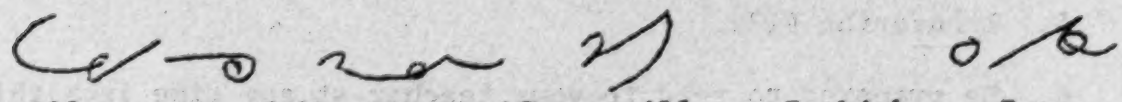

will you with your if you will I think I was

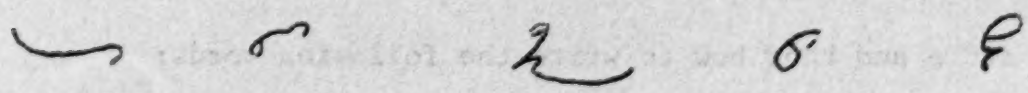

Hear from you by the write store end let bill

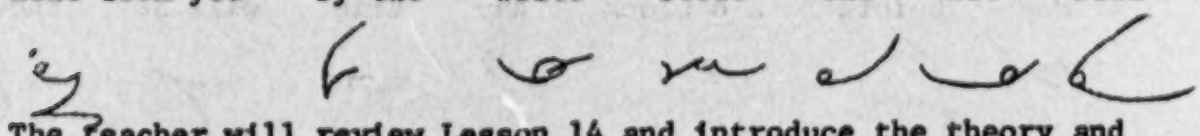

The teacher will review Lesson 14 and introduce the theory and brief forms presented in Lesson 15. New Matter dictation will be given.

Assignment:

1. Read all the theory and then write all the theory at least three times. Memorize the brief forms, #120, and be able to write them without hesitation when dictated.

2. Review the Business Vocabulary Builder, #124.

3. Read all of the reading and writing practice, spelling out the words you cannot immediately sight read.

4. Copy #125, 126, 127, and 128.

5. Transcribe #125.

16058

6. Be prepared to read to your teacher at any time.

7. Practice and know how to write the following words:

meeting me know my same day it will be to go

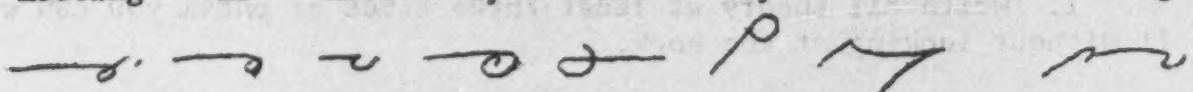

to the to be 3 o'clock let desire ship

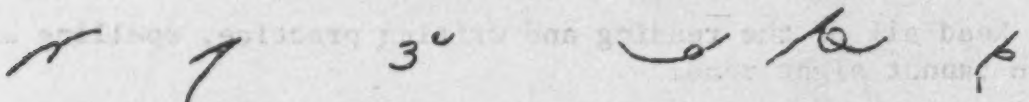

The teacher will review Lesson 15 and dictate the brief forms to you. She will also present Lesson 16. Some dictation from the book may be given and new matter dictation will be presented.

Assignment:

1. Read all the theory and write the theory at least three times.

2. Review the Business Vocabulary Builder, #133, and the Up and Down Check List on page 89.

3. Read all of the reading and writing practice.

4. Copy #134, 135, 136, and 137.

5. Transcribe #138.

6. Be prepared to read to your teacher at any time from this lesson or any previous lesson.

Practice and know how to write the following words:

May before 2 o'clock day Erie will be should be

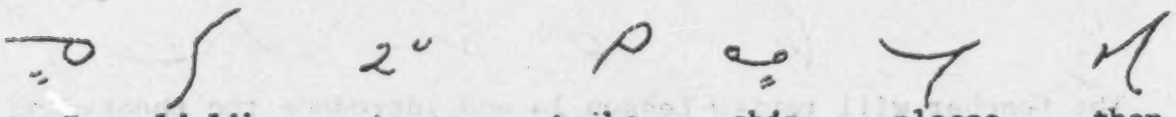

I would like to go to be ship please then

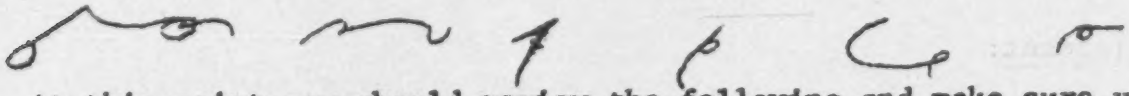

At this point you should review the following and make sure you know and can say them without hesitation.

Alphabet Sounds

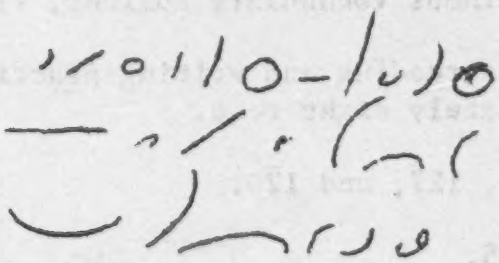

16059
16028

Word Endings

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Word Beginnings

re
be

The teacher will review Lesson 16 and present Lesson 17 to you. Some dictation will be given to you.

Assignment:

1. Read the theory and write the theory at least three times. Memorize the brief forms, #139, and be able to read and write them without hesitation when dictated.

2. Review #142, Business Vocabulary Builder.

3. Review #143, Similar-Words Drill. Read carefully the definitions and the illustrative sentences.

4. Read all of the reading and writing practice.

5. Copy #144, 145, 146, 147, 148, and 149.

6. Transcribe #144.

7. Be prepared to read to your teacher at any time.

8. Practice and know how to write the following words:

get rate pay cash data me Erie May you

you should have that will you like to pay I desire

I am going market all like desire then

The teacher will review Lesson 17 and introduce Lesoon 18 to you. Some dictation will be given to you both from the book and from new material.

16060

Assignment:

1. Read all of the Recall Chart, #154. Write each outline once and transcribe it in longhand at the side of the shorthand outline.

2. Read all of the reading and writing practice. Time yourself and determine your reading rate from the table on page 98.

3. Copy #156 and 157.

4. Review #155, Business Vocabulary Builder.

5. Be prepared for a test on Lesson 18 and also a test on all brief forms covered so far.

At this point a test will be given to you on Lesson 18, consisting of theory vocabulary transcription and connected matter transcription. A brief form test will also be given at this time. The brief form test will be dictated and both the shorthand outline and the transcription will be checked.

If you were able to pass the theory vocabulary transcription in 20 minutes with no more than 10 errors, the transcription of the connected matter in 20 minutes with no more than 10 errors, and the brief form test in 5 minutes with 95% accuracy, you are ready to proceed with Chapter IV.

16061

Shorthand I
(First Semester)

CHAPTER IV

Objective: The student will be able to transcribe 50 words taken from the words, brief forms, and phrases of the recall chart in Lesson 24 with a maximum or 10 errors in 20 minutes. The student will be able to transcribe some connected matter chosen by the teacher from Lesson 24 with a maximum of 10 errors in 20 minutes. The student will also be able to take from dictation a brief form test of 25 words and transcribe it in 5 minutes with 95% accuracy.

The teacher will introduce Chapter IV and Lesson 19 to you. She will present the new theory and brief forms. New Matter Dictation will be given. Practice and know how to write the following words:

case came 5 o'clock made home day people

settle letter desire

Assignment:

1. Read all the theory. Write all the theory at least three times. Memorize the brief forms so that you can write them and read them without hesitation.

2. Review #161, Business Vocabulary Builder.

3. Read all of the reading and writing practice.

4. Copy #162, 164, and 165.

5. Transcribe #162.

6. Be prepared to read to your teacher at any time.

Practice and know how to write the following words:

me Day May need 5 o'clock Erie to go

he will be able to see to have If you can hear from you

Dr... let letter please

The teacher will review Lesson 19 and present Lesson 20. Some dictation from Lesson 19 will be given and also some new matter dictation.

16063

16062

Assignment:

1. Write all of the theory at least three times.

2. Review the Business Vocabulary Builder, #172.

3. Read all of the reading and writing practice.

4. Copy #173, 174, 175, 176, and 177.

5. Transcribe #175.

6. Be prepared to read to your teacher at any time.

7. Practice and know how to write the following words:

help pay fee before plan I should like

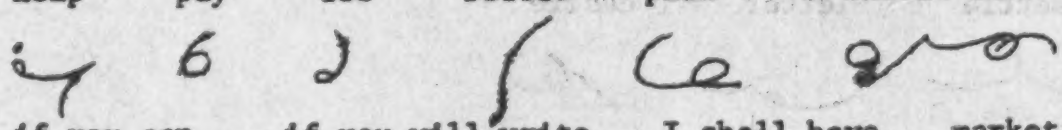

if you can if you will write I shall have market

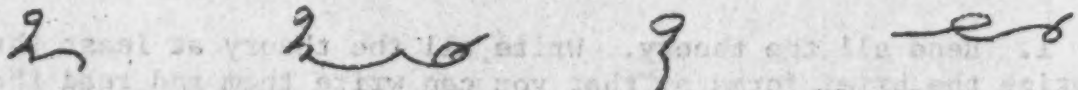

The teacher will review the theory of Lesson 20 and present Lesson 21. Some dictation from material in Lesson 20 will be given to you and some new matter dictation will be presented.

Assignment:

1. Read all of the theory and write the theory at least three times. Memorize the brief forms so that you can write them without hesitation when dictated.

2. Review the Business Vocabulary Builder, #182.

3. Copy #183, 184, 185, 186, and 187.

4. Transcribe #183.

5. Be prepared to read to your teacher at any time.

6. Practice and know how to write the following words:

meeting here people Dean late get begin

stay tea then all

The teacher will review the theory of Lesson 21. A review of all brief forms will be given and Lesson 22 will be presented. Some dictation will be given to you at this time.

16063

Assignment:

1. Read the theory and write all of the theory at least three times.

2. Review the Business Vocabulary Builder, #194, and the Proportion Check List on page 124.

3. Read all of the reading and writing practice.

4. Copy #195, 196, 197, and 198.

5. Transcribe #195.

6. Be prepared to read to your teacher at any time.

7. Practice and know how to write the following words.

January came doing thank you for your letter please

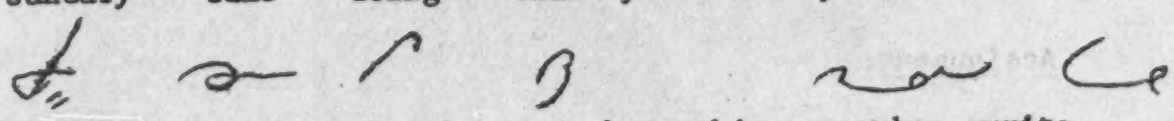

it will be there has been about this week write

necessary most matter long keep side market

The teacher will review the theory of Lesson 22 and present Lesson 23. Dictation from Lesson 22 will be given as well as new matter dictation.

Assignment:

1. Read all of the theory and write all the theory at least three times. Memorize the brief forms so that you can write them without hesitation when dictated.

2. Review #203, Business Vocabulary Builder, and #204, Similar-Words Drill.

3. Read all of the Reading and Writing Practice.

4. Copy #205, 206, 207, and 208.

5. Transcribe #205.

6. Review the Writing Tool Check List on the bottom of page 129.

7. Be prepared to read to your teacher at any time.

16064

8. Practice and know how to write the following words:

without fail Monday January November December

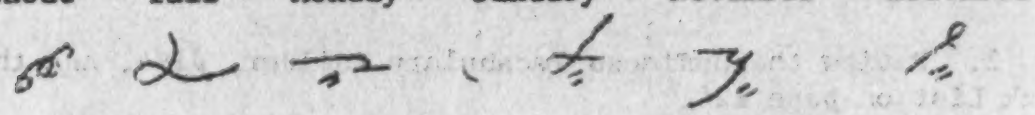

late taken care once help desire necessary

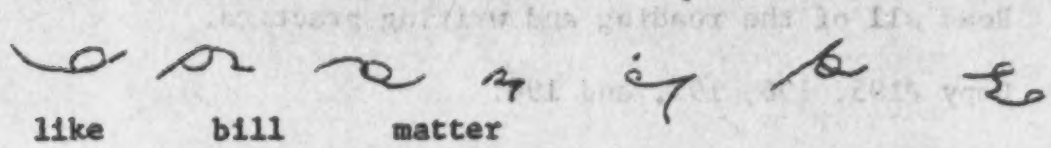

like bill matter

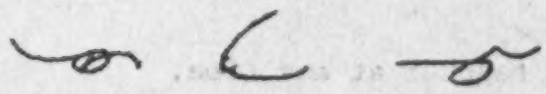

The teacher will review Lesson 23 and introduce lesson 24. A review of the brief forms will be given. Dictation from Lesson 23 will be given as well as some new matter dictation.

Assignment:

1. Read the Accuracy Practice and do the practice drills #209 and 210.

2. Read all of the Recall Chart #211. Write each outline once and transcribe it in longhand at the side of the shorthand outline.

3. Read all of the Reading and Writing Practice.

4. Copy #213 and 214.

5. Review the Business Vocabulary Builder, #212.

6. Be prepared for a test on Lesson 24 and also a test on all brief forms covered so far.

At this point a test will be given to you on Lesson 24, consisting of theory vocabulary transcription and connected matter transcription. A brief form test will also be given at this time. The brief form test will be dictated and both the shorthand outline and the transcription will be checked.

If you were able to pass the theory vocabulary transcription in 20 minutes with no more than 10 errors, the transcription of the connected matter in 20 minutes with not more than 10 errors, and the brief form test in five minutes with 95% accuracy, you are ready to proceed with Chapter V.

16065 16064

Shorthand I
(First Semester)

CHAPTER V

Objective: The student will be able to transcribe on the typewriter 50 words taken from the brief forms and words of the recall chart in Lesson 30 with a maximum or ten errors in 20 minutes. The student will be able to transcribe on the typewriter some connected matter chosen by the teacher from Chapter V with a maximum of ten errors in 20 minutes. The student will also be able to take from dictation a brief form test of 25 words and transcribe it in five minutes with 95% accuracy.

The teacher will introduce Chapter V and Lesson 25 to you. She will present the new theory and brief forms. Some new matter dictation will be given. Practice and know how to write the following words.

head know store did market desires all

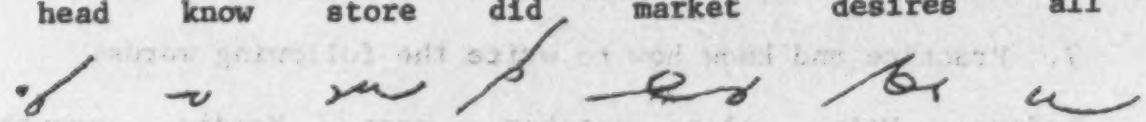

write letter like

Assignment:

1. Read all of the theory. Write all of the theory at least three times. Memorize the brief forms so that you can read them without hesitation and write them from dictation without hesitation.

2. Review #218, Business Vocabulary Builder.

3. Read all of the reading and writing practice.

4 Copy #219,220, and 221. Be sure that you can read your own shorthand notes.

5. Transcribe #219.

6. Be prepared to read to your teacher at any time.

7. Practice and know how to write the following words:

Erie meeting come most long letter date

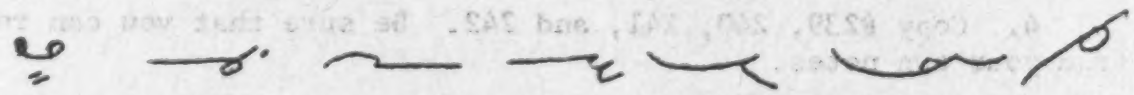

believe all like

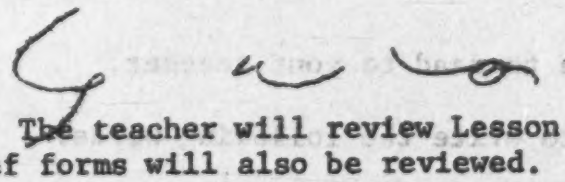

The teacher will review Lesson 25 and present Lesson 26 to you. The brief forms will also be reviewed. Dictation from Lesson 25 will be given and also some new matter dictation.

16066

Assignment:

1. Write all of the theory at least three times.

2. Review the Business Vocabulary Builder, #228.

3. Read all of the reading and writing practice.

4. Copy #229, 230, 231, 232, and 233. Be sure you can read your own notes.

5. Transcribe #232.

6. Be prepared to read to your teacher at any time.

7. Practice and know how to write the following words:

before Main plans taken care Monday property

desire matter office more week enable

individual let want matter unable

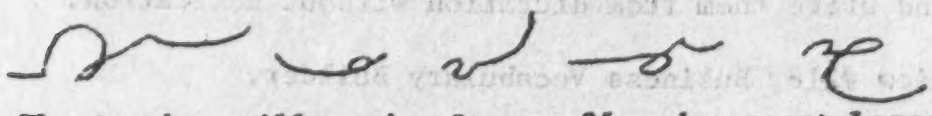

The teacher will review Lesson 26 and present Lesson 27. The new brief forms will be introduced. Some dictation from Lesson 26 will be given and also some new matter dictation.

Assignment:

1. Write all the theory at least three times. Memorize the brief forms and be able to read and write them without hesitation.

2. Review the Business Vocabulary Builder, #238.

3. Read all of the reading and writing practice.

4. Copy #239, 240, 241, and 242. Be sure that you can read from your own notes.

5. Transcribe #239.

6. Be prepared at any time to read to your teacher.

7. Practice and know how to write the following words:

October November paid things $10 do before

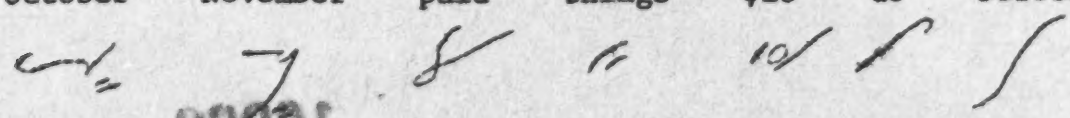

16067

if you can we have to keep this matter please

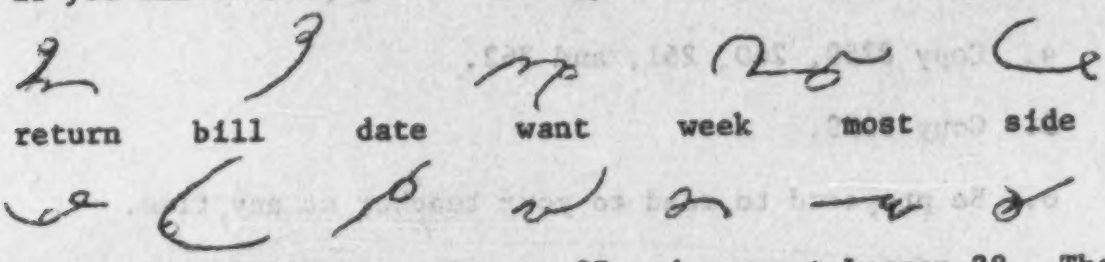

return bill date want week most side

The teacher will review Lesson 27 and present Lesson 28. The brief forms of Lesson 27 will also be reviewed. Some dictation from Lesson 27 will be given and also some new matter dictation.

Assignment:

1. Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #248.

3. Read all of the reading and writing practice.

4. Copy #249, 250, 251, and 252.

5. Transcribe #250.

6. Be prepared to read to your teacher at any time.

7. Practice and know how to write the following words:

know Main Saturday February money $5,000

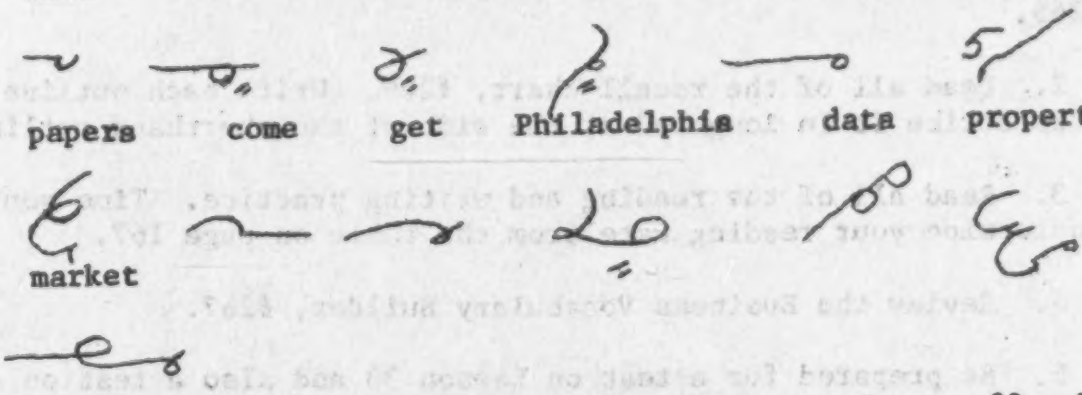

papers come get Philadelphia data property

market

The teacher will review Lesson 28 and present Lesson 29. New brief forms will also be presented. Dictation from Lesson 28 will be given and also some new matter dictation.

Assignment:

1. Write all of the theory at least three times. Memorize the brief forms so that you can read and write them without hesitation.

2. Review the Business Vocabulary Builder, #257, and the Similar-Words Drill, #258.

16068

3. Read all of the reading and writing practice.

4. Copy #259, 260, 261, and 262.

5. Copy #259.

6. Be prepared to read to your teacher at any time.

7. Practice and know how to write the following words:

told overdue since step action cash once

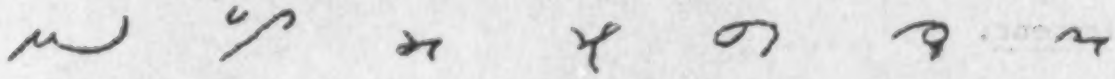

items fail plans summer usual necessary

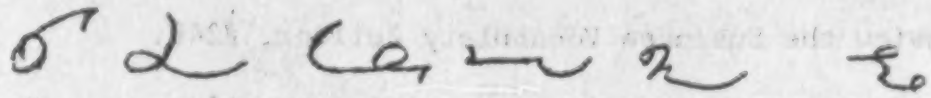

sale remittance

The teacher will review Lesson 29 and present Lesson 30. She will also review the brief forms. Some dictation from Lesson 29 will be given and also some new matter dictation.

Assignment:

1. Read the Accuracy Practice and do the accuracy drills #262, 264, and 265.

2. Read all of the recall chart, #266. Write each outline once and transcribe it in longhand at the side of the shorthand outline.

3. Read all of the reading and writing practice. Time yourself and determine your reading rate from the table on page 167.

4. Review the Business Vocabulary Builder, #267.

5. Be prepared for a test on Lesson 30 and also a test on all brief forms covered so far.

At this point a test will be given to you on Chapter V, consisting of theory vocabulary transcription and connected matter transcription. A brief form test will also be given at this time. The brief form test will be dictated and both the shorthand outline and the transcription will be checked.

If you were able to pass the theory vocabulary transcription in 20 minutes with no more than 10 errors, the transcription of the connected matter in 20 minutes with no more than 10 errors, and the brief form test in five minutes with 95% accuracy, you are ready to proceed with Chapter VI.

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Shorthand I
(First Semester)

CHAPTER VI

Objective: The student will be able to transcribe 50 words taken from the brief forms, words, and phrases in Lesson 36 with a maximum of 10 errors in 20 minutes. The student will be able to transcribe some connected matter chosen by the teacher from Chapter VI with a maximum of 10 errors in 20 minutes. The student will also be able to take from dictation a brief form test of 25 words and transcribe it in five minutes with 95% accuracy.

From this point on, you should be prepared each day to take from dictation 10 to 25 words that have been selected from your lesson. These words will be taken from the theory and also from the reading and writing practice. These words will be dictated in no more than 45 seconds and must be transcribed in no more than a minute and a half to two minutes.

The teacher will introduce Chapter VI and Lesson 31 to you. She will present the new theory and new brief forms. Some new matter dictation will be given. Practice and know how to write the following words:

Philadelphia	sale	form	30 per cent	off	decide

coats	suits	dresses	office

Assignment:

1. Copy all of the theory at least three times. Memorize the brief forms so that you can read and write them without hesitation.

2. Review thoroughly the Punctuation Practice, #272. Find the errors in the letter on page 173 and make sure that you insert and encircle all commas in your shorthand notes just as they are in the textbook.

3. Review the Business Vocabulary Builder, #273.

4. Read all of the Reading and Writing Practice.

5. Copy #274, 275, 276, and 277.

6. Transcribe #274.

7. Be prepared to read to your teacher at any time.

8. Practice and know how to write the following words:

December	sets	books	received	anything	help

16070

231 OF 327

ED

056 238

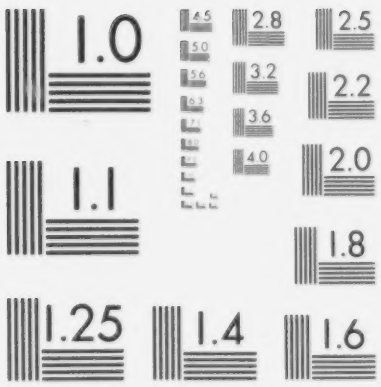

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: IX. CHASSIS

MILESTONE: IV. WHEELS, HUBS, AND DRUMS

PERFORMANCE OBJECTIVE NO.: 4 TITLE: Changing Tires

CONDITIONS:

This assignment will be performed on a tubeless tire and wheel obtained from the parts storage room.

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Obtain a tire and wheel from the parts storage room
2. Select proper manual and turn to appropiate chapter
3. Select proper tools and materials
4. Mount tire and wheel on tire changer following all steps as outlined in the manual
5. Remove tire from wheel following all steps as outlined in the manual
6. Perform all tests and checks as outlined in the manual
7. Mount tire on wheel following steps as outlined in manual
8. Inflate tire to proper pressure and perform leakage checks and tests
9. If all checks and tests are satisfactory, deflate tire and return tire and wheel to storage room
10. Return tools and materials to proper place
11. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove, test, and replace tire on wheel in 30 minutes.

Learning time: 2 hours

1602

January sale town come Main store off

pass in which has been if there is we can do we

we will have in this we would like will be if you can

individual

The teacher will review Lesson 31 and give a review of the new brief forms learned. She will present Lesson 32. Some dictation from Lesson 31 will be given as well as some new matter dictation.

Assignment:

1. Copy the theory at least three times.

2. Review the Business Vocabulary Builder, #282.

3. Review #283, Punctuation Practice, and make sure you know the meaning of apposition.

4. Read all of the reading and writing practice.

5. Copy #284.

7. Review the personal-use check list on page 184.

8. Practice and know how to write the following words:

records just enough wool April booklet number

visit credit arranged purchases

The teacher will review Lesson 32 and present Lesson 33. Some new brief forms will be presented. Some dictation will be given from Lesson 32 plus some new matter dictation.

231 16071 16070

Assignment:

1. Write the theory at least three times. Memorize the brief forms so that you can read and write them without hesitation.

2. Review the Business Vocabulary Builder, #293.

3. Review the Punctuation Practice, #294. Be sure you understand how to place commas in a series.

4. Read all of the reading and writing practice.

5. Copy #295, 296, 297, and 298.

6. Transcribe #295.

7. Practice and know how to write the following words:

June July unsatisfactory away up difference

missed meaning my given mine considered

The teacher will review Lesson 33 and present Lesson 34. She will also give a quick review of the new brief forms. Some dictation from Lesson 33 will be given as well as some new matter dictation.

Assignment:

1. Copy all the theory at least three times.

2. Review the Business Vocabulary Builder, #303.

3. Read all of the reading and writing practice.

4. Transcribe #304.

5. Practice and know how to write the following words:

list since received look into fill better

soon grade

The teacher will review Lesson 34 and introduce Lesson 35. Some dictation from Lesson 34 will be given as well as some new matter dictation.

Assignment:

1. Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #311.

3. Review the Similar-Words Drill #312.

4. Read all fo the Reading and Writing Practice.

5. Copy #313, 314, 315, and 316.

6. Transcribe #313.

7. Review the Shorthand Notebook Check List on the bottom of page 199.

8. Practice and know how to write the following words:

received come days delay unsatisfactory money

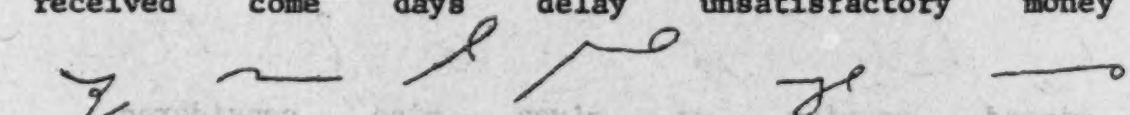

back details will you has not been I have

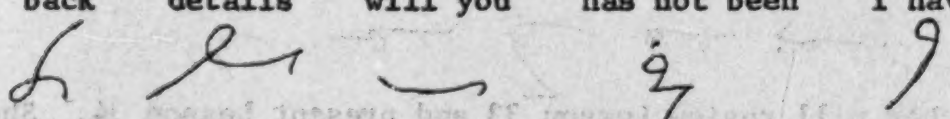

for many years as you know more than as soon as write

in this matter purchased usual consider please

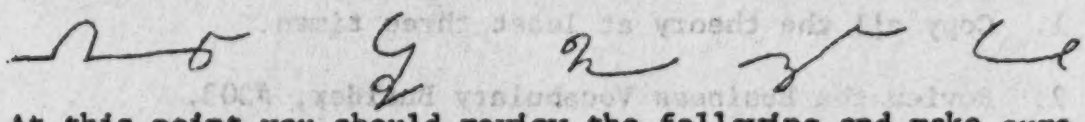

At this point you should review the following and make sure you know and can say and write them without hesitation.

Alphabet Sounds

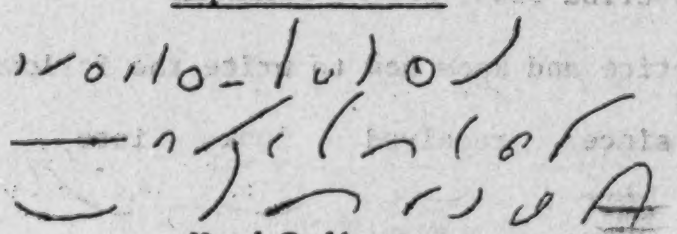

Word Endings

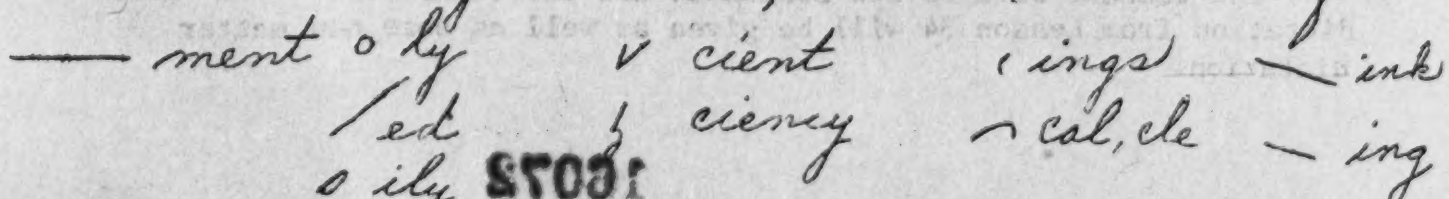

16073

Word Beginnings

e ex
— un, un, en
— con, com
— re
inter, intr, enter, entr
val / de di
(be) for, fore, fur
— mis / dis des
(per pur

The teacher will review Lesson 35 and introduce Lesson 36. Some dictation from Lesson 35 will be given as well as some new matter dictation.

Assignment:

1. Review #317, Principles of joining.

2. Review #318, Accuracy Practice, and do all of the practice drills, #318, 319, and 320.

3. Read all of the recall chart, #321. Write each outline once and transcribe it in longhand at the side of the shorthand outline.

4. Review #322, Business Vocabulary Builder.

5. Read all of the reading and writing practice.

6. Be prepared for a test on Lesson 36 and also a test on brief forms covered so far.

At this point a test will be given to you on Lesson 36, consisting of theory vocabulary transcription and connected matter transcription. A brief form test will also be given at this time. The brief form test will be dictated and both the shorthand outline and the transcription will be checked.

If you were able to pass the theory vocabulary transcription on 20 minutes time with no more than 10 errors, the transcription of the connected matter in 20 minutes with no more than 10 errors and the brief form test in five minutes with 95% accuracy, you are ready to proceed with Chapter VII.

Shorthand I
(First Semester)

CHAPTER VII

Objective: The student will be able to transcribe 50 words taken from the word beginnings and endings in Lesson 42 with a maximum of 10 errors in 20 minutes. The student will be able to transcribe some connected matter chosen by the teacher from Chapter VII with a maximum of 10 errors in 20 minutes. The student will also be able to take from dictation a brief form test of 50 words and transcribe it in 10 minutes with 95% accuracy.

The teacher will present Lesson 37 to you. Some new matter dictation will be given. Practice and know how to write the following words:

wrote done well place credit waiting purchase

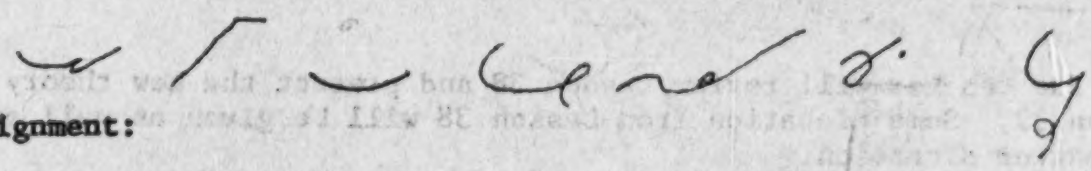

Assignment:

1. Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #331.

3. Review the Punctuation Practice, #332. Make certain you understand the meaning of the "if" clause.

4. Read all of the Reading and Writing Practice.

5. Copy #333, 334, 335, and 336.

6. Transcribe #334.

7. Practice and know how to write the following words:

proud rated credit Philadelphia traded unite

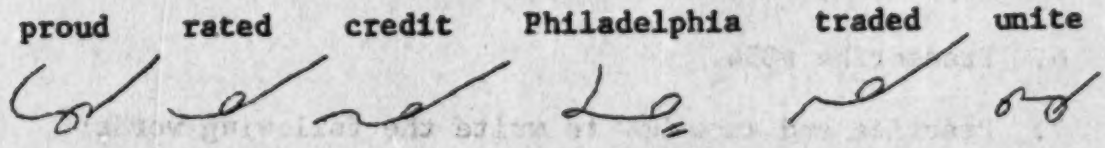

few possible believe individuals always market

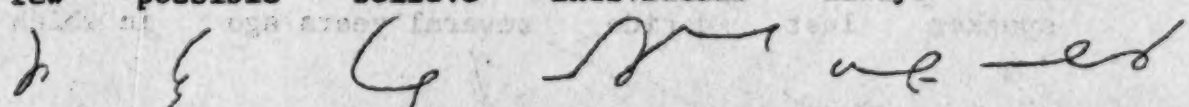

The teacher will review Lesson 37 and present Lesson 38. Some dictation from Lesson 37 will be given as well as some new matter dictation.

Assignment:

1 Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #340.

3. Review #341, Punctuation Practice, and be sure you know the meaning of the "as" clause.

16075

4. Read all of the reading and writing practice.

5. Copy #342, 343, 344, and 346.

6. Transcribe #344.

7. Practice and know how to write the following words:

workers eager know 500 suits ready way

manager return unable

The teacher will review Lesson 38 and present the new theory in Lesson 39. Some dictation from Lesson 38 will be given as well as new matter dictation.

Assignment:

1. Copy the theory at least three times. How are you doing with your word lists that are dictated each day? If you are having problems, you are not studying your theory enough.

2. Review the Business Vocabulary Builder, #351.

3. Review #252, Punctuation Practice. Be sure you understand the use of the comma with the "when" clause.

4. Read all of the reading and writing practice.

5. Copy #353, 354, 355, 356, and 357.

6. Transcribe #354.

7. Practice and know how to write the following words:

speaker last decide several years ago in which

very good has not been would be of the time do you think

should be has made during the past if you can remember

wanted always write

16076

The teacher will review Lesson 39 and present Lesson 40. Some dictation from Lesson 39 will be given as well as some new matter dictation.

Assignment:

1. Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #359.

3. Review the Punctuation Practice #360. Be sure you understand the "introductory" comma.

4. Read all of the reading and writing practice.

5. Copy #361, 362, and 363.

6. Transcribe #363.

7. Practice and know how to write the following words:

touch customers way sustain friendship department

written history seldom another choose items

The teacher will review Lesson 40 and introduce Lesson 41. Some dictation from Lesson 40 will be given as well as some new matter dictation.

Assignment:

1. Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #369.

3. Review the Similar Words Drill, #370.

4. Read all of the reading and writing practice.

5. Copy #371, 372, 373, 374, and 375.

6. Transcribe #373.

7. Practice and know how to write the following words:

Jones neighbor kind standing ways looking

16077

entire line ready purchase reference consider

The teacher will review Lesson 41 and present Lesson 42. Some dictation from Lesson 41 will be given as well as new matter dictation.

Assignment:

1. Read all of the Accuracy Practice and do the accuracy drills #376, 377, and 378.

2. Read all of the Recall Chart, #379. Write each outline once and transcribe it in longhand at the side of the shorthand outline.

3. Review the Business Vocabulary Builder, #380.

4. Read all of the reading and writing practice. Time yourself and determine your reading rate from the table on page 237.

5. Copy #381.

6. Be prepared for a test on Lesson 42 and also a test on all the brief forms.

At this point a test will be given to you on Lesson 42, consisting of theory vocabulary transcription and connected matter transcription. A brief form test will also be given at this time. The brief form test will be dictated and both the shorthand outline and the transcription will be checked.

If you were able to pass the theory vocabulary transcription in 20 minutes with no more than 10 errors, the transcription of the connected matter in 20 minutes with no more than 10 errors, and the brief form test in ten minutes with 95% accuracy, you are ready to proceed with Chapter VIII.

16078

Shorthand I
(First Semester)

CHAPTER VIII

Objective: The student will be able to transcribe 50 words taken from the words and phrases in Lesson 48 with a maximum of 10 errors in 20 minutes. The student will be able to transcribe some connected matter chosen by the teacher from Chapter VIII with a maximum of 10 errors in 20 minutes. The student will also be able to take from dictation a brief form test of 50 words and transcribe it in 10 minutes with 95% accuracy.

The teacher will introduce Lesson 43 to you at this time. Some new matter dictation will be given. Practice and know how to write the following words:

book ownership new needed receive classes

copies purchased property consider necessary

Assignment:

1. Copy all of the theory at least three times.

2. Review #386, Business Vocabulary Builder.

3. Review #387, Punctuation Practice. Be certain that you understand the "conjunction" comma.

4. Read all of the reading and writing practice.

5. Copy #388, 389, 390, and 391.

6. Transcribe #391.

7. Practice and know how to write the following words:

notification enterprise program location to be

to come to this in order sending them you should

you will see consider individual want purchase

The teacher will review Lesson 43 and present Lesson 44. Some dictation from Lesson 43 will be given to you as well as some new matter dictation.

16079

16080

Assignment:

1. Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #397.

4. Read all of the reading and writing practice.

5. Copy #398, 399, 400, and 401.

6. Transcribe #401.

7. Read the spelling and Punctuation Check List at the bottom of page 251.

8. Practice and know how to write the following words.

realize standing open another shipment attorney

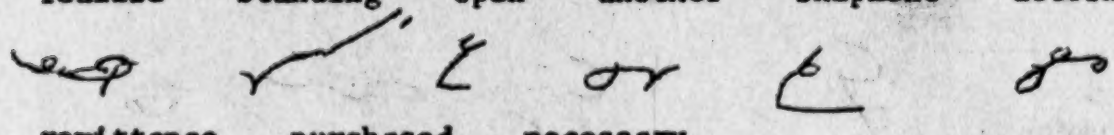

remittance purchased necessary

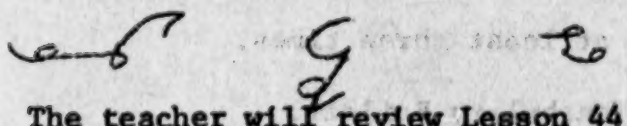

The teacher will review Lesson 44 and introduce Lesson 45. Some dictation from Lesson 44 will be given as well as some new matter dictation.

Assignment:

1. Copy all of the theory at least three times.

2. Review the Business Vocabulary Builder, #406.

3. Review thoroughly the Spelling Families, #407.

4. Read all of the reading and writing practice.

5. Copy #408, 409, 410, and 411.

6. Transcribe #409.

7. Read the homework check list at the bottom of page 257. You are supposed to be doing all of these items as you do your homework.

8. Practice and know how to write the following words:

December October receipt November accounts necessary

16079

16080

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: I. LUBRICATION

PERFORMANCE OBJECTIVE NO: 1 TITLE: Changing Oil and Grease

CONDITIONS:

Student will learn related information listed below

LEARN	REFERENCE	SOURCE
1. Lubricating systems	1. Automotive Fuel, Lubrication, and Cooling Systems, by Crouse. pp. 328 through 392 Automotive Engines Workbook, by Crouse. Jobs 34 and 35	1. Related Information Class
2. "Lubrication"	2. Filmstrip	2. Resource Materials Center

1603

written each taken care office delivered

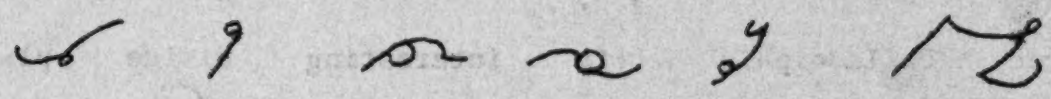

The teacher will review Lesson 45 and present Lesson 46. Some dictation from Lesson 45 will be given to you as well as some new matter dictation.

Assignment:

1. Copy all of the theory at least three times.
2. Review the Business Vocabulary Builder, #417.
3. Review the Similar Words Drill, #418.
4. Read all of the reading and writing practice.
5. Copy #419, 420, 421, and 422.
6. Transcribe #421.
7. Read the transcription check list at the bottom of page 262.
8. Practice and know how to write the following words.

early inquire interested special home original

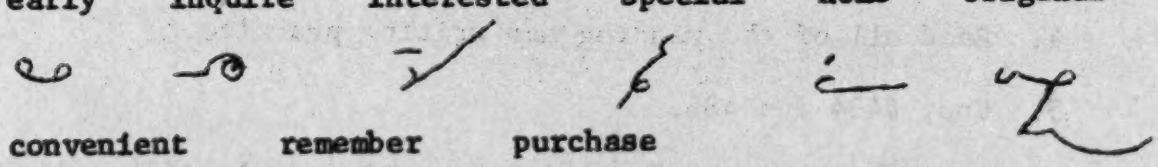

convenient remember purchase

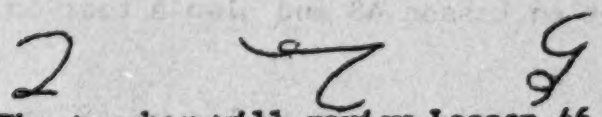

The teacher will review Lesson 46 and present Lesson 47. Some dictation from Lesson 46 will be given as well as new matter dictation.

Assignment:

1. Copy all of the theory at least three times.
2. Review the Business Vocabulary Builder, #424.
3. Review the Grammar Checkup, #425.
4. Read all of the reading and writing practice.
5. Copy #426, 427, 428, and 429.
6. Transcribe #426.
7. Read the brief-form check list at the bottom of page 267.

16081

8. Practice and know how to write the following words:

Fred Philadelphia trip interesting divide places

simple dresses better parties Friday morning

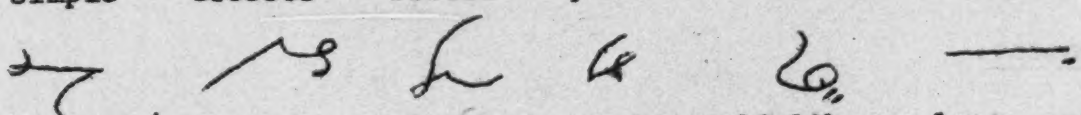

it will not I suggest that you would like let property

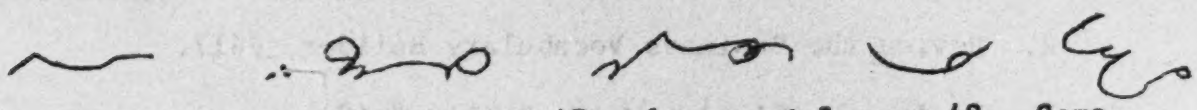

The teacher will review Lesson 47 and present Lesson 48. Some dictation from Lesson 47 will be given as well as new matter dictation.

Assignment:

1. Read all of the Accuracy Practice and do the accuracy drills #430 and 431.

2. Read all of the Recall Chart, #432. Write each outline once and transcribe it in longhand at the side of the shorthand outline.

3. Review the Business Vocabulary Builder, #433.

4. Read all of the reading and writing practice.

5. Copy #434 and 435.

6. Be prepared for a test on Lesson 48 and also a test on all the brief forms.

At this point a test will be given to you on Lesson 48, consisting of theory vocabulary transcription and connected matter transcription. A brief form test will also be given at this time. The brief form test will be dictated and both the shorthand outline and the transcription will be checked.

If you were able to pass the theory vocabulary transcription in 20 minutes with no more than 10 errors, the transcription of the connected matter in 20 minutes with no more than 10 errors, and the brief form test in 10 minutes with 95% accuracy, you are ready to proceed with Chapter IX.

16082

CHAPTER IX

Objective: The student will be able to pass a brief form and derivatives test consisting of 50 words and transcribe it in 10 minutes with 95% accuracy checking both the shorthand and transcription. The student will also be able to take from dictation at 40 wpm one of the letters from Lesson 56 and transcribe it in 20 minutes with a maximum of 10 errors.

You have now completed the theory portion of Gregg Shorthand. Chapter IX is reinforcement of brief forms and derivatives. Each lesson contains a review list of brief forms and derivatives and letters containing these same brief forms.

The following are the general instructions that should be followed for each lesson in Chapter IX (Lessons 49-56.)

Assignment:

1. Copy all of the brief forms and derivatives at the beginning of each lesson at least three times. Be sure that you are able to read your own notes.

2. Read all of the reading practice.

3. Copy all the letters in the lessons and pay particular attention to the Vocabulary Building, Grammar Checkups, and Similar Word Drills.

4. Transcribe the following letters in Chapter IX: #443, 451, 456,462,471,476,487, and 492.

5. Be prepared to take a brief form derivative test and a test consisting of a letter dictated at 40 wpm.

At this point a test will be given to you on Chapter IX. It will consist of a brief form and derivatives test consisting of 50 words. This will be dictated and both the shorthand outline and transcription will be checked. A letter chosen from Lesson 56 will also be dictated at 40 wpm.

If you were able to pass the brief form and derivative test in 10 minutes with 95% accuracy and the dictated letter at 40 wpm in 20 minutes with a maximum of 10 errors, you are ready to proceed with Chapter X.

16083

CHAPTER X

Objective: The student will reinforce the principles learned in the previous chapters. The student will be able to transcribe smoothly from his own shorthand notes and apply the nine uses of the comma that were introduced in Chapters VI, VII, and VIII.

Assignments:

1. Copy all letters in each lesson. Be sure to insert all punctuation. Be able to read your shorthand notes.

2. Check with your teacher after each lesson and she will tell you which letters you are to transcribe in that lesson.

3. Check your transcription with the key provided and hand it to your teacher. She will then give you further instructions.

4. Pay particular attention to the spelling families given in this chapter.

5. You have now completed your Gregg Shorthand theory. At this point you will be given a series of tests to determine whether or not you are ready to proceed to the next shorthand book.

TESTS

1. You will be given a 100-word theory test. (This test may be taken at any time after Chapter 8). It will be dictated in no more than 10 minutes, and you will be allowed 20 minutes for transcription. Words transcribed incorrectly and misspelled words will be counted as errors. Only the transcription will be checked. These words will cover all phases of shorthand theory. To pass this test you must attain at least 80% accuracy.

2. You will be given a dictated 50-word brief form test and allowed 10 minutes for transcription. Both shorthand and transcription will be checked. Each will be worth one point. Misspelled words will be counted as errors. To pass this test you must attain 95% accuracy.

3. You have been given dictation takes during the past semester. If you have passed at least three "takes" dictated at the rate of 40 wpm or more for three minutes on new, unpreviewed material and have transcribed the dictation with 95% accuracy in a time limit of 20 minutes, you have passed this part of the requirements for this semester.

SHORTHAND I
(2nd Semester)

Behavioral Objective:

At the end of the second semester:

1. The student will be able to pass two 100-word theory tests with at least 85% accuracy. Each 100 words will be dictated in no more than 10 minutes and will be transcribed in 20 minutes. Words transcribed incorrectly and misspelled words will be counted as errors. Only the transcription will be checked. The words will cover all phases of shorthand theory.

2. The student will be able to pass at least two 50-word brief form tests with 95% accuracy. The words will be dictated at the rate of one every 1 1/2 seconds and transcribed within a ten-minute time limit. Shorthand and transcription will be checked--each will be worth one point. Misspelled words will be counted as errors.

3. The student will be able to transcribe on the typewriter designated paragraphs from homework notes or dictated letters. She should be able to transcribe each shorthand outline accurately. This transcription should be set up on type paper using a 60- or 70-space line with double spacing and indented paragraphs. A maximum of three errors an assignment will be allowed to pass. A minimum of 15 transcripts will be required.

4. The student will be able to read from shorthand plates in the book without hesitation on studied material. She will be able to read new words through spelling the shorthand form using the shorthand alphabet.

5. The student will be able to take dictation at 60 words per minute for three minutes on new, unpreviewed material and transcribe the dictation with 95% accuracy in a time limit of 20 minutes. Actual word for word transcription will be required.

6. The student will be able to transcribe a dictated 50-word theory test with 85% accuracy in a 20-minute time limit. These words will be taken from the theory and marginal reminders in each chapter. The student will also be able to transcribe a dictated letter at 40 wpm. This will be taken from the chapter and must be transcribed in 20 minutes. A maximum of three errors will be allowed.

7. The student should be able to transcribe correctly from dictation all words in the theory, vocabulary builder, and marginal helps given in each lesson. From time to time word lists of 25 words will be given covering this material.

- - - -

During this semester's work your teacher will ask you to transcribe from your homework notes or from dictated material. In order to be able

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to transcribe accurately from your homework notes, care should be taken in writing each homework assignment. Be sure that you can read the material that you copy in these lessons so that you will be able to read and transcribe your own notes correctly.

Words will be dictated to you from time to time to transcribe. Study the theory review and marginal reminders in each lesson carefully because the words will be taken from them.

At the beginning of each chapter you will find a warmup phrase letter. You should read and copy the letter several times while working on this chapter. This phrase letter is a very good speed development letter. See how fast you can write it using all the phrases. This letter will be dictated to you several times as warmup and will be dictated at high speeds.

Each chapter will have a specific review on phrases, brief forms, word families, and word beginnings and endings. A thorough study of these words will enable you to increase your ability of writing unfamiliar words in your dictation. A grammar checkup, spelling pointers, and punctuation review are also included in each chapter.

Taped instruction will be used at various intervals. Follow the instructions given on the attached sheet as to the procedure for taped instruction.

Follow the listed instructions step by step to enable you to increase your ability to take dictation and to read your notes accurately. At any time that you have a question, do not hesitate to check with your teacher.

Chapter I

1. Take each lesson separately-a minimum of one lesson a day. You will not be required to have a regular homework assignment on weekends. However, if you need additional time on some of these lessons, the weekend could be used profitably. Also, if for any reason you get behind in your lessons (four per week), use the weekend to catch up.

2. Study the theory review in each lesson by reading the words as quickly as you can. Refer to the key for the words you cannot read. Copy the words and see if you can read them back from your own notes.

3. Study the vocabulary builders and similar-word drills carefully. These words will appear in the practice material and will help you in your transcription.

4. Read each letter and copy it at least once. At the end of the last lesson in each chapter you will find a secretarial hint called "The Secretary on the Job." These articles should be read carefully and copied. These are the same articles that you will be asked to transcribe in your transcription class.

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5. The transcription letter at the end of each lesson should be read carefully and punctuation inserted.

6. After you have copied each letter, try to read back from your notes. If you have difficulty reading your notes, you are not copying the material as you should. Take a little more time because copying will do you no good unless you can read your own work.

7. If a question arises in your mind at any time while doing these lessons, be sure to check with your teacher.

8. Each day you will be given specific material to read and transcribe. Also, vocabulary lists will be dictated daily.

9. On specified days you will complete your lesson through the use of tapes. Refer to your instruction sheet on tapes for directions.

10. At least one day a week will be set aside for "takes."

11. After you have completed each lesson in the chapter, check with your teacher and she will give you the chapter test.

12. After completing the chapter test, hand your papers to your teacher for checking. If you have passed the test within the prescribed standard, you will be allowed to go on to the next chapter.

Chapters II through XI

1. Follow the steps as outlined for Chapter I.

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INSTRUCTIONS FOR THE TEACHER

Type and transcription is set up to take one hour's time daily of a two-hour block with Shorthand I. If the two-hour block is not scheduled, the course can be a one-hour class daily, but only students who are registered in Shorthand I should be eligible for the class inasmuch as the transcription is correlated with the Shorthand I program.

Type and Transcription is written so that the student will begin transcription after successfully completing Chapter 3 in the Shorthand I book (Gregg Shorthand, D. J. Series). The student will work only on type production until this point is reached. When transcription is started, the teacher should check from time to time to make sure that the student is dividing his time between both type and transcription. The student should not be allowed to work on one area until it is completed before starting the other. It is very important that they work on both type and transcription. Because the transcription material is correlated with Shorthand I, the student will not be able to go beyond the point he has reached in his shorthand work.

The following books should be on a reference shelf available to the students as called for in their assignments:

Bell, Mary L. Speed Typing, Third Edition. Cincinnati: South-Western Publishing Company, 1958.

Bowman, Wallace B. Business Letter Typing. Cincinnati: South-Western Publishing Company, 1957.

Freeman, Louis. Guide to Typewriting. New York: Amsco School Publications, Inc., 1967.

House, Clifford R., and Samuel Skurow. Typewriting Style Manual, Seventh Edition. Cincinnati: South-Western Publishing Company, 1958.

Lessenberry, D. D., James T. Crawford, and Lawrence W. Erickson. 20th Century Typewriting, Eighth Edition. Cincinnati: South-Western Publishing Company, 1962.

Liguori, Frank E. Basic Typewriting Operations--Principles and Problems. Cincinnati: South-Western Publishing Company, 1965.

Lloyd, Alan C., John L. Rowe, and Fred E. Winger. Typing Power Drills, Second Edition. New York: McGraw-Hill, Inc., 1965.

Rowe, John L., and Faborn Etier. Typewriting Drills for Speed and Accuracy, Third Edition. New York: McGraw-Hill, Inc., 1966.

Rowe, John L., Alan C. Lloyd, and Fred E. Winger. Gregg General Typing 191 Series, Second Edition. New York: McGraw-Hill, Inc., 1967.

Rowe, John L., and Alan C. Lloyd. Gregg Typing. Second Edition, Complete Course. New York: McGraw-Hill, Inc., 1958.

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Wanous, S. J. Statistical Typing with Tabulation Problems, Second Edition. Cincinnati: South-Western Publishing Company, 1956.

After the student has completed a typing unit and filled out the printed record form indicating the number of pages and points for that unit, the number of points received should be recorded as reference for both teacher and student. The points received on each test should be recorded and these points only should be considered in the grade evaluation. It should be remembered that the student's score on his first attempt on a test is the score used in determining his grade. If the standard is not reached on the first attempt, however, he must review the unit and retake the test before going on to the next unit.

In transcription a given number of passing assignments is required; however, all transcription assignments should be recorded. If the standard is not reached on an assignment, it is not necessary to repeat it unless at the end of the course the required number of passing assignments has not been reached.

In a program of this type after an assignment has been checked and returned to the student, it is necessary that these papers are handed back to the teacher for filing. This eliminates the possibility of assignments being circulated among the students. It also serves as a double check if questions arise as to whether the assignment has been completed or not. It is suggested that a file folder be made for each student in which to keep these papers.

The instruction sheets for each unit should be returned before a new unit is given to the student. This prevents circulation of the units and also unnecessary reproduction.

Progress reports are used for students to keep a record of their work. A duplicate of this is also used as a nine-week report to the parents. A copy of a suggested progress report for each semester is included. Note that each required assignment is included on the report and there is also a place for the signature of a parent.

NOTE: It should be remembered that the requirements for timed writings and transcription assignments are minimum. This represents the average or "C" performance. If more timed writings are passed, the "B" and "A" grade can be determined by the number above the minimum requirement and the student's base increase or speed.

All transcription assignments must be completed with the minimum of 18 passing. However, if more assignments are passed, the grade can be determined from the average of the highest 18 plus a bonus for the additional passed assignments.

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TYPE AND TRANSCRIPTION (1st Sem.)

NAME _____

PROGRESS REPORT

This report lists the minimum required assignments for first semester type and transcription.

Completion of each assignment is indicated. The suggested term goals are given in red. However, this is just a guide. Progress beyond the suggested goal is encouraged.

The semester goal must be reached before the semester letter grade and credit is given.

ASSIGNMENT — COMPLETED

TYPE

Timed Writings (Words per minute for 5 minutes with no more than 1 error per minute)

1.	_____	6.	_____
2.	_____	7.	_____
3.	_____	8.	_____
4.	_____	9.	_____
5.	_____	10.	_____

Base Rate _____

Base rate increase _____

PRODUCTION (Units on the following areas completed according to the prescribed standards set up on the instruction sheets)

1. Centering _____
2. Rough Drafts _____
3. Tabulation _____
4. Manuscripts _____
5. Business Letters _____

TRANSCRIPTION (Transcription lessons from shorthand plates according to the standards set up in the instruction sheet. At least ten passing assignments (no more than four errors) are required.

1.	_____	9.	_____	17.	_____
2.	_____	10.	_____	18.	_____
3.	_____	11.	_____	19.	_____
4.	_____	12.	_____	20.	_____
5.	_____	13.	_____	21.	_____
6.	_____	14.	_____	22.	_____
7.	_____	15.	_____	23.	_____
8.	_____	16.	_____	24.	_____

Parent's Signature _____

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PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: I. LUBRICATION

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Changing Oil and Grease

CONDITIONS:

This assignment will be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Raise hood
6. Place protective covers on fenders
7. Place hoist arms and raise automobile to comfortable working height
8. Drain engine oil following all steps as outlined in the manual. Replace and tighten plug
9. Change oil filter following steps as outlined in manual
10. On standard transmissions, check level of lubricant following all steps as outlined in the manual
11. Check lubricant level in the differential following all steps as outlined in the manual

PERFORMANCE CRITERIA:

1604

TYPE AND TRANSCRIPTION (2nd Sem.)

NAME _____

PROGRESS REPORT

This report lists the minimum required assignments for second semester type and transcription.

Completion of each assignment is indicated. The suggested term goals are given in red. However, this is just a guide. Progress beyond the suggested goal is encouraged. The semester goal must be reached before the semester letter grade and credit is given.

ASSIGNMENT

Type

Timed Writings (5 minutes with no more than 1 error per minute)

1.	_____	6.	_____
2.	_____	7.	_____
3.	_____	8.	_____
4.	_____	9.	_____
5.	_____	10.	_____

Production (Units on the following areas completed according to the prescribed standards set up on the instruction sheets)

1. Carbon Copies	_____	6. Tabulation	_____
2. Envelopes	_____	7. Post Cards	_____
3. Letters	_____	8. Telegrams	_____
4. Memorandums	_____	9. Manuscripts	_____
5. Justifying Lines	_____		

Transcription (Transcription lessons from shorthand plates according to the standards set up in the instruction sheet--at least 18 passing assignments (no more than four errors) are required.

1.	_____	13.	_____	25.	_____
2.	_____	14.	_____	26.	_____
3.	_____	15.	_____	27.	_____
4.	_____	16.	_____	28.	_____
5.	_____	17.	_____	29.	_____
6.	_____	18.	_____	30.	_____
7.	_____	19.	_____	31.	_____
8.	_____	20.	_____	32.	_____
9.	_____	21.	_____	33.	_____
10.	_____	22.	_____	34.	_____
11.	_____	23.	_____		
12.	_____	24.	_____		

Parent's Signature _____

16091 00001

Base	UNDER 30	31-40	41-50	51-60	61-70	71+
A	11	10	9	8	6	4
B	10	9	8	7	4-5	3
C	6-9	5-8	5-7	5-6	3	2
D	5	4	4	4	2	1
F	0-4	0-3	0-3	0-1	0	0

A base rate is determined for each student after a series of timed writings has been given. Each student has the opportunity to earn an "A" in speed regardless of his level of typing. Example: If a student's base rate is 54, he would earn an "A" in speed if he increases his net words per minute to a 62 in a five-minute timed writing with no more than five errors. (Errors are limited to one per minute).

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SPECIAL SIGNS AND SYMBOLS[1]

Dash (--) Strike the hyphen twice; do not leave a space before or after the dash.

Exclamation Mark (!) Type the period, backspace, and type the apostrophe directly above the period.

Feet (') Use the apostrophe.

Inches (") Use the quotation marks.

Minutes (') Use the apostrophe.

Seconds (") Use the quotation marks.

Ditto (") Use the quotation marks centered under each word.

Multiplication Sign (x) Use the small letter x; leave a space before and after the sign.

Minus Sign (-) Use the hyphen; leave a space before and after the sign.

Plus Sign (+) Type the diagonal (/); backspace, and type the hyphen (-); leave a space before and after the sign.

Division Sign (÷) Type the hyphen, backspace, and type the colon; leave a space before and after the sign.

In Care Of Type the small "c," the diagonal, and the small "o" (c/o).

Caret (indicates an insertion). Type the diagonal (/) between the words where the insertion is to take place. Type the insertion on the line above.

Roman Numerals Use the capital letters I, V, X, L, C, D, M.

Equal Sign (=) Type the hyphen, backspace, turn the cylinder down slightly, and type the hyphen a second time. (Be sure to put the cylinder back in the original position). Leave a space before and after the sign.

Degree Sign (°) Roll the cylinder down a half line space and type the small "o" (88°). Some typewriters have half-space linespace regulators. If yours does not, use the ratchet release.

Superiors Type the number a half line space above (44^2).

Inferiors Type the number a half line space below (H_2O).

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[1]Freeman, Louis, Guide to Typewriting (New York: Amsco School Publications, Inc., 1967), p. 4.

Secret

16093

Type Production

Evaluation of Production
(With Erasing Allowed)

Number of Errors Per Page of Work					
	0	1	2	3	More
Points	5	4	3	2	1

* * *

Placement	1 error each
Instructions	1 error
Misspelled Words	1 error each
Type Errors	1 error each
Word Division	1 error each
Messy Erasing	1 error each
Missing Words	1 error each
Additional Words	1 error each
Strikeovers	F

Printed Record Sheet (Sample)

Name_____ Name of Unit_____

Date_____ Number of Pages_____

Type and Transcription Total Points_____

Semester_____

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Type and Transcription
(First Semester)

TYPE

Performance Criteria:
At the conclusion of the first semester:

1. The student will be able to pass at least ten 5-minute timed writings with no more than one error per minute and increase his base words-per-minute rate according to the attached chart.

2. The student will be able to pass an objective test on basic typing techniques with 80% accuracy.

3. The student will be able to locate, erase, and correct all typing errors made.

4. The student will be able to complete the following production work as set up in each individual unit. After completion of the production unit a test (or tests) will be given. A total of 5 points will be given for each page of the test with one point deducted for each error (see evaluation page). A minimum of 5 points per page will be required to pass.

   a. Centering
   b. Rough Drafts
   c. Tabulation
   d. Manuscripts
   e. Business Letters

Text: 20th Century Typewriting, Eighth Edition, Complete Course. Lessenberry, Crawford, and Erickson. Cincinnati: South-Western Publishing Company, 1962.

Timed Writings

Timed writings will be given at least once a week. Timings will also be given on an individual basis when needed. The student will check his papers carefully and circle all errors. Papers that have no more than one error per minute will be considered as passing and will be handed in. The base rate for each student will be figured by the teacher, and the grading scale for these base rates is attached.

Each timed writing should be set up in the following manner:

1. Double space.
2. 70-space line or as directed.
3. Type the following in the upper left corner.

   Name
   Type and Transcription
   Semester 1
   Timed Writing

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4. Circle entire word where error appears.
5. Record words per minute and number of errors at the top of the page. Example: 50/4

Production

The production work will be done in individual units. The student will obtain each unit from the teacher in the order designated above.

Each student will evaluate his own work. After completing each assignment in the unit, check your paper with the key at the checking table. Evaluate your own work according to the attached sheet. Record the number of errors per page in the upper right corner of each sheet. If you do not understand any part of the lesson, be sure to check with your teacher so that she can go over it with you. It may be necessary to retype the lesson to make sure that you know how to do it.

Keep each assignment in the unit until the entire unit has been completed. After the unit is completed and checked, fill out the printed record sheet. Sample attached. This should be stapled on top of the completed unit and placed in the basket for checking. REMEMBER! Check your work carefully. Be certain that you understand and know how to set up each lesson in the unit because your grade for the unit will be determined from your test scores.

Drills

Each day the student will be expected to spend five minutes on drill work. These drills should help improve the student's speed and accuracy in typing.

Drills should be chosen according to the type of production work you are doing. Some drills will be included with specific units. In other cases you are to choose your own drills or those drills that will help you the most. You may select drills from your type book or from the various typing drill books on the shelves.

The drills should be typed in the following manner:

1. Type the following in the upper left corner:
   Name
   Type and Transcription
   Semester 1
   Drill Sheet
2. Type the date at the beginning of each day's drill.
3. Set margins for each specific drill.
4. In the case of single line drills, type the line at least twice or until you can type it without error. Single space these lines and double space before starting a new one.

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5. In drill paragraphs, type the paragraph single space and double space between paragraphs.
6. Do not use a new sheet each day for drill work. Fill both sides of the paper.
7. Hand in drill paper when both sides are filled.

Note: A page showing how to type special signs and symbols is attached. Please read it carefully.

16097

Type and Transcription
(First Semester)

CORRECTION OF ERRORS

The student will be able to locate, erase, and correct all typing errors made. This will be accomplished through the study of rules and typing examples. No test will be given to cover this unit; however, it will be expected that the student will take care in reading and proofing all of his work so that he will be able to detect the errors made and make suitable corrections. This is a continuous unit--in all typing work corrections should be made carefully when errors are made.

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Even an efficient typist makes mistakes occasionally. The paper should not be wasted by "yanking" it out of the machine and starting over. Time is also wasted by doing this and time is expensive. If the error can be corrected and the copy be made usable, it should be done.

In order to be able to erase and make corrections efficiently, be sure to study the instructions and follow directions carefully.

Remember: No work is complete until it has been proofread carefully and all corrections made. It is just as important to be able to detect your errors and correct them neatly as any other typing skill.

The following are various ways in which you can make corrections in your work. Study them carefully and do the examples when you are directed to do so.

GUIDES FOR ERASING[2]

1. Use a plastic shield and a typewriter (hard) eraser.

2. Lift the paper bail.

3. Turn the paper forward if the error is on the upper two-thirds or backward if the error is on the lower third of the page.

4. Move the carriage to the left or right as far as you can (by using the margin release key) so the eraser crumbs will not fall into the typewriter mechanism.

5. Erase lightly. Blow eraser particles away as you erase.

6. Turn the paper back to writing position and type.

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[2] Lessenberry, Crawford, and Erickson, 20th Century Typewriting, Eighth Edition, Complete Course (Cincinnati: South-Western Publishing Company, 1962), p. 101.

16098

SQUEEZING AND SPREADING LETTERS[3]

It is often advisable to "squeeze" omitted letters into half spaces or to "spread" letters to fill out spaces to avoid erasing an entire word or retyping a page.

Squeezing Letters

A. If a letter is omitted within a word:
   1. Erase the misspelled word.
   2. The carriage of the typewriter moves forward half a space when you depress the space bar. The carriage moves forward another half space when you release the space bar. With the writing point placed in the space following the previous word, hold the space bar down and type the first letter of the word to be inserted. Release the space bar.
   3. Hold the space bar down and type the second letter. Release the space bar.
   4. Follow this same procedure until the entire word is typed correctly. (This procedure will reduce the spacing between the word being squeezed and the word immediately before and after it).

B. If a letter is omitted at the end of a word:
   1. Move the writing point to the last letter before the omitted letter.
   2. Hold the space bar down and type the omitted letter.

C. For electric typewriters:
   When using an electric typewriter, the typist must hold the carriage in the correct position with the hand as each key in a squeezed word is struck.

Turn to page 105 in your type book and practice "squeezing" letters (66-D). Follow directions given. Type the sentences as many times as you need to to make the corrections look neat. (This drill should be checked with your teacher so that you are sure you are doing it correctly). If you have any problem in making these corrections, be sure to ask your teacher for help.

Spreading Letters

A. If an extra letter is added to a word:
   1. Erase the misspelled word.
   2. Type the first letter of the word to be inserted a half space to the right of its original position.

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[3]Freeman, op. cit., pp. 2-3.

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3. Follow the same procedure for each letter until the entire word is typed correctly. The result of this procedure is to increase the spacing between the word being spread and the words immediately before and after it.

Type the following sentence as it is typed here:

Spelling correcttly is very important in writing.

Note: The word "correctly" has two "t's" instead of one.

Erase the word and type it in again spelled correctly. Repeat this process until you feel that you can do it well. Check with your teacher to see if you are doing it right.

Aligning and typing over a word:

At times it is necessary to retype a word after your paper has been removed from the machine. It is necessary to align the word so that the retyping will not be detected.

Turn to Page 70 in your type book and study 41-D carefully.

Follow the directions given until you can do the work accurately. Check with your teacher. If you have difficulty doing this, be sure to ask your teacher for help.

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: I. LUBRICATION

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Changing Oil and Grease

CONDITIONS:

BEHAVIOR:

12. Grease automobile following steps as outlined in manual
13. Remove all tools, materials, etc. from under automobile
14. Lower automobile to floor
15. Fill crank case with lubricant following all steps as outlined in the manual
16. Start engine and check for leaks
17. Check automatic transmission fluid level following steps as outlined in the manual
18. If all checks are satisfactory, return tools and materials to proper place
19. Remove fender covers and store in proper place
20. Return automobile to proper parking area
21. Remove front seat covers and store in proper place
22. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily change oil and grease automobile in 1 hour

Learning time: 3 hours

1605

Type and Transcription
(First Semester)

CENTERING

The student will be able to center material horizontally (using the backspace from center method) and vertically (both the exact center placement and the off-center or reading position).

The test will consist of centering a poem horizontally and vertically, centering between two vertical lines, and centering several lines horizontally within a prescribed time limit.

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Centering refers to the process of arranging material on paper so that the top and bottom margins are equal visually (vertical centering) and the left and right margins are approximately equal (horizontal centering).

POINTS TO REMEMBER

Horizontal Centering.

Number of spaces in a horizontal inch, pica type: 10
Number of spaces in a horizontal inch, elite type: 12
(The typewriters in the school are all elite type)
Dimensions of standard-size typewriting paper: 8 1/2 x 11"
Centering point for standard-size paper, pica type: 42
Centering point for standard-size paper, elite type: 51
(This is when your paper guide is set at 0 -- you can adjust your paper so that the center is 50 for easy centering)

Vertical Centering.

Number of line spaces to a vertical inch: 6
Number of available line spaces on a full sheet of paper: 66
Number of available line spaces on a half sheet of paper: 33
Number of available line spaces on a card 5 inches long: 30

"Spread Heading"

When a title is "spread," put one space between the letters and three spaces between the words. To center a spread heading, backspace from the center of the paper once for each letter except the last one in the line and once for each space between words.

Example: Spread each title listed below. Be sure to center horizontally. (Text, page 85).

(Use the same sheet of paper for all the examples of centering).

A THEME
OUTLINE FOR A THEME

SUMMER WORK
IN THE COOL OF THE DAY

161131

Steps in Centering Lines, Titles, and Headings[4]

1. Set the paper guide so that the paper will be centered when it is inserted into the typewriter.
2. Move the carriage to the center of the paper (centering point). Set a tab stop.
3. From the center of the paper, backspace once for every two strokes (letters, spaces, marks of punctuation, etc.) as you spell the copy to be centered. If there is one letter left, do not backspace for it.
4. Begin to type at the point where the backspacing is completed.
5. If there are more lines to be centered, tabulate to the centering point, and repeat step 3 and 4. Continue in this manner until all lines have been typed.

Steps in Vertical Spacing[5]

Typewritten material is most frequently single spaced so there are no blank lines between the typewritten lines. To make it easier to read (as in the case of manuscripts) such material is quite often double spaced (one blank line between typewritten lines). For special effects, such as headings, triple spacing (two blank lines between typewritten lines) is sometimes used.

This is	This is	This is
single	-	-
spacing	double	-
	-	triple
	spacing	-
		-
		spacing

1. Count all of the lines required to type the problem; include headings, lines in the body of the material, and all blank lines. Remember, every double space counts as one blank line; every triple space counts as two blank lines.

2. Subtract the total lines required to type the problem from the available lines on the page--66 on a standard page 11 inches long (6 lines to a vertical inch).

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[4]House, Clifford R. and Samuel Skurow, Typewriting Style Manual (Cincinnati: South-Western Publishing Company, 1958), p. 8.

[5]Ibid., p. 9.

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3. Divide the remaining number of lines by two to get the top and bottom margins. Drop the fraction if there is one.

These steps will place the copy in what is called exact vertical center, with equal space in top and bottom margins.

Off-Center or Reading Position

To type in off-center or reading position, figure for exact vertical centering and then roll the cylinder back three more times.

Drawing lines on work that is in the typewriter

Horizontal lines: Usually the underscore is used. However, if you use pen or pencil, lock the shift key and shift the ribbon to the stencil position. Insert your pencil, or pen, in the fork of the ribbon guide. Move the carriage across the page for the ruled line by pressing down on the pencil or pen and using the carriage-release lever.

Vertical lines: Release the platen for variable spacing. Roll the platen up while holding a pencil, or pen, point firmly at the desired spot. Do not put your pen or pencil on the ribbon.

Example: Draw several horizontal and vertical lines with your pencil while your paper is in the machine. Make a box by connecting horizontal lines. (If you have difficulty doing this, be sure to check with your teacher for help).

Centering Items Between Vertical Lines

1. Move the carriage to the first space to the right of the left line and note the figure on the scale.

2. Move the carriage to the last space before the right line and note the figure on the scale.

3. Add the figure indicating the point at which the space between the lines begins and the figure indicating the point at which the space ends, and divide by 2 to determine the exact center of the space.

4. Then move the carriage to the center point, backspace once for each two letters or letter and space in the heading to be centered, and start to type at the point at which the backspacing ends.

   Example:

   Set your left margin at 15 and, using the underscore, type five 50-space lines with triple spacing. (See illustration on the next page). Make the vertical lines with your pencil. Make three of these.

Solution to Drill 1[6]

Howard Chase Manufacturing Company
Room 602, Steward Building
465ß West 43rd Street
New York, New York 10032

Drill 1. Center each of the following lines, starting on line 2 of the first lined box.

Howard Chase Manufacturing Company
Room 602, Steward Building
4658 West 43rd Street
New York, New York 10032

Drill 2. Center the following items, one on each line, beginning on line 2 of the second lined box.

Dr. T. James Crawford
Graduate School of Business
Indiana University
Bloomington, Indiana 47401

Drill 3. Center the following items, one on each line, beginning on line 2 of the third lined box.

Your name
Your address
Your city, state, and ZIP code
Your telephone number

Centering Drills

Note: Each line to be centered is separated by a diagonal (/). (Material is listed at the end of instructions for Drill 3).

[6] Liguori, Frank E, Basic Typewriting Operations--Principles and Problems (Cincinnati: South-Western Publishing Company, 1965), p. 17.

Drill 1. Use a half sheet of paper and double spacing. Center each line horizontally and the entire exercise vertically.

Drill 2. Use a half sheet of paper inserted with the long edge at the left and double spacing. Center each line horizontally and the entire exercise vertically.

Drill 3. Use paper cut to 6 x 4 inches and inserted with the short edge at the left. Use double spacing. Center each line horizontally and the entire exercise vertically.[7]

THE JUNIOR ADVISERS/
Will meet on Thursday,
January 6,/ to hear Mr. William
Brown speak on/ "How to Advise
Effectively."/ Room 236 at 3:45 p.m./

Centering a Poem

Type the following poem on a half sheet of paper. Center it vertically and horizontally. Use a spread heading. (In figuring the horizontal centering in a poem, count the longest line to set your left margin).

His Handiwork[8]

The night held its breath,
Like a frightened child
Unexpectedly alone in an unlighted room.

Quick flashes of lightning
Cut through the jet blackness of the night,
As big raindrops splashed against the dry ground.

The drooping tulips lifted their petals joyously
As they drank in the cool freshness of the rain.
"And the firmament showeth His handiwork."

---

[7] Ibid., p. 15.

[8] Lessenberry, Crawford, and Erickson, p. 90.

16105

Centering an exact copy

Center an exact copy of the following enumeration on a full sheet of paper. Check your work carefully and make the corrections necessary.

CARE OF THE MACHINE[9]

1. Daily, clean the type faces by brushing them with a stiff brush or by using a commercial product made for the purpose.

2. Daily, dust the machine--use a long-handled brush for whisking out the inside and a soft cloth for wiping off the outside.

3. Daily, wipe off the desk--be sure that you wipe under the machine as well as around it.

4. Daily, cover the machine when not in use.

5. Weekly, wipe the carriage rails--use a soft cloth that has been dampened slightly in oil. Never put oil directly on any of the parts.

6. Monthly, wipe the cylinder with a soft cloth that has been dampened in alcohol.

After completing all the examples and production work, plus your daily drills in this unit, check your work carefully and hand your papers to your teacher. If this work has been done satisfactorily, you will be given the test for the unit.

After completing the tests for this unit hand your papers to your teacher for checking. If the work is satisfactory, your teacher will give you your next assignment, if not, supplementary work will be given to you.

---

[9]Rowe, John L., and Alan C. Lloyd, Gregg Typing, Second Edition, Complete Course (New York: McGraw-Hill, Inc., 1958), p. 68.

16106

TEST NO. 1

Type the following poem on a full sheet of paper. Use single spacing with double spacing between stanzas. Spread the heading and center the poem vertically and horizontally. You will have a time limit of 10 minutes.

ENGLISH PLURALS

English plurals,
You will agree,
Are a puzzling problem
For you and me!

One fowl is a goose,
But two are called geese:
Yet the plural of mouse
Is never called meese.

If the plural of man
Is always men,
Why shouldn't the plural
Of pan be called pen?

The cow in the plural
Is cows or kine,
But the plural of vow
Is vows--not vine.

If I speak of foot
You show me two feet,
If I give you a boot,
Would a pair be called beet?

One is a tooth
And a whole set is teeth,
Why shouldn't the plural
Of booth be called beeth?

If the singular's this
And the plural these,
Should the plural of kiss
Be known as kese?

We speak of a brother
And also brethren,
But though we say mother,
We never say Methren.

Then the masculin pronouns
Are he, his, and him.
But imagine the feminine--
She, shis, or shim!

16107801

TEST NO. 2

1. On your typewriter draw two vertical lines 4 inches apart and 2 inches long. (10-minute time limit)

   a. Center your name between the lines.

   b. Type the word THINKING (centered and "spread" a double space below your name.

2. On your typewriter draw a box. (5 inches horizontally and 3 inches vertically.) Within the box center the following:

   a. Your name

   b. Your school

   c. City and state of your school

TEST NO. 3

Center each of the following lines horizontally. Arrange all lines so that they are centered vertically. Use double spacing. This should be typed within a time limit of 15 minutes.

We worked and worked.
They looked in the pantry.
He asked for more time.
I learned how to throw and how to kick.
He told us to go.
The trip to the ship took two hours.
We should use a high quality of paper.
A party will take a lot of work if we are to write the folks.
He said it was as easy as a b c.
Dick said.
Dave plans to take a trip this summer.
Put your typewriter on a desk.
Have a comfortable chair.
Live so that you do your best every day.
Typewriting is a sport as well as a useful tool.
Organize your supplies.
Six ways to get a job.
Harper & Brothers
Clerical Office Practice

16108

ROUGH DRAFTS

Performance Criteria

The student will be able to type a corrected final copy from a rough draft copy using proofreader's marks. The test will consist of a one-page rough draft to be typed in final form in a time limit of 20 minutes.

- - - - - - -

A rough draft is an original copy corrected with pencil or ink. To type a final copy from a rough draft it is necessary to be able to read proofreader's marks. In typing a final copy, be sure that the information is complete and that it makes sense--all corrections must be made accurately.

Often when changes are made in the original copy, the following proofreader's marks are used to correct the rough draft. Listed below are a few of these proofreader's marks for you to use as reference.

Proofreader's Marks[10]

# Space	lc Lower Case	≡ Capitalize
^ Insert	⊐ Move to right	Spelling or Spell out
⁀ Close up	⊏ Move to left	¶ Paragraph
Delete (take out)	tr Transpose	⊙ Colon
sted Let stand	⊙ Period	

- - - - - - -

During this unit use the rough-draft paragraphs as drill material. You will find these in various sections of your type book. Spend from five to ten minutes a day on this drill. If there is any part that you do not understand, do not hesitate to ask the teacher for help.

Follow the steps in this unit carefully so that you will become familiar with the proofreader's marks and be able to type corrected copy from rough draft material.

1. Turn to Page 10 in Basic Typewriting Operations: Principles and Problems (on the reference shelf) and type each sentence twice. Be sure to make the corrections indicated according to the proofreader's marks.

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[10]Liguori, op. cit., p. 10.

Use Rough-Draft Sentences as the heading (type all in "caps"); 70-space line; double space after the second typing of each sentence. Center the material vertically. Be sure to check your work and make the necessary corrections.

2. Type the following rough-draft material. Use a two-inch top margin, 70-space line, double space, 5-space paragraph indention. Remember to space three times after the main heading. Check your work carefully and make the necessary corrections:

Business Education at Hamilton[11]

The business education department will again be offering a very complete program in the areas of Secretarial Studies. Bookkeeping, Clerical, and Distributive Education. For first time, a work experience program will be in operation in conjunction with the Distributive Education courses. In order to get practical experience, students will be placed in various businesses in the community. The Department is expected to expand this program of work-experience at the conclusion of this first experimental year. Business Education has something to offer to every student in the school, including those who intend to continue on to college. Among subjects especially geared to these students are personal notetaking, which teaches the students how to take notes in an abbreviated system and goes into other aspects of notetaking and studying, and personal typewriting. Shorthand and Typewriting are of tremendous value to students who wish to earn money while attending college. Business Law, bookkeeping, and office machines are also of value.

As always, the staff of the Business Education Department stands ready to be of help to all the students at Hamilton.

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[11] Freeman, op. cit., p. 69.

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X, SERVICING

MILESTONE: II, LUBRICATION

PERFORMANCE OBJECTIVE NO: 2 TITLE: Repacking Front Wheel Bearings

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. "Repacking Front Wheel Bearings"	1. Continuous film loop # 8351	1. Resource Materials Center
2. "Repacking a Universal"	2. Continuous film loop # 8369	2. Resource Materials Center

1609

3. Type the following memorandum in final copy form. Make all corrections indicated. Go down two inches from the top of your paper. Use a 60-space line. Double space the material. Proofread your paper for errors and make the necessary corrections.

TO ALL EMPLOYEES OF MODERN EQUIPMENT COMPANY:[12]

On September 5, we shall be opening our new store in the branchwood shopping center. Of necessity, there will be some confusion in changing from our present location. Your cooperation will take this transition easier and will be sincerely appreciated by your manager.

Part time help will be employed during the move to assist with much of the manual work. These people will also assist in arranging and displaying the merchandise.

During the week of the Grand Opening, the store will remain open until 9 p.m. each night, and you will have an opportukity for overtime work. All employees will return to their regular schedule of work assignments and hours of employment the following week.

The new store at Branchwood offers the advantages of the best possible location and ample facilities for customer parking. In addition, it provides our employees pleasant environment in which to work. All of these factors should result in a larger volume of business with increased earnings for all.

Philip Deatsman
President

4. Hand your production work in after checking it with the key. If your work is satisfactory, your teacher will give you your test material. If not, you will be given supplementary material to improve your skill in typing from rough-draft copy.

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[12] Ibid., p. 67.

TESTS

Test Nos. 1, 2, and 3 should be typed in a 30-minute time limit. After you have typed these tests, proofread them carefully and make the necessary corrections. Neat erasure will be allowed.

When you complete the tests, hand them to your teacher who will check them and give you your next assignment.

TEST NO. 1

Directions: Type the final copy of the following material. Use a full-size sheet of paper; 60-space line; 5-space paragraph indention; double spacing (except for numbered paragraphs); two and one-half inch top margin. Center the main heading horizontally and type it in capital letters.

HOW TO ERASE

The efficient ~~worker~~ typist strives for a usable first ~~writing,~~ copy ~~but~~ when errors are made, however, they must be cor ected ~~and~~ skill in making the a corrections ~~must be learned~~ will help to offset loss of time.

Study carefully the steps in erasing:

1. Move the ~~machine~~ carriage to the right or to the left before erasing. This will prevent ~~all the~~ erasure waste from falling in to the typewriter mechanism.

2. ~~The~~ use ~~of~~ an eraser shield to protect the writing that is not be erased.

3. If the erasure is made on the upper 2 two-thirds of the paper, turn the cylinder forward; ~~turn it backward~~ if the correction is to be made on the lower third of the paper, turn the cylinder backward so the proper alignment of the type will not be disturbed.

16112

TEST NO. 2

Directions: Type the final copy of the following theme. Use a full sheet of paper; 60-space line, double spacing; 3-inch top margin; type the heading centered horizontally and in all capital letters. Triple space after typing the heading.

MIRRORS

I have seen mirrors of rare beauty. In the cool, clear water of baxter's Creek that ran at the foot of the hill just below our house, I have seen mirrored, in inverted fashion the trees swaying lazily overhead. In the ballroom of the William Penn Hotel, walls of mirrors catch gleams of pure diamondlike beauty from the prisms of the chandeliers. A few books that mirror life and reflect something of great understanding and great love are now mine, too.

I know, too, an old man whose quiet eyes mirror the richness of a life well lived and the eager interest of a soul who views his numbered days without fear. Yes, I have seen mirrors of rare beauty.

16113

TEST NO. 3

Directions: Type the final copy of the following composition. Use a full sheet of paper; double spacing; top margin of 2 1/2 inches; 70-space line. Make all corrections indicated. Proofread your paper carefully.

all capital letters, center

Composition at the Typewriter

#

In your english classes you have learned to compose short theems and articles in Longhand. ~~You will be able to save considerable time~~ Considerable time can be saved if you learn to compose directly at the typewriter. When you compose first at the typewriter you may make more error than usual. These should be ignored or you may "x" them out and ~~then~~ type the correct word or words.

double space

When you compose letters or themes, it is well to think through and plan what you want to say. In the beginning, you that ~~the making of~~ a brief outline or a listing of the points to be covered will be an aid to you. Think and type and you will find that it is easy to gain composing skill ~~at the typewriter~~. You can gain skill by using the typewriter for any composing work that you do.

underline

Alternate the "x" and the "m" to speed up the process of "x'ing" out words.

TABULATION (Statistical Typing)

Performance Criteria

At the conclusion of this unit you will be able to set up material in tabulated form in an accurate and attractive manner. You will be given a test consisting of a simple two-column tabulation, a tabulation with column headings, a tabulation with money columns, and a tabulation within a letter. These tests will be typed from unarranged material so that you will have to figure the correct spacing. The tabulations must be accurate. Neat erasures will be allowed.

- - - - - -

In business today, more importance is being placed on the typing of numbers and tabulations.

To be able to type statistical matter such as tabulations, you should develop a skill in typing numbers. For your warm-up drills during this unit use the following drills: These drills are taken from the book, "Statistical Typing with Tabulation Problems."[13] These books are on the reference shelf. Use this material to build up your ability to type numbers more accurately. Try to do these drills without looking at your fingers. Keep your machine moving smoothly.

Pages 1, 2, and 3 -- Figure and Symbol Key Drills
Pages 4, 5, and 6 -- Building Skill in Typing Figures and Symbols

There are various number drills in your text book. Use these from time to time, especially when you are trying to learn the location of the numbers better. You should be careful in typing these drills so that you do not acquire bad habits such as looking at your fingers while you type and typing with poor rhythm.

You will be given simple tabulation problems at first and then more involved ones. You will also be given instructions as you go along for each new step. Follow these instructions carefully and you will find that it is not only challenging, but interesting to type tabulated material.

You will be instructed as to how to proofread statistical material. (See attached sheet). This is extremely important inasmuch as a tabulation is useless unless the material listed is correct.

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Follow the listed instructions step by step to develop your skill in tabulation typing: Be sure to read and study the supplementary sheets of instructions.

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[13] Wanous, S. J., Statistical Typing with Tabulation Problems, Second Edition (Cincinnati: South-Western Publishing Company, 1956)

116115

1. Turn to Page 59 in the type book. Type 33-B on a half sheet of paper, using a 60-space line, single spacing, block style. Center the material vertically. Remember to double space between paragraphs.

2. Type 33-C, Page 59 in the type book according to the directions given in the book. (This may be done on one sheet of paper.)

3. Drill 10-E, Page 24, in the type book. This drill will review the setting of tab stops. Follow the directions given in the book.

After completing this drill, turn to Page 26, 11-D and follow directions given.

Type 18-D, Page 37 following book instructions.

4. Turn to 35-C, Page 62, in the type book. Follow the directions given in the book.

5. Turn to Page 97 and read "Guides for Horizontal Placement of Columns."

6. Type 61-C, Problem 1, Page 97. Follow the book directions.

7. Type 62-C, Problems 1 and 2, Page 99 in your textbook. Follow book directions.

Note: Read and study "Guides for Spacing the Tabulation," Page 99 before typing 62-C.

8. To center columnar headings. From the point where the column is to begin, space forward once for each two spaces in the longest line in the column, which will bring the machine to the center of the column. From this point backspace once for each two spaces in the columnar heading. Begin to type where the backspacing ends.

Type 63-C, Problem 2, Page 100, in the type book.

9. Type 66-C, Problem 3, Page 104, in the type book. Follow book directions.

10. Type 67-B, Problem 1, Page 105, in the type book. Follow book directions.

11. Type 68-C, Problem 1, Page 107, in the type book. Follow the book directions with the exception of the carbon copy.

12. Type Problem 2, Page 115, follow the book directions.

13. Type 109-B, Page 169, in the type book. Follow the book directions.

14. Hand in all your production after you have checked it with the key. Your teacher will then give you the test material.

CFE 16116

15. Test Nos. 1 and 2 should be typed in 30 minutes. After typing these tests hand them to your teacher for checking. (Be sure to proofread carefully).

16. Type Nos. 3 and 4 in a 30-minute time limit. Check your papers carefully and hand them to your teacher for checking.

17. If you type these tests satisfactorily, your teacher will give you your next assignment. If not, she will give you some supplementary material to type.

16117

TYPING MONEY COLUMNS IN A TABLE[14]

1. Keep money columns even at the right. If a column becomes narrower it is wise to shift the tab. (As in the Dues column below).

2. Use the $ sign only at the top and, if a totals line is used, at the bottom of a column. If both signs are used, they must line up. (In the School column below, a space follows the first $ sign so it will line up with the one in the totals line at the bottom of the column).

3. If there is a bottom totals line, the word Totals may be (a) blocked with, or centered under, the first column; or (b) indented one space for each column in the table (as shown below).

4. When centering a money column under its heading, (a) note that the bottom totals entry, if there is one, may be the longest item in the column; and (b) ignore or count the $ sign, whichever makes centering easier. (Below: The $ sign is not counted for the Total column but is counted for the Dues and School columns).

BUDGETS FOR SCHOOL CLUBS

(1967 - 1968)

Organization	Dues	School	Total
Girls Athletic Club	$150	$ 50	$200
Boys Hi-Y	125	35	160
Business Club	75	25	100
Science Club	75	25	100
French Club	75	25	100
Forensics Club	50	25	75
Hobby Club	50	15	65
TOTALS	$625	$625	$825

[14] Freeman, op. cit., p. 118.

16118

SPACING TABLES[15]

Study the illustration below. It shows you how many spaces to allow between the various headings and parts of a table.

Note that top and bottom margins of the table are equal. The table is said to be centered vertically. To center a table vertically, proceed as follows:

1. Count the lines in the entire table, including the lines between the headings.
2. Subtract the number of lines from 66 if a full sheet is used or from 33 if a half sheet is used. Divide by two for equal top and bottom margins. This will place the copy in exact center position.
3. To place the copy in reading position, subtract three spaces from the top margin.

WEEKLY REPORT OF SALES ← Main heading

Double space →

Week Ending July 5 ← Secondary heading

Triple space →

Name	Amount ← Column heading
Double space →	
John Charles Barrons	$2,030.19 ← Column entry
Beverly Joyce Armstrong	1,975.50
Glenn Noble Bassett	1,875.80
Laurence Brent Carver	1,511.00
Roger Lee De Forest	1,500.56
Camillo Wilde	1,314.75
John Harlow, Jr.	925.89
Alice Kathleen Swan	910.50

[15] Wanous, op. cit., p. 9.

16119

HOW TO TYPE STATISTICAL COPY[16]

Copy containing figures must be typed and proofread with the greatest care. Errors are easy to make but hard to find. Yet the copy you prepare must be absolutely accurate, as errors in figures can be very costly. Use the guides below. They will help you to become an expert typist.

1. Type columns of figures horizontally with the aid of the tabulator mechanism.

2. Use a ruler as an aid in reading the correct figures in each column; otherwise, your eyes may skip some of the figures. Read across; then, move the ruler down for the next line.

3. In reading the numbers for typing, group figures and use comma divisions whenever possible. For instance, read 1235 as twelve thirty-five, not one, two, three, five; 1,235 as one, two thirty-five; 10.25 as ten point twenty-five, not ten and twenty-five hundredths.

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[16] Ibid., p. 131.

16120

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: II. LUBRICATION

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Repacking Front Wheel Bearings

CONDITIONS:

This assignment will be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Position hoist arms and raise automobile to comfortable working height
6. Remove front wheels and hubs following steps as outlined in the manual
7. Remove old grease from hubs and bearings following all steps as outlined in the manual
8. Make all tests and checks as outlined in the manual
9. Repack bearings following all steps as outlined in the manual
10. Install front wheels and hubs following all steps as outlined in the manual

PERFORMANCE CRITERIA:

1607

STEPS IN TABULATING[17]

1.

Center the paper in the machine.

2.

Clear the tab stops.

3.

Decide on the number of spaces that are to be used between the columns (4, 6, 8, 10, or 12)

4.

Move the carriage to the center of the machine.

5.

Backspace once for each two spaces in the longest word in each column.

6.

Backspace once for each two spaces between the columns.

7.

Set the left margin stop. This is the point at which the first column will start.

8.

From the left margin, space forward once for each letter, digit, and space in the longest item in the first column and once for each space between columns 1 and 2. Set the tab stop for the second column. Continue in this way until all stops have been set.

9.

Return the carriage. Operate the tab bar or key to determine whether all the tab stops have been set.

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[17] Ibid., p. 10.

16121

HOW TO PROOFREAD STATISTICAL COPY[18]

The guides given below have been found to be helpful in proofreading tables and other statistical matter. Study these guides. Use them in checking your work.

1. Proofread statistical copy in pairs. Read aloud from the original while someone else checks the copy you prepared.

2. If you must proofread your own work, place the original and the typed copies as close together as possible, matching the numbers on a horizontal plane. Read a number from the original copy first; then, compare it with the corresponding number in the typed copy.

3. Proofread straight columns of numbers vertically; that is, read and check the numbers in the first column, then the second and so on until you finish the job.

4. Proofread straight copy containing figures and table copy in which items are lined out and corrected horizontally; that is, line by line.

5. In proofreading numbers, use the procedures described and illustrated on Page 8.

EXPLANATION	NUMBER	PROCEDURE
Double figures and use comma divisions whenever possible. Note the illustration in the opposite column.	12	Twelve
	123	One twenty-three
	1234	Twelve thirty-four
	1,234	One two thirty-four
	12,345	Twelve three forty-five
	123,456	One twenty-three four fifty-six
For numbers that are repeated, use the word "twice." For numbers appearing three or more times, use "three times," "four times," etc.	325	Three twenty-five--
	325	twice
	672	Six seventy-two--
	672	3 times
	672	

[18] Ibid., pp. 7,8.

16122

Refer to a cipher as a 0 (pronounced oh) or zero.	2-05 2-05 2-05 2-05	Two dash zero five--4 times
For consecutive numbers, read all the digits in the first number, but only the last two digits of the remaining numbers.	1950 1951 1952 1953	Nineteen fifty, fifty-one, fifty-two, fifty-three

10123

TEST NO. 1

Directions. Set up the following data in two columns. Use 12 spaces between columns and double space the material in the columns. Center the tabulation vertically and horizontally. 15-minute time limit.

NUMBER OF TAXICABS OPERATED IN
15 LARGEST CITIES[19]

New York, New York, 11,796; Chicago, Illinois, 3,749; Philadelphia, Pennsylvania, 2,150; Los Angeles, California, 967; Detroit, Michigan, 1,310; Baltimore, Maryland, 1,1514; Cleveland, Ohio, 586; St. Louis, Missouri, 1,034; Washington, D. C., 9,534; Boston, Massachusetts, 1,525; San Francisco, California, 739; Pittsburgh, Pennsylvania, 617; Milwaukee, Wisconsin, 500; Houston, Texas, 551; Buffalo, New York, 375.

[19] Ibid., p. 13.

16124

Type and Transcription
(First Semester)
Tabulation

TEST NO. 3[21]

Directions: Type the following letter in Modified Block Form with Indented Paragraphs. 15-minute time limit.

Current Date.

Mr. Paul Cleary, Supreme Manufacturing Co., 2480 Washington Street, Mentor, Ohio 44060 Dear Mr. Cleary: It is with pleasure that we answer your inquiry about supply storage cabinets. All the cabinets we handle are steel, full height, double-door units. They have four adjustable shelves and are made to withstand heavy loading. Here are four of the most popular models:

Model No.	Depth	Height	Price
802	18"	72"	$42.50
803	18"	78"	54.00
840	24"	72"	52.00
841	24"	78"	64.50

(P) All cabinets are 36" wide, so they will fit into the space you have available. (P) Enclosed is literature on the four units described above. All are on display in our showroom and may be viewed at any time. (P) If we can be of any further assistance, please advise. Sincerely yours, Henry Dillon, Sales Manager, (initials), Enclosure.

[21] Freeman, op. cit., p. 38.

16126

Type and Transcription
(First Semester)
Tabulation

TEST NO. 4[22]

Directions. In attractive, tabular form, arrange and type the following material on a full-sized sheet of paper. Type the material in the columns double spaced. 15-minute time limit.

MODERN EQUIPMENT COMPANY
Special Sale of Office Equipment
August 21-31

Item	List Price	Sale Price
Clerical Posture Chair	$ 84.50	$ 63.40
Secretarial Chair	29.95	22.45
Junior Executive Chair	63.50	47.85
Executive Steel Desk	179.50	134.65
Conference Desk	315.90	261.25
Secretarial Desk	212.00	159.00

[22] Ibid., p. 111.

16127

Type and Transcription
(First Semester)

MANUSCRIPTS

Performance Criteria:

At the conclusion of this unit you will be able to type an outline and a manuscript without footnotes in correct form in 30 minutes. You will also be able to type a title page and a short manuscript with footnotes according to correct manuscript form. This will be done in a time limit of 30 minutes.

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Typists are often called upon to type in final form material which is not correspondence but which must be arranged neatly on a full sheet of good quality paper. Typing this material is usually referred to as manuscript or report typing.

Manuscript typing includes such items as school themes, research papers, master's theses, various kinds of business or technical reports, etc. Certain details are followed for the arrangement of material in manuscript form. Often school policy may determine the manuscript form and arrangement, but the details of form and arrangement that are used in this unit are acceptable for general use.

During this unit you should drill at least five minutes each day to increase your speed and accuracy in typing. You are to hand your drill papers in with the production lessons of this unit. Use the drills in your type book and select those that will help you the most.

Always proofread carefully and make the corrections as needed.

Note: A guide line sheet has been placed in this unit for your use. Place it behind your paper before you insert it in the typewriter. This will help you keep the proper margins for manuscript typing.

If any questions arise, please ask your teacher.

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Follow the listed instructions step by step to develop your skill in manuscript typing:

1. Turn to page 82 in the type book. Type Problem 51-B. Follow the book directions carefully.

2. Type Problem 2, 52-C, page 85, in the type book. Use a full sheet of paper and center the problem both vertically and horizontally.

16128

3. Type the following outline in correct form. Center the problem both vertically and horizontally.

Title: Control Panel Wiring[23]
I. TABULATOR (ACCOUNTING MACHINE)
A. Numerical Printing
B. Alphamerical Printing
C. Detail and Group Printing
D. Zero and Special Symbol Control
E. Arithmetic Operations
F. Program Control
G. Selecting
1. X cards vs. no X cards
2. Digit selection
3. Pilot selectors
4. Co-selectors
H. Summary Punching
II. REPRODUCER
A. Gang Punching
B. Reproducing
C. Combined Gang Punching and Reproducing
D. Summary Punching
E. Mark-Sensed Punching
III. COLLATOR
A. Matching
B. Merging
C. Selecting
D. Sequence Checking

4. Type Problem 88-D, page 137-138, in your type book. Read and follow carefully the book instructions.

5. When typing manuscripts, it is often necessary as in letters, etc., to divide a word at the end of a line. It is very important that this is done correctly. If it is not, it is considered an error. This exercise and some that follow will be helpful in reviewing the rules for word division. However, if you are ever in doubt as to how to divide a word, always consult your dictionary. A Rules for Word Division paper is attached.

6. Type Problem 81-C, page 126, in the type book. Follow the book directions. This guide should be kept for reference throughout this course.

7. Type Problem 55-C, page 89. Follow the book directions.

8. Type 81-D, Problem 1, page 127. Follow the book directions, but type this assignment on the bottom half of the sheet of paper used for the preceding problem.

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[23] Ibid., p. 60.

16129

9. Type 82-C, Problem 1, page 128, and Problem 1, 83-C, page 130. Use the top and bottom half of the same sheet of paper and follow the book instructions.

10. Type 88-C, page 137, 89-C, page 139, 90-C, and 91-C, page 145. Use a two-inch top margin for the first page and a one-inch top margin for all other pages. There should be approximately a one-inch bottom margin on all pages. Place the page number on all pages except the first page on the fourth line from the top of the page at the right margin. Then begin typing on line seven. Use a 70-space line. Type the number given for each guide outside the left margin. Do this by using the margin release, backspacing four spaces from the left margin stop. Do not underscore the letter underscored in red. This assignment should be kept for reference throughout this course.

11. Type 131-B, page 193, 132-B, page 195, 133-B, page 197, 134-B, page 199, and 135-B, page 200. Follow the instructions listed for assignment #10. This assignment should also be kept for reference throughout this course.

12. Type the following one-page manuscript in manuscript form. Refer to your outline of manuscript form for correct spacing and margins. Assume that this manuscript will be bound on the left.

Title: The Power of Speech

A great man once said that could he keep only one of his faculties, he would choose the power of speech. With this, he said, he could overcome the loss of his other faculties. This gives much emphasis to the power of speech, but speech is as vital to each of us as it was to that great man. (P) Think of the times and places in the last few days that people have stopped to talk to someone. How often we try to put across an idea, tell a joke, ask a question, or agree with another person! There is the talk with one's best friend about plans for Saturday evening, the explanation of how to do certain homework, the attempt to get parents' permission for something, and the casual talk at the school lunch table. (P) Speech plays a great part in everything that one does--and it also plays a major role in making up one's personality. Among the many qualities of personality, one of the most important undoubtedly is speech. The way in which people talk and what they say genuinely affect their attitudes toward one another. (P) If this be true, then everyone should strive diligently to learn to speak well. Probably the best time to begin is while we are in school. (P) A person who has learned to express himself easily and clearly will find that this ability opens doors of opportunity in his business and social life that might otherwise remain closed.

13. Type 84-C, page 132. Be sure that you read all of the instructions carefully. There will be a title page and table of contents in this assignment also. Follow the directions on page 132

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[24] Liguori, op. cit., p. 24.

/ PERFORMANCE OBJECTIVE STATEMENT /

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: II. LUBRICATION

PERFORMANCE OBJECTIVE NO.: 2 TITLE: Repacking Front Wheel Bearings

CONDITIONS:

BEHAVIOR:

11. Make finsl and adjustments
12. If all tests and adjustments are satisfactory, return tools and materials to proper place
13. Lower automobile to floor
14. Return automobile to proper parking area
15. Remove front seat covers and store in proper place
16. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove front wheels, pack bearings, and reassemble in 2 hours.

1608

Learning time: 2 hours

for these. The table of contents is to be typed after the manuscript is completed so that the page numbers will correspond with your paper. Use a left margin of 30 and a right margin of 76 for the table of contents. NOTE: Leaders connect the headings and their corresponding page numbers. Leaders are periods and spaces typed alternately, with a blank space before the first period and at least one blank space after the last period. Subsequent rows of leaders may be aligned by noting whether the first line is typed with the periods on odd or even numbers and maintaining the same placement line.

Before you start typing read the following final pointers for manuscript typing:

a. Keep all arrangements of material neat and simple.
b. Try to have at least two lines of paragraph at the bottom or at the top of a page.
c. Do not divide the last word of more than two lines in succession or the last word on the page.
d. When typing a sidebound manuscript, remember to center over the line of writing. The center will be 53 on your typewriter.

14. Refer to your capitalization guide sheet and re-read number six on footnotes. Also refer to your outline of manuscript form. Type 54-D, page 87. Follow the book directions. NOTE: Footnotes are separated from the last line of a manuscript by a single space, a 1 1/2 inch horizontal line from the left margin, and a double space. Remember the rule: single space before the line and double space after. Footnotes must appear on the same page as the notation to which they refer.

15. Type 55-B, page 88, Problems 1 and 2. Follow the book instructions except use a 70-space line.

16. Type 57-C, Problem 2, page 92. Do not follow the book instructions. Type this problem according to manuscript form. Refer to your guide to manuscript form if necessary. NOTE: If a manuscript does not take up a whole page or if it ends in the middle of a page, the line and footnote must be typed at the bottom of the page so that there is just an inch left at the bottom for a margin. If you have a question about this, ask your teacher.

17. Hand in all of your production work for this unit on manuscripts. Your teacher will give you the test material if you have completed the unit satisfactorily.

18. Test 1 and 2 should be typed in 30 minutes. After you have completed the tests, hand them to your teacher. Be sure to proofread carefully.

19. Test 3 should be typed in 30 minutes. Proofread your papers carefully and hand them to your teacher for checking.

20. If you type these tests according to the terms stated in the performance criteria, your teacher will give you the next assignment. If not, some supplementary material on this unit will be given to you.

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VISUAL GUIDE FOR A BOUND MANUSCRIPT

LINE 7: TEXT ON CONTINUATION PAGE

LINE 13: TITLE ON OPENING PAGE

	Unbound	Side-Bound	Top-Bound
Top margin (first page)	2"	2"	2 1/2"
Top margin (other pages)	1"	1"	1 1/2"
Left margin	1"	1 1/2"	1"
Right margin	1"	1"	1"
Bottom margin	1" - 1 1/2"	1" - 1 1/2"	1" - 1 1/2"

3

2

1

S T O P

16132

WORD DIVISION RULES FOR TYPEWRITING[28]

DO NOT

1. Do not divide words unless absolutely necessary.

2. Do not divide words of one syllable.
   Right: type Wrong: ty-pe

3. Do not divide words of four or five letters.
   Right: avoid Wrong: a-void

4. Do not divide contractions.
   Right: wouldn't Wrong: would-n't

5. Do not divide abbreviations.
   Right: f.o.b. Wrong: f.o.-b.

6. Do not divide a word after a beginning syllable of one letter.
   Right: amount Wrong: a-mount

7. Do not divide a word before a final syllable of one or two letters.
   Right: heav-enly Wrong: heaven-ly

8. Do not divide a number unless it is a very long number, and then divide it at a comma.
   Right: 1,000 Wrong: 1,-000
   100,000,-000 100,000,0-00

9. Do not divide proper names.
   Right: Mr. John Armstrong Wrong: Mr. John Arm-strong

10. Do not divide the last word on the last line of a page.

DO

1. Divide words between whole syllables. If you are in doubt about the syllables of a word, consult a dictionary.
   Right: ques-tion Wrong: quest-ion

2. Divide words after a prefix of three or more letters.
   Right: pre-sentable Wrong: pres-entable

3. Divide words before a suffix of three or more letters.
   Right: present-able Wrong: presen-table

4. Divide words after a single-vowel syllable.
   Right: hori-zontal Wrong: hor-izontal

5. Divide words between two adjoining single-vowel syllables.
   Right: anxi-ety Wrong: anx-iety

6. Divide a compound or hyphenated word only between the parts of the word.
   Right: brother-in-law Wrong: broth-er-in-law

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[28] Freeman, op. cit., p. 5.

16133 SCIA

7. Divide words between double consonants.

Right: buz-zard Wrong: buzz-ard

But:

Divide words after the double consonant when a suffix is added to a word that ends in a double consonant.

Right: bill-ing Wrong: bil-ling

Divide words between the double consonant when the last consonant is doubled with the addition of a suffix.

Right: stop-page Wrong: stopp-age

8. Divide dates (only if necessary) between the day and the year. Do not use a hyphen.

Right: May 12,
1966

Wrong: May 12,-
1966

TESTS

Test #1[25]

Directions: Set up the following information in correct outline form. Center the problem horizontally and vertically. The time limit on this problem is 15 minutes.

Title: Types of Business Ownership
I. Sole Proprietorship
A. Description
B. Advantages
C. Disadvantages
1. Limited capital
2. Unlimited financial liability
3. Limited life of business
II. Partnership
A. Description
B. Advantages
1. Capital
2. Organization
3. Management
C. Disadvantages
1. Unlimited financial liability
2. Limited life of business
3. Disagreement
III. Corporation
A. Description
1. Kinds
a. Municipal
b. Private
2. Method of formation
3. Form of organization
B. Advantages
1. Transferable ownership
2. Limited financial liability
C. Disadvantages
1. Impersonal relationship
2. Size
3. Government regulation
4. Separation of ownership and management
IV. Cooperative
A. Description
B. Advantages
C. Disadvantages

[25]Freeman, op. cit., p. 62

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Test #2 [26]

Directions: Type the following material in manuscript form. This particular manuscript will be unbound. The time limit on this problem is 15 minutes. You may use your guide sheet if you wish.

Title: The New Office Job

There are many problems facing the graduate who is ready to begin a new office job. In the first place, a transition must be made from a school class schedule to a quite different office schedule. In school, a great deal of work was routine and did not change much from day to day. In business, most of the work calls for decisions to be made by the worker and for the ability to meet new work situations. (P) In addition, a beginning office worker meets a social environment in the office which differs from that which he has known most of his school life. In school, the student worked mostly with people of about his own age and with those who had somewhat similar interests. The beginning office worker finds that fellow workers are probably older and that superiors often are middle-aged. He may need time to get used to the age factor. (P) Then, too, the beginning worker is subjected to a supervision far different from that which he knew in school. There, most of the supervision was provided by trained instructors who accepted mistakes and realized that mistakes are part of learning and growth. In the office, the worker is supervised by persons whose attitudes often may be that mistakes are expensive and have no place on the job. In class, when a given task was completed, the student was given something else to do under no pressure of time. On the job, he must learn how to keep busy. (P) In a study completed recently, a number of conclusions were made concerning graduates who had become office workers. Some of these conclusions relate to training that individuals can obtain in school. (P) It was found that a number of graduates did not have adequate training and information for locating a job. They were not well informed about office positions which might be available. They did not know the procedures to use to find job leads nor the methods they could use to make the initial job contact.

[26] Liguori, op. cit., p. 22.

Test #3[27]

Directions: Type the following material in correct manuscript form. This manuscript will be sidebound. You may use your guide sheet if you wish. Be sure to proofread carefully. Make a title page for this manuscript. Use your name and the school and today's date. The time limit for this problem is 30 minutes.

Title: Growth of Industry-Sponsored Economic Education

American business leaders have recently recognized economic education as a major responsibility of business. Both the public relations and the employee relations activities of many companies may now center on the same goal--economic education. "Economic education for employees is becoming accepted as a day-to-day operating problem a way of life for the well-managed business enterprise."[1] (P) Company efforts in economic education vary widely. Some programs consist merely of the sporadic distribution of posters or advertisements. Others are composed of formal courses in economic principles, in classes held for employees on company time at company expense and taught by trained economists. Within the last few years there has been a tremendous growth of formal course instruction. Information about free enterprise is perhaps the most widely used theme--and the one most commonly criticized. (P) In September, 1946, Mill and Factory, a handbook of production and maintenance know-how, reported a survey "made among all types and sizes of manufacturing companies about management's education on the many advantages of American free enterprise and how it functions."[2] About 500, or 48 percent, had programs called "employee education." The most frequently used media reported were employee publications, group meetings, and talks. Although companies frequently have encouraged employees by reimbursement of tuition to enroll for study in schools and colleges, the recent growth in course instruction has largely bypassed the use of academic institutions. (P) Few statistics on the actual extent of industry-sponsored economic education are available, due to the varied nature of the activities and the limited research on the subject. Some insight, however, can be obtained from the research which has been completed. (P) Although no one factor can be shown as the primary cause of industry's increased participation in economic education, four factors may be identified as basic causes: (1) the fear of socialism, (2) the growth of communism, (3) the desire to improve relations with employees, and (4) the desire to convey management's viewpoints and achievements to the general public.[3] Management of companies adopting programs of economic education was, by and large, motivated by one or a combination of these factors.

[1]"School Children Learn About Industry," The Public Opinion Index for Industry (Opinion Research Corporation, March 1950), p. 4.

[2]Glenn D. Overman, Economic Concepts Everyone Should Know, Monograph 95 (Cincinnati: South-Western Publishing Company, 1955), p. 6.

[3]Overman, p. 10.

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[27]Ibid., p. 30.

Type and Transcription
(First Semester)

BUSINESS LETTERS

Performance Criteria

At the conclusion of this unit you will be able to set up a business letter in an attractive and acceptable style. You should be able to type the letters in "mailable" form; that is, correct as to placement, typing, grammar, and punctuation. You should be able to proofread your work and make the proper corrections in a neat manner.

A test will be given at the end of the unit which will consist of typing letters in "mailable" form. The letters used in this test will be typed in the following styles: modified block with indented paragraphs, modified block with blocked paragraphs, and block. There will be examples of the long, average, and medium length letter and open and mixed punctuation. A time limit will be placed on the typing of these letters which will be approximately ten minutes for each short letter.

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There are a number of acceptable styles to use in typing business letters. We will use only three styles in this unit. It must be remembered that a stenographer or typist should follow the style used in the office in which she is working regardless of whether the style was given in her "type" book.

Business letters have various parts in them that will be introduced as you go through the unit. You will find a Letter Placement Chart, examples of Principal Letter Styles, and a Parts of the Business Letter chart attached. You are expected to refer to these materials to help you in setting up the letters in your lessons.

During this unit you should drill at least five minutes each day to increase your speed and accuracy in typing. Use the drills in your type book and those in the supplementary drill books that you may obtain from your teacher. Select those that will help you most.

Follow the steps in this unit carefully so that you will become proficient in typing business letters. Remember that proofreading is as important as the typing itself. Proofread all material carefully and make corrections as needed.

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1. Turn to Page 102 in the type book and study the style letter. This is a Modified Block Style with Block paragraphs. (This means that there is no indention for paragraphs). Mixed Punctuation is used in this letter. (Read the "mixed punctuation" note on this page very carefully.

2. Type the style letter on Page 102. Proofread your work carefully and make any corrections necessary.

3. Type Problem 2, Page 103, in your type book. Follow the book directions carefully.

4. Type Problem 3, Page 103 in your type book. Follow book directions.

5. Type 66-C, Problem 1, Page 104, in the type book. Use Modified Block Style with Block Paragraphs and Mixed Punctuation. Use the current date. Use a 60-space line with eight spaces between the date and the inside address.

6. Enclosure designation. This is an indication that something is being sent with the letter. It always starts at the left margin, either one or two lines below the reference initials.

Enclosure Forms

One Enclosure	Two or more enclosures (Change number when necessary)
Enc.	Enclosures
Enclosure	Enclosures 2
	Enc. 2
	Enclosures (2)
	Enclosures: 2

7. Type the following letter using Modified Block Style with Block Paragraphs and Mixed Punctuation. Use the current date. This is an average length letter. Refer to your chart for placement:[29]

(Current date)/ Moore Advertising Company/ 201 Fifth Avenue/ New York, New York 60132/ Gentlemen/ Enclosed is a copy of a letter we have received from the Mansfield, Ohio, "Index" concerning your May 31 advertisement in that paper. As you will note, the letter indicates that we must pay the national rate in Mansfield. (P) Since our contract with you does not authorize the payment of a national rate for a paper of the "Index" type, we should have your confirmation before approving the invoice for payment. (P) A prompt letter from you will be appreciated. We are eager to settle the matter without delay so as not to jeopardize our arrangements for future space in this publication. Please address your letter to this company, not to the writer./ Yours very sincerely/ Robert R. Gault/ Contract Manager/ (initials)/ Enclosure

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[29] Bowman, Wallace B., Business Letter Typing (Cincinnati: South-Western Publishing Company, 1957), p. 19.

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8. Type the following letter. Use Modified Block Style with Block Paragraphs and Mixed Punctuation: (This is an average length letter).[30]

(Current Date)/ Yearbook Faculty Adviser/ Monticello High School/ Monticello, New York 12701/ Dear Adviser/ Herbert Yearbook can assure you of a number of advantages over your present yearbook producer. (P) These advantages are probably most dramatically apparent in the Company's highly individual approach to customer services, which include a number of historic firsts in the yearbook printing and photography field. (P) For example, the photography division now has outstanding available light photographers. These photographers use the finest equipment obtainable to provide dramatic and exciting available light pictures for the key areas of your book. (P) Our representative, Mr. John Lovell, would very much like to call upon you. He can tell you about our services in every area of yearbook photography and printing. He can show you why so many leading schools and colleges are using our services year after year. (P) Won't you please indicate on the enclosed card a convenient time that he may visit you./ Sincerely yours/ Harry Herbert, President/ (initials)/ Enclosure

9. Turn to Page 151 in your type book. This is a Modified Block Letter with Indented Paragraphs and Mixed Punctuation. Study this letter carefully.

10. Type the style letter on Page 151. Note that there are 198 actual words in the body of the letter. (Refer to your chart for placement). Be sure to proofread your work carefully and make all necessary corrections.

11. Type 95-C, Problem 1, Page 152, in your type book. Refer to your placement chart for margins and spacing. Type this letter in the Modified Block Style with Indented Paragraphs and Mixed Punctuation. NOTE: In this letter type the official title on the first line with the name in the inside address. Separate the name and the title with a comma. In the closing lines, type the title on the line below the name.

12. Type Problem 2, Page 152 in your type book in Modified Block Style with Indented Paragraphs and Mixed Punctuation. Refer to your chart for placement.

13. Type the following letter in Modified Block Style with Indented Paragraphs and Mixed Punctuation:[31]

(Current Date)/ Mr. Charles M. Munroe/ 333 Lincoln Street/ Lancaster, Pennsylvania 21034/ Dear Mr. Munroe/ Mr. C. H. Carlton has submitted to us an interesting book entitled ADVERTISING--ITS PRINCIPLES AND PURPOSES. He has asked us to purchase the publication rights from the Webb Publishing Company, which has had some financial difficulty and is now not in position to market it satisfactorily. (P) Would you be willing to read the book and let us know whether you believe it has any textbook possibilities? It may be that some revision of text material and some reorganization of chapters will be necessary. Please keep this in mind when making your recommendations (P) Of course, we expect to pay you the usual fee for your work./ Sincerely yours/ David E. Duncan/ (initials)

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[30] Freeman, op. cit., p. 33.

[31] Bowman, op. cit., p. 16.

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: III. EXHAUST SYSTEM

PERFORMANCE OBJECTIVE NO: 3 TITLE: Remove and Replace Muffler and Tail Pipes

CONDITIONS:

Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Function, Construction, and Servicing of Exhaust Systems	1. Motor Service's Automobile Encyclopedia, by Toboldt and Johnson. pp. 286 through 290, 292 through 301 Auto Mechanics Fundamentals, by Stockel. pp. 6-32 through 6-33	1. Related Information Class and/or Shop Library

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056 238

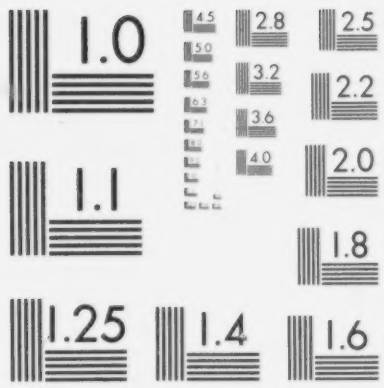

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

14. Type the following letter in Modified Block Style with Indented Paragraphs and Mixed Punctuation.

NOTE: In the closing of this letter the name of the company is used. This should be typed in two lines below the complimentary close and should be typed in all "caps." After you type the company's name, you should go down four lines (three blank spaces) to type the name or the title.[32]

(Current Date/ Mr. Charles M. Munroe/ 333 Lincoln Street/ Lancaster, Pennsylvania 21034/ Dear Mr. Munroe/ Mr. McGill and I have had time to give very careful attention to the competent and helpful report which you submitted to us concerning Carlton's ADVERTISING--ITS PRINCIPLES AND PURPOSES. We are particularly interested in your suggestion that Mr. Carlton revise his book in collaboration with some high school teacher of advertising. (P) If we were to persuade Mr. Carlton to consider such a revision, would you be in position to recommend a co-author? Or better still, would you be willing to undertake the revision yourself? In giving your answers, please keep in mind the importance of completing the revision in time to enable us to put the book on the market within the next eighteen months. (P) Our check is enclosed./ Sincerely yours/ MODERN PUBLISHING COMPANY/ David E. Duncan/ (initials)/ Enclosure

15. Turn to Page 71 in your text bock and study the style letter. This is a Block Style letter with Open Punctuation. (Read the notations on Open Punctuation carefully).

This is a personal letter and so the address of the person writing the letter appears on the letter. If this letter were a business letter, it would be written on letterhead paper and so the date is all that would be necessary to type.

16. Type the style letter on Page 71 of your type book. This is a Block Style letter with Open Punctuation. Proofread your work carefully.

17. Type the following letter in Block Style with Open Punctuation.[33] Refer to your chart for placement.

(Current Date)/ Mr. Sanford Barr, Manager/ Retailers, Inc./ 4444 Spring Street/ Opal Cliffs, California 95060/ Dear Mr. Barr/ We want to call your attention to the fact that, though you are an important executive in retailing, you are not getting the most practical business newspaper in your field, the highly specialized Retail News. (P) You are in a position where you have to know just about everything that is going on in the retail business. Retail News can show you by word and picture how other store managers are solving the very problems you might be having and how they are doing the very things you have to do. (P) Our editors canvass the whole country to get ideas--not spectacular things of great magnitude--but down-to-earth, everyday practical ideas which have proven successful for others and which you can adapt easily for your own store. (P) To keep a short note short, you can get your personal copy of Retail News by signing your name

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[32] Ibid., p. 178.

[33] Freeman, op. cit., p. 37.

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on the enclosed self-addressed card and returning it to us. We will bill you later./ Very truly yours/ Peter Barbera/ Subscription Manager/ (initials)/ Enclosure

18. Type the following letter in Block Style with Open Punctuation: Remember: When a company name is used in a closing it is typed in all caps.[34]

(Current Date)/ Dandry Manufacturing Company/ 604 Lovell Street/ Cincinnati, Ohio 46701/ Gentlemen/ The enclosed copy of our current catalog describes the flexible shaft tools about which you inquire in your letter of February 16. Quoted prices are net. (P) Our engineering department is at your service for help on any unusual problems. Further correspondence is invited./ Very truly yours/ Stone Tool Company, Inc./ Sales Department/ (initials)/ Enclosure.

19. After you have completed assignment 18, hand in your production work for this unit. Your teacher will give you the test material if your work is satisfactory.

20. When you have completed the tests for this unit, your teacher will give you your next assignment.

[34] Bowman, op. cit., p. 8.

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PRINCIPAL LETTER STYLES

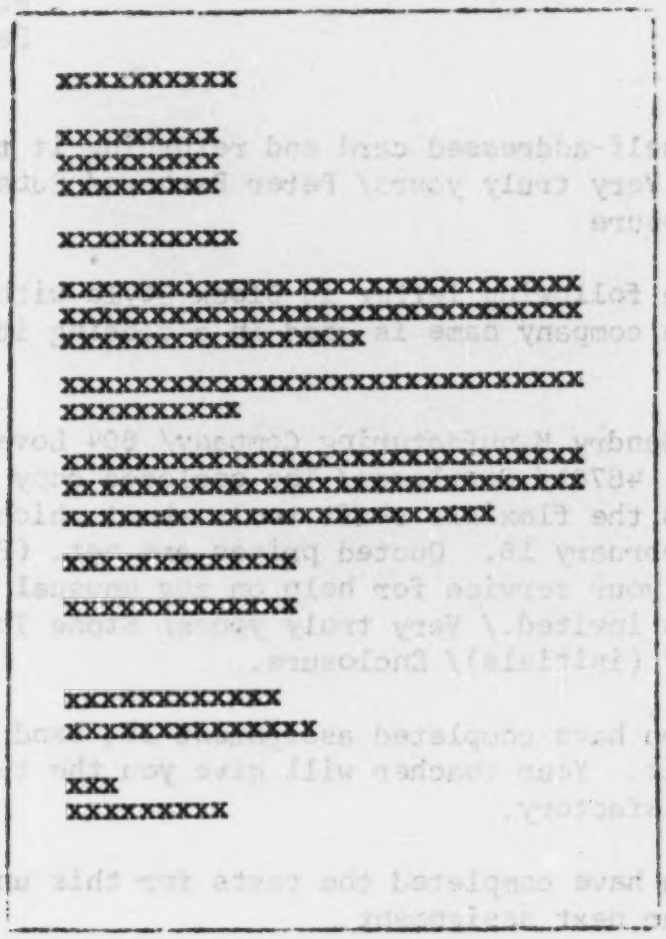

BLOCK

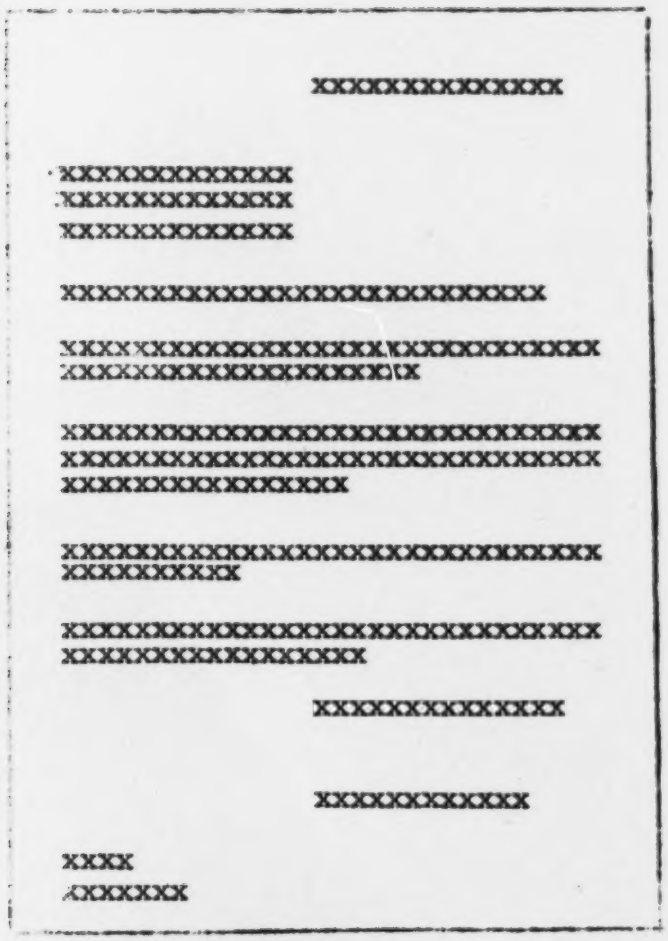

MODIFIED BLOCK

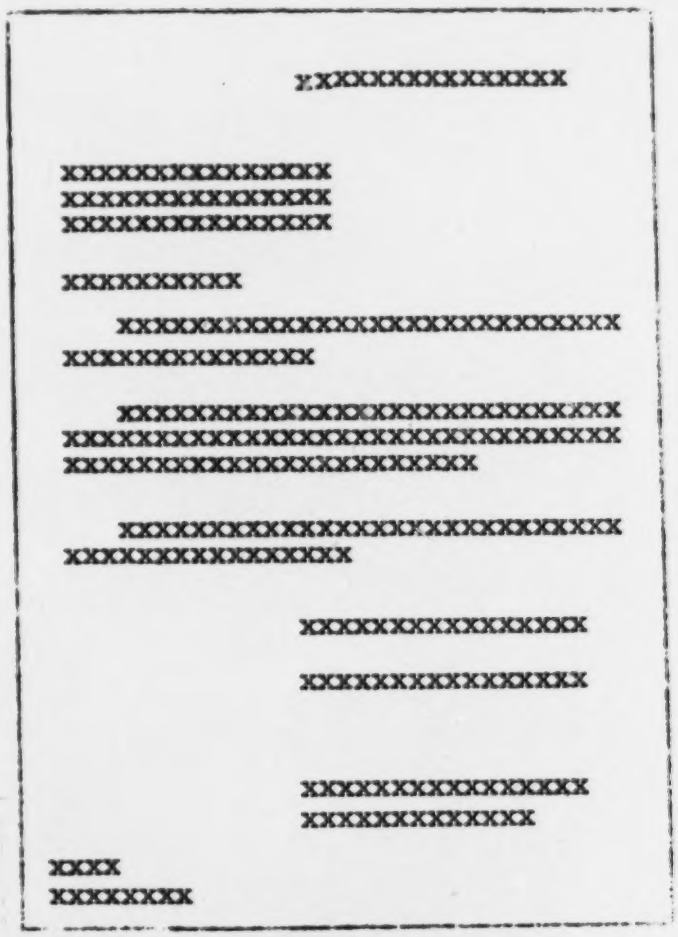

MODIFIED BLOCK
WITH
INDENTED PARAGRAPHS

16143 16143

PARTS OF A BUSINESS LETTER

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                                  xxxxxxxxxxxxxxxxxxx
                                  xxxxxxxxxxxxxxxx  - - - - - - - Letterhead
                                  xxxxxxxxxxx

Airmail - - - - xxxxxxxxxxxx            xxxxxxxxxxxxxxxxxx - - - -Date Line

Inside
Address - - - - xxxxxxxxxxxxxxxxxx
                xxxxxxxxxxxxxxxxxx
                xxxxxxxxxxxxxxxxxx

                xxxxxxxxxxxxxxxxxxxxxxxx - - - - - - - - - - - - -Attention
                                                                 Line
Salutation - - -xxxxxxxxxxxxxxxxxx

                                  xxxxxxxxxxxxxxxxxxxx - - - - - - Subject
                                                                  Line
                xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

                xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Body - - - - - -xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                xxxxxxxxxx

                xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

                                        xxxxxxxxxxxxxxxxx - - - - Complimentary
                                                                  Close
                  Firm Name - - - - - xxxxxxxxxxxxxxxxx
                  (In Caps)
                                        - - - - - - - - - - - - - Signature

                                        xxxxxxxxxxxxxxxxx - - - - Writer's
Reference                               xxxxxxxxxxxxxxxxx    Identification
Initials - - - -xxxxxx
                xxxxxxxxxx - - - - Enclosure Designation
Carbon
Copy - - - - - -xxxxxx
Designation
```

16144

16142

PLACEMENT CHART

Type the date 13-15 spaces down form the top of your paper if you are using plain paper.

If you are using a letterhead, always type the date a triple space after the last line of the letterhead. In such a case, you may have to add or subtract the number of lines between the date and inside address.

Length of Letter	Set Margins at: Pica	Elite	Number of Spaces between Date and inside Address Pica	Elite
300	10-70	15-90	2	4
275	10-70	15-90	3	4
250	10-70	15-90	4	5
225	10-70	15-90	5	6
200	10-70	15-90	6	7
175	15-65	20-85	7	8
150	15-65	20-85	8	9
125	15-65	20-85	9	10
100	20-60	25-80	10	11
75	20-60	25-80	11	12
50	20-60	25-80	12	13

Above 300 words (or above 250 with Pica type): Two-page letter.

Two page letter. Use 250 set up for first page. Leave 1-1 1/2 inch bottom margin. Go down 6 lines to second page notation (Addressee's name, page number, and the date), and then 3 more lines to the body of the letter.

Double-spaced letters: Double the number of words in the letter and fit into the above chart. Only double space very short letters.

16145

TESTS

Business Letters

TEST NO. 1 and 2

Test 1 and 2 should be typed in a 30 minute time limit. After you have typed these letters, proofread them carefully and make the necessary corrections. Hand them to your teacher who will check them.

TEST NO. 1[35]

Type the following letter in Modified Block Style and Block Paragraphs with Mixed Punctuation:

(Current Date)/ Mrs. William A. Buckley/ 519 College Plaza/ Chicago, Illinois 67012/ Dear Mrs. Buckley/ As you walked to the front door to get this letter, did you notice the floor in your entrance hall? It's perhaps the hardest floor in the house to keep clean and bright. No, you can't stop feet from tracking in and out, in and out. There is small wonder that most hall floors look dull and worn before their time! What can you do? (P) You might install permanently beautiful Compo-Roid floors, but perhaps your budget won't permit this at the present time. Then, we suggest the next best thing: Equip your entrance hall and the rooms of your home with Compo-Roid rugs. This is the time to do it, for we have just placed on display an entirely new stock of these modern, smooth-surfaced rugs. They're so attractive, and they're so reasonably priced. (P) If you'll come in, we shall be glad to show these new rugs to you./ Cordially yours/ Oxberry Home Equipment Company/ Alton M. Vessey/ (initials)

TEST NO. 2[36]

Type the following letter in Modified Block Style with Block Paragraphs with Mixed Punctuation:

(Current Date)/ Mr. David E. Penders/ 2746 Fremont Drive/ Springfield, Illinois 67512/ Dear Mr. Penders/ Central's engineering activities are twofold. On the one hand, there is the aeronautical group which is concerned with power plants, aircraft structures, aerodynamics, and electrical applications. On the other hand, there is the airways engineering group which is concerned with airports and building construction. (P) The enclosed booklet contains more detailed information about these two areas./ Very sincerely yours/ Central Airline Corporation/ Director of Public Relations/ (initials)/ Enclosure

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[35] Ibid., p. 66.

[36] Ibid., p. 10.

16146

TESTS

Business Letters

TESTS NO. 3 and 4

Tests 3 and 4 should be typed in a 30-minute time limit. Proofread your letters carefully and hand them to your teacher for checking.

TEST NO. 3[37]

Type the following letter in Modified Block Style with Indented Paragraphs with Mixed Punctuation:

(Current Date)/ Kessler Office Supply Company/ 564 Elkins Street/ Montpelier, Vermont 34012/ Gentlemen/ Old friends are essential in any business, but one must get acquainted with new folks to increase the number of old friends. Right? (P) This is a greeting from Dixon-Lamberton and a personal "thank you" for your recent order--your first with us. We appreciate your thinking of us. We hope that you will find the quality of our product and our service so satisfactory that you will call on us often./ Very truly yours/ Dixon-Lamberton Novelty Company/ Millard T. Burgess/ Sales Department/ (initials)

TEST NO. 4[38]

Type the following letter in Modified Block Style with Indented Paragraphs with Mixed Punctuation:

(Current Date)/ American Novelty Company/ 75 East Macon Street/ South Bend, Indiana 50321/ Gentlemen/ The Central Paper Company of your city, our American Bond distributor, has been requested to furnish you with a sample portfolio and other information concerning this exceptionally fine paper. (P) American Bond is not expensive, and yet it has every characteristic of quality. It will render you excellent service, and its attractive appearance will give your correspondence "customer appeal" that cannot be obtained by the use of ordinary bond paper. (P) We hope that you may consider the use of American Bond on some of your future requirements./ Yours very truly/ Collett Paper Company/ Oliver L. Leonard/ Sales Department/ (initials)/

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[37] Ibid., p. 33.

[38] Ibid., p. 22.

16147

TESTS

Business Letters

TEST NO. 5

This test should be typed in a twenty-minute time limit. Proofread your letter carefully and hand it to your teacher for checking.

TEST NO. 5[39]

Type the following letter in Block Style with Open Punctuation:

(Current Date)/ Mr. Walter H. Kent, Manager/ Imperial Park Theater/ Park Ridge, Illinois 68034/ Dear Mr. Kent/ Prior to the advent of talking pictures, the theater was chiefly concerned with vision, comfort, and capacity. When, however, talking pictures entered the scene, acoustics became the important factor in theater construction. (P) Because of the theater owner's vital concern in the improvement of acoustical qualities of his building, we had a series of laboratory tests conducted by Dr. Arthur S. Campbell, international authority and writer on acoustics of buildings. His experiments, which covered all types of theater chairs, had for their purpose the determination of relative values and importance in adjusting theater and auditorium acoustics. Exact standards and tables of values have been established. The results of these acoustical experiments are offered to you free of charge and without obligation on your part. (P) Of course, we manufacture and sell chairs, all kinds of chairs, but especially auditorium chairs. We believe, however, that every sale must have the two elements of quality and service. The quality of our product is guaranteed; so you need have no doubt about that element. It is our service element with which we wish to acquaint you. (P) Our acoustical department is equipped to prepare appropriate seating plans, to make acoustical analyses, and to offer suggestions for improvement. If you will send us a blueprint of the floor plan and the side elevation of your theater, we will prepare a diagram showing the width and the location of each chair. This diagram will be sent to you with our comments and suggestions. (P) May we have the opportunity of cooperating with you in the planning of and the selection of your seating equipment./ Sincerely yours/ Simmons Furniture Company/ Leonard M. Simmons, President/ (initials)

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[39] *Ibid.*, p. 38.

TRANSCRIPTION

BEHAVIORAL OBJECTIVE:

The student will be able to transcribe on the typewriter designated paragraphs from shorthand plates. She will be able to transcribe each outline accurately.

Each transcription assignment will consist of approximately one typewritten page. A total of 10 points will be given for each assignment with one point deducted for each error. A minimum of six points an assignment will be required to pass. The following will be considered as errors: Placement, not following instructions, misspelled words, type errors, word division, messy erasing, missing words, and additional words. A minimum of 10 passing transcripts will be required.

TEXTS: Gregg Shorthand (D-J Series), McGraw-Hill Book Company
Shorthand Transcription Studies (Fourth Edition D-J Series), South-Western Publishing Company.

Transcription is the ultimate goal of shorthand. The ability to take dictation is of no value unless the dictation can be transcribed accurately. In order to transcribe a student must be able to type, have abilities in English, and must be able to read shorthand notes fluently.

Transcription is a skill and should be developed throughout the entire shorthand course. This skill will be developed by observing the rules of punctuation, grammar, spelling, erasing, proofreading, and by learning to read in thought phrases and by keeping the typewriter moving at an even rate.

To develop this transcription skill, you should spend approximately two periods a week on the transcription lessons and drills. Occasionally your teacher will give you a special timed transcription drill.

The following instructions should be followed when typing transcription drills and lessons:

Drills:

1. Use a 70-space line.
2. If the same line is typed more than once, single space. Double space before starting a new line.
3. Type your name in the upper left corner of your paper.
4. Identify each day's drill with the drill number and date.

Lessons

1. Use a 1 1/2" top margin.
2. Use a 70-space line.
3. Double space and indent five spaces for paragraphs.

161490

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: III. EXHAUST SYSTEM

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove and Replace Muffler and Tail Pipe

CONDITIONS:

This assignment will be performed on a complete automobile

BEHAVIOR:

After satisfactory completion of all related training, proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Select proper manual and turn to appropiate chapter
4. Select proper tools and materials
5. Position hoist arms and lift automobile to comfortable working height
6. Remove muffler and tail pipe following all steps as outlined in the manual
7. Install muffler and tail pipe as outlined in the manual
8. Make exhaust leakage test and other checks and tests as outlined in the manual
9. If tests and checks are satisfactory, return tools and materials to proper place
10. Lower automobile to the floor
11. Start automobile and listen for exhaust leaks

PERFORMANCE CRITERIA:

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4. Type the following in the upper left corner of your paper:
   Name
   Type and Transcription
   Semester 1
   Assignment No.
5. Type the number of each paragraph to be transcribed before typing the paragraph.
6. If more space is needed, use the back of the paper so that the entire assignment is on one piece of paper.

Follow each step in the unit carefully. However, you must remember that transcription goes along with your shorthand, and you must not attempt to do the transcription lessons outlined below if they are beyond the lesson you are on in your shorthand book. If this point is reached, check with your teacher.

Complete assignments 1 though 7. If at any time you have a question or need help, do not hesitate to check with your teacher.

1. Turn to the brief forms in the back of your book. Read the first line. Make sure that you can spell each word. Type the transcription of each brief form. Follow each word with a comma. If one brief form has more than one meaning, type all meanings, spearating each word with a comma. Repeat this until you can type the entire line with a continuous movement of the typewriter. Be sure to keep your eyes on the shorthand plates. Repeat this procedure for the first three lines.

2. Turn to page 30 in your shorthand book. Transcribe Group A. (Start each number on a separate line.) After transcribing these sentences once, repeat the process two more times. Be sure to read the sentences carefully before you type, making sure that you can spell each word correctly. Keep your eyes on the shorthand plates.

3. Continue this same procedure with Group B and C. This is a transcription drill and this paper should be saved for the next transcription drill and handed in with the production lessons.

4. Turn to the brief forms in the back of the book and type lines four to six, using the same procedure as in Step 1.

5. Read paragraph 28, page 34, in your shorthand book. Check for spelling and punctuation. Transcribe the letter, trying to type smoothly and without hesitation with your eyes on the shorthand plates. Proofread your letter carefully and make any corrections necessary on the typewriter.

6. Transcribe No. 29, page 34, following the instructions in Step 5.

7. Continue the same process for Nos. 30, 31, and 32.

16150

8. Hand in assignments 1 through 7 to be checked.

9. From this point on, each day that is used for transcription, you should drill five to ten minutes on the brief forms at the back of the book and the recall charts in the recall lessons that you have completed, using the same process as outlined in Step 1. These drills should be saved until the page is filled before handling it. NOTE: Do not start each day's drill on a new sheet of paper unless the preceding drill page is full. Put the date at the beginning of each day's drill.

10. Complete the following assignments. Each assignment is approximately one page. If more space is necessary, use the back of your paper. When each assignment is completed, hand your paper in to be checked. Be sure to label each assignment and number each transcription. If a heading is used, it should be centered and typed in capital letters followed by three spaces before typing the paragraph.

The following assignments are from your shorthand book:

1. Transcribe Nos. 40, 42, and 44.
2. Transcribe Nos. 57, 58, and 59.
3. Transcribe Nos. 86, 88, and 89.
4. Transcribe Nos. 105, 106, and 107.
5. Transcribe Nos. 156 and 144.
6. Transcribe No. 173 and 157.
7. Transcribe No. 213.
8. Transcribe Nos. 229, 230, and 233.
9. Transcribe No. 268.
10. Transcribe Nos. 295 and 297.
11. Transcribe Nos. 304, 305, and 307.
12. Transcribe Nos. 323 and 324.
13. Transcribe Nos. 333, 334, and 346.
14. Transcribe Nos. 361, 363, and 365.
15. Transcribe Nos. 381.
16. Transcribe Nos. 398, 399, and 401.

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Instructions

The following assignments are to be transcribed after completion of Chapter 8 in your shorthand book. These assignments will all be found in the Shorthand Transcription Studies (Green Book). Continue to make all corrections on the typewriter and hand in each assignment as it is completed.

17. a. Type punctuation rule 1 and 2 on page 4. Single space the typing of the rules. Double space between rules. Triple space and transcribe the shorthand notes that follow. Double space the transcription. Triple space.

b. Turn to page 6, Activity 1C, and transcribe the material after following the directions given in the book. Triple space.

c. Turn to page 9, Activity 2A, and type punctuation rule 3 (single space). Triple space after typing the rule and transcribe the shorthand that follows (double space).

18. Transcribe Lesson 3A, page 11 and 12, (double space). Follow the directions given in the book with the exceptions that the notes will not be read and the exercise will not be timed.

19. a. Study the definitions given in Activity 2C, page 11. Transcribe (double space) the material, inserting the correct word given in color. Triple space.

b. Turn to page 5, Activity 18. Do not follow the book instructions. On a page from your shorthand notebook copy the theory three times. Attach this paper to the completed transcript of this assignment. Transcribe (double space) the shorthand plates that follow the theory. Triple space.

c. Turn to page 10, Activity 2B, and follow the same procedure as in Activity 1B.

Hand in your assignment to be checked. Be sure to attach your shorthand notes.

20. a. Type (double space) the punctuation rule 4 on page 15, Activity 3A. Triple space. Transcribe (double space) the shorthand notes that follow, inserting the correct punctuation according to rules 1, 2, 3, and 4. Triple space.

b. Turn to page 16, Activity 3C. Study the words and their definitions. Transcribe (double space) the material that follows. Triple space.

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c. Activity 3B, page 15. On a page from your shorthand notebook, copy the theory three times. Transcribe (double space) the shorthand plates (page 16) that follow the theory.

Hand in this assignment to be checked. Attach your shorthand notes.

21. Transcribe (double space) Lesson 4A, page 17. Insert the correct punctuation where needed.

22. a. Type (single space) punctuation rule 5, Activity 4A, page 19. Triple space. Transcribe (double space) the shorthand notes that follow, inserting the correct punctuation. Triple space.

b. Turn to page 20, Activity 4C. Study the words and their definitions. Transcribe (double space) the material that follows. Triple space.

c. Activity 4B, page 19 and 20. On a page from your shorthand notebook, copy the theory three times. Transcribe (double space) the shorthand plates, page 20, that follow the theory.

Hand in this assignment to be checked. Attach your shorthand notes to this assignment.

23. Transcribe (double space) page 21. Insert the correct punctuation where needed.

24. a. Type (single space) the punctuation rule 6, Activity 5A, page 22. Triple space. Transcribe (double space) the shorthand notes that follow on page 23, inserting the correct punctuation. Triple space.

b. Activity 5B, page 23. On a page from your shorthand notebook, copy the theory three times. Transcribe (double space) the shorthand plates that follow the theory. Triple space.

c. Turn to page 24, Activity 5C. Study the words and their definitions. Transcribe (double space) the material that follows.

Hand in this assignment with your notes attached.

TYPE

Performance Criteria:

At the conclusion of the second semester:

1. The student will be able to pass at least ten 5-minute timed writings with no more than one error per minute.

2. The student will be able to locate, erase, and correct all typing errors made.

3. The student will be able to complete the following production work as set up in each individual unit:

   a. Carbon copies
   b. Envelopes
   c. Letters
   d. Memorandums
   e. Justifying (varifying) lines
   f. Tabulation
   g. Post cards
   h. Telegrams
   i. Manuscripts

Text: 20th Century Typewriting, Eighth Edition, Complete Course. Lessenberry, Crawford, and Erickson. Cincinnati: South-Western Publishing Company, 1962.

Timed Writings

Timed writings will be given at least twice a week. The student will check his papers carefully and circle all errors. Papers that have no more than one error per minute will be considered as passing and will be handed in. The base rate for each student will be figured by the teacher, and the grading scale for these base rates is attached.

Each timed writing should be set up in the following manner:

1. Double space.
2. 70-space line or as directed.
3. Type the following in the upper left corner.
   Name
   Type and Transcription
   Semester II
   Timed Writing
4. Circle entire word where error appears.
5. Record words per minute and number of errors at the top of the page. Example: 50/4

16154

Production

The production work will be done in individual units. The student will obtain each unit from the teacher in the order designated above.

Each student will evaluate his own work. After completing each assignment in the unit, check your paper with the key at the checking table. Evaluate your own work according to the attached sheet. Record the number of errors per page in the upper right corner of each sheet. If you do not understand any part of the lesson, be sure to check with your teacher so that she can go over it with you. It may be necessary to retype the lesson to make sure that you know how to do it.

Keep each assignment in the unit until the entire unit has been completed. After the unit is completed and checked, fill out the printed record sheet. Sample attached. This should be stapled on top of the completed unit and placed in the basket for checking. REMEMBER! Check your work carefully. Be certain that you understand and know how to set up each lesson in the unit because your grade for the unit will be determined from your test scores.

Drills

Each day the student will be expected to spend from five to ten minutes on drill work. These drills should help improve the student's speed and accuracy in typing.

Drills should be chosen according to the type of production work you are doing. Some drills will be included with specific units. In other cases you are to choose your own drills or those drills that will help you the most. You may select drills from your type book or from the various typing drill books on the shelves.

The drills should be typed in the following manner:

1. Type the following in the upper left corner:
   Name
   Type and Transcription
   Semester II
   Drill Sheet
2. Type the date at the beginning of each day's drill.
3. Set margins for each specific drill.
4. In the case of single line drills, type the line at least twice or until you can type it without error. Single space these lines and double space before starting a new one.
5. In drill paragraphs, type the paragraph single space and double space between paragraphs.
6. Do not use a new sheet each day for drill work. Fill both sides of the paper.
7. Hand in drill paper when both sides are filled.

16155

CARBON COPIES

Performance Criteria:

The student will be able to assemble a carbon pack, erase properly on carbon copies, and type carbon copy notations and blind carbon copy notations in the correct place and the correct way. This will be accomplished through the study of rules and typing examples. No test will be given to cover this unit. This is a continuous unit and it is expected that the student will apply the rules learned and practiced here in the units that follow.

- - - -

If you cannot use carbon paper correctly, an employer will not be pleased with your work. Almost all forms and letters must be typed in duplicate, so it is important that you know the correct way to use carbon paper.

Assembling the Carbon Pack

Turn to page 234 in your type book, (Twentieth Century eighth Edition), and read thoroughly how to assemble a carbon pack.

Take your carbon paper that was given to you with this unit and some paper and practice assembling a carbon pack so that you are sure you are doing it correctly. Use some old paper that has been typed on for this practice. Type a line so that you can check to see if it is put together correctly. NOTE: Always double check to see if the carbon is in correctly before you type any assignments.

Erasing on Carbon Copies

Turn to page 140 in your type book and read the rough draft copy on how to erase on carbon copies. This gives a step by step method that you can follow.

After you have read the material, type 89-D, page 140. Follow the book instructions and make certain that you practice what you have read when you make your corrections.

Carbon Copy Notations and Blind Copy Notations

When a carbon copy of a letter is sent to one or more persons, a notation of this fact is made by typing the letters "cc" at the left margin either one or two lines below the reference initials or enclosure notation. These letters are followed by the name of the person to receive a carbon copy.

At times when the sender does not want to reveal this information, the carbon notation is made on all carbon copies, not on the original, and is called a blind carbon copy. This notation is made by typing the letters "bcc" at the left margin either one or two lines below the reference initials or enclosure notation. These letters are followed by the name of the person to receive a blind carbon copy. It is also correct form to type this "bcc" notation one inch from the top of the page at the left margin. NOTE: To type the "bcc" notation, place a file card back of the ribbon and alignment scale and in front of the original copy. After typing, remove the card.

The following are some examples of a "cc" and "bcc" notation.

Top edge of letter

bcc Mr. William Green

July 7, 1968

Parker Desk Company
3357 Martin Boulevard
Anderson, Indiana 46010

Gentlemen:

Thank you for the catalog which we requested. We have had our purchasing department compare your desks with the desks which we had

This year reservations will be made at the Hotel Gibson for all members of the Executive Committee and their spouses--by order of the President.

Sincerely yours,

Lillian B. Constant
Secretary

crl

cc: Miss Janice Graeter, Vice-President
Mr. Fred White, Program Chairman

P. S. Let me know your feelings on the first two items listed above.

Basic Typewriting Operations

This year reservations will be made at the Hotel Gibson for all members of the Executive Committee and their spouses--by order of the President.

Sincerely yours,

Lillian B. Constant
Secretary

crl

bcc Mr. Fred White, Program Chairman

Let me know your feelings on the first two items listed above.

Basic Typewriting Operations

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Type the following letter Block Style. Make a "cc" for the office file and one for Mr. George Allen.

August 21, 19--/ Clay & Wrenn Agency/ 2615 Rhode Island Avenue/ Washington 16, D. C./ Gentlemen/ We have just received from our district office at Columbus a latter regarding the May 31 advertisement in the Mansfield, Ohio, "Index," about which we have had considerable correspondence. (P) As we have supposed, the bill for this space was paid locally. A notation to this effect should have been made on the returned invoices. We are very sorry that the omission of such a notation has caused you so much trouble. (P) As the Mansfield matter now seems to be fully settled, we suggest that you close your files on this subject. Thank you for your cooperation./ Very cordially yours/ MOORE ADVERTISING COMPANY/ Arthur Dinsmore

Type the following letter Modified Block Style with indented paragraphs. Make a "cc" for the file and a "bcc" for Mr. Harry Davidson.

November 20, 19--/ Lawrence Machine Company/ 1220 Kearney Street/ Kansas City 14, Missouri/ Gentlemen/ As requested in your letter of November 15, we are sending you a copy of the instruction book to be used with the Piering Calculator. This will give you the information you need. (P) In order to convince you that the Piering will handle your figuring in the most efficient manner possible, we are asking our Missouri representative to call on you when he is again in your vicinity. He will gladly give you further information, and he may be able to suggest some shortcutting methods that will speed up your work. (P) This company is eager to cooperate with you in every possible way. Please, therefore, feel free to write to us about your figuring problems. Our Consulting Department is at your service./ Very truly yours

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: X. SERVICING

MILESTONE: III. EXHAUST SYSTEM

PERFORMANCE OBJECTIVE NO.: 3 TITLE: Remove and Replace Muffler and Tail Pipe

CONDITIONS:

BEHAVIOR:

12. If none are detected, return automobile to proper parking place
13. Remove front seat covers and store in proper place
14. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily remove muffler and tail pipe and check exhaust system for leaks in 2 hours

Learning time: 2 hours

ENVELOPES

Performance Criteria:

The student will be able to type addresses, return addresses, and special notations on both large and small envelopes according to the proper placement and correct rules given in this unit. A test will be given which will consist of addressing 16 envelopes. The time limit on the test will be 20 minutes.

- - - -

The Post Office Department now requires a Zip Code to be included with each address. If no Zip Code is given, look up the correct Zip Code in the book on the reference shelf. If the Zip Code is missing on your assignments, it will be considered an error.

REMEMBER: The inside address of the letter and the address on the envelope must be the same.

Addressing envelopes correctly is very important. It must be done accurately so that the proper person will receive it without delay. Also, the outside of the envelope gives the first impression of the sender.

A cardboard guide of a #10 envelope will be given to you with this unit. For each letter that is assigned to you in any succeeding units, trace this card on the back of the letter you type and address it in the correct manner. If no return address is given, you may use the school address.

Placement of Address.

The two most commonly used envelopes are the No. 6 3/4 (6 1/2" x 3 5/8") and the No. 10 (9 1/2" x 4 1/8").

Envelope Size	First Line	Left Margin
No. 6 3/4 (6 1/2" x 3 5/8")	12 lines from top	5 spaces left of center
No. 10 (9 1/2" x 4 1/8")	13 to 14 lines from top	5 spaces left of center

Style

Most envelopes are typed in block style without punctuation at the end of lines, except when an abbreviation ends a line.

16160

Spacing of Addresses

1. An address should never be typed on less than three lines. If necessary, place the city and state on separate lines.

2. Double space all three-line addresses.

3. Unusually long company names may be typed on two lines; indent the second line three spaces.

4. Single space all addresses of four or more lines.

5. Spell out street names which are represented by the numerals one to ten; use figures for street names represented by numerals of eleven and above.

6. The ordinals d, st, or th may or may not be added to the number that represents street names.

7. Use a hyphen preceded and followed by a space if the street name is a number and there is no intervening direction between it and the house number.

8. When the house number is one digit, spell out "One" but use figures for all other digits.

9. In street addresses, never abbreviate North, South, East, and West; likewise, never abbreviate Street, Avenue, Boulevard, Drive, etc. Never abbreviate the state. (The attached sheet shows the new form that is being adopted in some offices. This is not to be used in your classwork.)

NOTE: For an example of the placement, style, and application of rules, turn to page 173 in your type book.

Assignments:

1. Turn to the attached Addressing Envelopes Guide Sheet and type each rule three times plus the example for each rule once. Single space the typing of the rule. Double space before typing the example. Triple space after the typing of the example.

2. Turn to the attached sheet marked Envelope Addresses and type the addresses in correct form. Type the addresses in two columns on a full sheet of paper. Leave three blank lines between addresses. Set the left margin at 15 and the tab for the second column at 60.

Return Addresses

In most cases businesses have their own return address printed on the envelopes, but when it is necessary to type it on the envelope, it should be typed single spaced in the upper left-hand corner. Begin on the second line space form the top edge and three spaces from the left edge.

16161

Special Notations

a. Mailing directions, such as AIR MAIL, REGISTERED, AND SPECIAL DELIVERY, should be typed on the envelope below the point where the stamp will be placed, approximately nine or ten spaces below the top edge of the envelope. They should be underscored or typed in all caps.

b. Other instructions or special information, such as, ATTENTION PLEASE FORWARD, CARE OF, AND PERSONAL, should be typed in the lower left corner of the envelope, approximately three lines below the last line of the address, one-half inch from the left side of the envelope. Capitalize the first letter of each principal word or type in all caps.

Assignment:

1. Take out your cardboard letter guide and trace two envelopes on a sheet of paper. Type the following addresses, return addresses, and special notations on these two envelopes.

a. The Nordeen Publishing Co., Guerneville, Calif. 90178
From: Madison Business Council, 120 Monona Ave., Madison, Wisconsin 43987. Air Mail and Attention Mr. R. L. Block

b. Mr. Lloyd R. Reardon, Treasurer, Blake, Walsh, and Taylor Co., Inc., 101 Beale St., San Francisco, Calif. 93034
From: International Supply Co., Inc., 463 No. LaSalle St., Chicago, Illinois 64024. Registered and Personal

After you have studied this unit and completed the assignments, check your work with the key and hand your paper to your teacher. If this work has been done satisfactorily, you will be given the test for the unit.

After completing the test for this unit, hand your papers to your teacher for checking. If the work is satisfactory, your teacher will give you your next assignment. If not, supplementary work will be given to you.

ADDRESSING ENVELOPES GUIDE SHEET

1. An address should never be typed on less than three lines. If necessary, place the city and state on separate lines.

Hotel Utah	McCullough Automotive Supply
Salt Lake City	115 East Henderson Street
Utah 84111	Frankfort, Indiana 46041

2. Double space all three-line addresses; single space all addresses of four or more lines.

John M. Byrd and Sons	Mr. Charles D. Wesley Indiana Realty Company
118 North Chestnut Street	2235 South Sunset Street Indianapolis, Indiana 46216
Indianapolis, Indiana 46205	

3. Unusually long company names may be typed on two lines; indent the second line three spaces.

Mr. Arthur H. Lunsford Purchasing Agent Tree Manufacturing Company 115 Gulf Street Houston, Texas 77009	Mr. T. E. Tuckett, President Tuckett and Jones Savings and Loan Association 222 Washington Street Cleveland, Ohio 44121

4. Spell out street names which are represented by the numerals one to ten; use figures for street names represented by numberals of eleven and above.

Salt Lake Realty	Duplicator Supply Company
201 East Third South	258 East 15 Street
Salt Lake City, Utah 84111	Salt Lake City, Utah 84111

5. The ordinals d, st, or th may or may not be added to the number that represents street names.

Merzog Brothers	The Music Center
1505 East 21 South	219 South 15th East
Salt Lake City, Utah 84111	Salt Lake City, Utah 84111

16168

6. Use a hyphen preceded and followed by a space if the street name is a number.and there is no intervening direction between it and the house number.

Ex-Call-O Corporation	Publishers Central Bureau
434 - Tenth Street	33 - 20th Avenue
Buffalo, New York 14211	Long Island City, New York 11101

7. When the house number is one digit, spell out "One" but use figures for all other digits.

Mechanical Pencil Company	Indianapolis Real Estate Association
9th West Ninth Street	One Marshall Avenue
Indianapolis, Minnesota 46203	Indianapolis, Indiana 46209

8. In street addresses, never abbreviate North, South, East, and West; likewise, never abbreviate Street, Avenue, Boulevard, Drive, etc. Never abbreviate the state

Mr. Jesse Knight	Stein-Wiseman Agency
2347 South Leslie Avenue	47 North University Avenue
Carmel, Indiana 46032	Provo, Utah 84601

Type and Transcription
(Second Semester)
Envelopes

ENVELOPE ADDRESSES

Mr. Ralph J. Smith, R. I. Lewis Company, 10th and Carson Streets, Pittsburgh, Pennsylvania 15203

Idaho Typewriter Exchange, Inc., 87th and Kedzle Ave., Chicago, Illinois 60652

Kingsport Office Equipment Co., 3534 S. 108 St., Omaha, Neb. 68144

Mr. John L. Castle, 105 W. Ross Ave., Tampa, Florida 33602

Hamilton Press, Inc,, Lowell, Massachusetts 01853

Fairbanks Office Supply, Box 131, 225 2nd Ave., Buffalo, New York 15226

Mr. W. J. Noonan, 218 W. Market St., Pittsburgh, Pa. 15224

Mr. Albert L. Stofft, Howard & Stofft Company, 1005 Mt. Vernon Ave., Alexandria, Virginia 22310

Panther City Office Supply and Equipment Company, 518 18th St., Albany, Oregon 97321

Mason, Inc., 2 Bryan St., Houston, Texas 77033

Business Services, Inc., 3612 North 88 Street, Phoenix, Arizona 85016

Mr. Walton A. Keller, 424 3rd Ave., Commach, New York 11725

Riverside High School Ellwood City, Pa. 16117

Mr. L. W. Delabar, President, Delabar Distributors, 22328 South Main Street, Torrance, California 90502

Mechanical Pencil Co., 434-Tenth Street, Buffalo, New York 14221

Superior Parts Company, 424 North Indiana St., Springfield, Illinois 62702

The Music Center, 219 South Fifteenth East, Salt Lake City, Utah 84111

Ace Auto Parts, 1440 Turnbow Street, Columbus, Ohio 43205

Southeast Parts and Accessoriers, 234 Highway Street, Chicago, Illinois 60610

Mr. Jack J. Jackson, Office Manager, Nu-Way Shirt Co., 412-39th Street, Cleveland, Ohio 44102

Goldwater of Arizona, 822 S. Broadway, Phoenix, Arizona 85003

Newhouse Hotel, Salt Lake City, Utah 84111

Stockton Typewriter Co, 1 Miner Ave., Stockton, California 90852

16165

Type and Transcription
(Second Semester)
Envelopes
Test

Directions:

Place your name in the upper left-hand corner of your paper.

Type the correct form of the following addresses. Type them in two columns. Set the left margin at 15 and the tap for the second column at 60.

On the back of your paper trace two large envelopes from your cardboard guide and address them with the first two addresses. Send the first one air mail and personal, the second one special delivery.

Use the school address for the return address.

Weber County High School
1100 Washington Boulevard
Ogden, Utah 84404

You have a 20-minute time limit to complete this test.

1. Mr. Ralph J. Jones, The Thomas Manufacturing Co., 416 Broad Street, Pueblo, Colo. 81009

2. Mr. J. C. Graham, The Baker Co., 361 3rd Ave., N. Y., N. Y. 10016
3. Panther City Office Supply and Equipment Co., 518 18th St., Albany, Ore., 97503.
4. Mr. Harvey L. Cummings, Springfield, Ill., 361 Pine St., 67305
5. Salt Lake Realty, 201 E. 3rd So., Salt Lake City, Utah 84111
6. Ben Lomond Motor Lodge, Ogden, Utah 84401
7. The Music Center, 2 Bryon St., Phoenix, Ariz. 85016
8. Jackson of Colorado, 341 S. Broadway, Denver, Colo, 86067
9. First National Bank, Mr. Jack Jone, Macon, Georgia 02039
10. Mr. John Malcom, 1 Oak Ave., Boston, Maine 24113
11. Appleton and Appleton, 9th W. 9th St., Chicago, Illinois 42369
12. Becker and Co., 434-Tenth St., Buffalo, N. Y. 11101
13. New York, New York 10038, 366 Fifth Ave., The New York Automobile Club
14. Mr. Jesse Knight, 10 Indian Road, Carmel, Indiana 55555
15. Riverside High School, Ellwood City, Calif. 20394
16. Mr. James C. Day, Ellis Book Co. Inc. 416 Wilson Avenue, Tuscon, Ariz. 85714

16166

GUIDE FOR ADDRESSING ENVELOPES
WHEN USING TWO-LETTER STATE ABBREVIATIONS

1. Block the address lines. Do not arrange lines in an indented form.

Your name Address City, State ZIP Code	Bonneville High School 251 East 4800 South Ogden, UT 84403

2. Single space the address lines, regardless of the number of lines required.

Hotel Utah Salt Lake City, UT 84111	Mr. Charles D. Wesley Indiana Realty Company 2235 South Sunset Street Indianapolis, IN 46216

3. Include a personal courtesy title (Mr., Miss, Mrs., etc.) preceding the name of an individual. The title "Ms." may be used when writing to a woman whose marital status is unknown.

Ms. Dorothy L. Regan 16 Arballo Drive St. Louis, MO 63106	Dr. James R. Walsh 2016 Broadway Indianapolis, IN 46227

4. Place an executive's title or official position, which follows the name of the individual, in whichever of three positions that will provide the best balance; on the line with the person's name, separated from it by a comma; on a line by itself; or on the second line with the company name, separated from it by a comma. Unusually long firm names may be typed on two lines; indent the second line three spaces.

Mr. Arthur H. Lunsford Purchasing Agent Tree Manufacturing Company 115 Gulf Street Houston, TX 77009	Mr. T. E. Tuckett, President Tuckett and Jones Savings and Loan Association 222 Washington Street Cleveland, OH 44121

4. Type the name of the firm just as it appears on the letterhead. The word incorporated, however, is always abbreviated and preceded by a comma. Use amperstand (&) and the abbreviation for company (Co.) whenever they are used as part of the name.

Lawton, Higgins & Fulton 543 North Mississippi Avenue St. Louis, MO 63114	Weston Electronics, Inc. Market and Walnut Streets Long Beach, CA 90813

16167

6. Avoid abbreviations. Type out North, South, East, and West; likewise avoid abbreviating Street, Avenue, Boulevard, Drive, etc. However, it is sometimes permissible to abbreviate these words in order to balance the address block. When a ZIP Code is included, use two-letter state abbreviations.

Mr. Jesse Knight
2347 South Leslie Avenue
Carmel, IN 46032

Stein-Wiseman Agency
47 North University Avenue
Provo, UT 84601

7. Spell out street names which are represented by the numerals one to ten; use figures for street names represented by the numerals of eleven and above.

Salt Lake Realty
201 East Third South
Salt Lake City, UT 84111

Duplicator Supply Company
258 East 15 Street
Salt Lake City, UT 84111

8. Use a hyphen preceded and followed by a space when two consecutive numbers are used to designate the address. It is not necessary to use a hyphen when street names are represented by the numerals one to ten. The ordinals d, st, or th may or may not be added to the number that represents street names.

Ex-Cell-O Corporation
434 Tenth Street
Buffalo, NY 14211

Publishers Central Bureau
33 - 20th Avenue
Long Island City, NY 11101

9. Spell out the house number "one," but use figures for all other house numbers. The first number in an address is always the house number.

Mechanical Pencil Company
6 West Ninth Street
Indianapolis, IN 46203

Indianapolis Real Estate Association
One Marshall Avenue
Indianapolis, IN 46209

10. Place an attention line on any line of the address block above the street name. Do not include an executive's title when a specific name is used.

Acme Jewelry Co.
Attention Mr. James Wilson
301 Hartford Avenue
Buffalo, NY 14223

Wilberford, Inc.
Attention Personnel Director
P.O. Box 95
Norwood, OH 45212

16168

11. Place on-arrival directions like "Confidential," "Personal," "Hold for Arrival," or "Please Forward" four lines below the return address. These directions may be either underlined or typed in all capitals.

12. Place notations involving special mailing services like "Special Delivery" or "Airmail" Below the stamp position and at least three line spaces above the envelope address. These notations should be typed in all capitals.

16169

RELATED INSTRUCTION

SCHOOL: PETERSBURG, VIRGINIA FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: XI. TROUBLE SHOOTING AND TUNE - UP

MILESTONE: I. IGNITION AND CARBURETION

PERFORMANCE OBJECTIVE NO: 1 TITLE: Creating Malfunctions and Finding and Correcting Those Malfunctions

CONDITIONS:
Student will learn the related information listed below

LEARN	REFERENCE	SOURCE
1. Engine trouble shooting	1. Automotive Mechanics, by Crouse. pp. 248 through 270 Automotive Service and Troubleshooting Workbook, by Crouse. Jobs 1 through 9, 12 through 15	1. Related Information Class
2. "Engine Tune - up"	2. Filmstrip, kit E,part 1	2. Resource Materials Center
3. "Engine Tune - up"	3. Filmstrip, kit E,part 2	3. Resource Materials Center
4. "Engine Tune - up"	4. Filmstrip, kit A	4. Resource Materials Center
5. Troubleshooting	5. Teaching Machine cards 24A, 24B	5. Teaching Machine (Shop)

1612

TWO-LETTER ABBREVIATIONS

Alabama	AK	Montana	MT
Alaska	AL	Nebraska	NB
Arizona	AZ	Nevada	NV
Arkansas	AR	New Hampshire	NH
California	CA	New Jersey	NJ
Canal Zone	CZ	New Mexico	NM
Colorado	CO	New York	NY
Connecticut	CT	North Carolina	NC
Delaware	DE	North Dakota	ND
District of Columbia	DC	Ohio	OH
Florida	FL	Oklahoma	OK
Georgia	GA	Oregon	OR
Guam	GU	Pennsylvania	PA
Hawaii	HI	Puerto Rico	PR
Idaho	ID	Rhode Island	RI
Illinois	IL	South Carolina	SC
Indiana	IN	South Dakota	SD
Iowa	IA	Tennessee	TN
Kansas	KS	Texas	TX
Kentucky	KY	Utah	UT
Louisiana	LA	Vermont	VT
Maine	ME	Virginia	VA
Maryland	MD	Virgin Islands	VI
Massachusetts	MA	Washington	WA
Michigan	MI	West Virginia	WV
Minnesota	MN	Wisconsin	WI
Mississippi	MS	Wyoming	WY
Missouri	MO		

16170

Type and Transcription
Seeond Semester

BUSINESS LETTERS

Performance Criteria

At the conclusion of this unit you will be able to set up a business letter in an attractive and acceptable style. You should be able to type the letters in "mailable" form; that is, correct as to placement, typing, grammar, and punctuation. You should be able to proofread your work and make the proper corrections in a neat manner.

A test will be given at the end of the unit which will consist of typing letters in "mailable" form. These letters will be typed in the various styles covered, including carbon copies, special notations such as carbon copies, subject lines, attention lines. The time limit will be set at approximately 10 minutes per average length letter.

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You have already completed the unit on business letters including the modified block with indented paragraphs, the modified block with block paragraphs, and the block style. This unit will introduce the indented style, the two or more page letter, and the double space letter. However, for the production work be sure to follow directions carefully as to the style of letter indicated.

Follow the steps in this unit carefully. Remember to proofread your work and make all necessary corrections. These letters should be typed with the "mailable" goal in mind.

An envelope for each letter should be traced on the back of the paper and addressed according to the rules set up on your "Addressing Envelopes Guide Sheet."

1. Indented Letter Style. Refer to the indented letter style attached to this unit and study it carefully. The indented style is not used as often as the other styles you have studied, but is still used in some offices. Note: Each line in the inside address is indented five spaces from the beginning of the preceding line. Also, in the closing, start the complimentary closing at the center point and indent each of the following lines five spaces.

2. Type the following medium length letter in the Indented Style with Mixed Punctuation. (Remember: A colon follows the salutation and a comma follows the complimentary close.)

16171

(Current Date)/ Northern Electric Company/ 607 Dickinson Street/ Bismarck, North Dakota 34015/ Gentlemen/ Our local office at 225 Livingston Avenue, Bismarck, has been informed of your request for an opportunity to try some of your actual figure work on the Piering Calculator. That office will give you cheerful assistance. (P) You will be greatly pleased with the Piering, as it handles every type of figuring problem with a maximum of ease and simplicity, permitting a great many short-cutting operations. Our Consulting Department, too, is at your service for help and suggestions in solving caluclations which at the time may appear difficult. (P) You will hear from our Bismarck representative without delay. We are pleased to have this privilege of serving you./ Very truly yours/ Piering Calculators, Inc./ George O. Standing/ Advertising Director/ (initials)[1]

3. Type 66-C, Problem 1, Page 104 of your type book, using the Indented Style with Mixed Punctuation. Make one carbon copy.

4. Attention Line. When a letter addressed to a company is intended for a specific person's attention, an attention line is placed between the inside address and the salutation. Double space between the inside address and the attention line and between the attention line and the salutation. In the block style letter, the attention line starts at the left margin. In the modified block or indented styles, it may either start at the left margin or be centered.

5. Type the following letter in Modified Block Style with Indented Paragraphs and Mixed Punctuation. Include one cc for file and a bcc.[2]

(Current date)/ Bryant Tire Sales Company/ 2378 East Fifth Street/ Newburgh, New York 12550/ Attnetion Sales Manager/ Gentlemen/ It will pay you and your customers who plan to keep their cars for another year or more to learn about our new 4-Ply Federal Tire. (P) A tough 4-ply Nylcon-cord body gives the Federal Tire new skid resistance and a remarkable decrease in road noise. (P) The Federal Tire has been constructed with SAFETY in mind: More road-gripping rubber and more gripping edges for quick response on wet or dry surfaces. No wonder we can give a 36-month guarantee on Federal Tires! (P) Mr. Thomas Wallace, the Federal Tire representative in your area, will call on you within the next week or ten days to discuss the merits of this great new Federal Tire. Sincerely yours/ W. J. Cummings/ Sales Manager/ (initials)/ bcc Mr. George W. Smith

6. Subject Line. This indicates the subject matter of the letter. The subject line should be typed two spaces below the salutation and have two spaces follow it before starting the body of the letter. It may start at the left margin, be indented the same as the paragraphs, or be centered. It may be in all capital letters, or it may be underscored with only the principle words capitalized. Sometimes Subject: or In re: precedes the actual subject.

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[1]Bowman, Wallace B, Business Letter Typing (Cincinnati: South-Western Publishing Company, 1957), p. 27.

[2]Liguori, Frank, et. al., Basic Typewriting Operations--Principles and Problems (Cincinnati: South-Western Publishing Company, 1965), p. 51.

6172

7. Type the following letter using the indented style with mixed punctuation. Center the subject line and type it in "caps." [3]

(Current Date)/ Miss Mary L. Dolan/ 764 Hillside Avenue/ Charlotte, North Carolina 61023/ Dear Miss Dolan/ Your Order of September 5 (subject line) (P) As orders are usually shipped on the date on which they are received, your order of September 5 had already been mailed to you when your letter of September 6 reached us. (P) If it is now too late for you to cancel the order with the Burton Company and you cannot use the music that we sent you, it may be returned to us for credit. Very sincerely yours/ Raleigh Music Company/ Thomas E. Perkins, Manager (initials)

8. Postscripts. Points which have been forgotten in dictation or purposely withheld for emphasis may be added at the bottom of a letter in a postscript. Indention of a postscript follows the indention style of the letter. Postscripts are preferably typed without the letters "P.S." at the beginning, but this is a matter of choice.[4]

Example:

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be one that they will remember all their lives. We must not let them down. We know that you will do what you can to help.

Sincerely yours,

Secretary

JIR/jc

Enclosure

We shall send you our summer camp pamphlet soon. This pamphlet shows, in pictures, the highlights of these summer camps. You will enjoy it, I am sure.

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9. Notations such as airmail, special delivery, etc., should be placed between the date and the inside address and typed in "caps."

10. Two- or more-page Letter. Most business letters consist of one page; however, occasions arise when a longer letter is needed and it is carried on to the second or third page.

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[3] Bowman, op. cit., p. 29.

[4] Liguori, op. cit., p. 52.

16173

In setting up a letter of more than one page you should follow, in general, the placement chart of the long letter. In carrying the material over to a second or third page, you should observe the following practices:[5]

1. Never carry over to a second page material that will occupy fewer than two lines.
2. Unless at least two lines of a paragraph can be written at the bottom of a page, the whole paragraph should be carried over to the next page.
3. Only one side of a sheet of paper should be used for a letter. When a letter consists of two or more pages, the second and following pages must match the first in size, color, and quality of paper.
4. The first page of a letter may carry the printed heading of the business, but all subsequent pages should be written on blank paper. In order to avoid problems in both the mailing and the filing departments of a business, the subsequent pages should carry an identifying heading showing the name of the addressee (the person to whom the letter is written), the number of the page and the date on which the letter is written. Either of two forms may be used:

Mr. Edward J. Patterson 2 Date

or

Mr. Edward J. Patterson
Page 2
Date

Note: "Patterson" is the name of the addressee (the person receiving the letter, and not the name of the writer.)

The heading of the second page should be written one inch from the top edge of the paper. The message should be continued three lines lower.

11. Turn to Page 179 in your type book and type Problem 8. Follow the directions printed in red. (Note: There is an attention line, subject line, and a postscript in this letter).

12. Type the following 2-page letter in Block Style with Mixed Punctuation. To determine where to stop on the first page, let the bottom margin approximately equal the left margin. Remember that at least two lines must be carried to the second page. Use either form for the second-page heading.

16174

[5] Bowman, op. cit., pp. 44-45.

(Current Date)/ Globe Leather Stores/ 452-454 Madison Avenue/ New York, New York 10002/ Attention Sales Managers/ Gentlemen/ Subject; Kangaroo Leathers/ We would like each of you--and your staff of salespeople--to have some information about kangaroo leathers that will help our project to increase sales of kangaroo leather goods this year. (P) Besides being the most durable of the leathers, kangaroo is especially recommended for its light weight, flexibility, scuff resistance, and suppleness. These qualities have long made it a favorite material for athletic shoes, and the introduction of luster finishes in recent years has added much beauty to its other advantages. As a result, kangaroo leather is a growing favorite among a number of shoe manufacturers. (P) Kangaroo is different from most leathers in that, like pigskin, there is no separation of layers. The fibers of the skin are intermingled from the grain (outer) side to the flesh side, and the skin is never split but used in its full thickness. (P) Kangaroo has been tanned commercially since 1890's; and it has reached such a point of popularity that demand sometimes exceeds supply, particularly since the number of kangaroos killed each year is strictly regulated by the Australian government. The great demand coupled with restricted killing of kangaroos makes kangaroo leather very expensive. (P) Kangaroo is, therefore, limited primarily to better-grade footwear. But even though shoes of kangaroo leather cost more, the fact that they retain their appearance and are so long-wearing--yet comfortable--make them preferred by a growing number of customers. (Start page 2 here) (P) The home office wants every salesperson to become familiar with this leather, so that Globe Leather Stores can lead the race in leather sales./ Sincerely yours/ Globe Leather Stores, Home Office/ Leonard R. Webb, Vice-President/ (initials)[6]

13. Double Space Letters. Extremely short letters, such as a routine letter known as a "letter of transmittal," look best if double spaced. Start the inside address 10 or 11 spaces below the date and use a 40-space line. Double spaced paragraphs are always indented. Single space and block the inside address and double space the body of the letter.

14. Type the following letter in Double Space Style with Mixed Punctuation:[7]

(Current Date)/ Mr. William J. O'Brien/ O'Brien Engineering Company/ 225 Hemingway Road/ Louisville, Kentucky 40207/ Dear Mr. O'Brien/ We are returning your blueprint No. 789345-B, as requested in your letter of March 9./ Very truly yours/ John F. Melvin/ Purchasing Agent/ (initials)/ Enclosure

14. Letter of Application. One of the most important business letters you will ever write is the letter of application.

The purpose of the application letter is to introduce yourself and try to obtain a personal interview. If this letter is to represent "you," great care should be given in typing and setting it up. The letter should not be too long and should "look" good.

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[6]Liguori, op. cit., p. 60.

[7]Ibid., p. 45.

16175

A personal data sheet, in which you summarize your education, experience, training, personal qualities, and give references, should be attached to your letter. This should also be typed with great care and should be accurate.

16. Turn to Page 214 in your type book and type the letter of application. Follow the directions given in the book.

17. Type the data sheet on Page 215 of your type book to enclose with your letter of application. Type the data sheet as directed.

18. Type the following letters in good form. Choose any of the styles that we have covered this year. Be sure that they are well-balanced. Proofread your work carefully and make all necessary corrections.

(Current Date)/ Mr. Stanley F. Merrill/ 12 South Broad Street/ Richmond, Virginia 30214/ Dear Mr. Merrill/ Please accept with our compliments the assortment of Cranefield's YORKTOWN pencils which are being sent to you by separate mail today. Open your package with the full assurance that they represent the acme of quality in drawing pencils. (P) YORKTOWN is called "the master drawing pencil" because of its effectiveness in the hands of architects, engineers, and artists. Wherever the drawing board or the easel is found, you will find the YORKTOWN. All over the world this pencil is used by the most exacting critics, who accord it the recognition which is due superior merit. (P) The reputation of Cranefield's YORKTOWN as a pencil for draftingroom and studio use is the direct result of the patience and expert knowledge that the Cranefield Company puts into the making of each one of the 17 superb YORKTOWN degrees. (P) Try the samples, and then read the enclosed booklet, "Finding Your Pencil." When you have done this, you will know whether or not we have sent you the leads that you require; and you will also know what other leads to ask for in case the samples are not just what you desire. (P) It is Cranefield's desire and intention to meet your needs and to satisfy you in every possible way. Let us serve you through your local dealer. You may use the enclosed business reply card to give us his name and address./ Sincerely yours/ Cranefield Pencil Company/ Howard R. Hall, Sales Manager/ (initials)/ Enclosure.[8]

(Current Date)/ Dr. George L. Dobson/ 762 Professional Building/ Olympia, Washington 20013/ Dear Doctor Dobson/ You are undoubtedly familiar with the fact that one per cent of Western Gelatin dissolved and added to milk not only prevents excessive curd formation in the stomach, but also increases the available nourishment of the milk, making it more digestible and assimilable. Many physicians are using this with good results in infant feeding and for undernourished children. They also find it helpful in tubercular diets and for patients who are underweight or of low vitality. (P) In many diets, Western Gelatin is found to be exceedingly valuable, because it is so adaptable in combining with other nutritious foods. An endless variety of dishes may be prepared with it to vary

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[8]Bowman, op. cit., p. 36.

16176

monotonous diets. (P) You will find Western Gelatin decidedly helpful in a liquid diet. It not only adds nutritious value as a supplementary protein, but aids the digestion and absorption of other foods by its colloidal and emulsifying action. As a liquid diet is used chiefly in conditions requiring a maximum amount of nutrition with a minimum tax on the digestive tract, we believe you will find Western Gelatin indispensable./ Very sincerely yours/ Western Gelatin Company/ Merle B. Collins, President/ (initials)[9]

(Current Date)/ Mr. Clyde O. Vines, Chairman/ Business Education Department/ William H. Lane High School/ Seattle, Washington 21301/ Dear Mr. Vines/ For some months we have been preparing an informal correspondence manual based on our own needs. We have made selections from standard manuals, and we have adapted them to the circumstances in this company. Illustrations have been taken very largely from our own experiences. (P) These sheets have been issued irregularly, the time depending on the pressure of other work in this department. Believing that you will be interested in our enterprise, we are enclosing several issues. As you will see, some of the bulletins are intended maily for dictators; others, chiefly for stenographers and transcribing-machine operators. (P) After you have read these bulletins, we shall appreciate your opinion of them. Of course, we intend eventually to bind them in a complete office handbook./ Very cordially yours/ Associated Canneries, Inc./ Richard S. Terry/ Correspondence Supervisor/ (initials) Enclosure/ bcc Mr. John A. Moore/ [10]

19. After completing and checking all the letters in this unit, hand them to your teacher. If your work is satisfactory, you will be given the test for this unit.

20. When you have completed the test, hand your work to your teacher to be checked. If you have completed your work satisfactorily, you will be given your next assignment.

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[9] Ibid., p. 44.

[10] Ibid., p. 91.

161775

PRINCIPAL LETTER STYLES

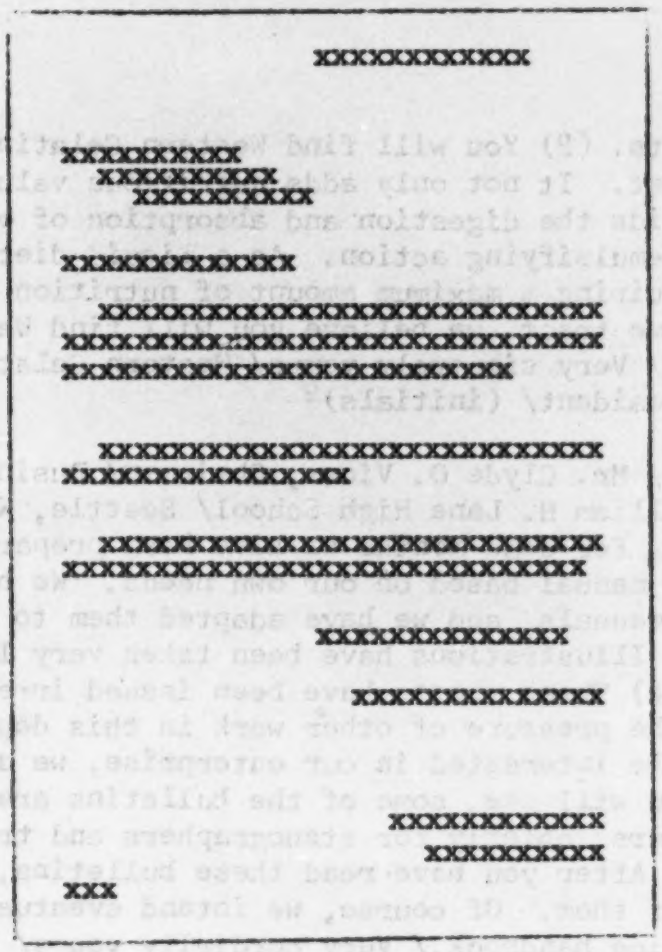

INDENTED

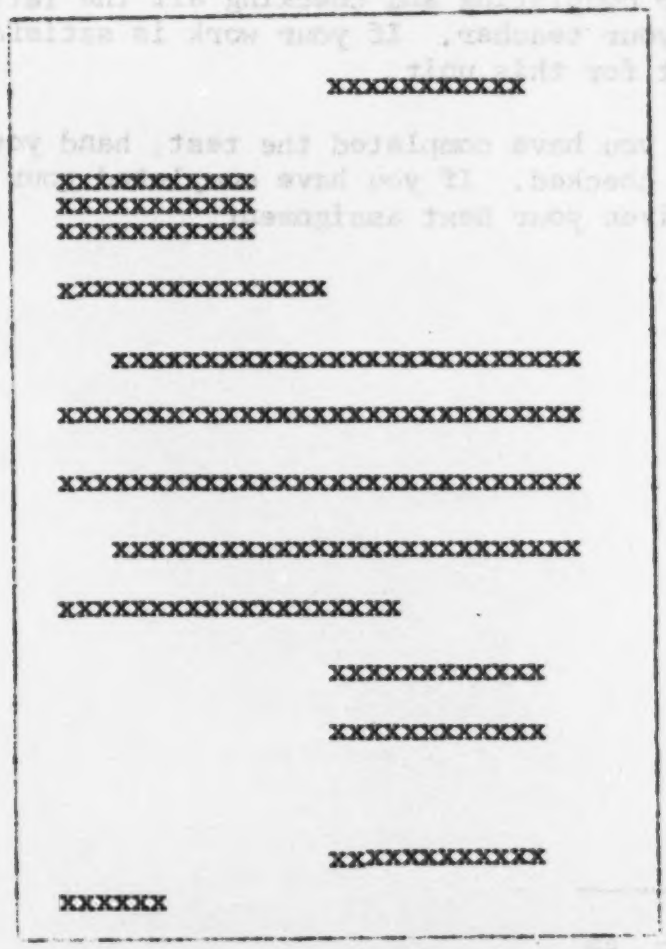

DOUBLE SPACE LETTER

161705181

Type and Transcription
(Second Semester)
Business Letters

TESTS

Tests 1, 2, and 3 will have a time limit of 10 minutes each. You will be allowed 15 minutes on Test No. 4. (45 minutes in all)

TEST NO. 1[11]

Directions: Type the following letter in Block Style with Mixed Punctuation. Make one carbon copy and an envelope.

(Current Date)/ Dr. T. James Crawford/ Graduate School of Business/ Indiana University/ Bloomington, Indiana 47401/ Dear Dr. Crawford/ Congratulations on your appointment to the staff of the Business Education Department of the Graduate School of Business of Indiana University. We are happy to welcome you and your family to Bloomington. (P) We invite you to open a charge account with us. All you need do is visit our credit department on the third floor any business day. With your permission, we will place your name on our list of customers to whom the privilege of a preferred charge account is extended. (P) You will enjoy, we feel sure, shopping at our store, with its quality goods and a staff of trained salespeople to serve you. (P) We hope you will join our many satisfied customers. You can be certain that we will try to please you in every way./ Very truly yours/ Bernard Gleason/ Credit Department/ (initials)

TEST NO. 2[12]

Directions: Type the following letter in Modified Block style with Blocked Paragraphs with Mixed Punctuation. Make one carbon copy and a blind carbon copy and an envelope.

(Current Date)/ Mr. and Mrs. Edward James/ 2943 Blue Haven Terrace/ Cincinnati, Ohio 45238/ Dear Mr. and Mrs. James/ Thank you for the opportunity to tell you about our program of arts and crafts for adults. (P) Leisure-time hobby classes for men and women will open at the Tri-State Arts and Crafts Center, 2101 Madison Road, the week of September 9 and will continue through December 7, with recess Thanksgiving week. (P) Last year, enrollment in the classes reached a total of 2,400 for the fall, winter, and summer terms. This year we will not be able to accommodate more than 700 for each session. (P) Mr. Fritz Koch is supervisor of all hobby classes, which include drawing and painting, portrait and figure drawing, oil painting, watercolor, toleware and tray painting, and ceramics. (P) If you would like to know more about these hobby classes, write or call us at the above address./ Sincerely yours/ Modern Art, Incorporated/ William Johnson, Director/ (initials P. S. Our supervisor, Mr. Koch, has just returned with some intriguing new ideas from an arts and crafts show at New York's Colosseum. We shall try to arrange for him to present them to our classes soon./ Blind carbon copy to Mr. Fred J. Grove

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[11] Liguori, op. cit., p. 46.

[12] Ibid., p. 46.

16179

PERFORMANCE OBJECTIVE STATEMENT

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: XI. TROUBLE SHOOTING AND TUNE-UP

MILESTONE: I. IGNITION AND CARBURETION

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Creating Malfunctions and Finding and Correcting

CONDITIONS:

This assignment will be performed on a complete automobile, engine on stand, and any other gasoline powered equipment available. To make this phase of training more realistic and more interesting, trainees will work in pairs. One creating a defect with the other finding and correcting it. Students will change places so both will become proficient at trouble shooting and tune-up work.

BEHAVIOR:

After satisfactory completion of all related training; proceed as follows:

1. Place protective covers on front seat of automobile
2. Move automobile into proper work station
3. Raise Hood
4. Place protective covers on fenders (Omit steps #1 - #4 on all equipment other than cars and trucks)
5. Select proper manual and turn to appropiate chapter
6. Select proper tools, testing equipment, and materials
7. Trainee #1 will create malfunction
8. Trainee #2 will find and correct malfunction
9. Trainee #2 will create malfunction
10. Trainee #1 will find and correct malfunction
11. Each trainee will create and correct an equal number of malfunctions as listed below:
    a. Primary ignition wiring 4
    b. Secondary ignition wiring 2
    c. Ignition coil 1
    d. Distributor 3

PERFORMANCE CRITERIA:

1613

TEST NO. 3[13]

Directions: Type the following letter in Modified Block Style with Indented Paragraphs and Mixed Punctuation. Make one carbon copy and an envelope.

(Current Date)/ Mr. James L. Vincent/ 708 Russellwood Avenue/ McKess Rocks, Pennsylvania 15136/ Dear Mr. Vincent/ It is a pleasure to make new friends--and we are counting you as one of ours. (P) The order you sent us yesterday gives us the pleasant feeling that we have begun a business friendship. We will try to make it a lasting one, through high quality products and outstanding company service. (P) We are certain that Purity Products will move as rapidly in your store as they do in most of the retail stores we serve throughout the country. Our salesman, Mr. George Braidic, will call on you soon. You will find him a good friend, ready to serve you at all times./ Yours very truly/ Purity Products Company/ George V. Bayly/ Sales Manager/ (initials)

TEST NO. 4[14]

Directions: Type the following 2-page letter in the style of your choice. Make an envelope, but no carbon.

(Current Date)/ Mr. Harry H. Raye, President/ Sandra Manufacturing Co./ 924 West Fourth Street/ New York, New York 10003/ Dear Mr. Raye/ Will your company profit when the nation's specialty stores spend $424,000,000 to build and equip the planned 430 new units and 195 remodeled units during next year?/ (P) These 430 units mean a 15.2% increase over the 2,828 stores now in operation and an increase in expenditures of almost $60,000,000 over the past year. This is proof of a fast-moving, big-spending field. It is one that must be kept up with to maintain your own sales increases this year. (P) How? On March 10, RETAIL NEWS will publish another milestone first: a definitive study of fisturing and equipment practices in the specialty field. It will overflow with information on shelving, gondolas, wall units, tables, carts, labeling and signing, checkouts, general equipment, and more. It will have a wealth of never-before-published data on this important area of specialty store operation. (P) It has every indication of becoming the planning guide for specialty store capital goods buyers and for busy presidents, vice presidents, and general managers--men your salesmen cannot always get to see. (P) Can you turn this to your advantage? (P) If more retail store business is part of your sales strategy (and why not?), this is the one issue that must represent your company. (P) RETAIL NEWS boasts the largest paid circulation in the field. More important, it reaches into both buying levels: head-quarters, where executives, merchandise managers, and capital goods buyers actually do the ordering; and the stores, where managers and department heads have their say about the kind of fixtures and equipment they need to best sell their merchandise. (P) The editorial atmosphere of the March 10 issue will be ideal for a presentation of your sales message. (P) You can be sure of prime positioning if you make your reservation early. Why not today? (P) Closing date for the March 10 issue is February 20. So fill in and mail the enclosed postage-paid card now. Sincerely yours/ George R. Dennis/ Advertising Manager/ (initials) Enclosure

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[13] Ibid., p. 46.

[14] Freeman, Louis, Guide to Typewriting. (New York: Amsco School Publications, Inc., 1967), p. 41.

16'80 Trial

MEMORANDUMS
(Interoffice Correspondence)

Performance Criteria

At the conclusion of this unit you will be able to type a memorandum or interoffice correspondence in the correct form in a prescribed time limit.

You will be given a test which will consist of typing three memorandums within a thirty minute time limit. These will be set up according to the directions given in the unit as to placement, accurate typing, punctuation, spelling, etc. Neat erasures will be allowed.

- - - - - - -

An interoffice memorandum is used for correspondence between departments or persons in the same organization. A memorandum contains certain guide words. If they are not printed on the forms (most companies have their own interoffice memorandum forms printed), they must be typewritten.

If you have to type your own forms, the following may be used as guides:[15]

1.

Date:

To:

From:

Subject:

2.

To: From:

Subject: Date:

3.

To: Date:

From: Subject:

NOTE: The guide words may be typed in all capitals.

16181

[15] Ibid., p. 74.

The following general instructions should be followed in typing memorandums:[16]

1. Type the information two spaces after the colon of the longest guide word. Double space between guides. Capitalize each major word in the information.

2. Generally, personal titles (Mr., Mrs., Miss) are omitted if the first name is used.

3. Omit the salutation and the complimentary close.

4. Triple space (leave two blank lines) between the heading and the body of the memorandum.

5. Single space the paragraphs, double space between paragraphs.

6. If the name or the initials of the writer is typed at the end of the memorandum, double space between the body and the name. Generally, however, the name is not typed and the memorandum is not signed.

7. If reference initials are used, double space between the typed name (if it is used) and the reference initials, or between the body and the reference initials when a typed name is not used.

8. For all notations, such as "enclosure," "cc," or "bcc," follow the instructions given for letters.

9. Margins:
   a. If guide words are printed, the left margin of the body is generally even with the left margin of the typed material in the heading.
   b. If guide words are typewritten, the left margin of the body is even with the left margin of the guide words. Adjust the margins according to the length of the memorandum.
   c. Paragraphs may be blocked or indented.

10. Review page 269, 183-C in the type book.

Follow the instructions given in typing the memorandum lessons in this unit.

1. Type the following memorandum. Use your own initials for reference:[17]

Date: (Current Date) To: Department Chairmen From: Henry G. Carroll, Principal Subject: Report on Examination Grades
Each chairman is to submit a report on the mid-year examination results in each subject in his department by February 5. The report should combine all sections of the subject and should include the following information;

16101

[16] Ibid., p. 74.

[17] Ibid., p. 77.

16182

1. Total number of students instructed.
2. Total number of students examined.
3. Total number of students passing the examination.
4. Percent of students passing the examination.
5. Total number of students failing the examination.
6. Percent of students failing the examination.

Please attach to the report a copy of each examination administered. Carroll (reference initials).

2. Type the final copy of the following memorandum rough draft:[18]

Date: March 18, 1968 To: All Salesmen From: Andrew Douglass, Sales Manager Subject: New Advertising Campaign

Next week our new advertising campaign for the new Zesty toiletries line will break in the trade journal Retail News with a two-page, four-color spread. This publication is the leader in the field and is read by all your potential customers.

Two weeks later, our advertising campaign form the general public will break with a uniform ads in all the leading magazines. A tear sheet of ~~these~~ this ads is enclosed so that you may show it to your customers.

Everything is being done at this end to promote the Zesty line to the consumer and to the retailer. It is your responsibility to promote it with your customers.

Start those orders rolling in. Remember--a special bonus on this one! (reference initials and enclosure)

3. Turn to page 269-70 in your type book and type the memorandum illustrated.

NOTE: This is a long memorandum and so two forms must be used if the short memorandum forms are printed. In this case, type "page 2" in the "subject" space provided on the second form. Some offices provide the full sheet memorandum forms for long memorandums.

On this memo a file number is included--the form provided does not allow for a file number and so you may omit it.

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[18] Ibid., p. 79.

4. After completing the memorandums, check them carefully and make all necessary corrections. Check them with the keys. Hand them to your teacher. She will check them and if they have been typed correctly, you will be given the test for this unit.

5. After typing the test, hand your papers to your teacher to be checked. If you have typed these satisfactorily, you will be given the next assignment.

16184

Type and Transcription
(Second Semester)

MEMORANDUMS

TESTS (Form will be provided)

1. Use the current date. Use your own reference initials. Type in proper form. Do not type the words that are underscored.

   Memo to Paul W. Graham, Training Bureau From Simon V. Johnston, Vice-President on the subject of Houston Converence
   I noted in an article in Junior Executive magazine that the University of Houston will conduct a conference for a week this summer for directors of office training. It seems to me that it might be wise for us to have you or a member of your staff take part in this program. New Paragraph Please write to the University and obtain full details. When you have them, please draft for me an estimate of what it would cost for us to send someone to this conference. If possible, let me have your report w ll before the first of March.
   S. V. J. (reference initials)

2. Use current date. Use your own reference initials. Type in proper form. Do not type the words that are underscored.

   Memo to N. P. Montclaire, Bureau of Personnel From Simon V. Johnston, Vice-President on the subject of New Kinds of Tests at sometime in the near future, Nate, please try to set up a meeting at which you, Miss Benz, Mr. Clark, and I could spend an hour or two in conference with Dr. Mark Bjorgens, of Hilton College, to talk about the tests we give to job applicants. New Paragraph Doctor Bjorgens has just wound up a long study on the values of some new kinds of tests for predicting the success of new office workers. From what I have been told, his findings should be of keen interest to us. We may ask him to review the tests we are now using.
   S. V. J.

3. Use current date. Use your own reference initials. Type in proper form. Do not type the words that are underscored.

   Memo to Ewell Blackstone, Art Department From George McAdams, Advertising Department on the subject of Art for McCalls Advertisement Thank you for letting me know about the delay in getting the art ready for the special McCalls campaign. I got in touch with the magazine as soon as I received your note and found we could have an extension of a week in the deadline. New Paragraph Even so, we shall have to move with dispatch in getting the art finished and the plates made. I hope it will be possible for you and your staff to place a high priority on the job for us. Thank again for your help. We appreciate it very much. McAdams

Type and Transcription
(Second Semester)

JUSTIFYING LINES

At the conclusion of this unit you will be able to "justify" lines in a given problem. That is, you will be able to type so that the right margin of your work is even, just as the left margin is even. No test will be given for this unit inasmuch as the assignments will be tests in themselves. All lines should be aligned at the right margin and the typing accurate to be satisfactory. Neat erasures will be allowed.

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Justifying (or varifying) the right margin means making the right margin straight and even. You may be asked to "justify" the margins of a letter, or the margins of a document that have to look extremely neat and symmetrical, such as copy for a school magazine, and special papers that are to be lithographed or mimeographed.

There are three ways to make lines end evenly at the right margin:[19]

1. You may sometimes change a word or a sentence so that all your lines will come out even. Authors do this from time to time to make their lines come out even.

2. You may put some extra spaces between the words, to spread them out so that they fill lines evenly. When you do this, try to avoid putting the extra spaces of one line directly under those of the preceding line.

3. You may spread or squeeze some words, if you prefer, thus stretching or condensing a line to make it fit.

   In all cases, you must type a line first, then see how much space is to be saved or added, and then type it over with all the lines "justified."

Follow the steps in the instructions carefully so that you will be able to "justify" lines correctly. This is interesting work to do and <u>it is not hard</u> if you take the time to follow each step.

<u>Be sure to check with your teacher if you need help.</u>

1. Turn to Page 176-77 in your type book and read Problem 6. Follow the directions given at the top of Page 177 and type the work asked for.

2. After completing Problem 6, Page 176-77, check with your teacher to make sure you are doing the work correctly.

3. Type the following lesson by "justifying" the lines. Spread the heading, use double space, center your work horizontally and vertically on a full sheet of paper.

(Be sure to attach your worksheet to this lesson when you hand it in).

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[19] Rowe, John L., and Alan C. Lloyd, Gregg Typing, Second Edition, Complete Course (New York: McGraw-Hill, Inc., 1958), p. 281.

16186

SALE[20]

We are pleased to tell our regular customers that we have just received a special shipment of 300 suits made of imported British tweed. The suits are of all sizes, are styled in the fashion of today, are all wool. Because we obtained this shipment at a great bargain, we shall be able to offer the suits at less than half the price for which they were intended. A public sale of these wonderful tweeds will begin in two weeks. We thought you would be pleased to come in before then, while there is still a wide selection. Thank you.

THE PARKER-HALE COMPANY

4. Type the following copy justifying the right margin. Use a full sheet. Type it double space, indent five for the paragraphs, use a 40-space line, center it horizontally and vertically. (Attach work sheet).

The FAIRLEIGH COMPANY is pleased to welcome you to its staff. Our company is young, but it is growing rapidly and offers many opportunities to those who may wish to work for advancement. We sincerely hope that you will be happy with us and your associates; you have within you the capacity to help both the Company and yourself to build and to prosper.

The purpose of this booklet is to describe for you the Fairleigh products and how you contribute to them, and tell you about Fairleigh policies and how they contribute to you and your career. If other questions occur to you for which this booklet provides no answers, please do not hesitate to phone or stop by to see us so that you can get the answers.

PERSONNEL DEPARTMENT[21]

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[20] Ibid., p. 283.

[21] Ibid., p. 283.

16187

5. Type the following copy justifying the right margin. Center it horizontally and vertically on a full sheet of paper. Use a 50-space line, double space, indent 5 spaces for paragraphs.

THE EDITORIAL STAFF of this issue of Remember Central! wish to acknowledge their deep gratitude to Miss June Shawe for the innumerable hours and ideas that she, as sponsor of this yearbook, contributed to this volume, to the editorial staff, and to the class whose history is recorded here. We are more than merely appreciative; we are inspired. We are more than merely grateful; we are resolved that her example of rich devotion to others and to their interests will stay before us always, an example to be remembered and emulated.

To MISS JUNE SHAWE, this yearbook is respectfully, and affectionately, dedicated in the hope that these lines will assure her that her contribution has served a worthy cause.

THE EDITORIAL STAFF[22].

6. After completing these lessons, hand them to your teacher for checking. (Be sure to attach your worksheet for each lesson). Proofread your work carefully and make the necessary corrections.

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[22] Ibid., p. 284.

/ PERFORMANCE OBJECTIVE STATEMENT /

SCHOOL: PETERSBURG FEDERAL REFORMATORY

CURRICULUM: VOCATIONAL

CLUSTER: AUTOMOTIVE

PROGRAM: AUTOMOBILE MECHANICS

MODULE: XI. TROUBLE SHOOTING AND TUNE-UP

MILESTONE: I. IGNITION AND CARBURETION

PERFORMANCE OBJECTIVE NO.: 1 TITLE: Creating Malfunctions, and Finding and Correcting

CONDITIONS:

BEHAVIOR:

11. continued
    - e. Spark plugs 1
    - f. Exhaust system 2
    - g. Intake manifold 2
    - h. Carburetor 3
    - i. Fuel pump 1
    - j. Cooling system 1
12. Upon satisfactory completion of items a through j, return all tools, testing equipment and materials to proper place
13. Remove fender covers and store in proper place
14. Close hood
15. Return automobile to proper parking area
16. Remove front seat covers and store in proper place (Omit steps #13 - #16 on all equipment other than cars and trucks)
17. Clean work station for next project

PERFORMANCE CRITERIA:

To be able to satisfactorily trouble shoot and correct malfunction in a reasonable length of time, which is determined by the instructor.

Learning time: 30 hours

1614

TYPEWRITING HONOR ROLL

(Based on Perfect 3-Minute Timings)

Names	Periods	Speeds
Ann Brown	3	56
Richard Case	1	53
Holly Anne Fisher	1	52
Paul Morton	3	51
Gladys Prince	1	51
Viola Perkins	1	50
Norman Whistler	1	50
Louis Douglass		

[23]

3. To type a boxed table: A boxed table is one with both vertical and horizontal ruled lines. Correct boxing divides the columns and headings, but does not close in the sides.

When drawing the horizontal lines, extend them about 1/4 inch beyond the actual width of the table.

4. Type the following example of a boxed table. Use a half sheet of paper. Leave 6 spaces between columns.

L E A G U E S T A N D I N G S

(As of February 8)

	Won	Lost	Per Cent
Woodlawn	9	3	.75
Montclair	8	4	.67
Freedom	8	4	.67
Dumont	7	5	.58
Greensburg	5	7	.42
DeLong	4	8	.33
Parksburg	4	8	.33
Brooker	3	9	.25

[24]

[23] Ibid., p. 114.

[24] Ibid., p. 117.

16190

5. Typing leaders in tables. In typing leaders, strike the period and space bar. To align the periods, note whether you are typing on odd or even numbers on the cylinder scale when you type the periods for the first line. Space once before starting the leaders. The right margin should be even.

6. Turn to page 81 in Basic Typewriting Operations: Principles and Problems (Red drill book) and type Problem 32. Follow the directions given in the book.

7. Turn to Page 336 in your type book and type Problem 2. Set this Income Statement up in correct form.

8. Tables in themes and other reports. In typing a table within a theme or report, note whether the report is to be bound at the left. If so, then you must remember that headings must be centered over the line of writing just as you did in manuscript writing.

9. Turn to Page 51 in Statistical Typing with Tabulation Problems (green drill book) and type Problem 1. Follow directions given in the book. This might not fill the full page because this is just part of a report.

10. Typing Tables Sideways on the Paper. When a tabulation requires a great many columns, it may be typed on a sheet turned lengthwise in the typewriter. This provides 51 vertical spaces (on regular typing paper 8 1/2" x 11") and 132 horizontal spaces (elite type).

11. For this problem, use either the electric typewriters or the Olympia typewriters. Turn to page 92 in Basic Typewriting Operations: Principles and Problems (red drill book) and type Problem 60. Follow the directions given in the book.

12. After completing No. 11, check your work carefully and make any corrections necessary. Check your work with the key and hand it to your teacher.

13. If your production work for this unit has been satisfactory, you will be given the test for the unit.

14. After completing the tests for this unit, hand them to your teacher for checking. If you have typed these satisfactorily, you will be given your next assignment.

Type and Transcription
(Second Semester)
Tabulation

TEST NO. 1

Directions: 1. Use a full sheet of paper and double spacing. 2. Leave 8 spaces between Columns 1 and 2; and 6 spaces between Columns 2 and 3 and 3 and 4. 3. Center the word Percentages over the last 3 columns. 4. Center 1963 over the third and fourth columns and underline the third and fourth columnar headings as a unit. Time limit: 20 minutes.[25]

CONSUMER FINANCIAL BEHAVIOR

Based on 1957-59 Base of 100

(Latest Department of Commerce and Federal Reserve Revisions)

	1962	1963	
	Second Quarter	First Quarter	Second Quarter
Personal Income	120.7	124.3	125.9
Personal Taxes	131.9	135.3	136.4
Disposable Personal Income	119.1	122.8	124.5
Personal Saving	124.2	112.9	123.3
Durable Goods Expenditure	117.6	125.2	126.2
Nondurable Goods Expenditure	112.9	116.2	116.7
Expenditures on Services	126.2	132.0	133.8
Consumer Installment Credit Extended	128.3	135.3	134.6
Consumer Installment Credit Repaid	123.0	130.8	129.3

[25] Liguori, op. cit, p. 78.

16192

TEST NO. 2

Directions: Set up the following report. The report is to be bound at the left. Double space the body of the report and single space the tabulation. Triple space between the textual matter of the report and the table. Allow a 1" top margin. Assume that this is page 3 of the report. Time limit: 20 minutes.

Unfortunately, work standards cannot be readily established on a nationwide basis for the wide variety of jobs found in business offices. Some efforts have been made by national associations to set standards on certain of the more common kinds of work; however, these will prove of reference value only to supervisors and others engaged in the setting of standards. Some standard time allowances which have been found to exist in a composite of business firms may be of interest. These time allowances are given in the table below:

TABLE VI

STANDARD TIME ALLOWANCES FOR TYPICAL OFFICE JOBS

Kind of Work	No. Per Hour
Type Addresses or Labels	141
Address Envelope by Hand	111
Straight Typing (Keystroke Count)	13,786
Type Ledger Sheets	111
Sort Bills of Lading into Sortograph	1,356
File Correspondence	130
Print and insert Index Cards	242
Tab Metal Addressing Plates	678
Emboss Metal Addressing Plates With Name and Address	61
Post Accounts on Bookkeeping Machine	242
Feed Envelopes Through Postage Meter	8,023

Serial 16193

TEST NO. 3

Directions: Type the following table with ruled lines and braced headings. Double space; 8 spaces between columns. Time limit: 15 minutes.[27]

EXTENDED COVERAGE INSURANCE RATES

By Territories

	First $5,000		Second $5,000	
Territory	1 Year	3 Years	1 Year	3 Years
I	$1.08	$2.70	$ .76	$1.90
II	1.04	2.60	.68	1.70
III	1.00	2.50	.64	1.60
IV	.94	2.35	.64	1.60
V	.86	2.15	.58	1.45
VI	1.00	2.50	.64	1.60
VII	.90	2.25	.58	1.45
VIII	.82	2.05	.54	1.35
IX	.94	2.35	.58	1.45
X	1.04	2.60	.68	1.70

TEST NO. 4

Directions: Type the following table in 3 columns. Double space, 10 spaces between columns. Time limit: 15 minutes.[28]

HIGH SCHOOL SUBJECTS OF SPECIAL VALUE
Reported by Graduates of St. Petersburg High School

Subject	Number	Per Cent
Typing	98	49.0
English	54	27.3
Bookkeeping	44	22.2
Psychology	43	21.7
Shorthand	30	15.2
Mathematics	29	14.6
Business English	18	9.1
Languages	11	5.6
Mechanical Drawing	10	5.1
Algebra	10	5.1
Home Economics	9	4.5
Social Studies	9	4.5
Secretarial Training	9	4.5
Physics	7	3.5
Commercial Law	5	2.5
Biology	4	2.1
Plane Geometry	4	2.1

[27] Ibid., p. 38.

[28] Ibid., p. 21.

16194

Some hourly standards have been assembled by a company that made a study of typewriting production in business firms throughout the country. These standards will appear in a report which is now being prepared.[26]

[26] Wanous, S. J., Statistical Typing with Tabulation Problems, Second Edition. (Cincinnati: South-Western Publishing Company, 1956), p. 53.

16195

TEST NO. 5

Directions: Type the following table with leaders. Double space; 12 spaces between columns. Time limit: 15 minutes.[29]

ADVERTISING BUDGET
City Business College

	Per Cent Budgeted
Advertising Media	
Direct Mail and Postage	34
Newspapers	28
Catalog	12
High School and College Publications	8
National - Magazines or Newspapers	5
Radio	5
Directories - City and Telephone	4
Calendars, Novelties, etc.	4
Total	100

TEST NO. 6

Directions: Type the following table sidewise on your paper. Center it horizontally and vertically. Use double spacing and allow 6 spaces between columns. Use an Olympia or an electric typewriter for this test. Time limit: 30 minutes.[30]

DUTIES OF OFFICE EMPLOYEES

Ranked According to Frequencies

Duties	Rank	Frequency	Steno-graphic Rank	General Clerical Rank	Record Keeping Rank	Machine Operator Rank
No. of Employees		1668	443	648	464	113
Use the Telephone	1	1405	7	2	1	2
Use Filing Systems	2	1219	20	1	4	1
Sort Business Papers	3	914	18	14.5	5	7.5
Use Adding Machine	4	892	36	5	3	3
Type Envelope Addresses	5	872	4	3	35	37
Make Carbon Copies	6	863	4	4	38	22
Type on Printed Forms	7	832	4	12	23	39
Verify and List Data from Business Papers	8	829	22	16	[illegible]	7.5

16196

Type and Transcription
(Second Semester)
Tabulation

Use Stapler	9	828	17	10	13	4
Type copies of Records	10	817	6	6	42.5	34.5
Prepare Material for Filing	11	802	21	7.5	17	11
Copy from Rough Draft on Typewriter	12	762	8	11	31	63

[29] Ibid., p. 3

[30] Ibid., p.

16197

POST CARDS

Performance Criteria:

The student will be able to type a message on a post card and address a post card in correct form which is outlined in this unit. A test will be given which will consist of typing and addressing three post cards. A time limit of 30 minutes will be given for the test. Neat erasures will be allowed.

- - - - - - - - -

The following are some rules for typing and addressing post cards:

Addressing the Card

1. The return address is to be blocked and single spaced in the upper left corner of the card. Start typing on the third line from the top and the second space from the left side of the card.

2. Begin the address a triple space below the printed address indentification and five to eight spaces left of center. (Begin the address below the "f" in "of" of the printed identification).

3. Use block form in typing the address. Double space a three-line address; single space a four-line address.

Typing the Message

1. Type the date on the third line.

2. Leave a one-half inch margin at each side. (There are 20 lines down a post card and 66 elite and 55 pica spaces across).

3. Do not type a return address or an inside address on the message side.

4. Triple space between the date and salutation, triple space between the body and the name and title of the person sending the message. A complimentary close is not necessary but may be used if the message is not too long and there is room on the card. If used, the complimentary close is typed a double space after the body.

16198

1. Using the forms attached, type the following message according to the rules given above.[31] To: Miss Mary Johnston/ 2345 Howard Street/ Mentor, Ohio 44060/ Return Address: Business Service Club/ Mentor High School/ Mentor, Ohio 44060. Use current date and block style. Dear Mary:/ This is just a reminder that the Decoration Committee of the Annual Dance will meet on Thursday in Room 215 at 3 p.m. This is the last time we will be able to get together before the decorations will have to be placed in the gym./ Sincerely,/ Helen Carroll, Chairman.

2. Turn to page 81 in your type book. Type 50-C, Problem 2. Follow the directions in your book and use the school as the return address. Use the form attached.

3. Type Problem 5, page 296. Do not follow the book instructions. Use the form attached. Directions: Address a post card and type the message to Thomas P. Kuchel/ Hillcrest Road/ Ft. Thomas, Kentucky 74810. Use the school address for the return address. Use the current date and type the message as given in the book.

After completing the production work in this unit, check your work carefully with the key and hand your papers to your teacher. If this work has been done satisfactorily, you will be given the test for this unit.

After completing the test for this unit, hand your papers to your teacher for checking. If your work is satisfactory, your teacher will give you your next assignment. If not, supplementary work will be given to you.

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[31] House Clifford R., and Samuel Skurow, Typewriting Style Manual, Seventh Edition, (Cincinnati: South-Western Publishing Company, 1958), p. 76.

16'99

/TRAINING PROGRESS REPORT/

SCHOOL : PETERSBURG FEDERAL REFORMATORY Enrolled : _____

CURRICULUM: _____ Completed: _____

CLUSTER : _____ Dropped : _____

PROGRAM : _____

PHASE : (Circle) Shop Rel. Inf. Prog. Inst. Resource Mat.

MODULE NUMBER	PERFORMANCE OBJECTIVES														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Hrs.
I															
II															
III															
IV															
V															
VI															
VII															
VIII															
IX															
X															
XI															
XII															
XIII															
XIV															
XV															
XVI															
XVII															
XVIII															
XIX															

STUDENT _____ NUMBER _____

1616

Type and Transcription
(Second Semester)
Post Card

Test: The following test is to be completed in a time limit of 30 minutes.[32]

1. Address the post card and type the message to Miss Linda Terrill/ 3827 Par Hills Drive/ Covington, Kentucky 41011. Use the current date and Weber High School for the return address. Dear Linda/ Our Music Club has 40 tickets for the opera FAUST for Friday, June 28, priced at $2.30 each. The first 10 people to purchase these tickets will be allowed a discount. Their tickets will cost only $2 each. (P) You like opera, I know; so join us on June 28, won't you? I'll hold a ticket for you./ Maria Bueno/ Secretary.

2. Center both vertically and horizontally the following announcement on a post card. Double space. Be sure to center each line horizontally. Address the post card to Mr. Arthur Dawson/ 3690 Harrison Boulevard/ Chicago, Illinois 87654.

   THE ACADEMIC HONORS SOCIETY
   announces
   Free Tutoring for Juniors and Seniors
   in
   Physics and Mathematics
   Wednesdays and Fridays
   3:45 to 5:15 p.m.
   Rooms 103 and 105

3. Address a post card and type the following message to Miss Mary W. Keane/ 1047 East Third Street/ Reno, Nevada 89503. Use the current date and your own address for the return address. Dear Miss Keane/ The next meeting of the Finance Committee of the Alumni Association will be held at 8:30 p.m., Saturday, December 10. It will be held at the home of John F. Elkins (1200 West 21 Street). The agenda includes a study of the finance plan for the Alumni House, a matter so important that committee members are urged to attend./ Richard Carlson/ Executive Secretary.

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[32] Rowe, John L., Alan C. Lloyd, and Fred E. Winger, Gregg General Typing 191 Series, Second Edition (New York: McGraw-Hill, Inc., 1967), p. 107.

TELEGRAMS

Performance Criteria:

The student will be able to type a telegram in a set time limit in correct form according to the rules set up for sending telegrams. A test will be given which will consist of typing four telegrams in a time limit of 30 minutes. Neat erasures will be allowed.

Telegrams are a type of dispatch communication that are used within the country. The urgency of the message determines the type of dispatch communication that is used, such as, letters, telegrams, telephone calls, etc.

Telegrams include the following classes: full-rate telegram, day letter, night letter.

A full-rate telegram is the fastest and most commonly used and is utilized for urgent messages. This type of telegram is transmitted without delay and is delivered immediately upon arrival at destination. (This is the most expensive).

The day letter is slower and less expensive than a full-rate telegram. It is delivered the same day that a person sends it.

A night letter is third in order of speed. It is delivered the following morning. These messages are accepted any time during the day or night up to 2 a.m. for delivery the following morning.

For the following assignments telegram forms will be provided.

1. Turn to page 266 in your type book. Read 181-C thoroughly and follow along with the example given.

2. Type 181-D, page 267, Problem 1 and 2 and 3. Note: Do not type the zone number given in the book. Type the Zip Code number instead.

3. Type the following telegrams as per instructions given:

   a. The following telegram is to be sent as a DAY LETTER. Use your own reference initials and charge this telegram to J. C. Bolton, Incorporated.

      Ogden, Utah 84401/ Current Date/ Louis Parke, Editor/ Stationers' Journal/ 2300 J. Street/ Washington D. C. 10011/ Am mailing today the article you requested. Hope it will serve your purpose. This purchase should be the wisest investment you have ever made./ Edward Bolton/ J. C. Bolton, Incorporated.

162015029

b. Send the following telegram FULL RATE. Use your own name and the name of the school as the signature line. Use your initials as the reference initials and charge this telegram to the school.

Salt Lake City, Utah 84301/ Current Date/ Mrs. Carolyn Hungerford/ Board of Education/ St. Louis, Missouri 64288/ Regret my inability to participate in your survey of business-training program. Explanatory letter follows.

c. Send the following telegram as a NIGHT LETTER. Use Mr. Jones' initials as reference initials. Charge it to the sender and the sender's address is to be transmitted.

Omaha, Nebraska 11111/ Current Date/ Supreme Manufacturing Company/ 6495 Prairie Avenue/ Chicago, Illinois 32201/ Your shipment of 1969 automobiles should arrive at your showroom within the next five days. Order delayed because of the recent railroad strike. Regret this slight delay./ Mark Paul JOnes, President/ Humbolt Automobile Company/ 14511 Lake Shore Drive/

d. The following message is to be sent FULL RATE. Charge it to the Union School District and use your own initials as reference initials. Do not transmit the sender's address.

Miami, Florida/ Current Date/ Mr. Lloyd R. Reardon, President/ Blake, Walsh, and Taylor, Inc./ 101 Beale Street/ San Francisco, California 94356/ Wire best price on 20 dozen #83 carbon paper. Also wire earliest shipping date/ R. L. Landers, Treasurer/ Union School District/ 1469 Terrace Road.

After completing the assignments in this unit, check your work carefully and hand your papers to your teacher. If this work has been done satisfactorily, you will be given the test for the unit.

After completing the test for this unit, hand your papers to your teacher for checking. If the work is satisfactory, your teacher will give you your next assignment. If not, supplementary work will be given to you.

162021031

Type and Transcription
(Second Semester)
Telegrams
Test

Follow the instructions for typing each of the telegrams listed below. Forms will be provided. You have a time limit of 30 minutes to complete this test. Neat erasures are allowed.

1. Type the following as a night letter. Charge the message to the National Fiber Company. Use your own reference initials. Use the current date.

Houston, Texas 54888/ Continental Distributors, Inc./ 5634 Middleground Road/ Savannah, Georgia 76810/ On March 24 the Memphis plant shipped Invoice #163028 for American Weavers, Inc., New Orleans, Louisiana, in Crate #17, weighing 329 pounds. A shortage of Item Z-29 has been reported. Investigate details of claim and report findings. Also report the re-weight on the merchandise./ Paul Smith

2. Type the following as a day letter. Charge the message to Hartwell Supply Company. Type your own reference initials and use the current date.

Spokane, Washington 94560/ McGlaze Manufacturing Company/ 624 West Jackson Avenue/ Chicago, Illinois 68790/ Please Cancel our Purchase Order #10832 mailed to you yesterday. We cannot use the goods that were written on that order. They are not adequate for our purpose. New order will follow with a new Purchase Order. Will contact you on this new order in the near future./ Kevin Gregory.

3. Type the following as a telegram. Charge the message to Manufacturers Institute. Type your own reference initials and use the current date. Transmit the sender's address.

New Orleans, Louisiana 43233/ Dr. Robert Rafael/ School of Business/ Wayne University/ Detroit, Michigan 87560/ Editorial Board has authorized new edition of your book. How woon can we have manuscript? Need it by next week on Thursday./ Donald Bideaux/ Manufacturers Institute/ 4053 Park Hills Drive.

4. Type the following as a telegram. Charge the message to United Steel Institute. Type your own reference initials and use the current date.

Salt Lake City, Utah 81101/ Dr. Maurice Trethaway/ School of Business/ University of Illinois/ Champaign, Illinois 54433/ New Simpson edition delayed until May 1. Shall we fill order with present edition?/ Donald Burt, United Steel Institute.

16203

Type and Transcription
(Second Semester)

MANUSCRIPTS

Performance Criteria:

At the conclusion of this unit you will be able to type a table of contents with leaders and a manuscript with footnotes and quotes in correct form in 45 minutes. You will also be able to type a rough draft manuscript and a bibliography in correct form in 45 minutes.

- - - - - - -

During this unit you should drill at least five minutes each day to increase your speed and accuracy in typing. Use the drills in your type book and select those that will help you the most.

Proofread carefully and check your papers with the key. All of the material in this unit should be handed to the teacher when you complete the unit.

If any questions arise, do not hesitate to ask your teacher.

- - - - - - - -

Follow the listed instructions step by step to develop your skill in manuscript typing.

1. Review the sheet in this packet called Word Division Rules for Typewriting. Type 99-C, #3, page 157. Follow the book directions.

2. On your drill sheet for your 5-minute drill, type 99-C, #2, page 156. If you have already typed your drill for today, use this for your tomorrow's drill.

3. Type 99-C, #1, page 156. Follow the book instructions.

4. Many college reports or research papers include quotations from other authors or references. These must be typed in the correct way in the manuscript. The following rules can be used as a guide:

   a. A quotation of <u>three</u> or fewer lines is displayed by being typed within quotation marks.

   b. Longer quotations are given special attention by single spacing and indenting five spaces from the regular margins on both sides. In some instances quotation marks are used around the quotations which are indented, however, when you indent quotations in manuscripts, it is preferred to omit the quotation marks.

   <u>Remember</u>: Commas and periods are <u>always</u> typed inside the quotation marks.

16204

c. The omission of words from a quotation is called ellipsis and is shown by three alternating periods and spaces, or four if the end of a sentence is included in the omission.[33]

For practice on each of these rules type the following. This may be done on one sheet of paper.

a. So began a three-day battle between the old man and the big fish. The old man had to battle thirst and hunger, and loss of sleep, too, and the pain of cut and bleeding hands and cramped fingers. Pain did not matter--a man could endure; and defeat he never admitted. "Man is not made for defeat," he said. "A man can be destroyed but not defeated."[1] [34]

b. Type the first three paragraphs of Problem 1, 60-C, page 96.

c. Type 56-D, page 91. Follow the book direct ns.

5. Type 58-C, Problem 1, page 93-94. Do not follow the book directions. Assume that this manuscript will be bound at the top. Type it according to correct manuscript form. If necessary, refer to your rules for manuscript form.

6. Type 145-D, page 212. Make up and type in your own page numbers. The following are some general rules for typing a table of contents. Use these as your directions for this problem.[35]

a. Use a full sheet of paper.
b. Center the exercise vertically.
c. Use the same margins as your report or manuscript. (For this problem, assume it is to be bound on the left).
d. Center the title over the line of writing.
e. Center the problem horizontally.
f. Triple space between the title and the word Page, double space before and after main headings in the table.
g. Indent and single space the secondary headings.
h. Separate the headings from corresponding page numbers with leaders (periods and spaces alternately typed). Align subsequent rows of leaders by noting whether the first line is typed with the periods on odd or even numbers and maintaining the same placement for each line. Leave a blank space before the first period and at least one after the last on each line.

7. Type the following problem and center it vertically. Use margins for a manuscript that is to be unbound.

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[33]Lessenberry, Crawford, and Erickson, 20th Century Typewriting, Eighth Edition, Complete Course (Cincinnati: South-Western Publishing Company, 1962), p. 91.

[34]Ibid., p. 88.

[35]Liguori, op. cit., p. 18.

16205

TABLE OF CONTENTS[36]

Chapter I the Problem Page 1
Statement of the Problem Page 1
Delimitations Page 2
Sub-Problems Page 3
Definitions Page 3
Significance of the Problem Page 4
Related Studies Page 6
Chapter II Procedure Page 10
Preparation of Bibliography Page 10
Analysis of Textbooks Page 12
Analysis of Literature Page 15
Conclusions by Comparison Page 18
Chapter III Aims of the Authors Page 20
What the Authors Claimed Page 22
Possible Reasons for Changes Page 30
Summary Page 34

8. A bibliography is a listing of all references used in the preparation of a manuscript. It may also be a general listing of references on a particular subject. The following is a guide to typing a bibliography.[37]

a. Use the same margins for the bibliography as for the body of the manuscript.
b. Start a bibliography two inches from the top of the page.
c. Center the heading "Bibliography" according to the writing line of the report. Triple space (leave two blank lines) after the heading.
d. List references alphabetically by author.
e. Double space between references. If a reference covers more than one line, single space the reference.
f. Start the first line of the reference at the left margin; indent five spaces for all other lines in the reference.
g. A reference to a book consists of the name of the author or authors (last name first), the title of the book, the place of publication, the publisher, and the yar of publication.
h. A reference to an article consists of the name of the author or authors, the title of the article, the title of the publication, the volume number and the date of publication, and the pages on which the article appears.
i. Titles of books and names of periodicals are typed in all capitals, or underscored with the first letters of major words capitalized.
j. The titles of magazine articles are placed in quotation marks.

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[36] Freeman, op. cit., p. 57.

[37] Ibid., pp. 51-52.

16206

9. Type the following information in bibliography form.[38]

BIBLIOGRAPHY

Crabbe, Ernest H.; Debrum, S. Joseph; and Haines, Peter G. General Business. Cincinnati: South-Western Publishing Co., 1966.

Gruenberger, Fred; and Hill, Richard H. "Let's Close the Knowledge Gap at the Top," Business Automation, Volume XIII (May, 1966), pages 39-41.

Wilhelms, Fred T.; Heimerl, Ramon P.; and Jelley, Herbert M. Consumer Economics, Third Edition. New York: Gregg Division, McGraw-Hill Book Company, 1966.

Yourd, Bryce W. " Accounting, Data Processing, and the Psychology of Learning," The Balance Sheet, Volume XLVII (May, 1966), pages 388-393.

10. Type 90-D, page 142-144. Follow the book directions. This manuscript is to be bound on the left. Be certain to know the spacing for side headings.

11. Type 93-C, Problems 2 and 3, page 147. Follow the book directions.

12. Hand in all your production work for this unit on manuscripts after you have checked with the key. Your teacher will check your work and give you the test material if you have completed the unit satisfactorily.

13. Tests 1 and 2 should be typed in 45 minutes. After you have completed the tests, hand them to your teacher. Be sure to proofread carefully.

14. Tests 3 and 4 should be typed in 45 minutes. Proofread your papers carefully and hand them to your teacher for checking.

15. If you type these tests according to the terms stated in the performance criteria, your teacher will give you the next assignment. If not, some supplementary material on this unit will be given to you.

16207

[38] Ibid., p. 51.

16206

Test No. #1

Directions: Set up the following table of contents in correct form using leaders. Use margins of a manuscript bound on the left and center it vertically. The time limit for this test is 15 minutes.[39]

TABLE OF CONTENTS

Introduction Page 1
Placing a Telephone Call Page 2
Long Distance Calls Page 2
Collect Calls Page 2
Unusual Telephone Situations Page 3
Complaints Page 3
Employer's Calls Page 3
Calls When Boss Is Out Page 4
Unexpected Calls Page 4
Expected Calls Page 5
Transferring Calls to Another Department Page 5
Telephone Problem Situations Page 6
Answering for Someone on Another Telephone Page 6
Changing the Time of an Appointment Page 7
Adding to or Changing an Order Page 7
Making Reservations Page 8
Reporting Lost Items Page 8
Summary Page 9

[39] Liguori, op. cit., p. 18.

16208

Test No. 2

Directions: Type the following material in manuscript form. This manuscript is to be sidebound. The time limit for this test is 30 min.[40]

Title: Work Organization

One of the goals of the efficient office worker is good work organization. When a person has learned to organize his work, he has solved one of the difficulties of the working world. Littlefield and Peterson emphasize the importance of work organization when they say:

> Many firms are in a static condition simply because the executives in charge lack organizing skill. This lack of skill may result in improper balance among the departments of the organization; in some departments being over-supervised and others being under-supervised; in problems arising due to an absence of clear-cut lines of authority; in disputes among personnel; in employees bypassing their supervisors; and in employees taking orders from more than one supervisor.[1]

The executive has his problems with organization. The office worker below the executive level must also concentrate on organization. First of all, he must take a positive attitude toward unfinished work. Unfinished work at the end of a day is depressing and frustrating: To have to stop work before finishing is upsetting to efficiency and disposition. Even children at play are goal-motivated, and it is asking too much of them to quit play instantly to come in for dinner. The wise parent asks the child to come in as soon as there is a stopping place in the play. So it is with adults, too. Workers are irritated if they are pulled off a job before they have finished. Unless it is an emergency, the wise boss advises the worker to fit in other work as soon as possible. Sometimes, moreover, an emergency may mean that the boss himself has done some poor planning! Interrupted work is unfinished work. Long visits, needless phone calls, unnecessary requests for help--all produce annoyance rather than efficiency. Necessary interruptions should be made with consideration to the worker. As a matter of fact, people who do not mind interruptions are not likely to be goal-motivated. (P) On the other hand, time for rest and peace is necessary. Every minute from arising to retiring cannot be used for productive effort: Overwork makes people go stale. (P) Time spend in waiting ordinarily should be neither rest nor relaxation. The efficient person has the habit of thinking about his work and planning ahead during the times he has to wait. This type of worker plans what to say to his employer and how best to say it, or he reviews his work methods with the aim of improving them. (P) A successful man who started out as an office boy and later formed a large company gives this advice: "The young man who spends his spare moments with greatest profit to himself will be able to sell his working hours in later life at the greatest profit."

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[1]C. L. Littlefield and R. L. Peterson, Modern Office Management (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1956), p. 540.

80081
16209

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[40]Ibid., p. 26.

TO : Vocational Training Program Coordinator Date:

FROM:

RE :

He has completed Performance Objective # _____ of Module # _____

TO : Vocational Training Program Coordinator Date:

FROM:

RE :

He has completed Related Information requirements for Performance Objective # _____ of Module # _____

TO : Vocational Training Program Coordinator Date:

FROM:

RE :

He has completed Programmed Instruction requirements for Performance Objective #_____ of Module # _____

TO : Vocational Training Program Coordinator Date:

FROM:

RE :

He has completed Resource Material requirements for Performance Objective # _____ of Module # _____

TO : Vocational Training Program Coordinator Date:

FROM:

RE :

Academic deficiencies, for which he has been referred to me, have been corrected.

Type and Transcription
(Second Semester)
Manuscripts
Tests

Test #3

Directions: Type the following rough draft material in manuscript form and make all corrections indicated. This manuscript will be topbound. The time limit for this test is 30 minutes. Remember to type the footnote in the proper place.

ADVERTISING AS A CAREER

~~A number of~~ Many people in the field of advertising are chiefly creative--the writers and artists. Some are active salesmen ~~and~~ who sell space, time or supplies. Others ~~do work in~~ analyz~~ing~~e and study~~ing~~ markets ~~or~~ research media to see what is going on in the world. Some ~~work in~~ manag~~ing~~e ~~and~~ coordinat~~ing~~e the work of others. Most jobs, in point of fact, call for ~~some~~ combination of these talents in what is considered one of the most important phases of ~~business~~ selling.

Toone, Simon, and McGill say ~~that~~

> By far the most important form of sales promotion is advertising. This paid form of publicity is used to create a demand for a product and stimulate business. It is also an informative and educational force that aids the consumer in making judgments and adds to his standard of living.[1]

Even though ~~the~~ work in advertising is varied, people who have done well in ~~the~~ field ~~of advertising~~ have ~~as~~ at least three traits in common: They like to solve problems; they are interested in people and things. They are all sales-minded. ~~Many people~~ Workers in other ~~work~~ lines have these traits, too, but ~~the~~ successful men and women in this field need them in large measure.

First, the person in advertising must like to solve problems. Often facts ~~must~~ have be gathered ~~to~~ and define the problem. A course of actions must be recommended, ~~and after it is~~ put into effect, ~~it must be checked~~ the results appraised and from time to time, to reappraise ~~the result~~. Sometimes even excellent work can be improved.

Second, the person should be sales-minded. He must think in terms of persuading people, ~~he must~~ present ideas in ways that will appeal to their interests.

16210

233 OF 327

ED

056 238

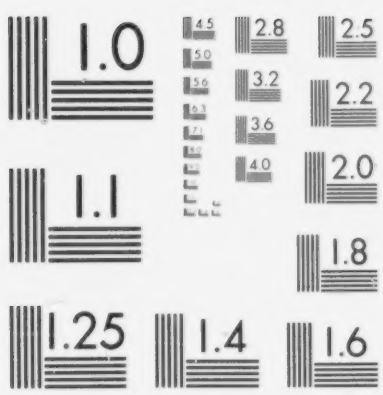

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Test #3
Page 2

The third ~~big~~ outstanding trait of advertising people is a great interest ~~in people and things and~~ in mankind, as well as the workings of business. The ~~hope of the~~ advertising man is to present a selling message in ways that draw attention, arouse interest, create a desire for the products, and persuade people to buy ~~it~~ them. He should be a salesman with a broad background in ~~a lot of the~~ varied subjects, ~~which he can take in school,~~ one both practical and cultural. A This background is shaped by his personal experiences, the courses he took in school, and his hobbies and other outside activities. It reflects the kind of young man he was and determines the kind of older man he will become.[4]

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[4]Herbert A. Tonne, Sidney J. Simon, and Eaby C. McGill Business Principles, Organization, and Management (2nd ed, McGraw-Hill Book Company, Inc., 1963), p. 144.

16211
233

[1]Ibid., p. 28.

Test #4

Directions: Type the following bibliography in correct form. Assume that it is to be sidebound. The time limit for this test is 15 minutes.[42]

Bibliography

Bell, Howard. Matching Youth and Jobs (A Study of Occupational Adjustment). Washington: American Council on Education, prepared for the American Youth Commission, 1940.

Bingham, Walter V., and Bruce V. Moore. How to Interview, 4th rev. ed. New York, Evanston, and London: Harper & Row, 1959.

Blum, Milton L., and Benhamin Balinsky. Counseling and Psychology. New YOrk: Prentice-Hall, Inc., 1951.

Brewer, John M. "Causes of Discharge," Personnel Journal. (Swarthmore: The Personnel Journal, INc.), XIV (1927), 171-172.

Cole, Luella. Psychology of Adolescence, 5th ed. New York; Holt, Rinehart, and Winston, Inc., 1959.

Forrester, Gertrude. Methods of Vocational Guidance, Rev. ed. Boston: D. C. Heath and Company, 1964.

16212

[42] Ibid., p. 36.

TRANSCRIPTION

BEHAVIORAL OBJECTIVE:

The student will be able to transcribe on the typewriter designated material from shorthand plates. She will be able to transcribe each outline accurately.

Each transcription assignment will consist of approximately one typewritten page. A total of ten points will be given for each assignment with one point deducted for each error. A minimum of six points an assignment will be required to pass. The following will be considered as errors: placement, not following instructions, misspelled words, type errors, word division, messy erasing, missing words, and additional words. A minimum of 18 passing transcripts will be required.

Texts:

Gregg Dictation (D-J Series), McGraw-Hill Book Company
Shorthand Transcription Studies (Fourth Edition D-J Series), South-Western Publishing Company

This unit is to help you further develop your transcription skill in both speed and accuracy. Keep in mind how important transcription is. The completed transcript, such as a "mailable" letter, is your ultimate goal to become an efficient secretary.

Follow the directions carefully. Being able to follow directions and work on your own are two qualities essential in obtaining and maintaining a good position.

Transcription drills should be continued as in the first semester. You may continue to use the brief forms in the back of your book, theory review at the beginning of each lesson, and the recall drills of word beginnings and endings and phrases that appear in the back of your book, pages 504 to 511. You will also be given a variety of drills throughout the following assignments. You will be expected to drill five to ten minutes each day on these transcription drills. Hand your drill paper in when both sides are full.

The following assignments are to be completed during this semester. Assignments from your shorthand book (Gregg Dictation D-J Series) can only be completed as you finish each chapter. Assignments from the transcription book (Shorthand Transcription Studies--Fourth Edition, D-J Series) should be worked on throughout the semester.

After the completion of each assignment, hand it in to be corrected.

DO NOT HESITATE TO CHECK WITH YOUR TEACHER AT ANY TIME IF YOU HAVE A QUESTION.

16213

ASSIGNMENTS

From the shorthand book

Use a 70-space line. Double space. Leave a one and one-half inch top margin. If an assignment takes more than one page, use the back of your sheet to complete it. REMEMBER--Always type the heading in all capital letters. Triple space after the heading. Type the following in the upper left corner of your paper: Name
Type and Transcription
Semester 2
Assignment No.

1. Transcribe #39, page 44-45.
2. Transcribe #79, page 76-77.
3. Transcribe #116, page 104-105.
4. Transcribe #156, page 136-137.
5. Transcribe #196, page 170-171.
6. Transcribe #235, page 200-201.
7. Transcribe #273, page 230-231.
8. Transcribe #310, page 258-259.
9. Transcribe #350, page 286-287.
10. Transcribe #387, page 314-315.
11. Transcribe #426, page 344-345.

16214

From the Shorthand Transcription Studies Book

Even though the following assignments are listed in groups, one group does not have to be completed before starting a new group. To be more interesting, it is suggested that you intersperse the assignments listed as Spelling Demons, Punctuation Study, and Word Differentiation with your assignments of Letters, Memorandums, and Outlines.

Remember to indicate your assignment with your heading in the upper left corner.

Spelling Demons, Punctuation Study, and Word Differentiation

DIRECTIONS:

Spelling Demons: Use a 70-space line. Number each sentence and double space. Transcribe the sentences once. The outlines in color represent frequently misspelled words. Use your dictionary if necessary. Don't guess. Triple space before transcribing the Punctuation Study.

Punctuation Study: Use a 70-space line. Type the punctuation rule or rules once single spaced, double spacing between rules. Triple space and transcribe the shorthand notes that follow, using double spacing. Triple space before transcribing the Word Differentiation.

Word Differentiation: Study the words and their definitions. Transcribe (double space) the material that follows. Be sure to select the correct word appearing in the brackets.

12. Transcribe page 128, 31A; page 29, 6A; page 40, 8C.

13. Transcribe page 131, 32A, page 34, 7A; page 48, 10C.

14. Transcribe page 135, 33A; page 42, 9A; page 54, 11C.

15. Transcribe page 138, 34B; page 47, 10A, page 61, 13C.

16. Transcribe page 141, 35A; page 53, 11A; page 71, 16B.

17. Transcribe page 180, 46A; page 67, 15A; page 87, 20B.

18. Transcribe page 182, 47A; page 70, 16A; page 102, 24B.

19. Transcribe page 187, 48A; page 94, 22A; page 149, 37A.

20. Transcribe page 190, 49A; page 97, 23A; page 156, 39A.

21. Transcribe page 193, 50A; page 101, 24A; page 158, 40A.

16215

Memorandums

Do not do this section until you have completed the unit on office memorandums in your type book.

You may use any of the three styles in your typing memorandum unit for the following memorandums. Use single spacing, double spacing between paragraphs.

22. Transcribe pages 28 and 29, 6D (2 memorandums).

23. Transcribe pages 33 and 34, 7D (2 memorandums).

24. Transcribe pages 81 and 82, 19B and pages 85 and 86, 20D.

Outlines

25. Transcribe page 221, 62A. (Memo to a Secretary). This memorandum gives instructions for the outline that follows.

On a separate sheet of paper, type the outline on page 223 and 224, 63B. Follow the book directions. Staple these papers (Memo and Outline) before handing them in.

Letters

Do not do this section until you have completed the letter unit in typing. AN ENVELOPE SHOULD BE TYPED ON THE BACK OF EACH LETTER. For the return address on your envelopes, use the name and address of your school.

26. Transcribe 12C, Letter No. 2, page 55. Follow the directions given in the book. Choose your own letter style. This is a short letter.

27. Transcribe 13C, Letter No. 2, page 59. Follow the book directions. Type this letter Modified Block with blocked paragraphs.

28. Transcribe 20B, page 84-85. This letter is dictated by Bruce Wade and is a long letter. Type this letter in Full-Block style. In the last paragraph i.e. is used. It should be typed as follows: address, i.e., 8 Blackwell Avenue. (i.e. means, that is).

29. Transcribe the letter at the top of page 120. Use Modified-Block style with blocked paragraphs. Refer to page 118 on how to type the postscript (P. S.). The dictator is Norman W. Quince, President.

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30. Transcribe 37B, page 147. Follow the book directions.

31. Transcribe 27C, No. 3, page 112. Use Blocked style. Read 27B, page 111 and 112 before typing this letter. The dictator is E. L. Langley, Credit and Adjustment Department.

32. Transcribe No. 3, page 116. Read 28B, page 115 before typing the letter. The dictator of this letter is Marcella Hogan, Manager, Trade Sales Department. Use Modified-Block style with indented paragraphs.

33. Review 17B, page 73. Transcribe 25A, No. 2, page 104. Use Modified-Block style with blocked paragraphs. The dictator is Peter I. O'Dell, Publicity Manager.

34. Read 22B, page 92. Special Delivery notations, Personal notations, and Hold for Arrival notations are all typed in the same position on the letter as the Air Mail notations discussed in 22B. Transcribe 22D, No. 1, pages 92 and 93. Use Blocked style. The dictator of this letter is M. O. Reid.

35. Read 49B, page 189 for instructions in typing listed material Transcribe 49C, No. 2, page 189. Use Modified-Block style with indented paragraphs. The dictator of this letter is Elvin A. Thomason, Manager, College Sales Department.

INSTRUCTIONS FOR THE TEACHER

Shorthand II is set up to take one-hour's time daily of a two-hour block with Secretarial Procedures. If the two-hour block is not scheduled, the course can be a daily one-hour class.

This course starts with Chapter 12 in Gregg Dictation. Diamond Jubilee Series. If instructional tapes are available. it is suggested that one taped lesson from each chapter be used. After completing Gregg Dictation,the Gregg Speed Building, Diamond Jubilee Series, book is used. No taped lessons need to be given for this book. A test consisting of 50-word theory (words taken from the theory, marginal reminders, and vocabulary builders in each chapter) and a dictated letter from the chapter is given at the completion of each chapter. A sample of a form used for the theory test is included. Homework should be checked at this time.

Word lists of 25 words are given at the beginning of each class period as a theory checkup. No more than two minutes should be allowed for the transcription of these words. Words should be dictated at approximately one word every one and one-half seconds.

The students should be encouraged to spend from 10 to 15 minutes a day on speed development tapes. If no tapes are available, live dictation should be given daily.

A spelling list in 15 groups is attached. It is suggested that spelling tests be given after the student has studied each group. Students are not told in advance when a spelling test is to be given. After a test is given on one group of words, the student should automatically study the next group of words. Other spelling tests can be used; such as, selecting the correct spelling of a word from word lists, proofreading letters for spelling,etc.

Special handouts are attached giving the student information on mailability, transcription rules, special brief forms, and phrases. Students should be encouraged to study these and use them in their dictation and transcription. A list of general instructions for shorthand is included. These instructions should be given to the students at the beginning of the course.

Inasmuch as the students are working individually and at their own rate, a paper should be available in a convenient place where the students can indicate what test (chapter, 100-word theory, brief form, "take" speed) is needed. It is suggested that one day a week be designated as "take" day. All students should take them on this day.

Progress reports are used for students to keep a record of their work. A duplicate of this is also used as a nine-week report to the parents. A copy of a suggested progress report for each semester is included. Note that each required assignment is included on the report, and there is also a place for the signature of a parent.

VT 011 334
Beginning Drafting. A Handbook for Grades Seven and Eight.

Kansas City Public Schools, Mo. Industrial Arts Dept.

MF AVAILABLE IN VT-ERIC SET.
Business Services Division, 601 Board of Education Building, 1211 McGee Street, Kansas City, Missouri 64106 ($1.00).
PUB DATE - Nov58 83p.

DESCRIPTORS - *WORKBOOKS; *INDUSTRIAL ARTS; *DRAFTING; *STUDY GUIDES; ORTHOGONAL PROJECTION; ENGINEERING DRAWING; TEACHING GUIDES; GRADE 7; GRADE 8; TRADE AND INDUSTRIAL EDUCATION; SECONDARY GRADES

ABSTRACT - Developed by a curriculum committee for the Kansas City Missouri Public Schools, this workbook is for teacher and student use in industrial arts drafting courses in Grades 7 and 8. Units are: (1) Freehand Sketching, (2) Charts, Maps, and Graphs, (3) Electrical Drafting, and (4) Freehand Working, Instrument Working, Pictorial, Architectural, Machine, and Sheet Metal Drawings. Each unit contains related general information and assignments. Worksheets for use with this document are available from the source of availability listed above. (GEB)

VT 011 334

Parent's Signature _____ SHORTHAND II
First Semester

NAME _____

PROGRESS REPORT

This report lists the minimum required assignments for first semester Shorthand II.

Completion of each assignment is indicated. The suggested term goals are given in red. However this is just a guide. Progress beyond the suggested goal is encouraged. The semester goal must be reached before the semester letter grade and credit is given.

ASSIGNMENT	COMPLETED
100-Word Theory (100 words from complete shorthand theory transcribed with at least 90% accuracy)	
1.	_____
2.	_____
Brief Form Tests (50 brief forms written and transcribed with at least 98% accuracy)	
1.	_____
2.	_____
Spelling (25 to 50 words spelled with at least 90% accuracy)	
1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____
7.	_____
8.	_____
Chapter Tests (Words--50 words from dictation, transcribed with at least 85% accuracy)	
Blue book	
Chapter 12	_____
Chapter 13	_____
Chapter 14	_____
Chapter 15	_____
Chapter 16	_____
Pink Book	
Chapter 1	_____
Chapter 2	_____
Chapter 3	_____
Chapter 4	_____
Chapter 5	_____
Chapter 6	_____

ASSIGNMENT	COMPLETED
Chapter tests (Letters taken from the chapters dictated at 60 wpm, transcribed with no more than 3 errors)	
Blue Book	
Chapter 12	_____
Chapter 13	_____
Chapter 14	_____
Chapter 15	_____
Chapter 16	_____
Pink Book	
Chapter 1	_____
Chapter 2	_____
Chapter 3	_____
Chapter 4	_____
Chapter 5	_____
Chapter 6	_____
Timed Writings (wpm for 5 minutes with no more than 1 error per minute)	
1. _____	6. _____
2. _____	7. _____
3. _____	8. _____
4. _____	9. _____
5. _____	10. _____
Mailable Letters (Transcribed from homework notes or from letters dictated)	
1. _____	11. _____
2. _____	12. _____
3. _____	13. _____
4. _____	14. _____
5. _____	15. _____
6. _____	16. _____
7. _____	17. _____
8. _____	18. _____
9. _____	19. _____
10. _____	20. _____
Dictation "Takes" (At least 3 at 60 wpm for 3 minutes transcribed with at least 95% accuracy.)	
1.	_____
2.	_____
3.	_____

0 10219

Parent's Signature_____

SHORTHAND II
Second Semester

PROGRESS REPORT

NAME_____

This report lists the minimum required assignments for second semester Shorthand II.

Completion of each assignment is indicated. The suggested term goals are given in red. However, this is just a guide. Progress beyond the suggested goal is encouraged. The semester goal must be reached before the semester letter grade and credit is given.

ASSIGNMENT

100-Word Theory (100 words from complete shorthand theory transcribed with at least 90% accuracy)

1. _____
2. _____

Brief Form Test (50 brief forms written and transcribed with at least 98% accuracy)

1. _____
2. _____

Spelling (25 to 50 words spelled with at least 90% accuracy)

1. _____
2. _____
3. _____
4. _____
5. _____

Chapter Tests (Words--50 words from dictation, transcribed with at least 85% accuracy)

Chapter 7 _____
Chapter 8 _____
Chapter 9 _____
Chapter 10 _____
Chapter 11 _____
Chapter 12 _____
Chapter 13 _____
Chapter 14 _____
Chapter 15 _____
Chapter 16 _____

Chapter Tests (Letters taken from the chapters dictated at 80 wpm, transcribed with no more than 3 errors)

Chapter 7 _____
Chapter 8 _____
Chapter 9 _____
Chapter 10 _____
Chapter 11 _____
12. _____
13. _____
14. _____
15. _____
16. _____

Timed Writings (WPM for 5 minutes with no more than 1 error per minute)

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

Dictation Tests" (At least 3 at 80 words per minutes for 3 minutes transcribed on the typewriter with at least 95% accuracy)

1. _____
2. _____
3. _____

Mailable Letters (Transcribed from homework notes or from letters dictated)

1. _____ 18. _____
2. _____ 19. _____
3. _____ 20. _____
4. _____ 21. _____
5. _____ 22. _____
6. _____ 23. _____
7. _____ 24. _____
8. _____ 25. _____
9. _____ 26. _____
10. _____ 27. _____
11. _____ 28. _____
12. _____ 29. _____
13. _____ 30. _____
14. _____ 31. _____
15. _____ 32. _____
16. _____ 33. _____
17. _____ 34. _____
35. _____

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GENERAL INSTRUCTIONS FOR SHORTHAND I AND II

Supplies

Each student should have the following supplies for his own use at all times:

1. Pen (this need not be an expensive fountain pen--a good ballpoint is sufficient.)
2. Pencil (you should have one with you at all times to use as a spare in case your pen does not write). A pencil will also be used for checking your work and for certain markings.
3. Typing paper (carbon paper will be supplied for you). Have your own.
4. Typing eraser--be sure to have your own. There will be no borrowing of erasers.
5. Shorthand notebooks (one for homework, and one for classroom work).
6. Dictionary (each student must have his own dictionary). This need not be expensive. A paperback edition which costs about 50 cents is very good for your use in class.
7. A folder in which to keep your type paper and assignments. A folder with side pockets is good because it helps keep your papers and work organized.
8. Your textbooks will be furnished. Take good care of them because you will be responsible for them. If they are lost, you will be required to pay for them, and if they are damaged in any way, you will have to pay the cost of repair.
9. Mark all of your own supplies with your name in case you leave them in the classroom. With your name on them they could be returned to you.

Instructions on the Use of Notebooks

1. Keep two notebooks--one for classroom dictation, and the other for homework lessons. Bring both notebooks to class with you each day.
2. In your homework notebook, make certain that you identify each lesson. Also, circle the number of each paragraph as you copy your lesson. This is necessary for reference when you are called upon to transcribe or read from your homework notes.

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3. When writing in your notebooks, be sure to go completely through the book on one side of the paper, then turn your notebook over and go completely through it on the other side of the paper. In this way you do not waste paper and it saves time during dictation. When the notebook is filled, keep it for at least one week before throwing it away. You may be called upon to transcribe from your notes that have been written two or three days previously.

4. Keep your notebooks in a definite place on your desk. Then you will be ready to take dictation at a moment's notice, assuming, of course, that you keep a pen and pencil with your notebook at all times.

5. Keep a rubber band around the <u>used</u> portion of your notebook.

6. Place the date and lesson number at the bottom of the first page of the day's dictation or homework lesson.

7. Draw a line through each letter as soon as you transcribe it.

8. When you are interrupted in transcribing a letter, mark your place with a pencil.

9. Leave a space at the beginning of each letter dictated for mailable transcription for special instructions such as mailing directions, multiple carbons, and so on.

10. Write out unfamiliar names in longhand. (Do not do this when taking "takes.")

11. When the boss (or teacher) is interrupted during dictation, use the time to read your shorthand notes, improving outlines and inserting punctuation.

12. Indicate the end of each item in some way such as by a wavy line.

13. When it is necessary to take dictation on loose paper, fasten the notes in the proper place in the notebook for later reference.

14. Learn to turn pages in your notebook while taking rapid dictation.

<u>Timed Writings</u>

Timed writings will be given at least once a week as a class to measure your typing speed and accuracy. Additional timed writings will be given individually as requested.

Your papers should be set up as follows:

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1. Type the following in the upper left corner of your paper:*

*(Shorthand I Students)	*(Shorthand II Students)
Name	Name
Type and Transcription	Shorthand II
Semester 1 or 2	Semester 1 or 2
Timed Writings	Timed Writings

2. Start your timed writing about an inch and an half from the top of your paper.

3. Set your machine for double spacing, 70-space line unless given other instructions by your teacher.

4. Record your words per minute and number of errors at the top of your paper in this manner: 55/4

5. To pass a timed writing, you must not have more than one error per minute.

6. Circle the entire word where an error appears.

7. Hand in "passing" timed writings only. A certain number (shown on your instruction sheets) will be required each semester.

Tapes

Tapes at various speeds are available to help you increase your speed in taking dictation. Regular dictation practice is necessary. You should allow yourself at least 10 minutes a day for dictation.

You will each be given a set of ear cushions for your own use. These should be kept in an envelope, stapled to your folder so that you will have them when you need them. If you lose them, you will be charged twenty cents for a new set. You must use your own set always.

All of the equipment involved in using taped material is expensive. If you are careless with this equipment, it might throw the entire system out and penalize all of the students until repairs are made. Please use the equipment with care.

If at any time your set does not work properly, be sure to report the trouble to your teacher immediately.

Dial the channel for the speed that will help you the most. You should practice at a speed that is a little beyond your ability to write at that time.

Brief Forms

It is necessary for you to know how to write brief forms without

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hesitation. Brief forms are words that are used often and have an abbreviated way of writing them. If you do not know these, you will have to write them out according to sound and this, of course, would take too much time. Learn your brief forms well. They are introduced in small groups to enable you to memorize them. You should review brief forms often throughout your study of shorthand to help you increase your ability to take dictation.

One way to help you automatize your writing of brief forms is suggested by Charles Swen, a champion shorthand writer. As a list of brief forms is presented, you take a piece of paper and copy the brief forms in one column. Then transcribe the brief forms by writing the transcription along side the shorthand symbol. After doing this, fold the paper under so that the shorthand forms do not show and then write new shorthand forms along side the longhand transcription. Next, fold the longhand words under and transcribe the shorthand forms. Continue this process until you have used the entire sheet. By the time you have written the brief forms and transcribed them a number of times you will have learned them.

When brief form tests are given, they will be dictated "live" or on tape. The special form to use for these tests will be provided. Transcription will be done on the typewriter. On brief form tests, both the shorthand forms and the transcription will be checked.

Word Lists

Word lists are used as a daily homework theory check. Fifteen to twenty-five words will be dictated by your teacher and should be transcribed on your typewriter.

Type your name in the upper left corner of your paper. Set your machine for double spacing, and set your left margin at 15. Words should be typed one under another in a column. If you cannot transcribe a word, leave the space--you may be able to transcribe it after you have completed the list. If you misspell a word while transcribing, do not erase or "x" out the mistake, just use the space bar and space once and retype the word correctly. You will be timed on your transcription and so you do not want to waste any time. Misspelled words will be counted as errors.

Always have a piece of paper in your machine with your name typed in the upper left corner.

Theory Tests

Tests will be given to test your knowledge of shorthand theory at the end of each chapter. The tests may be transcription from shorthand plates, "live" dictation, or "taped" dictation.

When taking a theory word test from "live" dictation or from "tape" a special form will be provided. You will write the shorthand symbol

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as the words are dictated and then be given a time limit for transcription. The transcription should be typed next to the shorthand form. Care should be taken in transcribing these words inasmuch as a misspelled word is counted as an error.

When a 100-word theory test is given, you will need two of the provided forms. These sheets should be stapled together before handing them in, and your name should appear on each page.

Takes

"Takes," three-minute timed dictation at various speeds, will be given at least once a week to help you measure your progress.

The material will be unpreviewed and will be dictated "live" or on tape. You will be allowed twenty minutes to transcribe and the transcription will be on the typewriter.

These "takes" are given to measure your ability to take dictation at a certain speed. Ninety-five per cent accuracy is required to pass a "take." A record of your achievement will be posted on the bulletin board, and you will be required to pass three takes at a certain speed before moving on to the next speed. Each "take" that is transcribed should be handed in to be recorded regardless of whether it is "passing" or not. A record will be kept of the number of errors made so that you will be able to see your progress. Word for word transcription will be required.

Directions for Transcribing "Takes"

1. Type your name, and the speed of your "take" in the upper left corner of your paper.

2. Use a 70-space line with five spaces for paragraph indention.

3. Set your machine for double spacing.

4. Type the salutation on one line followed with a colon:

5. Type the complimentary closing on a separate line followed with a comma. Start the closing at 50.

6. Erasers may be used for corrections.

7. When transcribing, if there is an outline you cannot transcribe at the time, leave a space. When you have completed the transcribing of the letter, if you can fill in the work or words that have been omitted, use the blank space that you have left. If you did not leave enough space for the word or words that were omitted, use the blank space between lines for the insertion.

16225

Name _____

1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
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43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50

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SHORTHAND II
(First Semester)

Behavioral Objective

At the conclusion of the first semester:

1. The student will be able to pass two 100-word theory tests with at least 90% accuracy. Each 100 words will be dictated in no more than ten minutes and will be transcribed in 20 minutes. Words transcribed incorrectly and misspelled words will be counted as errors. Only the transcription will be checked. The words will cover all phases of shorthand theory.

2. The student will be able to pass at least two 50-word brief form tests with 98% accuracy. The words will be dictated at the rate of one every 1 1/2 seconds and transcribed within a ten-minute time limit. Shorthand and transcription will be checked--each will be worth one point. Misspelled words will be counted as errors.

3. The student will be able to pass at least eight spelling tests of 25 to 50 words with a 90% accuracy. These words will be taken from special spelling lists given to the student to study.

4. The student will be able to transcribe accurately all words in the theory, vocabulary builder, and marginal helps given in each lesson. Tests will be given at the conclusion of each chapter which will consist of 50 words dictated in five minutes and transcribed in a ten-minute time limit. Accuracy of 85% will be required. One letter from each chapter will be dictated at 60 words per minute to be transcribed. Ten points will be given for each letter with a minimum of seven points required. One point will be deducted for each error. These letters should be set up in letter form.

5. The student will be able to pass at least ten 5-minute timed writings with no more than one error per minute.

6. The student will be able to take dictation at the minimum rate of 60 words per minute for three minutes on new unpreviewed material and transcribe the dictation with 95% accuracy in the time limit of 20 minutes. Actual word-for-word transcription will be required.

7. The student will be able to set up business letters in "mailable" form; that is, correct to placement, typing, grammar, and punctuation. These will be transcribed on the typewriter from dictation or from homework notes. She will be able to proofread her work and make neat corrections; with a minimum of 20 required.

Texts: Gregg Dictation (D.J. Series) by Louis A. Leslie, Charles E. Zoubek, Madeline S. Stroney; Gregg Publishing Division, McGraw-Hill Book Company, Inc., New York, New York; 1963

Gregg Speed Building (D.J. Series) by John R. Gregg, Louis A. Leslie, Charles E. Zoubek; Gregg Publishing Division, McGraw-Hill Book Company, Inc., New York, New York; 1964

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Remember to do each lesson carefully so that you can read the material and be able to transcribe your notes. Tests taken from the theory and marginal reminders will be dictated to you. Study these words so that you will be able to use them in your dictation.

The warmup letter at the beginning of each chapter will be used for speed development. Read, copy, and transcribe this letter several times while working on each chapter so that you will be able to take it in dictation at high speeds.

Pay particular attention to the grammar checkup, spelling pointers, and punctuation reviews that are included in each chapter to aid you in your transcription.

Taped instruction of lessons will be used at various intervals. Follow the procedure used in Shorthand I. When taped lessons are not given, allow yourself from 10 to 15 minutes each day for taped speed development. This is necessary if you expect to increase your dictation speed.

Follow the instruction steps carefully. You must complete at least four lessons a week in order to fulful the requirements for the semester. At any time that you have a question, do not hesitate to check with your teacher.

Chapter XII

1. Read your attached sheet on homework and notebooks.

2. Study the theory review in each lesson by reading the words as quickly as you can. Refer to the key for the words you cannot read. Copy the words and see if you can read them back from your own notes.

3. Study the vocabulary builders and similar-word drills carefully. These words will appear in the practice material and will help you in your transcription.

4. Read each letter and copy it at least once. Also copy the secretarial hint called "The Secretary on the Job" at the end of the last lesson of each chapter. Read these articles carefully because the hints given can be useful to you.

5. The transcription letter at the end of each lesson should be read carefully and punctuation inserted as called for in the letter.

6. After you have copied each letter, try to read back from your notes. If you have difficulty reading your notes, you are not copying the material as you should. Take a little more time because copying will do you no good unless you can read your own work.

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DO NOT FILM THIS PAGE

BEGINNING DRAFTING

INDUSTRIAL ARTS DEPARTMENT
PUBLIC SCHOOLS, KANSAS CITY, MISSOURI

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VT 011 337

7. If a question arises in your mind at any time while doing these lessons, be sure to check with your teacher.

8. Each day you will be given specific material to read and transcribe. Also, vocabulary lists will be dictated daily.

9. On specified days you will complete your lesson through the use of tapes. Refer to your instruction sheet on tapes.

10. At least one day a week will be set aside for "takes."

11. After you have completed each lesson in the chapter, check with your teacher and she will give you the chapter test. Your homework will be checked at this time.

12. After completing the chapter test, hand your papers to your teacher for checking. If you have passed the test within the prescribed standard, you will be allowed to go on to the next chapter.

Chapters XIII through XVI

Follow the steps as outlined for Chapter XII.

At the conclusion of Chapter XVI if you have completed your work satisfactorily, you will hand Gregg Dictation (blue book) in to your teacher and a new book, Gregg Speed Building (pink book), will be given to you.

Gregg Speed Building is designed to help you develop your shorthand skill and your ability to produce letters that can be rapidly and accurately transcribed on the typewriter as mailable letters. At the end of the first four chapters there is a chart of brief form derivatives and on the inside back cover there is a complete list of the brief forms given in alphabetical order. These brief forms should be reviewed continuously to enable you to increase your dictation speed. (At least 60% or more of the words in the average business letter are brief forms.) If you know these, it is not hard to be able to write the remaining words.

Punctuation, spelling, vocabulary building are also included in this book to help you develop your transcription skill.

Most of the lessons in this book contain letters that are in printed form (longhand). You should write each of these letters in shorthand. A preview of some of the words and phrases used precedes the letters.

The practice material in each chapter is devoted to a specific line of business or a specific industry. This material has been chosen not only for its shorthand value but also for its informative value.

Read pages 10, 11, 12 on self dictation. Any dictation practice that you can get, the more rapidly your shorthand speed will increase.

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Chapter I

1. Study the punctuation brushup at the beginning of the chapter carefully. This punctuation will be reviewed in the lessons of the chapter. It is very important that you review punctuation and learn to punctuate correctly inasmuch as the letters you transcribe must be mailable.

2. Take each lesson separately, a minimum of one lesson a day.

3. Study the theory review in each lesson by reading the words as quickly as you can. Copy the words and read them back from your own notes.

4. Study the vocabulary builders and the similar-word drills carefully. These will help you increase your vocabulary.

5. Read each letter or article and copy it at least once. In the case of the printed longhand letters, write these letters at least once in shorthand.

6. From time to time your teacher will dictate the progressive speed builder letters found in the last lesson of the chapter. Be sure that you can write these letters so that you will be able to increase the speed as dictated.

7. If a question arises in your mind at any time while doing these lessons, be sure to check with your teacher.

8. You will be asked to transcribe letters from your homework and, also, word lists will be dictated.

9. Remember to use at least 10 to 15 minutes a day on speed development through the use of tapes.

10. At least one day a week will be set aside for "takes."

11. After you have completed each chapter, check with your teacher before proceeding to the next chapter. A 50-word theory test and a dictated letter taken from the chapter will be given at the conclusion of the chapter.

Chapters II through VI

1. Follow the steps as outlined for Chapter I.

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TRANSCRIPTION RULES

1. A word that contains a hyphen may be divided only at the hyphen.

2. The hyphen is used in writing certain compound words. Sometimes two or more words are combined to form a compound adjective, thus: up-to-date building; an air-cooled engine; machine-made goods; law-abiding citizens; a first-class job; and out-of-way place.

3. The adjective high-grade and first-class are sometimes used as predicate adjectives, thus: Your equipment is high-grade in every way.

4. Notice that in the following sentences up to date, first class, and high grade are not used as adjectives:

   Up to date we have not heard from you.
   He was a member of the first class that was graduated.
   Have you made a high grade in the examination?

5. Most words that are formed by prefixing self to another word are written with hyphens, thus: self-confidence, self-control, self-evident.

6. Notice, however, that the word selfish and its derivatives are written without hyphens, thus: unselfish, selfishly, selfishness.

7. When you spell out numbers consisting of two digits, use the hyphens, thus: one-half; three-fourths, five-sixths, twenty-two.

8. Compound adjectives are often formed by joining a figure to such words as inch, foot, yard, story. In such cases the compound adjectives should be written with a hyphen, whether the figure is used or whether the number is spelled out in words, thus: a 40-foot frontage, a twelve-foot walk, a four-story building.

9. Here is a list of words that should be written without hyphens:

billhead	nevertheless	today	cannot
outgoing	tonight	bookkeeping	notwithstanding
underwriter	overdue	foreclose	tomorrow
incoming	postscript	warehouse	letterhead
prepaid	wholesale	without	typewrite

10. Always spell out a number when it begins a sentence.

11. As a general rule, spell out round numbers which occur in sentences, thus: The company has about ten thousand accounts.

12. Whole numbers (those that do not contain fractions) of less than 100 should usually be spelled out; numbers of 100 or more should be written in figures. We employ ten stenographers. The book has 212 pages. It has thirty-six pages.

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13. When numbers are used in a series, write them in figures, thus: Please order 9 copies of List No. 29, 17 copies of List No. 41, and 103 copies of List No. 7.

14. In legal papers and documents amounts are often spelled out and also written in figures, thus: The total estimated costs are Fifteen Hundred Dollars ($1500). It is not necessary to add .00 for the cents when you write whole numbers in documents or letters. The word Dollars is also capitalized. The amount in figures is written after the word Dollars.

15. Avoid the use of st., th, and d after the figure or number which represents a date, when the date is preceded by the name of the month.

16. When the date precedes the name of the month, add the proper ending, thus: He will arrive the 4th of February. The sale will start the 2nd of May.

17. When the day if given and not the name of the month, spell the number in words, thus: He usually gets here on the third of the month.

18. The ages of people should be spelled in words, unless the exact age is given in years, month, and days. The applicant is twenty-one years old. His age at the time of his death was 69 years, 11 months, and 9 days.

19. Avoid indicating months by figures except in tables and table work. (September 12, 1966 not 9/12/66).

20. In references to price list or catalogue numbers, the abbreviation No. is often used to precede the figure or number. The abbreviation is capitalized.

21. Fractions, such as one-half, one-third, one-fourth should be spelled out when they occur by themselves in sentences.

22. Amounts of money should be written in figures. Remember, however, that figures and numbers cannot begin sentences.

23. Cents may be abbreviated as ¢ or cts. in tabulations. In writing letters, however, abbreviations should be avoided.

24. It is correct to use a figure of a number to precede percent, or cents, thus: Our business shows an increase of 5 percent. The cost of only 7 cents each.

25. Use figures to express street numbers, thus: 1121 Fourth Street.

26. Avoid typing # or No. before street numbers.

27. Spell out a figure or number which precedes o'clock. Use figures, however, when a.m. or p.m. is used.

28. When two numbers come together, one of them should be spelled out, thus: two 5-inch cards.

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Shorthand II

SPELLING

A large vocabulary is an asset in both business and social life. It is especially important in business. A good vocabulary is necessary for the understanding of spoken and written instructions, the selection of appropriate words in speaking and writing, and the recognition of misused words when transcribing. However, a good vocabulary will be of no value to you unless you can also spell correctly.

Poor spelling reflects upon your personality as well as on the company for which you work. Employers will not "put up" with the inability of their stenographers to spell correctly and recognize errors.

Most misspelling is due to poor habits. Habits can be changed. It takes work, but you can improve your spelling if you concentrate on doing so.

If you have any question on how to spell a word, do not take a chance. Look it up in your dictionary to be sure. After you have misspelled a word once, see that you do not misspell the same word again. Keep a list of words that trouble you and study them from time to time.

Words that are often misspelled are attached. These words are in groups of 25 for your convenience. You will be given spelling tests by groups from time to time. The following procedure will be used:

1. Study group 1
2. Test on group 1
3. Study group 2
4. Test on group 2
5. Continue through all the groups in this manner

You will not be told in advance when a spelling test will be given. You should automatically study the next group of words after you have been tested on a particular group. You may also be given additional tests on any group of words that you have covered.

The number of passing (90% accuracy) spelling tests required is listed in your Shorthand II instruction sheet.

Remember: It is not enough to be able to spell a word correctly. You must know its meaning and how to use it.

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SPELLING AND VOCABULARY

Shorthand II

GROUP I

absence
accept
accidentally
accommodation
acknowledge
acquaintance
acquisition
adjustment
administrative
affirmative
aggregate
agreement
allege
anticipate
apparatus
apparently
appropriate
architecture
arrangement
assignment
associate
available
beginning
bookkeeper
bureaus

GROUP II

candidate
characteristic
circular
circumstance
commissioners
committee
competitors
conference
confident
consequence
controversy
convenient
co-operation
cordially
correspondent
creditor
criticism
current
customary
dangerous
decision
defendants
deferred
delegate
develop

GROUP III

difficulty
disappoint
disposal
dissatisfied
earliest
economical
efficiency
elimination
embarrass
entitle
especially
exclusively
exhibition
existence
extravagant
facilities
finally
financial
foreign
frequent
haphazard
illustration
immediately
incidentally
increasing

GROUP IV

indebted
industrial
injunction
install
interrupt
investigation
judgment
justifiable
legitimate
machinery
majority
maneuver
minimum
minority
necessary
negative
obstacles
occurrence
official
opponents
pamphlet
paragraph
partially
patient
peculiar

GROUP V

personnel
politician
possession
possibility
preliminary
premium
preparation
presidency
privilege
probably
proceed
proprietor
qualified
questionnaire
reasonable
receipt
receiving
recognition
recommendation
reference
referred
reliability
responsible
routine
sanitary

GROUP VI

schedule
seize
separate
similar
sincerely
socialism
soliciting
specimen
statistics
strenuous
structure
subsidy
successor
sufficient
superintendent
supersede
suspicious
sympathize
tariff
temporary
testimony
unanimous
undoubtedly
unusually
valuable

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GROUP VII

taxable
excelling
regrettable
transferrable
disappearance
abrupt
attacking
attorneys
benefiting
besiege
seize
siege
leisure
reference
proficient
accruing
bonuses
cement
clinical
awful
benefited
acknowledgment
receive
conference
ninth

GROUP VIII

auspices
outrageous
conspicuous
annulment
yardage
augment
decisive
ethical
denying
celebration
superficial
abnormal
amendment
cancellation
reservation
access
dailies
conquering
clumsy
commitment
difference
reference
conscience
conscientious
superstitious

GROUP IX

caliber
courtesies
crippling
cylinder
cargo
argument
changeable
congratulate
particle
lieutenant
abundance
congenial
debtor
camouflage
bravery
duly
penciled
surely
achievement
alien
chemical
challenge
accidentally
contradict
athletic

GROUP X

dividing
scenic
appropriate
computer
computation
commitment
alcohol
conceivable
allotment
conscious
promptly
applicable
petition
partition
testimony
personal
tomatoes
negroes
addition
all right
commence
collision
prospective
hackneyed
luncheon

GROUP XI

noticeable
receivable
paralleling
cashier
financier
canceled
apologize
curable
achieve
decisive
requirement
truly
neither
inference
arteries
controlling
begrudge
defray
denim
description
bulletin
recession
procedure
courageous
precedence

GROUP XII

privilege
knowledge
professional
prohibitive
customary
controlling
criticize
height
inaugurate
mortgage
prominent
maintenance
reciprocal
advisory
consultant
murmur
omitted
permissible
prairie
rhythm
acceptable
receptacle
recipe
receipt
concrete

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GROUP XIII

expedite
nucleus
itinerary
concession
credentials
stereotype
atypical
photographic
insurable
inflammable
lapsed
lobbying
statistical
uniformity
interruption
abandoned
vaguely
vacuum
hundredth
hesitancy
indispensable
bankruptcy
guaranteed
acquiesce
exaggerated

GROUP XIV

consistent
disastrous
affiliated
predecessor
feasible
forcible
illegible
fatiguing
candidacy
competent
overdue
route
endeavor
principle
principal
furthermore
psychology
occasion
sacrilegious
rarefy
liquify
irrelevant
verbatim
harassed
dictionary

GROUP XV

stationery (paper)
stationary
misspelled
accessible
column
gauge
convalescent
counterfeit
nevertheless
neighborhood
affidavit
definitely
environment
except
accumulate
corporation
calendar
capital
capitol (building)
census
choose
chose
genuine
envelope
intelligent

MAILABLE LETTERS

All of the letters you will transcribe will be set up as business letters. Placement of the letter will be determined by its length. Each letter should be typed with the goal of "mailability" in mind. A "mailable" letter is one that is correct as to placement, typing, grammar, punctuation, and correct transcription. It is one that your employer would be proud to sign.

The goal of "mailability" should be kept in mind at all times.

The following will be considered errors:

1. Misspelled words or names
2. Materials omitted or added
3. Careless erasures
4. Serious misplacement
5. Omission of date
6. Transposed words
7. Errors in figures
8. Smudge marks
9. Raised Capital letters
10. Incorrect word division
11. Single line on second page
12. Strike-over letters

Remember, a definite number of mailable letters are required to complete the course.

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PROOFREADING CHECK LIST

1. Accuracy of transcript

   Is it an accurate record of the dictation? Are all figures, names, addresses, etc., correct?

2. Sense of transcript

   Have I read for thought to be sure transcript makes sense? Are there any omitted words, lines, or sentences?

3. Directions

   Do I have the right number of carbon copies? Are enclosures included? Have I made special notations such as Special Delivery?

4. Spelling and word division

   Are any words misspelled, such as to for two or expecially for especially? Have I observed rules for word division at ends of lines?

5. Appearance: placement and corrections

   Is arrangement on page attractive? Am I proud of its appearance? Is copy clean? Are corrections hard to detect?

6. Punctuation, capitalization, use of figures, grammar

   Have I checked usages about which I am uncertain?

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BEGINNING DRAFTING

A Handbook for Grades Seven and Eight

November, 1958

Kansas City, Missouri, Public Schools

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ADDITIONAL BRIEF FORMS

These are additional brief forms that you may learn <u>if you want to</u>. Some of them could prove valuable to you in building your speed. Learning these <u>is not a requirement</u> and you <u>will not</u> be tested on them.

1. above
2. allow
3. already
4. also
5. altogether
6. always
7. am, more
8. among
9. another
10. answer
11. approximate
12. arrange
13. ask
14. attention
15. because
16. been
17. belief, believe
18. bring
19. collect
20. correct
21. committee
22. confident
    confidence
23. consider
    consideration
24. country
25. definite
26. deliver
27. Dear Sir, desire
28. different
29. direct
30. Dr., during
31. else
32. excellent
33. favor
34. follow
35. friend
36. from
37. gave
38. give
39. go, good
40. individual
41. industry
42. inquire
43. instant, instance
44. invoice
45. knowledge
46. let, letter
47. like
48. long
49. love
50. matter

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51. Mr., market
52. most
53. much
54. name
55. necessary
56. nothing
57. office
58. people
59. please
60. point, appoint
61. possible
62. prepare
63. purchase
64. receive
65. record
66. room
67. refer, reference
68. remember
69. remit, remittance
70. report
71. return
72. satisfy, satisfactory
73. sure
74. together
75. tomorrow
76. usual, wish
77. want
78. without
79. while
80. yes
81. catalogue
82. against
83. thousand
84. various
85. behind

ADDITIONAL PHRASES

These additional phrases are for you to use <u>if you want to</u>. Phrasing is only valuable if you can write them without hesitation. If you have to stop to decide whether to phrase or not, you could write the words out in less time. You are <u>not</u> required to learn these phrases and you <u>will not</u> be tested on them.

1. of course
2. at once
3. at any rate
4. great deal
5. on hand
6. one another
7. do you know
8. great pleasure
9. your order
10. first class
11. at the same time
12. in other words
13. once in a while
14. in my opinion
15. in the first place
16. over and over again
17. all over - - - -

    all over the city

    all over the world
18. more and more
19. more or less
20. department

    state department

    personnel department
21. quicker than
22. rather than
23. greater than
24. have done
25. has been done
26. will be done
27. would be done
28. should be done
29. extra discount
30. enter the
31. enter into
32. over the
33. under any
34. center line
35. in the world
36. day or two
37. one or two
38. some of them
39. here and there
40. in reply to your
41. question of time
42. in a week or two
43. sooner or later
44. in reference to the matter
45. short time

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46. by the way
47. on the question
48. up to the time
49. hand in hand
50. that is to say
51. to me
52. to know
53. in due course
54. what to do
55. I had
56. as soon as
57. as soon as possible
58. as well as
59. as good as
60. as good as
61. as great as
62. as much as
63. in reference to the matter
64. up to the time
65. on the market
66. in the matter
67. hand in hand
68. able to say
69. little or nothing
70. I should like to have
71. I should like to know
72. I hope
73. we hope
74. I am sorry
75. I want
76. you want
77. be sure
78. we are sure
79. I am sure
80. to me
81. to meet
82. to know
83. to make
84. at any time
85. what to do
86. from time to time

SHORTHAND II
(Second Semester)

Behavioral Objective:
At the conclusion of the second semester:

1. The student will be able to pass two 100-word theory tests with at least 90% accuracy. Each 100 words will be dictated in no more than ten minutes and will be transcribed in 20 minutes. Words transcribed incorrectly and misspelled words will be counted as errors. Only the transcription will be checked. The words will cover all phases of shorthand theory.

2. The student will be able to pass at least two 50-word brief form tests with 98% accuracy. The words will be dictated at the rate of one every 1 1/2 seconds and transcribed within a ten-minute time limit. Shorthand and transcription will be checked--each will be worth one point. Misspelled words will be counted as errors.

3. The student will be able to pass at least five spelling tests of 25 to 50 words with a 90% accuracy. These words will be taken from special spelling lists given to the student to study.

4. The student will be able to transcribe accurately all words in the theory, vocabulary builder, and marginal helps given in each lesson. Tests will be given at the conclusion of the chapters which will consist of 50 words dictated in five minutes and transcribed in a ten-minute time limit. Accuracy of 85% will be required. One letter from each chapter will be dictated at 80 WPM to be transcribed. Ten points will be given for each letter with a minimum of seven points required. One point will be deducted for each error.

5. The student will be able to pass at least ten 5-minute timed writings with no more than one error per minute.

6. The student will be able to take dictation at the minimum rate of 80 words per minute for three minutes on new unpreviewed material and transcribe the dictation with 95% accuracy within a 20-minute time limit. Actual word-for-word transcription will be required.

7. The student will be able to set up business letters in "mailable" form; that is, correct to placement, typing, grammar, and punctuation. These will be transcribed on the typewriter from dictation or from homework notes. She will be able to proofread her work and make neat corrections. A minimum of 35 will be required.

- - -

Continue to do each lesson carefully. Be sure that you can read your shorthand notes so that you will be able to transcribe them. Review the theory and marginal reminders in each lesson. Words will be dictated to you from these words. A thorough understanding of the basic principles of shorthand is necessary if you want to increase your dictation speed.

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Use the warmup letter at the beginning of each chapter for speed development. See how fast you can read and copy the letter, keeping in mind that you should be able to transcribe your notes.

In order to be able to set up a mailable letter, be sure to study the grammar checkups, spelling pointers, and punctuation reviews in each chapter.

Allow at least 10 to 15 minutes each day for speed development from the tapes. This will help you to increase your dictation speed. During the semester you will continue to take timed writings. Remember that your shorthand skill is no use to you if you cannot type accurately. You should also have a reasonable degree of speed.

Follow the instruction steps as outlined below. Do not hesitate to check with your teacher at any time if you have a question. This semester's work is a completion of your shorthand study. Keep in mind at all times that your goal is to be employable. Your skill will be extremely important to you in obtaining and maintaining a good secretarial position.

Chapter VII

1. Study the punctuation brushup at the beginning of the chapter carefully. This punctuation will be reviewed in the lessons of the chapter. It is very important that you review punctuation and learn to punctuate correctly inasmuch as the letters you transcribe must be mailable.

2. Take each lesson separately, a minimum of one lesson a day.

3. Study the theory review in each lesson by reading the words as quickly as you can. Copy the words and read them back from your own notes.

4. Study the vocabulary builders and the similar-word drills carefully. These will help you increase your vocabulary.

5. Read each letter or article and copy it at least once. In the case of the printed longhand letters, write these letters at least once in shorthand.

6. From time to time your teacher will dictate the progressive speed builder letters found in the last lesson of the chapter. Be sure that you can write these letters so that you will be able to increase the speed as dictated.

7. If a question arises in your mind at any time while doing these, be sure to check with your teacher.

8. You will be asked to transcribe letters from your homework and, also, word lists will be dictated.

9. Remember to use at least 10 to 15 minutes a day on speed development through the use of tapes.

10. At least one day a week will be used for "takes."

11. After you have completed each chapter, check with your teacher before proceeding to the next chapter. A 50-word theory test and a dictated letter taken from the chapter will be given at the conclusion of the chapter.

Chapters VIII through XVI

1. Follow the steps as outlined for Chapter VII.

INSTRUCTIONS FOR THE TEACHER

Secretarial Procedures is set up to take one-hour's time daily of a two-hour block with Shorthand II. If the two-hour block is not scheduled, the course can be a daily one-hour class.

Instructional materials for the course have been divided into fourteen units. These units have consequently been divided into four sections. Each section is equivalent to a quarter of a year. Grades and credits can be given upon the successful completion of a section.

A wide variety of instructional materials have been listed in the "Unit Instruction Sheets" that have been prepared for this course. Copies of the following textbooks should be available:

Agnew, Peter L., et. al. Secretarial Office Practice. Seventh edition. Cincinnati: South-Western Publishing Company, 1966.

Gavin, Ruth E., and William A. Sabin. Reference Manual for Stenographer and Typists. Fourth edition. New York: McGraw-Hill Book Company, 1970.

Gregg, John Robert, et. al. Applied Secretarial Practice. Sixth edition. New York: McGraw-Hill Book Company, 1968.

Lessenberry, D. D., et. al. College Typewriting. Eighth edition. Cincinnati: South-Western Publishing Company, 1969.

Meehan, James R., and Gilbert Kahn. How to Use Adding Machines--Ten-Key, Full-Key, Printing Calculator. New York: McGraw-Hill Book Company, 1962.

Reigner, Charles G. College Business Correspondence. Second edition, revised. Baltimore: The H. M. Rowe Company, 1964.

Rowe, John L., et. al. Gregg Typing, 191 Series, Book 2: Vocation Office Typing. Second edition. New York: McGraw-Hill Book Company, 1967.

Strony, Madeline S., et. al. The Secretary at Work. Third edition. New York: McGraw-Hill Book Company, 1966.

Transcription Techniques. New York: International Business Machines Corporation, 1960.

Whitcomb, Helen, and Rosalind Lang. Charm. New York: McGraw-Hill Book Company, 1964.

These textbooks may be placed on a reference shelf for use within the classroom or pockets and cards placed inside the texts so that they can be checked out by students. Answer sheets and miscellaneous forms should be easily accessible to the student. Desk trays placed on a counter are very handy for dispensing these forms quickly and conveniently.

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Copies of forms have not been included in order to allow the teacher to select the forms that will best fit into his own situation.

In addition to having copies of the above textbooks for reference, each student will need a copy of the following workbook and practice set:

Connor, Donald W. Filing Practice Workbook. Third edition. New York: Pitman Publishing Corporation, 1969.

Witherow, Mary. The Secretary on the Job. New York: McGraw-Hill Book Company, 1967.

The following free booklets should be obtained from thepost office, telephone company, and the telegraph company: "Zip Code Directory;" "Domestic Postage Rates, Fees, and Information;" "Mountain States Telephone Directory;" "How to Prepare and Use Telegrams."

A point system is used for evaluation. The time allowance given in the course outline was used as a basis in determining the number of points possible for each unit. Fifty points are possible for each time allowance of one week. It was not possible to use this scale on two units. These units are "Transcribing Machines" and "Secretarial Typewriting." A point conversion will have to be made on the transcribing unit only, since the typewriting unit is a section in itself.

Since this is primarily a "doing" course, formal testing has been kept to a minimum. Formal tests are given in three units--"Filing Systems and Procedures," "Using Office Machines--adding machines," and "Using Office Machines--calculators." No sample tests have been included since situations and equipment vary so on these units. It is suggested that alternate tests be available for these units in case more than one student is taking a test on a given day or a test needs to be repeated. NOTE: The first score the student receives on a test is the one that should be used in determining his grade.

Progress reports are optional for this course since credit can be granted on a quarter basis.

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COURSE OUTLINE

Secretarial Procedures and Machines

A secretary is supposed to be a "Jill-of-all trades," which includes being a psychologist, politician, diplomat, research expert, memory shark, writer, business lawyer, machinist, personal banker for her boss, errand girl, and desk duster. Furthermore, she is a mind reader, voice culturist, and clothes model. She is calm, polite, dignified, charming, good-natured, and unswervingly loyal to her boss.

Ralph Knight

Texts and Materials

You must have the following materials for your own use at all times:

1. Type paper and typing eraser
2. Pen and pencil
3. Dictionary
4. Folder to keep typing paper and assignments

You will be using a variety of instructional materials in order to provide you with a basic understanding of secretarial procedures and business machines. The following basic textbooks are available for you to use throughout this course:

1. Applied Secretarial Practice, sixth edition
2. Secretarial Office Practice, seventh edition
3. Reference Manual for Stenographers and Typists, fourth edition
4. How to Use Adding Machines
5. College Business Correspondence, second edition, revised

No one text or booklet is sufficient to give you all the information you will need to become proficient in any phase of secretarial work. Each Unit Instruction Sheet will give the titles and page numbers of the texts you will need. The above listed texts are used frequently, but additional texts and supplemental booklets will also be used for specific units.

Course Content

Shorthand, typewriting, and transcription are only three of the many skills and abilities a qualified secretary must have. To succeed in the

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secretarial field, you must have the ability to adjust yourself to the numerous requirements of the position. During the course you will complete units pertaining to these requirements.

Goals of the Course

Upon the completion of this course, you should be able to:

1. Complete projects and pass tests pertaining to the various tasks of a secretary, as set up in individual units.

   a. Today's Secretary
   b. Meeting the Public In Person
   c. Meeting the Public by Telephone
   d. Composing Assignments of the Secretary
   e. Filing Systems and Procedures
   f. Telegraph Communications
   g. Using Postal Services and Processing the Mail
   h. Using Office Machines--adding machines
   i. Using Office Machines--calculators
   j. Using Transcribing Machines
   k. Preparing Multiple Copies
   l. On-the-Job Training
   m. Bulletin Boards
   n. Secretarial Typewriting

2. Locate, erase, and correct errors in your secretarial units.

Classroom Procedures

1. Unit Instructions

   a. Complete this course in individual units. On the average you should be able to complete a unit within the suggested time allowance listed below. This time allowance is only a guide and you may find that some of the units will take more time than suggested or you may complete them in less time.

   b. Complete instructional units in the sequence listed for each section. In order to use the equipment available, it is necessary to use a "rotational system." It will be necessary for part of the class to work on Section II while the other half of the class works on Section III. The units have been divided into the following sections:

      (1) Section I

         (a) Today's Secretary (1 week)
         (b) Meeting the Public in Person (1/2 week)

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(c) Meeting the Public by Telephone (1/2 week)
(d) Composing Assignments of the Secretary (1 1/2 weeks)
(e) Filing Systems and Procedures (2 1/2 weeks)
(f) Using Postal Services and Processing the Mail (1 week)
(g) Telegraph Communications (1 week)

(2) Section II

(a) Using Office Machines--adding machines (4 weeks)
(b) Using Office Machines--calculators (4 weeks)

(3) Section III

(a) Transcribing Machines (3 weeks)
(b) Preparing Multiple Copies (2 weeks)
(c) On-the-Job Training (2 weeks)
(d) Bulletin Boards (1 week)

(4) Section IV

(a) Secretarial Typewriting (8 weeks)

c. Complete one section at a time. Upon the successful completion of a section, one-fourth credit and a letter grade will be given.

2. General Instructions

a. Follow directions well.

b. Accept constructive criticism intelligently and graciously.

c. Proofread accurately.

d. Use all time to good advantage.

e. Give evidence of initiative, dependability, and a deep sense of responsibility.

(1) Attack the job intelligently: Plan the assignment to get the best results
(2) Keep at it until the job is done.
(3) Ask essential questions; avoid asking unnecessary ones.
(4) Feel free to make constructive suggestions.

f. Work co-operatively with the class in the "give and take" of successful team work.

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g. Feel free to call on your teacher if you need help, and she will be glad to assist you. Check with your teacher before proceding to the next unit.

h. Replace all texts and materials in their appropriate places before the bell rings.

i. Remain seated until the bell rings. Do not become a clock watcher.

j. Remember that this class is your class, and the benefit you will receive from it will be in direct proportion to the amount of time and energy that you put into it.

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She is the front office buffer for the boss against the world . . . She's sympathy with a bottle of aspirin stuck away in the lower left-hand drawer of her desk . . .

She's as efficient as tomorrow . . . and as charming as yesterday.

She lives in a hurried, hurried world. She gets her boss to appointments on time . . . and sees that he has the right tickets for the right plane or the right railroad at the right time . . . She sees that his insurance premiums are paid when due . . . and that the office boy gets a special smile on his birthday . . .

A million details race through her head each day . . . She can bring instant order out of temporary panic . . .

She's a secretary.

If all the secretaries of the world would stop work for a single day, there would be nothing but chaos in the business world. Frantic vice-presidents couldn't find copies of memos, presidents couldn't write letters, sales managers would not prepare sales bulletins. Shipping clerks would scramble for misplaced invoices . . . and there would be nobody to send out at 5 p.m. to buy a box of candy for the forgotten birthday of the bosses' old-maid aunt . . .

She can manage a smile when the boss dictates a shelf of letters 10 minutes before quitting time . . . She can warm an office with a tinkling laugh . . . She can always find things that other people have lost . . .

Her desk drawer contains such items as 52 cents in small change in a tin box . . . Five bobby pins . . . a mirror . . . two combs . . . and a folder advertising a vacation in Hawaii she'll probably never take . . .

She can take shorthand . . . Type a letter . . . Open mail . . . Make decisions . . . Tell little white lies for her boss . . . and still look pretty and efficient when the office clock hits 5 o'clock.

She's America's favorite "Girl Friday" . . . every day of the week . . .

She's a secretary.

Unit Goal

1. You will be able to demonstrate your knowledge of the secretary's place in the business world, of the secretary's personality, and of the secretary's appearance. This will be accomplished by completing the various assignments in this unit.

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Texts and Materials

1. Applied Secretarial Practice, fifth edition
2. Applied Secretarial Practice, sixth edition
3. Secretarial Office Practice, seventh edition
4. The Secretary at Work, second edition
5. Charm
6. Rating scales and charts from Applied Secretarial Practice sixth edition

Procedure for Completing Unit

1. Choose a text and read the chapters that deal with personal qualities, appearance, attitudes, career, and general image of a successful secretary. Use the table of contents to locate the information dealing with these topics.
2. Complete the seven projects listed in the assignment section of this unit. Follow closely the directions for each project.
3. Ask for help if there is any assignment that you do not understand. Do not hesitate to obtain assistance from your teacher.
4. Hand in your assignments for evaluation.

Assignments

1. Complete the "Rating Scale for Skills" that is provided so that you may evaluate yourself on the secretarial qualifications you will need. (5 points possible)
2. Using the title "My Secretarial Future," describe the type of position you would like to have upon completion of your preparation for secretarial work. Answers to the following questions might be included in your description:

   a. What type of business do you think you would prefer--for example, a law firm, an insurance company, a store, a railroad office, a government office, or a doctor's office?

   b. Would you prefer to work in a large or a small office? Would you like a position in which you would be meeting many people from the outside, one in which you would work by yourself, or one with only a few people within the organization?

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c. Which of the skills listed in the "Rating Scale for Skills" do you think this position might require? (10 points possible)

3. How would you rate yourself in terms of your personality and your general personal effectiveness? Complete the rating form, "How Well Do You Know Yourself". It is often said that more people lose jobs or fail to receive promotions because of personality deficiencies than because of lack of necessary skills. (5 points possible)

4. Briefly answer the following questions:

   a. How can poor health impair an office worker's opportunities of advancement?

   b. Suggest some of the hazards of conveying office gossip?

   c. How does the secretary's punctuality and reliability affect the operation of her employer's office?

   d. What is tact? What part may tact play in the work of the secretary?

   e. What do we mean by the expression "follow'through" when referring to desirable work habits? (10 points possible)

5. Rate yourself on the "Good Grooming Chart." Are you satisfied with your rating? Select three or four points which need improvement and give them your immediate attention. (5 points possible)

6. List in one column four main points about your face and figure that you must consider in selecting attractive clothing. Opposite these points, in the second column, briefly describe the general style of clothing you should choose to emphasize good points and minimize the weaker ones. (5 points possible)

7. Prepare a page illustrating the correct dress and general appearance for a secretary. Choose a basic dress or suit. Illustrate the accessories you might select for office wear; provide for at least three changes suitable for the office. (10 points possible)

18255

UNIT INSTRUCTION SHEET

Meeting the Public in Person

There is no magic formula for greeting visitors, other than courtesy, attentiveness, and tact. Your employer places a great deal of importance on maintaining effective public relations because it develops goodwill for the company. Goodwill is good business. One of the most important duties you will perform as a secretary is that of acting as a receptionist.

A receptionist can make or break all the glamorous effects of an office. Customers are sensitive and sometimes tempermental—the first human touch can persuade them to be reasonable. They need to feel that someone is genuinely interested in their problems. A receptionist must be warm, firm, gracious, concerned, and tactful; she's a shock absorber and a stage setter.

Unit Goals

1. You will be able to schedule and record appointments correctly.
2. You will become acquainted with proper techniques for handling callers.

Texts and Materials

1. Secretarial Office Practice
2. Applied Secretarial Practice, sixth edition
3. Form for mailing appointment
4. "Visitor's Log" report form

Procedure for Completing Unit

1. Read and study pages 245-263 in Secretarial Office Practice.
2. Read and study pages 203-213 in Applied Secretarial Practice.
3. Complete the four assignments listed in the assignment section of this unit. Follow closely the directions for each assignment given in your text or this instruction sheet.
4. Ask for help if there is any assignment that you do not understand. Do not hesitate to obtain assistance from your teacher.
5. Hand in your assignments for evaluation.

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Assignments

1. Answer questions 1-5 under "What Do You Think?" on page 255 in Secretarial Office Practice. Type the Question first and then the answer. (5 points possible)

2. Complete Problem 25 on page 257 in Secretarial Office Practice. Follow the direction given in the textbook. Use the attached forms. (5 points possible)

3. Keep a record of callers. In some companies a record is maintained of all callers. This record is sometimes called a "Visitor's Log" Using the attached form, record the arrival and referral of callers on Wednesday, October 8.

   a. 10:10 a.m.: Dave Baker, salesman, Brown Products Company, requested to see Mr. Ballif, Purchasing Department. No appointment. Escorted to Mrs. Grant at 10:13 a.m.

   b. 10:17 a.m.: C. C. Hogge, attorney, to se Mr. Nelson, Vice-president. No appointment. Mr. Nelson out. Make appointment for 2:30 p.m., October 27, through Mr. Nelson's secretary. Departed at 10:20 a.m.

   c. 10:24 a.m.: Miss Linda Randall, job applicant. Filled out application form. Referred to Personnel Department.

   d. 10:43 a.m.: Ed Anderson, designer, to see Mr. Call, Advertising Department, by appointment. Escorted to Mr. Call's office at 10:45 a.m.

   e. 10:59 a.m.: Vern Gardner, Investment Counselor, to see President Selander. No appointment. President not interested. Departed 11:00 a.m. (5 points possible)

4. Complete the project given on page 256 in Secretarial Office Practice under "Secretarial Work." Write what the receptionist and caller might say in each of these situations. (5 points possible)

UNIT INSTRUCTION SHEET

Meeting the Public by Telephone

Of course you know how to use the telephone! Picking up the telephone is almost second nature. You realize the importance of a good social telephone personality, but have you ever thought about how vital the devlopment of a good business telephone personality is in a business career?

Many companies prefer to telephone clients rather than to write them. Here is where a secretary's telephone assets are in demand. Her knowledge of proper telephone techniques and her use of telephone courtesy will pay dividends not only to her employer but to herself.

A secretary is usually expected not only to answer the telephone but to place calls for her employer. She may often need to make local calls to get information or to leave a message. She may place countless calls to persons within the country both for herself and her employer. Sometimes she may also be asked to place long distance calls. To measure up to these expectations, she needs to be expert in various telephone techniques.

Unit Goals

1. You will become acquainted with proper business telephone etiquette and techniques.
2. You will be able to take and record messages accurately and neatly.
3. You will be able to locate frequently used telephone numbers from the alphabetic and classified sections of the telephone book.
4. You will be able to place and record outgoing calls correctly.

Texts and Materials

1. Secretarial Office Practice, seventh edition
2. Mountain States Telephone Directory--Metropolitan Ogden
3. Telephone Message Form
4. Telephone Charges Form

Procedure for Completing Unit

1. Read and study pages 211-229, 233-237, and 239-243 in Secretarial Office Practice.

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2. Complete the five assignments listed in the assignment section of this unit. Follow closely the directions for each assignment given in your text or in this instruction sheet.

3. Ask for help if there is any assignment that you do not understand. Do not hesitate to obtain assistance from your teacher.

4. Hand your assignments in for evaluation.

Assignments

1. Answer study questions 1-16 on page 229 in Secretarial Office Practice. (5 points possible)

2. Type on a plain sheet of paper an improved version of these conversations. Give the exact wording you would use. Keep in mind the pointers on telephone etiquette given in the text. (5 points possible)

a. Mrs. Orton: "Bigalow'n Brown."

Mr. Francis: "What?"

Mrs. Orton: "Bigalow and Brown. May I help you?"

Mr. Francis: "Yes. I want to talk to Mr. Jensen."

Mrs. Orton: "What department is he in?"

Mr. Francis: "Shipping, I think"

Mrs. Orton: "Jist a minute." (The line went dead for about 20 seconds.)
"Sir?"

Mr. Francis: "Yes?"

Mrs. Orton: "I'm sorry, Mr. Jensen has left the building."

Mr. Francis: "Do you know when he'll be back?"

Mrs. Orton: "No, I'm sorry."

Mr. Francis: "May I leave a message?"

Mrs. Orton: "Of course."

Mr. Francis: "Tell him to call Val Parrish of History Alley when he gets in."

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Mrs. Orton: "Thank you. I'll give him the message."

b. Mrs. Frey: "H'lo."

Mr. Boren: "Is this Bonneville High School?"

Mrs. Frey: "Yeah."

Mr. Boren: "May I please speak with Mr. Selander?"

Mrs. Frey: "He went out to lunch and hasn't come back yet"

Mr. Boren: "Do you know when to expect him?"

Mrs. Frey: "Nope. He should be here now!"

Mr. Boren: "Well . . . I'll try later."

Mrs. Frey: "O. K. Bye-bye." (Hangs up.)

3. Look up in a telephone directory the telephone numbers of the following business and services that your employer will be needing from time to time. Type them on a sheet of paper.

a. Locate the following numbers in the alphabetic section of the telephone book:

1. Western Union
2. Police department - Washington Terrace
3. Post office - Washington Terrace branch
4. Main local office of the state employment service
5. County Department of Public Welfare
6. The area codes of Chicago, Los Angeles, Philadelphia, San Francisco, Dallas, and Boston

b. Locate the following number in the Yellow Pages or classified section:

1. An agent for calculating machines
2. A certified public accountant
3. A tax return specialist
4. A lawyer
5. A florist in Clearfield

c. Arrange these telephone numbers in alphabetic order and type them on a 5½ by 8 1/8 inch sheet of paper to be fastened to the cover of your employer's telephone directory:

1. A physician
2. A travel bureau
3. Typewriter dealers (Remington and IBM)

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4. Office supply stores (Weber Office and Ogden Desk)
5. Fire Department
6. Airport
7. Telephone information
8. A local bank
9. Weber County Library
10. Business Office of the telephone company
(10 points possible)

4. Fill out a brief memorandum for each of the following incoming telephone calls which were received while your employer, Mr. Anderson, was out of the office. Record on forms provided.

a. Mr. Selander, of the Cleveland office, called long distance at 4:10 p.m. to tell you that the Bonneville Supply House order is to be cancelled.

b. William R. Boren of Chicago called at 10:30 a.m. in regard to an order. Mr. Boren's telephone number is 312 555-3456. He will call again at 2 p.m.

c. Mrs. J. F. Anderson called Mr. Anderson (her husband) at 12:30.

d. Mr. Lamont Heslop of Philadelphia called at 11:35. He said that he had received order No. 10256 but had not received order No. 10245, which had been placed a week before the other order. His telephone number is 215 555-8230. (5 points possible)

5. Assume that your employer, Mr. J. F. Anderson, wishes to make the following out-of-town calls from the office telephone, 399-1113, on the current date. In order that the monthly toll statement received from the telephone company may be audited (checked for correctness) and the charges allocated to the proper offices or persons, the secretary keeps a record of each toll call when it is made. Record on the forms provided the toll calls made. All calls other than personal ones are charged to General Administrative Expense (GAE). The cost is given after each call. (5 points possible)

a. A person-to-person call to Scott W. Ballif, of Fort Worth, Texas, relative to a personal matter. You do not know his number or address, but he is a noted eye specialist. $2.65.

b. A call to Mr. Harry Burchell of the Brown Construction Company; Walnut Street; Baltimore, Maryland; regarding a back order for parts. $4.25.

c. A station-to-station call to Mr. Anderson's mother, who

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Mrs. Orton: "Thank you. I'll give him the message."

b. Mrs. Frey: "H'lo."

Mr. Boren: "Is this Bonneville High School?"

Mrs. Frey: "Yeah."

Mr. Boren: "May I please speak with Mr. Selander?"

Mrs. Frey: "He went out to lunch and hasn't come back yet"

Mr. Boren: "Do you know when to expect him?"

Mrs. Frey: "Nope. He should be here now!"

Mr. Boren: "Well . . . I'll try later."

Mrs. Frey: "O. K. Bye-bye." (Hangs up.)

3. Look up in a telephone directory the telephone numbers of the following business and services that your employer will be needing from time to time. Type them on a sheet of paper.

a. Locate the following numbers in the alphabetic section of the telephone book:

1. Western Union
2. Police department - Washington Terrace
3. Post office - Washington Terrace branch
4. Main local office of the state employment service
5. County Department of Public Welfare
6. The area codes of Chicago, Los Angeles, Philadelphia, San Francisco, Dallas, and Boston

b. Locate the following number in the Yellow Pages or classified section:

1. An agent for calculating machines
2. A certified public accountant
3. A tax return specialist
4. A lawyer
5. A florist in Clearfield

c. Arrange these telephone numbers in alphabetic order and type them on a 5½ by 8 1/8 inch sheet of paper to be fastened to the cover of your employer's telephone directory:

1. A physician
2. A travel bureau
3. Typewriter dealers (Remington and IBM)

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4. Office supply stores (Weber Office and Ogden Desk)
5. Fire Department
6. Airport
7. Telephone information
8. A local bank
9. Weber County Library
10. Business Office of the telephone company
(10 points possible)

4. Fill out a brief memorandum for each of the following incoming telephone calls which were received while your employer, Mr. Anderson, was out of the office. Record on forms provided.

a. Mr. Selander, of the Cleveland office, called long distance at 4:10 p.m. to tell you that the Bonneville Supply House order is to be cancelled.

b. William R. Boren of Chicago called at 10:30 a.m. in regard to an order. Mr. Boren's telephone number is 312 555-3456. He will call again at 2 p.m.

c. Mrs. J. F. Anderson called Mr. Anderson (her husband) at 12:30.

d. Mr. Lamont Heslop of Philadelphia called at 11:35. He said that he had received order No. 10256 but had not received order No. 10245, which had been placed a week before the other order. His telephone number is 215 555-8230. (5 points possible)

5. Assume that your employer, Mr. J. F. Anderson, wishes to make the following out-of-town calls from the office telephone, 399-1113, on the current date. In order that the monthly toll statement received from the telephone company may be audited (checked for correctness) and the charges allocated to the proper offices or persons, the secretary keeps a record of each toll call when it is made. Record on the forms provided the toll calls made. All calls other than personal ones are charged to General Administrative Expense (GAE). The cost is given after each call. (5 points possible)

a. A person-to-person call to Scott W. Ballif, of Fort Worth, Texas, relative to a personal matter. You do not know his number or address, but he is a noted eye specialist. $2.65.

b. A call to Mr. Harry Burchell of the Brown Construction Company; Walnut Street; Baltimore, Maryland; regarding a back order for parts. $4.25.

c. A station-to-station call to Mr. Anderson's mother, who

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lives in Grand Rapids, Michigan. Her number is 616 281-6912. $1.15

d. A call to Mr. Dennis Hogge, of the Attendance Supply Company, in Freyville. The call is to check the reference of Reid Hansen, an applicant. $3.75

e. A call to Allen Products Company, on Twelfth Avenue, in Allentown, about the cancellation of our order. The number is 237-6123. The charges are to be reversed.

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UNIT INSTRUCTION SHEET

Composing Assignments of the Secretary

The extent to which a secretary helps an employer compose communications depends on her ability and the confidence her employer has in it. Employers value secretaries who are willing and able to assume responsibility for routine correspondence such as giving routine information, asking for something, transmitting material, making or changing appointments, or acknowledging receipt of something. Many employers need a secretary who knows how to take hastily dictated notes and expand them so that they sound right and are carefully punctuated and edited.

Letter writing is a complex office activity that defiles efforts to reduce it to a simple set of rules or a formula. But is is possible to isolate two qualities characteristic of all good letters. Letters should be clearly written and communicate information in such a way that they create a favorable response from the reader.

Goethe wrote, "Remember that: Write only as you would speak; then your letters will be good."

A LETTER TALKS TO ITS WRITER

Before you sign me, let me say
That I don't feel so good today;
I'm not prepared to meet a buyer!
I seem to lack the kind of fire
That drives home what you would convey.

My head (I mean my letterhead)
Is uninspiring, flat and dead;
It doesn't catch the reader's eye.
Remember, sir, that I must vie
With other letters to be read.

The way I talk is insincere;
My meaning is not crystal clear;
I'm cluttered up with phrases trite--
The kind of stuff they used to write
Way back there in a distant year.

Forget the "I" and make it "You"
And get the reader's point of view;
Rewrite, delete, correct, revamp
So that my six-cent postage stamp
Presents a story fresh and new.

By Orville E. Reed

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Unit Goals

1. You will become acquainted with basic letter-writing techniques. It is important for you to understand the essentials of a clear, effective letter.

2. You will be able to compose letters that are most frequently written by secretaries in a concise and complete fashion using basic letterwriting techniques.

Texts and Materials Needed

1. College Business Correspondence, second edition, revised

2. Applied Secretarial Practice, sixth edition

3. Typing Paper and eraser

Procedure for Completing Unit

1. Read and study the pages given in each assignment.

2. Complete the eight projects listed in the assignment section of this unit.

3. Follow closely the directions given for each assignment when completing a basic letter-writing technique project. Do not write or complete any project in the textbook itself.

4. Read the letter you are to answer in its entirety before you begin composing a letter. Decide what the answers to the questions will be and what information should be given before you begin to write. Make brief notes of what you want to say and the points you want to cover.

5. Ask for help if there is any assignment that you cannot understand. Do not hesitate to obtain assistance from your teacher.

6. Hand in your assignments for evaluation.

Assignments

1. Read and study pages 9-12 in College Business Correspondence. Proofread the letter on page 23. Type the letter in double spaced form, cross out all incorrect words, and write the correct words above. This letter contains twenty-five errors. (5 points possible)

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2. Read and study pages 25-29 and 37-44 in College Business Correspondence. Certain phrases and long words make a sentence too bulky. Type the sentences on page 47 first as they are, and then type the correct sentence below it. This exercise will test your skill in selecting a short, concise word to replace a long word or phrase. (5 points possible)

3. Read pages 49-51 in College Business Correspondence. Courtesy and character are important in beginning and ending a letter. Rewrite sentences 5, 19, 15, 20, 25, 30, 35, and 40 on pages 52-54. Type the sentence as it is first, and then the revised one below it. Make the sentences as concise and clear as possible. (5 points possible)

4. Read pages 11-117 in College Business Correspondence. An order is the first link in the business chain. Write order letters for Problems 2 and 7 on pages 118 and 119. Refer to page 112 for an illustration of an order letter. Avoid including unnecessary details in your letters. (15 points possible.)

5. Read pages 125-129 in College Business Correspondence. One of the best ways in which any business can build and maintain good will is to acknowledge each order promptly. Write letters of acknowlegement for Problem 2 and 5 on pages 129 and 130. Pages 126 and 127 have several good examples of the different types of acknowledgement letters. (15 points possible)

6. Read pages 133-138 in College Business Correspondence. A business can build good public relations by saying "thank you" for remittances it receives from customers. Write a thank you letter for Problem 3 on page 139. Be sure to make the letter cordial in tone. (10 points possible)

7. Read pages 141-143 in College Business Correspondence and write a reply to the inquiry letter in Problem 7 on page 144. Remember to give the exact information requested. (10 points possible)

8. Refer to page 101 in Applied Secretarial Practice for an example of a letter written by a secretary when her boss was out of town. Mr. William A. Jones decides to leave on a trip that will keep him away for several days. Therefore, all appointments for that time must be canceled. Local appointments are canceled by telephone, but those with persons out of town are canceled by mail or wire. Write a letter to Mr. Thomas, who has an appointment with Mr. Jones on Friday afternoon, June 9, at 3 9'clock. This letter must be definite in referring to the time and place of the original appointment. Like all business letters, it must be written from the reader's point of view, expressing regret for inconvenience caused and extending the courtesy of another time for the appointment. This letter should be signed with your name as secretary to Mr. Jones.

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UNIT INSTRUCTION SHEET

Filing Systems and Procedures

Filing and finding business papers is an important responsibility for all secretaries. Due to the tremendous volume of business correspondence, it is imperative that accurate and up-to-date files be kept. The records in the files are so vaulable that they are sometimes referred to as the "memory" of the business.

We can say that filing is the process of classifying and arranging records so that they will be kept safely and will be obtainable quickly when needed. Filing is not merely the storing of records to get them out of sight, but a systematic organization of those records so that they can be located quickly.

I don't have to say that my grandmother died
If I want to turn out for the Dodgers,
My boss won't grumble, my boss won't chide,
I've got it down to a science!
I don't have to faint, or resort ot tears,
Or use any feminine wiles--
They can't fire me--for the last two years
I've been keeping the office files.

Yes, I have a system that's all my own,
And it can't be explained, and it can't be shown.
I file by number, I file by letter,
I file by ways that are the times better,
I file by subject, I file by date,
I file by city, I file by state.
I shun the trite, and I scorn conventions,
My filing system has four dimensions.

I regard "In re" at the top of a letter
As something to make it balance better.
I pay no attention to underlining
And seldom get to the persons signing.
I've got the names of the firm's officials
Neatly arranged by their middle initials.
Customers' letters I've filed instead
By the color and size of their letterhead.

I've got the catalog mailing list
Filed under "Farley"--you get the gist.
Our financial reports, for my own good reasons,
Instead of by months, I've arranged by seasons.
I've put Mrs. Duffy's damage suit
In a folder entitled "Big Dispute."
And for anything I consider extraneous,
I've three whole drawers labeled "Miscellaneous."

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To The Beginning Drafting Student:

Before jet engines, automobiles, rockets, electrical appliances, and buildings can be constructed, a drawing of each part must be made. A person who can read and make good drawings is a more valuable employee in many lines of work. Drafting is most important to anyone who expects to work in the manufacturing, construction trades, or who wishes to become a professional engineer. Our mass production methods of manufacture would not be possible without the drawings made by draftsmen.

Drafting can be a very important subject for you. The course can help you develop skills that will be useful in everyday life as well as in industry. Drafting will teach you a way of explaining and showing by use of pictures instead of words or the real thing. You will actually be learning a new language—the language of industry. This language can be understood anywhere in the world.

This course will give you an opportunity to explore several areas of drafting. You will have an opportunity to read and make drawings that will be helpful to you. If you plan to become a scientist, engineer, or go into industrial work, you should plan to take more drafting. Each year in high school you will be given an opportunity to elect advanced courses in drafting which will help you become more skillful in reading and making drawings. You will have a chance to develop more skill in the use of the tools used by draftsmen and to specialize in one area of drafting such as Mechanical or Architectural.

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I'm the indispensable employee,
They can't take a step without me;
And it cost them a raise and half-day free
Every time they attempt to flout me.
So they can't fire me, no matter how cross,
No matter how mean and riling!
I'm Monroe herself--I'm the boss's boss,
For I take care of the filing.

--Successful Suzy

Unit Goals

1. You will be able to apply the basic alphabetic rules of filing.

2. You will be able to pass a test involving indexing, coding, and filing of names of individuals and a test involving indexing, coding, and filing of names of businesses. At least 84% accuracy will be required to pass each test.

3. You will be able to apply the basic geographic rules of filing.

4. You will be able to pass a test involving indexing, coding, and filing of names of individuals and businesses geographically. At least 84% accuracy will be required to pass the test.

5. You will become familiar with the advantages and disadvantages of alphabetic, geographic, subject, and numeric filing; the general rules and suggestions for filing; and clues for finding papers that have been misfiled.

Texts and Materials Needed

1. Filing Practice Workbook, third edition

2. Applied Secretarial Practice, sixth edition

3. Shorthand notebook

4. Rubber bands

Procedure for Completing Unit

1. Obtain a copy of Filing Practice Workbook from your teacher. Staple the pocket on the back cover so you will have a space to keep your filing slips.

2. Read carefully the introductory material on the inside covers of your workbook.

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3. Rules and examples are given at the top of each job in the workbook. Be sure to study these rules and examples before starting to do the job.

4. Tear out filing slips as you reach a specific job. Whe you separate the slips, keep them together by placing a rubber band around the slips for each job.

5. Save the filing slips after you tear them apart. You will need them for later jobs.

6. Remember the following four steps in filing:

   a. Indexing--determine what to put it under

   b. Coding--underline the primary index unit

   c. Sorting--arranging in preliminary order

   d. Filing--place in a file container

7. Code the primary index unit of each filing slip. For example: In Job 1 you would underline the surname, Washington.

8. Use the code number contained on each slip. Code number 3--8 means that is is filing slip No. 8 in Job 3. This code number is important in reporting your answers.

9. Use a shorthand notebook (one that is not used in your shorthand class) to record each filing job. Write your name at the top of each page and indicate the job number. You may use both sides of the paper.

10. Arrange all the slips in a job in correct filing order and report your arrangment through the use of the code numbers. For example: Number your paper from 1 to 18. Start with your first slip to be filed and record its code number next to the No. 1 on your paper.

11. Check each job with the key when you have completed it. Write the number of errors at the top of the answer sheet. If you do not understand the order of some of the filing slips as recorded in the key, be sure to check with your teacher. Do not proceed to the next job until you are sure you understand the rule covered in the job you have just completed.

12. Complete Assignment 1 and turn in the answer sheets for these jobs.

13. Take the test for the filing of names of individuals. (50 points possible)

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14. Complete Assignments 2 and 3 and turn in the answer sheets for these jobs.

15. Take the test for the filing of names of businesses. (50 points possible)

16. Read and study pages 401 - 412 in Secretarial Office Practice, sixth edition.

17. Complete Assignment 4.

18. Read carefully the introductory material on the inside back cover of Filing Practice Workbook dealing with geographic filing. Complete Assignment and turn in the answer sheets for these jobs. (Assignment 5)

19. Take the test for the filing of names of individuals and businesses geographically. (25 points possible)

20. Read and study pages 429-453 in Secretarial Office Practice, sixth edition.

21. Complete Assignment 6.

22. Hand in Assignments 4 and 6 for evaluation.

Assignments:

1. Complete Jobs 1 through 12. Also, complete the following Optional Jobs: 8C, 8D, 12C, and 12D. All other Optional Jobs should be omitted.

2. Complete Jobs 13 through 23 and 25 through 26. Also, complete the following Optional Jobs: 20C, 20D, and 24C. Job 24 and all other Optional Jobs should be omitted.

3. Jobs 27 through 32 may be completed for review.

4. Answer questions 13-17 on page 413 in Applied Secretarial Practice, sixth edition.

5. Complete Optional Filing Jobs 27A-32A, 32E, and 32I in Filing Practice Workbook.

6. Complete Bonus Project 6 on page 457 in Applied Secretarial Practice. Make a carbon copy of this assignment. The carbon copy should be turned in and the original copy kept for future reference.

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UNIT INSTRUCTION SHEET

Telegraph Communications

Many times urgent business messages that must be sent to distant points can be reduced to a very few words. In such cases, it would be wasteful to pay for a minimum of three minutes of long distance telephone time to ask a question of 5 or 6 words. On the other hand, asking the question even by the fastest mail may be too slow.

Fortunately for the businessmen, commercial telegraph service is a solution to the problem of getting immediate attention or responding without delay. Brief messages can be sent economically and quickly to any part of the country.

After you are employed as a secretary, you will be expected to know when to send telegrams and which type of service to use. You will also be expected to know how to compose telegrams and how to get your message to the telegraph office.

Unit Goal

1. You will be able to compose a telegram, determine the number of chargeable words in a telegram, and type a telegram in acceptable form.

Texts and Materials Needed

1. Secretarial Office Practice
2. Reference Manual for Stenographers and Typists, fourth edition
3. College Typewriting, eighth edition
4. Booklet entitled "How to Prepare and Use Telegrams"
5. Telegram blanks

Procedure for Completing Unit

1. Read and study pages 197-207 in Secretarial Office Practice. Up-dated information can be found in the booklet entitled, "How to Prepare and Use Telegrams."
2. Complete the five assignments listed in the assignment section of this unit. Follow closely the directions for each assignment given in your text or this instruction sheet.

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3. Ask for help if there is any assignment that you do not understand. Do not hesitate to obtain assistance from your teacher.

4. Hand in your work for evaulation.

Assignments

1. Determine the number of chargeable words for each of the following telegrams. Type these telegrams on a plain sheet of paper. If a word or group of letters, figures, or characters represents more than one chargeable word, underscore the item and indicate by a small figure beneath the underscore the number of chargeable words included. Omit spaces where permitted if it will result in savings in word counts. Place the number of chargeable words in parentheses at the end of the telegram. Refer to the section entitled "Counting the Chargeable Words" on pages 199-201 in Secretarial Office Practice in completing this assignment. (8 points possible)

   a. CHANGE CATALOG GROSS PRICES ON AS123 TO $117.92; 10B10 to $192.21; 15X102128 TO $85.72.

   b. STOCK EXHAUSTED ON KNRP, KNRPVO, AND VT.

   c. ENJOYED SEEING LOCKS AT SAULTE STE MARIE. HEADING FOR CANADA TODAY. RETURNING TO UNITED STATES 10 P.M. WEDNESDAY. FEELING OK.

   d. CHANGE 1-½ to 7-½ IN 17th LINE ON PAGE 21 IN PLUMBING SPECIFICATIONS.

2. Complete Problem 1-6 on page 208 in Secretarial Office Practice. Determine what type of service should be used in each situation. Remember that only two types of services are now available. (12 points possible)

3. Type a file copy of the following telegrams. Refer to page 170 in College Typewriting for an example of how to type a file copy of a telegram. It is not necessary to include a zip code since the zip code is not transmitted by the telegraph company at the present time. Type your name and telegram number in the upper left corner of each telegram. Count the number of chargeable words in each telegram. Type this number in the upper right corner of each telegram. (8 points possible)

   a. Overnight telegram from Skidmore, Jones, and Walsh; Ogden, Utah; current date to Henry Samson; 18 Mill Street;

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Rockaway, New Jersey. Advising that beginning the first of next month all prices will be increased from 10 to 25 percent on all items due to shortages of materials and increased labor cost. Suggest that you estimate your needs and order immediately to take advantage of present prices. Skidmore, Jones, and Walsh.

b. Telegram from Skidmore, Jones, and Walsh; Ogden, Utah; current date to William Martin; 110 Morningside Drive; New York, New York. Please rush all architectural drawings for Imperial House. Must have by the fifteenth. Skidmore, Jones and Walsh.

c. Telegram from Skidmore, Jones, and Walsh; Ogden, Utah; current date to Hartwell Supply Company; 624 West Jackson Avenue; Chicago, Illinois. Please cancel our Purchase Order #10832 mailed you yesterday. New Order will follow. Skidmore, Jones, and Walsh.

d. Telegram from Skidmore, Jones, and Walsh; Ogden, Utah; current date to Farris Mechanical Engineering Company, 5702 West Union Street; Evansville, Indiana. Final hearings on bids for Westside Shopping Center will be held in our Executive Board Room on November 13, 19--. All bids must be received at least 15 days prior to hearing date. Please get your bids to me as soon as possible. Skidmore, Jones, and Walsh.

4. Rewrite each of the following telegraph messages, using not more than 15 words so that the message may be sent as a fast telegram. Type the old message first and then your revised message on a sheet of paper. (10 points possible)

a. THERE WILL BE A SALES MEETING SATURDAY MORNING IN THE OFFICE AT TEN O'CLOCK. PLEASE ARRANGE TO BE THERE. BRING REQUESTED ESTIMATES.

b. MR. WILCOX WIRED SAYING HE WOULD BE HERE TOMORROW. IS IT POSSIBLE FOR YOU TO COME BACK? MUST KNOW BY THREE O'CLOCK.

c. IN ANSWER YOUR TELEGRAM SUGGEST YOU OFFER A 40% DISCOUNT TERMS 2% 10 DAYS. DELIVERY TO BE MADE FOR NEW YORK.

d. I AM GOING TO DETROIT TOMORROW TO INTERVIEW HARRISON. DO YOU WANT ME TO TELEPHONE SMITH, TOO, WHILE I AM THERE?

e. MODEL DR-3, CALLED FOR ON YOUR ORDER NO. 9952, HAS BEEN DISCONTINUED. MAY WE SHIP MODEL XE-4 INSTEAD OF THAT ORDER?

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5. Complete Problems 1-3 on page 209 in Secretarial Office Practice under the heading "Secretarial Work." Compose message for these situations and then type your messages on telegram blanks which are available. Refer to page 226 of the Reference Manual for Stenographers and Typists for an example of how to type a telegram on the new telegraph blanks. This blank varies slightly from the illustrations in the Secretarial Office Practice text.
(12 points possible)

UNIT INSTRUCTION SHEET

Using Postal Services and Processing the Mail

Your mail is important. It represents you when you can't be there in person. Mail handling deserves your careful consideration. Out-dated mailing methods can be costly and time-consuming without your ever realizing it.

To serve your employer well, you must be familiar not only with the simple routine of mailing and distributing letters and packages but also with the numerous services of the Post Office Department. You must also know where to find current, accurate information regarding these services and procedures.

Unit Goal

1. You will be able to classify mail, use a register of expected mail, address an envelope correctly, figure the cost of postage, and type file cards for a mailing list.

Text and Materials

1. Secretarial Office Practice
2. Booklet entitled "Domestic Postage Rates, Fees, and Information"
3. Form for Mail Expected Under Separate Cover
4. 3 X 5 Index cards

Procedure for Completing Unit

1. Read and study pages 171-193 in Secretarial Office Practice.
2. Complete the five projects listed in the assignment section of this unit. Follow closely the directions for each project given in your text. Due to changes in the postal system, updated information has been included in the assignment section. Illustrations for filling out postal forms are found in the text.
3. Ask for help if there is any assignment that you do not understand. Do not hesitate to obtain assistance from your teacher.
4. Hand your work in for evaluation after completing the five projects in this unit.

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Assignments

1. Determine what class of mail applies to each of the following items:

   a. Package (4 pounds)
   b. Look Magazine
   c. Postal card
   d. Blue Spruce Tree (small)
   e. Circular
   f. Birthday card
   g. Carton (75 pounds)
   h. Business Reply Card
   i. Sample box of Dash soap
   j. Typed letter
   k. January White Sale Advertisement
   l. Longhand report
   m. Inter-office memorandum
   n. Merchandise sample (4 ounces)
   o. Air Card
   p. Double post card
   q. Catalog (350 pages)
   r. Newspaper
   s. Baby Chickens
   t. Flower Seeds

2. Complete Problem 20 on page 178 in Secretarial Office Practice. Record on the form provided and refer to page 176 for illustration. (5 points possible)

3. Complete Problem 4 on page 194 in Secretarial Office Practice. Type the addresses in correct form on slips of paper 3 5/8" by 9 1/2". With the advent of zip code, the following changes have been made in the typing of addresses:

   a. Single space the address lines, no matter how many lines there are. An address should never be typed on less than three lines. If necessary, place the zip code on a separate line.

   b. Block the address lines. Do not arrange them in indented form.

   c. Avoid abbreviations. In street addresses, never abbreviate North, South, East, and West; likewise, never abbreviate Street, Avenue, Boulevard, Drive, etc.

   d. Use the new two-letter abbreviations for state names. Space three spaces between the two-letter state abbreviation and the zip code.

   e. Use a personal courtesy title (Mr.,Miss, Mrs., Etc.) preceding the name when the letter is addressed to an individual. (10 points possible)

4. Complete Problem 5 on page 195 in Secretarial Office Practice. Refer to the booklet entitled "Domestic Postage Rates, Fees, and Information" for current postal rates. Figure each item and list it separately. Obtain a grand total for all the items. Remember that a fee for special postal services must be paid in addition to the regular postage rate. (15 points possible)

5. Complete Problem 6 on page 195 in Secretarial Office Practice. Obtain 16 index cards from your teacher for this project. Refer to page 190 for an illustration on how to type these cards. Use the second example. Begin typing on the third line from the top edge and set a one-half inch left margin. Triple space after typing the first line and use a two-letter state abbreviation for the name of the state. (15 points possible)

UNIT I — FREEHAND SKETCHING

General Information

Freehand Sketching:

Have you ever made a sketch to explain something? This is making a freehand drawing. The advantages of freehand drawings are that they are quicker and more convenient to make since the only tools required are a pencil and an eraser. Skill in freehand sketching is useful for everyone. It is a necessity for those engaged in industrial or technical work. This skill can be acquired by anyone if he will follow certain simple procedures and practice consistently.

The T-square and the triangles are the straight-edged tools used to make a finished working drawing. However, drawings of several views of an object which show clearly the size and shape of all of its parts can be made entirely without the use of instruments. The general principles involved are the same as in mechanical drafting.

The technique of sketching consists in knowing what pencil is best suited to the paper being used, keeping the pencil sharp, holding it correctly, and following a few well-founded procedures:

1. Sketch horizontal lines from left to right as in Figures 2 and 3, which are illustrated on page 9. The stroke is either a wrist or forearm movement and should be only as long as can be conveniently made. The hand should then be shifted to the right for the next stroke.
2. In drawing any straight line between points, keep the eye on

UNIT INSTRUCTION SHEET

Usin. Office Machines--adding machines

Two major classifications of computing machines according to use are: adding and calculating. During this unit, you will be using adding machines. Now days when the term "adding machine" is used, it means the ten-key adding machine. This machine is probably the simplest and most common type to be found in the office. The skills you will learn on this machine are basic and will carry over when using other machines.

The ten-key adding machine is so named because its basic keyboard contains only ten number keys (1, 2, 3, 4, 5, 6, 7, 8, 9, and 0). The keyboard is designed for a touch system of fingering. In other words, you do not have to watch the keyboard but can concentrate completely on the copy. This concentration results in accurate recording and higher speed. This machine is designed primarily to solve problems in addition and subtraction, but multiplication and even division can also be done. You must develop a good skill in addition since this is the most important function of the machine.

Even though ten-key adding machines are made by several manufacturers; if you know the basic operating principles of one model, you can easily become familiar with the operating features of other models.

Unit Goals

1. You will be able to perform all of the basic mathematical functions associated with the operation of a ten-key adding machine using the touch method of operation.

2. You will be able to add 39 problems consisting of from three to six digits in 15 minutes with a score of 70% or more.

3. You will be able to complete two 50 problem tests covering basic mathematical functions and covering practical applications on the ten-key adding machine with a score of 70% or more.

Text and Materials

1. How to Use Adding Machines
2. Business Arithmetic Pretest
3. Answer Sheets--Ten-Key Adding Machine--Lesson 1-6.
4. Answer Sheets--Ten-Key Adding Machine--Lessons 7-10

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Procedure for Completing Unit

1. Pick up a loose-leaf text for the ten-key adding machine each day as you enter the room. Do not remove pages from this text. This text must be replaced at the end of the period.

2. Obtain the Answer Sheets for Lesson 1-6. Answer sheets are available in the shelf trays on the counter. The Answer Sheets will give the page number and the number of problems to complete for each lesson.

3. Use the connecting door to move from the classroom to the machine's lab.

4. Clear the adding machine's table of all books and papers that do not pertain to the course. Place the machine to the right of the table and the textbook to the left. Position the machine and text to give you ease of operation and reading.

5. Sit erect, relax, and put both feet flat on the floor.

6. Clear the machine by depressing the total key. Always be sure your machine is clear before starting to work a problem. Also, never force a key on a machine. If keys won't work, get help from your teacher.

7. Correct your answers with the Key after you have completed a lesson. The Key is available in a loose-leaf. Rework any problems that are incorrect. Hand in each lesson with the adding machine tape to this lesson stapled on to the back of the Answer Sheet.

8. Complete the first six lessons and correct your Answer Sheets. When you have completed these lessons, you should be prepared to take the speed test and the test on basic mathematical functions. The adding machine tapes to these tests must be stapled on to the back of each test.

9. Obtain the Answer Sheets for Lessons 7-10.

10. Complete Lessons 7-10 and correct your Answer Sheets. When you have completed these lessons, you should be ready to take the test on practical applications. The adding machine tape to this test must be stapled on to the back of the test.

Assignments

1. Complete the Business Arithmetic Pretest and correct your answers with the key. This pretest will help to pinpoint any weaknesses in arithmetic you may have.

2. Complete the Answer Sheets for Lessons 1-6.

3. Complete the Answer Sheets for Lessons 7-10

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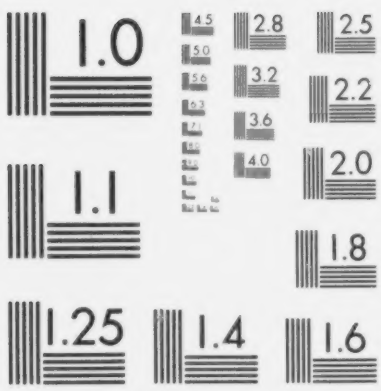

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

BUSINESS ARITHMETIC PRETEST

Name _____

Do the following problems, place the answers in the blanks at the right.

DECIMALS:

In arithmetic the most important point is the decimal point.

1. 13 + 152 = 1. _____
2. 1.3 + 1.52 = 2. _____
3. 13. + 15.2 = 3. _____
4. 14 - 12 = 4. _____
5. 1.4 - .12 = 5. _____
6. 1.4 - 1.2 = 6. _____
7. 4 X .6 = 7. _____
8. .4 X .6 = 8. _____
9. .4 X .06 = 9. _____
10. 14 X .006 = 10. _____
11. 24 by 8 = 11. _____
12. 24 by .8 = 12. _____
13. 24 by .08 = 13. _____
14. .24 by .8 = 14. _____
15. 2.4 by 8 = 15. _____
16. .24 by .08 = 16. _____

FRACTIONS:

17. 1/4 + 1/4 = 17. _____
18. 1/4 + 1/2 = 18. _____
19. 1/3 + 1/6 = 19. _____
20. 1 1/3 + 3/4 = 20. _____
21. 5 1/6 + 4 1/2 = 21. _____

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22. 1 - 3/8 = 22._____

23. 2 1/2 - 1 3/4 = 23._____

24. 1 X 1/2 = 24._____

25. 1/2 X 1/2 = 25._____

26. 1 by 1/2 = 26._____

27. 1/2 by 1/4 = 27._____

CHANGE THE FOLLOWING PRACTIONS TO DECIMALS:

28. 1/2 28._____

29. 3/8 29._____

CHANGE THESE DECIMALS TO FRACTIONS IN THEIR LOWEST TERMS:

30. .25 30._____

31. .6 31._____

WRITE THESE NUMBERS AS A PERCENT:

32. .75 32._____

33. 2.50 33._____

34. 1. 34._____

35. .05 35._____

WRITE THESE PERCENTS AS A DECIMAL:

36. 36% 36._____

37. 2.6% 37._____

38. .56% 38._____

39. 126% 39._____

40. What is 50% of 200? 40._____

41. What is 100% of 200? 41._____

42. What is 150% of 200? 42._____

ANSWER SHEET--Ten-Key Adding Machine
Lesson 1

Name_____

Score_____

Page 3-4

1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9._____
10._____
11._____
12._____
13._____
14._____
15._____
16._____
17._____
18._____
19._____
20._____
21._____
22._____
23._____
24._____

Page 4

1._____
2._____
3._____
4._____
5._____

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UNIT INSTRUCTION SHEET

Using Office Machines--calculators

Two major classifications of computing machines according to use are: adding and calculating. During this unit, you will be using calculating machines. These machines are designed primarily for multiplication and division, but they may also be used for addition and subtraction.

In the modern office, machines known as printing calculators and electronic calculators have replaced key-driven and rotary calculators. The keyboard of the printing calculator and the electronic calculator resemble that of the ten-key adding machine. Special keys have been added to provide for automatic processes. The printing calculator is rapidly becoming the popular all-round workhorse in any office where a tape listing of figures is desired. On the other hand, the electronic calculator is relatively new. This machine operates silently at virtually the speed of light to supply the answer in a few mili-seconds or less.

Even though calculating machines are made by several manufacturers; if you know the basic operating principles of one model, you can easily become familiar with the operating features of other models.

Unit Goals

1. You will be able to perform all of the basic mathematical functions associated with the operation of a printing calculator and an electronic calculator using the touch method of operation.

2. You will be able to complete a 50 problem test covering basic mathematical functions on the printing calculator with a score of 70 percent or more.

3. You will be able to complete a 50 problem test covering basic mathematical functions on the electronic calculator with a score of 70 percent or more.

Texts and Materials

1. How to Use Adding Machines

2. Text for the Electronic Calculator

3. Answer Sheets--Printing Calculator--Lessons 1-7

4. Answer Sheets--Electronic Calculator--Lessons 1-4

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Procedure for Completing Unit

1. Pick up a loose-leaf text for the printing calculator each day as you enter the room. Do not remove pages from this text. This text must be replaced at the end of the period.

2. Obtain the Answer Sheets for the printing calculator for lessons 1-7. Answer Sheets are available in the shelf trays on the counter. The Answer Sheets will give the page number and the number of problems to complete for each lesson.

3. Use the connecting door to move from the classroom to the machine's lab.

4. Clear the machine's table of all books and papers that do not pertain to the course. Place the machine to the right of the table and the textbook to the left. Position the machine and the text to give you ease of operation and reading.

5. Sit erect, relax, and put both feet flat on the floor.

6. Clear the machine by depressing the total key. Always be sure your machine is clear before starting to work a problem. Also, never force a key on a machine. If keys won't work, get help from your teacher.

7. Correct your answers with the Key after you have completed a lesson. The Key is available in a loose-leaf. Rework any problems that are incorrect. Hand in each lesson with the adding machine tape to this lesson stapled on to the back of the test.

8. Complete Lessons 1-7 and correct your Answer Sheets. When you have completed these lessons, you should be prepared to take the test on basic mathematical functions. The adding machine tape to this test must be stapled on to the back of the test.

9. Pick up the loose-leaf text for the electronic calculator. Do not remove pages from this text.

10. Obtain the Answer Sheets for the electronic calculator for Lessons 1-4.

11. Complete Lessons 1-4 and correct your Answer Sheets. When you have completed these lessons, you should be ready to take the test on basic mathematical functions.

Assignments

1. Complete the Answer Sheets for the printing calculator for Lessons 1-7.

2. Complete the Answer Sheets for the Electronic Calculator for Lessons 1-4.

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UNIT INSTRUCTION SHEET

Using Transcribing Machines

Even though you will probably be employed as a shorthand writer and transcriber, you may from time to time be asked to transcribe dictation that has been recorded on a machine. Some executives use dictation machines to handle after-hours dictations; some use portable machines to record letters and reports while they are away from the office on business trips; still others prefer to handle most, if not all, of their dictation in this manner. It is important, therefore, that you be acquainted with the operating principles of dictating and transcribing machine and that you follow efficient procedures in using them.

Unit Goal

1. You will be able to operate a transcribing machine efficiently by setting up dictated letters and manuscripts in mailable form.

Texts and Materials Needed

1. IBM Transcription Techniques
2. ZIP Code Directory
3. Electric typewriter
4. Transcribing machine
5. Pre-recorded transcription belts.

Procedure for completing Unit

1. Read the out-of-class preparation for Lessons 1, 2, and 3 in IBM Transcription Techniques.
2. Obtain transcribing equipment and transcription belts.
3. Set up equipment at a desk next to an electrical outlet.
4. Adjust the controls of the machine to suit your particular needs; the speed control, until the voice is clear (neither too fast nor too slow); the volume control, to suit your own listening preference; and the tone control, for pleasant listening.

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5. Use the index tab which accompanies each recording as a guide to letter placement and as a key to corrections in the dictation. Remember that a correction will appear on the lower half of the index tab. Listen to the corrections and special instructions before you begin to type from the recording.

6. Start transcribing slowly: Start the machine; listen to a few words at a time; stop the machine; transcribe those words; start the machine again and repeat the process.

7. Use the repeat control on the machine which permits you to repeat the last few words of the dictation. Try to develop the power to carry dicatation in your mind for more continuous transcription.

8. Label all letters and manuscripts according to the belt number. Type your name and belt number in the upper left corner of each sheet of paper. Each exercise on a belt must be placed on a separate page.

9. Proofread each transcribed item at least twice.

10. Remove the belt and index tab from the machine and place it in the proper container at the end of each period.

11. Complete the transcription of a belt, staple all papers together in the upper left corner, and correct your work with the Key for this unit. Each page of transcription must be typed in "mailable" form. Each page will be worth five points, one point deducted for each error. A minimum of three points per page is required.

Assignments

1. Answer the following questions from your reading:
   a. What is the foot control used for?
   b. What is the index tab used for?
   c. How should the belt be inserted into the machine?
   d. When you hear double voices on the machine, what should you do?

2. Use belts 3 and 4 for practice. Type them in rough-draft form in order to get the "feel" of the machine.

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the points to which the line is to go rather than on the pencil. Do not try to draw the entire length of the line in a single stroke. It may be an aid to draw a very light line at first, then to sketch the finished line, correcting the direction of the line without rubbing it out. Do not be disturbed by any nervous waviness. Accuracy of direction is more important than straightness of line.

3. Vertical lines and inclined lines sloping downward from right to left are drawn easily with a finger movement in a series of short easy strokes with the hand holding the pencil in the position of Figure 4, Illustration Sheet 1, page 9.
Vertical lines and inclined lines, sloping down from left to right, may be drawn by turning the paper and drawing them as horizontal lines.

Freehand sketching has the following uses:

1. It is a rapid method of developing ideas, inventions, and designs.
2. It is the best way to plan the layout of a mechanical drawing.
3. It is used as a quick means of communicating ideas from designer to draftsman.
4. It is the best means of recording information which must be obtained outside the drafting room.
5. It is an aid in conveying ideas and mechanical information from foreman to workman, salesman to buyer, or from teacher to pupil.

You should be ready to complete Work Sheets numbers 1, 2, 3, and 4. Turn to page 15.

3. Transcribe in mailable form all exercises contained on belts 5, 7, 8, and 10. Omit the dictated words at the beginning of belts 5 and 10. The material on all belts should be typed directly as final "mailable" copy without using a rough draft. Keep the following points in mind when transcribing:

   a. Paragraphs should be set up in unbound manuscript form.

   b. Manuscripts should be typed in bound manuscript form.

   c. Letters should be typed in modified block style. Use two-letter state abbrevations and obtain the correct zip code from the ZIP Code Directory. Carbon copies are not required, but make a carbon copy notation on the original if a carbon copy is requested on the transcription belt.

UNIT INSTRUCTION SHEET

Preparing Multiple Copies

Practically nothing in an office is "a single copy." Modern business activity requires an almost incredible number of extra copies of papers--letters, memos, reports, brochures, bulletins, notices, manuals, names and addresses, and so forth. Business thrives on multiple copies, sometimes thousands, to inform everyone who should be informed. Many different kinds of processes are on the market to produce these extra copies. There is still no one process that will handle all the various copy-making requirement of an organization. The secretary must be able to select the most appropriate one from those that are available. What is to be copied, when it will be needed, and how it will be used must be considered when selecting a process. After a process has been selected and the master prepared, the desired number of copies are run off on the appropriate machine.

Unit Goals

1. You will be able to prepare copy for photo-copying machine, prepare spirit masters, and type an offset paper master.

2. You will be able to operate a "Thermo-Fax" copying machine, an illuminated drawing board, a "Standard" fluid duplicator, and a "Gestetner" stencil duplicator.

Texts and Materials Needed

1. Secretarial Office Practice

2. Vocational Office Typing

3. College Typewriting

4. Letterhead stationary

5. Thermo-Fax copy paper

6. Thermocopy master

7. One spirit master and red, green, blue, and black carbons

8. Two regular stencils

9. One bulletin stencil

10. One offset paper master

11. Tracing sheets

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12. Correction fluid

13. Lettering guides, stylus, and shading plates

14. Duplicating paper

Procedure for Completing Unit

1. Read and study the reference material given in each assignment.

2. Use the following procedure for obtaining materials and caring for equipment:

   a. Obtain stencils, masters, lettering guides, shading plates, and tracing sheets from the duplicating cupboard.

   b. Set up the illuminated drawing board on the duplicating table at the back of the room.

   c. Replace lettering guides and styli after each use in their proper containers.

   d. Replace the tracing sheets in the proper loose-leaf and in the correct numbered order. Do not remove tracing sheets from the room.

   e. Clean the flexible writing plate for the illuminated drawing board when necessary.

   f. Be careful not to waste duplicating supplies and paper.

   g. Put away equipment and materials at the end of class.

3. Use the following procedure for typing and correcting a stencil:

   a. Type the material on paper first so that you can position the copy more accurately on the stencil. Use the same size paper as will be used for the final copies. Be sure to keep your typing within the marginal limits of the stencil or at least 3/4 inch.

   b. Use an electric typewriter, set the ribbon on "stencil" position (so the type does not print), and check to see that the touch is not too heavy.

   c. Clean the type with a dry brush. Make sure the typewriter keys that collect ribbon ink most easily--o, p, m, w, e, and so on--are completely clean; otherwise they will not

162[illegible]

cut a clear impression. Type over the entire keyboard several times on scrap paper in order to remove any trace of ribbon ink.

d. Place a cushion sheet between the stencil and the backing sheet. The coated, or glossy surface of the cushion sheet should be next to the stencil. Film should be placed on top of the stencil.

e. Insert a stencil in the typewriter and straighten if it is necessary. Observe carefully the margin guides printed on the stencil.

f. Use the following basic steps in correcting an error on a stencil:

(1) Turn the stencil upward in the machine a line or two so that the error can be reached readily. Detach the film and lay it over the hood of the machine.

(2) Use a glass burnisher or a paper clip to rub the surface of the error to "close" the fibers separated by the error.

(3) Open a bottle of correction fluid; dip the brush into the fluid, pressing it lightly against the neck of the bottle to release any excess fluid from the brush. Apply the fluid to the burnished area in one or two vertical strokes. Do not put a heavy layer of fluid on the error. Let it dry 30 seconds. Be sure to close the bottle as quickly as possible because the evaporation rate is high; and, when the fluid becomes thick, corrections are poor.

4. Use this procedure for typing and correcting an offset master:

a. Make sure that you know the correct placement of the material before starting to type the master. It is wise to make a model copy on plain paper before beginning to type the master.

b. Be sure your typewriter keys are clean.

c. Make sure that your typewriter has a carbon ribbon and a wide enough carriage to accommodate the master horizontally.

d. Move the paper bail rollers to the extreme right and left edges of the master.

e. Insert the master into the typewriter, being careful not to crease or crack the master. Any cracks or crease marks will reproduce. All typing is done on the white or ruled side of the master.

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f. Use a uniform touch in typing, sufficient to deposit an even, uniformly dark image. Too heavy a touch results in embossing on the opposite side of the master. Embossment is undesirable since the embossed letters may be pressed beyond the reach of the ink roller of the offset duplicator, resulting in hollow-looking reproduction. On an electric typewriter, the pressure control should be set to the lowest position where all characters will print.

g. Use an offset or soft eraser to make corrections. Erase the image very lightly. Remove the error as completely as possible. It is not necessary to remove the stain or ghost image left by the dye from the typewriter ribbon, as this stain will not reproduce. It is necessary, however, that the slick surface of the area being erased is left unharmed. Be sure to keep the eraser clean by frequently rubbing it on a piece of clean paper.

5. Refer to the examples of finished assignments which will be posted on a bulletin board or may be found in a file folder in the duplicating cupboard. These are only examples and should not be copied.

6. Illustrate some of your assignments. Pictures or tracing sheets that may be used are available in the duplicating cupboard or you may use pictures from magazines, newspaper, coloring books, etc.

7. Ask for help if there is any assignment that you do not understand. Do not hesitate to obtain the assistance from your teacher.

8. Sign your name on the heading of each stencil or in the lower right-hand corner of each master.

9. Consult your teacher when you have completed an assignment area. You will then be shown how to operate the appropriate machine. DO NOT ATTEMPT TO OPERATE ANY MACHINE WITHOUT YOUR TEACHER BEING PRESENT.

10. Hand in all assignments for evaluation. They will be judged on neatness, placement, quality of reproduction, and originality.

<u>Assignments</u>

1. Read and study pages 351-363 in <u>Secretarial Office Practice</u> which deal with office copying machines. During this assignment, you will be using a "ThermoFax" machine or the infrared process which is described on pages 353-355.

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a. Type a letter on letterhead stationary. You may use a letter from your shorthand textbook or any typewriting textbook. Be sure that you type this letter on a typewriter that has a dark ribbon. Make a photocopy of this letter on the "Thermo-Fax" machine. (5 points possible)

b. Complete Problem 161C on page 276 in College Typewriting. On a plain sheet of typewriting paper, type a copy of this project. Be sure that you type this letter on a typewriter that has a dark ribbon. Make a thermocopy spirit master of this project using the "Thermo-Fax" machine. Run off 5 copies on the fluid duplicator. (5 points possible)

2. Read and study pages 386-392 in Secretarial Office Practice which deal with fluid duplicating. Obtain a master sheet. Using the fluid process, make a multi-colored master. Use red, green, purple, blue, or black carbons. You must use at least three colors and your illustrations must depict a central theme such as Mother's Day or Christmas. You need not use the lettering guides. Use the illuminated drawing board for tracing the picture on to the master sheet with a light pencil outline, then copy the illustration using carbons and a pen outline. DO NOT TRACE DIRECTLY ON TO THE ILLUSTRATIONS YOU ARE COPYING WITH PENCIL OR PEN. Run off 5 copies on the fluid duplicator. (20 points possible)

3. Read and study pages 366-383 in Secretarial Office Practice which deal with stencil duplicating.

a. Obtain a regular stencil. Using the stencil process, type up a form letter. On the electric typewriter, type the letter on page 236 in Vocational Office Typing. Use your own name as executive secretary. Omit the inside address and the salutation. Run off 10 copies on the stencil duplicator. After you have run off this assignment, type the inside address and salutation in. Use the names and addresses listed on page 237. (20 points possible)

b. Obtain a regular stencil. Using the stencil process, make an illustration using lettering guides and tracing sheets. Announce some event or advertise some type of merchandise. Your assignment should be complete as to when, where, and what. You will be using regular 8 1/2" by 11" paper so do not go beyond the horizontal line indicating this size paper on your stencil. Run off 5 copies on the stencil duplicator. (20 points possible)

c. Obtain a bulletin stencil. Using the stencil process, make a French fold program or card. In preparing a program, list the menu (if it is a dinner program),

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program, committee members, etc. Strive for simplicity in your illustrations and use the smaller lettering guides. Make a copy of what you want to reproduce on a regular sheet of paper folded in fourths before cutting the stencil. BE SURE THAT THE TOP OF YOUR ILLUSTRATIONS OR LETTERING FACES THE CENTER OF THE STENCIL ON BOTH HALFS OF THE PROGRAM OR CARD. (15 points possible)

4. Read and study pages 395-406 in Secretarial Office Practice dealing offset and other reproduction processes. Type an offset master of Problem 157C in College Typewriting on page 271. Type this exercise up in rough-draft form preparatory to typing on the offset master. (15 points possible)

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UNIT INSTRUCTION SHEET

On-the-Job Training

The day and the hour is here. This unit will provide you with actual job situations. Your success in this unit will depend upon yourself, your relationship with others, and your efficiency on the job. Your work reflects you. Do a good job.

Unit Goal

1. You will be able to perform in actual "On-the-Job" situations by aiding the administration, teachers, and organizations in the school; or assisting in projects for the community.

Materials Needed

1. "On-the-Job" report form

Procedure for Completing Unit

1. Obtain your instructions from the person for whom you are working. Each assignment will be different.

2. Get off to a good start by working efficiently. Follow these five suggestions to increase the efficiency of your work:

   a. Follow directions. Do the job exactly as it is outlined to you. Be sure to listen to the directions carefully.

   b. Ask questions. If you are not sure how you should go about an assignment, ask your "employer."

   c. Produce your work on time. If your "employer" is waiting for something you are doing, complete the work even if it keeps you overtime.

   d. Maintain high standard. Whatever work you produce, keep your production standards high. No copy should leave your machine until you are absolutely positive that there is not a mistake in it, that corrections are not obvious and that the paper is smudge free.

   e. Check your facts and figures. Check all facts, figures, titles, names, addresses, and dates at their source whenever it is possible.

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3. Keep an accurate record of the time involved in completing your assignment. Fill out an "On-the-Job" report form for each project that you complete.

Assignment

1. Spend at least 10 hours performing in actual "On-the-Job" situations during the year.

UNIT INSTRUCTION SHEET

Bulletin Boards

Bulletin boards give the classroom or the office a lift, a sparkle, and a personality. They can be used for announcements, current news, presentation of a theme (seasonal or subject). To be effective they must be "eye catching" and put over the idea intended.

Unit Goal

1. You will be able to plan, prepare, and display two bulletin boards. A total of twenty-five points will be given for each board--10 points for originality, 5 points for following instructions, and 10 points how well you present your idea.

Procedure for Completing Unit

1. Decide on a subject. It should be timely and informative; it should have true educational value; it should have the virtue of simplicity; and it should have a focal point of interest.

2. Work out a caption. Here originality is the most important consideration. The possibility of humorous treatment is another point to keep in mind. As for an idea, you can frequently get a good one by playing with a song, book, or movie title; also, proverbs and idiomatic phrases offer good points of departure.

3. Gather your materials. Keep it clear, complete, concise, attractive, and colorful. Cartoon characters can be used effectively.

4. Plan your arrangment. Keep in mind that three colors are better than two. Try to get an effect of action. Use real objects--dolls, pipe cleaner, toys, flags, cotton snowmen, leaves, pine branches,popcorn blossoms, angel hair clouds, marshmallow eyes, candy spearmint leaves.

5. Decide on your lettering. Use string, rope, ribbon, or cut-out letters in varied sizes.

6. Complete a minature copy on 8½" by 11" construction paper. This copy should be done in color and a full description of materials to be used should be written on the back along with the names of the students preparing the bulletin board.

7. Submit your minature copy to your teacher one week before the bulletin board is due. You will be assigned a date to display your board and will be expected to have it ready on time.

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The Importance of Lettering:

The shape of any machine, building or piece of furniture may be shown by a drawing consisting of one or more views. This drawing is known as an orthographic drawing. The information as to size, methods of manufacture, kinds of material, types of finish and other notes is placed on the drawing by freehand lettering.

Origin of Lettering: The historical background of lettering is very interesting. The Egyptians, Babylonians, Hebrews, Greeks and Romans all contributed to the development of the alphabet which is now commonly used by English speaking peoples. It is called the Roman alphabet. A modification of this alphabet, called the Gothic, is the one generally used by draftsmen. It occurs in two forms, the slant and the vertical. The vertical style of capitals is the one preferred in most drafting rooms and is the one to be used exclusively in the drawings of this course.

Guide Lines: Horizontal guide lines are necessary to keep the letters uniform in height and in a straight line. These guide lines should be drawn very lightly with a soft pencil (F or HB).

Spacing and Composition: Letters in words should be so spaced that a pleasing, uniform tone is secured in the overall appearance of the lettering area. The areas between letters should be equalized rather than the spaces between the nearest points of adjacent letters. This is illustrated on the Lettering Chart, page 11, line two.

Comparative Proportions: The normal ratio of the width of a letter to its height is 4 to 5. In other words the width is normally four-fifths of the height. Some letters such as O, M and W are ex-

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Assignment

1. Complete two bulletin boards during the year. You will be working in pairs. One of the bulletin boards should apply to the secretarial field and the other to any area of business.

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UNIT INSTRUCTION SHEET

Secretarial Typing

Certainly, one thing is true: you will encounter a wide variety of tasks in a secretarial career. These tasks include taking dictation and transcribing letters and memorandums, typing duplicating masters, adapting form letters, typing from rough drafts, composing replies to incoming mail, working itineraries and making travel and hotel reservations, keeping petty cash records, and making out payroll statements.

Unit Goal

1. You will be able to perform the everyday tasks of the secretary on the job. This will be accomplished by completing a practice set which is designed to simulate as closely as possible the secretary's actual working experience.

Text and Materials Needed

1. The Secretary on the Job (Practice set)
2. Carbon paper
3. Supplementary instructions

Procedure for Completing Unit

1. Keep the following points in mind when completing the 28 jobs in The Secretary on the Job:

   a. Refer to pages 1 through 30 of the "Source Material" booklet for notes and correspondence you must refer to in order to complete some of the assignments.

   b. Suggestions to aid you in completing some assignments have been duplicated.

   c. Use the "Working Paper" on pages 33 through 59 for business forms needed to complete jobs. Stationery is provided for originals of correspondence only. When instructed to type and envelope, use one of the envelopes included in the practice set. Make an envelope on plain paper for all other correspondence.

   d. Refer to pages 1 through 5, which contain information on procedures, throughout this unit.

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e. Use the rules for Word Division on pages 4-5 of the "Source Material" when hyphenating a transcript.

f. Material to be dictated will appear on transcribing belts.

g. Use a spirit master when an assignment requires that a letter or memorandum be typed on a stencil or spirit duplication master. Copies should be run off on plain paper. Use the necessary heading at the top of a memorandum that is to be duplicated.

h. Maintain a chronological file of all correspondence and reports.

2. Ask for help if there is any job that you do not understand. Do not hesitate to obtain assistance from your teacher.

3. Critize your work. After completing each job, proofread carefully and pay special attention to numbers. Every page should be attractive, neat, and accurate. Every original page will be worth 10 points.

4. Hand in each job for evaluation.

Assignments

1. Complete the 28 jobs contained in the practice set, The Secretary on the Job, in their proper sequence.

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VT 013 040
Individualized Vocational Curriculum for Secretarial and Clerical Office Procedures at Weber High School.

Weber County School District, Utah.
MF AVAILABLE IN VT-ERIC SET.
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ABSTRACT - With the support of school administrators, two business education teachers developed this package of individualized curriculum materials. These materials are arranged in five parts which pertain to secretarial procedures, office machines, business machines, and on-the-job training. Following the continuous progress approach, this document includes assignments and quizzes for each of the above units as based on selected textbooks. Behavioral objectives for the student and instructions for the teacher are also included. The unit covering on-the-job training provides a student evaluation sheet. (JS)

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CD

INDIVIDUALIZED VOCATIONAL CURRICULUM
FOR
SECRETARIAL AND CLERICAL OFFICE PROCEDURES

Weber High School

VT013040

Secretarial or Clerical Procedures
Office Machines
Transcribing and Duplicating Machines
Business English
On-the-Job Training

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INDIVIDUALIZED VOCATIONAL CURRICULUM
FOR
SECRETARIAL AND CLERICAL OFFICE PROCEDURES
AT
WEBER HIGH SCHOOL

PART ONE

SECRETARIAL OR CLERICAL PROCEDURES

PART TWO

OFFICE MACHINES

PART THREE

TRANSCRIBING AND DUPLICATING MACHINES

PART FOUR

BUSINESS ENGLISH

PART FIVE

ON-THE-JOB TRAINING

SUPPORTED BY: Weber County School Board and Federal Part B
Funds - Project No. DFB 54 (r)

July, 1970

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W E B E R C O U N T Y S C H O O L D I S T R I C T

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INTRODUCTION

The philosophy of the continuous progress individualized instruction business curriculum of the Weber High School is to enable the student to progress at his own rate according to his ability. Not only do we feel that a student should be allowed to progress at his own rate, but also that he should have the opportunity of choosing the areas in which he has an interest. Therefore, many courses have been set up with the student in mind so that he may prepare himself for work upon completion of high school. Courses selected should be of the student's choosing.

Behavioral objectives are established for each course and unit within the course. Performance standards, based on the norms of average ability which have been derived from past experience in traditional teaching and recommendations from the Business and Marketing Education Guide for the Utah State Board of Education, have been set. Each student must reach this criterion before he is allowed to progress to the next unit in each course. If a student does not reach the standard, he is given supplemental material and help from the teacher to reinforce his learning and to bring him to the standard established; thus, enabling him to move to the next unit. In this manner a student is able to proceed at his own rate and ability.

Instructional material has been developed so that the course is equivalent to one-fourth or one-half credit. The student selects the material he desires as he proceeds successfully from one course to another. Upon the successful completion of any specific individualized course, the student is awarded credit and a letter grade.

In this program, an accelerated student has the opportunity to complete several courses in a year's time. On the other hand, if a student needs more time to complete the course, he may take the time

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necessary and still receive credit and a letter grade upon completion instead of experiencing failure for not being able to "keep up" with the class. Through his own selection, he also has the opporutnity to work on material in which he has special interest.

It is important that no grade or credit be issued until the student has completed the requirements for the course. The grade and credit can then be recorded on the student's permanent record.

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INSTRUCTIONS FOR THE TEACHER

The following courses dealing with the various tasks of a secretarial or clerical position have been set up to take the second hour of a two-hour block with Shorthand II or a one-hour class:

Secretarial or Clerical Procedures	one-half credit
Office Machines	one-fourth credit
Transcribing and Duplicating Machines	one-fourth credit
Business English	one-half credit
On-the-Job Training	one-half credit

The student has the opportunity to complete as many of the above courses during the year as she can according to her individual ability. Each course is complete in itself as to letter grade and credit received. All students are required to complete the course on Secretarial or Clerical Procedures. Other than this requirement, the student may choose the course or courses in which she has the most interest.

Suggestions for the teacher pertaining to each individual course are given in the following paragraphs:

SECRETARIAL OR CLERICAL PROCEDURES

I. Review of Typing

It is suggested that this unit be given to the class as a whole the first week of school inasmuch as it is merely to refresh the student's memory on some of the basic rules of typing.

Two No. 10 envelopes should be provided for each student for this unit.

The business form that the student is required to complete could be a form made out to give you personal information on the student. These forms should be duplicated so that all the student

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ceptions. The comparative proportions of the letters are shown on your lettering chart where the widths are indicated in units above or below each letter.

You may now complete Work Sheets numbers 5 and 6. Turn to page 16.

has to do is fill in the information necessary.

If the handout "The Typing of a Master Sheet" is duplicated on a spirit duplicating machine, it will show the student the difference between mimeograph and spirit duplicating.

II. Traits of a Successful Secretary

At the end of the school year, the assignments in this unit should be returned to the students to be included in their reference manuals.

The tape mentioned in Assignment 11 is a tape that the teacher can make up giving special hints on how to become a super secretary. This assignment can be omitted if you desire.

Traits of a Successful Clerical Worker

You will notice that under the Clerical Office Course, Units I, III, IV, and V have been omitted. This is because the student in Clerical Office Typewriting may select the same units that are printed under Secretarial Procedures. Units II and VI are written specifically for the clerical office typewriting student.

At the end of the school year, the assignments in this unit should be returned to the students to be included in their reference manuals. This will eliminate circulation of completed jobs to other students.

III. Meeting the Public

Appointment forms and telephone forms should be made available for the students.

The Mountain States Telephone Company is cooperative in supplying resource personnel and materials to enrich the telephone section.

On Assignment No. 7 of the unit "Meeting the Public by Telephone", have a tape available for the student to record her voice. If tape recording equipment is not available, this assignment may be omitted.

IV. Filing

It is suggested that the following assignments be used as tests: After Job 12, 12C or 12D; after Job 26, 24C or 24D; after Job 32B, 32C or 32F.

Before these tests are taken, the students should hand in all of their assignments up to that point and arrange their filing cards for that section back in numerical order.

V. Mail Service

The latest Postal Guide furnished by the post office should be available for student use.

VI. Practice Set (Secretary on the Job)

This practice set does not include enough envelopes to have one for each letter; therefore, it is necessary either to supply the students with extra envelopes or give each student a No. 10 envelope guide made from poster paper so that it can be traced on the back of the letters without envelopes.

Because the students complete this practice set at different times, it is suggested that all material be kept in the student's individual file and returned at the end of the year. This will prevent students using each other's assignments.

As the students will complete this unit on an individual basis, the material to be dictated throughout the set should be on tape so

that the material does not have to be dictated to each student individually by the teacher.

Practice Set (Typewriting Office Practice)

This practice set contains all the materials needed for the various jobs. Students should be reminded to use their material carefully.

The students have been instructed to hand in each job as it is completed. You may, of course, have them hand their work in as you desire for checking.

The students will be completing jobs at different times and so it is suggested that all papers be kept in an individual file until the end of the year to prevent circulation.

OFFICE MACHINES

I. Ten-Key Adding and Printing Calculator, Electronic Calculators

Answer sheets must be prepared and provided for the students. Name, job number, machine used, date, and class period should be indicated on the form. Lines should also be drawn, but numbers should be omitted so that the students can fill them in as needed.

You can make up your own tests or use the tests provided by the publishers for specific machines.

II. Data Processing

The four tests given are the review tests in the data processing text. These lessons should be removed from the text and given to the students as needed and should not be used as an open-book test.

The practice problems mentioned in Assignment 11 can be as simple or complex as you want to make them according to the material

you have covered and the time you want to spend. You want the student to be capable of operating the machine.

If the students desire further instruction and practice on the keypunch machine, the taped course put out by IBM Corporation may be used.

TRANSCRIBING AND DUPLICATING MACHINES

II. Duplicating Machines

Displays of the various types of duplicating problems should be placed on a bulletin board for students to see.

BUSINESS ENGLISH

I. Business English Essentials

In part IV students should be reminded that the letters and worksheets are to be handed in together as indicated in the textbook.

The two spelling lists should be given to the students when the book is issued. As indicated in the assignments, one test will be given after Part II is completed and the other after Part IV. The tests should be 50 words each taken from the corresponding lists.

II. Sources of Information

A number of the books required in this unit may be on your reference shelf, however, it is suggested that you encourage the students uo use the library. This will give them the experience in a library situation of finding the materials needed.

III. Spelling Improvement

The diagnostic tests and the achievement test should be removed

and placed in plastic protective sheets so they can be given to the students as needed.

ON-THE-JOB TRAINING (Or Simulation)

On-the-Job Training in the school offices is given where simulated office is not in effect. You will note that the On-the-Job work carries one-half credit inasmuch as the student works for two hours a day for nine weeks. If you use a simulated office unit for one hour a day, only one-fourth credit should be issued. However, credit should be determined according to the amount of time spent on a simulated office unit.

The evaluation sheet attached to the course is merely an example of what can be used. It is felt that any form used should include at least the categories listed.

PART ONE

SECRETARIAL OR CLERICAL PROCEDURES

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SECRETARIAL PROCEDURES

At secretary is supposed to be a "Jill-of-all-trades," which includes being a psychologist, politician, diplomat, research expert, memory shark, writer, business lawyer, machinist, personal banker for her boss, errand girl, and desk duster. furthermore, she is a mind reader, voice culturist, and clothes model. She is calm, polite, dignified, charming, good-natured, and unswervingly loyal to her boss.

Ralph Knight

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BEHAVIORAL OBJECTIVE

At the conclusion of this course, you will be able to perform the various tasks of a secretary. Shorthand and typewriting are only two of the many skills and abilities a qualified secretary must have. These skills are covered in the Shorthand II course. To succeed in the secretarial field, you must have the ability to adjust yourself to the numerous requirements of the position. During the course you will complete units pertaining to these requirements. Standards of performance are included in each of the units.

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The following units will be covered in this course:

I. Review of Typing
II. Traits of a Successful Secretary
III. Meeting the Public
IV. Filing
V. Mail Service
VI. Practice Set (The Secretary on the Job)

The ability to understand and follow instructions is high on the list of desirable traits in business. To help develop this trait, you will be working on each unit individually and, therfore, it is necessary that you read and follow each instruction sheet carefully.

After successfully completing the above units, a letter grade and one-half credit will be awarded.

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UNIT I

REVIEW OF TYPING

BEHAVIORAL OBJECTIVE:

At the conclusion of this unit the student will have demonstrated his skill in typing a business letter, memorandum, tabulation problem, spirit master, stencil, and filling out a business form. The student will also demonstrate his skill in cleaning a typewriter and changing a ribbon. No test will be given.

This is a short unit used as a refresher on problems that will occur in various units throughout the year. Basic principles will be reviewed.

Reference Books:

20th Century Typewriting, Eighth Edition; Lessenberry, Crawford, and Erickson; South-Western Publishing Company; Cincinnati, 1962.

Applied Secretarial Practice, Sixth Edition; Gregg, Fries, Rowe, and Travis; McGraw-Hill Book Company; New York, New York, 1968.

Assignments:

1. Review the parts of the business letter as illustrated on the attached sheet.

2. Turn to page 317, Problem 2, in 20th Century Typewriting. Follow the book directions. This letter is to go airmail so make the proper indication on the letter and envelopes. Don't forget the zip code. You will be given two #10 envelopes for this assignment. Use your name and the school address for the return address on the envelope. Insert the letter in the correct envelopes. (Refer to page 172 in the typing book for instructions on folding letters.)

3. Hand in your letters, using a paper clip to clip them together.

4. Type the interoffice memorandum, Problem 3, page 272, of your typing book. Make three carbon copies. (This includes one copy for the office file. Most offices will have their own printed interoffice correspondence form. However, some offices do not and you would have to make up your own form. In this assignment, you will type your own form. An illustration appears on page 269 and 270 of the type book.

Be sure your name is in the upper left corner of your paper. Staple all copies together and hand them in for checking.

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THE TYPING OF A STENCIL

A stencil is a sheet of tissue paper coated with plastic, wax, or gelatin. For convenience in handling, stencil sheets are fastened by the manufacturer to stiff backing sheets. As you type on a stencil, its thin coating is pressed aside where the type bars strike the coating, thus permitting ink to flow through each opening when the stencil is, later, placed on the duplicating machine.

The typing of a stencil consists of these steps:

1. Prepare the copy--verify that it is correct and can be typed with margins of at least 3/4 inch.

2. Prepare the machine--clean the type bars and disengage the ribbon by setting it for stencil work.

3. Prepare yourself--read the directions printed on the package in which the stencils come (instructions vary in some details in different brands).

4. Prepare the stencil--insert a "Cushion Sheet" (a number of these tissue sheets are packed in each quire) between the stencil and its backing sheet.

5. Insert the stencil in the typewriter and begin to type, using a very even and very firm touch.

If an error is made, the stencil coating must be smoothed out and strengthened; then the correction can be typed. These are the steps for correcting an error:

1. Smooth out the error--rub the coating back into position by rubbing the area gently with a glass burnisher (it comes in the box with the correction wax) or round end of a smooth paper clip.

2. Strengthen the area--put a light coating of wax over it. The wax is called "Correction Fluid" and comes in a small bottle with a brush cap.

3. Type the correction.

4. When the stencil is finished, remove the tissue cushion gently; it sometimes adheres to the correction fluid and can cause rips in the stencil.

--Reported by Laren Williams

16317

FIG. 1
A CORRECTLY SHARPENED PENCIL

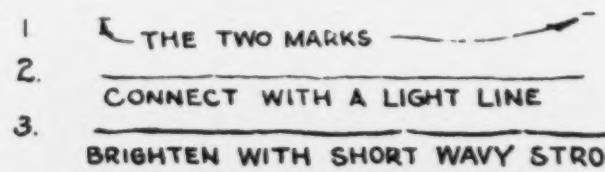

FIG. 2. SUCCESSIVE STEPS IN SKETCHING A STRAIGHT LINE.

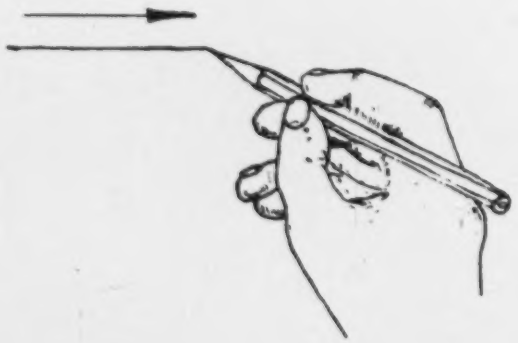

FIG. 3. SKETCHING A HORIZONTAL LINE.

FIG. 4. SKETCHING A VERTICAL LINE.

POSITION OF HAND FOR DRAWING STRAIGHT LINES.

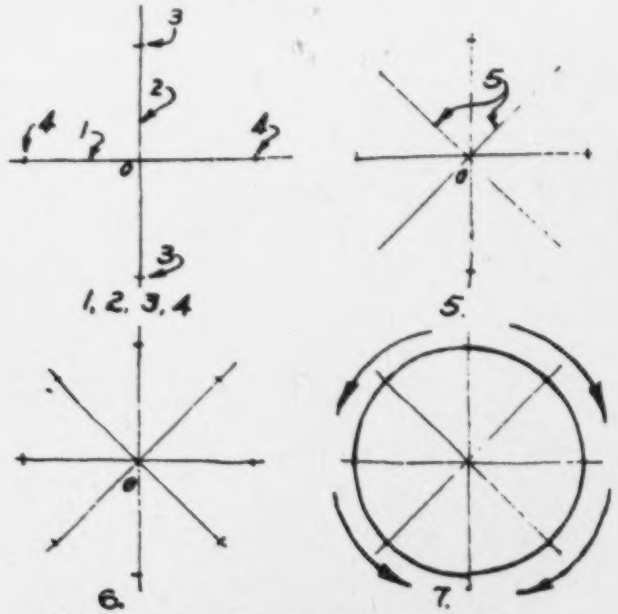

FIG. 6. SUCCESSIVE STEPS IN SKETCHING A CIRCLE.

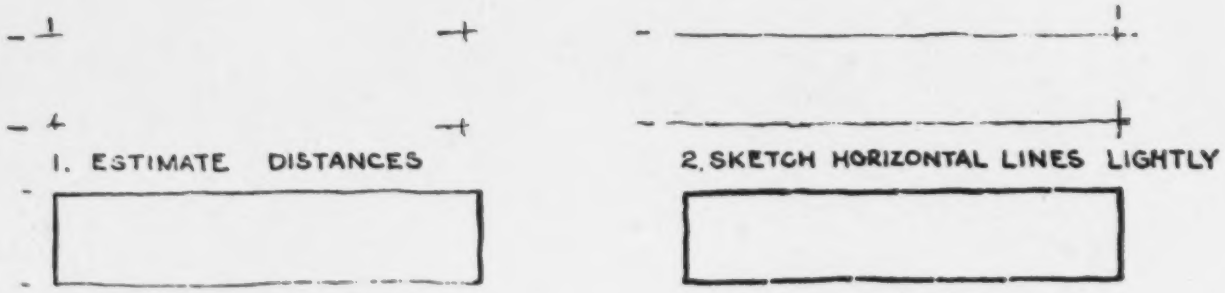

FIG. 5. SUCCESSIVE STEPS IN SKETCHING A RECTANGLE.

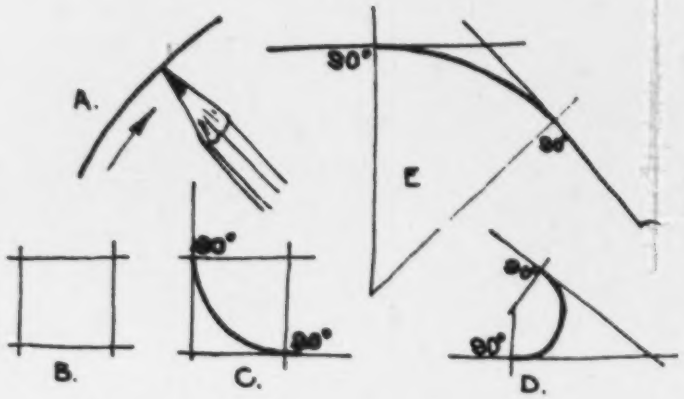

FIG. 7. BLOCKING-IN AND SKETCHING ARCS.

ELEMENTS OF FREEHAND SKETCHING

ILLUSTRATION SHEET I.

1629

THE TYPING OF A MASTER SHEET

A "master" is a sheet of special glossy paper, fastened at the bottom to another sheet that is coated with a layer of carbon containing a special reproducing dye. When you write on the master, carbon is transferred from the backing sheet to the back of the master sheet; then later, when the master is placed on the duplicating machine, copies are made when other sheets of paper, dampened by a chemical in the machine, are pressed against the carbon on the back of the master.

Typing the master sheet consists of these steps:

1. Prepare the copy--verify that it is correct.

2. Prepare the typewriter--clean the type.

3. Prepare yourself--read the directions on the box in which the master packs come.

4. Prepare the master pack--remove the protective sheet that separates the master page from the carbon page.

5. Insert the master pack, being sure to insert the unbound end first. Type with a very even touch.

Making a correction is a matter of removing the carbon of the error and replacing it by the carbon of the correction, a process that can be done in many ways. The usual procedure:

1. Roll the paper up and bend the master toward you to expose the carbon that contains the error.

2. Using a blade (knife or razor), carefully scrape off the carbon that contains the error.

3. Place a slip of unused carbon (cut from another sheet of the carbon paper) between the backing sheet and the master in such a way that the new carbon will be at the point of the correction.

4. Roll the paper back to the typing position and type the correction without erasing the original incorrect typewriting.

5. Pause to remove the slip of carbon paper; then continue typing the rest of the job.

--Reported by Lauren Williams

16318

PARTS OF A BUSINESS LETTER

```
                                  xxxxxxxxxxxxxxxxxxxx
                                    xxxxxxxxxxxxxxxx   - - - - - - - - - Letterhead
                                      xxxxxxxxxxx


Airmail        xxxxxxxxxxxx                xxxxxxxxxxxxxxxxxxxxx - - - Date Line


Inside         xxxxxxxxxxxxxxxxx
Address - - -  xxxxxxxxxxxxxxxxx
               xxxxxxxxxxxxxxxxx

               xxxxxxxxxxxxxxxxxxxxxxx  - - - - - - - - - - - - - - - Attention
                                                                      Line
Salutation - -xxxxxxxxxxxxxxxxx

                         xxxxxxxxxxxxxxxxxxxxxxxxxxxx - - - - - - Subject
                                                                  Line
               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
               xxxxxxxxxxxx

               xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Body - - - - - xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

                                       xxxxxxxxxxxxxxxx - - - - - -Complimentary
                                                                    Close
                   Firm Name - - - - - xxxxxxxxxxxxxxxx
                   (In Caps)
                                       - - - - - - - - - - - - - - Signature

                                       xxxxxxxxxxxxxxxx - - - - - -Writer's
                                       xxxxxxxxxxxxxxxx       Identification
Reference
Initials - - -xxxxxx
               xxxxxxxx - - - - Enclosure Designation
Carbon
Copy - - - - -xxxxxxx
Designation
```

16319

UNIT II

TRAITS OF A SUCCESSFUL SECRETARY

BEHAVIORAL OBJECTIVE:

The student will demonstrate her knowledge of the attitudes and personal appearance appropriate for the secretary on the job. This will be accomplished by completing the various assignments listed in the unit. No test will be given. In order for the student to successfully complete this unit, she must do all the assignments. The evaluation will be determined by the completeness of answer and neatness of presentation.

- - - -

Your boss does not want glamour and showiness in his secretary. He does, however, value his secretary for her good good grooming, her intelligent choice of clothing, and her pleasing personality. To achieve this smart appearance, every detail of your personal appearance must become a daily routine. Your image reflects your boss and your company. You are your company. START NOW to acquire and refine these traits that will win the respect and admiration of your employer, your co-workers, and the public.

Reference Books:

Applied Secretarial Practice, Fifth Edition; Gregg, Fries, Rowe, and Travis; McGraw-Hill Book Company; New York, New York 1962.

Applied Secretarial Practice, Sixth Edition; Gregg, Fries, Rowe, and Travis; McGraw-Hill Book Company; New York, New York 1965.

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Charm, Whitcomb and Lany, McGraw-Hill Book Company, New York, New York 1964.

The Successful Secretary, By the Parker Publishing Company Editorial Staff, Parker Publishing Company, Inc., West Nyack, New York 1964.

Secretary's Desk Book, Parker Publishing Company Editorial Staff, Parker Publishing Company, Inc., West Nyack, New York 1965.

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Secretary's Index to English, Jean C. Vermes, Parker Publishing Company, Inc., West Nyack, New York 1967.

Complete Secretary's Handbook, Revised Edition, Doris and Miller, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 1963.

Private Secretary's Encyclopedic Dictionary, Besse May Miller, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 1962.

Assignments:

On the following assignments, unless otherwise directed, type the questions first and then the answers. You may set them up in any style you want. These assignments can be used as reference material for you later.

1. Complete the attached chart, "How Do You Look."

2. Choose a book from the reference shelf and read the chapters that deal with personal qualities, appearance, attitudes, career, and general image of a successful secretary. Use the table of contents to locate the information dealing with this assignment.

3. In one column list four main points about your face and figure that you must consider in selecting attractive clothing. Opposite these points in the second column, briefly describe the general style of clothing you should choose to emphasize your good points and minimize your poor points.

4. Prepare a page illustrating the correct dress and general appearance for a secretary. Pictures may be obtained from catalogues, magazines, etc.

5. Complete the attached "How Well Do You Know Yourself?" chart.

6. Experienced stenographers and secretaries have often been faced with the questions listed below. How would you answer them? Use a separate sheet of paper for your answers. (Be sure to type the question first.)

   (a) Should I tell my co-worker that her constant humming at the desk disturbs my concentration? If so, how should I go about it?

   (b) I'd like to change my lunch hour so that I can go with my friends. Should I ask permission of my immediate supervisor, or should I simply work it out with my associates?

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(c) When my boss is away, I sometimes run out of work. I like to keep busy, and I could help one of the other secretaries who is often overloaded. Should I offer my services? How do I go about it tactfully?

(d) Sometimes when I am on the telephone, two or three people gather around and begin noisy conversations. How should I handle this problem?

(e) One of the stenographers under your supervision has been careless about her dress lately. Would you:

(1) Ignore the matter, hoping she will improve?

(2) Call her aside and speak to her tactfully about the importance of good grooming every day?

(3) Give hints and suggestions that you know she can overhear?

7. Janet Martin is executive secretary to Mr. Phillips, president of the Phillips Paper Company. Janet handles many confidential matters, such as salary reports, personnel changes, and advance market information. Her job requires the utmost in diplomacy. Answer the following questions on a separate piece of paper: (Applied Secretarial Practice, Fifth Edition, page 47)

(a) Recently, Mr. Daugherty, a young executive, told Janet he heard a rumor that several executives were getting salary increases and he wondered if he were included. If you were Janet, how would you handle this situation?

(b) A customer comes in while Janet is typing a confidential report concerning advance market information. Realizing that this information would be of interest to the customer, Janet must greet the caller in such a way that he does not see the report. How should she handle this situation?

(c) What precautions can you take when handling confidential matters on which you are working at your desk? At your typewriter?

8. Answer the following questions on a separate piece of paper: (Make short answers.)

(a) How does poor health affect the secretary's opportunities for advancement?

(b) What harm is there in office gossip?

(c) How does the secretary's punctuality and reliability affect the operation of her employer's office?

(d) What is tact? What part may tact play in the work of the secretary?

(e) What do we mean by the expression, "follow-through" when referring to desirable work habits?

(f) Why should a secretary include the reading of a newspaper in her daily activities?

10. Using the title "My Secretarial Future," describe the type of position you would like to have upon completion of your preparation for secretarial work. Answers to the following questions might be included in your description:

(a) What type of business do you think you would prefer--for example, a law firm, an insurance company, a store, a railroad office, a government office, or a doctor's office?

(b) Would you prefer to work in a large or a small office? Would you like a position in which you would be meeting many people from the outside, one in which you would work by yourself, or one with only a few people within the organization? (Applied Secretarial Practice, Fifth Edition, page 10)

11. Obtain the tape on "How to Become a Super Secretary" from your teacher. Listen carefully to this tape. It will give you a complete review of this unit.

12. Hand your completed assignments to your teacher and you will be given your next unit (Meeting the Public) in this course.

16322

HOW DO YOU LOOK?

Score yourself on these important grooming factors as follows:

Yes--3 points Most of the time--2 points
Seldom--1 point

	Yes	Most of the Time	Seldom
Clothing			
1. Do you choose clothes that are becoming to your figure?	___	___	___
2. Do you wear colors that look well on you?	___	___	___
3. Do you avoid extremes in style?	___	___	___
4. Do you wear clothes appropriate to the occassion?	___	___	___
5. Do you keep your clothes free from ripped seams, tears, frayed collars and cuffs, uneven hemlines?	___	___	___
6. Do you keep your shoes in good condition, with the heels and toes in repair?	___	___	___
Accessories			
7. Are your accessories always appropriate for your outfit?	___	___	___
8. Do the belts and scarves you wear harmonize with your outfits?	___	___	___
9. Do you refrain from wearing too much jewelry?	___	___	___
10. Do you keep your gloves clean?	___	___	___
Personal Cleanliness			
11. Do you bathe at least once a day?	___	___	___
12. Do you bathe soon after participating in strenuous activities?	___	___	___
13. Do you wash your hands before meals?	___	___	___
14. Do you use an effective deodorant daily?	___	___	___
15. Are your undergarments kept fresh and clean?	___	___	___
16. Do you keep your outer garments free from dandruff, lint, and so on?	___	___	___
17. Do you have a dental check-up at least once a year?	___	___	___
18. Do you brush your teeth at least twice a day?	___	___	___
19. Do you use a preventive as often as necessary to avoid offensive breath?	___	___	___
20. Do you wash your hair at least once a week?	___	___	___
21. Do you brush your hair daily?	___	___	___
22. Are your fingernails clean and filed to moderate length?	___	___	___

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	Yes	Most of The Time	Seldom
Grooming Details			
23. Do you refrain from biting your fingernails?	___	___	___
24. Do you remove or repair nail polish when chipped?	___	___	___
33. Is your makeup applied in moderation?	___	___	___
34. Do you avoid applying makeup in public	___	___	___
35. Do you keep your hair neatly brushed or combed?	___	___	___
36. Do you avoid combing your hair in public?	___	___	___
37. Do you use a suitable perfume or cologne and the right amount of it?	___	___	___
Health			
38. Do you eat three well-balanced meals every day?	___	___	___
39. Do you drink pleaty of milk and water daily?	___	___	___
40. Do you avoid eating anything that you know is harmful to your complexion?	___	___	___
41. Do you watch your weight carefully and try to keep it at the recommended weight for you?	___	___	___
42. Do you get sufficient physical activity?	___	___	___
43. Do you have physical check-ups regularly?	___	___	___
44. Do you get enough sleep each night?	___	___	___
Posture			
45. Do you sit properly, without slouching?	___	___	___
46. Do you stand properly, with back erect, shoulders back, stomach in?	___	___	___
47. Do you walk confidently, with poise and good posture?	___	___	___

HOW DO YOU RATE?

If your score is over 105 You look sharp!
If your score is 85-104 You're average
If your score is below 85 Better work hard to improve your grooming!!

16324

HOW WELL DO YOU KNOW YOURSELF?

Instructions::Rate yourself to the best of your ability in the appropriate column. If your answer is not a definite yes or no, use the (?) column. Score yourself as follows:

Yes--2 points ?--1 point No--0 points

Your Work Habits	Yes	(?)	No
1. Do you listen to directions carefully so that you don't have to ask too many questions?	___	___	___
2. Do you plan ahead so that you can keep more than one job moving?	___	___	___
3. Do you do a job in the best or the most suitable way, such as studying your problem and then arranging the procedure logically?	___	___	___
4. Do you do your best whether you enjoy what you are doing or not?	___	___	___
5. Do you usually do things right the first time?	___	___	___
6. Do you stick to a job until it is done?	___	___	___
7. Do you get your assignments done well, inspite of interruptions?	___	___	___
8. Do you study your lessons consistently?	___	___	___
9. Do you keep your materials and equipment neat and in order?	___	___	___
10. Do you have necessary supplies for class each day?	___	___	___
11. Are you proud of the work you do?	___	___	___
12. Do you work accurately and rapidly?	___	___	___
13. Do you proofread your work well?	___	___	___
14. When confronted with a question, do you try to find an answer yourself?	___	___	___
Your Honesty and Dependability			
15. Are you honest when you have a test?	___	___	___
16. When you are asked for your hones opinion, are you sincere?	___	___	___
17. Do you meet obligations promptly?	___	___	___
18. Are you the type of person who can be relied upon?	___	___	___
19. Do you submit your assignments at the time they are due?	___	___	___
20. Can you finish a job without being reminded several times?	___	___	___
21. Do you actually work on your studies when you are given time to study them?	___	___	___

1. Gregg, Frees, Rowe, and Travis, Workbook for Applied Secretarial Practice, Fifth Edition; McGraw-Hill Book Company, Inc., New York, 1962.

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	Yes	(?)	No
22. Do you get to classes on time?	___	___	___
23. Are you punctual?	___	___	___
24. Do you admit your mistakes rather than make excuses for them?	___	___	___
25. Can you handle a little extra work?	___	___	___
Your Personality			
26. Do you develop an interest in related areas of activity?	___	___	___
27. Are you sincere in your speech and actions?	___	___	___
28. Do you have confidence in yourself to handle a job or situation well?	___	___	___
29. Do you greet people with a smile?	___	___	___
30. Do you have a good sense of humor?	___	___	___
31. Is the tone of your voice pleasant?	___	___	___
32. Do you speak clearly and distinctly?	___	___	___
33. Do you practice good manners?	___	___	___
34. Do you easily adapt yourself to new situations?	___	___	___
Your Poise			
35. Do youthink of what you're going to say before you say it?	___	___	___
36. Do you dress appropriately for school?	___	___	___
37. Are you well groomed?	___	___	___
38. Do you feel at ease when talking with others?	___	___	___
39. Do you avoid emotional outbursts and displays of temper?	___	___	___
40. Can you discuss something without arguing?			
Your Tolerance			
41. Are you careful not to say things that might offend other?	___	___	___
42. Do you consider the feelings of others in your everyday activities; such as riding the bus, walking down the halls, or sitting in class?	___	___	___
43. Are you open minded and willing to listen to all sides of a question?	___	___	___
44. Do you respect the ideals and feelings of others?	___	___	___
45. Are you courteous and tactful when you come into contact with someone you don't particularly care for?	___	___	___
Your Health			
46. Are you in good physical and emotional health?	___	___	___
47. Do you spend adequate time on your personal cleanliness ?	___	___	___

16326

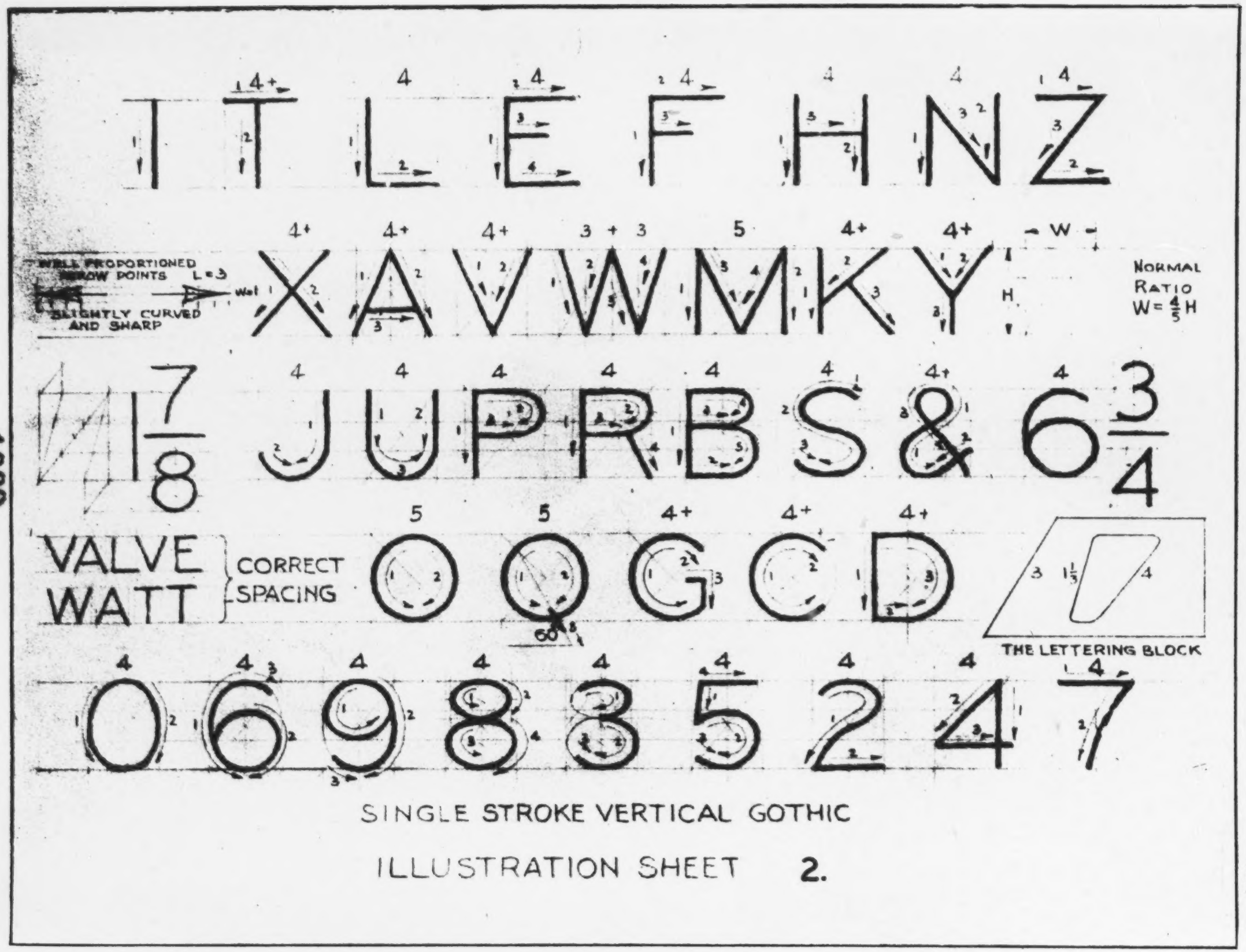

SINGLE STROKE VERTICAL GOTHIC

ILLUSTRATION SHEET 2.

1630

11/d

Your Desire to Improve	Yes	(?)	No
48. Can you accept constructive criticism without resentment?	___	___	___
49. Are you able to give constructive criticism without offending anyone?	___	___	___
50. Do you show genuine appreciation when someone? helps you?	___	___	___
51. Are you grateful for the opportunity of learning?	___	___	___
52. Do you have a definite goal that you are striving toward?	___	___	___
53. Do you really try to make the most of your talents, training, and experience?	___	___	___
Your Relationship with Others			
54. Are you enthusiastic about the clubs and activities to which you belong?	___	___	___
55. Are you pleasant and co-operative?	___	___	___
56. Do you try to help someone else if and when you can?	___	___	___
57. Do you treat your classmates with courtesy and respect?	___	___	___
58. Are you courteous and respectful to your teachers?	___	___	___
59. Do you try to get along with all types of people?	___	___	___
60. Are you a person who cultivates friendship?	___	___	___
61. Are you loyal to your friends?	___	___	___
62. Are you loyal to your school?	___	___	___
63. Do you keep confidences?	___	___	___
64. Are you courteous and respectful to your parents?	___	___	___

HOW DO YOU RATE?

If your score is 120-128	What's your secret?
108-119	You're doing well!
96-107	Are you willing to be just average?
Below 96	You'd better start improving Now!!

16327

CLERICAL OFFICE

A secretary is supposed to be a "Jill-of-all-trades," which includes being a psychologist, politician, diplomat, research expert. memory shark, writer, business lawyer, machinist, personal banker for her boss, errand girl, and desk duster. Furthermore, she is a mind reader, voice culturist, and clothes model. She is calm, polite, dignified, charming, good-natured, and unswervingly loyal to her boss.

Ralph Knight

- - - - -

BEHAVIORAL OBJECTIVE:

At the conclusion of this course, you will be able to perform the various tasks of a clerical office worker. Typewriting is only one of the many skills and abilities a qualified clerical office worker must have. This skill has been covered in a regular typing course. To succeed in the clerical field, you must have the ability to adjust yourself to the numerous requirements of the position. During the course you will complete units pertaining to these requirements. Standards of performance are included in each of the units.

- - - - -

The following units will be covered in this course:

I. Review of Typing
II. Traits of a Successful Clerical Worker
III. Meeting the Public
IV. Filing
V. Mail Service
VI. Practice Set (Typewriting Office Typewriting)

The ability to understand and follow instructions is high on the list of desirable traits in business. To help develop this trait, you will be working on each unit individually and, therefore, it is necessary that you read and follow each instruction sheet carefully.

After successfully completing the above units, a letter grade and one-half credit will be awarded.

16328

UNIT II

TRAITS OF A SUCCESSFUL CLERICAL WORKER

BEHAVIORAL OBJECTIVE:

The student will demonstrate her knowledge of the attitudes and personal appearance appropriate for the clerical office worker. This will be accomplished by completing the various assignments listed in the unit. No test will be given. In order for the student to successfully complete this unit, she must do all the assignments. The evaluation will be determined by the completeness of answer and neatness of presentation.

- - - - -

Your boss does not want glamour and showiness in his office. He does, however, value his office workers for their good grooming, intelligent appearance, every detail of personal appearance must become a daily routine. Your image reflects your boss and your company. You are your company. START NOW to acquire and refine these traits that will win the respect and admirations of your employer, your co-workers, and the public.

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The Successful Secretary, by the Parker Publishing Company Editorial Staff, Parker Publishing Company, Inc., West Nyack, New York 1964.

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Assignments:

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1. Complete the attached chart, "How Do You Look?"

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16330

3. In one column list four main points about your face and figure that you must consider in selecting attractive clothing. Opposite these points in the second column, briefly describe the general style of colthing you should choose to emphasize your good points and minimize your poor points.

4. Prepare a page illustrating the correct dress and general appearance for a secretary. Pictures may be obtained from catalogues, magazines, etc.

5. Complete the attached "How Well Do You Know Yourself?" chart.

6. Experienced stenographers and clerical officer workers have often been faced with the questions listed below. How would you answer them? Use a separate sheet of paper for your answers. (Be sure to type the question first.)

   (a) Should I tell my co-worker that her constant humming at the desk disturbs my concentration? If so, how should I go about it.

   (b) I'd like to change my lunch hour so that I can go with my friends. Should I ask permission of my immediate supervisor, or should I simply work it out with my associates?

   (c) When my boss is away, I sometimes run out of work. I like to keep busy, and I could help one of the other office workers who is often overloaded. Should I offer my services? How do I go about it tactfully?

   (d) Sometimes when I am on the telephone, two or three people gather around and begin noisy conversations. How should I handle this problem?

   (e) One of the office workers under your supervision has been careless lately about her dress. Would you:

      (1) Ignore the matter, hoping she will improve?

      (2) Call her aside and speak to her tactfully about the importance of good grooming every day?

      (3) Give hints and suggestions that you know she can overhear?

7. Janet Martin is executive secretary to Mr. Phillips, President of the Phillips Paper Company. Janet handles many confidential matters, such as salary reports, personnel changes, and advance market information. Her job requires the utmost in diplomacy. Answer the following questions on a separate piece of paper. (Applied Secretarial Practice, Fifth Edition, page 47)

16331

(a) Recently, Mr. Daugherty, a young executive, told Janet he heard a rumor that several executives were getting salary increases and he wondered if he were included. If you were Janet, how would you handle this situation?

(b) A customer comes in while Janet is typing a confidential report concerning advance market information. Realizing that information would be of interest to the customer, Janet must greet the caller in such a way that he does not see the report. How should she handle this situation?

(c) What precautions can you take when handling confidential matters on which you are working at your desk? At your typewriter?

8. Answer the following questions on a separate piece of paper: (Make short answers.)

(a) How does poor health affect the office worker's opportunities for advancement?

(b) What harm is there in office gossip?

(c) How does the office workers' punctuality and reliability affect the operation of her employer's office?

(d) What is tact? What part may tact play in the work of the clerical office worker.

(e) What do we mean by the expression, "follow-through," when referring to desirable work habits?

(f) Why should an office worker include the reading of a newspaper in her daily activities?

10. Using the title "My Clerical Office Future," describe the type of position you would like to have upon completion of your preparation for office work. Answers to the following questions might be included in your description:

(a) What type of business do you think you would prefer-- for example, a law firm, an insurance company , a store, a railroad office, a government office, or a doctor's office?

(b) Would you prefer to work in a large or a small office? Would you like a position in which you would be meeting many people from the outside, one in which you would work by yourself, or one with only a few people within the organization? (Applied Secretarial Practice, Fifth Edition, page 10)

11. Hand your completed assignments to your teacher and you will be given the next unit (Meeting the Public) in this course.

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Unit II

HOW DO YOU LOOK?

Score yourself on these important grooming factors as follows:

Yes--3 points Most of the time--2 points
Seldom--1 point

	Yes	Most of the Time	Seldom
Clothing			
1. Do you choose clothes that are becoming to your figure?	___	___	___
2. Do you wear colors that look well on you?	___	___	___
3. Do you avoid extremes in style?	___	___	___
4. Do you wear clothes appropriate to the occassion?	___	___	___
5. Do you keep your clothes free from ripped seams, tears, frayed collars and cuffs, uneven hemlines?	___	___	___
6. Do you keep your shoes in good condition, with the heels and toes in repair?	___	___	___
Accessories			
7. Are your accessories always appropriate for your outfit?	___	___	___
8. Do the belts and scarves you wear harmonize with your outfits?	___	___	___
9. Do you refrain from wearing too much jewelry?	___	___	___
10. Do you keep your gloves clean?	___	___	___
Personal Cleanliness			
11. Do you bathe at least once a day?	___	___	___
12. Do you bathe soon after participating in strenuous activities?	___	___	___
13. Do you wash your hands before meals?	___	___	___
14. Do you use an effective deodorant daily?	___	___	___
15. Are your undergarments kept fresh and clean?	___	___	___
16. Do you keep your outer garments free from dandruff, lint, and so on?	___	___	___
17. Do you have a dental check-up at least once a year?	___	___	___
18. Do you brush your teeth at least twice a day?	___	___	___
19. Do you use a preventive as often as necessary to avoid offensive breath?	___	___	___
20. Do you wash your hair at least once a week?	___	___	___
21. Do you brush your hair daily?	___	___	___
22. Are your fingernails clean and filed to moderate length?	___	___	___

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	Yes	Most of The Time	Seldom
Grooming Details			
23. Do you refrain from biting your fingernails?	___	___	___
24. Do you remove or repair nail polish when chipped?	___	___	___
33. Is your makeup applied in moderation?	___	___	___
34. Do you avoid applying makeup in public	___	___	___
35. Do you keep your hair neatly brushed or combed?	___	___	___
36. Do you avoid combing your hair in public?	___	___	___
37. Do you use a suitable perfume or cologne and the right amount of it?	___	___	___
Health			
38. Do you eat three well-balanced meals every day?	___	___	___
39. Do you drink pleaty of milk and water daily?	___	___	___
40. Do you avoid eating anything that you know is harmful to your complexion?	___	___	___
41. Do you watch your weight carefully and try to keep it at the recommended weight for you?	___	___	___
42. Do you get sufficient physical activity?	___	___	___
43. Do you have physical check-ups regularly?	___	___	___
44. Do you get enough sleep each night?	___	___	___
Posture			
45. Do you sit properly, without slouching?	___	___	___
46. Do you stand properly, with back erect, shoulders back, stomach in?	___	___	___
47. Do you walk confidently, with poise and good posture?	___	___	___

HOW DO YOU RATE?

If your score is over 105 You look sharp!
If your score is 85-104 You're average
If your score is below 85 Better work hard to improve your grooming!!

Unit II

HOW WELL DO YOU KNOW YOURSELF?

Instructions::Rate yourself to the best of your ability in the appropriate column. If your answer is not a definite yes or no, use the (?) column. Score yourself as follows:

Yes--2 points ?--1 point No--0 points

Your Work Habits	Yes	(?)	No
1. Do you listen to directions carefully so that you don't have to ask too many questions?	___	___	___
2. Do you plan ahead so that you can keep more than one job moving?	___	___	___
3. Do you do a job in the best or the most suitable way, such as studying your problem and then arranging the procedure logically?	___	___	___
4. Do you do your best whether you enjoy what you are doing or not?	___	___	___
5. Do you usually do things right the first time?	___	___	___
6. Do you stick to a job until it is done?	___	___	___
7. Do you get your assignments done well, inspite of interruptions?	___	___	___
8. Do you study your lessons consistently?	___	___	___
9. Do you keep your materials and equipment neat and in order?	___	___	___
10. Do you have necessary supplies for class each day?	___	___	___
11. Are you proud of the work you do?	___	___	___
12. Do you work accurately and rapidly?	___	___	___
13. Do you proofread your work well?	___	___	___
14. When confronted with a question, do you try to find an answer yourself?	___	___	___
Your Honesty and Dependability			
15. Are you honest when you have a test?	___	___	___
16. When you are asked for your hones opinion, are you sincere?	___	___	___
17. Do you meet obligations promptly?	___	___	___
18. Are you the type of person who can be relied upon?	___	___	___
19. Do you submit your assignments at the time they are due?	___	___	___
20. Can you finish a job without being reminded several times?	___	___	___
21. Do you actually work on your studies when you are given time to study them?	___	___	___

1. Gregg, Frees, Rowe, and Travis, Workbook for Applied Secretarial Practice, Fifth Edition; McGraw-Hill Book Company, Inc., New York, 1962.

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	Yes	(?)	No
22. Do you get to classes on time?	___	___	___
23. Are you punctual?	___	___	___
24. Do you admit your mistakes rather than make excuses for them?	___	___	___
25. Can you handle a little extra work?	___	___	___
Your Personality			
26. Do you develop an interest in related areas of activity?	___	___	___
27. Are you sincere in your speech and actions?	___	___	___
28. Do you have confidence in yourself to handle a job or situation well?	___	___	___
29. Do you greet people with a smile?	___	___	___
30. Do you have a good sense of humor?	___	___	___
31. Is the tone of your voice pleasant?	___	___	___
32. Do you speak clearly and distinctly?	___	___	___
33. Do you practice good manners?	___	___	___
34. Do you easily adapt yourself to new situations?	___	___	___
Your Poise			
35. Do youthink of what you're going to say before you say it?	___	___	___
36. Do you dress appropriately for school?	___	___	___
37. Are you well groomed?	___	___	___
38. Do you feel at ease when talking with others?	___	___	___
39. Do you avoid emotional outbursts and displays of temper?	___	___	___
40. Can you discuss something without arguing?			
Your Tolerance			
41. Are you careful not to say things that might offend other?	___	___	___
42. Do you consider the feelings of others in your everyday activities; such as riding the bus, walking down the halls, or sitting in class?	___	___	___
43. Are you open minded and willing to listen to all sides of a question?	___	___	___
44. Do you respect the ideals and feelings of others?	___	___	___
45. Are you courteous and tactful when you come into contact with someone you don't particularly care for?	___	___	___
Your Health			
46. Are you in good physical and emotional health?	___	___	___
47. Do you spend adequate time on your personal cleanliness ?	___	___	___

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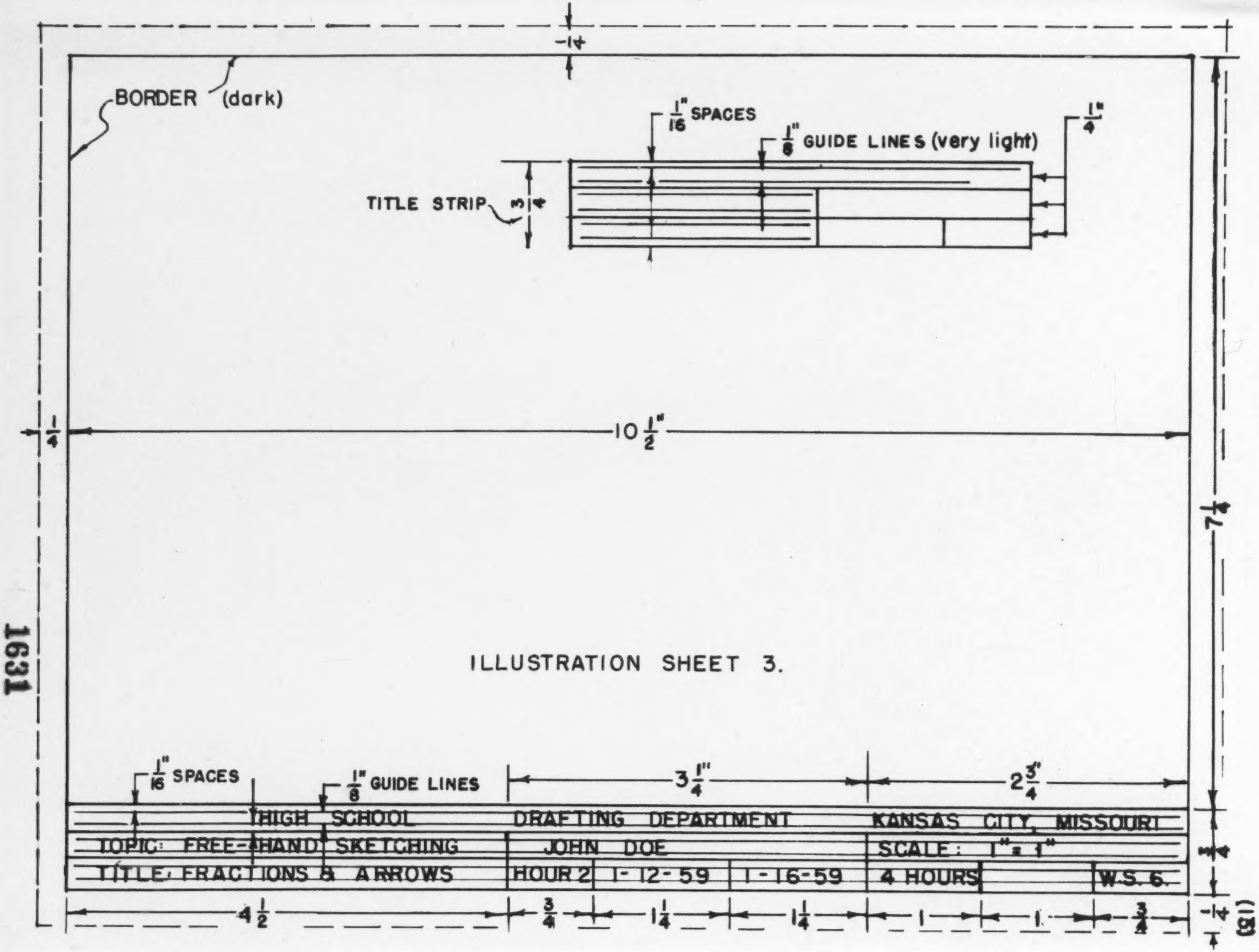
BORDER (dark)
1/16" SPACES
1/8" GUIDE LINES (very light)
1/4"
TITLE STRIP
3/4"
1/4"
10 1/2"
7 1/4"
ILLUSTRATION SHEET 3.
1/16" SPACES
1/8" GUIDE LINES
3 1/4"
2 3/4"
HIGH SCHOOL
DRAFTING DEPARTMENT
KANSAS CITY, MISSOURI
TOPIC: FREE-HAND SKETCHING
JOHN DOE
SCALE: 1" = 1"
TITLE: FRACTIONS & ARROWS
HOUR 2
1-12-59
1-16-59
4 HOURS
W.S. 6.
4 1/2
3/4
1 1/4
1 1/4
1
1
3/4
3/4
1/4

Your Desire to Improve	Yes	(?)	No
48. Can you accept constructive criticism without resentment?	___	___	___
49. Are you able to give constructive criticism without offending anyone?	___	___	___
50. Do you show genuine appreciation when someone? helps you?	___	___	___
51. Are you grateful for the opportunity of learning?	___	___	___
52. Do you have a definite goal that you are striving toward?	___	___	___
53. Do you really try to make the most of your talents, training, and experience?	___	___	___

Your Relationship with Others			
54. Are you enthusiastic about the clubs and activities to which you belong?	___	___	___
55. Are you pleasant and co-operative?	___	___	___
56. Do you try to help someone else if and when you can?	___	___	___
57. Do you treat your classmates with courtesy and respect?	___	___	___
58. Are you courteous and respectful to your teachers?	___	___	___
59. Do you try to get along with all types of people?	___	___	___
60. Are you a person who cultivates friendship?	___	___	___
61. Are you loyal to your friends?	___	___	___
62. Are you loyal to your school?	___	___	___
63. Do you keep confidences?	___	___	___
64. Are you courteous and respectful to your parents?	___	___	___

HOW DO YOU RATE?

If your score is 120-128	What's your secret?
108-119	You're doing well!
96-107	Are you willing to be just average?
Below 96	You'd better start improving Now!!

UNIT III

MEETING THE PUBLIC--IN PERSON--BY TELEPHONE--BY LETTER

BEHAVIORAL OBJECTIVE:

At the conclusion of this unit the student will be able to solve the various problems that arise in an office by being able to greet the office caller in an acceptable manner, take care of company business on the telephone, and write letters for her employer. This will be accomplished by completing assignments throughout the unit. No test will be given. In order for the student to successfully complete this unit, she must do all the assignments. The evaluation will be determined by the completeness of answer and neatness of presentation.

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> In a very real sense, the secretary is a communicator. Whether by letter, by phone, or in person, she represents her immediate superior and the company. The secretary must be sure that what she communicates is accurate as to facts, clear as to form, pleasant as to tone, and, most important, understandable to the recipient.
>
> Dallas Shenk, CPS

Reference Books:

Applied Secretarial Practice, Fifth Edition; Gregg, Fries, Rowe, and Travis; McGraw-Hill Book Company; New York, New York 1962.

Applied Secretarial Practice, Sixth Edition; Gregg, Fries, Rowe, and Travis; McGraw-Hill Book Company; New York, New York 1968.

Secretarial Office Practice, Seventh Edition; South-Western Publishing Company; Cincinnati 1966.

The Secretary at Work, Third Edition; Strony, Smith, and Garvey; McGraw-Hill Book Company; New York, New York 1966.

Reference Manual for Office Personnel, Fifth Edition; House and Koebele; South-Western Publishing Company; Cincinnati 1970.

Reference Manual for Stenographers and Typists, Fourth Edition; Gavin and Sabin; McGraw-Hill Publishing Company; New York, New York, 1970.

Charm, Whitcomb and Lany, McGraw-Hill Book Company, New York, New York 1964.

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The Successful Secretary, by the Parker Publishing Company Editorial staff, Parker Publishing Company, Inc., West Nyack, New York 1964

Secretary's Desk Book, Parker Publishing Company Editorial Staff, Parker Publishing Company, Inc., West Nyack, New York 1965.

Secretary's Index to English, Jean C. Vermes, Parker Publishing Company, Inc., West Nyack, New York 1967.

Complete Secretary's Handbook, Revised Edition, Doris and Miller, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 1963.

Private Secretary's Encyclopedic Dictionary, Besse May Miller, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 1962.

Follow the instructions step by step to complete this unit. You may use any of the reference books listed.

A. MEETING THE PUBLIC IN PERSON

There is no magic formula for greeting visitors, other than courtesy, attentiveness, and tact. Your employer places a great deal of importance on maintaining effective public relations because it develops goodwill for the company. Goodwill is good business. One of the most important duties you will perform as a secretary is that of acting as a receptionist. You will find in your work as a receptionist that each person is different from every other person and that you will be meeting many types of people.

There will be quiet ones and noisy ones, shy ones and agressive ones, uncertain ones and certain ones who approach your desk for information, advice, entrance to your employer's office, or for a number of other purposes. You will need to receive them all with the graciousness that will put each of them at ease and will allow you to act responsibly in your position as receptionist. (Secretarial Office Practice, Seventh Edition, page 245)

Assignments:

On the following assignments, unless otherwise directed, type the question first and then the answer. You may set them up in any style you want. These assignments can be used as reference material for you later.

1. Read Unit 9, page 203, Applied Secretarial Practice, Sixth Edition.

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2. Turn to page 215, Applied Secretarial Practice, Sixth Edition, and complete Probelm #3, using an appointment form. This should be done in handwriting.

3. Turn to page 214, Applied Secretarial Practice, Sixth Edition, and complete Problem #1.

4. Turn to page 255, Secretarial Office Practice, Seventh Edition, and answer the five questions under "What Do You Think?"

B. MEETING THE PUBLIC BY TELEPHONE

Every time you pick up the phone, your public relations are showing. Make the most of this opportunity to create goodwill for your company, your employer, and yourself. You will be called upon to make and answer all types of telephone calls. The effectiveness of each of your calls, to a large extent, depends upon how well your callers understand you. Therefore, it is essential that you understand the proper techniques for using the telephone in every business situation. (Secretarial Office Practice, Seventh Edition, page 211)

Assignments:

1. Read Unit 7, Part 1, pages 211-229 in Secretarial Office Practice.

2. Turn to page 230, Secretarial Office Practice, and answer Problems 1, 2, 3, and 5 under "What Do You Think?"

3. In the same book, page 230, read the situation listed under "Your Personal Qualities" and answer the questions following it.

4. In the same book, page 231, complete the Problems 1 and 2 under "Secretarial Work."

5. Using telephone message forms, complete the problems at page 232 in the same book.

6. Type the following telephone tips to be used for future reference.

   a. Always hand up promptly when your business is finished.

   b. Be sure your boss is available when you are placing a call for him.

   c. In placing a call, if you find the person called is not available, ask when you may call back.

   d. Check the difference in time when you wish to place a long distance call. Remember to take daylight-saving time into account, too.

   e. Give your area code as part of your telephone number to people in distant cities.

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f. Keep a record of collect calls that you accept if such is needed to substantiate phone charges for your employer.

g. Investigate the toll credit card for your boss's use if he travels much.

h. When answering a person-to-person long distance call for someone else, always note the operator's number, city and state, telephone number, and name of the party and/or his extension number if given.

i. If you reach a wrong number after dialing an out-of-town call, ask the name of the city and state you reached by mistake. Report this information promptly to the operator so that you won't be billed for the call.

j. If you are responsible for ordering stationery or other printed material for your firm, it is useful to have the area code as well as your telephone number shown on the stationery.

7. Obtain a tape from your teacher and record your voice by reading a prepared script. After completing the tape, play it back so that you can analyze the quality of your voice. A check list including the following characteristics will be used for this analysis: tone, clarity, enunciation, volume, and inflection.

C. MEETING THE PUBLIC BY LETTER

As a secretary, one of your responsibilities will be to write many of the routine letters for your employer. Each letter that you compose should be a commendable example of the kind of work that you do. You must remember that they are important for they frequently deal with details that are critical. Above all, you will want to communicate the message in a complete and gracious fashion, accomplishing the purpose of the letter.

Assignments:

1. Read Unit 10, pages 212-230, Applied Secretarial Practice, Fifth Edition.

2. Complete #1 under "Job Experience Projects" in Applied Secretarial Practice Fifth Edition. Type this letter in the style of your choice. This is on page 231-232.

3. Complete #2, under "Job Experience Projects: in the above book, page 232.

4. Complete #5, page 232, in the above book.

5. Turn to page 105 in the Secretary at Work. Assume you are working for Mr. Frank X. Cartwright and answer the letters according to the notations he has made. These letters are to be typed for his signature. Use modified block style with blocked paragraphs and mixed punctuation.

6. At the completion of this unit, hand your papers to the teacher for checking. She will give you the next unit (Filing) in this course.

FILING

BEHAVIORAL OBJECTIVE:

At the conclusion of this unit you will be able to apply the basic rules of filing by indexing, coding, and filing various jobs as given in the filing workbook. Three tests will be given which will involve indexing, coding, and filing names similar to those in the workbook exercises. At least 90% accuracy will be required to pass these tests.

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Although many large firms have a central filing department, you will have to maintain certain files in your department for your employer's convenience and your own. A thorough knowledge of basic filing principles will help you in getting correspondence and other information from the files. This is an important part of your daily procedure. You must be able to locate material immediately when it is needed.

Text: Filing Practice Workbook, Second Edition, Pitman Publishing Corporation, New York, New York 1958.

Assignments:

1. Obtain a filing practice workbook from your teacher. This book will be for your own use. Tape the pocket on the last page as instructed on that page so that you will have a place to keep your filing slips.

Do not tear out filing slips until you reach the specific job. When you separate the slips, keep them together by placing a rubber band around the slips for each job.

Use a shorthand notebook (one that is not used in your shorthand class) to record each filing job. Write your name at the top of each page and indicate the job number. You may use both sides of the paper.

A key is available for you to use in checking each job as you complete it. Be sure you return the key to the proper shelf when you have completed checking a job so that other students may use it. Do not write in the key and do not lose it. If you do not understand the order of some of the filing slips as recorded in the key, be sure to check with your teacher. Do not proceed to the next job until you are sure you understand the rule covered in the job you have just completed.

2. Read carefully the material on the back of the front cover.

3. Read and study the rule and example for filing Job #1. Follow the directions given and record the order of your slips by copying the coded numbers of the slips in your shorthand notebook. After recording the order of the slips, check your answers with the key.

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Be sure that you code each item. Coding is a prerequisite to accuracy in filing. Use a red pencil to do your coding. If the primary index unit is an abbreviated one, it should be spelled out in red pencil.

4. Continue with Jobs #2 through 12, following the same procedure as given in Assignment 3. Be sure you complete each job and check it before going to the next job. Include all optional jobs.

5. After completing Job #12, tear the pages from your shorthand notebook that have the jobs recorded on them and give them to your teacher. She will give you a test covering Jobs #1 through 12.

6. If you were able to attain at least 90% on the test, you may continue with the next assignment.

7. Complete Jobs #13 through 26, following the same procedure as given in Assignment 3. Include all optional jobs.

8. After completing Jobs #13 through 26, tear these pages from your shorthand notebook and give them to your teacher. She will give you a test covering all the material you have completed in this unit.

9. If you were able to pass this test with at least 90% accuracy, you may proceed with the next assignment.

10. Read the material on the inside of the back cover covering geographic and numeric filing.

11. Complete Optional Filing Jobs 27A, 28A, and 29A, following the same procedure as given in Assignment 3.

12. Complete Optional Filing Jobs 30B, 31B, and 32B.

13. After completing Assignments 11 and 12, hand them to your teacher. She will give you a test that reviews all the rules of alphabetic filing.

14. If you were able to attain at least 90% accuracy on the test, your teacher will give you the next unit. (Mail Services)

UNIT V

MAIL SERVICE

Behavioral Objective:

At the conclusion of this unit the student should be able to classify mail and figure the cost of postage.

Given specific assignments, the student will be able to identify the proper handling of office mail. Eighty-five percent accuracy on each assignment will be required to successfully complete this unit. No test will be given.

Text:

Applied Secretarial Practice, Fifth Edition; Gregg, Fries, Rowe, Travis; McGraw-Hill Book Company, New York, 1962.

Assignments:

1. Read pages 179 to 192, Applied Secretarial Practice. Read this material carefully as you will have to know the information given to complete your assignments.

2. Complete the attached sheet, "Classification of Mail." In the space provided, give the type of classification necessary for the listed item. (Refer to your text and Postal Guide on the reference shelf.)

3. Complete the following problem. Use a sheet of type paper and type your name in the upper left corner. Use "Cost of Postage" for the heading. In these problems use the current postal rates, which may be secured from the latest issue of the Postal Guide which is available on the reference shelf.

   a. On January 15, Weber High mailed the following items to out-of-town addresses. List each item separately and find the total cost of postage:

      18 letters, each weighing 1 ounce
      2 letters, each weighing 1 1/8 ounces
      5 letters, each weighing 2 ounces
      3 letters, each weighing 1 ½ ounces, special delivery
      6 letters, each weighing 2 ½ ounces, special delivery
      7 letters, each weighing 2 ¼ ounces, airmail
      2 letters, each weighing 1 ounce, airmail, special delivery
      1 package, first class, weighing 4 pounds, to be mailed to a city in the third zone

4 parcel-post packages, weighing 4 pounds, to be mailed to the fourth zone
1 parcel-post package, weighing 4 ½ pounds, to be sent 175 miles marked "Special Handling"

b. On January 16, the Karmelkorn Shop in Ogden, Utah, mailed the following items to local and out-of-town addresses. List each item separately and find the total cost of postage:

Out-of-Town Mail

40 letters, each weighing 1 ounce
3 letters, each weighing 2 ounces, arimail
25 circulars, each weighing 2 ½ ounces
5 parcel-post packages, each weighing 2 pounds, addressed to cities in second zone
2 parcel-post packages, each weighing 3 ½ pounds, addressed to a city 149 miles from the company.
6 boxes, each weighing 5 pounds, shipped to the seventh zone, marked "Special Handling"

Local Mail

23 letters, each weighing 1 ounce
3 letters, each weighing 4 ounces
4 letters, each weighing 1 ounce, special delivery
34 circulars, each weighing 2 ½ ounces
4 parcel-post packages, each weighing 3 pounds

4. Hand your completed assignments to your teacher, and you will be given the next unit (Practice Set) in this course.

Assignment

WS. 1. Rectangles; Complete the rectangles on the Work Sheet shown at the right of the samples by sketching freehand lines like those shown in the samples. Do not use a straightedge for drawing lines. This work is to be done freehand. Solid sketching lines may be used instead of broken lines if you prefer. Write your name and hour in the title strip. Do not letter Work Sheets 1, 2, 3, or 4. Have your drawing checked.

WS. 2. Two-view Sketches; The views shown are two-view drawings of three different objects. Notice that the end view of the bottom object shows invisible edge lines. In the space to the right of the objects, make freehand sketches like those shown in the samples. Write your name and hour in the title strip. Have your drawing checked.

WS. 3. Circles and Arcs; In the space below the objects, make freehand sketches like the samples. Notice that the outline of the object is dark and the blocking-in (construction) lines are light. Write your name and hour in the title strip. Have your drawing checked.

WS. 4. Rounds and Ovals; In the space to the right of the objects shown, make freehand sketches like the samples. These objects have both straight and curved lines. Be sure your construction lines are light. Write your name in the title strip. Have your drawing checked. Arrange your first four sketches in numerical order with number 1 on top and turn them in to be graded.

Classifications of Mail

1. Package (4 pounds) _____
2. Look Magazine _____
3. Postal card _____
4. Blue Spruce Tree _____
5. Circular _____
6. Birthday Cards _____
7. Carton (75 pounds) _____
8. Business reply card _____
9. Sample box of Dash Soap _____
10. Typed letter _____
11. January White Sale Advertisement _____
12. Longhand report _____
13. Interoffice memorandum to a branch office _____
14. Merchandise sample (4 ounces) _____
15. Air Card _____
16. Double post card _____
17. Catalogue _____
18. Newspaper _____
19. Baby Chickens _____
20. Seeds _____

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UNIT VI

PRACTICE SET
(Secretary on the Job)

BEHAVIORAL OBJECTIVE:

The student will demonstrate her secretarial skills by completing a practice set which offers a useful and realistic orientation for a secretarial job. Ten points will be given for each assignment; six points are required to pass an assignment. No test will be given.

Text:

The Secretary On The Job (Practice Set), by Mary Witherow, McGraw-Hill Book Company, New York, New York, 1967.

Supplementary Instructions for the Student:

Source Material, pages 1 through 30 of the 65-page booklet, contains the notes and correspondence you will have to refer to in order to complete some of the assignments. The second half of the booklet, the Working Papers, consists of business forms to be filled out and handed in for checking.

The memorandum from Helen Jefferson, Source Material pages 3 through 5, contains information on procedures, which you will refer to throughout the practice set. You must follow the procedures outlined so you should study the memo carefully.

The material to be dictated throughout the set is on tape. When you need the dictation, ask your teacher for the tape for the job you need.

When an assignment requires that a letter or memorandum be typed on a stencil or spirit duplication master, the copies should be run off on plain paper. Stationery is provided for originals of correspondence only.

For duplicated memoranda, you should type the necessary headings at the top of each memo master using some acceptable arrangement of TO, FROM, SUBJECT, and DATE.

There are not enough envelopes in your working papers to cover all of the assignments in your practice set. However, an envelope must be typed for each letter. When you are not instructed to use the envelopes in your set, address an envelope on the back of your letter. Remember: some kind of envelope must be included or points will be deducted.

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Hand in your work after completing Jobs 5, 10, 15, 20, and 28. Be sure to keep your material in the proper folders--chronological file or signature file. All of your material will be returned to you at the completion of the unit.

Job #1

You may use any style you wish for your Resume. Refer to the secretarial books on the reference shelf for suggestions on the form to use.

Be sure to list complete address and phone numbers for all references. Résumé is correct with two acute-accented e's or with no accents at all (Resume). Resumé with only the final e accented is not correct.

Job #2

The memo to Mr. Joseph Dickinson should be typed on a Stover memo form.

The memo to Field Sales Managers should be duplicated on plain paper.

Job #8

The company names, capitalized in the list, should be typed in the upper and lower case in the letters, and the addresses should not contain abbreviations.

Job #13

The secretary must know the class of service that her employer prefers or her company specifies. Many firms require that all but their top officers fly coach; others want their executives to fly first class only. Sometimes, of course, these regulations must give way to expediency. Whichever class you choose for Mr. Wilson's flight, the price of the ticket should be correct for that service.

In some cities there is more than one airport serving commercial passenger planes. In this case, there is no choice. St. Louis has only Lambert Field, and O'Hare is the only airfield in Chicago used for this purpose.

You must remember to allow Mr. Wilson ample time to reach the Palmer House and have enough time to check in and have lunch before his 2:30 meeting time. You also must give him time to allow for delays.

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056 238

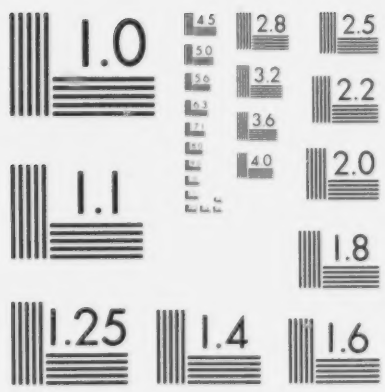

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

In the winter, weather conditions are uncertain and so you must allow for delays, also.

On his return trip you must allow Mr. Wilson time for the luncheon engagement listed among his appointments and that gets him into St. Louis in time to reach his office Friday afternoon.

The telegrams you write should include all the information mentioned in the assignment.

Job #14

You should not give out too much information during your employer's absences. In the letter to Mr. Myers, you should not mention the date of Mr. Wilson's return to the office. You should protect your employer from unnecessary interruptions, such as calls from suppliers, on what would normally be a very busy day.

Job #17

The petty cash statement and check should be done in ink--not on the typewriter.

If you are not sure how to do these items, check with some of the books on the reference shelves.

Job #19

You should record under Entertainment expenses for meals at which the executive entertains business associates. The cost of his own meals on business trips, when he is not involved with business entertainment, are entered under the heading Meals.

When dates for entries are unspecified, enter the expenses at the beginning or end of the report.

Remember that the sum of the vertical totals should equal the sum of the horizontal totals.

NOTE: An error in the first printing of the text-kit, SM21, has 2/6 for item 5; this should be 1/6.

Job #25

The checks in this job may be typed or handwritten.

At the successful completion of this practice set, a letter grade and one-half credit will be awarded.

UNIT VI

PRACTICE SET
(Typewriting Office Practice)

BEHAVIORAL OBJECTIVE:

The student will demonstrate her clerical office typewriting skills by completing a practice set which offers a useful and realistic orientation for a clerical office typewriting position. Ten points will be given for each assignment; six points are required to pass an assignment. No test will be given.

Text:

Typewriting Office Practice, Fourth Edition (Practice Set) by Peter L. Agnew and Phillip S. Atkinson, South-Western Publishing Company, Cincinnati, Ohio, 1968.

Supplementary Instructions for the Student:

1. Write your name on the envelope of your practice set where indicated.

2. Write your name on the front of each folder that is inside your practice set. This will identify your work and prevent loss of your material. If your practice set is lost, you will be required to purchase a new one.

3. Read pages i and ii of your instruction manual carefully. These instructions will help you throughout the practice set.

4. Each job gives you specific instructions--FOLLOW THEM CAREFULLY.

5. After completing each job, hand it to your teacher in Folder 5.

6. If at any time you do not understand the job on which you are working, please check with your teacher for additional help.

7. BE CAREFUL WITH YOUR MATERIAL. The only papers available for this course are in your practice set.

16351

PART TWO

OFFICE MACHINES

16352

OFFICE MACHINES

BEHAVIORAL OBJECTIVE:

At the completion of this course the student will be able to perform all of the basic mathematical functions associated with the operation of the Ten-Key Adding and Printing Calculators and the Electronic Calculators according to the standards set up in the individual unit.

The student will also be able to perform the operation of the keypunch machine and have a basic understanding of processing data both manually and electronically according to the standards set up in the individual unit.

The following units will be included in this course:

Unit I Ten-Key Adding and Printing Calculators, Electronic Calculators
Unit II Data Processing (Keypunch)

After the successful completion of the above units, one-fourth credit and letter grade will be awarded.

16353

UNIT I

10-KEY ADDING AND PRINTING CALCULATORS,
ELECTRONIC CALCULATOR

BEHAVIORAL OBJECTIVE:

At the completion of this unit the student will be able to perform all of the basic mathematical functions associated with the operation of the 10-Key Adding and Printing Calculator. The student must attain a speed of 100 net strokes per minute and a production test of method and accuracy must be completed with a minimum of 75 per cent.

The Electronic Calculator will be used for part of the production solving problems and no test will be given on this machine.

Texts:

1. Office Machines Course, Third Edition; Agnew and Cornelia; South-Western Publishing Company; Cincinnati, 1962.

2. Ten-Key and Printing Calculators, Third Edition; Agnew and Pasewark; South-Western Publishing Company; Cincinnati, 1963.

3. Rotary Calculator Course, Fourth Edition; Agnew and Pasewark, South-Western Publishing Company, 1962.

General Instructions:

Each day as you enter the room, pick up the text from the storage cabinet. If answer sheets are needed, pick them up at the same time. Fill in all blanks on each answer sheet completely, numbering the assignment, job, and practice numbers.

Clear your desk or table of books and papers that do not pertain to the course. Place the machine to the right of your desk or table, at a slight right angle, and the book at the left. Keep your personal belongings away from the machines.

Position the machine and book to give you ease of operation and reading.

Sit erect, relax, and put both feet flat on the floor.

Place the first, second, and third fingers on the middle bank of keys--the keys 4, 5, and 6.

Clear the machine by depressing the total button. Always be sure your machine is clear before starting to work a problem.

16354

Assignments:

1. When you have a clear machine, turn to page 25 of the text (Office Machines Course) and add each problem in Job 11, page 23, two times. Record your answer on the sheet provided. As you add, do not look at the keys, concentrate on the problem. When completed and double checked, go to the next assignment.

2. Complete all of the problems in Job 12, page 29, except the Timed Drill. Add each problem 2 times.

   The use of the Non-Add key is introduced. When N appears by a number, depress the Non-Add key on your machine. This key is coded with the following symbols: #, N, or .

3. Complete all of the Problems in Job 13, page 31-32. In This job you will learn the use of the repeat key to repeat whole numbers or to repeat numbers by columns in order to multiply. Read the overview and Procedure on page 31.

   If the machine on which you are working is not covered by the procedure given or you do not understand, check with your teacher for assistance.

4. Complete all of the problems in Job 14, page 33 and 34, including Timed Drills. This is a review of previous functions.

5. Complete Job 15, page 35 and 36, including the Timed Drill. Always be sure your machine is clear.

   To subtract, enter minuend (top number) in machine and depress + bar. Enter sbutrahend (bottom number) in keys and depress minus key. Take total.

   Note: The minus key can be used to correct errors. If the wrong number has been printed, re-enter that number and subtract. Then enter correct number.

6. Complete Job 16, pages 37 and 38, including the Timed Drill. Sometimes it is necessary to get subtotals on problems. When an S appears by a total space, depress sub-total key instead of total. This causes the machine to print a total of the figures in the machine but does not clear the machine. Any figures entered after the sub-total key is marked with an S, ST, or , and the same symbol will appear on the tape.

7. Complete all problems in Job 17, pages 39 and 40, including the Timed Drill.

WS. 5. Lettering: On page 11 you will find an Illustration Sheet on lettering. Notice that the numbers show the order for making the strokes, and the arrows show the direction of strokes used in forming the letters. The width and proportion of the letters are also shown. Letter the lines below the samples. Also fill in the extra practice spaces. The title strip is also to be lettered, not written. Illustration Sheet 3, page 13, gives help for making title strips. Use all capitals and use light guide lines for keeping your letters neat and uniform in height. Have your Work Sheet checked and graded.

WS. 6. Dimensioning: Complete the Work Sheet by following the samples shown. The title strip is to be lettered in, using guide lines for keeping the letters uniform in height. Have your Work Sheet checked and graded.

1633

When the subtrahend is larger than the minuend, the resluting total will be a credit balance. All of your machines will give an automatic credit balance, indicated with the following symbols: cr or *. When you record your answer, indicate the credit balance with cr written after the answer.

8. A ten-key adding machine will not divide without special manipulation. To divide you must multiply. This is done by converting the divisor to a reciprocal (given in charts on page 41) and multiplying the reciprocal times the multiplicand. (The multiplicand is the top number of your problem.) CAUTION: If there are decimals in the problem, then there will be decimals in the answer. If there are no decimals in the problem, then there cannot be a decimal in the answer. If the machine you are using prints a decimal, this is for convenience in adding dollars and cents only, and must be ignored any other time.

   Complete all of the problems in Job 18, page 41, 42, and 43. Do not do the Timed Drill.

   NOTE: In completing problems 21 - 40, use only 5 places in the reciprocal instead of the 8 given. Cross off the last three places.

9. Complete Job 19, pages 45 and 46, including Timed Drill. Job 19 contains a problem in vertical and horizontal addition. Add each vertical column at least twice. As you record your answers, mark them with a V. If you obtain the same answer twice, you can be reasonably sure it is correct. After all the columns have been added vertically, add across the lines horizontally, again two times or more using the same procedure as before, and marking totals with an H.

   When all of the totaling is complete and double-checked, add all of the vertical totals to obtain a grand total. Also, add all of the horizontal totals and obtain a grand total. This grand total from both sources must agree. If it does not, again check all of your addition until it does.

10. This job is a review of all of the operating principles covered, It is an excellent preparation for the tests to be given when you are ready. Complete the problems in Job 20, pages 47 and 48, for practice twice. If there is any problem you do not understand clearly, ask your teacher for help and be sure you do understand before you complete the job.

11. At this point you will take a production test of method and accuracy. A minimum of 75 % accuracy is required. If you do not pass this test, you must review and take another test.

12. Obtain a drill book from your teacher. Practice addition problems consisting of three or more digits. When you feel you can pass the speed tests with the required 100 net strokes per minute, ask your teacher for the test.

13. The following problems will apply the methods you have learned to actual business problems and forms. For these problems you will use the text, 10-Key adding and Printing Calculator Course (Gray Book).

14. Complete Problem 13 of Job 6 on page 23. Follow very carefully the instructions given.

15. Complete Problems 38 to 42 of Job 12 on page 43. Follow the instructions carefully.

16. Complete Problems 16 to 24 of Job 14 on page 51. Follow the instructions carefully.

17. Complete Problems 6 to 11 of Job 16 on page 57 and Problems 28 to 35 of Job 16 on page 59.

18. Complete Problems 17 and 18 of Job 22 on page 79. Follow the instructions carefully.

19. Complete Problems 1 to 6 of Job 23 on page 81.

20. Complete Problems 6 to 15 of Job 24 on page 86.

21. Complete Problems 11 to 31 of Job 27 on page 98. Use the 1968 percentage for FICA.

22. The following assignments will be completed on an electronic calculator. For these problems you will use the text, Rotary Calculator Course, (Blue Book).

23. Complete Problems 21 to 36 of Job 3 on page 11.

24. Complete Problems 11 to 26 of Job 7 on page 24.

25. Complete Problems 31 to 43 of Job 8 on page 29.

26. Complete Problems 31 to 41 of Job 11 on page 35.

27. Complete Problems 31 to 46 of Job 13 on page 43.

28. Complete Problems 16 to 30 of Job 17 on page 56.

29. You have now completed Unit I of this course. Check with your teacher, and you will be given Unit II (Data Processing).

NOTE: If you are interested in receiving further instruction on office machines (rotary calculator and key-driven machines) you may complete an additional course. This course will take seven to nine weeks and an additional one-fourth credit will be awarded.

UNIT II

DATA PROCESSING (KEYPUNCH)

BEHAVIORAL OBJECTIVE:

The student will demonstrate his understanding of the processes of the keypunch machine by completing four tests given throughout the unit. At the completion of this unit the student will be able to perform the operation of the keypunch machine by completing actual problems on the machine. The tests given must be passed with a minimum of 75% accuracy.

Text: Data Processing, Volume I; Ray W. Hass; 3M Education Press, St. Paul Minnesota, 1966.

Data Processing Illustrations, Volume I-III; Ray W. Hass, 3M Education Press; St. Paul, Minnesota, 1966.

Assignments:

1. Obtain the above two texts from your teacher as you enter the class each day. These are not to be taken from the room at any time.

2. At this point a test will be given to you, covering the material you have read so far.

   If you complete this test with 75% accuracy, proceed to the next assignment.

3. From this point on all answers to the programmed questions must be written in an organized notebook.

   Be sure you identify your answers properly, using correct titles and question numbers.

   This notebook must be handed in at the end of this unit.

   Read page i of the Card Format Section very carefully. If you make an incorrect response, cross out your answer in your notebook, review the material you have just read, and write the correct answer in your notebook.

   NOTE: Be as neat as possible in organizing your notebook, but crossed-out answers are expected and will not lower your grade.

4. Begin using your notebook and read and answer the questions on page ii to v.

5. Proceed at your own rate, using the above directions and complete the questions on pages 1 through 19.

6. At this point a test will be given to you covering the material you have just completed. If you have completed this test with at least 75 per cent accuracy, proceed to the next assignment.

7. Complete the questions on pages 21 through 47.

8. At this point a test will be given to you covering the material you have just completed. If you complete this test with at least 75 percent accuracy, proceed to the next assignment.

9. Turn to page 2 of the Keypunch Machine Section of the textbook. Complete all the problems on page 2 through 43.

10. At this point a test will be given to you covering the material you have just completed. If you complete this test with 75% accuracy, proceed to the next assignment.

11. Check with your teacher. She will give you some practice problems to be completed on the keypunch machine and assist you in the operation of the machine.

12. When you have satisfactorily completed the problems on the keypunch machine, you will be awarded a letter grade and one-fourth credit for this course.

NOTE: If you are interested in receiving further instruction and practice on the keypunch machine, you may complete an additional course on keypunch operation. (This course will take seven to nine weeks and an additional one-fourth credit will be awarded.)

PART THREE

TRANSCRIBING AND DUPLICATING MACHINES

16361

TRANSCRIBING AND DUPLICATING MACHINES

BEHAVIORAL OBJECTIVE:

At the conclusion of this unit the student will be able to operate a transcribing machine efficiently by setting up dictated letters and memorandums in mailable form and other dictated material in manuscript form according to the standards set up in the individual unit.

The student should be able to prepare spirit duplicating masters, offset masters, and cut stencils for the mimeograph. The student will also be able to operate the spirit duplicating machine, the stencil duplicating machine, copying machines, and the illuminated drawing board according to the standards set up in the unit.

The following units will be included in this course:

Unit I Transcribing Machines
Unit II Duplicating Machines

At the successful completion of the above two units, one-fourth credit and a letter grade will be awarded.

16362

UNIT I

TRANSCRIBING MACHINES

BEHAVIORAL OBJECTIVE:

The student will be able to complete various assignments on the transcribing machine. Lesson 4 will be given 90 points; Lesson 8, 80 points; Lesson 9, 60 points; Lesson 13, 80 points; and Lesson 19, 80 points. A minimum of 75 per cent accuracy will be required. At the completion of the above lessons, you will be given one class period for a test. Ten points per page will be given with one point deducted for each error.

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To improve efficiency in the use of the executive's time and the secretary's, a wide variety of recording and transcribing equipment has been introduced into the business office. Your boss, for example, may dictate many of his reports while he travels by using a small portable dictating unit. You may have an employer who uses dictating equipment much of the time or as a supplementary aid when he must work after regular hours. It is important, therefore, that you be acquainted with the operating principles of transcribing machines.

Text: IBM Executary, Transcribing Techniques with IBM Executary Dictation Equipment, which includes student text and set of prerecorded belts; New York, New York.

Assignments:

1. Obtain the transcribing machine equipment and belts from the shelf and set up the equipment at a desk or table next to an electrical outlet.

   NOTE: At the end of each period you must remove the belt and index tab from the machine and place it in the proper container and return all equipment to its appropriate place on the shelf.

2. Obtain the IBM booklet, Transcribing Techniques, from the reference shelf. Also, obtain the small blue IBM brochure entitled "Easier Transcription with your new IBM Dictation Equipment" from the shelf.

3. a. Read Lesson 1 and follow the instructions. Also, read the brochure you obtained from the shelf. NOTE: Do not try to transcribe from the belts without first reading these instructions. Lesson 1 gives you step by step instructions and pictures as to how to set up your machine and type from a belt.

b. Lesson 1 is a practice belt. Remember: Type more slowly than you normally type. Try to be accurate but do not stop and correct errors when you make them.

c. Because this is a practice belt, you may type on both sides of your paper. Use manuscript form for this lesson. Type your name and the belt number in the upper left corner of the first page of your lesson transcription. After you have completed the transcription of Lesson 1, place all the papers in order, staple them together in the upper left corner, and hand them to your teacher before proceeding to the next lesson.

4. a. Read and follow instructions given in Lesson 2.

b. This is also a practice belt so you may use both sides of your paper. You do <u>not</u> have to correct errors.

c. Use manuscript form.

d. Follow the instructions given in 3c.

5. a. Read and follow instructions given in Lesson 3.

b. This is your last practice belt. Use both sides of the paper. You do not have to correct errors.

c. Set the letters up in full-block style and use manuscript form for the other material given.

d. In the inside address for each letter a zone number will be dictated. Omit this number and add a zip code. This should be done on all letters typed in this entire unit.

e. Type your name and the belt number in the upper left corner of the first page of transcription.

f. Put your papers in order, staple them together, and hand them to your teacher before proceeding to the next belt.

6. a. From this point on the material in <u>all</u> lessons should be set up as <u>mailable</u> transcripts.

b. <u>All</u> errors should be corrected.

c. Use only one side of your paper.

d. Paragraphs should be set up in unbound manuscript form.

e. Letters should be mailable. You may use the letter style of your choice. Use the current date on your letters, and remember to add zip codes and omit the zone numbers.

f. The material must be typed directly as a final copy. Do not type it as a rough draft and then retype it as a final copy. The goal of this course is for continuous, accurate typing directly from dictation.

g. As each belt is completed, put your papers in order, staple them together, and hand them to your teacher before you proceed to the next belt.

h. Be sure you have your name and belt number on the first page before handing in your papers.

7. Transcribe all material on Belt No. 4. Do not follow the book directions. You do not have to make carbon copies for the letters on this belt but be alert for directions for carbon copies and enclosures mentioned and make the proper notations at the close of the letter. Be sure to follow the directions outlined in the preceding instruction.

8. Transcribe all material on Belt No. 8. Do not follow the book directions. For the letters you type on this belt, assume you are working for the Winslow Insurance Agency, 766 Main Street, Dearborn, Missouri. You are secretary to the president of the company, Mr. Frank H. Winslow. Follow instructions given in assignment 6. No carbons are necessary but make correct notations.

9. Transcribe all material on Belt No. 9. Do not follow the book directions. On this belt you will hear a woman's voice, but you are still to assume you are working for the president of the company, Mr. Frank H. Winslow. No carbons are necessary but continue to make the correct notations where necessary. Follow the steps outlined in assignment 6. Be sure to be a good proofreader and correct all errors.

10. Transcribe all material on Belt No. 13. Do not follow the book directions. On this belt you are working for Carl B. Long, Station Manager. Make a carbon copy for each of the letters on this belt.

Sometimes the person dictating occasionally makes grammatical errors because he is concentrating more on the message than the form. It is the typist's responsibility to be alert and correct any error made by the dictator. On Belt No. 13 there is one grammatical error and one dictation error which you should correct. Remember: Before you begin to transcribe, be sure to check the Index Tab and find out the point where the dictator instructs you to make a correction. As you approach this point, stop typing and listen ahead for the error and its correction so you won't type the wrong words and have to erase.

UNIT II — CHARTS, MAPS, AND GRAPHS

General Information

Diagrams, Charts, and Graphs:

Have you ever heard the old proverb, "One picture is worth a thousand words"? A picture, chart, map, or graph can be used to explain things clearly and quickly. They save using many words.

Diagrams, charts, and graphs are frequently used in magazines, books, and newspapers. They can present certain kinds of facts more clearly and quickly, using less space.

There are many kinds of graphs. Some common ones are line graphs, bar graphs, and circle graphs. They are all used to give a quick, clear view of related facts.

Maps:

Maps are used to establish the boundaries of national, public or private properties; to locate or describe the physical features within these boundaries; and to direct the courses of travelers on land, on the sea, or in the air.

The information from which various kinds of maps are drawn is called field data. The branch of civil engineering that has to do with gathering these data is known as surveying. The map draftsman works from the surveyor's data and field notes, or from aerial photographs.

Maps of small areas of the earth's surface, such as states, counties or cities may be thought of as top views, giving an out-

11. Transcribe all material on Belt No. 19. Do not follow the book directions. No carbons are required. Correct any errors you hear.

    Sometimes when a boss is dictating he is reminded of other duties that need to be done. He, therefore, might dictate these instructions on the belt to his secretary. The secretary should type up these directions so that she will have a written reminder and will not forget them

    On Belt No. 19 you are working for Mr. Joseph C. Newman, Assistant Manager. He will give you some instructions as to some duties you should perform. Type up the special directions, but you do not have to carry out the instructions.

12. If you have successfully completed the above assignments, you will be given a test belt to transcribe. You will be given one class period for this test. Ten points per page will be given with one point deducted for each error.

UNIT II

DUPLICATING MACHINES

BEHAVIORAL OBJECTIVES

At the conclusion of this unit the student will be able to prepare spirit duplicating masters, offset masters, and cut stencils for the mimeograph. The student will also be able to operate the spirit duplicating machine, the stencil duplicating machine, copying machines, and the illuminated drawing board. Evaluation will be on the following:

1. A written test will be given on the preparation of a master sheet and a written test will be given on the preparation of stencils. Eighty per cent accuracy will be required to pass these tests.

2. All duplicating assignments will be graded. They will be judged on neatness, placement, sharpness, and originality. Ten points will be given for each assignment. Eight points are required to pass.

Reference Books:

Applied Secretarial Practice, Sixth Edition, Gregg, Fries, Rowe, Travis, Gregg Division, McGraw-Hill Book Company, New York, 1968.

Secretarial Office Practice. Seventh Edition, Agnew, Meehan, Oliverio. South-Western Publishing Company, Cincinnati, 1966.

20th Century Typewriting, Eighth Edition, Lessenberry, Crawford, Erickson, Southwestern Publishing Company, Cincinnati, 1962.

A Guide to Duplicating and Copying Processes, Olga B. Brown, Weber State College, 1969.

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When only a few copies of an item are involved, carbon copies are an effective and inexpensive means of reproduction. When many copies of manuscripts, schedules, policy statements, memorandums, personnel bulletins, and other company news are needed, duplicating equipment is used for this purpose.

It is your responsibility to determine which type of duplicating process to use. After reading and completing the assignments in this unit, you will know the advantages and disadvantages of each process.

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Assignments:

Stencil Duplicating and Illuminated Drawing Board

1. Read Section 4, pages 352-356 in Applied Secretarial Practice, Sixth Edition. Read these pages carefully because you will be tested on this material. Check with your teacher if you have any questions. (Addition information may be found in Secretarial Office Practice, Seventh Edition, Pages 366-383.)

2. Obtain a test from your teacher. Follow directions carefully. When you have completed this test, hand it to your teacher for checking. If you have obtained at least 80 percent accuracy on the test, you will proceed to the next assignment.

3. Obtain a stencil from your teacher. With the use of the illuminated drawing board, prepare the stencil by illustrating various types of letter styles. Use the different lettering guides and styli available (see page 356). You may use any words you wish. This is a practice stencil.

   You should also use the shading screens in at least one letter style. Sign your name in the lower right corner of the stencil. You will be using a regular 8 1/2" x 11" paper so do not go beyond the horizontal line indicating this size paper on your stencil. When you have completed this stencil, hand it to your teacher. When all stencil assignments are complete, you will be shown how to run them off on the stencil duplicating machine. Five copies of this stencil are required.

4. Obtain a stencil from your teacher. Prepare a stencil for announcing some type of an event or advertising some type of merchandise. Use both lettering guides and pictures. This should be complete as to "when", "where," and "what," Pictures that may be used as illustrations are available on the shelf, or you may use pictures from magazines, newspapers, etc. When you have completed this stencil, hand it to your teacher. Five copies of this stencil will be required.

5. Obtain a stencil from your teacher. Prepare a program for a fashion show, banquet, or a party. List the menu (if it is a dinner program), program, committee members, etc. Appropriate pictures should be used to make this program attractive and "eye catching." This is the type program that is folded four ways (French fold). Type a copy of what you want to reproduce on a regular sheet of paper before making the stencil. This will enable you to prepare your material correctly. Check the illustrations on the board. After you have completed this assignment, hand it to your teacher. Five copies of this stencil will be required.

6. Obtain a stencil from your teacher. Turn to page 326 in 20th Century Typewriting (Text). Type the form letter 253C. Do not follow the book instructions. Choose your own letter style. Read the following instructions before you begin:

   As you type this letter, you must not type the date or the inside address, but you must leave space for these items to be added after you run off your stencil.

   This is a form letter and various information has to be inserted in the letter as it is sent to different people. Therefore, there are also some other blank spaces that will have to be left when you type the body of the letter.

   Check the three problems to the right of the letter and under each item determine the longest one in the three problems. This will tell you how many blank spaces you will have to leave on your stencil for that particular item. Run ten copies of this stencil. You will then have to insert three of these forms in your typewriter and type the information in Problems 1, 2, and 3, page 326.

7. At this point you will be shown how to run your stencils on the duplicating machine. Hand in two copies of each stencil. One of the french fold programs should be folded and the other one left flat. Hand in the three copies of the form letter that has been completed. Put a paper clip on these papers to keep them together. Be sure your name is on them.

Spirit Duplicating

1. Read carefully Section 3, pages 348-351, in Applied Secretarial Practice, Sixth Edition. You will be tested on this material. If you have any questions, be sure to check with your teacher.

2. Obtain a test from your teacher. Follow directions. When you have completed the test, hand it to your teacher for checking. If you have obtained at least 80 per cent accuracy on this test, you will proceed to the next assignment.

3. Obtain a master sheet from your teacher. Make a multi-colored master. Use red, green, purple, blue, or black carbons. You must use at least three colors. (The colored carbons are available on the shelf.) You may use the illuminated drawing board for tracing pictures on to the master sheet with a light pencil outline, then copy the illustration using carbons. DO NOT TRACE DIRECTLY ON THE ILLUSTRATIONS YOU ARE COPYING WITH PENCIL OR PEN UNLESS THEY ARE YOUR OWN.

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Illustrations are available on the shelf for your use, or you may find your own pictures in magazines, newspapers, etc. You may make a bulletin, an announcement, an advertisement, or an illustration. Your page should be well balanced and should include typing and printing as well as illustrations (pictures).

When you have completed this master, check with your teacher. She will show you how to operate the spirit duplicating machine. Run 10 copies of this master.

4. Obtain two master sheets from your teacher. For this assignment you will make a folded program for a school, church, or community function. Take a sheet of type paper and fold it in half. Make a rough draft of your program on this sheet of paper. This will show you the placement necessary of the material on your master sheets.

   Two masters are necessary for one program because the paper must be run through the machine twice to get print on both sides. When typing the masters, be sure that you are typing on the right portion of it so that it will come out right on the paper. Be sure to check with your teacher before you type the master.

   When you have completed this assignment, run 10 copies of this master.

5. Hand in two copies of each master. One of the folded programs should be folded and the other one left flat. Put a paper clip on these papers to keep them together. Be sure your name is on them.

Offset

1. Read pages 46 to 53 in "A Guide to Duplicating and Copying Processes."

2. Obtain an offset paper master from your teacher. Reread instructions, "Preparing a Paper Master" one through seven starting on page 50 of the booklet before you prepare your master.

3. Type an exact copy of the attached sheet, "Success Calls for Special Qualities," on your offset paper master. Follow each step outlined in the booklet carefully.

   Center your name one inch from the bottom of the page.

4. Examples of offset reproductions are shown on the bulletin board.

5. After completing the master, hand it to your teacher. If an offset machine is available, you will be shown how to run off your master.

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Copying Machines

1. Read Unit 10, pages 351-363, in Secretarial Office Practice, Seventh Edition.

2. On a sheet of type paper, make a copy of a medium length letter. You may choose any letter and style from any of the reference books on the shelf. When you have completed this letter, your teacher will show you how to make a copy of it using a copying machine.

3. Turn to page 163 in Secretarial Office Practice, Seventh Edition. On a sheet of type paper, make an exact copy of the minutes illustrated. Substitute your name as secretary and sign your name in ink. When you have this completed, your teacher will show you how to make a spirit master from a copying machine.

   After you obtain the spirit master, run 10 copies on the spirit duplicating machine.

4. Hand in the one copy you made of your letter and two copies of the minutes from the spirit master. Put these papers together with a paper clip and be sure your name is on them.

After successfully completing Unit I and Unit II of this course, you will be awarded a letter grade and one-fourth credit.

16371

SUCCESS CALLS FOR SPECIAL QUALITIES

The girl who finds her greatest reward in being part of a team, rather than a solo star, shows the natural talent to work for and with others toward a joint goal that is essential to success as a secretary.

Loyalty, judgment, integrity and adaptability are high on the list of other requirements.

The girl who makes and keeps friends, and who sticks up for them and for her family at all times, shows the loyalty in word and deed that a secretary must bring to her boss and her company.

Can you accept sudden changes of plan amiably and without flurry? The secretary must be able to turn on a dime, occasionally, and work efficiently under heavy pressure when an emergency challenges her chief.

Are you accurate? Your boss must be able to rely with total confidence on your reports. Neatness, good spelling, and promptness in completing school papers show the respect for detail and the reliability needed by a secretary.

Are you adaptable? The secretary deals with all kinds of people. The girl who is liked by teachers and neighbors as well as by many fellow students shows the capacity to make her way in a big group--rather than stick with a clique--that is needed by the secretary.

Perhaps a prime requisite for success in the profession is approaching secretaryship as a chosen career--not as a stop-gap before marriage, or as a stepping stone to other positions.

The girl who does will gain experience in her working years that will serve her well, no matter what life brings, because she will have learned the secret of greatest happiness in all human relations; the more imaginatively, loyally and consistently she works for and with another person for his success, the more she benefits herself.

By Clare H. Jennings, CPS

16372

PART FOUR

BUSINESS ENGLISH

16373

BUSINESS ENGLISH

BEHAVIORAL OBJECTIVE:

At the conclusion of this course the student will be able to write business letters that will achieve the results desired. Practical letterwriting principles and techniques will be used pertaining to organization, completeness, clarity, conciseness, accuracy and similar aspects of written communications. The student will also be able to type these letters in "mailable" form. In order to attain this goal the student will be able to apply the fundamentals of practical English. He will be able to pass basic English tests with at least a 75% accuracy. These tests will involve the parts of speech and the rules of grammar which are the tools needed to construct a sentence, the basic unit of communication. Two spelling tests will be given (words will be taken from the words given in the worksheets). The student will be able to pass these spelling tests with at least 90% accuracy.

The student will also be able to locate information on a variety of topics quickly and accurately according to the standards set up in the "Sources of Information" unit.

The student will be able to improve his spelling and business vocabulary by developing special spelling techniques through the completion of assignments according to the standards set up in the "Spelling Improvement" unit.

The following units will be included in this course:

Unit I	Business English Essentials
Unit II	Sources of Information
Unit III	Spelling Improvement

After the successful completion of the above units, one-half credit and a letter grade will be awarded.

16374

UNIT I

BUSINESS ENGLISH ESSENTIALS

"English is for you a 'bread and butter' subject. In whatever position you find yourself after graduation, you will display your brand of English in letters and reports, in telephone conversations and personal conferences. Clear and accurate use of English can be the deciding factor in getting a good job, in being promoted to a position of responsibility, in making a sale, and in making a satisfactory adjustment with a customer.

The ability to speak and write well is an accomplishment well worth a considerable investment of time and effort." (Business English Practice, Pitman Publishing Corporation.)

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Text: Business English Essentials, Third Edition by Greta LaFollette Henderson, Gregg Division, McGraw-Hill Book Company, New York, New York 1965.

The following parts will be included in this unit:

Part I Review of English Essentials
Part II English for Business Communications
Part III Punctuation for Business Letters
Part IV Writing the Business Letter

Directions:

Read page iv of your text carefully and take the pretest, "English Essentials Inventory." If you pass the pretest with 90% accuracy or better, you are to omit Part I of the Unit.

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line of the shape of the area and relative distances within it. The making of top-view maps is known as topographical drawing. Some maps give the elevations and irregularities of surface or area included and are known as relief maps and contour maps.

Symbols are devised to represent data on the map or chart. Some examples of symbols which may be used to represent facts are found on Illustration Sheet 4, page 19.

Using Topographical Maps:

An athletic field must be a level plot of ground which is well drained. However, some athletic fields are located where the original contour of the land is rather rough and it becomes necessary to grade down hills and make fills in order that a suitable plot may be obtained.

Much preliminary work must be done by the civil engineer or the surveyor before the grading and leveling process can take place. Preliminary grade drawings are made from data obtained by the surveyor. These drawings are then used by the grading contractor in the actual grading process.

When the grading is complete, both the track and the football field are layed out by the surveyor. These measurements must be very accurate since they must conform to the rules set up by the National Federation of State High School Athletic Associations. The curves on the track must be calculated together with the straightaway in order to determine a definite distance from a specific starting point. Illustration Sheet 5, page 21, shows one use of a topographical map. It shows the shape and size of a high school athletic field. What other facts can you figure out from this map?

PART I

REVIEW OF ENGLISH ESSENTIALS

BEHAVIORAL OBJECTIVE:

At the conclusion of this part, you will be able to use the tools of communications skillfully. You will be able to construct a grammatically complete sentence expressing the thought you wish to convey.

You should be able to complete Assignments 1 through 23 with at least 75% accuracy and pass a test on Part I with at least 75% accuracy.

Assignments:

1. Read and study the material under Topic 1, page 1 of your text.

2. Complete Worksheets 1, 2, and 3.

3. Hand Worksheets 1, 2, and 3 to your teacher to be checked.

4. If you were able to complete Worksheets 1, 2, and 3 with at least 75% accuracy, you should proceed to the next topic in your text.

5. If you were unable to reach 75% accuracy on the worksheets, you will be required to do supplemental work provided by your teacher before proceeding to the next topic. Check with your teacher for help. Do not try to go to the next step unless you understand the previous one.

6. Continue through Worksheet 23 using the steps outlined in Assignments 1, 2, 3, 4, and 5.

7. After successfully completing all of the assignments in Part I, you will be given a test on the fundamentals of grammar.

8. If you were able to pass the test on Part I with at least 75% accuracy, you may proceed to Part II.

9. If you were unable to reach 75% accuracy on the test for Part I, check with your teacher for additional help before proceeding to the next part.

16376

PART II

ENGLISH FOR BUSINESS COMMUNICATION

BEHAVIORAL OBJECTIVE:

At the conclusion of this part, you should be able to avoid common errors in language usage both in speech and in writing. You should be able to write so as to convey the meaning intended without the possibility of misunderstanding.

You should be able to complete Worksheets 24 through 63 with a minimum of 75% accuracy and pass a test on Part II with a minimum of 75% accuracy. This test will consist of words for which you are to supply the possessives (singular and plural), indentification of parts of speech in sentences, being able to use active and passive voice correctly, and the correct usage of words in a sentence. You will also be given a 50-word spelling test (words taken from Worksheets 43 and 63). You must pass this spelling test with a minimum of 90%.

Assignments:

1. Read Topic 7 in your text on pages 9 and 10. Be sure to study each example carefully.

2. Complete Worksheets 24 and 25 and hand your papers in to be corrected.

3. If you were able to attain at least 75% accuracy on Worksheets 24 and 25, you may proceed to the next topic.

4. If you were not able to reach 75% accuracy on Worksheets 24 and 25, your teacher will give you some supplemental material for you to do before proceeding to the next topic in your text.

5. Continue through Worksheet 63 using the steps outlined above.

NOTE: Worksheets 43 and 63 are spelling reviews. These words are given to you on an attached sheet. You are to study these words and you will be tested on them at the end of Part II.

6. After you have successfully completed all the worksheets in Part II, you will be given a 50-word spelling test on the words in Worksheets 43 and 63. You are required to pass this spelling test with a minimum of 90%. If you do not reach this standard, you will be required to take another test on these words.

16377

PART III

PUNCTUATION FOR BUSINESS LETTERS

BEHAVIORAL OBJECTIVE:

At the completion of this part you should be able to use punctuation to provide clear and understandable sentences.

You should be able to complete Worksheets 64 through 73 with a minimum of 75% accuracy and pass a test on Unit III with at least 75% accuracy. This test will consist of a number of sentences for you to punctuate correctly. It will also consist of sentences including numbers. You should be able to write these numbers correctly.

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This part supplies you with a comprehensive list of punctuation rules and with worksheets for applying these rules. This section is a handy reference source for your use. You should refer to it whenever a question arises about correct punctuation.

A punctuation mark is merely a "signal" from the writer to the reader. For example, a period shows that a sentence has been ended or that an abbreviation has been used. A comma may show a slight break in thought, separate the two parts of a compound sentence, or be used in one of several other ways.

Some sentences may be punctuated in more than one way to convey the meaning of the writer.

Some professions and businesses have their own style of punctuation. A journalist, for example, may omit some punctuation marks which normally are included in a business letter. A lawyer uses many more punctuation marks when preparing a legal form than are necessary for most types of business writing.

The great majority of all questions about punctuation may be answered with a knowledge of a few simple principles. These principles are given in Part III. No attempt is made to give the principles covering the occasional, rare, and difficult problems that may arise.

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Assignments;

1. Study each topic in this unit carefully.

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2. Read each rule and study the example so that you can use it in your own work.

3. At the end of each topic complete the worksheets listed.

4. After completing the worksheets at the end of each topic, hand your papers to your teacher for correction.

5. Your teacher will check your papers and go over them with you.

6. If you are able to complete the worksheet with 75% accuracy or better, you can proceed to the next assignment. If you do not reach 75% accuracy, your teacher will guide you to supplementary material on the specific subject.*

7. When you have completed Worksheets 64 through 73 with 75% accuracy or better, you may take your test on Part III.

8. If you were able to complete the test on Part III with 75% accuracy or better, you may proceed to the next part.

9. If you were unable to complete the test on Part III with 75% accuracy or better, you will be given supplementary material to complete before going on to the next part.

*NOTE: Worksheet 71 is to be omitted.

16380

PART IV

WRITING THE BUSINESS LETTER

BEHAVIORAL OBJECTIVE:

At the conclusion of this part you should be able to write business letters that achieve the results you want. You should be able to use correct letter-writing principles that pertain to organization, completeness, clarity, conciseness, and accuracy. You should be able to type these letters in mailable form.

You should be able to pass a test on Part IV with a minimum of 75% accuracy. This test will consist of questions on the parts of a business letter discussed in Part IV, arrangement and punctuation, styles of letters, and various types of letters.

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Letters are very essential in business. There are times when the letter is the only contact a company has with its customers. Letters are sometimes used to create new business or build good will. It is necessary, therefore, that the letter say what you really want it to in order to reach this result.

Planning is necessary to write a good letter. The letter will represent "you" and your company. The message intended must be clear to get the desired result.

Certain fundamentals apply to all types of business letters. The following points would be kept in mind when writing a letter:

1. Write from the reader's point of view. Use "You" and "yours" instead of "I", "mine", "we", and "ours," You want the reader to feel that the letter was written especially for him.

2. The first sentence is important. The first sentence is the most important one in the letter. It sets the "tone" for the entire letter. Go directly to the point and purpose of the letter without wasting time by referring to long references to previous correspondence. Stress what the reader wants to know.

3. Be concise. You should make every word count. However, don't lose completeness in working toward brevity. You should make your letter just long enough to make your message clear without wasting the reader's time.

4. Be courteous. In making your letter concise don't let your letter sound abrupt. Courtesy will follow naturally if you write with the reader in mind. Don't ever send out a letter in anger. The friendly tone should be evident.

16381

5. Use a positive approach. Even though difficulties may arise in business they can be acknowledged in a friendly tone that suggests that a satisfactory solution can be reached.

6. Be accurate. A letter becomes a record. You must be accurate. If you quote anyone, be sure that the quotation is accurate and the person being quoted would not mind being quoted. Do not talk against anyone's character. Do not make a claim that you cannot back up.

7. Paragraph wisely. Paragraphing in business letters can often be used as an attention getter. Often a business letter is just one idea, but it is more easily understood if it is broken up into more than one paragraph.

8. Be grammatically correct. Good writing depends on the correct use of English. To write a clear, concise letter, the writer must know the rules of English and use them. A letter containing errors in English reflects on the writer and the company.

9. Make your closing effective. Your closing sentence or paragraph should be carefully stated. In short letters the complimentary closing is often the only closing that is needed. Avoid the participal endings such as "trusting," "hoping," and "thanking." These are very weak.

10. Watch your spelling and punctuation. Your spelling should be correct. If you are not sure, use your dictionary. Punctuation helps make the meaning clear to the reader.

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Assignments:

1. Read Section I on Business Letter Mechanics in your text. Study this material carefully. Be sure to check with your teacher if you have any questions. The test on Part IV includes questions on this material.

*NOTE: Worksheets 75, 89, and 95 are spelling reviews. These words are given to you on an attached sheet. You are to study these words and you will be tested on them at the end of Part IV.

2. Complete Worksheets 74, 76, 77, and 78.

3. Read Section II of your text on Letters of Inquiry. Study it carefully and check the illustrations. If you have any questions, be sure to check with your teacher.

4. Complete the assignments and worksheets under this section.

16382

NOTE: All Letters must be set up on the typewriter in letter form. You may choose the style you want. Ten points will be given for each letter with one point deducted for each error. Seven points are required to pass. Each letter should be identified in the upper left corner, directly under your name.

5. After completing the worksheets and assignments under this section, hand them to your teacher for checking.

NOTE: Letters and worksheets should be handed in after completing each topic.

6. Your teacher will go over your letters carefully. If you have any problems with a specific letter, she will give you supplemental work to help you overcome your problem. She will also check your worksheets.

7. If you attain at least 75% accuracy on your worksheets and your letters are satisfactory, you may proceed to the next topic.

8. You are to follow the same directions given for Section II (Assignments 3, 4, 5, and 6) for the remaining sections in the book. Be sure to hand letters and worksheets in after completing each topic.

9. After successfully completing all the letters and worksheets in Part IV, you will be given a spelling test on the words in Worksheets 75, 89, and 95. You are to pass this test with a minimum of 90%. If you do not reach this standard, you will be required to take another test on these words.

10. After successfully completing the spelling test for Part IV, you will be given a test on the material covered in Part IV. This test consists of a review of the various parts of the business letter and the arrangement and punctuation styles of business letters.

11. After you have completed the test for Part IV, hand it in for checking.

12. If you were able to attain at least 75% accuracy on the test for Part IV, you will be given the Final Test on Business Essentials. This test will consist of a review of punctuation, capitalization, numbers, vocabulary and sentence completion.

13. If you were unable to attain 75% accuracy on the test for Part IV, you will be given some supplemental work and help from your teacher before repeating the test and going on to the final test.

14. When you complete your final test, hand it to your teacher for checking.

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15. If you were able to pass the final test with at least 75% accuracy, you will be given the next unit (Sources of Information) in this course.

16. If you were unable to attain 75% accuracy, your teacher will give you supplementary material and help before retaking the final test.

When you have successfully completed this unit, you will be given Unit II. (Sources of Infotmation)

16384

SPELLING WORDS

(#89 Continued)

51. bow
52. currant
53. current
54. hem
55. him
56. hymn
57. aid
58. aide
59. heal
60. heel
61. holey
62. holy
63. wholly
64. precedents
65. precedence
66. correspondents
67. correspondence
68. capital
69. capitol
70. feat
71. feet
72. beat
73. beet
74. find
75. fined
76. ceiling
77. sealing
78. assent
79. ascent
80. sole
81. soul
82. vain
83. vane
84. vein
85. vale
86. veil
87. threw
88. through
89. flew
90. flue
91. seem
92. seam
93. scent
94. sent
95. wares
96. wears
97. wry
98. rye
99. cell
100. sell

Work Sheet No. 95

1. mayor
2. miscellaneous
3. necessarily
4. nicket
5. occasionally
6. patient
7. peculiar
8. percentage
9. permanent
10. preliminary
11. prepaid
12. preparation
13. presentation
14. prevailing
15. primarily
16. privilege
17. prominent
18. proportion
19. prospective
20. prosperous
21. questionnaire
22. receive
23. recommendation
24. remittance
25. respectable
26. respectively
27. responsible
28. salary
29. sanitary
30. satisfactory
31. secretary
32. seized
33. separate
34. signature
35. similar
36. solicit
37. stationery
38. strictly
39. subsidiaries
40. superintendent
41. supervision
42. supersede
43. telegram
44. temperature
45. temporarily
46. treasurer
47. truly
48. undoubtedly
49. warehouse
50. Wednesday

16385

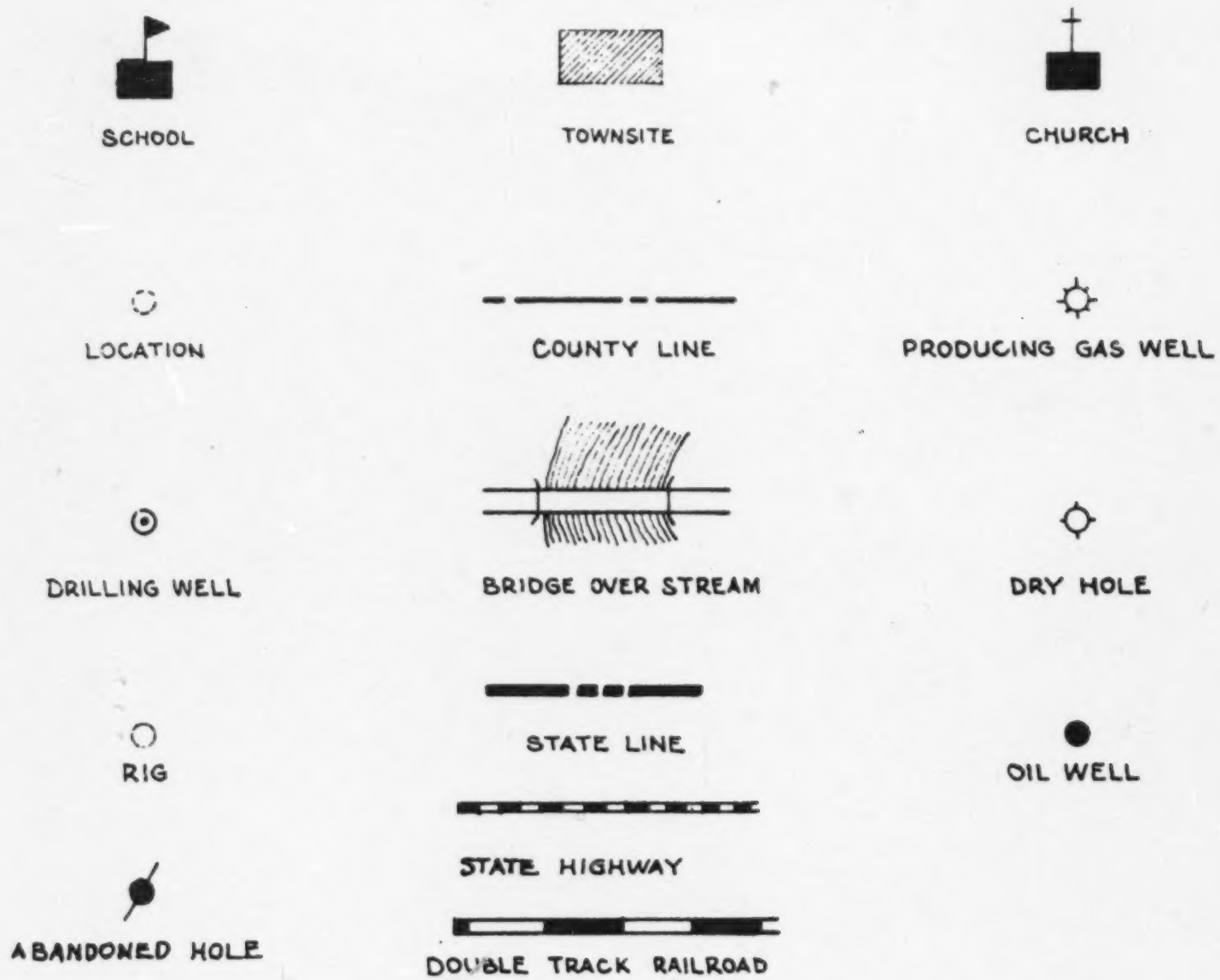

TOPOGRAPHICAL SYMBOLS

ILLUSTRATION SHEET 4.

1636

SPELLING WORDS

Work Sheet No. 75

1. air
2. ere
3. heir
4. aisle
5. I'll
6. isle
7. bail
8. bale
9. bare
10. bear
11. board
12. bored
13. break
14. brake
15. lone
16. loan
17. buy
18. by
19. cast
20. caste
21. fair
22. fare
23. cede
24. seed
25. cent
26. scent
27. sent
28. chased
29. chaste
30. choir
31. quire
32. cite
33. sight
34. site
35. climb
36. clime
37. coarse
38. course
39. core
40. corps
41. lessen
42. lesson
43. dear
44. deer
45. dun
46. done
47. duel
48. deal
49. here
50. hear
51. aught
52. ought
53. waive
54. wave
55. foul
56. fowl
57. cymbal
58. symbol
59. principal
60. principle
61. lean
62. lien
63. session
64. cession
65. counsel
66. council
67. cord
68. chord
69. scene
70. seen
71. hole
72. whole
73. miner
74. minor
75. pore
76. pour
77. plane
78. plain
79. strait
80. straight
81. waver
82. waiver
83. calendar
84. calender
85. canvas
86. canvass
87. current
88. currant
89. shear
90. sheer
91. suite
92. sweet
93. right
94. rite
95. write
96. waist
97. waste
98. pear
99. pair
100. pare

Work Sheet No. 89

1. fate
2. fete
3. fir
4. fur
5. flea
6. flee
7. foul
8. fowl
9. gait
10. gate
11. guilt
12. gilt
13. grate
14. great
15. guessed
16. guest
17. hall
18. haul
19. hole
20. whole
21. heard
22. herd
23. hew
24. hue
25. horde
26. hoard
27. hoarse
28. horse
29. jam
30. jamb
31. knave
32. nave
33. knead
34. need
35. knew
36. new
37. knight
38. night
39. knows
40. noes
41. nose
42. lead
43. led
44. leased
45. least
46. lie
47. lye
48. pleas
49. please
50. bough

16386

SPELLING WORDS

Work Sheet No. 43

1. accessories
2. accidentally
3. accommodation
4. all right
5. auxiliary
6. beneficiaries
7. benefited
8. definitely
9. disappointment
10. embarrassment
11. enforceable
12. exhilarate
13. indebtedness
14. indispensable
15. irresistible
16. jeopardize
17. laboratory
18. judgment
19. licensing
20. maintenance
21. manageable
22. miscellaneous
23. necessarily
24. parallel
25. recommendation
26. procedure
27. separately
28. serviceable
29. superseding
30. transferable
31. abridgment
32. advisable
33. anonymous
34. attorneys
35. comparable
36. conscientiously
37. dissension
38. divisible
39. equipment
40. extraordinarily
41. financially
42. incessantly
43. incidentally
44. interceding
45. misspelled
46. omitting
47. superficially
48. subsidiaries
49. temperamental
50. unnecessary

Work Sheet No. 63

1. buffaloes
2. quizzing
3. knocking
4. calmly
5. cargoes
6. thinly
7. loaves
8. foolish
9. dwarfs
10. riddance
11. bailiffs
12. wrapped
13. knitted
14. courts-martial
15. appendices
16. monkeys
17. companies
18. sweeter
19. geniuses
20. wives
21. chopped
22. mottoes
23. taxing
24. genii
25. annulment
26. cupfuls
27. weigh
28. paralleling
29. Misses
30. beige
31. bier
32. Messrs.
33. sopranos
34. either
35. boxes
36. tobaccos
37. seize
38. chassis
39. embargoes
40. media
41. Mesdames
42. condemning
43. handkerchiefs
44. menservants
45. appealing
46. foreign
47. necessities
48. occurrence
49. leisure
50. pianos
51. equipping
52. Eskimos
53. sleight
54. wharves
55. deferring
56. attorneys
57. ratios
58. regrettable
59. desperadoes
60. benefiting
61. canceled
62. dynamos
63. alumnae
64. bacteria
65. data
66. paneling
67. foci
68. proficient
69. relief
70. larvae
71. quarreling
72. rein
73. stadia
74. neither
75. rebellion
76. synopses
77. weird
78. beveling
79. stimuli
80. height
81. preference
82. tableaux
83. provisos
84. tunneling
85. forbidding
86. vertebrae
87. mathematics
88. sovereign
89. children
90. ellipses
91. valleys
92. conscience
93. Adamses
94. forfeit
95. facilities
96. theses
97. brief
98. tomatoes
99. scissors
100. 6's

16387

UNIT II

SOURCES OF INFORMATION

BEHAVIORAL OBJECTIVE:

At the conculsion of the unit you will be able to locate information on a variety of topics, when it is needed, quickly and accurately by being acquainted with the standard reference sources. No test will be given on this unit. This is a continuous unit and should be applied through the course.

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Text: Applied Secretarial Practice, Sixth Edition, by Gregg, Fries, Rowe, and Travis; McGraw-Hill Book Company, New York, New York 1968.

In most jobs it is not so important to know details of information not primarily connected with your work as it is to know where to find what you want, when you want it. Therefore, you must be acquainted with standard reference sources as well as the resources of your own company office and library. A list of reference sources is included with this unit.

Assignments:

A. Read and study Unit 7, pages 145-161 in Applied Secretarial Practice, Sixth Edition so that you will be able to complete the succeeding assignments successfully.

B. Using the attached sheet, "Reference Sources," And the facilities in the library and the reference material available on the shelves in the Business Department, type the correct answers to the following inquires on a separate sheet of paper. Type the questions and then the answers. Be sure to include the source of your information:

1. Today the following words were misspelled. What is the correct spelling?

   (a) Czecholovakia
   (b) Phillipines
   (c) Wilkes Barre
   (d) Cincinatti
   (e) Milwalkee

2. Your employer has asked you to find a quotation about "friends" which he can use in a speech he is giving on Monday of next week. Locate a quotation on "Friends".

3. Some words are frequently overworked in letter writing. Prepare a list of synonyms that could be used for each of the following:

   (a) nice
   (b) unusual
   (c) important
   (d) fine
   (e) put

4. What is the correct salutation for a clergyman?

5. Should cooperate and reread be hyphenated?

6. Is there a space after the first period in writing Ph.D.?

7. Find the names and addresses of five firms in your community or area that sell linoleum.

8. What is the population of Philadelphia?

9. What is the difference in the meaning of each of the following pairs of words?

   (a) effect
       affect

   (b) accede
       exceed

   (c) principle
       principal

   (d) elicit
       illicit

   (e) correspondents
       correspondence

10. Who said, "He who rebukes the world is rebuked by the world"?

11. Who are the present members of the U. S. Supreme Court?

12. What was the population of St. Louis, Mo., at the last official census?

13. What do the middle initials stand for in the name Samuel F. B. Morse?

14. What was the enrollment at Utah State University last year?

15. Your employer has dictated the following quotations from memory:

    (a) "He that has a merry heart has a continual feast."

    (b) "If you laugh, the world laughs with you; If you weep, you weep alone."

    (c) "The old order changes, giving place to new;
    And God fulfills himself in many ways, For fear
    one custom should corrupt the world."

    Verify the accuracy of each quotation. Give the name of the author and the source (book, play, poem, etc.) of each quotation.

16. What is the source of the expression, "Something is rotten in Denmark"?

17. List ten kinds of information found in the World Almanac or Information Please Almanac.

18. James Rogers used "S. J. D.," after his name, as author of a magazine article. What does it stand for?

19. Using a secretarial handbook, make a list of twelve kinds of information found there that you believe would be especially helpful to you as a secretary.

20. Correct the spelling of the following geographical names:

    (a) Wooster, Massachusetts
    (b) Muncie, Pennsylvania
    (c) Annarber
    (d) San Deago

21. What do the abbreviations sec., opp., prop., wrnt., and asst. stand for?

22. What is the correct formal salutation for all military and naval personnel irregardless of rank or rating?

23. Name two plays written by Thornton Wilder.

24. In looking up quotations, you will find the following abbreviations: ib., ibid., can., v., l., and st. What words do they stand for and what do they mean?

25. Using the two-letter state abbreviations that can be used with zip code, how would you abbreviate the following states? Ohio, Wyoming, Iowa, Florida, and New Mexico?

26. What do e.g. and i.e. stand for and how does one distinguish between their usage?

27. Find the meanings for the following abbreviations: USES, FDIC, CPA, CLU, EKG, and VIP.

28. How would you address a letter for the Governor of Utah? Give the complete inside address for the letter.

29. How far is it from Salt Lake City to Boise, Idaho? to Chicago? to New Orleans?

30. Whose face was said to have "launched a thousand ships"?

31. What do the following abbreviations used by the post office stand for:

    (a) ct.
    (b) sta.
    (c) R.
    (d) Al.
    (e) Ter.

32. A visitor remarked, "This office would be Utopia if it had air conditioning." What does "Utopia" mean?

33. In military or governmental correspondence, how is the date typed?

34. What cities have buildings over 1,000 feet in height? Also, list the name of the buildings.

35. What are the zip codes for the following addresses or cities:

    (a) 180 Fair Oaks Way
        Salem, Oregon

    (b) City Hall
        Inston-Salem, North Carolina

    (c) Monroe Community College
        Rochester, New York

    (d) 6396 Borg Circle
        Ogden, Utah

    (e) Utah cities: Leeds, Hiawatha, Thistle, Deseret, and Sunnyside

36. Look up, identify, and give the correct pronunciation by markings of the following: Pierre, Worcester, Baton Rouge, Eau Claire, San Joaquin, Puerto Rico, Oahu.

37. What is the size of Baronial stationery and the preferred envelope size number?

38. How high is Mt. McKinley?

39. What is the address and zip code for Hill Air Force Base?

40. What is the correct form for an unmarried woman to use on the signature line of a letter?

41. Who won the World's Series in baseball last year?

42. The following address was found on a letter in today's mail: 1439 West 205 North, N.W. What does the "N.W." stand for and should there be a space after the first period? Should this abbreviation be spelled out?

43. In what year and where was Richard M. Nixon born?

44. What title should be used if you do not know if a woman is Miss or Mrs.?

45. What is the fastest means of sending a short written message to England? How will the charge for this message be determined?

46. In what year did George Washington become the first president of the United States?

After successfully completing this unit, you will be given Unit III (Spelling Improvement).

REFERENCE SOURCES

The following list has been prepared that will group reference books under various headings to make it easy for you to locate information:

Information concerning people and business concerns:

1. Telephone directory--contains names and addresses of subscribers.
2. Classified directory--a telephone directory classified according to types of business or professions.
3. City directory--contains names and addresses of residents of a community.
4. Who's Who in America--an alphabetical list of important living people in the United States.
5. Trade, Professional, or Institutional Directories--lists doctors lawyers, insurance agents, and many others.
6. Credit Information--Dun and Bradstreet gives information concerning credit ratings of businessmen and firms. The local credit bureau gives information concerning credit ratings of individuals in a community.

Information concerning words:

1. Dictionaries--spelling, pronunciation, syllabification, meaning of words, and so forth.
2. Synonyms and Antonyms--show words of same meaning and words of opposite meaning.
3. Thesaurus--collection of words according to ideas.
4. Quotations--collection of quotations listed alphabetically according to authors and topics.
5. Secretarial Handbooks

Information concerning facts:

1. The Encyclopedia--gives information on many subjects.
2. The World Almanac and Information Please Almanac
3. The New York Times Index--guide to news items
4. Reader's Guide to Periodical Literature
5. Specialized dictionaries, encyclopedias, and handbooks, based on subject or profession.

Information concerning geography, travel, and transportation:

1. Atlases--collections of maps
2. Automobile guidebooks
3. Gazetteers--names and descriptions of town, cities, rivers, mountains, and countries
4. Maps--road maps, subw ay maps, and so forth
5. Official Hotel Red Book and Directory
6. Shipping and railway guidebooks
7. United States Official Postal Guide
8. National Zip code directory

UNIT III

SPELLING IMPROVEMENT

BEHAVIORAL OBJECTIVE

At the conclusion of this unit the student will demonstrate his mastery of business vocabulary through spelling correctly, according to the rules set up in the unit. He will complete various assignments and be able to pass three diagnostic tests and one achievement test with a minimum of 90% accuracy.

- - - - - -

Text: English Style Skill-Builders, Joseph B. Cleary, Ed.D.; McGraw-Hill Book Company, New York, New York 1967

The major area of knowledge in which stenographers need improvement is SPELLING. Correct spelling is a "must" for the prospective stenographer. The "mailable" transcript is the only standard for judging the quality of a transcript--a misspelled word automatically makes the transcript unusable.

Assignments:

1. Obtain a spelling improvement booklet from your teacher.

2. Read and study carefully the material on page 1 and 2 of the booklet. Pay particular attention to the "Study Techniques" listed on page 1. These techniques give good suggestions on how to spell better.

3. Go over the list of "Business Words" on page 2. This list is made up of words frequently misspelled in business correspondence. You can master the spelling of these words if you follow the procedure set forth under "Study Techniques" on page 1.

As you study this list of words, start your own "study list" of the words that may give you trouble. You should add to your "study list" from time to time as you come across words that are difficult for you to spell in your various transcription assignments.

You will be tested on your mastery of these words in the drills to follow--study them well.

4. After you have studied the words on page 2 carefully, ask your teacher for Drill 1.

5. You are to type your answers to the questions in the drill on a piece of type paper. Be sure to number each question (you do not need to type the lines). You should identify your paper by typing

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your name and drill number in the upper left corner of your paper. Use double spacing. You may use both sides of the paper when necessary so all of the drill can be on one sheet.

6. After you have completed Drill 1, check it with the key. Take one point off for each error. Put the total errors at the top of the paper. Add the words you have missed to your "study list" so that you may master these words. Hand your drill in to be recorded.

Read and study page 3 in the spelling improvement booklet. You may also add cities in your own area, that might give you trouble, to your list.

The "memory aids" are good suggestions--make some of your own.

7. Obtain Drill 2 from your teacher and proceed as directed in Assignment 5 and 6. The letter in Drill 2 should be typed twice--single spaced on the back of the paper used for Drill 2. This is a typing drill, and the errors should be counted in the total for Drill 2.

8. Read and study 1, 2, and 3 on page 4 of the spelling improvement booklet.

9. Obtain Drill 3 from your teacher and proceed as indicated in Assignments 5 and 6.

10. Study 4, 5, 6, 7, 8, 9, and 10 on pages 4 and 5 of the spelling improvement booklet.

11. Obtain Drill 4 from your teacher and proceed as directed in Assignments 5 and 6. In Drill 4B type the entire word in each case.

12. Obtain the Diagnostic Test A from your teacher. Type your answers on a piece of type paper. Use double spacing and number each item. You do not need to type the line or the rule number. Be sure to identify your paper as you did on your drills.

13. After completing the Diagnostic Test A, hand your paper to your teacher for checking. If you were able to attain 90% or more accuracy on this test, you may proceed to the next step. If not, your teacher will give you supplementary material.

14. Study the words frequently confused in transcription on pages 5 and 6 of the spelling improvement booklet. Even though words may sound alike they are spelled differently. It is necessary to know the meaning of the word to be able to spell it correctly.

15. Obtain Drills 5 and 6 from your teacher. Type the answers to Drill 5 on one piece of paper and Drill 6 on another. In Drill 6, type the entire letter using single spacing. Fill in the correct word and underscore it.

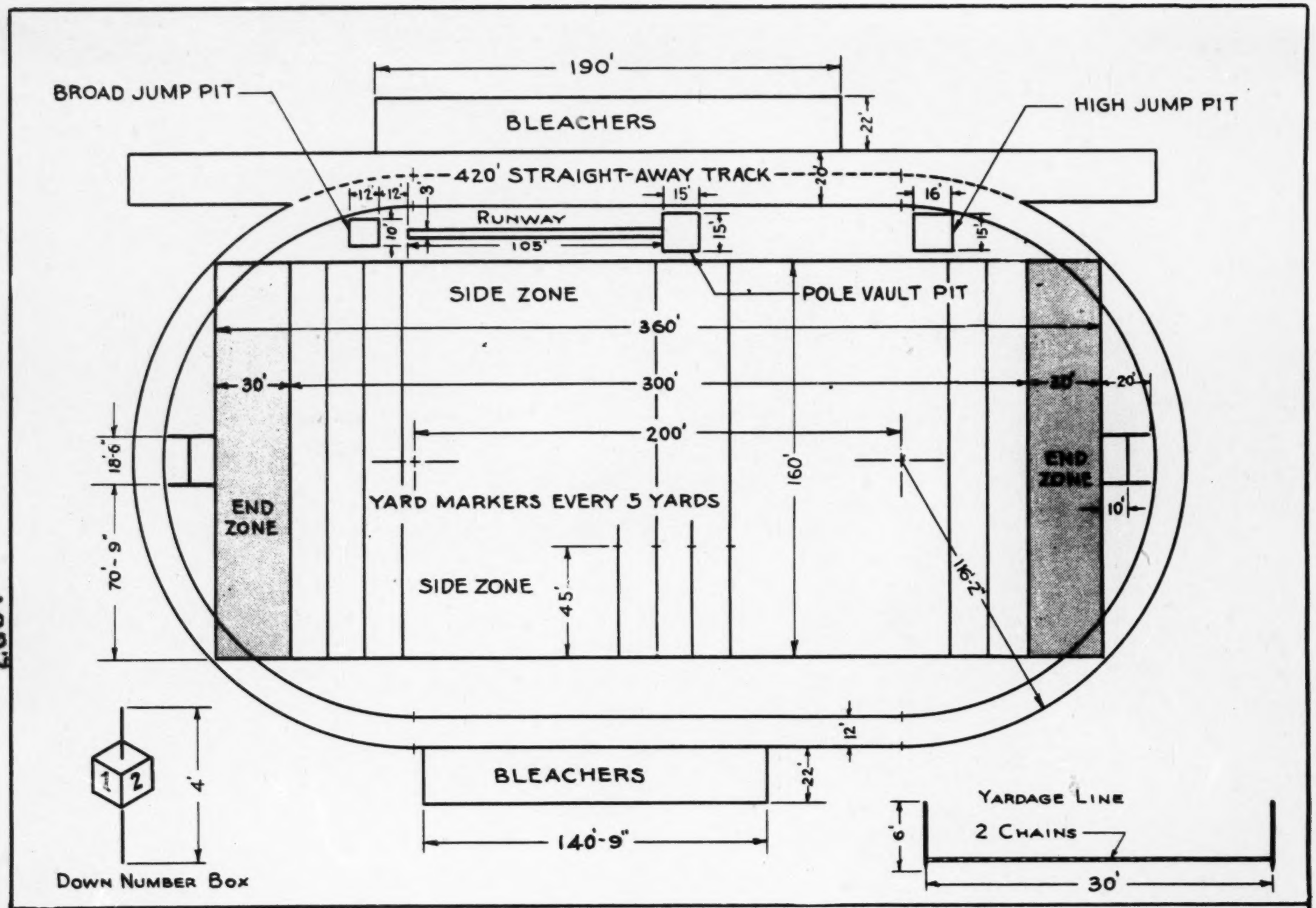

ILLUSTRATION SHEET 5.

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16. After completing Drills 5 and 6, check them with the key according to Assignment 6.

17. Obtain the Diagnostic Test B from your teacher and complete it according to Assignments 13 and 14.

18. Read and study the material under "One Word or Two?" on pages 6 and 7.

19. Obtain Drill 7 from your teacher and proceed as directed in Assignments 5 and 6. Type the entire letter Drill 7 using single spacing. Fill in the correct word and underscore it.

20. Read and study the material on pages 7 and 8.

21. Obtain Drills 8 and 9 from your teacher and proceed as instructed in Assignments 5 and 6. Be sure to put each drill on a separate piece of paper.

22. Obtain the Diagnostic Test C from your teacher and complete it according to Assignments 13 and 14.

23. Obtain the Achievement Test from your teacher. Type your answers on a sheet of type paper. Use double spacing and number each item. You do not need to type the line. Use one sheet of paper. If necessary, use both sides of the paper.

24. After completing the Achievement Test, hand it to your teacher for checking.

25. If you were able to attain at least 90% accuracy, you have completed the unit on Spelling Improvement. If you were unable to attain 90% accuracy, your teacher will give you supplementary material and help before retaking the test.

After you have completed Unit I, Unit II, and Unit III of this course, you will be awarded a letter grade and one-half credit.

PART FIVE

ON-THE-JOB TRAINING

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ON-THE-JOB TRAINING

BEHAVIORAL OBJECTIVE:

The student should be able to adapt herself to an actual job situation. This is accomplished by working in one of the school offices performing the various tasks of that office or completing a simulated office unit. Students will be evaluated on ability to perform on the job as to skills, attitudes, dependability, initiative, grooming, and personality. No test will be given on this unit.

- - - - -

INSTRUCTIONS:

You must complete Unit I. Review of Typing, of the Secretarial Procedures or Clerical Office Course. This unit is presented the first week of school. However, if more training is needed on a certain skill, it must be completed before you are placed on the job.

You will be placed in one of the school offices two hours a day for a nine-week period where you will have various tasks to perform.

A copy of the evaluation sheet used is attached. The evaluation given will determine your grade for the course.

After completing your nine-week training period, you will be issued a letter grade and one-half credit.

NOTE: If a simulation unit is used, it will substitute on-the-job training in a school office and will be given the second semester, one hour a day for a nine-week period. At the conclusion of this simulation unit, you will be awarded a letter grade and one-fourth credit.

WEBER HIGH SCHOOL

On-the-Job Training

Instructor _____

_____

Student's Name _____

Date: From: _____ Supervisor _____

To: _____

Rating: _____

Directions: Read over each line carefully. Circle the number over the phrase which describes the student most accurately. Make only one circle on each line, and be sure to circle every line.

1. Appearance

10	9	8	7	6	5	4	3
Makes an excellent appearance		Usually neat and tidy in appearance		Sometimes neglects appearance		Should improve appearance	

Comments: _____

_____

2. Personality

10	9	8	7	6	5	4	3
Personality is outstanding		Has a pleasing personality		Personality is unimpressive		Does not get along well with others	

Comments: _____

_____

3. Interest

10	9	8	7	6	5	4	3
Usually enthusiastic about work		Shows interest in work most of the time		Interested only in certain phases of job		Should show more interest in work	

Comments: _____

_____

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4. Cooperation

10	9	8	7	6	5	4	3
Goes out of way to cooperate		is usually cooperative		helps only when asked		Does not work well with others	

Comments: _____

_____

5. Directions

10	9	8	7	6	5	4	3
Reliable in following Directions		Usually follows Directions well		Sometimes careless in following directions		Cannot always rely on to follow directions	

Comments: _____

_____

6. Initiative

10	9	8	7	6	5	4	3
Recognizes work to be done and does it without direction		Sometimes goes ahead in work not assigned		Performs regular routine duties only		Seldom seeks work beyond regular routine duties.	

Comments: _____

_____

7. Judgment

10	9	8	7	6	5	4	3
Wise in actions and in making decisions		Usually shows sound judgment		Sometimes shows lack of judgment or discretion		Lacks ability to make sound decisions	

Comments: _____

_____

8. Absence

10	9	8	7	6	5	4	3
Has perfect attendance		Occasionally absent but with good excuse and advance notification		Occasionally absent without good excuse		Frequently absent	

Comments: _____

_____

9. Tardiness

10	9	8	7	6	5	4	3
Always on time		Occasionally late but with good excuse		Sometimes late without good excuse		Frequently late	

Comments: _____

_____

10. Production

10	9	8	7	6	5	4	3
Is outstanding in production		Exceeds average production		Is average in production		Should produce better	

Comments: _____

_____

11. Public Relations

10	9	8	7	6	5	4	3
Meets and talks with people exceptionally well		Is good with public most of the time		Needs to improve in meeting and talking with people		Is not at all public oriented	

Comments: _____

_____

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Fire Control: Flammable Liquids and Gases.
California Fire Training Program.

California State Dept. of Education,
Sacramento. Instructional Materials Lab.
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ABSTRACT - Developed by the Instructional Materials Laboratory of the California State Department of Education for use by local fire departments in planning, developing, and maintaining fire training programs, this instructional manual provides a guide for intensive training in controlling and extinguishing oil and gas fires. The contents, following the plans used by oil industry instructors and by several fire service schools, are divided into four parts: (1) Fundamentals, (2) Oil Fire Control Problems, (3) Practical Training Techniques, and (4) Oil Fire Training Films. The manual is illustrated with numerous photographs and diagrams. (GEB)

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FIRE CONTROL

FLAMMABLE LIQUIDS AND GASES

CALIFORNIA FIRE TRAINING PROGRAM

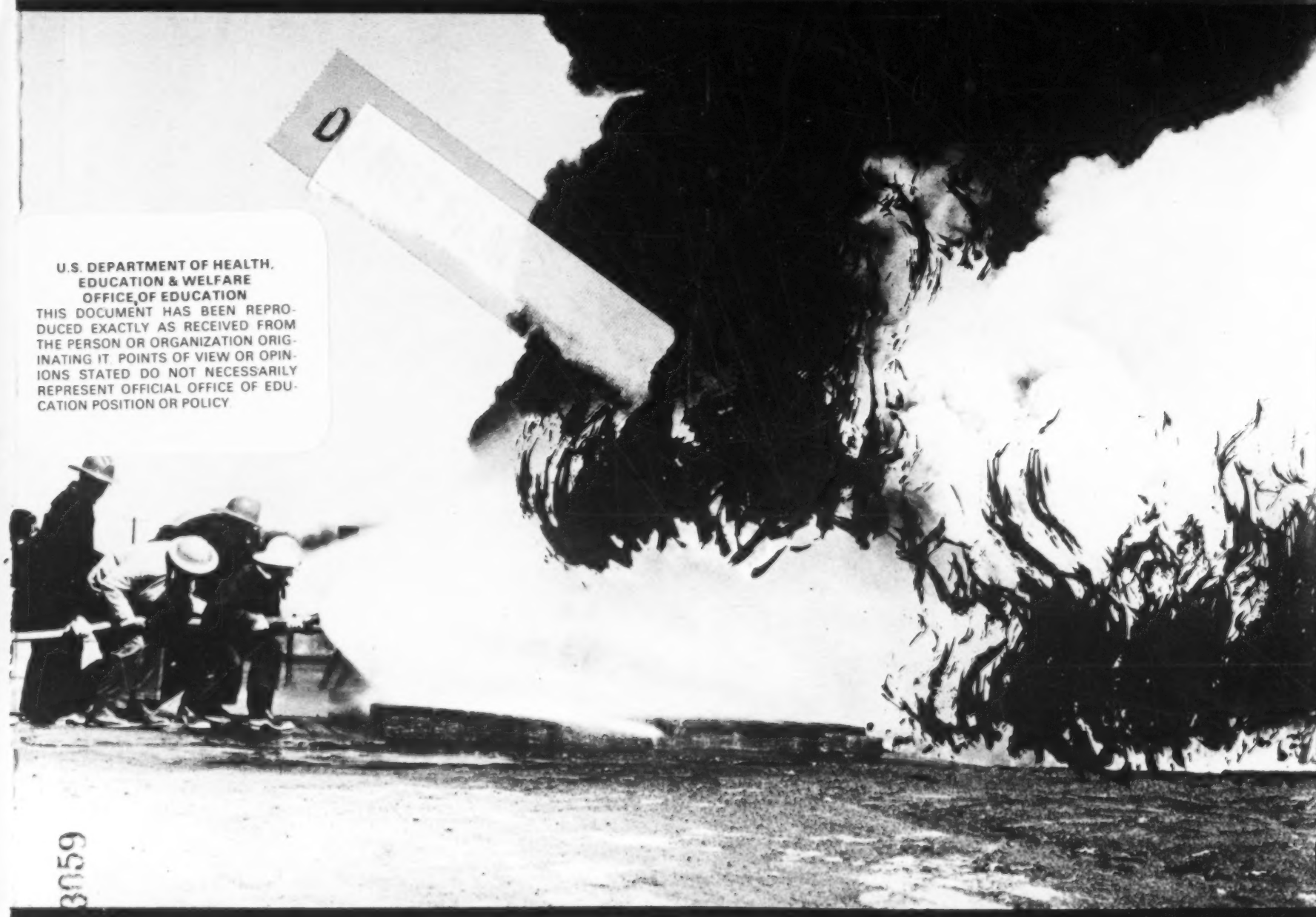

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CALIFORNIA STATE DEPARTMENT OF EDUCATION
BUREAU OF INDUSTRIAL EDUCATION

FIRE CONTROL

FLAMMABLE LIQUIDS AND GASES

CALIFORNIA FIRE TRAINING PROGRAM

INSTRUCTIONAL MATERIALS LABORATORY

BUREAU OF INDUSTRIAL EDUCATION

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FOREWORD

Firemen must be properly trained to meet their responsibilities. Not all of their training can be acquired early in their employment because fire problems change as new combustible materials are invented or used, new kinds of structures are designed, and new methods of fire protection are developed. Training, therefore, must be an on-going process to keep the experienced man abreast of developments as well as to teach the rookie. Training is also necessary for the special areas of fire work, of which the control of flammable liquids and gases is one.

The greatest problem in training firemen for oil fire control is providing adequate experience. This manual shows how to set up practice fires with small, inexpensive props. It outlines practice drills step by step and presents demonstrations for the drill field and the classroom. In addition, it contains related information and sources of visual aids.

This manual should be most useful in planning, developing, and maintaining fire training programs. It should also stand as a tribute to the public servants and members of the oil industry who developed these important techniques.

Max Rafferty

Superintendent of Public Instruction

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Assignment

WS. 7. Circle Graph: A circle is given which represents a 24 hour day. First make a plan of how many hours you spend each day on each of the activities shown in the chart in the lower left-hand corner of the Work Sheet. The hours should total 24, the number of hours in one complete day (day and night). Draw guide lines in the blank spaces of the chart and letter carefully the number of hours you have chosen for each of the activities shown. Try to allot your time so that you have no fractions of hours under ½ hour, such as, meals 1½ hours. Now letter in the ratio of hours each activity takes in relation to the whole day. An example of this might be the case of a boy who spends 9 hours in sleep. The ratio would then be 9/24 (or reduced - 3/8).

From our study of arithmetic, we know that a complete circle divided into 24 parts (360° ÷ 24) would equal 15 degrees for each part, or 15 degrees represents 1 hour. To find how many degrees each activity will take up on the circle, multiply the number of hours for the activity by 15 degrees. As an example, if a boy slept 9 hours of the day, he would multiply 9 times 15 degrees and his answer would be 135 degrees to represent hours spent in sleeping.

Find the degrees for each activity, as in the example above, and check to see that the total comes to 360 degrees. Now letter-in neatly (do not write as in arithmetic) the degrees for each activity.

PREFACE

Most firemen are experienced in fighting average structural fires, such as fires in residences, business establishments, and factories. Some firemen are specialists in forest and brush fires. Some are experienced in ship fires and airplane crash fires. Large oil fires are also in a special category. In some areas of California, where oil fields and refineries are concentrated, the local firemen have had much experience with oil fires, and they work closely with the oil industry fire protection engineers.

For many years the fire protection personnel of the oil industry have conducted small oil fire training sessions with firemen in limited areas. In 1955 the Fire Training Program of the Bureau of Industrial Education, California State Department of Education, organized a statewide Oil Fire Control School at Bakersfield. The Kern County Fire Department, with long experience in fighting oil fires, and the oil industry fire protection personnel (through the Western Oil and Gas Association Fire Committee) cosponsored and operated this school in cooperation with the State Fire Training Program.

This three-day school started March 24, 1955, with 583 firemen attending the indoor classroom sessions and outdoor fire demonstrations and participation drills. A repeat school was held on March 9-11, 1961, with 641 firemen in attendance. Obviously, many firemen were unable to participate in this training, and they have asked for more schools. Since these large-scale projects are costly and time-consuming, however, they cannot be held often.

To assist local fire departments in conducting their own oil fire training programs, therefore, members of the California Fire Training Program staff decided that this manual should be prepared. It contains most of the material from the manuals used at the Bakersfield schools. The papers have been revised and brought up to date, and a large amount of new material has been added.

The writers have had long experience in the practical side of the prevention, control, and investigation of oil and gas fires. Men who know them consider them experts in this field. Each of the papers indicates the name of its author except the papers that have been added by the editor, James E. Hill, formerly of Union Oil Co. of California. The editor also wrote introductions to help the

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reader relate the subject of each paper or group of papers to the entire field of oil fire fighting. The project was developed under the auspices of the California Fire Training Program, Thomas S. Ward, Supervisor.

RICHARD M. CLOWES, Chief
Division of Instruction

ERNEST G. KRAMER, Chief
Bureau of Industrial Education

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INTRODUCTION

Gasoline causes more fires than solvents . . . kerosene . . . diesel, stove, and fuel oils . . . lube and grease stocks . . . and asphalt--or all of these combined, even though their total volume is more than that of gasoline. These products are nonvolatile and less hazardous than gasoline, and their fires are much easier to extinguish.

Most vehicles use gasoline. In 1961 there were 63 million automobiles and 11 million trucks in the nation. In 1962, in California alone, 8.6 million cars and trucks used more than 6 billion gallons of gasoline. Still more is used in motor boats, power lawn mowers, stationary engines, etc.

When the enormous consumption of gasoline is considered, it is surprising that more fires do not start from the misuse and mishandling of this fuel. Possibly it speaks well for the fire prevention codes and standards and safe practices within the oil industry itself. Continuing education of fire service personnel, oil industry people, and the consumer is the most important factor in reducing the annual national fire loss of $1.5 billion. This loss presents a continuing challenge to us all.

Part of the answer to this challenge is, it is hoped, the publication of this manual. It is a guide for intensive training in controlling and extinguishing oil and gas fires. Its content follows the plan developed by oil industry instructors for training oil industry employees and used in several fire service schools in addition to the Bakersfield Oil Fire Control Schools of 1955 and 1961. Parts 1 and 2 of this manual present topics covered in the classroom sessions of the Bakersfield schools. These represent the theory of the course--basic information and techniques of fighting oil fires.

Part 3 covers the outdoor, practical portion of the instruction. Firemen often find this to be the most interesting part of the work. Included are drills for the men and demonstrations to be presented by the instructors, together with instructions for constructing inexpensive, adequate props for many fire problems. Questions and answers, to test readiness for these field problems and to stimulate discussion and review, are included in Part 3. So is a history of fire schools, which contains photographs of additional props.

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Part 4 lists films that are helpful in training men for oil fire duty.

Although the authors are members of the western oil and gas industry, they do not necessarily describe the opinions or practices of all participants in the Bakersfield Oil Fire Control Schools or of the members of the Western Oil and Gas Association. Nor have they attempted to cover completely all of the subjects relating to oil fires.

THOMAS S. WARD, Supervisor
Fire Training

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PART 1 FUNDAMENTALS

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1 BASICS OF OIL FIRE PROTECTION

This is an elementary explanation of the term "fire protection" and of the burning characteristics of different gas and oil fuels. It lays the groundwork for the papers that follow.

Every fireman knows that water should not be put directly into a hot tar pot--and why. He knows that he should not extinguish a gas fire unless the gas fuel has been shut off. However, he may not know other important techniques that are not so obvious. Many oil fires are handled improperly and unsafely because the fireman has not learned the fundamentals. This applies to all phases of fire fighting but it is especially important with oil fires, because different fuels sometimes behave differently.

The fundamentals presented in this paper should be reviewed thoroughly. While reading the material, for instance, underline what is meant by "flash point" and "flammable limits" of a fuel. After you have finished reading, try to recall the meanings of these terms and the other important facts. Then answer the questions in No. 5 of Part III, and compare your answers with the answers provided. (This paper is a revised reprint from the manuals of the 1955 and 1961 Bakersfield Oil Fire Control Schools.)

"Fire protection" is a combination of fire prevention, fire control, and fire extinguishment. Fire prevention is taught to acquaint people with the causes of fires so they can be prevented more readily. Fire control is taught to minimize the spread of fire and to decrease the damage from fire. Some fires are fought best by permitting the fuel to burn out under control until the source of fuel can be shut off. Fire extinguishment is taught so that fires can be fought quickly, skillfully, and effectively.

Essentials of Combustion

In order for fire to start, three factors must be present together and under the right conditions: fuel, air, and a source of ignition.

Fuel. Fuel is something to burn. Oil fuels normally must be in the form of vapor to burn. Some fuels already are in vapor form or will release vapor at ordinary air temperatures. LP (liquefied petroleum) gas and gasoline are examples of this type of fuel. Heavier oils, wax, asphalt, tar, and most solid fuels, such as wood, will supply vapor when heated. They must be raised to their flash point before they can be ignited.

16414 J/

The "flash point" of an oil is that temperature to which the oil must be heated to give off enough vapor to ignite when a flame is brought near it. The flash point test is performed in standardized laboratory apparatus. Gasoline, being very volatile, has a low flash point, about -50° F. When the very volatile fractions are removed from gasoline in the refinery, a relatively safe cleaning solvent (Stoddard Solvent) is made. Its flash point is about 105° F. Other oils have still higher flash points, as shown in Table 1, which also indicates the flash points of two oils that are less volatile by far than the rest. All these oils are termed "nonvolatile."

TABLE 1
Flash Points of Various Oils

Type of Oil	Approximate Degrees F
Kerosene	125-140
Stove oil	120-165
Diesel oil	150-180
Heavy fuel oil	150-180
Lube oil	450
Petroleum wax	450

Nonvolatile oils, which are any oils with flash points higher than the ordinary temperature of air, are relatively safe if not heated above their flash point.

Under some rare conditions, mists or sprays of high flash oils may actually ignite. Such an occurrence is similar in principle to explosions of flour or coal dust.

Air. The second essential for combustion is air, which is needed to supply the oxygen necessary for combustion. Air contains 21 percent oxygen. The remaining percentage is composed primarily of nitrogen, which, being an inert gas, neither burns nor supports combustion. All oil and gas fuels require air to burn. For example, one volume of gasoline vapor requires nearly 16 volumes of air to burn. This is equivalent to a mixture containing about 94 percent air and 6 percent vapor.

A practical example of the burning limits of an air-gasoline vapor mixture is illustrated by the automobile engine. Under atmospheric conditions, if there is less than about 1 percent vapor in the mixture, it is too lean to burn, and

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if there is more than about 6 percent vapor present, the mixture is too rich to burn. This range between 1 and 6 percent for gasoline is called its "flammable" range. Kerosene and other common oil vapors have approximately the same range or limits.

Flammable ranges of other common fuels are shown in Table 2.

TABLE 2
Flammable Ranges

Fuel	Approximate Percent
Fuel gas (methane)	5-14
Propane	2-10
Butane	2-9
Hydrogen	4-75
Acetylene	3-81
Grain or ethyl alcohol	4-19

The specific figures for each fuel are called its "lower flammable limit" and "upper flammable limit." Although the term "explosive limit" sometimes is used, it is not accurate, since ignition and fire usually occur without an explosion.

A source of ignition. A fire cannot start without a source of ignition. The heat must be in sufficient quantity and at a sufficiently high temperature to ignite petroleum vapors.

The ignition temperature of a fuel vapor is the lowest temperature to which a flammable fuel-air mixture must be heated to ignite. The ignition temperature of a fuel is not a fixed value since it depends upon the method of contact of the flammable mixture with the heating surface and other factors. For example, the ignition temperature of gasoline vapor may vary from about 500° F to above 1000° F, depending upon the testing method. The NFPA Handbook of Fire Protection, twelfth edition, lists the ignition temperature of gasoline vapor at 536° F to 880° F, depending on the grade. These are temperatures established by special testing methods where a static film of fuel is exposed to a hot surface. In ordinary practice, when gasoline vapor flows over a hot surface or liquid is sprayed on it, as has been determined by practical tests, the hot surface must be well above 1000° F to produce ignition.

Some fuels ignite more readily than others. For example, gunpowder, hydrogen, and acetylene and some others ignite much more easily than LP gas or gasoline vapors.

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Ignition temperature values should not be confused with flash points. The flash points indicate ease of evaporation; ignition temperatures indicate the ease of ignition. The lighter oils (such as propane, butane, gasoline, and others), being highly volatile, have flash points much below zero but, being stable chemicals, ignite at high temperatures--over 1000° F. Heavy oils, like lube oil, wax, and asphalt, have high flash points but ignite at temperatures relatively lower than the lighter oils. Also, as heavy liquids, they may remain in contact with a hot surface, while the lighter oils will not.

A flame is an unfailing source of ignition. Hot arcs from electric power or lighting circuits and storage batteries are well-known ignition hazards. Minute, low-energy electrical sparks from some sources, such as a three-cell flashlight, do not ignite petroleum vapors. But sparks from static electricity may be ignition hazards.

Friction sparks from hand tools have been found to have too little energy to ignite petroleum vapors, although they may ignite gunpowder, hydrogen sulfide, or other easily ignitable materials. Friction sparks from a cigarette lighter come not from steel, but from a special alloy; they contain sufficient heat to light vapor from lighter fluid (similar to gasoline). The glowing coal from a cigarette usually is at too low a temperature to ignite petroleum vapor in air, but impurities in the tobacco or paper can cause ignition. The hot ash can ignite paper, which, as it burns, can in turn ignite oil vapor. The discarded match is also a great potential hazard.

To summarize, fire requires three conditions to start:

1. Fuel in vapor form (or under some conditions, in a finely atomized form).
2. Air in proper proportion with the fuel vapor (within the flammable range).
3. A source of ignition, with heat of sufficient amount and temperature to ignite the particular fuel vapor.

Fire Prevention

To prevent fires, one of the three essentials of combustion must be kept away from the other two. Fuel should, as much as practicable, be kept in closed substantial containers and should not be permitted to escape. Air is present almost everywhere; hence, except in special cases involving closed vessels or gas-blanketed or inerted systems, exclusion of air is not a practical way of preventing fire.

Sources of ignition should be controlled. In many areas, smoking is prohibited, "hot work" (welding) cannot be done without special safety permits;

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Using a protractor divide the circle into parts representing each activity by degrees.

Shade each division according to the legend shown in the right-hand corner of the Work Sheet. Use the T-square and triangle for drawing your lines. Now letter the title strip and have your drawing checked and graded.

WS. 8. Bar Graph: Complete the lines of the bar graph using the figures given in the table. The table shows the miles per hour (M.P.H.) traveled by an automobile, the distance traveled while thinking, and the distance traveled while using the brakes before coming to a complete stop. Use the scale given at top of the sheet for projecting down the number of feet required for "thinking" and the number of feet required for "braking". Use the 60 degree triangle for the lines which indicate "thinking". Shade in with your pencil the solid part which indicates "braking". Letter your title strip. Have your drawing checked and graded.

WS. 9. Oil Field Map: This Work Sheet shows twelve sections of a township. A section is a square 1 mile on a side, so a section is 1 square mile in area. By projecting with a T-square and triangle, draw light lines from the scales at the left and bottom of WS 9. This will give you a system of grid lines for locating objects on the map. Locate the following wells and structures as indicated by the coordinates given below. The first of the two numbers given is found on the bottom scale. The second number is found on the scale at

electrical work is done by qualified persons; and certain static protection devices and procedures are used.

Fire Extinguishment

To extinguish fires one of the three essentials of combustion must be removed from the other two. These three methods are commonly known as:

1. "Starving"--removing fuel from air and heat.
2. "Quenching"--removing heat from fuel and air.
3. "Smothering"--removing air from fuel and heat.

Common methods of extinguishing oil and gas fires employ one or more of these methods. For example:

Starving. Removing fuel supply is the best method of extinguishing gas and LP gas fires and many fires involving liquid fuels. Certain positive methods include closing valves, crimping, or plugging pipelines. Water can be pumped into a leaking pipeline or tank so that the water replaces the oil at the leak. Closing a dome on a tank truck prevents escape of the vapor.

Quenching. Cooling with water is a common method. The use of water fog to chill a burning oil surface below its flash point or the use of water on wood fires is considered to be quenching by some. Actually, this is a method of starving, as it consists of stopping the source of flammable vapor.

Smothering. Removing the air supply is the third method. Using steam, carbon dioxide, or carbon tetrachloride vapor reduces the oxygen content of the air at the seat of the flame to 12-15 percent, or below, and smothers the fire. When water fog is used on gasoline fires in deep containers, the steam generated may smother the fire.

Applying a foam blanket on a gasoline fire or frothing a fire of viscous oil with water can be considered either starving or smothering. In practice, it simply is separating the air from the vapor or vice versa.

The use of chemical powder does not clearly fall into any one of these three categories. It does not supply sufficient CO_2 by decomposition of the sodium bicarbonate to smother the flame. The subject of dry chemical extinguishers is discussed later in this paper.

Extinguishing Agents

Each type of extinguishing agent has its own special applications and limitations. For this purpose, oil and gas fires may be divided into two subgroups;

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1. Oil fires burning from a substantially flat horizontal surface, such as in a tank, vat, trench, or a spill on the ground. Sometimes they are referred to as "two-dimensional" fires.

2. Oil fires involving jets, sprays, or falling burning streams of oil or fuel flowing down a vertical or a slanting wall or surface. Sometimes they are referred to as "three-dimensional" fires. Vapor or gas fires are in this class.

The best type of agent or agents to employ depends upon the nature or type of fuel and whether it is a two- or three-dimensional fire.

Foam. Formerly considered the most effective extinguishing agent for all oil fires, foam seldom is used today, primarily because of the rarity of tank and large-area spill fires and because of the modern development in the use of fog nozzles and dry chemical extinguishers. Spill fires involving high flash oils (like kerosene and diesel) used to be fought with foam, but today they are extinguished successfully with water fog. The only exceptions are very large spills, which are beyond the reach and capacity of fog nozzles, and large tank fires, where foam must be used. Tank fires are relatively uncommon in the oil industry, considering the enormous number of tanks in use. Since they require special techniques, they are not discussed in this paper on basic principles. Fires involving large spills or open areas of gasoline, light crude oil, and jet fuels (as in a tank) normally are handled by foam. The flash point is too low for the fuel to be extinguished by water fog. Sometimes foam is applied to an unburning spill of gasoline to stop rapid evolution of vapor and reduce risk of ignition.

To form an effective blanket, the foam should be applied gently so it flows across the surface. In some cases, the foam may be applied to some smaller gasoline fires as a "fog foam," gently raining down onto the burning oil surface to form a blanket. Some liquid fuels (alcohol, ether, ketones) quickly decompose a foam that is effective on oil fires. For such fuels a special "alcohol foam" is required.

Of course, foam must not be applied to a hot asphalt tank, because it will froth over. Such fires sometimes can be extinguished by very skillful and gentle applications of long-range water streams by frothing the burning surface. Spill fires involving hot asphalt and other high flash, froth-producing oils can be controlled best by water fog or broken-up straight streams.

Water fog or spray. This is the most common and the most satisfactory extinguishing or controlling agent for most oil and gas fires. As water evaporates, it absorbs more heat than any other material. The fine droplets of water in water fog provide large surfaces for evaporation and greatly reduce

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the fire intensity or extinguish the fire of high flash oils. The steam produced may act as a smothering agent.

Fog is effective in controlling and reducing the intensity of gasoline, LP gas, and gas fires; it protects personnel while they close valves or perform other emergency operations. It may be used on two- or three-dimensional gasoline fires until the proper extinguishing agent or means is available. It is excellent

Los Angeles County Fire Department

Fig. 1. Cooling the top surface of an LP gas tank truck that is half full of butane. The fuel to the ground fire under the tank truck has been shut off, and the cooling of the two sides of the shell is continuing.

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for controlling a gas or an LP gas fire and it minimizes damage and spread until the source of fuel can be shut off. Fog is also very effective for extinguishing two- or three-dimensional fires of fuels having a flash point above atmospheric temperature, if they are within the capacity of the nozzles.

Some firemen have been prejudiced against the use of water on an oil fire because, when misused, water has caused bad spread of the fire. Also there was some prejudice against fog nozzles because early nozzles were inefficient. Oil industry fire fighters, using modern nozzles, have demonstrated the great effectiveness of fog on the most stubborn and difficult types of oil fires.

Straight streams. Straight streams of water also have their place for certain fire control and extinguishing uses. Although the large coarse drops from straight streams are much less effective than water fog, they do cool hot surfaces at long range. Water, either in the form of broken straight streams or fog, is effective in cooling and protecting pressure containers and preventing them from overheating and rupturing in an exposure fire (see Fig. 1). As little as 0.1 gpm per square foot of surface often is adequate.

Broken straight streams are effective in frothing certain viscous oils and extinguishing flat surface fires of such oils.

Dry chemical extinguishers. The most effective hand extinguishers utilize sodium bicarbonate (baking soda), which, being a solid, may be projected at a considerable range into the seat of the fire. The dry chemical powder in the flame zone interferes with the complex chemical chain reaction of burning and extinguishes the fire. A technical discussion of this complex subject appears in the NFPA Quarterly, April, 1960, page 334. The powder is milled with a water-repellent agent. This not only keeps it fluffy when dry but also permits the solid powder to be projected through a water fog blanket. A very severe fire may be reduced in intensity by water fog and extinguished simultaneously by the dry chemical.

When a fire has burned for some time, it may form embers or hot surfaces. If these are not cooled by water fog first, the dry chemical may extinguish the fire, but the vapor may reignite. The effectiveness of dry chemical extinguishers may be enhanced greatly by using them in combination with water fog. This special technique should be learned by training with live fires.

Carbon dioxide. CO_2 is effective where the entire area or front of the fire can be blanketed to prevent reignition. Its range is much less than that of the dry chemical, and it is seriously affected by wind.

Carbon tetrachloride. The "CTC" extinguisher agent was good in its day but it has passed out of favor because of the toxicity of the vapor and its lack of

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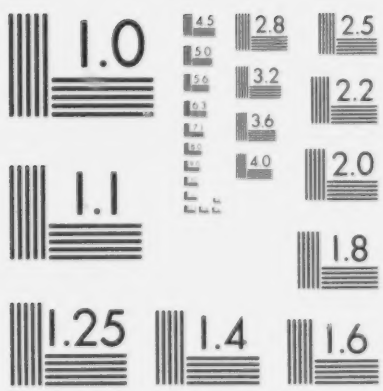

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

effectiveness in comparison with CO_2 and dry chemical. Also, "CTC" extinguishers are less dependable mechanically. Carbon tetrachloride is electrically nonconductive.

Soda acid extinguishers. These extinguishers have their place for combating ordinary combustible fires, but they are being replaced by water pump tanks and garden hoses.

Miscellaneous Notes

Problems of spontaneous combustion are encountered wherever paints are involved. The mineral ingredients in paints are mixed with a thinner (turpentine or mineral oil thinners) and a vehicle (linseed oil or equivalent). When paint is applied to a surface, the thinner evaporates and the vehicle oxidizes and hardens the paint. This oxidation liberates heat, but the heat is conducted to the air without an appreciable rise in temperature. If paint or linseed oil is left in wadded rags, the oil will oxidize slowly, just as it does on a wall. Because the heat of oxidation cannot escape, however, the temperature rises and the oil-soaked rags finally may burst into flame.

Common oily materials (other than paint oils) that may cause spontaneous combustion include okum, tung oil, and fish oil. Petroleum or other mineral oils do not oxidize in this manner to cause spontaneous ignition. Any oily rag, however, must be considered dangerous unless the type of oil is known. Rags containing grease lubricating or other mineral oils act as a good kindling medium when involved in a small fire. Unless disposed of promptly, they represent poor housekeeping.

Sources of information. For the past 30 years, fire protection engineers in the petroleum industry throughout the United States have corresponded and have met periodically to discuss oil fires, compare tests on fire fighting methods and equipment, and exchange information. Through this interchange, much valuable information on fire protection has been accumulated, and some of it has been published. Copies are available by writing to Director, Division of Science and Technology, American Petroleum Institute, 1271 Avenue of the Americas, New York 20, N.Y. The National Fire Protection Association also has published some excellent papers on fire protection of flammable liquids. Write to Flammable Liquids Engineer, NFPA, for information.

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2 IGNITION AND COMBUSTION

Oliver W. Johnson
Standard Oil Co. of California

Before starting to read this paper, glance through it and read the headings. Reading them will provide an idea of the scope and content prior to more detailed study. Note that the paper deals mainly with fire prevention, which is closely allied to fire extinguishment and is equally important. The discussion still concerns proper terms and their meanings. Necessarily, there is some overlap with the preceding paper, and this is good. It re-emphasizes the important facts but presents them in slightly different ways. It also lays the groundwork for the applied phase of oil fire fighting, which follows in Parts II and III.

This paper is more technical than the first, and it shows that fire protection in the petroleum industry is not a simple subject. Study it carefully, because it contains much valuable information. It should correct some prevalent misconceptions and aid in the investigation of fires. (This is a revised reprint from the manual of the 1961 Bakersfield Oil Fire Control School.)

Prevention of accidental and uncontrollable fires is the principal objective in fire protection. The word "accident" implies something neither planned nor expected, but it does not mean that the event is ruled by chance. In the words of one authority, "An accident is viewed as occurring in the regular course of things, but subordinate to the main purpose, or aside from the main design." Since an accident is something unforeseen, it follows that accidents may be prevented by forethought and knowledge. This is true of accidental fires.

Fire prevention is sometimes approached with the goal of eliminating everything that will burn. At other times the approach is to attempt to exclude everything that could be a means for the start of a fire. Neither course, however, can be carried to its conclusion in an industry where all principal products are combustible, and where heat (and fire) is the principal agent in the refining process and the basis of transportation of the products.

In petroleum operations generally, the most practical approach to fire protection is, first, to learn how accidental fires start; and, second, to work out procedures and practices that will be both effective and economical in assuring that the unexpected does not happen. If all contingencies are considered, there may be "incidents" but no "accidents."

An intelligent approach to fire prevention requires knowledge of the processes of ignition and combustion. The following sections give some basic information on these subjects and indicate sources of more detailed information.

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Definitions

"Combustion" may be either burning or only a chemical process. It is the rapid reaction of oxidizable material with oxygen (usually, oxygen in the air), accompanied by heat and, usually, flame.

"Fuel," used in the broad sense, means a material capable of undergoing combustion. It particularly designates the material (gas, liquid, or solid) that feeds a fire.

"Flammable" refers to any material that is very easily ignited or that burns rapidly. It is usually applied to gases or liquids. The synonymous term "inflammable" is now considered obsolete because it was too readily confused with "nonflammable." Flammable liquids, as legally defined, have a flash point under 200° F.

"Combustible" refers to that property of a material that can burn, and the term implies less risk of accidental ignition and flame spread than "flammable" does. There is, however, no precise demarcation between a material that is flammable and one that is combustible. The word "combustible" is frequently applied to solid fuels and sometimes to liquids having flash points of 200° F and above.

Fire Triangle

The three essentials that must be present in order for a fire to start are frequently illustrated by a triangle, in which the three sides are labeled "fuel" (vapor), "air" (oxygen), and "source of ignition" (heat).

Fuel. For this demonstration, fuel must be present in dispersed form as a vapor. Liquid fuel mists or finely divided solid fuels that are readily converted to vapor have much the same combustion characteristics as vapor. (Carbon and some metals are exceptions to the general rule that fuel must be in the form of vapor before it can burn.)

Air. Air (which supplies the oxygen necessary for combustion) must be present and mixed in suitable proportion with the fuel vapor to form a mixture that can be ignited.

A source of ignition. Some source of ignition (high temperature and energy sufficient to initiate the chemical reaction of combustion) must be present.

The start of a fire requires the presence of all three at the same time and place. Extinguishment usually requires that either the fuel or the air be eliminated or that they be prevented from reaching one another.

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Elements of Fire Prevention

Practical fire prevention requires a thorough understanding of:

1. Vaporization--the conditions under which flammable and combustible materials vaporize.
2. Flammable mixtures--what is meant by "suitable proportions."
3. Ignition sources--and how combustion spreads from such sources.

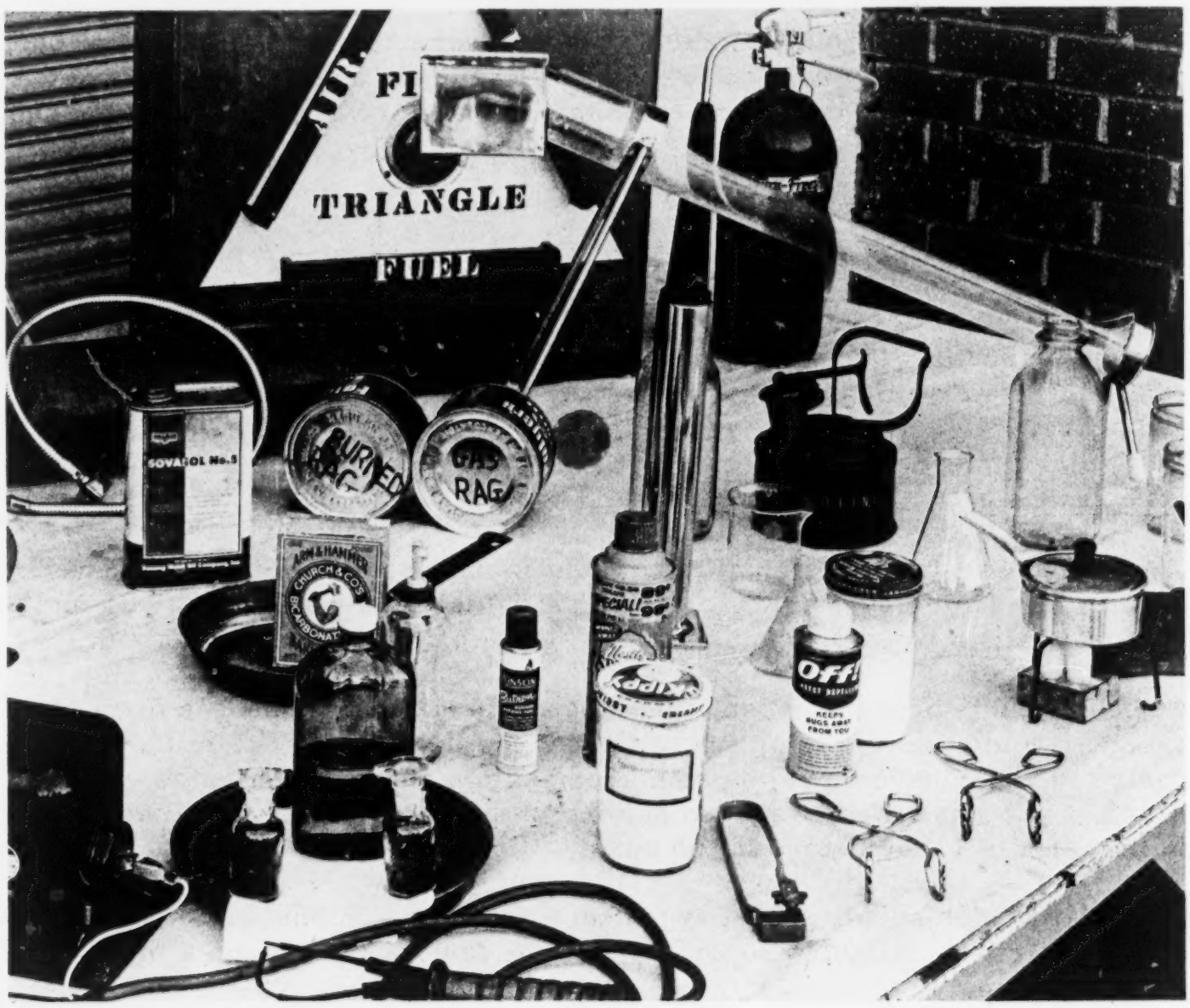

Torrance Fire Department

Fig. 2. Typical apparatus for a tabletop demonstration on flammable liquids. Note the fire triangle.

Vaporization. To understand the process of vaporization, consider the surface between a liquid and a closed, air-free space above it. Molecules of the liquid tend to escape from the liquid state and assume the properties of a gas. Other molecules previously released may strike the liquid surface and

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re-enter it. When the number of molecules leaving and re-entering the surface becomes equal, a state of "equilibrium" is said to exist. At equilibrium, the pressure exerted by the molecules in the vapor state is called the "vapor pressure" of the liquid at that temperature. Vapor pressure is a characteristic of any liquid. The vapor pressure of a liquid increases as its temperature is raised.

If the space above the liquid already contains a gas--say, air--vaporization will proceed exactly as above. When equilibrium is established, the space above the liquid will contain just as many vapor molecules as though the air were not there. The liquid evaporates just as though the air were not present. The total pressure exerted by the vapor-plus-air mixture, however, now will be greater by the pressure exerted by the air. The partial pressure of the vapor divided by the total pressure of air-plus-vapor is the volume percent concentration of the vapor.

For easy comparison, vapor pressures of petroleum liquids usually are measured at a standard temperature--100° F--by the Reid method described in ASTM Standard D-323. From the fire protection standpoint, it is the vapor pressure of a liquid petroleum product at the temperature at which it is handled that is significant, because it is this vapor pressure that controls the composition of the air-vapor mixture over the liquid surface.

Vapor pressure cannot readily be measured in the low range where it is significant as a criterion of fire hazard. Hence, the results of another test, the flash point test (described later in this paper), is more generally relied upon for this purpose.

Flammable mixtures. A fuel vapor-air mixture cannot be ignited unless the ratio of vapor to air lies within certain well-defined limits, called the "lower" and "upper limits" of flammability, usually expressed in terms of volume percent at atmospheric pressure and temperature. The least concentration (percentage by volume) of fuel vapor in a vapor-air mixture that can be ignited is called the "lower limit" of flammability. The highest percentage by volume of fuel vapor in air in which ignition can be produced is called the "upper" or "higher limit" of flammability. The region between these two percentages is called the "flammable range."

For gasoline vapor this range extends from about 1 percent to about 6 percent by volume of gasoline vapor in air. Mixtures containing less than about 1 percent are said to be "too lean" to burn; they cannot be inflamed by any source of ignition, however intense. Mixtures containing more than about 6 percent are said to be "too rich" to burn. A closed space filled with such a mixture cannot be ignited; but, if allowed to escape into the open air so that further dilution can occur, the issuing mixture can be ignited.

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the left. The point at which these two lines intersect is the location indicated by the numbers.

Use page 19 showing Topographical Symbols to indicate the following objects:

Sec. 2 Dry Hole at (17,23).
" 3 Gas Well at (9,19).
" 4 Oil Well at (7,17).
" 4 Oil Well at (1,17).
" 5 Townsite, 1 mi. sq.
" 6 Oil Well at (9, 9).
" 7 Abandoned Hole (17,15).
Sec. 8 School at (25.5,15.5).
" 9 Church at (25, 6).
" 10 Rig at (17, 1).
" 11 Location (15, 1).
" 12 Oil Wells at (7, 4.5) and 1, 7).

Show a state line at the top of the map and a county line at the right of the map. Show a state highway running east and west across the map at (0, 16). Show a bridge at (27.5, 16) crossing the stream east and west. Show a double track railroad running through points (0,14) and (24,8). Letter-in the name of the river, BIG BLUE, in the center of the stream in capitals 1/8" high. Complete the title strip, have your drawing checked and graded.

WS. 10. Athletic Field: Fill in the blanks provided on the Work Sheet to make the statement correct. Refer to Illustration Sheet 5, on page 21 to find the correct answers.

When the vapor is mixed with an atmosphere containing more than the normal 21 percent of oxygen, the lower flammable limit is only slightly lowered; but the upper limit is raised, thus broadening the flammable range. With mixtures of fuel vapor in pure oxygen, the range may be as much as seven times that of vapor in air. Conversely, when an atmosphere contains less than the normal 21 percent of oxygen, the flammable range is narrowed. Here, again, the lower limit is only slightly affected, but the upper limit is reduced. At some point, where the oxygen in the original atmosphere is reduced to around 12-15 percent, depending on the diluent gas used, it becomes impossible to produce a flammable mixture with any proportion of fuel vapor. This process of diluting the atmosphere with some gas lean in oxygen (such as nitrogen, carbon dioxide, or flue gas), which will prevent the possibility of the formation of a flammable mixture, commonly, though somewhat incorrectly, is called "inerting."

The flash point test involves the concepts of both volatility and flammable range. Consider a flammable liquid at a temperature so low that the vapor pressure is insufficient to produce, over the liquid surface, an equilibrium mixture within the flammable range. As the temperature slowly is increased, the vapor pressure will rise and the amount of vapor in the mixture above the liquid surface will increase. Until the lower flammable limit is reached, introduction of a source of ignition--such as a small flame--into the vapor space will not cause combustion. When the composition reaches the lower limit of flammability, introduction of a flame will cause ignition and a flame will spread momentarily across the oil surface. This is the method used in the closed-cup flash test. The flash point is the lowest temperature at which the vapor pressure of liquid is just sufficient to produce a mixture at the lower limit of flammability.

Contrary to what the words might seem to imply, "flash point" does not mean the temperature at which a flash appears spontaneously: introduction of a source of ignition is essential. It is also worth noting that increasing flash point temperature is usually associated with decreasing hazard; "high flash point" means low hazard, and vice versa.

There is no generally accepted similar test to determine the temperature at which the vapor composition over a liquid passes out of the flammable range into the "too rich" region. Consequently, temperatures corresponding to the upper flammable limit are not as generally available as those for the lower flammable limit.

The flash point of gasoline, the most commonly used volatile petroleum liquid, is well below zero at atmospheric pressure. Under ordinary handling temperatures, the vapor pressure of gasoline is high enough to produce an equilibrium mixture above the upper limit of flammability. Kerosene and domestic

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fuel oils usually have flash points within the range 100-130° F. For industrial fuel oils, the minimum flash point is usually above 130° F. This means that these oils will not usually produce ignitable mixtures over their surfaces unless heated.

Crude oils vary widely in their characteristics and may range from practically water-white liquids more volatile than ordinary gasoline to thick, heavy substances such as asphalt. Therefore, to determine the flammability of any particular crude oil, it is necessary to know its characteristics. So-called refinable crude usually contains sufficient light components to place it in a flash point classification comparable with gasoline.

Ignition sources. In the preceding discussion of the fire triangle, the third requirement for fire was designated simply as a "source of ignition," with the reservation that, for the particular chemical reaction concerned, considerations of both temperature and energy are involved. An ignition source starts the process of combustion. Thereafter, the heat of combustion itself provides the energy for continuation of the reaction so long as proper proportions of the other two ingredients--fuel and air--are available.

A "source of ignition" is actually defined in terms of the result. If fire occurs, then an ignition source must have been present. Other things (like the proper mixture) being favorable, absence of fire proves the absence of the proper combination of temperature and energy to meet the requirement of an ignition source. Different fuel substances have different ignition characteristics, and whether or not ignition can occur is influenced by the factors of the temperature, size, duration, and energy of the potential source of ignition.

Under these circumstances, it is impossible strictly to define an ignition source and equally impossible to assign to any fuel substance a particular ignition characteristic (such as the so-called ignition temperature) that will be an unvarying property under all conditions. Even though a source of ignition cannot be strictly defined, it is still desirable, however, to review in general terms the applicable principles so as to establish a basis for evaluation of practical problems.

The ignition susceptibility of various fuel substances varies widely, depending on physical state, chemical composition, nature of the ignition source, and conditions under which the two are brought together. For gas-air mixtures, ignition is commonly thought of as being an almost instantaneous process, although this is not true under some conditions to be discussed later. Solid substances must usually be vaporized before ignition can occur, bringing in the time element. Also, if the atmosphere contains more than the normal amount of oxygen, ignition is made easier. Although rigid classification is impossible, common fuel substances fall roughly into three groups:

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1. Easily ignited--chemically active vapors and gases such as carbon bisulfide, acetylene, and hydrogen.

2. Less easily ignited--hydrocarbon gases and vapors, including all of the products of petroleum together with most oxygen-containing organic chemicals, such as alcohols, ethers, and acetones, which have higher ignition energy requirements.

3. Slowly ignitable at low temperature--cellulose-containing solids, such as paper, wood, and rags, which under long exposure to relatively low temperatures may dry out, char, finally glow, and possibly burst into flame.

Within each group of fuel substances, there are variations in ignition susceptibility, which in turn may vary with the nature of the ignition source. Common sources of ignition are:

1. Flames--All flames, except very tiny ones that can be produced only under controlled laboratory conditions, are sources of ignition.[1] Flames of the shortest possible duration will ignite properly proportioned vapor-air mixtures; continuing flames can also volatize solid or liquid fuels and ignite the vapor released. As mentioned previously, once the chemical reaction of combustion has been started, the heat of the reaction releases the energy (flame that perpetuates the process).

2. Electric sparks--Electric sparks are a well-recognized ignition source. Here, however, practical limitations arise. All electric sparks are extremely hot, but the total energy is subject to extremely wide variation. The fact that a spark is readily visible is not proof that it is capable of producing ignition. The electrical characteristics of the system--open circuit voltage, resistance, capacitance, and inductance--control the energy available. Although the limiting minimum spark energy necessary to produce ignition of some one fuel mixture can be determined for some simple system--for example, a jump spark, where capacitance and length are the only variables--it has not been found possible to relate, other than directionally, the effect of all the variables. These include, in addition to those previously enumerated, the size and shape of the electrodes and their spacing or rate of separation.

   In some electric devices, the total energy available for production of sparks is strictly limited--for example, a hand flashlight or an

[1] J. H. Holm, Philosophical Magazine, 7th Series, 14 (July, 1952), pp. 18-56.

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electric tachometer generator--and it is possible by test to determine that for certain atmospheres the device is "intrinsically safe." This means that under no condition of mechanical failure is it possible to produce a spark capable of producing ignition. For a tachometer generator, the most dangerous fire hazard is a short circuit of one of the windings. To establish the factor of safety, the test could include abnormally high speed and the use of a mixture that can be ignited more easily than any mixture liable to be present under service conditions.

In general, all sparks produced by line-powered devices are considered to be incendiary. If desired, however, some line-powered devices can be made intrinsically safe by a combination of steps such as voltage or current limitation and the use of capacitors, rectifiers, Zener diodes, and limitation of rate of electrode separation or gap length. Sparks produced by short-circuiting a few ordinary dry cells will not produce ignition of petroleum vapors.[2] Neither will the sparks produced by interruption of noninductive circuits, even when carrying large currents at low voltage.[3]

Sparks produced by release of charges of static electricity can produce ignition if enough energy is involved. The conditions required to store up sufficient energy to be dangerous cannot be strictly defined, but they are usually associated with large metallic bodies well insulated from the earth (a tank truck on very dry rubber tires) or with extensive surfaces of oil inside tanks.

Ignition by an electric spark requires the release of a certain minimum amount of energy across a gap of optimum length, called the "quenching distance" (about 0.08" for C_2-C_5 hydrocarbons).[4] The energy required increases sharply at lesser distances. The fact that short sparks can harmlessly dissipate a relatively large amount of energy is important in connection with bonding for the equalization of static charges. In many cases, a bond connection can have high ohmic resistance because of rust and other causes; yet it will be

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[2]A. B. Hooher and E. J. Coggeshall, "Dry Cells and Their Application to Mining," U.S. Bureau of Mines, Report of Investigations 3231 (Washington, D.C.: U.S. Printing Office, 1934), 8 pp.

[3]H. H. Clark, "Portable Electric Mine Lamps," U.S. Bureau of Mines, Technical Paper 47 (Washington, D.C.: U.S. Printing Office, 1913), 13 pp.

[4](Ethane-pentane, for example--Editor.)

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effective even if there is a small air gap, because as the potential builds up, a short harmless spark can occur across this gap, and a longer dangerous spark is prevented.

3. Hot surfaces--Hot surfaces, if large enough and hot enough, are an unfailing source of ignition. It has been shown that, as the area of the surface becomes smaller, the temperature required to produce ignition becomes higher.[5] This refers to the introduction of relatively small heated bodies into a much larger combustible mixture held at ordinary ambient temperature.

   If the heated surface becomes very large, so as to completely envelop the mixture under test, the temperature required to produce ignition (after a lapse of time) becomes much lower. The so-called autogenous ignition temperatures tabulated in numerous publications frequently are determined by methods in which the heated surface completely encloses the test mixture. In such tests, a time lag between introduction of the fuel and appearance of the flame may be as much as several minutes.[6] The temperature obtained might properly be called the "environmental ignition temperature," because it is actually the temperature of the environment at which the oxidation reaction starts, progressing, with self-heating, up to the point at which the flame appears.

   This process is similar to the "spontaneous ignition" at ordinary room temperature in a rag soaked with linseed oil, with the important difference that, for mineral oils, the slow oxidation that produces self-heating and ultimate ignition does not take place until the temperature of the surroundings is raised to a relatively high level. Spontaneous ignition of oil-soaked insulation at a temperature in the range of 600° F is an example. Environmental ignition temperatures are much lower than those obtained by the introduction of a heated body into a large volume of cold mixture or the contact of a drop of liquid fuel with a heated surface in an atmosphere of ordinary ambient temperature. For example, the environmental temperature for the

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[5]Robert S. Silver, "Ignition of Gaseous Mixtures by Hot Particles," Philosophical Magazine, 7th Series, 23 (April, 1937), pp. 633-57.

[6]Journal of Research, U.S. Bureau of Standards, Vol. 53, No. 1 (July, 1954), pp. 49-66. See also: Brian Percival Mullins, "Spontaneous Ignition of Liquid Fuels," North Atlantic Treaty Organization Advisory Group for Aeronautical Research and Development, Agardograph Series No. 4 (London: Butterworth & Co., 1955), 117 pp.

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ignition of gasoline is 478° F,[7] but a hot plate would have to reach 1200° F to ignite a drop of gasoline splashed against it. These figures support the observation that bare pipes carrying hot oil or gases (such as hot exhaust pipes) seldom are sources of ignition, even when they are at a temperature well above the temperatures determined by environmental methods.

Environmental ignition temperature is substantially lowered by an increase in the pressure of as little as five atmospheres. This probably explains in part the internal burning occasionally observed in hot asphalt lines when blown with air.

The above explains why sparks produced by the impact of steel on steel, stone, or other hard substance (dropping tools, for instance) ordinarily will not ignite vapors of gasoline or other petroleum products. The temperature of the sparks so produced is relatively high, but the particles are small and the time of exposure short, and the energy transmitted to any one volume of vapor-air mixture is insufficient to produce ignition. Incendiary sparks can be produced, however, by the impact of large bodies or by high velocity rubbing at high unit pressure (for example, the sliding of some steel part of a vehicle along the pavement as the result of a crash). No sharp dividing line can be drawn between steel objects that produce harmless sparks and those that produce incendiary sparks. In some areas, power tools are arbitrarily placed in the latter category.

These facts, often of little importance, may become very important when a suspected source of ignition in an unexplained fire is investigated. Hasty and incorrect conclusions may result in failure to find the real cause of the fire; a waste of time, money, and effort; and the risk of another fire.

Spread of Flame

In a flammable vapor-air mixture, flame will spread in all directions until the entire mixture is consumed. The rate at which the flame front moves--called "rate of flame propagation"--is subject to wide variation. In mixtures of either low-limit or high-limit composition, in which the reaction is barely self-sustaining, the rate of flame propagation is low--half a foot per second or less--and no significant pressure rise results. Mixtures closer to the center of the flammable range produce more vigorous flames, which spread faster initially and tend to accelerate. The rate is also influenced by the

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[7] Journal of Research, National Bureau of Standards (July, 1954), pp. 49-66. The addition of lead tetraethyl usually results in a substantial increase in the observed temperature of ignition.

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nature of the combustion. Maximum rates of flame propagation, with accompanying maximum explosive effects, occur in mixtures slightly on the rich side.

The bunsen burner provides an example of a type of flame propagation that is industrially important. Premixed air and gas in proportions with the flammable range can be ignited above the burner tube, where the velocity slows because of expansion of the steam, but the flame does not pass down the tube (or "strike back") because the normal rate of flow is higher than the rate of flame propagation in the turbulent mixture in the tube. If the rate of flow is sufficiently reduced, a condition may be reached where flashback can occur.

Earliest attempts to measure the rate of flame propagation employed this method. The flame velocity so obtained depends on the composition of the mixture and, to a lesser extent, on the tube diameter. Velocities determined by this method are reproducible and are free of the variations and uncertainties that accompany rates of burning of mixtures initially at rest in pipes or vessels. Hence, velocities so measured may be used with confidence in the design of burners and in the appraisal of risk of flashback in pipes, certain types of flame arresters, and the like.

In the open, burning a petroleum vapor-air mixture may produce speeds up to about 8 or 10 feet per second, with no spectacular manifestation beyond the

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Fig. 3. Showing the principles of vapor drift at a tabletop demonstration.

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appearance of the flame and an outward rush of gases sometimes described as a "whoosh." If the burning takes place in a closed space, the heat produces a rise in pressure. If the pressure exceeds the strength of the container (a tank, for example), failure will result, and an "explosion" is said to have occurred. If the container is strong enough (the cylinder of a gasoline engine, for instance), there may be no outward sign at all.

Detonation

In a container that provides opportunity for a long path of flame travel, such as a pipeline or large process vessel, ignition of a mixture capable of producing a fast-moving flame may lead to the development of "detonation." Instead of a layer-by-layer process of flame spread, the energy to initiate flame is transferred, by means of a shock wave, ahead of the flame front to the unburnt gas mixture. Detonation in gas mixtures travels over the speed of sound in atmospheric air, often 6000 to 8000 feet per second, and the sudden release of energy can produce destructuve effects that are many times more severe than the relatively slow pressure rise of ordinary burning.

Detonation is the result of shock waves reflected from the walls of the container; hence it does not develop in flames burning in the open, is unlikely in containers of highly irregular shape, and is favored by containers permitting long, uninterrupted flame travel, such as pipes.

Detonation as used here should not be confused with engine "knock," which is believed to arise from a different mechanism. The difference is illustrated by the fact that tetraethyl lead will not slow down or arrest detonation in a pipe. Detailed discussion of the mechanism of detonation and calculation of detonation velocity and pressure are beyond the scope of this discussion.[8] The tendency to detonate is associated with a high initial rate of flame travel and high energy release per unit volume; and detonation is favored by high initial pressure, oxygen-enriched atmospheres, and such fuels as hydrogen and acetylene.

Mixtures of petroleum vapor and air at high pressure have developed detonation in process vessels and long pipelines. No similar incidents have occurred at atmospheric pressure, probably in part, because under practical conditions it

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[8]Bernard Lewis and Guenther Von Elbe, Combustion Flames and Explosions of Gases (New York: Academic Press, Inc., 1951), Chap. XI. See also: Wilhelm Jost, Explosion and Combustion Processes in Gases (New York: McGraw-Hill Book Company, Inc., 1946), Chap. V; and: The Standing Committee on Combustion Symposia (Bernard Lewis, et al.), Fourth International Symposium on Combustion, Combustion and Detonation Waves (Baltimore: The Williams and Wilkins Company, 1956).

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is unlikely that a uniform mixture within the necessary narrow composition range can be present throughout a large space. In carefully controlled experiments, a flowing stoichiometric mixture of natural gas and air has produced detonation in a two-foot diameter pipe, 300 feet long, at atmospheric pressure and below.

Explosion Hazard

From a practical standpoint, determination of the percentage composition of mixtures of flammable vapor with air is of great importance. Mixtures that are too lean to burn do not constitute a fire hazard. If a mixture should be close to the lower flammable limit, however, some concern should be given to the possibility that changing conditions--such as an increase in temperature--might change the composition sufficiently to make it flammable.

Mixtures that are too rich to burn do not constitute a fire hazard. In some cases, however, such mixtures may become diluted with enough air to be flammable. Therefore, the surrounding conditions must be carefully studied to determine whether a potential explosion hazard exists.

Mixtures that are within the flammable range are potentially very dangerous since they require only the presence of a source of ignition to burn or explode. The degree of hazard depends on the volume of the mixture, its location, the degree of confinement, and the likelihood that a source of ignition might occur accidentally. Flammable mixtures in large volume in partially or wholly confined spaces (such as tanks and basements) are particularly dangerous because the force of the explosion may not only destroy the enclosure but also damage adjacent equipment. The likelihood of severe destruction is increased when the mixture is initially at above-atmospheric pressure in a vessel capable of sustaining a proportionally high pressure before failure. The hazard will be particularly acute if men are required to be in, or adjacent to, such structures.

The presence of petroleum vapors in the range from zero to the lower flammable limit readily can be determined by portable combustible gas indicators. The scale of the "J-W" combustible gas indicator, as generally used throughout the company, provided a figure "1" near the upper end, to indicate an explosive mixture; the space between zero and this point is divided into tenths, marked ".2," ".4," and up, to indicate fractions of the lower explosive limit. Thus the safety range of any mixture easily can be determined. Tests of atmospheres within any confined space are usually required before hot work is done or men are permitted to enter. Departmental rules generally prescribe the methods for testing and set limits within which entrance is prohibited. These limits are generally only a small fraction of the lower explosive composition, because breathing richer mixtures might cause discomfort or even have toxic

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effects if long continued. In some states legal requirements have been established for hot work and the entry of spaces in which flammable or toxic vapors may be present (for example, State of California Petroleum Safety Orders, No. 6777, 6793, 6810).

A special problem is the determination of the exact composition of vapor mixtures within or above the flammable range. An approximate idea of the composition may be obtained by the use of the combustible gas indicator or a dilution valve or by other special techniques, but precise knowledge of the flammability of rich mixtures or those containing "inert" gas must be derived from laboratory analysis or direct explosion test. The need to know the exact composition of mixtures above the lower flammable limit seldom arises. All such mixtures must be considered potentially dangerous because of the possibility that dilution might bring them within the flammable range, which depends more on the source of vapor and the physical surroundings than it does on the original composition.

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UNIT III — ELECTRICAL DRAFTING

General Information

Electrical Drafting:

The result of electrical drafting is the schematic drawing. The "schematic" is to the electronic engineer or technician the same as a road map is to a motorist in a strange country. It can show how to wire a house, construct a radio, or trace the ignition on an automobile. Constructing and servicing electrical appliances would be impossible without electrical drafting.

Each symbol on the "schematic" represents an electronic part, and shows exactly how it is connected into the circuit.

The drawings included in this unit will introduce you to some of the terms and symbols used in this field of drafting.

It will be necessary for you to become familiar with the symbols given on Illustration Sheet 6, page 29. You will also want to know the definition of and be able to spell the following words:

a. electronic	f. transistor
b. schematic	g. current
c. technician	h. condensor
d. symbol	i. resistor
e. circuit	j. antenna

TABLE ON HYDROCARBONS

TABLE 3
Reference Data on Hydrocarbons and Other Common Materials

(Some of these values are approximate but they are suitable for most calculations)

Name	Formula	Boiling Point °F	Liquid Density			Vapor Density		Volume Ratio Gas to Liquid Std. Cond.	Vapor Pressure PSIA at 100°F	Flammable Limits Volume Percent	
			Sp. Gr.	°API	Lb./Gal.	60°F & Sp. Gr. Air=1	1 Atmos. Lb./MCF			LFL	UFL
Methane	CH_4	-259	0.3	340	-	0.554	42.4	442	-	5	14
Ethane	C_2H_6	-128	0.37	247	-	1.04	79.2	294	780	3	11
Propane	C_3H_8	- 44	0.51	147	4.24	1.52	116	273	190	2	9
Isobutane	C_4H_{10}	10	0.56	119	4.70	2.00	153	230	74	2	9
n-Butane	C_4H_{16}	31	0.58	111	4.86	2.00	153	238	52	2	8
Isopentane	C_5H_{12}	82	0.62	95	5.20	2.49	190	205	20	2	8
n-Pentane	C_5H_{12}	97	0.63	93	5.25	2.49	190	207	16	2	8
n-Hexane	C_6H_{14}	156	0.66	82	5.53	2.98	237	182	5	1	6
n-Heptane	C_7H_{16}	209	0.69	74	5.73	3.46	264	163	1.6	1	6
n-Octane	C_8H_{18}	258	0.71	69	5.88	3.94	301	146	0.5	1	6
Xylene	$C_6H_4(CH_3)_2$	291	0.88	29	7.35	3.66	280	197	-	1	6
Acetylene	C_2H_2	-119	-	-	-	0.90	68.6	-	-	2	81
Air			0.86	165	7.14	1.00	76.3	-	-	-	-
Ammonia	NH_3	- 37	0.82	-	6.81	0.59	44.9	1140	212	16	25
Benzene	C_6H_6	42	0.88	-	7.35	2.69	206	268	3.4	1	8
Carbon Dioxide	CO_2	-109	1.22	-	10.1	1.52	116	656	-	-	-
Carbon Monoxide	CO		0.81	-	-	0.97	73.8	-	-	13	74
Hydrogen	H_2	-423	-	-	0.59	0.069	5.27	-	-	4	74
Hydrogen Sulfide	H_2S	- 77	0.79	48	6.58	1.18	89.8	549	554	4	46
Water	H_2O	212	1.00	10	8.32				0.9	-	-

Examples of the use of the data in Table 3 are:

1. About how much liquid butane is needed in an empty 1000-gallon butane tank to make the atmosphere explosive?

   The table shows that the lower flammable limit of butane is 2 percent; therefore, the tank should contain 980 gallons of air and 20 gallons of butane vapor. The table shows that 1 gallon of liquid normal butane produces 238 gallons of vapor. The minimum amount of liquid required would be 20/238, or about 1/10 gallon, or roughly 1 pint of liquid.

2. Gasoline is not shown in the table because it is a mixture, not a pure compound. Its lower flammable limit is about 1.4 percent and its liquid-vapor ratio is about 1:200. With these data the minimum volume of liquid gasoline, fully vaporized, would be about 14/200 × 1 gallon or 1/15 gallon--or less than that for butane.

3. Assume there has been a severe explosion in a 5000-gallon gasoline tank. How much liquid gasoline is needed?

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A severe explosion would call for a vapor concentration in about the middle of the flammable range, or about 5 percent vapor. Five percent of 5,000 gallons would be 250 gallons of vapor or 1.3 gallons of liquid, assuming the entire amount vaporized and filled the tank uniformly with the 5 percent mix. However, it would not be necessary completely to fill the tank with this mixture to cause a severe explosion. If the vapor stratified near the bottom and a blanket of 5 percent mix located near the source of ignition, less than 1.3 gallons would be needed. It should be evident that precise calculations are impractical when various assumptions are involved. Approximate results, however, may be of value.

Some of the data in the table have no practical application for the average reader; they are included only for comparative interest. For example, liquid hydrogen is only 7 percent as heavy as water.

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3 STATIC ELECTRICITY AND FLAMMABLE LIQUIDS

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Static electricity has no direct bearing on fire fighting, but it is important to fire prevention concerning flammable oils and gases. To most people static electricity is a mysterious, and often misunderstood, subject. Very little has been written about it in layman's language.

The following paper was prepared by an expert in the petroleum industry who has had much practical experience with problems of static electricity. His paper covers both theory and practical application, and it is written in non-technical language. Those who wish to study the subject further may write to Director, Division of Science and Technology, American Petroleum Institute, 1271 Avenue of the Americas, New York 20, New York, to obtain a copy of the API Manual RP-2003, Protection Against Ignition Arising Out of Static, Lightning and Stray Currents, $1. The NFPA Pamphlet 77M "Static Electricity," $1, is excellent. (The present paper is a revised reprint from the manual of the 1961 Bakersfield Oil Fire Control School.)

To the average person the term "static electricity" means either a noise in the radio receiver that interferes with good reception or an electric shock that is experienced after walking across a carpeted floor or sliding across the plastic seat cover in an automobile. Some women wearing wool, silk, or synthetic fiber garments also may hear mysterious crackling noises and notice a tendency for some of their clothing to cling. Most people recognize that these phenomena occur mainly when the atmosphere is dry. They are simply annoyances.

Safety and fire protection engineers have a much more than superficial interest in the occurrence and properties of these sparks, which frequently are blamed for fires and explosions. They are concerned because, if static electricity actually causes fires, they should know how to prevent them. But, if static electricity does not cause fires, they should know this in order to locate and correct the cause.

Terms and Definitions

The word "electricity" is derived from the ancient Greek word "electron," meaning "amber," because it was with amber that the phenomenon of electrification first was observed. For centuries the word "electricity" had no meaning other than "the property exhibited by some substances of being able to attract or repel light objects after being rubbed with a material like silk

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or wool." In recent times, when the properties of flowing electricity were discovered, the word "static" came into use as a means of describing the first type of electricity.

Without attempting to be technically precise, we may say that electricity behaves as though it were an imaginary, weightless, and indestructible fluid, which can flow freely through some substances (such as metals) that we call "conductors," but which can flow with difficulty or not at all through or over the surface of a class of substances called "nonconductors" or "insulators." The latter group includes most gases, glass, rubber, amber, resin, sulfur, paraffin, and most dry petroleum oils. When electricity is present on the surface of a nonconducting body, where it is trapped or prevented from escaping, it is called "static" electricity. Electricity on a conducting body that is in contact only with nonconductors also is prevented from escaping and can be said to be "static." In either case the body on which this static electricity is present is said to be "charged." The implication that static electricity always stays at rest is, of course, erroneous; it is when static electricity finds a means of escape and is discharged that it causes the most concern to fire protection personnel.

A "charge" may be either positive or negative. At one time it was thought that there were two kinds of electricity, positive and negative, and that in a neutral (uncharged) body they were present in exactly equal amounts. Instead of there being two kinds of electricity, however, there actually are two kinds of particles in an atom. The negatively charged particle is called the "electron"; in electric conductors this particle is only loosely bound in the atom and it is therefore free to move from one atom to another. The positively charged particle is called the "proton"; this is a part of the atomic nucleus and therefore does not move among atoms. When there is an excess of electrons in any atom, that atom has a negative charge; when an atom has lost electrons, so that there is a deficiency, that atom has a positive charge.

A charged body, then, is one in which an electrical imbalance exists. The charge resides on the surface. On a conductor the charge is free to migrate over the surface and does so under the influence of charges on adjacent bodies. Like charges repel; unlike charges attract. On a nonconductor the charge is not mobile. If the body were a perfect insulator it would remain indefinitely. As a practical matter, a charge on the surface of a nonconductor remains only a portion of an hour at most, because no insulator is "perfect." Even the air exhibits a very slight conductivity.

Electricity is a form of energy and may be produced by expenditure of energy in some other form such as mechanical energy, chemical energy, heat, or visible radiation. Likewise, when electrical energy is expended, its equivalent appears in one or the other of these same forms.

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Static electricity, then, is an electric charge on the surface of an insulator or an insulated conducting body. It is "generated," usually, by the expenditure of mechanical work, although it must always be remembered that in this sense "generated" means "liberated" or "made alive"; electricity cannot be created.

Since electricity cannot be created but can only be moved from one substance to another, it follows that in any system the total quantity of electricity is constant, and that the sum of all positive and negative charges is zero. For every (+) charge there must be somewhere, as close as the conditions will allow, enough free electrons to make up an equal and opposite (-) charge. This concept of equal and opposite charge is extremely important.

The "generation" of static electricity is a mechanical separation of charges. When two bodies are in contact, the distribution of electrons at the contact surfaces is likely to be unequal, and a certain attractive force exists between the surfaces because of this unbalanced distribution. When the surfaces are separated, work is done in opposition to these attractive forces, and the work appears as an increase in the electrical tension, or voltage, between the two surfaces. If a conducting path is available, the charges thus separated will immediately reunite. If no such path is available, the potential may easily build up to several thousand volts.

Practically, static electricity is generated by contact and separation of two bodies, at least one of which usually is an insulator. Some examples are the rolling of rubber tires along the pavement, the flow of oil through a pipeline, the rubbing of dry shoes on a carpet, and the like. Under most conditions the creation of a static potential immediately sets up a flow of current; the separated charges flow back together, following any and all available conducting paths. If the resistance of the path is high enough, however (that is, if the two bodies on which the charges reside are highly insulated, one from the other), a potential of several thousand volts may develop before the discharge rate equals the rate of generation. Under these conditions the potential may become high enough to produce a visible spark if the two bodies are brought close together, or if some conducting body partially bridges the gap between them. Such sparks may be an ignition hazard if they occur in the presence of the vapors of a flammable liquid in ignitable concentration.

Control of Hazard

Three things are necessary in order that static may produce a hazard:

1. A generating mechanism.
2. An insulated conducting body to serve as an accumulator.
3. A discharge path, including a spark gap at a point where combustible vapors may be present.

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The generating mechanism is inherent in many operations, such as the transfer of oil, and cannot be avoided; and the presence of the possible discharge path may be beyond reasonable control. Therefore, practical measures for minimizing static hazard usually place emphasis on avoiding the presence of an insulated body on which a charge might accumulate. This can be accomplished by making sure that all bodies in the path of possible flow of static electricity are electrically interconnected.

The word "bonding" usually is employed to describe the connection of a conductor between two bodies for the specific purpose of reducing the electrical resistance between them. Bodies or structures are "inherently bonded" when they are, by the nature of the installation, connected with an electrical path having a resistance low enough to prevent the accumulation of dangerous static charges. A "ground" is the special case of a bond, one end of which is connected to the earth or to a body in contact with the earth. If each of two bodies is grounded, the two are in effect bonded together. It should be noted that here the importance of the connection to the earth is incidental. If the two bodies are electrically connected, such as when a bond is used to connect two vessels between which oil is being transferred, building up a hazardous potential difference between the two vessels will be prevented--whether or not the containers are grounded. At other times a charge might build up on a body insulated from the earth (the equal and opposite charge residing on the earth itself), and a ground connection is the bond that provides a path for the dissipation of the charge.

Practical Considerations

Although manifestations of static electricity are fairly common in everyday life, most of these arise under circumstances that constitute only a petty annoyance and involve little or no hazard.

In the petroleum industry the generation of static electricity by transfer of products is unavoidable. The ability of different products to generate static electricity varies widely and uncontrollably. However, the presence of static electricity can be a hazard only where some flammable vapor is present. Experience shows that static is a hazard in few circumstances:

1. In pouring flammable liquids from one container to another--If both of the containers are of metal, a difference in potential may develop between them; and if the spacing is not too wide, or a conducting body partially bridges the gap, a dangerous spark may result. A simple remedy adequate for most circumstances is to keep the two containers in metallic contact during the transfer. When only one of the containers is metal, the hazard is much reduced, although it is still possible for the metal container, if insulated, to accumulate a dangerous

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potential with respect to its surroundings. This condition may be avoided by placing the container in some conducting surface so that any charge delivered to it is equalized with the surroundings. When both containers are nonconductive, the electrostatic capacity is so low that it is almost impossible for dangerous sparks to result.

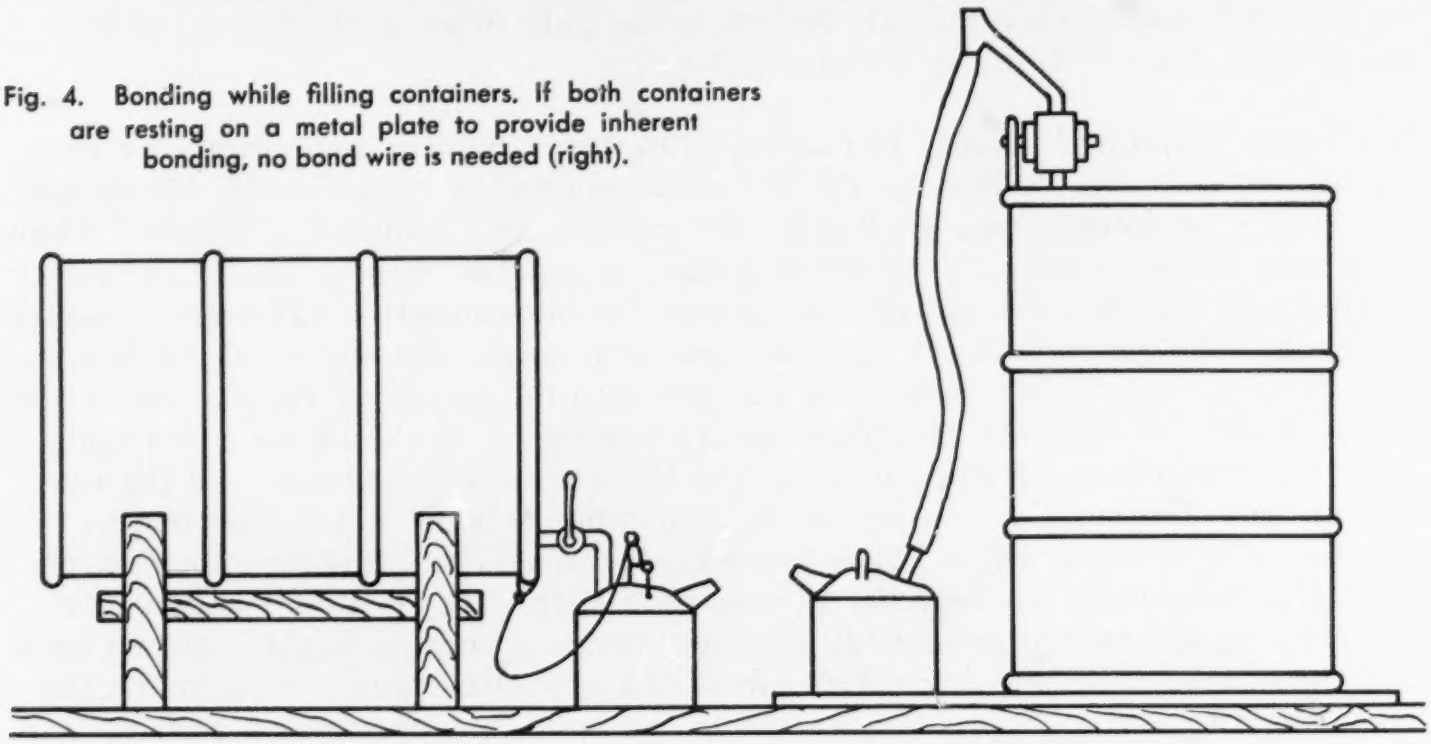

Fig. 4. Bonding while filling containers. If both containers are resting on a metal plate to provide inherent bonding, no bond wire is needed (right).

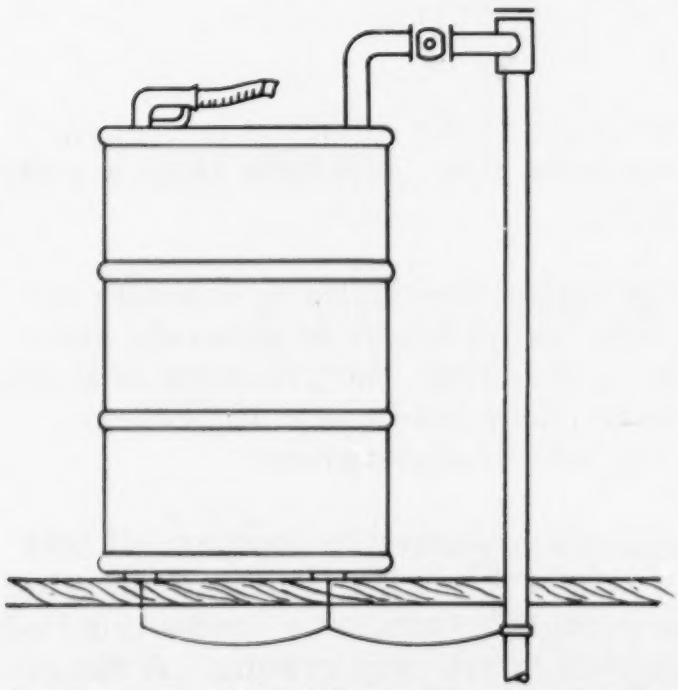

Fig. 5. Bonding while filling container. Metal strips fastened to the floor and bonded to the fill pipe serve as an inherent bond. If the fill nozzle maintains firm contact with the barrel head, no other bonding is needed.

2. In filling or emptying tank vehicles supported on rubber tires--Under some circumstances the generating mechanism can produce a potential difference between the vehicle and the supply piping that can become highly dangerous. In wet weather, rubber tires are sufficiently conductive to prevent dangerous charges, but in dry weather a vehicle so filled can accumulate a high potential unless some conducting path is provided. When vehicles are filled through open domes (the fill pipe either nonconductive or not touching the tank) sparking may occur at the opening where vapor is present unless some deliberately applied "bond" connection is made between the fill piping and the vehicle to provide a path over which the separated charges

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3. In tank filling--Pumping a petroleum product through a pipe can produce a charge of static electricity within the liquid, an equal and opposite charge being left on the pipe. As soon as the liquid comes to rest in a container, the charge tends to migrate toward the vessel walls and also toward the upper surface of the liquid. The rate at which the charge reaches the wall, where it is neutralized, depends on the conductivity of the liquid. The charge that reaches the surface cannot escape so readily, and in extreme cases the surface voltage may build up to a point where a spark may jump across the surface to the vessel wall. Such "surface charges" cannot be prevented by any process of bonding or grounding. Fortunately, the conditions that produce dangerous charges by this means seldom occur. Since the rate of charge generation is roughly proportioned to the velocity (rate of pumping), a precaution sometimes followed is to employ slow pumping rates at the start of filling. Agitation, which seems to assist in bringing the charge to the surface, will thereby be reduced.

A somewhat similar condition can result when a petroleum liquid in a tank is agitated by bubbling air through it, or by propellers, or even by filling through an overshot line. The effect will be intensified if water or chemical solutions are present. The mechanism of possible spark discharge is as previously described, and "grounding" the tank can have no influence either on the generation of static sparks by this means or on any hazard that may be associated with it. The only way to prevent this type of generation of static electricity is to avoid the agitation. The charge can be prevented from becoming dangerous by limiting the surface area on which it can accumulate. Experience has indicated that dangerous static sparks are unlikely in tanks with diameters under about 10 feet. Other methods of control are to eliminate the vapor space above the oil surface by using a floating roof or to inert or to use other equivalent means to insure that an ignitable mixture is not present.

Bonds

It has been emphasized that a static charge can accumulate only on a highly insulating surface or on a conducting body completely insulated from its surroundings. It is difficult to appreciate the high degree of insulation necessary to prevent escape of a static charge. All common concepts based on experience with electricity from batteries or power sources must be discarded, not because electricity from different sources is different, but because of the vast difference in the quantity involved and the voltage available. Ohm's law applies, but the magnitudes involved are unfamiliar.

In tests made at California Institute of Technology, Dr. S. S. Mackeown found that, while filling a tank truck with gasoline at 800 gpm, the rate of current generation was less than one-millionth of an ampere. With currents at this

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magnitude and voltages up in the thousands, a static charge will leak away as fast as generated if there is any path available having a resistance lower than a few hundred or thousand million ohms. Insulation to this degree can be achieved only with extreme care and special materials. Objects permanently resting on the earth are likely to have a resistance to the ground of very much less than this, and hence will be immune from the accumulation of a dangerous static charge.

Summary

1. Static electricity will be manifest only where highly insulated bodies or surfaces are found.
2. If a body is charged with static electricity there will always be an equal and opposite charge somewhere in the vicinity.
3. If a hazard is suspected, the situation should be analyzed to determine the location of both charges and to see what conducting paths are available between them.
4. Tests of the resistance of possible conducting paths should be made with an applied potential of at least 500 volts. Resistances below about 10,000 megohms will provide an adequate bond in many cases.
5. Where artificial bonds are applied, they should connect the bodies on which the two opposite charges are found; connection to the earth is incidental.

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Transistor Receiver:

During recent years many inventions have been made in radio receiving. One of these has been the use of transistors in the place of electron tubes (radio tubes). Transistors use less electrical current and generate less heat. For this reason transistor receivers can have smaller batteries and smaller, lighter cases.

4 SPONTANEOUS COMBUSTION

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Spontaneous combustion is another subject that sometimes is misunderstood, and hence is included in this manual. As stated in the following paper, vegatable and animal oils are the prime offenders; pure mineral oils are not subject to spontaneous ignition in the same manner. You may ask, therefore, "Why is this paper included in a manual about petroleum oil fuels?" The reason is that paints and paint oils commonly are used in the petroleum industry, and fires have started from the spontaneous combustion of paint rags and have destroyed oil property.

The subject of spontaneous combustion is included to round out the fireman's knowledge of fire prevention. Because this book can serve as a reference text as well as a training manual, this brief discussion may prove useful. (It is a revised reprint from the manuals of the 1955 and 1961 Bakersfield Oil Fire Control Schools.)

The Combustion Process

"Combustion," according to the dictionary, means "oxidation or the combining of some substance with oxygen accompanied by the evolution of heat." Everyone is acquainted with two common forms of combustion: rusting and fire. In the rusting of iron and, similarly, in the drying of paint, oxidation occurs, but it takes place so slowly that the heat that is given off is carried away by air circulation, and therefore, there is no temperature rise. In the case of fire, however, oxidation occurs so rapidly that not only heat but also light is given off.

Between these extremes spontaneous combustion lies. In spontaneous combustion, oxidation is occurring, and heat is being given off. Usually, however, air cannot carry away the heat because of insulation or poor circulation. Thus, a paint-soaked rag lying in the bottom of a locker may undergo spontaneous combustion. No more heat is being given off than would be given off by the drying of the same quantity of paint on a wall; but because air is unable to circulate and carry away the heat, the temperature rises. In some cases the temperature rises only very slightly, and no damage results. In other cases the temperature may rise to such an extent that the rag is charred. In extreme cases the temperature may rise to such a point that the rag actually catches on fire. When this does occur, we say that the material has been spontaneously ignited.

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Paints and Paint Oils

A great many substances can induce spontaneous heating or spontaneous combustion and may even result in ignition. In this connection vegetable oils and some animal oils are particularly dangerous. Since these oils are used to a large extent in paint, the following suggestions are presented for the guidance of those who use paints and paint oils:

Housekeeping. Whenever any painting is done, care should be taken that all rags are properly disposed of and all paint cans are capped tightly after use.

Los Angeles City Fire Department

Fig. 8. Ingredients of spontaneous combustion.

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Disposal. The proper disposal for paint-covered rags and clothing is either to burn them in an incinerator or to place them in a fireproof container, such as a metal trash can with a tight-fitting cover. They should never be dumped into the general trash can, because they are likely to ignite other materials.

Storage. A separate storage space should be chosen for paint cans. If possible, this should be a shelf with a rim or bead at the front to prevent their falling to the floor. All cans should be closed tightly and stacked no more than one can high. Under no circumstances should rags, trash, excelsior, cartons, and other ignitable items be stored on or underneath the paint shelf.

Closed lockers are not the best for storing paints, for these lockers often serve as catch-alls for other miscellaneous materials and add to the fire hazards unless particular care is taken to insure that the locker is used only for paints. If paints are stored on open shelves, any poor housekeeping is evident to anyone passing by; and therefore, the storage is more likely to be maintained safely. Some plants, however, have old steel truck lockers that are used effectively for paint storage, and these are acceptable.

It is safer not to store paints in areas closely adjacent to warehouses containing large quantities of readily combustible mineral oils. Paints should be stored in cool places where the cans will not overheat and pop off their lids. Paint oils should not be stored in glass containers.

Brushes. Brushes used for painting should be thoroughly cleansed. It is not necessary to use high-priced paint oils, turpentine, or solvents for this purpose. It has been found that stove oil makes an excellent brush cleaner and leaves a film of mineral oil on the brushes that keeps them soft and serviceable for future use.

Commercial Mineral Oils

The regular commercial lines of mineral oils are not subject to spontaneous ignition. However, mineral oils, oily rags, and oily trash will greatly accelerate a fire. Good fire protection demands good housekeeping for all such materials.

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5 USING WATER ON OIL FIRES

Oliver W. Johnson
Standard Oil Co. of California

The following paper was presented at the 1961 Bakersfield Oil Fire Control School, but copies were not available to include in the manuals distributed at the school.

Although the paper contains some technical discussion, it presents the subject clearly with much information of value to firemen. Study it carefully.

Ever since the days of the bucket brigade, water has been recognized as the principal agency for the control of accidental fires. The grading schedule of the National Board of Fire Underwriters gives 75 percent of the credit to water supply and equipment for the use of water. Without such facilities, no city could possibly achieve a rating above Sixth Class. In the NFPA Handbook of Fire Protection, nearly half of the space is devoted to discussion of water sources, distribution systems, and equipment used for applying water. Most fire department training devotes much time to teaching how to pump and handle water, how to apply it to a fire, and how to prevent damage when excess water gets to places not intended or desired.

Water is the basis for the control of the type of fire that occurs in what are loosely termed the "ordinary combustibles"--the materials of building construction and the objects of fabric, wood, paper, and similar products that surround us in our daily lives. But how about the use of water on fires in flammable liquids--specifically, the products of petroleum?

Once we often heard, "Never put water on an oil fire," but we know now that water is the best and most effective agent for controlling oil fires. Compared with the use of water on structural fires, there are differences in methods and results, which will be discussed. First, however, consider the role of water in controlling the "ordinary" fire.

Water as a Cooling Agent

Water is said to be pre-eminently a cooling agent. In an article by E. A. Hibbitt, Senior Fire Prevention Officer, Fire Brigade, Manchester, England,[1] the following appears:

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[1] E. A. Hibbitt in Fire Research Abstracts and Reviews (September, 1960).

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> Water has always been the principal medium used for fighting fires, and it is unlikely that it will be superseded in the forseeable future. Water is cheap, usually plentiful, and has the highest specific heat of any known substance, which gives it remarkable cooling properties. The difficulty has always been to find the best method of using it.
>
> Theoretically, the ideal way to extinguish a fire with water is to use exactly the right quantity, which in vaporizing will absorb sufficient Btu to cool the burning substance below its ignition temperature. If this could be achieved, the danger of damage by water to valuable commodities untouched by the fire would be eliminated.

Mr. Hibbitt goes on, under the heading of "The Arithmetic of Fire-Fighting," to show that the rate of heat release is likely far to exceed the rate of heat absorption of all the water that it will be practical to apply.

Much the same thought is expressed in an article by S. D. Klinger:[2]

> As a corollary to the principle of finding the fire and hitting it with water, it might be added that even though you are hitting the fire, it cannot be extinguished unless the cooling effect of the water exceeds the rate at which the fire is producing heat.

In both of these quotations the underlying idea is to relate the cooling effect of water to the heat release in the fire. This relationship will be developed in more detail. Since the properties of water are more familiar, the cooling effects of water will be explained first.

It is obvious that if equal quantities of hot and cold water are mixed, the resulting mixture will have a temperature between the two initial temperatures. The water at the lower temperature absorbs heat from the hot water and "cools" it but is itself heated up in the process. The amount of heat required to heat one pound of water by 1° F is called a "British thermal unit," abbreviated "Btu." This term is used in engineering calculations in the U.S.

Since water used for cooling must be heated, the number of degrees by which its temperature is raised is a measure of its cooling effect. If a stream of water at 62° F was used to cool a hot object, and all of it ran off at exactly 212° F, the total amount of cooling effect would be 212° F minus 62° F or 150 Btu's per pound of water used, or 150 × 8.34 = 1251 Btu per gallon of water applied.

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[2]S. D. Klinger, "Make Better Use of Men and Equipment," Firemen (February, 1961).

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When water is applied to a fire, at least some of it is converted to steam, and in this process it absorbs a much greater amount of heat. The relative heat quantities involved are tabulated below. You see that boiling a gallon of water absorbs almost six times as much heat as is taken up in heating it from 62° F to the boiling point.

TABLE 4
Water as a Cooling Agent

Heating Operation	Heat Absorption, Btu	
	Per Lb.	Per Gal.
Heat 62° F to 212° F	150	1250
Boil at 212° F	970	8080
TOTALS	1120	9330

The maximum cooling effect of water applied in fire fighting would be achieved if all of the water was converted to steam and none of it ran off. The location of the seat of the fire and many other factors combine to make it difficult to achieve this ideal efficiency in the use of fire fighting water. When the runoff feels barely warm to the touch, it is apparent that, for some reason, most of the useful cooling effect of the water has been wasted. Often, through a change in technique, the water can be used more effectively.

The Rate of Heat Release

Now to turn to the other half of the question: the rate of heat release. Both of the authors just quoted have concluded, in effect, that, to extinguish a fire, it is necessary to apply enough water to absorb all of the heat produced by the fire, as fast as it is released. The writer cannot agree with this conclusion, for reasons that will be explained later. Before analyzing this, however, consider the matter of the rate of heat release in a fire. You may say that this is a profitless subject--that it is impossible to estimate how fast a fire will burn; that the rate depends on too many unknown and variable factors; that there is no sense in trying to make calculations because in any actual fire the best approach is to put on all the water you can as fast as you can.

Probably you are right to a great extent--the brute force method has worked many times and will continue to be successful in many cases. It may be possible to demonstrate, however, that there is a great deal to be gained by considering the maximum probable heat release from a fire and that this approach will have great usefulness in explaining some of the characteristics of oil fires.

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The "heat release" from a fire--in other words, the rate at which the fire burns--obviously depends on a number of factors. As one extreme, consider a jet of gas released from a pipe and burning in the open. The rate of burning depends primarily on the rate at which the gas is escaping. In the surrounding atmosphere there is an unlimited supply of oxygen and--except for the small amount of carbon that escapes combustion and appears as smoke--all of the fuel burns as fast as it is released. The size of the flame adjusts itself on the basis of the rate at which the oxygen from the surrounding air can reach and mix with the gas. A big gas release produces a big flame; a small release produces a small flame--because the air supply is not the controlling factor. When a fire starts inside a closed building, however, the situation may be quite the opposite. Here, there is probably a large quantity of material that can burn. But because there is a limited access of air, a fire within a building or other enclosure may develop slowly until the breaking of windows or a structural collapse augments the air supply and permits the rate of burning to accelerate.

To assess the value of water in absorbing the heat of a fire, it is necessary to know how fast the heat is being released. It is somewhat surprising that this subject has not been investigated more completely. Although no single figure applies to all cases, some order-of-magnitude figures are of interest.

The NFPA Handbook of Fire Protection does not, at first glance, appear to be of much help. Under the heading, "Quantity of Fire," it states:

> There is not in use any generally accepted method of measuring quantity of fire, as distinguished from its severity. Measurement in terms of Btu's per minute has been suggested, but has not been used except for a few specialized applications.

Although this statement might appear to discourage further consideration of the subject, the discussion of fire loads in the pages that immediately follow gives an interesting approach to the problem. Time-temperature plots are given of the actual burning of six different structures, including an office occupancy, a record storage vault, a household furniture storage, and a dwelling. These were full-scale tests. The total fire load, or amount of combustible material per square foot, is given in each case. By noting the period of time during which combustion proceeded at the most rapid rate, as indicated by the temperature curve, it is possible to make a fair estimate of the rate at which the fuel substance was being consumed and hence also the rate of heat release. The estimated rate of fuel consumption in all six fires averaged between .30 and .46 pounds per minute per square foot, amounting roughly to a heat release of 3000 Btu per minute per square foot of building area. This is an average figure that prevailed over periods of 30 to 60 minutes; the peak rate must have been several times higher.

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Another basis for estimating the rate of burning of a solid fuel is available in the tests of the furnaces of steam boilers. Here the rate at which fuel is supplied is known, the area of the grate on which the fuel burns is known, and the air supply is adequate. Even though boiler furnaces vary greatly in size and shape, the results of numerous tests fall into a fairly consistent pattern. In one textbook the results of tests of some 30 different boilers are tabulated. The lowest rate of heat release was 2000 Btu per minute per square foot, and the highest, 20,000 Btu per minute per square foot; but the great majority were around 12,000 Btu per minute per square foot of grate area. This is four times the average figure derived from the tests on the burning of actual buildings. This ratio seems quite reasonable in view of the ample and controlled air supply in a boiler furnace as compared to a partially enclosed building; it is about the same as our estimate of peak rate for structures.

Another interesting source of information is the rate of burning of flammable liquids in open-top containers. In addition to practical experience that has been acquired in actual fires of large size, a great amount of laboratory work has been done in this area, mostly with petroleum oils. It has been determined that, for any one fuel, the rate of burning per square foot of surface remains substantially constant as the area increases above some minimum size--usually only a few square feet in area. Also, the burning rate is influenced by the kind of fuel and, for outdoor fires, by wind and other factors. Nevertheless, the range of rates observed is fairly narrow--about 5 to 18 inches per hour, and a figure of 12 inches per hour for gasoline will be a good average or a little high. By simple arithmetic, one foot per hour is 1/60 of 1728 or 28.8 cubic inches per minute per square foot, or 1/8 gallon per minute per square foot. This last figure is easy to remember and can be useful in several ways, which will be discussed later. One-eighth of a gallon per minute per square foot is equal, for an average oil, to a heat release rate of 14,000 Btu per minute per square foot.

The three heat release figures just discussed are given in Table 5. It is readily seen that there exists an indication of how fast a fire burns. The next question is how this information can be usefully applied.

TABLE 5
Rates of Fuel Consumption and Heat Release

Type of Fire	Lb./Min./Sq. Ft.	Btu/Min./Sq. Ft.
Structural Fire, Average	.4	3,000
Structural Estimated Maximum	1.6	12,000
Furnace, Coal-fired	.9	12,000
Oil Fire, Open Tank	1.0 (1/8 gal.)	14,000

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Extinguishing Oil Fires

If extinguishment were to depend, in fact, on the removal of all of the heat of combustion by fire fighting streams, the quantities of water needed could be easily computed, as shown in Table 6. Even casual inspection, however, shows that these figures are unrealistically high. A fire building 50 × 100 feet would need over 5000 gpm. Remember, these figures assume that all of the water would be used. You have seen extinguishment with much smaller water rates, even with a large runoff.

TABLE 6
Water Required to Absorb Total Heat Release of a Fire

Type of Fire	Btu/Min./Sq. Ft.	Gal./Min./Sq. Ft.	
		Heat 62 -212 F	Heat and Boil
Structural	3,000	2.4	0.32
Structural	12,000	9.6	1.27
Furnace	12,000	9.6	1.27
Oil	14,000	11.2	1.50

In spite of the two references that are quoted, it is apparent that the "total heat" theory of extinguishment must be abandoned. Extinguishment from a slightly different point of view--one that will bring us closer to the main subject of oil fires--will now be discussed.

Ordinary combustion. First, consider the actual mechanism of combustion. The NFPA Handbook states:

> In the burning of most substances, the actual combustion takes place only after the solid or liquid fuel has been vaporized or decomposed by heat to produce a gas, and the visible flame is the burning gas.[3]

It naturally follows that anything that interferes with the transfer of heat to the as yet unvaporized fuel will interfere with the process.[4] (This is implied, but not explicitly stated in the Handbook.)

When water is applied to a fire in wood or other similar combustible, its principal effect is to cool off the unburned wood, stop the evolution of vapor

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[3]NFPA Handbook of Fire Protection, p. 93.

[4]Ibid., p. 99.

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from it, and thus starve the flame that feeds upon this vapor. Later, of course, it can quench the red-hot embers to result in complete extinguishment. The fire is stopped at its source because the material on which it feeds (the vapors from the heated wood) ceases to be given off.

Certain oils burn in the same way. Consider heavy fuel oil, lubricating oil, or asphalt. None of these produces vapor in a significant amount until heated to a high temperature. This is why they are said to have a high flash point. But, if a fire is once started by combustion of some other material close by, the oil will give off enough vapor to burn. Once started, the supply of vapor is maintained because the flame continues to supply heat to the oil surface to create more vapor.

If no preventive steps are taken, the fire will continue until the fuel is consumed. However, if water (preferably in the form of a light spray) is applied to the surface, the surface will be cooled down, the release of vapor to feed the flame will cease, and the fire will presently be extinguished.

Thus, for fire in some kinds of oil, water is well suited for extinguishment and accomplishes extinguishment in much the same way as it does with wood or other ordinary combustibles--by cooling the material to the point where vapors are no longer given off. For nonvolatile or "heavy" oils, cooling is a means of shutting off the vapors that feed the fire.

Fires in heavy oil. For fires occuring in heavy oil, the data in Tables 6 and 7 give the basis for estimating the theoretical quantity of water required to effect extinguishment by interrupting the fuel supply. It was seen that the total heat released of 14,000 Btu per minute per square foot was produced by burning 1/8 gallon per minute per square foot. The latent heat of vaporization of oil is around 800 Btu per gallon, so it would take only about 1/8 of this, or 100 Btu per minute per square foot of fire area, to produce the vapor to achieve this burning rate. You will note that this is only a very small fraction of the total heat release of 14,000 Btu per minute per square foot. If a way could be found to intercept this small amount of heat so that it could not reach the oil surface, vaporization would cease and the fire would go out.

If the oil should have a boiling point above 212° F, any water reaching the oil surface would boil preferentially, and would exert its maximum possible cooling effect. Even if the water was heated to 212° F in passing through the flame, all that reached the oil surface would still be capable of absorbing nearly 8000 Btu per gallon. Thus, it would require only that 100/8000 or 1/80 of a gallon per minute per square foot to actually reach the oil surface to accomplish all of the desired cooling, and thus extinguish the fire. This is .012 gallon per minute per square foot. These figures are summarized in Table 7.

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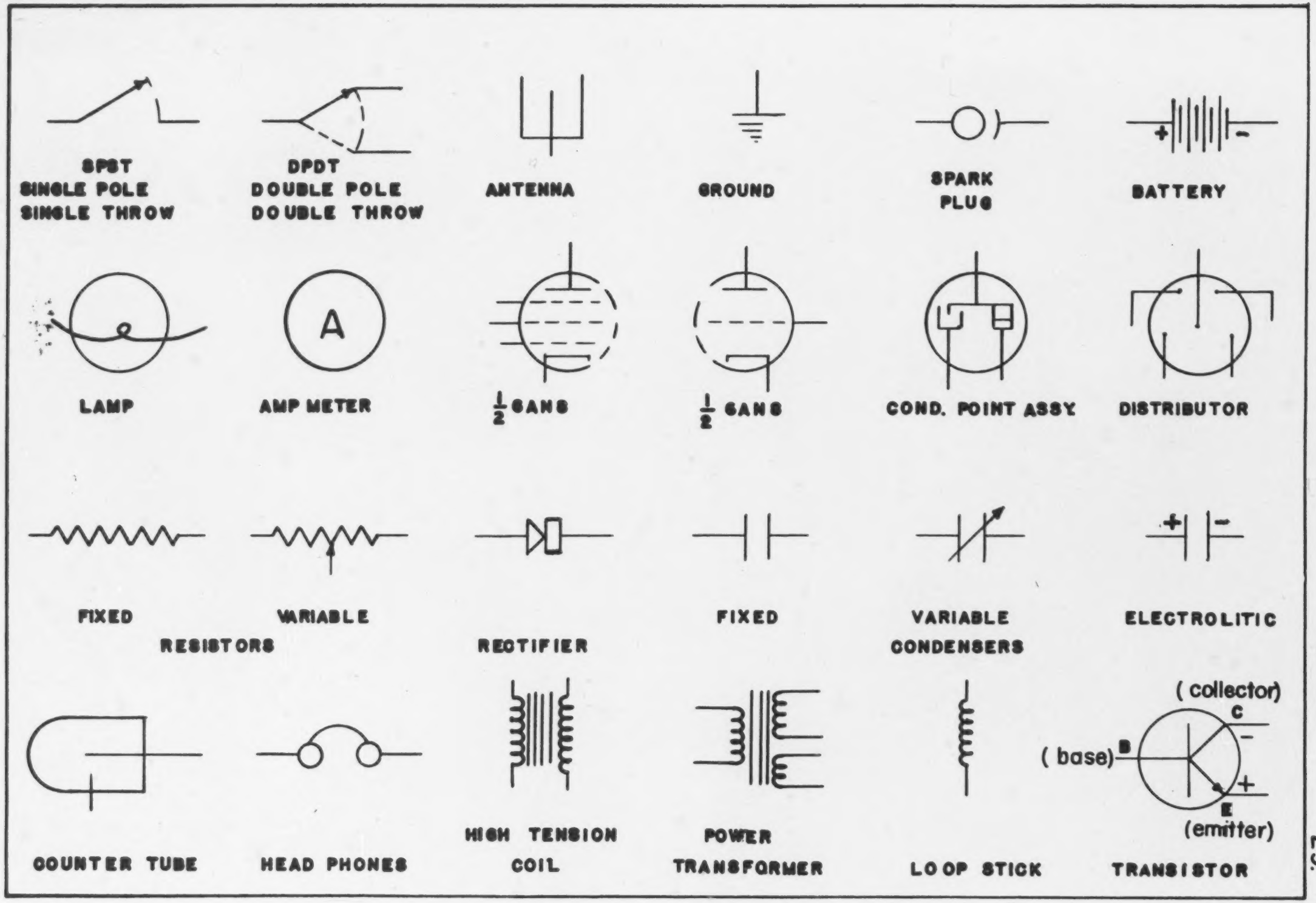

ILLUSTRATION SHEET 6.

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TABLE 7
Water Required to Absorb Heat from Flame--Exposed Surfaces

Type of Fire	Gpm/Sq. Ft.		
	Theoretical Heat 62-212° F	Boiling Point At 212° F	Practical Rate
Oil Surface 100 Btu/Min./Sq. Ft.	.08	.012	.10
Tank Shell 330 Btu/Min./Sq. Ft.	.26	.04	.20

When considering a fire in a heavy oil, with a boiling point above 212° F, you will see that theory suggests that water applied at rates that are wholly practical should be effective. Naturally, only a part of the water will reach the oil surface, and the total quantity used will be somewhat greater than, but still far below, that required by the total heat theory.

However, with the class of flammable liquids that is called "light," or "volatile," NFPA Class I and II, a different situation prevails. These oils give off sufficient vapor to burn at ordinary temperatures. Any water reaching the oil surface will not boil; it will probably sink to the bottom without being greatly heated; hence its cooling effect is negligible. The principal effect that it will have will occur within the flame itself, where any small drops can, of course, be vaporized to remove heat. But this means fighting the flame, not the fire. The figures just shown indicate that vastly greater quantities of water will be required if the "total heat" is to be absorbed.

In general, water is ineffective as an extinguishing means on fires fed by gases or vapors from volatile oils. However, there are other important functions that water may perform, to be covered later.

Special considerations. The discussion so far is intended to demonstrate that oil fires basically are the same as ordinary fires. There are, however, some important differences, which arise from the following:

1. Since oil fires usually occur in the open, the rate of heat release may be higher than in a building where access of air is restricted.
2. Oil can flow from one place to another, whereas a structural fire usually "stays put."
3. Since oil floats on water, the act of applying water in an attempt to control the fire may introduce complications, which are discussed below.

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Consider what will happen if, as a result of an accident, a pipe is broken, and gasoline leaks out at the rate of, say, 10 gallons a minute. Assume that this gasoline is ignited immediately. The fire area will be small at first, but it will speedily enlarge until the area is sufficient to consume all of the fuel just as fast as it escapes. From the figures previously given, the burning rate is 1/8 gallon per minute per square foot, or 8 square feet for each gallon per minute. A leak of 10 gallons a minute will produce a fire area of at least 80 square feet. This is equivalent to an area 4 feet wide by 20 feet long, and if the terrain is such that the flow tends to follow this pattern, the fire will approach this area and then cease to expand. It will continue to burn, occupying about this same area, so long as the rate of fuel supply is maintained. It can grow no larger because the fuel burns up as fast as supplied. It will not grow smaller because just this much fire area is required for access, heat transfer, and vaporization to balance the feed rate. This situation leads us next to the question of what will happen if a water stream is applied.[5]

Some of the water will be in small drops even if a straight stream is used. Some of the small drops will be evaporated to absorb heat from the flame, thus slightly decreasing the rate of heat transfer to the oil surface. The water that reaches the surface will cool it slightly, decreasing the rate of vapor release. Both effects will be to decrease the burning rate per square foot. Since the fire is being fed at a constant rate, the fire (if the terrain permits) will expand its area to make up for the decreased burning rate. The fire will spread. Of course, if it is so restrained that it cannot spread, the level will rise until the enclosing walls cease to contain it.

Remember, this is a gasoline fire. Most of the water used on such a fire sinks beneath the oil, floating it so as to raise the level; this also will tend to make it overflow any existing restraining walls. The oil may flow to a new place, but it cannot burn any faster than the rate of fuel supply or any slower than the rate at which heat transfer releases vapor from the oil surface.

To conclude this part of the discussion, it may be said that water is an extinguishing means for fires in "heavy" nonvolatile oils and that it cannot extinguish a fire involving gas or light volatile oils, except under highly unusual circumstances.

Cooling with Water

The use of water to keep cool or "protect" objects exposed to flame is known to every fire fighter. Wood structures will ignite and burn if exposed to flame

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[5]This was demonstrated in the field at the Bakersfield Oil Fire Control School in 1961, but with the use of less than 10 gallons per minute of fuel. See p. 161.

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or even to intense radiant heat. Steel structures are less likely to be affected by radiant heat, but flame contact can heat them so that they soften and ultimately fail. Water, applied properly and in sufficient quantity, can absorb this heat and prevent damage. Here again, the water can take the maximum amount of heat only from surfaces that are above its boiling point. A heat transfer rate of 20,000 Btu per hour per square foot is often mentioned as a peak rate for heat transfer to fire-exposed steel, such as the shell of a tank. This is 330 Btu per minute. If the surface was above 212° F, so that all of the water that reached it would boil, this amount of heat could be absorbed, and the steel could be protected from overheating--that is, kept from rising above 212° F--if only about .04 gallon per minute reached the surface. Of course, in any practical case, only part of the water can actually reach a surface to do this maximum amount of cooling, and a rate of about five times as much, or .20 gallon per minute per square foot is frequently recommended, as shown in Table 7.

Selection. With regard to the subject of cooling, it is well to emphasize one other point. Many of the liquid petroleum products that you will encounter have boiling points well below 212° F. Gasoline, kerosene, and stove oils all start to boil below the boiling point of water. If a tank contains such an oil, the part of the shell that is below the liquid level will be kept cool by the liquid inside. Even though this contained liquid is boiling, the steel that it contacts cannot get very hot. Fire fighting water applied to such a surface cannot absorb the maximum amount of heat. Water from the lower oil-wet parts of a tank may run off barely warmed, and thus be largely wasted.

This point should always be remembered: Water does its most effective job of cooling when it is converted into steam. Judgment is required to direct the available water supply in such a way as to make it most effective. Select the areas most severely exposed and avoid wasting water on objects that are so far from the flame as to need no cooling.

As far as tanks and other similar petroleum equipment are concerned, it is a safe rule to say that equipment will not need cooling unless flames actually touch it. Radiant heat will not damage equipment. The parts of the equipment that are invisible because they are enveloped in the flame need the protection; the parts that can be seen are unlikely to be endangered.

Application. Water applied to an oil fire may be used in two principal forms--spray (or fog) and straight stream. Each has its particular advantages, disadvantages, and scope of application. If we consider the type of pattern delivered by the usual fully adjustable nozzle, there are, of course, a variety of intermediate patterns between the wide angle fog and the straight stream, and each of these in turn has advantages and disadvantages. In general, it may be said that the straight stream has the greatest range and driving force, that the wide

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angle fog has a short range and affords the maximum protection for the fire fighter, and that some in-between position, which combines the two, will in most cases be the most desirable.

A dense spray of water may stand as a barrier between flame and fire fighters, to protect them against radiant heat, thus permitting closer approach for such important steps as closing a valve to shut off the flow of fuel feeding the fire. This use is too well-known to require discussion.

There is no need in this paper to take a position in the arguments on high pressure versus low pressure or on the merits of various types of nozzles. Although firemen may have opposing opinions as to how this can best be accomplished, the object is to get the water where it will do the most good.

Mechanical Effects of Water

Most of what has been previously said relates to the cooling effect of water. The mechanical effects are almost of equal importance. The place where oil burns may be very important. Oil floats on water, and flooding a fire area may cause burning oil to flow to an area where it could do a great deal more damage. Again, it may be diverted into an area where it could burn without doing any damage at all. This may be accomplished by the combined effects of floating and the force of hose streams.

If a container develops a bottom leak, adding water may float the oil above the level of the leak.[6] This method has been used to stop the flow of oil feeding an otherwise uncontrollable fire, and also to cut off a leak before fire has occurred. Water for this purpose may be added to the top of the container by hose stream or pumped into a line that communicates with the tank.[7]

- One word of caution: Don't overflow the tank! The rate of water addition must match the rate of leakage.

If a stream of oil is issuing from an open-end pipe or valve, fed at a pressure lower than the nozzle pressure, it is possible completely to stop the escape of fuel by playing a hose stream into the opening. This can often successfully be done even though the leak has already taken fire.[8] If a leak in a pipeline has occurred in such a way that a hose stream cannot be played directly

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[6] See pp. 186 and 187 of this publication--Editor.

[7] See Drills 7 and 8 of Section 3 of Chapter III--Editor.

[8] Loc. cit.--Editor.

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against the leak to stop it, it is sometimes possible to make an emergency connection somewhere else on the same line. The connection can be used to force water through the line so that water leaks out of the opening instead of oil.[9]

Summary

Water is the best fire-extinguishing medium available in the quantities required for large fires. For oil fires it is valuable in three principal ways:

1. As a cooling agent, water may be used to:

   - Cut off the release of vapor from the surface of a heavy oil, thus extinguishing the fire.
   - Protect fire fighters from flame and radiant heat when closing a valve or doing other work requiring close approach to the fire.
   - Protect flame-exposed surfaces, most effectively when the surface is shown 212° F.

2. As a mechanical tool, a water stream can do work at a distance to:

   - Control leaks.
   - Direct the flow of oil to prevent its ignition or to move the fire to an area where it will do less damage.
   - Dissipate escaping gas into the atmosphere to prevent widespread ignitable vapor clouds.

3. As a displacing medium, because water is heavier than oil, it may be used to:

   - Float oil above a leak in a tank to interrupt a leak, either before or during a fire.
   - Back-pump a line to cut off fuel escape.

Water may be misused because, injudiciously applied, it may push fire to new areas to increase the fire damage, and may overflow containers.

Conclusion

In the space available it is not possible even to mention all of the ways in which water may be used in fighting oil fires. In whatever quantity it is available, water will be employed most usefully when all of its capabilities and limitations are known and when fire fighting strategy is carefully planned with these facts in mind.

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[9]See p. 162--Editor.

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6 IGNITION OF HYDROCARBONS BY HOT SURFACES

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In the oil industry much attention is given to fire prevention. This includes frequent inspections of operating equipment and work procedures and, most important, a careful analysis of past fires. Sometimes the source of ignition is obscure. Simply guessing at the cause is never satisfactory, since the true cause may pass undetected and no lessons can be learned from it.

Oils and gases can ignite from hot surfaces--but not from every hot surface, because the degree of heat, time of exposure, and the nature of the oil are controlling factors. When a fire service inspector checks the cause of the fire, he can do a much better job if he knows these facts.

The control of fire hazards in industrial plants requires a knowledge of the factors influencing the ignition of various materials that accidentally may come in contact with hot surfaces, such as steam pipes or engine exhaust manifolds. The temperature to which a surface must be heated in order to produce ignition can be determined experimentally. It is influenced both by the nature of the combustible material and the manner in which it contacts the surface. It is impossible to establish any general rules that will apply to all conditions.

In general, fixed gases are more difficult to ignite than the vapors produced by charring solid materials or by evaporating and cracking the residues of heavy oils. Also, as a general rule, any circumstance that tends to increase the time of contact of the vapor with the heated surface will promote ignition at lower temperatures. When ignitable vapors remain in long contact with the heated surface, it can be shown experimentally that oxidation may proceed first at a slow rate, yielding heat, which raises the temperature of the mixture; this temperature rise in turn accelerates the reaction, resulting ultimately in flame. This effect cannot occur where the surface is in the open air so that normal convection currents prevent retention of the mixture close to the heated surface. As an extreme example, flame can result from introducing a drop of gasoline into an enclosure, the walls of which are heated to about 500° F; whereas, when a pipe or other similar metallic surface is exposed to the air under ordinary atmospheric conditions, a surface temperature of over 1200° F will be required to produce ignition when a drop of gasoline is splashed or sprayed against it. The lowest temperatures reported in fire prevention literature as "ignition temperatures" for various substances all are determined by the method that is used to introduce the material into a heated enclosure.

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Following in Table 8 are results of tests recently made to determine the temperature to which a surface exposed to free convection on all sides must be heated in order to produce ignition of various substances. The heated body was made of cast iron, about 3 inches by 4 inches in horizontal dimensions and 1 inch thick, and was supported on a vertical rod so as to be completely surrounded by air. It was electrically heated, and the temperature was measured with a thermocouple placed in a hole in the upper surface. As a matter of convenience, the substances to be tested generally were placed on the top surface; a few trials made by bringing materials into contact with the sides did not produce different results.

TABLE 8
Ignition Reactions

Material	Reaction	Degrees F
Sulphur	Ignites	570
Paper	Smokes and chars	630
Paper or sawdust	Shows first spark	880
Paper or sawdust	Ignites and burns	1000
Drops of ethyl ether	Ignite	1100
Lube oil	Ignites when held in contact with hot surface by charred paper	1170
Gasoline	Ignites when held in contact with surface as above	1200
Drops of petroleum ether or lube oil	Ignite when placed on bare metal	1230
Spray of petroleum ether	Fails to ignite when directed at surface	1240
Petroleum ether vapor	Ignites when released close to the surface	1300

The conditions of these tests closely simulate field conditions, wherein drops of petroleum may be sprayed on heated surfaces or where the vapors from petroleum are carried across such surfaces by the wind. The figures given above may be used as a rough guide in evaluating the hazards of ignition from accidental exposure of this kind. The figures obviously do not apply to the case where oil or vapor is held for long periods in contact with the heated surfaces, such as when insulation around a hot oil line is wet with liquid oil.

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PART 2 OIL FIRE CONTROL PROBLEMS

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7 PRINCIPLES OF OIL FIRE FIGHTING

W. B. Klaus
Tidewater Oil Co.

The first paper in Part II covers general principles. The fire-fighting practices described may be applicable to fires in an oil field, in a refinery, bulk plant, service station, or any oil plant or consumers' property. In a practical way the author describes various methods of fighting oil fires and brings out the necessity for properly assessing the job in order to select the most effective and safest method, depending upon the type of oil involved and the situation at hand. The paper sets the stage for subsequent papers, which deal with specific types of oil properties such as bulk plants, tank trucks, and service stations. (This paper, which was presented at the 1955 and 1961 Bakersfield Oil Fire Control Schools, has been revised for this book.)

Long Beach Fire Department

Fig. 9. Many fire departments use tabletop demonstration apparatus for discussion of the "three essentials."

Oil fires are not conflagration breeders. There are no flying brands to carry over the heads of the fire fighters. Although spectacular clouds of black smoke make oil fires look threatening, those very clouds absorb the heat of burning gases and reduce exposure temperatures. There are fewer exposure hazards. Sometimes it is better to control an oil fire and let it burn until the

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fuel supply can be shut off than it is to extinguish it. Because such facts are not generally known outside the industry and oil fires always seem to make good newspaper copy, stories with erroneous terms, such as "explosive gasoline fires," and spectacular photographs of massive columns of smoke have engendered a fear psychology in the public mind.

You know that a fire requires three essentials. First, you must have fuel in vapor form. Second, you must have air mixed with fuel vapor in the right proportion to form a flammable mixture. And third, you must have some source of ignition. These essentials provide three avenues to fire control and extinguishment.

Disregard the kind of fuel involved for the purpose of the following discussion. Assume that a fire is under way and select one or more of the principal methods to extinguish it.

Controlling or Shutting Off the Fuel

Each of you has used gas appliances or gasoline camp stoves. You have extinguished fires in them by closing the fuel supply valve. Similarly, the most common method of extinguishing petroleum fires is to shut off or interrupt the fuel supply by closing a valve.

Sometimes, if there is no valve and if the leaking pipeline is small, you may be able to crimp or flatten the pipe and shut off the fuel. Gas companies have viselike tools for this purpose. If a leak develops in a drum or tank, or if an open pipe is discharging gas or liquid, the flow may be stopped by directing a hose stream into the opening; and if the volume and the pressure of the fire stream is greater then the pressure inside the drum, tank, vessel, or pipeline, the flow of fuel can be stopped. If a pipeline is leaking, fire hoses can be connected to the line and water can be used to displace the fuel in the line. This method has been used successfully on many occasions. Fuel leaking from a valve on the bottom or side of a tank may be stopped by adding water to the tank and floating the fuel above the leak, thereby cutting off the source of the fire. When the fuel is floated like this, care must be taken that the flammable contents of the tank will not overflow. You must know the fuel level of your tank.

So far the topic of discussion mainly has been shutting off the source of liquid fuel or gas fuel from a pipeline, tank, container, or similar equipment. Sometimes the fuel cannot be shut off, but it can be flushed or piped away and burned at a safe location. Burning gasoline from a leaking bottom connection of a tank truck on an open highway could be washed away to burn in a safe place. In a closely built-up area, however, another method may be more practical. Simultaneously with extinguishing operations, firemen must also protect

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Assignment

WS. 11. Light Circuits; Notice the letters and numbers in the open spaces of the One lamp - one switch circuit. These letters and numbers used with the descriptions given below and Illustration Sheet 6, page 29, tell you what symbol to draw in the space. Complete the drawing by inserting the proper symbols.

S_1 = SPST, single pole, single throw switch for controlling the light bulb.

L_1 = Lamp (light bulb).

Now look at the open spaces in the One lamp - two switch circuit.

Complete the drawing by inserting the proper symbols.

S_1-S_2 = DPDT, double pole, double throw switch. Used for controlling a single bulb from two locations such as top and bottom of a stairway.

WS. 12. Ignition System; Complete the drawing by inserting the proper symbols found on page 29.

B_1 = 6 or 12 volt battery which furnishes the electrical current.

A = Ammeter for reading current flowing in system.

S_1 = SPST switch for turning current on and off. Use to start and stop car.

H.T. Coil = High tension coil, transforms 6 or 12 volts from car battery into 2,000 volts to spark plugs.

Fig. 10. A "Christmas tree" prop is commonly used in training in shutting off a fuel supply valve.

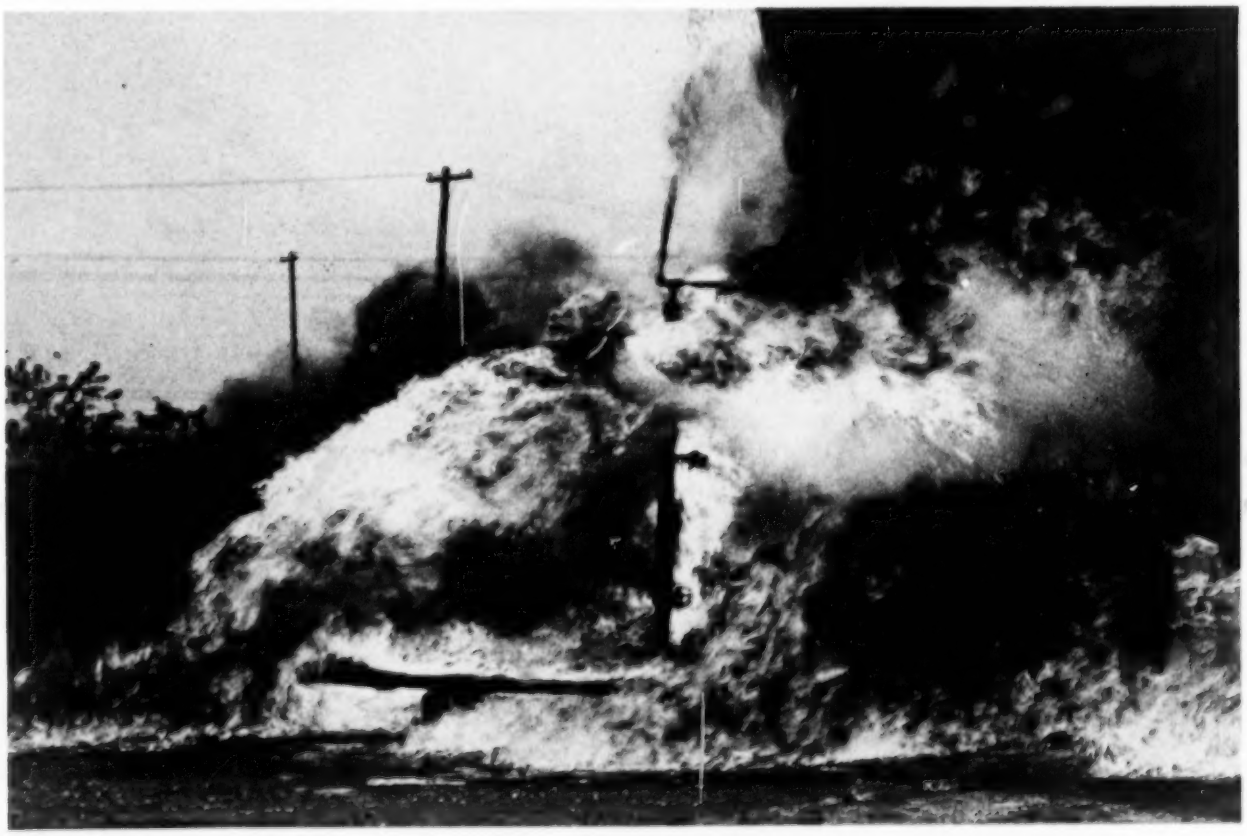

Fig. 11. A Christmas tree ablaze.

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exposures and confine the fire. Water fog or spray absorbs heat very rapidly, covers exposures most efficiently, and confines the fire. Heat-absorbing fog or spray is excellent for protecting personnel and providing a means of approaching a valve for closure. After the source of fuel has been shut off, the water spray must be continued to protect the exposed facilities and to prevent spread while the remaining fuel is consumed.

When large leaks of gas or volatile oil such as gasoline are the source of fuel and when there is a chance of reignition, extinguishment without control of the fuel may be extremely dangerous. The only safe method may be to let the fire burn under control until the source of fuel is exhausted or shut off. Fires in ordinary fuels, such as wood and similar combustibles, generally are extinguished by cooling or quenching the fuel to a point where fuel vapor is no longer formed in sufficient quantities to sustain combustion.

Kern County Fire Department

Fig. 12. A safe approach to the shutoff valve.

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The same principle can be applied to kerosene or diesel oil fires. The burning surface may be cooled down with water fog to below the oil's flash point; no more vapor will be released and the fire will go out. This is just another way of shutting off the fuel vapor. Heavier oils, such as fuel oils and asphalts, may be extinguished with water sprayed on the surface of the oil. When the water droplets strike the hot, viscous oil, the steam that is formed produces a froth on the surface. This froth is further cooled until it no longer gives off sufficient vapor to burn, and the fire is extinguished. This method of control is effective on fires involving relatively thin layers of crude oil--that is, up to a few inches in depth--resulting from spills, leaks, or boilovers. If the fire burns long enough to consume the light fractions, the residue is similar to a heavy fuel.

Actually, two kinds of extinguishment are occurring simultaneously when a viscous oil is frothed. As the cool froth shuts off the source of fuel vapor, by holding the oil temperature below its flash point, it also blankets oil surface and shuts off the supply of air from above. This leads us to the second method of extinguishment.

Shutting Off the Air or Smothering the Fire

A fire in an open-top can or tub can be extinguished by placing a tightly fitting metal cover over the can or tub. The fuel vapor-air mixture is controlled by putting a cover on, and the fire is smothered. Using a wet blanket as a cover is utilizing the same principle. It may be impossible to get a cover of sufficient size and proper shape to fit all situations. If a bucket of burning gasoline was leaking onto a table, and the burning gasoline was running onto the floor, a mechanical lid or cover would be impractical; a gas blanket of CO_2 may serve very well.

Blanketing a fire or smothering it with an inert gas has its limitations. Before extinguishment is attempted, sufficient equipment and manpower must be at hand to permit covering the entire area with a concentration adequate to smother the flame. Partial covering is ineffective. Any burning wood or highly heated metal must be cooled before a fire can be extinguished. The same applies to extinguishing with dry chemical powder.

Care must be taken in smothering a fire fed with gas under pressure, such as natural gas, butane, or propane. If there is a relatively small leak, with little likelihood of reignition, extinguishment by smothering may be accomplished safely. But as mentioned previously, a large leak with little chance of being rapidly dissipated by the wind may become dangerous if extinguished without shutoff. The gas, continuing to flow, will form a cloud over an area where men may have moved in, and they may be caught in the flash of reignition.

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We have been speaking of covers or blankets for fire extinguishment. One type of blanket, which has proved to be very effective on standing oil pools and tanks, is a blanket of chemical, mechanical, or air foam. The foam blanket, however, must be applied at a sufficient rate and in a proper manner to overcome breakdown by heat or oil submersion. If foam is floated gently onto an oil surface, rates as low as 2/100 to 3/100 gallon per minute per square foot of burning oil surface are adequate. These are water rates supplying the generating equipment, or foam solution rates. Less efficient splash application from a tank top may require rates up to 1/10 gallon per minute per square foot of burning oil surface. Hose stream application on a large fire may not be effective with rates of less than 3/10 to 4/10 gallon per minute per square foot of burning oil surface. For example, a vat of burning gasoline that has 2500 square feet of oil surface may require hose stream equipment capable of delivering water or foam solution at 750 to 1000 gallons per minute for extinguishment.

Fig. 13. Small CO_2 extinguishers are particularly suited to fires on laboratory benches where cleanup and contamination in surrounding areas may be a problem.

Each extinguishing agent has its special field and limitation. Foam, CO_2, dry powder--all have limitations. Water is the most versatile extinguishing agent--and fortunately, the most plentiful--as well as the most readily available and the least expensive.

When using water, you must remember that too rapid application results in an additional problem of waste water, for which drainage is absolutely essential. It is seldom that you can control the use of water to the point where drainage is not necessary. Be practical--drainage must be considered.

Controlling the Source of Ignition

Once a fire has started and the flame from burning shows, the extinguishment of this flame automatically removes this source of ignition. Not all fires are so simple. In other conditions there may be secondary sources of ignition that must be controlled as well. Burning embers, very hot metal surfaces, and sometimes, faulty electrical circuits must be controlled to prevent reignitions. Therefore, in sizing up a fire prior to extinguishment, you may have to plan to quench the embers, cool the hot surface, kill the electric circuit, or take other steps before extinguishing the main fire.

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We have covered the three essentials or principles of oil fire control and extinguishment:

- Flame arresting is not a practical approach.
- Smothering with a blanket of inert gas or foam has many limitations.
- Controlling or stopping the flow of fuel, coupled with the intelligent use of water, is the most advantageous approach.

Water is economical and plentiful and has a great heat-absorbing capacity. It is your best weapon for the control and extinguishment of all fires, including oil fires.

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8 OIL GATHERING AND PIPELINE OPERATIONS

S. D. Clithero
General Petroleum Corp.

In the application of fire protection principles to specific oil industry operations, it is logical to arrange the subjects in the order of the flow of the oil from its source in the oil field, through the various stages, to the ultimate consumer. These stages were discussed briefly in the Introduction to Part I. An important early stage in this operation is the pumping of the oil at high pressures and rates through hundreds of miles of pipelines to and from the refineries. This paper describes fire protection in pipeline operations, evaluates the potential fire risks, and points out that fighting fires from leaking pump glands in pipelines, and in storage tanks, is no different from fighting fires in other operations. (This paper was presented at the 1955 and 1961 Bakersfield Oil Fire Control Schools.)

This branch of oil industry activity includes dehydration and long-line pumping. Wet crude oils are dehydrated at field gathering stations and then pumped to refining centers. From refineries the refined products are pumped to terminals and distributing centers.

The principal character of each element of this operation follows.

Oil Gathering and Dehydration

Dehydration (removal of water and sediment) is generally done at oil lease gathering tanks. Generally it involves the use of stable, noncombustible chemicals, heat, and sometimes, special electrical processes conducted in low pressure treating shells. In this phase of operation, most difficulties result from lack of proper temperature controls for heating the oil. Overheating occasionally causes treating tanks to boil over and their vapors to spread to ignition sources that normally are safely located. In the electrical method, proper design and measures to control or relieve container pressure have proved effective; fires have been very rare.

Gas engine drives are quite common for pumping from the lease gathering tanks to the main pipeline junctions. Lack of fire incidence strongly discounts concern over this practice.

Pipeline Pump Stations

Pipeline pump stations frequently include substantial tankage. The stations generally are a good many miles apart, necessitating pumping at high pressures.

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Steam, electric motors, and reciprocating engines all are common prime movers for the pumps. The distances and pressures, together with a requirement for continuous operation, have resulted in high standards of design and inherently rugged equipment. These features have contributed to an exceptionally good fire record. Proper separation between pumps and their boilers or engines and sensible layout also have proved to be effective safeguards against fire.

The tank fire experience at pipeline stations is similar to other tank experience. The same factors that prevented or caused tank fires elsewhere apply here in about the same degree. One necessary practice, however, is somewhat of a problem, and has caused some fires. Oils pumped into the system come from various and often unrelated sources. The nature of products ranges from butane or unstabilized casinghead to heavy crude. A median blend of pipeline oil is produced by coordinated pumping, which is subject to a variety of circumstances that are difficult to control perfectly. Any one of these circumstances may cause an important change in the character of the oil at any given interval. As a result, slugs of high vapor pressure product getting into the wrong type of tankage or unanticipated deviation in flow rates have caused three or four West Coast fires. However, an elaborate frequent check-call program to the operating or dispatching headquarters (often at one-hour intervals), electronic gauging and recording flow meters, and numerous other special devices are designed to minimize the likelihood of such occurrences and obviously are quite effective in doing so. Considered in relation to the scope of pipelining operations on the West Coast, the lack of difficulty clearly points to a splendid degree of coordination in widespread operations.

Long-Line Piping Systems

The long-line systems unavoidably must be routed through some developed areas. Customarily the line routings are under continuous surveillance by line-walkers, line-riders, airplanes, and remote pressure indicators. The pipeline itself is generally subjected to periodic elevated pressure tests. Internal corrosion is not a special problem; external corrosion is safeguarded against by highest quality of pipe coatings, by cathodic protection, etc. Therefore, most troubles in this part of the operation result, as would be expected, from human failure. Company employees are responsible for only a small proportion of these errors. The majority of accidents result when persons outside the industry carelessly operate heavy duty machinery, which cuts into pipelines. Some serious fires have resulted, because most excavation work is done in built-up areas. Fires caused by "hot work" in connection with repairs of pipeline leaks have been few because the job routine is careful, competent, and planned.

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The Fire Record

According to long-term API records, pipeline operations are well within the best half of the industry divisional averages. The records indicate an average experience of one $3000 fire during each 50 years of station operation. This equals approximately $60 loss per year per plant, an overall average loss of about 6¢ each year for every $100 of insurable value.

The West Coast fire record has been substantially better than the national average since the early 1920's, when a series of disastrous reservoir and tank farm fires occurred in wood roof tanks without lightning protection. This type of storage for crude oil was discontinued thereafter, and the subsequent experience has indeed been gratifying in relation to the volume and scope of operation. Some of the details are noteworthy: One company reports 40 years of operating 25 stations without a single station fire. A loss of a total of only $466 is reported for 15 years of entire pipelining operation over Southern California. Another company reports only one tank fire in 45 years of extensive operation.

Several companies equal or surpass one or more of these excellent records. A summary of the composite records of two of the larger companies, which in total fairly well reflects approximately 25 years of the principal West Coast operations, shows that what fires have occurred have been caused:

- 40 percent, human error or faulty judgment
- 15 percent each, lightning and outsiders
- 7 percent, electrical installations
- 38 percent, miscellaneous or undetermined factors

The sources of ignition for these fires were:

- 39 percent, open flames and sparks, including hot work
- 20 percent, lightning
- 4 percent, exposure fires spreading to the company operation
- 9 percent, excavating machinery
- 10 percent, electric sparks
- 18 percent, other or unidentified sources

The Fire Control Pattern

The typical long-term record suggests certain areas in which the fire services could contribute most in preventing losses.

Tankage. Good maintenance is essential; modern all-steel tanks are most unlikely to have fires. So far as pipeline blending and product control is concerned, it appears unlikely the fire service can add very much to what the

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companies are already attempting to accomplish internally. The fire service certainly should be informed about a pumping control program, and most assuredly the service is directly concerned with an adequate communication system. The dehydration problem is largely isolated from public interests, but the fire service has a legitimate interest in heat control in individual cases.

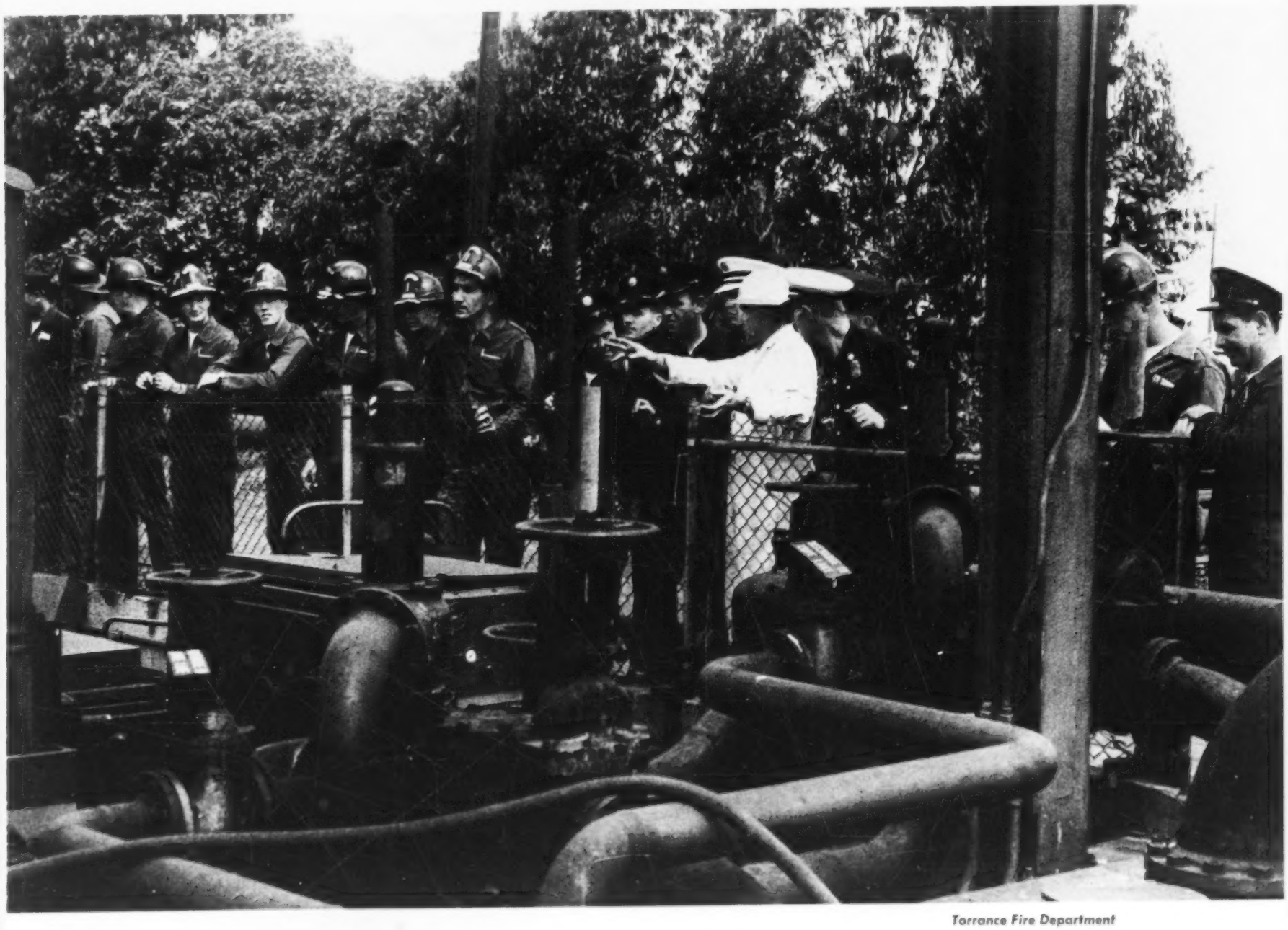

Torrance Fire Department

Fig. 14. Prefire planning at a pipeline station. Firemen learn the layout of the plant, its built-in protection facilities, and how to coordinate their work with that of the plant personnel.

Pumping stations. The fire service should participate in prefire planning. Although characteristically good, housekeeping is, of course, of interest.

Layout. Conformity with basic good practice is clearly adequate. Although NFPA 30, Recommended Standard on Storage and Handling of Flammable

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Liquids, is an acceptable guide for developed areas, it is entirely too conservative for application to isolated pipeline operations.

Pipelines. Outsiders should never close pipeline block valves on their own initiative. If volatile oil leaks occur, prompt notification of the pumping source, diversion of traffic, and above all, extinguishing of dangerous flames in the vicinity all can be expedited by the fire service. Keep in mind the possibilities of using artificial ventilation by hose streams to disperse vapors from oil leaks.

The fire service can most definitely assist on the problem arising from excavation by outsiders. Franchises require the accurate recording of the identity, routings, and locations of pipelines. In developed areas, excavations should be done only under a permit system. The authorities thoroughly should review every permit, and where there is any need indicated, they should advise the pipeline operator of the contemplated excavation, so that both the operator and the authority can inspect the site and, if need be, stand by.

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Cond. = Condenser which stores electricity. In electronics work, the term condenser has been replaced by capacitor.

Point Assembly = Breaker points which make and break current flow in low tension primary circuit.

Dist. Cap = Distributor cap directs high tension current from secondary windings of H.T. coil to spark plugs in firing order of engine.

WS. 13. Geiger Counter: Complete the drawing by inserting the proper symbols found on page 29.

B = Battery which supplies current for system.

R_1 = Resistor for slowing current flow.

V_1 = Counter tube filled with a gas which will conduct electricity when rays of a radio-active substance pass through it.

P_1 = Earphones for hearing clicks of battery current when gas conducts it between electrodes of V_1.

S_1 = SPST, switch turns counter on and off.

Gnd = Electrical ground.

WS. 14. Transistor Receiver: Complete the drawing by inserting the proper symbols found on page 29.

Ant. = Antenna

C_1, C_3, C_4 = Paper or mica condensers

C_2 = Variable condenser

9 BULK PLANTS AND TERMINALS

S. D. Clithero, General Petroleum Corp. and
Frank Bartholomew, Socony Mobil Oil Co., Inc.

Bulk plant fires are rare, considering the number of bulk plants in the nation. The average fireman has had little experience in fighting them. As a result, some fires have been poorly handled, and some firemen have been killed. The bulk plant fire at Kansas City on August 18, 1959, is a well-known example.

Experience has shown that no plant can be made 100 percent safe, especially where bulk products are flammable and where the public is invited. Even with the most conscientious dealer and the safest plant, a careless employee or careless customer can set the stage for an emergency. Firemen should have the knowledge and skill to control it properly.

Firemen should know all the plants in their area. They should hold prefire training sessions at each plant, know where the most likely fire problems are at each plant, and plan the best procedure to use for each type of emergency that could arise. Techniques that are applicable to the average industrial plant may not apply to a bulk plant fire.

In the following paper, which was presented at the 1961 Bakersfield Oil Fire Control School by Mr. Bartholomew, Messrs. Clithero and Bartholomew evaluate the hazards and recommend fire control procedures.

To meet the demand for a variety of petroleum products, bulk distributing plants are located in a good many communities. Many of these plants are locally owned or operated. The business they do and the salaries and taxes they pay help the economy of a community. The products distributed are essential to nearly every activity. At the moment, however, our interest is concerned with the emergency rather than economic aspects.

A properly constructed and operated bulk plant or terminal is not a menace to its neighbors or the community. But some fires do occur, and most of these are the same kind of fires that occur in other commercial and industrial activities. In other cases, the petroleum products or special facilities become involved or exposed. When this happens, you need to be able to anticipate the behavior of the involvement in order to work safely and efficiently.

The National Fire Protection Association's suggested ordinance on the storage, handling, and use of flammable liquids (NFPA 30) defines a bulk plant as, "That portion of a property where flammable liquids are received by tank vessel, pipelines, tank car, or tank vehicle, and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car,

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tank vehicle, or container." Such a plant usually consists of tanks of from 500- to 5000-barrel capacity with the piping, pumps, and accessories needed to receive and pump the oils. It includes a loading rack where the local delivery trucks are filled. Generally, there is a warehouse for barrel and package goods. In the small plants, this structure often includes an office and garage space for the trucks. At more extensive operations, there may be facilities for reconditioning and filling barrels and for mechanical and automotive maintenance, along with larger tanks and perhaps a pier or wharf for ships and barges.

Before these products, facilities, and operations are examined in detail, their over-all fire record should be considered. An American Petroleum Institute summary covering over 300,000 plant years of operation indicates a fire frequency of about 165.5 plant years with an average loss per fire of about $1720. The average loss of $10.40 per plant per year is probably considerably below the average annual fire insurance premium on your home.

Three of the larger companies operating in the West found that 39 percent of their fires were related to the usual gasoline transfer operations and that another 12 percent resulted from the maintenance and repairs to gasoline-handling facilities or from the use of volatile products for cleaning.

The Products

A preliminary to considering factors that are most likely to give trouble is a review of the fire hazard characteristics of the products. These can be grouped in two general classifications based on the temperatures at which the oils are normally encountered. The first group includes gasoline, and sometimes liquefied petroleum gases. These are called "low flash, volatile products." The second group includes the solvents, kerosenes, and burner and diesel oils. These are called "high flash, nonvolatile products." This group also includes lubricants and greases that have such low volatility that they are not considered flammable liquids in the National Fire Protection Association classifications. To define the first group as "hazardous" and the second group as "nonhazardous" is not altogether correct. Certain features of the low flash volatile oils actually contribute to the safety of their storage in closed containers. Therefore, the characteristics must be analyzed more closely in order properly to evaluate the conditions under which the various oils may be of concern.

Fire requires a proper mixture of air and vapor. Too much or too little oil vapor in the mixture makes it not flammable. Between the upper and lower flammable limits is the ignitable range. For most bulk plant products, the ignitable range is within 1 percent to 7 percent oil vapors in air. It is necessary to be concerned, therefore, with the conditions under which oils may give

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off vapors to produce or exceed this flammable range. All oils have a tendency to evaporate, and they evaporate more rapidly at increased temperatures. Oils that evaporate more rapidly and at lower temperatures are referred to as more "volatile" than other oils that vaporize more slowly. Gasoline is volatile; it produces enough vapor to reach the lower flammable limit at temperatures much lower than does diesel oil. The flash points are roughly minus 50° F for gasoline and plus 150° F for diesel oil.

Oil vapors have a tendency to diffuse into the surrounding atmosphere. When vapors are free to diffuse into the atmosphere without restriction, the area of ignitability extends farthest from the volatile oil. When dispersion is restricted, as by the shell and roof of a gas-tight tank, the volatile oil (gasoline) can make the mixture so rich that combustion within the tank vapor space is impossible. Then, if such a tank is properly vented to limit the pressure the oil vaporization can exert, explosion is impossible. At normal room or atmospheric temperature, the less volatile oils do not form ignitable mixtures within tanks or even at the oil surface. In the open, only gasoline and LP gas produce ignitable vapors over large areas and a breeze disperses them. JP-4 may be stored at large terminals but not at bulk plants (see p. 97).

Vapors from bulk plant products are heavier than air. They may tend to seek and remain in low spots. Vents, therefore, preferably should discharge upward and at some reasonable elevation above grade.

The Facilities

When petroleum handling is involved, most fires occur at the tanks, pumps, and loading racks, the latter having the greatest number of fires. Although some of the most dangerous fires originate around tanks, the factors responsible are clearly recognizable deficiencies in design.

Bulk plant and terminal fires almost never start with the explosion of gasoline tanks. Troubles in tank areas most frequently originate as spills and ground fires. When tanks are inadequately vented to withstand direct fire envelopment, they may burst. Vertical tanks, which are most common in California, behave differently from horizontal tanks when exposed to surrounding fires. (This subject is discussed in some detail later in this paper.) Some poorly vented horizontal tanks have rocketed dangerously. If elevated tanks drop, due to failure of supports to resist fire exposure, contents are likely to be spilled. Actually, there is little excuse for any of these occurrences. Experience points up the following procedures.

Avoiding spills. Most oil spills result from operational failure. The source (pumps, truck, tank car, ship, or barge) from which oil is being discharged into tanks often is remote or out of sight. Good operation includes: (1) Before

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starting oil transfers, gauge the tank, check the valve and piping lineup, then recheck the delivery orders and communications. (2) After starting the transfer, check to be certain that piping is tight and that the stream is going into the proper tank at the anticipated rate. (3) At reasonable intervals, recheck the tank gauge to verify the receiving rate. This procedure eliminates most spills or reduces the quantity of a spill.

If the initial spill is high flash oil, fire seldom results. If the spill is volatile low flash oil, few ignitions occur at sources more than 50 feet from oil accumulations, even with such products as gasoline.

Specifying piping and tanks. Piping subjected to ground fire is more vulnerable to damage than tanks are. Cast iron fittings are subject to earlier failure from thermal shock and expansion strains than steel fittings; flanges and threaded joints are relatively more vulnerable than cast iron valve bodies. Total failure of cast iron fitting details is common in from 15 to 30 minutes unless there is cooling by water streams or product flow. Prolonged severe fire exposure seriously damages steel pipe and fittings; however, leakage rather than total failure is the rule. A little cooling water can do a great deal of good. The main valve against the tank is, of course, of prime importance.

Most tanks installed in recent years conform with API Standards 12-A or 12-C, the specifications for riveted and welded tanks, respectively. NFPA has specifications for shop-fabricated small tanks. Many older tanks, while deviating in minor details from the high API standards, are entirely adequate. The criteria are the type of attachment of roof to the shell and the adequacy of vents. It is the intent of both NFPA 30 and API specifications to guard against failure of the tank shell or bottom. It is contemplated that, at worst, the roof of a tank will blow off, leaving the shell and bottom intact to contain oil. It will do this because the shell is not vulnerable so long as it is moistened by the contents. Dry portions of the shell (above liquid level) may distort or crumple; the steel below the liquid level, however, will be kept cool by the oil inside and retain its full strength.

Venting tanks. To preserve product quality and reduce vapor losses, most companies use gas-tight bulk plant tanks for low flash volatile oils like gasoline. Gasoline gives off rich vapors. These are valuable components. Gauge openings on gasoline tanks, therefore, are equipped with tight covers. Vents, to accommodate oil movements and normal breathing with temperature changes, have small pallet valves, which are designed to hold a slight pressure on the tanks most of the time. The inbreathing valve in the pallet opens under slight vacuum as the temperature drops at the end of the day or at night or during rain; it also may open to admit air when the product is pumped out. The outbreathing valve in the pallet opens while the tank is being filled or when heated by sunlight. The capacity requirements of these vents, not only for normal

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breathing but also for fire exposure, have been carefully developed by test and experience. The specifications are set forth in API Bulletin No. RP 2000, entitled "Guide to Tank Venting," and have been adopted by NFPA 30.

As brought out clearly by NFPA 30, all tanks also need provisions for emergency venting in the case of an exposed fire. The NFPA film Fighting Tank Fires describes the difference between the venting needs of vertical and horizontal tanks. In brief, it states that:

- In vertical welded tanks designed according to NFPA 30 and API Standard 12-C, the special roof-to-shell seam attachment is designed as a weak seam that will open under overpressure and release vapor from the vapor space. It is designed to be weaker than the bottom-to-shell seam or the seams in the shell itself.

- Some other means of emergency venting must be provided for all other vertical tanks that are not fitted with this special roof-to-shell weak seam. Various means are used, including: (1) large-size conventional relief valves of adequate capacity, or (2) a hinged manhole cover plate, which opens under low pressure or, (3) conventional flat manhole cover plate, which is loosely aligned on the manhole flange with long flange bolts that permit the plate to lift under low pressure.

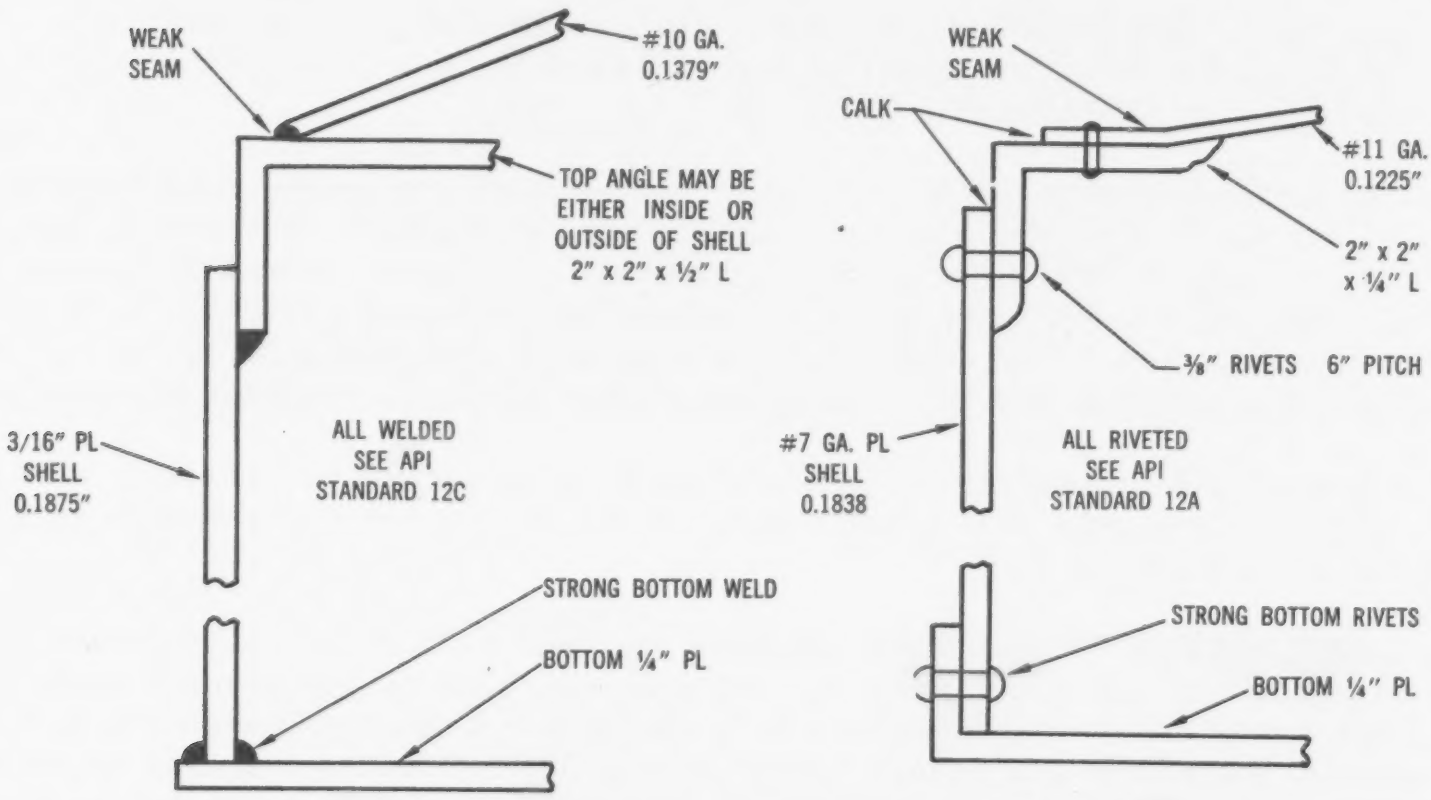

Fig. 15. The location of the special roof-to-shell "weak seam" attachment, which is typical of vertical tanks found in bulk plants and oil storage tanks. This figure is not drawn to scale.

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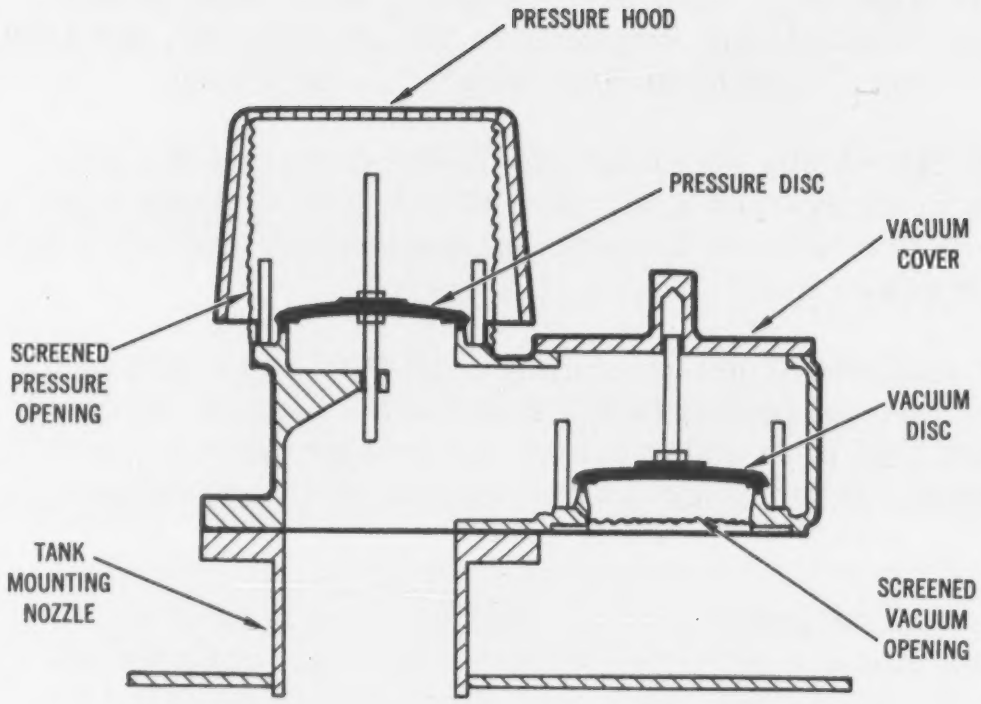

Fig. 16. Typical pressure-vacuum pallet type of operating vent for a storage tank. Coarse screens in the opening exclude foreign material.

- Horizontal tanks must be fitted with emergency venting such as described in the preceding item.

High flash, nonvolatile oils give off so little vapor that gas-tight tanks are unnecessary. However, openings through which the tank must vent should conform with NFPA venting standards.

Oil tanks exposed to fire of adjacent structures have not proved vulnerable so long as they are properly vented; neither is the propagation of fire from tank to tank likely in the light of modern practices. Extensive experience shows that spacing between tanks, or from tanks to adjacent property lines, is clearly of less importance than considerations of venting, good piping layout, and grading and drainage of tank areas to minimize any problems resulting from spills.

If heated by surrounding fire for some time, tanks storing oil at temperatures below the flash point may become dangerous. Tanks containing volatile oils will remain rich.

Cooling the tank shell by water streams prevents the high flash oils' forming dangerous mixtures but does not cool gasoline tanks enough to make them explosive. Some companies base their design for water fire systems on 0.1 gallons per minute per square foot of tank shell and roof area that may require protection. This rate, applied to the tank steel, has proved adequate to prevent serious developments.

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Installing dikes. NFPA 30 suggests installation of walls or dikes around tanks "where deemed necessary by the Fire Chief," because of the nature of the topography and proximity of waterways or places of public assemblage; furthermore, subsections specifically give the fire chief discretionary power to alter the proposed standards. This discretion is highly advisable, since a good many experiences in which impounded oil has been held close around tanks have shown that walls may interfere with fire fighting and contribute to the severity of the loss. The contrary also has been true in some instances. There are times where there would be no alternative to impounding in the immediate tank area. Each case should be carefully considered with the following facts in mind:

- The present design trend, because it is best, is to grade areas of possible spills away from piping and tanks. It is preferable to divert oil to areas where its burning would be least damaging and where there is a minimum of interference to the controlling of possible continuing oil flow. Even where surroundings dictate the building of impounding walls or curbs around the tanks, the cell area should be graded away from the most vulnerable facilities. The impounding areas should have drains of adequate capacity.

- Fire walls of any capacity are unlikely to be of much benefit if horizontal tanks rocket. High fire walls retard vapor dispersion and interfere with safe access and fire fighting effectiveness.

- Under NFPA 30, basic impounding capacity is the drain-out capacity of the largest tank within a common enclosure. This capacity stipulation can be modified at the discretion of the chief, for tanks seldom fail.

From an analysis of a great many fires, the writer is convinced that good grading, low curbs, and remote impounding capacity of small volume with proper drainage provide a better opportunity for controlling emergencies than the high diking practices of the past.

Fighting fires at loading racks. Tank trucks and tank cars receive their products at loading racks where the pipe risers terminate in swing joints that permit the fill stems to be inserted into the open domes of the compartments or tank. While closed transfer systems are used for LP gas, filling through open domes is common for both low and high flash oils. Under typical outdoor conditions, it has been found the vapor hazard is zero 4 or 5 feet away from the open domes of the gasoline trucks being filled. Longer extensions for fill stems are often used for gasoline loading. By extending nearly to the bottom of the tank, these permit high filling rates with less splashing and vapor loss. Filling rates vary widely; from 100 to 600 gallons per minute is a common range. These rates require the strict attention of the loader. For

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the sake of close control, many fill stems have self-closing lever valves of the "dead man" type. Some newer racks handling large volumes utilize preset meters for automatic filling controls.

Fires at loading racks usually are of two kinds--the simple dome fire and a fire involving running the tanks over. Simple dome fires are almost always caused by lax static bonding procedure, not by vapors drifting away from the truck and igniting at some distance from the dome. As a part of their regular fire prevention studies, oil industry fire protection engineers have made extensive studies of vapor drift at loading racks. They have found that vapor being released from the open dome vertically into the air, some distance above ground level, quickly dissipates into the air, even with no wind. This also is proved by years of experience at busy loading racks with complete freedom from ignition by nearby traffic.

In avoiding dome fires the main attention is directed toward preventing smoking by the loader on the truck and to insuring proper static bonding procedure. The latter necessitates attaching the bond wire from the loading rack to the tanks before opening the dome cover and not disconnecting the wire until after the loading is completed and all dome covers are latched in place. In many locations loaders are required to use this procedure regardless of the flash point of the oil being loaded or by wet or dry weather conditions. Its proponents consider this should be a standard procedure, regardless of whether there is a potential static hazard or not.

The flow of gasoline or other dry oil into the truck tank generates a static charge on the vehicle. If the vehicle is bonded to the fill pipe or rack structure ("ground"), this charge bleeds off as fast as generated. If the tires and pavement are damp, the charge bleeds off as fast as generated, even though the bond wire is not used. If the condition is dry and the bond wire is not used, the charge builds up on the vehicle; and then, if the fill stem touches the neck of the dome opening while loading is underway, the charge may spark over the gap between the fill pipe and the neck of the dome. If the surrounding vapor-air mixture is flammable, this spark may ignite the vapor. If a high flash oil is being loaded, no vapor will be present to ignite.

A simple dome fire is easy to handle. When the loader releases the handle of the self-closing "dead man" valve, the flow of oil stops; the rate of vapor release is reduced, and the small, lazy fire may be readily extinguished with a dry chemical or CO_2 extinguisher or by smothering with a blanket or large heavy cloth. Some dome fires have started by a "single action" or unhooded cigarette lighter's dropping out of the shirt pocket of the loader and landing upside down on the truck near the dome opening. The Safety Order No. 6772 prohibits the carrying of this type of lighter at operations where there is a potential ignition hazard. Some dome fires have been caused by the bond wire

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clip's being disconnected near the dome opening while loading into this dome was in progress.

The greatest single hazard at a gasoline loading rack is a bad spill. Serious spills never should occur when self-closing "dead man" valves or preset meter controls are used at the fill pipes. Of course, loaders should check to see that bottom valves on the tank truck are closed before starting to load. Steps in handling a spill fire should include:

- Shut off the source of fuel to the rack, using a remote control valve in the pipeline leading to the rack. (Do this before the firemen arrive.)
- Flush the burning spill out from under the truck so that it will burn off at a safe location. (Don't use so much water that the burning oil may flow to and involve other equipment or property.)

Fig. 17. Refinery fire fighters tackling a full-scale tank truck training prop.

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- Extinguish the ground and tire fires first, then the dome fire. (Don't get water into the truck and cause more spill.)

Operating pumps and piping. Most troubles originating around the pumps are due to poor housekeeping, leaky packing, and poor maintenance. The modern trend is toward outdoor pumps, to get the maximum benefit of natural ventilation, and toward the use of mechanical seals instead of packing. Ventilation for gasoline pumphouses should be at floor level.

Normally, pumps operate at moderate pressures (about 50 psi), and their characteristics are not such as to make the prime movers of extraordinary concern. Although most companies use nonsparking induction electric motors, these often are not totally enclosed. It is of interest to recall that companies used gas engine drives on bulk plant pumps for many years without a particularly bad record. It is general practice, however, to avoid installing sparking electrical equipment inside pump houses or closer than 15 to 50 feet away outside, depending upon the type of pumping installation. Hot bearings or packing, improper electrical installation, and careless use of open flames have ignited most fires. Severe developments have resulted from failure to close tank valves after cast iron fittings failed through lack of thermal relief or prompt cooling by small water streams.

Warehousing. Most warehouse structures are of light, commercial-type construction, often of corrugated iron on wood or steel frames; floors generally are elevated to truck bed height and designed for heavy loading to accommodate storage of barreled products. Floors and substructures of wood are common. Some companies provide outside storage areas for drums of low flash volatile oils, restricting the warehouse to the storage of high flash, nonvolatile products except for insignificant quantities of specialties. With proper provisions, however, including solid substructure for the floor and adequate ventilation, gasoline drum storage--and even gasoline drum filling--has been handled safely inside warehouses. In many of the one-man plants, truck fill stems are at the warehouse loading dock. Although this is not a recommended arrangement, it has been safely accommodated by attention to valving, grading, and fire stop construction for the face of the dock.

Supplying proper fire fighting equipment. Generally, both local delivery and transport trucks carry an extinguisher. An extinguisher generally is located centrally with respect to pumps, piping manifolding, and the loading rack; also at the warehouse. Currently, the dry chemical or the CO_2 extinguishers are favored. Domestic water services generally are used to supply one or two small first aid water hoses. Garden hose, of 1-1/2 inches at most, has proved highly useful; large hose is impractical because of lack of manpower. The fire record fails to justify foam protection at bulk plants. The most important need is for plant operators to understand how much good can be accomplished with first aid fire fighting equipment and to learn how to use it.

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L_1 = Antenna coil

L_2 = Feedback coil

TR = Transistor

R_1 = Variable resistor

P_1 = Earphones

B_1 = Battery

S_1 = SPST switch

Collaboration Between Fire Service and Bulk Plant Operators

In view of the foregoing discussion, just what can be done jointly by the fire service and plant operators to their greatest mutual advantage? The answers appear to be simple:

- Learn what factors are of justified concern, and concentrate on those in an effort to prevent fires.

- Visit plants and preplan for emergencies.

  1. Discuss procedures and question those you feel may be improved.

  2. Encourage procedures that minimize the number of handlings required to get gasoline to consumers.

  3. Help educate operators in the proper use of bonding facilities and encourage consistent, correct use of bond wires.

  4. Become familiar with how details suggested by the foregoing procedures apply to the individual plant so that, should trouble occur, a predetermined plan of operations can be carried out by plant personnel preceding your arrival. It is most helpful to educate, or preferably to train, local operators in what can be accomplished with first aid protection, especially with a small water hose.

  5. Critically enforce good housekeeping.

It is somewhat doubtful that many changes in layout and equipment will be justified at existing plants. However, the fire service rightfully should insist that tanks be properly vented and should encourage development of grading that minimizes the problem of possible oil spills.

Remember that your visit to the plant will be most welcome and helpful. Continual vigilance is necessary to the safe handling of petroleum products, and your occasional visit will stimulate close attention, which in the long run will benefit industry and reduce the likelihood of your having to fight fire.

Editor's note. To the preceding paper on bulk plants, suggestions may be added concerning fire control of drum or barrel storage.

Full drums usually are stored on end with the bungs up, so that the bungs do not leak in storage. Experience has shown that when a closed upright drum is exposed to fire, it usually blows out the bung or the top head without releasing its contents. This happens because the steel below the liquid level in the drum does not heat above the liquid temperature. If exposed to flames, the top seam and head above the liquid level heat much more and can weaken the metal, seam,

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or bung opening. When the upright drums contain heavy nonvolatile oil, the heads usually bulge upward and crack at the seams. Drums that contain a more volatile product may blow out their top heads violently, but they almost always remain standing upright in place and do not spill their contents.

From a fire protection standpoint, drums should be stored on end but sometimes operating difficulties require them to be stored on their sides.

Where possible, full drums should be stored only one deep, with aisles between to permit proper cooling with long-range straight streams. Good drainage is desirable, so that burning fuel is flushed away from the storage area and the flames do not contact other drums. As demonstrated in Drill 9, page 187, not much water is needed if it is applied properly; and this is a decided advantage, particularly when drainage is not the best. With horizontal storage, the firemen should work from the side and not expose themselves to the possible danger of a drum head's blowing out.

Sometimes the question arises as to whether or not a gasoline spill should be kept out of the sewers. Most firemen who have experienced the problem agree that it is almost always desirable to wash the gasoline underground into the sewer as quickly as possible, particularly when there is no strong wind to rapidly dissipate the vapor from a spill. The light ends normally evaporate in the sewer and dissipate en route to the sewer outlet. However, the authorities in charge should be notified promptly so that they can take proper precautions. When burning gasoline is flushed into a sewer where there is a deficiency of air, the underground fire quickly smothers itself. Experience has shown that danger of an explosion in a sewer is remote.

In this paper there are no illustrations of drill ground props that can be applied to the kinds of fires that can occur at a bulk plant. Such pictures would duplicate those in Part 3. See, for example, loading rack fires: Figs. 53, 69, 71, and 72; pump and bleed fires: Figs. 36, 45, Figs. 67 and 78.

Often bulk plant deliveries are made to customers' properties. These facilities may be similar to a bulk plant, with oil storage, pumps, pipelines, and a wide variety of warehousing and operating equipment. Often the equipment is congested and the housekeeping may be substandard in comparison with the average bulk plant. Some unique fire fighting problems may be evident in prefire training sessions. Also, the employees may not be adequately trained to handle even minor fires.

It is particularly important that:

- The fire prevention bureau inspectors check customer facilities periodically and have deficiencies corrected.
- The suppression officers familiarize themselves with the facilities' fire problems and do an adequate job of prefire planning. (See Fig. 14.)
- The training officers encourage the local plant management to permit them to assist with in-plant fire training and the coordination of plant supervision with the fire department.

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10 CONTROLLING FIRES IN GASOLINE TANK TRUCKS

Donald M. Johnson
Standard Oil Co. of California

Tank trucks may be used to transport crude oil from oil fields in lieu of pipelines. However, the most common use is the delivery of gasoline as covered in the following paper. Since tank truck construction and operations are so well known, the author devotes his discussion to fire control technique.

At many of the fire schools described in Part III, much training was devoted to fires involving tank trucks. This included closing off valves at the fill stem when loading and closing the bottom valve when unloading. Other training covered closing valves or gaining other kinds of controls under a wide variety of conditions such as spills, gutter fires, etc. (This paper was presented at the 1961 Bakersfield Oil Fire Control School.)

Gasoline is a volatile flammable liquid, which vaporizes readily at most atmospheric temperatures. Inside a container, such as the cargo tank on a tank truck, the vapor space normally is too rich in vapor to burn if the liquid has been in the tank for long. Fires of the cargo tank of any tank truck are almost always a result of gasoline's being released, in either liquid or vapor form. Vapor will not travel far from its source, but liquid may flow some distance, depending upon volume and terrain. These characteristics often can be used to advantage in controlling a fire involving spilled gasoline.

The tactics employed in each situation will depend upon existing conditions. As in any fire, it is important that these conditions be quickly and accurately determined as a part of the size-up. Some of the questions that must be answered before an effective plan of attack can be selected are:

- Are there any rescue operations needed, and what actions are required to make the rescue?

- What are the exposures? Can they be protected by water cooling? Or can straight streams be used effectively to flush fuel away from exposures into less vulnerable areas? Will application of water tend to spread spilled fuel in an undesirable direction?

- What steps are necessary to gain confinement of the fire? What is the source of fuel? Is it vapor coming from liquid inside the tank? Is it spilled liquid outside the tank, and if so, is liquid continuing to be spilled and from what source? How can the flow of fuel be stopped? Are there

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any valves or other controls that will stop the flow of fuel, and if so, how can they be reached? Will cooling the tank with water reduce the rate of fuel release, or is water likely to spread the fire into a larger area or toward important exposures?

- After the fire has been contained, how can extinguishment be achieved? Can the fire be extinguished with a smothering agent? Or will the spilled fuel have to burn out under control?

- After all of the flame has been extinguished, what overhaul steps are necessary? Is there fuel remaining, and if so, what precautions are necessary to avoid reignition? How can the remaining fuel be disposed of or removed from the area in a safe manner?

Suggested plans of attack, based on several different situations, are discussed in the following paragraphs, using the basic divisions of fire fighting tactics--that is, rescue, exposures, confinement, extinguishment, and overhaul. Note that all of the tactics suggested in the examples below involve only equipment and materials normally available and familiar to all fire fighting organizations. In tank truck fire control, as in most other types, the small water hose with a limited volume of water is the basic fire fighting tool.

Fire at the Dome of a Tank Truck at a Loading Rack

Rescue. Seldom involved, except for possibility of the loader's being injured in initial flash.

Exposures. Normally, exposures are limited to fill piping and valve. No protection normally is needed unless there is considerable delay in closing the valves in supply piping. If water is used, avoid getting enough into the truck tank to overflow gasoline out the open dome.

Confinement. See that the valves in loading rack risers are closed and supply pumps are turned off. If these controls at the loading rack cannot be reached, see that the valves at the tanks are closed and the main switch or individual switches at pumps are turned off. Do not attempt to remove the fill stem from the dome opening, for there is too much chance of liquid's spilling or splashing onto personnel. Under most conditions, attempting to move the truck before the fire is extinguished is more likely to spread the fire than to make it easier to control.

Extinguishment. If dome is unobstructed, close cover or smother flames with dry chemical, CO_2, blanket, coat, or similar item. Use the same tactics if the dome is obstructed with the fill pipe, except that the cover cannot be closed. In some cases the flames can be "blown out" with a straight stream of water

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directed across the opening, but care must be taken to avoid overflowing the tank or splashing gasoline out, onto the truck.

Overhaul. After the fire is out, the fill pipe, if any, can be removed and the cover replaced.

Spill on Ground under Truck

Rescue. Seldom involved.

Exposures. Normally the truck is the only exposure. If conditions permit, flush out spilled fuel from under the truck and away from other exposures, into open area or into closed drains. Apply small amount of water to portions of the cargo tank in contact with flame to keep the contents from expanding or boiling to overflow the tank. Be careful to avoid getting enough water in the tank to cause overflow. If tires are involved, a small amount of water will cool the burning rubber.

Confinement. If the truck is equipped with internal valves, make certain that they are all closed. Most trucks have at least one internal valve control remote from the meter compartment. These points are designated by a sign marked "Emergency Valve Control." Burning vapor at the vent in the dome cover is not likely to do any harm, and the flame will go out by itself when pressure in the tank is reduced.

Extinguishment. After the flow of fuel has been stopped, attack the fire on the ground. In most cases, the spilled fuel will have to be allowed to burn while the truck is protected, as discussed under "Exposures," above. If spill is small or nearly consumed, dry chemical may be used effectively, but be cautious to avoid injury in the event of reflash of remaining fuel in case some undetected ignition source is present. Any remaining fire at the dome of the truck can be extinguished by one of the methods described in the previous example.

Overhaul. Sources of ignition should be carefully guarded against in the vicinity of any remaining gasoline until it is dissipated through evaporation, covered with sand or dirt, or otherwise removed. Automotive or other internal combustion engines must always be considered sources of ignition. Close and latch all dome covers, or otherwise tightly cover all dome openings before attempting to move the truck.

Large Spill around Truck without Fire

Rescue. In a serious accident the driver of the truck and other persons may be trapped. Where gasoline has been spilled but not ignited, all possible precautions must be taken to avoid ignition. Rescue or other vehicles must

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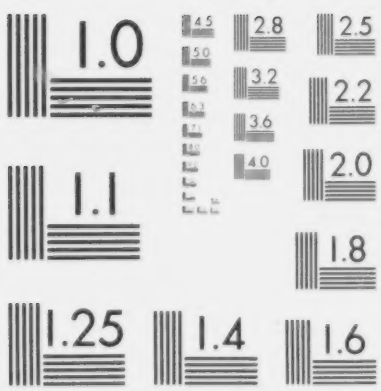

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

not be operated within the vapor area. Use of hose streams to flush gasoline away from trapped persons, or a water spray stream as protection for rescuers and victims, in case spill should ignite accidentally, usually is desirable.

Exposures. Using water streams, dirt, sand, or other available materials, attempt to divert spilled gasoline from potential exposures. When using water, take care not to spread the spilled fuel toward potential exposures or ignition sources.

Confinement. Limit spread of spilled fuel, as already discussed. It is usually safer to flush it into a closed drainage system, if available, than to leave the fuel out in the open. If possible, stop the flow of fuel from the truck tank. If the leak is relatively small, a soft wooden plug may be effectively used in stopping the leak; or if the leak is near the bottom of the tank, the leaking gasoline sometimes can be displaced by putting water in the top until the water is being released at the leak. Keep water entering at about the rate of leakage until the leak can be stopped by other means, being careful not to overflow the tank. Clearing the area of all nonessential personnel and patrolling the area is important, but open flame road flares should not be used as warning devices within the area of possible liquid or vapor travel.

Extinguishment. Not applicable in this case, because there is no fire.

Overhaul. Most of the hazards mentioned above under "Exposures" and "Confinement" will remain until the spilled gasoline has been removed by evaporation, covering it with dirt or other material, pumping it to another truck, or another method. Take care, when righting or moving the damaged truck, to avoid spilling more fuel.

Large Spill and Fire around Truck

Rescue. In an accident of this type, rescue efforts must be made promptly, usually with straight water streams for flushing and spray streams for personnel protection, as discussed in the previous example.

Exposures. In general, exposures do not require cooling unless flame is actually contacting them or paint is being blistered. In most cases, spilling gasoline burns about as fast as it is released and so does not flow far from the tank. Fires of this type do not release burning brands or other flying objects, which may ignite material some distance from the fire scene. Where nearby structures or materials are being seriously exposed, keep them wet with water, keeping in mind that water that runs off is excess.

Containment. Attempts should be made to contain the spilled fuel by the methods discussed in the preceding example. Tank trucks normally are vented to protect

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them from excessive internal pressure, so fire fighters can approach them safely. Tires may burst from excessive internal pressure due to the heat, along with weakening of the tire through burning. Tire bursts should not be mistaken for cargo tank "explosions."

Extinguishment. In most fires of this kind the spilled fuel must be permitted to burn out. This is not only the safest for fire fighting personnel, but it also simplifies the problems associated with overhaul. In some cases the last small flames, such as those at dome openings, can be extinguished with portable dry chemical or carbon dioxide extinguishers. Make certain all hot metal and glowing materials have been cooled before extinguishment with the smothering type of extinguishers is attempted.

Overhaul. Any gasoline remaining in the truck tank after the fire is out is likely to be hot, giving off vapor at an unusually high rate. Guarding against reignition is very important. Otherwise, overhaul procedures should follow the same pattern as discussed in preceding examples.

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11 SERVICE STATION FIRES

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Tidewater Oil Co.

This paper on service station fires presents two hypothetical cases--a fire at a pump island and a fire in the lube room. Some fires occur when a tank truck overfills an underground tank, but this type of fire already has been discussed in the paper dealing with tank trucks. (At the 1961 Bakersfield Oil Fire Control School, Mr. R. A. Walker of the Tidewater Oil Company spoke on this subject. The manual contained an outline of his talk, on which this article is based.)

Should a fire occur at a service station, there are, as with other types of fires, certain tactics that must be considered. As you know, the size-up and strategy used will have a tremendous bearing on the outcome. Your best means of being prepared for any such fire is through prefire planning and fire drills. In the first sizing-up of any fire, it is assumed that the ranking officer will consider such factors as wind direction, weather, drainage, closeness of other exposures, accessibility of water supply, and promptness of response of help.

A Spill Fire at the Pump Island

One example of a fire at a service station is a spill fire following a failure of the dispenser hose. Assume that the flow of gasoline is approximately 12 gallons per minute and has spread around the customer's car and the pump island. First you should size up the situation and determine what work will have to be started immediately.

Rescue. Should there be occupants in the car, use straight streams of water to flush the burning gasoline from under and away from the car. Also, water fog can be used on a close approach to protect the occupants and fire personnel until the rescue is completed. The same tactic may be used when checking the service station office and lube room areas for personnel who may have been injured or trapped therein.

Exposures. Generally, the fire exposure is limited to the immediate area. However, collapse of the overhead canopy, other cars in the fueling area, drainage, adjoining buildings, and wind direction may need to be considered in the comprehensive size-up. Using water wisely will help to control the fire. Enough should be used to effect cooling without flooding and spreading the fire unnecessarily.

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Confinement. Through preplanning, the officer in charge should know where the electric switch panel is located, and he should promptly shut down the pump, if the attendant has not done so already. The attendant may have been injured and may not have shut down the pump. If the officer does not locate the switch panel, the approach to the pump switch should be possible under water fog protection. Drainage and sewers and the direction of attack must be considered to minimize the chance of additional exposure problems.

Extinguishment. Of course, water should be used for flushing the burning spill into the open or into a nearby sewer inlet while the pump is being shut off and afterwards. If sufficient dry chemical powder is available, however, it can be used in conjunction with water fog cooling streams for complete extinguishment. If gasoline has been washed into the sewer, the appropriate authorities should be notified promptly.

Overhaul. If the fire is extinguished before all the fuel is burned, there will be the risk of reignition of the vapor from glowing embers, from burning tires, electrical sparks in the automobile at the island, etc. Hence, it may be advisable in some circumstances to flush the residual fuel into the open, away from the potential source of ignition, and let it burn out safely under control of fog nozzles. In other cases the fire may be extinguished, flushed into the sewer, absorbed in dirt, and disposed of. The area should be thoroughly hosed down to quench all embers, and electrical ignition sources should be checked out.

Fire in an Elevated Car

Another example of a service station fire is a vehicle on a lube room hoist that develops a gas tank leak and ignites from an unknown source. The maximum amount of fuel from the vehicle would be 20 gallons.

Rescue. The probability of a rescue in this situation is not likely. However, should there be occupants in the vehicle, the hoist should be lowered immediately while water fog protection is provided for the occupants and for cooling the vehicle gas tank.

Exposures. These are the close-by service station equipment and the supplies generally found in the lube room and in the vehicle itself.

Confinement. Keeping in mind that the vehicle fuel supply will be 20 gallons or less, the firemen should attempt to flush burning gasoline out of the lube room entrance so that it will burn in the open under control, and also should protect the exposures with water fog. The best approach may be through the office or the back window of the lube room. Consideration should be given to covering the lube room floor drain to prevent entrance of burning gasoline.

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UNIT IV — FREEHAND WORKING DRAWINGS

General Information

In this unit, Freehand Working Drawings, we are to make freehand sketches of simple objects in "orthographic" projection. This means that we make two or more views of an object, usually three views, with the views in a certain definite relationship to each other. For instance, the top view is always placed directly above the front view. In fact, one view is "projected" from the other. The right end view is placed to the right of the front view and is "projected" directly from the front view.

The reason why there is always this relationship between views will be shown by looking at Illustration Sheet 7 on page 37. On Figure 1 of the Illustration Sheet you will see that if a piece of glass is placed in front of the object and the surface of the object is reflected back to the piece of glass it will give us the outline we need to represent the front view. Now if we bring our point of vision around to the right side and look in at the right end of the object, the reflected image on the glass will give us the outline we need for the right side view. If we think of these two pieces of glass as being hinged together and then open them out into one flat plane, we see that the two views have a definite relationship to one another and are "projected" one from the other.

A look at Figure 2 will also show the relationship between the front view and the top view.

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Extinguishment. Water fog should be used to cool the fire and protect exposures until the gasoline is consumed. Should the fire be controlled, yet not extinguished, the firemen should attempt to extinguish it with a combination of dry chemical powder and water fog, making sure that proper quenching has preceded the extinguishment to prevent reignition. If the fire is very small, it may be extinguished with a portable hand foam extinguisher or other available hand extinguishers.

Overhaul. After checking to insure all sources of ignition have been eliminated, flush remaining unburned gasoline away, using water hose streams. When checking for sources of ignition, be sure to inspect the vehicle tires, upholstery, wiring, etc. If the station building is made of wood, use the normal overhaul precautions that apply to structural fires.

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12 TESTING UNDERGROUND GASOLINE TANKS

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When it is suspected that an underground gasoline tank or tank piping at a service station is leaking, it may be necessary to test the equipment. A simple and dependable method, which will be of interest to the fire service, has been used in the oil industry. (This paper was presented at the 1961 Bakersfield Oil Fire Control School.)

The following procedure is useful in checking the tightness of any buried gasoline storage tank. The equipment is simple and easily assembled from readily available materials; and if the tank is tight, the test can be completed in less than two hours. Unless this preliminary test shows some sign of leakage, there will be no need to uncover the tank.

Equipment

1. A piece of standard weight steel pipe approximately 4 feet long, 3 inches in diameter, threaded one end. For repeated use, the pipe should be equipped with a boiler gauge glass, close to the unthreaded end. If this is not readily available, readings of sufficient accuracy can be made by measuring from the top of the pipe down to the gasoline liquid level with a measuring tape or ruler.

2. Threaded bell reducer (or coupling and bushings) to connect the test pipe to the fill opening of the tank.

3. Gasoline can of 5-gallon capacity, preferably of the "safety" type.

Procedure

1. Prior to making the test, the tank should be filled shell-full with gasoline. (If two or more tanks are connected with siphons, all tanks so connected must be filled. Any manifold connections between tanks should be broken and the lines capped.)

2. Remove gasoline fill pipe cover and the fitting on which it screws, exposing the pipe thread on the fill pipe. By means of a coupling, bell reducer, or bushings, attach the test pipe to the fill opening. Threads

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must be in good condition, and must be made up gasoline-tight, using pipe dope if necessary. (Tightly cap the fill pipe of all other tanks connected to the test tank by siphons, as all tanks so connected will be tested as a unit.)

3. All pumps to which this particular tank is connected must be temporarily taken out of service. If the vent line from this tank is manifolded to that from any other tank, the vent line must be disconnected and capped; if the vent line serves only this tank, it need not be disturbed for the present.

4. Fill the test pipe by pouring gasoline into the top until the gasoline level is close to the top of the gauge glass, or within a few inches of the top of the test pipe. Make a preliminary inspection to see that there is no leakage at the point where the test pipe connects to the fill pipe of the tank, at the pump, or at any other point where piping is exposed.

5. Mark the gasoline level on the gauge glass, or accurately measure and record the distance from the gasoline level to the top of the test pipe. Cover the top of the pipe with a tin can to reduce evaporation.

6. Keep close track of the level of gasoline in the test pipe to detect signs of leakage. With a 3-inch test pipe, a drop of 1 inch in 10 minutes will equal a leakage rate of about 5 gallons per day. Since the test is made at a pressure several times that of normal service conditions, the actual leakage would probably be less. A tank is considered tight for practical purposes if the drop in the gasoline level in the test pipe does not exceed 1 or 2 inches in an hour, since temperature change and absorption of air bubbles will account for some change.

It will be noted that this preliminary test includes not only the tank, but also the fill pipe, vent line, and all gasoline piping up to and including the pump. If significant leakage is found, it will be necessary to disconnect the piping and repeat the test in order to prove that it is the tank which is leaking and not the pipe. Hence, if leakage is indicated, continue the test by taking the following additional steps:

7. Pump gasoline out of the tank through the service station pump to lower the gasoline level to the tank top. Uncover the tank and disconnect and cap the vent line connection of the tank. Refill the test pipe and repeat the test. If the leakage has stopped, this proves that the leak is in the vent line. If leakage persists, it must be either in the tank or pump piping, and another step will be necessary.

8. Pump out gasoline to lower the level in the test pipe, then disconnect and cap all gasoline lines at the top of the tank. Refill the test pipe

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and repeat the test. If leakage still persists, then it is the tank that is leaking, and appropriate steps must be taken. (When two or more tanks have been tested as a unit, this final test must be made on each tank individually.)

Discussion

It will be noted that the above procedure involves testing the tank and all associated piping as a unit, and that it is not necessary to dig up the tank or uncover the piping unless a leak is found. Since the majority of service station tanks will be found to be tight, they will usually pass the first test, and no time will be wasted in digging. Where leaks are found, some excavating will be necessary in any event, so that the time spent in uncovering the tank will not be wasted.

The same general procedure can also be used for checking the tightness of underground tanks storing other products, such as fuel oil. The test pipe should be filled with the same product as in the tank. Lines to burners, etc., must be disconnected and capped, and means must be provided for removing excess oil after the test is completed.

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13 LIQUEFIED PETROLEUM GAS

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By NFPA definition, LP gas is not a flammable liquid--mainly because it is handled, transported, and stored in pressure vessels, not in atmospheric tanks. Chemically it is similar to the light volatile components of gasoline. In fact, winter-grade gasoline contains dissolved butane for "quick-starting" a cold motor.

LP gas quickly vaporizes on release to air; bubbles up through, and is not extinguished by, foam; and can present a greater fire hazard than gasoline. Fire control of a fire-exposed pressure vessel of LP gas is different from that for a thin-skinned atmospheric tank of a similar size and shape, but containing gasoline.

LP gas often is extracted directly from the rich gas in the oil fields by means of compression, absorption, and fractionation to separate the propane from the butane. It may be manufactured in refineries and transported by trunk pipelines. Usually tank trucks or tank cars transport LP gas to the distributing plant, and tank trucks deliver it to the consumer.

Answers to many of the questions about LP gas that puzzle firemen are to be found in the following paper.

"Liquefied petroleum gas," as the name implies, is petroleum-derived gas, which is compressed into a liquid and stored and handled like a liquid under pressure. Its principal sources are natural gas produced with crude oil and the crude oil itself, from which it is separated in the refining process. The properties of LP gas reflect those of the better-known materials from which it is derived.

At atmospheric pressure and ordinary temperature, petroleum gas, like natural gas, is a colorless and odorless gas, which burns with a yellow luminous flame. However, it is somewhat heavier than natural gas, has a higher heat of combustion per cubic foot, and in some ways more closely resembles the vapors of the volatile liquid petroleum oils. These similarities are explained by the fact that all of these materials (those that are derived from petroleum and natural gas) belong to the same chemical family of hydrocarbons and that they are made up of the same two elements, hydrogen and carbon. The differences between them are the result of differences in the number and arrangement of the atoms that make up the molecules of each individual member of the family.

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LP gas may be either a relatively pure compound (propane, for example) or a mixture of two or more of the hydrocarbon gases (propane, normal butane, iso-butane, and the butenes). These gases may be condensed to clear, colorless liquids by cooling or (at ordinary temperatures) by compressing. The pressure required to hold them in the liquid state is called "vapor pressure." At 60° F the vapor pressure of pure propane is about 92 pounds per square inch of gauge pressure; that of iso-butane is 24 pounds; and that of normal butane, about 12 pounds. Mixtures of the liquids have vapor pressures intermediate between vapor pressures of the components. For example, increasing the proportion of propane in a mixture raises the vapor pressure; increasing the proportion of butane lowers it.

Vapor pressure increases with temperature. This fact is important because containers must be strong enough to withstand the maximum service pressure, and this resistance will depend on the maximum temperature that will occur as well as on the composition of the mixture.

When temperature of liquefied gas is lowered, the vapor pressure decreases. If n-butane is cooled to 31° F, its vapor pressure falls to 0 pounds gauge. At that temperature it is a liquid at ordinary atmospheric pressure. In a cold winter climate the appearance and behavior of butane would be very much the same as that of gasoline on a warm summer day. Stated another way, the boiling point of n-butane is 31° F at atmospheric pressure. The boiling point of iso-butane is 10° F, and that of propane about -44° F.

The effect of low temperature on the vapor pressure is important, because in many cases the pressure is relied upon to deliver the liquid or vapor to the point of use, and the system would fail to function if the pressure ever fell as low as 0 pounds gauge. For this reason the LP gas sold under various trade names for domestic use may consist of almost pure propane. For other uses, such as automotive fuel, the liquid may be composed largely of butane.

There are other differences in the properties of the three LP gas hydrocarbons. The density of the liquid and the vapor, and the heat of combustion, are greater for the butanes than they are for propane; and the rate of diffusion is slightly less. These differences are usually unimportant from the practical standpoint.

In the following discussion the expression "LP gas" will be used to designate the commercial liquefied gas ordinarily sold, irrespective of composition.

Containers

The principal way in which LP gas differs from other liquid fuel is that it must be stored and handled in closed containers under pressure. These containers,

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like the similar pressure vessels used for handling air or water, must be strong enough to withstand any pressure that may occur, even under extreme conditions.

Standards for the design and operation of LP gas installations are contained in Standard 58 of the National Fire Protection Association. This standard covers almost all phases of handling LP gas, and compliance with it will go far toward avoiding accidents.

When a prospective user wants to buy a steam boiler, the first question asked is, "What will the operating pressure be?" The same problem arises in procuring a tank for LP gas. The National Board standard requires that the design pressure of the vessel be stamped on it, and prohibits filling it with any product that has a vapor pressure exceeding the design pressure under certain specified conditions. Therefore, the user should know what product is to be used before a container is purchased. In many instances, to guard against possible future changes in specification, it has been felt desirable to purchase containers good for the highest pressure likely to ever be required, which is that for nearly pure propane.

Safety Precautions in Use

LP gas may be used in most places where either gasoline or natural gas is used. Safety precautions are similar to those for common fuels.

Although stored as a liquid, LP gas is always converted into a gas before use. For small installations (such as domestic service), this conversion is accomplished simply by drawing off vapor from the upper part of the container. As the gas is withdrawn, the pressure falls slightly, and some of the liquid evaporates to replace the gas withdrawn. For larger installations it may be necessary to carry the liquid to the point of use, and convert it into gas by releasing the pressure and supplying heat, in a special "vaporizor."

When LP gas is used in place of city gas, the pressure must be regulated and the flow controlled by valves, in the same way as for city gas and with the same type of equipment. Burners must have smaller orifices than they have for city gas, because of the higher heat value of LP gas, but otherwise appliances are quite similar to those used for city gas. When LP gas is used as an engine fuel, it is usually brought to the engine as a liquid, the same as gasoline; but a somewhat different type of carburetor will be required, incorporating a means of supplying heat to assist in vaporization.

Confined in pipes and containers, LP gas offers no hazard. If permitted to escape it may produce a condition that is in some ways more dangerous, and in some ways less dangerous, than a similar escape of gasoline.

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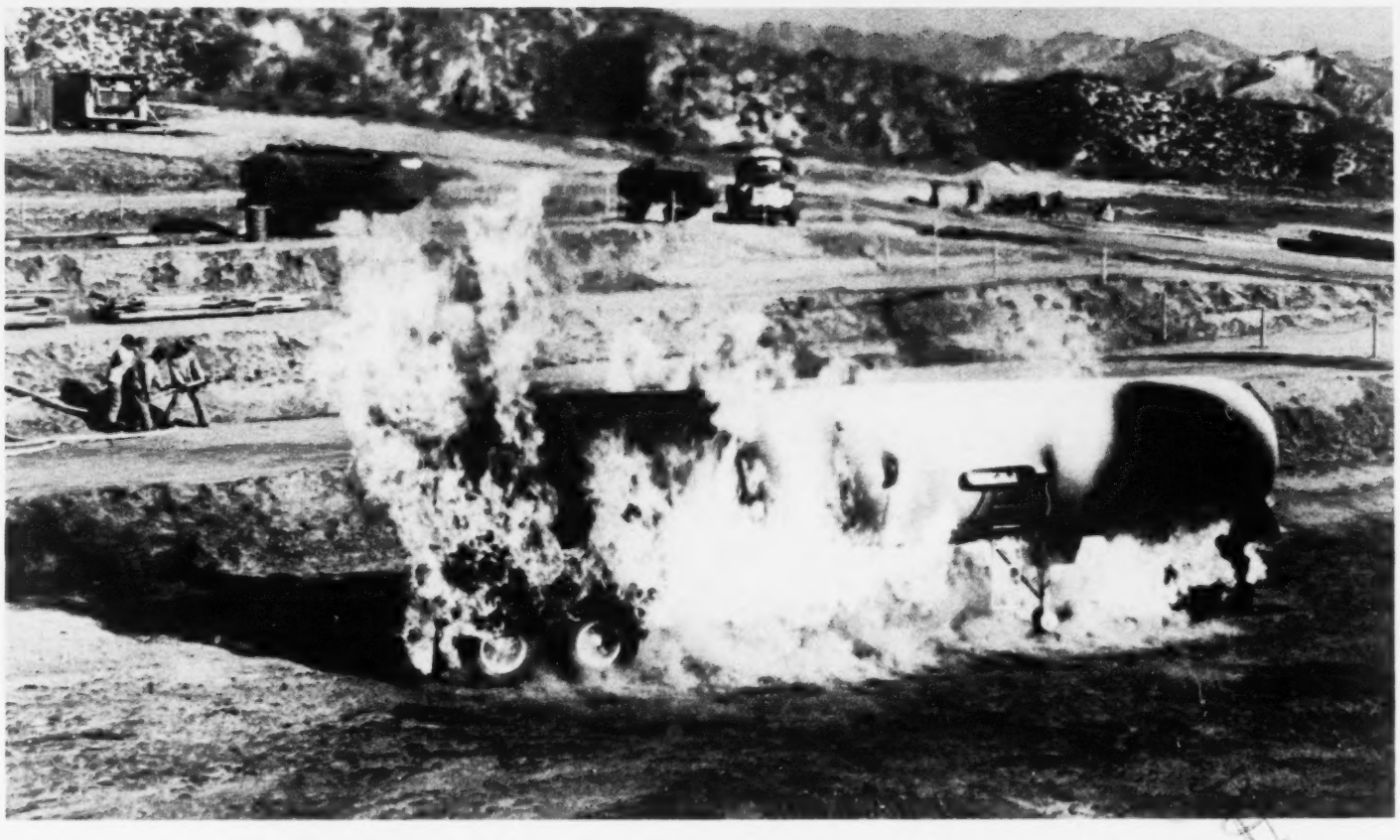

Fig. 18. The top photograph shows the simulated emergency fire with one hose crew ready to start cooling. The other crew is out of the picture to the lower right. In the lower picture both crews have hose streams properly directed to cool the tank shell above the liquid level in the tank.

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If Leaks Occur

A small leak of LP gas is similar to a natural gas leak, since the liquid will vaporize promptly; and if not ignited, it quickly dissipates. Since LP gas vapor is heavier than air, vapor released at floor or ground levels dissipates less quickly than that released at an elevation. When mixed with air in explosive proportions, both gasoline and LP gas mixtures have very nearly the same density as air, and the mixture may fill any space to which it has access.

When an accident results in the escape of LP gas, precautions should be taken, as with any other fuel, to try to prevent it from taking fire. Spectators should be kept out of the affected area, motor vehicles should not be operated, and every effort should be made to guard against any source of ignition.

If LP gas continued to escape, it is important to try to determine the source of the leak and to attempt to control it. It may be possible to close valves ahead of the break. If there are no valves, it may be possible to crimp the pipe and thus shut off the flow. Men should use every precaution to avoid ignition while working in the dangerous area. In some instances, a water hose stream is valuable in diverting the flow of gas or liquid, and thus assists in making a shutoff (see Fig. 83).

Even if the flow cannot be stopped, sometimes much good can be done with hose streams, which assist in vaporizing spilled liquid. The effect of prevailing wind may be intensified by removing fences or other obstructions. When the supply of LP gas is exhausted, the residual vapor will quickly dissipate. The area should be guarded until tests made with a combustible gas indicator show that ignitible vapors are no longer present.

If Fire Starts

If ignition occurs, first efforts should be confined to control rather than extinguishment. Since the limits of a fire are clearly visible, it is safer in some ways to work close to the fire than it is to work close to a source of leakage where ignition has not occurred. If any structures are exposed to the flame or are close to it, these should be protected with water streams, using spray, if available. It is possible to prevent the ignition of combustible structures, when they are close to the flames or even actually enveloped by flames, by spraying them thoroughly and continuously with water.

When escaping LP gas is burning at a point remote from the tank, it frequently is possible to control the fire simply by closing a valve. If possible, someone familiar with the piping system should be consulted, since he may know details of the installation that cannot be readily ascertained because of the fire. If

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valves are inaccessible because of the flames, it sometimes is possible to drive the flame away by means of a water spray or to reduce its intensity so that the valve can be closed. It may be possible to crimp a pipe under similar circumstances.

Where men must work close to the fire under protection of water sprays, it is very important to make sure that the flow of water is not interrupted. Two or more hose lines should be used, wherever possible, to guard against a hose break; and if the hoses can be supplied from different sources, it will be that much safer. Care should be taken that hooking up additional fire pumps does not rob water from hose lines already in use. Men should advance toward the fire under protection of the hose stream, and under no circumstances should the stream be turned off until the men are safely back out of the danger area.

Although small LP gas fires can be extinguished with water spray, or with portable dry chemical or CO_2 extinguishers, it is not ordinarily advisable to extinguish the fire unless it is certain that the gas flow can be shut off immediately. Portable extinguishers can also be used to control the flame and assist in making a shutoff. However, since the supply of extinguishing agent available from a portable extinguisher is limited, the fire fighter should be prepared to retreat rapidly when the extinguisher is exhausted.

A fire in LP gas usually will be less widespread than one of a comparable stream of gasoline, because the LP gas vaporizes and burns in one place, whereas the gasoline stream may flow and spread the fire over a greater area. Water may spread a gasoline fire, but an LP gas fire "stays put," and will not increase in intensity when a water stream is played on it.

If the flow of LP gas cannot be shut off, either before or immediately after the flames are extinguished, it is preferable to let the fire burn under control and to confine efforts to protecting adjacent property.

Where flame from any type of fire is in contact with a tank holding LP gas, the contents heat up, the pressure rises, and the relief valve opens. Most likely, escaping gas will ignite and burn in the air over the top of the vessel, producing a pillar of flame, which is spectacular but not dangerous. Relief valves on storage tanks built according to NFPA Standard 58 are adequate in size to release all of the gas produced by a fire of maximum intensity while holding the vessel pressure to a safe level.

The flame that heats the contents of an LP gas vessel to the boiling point usually also heats the portion of the shell above the level of the liquid. Here there is no liquid in contact with the steel to keep it cool. The steel gets hot and, in extreme cases, heats enough to lose its strength, and the vessel fails. For

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In Figure 3, we can see the relationship of three views of the object when viewed through a "glass box". If we think of the box as having hinges which will allow it to open out into one flat plane we can see the relationship of the three views and the fact that the views are "projected", one from another.

This system of "orthographic" projection is the basis for all working drawings and is used throughout industry in the design and manufacture of most commercial products.

Illustration Sheet 8, page 39, shows the way a slanting surface would would be represented in a drawing. Illustration Sheet 9, page 41, shows the method of dimensioning a drawing and Illustration Sheet 10, page 43, shows the uses of geometrical terms used in drafting. With experience in solving the relationship of views you will become familiar with this "language of industry" and will have added a knowledge and skill that will benefit you over and over in everyday use.

On the following plates you are to give all necessary dimensions.

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Los Angeles City Fire Department

Fig. 19. Cooling LP gas tanks above the liquid level while the fire burns itself out.

this reason, it is important to keep the top of such a vessel cooled with water streams in the areas where it is exposed to flame.

The need to concentrate available water on the areas where it is most needed cannot be overemphasized. Portions of the vessel shell below the liquid level are kept cool by the liquid inside. The liquid cannot be heated above the boiling point, which, at the set pressure of the relief valve, is not over 120-180° F. Water applied to a surface at this temperature does not have a very great cooling effect. On the other hand, the upper portions of the shell are out of contact with the contained liquid, and can heat quickly to a high temperature. Water streams applied to this area do the maximum amount of good. The areas in greatest need of cooling are those that are so enveloped in flame that they cannot be seen. These deserve first consideration. Streams should be directed from the sides of the vessel, and fire fighters should avoid taking positions in line with the ends, since if a horizontal pressure vessel fails, it usually moves endways.

Summary

So long as LP gas is confined in the tanks and lines provided for it and is used in the intended manner, it is no more dangerous than any other liquid or gaseous fuel. If the installation is made in a correct manner, in conformity with accepted standards of good practice, there is little danger of mechanical failure. By far the greater portion of accidents occur because of incorrect handling, sometimes as a result of neglecting obvious rules of safety. If good judgment and reasonable precautions are employed, the handling of LP gas need not be unduly hazardous.

Rules for Handling JP-4

It is evident that the tank vapor space atmosphere may be in the flammable range over wide temperature variations in the commodity and atmosphere. From the flash point, it is evident that, in the open, the material may be only slightly less hazardous than gasoline. From these two facts, it is possible to establish two broad specifications for fire prevention in handling JP-4:

1. The normal handling of JP-4 in barrels, cans, or tank vehicles requires precautions identical to those established for the normal handling of any flammable liquid. No smoking, open lights or fires, arc or spark-producing devices or nonvaporproof equipment should be permitted in the immediate vicinity. Requirements of NFPA Pamphlets 30 and 85 should be invoked.

2. Because the real problem is the flammable atmosphere in the tank vapor space, sources of ignition within the tank must be eliminated. This may be accomplished by using floating-roofed tanks or observing certain precautions in using cone-roofed tanks.

Use of floating-roofed tanks. The most certain method of protection is to use floating-roofed tanks. This completely eliminates the vapor space (except when the tank is substantially empty) and eliminates any possibility of static generation, accumulation, and discharge within the tank.

Precautions with cone-roofed tanks. Where cone-roofed tanks must be used, added precautions must be taken. The tank roof must be maintained in a vapor-tight condition, and vacuum pressure relief valves must be used. In other words, the tank should meet API 12-C tank construction specification.

- Flame arresters not only are of no value, but because of inevitable plugging, they may increase the hazard.

- Because fillers tend to corrode out, they may engender a false sense of security.

In a refinery--but not in a bulk plant--a gas blanketing system is valuable to insure that a rich atmosphere is maintained in the vapor space.

These operations conducive to the generation of static must be prohibited:

- Overshot filling with a line entering the top of the tank.

- Blowing the tank contents with air or with inert or flammable gas. Air pockets in the lines to the tank must be avoided.

- Pumping into the tank at such a rate as to cause violent agitation of the contents. This can be avoided by insuring that the nozzle velocity of the entering stream is kept at or below 3 feet per second until at least 6 feet of material is in the tank.

- Mixing water or any aqueous solutions with the contents of the tank.

Protective measures for cone-roofed tanks. Some regulations require the use of permissible flashlights, nonsparking hand tools, and shoes without nails. None of these is a reasonable requirement. Neither is the specification, which some companies and many legislative bodies have, that tanks must be "grounded" by driven grounds, with wires from the grounds to the tanks. Such devices are ineffective because static does not accumulate on the tank; static accumulates on the surface of the oil. The following protective measures, however, are effective:

- All steel construction, including lines, valves, fittings, and accessories should be required from the tank shell to a point at least outside the dike. If an explosion occurs as a result of ignition of the flammable vapor-air mixture in the tank's vapor space, the roof will blow off, even at tank diameters as low as 10 feet. Cast iron fittings in the lines leading to and from the tanks are almost invariably broken by the shock.

- A "gauging well" is a very valuable protective device. It consists of a perforated or slotted pipe, permanently affixed to the gauge hole and extending to the bottom of the tank. Accurate gauges can be taken in the pipe, with no possible static discharge from the oil to the gauge tape of the plumb bob. If gauging wells are not used, a tank should not be gauged with a conventional gauge tape or temperature-taker or sampled with a "thief sampler" until the tank has been quiet for a period of at least 15 minutes after the ending of the flow of the product into the tank.

Fighting JP-4 Fires

Fire fighting methods for JP-4 fires are identical to those for any other petroleum product. Fog is valuable for protection and control, and alone or with dry chemical extinguishers it is an effective extinguishing agent for open fires. If foam is to be required on other tanks in a particular installation, it should be specified for the JP-4 tanks.

Possibly some of the concern felt by those who question the use of routine fire fighting procedures for JP-4 results from a misunderstanding of the mechanism of the ignition of a tank fire. This may be clarified as follows:

Ignition of a tank fire. In order for a fire to occur in a tank, a flammable vapor-air mixture must exist within the tank vapor space. This may develop in three ways, depending upon the nature of the commodity.

1. The material is light enough that the tank vapor space normally will contain a mixture that is too rich to be ignited. Fires have occurred, however, as a result of the reduction of the concentration to within the flammable range by rapid pump-out, sudden atmospheric temperature drop, poor condition of tank roofs alone or associated with extraordinarily high winds.

2. The nature of the commodity (JP-4, some industrial solvents, and intermediate refinery products, for example) is such that the tank vapor-space atmosphere normally can be expected to be in the flammable range.

3. The material is heavy enough (kerosenes, stove oil, diesel fuel, and fuel oil, for example) that the vapor-space atmosphere is too lean to burn. Heating the commodity by means of steam coils, heat interchangers, or exposure fires raises the temperature sufficiently to raise the concentration of vapor to within the flammable range.

Results of ignition. If the flammable vapor-air mixture in the tank is ignited, regardless of the nature of the fuel that supplies the vapors, the roof will blow off.

- If the vapor concentration of the mixture is near the lower flammable limit, the explosion will be sharp, but the roof may not life completely. It may tear loose around the entire periphery of the tank and lift only slightly, or it may tear loose only in spots. In at least one case, the roof settled back in place and extinguished the fire. In others, the roof sagged into the tank.

- If the vapor concentration of the mixture is at or near the middle of the flammable range, the explosion will be sharp, and the roof probably will be blown completely off the tank.

- If the vapor concentration of the mixture is at or near the upper flammable limit, the explosion will be "low grade"--hardly audible. The results will be similar to those encountered in explosions of lean mixtures.

Position in the flammable range. The effects of ignition and the violence of the resulting explosion depend upon the relative position in the flammable range occupied by the concentration of vapor in the flammable mixture. It is true

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that the nature of the vapors has some slight effect. Thus, methane (natural gas) usually produces a more violent explosion than, for example, fuel oil vapor. If, however, the fuel oil vapor concentration was at the middle of its flammable range, and methane vapor concentration was just under its upper flammable limit, the fuel oil vapor explosion might be more vigorous. It follows that, although JP-4 is more likely to produce an ignitable flammable vapor-air mixture in a tank than any of the products on either side of it in the volatility range, it will not necessarily produce an explosion that is more violent. The application of shell-entering foam chambers to cone-roofed tanks, or the use of foam towers for floaters, therefore, is suitable regardless of the nature of the fuel.

TABLE 9*
Government Specifications, Typical Tests
And Calculated Data for JP-4 Jet Fuels

Laboratory Tests	Government Specifications		Typical Sample
	Minimum	Maximum	
1. Distillation			
IBP	--	--	154° F
10% Distilled	--	--	236° F
20% "	--	270° F	268° F
30% "	--	--	292° F
40% "	--	--	312° F
50% "	--	--	334° F
60% "	--	--	356° F
70% "	--	--	376° F
80% "	--	--	400° F
90% "	--	470° F	438° F
95% "	--	--	470° F
End Point	--	--	494° F
2. Gravity, API 60° F	45	55	47
3. Vapor Pressure, Reid 100° F	2.0 psi	3.0	2.3 psi
4. Flash Point (Tag CC)	--	--	-10° F**
5. Lower Flammable Limit	--	--	0.7%**
6. Upper Flammable Limit	--	--	5.5%**

*Mil-Military Specifications F-5624B (Washington, D.C.: U.S. Department of Defense), December 7, 1953, amended March 18, 1954.

**Calculated data.

It will be noted that the initial and 10 percent points are not specified in the table. Moreover, the nature of the crude oil has a profound effect upon the

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vaporization characteristics of the product. Accordingly, the tank vapor space atmosphere may be above the lower flammable limit at temperatures from to below zero to slightly above freezing. Similarly, the tank vapor space atmosphere may be below the upper flammable limit at temperatures from freezing to approximately 100° F. Storage at higher elevations--in Denver, for example--lowers the temperature range within which the product produces tank-vapor-space atmospheres within the flammable range.

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15 CHECKING COMBUSTIBLE GAS INDICATORS

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Most fire departments are equipped with one or more combustible gas indicators. These instruments sometimes are called "sniffers," "explosometers," or other similar names. Although the different types vary in size and design, they operate in somewhat similar fashion and are used for the same purpose--testing air for the presence of a flammable gas or vapor. In order to obtain a correct and dependable reading three conditions are necessary:

1. The operator must know how to operate the instrument and interpret the readings.

2. The instrument must be accurate and properly maintained.

3. The air-vapor mixture must be suitable for checking. It must consist only of air and the gas or vapor being tested. In other words, the mixture in a gasoline fuel tank that has been inerted with dry ice, CO_2, etc., cannot be tested.

The instrument has a definite range of use. The reader will recall from the papers in Part I what is meant by the "lower flammable limit" of a vapor-air mixture. For gasoline vapor it is about 1 percent. The instrument has an operating range from 0 percent to about 1 percent, and it will analyze a mixture in which the vapor content is less than the lower flammable limit. If, for a given sample, it reads 30 percent of the lower flammable limit, the sample contains about 0.3 percent vapor, indicating about how much more ventilation is needed to make the space or container gas free.

Gasoline vapor has a distinct odor. A man with a trained, sensitive nose can recognize gasoline odor in clean air in concentrations as low as 0.03 percent, but obviously smelling is not a reliable method of analyzing air for gasoline vapor. A combustible gas indicator can detect a trace of vapor (less than 10 percent of the lower flammable limit or 0.1 percent), and it should be used to secure dependable results. An undependable reading is worse than none at all, because it may lead to a false sense of security.

The purpose of including the following paper is to describe what steps are needed to check an instrument to see if it is in good working order. The author is the co-inventor of the J-W indicator, and as he states, the principles described apply to indicators of any make. (This paper was published in the manual of the 1961 Bakersfield Oil Fire Control School.)

Everyone who may have to test the atmosphere for flammable gas or vapor to determine if it is safe for man or free from fire hazard should become thoroughly familiar with the operation of a combustible gas indicator. He should be able to ascertain that the instrument is in good operating condition.

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Test for Gas Indicators

The following simple tests, needing no special equipment, meet all usual requirements:

1. Turn on the current and adjust the voltage to the correct value. This tests the batteries. (With the J-W Sniffer Model G the current is turned on by rotating the bulb, and the voltage is adjusted by turning the right-hand knob to bring the meter hand to the green line when the voltage test button is depressed. Other models or makes of indicator may require slightly different techniques.)

2. Lift the zero adjuster knob to engage the clutch, and turn the knob, observing that the meter hand moves freely. (In J-W Models F and G, the zero adjuster knob is the left-hand knob.) This test and the next cannot be completed unless the filament and all electric circuits are intact and operating correctly.

3. Work the aspirator bulb to draw fresh air through the instrument. This dispels any vapor left from a previous test. Observe that the meter hand fluctuates slightly each time the bulb is pressed. Set the meter hand to zero.

4. Place a few drops of gasoline on a cloth, hold it close to the sample cock (handle turned to the right), and work the aspirator bulb slowly. The meter hand should rise up on the scale. (If it flies to the top of the scale, or if a slight explosion is heard inside the instrument, no harm has been done.) Purge thoroughly and check the zero setting.

   This test proves that the indicator responds to combustible gases. It need be made only occasionally--never more often than once a day.

   In making the test, avoid using an excessive amount of gasoline, which might result in drawing liquid into the instrument, making it difficult to purge. When the indicator is to be used predominantly for testing for natural gas, it is preferable to use natural gas for this test rather than the vapor from gasoline. There is available a test kit, which includes breakable glass ampoules containing enough natural gas to make a calibration check.

   If the instrument is to be used by carrying it into the suspected space, no further testing or adjustment is necessary. If the instrument is to be used with a "sample hose," which draws samples from a remote location, one further step is necessary--to make sure that the sample is actually gas drawn through the hose, not fresh air drawn through the air opening in the sample cock.

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5. Observe that, when the handle of the sample cock is in the upright position, air is drawn in through the hole on the right-hand side of the body, and that when the handle is turned horizontally to the right, the sample is drawn in through the threaded connection. The handle must be turned to the right when drawing the sample through the sample hose. To check this, connect the sample hose, and place a finger over the end of it while operating the aspirator bulb, which should remain flat until the finger is removed if all connections are tight. As an alternate test, place the end of the sample hose close to the ear and listen to make sure that the sample is actually entering the end of the sample tube.

Maintenance of Gas Indicators

Tests 1, 2, and 3 should be made prior to every use of the indicator. The fact that the voltmeter can be set to the correct point and that the indicator meter hand responds to the zero adjuster proves that the instrument is ready to use. It is good practice to repeat Test 3 after every test in which vapor is encountered, in order that the indicator will be purged of vapor and ready for the next test.

To conserve the battery, be sure that the switch is turned off except when the indicator is actually being used.

Inability to set the voltmeter to the correct point (Test 1), or rapid falling of the voltage during use, indicates weak batteries. Replace them. Jerky or

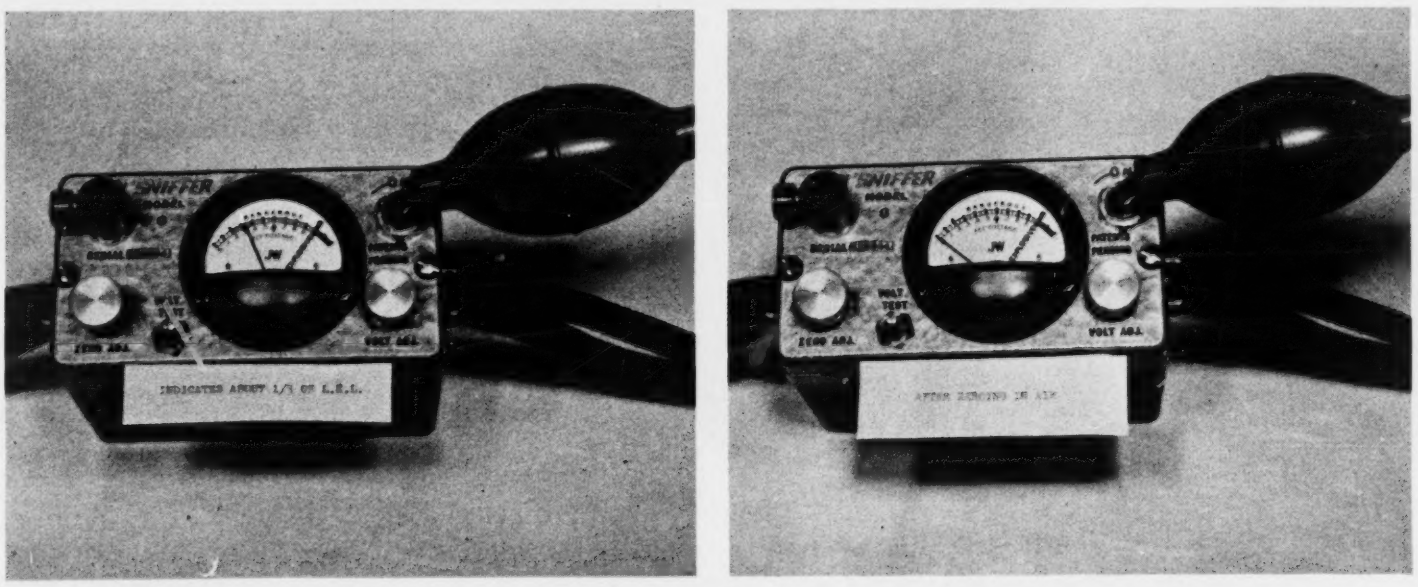

Fig. 20. Two types of dials used on combustible gas indicators. The upper scale is graduated in percent of lower flammable limit. In the lower scale the graduations are in tenths of the lower flammable limit with smaller subdivisions. Such instruments cannot indicate directly percentage concentrations above the lower flammable limit.

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ORTHOGRAPHIC PROJECTION

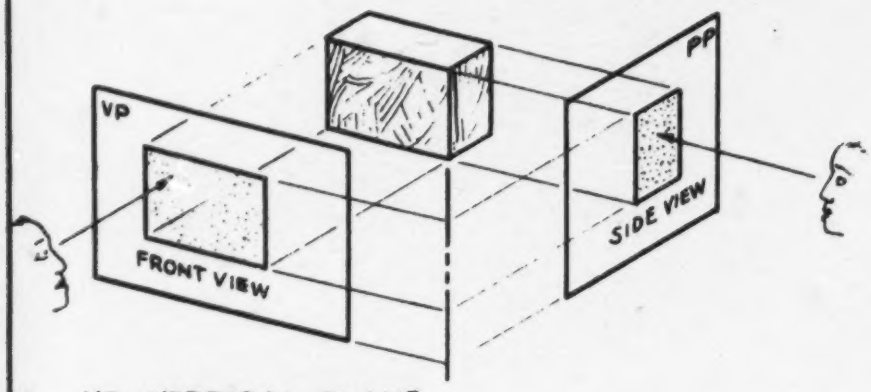

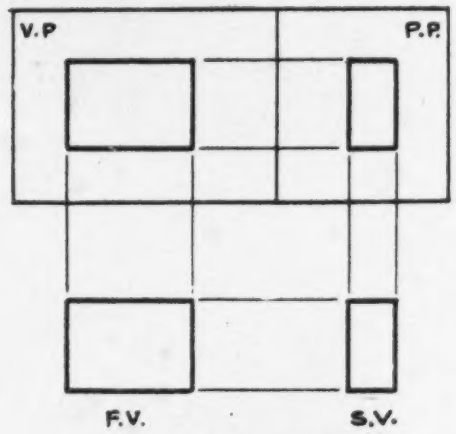

VP = VERTICAL PLANE
HP = HORIZONTAL PLANE
PP = PROFILE PLANE

A TWO VIEW DRAWING
F.V. = FRONT VIEW S.V. = SIDE VIEW
T.V. = TOP VIEW

FIG. 1

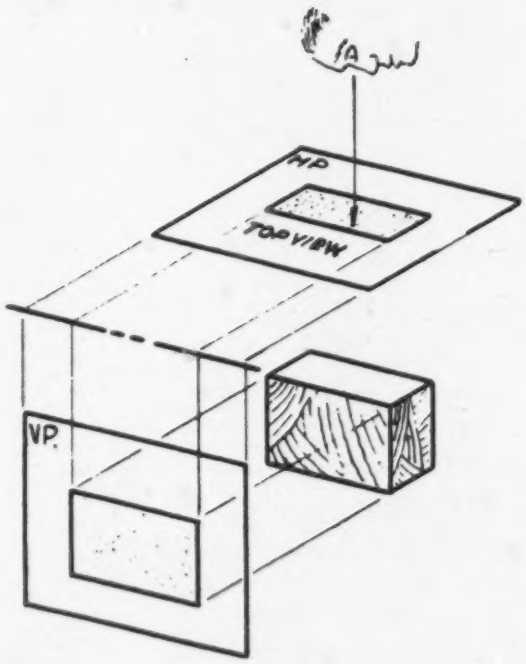

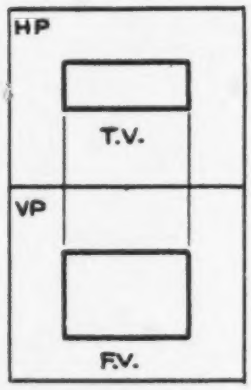

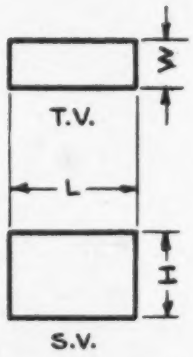

A TWO VIEW DRAWING

FIG. 2

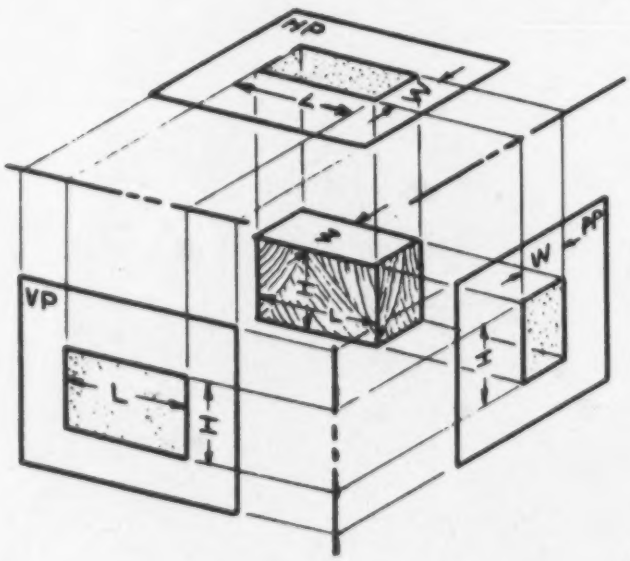

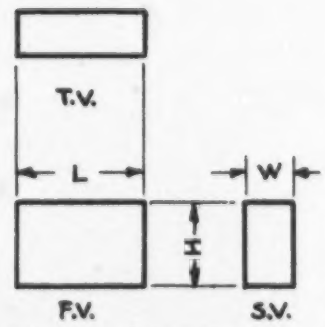

A THREE VIEW DRAWING

FIG. 3

ILLUSTRATION SHEET 7.

erratic motion of either meter hand indicates loose connections. Tighten them before using. If the hand of the indicator flies to the top or bottom of the scale as soon as the switch is turned on, and fails to respond to the zero adjuster, it indicates either a burned-out filament or a loose connection of the filament. If the indicator meter hand follows the zero adjuster but cannot be set to zero (Test 3), this indicates either a loose filament connection or that the filament has reached the end of its useful life.

Conclusion

If the routine described above is always followed, the operator will become thoroughly familiar with the performance of the indicator, and he will have confidence in the results of his tests.

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16 ECONOMICS OF FIRE PROTECTION

C. E. Williams
Standard Oil Co. of California

The economics of fire protection is a very important subject. Everyone is concerned whether it relates to his home, his ranch, his car, or his bulk plant, if privately owned. On a much larger scale it may relate to an oil refinery. Obviously, built-in fire protection that can handle every conceivable emergency, regardless of how great, cannot be justified financially. Many factors must be considered. In the following paper this subject is discussed in some detail. (Mr. Williams presented this paper at the Bakersfield Oil Fire Control School in 1961.)

In a discussion of fire protection it should be understood that the term "fire protection" includes all phases of fire prevention, fire control, and fire extinguishment. None of these phases is more complicated than finance.

Every fire chief knows that, to get approval for his budget, he must demonstrate to his superior, and possibly also to the public, that the cost of operating his department will bring a commensurate return in the form of decreased chance of injury or loss of life, reduction of fire loss, and decreased fire insurance premiums. Some of these factors are easily expressed in dollars; others are largely intangible.

Fire protection is not acquired without cost. However, it should be considered an investment--not an expense, and certainly not a speculation. Before the average person spends his money or his time, he analyzes the probable return on his investment. When we purchase a home or invest our money, we consider every detail. Certainly, an investment in fire protection, upon which the safety of a larger investment depends, is just as worthy of scrutiny.

Every fire protection engineer knows that, when he submits a recommendation for an expenditure to cover the cost of equipment or a change in design calculated to reduce the risk of fire, he must be able to show not only that the expenditure will accomplish all that he claims but also that there is no simpler or more economical way to accomplish the same result.

Probable Loss without Protection

Before we can determine the probable loss by fire, we must have some idea of how frequently fire can occur in the facility under consideration. This should

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not be based on a few individual cases, but if possible, should take into account the total fire experience in similar installations in other plants. For example, the annual fire loss data compiled and distributed by the American Petroleum Institute provide a good index for different types of oil properties. Studies of insurance-rating schedules and rates on different classes of properties or facilities show relative risks of fire. Also, we should consider exposures, improvements in construction, and fire-extinguishing equipment available for the protection of the installation in question. Are these items better or worse than were provided for the average installation from which the data were developed?

Fire frequency. In a like manner we can develop data on frequency of fires involving different types of equipment. When the problem involves truck deliveries of flammable liquids, comparison of the number of tank truck fires with the number of gallons transported or number of vehicles in use gives a reliable frequency figure.

Direct damage to property. Fire frequency is important, but we must also know what the direct monetary loss would be if fire did occur. We must consider the replacement value of the structure, the probable time required to restore the unit to operating efficiency, the production losses that may occur during this time, the chance that the fire may be controlled before the structure is completely destroyed, and the possibility that the fire may spread to other structures.

Damage to exposures. Exposures should be appraised in the same manner to establish their probable loss values. Exposures or lack of them, often are overlooked in estimating the importance of possible fires. Similar properties or facilities, with different exposures, may require entirely different fire protection. It is difficult to arrive at an exact figure when answering these questions; yet it is usually possible to arrive at a fair total.

Intangible losses. The most difficult problem is to evaluate the intangible losses associated with a fire. These may include possible injury to personnel, loss of production, interruption of business, adverse public opinion, and similar considerations. Here again most of the figures are opinions. Experience, however, has shown that by breaking down the problem and making several assumptions, we can arrive at a more accurate figure than by guessing. If public opinion is adverse, the intangible losses may be greater than the monetary loss. This is particularly true when there are fatalities. A single death resulting from an explosion or a fire will arouse more concern than a number of deaths resulting from a traffic accident. Good will is a valuable intangible asset; and as we all know, serious or spectacular fires may create ill will and provoke public demands for extreme and costly measures of protection.

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Probable Loss with Protection

So far we have dealt with conditions as they exist without protection. The next problem is to repeat the process, estimating what the loss might be with protection. In other words, to what degree would the proposed protection reduce the possible loss by fire? At first glance the installation of vaporproof lights at a truck loading rack may seem important. To what degree, however, would it reduce the possibility of ignition? At first it seems apparent that the installation of vaporproof equipment could greatly reduce the probability of fire, but further study shows that electrical equipment is not the only source of ignition in the area. Trucks, which are entering and leaving the rack during loading operations, have electrical systems that are not vaporproof and engines that may present hazards as well. These trucks are operating near ground level, where vapors are more likely to collect than up near the lights. So how effective in preventing ignition would the installation of vaporproof lights be in relation to all the other sources of ignition about which nothing would be done?

We now have two figures: first, probable loss without fire protection, and second, estimated loss with protection. The difference between these two figures constitutes the return of our fire protection investment. However, we still do not know the amount of the investment.

Fire cost factors. Now let us summarize what we have covered to this point. In any estimate of loss without protection and then loss with protection, the cost factors to be taken into account are:

- Fire frequency
- Direct damage to property
- Damage to exposures
- Value of loss of use and income
- Possible loss of life
- Possible effect of a fire on the public

Cost of Protection

It is not difficult to determine the cost of fire fighting equipment or fire resistive construction. These may represent, however, the smallest part of the cost. We must also consider the cost of maintaining the equipment. If it is manually operated, how many men are required to operate it? Are there enough men available, and can they be spared for direct fire fighting? What would it cost to train men to operate the equipment efficiently? What effect would this expense have on the plant operating costs? The answer to the last question frequently presents the greatest cost of fire protection. Changes in design or revisions in operating or maintenance procedures, because they

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involve a hazard of fire, may require the adoption of more costly procedures or may lower production and revenue. Such costs should be considered part of fire protection and included in estimating the proposed investment. Fortunately, good operating designs and good operating practice usually add up to good fire protection.

Now, what has been accomplished in this analysis? The cost of protection has been estimated by taking into account the cost of installation, maintenance, and operation. The estimated saving in fire loss by reason of the protection has been established by evaluating the probable loss with and without protection. The difference between these two figures should give us a rough idea whether the protection is a justified investment.

This may seem like a cumbersome way of arriving at what appears to be a simple answer. During the course of the analysis, however, a better way for accomplishing the same purpose may present itself. The various plans should be studied in order that the most economical one may be selected. It should be remembered that the cheapest method of meeting the legal requirements may not be the most economical in the long run. However, any part of the investment above the cheapest way should be shown to be profitable.

A Fire Training Program

In our company the fire fighting training program is considered to be one of the major factors in reducing loss by fire. The installation of fire fighting equipment in any plant is of little use unless the employees are trained to use the equipment efficiently. Instruction and drills in all phases of fire emergency should be systematically given to stress the importance of fire protection to all plant personnel. Each employee should know how to turn in a fire alarm. He should know the location of fire fighting equipment in the area where he normally works, and know how to use it. So far as practicable, each should be given actual experience from time to time in handling the equipment on small test fires simulating, as closely as possible, actual situations that may occur under operating conditions. Periodic inspections of such equipment should be made by the men likely to use it. This will serve to remind them of the importance of prompt and effective action in curbing fires in their incipient stages.

In addition to its direct result of improving fire control, fire fighting has an important indirect benefit. It develops fire consciousness in employees, who become more alert to prevent fire. The records seem to prove this.

We work closely with our design engineers to select and properly place fire protection equipment. This requires a close check of plans before construction and a continuous "on plot" check during construction. Through the

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cooperation of design engineers, operating personnel, and fire protection personnel, the most benefit from fire protection effort can be obtained.

You will agree that no one can become expert solely as a result of his own personal experience. We all depend on each other to complete our knowledge. One of the important gains from training programs such as the Bakersfield Oil Fire Control School is the opportunity it gives to meet and talk with other people, to learn their points of view and hear about their experiences.

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17 LET THE FIRE BURN

This paper and the subsequent materials in this manual did not appear in the manuals of the 1955 or 1961 Oil Fire Control Schools at Bakersfield. They were prepared especially for this manual by James E. Hill, formerly with Union Oil Co. of California. One exception is Section 5 of Part III, which includes the questions and answers used at these two schools.

In some cases it is better to let an oil or gas fire burn out under control than to extinguish it. This is particularly true for fuel gas or LP gas if the source of the fuel cannot be shut off quickly. "Whitey" Klaus points this out in the first paragraph of "Principles of Oil Fire Control and Extinguishment," the first paper in Part II. It is always a challenge, of course, to extinguish a fire promptly. The reasons why some fires should not be extinguished but should be permitted to burn out under control are brought out by the following examples.

Gas Fires

Assume that a major leak in a buried domestic gas line in the middle of a street has ignited. It could be handled in one of two ways: (1) Possibly the fire could be extinguished with dry chemical under the protection of water fog. (2) The firemen could stand by and protect exposures until the gas company shuts off the line and while the line depressures. Which one of the two is the safer method? Under most circumstances, it would be safer to let the fire burn out under control.

First, assume that the fire was extinguished and the odor of the gas is slight. What is the risk of reignition if all spectators are kept away?

Natural gas usually consists of methane and ethane. Methane is about half as heavy as air and ethane has the same vapor density as air. The mixture, therefore, is lighter than air, and it will rapidly disperse upward from the street. Also, the lack of a strong odor indicates that the gas has not reached its lower

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flammable limit, which is 5 percent for methane and 3 percent for ethane. (Some cities that are not close to sources of natural gas manufacture their own odorized gas from propane and butane.) At these concentrations the odor is very strong. Therefore, an unburning gas leak that is well out in the open where it can dissipate quickly is not particularly hazardous unless a thoughtless spectator tosses a burning match into it to see if it is flammable.

If the gas has ignited, however, it is best to let it burn out. The vapor of these gases in pure form is somewhat heavier than air, and if the flame is extinguished prematurely, serious problems can develop in a confined area where no wind disperses the vapor.

LP Gas Pipelines

In full concentration, or 100 percent pure, propane is 1.5 times as heavy as air, and butane is twice as heavy as air. If a vapor leak of these gases is small, a slight breeze will dissipate it quickly. The flare pot tests at Bakersfield proved that point, as illustrated in Fig. 83. If the leak is already burning, however, it would be better to let it burn out under control, just as with natural gas. In some areas in California, casinghead or "natural gas," as it is called, flows in liquid form in a pipeline from the oil fields to refineries. It consists mainly of propane and butane, and it is unodorized because it is not a product for direct domestic use but is used in bulk commercial transportation. When released on the ground in quantity as a liquid, under little or no wind conditions, the vapor tends to hug the ground and drift a considerable distance before it is dispersed. A small breeze will hasten the dispersal, and a strong wind will disperse it quickly. The hazard may be appraised with a combustible gas indicator.

Should an unignited release of LP gas be deliberately ignited? One can imagine situations where early ignition would be desirable. No simple rules apply because each situation must be judged on its own merits. Prefire planning sessions may include this problem where applicable, and proper consideration should be given to the safe ignition and burning of the gas.

If a jet of vapor or liquid is projected well into the air under pressure, the vapor or spray usually disperses rapidly, much like steam. At the two Bakersfield Oil Fire Control Schools, butane liquid was released into an open ground area surrounded by flare pots to demonstrate vapor drift, rate of dispersal, and ability to accelerate dispersal with water spray streams, as illustrated by Fig. 83.

If a leak from an underground natural gas transfer line is ignited, it should be permitted to burn out under control. If a leak from equipment above ground is ignited, the same principle applies, although under some circumstances

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the control measures may be more difficult. In Part II, Mr. Johnson's paper entitled, "Liquefied Petroleum Gas," contains a good discussion on handling various emergencies of this type.

Gasoline and Other Liquid Fuels

Under some conditions a fire from a large spill may directly expose surrounding property and should be extinguished, if possible. Under other circumstances the fuel may be flushed away from exposures with water to a point where the flames do not contact exposures. In that case it may be advisable to let the

Fig. 21. A surprisingly small amount of water is needed to prevent the paper from igniting from the butane flame. When a garden hose is unavailable, a 1-inch fog will do, although it supplies too much spray for this demonstration.

fire consume all of the fuel, under control. This minimizes the following clean-up job and, in the case of a gasoline spill, eliminates the reignition risk.

Flaring or Burning

There have been cases where an LP gas or gasoline tank truck has been involved in a serious accident with or without fire, and (after extinguishment, in case of fire) there is the problem of disposing of the remaining liquid fuel. Sometimes it is impossible to pump it off into a salvage truck. In such cases, it may be advisable to pipe it away to a safe distance from the tank and burn off the excess product.

There have been cases where an almost empty storage tank has caught on fire and the side walls have been so badly damaged that the tank was worthless.

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The cost of extinguishing the fire may be much more than the value of what might be saved. In such cases the fire will be permitted to burn out under control.

Summary

Each case must be judged on its own merits. There have been cases where gas or vapor fires should not have been extinguished, and reignition has injured firemen. In some other cases involving heavier oils, unnecessary extinguishment has created a serious clean-up problem.

16 525

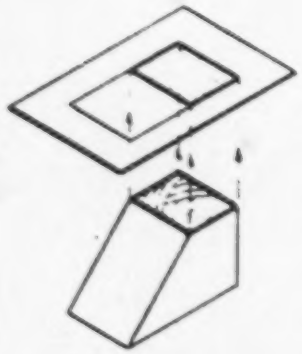

FIG. 1

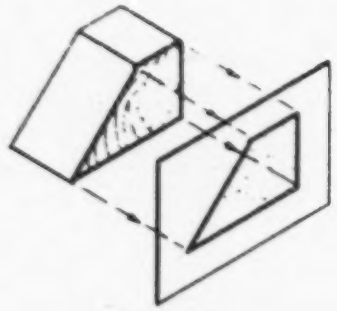

FIG. 2

PRINCIPLE 1. A FACE OR LINE PARALLEL TO A PLANE OF PROJECTION.

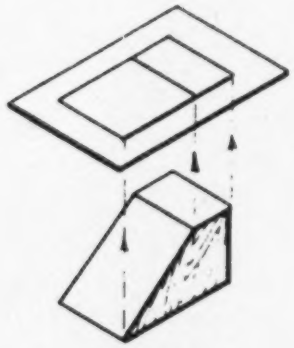

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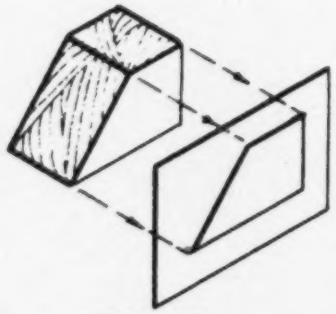

FIG. 2.

PRINCIPLE 2. A FACE PERPENDICULAR TO A PLANE OF PROJECTION.

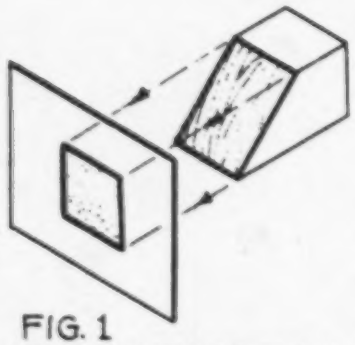

FIG. 1

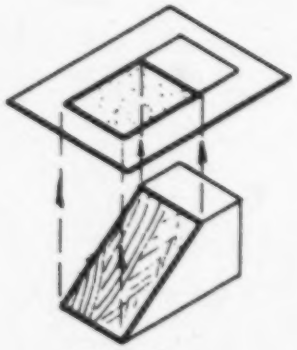

FIG. 2

PRINCIPLE 3. A FACE INCLINED TO A PLANE OF PROJECTION.

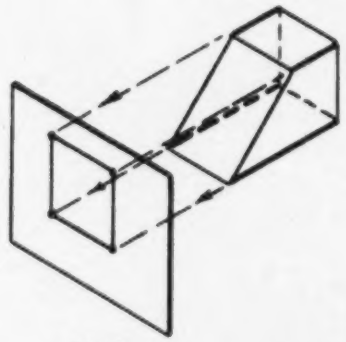

FIG. 1

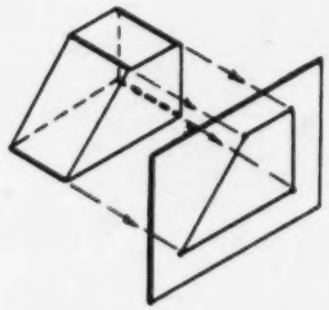

FIG. 2

PRINCIPLE 4. A LINE PERPENDICULAR TO A PLANE OF PROJECTION.

TWO PARALLEL PLANES INTERSECTED BY A THIRD PLANE

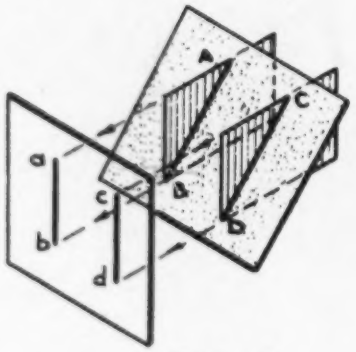

FIG. 1

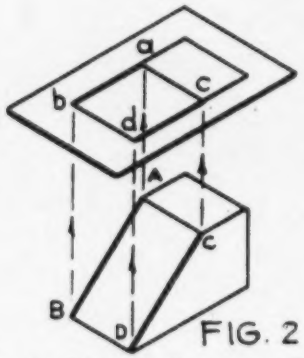

FIG. 2

PARALLEL LINES PROJECTED ON A PLANE

PRINCIPLE 5. A LINE INCLINED TO A PLANE OF PROJECTION.

ILLUSTRATION SHEET 8.

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18 USING FOG NOZZLES ON OIL FIRES

One of the most important techniques for a fireman to learn in order safely and effectively to combat many flammable liquid and LP gas fires is the proper handling of fog nozzles. A fireman who is experienced in the use of fog nozzles for structural and other fires not involving oil or gas may not know these techniques, and he may unknowingly expose himself and other firemen to unnecessary danger.

Special techniques have been developed on drill grounds that are designed specifically for fighting oil and gas fires. These techniques have been used successfully in the control and extinguishment of large fires. Some large fires cannot be controlled effectively without these techniques.

Types of Fog Devices

All fog devices have as their primary function the breaking up of water into fine droplets. Some whirl the water stream under high or low pressure; others cause the dispersion by impinging streams of water against each other or against metal plates by either internal or external impingement design. Because of the wide variety of uses and methods of dispersal, it is helpful to outline the scope of these water distribution devices.

I. Portable (as on hose lines)
   1. Fog nozzles (adjustable)
      a. All-purpose nozzle (fog or straight stream, or applicator)
      b. Combination (fog through spray into straight streams)
   2. Fog heads (nonadjustable)
      a. Volumetric (low velocity to fill a space)
      b. Directional (to project pattern toward a single target)

II. Fixed systems
   1. Distributor heads (not true fog heads)
      a. Conventional sprinkler heads, mainly for Class A protection
      b. Spoon, dish or nonfogging heads to cover a surface with a thin sheet or skin of water
   2. Fog heads (true fixed fog systems)
      a. Volumetric (low velocity to fill a space with fog)

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b. Directional (to project patterns toward a single location or apply a fan or curtain of fog)

Fire inspectors may have seen various kinds of fixed systems in the more modern installations in large plants. The nonfogging heads are used on some LP gas tanks and the conventional fog heads in all other places. Most of the most modern portable nozzles used by refinery fire departments are the combination type, operating from about 75-150 psi. Extensive tests with the high pressure nozzle (about 400 psi) showed less efficiency on oil fires, possibly because of the induction of air into the high velocity stream.

History of the Fog Nozzle

Chief Glen Griswold of the Los Angeles County Fire Department was responsible for the early testing and development of the fog nozzle for combating oil fires. In the 1920's and 1930's, he was stationed at the old Santa Fe Springs oil fields, where he had much experience with fires involving oil wells, oil tanks, and gas absorption plants. He found that even coarse water spray was effective in reducing flame size and radiant heat. The chief reasoned that, if coarse droplets were good, a finer spray would be better. He knew that a great deal of heat is absorbed when water spray evaporates and that the rate of heat absorption increases with smaller droplets. He also knew that the smaller droplets remain suspended in the air longer, that they form a denser pattern, and hence, are more efficient in reducing flame size than coarse spray using the same amount of water.

After considerable experimenting with various prototype nozzles on the fire drill ground at the old Station 17 at Santa Fe Springs in the early 1930's, he developed an impinging stream, fan-pattern type. After he patented it in 1931, the nozzle was manufactured. Insofar as is known, this was the first practical fog nozzle that was made commercially and used in this country.

Terminology. For a time the use of the term "fog nozzle" was controversial because some people contended that "spray nozzle" was correct. Most firemen prefer the term "fog" for a nozzle designed to produce very small droplets. The term "spray," they feel, more clearly defines the coarse droplet pattern that is produced when fanning a straight stream or using a conventional fixed sprinkler head.

Fire drill grounds. During the early part of World War II the navy nozzle was most popular. It was used extensively at the navy drill grounds when teaching sailors how to fight mainly gasoline and diesel oil fires. At the same time some oil refineries developed their own fire drill grounds and started using the all-purpose navy nozzle.

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Fig. 22. Chief Glen Griswold was with the Los Angeles County Fire Department for many years prior to joining the U. S. Army Engineers in World War II. When an army captain in charge of a large civilian area in Naples, he was killed by an explosion in an ammunition storage depot.

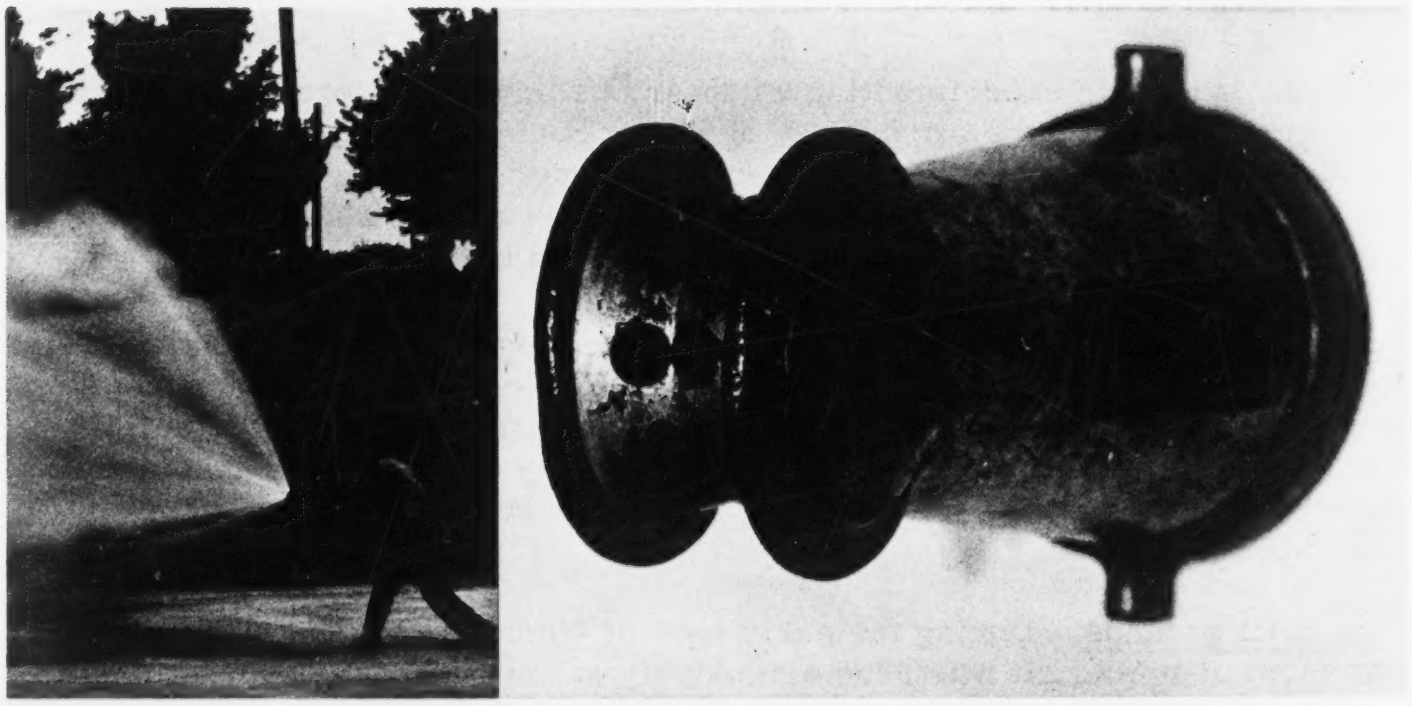

Los Angeles County Fire Department

Fig. 23. One of the earlier commercial types of Chief Griswold's fog nozzle. This 2½-inch size delivers 160 gpm at 100 psi nozzle pressure. The pattern of this nozzle is shown by the photograph on the left.

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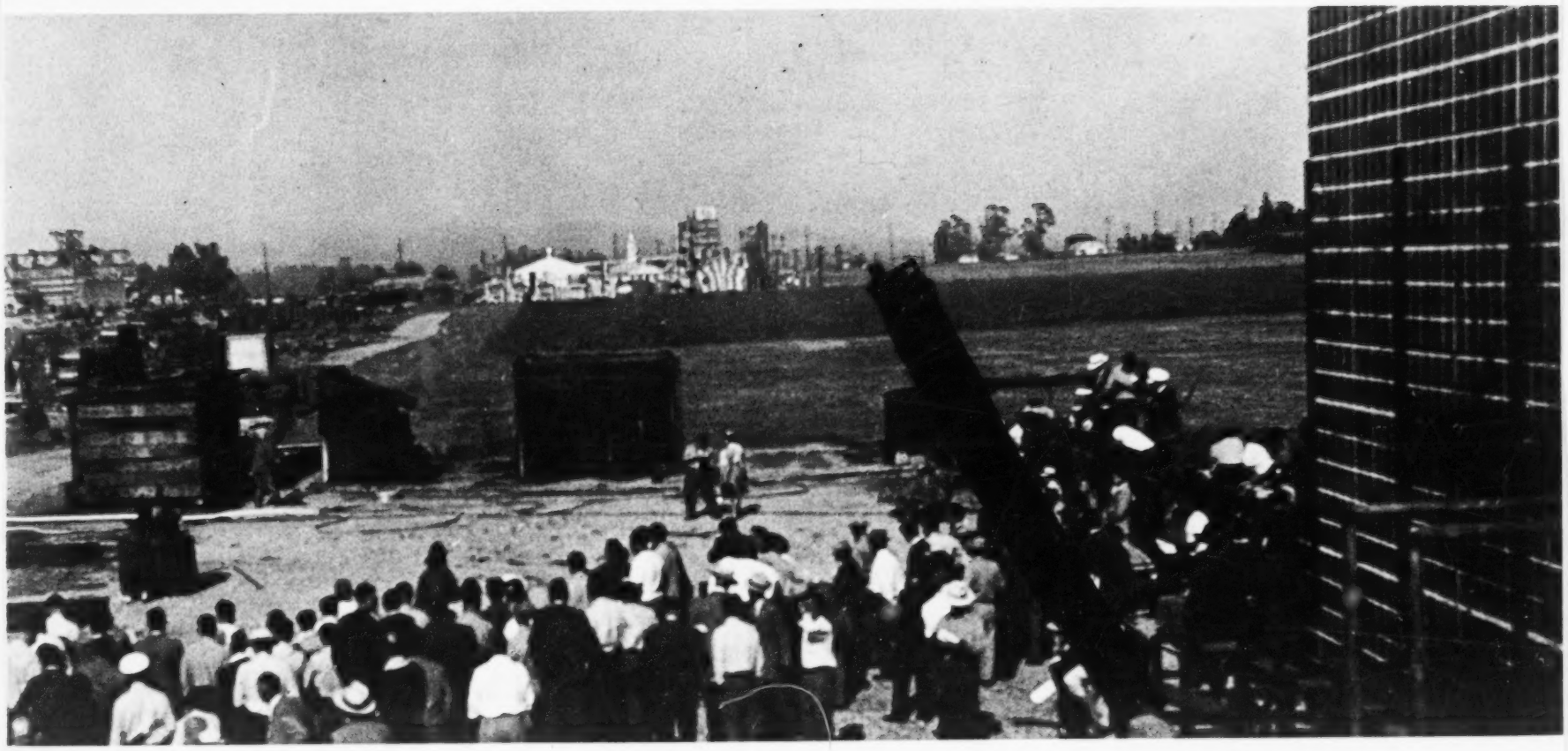

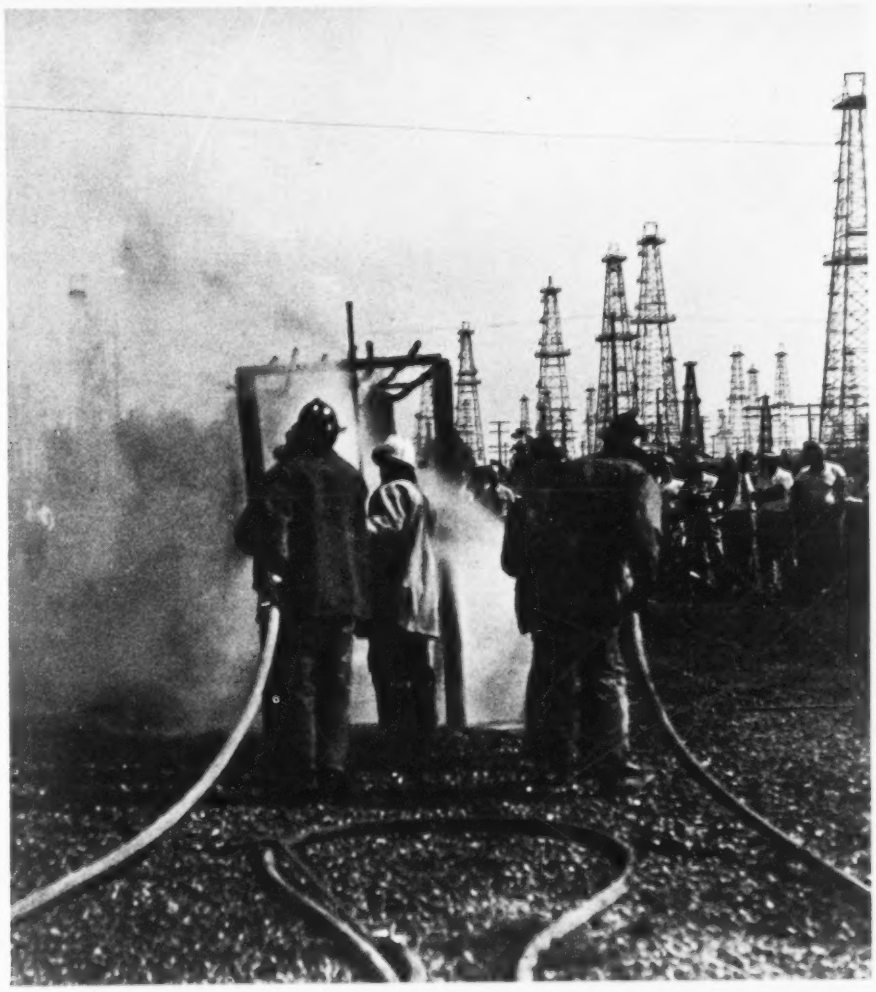

Los Angeles County Fire Department

Fig. 24. Above: an early view of the fire training area at Station 17 at Santa Fe Springs. The grid board was used by Chief Griswold when checking the fog patterns of his new nozzles. Right: the chief is demonstrating his nozzle to spectators.

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Long Beach Fire Department

Fig. 25. Long Beach Fire Department testing two types of Griswold nozzle in 1936.

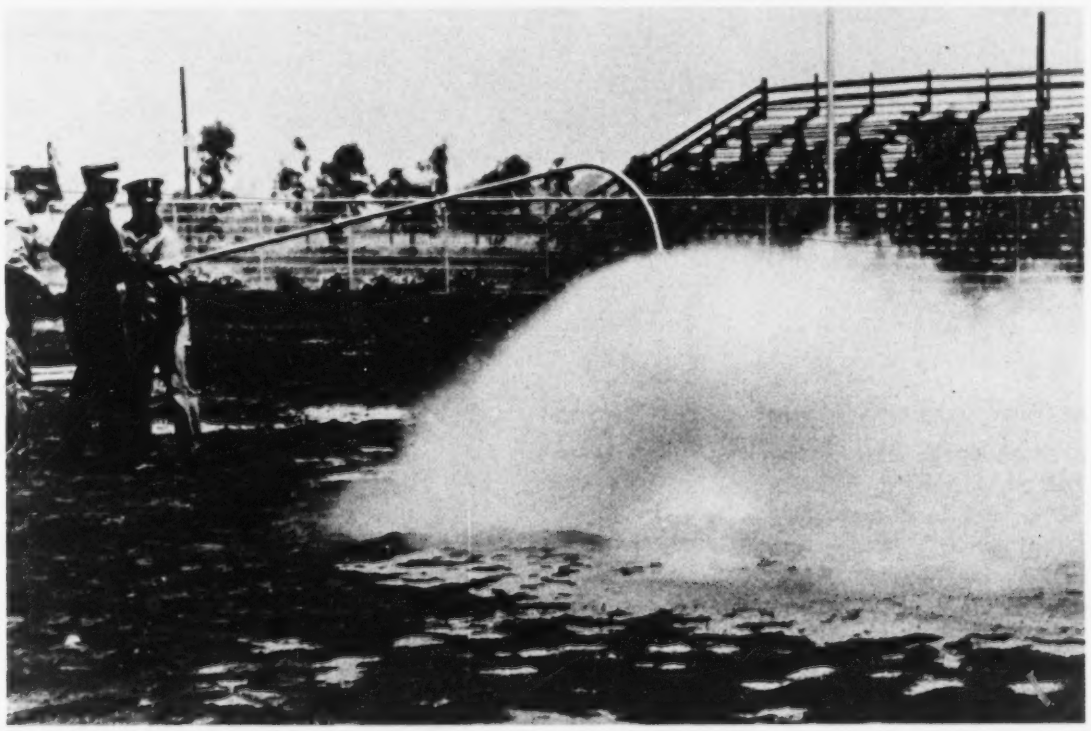

Since refineries and other oil operations grew in size during the war, it was important that refinerymen learn the best techniques to handle the new nozzle at their fires. This training was done often on large oil fires, and local municipal and county firemen were invited to participate. The earliest training was done with the navy-type nozzle. As newer and more efficient designs became available, they were tested by the refinerymen, and the better designs were

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adopted. At the same time, techniques in the best use of the nozzles also were developed.

Fig. 26. A steel panel board is one of the best props for showing how water fog absorbs heat. This early photograph shows Chief Cooper instructing. Panel boards can be used with various fuels and various methods of releasing fuels.

Most firemen are familiar with the old type of navy nozzle. With a side lever it could be used either on full fog or full straight streams. Also there was a connection for attaching a fog applicator. The applicator pipe was fitted with a fog head that produced a soft low velocity or volumetric-type pattern while the conventional head produced a high velocity stream with a directional pattern. Figure 27 illustrates a fireman using an applicator on a navy nozzle at one of the early refinery drill grounds, possibly in the 1940's. Figure 28 shows firemen using a later type of directional fog nozzle on the same tanks.

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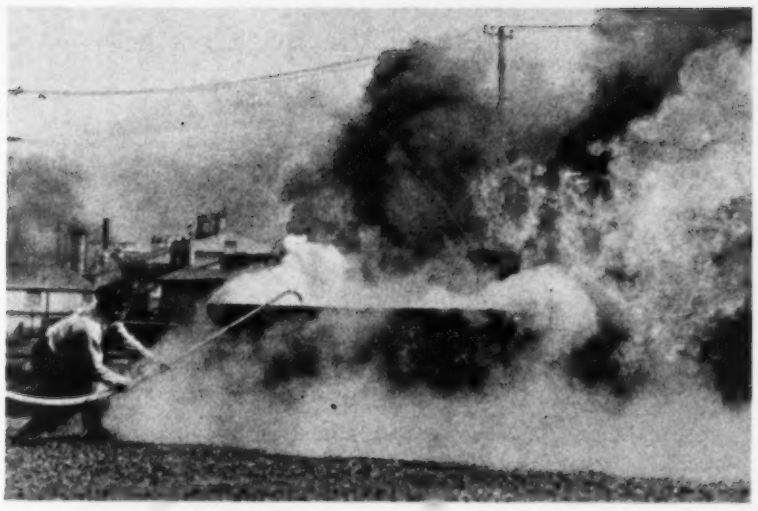

Fig. 27. In a shallow, large-diameter tank it is practically impossible to extinguish a gasoline fire with water because convection currents carry away the steam smothering blanket too rapidly. A fire involving a high flash oil, however, may be readily extinguished in the same tank with the same nozzle.

Fig. 28. Under these circumstances it is more difficult to extinguish a fire with directional fog from a conventional nozzle than with volumetric fog from an applicator.

Using Common Nozzles

Most fog nozzles used today are variations of the adjustable or combination straight stream and directional fog nozzle. The fog pattern is more dense and the stream has more drive near the nozzle than out at the outer fringe of the fog stream. This difference in drive and density of pattern is most important, and the experienced fireman knows how to take advantage of it in protecting himself when cooling the flame. It is the purpose of this paper to describe these techniques.

The one-nozzle approach. Let us assume that there is a flame about 8 feet high and 4 feet wide at the base and that a fireman wishes to move into the edge of the fire and close a small valve that is supplying the oil fuel to the fire. This valve is about 12 inches above ground. He is alone with a 1-inch booster line or a 1-1/2-inch line and realizes that to kill the fire he must close the valve and shut off the source of fuel. He sets his nozzle on the full-fog adjustment with about a 90° pattern. The size and intensity of the flame may

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change while he is at the valve, and he must have maximum protection from both radiant heat and the flame itself. If he moves in with the nozzle at waist height, pointing straight ahead, the fog pattern will be about like that shown by Fig. 29. The danger points are shown by the shaded areas, where the flame may whip around the bottom or top edges of the fog patterns because the drive and water fog density are the least.

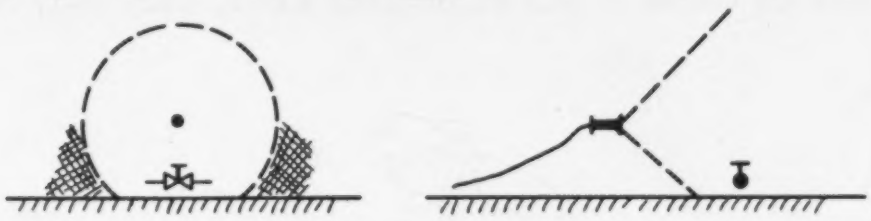

Fig. 29

As he approaches the valve, he squats down somewhat, as illustrated by Fig. 30. His head will be closer to the nozzle, with better protection and the risk of fire whipping around his feet is reduced. The nozzle is still in a horizontal position. He can improve his safety if he will tip up the nozzle slightly as shown in Fig. 31. Note in Fig. 31 that the drive of the pattern near the valve is improved when the nozzle is held at a slight upward angle, and the fog pattern at ground level has a better sweeping or driving action. It is true that the fireman will be squatting in a somewhat more awkward position than that shown in

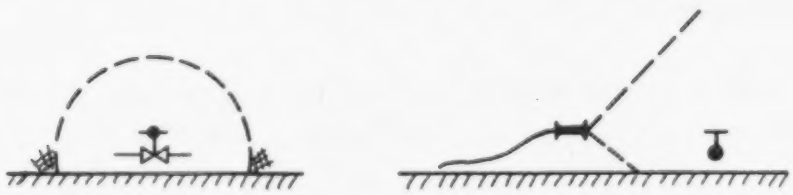

Fig. 30

Fig. 29; therefore, he cannot retreat so fast as he can when standing upright. Close to ground level, however, the tilted nozzle makes a denser forward-driving pattern and provides protection against a flashback along the ground. The vertical top part of this pattern gives good protection from overhead flash.

Fig. 31

The stance and pattern shown by Fig. 31 have been found by trial and error to be the best to use with nozzles where the target (the valve) is below knee level.

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If the target is higher and larger nozzles are used, the stance and angle of the nozzle should be adjusted to suit the particular problem. Experience is the best teacher, and training on the drill ground with different kinds and sizes of fires is a "must" to gain proficiency. The most difficult problem in such training is to break down old prejudices and practices. Firemen, like other people, are resistant to change. If they use the horizontal, belt-level approach with booster lines on Class A and structural fires, they may feel that it also is

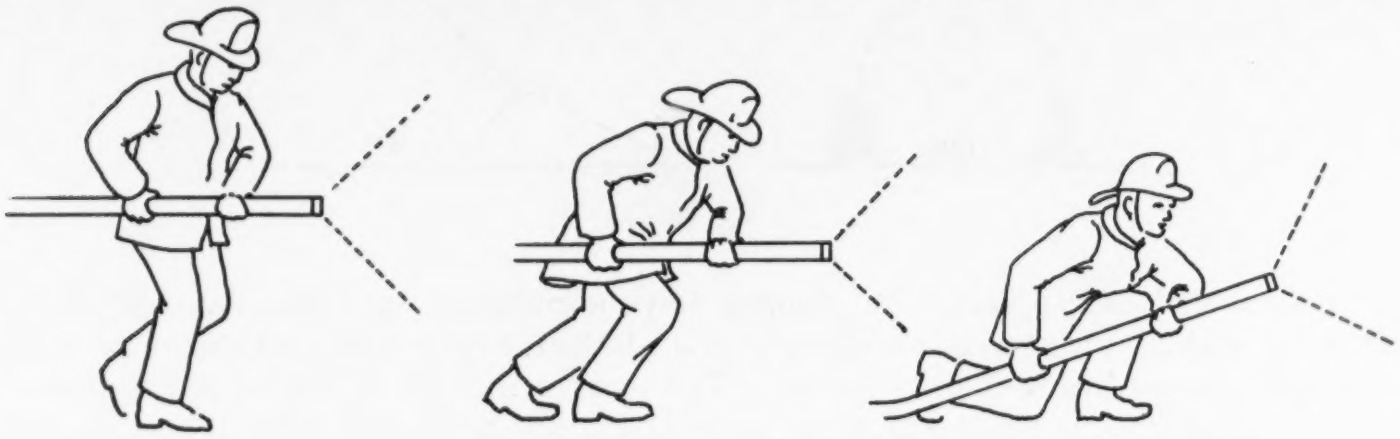

Fig. 32

best for oil and gas fires, regardless of the location of the target. Oil fires, however, unlike Class A fires, may change in intensity very rapidly, and it is only through open-minded, serious training that the new techniques may be learned and remembered.

The retreat from any oil and gas fire may be more important than the approach because of the risk of reignition and reflash. This is the most common argument against the low angle stance when not used correctly. It is most essential that backup men on the hose also be trained properly to aid the nozzle man while he makes a retreat. The nozzle man must not trip and fall over his own hose,

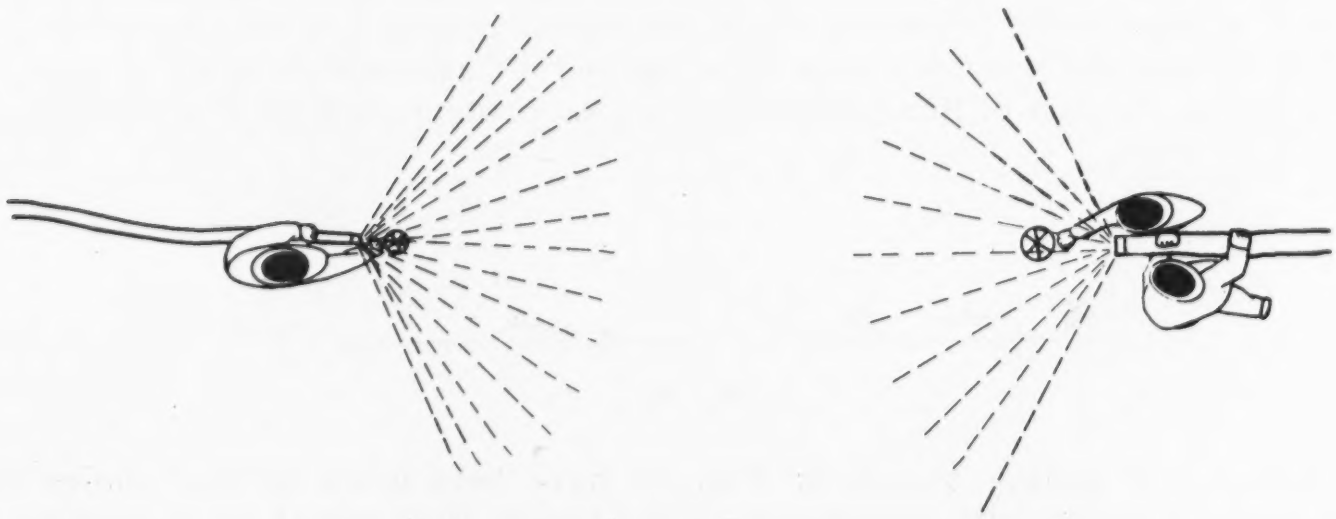

Fig. 33. Bird's eye view of one- and two-man approach to a shutoff valve.

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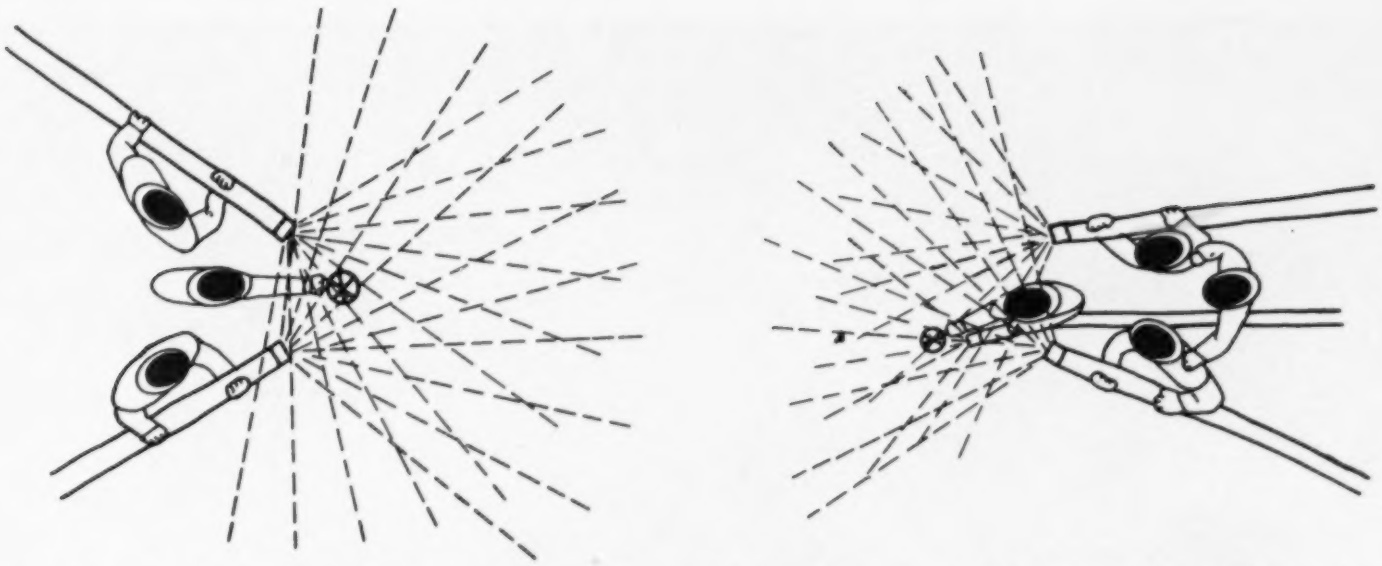

Fig. 34. The left-hand sketch illustrates a typical ground fire approach. At right is an elevated fire, with the 1½-inch nozzles tilted up for protection. For added protection the captain is using a booster line.

for serious injuries may result either from burns or from a loose, whipping hose. Close to the target, the nozzle must be held low to maintain the proper protection, and after a few steps backward, the nozzle man can rise and back off at a higher stance. A careful, deliberate retreat is essential. Under all circumstances the nozzle should not be shut off until the men are completely out of danger.

The two-nozzle approach. When two hose lines are available, it is good to use them, but the nozzle men must learn to work in unison with proper teamwork. This is most important when the size of the flame is almost beyond the capacity of the two nozzles. As a general rule the nozzle men and the men on the hose close behind them should be on the inside of the inverted "V" lay of the two hoses. If one of the men is right-handed, he should stand on the

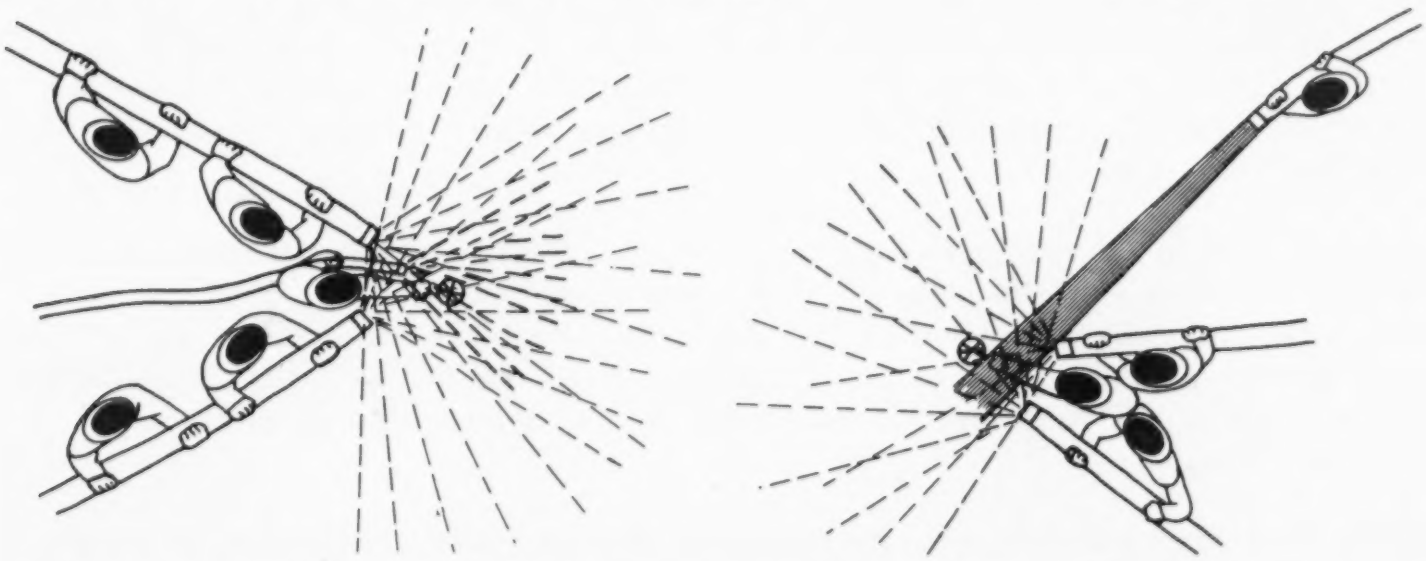

Fig. 35. Left: a supplemental booster line on a ground fire. Right: use of a straight stream for sweeping away a ground fire.

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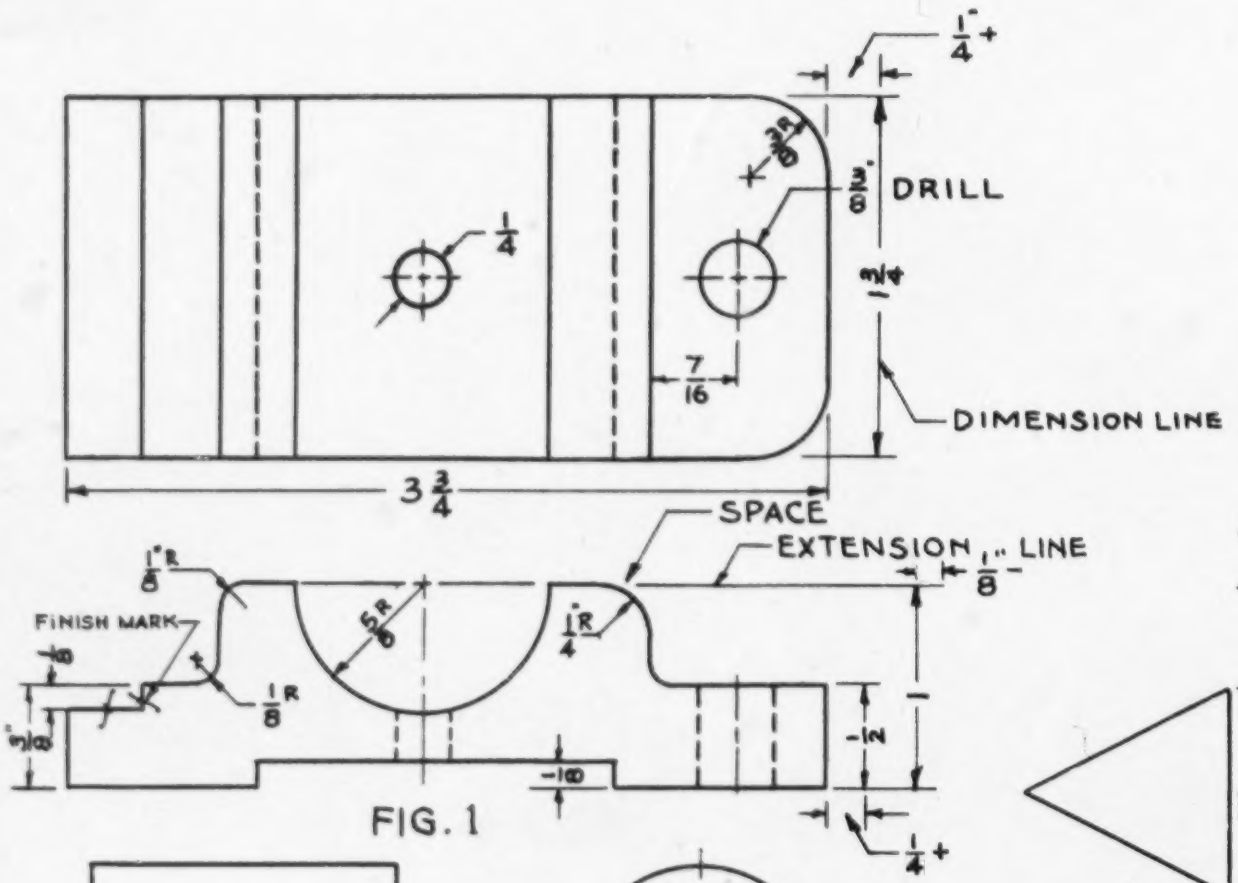

FIG. 1

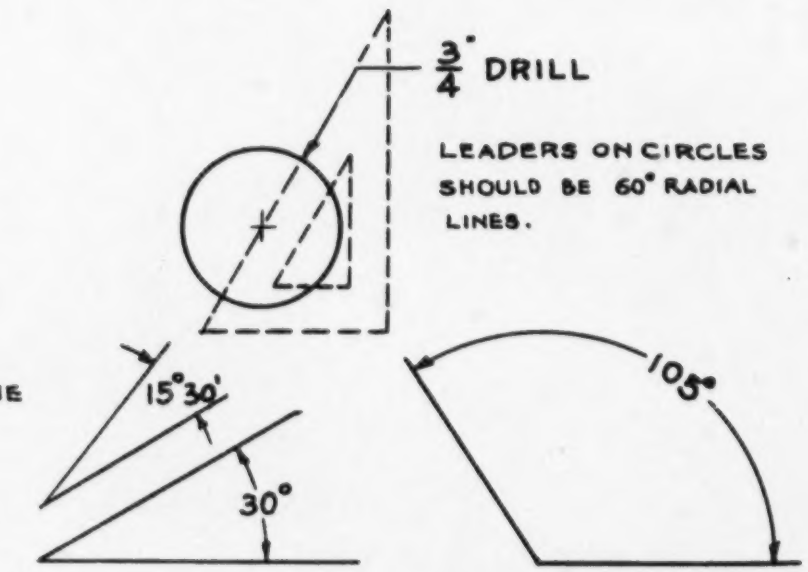

FIG. 2

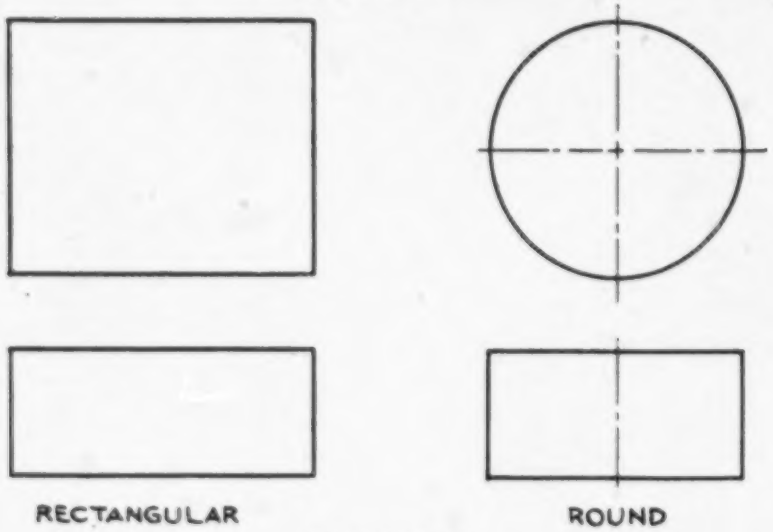

PLINTHS

FIG. 3

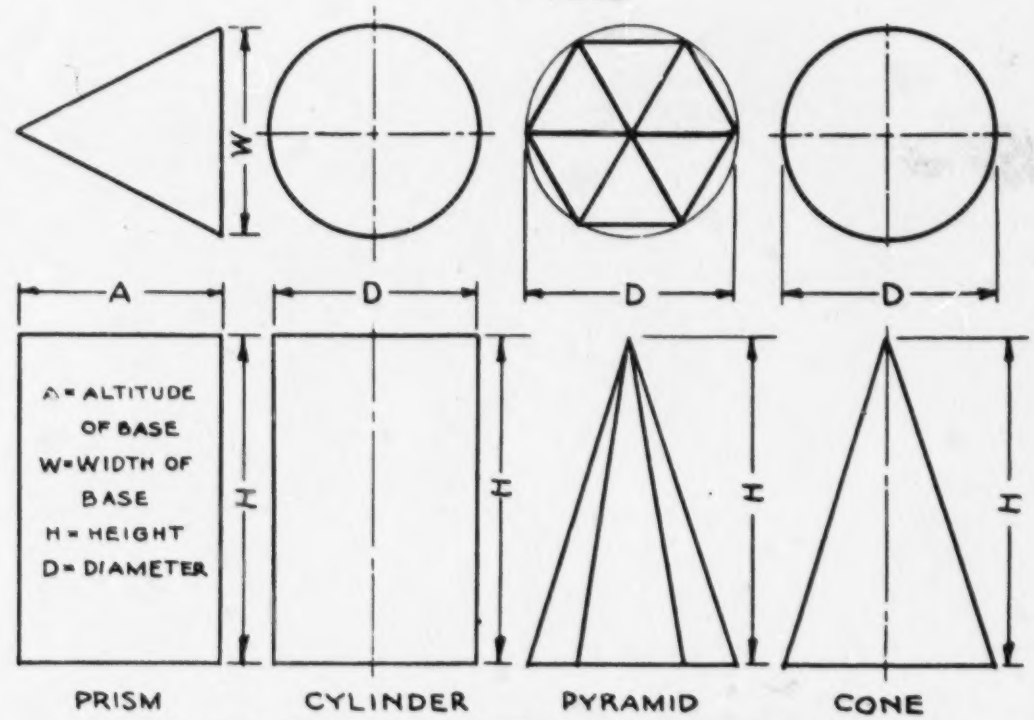

DIMENSIONING FUNDAMENTAL GEOMETRIC SHAPES

FIG. 4

ILLUSTRATION SHEET 9.

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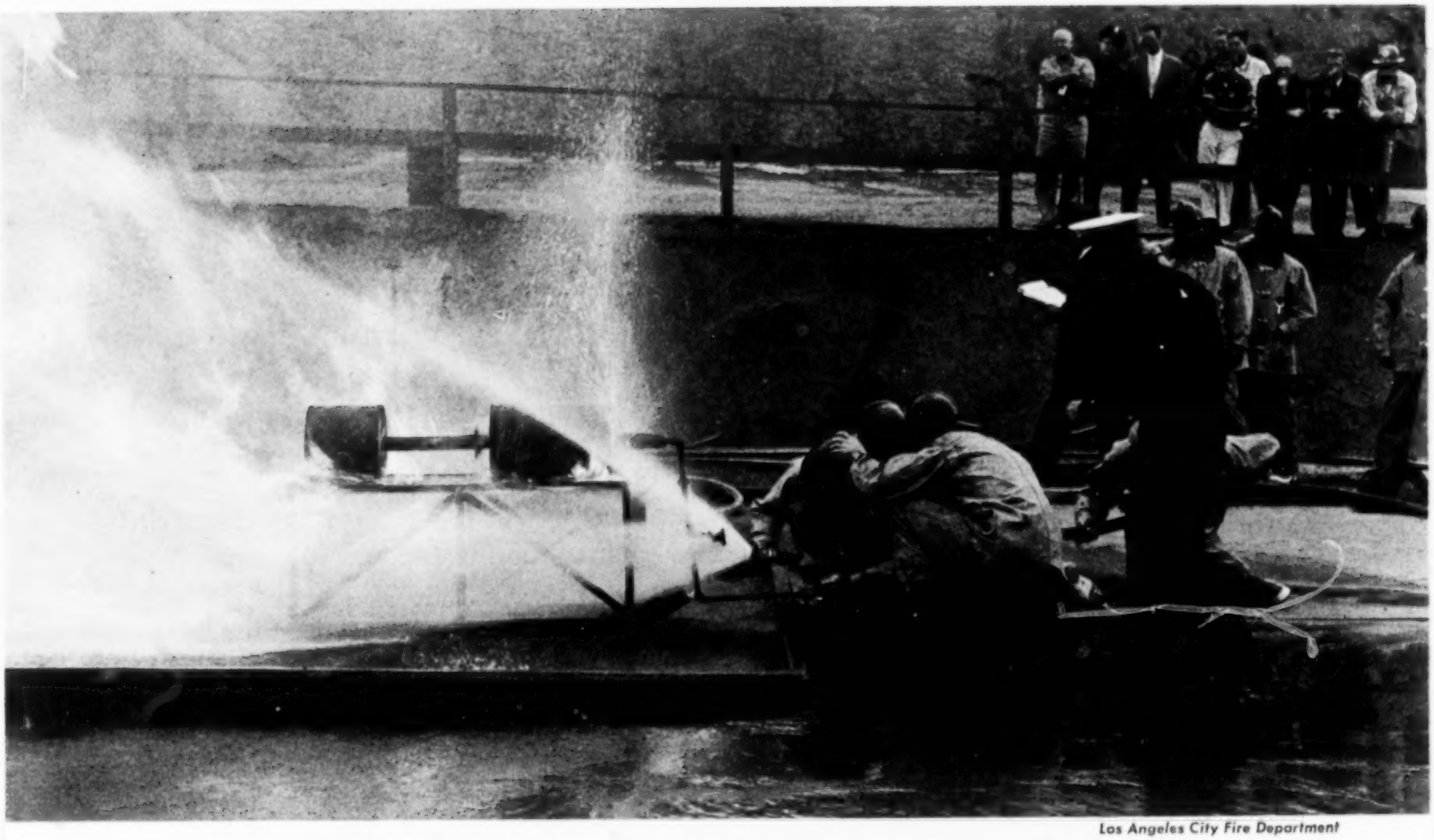

Los Angeles City Fire Department

Fig. 36. Using a 1-inch fog nozzle to close a gasoline valve of a simulated pump. Chief Floyd Adams is overseeing the training.

left side so he can close the valve with his right hand. As the men approach the valve, the two fog patterns should overlap as shown in Fig. 40, and the final stance for each nozzle should be as shown in Fig. 34, if the valve is near the ground level. The forward speed should be slow and deliberate as they move in. The main objective is to get the valve closed promptly without injuries (see Fig. 36).

Assume that the main fire shifts to the right. If the right-hand nozzle man swings his nozzle to the right, it may open a gap between the two fog patterns, and both men may be burned by the flame that can whip through the gap. They may jointly veer their overlapping patterns to the right, back off, and size up the job again. Two or more trials may be necessary, or they may have to wait for help.

If the fire remains constant, they may be able to move in close to the valve, with the left-hand man taking charge so as to use his right hand for the shut-off. By carefully and constantly sizing up the problem while deliberately

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moving in, they will finally get in close enough for the left-hand man to reach in and touch the valve. At that time the left-hand man's attention will be devoted mainly to getting the valve closed, while the right-hand man must watch the overlapping fog patterns. When the valve man is ready, he should shout to his companion that he is ready to try to close it.

This is the critical period in which the right-hand man must watch out for both of them. There is a tendency for some overconfident, foolhardy men to rush in to make a fast shutoff and get out fast. From the standpoint of risk to himself and crewmen, that is about as smart as dashing across a roof that is ready to cave in.

When the valve is closed, the fire may continue to burn vigorously from the fuel on the ground, and the proper backoff again is important. Firemen behind the nozzle men must be alert to keep the hose out from underfoot to avoid tripping, particularly by the nozzle men.

When teaching firemen to close valves, the instructor should start with small fires with the valves near ground level, as shown in Fig. 30. One student may be taught how to approach the valve correctly, first without a fire and then with fire. Then the fire can be enlarged and two hose lines can be used, as in Fig. 44, first with and then without fire. Then similar fires can be handled, with the valve knee high or higher, and the different approach taught.

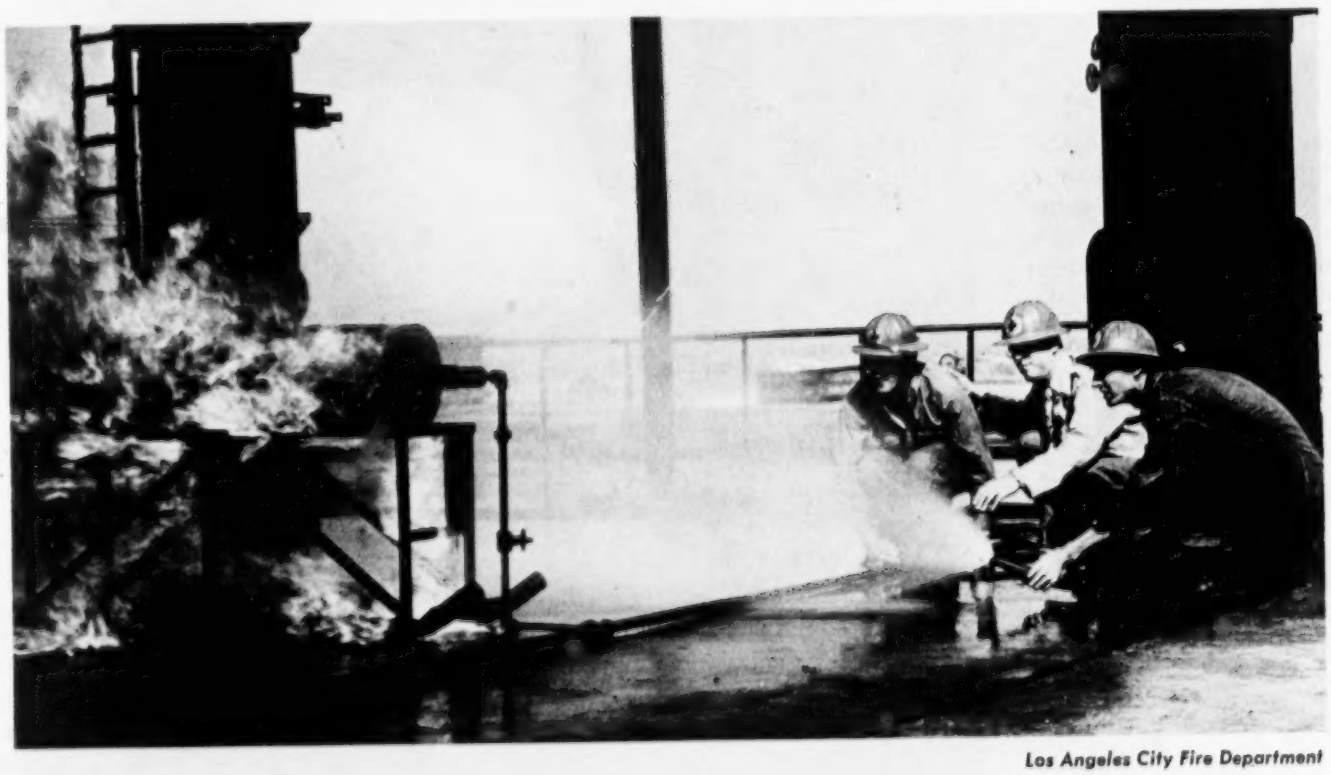

Los Angeles City Fire Department

Fig. 37. The low approach is particularly good where the water supply is limited and one of the objectives is to sweep the ground fire away from under the valve while closing it.

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Fig. 38. When a ground fire cannot be flushed forward, it is important that the nozzles be adjusted and tilted to provide the best drive to overcome this problem.

Los Angeles City Fire Department

Fig. 39. Firemen preparing to move in to close a valve that is supplying butane fuel to a fire. This is the climax of classroom and drill ground training.

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After the men receive careful individual training, they are ready for handling larger, more complex fires, as shown in Figs. 45, 46, and 47. Too often rookies are given advanced training on large fires without the primary training on smaller fires.

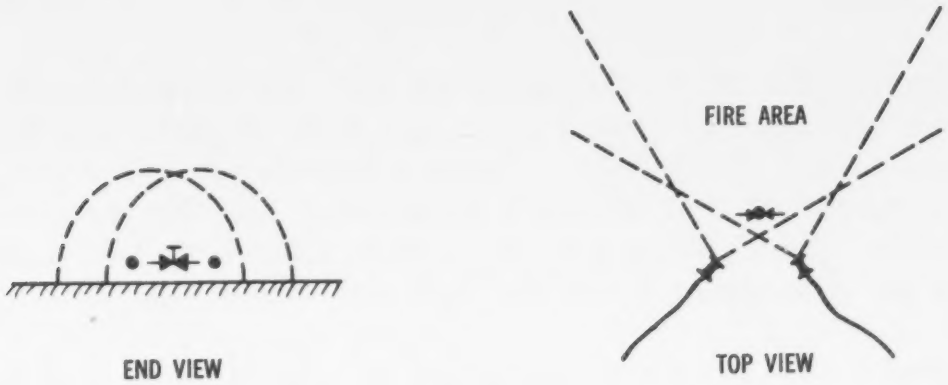

Fig. 40

Two-nozzle approach with captain. When three front men are available, it is good to use all three with a two-nozzle approach. Then both nozzle men can give their full attention to their nozzles, and the third man or captain can direct the crew and make the shutoff. (See Fig. 34 and 35.)

Obviously, at least two men for each nozzle are essential when using 2-1/2-inch lines because of the reactions of the nozzles and the stiffness of loaded hose lines. The captain should be in full charge, and the men should take all

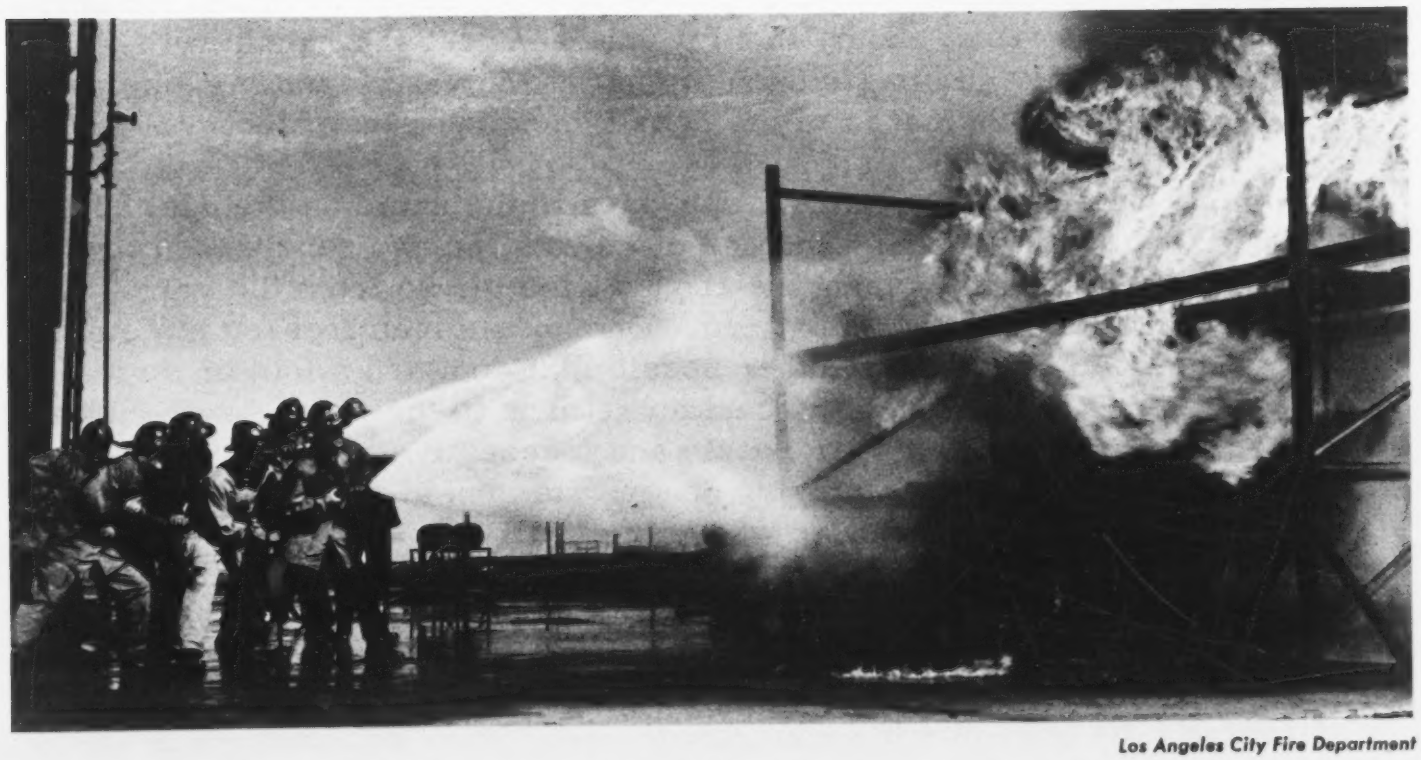

Los Angeles City Fire Department

Fig. 41. Approaching a high fire for valve shutoff where the nozzles will be held waist high for the final approach.

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of their orders from him and not shift the direction of their streams or alter their fog pattern until he so directs.

Two types of approaches have been used successfully, the dual approach and the single approach.

1. Dual approach--After sizing up the job, the captain spots the nozzle men on each side of him, and he has them adjust their nozzles to the desired angles of fog pattern before starting to move in. Then he places his hands on his men's shoulders, and the three move forward as a unit. The captain moves slightly behind his two nozzle men to direct the overlap of their fog patterns. (See Fig. 35 and 47.)

   It is preferable for another captain or experienced man to remain in the rear in charge of the hose men to make sure that the hose is laid out in such a manner that, if a hasty retreat is needed, this hose does not interfere with the back-off movement. This is particularly important where the footing is insecure because of mud, oil slick, or irregular terrain.

   When the three-man crew gets close to the valve, the captain continues his instructions by voice and hand pressure on the shoulders of his men, or if the noise is severe, by hand pressure only. The low approach, as illustrated in Fig. 31, should be used when close to a ground-level target. The captain sets the proper overlap fog pattern and reaches in to close the valve. Sometimes it may be necessary for him to crawl in, practically on his stomach, to get at the valve, and his safety may lie entirely in the hands of the nozzle men, as illustrated in Fig. 48.

2. Single approach--The single approach is the same as the dual approach except for one feature. Instead of moving the two nozzle men together, when the three front men are about 15 feet or so from the valve, the captain sets the overlap pattern. One nozzle man freezes his stance as the captain edges the other nozzle man forward a foot or so into a frozen position. Then the captain returns to the rear nozzle and moves it forward past the closer nozzle and freezes it. He continues this positioning technique, moving one nozzle man at a time until they are together at a point close to where they will be when he closes the valve.

   After sizing up the character of the fire and effectiveness of the two overlapping fog patterns, the captain finally waits a moment or two to see if the fire appears to be unchanging, and then he tries to close the valve. He may find it necessary to make other adjustments of the nozzles before he is satisfied that they are positioned properly for him to devote his full attention to the valve and make the shutoff.

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Los Angeles City Fire Department

Fig. 42. Some training fires are made sufficiently large to instruct in multiple hose line approach. In this case a butane fire is blasting against a steel backplate.

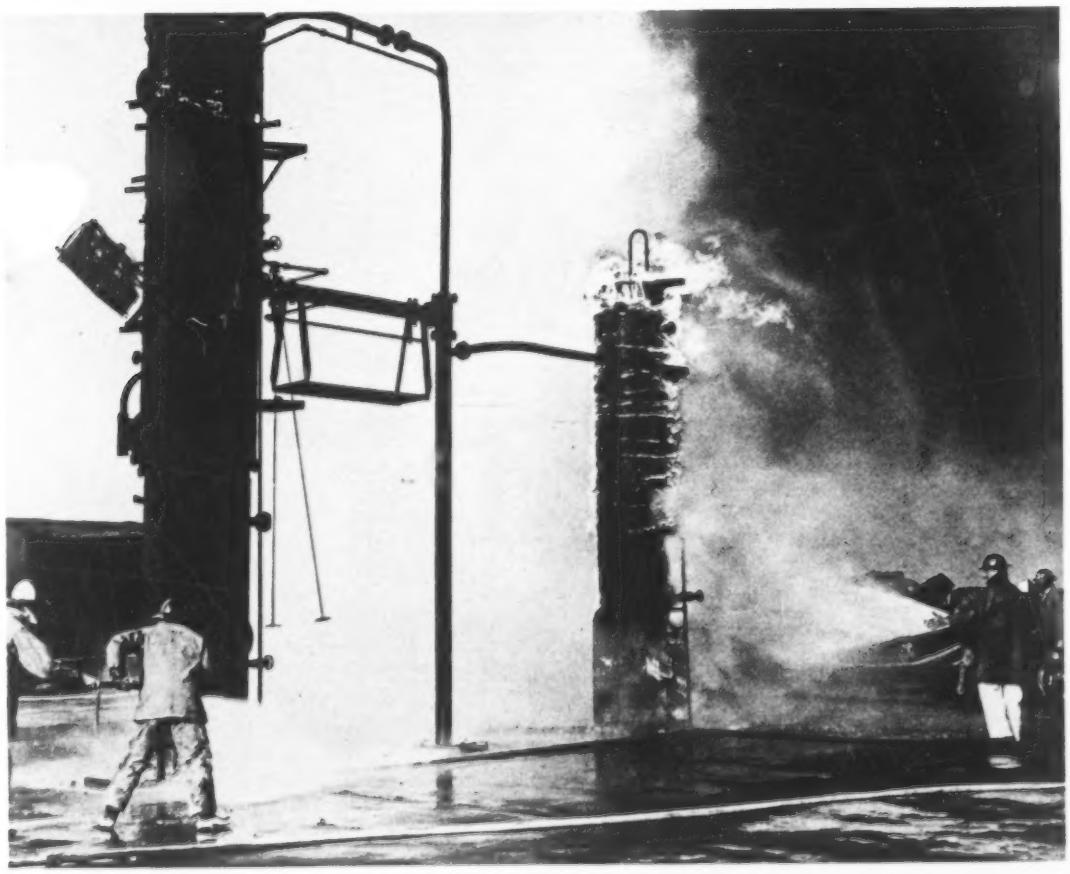

Long Beach Fire Department

Fig. 43. Gasoline is starting to flow down the side of a tower and the men, under water fog protection, will close off the valve about 5 feet above ground level. Many firemen know Instructor Van Marter at the right.

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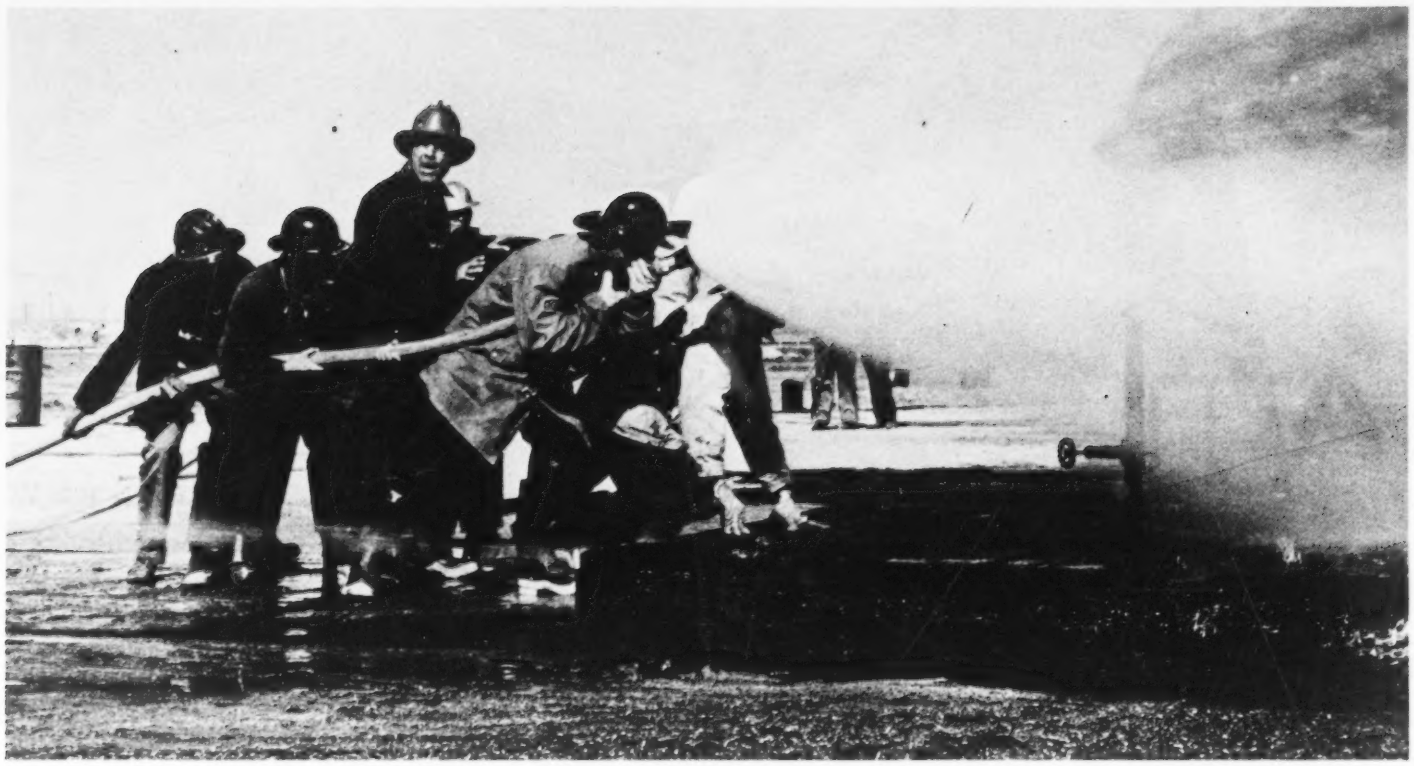

Kern County Fire Department

Fig. 44. Battling a top fire at the Bakersfield School in 1961. This can be dangerous if an unexpected ground flash penetrates the thin fog at the edge of the pattern.

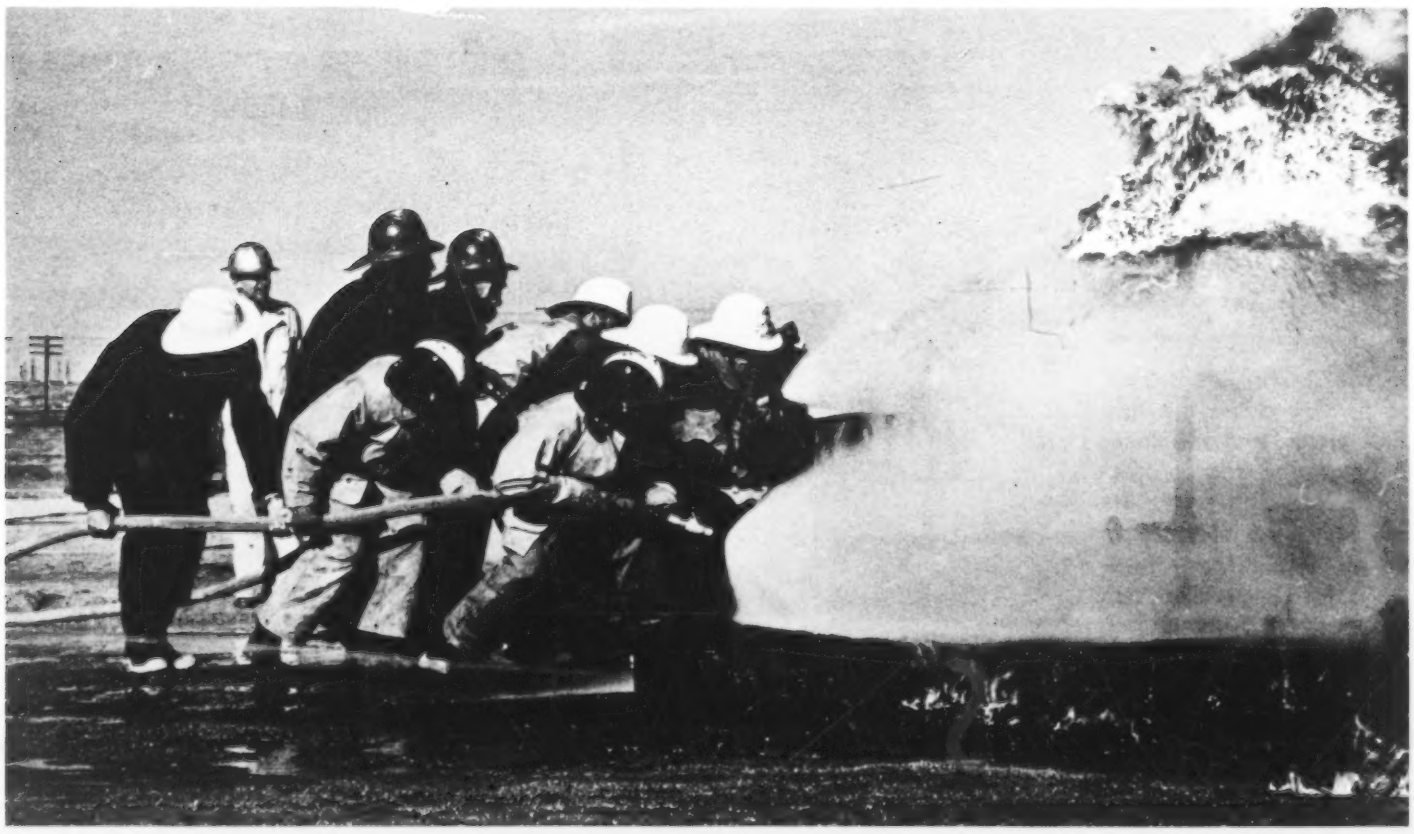

Kern County Fire Department

Fig. 45. Lowering one nozzle to extinguish some ground fire. Later both nozzles may be lowered but tipped upward while the shutoff valve is closed.

16542

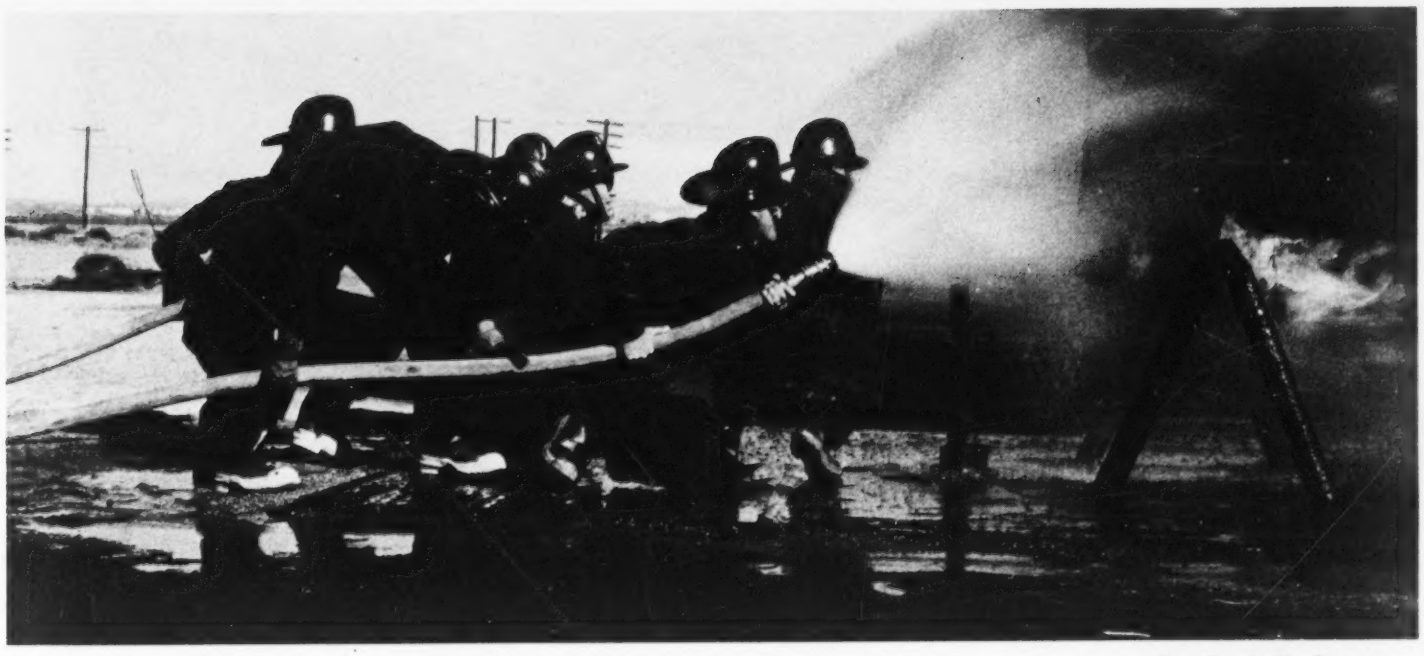

Kern County Fire Department

Fig. 46. Using two 1½-inch lines while shutting off the bottom valve on an elevated tank.

Los Angeles County Fire Department

Fig. 47. The captain sizes up a Christmas tree fire while moving in two hose lines to close the fuel valve.

16543

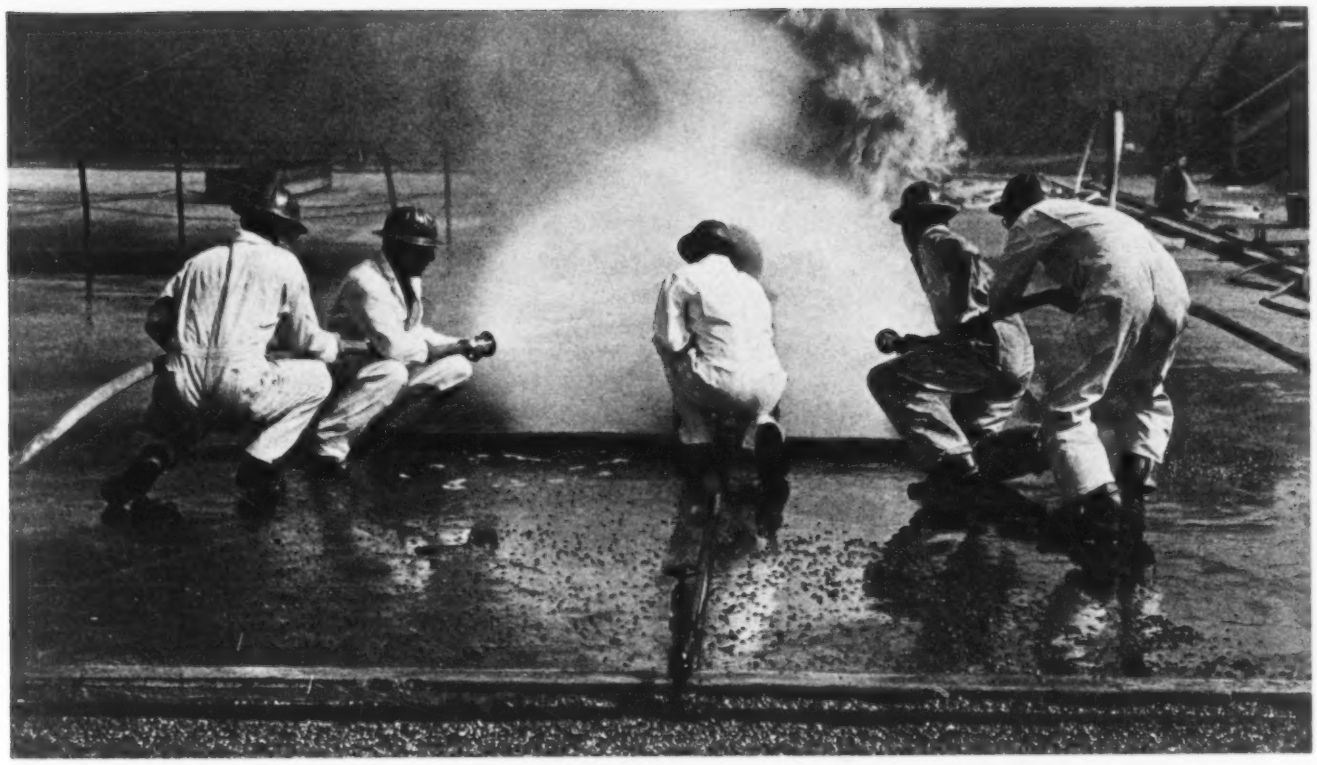

Fig. 48. The position and stance of the captain and his two nozzlemen vary depending upon the location of the valve, the character of the fire, wind direction, etc. The two backup men will be the nozzlemen on the next shutoff.

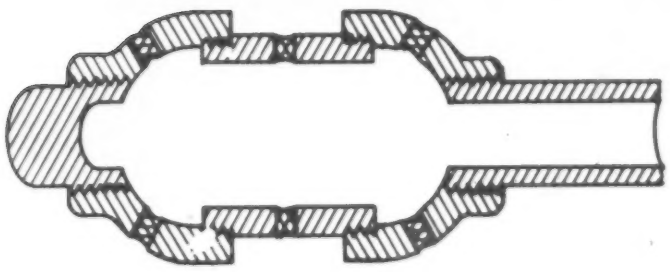

Fig. 49. Some drill ground instructors have had difficulty using LP gas jet burner pipes at high delivery rates because the flame may blow itself out, especially when handled with a fog nozzle. Care must be taken to avoid self-extinguishment because the fire might reignite on some undetected ember and the reflash injure the fireman when in close. This drawing shows a special type of LP gas burner tip that will not blow itself out. The tip is not applicable to LP gas props shown in Figs. 83 and 93.

Both the dual and single approaches are used by experienced fire fighters, but it has been found that the single approach may be needed when the job is particularly difficult. After the valve has been closed, a dual retreat is used nearly always.

Backup lines. In some cases it may be necessary to use other fog lines to remove the radiant heat from severe overhead or side fires, or for possible added protection of the three front men should there be a quick increase in the intensity of the fire.

Sweeping ground fires. If the accumulation of burning oil on the ground makes it hazardous for the front men to reach their target, additional straight streams may be needed to knock the ground fires away from the front men.

Cooling equipment. It may be also necessary to cool close-by vessels or tanks that are exposed to direct flame contact, and more lines may be needed.

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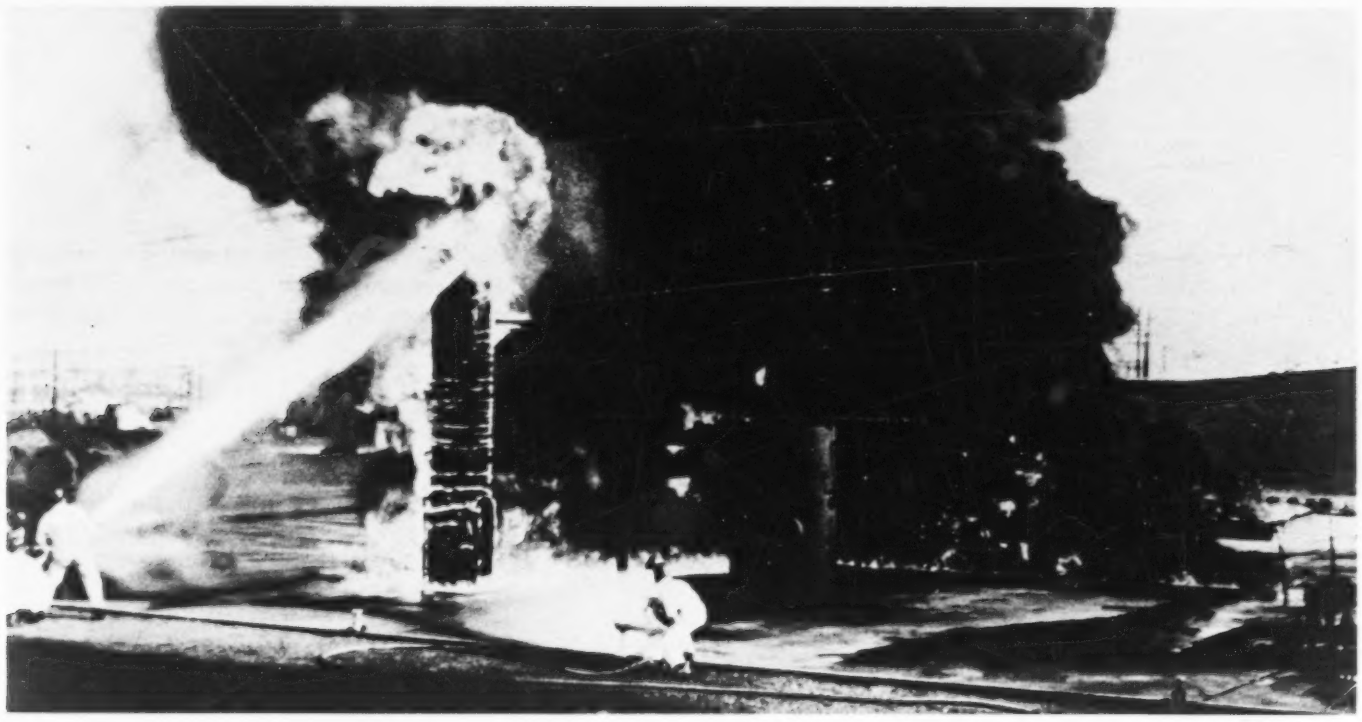

Fig. 50. Refinery training ground prop with gasoline fuel flowing down the sides of a vessel. The problem is to close a fuel supply valve on the side of the vessel about 4 feet from the ground level. One stream is sweeping the fuel from above the valve and the other is flushing the ground fire.

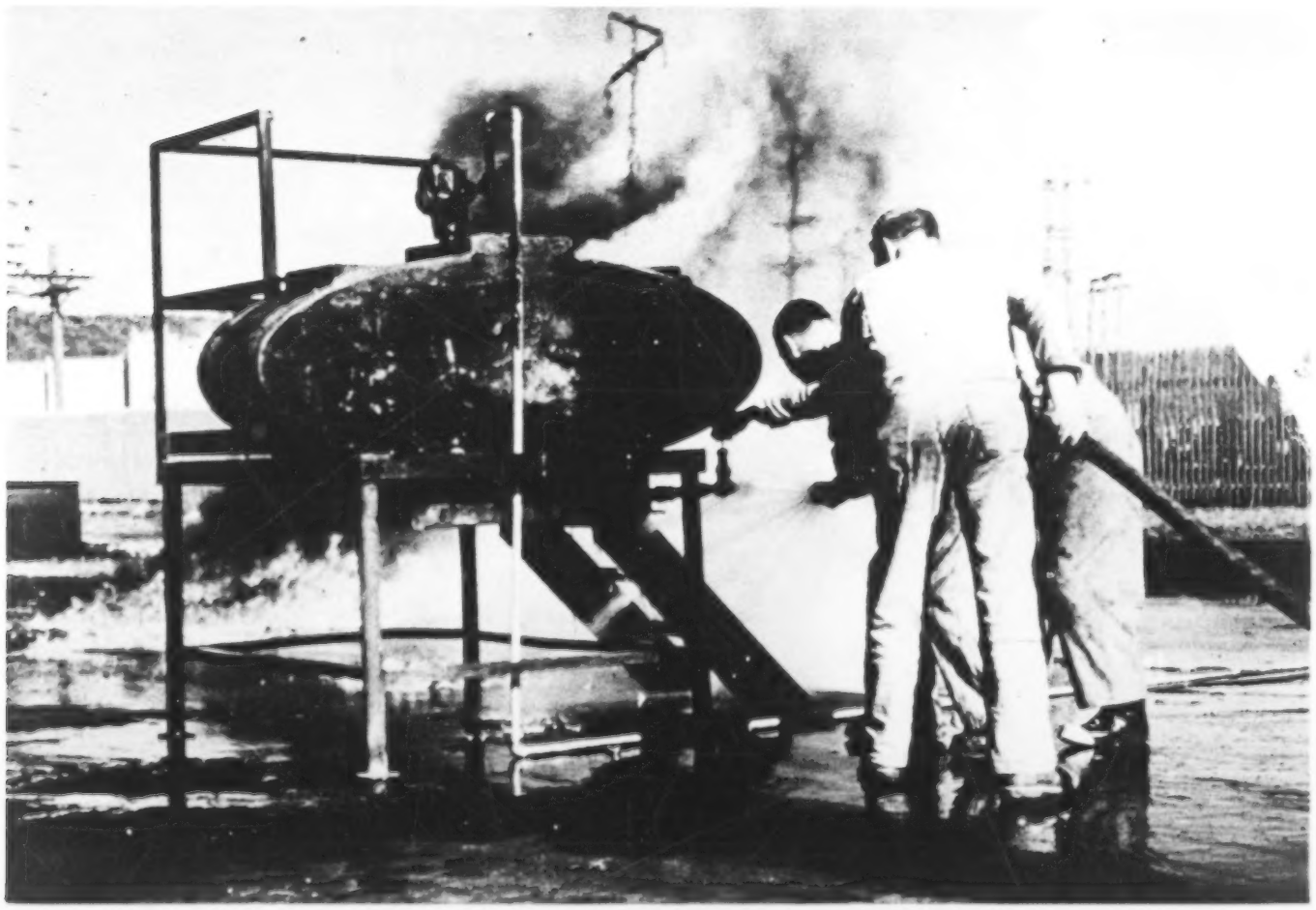

Fig. 51. Closing a bottom valve at a tank truck prop.

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THE GEOMETRY OF DRAFTING

DEFINITIONS & SYMBOLS

ILLUSTRATION SHEET 10.

LINES

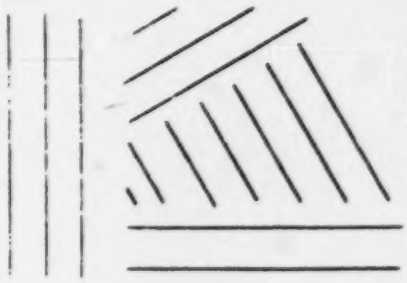

FIG. 1 PARALLEL LINES
SYMBOL: ||

FIG. 2 HORIZONTAL LINES

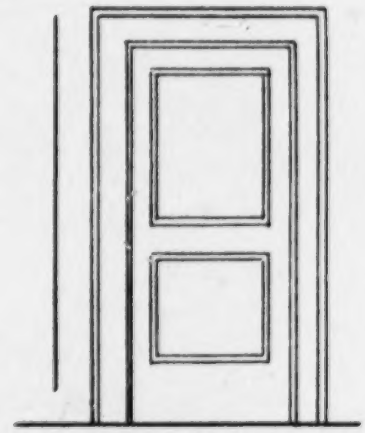

FIG. 3 VERTICAL AND HORIZONTAL

ANGLES, SYMBOL: ∠, ∠s

FIG. 4. RIGHT ANGLE

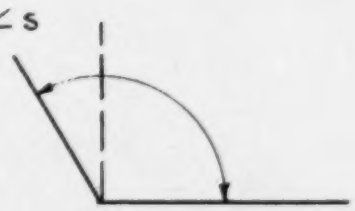

FIG. 5 OBTUSE ANGLE
MORE THAN 90°

FIG. 6 ACUTE, LESS THAN 90°

POLYGONS POLY = many GON = side

SQUARE

TRIANGLE

HEXAGON

OCTAGON

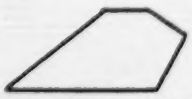

IRREGULAR, SIDES AND ANGLES UNEQUAL

REGULAR POLYGONS
SIDES AND ANGLES ALL EQUAL

TRIANGLES, SPECIAL KINDS SYMBOLS △, △s.

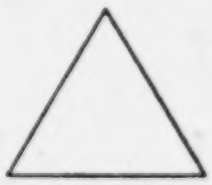

EQUILATERAL
ALL SIDES EQUAL

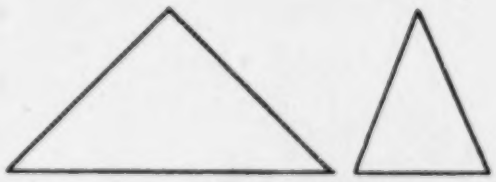

ISOSCELES
TWO EQUAL ∠s

SCALENE
HAS ONE OBTUSE ∠

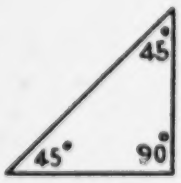

RIGHT
ONE ∠ = 90°

THE SUM OF THE THREE ∠s OF ANY △ = 180°

CIRCLES, ARCS, DEGREES AND TANGENTS

SYMBOL

360° OR UNIT ARCS IN A

CONCENTRIC S

LINES OF THE

COMMON TANGENTS

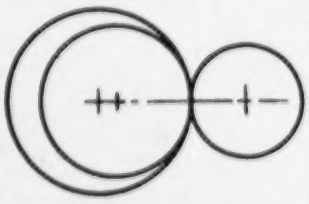

TANGENT CIRCLES

Fig. 52. Many new oil company employees are first taught the principles of extinguishing a fire by closing a valve about waist high.

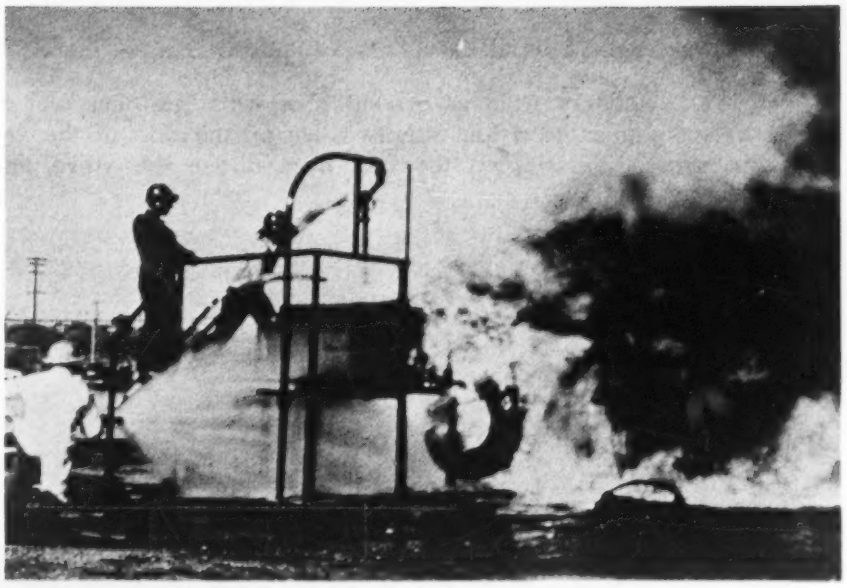

Fig. 53. More advanced training includes closing an elevated valve on this simulated tank truck.

Fig. 54. The fire can be increased considerably by pumping gasoline at a faster rate into the overfilling dome of a tank truck. This can be a tricky fire for two men to handle.

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Teamwork. In complex fires a number of crews may be working simultaneously in the same close area, each having their own job but all working toward the prime objective of aiding the men who have to be close in while making the shutoff. The chief should get his captains together to discuss strategy and the importance of teamwork. Each captain should know clearly what his job is and what the others are to do. The chief may start the ground-sweep operation first and evaluate its effectiveness. He may then set up the backup and reserve lines and see how they operate. Then he will be ready to give his main attention to the shutoff operation and at the same time keep a close eye on the supporting crews.

Other conditions. The foregoing descriptions relate to ground-level situations where the main objective is to get in to close a valve. They may range from a simple fire where one man makes a shutoff to a large fire where a number of crews work together, as already described. We observed one case where the two close-in nozzle men used 2-1/2-inch jumbo nozzles (about 450 gallons per minute apiece) at a pit fire. The captain had to lie on his stomach over the edge of the pit to reach the valve wheel, and he used a 1-inch fog nozzle (20 gallons per minute) to protect his hand on the valve. Backup lines also were used. Sometimes the valve may be in an elevated position with the ground fire above or below.

Conclusion

Each fire has its own problems and requires good leadership and perfect teamwork. Ignorance of the best technique to use not only is a great risk of life but often means no control of the fire.

The best way to learn the best fire fighting methods is to get good training on large fires on drill grounds. Before working on the complex problems, however, all men should first be trained individually on small fires. Difficult emergency fires are not likely to duplicate training fires, and comprehensive training on various types of large fires is imperative.

16547

19 USING DRY CHEMICAL EXTINGUISHERS

Because the dry chemical extinguisher is the best hand extinguisher for oil or gas fires, learning the proper technique to obtain its greatest effectiveness is especially important. A 20-pound extinguisher will exhaust itself in about 20-25 seconds, and a 30-pound unit, in about 20-30 seconds. In this short a time a fireman cannot correct his errors without serious waste of powder charge. Therefore, he must know the best method before he starts to use the extinguisher.

One of the most difficult problems in training men in the proper use of dry chemical extinguishers is to get them to stand back far enough. This is particularly true with the older firemen, who have had a great deal of experience with CO_2 extinguishers. It is much easier with younger men who are learning from scratch.

Recommended Training Procedure

The step-by-step process is the best training procedure. By learning one point at a time, the fireman retains the knowledge and, in an emergency, does the best job. Suggested steps for the instructor to follow in the training procedure are:

1. Train yourself not to expose your mistakes to the students and lose their confidence.

2. Work with three or four students at a time so they can learn by doing.

3. Select a flat area at least 10 feet wide by 20 feet long and preferably on a day with little or no wind. The area should not be obstructed by equipment.

4. Mark a "foul line" at one end of the area. Step off about 10 feet and place some small object like a spanner wrench or other flat target on the ground, preferably down wind, if there is a breeze.

5. Place the extinguisher at the foul line and draw a line on the ground from the extinguisher to the target. Then explain to the students that,

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first, you are going to show them the pattern of the powder when shooting straight at the target.

6. Squat down at the foul line, holding the nozzle steady and horizontal, with the nozzle about 12 inches from the ground, and squeeze the handle to provide one single burst of powder. The white powder will lay a sharp triangular pattern on the ground and properly cover the target.

7. Explain to the students that this is about the correct range to get the greatest effectiveness from a dry chemical hand extinguisher. The 10-foot distance is selected as a fair average. Some makes of extinguishers or nozzle designs may require more or less distance. It is best to obtain this information before the class meets.

8. Pick up the target and place it 5 feet from the foul line. Show the men that, if the target had been 5 feet from the foul line, much of the powder would have overshot the target and would have been lost. If the size of the fire had been close to the capacity of the extinguisher, much of the powder would have been driven right through the flames at ground level, and the fire might not have been extinguished.

9. Move the target back to its original place, 10 feet from the foul line, and tell the students that usually the fire is larger than the small target. Using another target, place it close to the left edge of the powder pattern on the ground and 10 feet from foul line, and relocate the original target at the right side of the pattern. Tell them to assume that the fire is of that breadth. Ask them, "Now what is the best technique to use?"

10. Pick up the extinguisher again and, squatting down again in the same position, discharge the entire extinguisher, but rapidly fan the nozzle so as to widen the angle of the pattern of the deposited powder to cover the targets properly, without significant waste of powder on the side.

11. As the extinguisher starts to lose pressure and range, move in closer and continue the fanning.

12. Go back and discuss the session, driving home the important points:

    - Use the proper distance at the start.
    - Strike the fire at its base or at the bottom of the flame.
    - Fan the nozzle to get full coverage.

16549

Kern County Fire Department

Fig. 55. Note the difference in range of the two extinguishers with no wind.

- Move closer as extinguisher pressure decreases when almost expelled.
- Work down wind where possible.

13. Tell the students how close to the target the fireman should be if he has a CO_2 instead of a dry chemical extinguisher. Using a CO_2 extinguisher, demonstrate the preferred distance and draw a new foul line for a common CO_2 unit. Clearly point out this difference between the two foul lines and the mistake that many firemen make in getting in much too close with a dry chemical extinguisher.

14. Demonstrate with a live fire. Use a 3-foot by 3-foot pan about 2 inches deep. Place the pan in a clear area where there is no powder on the

16550

ground around it. Fill it with water and level the pan. Dump out about half of the water and add gasoline to a level of about 1/2 inch below the rim. (You could start the demonstration at Step 4 with the pan fire first, but experience has shown that the fire distracts the students' interest from the instructor. He should have their full attention in Steps 4-13.)

15. Ignite the gasoline and, from the 10-foot foul line, extinguish the fire, using the fast fanning motion with the nozzle.

16. Move the extinguisher up to the CO_2 foul line, relight the fire, and repeat the process. Show the students how much powder was wasted by shooting beyond the pan. You may not extinguish the fire at close range.

17. Relight the fire and move in with the nozzle to only about 18-24 inches from the fire. By impinging the powder blast onto the gasoline surface, some of the burning gasoline can be knocked out of the pan onto the ground.

18. Back off to the 10-foot line and make a fast kill. Discuss the error of the very close approach. (Now the students are ready to learn by doing. It is assumed here that the students learned the basic design and operating features of the extinguisher when you opened, emptied, and refilled the extinguisher while talking to them.)

19. Explain to the students that not everyone can kill a training fire on the first attempt. Tell them not to be embarrassed, especially if they follow instructions. Select the most likely candidate, mark off a new foul line, step off 10 feet, put down the target, and have him shoot it with one short blast as you did. Discuss the job and then move over to the pan. Repeat to him the points covered in Step 12, while another student lights the fire. If the subject fails to extinguish the pan fire, you, and not one of the other students, should tell him what was wrong. Have him repeat the attempt until he makes a clean "kill."

20. Repeat with the other students.

21. Ask each student to explain to you each of the key points in Item 12.

Other Training Props

Also see Drills 2 and 3 of Section 2 of Part III for other types of props that are suitable for dry chemical training. Figure 90 illustrates one in action.

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20 USING WATER FOG WITH DRY CHEMICAL EXTINGUISHERS

For any given size of dry chemical extinguisher, there can be a fire that is slightly too large or too complex to be extinguished by it. This can be serious if the fire must be extinguished promptly and there is only one extinguisher available at the moment. On the other hand, flame size can be reduced considerably by water fog, but fog alone may not extinguish a gas, LP gas, or gasoline fire, for example. Using a combination of water for reducing the size of the flame and dry chemical powder to put it out will extinguish a much larger fire than using one extinguisher without the fog.

Long Beach Fire Department

Fig. 56. A 1947 photo showing a refinery instructor demonstrating the stand-back technique using the early model of dry chemical extinguisher available at that time.

Fire-Extinguishing Elements

How dry chemical works. The active ingredient in the dry chemical extinguisher is sodium bicarbonate--common baking soda. When carbonate is decomposed by flame, carbon dioxide gas is produced. Some people have reasoned erroneously that it is the CO_2 that extinguishes the fire, but not enough CO_2 is produced to do the job alone. Besides, some other powders that do not produce CO_2 can extinguish a fire. The extinguishment actually is accomplished by the powder's entering into and inhibiting the complex chemical reaction of burning. Recently available extinguishers using potassium bicarbonate are about 50 percent more effective than sodium bicarbonate in extinguishing fires.[1]

How water fog works. The small droplets in water fog are evaporated by the

[1] NFPA Quarterly (April, 1960), p. 334. This is a highly technical article on the subject of how a dry chemical functions.

16552

Long Beach Fire Department

Fig. 57. At a 6- x 60-foot trench at a refinery drill ground in 1947, an instructor is using a dry chemical extinguisher in combination with a 1-inch fog nozzle. The man with the fog nozzle is on the opposite side of the trench, hidden by the cloud of steam and powder. It would be difficult to extinguish this fire with one nozzle alone, but it is done readily when a hand extinguisher is also used with the proper technique.

flame. This requires considerable heat absorption and hence reduces the size of the flame.

Combining Fog and Dry Chemicals

History and development. In the early 1940's, when dry chemical extinguishers first were used in quantity by oil refineries in California, they were found to be far more effective than old CO_2 and 2-1/2-gallon foam extinguishers. Yet sometimes fires that had been fully extinguished with a dry chemical extinguisher reignited some seconds afterward, either because the vapor itself was so hot that it reflashed or because it was reignited by the heat from metal surfaces or glowing embers. Such experiences indicated the need for quenching the fire area with water before using the dry chemical extinguisher.

Some people argued that water fog would dissolve the bicarbonate too quickly, but fire tests on the drill grounds showed that the combination of the two is unusually effective. Fast-acting 1-inch or 1-1/2-inch hose for water fog has

16553

Fig. 58. Using hand extinguishers with water fog is not a new technique. This 1945 photo shows a 30-pound CO_2 extinguisher and fog applicator being used on a gasoline spill fire in a crushed rock surface of a refinery drill ground.

16553

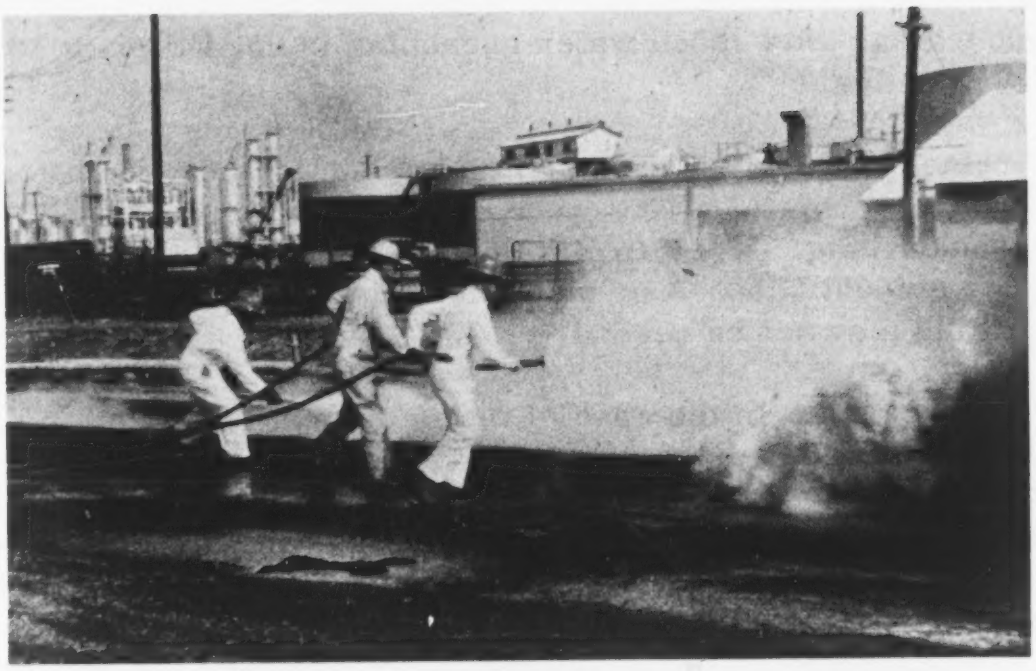

Fig. 60. Refinery employees practicing the combination technique in a long pipe trench. Some extinguishers have nozzles with less range than others, and range governs the distance from the target.

been installed in operating areas for prior quenching, and during the second or two that the dry chemical powder is projected through the fog it does not dissolve. This is because, when the powder is milled in manufacture, it is coated with a skin of water repellent that keeps it fluffy and reduces caking in storage. (This short-term waterproofing can be demonstrated by stirring a teaspoon of the powder in a glass of water.) The combination technique has proved very successful in emergency fires.

Preferred combination technique. Oil and gas fires vary considerably in type, character, and size, and no one technique is applicable to all conditions. One preferred method, if a spill or ground fire is within the capacity of the extinguisher or extinguishers on hand, is:

1. Sizing up the job. The experienced captain will size up the job in a moment or two in order not to overlook any condition that might spoil the chances of a kill on the first trial. Factors to consider are:

   - Layout--Is it a simple flat area with no holes, baffles, or interfering equipment? Can the approach be made from any one of a number of sides? (If so, you are lucky!)

   - Extinguishers--Is one extinguisher enough, or should you wait until more are brought up? If two or more extinguishers are needed, should you use them simultaneously or hold them in reserve until the first extinguisher is nearly expelled?

16554

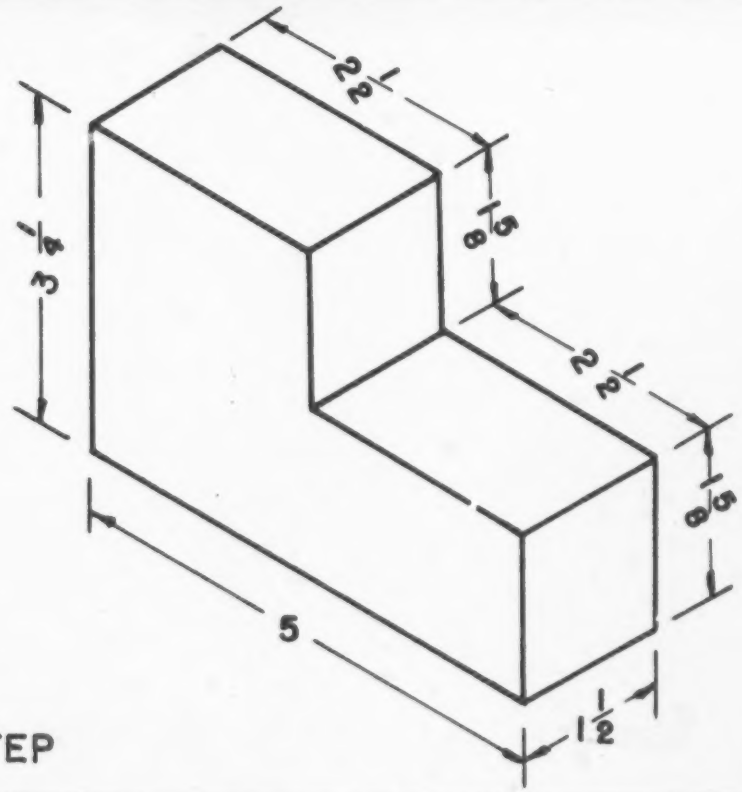

STEP W.S. 15

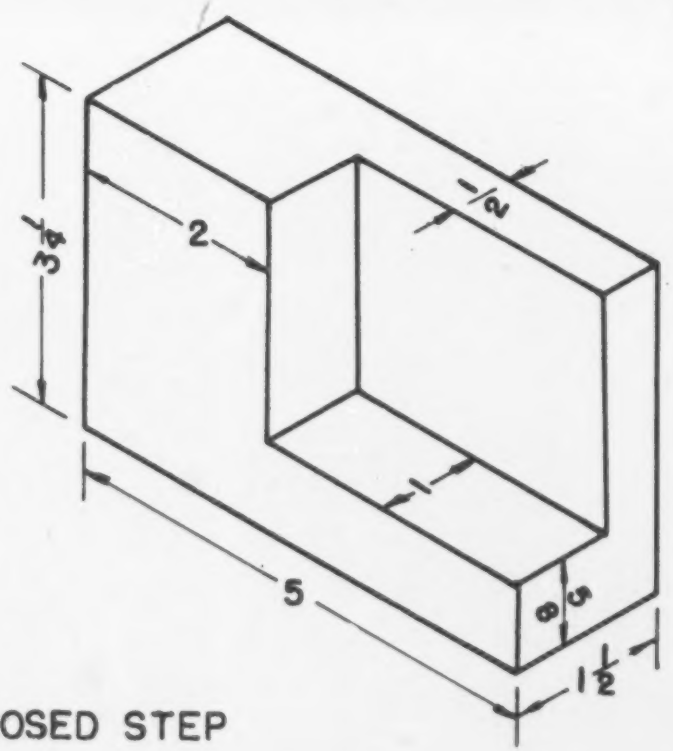

ENCLOSED STEP W. S. 16.

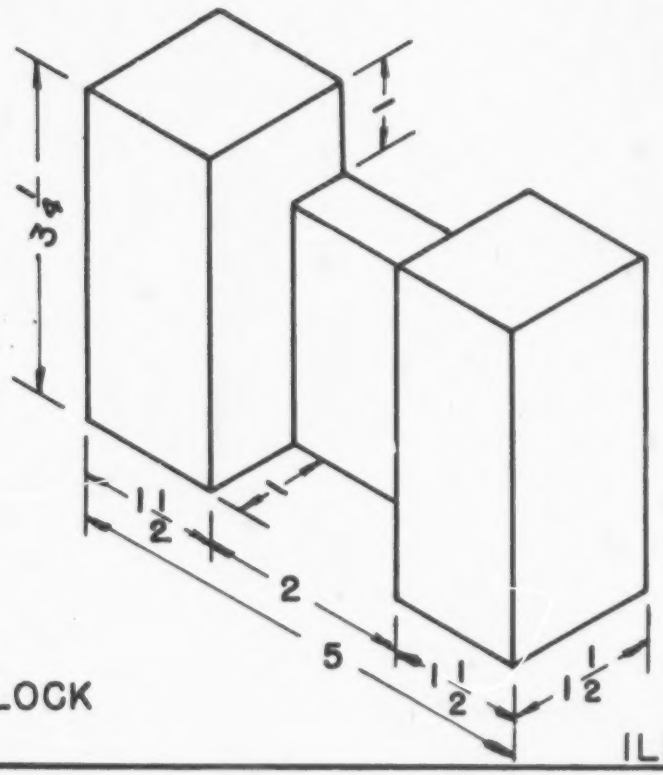

H BLOCK W.S. 17.

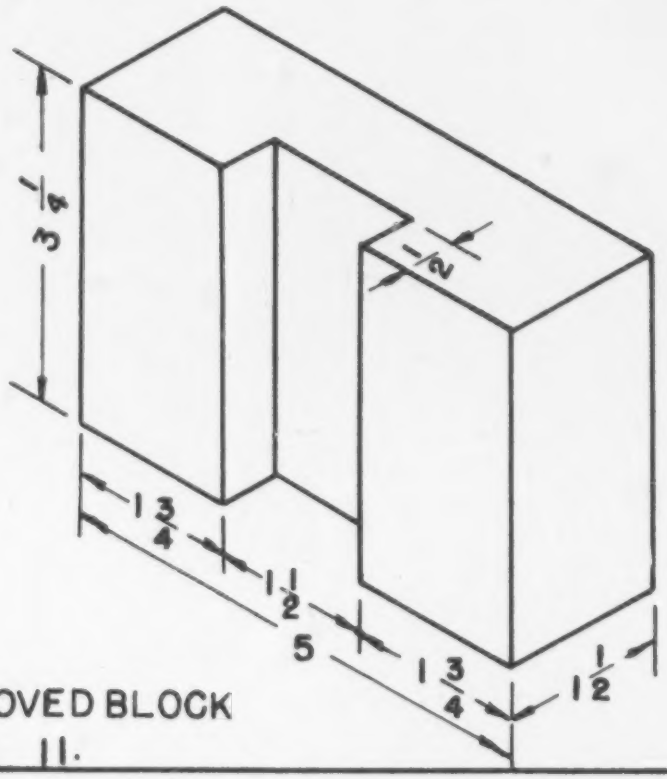

GROOVED BLOCK W. S. 18.

ILLUSTRATION SHEET 11.

1653

- Quenching--How much water quenching is needed prior to using the dry chemical?

- Firemen--Where will you spot your men for best teamwork?

2. First quenching. If the fire is on a clean, hard surface like concrete with no evident Class A or other materials that may cause reignition, quenching may not be needed.

3. Extinguishment. In the case of a simple ground or flat surface fire, it is best to select a beachhead and plan the movement across the fire area. Dry chemical extinguishers have a good range, up to 15 feet or more; and by fanning the nozzle, a considerable breadth of area may be covered by one extinguisher. First, the fog stream should be directed in the beachhead to reduce the flame size, and then the dry chemical should be applied directly under the fog pattern, as illustrated in Fig. 61.

If one fog nozzle and one extinguisher are available, the fog may be fanned back and forth, and the dry chemical extinguisher may be fanned under it. If two nozzles are available, they may be operated side by side, and one or more extinguishers may be used together. Good teamwork is essential, and this can be learned best by training on drill grounds.

When the beachhead is gained, the nozzle man will move out over the fire surface with the extinguisher blast being maintained, as shown in Fig. 61. As one extinguisher is expelled, another should be started without a lapse of time. If the ground fire is complicated by equipment such as pump bases, large piping, small pits, or trenches, more sizing-up is needed. For example, it may be impossible to extinguish some simple fires with a dozen extinguishers used one at a time, although the same fire may be easily extinguished with two extinguishers used together.[2]

High Fires

High fires can present difficult problems. Those that are within the range of a fog nozzle and dry chemical extinguisher often can be extinguished best if the flame size is reduced with water, and the dry chemical is shot directly through the fog stream at the bottom of the flame. Such fires require skilled

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[2] A simple prop for learning this technique is described in Part III, Section 2, Drill 3C, and is shown in Fig. 90. It is excellent for training firemen in the need for sizing-up the job and for correcting the overconfident grandstander. A primary drilling prop is described in Drill 2.

16555

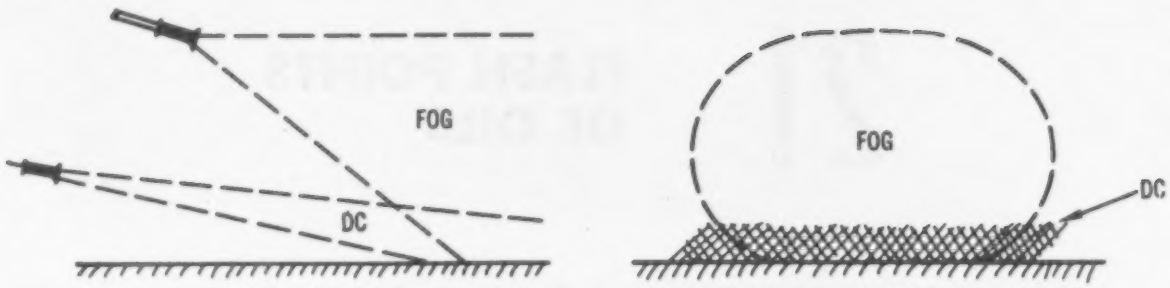

Fig. 61. Side view (left) and end view (right).

sizing-up, particularly where more than one nozzle and extinguisher must be used simultaneously.

Supplemental Lines

Sometimes it may be necessary to use straight streams to sweep the ground under the fog nozzle and extinguisher operators where they must work in close to the fire. In all such cases it is necessary to extinguish the ground fire first and quickly work up to the elevated fire.

16556

21 FLASH POINTS OF OILS

Comparative Flash Points

In an earlier paper there is a good description os what is meant by "flash point." This term is used frequently in discussions of the relative hazards of different oils and also the relative ease of extinguishment. A few approximate comparisons are shown in Table 10.

TABLE 10
Comparative Flash Points

Fuel	Flash Point	Characteristics
LP gas and gasoline	Below 0 F	Easy to ignite and difficult to extinguish
Cleaning solvent	About 111 F	Not easy to ignite and not easy to extinguish
Heavy fuel oil	About 170 F	Difficult to ignite and usually easy to extinguish
Lubrication oil	About 450 F	Very difficult to ignite and usually very easy to extinguish

Flash Point Tests

Some firemen have said that the term "flash point" would mean more to them if they knew how the flash point test was made. Then they would have a better understanding of why an open pool of burning diesel oil--say, 10 feet in diameter--can be extinguished with water fog but why the same-size pool of burning gasoline cannot be extinguished with the same fog nozzle and water rate.

Briefly, a flash point test is made by slowly heating a small sample of oil and watching its temperature rise, as indicated by a thermometer. From time to time the atmosphere over the oil is checked by means of a small test flame. When the oil is hot enough, it releases vapor, which is ignited by the test flame. The lowest oil temperature at which the vapor ignites is called the oil's "flash point." Because this is a precise measurement, one of three types of apparatus

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is used, depending upon the approximate flash point of the oil being tested. One common type, the closed cup Tagliabue or "tag" tester, is shown in Fig. 62. The other two types of apparatus are similar in principle, and their differences are described later.

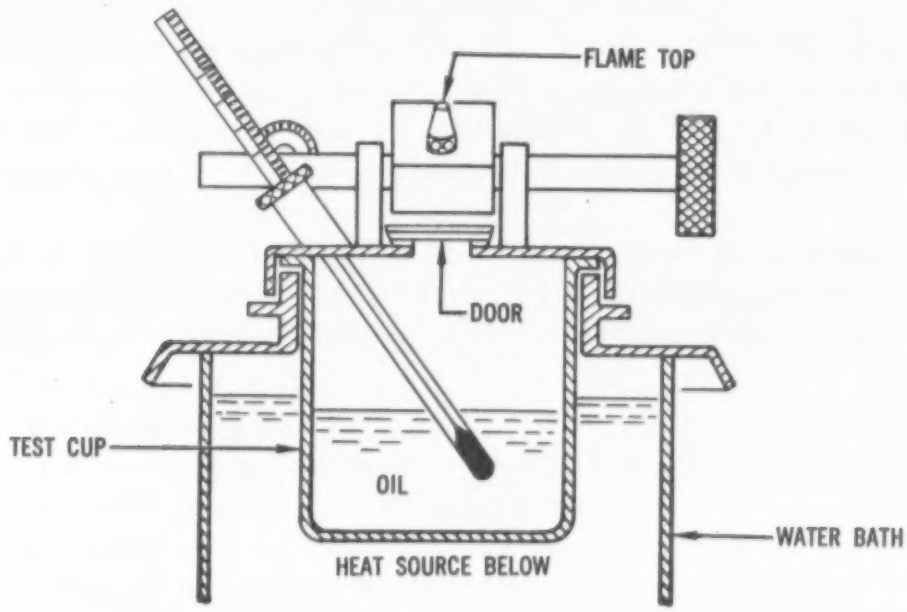

Fig. 62

The operation of the tag-closed tester is as follows:

1. The inspector fills the outer container or water bath with cold tap water to a specified level.

2. He places a specified amount of the oil (50 cubic centimeters or about 2 liquid ounces) to be tested in the cup, or inner container, sets it in the outer container (like a double boiler), and places the lid over the oil cup. Finally he checks to see that the small trap door in the lid is closed.

3. On the top of the lid there is a small gas burner that normally stands in a tilted position. The inspector lights the burner and adjusts it to get a flame that is about an eighth of an inch long.

4. Under the water bath is either an electric heating element or a gas burner. He lights this and adjusts it to a low flame.

5. Either from prior tests or general knowledge, the skilled inspector knows the approximate flash point of the oil. When the oil temperature reads about 10° F less than the expected flash point of the oil, he adjusts the heating element under the water bath so as to increase the heat of the oil sample at a uniform rate of about 2° F per minute.

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6. At the same time he rotates a knurled wheel on the lid. This simultaneously opens the trap door and turns the test flame down into the opening and thereby checks the atmosphere in the cup momentarily for vapor. Then he closes the door promptly.

7. Then at each 1° F rise in oil temperature, he continues checking until the vapor at the trap door reaches its lower flammable limit and ignites (or "flashes"), and he reads the oil temperature. The flash point is the lowest oil temperature at which the test flame causes ignition.

Since this is a precision test, there are other refinements in the standard testing procedure; but for the sake of brevity, they are not included in the above description. The illustrated apparatus is used for testing samples of certain oils having flash points ranging between room temperature and about 175° F. For samples of certain other oils with flash points ranging between room temperature and about 230° F, a slightly different apparatus, the Pensky-Martens closed-cup tester is used. Some asphalts with flash points to 500° F may be tested; of course, a liquid with a high boiling point is used instead of water for the bath. In principle, the apparatus is the same as that illustrated except that in the oil cup there is a stirring device, which rotates continuously except for the moment that the trap door opens. For samples of very heavy oil, such as lubricating oil, road oil, etc., with flash points above about 160° F, the Cleveland open-top cup is used.

Practical Applications

For the purpose of fire prevention training, the flash test indicates how easily an oil may be ignited intentionally or accidentally. Kerosene, with a flash point of about 130° F, cannot be ignited by passing a lighted match over its surface. If the flame is held very close to the cold oil surface for a short time, however, the surface will heat to above 130° F and the vapor will ignite.

Cleaning solvent, with a flash point of about 110° F, behaves the same as kerosene, but a match ignites it more easily than kerosene because its flash point is lower. In a closed room, thin layers of cold cleaner's solvent evaporates in time and produces a hazardous atmosphere, but obviously, it is not so hazardous as gasoline, which has a flash point below zero. Because its flash point is so low, it is not practical or useful to test gasoline for flash point.

The volatilities of different gasolines are measured by a vapor pressure test in standard apparatus. Cold fuel oil is practically impossible to ignite with a match because its flash point is usually about 160° F.

The foregoing examples of flash points are approximate. Typical ranges of flash points for common fuel are listed in the first paper of this publication.

16559

Fig. 63. Radiation from an asphalt pit fire can tax the protection from a small hand line before the beachhead of frothing is established.

Kern County Fire Department

Fig. 64. Training on a high flash oil fire in an oil field pit.

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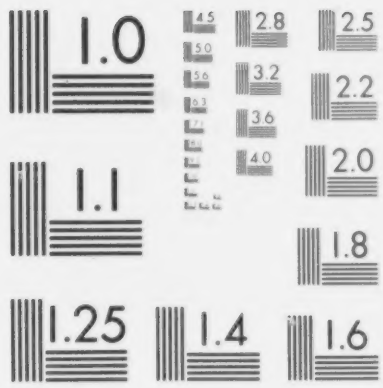

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Fire Extinguishment

Let us consider again the three oils--kerosene, cleaner's solvent, and fuel oil--with approximate flash points of 130°, 110°, and 160° F respectively. Assume, for test purposes, that there is a shallow pan 6 feet in diameter, and a 1-inch fog applicator.

First, the pan contains burning kerosene. The radiant heat from flames heats the surface of the kerosene and starts to produce vapor. When the water fog is applied, the evaporation of the water droplets first extracts heat from the flames and greatly reduces the size of the flame. Additional water cools the hot oil surface to below its flash point of 130° F; vapor release discontinues, and the fire goes out.

The same process takes place when a cleaning solvent fire is quenched in the test pan but it takes longer and is more difficult to extinguish because of its lower flash point. The fire of fuel oil with a flash point of 160° F is noticeably easier to extinguish than the kerosene fire.

This simple principle was demonstrated at the two Bakersfield Oil Fire Control Schools, using 5-gallon open buckets containing fuels ranging from gasoline to heavy fuel oil. These demonstrations clearly showed that, from a practical standpoint, "the higher the flash point, the more difficult it is to ignite the fuel and the easier it is to extinguish the fire."

Let us assume that gasoline is burning in the test pan. Water fog reduces the flame size, but the 70° F water cannot quench or chill the gasoline surface down to its flash point, which is much below 0° F, and therefore cannot extinguish the pan fire. Water fog can kill a gasoline fire only when the container has very high side walls--like a narrow, deep tank--so that the steam formed by the evaporation of the water remains over the burning gasoline and smothers the fire.

Conclusions

1. In order to burn, oil must be in the form of vapor.

2. To release enough vapor to ignite, the surface of the oil must be heated to its flash point.

3. When the oil surface is cooled to below its flash point, vapor release will discontinue sufficiently for the fire to go out.

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PART 3 PRACTICAL TRAINING TECHNIQUES

16562

SECTION 1 DEMONSTRATION DRILLS

Fig. 65. Crowd at the 1955 Oil Fire Control School watching relative times for extinguishing fires from different fuels using various methods and extinguishing methods.

Demonstration Drills at the 1955 School

At the 1955 Bakersfield Oil Fire Control School, oil industry instructors presented a half-day of demonstrations. The instructors were assisted by one man who explained the work over a public address system. He announced that the demonstrations showed many of the principles that had been covered in the classroom and that the demonstrations were prerequisite to the participation training that was to follow. The work consisted of:

1. Boilover Characteristics of Crude Oil. Many firemen had never seen a boilover of a crude oil tank during a fire. Few ever have to contend

16563

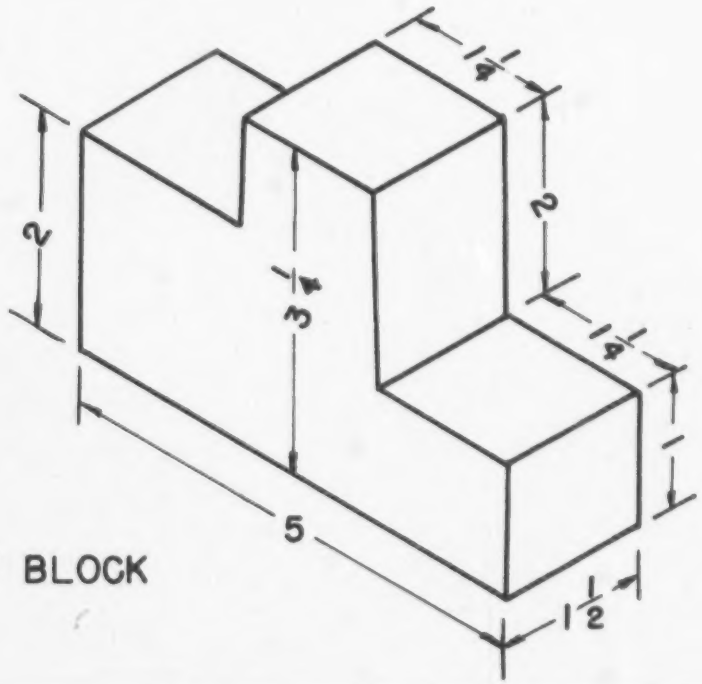

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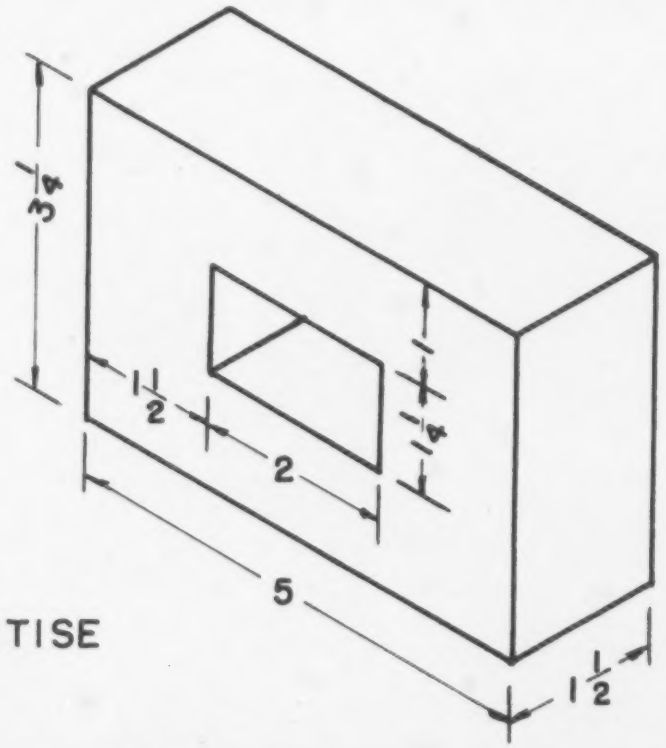

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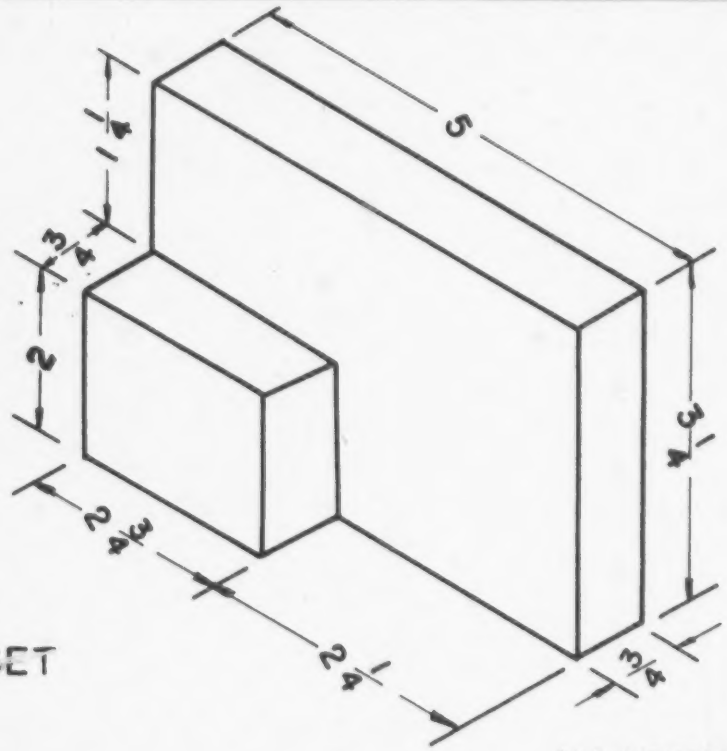

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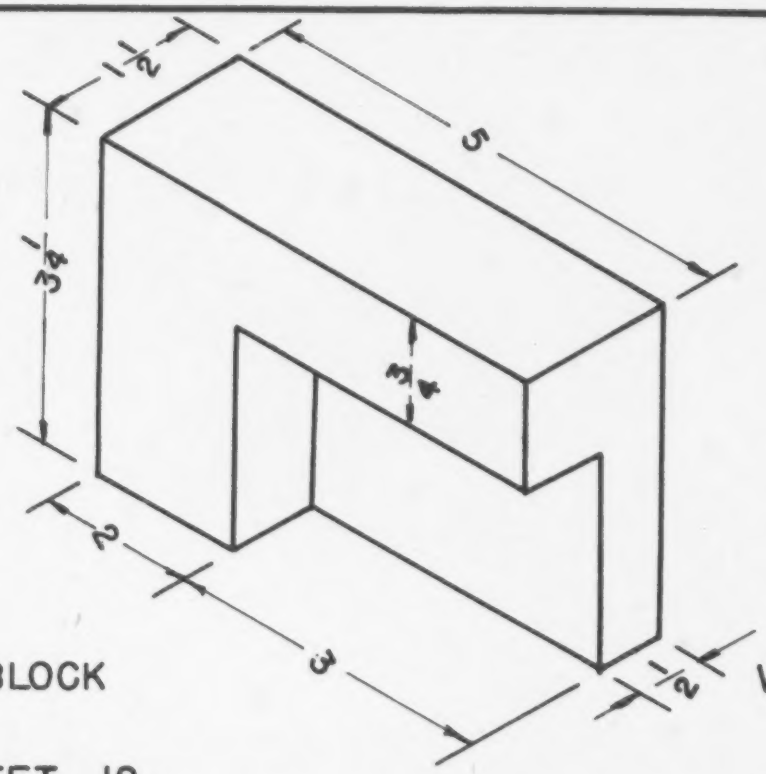

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ILLUSTRATION SHEET 12

1054

with such fires, except in oil field areas. The demonstration was made, however, to show a true boilover. This test was started first because it required almost half a day to complete, and from time to time the announcer called attention to the progress of the burning.

Crude oil is raw petroleum from the oil wells, before it is refined. About 1 quart of water was put in the drum, and the oil was ignited. It burned quietly, for about two hours, while the other demonstrations were conducted. During this period the volatile fractions burned out, leaving a hot residuum overlying the cooler unburned oil. When practically all of the lighter components had burned off, the hot residuum contacted the water in the bottom of the drum, flashed the water into steam, and frothed over the rim of the drum, much like a hot tar pot boils over when water is poured into the tar.

2. Ignition and Extinguishing Characteristics of Various Fuels. Drums, cut off to one-third depths, were filled with gasoline, JP-4 fuel, kerosene, stove oil, and fuel oil. Only the gasoline and JP-4 were easy to ignite, and only the gasoline and JP-4 could not be extinguished with a spray nozzle on a garden hose. The flash point relationship was discussed. All fuels were extinguished with both a CO_2 extinguisher and a 2-1/2-gallon foam unit, which were commonly used by some of the fire units at that time. Much of the oil industry and some fire departments had converted to dry chemical extinguishers and fog long before 1955.

3. Burning Rates of Various Fuels. Other one-third drums of various oil fuels were permitted to burn out, and the liquid levels in the drums were shown by a stripe of heat-indicator paint on the outside surface of each drum. The more volatile the oil, the faster it burned off. The paint on the crude oil drum showed the slow downward progress of the heat-wave layer prior to its boilover.

4. Development of Vapor Pressure in Closed Containers. Three 1-gallon paint cans were used. One contained water and the other two contained gasoline. A hole was punched in the lid of one of the gasoline cans to serve as a vent. All three cans were placed over a fire. The closed water and gasoline cans soon blew off their lids. The vented gasoline can burned at the vent as the gasoline boiled away.

5. Characteristics of LP Gas. Vapor drift and ignition by wood flares were demonstrated. This was similar to Drills 12A and 12B, pages 193 and 194. In addition, a domestic LP gas bottle was used to show release of fuel as liquid and as vapor and also the use of the regulator.

After the characteristics of petroleum products were illustrated, principles of control and extinguishment of small fires were demonstrated:

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Fig. 66. An unvented 1-gal. paint can makes a spectacular demonstration. The adequately vented can burned quietly at its vent.

6. Three Smothering Methods of Extinguishment. Three one-third drums of gasoline were used. One was extinguished by placing a cover on the open top of the drum and one was extinguished with chemical foam. The third container was smothered with steam generated from a fog applicator. The high side walls retained the steam blanket.

7. Extinguishing Heavy Oil by Frothing. A one-half drum of burning viscous oil was extinguished by frothing, using a gentle, small spray of water from a garden hose.

8. Extinguishing by Shutting Off Source of Fuel. Two methods were used as described in Drills 1, 2, and 6, pages 164 and 165.

9. Controlling Vapor Release by Cooling. This was a demonstration of the method described in detail in Drill 9, page 187.

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Kern County Fire Department

Fig. 67. A lively Christmas tree fire is always good experience for veterans as well as rookies.

Fig. 68. Two industry instructors demonstrating a two-man bottom valve shutoff using one 1-inch fog line. Larger fires would call for two 1-inch lines; and still larger fires, for one or two 1½-inch lines.

Kern County Fire Department

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10. Inability to Extinguish a Gasoline Fire. A 3-foot by 3-foot shallow pan of gasoline could not be extinguished with water fog because of its low flash point. It was smothered with a foam blanket from a hand extinguisher. After the demonstrations on small fires, the extinguishment of larger fires was shown by the following props.

11. Directional and Volumetric Fog. Fog patterns from the navy type and Mystery Elkhart type of high velocity directional nozzles were compared with the low velocity volumetric fog from an applicator. Both used about 125 psi nozzle pressure.

12. Use of Directional Nozzles. A Christmas tree valve was shut off under the protection of two fog nozzles using the technique shown in Drill 6 of Part 2 of Chapter III but with a much larger fire than used in Demonstration 8 above.

13. Use of Volumetric Nozzle. Diesel oil (primed with gasoline) was burned in a 15-foot-diameter by 4-foot-deep tank, and the proper use of an applicator was demonstrated.

14. Extinguishing with Foam. The same tank fire was extinguished with a small chemical foam generator and "2-1" chemical foam powder. This has a commercial mixture of sodium bicarbonate, aluminum sulphate, and foaming agent.

15. Extinguishing with Foam. The same 15-foot by 4-foot tank, burning diesel oil, was extinguished with a small mechanical form generator and 3 percent solution.

16. Three-Step Process of Training. The step-by-step technique often is used by oil industry instructors in training procedures where fire is a distraction. It is particularly applicable to teamwork training on complex fires. This highly recommended method of training was demonstrated by means of an outlet valve fire at a simulated tank truck.

    Step 1. A student group was trained as to proper approach, stance, etc. The fuel valve was closed, and there was no fire and no water at the nozzles. The prop is illustrated, without fire, by Fig. 69.

    Step 2. The men repeated Step 1, but with fog to show fog patterns and their use. Emphasis on proper procedure was gained without a fire to distract them.

    Step 3. The valve was opened, the fuel ignited, and the men, applying the lessons learned in Steps 1 and 2, approached and shut off the bottom valve.

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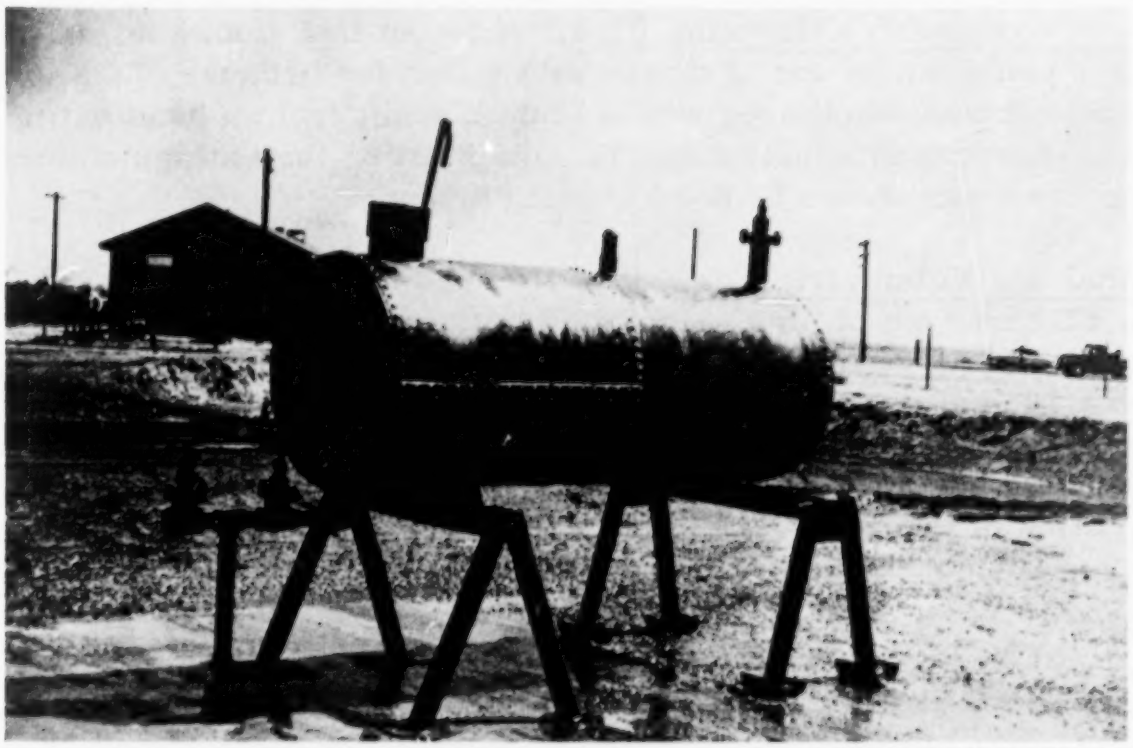

Kern County Fire Department

Fig. 69. This is a particularly good prop for three-step training. The inside valve can be opened to produce a relatively small fire for beginners and the shutoff can be made with the outside valve. Then the regulating valve can be opened more to produce a larger fire for the men who have gained some skill.

Fig. 70. A view of the first demonstration at a Bakersfield school as seen from the grandstand. The announcer with the PA system on the platform describes each step of the demonstrations.

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At the end of the half-day demonstration session, a number of the fire service instructors extinguished some of the fires just demonstrated to be ready for their participation training the next day.

Demonstration Drills at the 1961 School

In the 1961 Bakersfield Oil Fire Control School demonstrations also were run for a half-day in a similar manner. Although many of the demonstrations repeated those used in 1955, some new ones were used, and some were modified as described below:

1. Ignition and Extinguishing Characteristics of Various Petroleum Fuels. Six different oils were put in labeled 5-gallon buckets. They were gasoline, JP-4 jet fuel, Turbine Fuel A, cleaning solvent, diesel oil, and heavy fuel. In order to round out the family, a 5-gallon cylinder of butane was added. The containers were lined up in the order of flash points, with the butane on one end and heavy fuel at the other. A torch was used to show that high flash fuel oil ignited with difficulty and ignition was easier for oils with progressively lower flash points. It was necessary to prime the fuel and diesel with a little gasoline in order to ignite it.

   Each of the bucket fires was snuffed out by sliding a lid over the buckets. Then they were reignited, and extinguishment was attempted with water fog. JP-4, gasoline, and butane could not be cooled below their flash points and consequently were not extinguished.

2. Extinguishment by Frothing. A large pit with heavy high flash point crude oil could not be ignited until it was primed with a little gasoline. The operator demonstrated how to froth out the fire using a 1-inch coarse spray nozzle (see Fig. 63 and 64).

3. Rate of Burning. This demonstration illustrated the rate of burning as discussed in the fifth paper in Part I. A hand pump in a barrel of gasoline pumped the fuel at a low rate into the high end of a shallow, sloping, 2-foot by 20-foot trench. At the low flow rate the gasoline burned in the upper 6 feet of the trench as fast as supplied. At a higher supply rate the burning stream extended to about 15 feet. At a much higher rate it burned on into a pool at the lower end of the trench, a simulated safe area for burning. Then to show fire control in the trench, water fog was used to reduce the flame intensity and quickly flush the burning stream into the pool. Figures 78 and 82 illustrate practical applications of the principles brought out by this demonstration.

4. Controlled flushing. Controlled flushing, which has been used successfully in preventing the spread of some oil fires, is illustrated in Fig. 78

16569

a little water was played on the upper part of the drum and the small vent fire went out, because no more vapor was vented. The demonstration showed, first, that a properly vented gasoline tank will not cause trouble even though exposed to fire and, second, that the venting fire will quickly subside after the ground fire is killed.

11. Making a Delivery. No fire was involved. With an LP gas tank truck and an LP gas tank, the operator slowly went through all of the proper steps of making a delivery, while the man at the public address system described these steps and the reasons for them.

As at the 1955 school, the announcer said that instructors in the fire service would find some or all of these demonstrations easy to conduct at their own oil fire control schools and that the demonstrations would help students to understand the classroom work. He pointed out that, in order for each demonstration to be effective, the instructor should repeat the principle to be demonstrated and clearly tie it in with the classroom discussion. He also pointed out that, when the student understands these principles and is confronted with an emergency oil fire, he should be better prepared to size up the fire fighting problem intelligently and to do an efficient job of control or extinguishment. Too many firemen have been injured, and too many oil and gas fires have caused great damage because of an improper size-up and poor supervision.

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SECTION 2 PARTICIPATION DRILLS

Both the 1955 and 1961 fire schools had two drill grounds, which ordinarily are used by two different oil companies to train their own pipeline and production department employees. Prior to the school, the oil industry instructors and officers from the Kern County Fire Department ran dress rehearsals to check out the planned drills. On the day of the drills the group was divided into two main sections; each section completed the work at one drill ground and then moved to the other. The two sections were divided into small groups, each under the supervision of an instructor from the State Fire Training Program.

It is not practical for most fire departments to construct permanent drill grounds of this kind. However, there are many smaller, portable props, which can be used by any fire department. Such props are described in Section 3 of this chapter.

Participation Drills at the 1955 School

Some of the drills used in the 1955 school were repeated in the 1961 school. The following descriptions include the drills used at both schools, as well as those used only at the 1955 school.

1. Tank Truck Overflow. This prop simulated a truck tank overflow at a loading rack. The fill-stem valve was opened and the tank overflowed to produce a typical overflow and spill fire. Using two 1-1/2-inch fog lines for protection, the fill-stem valve was closed and the ground fire burned out under control. (This drill was repeated in 1961 at both drill grounds because of the importance of the techniques used.)

2. Tank Truck Bottom Valve. A 1-inch bottom drain valve on the simulated tank truck was opened, and the spill and ground fires were ignited. Using one 1-1/2-inch and one 1-inch fog nozzle, the students closed the valve. (The same props were used for Drills 1 and 2 at both drill grounds. This drill was not repeated in 1961, when new drills were substituted.)

3. Trench Fire. Burning diesel oil in a trench about 50 feet long by 5 feet wide by 4 feet deep with a 10-foot ell section in one end was extinguished with two 1-inch fog nozzles. (This was not repeated in 1961.)

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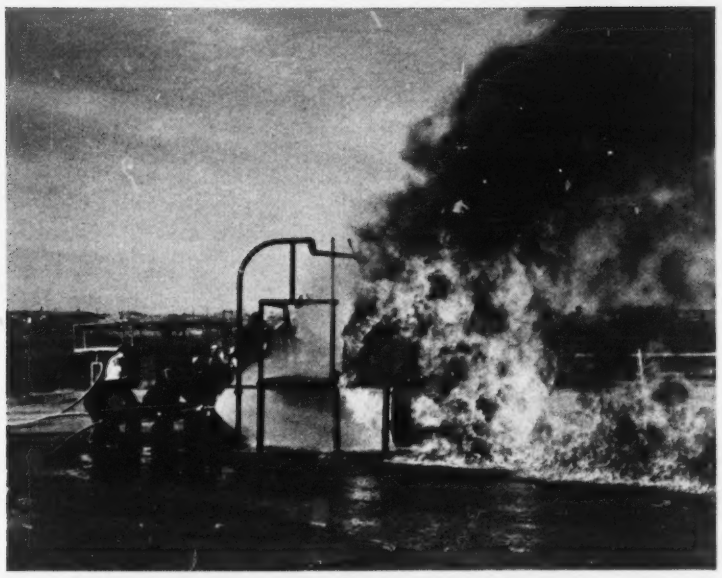

Kern County Fire Department

Fig. 71. Gasoline overflow fire from a simulated tank truck. The valve on the fill stem that was closed has a slanting handle, which can be seen at the top left edge of the flame. Firemen are starting to get the fire under control prior to closing the valve.

4. A "10 by 10" Pit Fire. A concrete pit, 10 feet by 10 feet, was filled with heavy high flash oil. The oil was kindled with gasoline, ignited, and frothed out, using a 1-inch hose stream. See Fig. 74. (This was not repeated in 1961.)

5. A "15 by 35" Pit Fire. A 15- by 35-foot earth pit was filled with high flash heavy crude oil, which was primed with light oil and ignited. Using a 1-1/2-inch combination fog-straight stream, the firemen extinguished the fire by reducing the surface temperature of the oil below its flash point, assisted by frothing the surface. (This drill was repeated in 1961.)

6. Christmas Tree. This type of prop, with its unusual name, has been used on drill grounds for over 20 years. It consists of a vertical pipe

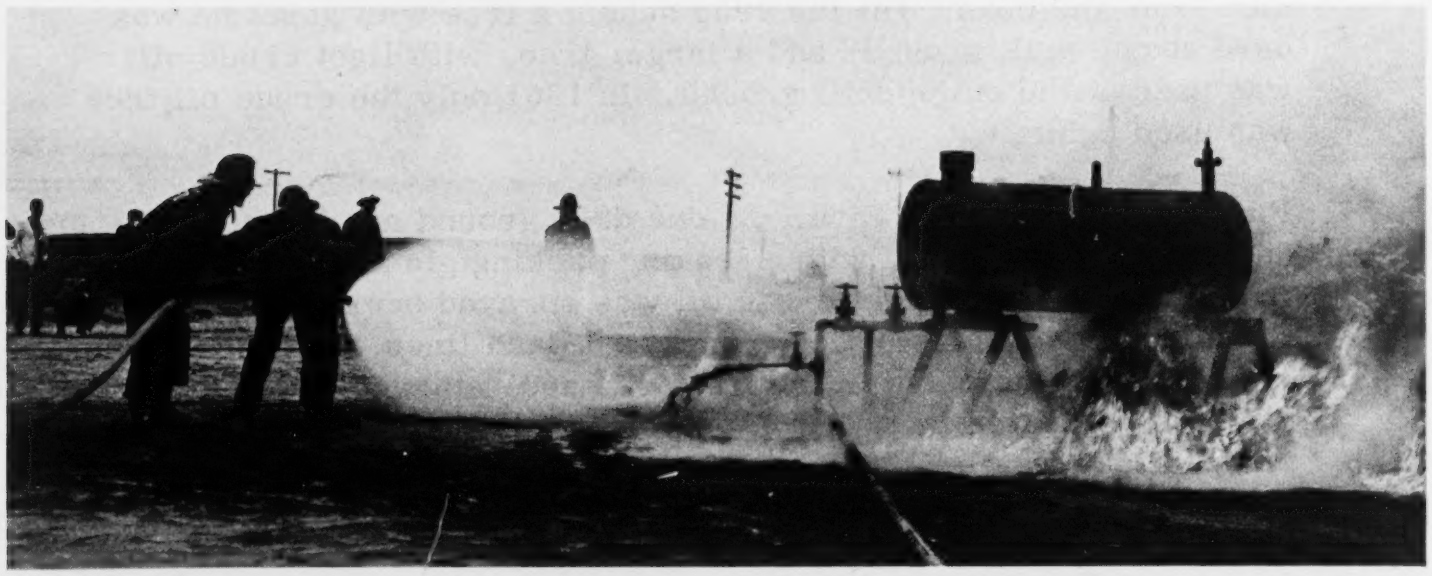

Kern County Fire Department

Fig. 72. Sizing up a bottom valve problem prior to making a two-man shutoff using one 1½-inch hose line.

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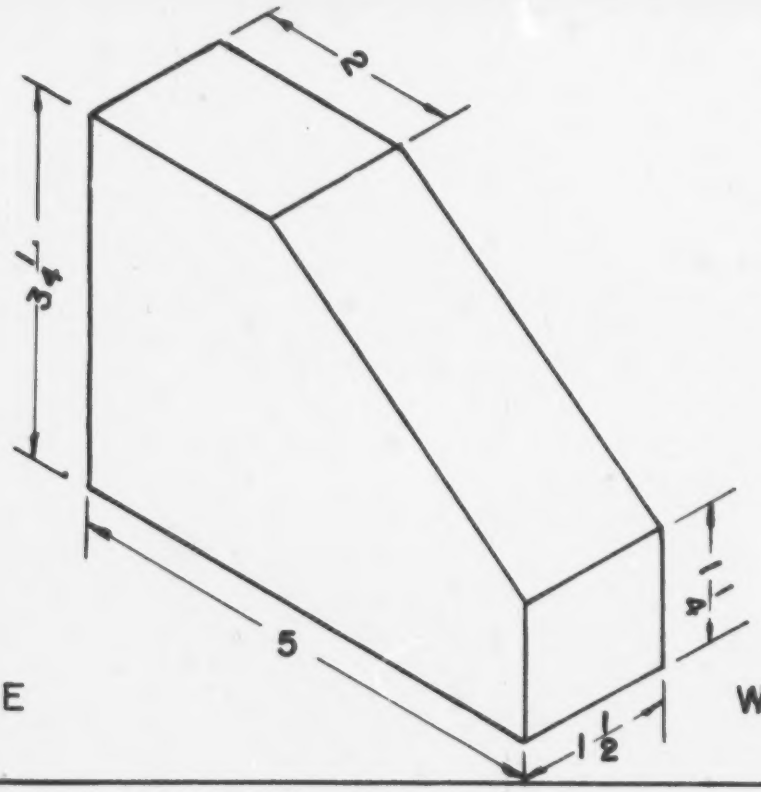

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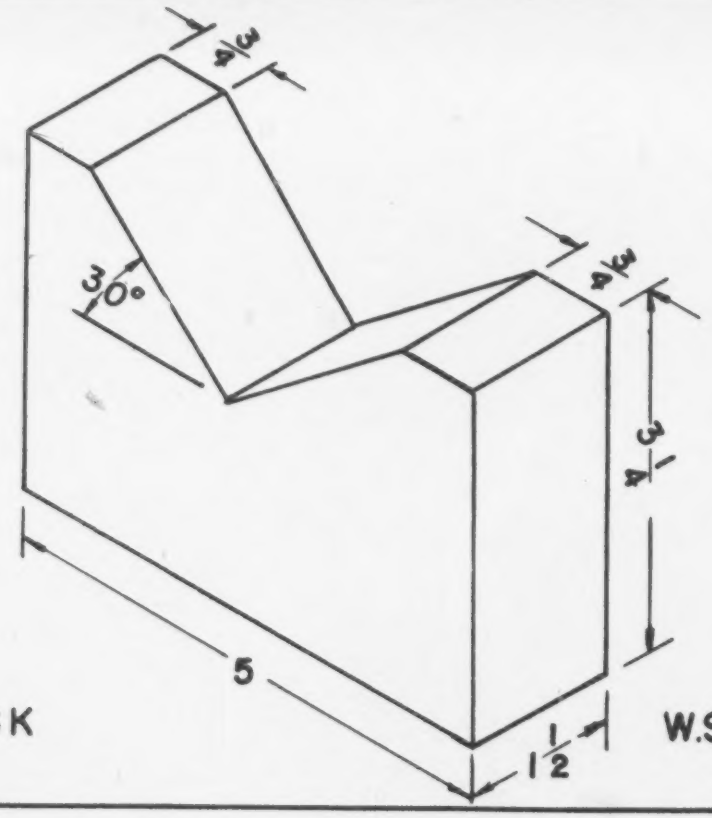

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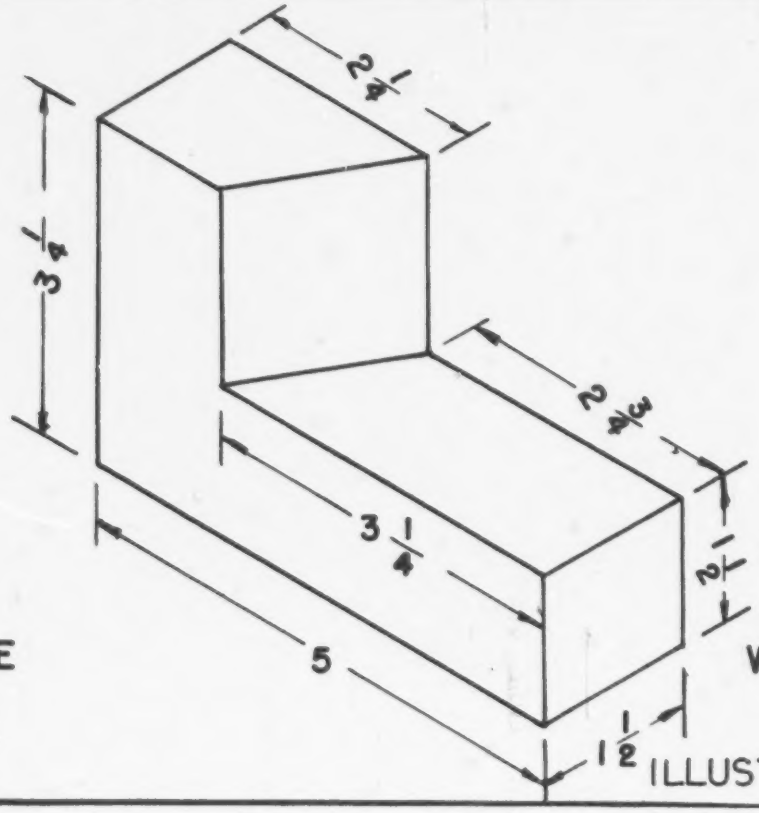

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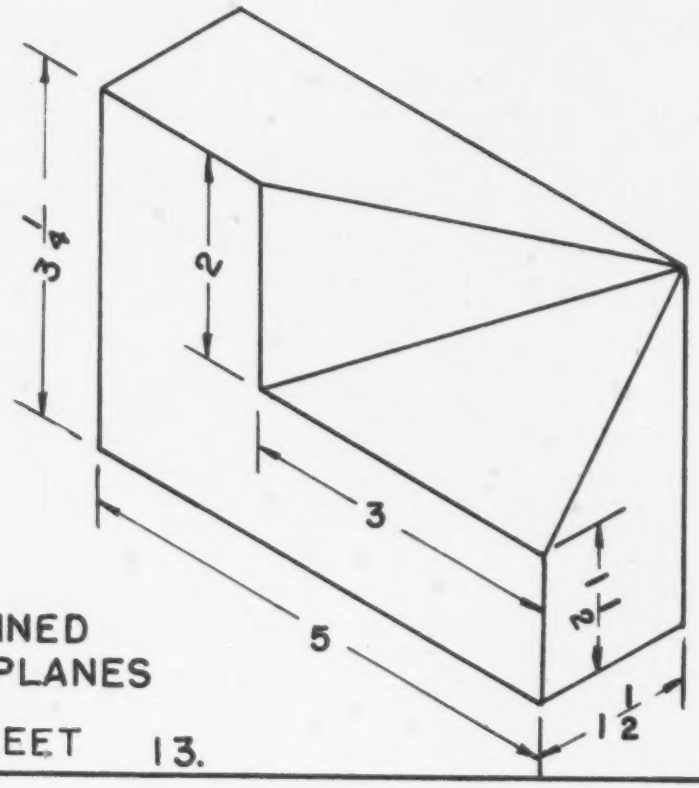

INCLINED PLANES W.S. 26.

ILLUSTRATION SHEET 13.

1655

Kern County Fire Department

Fig. 73. Firemen are using two 1-inch fog lines to extinguish the trench fire.

with side branch outlets, which can be adjusted to produce various patterns and sizes of fires. It has the reputation of separating the men from the boys. (At the 1955 school a tree with gasoline was used at one drill ground, and a larger tree, with light crude oil, was used at the other drill ground. In 1961 only the crude oil tree was used again.)

7. Pump or Flange Leak Fire. At one drill ground an old reciprocating duplex pump was fitted with a leaking packing gland and a leaking flange, from which burning light crude oil was sprayed over the pump and surrounding ground. Using fog from two 1-inch lines, the firemen moved in and closed the valve in the fire area and "starved the fire." (This drill was repeated in 1961.) At the other drill ground, gasoline was pumped to a smaller pump, and one man with one 1-inch line made a similar shutoff. (This was not repeated in 1961.)

8. Simulated Floating Roof Seal Fire. (Floating roof tanks contain a seal space between the outside edge of the roof and the shell of the tank, and

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the void is sealed with a special sliding mechanism, which is reasonably vapor tight. On rare occasions the seals have been ignited by lightning, and it is necessary for firemen to extinguish the light oil gutter

Kern County Fire Department

Fig. 74. Frothing out a fire involving high flash oil in a 10- x 10-foot pit with straight stream spray from a 1-inch fog nozzle.

fire with either dry chemical or foam.) A simulated seal space was fabricated from light steel plate, forming a gutter whose approximate dimensions were 1 foot wide by 1 foot deep by 25 feet long. This gutter was partly filled with gasoline. The firemen extinguished the fire with small, portable air or mechanical foam generator equipment. (This drill was not repeated in 1961.)

9. Complex Gasoline Fire. In principle this prop resembled Drill 3C, described on page 180. It illustrated the ability of a 1-inch fog stream to reduce the size of the gasoline fire sufficiently to be extinguished with a 20-pound dry chemical extinguisher; whereas without the fog it would be difficult to extinguish with one chemical extinguisher. The prop consisted of an open-top half drum mounted on a 30-inch-long piece of 6-inch pipe. This prop was easier to handle than a simple open-top drum like the one illustrated for Drill 3C. (This drill was not repeated in 1961.)

Demonstrations at the 1955 School

Four demonstrations also were run at the 1955 school. They were not repeated at the 1961 school because of lack of time.

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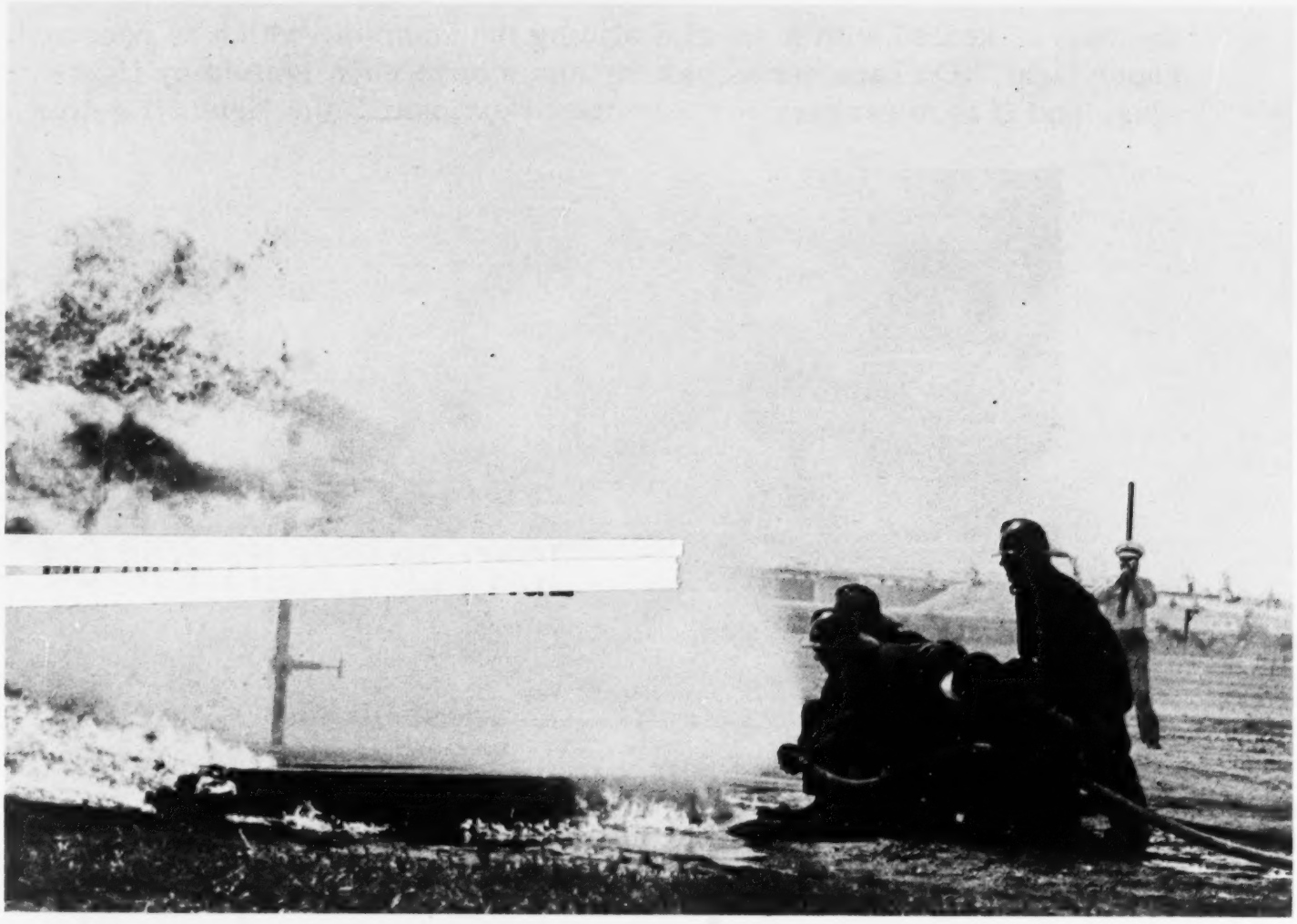

Kern County Fire Department

Fig. 75. Christmas tree prop during approach with two 1½-inch fog nozzles. Note the low approach and proper tilt of the nozzle.

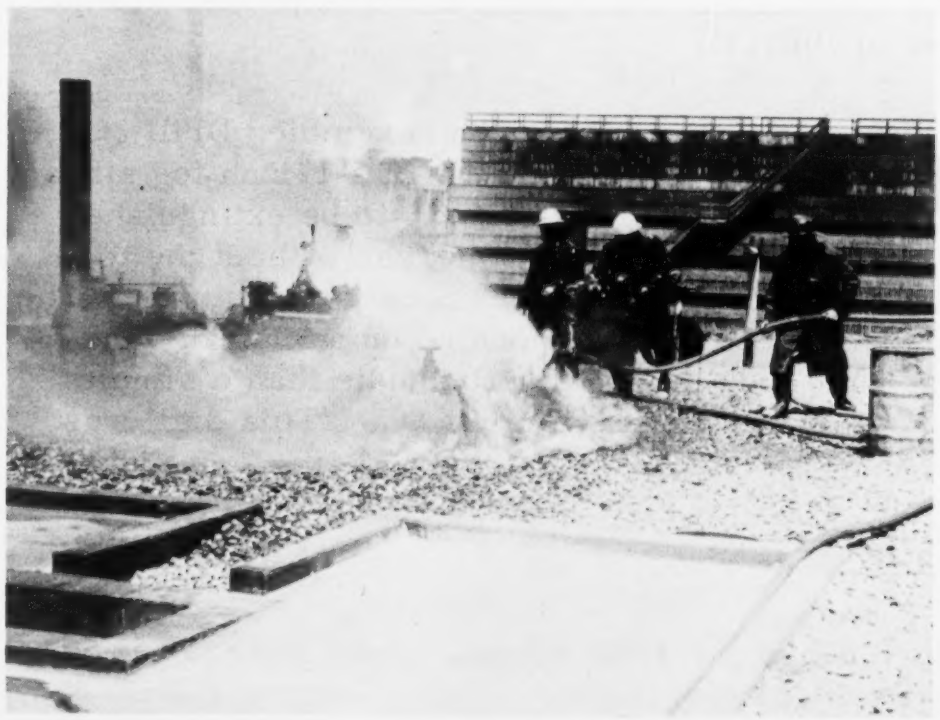

Fig. 76. Crude oil is flowing from an open bleed valve in a large pump, and the shutoff will be made using one 1½-inch fog line. Various kinds of problems can be set up with a prop of this kind.

16576

1. Tank Truck Dome Fire. The safety features of a tank truck were pointed out, and the vapor at an open dome was ignited showing the lazy, small dome fire that can be extinguished readily with a dry chemical or CO_2 extinguisher, by smothering with a wet blanket, or simply by closing the dome cover, if the fill stem was not in the dome opening.

2. Tank Fire. A tank 9.5 feet high by 24 feet in diameter and containing diesel oil was primed with gasoline and ignited. With a small mechanical foam generator and an overshot, the fire was extinguished.

3. Long Ditch Fire. A shallow sloping ditch about 150 feet long was filled, from the upper end, with light crude oil. The fire was knocked back,

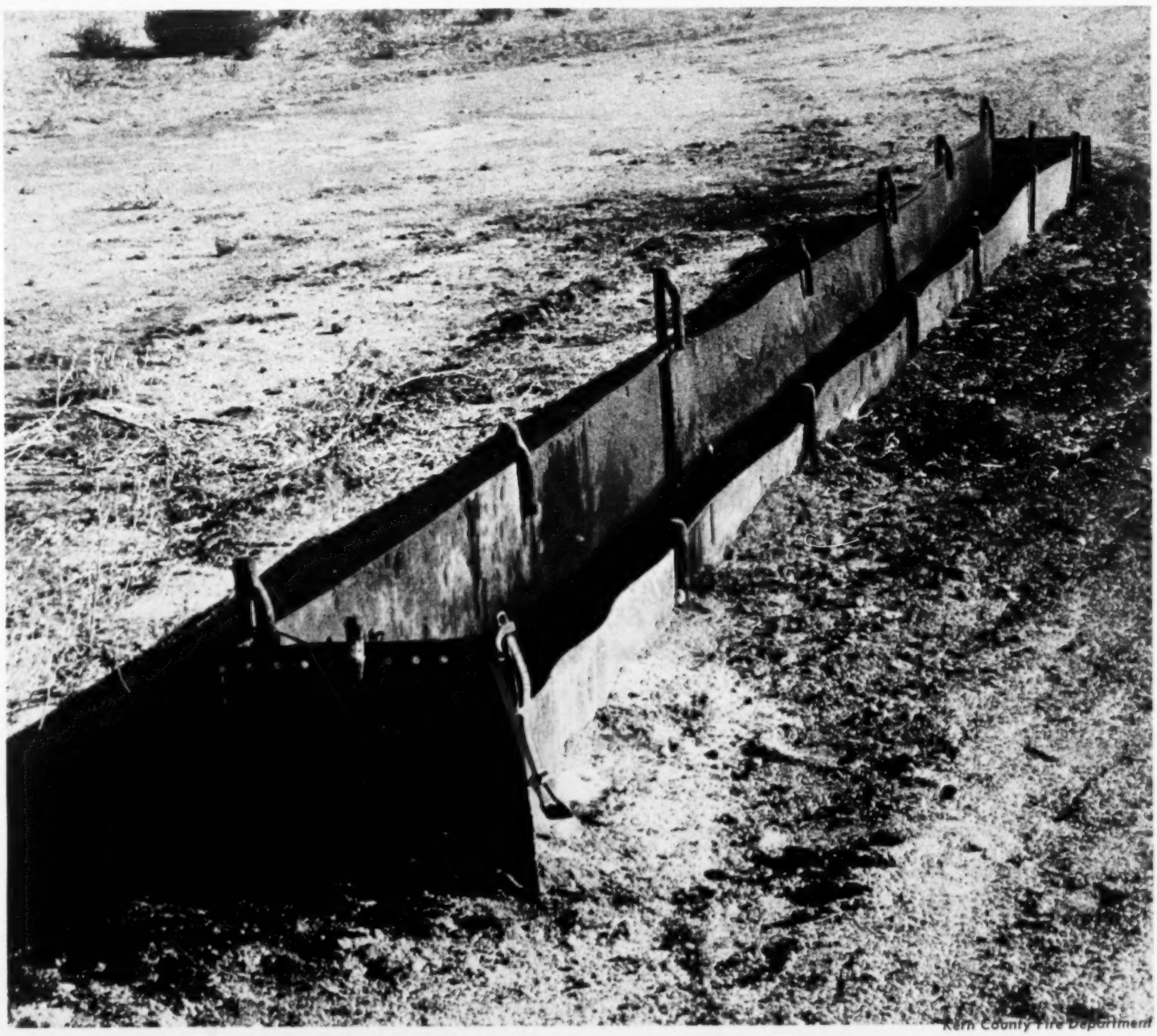

Fig. 77. Simulated seal space for a fire on a floating roof tank.

16577

controlled with water fog, and extinguished with foam. Because of its narrow width, it could have been extinguished readily with dry chemical, but the purpose of the test was to show the use of foam.

4. Spill Fire on Rocks. A gasoline spill fire over crushed rock was used to show the difficulty of extinguishment compared with open ground.

Between 1955 and 1961 the techniques in the use of water fog and dry chemical in the oil industry had improved so much that the use of foam (except on large spill or large tank fires) was almost discontinued. Foam requires special

Fig. 78. Spray from a 1-inch line is adequate to flush a small fire back in a simulated gutter made by overlapping corrugated iron sheets. Large fires are handled with larger lines, and the excess oil is flushed aside to burn out under control.

equipment (often not on hand when needed), time to set up for use, and special training. Since the extinguishment is gained by applying a foam blanket on a flat, quiet surface, foam has limited applications. Hence the foam demonstrations were not repeated at the 1961 school in order to devote more time to other, more important props.

Participation Drills at the 1961 School

Approximately 700 firemen from the several western states attended the 1961 school. They were separated into seven groups and they worked at several props at the two drill grounds. About 20 to 50 drills were run at each prop, depending upon the number of firemen who could participate as a team on each drill. Instructors from both the Kern County Fire Department and oil industry trained the firemen students. In addition to Drills 1, 5, 6, and 7 of the 1955 school, the following drills were given at the 1961 school.

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Western Oil and Gas Association

Fig. 79. Preparing to make a two-man shutoff on a ground level valve at a Christmas tree prop at the Bakersfield Oil Fire Control School in 1961 with two 1½-inch fog nozzles.

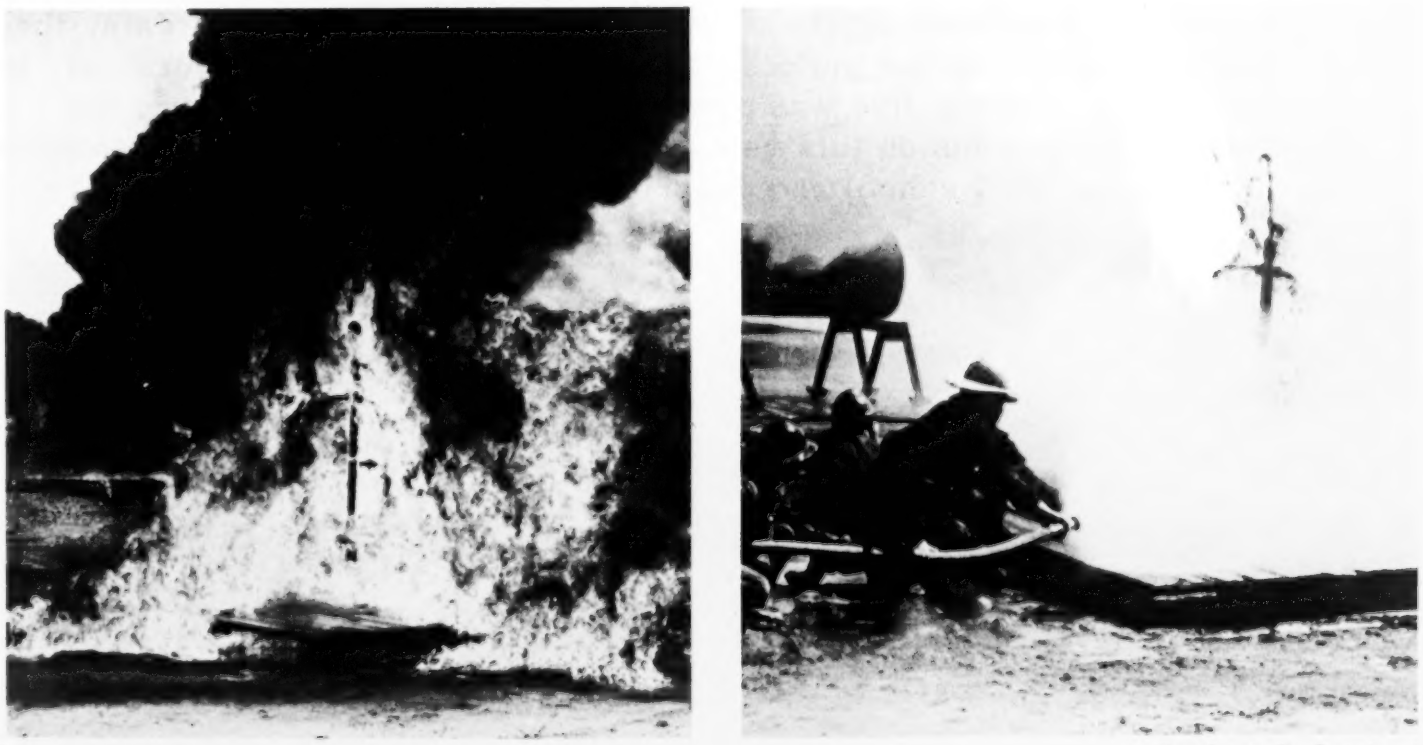

Kern County Fire Department

Fig. 80. Burning Christmas tree prop (left) and firemen establishing control prior to shutting off the fuel supply valve at the base of the tree (right).

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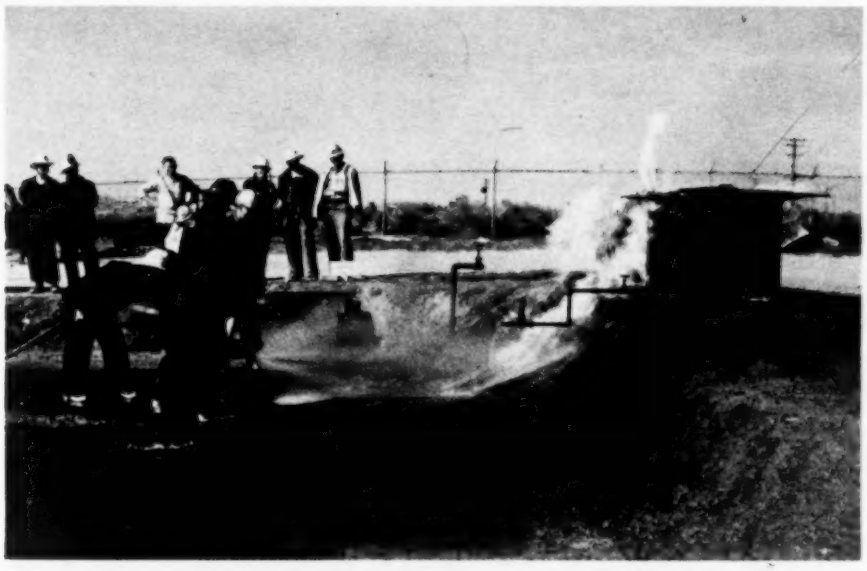

Kern County Fire Department

Fig. 81. After the ground fire is flushed away, firemen will direct a straight stream into the open end of the gasoline fuel pipe to drive the fuel back into the line and close the fuel valve.

1. Pipeline Leak and Fire. A 100-gallon elevated gasoline tank had one valve in a drain line near the tank and another valve in the horizontal outlet nipple. The tank was located so that the ground fire under the valve and outlet would not be swept away easily. In principle the prop corresponded to Drill 6, page 165. By directing a straight stream from a 1-inch nozzle into the end of the open nipple, the flow of fuel through the valve was restricted and the valve was approached and shut off.

2. Gutter Fire. A long, sloping, shallow trench was made to simulate a typical gutter, and gasoline was hand-pumped from a drum into the top end of the trench and ignited. With a 1-1/2-inch straight stream, the fuel was backed up the gutter and thrown out to the side to burn out "in the street," and the fire was prevented from spreading on down the trench. Principles on this rate of burning were covered in Demonstration 3 of the 1961 school and described on page 161.

Kern County Fire Department

Fig. 82. Starting to control the gutter fire.

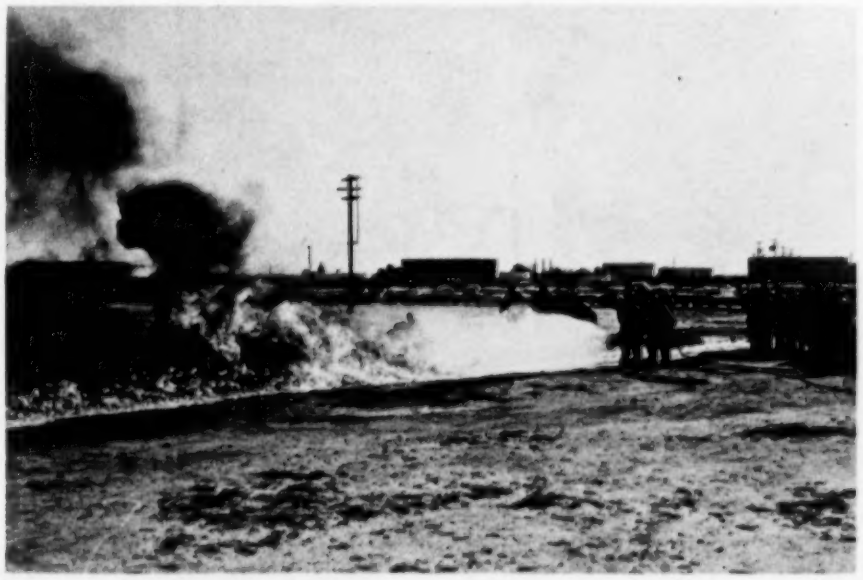

16580

3. LP Gas Release. This prop demonstrated the vapor drift of butane from an open line with ignition for surrounding flare pots. The firemen used a 1-inch nozzle, adjusted to narrow spray, to dissipate the vapor and prevent ignition. This technique is described in the thirteenth paper, pages 90 to 96. One demonstration was given at the 1961 school.

Demonstration at the 1961 School

The tank truck dome fire of the 1955 school was repeated with the addition of an underground tank fire. A small tank was provided with a vent pipe and buried. A few days before, some gasoline had been put in the tank to create the usual rich vapor atmosphere. During the demonstration, while a dump was being made, the vapors at the vent and at the fill opening were ignited to show that the vapor content of the atmosphere being vented was above its upper flammable limit and hence not flammable or explosive within the tank. The flames diminished to a small flicker when the dump was stopped.

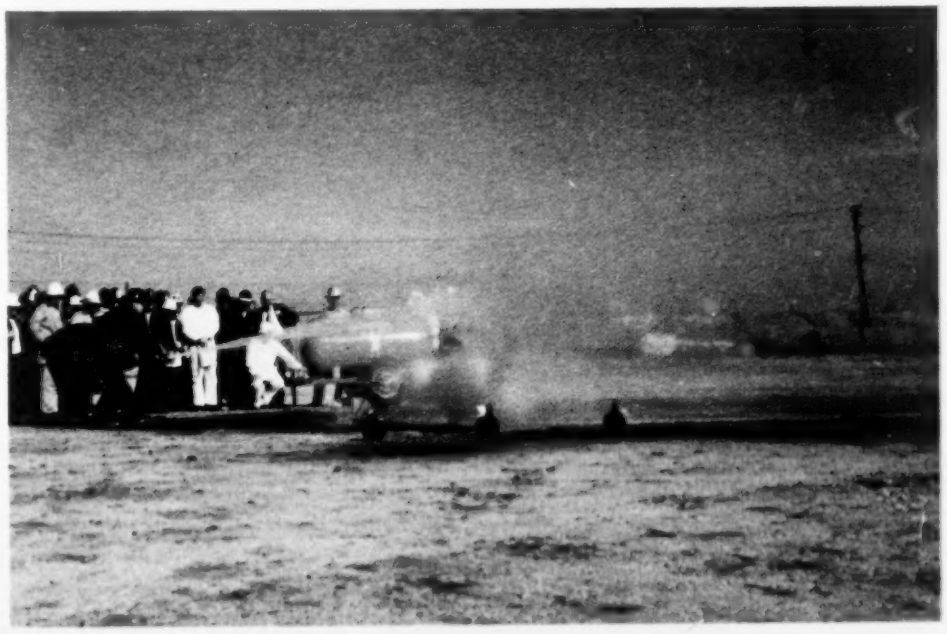

Kern County Fire Department

Fig. 83. Dissipating butane vapor release away from flare pots, using a 1-inch spray nozzle.

Comments on Participation Drills

The 1961 Oil Fire Control School was attended by some 700 firemen. The majority of these men were able to do all of the drills by operating most of the props simultaneously at the two drill grounds. One prop at a time is used for employee training during the oil industry's use of these grounds. The employees are divided into small groups and given intensive training on each prop. Many employees, farther from the permanent drill grounds, secure their training by using portable props, such as those described in the following section.

Local fire departments may well follow the example of the oil companies, with the exception of maintaining permanent drill grounds. Only large concentrations

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of firemen would justify such an expense. Fire departments too, however, can conduct very efficient training by using smaller portable props and giving close, individual instruction to small groups of men. Such training should not be delayed until fire chiefs can have fixed props constructed. With imagination, ingenuity, and only a little money, they can construct props that serve the purpose very well.

Participation drills are of limited value unless they are preceded by proper classroom and demonstration work, coupled with examinations, to assure adequate preparation for field drills.

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SECTION 3 SIMPLE TRAINING PROPS

The oil industry has had long experience in the design and use of fire drill grounds, and many men in the fire service have worked in fire-training areas at refinery, oil field, and pipeline properties where large props have been used.

Portable props also are used for employees and fire-service personnel when large props are not available. These smaller props are very satisfactory for training, because they are inexpensive to make, do not use much fuel, and can be used in limited areas. They are highly recommended. Small props are excellent for retraining the most experienced firemen, for they present problems that even seasoned men find hard to handle with the equipment at hand.

The following props and drills are designed for small classes, for the most effective training is accomplished with six or less men at a time. These drills range from the simplest, for teaching fundamentals to rookies, to the most difficult, for teaching advanced techniques to experienced firemen.[1]

Oil industry instructors, who are specialists with long experience in the handling of oil and LP gas emergency fires, have observed one fundamental: There is a tendency on the part of some of the older fire servicemen to discount the need for training with small, simple props, using small fires. Many of these overconfident firemen do not know how to use the special techniques on oil and

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[1]Some of the illustrations are included to show the props that were used in many schools; others show control and extinguishing techniques that were tried. Unfortunately, it was impossible to secure pictures from all of the schools, and some of the photographs are not too clear.

Sometime in the future this manual may be reissued or supplemented, and new photographs will be needed. If any of you have any good pictures of props in use at the oil fire control schools before 1940, please send glossy prints to Thomas S. Ward, Supervisor of Fire Training, State Department of Education, 721 Capitol Mall, Sacramento, Calif., 95814. Your accompanying letter should include the date, location, and a brief description of both the prop and the school. Large black and white photographs of good props that have not been illustrated in this manual also are desired. These pictures and descriptive information will be kept on file for future use.

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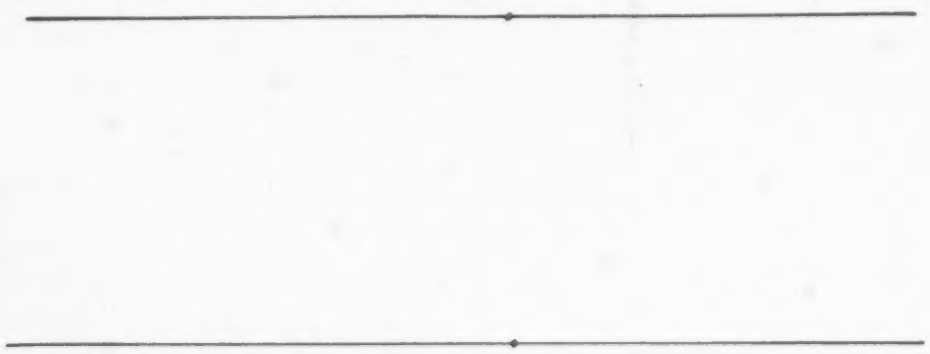

STEP 1.

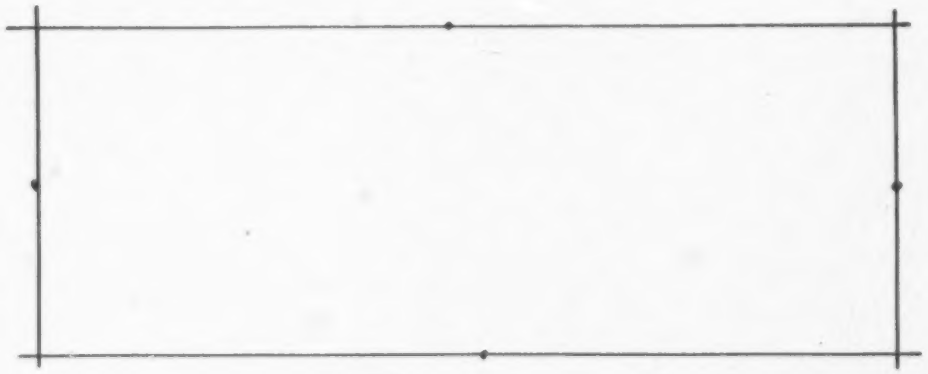

STEP 2.

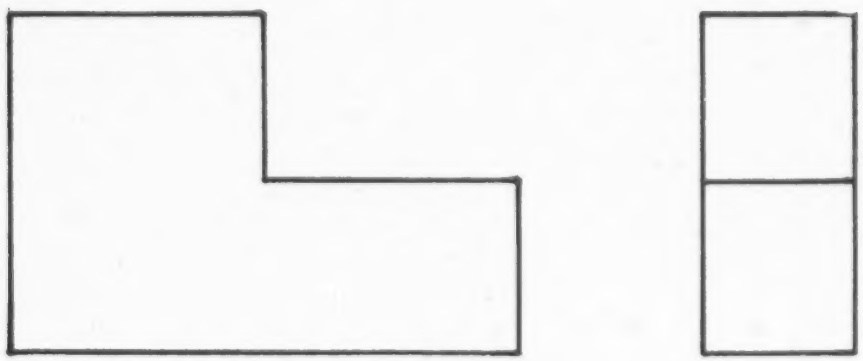

STEP 3.

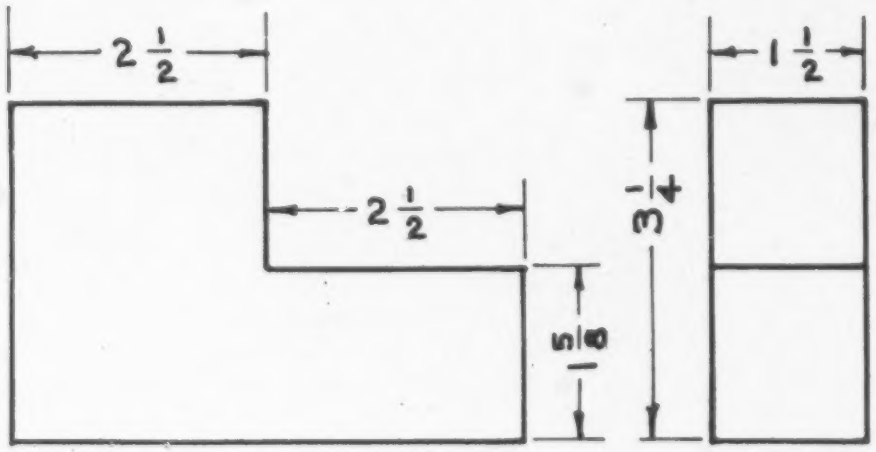

STEP 4.

ILLUSTRATION SHEET 14.

1956

Fig. 84. Very few firemen have occasion to fight a large, industrial-type fire of the kind shown by this prop on a refinery drill ground. For earlier sequences on this prop, see Figs. 43 and 50. Students learning new techniques should train first on small props and then graduate to the larger ones. Bad habits can be acquired by starting on big props.

LP gas fires. Often these men expose themselves to unnecessary danger. For example, six firemen died in the Kansas City bulk plant fire of August 18, 1959. In other cases, small fires have rapidly developed into uncontrolled large fires because of the use of wrong fire fighting procedures. Brute strength or awkwardness plus excess water or other extinguishing agent are not the answer. Much valuable training can be gained with the use of the small portable props described in this paper.

In all cases, hand extinguishers and/or small booster lines are used in teaching basic techniques. After the rookie firemen become proficient, they are ready to train with advanced props with larger and more complex fires.

Drill 1

Objective. To show that a fire cannot be extinguished when the fuel is flowing or falling to a lower level, unless it is fought from the bottom up.

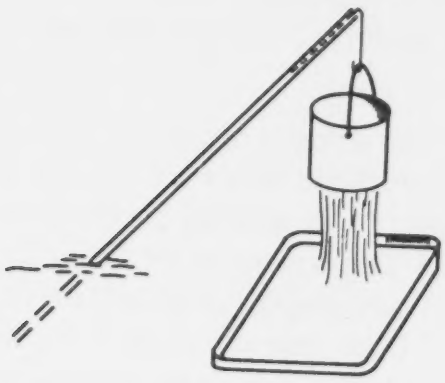

Fig. 85

Prop. A 5-gallon bucket with holes punched in the bottom is hung from a sloping piece of scrap pipe. It is suspended about 2 feet over a shallow 3-foot by 3-foot pan or pit, which contains an inch or two inches of water. (Fig. 85.)

This is the primary or "rookie" prop. Experienced firemen have been seen tackling it with indifference and improper technique, requiring excessive time and powder. Then, after attacking the large tub prop of the same

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type, they were unable to make the kill with one extinguisher, although well-trained rookies could do the job. In a real emergency such lack of skill could be serious.

Procedure

1. Train yourself on every new prop until you are fully proficient in its use and develop the "chatter" and proper sequence of steps to use with your students. A precise, crisp technique can be developed by an instructor only through practice on untried props. Be self-critical until you have gained enough smoothness and proficiency to start training your men. (It is assumed that you have already instructed your students on the proper distance or range techniques that are described in Paper 19, pages 138 to 141.)

2. Have on hand half a dozen or so charged 20- or 30-pound dry chemical extinguishers, plus extra chemical or cartridges for recharging as needed.

3. Describe the purpose of the prop and the correct technique to use and why. The extinguishers, already located about 10 feet upwind from the prop, will be used promptly to kill first the pan fire, then the falling fire, and finally the fire in the bucket. The residual fire in the bucket may require a closer approach for the final step of extinguishment.

4. Pour a gallon of gasoline into the bucket and be ready to ignite the fire in the pan and bucket after the water in the pan is covered with gasoline.

5. Without wasting fuel, quickly light the fire and attempt to extinguish it from the top down, to illustrate the improper technique.

6. Extinguish the fire by the correct method.

7. Before recharging the bucket with fuel, quench the prop with water fog to avoid reignition from embers and almost certain injury.

8. Select a student. Have him explain what technique he will use and why.

9. Add the fuel, ignite it, and have the student extinguish the fire. If an exceptionally fast extinguishment is achieved, be ready to reignite the fuel and have the student try it again.

10. Have other students go through the same procedure.

For advanced training on the same type of prop, some instructors have used a small tub or larger pan or pit to provide a larger and faster flow of fuel,

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using the same basic technique. The bucket is ideal for the rookie, and the larger prop can be designed to tax the capacity of one small extinguisher in the hands of a skilled and experienced fireman. The larger prop is not difficult if handled correctly.

Drill 2

Objective. To show that the fire described in Drill 1 can be extinguished with with greater ease if the flames are reduced in size by use of water fog from a 1-inch hand line and then extinguished with dry chemical shot through the fog. This requires the proper teamwork of two firemen.

Prop. The same as in Drill 1 except that a charged 1-inch hand or booster line is ready for use.

Procedure

1. You and your assistant should gain proper proficiency before performing before students. See the twentieth paper, pages 142 to 147.

2. After describing the purpose of the drill and technique to follow, your assistant should demonstrate, without fire, the proper fog pattern and nozzle procedure, and the reason for using the fog with the dry chemical. This is for the purpose of reducing the size of the fire and also to quench all embers, to prevent reignition after extinguishment.

3. The subsequent training steps should follow in general the procedure in Drill 1, being sure that the students know the fog nozzle handling and the extinguisher handling as well as the teamwork.

Drills 3A, 3B, and 3C

Objectives. There are three objectives for three successive drills covering the three following points:

1. Teaching proper distance for handling dry chemical extinguishers. This is Drill 3A.

2. Teaching extinguishing the bottom fire first and the top fire next. This is Drill 3B.

3. Sizing up a problem. In Drill 3C, it is almost impossible for one man, regardless of his skill and experience, to extinguish this small fire even if he has a dozen hand extinguishers available for immediate use. It is a most excellent drill to eliminate overconfidence in the "show off" fireman.

16586

Prop. The same prop is used for all three drills. An ordinary steel oil drum has its top cut off level all around. With a hairpin-shaped 1-inch pipe (shown in Fig. 82) connected to a garden or booster hose, fill the drum with water to the point of overflow. Then level the drum accurately with shovel and dirt so that a small amount of water overflows the rim of the drum evenly all around when supplied through the 1-inch pipe. (Fig. 86.)

Drill 3A

Objective. To teach the student to stand back the proper distance with a dry chemical extinguisher to gain the most effective use. The prop is a good one to use for refresher training in this technique, as covered in the nineteenth paper, pages 138 to 141.

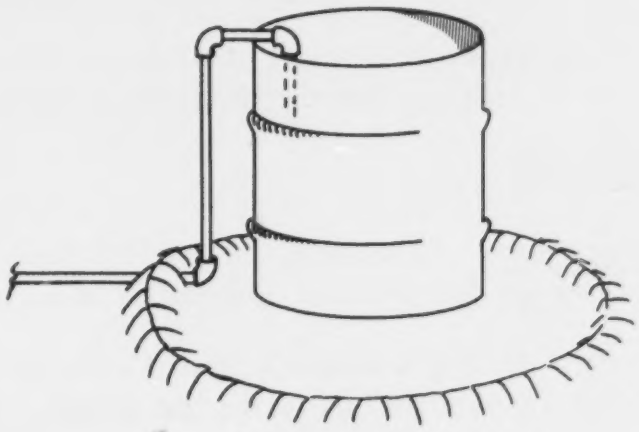

Fig. 86

Procedure

1. Using a bucket, bail about 10 gallons of water out of the barrel and add gasoline to give about 1/2 inch of free board.

2. Ignite the gasoline and extinguish the fire quickly with one short blast of the extinguisher, standing back the proper distance.

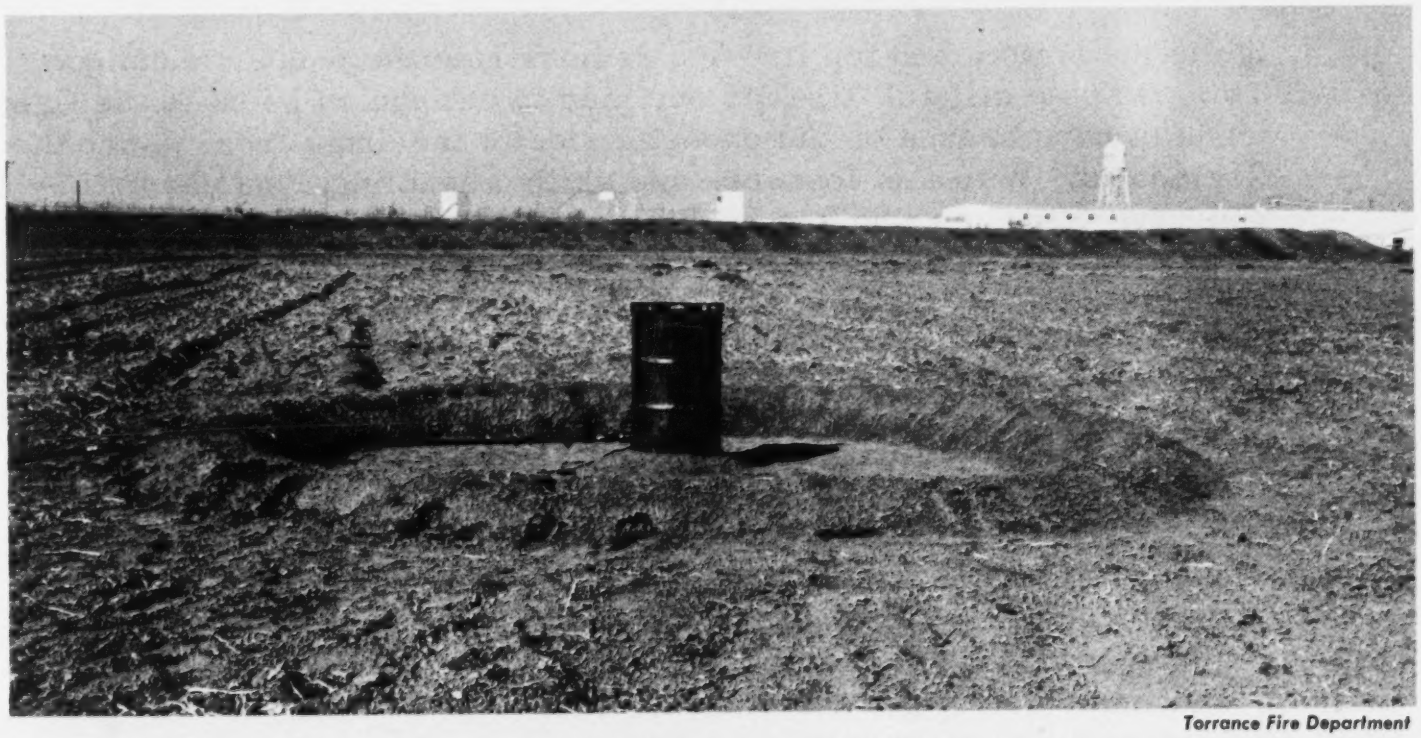

Torrance Fire Department

Fig. 87. Some drums have a bung in the shell near one end. With a bell-reducer a prop can be readily assembled without using a welder. With minor changes in piping, the one prop may serve for Drills 3-9. Here the drum is being leveled for use on Drills 3C and 5.

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3. Move up to within 18 inches of the drum, reignite the fuel, and direct the power charge directly into the burning gasoline, showing how the blast from the extinguisher can throw burning fuel out of the drum. Then step back to the proper distance and extinguish the fire.

4. If a CO_2 extinguisher is handy, demonstrate how a much closer range is needed to gain fast extinguishment.

5. Have one student after another extinguish the fire, using a shorter range only as the extinguisher pressure noticeably decreases.

Drill 3B

Objective. To teach the student to kill the bottom fire first. This is a good follow-up for Drill 1, because it is a much more complex fire.

Prop. Using a shovel, build a 6- to 8-inch compact, circular dike of earth, about 18 inches out from the drum. With fog, wet down the inside of the dike and add about 1/2 inch of water, so that gasoline will not be absorbed in the soil. Add fuel to the drum to offset that burned off in Drill 3A. Pour about 1-2 inches of gasoline around the drum within the dike.

Procedure

1. Explain the purpose of the drill, re-emphasizing the necessity of extinguishing the bottom fire first.

2. Ignite the bottom and top fire and demonstrate the proper technique. This can be a difficult fire for one man to extinguish because the flame tends to burn around on the opposite side of the drum from where the fireman is. With fast footwork and skilled handling, you can extinguish it. Firemen who are overconfident can learn good techniques from the simple fire.

3. With rookies, you may find it advisable not to use a full charge of fuel within the dike.

Drill 3C

Objective. After Drill 3B, 3C is most important. An emergency can occur that one fireman cannot handle by himself, and it is a waste of critical time and extinguisher charge to attempt it alone. The fireman should be able to size up the fire, note its complexity, realize that he cannot extinguish it without help, and immediately get assistance. This drill also teaches the two-man--two-extinguisher technique and killing a single fire coupled with the bottom-up technique. It is an excellent drill to teach men to maintain their proper distance, work from the bottom up, and use teamwork.

Prop. Sufficient water is bailed out of the drum to permit charging with about 10 gallons of gasoline fuel. The water inlet of the 1-inch hairpin pipe is placed over the rim of the drum and connected to a garden hose or booster hose line. A charge of about 1 inch of gasoline is poured on the water within the diked enclosure around the drum. This prop was used in Demonstration 8 in the 1961 Bakersfield Oil Fire Control School and has been used many times in smaller fire schools.

The equipment shown in Fig. 86, page 179, is commonly used for Drills 3A, B, and C because no welding is needed to assemble it. Sometimes a drum can be found that has a side bung near one end, and with proper piping it can be made sufficiently versatile to use for these drills; or a drum with a welded-in collar may be used.

The diameter of the dike shown in Figs. 87, 89, and 90 is larger than noted in Fig. 86 in order to use larger ground fires for advanced students.

Fig. 88. A plan view of the layout used in Drill 3C.

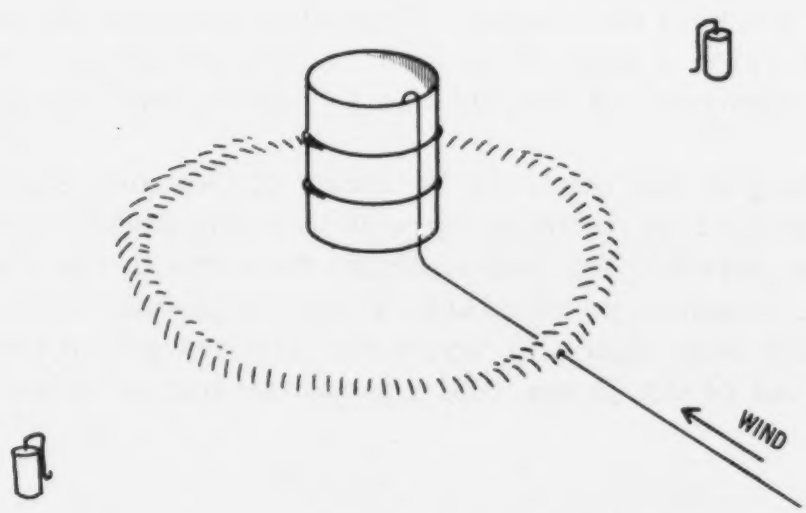

Fig. 89. This sketch illustrates the layout of the prop for Drill 3C.

16589

Procedure

1. Use two assistants in this drill. Explain the two purposes of the drill, namely: (1) to learn important size-up and (2) to learn the teamwork of using two extinguishers simultaneously.

2. Have one assistant regulate a slow flow of water into the drum to provide a slow, uniform overflow of gasoline all around the rim of the drum into the diked area below.

3. Considering wind direction, place two pressurized extinguishers at the proper distance from the drum opposite one another on each side of the drum.

4. Have the two assistants position themselves correctly; the "water control" man first lights the top and bottom fires, quickly moves to his water control valve, and starts overflowing the drum at the desired rate.

5. When you give the signal, both extinguishers are used to make the kill.

6. You can prearrange an impressive supplement, which always is beneficial for the students. Secure the aid of an experienced fireman who "just happens to be on hand" at the start of Drill 3C. After Step 5, above, the old hand contends that he can extinguish the fire alone with two extinguishers, one used after the other. After a short argument, a $1 bet is arranged, and one of the students holds the money.

   Of course, you win the bet, particularly if the water control assistant provides a proper uniform overflow fire down the sides of the drum. After the fireman's failure, help him to kill the fire, using proper teamwork and correct technique. This supplemental demonstration never fails to provide a good show and teaches the proper size-up lesson. The students then realize that this is a "put-up job" for their benefit.

7. The training of the students in teams of two men should follow. All failures should be followed up with precise instruction. In the excitement it is possible for two students to move in too close to the drums and waste powder, particularly when the powder cloud reduces visibility. There have been cases in which one student got in too close, blasted gasoline out of the drum, and burned the hands of the other student.

Drill 4

Objective. This demonstrates the same principles as Drill 2, except that the prop for 3C is used to achieve added teamwork involving the use of a fog nozzle on a booster line.

Torrance Fire Department

Fig. 90. This prop is now being used for an overflow fire. Water is being supplied to the drum through the bottom pipe and hose to spill over the gasoline. The fire is quickly extinguished with the simultaneous attack from the two sides of the drum. Note that the men are standing on the dike, which is over 10 feet from the drum.

16591

Prop. Use 3B or 3C, plus one or two hose lines.

Procedure. Work this out before the class meets, using the combination techniques of Drills 2 and 3B and 2 and 3C.

Discussion. It is not necessary to use large, expensive props and a lot of fuel, like the Bakersfield Oil Fire Control Schools, in order to do a good fire-training job. The simple inexpensive props, like those described for Drills 1, 2, and 3, are most excellent for teaching proper techniques. They are portable, require only a small training area, and use very little fuel.

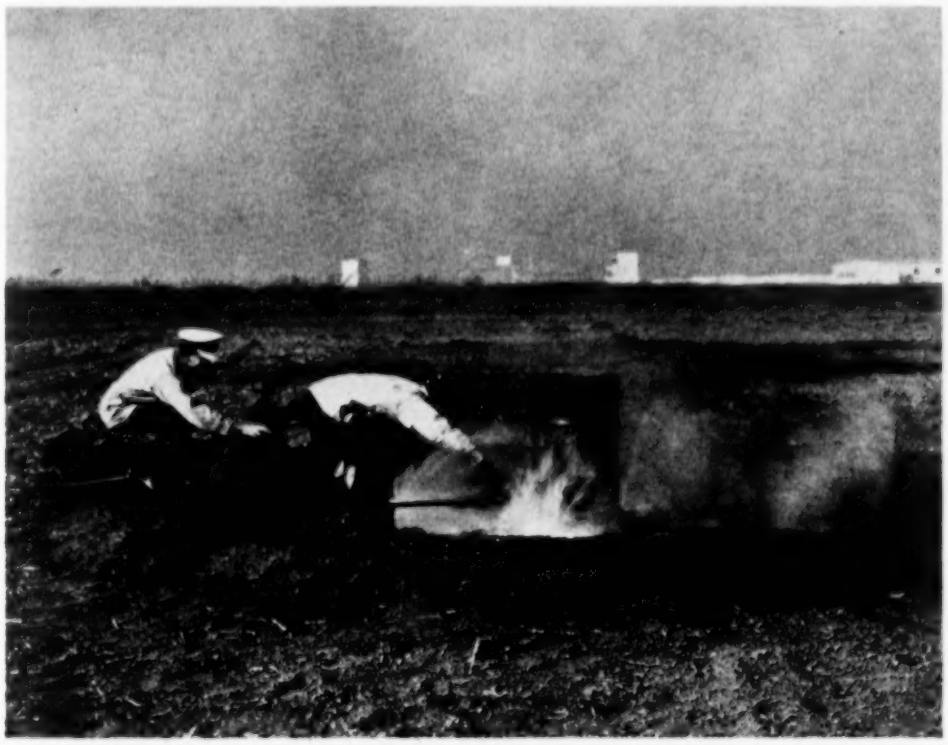

Torrance Fire Department

Fig. 91. The rookie is closing off the valve, and the fireman with the 1-inch fog nozzle is barely visible. The main fire was burning in a pit directly under the valve until water fog reduced it.

By using ingenuity you can vary the props somewhat. For example, in Drill 3, using a drum of gasoline and a barrel pump connected to the pump line, you can supply gasoline directly to the open-top drum. With a slight variation, as shown in Drill 5, the gasoline fuel can be supplied to the bottom of the drum, and this bottom connection also can be used to drain water as well as teach other principles covered in Drill 6.

Drill 5

Objective. To train a man to extinguish a fire by "starving" the fire, as described in the first paper of Part I and Part II, and by using the one-man approach covered in Paper 18 of Part II.

Prop. Use an open-top drum, as illustrated for Drills 3 and 4. Weld a 3/4-inch or 1-inch coupling into the shell of the drum near the bottom. Build a dike, as described for Drill 3B. Place the drum securely on bricks about

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4-6 inches off the ground in the center of the circular dike. Level the top of the drum with a spirit level. Fit a steel gate valve into the coupling with a 3-inch nipple. Provide a short nipple and tee at the outlet of the valve and plug the tee.

If this prop is also to be used for Drill 3, fill the drum with water through the bottom outlet instead of using the removable hairpin pipe and level the drum accurately as done for Drill 3. Then empty the drum by removing the plug in the tee. Make a cut in the dike on the side of the drum opposite the valve and spade a ditch away from the dike to dispose of the water from draining the drum and also from the fog nozzles to be used later in Drill 5.

Then add enough gasoline to the drum. It may be bucketed in. If this prop has been used in Drill 3, the tee may be connected to a 20-foot length of pipe connected to an outlet hose from a barrel pump. The fuel may be supplied from a drum of gasoline located a safe distance from this prop and the drum charged for Drill 5 with the barrel pump. After the charge is completed, close the valve and remove the plug from the bull of the tee.

Procedure

1. Explain the purpose of the drill to your students. The valve will be opened, the fuel from the open tee drained into the dike; and after the flow is established, the fuel will be ignited.

2. Demonstrate to the students the proper technique for making a one-man shutoff, as illustrated in Fig. 33.

3. Follow through with the students. Make the shutoff soon after the valve is open so as not to waste the fuel and not to heat the drum excessively. The vapor in the drum may ignite after a number of students have been trained, but this fire may be allowed to burn. It will not interfere with training at the valve, particularly if the liquid level is low in the drum.

Drill 6

Objective. In principle this is the same as Participation Drill 5, given at the 1961 Bakersfield School and described on page 165 and in Fig. 77.

Prop. Use the same prop as for Drill 5. Remove the tee and connecting short nipple into the valve and in its place screw in 12-inch-long pipe nipple. Provide a wooden plug to fit into the outlet end of the nipple.

Procedure. Explain the purpose of the drill. Sometimes there is a leak in a pipeline or shell of a container where it is impossible to move in and make

Assignment

WS. 15. Step: Refer to Illustration Sheets 11, 12, 13, and 14 pages 45, 47, 49, and 51 for this unit of work. You will make a freehand sketch on full-size practice paper of the front view and the right end view of the step. First, draw a border around the paper about ½ inch in from the edges. In the lower right hand corner below the border draw two light guide lines and letter-in your name and hour. Block in your views by using light construction lines as shown on Illustration Sheet 14, page 51. Save it for handing in and grading when you have completed WS 15, WS 16, WS 17, and WS 18.

WS. 16. Enclosed Step: You will make a two-view freehand sketch of the Enclosed Step showing top and front views. Follow the directions given for WS 15. Have your drawing checked. Save it for handing in and grading when you have completed WS 15, WS 16, WS 17, and WS 18.

WS. 17. H Block: Make a three-view freehand sketch of the H Block. Show top, front, and right end views. Follow the directions given for WS 15. Have your drawing checked. Save it for grading later.

WS. 18. Groove: Make a three-view freehand sketch of the groove. Show top, front, and right end views. Follow the directions given for WS 15. Have your drawing checked. Now staple Work Sheets 15, 16, 17, and 18 together in the upper left-hand corner and turn them in for grading. One grade will be given for the four sketches.

repairs with the fire under way. By directing a straight water stream into the hole, the outflow of the fuel can be greatly reduced or stopped while the ground fire is swept away with another hose stream and the hole is plugged with a wooden plug. As in the case with all props, it is necessary to practice to gain proficiency before training the students. The method has been used to handle emergencies in the industry.

This drill requires two students, each with a 1-inch hose line. First one student should squat down about 8 or 10 feet from the open end of the 1-inch pipe and practice hitting the open end of the 12-inch nipple with his straight stream. He should shut off his stream while the fuel valve is partially opened and the fuel falling from the 12-inch nipple ignited. The other student, with wooden plug in pocket, has the other 1-inch hose line.

On signal the student should direct his straight stream into the pipe to stop the flow while the other student sweeps away the residual ground fire and then, with his nozzle on fog to protect himself from any small reflash, puts the wooden plug in the hole to stop the flow.

The valve is not a part of this drill, but the valve should be closed between each drill.

This drill can be made more realistic by altering the dike around the drum so that the fuel flows down a shallow ditch to a burning basin located 10 feet or more from the drum. Then when the fuel is replaced with water, it flushes the burning fuel away from the hole into the basin.

Drill 7

Objective. To illustrate another way to starve a fire from a leaking pipeline by replacing the leaking fuel with water. This drill was used as Demonstration 7 at the 1961 Bakersfield School. The technique has been used many times in the industry to handle emergencies.

Prop. Following Drill 6, replace the 12-inch nipple with the tee and short nipple as shown in the sketch for Drill 5. Remove the plug from end of the tee and screw in a 10-foot (or so) length of pipe in place of the plug. Attach a 1-inch or garden hose to the open end of the long pipe.

Procedure. Explain the application of this technique to the students. Open the valve, start the fuel flow in the ditch and burning basin, ignite the fuel, and start the water flow. Point out that the fuel leak is now replaced by a water leak. Extinguish the residual fire with a dry chemical, flush it into a nearby safe burning basin or let it burn out under control with water fog.

Drill 8

Objective. This demonstration is similar to Drill 7, except that it illustrates a method of stopping a fuel leak in the bottom of a tank, vessel, or container. It has been used when tank trucks have turned upside down in an accident and gasoline is leaking from sprung dome covers.

Prop. Refit the drum assembly, as in Drill 5, and use the tank and burning basin, instead of the dike around the drum. Have on hand the hairpin pipe turn, connected to the water hose as shown in the sketch for Drill 3, but not placed in the drum.

Procedure. Explain the purpose of the drill. Open the fuel valve and ignite the fuel in the ditch and burning basin. Under fog protection insert the hairpin turn (see sketch for Drill 3) and start the water flow at full rate. As soon as the water level in the drum has covered the oil outlet, the oil leak will be replaced by a water leak. Lower the water rate to avoid overfilling the drum but still prevent gasoline from coming from the leak at the tee. Handle the residual fire as in the case of Drill 7.

Drill 9

Objective. To demonstrate the small amount of water needed adequately to cool a fire-exposed container of gasoline.

Prop. Place upright a full drum of motor fuel gasoline in a diked enclosure similar to that used in Drill 3B, but use at least an 8-inch dike. Remove the plug from the 3/4-inch (or larger) bung and insert in its place an 8-12-inch-length standard nipple of the same pipe size as the bung opening. Add water to the dike, letting it saturate the soil to avoid loss of fuel by absorption into the ground. Use a garden hose with a domestic spray nozzle for the fire control.

If the prop is used for successive training sessions or demonstrations, take care to keep the fuel replenished in the drum, and maintain a high liquid level. If, through successive uses, the light fractions are boiled off and the drum is cooled, the shrinkage of the atmosphere may draw in enough air to produce a flammable vapor-air mixture in the drum and be dangerous when used again.

Usually this prop is used only for one or two demonstrations, since it takes too long to heat up and cool down for a number of students. However, if used successively, the above safety precaution must be followed to avoid explosion.

Procedure.

1. In preparing for this demonstration, read Paper 5, pages 39 to 50. Explain to the students the purpose of the demonstration. In the case of a

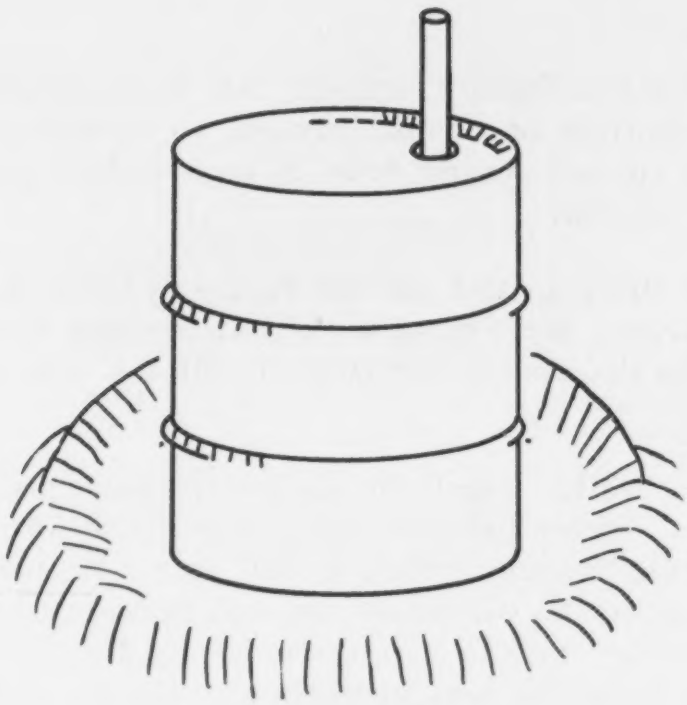

Fig. 92

tank fire or a gasoline truck fire, a small amount of water, properly applied, provides adequate cooling to prevent or stop the boiling of the liquid and reduce the excess vapor pressure and strong venting.

2. Demonstrate the proper application of water before lighting the fire, because flame distracts the attention of the class. State that in fixed water fog systems as little as 0.1 gallon of water per minute per square foot of surface to be cooled often is adequate for cooling the contents of the container. Show that impinging a straight stream on a vessel is ineffective because so much of the water bounces off. Uniform spray distribution is the best. Many times there is a deficiency of water, and it must be used economically. In other cases drainage may be poor and areas may be flooded with burning fuel, endangering firemen and exposed nearby facilities. In many fires water has been wasted so that critical streams have had inadequate nozzle pressure to reach their objectives.

3. Pour about 5 to 8 gallons of gasoline around the drum and ignite it. While the drum is warming, discuss the points that are covered in the preceding paragraph, but be alert to the start of strong venting of the vapor.

4. Point out to the students that vapors projected into the air will normally disperse into the air quickly and not seek ground level and be ignited by the flames below them. Do not try to ignite the vapor at the vent. Unless the ground fire flames are near the vent, the vapors will not ignite but will disperse into the air readily, even with no wind. Remember, it requires a vapor concentration of 1 percent vapor in air to reach the lower flammable limit. As the gasoline in the drum becomes warmer the venting will increase, but probably without ignition, especially if there is a breeze.

5. If a full drum has been used as illustrated, the liquid level in the drum will be an inch or so below the top head. As it starts to boil, liquid gasoline sprays out of the vent and falls on the drum, and the vent

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should ignite. If it does not, ignite the vent yourself, using an oil-soaked rag tied to the end of the 20-foot pipe. Now the vent will burn with a brisk flame, and you are ready to demonstrate the cooling.

6. Using the garden hose, cover the top of the drum with water until it spills over the rim and runs down the sides. Also cool the side of the drum, especially the downwind side where the hottest flames from the ground fire are.

7. Be patient and continue the cooling until the vent fire dies down to a flicker. (It may require a few minutes of cooling to stop the boiling and strong flame.) At this stage the residual ground fire, if any, should be flushed away from the drum and burned out. The vent fire will extinguish itself as the drum is cooled.

8. Read again the precautions to avoid developing a flammable vapor-air mixture in the drum.

Drill 10

Objective. To demonstrate the dissipation of vapor from an outdoor ground spill of gasoline. This demonstration is satisfactory only if there is no wind; otherwise, the vapor dissipates too rapidly for detection.

Prop. In a flat, open area prepare a shallow circular dike with a diameter of 6 feet or more. Fill it with water and let it soak in. Provide a combustible vapor indicator. Check the indicator (see Paper 15, pages 103 to 106) to see that it functions satisfactorily. Make a long-handled torch by rolling a wad of rag on a handle and tying it in place.

Procedure.

1. Explain to the students the differences between a vapor release from an elevated vent, as shown by Drill 9, and a quiet release from a ground spill, as shown in this drill.

2. Compare the lesser hazard of a ground spill in the open where there is air movement (even with no wind) and a similar spill indoors or in a depressed area like a pit at a service station.

3. Using a rag wet with gasoline, demonstrate the use of combustible vapor indicators.

4. Fill the shallow diked area with about 1-2 inches of water, warn everyone not to smoke, and add about a 1/4-inch layer of gasoline to the water.

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5. Promptly start checking at ground level around the outside of the dike with the sample tube of the indicator. If there is a very slight breeze, preferably check downwind, and mark on the ground the limit of vapor drift as shown by a trace indication on the instrument dial.

6. Move the students back from the pool and light the torch. Start the test flame a greater distance away from the pool than the ground mark where the trace indication was noted by the instrument and work up to the dike until the vapor is ignited.

7. Let the fuel burn off completely, and then quench the area thoroughly with water fog.

8. Again demonstrate to the students the use of the vapor indicator with a gasoline-wet rag and explain the range of the dial on the instrument. This dial ranges between zero and about 1 percent vapor in air. The top of the dial or range is at the lower flammable limit of the vapor in air. The instrument is designed to indicate a trace of vapor in air. If there were no air movement and the demonstration could be made under ideal test conditions, the trace mark on the ground would be much farther away from the dike than where the torch ignited the vapor.

   Point out that, when the gasoline pool first starts to evaporate, the very lightest components are given off first; and these vapors, if 100 percent pure, are about twice as heavy as air. However, they dissipate rapidly into the air, and the mixture has almost the same vapor density as pure air. Before long, the next less-volatile components evaporate and also are lost. The evaporation then proceeds at a much lower rate as the still heavier materials evaporate.

   Gasoline vapor sometimes is listed as about three to four times as heavy as air. This would be true if all the gasoline were vaporized and trapped and the density of the 100 percent pure components were measured. As the vapor mixes with air, and evaporates in the open, however, the mixture is almost the same weight as pure air. Hence, it dissipates rapidly. (The purpose of this demonstration is not to minimize the hazard of gasoline vapor but to point out how rapidly it dissipates in the open.)

9. Wet down the area again with water fog to insure quenching of all embers. Add water to the pool again and cover the water with gasoline. (Students benefit from a repeat performance.)

10. Check around the dike with the combustible indicator, or preferably have one of the more attentive students do the job.

16598

11. Have another student explore with the lighted torch, as in Step 5, and compare the results with Steps 4 and 5. If he uses a long-handled torch and common-sense safety, the ignition should not be a hazard.

12. Explain that, if the pool were 100 feet in diameter, the greater distance of vapor drift would be too risky to experiment with.

13. Point out the difference between a spill on land and on open water. A spill on land usually results in a pool of some depth--possibly an inch or more. The vapor is released slowly because the surface is limited. The same amount of gasoline on water quickly spreads out to a very thin layer. Evaporation is much faster, and the area is larger for dissipation. On open water the evaporation of the volatile components is very rapid, particularly in a breeze or on choppy water. Confined under docks, it is slower and the vapor dissipation may be restricted and hazardous. The hazard can be reduced by churning up the water with straight streams, but nearby sources of ignition must be controlled promptly.

Drill 11

Objective. To demonstrate the difference between an outdoor and an indoor demonstration, which is much more hazardous. The instructor may not have a suitable prop for this drill; if not, he can point out the principles verbally.

Prop. On some existing drill grounds there may be a deep trench or an open-top tank with side walls 3 feet high or higher. In order to secure the best results, the test should be run where there is no wind. Again, a combustible vapor indicator and long-handled torch are needed.

Procedure. This test should be made right after Drill 10, while the lessons learned are fresh in the students' minds.

1. Fill the bottom of the trench or tank with water in order to secure a flat surface. Stop all smoking.

2. Put a 1/4-inch layer of gasoline in the container, wait a minute or two, and start checking with the indicator over the rim of the container for vapor. Point out the fact that, with no wind, the side walls of the container retain the vapor differently from Drill 10, and hence a blanket of vapor builds up. In this case it should be possible to pick up a trace of vapor higher up in the container. Closer to the liquid level, the instrument will read higher on the scale. Each time a reading is taken, of course, the sample tube should be removed from the vapor area, and the tube and instrument should be purged with clean air.

16599

3. After exploration with the instrument is completed, use the torch to ignite the vapor. The students should stand back from the vapor flash.

4. Now explain how and why the vapor has not had the chance to dissipate into the surrounding air, why it drifts and seeks lower depressions, and in a house, may drift along the floor, through open doors, etc.

5. Following up with a blackboard talk, show how only a small amount of liquid gasoline can make a large container explosive. If one gallon evaporates fully in a 10,000-gallon truck tank, it will produce about 200 gallons of gasoline vapor. If this vapor is mixed thoroughly with the air in the tank, the mixture will contain about 2 percent vapor. Does this make an explosive mixture in the tank? The flammable or explosive limits of gasoline vapor in the air are about 1 to 7 percent. Hence, the mixture would be explosive.

   If one quart of gasoline was used, the fully mixed atmosphere in the tank would be 0.5 percent or too lean to ignite; and if 10 gallons were used, the mixture would be 20 percent vapor, or too rich to explode. In large containers with no air movement, there is a tendency for the heavier vapor to stratify, so whether 1 quart, 1 gallon, or 10 gallons of fuel were used, there could be zones in the tank where the mixture would be too lean, and other areas where it would be too rich, and others where it would be explosive. This uncertainty justifies the old statement that, "The empty tank is the dangerous one!" In large tanks vapors tend to dissipate fairly uniformly throughout the tank. They may stratify somewhat, however, with a higher concentration near the bottom and lighter concentration at the top.

6. Take the time to discuss that no-smoking rule in Drills 10 and 11, which may elicit comments from students who have heard that you cannot ignite gasoline vapor with the hot ash from a cigarette. Discussion of this subject takes valuable time from the training work and you may wish to dismiss the question; but unless it is handled properly, incorrect assumptions may be made.

   In 99 out of 100 times, a burning cigarette can be doused in a bucket of gasoline without ignition. The glowing ash is surrounded by a blanket of inert products of combustion; and also, it may not be hot enough or contain sufficient energy to ignite gasoline vapor, although it might ignite other more easily ignitable materials.

   Using the bucket prop, demonstrate two other acts:

   - Light a cigarette, and drop the flaming match into the bucket.

- With the cigarette ignite some paper or other Class A material, and drop it into the bucket.

The fact that the hot ash of a cigarette normally does not ignite vapor is only of novel and academic interest, because the other operations that accompany smoking are demonstrably hazardous.

Drills 12A and 12B

Objective. To demonstrate the vapor drift from a release of LP gas. This simple demonstration was used at both Bakersfield Oil Fire Control Schools.

Prop. Have a butane bottle with flexible hose leading to a 20-foot piece of pipe. Supply six or eight flare pots. (This test works best, of course, on a day when there is no wind.)

Drill 12A

Procedure. Explain that the demonstration is shown in two parts (12A and 12B). The first part illustrates the vapor drift from a liquid spill. As in the case of all of these drills, run your own dress rehearsal to polish the demonstration.

Some variances from these instructions may be desirable, depending upon the equipment used, and terrain, weather conditions, etc. Study Paper 13, pages 90 to 96, and Fig. 83.

1. Connect the hose to the liquid side of the butane container and attach the 20-foot pipe.

2. Place the flare pots in a semicircle with a diameter of 20 feet. Space them equally around the outlet of the pipe.

3. Explain to the students the purpose of the demonstration. Point out to them that, when the liquid butane is released from the bottle, it will be heated by the hose and pipe and the released butane vapor will be invisible at first. When the hose and pipe are chilled to about 31° F (the boiling point of butane), there will not be sufficient heat left in the hose and pipe to evaporate all of the fuel, and it will be discharged as a spray.

   This spray freezes the moisture out of the air, producing a visible water fog, not butane fog. The butane is invisible and extends beyond the fog. If propane is used, more fog will be produced as its boiling point is 44° below zero. Both butane and propane vapor, in 100 percent concentration, are heavier than air. Butane vapor is twice as heavy as air, and pure propane vapor is 1.5 times as heavy.

Remind the students that in Drill 10 the heavy gasoline vapor quickly dissipated in the air and air-vapor mixture, being about as light as the air, disappeared rapidly. The LP gas vapor, being lighter than gasoline vapor, may disappear even faster.

Point out that these facts relate to fairly small spills. If, however, there are massive spills of either gasoline or LP gas, much more fuel is available, much more vapor is produced, and under quiet wind conditions the vapor can drift a considerable distance and be ignited. It is impractical to demonstrate massive spills; small releases are used only to demonstrate general principles.

4. Ignite the pots and release the liquid butane to the pipe. (Dress rehearsal checks will have shown the desired rate of release to show the vapor drift and the preferred distance of the flares from the end of the pipe.)

5. On ignition, shut off the fuel at the bottle and repeat the test several times.

Drill 12B

This second part of Drill 12 shows how a fog nozzle aids in hastening the dissipation of the vapor.

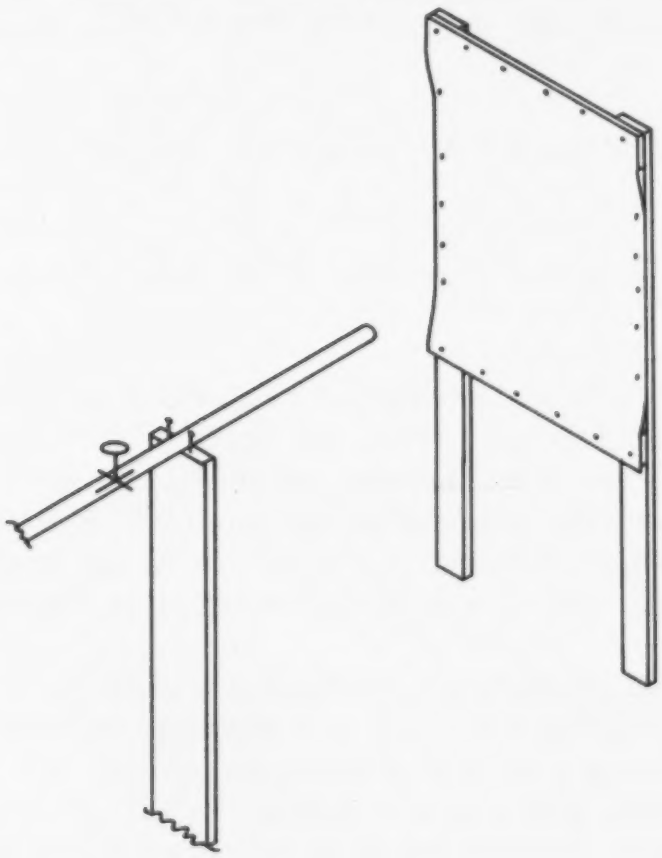

Fig. 93

1. Using a booster line, turn on the fog nozzle and--without releasing the butane--demonstrate the method used to dissipate the vapor.

2. Have your assistant open the bottle at the same rate used in Drill 10 and show the effectiveness of water fog.

Drill 13

Objective. To demonstrate the effectiveness of water fog to cool a surface and prevent it from overheating, even when in direct contact with a fire.

Prop. Make a 2- × 3-foot frame, using small boards such as 1/2- × 2-inch pieces. Thumbtack to the frame a piece of waterproof paper, such as butcher paper. Mount the frame on two light

166002

sticks about 2-3 feet above the ground. Provide the LP gas bottle and hose as used in Drill 12. Use a garden hose with a small adjustable water spray nozzle. A booster line is much too large. Connect the hose to the vapor side of the bottle. This prop is illustrated in Figs. 21 and 93.

Procedure.

1. Explain to the students the purpose of the test. Tell them that you will apply a very light spray of water on the paper and then direct an LP gas flame upon the paper. This very small amount of water, uniformly applied, will prevent the flame from igniting the paper. Then you will quickly remove the spray and the paper will ignite suddenly. The purpose of the test is to show how small an amount of water is needed to do the job.

2. While you are wetting the paper, have your assistant turn on the butane vapor and ignite it. Be sure that the flame impinges directly against the wet paper.

3. Call attention to the very small amount of water that is being used and tell the students to watch the paper carefully when you remove the cooling.

4. Quickly turn the spray stream away from the paper, and see how quickly the paper ignites.

5. Turn off the fire and water stream.

6. Arrange for a continuation of the discussion of this subject using a blackboard classroom session.

Later blackboard talk. This is a most important phase of this drill. The field demonstration is spectacular, but it is so short that students lose its value unless it is followed up with a blackboard talk and group discussion.

Before the students arrive, sketch on the blackboard a vertical tank as used in a bulk plant; an elevated horizontal tank as used in many industrial plants; a "semi" gasoline tank truck; and a horizontal LP gas tank on a tank truck. Refresh your mind by studying Paper 5, pages 39 to 50.

Tell the students that you are going to talk about the practical aspects of the use of water in cooling various types of tanks containing oil and LP gas. Point out that there are differences in the handling of these various kinds of fires and there are also similarities. Take one case at a time and cover these differences and similarities. First, cover the similarities that apply to all cases. Before getting down to specific cases, review some common principles. (This should be a participation session, not a lecture. It is impractical to detail

166003

WS. 19. Stop Block: Make a three-view freehand sketch of the Stop Block. Show top, front, and right end views. Follow directions given for WS 15. Have your drawing checked. Save it for later grading.

WS. 20. Mortise: Make a three-view freehand sketch of the Mortise Block. Show top, front, and right end views. Follow the directions given for WS 15. Have your drawing checked. Save it for later grading.

WS. 21. Offset: Make a three-view freehand sketch of the Offset. Show top, front, and right end views. Follow directions given for WS 15. Have your drawing checked. Save it for later grading.

WS. 22. L Block: Make a three-view freehand sketch of the L Block. Show top, front, and right end views. Follow directions given for WS 15. Have your drawing checked. Now staple Work Sheets 19, 20, 21, and 22 together in the upper left-hand corner and turn them in for grading. One grade will be given for the four sketches.

WS. 23. Wedge: Make a three-view freehand sketch of the Wedge. Show top, front, and right end views. Follow directions given for WS 15. Have your drawing checked. Save it for later grading.

WS. 24. V Block: Make a three-view freehand sketch of the V Block. Show top, front, and right end views. Follow directions given for WS 15. Have your drawing checked. Save it for later grading.

WS. 25. Angle Guide: Make a three-view freehand sketch of the Angle Guide. Show top, front, and right end views. Follow directions given for WS 15. Have your drawing checked. Save it for later grading.

all of the points that you may wish to present, but some of the key points to be covered follow.)

In your opening remarks, review the last field demonstration. Point out that water is such a good material for controlling fires because it is nonflammable and safe to use; cheap and often available in quantity; easy to pump and handle and--very important--if used properly, it has the property of absorbing a great amount of heat. Water will not extinguish gasoline, an LP gas, or a gas fire in the open, because it cannot reduce the temperature of the fuel to below its flash point and stop the release of vapor; but, properly used, it is ideal for cooling equipment, reducing the intensity of the fire, and preventing failures of pressure vessels or inadequately vented vessels.

Illustrate the application of the above with four examples on the blackboard.

1. The vertical oil storage tank--Assume that the tank contains gasoline and that there is a fire burning around the bottom of the tank. When sizing up the problem, the chief must consider several factors.

   a. What is the source of fuel, and can it be shut off?
   b. Is the tank adequately vented? In his prefire planning sessions at the plant the chief will have determined the adequacy of vents (see Fig. 16 and related text).
   c. Is more than one tank exposed, and howis it vented?
   d. What is the area drainage? Can the ground fire be flushed away so that the flames will be in the open and not contact exposures? What initial steps should be taken? (These depend upon the situation at hand but some general factors apply.)
   e. If the fuel is coming from a leak at the bottom of one of the tanks, can it possibly be shut off by adding water to the tank--if open valves permit--using one of the procedures covered in Drill 7 and 8?

The boiling of the oil in the tank can be prevented by the procedure used in Drill 9. A minimum of water should be lofted on top of the cone of the tank so that a thin sheet runs down the side of the tank exposed to fire. Impinging a stream on the vertical side wall of the tank and bouncing the water off the tank is of no value, for very little cooling is accomplished and the excess water on the ground can create a bad run-off problem.

The atmosphere in a bulk plant gasoline tank is above its flammable limit, with no risk of internal explosion. The internal vapor pressure in the tank can be checked by the rate of venting. A small flame indicates no significant pressure and no need for cooling. Excess pressure is indicated by a much larger flame, usually accompanied by noise of venting when proper cooling of the tank is needed.

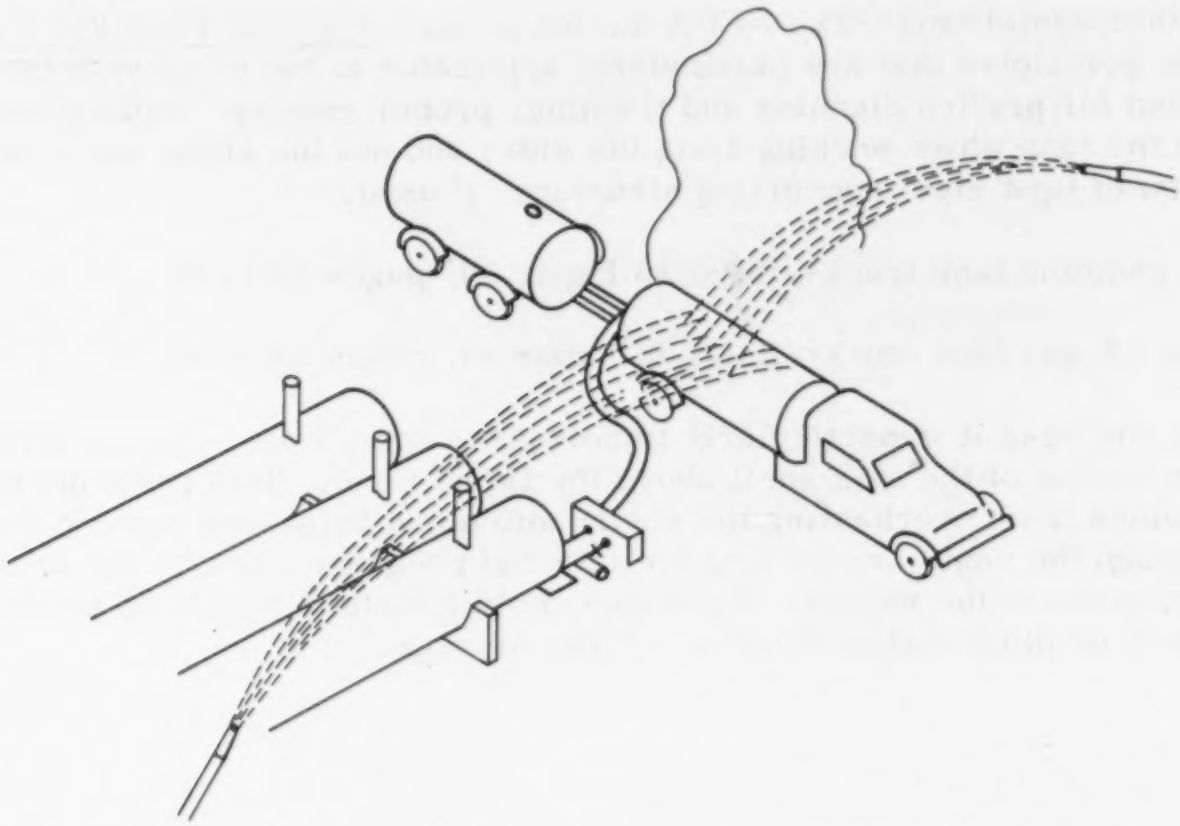

Fig. 94. The main rule in fighting tank fires is to concentrate the water where it is needed. Radiant heat is no hazard to tank shells—only direct flames can overheat the tank shell to the danger point. Work from the sides of the exposed tank—not from the ends.

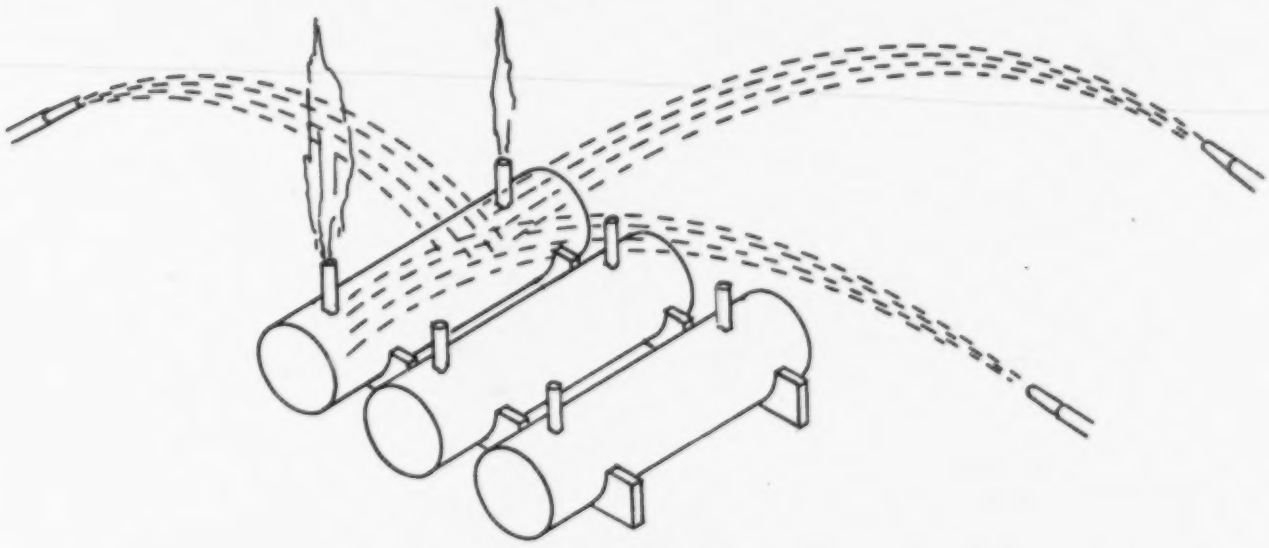

Fig. 95. Again—don't waste water on unexposed tanks. Close the valves of nearby tanks and concentrate the water where it is needed.

A serious spread of the ground fire usually results from needless water on adjacent tanks that are not venting and especially from the indiscriminate use of water thrown into the ground fire itself.

Finally, it is assumed that the tank is adequately protected by a weak roof-to-shell seam or properly sized venting equipment.

16605

2. A horizontal tank--The NFPA motion picture Fighting Tank Fires covers the principles that are particularly applicable to the horizontal tank; the need for prefire planning and training; proper venting; cooling the top of the tank while working from the sides and not the ends; early attention to light steel supporting structure, if used.

3. A gasoline tank truck--Refer to Paper 10, pages 79 to 83.

4. An LP gas tank truck--Refer to Paper 13, pages 90 to 96.

   In this case it is particularly important to apply water cooling streams on the top of the tank shell above the liquid level. This prevents the flames from overheating the shell, which can bulge and rupture even though the vents are holding the internal pressure down to the setting pressure of the valves. The same cooling method should be applied to fixed or plant installations of LP gas storage.

16607

SECTION 4 HISTORY OF TRAINING IN THE WEST

Whether a training officer is planning a new program or revising an old one, he can benefit greatly from the experience of others. This is particularly applicable to training in oil fire control. This special work is a fairly new activity in the fire service.

The first oil fire control training was conducted by refinery fire departments in the early 1920's. Some years later the Los Angeles County and Kern County Fire Departments, in widely separated oil field areas, independently started joint training work with the industry. Fear of sabotage during World War II intensified this cooperative work, and the fire service joined the oil industry in conducting large oil fire schools. Some individual fire departments trained their men on local oil industry drill grounds.

The first really large schools were held in Bakersfield in 1955 and 1961, and many smaller schools have been conducted in most of the western states during the last 10 years. Today the Los Angeles County Fire Department has one of the largest and finest drill grounds in the country, and at the dedication of the new area in 1962 Chief Klinger said that it will be made available to other departments. Cooperative training like this is the culmination of the work of many years.

Early Oil Fire Control Schools

The need for oil fire control. The petroleum industry started in California before 1900. Shortly following the discovery of the oil fields in Southern California in the early 1920's, there was a surplus of crude oil, and much of it was stored in large, shallow, concrete-lined, wood-and-tar-paper-roofed reservoirs and nonsteel-roofed tanks. These roofs were vulnerable to lightning ignition, prior to the use of lightning protection, and a number of costly and very spectacular fires occurred in remote areas. Commercial scale, high pressure and high temperature (about 1000 psi and 800° F) cracking units, before the advent of alloy steels, accounted for some early serious refinery fires. Large well fires in the oil fields were common. Oil companies assigned fire protection engineers to find methods of preventing and combating these serious fires. The engineers from different oil companies worked jointly and formed the first oil industry fire committee about 1925.

16608

This group of engineers (Anfenger, Moeller, Prussing, Wilson, and Knobman) and their assistants were known initially as "the Buzzards" as they met at large oil fires and picked the bones of information clean to learn all the possible lessons of fire protection from these losses. Later they formed a permanent committee, which eventually became the Western Oil and Gas Association Fire Committee. Their pioneer development and research into all phases of fire protection on flammable and combustible liquids and LP gas led to many of the early codes and standards of the American Petroleum Institute, the National Fire Protection Association, and the National Board of Fire Underwriters. Some of the local fire chiefs also participated in the early study of oil fire fighting techniques, including the special training of firemen.

First training. The earliest oil fire training was done in the refineries in the middle 1920's; the first training conducted jointly by the fire service and industry was in the oil fields in the early 1930's. The first permanent drill area with large props was constructed about 1933 at the Los Angeles County Fire Department Station 17 at Santa Fe Springs, on the grounds where Chief Griswold had conducted his first work on fog nozzles a few years earlier (see Fig. 22 to 25). Chiefs Griswold and Klinger, Stanley Clithero of General Petroleum Corp., and other engineers were the pioneers. Mr. Clithero also worked with Chiefs Freer, Van Horn, and Craig of the Kern County Fire Department at Bakersfield in similar testing and training starting about 1935.

During the early part of World War II the navy set up drill grounds at Mare Island and San Pedro for training sailors in the handling of ships' fires. Fire service personnel and oil industry fire protection people witnessed this work. Navy drill grounds stimulated the construction of permanent oil industry drill grounds with large props that resembled refinery equipment and provided refinery-type fires.

Up to 1941 all of the oil fire control schools were conducted at a local level, mainly in oil field and refinery areas, and only the local firemen benefited.

First Bakersfield fire school. In order to spread this benefit, the Kern County Fire Department, the Bureau of Trade and Industrial Education of California State Department of Education, and the Western Oil and Gas Association Fire Committee jointly sponsored the first large-scale oil fire control school at Bakersfield on January 29, 30, and 31, 1941. The general format resembled those schools conducted in 1955 and 1961, for the program included indoor classroom sessions and outdoor demonstrations and participation drills.

At that time, liquefied petroleum gas was first being used in large quantities, and many of the drills covered the handling of LP gas fires. Motion pictures of this first Bakersfield fire school show some of the early techniques. This training included:

16609

Fig. 96. Fire training at a refinery drill ground in the early 1930's. City firemen and refinerymen are using a CO_2 extinguisher and a 40-gallon foam extinguisher.

16610

Fig. 97. Two photographs of historical interest. The upper picture shows refinerymen using two steam lances to snuff out a heavy oil fire at their drill ground. The Civil War cannon was used by Texas firemen prior to 1920 to shoot a 3-inch ball into tanks that were on fire. In one case they overshot the flaming tank but hit the tank in back of it and lost both tanks. After several trials, this method of hastening the draining was found to be of no value and was discontinued.

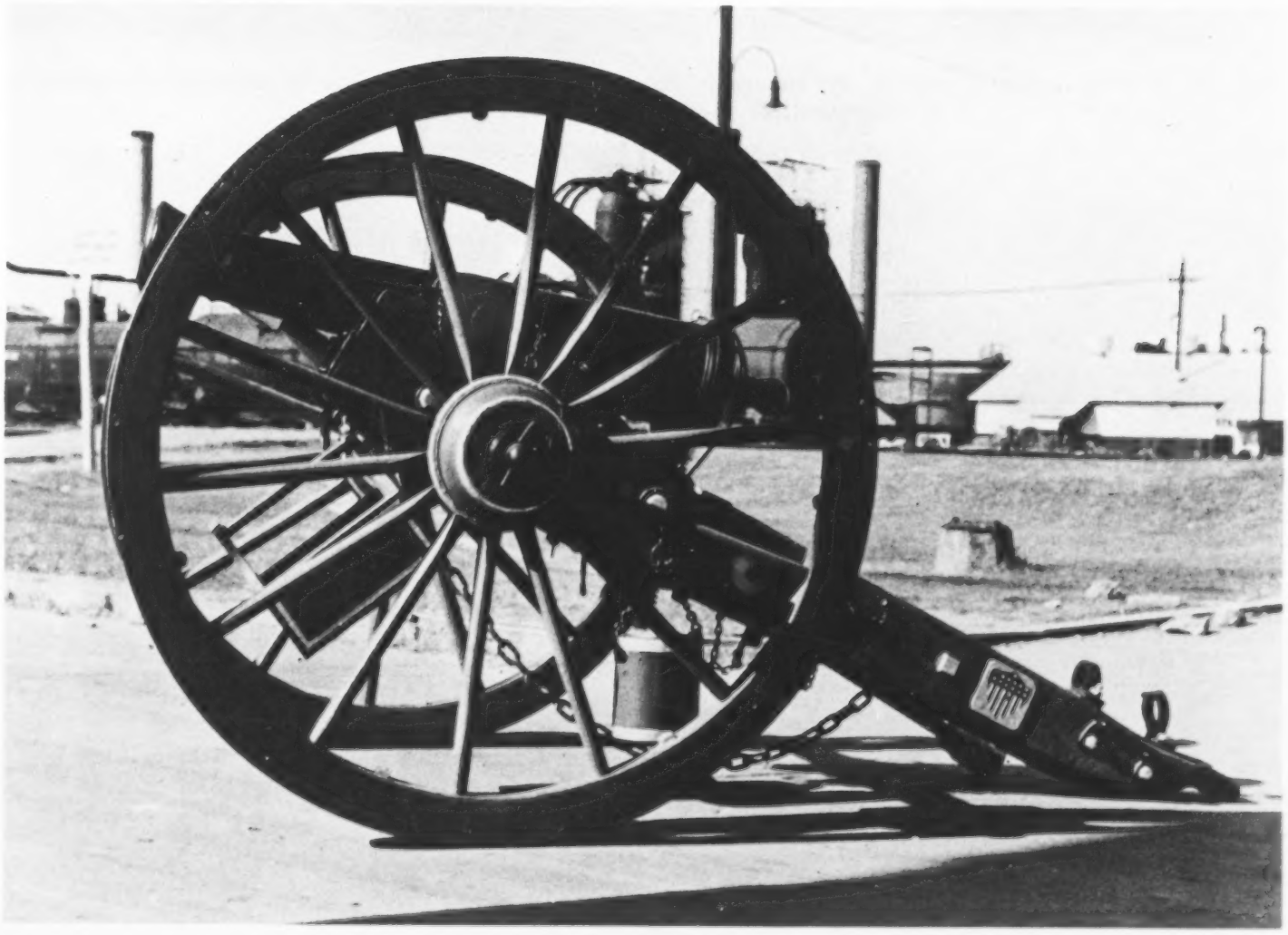

16610

- LP gas fires--An open straight jet of LP gas was ignited. The control valve near the outlet of the jet was closed under the protection of water fog. The fog pattern did not appear to be very efficient. The jet flame was extinguished with dry chemical and with CO_2, and no doubt, the men were warned that this was an unsafe technique because of the risk of reignition.

  An elbow was put on the end of the LP gas pipe to direct the stream onto the ground below, and shutoffs were made under the protection of fog nozzles. The stream was deflected against a steel baffle and the same technique was used. A strong straight stream was used at right angles to the jet to deflect the LP gas streams to one side, and a shutoff was made. The radiant heat from the deflected flame was much less than for a comparable oil fire, and it permitted approach with fog nozzles.

- Oil fires--Crude oil was substituted for LP gas for the straight jet fire, and shutoffs were made.

  Open-top drum fires were extinguished with foam and CO_2, and high flash oils were extinguished with fog applicators.

  A tar pit was frothed out with water.

  Shallow pan fires, using gasoline and crude oil, were tackled with a fog applicator to show that fog reduces the size of the fire but does not extinguish it.

  Various oil spill fires were extinguished with dry chemical and small spills were extinguished with CO_2 and hand foam extinguishers.

- Miscellaneous fires-- Tank truck dome fires were extinguished with a blanket and by closing the dome cover.

  A wrecked automobile was ignited, and the fire was fought by various methods.

  A foam tower was erected, and the operations of chemical foam generators were demonstrated. Unfortunately, no photographs other than one movie film could be found. This movie is listed in Part IV.

The main purpose of the 1941 Bakersfield Oil Fire Control School was to prepare the student representatives of local fire departments so well that they could return home and conduct adequate training programs on a continuing basis for fire departments in their own areas. A fire marshal of a major California city commented on the schools:

16611

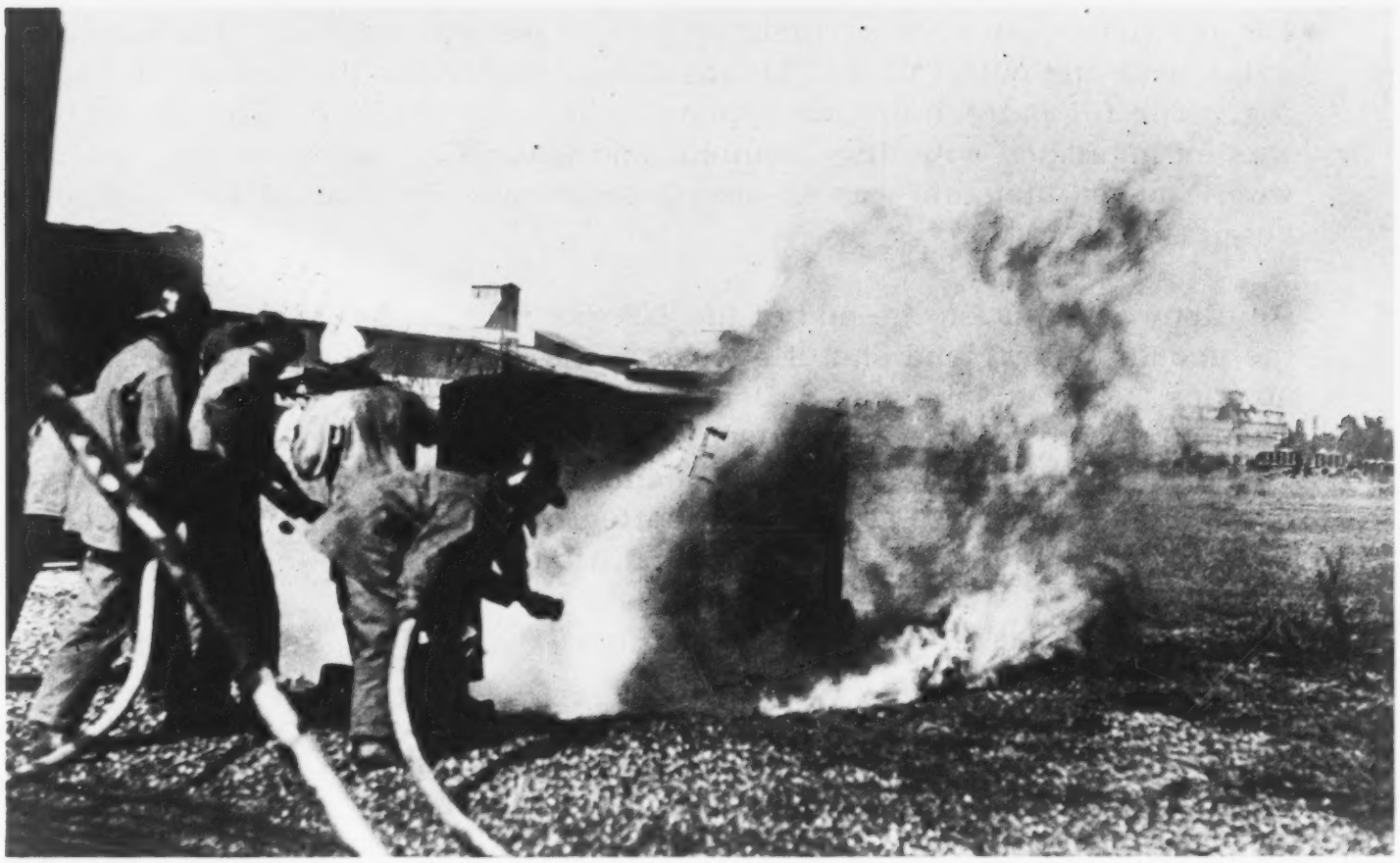

Los Angeles County Fire Department

Fig. 98. Early day photos showing training at Station 17 at Santa Fe Springs. The prop is a rectangular tank, supported on concrete piers over an oil pit. The 1½-inch directional fog nozzle in both photos appears to be of the same type as that shown in Fig. 23. The applicator appears to be on an early type of navy nozzle.

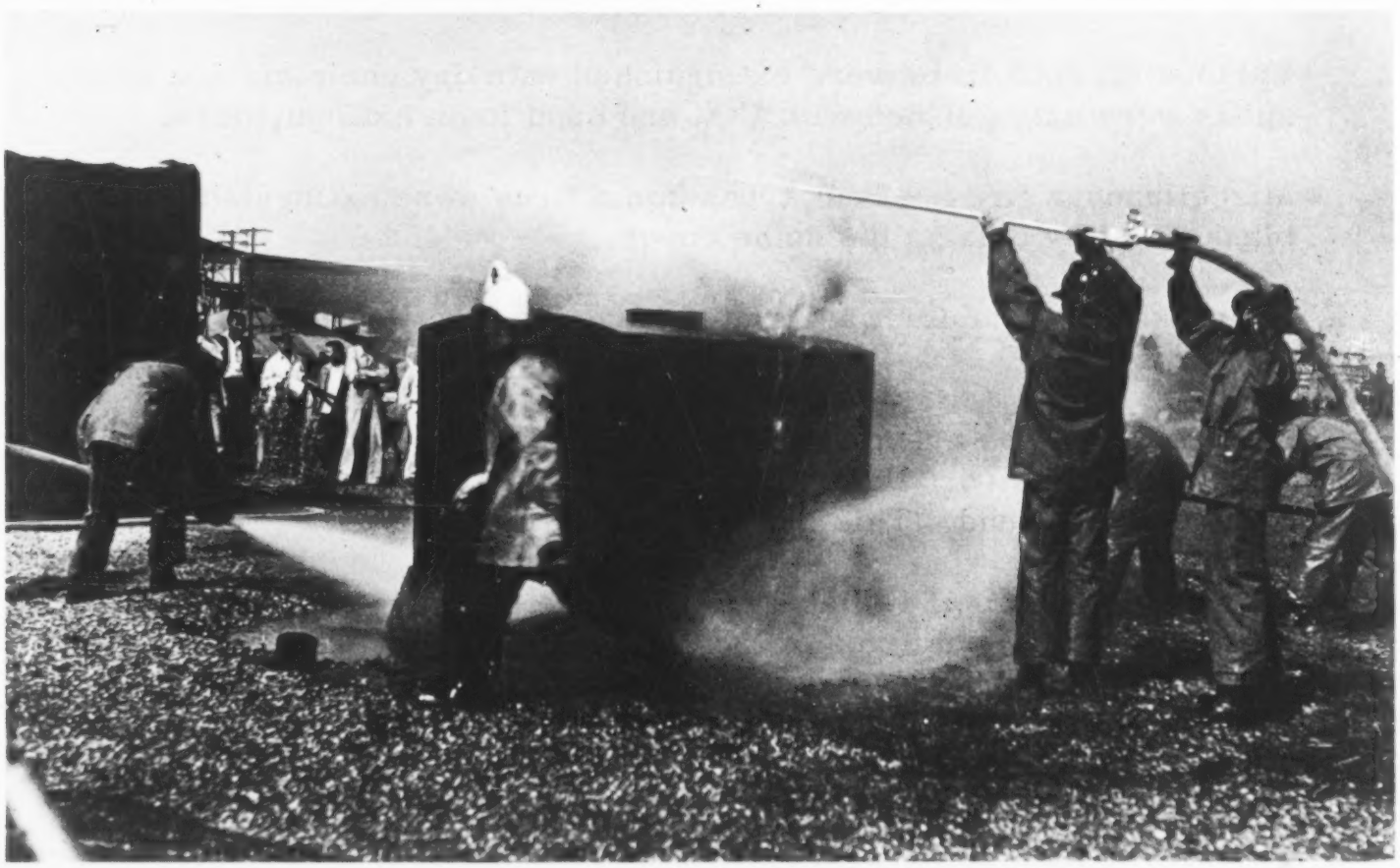

> These sessions will have saved the lives of firemen who otherwise might have been lost had they not gained the knowledge and understanding of the fire characteristics of petroleum products which the schools afforded them. There are many instances in other parts of the United States where firemen have died because they had had no such training.

Regarding the 1941 school, Assistant Chief Harry Van Horn, Kern County Fire Department, in charge of oil fire fighting, said recently:

> In the early days we had many fires in the oil fields, and we handled them the best we could, with brute strength and awkwardness. In the 1930's oil industry fire protection people started to teach us the technical side of the problem and the proper techniques to use in the field. This work was not only very interesting but we tackled our fires with confidence and with much greater safety to ourselves.
>
> These small local schools led up to the first oil fire control school here in Bakersfield in 1941. During the last 20 years the oil industry men and our department have jointly conducted many small schools as well as the two large ones in 1955 and 1961. Any fire department can become proficient in this special kind of fire prevention and control if they will learn the principles as taught in the classroom and then train on live fires on the drill ground.

Other early schools. The war stimulated interest in oil fire control schools. In Long Beach on July 29, 30, and 31, 1941, a school was conducted by the fire service and the oil industry. In his speech there, Chief Griswold said:

> Some of us representing fire departments, who have had the opportunity to work with the industry engineers, face the war future with confidence because of the assurance of their engineers' support. Their fire fighting practices and procedures, as exemplified in this school, will unite the fire department and oil industry into an organization which will defy anything the Axis powers can give.

We have no records of the specific props or training techniques that were used at Long Beach, but we assume that they were similar to those used elsewhere at that time. Firemen from the Southern California Area attended. A number of similar schools were held in other West Coast cities in 1941 and 1942.

Modern Oil Fire Control Schools

Large fire schools. During the war the Great Lakes Regional Committee on Protection of Petroleum Facilities sponsored a large-scale school in Chicago.

16612

WS. 26. Inclined Planes; Make a three-view freehand sketch of the Inclined Planes block. Show top, front, and right end views. Follow directions given for WS 15. Have your drawing checked. Now staple Work Sheets 23, 24, 25, and 26 together in the upper left-hand corner and turn them in for grading. One grade will be given for the four sketches.

The oil industry instructors who conducted the Bakersfield school in 1941 served as the "faculty" for the Chicago Fire School on May 24, 25, and 26, 1943. They developed and brought with them an excellent motion picture, Chicago Oil Fire Control School, the first fire control film that was specific to oil and LP gas fires.

At one of the sessions the instructor, commenting on over 15 years of fire protection experience of the school staff and also on the joint activity on the West Coast said:

> Out of this experience, there have been put together methods of teaching fire prevention and control to which each man had added what he seemed best qualified to contribute. For years this teaching technique was limited to the employees of the companies that we individually served. Then it was found that fire departments were interested, and some schools were run for their benefit. Now the war has brought into the picture of oil fire fighting not only the civilian fire departments, but specialists of the army, navy, and coast guard. And for groups of these men, fire schools have been conducted in several large cities of the Pacific Coast in the past year.

Los Angeles City Fire Department

Fig. 99. When an applicator for volumetric (low velocity) fog is not on hand, sometimes it is necessary to use the harder method with directional fog. Firemen should be trained to meet such problems. Here local city firemen are training at a refinery drill ground in 1945, using the old navy nozzle.

16613

The Chicago school consisted mainly of classroom and outdoor demonstration sessions. One prop was particularly interesting. A crude oil and butane mixture was pumped out of an open 2-inch flange, representing a split pipeline. The radiant heat from the vertical flame was particularly severe, and the problem was to move in under the protection of two 1-1/2-inch old-style spray nozzles and make a shutoff. Two streams from 5/8-inch straight-stream tips off a 1-inch hose were directed at the fire a few inches above where the jet flame was coming out of the pipe. These small streams bent the vertical fire away from the men at the valve and aided the fog nozzles.

The next school of importance was held in Fresno during the California Rural Fire Association conference on March 28, 29, and 30, 1947. The outdoor training was designed for rural fire departments and was conducted by the Western Oil and Gas Association Fire Committee. Small, inexpensive portable props were used, partly to demonstrate examples of what small fire departments could make for their own training.

Small local fire schools. From 1947 up to the time of the second Bakersfield School of 1955, only small schools were conducted. In the 1945-1955 period a number of the oil companies conducting training for their own employees invited local fire departments to participate. At one refinery the local fire department's training officers were given special instruction, and they, in turn, trained their own fire service personnel. At one refinery over 2000 received this training course with classroom sessions and, in some cases, field work as well.

In many nonrefinery areas, instructors from individual oil companies ran special small schools for fire department personnel alone. Many motion pictures specific to fighting oil fires became available. Much attention was given to prefire planning with inplant sessions on simulated fires. In the investigation of larger fires, the fire service and oil industry cooperated closely so as to benefit jointly from the lessons that were learned. This was an important developmental period in oil fire protection from a standpoint of learning new techniques and new developments in fire fighting equipment. The latter included dry chemical extinguishers' replacing hand CO_2, foam, and CTC extinguishers. More efficient fog nozzles became available. Mechanical or air foam started to replace chemical foam at new installations, and an appreciation of the value of water in place of foam was generally recognized. The more maneuverable 1-1/2-inch hose lines were used in the majority of oil fires. The importance of drainage and of using water more effectively and in smaller amounts became evident. The training in the use of these newer and more effective concepts of oil fire control techniques required smaller classes, both in the classroom and on the drill grounds. Greater emphasis was given to prefire planning. The refineries found that fewer fires occurred when the operators were given live fire training.

16614

Kern County Fire Department

Fig. 100. Prefire planning and training on oil fires, illustrated above and by many other pictures, pays off when "the chips are down."

New developments in fire codes and fire prevention also took place even though there was resistance in some areas. Although new fire fighting equipment usually is accepted, there is a natural reluctance to change codes and standards. As information on current fire history improved, particularly through the NFPA publications, greater reliance was placed on experience, and codes were modernized for the benefit of both the fire service and industry.

A good example of this code change relates to heights of dikes around storage tanks. To comply with the old code, dikes often required walls 10 feet high or higher. Long experience indicated no need for such heights, and fire fighters had much trouble in combating tank fires behind these high barriers. Mainly through West Coast experience, the NFPA 30 code has been changed to a more practical and reasonable design. For example note the 1963 NFPA code on dikes and drainage. Continued cooperative work with the fire service and industry engineers has led to greater confidence in one another in the joint efforts of drafting codes.

In this period greater emphasis was given to prefire planning and a better technical knowledge of the fire characteristics of petroleum products. The fire schools contributed greatly in the dissemination of this knowledge. Examples of lack of proper prefire training have been stressed at the fire schools particularly through the use of the film on the Kansas City bulk plant fire of 1959 with supplemental discussion. Some recently available motion pictures have

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aided greatly. The increasing interest in the subject of oil fire control at the local level created a greater demand for similar schools in other communities, and this led to the second Bakersfield Oil Fire Control School in 1955.

Bakersfield fire schools of 1955 and 1961. Both of these three-day schools were jointly sponsored by the Fire Training Program, Bureau of Industrial Education, California State Department of Education; the Kern County Fire Department; and the Western Oil and Gas Association Fire Committee. Indoor classroom sessions were held during the mornings and evenings and the afternoons were devoted to demonstrations and participation drills at two local industry training grounds. There was no attendance fee. Approximately 600 registered for the March 24, 25, and 26, 1955, school and about 700 for the March 9, 10, and 11, 1961, school. Fire service officers and oil industry fire protection engineers were instructors. Guest participants on panels, etc., included:

Loren S. Bush, Chief Engineer, Board of Fire Underwriters of the Pacific
R. C. Stange, Assistant General Manager, National Board of Fire Underwriters
Paul Lofgren, Assistant Supervisor, Trade and Technical Teacher Training, University of California
Miles E. Woodworth, Flammable Liquids Engineer, NFPA

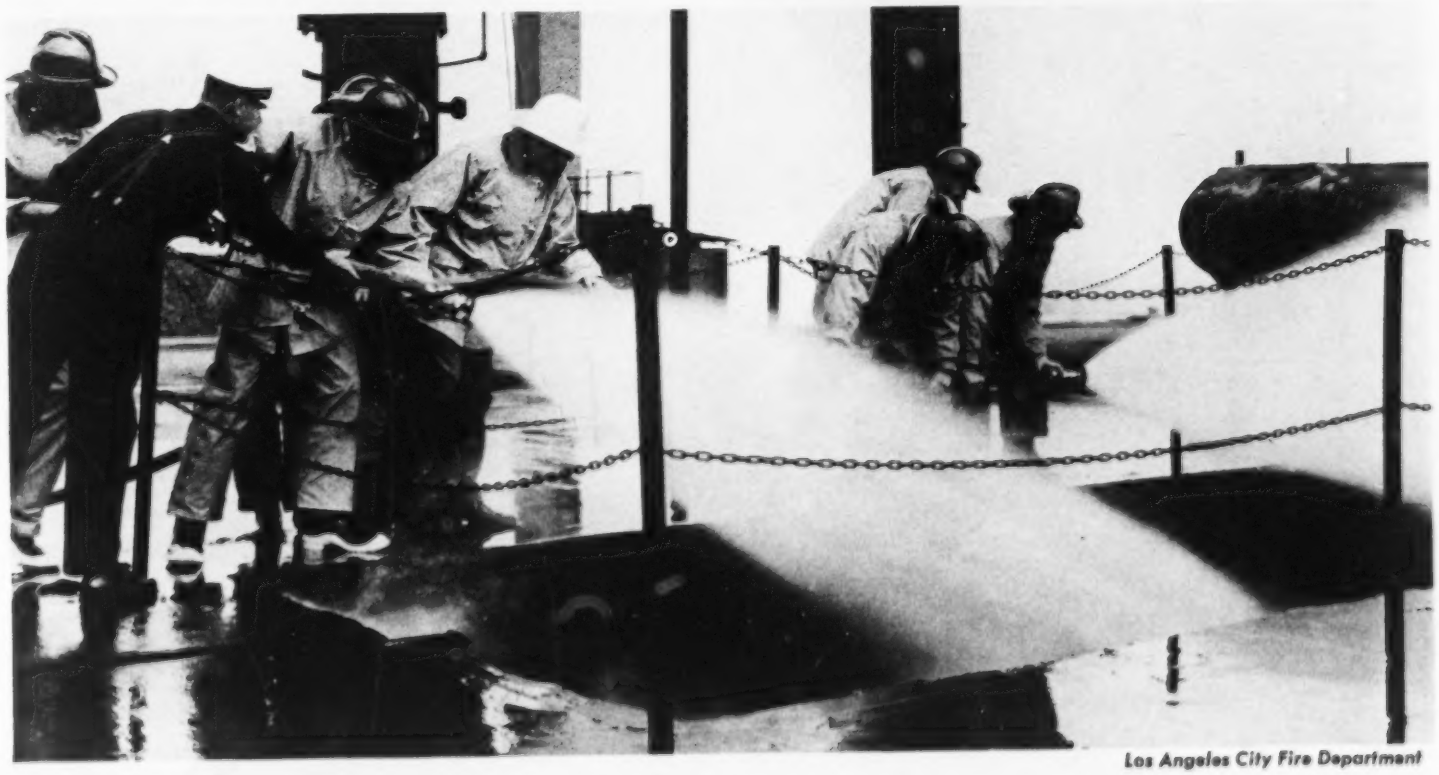

Los Angeles City Fire Department

Fig. 101. Training municipal firemen at a refinery drill ground with the pipe trench prop also shown in Fig. 102. Instructor Chief Floyd Adams (second from left), one of the most experienced and highly skilled fire fighters in the country, was a pioneer in such training.

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Certificates of Completion were issued by the California State Department of Education, Bureau of Industrial Education, Fire Training Program, to all participating firemen; and "red book" manuals, containing copies of the papers presented and other instructional material, were distributed. Many of these papers (some revised) comprise much of the material in the first two parts of this manual. A description of the outdoor work at these two schools is given in the first two sections of Part III. Comments from some who attended:

- K. E. Klinger, Chief Engineer, Los Angeles County Fire Department:

  I wish to express my sincere appreciation for permitting our personnel to attend the recent oil school seminar held in Bakersfield. I feel that the information derived will be very beneficial in our training procedures.

- R. M. Hill, Fire Marshal, Los Angeles City Fire Department:

  The opportunity to progress toward greater safety in the petroleum industry has been greatly enhanced by the enthusiastic

Long Beach Fire Department

Fig. 102. The job is much easier if started from the short end of the "L." Men are trained, however, to start at either end.

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Los Angeles City Fire Department

Fig. 103. City and refinery firemen working together on a dramatic night fire.

Los Angeles City Fire Department

Fig. 104. In many refinery fires the plant workers and city firemen work side by side. Both are well trained on the same plant fire drill grounds.

16618

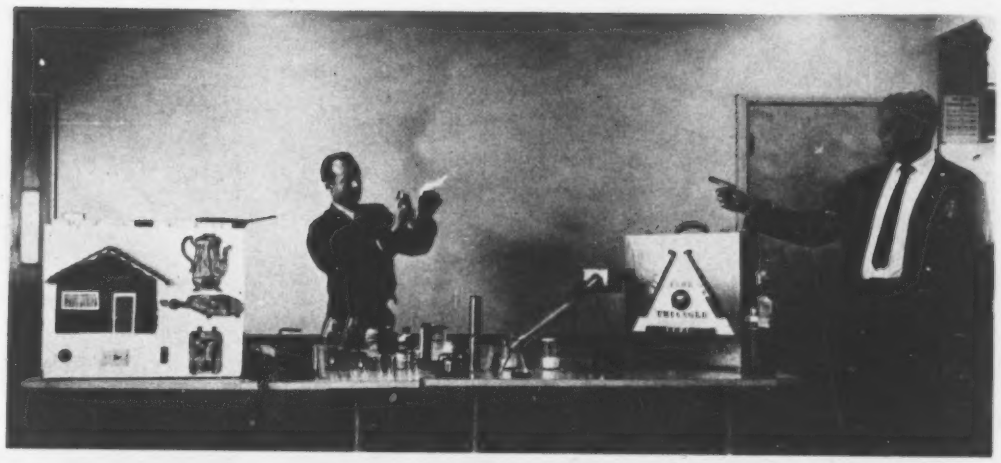

Torrance Fire Department

Fig. 105. Chief Northington (right) and aid at tabletop demonstrations.

participation in the school of fire departments across the state. It is also evident that a greater understanding of our mutual problem has resulted.

- R. B. Hamilton, President, California Conference of Fire Training Officers, Southern Section:

By unanimous motion we wish to thank you and those responsible for the fine program at the oil fire control school. The representative oil companies and their facilities did an excellent job in preparing the various fire problems and the equipment assembled in the props did much to show good fire suppression techniques.

- M. C. Woodworth, Flammable Liquids Engineer, National Fire Protection Association and formerly Fire Marshal, Portland, Ore.

The oil fire control schools sponsored by the Western Oil and Gas Association in cooperation with the fire services are truly outstanding examples of working together on problems of mutual concern. Unquestionably these schools have improved the effectiveness of fire departments on the West Coast in fighting flammable liquid fires as well as increased the safety of the fire fighters in handling such incidents. I know of no other section of the world where such cooperation exists, with industry cooperating to train fire fighters in a number of different states as it does on the Pacific Coast.

I do suggest, however, that it is imperative that the lessons learned at these schools, to be truly effective, be taken back to the local fire departments and the principles learned at the school applied to their own local conditions. Special emphasis should be placed

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upon prefire planning of all flammable liquid and LP gas installations under the jurisdiction of each particular fire department. This prefire planning also should include the chemistry of fire as well as the variables of many types of flammable liquids that may be stored in a particular community. Since each flammable liquid in an LP gas bulk plant may present its own individual problems, such as the type of liquids stored, tank construction and design, piping arrangements and materials, and emergency venting provisions, prefire planning is a necessity for each plant.

Although many large departments are able to provide training centers with specialized flammable liquid fire problems to train their men, such elaborate training facilities are frequently impossible to obtain for small departments and volunteer fire departments. However, such large training aids are not a

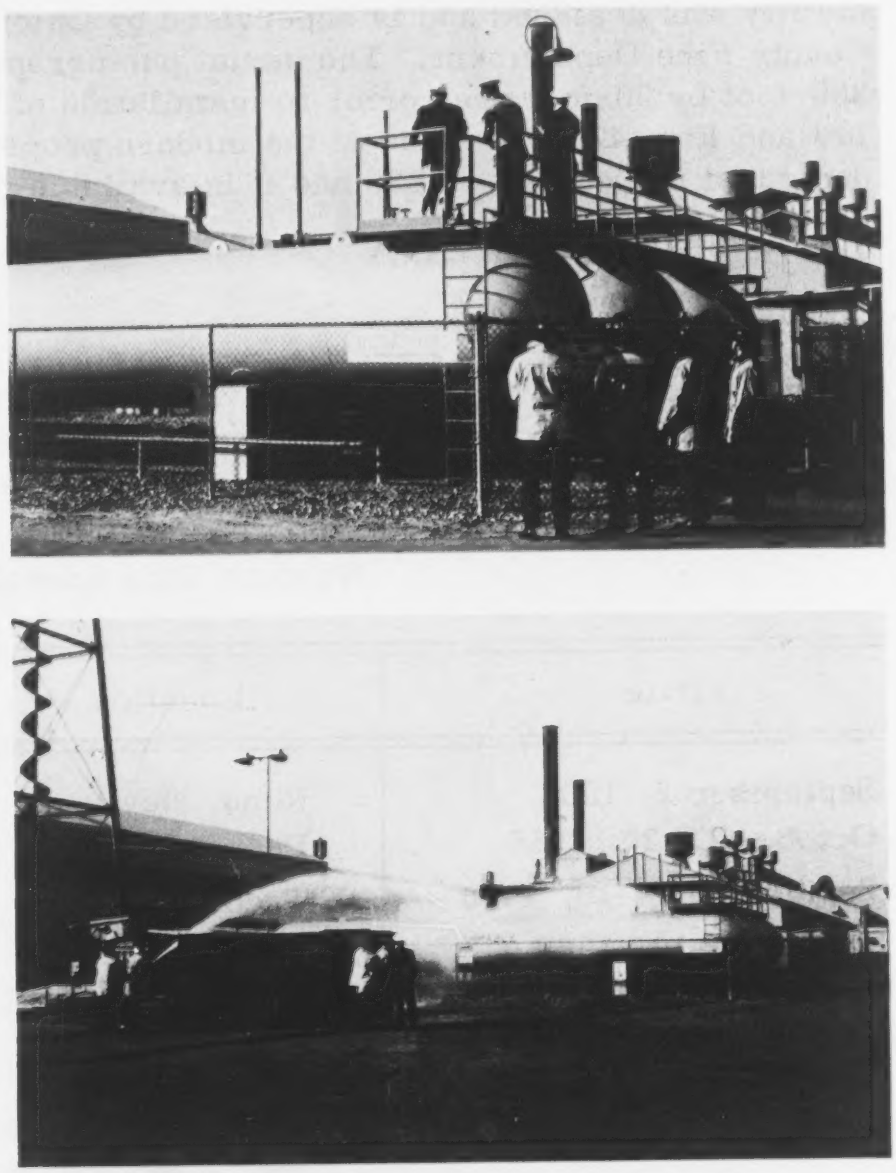

Torrance Fire Department

Fig. 106. A typical large LP gas storage area at a large steel mill and fabricating plant. The principles of prefire training at bulk plants apply to storage and operating areas in other industrial plants as well. The training officer and the plant fire and safety supervisor are shown studying the problem with local fire service officers and firemen (top). Then (bottom) they used water streams from one of a number of selected locations.

16620

necessity, since there are many simple props which can be used for achieving the necessary fire fighting training. The same techniques can be demonstrated on a small basis as can be demonstrated on a large basis.

Other California fire schools. Other oil fire control schools have been conducted by the fire service alone, using techniques and portable props similar to those at the Bakersfield schools. Two excellent schools were held in San Jose (August 16-17, 1961, and August 15-16, 1962) and one in Coachella Valley on November 3-4, 1962, with attendance at each school ranging from 150 to 200 firemen. A full-size tank truck prop was used at the last San Jose School. It is illustrated in the NFPA Fireman, February, 1962, and the entire school was described in Fire Engineering, February, 1962.

The largest and best-equipped drill ground for training oil fire control personnel is located at Del Valle, near Castaic Junction, north of Los Angeles. The facility was designed and is supervised by Chief Bixler of the Los Angeles County Fire Department. The aerial photograph, Fig. 112, illustrates the 260-foot by 20-foot area prior to installation of all props. Figures 113 to 116 and Fig. 47 show some of the modern props in use there. The area was dedicated in October, 1962, and it is available for use by fire departments in Southern California.

Schools in Other States

A number of large fire schools have been held in other western states. The majority were conducted jointly by the state supervisor of fire training, the

TABLE 11
Western Fire Schools

Date	Location	Attendance
September 2, 1952	Reno, Nev.	Demonstration only
October 18-20, 1955	Phoenix, Ariz.	500
September 14-16, 1956	Tacoma, Wash.	410
March 17-19, 1960	Salem, Ore.	380
September 14-16, 1962	Kennewick, Wash.	310
June 8-9, 1963	Sparks, Nev.	175
February 14-16, 1964	Phoenix, Ariz.	140

16621

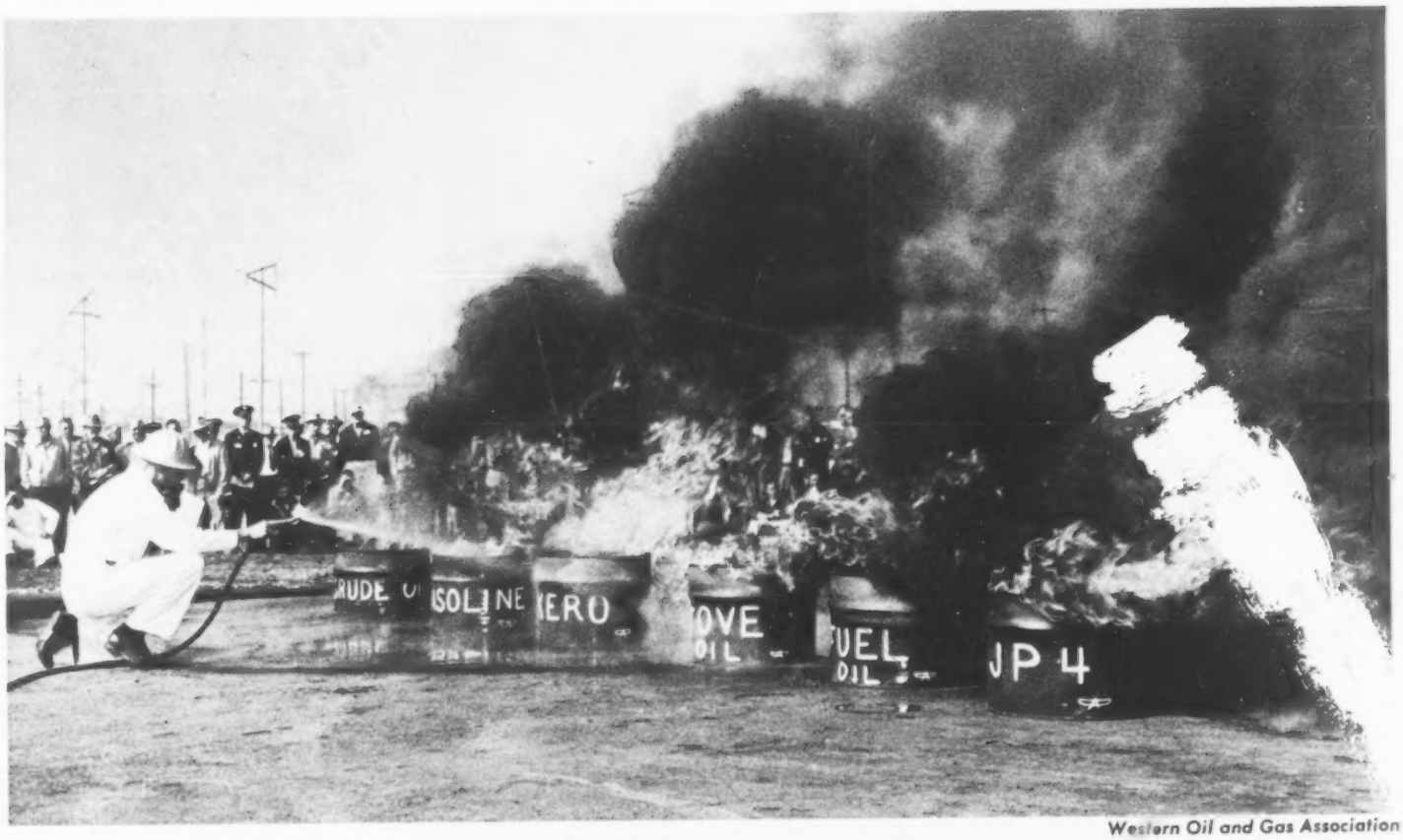

Western Oil and Gas Association

Fig. 107. Starting to use spray from garden hose on fuels of various flash points burning in half drums.

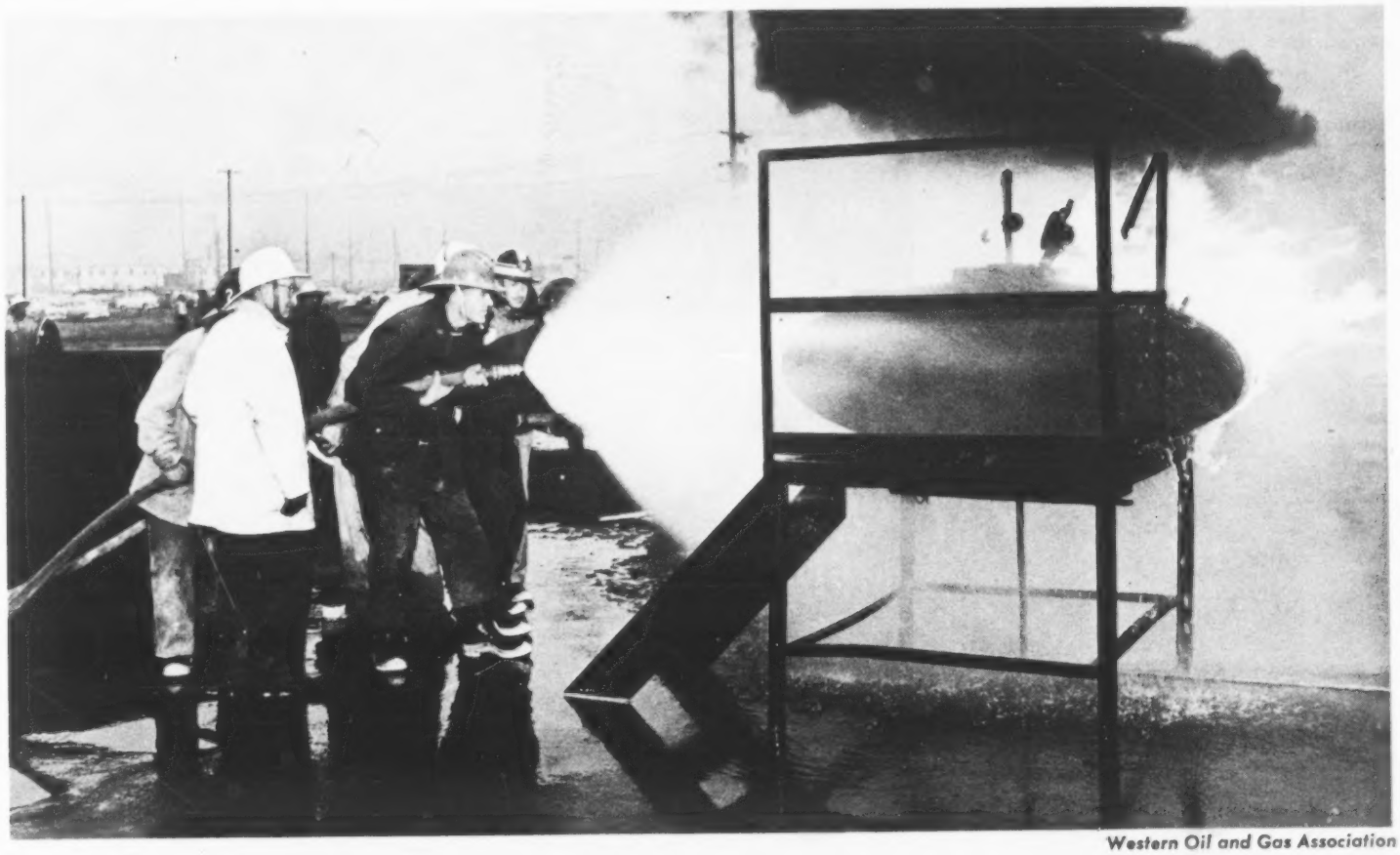

Western Oil and Gas Association

Fig. 108. Approaching simulated truck tank and loading rack to shut off fill stem valve during dome overflow.

16622

UNIT V — INSTRUMENT WORKING DRAWINGS

General Information

A working drawing made with instruments is used in industry to guide the workman in making an accurate part or complete product for the commercial market. The chief job of the draftsman in industry is to do detailed drawings and assembly drawings. The workman must have a complete understanding of what is required for the exact shape and size of the part he is concerned with in his work. Mistakes in the drafting room can be costly if allowed to go into production. The draftsman must see that his drawings do not become the cause of costly mistakes. He must do all lettering carefully and neatly and his dimensioning must be accurate and easily read.

The use of triangles, T-square, and compass have been included in previous units. These, along with the architect's scale, are considered to be basic drafting tools. The draftsman, designer, engineer, and architect use a wide variety of precision instruments and special equipment to produce very accurate, exact drawings. It should not be concluded, however, that instruments alone will insure professional results. The usefulness and appearance of any drawing depend chiefly on the person making the drawing and <u>not on the tools</u>. Drawing instruments are available individually or in sets. Sets, depending on the quality and price, usually include as a minimum two compasses of the same type (friction or spring joint) but of different sizes for large and small circles and arcs; a divider, used to lay

Western Oil and Gas Association

Fig. 109. Letting a gasoline spill fire burn out under control.

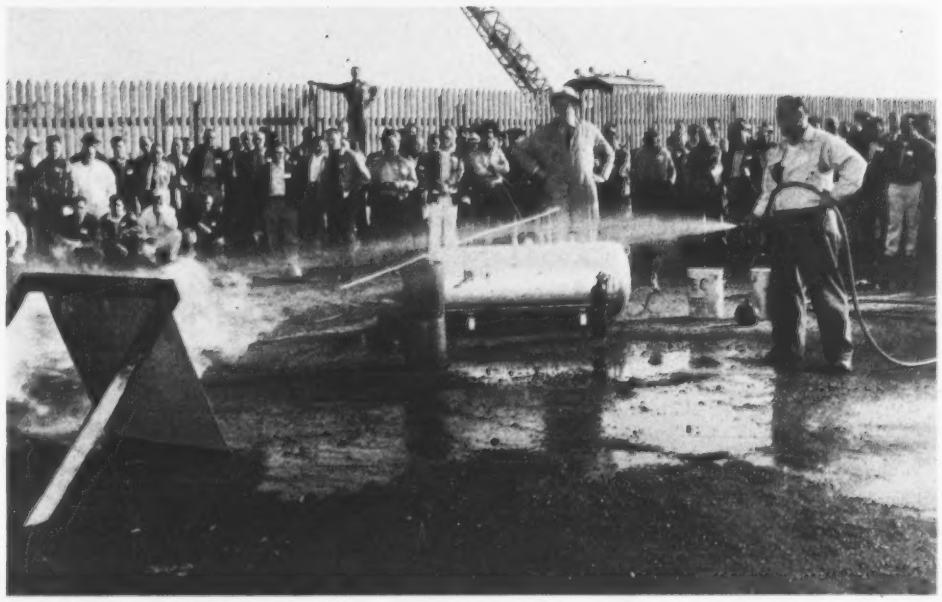

Western Oil and Gas Association

Fig. 110. Cooling a plywood panel that has a butane vapor jet fire burning against it.

Western Oil and Gas Association

Fig. 111. Starting to move in to close a valve at the base of one of the upright pipes supplying gasoline fuel to the leaking flange above. There are three empty horizontal drums on the ground.

16623

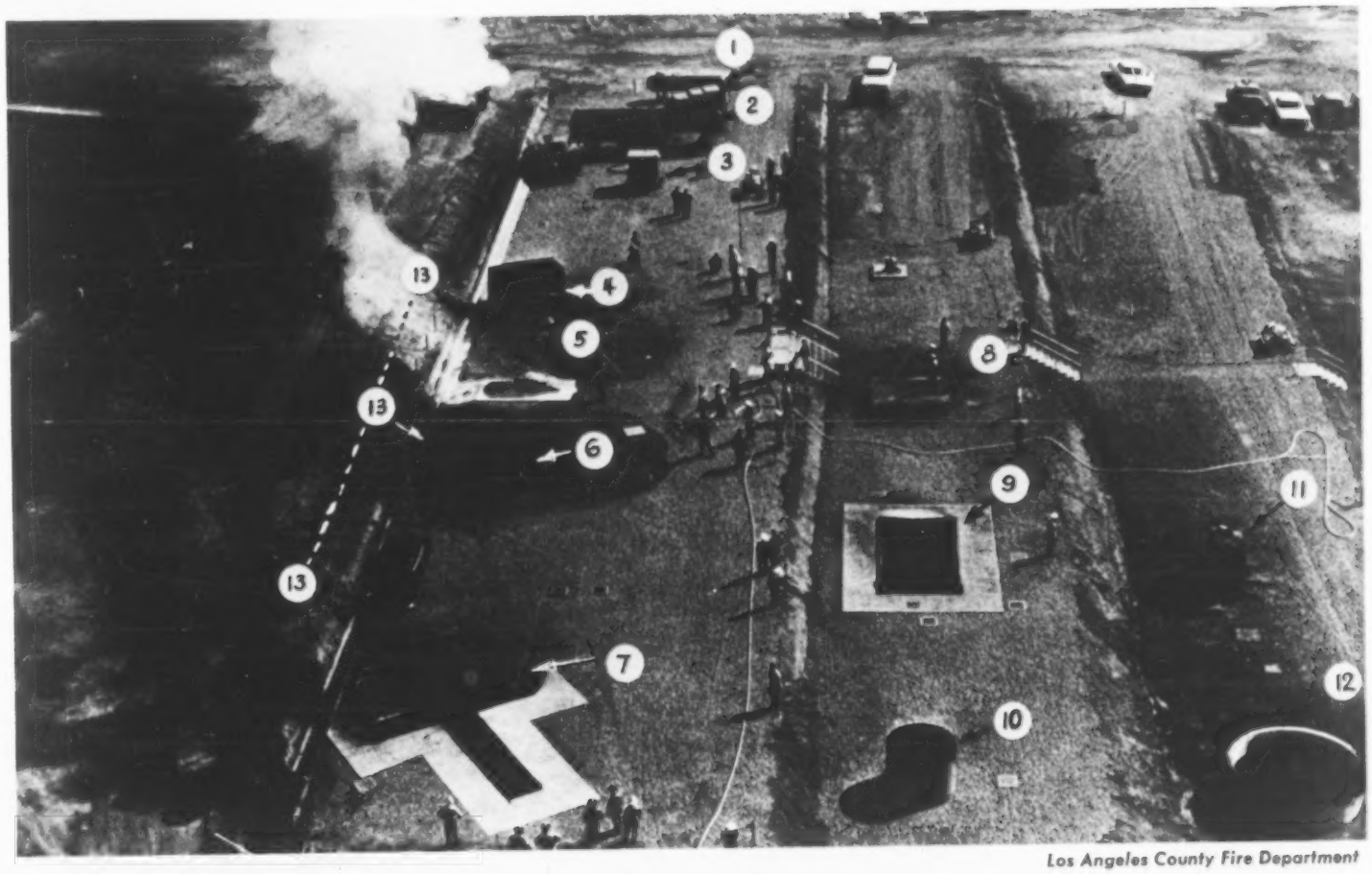

Los Angeles County Fire Department

Fig. 112. Aerial view of the 260- by 290-foot drill grounds of the Los Angeles County Fire Department: (1) 1150-gallon LP gas storage; (2) a fire-compartmented, 6000-gallon tank for flammable liquids; (3) pump house; (4) backboard for LP gas fires; (5) spill fire area; (6) Christmas tree; (7) 21- by 30-foot cross-shaped trench; (8) 10- by 10-foot oil well cellar; (9) 10- by 20-foot tank; (10) 8-foot-diameter tank; (11) loading rack; (12) 18-foot-diameter tank; (13) 200-foot gutter. Some new props and fuel storage tanks have been installed since this picture was taken.

Los Angeles County Fire Department

Fig. 113. A 10- by 10-foot concrete pit, simulating an oil well cellar covered with a heavy wood plank derrick floor.

16624

Los Angeles County Fire Department

Fig. 114. Working the cross-shaped pipe trench.

Los Angeles County Fire Department

Fig. 115. Simulated tank truck loading rack with a square tank supported upon concrete piers.

local fire department, and members of the Fire Committee of the Western Oil and Gas Association. The larger schools of which there is record are given in Table 11.

Figures 103 to 108 for Tacoma, and Fig. 109 to 111, inclusive, for Kennewick show that the majority of the props were similar to those used in the California schools. The overall patterns for indoor basic and outdoor demonstration and participation drills also were similar. Lyle Goodrich, Supervisor of Fireman Training Programs, has conducted excellent schools in the Northwest. Figures 117 and 118 illustrate excellent inexpensive props that were used in the 1963 school at Sparks, Nevada.

16625

Los Angeles County Fire Department

Fig. 116. The captain closes the butane control valve. Against the backboard there is smokeless flame, which has been reduced by the fog nozzles.

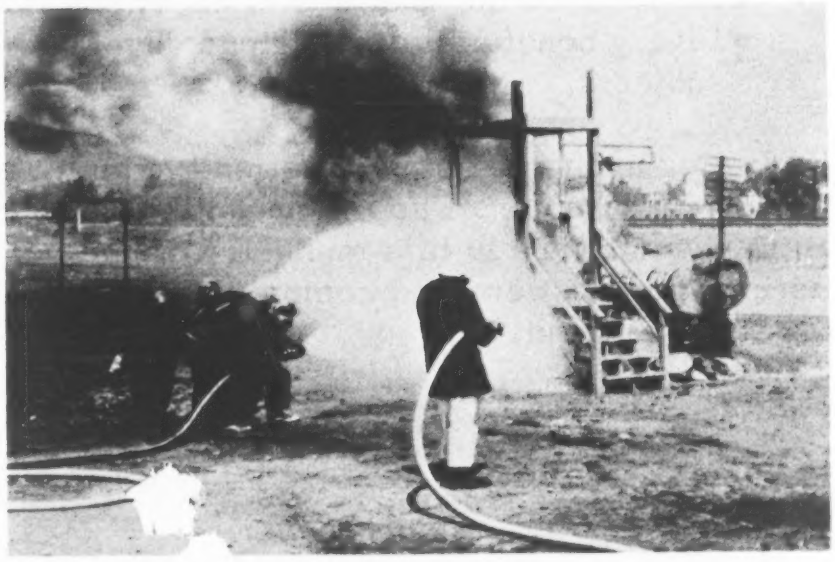

Western Oil and Gas Association

Fig. 117. An inexpensive prop made from an old, small tank supported on brick and a sturdy wooden loading platform. Because the wood is wet by the fog lines, it will last a long time.

Western Oil and Gas Association

Fig. 118. Using a 1½-inch line and sizing up the job prior to moving in to close the fuel valve at the bottom of the left-hand riser located close to where the burning fuel is falling on the ground. This prop, made from 2-inch pipe and a flange with the bottom third of the gasket cut out, is inexpensive and a good training aid.

16626

SECTION 5 QUESTIONS AND ANSWERS

Review examinations at the 1955 and 1961 fire schools in Bakersfield were given to all students during the two evening sessions. The large group was divided into small groups and each met in separate classrooms at the local high school. The examinations served a number of purposes.

- Each student found out how well he had learned his lessons.
- He secured the answers to questions that he did not know.
- Lively beneficial discussions developed, particularly on controversial subjects.

Following are two sets of questions, which were used at the 1961 school. For the benefit of others who may read this chapter, it is suggested that you do not mark the answers in this manual. Use a separate sheet of scrap paper for listing your answers and compare them with the correct answers, which follow the questions.

16627

INSTRUCTION SHEET FOR REVIEW QUESTIONS

Part I

The review is divided into two parts. One part will be given each day for that day's work.

You will be given two sets of questions. You will complete one set and then copy your answers onto the second set. You will give one set to your group leader, and you may keep the other for reference during the discussion period that will follow the review.

Tips for the student: Do not try to answer the questions in their numerical order. Read through the set and first answer those that are easy to answer. Then return and devote more time to those that are more difficult. Hold the most difficult ones for the last. Answer as many as you can.

There are no "trick" questions in this review. Some are more difficult than others. It is not expected that all students will be able to answer all questions correctly.

After the review is completed, the group leader will give you the correct answers so that you can correct your duplicate set of questions and keep it. Feel free to challenge the leader on any point with which you do not agree or to ask questions about any point that is not clear to you.

One of the objectives of the review is to stimulate group discussion. Take advantage of the opportunity.

16628

OIL FIRE CONTROL SCHOOL

Bakersfield, California
March 9-11, 1961

REVIEW QUESTIONS
Part I

_____ _____
Name of Participant City State

_____
Score

Instructions: Draw a circle around the letter "T" if the statement is true, or around the letter "F" if the statement is false, or fill in the blank at right in the multiple choice questions.

1. One of the important purposes of conducting this fire school is to acquaint the fire service with the properties of various oils and gases so that firemen can combat these fires with better understanding, effectiveness, and safety to themselves. T F

2. Another one of the purposes is to enable you to do a better job of fire prevention and fire investigation when petroleum oils and gases are involved. T F

3. All oil fuels must be in the form of vapor in order to ignite. T F

4. The flash point is the temperature to which oil must be heated in order for the vapor given off from the oil to ignite:

   (a) Without any applied source of ignition
   (b) If a flame is brought near the surface of the oil

   _____ (a or b)

5. Gasoline gives off flammable amounts of vapor even at temperatures well below zero. T F

6. Kerosene, stove oil, and diesel oil give off sufficient vapor at summer temperatures (100° F) to ignite readily. T F

16629

239 OF 327

ED

056 238

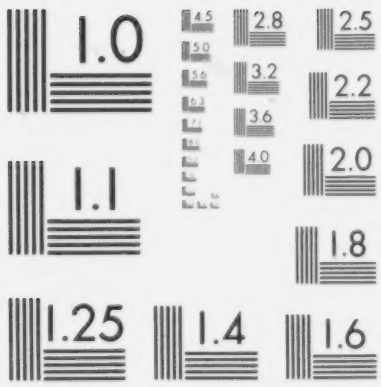

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

7. An odorant is added to LP gas to make it easier to detect when it leaks. T F

8. Any visible spark ignites gasoline vapor. T F

9. Gasoline vapor, even though heavier than air, is readily dispersed by wind. T F

10. Everyone with nails in his shoes should be kept away from a gasoline spill because sparks from the nails are a potential source of ignition. T F

11. Which of the following fuels will ignite spontaneously?

    (a) A rag wet with petroleum oils
    (b) A rag wet with linseed oil or paint
    (c) A rag wet with gasoline

    (a, b, or c)

12. Which one of the following fuels has the highest flash point?

    (a) Lubricating oil
    (b) Cleaning solvent
    (c) Gasoline
    (d) Butane

    (a, b, c, or d)

13. Gasoline spilled onto water tends to spread out in a thin layer, and in a short time it evaporates to the point where it may be difficult to ignite. T F

14. Evaporation of gasoline spilled on water can be accelerated by agitating the surface with straight water streams. T F

15. If open-flame warning devices are used at the scene of an accident involving a gasoline spill on the highway, extreme care should be taken to place them out of the range of possible vapor travel. T F

16. The cleaning solvent sold in most service stations is a high flash point solvent, which cannot be ignited until its temperature is raised to above 100° F. T F

16630

17. Dispersal of a heavy vapor such as LP gas vapor will be assisted by the use of a spray stream from a fog nozzle. T F

16631

off equal distances on a straight or curved line, to transfer measurements and to divide a line into equal parts; a ruling pen for inking straight lines; and compass attachments for inking circles and arcs, plus extra leads and repair parts.

0391 1661

OIL FIRE CONTROL SCHOOL

Bakersfield, California
March 9-11, 1961

REVIEW QUESTIONS
Part II

Name of Participant _____ City _____ State _____

Score _____

Instructions: Draw a circle around the letter "T" if the statement is true, or around the letter "F" if the statement is false, or fill in the blank at right in the multiple choice questions.

1. Assume an LP gas tank truck has been involved in an accident and is producing a leak, which is burning like a jet directed outward or upward, with no flame touching the tank shell. The best procedure is to:

   (a) Attempt to extinguish the flame with hand extinguishers or water fog.
   (b) Let it burn.
   (c) Apply water to keep the entire tank shell wet.

   (a, b, or c) _____

2. Same as above except that flame is playing against the shell of the tank. The best procedure is to:

   (a) Let it burn.
   (b) Attempt to extinguish the fire.
   (c) Apply water spray to cover the entire tank shell.
   (d) Concentrate available water particularly on the shell above the liquid level where most severely exposed to flame.

   (a, b, c, or d) _____

3. A gasoline tank truck has been involved in an accident, perforating the tank, so that liquid gasoline is spilling to feed a fire on the ground. The best procedure is to:

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(a) Keep all people, including firemen, well away from the truck.
(b) Attempt to flush burning gasoline away from the truck with hose streams.
(c) Shoot holes in the tank.
(d) Attempt to keep the fire-exposed portions of the shell wet with water.

(a, b, c, or d)

4. A fill opening fire occurs during the loading of a tank truck at a loading rack and the flow has been cut off, but the fill stem is still in place. The best procedure is to:

(a) Let the fire burn.
(b) Pull the tank truck out from under the loading rack.
(c) Remove the fill stem and close the cover.
(d) Extinguish with a hand extinguisher.

(a, b, c, or d)

5. Assume that an underground tank at a service station is being filled from a tank truck, and a small fire occurs at such a location that the usual control valve cannot be reached. The best procedure is to:

(a) Drive the truck away.
(b) Shut off the flow by means of the remote emergency release.

(a or b)

6. Suppose, during the filling of an underground tank from a tank truck, the vapors issuing from the vent become ignited. The best thing to do is to continue the flow so as to prevent the flame from flashing back into the tank. T F

7. The water hose at the service station pump block is the best extinguisher for upholstery fires. T F

8. If the dispenser at a service station is knocked over by an automobile, no more than a gallon or two of gasoline is likely to be spilled. T F

9. Let us assume that a severe fire is burning on the ground around a conventional 10-foot by 30-foot vertical gasoline tank two-thirds full. The gasoline in the tank will not explode. T F

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10. Assume the gasoline in the same tank starts to boil and the vent cannot handle the vapor. The roof pulls loose from the shell. It is likely that the gasoline will boil over and cause a severe spread of fire on the ground. T F

11. A tar pot containing very hot asphalt catches on fire. One good way to extinguish it is to agitate it with a straight water stream. T F

12. A leak in the bottom of an oil storage tank can cause an oil spill that could be serious if ignited. Introducing water into the tank to float the oil above the level of the leak is a good emergency measure. T F

13. In a spill fire involving hot asphalt or heavy fuel oil, a good method of extinguishment is gently to spray the surface with water to produce a froth. T F

14. Where a large LP gas storage vessel designed to nationally recognized standards has failed in a fire, the cause has most likely been that:

    (a) The product in the vessel exploded like TNT
    (b) The pressure in the vessel greatly exceeded the relief valve setting.
    (c) The fire softened the unwetted portion of the shell above the liquid until it bulged out and failed.

    (a, b, or c)

15. It is always important to open the main electric service switch before starting to fight a fire in a service station. T F

16. A large burning stream of gasoline issuing under pressure from a leak can seldom be extinguished with water spray. T F

17. Fog nozzles may be much more effective in the control of oil fires than straight streams where close approach to the fire is possible. T F

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OIL FIRE CONTROL SCHOOL

Bakersfield, California
March 24-26, 1955

REVIEW QUESTIONS

A few questions that were used in the 1955 school were not used in the 1961 school because other questions were substituted for them. Some of these 1955 questions are added below for further review.

18. A spark produced below the surface of gasoline liquid will cause it to explode. T F

19. Water spray is good for killing a fire involving a fuel with a flash point above atmospheric temperature because the water spray cools off the burning oil surface and stops the evolution of vapor. T F

20. An open, shallow 10- by 10-foot pit of gasoline is on fire. It can be extinguished with spray alone. T F

21. The same pit contains kerosene, which is on fire. It can be extinguished with water spray alone. T F

22. Vapors from carbon tetrachloride are not poisonous. T F

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ANSWERS

Part I

Question Number	Answer
1	True
2	True
3	False

(In practically all cases the correct answer is "true." Under some circumstances, however, a concentrated spray or mist of heavy, high flash oil may be ignited at a temperature below the flash point of the oil. In principle, this is similar to the ignition of dusts, coal, wood, flour, etc.)

4	b
5	True
6	False
7	True
8	False

(As an example, a visible spark from a single flashlight battery cell has too low an energy content to ignite gasoline vapor. However, it may ignite other more easily ignitable fuel vapor, such as carbon bisulfide [a rodent-killing material], etc.)

9	True
10	False

(Sparks from shoe nails, like sparks from hand tools, have too small an energy content. In a tank truck accident, however, an overturned truck sliding over concrete pavement may produce higher energy sparks, which could ignite gasoline vapor.)

11	b
12	a
13	True
14	True
15	True
16	True

(This can be checked by filling a saucer with cleaning solvent and attempting to ignite it with a match. Gasoline ignites promptly, but cleaner's solvent does not. However, if the match flame is held near the surface of the solvent

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for a moment the radiant heat from the flame will heat a local surface area of the solvent above the approximately 105° F flash point, and the fuel will ignite.

(Other fuels with much higher flash points may be very difficult or impossible to ignite in the same manner. An example is lube oil.

(A large garment wet with cleaner's solvent and hung up to dry in a small closed service porch can form an explosive atmosphere when the air temperature is less than 100° F.)

17	True

Question Number	Answer
1	b
2	d

(The answers [c] for Questions 1 and 2 were added to stimulate discussion. There is no harm in using [c] as a precautionary measure, but it is not absolutely necessary and should not be done if the water supply must be conserved.)

3	b and d
4	d first and c second
5	b
6	False

(The gasoline vapor concentration in the atmosphere in the underground tank will be above its flammable limit, and hence the flame will not pass into the tank but simply will burn in the open above the fill opening.)

7	True
8	True

(That is, assuming the pump is located within the dispenser unit. This question and some others were included to stimulate good group discussion to cover variations of the particular problem.)

9	True
10	False
11	False
12	True

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(The rate of water added should be sufficient to maintain the water level above the leak but not so great as to overflow the tank.)

13	True
14	c
15	True
16	True
17	True

1955 Test

18	False
19	True
20	False
21	True
22	False

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PART 4 OIL FIRE TRAINING FILMS

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USING OIL FIRE FILMS

This part of the manual contains a list of available films and suggestions on how to gain the most value from their use. Films are used extensively in schools and universities. Students retain their lessons best if the subject matter is discussed and also illustrated.

TABLE 12
Retention of Subject Matter

Method of Instruction	Retained After 3 Hours	Retained After 3 Days
Lecture only	25-70%	10%
Film only	75%	20%
Film and discussion	80%	65%

Some instructors neglect to preview a film before the showing and to conduct a discussion afterward on the lessons to be learned from the film. They use the lazy method of letting the film do their job. With this method, the students retain only 20 percent of the subject matter after three days. If the proper instruction is used, they may retain 65 percent.

Techniques for Teaching with Films

Before the Meeting

1. Preview the film. Take notes outlining the film's content and main lessons. Do not use the film unless it illustrates the key points that you wish to put over. A short film on a specific subject has better training value than a long one of more general interest.

2. From your notes prepare an outline of the discussion to precede and follow the showing. If applicable, prepare a true-false test or other type of simple quiz for use after the discussion.

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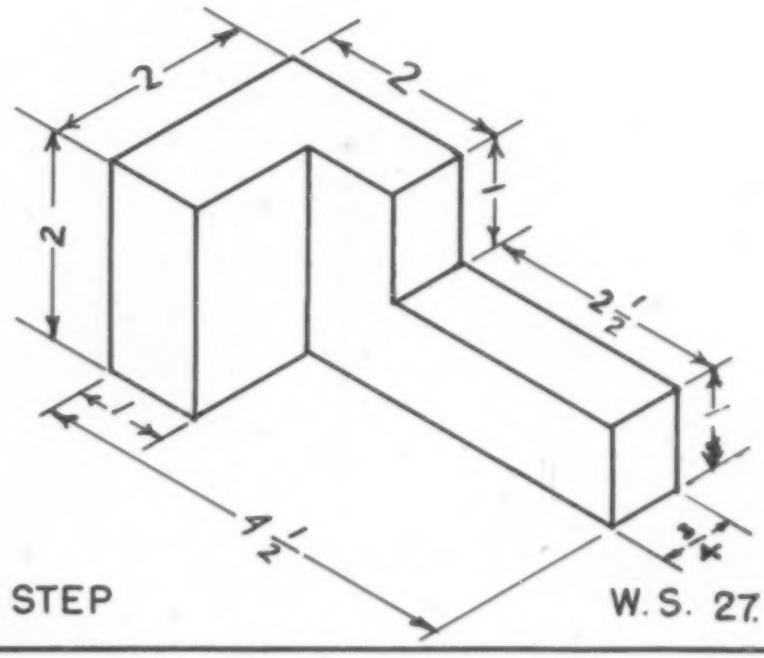

ANGLE STEP W.S. 27.

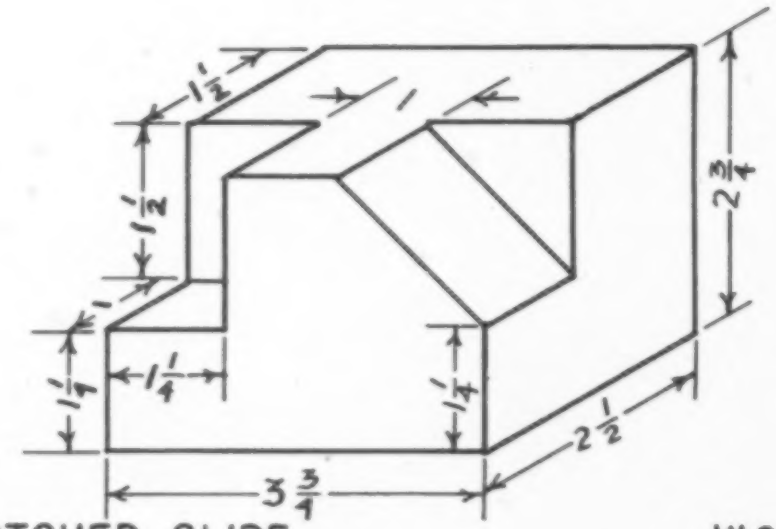

NOTCHED SLIDE W.S. 28.

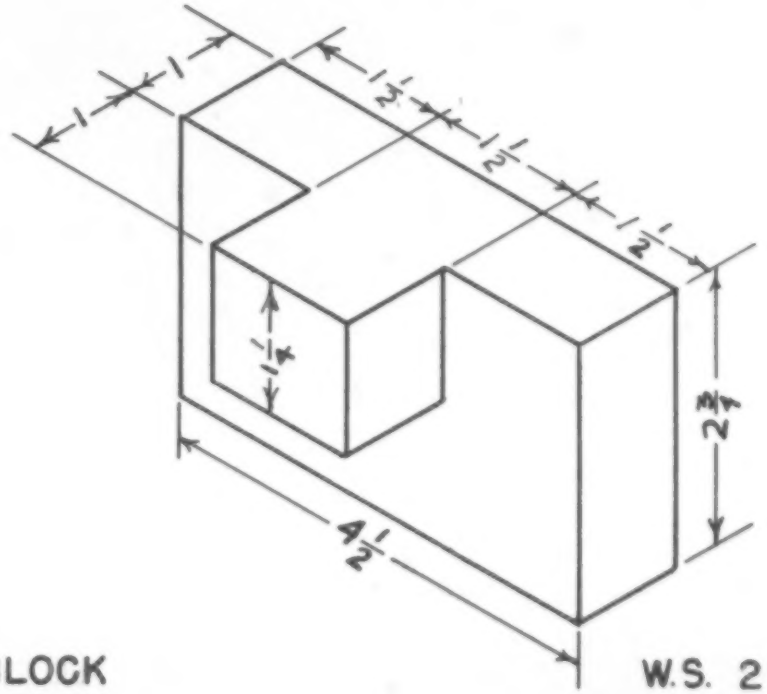

T. BLOCK W.S. 29.

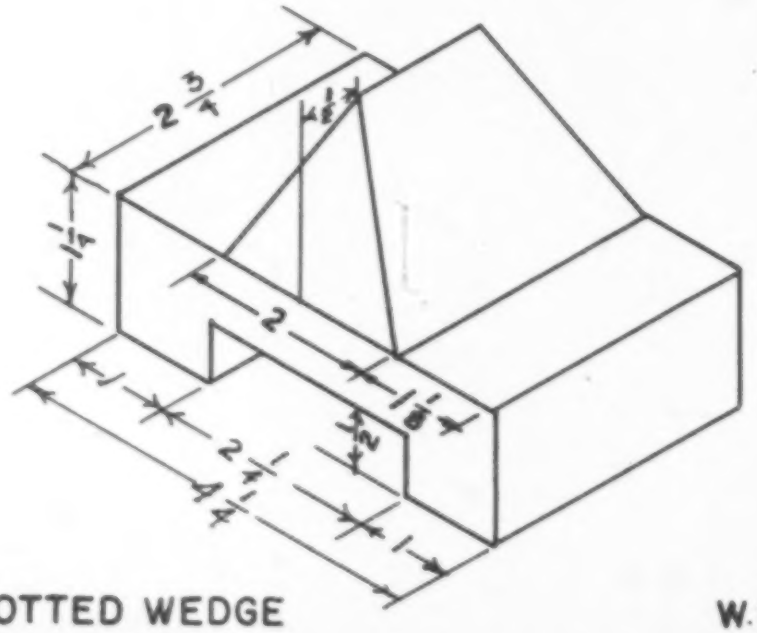

SLOTTED WEDGE W.S. 30.

ILLUSTRATION SHEET 15

3. Select a properly darkened room with good ventilation. Arrange the seating to provide the best visibility and comfort. Eliminate or minimize distracting noises

During the Meeting

1. Explain to the firemen why you selected this particular film and what it is about.

2. Prepare them for what is coming. Tell them what key points to look for. Distribute note pads and pencils.

3. When applicable, tell them that you will pass out a quiz sheet after the film.

4. Show the picture.

5. After the showing, use your preview notes. Ask each man a question or two. Elicit discussion, particularly from the quiet ones. Cover the key points thoroughly.

6. If necessary and time permits, reshow the film to clear up any controversies or emphasize important points.

7. Pass out the quiz sheets.

8. Provide the answers and have the men grade and keep their copies.

After the Meeting

In your log book post the title and source of the film, its length in minutes, your appraisal of its value, your preview notes, and a copy of the quiz sheet, all for possible future use.

Available Training Films

The majority of the following 16 mm. motion pictures were taken from an NFPA listing. The code letters at the end of each description show the sources. The code key follows at the end of the listings. This is not a complete list of all films available, but it does contain most of the good films on oil fire control. Some suppliers of fire fighting equipment also have good training films--for example, the Ansul Chemical Co., which lends films on dry chemical extinguishers. In 1963 the National Foam System, Inc. (N-6), produced an excellent 21-minute film covering the development of foams for fighting large oil fires and demonstrating modern equipment and methods.

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Oil Fire Control Films

1. Fighting Tank Fires, 26 min., color, 1961. Actual fire company attack on oil tank fires; how to position crew, choose nozzle size, lay lines, move in. Loan, W-2. Buy, N-5, $165. (NFPA Flammable Liquids Engineer Miles Woodworth has also prepared a set of 36 colored 35-mm. slides and a script on the slides. The movie is excellent in itself, but its value is greatly enhanced by the supplementary use of the slides and commentary. If you borrow this film, we highly recommend that you purchase the slides and commentary booklet from NFPA for $15. Chiefs who have used both say the supplemental use of the slides increases retention four to five times the retention of information when the film is viewed alone.)

2. Oil Fire Protection Through Knowledge, 30 min., color, 1956. The chemistry of fire, sources of ignition, control, prevention through operation, maintenance, design, fire control, extinguishment, and training. Loan, S-4. Buy, S-4, $275.

3. The Chemistry of a Petroleum Fire, 32 min., color, 1962. Tabletop demonstrations of the characteristics of flammable liquid fires, safety measures. Loan, A-1. Buy, A-1, $140.

4. Fire Power, b&w, 1951. Tabletop demonstrations of the hazards created by gasoline vapors, showing methods for their control. Loan, E-2, S-5. Rent, U-11.

5. Analysis of a Bulk Plant Fire (Kansas City Bulk Plant Fire), 24 min., b&w, 1962. Dramatic tank explosion scenes, in a newsreel type of film but with new explanatory prologue (added in 1962) on conditions prior to the fire and an epilogue containing important suggestions relating to effective fire fighting procedures and personal safety to fire fighters. Loan, W-2, A-1. Buy, A-1, $45.

6. Heating Safely, 6 min., b&w, color, 1954. Safe ways to use portable oil heaters and stoves. Loan, N-2, W-2.

7. Kerosene the Killer, 17 min., b&w, 1953. The many hazards of kerosene and kerosene stoves. Loan, M-3.

8. Under Control, 17 min., color. Characteristics of volatile substances and the procedures for their safe handling. Loan, E-3.

9. A Pound of Prevention, 38 min., color. Step-by-step demonstration of safety procedures for tank truck operations. Loan, E-3.

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10. Pipeline on Wheels, 28 min., color, 1951. Safety factors in fuel tank truck operations from a driver's point of view. Safe construction of tank trucks and safe driving practices. Fire training ground scene involving full-sized tank truck fire. Loan, D-3, S-5.

11. Tank Truck Fires, 15 min., color, 1956. Instructional film on oil industry training methods. Training of drivers, handling of tank truck fires, use of dome covers and emergency valves. Fire extinguishment under the hood and at the dome as well as spill fires. Loading rack overflow fires using truck and plant extinguishers. Loan, A-5, S-2. Buy, A-5, $100; T-2, $97.

12. Farm Petroleum Safety, 28 min., b&w. Safe and unsafe ways of handling petroleum products. Rent, U-10, $1. Buy, A-1, C-7, $127.50.

13. Safe Every Second, 22 min., color. Need for constant alertness in gasoline service station operations. Loan, S-4.

14. Water Fog--Master of Fire, 37 min., color. How water fog controls flammable liquid fires. Also Class A fires. Principle and operation of equipment. Good film for industrial plants, refineries, fire departments. Loan, R-3. Buy, R-3, $250.

15. Let's Try Fog, 18 min., color, 1955. Actual tests of fires in oil pits, tank truck oil storage tank, rubber tires, and small arms ammunition. Demonstrations of application of wetting agent from special nozzles, master devices, fixed foam chambers, and use of plain water. Loan, W-2. Buy, S-6, $97.50.

16. Fog Techniques, 20 min., silent and titled, color. A fire training film showing an actual oil well fire and its shut-in and extinguishment by trained men applying the water fog technique. It also shows the drill ground training with fog that these men received. Loan, U-1. Buy, A-1, $70.

17. Fire on Signal Hill, 30 min., sound, color. Portrays two days of fire fighting experiences gained during the largest refinery fire on the West Coast. Emphasizes prefire planning, mutual aid, and communication. Stresses important lessons learned in design and fire fighting, etc. Includes some of the finest oil fire fighting film ever taken under major fire conditions. Loan, E-2. (See also film No. 23.)

18. Petroleum Fires, color. Characteristics of petroleum fires. Methods of prevention and control. Equipment and techniques for extinguishing various types of petroleum fires. Loan, T-1. Buy, N-5, $125.

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19. LP Gas Fire Control, 11 min., sound, color, 1959. On-the-scene graphic report showing how preplanning helped one fire department do an outstanding job in handling an LP gas tank truck fire. Produced for the NFPA Gases Field Service. Loan, L-3, W-3. Buy, N-5, $75.

20. Safe Handling of Light Ends, 20 min., color, 1962. Fire prevention in pumping, handling, storage, and transportation of LP gas products. Good fire action scenes in proper cooling of flaming tank truck. Loan, D-3. WLGA (Code W-3) recommends their 35-mm. strip film of 32 frames using clip shots taken from the above movie, with a supplementary Leader's Manual for the instructor. Loan, W-3.

21. Respect, 35-mm. strip film with a record. Plant owner shows new employee through the plant, properties, describing properties of LP gas, delivery, safe truck handling, tank installations at various destinations, and how excess and relief valves work. Loan W-3, P-1.

22. Emergency Control of Natural Gas, 30 min., color. Various control procedures for emergencies involving natural gas. City distribution of gas, physical properties, areas of hazard, actual fire scenes. Based upon operating procedures of a Los Angeles Gas Company. Loan, A-2. Buy, C-2, $187.50.

Films of Related Interest

23. Danger Water, 30 min., sound, color. Dangers of accidental introduction of water into hot oil systems--animation, tabletop demonstrations, and actual case histories. A good companion picture to film No. 17. Loan, E-2.

24. Danger Air, 35 min., sound, color. Explosions and detonations in processing equipment. Fire prevention measures. Loan, E-2.

25. School for Fire Fighters, 30 min., b&w. Hose connections, the proper way to roll hose, and proper use of fire fighting tools to control various types of fire in flammable liquids and ordinary combustibles. Loan, R-3.

26. Using Water Wisely, 23 min., sound, color. Indirect fog application of test fires on small structures where water quantities used were recorded. Application to confined fires in oil installations. Booster and 1-1/2-in. lines are covered. Loan, T-3.

27. Master Spray Stream Problems, 20 min., sound, color. Large spray nozzles used on heavy stream units, deluge sets, deck guns, and ladder

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pipes and multiple hose lines from 1000 gpm or larger pumpers. Loan, T-3.

28. Fog Against Fire, 20 min., sound, color. Proper fog patterns, nozzle sizes on fires larger than those covered in film No. 27. Fog curtains for exposure protection and master spray streams. Loan, T-3.

Films of Historical Interest

The following films relate to Section 4 of Part III.

29. Fighting Petroleum Fires, 45 min., silent, b&w. This rare film, made about 1935 and sometimes called the "Chicago Fire School Film," was used by the "West Coast faculty" at the May, 1943, fire school in Chicago. It is probably the first training film relating specifically to flammable liquid fires. It covers tabletop demonstrations, a discussion of static, extinguishing techniques of the time (including the handling of large tank fires), etc. Except for the classroom part, which is good today, the remainder is of historical interest only. This film is not available for general loan. It is owned by Western Oil and Gas Association.

30. Oil Fires and Their Extinguishment, 45 min., sound, b&w. Same as the preceding film No. 29 except that it has a sound track, added about 1941, and a new title. Many years ago it was available for loan from the Ethyl Corporation. The Western Oil and Gas Association has a print.

31. Chemistry of Fire, World War II Navy Fire Fighters School training film in two parts. Some of the material is similar to parts of films No. 29 and 30. Although this film shows older techniques of extinguishment, the tabletop demonstrations deserve review. Part I, 32 min., sound, b&w. Good tabletop demonstrations of flammable liquids, other oils, and combustibles, as found aboard ships. (Data quoted on ignition temperatures are in error. See Part I of this manual on the subject.) Part II, 15 min., sound, b&w. Tabletop demonstrations of ship and shore-side extinguishing techniques. Steam smothering, CO_2, foam, and water fog. Loan, T-3.

32. 1941 Bakersfield Oil Fire Control School, silent, color. Scenes from the first fire school in Bakersfield. This rare film is of historical interest only. It is not available for loan but may be seen by appointment. It is owned by the Kern County Fire Department.

33. 1955 Bakersfield Oil Fire Control School, silent, color. Film record of the demonstration and participation drills at the 1955 school. Film is kept in Thomas S. Ward's office (T-3).

Insofar as known there is no film on the 1961 Bakersfield Oil Fire Control School.

Sources of Films[1]

A-1 American Petroleum Institute, 1271 Avenue of the Americas, New York 20, N.Y.
A-2 American Gas Association, 420 Lexington Ave., New York 17, N.Y.
A-5 Ansul Chemical Co., Marinette, Wis.
C-1 Cinesound Co., 1037 North La Brea, Hollywood 30, Calif.
C-7 John Colburn Associates, 1122 Central Ave., Wilmette, Ill.
D-3 E. I. DuPont Co., Petroleum Chemicals Division, 612 South Flower St., Los Angeles 17, Calif.
E-2 Ethyl Corp., 1141 Huntley Dr., Los Angeles 26, Calif.
E-3 Esso Standard Oil Co., 15 West 51st St., New York 19, N.Y.
L-3 Liquefied Petroleum Gas Association, 1355 Market St., San Francisco 3, Calif.
M-3 Memphis Fire Department, Fire Prevention Bureau, 65 South Front St., Memphis, Tenn.
N-2 National Board of Fire Underwriters Film Library, 1840 Alcatraz Ave., Berkeley, Calif.
N-5 National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass.
P-4 Phillips Petroleum Co., Bartlesville, Okla.
R-3 Rockwood Sprinkler Co., 38 Harlow St., Worcester, Mass.
S-2 Socony-Mobil Oil Co. Film Library, 150 East 42nd St., New York 17, N.Y., or 903 W. Grand Boulevard, Detroit 32, Mich.
S-4 Standard Oil Co. of California, 225 Bush St., San Francisco 20, Calif.
S-5 Standard Oil Co. of Ohio, Midland Building, Cleveland 15, Ohio
S-6 Steve Smith Pictures, 623 Kansas Ave., Topeka, Kan.
T-1 Tidewater Oil Co., 4201 Wilshire Blvd., Los Angeles 5, Calif.
T-2 Texas Industrial Film Co., 2528 Northern Blvd., Houston, Tex.
T-3 Thomas S. Ward, Supervisor of Fire Training, State Department of Education, 721 Capitol Mall, Sacramento, Calif., 95814.
U-1 Union Oil Co. of California, P.O. Box 7600, Los Angeles 54, Calif.
U-10 University of Missouri, Visual Education Department, 23 Jesse Hall, Columbia, Mo.
U-11 University of Texas, Visual Instruction Bureau, Austin 12, Tex.
W-1 Western Oil and Gas Assoc., National Oil Bldg., 6th and Grand St., Los Angeles 17, Calif.
W-2 Western Actuarial Bureau, 222 West Adams St., Chicago 6, Ill.
W-3 Western Liquid Gas Association, 1355 Market St., San Francisco, Calif.

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[1]Please book loan films in advance.

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ABSTRACT - Developed by the Iowa Department of Public Instruction with the cooperation of educational personnel, this curriculum guide is designed for the instructor's use in planning industrial arts programs and activities. A definition, philosophy, and specific objectives for industrial arts are stated. Other units considered in the first part of this document include: (1) Requisites of Quality Industrial Arts, (2) Scope and Sequence of Industrial Arts Programs, (3) Selected Aspects of Organization and Administration, (4) Purposeful Teaching, (5) Measurement of Student Achievement, and (6) Useful Information for the Teacher as a Professional. The Second Part contains background information, learning activities, selected instructional aids or sources, equipment, and supplies of tools and equipment for eight specific areas of industrial arts. (GEB)

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INDUSTRIAL ARTS for IOWA SCHOOLS

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Allen Suby, Industrial Arts Instructor, Belmond Community Schools, Belmond, Iowa

Plastics

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Power (Power Mechanics, Auto Mechanics)

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University of Northern Iowa Cedar Falls, Iowa

16651

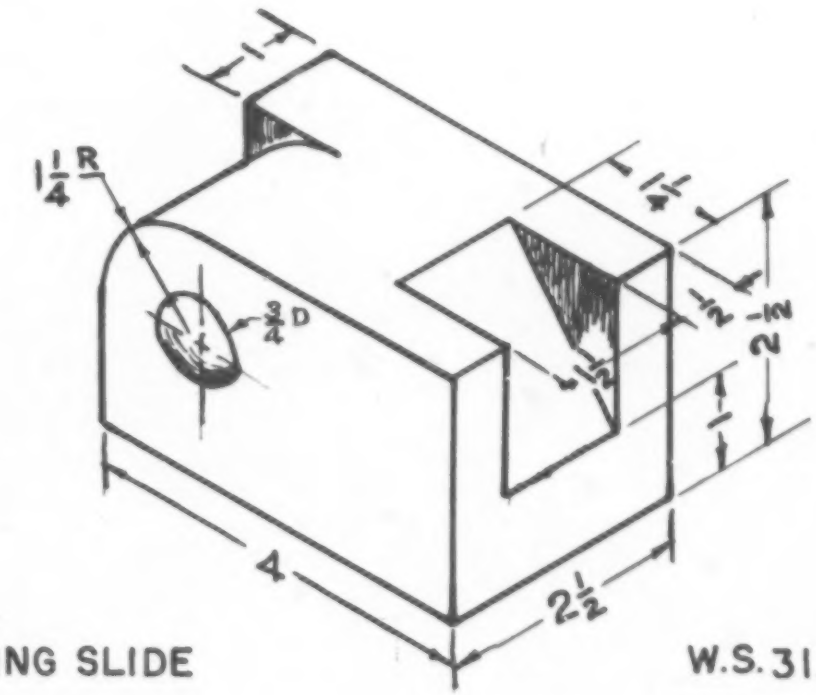

BEARING SLIDE W.S. 31.

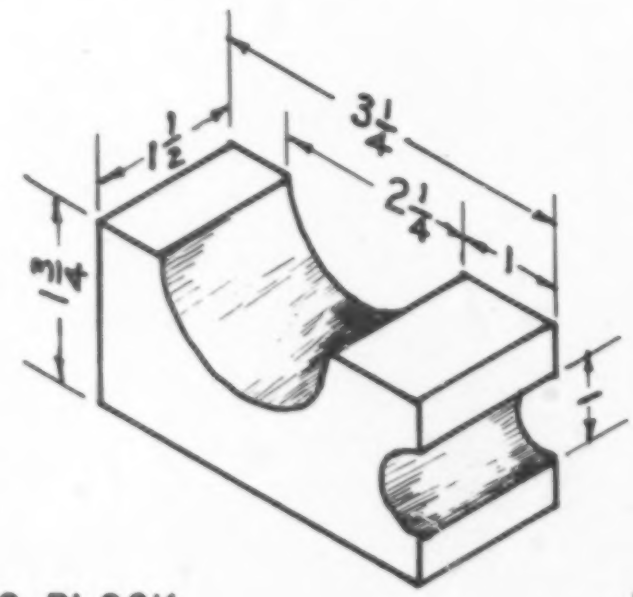

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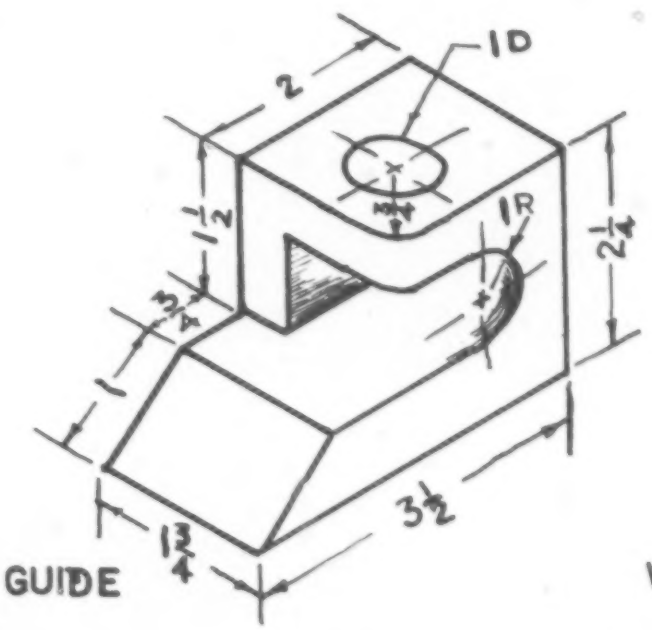

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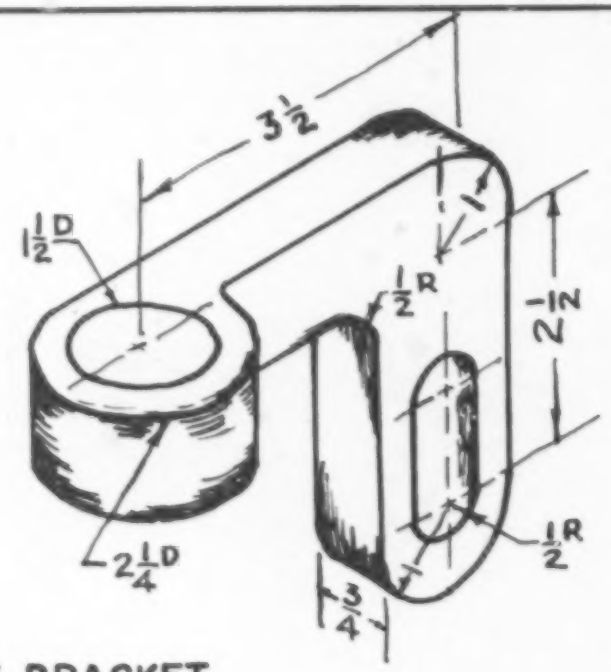

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FOREWORD

Industrial arts is in transition. Moving from the earlier programs where only two or three instructional areas were taught, the industrial arts offerings must now provide for more areas and more technical instruction in these areas if industrial arts is to be representative of the vast technology of our ever-expanding industrial environment.

Iowa is an important part of this industrial environment. Although many people think of Iowa as primarily an agricultural state, few are aware that Iowa's industrial output of $2.5 billion in 1950 surpassed that of agriculture. Industrial output in Iowa has continued to grow, exceeding $10 billion in 1968 compared to an agricultural output of $3.3 billion.

In today's rapidly changing world, it is not enough that the industrial arts teacher be knowledgeable only in his field. He must become a perennial student of social and economic change and should sense change through personal contacts with industry, business, and education in his own community.

The Department of Public Instruction recognizes the importance of industrial arts as a part of the total curriculum. Administrators and school boards are urged to give serious consideration to incorporating a modern program of industrial arts in their school curriculum.

PAUL F. JOHNSTON
State Superintendent of Public Instruction

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PURPOSE

The purpose of this guide is to help those responsible for curriculum planning to develop and implement a modern program of industrial arts. This guide has been developed by experienced industrial arts educators. Every school system should find it a practical instrument for the improvement of instruction in industrial arts.

School administrators should find the information in the first portion of this guide helpful in keeping abreast of current developments in this important curriculum area. Industrial arts teachers should find this publication to be of particular value in developing sound programs and well-organized courses.

Our increasingly technological society has focused attention on the importance of industrial arts as a curriculum area. At the same time, industrial arts is being challenged to expand and clarify its function. Therefore, re-evaluation of current emphasis in industrial arts is essential.

A modern industrial arts curriculum should reflect current trends in technology. Traditional practices in familiar areas such as drafting, metals, and woodworking should respond to innovations by various changes in emphasis. Less familiar areas such as electricity-electronics, graphic arts, plastics, and power mechanics should receive increased attention as the impact of atomic energy, automation, and space research is revealed and understood.

It is hoped that all who are responsible for programs of industrial arts will be aided by this publication as they plan new industrial arts programs or revise existing programs to meet the needs of the youth of Iowa.

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I DEFINITION OF INDUSTRIAL ARTS

Industrial arts is that portion of general education devoted to understanding and solving the technical and human problems brought about by the industrialization and technological advancement of our society. It is especially concerned with technical communication (sketching, drafting, technical writing, and methods of reproduction including the graphic arts), research and development (improvements and inventions), production (manufacturing), and consumption (product selection, use, care, and maintenance).

Industrial arts is a categorical heading for subject matter of its own kind. Just as mathematics includes such content as arithmetic, algebra, geometry, and trigonometry; industrial arts includes such content as construction technology, drafting, electricity-electronics, graphic arts, industrial plastics, metal, power, and wood.

Preparation of students for employment is not a specific purpose of industrial arts; however, many students of upper level high school courses in this curriculum area are found to possess the type of attitudes, knowledge, and skills sought by employers.

Industrial arts may be used to enrich elementary education. Appropriate industrial arts course work should be taught to all boys and some girls in junior high school not later than eighth grade, and continued through the senior high school. Industrial arts, taught as an exploratory program, should give students the opportunity to identify their interests and aptitudes before they make decisions which commit them to a definite occupational or educational goal.

Industrial arts provides a means by which the student can apply in practical and meaningful situations the theoretical principles of science, mathematics, social studies, and other related subjects.

Industrial arts is often confused with industrial education, vocational-industrial education, and technical education, but it is not the same as any of these. Industrial education is the generic term used to include several *different* educational programs dealing with various aspects of industry. Industrial arts is closely related to vocational-industrial education and may make important contributions as a pre-vocational activity. However, it must not be confused with vocational or trade training. Its objectives are those of general education, and instruction in industrial arts should be valuable to any person regardless of his vocational choice. The following chart sets forth the similarities as well as the differences between the aforementioned types of industrial education.

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A COMPARISON OF INDUSTRIAL ARTS, VOCATIONAL-INDUSTRIAL EDUCATION, AND TECHNICAL EDUCATION*

Industrial Education			
	Industrial Arts	**Vocational-Industrial Education**	**Technical Education**
Type of Training	General exploratory education of industrial processes	Specialized training in a trade skill	Extensive knowledge of a field of specialization
Grade Levels	Grades 1 - 12	High school or post high school	Post high school
Hours per Week	1 - 10 hours per week	Minimum of 15 hours per week	Unspecified
Time and Location	Classes during regular school day on school grounds	During school day, class may or may not be on high school grounds	Classes day and night, on post-high school campus
Curriculum	Introduction to our nation's industry through courses in construction technology, drafting, electricity-electronics, graphic arts, industrial plastics, metal, power, and wood	Subjects vary with needs of community	Mathematical, scientific, and engineering processes that are related to the field
Teacher Preparation	College graduate	Skilled tradesman, need not be a college graduate	College graduate or technical institute graduate, plus appropriate experience
Job Placement	No effort for job placement	Student placed and followed	Students placed and followed, or may be oriented toward higher education
Equipment Necessary	Modern tools and equipment essential	Modern production equipment essential	Modern industrial equipment together with testing devices and specialized instruments.
Federal Aid	Some federal aid available under certain conditions	Federal aid	Federal aid

*Adapted from: Melvin V. Keil and John W. Neubaur, "What Is Industrial Education," *Phi Delta Kappan,* April 1965, pp. 402-03.

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II PHILOSOPHY OF INDUSTRIAL ARTS

The important place of industry in our society of today and its probable importance in the future demand that all members of our society have some understanding of the industrial world. In such a society each of us is dependent upon others in providing for his needs and it is important that the worth of each individual be valued, whether he be a tradesman, a production worker operating a machine in a large factory, a foreman, a draftsman, an engineer, or an executive. The contribution industrial arts can make here is unique in that understandings of work and appreciations of individuals become meaningful through first-hand experiences with the tools, materials, and processes of industry in a shop situation as well as in activities such as lecture-discussion and textbook assignments normally found in a classroom situation. Although various occupations require differing kinds and amounts of education, it is important for our youth to realize that it is honorable to work for a living regardless of their level of educational attainment. Our type of industrial society cannot survive by preparing well only those in the professions.

A good industrial arts program should be available for all boys and some girls. At the elementary level, it is usually integrated with the common core of elementary school subjects, frequently drawing content from historical events, geographical phenomena, and everyday life experiences. Major provisions for formal industrial arts at this level are not developed in Iowa to any appreciable degree at this time. At the junior high level, significant segments of industry become more clearly defined so that the general education objectives may be more readily attained. Fundamental practices in a variety of industrial pursuits should be evident at this level. Senior high school industrial arts should provide opportunities for more individual selectivity of content, with provision for greater specialization in the respective areas.

Properly presented, industrial arts has attributes which challenge students of all levels and interests. It embodies the content, and exhibits the practices, which fulfill the needs of students with varied educational objectives, from those who will enter employment immediately upon graduation to those who will continue education through apprenticeship programs, technical institutes, or four-year colleges or universities. It should not be forgotten that industrial arts courses are rich in opportunity for the development of interests which lead to worthwhile avocations.

A significant criterion for continued growth of industrial arts as a curriculum area is that it should reflect modern industry with some degree of accuracy and that instruction should capitalize on the use of problem-solving principles and increased application of science and mathematics.

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The accelerated rate in scientific and technological developments requires tremendous effort to reduce the educational lag.

The objectives for industrial arts must be carefully developed so that the efforts of those responsible for such instruction will be focused on meeting the determined needs of youth. The five objectives* listed below are believed to be unique to industrial arts and should be emphasized in the schools of Iowa.

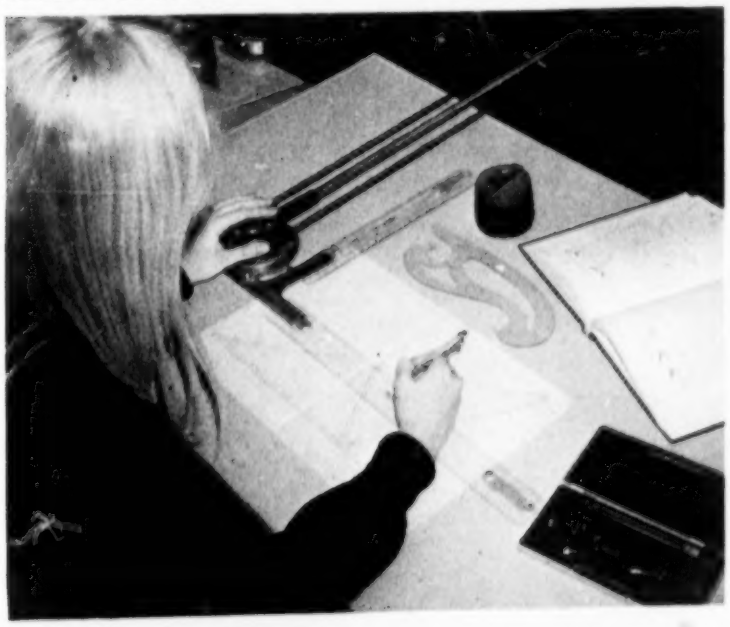

Girls should have an opportunity to explore the various areas in shop.

III OBJECTIVES

1. **Develop an insight and understanding of industry and its place in our culture.** Industry is such a dominant element in our society that no individual in this country can claim to be an educated person unless he has some understanding of our industrial society and himself as a part of it. Industrial arts contributes to this understanding in a very effective manner because students are provided first-hand experiences with tools, materials, and problems of modern industry.

2. **Discover and develop talents, aptitudes, interests, and potentialities of students for the technical fields and applied sciences.** Students have a diversity of talents. The school's responsibility is to assist students in discovering and developing their talents. It is the responsibility of industrial arts education to identify special talents in industrial-technical fields.

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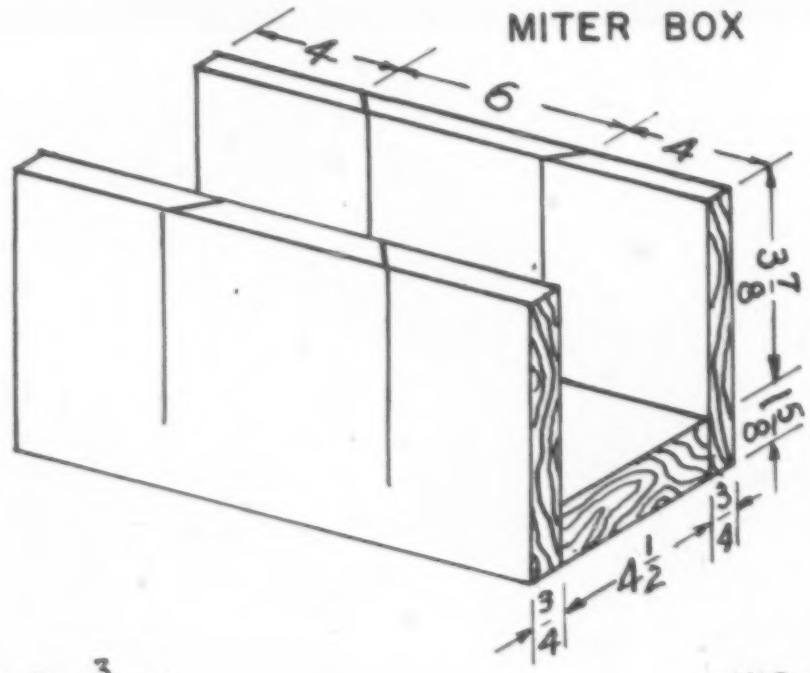

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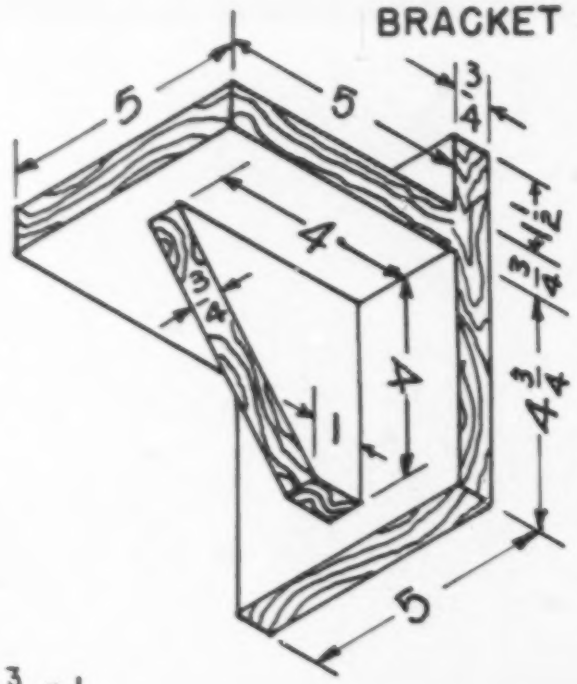

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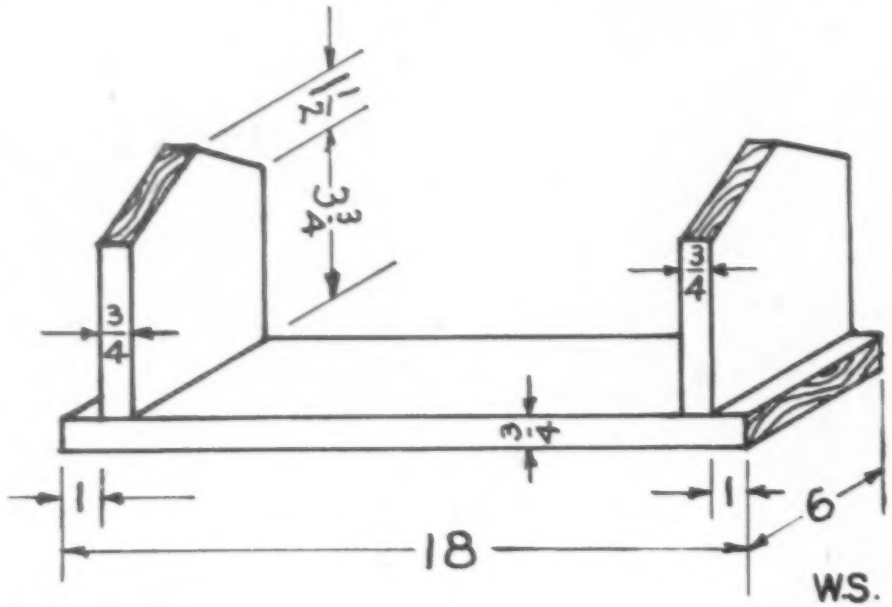

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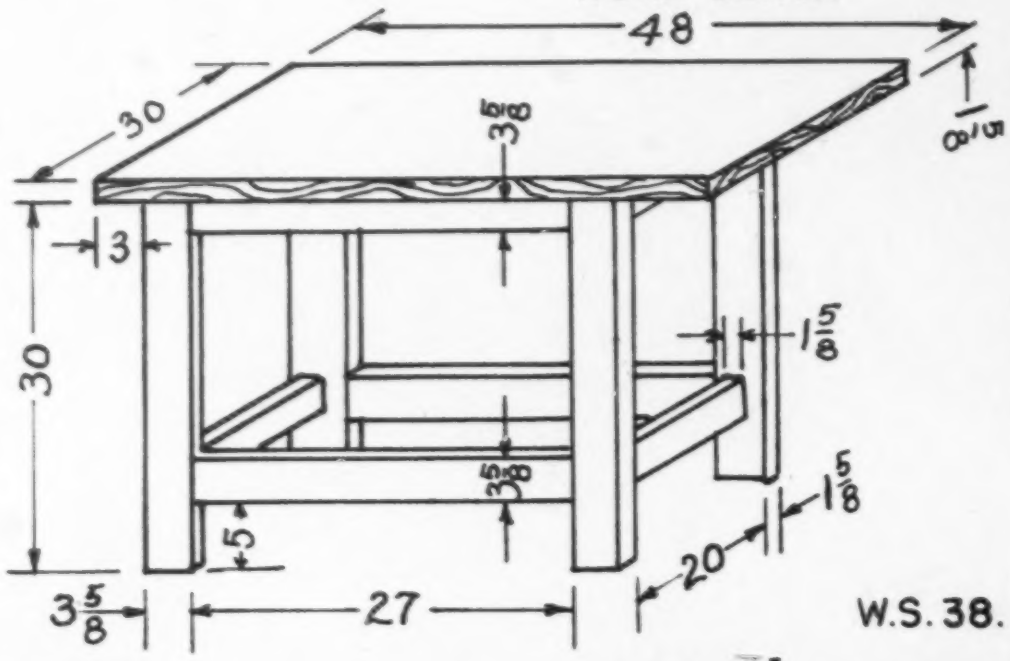

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3. **Develop an understanding of industrial processes and the practical application of scientific principles.**
   Industrial arts provides opportunities for the practical application of scientific and mathematical principles to the solution of technical problems. Students encounter such problems as they complete exercises, experiments, and projects that involve industrial processes.

4. **Develop basic skill in the proper use of common industrial tools, machines, and processes.**
   Even though it appears that training and retraining (perhaps for several different occupations) will be necessary for workers of the future, well-developed manipulative skills in using common industrial tools and machines should do much to facilitate such retraining. Manipulative skills have always been an important part of industrial arts, and this important learning-by-doing should not be lost. But manipulative skills should be kept in proper perspective as the vehicle students use to achieve their goals rather than the end or goal of industrial arts instruction. As course work becomes more technical, emphasis and time directed to developing manipulative skills should be reduced somewhat so that theoretical material can be presented effectively.

5. **Develop problem-solving and creative abilities involving the materials, processes, and products of industry.**
   The industrial arts shop is an especially useful setting for promoting creative thinking and providing opportunities for students to define problems, work out logical solutions to those problems, and evaluate the effectiveness of their solutions. Traditional programs of industrial arts have seldom realized their full potential for fostering problem-solving abilities and creativity, but flexibility in methodology and keeping content up to date will do much to provide students with the type of experiences they need in this area.

These objectives are considered basic for all industrial arts. Supplementary objectives should be developed for elementary school, junior high school, and senior high school, and for adult programs, as well as special programs for students with special needs.

*Adapted from *A Guide To Improving Instruction in Industrial Arts,* American Vocational Association, August 1968.

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IV REQUISITES OF QUALITY INDUSTRIAL ARTS

A Well-prepared and Enthusiastic Teacher

A well-prepared industrial arts teacher who is enthusiastic about his job is the most important of a number of aspects that must be considered if the curriculum area of industrial arts is to make the type of contribution it should make to the education of the youth in a school system. Such a teacher can do much despite inadequate facilities and equipment, but he should not be handicapped this way.

It is difficult to develop a well-balanced industrial arts program where teacher turnover takes place every year or two. School systems that are plagued with turnover problems should make every effort to solve these problems, for changes in teaching personnel often place a good program in jeopardy. Administrators should be sufficiently familiar with the industrial arts programs being offered in their schools that they will seek to employ not just any certificated industrial arts teacher but one who is qualified, by preparation and experience, to teach the type of program that should be taught.

A Well-planned Program

The purposes and objectives of industrial arts should be clearly defined and thoroughly understood before attempting to plan the expansion of existing programs or the development of new ones. Subject-matter areas and courses must then be identified. Experiences that are desirable and educationally significant must be ascertained before tools and equipment needs can be determined. Permitting equipment to determine the curriculum is educationally unsound.

Important steps in program planning, not necessarily in the exact order given, are:

- Predicting enrollment
- Planning size and number of classes
- Visiting other school industrial arts programs
- Securing consultative services (Department of Public Instruction and field services of Iowa State University and University of Northern Iowa)
- Determining type of program
- Estimating available funds
- Deciding principal shop areas

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Facilities Appropriate to the Program

An effective program of industrial arts is dependent upon well-planned physical facilities. Wise planning pays dividends in constructing new facilities, remodeling existing facilities, or rearranging the layout in existing industrial arts shops to facilitate a curriculum revision. Experience has shown that poor initial planning usually results in long-lasting ill effects on the program. Once a building is constructed, changes are difficult to achieve.

Administrator - teacher planning for program and equipment.

Space in this publication will not permit providing specific recommendations for facilities. Those responsible for planning facilities are urged to:

1. Visit school shops that are reputed to have fine facilities.

2. Study materials which deal with specific aspects of shop planning. Some of the following may be helpful:

   - *Planning and Designing Functional Facilities for Industrial Arts Education,* Publication OE-5105, Marshall L. Schmitt and James L. Taylor, U.S. Dept. of Health, Education, and Welfare, Office of Education, 1968.

     Order from:
     U.S. Government Printing Office
     Washington, D.C. 20402
     Price 45c.

   - *Modern School Shop Planning,* Fifth edition, Prakken Publications, Inc., Ann Arbor, Michigan, 1967. Cost approximately $4.

   - *Planning Industrial Arts Shops (for Secondary Schools),* Educational Service Publication No. 31, Willis H. Wagner, Dept. of Industrial Arts and Technology, University of Northern Iowa, 1966.

     Order from:
     Extension Service
     University of Northern Iowa
     Cedar Falls, Iowa 50613
     Single copy $1, payment to accompany order.

   - *Planning Industrial Arts Facilities,* Eighth Yearbook, American Council on Industrial Arts Teacher Education, 1959, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701.
     List price $6.60 — School price $4.95.

   - *A Guide for Planning Specialized Departments for High Schools in Iowa,* Industrial Arts, Bulletin 127.3, Lowell L. Carver, Dept. of Industrial Education, Iowa State University, Ames, Iowa, 1956.

     Order from:
     Engineering Extension
     Iowa State University
     Ames, Iowa 50010

   - The annual March issue of *Industrial Arts and Vocational Education* focuses on shop planning.

3. Prepare preliminary specifications for physical facilities.

4. Consult with qualified persons as necessary. Services of consultants to assist in planning

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industrial arts facilities may be secured through:

- Dr. Raymond Schlicher
  Director of Field Services
  University of Northern Iowa
  Cedar Falls, Iowa 50613

- Dr. Marvin Anderson
  Dean of Extension Division
  Iowa State University
  Ames, Iowa 50010

5. Make final plans for physical facilities. It is most important that this phase of the work be the responsibility of local personnel. The following may be useful as a check list:
   - Size, shape, and location of industrial arts facility to accommodate program
   - Type of shop (unit or comprehensive)
   - Walls, floors, and ceilings
   - Windows and doors
   - Illumination and painting
   - Equipment
   - Storage space
   - Sinks and fountains
   - Safety and health
   - Heating and ventilation
   - Water, gas, and electricity
   - Auxiliary rooms and areas
   - Entrances and exits

Equipment Adequate to Instructional Needs

Serious errors may be made in purchasing industrial arts equipment, including machinery and tools, unless the following are considered:

- Objectives of the program
- Course offerings (scope and sequence)
- Age and grade level of student
- Present and future needs
- Design, quality, and safety features of the tools and equipment
- Budget — initial, annual

Note: The annual April issue of *School Shop* contains a suppliers directory which may be helpful.

Appropriate Attention to Safety

Industrial arts teachers, administrators, and school districts have a legal responsibility to provide and maintain a safe environment in which industrial arts activities may be conducted safely and under healthful conditions.

Safe Environment. Aspects which must be considered in developing a safe environment are:

- **Physical facilities.** Such factors as lighting, ventilation, condition of floors, placement of machines, storage, disposal of waste, adequate dust collection and exhaust systems, and many others must be considered when setting up a shop which will promote safety.

- **Machines.** The degree of hazard involved in the operation of different machines varies greatly. It is important that safety devices, guards, and shields designed for a specific piece of equipment be secured when the machine is purchased. Furthermore, teachers must be careful to abide by the safety instruction they present to students for if students observe a teacher using a hazardous machine with the guard removed, they may follow the teacher's example rather than his instructions. Industrial arts teachers should require students to pass a safety test on each piece of machinery or each portable power tool before they give permission to use such equipment. These tests should be kept on file for whatever value they might have as evidence in litigation resulting from an accident.

- **Tools.** Seldom are hand tools thought of as being particularly hazardous. However, all edge tools and tools such as hammers that might have loose heads are potentially dangerous. Close attention should be given to maintaining such tools in proper condition. High quality tools are generally the safest, require least maintenance, and are less expensive in the long run.

- **Procedures.** If the teacher fails to adequately instruct a pupil on the correct procedure for using a hazardous machine or tool, or if he fails to warn of the dangers that may arise if safety rules are disobeyed, or if the use of safety devices is ignored, or if personal protective equipment is not worn, then the teacher has omitted a specific legal duty and would be liable for negligence in event of an accident.

Safety Consciousness. All facets of the industrial arts program, including the physical facilities, tools and equipment, the instructional program, and supervised activity, must contribute to the development of a safety consciousness or attitude to govern the daily habits of students in the shop. Accident prevention should be taught as an integral part of all courses. It should be so well integrated into instruction that it loses its identity as a separate concept. The attitude of the teacher and the example he sets will have a significant effect upon the type of attitudes developed by students.

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Eye protection is mandatory.

Literature Pertaining to Safety. Considerable literature pertaining to school shop safety is available. It is suggested that those seeking more detailed information on this important subject start their search with the following:

- *Accident Prevention Manual for Shop Teachers,* William A. Williams, Editor. A professional publication of the National Association of Industrial Teacher Educators, American Technical Society, Chicago, Illinois, 1963. List price $7.50 — school price $6.
- *Education for Safety Through the School Shop.* A publication of the Accident Prevention Department, Association of Casualty and Surety Companies, New York, and the Center for Safety Education, Division of General Education, New York University, 1952.
- *Safety Rules for the Safe Operation of Power Woodworking Tools,* Frank Paxton Lumber Company, Box 683, Des Moines, Iowa 50303. 10c.

Eye Safety. On May 14, 1965, Governor Harold Hughes signed into law the eye protection legislation now included in Section 280.20, *Code of Iowa:*

Eye Protective Devices. Every student and teacher in any public school participating in any of the following courses:

1. Vocational or industrial arts shops or laboratories involving experience with any of the following:

   a. Hot molten metals;

   b. Milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials;

   c. Heat treatment, tempering, or kiln firing of any metal or other materials;

   d. Gas or electric welding;

   e. Repair or servicing of any vehicle while in the shop;

   f. Caustic or explosive materials;

2. Chemical or combined chemical-physical laboratories involving caustic or explosive chemicals or hot liquids or solids when risk is involved; is required to wear industrial quality eye protective devices at all times while participating in any phase or activity of such course which may subject the student or teacher to the risk or hazard of eye injury from the materials or processes used in said courses. It shall be the duty of the teacher or other person supervising the students in said courses to see that the above requirements are complied with. Any student failing to comply with such requirements may be temporarily suspended from participation in said course and the registration of a student for such course may be cancelled for willful, flagrant or repeated failure to observe the above requirements. The board of education having jurisdiction of any school coming within the purview of this Act shall provide the safety devices required herein. Such devices may be paid for from the general fund but the board may require students and teachers to pay for said devices and shall make them available to students and teachers at no more than the actual cost to the district.

"Industrial quality eye protective devices," as used in this section, means devices meeting the standards of the American Standards Association Safety Code for Head, Eye, and Respiratory Protection, Z2.1-1959, promulgated by the American Standards Association, Inc.

Selection of eye protective devices should be according to the law. Such equipment will be adequate only if it can withstand certain tests such as impact, heat deformation, water absorption, and flammability. Other important factors would be high optical standards, comfortable fit, good workmanship, and interchangeability of parts. Buyers should insist that eye protective devices be guaranteed to meet the American Standards Safety Code 22.1-1959 mentioned above. Suppliers are eager to assist and should be contacted for information, demonstration, and price lists. Examples of literature that would be helpful in this regard are:

- *How To Install a School Eye Protection Program,* Fend-all Company, 2222 Diversey Parkway, Chicago, Illinois 60647.

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- *Establish an Effective School Eye Safety Program,* Sellstrom Manufacturing Co., 275 South Hicks Road, Palatine, Illinois 60067.

A proper program of hygiene should be carried on in each shop to minimize contagion and maintain cleanliness. Spectacle-type eye protectors generally are thought of as personal items and should be assigned permanently to the individual wearer whenever possible. Spectacles used by more than one person should be sanitized in a cabinet equipped with an ultraviolet germicidal lamp or by immersing in a cleaner-sanitizer solution. Equipment such as welding helmets should be treated in a similar manner.

Schools vary in their policies regarding the financing of eye protective equipment. Some schools assume the expenditure for eye protection and assign them to pupils and teachers at no cost. Others purchase them and resell them to recover their investment. Students who must wear prescription glasses generally assume their cost with the school making necessary arrangements for their acquisition. Certain local civic organizations have been known to assist such students to help alleviate cases of financial hardship.

Proper Emphasis on Evaluation

Evaluation is primarily a diagnosis resulting from objective and subjective data which constitute the basis for accurate judgments. Its overall purpose in education is to improve the work of the school.

Evaluation is not a one-time endeavor. To be effective it must be a continuing function.

Areas to be considered are:

- The program
- The facilities
- The teacher
- The student
- The administration

Checklists are available for evaluating the industrial arts area. Some are given below:

- Booklet: *AVA Evaluative Criteria for Industrial Arts Education,* Industrial Arts Education Division, American Vocational Association, Inc., 1010 Vermont Avenue, N.W., Washington, D.C., 1961.
- Booklet: *Upgrading the Industrial Arts Program,* Norman C. Pendered, College Science Publishers, Box 798, State College, University Park, Pennsylvania 16801, 1959, $1.
- Sheet: *Evaluation of Industrial Arts Programs,* Dept. of Education, State of Missouri, Vocational Division, Industrial Education, Jefferson City, Missouri 65101.

Appropriate Attention to Guidance

An effective program of industrial arts will make a substantial contribution to the guidance function served by the school. Experiences gained in industrial arts and talking with an industrial arts teacher who strives to accept responsibility in this area can assist the student in making wise choices, decisions, and adjustments as he moves toward maturity. The services designed to meet guidance needs of students enrolled in industrial arts may be classified as appraisal, information, counseling, placement, and follow-up.

Appraisal Service. The appraisal service should be designed to provide essential information concerning each individual pupil which will assist pupils to see themselves as they really are. The informal atmosphere of an industrial arts shop may be particularly helpful in providing students with the type of information about themselves that is not revealed in the more formal classroom situations.

Information Service. The rapid growth of technology has provided environmental forces, unknown a few years ago, which must be considered in making choices and decisions that will not be jeopardized by an uncertain future. Such decisions will be dependent to a great extent upon the amount and accuracy of information concerning present and future opportunities for each student.

The training, experience, and interests of the industrial arts teacher should enable him to provide such information which would be especially helpful for those interested in technical fields and applied sciences.

Counseling Service. Counseling represents that part of the guidance program where pupils should be helped to make major decisions. It is the most crucial service in the entire guidance program and unless it is carried out in a skillful manner, all other guidance services lose their reason for existing. The involvement of most industrial arts teach-

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ers in counseling may be limited to the identification and referral of students to the professionally-trained and certified counselor; however, industrial arts teachers with proper backgrounds can be unusually effective in counseling with students.

Placement Service. Assisting students in securing appropriate employment or in selecting suitable educational programs is an important aspect of guidance. Few industrial arts teachers are actively engaged in formal or well-organized programs of placement, but they are often contacted by employers and teachers of higher levels of education for their personal assessment of former students.

Follow-up. The follow-up on students is a large task and requires the coordinated efforts of many persons. If the school has an organized follow-up service, the industrial arts teacher's special training, experience, and contact with the student and employer may be very helpful in the assessment and interpretation of follow-up information collected regarding students formerly enrolled in industrial arts programs.

Conclusion. The guidance functions presented here are not intended to add to the industrial arts teacher's load. The degree in which the industrial arts teacher understands the purpose and function of guidance services and the degree to which he sees a need to know and understand pupils play an important part in determining the extent to which he will accept responsibilities in this area.

Appropriate Effort Devoted to Public Relations

Interpreting the industrial arts program to the school and community is an important responsibility of the teacher. The public relations program is a two-way process in which the flow of ideas from the public to the school is as vital as the school communicating with the public. The environment in which the industrial arts program will function is dependent upon a well-informed and receptive community. The industrial arts shop can be made one of the show places of the school.

To be effective, public relations must be:

- Comprehensive
- Honest
- Frank
- Simple
- Direct
- Continuous

Following are some techniques that may be useful:

- Involve the student as a means of communication from school to home and vice versa
- Exhibits
- News media (newspapers, radio, television)
- Assemblies
- Contests
- Open houses
- Awards

Helpful information regarding public relations may be found in the following articles:

- "Public Relations: Whose Responsibility?" L. S. Wright, *Industrial Arts Teacher,* 22:11, September 1962.

- "Improving Industrial Arts Through Public Relations," B. Dennison, *Industrial Arts and Vocational Education,* 57:40-41, June 1968.

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SCOPE AND SEQUENCE OF INDUSTRIAL ARTS PROGRAMS

The degree to which students might be involved in industrial arts, the types of course work in which they could participate at different levels, and the contributions industrial arts might make to their educational or vocational goals are considered in the following materials:

Student Flow

K-6th	Construction activities integrated with science, mathematics, English, and social studies as opportunities arise.			
7th	Required for all boys—(may include girls)	1 period daily for 18 weeks	2 Areas: 1 and 2, or with additional time include 6 and 7	1. Metal 2. Wood 3. Drafting 4. Electricity-Electronics
8th	Required for all boys — (may include girls)	1 period daily for 18 weeks	2 Areas: 3 and 4, or with additional time include 5	5. Power Mechanics 6. Industrial Plastics 7. Graphic Arts
9th	Required or elective boys or girls	1 period daily for 36 weeks	Advanced instruction in at least 3 areas including drafting. Select at least two others from 1, 2, 4, 5, 6, or 7 **NOTE:** In the absence of organized programs in grades 7 and 8, devote approximately equal time to areas 1, 2, 3, 4, or select from alternate plans shown on page 14	
10th 11th 12th	Elective boys or girls	At least 5 periods per week for each course in which student is enrolled	At least 2 *sequential* years of course work should be available in at least 3 of the areas listed. The first year of work in areas marked * should build on course work offered at previous levels	1. Construction Technology *2. Drafting *3. Electricity—Electronics *4. Graphic Arts *5. Industrial Plastics *6. Metal *7. Power *8. Wood

Post Secondary School Goals
College or University
Armed Services

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Immediate Employment
Area Vocational-Technical School or Community College

Post Secondary School Goals
- College or University
- Armed Services
- Immediate Employment
- Area Vocational-Technical School or Community College

Recommended Minimum Program for Industrial Arts in Iowa*

It is strongly recommended that industrial arts be included as a significant curriculum area in the comprehensive secondary school program of education.

SEVENTH GRADE

MINIMUM PROGRAM — 18 weeks (90 periods)	ENRICHED PROGRAM — 36 weeks (180 periods)
Areas recommended: Metal (suggested content, pp. 126-33) Wood (suggested content, pp. 164-66)	Areas recommended: Metal Wood Graphic Arts (suggested content, pp. 104-07) Industrial Plastics (suggested content, pp. 115-20)
Approximately equal amounts of time should be devoted to metal and wood.	Approximately equal amounts of time should be devoted to metal, wood, graphic arts, and industrial plastics.

NOTE: If industrial arts is offered only in the eighth (or seventh) grade, it should consist of 36 weeks and 180 periods and should include four areas, drafting, electricity, metal, and wood, with approximately equal amounts of time devoted to each.

EIGHTH GRADE

MINIMUM PROGRAM — 18 weeks (90 periods)	ENRICHED PROGRAM — 36 weeks (180 periods)
Areas recommended: Drafting (suggested content, pp. 71-74) Electricity-Electronics (suggested content, pp. 85-87)	Areas recommended: Drafting Electricity-Electronics Power Mechanics (suggested content, pp. 146-51)
Approximately equal amounts of time should be devoted to drafting and electricity-electronics.	Approximately equal amounts of time should be devoted to drafting, electricity-electronics and power mechanics.

*Adapted from Program proposed by the State Committee on Industrial Arts Teacher Education in cooperation with the Iowa Department of Public Instruction, January 1963, revised October 1966.

NINTH GRADE

In a sequential program in grades seven through nine, it is recommended that each pupil receive advanced instruction in at least three areas and that drafting be one of the areas with the remaining two selected from those listed below. Note: 36 weeks (180 periods).

Electricity-Electronics
Graphic Arts
Industrial Plastics
Metal
Power Mechanics
Wood

NOTE: In the absence of an organized program of industrial arts in grades seven and eight, exploratory opportunities should be provided patterned after one of the following plans:

Four Areas 9 weeks each of:	Five Areas 7 weeks each of:	Six Areas 6 weeks each of:	Seven Areas 5 weeks each of:
Metal	Metal	Metal	Metal
Wood	Wood	Wood	Wood
Drafting	Drafting	Drafting	Drafting
Electricity-Electronics	Electricity-Electronics and *1* of:	Electricity-Electronics and *2* of:	Electricity-Electronics
	Power Mechanics	Power Mechanics	Power Mechanics
	Graphic Arts	Graphic Arts	Graphic Arts
	Industrial Plastics	Industrial Plastics	Industrial Plastics

TENTH, ELEVENTH, AND TWELFTH GRADES

At the senior high school level, industrial arts should be available five periods per week. Instruction should be so designed that the pupil can take two years of sequential course work in at least three of the following areas:

Construction Technology (carpentry, concrete, masonry)
Drafting (general, machine, engineering, technical, architectural)
Electricity-Electronics (appliance repair, house wiring, motor maintenance, radio, television, industrial electronics)
Graphic Arts (letter press printing, offset, lithography, intaglio, silk screen, book binding, photography)
Industrial Plastics (injection, rotational and compression molding, reinforced resins, extrusions, foams, thermoforming, coatings)
Metal (foundry, sheet, welding, ornamental, bench, spinning, forging and heat treating, machine)
Power (power mechanics, auto mechanics)
Wood (wood technology, cabinet making, pattern making, finishing, upholstery)

There are a number of emerging programs in industrial arts that warrant attention (see pages 43-45). Conscientious teachers may be able to use certain aspects of some of these to enrich their programs.

Industrial Arts Programs

Kindergarten-Sixth. Elementary industrial arts activities help reduce the level of abstraction and give more adequate meaning to some of the academic subject matter.

Classroom work is enriched through the use of manipulative activities which involve using tools

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and materials commonly found around the home. This helps pupils modify their strong individualistic tendencies by working and sharing with other children in a creative atmosphere.

Through integrated constructive handwork, pupils have an opportunity to enjoy the satisfaction of producing educationally-useful objects related to their studies. Such activity can do much to facilitate learning.

Approaches

- Self-contained class
- Self-contained class with assistance by industrial arts teacher
- Self-contained with instruction in the industrial arts laboratory
- Industrial arts separate, no self-contained class work

Program (for boys and girls)

Primary

- Group project activities — miniature stores, bus, train
- Related to subject areas
- Whole child is involved
- Activity limited to classroom

Intermediate

- Separate room desirable
- Serves individual needs
- Varied media should be available
- Provide for individual interest
- Projects should relate to basic subjects

Activities (pupil involvement in)

- Planning and designing
- Constructing
- Experimenting
- Visiting
- Exploring
- Collecting
- Observing

Fundamental skills can be acquired early.

Industrial arts should have its beginning at the elementary level.

Junior High School. Industrial arts is an integral and necessary part of the total program of education for all boys and some girls in grades seven through nine. Students at this grade level should be guided through a sequence of exploratory experiences in a variety of industrial arts areas. Included in the recommended minimum program for Iowa are: drafting, electricity-electronics, metal, and wood. Enriched programs at this level are encouraged when time permits and would include additional drafting as well as industrial plastics, graphic arts, or power mechanics.

At this level, special emphasis should be placed on helping students discover and develop their aptitudes, abilities, and interests. An understanding of the industrial-technological world and its effect upon our society should be developed. Provision should be made for the development of a variety of different kinds of skills. Opportunities should be provided for the creativity and ingenuity of students to come to the fore. A degree of proficiency in a variety of basic mechanical skills should be developed. Activities involving the practical application of mathematics, science, language arts, and social studies are inherent in industrial arts and should be exploited. Safe practices in the use and care of materials, tools, and equipment should be emphasized. Also, the program should assist in developing the ability to select, purchase, use, maintain, and service industrial products.

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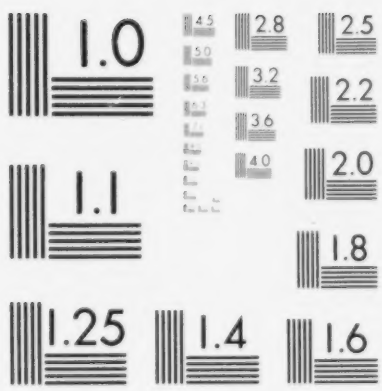

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Senior High School. The purposes for which students in grades nine (or ten) through twelve take industrial arts include general education, pre-collegiate, and to lay the foundation for occupational training.

Especially at this level, it is important to note that course work in industrial arts involves more than building a project. It is not reasonable to expect full attainment of industrial arts objectives through construction activities alone. Students should use textbooks, complete assignments in and outside of class, and, in general, approach their work as seriously as is done in any other area of the high school curriculum.

The well-rounded industrial arts curriculum at this level should include opportunities for students to engage in some activities not provided at the junior high school level, plus opportunities for advanced experiences in areas previously studied. The curriculum should provide opportunities for students to have comprehensive and enriching experiences that will enable them to acquire basic knowledge, understanding, and skill in the fundamental principles, techniques, procedures, and processes used in industry.

At this level emphasis should be placed on occupational practices and information relating to the specific industrial arts area. In this way advanced industrial arts work is effective occupational guidance for some students, while for others it provides opportunity for valuable experiences within an occupational area of their choice.

In addition, industrial arts activities offer excellent opportunities for students to develop leisure-time interests and skills so necessary for a well-rounded life.

It is strongly recommended that students have experiences in at least four of the industrial arts areas available in the school before they select an area for concentration.

Special Programs. Although little information is provided in this guide, the reader should remember that industrial arts can make valuable contributions to the education of adults, girls, academically talented, slow learners, and those that are physically or educationally handicapped.

Relationship of Industrial Arts and Area Vocational-Technical Schools or Community Colleges. The 1965 Iowa General Assembly passed legislation which provided for establishing a system of area schools to develop programs of vocational and technical education to serve the people of Iowa. This system of schools is designed to provide programs of up to two years in length to prepare people for employment in the broad fields of transportation, manufacturing, business, and the health occupations. Previous to this, relatively little opportunity for post-high school preparation in these fields existed in Iowa.

Area schools are of two general types:

- Area Community Colleges, which offer programs both in vocational and technical education and two-year junior college-type programs in the arts and sciences
- Area Vocational-Technical Schools, offering only the vocational and technical programs

Industrial arts attempts to *acquaint* students with the industrial world. Area schools seek to help people *acquire* the skills and knowledge necessary to enter the jobs which exist in industry. Since the two share some common interests and concerns, it seems in the best interests of the student and education in general that mutual contact and communication be carried on between these two areas of education.

The expanded opportunities in vocational and technical education made possible by the area schools in no way reduces the need for sound, comprehensive industrial arts programs. Indeed, an additional responsibility is placed on the secondary schools. The industrial arts programs in particular must provide young people with the kinds of experiences which will enable them to make the most effective use of the new opportunities at the area school level. In secondary preparation, students need a broad base of exploratory experiences to acquaint them with the wide variety of occupational areas. These experiences help them make realistic choices in future educational programs that lead to successful vocational placement.

In vocational and technical fields, industrial arts programs furnish the primary basis for obtaining such experiences. In fact, the full success of the area schools is dependent, to a large degree, upon sound industrial arts programs.

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The industrial arts teacher, with his practical knowledge of the world of work, is often looked to for vocational guidance information. In interpreting industry to students, he should be able to help them understand the types of education needed for different occupational fields, and the ways in which this education may be obtained. He should be acquainted with the programs offered in the local area school, the entrance requirements, and the procedures required in applying for admission. He will find it generally helpful, also, to have information available on programs offered in area schools outside his local area since many programs will not be offered in all areas.

Basic information on the program in each area school may be obtained from the manual, *Occupational Education Programs Serving Iowa Students,* published jointly by the Iowa Personnel and Guidance Association and the Guidance Services Section of the Iowa Department of Public Instruction. The counselors in your school should have a copy of this publication. Specific program information may be obtained from the area school's director of student personnel services.

Both industrial arts and area school personnel should work to develop mutual contacts and communication. In many cases they will be members of the same professional organizations. Area meetings, such as those sponsored by the Iowa Industrial Education Association, should involve both secondary school and area school people and should occasionally be held in the area school.

Area school personnel will welcome opportunities to speak to high school classes. They also encourage groups of students to visit the area school. Again, the director of student personnel services will generally be the best person to contact for such arrangements.

Frequent contact with the area school may be beneficial in other ways. Area schools will be conducting surveys of business and industrial firms in their areas to determine employers' needs for skilled personnel in various occupations. Information on such needs and trends will be available to industrial arts teachers.

The young people of Iowa will benefit to the maximum from post-secondary education if industrial arts teachers are familiar with the area schools, their programs, and goals. Such schools will become the next educational step for a number of industrial arts students.

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VI SELECTED ASPECTS OF ORGANIZATION AND ADMINISTRATION

Class Size and Teacher Load

The number of students in industrial arts classes should not be considered as a constant. Certain of the subject matter areas such as drafting lend themselves to larger classes than areas such as graphic arts where the diversity of activity or expensive and complicated equipment demands more individual supervision.

In no instance should the number of students exceed the equipment that is necessary to support instruction. Because of the nature of laboratory activities, the ideal class size may be as high as 24 students for drafting and as low as 16 for auto mechanics. In general, however, 20 students is considered to be a maximum class size for one teacher. Local conditions, such as high demand for certain classes and above-average facilities, may temporarily justify a small increase above these maximums.

The teaching load of an industrial arts instructor should always provide a period for preparation. A second period or a teacher assistant can certainly be justified and should be provided for the maintenance work that is inevitable when instruction in shop practices is being provided for novices, and the procurement of tools, equipment, and supplies necessary for instruction. *It is strongly recommended that the talents of professionally prepared industrial arts teachers be used in teaching and preparing for teaching activities — not dissipated in study hall supervision and non-related assignments.*

Schedule Practices

Students should be scheduled into industrial arts classes as they are scheduled into other classes, strictly on the basis of previous experience. The practice of scheduling according to grade level regardless of previous experience results in two or more levels within a class. Such an arrangement can be handled only by the most competent of teachers and then only by extra effort on the part of the teachers and students alike. Only if classes are unusually small can such a procedure be justified and educationally profitable.

Proper scheduling is probably more difficult for the smaller schools than for those of medium or larger size but even in the smaller schools scheduling problems have vanished as administrators with the knowledge of how students should be scheduled have attacked problems of this nature with a determination to solve them.

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Budgetary Practices

The industrial arts program must have adequate financial support if it is to achieve its goals. Although specific aspects of budgetary practices may vary, there are certain general principles which are worthy of comment.

Equipment Budget. There should be an amount of money set aside in the annual school budget for industrial arts equipment. This should be sufficient for replacing equipment that is obsolete and adding newly developed equipment for enriching the program. When a program is undergoing substantial change, it is sometimes advisable to set up a plan for purchasing equipment over a two- or three-year period. Normally this works no hardship, for programs which provide for two or more years of sequential coursework involving prerequisites do not happen overnight, they grow to full status over a period of years. The teacher who is to be responsible for selecting needed equipment should be informed of the size of his equipment budget so that plans can be made to secure the equipment most essential to his program as inexpensively as possible through the use of competitive bids.

Expendables Pertaining to Tools and Equipment. A separate budget should be set up for the purchase of expendables such as hack saw blades, files, circular saw blades, welding tips, and hand tools. Maintenance costs for repair or replacement of broken machine parts would be included here, too. Some school systems require that such expendables be requisitioned on an annual basis. This can be done, but it works a hardship on the teacher. Making accurate estimates of such needs on an annual basis is rather difficult unless the teacher has a backlog of experience in the specific teaching position at hand, and the tendency is to stockpile to guard against running short. It is suggested that a more reasonable approach is to purchase most of the materials on an annual basis. Quantity buying and taking competitive bids permits teachers to requisition smaller quantities of expendables as needed throughout the year. In addition, a small petty cash fund to meet emergencies will help the teacher in a metropolitan area to keep his shop operating at 100 per cent efficiency. Keeping this fund at a modest level of about $25 and having the teacher secure receipts for purchases should enable such a fund to be used in a businesslike manner.

Instructional Supplies. The cost of expendables such as glue, nails, rivets, solder, flux, photographic chemicals, printer's ink, oxygen, acetylene gas, and similar instructional supplies is often borne by the school. However, in some instances, the cost of such materials is cared for by charging each student a shop fee. Regardless of the approach that is used, it is suggested that the procedure outlined above be followed in securing such materials.

As programs come to include exercises, experimentation and research activities in addition to the traditional take-home project, needs for expendables of this type can be expected to increase.

Resale Materials. Except where school funds are used to provide materials for seventh, eighth, and sometimes ninth grade students, such materials as are used in take-home projects are usually paid for by the students. A punch card system that is used like a meal ticket with the cost of each project punched off as the materials are secured from the storeroom — or at the completion of the project — is commonly used. It is recommended that these shop cards be purchased at the school office, thus eliminating the need for the teacher to handle money.

The industrial arts department should not be expected to stock all materials which students might need in the construction of projects. There is much educational value to be derived from students' shopping for some of the needed materials. However, efficiency demands that the school stock materials which would be difficult to procure in the local area and materials which would be too cumbersome or heavy for students to bring with them.

Here again, it is recommended that the majority of such resale materials be purchased once a year in quantity, taking advantage of competitive bidding; but the teacher should be able to requisition materials which he finds in short supply as the need arises. Here, too, a small petty cash fund will be most helpful in meeting needs of an emergency nature.

School funds will, of course, be needed to establish an adequate supply of resale materials to support the instructional programs. When this has been done, the buying and selling of such materials should be operated from a revolving account which will remain relatively constant if materials are sold on a non-profit basis as they should be. The debits in this account are actually materials in the storeroom and the size of the expenditure reflects, to a degree, the readiness for instructional activities.

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Special Problems Relating to the General Shop (Drafting)

Regardless of how instruction is organized in the comprehensive general shop, a common method of getting started in the fall is to cover the drafting area in the first five, seven, or nine weeks before proceeding to any construction work in the shop. This approach is often justified on the basis that the student should be able to make working drawings for the construction work he will undertake. But many times the drafting that is taught is traditional plate making and little attention is given to project drawing and planning. If the teacher feels that instruction is most effective by covering drafting first, it is suggested that he be sure that such instruction be focused on the construction activities that will follow.

A different approach, which capitalizes on student interest by starting construction activities immediately upon the opening of school, is recommended. With a small amount of instruction in the reading of drawings, students can get off to a fast and exciting start in teacher-planned work. Drafting (including design and procedure planning) that is integrated closely with the work done in the shop can be taught one day per week throughout the year and gradually bring the student to the point where he is competent to plan his manipulative work on his own.

Adapting Programs to Local Needs

The realization that an industrial arts program should not be unduly influenced by local circumstances has been gradual but this idea is accepted now in most quarters. In fact, at present, there is substantial interest in a national curriculum for industrial arts. This would not be to limit local programs but to ensure that they include common essentials so that children of our highly mobile population not be victimized by a move from one state, city, or town to another but be able to make a smooth transition. Since industrial arts is general education, it follows that the basic program might well be the same regardless of locale. However, local conditions may be used to add zest to a sound program. For example, a resort area which abounds in water sports may emphasize construction of water skis in course work of an advanced nature. Activity that capitalizes on local conditions should never be allowed to dilute the basic program.

Integrating Mathematics, Science, and Other Subjects with Industrial Arts

The orbiting of Sputnik in 1957, some four months before Explorer I, brought the public school education of this country under sharp and sometimes critical scrutiny. The result was a crash program emphasizing those subjects which appeared to have the greatest potential for bettering our position in the space race. In the four to six years that followed, science and mathematics became the prestige subjects; and many of the practical arts, including industrial arts, waned, particularly in their ability to attract academically-talented students. This resulted in a trend toward justifying industrial arts for its ability to make scientific and mathematical principles meaningful through practical application. Some pursued this course to the point where industrial arts lost its identity as such and became secondary to the prestige subjects.

Now, with the advantage that hindsight always brings, two matters are quite clear: as important as the disciplines of science and mathematics are, they must take their place *along with*, rather than *supersede*, other subject matter areas; and industrial arts has more than enough content of its own to justify its being taught for the unique contribution it can make to the education of youth rather than the service it can provide for other disciplines.

With this understood, one can speak of the rich opportunities industrial arts provides for the practical application of scientific principles. The use of rules, squares, and dividers involves the meaningful use of mathematics. Many opportunities for increasing students' vocabularies exist in the names of new tools, machines, processes, and materials. The reading of specifications and writing of plan sheets provides experiences which require some facility in English. All industrial arts courses present many practical problems which serve to apply, reinforce, and extend students' knowledge in science, mathematics, English, and other subjects.

Record Keeping

Well-kept class and individual records are essential if classes are to be taught purposefully. They should help the teacher in his work rather than burden him. Most of the records which are kept will pertain to instruction but administration and safety records, as well as information pertaining to the physical facilities and supplies, should be recorded

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in a business-like manner, too. Various record forms are not difficult to find in professional books and magazines, but teachers often develop record forms tailored to fit their own situations. The following book, which consists entirely of forms which have been designed for use in industrial arts, has been published recently:

- *Organization and Administration Forms for Industrial Arts,* Instructional Materials Service, Series 1,000, Box 244, Kennedy, Minnesota 56733.

Records Pertaining to Instruction. It is well-nigh impossible for a teacher to remember what instruction has been presented to each of his classes, and individual students in those classes, together with the accomplishments and quality of work of each student. A record of demonstrations given and a well-kept progress chart for each class — together with individual planning sheets used by students — should enable the teacher to keep important instructional records in order.

Administration Records. Some of the records kept by teachers must conform to policies of the administration. Special forms together with instructions for their use are generally provided. Attendance records, daily work, test grades, and some indication of student deportment are typical of what is needed to maintain the permanent records of students. Many teachers find the most convenient way to contribute meaningful information on student deportment is to keep anecdotal records whereby unusual student behavior is noted on a card and placed in the student's folder.

Records Pertaining to Safety. A factual record should be made of all accidents which occur in the school shop. Student Accident Report forms are readily available from such sources as the National Safety Council and industrial commissions of some states.

If forms are not available, or if a school desires to develop its own forms, provision should be made for at least the following information: date, time, name of injured, site of injury, teacher in charge, nature of injury, cause of injury, how injury could have been prevented, by whom first aid was administered, disposition of case, and witnesses.

Two copies should be signed by the teacher, who should keep one copy. The other copy should be filed in the school office the same day of the injury.

General safety tests and individual machine tests, which must be passed before one is eligible to operate the specific machine, should be included in the safety records of teachers.

Records Pertaining to Physical Facilities and Supplies. Well-kept inventories of tools, equipment, supplies, books, and library materials will keep the teacher informed on the condition and replacement needs of such things, provide valuable information for the processing of requisitions, and furnish a new teacher with invaluable factual data as to what he can expect to find in the shop to which he is assigned.

Student Personnel Organization

The student personnel plan in industrial arts provides an excellent opportunity for students to develop desirable civic responsibilities as well as contributing to the efficient operation of the shop. Industrial arts classes have long used an organized system for cleaning and restoring the shop to order at the end of the period.* A student personnel

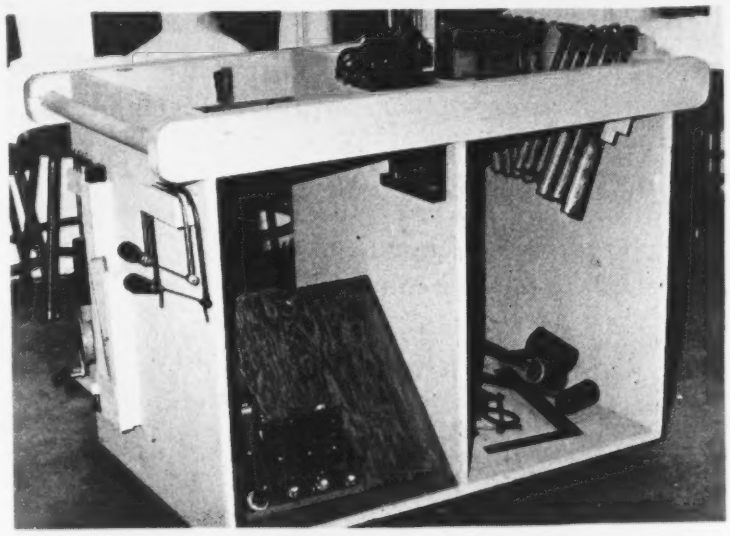

Movable tool storage.

***NOTE:** It is recommended that students be responsible for storing projects and personal articles, returning tools to their proper places, and cleaning all equipment and work benches down to the floor, but they should not be required to sweep the floor except in areas (such as around machines) where not to do so would result in hazardous conditions. Such a cleanup can be completed in about five minutes. Sweeping the floor each period will about double the cleanup time. Time is too precious to permit each class to lose 900 minutes (15 hours) a year in something as limited in educational potential as sweeping the floor. It is strongly recommended that janitor service be provided for industrial arts shops as is done for all other areas of the school.

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system extends this approach to other aspects of administration to make for smoother operation and increase the number of desirable student experiences. With proper direction, students can assist with such things as record keeping, taking attendance, dispensing materials from the storeroom, assuming certain responsibilities in regard to safety, checking in tools, and sharing in evaluations. Utilizing the student personnel plan places the student in many different situations which are quite real and closely related to future living. Students are caused to assume positions of leadership where they help make and enforce rules and are also placed in the position of having to follow directions of others.

Special Arrangements for Academically Talented Students

Oftentimes, students with college potential are prevented from taking industrial arts by the pressure of courses required for college entrance. Such students should be encouraged to take some industrial arts course work as a fifth subject, especially if they are interested in engineering, industrial arts teaching, industrial management, or any profession such as dentistry where small muscle coordination and finger dexterity are essential. Sometimes it is necessary to provide such a student with a varied schedule for each day of the week. This arrangement has been used successfully where students "contract" with the principal and teacher to follow a predetermined schedule which may indicate a different period each day in the week but still provide for five periods of industrial arts classtime per week. Contract students receive full credit and often serve as excellent examples of achievement to other students. It is believed that the contract approach for individual students is particularly appropriate in schools where industrial arts classes are small. In larger schools it may be possible for such students to receive industrial arts course work in a class that would meet on a varied schedule.

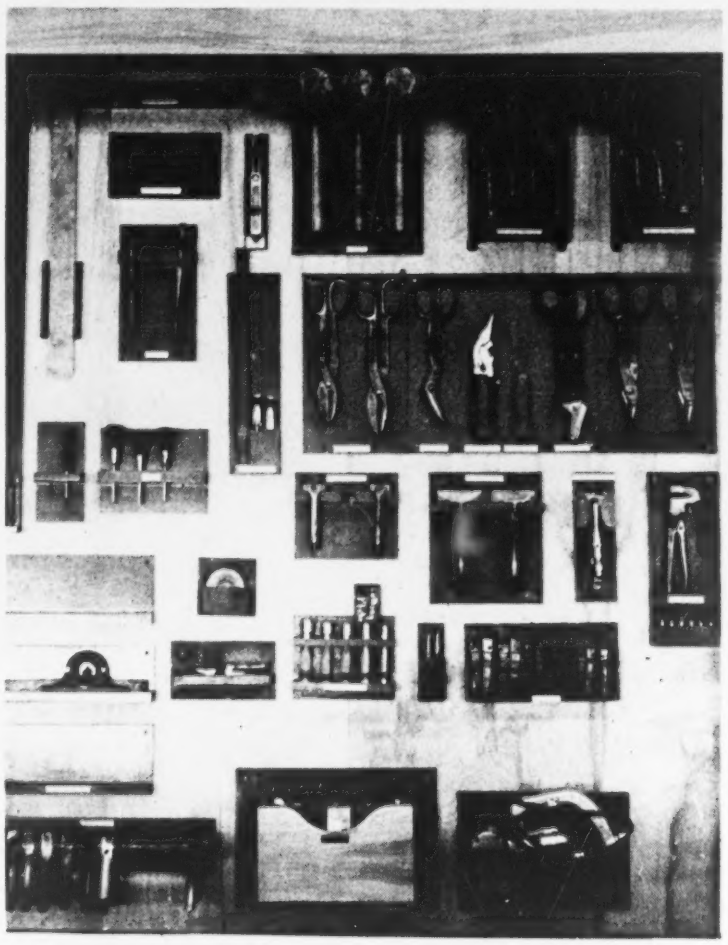

A well-designed, open tool panel is a must for each area of the shop.

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So often industrial arts has been less effective than intended because teachers did not write or follow course outlines, unit plans, or daily lesson plans and allowed their industrial arts courses to become practically 100 per cent activity, with learning taking place incidentally rather than purposefully.

Balancing Classroom and Shop Activities

Industrial arts should be taught in a purposeful manner with some attention given to the value of appropriate textbooks, outside-of-class assignments, supervised study, written examinations, performance tests, and the like. Some of the newer innovative programs (see pages 43-45) are criticized for placing too much emphasis on classroom activity and evaluative techniques. Such criticism may be justified. However, it should be remembered that traditional programs which are practically devoid of classroom activity can defeat the purpose of industrial arts as well as programs which involve too much classroom activity and insufficient shop activity. Some authorities have suggested that approximately 25 per cent of the available time be devoted to classroom activities and 75 per cent to shop-type activities. Teachers are encouraged to study this matter carefully and attempt to strike a balance between classroom and shop activities that proves to be most effective in helping the student to learn.

VII PURPOSEFUL TEACHING

Activities Appropriate to the Classroom

Classroom activity should be as carefully planned as activity that is carried on in the shop. A variety of classroom activities may be used appropriately in industrial arts courses. Some activities which seem especially useful and others that seem to require special comment are discussed below.

Use of Textbooks. Textbooks are as important as tools in present-day industrial arts. Early educational construction activities did not involve using textbooks, for the primary emphasis was on the development of skill in using tools. Nothing could replace activities in the shop in the attainment of such a goal. As an extra precaution in this, it was common for shop classes to meet double periods.

Since industrial arts classes have been placed on the same time schedule as other classes and goals have come to include the attainment of certain knowledge, attitudes, interests, appreciations, and skills, the need for using textbooks in industrial arts

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courses has become imperative. Out-of-class reading assignments can be given that will familiarize students with processes that are to be demonstrated, and the demonstration can then proceed with more understanding and efficiency. Similar assignments covering related information will permit in-class time to be used more profitably in discussion.

Classroom instruction is a vital part of industrial arts.

Many other opportunities exist for improving instruction in industrial arts through the use of a good textbook; in fact, textbooks are used in industrial arts just as they are in other courses except, perhaps, to a lesser extent. It is important that the time devoted to reading activity not jeopardize the shop time that must be reserved for manipulative activity if industrial arts is to make the type of unique contribution it should.

Lecture-Discussion. One of the oldest teaching methods which is used a great deal in formal education is the lecture. Unfortunately, as it is commonly used, it is one of the least effective methods of instruction. Its value in industrial arts is undoubtedly more limited than in disciplines such as social science; but as industrial arts courses become more technical in nature, some increase in the use of this teaching method may be appropriate. At such times careful preparation should be made and many illustrations be used — flip charts, overhead transparencies, and oral illustrations. Pertinent questions should be directed to students to encourage their involvement and to see if main ideas are being understood.

Team Teaching

It is becoming increasingly difficult for a single teacher to be highly competent in several industrial arts subject matter areas. Although large numbers of teachers must still attempt to do an acceptable job of teaching in more than one area, some teaching situations could use team teaching to good advantage. Where school systems operate a comprehensive general shop and two or more teachers are involved, team teaching might improve the instructional program. Many large junior high schools could take advantage of such an arrangement.

In large schools which offer several sections of the same course, the two or more instructors involved could easily form a team which would capitalize on the special teaching abilities and skills or knowledge of each.

Team teaching could also take place on an informal basis with teachers of different courses changing places for short periods of time, to teach units in the instructor's area of specialty to the other class.

Properly organized, this method should provide participating instructors more time for research and planning, resulting in richer content being presented to classes in a more efficient and understandable manner.

Programed Instruction

One of the newer methods of presenting content for a unit or course is by programed instruction. The initial furor over teaching machines died down as it came to be realized that the machine was comparable to the covers of a book whereas the program, the equivalent of the text of a book, was the heart of any teaching machine. Although many programs are designed to be used in specific machines, a number have been produced in book form or in ways that require very unsophisticated gadgets or none at all. Regardless of the form in which it appears, programed instruction is being used a great deal in industrial and military training programs and to a considerable extent in formal education. It requires that the learner be an active participant in the learning process and provides high retention, an effective means for individualizing instruction, and greater opportunity for teachers to increase their effectiveness through individual contacts with students. Research has shown programed instruction to be effective at all educational and ability levels and in many different subject matter areas, including industrial arts.

The industrial arts teacher who would like to use programed instruction in his courses will find that commercially prepared programs for this area are still somewhat limited, and suitable material may not be available. This situation is improving but rather than waiting for programs to be commercially produced or deprecating the method, it is recommended that teachers attempt to write short programs to

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use in their courses. This will require some study of the theory of programing and rigorous attention to detail when writing as well as a substantial investment in time, but those who have accepted the challenge of writing programs generally concur as to the value of this experience. Even if the program is less effective than desired, many values which result from the detailed structuring of discreet bits of subject matter accrue to the writer.

Resource Speakers, Field Trips, and Other Community Resources

The industrial arts teacher should be alert to the community resources that exist in his immediate area and opportunities that exist for improving instruction by utilizing them.

Resource Speakers. Persons from industry are willing and often enthusiastic about speaking to a group or class about an industry or some aspect of it in which they have some expertise.

Field Trips. It is not possible to duplicate the physical setting of industry in the school shop. However, it is possible to take the students to an industry where they can see the various talents, equipment, and teamwork needed to produce a product. Through field trips, students will be able to associate industrial methods and activities with the experiences they have encountered in the school shop. It is important that the teacher provide adequate orientation for the students before the trip so they will know what to look for. After the field trip, a discussion of what was seen is most appropriate to emphasize concepts which have been taught in the classroom. As more and more small industries develop in Iowa, it seems unlikely that any school will be so far from an industrial plant of some kind that the instructor cannot include one or more valuable field trips in his instructional program.

Other Community Resources. Some local suppliers are willing to bring equipment into the school shop and demonstrate a process which is so new that little published material exists. Few methods are more effective in capturing the interest of students, enriching instruction, and keeping the industrial arts program up to date. An alert, conscientious teacher will usually find other community resources that may be utilized to good advantage.

Out-of-class Activities

Industrial arts does not have the reputation for requiring time consuming or rigorous out-of-class activities and certainly this situation has considerable appeal for some students. However, as industrial arts courses are expanded and technical background information becomes increasingly important to the successful pursuit of shop activities, carefully planned out-of-class activities should become commonplace.

Homework. Industrial arts teachers should not hesitate to make assignments that would require several hours per week of out-of-class time. If industrial arts is to be on a par with other courses that are respected by students, faculty, and the community, it must compare favorably in the challenges it provides and the standards of work demanded; and appropriate homework assignments should not only result in coursework that is more meaningful and rewarding but might well improve the image of industrial arts.

Home Workshops. It is well-accepted that industrial arts has considerable potential for promoting the wise use of students' leisure time. Technology of the future promises a substantial reduction in hours per week of work and a corresponding increase in the amount of leisure time. It may be that industrial arts can make a most significant contribution in this area by encouraging the development, improvement, and use of home workshops. The industrial arts teacher can do a number of things to promote such activity. Discussing the value of hobbies and tools and equipment needed for certain hobbies; surveying and arranging for students to visit home workshops in the community; teaching a unit on reconditioning old tools; initiating a carefully organized tool-lending program; encouraging students to construct home workshop equipment such as miter boxes, bench hooks, and chisel handles as school projects; exhibiting work produced in home workshops; and many other things can be done to create interest in home workshops.

One of the most effective means of getting students actively involved is to allow credit for work done in developing or improving a home workshop and using a workshop for general repair work or construction of projects. If this is to be done, some means should be devised to see to it that no students are disadvantaged by their environment. The tool-lending program mentioned above may serve here.

Another important aspect of the matter which needs careful attention is that the teacher have some assurance that work submitted by the students be that of the student and no one else. A plan wherein students contract by a written agreement

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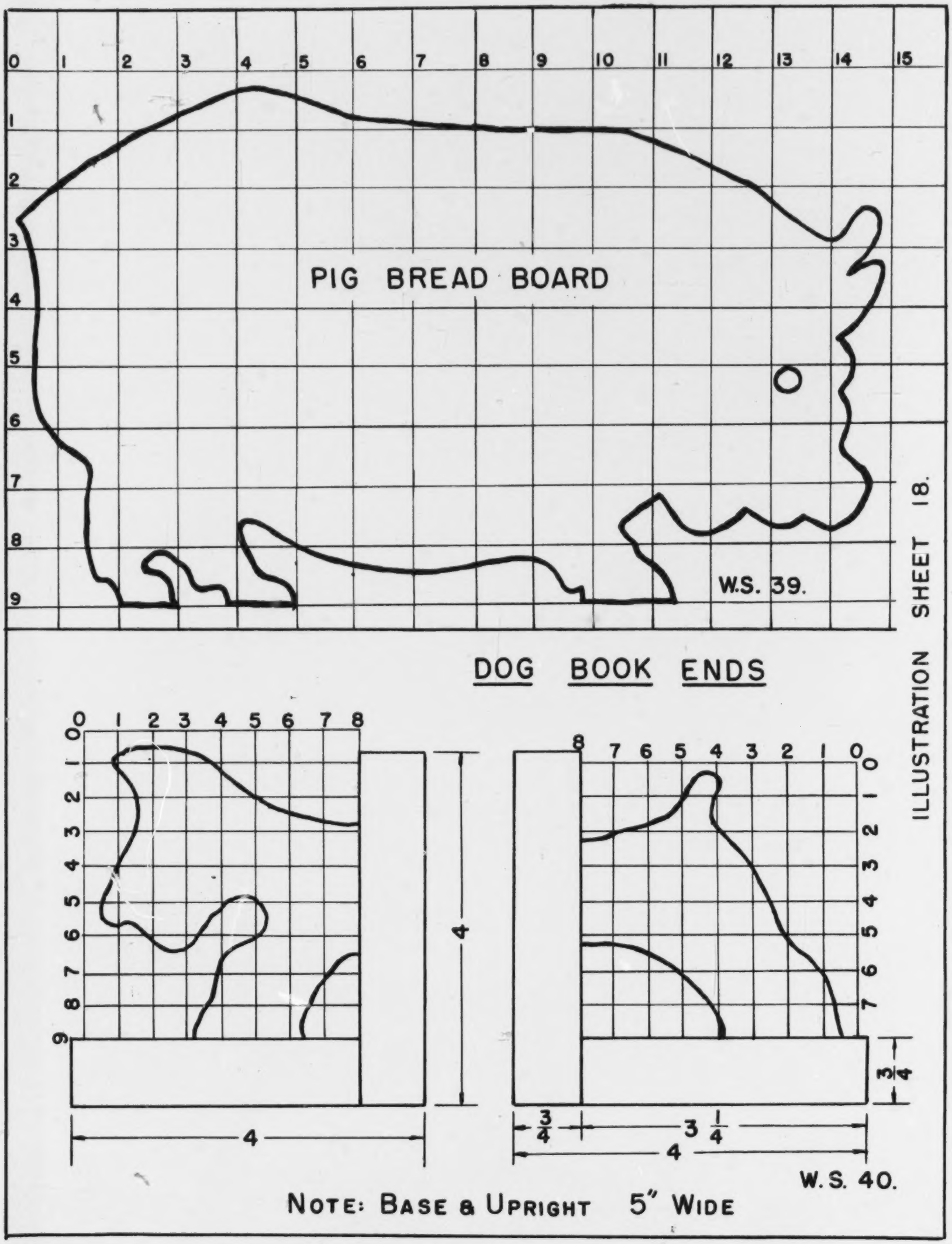

ILLUSTRATION SHEET 18.

with the teacher to carry out certain work on their own may provide the desired amount of control here. Admittedly, allowing credit for shop work that is done at home may be problematic, but it is felt that its value can outweigh any extra efforts that may be required to incorporate this feature in one's program.

Activities Appropriate to the Shop

Forerunners of industrial arts placed emphasis on various types of construction activity. Manual training emphasized acquiring skill with hand tools through wooden joint exercises. Sloyd focused on construction of articles that would have a utilitarian value in the home. Manual arts stressed that useful, take-home projects should be artistically satisfying. Industrial arts has capitalized on the inherent interest of construction and generally has considered the project as a vehicle for learning.

The emphasis of industrial arts on the project sometimes has resulted in unfortunate situations where the public relations value of large projects took precedence over their relevance to learning; where teachers involved themselves almost 100 per cent in individual supervision of students engaged in project construction with learning taking place incidentally rather than resulting from teaching certain important subject matter in each course on purpose; and where projects become the end goal rather than only one important means to the end. It should be realized that certain types of activity are more appropriate for changing certain types of behavior, and that choices should be made accordingly, keeping in mind some of the newer types of activity as well as the more traditional ones. (See pp. 43-45.)

Projects. Traditional, take-home projects are useful when they involve students in learning those things specified by the teacher in his course outline. Many large projects involve much repetitious work requiring skills of a rather low order. Under such circumstances, the student receives a diminished educational return on his investment of time and money. All projects, but especially the large showy ones, should be carefully evaluated and rejected as educationally unsuitable if they are found to involve work that is repetitious in nature. Due consideration should be given to the interest that is inherent in the construction of projects selected by students to meet specific needs but this should always be secondary to the one important question of whether the learning that results from building the project is educationally desirable.

Exercises. Although many industrial arts teachers feel there is a stigma attached to exercises, certainly well-designed exercise work is most appropriate when perceptual motor skills are to be acquired. Many students find exercises quite challenging and are strongly motivated to perform the exercises until they can demonstrate a high degree of skill in each. Some students, however, are not so challenged by this approach. The interest of these students can usually be maintained by allowing project work between exercises which involve only those skills mastered in previous exercise.

Experiments. Although the value of shop experiments has long been recognized by some teachers, it was not until some of the recent work in industrial arts curricula lent status to this type of activity that shop-experiments were given the impetus they deserved. Even though such activities result in a report rather than a project, experiments are capable of generating a great deal of student interest. Experiments should be well conceived and executed precisely, with data carefully recorded so that acceptable written reports may be made. Several shop experiment titles from the metal area are provided for illustrative purposes:

- An experiment in fluidity of aluminum at various temperatures.
- An experiment to determine the best temperature for pouring a certain casting.
- An experiment to determine the superiority, if any, of electrodes of the same AWS classification made by different manufacturers.
- An experiment to illustrate the manner in which aluminum flows during the spinning process.

The following publication should be of value to teachers and students who are interested in activity of this nature:

- *Experiments with Materials and Products of Industry,* Arthur W. Earl, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1960.

Group Projects

In the past the common vehicle of learning in industrial arts has been the project, designed and constructed by the individual student. But little of modern industry is based on the turning out of products which have been designed and constructed by individual craftsmen. A group project, where several students are involved with the problem of design, construction of the various components, and assembly of a one-of-a-kind finished product, is somewhat more representative of the team approach used in modern industry than the typical project

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approach. A machine or device needed for the school shop might be suitable for such a project.

Mass Production

Modern industry could not exist if it were not for mass production. The individual student project has some elements of industry insofar as design and construction of a pilot model is concerned, but it has little in common with the complex organization which enables industry to produce large quantities of items in the quickest, cheapest way possible.

If industrial arts is to realize one of its most important goals — that of developing an understanding of industry — some time during the latter portion of all basic industrial arts courses should be given over to a simulation of industry that is as valid as school shop facilities will allow. The mass production of some small product, with the students involved with both the design of the product and of the necessary jigs and fixtures needed for production, followed by the production of the component parts and assembly and finishing of the product, will do more for the development of an understanding of modern industry than mere words could ever do.

Wholesome guidance value may accrue from such activity, with students learning important things about themselves, such as their possession of a flair for organization, a distaste for dirty work, an interest in things requiring meticulous attention to fine detail, and a low tolerance for monotonous type work. A strong leaning toward a specific occupation may appear, or an abiding interest in the conditions and problems surrounding industrial employment may be developed.

Suggestions for organizing and carrying out a unit in mass production may be found in the professional journals. Teachers who have tried this method and are enthusiastic about the impact it has on students often submit articles containing information of value to the teacher who has yet to use mass production.

Two publications which may be useful are:

- *Manufacturing in the School Shop,* Robert W. Haws and Carl J. Schaefer, American Technical Society, Chicago, Illinois, 1960.
- *Industrial Techniques in the School Shop,* Irwin Sexton, Bruce Publishing Co., Milwaukee, Wisconsin, 1955.

Steps in small project mass production: acquire material, make layout, drill, saw, assemble. Result: the finished product.

Problem Solving*

The need for problem solving abilities in everyday life, together with the opportunities for problem solving that exist in the handling of tangible two- and three-dimensional materials in industrial arts, has fostered much interest in problem solving as an important learning activity in this area. Use of the technique is particularly appropriate for promoting original design of take home projects. The separate steps that are involved in problem solving are:

- *Identifying the problem.* All steps are important, but the first — identifying the problem — can make or break this approach. The problem must be carefully worded by the teacher to avoid restricting students' thinking. "A support for 8-10 books made primarily of wood" is likely to stimulate thinking and produce a greater variety of solutions than would result if "book ends, book shelf, book ramp, or book trough" were used.

- *Analyzing the problem.* This may be done individually, but it lends itself to group brainstorming sessions in which criteria such as stability, books well supported but easy to remove, book titles visible, easy to clean, structurally sound, and reasonable cost should be identified.

*Adapted from "Problem Solving and Design," Fern and Anderson, *School Shop,* May 1960, pp. 12-13+.

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- *Arriving at some tentative solutions.* The important thing here is that students not stop with their first idea. Students who are highly original should be encouraged in this. Others should be encouraged to search for book supports in stores, catalogs, or wherever they may be found for the ideas these can generate and the possibility of developing combinations or modifications that fit the criteria.

- *Selecting the most promising solution.* A scale model should be built to provide a three-dimensional look into problems concerning materials, construction, shape, size, finishes, and the like. Further modifications are made if necessary and drawings, together with a bill of materials, should be made for the final solution.

- *Constructing the project accordingly.* The construction phase involves many challenging problem situations. Considering and selecting the best method to join two pieces together or the best method to cut a compound angle are typical problems in which students may be involved. The instructor will be able to demonstrate those operations for which there is a common need. Special instructional needs which arise can be cared for on an individual basis.

- *Evaluating the project in terms of how adequately it satisfies each of the criteria specified in the analysis.* It is important that the student play a major role in this evaluation, individually or as a part of a teacher-student conference or a group discussion.

This type of problem solving permits members of a class or group, working cooperatively, to employ mass production techniques. It is not always necessary that students know all the operations in a given area before they undertake work in that area. Careful planning should permit successful use of this approach with beginning students.

Student Demonstrations

It is generally accepted that one seldom learns anything quite as well as when he is faced with the problem of passing on his information or skill to someone else. This is sufficient justification for involving students in the giving of demonstrations. There are a number of ways in which students can be so involved. In advanced courses in industrial arts, it is not uncommon to find students who have become sufficiently competent in a certain procedure on an out-of-school basis or in some other school to give a demonstration which the teacher would ordinarily present to the class. Also, students from advanced classes can be used to assist the teacher in giving some of the demonstrations which are presented to classes of beginners. It is, of course, important that the teacher go over details with student demonstrators ahead of time to ascertain that the presentation will be up to standard.

Another approach which is especially appropriate for use in general shop type courses involves students in presenting personal demonstrations to a fellow class member. If motivation is required, a minimum of one such demonstration can be set up as a course requirement with extra credit allowed for additional demonstrations. The procedure below provides directions for students in meeting this requirement.

As you near the completion of work in an area:

1. Find a classmate who will be moving into this area in the near future.

2. Agree upon a suitable operation (something of consequence yet not so complex that it would take more than 20 minutes to check someone out on it).

3. Schedule the demonstration at a time convenient to you, your classmate, and your instructor.

4. Practice until you feel sure of yourself. Be sure you are using an accepted procedure. Check details with instructor as necessary.

5. Give the scheduled demonstration.

6. Supervise your classmate in the activity.

7. Submit a brief report to your instructor containing the following:

   - date, time, and title of demonstration.

   - name of student receiving demonstration.

   - key points covered in demonstration.

   - evaluative comments by student receiving demonstration.

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VIII MEASUREMENT OF STUDENT ACHIEVEMENT

One of the most important jobs that a teacher has to do is that of evaluating his students.

Pertinent Aspects of Student Evaluation

Evaluation must be based upon the objectives assigned by the teacher to the course in question. Objectives should be clearly defined so that evaluation can show growth attained by students in accomplishing the objectives or disclose where the teacher should improve his instruction. It is most important that students be informed early in a course of the various types of performance that will enter into calculation of the course grade and the relative weight assigned to each.

Students in industrial arts become involved in many activities that are quite different from those found in the usual academic classroom. They participate in physical activity wherein materials of industry are processed with tools and machines to produce projects and carry out other types of manipulative activity as well as the acquisition of knowledge appropriate to the area.

Although the latter may be evaluated with paper and pencil tests, objective observation is important to document student development in manipulative skills, habits, and attitudes. Rating scales are recommended for evaluating industriousness, initiative, safety, cooperation, honesty, and consideration for others.

Tests are normally thought of in connection with determining achievement, but they are always more useful if they can be used also as teaching devices. Except for final examinations, this can usually be done by conducting test reviews as soon as possible after the tests have been taken and scored. This provides an opportunity for students to see where they responded incorrectly to specific questions and to clear up misconceptions they had at test time. It is important, of course, that all tests are prepared carefully. Unless a test is valid (measuring what it purports to measure) and reliable (always measuring the same under comparable conditions) its value is questionable.

Progress Chart

Progress charts are commonly used to show student achievement in industrial arts. Individual progress charts of a size that will fit in a loose-leaf notebook may be used, but it is more common for

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larger charts, mounted on a board and displayed publicly, to be used. Many teachers use progress charts to record only manipulative work; but if the display of this kind of performance is useful in providing motivation for the learning process, it is reasonable to expect that test grades and other evidence of student performance could be included and would be of similar value.

A progress chart provides students with an easy to understand picture of course work that has been accomplished, work that is under way, and that which lies ahead, and some have claimed it to be the greatest foe of indolence and indifference. This seems to be true especially at the junior high school level where students generally respond to competition in a wholesome manner. On the other hand, some educators fear that use of publicly displayed progress charts will focus attention on slower students and cause them to become discouraged. It is recommended that the teacher study this matter carefully and use the type of progress chart that he feels best fits his situation and students.

Student Self Evaluation

When a student turns in a piece of work and the teacher grades it, the student is being deprived of a very valuable learning experience. After all, the student who did the work is more familiar with what was done than anyone else; and if he has some knowledge of the standards of workmanship that are acceptable, he is one of the individuals best qualified to evaluate it. Being responsible for evaluating work they have done enables students to take pride in aspects of work that were well done and to honestly admit where improvements are needed. Improvement starts with one's realizing his deficiencies, but these deficiencies are easier to accept when self-awareness precedes criticism by the teacher.

Teachers who have not used this technique sometimes are concerned that students will not be sufficiently discriminating and will tend to rate themselves too high. The reverse is usually found to be true. But whether students tend to rate aspects of their work higher or lower than the teacher matters little. The opportunity that is presented for helping students recognize their work for what it is and adjust their standards to those of the teacher is what is important.

Self evaluation by students, of course, should not replace teacher evaluation. It should supplement teacher evaluation, always coming before it. The final grade for the work remains the responsibility of the teacher, but the single letter grade which usually represents the quality of the work is more meaningful to the student if he has had some self evaluative responsibilities.

A test of workmanship has been used on teacher-prepared plan sheets to introduce self evaluation to students. Students with experience in using such sheets can usually write their own test of workmanship for later work that is of their own choice and self planned. If tests of workmanship are felt to be too rigid, less formal paragraph-type self evaluations can be used.

Tests Which Are Appropriate

A number of tests can be used appropriately in industrial arts including objective tests, essay or short answer tests, tool recognition tests, object tests, and manipulative-performance tests.

Objective Tests. The objective test is the most satisfactory method of measuring the achievement of factual information in industrial arts. The test can be administered easily and a wide range of material can be covered in a minimum amount of time. Questions such as multiple choice, true-false, completion, and matching can be scored quickly without involving the personal judgment of the teacher. Such tests, however, are time consuming and rather difficult to write if they are to be valid and reliable. Another disadvantage of this type of test is that it does not allow the student to express himself in writing.

Essay or Short Answer Tests. Test questions that require students to compare, describe, or explain certain points are classified as essay questions if extensive writing is required. Short answer questions are those that can be answered satisfactorily with several words, phrases, one or two sentences, or a sketch. Essay tests have been criticized for the subjectivity of scoring, limited sampling, and the possibility of student bluffing. Short answer questions are somewhat less subject to such criticism. It is recommended that some carefully prepared essay and short answer tests be used in industrial arts course work to provide some opportunity for measuring the ability of students to organize their thoughts and express themselves clearly.

Tool Recognition Tests. The use of tests involving the recognition of tools is highly appropriate and

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popular with students and teachers. Tool recognition tests may be administered in an informal manner by displaying various tools for the students to identify. A more sophisticated variation of this test involves pasting one or more catalog pictures of tools on cards, which are passed, on signal, from one to another with students seated in a circle. By positioning himself in the circle, the teacher can handle extra picture cards if there are more cards than students. A further refinement is to have multiple-choice answers for each picture. This permits the use of answer sheets that can be machine scored, controls the use of slang or colloquial names of tools which students sometimes favor, and allows the test to be administered as a time test if this is desired. With the increasing availability of copying equipment, sets of picture cards can be easily reproduced. Some tool recognition items can be included in almost any paper and pencil test.

Object Tests. An object test in which the student identifies actual tools, materials, and supplies is highly appropriate for industrial arts. The items are displayed at various stations, and students move on signal from station to station in an orderly manner. Limited use of tools to make measurements or perform simple operations may be involved. The use of actual items is more realistic than pictures or word descriptions, and such a test is not only highly valid and reliable but is one that students find interesting.

Manipulative-Performance Tests. Written tests seldom are valid for the measurement of manipulative skills. Such skills are most generally evaluated by the industrial arts teacher as he examines specific manipulative work resulting from on-going activity in the shop and enters grades on a progress chart of some kind. This kind of record is useful if student activity in the shop is rigidly controlled, otherwise only a partial record of the manipulative skills of various students may result. A manipulative-performance test could be an objective, reliable, and valid means for completing the record. It requires students to complete one or more significant operations under rigidly controlled conditions. Each operation may require a number of steps. Students are often tested one at a time so each student can be observed carefully and a detailed record made of his performance. Where groups are being tested, the work pieces which result are carefully checked for accuracy and proper use of tools in the correct order. Individual manipulative performance tests may be as short as 10 minutes or as long as 50 minutes. A time of 30 to 40 minutes is suggested for manipulative performance tests administered to groups.

Utilizing Standardized Tests

Only a very limited number of standardized tests which apply specifically to industrial arts, or some particular course in this area, have been produced. The best source for standardized tests, Buros' *Mental Measurements Yearbook,* sixth edition, copyright 1965, lists just one high school industrial arts test of a general nature which might be of value. The entry is as follows:

> "Industrial Arts: Every Pupil Scholarship Tests." High school; 1962-63; new form (2-4 pages) usually issued each April; forms from previous testing programs also available; general directions sheet (1963, 2 pages); no data on reliability; norms for new forms available following testing program, 4 cents per test; 4 cents per key; postage extra; 40(45) or 50(55) minutes; Bureau of Educational Measurements, Kansas State Teachers College, Emporia, Kansas 66801.

It seems reasonable to assume that new forms have been and continue to be issued each April.

Another good source, *Tests in Print* by Oscar K. Buros, copyright 1961, lists two mechanical drawing tests and the *Middleton Industrial Arts Test* for high school. The dates are 1937, 1945, and 1951 respectively, and because of their age are assumed of little value.

A *Drawing Aptitude Test* is available from McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, but its copyright date of 1940 causes its value to be suspected.

Although the number of useful standardized tests which apply specifically to industrial arts is limited, a number of standardized tests exist which purport to provide information about spatial aptitude, manual dexterity, mechanical ability and comprehension, and vocational or occupational interests. The industrial arts teacher may wish to have guidance personnel administer one or more tests of this type to certain students. Some of these tests are listed below.

Spatial Relations

- *Spatial Tests,* 1950-1959, Newnes Educational Publishing Co. Ltd. Town House, 8-11 Southhampton Street, London, W.C. 2, England.

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- *Flags: A Test of Space Thinking,* 1959, Education-Industry Service, 1225 East 60th Street, Chicago, Illinois 60637.

Manual Dexterity

- *Minnesota Rate of Manipulation Test,* 1946, Educational Test Bureau, Division of American Guidance Services, Inc., 720 Washington Avenue, S.E., Minneapolis, Minnesota 55414.
- *Purdue Pegboard,* 1941-1948, Science Research Associates, Inc., 259 East Erie Street, Chicago, Illinois 60611.

Mechanical Ability and Comprehension

- *Curtis Object Completion and Space Form Tests,* 1960-1961, Psychometric Affiliates, 1733 Monterey, Chicago, Illinois 60693.
- *Test of Mechanical Comprehension,* 1940-1954, The Psychological Corporation, 304 East 45th Street, New York, New York 10017.
- *Mechanical Movements: A Test of Mechanical Comprehension,* 1959-1963, Education Industry Service, 1225 East 60th Street, Chicago, Illinois 60637.
- *Purdue Mechanical Adaptability Test,* 1945-1950, University Book Store, 312 State Street, West Lafayette, Indiana 47906.

Vocational and Occupational Interest

- *Kuder Occupational Preference Record,* 1956-1963. Science Research Associates, Inc., 259 East Erie Street, Chicago, Illinois 60611.
- *Strong Vocational Interest Inventory,* 1927-1959. Consulting Psychologists Press, Inc., 577 College Avenue, Palo Alto, California 94306.

All of these tests are relatively inexpensive, except for the manual-dexterity tests which cost about $20 per set. It is believed that information provided by some of these, or similar, standardized tests, may help industrial arts teachers to be more effective in planning suitable instruction and in counseling individual students.

Recommendations for Project Grading

Projects and other types of manipulative work should be evaluated with more than one grade. A number of factors are involved in work of this kind. The quality of workmanship that is evidenced should be evaluated and a grade assigned. The quantity or productiveness that is represented by such things as the physical size of the work, its complexity, the degree of ingenuity exhibited, and the time required for its completion should also be evaluated and another grade assigned. Evidence of the student's ability to plan his work and follow his plan should also receive consideration and a separate grade. Confusion results when some or all of these, together with student attitude or cooperation, are combined into one letter grade for the project.

A project grading system in which specifics are isolated and can be examined and understood by whoever may be concerned, will improve communications in this area.

Reporting Course Grades with a Profile Card

A course grade is always a composite of various kinds of student performance. The teacher is aware of this because he is intimately involved in making whatever calculations are involved in arriving at the course grade. To the extent that they understand the grading system, students are also aware that the course grade is a composite; but even the better students seldom know, or remember, how they stand in the several different performances that are involved. Under these circumstances, the final course grade tends to obscure rather than communicate this information.

Parents usually have little idea of what makes up a final course grade and are seldom concerned unless they think their children have received a lower grade than was deserved. Communication can be improved in this area by supplementing the final course grade with profile cards.

The various kinds of student performance and weights used in the example below are illustrative only and should not be construed as an exact example to follow. Columns could be divided as shown or could show the frequency distribution in each category with the student's score encircled. (The teacher will likely have made these distributions for his own use anyway). For more sophistication, raw scores could be converted into percentile ranks and entered in each category, but it is questionable whether communications would be improved in proportion to the extra time which would be required to do this.

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Name of School _____ Date _____

John Doe's _____ performance in General Metal is shown below:

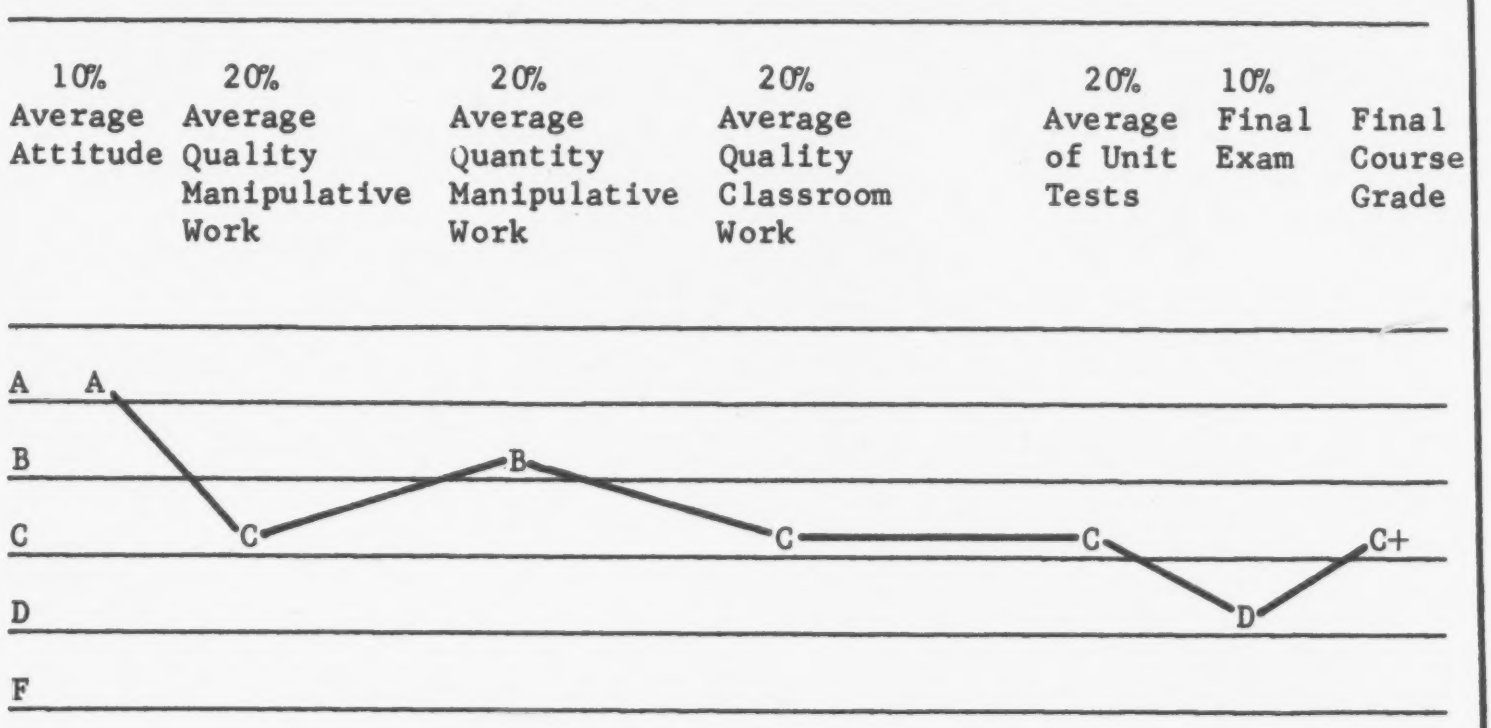

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IX USEFUL INFORMATION FOR THE TEACHER AS A PROFESSIONAL

Certain materials believed to be important to industrial arts teachers who are interested in improving their profession are included in this section.

Federal Funds for Industrial Arts

There has been a great expansion in legislation in recent years which has resulted in federal funds being made available for many different areas of education. The legislation which pertains to industrial arts is briefly described below.

National Defense Education Act. The National Defense Education Act of 1958 was the first major education act specifically designed to improve the instruction in academic subjects through direct aid to public schools. This act has been modified a number of times. The 1965 modifications included industrial arts in Title XI of the act. Basically, Title XI establishes institutes for advanced study for educators at many different levels.

Since January 1966, Congress has appropriated sufficient funds to support 63 NDEA institutes in industrial arts. Five pilot institutes in industrial arts were conducted in the summer of 1966, and 29 NDEA institutes were held in the summers of 1967 and 1968. A number of Iowa industrial arts teachers have profited from participating in one or more of these institutes. Such institutes will henceforth be supported by funds under a new Education Professions Development Act.

The Higher Education Act of 1966 was amended to include industrial arts as one of the critical areas under Title III of the National Defense Education Act. Passed October 21, 1966 (effective June 30, 1967), industrial arts, as a subject area, was included in all general federal legislation along with science, mathematics, English, and modern foreign languages.

NDEA Title III guidelines were revised April 1967, making industrial arts eligible to use any of the federal funds appropriated under this title for industrial arts. Such funds are contingent upon approval by the United States Office of Education of a state plan setting forth how the funds are to be used. Approved state plans permit the use of federal funds for equipment, teaching materials and aids, minor remodeling of buildings for industrial arts, inservice training of industrial arts teachers, and loans to private schools for improving industrial arts programs. Such funds became available to the states on July 1, 1967.

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Schools interested in qualifying for such funds may secure appropriate forms from the Coordinator, Title III, National Defense Education Act, Department of Public Instruction, Des Moines, Iowa 50319. A number of schools in the state have received industrial arts equipment with funds provided by the legislation.

Elementary and Secondary Education Act. Another major piece of federal legislation that has some effect on industrial arts is PL 89-10, Elementary and Secondary Education Act of 1965, passed April 11, 1965. This act contains five titles as follows:

Title I provides funds to school districts under state plans approved by the United States Office of Education to strengthen and improve elementary and secondary school programs for educationally deprived children in low-income areas. (Approximately 95 per cent of all school districts can qualify.) Funds can be used for equipment, instructional aids, more teachers, inservice training of teachers, and construction of facilities or buildings.

Title II provides funds for the purchase of library books, audiovisual material, textbooks, magazines, and reference books.

Title III of the bill, called "Supplementary Educational Centers and Services," provides funds for the establishment of special educational programs which have not been available previously.

Title IV provides funds to extend the cooperative research program of the U.S. Office of Education.

Title V authorizes funds for improving the effectiveness of state departments of education. In 1966, funds from PL 89-10, ESEA of 1965 were secured to provide a consultant in industrial arts for the State of Iowa and to develop a public information program designed to emphasize industrial arts as an aspect of general, non-vocational education.

Those interested in securing funds under the above titles are encouraged to contact their local administrators in charge of ESEA funds as to the procedure to be followed.

Higher Education Act. The Higher Education Act of 1965 includes industrial arts teachers and prospective teachers as eligible for graduate and undergraduate fellowships, loans, and grants of various kinds.

Conclusion. The initiative for securing federal funds rests with the individual teacher or local school district.

The following publication contains detailed information on the legislation cited above as well as some guidelines and outlines that would be helpful in preparing proposals:

- *Federal Aid for Industrial Arts,* The American Industrial Arts Association, 1210 16th Street, N.W., Washington, D.C. 20036. $3.75 (soft cover).

Legal Responsibility of the Industrial Arts Teacher

National Safety Council records show that at least one out of every eight school accidents takes place in school shop-labs. Laws which govern court action resulting from student injuries sustained in schools vary from state to state.

Most states still hold to common-law principles that provide immunity for school districts as agents of the state engaged in governmental functions. In such states the individual teacher tends to become the target for litigation; however, the limited financial resources of most teachers has tended to discourage such court action. Serious doubts have been raised concerning the justice of common-law principles; and a few states, including Iowa, have passed legislation that enables injured persons to recover damages from the school district. This reduces, but does not eliminate the likelihood that suits would be brought against individual teachers.

On January 1, 1968, the Tort Liability Act (Senate File 710) passed by the 62nd General Assembly went into effect. This legislation makes school districts in Iowa liable for the torts (wrongful acts which result in injury to another's person or property, and from which the injured party is entitled to compensation) of their employees. It also legalizes the purchase of liability insurance by school districts and makes some provision for school districts to provide defense for employees who are sued in the course of performing their work, and to compensate them for incurred loss when they are held liable.

As a result of this legislation, industrial arts teachers in Iowa may be somewhat more isolated

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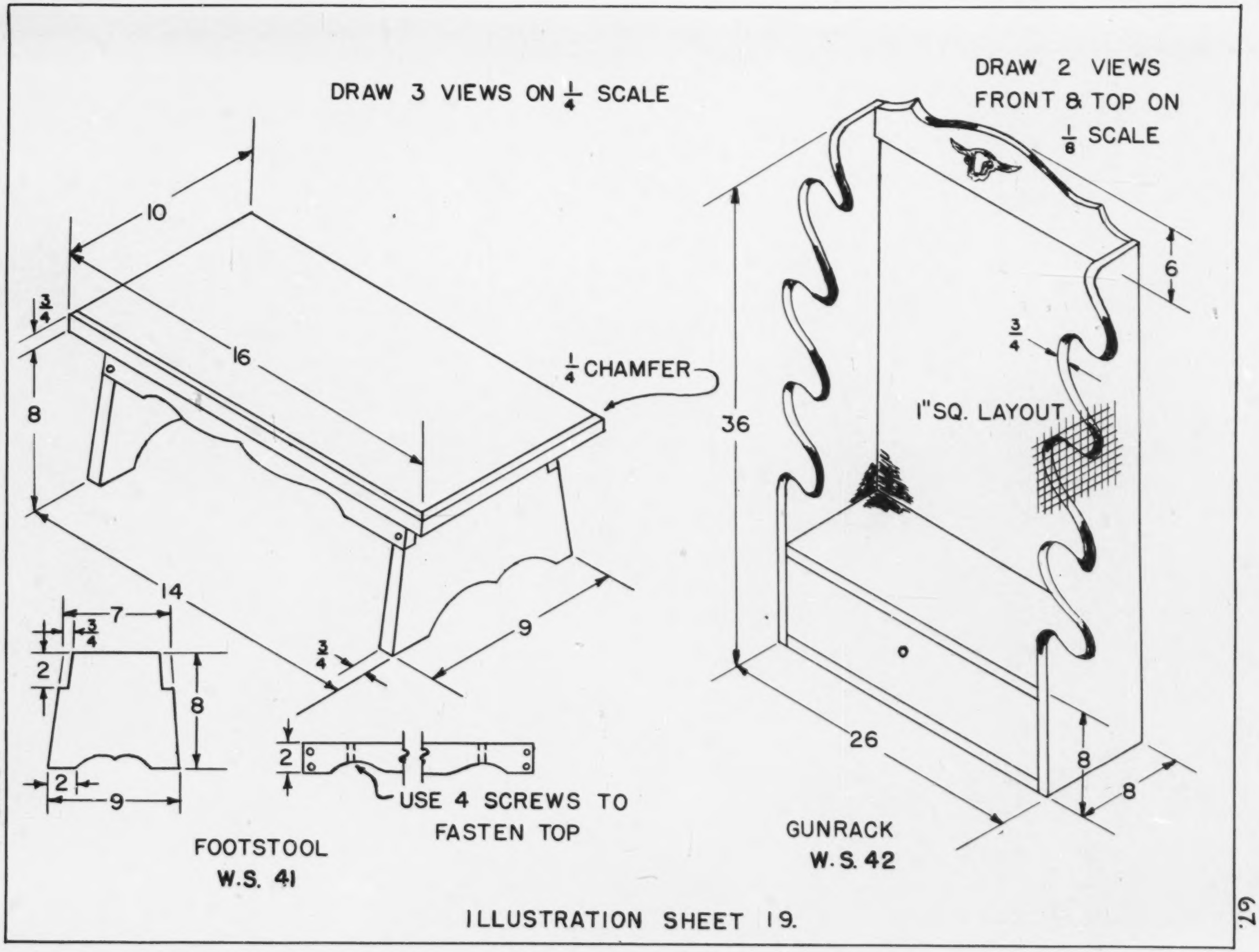

ILLUSTRATION SHEET 19.

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from court actions resulting from student injury than ever before. However, none of the above may pertain if the teacher is proved negligent. Under these circumstances the personal liability insurance provided by the Iowa State Education Association for its members may be valuable. This insurance, which is underwritten by the Horace Mann Insurance Company, agrees to pay up to $150,000 for bodily injury caused by the teacher's personal acts committed in the course of duty as an employee of the school district. The insurance company also agrees to pay for the teacher's defense even if suit for damage is groundless, false, or fraudulent.

Other sources of liability insurance exist. For example, the American Industrial Arts Association offers $10,000 protection for $1 per year.

It is most important to realize that any amount of legal protection does not relieve the teacher of the moral responsibility to do all within his power to prevent accidents. Since students are minors, they are held only to the degrees of reference set by members of their own age group and not by adult standards. The teacher is held responsible for the actions of the students under his supervision. Accidents resulting from lack of proper safety instruction, unsafe machinery, hazardous aspects of the physical facility, or even carelessness of a student may be assessed as negligence on the part of the teacher. To prevent this, the teacher should establish a safety program that is a definite part of his course of study and be able to prove that each pupil received adequate safety instruction.

Safety Tests. Teachers should use safety tests. These tests should be kept because they provide a certain degree of legal protection. In addition they provide assistance in the instructional process.

Accident Reports. An accurate written report of an accident compiled right after it happened may be helpful in analyzing accident cause as well as of some value from a legal standpoint.

Waiver Forms. Waiver forms do not relieve a teacher of responsibility in accident cases. He remains liable for acts of negligence regardless of his possession of a form showing parental permission for a student to participate in school shop activities.

Workmen's Compensation. Teachers are sometimes injured in carrying out their employment responsibilities. In Iowa, teachers are included under the provisions of workmen's compensation, which basically provides compensation in lieu of wages for employees injured on the job.

Conclusion. It is suggested that specific state laws and references such as Chapter 10, "Shop Teacher Liability," in *Accident Prevention Manual for Shop Teachers* be used to provide additional information on this subject.

Professional Organizations

ACESIA. The American Council for Elementary School Industrial Arts, which is an affiliate of the American Industrial Arts Association, seeks to promote industrial arts in kindergarten through sixth grade. Membership is open to all members of AIAA. Annual dues are $3. Annual meetings are held in conjunction with the national convention of the AIAA. For more information write to: American Council for Elementary School Industrial Arts, 1201 - 16th Street, N.W., Washington, D.C. 20036.

ACIAS. The American Council of Industrial Arts Supervisors, which is an affiliate of the American Industrial Arts Association, seeks to promote better industrial arts in the public schools by improved supervision. Membership is open to members of the AIAA who are employed as supervisors of industrial arts. Annual dues are $3. Annual meetings are held in conjunction with the national convention of the AIAA. For more information write to American Council of Industrial Arts Supervisors, 1201 - 16th Street, N.W., Washington, D.C. 20036.

ACIATE. The American Council on Industrial Arts Teacher Education is an affiliate of the American Industrial Arts Association. Membership is open to AIAA members in higher education who are engaged in the preparation of industrial arts teachers. A yearbook, published annually, is distributed to members at no charge. A monograph series is also published. Annual meetings are held in conjunction with the national convention of the AIAA. For more information write to American Council on Industrial Arts Teacher Education, 1201 - 16th Street, N.W., Washington, D.C. 20036.

AIAA. The American Industrial Arts Association, which is an affiliate of the National Education Association, attempts to derive, define, and foster the professional ideals of industrial arts as a part of general education. It publishes the *Journal of Industrial Arts Education* magazine five times per

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year, which is distributed at no cost to members. It also publishes brochures and provides a packet mailing service for members. The organization has a national convention in the spring of each year.

Membership dues are $10 per year. For more information write to American Industrial Arts Association, 1025 - 15th Street, N.W., Washington, D.C. 20005.

AVA. The American Vocational Association has advocated the further development and improvement of industrial arts in the public schools for many years. This organization, which also includes such areas as agriculture, business, and home economics, has a vice president for industrial arts. It publishes *The American Vocational Journal* nine times per year which is distributed to members at no cost. A national convention is held each year in December. Membership dues are $12 per year ($8 if paid along with Iowa Vocational Association dues of $6). For more information write to American Vocational Association, 1025 - 15th Street, N.W., Washington, D.C. 20005.

Epsilon Pi Tau. This fraternity was founded in 1929 at Ohio State University. It is a professional fraternity of industrial arts advocates. Membership is by invitation only. Its purpose is social relationships, research, and the creation of skill in real craftsmanship.

IIEA. The Iowa Industrial Education Association includes teachers, supervisors and teacher educators of industrial arts, vocational industrial education, and technical education. It publishes a newsletter several times a year, which is distributed free of charge to all members. Annual meetings are held in conjunction with the meeting of the Iowa State Education Association in October of each year in Des Moines. Membership dues are $3.50 per year. For more information write to Robert Reuter, Treasurer of IIEA, East High School, Waterloo, Iowa 50703.

ISEA. The Iowa State Education Association has two publications. The *ISEA Communique* is a monthly newsletter type of publication. The *Communique* concerns itself with Iowa educators and the awards presented to some of them. It carries flash reports of general happenings in the field of education. The second ISEA publication is *Midland Schools*, which is printed bi-monthly. The magazine provides information on conventions and items of interest in general education. Both publications are provided to members free of charge. Dues are .4 per cent of the Iowa average instructional staff salary of the previous year. This association has been instrumental, along with the NEA, in increasing the salaries and improving the working conditions of educators in Iowa. For more information write to Iowa State Education Association, 4025 Tonawanda Drive, Des Moines, Iowa 50312.

Iota Lambda Sigma. Iota Lambda Sigma was founded in 1925 at Pennsylvania State College, now Pennsylvania State University. It is a professional fraternity of teachers, supervisors, and administrators of industrial arts and trade and industrial education. Membership is by invitation only. Its purpose is to promote industrial education by recognizing scholarship and training and to create a bond among persons in industrial education.

NAITTE. The National Association of Industrial and Technical Teacher Educators is an organization comprised of those who are members of an industrial teacher education staff or teachers, supervisors, or administrators of industrial education. It publishes the *Journal of Industrial Teacher Education*, a publication of research and professional reports of industrial teacher education. The *Journal* is published four times a year and is distributed to all members at no cost. Membership dues are $3 per year. For more information write to Membership Chairman of NAITTE, Purdue University, Lafayette, Indiana 47907.

NEA. Yearly dues for membership in the National Education Association are $15. The association publishes *Today's Education* and a newsletter, the *NEA Reporter*. *Today's Education* carries many current ideas and trends on education, unions, teaching methods, legislation, and the general movements and thoughts in education. For more information write to National Education Association, 1201 - 16th Street, N.W., Washington, D.C. 20036.

National Exhibitors Association-Ship. Founded in 1922 in St. Louis, Missouri, as a social organization, Educational Exhibitors Association-Ship is an organization of commercial people who deal directly with schools. Its purpose is to provide service, friendship, and fair dealings. It recognizes outstanding industrial arts educators as the "Ship's Man of the Year." The Ship provides advice to convention committees dealing with industrial education. It gives the industrial arts field a unique tie with personnel in industry and new products available from industry. Industrial arts personnel are not eligible for membership in this association, however, they should be aware of its existence.

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Recruiting Future Teachers

The present demand for industrial arts teachers far exceeds the supply. The prognosis for correcting this imbalance in the near future is not good. Industrial arts teachers can help with this problem by encouraging promising high school students to give strong consideration to preparing for teaching in this important curriculum area. Research indicates that teachers can be very influential in the recruiting of future teachers.

Industrial Arts Clubs

For many years some aggressive secondary school teachers have organized industrial arts clubs in their local school systems. Such clubs can now become a part of a nationwide network of American Industrial Arts Association-sponsored student organizations dedicated to "Learning to Live in a Technical World." Such topics as organizing and financing clubs, conducting meetings, suggested activities, and developing a constitution and bylaws are described in a handbook. Single copies of the handbook, certificate of merit and achievement, certificate of leadership, club charter, creed, motto, and the student membership card are available from the national office at no cost. To affiliate with the AIAA national industrial arts student club program, a list of student members' names and a check or money order for $1 per student are forwarded to the national office. A charter, signed and sealed, will be sent to the sponsor, together with membership cards to be filled in by the sponsor, signed by the school principal, and distributed to the student members.

Each student member will receive five issues each year of a newsletter with information on activities of other clubs, occupational trends, and articles of general interest. Club pins, keys, jackets, blazers, emblems, banners, office symbol plaques, secretary's books, treasurer's books, and club scrapbooks are available for affiliated clubs.

To affiliate or secure more information write to Director of AIAA Student Clubs, 1201 - 16th Street, N.W., Washington D.C. 20036.

Advisory Committees for Industrial Arts

The advisory committee concept has long been an integral part of most vocational programs. The 1963 Vocational Education Act requires that there be such a committee in operation on the local level for vocational education. Although advisory committees have not been used widely in industrial arts, some interest in this approach has been evidenced; and a number of local industrial arts programs are profiting from the use of such committees.

Advisory committees, if directed and used properly, can be helpful in initiating, improving, and maintaining a program. Typical activities include program evaluation, updating courses of study, surveying committee needs, arriving at standards, influencing legislation, publicizing school programs through news media, promoting school-community projects, and assisting in procurement of supplies, equipment, and physical space.

The following suggestions may be helpful in utilizing such a committee:

1. The instructor or administrator who is responsible for working with an industrial arts advisory committee should have some formal training prior to establishing a new committee or working with an existing one. He must be knowledgeable to the extent that he can define the differences in the philosophy of a vocational program and his program.

   Committee members must understand that an industrial arts program offers experiences for guidance and informational purposes. It should develop student interests, discover occupational aptitudes, provide safety education and acquaint students with industrial nomenclature. It should be the foundation for vocational and technical training, or engineering, or science, but normally would stop short of attempting to develop employable skills in trades or technical areas.

2. In communities where vocational programs are in operation, an advisory committee will probably already be functioning. It is possible that this committee might also serve the industrial arts program, provided that its members have a clear understanding of the differences in the aims and objectives of the separate programs and are willing and capable of acting discriminately.

3. The committee should function strictly in an advisory and promotional capacity and the responsibilities of the members should be clear-

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ly defined. Their activities must not usurp the authority of the school administrators or teachers.

4. There is no definite formula for selecting or appointing committee members. It is advisable to select or recommend citizens who are familiar with current industrial concepts, who are intelligent, who possess social vision and leadership qualities, and who enjoy social acceptance within their community. Final appointment should always be made through the superintendent of schools and by the board of education. The number of members can vary, but normally there is a minimum of three.

More detailed information can be found in the publications listed below. It is recommended that one or more of these be reviewed before attempting to formulate a committee.

- *American Vocational Journal,* May issue, 1965, is entitled, "The Role of Advisory Committees in Strengthening Vocational Education," and contains three articles pertaining to advisory committees.

- *Journal of Industrial Teacher Education,* "Functional Advisory Committees for Vocational-Technical Education Programs," Stadt and Jensen, Vol. 4, No. 2 (December issue, 1966) pp. 4-11.

- *Teaching Successfully in Industrial Education,* Curry Silvius, pages 598-601, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1967.

- *U.S. Office of Education, Publication No. 84009,* "Organization and Effective Use of Advisory Committees," Washington, D.C.

- *Vocational Advisory Committees,* 32 pages, 1959, order from American Vocational Association, Inc., 1025 - 15th Street, N.W., Washington, D.C. 20005, 30c.

Keeping Abreast of Research

More research is being carried on today than at any other time in the history of industrial arts. Those teachers who are working toward an advanced degree full time, summers, or by taking evening or Saturday classes are usually forced to keep abreast of research by the course work in which they enroll. Others must do it themselves, and this can be more difficult. The professional journals are suggested as being helpful. *School Shop* and *The Journal of Industrial Arts Education* often include articles based on a specific piece of research. *Industrial Arts and Vocational Education* publishes similar articles. A column on recently completed research by Dr. William P. Spence, dean of the School of Technology, Kansas State College, Pittsburg, Kansas, is published from time to time. *The Journal of Industrial Teacher Education* is especially useful since it is devoted primarily to reporting research.

Institutions which offer work leading to a doctor's degree in industrial education usually publish abstracts or reviews of research completed under their auspices and are willing to send such reports to educators requesting them. Of course, teachers who are close to college or university libraries can avail themselves of such resources as dissertation abstracts.

Keeping Pace with Technological Changes

There are those who feel that traditional industrial arts as taught by an enthusiastic and energetic teacher will attain the major objectives as set forth on pages 5-6 in an admirable manner. Others feel that some of the new concepts which are emerging from innovative programs in this curriculum area are better suited to attaining these objectives. It is not the place of this publication to prescribe the direction which local industrial arts programs should take. It is suggested, however, that teachers become quite sensitive to the effectiveness of the approach they use, keep abreast of new developments, and ever seek to improve their industrial arts program, specific courses within the program, and all aspects of instruction within the courses.

Contributions of Industry

Industry not only supplies the subject matter for industrial arts, but it stands ready to assist in many ways. Resource persons, to present materials to classes or assist the teacher with specific problems, are available upon request. Many good motion pictures produced by various industries are available on free-loan. Most local industries stand ready to open their doors to industrial arts classes for field trips. In some instances certain equipment that a local industry considers extra or outdated can prove to be very valuable in a

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school shop. Local industries are often willing to donate such equipment and serve in other ways to pave the way for securing equipment and materials which are beyond the financial means of the school or are difficult to procure.

It is important to realize that the key to securing help from industry is the industrial arts teacher. Unless he makes his needs known, industry's resources will go untapped.

New Directions for Industrial Arts

Over 60 years ago Charles Richards questioned more or less meaningless projects in industrial arts and expressed concern that an orderly way should be sought to develop an insight into the basic industries of our time. Although 60 years have passed, Richards' words are possibly more significant today than ever before. Many industrial arts programs today are inadequate for fostering a proper understanding of today's vast industrial complex. Yesterday's skills are not sufficient for today's and tomorrow's ever-changing occupations. A program that reflects a broad perspective of our industrial society should be provided. Industrial arts teachers cannot remain oblivious to the vast knowledge explosion and continue a traditional skill-development approach with antiquated tools and equipment. Such programs tend to enclose the students in a teacher-dominated environment with little or no opportunity for problem solving, creativity, or self discovery on the part of the student.

Fortunately for the profession, many leaders in the field of industrial arts have become vitally concerned about the future of industrial arts. Many efforts have been focused on determining a truer perspective of industry and using current educational psychology and recent research in learning to develop new approaches. Some of the new approaches have been designed as entirely new programs to replace industrial arts, but others may be considered as options in an existing program. Teachers are encouraged to examine these new approaches carefully as they search for more effective means of providing instruction more relevant to the needs of today's students.

American Industry Project

Objectives. To understand industrial concepts and develop problem-solving abilities related to industry.

Central theme. Conceptual analysis of a body of knowledge needed to understand any industry based on interrelationships of communication, transportation, public interest, finance, physical facilities, research, purchasing, industrial relations, marketing, management, production, materials, processes, and energy.

Grade level (experience levels used). General understanding of the structure of industry, greater depth in the major conceptual area of the structure, and independent research of a problem of interest in one of the conceptual areas of the structure.

For further information. Dr. Eugene Flug or Dr. Wesley Face, Stout State University, Menomonie, Wisconsin 54751.

A New Industrial Arts for Today's Schools (Prospectus 1966)

Objectives. To help students, by a study of their technological environment, to discover, develop, release, and realize their own native potential therein.

Central theme. Body of knowledge derived from analyzing the manufacturing, construction, transportation, communication, power, service, management, and research categories of American industry.

Grade level. All levels.

For further information. Dr. Delmar W. Olson, Kent State University, Kent, Ohio 44240.

Functions of Industry

Objectives. To provide vocational guidance through experiences that promote understanding about industry and prepare students for active participation in industry.

Central theme. Functions of industries including activities essential to the production of a product — research, development, planning, and manufacture; and activities essential to the servicing of a product — diagnosis, correction, and testing.

Grade level. Designed for exploratory phase of industrial education.

For further information. Dr. Willard M. Bateson, Wayne State University, Detroit, Michigan 48202.

Industrial Arts Curriculum Project

Objectives. To enable students to describe the basic steps that must be taken to produce a product in their environment.

Central theme. Industrial praxiology. Groups of students pursue construction and manufacturing activities. Ability to do is essential. Knowledge of how to service a product is derived from a knowledge of how it is made.

Grade level. Presently seventh, eighth, and ninth grades but may be expanded to tenth, eleventh, and twelfth grades in the future.

For further information. Dr. Donald G. Lux, Ohio State University, Columbus, Ohio 43210.

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At this writing it is not possible to determine what specific direction a new program for the teaching of industry may take. The industrial arts program of the future may concern itself with industrial technology where the general rather than the specific reaches its ultimate. The industrial technology laboratory of the future may present opportunities for investigation, experimentation, and problem solving using tools, machines, and materials which are rarely found in present industrial arts shops. Wind tunnels, water tanks for marine testing, equipment for refrigeration and heating units, and extensive testing equipment may be common to such facilities.

Examining specimens with a metallurgical microscope.

The teacher may be featured in the role of providing guidance rather than masses of facts. Having a student's pursuits exceed his own knowledge in any given subject may be commonplace. Whatever the future brings, it should be exciting.

Selected Professional Publications

- *Accident Prevention Manual for Shop Teachers,* William A. Williams, (editor), a professional publication of the National Association of Industrial Teacher Education, American Technical Society, Chicago, Illinois, 1964.

- *Addresses and Proceedings of the American Industrial Arts Association Convention,* published annually following the convention, American Industrial Arts Association, 1201 - 16th Street, N.W., Washington, D.C. 20036.

- *American Vocational Journal,* published monthly September through May, official publication of the American Vocational Association, Inc., 1025 - 15th Street, N.W., Washington, D.C. 20005. Distributed at no cost to members, library subscription $4 per year.

- *Course Construction in Industrial Arts and Vocational Education,* J. W. Giachino and Ralph Gallington, American Technical Society, Chicago, Illinois, 1961.

- *Course Making in Industrial Education,* John F. Friese and William A. Williams, C. A. Bennett Company, Peoria, Illinois, 1966.

- *Diamond Dust,* Tom Diamond, Prakken Publications, Inc., Ann Arbor, Michigan, 1959.

- *Education and Productive Society,* H. R. Ziel, (editor), Report of Inaugural Conference, Department of Industrial and Vocational Education, University of Alberta, Edmonton, Canada, 1964.

- *Guide to Industrial Arts Teaching,* Joseph Littrell, C. A. Bennett Company, Peoria, Illinois, 1966.

- *History of Industrial Education in the United States,* Melvin L. Barlow, C. A. Bennett Company, Peoria, Illinois, 1967.

- *Improving Instruction in Industrial Arts,* William A. Bakamis, Bruce Publishing Company, Milwaukee, Wisconsin, 1966.

- *Industrial Arts Education,* John L. Feirer and John R. Lindbeck, Center for Applied Research in Education, Inc., 70 Fifth Avenue, New York, New York 10011, 1964.

- *Industrial Arts in General Education,* Gordon O. Wilber and Norman C. Pendered, International Textbook Company, Scranton, Pennsylvania, 1967.

- *Industrial Arts Education, Purposes, Programs, Facilities, Instruction,* American Council of Industrial Arts Supervisors, American Industrial Arts Association, Washington, D.C. 20005, 1963.

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- *Industrial Arts and Technology,* Delmar W. Olson, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632, 1963.

- *Industrial Arts and Vocational Education,* published monthly except during July and August, Bruce Publishing Company, 400 North Broadway, Milwaukee, Wisconsin 53201. $4 per year.

- *Industrial Education: American Ideals and Institutions,* Berenice M. Fisher, University of Wisconsin Press, Madison, Wisconsin 53706, 1967.

- *Iowa Industrial Education Association Newsletter,* published several times a year, editor, Kenneth Rogers, Industrial Arts Instructor, Columbus High School, Waterloo, Iowa, distributed at no cost to members of Iowa Industrial Education Association.

- *Journal of Industrial Teacher Education,* four issues per year, official publication of the National Association of Industrial and Technical Teacher Educators, distributed at no cost to members. Library subscription $5 per year. Mail to: Professor Howard McVicker, Purdue University, Lafayette, Indiana 47907.

- *Measuring Educational Achievement,* William J. Mickeels and M. Ray Karnes, McGraw-Hill Book Company, Inc., New York, New York, 1950.

- *Modern School Shop Planning,* Prakken Publications, Inc., Ann Arbor, Michigan, 1967.

- Monograph Series, American Industrial Arts Association, 1201 - 16th Street, N.W., Washington, D.C. 20036.

- *Organizing Course Materials for Industrial Education,* G. Harold Silvius and Ralph C. Bohn, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1961.

- *School Shop,* published monthly except during July and August, Prakken Publications, Inc., Box 623, 416 Longshore Drive, Ann Arbor, Michigan 48105. Distributed at no cost to teachers of industrial arts. Write on school stationery requesting that your name be placed on the mailing list. Library subscription $4 per year.

- *Selected Readings for Industrial Arts,* Rex Miller and Lee H. Smalley, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1963.

- *Teacher Liability in School-Shop Accidents,* Dennis J. Kigin, Prakken Publications, Inc., Ann Arbor, Michigan 48105, 1963.

- *Teaching Successfully in Industrial Education,* G. Harold Silvius and Estell H. Curry, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1967.

- *Teaching the Industrial Arts,* Emanuel E. Erickson, C. A. Bennett Company, Peoria, Illinois, 1960.

- *The Instructor and His Job,* Homer Rose, American Technical Society, Chicago, Illinois, 1961.

- *The Journal of Industrial Arts Education,* published five times during the school year, 3110 Elm Avenue, Baltimore, Maryland 21211, official publication of the American Industrial Arts Association, distributed at no cost to members. Single copies to non-members $1.50, library subscription $6 per year.

- *Yearbook of the American Council on Industrial Arts Teacher Education,* published annually in the spring, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, distributed at no cost to members of the Council. Orders and requests for information about cost and availability of yearbooks should be addressed to the company.

Selected Publishers of Industrial Arts Books

The last few years have seen quite a number of book publishers join the ranks of those that have been publishing industrial arts books for many years. The following list includes some of the newer publishers which seem to have the most to contribute to the field together with those publishers that are well established and better known. Catalogs or information about specific publications may be secured by writing to the address given.

- American Technical Society, 848 East 58th Street, Chicago, Illinois 60637.

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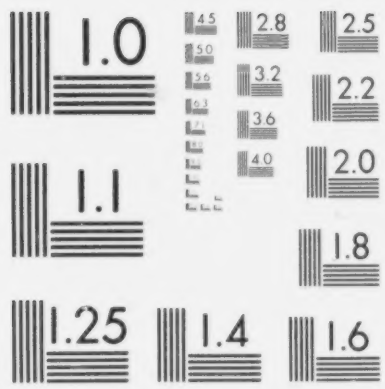

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

- Arco Publishing Company, Inc., 219 Park Avenue South, New York, New York 10003.
- Theo. Audel Division, Howard W. Sams & Company, Inc., 4300 West 62nd Street, Indianapolis, Indiana 46206.
- Bellman Publishing Company, Box 172, Cambridge, Massachusetts 02138.
- Charles A. Bennett Company, Inc., 237 North Monroe Street, Peoria, Illinois 61602.
- William C. Brown Company Publishers, 135 South Locust Street, Dubuque, Iowa 52001.
- The Bruce Publishing Company, 400 North Broadway, Milwaukee, Wisconsin 53202.
- Chilton Books, c/o Educational Division, 525 Locust Street, Philadelphia, Pennsylvania 19106.
- Delmar Publishers, Inc., Mountainview Avenue, Albany, New York 12205.
- Goodheart-Wilcox Company, Inc., 18250 Harwood Avenue, Homewood, Illinois 60420.
- Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017.
- Home Craftsman Corporation, 220 Ripley Street, Davenport, Iowa 52801.
- International Textbook Company, Scranton, Pennsylvania 18515.
- The Macmillan Company, 60 Fifth Avenue, New York, New York 10011.
- McCormick-Mathers Publishing Company, Box 2212, Wichita, Kansas 67201.
- McGraw-Hill Book Company, 330 West 42nd Street, New York, New York 10036.
- McKnight and McKnight Publishing Company, U.S. 66 at Towanda Avenue, Bloomington, Illinois 61701.
- Motor Book Division of Hearst Magazines, 250 West 55th Street, New York, New York 10019.
- Nelson-Hall Company, 325 West Jackson Boulevard, Chicago, Illinois 60606.
- Office of Education, U.S. Dept. of Health, Education, and Welfare, Superintendent of Documents, Division of Public Documents, Washington, D.C. 20402.
- Pitman Publishing Corporation, 20 East 46th Street, New York, New York 10017.
- Popular Mechanics, 575 Lexington Avenue, New York, New York 10022.
- Prakken Publications, Inc., 416 Longshore Drive, Ann Arbor, Michigan 48107.
- Prentice-Hall, Inc., Educational Book Division, Englewood Cliffs, New Jersey 07632.
- Reinhold Book Division, 430 Park Avenue, New York, New York 10022.
- John F. Rider Publishers, Inc. (Hayden Book Companies), 116 West 14th Street, New York, New York 10011.
- Royalle Publishing Company, Inc., 17701 Annchester, Detroit, Michigan 48219.
- Steck Company, Publishers, Box 16, Ninth at Lavaca Streets, Austin, Texas 78761.
- Syracuse University Press, Box 87, University Station, Syracuse, New York 13210.
- D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, New Jersey 08540.
- John Wiley & Sons, Inc., Interscience Publishers, 605 Third Avenue, New York, New York 10016.

Certain societies and manufacturers of equipment commonly used in the school shop publish books which are useful. The following list is not complete, only illustrative:

- American Welding Society, United Engineering Center, 345 East 47th Street, New York, New York 10017.
- Hobart Brothers Company, Box D17-390, Troy, Ohio 45373.

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Assignment

Work Sheets 27 to 32 inclusive: Make a three-view dimensioned instrument drawing of each of these objects. Show top, front, and right end views. Refer to Illustration Sheets 15, 16, 17, 18, and 19, pages 59, 61, 63, 65, and 67. First make a freehand plan on practice paper and have it checked. When the plan is approved, make the instrument drawing on the Work Sheet including the lettering in the title strip. Have the drawing checked and graded.

WS. 27. Angle Step.

WS. 28. Notched Slide.

WS. 29. T Block.

WS. 30. Slotted Wedge.

WS. 31. Bearing Slide.

WS. 32. Forming Block.

WS. 33. Wedge Guide: Make a three-view dimensioned instrument drawing of the Wedge Guide. Show top, front, and left end views. Note that a left end view is called for because the left end shows the object more clearly than a right end view would show it. First make a freehand plan and have it checked. When the plan is approved make the instrument drawing, including the lettering in the title strip. Have the drawing checked and graded.

WS. 34. Guide Bracket: Follow the directions given for Work Sheets 27 to 32.

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- The Lincoln Electric Company, Box 3115, 22801 St. Clair Avenue, Cleveland, Ohio 44117.

- The L. S. Starrett Company, Athol, Massachusetts 01331.

- National Rural Electric Cooperative Association, 2000 Florida Avenue, N.W., Washington, D.C. 20009.

- Rockwell Manufacturing Company, 4020 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Sources for Free and Inexpensive Teaching Aids

Free and low cost teaching aids exist in great abundance. Brochures, catalogs, folders, posters, wall charts, bulletins, manuals, and literature which might be useful in teaching are available from suppliers and manufacturers of school shop tools and equipment for the asking. Teachers are encouraged to scan the advertisements in professional journals for offers of this type. Of special interest is the October 1968, issue of *School Shop* which lists specific materials offered by 171 advertisers. Similar special issues focusing on "Shop Teachers' Service" have been published on an annual basis for a number of years.

Members of the American Industrial Arts Association will receive certain free materials through the packet mailing service provided by the organization.

Sources for Films and Filmstrips

A number of excellent films and some filmstrips are available from large companies on a free loan basis. Careful previewing by the teacher is essential to screen out those of doubtful instructional value. However, these sources should not be relied upon for supplying all such needs. Your school should have some of the following reference materials on hand.

- *Educational Media Index,* Volume 9. McGraw-Hill Book Company, New York, 1964. Cost about $7. Includes industrial arts, technical training, vocational training, and agricultural education.
- *Educators Guide to Free Films,* Educators Progress Service, Randolph, Wisconsin. Cost about $9. Revised annually; motion pictures in all subjects.
- *Educators Guide to Free Filmstrips,* Educators Progress Service, Randolph, Wisconsin. Cost about $6. Revised annually, filmstrips and slides in all subjects.
- *Motion Pictures and Filmstrips,* Library of Congress, Washington, D.C., 1953 to date. Published quarterly; annual cumulations; all motion pictures of educational value released in the United States or Canada and cataloged by the Library of Congress.

Many colleges and universities have film libraries from which motion pictures, filmstrips, and other audiovisual materials may be rented. These and certain other sources are included in:

- *A Directory of 3,660 16mm Film Libraries,* United States Government Printing Office, Washington, D.C., 1959.

Your school should have catalogs from at least the following:

- Bureau of Audio-Visual Instruction, Extension Division, University of Iowa, Iowa City, Iowa 52240.
- Visual Instruction Service, Iowa State University, Ames, Iowa 50010.

Several other sources which may be useful are:

- Association Films, Inc., 561 Hillgrave Avenue, La Grange, Illinois 60525.
- Bureau of Mines, Motion Picture Distribution Center, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213.
- Modern Talking Pictures Service, Inc., c/o Modern Sound Pictures, Inc., 1410 Howard Street, Omaha, Nebraska 68102.
- Modern Talking Pictures Service, Inc., c/o Pratt Sound Films, Inc., 129 Third Avenue, S. W., Cedar Rapids, Iowa 52404.

The value of purchasing films that will have regular use over a period of years should not be overlooked. Films and filmstrips keyed to textbooks are available. Some information along this line is available from:

- McGraw-Hill Text Film Division, 327 West 41st Street, New York, New York 10036.

16701

CONSTRUCTION TECHNOLOGY

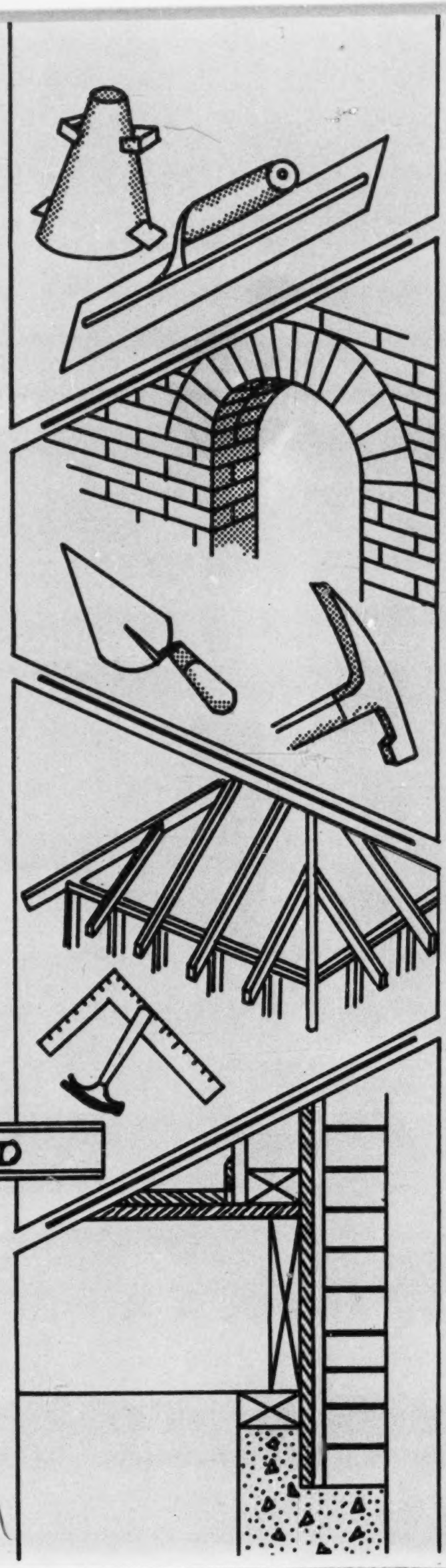

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Financially, the construction industry is the largest industry in America. Its existence satisfies the basic human need of shelter, as well as a multitude of additional necessities and luxuries found in our everyday life. Our current population explosion, coupled with our tremendous desire for a high standard of living, places an enormous demand upon this industry.

This demand is so great that the U.S. Department of Labor has made the astounding statement that in the next 30 years there will be as much new construction in America as presently exists.

At the present time, the greatest deterrent to meeting the needs is that of manpower. By 1975 we will need one million more construction workers. The present rate will provide only 150,000, which leaves a net shortage of 850,000 workers in the construction industry.

Youngsters seem to be naturally curious about construction in the community. Some study of the contributions made by carpenters, masons, plumbers, electricians, and other skilled tradesmen to our way of life could enrich classroom instruction at the elementary level. Field trips could be taken to construction sites where the whir of the saw biting into wood and the groan of the crane lifting steel girders into place can make indelible impressions on young minds.

Although much study and substantial activity could be pursued in this area at the junior high school level, fewer limitations and greater interest seem to exist in construction technology at the senior high level. Here, students are sufficiently mature, physically, to engage in common construction activities, and they are of an age when many see the value of acquiring knowledge and skill in this area as a stepping stone to possible part-time employment. It is important that courses in this area be designed to help students lead fuller lives through understanding and skills acquired. Limited work in this area can be undertaken with the tools and equipment commonly found in a general shop or unit wood shop, but a strong offering in construction technology will require certain specialized tools, equipment, and facilities.

Mathematical and scientific principles should be integrated with such course work, and safety instruction is essential to this area. Much of the student activity should involve the group approach; however, mass production and individual activities have merit under certain conditions.

Objectives

Every student should have the opportunity:

- To develop interest in and enthusiasm for the fundamental principles and work experiences of the building construction industry.
- To develop knowledge and basic skills in the use of common materials and tools of the building construction industry.
- To develop understanding and appreciation for the building trades and their major role in our culture.
- To learn desirable work habits and a responsible attitude toward personal safety and safe construction practices.

Content

Although some common areas of industrial arts have a marginal relationship with the construction industry, this important industry has seldom received adequate consideration in industrial arts programs. Three construction technology courses, carpentry, concrete technology, and masonry, are presented in the following outline.

It is believed that these materials will help industrial arts teachers in establishing an exciting and stimulating offering which will promote a better understanding of this great industry. The teacher should recognize that this is a guide and draw from it those portions that best fit his school and teaching situation. Since this is one of the newer areas, teachers may find suggested student activities to be particularly helpful. Some activities are included and are illustrated for quick reference.

Carpentry

I. Introduction

II. History

III. Materials
- A. Hardwoods (types and grades)
- B. Softwoods (types and grades)
- C. Plywoods (types and grades)
- D. Wood composition boards
- E. Plastic laminates
- F. Insulation materials
- G. Gypsum materials

C

16703

H. Asphaltic materials
I. Adhesives
J. Fastening devices

IV. Tools
A. Measuring tools
B. Guiding and testing tools
C. Marking tools
D. Tooth-cutting tools
E. Sharp-edge cutting tools
F. Smooth-facing tools
G. Boring tools
H. Fastening tools
I. Holding tools
J. Power tools

V. Safety
A. Work habits
B. Housekeeping
C. Personal protective equipment
D. Lifting and carrying
E. Scaffolds and ladders
F. Hand tools
G. Electrical tools
H. Power-actuated tools

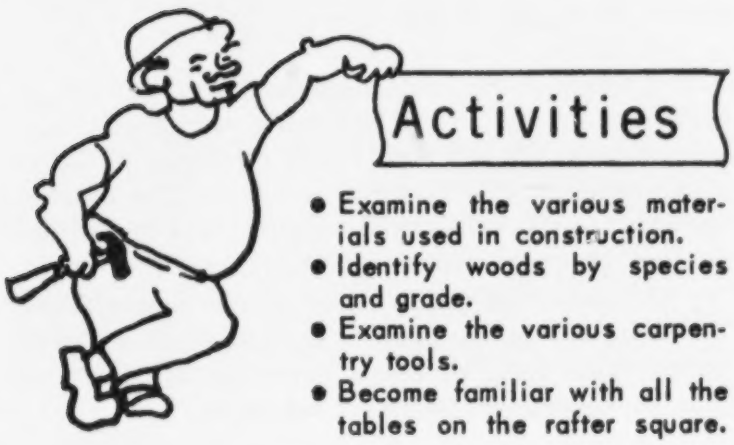

VI. Foundations
A. Layout
1. Use of hand level
2. Use of builder's level
3. Setting batter boards

B. Footing forms
1. Pads
2. Continuous footing

C. Wall forms
1. Whalers
2. Cleanouts

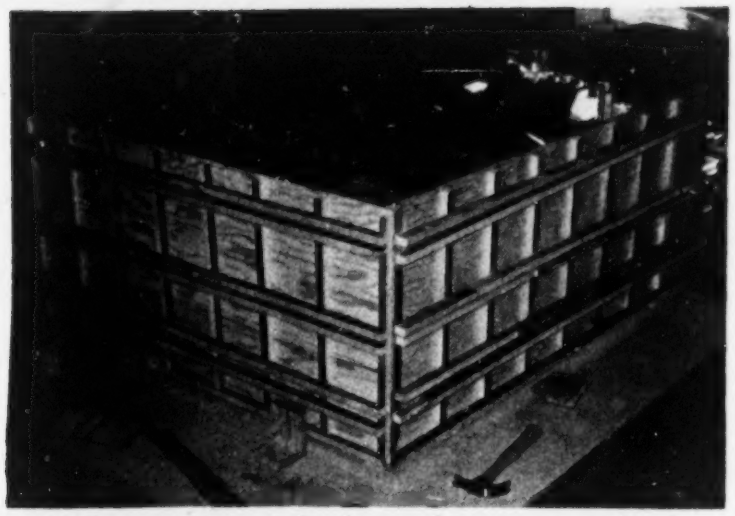
Construction technology: form construction.

3. Plumbing outside corners
4. Aligning wall forms
5. Bracing wall forms
6. Girder pockets
7. Opening bucks
8. Nailing blocks
9. Anchors
a. For plates
b. For intersecting walls
c. For masonry veneers

D. Concrete handling apparatus
1. Concrete chute
2. Splash board
3. Runways
4. Wheelbarrows
5. Concrete buggies
6. Auger and pneumatic systems
7. Conveyor

E. Sectional forms
1. Job constructed
2. Commercial

F. Stripping concrete wall forms

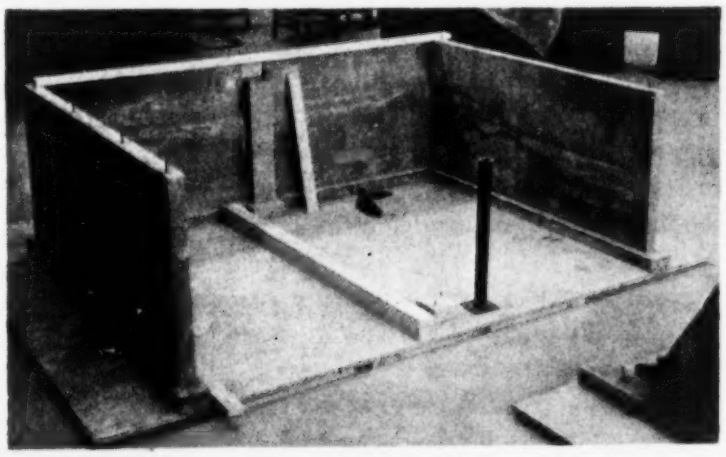
Foundation wall.

167 04

Activities

- Lay out a foundation for a building and set batterboards. Construct footing forms; both "T" and keyed.
- Make detailed sketches of wall forms for a building.
- Build a section of wall forms using different types of ties.
- Visit a construction site where forms are being constructed and stripped.

VII. Rough framing

A. Sills
   1. Aligning and installing plate
   2. "L" sill
   3. "T" sill
   4. Joist layout
      a. Wood frame construction
      b. Masonry construction

B. Joists
   1. Framing, installing and aligning joist
   2. Bridging
      a. Wood
      b. Metal
   3. Layout and framing of floor openings
   4. Masonry tile floors
   5. Exterior door sills

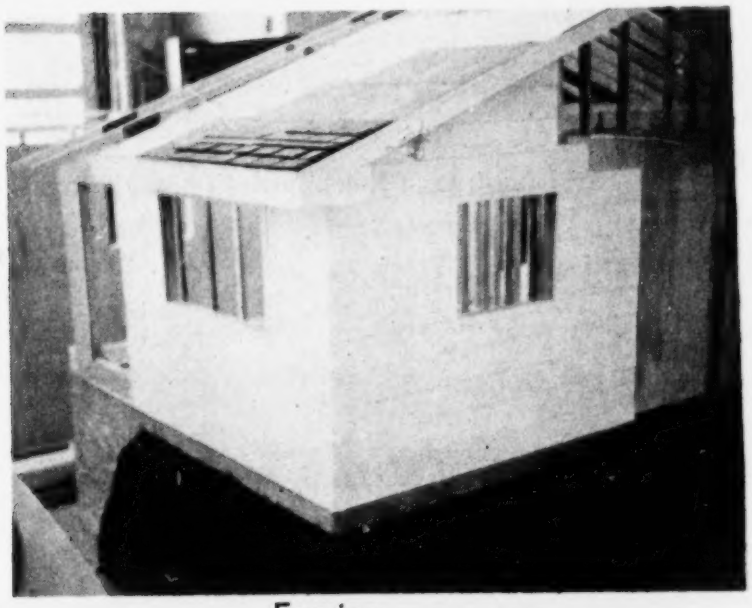

Framing.

C. Subfloors
   1. Diagonal
   2. Straight

D. Stairs
   1. Story pole
   2. Well opening layout
   3. Stringer layout
      a. Cutout
      b. Build-up
      c. Cleated

E. Walls
   1. Laying out wall plates
   2. Laying out wall frame story pole
   3. Framing exterior and interior corner post
   4. Framing window and door opening
   5. Assembling wall frames
   6. Raising wall frames
   7. Plumbing and aligning wall frame assembly
   8. Installing diagonal bracing and alternatives
   9. Installing top wall double plates
   10. Laying out and framing arches
   11. Furring masonry walls

F. Ceiling joists
   1. Framing and placing
   2. Installing backing for lath, dry wall, hanging fixtures, cabinets, traverse rods

G. Scaffolding
   1. Double pole (wood and steel)
   2. Single pole
   3. Mason's

H. Sheathing
   1. Structural fiberboard, plywood, or gypsum
   2. Horizontal
   3. Vertical
   4. Diagonal

C

167 05

Activities

- Build section showing different sill construction.
- Construct a small building to show proper methods of rough framing.
- Lay out and construct a simple stair.
- Visit a job site in the rough framing stage.

VIII. Roof framing

A. Roof design
   1. Shed
   2. Gable
   3. Hip
   4. Gambrel
   5. Mansard

B. Trusses
   1. Types
   2. Installing

C. Use of framing square

D. Ridge boards
   1. Lay out
   2. Raise, plumb

E. Types of rafters
   1. Common
   2. Hip
   3. Jack

F. Laying out and cutting rafter
   1. Determine length
   2. Make plumb and cheek cuts
   3. Seat cut and overhang

G. Framing of openings in roofs

H. Sheathing roofs — cuts on hip line

I. Unequal pitch roof

J. Gable end studding

K. Shingling
   1. With wood shingles
   2. With composition shingles
   3. Around roof vents and chimneys

Activities

- Construct a hip roof on the rough frame.
- Lay out and construct roof trusses.
- Frame an opening in the roof section for a dormer.
- Shingle the constructed, sheathed roof section.

IX. Exterior finish

A. Exterior doors
   1. Jambs — laying out, cutting, and setting
      a. In wood frame construction
      b. In masonry construction
   2. Pre-hung doors

B. Windows — frame and masonry construction
   1. Double hung
   2. Casement
   3. Fixed
   4. Awning

C. Water tables

D. Cornice construction
   1. Open
   2. Box

E. Gutters

F. Columns, beams, newels, and railings

G. Corner treatment

H. Siding
   1. Horizontal
   2. Vertical
   3. Plywood
   4. Shakes

I. Hanging overhead doors

16706

Activities

- Hang an exterior door.
- Construct a pre-hung door.
- Install windows.
- Construct several different cornices.
- Install gutters and downspouts.
- Install several different types of siding.

Activities

- Insulate a building.
- Install drywall and tape joints.
- Panel a wall.
- Hang an interior door.
- Lay a hardwood floor.

C

X. Interior finish

A. Checking, sorting, and storing interior trim

B. Insulation

C. Drywall installation

D. Plywood paneling installation

E. Laying out and applying acoustical ceiling material

F. Windows
1. Laying out, constructing, and setting jambs
2. Hanging doors
   a. Pocket, double-acting, bi-fold, bi-passing, swing
   b. Hinges, butts, locks

G. Flooring
1. Subfloor
2. Underlayment
3. Hardwood
4. Resilient

H. Baseboards and shoe

I. Built-ins
1. Laying out cabinets
2. Constructing cabinets
3. Installing mill-built cabinets
4. Constructing closets and wardrobes
5. Installing plastic laminates

XI. Blueprint reading and estimating

A. Dimensions

B. Lines
1. Section
2. Hidden
3. Center
4. Extension
5. Border

C. Scale

D. Elevations

E. Foundation plans

F. Floor plans

G. Roof plans

H. Symbols

I. Specifications

J. Estimating check list
1. Stock bill
2. Survey
3. Subcontractors
4. Overhead
5. Summary sheet
6. Labor

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XII. Job opportunities in carpentry

A. Construction outlook

B. Manpower requirement

C. Related jobs

D. Personnel requirements
   1. Type of individuals wanted
   2. Education and training

E. Other considerations
   1. Job stability
   2. Salary
   3. Opportunities for advancement
   4. Working conditions

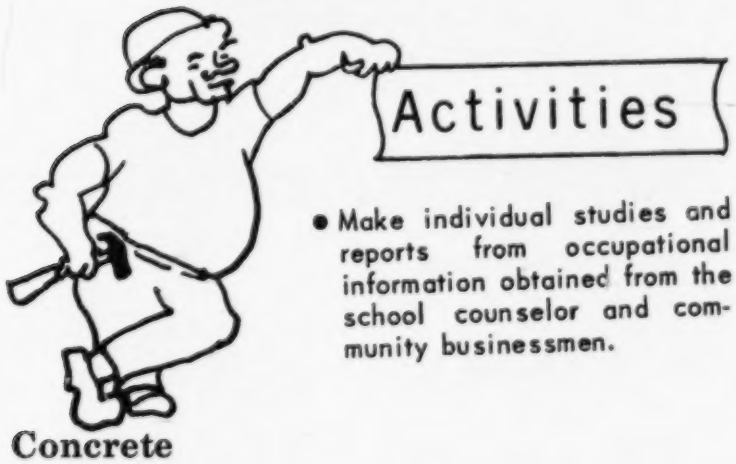

Concrete

I. Introduction

II. History

III. Properties of concrete

A. Plastic concrete

B. Hardened concrete

C. Variables that influence quality

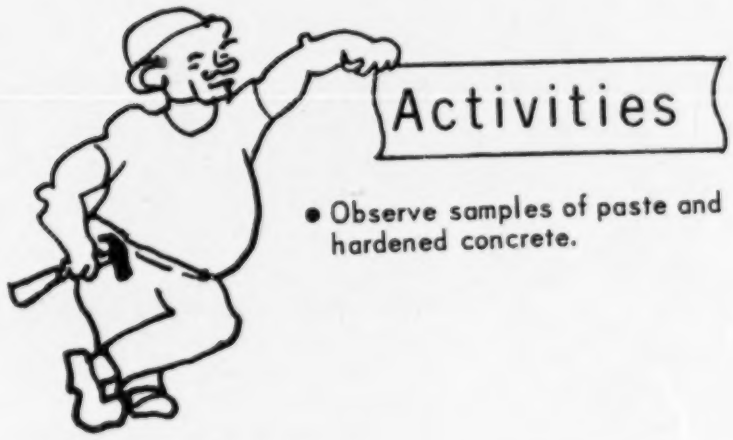

IV. Uses of Concrete

A. Reinforced concrete

B. Pre-stressed concrete
   1. Pre-tensioning
   2. Post-tensioning

C. Pre-cast concrete

D. Lightweight concrete

E. Thin-shell concrete

F. Shotcrete

G. Tilt-up concrete

H. Sandwich wall

I. Lift slab

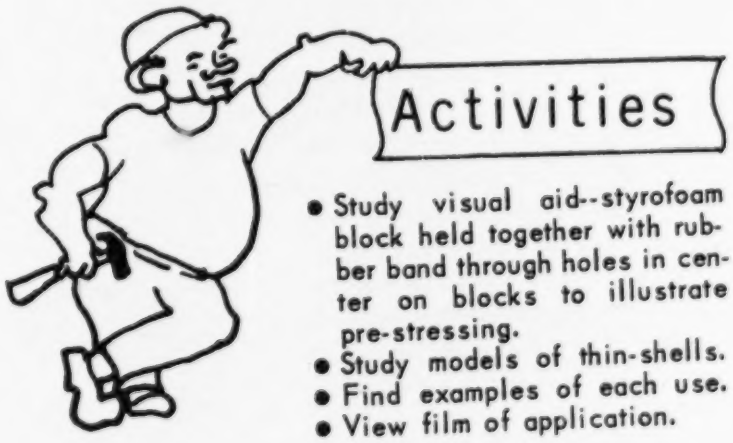

V. Portland cement

A. History of cementing materials

B. Raw materials
   1. Lime

16708

2. Silica
3. Iron oxide
4. Aluminum
5. Gypsum

C. Manufacturing process

D. Packing and storing

E. Classification of Portland cement — types I, II, III, IV, and V

VI. Water for mixing concrete — effect of impurities

A. Inorganic materials

B. Organic materials

VII. Aggregates for concrete

A. Characteristics of aggregates
1. Abrasion resistance
2. Resistance to freezing and thawing
3. Compressive strength
4. Chemical stability
5. Particle shape and surface texture

B. Quality testing of aggregates

C. Bank-run and commercially recombined aggregates

D. Lightweight and heavyweight aggregates

E. Graduation of aggregates

F. Maximum size determination of coarse aggregate

G. Storage of aggregates

VIII. Air-entrained concrete

A. Effects of entrained air
1. On fresh concrete
2. On hardened concrete

B. Air-entraining materials

C. Factors affecting air content

D. Measurement of air content

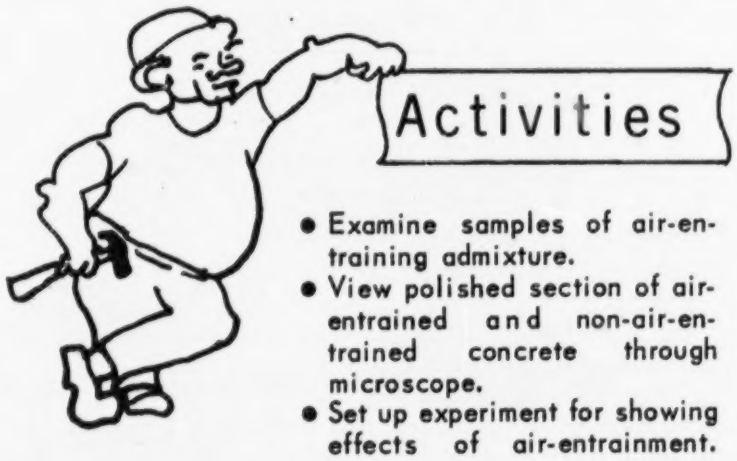

IX. Characteristics of concrete mixtures

A. Water-cement ratio

B. Maximum aggregate size

C. Air content

D. Slump

C

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X. Sampling and testing plastic and hardened concrete

A. Methods of sampling fresh concrete
   1. From stationary mixers
   2. From paving mixers
   3. From revolving drum truck mixers
   4. From open top trucks, mixers, or containers

B. Methods of testing fresh concrete
   1. Consistency test
      a. Slump test
      b. Ball penetration test
   2. Weight test
   3. Air content test
      a. Pressure method
      b. Volumetric method
      c. Gravimetric method

C. Methods of testing hardened concrete
   1. Specimen tests
   2. Compression tests
   3. Flexure tests

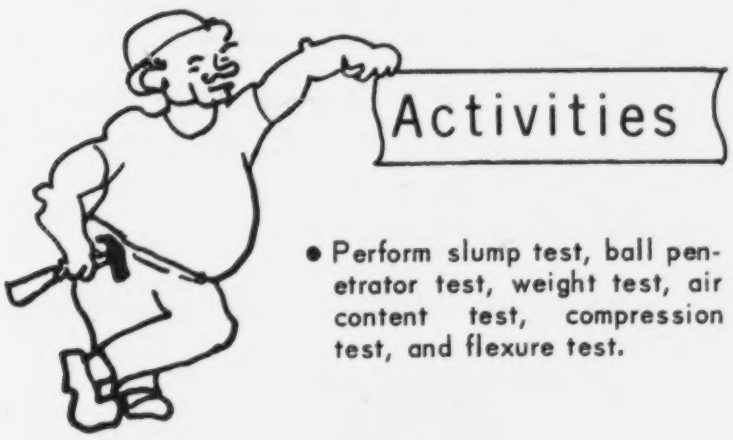

XI. Ready-mixed and job-mixed concrete

A. Production of ready-mixed concrete
   1. Advantages of ready-mixed concrete
   2. Specifications for ready-mixed concrete
   3. Remixing concrete

B. Preparing for ready-mix delivery
   1. Forms
   2. Tools and equipment
   3. Preparation of subgrade
   4. Vibration equipment
   5. Curing materials available

C. Dangers of adding water to ready-mix

D. Water-cement ratio for job-mixed concrete
   1. For exposure conditions
   2. For required compressive strength

E. Selection of good ingredients for job-mix
   1. Aggregate
   2. Mixing water
   3. Portland cement
   4. Air
   5. Sand — allowance for moisture

F. Proportions of materials

G. Mixing concrete

H. Cleaning equipment

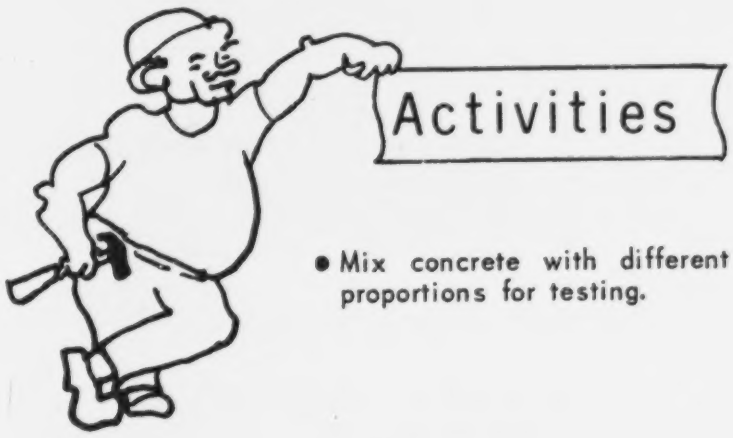

XII. Placing and finishing concrete

A. Tools
   1. Straightedge
   2. Darby
   3. Bull float
   4. Edger
   5. Jointer or groover
   6. Power joint cutter
   7. Hand and power floats
   8. Hand and power trowels

16710

WS. 35. Miter Box: Make a three-view dimensioned instrument drawing. Use the scale 3/8" = 1". Show top, front, and right end views. First make a freehand plan and have it checked. When the plan is approved, make an instrument drawing, including the lettering in the title strip. Have the drawing checked and graded.

WS. 36. Bracket Shelf; Follow directions given for WS 35.

WS. 37. Book Ends: Follow directions given for WS 35 except that the scale is ¼" = 1".

WS. 38. Work Bench; Make a two-view dimensioned instrument drawing. Use the scale 3/32" = 1". Show a front view and a right end view. First make a freehand plan and have it checked. Complete the drawing.

WS. 39. Pig Bread Board: Layout lightly the horizontal and vertical lines. Make ½" squares, 15 squares long and 9 squares wide. Refer to Illustration Sheet 18, page 65. Draw the pig on the Work Sheet, placing the parts exactly on the larger squares. This is a method for enlarging a drawing.

WS. 40. Dog Book Ends: Make a full size front view of the Dog Book Ends. Layout lightly the horizontal and vertical lines to make the squares as shown in Illustration Sheet 18, page 65. Make the squares 3/8" in both directions. Enlarge the figure of the dog using these squares.

WS. 41. Footstool: Make a three-view dimensioned instrument drawing. Use the scale ¼" = 1". Make a freehand plan and have it checked before making the instrument drawing.

B. Placing concrete
   1. Time
   2. Transportation on the job
   3. Placing in forms — drop chute
   4. Consolidating concrete in forms — vibrators

C. Finishing concrete slabs
   1. Consolidating
   2. Striking off (screeding)
   3. Edging and jointing
   4. Floating
   5. Final finishing
      a. Broom finish
      b. Burlap or belt finish
      c. Hand float finish
      d. Troweling
      e. Patterned, textured, colored, and exposed aggregate finishes

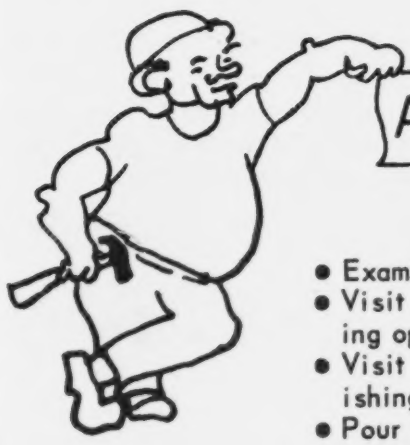

Activities

- Examine all tools.
- Visit a job site during pouring operation.
- Visit a job site during finishing operation.
- Pour slabs and use tools for various finishes.
- List various types of finishes found in vicinity of school.

XIII. Curing concrete

A. Effect of curing

B. Methods of curing
   1. Water curing
   2. Water retaining
   3. Mechanical barriers
   4. Chemical membranes

C. General requirements of curing

Activities

- Use various methods for curing the student-finished slabs and observe effects of each.

XIV. Joints and reinforcements for concrete

A. Necessity for joint

B. Placement of joint
   1. Isolation joint for point of abutment
   2. Predetermination of crack location
   3. Large areas placed in stages
   4. Combination control and construction joints

C. Kinds of reinforcement

D. How reinforcement works
   1. Factors influencing reinforcing
      a. Temperature and moisture
      b. Placement of steel
   2. Splicing reinforcement
   3. Slab reinforcement

E. General rules for steel reinforcement

F. New developments in reinforcement

Activities

- Place joints in student-finished slabs.
- Test effectiveness of different joints.
- Find examples of properly and improperly used joints in the homes, school, and community.

XV. Estimating concrete for jobs

A. Materials required for job batching

C

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B. Concrete estimating short cuts

C. Concrete calculator

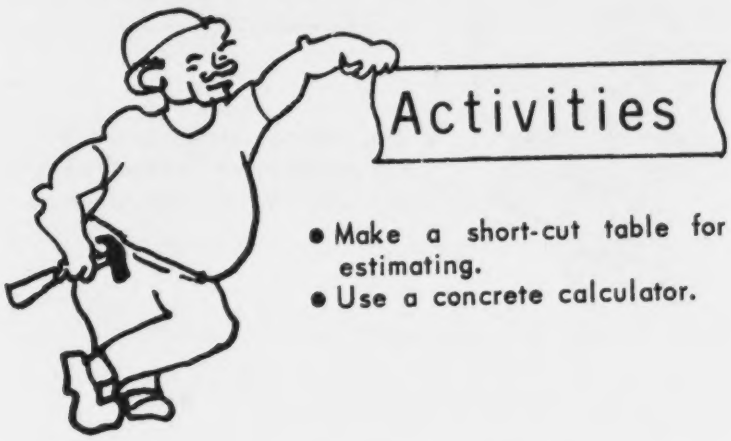

XVI. Concreting in hot and cold weather

A. Special arrangements and precautions for hot weather
   1. Preventing rapid evaporation
      a. Temperature
      b. Relative humidity
      c. Wind
   2. Arrangements for placing concrete
   3. During and after concrete placement
   4. Use of admixtures

B. Special arrangement and precautions for cold weather
   1. Effect of concrete temperatures
   2. High-early-strength concrete
   3. Use of chemical accelerators
   4. Arrangements before placing concrete
   5. Arrangements after placing concrete
   6. Curing methods for cold weather

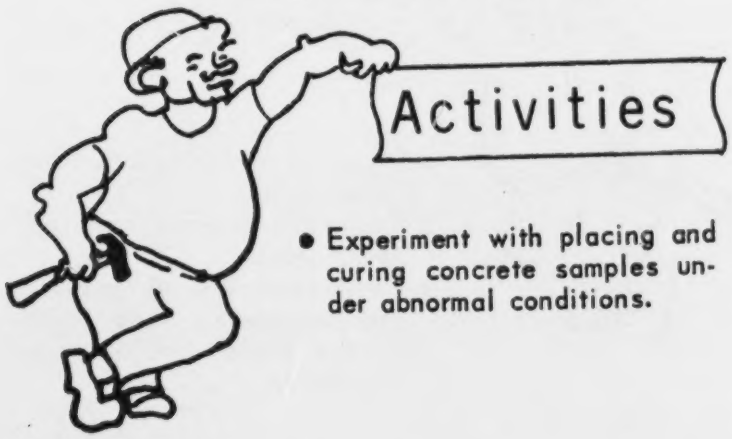

XVII. Job opportunities in the concrete industry

A. Construction outlook

B. Manpower requirements

C. Job opportunities
   1. Ready mixed concrete industry
   2. Precast concrete industry
   3. Concrete masonry and concrete products industry
   4. Construction industry
   5. Allied industries

D. Personnel requirements
   1. Type of individuals wanted
   2. Education and training

E. Other considerations
   1. Job stability
   2. Salary
   3. Opportunities for advancement
   4. Working condition

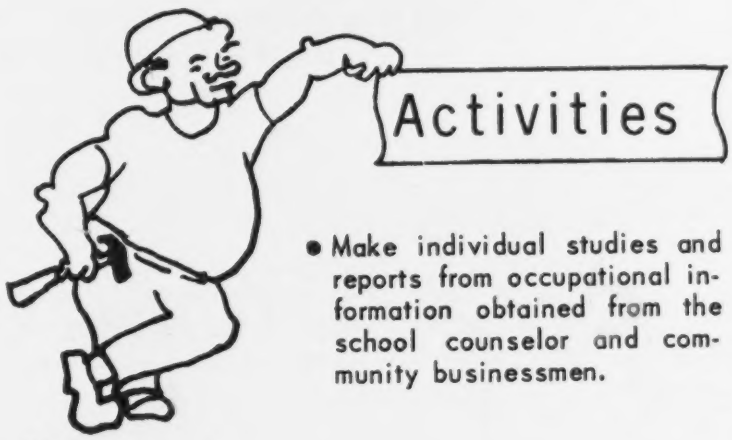

Masonry

I. Introduction

II. History

III. Manufacture of masonry units

   A. Brick

   B. Structural clay tile

   C. Concrete block

IV. Modular dimensions

   A. Unit designations

   B. Sizes and shapes

   C. Specification

V. Properties of masonry units

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VI. Tools and equipment

A. Tools
   1. Brick trowel
   2. Brick hammer
   3. Mason's rule
   4. Blocking chisel
   5. Plumb rule
   6. Mason's line
   7. Story pole and gage stick
   8. Trig

B. Equipment
   1. Mason's scaffold
   2. Mortar mixer

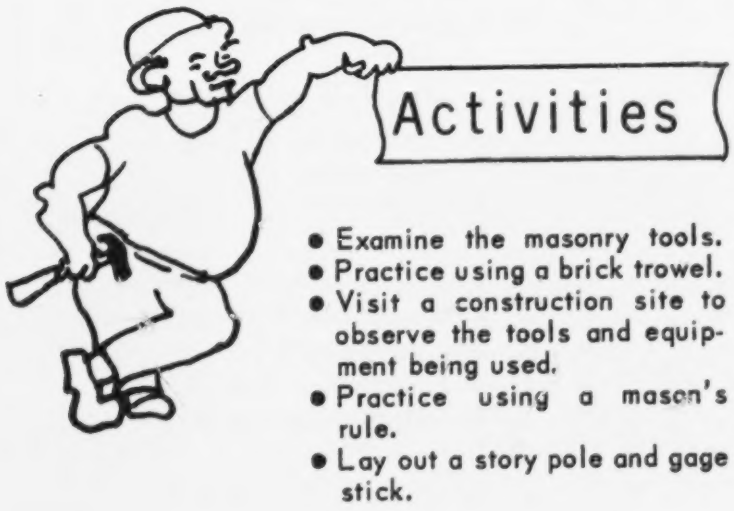

VII. Mortar and ties

A. Mortar
   1. Components
   2. Types (M, S, N, O, K)
   3. Masonry cement
   4. Uses for mortar types

B. Mixing mortar

C. Metal ties
   1. Types
   2. Uses

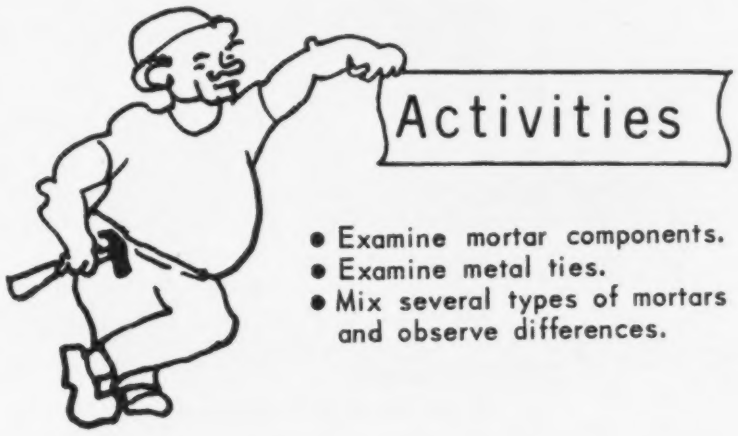

VIII. Masonry construction procedures and practices

A. Preparation of materials
   1. Brick
   2. Block
   3. Mortar

B. Workmanship
   1. Spreading uniform bed of mortar
   2. Taking care of excess mortar
   3. Placing closers
   4. Laying to a line
   5. Striking the joints

C. Flushing

D. Expansion joints

E. Protection of masonry
   1. From rain during construction
   2. From freezing during construction

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IX. Bonds, patterns, and texture

A. Terms applied to brick position
1. Stretcher
2. Header
3. Soldier
4. Shiner
5. Rowlock
6. Sailor

B. Bonds
1. Structural bonds
2. Pattern bonds
3. Mortar bonds

C. Mortar joints
1. Concave and V-shaped joint
2. Weathered joint
3. Rough cut or flush joint
4. Struck joint
5. Raked joint

Activities

- Observe different masonry patterns in the community.
- Observe different masonry joints in the community.
- Lay up different patterns with "Lego" blocks.
- Practice making different types of mortar joints.
- Plan small structures using different pattern bonds.

X. Reinforced brick masonry

A. Strength of masonry units and mortar
1. Forces involved
2. Strength ranges for compression, shear, and tension forces

B. Bending forces
1. Cantilever
2. Continuous beams

C. Reinforcing materials
1. Brick or tile
2. Steel
3. Mortar
4. Grout

D. Reinforcing methods
1. For steel
2. For grout

Activities

- View structural drawing of various reinforcing methods.
- Visit a reinforced brick masonry job site.
- Construct and test small reinforced and non-reinforced masonry structures.

XI. Masonry structures

A. Walls
1. Requirement for walls
2. Contemporary bearing wall
3. Exterior walls
   a. Brick veneer
   b. SCR brick wall
   c. Cavity wall
   d. Masonry bonded hollow wall
   e. Solid brick walls

B. Chimneys and fireplaces
1. Chimney construction
   a. Heights
   b. Support
   c. Corbeling
   d. Materials
   e. Liners
2. Connections
3. Chimney tops and flashing
4. Chimney test and repair
5. Fireplace types
   a. Single-face fireplace
   b. Multi-face fireplace
6. Parts of fireplace
7. Fireplace dimensions
8. Construction details

C. Arches
1. Arch forms
   a. Jack
   b. Segmental
   c. Multi-centered
   d. Tudor
   e. Roman or semicircular
   f. Gothic
   g. Parabolic

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2. Arch terminology
3. Arch construction — Temporary shoring or centering

D. Floors and pavements
1. Interior floors
   a. With mortar joint
   b. Mortarless brick floors
2. Exterior paving
   a. Drainage
   b. Edging
   c. Construction
3. Reinforced brick floors
4. Finishing and maintenance of brick floors

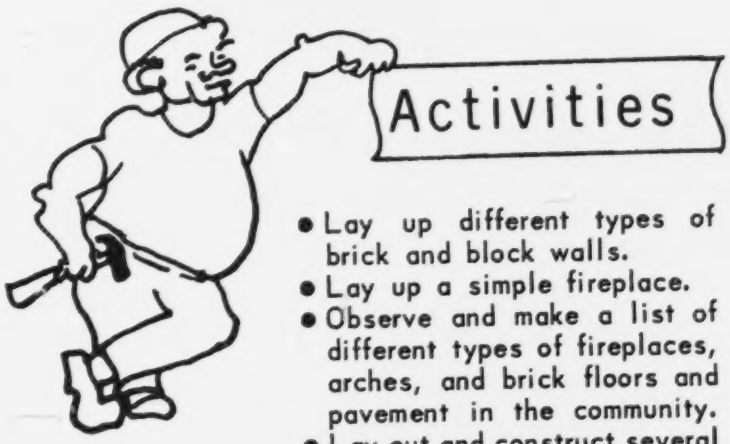

XII. Cleaning clay products masonry

A. Cleaning new masonry
1. Acid solution
   a. Dark brick
   b. Light colored brick
   c. Textured brick
   d. Glazed brick and tile
2. Proprietary cleaning compounds
3. Sandblasting

B. Removing efflorescence

C. Removing vanadium stain

D. Removing manganese stain

E. Removing externally caused stains
1. Poultice
2. Paint stain
3. Copper or bronze stain
4. Welding splatter
5. Smoke stains
6. Oil and tar stains
7. Plant growth
8. Stains of unknown origin

F. Cleaning existing masonry
1. High-pressure steam
2. Sandblasting
3. Hand washing
4. High-pressure cold water
5. Chemicals and steam
6. Wet sand cleaning
7. Wet aggregate cleaning

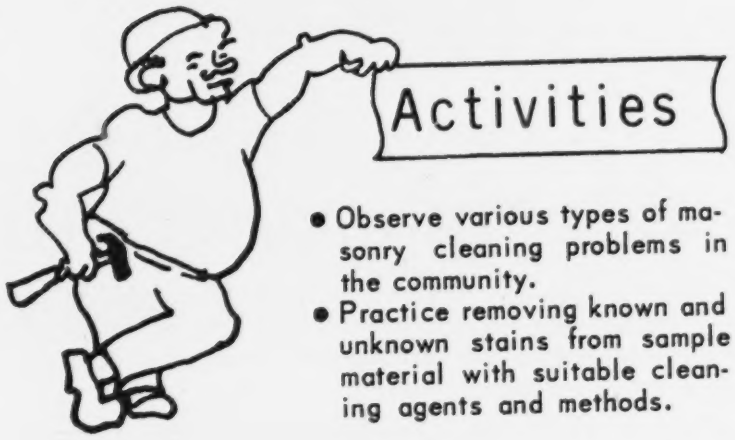

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XIII. Estimating quantities of clay masonry

A. Estimating procedure
1. Wall area method
2. Mortar quantities

B. Use of modular materials tables

C. Rule of thumb

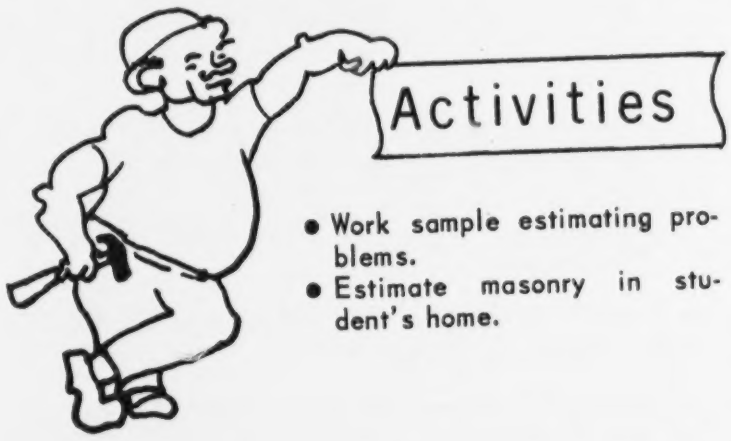

XIV. Job opportunities in masonry

A. Occupational outlook

B. Manpower requirements

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C. Job opportunities
   1. Brick and tile plants workers
   2. Bricklayers
   3. Stone masons
   4. Concrete block layers
   5. Others

D. Personnel requirements
   1. Type of individuals wanted
   2. Education and training

E. Other considerations
   1. Job stability
   2. Salary
   3. Opportunities for advancement
   4. Working conditions

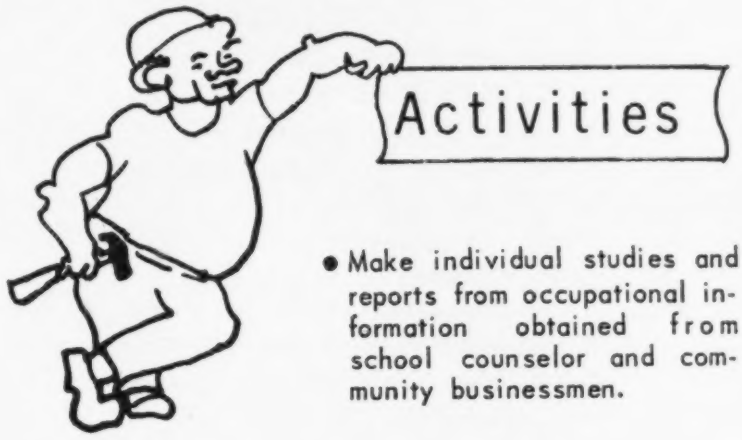

- Make individual studies and reports from occupational information obtained from school counselor and community businessmen.

SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purposes of illustration. Sources that pertain to Construction Technology are included if specific material is not listed below. Additional information of a general nature may be found on page 48.

Miscellaneous Materials

Carpentry

An abundance of useful material can be secured from the following sources:

- American Forest Product Industries, Inc., 1816 N Street, N.W., Washington, D.C. 20036.
- California Redwood Association, 617 Montgomery Street, San Francisco, California 94111.
- Douglas Fir Plywood Association, Tacoma, Washington.
- Forest Products Laboratory, North Walnut St., Madison, Wisconsin 53705.
- National Lumber Manufacturers Association, Technical Service Division, 1619 Massachusetts Avenue, N.W., Washington, D.C. 20036.
- West Coast Lumberman's Association, 14105 Morrison Street, Portland, Oregon 97203.
- Western Wood Products Association, 700 Yeon Building, Portland, Oregon 97204.
- Weyerhaeuser Company, Tacoma Building, Tacoma, Washington, 98401.

Concrete Technology

- Booklet: "Portland Cement Association — What It Is and What It Does" (E 102)
- Booklet: "The Making of Portland Cement" (E 108)
- Chart: "Manufacture of Portland Cement" (E 112)
- Booklet: "Cement and Concrete Reference Book" (M 109)
- Single copies are available free, Portland Cement Association, Old Orchard Road, Skokie, Illinois 60076.
- Designation C31, "Standard Methods of Making and Curing Concrete Compression and Flexure Test Specimens in the Field."
- Designation C39, "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders."
- Designation C149, "Standard Method of Slump Test for Consistency of Portland Cement."

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- Designation C172, "Stand Method of Sampling Fresh Concrete."

  The above publications and others are available at a nominal price, American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

- ACI 347, "Recommended Practice for Concrete Formwork"

- ACI 604, "Recommended Practice for Winter Concreting"

- ACI 605, "Recommended Practice for Hot Weather Concreting"

- ACI 613, "Recommended Practice for Selecting Proportions Concrete"

- ACI 614, "Recommended Practice for Measuring, Mixing, and Placing Concrete"

- Special Publication SP-1, "Concrete Primer"

  Available at a nominal price from the American Concrete Institute, Box 4754, Redford Station, Detroit, Michigan 48219.

Other publications are available from the following sources:

- National Ready Mixed Concrete Association, 900 Sprint Street, Silver Spring, Maryland 20910.

- Expanded Shale, Clay and Slate Institute, National Press Building, Washington, D.C. 20004.

- National Academy of Sciences — National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20037.

Masonry

- Technical Notes: Monthly reports on latest technology of structural clay products are available through SCPI. A complete list of all Technical Notes is also available. Structural Clay Products Institute, 1750 Old Meadow Road, McLean, Virginia 22101.

- Posters: Essentials of Good Brick and Tile Construction — A series of six posters which give step-by-step explanation of good bricklaying workmanship. Structural Clay Products Institute, 1750 Old Meadow Road, McLean, Virginia 22101.

Slides

Carpentry

- 35mm teacher-prepared slides from construction site visitations.

Concrete Technology

- The PCA slide set, *Mr. Quality Concrete,* consisting of 40, 2"x 2" color slides is available at a cost of 25 cents per slide from the Portland Cement Association, Old Orchard Road, Skokie, Illinois 60067.

Masonry

- "Classification and Manufacture of Structural Clay Products," (Use in Unit 1).

- "Contemporary Bearing Wall."

- "Selection of a Building Wall."

- "SCR Insulated Cavity Wall."

  The above lecture slides may be borrowed or purchased from the Structural Clay Products Institute (SCPI), 1750 Old Meadow Drive, McLean, Virginia 22101.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.

- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.

- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.

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- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.

- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Filmstrips

Masonry

The following filmstrips may be borrowed or purchased from the Structural Clay Products Institute (SCPI), 1750 Old Meadow Road, McLean, Virginia 22101.

- *Cavity Walls of Brick and Tile*
- *Bonding Brick and Tile Walls*
- *Modular Masonry*
- *Moistureproof Wall*
- *Reinforced Grouted Brick Masonry*
- *SCR Brick*

Motion Pictures

Carpentry

- *Lumber for Houses,* Visual Instruction Service, Iowa State University, Ames, Iowa 50010, NS - 734.

- *Wood: Masterpiece of Creation,* Visual Instruction Service, Iowa State University, Ames, Iowa 50010, NS - 6329.

- *Building a House,* Visual Instruction Service, Iowa State University, Ames, Iowa 50010, NS - 2430.

Concrete Technology

The following 16mm sound-color motion pictures, produced by the PCA, are available on a free loan basis from Portland Cement Association, Old Orchard Road, Skokie, Illinois 60076.

- *Building a Highway* (15 1/2 min.)
- *Concrete Example* (16 min.)
- *Concrete in the Sixties* (22 1/2 min.)
- *Construction of a Demonstration Section of Prestressed Concrete Pavement* (10 min.)
- *From Mountains to Microns* (24 1/2 min.)
- *How To Make Decorative Patio Floors for Outdoor Living* (19 1/2 min.)
- *How To Transport, Place, Finish, and Cure Quality Concrete* (32 min.)
- *New Shapes in Concrete* (16 1/2 min.)
- *Principles of Quality Concrete* (37 min.)
- *Quality Ready Mixed Concrete* (31 1/2 min.)
- *Tilt-Up Construction on the Farm* (15 1/2 min.)

Masonry

The following motion pictures may be purchased or borrowed from the Structural Clay Products Institute (SCPI), 1750 Old Meadow Road, McLean, Virginia 22101.

- *ABC's of Masonry Construction* (also available from: Visual Instruction Service, Iowa State University, Ames, Iowa 50010, NS-1705)

- *Basic Bricklaying* (16mm, color, 12 min.)

- *Clay and Craftsmanship* (16mm, color, 20 min.)

- *Concepts in Clay* (16mm, color, 23 min.)

- *Earth and Fire* (16mm, color, 12 min.)

- *Man and Masonry,* (16mm, B & W, 24 min.)

- *Prologue in Masonry* (16mm, B & W, 24 min.)

Books

Carpentry

- *Cabinet Making and Millwork,* Dahl and Wilson, American Technical Society, Chicago, Illinois, 1956 (6th printing in 1965).

- *Carpentry and Building Construction,* Dept. of the Army, United States Printing Office, Washington, D.C., 1960 (TM 5-460).

- *Construction Pricing and Scheduling Manual,* F. W. Dodge Company, McGraw-Hill, Inc., New York, New York, 1968.

- *Estimating for the Building Trades,* Joseph Steinberg and Martin Stempel, American Technical Society, Chicago, Illinois, 1965.

- *Field Inspection of Building Construction,* McKaig, McGraw-Hill, New York, New York, 1958.

- *Framing, Sheathing, and Insulation,* Raymond Jones, Delmar Publishers, Inc., New York, New York, 1964.

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- *Fundamentals of Carpentry,* Walter Dunbahn, American Technical Society, Chicago, Illinois, 1967 (Vol. I and II).

- *Rafter Layout with the Framing Square for School and Home Workshop,* Bear and Hoerner, Bulletin 166, Hobar Publications, 1305 Tiller Lane, St. Paul, Minnesota 55112.

- *Specifications,* Edwards, D. Van Nostrand Company, Inc., Princeton, New Jersey, 1961.

- *Vest Pocket Estimator,* Frank R. Walker, Walker Company, Chicago, Illinois, 1967 (15th edition).

Concrete Technology

- *Concrete Technology,* Portland Cement Association, Skokie, Illinois 60076.

Masonry

- *Brick and Tile Construction Details,* Structural Clay Products Institute, Ames, Iowa 50010, 1968.

- *Bricklaying I,* Structural Clay Products Institute, Delmar Publishers, Inc., Albany, New York, 1952.

- *Bricklaying Vocational Training,* W. F. Roark, and H. C. Plummer, Structural Clay Products Institute, McLean, Virginia 22101, 1968.

- *Concrete Masonry Handbook,* Portland Cement Association, Skokie, Illinois 60076, 1951.

- *Recommended Practice for Laying Concrete Block,* Portland Cement Association, Skokie, Illinois 60076, 1963.

C

EQUIPMENT

Carpentry

Few tools and equipment will be needed in addition to what would be available in a well-equipped unit wood shop. See pages 172 to 175 for such recommendations.

Concrete Technology

A partial list of tools, equipment, and materials which are required to do concrete work is as follows:

Tools and equipment

Glass bottles for silt test
Set of laboratory sieves
Pocket-size air indicator
Slump cone, rod and rule
Compressive test mold
Hydraulic press
Small concrete mixer
Straight edge or strick-off rod
Hand tamper
Darby
Bull float
Edgers (several different sizes and types)
Jointers or groover (several different bits depths)
Hand floats (wood and magnesium)
Steel hand trowel (several sizes)
Concrete calculators

Materials

Aggregate samples
Portland Cement — Type I and I-A
Air-entraining mixture (sample of sand)
Releasing agents (samples of)
Reinforcing rods and mesh (samples of)
Wood for building forms

Masonry

A partial list of tools, equipment, and material which are unique to masonry is as follows:

Tools and Equipment

Brick tongs
Mortar stands
Wheelbarrow
Mortar mixing box
Water hose
Shovels (#2 Flat and round point)
Masonry saw
Mortar mixer
Bricklaying trowels
Plastering trowels
Pointing trowels
Brick hammers
Plumb rule (48")
Spacing rule

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Brick set
Mason's line
Line pins
Line trigs
Line blocks
Jointers, convex
Raker jointer
"V" jointer
Plumb bob
Steel measure (50')

Materials

Facing brick
Hydrated lime
Mason sand
Steel lintels
Wall ties
Structural clay facing tile

SUPPLIERS OF TOOLS AND EQUIPMENT

- Broadhead-Garrett Company, 4560 East 71st Street, Cleveland, Ohio 44105.
- Midwest Shop Supplies, Inc., 301 Jackson Street, Sioux City, Iowa 51101.
- Paxton Equipment and Supply, 7401 South Pulaski Road, Chicago, Illinois 60629.
- Satterlee Company, 2200 East Franklin, Minneapolis, Minnesota 55404.

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WS. 42. Gun Rack: Make a two-view dimensioned instrument drawing of the Gun Rack. Use the scale 1/8" = 1". Show front and right end views. Make a freehand plan and have it checked before making the instrument drawing.

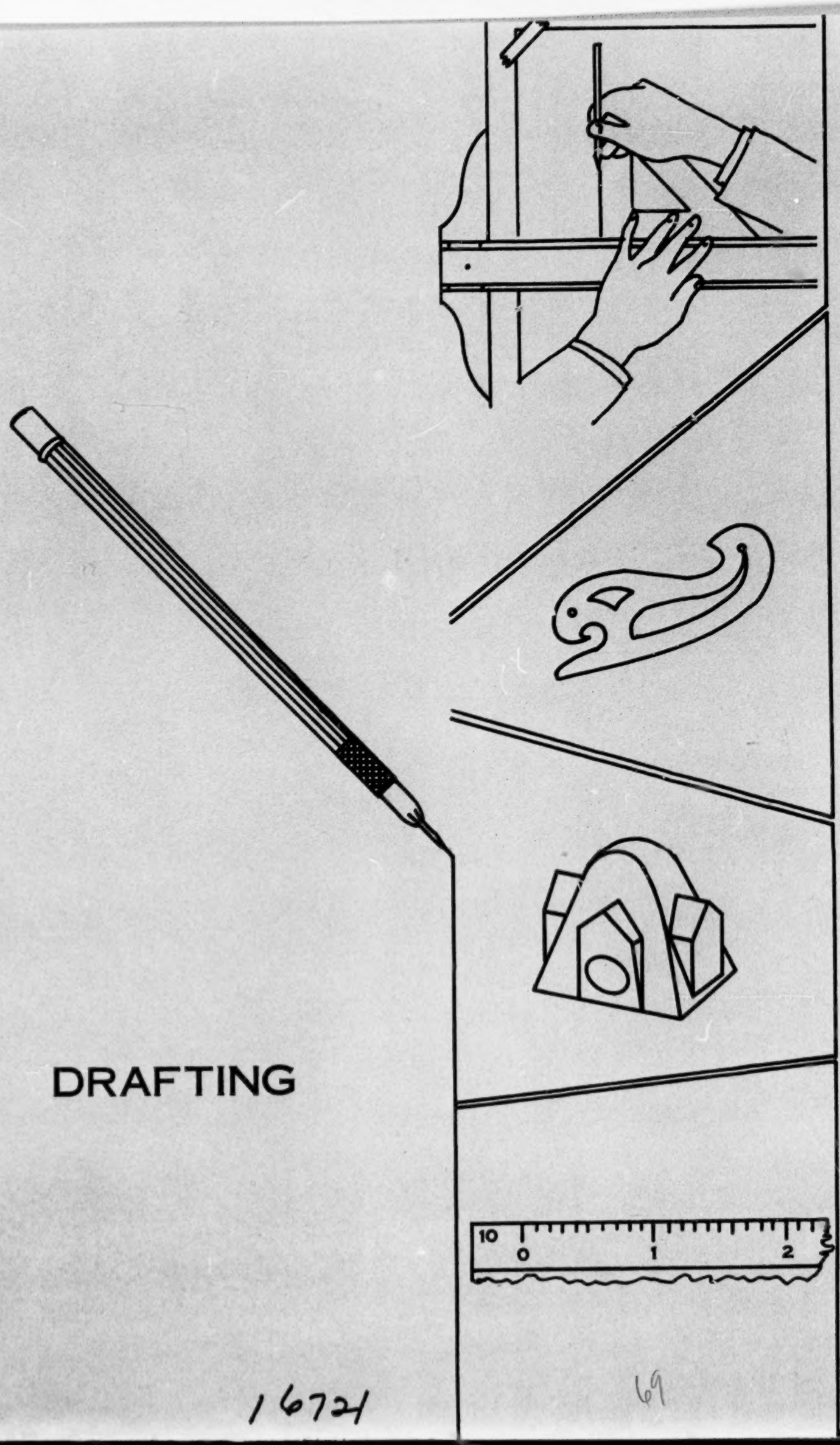

DRAFTING

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Drafting has been called a universal language because products of the drafting room can be understood rather well by industrialists in any quarter of the globe regardless of their ability to understand the mother tongue of the draftsman who produced the drawing. This area, in which students learn to visualize, express their own ideas graphically, and interpret ideas of others, is essential to the understanding of today's modern industry.

Certain basic drafting principles could be introduced at the elementary level. Using sketching to make simple pictorial or view drawings would provide pupils with another means of communication which could be used to advantage in reducing abstractions.

Drafting makes important contributions in junior high school industrial arts programs by providing introductory experiences in graphic communication including basic drafting principles, design and planning of projects, and the like.

At least two years of sequential coursework in drafting should be available at the senior high school level. At this level drafting is carried out in a drafting room with such specialized equipment as drafting tables, instruments, drafting machines, and reproduction machines. Courses such as engineering drafting and architectural drafting may be taught in addition to one or more basic courses. Course work at this level, despite the high degree of proficiency attained by some students, should not be considered as training for earning a wage.

Drafting offers rich opportunities to apply mathematics. Design activities have much potential for utilizing scientific principles and other aspects of general education.

This area is appropriate for girls and any interest they have in it is usually accompanied by considerable aptitude.

If additional courses are offered on the junior high school level, instruction should progress into more specific types of drawings, print reading, dimensioning, project planning, use of instruments, and drawing reproduction.

The instructional content should include what is presented in this guide in so far as the local schedule will allow. It is strongly recommended that the student experience the processes outlined here by the time he completes the ninth grade so that he will be prepared for further instruction in drafting.

The order of units in this outline is not intended to interfere with flexibility in the sequence of presentation. Likewise, the extent of class involvement with each unit is dependent on the individual situation. It is hoped that the teacher will supplement the material with pertinent information relative to the needs of his students and the changing conditions of our industrial society.

Objectives. Every student should have the opportunity:

- To develop an awareness of the purpose of drafting in industry; its place in design, production, and distribution.
- To develop the ability to use drafting techniques in the solution of common problems.
- To develop the ability to communicate through graphic production and interpretation.
- To develop basic skills, knowledge, work habits, and attitudes which will be of value in further work in industrial arts and other subject matter areas.
- To realize personal interests and abilities in drafting and gain some understanding of the occupational opportunities in this field of work.

Drafting for Junior High Schools (7-9)

The first course or unit in drafting should be devoted to developing fundamental concepts. No attempt should be made to develop a high degree of skill or depth of knowledge in the field. An emphasis should be placed on sketching, measurement, view construction and interpretation, and the significance of drafting in industry.

Content. Part One of the outline deals with fundamental concepts of drafting through the sketching approach. In Part Two the use of instruments is employed to provide more depth in these concepts and to introduce additional concepts. No attempt has been made to identify specific courses. The instruction may be accomplished in a single course or in several shorter courses depending upon the local scheduling arrangements. So many good

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D

sources for student activities in drafting are available in textbooks and professional journals that none are included here.

Part One — Sketching and Fundamentals of Drafting

I. General introduction to drafting — Grades 7-9

- A. Objectives of drafting
- B. Course content
- C. History of drafting
- D. Drafting as communication
- E. Drafting as problem solving
- F. Opportunities in drafting
- G. Safety precautions
  1. Pointed instruments
  2. Reproduction solutions

II. The sketching process

- A. Value and uses of sketching
- B. Materials and tools
  1. Graph paper
  2. Sketch pad
  3. Soft pencil
  4. Eraser
- C. Techniques
  1. Straight lines
  2. Curves, circles, arcs
  3. Border and title layout

III. Lettering

- A. Gothic single stroke
  1. Vertical
  2. Inclined
- B. Proportion
- C. Spacing

IV. Pictorial sketching

- A. Oblique
  1. Cavalier
  2. Cabinet
- B. Isometric
- C. Perspective
  1. 1 point
  2. 2 point

V. Multiview Sketching

- A. Principles of shape description
- B. Visualization
- C. Layout and arrangement of views

VI. Dimensioning

- A. Measuring full scale
- B. General rules
- C. Alphabet of lines
- D. Basic techniques

Part Two — Instrument Drafting

I. Introduction to common tools and materials

- A. Board
- B. T-square, parallel rule, drafting machine
- C. Triangles
- D. Architect's scale
- E. Pencils, erasers, erasing shields
- F. Compasses, bow instruments, templates
- G. Irregular curves
- H. Drafting papers and other media

II. Measuring

- A. Techniques
- B. Inches and fractional parts
- C. Decimal conversions
- D. Metric system

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E. Common mathematical computations

F. Drawing to scale

III. Drafting techniques

A. Proper care and use of instruments

B. Techniques of penciling straight lines, circles, arcs, and curves

C. Angles, intersections

IV. Drawing layout

A. Sheet sizes and layout
1. Border
2. Record strip

B. Object drawing
1. Placements
2. Spacing
3. Neatness

V. Geometric constructions

A. Bisecting
1. Lines
2. Angles

B. Erecting perpendiculars
1. To a point on a line
2. From a point outside a line

C. Dividing a line into equal number of parts

D. Constructing tangents
1. Straight line to a circle
2. Arc to straight lines
3. Arc to circle

E. Constructing a pentagon, hexagon, agon octagon

F. Constructing ellipses

G. Others as needed

H. Single view drawings involving geometric constructions

VI. Orthographic projection

A. Preliminary sketching and visualization

B. Principals of shape description
1. View selection
2. Spacing of views
3. Projecting from view to view
4. Order of penciling
5. Correct use of hidden lines
6. Correct use of center lines

VII. Dimensioning

A. General rules and techniques

B. Lines, arrowheads, spacing

C. Lettering
1. Notes
2. Numerals
3. Mechanical aids

VIII. Sections

A. Full

B. Half

C. Line work and symbols

IX. Auxiliary views

A. Primary auxiliaries only

B. Use and location of reference planes

X. Graphs and charts

A. Bar graph

B. Line graph

C. Circle graph

D. Flow diagrams

XI. Project planning and design

A. Student design of a simple object

B. Application of techniques of sketching and drafting

C. Construction of a bill of material

XII. Review of reproduction processes

A. Blueprinting

D

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B. White printing
   1. Moist diazo
   2. Dry diazo

XIII. Print reading

A. Interpreting views and symbols

B. Locating and identifying specific information

Drafting for Senior High Schools (10-12)

Drafting at the senior high school level should serve several functions. It should serve to provide an introductory course for students who have not had previous drafting instruction and who wish to test their interest and ability in this field. To serve this function it would be well to offer a course patterned after the junior high school drafting outline in this guide.

Secondly, it should serve a general educational purpose in helping students in the development of their capacity to analyze, organize, and express themselves graphically in a precise, accurate manner; and to interpret ideas that have been expressed graphically by others.

In addition, it should serve a function of providing differentiating education for students who have an interest in a particular area of drafting or industrial occupations which rely on drafting as a means of communication.

Finally, it should serve a preparatory function for students who wish to equip themselves for gainful employment in drafting or who plan to continue their education in engineering or technical schools.

Objectives. Every student should have the opportunity:

- To develop further the fundamental concepts of drafting which were established in junior high school drafting.
- To explore special areas or phases of drafting.
- To develop an appreciation of the importance of drafting in a technological world and an awareness of its opportunities and requirements as a vocation.
- To express himself through creative work and to develop an appreciation for quality in design and craftsmanship.
- To develop knowledge, skill, and judgment in industrial drafting practices to the fullest extent of his interest and ability.
- To realize the value of mathematics and science in the solution of graphical problems.

Content. It is recognized that local situations may justify modification of course titles, sequence of instruction, and extent of student involvement in the outline presented here. Four courses, general drafting, machine drafting, engineering-technical drafting, and architectural drafting, are presented in the following outline.

The teacher should recognize this as a guide and draw from it those portions which best fit his students and teaching situation. It is highly recommended, however, that the content outlined here be covered in courses of comparable purpose.

Since appropriate student activities for this area are so readily available in textbooks and professional journals none are included here.

General Drafting (1-2 semesters)

I. Review of basic fundamentals

A. Equipment
   1. Names, purposes, quality
   2. Uses, care

B. Materials
   1. Names, purposes, quality
   2. Uses, care

C. Basic procedures
   1. Sketching pictorials
   2. Freehand lettering
   3. Use of instruments
   4. Drafting geometry
   5. Techniques of producing a drawing

D. Dimensioning
   1. Lines, arrowheads, notes, and numerals
   2. Placement
   3. Techniques
      a. Circles, arcs, angles, cylinders
      b. Restricted space dimensioning

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4. Decimals, fractions
5. Metric system

II. Multiview projection

A. Working drawings
1. Orthographic
a. Techniques of projection
b. Related lines and symbols
c. Dimensioning and basic toleranc-ing
2. Detail and assembly drawing
a. Purposes of each
b. Characteristics of each

B. Sections
1. Full, half, offset
2. Assembly sections
3. Broken out, revolved, removed
4. Related lines and symbols

C. Auxiliary views and revolutions
1. Projection of primary auxiliaries
a. Inclined surfaces
b. Curved surfaces
2. Related lines and symbols
3. Revolutions in true length line de-termination

III. Sheet metal developments

A. Rectangular or simple line developments

B. Parallel line

C. Radial line

D. Related lines and symbols

IV. Electronic drafting

A. Wiring diagrams

B. Schematics

C. Related lines and symbols

V. Map drafting

A. Plots, plats

B. Topographic maps, weather maps

C. Others

D. Related lines and symbols

VI. Architectural sketching

A. Simple floor plans

B. Simple evaluation

C. Basic dimensioning

D. Related lines and symbols

High school drafting equipment.

D

Machine Drafting (1-2 semesters, grades 11-12, prerequisite: General Drafting)

I. Review of basic techniques

A. Lettering

B. Line work

C. Procedure for developing a drawing

II. Orthographic projection

A. Planes of projection

B. First and third angle projection

C. Partial views

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D. Shop processes
   1. Cutting and shearing
   2. Bending and forming
   3. Drilling, boring, reaming
   4. Turning, shaping, milling
   5. Heat treating and welding
   6. Surface finishing

III. Dimensioning practices

A. Special rules

B. Limits and tolerances

C. Decimal system

D. Metric system

E. Unilateral and bilateral tolerance system

F. Description of standard fits

G. Dimensioning for standard fits

H. Positional tolerances

I. Surface finish specifications

IV. Auxiliary views and revolution

A. Partial and complete views

B. Type of primary views

C. Secondary auxiliaries

D. Revolutions

V. Fasteners

A. Classification of fasteners

B. Symbolic forms

C. Dimensions and specifications

D. Use of templates

VI. Production drawings

A. Detail drawings
   1. Pattern shop
   2. Weldments
   3. Machine
   4. Stampings

B. Assembly drawings
   1. General
   2. Design layout
   3. Sub-assemblies
   4. Sub-weldments

C. Material lists
   1. Placement and information included
   2. Keyed to drawings

D. Application of dimensions
   1. Detail drawing
   2. Assembly drawing

E. Corrections and revisions

F. Use of sectioning
   1. Basic applications
   2. Conventional practices

VII. Reproduction of drawings

A. Processes
   1. Moist diazo
   2. Dry diazo
   3. Thermo
   4. Xerography
   5. Microfilming

B. Materials
   1. Papers
   2. Plastic films
   3. Cloth

C. Techniques of use
   1. Original copy
   2. Intermediate copies
   3. Reproducing opaque originals
   4. Scissor editing
   5. Photographic

D. Safety precautions

VIII. Pictorial drafting

A. Types
   1. Oblique projections
   2. Isometric
   3. Perspectives

B. Related materials and equipment and their use
   1. Grid papers
   2. Templates
   3. Mechanical devices

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C. Applications
1. Exploded views
2. Shading and color
3. Dimensioning

Engineering-Technical Drafting (1-2 Semesters, Grades 11-12, Prerequisite: General Drafting)

I. Introduction

A. Purpose and scope of the course

B. Review of drafting techniques

II. Cams and gears

A. Types of gears

B. Gear representation, terminology, formulas, and dimensioning

C. Types of cams

D. Cam representation, terminology, profiles, motion diagrams, and dimensioning

III. Structural steel drafting

A. Conventions, dimensioning, notes, symbols

B. Mill tolerance

C. Fabrication
1. Right and left details
2. Simple square framed beams

D. Fasteners, rivets, bolts

E. Erection clearance for seated connections

F. Column details

G. Beam details

IV. Descriptive geometry

A. Points-location

B. Lines
1. True length
2. Slope, grade, bearing
3. Point view
4. Parallel and perpendicular
5. Shortest distance between
6. Visibility

C. Planes
1. Formation of
2. Strike
3. Dip
4. Edge view
5. True shape
6. Lines parallel and perpendicular to
7. Piercing point of line
8. Intersection of plane
9. Visibility
10. Dihedral angle

D. Revolutions
1. Point
2. Lines
3. Plane
4. True length of line
5. True shape of plane
6. Dihedral angle

E. Surface developments
1. Intersections of prisms, cylinders, pyramids, and cones
2. Truncated prisms, cylinders, pyramids, and cones
3. Transitions

V. Design problems

A. Simple machine design
1. Analysis and design
2. Working drawings or assembly drawings
3. Determination of weights, volumes, and cost of parts

B. Jigs, fixtures, tools, and dies
1. Definition and description
a. Principles of jig and fixture design
b. Tool drawings
c. Dies
2. Analysis and design
3. Working drawings or assembly drawings

VI. Recent developments

A. Simplified drafting
1. Elimination of unnecessary views
2. Sketched production drawings
3. Simplified sectioning, dimensioning notes, and symbols

D

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B. Drafting for numerical controlled machines
   1. XYZ coordinates
   2. Base line dimensions

C. Geometric tolerancing
   1. Symbol identification
   2. Datum surfaces
   3. True position

D. Computorized drafting

E. Materials and tools
   1. Films and papers
   2. Overlays, appliques, tape lines
   3. Technical fountain pens and compasses
   4. Mechanical lettering devices
   5. Special templates

VII. Additional areas of specialization

A. Automotive drafting

B. Pipe drawing

C. Aircraft drafting

D. Electrical drafting

E. Photo drafting

Architectural Drafting (1-2 Semesters, Grades 11-12, Prerequisite: General Drafting)

I. Organization and orientation

A. History and background

B. Basic housing
   1. Community
   2. Types
   3. Materials
   4. Construction and design

C. New trends in housing
   1. Prefabricated
   2. Design for flexibility
   3. Styling
   4. New materials and procedures

II. Planning

A. Area planning
   1. Living area
   2. Service area
   3. Sleeping area
   4. Basement area

B. Lot and grounds
   1. Lot location
   2. Size and contour
   3. Plantings
   4. Natural setting
   5. Soil structure
   6. Driveways and walks

C. Elevations
   1. Style of house
   2. Size of house
   3. Exterior design

D. Electrical
   1. Outlets, switches, fixtures
   2. Symbols
   3. Building codes
   4. Built-in appliances

E. Plumbing
   1. Symbols
   2. Building codes
   3. Water system, sewer system
   4. Bath floor plan
   5. Kitchen plan and plumbing details

F. Heating, cooling, and insulation
   1. Placement of heating and cooling units
   2. Forced air systems
   3. Electrical systems
   4. Water systems
   5. Steam systems
   6. The heat pump
   7. Fireplaces — conventional and prefabricated
   8. Insulation — functions, types, placement
   9. Heat loss computations
   10. Building codes

G. Estimating
   1. Square footage
   2. Cost take-off
   3. Comparison of materials
   4. Labor costs

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H. Specifications

I. Financing
   1. Mortgage
      a. Federal Housing Administration
      b. Veterans Administration
      c. Conventional
   2. Construction loan
   3. Contract for deed
   4. Insurance
   5. Taxes

III. Drafting techniques

A. Symbols

B. Linework

C. Dimensioning

D. Schedules — door and window

IV. Execution or production of drawings

A. Plan views
   1. Preliminary sketch
   2. Footing, basement plans
   3. First floor, second floor

B. Details
   1. Framing
      a. Cornice
      b. Floor
      c. Wall section
      d. Sill
      e. Window
      f. Stair
      g. Roof
      h. Door
   2. Built-ins
      a. Cabinet, storage
      b. Fireplace
      c. Furniture

C. Elevation
   1. Front, sides, rear
   2. Sections

D. Electrical

E. Heating and cooling

F. Plumbing

G. Plot plan

H. Presentation drawings
   1. Pictorials
   2. Plot and plan view
   3. Elevational views
   4. Renderings

V. Reproduction of drawings

VI. Models

D

SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purposes of illustration. Sources that pertain to drafting are included if specific material is not listed below. Additional information of a general nature may be found on page 48.

Miscellaneous Materials

- Chart: "Decimal Equivalents," Frederick Post Company, 3650 North Avondale Avenue, Chicago, Illinois 60618.

- Pamphlet: "Can I Be a Draftsman?" Public Relations Staff, General Motors, Detroit, Michigan.

- Pamphlet: "Designers Guide to Surface Texture," Micrometrical Manufacturing Company, 3621 South State Road, Ann Arbor, Michigan 48104.

- Pamphlet: "11 Ways To Save Drafting Time," Frederick Post Company, 3650 North Avondale Avenue, Chicago, Illinois 60618.

- Pamphlets: "Microfilming and You, the Draftsman," and "Preparation of Engineering Drawings on Drafting Film," Western Electric Company, Inc., Engineering Division, 222 Broadway, New York, New York 10012.

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UNIT VI — PICTORIAL DRAWING

General Information

Many times a workman will need to show his ideas and plans for such things as a house, a wood project or a screw driver handle to another person. This person may not be familiar with conventional drawing techniques. To do this you may use a form of drawing known as pictorial drawing. Pictorial drawings resemble a true picture closer than any other type of drawing. Two or three sides appear on the same view of the object as pictured in Illustration Sheet 20, on page 75. There are four principal types of pictorial drawings, isometric, oblique, cabinet and perspective. In this unit you will learn to make isometric and oblique drawings.

The most popular and most used type of pictorial drawing is the isometric. An isometric drawing clearly shows three surfaces of an object. The drawing is laid out on an isometric axis of three lines, one vertical, one 30 degrees to the left, and another 30 degrees to the right as shown in Figure 1, Illustration Sheet 21, page 77. The object is drawn accurately to the scale you wish to use.

The oblique drawing resembles an isometric except that one face of the object is shown as a true front view. See Figure 2, Illustration 21. The receding sides go back at any convenient angle, usually 45 degrees. When making an oblique drawing select the face that is most irregular or complicated in shape to serve as the front of the

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- Pamphlet: "Reproduction Guide," International Association of Blue Print and Allied Industries, 33 East Congress Parkway, Chicago, Illinois 60605.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.
- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.
- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.
- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.
- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Cartridged Super 8mm Single-Concept Films

- Sixty-six titles on basic drafting techniques, The Waldon Film Corporation, 39 East 31st Street, New York, New York 10016.

Motion Pictures

- Mechanical Drawing Series
- Engineering Drawing Series

  The above may be purchased from The McGraw-Hill Book Company, 330 West 42nd Street, New York, New York 10036.
  They may be available on a rental basis from your nearest University Film Library.

- Eastman Kodak Company, BSMD Sales Division, 343 State Street, Rochester, New York 14650.
- General Motors Public Relations Section, Detroit, Michigan 48202.
- Modern Talking Pictures Service, Inc., 129 Third Avenue, S.W., Cedar Rapids, Iowa 52404.

Books

- *Architecture: Design — Engineering — Drawing,* Spence, McKnight and McKnight Publishing Company, Dept. 544, Bloomington, Illinois 61701.
- *Architectural Drafting and Design,* Hepler and Wallach, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.
- *Architectural Drafting: Functional Planning and Creative Design,* Stegman and Stegman, American Technical Society, Department W653, 848 East 58th Street, Chicago, Illinois 60637.
- *Architectural Drawing and Planning,* Goodban and Hayslett, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.
- *Architectural Graphic Standards,* Ramsey and Sleeper, John Wiley and Sons, Inc., 605 Third Avenue, New York, New York 10016.
- *Basic Mechanical Drawing,* Shaeffer and Spielman, Bruce Publishing Company, 710 Bruce Building, Milwaukee, Wisconsin 53201.
- *Drafting and Technical Communication,* Wright, McKnight and McKnight Publishing Company, Dept. 544, Bloomington, Illinois 61701, 1968.
- *Drawing and Blueprint Reading,* Coover, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.
- *Engineering Drawing,* Zozzora, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.
- *Engineering-Technical Drafting and Graphics,* Giachino and Beukema, American Technical Society, Dept. W653, 848 East 58th Street, Chicago, Illinois 60637.
- *Fundamentals of Engineering Drawing,* French and Vierck, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.

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- *General Architectural Drawing,* Wyatt, Charles A. Bennett Company, Inc., Dept. 467, 809 West Detweiller Drive, Peoria, Illinois 61614.

- *Industrial Arts Drafting,* Walker, Goodheart-Willcox, Dept. 5267, 18250 Harwood, Homewood, Illinois 60430.

- *Machine Drafting and Related Technology,* Yankee, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.

- *Mechanical Drawing,* French and Svenson, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.

- *Military Standards — Dimensioning and Tolerancing,* Cat. No. D70.10:8C, United States Government Printing Office, Division of Public Documents, Washington, D.C.

- *Military Standards — General Drawing,* Cat. No. D70.10:1B, United States Government Printing Office, Division of Public Documents, Washington, D.C.

- *Programmed Blueprint Reading,* Coover and Helsel, McGraw-Hill Book Company, Webster Division, Manchester Road, Manchester, Missouri 63011.

- *Technical Drawing,* Giesecke, Mitchell, Spencer, and Hill, The Macmillan Company, 866 Third Avenue, New York, New York 10022.

- *USA Standards Manual,* United States of America Standards Institute (USASI), American Society of Mechanical Engineers, 345 East 47th Street, New York, New York.

Magazines

- *Engineering Graphics,* St. Regis Publication, Inc., 25 West 45th Street, New York, New York 10036 (free to drafting teachers by writing to Keuffel and Esser Company, 500 Central Avenue, Northfield, Illinois 60094).

- *Graphic Science,* 9 Maiden Lane, New York, New York 10038 (free upon request by drafting teachers).

- *Visual Communication Instructor,* 25 West 45th Street, New York, New York 10036 (free to drafting teachers).

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EQUIPMENT

The following list is presented as a guide in the selection of furniture and equipment needed to teach drafting. The approximate number of each item needed for a small, medium, or large number of students in a drafting room is indicated as well as items needed to equip a planning and drafting area of a general shop.

Basic Equipment for the Planning and Drafting Area of a General Shop

	No. Needed
Furniture	
Cabinet for storing drafting equipment	1
Chairs for planning and conference table	3
Drafting chairs or stools	3
Drafting tables 29" or 36"	3
Planning and conference table	1
Equipment	
Chalkboard set: T-square, straight edge, triangle, protractor, and compass	1
Drafting boards, 20 by 24 inches, basswood	6
Drafting instruments set, min. of dividers, compass	4
Drafting standards manuals: either USASI or SAE	1
Erasing shield	6
French curves 8 inches, min. of 2 curves forms	2
Machinists and engineers data handbook	1
Overhead projector	1
Paper knife-board, 24 by 24 inches	1

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Pencil sharpener (regular)	1
Pencil sharpener (draftsman)	1
Portable drafting kit	2
Printing frame	1
Printing machine	1
Projection box	1
Protractor, semi-circular 5 inches	1
Scales: 12" hardwood architects	6
Scales: 12" combination, architect, civil and mechanical engineers	6
Textbook	10
Triangles 30-60 degrees 10 inches	6
T-squares 24 inches — hardwood, plastic edge, fixed head	4

Basic Equipment for the Drafting Room

	Class Size		
	Small (10)	Medium (16)	Large (24)
Furniture			
Bookcase	1	1	1
Cabinet for storing drafting equipment	1	1	1
Chairs for planning and conference table	3	6	8
Desk and chair for instructor	1	1	1
Drafting chairs or stools	10	16	24
Drafting tables 29" or 36"	10	16	24
Filing cabinet	1	1	1
Planning and conference table	1	1	2
Supply cabinet	1	1	1
Equipment			
Chalkboard set: T-square, straight edge, triangle, protractor, and compass	1 set	1 set	1 set
Drafting board 20"x 24", basswood	10	16	24
Drafting instruments set, minimum of dividers, and compass	10	16	24
Drafting standards manuals: either USASI or SAE	1	1	1
Drafting tables, 32"x 42" with stools or chairs	10	16	24
Erasing shield	10	16	24
French curves 8", minimum of 2 curve forms	10	16	24
Machinists and engineers data handbook	1	1	1
Overhead projector	1	1	1
Paper knife — board, 24"x 24"	1	1	1
Pencil sharpener (regular)	1	1	1
Pencil sharpener (draftsman)	1	1	1
Printing frame	1	1	1
Printing machine	1	1	1
Projection box	1	1	1
Protractor, semi-circular 5"	10	16	24
Scales: 12" hardwood architects	10	16	24
Scales: 12" combination, architect, civil and mechanical engineers	4	8	12
Technical fountain pen	4	8	12
Textbook	10	16	24
Triangles 30-60 degrees 10"	10	16	24
Triangles 45-45-90 10" celluloid	10	16	24
T-squares 24" — hardwood, plastic edge, fixed head	10	16	24
Drafting machines — 18" arm	10	16	24

SUPPLIERS OF EQUIPMENT

- Broadhead Garrett Company, 4560 East 71st Street, Cleveland, Ohio 44105.
- Eugene Dietzgen, 2425 North Sheffield Avenue, Chicago, Illinois 60614.
- Frederick Post Company, Box 803, Chicago, Illinois 60690.
- Keuffel and Esser Company, Audiovisual Division, Hoboken, New Jersey 07030.
- Midwest Shop Supplies, Inc., 301 Jackson Street, Sioux City, Iowa 51101.
- Olson Manufacturing Company, Box 109, Ames, Iowa 50010.

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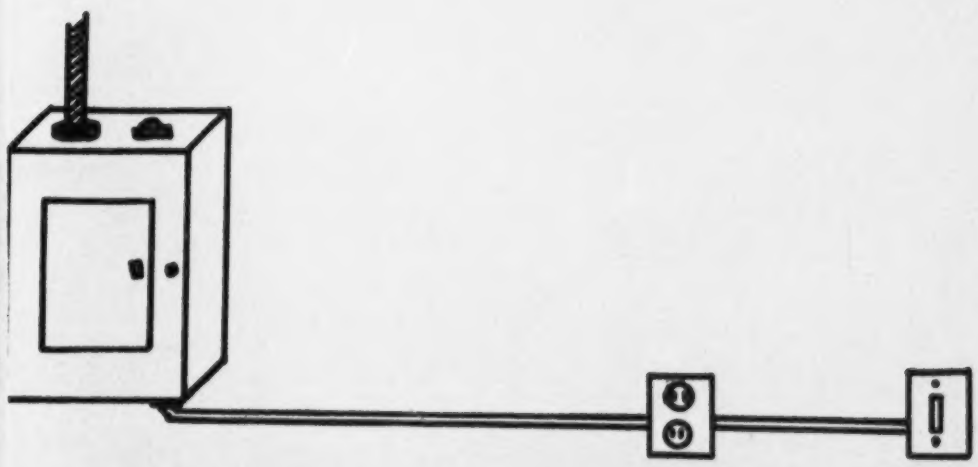

ELECTRICITY–ELECTRONICS

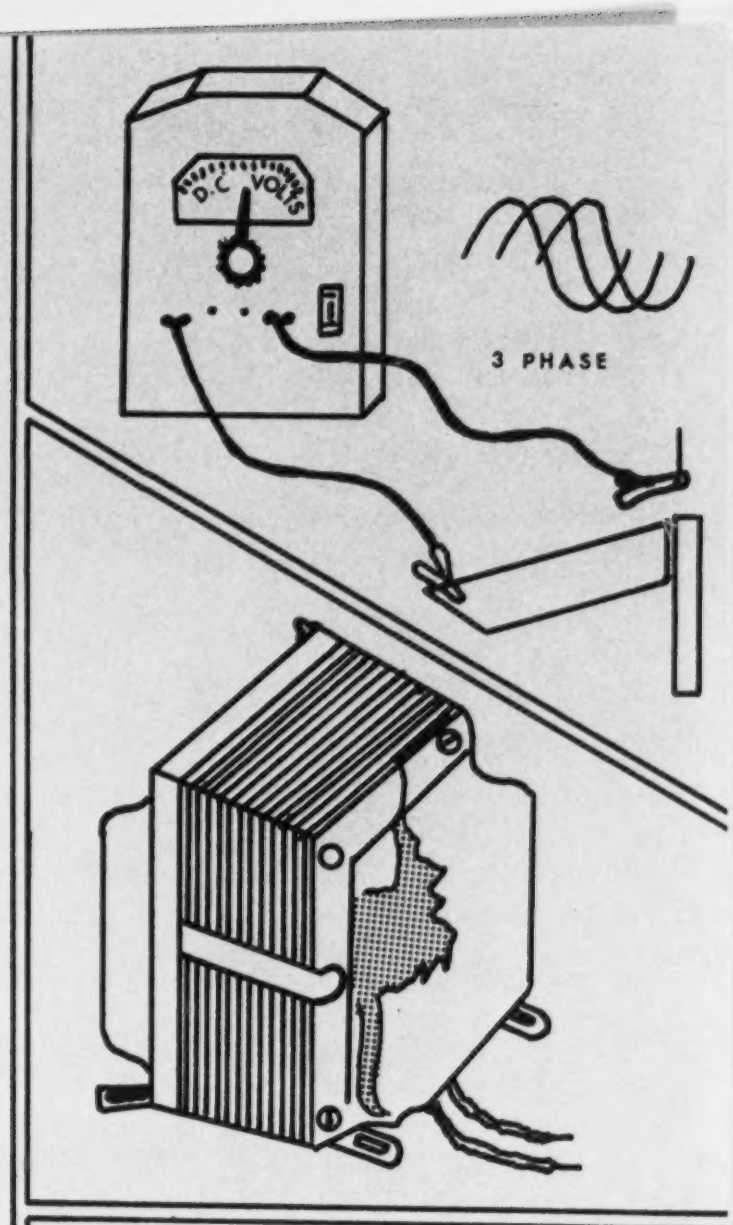

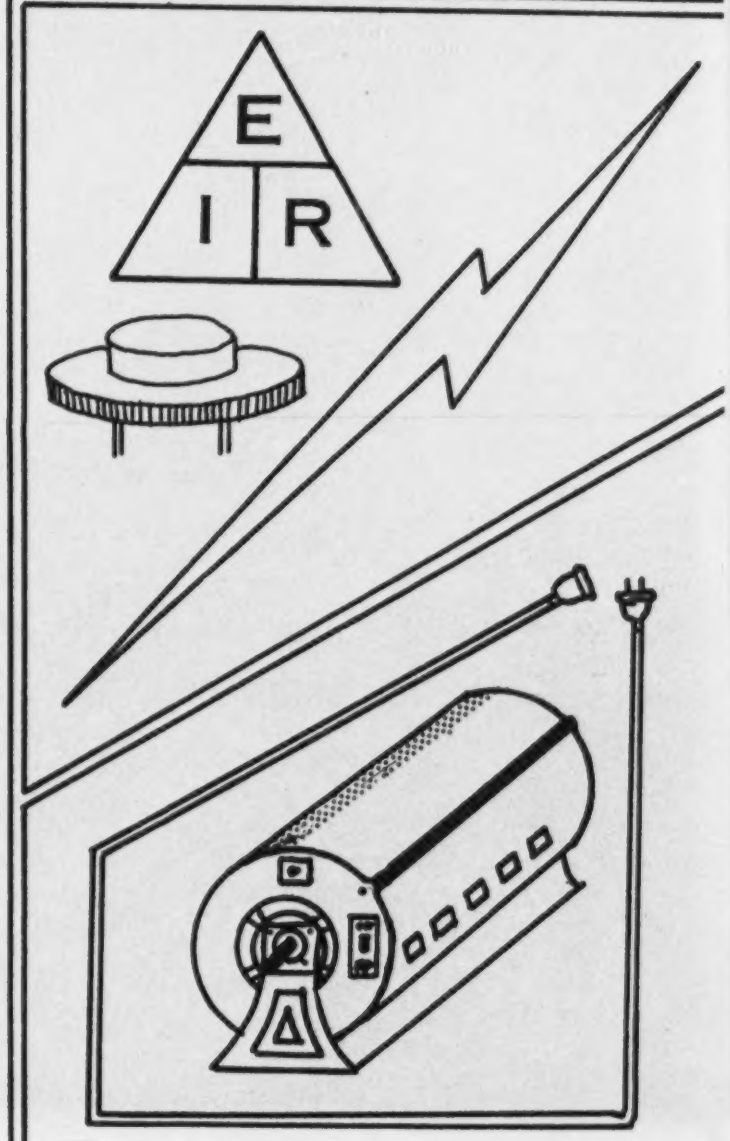

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The impact of electricity-electronics on our society has been far reaching. It is a rapidly expanding and changing field which requires continued updating. Students need an adequate understanding of this field if they are to adjust to new developments and products that will continually change their way of life.

At the elementary level, such things as studying how electricity is made and the importance of electricity to our way of life could enrich the classroom activity.

Normally, electricity-electronics courses should be started in the eighth grade and required of all boys. Girls could participate in this area. There is little about the work which would put them at a disadvantage. Time permitting, instruction in this area should be continued in the ninth grade.

Additional instruction in this area should be offered in the senior high school where at least two years of elective sequential course work should be available. Equipment and facilities adequate for such specialization must be provided. Coursework at this level, despite the degree of proficiency attained by some students, should not be considered as training for earning a wage.

Many opportunities are provided by this area for utilizing mathematical and scientific principles and reducing abstractions in relation to them. Safety education is of primary importance in electricity-electronics, and every effort should be made to help students understand safety as it applies to this area and develop safe habits of working in it. Activity in this area usually involves each student working on a suitable project at his own pace. However, opportunities abound for manipulative activities that are experimental in nature, involve exercises, or utilize the problem solving approach.

Electricity-Electronics for Junior High Schools (7-9)

The junior high program in electricity-electronics should be exploratory in nature. It should be designed to provide the student with a wide range of experiences in the basic fundamentals. A minimum of 14 weeks is suggested during the junior high years.

Modern electronic equipment.

Objectives. Every student should have the opportunity:

- To develop the ability to use and care for common tools and equipment used in electricity-electronics.
- To realize personal interests and abilities in electricity-electronics and gain some understanding of occupational opportunities and leisure time activities in this field.
- To develop habits of safe practices and conduct in the use of electricity.
- To develop an understanding of electricity-electronics theory and circuitry.
- To develop cooperative attitudes in working with others.
- To develop desirable habits that allow him to pursue a problem to its final solution.

Content. The following outline includes content which would be appropriate to teach in junior high school. It is presented in sequential order. No attempt has been made to identify specific units or courses. It may be organized into one course or several depending on the local scheduling arrangements and the equipment available. So many good sources for student activities exist in textbooks and professional journals that none are included in the material which follows.

I. Electrical safety

A. Electrical shock

E

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B. Prevention

C. First aid

D. Home and shop safety

E. Use of fire extinguisher

II. Occupational information

A. Further experiences

B. Job opportunities

III. Consumer knowledge

A. Purchase and use of electrical products

B. Maintenance

IV. Soldering and wiring

A. Preparation

B. Skills needed

C. Application

V. Introduction

A. Electron theory of matter

B. Static electricity

C. Current electricity

VI. Sources of electricity

A. Chemical

B. Light

C. Heat (thermal)

D. Mechanical

E. Piezoelectric effect

F. Static

VII. Magnetism

A. Poles' fields

B. Laws

C. Natural magnets

D. Earth's field

E. Electromagnets

F. Solenoids

G. Relays

H. Generators, A.C. and D.C.

I. Motors, A.C. and D.C.

J. Coils

K. Transformers

VIII. Low and high voltage circuits, A.C. and D.C.

A. Schematics and symbols

B. Current flow

C. Meters and measurements

D. Series

E. Parallel

F. Combination

G. Ohm's law

H. Household wiring

IX. Resistance, capacitance, inductance

A. Definition and identification

B. Use

C. Components

D. Circuits

E. Reactance

X. Vacuum tubes

A. Definition

B. Use

C. Construction

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D. Identification

E. Diode

F. Triode

G. Basic tube circuits

H. Oscillation

I. Rectification

J. Amplification

K. Detection

XI. Semi-conductors

A. Early types

B. Diodes
1. Identification and use
2. Compared to diode (tube)
3. Materials used

C. Transistors
1. Type PNP, NPN
2. Identification and use
3. Compared to triode (tube)
4. Materials used

XII. Transmitters and receivers

A. Definition

B. Operation

C. Block diagram

D. One-transistor radio

E. Code oscillator

F. One-transistor amplifier

G. Wave propagation

XIII. Related topics

A. Television

B. AM, FM, FM Stereo

C. Sonar, radar

D. Short wave, ham, citizens band

E. Lasers, masers

F. Medical electronics

G. Space electronics

H. Nuclear electronics

I. Avionics

J. Data processing and computers

K. Integrated circuits

L. Ultrasonics

M. Chips

N. Tape recording

XIV. Projects

A. Related

B. Up-to-date

C. Value

D. Student interest and experience

E

Electricity-Electronics for Senior High School (10-12)

Should electricity-electronics not be taught at the junior high school level, it is most important than an introductory course be provided in this area at the senior high school. A one-semester course patterned after the junior high school electricity-electronics outline in this guide would serve well here. This could be followed with:

- *Fundamentals of Electricity - Electronics.* Course content is derived from the basics common to both the courses listed below. A minimum length of one semester is recommended.

- *Electricity.* This course is designed to give the student some competence in the electrical field. Emphasis is on electrical construction, installation, operation, and servicing. A minimum program of one year is recommended.

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- *Electronics.* This course is designed to give the student some competence in the field of electronics. Emphasis is on fundamental concepts and principles, and practical application of knowledge gained. A minimum program of one year is recommended.

Objectives. Every student should have the opportunity:

- To develop the ability to use and care for common tools and advanced equipment used in electricity-electronics.
- To develop desirable habits and procedures for use in problem solving situations in electricity-electronics.
- To gain further understanding of industrial standards for electricity-electronics.
- To develop a further understanding of the purchase, use, and maintenance of electrical-electronic equipment.
- To continue building good safety habits in the use of electrical and electronic products.
- To use science, mathematics, and other aspects of general education that may be helpful in developing an in-depth understanding of electricity-electronics theory and circuitry.

Content. The areas of electricity and electronics are closely related, but it is important to understand how they differ.

Electricity is generally considered to be a movement of electrons through a solid.

Electronics is generally considered to be the field that deals with the emission, flow, and effect of electrons in a vacuum, gases, and solid state materials.

It is recognized that course titles, sequence of instruction, and extent of student involvement may be modified by local conditions. The suggested content is presented as a guide only. How this or other information is presented is the responsibility of the individual instructor. Since appropriate student activities for this area are so readily available in textbooks and professional journals none are included here.

Electricity (2 to 4 semesters)

I. History

A. Chronological developments
1. Major events
2. Biographies

B. Predictions

II. Occupational information

A. Job opportunities, wage rates

B. Post high school training

C. The future

III. Related math

A. Purpose

B. Application

IV. Consumer knowledge

A. Purchasing electrical products
1. Evaluation
2. Limits
3. Economics

B. Maintenance and repair
1. Safety precautions
2. Experience level
3. Troubleshooting

V. Electrical safety

A. Accident prevention
1. School
2. Home
3. Corrective measures

B. Electrical shock
1. First aid
2. Fire extinguishers
3. Safety glasses

VI. Soldering and wiring or electrical and electronic circuits

A. Composition

B. Types

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C. Flux

D. Repair and safety

E. Procedures

F. Circuits, printed

G. Mechanical connectors

H. Mounting integrated circuits and other components

VII. Schematic diagrams

A. Symbols

B. Reading

C. Construction

VIII. Nature of electricity

A. Static

B. Current, A.C. and D.C.

IX. Magnetism

A. Poles and fields

B. Laws

C. Earth's magnetism

X. Effects of current flow

A. Thermal, luminous, chemical

B. Magnetic effect
1. Fields
2. Electromagnetism
3. Magnetic units

C. Magnetic devices
1. Meter movements
2. Motors
3. Generators
4. Alternators

XI. Units of electrical measurements

A. Basic measurements and use of test equipment

B. Electrical power and energy

C. Mathematical concepts
1. Scientific notation
2. Ohm's law
3. Metric system
4. Vector
5. Trigometric functions

XII. Sources of electromotive force

A. Chemical

B. Mechanical

C. Piezoelectric effect

D. Thermoelectric

E. Photoelectric

F. Solar

G. Nuclear

H. Static

XIII. Electrical circuits

A. Circuit media
1. Solids
2. Liquids
3. Gases
4. Vacuum

B. Circuits
1. Series
2. Parallel
3. Series-parallel

XIV. Direct current measurements

A. Use of volt, ohm, ammeters

B. Use of wattmeters, bridges

C. Calculation and measurement

D. Maintenance and repair

XV. Alternating current measurements

A. Calculations and measurements

B. Resistance, inductance, capacitance

E

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C. Impedance

D. Series, parallel, combination circuits

E. Power factor meters

XVI. Power distribution

A. Pole lines, construction and guying

B. Troubleshooting and repair

C. Underground wiring

D. Distribution installations

E. Grounding systems

F. High tension lines

G. Designing distribution installations

H. Safety

XVII. Transformers

A. Classifications, purpose

B. Characteristics

C. Ratings, ratios

D. Loading, test temperature rise, short-time loads above ratings

E. Losses

F. Polyphase and single phase connections

G. Troubleshooting and repair

H. Transformer design

I. Schematics and symbols

J. Safety

XVIII. Wiring—residential and rural

A. Interior

B. Exterior (outdoor)

C. National Electric Code — city ordinances

D. REA regulations

E. Over-current protection

F. Low voltage wiring

G. Design of wiring installations

H. Schematics and symbols

I. Remote control circuits

J. Electric lighting
   1. Units of measurement
   2. Lamps, types: fluorescent, incandescent (filament), mercury vapor, sodium vapor, neon, ultraviolet

K. Types of wire, size, installation

L. Terminal connections

M. Cable joints

N. Switch classifications

O. Switchboards and switching gear

P. Troubleshooting and repair

Q. Safety

XIX. Appliance maintenance and repair

A. Preventive maintenance

B. UL Approval

C. Heat appliances

D. Other appliances

E. 110 volt, 220 volt appliances

F. Schematics and symbols

G. Safety

XX. Automatic controls

A. Connecting, operating, installation

B. Temperature, pressure, level control

C. Heating, refrigeration, ventilation, air conditioning

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drawing. It is also desirable to select as the front face the one involving circles (if there are any) or one of the larger faces of the object. Refer to Illustration Sheet 20, page 75.

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D. Schematics and symbols

E. Safety

XXI. DC generators and motors

A. Connection, operation, testing

B. Classification
   1. Series, shunt
   2. Compound, short and long shunt

C. Lap windings

D. Wave windings

E. Flat compound, over compounded, under-compounded generators

F. Generators, rating

G. Speed characteristics

H. Control devices

I. Torque characteristics

J. Field excitation

K. Schematics and symbols

L. Safety

XXII. AC generators, alternators, and motors

A. Generator classifications
   1. Synchronous alternators
   2. Induction alternators

B. Single phase alternators

C. Polyphase alternators

D. Exciters

E. Motor classifications

F. Torque characteristics

G. Classifications
   1. Speed
   2. Service

H. Starting currents

I. Efficiency

J. Braking

K. Control devices

L. Schematics and symbols

XXIII. Motor repair

A. Testing

B. Repairing

C. Overhauling

D. Schematics and symbols

E. Safety

XXIV. Introduction to industrial electronics

A. Maintenance

B. Troubleshooting procedures

C. Circuit analysis

D. Lighting controls

E. Time delay controls

F. Welding controls

G. Photoelectric controls

H. Capacitive controls

I. Counting systems

J. Dielectric heaters

K. Motor controls

L. Schematics and symbols

M. Safety

XXV. Other topics

A. Computer circuitry

B. Instrumentation circuitry

E

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Electronics (2-4 semesters)

I. History

- A. Chronological developments
  1. Major events
  2. Biographies
- B. Predictions

II. Occupational information

- A. Job opportunities, wage rates
- B. Post high school training
- C. The future

III. Related math

- A. Purpose
- B. Application

IV. Consumer knowledge

- A. Purchasing electrical products
  1. Evaluation
  2. Limits
  3. Economics
- B. Maintenance and repair
  1. Safety precautions
  2. Experience level
  3. Troubleshooting

V. Electrical safety

- A. Accident prevention
  1. School
  2. Home
  3. Corrective measures
- B. Electrical shock
  1. First aid
  2. Fire extinguishers
  3. Safety glasses

VI. Soldering and wiring or electrical and electronic circuits

- A. Composition
- B. Types
- C. Flux
- D. Repair and safety
- E. Procedures
- F. Circuits, printed
- G. Mechanical connectors
- H. Mounting integrated circuits and other components

VII. Schematic diagrams

- A. Symbols
- B. Reading
- C. Construction

VIII. Nature of electricity

- A. Static
- B. Current, A.C. and D.C.

IX. Magnetism

- A. Poles and fields
- B. Laws
- C. Earth's magnetism

X. Effects of current flow

- A. Thermal, luminous, chemical
- B. Magnetic effect
  1. Fields
  2. Electromagnetism
  3. Magnetic units
- C. Magnetic devices
  1. Meter movements
  2. Motors
  3. Generators
  4. Alternators

XI. Units of electrical measurements

- A. Basic measurements and use of test equipment

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B. Electrical power and energy

C. Mathematical concepts
   1. Scientific notation
   2. Ohm's law
   3. Metric system
   4. Vector
   5. Trigometric functions

XII. Sources of electromotive force

A. Chemical

B. Mechanical

C. Piezoelectric effect

D. Thermoelectric

E. Photoelectric

F. Solar

G. Nuclear

H. Static

XIII. Electrical circuits

A. Circuit media
   1. Solids
   2. Liquids
   3. Gases
   4. Vacuum

B. Circuits
   1. Series
   2. Parallel
   3. Series-parallel

XIV. Alternating current

A. Sine wave

B. Characteristics

C. Values of A.C. voltage

D. Vector analysis

E. Measurement

XV. Inductors

A. Coils and chokes

B. Transformers

C. Circuit design

D. Inductance

E. Counter EMF

F. Inductive reactance

XVI. Capacitors

A. Characteristics

B. Types

C. Circuit design

D. Capacitance

E. Capacitive Reactance

XVII. Resistance

A. Materials

B. Types

C. Circuit design

D. Color code

XVIII. Resonance

A. L-C circuits

B. L-R circuits

C. LCR series circuits

D. LCR parallel circuits

E. High and low pass filters

XIX. Vacuum tubes

A. Definition and purpose

B. Elements

C. Basing diagrams

D. Symbols

E. Diodes

E

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F. Triodes

G. Tetrodes

H. Pentodes

I. Nuvistors

J. Compactrons

K. Special purpose

L. Physical characteristics

M. Testing

XX. Electronic communications

A. Purpose and regulations of FCC

B. Block diagram

C. Modulation

D. Antennas
1. Transmitting
2. Receiving

E. One transistor transmitter-receiver

F. Detection

G. TRF (tuned radio frequency)

H. Super heterodyne

I. Types of receivers

J. Types of transmitters

K. Super-regeneration

L. Troubleshooting and repair

M. Microphones

N. Ham radio — citizens band — short wave
1. Theory
2. Use
3. Regulations
4. Code transmission
5. Single side band
6. Phone (voice transmission)
7. Transceivers
8. AM, FM, high and low band
9. Frequencies
10. Clubs

XXI. Introduction to radio

A. Wave motion

B. Types of waves

C. Frequency

D. Changing sound waves to impulses

E. Amplitude modulation

F. Microwaves

G. Block diagrams

H. Schematic diagrams

I. Troubleshooting and repair

J. Frequency modulation

XXII. Power supplies

A. Voltage requirements

B. Circuits uses

C. Rectifiers
1. Half-wave
2. Full-wave
3. Doublers

D. Filters

E. Regulators

F. Transformers

XXIII. Amplification

A. Voltage

B. Power

C. AF, RF, video

D. Class A, B, (AB, Ab_2) C

E. Coupling

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F. Biasing

G. Impedance matching

XXIV. Oscillator

A. L-C oscillators

B. R-C oscillators

C. Crystal

XXV. Semi-conductors

A. History

B. Basic theory

C. Amplification

D. Thermistor and varistor

E. Diodes, power and crystal

F. Transistors, basic

G. Comparison of tubes and transistors

H. Semi conductor circuits
1. Common emitter
2. Common base
3. Common collector

I. Current, resistance, voltage, and power gain

J. Operating charcteristics

K. Photo diodes, phototransistors

L. Rectifiers
1. Half
2. Full

M. Junction transistor, PNP, NPN, tetrode

N. Multi-vibrators

XXVI. Industrial electricity-electronics

A. Introduction — definition

B. Controls

C. Power applications

D. Automation

E. Electro-chemical applications

A. Transmission of signals

B. Reception of signals

C. Block and schematic diagram

D. Black and white TV

E. Color TV

F. Cathode ray tube

G. Controls

H. Frequency modulation

I. Schematic diagrams

XXVIII. FM radio — multiplexing

A. Definition

B. Advantages

C. Frequency modulation

D. Stereo effect

E. Record chambers

F. Record cutting and playback

G. Tape recorder

H. Tape recording and playback

I. Microphones

J. Speaker systems

XXIX. Computers

A. Introduction

B. Present use

C. Basic operation

D. Binomial system

E. Semiconductor switching

E

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F. Future uses

XXX. Integrated circuits

A. Introduction

B. Use

C. Manufacture

D. Chips

XXXI. Lasers, masers

A. Definition

B. Unit manufacture

C. Applications

XXXII. Areas for further study

A. Avionics

B. Space communication

C. Medical electronics

D. Ultrasonics

E. Nuclear electronics

F. Radar, sonar

G. Electrical discharge machine

H. Numerical machine control

XXXIII. Projects

A. Student experience

B. Use and value

C. Costs

SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purposes of illustration. Sources that pertain to electricity-electronics are included if specific material is not listed below. Additional information of a general nature may be found on page 48.

Miscellaneous Materials

- Pamphlet: "Dictionary of Electronic Terms," Allied Radio Corporation, 100 North Western Avenue, Chicago, Illinois 60612.

- Pamphlet: "Operation and Servicing of Dry Batteries," Burgess Battery Company, Division of Servel, Inc., Freeport, Illinois 61032.

- Pamphlet: "Handbook on Fuses," Bussman Manufacturing Company, Division of McGraw-Edison Company, University and Jefferson Streets, St. Louis, Missouri 63107.

- Pamphlet: "Magnetism and Electricity," Chrysler Corporation, Educational Service, Public Relations Dept., Box 1919, Detroit, Michigan.

- Wall Chart: "Capacitor Application Wall Chart," Cornell-Dubilier Electric Corporation, 333 Hamilton Avenue, South Plainfield, New Jersey 07080.

- Pamphlet: "Permanent Magnet Design," Crucible Steel Company of America, 3338 South Malt Avenue, Los Angeles, California 90022.

- Manual: "Career Guidance Manual," DeVry Technical Institute, 4141 Belmont Avenue, Chicago, Illinois 60641.

- Pamphlet: "How To Make a Demonstration Fuel Cell," Esso Research and Engineering Company, Box 45, Linden, New Jersey 07036.

- Pamphlets: "Adventures in Electronics" and "Edison and Electricity," General Electric Company, Educational Relations, Schenectady, New York.

- Pamphlet: "The Amazing World of Short Wave Listening," Halicrafters, Dept. 21, Chicago, Illinois.

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- Pamphlets: "Light for Living Outdoors" and "Residential Wiring Handbook," Indianapolis Power and Light Company, 25 Monument Circle, Box 1595, Indianapolis, Indiana 46204.

- Manual: "Electric Wiring and Modern Homemaking," National Adequate Wiring Bureau, Educational and Promotion Dept., 155 East 44th Street, New York, New York 10017.
- Manual: "Simplified Electric Wiring Handbook," and Calculator: Service Entrance Equipment Selector, Sears Roebuck and Company, 925 South Homan Avenue, Chicago, Illinois 60624.

- Pamphlet: "Portable Power Handbook. . .The Inside Story of Dry Batteries," Union Carbide Consumer Products Company, Division of Union Carbide Corporation, 30-20 Thomson Avenue, Long Island City, New York 11101.

- Booklet: "Planning a Career in Electronics," Electronic Industries Association, 2001 I Street, N.W., Washington, D.C. 20006.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.

- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.

- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.

- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.

- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Filmstrips

- FOMC, Filmstrip-of-the-Month Club, Inc., 255 Lexington Avenue, New York, New York 10016.

- The Filmstrip House, 25 Broad Street, New York, New York 10004.

- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.

- Life Film Strips, Time and Life Building, Rockefeller Center, New York, New York 10020.

- McGraw-Hill Text Films, 330 West 42nd Street, New York, New York 10036.

Motion Pictures

- General Electric Company, 1 River Road, Schenectady, New York 12306.

- McGraw-Hill Text Films, 330 West 42nd Street, New York, New York 10036.

Books

- *Basic Electricity (and an Introduction to Electronics)*, Engineering Staff, Howard W. Sams & Co., Inc., Bobbs-Merrill Co., Inc., Indianapolis, Indiana, 1960.

- *Basic Electronics,* (Second Edition), Bernard Grob, McGraw-Hill Book Co., New York, New York 10036, 1965.

- *Basic Electronics* Alfred A. Lease, Bruce Publishing Co., Milwaukee, Wisconsin, 1965.

- *Electricity,* Howard H. Gerrish, Goodheart-Willcox Co., Inc., Homewood, Illinois 60430, 1961.

- *Electricity & Electronics,* Howard H. Gerrish, Goodheart-Willcox Co., Inc., Homewood, Illinois 60430, 1964.

- *Electricity Electronics Dictionary* Howard H. Gerrish, Goodheart-Willcox Co., Inc., Homewood, Illinois 60430, 1966.

- *Electronics,* Howard H. Gerrish, Goodheart-Willcox Co., Inc., Homewood, Illinois 60430, 1961.

- *National Electrical Code Standard for Electrical Wiring Apparatus* (NBFU #70), National Board of Fire Underwriters, 222 West Adams Street, Chicago, Illinois 60606.
- *Understanding Electricity & Electronics,* Buban & Schmitt, McGraw-Hill Book Co., New York, New York 10036, 1962.

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TOOLS AND EQUIPMENT

The following list is presented as a guide in the selection of tools and equipment needed to teach electricity-electronics. The appropriate number of each item needed for a small, medium, or large number of students in an electricity-electronic unit shop is indicated as well as items needed to equip an electricity-electronics area of a general shop.

Basic Equipment for the Electricity-Electronics Area of a General Shop

	No. Needed
Equipment	
Cat's fur	1
Rubber rod	1
Glass rod	1
Silk cloth	1
Pith balls	6
Metal induction spheres	2
Laboratory permanent magnet set	1
Electro-magnetic materials	1
Tools	
Pliers, long nose, insulated handle	2
Pliers, diagonal oblique cutting, insulated handle	4
Pliers, 8" electrical side cutter, insulated handle	1
Soldering gun, 125 w	2
Soldering iron, electric 40 w	2
Wire gauge	1
Wire stripper	1
Miscellaneous hand tools from other areas can be used	
Instruments	
Volt-ohm-milliammeter, 20 k ohm/volt sensitivity	2
Galvanometer, 50-0-50	1
A.C. Ammeter, ranges 0-5, 0-30	1
D.C. Ammeter, ranges 3/5/30 amps	1
A.C. Voltmeter, ranges 50/100/200 volts	1
D.C. Voltmeter, ranges 1.5/15/150 volts	1
Power supply	
Variable Low voltage D.C. 0 to 50 volts	1
Variable Low voltage A.C. 0 to 50 volts	1
Batteries, $1^1/_2$V, 6V, 9V, 12V	1 ea.

Demonstration boards and mockups

Constructed or purchased as determined by instructor needs.

Basic Tools and Equipment for the Electricity-Electronics Unit Shop

	Class Size Small (8)	Medium (12)	Large (16)
Tools			
Alignment tools	2 sets	4 sets	8 sets
Allen screw key wrenches	1 set	1 set	1 set
Chassis punches, round	1 set	1 set	1 set
Chassis punches, square	1 set	1 set	1 set
Cold chisels	2	3	4
Combination square	2	4	6
Countersink, metal	1	2	2
Dial cable tool	1	1	1
Drill, electric $\frac{3}{8}$" capacity	1	2	2
Drills, high speed twist set ($\frac{1}{16}$"-$\frac{1}{2}$") $\frac{3}{8}$" shank	1	1	1
Drill press, 15"	1	1	1
Dividers, 6"	1	2	3
Files, assorted 8" set	1	2	3
File cards	2	3	4
Files, Swiss pattern set	1	1	1
Framing square	1	1	1
Fuse puller	1	2	2
Hack saw frame and blades	1	2	3
Hammer, 8 oz. ball peen	1	2	3
Hammer, electricians	1	1	1
Hammer, claw	1	1	1
Hydrometer	1	1	1
Hole saw set, $1\frac{1}{2}$"-$2\frac{1}{2}$"	1	1	1
Mallet, rawhide	1	2	4
Micrometer, 1" cap.	1	2	3
Mirror, inspection	1	2	4
Neon pocket test lamps	2	4	6
Pipe wrench, 8"	1	1	1
Pickup tool	1	2	3
Pincers, 10"	1	1	1
Pliers, channel lock	1	1	1
Pliers, long nose, insulated handle	8	12	16
Pliers, 8" electricians side cutter, insulated handles	1	1	2

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	Small (8)	Medium (12)	Large (16)
Pliers, combination, insulated handles	2	2	3
Pliers, diagonal oblique cutting, insulated handles	8	12	16
Pop rivit gun	1	1	1
Punches, center	2	3	3
Punches, chassis set ($\frac{1}{2}$"-$1\frac{1}{2}$" round)	1	1	1
Punches, chassis set ($\frac{5}{8}$"-1" square)	1	1	1
Romex stripper	1	2	3
Rules, 1', steel	1	2	3
Screwdriver, flexible	1	2	3
Screwdriver, stubby	1	2	3
Screwdriver, shockproof thin blade 6"	8	12	16
Screwdriver, shockproof thin blade 8"	1	2	2
Screwdriver, Phillips set	1	2	4
Screwdriver, Phillips offset	1	1	1
Slug retriever, 12"	1	1	1
Screwdriver, standard offset	1	1	1
Scriber	2	4	6
Snips, aviation cuts left	2	4	6
Snips, aviation cuts straight	2	4	6
Snips, aviation cuts right	2	4	6
Soldering aid tool	8	12	16
Soldering guns, 125W	2	6	8
Soldering iron, electric 100W	2	3	3
Soldering iron, electric 450W	1	1	1
Soldering iron, pencil 40W	8	12	16
Steel tape, 12'	1	1	1
Tap and die set (electricians)	1	1	1
Template fly cutter	1	1	1
Try square, 6"	3	6	9
Tube pin straightener	1	2	2
Tube puller	1 set	2 sets	3 sets
Vise, 4" machinist	4	6	8
Voltage tester, solenoid type	1	1	1
Wire gauge	1	1	1

	Small (8)	Medium (12)	Large (16)
Wire stripper	8	12	16
Wrenches, hex nutdriver sets	2	4	6
Wrenches, set open end, $\frac{1}{4}$"-$\frac{3}{4}$"	1	2	3
Solderless terminal kit and crimping tool	1	1	1
Cat's fur	1	1	1
Rubber rod	1	1	1
Glass rod	1	1	1
Silk cloth	1 sq.ft.	1 sq.ft.	1 sq.ft.
Pith balls	6	6	6
Metal induction spheres	2	2	2
Box and pan brake, 24"	1	1	1
Bench grinder, $\frac{1}{3}$ H.P., 2 wheels	1	1	1
Engine lathe, 10" swing	1	1	1
Metal shear, 18 gauge	1	1	1
Coil winder	1	1	1
Instruments			
A.F. single generator	5	7	9
Capacitor checker	1	1	1
Dynamic demonstrators			
A.C. ammeter	1	1	1
A.C. voltmeter	1	1	1
D.C. ammeter	1	1	1
D.C. voltmeter	1	1	1
Galvanometer	1	1	1
Ohmmeter	1	1	1
Wattmeter	1	1	1
Oscilloscopes 5"	3	6	9
Vacuum tube volt-ohm-milliammeter	5	10	15
Portable meter			
A.C. ammeter, ranges 0-30 amps.	8	12	16
D.C. ammeter, ranges 3/5/30 amps.	8	12	16
A.C. voltmeter, ranges 50/100/200 volts	8	12	16
D.C. voltmeter, ranges 1.5/15/150 volts	8	12	16
Galvanometers	5	7	9
Volt-ohm-milliameter, 20Kohm/volt sensitivity	5	10	15
R.F. signal generator, A.M. and F.M.	5	7	9

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	Class Size		
	Small (8)	Medium (12)	Large (16)
Transistor tester	1	1	2
Tube tester	1	1	2
Wheatstone bridge	1	1	1
Capacitor substitution box	1	2	2
Resistor substitution box	1	2	2
Magnets			
Laboratory permanent magnet set	1	1	1
Bar magnets	10	20	30
Ring magnets	2	3	4
Horse shoe magnets	5	10	15
Electro-magnet	1	1	1
Power supply			
Variable-low voltage D.C. 0-50 volts, 10 amps.	1	4	8
Variable-high voltage D.C. 0 to 400 volts, 1 amp.	1	4	8
Variable A.C. voltage 0 to 120 volts, 15 amps.	1	4	8
Battery eliminator 6-12 volt	1	1	2

Miscellaneous equipment

Armature growler
Alignment tools
Bearing puller
Conduit bender
Fish tape
Punches, pin type, set
Reamer, expandable set, $\frac{1}{4}$"-$\frac{3}{4}$"
Tachometer
Television analyzer
CRT tube tester and rejuvinator
Sine, square, and sawtooth wave generator
Dual trace oscilloscope
Battery charger
1. quick charger
2. trickle charger
Electro-plating equipment
Vector oscilloscope
Grinder
Jig saw
Drill press
Isolation transformers
Spot welder
In-circuit transistor checker
In-circuit capacitor checker
Commutator servicing equipment

SUPPLIERS OF TOOLS AND EQUIPMENT

- Aladdin Kits Company, 21011 Dequindre Road, Hazel Park, Michigan 48030. (Breadboard systems speed working testing circuits)
- Ariel David Manufacturing Company, 2975 South Second, West, Salt Lake City, Utah 84115. (Power supply)
- Broadhead-Garrett Company, 4560 East 71st Street, Cleveland, Ohio 44105. (Equipment and supplies, technical trainer equipment)
- Dede Tool and Die Company, 538 North 16th Street, Terre Haute, Indiana 47807. (Coil winding equipment)
- McKnight and McKnight Publishing Company, Dept. 301, Bloomington, Illinois 61701. (3E experimenter)
- Mid-West Shop Suppliers, 301 Jackson Street, Sioux City, Iowa 51101. (Equipment, training materials)
- Parent Metal Products, Inc., 6800 State Road, Philadelphia, Pennsylvania 19135. (Electrical benches)
- RCA Electronic Trainers Dept., Building 204-1, Camden, New Jersey 08101. (Electrical and electronic fundamentals, transistor fundamentals)
- Science Electronics, Inc., 195 Massachusetts Avenue, Cambridge, Massachusetts 02139. (Training equipment)
- Shallcross Manufacturing Company, Preston Street, Selma, North Carolina 27276. (Catalog—resistors, switches, resistance bridges, audio attenuators)
- Warner Electric Company, Inc., 1512 West Jarvis Avenue, Chicago, Illinois 60626. (Electroplating accessories)
- Xcelite Inc., 72 Bank Street, Orchard Park, New York 14127. (Tools)

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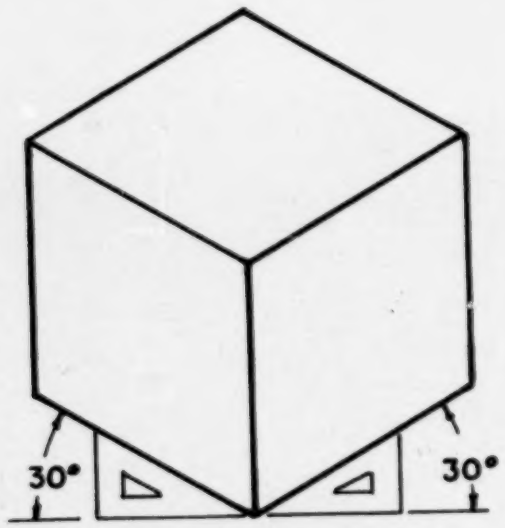

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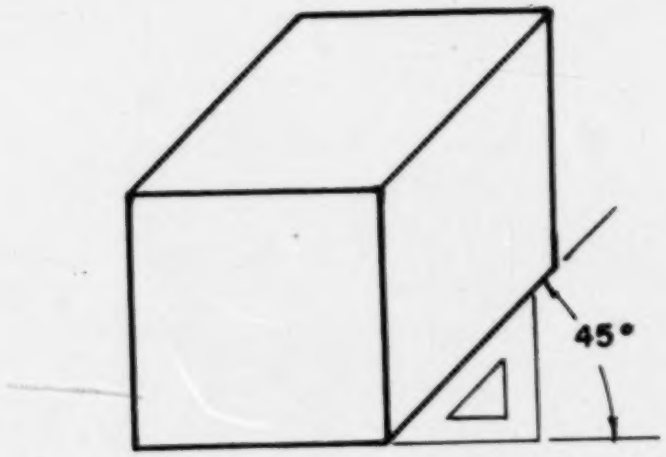

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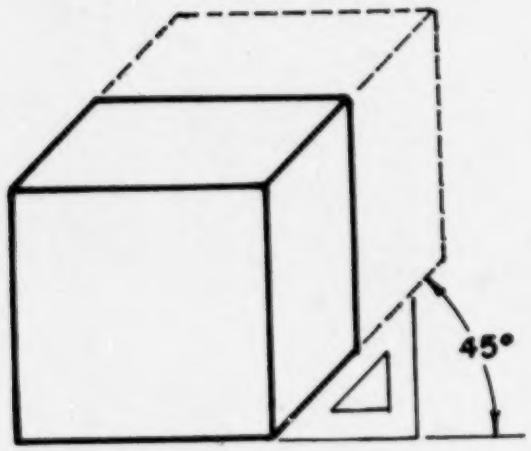

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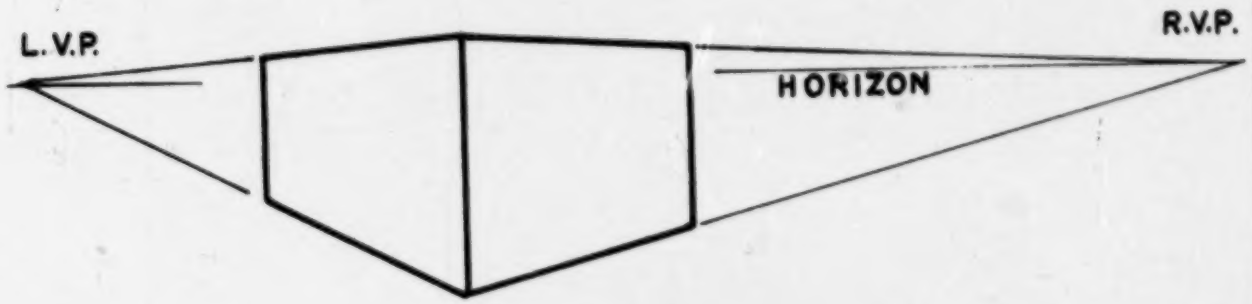

PERSPECTIVE

ILLUSTRATION SHEET 20.

1672

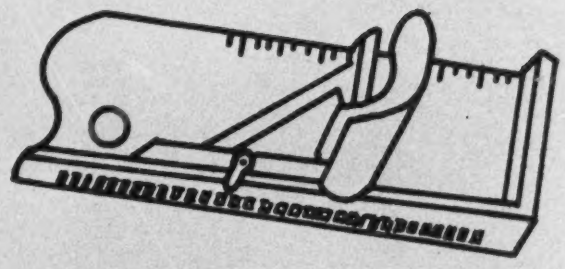

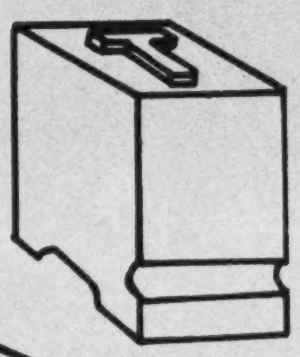

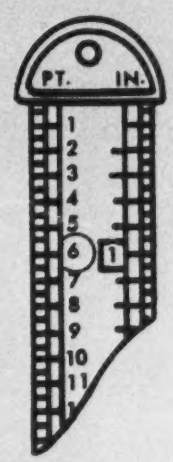

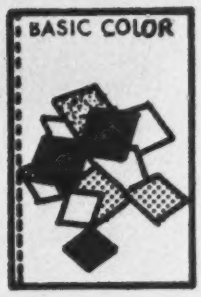

DEVELOPER

STOP BATH

FIXER

PRESSES

PLATEN

CYLINDER

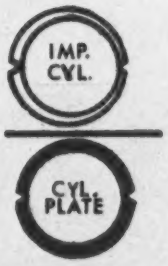

ROTARY

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Man's progress from primitive to present society has been largely dependent upon his ability to develop effective means of audio and visual communication. Graphic arts is concerned with the visual communications and is known as the preservative of the arts.

At the elementary level, such things as learning the alphabet, studying the printed work, making paper, binding a geography booklet, taking pictures with a pinhole camera, and studying the detailed engravings on postage stamps are appropriate graphic arts activities which are either of primary instructional importance or valuable for their enriching effect upon classroom instruction.

When possible, specific graphic arts courses should be started in the seventh grade and required for all boys. This is an appropriate and interesting area for girls, and they should be included if scheduling permits. Students at this level can develop proficiency in the skills of printing and duplicating processes using materials and equipment commonly found in a graphic arts shop.

Additional instruction in this area should be offered in the senior high school where at least two years of elective sequential course work should be available. Equipment and facilities adequate for such specialization must be provided. Course work at the senior high level, despite the high degree of proficiency attained by some students, should not be considered as training for earning a wage.

Graphic arts may make unique contributions to the industrial arts program by providing introductory experiences in many phases of visual communication in a laboratory setting. Here, proficiency in the skills of printing and duplicating processes can be developed using methods and equipment common to a graphic arts shop. The use of good English, applied mathematics, science, and design skills is required. Safety education is important in the teaching of every graphic arts operation, and special emphasis is placed on developing good safety habits. Students should be given the opportunity to develop original designs and a chance to modify existing work to meet their individual needs. Courses in this area are usually taught using the craftsman's approach. This allows each student to work on a suitable project at his own pace. However, such courses lend themselves to production work compatible with the instructional program and serve to acquaint students with modern industrial practice. Activities centered around research and experimentation should thrive on the increasing complexity of modern graphic arts techniques and the rapid advance of new reproduction methods.

Objectives

Every student should have the opportunity:

- To develop an awareness of the economic, historical, and social significance of the graphic arts.
- To develop an interest in and a knowledge of the mechanical principles, skills, and science underlying the graphic arts processes.
- To improve aesthetic appreciation and the integral techniques of planning and designing involved in the printing of a final product.
- To experience introductory activities in all the graphic arts areas.
- To develop an awareness of safety hazards peculiar to graphic arts and the importance of following good safety practices.
- To increase avocational interest in pursuing some phase of the graphic arts for pleasure.
- To develop the ability to recognize good design and workmanship and the ability to select, care for, and use printed materials wisely.
- To develop the habit of orderly, efficient, and complete performance of all tasks.
- To reinforce and extend academic skills in grammar, spelling, punctuation, composition, mathematics, and science by applying them in solution of specific problematic situations.
- To experience vocational guidance in the field of graphic arts.

Content

The following outline includes content which would be appropriate to teach in both junior and senior high school. It is presented in sequential order. The extent of class involvement with each unit is dependent upon the time allocated to graphic arts by the local schedule and the equipment available.

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Many good sources for appropriate student activities exist in textbooks and professional journals.

Graphic Arts for Junior High Schools (7-9)

I. History of printing

- A. Development of the alphabet
- B. Development of paper
- C. Early printing methods
- D. Invention of movable type
- E. Development of lithography
- F. Development of intaglio printing
- G. Development of screen printing
- H. Advancement of photography
- I. Development of printer's ink
- J. Beginning of copy reproduction

II. Study of basic processes

- A. Relief printing
- B. Planography (offset lithography)
- C. Stencil (silk screen)
- D. Intaglio (gravure)
- E. Electrostatics
- F. Bindery
- G. Photography

III. Design and layout

- A. Design principles
- B. Basic type styles
- C. Proper type selection and harmony
- D. Printing layouts
- E. Copy fitting

IV. Mathematics for printers

- A. Tools and equipment
- B. Printer's systems of measurement
- C. Measuring type
- D. Cutting paper
- E. Figuring quantity and spoilage allowance
- F. Figuring job costs
- G. Light principles
- H. Optics
- I. Exposure computations
- J. Labor and management
- K. Overhaul
- L. Machine time

V. Printing papers and inks

- A. Tools and equipment
- B. Papermaking in the classroom (Hammermill Kit)
- C. Basic sizes and weights of paper
- D. Kinds of paper
  1. Newsprint
  2. Bookpapers
  3. Writing papers
  4. Cardboards
  5. Cover papers
  6. Miscellaneous papers
- E. Printing inks
  1. Pigments
  2. Vehicles
  3. Driers
  4. Kinds of inks and special uses
  5. Fitting inks to substrate press
  6. Printing ink problems
  7. Ordering, estimating, and handling

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VI. Relief printing

A. Introduction to letterpress industry
   1. Importance of printing
   2. Design and layout
      a. Preparation of rough copy
      b. Thumbnail sketches
      c. Type faces
      d. Points and picas
      e. Spacing materials
   3. Hand composition
      a. Type cases
      b. Composing stick
      c. Line gauge
      d. Galley
      e. Chase
      f. Planer block
      g. Quoins
      h. Furniture
      i. Reglets
      j. Lockup
   4. Platen and pilot press
      a. Preventative machine maintenance
      b. Make-ready
      c. Press operation
      d. Press cleanup
   5. Hot type (three dimensional) composition
      a. Foundry type
      b. Monotype
      c. Linotype
      d. Intertype
      e. Ludlow
      f. Wood type
   6. Cold type (two dimensional) composition
      a. Photocopying printed work
      b. Mechanical composition
         (1) Clip art
         (2) Hand drawn lettering and art work
         (3) Pressure-sensitive (self-adhesive) copy
         (4) Tab-type lettering
         (5) Adhesive type
         (6) Transfer type
         (7) Typewriter (impact) composition
   7. Original and duplicate printing plates
      a. Electrotypes
      b. Engravings
      c. Bycril
      d. Plastic printing plates
      e. Duplicate printing plates
      f. Stereotypes
   8. Project planning and layout
   9. Project
   10. Safety

B. Linoleum block carving and printing
   1. Tools and equipment
   2. Materials
   3. Design and layout
   4. Project planning
   5. Project
   6. Safety

C. Rubber stamp printing
   1. Tools and equipment
   2. Materials
   3. Type setting
   4. Machine operation
   5. Project
   6. Mounting
   7. Safety

VI. Planography (offset-lithography)

A. Principles of lithographic printing

B. Copy preparation

C. Offset equipment

D. Direct image plates

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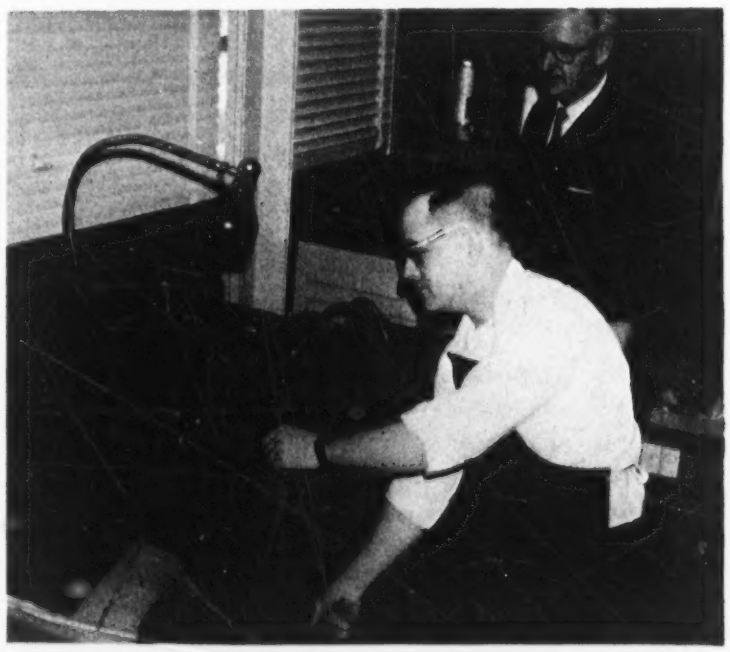

Operating an offset press.

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E. Make lithographic print

F. Production run

G. Safety

VII. Intaglio (gravure) printing

A. Tools, equipment, and supplies

B. Principles of gravure printing
1. Copper and steel engraving
2. Rotogravure printing
3. Collotype

C. Dry point etching in the classroom

D. Uses of dry point etched prints

E. Safety

VIII. Silk screen printing

A. Tools, equipment, and supplies

B. Principles of silk screen printing

C. Industrial uses of silk screen

D. Design and layout techniques

E. Cutting a stencil
1. Applying silk to a frame
2. Adhering to silk
3. Registry
4. Blockout
5. Inking
6. Making prints
7. Cleanup

F. Safety

IX. Bindery operations

A. Tools and equipment

B. Bindery supplies

C. Principles of binding
1. Saddle stitching
2. Side stitching
3. Binding post loose leaf
4. Mechanical plastic binding
5. Mechanical wire binding
6. Loom sewing
7. Ring binding
8. Padding

D. Paper cutting

E. Paper folding (collating)

F. Binding glues and adhesives

G. Book presses

H. Gold stamping

I. Marbling

J. Safety

Operating a folding machine.

X. Introduction to photography

A. Fundamentals of photographic cameras
1. Lenses
2. Camera bodies
3. Shutters
4. View finders
5. Aperature and shutter settings
6. Various cameras and their uses

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B. Photographic films and special uses

C. Photographic papers and special uses

D. Developing and fixing chemicals

E. Photographic printing processes

F. Making contact prints

G. Enlarging and projection printing

H. Preparation of slides

I. Color character of light filters and films

J. Color photography

K. Ultraviolet and infrared photography

L. Motion picture photography

M. Composition and better pictures

N. Portrait
   1. Outdoor
   2. Indoor

O. Copying, paper negatives, and microfilm photography

P. Principles of flash photography

Q. Laboratory experiments with fundamental processes

R. Safety

Graphic Arts for Senior High Schools (10-12)

I. Today's graphic arts industry and allied fields

A. Occupational opportunities
   1. Films
   2. Field trips to local industry

B. Practical work
   1. Composition
   2. Proofing
   3. Imposition
   4. Press work
   5. Auxiliary operations
      a. Perforating
      b. Scoring
      c. Slitting
      d. Numbering

C. Introduction to photography
   1. Lens
   2. Cameras
   3. Films
   4. Process work
      a. Line negatives
      b. Half-tone negatives

D. Introduction to offset-lithography
   1. Copy preparation
   2. Masking and stripping
   3. Plate making
   4. Presses
      a. Two-cylinder
      b. Three-cylinder

E. Photo stencil silk screen

F. Duplicating processes
   1. Mimeograph
      a. Stencils
      b. Paper
   2. Spirit
      a. Masters
      b. Paper

G. Safety

II. Practical problems in printing

A. Advertising (commercial art)
   1. Layout
   2. Design
   3. Color
   4. Copy preparation

B. Management
   1. Estimating
   2. Purchasing

C. A look at the future
   1. Electronics and computers
   2. Photostatic printing
   3. Letterset (dry offset)
   4. Web as opposed to sheet feeding

D. Occupational opportunities
   1. Skilled trades
   2. Management
   3. Education

E. Safety

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F. School production
   1. Forms
   2. Handbooks
   3. Play programs and tickets
   4. Athletic event programs

SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purposes of illustration. Sources that pertain to graphic arts are included if specific material is not listed below. Additional information of a general nature may be found on page 48.

Miscellaneous Materials

- Brochure: "Graphic Communications" (for the student)
- Booklet: "Graphic Communications" (for the administrator)
- Poster: "Graphic Communications, Not Just a Job — But a Career"
  Addressograph-Multigraph Corporation, 1200 Babbit Road, Cleveland, Ohio 44117.
- List: List of Printing and Graphic Arts Movies (free)
- Posters: Printing Education Week (free)
- Brochure: "Your Career in Printing and Graphic Arts" (free)
- Course of study: "Suggested Outlines for Courses of Study in Graphic Arts" ($1.50)

  International Graphic Arts Education Association, 1411 K Street, N.W., Washington, D.C. 20005.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.
- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.
- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.
- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.
- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Filmstrips

- *How To Build a Silk Screen Frame,* 46 frames, nearest university film library.

Motion Pictures

- *Printing Through the Ages,* (18 minutes, B&W), nearest university film library
- *Training To Set Type,* (15 minutes, B&W) nearest university film library.
- *Platen Press Make-ready,* (13 minutes B&W) nearest university film library
- *Fundamentals of Photography,* (28 minutes, B&W) nearest university film library
- *Blue Sky Thinking* (silk screen process, color) Vlano Products Company, 210 East 86th Street, New York, New York 10028

Books

- *Bookbinding Made Easy,* Lee M. Klinefelter, The Bruce Publishing Company, 400 North Broadway, Milwaukee, Wisconsin 53201, 1960.
- *General Bookbinding,* Chris Groneman, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1946.
- *General Printing,* Glen V. Cleeton and Charles W. Pitken, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1953. (Junior and Senior)

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- *Graphic Arts,* Darvey E. Carlson, Charles A. Bennett Company, 237 North Monroe Street, Peoria, Illinois 61602, 1958. (Junior and Senior)
- *Graphic Arts,* Frederick D. Kagy, Goodheart-Wilcox, 18250 Harwood, Homewood, Illinois 60430.
- *Graphic Arts Procedures,* R. Randolph Karch, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637, 1957. (Senior)
- *Linoleum Block Printing,* Francis J. Kafka, Taplinger Publishing Company, Inc., 119 West 57th Street, New York, New York 10019, 1953.
- *Photo-Offset Fundamentals,* John E. Cogoli, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1960.
- *A Practical Introduction to the Graphic Arts,* Hartley E. Jackson, McGraw-Hill Book Co., 330 West 42nd Street, New York, New York 10036, 1957.
- *Practical Photography,* Robert A. McCoy, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1959.
- *Silk Screen Printing,* James Eisenberg and Francis J. Kafka, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1957.

Magazines

- *Business Graphics,* Graphic Arts Publishing Company, 7373 North Lincoln Avenue, Chicago, Illinois 60646.
- *Graphic Arts Products News,* 6725 Sunset Boulevard, Los Angeles, California 90028.
- *Industrial Photography,* United Business Publications, 200 Madison Avenue, New York, New York 10016.
- *In-Plant Printer,* United Business Publications, Box 7307, Philadelphia, Pennsylvania 19101.
- *Printing Impressions,* Box 8161, Philadelphia, Pennsylvania 19101.
- *Printing Production,* Penton Building, Cleveland, Ohio 44113.
- *Reproduction Methods,* Box 14217, Annex Station, Cincinnati, Ohio 45214.
- *Visual Communications Instructor,* Syndicate Magazines, 25 West 45th Street, New York, New York 10036.

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EQUIPMENT

The following list is presented as a guide in the selection of tools and equipment. The approximate number of each item needed for a small, medium, or large number of students is indicated. The list is set up on a unit shop basis. If the graphic arts area of a general shop is to be set up, some of the items could be reduced to about 1/4 or 1/3 the number listed.

	Class Size		
	Small (10)	Medium (15)	Large (20)
Furniture			
Book case	1	1	1
Filing cabinets	1	1	2
Drafting table	1	1	1
Metal cabinet for combustibles	1	1	1
Refrigerator	1	1	1

	Class Size		
Equipment	Small (10)	Medium (15)	Large (20)
Letter press			
Pilot press, hand operated with combination press stand and cabinet	1	1	2
Proof press and stand	1	1	1
Double type case bank	1	1	2
Imposing stone with galley rack underneath	1	1	1
10 point century old style type	1	2	3
12 point century old style type	1	2	3
18 point century old style type	1	2	3
24 point century old style type	1	1	2

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	Class Size		
	Small (10)	Medium (15)	Large (20)
36 point century old style type	1	1	2
10 point century old style bold type	1	2	3
Furniture, wood	1	2	2
Furniture, metal	1	1	2
Pica rules	3	6	6
Chase	2	4	6
Quoins and quoin key	4 pr.	10 pr.	10 pr.
Ink knife	1	1	2
Leads and slugs with rack	1	1	1
1 point rules	2	2	4
Brayer	1	1	1
Wood mallet	1	1	1
Paper knife	1	1	1
Paper cutter		1	1
Proof planer	1	1	2
Waste container (oily rags)	1	1	1
Benzine can	1	1	1
Gasoline safety can	1	1	1
Fire extinguisher	1	1	1
Composing sticks	2	3	6
Galleys	4	8	12
Photography			
Process camera	1	1	1
Camera — flash attachment	1	1	2
Safe lights	2	4	4
Light meter	1	1	2
Flood light	2	4	8
Enlarger	1	2	4
Print dryer (rotary drum)	1	1	2
Electric chemical mixer		1	1
1 gal. stainless steel mixing container	1	1	2
32 oz. stainless steel mixing pitcher	1	1	2
Developing tank	5	8	10
Developing tray	5	8	10
Contact printer	1	2	2
Timer	2	2	2
Thermometer	2	4	6
Funnel	3	6	6
16 oz. graduate	2	2	4
8 oz. graduate	2	4	6
Print roller	1	1	1
Tongs	6	9	12
Rubber gloves	1 pr.	1 pr.	1 pr.
Rubber apron	1	1	1
Stirring rod	3	3	6
Bookbinding			
Trimming shelf	1	1	1
Drilling jig	1	1	1
Drilling backstop	1	1	1
Back rounding metals	2	2	2
Sewing frame and board	1	1	1
Bookbinding vise	1	1	1
Hand drill	1	1	1
Bookbinding bench	1	1	1
Press, hand screw	1	1	1
Offset			
Stone, lithograph	1	1	1
Press	1	1	2
Light tables	1	2	3
Electric typewriter (for setting type)	1	1	1
Photographic strip printer	1	1	1
Platemaker	1	1	1
Paper drill		1	1
Folding machine		1	1
Foot stapler	1	1	1
Collator			1
1 gal. gas safety can	1	2	2
1 gal. mixing beaker	1	1	1
Drawing boards	2	4	6
T squares	2	4	6
Silk screen			
Drying rack	1	1	1
Silk screen frames	2	4	6
Squeeges	2	2	3
Brush	1	1	1
Stencil knives	2	2	3
Linoleum block			
Bench hook	1	1	1
Carving tool set	1	1	1

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SUPPLIERS OF TOOLS AND EQUIPMENT

- Basic Crafts Company, 312 East 23rd Street, New York, New York 10010. (book binding)
- Brown Manufacturing Company, 2000 Dempster Street, Evanston, Illinois 60204. (process cameras)
- Challenge Machinery Company, 1433 Fulton Street, Grand Haven, Michigan 40417. (presses)
- Eastman Kodak Company, 343 State Street, Rochester, New York 14650.
- G. A. Pratt Co., 1108 West Chicago Avenue, East Chicago, Indiana 46312. (rubber stamp)
- Hamilton Manufacturing Company, Two Rivers, Wisconsin 54221. (type cabinets, imposing tables)
- H. B. Rouse and Company, 2214 North Wayne Avenue, Chicago, Illinois 60614.
- Martin Driscol and Company, 777 North Merrimac Avenue, Miles, Illinois 60648.
- NuArc Company, 4100 West Grand Avenue, Chicago, Illinois 60651. (process cameras, light tables, platemakers)
- Ulano Products Company, 210 East 86th Street, New York, New York 10028. (silk screen)

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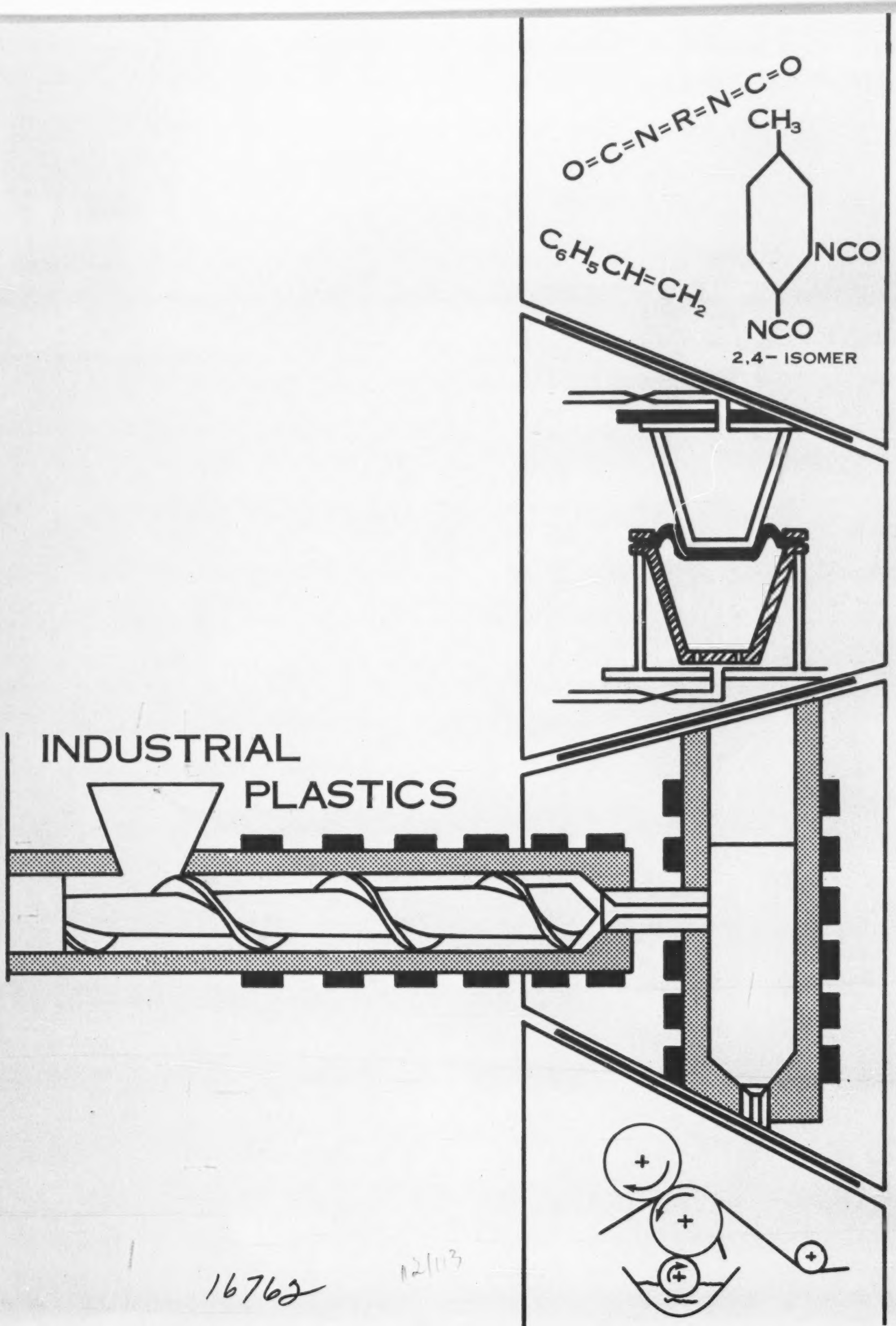
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INDUSTRIAL
PLASTICS

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Plastics is an industry evolving at a rate seldom experienced by other industries. It is out of necessity to meet the needs of our demanding social and technological societies that this is true. Because of its astounding rate of change few industrial arts teachers have realized the necessity of teaching this rapidly emerging discipline.

Plastics as discussed here is not to be confused with craft plastics activities of sawing, filing, buffing, and internal carving, which has been taught for years in many Iowa schools. Plastics is an intriguing and cardinal component of industry, and it is most important that students know something of the industry and manufacturing methods common to it.

A variety of activities utilizing plastic materials may be carried on at the elementary level and could lead to an investigation of the plastic industry — how man has supplemented traditional materials provided by nature. Classroom activity can be enriched as learners become involved with and knowledgeable about plastics, the material we all use but know so little about.

If time permits, specific course work in this exciting area should be taught at the junior high school level. There is more than enough subject material to offer work here and at the senior high school level, too. A certain amount of makeshift equipment can be developed by the teacher or students under the teacher's supervision, but an increasing amount of specialized equipment is being produced commercially. Instruction can be provided in a general shop or a unit wood shop if space for the specialized equipment is available. As additional specialized equipment is acquired, it may be desirable to set up a special unit shop for industrial plastics.

This area is well suited for the utilization of mathematical and scientific principles, since the material itself is man-made. This is true in the development of equipment; but, even if such activity is not pursued, the development of various forms and molds and the study of the chemistry of synthetic materials provides considerable opportunity for introducing mathematics and science, and originality as well. The heat that is involved in many industrial plastics operations requires that emphasis be placed on the development of good safety habits. Courses in this area provide ample opportunity to use group projects, problem solving, and mass production as well as the traditional approach of each student's working on a suitable project at his own pace.

Objectives

Every student should have the opportunity:

- To understand the present status and vast potential of plastics in our society.
- To develop a degree of familiarity with the kinds, composition, and characteristics of plastics.
- To know the industrial processes employed to form and fabricate plastic materials into functional items.
- To learn to select suitable plastic materials for given uses and forming techniques.
- To learn to use plastic forming machines and equipment properly.
- To learn to plan and construct limited dies and molds for molding, forming, and fabricating plastics.

Content

It is recognized that sequence of instruction and extent of student involvement may be modified by local conditions. The suggested content is presented as a guide only. How this or other information is presented is the responsibility of the individual instructor. No effort has been made to specify levels of content. One or more complete courses in this important area at several different levels may be designed from the following outline. Many good sources for student activities are included in textbooks and professional journals. For illustrative purposes, some useful activities are included and are illustrated for quick reference.

I. Introduction

A. Development of the plastics industry

B. Applications of plastics products
1. Construction
2. Transportation
3. Forming
4. Aerospace
5. Home consumer products

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C. Classification and identification of plastics
   1. Common plastics
   2. Engineering plastics

Activities

- Tabulate the use of plastics.
- Identify and classify common plastic items.

II. Molding

A. Injection molding
   1. Historical development
   2. Machine components and their functions
   3. Industrial considerations
   4. Principles of operation

B. Extrusion
   1. Historical development
   2. Machine components and their functions
   3. Industrial considerations
   4. Principles of operation

C. Blow molding
   1. Historical development
   2. Machine components and their functions
   3. Industrial considerations
   4. Principles of operation

D. Compression molding
   1. Historical development
   2. Machine components and their functions
   3. Industrial considerations
   4. Principles of operation

E. Transfer molding
   1. Historical development
   2. Machine components and their functions
   3. Industrial considerations
   4. Principles of operation

F. Rotational molding of powdered polyethylene
   1. Historical development
   2. Machine components and their functions
   3. Industrial considerations
   4. Principles of operation

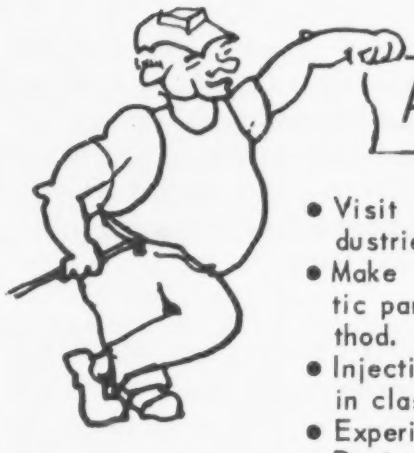

Activities

- Visit plastics molding industries.
- Make a collection of plastic parts molded by each method.
- Injection mold plastic objects in class.
- Experiment with color mixing.
- Design and construct a unit to do extrusion on an injection molder.
- Extrude plastic materials.
- Blow mold an article from stock plastic tubing.
- Compression mold an object.
- Rotational mold an article of powdered polyethylene.
- Evaluate and compare various molded objects.
- Compare and contrast various molding processes.

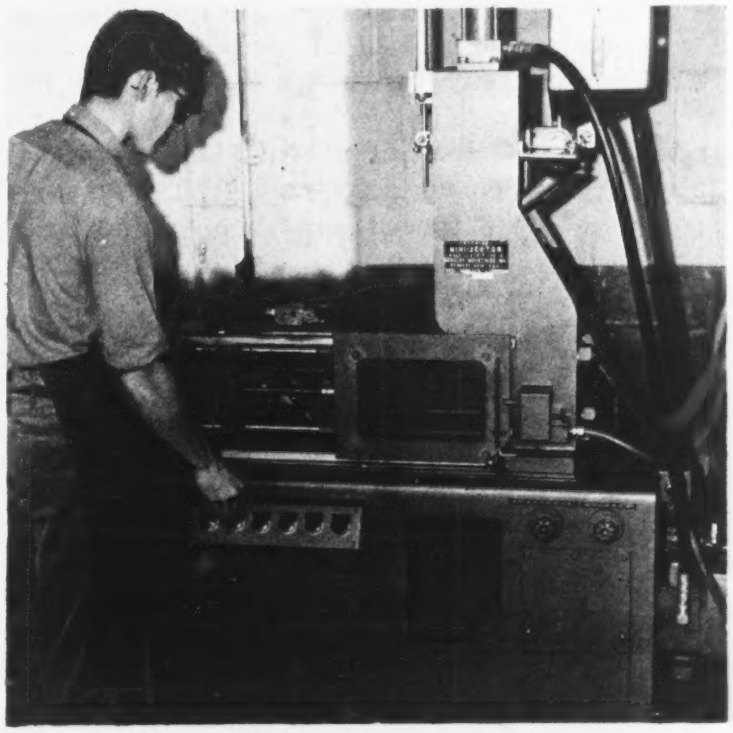

Plastic injection molding machine.

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III. Thermoforming

A. Methods
   1. Vacuum cavity forming
   2. Drape vacuum forming
   3. Vacuum snap-back forming
   4. Plug and ring forming
   5. Air pressure forming
   6. Matched mold forming
   7. Mechanical stretch forming
   8. Combination of vacuum and pressure forming

B. Scientific principles involved

C. Applications

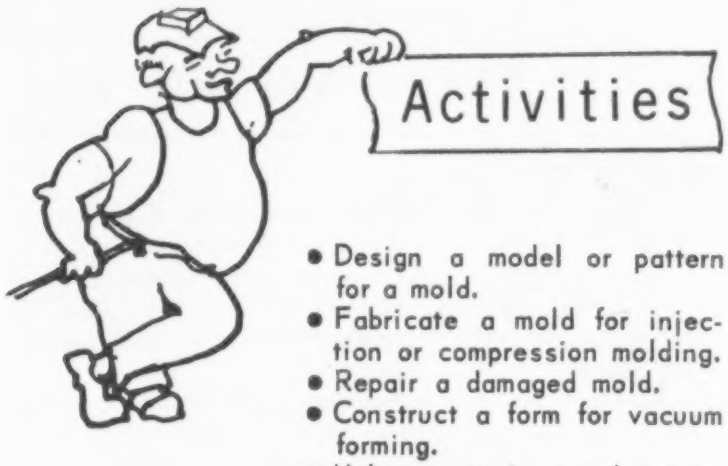

- Design a model or pattern for a mold.
- Fabricate a mold for injection or compression molding.
- Repair a damaged mold.
- Construct a form for vacuum forming.
- Make a one-piece and a two-piece mold by using elastomers.

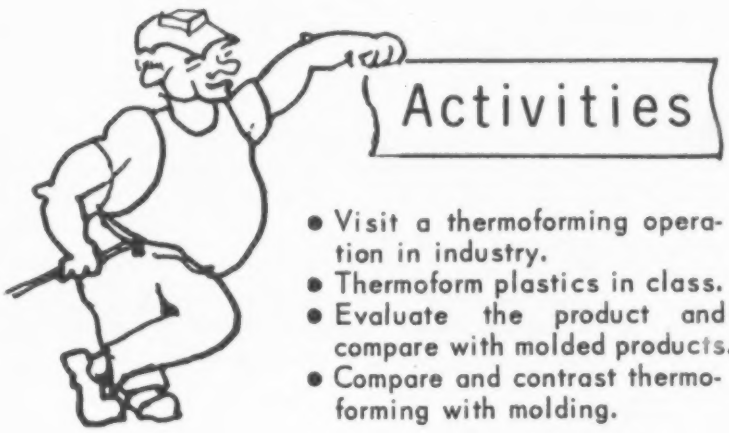

- Visit a thermoforming operation in industry.
- Thermoform plastics in class.
- Evaluate the product and compare with molded products.
- Compare and contrast thermoforming with molding.

IV. Moldmaking and form construction

A. Moldmaking
   1. Mold design
   2. Moldmaking materials
      a. Gypsum cement
      b. Metal filled epoxy
      c. Metal molds
   3. Methods of moldmaking

B. Form construction
   1. Designing forms
   2. Methods of construction

C. Elastomers
   1. General characteristics of elastomers
   2. Specific elastomers
   3. Uses of elastomers
   4. Moldmaking with RTV materials

V. Bonding

A. Welding and cementing

   1. Cohesive bonding
      a. Welding of thermoplastics — common joints, application methods, and technical considerations in each of the following
         (1) Hot gas welding
         (2) Heated tool welding
         (3) Friction welding
         (4) High frequency welding
         (5) Ultrasonic welding
      b. Solvent cementing — common joints, application methods, and technical considerations.
         (1) Solvent cement
         (2) Dope cement

   2. Adhesive bonding — common joint, application methods, and technical considerations
      a. Monometic cements
      b. Polymerizable cements

B. Methods of heat sealing

   1. Electrical resistance sealing
   2. High frequency sealing
   3. Ultrasonic generation
   4. Heat shrinking

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Activities

- Experiment with the various types of welding processes.
- Observe and determine the method of bonding used to fabricate various plastic objects.
- Arrange a project using welding as a process.
- Experiment with heat selin
- Experiment with heat sealing on various plastic films.
- Make a kite using plastic film which can be heat sealed.

VI. Laminates

A. Reinforced plastics
   1. Development of reinforced plastics
   2. Characteristics of reinforced plastics
   3. Material used in reinforced plastics
   4. Techniques of fabricating

B. Low pressure laminates
   1. Heat laminating
   2. Pressure sensitive laminating

C. High pressure laminates
   1. Structural types
   2. Materials
      a. Non-plastic
      b. Resins
   3. Machines and equipment
   4. Laminating process

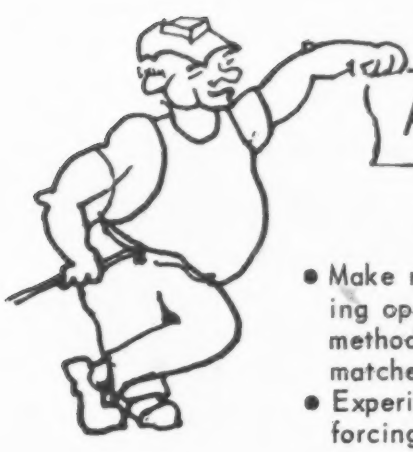

Activities

- Make reinforced items by using open molds, pressure bag method, and male and female matched molds.
- Experiment with various reinforcing materials.
- Visit an industry which produces reinforced plastic objects.
- Laminate social security card and other cards.
- Laminate plastics to other materials.
- Develop a chart of heat ranges for laminating various plastics.
- Compare high pressure laminates with finished wood samples.
- Make a high pressure laminate circuit board.
- Experiment with different resins and fillers.

VII. Encapsulation

A. Embedding

B. Casting

Activities

- Experiment with different resins, catalysts and cure cycles.

VIII. Foams

A. Expandable polystyrene beads
   1. Polystyrene chemistry
   2. Processing techniques
   3. Applications
   4. Molding procedures

B. Expandable polyurethane resin
   1. The process
      a. Open cell
      b. Closed cell
      c. Foaming and blowing agent
      d. Uniformity of cells
   2. Urethane foam characteristics
   3. Procedure

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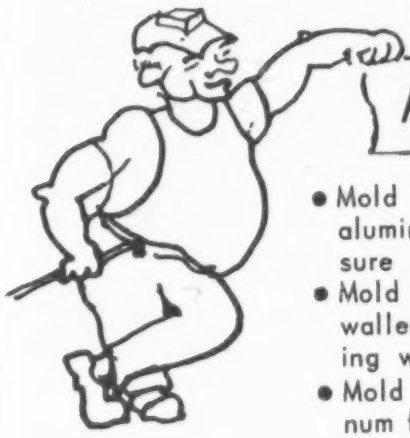

Activities

- Mold bead foam in a cast aluminum mold using a pressure cooker.
- Mold bead foam in a thin-walled mold immersed in boiling water.
- Mold bead foam in an aluminum foil mold using a radiant source.
- Mold coasters for glasses, thermos-type bottles, and swimming pool bouy with expandable resin foam.

IX. Coatings

A. Definitions and purposes of coating

B. Plastic coating resins

C. Basic coating processes
1. Painting
2. Dipping (hot and cold)
3. Fluidized bed coating
4. Vacuum metallizing
5. Electroplating
6. Silk screening
7. Calendering
8. Flame spraying
9. Extrusion coating

D. Techniques for
1. Cold dipping
2. Hot dipping
3. Fluidized bed
4. Electroplating

Activities

- Dip coat an object by the hot and cold process.
- Experiment with variations of temperature.
- Make a display of vacuum metallized parts.
- Compare electroplated samples with vacuum metallized products.
- Electroplate ABS plastic products.

X. Vinyl dispersion-thermofusion

A. Vinyl dispersion
1. Materials used
2. Types of castings
3. Mold considerations
4. Molding process
5. Applications
6. Industrial considerations

B. Thermofusion molding
1. Molding procedures
2. Mold preparation
3. Industrial and consumer considerations

C. Rotational molding of vinyl dispersion
1. Preparation of the mold
2. Molding
3. Curing

Activities

- Slush mold an article.
- Make articles by the thermofusion molding process.
- Mold an article by rotational molding process.

XI. Decorating

A. Decorating, coloring, and finishing
1. Coloring
   a. Definition of colorant
   b. Three general types of colorants
2. Decorating
   a. Inlaying
   b. Printing
   c. Embossing, engraving, decalcomania
3. Finishing
   a. Sanding, buffing, polishing
   b. Air blasting and etching
   c. Deflashing — with and without air

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d. Chemical solvent
e. Flame polishing

B. Hot foil stamping
1. Description
2. Equipment, set-up and operation

XII. Materials

A. Testing plastic materials
1. Mechanical tests
a. Purpose
b. Strength
2. Permanence properties tests
a. Dimensional stability tests
b. Weathering tests
c. Effects of radiation
d. Moisture resistance
e. Effects of molded stresses
3. Thermal properties tests
4. Burning tests
5. Specific gravity tests

B. Plastics chemistry
1. Historical origin
2. Families of plastics
3. Branches of chemistry
4. Thermoplastics
5. Thermoset plastics

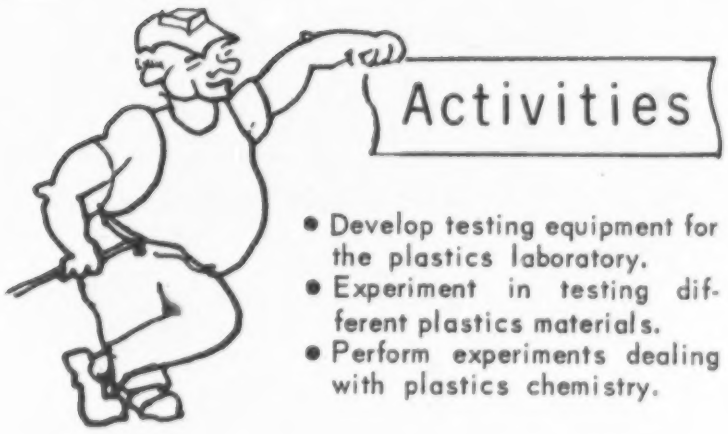

XIII. Guidance — occupational opportunities in plastics

A. General employment outlook

B. Wage consideration

C. Working conditions

D. Education and training

E. Plant locations

F. Future of the industry

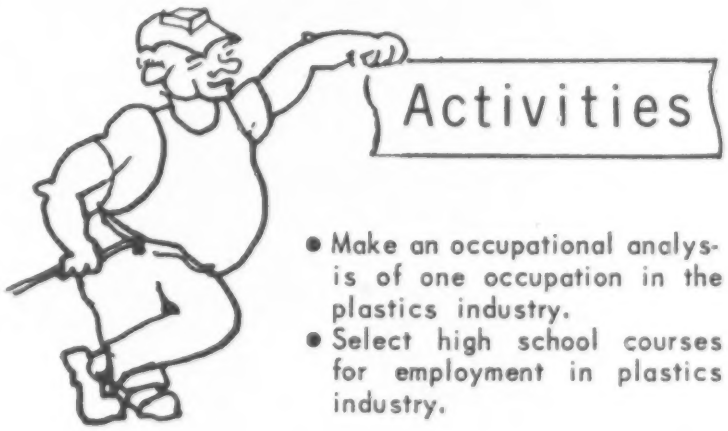

SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purpose of illustration. Sources that pertain to industrial plastics are included if specific material is not listed below. Additional useful information of a general nature may be found on page 48.

Miscellaneous Materials

- Booklets: "Forming of Large Area, Deep Drawn Parts," and "Injection Molding Technology Fundamentals," Dow Chemical Company, Plastics Dept., Midland, Michigan 48640.

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- Chart: "How We Get Our Plastics," Hinchman Manufacturing Company, Inc., 259 East First Avenue, Roselle, New Jersey 07203.

- Booklets: "The Fundamentals of Blow Molding," "Fundamentals of Thermoplastic Extrusion," "Injection Molding," and "Production Techniques for Vacuum Forming," Monsanto Company, Hydrocarbons and Polymer Division, 800 North Lindbergh Boulevard, St. Louis, Missouri 63166.

- Booklet: "Plexiglass Design and Fabrication Data," Rohm and Haas Company, Plastics Dept., Philadelphia, Pennsylvania 19105, revised 1964.

- Booklet: "Plastics Engineering Handbook," Third edition, Society of the Plastics Industry, Inc., Reinhold Publishing Corporation, 430 Park Avenue, New York, New York 10022, 1960.

- Booklet: "The Story of the Plastics Industry," The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017.

- Leaflet: "Trade Publications and Books Pertaining to the Plastics Industry — A Partial List," The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017.

- Resource Unit: "An Experimental Resource Unit in Plastics for Industrial Arts," University of the State of New York, Albany, New York 12203, 1966.

- Catalog: Film Catalog of the Plastics Industry, The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.

- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.

- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.

- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.

- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Motion Pictures

- *Plastics: Industrial Processes and Products,* (24 minutes, sound/color, correlated with *Plastics Technology,* by Robert S. Swanson). Price $200 from Stout State University, Menomonie, Wisconsin 54751. May be available for rental from nearest university film library.

Books

- *Introduction to Plastics,* Lionel K. Arnold, The Iowa State University Press, Ames, Iowa 50010, 1968.

- *Plastics,* Harry J. DuBois, Reinhold Publishing Corporation, 430 Park Avenue, New York, New York 10022, 1968.

- *Plastics Technology,* Robert S. Swanson, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1965.

Magazines

- *Machine Design,* Plastics-Reference Issue, Penton Building, Cleveland, Ohio 44113, June 16, 1966.

- *Modern Plastics Magazine,* 1301 Avenue of the Americas, New York, New York 10019, monthly publication.

EQUIPMENT

It is assumed that industrial plastics will be taught in a wood or general shop that is reasonably well equipped. Additional special equipment that may be required is included in the following list.

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	No. Needed
Basic Equipment	
Balance	1
Compression/laminating press; 12 ton capacity or larger	1
Electric oven, 26"x 20"x 20" or larger	1
Electroplating unit, 5 amp. or larger	1
Heat sealer	1
Hot stamping machine	1
Injection molding machine, $\frac{1}{5}$ oz. or larger	1
Mold blank for molding machine	6
Plastics welding unit	1
Pressure cooker, 10 qt. or larger	1
Surface pyrometer 50°-600° range	1
Vacuum, pressure and mechanical former with heating unit, material clamping device, and vacuum and pressure sources, 18"x 18" or larger	1
Enrichment Equipment	
Blow molding attachment for extruder	1
Extruder, laboratory type, $\frac{3}{4}$" screw or larger	1
Materials tester — tensile, compression, shear	1
Rotational molding machine	1
Spray gun equipment	1

SUPPLIERS OF TOOLS AND EQUIPMENT

- Broadhead-Garrett Company, 4560 East 71st Street, Cleveland, Ohio 44106.
- Cope Plastics, Highway 100, Godfrey, Illinois 62035.
- Industrial Arts Supply Company, 1408 West Lake Street, Minneapolis, Minnesota 55408.
- Satterlee Company, 2200 East Franklin, Minneapolis, Minnesota 55404.

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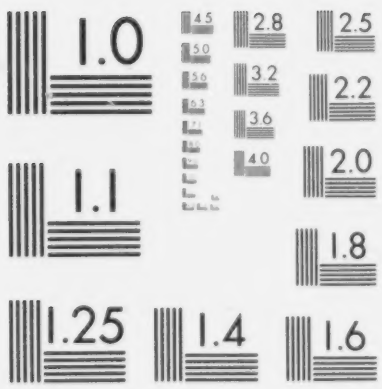

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

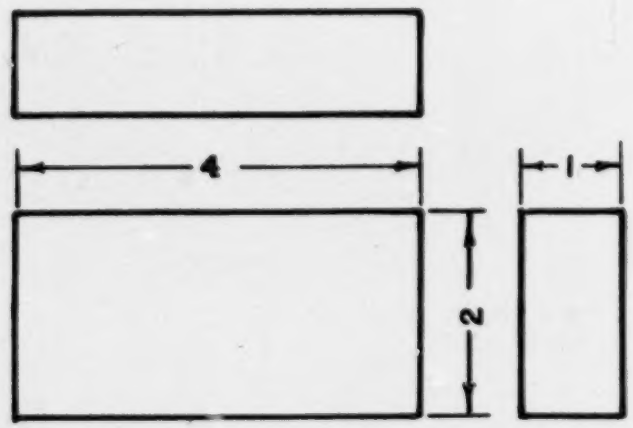

VISE BLOCK W.S. 43.

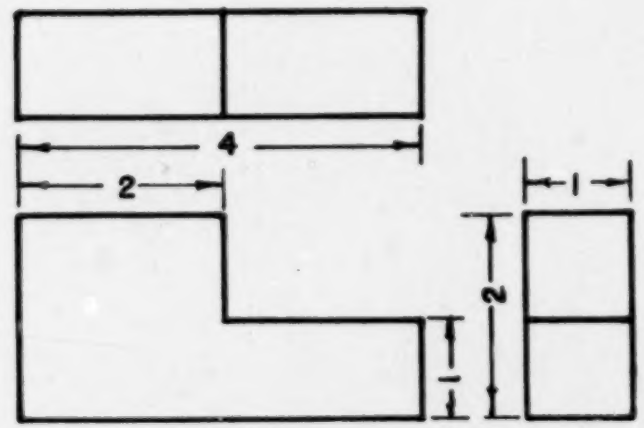

STEP W.S. 44.

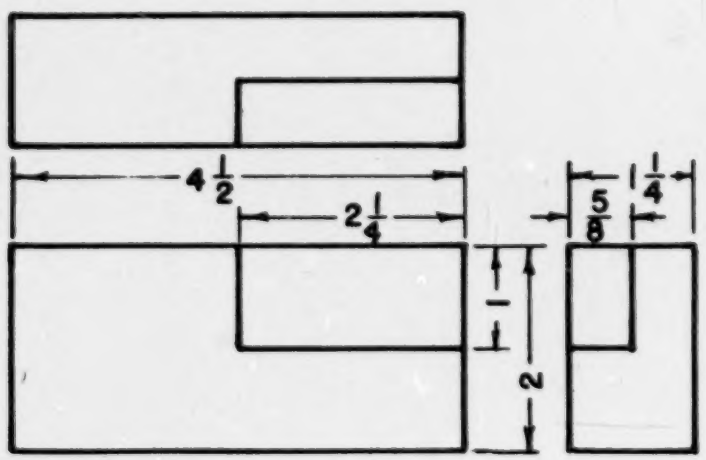

ENCLOSED STEP W.S. 45.

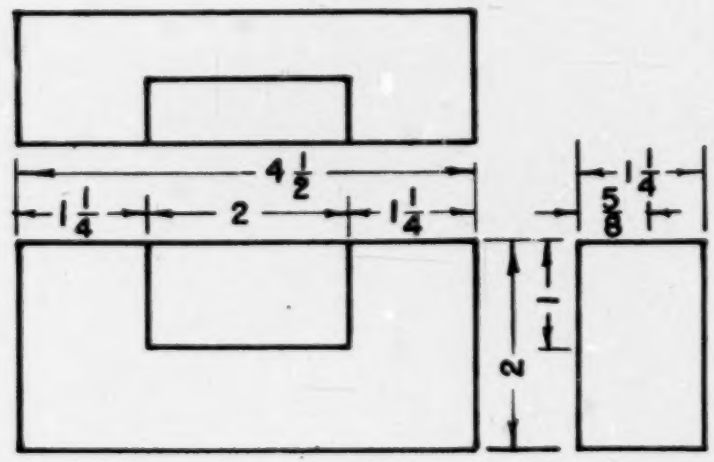

ANGLE STEP W.S. 46.

ILLUSTRATION SHEET 22.

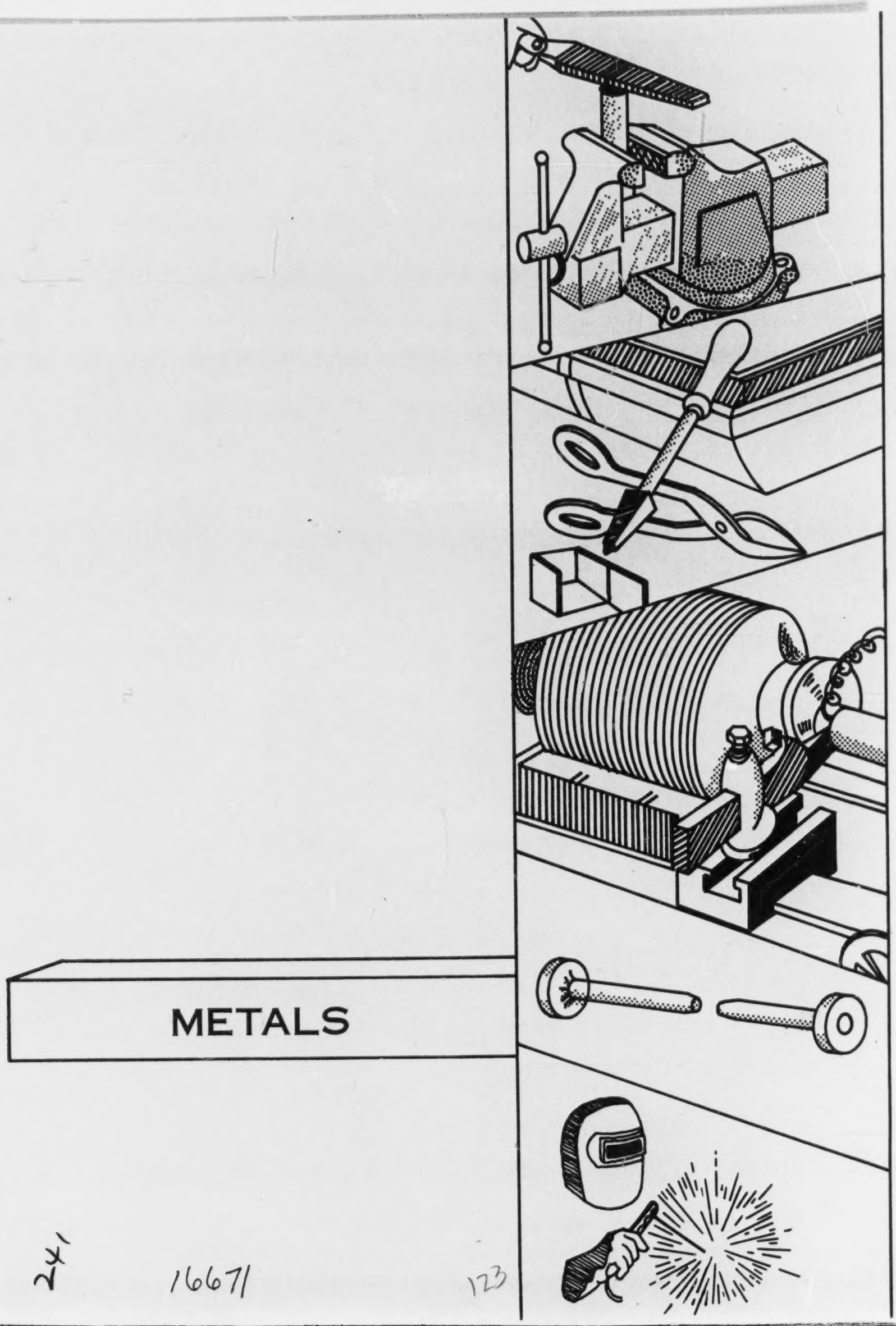

METALS

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The various fields of metal have played an important role in the development of our present civilization. Today, millions of people are employed in the metal industries. The products they produce influence the lives of every individual.

The study of metal and its contribution to the progress of man and the strength of the nation is appropriate at the elementary level.

Metals is a vital area in the junior high school industrial arts program. Here, students should acquire skill and knowledge in the basic processes and uses of metals. A knowledge of industrial applications of metal processes and an appreciation of safe practices in metal work should be developed. The student should also gain an understanding of some of the occupational opportunities and requirements for employment in the metal trades and industrial fields. They should catch a glimpse of the exciting activity that can be pursued if they elect to take additional work in this area in senior high school.

At least two years of sequential course work in metals should be available in the senior high school. Semester length courses in certain areas such as foundry, welding, and sheet metal and a full year course in machine metals may be taught in addition to a basic course in general metals. Equipment and facilities adequate for some specialization must be provided. Course work at this level, despite the high degree of proficiency attained by some students, should not be considered as training for earning a wage.

The metals area is potentially rich in opportunities for students to apply scientific and mathematical principles. Students deficient in reading ability are often motivated to improve in this area when they find that technical papers contain answers to problems they long to solve. Writing skills can also improve as students seek to record information they have struggled to find. Safety education is of critical importance in most of the work done in metals and should be emphasized accordingly. The opportunity to develop original designs exists in a number of the metals areas. Individual manipulative activity of many kinds (projects, exercises, shop experiments) as well as group projects, mass production, and other newer approaches can all be utilized to good advantage in this important subject-matter area.

A reference library is vital to the comprehensive shop.

Metals for Junior High School (7-9)

Metals is indeed an important activity in the junior high school industrial arts program. The program should be planned to meet student needs and should be undergirded with adequate facilities, instruction, and time.

The first course (or unit) in metals should be devoted to developing fundamental concepts. It is important that a number of different areas be explored rather than attempting to develop a high degree of skill or depth of knowledge in a single area. Students should have a minimum of 25 class periods (five weeks) of instruction before completing junior high school. If time permits, as many as 105 class periods (21 weeks) or more could be spent profitably in junior high school metals.

The order of units in this outline is not intended to interfere with flexibility in the sequence of presentation. Likewise the extent of class involvement with each area may vary somewhat depending on individual circumstances. In many instances facilities will dictate that several shop activities be pursued at the same time. It is hoped that the teacher will supplement this material to keep pace with the changing conditions of our industrial society and the needs of his students.

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Objectives. Every student should have the opportunity:

- To have experiences which will assist in planning of future educational and occupational pursuits.
- To acquire an understanding of the occupational opportunities in the metal industries.
- To gain knowledge of industrial processes related to the metalworking industry.
- To acquire skill in the basic use of the common tools in metals.

Content. Areas of metals should be divided into two categories — major and minor. The major areas should include foundry, oxyacetylene and electric welding, sheetmetal, and machine metal. Bench metal, metal spinning, and forging and heat treating are considered minor areas. The areas which are included in a junior high school program will depend on the grade level at which metal is taught and the amount of time devoted to this subject. A broad program in which the student has fundamental experiences in as many of the areas as possible is preferable to a program which encompasses only one or possibly two areas.

It seems reasonable to assume that this guide encompasses more than five weeks of study, particularly if it involves grades seven, eight, and nine. The teacher should recognize this as a guide and draw from it those portions which best fit the needs of his students and his teaching situation.

Appropriate student activities for this area are readily available in textbooks and professional journals.

I. Introduction to general metals

  A. History

  B. Industrial uses

II. Kinds of metals

  A. Grouping

  B. Characteristics

III. Measuring devices

  A. Types

  B. Uses

IV. Metal fasteners

  A. Types

  B. Applications

V. Tools and materials used in metals

  A. Types

  B. Applications

VI. Industrial uses

VII. Safety

VIII. Orientation on units of future study

  A. Major areas
    1. Foundry
    2. Oxyacetylene welding
    3. Electric arc welding
    4. Sheetmetal
    5. Ornamental iron
    6. Machine metal

  B. Minor areas
    1. Metal spinning
    2. Bench metal
    3. Forging and heat treating

IX. Occupations related to metalworking

X. Operations performed in junior high metals

NOTE: Each area should have operations listed in order of difficulty (See senior high school material which follows). A junior high student probably will not complete all the operations in junior high. Some may be either started or completed in the senior high school.

Metals for Senior High Schools (10-12)

Students who become interested in metals as a result of experiences in this area at the junior high level should be able to follow this interest through at least a two-year sequence in senior high school.

In this outline metals areas have been divided into two categories — major, for those which are

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of predominant importance industrially; and minor, for those which are of relatively lesser importance industrially or because school shop facilities ordinarily do not permit dealing with the area in more than a minor manner. The major areas include foundry, oxyacetylene and electric welding, sheetmetal, and machine metal. Bench metal, metal spinning, forging, and heat treating are considered minor areas.

No intent has been made to split the units between junior high school and senior high school. It would be better that each unit start with simple and proceed to complex. It could then be taught in either junior or senior high.

Since the following content is outlined to cover various age groups and abilities, the instructor should feel free to glean the outline and use those portions which best accomplish his course objectives.

Objectives. Every student should have the opportunity:

- To have some understanding about occupations in the metals industries.
- To develop an understanding and appreciation of good design and craftsmanship.
- To apply science, mathematics, social sciences, and the language arts in the area of metals.
- To develop good safety and health practices in the area of metals.
- To enjoy valuable experiences with metalworking tools, materials, and processes.
- To develop the ability to do independent planning and creative thinking, leading to self expression in the area of metals.
- To develop an understanding of the industrial processes and technology in the metalworking industry.

Content. The material which follows is not organized into courses, but there is more than enough material to permit the basis for several courses. All areas may be covered in a general metals course which would build on experiences gained in the metals course work offered at the junior high school level. This could be followed with semester length or full year courses in major areas. It is recognized that course titles, sequence of instruction, and extent of student involvement may be modified by local conditions. The suggested content is presented as a guide only. How this or other information is presented is the responsibility of the individual instructor. Appropriate student activities for this area are readily available in textbooks and professional journals.

Foundry — Major Area

I. Introduction to foundry

A. History

B. Safety

II. Identification of metals (non-ferrous)

A. Capabilities

B. Classification and melting temperature

III. Pattern making

A. Nomenclature

B. Methods

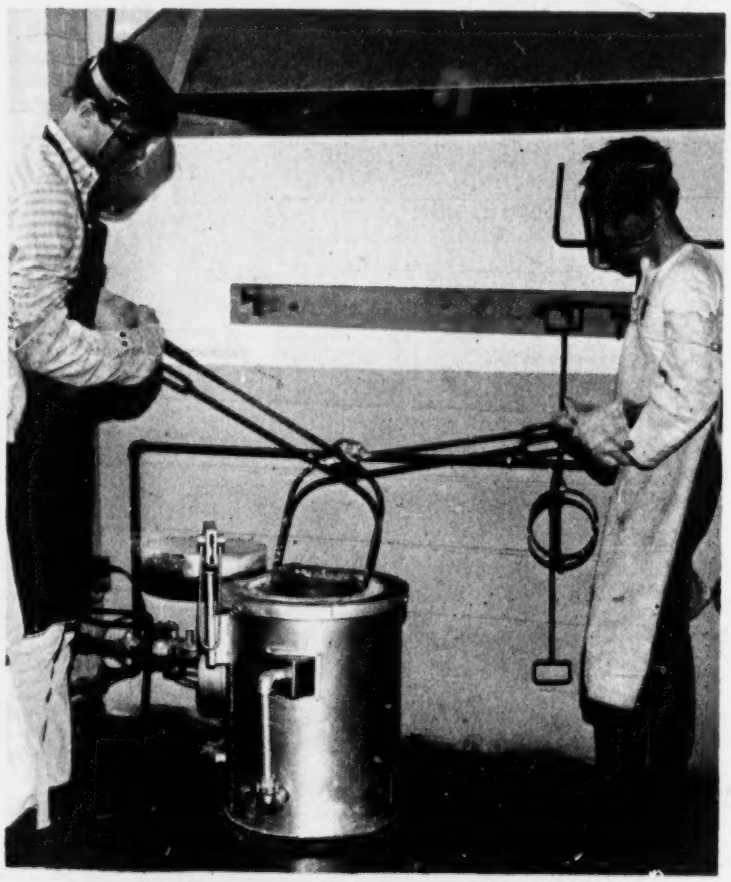

Foundry practice should be taught.

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IV. Foundry sand

A. Types

B. Characteristics

V. Crucibles

A. Types

B. Uses

VI. Flasks

A. Nomenclature

B. Applications

VII. Casting process

A. Tools

B. Uses

VIII. Occupational awareness

A. Types of occupations related to foundry

B. Working conditions and salary

C. Requirements for job entry

D. Employment outlook

IX. Safety instruction

A. Attitudes

B. Apparel

C. Physical plant layout

X. Operations

A. Planning and making patterns

B. Conditioning sand

C. Ramming up molds (one piece flat-back patterns)

D. Cutting sprues, pouring basins, sprue bases, runners, gates and risers

E. Removing patterns

F. Repairing and closing molds

G. Lighting the furnace

H. Fluxing metal

I. Pouring

J. Removing gating system and cleaning castings

K. Molding different kinds of patterns
1. Split patterns
2. Patterns with irregular parting lines
3. Matchplates
4. Patterns requiring check molding

L. Making and placing cores

M. Other foundry processes (other than green sand molding)
1. Shell cores
2. Shell molding process
3. Permanent mold casting
4. Plaster mold casting
5. Precision investment casting (ceramic shell mold)

Welding — Major Area

I. Introduction to welding

A. History

B. Safety

II. Welding — oxyacetylene

A. Equipment
1. Nomenclature
2. Types and uses

B. Selection and uses of welding rod

C. Fluxes

D. Types of welds

E. Industrial applications

III. Operations

A. Selecting correct tips

B. Assembling torches

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C. Setting regulators

D. Lighting and adjusting

E. Determining correct welding procedures
   1. Mild steel welding (flat position)
      a. Melt strips
      b. High flange weld
      c. Low flange weld
      d. Outside corner weld
      e. Beads
      f. Thin butt weld
      g. Thick butt weld
      h. Lap weld
      i. "T" weld
      j. Brazing
      k. Bronze welding
   2. Cast iron
      a. Welding
      b. Bronze welding
   3. Non-ferrous welding and brazing
      a. Aluminum
      b. Stainless steel
   4. Out of position welding
   5. Hard surfacing
   6. Silver soldering
   7. Pipe welding

F. Cutting

IV. Welding — electric arc

A. Equipment
   1. Nomenclature
   2. Types and uses

B. Electrode selections

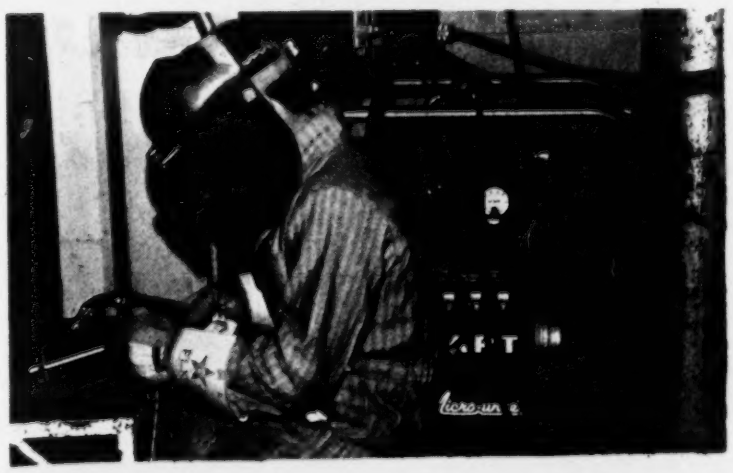

Modern welding equipment is important.

C. Types of welded joints

D. Industrial applications

V. Metallurgy

A. Researching

B. Specimen testing
   1. Face bend
   2. Root bend

C. Etching

D. Crack detection

E. Tensile testing

F. Hardness testing

VI. Safety

A. Apparel

B. Attitudes

C. Physical layout

VII. Occupational awareness

A. Types of occupations related to welding

B. Working conditions and salary

C. Requirements for job entry

D. Employment outlook

VIII. Operations

A. Selecting correct electrode

B. Striking and holding an arc

C. Mild steel welding (flat position)
   1. Arc striking
   2. Crater filling
   3. Restarting
   4. Padding
   5. Lapweld
   6. Multiple pass "T" weld
   7. Thin butt weld
   8. Thick butt weld

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D. Welding at various positions
   1. Vertical down position
   2. Horizontal position
   3. Vertical up position
   4. Overhead position

E. Tig welding

F. Non-ferrous welding

G. Cutting

H. Hardsurfacing

Sheetmetal — Major Area

I. General introduction to sheetmetal

A. History

B. Scope of the unit

II. Metals used

A. Types

B. Classifications

III. Hand tools used

A. Types

B. Applications

IV. Machine tools used

A. Nomenclature

B. Operations

V. Hems, edges, and seams

A. Types

B. Applications

VI. Metal fastening materials and tools

A. Procedures

B. Applications

VII. Industrial processes

VIII. Research

A. Procedures

B. Results

IX. Safety

A. Attitudes

B. Apparel

C. Physical layout

X. Occupational awareness

A. Types of occupations related to sheetmetal

B. Working conditions and salary

C. Requirements for job entry

D. Employment outlook

XI. Operations to be performed in sheetmetal

A. Planning

B. Blueprint reading

C. Laying out and developing patterns

D. Drilling

E. Punching

F. Cutting

G. Filing

H. Hemming, seaming, and forming

I. Bending

J. Grooving

K. Fastening

L. Annealing
   1. Ferrous
   2. Non-ferrous

M. Finishing

N. Testing and researching

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Machine Metal — Major Area

I. Introduction to machine metal

II. Measuring instruments

- A. Types
- B. Uses

III. Cutting tools

- A. Maintenance
- B. Adjustment

IV. Nomenclature, operations, speeds and feeds, and accessories

- A. Engine lathe
- B. Metal shaper
- C. Milling machine
- D. Bandsaw
- E. Drill press

V. Grinders

- A. Operations
- B. Maintenance

VI. Arbor Press

- A. Nomenclature
- B. Operation

VII. Maintenance and adjustment

- A. Preventive maintenance
- B. Repair

VIII. Laying out and measuring

IX. Safety instruction

- A. Apparel
- B. Attitudes
- C. Physical layout

X. Occupational awareness

- A. Types of occupations related to machine metals
- B. Working conditions and salary
- C. Requirements for job entry
- D. Employment outlook

XI. Operations used in machine metal

- A. Lathe
  1. Adjusting
  2. Centering
  3. Sharpening tools
  4. Rough turning
  5. Cutting off
  6. Straight turning
  7. Taper turning
  8. Finish turning
  9. Filing
  10. Thread cutting
  11. Chucking

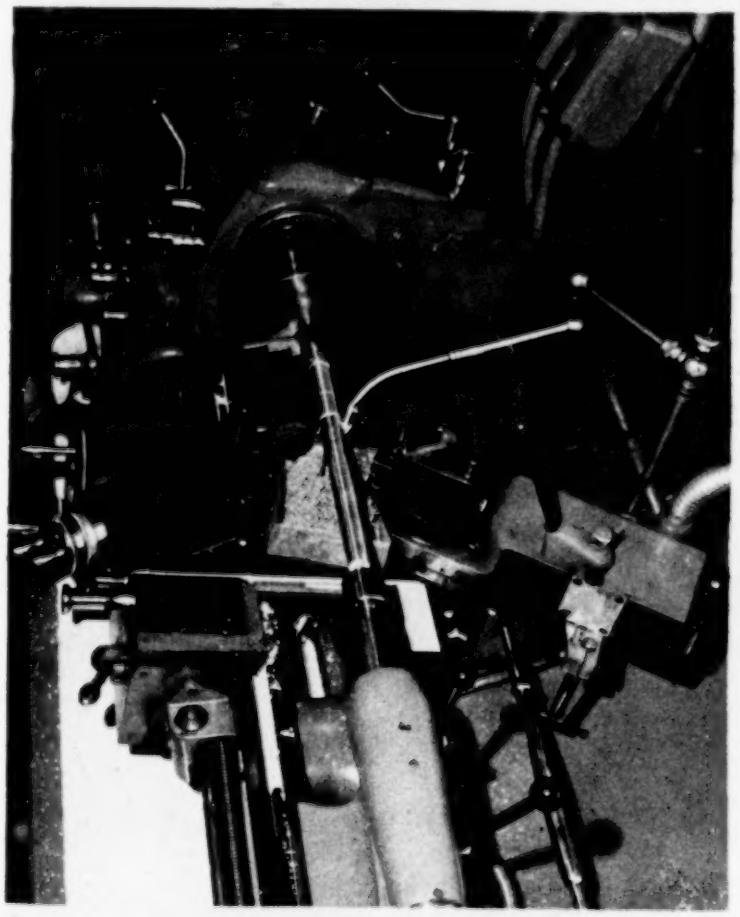

Hydraulic tracing lathe.

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12. Reaming
13. Drilling
14. Boring
15. Cutting keyways
16. Facing
17. Eccentric turning
18. Internal tapering
19. Knurling
20. Spherical turning

B. Shaper
1. Setting up work
2. Adjusting speed
3. Cutting

C. Arbor press
1. Pressing bushings and bearings
2. Straightening shafts

D. Milling machine
1. Setting up
2. Surfacing
3. Milling
4. Drilling, reaming, and boring
5. Indexing
6. Gear cutting
7. Threading

E. Grinders
1. Tool grinding
2. Grinding
   a. Tapers
   b. Cylinders
3. Cam grinding

Bench Metal — Minor Area

I. General introduction to bench metal

II. Hand tools

A. Hack saws
1. Sizes
2. Types
3. Number of teeth
4. Set

B. Cold chisels
1. Types
2. Uses
3. Materials

C. Bench shears
1. Bench lever shears
2. Throatless

D. Drills and reamers
1. Sizes
2. Materials
3. Types
4. Nomenclature
5. Holding devices

E. Files
1. Types
2. Sizes
3. Shapes
4. Cuts
5. Kinds
6. Care

III. Drilling machines

A. Types

B. Speeds

C. Feeds

D. Lubricants

IV. Grinding machines

A. Types

B. Wheels

C. Sharpening tools

D. Maintenance

V. Threads

A. Types and sizes

B. Taps

C. Dies

VI. Metal fasteners

A. Types

B. Applications

VII. Assembly tools

A. Machinist's vise

B. Clamps

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C. Pliers

D. Jigs

E. Mallets

F. Screwdrivers

G. Wrenches

VIII. Research

A. Procedures

B. Results

IX. Occupational awareness

A. Types of occupations related to bench metal

B. Conditions and salary

C. Requirements for job entry

D. Employment outlook

X. Safety instruction

A. Attitudes

B. Apparel

C. Physical plant

XI. Operations used in bench metal

A. Laying out

B. Cutting

C. Bending

D. Twisting

E. Forming

F. Threading

G. Fastening

Metal Spinning — Minor Area

I. Introduction to metal spinning

II. Nomenclature

III. Speeds

IV. Operations

Forging and Heat Treating — Minor Area

I. Introduction to forging and heat treating

II. Tools and equipment

A. Anvil

B. Tongs

C. Forging hammer

D. Heat treating furnace

III. Information

IV. Operations

A. Hand forging

B. Grinding

C. Filing and polishing

D. Annealing

E. Hardening

F. Tempering

G. Case hardening

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SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purposes of illustration. Sources that pertain to metals are included if specific material is not listed below. Additional information of a general nature may be found on page 48.

Miscellaneous Materials

- Booklets: "The Foundry Is a Good Place To Work," "Your Future in the Cast Metals Industry," and "Foundry Instructor's Guide,"

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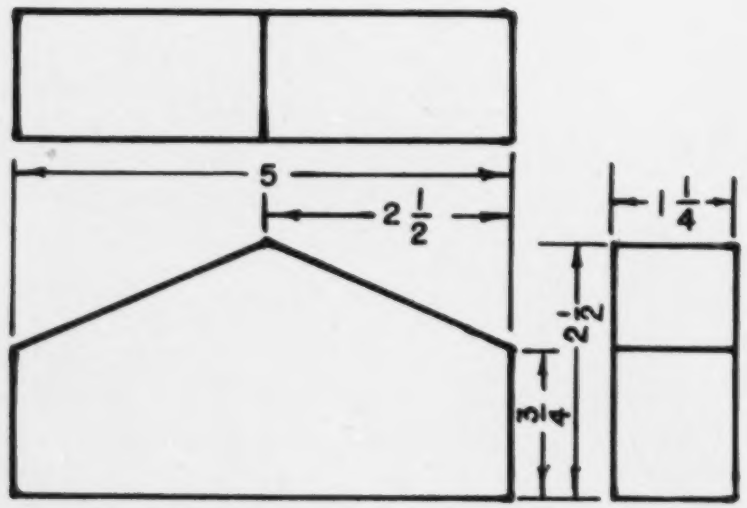

GABLE W.S. 47.

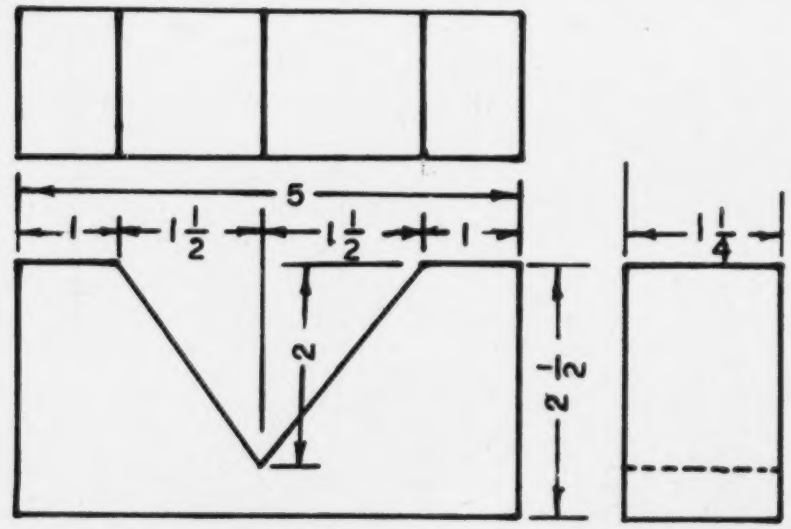

V- BLOCK W.S. 48.

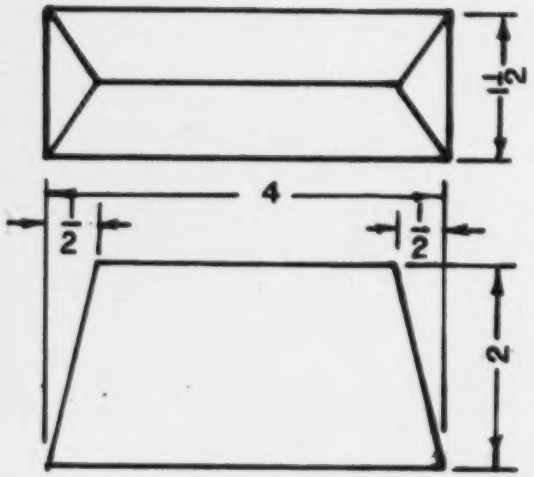

WEDGE

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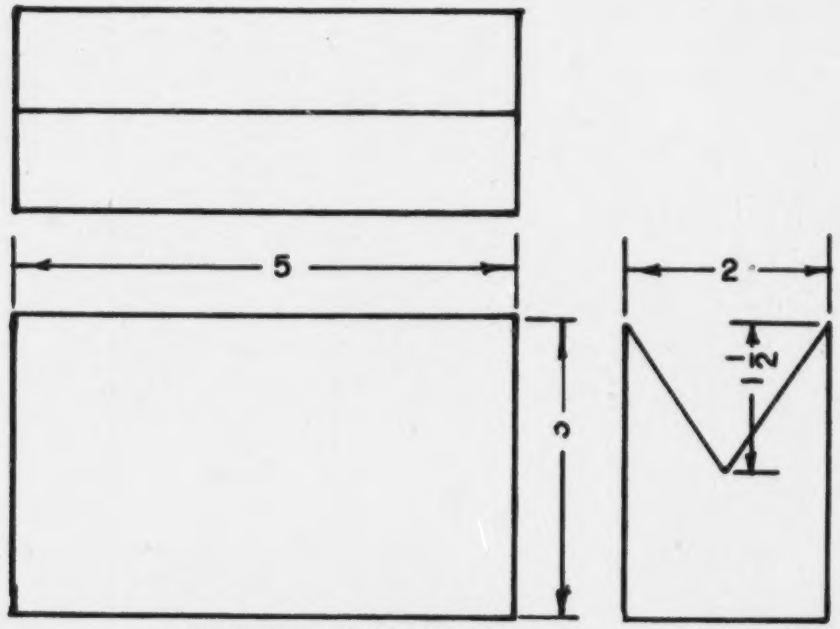

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ILLUSTRATION SHEET 23.

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American Foundrymen's Society, Golf and Wolf Roads, Des Plaines, Illinois 60016.

- Booklet: "Reference and Audio-Visual Material on Iron and Steel," American Iron and Steel Institute, 150 East 42nd Street, New York, New York 10017.

- Booklet: "A Career in Metallurgy Will Extend Your Reach," Career Guidance Dept., American Society for Metals, Metals Park, Ohio 44073.

- Wall Charts: "Decimal Equivalents," "How To Read a Micrometer," Brown and Sharp Manufacturing Company, Precision Park, North Kingstown, Rhode Island 02853.

- Booklet: "How To Read a Micrometer," Central Tool Company, 456 Wellington Avenue, Cranston, Rhode Island 02910

- Booklet: "Solder — Its Fundamental Usage," Kester Solder Company, 4201 Wrightwood Avenue, Chicago, Illinois 60639

- Booklets: "Principles of Arc Welding," and "Welding and the World of Metals," Miller Electric Manufacturing Company, Box 1087, Appleton, Wisconsin 54910.

- Booklet: "File Filosophy" (How to get the most out of files), Nicholson File Company; Providence, Rhode Island.

- Booklets: "Recommendations for Teaching Welding," (EW-204), "Welding Projects for School Shops," (EW-274), "Arc Welding Symbols," (EW-342), and "Hobart Vest Pocket Guide," Hobart Welding School, Trade Square East, Troy, Ohio 45373.

- Booklet: "Short Course on Welding, Brazing and Cutting,"

- Chart: "Oxy-Acetylene Flame Chart" (color), and

- Chart: "Oxy-LP Gas Flame Chart" (color), Smith Welding Equipment, c/o OKI Supply Company, Box 37717, Cincinnati, Ohio 45237.

- Booklets: "How Steel Is Made," and "The World of Steel," United States Steel Corporation, 71 Broadway, New York, New York 10010.

Cartridged Super 8mm Single-Concept Films

- Fourteen on welding from *Starting the Arc* to *The Overhead Fillet,* School Service Department, Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.

Motion Pictures

- "It's Easy To Bend," (color, sound), free loan from Di-Acro, 611 Eighth Avenue, Lake City, Minnesota 55041.

- The following list of 16mm films can be obtained from Visual Instruction Service, Iowa State University, Ames, Iowa 50010:

Rental

I. Bench Metal

- NS-1737 *Americans at Work, Steelworkers* . . . . . $ .75
- NS-1642 *Americans at Work, Pattern Makers* 75
- NS-1723 *Americans at Work, Missile Makers* 75
- NS-1754 *Americans at Work, Aluminum Workers* 75
- NS-6138 *The Metal Worker* 75

II. Sheet Metal

- NS-411 *The Meaning of Pi* 1.50
- NS-1749 *Americans at Work, Air Conditioning Workers* 1.50
- NS-534 *The Sheetmetal Worker* . 1.50

III. Machine Metals

- NS-2349 *Industrial Arts; Boring and Drilling Tools* 1.50
- NS-1066 *Machining a Cast Iron Rectangular Block* 2.40
- NS-1065 *Machining a Tool Steel V Block* 2.40
- NS-1287 *Cutting an External National Fine Threat* 1.20
- NS-1050 *Cutting a Taper with the Compound Rest and with a Taper* .90
- NS-2034 *Drilling, Boring, and Reaming Work Held in a Chuck* 90
- NS-917 *Elementary Operations on the Engine Lathe* 1.50
- NS-1288 *Fixed Gages* 1.40

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- NS-27 *Giving a Shop Demonstration* 1.50
- NS-122 *Height Gages and Test Indicators* 1.20
- NS-353 *Micrometer* 1.20
- NS-1017 *The Milling Machine* 90
- NS-5474 *Plan Indexing and Cutting a Spur Gear* 2.40
- NS-2036 *Rough Turning Between Centers* 1.40
- NS-1082 *The Steel Rule* 90
- NS-2035 *Turning Work of Two Diameters* 1.40
- NS-1259 *Verniers* 1.40
- NS-533 *The Machinist and Tool Maker* 1.50
- NS-815 *The Machine Maker* 1.50
- NS-1627 *Americans at Work — Machinists* 75

IV. Welding

- NS-9925 *Bronze Welding* 1.00
- NS-4069.70 *Fundamentals of Manual Shielded Metal Arc Welding Techniques* 4.80
- NS-515 *The Inside of Arc Welding Horizontal Position* 1.80
- NS-3511 *Oxy-Acetylene Flame — Master of Metals* 75
- LS-662 *Arc Welding* (2"x2" slides) 2.00
- Catalog of 175 Training Aid Educational Motion Pictures, National Machine Tool Builders Association, Publications Dept., 2139 Wisconsin Avenue, N.W., Washington, D.C. 20007.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.
- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.
- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.
- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.
- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Filmstrips

- *The Chemistry of Iron* (35 frames, color) Revised 1964, One copy free to a school system. Teaching manual available.
- *The Chemistry of Steel* (50 frames, color) Revised 1964. One copy free to a school system. Teaching manual available.
- *How Steel Is Made* (55 frames, color) 1962. A teacher's guide with filmstrip text is available.
- *Raw Materials of Steelmaking* (43 frames, color) Revised 1965. One copy free to a school system. Teaching manual available.

Above filmstrips are available from American Iron and Steel Institute, 150 East 42nd Street, New York, New York 10017.

Books

- *General Industrial Machine Shop,* Harold V. Johnson, Charles A. Bennett Company, Inc., 237 North Monroe Street, Peoria, Illinois 61602, 1963.
- *General Mathematics for the Shop,* Nelson, Moore, Hamburger, and Becker, Houghton Mifflin Company, Batavia Avenue, Geneva, Illinois 60134.
- *General Metals,* John L. Feirer, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, New York 10036, Third edition, 1966.
- *General Metals,* Fraser and Bedell, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, Second edition, 1962.
- *General Metals for Technology,* J. W. Giachino and Neil Schoenhals, Bruce Publishing Company, 400 North Broadway, Milwaukee, Wisconsin 53201, 1964.
- *General Shop Metalwork,* A. W. Dragoo, and Howard O. Reed, McKnight and McKnight, Bloomington, Illinois 61701, Revised edition, 1964.

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- *IA Metal Work,* Dr. John L. Feirer, and Dr. John R. Lindbeck, Charles A. Bennett Company, Inc., 237 North Monroe Street, Peoria, Illinois 61602, 1965.

- *Lessons in Arc Welding,* Hobart Welding School, Troy, Ohio.

- *Machine Tool Operations,* Parts I & II, Burghardt, Anderson and Axelrod, McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, New York 10036, Fifth edition, 1953.

- *Machine Tool Metalworking,* John L. Feirer and Earl E. Tatro, McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, New York 10036, 1961.

- *Metallurgy,* Johnson and Weeks, American Technical Society, 848 East 58th Street, Chicago, Illinois 60737, Revised edition, 1965.

- *Metalworking,* Gardner T. Boyd, Goodheart-Wilcox, Homewood, Illinois 60430.

- *Metalwork Technology and Practice,* Oswald A. Ludwig and Earl A. Ludwig, McKnight & McKnight, Bloomington, Illinois 61701, Fourth edition, 1962.

- *Modern Metalwork,* John R. Walker, Goodheart-Wilcox, Homewood, Illinois 60430, 1965.

- *The New American Machinists Handbook,* Rupert LeGrand, McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, New York 10036.

- *Patternmaking and Founding,* Robert E. Smith, McKnight & McKnight, Bloomington, Illinois 61701, revised edition 1954.

- *Processes and Materials of Manufacture,* Roy A. Lindberg, Allyn and Bacon, Boston, Massachusetts, 1964.

- *Sheet Metal Shop Practice,* Leroy Bruce and Leo Meyer, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637, Third edition, 1965.

- *Sheet Metal Work,* Robert E. Smith, McKnight & McKnight, Bloomington, Illinois, Revised edition, 1961.

- *Technical Metals,* Harold V. Johnson, Charles A. Bennett Company, Inc., 237 N. Monroe Street, Peoria, Illinois 61602, 1967.

- *Tool Steel Simplified,* Frank R. Palmer and George Luerssen, Carpenter Steel Company, Reading, Pennsylvania, Revised edition, 1960.

- *Welding Skills and Practices,* Giachino, Weeks, and Brune, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637, Second edition, 1965.

- *Welding Technology,* Giachino, Weeks, Johnson, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637, 1968.

Magazines

- *American Machinist*
- *American Molder*
- *Design*
- *Design Quarterly*
- *Foundry*
- *Iron Age*
- *Machinery*
- *Modern Casting*
- *Welding Engineer*

TOOLS AND EQUIPMENT

The following list is presented as a guide in the selection of tools and equipment needed to teach metals. The approximate number of each item needed for a small, medium, or large number of students in a unit shop in metals is indicated, as well as items needed to equip a metals area of a general shop.

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Basic Equipment for the Metals Area of a General Shop

	Number Needed
General (bench metal)	
Anvil 100 lb.	1
C Clamps, 4", 6", 8"	4 each
Chisel, cold, $\frac{3}{8}$", $\frac{1}{2}$", $\frac{3}{4}$"	10 each
Dividers, 6" or 8"	2
Dresser, emery wheel	1
Drill, hand	1
Drill press	1
Drills, sets, high speed, fractional and number	1 each
Files, assortment, 8" and 10", mill, flat, round, half round, three square	
File card and brush	6
File handles	20
Face shields, safety	6
Grinder, pedestal or bench	1
Hacksaw frames	3
Hammer, ballpeen, 8 and 12 oz.	2
Nippers, end cutting, 10"	1
Mallets, wood, assortment	4
Pliers, combination	2
Rule, steel, 24"	1
Screwdrivers, 4", 6", 8"	2 each
Scriber	4
Square, combination, 12"	2
Tap and die set	1
Vise, machinist, 3" or 3½" jaws	2
Wrench, adjustable end, 8"	1
Sheet metal (special tools)	
Awls, scratch	4
Bar folder*	1
Box and pan brake, 24" to 48"	1
Bench, complete with benchplate	1
Bench, soldering	1
Furnace, bench, gas	1
Groover, hand, No. 2 and No. 4	1 each
Hammer, riveting, 12 oz.	2
Hammer, tinners setting, 12 oz.	1
Rivet sets, No. 4, 5, 6, 7, 8	1 each
Rotary machine, deep throat (combination) (with burring, turning, wiring, crimping and beading rolls)	1
Rule, circumference, 36"	1
Seamer, hand	4
Shear, squaring*	1
Snips, aviation, right and left cut	1 each
Snips, combination 3" jaw	3
Slip roll forming machine	1
Soldering coppers, 1 lb. pr., 2 lb. pr.	1 each
Stake, conductor, candlemold, hatchet, beakhorn, blowhorn, square, hollow mandrel, coppersmith	1 each
Ornamental metal (special tools)	
Buffing head	1
Clamps, spring	6
Polishing wheels, cloth	2
Jewelers saws	3
Swiss pattern files	1 set
Tray — for etching	1
Jar — for pickling	1
Metal casting	
Bellows, molders	1
Bench, molding	1
Bulb, sponge	1
Crucible, graphite	2
Crucible tongs	1
Crucible pouring ring	1
Flask and molding boards, 10"x 12"	1 set
Founder's trowel	1
Founder's slick and spoon	1
Melting furnace	1
Hammer	1
Riddle, No. 8 mesh	1
Sand, foundry, 100 lb. bag	3
Shovel, square point, short handle	1
Sprue cutter	1
Welding	
Arc welder, A.C. 180 amp., complete with cables, holders, ground clamp	1
Arc welding helmet with No. 10 filter	1
Arc welders gloves	1 pr.
Oxyacetylene welding outfit, complete with hose, lighter, gloves, etc.	1
Welding trips for torch, No. 1, 3, 5, 7	1 each
Welder, spot*	
Machine metal (special tools)	
Calipers, inside, 6"	1
Calipers, outside, 6"	1
Center gauge No. 391	1
Combination countersink and drill	1 doz.
Drill press, complete	1
Engine lathe, 10" or 12", complete	2
also lathe dog, ½", ¾", 1", 1¼", 1½"	1 each
Universal 3-jaw chuck	1

*Desirable but not absolutely necessary.

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	Number Needed
Independent 4-jaw chuck	1
Knurling tool	1
Cutoff tool	1
Gauge, screw pitch	1
Micrometer, 0-1"	1
Micrometer, 1"-2"	1
Milling machine, vertical, complete	1
Milling cutters and arbors, assortment	
Milling machine swivel vise	1
Parallels	1 set

Basic Tools and Equipment for the Metals Unit Shop

	Class Size Small (10)	Medium (16)	Large (20)
General metal			
Anvil, 100 lb.	1	1	1
Bar folder, 30", adjustable	1	1	1
Box and pan brake, 24"-36" or 48" width	1	1	1
Bench brush	2	4	6
Bench, sheet metal (complete with stakeplate)	1	1	2
Bench, soldering	1	2	3
Bending jig, formband	1	1	1
Bending jig (Hossfeld hand operated scroll bender)*	1	1	1
Bending machine (No. 1A DiAcro or No. 1 Hossfeld universal bender)*	1	1	1
Buffing head	1	1	2
Counter sink, $\frac{3}{4}$", for metal	1	1	2
C clamps, 3", 4", 6", 8"	2 ea.	3 ea.	4 ea.
Clamps, spring	6	12	18
Chisel, cold, $\frac{3}{8}$", $\frac{1}{2}$", $\frac{3}{4}$"	1 ea.	1 ea.	1 ea.
Dividers, 8"	2	4	6
Drill, hand	1	1	1
Drill, portable electric $\frac{3}{8}$"	1	1	1
Drill press, 15" minimum bench or pedestal	1	1	1
Drills, set of high speed steel fraction by 64ths, $\frac{1}{16}$" to $\frac{1}{2}$"	1 set	1 set	1 set
Drills, set of high speed steel, No. 1-60	1 set	1 set	1 set
Files			
Mill			
8" smooth	2	3	4
8" 2nd cut	2	3	4
8" bastard	2	3	4
10" smooth	2	3	4
10" smooth	2	3	4
10" 2nd cut	2	3	4
10" bastard	2	3	4
Flat			
10" smooth	2	3	4
10" 2nd cut	2	3	4
10" bastard	2	3	4
Hand			
10" smooth	2	2	2
Warding			
6" smooth	2	3	3
8" bastard	2	3	3
Knife			
6" smooth	1	2	2
8" bastard	1	2	2
Round			
6" smooth	2	2	3
8" 2nd cut	2	2	3
10" bastard	2	2	3
Square			
6" smooth	2	2	3
8" 2nd cut	2	2	3
Half round			
6" smooth	2	2	3
8" 2nd cut	2	2	3
Three square			
6" smooth	2	2	3
8" 2nd cut	2	2	3
Knife			
6" smooth	2	2	3
8" 2nd cut	2	2	3
Flat aluminum, type A			
8"	1	1	2
10"	1	1	2
1 set (12) assorted Swiss pattern files	1	1	1
File card and brush	6	9	12
File handles, screw on type	5 doz.	6 doz.	7 doz.
Furnace, soldering, natural gas	2	3	4
Gauge, U.S. standard	1	1	1
Gauge, American standard (for non-ferrous)	1	1	1

*Desirable but not absolutely necessary.

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	Class Size Small (10)	Medium (16)	Large (20)
Glasses, safety (required for each student)			
Grinder, pedestal or bench 7"	1	1	1
Groover, hand, No. 2, 3, 4	1 ea.	1 ea.	2 ea.
Hacksaw frames	2	3	4
Hammer, ball peen, 8 ounces	1	2	3
Hammer, ball peen, 12 ounces	2	3	4
Hammer, ball peen, 16 ounces	1	1	1
Hammer, riveting	1	2	3
Hammer, tinner's setting	1	2	3
Knives, sloyd	2	3	4
Nippers, end cutting 10"	1	1	1
Mallet, rawhide	1	2	2
Mallet, tinner's, hickory	2	4	6
Microscope, metallurgical	1	1	1
Panel, for metalwork tools	1	1	1
Pliers, combination, 6"	2	4	6
Pliers, combination, 8"	1	1	1
Pliers, vise grip 10"	2	2	2
Rivet sets, Nos. 4, 5, 7, 8	2 ea.	2 ea.	2 ea.
Pop riveter	1	1	1
Rotary machine, Pexto No. 622 complete	1	1	1
Rotary machine, Pexto No. 1544 complete	1	1	1
Rules, steel 24"	2	3	4
Rule, tinner's circumference	1	1	1
Screwdriver, 4"	1	2	2
Screwdriver, 6"	1	2	2
Screwdriver, 8"	1	2	2
Screwdriver, 12"		1	1
Scriber or scratch awl	4	6	8
Seamer, hand	1	1	2
*Shears, Beverly No. 132	1	1	1
Shear, squaring 36" width, 18 gauge soft steel capacity	1	1	1
*Shears, Stanley unishear	1	1	1
Snips, hawks bill, 3" cut	1	1	1
Snips, aviation—cuts left	1	2	2

	Class Size Small (10)	Medium (16)	Large (20)
Snips, aviation—cuts right	1	2	2
Snips, combination 3" cut	2	3	4
Slip roll forming machine	1	1	1
Slip roll forming machine	1	1	1
Soldering coppers, 1 lb. pair with handles	1 pr.	2 pr.	3 pr.
Soldering coppers, 1½ lb. pair with handles	1 pr.	2 pr.	3 pr.
*Spot welder	1	1	1
Square, combination, 12"	3	5	7
*Stake, candle mold	1	1	1
Stake, conductor	1	1	1
Stake, blowhorn	1	1	2
Stake, beakhorn	1	1	1
Stake, hatchet	1	1	2
*Stake, hollow mandrel	1	1	1
*Stake, needle case	1	1	1
Tap and die set, Machine Screw — 6x32, 8x32, 10x24, 12x24, ¼"x 20	1	1	1
Tap, pipe—⅛"	1	1	1
Torch, natural gas and air, Prestolite or propane	1	1	1
Trammel points	1	1	1
Vise, drill press	1	1	1
Vises, machinist, 3" or 3½" jaws	2	3	4
Wire brushes	1	1	2
Wrench, pipe, 16"	1	1	1
Wrench, pipe, 12"		1	1
Wrench, adjustable end, 4"		1	1
Wrench, adjustable end, 6"	1	1	1
Wrench, adjustable end, 8"	1	1	1
Wrench, adjustable end, 10"		1	1
Wrench, monkey, 12"	1	1	1
Foundry			
Bellow, molder's	1	2	3
Bench, molding, metal lined	1	2	3
Boards, molding to fit flasks	4	6	8

*Desirable but not absolutely necessary.

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	Class Size Small (10)	Medium (16)	Large (20)
Bulb, sponge, 4 oz.	1	1	2
Crucible shank, safety type (for pouring)	1	1	1
Crucible tongs	1	1	1
Flasks, molder's 10" by 10"	1	1	2
Flasks, molder's 10" by 12"	1	1	2
Flasks, molder's 10" by 16'		1	1
Founder's trowel	1	2	3
Founder's slick and oval spoon	1	2	3
Leggings, asbestos	2	2	2
Melters and pourers for face shields	2	2	2
Melting furnace, blower type, complete with graphite crucible	1	1	1
*Pyrometer, lance type	1	1	1
Panel for foundry tools	1	1	1
Rammer, hardwood, $3\frac{1}{2}$" by 14"	1	2	3
Riddle, foundry No. 8 mesh	1	2	3
Sand, foundry, 100 lb. bag	4	8	12
Shovel, square point, short handle	1	2	3
Tapered sprue cutter $\frac{7}{8}$" x $1\frac{1}{4}$"	1	2	3
Welding			
Arc welder, A.C.-D.C. combination, transformer, 250 amperes complete with cables, electrode holder, ground clamp, and helmet	1	2	3
Arc welding accessories — welding helmet with No. 10 filter and cover lenses, lift front type	1	2	3
Hand type helmet with No. 10 filter and cover lenses	1	2	3
Chipping hammer and brush (dual tool)	1	2	3
Welder's gloves, gauntlet type	1	2	3
Arc welding booth with table	1	2	3
Oxyacetylene welding outfit, complete with cutting attachment, hose, wrenches, lighter dual stage regulators	1	2	3
Oxyacetylene gas welding accessories: Welder's gloves, small cuff type	1	2	3
Welder's goggles (Jackson unigoggle)	2	3	4
Triple flint friction lighter	1	2	3
Welding tips — size 1, 2, 3	1	2	3
Welding tips size 5	1	1	1
Welding tips size 7	1	1	1
Oxyacetylene welding table — fire brick top	1	2	3
Panel for welding accessories	1	1	1
Machine metal			
Arbor press	1	1	1
Calipers, inside, 6"	1	4	6
Calipers, outside, 6"	1	4	6
Center gauge No. 391	2	4	4
Combination counter sink and drill	1 doz.	1 doz.	1 doz.
Drill, electric, $\frac{1}{4}$" or $\frac{3}{8}$" portable		1	1
Drill press, 15" floor model complete with motor key and chuck	1	1	2
Drill press accessories			
Drill press vise	1	1	2
V-blocks and clamps	1	1	2
Engine lathe — 10" quick change complete with motor and standard attachments as follows'			

*Desirable but not absolutely necessary.

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	Class Size Small (10)	Medium (16)	Large (20)
Face plate 6"	2	4	4
Tool post assembly	2	4	4
Centers	4	8	8
Reducing sleeve for headstock center	2	4	4
Engine lathe accessories			
Boring bar	1	2	2
Center, crotch	1	1	1
Chuck, Jacobs drill, No. 2 Morse taper shank	1	2	2
Chuck, universal, with 2 sets of jaws	2	4	4
Collets and draw-in attachments	1	1	2
Dog, lathe, $\frac{3}{4}$"	2	4	4
Dog, lathe, $1\frac{1}{4}$"	1	2	2
Dog, lathe, $1\frac{3}{4}$"	1	1	1
Dog, lathe, 3"	1	1	1
Follow rest	1	1	1
Independent chuck with reversible jaws	1	2	2
Indicator dial (set)	1	1	2
Mandrel, $\frac{7}{8}$", $\frac{5}{16}$", $\frac{1}{4}$"	1	1	1
Mandrel, $\frac{5}{8}$"	1	1	1
Mandrel, $\frac{3}{4}$"	1	1	1
Mandrel, 1"	1	1	1
Steady rest	1	1	1
Stop	1	1	1
Tool holder, cut off	1	2	2
Tool holder, knurling	1	2	2
Tool holder, left hand	2	4	4
Tool holder, right hand	2	4	4
Tool holder, straight	2	4	4
Tool post grinder		1	1
Gauge, screw pitch	1	2	2
Grinder, $\frac{1}{2}$ H.P. pedestal	1	1	2
Hacksaw, power, 5"x 5", complete with motor and vise		1	1
Metal shaper, 2" to 10" bench model and stand complete with motor, belt guards, crank handle, and wrench		1	1
Swivel vise and wrench		1	1
Tool holder		1	1
Tool holder, extension		1	1
Micrometer, 0-1"	2	4	4
Micrometer, 1-2"	1	1	1

	Class Size Small (10)	Medium (16)	Large (20)
Micrometer, 2-3"	1	1	1
Milling machine (horizontal), complete with motor, safety belt guards, and arbor	1	1	1
Milling machine (vertical), complete with motor, safety belt guards	1	1	1
Milling accessories			
Dividing head and tail-stock (accessories)		1	1
Vise, swivel	2	2	2
Metal slitting saw, $2\frac{1}{2}$" x $\frac{1}{8}$"	1	1	1
Plain milling cutter with helical teeth, $2\frac{1}{2}$"x 3"	1	1	1
Plain side milling cutter, $2\frac{1}{2}$"x $\frac{1}{2}$"	1	1	1
Plain milling cutter with straight teeth, $2\frac{1}{2}$"x $\frac{7}{16}$"	1	2	2
Solid end mills, double spiral flute, $\frac{1}{4}$", $\frac{5}{16}$" $\frac{3}{8}$", $\frac{1}{2}$", $\frac{5}{8}$"	2	2	2
Shell end mill, 2"	1	1	1
Arbors for solid end mills and shell end (for each)	1	1	1
Jacobs chuck (drill) for vertical	1	1	1
T-bolts and finger clams (set)	1	1	1
Jacobs chuck and flex collects (horizontal)		1	1
Collet set and draw-bar (vertical)	1	1	1
Boring head	1	1	1
Oil cans, $\frac{1}{2}$ pint	3	6	6
Punch, center	4	8	8
Reamers, $\frac{1}{2}$", $\frac{5}{8}$", $\frac{3}{4}$", 1" adjustable	1 set	1 set	1 set
Rules, steel 6"	2	4	4
Surface gauge, universal	1	2	2
Surface plate	1	1	1
Square, combination with centering head	1	2	2
Taper shank drill bit, $\frac{39}{64}$"	1	1	1

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	Class Size Small (10)	Medium (16)	Large (20)
Taper shank drill bit, $\frac{5}{8}$"	1	1	1
Taper shank drill bit, $\frac{47}{64}$"	1	1	1
Taper shank drill bit, $\frac{3}{4}$"	1	1	1
Taper shank drill bit, $\frac{63}{64}$"		1	1
Taper shank drill bit, 1"		1	1
Vise, machinist, $3\frac{1}{2}$" swivel base	1	2	4
Wheel dresser, grinding, carborundum No. 55	1	1	1
V-blocks, large	1	1	1
90° L-plate	1	1	1
Parallels (layout set)	1	1	1

	Class Size Small (10)	Medium (16)	Large (20)
Straight shank drills:			
Twist high speed number (1 to 60) complete with index container	1	1	1
Twist high speed letter set — complete with index container	1	1	1
Twist high speed fractional $\frac{1}{16}$"- $\frac{1}{2}$" — complete with index container	1	1	1
N.F. taps and dies $\frac{1}{4}$"- $\frac{1}{2}$"	1	1	1
N.C. taps and dies $\frac{1}{4}$"- $\frac{1}{2}$"	1	1	1

SUPPLIERS OF TOOLS AND EQUIPMENT

- Baldor Electric Company, Box 6238, Fort Smith, Arkansas 72901. (grinders, grinder-buffers)
- Di-Acro, 611 Eighth Avenue, Lake City, Minnesota 55041.
- Heinrich Tools, Inc., 2707 Industrial Drive, Racine, Wisconsin 53403. (hand nibs, production vises)
- Jackson Products, 5523 Nine Mile Road, Warren, Michigan 48091. (welding and safety equipment)
- Johnson Gas Appliance Company, 584 East Avenue, N. W., Cedar Rapids, Iowa 52405. (furnaces)
- Karl Spin-Shop Company, 105 South State, North Warren, Pennsylvania 16365. (metalspinning machines)
- Keller Division of Sales Service Manufacturing Company, 2363 University Avenue, St. Paul, Minnesota 55114. (power hacksaws)
- L. S. Starrett Company, Athol, Massachusetts 01331. (precision measuring tools)
- Lucifer Furnaces, Inc., 31 Warrington, Pennsylvania 18976. (heat-treating furnaces)
- McEnglevan, Box 31, Danville, Illinois 61832. (furnaces)
- Peck, Stow and Wilcox Company, 1234 Center Street, Southington, Connecticut 06489. (sheet metal machinery)
- Sheldon Machine Company, Inc., 4258 North Know Avenue, Chicago, Illinois 60641. (lathes)
- South Bend Lathe, 400 West Sample Street, South Bend, Indiana 46623. (lathes, shapers, drill presses)
- Wilson Instrument Division, American Chain and Cable Company, 230 Park Avenue, New York, New York 10017. (Rockwell Hardness Testers)

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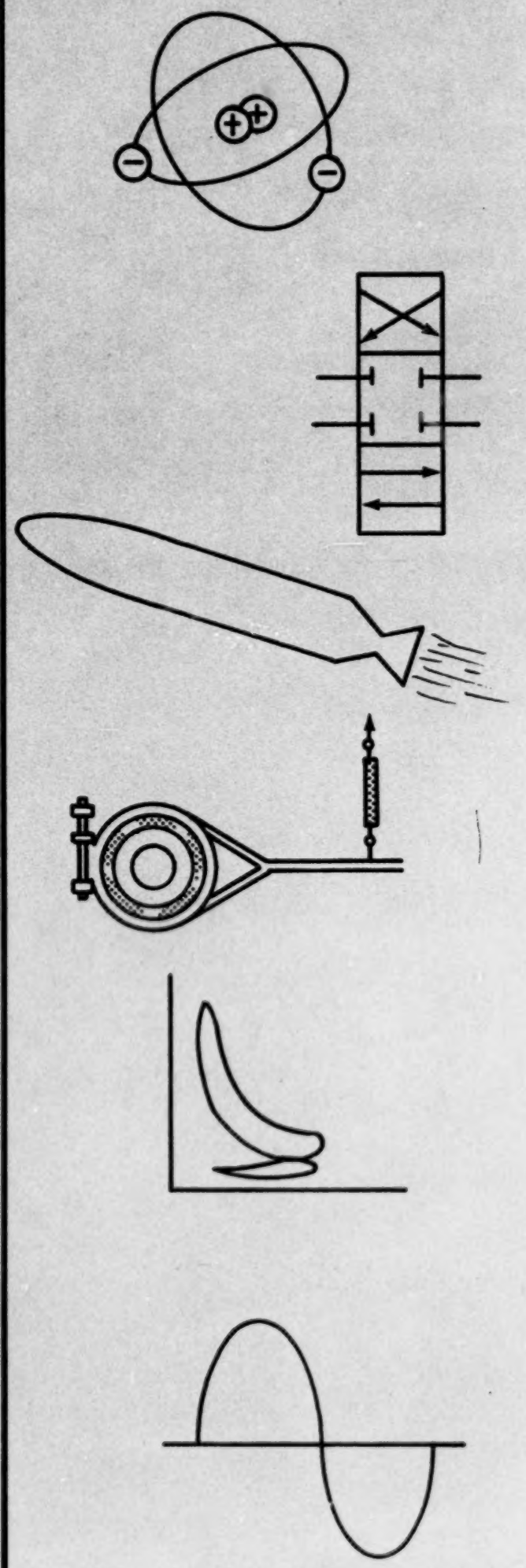

POWER MECHANICS

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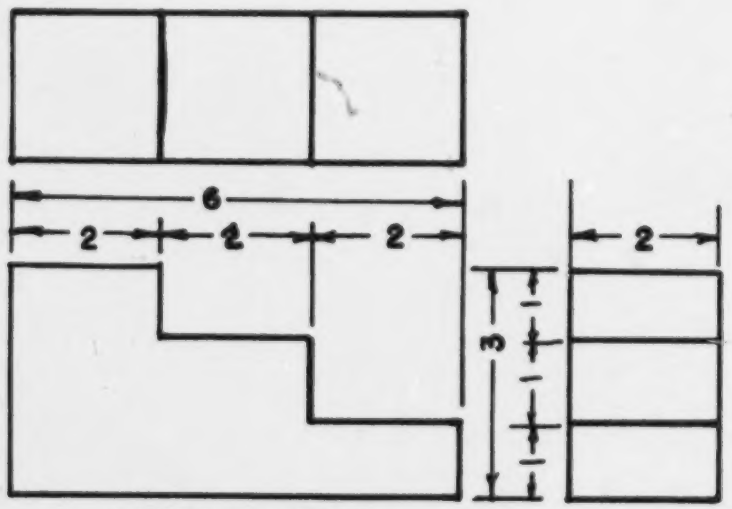

STEP BLOCK W.S.51.

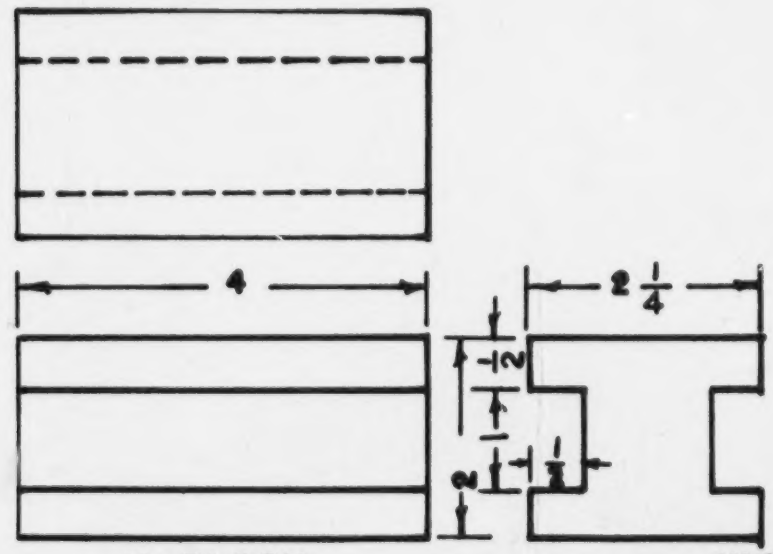

H-BLOCK W.S.52.

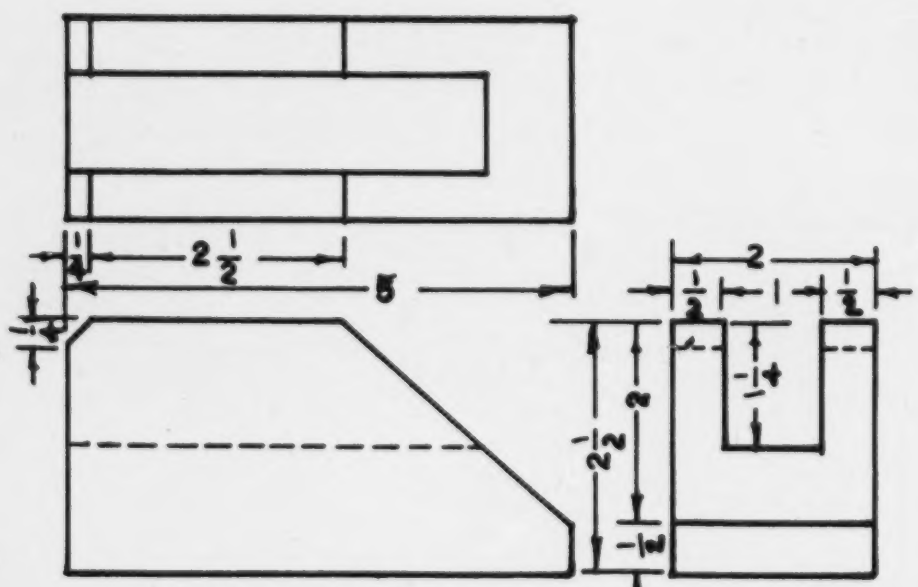

SLIDE BLOCK W.S.53

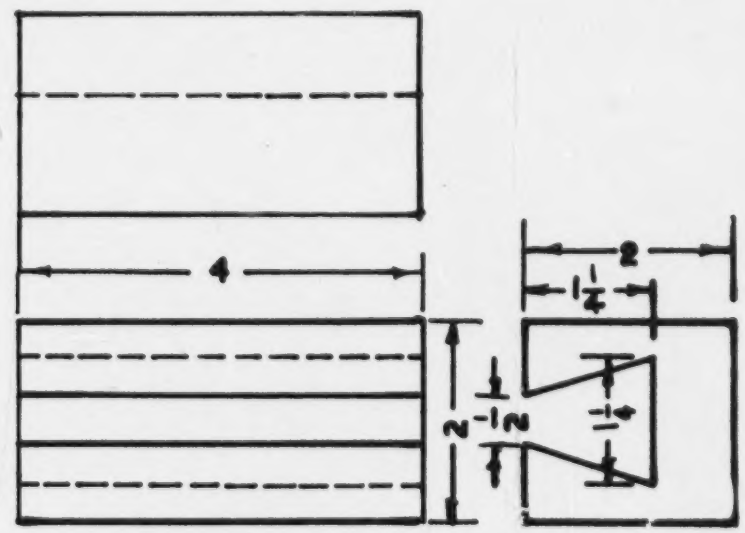

DOVETAIL W.S.54.

ILLUSTRATION SHEET 24.

Man has always been concerned with efficient means of moving loads, transporting himself from place to place, and accomplishing work more efficiently than can be done by manpower alone. The area of power in industrial arts deals with similar concerns.

Iowa is developing into an important industrial state. The evolution of this industrial movement has been and continues to be dependent on power. This trend in Iowa toward more industrialization emphasizes the importance of the knowledge of power production, power transmission, and power use.

The imaginative elementary teacher, perhaps with the help of the industrial arts teacher, should be able to plan a number of activities pertaining to power that would enrich instruction and reduce abstractions. Construction of simple devices like water wheels and windmills by small groups of students can do much to make basic principles meaningful and capture the interest of students. Educational field trips can be made to hydroelectric plants. Units on transportation can provide wholesome appreciations for transportation of the past and present along with some expectations for what the future may bring.

If time permits, specific course work in this exciting area should be taught at the junior high school level. Students at this level seem to thrive on mastering the theory of small engines and the challenges involved in disassembling, reassembling, running, and testing them.

Instruction in this area in the senior high school can capitalize on the high degree of interest most teenage boys have in automobiles. At least two years of sequential course work in this area should be available, which, despite the high degree of proficiency attained by some students, should not be considered as training for earning a wage. Instruction in power mechanics and auto mechanics can hardly proceed without involving the practical utilization of scientific principles. In addition, many opportunities exist for using mathematics in the projection of test results and calculating horsepower. Although this area is not particularly hazardous, many opportunities exist for important safety lessons to be taught and good safety habits to be learned. Activities usually proceed on an individual or small group basis, and some time can be spent profitably in testing and experimental work in addition to the diagnosis, disassembly, reassembly and similar activity common to this area.

Power Mechanics for Junior High Schools (7-9)

The junior high program in power should be introductory and exploratory in nature. It should provide the student with the opportunity to learn basic concepts related to power and to develop some fundamental shop skills and good work habits. A minimum of 25 periods (five weeks) of instruction in this area should be presented at this level. If time permits as many as 95 periods (19 weeks) or more could be spent profitably in power mechanics at the junior high level.

Power mechanics is not new to industrial arts, but it would be new to many Iowa schools. Unfortunately, it has not found its way into industrial arts programs to the extent that it should. It is strongly recommended that every effort be made to include a unit or course in power mechanics in junior high schools where it has not been offered and to strengthen the courses that presently exist.

Objectives. Every student should have the opportunity:

- To develop an understanding of the sources of power.
- To develop a realization of how power is applied.
- To develop an awareness of the power-producing devices that exist.
- To develop an understanding of the operation of power units.
- To develop the ability to use the tools and equipment common to the power industry.
- To develop the ability to perform operations necessary to the repair and maintenance of power units.
- To develop a desire for continuing investigation into the area of power.
- To develop judgement in selection and purchase of power units.

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- To develop personal behavior traits, habits, and attitudes which complement the power industry.

- To develop an awareness of the opportunities existing in the power industry.

Content. The following outline includes content which would be appropriate for junior high school course work in power mechanics. It is presented in sequential order, but this is not meant to interfere with flexibility in the order of presentation. The extent of class involvement with certain units may vary somewhat depending on individual circumstances. No attempt has been made to identify specific courses. The material here may be organized into one course or several depending on local scheduling arrangements and the equipment available. Since this area may be less familiar than some, teachers may find suggested student activities to be particularly helpful. Some are included and illustrated for quick reference.

I. Sources of energy

A. Mechanical (physical)

B. Heat

C. Chemical

D. Electrical

E. Nuclear

II. Chronological development of power-producing devices

A. Elements
1. Sun
2. Rain
3. Freezing
4. Wind
5. Water

B. Manpower

C. Animal power

D. External combustion engines (steam)
1. Hero's device
2. Steam engines
   a. Savery
   b. Newcomen
   c. Watt
   d. Hornblower
   e. Woolf
3. Steam engine-driven devices
   a. Locomotives
   b. Steamboats
4. Steam turbines
   a. Principle of operation
   b. Uses

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Activities

- Build an atmospheric steam engine.
- Build a piston-type steam engine.
- Make a pressure-volume diagram of a steam engine.
- Report on how the steam engine influenced the development of the United States.
- Report on steam and the industrial revolution.
- Visit a steam engine exhibition.
- Build a steam turbine.
- Build a model of a steam turbine powered ship (nuclear submarine).
- Draw plans for a steam engine.

E. Internal combustion engines
   1. Reaction engines
      a. Rockets
         (1) Solid fuel
         (2) Liquid fuel

Activities

- Read about various rocket uses.
- Build models of solid and liquid fuel rockets.
- View film on the development of rockets.

      b. Jets
         (1) Ram
         (2) Pulse
         (3) Turbo
         (4) Turbo-prop
         (5) Gas turbines for cars and trucks

Activities

- Operate a model jet engine.
- Visit an airport or a vocational school to see a jet aircraft engine.
- Report on success of race car turbine engines.

   2. Piston engines
      a. Two-stroke
         (1) History
         (2) Operation
         (3) Uses

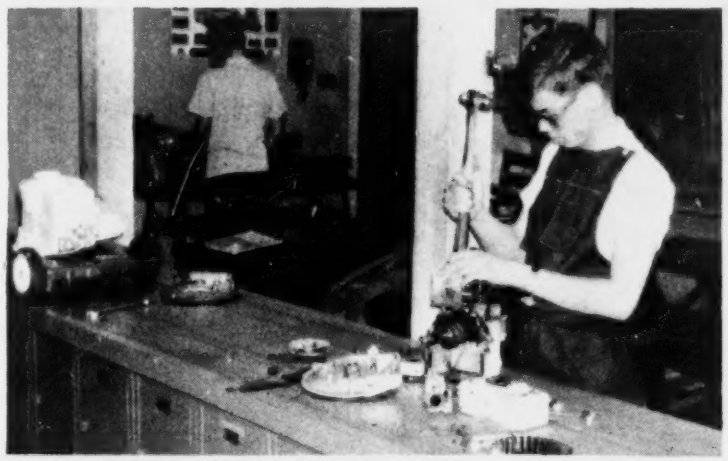

Small engine repair.

Activities

- Observe two-stroke engines in operation.
- Bring model airplane engines in to demonstrate.
- List the uses of a two-stroke engine.
- Disassemble a two-stroke engine, become familiar with its parts, and reassemble it.

      b. Four-stroke engine
         (1) History
         (2) Operation
         (3) Types
            (a) Gas

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(b) Diesel
(c) LPG
(4) Uses
(5) Configuration
(6) Systems
(a) Electrical
(b) Fuel
(c) Lubrication
(d) Cooling
(7) Materials
(a) Parts
(b) Gaskets
(8) Safety precaution for operation

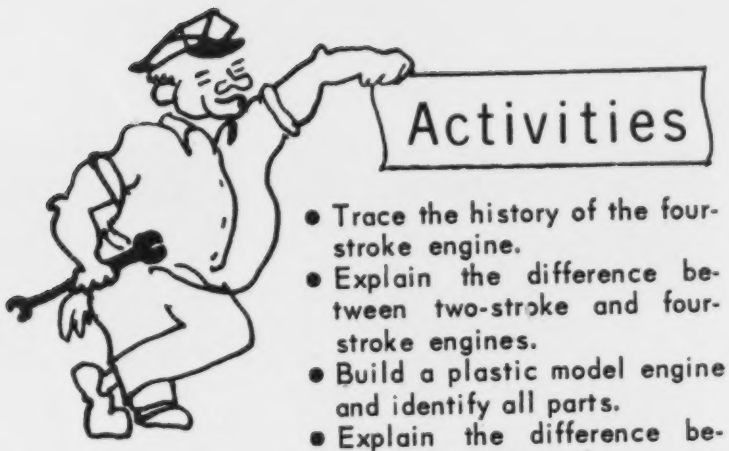

- Trace the history of the four-stroke engine.
- Explain the difference between two-stroke and four-stroke engines.
- Build a plastic model engine and identify all parts.
- Explain the difference between diesel and gas engines.
- Describe in-line, V-type, OHV, L-head engines.
- Examine a diesel tractor or truck.
- Disassemble a four-stroke single cylinder engine, reassemble it, start it, adjust carburetor.
- Examine the four systems of the engine.
- Trace each circuit--electrical, fuel, lubricant, coolant.
- Test each for proper operation.
- Adjust each system (where applicable).
- Distill some crude oil to get petroleum products.
- View a film on petroleum refining.
- Construct a display of a fractional distillation tower.

3. Rotary combustion engine (Wankel)
   a. History
   b. Operation
   c. Uses

F. Electrical power

Note: Except for ignition, starting and charging systems, electrical power is left to the electricity-electronics area.

G. Nuclear power

- Report on nuclear warfare.
- Build a model of a nuclear power plant.
- Tour a nuclear power plant.

III. Power Transmission

A. Mechanical
   1. Principles
      a. Simple machines
         (1) Lever
         (2) Wheel and axle
         (3) Inclined plane
         (4) Pulley
         (5) Wedge
         (6) Screw

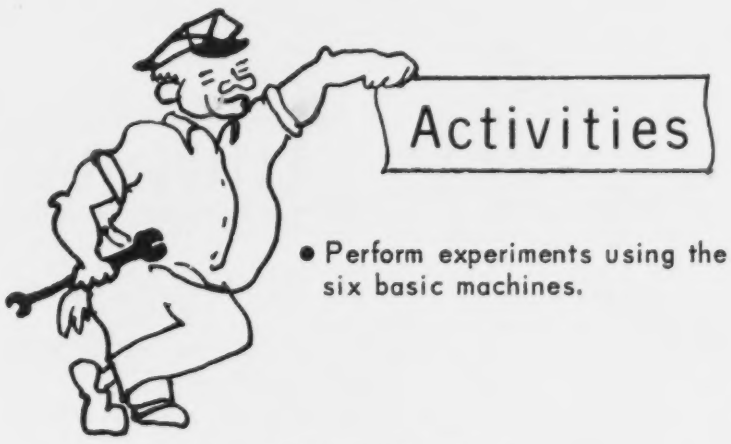

- Perform experiments using the six basic machines.

   2. Basic mechanisms
      a. Pulley and belt
      b. Sprocket and chain
      c. Cam and eccentric
      d. Bell crank and lever
      e. Piston and cylinder
      f. Spring
      g. Shafts
         (1) Extension
         (2) Crank
         (3) Cam

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Activities

- Disassemble and operate bicycle components -- single speed, 3-speed, and 10-speed.

h. Couplets
   (1) Positive
   (2) Friction
   (3) Fluid

Activities

- Examine and operate various clutches.

i. Gears
   (1) Types of teeth
      (a) Spur
      (b) Helical
      (c) Spiral
   (2) Arrangements
      (a) Internal teeth
      (b) External teeth
      (c) Rack and pinion
      (d) Worm
      (e) Bevel
      (f) Herringbone
      (g) Idlers
      (h) Planetary combinations

Activities

- Disassemble and examine transmission, steering gears, differential, and planetary gears of a 3-speed bicycle, and reassemble.

j. Bearings
   (1) Plain
      (a) Solid
      (b) Bushing
      (c) Split (insert)
   (2) Antifriction
      (a) Ball
      (b) Roller
      (c) Pin or needle
   (3) Materials
      (a) Requirements and conditions
      (b) Metals
      (c) Nonmetals
      (d) Lubricant impregnation
   (4) Applications
      (a) Radial
      (b) Axial
      (c) Load and speed

3. Maintenance and lubrication of basic mechanisms

Activities

- Identify types of bearings.
- Check bearing conditions.
- Adjust bearings.

B. Fluid
   1. Hydraulic
      a. Principles
         (1) Incompressibility of liquids
         (2) Multiplication of forces
         (3) Hydrodynamics

Activities

- Perform hydraulic jack experiments.
- Disassemble various types of pumps and valves.
- Trouble-shoot hydraulic malfunctions.

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b. Components and symbols
   (1) Pumps
   (2) Motors
   (3) Valves
   (4) Reservoirs
   (5) Lines
   (6) Cylinders
   (7) Accessory components

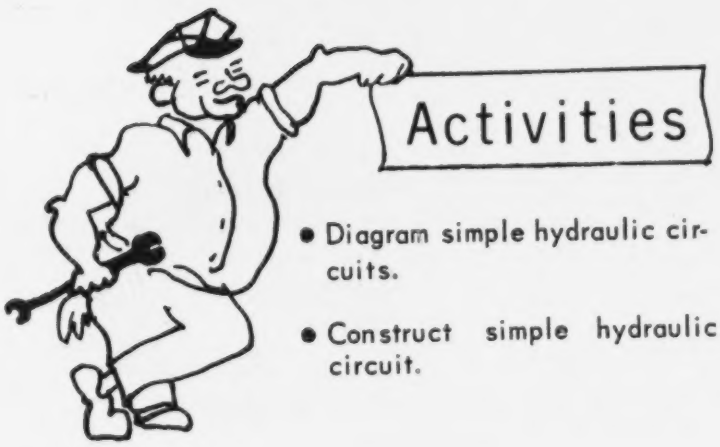

2. Pneumatic
   a. Principles
   b. Components and symbols

      (1) Reciprocating compressors
      (2) Rotary compressors
      (3) Lobe type
      (4) Liquid piston
      (5) Centrifugal
      (6) Axial flow
      (7) Vacuum pumps
      (8) Combination vacuum pumps and compressors

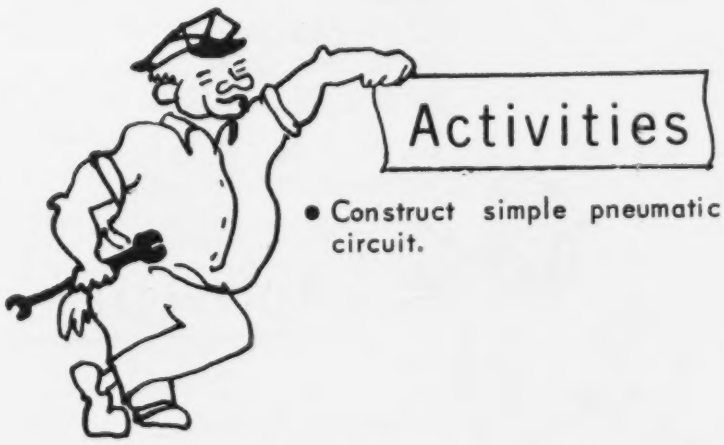

   c. Circuitry
   d. Maintenance and safety
   e. Applications

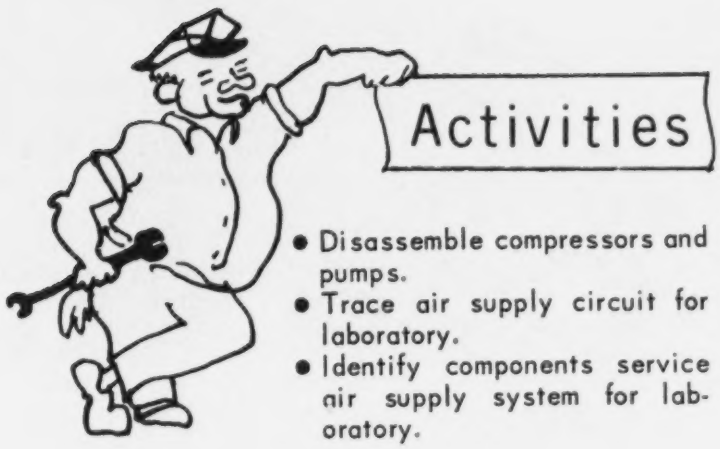

IV. Power measurement

A. Definitions
   1. Work
   2. Energy
   3. Power
   4. Inertia
   5. Torque
   6. Horsepower

B. Determining engine size
   1. Displacement
   2. SAE horsepower
   3. Indicated horsepower
   4. Brake or developed horsepower

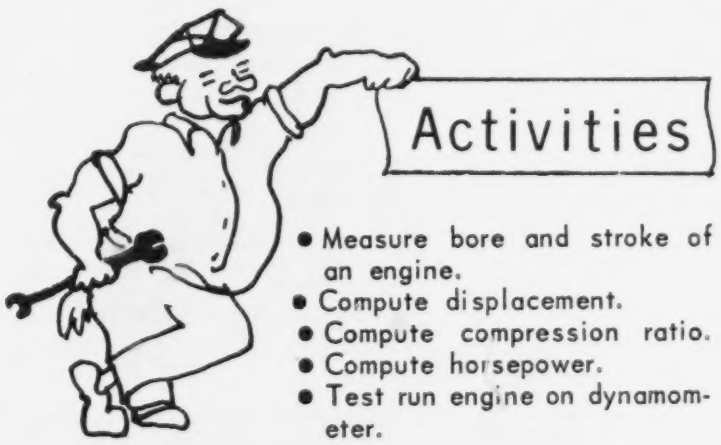

   5. Friction horsepower
   6. Torque

C. Measuring engine efficiency
   1. Mechanical
   2. Thermal
   3. Volumetric

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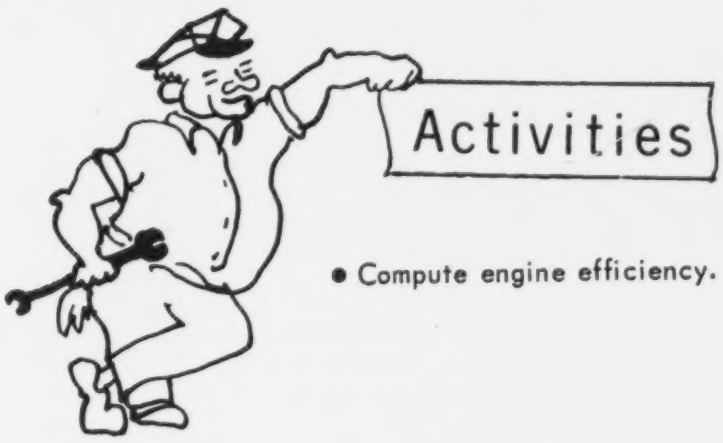

V. Opportunities in the power industry

A. Service

B. Manufacturing

C. Research

Auto Mechanics for the Senior High Schools (10-12)

Should power mechanics not be taught at the junior high school level, it would be best to offer a sound one-semester or full year course in this area and consider it as a prerequisite for auto mechanics.

Further study can be done in most areas of power without the automobile as the subject; however, the automobile serves admirably as a self-contained, portable power mechanics laboratory. Many of the energy conversion and transmission devices studied in power mechanics are used on the automobile. Because of this and because of the availability of the automobile, it is most frequently used as the medium for advanced studies in power.

It is important that instruction in auto mechanics be planned and executed in a purposeful manner. Tinkering in a hit-or-miss fashion should not be tolerated. "Junkers" should not be allowed to take up valuable floor space in the shop nor allowed to clutter the exterior. Extra interest and valuable experience can result from modifications, but these should be carefully designed and based on scientific principles. The instructional program must never suffer to accommodate owners of cars which have been accepted for repair or tune up.

Objectives. Since auto mechanics is a branch of power mechanics, the objectives are the same, but greater awareness, understanding, and skill should develop.

Content. The content which follows is not organized rigidly into courses. It is, however, outlined under three main headings, chassis, automobile engines, and auto electricity and tune-up which could be covered in a full year course or become the titles of semester length or full year courses. A number of satisfactory arrangements may be developed. This material is presented as a guide only. How this or other information is presented is the responsibility of the individual instructor working within the limitations of available time and facilities.

Chassis

I. Brakes

A. The principles of braking
   1. Friction
   2. Types and history of brakes

B. Hydraulics — principles and function of parts

C. Types of brake action
   1. Single anchor
   2. Double anchor
   3. Double anchor, double cylinder brake
   4. Self-energizing brake shoe
   5. Servo-action
   6. Caliper-action

D. Servicing brakes
   1. Turning drums
   2. Arcing shoes
   3. Resurfacing discs
   4. Replacement of cylinder kits

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E. Adjustment
   1. Adjusting shoes, manual, and self-adjusting
   2. Adjusting front bearings
   3. Bleeding brake lines
   4. Adjusting mechanical linkage

F. Special braking devices
   1. Power brakes
   2. Anti-roll device
   3. Emergency brakes
   4. Brake lights

II. Suspension

A. Importance of alignment

B. Types of suspension systems
   1. Leaf springs
   2. Coil springs
   3. Torsion bar springs
   4. Air springs
   5. Solid axle suspension
   6. Independent suspension

C. Geometry of the suspension system
   1. Caster — definition, function, and adjustment
   2. Camber — definition, function, and adjustment
   3. Toe-in and toe-out — definition, function, and adjustment
   4. Kingpin or steering axis inclination — definition and function
   5. Turning radius and slip angle

D. Steering linkage
   1. Inspect and adjust steering gear box
   2. Inspect and adjust steering linkage (Pitman arm, idler arm, center link, tie rod)

E. Alignment

III. Drive line

A. Universal joints

B. Propeller shaft

IV. Transmission

A. Conventional
   1. 3-speed
   2. 4-speed
   3. Other

B. Overdrive

C. Automatic
   1. Basic structure
   2. Fundamentals of operation
      a. Couplings
      b. Converters
      c. Planetary units
   3. Control systems
   4. Service operations

V. Differential

A. Conventional
   1. Operation
   2. Adjustment
   3. Repair

B. Limited slip
   1. Operation
   2. Adjustment
   3. Repair

Automobile Engine

I. Review of fundamentals

A. 4-stroke cycle

B. Engine measurement
   1. Bore and stroke
   2. Piston displacement
   3. Compression ratio
   4. Brake horsepower
   5. Torque
   6. Volumetric efficiency

II. Introduction

A. Fuel system

B. Electrical system

C. Cooling system

D. Lubricating system

E. New tools and equipment

III. Engine overhaul procedure

A. Diagnose engine troubles

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B. Follow logical order for disassembly

C. Observe defects

D. Measure clearance

E. Make use of manuals

IV. Engine systems

A. Intake and exhaust

B. Cooling

C. Lubrication

D. Valves

E. Pistons

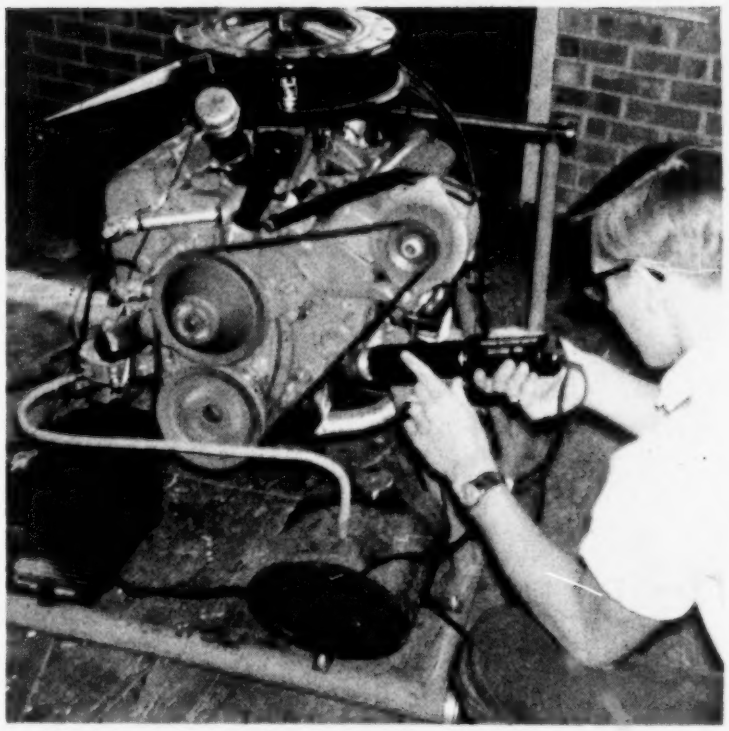

Timing an engine.

Auto Electricity and Tune-up

I. Electrical fundamentals

A. Electricity

B. Magnetism

C. Induction

II. Storage batteries

A. Construction

B. Operation

C. Service

III. Ignition systems

A. Coils

B. Distributors
1. Advance mechanisms
2. Primary circuit
3. Secondary circuit

C. Resistors

D. Suppressors

E. Spark plugs

F. Service
1. Analyzing
2. Repairing

IV. Cranking motors

A. Fundamentals of D.C. motors

B. Circuits

C. Switches

D. Drives

E. Service

V. Fuel systems

A. Carburetors
1. Fundamentals
2. Service

B. Fuel pumps
1. Fundamentals
2. Service

VI. D.C. charging systems

A. Generators
1. Operating principles
2. Service

B. Regulators
1. Relay

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2. Voltage regulator
3. Current regulators

VII. A.C. charging systems

A. Generators
1. Operating principles
2. Service

B. Regulators

VIII. Semi conductors

A. Fundamentals

B. Regulation

C. Ignition

IX. Tune-up procedures

A. Analysis

B. Repair

C. Flat rate

SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purposes of illustration. Sources that pertain to power are included if specific material is not listed below. Additional information of a general nature may be found on page 48.

Miscellaneous Materials

- Wall Chart: "Spark Plug Wall Chart and Leader's Guide," AC Spark Plug Division, General Motors Corporation, 1300 North Dort Highway, Flint, Michigan 48506.
- Manual: "AC Spark Plug Shop Manual," AC Spark Plug Division, General Motors Corporation, 1300 North Dort Highway, Flint, Michigan 48506.
- Pamphlet: "A.S.I.A. Booklet entitled, "Automotive Instructional Material," Automotive Service Industry Association, 168 North Michigan Avenue, Chicago, Illinois 60601.
- Pamphlets: "Regulation and the Charging Circuit (DR-9015)," "Distributor Coil Generator Regulator (DR-9019)," and "The Cranking Circuit and How It Works (DR-9025)," Delco-Remy Division, General Motors Corporation, Anderson, Indiana.
- Pamphlet: "Facts About Storage Batteries," and Wall Chart: "How a Storage Battery Works," Exide Sales, Automotive Division, The Electric Storage Battery Company, Box 6266, Cleveland, Ohio 44101.
- Booklet: "A Message to America's Educators About Plymouth Trouble Shooting," Plymouth Division, Chrysler Motor Corporation, Detroit, Michigan.
- Leaflet: "The One-Leaf-Book Story of Flight and Air Transportation," United Air Lines, School and College Dept., Box 66141, Chicago, Illinois 60666.
- Booklet: "Compressed Air Power in Manufacturing," The Sub-committee on Engineering Education of Compressed Air and Gas Institute, 55 Public Square, Cleveland, Ohio 44113.
- Pamphlet: "Facts About Spark Plugs and Engines," Champion Spark Plug Company, Toledo, Ohio.
- Booklet: "Facts for Study," Educational Services, Automobile Manufacturers Association, 320 New Center Building, Detroit, Michigan 48202.
- Pamphlet: "Career Opportunities in Automotive Service," Automobile Manufacturers Association, Inc., 320 New Center Building, Detroit, Michigan 48202.
- Booklet: "The Story of Gas," Educational Service Bureau, American Gas Association, Inc., 605 Third Avenue, New York, New York 10016.
- Manual: "Service and Merchandising Manual," Champion Spark Plug Company, Toledo, Ohio.

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Assignment

WS. 43-50 Make an isometric drawing of each object shown on Illustration Sheets 22 and 23, pages 79, and 81. Draw one object on each Work Sheet. In order to center the objects on your Work Sheets, it will be necessary to follow this procedure:

1. Draw only the outline of the object on a piece of practice paper to obtain overall dimensions.
2. Locate isometric axis on Work Sheet so object being drawn will be centered on drawing.

WS. 43. Vise Block.

WS. 44. Step.

WS. 45. Enclosed Step.

WS. 46. Angle Slot.

WS. 47. Gable.

WS. 48. V. Block.

WS. 49. Wedge.

WS. 50. Centering Block.

WS. 51-54 Make an oblique drawing of each object shown on Illustration Sheet 24, page 83. Draw one object on each Work Sheet. In order to center the objects on your Work Sheets it will be necessary for you to follow the procedure given for isometric drawings.

WS. 51. Step Block.

WS. 52. H Block.

WS. 53. Slide Block.

WS. 54. Dovetail.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.
- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.
- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.
- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.
- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Books

- *All About Small Gas Engines,* Purvis, Jud, Goodheart-Willcox, 18250 Harwood Avenue, Homewood, Illinois 60430.
- *Auto Mechanics Fundamentals,* Stockel, Martin W., Goodheart-Willcox, 18250 Harwood Avenue, Homewood, Illinois 60430.
- *Automechanics,* Glenn, Harold T., Charles A. Bennett Company, Inc., 809 West Detweiller Drive, Peoria, Illinois 61614, 1962.
- *Automotive Diagnosis and Tune-Up,* Wetzel, Guy F., McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1965.
- *Automotive Electrical Systems,* 2nd edition, I. Frazee, and E. Bedell, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637.
- *Automotive Encyclopedia,* W. K. Toboldt, editor, Goodheart-Willcox, 18250 Harwood Avenue, Homewood, Illinois 60430, 1968.
- *Automotive Engines — Maintenance and Repair,* 3rd edition (Includes fuel and ignition systems), W. E. Billiet and E. A. Venk, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637.
- *Automotive Fundamentals,* 3rd edition, Ernest A. Venk, and W. E. Billiet, American Technical Society, 848 East 58th Street, Chicago, Illinois 60637.
- *Auto Service and Repair,* Martin W. Stockel, Goodheart-Willcox, 18250 Harwood Avenue, Homewood, Illinois 60430, 1969.
- *Exploring Power Mechanics,* Harold T. Glenn, Charles A. Bennett Company, Inc., 809 West Detweiller Drive, Peoria, Illinois 61614, 1967.
- *Power Mechanics,* Pat H. Atteberry, General Shop Texts, Goodheart-Willcox, 18250 Harwood Avenue, Homewood, Illinois 60430.
- *Power Mechanics,* George E. Stephenson, Power Mechanics, Delmar Publishers, Inc., Albany, New York.
- *Power-Prime Mover of Technology,* Joseph W. Duffy, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1964.
- *Understanding Your Car,* Samuel Beeler, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1967.

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TOOLS AND EQUIPMENT

The following list is presented as a guide in the selection of tools and equipment needed to teach power. The approximate number of each item needed for a small, medium, or large number of students in unit shop for power is indicated as well as items needed to equip a power area of a general shop.

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Basic Tools and Equipment for the Power Area of a General Shop

	No. Needed
Tool kits (1 kit for every 3 students)	
Combination wrench set $\frac{1}{4}$" to 1"	13 pieces
Screw driver set	5
Putty knife	1
Combination needle nose pliers and side cutters	1
$\frac{3}{8}$" socket set including:	
Ratchet	1
Extensions, 12", 7", 3"	3
Speed handle	1
Universal joint	1
Sockets $\frac{5}{16}$" to $\frac{7}{8}$"	10
Spark plug socket $\frac{13}{16}$"	1
Hammer, ballpeen 12 oz.	1
Hammer, soft face	1
Cabinet	1
Spark plug cleaner and tester	1
Coil condenser tester	1
Grinder (pedestal)	1
Valve and valve seat refacer	1
Valve and lapping device	1
Ring compressor 1" - 3"	1
Ring remover	1
Universal puller set and bushing removers	1
Manufacturers manuals (assorted)	
Flip charts (set)	1
Engines (1 cylinder, 4-stroke)	4
Demonstration equipment (models, mock-ups)	
Benches	4
Tool, equipment supply storage	
Vises	4
Parts cleaner	1
Compressed air service	
Gasoline cans (safety) 2 gal.	1
Can with pouring spout 3 gal.	1
Oil cans	2
Funnel, small	1
Funnel, medium	1
Oily waste cans	2
Fire extinguishers	1
Demonstration bench	1
Chalk board	1
Chairs	8
Soldering coppers (electrical)	1
Micrometer 0-1", 0-2", 0-3"	1 ea.
Feeler gauges (set .001-.030)	1

	Class Size		
	Small (8)	Medium (12)	Large (16)
Feeler gauges	1	2	2
Spark plug gap gauge	1	1	1
Dial indicator	1	1	1
Set small hold gauges $\frac{1}{8}$" - $\frac{1}{2}$"	1	1	1
Set telescope gauges $\frac{1}{2}$" - 2"	1	1	1
Tape measure 6"	1	1	1

Basic Tools and Equipment for the Power Unit Shop

Power mechanics

Tool kits (1 kit for every 3 students)
Combination wrench set $\frac{1}{4}$" to 1" (13 pieces)
Screwdriver set (5)
Putty knife (1)
Combination wrench set $\frac{1}{4}$" to 1" (13 pieces)
Screwdriver set (5)
Putty knife (1)
Combination needle nose pliers and side cutters (1)
$\frac{3}{8}$" socket set including: (17)
Universal joint (1)
Sockets $\frac{5}{16}$" to $\frac{7}{8}$" (10)
Spark plug socket $\frac{13}{16}$ (1)
Hammer, ballpeen 12 oz. (1)
Hammer, soft face (1)
Cabinet (1)

	Class Size		
	Small (8)	Medium (12)	Large (16)
Spark plug cleaner and tester	1	1	1
Coil condenser tester	1	1	1
Grinder (pedestal)	1	1	1
Valve and valve seat refacer	1	1	1
Valve lapping device	1	1	1
Ring compressor 1"- 3"	1	1	2
Ring remover	1	2	2
Universal puller set and bushing removers	1	1	1
Manufacturer's manuals (assorted)			
Flip charts (set)	1	1	1
Engines (1 cylinder, 4 stroke)	4	6	8
Demonstration equipment			
Benches	4	6	8
Tool, equipment supply storage			
Vises	4	6	8
Parts cleaner	1	1	1
Compressed air service			
Gasoline cans (safety) 2 gal.	1	1	1

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	Class Size Small (8)	Medium (12)	Large (16)
Can with pouring spout 3 gal.	1	1	1
Oil cans	2	3	4
Funnel, small	1	1	1
Funnel, medium	1	1	1
Oily waste cans	2	2	2
Fire extinguishers	1	1	1
Demonstration bench	1	1	1
Chalk board	1	1	1
Chairs	8	12	16
Soldering coppers (electrical)	1	1	2
Auto engine			
Valve shop with valve and seat refacer	1	1	1
Valve spring compressor	1	1	2
Valve spring tester	1	1	1
Ridge reamer	1	1	2
Cylinder hone	1	1	1
Ring compressor 2" - 5"	1	1	1
Ring groove cleaner	1	1	1
Bearing leak detector	1	1	1
Engines 6 cylinder	1	2	4
Engines 8 cylinder	2	4	4
Engines 4 cylinder (air cooled)	1	2	2
Engine stands	4	6	8
Engine lift (hydraulic)	1	1	1
Creepers	1	2	2
Oil drain pans	1	1	1
12 volt battery	2	3	4
Electrical and tune-up			
Timing light	1	1	2
Compression tester	1	1	1
Engine oil pressure tester	1	1	1
Tach-dwell indicator	1	1	2
Vacuum-pressure gauge	1	1	1
Cylinder leakage tester	1	1	1
Distributor test stand	1	1	1
Point-tension scale	1	1	1
Engine analyzer scope	1	1	1
Battery charger	1	1	1
Portable generator tester (voltmeter, ammeter, and ohmmeter)	1	1	1

	Class Size Small (8)	Medium (12)	Large (16)
Growler with continuity tester	1	1	1
Low voltage reheostat	1	1	1
Battery kit (cell tester, hydrometer, filler, tools)	1	1	1
Starter tester	1	1	1
Starter brush scale	1	1	1
Armature lathe	1	1	1
Generator-regulator test stand	1	1	1
Generator, alternator, regulator tester (portable)	1	1	1
Exhaust analyzer	1	1	1
Manufacturer's manual (assorted) auto			
Manufacturer's manual (assorted) carburetor			
Flip charts (assorted)			
Generators D.C. and regulator set	4	6	8
Starters	4	6	8
Distributors	4	6	8
Alternators with regulators	4	6	8
Coils	4	6	8
Condensers	4	6	8
Carburetors 1, 2, 4 barrel	4	6	8
Delco charts	1	1	1
Delco specifications manual	1	1	1
Delco service manual	1	1	1
Autolite specifications manual	.	1	1
Autolite service manual	1	1	1
Chassis dynamometer			
Preventive Maintenance			
Greasing equipment	1	1	1
Tire gauge	1	1	1
Air chuck	1	1	1
Floor jack	1	1	1
Adjustable jack stands	4	6	8
Bumper jack	1	1	1
Two-post lift	1	1	2
Tire tool repair set	1	1	1
Power train			
Transmission (standard)	2	4	5
Transmission (automatic)	2	4	5

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	Class Size Small (8)	Medium (12)	Large (16)
Rear axle assembly	2	4	5
Universal joint	2	2	3
Propeller shaft	1	1	1
Front end and brakes			
Alignment equipment	1	1	1
Wheel balancer	1	1	1
Brake tools (set)	1	1	2
Brake shop			
Cylinder hone	1	1	1
Brake gauge set	1	1	1
Power bleeder	1	1	1
Hydraulic brake models (power and non-power)	1	2	4
Front end assembly on stand (suspension steering)	1	2	4
Power steering model	1	2	4
Master cylinder	1	2	4
Wheel cylinder	1	2	4
Hand tools			
Set end wrenches $\frac{7}{16}$" - $1\frac{1}{4}$"	1	1	2
Set box wrenches $\frac{3}{8}$" - $1\frac{1}{4}$"	1	1	2
Set box end combination wrenches $\frac{3}{8}$" - 1"	1	1	2
Set socket wrenches $\frac{1}{4}$" drive	1	1	2
Set socket wrenches $\frac{3}{8}$" drive $\frac{3}{8}$" - $\frac{3}{4}$"	1	1	2
Set socket wrenches $\frac{1}{4}$" drive	1	1	2
Set socket wrenches $\frac{3}{4}$" drive $\frac{3}{4}$" - 2"	1	1	1
Torque wrenches $\frac{1}{4}$" drive 0-150#	1	1	2
Stud remover $\frac{1}{2}$" drive	1	1	2
Set spark plug sockets $\frac{1}{2}$" drive	1	1	2

	Class Size Small (8)	Medium (12)	Large (16)
12" pipe wrench	1	1	1
16" pipe wrench		1	1
Set tappet wrenches	1	1	1
Set Allen wrenches	1	2	3
Vice grip pliers	1	1	2
Diagonal pliers	1	2	3
Needle nose pliers	1	2	3
Combination pliers	1	2	3
Water pump pliers		1	1
Hacksaws	1	1	1
Set pin punches	1	1	1
Set center punches	1	1	1
Set starting punches	1	1	1
Set chisels	1	1	1
Ignition tool set	1	1	2
Set of taps and dies NC $\frac{1}{4}$" - 1"	1	1	1
Set of taps and dies NF $\frac{1}{4}$" - 1"	1	1	1
Set H.S. fractional drills $\frac{1}{8}$" - $\frac{1}{2}$"	1	1	1
Cleaning brushes	2	4	6
Wire cleaning brushes	2	2	4
Tubing cutting and flaring set	1	1	1
$\frac{1}{4}$" electric drill H.D.	1	1	
$\frac{1}{4}$" electric drill H.D.	1	1	1
Extractor set	1	1	1
Putty knives	1	2	3
Files (Mill)	2	2	4
Ball peens — 8 oz.	1	1	2
Ball peens — 12 oz.	1	1	2
Ball peens — 20 oz.	1	1	2
Soft face hammers	1	1	2
Brass hammers	1	1	2
Safety goggles (to fit over personal safety glasses when working under dirty cars)	2	3	4
Screwdrivers			
Small	2	2	3
Medium	2	2	3
Large	2	2	3
Phillips set	1	1	1
Clutch head set	1	1	1
Tin snips	1	1	1
Carter carburetor tool set	1	1	1
Rochester tool set	1	1	1

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	Class Size		
	Small (8)	Medium (12)	Large (16)
Measuring tools			
0-1" micrometer, outside	1	1	1
1-2" micrometer, outside	1	1	1
2-3" micrometer, outside	1	1	1
3-4" micrometer, outside	1	1	1
4-5" micrometer, outside	1	1	1
0-6" micrometer set	1	1	1
Inside micrometer set	1	1	1
Outside calipers 6"	1	1	1
Inside calipers 6"	1	1	1
Combination square set 12"	1	1	1

SUPPLIERS OF TOOLS AND EQUIPMENT

- Ammco Tools, Inc., 2100 Commonwealth Avenue, North Chicago, Illinois 60064. (wheel alignment and brakes)
- Automotive literature. Bear Manufacturing Company, 2830 Fifth Street, Rock Island, Illinois 61201. (wheel alignment, balancing, brake)
- Merc-O-Tronic Instruments Corporation, 215 Branch Street, Almont, Michigan 48003. (test equipment)
- Snap-on Tools Corporation, 8079 28th Avenue, Kenosha, Wisconsin 53140. (wrenches and mechanics maintenance tools)
- Sun Electric Corporation, 6323 Avondale Avenue, Chicago, Illinois 60631. (portable engine testing equipment)
- Autopower Corporation, 3163 Adams Avenue, San Diego, California 92116. (universal engine stands)

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WOODWORKING

FINISHING

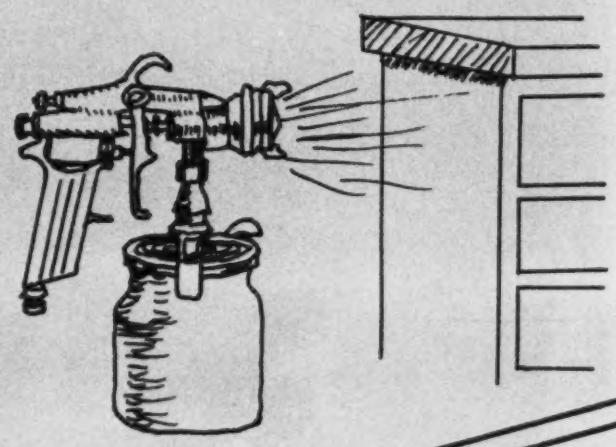

SKILLS

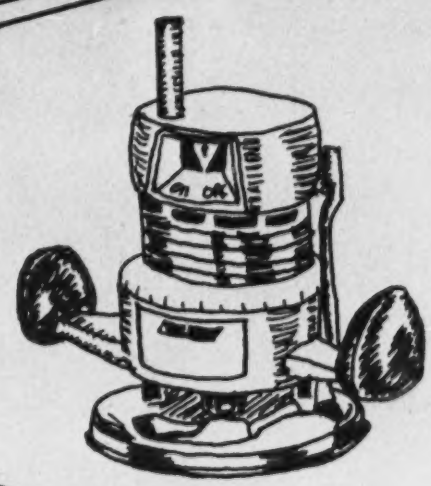

PLANNING & DESIGN

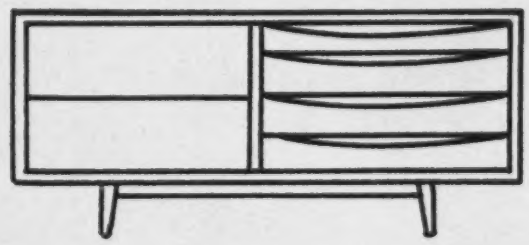

TECHNOLOGY

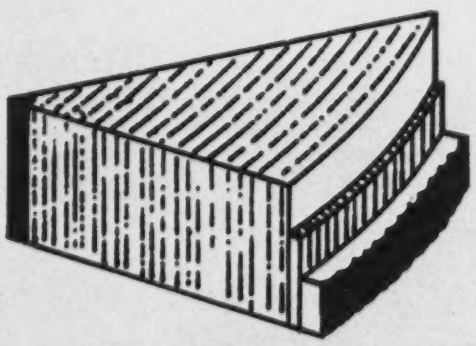

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One of our greatest natural resources is wood, from which a host of wood products are derived. Today, with the new wood products being produced, additional knowledge and skills must also be developed.

A relatively small percentage of our students will be employed in the wood industries, but all will be consumers, wage earners, and many will be home owners. A knowledge of wood and wood products is needed.

This area lends itself to certain construction activities with simple hand tools at the elementary school level. Tools are readily available and relatively inexpensive. The availability of free or inexpensive materials also encourages the use of construction activities at the elementary school level. If facilities permit, individually-made, take-home projects can be produced, but the thrust of industrial arts at this level is generally toward activities that result in the construction of a device or object that enriches or motivates interest in some phase of classroom instruction.

Woodworking is an important area in the junior high industrial arts program. Here, students should acquire skill and knowledge in the basic processes and uses of wood. They should learn about industrial applications of wood processes and develop an appreciation of safe practices in woodworking. An understanding of some of the occupational opportunities and requirements for employment in the wood industries is also important. They should catch a glimpse of the exciting activity that can be pursued if they elect to take additional work in this area in senior high school.

Basic concepts of industrial arts should be a part of elementary teacher training.

At least two years of sequential course work in woodworking should be available in the senior high school. Semester length courses in certain areas such as machine woodworking, wood finishing, upholstery, wood turning, pattern making, and boat building could be offered or certain of these areas could be combined or arranged to make up two or more full-year courses. Equipment and facilities adequate for some specialization must be provided. Course work at this level, despite the high degree of proficiency attained by some students, should not be considered as training for earning a wage.

Woodworking presents some opportunity for the application of mathematical and scientific principles and certain other aspects of general education. Safety instruction is essential to this area, and special emphasis should be placed on developing an understanding of what constitutes safe working conditions. Likewise, the development of good safety habits should be stressed. Students should be encouraged to develop original designs or modify existing designs as they undertake project work of a traditional nature. Mass production work, special investigation of a technical nature, experimentation, and other newer approaches may be utilized to good advantage in this important area.

Woodworking for Junior High Schools (7-9)

One of the industrial arts courses most commonly offered in school shops across the nation, and in Iowa as well, is that of woodworking. It is most appropriate to offer some instruction in this area at the junior high school level. Students have sufficient physical maturity to use junior sizes, or even some standard sizes, of common woodworking tools with substantial success. Students enjoy working in this area and they often come to it with strong interests, needs, and somewhat unrealistic goals. The first course should capitalize on such enthusiasm and provide the opportunity for students to learn basic concepts related to woodworking; and to develop good work habits and a degree of skill in using common woodworking tools and certain machines.

A minimum of 25 periods (5 weeks) of instruction in this area should be presented at this level. If time permits, as many as 105 periods (21 weeks) or

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more could be spent profitably in woodworking at the junior high level.

Objectives. Every student should have the opportunity:

- To explore the area of woodworking and the related information about industries dependent upon wood and its uses.
- To develop skills in handling tools, wood, and wood-related products.
- To develop appreciation of good craftsmanship in design and construction of wood products.
- To develop cooperation, communication, and responsibilities towards others while working with others.
- To discover aptitude and interest in woods and woodworking.
- To develop the ability to make better selections of wood products.
- To develop careful planning procedures and safe work habits in wood construction.

Content. The following outline includes content which would be appropriate to teach in junior high school course work in wood. Woodworking must be a sequential process leading from the simplest to the more advanced techniques. The junior high program is an introduction into various woodworking units. Many of the units covered must be expanded and continued in later woodworking courses.

The following is a guide on which to build a program suited to each individual situation. No attempt has been made to identify specific courses. The material here may be organized into one or more courses depending on local scheduling arrangements. Appropriate student activities are available in textbooks and professional journals, but some are included here. These are illustrated for quick reference.

I. Introduction

- A. Objectives
- B. History
- C. Nature of wood and woodworking
- D. What is expected of students
- E. Career opportunities

II. Drawing and planning

- A. Kinds of drawings
  1. Sketches
  2. Working drawings
- B. Bill of materials
- C. Estimating costs of woodworking materials
- D. Purchasing and ordering lumber
- E. Order of procedure
- F. Sources of materials

III. Design

- A. Styles of furniture
- B. Function
- C. Designing procedures
- D. Materials
- E. Construction
- F. Appearance

IV. Wood technology

- A. Nature of wood
  1. Composition and chemistry
  2. How it grows
- B. Lumbering
  1. Forests
  2. Conservation
  3. Saw mills
  4. Seasoning
- C. Kinds and classification
  1. Hardwoods and softwoods
  2. Common woods identification
  3. Characteristics
- D. Grading and dimensions
  1. Hardwood, softwood, plywoods

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2. Defects, enemies and moisture
3. Plywood and veneers
   a. Production
   b. Grades
   c. Uses
   d. Advantages
   e. Disadvantages
4. Lumber products
   a. Hardboard, particle board, laminates
   b. Production — uses

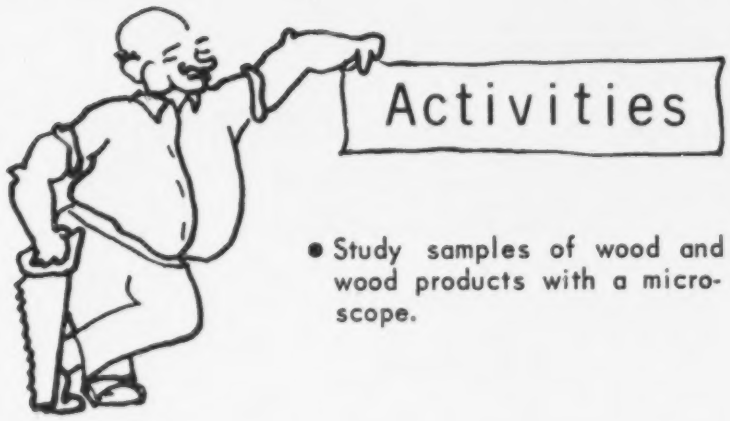

V. Safety

A. General rules

B. First aid

C. Organization of equipment

D. Cleanup

E. Specific tool and machine rules

VI. Hand tools

A. Importance of good tools

B. Measuring and layout

C. Squaring

D. Cutting

E. Scraping

F. Drilling and boring

G. Care and sharpening
   1. Edges and angles
   2. Grinding and honing

H. Adjustment and use

VII. Portable power tools

A. Drills
   1. Sizes ($\frac{1}{4}$", $\frac{3}{8}$", $\frac{1}{2}$")
   2. Speeds
      a. Constant
      b. Variable
      c. Reversible

B. Sanders
   1. Belt
   2. Orbital
   3. Straight line vibrator

C. Cutting
   1. Saber saw
   2. Circular saw

VIII. Non-portable power tools

A. Scroll saw

B. Band saw

C. Table saw

D. Radial saw

E. Lathe

F. Drill press

G. Jointer

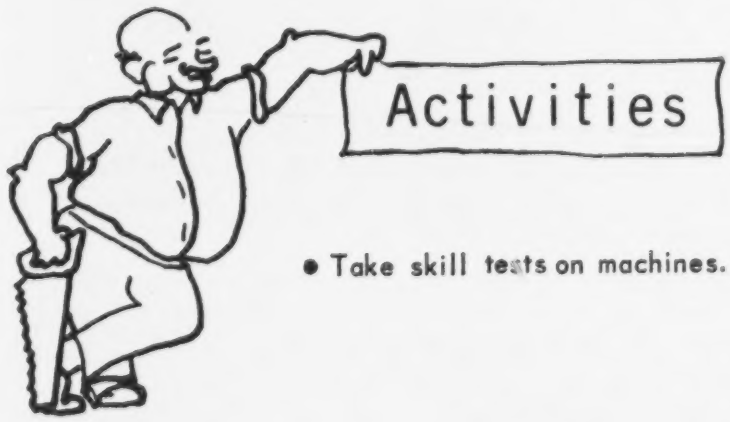

IX. Construction

A. Joints and joining
   1. Butt
   2. Dado

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3. Rabbet
4. Miter
5. Lap

B. Adhesives
1. Kinds
2. Characteristics
3. Uses

C. Clamping
1. Types
a. Bar
b. Handscrew
c. Corner
2. Application and pressure

D. Abrasives
1. Kinds
2. Quality
3. Grit
4. Use

E. Fasteners
1. Types
2. Selection
3. Use

Surface preparation for wood finishing.

X. Wood finishing and refinishing

A. Preparing the surface

B. Staining

C. Fillers

D. Finishes

E. Application

Activities

- Experiment with finishes and application.

XI. Upholstery

A. Simple padding methods involving foam materials

B. Covering procedures

XII. Consumer knowledge

A. Manufacturer

B. Division of labor

Woodworking for Senior High Schools (10-12)

Industrial arts in the senior high school should be a continuation of the program started in the junior high. The students interested in this field should be able to continue through another two-year sequence. It is important that woodworking at this level not be confined to furniture building regardless of the high interest of students and esteem of school patrons in regard to such activity. Many experiments may be conducted, the structure of wood studied, texts and reference materials used, and shop activity should expose students to a number of kinds of woodworking activity in addition to furniture building.

Some schools have sought to strengthen their industrial arts programs by eliminating courses in this area at the senior high level. Admittedly, many Iowa schools have in the past emphasized woodworking to the near exclusion of other subject areas and to the detriment of their program. But to eliminate woodworking from the senior high school level does not necessarily strengthen the industrial arts program. It is required that programs include a number of challenging subject-matter areas, that traditional woodworking programs be improved and

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UNIT VII — ARCHITECTURAL DRAWING

General Information

An architect is a professional man who designs buildings, draws plans, and supervises the construction of a building. The architect must know the needs of the person for whom he is going to build. He must know the kind, size and style of house his client wants, as well as the amount of money his client has to spend. He then has to record this information in a "set" of plans so that the builder can build what his client desires.

An architect usually does not sell his plans and specifications of a building; he sells his services.

A number of drawings are necessary to complete a "set" of house plans. They should include; floor plan, basement or foundation plan, elevations, plot plan, and details as needed. Architectural drawings are usually drawn to scale with one foot on the building equal to one-fourth inch on the drawing. Thus $\frac{1}{4}$" = 1' - 0".

Illustration Sheet 26, page 91, shows the method an architect would use to block-in a floor plan.

Elevations of a building are merely finished drawings that provide outside views that show the general design of the building. They show the type, design, and location of windows and doors; the style of the roof, the kind of shingles used, the type of cornice used, and describe the exterior appearance of the building.

Illustration Sheet 28, page 95, shows a section through a

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up-dated, and that woodworking courses be permitted to make their legitimate contribution to the overall industrial arts program without encroaching on other areas that have equally important contributions to make.

Objectives. Every student should have the opportunity:

- To further develop background and information in relation to the industries of wood and wood products in this country.
- To further develop skills in handling tools and shaping wood and wood products.
- To develop appreciation of good design and craftsmanship.
- To continue the development of safe work habits.
- To improve the ability for intelligent selection and usage of wood products.
- To make and read working drawings.
- To further develop cooperation, communication, and responsibility to others when working in groups.

Content. The content which follows is not organized into courses, but there is more than enough content to permit the basis for several courses. All areas may be covered in a woodworking course which would build on experiences gained in the course work offered in this area at the junior high school level. This could be followed with semester length or full year courses in major areas. It is recognized that sequence of instruction and extent of student involvement may be modified by local conditions. The suggested content is presented as a guide only. How this or other information is presented is the responsibility of the individual instructor. Appropriate student activities for this area are readily available in textbooks and professional journals.

I. Introduction

A. Objectives

B. What is expected of the students

II. Drawing and planning

A. Reading and making blueprints

B. Geometric work

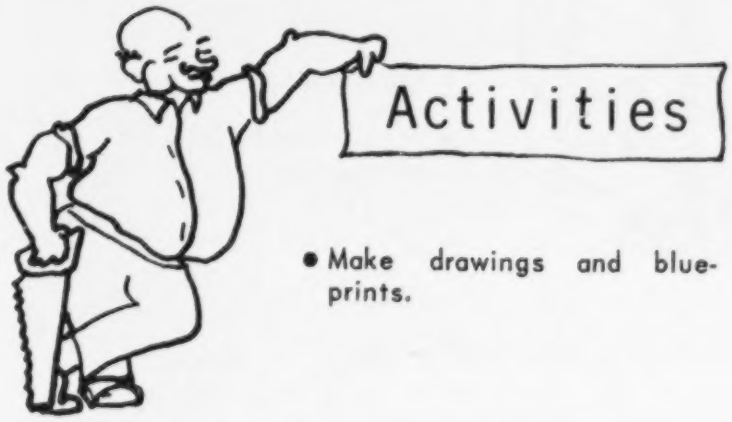

III. Shop math

A. Board measure

B. Fractions and decimal

C. Metric measurement

IV. Design

A. Styles

B. Principles and elements

C. Design evaluation

D. Color

V. Wood technology

A. Wood identification

B. Physical properties

C. Wood analysis
1. Composition
2. Chemistry
3. Moisture
4. Content
5. Shrinkage
6. Warpage

D. Wood preservation
1. Wood-destroying organisms and molds
2. Insect treatment
3. Fire treatment

E. Tree surgery

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VI. Occupational information

- A. Manufacturers
- B. Division of labor
- C. Employer-employee relations
- D. Unions
- E. Automation

VII. Safety

- A. General rules
- B. Specific

VIII. Review of hand tools

IX. Portable power tools

- A. Circular saw
- B. Sabre saw
- C. Reciprocating saw
- D. Router
- E. Plane

X. Non-portable power tools

- A. Table saw
- B. Radial arm saw
- C. Band saw
- D. Surfacer
- E. Jointer
- F. Router
- G. Shaper
- H. Lathe
- I. Mortiser
- J. Drill press
- K. Scroll saw
- L. Belt sander
- M. Disc sander
- N. Disc cutter head jointer (uniplane)

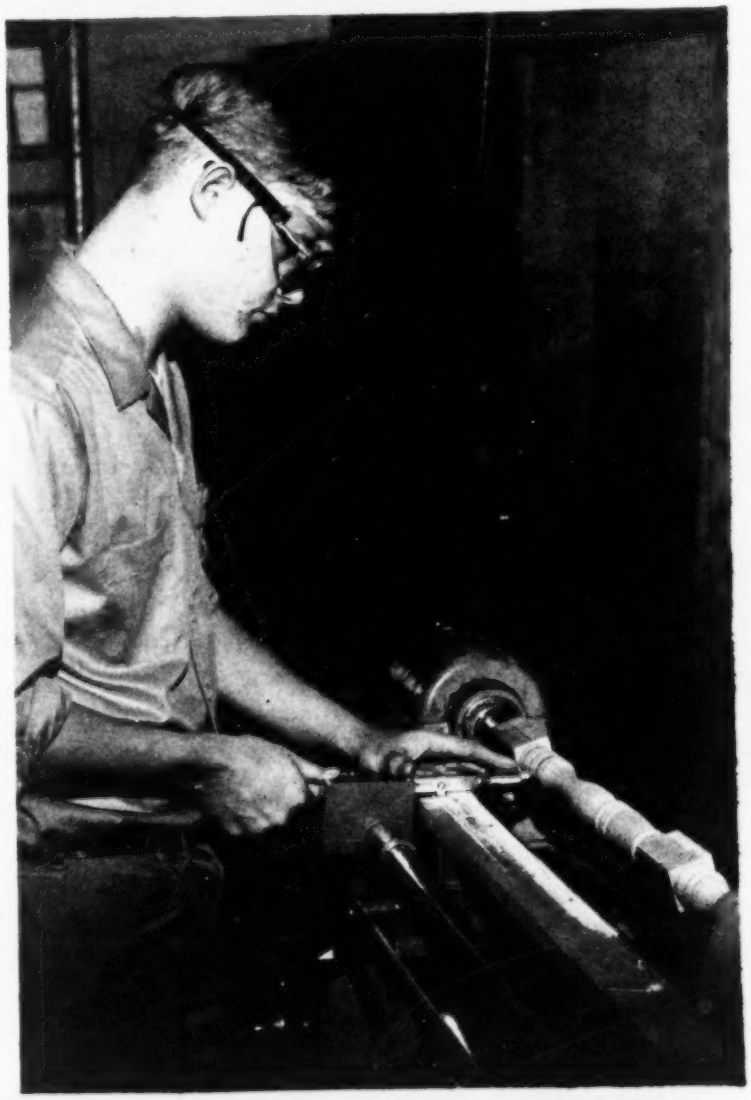

Duplicate wood turning.

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XI. Construction

A. Joints and joining
   1. Dowel
   2. Mortise and tenon
   3. Tongue and groove
   4. Dovetail

B. Adhesives
   1. Natural and synthetic
   2. Pressures
   3. Temperature
   4. Electronic gluing
   5. High frequency gluing

C. Clamping
   1. Belt clamps
   2. Specialty clamps

D. Abrasives
   1. Natural and artificial
   2. Grit and procedure

E. Fasteners and plugs

F. Edge treatment

G. Drawer construction

H. Door construction

I. Inlays and overlays

XII. Wood finishing and refinishing

A. Preparing the surface

B. Stains and bleaches

C. Fillers
   1. Paste
   2. Stick

D. Finishes
   1. Hot lacquers
   2. Polyurethane, epoxy, and polyester resin

E. Application

F. Touch-up

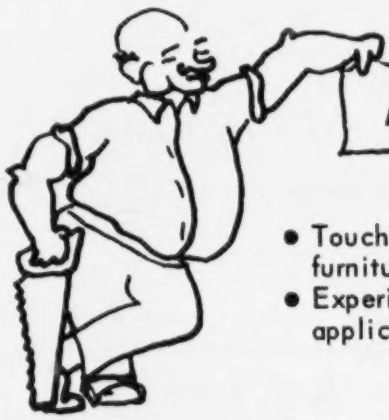

Activities

- Touch up a mar on finished furniture.
- Experiment with types and applications.

XIII. Upholstery

XIV. Hardware

A. Hinges

B. Pulls

C. Catches

D. Casters and glides

E. Locks

XV. Special products

A. Plastic laminates

B. Hardboard

C. Particle board

D. Compreg

E. Impreg

F. Tile

G. Upholstering

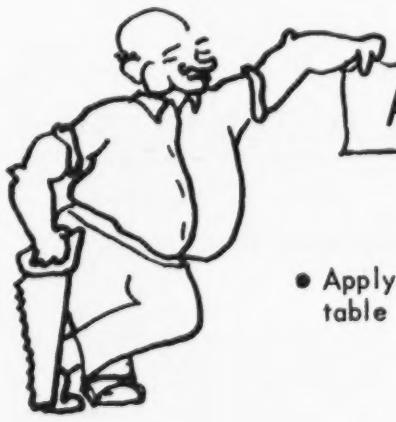

Activities

- Apply plastic laminate to a table top and trim the edges.

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XVI. Furniture repair

A. Reassembly

B. Replacement parts

C. Touch-up

XVII. Mass production techniques

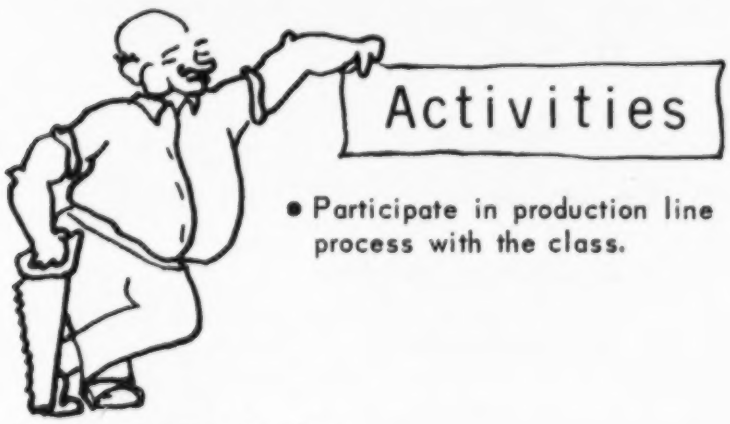

XVIII. Bending lumber

A. Steam or boiled

B. Laminates

C. Kerf

D. Anhydrous ammonia

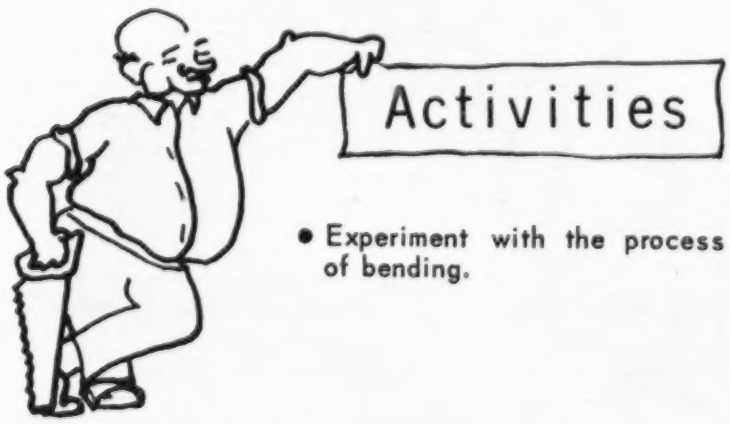

XIX. Carpentry

A. Surveying and excavation

B. Foundations and concrete

C. Framing

D. Exterior covering and finishing

E. Interior finishing

F. Materials
   1. Mill work
   2. Floor covering

G. Painting and finishing

H. Estimating

XX. Pattern making

A. One piece

B. Split

C. Loose piece

D. Match plates

E. Core boxes

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XXI. By-products of woodworking

A. Hard board and particle board

B. Insulating materials

C. Paper and cardboard manufacturing

D. Resins used for paints, lacquers, and rayon

E. Laminates and plastics

XXII. Boat building

XXIII. Home workshops

SELECTED INSTRUCTIONAL AIDS OR SOURCES

Only a limited amount of specific material is included here. Many entries are primarily for purposes of illustration. Sources that pertain to wood are included if specific material is not listed below. Additional useful information of a general nature may be found on page 48.

Miscellaneous Materials

- Pamphlet: "Bibliography of Teaching Aids," American Forest Products Industries, Inc., 1816 North Street, N. W., Washington, D. C. 20036.
- Pamphlet: "How To Select, Use, and Care for Wood Bits," The Irwin Auger Bit Company, Wilmington, Ohio 45177.
- Manual: "Particleboard Design and Use Manual," National Particleboard Association, 711 14th Street, N. W., Washington, D. C. 20015.
- Booklet: "Your Guide to Better Natural Wood Finishing," McCloskey Varnish Company, 7600 State Road, Philadelphia, Pennsylvania 19136.
- Leaflet: "Handy Hints," Johnson's Wax, Consumer Education Dept., Racine, Wisconsin.
- Booklet: "The Story of Hardboard," American Hardboard Association, 205 West Wacker Drive, Chicago, Illinois 60606.
- Pamphlet: "The Story of the Redwood Forest," California Redwood Association, 617 Montgomery Street, San Francisco, California 94111.
- Leaflet: "Flexible Wood-Trim," U. S. Plywood Corporation, 2305 Superior Avenue, Kalamazoo, Michigan 49003.
- Leaflet: "3 Easy Recipes for Finishing Furniture," Consumer Education Department, Johnson's Wax, Racine, Wisconsin.
- Manual: "Facts. . . .on Preserving and Finishing of Beautiful Wood and Wood Finishing Manual," General Finishes Sales and Service Company, 1548 West Bruce Street, Milwaukee, Wisconsin 53204.
- Booklet: "Hints to the Handyman," Masonite Corporation, 29 North Wacker Drive, Chicago, Illinois 60606.

Transparencies

The following is a list of companies that are producing transparencies. They should be contacted directly to obtain a complete list of such materials.

- Charles Beseler Company, 219 South 18th Street, East Orange, New Jersey 07018.
- DCA Educational Products, Inc., 4865 Stenton Avenue, Philadelphia, Pennsylvania 19144.
- Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan 48211.
- 3M Company, Visual Products, Box 3100, St. Paul, Minnesota 55101.
- United Transparencies, Inc., Box 888, Binghamton, New York 13902.

Cartridged Super 8mm Single-concept Films

- Eighty-six titles on basic woodworking, The Walden Film Corporation, 39 East 31st Street, New York, New York 10016.

Books

- *Advanced Woodwork and Furniture Making,* John L. Feirer, Charles A. Bennett Company, Inc., 809 West Detweiller Drive, Peoria, Illinois 61614, 1963.

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- *Cabinetmaking,* John L. Feirer, Charles A. Bennett Company, Inc., 809 West Detweiller Drive, Peoria, Illinois 61614, 1967.
- *Finishing Materials and Methods,* George A. Soderberg, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1959.
- *General Shop Woodworking,* Verne C. Fryklund, and Armand J. LaBerge, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1965 edition.
- *Industrial Arts Woodworking,* John L. Feirer Charles A. Bennett Company, Inc., 809 West Detweiller Drive, Peoria, Illinois 61614, 1965.
- *Modern Upholstering Methods,* William F. Tierney, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1965.
- *Modern Woodworking,* Willis H. Wagner, Goodheart-Willcox, 18250 Harwood, Homewood, Illinois 60430.
- *Wood Laminating,* J. Hugh Capron, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1963.
- *Wood Turning Visualized,* Ross C. Cramlet, Bruce Publishing Company, 400 North Broadway, Milwaukee, Wisconsin 53201.
- *Woodworking for Industrial Arts,* Ira C. Madden, Goodheart-Willcox, 18250 Harwood, Homewood, Illinois 60430.
- *Woodworking Technology,* James J. Hammond, E. T. Donnell, Walter F. Harrod, and N. A. Rayner, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1966.
- *Woodworking,* Willis H. Wagner, General Shop Texts, Goodheart-Willcox, 18250 Harwood, Homewood, Illinois 60430.
- *Woodwork Visualized,* Ross C. Cramlet, Bruce Publishing Company, 400 North Broadway, Milwaukee, Wisconsin 53201.
- *Woodworking with Machines,* J. H. Douglass, McKnight and McKnight Publishing Company, Bloomington, Illinois 61701, 1960.

TOOLS AND EQUIPMENT

The following list is presented as a guide in the selection of tools and equipment needed to teach woodworking. The approximate number of each item needed for a small, medium, or large number of students in a unit shop in woodworking is indicated. The list is set up on a unit shop basis. If the woodworking area of a general shop is to be set up some of the items could be reduced to about one-quarter or one-third of the numbers listed.

	Class Size		
	Small (10)	Medium (16)	Large (20)
Machines and Benches			
Air compressor	1	1	1
Band saw 16" or larger, complete with motor and enclosed stand	1	1	1
Bench, gluing bench or table, clamp storage below	1	1	1
Bench, wood finishing, steel, cabinet	1	1	1
Benches, woodworking, maple top, complete with vises, student storage lockers, or drawers in base	3	4	5
Drill press, floor model complete with motor mortising attachments and ½" Jacobs chuck	1	1	1
Grinder, pedestal type, with safety flanges and eye shields, with 1 wheel dresser	1	1	1

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	Class Size Small (10)	Medium (16)	Large (20)
Electric hand drill $\frac{3}{8}$" chuck, variable speed	1	1	1
Electric hand drill $\frac{1}{2}$" reversible	1	1	1
Electric hand sabre saw	1	1	1
Jig saw, direct motor or belt driven, complete	1	1	1
Jointer 6" or 8", table fitted for rabbeting. Safety cylinder type, complete with guard and motor	1	1	1
Lathe, wood turning, complete with motor switch, tool rest, centers, and face	2	2	3
Mortiser	1	1	1
Portable power hand saw	1	1	1
Portable power plane	1	1	1
Radial arm saw 9" or larger, complete	1	1	1
Reciprocating or bayonet saw	1	1	1
Router-shaper with cutters, dovetail attachments, and laminate cutting attachments	1	1	1
Sander, combination disk and belt sander with *dust collector*	1	1	1
Sander, belt, portable with dust bag	1	1	1
Sander, finishing orbit, inline portable	1	2	3
Spray gun, complete with hose, nozzles, and air compressor	1	1	1
Spindle shaper	1	1	1
Surfacer with unit dust collector system		1	1
Table saw, 10", tilting arbor complete with motor, guard, fences, and blades	1	1	1
Tool sharpener — slow speed with grinding attachments	1	1	1
Vacuum cleaner, industrial type	1	1	1
Tool panel	1	1	1
Tool panel for accessories	1	1	1

Tools	Class Size Small (10)	Medium (16)	Large (20)
Awl, brad	1	2	2
Bevel, sliding-T	1	2	2
Bits, auger, $\frac{1}{4}$" - 1" by 16ths (set)	1	1	2
Bits, dowel, $\frac{1}{4}$" to $\frac{5}{8}$", 1 set	1	1	1
Bits, counter sink, rose pattern, sizes $\frac{1}{4}$", $\frac{5}{8}$", $\frac{3}{4}$"	1 ea.	1 ea.	1 ea.
Bits, forstner, $\frac{1}{4}$" to $\frac{1}{2}$" by 16ths	1 set	1 set	1 set
Bits, counter sink, high speed	1	1	1
Bits, screwdriver, $\frac{1}{4}$", $\frac{5}{16}$", $\frac{3}{8}$"	1 ea.	1 ea.	1 ea.
Bits, expansive	1	1	1
Bits, machine forstner, $\frac{1}{4}$" to 1"x $\frac{1}{8}$"	1 set	1 set	1 set
Braces, 8", ratchet types	1	2	2
Braces, 10", ratchet type	1	1	2
Brushes, bench—10"	6	10	12
Burnisher	1	1	1
Calipers, 8" outside (solid nut)	1	2	3
Calipers, 6" inside (solid nut)	1	1	1
Carving tools, 6 tool set	1	1	2
Chalk line	1	2	3
Chisels, socket firmer, 1 set of $\frac{1}{8}$", $\frac{1}{4}$", $\frac{3}{8}$", $\frac{1}{2}$", $\frac{5}{8}$", $\frac{3}{4}$", 1", $1\frac{1}{2}$"	1 ea.	1 ea.	2 ea.
Chisels, wood turning sets			
Parting tool $\frac{1}{8}$"			
Round nose, $\frac{1}{4}$", $\frac{1}{2}$"			
Spear points $\frac{1}{2}$"			
Square nose $\frac{1}{2}$", $1\frac{1}{4}$"			
Gouges $\frac{3}{4}$", $1\frac{1}{2}$"			
Skews $\frac{3}{8}$", 1"			
Clamp, C 2" opening	2	4	4
Clamps, C 4" opening malleable iron	4	4	6
Clamps, C 6" opening malleable iron	2	2	2
Clamps, I bar, 24"	4	8	10
Clamps, I bar, 36"	4	8	12
Clamps, I bar, 48"	2	4	6

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	Class Size Small (10)	Medium (16)	Large (20)
Clamps, Jorgensen hand screws, 8"	4	8	12
Clamps, Jorgensen hand screws, 10"	2	4	6
Clamps, spring	6	8	12
Counter sink	1	1	1
Dividers, 8"	1	1	2
Doweling jig, with bushings	1	1	1
Drill bits, twist, straight shank, $\frac{1}{16}$" to $\frac{1}{2}$", by 32nds, and drill bit gauge	1	1	1
Drills brad point $\frac{1}{2}$" shank	1	1	1
Drills, multi spur $\frac{1}{4}$" to $\frac{1}{2}$"	1 set	1 set	1 set
File, auger bit	1	2	2
Drill hand $\frac{1}{4}$" chuck	1	2	2
Drill, automatic (Yankee)	1	1	1
Files, cabinet, round and half-round 10"	2 ea.	2 ea.	2 ea.
Files, saw, assorted sizes, extra slim taper, and slim taper	1	2	2
Files, mill, smooth cut 10"	4	4	6
Fire extinguisher	2	2	2
First aid cabinet and supplies	1	1	1
Gauges, marking	2	3	4
Glass cutter	1	1	1
Glue gun	1	1	1
Glue injector	1	1	1
Gouges, outside ground $\frac{3}{8}$", $\frac{1}{2}$", $\frac{3}{4}$", 1"	1 ea.	1 ea.	1 ea.
Gouges, inside $\frac{3}{8}$", $\frac{1}{2}$", $\frac{3}{4}$", 1"	1	1	1
Hammers, nail, 13, 10, 7 ounces—16 & 20	1 ea.	1 ea.	1 ea.
Hatchet	1	1	1
Hole saw, $1\frac{1}{4}$" to 6"	1 set	1 set	1 set
Knife, putty	1	1	2
Knife, sloyd, 3" blade	1	2	3
Level, 24", 30" and 4"	1	1	1
Miter box	1	1	1
Mallet, wood, barrel-shaped head	2	3	4
Microscope	1	1	1
Micrometer, 0-1"	1	1	1
Nail sets, $\frac{2}{32}$", $\frac{3}{32}$", $\frac{4}{32}$"	1 ea.	2 ea.	2 ea.

	Class Size Small (10)	Medium (16)	Large (20)
Oilers, bench $\frac{1}{3}$ pint coppered	2	2	3
Oil stones, 1"x 2"x 8", combination	2	2	3
Oil stones, slip, medium	1	1	1
Plane, router, with cutters	1	1	2
Plane bull nose	1	1	1
Plane rabbet	1	1	1
Plane, smooth, 9", 2" cutter	2	4	6
Planes, block	2	2	3
Planes, jack, 14"	2	4	6
Pliers, combination, 6"	1	2	2
Plug cutters, set	1	1	1
Plumb bob	1	2	3
Respirator	1	2	3
Rule, board (measures 7' to 16' lengths)		1	1
Rules, bench, maple, 24", graduated in $\frac{1}{8}$ths and $\frac{1}{16}$ths, brass capped	4	7	10
Saw, compass, 10"	1	1	1
Saws, crosscut, skew back, 22" blade, 10 points	2	2	3
Saws, rip, 22" blade, 7 points	1	1	1
Saws, back, 12"	2	4	6
Saws, coping (simple frame type)	2	4	6
Saw dovetail	1	1	1
Scraper, swanneck 3"x5"	1	1	1
Scraper, cabinet double handle	1	2	2
Scrapers, hand, 3"x 6"	2	3	4
Screwdriver, automatic, with bits (Yankee)	1	1	1
Screwdriver, 2"	1	1	1
Screwdriver, 4"	1	2	3
Screwdriver, 6"	1	1	1
Screwdriver, stubby	1	1	1
Screw gauge	1	1	1
Spoke shaves, adjustable, 10"	1	1	1
Squares, steel framing, 24"x 16"	2	3	4
Squares, try and miter, 8"	3	6	10
Stops, bench	10	15	20
Ripping bar 24"	1	1	1

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	Class Size		
	Small (10)	Medium (16)	Large (20)
Trammel points, with pencil clasp	1	1	1
Transit and height stick	1	1	1
Wrecking bar	1	1	1

	Class Size		
	Small (10)	Medium (16)	Large (20)
Wrenches, adjustable 4", 6", 8"	1 ea.	1 ea.	1 ea.
Wrenches, open end 1 set	1	1	1
Wrenches, Allen	1 set	1 set	1 set

SUPPLIERS OF TOOLS AND EQUIPMENT

- Albert Constantine and Sons, Inc., 2062 Eastchester Road, Bronx, New York 10461.
- Bret Guard Corporation, 160 Woodbine Street, Bergenfield, New Jersey 07621.
- Broadhead-Garrett Company, 4560 East 71st Street, Cleveland, Ohio 44105.
- Craftsman Wood Service, 2727 South Mary Street, Chicago, Illinois 60608.
- Cizco, 11705 East Washington Boulevard, Whittier, California 30606. (woodturning attachments)
- Midwest Shop Supplies, Inc., 301 Jackson Street, Sioux City, Iowa 51101.
- Minnesota Woodworkers Supply Company, 925 Winnetka Avenue North, Minneapolis, Minnesota 55427.
- Northfield Foundry and Machine Company, Box 140, Northfield, Minnesota 55057. (All woodworking machinery)
- Parks Woodworking Machine Company, 1501 Knowlton Street, Cincinnati, Ohio 45223. (woodworking machines)
- Paxton Equipment and Supply, 7401 South Pulaski Road, Chicago, Illinois 60629.
- Powermatic, Division of Houdaille Industries, Box 70, Morrison Highway, McMinnville, Tennessee 37110. (woodworking machinery)
- Rockwell Manufacturing Company, Power Tool Division, Rockwell Building, Pittsburgh, Pennsylvania 15208. (all woodworking machinery)
- Satterlee Company, 2200 East Franklin, Minneapolis, Minnesota 55404.
- Work Rite Products Company, 1315 South Flower Street, Burbank, California 91502. (electronic wood welders)

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VT 013 068
Industrial Physics, Five-Year Program Grades 11 and 12.

Department of Education, Ottawa (Ontario).
MF AVAILABLE IN VT-ERIC SET.
Curr-S-27-C
PUB DATE - 67 13p.

DESCRIPTORS - *VOCATIONAL EDUCATION; *TECHNICAL EDUCATION; *PROGRAM GUIDES; *COURSE CONTENT; INSTRUMENTATION; ELECTRICITY; *FLUID POWER EDUCATION; GRADE 11; GRADE 12; CURRICULUM DEVELOPMENT

ABSTRACT - Prepared by the Department of Education in Ottawa, Canada, this publication is a program guide for Industrial Physics in Grades 11 and 12. The material is based upon 10 periods per week, a total of 150 periods, plus or minus 20 percent. Specific objectives are to: (1) convey clearly some fundamental principles of physics, (2) encourage creative expression within the medium of science and technology, (3) achieve a basic competence in certain technical areas of employment, and (4) acquaint the student with the sociological implications and effects of technology. The contents are organized into four divisions: (1) Mechanics and Materials, (2) Fluids, (3) Instrumentation, and (4) Electricity, with each division sub-divided into separate units. A curriculum guide will be published at a later date. (GEB)

VT 013 068

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typical frame wall. Some details have been omitted for simplification, for example, wall sections are usually drawn to show a window. However, you will study the parts of a window in a later Work Sheet.

Illustration Sheet 29, page 97, shows a half-exterior view and a half-interior view of a two sash window commonly called a double hung window and designated on plans and elevations as a "DH" window. The frame which holds the glass is called the sash. If the glass is undivided, it is called a single light sash. If the glass in the upper sash consists of more than one light, it is called a "divided light". Division bars are called "muntins" or "mullions".

Each sash is counter-balanced by two iron weights attached to the sash by a sash cord.

Outside doors are made in many styles to harmonize with the style of the house where they are used. The width of standard doors varies from 2' -0" to 3' -6" and are from 6' -8" to 7' -0" in height. A front door is usually larger and heavier than an inside door. Some outside doors have four panels placed vertically or horizontally. Others have the upper part glass and the lower part panelled while still others have one big glass and no panels. These and other styles are listed and illustrated in the catalogs issued to architects and builders by the sash and door companies.

EDO 56238

ONTARIO DEPARTMENT OF EDUCATION

CURRICULUM SERIES

INDUSTRIAL PHYSICS

FIVE-YEAR PROGRAM

GRADES 11 AND 12

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1967

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FOREWORD

This publication is a major revision of the Five-year Industrial Physics Course as outlined in Curriculum R.P.27. The span of subject content has been reduced considerably, and one new area, Instrumentation, introduced. As organized in its present form, the outline overlaps Grade 11 Physics, Curriculum S.17A, 1966, to a minor extent.

Industrial Physics is primarily concerned with physical principles as applied in industry. If students are to develop their understanding, they need "hands-on" experience with equipment that embodies these principles. If the emphasis is properly placed, the opportunity to work with suitable hardware will greatly enhance the students' ability to grasp underlying concepts.

Students of Industrial Physics will have considerable time available for laboratory activity. This is made possible by the scheduling of 10 periods per week in addition to the regular science periods in Grades 11 and 12.

The course has four Divisions: Mechanics and Materials, Fluids, Instrumentation, and Electricity. As such, it offers a broad look at industrial applications in these areas, and provides a good basis for further education in the theoretical and applied physical sciences. The teacher should stress the principles common to each Division. Students' useful knowledge and insight will grow when they note that the same concepts and laws are repeated in the various subject areas.

Based upon 10 periods per week, a total of 150 periods, plus or minus 20 per cent, is suggested for each Division. In addition to this flexibility, the teacher may omit the optional topics and substitute material which he deems more essential. As a guideline, estimated periods have been assigned to each unit, the letter "T" being used to indicate teaching periods and the letters "S.A.", student activity.

The teacher of Industrial Physics must have a genuine appreciation of applied physics. Industrial experience, as an engineer or senior technologist, is vital. Only a person with such a background can convey the excitement and power of creative technology to his students.

Instruction pertaining to Division Four will normally be given by the teachers of Electricity or Electronics in their shops. It is possible, however, that the teacher of Industrial Physics may be required to teach the whole course. Whatever the arrangement, Electricity should integrate with the other Divisions.

Since the Course is a two-year entity covering both Grades 11 and 12, the teachers must decide the extent to which any Unit will be studied in either grade. They must also determine the weekly and monthly sequence of topics because the Outline does not include any suggestion of optimum organization. Certainly any mechanical use of the material will result in a poor presentation.

A Curriculum Guide will be published shortly. It will expand the Outline in considerable detail.

OBJECTIVES

- To convey clearly many of the fundamental principles of physics.
- To provide a familiarity with some of the industrial applications of physical principles.
- To stimulate curiosity in the realm of science and technology.
- To serve as preparation for further education, particularly in the physical sciences.
- To encourage creative expression within the medium of science and technology.
- To develop problem-solving ability by means of exercises dealing with realistic problems of a technological nature.
- To instil a degree of confidence in the ability to comprehend, and work with complex industrial machines and processes.
- To teach some laboratory methods and techniques.
- To achieve a basic competence in certain technical areas of employment.
- To provide an overview of Canadian industry in order to make possible a selective orientation to the various areas of opportunity in technology.
- To acquaint the student with the sociological implications and effects of technology.

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ORGANIZATION

Estimated periods: 150 ± 30 per division

DIVISION 1 MECHANICS AND MATERIALS

Units 1.1 Introduction to Mechanics
1.2 Dynamics
1.3 Introduction to Statics
1.4 Materials

DIVISION 2 FLUIDS

Units 2.1 Fundamentals of Hydraulics
2.2 Hydraulic Components
2.3 Hydraulic Circuits
2.4 Fundamentals of Pneumatics
2.5 Pneumatic Components and Circuits

DIVISION 3 INSTRUMENTATION

Units 3.1 Measurement and Indication
3.2 Transmitting and Receiving Devices
3.3 Analysis
3.4 Control

DIVISION 4 ELECTRICITY

Units 4.1 Fundamentals of Electricity and Magnetism
4.2 Electrical Devices
4.3 Electronic Devices
4.4 Circuits and Systems

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UNIT 1.3

INTRODUCTION TO STATICS
24T 25SA

Tensile Force
Deflection
Strain
Stress
Interrelationships

Compressive Force
Deflection
Strain
Stress
Interrelationships

Shear Force
Deflection
Strain
Stress
Interrelationships

Area Relationships (O)
First moment of area
Second moment of area
Polar moment of area

Bending Moments
Deflection of a beam
Force-deflection relationships
Bending Stress
Shear force and bending moment diagrams

Twisting Moments
Origin
Deflection
Strain
Stress
Interrelationships

Failure Under Load
Static loads
Dynamic loads
Repetitive loads
Stress concentration

UNIT 1.4

MATERIALS
16T 24SA

Types of Properties
Density
Conductivity
Thermal
Surface
Mechanical

Measurement of Properties
Density
Conductivity
Thermal
Surface
Mechanical

Change of Properties
By composition
By heating and cooling
By mechanical processing

Explanation of Properties
Atomic
Homogeneous materials
Heterogeneous materials

Selection of Materials
Criteria for choice
Economics

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DIVISION 2: FLUIDS

INTRODUCTION

Although energy transmission by means of a fluid medium is an old concept, many new specific applications are being employed in automated processes. The development of fluid logic apparatus promises to give further impetus to the fluid applications, since these components are easy to manufacture and trouble free in operation.

This Division is not meant to be an extensive fluid power study. It is hoped that the study of fluid properties will be channeled toward application rather than the reverse; for instance, the differing response rates for hydraulic and pneumatic systems should be explained on the basis of differing physical properties of oil and air, respectively.

The question of whether to teach pneumatics or hydraulics first is still not resolved. The teacher is free to start with pneumatics if he so wishes. If he chooses the other presentation order, he should spend a greater amount of time on pneumatics than suggested in the course of study. Once the fundamentals of pneumatics have been mastered, a correspondingly shorter time period needs to be spent on hydraulics.

Hydraulic pumps and motors, as well as air compressors, should not receive exhaustive treatment. In each case, one or two frequently occurring types should be examined carefully and reference to other types limited to operating principle only. In general, emphasis should be concentrated on efficiency of energy conversion rather than specific design features.

The use of high supply pressure is to be avoided. Hydraulic and pneumatic supply pressures less than 100 psi are quite enough for demonstration and experimentation in the laboratory, as brute force application is not being investigated.

The teacher is asked to make cross-reference to phenomena which occur in this Division but which have either direct application or analogy in other areas of study; for example, the one-way valve is the counterpart of the electrical diode since it allows only unidirectional flow. Through such cross-references the student will gain a knowledge and respect for the fundamental principles which govern our universe

UNIT 2.1

FUNDAMENTALS OF HYDRAULICS
15T 20SA

Introduction to Fluids
Historical Development of fluid mechanics

Liquids
Chemical Properties
Physical Properties

Hydrostatics
Pressure in a static fluid
Force multiplication

Fluid Dynamics
Continuity principle
Conservation of energy
Fluid flow
Forces on bodies immersed in moving fluids
Fluid-Dynamic Applications

UNIT 2.2

HYDRAULIC COMPONENTS
20T 21SA

Valve Construction and Operation
Pressure Control
Volume Control
Directional Control
Pilot operated

Actuators
Classification of types
Design Features

Pumps
Classification of types
Performance characteristics (O)

Motors (O)
Classification of types
Performance characteristics

Ancillary Components
Fluid conditioning, transport, and system sealing apparatus
Storage Devices

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UNIT 2.3

HYDRAULIC CIRCUITS
5T 19SA

Analysis
Characteristics of Hydraulic Systems
Elementary Circuits
Advanced Circuits

UNIT 2.4

FUNDAMENTALS OF PNEUMATICS
4T 4SA

Introduction to Pneumatics
Physical Properties of Gases
Gas Flow (O)
Characteristics of Pneumatic Systems

UNIT 2.5

PNEUMATIC COMPONENTS AND CIRCUITS
16T 32SA

Air Compressor and Accessories
Positive displacement type piston compressor
Air storage and distribution system

Valve Construction and Operation
Directional control
Flow control
Sequence valves

Pneumatic Actuators
Linear
Rotary (O)

Circuits
Basic circuits
Advanced circuits

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DIVISION 3: INSTRUMENTATION

INTRODUCTION

This Division includes the study of instrumentation in order to meet industry's increasing demands for personnel with a knowledge of industrial process control fundamentals. Since secondary schools offer very few courses in this field, most students are unaware of its opportunities.

The term "instrumentation" has a broad association within industry. In this course, its meaning is narrowed to include the measurement and control of flow, level, temperature and pressure as well as gas chromatography, spectrophotometry and ph analysis procedures.

In harmony with the aims of Industrial Physics, the teacher should try to give the student a clear understanding of fundamental principles rather than an extensive knowledge of specialized calibration procedures. Once he has mastered fundamental principles, the student will be able to extend his knowledge to more specialized manual applications. Hardware should thus be examined from a first principle basis with less emphasis on specific design characteristics.

Whenever possible, the student should concentrate on the numerous applications of control apparatus which can be found in his domestic environment. The automatic electric water heater is an excellent example of a closed loop temperature control system. The water closet is an example of a simple level sensing and control system.

Proportional control should be treated carefully. A superficial approach can do little to benefit the student whereas an in-depth study is above the Grade 11 and 12 level.

The teacher should not overlook the opportunity to refer to the extremely broad significance of basic principles. The concept of a time constant is associated with electronic circuits even though a thermometer exposed to a change of temperature exhibits the phenomena. Amplification, also a term usually associated with the field of electronics, also, interestingly, applies to pneumatic signal transmission devices.

In some areas of the province, there may be a local need for a more detailed coverage of this Division. Where this is the case, the teacher should make use of the time flexibility built into the Industrial Physics Course and expand the treatment of the Division accordingly.

UNIT 3.1

MEASUREMENT AND INDICATION
45T 61SA

Pressure
The physical nature of pressure
Primary measuring methods

Flow
Flow characteristics
Rate-of-flow meters
Total flow meters

Level
Direct liquid measurement
Indirect liquid measurement

Temperature
Changes in the physical properties of materials
Radiant energy

UNIT 3.2

TRANSMITTING AND RECEIVING DEVICES
8T 12SA

Pressure and Level Transmitters
Theory of operation
Design considerations
Calibration

Flow Transmitters
Differential pressure transmitters
Calibration

Receiving Devices
Universal recorders

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UNIT 3.3

CONTROL
10T 10SA

Control Mechanics
Control system analysis
Modes of control (O)

UNIT 3.4

ANALYSIS
5T 5SA

Fluid Properties (O)
Viscosity
Ph
Gas thermal conductivity

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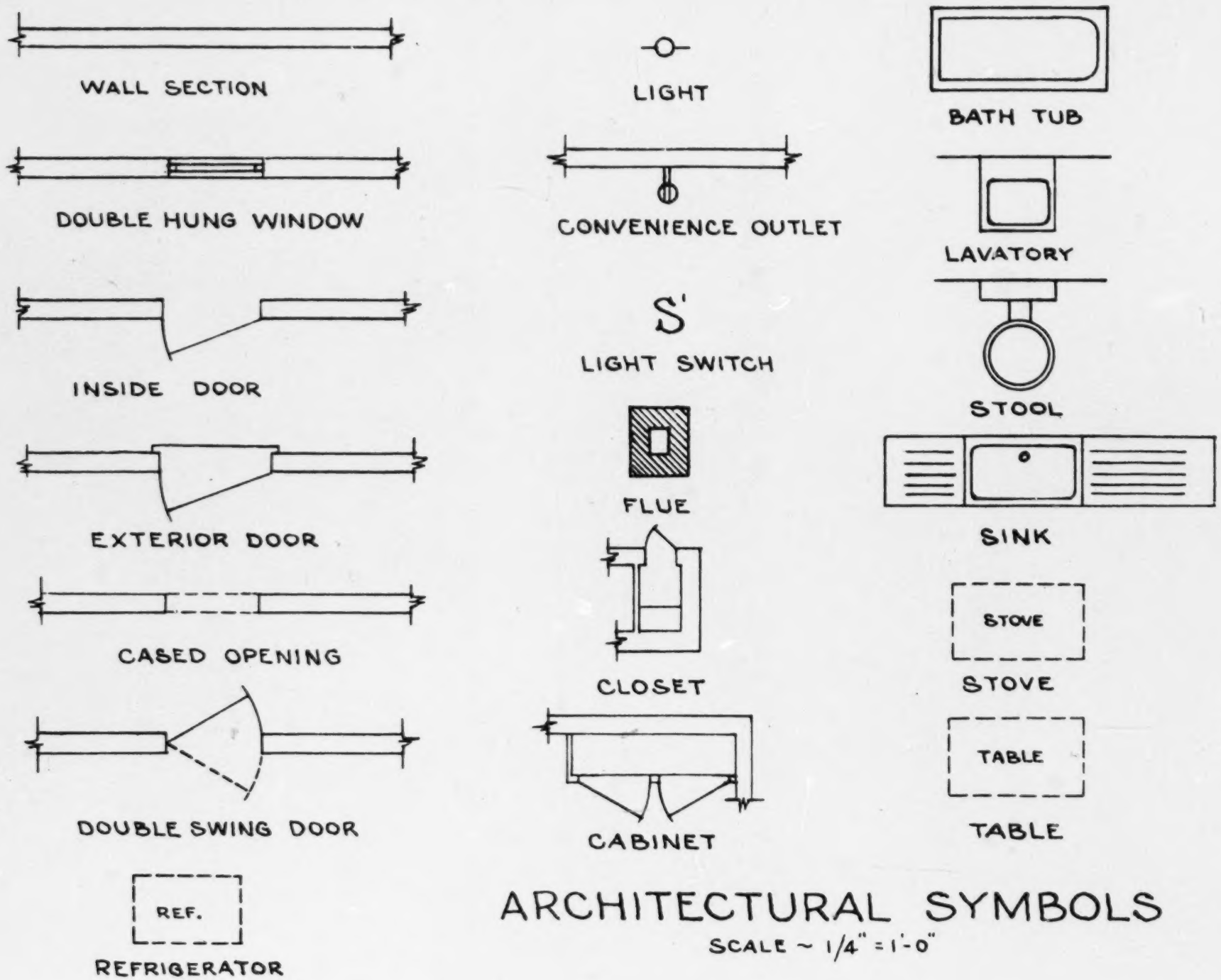

ARCHITECTURAL SYMBOLS

SCALE ~ 1/4" = 1'-0"

ILLUSTRATION SHEET 25.

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DIVISION 4: ELECTRICITY

INTRODUCTION

Although this Division will normally be taught by teachers of Electricity and Electronics, it should be considered as an integral part of Industrial Physics. The participating teachers should coordinate their instruction so that the work done in Electricity supplements and reinforces the principles taught in the other Divisions.

Many concepts and principles appear in more than one Division; for example, conductivity, conservation of energy, vectors, power, sensitivity, amplification, feedback and time constants occur in Division 4 and elsewhere. These and other concepts can be clearly conveyed to the student if the teachers try to show interrelationships between subject areas. Indeed, the basic aim of the course is only achieved if the students are able to see the repeated applicability of basic physical principles.

Unit 4.1 should be presented with particular care and thoroughness. The students must obtain a good grounding in electron phenomena and circuit analysis. The teachers of Electricity and Industrial Physics should agree on basic definitions, units and terminology.

The material in this Division is not arranged in a teaching sequence: it is an analysis of the subject matter, to be used as the teacher sees fit. Having introduced a topic from Unit 4.1, he may move to a related application referred to in another unit; or, he may discuss the properties of resistance, capacitance and inductance as part of the study of components (Unit 4.2) and then proceed to alternating current circuits (Unit 4.1). An infinite series of sequences are possible: the teacher should select those that appear to be logical and interesting.

Due to the limited time available, many legitimate topics have been omitted from the Outline. The teacher may wish to replace some of the optional topics with material that he considers more essential. Whatever the selected content, he should be keenly aware that the object of Industrial Physics is to convey basic concepts with the aid of suitable hardware: laboratory equipment is a means to an end, not an end in itself.

UNIT 4.1

FUNDAMENTALS OF ELECTRICITY AND MAGNETISM
38P

Electron Phenomena
Electron theory
Electrical charges
Electrostatic fields
Electrical potential

D. C. Circuits
Electrical conductors and insulators
Circuit analysis: Ohms Law, Kirchhoff's Laws
Power and energy

Magnetism
Theory of magnetism
Magnetic properties of materials
Magnetic circuits

Alternating Current Circuits
Scalar and vector quantities
Sinusoidal waveform
Non-sinusoidal waveforms
Purely resistive circuits
Purely inductive circuits
Purely capacitive circuits
L-C-R circuits, impedance
Power
Resonance

UNIT 4.2

ELECTRICAL DEVICES
44P

Basic Components
Resistors
Inductors
Capacitors

A. C. Machines
Transformer
Motors
Alternator

Measurement
D'Arsonval Galvanometer
Electrical bridges

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UNIT 4.3

ELECTRONIC DEVICES
22P

Electron Emission
Vacuum diode
Vacuum triode
Vacuum pentode

Solid State
Diodes
Junction transistors
Field effect transistors (O)

Photo-electric Effect (O)
Photo-emissive
Photo-voltaic
Photo-conductive

UNIT 4.4

CIRCUITS AND SYSTEMS
46P

Rectifying Circuits
Half wave
Full wave
Smoothing filter networks
Silicon controlled rectifier (O)
Voltage doubler (O)

Amplifying Circuits
Voltage amplifiers
Power amplifiers
Feedback
Oscillators

Control Circuits (O)
Photo-electric
Voltage regulation
Motor speed

Test Equipment Systems
Electron Voltmeter
Oscilloscope
Signal generator (O)

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VT 013 069
Mechanical Trade Drafting Syllabus.

New York State Education Dept., Albany.
Bureau of Secondary Curriculum Development.
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PUB DATE - 71 43p.

DESCRIPTORS - *TEACHING GUIDES; *CURRICULUM GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *DRAFTING; DRAFTSMEN; BIBLIOGRAPHIES; SUPPLIES; RESOURCE MATERIALS; INDUSTRIAL ARTS; METALS; POWER MECHANICS; ENGINEERING DRAWING; ORTHOGONAL PROJECTION

ABSTRACT - Developed by the Bureau of Secondary Curriculum Development of the New York State Education Department, this teaching guide is for teacher use in building a course of study in drafting. The material is designed for use over a 2-year period, each consisting of 175 teaching days of 135 minutes per day. Objectives include the development of skills and techniques, acquaintance with systems and procedures related to draftsman's functions, and the development of habits of independent and methodical procedure in the production of drawings. The course is divided into two major units, with each unit divided into 14 sections. Each section contains objectives, a suggested time, and suggested topics. A bibliography, supplies and equipment list, visual source directory, and a visuals list are included. (GEB)

VT 013 069

MECHANICAL TRADE DRAFTING SYLLABUS

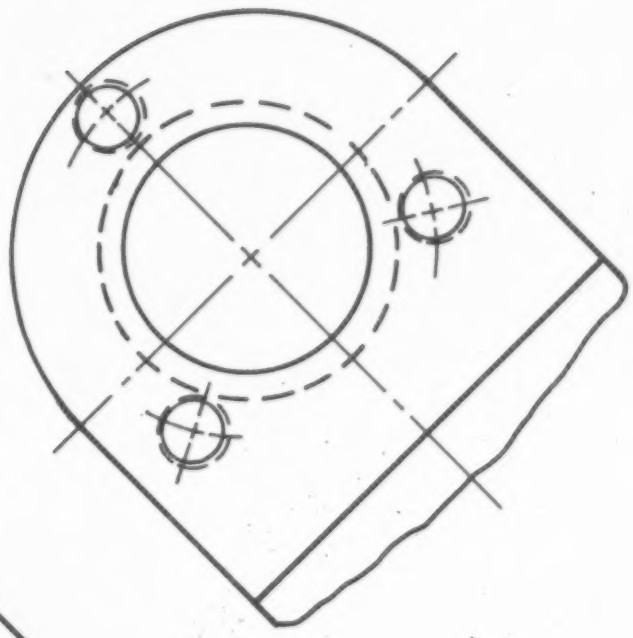

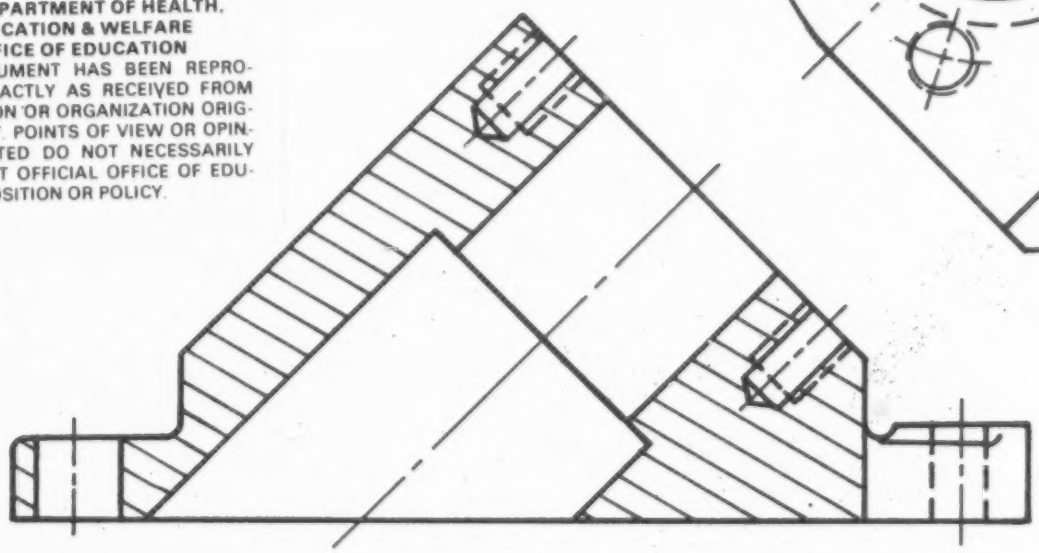

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THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT
ALBANY, NEW YORK 12224 | 1971

SYLLABUS

MECHANICAL TRADE DRAFTING

The University of the State of New York/The State Education Department
Bureau of Secondary Curriculum Development/Albany, 1971

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1977	Joseph T. King, LL.B.	Queens
1974	Joseph C. Indelicato, M.D.	Brooklyn
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1979	Francis W. McGinley, B.S., LL.B., LL.D.	Glens Falls
1980	Max J. Rubin, LL.B., L.H.D.	New York
1971	Kenneth B. Clark, A.B., M.S., Ph.D., Litt.D.	Hastings on Hudson
1982	Stephen K. Bailey, A.B., B.A., M.A., Ph.D., LL.D.	Syracuse
1983	Harold E. Newcomb, B.A.	Owego
1981	Theodore M. Black, A.B.	Sands Point

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Berton P. Plummer

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FOREWORD

The recent increase in the number of courses in mechanical trade drafting has created a need for the first State syllabus in this subject.

In the summer of 1969, David Jones of Allegany County BOCES, and Samuel Yaslow of New York City's Alexander Hamilton Vocational-Technical High School, assisted by Harold Wassmer, Associate in Trade and Technical Education, produced a topical outline of course content. During the following summer a committee composed of Mr. Jones, John Hoglund of Suffolk County BOCES #3, William Linton of Trott Vocational High School, Niagara Falls, and Joseph Svoboda of Broome-Tioga BOCES, met with Mr. Wassmer, and Joseph Messier, Associate in Vocational Curriculum, to organize the topical outline into a mechanical trade drafting syllabus.

The nature of the course content, and the advice of industrial contacts assisting in its organization, indicate a need for establishment of student qualifications for admission to a trade drafting course. These prospective employers firmly believe that success in the field demands not only a working knowledge of the graphic language and industrial technologies, but also an ability to apply basic algebra, geometry, and the natural trigonometric functions. This syllabus should, then, be of interest to guidance personnel as well as drafting instructors and administrators of occupational education.

Gordon E. Van Hooft
Chief, Bureau of Secondary Curriculum Development

William E. Young
Director, Curriculum Development Center

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TO THE TEACHER

This syllabus in mechanical trade drafting is organized on the basis of a 2-year course, each year consisting of 175 teaching days, of 135 minutes per day.

Like all syllabuses, the subject content is the acceptable minimum, organized in some logical sequence. The teacher must, therefore, use the syllabus as a basis on which to build his own course of study, arranging the included subject matter and adding appropriate content to reflect local conditions.

Each unit of study contains objectives and a suggested allotment of total course time. The objectives are stated behaviorally for, of course, the student's ability to function to entry-level industrial standards in an industrial situation is the true criterion of successful trade education. The time to be devoted to each unit is suggested only as a guide, for various local factors will necessitate modification of these allocations. Suggestions for teaching, and for limiting the required learning to entry-level, appear at intervals to the right of the course content.

At the end of the syllabus is a resource list and a list of equipment suggested for updating or establishing an industrially oriented trade drafting program. The equipment list is formulated on the basis of a 20 student class unit.

Berton P. Plummer
Chief, Bureau of Trade and Technical Education

Robert H. Bielefeld
Director, Division of Occupational Education

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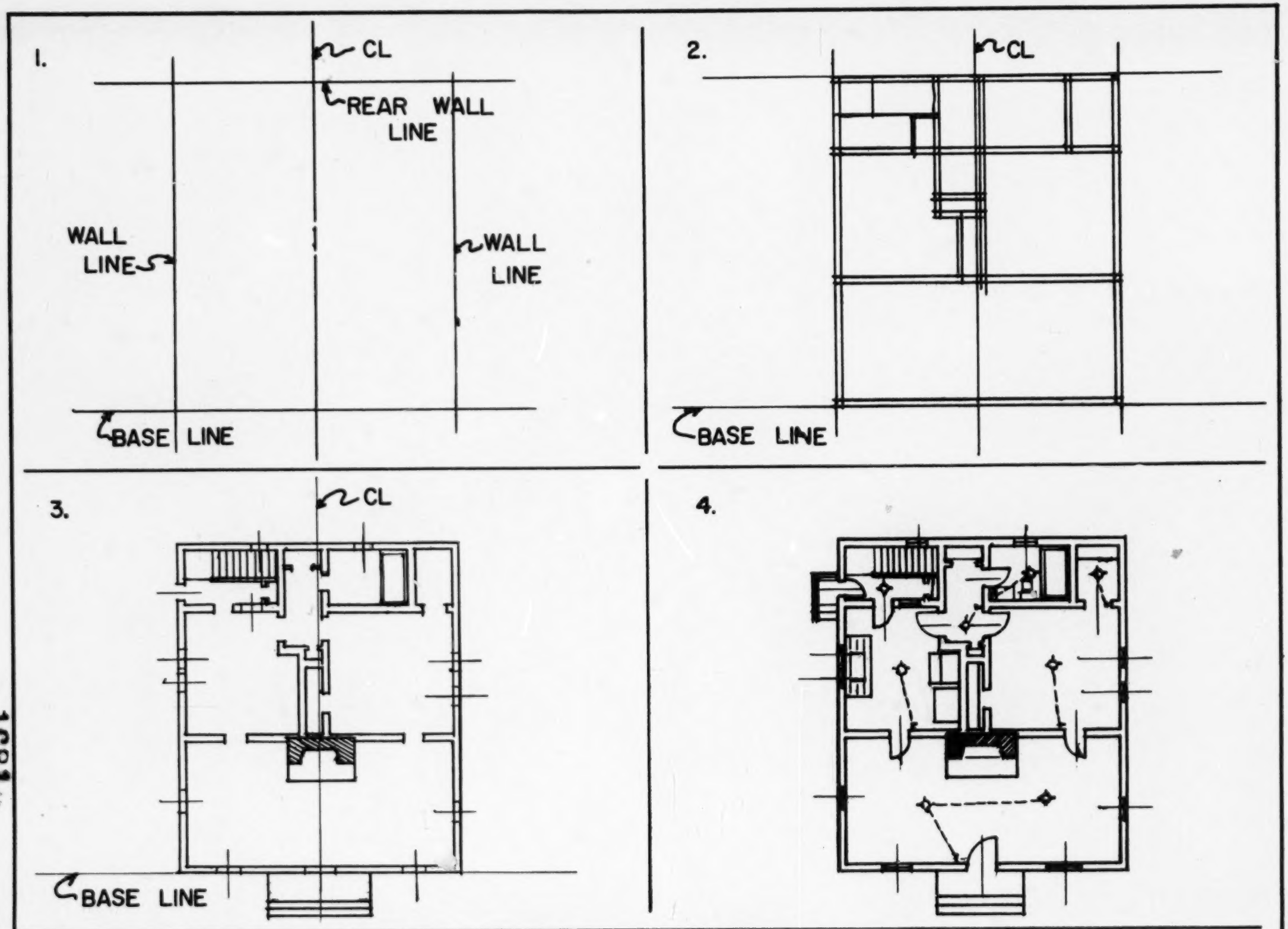

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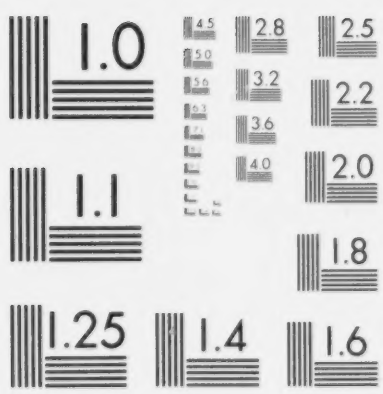

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

GENERAL OBJECTIVES

To aid the student to—

Develop skills and techniques necessary to performance of required manipulative operations;

Become acquainted with systems and procedures related to the draftsman's function;

Become capable of exercising initiative in the use of standard reference and auxiliary sources of materials information;

Develop habits of independent and methodical procedure in the production of drawings;

Appreciate the importance of accuracy compatible to industrial standards in applied mathematics and the production of drawings; and

Appreciate the importance of the individual draftsman's contribution to the success of a group effort.

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/Unit I-1: INTRODUCTION TO DRAFTING DEPARTMENT PRACTICES

The student should be aware of the skills and knowledge required for successful employment as an entry-level draftsman.

The student should be acquainted with the duties of the various drafting job levels, and with their interrelationship.

The student should be aware of the opportunities for advancement, and with the procedures for advancing through the sequence of department job levels.

The student should be familiar with standard drafting procedures in the progress from basic idea to final approved drawing.

SUGGESTED TIME: 2 DAYS

A. DEPARTMENTAL ORGANIZATION
- Job levels
  - Tracer
  - Junior draftsman
  - Draftsman
  - Senior draftsman
  - Checker
  - Design draftsman
  - Designer
  - Senior designer
  - Engineering designer

This unit should be presented as the initial lessons in the course. The student should not, however, be required to memorize the information since this learning should take place throughout the course on a basis of daily experience.

B. DUTIES AND RESPONSIBILITIES
- Fully understand drafting terminology
- Skilled in drafting techniques
- Neat in application of drafting techniques
- Accurate in applying drafting mathematics
- Acquainted with manufacturing and assembling operations
- Familiar with United States of America, Standards Institute, Manual Y14
- Familiar with use of vendor catalogs

C. ROUTING OF DRAWINGS
- Design sketches
- Preliminary layouts
- Models, mock-ups, prototypes
- Finalization of design

/Unit I-2: DRAFTING SUPPLIES, INSTRUMENTS, AND EQUIPMENT

The student should be able to identify and select from the department's supply, any teacher-specified basic drafting tool or material.

The student should be able to describe the purpose of the various basic equipment and materials used in the production of drawings.

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SUGGESTED TIME: 3 DAYS

A. DRAFTING SUPPLIES
- Pencils
  - Graphite
  - Plastic
- Leads
  - Graphite
  - Plastic
- Sharpeners
- Media
  - Vellum
  - Cloth
  - Plastic film
- Erasers
- Erasing shields
- Drafting tape

B. INSTRUMENTS
- T-Square
- Parallel straight edge
- Drawing board
- Triangles
- Scales
- Compass
- Divider
- Irregular curve
- Templates
- Protractor

Excellent filmstrip sets on the nomenclature and uses of scales, and of compasses and bow instruments are available from commercial suppliers.

C. MAJOR EQUIPMENT
- Drafting table
- Light table
- Layout board
- Drafting machine
- Storage file
- Whiteprinting unit

/Unit I-3: FREEHAND SKETCHING

The student should be able to identify by name, the various types of lines used in rough drawings.

The student should be able to demonstrate by any teacher-specified means, a knowledge of the basic characteristics of pictorial and orthographic drawing.

The student should be able to select equipment and prepare a rough drawing necessary to express a basic idea or to plan a method of approach to a finished drawing.

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SUGGESTED TIME: 7 DAYS

A. ELEMENTS
- Line segment
- Angles
- Curves
- Irregular curves
- Combinations

B. TYPES
- Pictorial
- Orthographic

Both filmstrip sets and prepared transparencies are available from several commercial suppliers.

C. INTERPRETATION
- Orthographic to pictorial

D. USE OF GRIDS
- Isometric
- Orthographic
- Proportional
  - Reduce
  - Enlarge

The student should be aware of the existence of this procedure, but proficiency in use is beyond the scope of this course.

/Unit I-4: ORTHOGRAPHIC PROJECTION

The student should be able to demonstrate by any teacher-specified means, an awareness of the principles of third angle projection.

The student should be able to prepare an orthographic drawing using personally selected equipment and teacher-supplied information of any standard type.

SUGGESTED TIME: 15 DAYS

A. VIEWS
- Relationship
- Selection
- Placement

At this stage, student proficiency should be judged on proper use of orthographic principles rather than on quality of workmanship.

B. SOURCE OF INFORMATION
- Measured object
- Pictorial drawing
- Specifications; written or oral
- Rough sketch
- Assembly drawing
- Layout

/Unit I-5: GEOMETRIC CONSTRUCTIONS

The student should be sufficiently acquainted with the principles of plane geometry to readily identify pertinent shapes.

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The student should be able to draw lines in specific relationship to form any teacher-specified geometric shapes, using teacher-specified drafting instruments.

SUGGESTED TIME: 3 DAYS

A. POINTS

B. LINES

C. ANGLES

D. POLYGONS

E. TANGENTS TO ARCS AND LINES

F. TANGENTS TO ARCS AND ARCS

G. ELLIPSES

The teacher should be prepared to aid student recall of geometric principles.

Basic shapes should always be drawn as parts of actual objects — never as a shape only!

Transparency sets on graphic solutions are available from several commercial suppliers.

/Unit I-6: SECTIONS

The student should be able to demonstrate by any teacher-specified means, an awareness of the reasons for sectioning, and of the basic procedures in interpreting and making section drawings.

The student should be able to identify and interpret sectioning symbols.

The student should be able to demonstrate the ability to use section drawings to simplify interpretation of complex internal detail.

The student should be able to demonstrate by any teacher-specified means, the ability to apply the type section required for a specific part drawing.

SUGGESTED TIME: 15 DAYS

A. CUTTING PLANE LINE

B. SECTION LINE

C. TYPES
- Full
- Half
- Partial views
- Revolved
- Removed
- Broken out
- Offset
- Isometric
- Assembly
- Aligned

The teacher's discretion will determine which symbols the student must <u>know</u> — and which he must only know where to <u>find</u>.

Both filmstrip sets and prepared transparencies on sectional views are available from commercial suppliers.

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D. DEVIATION IN DRAWING PRACTICE
- Conventional breaks
- Runouts and filleted intersections
- Invisible lines
- Elements in section
  - Rib
  - Spoke
  - Web
  - Lug

/Unit I-7: AUXILIARY VIEWS

The student should be aware of the nature of auxiliary views, and acquainted with the conditions requiring their use.

The student should be able to draw the views required to define the true size and shape of inclined surfaces of an assigned part.

SUGGESTED TIME: 12 DAYS

A. PRIMARY
- Classification
  - Complete
  - Partial
  - Symmetrical
  - Curved line
- Methods of drawing
  - Projection
  - Reference line
    - Unilateral
    - Bilateral

B. SECONDARY

Note — Auxiliary views should be used only where no other method will show the true size and shape of those part surfaces inclined out of the vertical or horizontal planes.

Both filmstrip sets and prepared transparencies on auxiliary views and revolutions, and related constructions are commercially available.

The student should be aware of the existence of secondary views and acquainted with their nature, but at this level he should not be required to be proficient in their use.

/Unit I-8: PICTORIAL DRAWING

The student should be acquainted with the various types of pictorial drawing, and be aware of the circumstances under which they are used.

The student should be aware of the particular usefulness of exploded drawings.

The student should be able to make a pictorial drawing of any teacher-specified type, using personally selected instruments and equipment.

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SUGGESTED TIME: 12 DAYS

A. TYPES
- Axonometric
  - Isometric
  - Dimetric
  - Trimetric
- Perspective
- Oblique

The student should be aware of the existence of dimetric and trimetric drawing, but emphasis should be on proficiency in isometric drawing.

B. PROCEDURES
- Selection of plane
- Instruments
  - Templates
  - Technical fountain pens
- Pictorial plan dimensioning
- Exploded views

/Unit I-9: BASIC DRAFTING TECHNIQUES

The student should be acquainted with the characteristics of the various lines, and be aware of the necessity of conforming to standard use.

The student should be acquainted with the purpose and nature of title block information, and demonstrate an ability to complete the drawing format as required.

The student should be sufficiently acquainted with the concept of scale as a proportional enlargement or reduction, to enable interpretation and preparation of drawings.

The student should be acquainted with the various means and standards of lettering, and demonstrate proficiency in their use.

SUGGESTED TIME: 8 Days

A. ALPHABET OF LINES

B. SHEET SIZES —— U.S.A.S.

C. DRAWING FORMAT
- Title block
  - Drawing number block
    - Drawing number system
  - Drawing title
  - Corporate name
  - Original date of drawing
  - Signatures
  - Tolerance block
  - Scale block
  - Material specification

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- Security block
- Application block
- Border
- Zoning
- Revision block
- Material list/Parts list

D. SCALE
- Reduced
- Full
- Enlarged
- No scale

The teacher should be prepared to assist students in recalling use of scale.

E. LETTERING —— FREEHAND AND MECHANICAL
- Types
  - U.S.A.S.
  - Microfilm
- Procedures

Filmstrips on freehand lettering are available from several commercial suppliers.

/Unit I-10: MANUFACTURING PROCESSES

The student should be sufficiently acquainted with production processes to relate to the process in applying notes and specifications to the drawing.

The student should be acquainted with the sources of the technical information required for production process related drawings.

The student should be able to demonstrate by any teacher-selected means, an entry-level proficiency in selection and use of technical data in preparation of production process related drawings.

SUGGESTED TIME: 15 DAYS

A. SURFACE QUALITY
- Controlled symbol
- Noncontrolled symbol

Films on the drawing/production relationship are available from several commercial suppliers. Their use should be most advantageous.

B. CASTING
- Types
  - Sand mold casting
  - Investment casting
  - Centrifugal casting
  - Die casting
  - Plaster mold
  - Powder metallurgy
  - Injection molding

The student should be thoroughly acquainted with the process of sand mold casting. He need only be aware of the existence of other casting methods.

C. FORGING
- Types
  - Drop forging
  - Press forging

The student should be thoroughly acquainted with the process of drop forging. At this point, he

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- Rolling
- Upsetting
- Extruding

need only be aware of the existence of other forging methods.

D. STAMPING
- Operations
  - Blanking
  - Punching
  - Forming
  - Drawing
  - Trimming
  - Coining

The student should be thoroughly acquainted with the process of punching. He need only be aware of the existence of other stamping methods.

E. MACHINING
- Classification
  - Forming surface
  - Generating surface
- Factors
  - Greater accuracy
  - Surface quality
  - Adding features
- Items
  - Casting and forging
  - Standard stock
    - Sheet and plate
    - Bar
    - Shafting
    - Tubing
    - Structural shapes
  - Weldments

F. MACHINE TOOLS
- Engine lathe
  - Operations
    - Turning
    - Boring
    - Reaming
    - Facing
    - Threading
    - Knurling
- Drill presses
  - Types
    - Radial drill
    - Multiple spindle
  - Operations
    - Drill
    - Ream
    - Bore
    - Spotface
    - Countersink
    - Counterbore
- Milling machine
  - Types

Projection of U.S.O.E. films
#OE 68 - The Lathe, and
#OE 7 - Turning Work of Two Diameters
should be advantageous.

Projection of U.S.O.E. films
#OE 11 - The Milling Machine,

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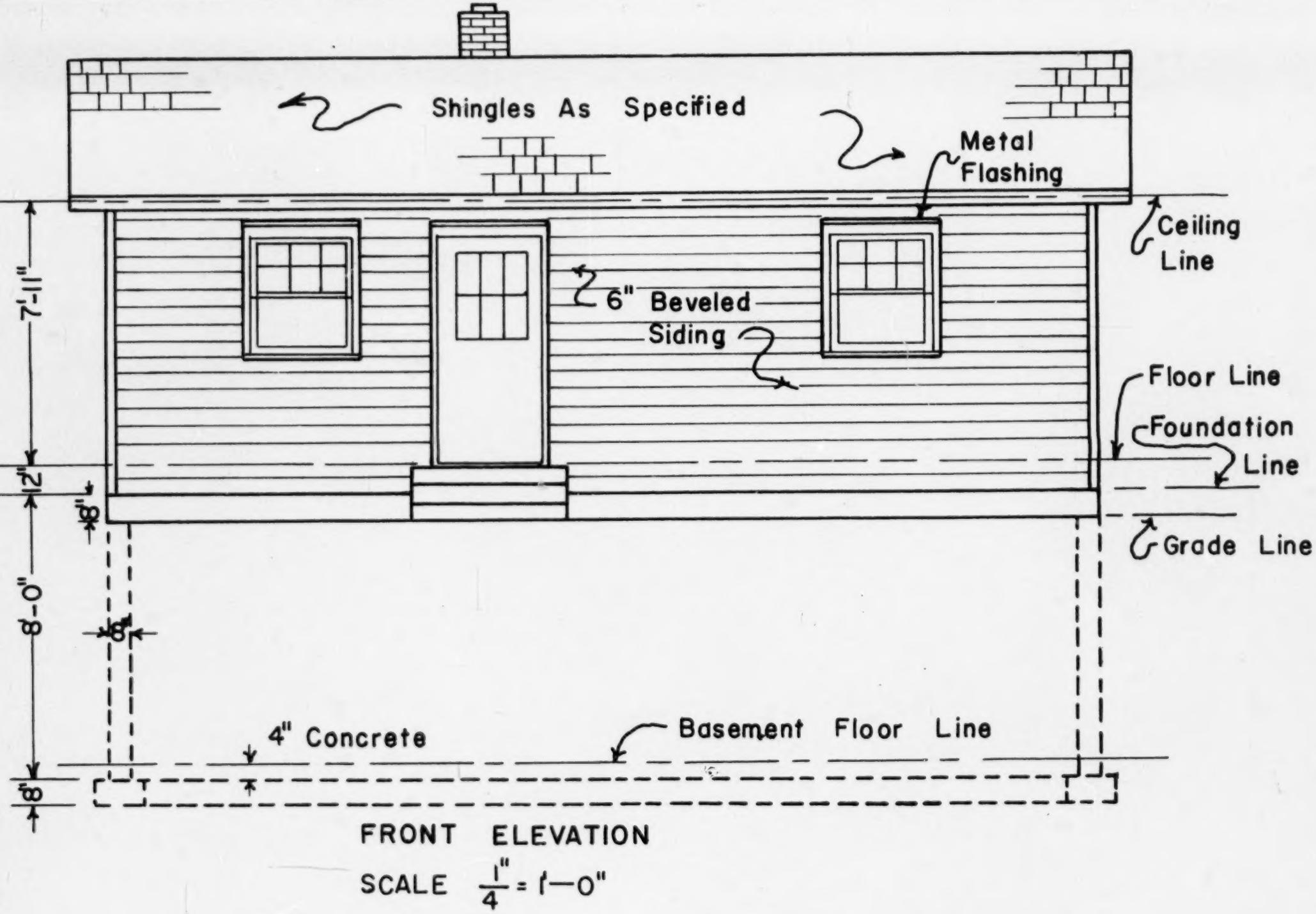

FRONT ELEVATION

SCALE $\frac{1}{4}$" = 1'-0"

ILLUSTRATION SHEET NO. 27.

1682

- . Vertical
- . Horizontal
- Operations
  - . Cutting Keyways
  - . Hobbing
    - Gear teeth
    - Threads
    - Splines
  - . Reaming
  - . Boring
  - . Drilling
  - . Profiling
- o Broaching machine
  - Operations
    - . Holes
      - Circular
      - Square
      - Irregular
    - . Internal gear teeth
    - . Splines
    - . External contours
- o Grinding machine
  - Types
    - . Cylindrical
    - . Centerless
    - . Surface
- o Shaper
- o Planer
- o Lapping machine
- o Boring mill
  - Types
    - . Vertical
    - . Horizontal
- o Electric discharge machine

#OE 15 - Plain Indexing and Cutting a Spur Gear,
#OE 14 - Straddle Milling, and
#OE 12 - Cutting a Keyway,
should be advantageous.

At this point it is sufficient that the student be aware of the existence of shapers, planers, lapping machines, boring mills, and electric discharge machines.

/Unit I-11: SCREW THREADS AND FASTENERS

The student should be acquainted with the various means of either permanently or temporarily holding parts in position.

The student should be acquainted with the sources of technical data required for drawing threads and fasteners.

The student should be able to demonstrate an entry-level proficiency in selecting and using technical information necessary for drawing threads and fasteners.

SUGGESTED TIME: 17 DAYS

A. SCREW THREADS
- o Terminology
  - External thread

Prepared transparencies on bolts and screws are commercially available.

16850

- Internal thread
- Major diameter
- Pitch
- Lead; multiple-thread
- Right hand
- Left hand

o Profile; forms

o Unified National/American National

- Representation
- Series
- Class of fit
- Designation
  . External
    Nominal size
    Threads per inch
    Thread series
    Class of screw thread
    Hand
  . Internal
    Tap drill size
    Tap drill depth
    Thread specification
    Minimum tap depths
- Methods of production
  . Cutting
  . Rolling
  . Grinding
  . Molding

The student should not necessarily be required to demonstrate ability to draw all types of thread. Proficiency in selecting and using available data is required.

B. FASTENERS

o Bolts

- Type
- Series
- Designation
  . Complete
    Thread specifications
    Length
    Material
    Type of finish
    Type of head
    Name
  . Abbreviated
    Nominal size
    Length
    Material
    Type of head
    Name

o Nuts

- Type
- Series
- Designation
  . Complete

Note — The designation of each type fastener shall include those appropriate items specified for Bolts, and the additional items listed for the specific fastener.

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- Capscrew
  - Type
  - Series
  - Designation
    - Complete
    - Abbreviated
- Machine screws
  - Type
  - Series
  - Designation
    - Complete
    - Abbreviated
- Set screws
  - Type of head
  - Type of point
  - Series
  - Designation
    - Complete
      Type of point
    - Abbreviated
      Type of point
- Studs
  - Type
  - Designation
- Washers
  - Type
  - Series
  - Designation
- Pins
  - Type
  - Designation
- Springs
  - Type
  - Designation

/Unit I-12: DIMENSIONING AND TOLERANCING

The student should be able to demonstrate by any teacher-selected means, a proficiency in measurement systems commensurate with entry-level drafting requirements.

The student should be able to demonstrate an ability to select a manner of representation of the feature dimensions and to place the information on the drawing.

The student should be aware of the necessity of maintaining size limitations, and be acquainted with the methods of stating the limitations on the drawing.

The student should be able to demonstrate an entry-level ability to prepare drawings, utilizing established methods of dimensioning and tolerancing.

16852

SUGGESTED TIME: 23 DAYS

A. GENERAL DIMENSIONS

- Units of measurement
  - Fractions
  - Decimals
  - Dual system; decimal/metric
  - Angular

The teacher should be prepared to aid the recall of fraction/decimal systems, as well as to teach the metric system.

- Arrangement
  - Aligned
  - Unidirectional
- Functional dimensioning
- Classification
  - Size
  - Location
    - Center-to-center
    - Coordinates
    - Finished surface to feature
- Reference dimensions
- Tabular dimensions
- Standard features
  - Cylinders
  - Arcs
  - Radii
  - Rounded ends
  - Irregular curves
  - Holes
  - Chamfers
  - Keyways
  - Keyseats
  - Tubing

Both filmstrip sets and prepared transparencies on dimensioning are commercially available.

B. APPLICATION OF TOLERANCES AND LIMITS

- Tolerancing methods
  - Limits
  - Plus and minus
- Effects of surface coatings
- Selective assembly

/Unit I-13: NOTES AND SPECIFICATIONS

The student should be acquainted with the various methods of designating materials.

The student should be sufficiently acquainted with basic metallurgy to relate treatments to materials.

The student should be sufficiently acquainted with manufacturing processes to correlate indicated operations to materials.

The student should be able to demonstrate entry-level proficiency in applying notes and specifications to drawings.

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SUGGESTED TIME: 10 DAYS

A. GENERAL NOTES
- Method of production
- Size and specification of materials
  - Metals
    - Cast iron
    - Hot rolled steel
    - Cold rolled steel
    - Tool steel
    - Copper
    - Brass
    - Bronze
    - Aluminum
  - Coding system for steel
    - AISI/SAE
    - ASTM
  - Nonmetals
    - Cork
    - Rubber
    - Ceramics
    - Plastics
    - Paper
    - Leather
- Heat treatments
  - Ferrous metals
    - Annealing
    - Normalizing
    - Tempering
    - Case hardening
  - Nonferrous metals
  - Hardness testing
    - Brinell
    - Rockwell
- Opposite hand parts
- Specification of tolerances
- Specification of surface quality
- Surface treatment
  - Electroplating
  - Metallizing
  - Hot dipping
  - Anodizing
  - Painting

B. LOCAL NOTES
- Leaders
- Types
  - Holes
  - Countersink
  - Counterbore
  - Spotface
  - Heat treat
  - Upset

16854

- Saw
- Chamfer
- Relieve
- Knurl
- Tap
- Taper

/Unit I-14: PRODUCTION DRAWING

The student should be sufficiently acquainted with the presented drafting "know-how" to demonstrate entry-level proficiency in the production of detail drawings.

SUGGESTED TIME 20 DAYS

A. SOURCE OF INFORMATION
- Sketch
- Specification
- Design layout
- Manufactured part

B. DESCRIPTION
- Size
- Shape
- Location of features
- Standard format
- Notes
- Symbols

C. TYPES
- Casting
- Forging
- Machining
- Stamping
- Welding
- Tabulated

D. FINAL OPERATIONS
- Checking system
- Checker changes
- Approval
- Release for production

E. REPRODUCTION
- Diazo
- Xerography
- Heat process
- Microfilming
  - Drafting standards
  - Aperture card
  - Blow back
  - Viewer

The student should be aware of the various methods of reproducing drawings but should not be required to understand the processes involved.

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/Unit II-1: ORIENTATION TO DRAFTING II

The student should be aware of changes in conditions in the drafting field.

The student should be acquainted with the scope of Drafting II, and with the course requirements.

SUGGESTED TIME 3 DAYS

A. SALARY AND BENEFITS

B. WORKING CONDITIONS

C. DRAFTING DEPARTMENT PRACTICES

D. COURSE DESCRIPTION AND REQUIREMENTS

/Unit II-2: INTERSECTIONS AND DEVELOPMENT

The student should be sufficiently acquainted with the principles of geometry to identify pertinent three-dimensional shapes.

The student should be sufficiently acquainted with the principles of mathematics to perform necessary calculations.

The student should be able to demonstrate entry-level proficiency in drawing the layout of intersections.

SUGGESTED TIME: 15 DAYS

A. SURFACES
- Plain
- Single curved
- Double curved
- Warped

B. PARALLEL LINES
- Prism
  - Regular
  - Right
  - Oblique
  - Truncated

C. RADIAL LINE
- Cylinders
  - Circular
  - Right
  - Oblique
  - Truncated

Both filmstrip sets and prepared transparencies on intersections, developments, and layout, are commercially available.

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- Pyramids
  - Regular
  - Right
  - Oblique
  - Triangular lateral surface
  - Regular polygon base
  - Truncated
  - Frustum

The student should be aware of the existence of methods of drawing pyramids, but proficiency therein is beyond the scope of this course.

- Cones
  - Right
  - Oblique
  - Truncated
  - Frustum
- Triangulation; transition piece
  - Oblique pyramids
  - Truncated solids
- Intersections
  - Straight lines
  - Curved lines
  - Auxiliary views

The student should be aware of the existence of triangulation procedure, but should not be expected to develop proficiency in use.

/Unit II-3: POWER TRANSMISSION

The student should be acquainted with the principles of mechanical power transmission.

The student should be able to demonstrate by any teacher-specified means, an ability to identify the various means of mechanically transmitting power.

The student should be able to prepare drawings of entry-level quality, using teacher-supplied information and personally selected standards, instruments, and equipment.

SUGGESTED TIME: 8 DAYS

A. GEARS
- Method of production
- Physical characteristics
  - Plain
  - Webbed
  - Spoked
- Types
  - Spur
    - Terminology and symbols
    - Pitch circle
    - Pitch diameter
    - Number of teeth
    - Diametral pitch
    - Circular pitch
    - Addendum

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- Dedendum
- Outside diameter
- Root diameter
- Whole depth
- Working depth
- Clearance
- Circular thickness
- Chordal thickness
- Chordal addendum
- Pressure angle
- Base circle
- Gear ratio
- Face of tooth
- Flank of tooth

- Forms of teeth
  - Composite
  - Involute
- Detail drawing; USAS-Y14.7
  - Tooth profile
    - Geometric construction
    - Template
  - Sectional view
  - Dimensioning
  - Tooth data
- Rack
  - Terminology and formula
  - Circular pitch
  - Working depth
  - Basic tooth thickness
  - Minimum dedendum
  - Addendum
  - Minimum clearance
  - Minimum total depth
  - Detail drawing; USAS-Y14.7
  - Tooth profile
  - Datum
  - Dimensioning
  - Tooth data
- Bevel gears; straight bevel, and spiral bevel
  - Terminology and symbols
  - Pitch diameter
  - Cone distance
  - Addendum
  - Dedendum
  - Addendum angle
  - Dedendum angle
  - Face angle
  - Root angle
  - Back angle
  - Outside diameter
  - Crown height
  - Backing
  - Crown backing
  - Mounting distance
  - Face width

The student should be acquainted with the use of the USAS-Y14.7 standards, but not necessarily proficient in use thereof.

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. Chordal addendum
. Detail drawing; USAS-Y14.7
. Single sectional view
. Dimensioning
. Tooth data

- Worm gears
  . Terminology and symbols ; Wheel
    Pitch diameter
    Whole depth
    Outside diameter
    Face length
  . Terminology and symbols; Worm Gear
    Pitch diameter
    Throat diameter
    Outside diameter
    Face radius
    Rim radius
    Face width
    Center distance
  . Detail working drawing; USAS-Y14.7
    Gear blank information
    Tooth cutting data
    Reference data, pertinent to mating part

B. CAMS
- Purpose
- Types
  - Plate/Radial
  - Cylindrical
- Types of motion
  - Uniform/constant velocity
  - Harmonic
  - Uniform accelerated/retarded
- Cam followers
  - Pointed
  - Roller
  - Flat faced
  - Spherical faced
- Displacement diagrams
  - Motion
  - Rise
  - Fall
- Plate cam profile
  - Follower on center
  - Pivoted follower
  - Offset follower
- Circular arc
- Cylindrical cam development

C. BEARINGS
- Classification
  - Thrust
  - Radial

16859

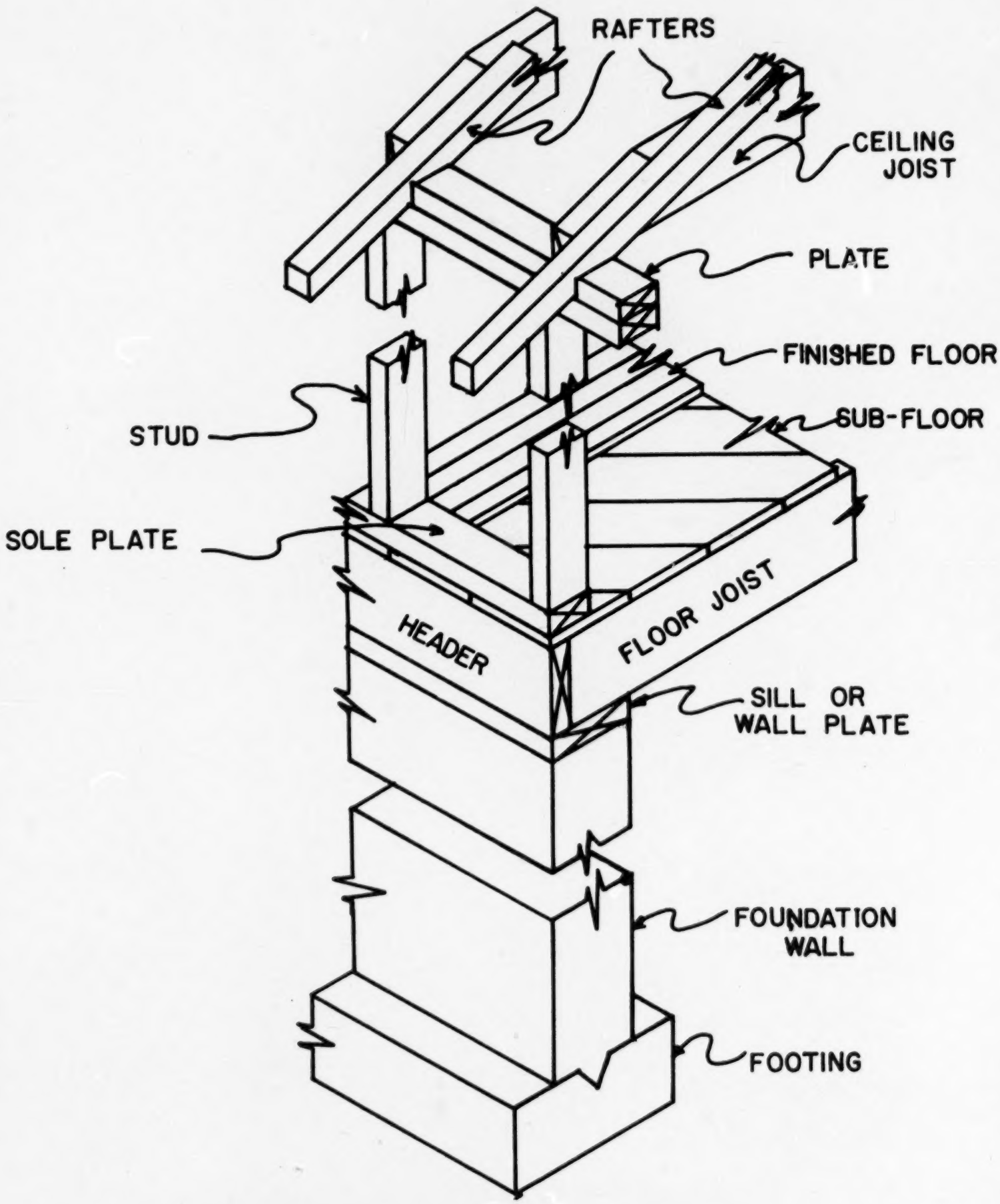

ILLUSTRATION SHEET NO. 28.

- Types
  - Sleeve
  - Ball
  - Roller
  - Thrust
  - Pillow block
- Selection
  - Load
  - Shaft fit
  - Housing fit

/Unit II-4: WELDING

The student should be acquainted with the basic processes used in the various types of welding.

The student should be acquainted with the American Welding Society manual of standard welding symbols.

The student should be able to demonstrate entry-level proficiency in selecting welding symbols, and in applying the symbols to the drawings.

SUGGESTED TIME: 10 DAYS

A. FUSION
- Oxyacetylene
- Metallic arc
- Atomic hydrogen
- TIG
- MIG
- Submerged arc

The student should be well acquainted with the nature of, and basic procedures involved in, the various common types of welding.

B. RESISTANCE
- Spot
- Projection
- Seam
- Butt
- Flash

Films on welding, and on designing for welding, are commercially available.

C. BASIC SYMBOLS —— AWS STANDARD
- Fillet
- Bevel
- Plug
- Square
- Butt
- Spot
- Flair
- Surfacing

D. ELEMENTS OF WELDING SYMBOLS
- Reference line
- Connecting arrow

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- Basic symbol
  - Near side
  - Far side
  - Combination
- Contour symbol
  - Flush
  - Convex
  - Finish symbol
  - Tail
  - Specification of reference
  - Length of weld
  - Skip weld; pitch
  - Root opening
  - Number of spots/projections
  - Supplementary information
    - Weld all around
    - Field weld
    - Method of obtaining contour

/Unit II-5: PIPING

The student should be aware of the uses of pipe assemblies, and acquainted with piping materials and the processes of assembling pipe systems.

The student should be acquainted with the standard piping symbols of the USAS-Y14 manual.

The student should be able to demonstrate entry-level proficiency in production of pipe drawings.

SUGGESTED TIME: 12 DAYS

A. PIPE
- Material
  - Cast iron
  - Steel
  - Black iron
  - Galvinized iron
  - Plastics
  - Brass
  - Copper
- Weight classification
- Designation

B. TUBING
- Shapes
- Material
  - Copper
  - Brass
  - Aluminum
  - Steel
  - Stainless steel
  - Plastics
  - Glass

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- Designation

C. FITTINGS
- Pipe
  - Threaded
  - Flanged
  - Welded
  - Solvent-welded
- Tubing
  - Soldered
  - Welded
  - Compression-fitted
- Designation
  - Nominal size
  - Material and strength factor/Pressure rating
  - Name

D. VALVES
- Gate
- Globe
- Check
- Diaphram

E. DRAWING TECHNIQUES
- Types
  - Two-line
  - Schematic
- Symbols

F. DIMENSIONING
- Center to center
- Straight lengths

G. AMERICAN STANDARD PIPE THREADS
- Conventional thread symbols
- Engagements

/Unit II-6: ADVANCED DRAFTING DEPARTMENT PROCEDURES

The student should be aware of the existence of individual corporation standards of procedure in production and revision of drawings.

The student should be acquainted with the more common time-saving techniques allowable in specific industrial situations.

The student should be able to demonstrate an entry-level proficiency in processing engineering changes.

The student should be able to demonstrate entry-level proficiency in use of the more common time-saving techniques.

SUGGESTED TIME: 7 DAYS

A. REVISION OF DRAWINGS
- Engineering change order —— ECO
- Change letter —— Noting
- Routing of change

B. STANDARD PARTS
- Purchased
- Controlled drawings

C. TEAM DRAFTING

D. DRAWING LEVELS

E. DASH NUMBERS

F. SIMPLIFIED DRAFTING
- Using verbal descriptions instead of drawings wherever practical
- Eliminating views by using abbreviations and symbols
- Drawing of partial views
- Avoiding repetitious detail
- Using symmetry techniques whenever applicable
- Omitting unnecessary hidden lines
- Listing instead of drawing standard parts
- Using outline section linings in large section areas
- Omitting unnecessary duplication of notes in lettering
- Using symbolic representations
- Using calculators, templates, plastic overlays, and other labor-saving devices
- Eliminating unnecessary details on assembly drawings
- Using ordinate dimensions where applicable
- Avoiding sectional views where external views will be adequate

G. TRICKS-OF-THE-TRADE IN DIAZO PROCESSING
- Corrector fluids
- Scissors drafting
- Block-out
- Masking
- Transparent matte tape
- Nonreproducible blue
- Variable addition; film intermediate
- Pick-off transfers
- Composite grouping
- Composite overlays
- Preprinted data

/Unit II-7: PRODUCTION ASSEMBLY DRAWINGS

The student should be aware of the nature and uses of assembly drawings.

The student should be acquainted with the various types of assembly drawing, and the conditions which require their use.

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The student should be able to demonstrate by any teacher-specified means, an entry-level proficiency in preparation of assembly drawings.

SUGGESTED TIME: 25 DAYS

A. TYPES
- General
- Detail
- Diagram (schematic)
- Display (exploded)
- Tabulated
- Installation
- Arrangement
- Matched parts
- Kit drawing

The student should be aware of the existence of installation, arrangement, matched parts, and kit drawing assembly drawings. Proficiency in preparation thereof is beyond the scope of this course.

B. DESCRIPTION
- Views
- Sections
- Principal dimensions
- Necessary hidden features
- Identification of parts
  - Balloon callouts
  - Leaders
- Parts list/List of materials
  - Item number
  - Part name/description
  - Number of items required
  - Material specification
  - Detail drawing number
  - Weight, if required
  - Manufacturer (purchased parts)
  - Miscellaneous notation
- Standard format
- Notes and symbols

C. SOURCES
- Detail drawings
- Design layout
- Manufactured parts

/Unit II-8: MEASURING INSTRUMENTS

The student should demonstrate the ability to identify and select from a representative supply, any teacher-specified measuring instrument.

The student should be acquainted with the uses and with the limitations of each necessary measuring instrument.

The student should be able to demonstrate by any teacher-specified means, an entry-level proficiency in use of necessary measuring instruments.

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SUGGESTED TIME: 10 DAYS

A. STEEL RULES
- Machinist's scale
- Combination square

B. CALIPERS
- Inside
- Outside
- Vernier
- Micrometer

C. GAGES
- Thread pitch
- Hole
- Radius
- Depth
- Center

Projection of U.S.O.E. films
#OE 2 - How to Read a Micrometer,
#OE 3 - Fixed Gages,
#OE 4 - The Vernier, and
#OE 5 - Height Gage and Test Indicator,
should be advantageous.

/Unit II-9: PRECISION DIMENSIONS

The student should be sufficiently acquainted with measurement systems and terminology to perform operations necessary to precision dimensioning.

The student should be aware of the reasons for precision dimensioning.

The student should be able to demonstrate an ability to interpret data and to convert it to relevant information by use of standard tables of fit.

The student should be able to demonstrate an entry-level ability to place on the drawings the dimensional values and appropriate symbols.

SUGGESTED TIME: 15 DAYS

A. DECIMAL SYSTEM

B. TOLERANCING METHODS
- Unilateral
- Bilateral

C. TERMINOLOGY
- Nominal size
- Basic size
- Allowance
- Limits
  - Upper
  - Lower
  - Interpretation

D. PART INTERCHANGEABILITY
- General
  - Clearance
  - Interference
  - Transition

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- Systems
  - Basic hole
  - Basic shaft
- Standard cylindrical fits
- Position tolerance
  - Tolerance zones
    - Rectangular coordinates
    - Angular
  - Features in reference to datum
    - Linear
    - Angularity

E. GEOMETRIC DIMENSIONING AND TOLERANCING

- Geometric characteristics
  - Form tolerance
    - Flatness
    - Straightness
    - Angularity
    - Perpendicularity
    - Parallelism
    - Roundness
  - Position
    - Symmetry
    - Concentricity
    - True position
- Control box
  - Datum identifying
  - Feature control
  - Combination
- Modifiers
  - Maximum material condition —— MMC
  - Regardless of feature size —— RFS
  - Full indicator reading —— FIR

/Unit II-10: DRAFTING FOR NUMERICAL CONTROL

The student should be acquainted with the nature of numerical control of machines.

The student should be sufficiently acquainted with rectangular coordinates and basic trigonometric functions to perform operations necessary in preparing numerical control drawings.

The student should demonstrate an ability to select and establish the most advantageous position for datum lines.

The student should demonstrate an ability to convert dimensions to coordinate positions, and to place the information on the drawing in the manner most easily programed.

SUGGESTED TIME: 15 DAYS

A. INTRODUCTION

- Definition

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- Application
- Flow chart

B. BASIS
- Rectangular (cartesian) coordinates
  - Two axis
  - Three axis

C. CONTROL SYSTEMS
- Positioning —— Point-to-Point
- Continuous —— Path/Contouring

D. PROGRAMING
- Programer/Process Planner
- Medium
  - Paper tape
  - Magnetic tape
- Planning sheet
  - Format
  - Location number
  - Sequence of machine operations
  - Coordinate dimensions
  - Auxiliary functions

E. DRAWING PREPARATION
- Principal views drawn as viewed by the cutting tools
- Decimal-Inch system
- Axis
  - Horizontal —— X, paralleling the bottom of the drawing
  - Vertical —— Y, paralleling the sides of the drawing
  - Transverse —— Z, perpendicular to the plane of the drawing
  - Direction —— plus and minus
- Ordinate dimensioning
  - Zero reference point
    - On the physical part
    - Outside the physical part
  - Extension lines without lines or arrowheads
  - Tabular form for P-to-P
  - Locate target points for contouring
- Polar coordinate dimension locating of holes on a circular hole pattern
- Definition of linear hole patterns
- Bend radii for changes in contour; defined and given as reference dimension
- Tabulated form for contouring
  - Established reference planes
  - Tabulated dimensions
  - Identified contour departures
- Separation of tolerances from dimensions

/Unit II-11: FACTORS AFFECTING MANUFACTURED PARTS

The student should be sufficiently acquainted with the manufacturing

/6867

processes to relate to the process in preparing the drawing.

The student should be acquainted with the standard sources of the technical information required for production-process related drawings.

The student should be able to demonstrate by any teacher-specified means, an entry-level proficiency in selection and use of technical data in preparation or production-process related drawings.

SUGGESTED TIME: 10 DAYS

A. DESIGN FACTORS
- Castings
  - Economics
    - Quality
    - Quantity
    - Cost
  - Material
  - Part size
  - Part shape
  - Degree of accuracy
  - Casting tolerance
- Forgings
  - Strength
  - Accuracy
  - Surface quality
- Stampings
  - Size
  - Nesting of blanks
  - Notches
  - Beads and ribs
  - Flanges
  - Radii
  - Holes

B. MISCELLANEOUS MANUFACTURING PROCESSES
- Blasting
  - Sand
  - Grit
  - Shot
- Sawing
- Torch cutting
- Tumbling
- Snagging

It is necessary that the student be aware of the existence of these processes, and be acquainted with the basic procedures. Detailed knowledge is beyond the scope of this course.

/Unit II-12: JIGS AND FIXTURES

The student should be aware of the purpose of jigs and fixtures.

The student should be able to demonstrate an ability to recognize jigs and fixtures.

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The student should be able to demonstrate by any teacher-specified means, a knowledge of the characteristics of various type jigs and fixtures.

The student should be able to demonstrate entry-level proficiency in the preparation of jig and fixture drawings.

SUGGESTED TIME: 25 DAYS

A. JIGS
- Function
- Types
  - Plate
    - Template
    - Leaf
  - Box
    - Tumble
    - Turnover
  - Built-up
    - Ledge
  - Pump
  - Index
  - Universal

B. FIXTURES
- Function
- Types
  - Turning
  - Milling
  - Grinding
  - Welding
  - Assembly

C. ESSENTIAL FEATURES
- Body
- Nest
- Clamping devices
- Tool components
  - Locating pin
  - Locating retainer
  - Relieved locating pin
  - Flat clamp
  - Round end clamp
  - Lockscrews
  - Shoulder liner
  - Plain renewable bushing
  - Slip renewable bushing
  - Head press-fit bushing
  - Headless liner
  - Jig feet
    - Button
    - Rest button

16869

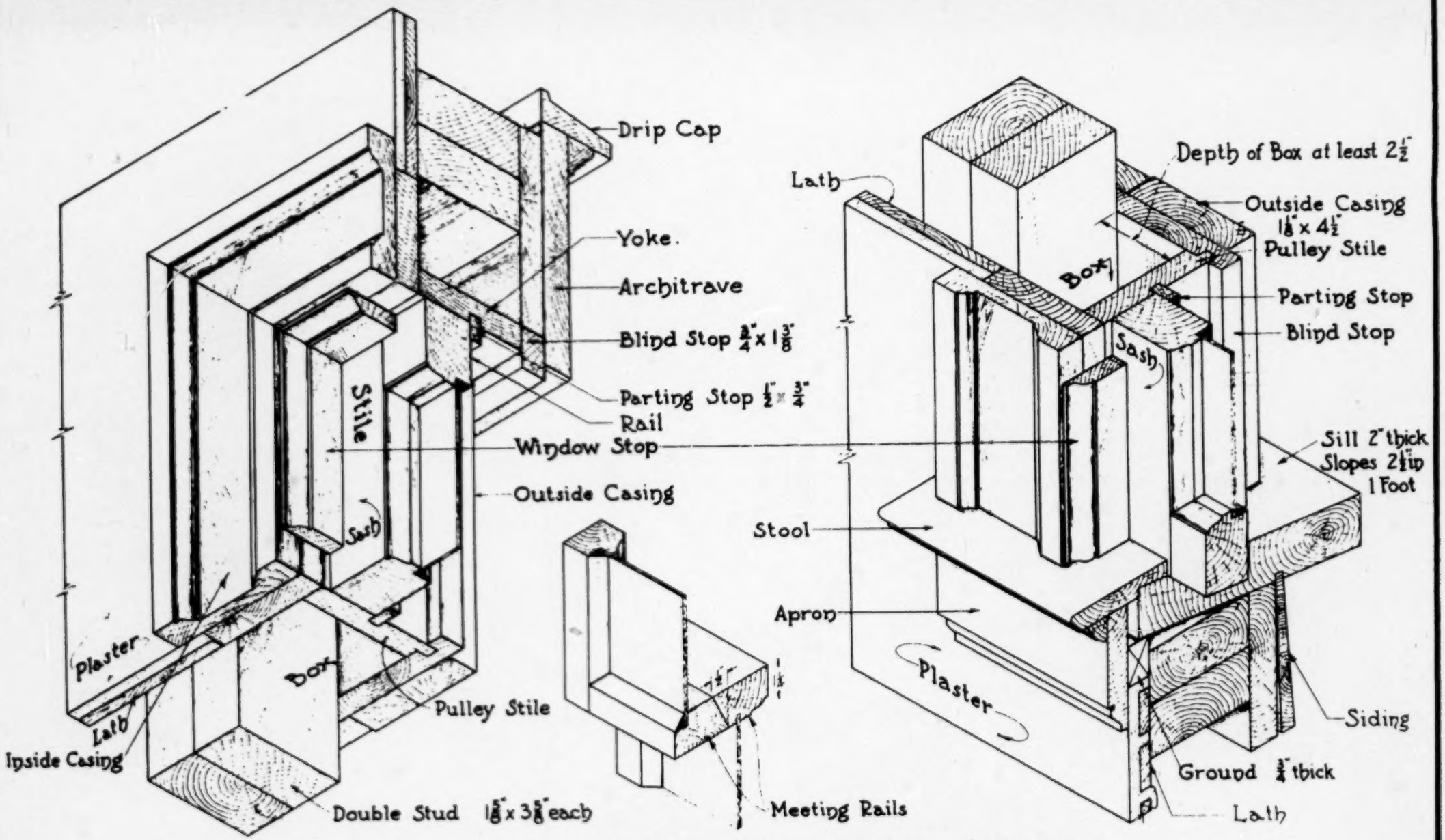

DETAILS OF WINDOW FRAME & TRIM.

ILLUSTRATION SHEET 29.

/Unit II-13: CHARTS AND GRAPHS

The student should be aware of the nature and purpose of charts and graphs.

The student should be able to demonstrate by any teacher-specified means, an ability to interpret charts and graphs.

The student should be able to demonstrate entry-level proficiency in preparing charts and graphs from drawings.

SUGGESTED TIME: 7 DAYS

A. FORMAT TYPE
- Quantitative
- Qualitative

B. TYPES
- Rectangular coordinate graph
- Semilogarithmic graph
- Logarithmic graph
- Bar chart
- Percentage bar chart
- Pie chart
- Pictorial chart
- Flow chart
- Operation process chart
- Organization chart
- Polar coordinate chart
- Trilinear chart
- Alignment chart (Nomograph)

C. INTERPRETATION

/Unit II-14: PREPARATION FOR EMPLOYMENT

The student should be aware of the personal and professional qualifications required by personnel departments.

The student should be acquainted with the common sources of employment opportunity information.

The student should be acquainted with the standard procedures of applying for employment.

The student should be able to demonstrate proficiency in completing a representative sample job application form.

SUGGESTED TIME: 3 DAYS

A. QUALIFICATIONS
- Resumé
  - Factual

Films on job interviews are available from commercial suppliers.

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- Neat
- Complete
- Chronological order
- References
- Person
  - Speech
    - Clear
    - Concise
    - "Good" English
  - Appearance
    - Clean
    - Neat
    - Moderation in dress

B. SOURCE OF INFORMATION
- Newspapers
- Agencies
- Trade publications

C. APPLYING
- Manners
- Forms
  - Standard types
  - Information required
  - Methods of completion

16871

BIBLIOGRAPHY

American Society of Tool Engineers and the New York State Vocational and Practical Arts Association. *Jig and fixture design, vol 1 & 2.* Albany, New York. Delmar Publishers, Inc. 1947.

Dygdon, S. *Basic technical drawing.* New York. The Macmillan Co. 1968.

French, T.W. & Vierck, C.J. *A manual of engineering drawing for students and draftsmen.* 10th ed. New York. McGraw-Hill Co. 1966.

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*Oberg, E. & Jones, F.D. *Machinery's handbook for machine shop and drafting room.* 18th ed. New York. The Industrial Press. 1968.

*United States of America Standards Institute. *Drafting manual USAS-Y14.* New York. The Institute.

United States Department of Health, Education, and Welfare. *Numerical Control of Machine Tools: A Point-to-Point System, OE-87051.* Washington. Superintendent of Documents. 1970.

Walraven, H.D. *A handbook of engineering graphics.* Bloomington, Illinois. McKnight & McKnight. 1969.

Wright, L.S. *Drafting-technical communication.* Bloomington, Illinois. McKnight & McKnight. 1968.

Yankee, H.W. *Machine drafting and related technology.* New York. McGraw-Hill. 1966.

Yaslow, Samuel. *Elements of mechanical drafting.* New York. The Industrial Press. 1969.

*Copies of these books should be standard equipment in the school trade-drafting room.

16872

SUPPLIES AND EQUIPMENT

A Suggested Minimum for a Class Unit of 20 Students

EQUIPMENT:

Drafting machine	21 units
Draftsman's stool	22 units
Drafting table	20 units
Parallel straight edges	6 units
Reproduction machine	1 unit
T-square and drafting board	6 sets
Tracing table	1 unit
Machinery's Handbook	5 copies
USAS-Y14 Manual	1 copy

INSTRUMENTS:

Beam compass	6 units
Bow compass, large	24 units
Bow compass, small	24 units
Circle template, three size ranges	24 units
Decimal equivalent chart	6 units
Dusting brush	24 units
Electric eraser	4 units
Ellipse template, three size ranges	24 units
Engineer's scale	24 units
Erasing shield	24 units
Flexible curve	6 units
Hexagon template	24 units
Irregular curves, two sizes	24 units
Lead holder	24 units
Lead pointer	21 units
Mechanical engineer's curves	4 units
Mechanical lettering set *	4 sets
Protractor	24 units
Technical fountain pen, set of seven sizes	4 sets
Triangle, 30° - 60°	24 units
Triangle, 45°	24 units

* Must include scriber designed to use technical fountain pens.

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SUPPLIES:

Dusting powder	36 units
Ink, technical pen, 1 oz. bottles	26 units
Pencil leads, HB	12 pkgs.
Pencil leads, H	12 pkgs.
Pencil leads, 2H	12 pkgs.
Pencil leads, 3H	12 pkgs.
Plastic film, 11 x 17, 100 count	2 pkgs.
Tracing cloth, 11 x 17, 100 count	2 pkgs.
Vellum, 8 1/2 x 11, 250 count	2 pkgs.
Vellum, 11 x 17, 250 count	2 pkgs.
Vellum, 17 x 22, 250 count	1 pkg.
Vellum, 22 x 34, 250 count	1 pkg.
Vellum, 24 inch x 50 feet	2 rolls
Vellum, 36 inch x 50 feet	2 rolls
Whiteprint paper, 8 1/2 x 11, 250 count	2 pkgs.
Whiteprint paper, 11 x 17, 250 count	2 pkgs.
Whiteprint paper, 17 x 22, 250 count	2 pkgs.
Whiteprint paper, 22 x 34, 250 count	2 pkgs.
Whiteprint paper, 24 inch x 50 feet	2 rolls
Whiteprint paper, 36 inch x 50 feet	2 rolls

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VISUALS SOURCE DIRECTORY

Associated Films, Inc.
600 Grand Avenue
Ridgefield, N.J. 07657

Bailey-Film Associates
11559 Santa Monica Blvd.
Los Angeles, California 90025

Bethlehem Steel Corporation
Advertising Division
Bethlehem, Pennsylvania 18016

Churchill Films
662 North Robertson Blvd.
Los Angeles, California 90069

Fellows Gearing Shape Co., Ltd.
Publicity Department
78 River Street
Springfield, Vermont 05156

Gaskell Teaching Aids
13 Thistledown Drive
Columbia, Missouri 65201

Geyer Instructional Aids Co., Inc.
P.O. Box 2588
Fort Wayne, Indiana 46807

Industrial Products Group - Crane Co.
4100 South Kedzie Avenue
Chicago, Illinois 60632

Lapine Scientific Company
South Buckout Street
Irvington, N.Y. 10533

McGraw-Hill Films
330 West 42nd Street
New York, New York 10036

Superintendent of Documents
United States Government Printing Office
Washington, D.C. 20402

Tweedy Transparencies
208 Hollywood Avenue
East Orange, N.J. 07018

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VISUALS LIST

16 mm. Sound Films

Choosing the right valve. Industrial Products Group. 25 min. b&w.

Design for arc welded structures. Associated Films, Inc. 15 min. color.

Design for manufacture, #60240. University of Illinois and Kearney & Trecker Corp. 23 min. b&w.

Designing machinery for arc welding. Associated Films, Inc. 15 min. color.

Drawings and the shop, #68200. McGraw-Hill Films. Engineering Drawing Series. 14 min. b&w.

Forged hardened steel rolls. Bethlehem Steel Corp. 20 min. color.

Holding power. Bethlehem Steel Corp. 22 min. b&w.

Job interviews for men. Churchill Films. 15 min. color.

Job interviews for women. Churchill Films. 15 min. color.

Pageant of steel. Bethlehem Steel Corp. 28 min. color.

Piping pointers. Industrial Products Group. 25 min. b&w.

Shop procedures, #55200. McGraw-Hill. Mechanical Drawing Series. 18 min. b&w.

Skylines. Bethlehem Steel Corp. 30 min. color

Special performance. Bethlehem Steel Corp. 24 min. color.

Steel pipe at your service. Bethlehem Steel Corp. 14 min. color.

Steel plates from Bethlehem. Bethlehem Steel Corp. 10 min. color.

Team work. Bethlehem Steel Corp. 31 min. color.

The art of genorating. Fellows Gearing Shape Co., Ltd. 40 min.

The factory: how a product is made, #60073. Film Associates. 14 min. color.

The long pull. Bethlehem Steel Corp. 29 min. color.

The new Bethlehem steel. Industrial Products Group. 20 min. color.

This is steel. Bethlehem Steel Corp. 32 min. color.

16876

United States Office of Education

OE-2 *How to read a micrometer.*
OE-3 *Fixed gages. 17 min. b&w.*
OE-4 *Verniers. 19 min. b&w.*
OE-5 *Height gage and test indicator. 12 min. b&w.*
OE-7 *Turning work of two diameters. 14 min. b&w.*
OE-11 *The milling machine. 8 min. b&w.*
OE-12 *Cutting a keyway. 13 min. b&w.*
OE-14 *Straddle milling. 17 min. b&w.*
OE-15 *Plain indexing and cutting a spur gear. 26 min. b&w.*
OE-68 *The lathe. 15 min. b&w.*

Filmstrips - 35 mm.

Mechanical Drawing Series. McGraw-Hill. Set #3.
Compasses and bow instruments.
Freehand lettering.
Intersections and developments.
Isometric drawing.
Scales.

Mechanical Drawing Series. McGraw-Hill. Set #4.
Auxiliary views and related constructions.
Dimensioning, parts I and II.
Orthographic drawing, parts I and II.
Sectional views.

Slides - 35 mm.

Drafting sets. Gaskell Teaching Aids.

Solid Models - Transparent

Drafting and models. Geyer Instructional Aids.
Models for Vocational Education. Lapine Scientific Co.

Transparencies

Drafting series. Tweedy Transparencies.
Mechanical Drafting Series. McGraw-Hill.
Auxiliary views and revolutions.
Bolts and screws.
Dimensioning
Orthographic projection.
Pictorial drawing.
Sectional views.
Sheet metal layout.

16877

VT 013 099
Law Enforcement Officer Training, Basic Course. The Ohio Law Enforcement Officers' Training Program. Learner's Manual.

Ohio State Dept. of Education, Columbus. Trade and Industrial Education Service.
MF AVAILABLE IN VT-ERIC SET.
Ohio Trade and Industrial Education Service, Instructional Materials Laboratory, The Ohio State University, 1885 Neil Avenue, Columbus, Ohio 43210.
PUB DATE - 68 241p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *STUDY GUIDES; *POLICE; *LAW ENFORCEMENT; JOB TRAINING; ADULT VOCATIONAL EDUCATION; COURSE CONTENT; BIBLIOGRAPHIES

ABSTRACT - This learner's manual was prepared by the Division of Vocational Education of the Ohio State Department of Education, in cooperation with various persons and organizations, for use in the Ohio Law Enforcement Officers' Training Program. The program is designed to adequately meet the needs and improve the competencies and skills of local law enforcement personnel. Included in the 25 training procedures are: (1) Uniform, Acquiring and Maintaining, (2) Felonies, Handling, (3) Testifying in Court, (4) Fire Scenes, (5) Traffic Congestion, Handling, and (6) Emergency Care--First Aid. The appendixes consist of 45 sections, including: (1) Bill of Rights, U.S. Constitution, (2) Business Security Survey Report, (3) Field Sketch Sheet, (4) Commercial Restraint Devices, and (5) Report of Death. A bibliography is provided, and the manual is illustrated with line drawings, diagrams, and photographs. Related documents are available as ED 016 025 and ED 016 027 (VT 000 689 and VT 000 692, respectively, both in AIM Spring 1968). (GEB)

VT 013 099

ED0 56238

C1

LAW ENFORCEMENT OFFICER TRAINING

BASIC COURSE

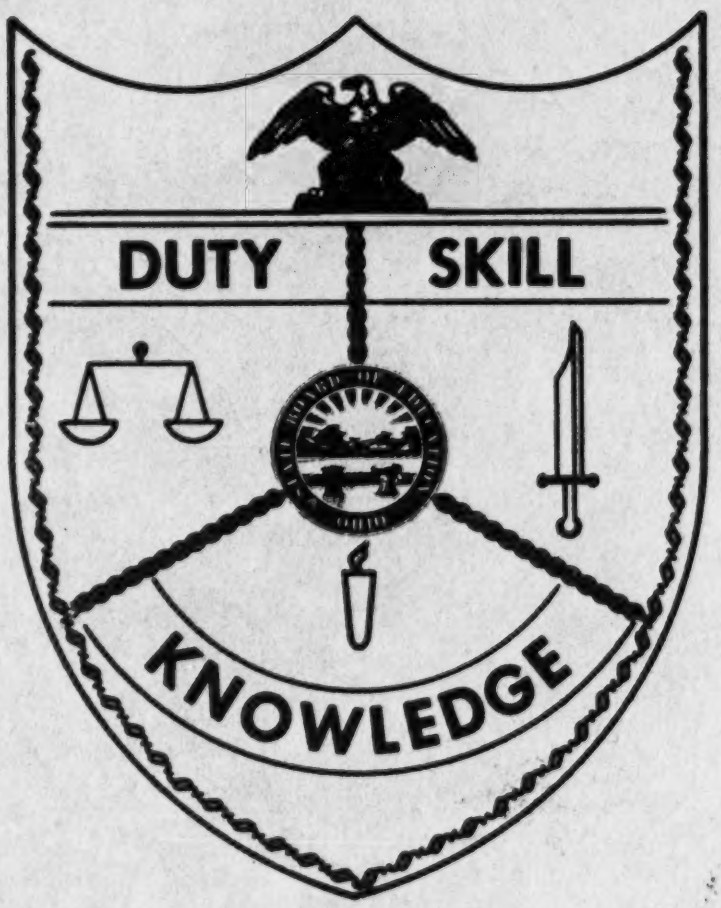

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Learner's Manual

OHIO TRADE AND INDUSTRIAL EDUCATION SERVICE

DIVISION OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF EDUCATION
COLUMBUS, OHIO

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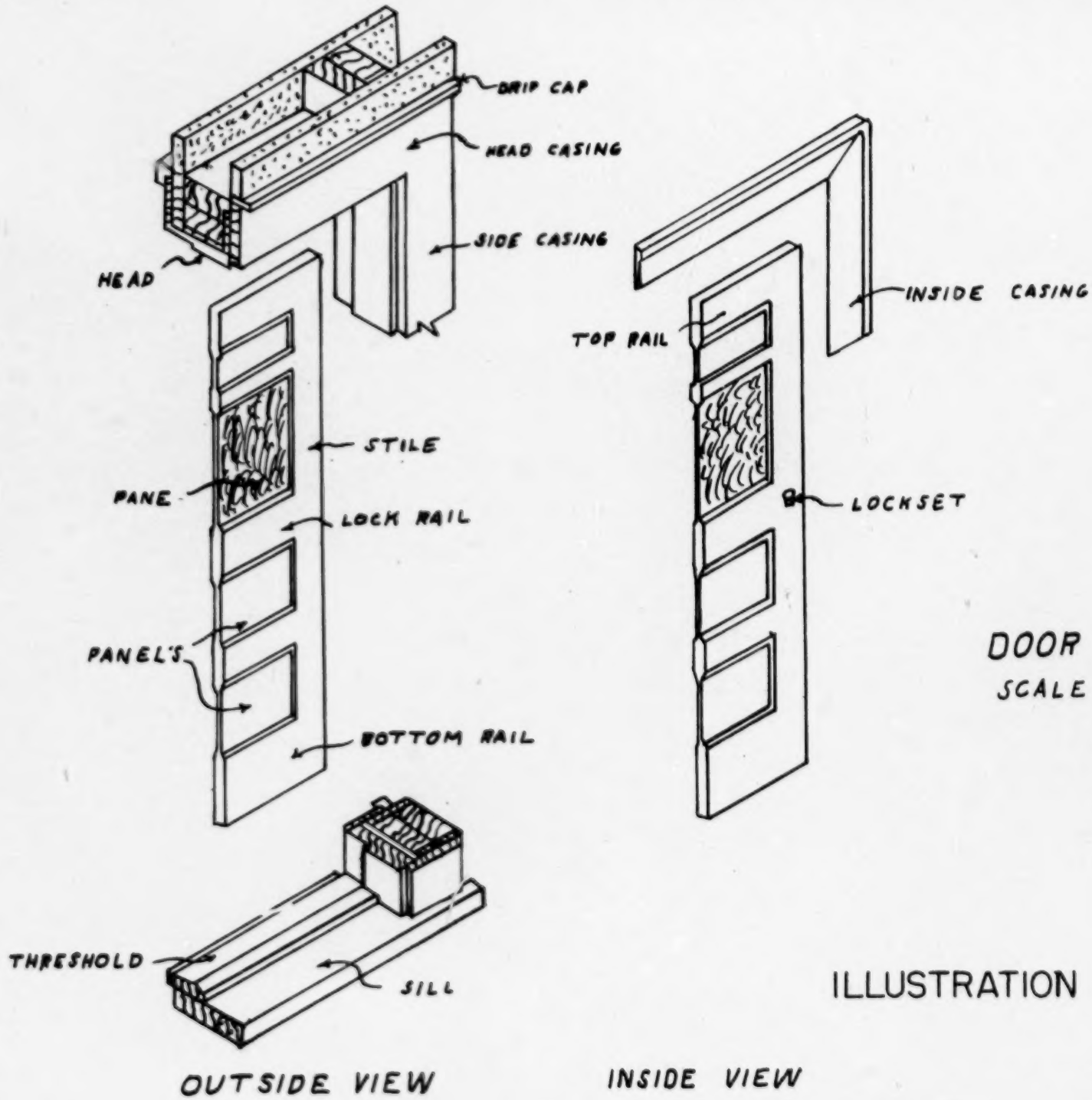

DOOR DETAILS

SCALE: DOORS 1" = 24"
FRAMERS 1" = 12"

R. SOLEM, S.H.S. '57

ILLUSTRATION SHEET NO. 30.

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LAW ENFORCEMENT OFFICER TRAINING

BASIC COURSE

THE OHIO LAW ENFORCEMENT OFFICERS' TRAINING PROGRAM

Learner's Manual

OHIO TRADE AND INDUSTRIAL EDUCATION SERVICE

DIVISION OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF EDUCATION
COLUMBUS, OHIO

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Preface

The State Department of Education has been instrumental in providing training in skilled and technical occupations to the citizens of Ohio since 1918, through the Trade and Industrial Education Services, Division of Vocational Education.

Training in trade and industrial education enables individuals, both male and female, to prepare for initial employment in a trade, technical or service occupation. In addition, it enables employed workers to upgrade themselves and advance in their chosen occupations, and retrains those who are temporarily unemployed.

In the adult category, special emphasis is placed on training for public service personnel, such as fire fighters, rescue and emergency personnel, school bus drivers, custodians, hospital housekeepers, electric linemen and law enforcement officers. The purpose of this training is to upgrade the services rendered to the citizens of a community by improving and providing additional skills and/or knowledge, thereby resulting in more efficient and effective services.

The cost of crime and traffic accidents, including the human suffering resulting therefrom, is an enormous waste of every community's resources. A well trained and efficient law enforcement officer is probably the most effective means of reducing this human toll and suffering.

The Law Enforcement Training Program of the Vocational Trade and Industrial Education Services in Ohio is intended to provide training to officially designated law enforcement agencies. The purpose of this manual is to supplement this organized training program planned to provide the law enforcement officer with the skills and technical knowledge essential in carrying out his duties. It outlines methods of effective operation which will enable each officer to recognize the importance of his position within the law enforcement agency and to stimulate the officer in performing his service with pride.

The Law Enforcement Officers Training Program and this publication are provided through the cooperative efforts of the Trade and Industrial Education Services, Vocational Division, State Department of Education; College of Education, The Ohio State University; and the public schools of Ohio.

Martin Essex, Superintendent of
Public Instruction

Byrl R. Shoemaker
Director of Vocational Education

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Foreword

The Law Enforcement Officers Training Program was developed by the Trade and Industrial Education Services, Division of Vocational Education, to meet the needs expressed by the Buckeye State Sheriffs' Association and the Ohio Association of Chiefs of Police, for an effective training program.

This training program is designed to provide law enforcement officers with a better understanding of the many problems involved in providing good law enforcement services. It presents practices which have been used successfully in organized training programs in various sections of the country.

In former years, law enforcement services were primarily concerned with enforcing a few state and local laws, controlling a comparatively small number of vehicles, and effecting the arrest of local violators. New officers were often placed on duty without receiving adequate training, necessary supplies and equipment. This frequently resulted in ineffective law enforcement services. Fortunately today, ineffective practices are not as prevalent as they once were. The recent increase in the number and variety of laws, increase of ownership and use of vehicles, the growth of urban areas, and the demands of a better educated public has led Ohio to recognize the need for training in the knowledge, skills and services of a specialized nature. The Ohio Law Enforcement Officers' Training Program should help communities provide more effective and efficient law enforcement services.

The objectives of this training program sponsored by the Trade and Industrial Education Services are as follows:

1. To determine local, county, regional and state needs and to implement a program to adequately meet these needs on a continuing basis.

2. To improve the competencies and skills of local law enforcement personnel.

The state supervisor and the law enforcement training staff within the Trade and Industrial Education Services utilized a State Law Enforcement Advisory Committee in order to determine the previously mentioned objectives; the principles and policies for the law enforcement training program; and the manner in which it is conducted in Ohio. This advisory committee is composed of representatives from The Buckeye State Sheriffs' Association and The Ohio Association of Chiefs of Police, Incorporated.

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A comprehensive training program for law enforcement officers is being implemented. The following types of training are now available:

Basic Training
Advanced Training
Regional Law Enforcement Institutes'
State Law Enforcement Institute
Arson Investigation

Officer Leadership Training:
- Instructor Training
- Conference Leadership
- Effective Speaking
- Human Relations
- Job Methods

The intent of this manual is to provide the necessary instructional material, which will serve as an up-to-date and comprehensive source of information, covering the practices and techniques of the procedures included in the Basic Course - Unit I. Instructional materials of this type are the key to conducting an effective and efficient training program.

It is our sincere desire that law enforcement officers throughout the state will realize the ultimate benefits to be gained in the organized state training programs utilizing this manual and its procedures.

Harry Davis, Supervisor
Trade and Industrial Education Services

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Acknowledgments

The Trade and Industrial Education Services acknowledges the cooperation and contributions made by the various persons in devoting their time, and giving advice and council in the development of this manual.

Special acknowledgment is extended to the members of the State Advisory Committee for Law Enforcement Training, and to the two statewide organizations which they represent, for their encouragement and assistance in the development of this material and the overall training program. Members representing the two organizations and consultants to the committee are as follows:

The Buckeye State Sheriff's Association
Doug Ziegler, Sheriff, Defiance County, Ohio
Roger D. Stillings, Sheriff, Champaign County, Ohio
Dwight E. Radcliff, Sheriff, Pickaway County, Ohio

The Ohio Association of Chiefs of Police
Milan Duris, Chief of Police, Bedford, Ohio
Robert Temple, Chief of Police, Circleville, Ohio
Frank Burnodky, Chief of Police, Canton, Ohio

Consultants to the committee
Harry Davis, Supervisor, Trade & Industrial Education Services
Frank Oliverio, Assistant Supervisor, Trade & Industrial Education Services
Dr. Robert M. Reese, Director, Trade & Industrial Education Services, The Ohio State University
Dr. Byrl R. Shoemaker, Director Division of Vocational Education, State Department of Education, Columbus, Ohio
Robert S. Takacs, Consultant, Law Enforcement Training
Harry L. Smith, Specialist, Law Enforcement Training

Acknowledgment is extended to the various associations and companies who granted permission for use of certain of their materials, as acknowledged by courtesy lines in the Appendix.

Special credits are extended to Robert S. Takacs, Consultant, and Harry L. Smith, Specialist, Law Enforcement Training staff, Trade and Industrial Education Services, for the development of the content and to Dr. Robert M. Reese and Wilbur F. Stover, Consultant, Instructional Materials Laboratory, The Ohio State University, for developing the format and editing the content of the material.

Special mention is extended to the staff of the Instructional Materials Laboratory for their efforts in the composition and production of this manual.

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Training Procedure No. 1

UNIFORM, ACQUIRING AND MAINTAINING

INTRODUCTORY INFORMATION:

Law enforcement officers wear uniforms in order to perform their duties more effectively and safely.

The officer in uniform is the government's symbol of law and order. The very sight of an officer, in most instances, stops the potential law violator from committing a crime for fear of apprehension. In this respect, the uniform serves a crime preventive function. Since the prevention of crime is the officer's primary responsibility, the uniform which is seen most often by the most people is the most effective.

The uniform identifies the officer as a member of that arm of government which is responsible for ensuring compliance with the law. Due to the hazardous nature of the duties involved, such as, the use of firearms in arresting a criminal, it is imperative that not only the person being arrested recognize the officer, but spectators as well. This is necessary in order that the criminal have no excuse for non-compliance and the law abiding no misunderstanding as to what is taking place--an arrest or a robbery. In this respect it aids the officer's personal safety.

Because the law enforcement officer will be required to wear a uniform he must concern himself with quality, economy, and appearance. Since there is no substitute for good quality, the officer should accept nothing less. Whether the officer personally purchases or is issued a uniform does not alter the fact that it costs money to purchase and to maintain. By following a few simple procedures the officer can extend the life of the uniform thereby saving money and at the same time maintaining a neat appearance. The neat appearing officer finds it less difficult to have people comply with his requests and creates a favorable impression in the eyes of the public for himself and his department.

EQUIPMENT NEEDED:

Clothes hangers, Wooden
Fabric Cleaning:
- Cleaning fluid
- Cloth, Soft white
- Clothes brush, Hard bristle
- Hat brush, Soft bristle
- Lint remover

Leather Polishing:
- Brush
- Cloth, Polishing
- Metal polish dauber (with scraper)
- Saddle soap
- Shoe polish, Black
- Sole dye, Black

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Assignment

WS. 55. First Floor Plan: Using Work Sheet 55, fill in the symbols shown on Illustration Sheet 25, page 89. The numbers on the floor plan shown on WS 55 indicate the location of the different symbols. Square the Work Sheet on your drawing board and use instruments to draw the symbols. Letter-in the title strip and hand the drawing in for grading.

WS. 56. Garage Elevations: Using Work Sheet 56, complete the front and side elevations of the garage. Square the Work Sheet on your drawing board and use instruments to complete the drawing. Illustration Sheet 27, page 93, shows an elevation of a house.

WS. 57. Wall Section: Study Illustration Sheet 28, page 95, and learn the names of some of the parts of a house. Now use Work Sheet 57 and letter-in the name of the house part corresponding to each number. Using the lines already given opposite the number, measure 1/8" above each line and draw a light guide line through your measurement. This will give you a set of guide lines 1/8" apart for your lettering.

WS. 58. Double Hung Window: Study Illustration Sheet 29, page 97, and learn the given parts of a double hung window. Now use Work Sheet 58 and letter-in the name of the window part corresponding to each number. Using the lines already given opposite the number, measure 1/8" above each line and draw a light guide line through your measurement. This will give you a set of guide lines 1/8" apart for your lettering.

Training Procedure No. 1

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
		1.10	Having snaps sewn on both ends of all pocket flaps of jackets and shirts
2.	Dry clean woolens	2.1	Regularly
		.2	Selecting a reputable firm
		.3	Identifying stain by attaching note
		.4	Requesting military crease in shirts
3.	Launder cottons	3.1	After each wearing
		.2	Ironing military creases into shirts
4.	Brush clothing	4.1	Frequently
		.2	Before and after wearing
		.3	Outdoors in sunlight
		.4	Brushing hats gently using soft bristle brush
		.5	Using hard bristle brush on clothing and caps
		.6	Brushing clothing vigorously
		.7	Removing lint with lint remover
5.	Shine leather	5.1	Shoes daily
		.2	Other leather at least once a month
		.3	Cleaning with saddle soap regularly
		.4	Preventing excessive accumulation of polish
		.5	Avoiding a hard finish (high gloss) on leather parts that flex
6.	Shine metal	6.1	Daily, using correct polish for particular metal finish
		.2	Following instructions on polish containers
		.3	Avoid scratching of surface
		.4	Avoid handling polished metal
7.	Dry out wet uniform	7.1	Promptly
		.2	To prevent mildew and maintain shape

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LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
7.a. Caps or hats	7.a.1	Shaking off excess water
	.2	Blotting visor with soft absorbent cloth
	.3	Wiping metal buttons dry
	.4	Removing cap badge
	.5	Turning leather liner down
	.6	Removing all size adjusting material
	.7	Placing on flat surface
	.8	Setting on visor and brim
7.b. Clothing	7.b.1	Removing belts
	.2	Emptying all pockets
	.3	Removing all metal insignia
	.4	Shaking off excess water
	.5	Wiping all metal parts dry
	.6	Fastening buttons
	.7	Closing zippers
	.8	Hanging shirts and coats on wooden hangers
	.9	Using wooden clamp hangers for trousers
	.10	Placing on hangers carefully
	.11	Removing and smoothing wrinkles
	.12	Allowing adequate air circulation
	.13	Allowing to dry naturally
	.14	Keeping away from heat
	.15	If excessively wet, have dry cleaned after drying
7.c. Shoes and overshoes	7.c.1	Wiping off excess water outside and inside
	.2	Using wooden shoe trees to retain shape
	.3	Lacing and tying shoe laces to retain shape
	.4	Laying shoes on sides on protective covered flat surface
	.5	Allowing to dry naturally
	.6	Keeping away from heat

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LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
7.d. Leather, weapon and foul weather gear	:	7.d.1	Wiping off water
	:	.2	Removing equipment from holster and cases, following safe weapon procedures
	:	.3	Removing cartridges from revolver
	:	.4	Hanging belts and straps from buckles - straight
	:	.5	Wiping dry all metal
	:	.6	Emptying pockets of leather jacket
	:	.7	Hanging jacket on wooden clothes hanger
	:	.8	Placing on hanger carefully
	:	.9	Buttoning buttons
	:	.10	Closing zippers
	:	.11	Removing wrinkles
	:	.12	Turning collars up
	:	.13	Placing glove on upright stick to aid circulation
	:	.14	Allowing adequate air circulation
	:	.15	Allowing to dry naturally
8. Clean revolver	:	8.1	Remaining isolated
	:	.2	Rechecking cylinder to make certain it is empty
	:	.3	Handling to prevent damage
	:	.4	Inspecting for serviceability
	:	.5	Completely
	:	.6	Using proper materials and equipment
	:	.7	Securing weapon after cleaning
9. Remove loose dirt	:	9.1	When thoroughly dry
	:	.2	Working in area covered with newspaper
	:	.3	Using clothes brush on clothing
	:	.4	Brush with and against nap carefully
	:	.5	Using scraper on shoes
	:	.6	Avoid scuffing of leather
10. Remove stains	:	10.1	Promptly
	:	.2	Avoid damaging the fabric
	:	.3	Placing clean absorbent cloth under stain

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Training Procedure No. 2

PATROLLING ON FOOT - DAYTIME - *NIGHTTIME

INTRODUCTORY INFORMATION:

The officer is responsible for guarding persons, their rights, and property in a designated area by requiring all people therein to obey the law. This guard duty is performed best when the officer goes about his designated area (beat) inspecting persons and property as often as possible. Performing this duty is called patrolling. The officer enforces the law on all persons on his beat by persuasion if possible, by force if necessary.

Patrolling, when properly performed, is the best method by which the law enforcement officer can carry out his primary responsibility of preventing crime. The basic method of patrolling is on foot. Its chief advantage over other methods is the officer's daily intimate contact with the people and the property on his beat. It is from these contacts that the officer learns who resides, earns a livelihood, and engages in recreation on the beat. By careful observation, he soon learns who and what is usual or unusual.

The law enforcement officer can become more proficient and effective during the time he is on duty (watch) by the constant application of the proper patrolling techniques contained herein.

EQUIPMENT NEEDED:

Baton, Riot
Belt, Sam Browne
Card, Identification (See Appendix 13)
Cards, Business
Cartridges, 12, Extra Revolver
Case, Cartridge, Double
Case, Handcuff
Chain, Whistle
Citation Book, Traffic
Dimes
Flashlight, with extra bulb

Forms:
- Business Security Survey Report
- Information on Personalities
- Persons Report
- Preliminary Investigation Report (See Appendix 14)

Handcuffs
Holster, Closed Revolver
Key, Handcuff
Keys, Other (as required)
Knife, Pocket
License, Operator's
Map, Local
Notebook, Pocket
Pen, Ball Point
Pencil, Mechanical
Radio, Portable Two-way Transistor
Revolver, Loaded Service

Note: Items identified by an asterisk pertain to nighttime patrolling only.

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LAW ENFORCEMENT OFFICER TRAINING

Ring, Baton (with strap)
Ruler, 6" Plastic
Schedule, Local Commercial Transportation
Stick, Yawara
Timepiece
Uniform of the Day
Whistle, Traffic

GENERAL SAFETY PRACTICES:

Maintain physical fitness
Wear six inch duty shoes with protected toes and rubber heels
All eye glasses, including sunglasses, should have hardened lens and be prescribed by an oculist
Be constantly alert for potential personal hazards
Stop and listen before turning corners
Weapons must never be given to anyone in the field
Secure all equipment from rattling
Approach all persons and things with caution
Use prescribed whistle and flashlight signals
Carry change in watch pocket
Hold flashlight in weak hand
Keep flashlight away from body when in use
Check flashlight for serviceability
*Night duty should never be performed with a cold or persistent cough
*To maintain night vision, avoid heavy smoking and use of intoxicating beverages
*Loud talking, singing, or whistling should be avoided
*Close one eye when a bright light appears, to maintain night vision
*Maintain your sense of direction
*Run only when absolutely necessary
*Avoid smoking when walking the beat
*Secure all equipment from reflecting

STEPS		KEY POINTS
ON DUTY RELIEF		
1. Prepare for watch	1.1	Inspecting personal equipment for serviceability
	.2	Reporting in well groomed
	.3	Wearing uniform of the day
	.4	Reporting before prescribed time
	.5	Avoid loitering in business offices
	.6	Checking bulletin board
	.7	Recording date, day of week, watch, beat, weather condition, supervisor's name on Note Book Log Sheet (See Appendix 4)

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STEPS	KEY POINTS
	1.8 Receiving orders and pertinent information from watch commander
	.9 Recording necessary law enforcement intelligence in notebook (See Appendices 5 and 6)
	.10 Standing inspection for watch commander
	.11 Discussing beat activity with supervisor (See Appendix 7)
2. Proceed to watch relief point	2.1 At pre-determined location
	.2 Arranging for transportation with supervisor
	.3 Varying time and route pattern
	.4 Handling violations witnessed enroute
	.5 Arriving early
	.6 Being inconspicuous
3. Meet with beat officer	3.1 Recording:
	.1 Name
	.2 Number
	.3 Time
	.4 Location
	.2 Obtaining pertinent information:
	.1 Cases requiring follow-up
	.2 Requests for law enforcement intelligence
	.3 Law enforcement hazards
	.4 Previous information
	.5 Safety hazards
	.6 Changes in trafficways
	.3 Selecting next watch relief point:
	.1 Having good view of beat
	.2 Should be inconspicuous
	.3 Sheltered location during inclement weather
	*.4 Should be lighted and safe
	.5 Varying the location
	.6 Recording location
	.4 Notifying dispatcher when unable to make contact

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LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
4. Relieve beat officer	:	4.1	Taking charge of beat
	:	.2	Leaving beat only for required duties
	:	.3	Requesting supervisor's permission to leave
	:	.4	Notifying dispatcher of location
	:	.5	Recording all absences from beat and reasons therefore
	:	.6	Acting on pending assignments requiring immediate action
	:	*.7	Inspecting pedestrian or other hazards requiring lighting
RECONNAISANCE PATROL			
5. Proceed to area to be reconnoitered	:	5.1	Selecting area with:
	:	.1	High criminal, pedestrian, or vehicle activity
	:	.2	Larger proportion of law enforcement or safety hazards
	:	.3	Activity which is to take place during watch
	:	*.4	Bright lighting first
	:	*.5	Little or no lighting last
	:	.2	Varying time and route pattern
6. Reconnoiter the area	:	6.1	Being systematically unsystematic in patrolling
	:	.2	Covering selected areas fairly rapidly
	:	.3	Constantly utilizing peripheral vision
	:	.4	Stopping and listening for unusual activity before turning corners
	:	.5	Be alert to present and future activity
	:	.6	Noting activity that may occur during watch
	:	.7	Handling only those problems requiring immediate attention
	:	*.8	Dark-adapting eyes by closing them momentarily before entering dimly lighted areas
	:	*.9	Avoid direct bright lights

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STEPS		KEY POINTS	
		*6.10	Stand and look into darkened areas
7.	Talk with sources of information	7.1	Having vantage occupations
		.2	Learning of activity that may occur during watch
8.	Observe persons, places, and things	8.1	Anything unusual
		.2	Indicating activity that may occur during watch
		*.3	Observing distance reduced and distorted during nighttime and certain weather conditions
	STANDARD PATROL		
9.	Proceed to location to be inspected	9.1	Walking slowly and erectly
		.2	Letting yourself be seen
		.3	Grasping strong hand with weak hand behind back
		.4	Unofficial objects must not be carried
		.5	Using heel to toe method--on outside edge
		.6	Walking on ball of foot when using stairs
		.7	Avoiding surveillance by others
		.8	Stopping and looking back over route traveled
		.9	Being aware of physical background
		.10	Looking at opposite side of street, upper floors, and roofs of buildings
		.11	Stopping and listening for unusual activity before turning corners
		.12	Being aware of changes in trafficways
		.13	Handling problems as they occur:
		.1	Within jurisdiction and capabilities
		.2	Requesting departmental assistance from supervisor or dispatcher when necessary

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STEPS	KEY POINTS
	9.13.3 Criminal, traffic, juvenile, and special requests in that order
	.14 Time and place of patrol interruptions should be recorded
	.15 Telephone service should be available at location of interruption
	.16 Varying time and location of personal breaks and meal period
	.17 Covering beat as often as possible until time of relief
	*.18 Walking quietly
	*.19 Standing and walking in shadows
	*.20 Avoiding being seen or silhouetted
	*.21 Crossing streets where there is least amount of light
	*.22 Being alert for potential assaults in dimly lighted areas
10. Inspect public property	10.1 Recording time and location of:
	.1 Unsafe conditions
	.2 Damaged property
	.3 Improperly functioning equipment
	.4 Dead or injured animals
	.2 Correcting unsafe conditions immediately when within authorization and capability
	.3 Notifying dispatcher when immediate corrective action beyond capability, is necessary
	.4 Reporting, in writing, unsafe conditions and recommendations for improvement to supervisor (See Appendix 7)
11. Conduct business security survey	11.1 Contacting businessmen periodically and leaving business card on first contact (See Appendix H)
	.2 Assuring periodic inspection
	.3 Inspecting business security measures
	.4 Completing Business Security Survey Report form (See Appendices 9 and 10)

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STEPS	KEY POINTS	
	11.5	Recording current information:
	.1	Name, address, and telephone number of business, manager, and assistant manager
	.2	Type and amount of security equipment
	.3	Security measures taken in operations
	.4	Security hazards
	.5	Selected employees
	.6	Recommended improvements
	.6	Requesting beat officer on night watch to check nighttime security and to make recommendations
	.7	Giving completed form to supervisor
12. Inspect security of buildings	12.1	Those closed for special reasons
12.a. Exterior	*a.1	At close of business day
	.2	Locating security alarms, knowing type and nature of installation
	.3	Checking security equipment to be in place, original, and serviceable
	.4	Remaining inconspicuous to anyone inside
	.5	Trying all accessible means of entry and exit, especially rear and roof
	.6	Looking for indications of attempted and completed forced entry from without and within
	.7	Looking and listening for movement from within
	.8	Checking interior physical arrangement for alterations
	.9	Recording inadequate security measures
	.10	Recommending adequate security measures, if requested by owner
12.b. Interior	b.1	Recording time building found unsecured

16898

WS. 59. Door: Study Illustration Sheet 30, page 99, and learn the given parts of a door. Now use Work Sheet 59 and letter-in the name of the door part corresponding to each number. Using the lines already given opposite the number, measure 1/8" above each line and draw a light guide line through your measurement. This will give you a set of guide lines 1/8" apart for your lettering.

STEPS		KEY POINTS
	12.b.2	Recording name and address of occupying firm
	.3	Notifying dispatcher of name of firm, building, and location
	.4	Requesting assistance for interior inspection
	.5	Requesting dispatcher to notify owner, request his presence, and determine his estimated time of arrival
	.6	Determining if authorized person is inside
	.7	Checking authorized person's identity with owner
	.8	Recording name, position of employee, home address, and telephone number
	.9	Recording name and position of person responding in place of owner
	.10	Entering building with another officer
	.11	Avoiding being silhouetted
	.12	Carrying revolver in strong hand
	.13	Carrying flashlight in weak hand, if interior dark
	.14	Holding flashlight to side and slightly ahead of body when in use
	.15	Keeping other officer or flashlight in view at all times
	.16	Using proper flashlight signals
	.17	Avoiding cross fire
	.18	Checking one room at a time
	.19	Looking up as well as on floor level
	.20	Starting on lowest floor, working up
	.21	Closing all doors after entering each room
	.22	Locking all doors after searching each room
	.23	Walking quietly, using short steps
	.24	Stopping and listening for movement sounds
	.25	Completing search of building even if one suspect apprehended

16899

STEPS	KEY POINTS
13. Inspect security of property	13.1 Checking security equipment to be in place, original, and serviceable
	.2 Checking physical arrangement of property
	.3 Recording inadequate security measures
	.4 Notifying owner of inadequate security measures
	.5 Recommending adequate security measures, if requested by owner
14. Inspect parked vehicles	14.1 Selecting those that are unusual as to:
	.1 Area
	.2 Beat
	.3 Location in which parked
	.4 Manner in which parked
	.5 Time at which parked
	.6 Length of time parked
	.7 Neglected care or condition
	.8 Altered or absence of required identification
	.9 Contents
	.2 Approaching from rear cautiously
	.3 Checking for occupants cautiously
	.4 Checking license number against Wanted Vehicle list (See Appendix 6)
	.5 Determining if stolen or abandoned
	.6 Determining if wanted--with or without occupants
	.7 Determining if being or has been used in committing crime
	.8 Determining ownership
	.9 Recording license number, description, and location of suspicious vehicles
	.10 File checking with dispatcher at first opportunity

16900

STEPS		KEY POINTS
	14.11	Marking rim of tire with pencil for future identification
	.12	Citing flagrant parking violators
	.13	Maintaining wanted vehicle list
15. Inspect transient lodging facilities	15.1	Hotels, motels, and trailer courts
	.2	Including parking facilities
	.3	Talking with employees regarding guests
	.4	Reviewing registers
	.5	Noting new guests
	.6	File checking selected guests and vehicles
	.7	Having employees look at photographs of wanted persons
	.8	Walking quietly around corridors
16. Inspect establishments considered a law enforcement hazard	16.1	Including hangouts of known or suspected criminals
	.2	At time of opening and closing
	.3	At time of peak activity
	.4	At time violations most likely to occur
	.5	Frequently
	.6	Locating all entrances and exits before entering
	.7	Varying points of entry and exit
	.8	Pausing and listening before entering
	.9	Dark-adapting eyes by closing them momentarily before entering dimly lighted establishments
	.10	Using caution in entering
	.11	Carrying flashlight in weak hand
	.12	Observing activity, especially the unusual, throughout establishment
	.13	Noting employees and clientele
	.14	Noting changes of employees and clientele
	.15	Noting potential violations and violators
	.16	Noting changes in physical facilities
	.17	Avoid lingering

16901

STEPS		KEY POINTS
17. Inspect locations considered a law enforcement hazard	17.1	At time violations most likely to occur
	.2	More frequently and intensively where crime rate is high
	.3	Varying avenue of approach, points of entry, and exit
	.4	Checking physical arrangement, entrances, and exits
	.5	Talking with persons who frequent the location
	.6	Keeping known criminals away, legally, or under surveillance
	.7	Advising clientele and attendants of crime preventive procedures
	.8	Noting potential violations and preventing them from becoming actual
	.9	Determining how the hazards can be reduced
	.10	Reporting recommendations to supervisor
18. Develop sources of information	18.1	Selecting persons with vantage occupations
	.2	Recording data about source on Information on Personalities form (See Appendix 11)
	.3	Building confidence
	.4	Gathering law enforcement intelligence
	.5	Determining conspicuousness by source and circumstances
19. Interrogate suspicious persons	19.1	When time, place, appearance, and/or actions of a person appears to be out of the ordinary
	.2	To know unusual people or criminals on the beat
	.3	Approaching with caution
	.4	Remaining at a discreet distance

16902

STEPS		KEY POINTS
	19.5	Asking as few questions as possible
	.6	Keeping strong side away from person being interrogated
	.7	Speaking in conversational tone
	.8	Recording all field interrogations
	.9	Completing Persons Report later (See Appendix 5)
	.10	File checking selected suspicious persons
	.11	Maintaining wanted persons list
	.12	Determining if wanted, runaway, or lost
20. Report in	20.1	As ordered or scheduled
	.2	To dispatcher
	.3	For security check
	.4	Within 10 minute leeway of designated time
	.5	Varying time and location
	.6	Selecting sheltered location during inclement weather
	.7	Identifying location and telephone number
	.8	Using identifying code
	.9	Having pen and notebook ready for note taking
	.10	Obtaining pertinent information
	.11	Arranging for information pick-up point, when necessary
	.12	Keeping conversation brief and to official business only
	.13	Recording dispatcher's name
	.14	Recording time and location of report in
	*.15	Closing call box door quietly
	*.16	Keeping outdoor public phone booth light off by leaving door open
	*.17	Dialing operator only if silence required
	*.18	Cupping flashlight head with hand

16903

STEPS	KEY POINTS
OFF DUTY RELIEF	
21. Proceed to watch relief point	21.1 Meeting the relief officer
	.2 At end of duty hours
	.3 At pre-determined location
	.4 Varying time and route pattern
	.5 Handling violations witnessed enroute
	.6 Arriving after relief officer
22. Meet the relief officer	22.1 To be properly relieved of beat
	.2 Recording:
	.1 Name
	.2 Number
	.3 Time
	.4 Location
	.3 Providing pertinent information:
	.1 Cases requiring follow-up
	.2 Requests for law enforcement intelligence
	.3 Law enforcement hazards
	.4 Previous information
	.5 Safety hazards
	.6 Changes in trafficways
	.4 Selecting next watch relief point:
	.1 Having good view of beat
	.2 Should be inconspicuous
	.3 Sheltered location during inclement weather
	*.4 Should be lighted and safe
	.5 Varying the location
	.6 Recording the location
	.5 Turning beat over to relief officer
	.6 Notifying the dispatcher when unable to make contact
23. Proceed to headquarters	23.1 Completing and turning in required reports
	.2 Varying time and route pattern
	.3 Handling violations witnessed enroute
	.4 Reporting off duty to supervisor or dispatcher upon arrival

16904

STEPS		KEY POINTS
	23.5	Avoid loitering in business offices
24. Complete required reports	24.1	Recording activities and law enforcement intelligence
	.2	Before leaving headquarters
	.3	Using pen or typewriter
	.4	Properly and legibly
	.5	Officer's Watch Activity Report (See Appendix 12)
	.6	Turning in reports to supervisor
	.7	Retaining a copy of all reports for personal file

16905

Training Procedure No. 3

PATROLLING IN AN AUTOMOBILE - DAYTIME - *NIGHTTIME

INTRODUCTORY INFORMATION:

Since the uniformed officer is more effective in preventing crime when constantly patrolling, it also follows that a properly and conspicuously marked automobile is more effective when kept constantly on patrol. The law enforcement officer must realize that a patrol car is an expensive piece of equipment and only when properly used can it aid him in performing his duties more efficiently and safely, while at the same time providing economical law enforcement services to the community.

Proper patrolling in an automobile is by far the most efficient method of providing law enforcement services to a large area. An officer can check a beat involving a greater area more often and with less fatigue with a patrol car than by foot. The patrol car radio affords constant and instant contact with headquarters and other patrol cars should assistance be required for the officer's safety. Calls and assignments can be answered more rapidly, thereby, increasing the officer's efficiency and improving the services rendered. It provides protection during inclement weather and in gun battles. It permits carrying and having readily available a variety of equipment, thereby, making the officer practically self-supporting. The transporting of officers, prisoners, and other authorized persons are more easily and rapidly handled. A patrol car provides the officer with an element of surprise due to the patrol car's speed and mobility.

There are many other advantages in the use of a patrol car than those listed above, however, the real value of patrolling in an automobile is dependent upon the officer using the car properly and effectively.

EQUIPMENT NEEDED:

- Accident Investigation Kit
  - Crayon, Marking (yellow lumber)
  - Paper, Graph
  - Tape Measure, 100 ft. Metal Reinforced Cloth
  - Tape Measure, 10 ft. Spring Steel (white surface)
  - Template, Accident Investigator's
- Bags, Evidence
- Baton, Traffic (red)
- Belts, Safety Seat
- Bulb, Traffic Baton (extra)
- Camera Kit:
  - Bulbs, Flash
  - Camera
  - Flash Unit (battery condenser type)
  - Film
- Clipboard
- Code Book, Motor Vehicle

Note: Items identified by an asterisk pertain to nighttime patrolling only.

 16906

Code, Radio
Compass, Magnetic
Credit Card, Gasoline, Departmental
Desk, Patrol Car
Fire Extinguisher, Carbon Dioxide
First Aid Kit
Forms, Prepared Report (as required)
Gloves, Driving
Helmet, Safety
Holder, Riot Baton
Holder, Traffic Baton
Holder, Fire Extinguisher
Holder, First Aid Kit
Holder, Flashlight
Holder, Electric Lock Shotgun
Holder, Shotgun Shell
Keys, Patrol Car
Light, Interior (Manually operated only)
Light, Emergency Beacon
Light, Plug-in Spot (with 100' cord)
Lights, Two Spot
Mirrors, Outside Rear View (2)
Panel, Switch
Radio, Three-way
Raincoat
Rescue Kit:
- Bar, Crow and/or wrecking
- Blanket
- Crash-axe, Shock Proof
- Fusees, Red, 30 Minute (12)
- Gloves, Cloth (plastic coated)
- Holders, Fusee (12)
- Rope, 1/2" Polypropylene or Nylon (100 ft.)
- Stands, Fusee (2)

Screen, Folding Plexiglass Dividing
Shotgun, Riot
Signal, Recall
Siren, Vehicle (Electronic)
Speedometer, Calibrated (with lock button)
Tags, Property

GENERAL SAFETY PRACTICES:

Be constantly alert for potential personal hazards
Maintain physical fitness
All eyeglasses, including sunglasses, should have hardened lens and be prescribed by an oculist
Use safety seat belts
Do not drive when ill
Maintain proper vehicle ventilation
Keep the vehicle under control at all times
Obey all traffic laws
When leaving vehicle, notify dispatcher as to location
Park properly
Approach all persons and things with caution
*To maintain night vision when driving, focus eyes slightly away from bright head lights
*Close eye nearest bright light, in order to maintain night vision
Effectiveness of senses is impaired during vehicle operation

16907

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	ON DUTY RELIEF
1. Prepare for watch	1.1 Obtaining assigned patrol car at headquarters
	.2 Inspecting patrol car: (See Appendix 15)
	.1 Serviceability of vehicle and equipment
	.2 Condition of exterior and interior
	.3 Recording and reporting damage to supervisor
	.4 Quantity of fuel and oil
	.5 Testing electrical equipment and brakes
	.6 Verifying performance of radio
	.7 Counting quantity and determining serviceability of auxiliary equipment
	.8 Searching interior for discarded weapons, evidence, and lost or forgotten property
	.9 Removing all unofficial objects
	.10 Recording patrol car number, starting mileage, and time
	.11 Signalling "On Duty" to dispatcher, using approved radio code
2. Proceed to watch relief point	2.1 Requesting beat officer to designate location
	.2 Securing safety seat belt
	.3 Obeying all traffic laws
	.4 Being a courteous driver
	.5 Keeping both hands on steering wheel
	.6 Parking properly
	.7 Parking patrol car facing exit when using off-street facilities
	.8 Being inconspicuous
	*.9 Turning off all lights
	*.10 Keeping foot off brake pedal
	*.11 Turning radio volume down
	.12 Setting emergency brake

16908

UNIT VIII — MACHINE DRAWING

General Information

Machine Drawing:

Machine drawings are those that describe some machine part or the entire machine. Included in machine drawing may be most any object made of metal, especially metal objects that have to be made with a metal-working machine. These are said to be "machined". Machined parts of jet engines, rockets, and automobile engines must be made very accurately and finished in some cases to two or three ten thousandths of an inch. To check these parts for accuracy, tools such as micrometers, gages, and other measuring instruments are used. The Ford Motor Company puts out what is known as the Johannesen Gage Blocks which are accurate to the almost unbelievable figure of TWO MILLIONTHS of an inch.

Machine parts are made of cast iron, various kinds of steels, brass, bronze, tin, aluminum, and many alloys. Some metals are cast, some are forged, and some are cut from solid blocks into the required shapes. Accurate drawings have to be made of these parts showing exact dimensions. Other important information about the part such as type of finish, kind of metal, and how it is to be heat treated is included on the drawing.

The projects in this unit are tools which can be made in the school metal shop.

1688

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
		*2.13	Covering exposed interior lights
		.14	Turning off motor
3.	Meet with beat officer	3.1	Inspecting assigned patrol car when obtained from beat officer (See Appendix 15)
		.2	Recording pertinent information regarding patrol car
4.	Relieve the beat officer	4.1	Signalling "In Service" to dispatcher
	RECONNAISANCE PATROL		
5.	Proceed to area to be reconnoitered	5.1	Selecting area (Varying avenue of approach and exit)
6.	Reconnoiter the area	6.1	Driving in lane offering best view
7.	Talk with sources of information	7.1	Alighting from patrol car
8.	Observe persons, places, and things	8.1	Realizing that effectiveness of senses is impaired during vehicle operation
	STANDARD PATROL		
9.	Proceed to location to be inspected	9.1	Driving slowly, safely, and courteously in lane offering best view
		.2	Obeying all traffic laws
		.3	Avoid starting a caravan
		.4	Using rear view mirrors
		.5	Reducing speed at all intersections
		.6	Watching for traffic violations, criminal offenses, and suspicious vehicles
		.7	Anticipating and being ready for the unusual or unexpected
		.8	Using peripheral vision
		.9	Looking down side streets and between buildings

16909

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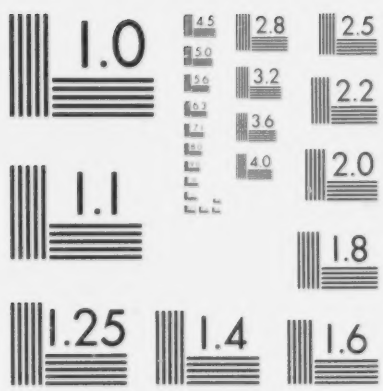

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

STEPS	KEY POINTS
	.10 Looking for traffic hazards before taking eyes off roadway
	.11 Checking buildings in the distance from roof down to street level
	.12 Being aware of changes in trafficways
	.13 Parking occasionally to observe
	.14 Alighting from patrol car
	.15 Avoiding surveillance by others
	*.16 Using high beams on headlights when traffic conditions permit
	*.17 Avoiding unnecessary and improper use of spot light
	*.18 Using spot light in short flashes
	*.19 "Sweeping" with spot light when complete coverage required
	.20 Reducing speed when using spot light and observing
	.21 Handling pending assignments to gather information and/or complete disposition of complaint
	.22 Handling problems as they occur:
	.1 Within jurisdiction and capabilities
	.2 Requesting departmental assistance from supervisor or dispatcher when necessary
	.3 Criminal, traffic, juvenile, and special requests in that order
	.23 Recording time, location and reason for patrol interruption
	.24 Telephone service should be available at location of interruption
	.25 Varying time and location of personal breaks and meal period
	.26 Practicing techniques of observation
	.27 Covering beat as often as possible until time of relief
10. Patrol on foot	10.1 Making all inspections
	.2 Improving observations
	.1 Talking with sources of information
	.2 Interrogating suspicious persons

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16910

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	10.3 Selecting safe location to park patrol car
	.4 Parking near outdoor public telephone
	.5 Parking properly
	.6 Signalling "Out of Car", location, and reason to dispatcher
	.7 Notifying dispatcher of telephone number:
	.1 Keeping unit available for assignment
	.8 Waiting for clearance from dispatcher before leaving patrol car
	.9 Recording time "out of" and "back in" service, location, and reason
	.10 Removing patrol car keys from ignition
	.11 Taking required equipment when leaving patrol car
	.12 Opening patrol car door and alighting with caution
	.13 Closing patrol car door quietly, carefully, and safely
	.14 Locking patrol car
	.15 Signalling "Back in Car" to dispatcher
11. Stop selected moving vehicles	11.1 To interrogate occupants
	.2 To check contents or search vehicle
	.3 Selecting vehicles that are unusual:
	.1 To area
	.2 To beat:
	.1 Location in which driven
	.2 Time at which driven
	.3 Manner in which driven
	.4 Length or number of times observed in area
	.5 Altered or absence of required identification
	.6 Neglected care or condition
	.3 To occupants
	.4 To contents

16911

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	11.4 Recording license number on patrol car desk pad before taking any action
	.5 Checking license number against wanted vehicle list
	.6 File checking license number with dispatcher
	.7 Requesting departmental assistance from dispatcher:
	.1 Notifying dispatcher of pursuit and route
	.2 Using beacon and siren during pursuit
	*.8 Selecting parking place for stop--well lighted at night
	.9 Avoiding busy location
	.10 Watching for discarding of weapons or evidence
	.11 Noting possible avenues of escape open to occupants
	.12 Driving patrol car to the left of and about two feet behind driver of selected vehicle
	.13 Turning on emergency beacon light
	.14 Attracting driver's attention with series of short horn signals
	*.15 Attracting driver's attention by flashing or sweeping spotlight or flashlight across mirrors at night
	*.16 Avoid blinding driver
	.17 Using siren as last resort
	.18 Ordering driver where to stop and park in loud clear voice
	.19 Using hand signals to designate correct stopping place
	.20 Avoid "overshooting" vehicle
	.21 Keeping alert to erratic movement of vehicle
	.22 Falling in behind vehicle to be stopped
	.23 Maintaining assured clear distance

 16912

STEPS		KEY POINTS
	11.24	Parking vehicles out of traffic lanes
	.25	Stopping and parking 8 to 15 feet behind vehicle and about 2 feet to the left
	*.26	Turning on left and right spotlights
	.27	Notifying dispatcher of vehicle stop, description of vehicle, location of, and reason for stop
	.28	Watching occupants and interior of vehicle through rear and side windows
	.29	Keeping alert for any quick or furtive movements by occupants
	.30	Paying particular attention to hands and shoulders of occupants
	.31	Looking in rear view mirrors for approaching traffic
	.32	Unfastening revolver holster flap
	.33	Taking required equipment
	*.34	Carrying flashlight in weak hand
	.35	Alighting from patrol car after receiving reply on file check and clearance from dispatcher--with caution
	.36	Approaching vehicle from left side--slowly and carefully
	.37	Using caution when passing vehicle's blind spot
	.38	Stopping at the rear of the vehicle's front door
	.39	Keeping back to approaching traffic when one occupant only
	.40	Facing side of vehicle when front and and rear seats occupied
12. Search selected vehicles	12.1	Selecting vehicles:
	.1	Wanted in connection with a crime
	.2	Similar in description to wanted vehicles
	.3	With indications of having been used in crime

16913

STEPS	KEY POINTS
	12.1.4 Having suspicious occupants
	.5 As a result of questioning occupants
	.2 Arresting occupants first
	.3 Requesting permission of driver, if no arrest made
	.4 Checking contents or gathering evidence
	.5 Notifying dispatcher of location of wanted vehicle
	.6 Verifying identification of wanted vehicle with dispatcher
	.7 Requesting dispatcher to:
	.1 Notify responsible investigating officer of find
	.2 Ascertain further instructions regarding disposition
	.8 Requesting departmental assistance from dispatcher if:
	.1 Any occupant is wanted for or suspected of a felony
	.2 Any occupant is known or suspected of being armed or dangerous
	.3 Vehicle is occupied and is to be searched in the field
	.9 Removing all occupants
	.10 Watching for approaching traffic
	.11 Requesting or ordering driver to get out first--slowly
	.12 Keeping out of range of open door
	.13 Keeping driver between officer and occupants until all have alighted from vehicle
	.14 Selecting and moving to safe position on right side of vehicle
	.15 Walking behind vehicle
	.16 Requesting or ordering passengers to get out right side of vehicle in following order: right front seat, right rear seat, and left rear seat

 16914

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS	
	12.17	Watching passengers to prevent discarding of evidence
	.18	Having passengers face away from officer
	.19	Keeping passengers in view at all times and away from vehicle
	*.20	Re-aiming right spot light on occupants
	.21	Standing outside of spot light beam behind opened right front door of patrol car
	.22	Examining every part of vehicle, systematically
	.23	Searching left then right side of vehicle, front to rear and back again
	.24	Searching logical places
	.25	Avoid unnecessarily damaging vehicle or contents
	.26	Collecting all evidence and items of value as law enforcement intelligence
	.27	Looking for objects foreign to occupants or vehicle
	.28	Calling the attention of witnessing officer to found evidence
	.29	Recording:
	.1	Description of evidence
	.2	Circumstances under which found
	.3	Name of witnessing officer
	.30	Avoid overlooking any possible hiding place
13. Stop selected pedestrians	13.1	Those wanted or suspicious persons
	*.2	Selecting well lighted location for stop at night
	.3	Avoid busy locations
	.4	Noting possible avenues of escape
	.5	Approaching pedestrian from the rear
	*.6	Stopping patrol car at slight angle to curb to illuminate area

16915

STEPS		KEY POINTS
	13.7	Avoid violating traffic law
	.8	Avoid "overshooting" pedestrian
	*.9	Stopping ahead of pedestrian when approaching from front making certain he cannot pass patrol car before officer alights
	.10	Unfastening revolver holster flap
	.11	Watching for any quick or furtive movements when alighting from patrol car
	.12	Paying particular attention to pedestrian's hands
14. Inspect unoccupied homes	14.1	Temporarily unoccupied
	.2	Upon request
	.3	Removing evidence of non-occupancy
	.4	Completing Unoccupied Home Report (See Appendix 16)

OFF DUTY RELIEF

15. Proceed to watch relief point	15.1	Notifying relief officer of designated location
16. Meet with beat officer	16.1	Recording ending mileage
	.2	Removing all personal equipment
	.3	Notifying relief officer of any damage or desired repairs to patrol car and shortage of auxiliary equipment
	.4	Turning patrol car over to relief officer
	.5	Signalling "Out of Service" to dispatcher when patrol car not turned over to relief officer
	.6	Signalling "Off Duty" to dispatcher when patrol car turned over to relief officer
17. Proceed to headquarters	17.1	Turning in patrol car at garage

16916

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
18. Complete required reports	:	18.1	Turning in found property and evidence to property officer
	:	.2	Completing Property Tag (See Appendix 17)

16917

How To Make Blueprints:

1. Paper--Blueprint paper is white paper coated with a mixture of two chemicals that are sensitive to light. They are:

   Iron Citrate of Ammonia

   Ferricyanide of Potassium

   Blueprint paper comes in rolls of 10 to 50 yards each, and in widths of 24", 36", and up.

2. Printing--The blueprint is made from a tracing which is a drawing made on tracing cloth or tracing paper. The tracing is placed in a frame or a blueprinting machine with the lined side against the glass. A piece of blueprint paper is placed with its sensitive side next to the tracing. The hinged back is then placed in the frame and clamped by means of the spring clamps. The print is then exposed to the sunlight for approximately 1½ minutes, depending upon the condition of the weather and the time of year.

3. Washing--After being correctly exposed the print is then washed thoroughly in clear water and hung up to dry.

4. Drying--If prints are allowed to come in contact with any surface that is not perfectly clean they will become stained and their appearance ruined. Ammonia, soap or cleaning powder of any kind will bleach prints and cause spots. Care should be taken that none of these things are in the trays or sinks used for washing prints. Blueprints may be immersed in a Potassium Bichromate solution which has the property of making the colors more distinct.

Training Procedure No. 4

MISDEMEANORS WITNESSED BY OFFICER, HANDLING

INTRODUCTORY INFORMATION:

There are a great many laws regulating a person's behavior. Violation of these laws, in the majority of instances, constitutes a misdemeanor. Because these laws tend to regulate behavior they present a constant challenge to an officer's judgement and analyzing ability. The perpetration of a misdemeanor knows no social status. Persons on any rung of the social ladder may inadvertantly or deliberately commit an offense.

Community security is almost entirely dependent upon officers assigned to the area. Witnessing an offense and the subsequent proper handling by the officer serves the community and officer to the best advantage. Anything an officer does legally to deter offenses will certainly receive the approval of the public and the officer's supervisors.

EQUIPMENT NEEDED:

- Bags, Evidence
- Camera Kit
  - Bulbs, Flash
  - Camera
  - Film
  - Flash Unit (battery condenser type)
- Citation Book
- Clipboard
- Compass, Magnetic
- Crayon, Marking (lumber yellow)
- Form, Preliminary Investigation Field Report
- Handcuffs
- Knife, Pocket
- Notebook, Pocket
- Paper, Graph
- Pen, Ball Point
- Pencil, Mechanical
- Ruler, Architects'
- Tags, Evidence
- Tape Measure, 100 ft. Metal Reinforced Cloth
- Tape Measure, 10 ft. Spring Steel (white surface)

GENERAL SAFETY PRACTICES:

Be calm
Under all circumstances, notify dispatcher of location before leaving patrol car
Be constantly alert for potential personal hazards
Smoking should be avoided
Be certain you understand and are understood

16918

Training Procedure No. 4

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
1. Witness the misdemeanor	1.1 Using the senses
	.2 Recognizing the elements that constitute the offense
	.3 Noting general identification characteristics of perpetrator
	.4 Noting time, place, and other witnesses
	.5 Requesting, when possible, other witnesses to remain
2. Apprehend perpetrator	2.1 As soon as practical
	.2 Approaching with caution
	.3 Keeping arrestee away from strong hand side
	.4 Speaking clearly
	.5 Commanding, "Don't move!"
	.6 Ordering perpetrator to move only as told
	.7 Informing, "You are under arrest!"
	.8 Preventing violence
	.9 Using only that amount of force necessary to overcome resistance
	.10 Using special care with women, juveniles, and mentally ill
	.11 Noting what is said by arrestee
	.12 Answering inquiries courteously and concisely
3. Identify arrestee	3.1 Being certain it is same person that committed the offense
	.2 Noting particular identification characteristics:
	.1 Clothing worn
	.2 Body features
	.3 Speech
	.4 Mannerisms
	.3 Requesting arrestee pronounce and spell name and give present address
	.4 Requesting or searching for identification documents

16919

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	3.5 When requesting, accept only identification documents
	.6 Checking verbal information against document
	.7 Noting discrepencies
	.8 Questioning arrestee further, depending on answers given
4. Issue citation (If not arresting)	4.1 According to departmental policy
	.2 When reasonably certain perpetrator will appear
	.3 Filling out form while standing in a safe location
	.4 Using prescribed form (See Appendix 18)
	.5 Establishing time and date mutually agreeable, for court, officer, and perpetrator, when possible
	.6 Printing information legibly
	.7 Rechecking information on citation for accuracy
	.8 Handing citation and all documents to the perpetrator
	.9 Asking perpetrator if information on citation is understood clearly
	.10 Having perpetrator sign citation
5. Secure arrestee	5.1 Handcuffing hands behind back, palms out, key holes up, double lock pins away from arrestee
	.2 Handcuffing to fixed object
	.3 Assuring arrestee that his rights will be protected
	.4 Keeping all unauthorized persons away
	.5 Preventing arrestee from injuring himself or others
	.6 Preventing others from injuring arrestee
	.7 Isolating arrestee from exits, when possible

16920

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS	
	5.8	Refusing requests of arrestee and/or persons wishing to see or speak to him at the scene
6. Search arrestee	6.1	After arrest
	.2	After handcuffing
	.3	Informing arrestee that search will be made
	.4	Isolating searcher and arrestee
	.5	Adhering strictly to laws of search for weapons and evidence
	.6	For safety
	.7	Using spread-eagle method
	.8	Removing all metal objects that may be potential weapons
	.9	Completing bodily search even though weapon or evidence found
	.10	Using female officer or trusted adult woman on females
	.11	Calling for assistance, when necessary
7. Gather evidence	7.1	To legally substantiate facts
	.2	Completing Preliminary Investigation Field Report (See Appendix 19)
	.3	Before or after removal of arrestee, as appropriate
	.4	Contacting other witnesses for:
	.1	Name
	.2	Address
	.3	Information about offense
	.4	Availability to testify
	.5	Searching scene systematically
	.6	Observing minutest detail
	.7	Including area adjacent to crime scene
	.8	Collecting sufficient amount of specimens for scientific examination
	.9	Placing in appropriate containers

16921

STEPS		KEY POINTS
	7.10	Avoiding contamination by using separate containers
	.11	Recording description and location found
	.12	Recording names and addresses of persons having knowledge or possession of evidence
	.13	Initialing in suitable place on evidence
	.14	Avoiding damage for scientific examination
8. Remove arrestee from scene	8.1	Taking to jail
	.2	Walking to jail, if practical
	.3	Calling supervisor to arrange for transportation
	.4	In patrol car or patrol wagon
	.5	Removing high or spiked heel shoes from females
	.6	Refusing requests for unauthorized means of transportation
	.7	Placing arrestee on front seat, when alone and without screen
	.8	Placing arrestee on rear seat, if screen provided
	.9	Locking doors
	.10	Refusing requests to smoke, get out of or change positions in patrol vehicle
	.11	Noting statements made by arrestee, for later recording
	.12	Keeping constantly alert against personal attack
9. Process arrestee	9.1	Upon arrival at jail
	.2	Consigning arrestee to jailer
	.3	Furnishing necessary information
	.4	Assisting or filling in all forms as required
	.5	Removing handcuffs where and when designated

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LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	9.6 Keeping constantly alert against attack or escape
10. Submit evidence	10.1 Maintaining legal chain
	.2 To property officer
	.3 Filling in forms as required
	.4 Recording:
	.1 Time
	.2 Property officer's name and number
	.3 Location stored
11. Submit reports	11.1 To supervisor
	.2 To complete disposition
	.3 Before going off duty
	.4 For department information
	.5 For use in prosecution
	.6 Using Preliminary Investigation Field Report form (See Appendix 20)
	.7 Typed
	.8 Referring to notes
	.9 Including who-what-why-when-where-and how (See Appendix 21)
	.10 Spelling correctly
	.11 Choosing words carefully
	.12 Avoiding legalistic words, phrases, or slang
	.13 Being objective in information
	.14 Using only widely accepted abbreviations
	.15 Using quotation marks for exact words spoken or written by persons
	.16 Reviewing and editing the report before submitting

16923

MISDEMEANOR NOT WITNESSED BY OFFICER, HANDLING

INTRODUCTORY INFORMATION:

Three major considerations must be given to the handling of any criminal law violation. First, the law must be complied with; second, that the departmental regulations be adhered to; and third, that a disposition which is satisfactory, within the above requirements, to the complainant be achieved.

There are many times, when an offense is committed, that the complainant will desire or demand that action be taken by the officer. But, because of the type of offense the officer will be unable to act due to the requirements of the law. It is difficult to convince the complainant under such circumstances that there is nothing the officer can do to enforce the law.

Most law enforcement departments are operating under the handicaps of manpower shortage and excessive case and work loads. Departmental regulations which limit the extent of handling in certain cases are a justifiable result of such handicaps.

The complainant, on the other hand, still has a problem which is of the utmost concern and has sought the assistance of the officer in solving the problem. A satisfactory disposition still may be achieved, even though the officer is limited by law and departmental regulations, by performing the proper handling procedure.

EQUIPMENT NEEDED:

- Bags, Evidence
- Camera Kit:
  - Bulbs, Flash
  - Camera
  - Film
  - Flash Unit (battery condenser type)
- Citation Book
- Clipboard
- Compass, Magnetic
- Crayon, Marking, (lumber yellow)
- Form, Persons Report
- Form, Preliminary Investigation Report
- Handcuffs
- Knife, Pocket
- Notebook, Pocket
- Paper, Graph
- Pen, Ball Point
- Pencil, Mechanical
- Ruler, Architects'
- Tags, Evidence
- Tape Measure, 100 ft. Metal Reinforced Cloth
- Tape Measure, 10 ft. Spring Steel (white surface)

16924

Training Procedure No. 5

LAW ENFORCEMENT OFFICER TRAINING

GENERAL SAFETY PRACTICES:

Be calm
Notify dispatcher of location, before leaving patrol car, under all circumstances
Be constantly alert for potential personal hazards
Smoking should be avoided

STEPS	KEY POINTS
1. Receive assignment and information	1.1 From dispatcher
	.2 From citizen, notifying dispatcher
	.3 Recording on Patrol Car desk pad:
	.1 Time received
	.2 Location of scene
	.3 Type of crime
	.4 Person to be contacted and/or complainant and address
	.4 Repeating location to dispatcher
	.5 Stopping patrol car before writing
	.6 Requesting verification for accuracy
2. Proceed to scene	2.1 Driving safely
	.2 Immediately, unless otherwise instructed
	.3 Using extreme caution when disobeying traffic laws
	.4 Avoiding use of red light and siren unless otherwise instructed
3. Arrive at scene	3.1 Parking properly
	.2 Notifying dispatcher of exact location
	.3 Signaling dispatcher "out-of-service"
	.4 Removing ignition key
	.5 Recording time of arrival
	.6 Taking required equipment
	.7 Alighting from patrol car with caution
	.8 Locking patrol car
	.9 Entering all premises with caution
	.10 Approaching all persons and things with caution
4. Observe scene and situation	4.1 To determine course of action
	.2 Selecting safe location for officer

16925

STEPS		KEY POINTS
	4.3	Scanning persons present for weapons
	.4	Scanning area for potential weapons
	.5	Physical and mental condition of persons involved
	.6	Mood and state of by-standers
	.7	Being alert to conversations
	.8	For future information
5. Preserve the peace	5.1	To prevent violence
	.2	Requesting or ordering all concerned to desist
	.3	Separating combatants
	.4	Quieting or calming persons present
	.5	Removing or isolating complainant and perpetrator
	.6	Calling for assistance when necessary
	.7	Requesting assistance of persons present
6. Identify participants	6.1	Complainant
	.2	Victim
	.3	Perpetrator
	.4	Witnesses
	.5	To assist in gathering facts
	.6	Directing questions
	.7	Observing which persons seem most concerned
	.8	Listening to conversations
	.9	Requesting complainant to identify perpetrator
	.10	Requesting complainant and/or perpetrator to identify witnesses so by-standers may be dismissed from scene
	.11	Requesting perpetrator to identify himself
	.12	Recording names, addresses and telephone numbers
	.13	Gathering information about perpetrator, if not at scene

16926

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
7. Interview participants	:	7.1	Getting all sides of the story
	:	.2	Determining if necessary elements of offense are present
	:	.3	Allowing each to give his own version uninterrupted
	:	.4	Being impartial
	:	.5	Requesting witnesses to remain
	:	.6	Requesting witnesses not discuss the case with each other
	:	.7	Separating and interviewing each person concerned
	:	.8	Recording pertinent information in pocket notebook or on appropriate form
	:	.9	Determining if complainant or victim will initiate steps for prosecution
8. Inform persons involved	:	8.1	Complainant
	:	.2	Victim
	:	.3	Perpetrator
	:	.4	Witnesses
	:	.5	Complainant or victim of necessary elements to prove offense
	:	.6	Informing all persons involved to appear before magistrate at court of jurisdiction and venue
	:	.7	Informing complainant or victim of location for signing affidavit for warrant
	:	.8	Informing witnesses what will be expected of them
	:	.9	Recording names, addresses and telephone numbers of persons for possible court action
	:	.10	Answering other questions of involved persons

COMPLETE FOLLOWING STEPS IF PROSECUTION WILL RESULT

9. Preserve scene	:	9.1	Guarding scene at all times
	:	.2	Removing all persons

16927

5. Pressing—When dry, prints should be either ironed out with a hot flatiron, or pressed under a weight to make them smooth and straight. Small prints may be stretched by drawing them over the edge of a table or the edge of a ruler. They may also be pressed by clamping them in the printing frame.
6. Trimming—When the prints have been dried and pressed, they should be trimmed with large shears or on a trimming board, so that they will have uniform margins and straight edges.

STEPS	KEY POINTS	
	9.3	Staying out of scene as much as possible
	.4	Roping off or locking-up
	.5	Keeping unauthorized persons away
	.6	Keeping everything in place
	.7	Determining if crime scene has been altered
	.8	Checking with person who knows crime scene intimately
	.9	Calling for assistance, when necessary
10. Photograph scene	10.1	As soon as possible
	.2	Getting over-all view first without altering scene
	.3	Taking over-all view with identification
	.4	Taking pictures of physical evidence without identification
	.5	Taking pictures of physical evidence with identification
	.6	Recording photographic data:
	.1	Type of camera
	.2	Lens opening
	.3	Shutter speed
	.4	Type of film
	.5	Accessories used
	.6	Time taken
	.7	Location of camera for each photograph
11. Sketch scene	11.1	Locating the position of pertinent items
	.2	Providing a permanent record to supplement word description
	.3	Using Field Sketch Sheet (See Appendix 10)
	.4	Obtaining general impression of scene before starting sketch
	.5	Locating north at top of sketch
	.6	Using magnetic compass to determine north
	.7	Determining fixed base line or fixed points

16928

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	11.8 Determining what is to be included
	.9 Determining scale used
	.10 Determining when in the investigation sketch should be made
	.11 Recording on sketch:
	.1 Brief descriptive statement
	.2 Address or location
	.3 Type of offense
	.4 Case number
	.5 Scale used
	.6 Arrow indicating north
	.7 Name of person making sketch
	.8 Legend
	.9 Names of persons assisting with measurements
	.10 Date sketch
	.12 Measuring accurately
	.13 Using rectangular coordinates or triangulation from fixed points for locating items on sketch
	.14 Using the words "feet" and "inches" in recording distance in notebook
	.15 Confirming all measurements
	.16 Including all details pertinent to offense
	.17 Using standard symbols when possible
12. Gather evidence	12.1 Substantiating facts
	.2 Searching systematically, clockwise
	.3 Observing minutest detail
	.4 Including area adjacent to crime scene
	.5 Carefully
	.6 Handling as little as possible
	.7 Collecting sufficent amount of specimens for scientific examination
	.8 Avoiding contamination by using separate containers
	.9 Placing in proper containers
	.10 Recording its location
	.11 Recording description

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STEPS		KEY POINTS
	12.12	Recording names and addresses of persons having knowledge or possession of evidence
13. Mark evidence	13.1	For future identification
	.2	Initialing in suitable location
	.3	Using metal scribe, pen, tag, tape, as appropriate
	.4	Avoiding damage for scientific examination
	.5	Recording in notes where and how marked
14. Preserve evidence	14.1	Keeping in personal possession
	.2	Preventing loss, damage, removal
	.3	Releasing only to proper authority
	.4	Handling with gloves, when appropriate
	.5	Allowing natural drying of wet items
	.6	Using appropriate containers
15. Follow-up	15.1	Completing unfinished details
	.2	Locating and arresting perpetrator after warrant issued
	.3	Recovering property
	.4	Gathering additional facts
	.5	Leads furnished or discovered
16. Book evidence	16.1	Maintaining legal chain of evidence
	.2	Turning over to authorized officer
	.3	Securing to avoid tampering
	.4	Receiving receipt
	.5	Recording location
	.6	Recording names of all persons handling
17. Submit report (See Appendix N)	17.1	After step 8 - if no prosecution
	.2	As required
	.3	Completing disposition
	.4	Before going off duty
	.5	For department information

16930

STEPS		KEY POINTS
	17.6	For use in prosecution
	.7	Using prescribed form
	.8	Typed
	.9	Referring to notes
	.10	Including who-what-why-when-where and how
	.11	Spelling correctly
	.12	Choosing words carefully
	.13	Avoiding legalistic words or phrases and slang
	.14	Being objective in information
	.15	Using only widely accepted abbreviations
	.16	Reviewing and editing the report before submitting

 16931

FELONIES, HANDLING

INTRODUCTORY INFORMATION:

The beat officer has many splendid opportunities to render service to the public, but none so impresses the members of a community with the efficiency of the officer and the department as the investigation and apprehension of a felon. The building of a solid case, getting and checking out leads, and concluding with the perpetrator's apprehension is viewed with awe and pride when the citizen originally thought the case was unsolvable due to the apparent lack of clues and facts.

The officer who knows how to perform his duties in a quiet, efficient, and professional-like manner inspires the confidence of the public in law enforcement, ultimately acquiring the community's backing in the further prevention of crime and increasing sources of information.

EQUIPMENT NEEDED:

- Bags, Evidence
- Clipboard
- Compass, Magnetic
- Containers. Evidence
- Crayon, Marking (yellow lumber)
- Forms:
  - Field Interrogation Report
  - Injured Prisoner Report
  - Preliminary Investigation Report
  - Prisoner's Property Receipt
  - Property Tag
  - Format for Statement (Sample, Appendix 20)
- Handcuffs
- Knife, Pocket
- Paper, Graph
- Pen, Ball Point (black)
- Pen, Ball Point (red)
- Pencil, Mechanical
- Ruler, 12"
- Tape, 100 ft. Metal Reinforced Cloth Measuring
- Tape, 10 ft. Spring Steel Measuring (White surface)

GENERAL SAFETY PRACTICES

Consider every felon as armed and dangerous
Always keep arrestee in view
Keep arrestee away from officer's strong hand side
Be certain that you understand and are understood
Refuse all of arrestee's requests in the field
Be constantly alert for personal hazards
Notify dispatcher of any change in location

16932

Training Procedure No. 6

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
1. Receive assignment and information	1.1 From dispatcher
	.2 Acknowledging initial call immediately
	.3 Identifying unit and giving location
	.4 From citizen, notifying dispatcher
	.5 Stopping patrol car before writing
	.6 Recording on patrol car desk pad:
	.1 Location of scene
	.2 Type of crime
	.3 Person to be contacted and/or complainant and address
	.4 Description of perpetrator and his vehicle
	.7 Noting:
	.1 Situation at scene
	.2 Actual or potential hazards to persons involved
	.3 Type of weapon used by perpetrator
	.4 Route of escape of perpetrator
	.8 Requesting:
	.1 Additional required information
	.2 Departmental assistance
	.9 Notifying dispatcher of personal knowledge
	.10 Repeating location of scene for verification by dispatcher
	.11 Acknowledging receipt of transmission
2. Proceed to scene	2.1 Immediately
	.2 Driving safely
	.3 Using extreme caution when disobeying traffic laws
	.4 Avoid using beacon light and siren, unless otherwise instructed
	.5 Using most expeditious route
	.6 Considering the perpetrator's route of escape
	.7 Watching for the perpetrator and/or his vehicle
	.8 Considering the possibility of error and/or change

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LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	2.9 Participating in department's tactical operations
	.10 Planning personal operations based on known information
	.11 Turning off beacon light and/or siren
3. Arrive at scene	3.1 Parking properly
	.2 Signalling dispatcher "out-of-service"
	.3 Giving dispatcher exact location
	.4 Recording time of arrival
	.5 Removing ignition key
	.6 Taking required equipment
	.7 Unfastening holster flap
	.8 Alighting from patrol car with caution
	.9 Locking patrol car
	.10 Entering all premises with caution
	.11 Approaching all persons and things with caution
	.12 Selecting location for personal safety

PRELIMINARY INVESTIGATION - PRIMARY PHASE

4. Observe scene and situation	4.1 Appearing and keeping calm
	.2 Gathering information to determine:
	.1 Personal safety
	.2 Participants' safety
	.3 Security of perpetrator
	.4 Course of action
	.3 Noting:
	.1 Mood and state of assembly
	.2 Physical and mental condition of participants
	.4 Scanning:
	.1 Assembly for weapons
	.2 Area for potential weapons

STEPS	KEY POINTS
	4.4.3 Possible escape routes for perpetrator
	.5 Being alert to conversations
	.6 Fastening holster flap
5. Preserve the peace	5.1 Preventing violence and/or further injury
	.2 Performing duties objectively
	.3 Requesting or ordering all concerned to stop
	.4 Separating combatants
	.5 Quieting or calming persons present
	.6 Requesting bystanders to leave
	.7 Handling other situations as they arise
	.8 Removing or isolating victim and perpetrator
	.9 Calling for assistance when necessary
	.10 Requesting assistance of persons present
6. Care for injured	6.1 As soon as possible
	.2 Requesting citizen to summon appropriate assistance
	.3 Rendering appropriate first aid
	.4 Requesting citizen to stand by injured
	.5 Arranging for transportation to medical facility
7. Identify participants	7.1 By:
	.1 Observing which persons seem most concerned
	.2 Listening to conversations
	.2 Contacting personally:
	.1 Victim
	.2 Perpetrator
	.3 Complainant
	.4 Witnesses
	.3 Requesting:
	.1 Victim to identify perpetrator and witnesses
	.2 Perpetrator to identity himself

16935

STEPS	KEY POINTS
	7.3.3 Witnesses to identify themselves, victim, and perpetrator
	.4 Witnesses to remain near the scene at location designated
	.5 Witnesses not to discuss matter under investigation
	.6 Bystanders to leave
8. Preserve crime scene	8.1 Removing and keeping all persons away from scene
	.2 Guarding scene at all times
	.3 Placing civilians at approaches
	.4 Roping off or locking up
	.5 Permitting access to authorized persons only
	.6 Keeping everything in place
	.7 Determining if crime scene has been altered
	.8 Checking with person who knows crime scene intimately
	.9 Requesting departmental assistance
9. Interview participants	9.1 Establishing elements of offense
	.2 Getting accurate information
	.3 Separately:
	.1 Victim
	.2 Perpetrator
	.3 Complainant
	.4 Witnesses
	.4 Recording:
	.1 Name - first, middle initial, and last
	.2 Race
	.3 Sex
	.4 Age
	.5 Occupation
	.6 Addresses of home and place of employment
	.7 Telephone number of home and place of employment

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STEPS	KEY POINTS
	9.5 Allowing participants to tell, uninterrupted, own version of event
	.6 Asking as few questions as possible
	.7 Completing Preliminary Investigation Field Report (See Appendix 19)
	.8 Recording statements (See Appendix 20)
	.9 Use abbreviations(See Appendix 25)
	.10 Describing perpetrator's method of operation:
	.1 What he did and said
	.2 How he did it and said it
	.11 Describing perpetrator:
	.1 Name - including aliases
	.2 Color
	.3 Nationality
	.4 Sex
	.5 Age
	.6 Height
	.7 Weight
	.8 Build
	.9 Hair - Color, amount, type, and manner of wearing
	.10 Eyes, including glasses - type and color
	.11 Beard, including mustache - color, amount, type and manner of wearing
	.12 Complexion - color and appearance
	.13 Physical deformities, disfigurations, and their effects
	.12 Remembering perpetrator may be simulating or feigning physical condition and appearance
	.13 Describing clothing:
	.1 Headdress - type, color, material, and manner worn
	.2 Disguise - facial and other
	.3 Shirt - type, color and material
	.4 Neckwear - type, color, material and manner worn

16937

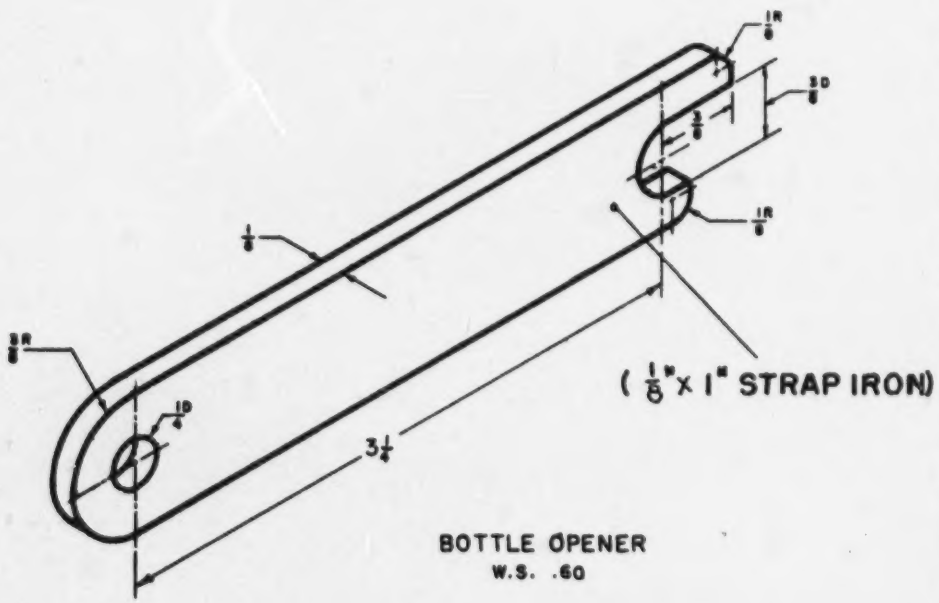

BOTTLE OPENER
W.S. .60

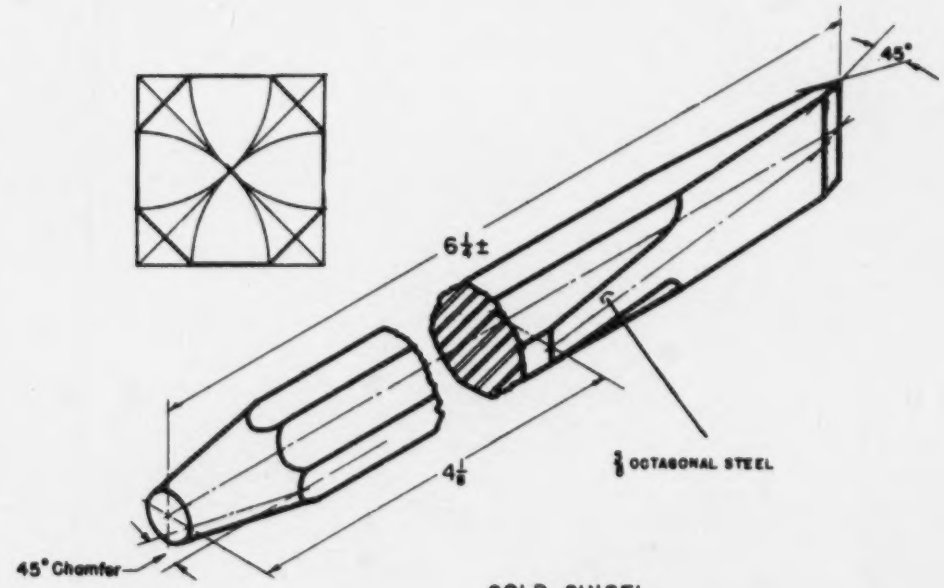

COLD CHISEL
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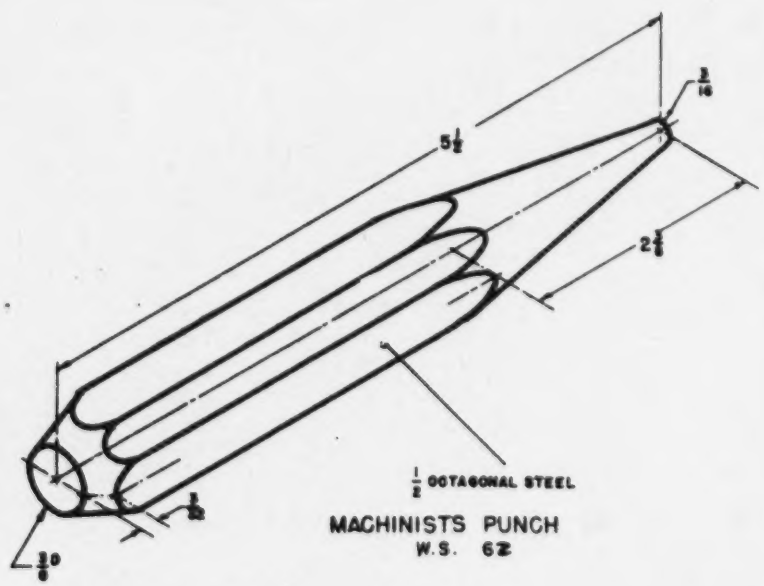

MACHINISTS PUNCH
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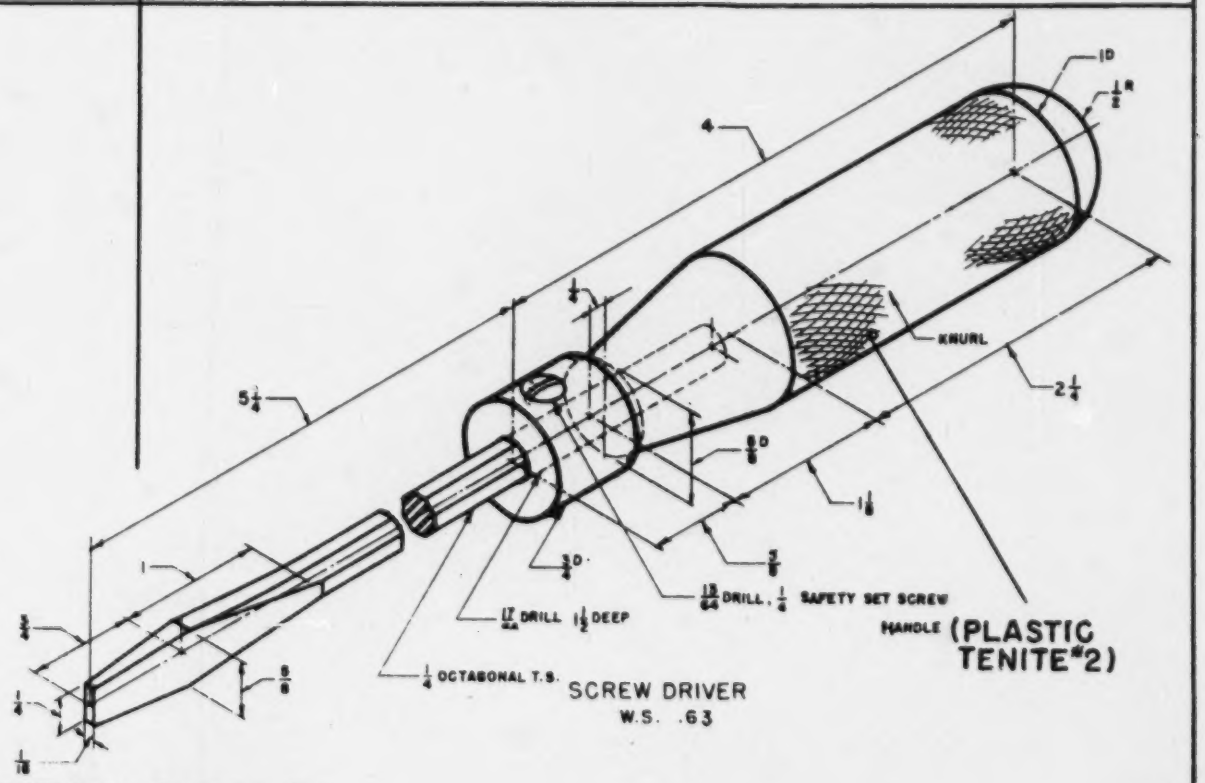

SCREW DRIVER
W.S. .63

ILLUSTRATION SHEET 31.

STEPS	KEY POINTS
	9.13.5 Overcoat - type, color, and material
	.6 Outer garment - type, color, and material
	.7 Gloves - type, color, and material
	.8 Jewelry - type, color, and metal
	.9 Trousers - type, color, and material
	.10 Socks - type, color, and material
	.11 Footwear - type, color, and material
	.14 Remembering perpetrator may discard or change clothes
	.15 Describing perpetrator's vehicle:
	.1 Color - from top to bottom
	.2 Year
	.3 Manufacturer
	.4 Body type
	.5 License number - including state
	.6 Accessories
	.7 Distinguishing features - including stickers
	.16 Remembering vehicle or license plates may be stolen, borrowed, or altered
	.17 Describing weapon used:
	.1 Color
	.2 Metal
	.3 Make
	.4 Type
	.5 Caliber
	.6 Distinguishing features
	.18 Remembering it may be a toy
	.19 Describing loot:
	.1 Total value
	.2 Quantity of each item
	.3 Each item, going from major categories to specific items
	.20 Describing route of escape

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LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS	
SUPPLEMENTAL STEPS FOR COLD CASES		
10.a. Request departmental assistance	10.a.1	Through supervisor
	.2	Keeping out of hearing distance of participants
	.3	Using radio or telephone
	.4	Identifying yourself
	.5	Giving exact location
	.6	Indicating type of assistance needed
	.7	Giving a summary of the case and what physical evidence is known and/or believed to be present
	.8	Answering questions
	.9	Identifying statements which are opinions
	.10	Notifying other law enforcement agencies, as ordered
b. Turn-over investigation	b.1	Upon arrival of:
	.1	Criminal investigator and/or physical evidence technician
	.2	Keeping out of hearing distance of participants
	.3	Briefing investigator or technician
	.4	Introducing and identifying investigator to participants
	.5	Assisting as requested
SUPPLEMENTAL STEPS FOR HOT CASES (The following steps and key points on Hot Cases are preceded by Steps 1 through 9)		
10.a. Notify dispatcher	10.a.1	Furnishing information from Preliminary Investigation Form
	.2	As soon as possible
	.3	Talking slowly and clearly
	.4	Using telephone, preferably
	.5	Stating exact offense committed and location

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STEPS	KEY POINTS
	10.a.6 Using phonetic alphabet in spelling (See Appendix 26)
	.7 Describing:
	.1 Perpetrator
	.2 Clothing
	.3 Vehicle
	.4 Weapon
	.5 Loot
	.6 Route of escape
	.8 Giving warning regarding officers' safety
	.9 Checking accurate reception of information by dispatcher
	.10 Checking that allied law enforcement agencies have been notified
b. Request departmental assistance	.b.1 As required
	.2 Through supervisor
	.3 Keeping out of hearing distance of participants
	.4 Using radio or telephone
	.5 Identifying yourself
	.6 Giving exact location
	.7 Indicating type of assistance needed
	.8 Giving a summary of the case and what physical evidence is known and/or believed to be present
	.9 Answering questions
	.10 Identifying statements which are opinions
	.11 Notifying other law enforcement agencies, as ordered
c. Turn-over investigation	.c.1 Upon arrival of:
	.1 Criminal investigator and/or physical evidence technician
	.2 Keeping out of hearing distance of participants
	.3 Briefing investigator or technician
	.4 Introducing and identifying investigator to participants
	.5 Assisting as requested

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STEPS		KEY POINTS
10.d. Pursue perpetrator	10.d.1	Within jurisdiction and capabilities
	.2	Following leads to their conclusion
	.3	Participating in intra-departmental tactical operations

SUPPLEMENTAL STEPS FOR PERPETRATOR IN CUSTODY OF CIVILIAN
(The following steps and key points on Perpetrator in Custody of Civilian are preceded by Steps 1 through 9)

10.a. Arrest Perpetrator	10.a.1	Stating reason
	.2	Taking into physical custody
	.3	Using only that amount of force necessary to overcome resistance
	.4	Always recording physical condition of perpetrator (See Appendix 24)
	.5	Recording mental condition
	.6	Bringing physical and mental condition to the attention of selected witnesses
	.7	Recording witnesses name
b. Secure arrestee	.b.1	Preventing escape
	.2	Isolating arrestee as soon as possible
	.3	Handcuffing hands behind back, palms out, key holes up, double lock pins away from arrestee
	.4	Handcuffing to fixed object
	.5	Preventing arrestee from injuring himself or others
	.6	Preventing others from injuring arrestee
	.7	Refusing arrestee's requests
	.8	Keeping in view
	.9	Staying at discreet distance
	.10	Blocking exits
	.11	Using civilian assistance
	.12	Keeping all unauthorized persons away
c. Search arrestee	.c.1	After handcuffing
	.2	For the safety of all concerned

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LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
	10.c.3	For weapons and/or evidence
	*.4	Choosing well lighted location at night
	.5	Choosing location away from people
	.6	Telling arrestee he will be searched
	.7	Using "spread-eagle" method
	.8	Methodically from head to toe
	.9	Using grasping motion of hand against garment and body
	.10	Feeling for objects, not patting
	.11	Removing all metal objects that may be potential weapons
	.12	Examining objects carefully to determine if converted to weapon
	.13	Noting and recording location where weapon or evidence was found
	.14	Completing body search even though one weapon found
	.15	Requesting departmental assistance
	.16	Using female officer or trusted adult woman for females
	.17	Providing security for female searcher
d. Request departmental assistance	.d.1	Through supervisor
	.2	Keeping out of hearing distance of participants
	.3	Using radio or telephone
	.4	Identifying yourself
	.5	Giving exact location
	.6	Indicating type of assistance needed
	.7	Giving a summary of the case and what physical evidence is known and/or believed to be present
	.8	Answering questions
	.9	Identifying statements which are opinions
	.10	Notifying other law enforcement agencies, as ordered
e. Turn-over investigation	.e.1	Upon arrival of:

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STEPS	KEY POINTS
	10.e.1.1 Criminal investigator and/or physical evidence technician
	.2 Keeping out of hearing distance of participants
	.3 Briefing investigator or technician
	.4 Introducing and identifying investigator to participants
	.5 Assisting as requested
CRIME SCENE INVESTIGATION (To be followed when not performed by criminal investigator or technician)	
11. Photograph scene	11.1 As soon as possible
	.2 To substantiate position and location of pertinent objects
	.3 Avoiding alteration of scene
	.4 Adding nothing to first photograph
	.5 Adding law enforcement agency's identification to second photograph
	.6 Picturing the initial appearance of evidence
	.7 Recording photographic data:
	.1 Type of camera
	.2 Type of lens
	.3 Shutter speed
	.4 Lens opening
	.5 Type of film
	.6 Time taken
	.7 Location of camera
	.8 Light condition
12. Sketch scene	12.1 To substantiate position and location of pertinent objects
	.2 Determining when it should be made in the course of the investigation
	.3 Obtaining a general impression before starting
	.4 Using Field Sketch Sheet and straightedge (See Appendix 10)
	.5 Locating directions with a magnetic compass

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LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
		12.6	Determining scale to be used
		.7	Determining fixed base line or fixed points
		.8	Determining what must be included
		.9	Adding nothing superfluous
		.10	Making preliminary sketch in pencil, lightly
		.11	Using black ink
		.12	Identifying pertinent objects with letters in red ink
		.13	Measuring accurately
		.14	Using "feet" and "inches" to designate distances
		.15	Locating and indicating "North" at top of page
		.16	Recording information in lower right corner
13.	Search for physical evidence	13.1	According to laws governing search
		.2	To substantiate facts
		.3	Proving elements of the offense
		.4	Examining scene clockwise
		.5	Beginning with the perimeter
		.6	Proceeding spirally
		.7	Examining scene minutely
		.8	Completing one area before going to another
		.9	Examining adjacent area and route of approach
14.	Collect physical evidence	14.1	Carefully, with minimum handling
		.2	For preservation
		.3	Apprising witness(es) of find
		.4	Photographing where found
		.5	Recording description and location
		.6	Including it in sketch
		.7	Getting sufficient quantity of known sample
		.8	Giving receipt to owner for valuable property

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LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
15. Mark physical evidence	15.1	For future identification
	.2	Initialing and dating in suitable location avoiding damage for scientific examination
	.3	Using appropriate marking devise
	.4	Recording mark and location
	.5	Attaching completed evidence tag
	.6	Starting and maintaining the chain of evidence
16. Preserve physical evidence	16.1	Maintaining it in its original state
	.2	Keeping in personal possession
	.3	Packing in suitable container
	.4	Separating to prevent contamination
	.5	Preventing damage
	.6	Preventing excessive handling

PRELIMINARY INVESTIGATION - SECONDARY PHASE

17. Take written statements	17.1	From participants (See Appendix 20)
	.2	At suitable time and location
	.3	Using separate sheets for each and one side only
	.4	Using permanent writing material
	.5	Identifying with case number and person making statement
	.6	Chronologically
	.7	Have closing verification paragraph included
	.8	Having statement signed by:
	.1	Maker
	.2	Recorder
	.3	Witnesses
18. Transport arrestee	18.1	To appropriate confinement facility
	.2	Personally or by arrangement with supervisor
	.3	Using caution when placing in patrol car
	.4	Driving safely
	.5	Locking doors securely

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LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
	18.6 Using most expeditious route
	.7 Maintaining alert for:
	.1 Personal attack
	.2 Escape attempt
	.8 Notifying dispatcher and recording starting and ending location and odometer reading for females
	.9 Recording starting and ending time
19. Process arrestee for confinement	19.1 As required by facility
	.2 Preparing documents
	.3 Having physician examine injured perpetrator
	.4 Completing Injured Prisoner Report form
	.5 Providing custodian with necessary information
	.6 Removing handcuffs from arrestee
	.7 Removing and giving custodian all personal property and potential weapons of arrestee
	.8 Verifying arrestee's property
	.9 Issuing receipt to arrestee for personal property taken as evidence
	.10 Obtaining receipt of confinement from custodian
	.11 Apprising custodian of arrestee's physical and/or mental condition
	.12 Recording confinement time, facility, and custodian
20. Submit evidence	20.1 To property officer
	.2 For safeguarding
	.3 Maintaining chain of evidence
	.4 Completing Property Tag form and receiving receipt (See Appendix 17)
	.5 Recording:
	.1 Time
	.2 Property officer's name and number
	.3 Location stored

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Training Procedure No. 6

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
21. Follow-up leads	:	21.1	As soon as possible
	:	.2	Within jurisdiction and capabilities
	:	.3	Gathering evidence
	:	.4	Interviewing informants
	:		
22. Submit reports	:	22.1	To supervisor
	:	.2	As required
	:	.3	To complete disposition
	:	.4	Before going off duty
	:	.5	For department's information
	:	.6	For use in prosecution
	:	.7	Completing Preliminary Investigation Report form (See Appendix 14)
	:	.8	Typing information
	:	.9	Referring to notes
	:	.10	Including who, what, why, when, where, and how
	:	.11	Spelling correctly
	:	.12	Choosing words carefully
	:	.13	Avoiding legalistic words, phrases, or slang
	:	.14	Being objective in information
	:	.15	Using only widely accepted abbreviations
	:	.16	Reviewing and editing the report before submitting
	:	.17	Attaching pertinent forms
	:		
23. Follow-up case	:	23.1	Transmitting known information to other interested law enforcement agencies
	:	.2	Requesting their assistance
	:	.3	Having physical evidence examined by the criminalistician
	:	.4	Checking available law enforcement agency records
	:	.5	Interviewing new sources of information
	:	.6	Contacting the victim personally at periodic intervals, informing him of developments

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Assignments

WS. 60. Bottle Opener: Study the pictorial drawing of the bottle opener on Illustration Sheet 31, page 107. Decide what views and dimensions will be needed to make a complete working drawing of the object. Make a freehand sketch of the bottle opener showing the necessary views and dimensions. Draw each view in its proper position. Have your instructor approve the sketch. Using instruments, make a working drawing of the bottle opener on a Work Sheet. Be sure to space views properly on the Work Sheet and do a neat job of dimensioning and lettering.

WS. 61. Cold Chisel: Refer to Illustration Sheet 31, page 107. Make a complete working drawing of the cold chisel, showing the necessary views and dimensions. Have your sketch approved by the instructor before you make the drawing with instruments. Study the construction of the octagon shown on Illustration Sheet 31, WS 61, and practice the drawing of an octagon with your drafting instruments on a piece of practice paper before making your instrument drawing.

WS. 62. Machinist's Punch: Refer to Illustration Sheet 31, page 107. Make a working drawing on tracing paper of the punch showing the necessary views and dimensions. Have your sketch approved by the instructor before making the drawing with instruments. Make a blueprint of your drawing if your instructor thinks the tracing is good enough to make a print. Refer to the information given on pages 104 and 105, on how to make a blueprint.

Training Procedure No. 7

TRAFFIC VIOLATIONS, HANDLING

INTRODUCTORY INFORMATION:

One of the most pressing problems facing the public and law enforcement agencies is finding additional ways and means of reducing deaths, injuries, and amount of property damage that are occurring daily on the nation's trafficways. Law enforcement officers contribute substantially towards this reduction when they detect, apprehend, and take enforcement action against the traffic law violator.

A great number of an officer's personal contacts with the public is due to the large number of traffic violations which must be handled. It is under these circumstances that an officer will affect the public image of the department and the service rendered, either favorably or unfavorably. An officer creates the best impression for the department by exhibiting exceptional judgement and conducting himself above reproach while handling the traffic violation.

EQUIPMENT NEEDED:

Citation Book
Pen, Ball Point
Pencil, Mechanical
Traffic Code Book

GENERAL SAFETY PRACTICES:

Notify dispatcher of location before leaving patrol car, under all circumstances
Be extremely cautious in pursuit driving
Use safety seat belt
Keep constantly alert for erratic movements of vehicle or person
Keep alert to moving traffic
Know the condition and limitation of patrol car

STEPS		KEY POINTS
1. Witness violation	1.1	Of driver
	.2	Recognizing elements of the offense
	.3	Determining action to be taken
	.4	Noting general identification characteristics of violator
	.5	Noting time and place

Note: Items identified by an asterisk pertain to nighttime only.

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Training Procedure No. 7

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
	1.6	Noting vehicle make, year, model, color, license number, and any unusual appearance
2. Apprehend violator	2.1	As soon as practical
	.2	Being certain safety seat belt is fastened before pursuing
	.3	Moving into traffic safely
	.4	Pacing violator's vehicle properly on speed violations
	.5	Selecting location to stop violator
	*.6	Selecting well lighted location at night, when possible
	.7	Driving patrol car to the left of and two (2) feet behind driver
	.8	Be careful not to overshoot vehicle
	.9	Using second gear or low range in heavy traffic
	.10	Attracting driver's attention with short horn signals-daytime
	*.11	Flashing spotlight across inside and/or outside rearview mirror
	*.12	Avoid blinding driver
	.13	Keeping constantly alert for erratic vehicle movements
	.14	Using hand signals to designate selected stopping place
	.15	Falling in behind vehicle to be stopped
	.16	Maintaining assured clear distance
	.17	Using red beacon light and siren in high speed pursuit
	.18	Keeping dispatcher informed when pursuit is involved
	.19	Notifying dispatcher if assistance required
	.20	Watching for items that might be thrown from pursued vehicle
	.21	Parking patrol car about 8 to 15 feet behind and a little to the left of violator's vehicle

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STEPS		KEY POINTS
	2.22	Notifying dispatcher before leaving patrol car
	.23	Turning or leaving on red beacon light to warn motorists
	.24	Recording license number on car desk pad before alighting
	.25	Removing sunglasses
	.26	Unfastening holster flap
	.27	Approaching violator and vehicle with caution
	.28	Observing interior of violator's vehicle through rear and side windows
	.29	Noting occupants and contents
	.30	Noting escape routes
	.31	Noting available cover
3. Make identification	3.1	Taking a position to the rear of driver's door and out of range of other door for conversation
	.2	Keeping alert to occupant's movement
	*.3	Keeping flashlight beam out of occupants eyes
	.4	Greeting courteously using "Sir" or "Ma'am"
	.5	Requesting violator remain seated in the vehicle
	.6	Informing violator of reason for stopping
	.7	Using tone of voice indicating statement of fact
	.8	Asking for driver's license and vehicle registration
	.9	Accepting only requested documents
	.10	Examining documents for validity
	.11	Requesting verbal pronunciation, spelling of name, and present address
	.12	Addressing by proper title and name thereafter

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STEPS		KEY POINTS
	4.12	Recording section number of violation
	.13	Having violator sign citation
	.14	Comparing signature with that on driver's license
5. Release violator	5.1	After enforcement action
	.2	After rechecking citation for accuracy and legibility
	.3	After ascertaining if driver understands information on citation
	.4	Returning all documents
	.5	Noting where driver puts documents
	.6	Thanking driver for cooperation
	.7	Asking driver if he would like assistance to return to trafficway

16953

Training Procedure No. 8

TRAFFIC ACCIDENTS, HANDLING

INTRODUCTORY INFORMATION:

A traffic accident defies a rigid set of chronological steps for proper handling. The urgency of any one of its aspects will govern the officer's course of action.

Confusion, hysteria, injuries, fire, foul weather, bad location, high speed, traffic and poor visibility are some of the things encountered at the scene. The need and ability to make sound decisions quickly and see to it that they are carried out are imperative. The officer must control the situation.

EQUIPMENT NEEDED:

Accident Investigation Kit:
- Crayon, Marking (lumber yellow)
- Paper
- Tape Measure, 100 ft. Metal Reinforced Cloth
- Tape Measure, 10 ft. Spring Steel (white surface)
- Template, Accident Investigators

Motor Vehicle Accident Form
Form, Statement

GENERAL SAFETY PRACTICES:

Drive safely
Park properly
Be constantly alert for hazards, personal and others
Place all civilian help as safely as possible

STEPS	KEY POINTS
1. Receive accident information :	1.1 From dispatcher
:	.2 From citizen, notifying dispatcher
:	.3 Recording:
:	.1 Name and address of citizen reporting
:	.2 Type of accident:

Note: Items identified by an asterisk pertain to nighttime only.

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STEPS	KEY POINTS	
	1.3.2.1	Personal injury
	.2	Property damage only
	.3	Time received
	.4	Location
	.4	Obtaining as much information as possible
2. Proceed to scene	2.1	Planning action
	.2	Using extreme caution when disobeying traffic laws
	.3	Driving safely
	.4	Using shortest and quickest route
	.5	Using siren and emergency lights in accordance with departmental policy
	.6	Observing weather and road conditions
	.7	Being alert for cars leaving scene
3. Arrive at scene	3.1	Parking car at safe distance from nearest object to be protected
	.2	Leaving emergency lights operating
	*.3	Illuminate accident scene with car lights when necessary
	.4	Using off-street facilities when available and accident is not serious
	.5	Parking car crosswise to road to protect scene when necessary
	.6	Recording time arrived
4. Observe scene and situation	4.1	By quickly scanning area
	.2	To determine course of action
	.3	Traffic flow
	.4	Congestion
	.5	Road blockage
	.6	Urgent matters needing immediate accident
	.7	Hazards which could compound the accident
	.8	Positions of victims if thrown from car
5. Protect scene	5.1	To preserve evidence
	.2	Warning approaching traffic

16955

STEPS	KEY POINTS
	5.3 Setting fusees
	.4 In locating warning device, consider speeds, visibility and road condition
	.5 To prevent further damage and other accidents
	.6 To prevent theft from vehicles or injured persons
	.7 Re-parking patrol car if necessary
	.8 Roping off scene area
	.9 Detouring traffic
	.10 Requesting assistance from bystanders:
	.1 Using professional drivers when possible
	.2 Directing activities of assistants
	.11 Requesting assistance needed from headquarters - be specific
	.12 Using tow trucks or other emergency vehicles and their lights when necessary
	.13 Turning off ignitions and lights of vehicles involved
	.14 Guarding spilled gasoline or other inflammables
6. Care for injured	6.1 Moving occupants ONLY if life endangered
	.2 Calling for rescue squad, ambulance and/or medical help when necessary
	.3 Stop bleeding
	.4 Preventing shock or exposure by keeping injured warm
	.5 Assisting minor injured persons from vehicles safely
	.6 Preventing theft of personal belongings from injured persons
	.7 Noting unusual condition of injured while aiding them, such as evidence of alcohol
	.8 Keeping onlookers away from injured

16956

STEPS		KEY POINTS
	6.9	Using best help available when necessary
7. Locate and question drivers and witnesses	7.1	To establish ownership and identity
	.2	By observing
	.3	By inquiring
	.4	Recording license numbers of vehicles at accident scene - possible witnesses
	.5	If driver cannot be located, assume it is a hit and run case
	.6	Examining driver's condition
	.7	Obtaining names and addresses
	.8	Having drivers or owners assist in caring for their property
	.9	Ascertaining number of people involved and possible injuries
8. Photograph scene	8.1	When necessary
	.2	As soon as practical
	.3	To record things that were not noticed
	.4	To record original scene before changed
	.5	To show damage before vehicles are moved
	.6	To prove statements
	.7	Being selective in photographs taken
	.8	To preserve evidence or clues which may disappear
9. Sketch scene	9.1	Using Field Sketch Sheet (See Appendix 10)
	.2	To show general relationship of things
	.3	Making as neat and complete as possible - avoid erasing or altering
	.4	Sketch should be identified, day and hour of accident, names of roads, direction of north, names of people who took measurements and made drawing

16957

STEPS		KEY POINTS
10. Measure distances	10.1	Making measurements with tape
	.2	At all accidents
	.3	Locating point of impact by triangulation with permanent objects
	.4	Of all skidmarks and gouges
	.5	Locating final position of vehicles from point of impact
	.6	Location of dead or injured from point of impact
	.7	By marking various points with yellow crayon after deciding what is to be measured
	.8	Using tape cautiously near electrical wires
	.9	Stopping or warning traffic if necessary
	.10	Being accurate as possible
	.11	Locating temporary objects or things as soon as possible
	.12	Locating any possible traffic hazards
11. Gather physical evidence	11.1	By systematic search from point of approach to scene to point of departure
	.2	By collecting adequate specimens
	.3	Marking or tagging for identification
	.4	To verify or disprove statements of drivers and witnesses
	.5	Determining condition of vehicle both mechanical and otherwise
12. Take written statements	12.1	From drivers
	.2	From witnesses - first from those who may leave or be hard to reach
	.3	At the scene - or the most convenient place
	.4	Be sure statement contains necessary information
	.5	When possible, have signatures witnessed

16958

WS. 63. Screw Driver; Refer to Illustration Sheet 31, page 107. Make a working drawing of the screw driver showing the necessary views and dimensions. Have your sketch approved by the instructor before making the drawing with instruments.

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
13. Complete Motor Vehicle Accident Report form (See Appendix V, pages 247-250)	13.1	Printing information legibly
	.2	At scene
	.3	To systematically gather information
	.4	For departmental records
	.5	To record, who-what-why-when-where and how
	.6	To furnish information to related government agencies and others
	.7	To be used in planning and research
	.8	Information must be complete
	.9	Names and addresses should be verified for spelling and correctness
14. Make arrest or issue citation	14.1	To take enforcement action
	.2	After analyzing accident
	.3	Where elements of violation can be proven in court
	.4	According to departmental policy
	.5	For violations not directly contributing to accident
	.6	For violations contributing to accident
	.7	Be specific in charging violation
	.8	Follow-up arrest or citation by explaining to citizen reason for enforcement action
15. Clear roadway	15.1	As soon as practical
	.2	Restoring normal traffic flow
	.3	Utilizing towing service
	.4	By hand pushing vehicles
	.5	Recording name of towing service
	.6	Requesting owner or driver to select tow truck service, when possible
	.7	Removing or having removed hazardous material from trafficway
	.8	Avoiding unnecessary damage to vehicle
	.9	Being alert to dangers from cables used in towing or righting vehicles
	.10	Being alert and in a safe position while tow truck is maneuvering

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Training Procedure No. 8

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
16. Answer inquiries	:	16.1	Of involved persons only
	:	.2	Telling drivers what reports they must file and where obtained
	:	.3	Giving reliable and helpful information
	:	.4	Being courteous
	:	.5	Concerning local and state traffic laws
17. Follow-up	:	17.1	Gathering facts not obtained at scene
	:	.2	Obtaining medical reports from doctor or hospital
	:	.3	Questioning drivers or witnesses that left the scene
	:	.4	Arranging for or notifying relatives of dead or injured
	:	.5	Completing necessary reports
	:	.6	Requesting departmental assistance
	:	.7	Notifying dispatcher upon completion of handling accident

16960

Training Procedure No. 9

ARRESTING

INTRODUCTORY INFORMATION:

Law enforcement agencies are given the responsibility and authority to arrest in order to protect society from the criminal. Upon the law enforcement officer is conferred the power to arrest, to use it justly and wisely is the officer's duty.

Accompanying arrest are the inherent potential dangers of physical injury or death and civil liability. Every arrest situation demands diagnosis by the officer. No two arrests are alike, they are only similar in certain phases. Each officer must be knowledgeable in both the practical and legal aspects of arrest. In the practical aspect, to develop techniques for deterring or combatting violence and to overcome the mental resistance of an arrestee. In the legal aspect, to assure compliance with the requirements of the law and to preclude legal and departmental discipline as a result of unlawful or improper handling of the arrest.

EQUIPMENT NEEDED:

Baton, Riot
Handcuffs
Injured Arrestee Field Report
Revolver
Stick, Yawara

GENERAL SAFETY PRACTICES:

Maintain physical fitness
Be constantly alert
Approach all persons and onto and into all premises with caution
Request assistance when judgment indicates
Watch arrestee's hands

STEPS		KEY POINTS	
1. Approach suspect	:	1.1	As soon as possible
	:	.2	Unfastening holster flap
	:	.3	Scanning surrounding area
	:	.4	Planning action
	:	.5	Selecting spot for arrest
	:	.6	Moving in from rear and/or side
	:	.7	Calmly
	:	.8	Quietly
	:	.9	Cautiously
	:	.10	Cutting off escape route

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STEPS	KEY POINTS	
	1.11	Expecting escape attempt
	.12	Using peripheral vision to detect physical or other hazards
	.13	Using available cover or shadows
	.14	Avoid being silhouetted
	.15	Noting dress for identification
	.16	Watching suspect constantly - especially hands
	.17	Watching for objects that suspect may discard
	.18	Noting his physical and mental condition
	.19	Noting personal physical characteristics for identification
2. Apprehend suspect	2.1	As soon as possible
	.2	Taking by surprise
	.3	Stopping actions
	.4	Pursuing, as required
	.5	Using force as a last resort
	.6	Restraining physically, as required
	.7	Adhering strictly to the laws of arrest
	.8	Keeping suspect away from strong hand side
	.9	Standing slightly to the rear and right of suspect
	.10	Using only that amount of force necessary to overcome resistance
	.11	Using special care with women, juveniles, and mentally ill
	.12	Using revolver for protection of life or preventing escape of felon
	.13	Requesting assistance
3. Arrest suspect	3.1	Commanding "Don't move"
	.2	Identifying self as law enforcement officer
	.3	Ordering to move only as told
	.4	Stating "You are under arrest"
	.5	Stating reason for arrest
	.6	Speaking clearly

16962

STEPS		KEY POINTS
	3.7	Using authoritative tone of voice
	.8	Noting statements by arrestee for later recording
4. Secure arrestee	4.1	Preventing escape
	.2	Ordering arrestee to assume spread-eagle position using vertical surface
	.3	Removing handcuffs from case with weak hand
	.4	Handcuffing hands behind back, palms out, key holes up, double lock pins away from arrestee
	.5	Double locking handcuffs
	.6	Isolating arrestee as soon as possible
	.7	Handcuffing to fixed object, when appropriate
	.8	Keeping in view
	.9	Blocking exits
	.10	Preventing arrestee from injuring himself or others
	.11	Preventing others from injuring arrestee
	.12	Refusing request of arrestee and/or persons wishing to see or speak to him at the scene
5. Search arrestee	5.1	After handcuffing
	.2	Select location:
	.1	Away from people
	.2	Well lighted
	.3	Away from avenues of escape
	.3	For weapons (See Appendix 27)
	.4	For evidence (See Appendix 27)
	.5	Keeping arrestee in spread-eagle position with head against vertical surface
	.6	Methodically from head to toe
	.7	Using grasping motion of hand on garment and body
	.8	Feeling for objects
	.9	Noting any peculiarities of garments

16963

STEPS		KEY POINTS
	5.10	Using female officer or trusted adult woman for females
	.11	Providing security for female searcher
	.12	Removing all metal objects that may be potential weapons
	.13	Examining objects carefully to determine if converted to weapon
	.14	Completing bodily search even though weapon or evidence found
	.15	Calling for assistance, when necessary
6. Remove arrestee from scene	6.1	Immediately from a belligerent crowd
	.2	As soon as possible
	.3	Taking to confinement facility or magistrate
	.4	Walking arrestee to confinement facility, if practical
	.5	Holding handcuff chain at all times when moving arrestee
	.6	Requesting departmental assistance for transportation
	.7	Placing arrestee in safest location within vehicle
	.8	Taking purse and spike heeled shoes from female arrestee
	.9	Notifying dispatcher and recording the starting and ending location and odometer reading for females
	.10	Refusing requests of arrestee
	.11	Keeping constantly alert against personal attack or attempt to escape
	.12	Noting statements made by arrestee during transporting
7. Process arrestee for confinement	7.1	Providing required medical treatment
	.2	Completing Injured Arrestee Field Report (See Appendix 24)
	.3	Delivering to custodial officer at appropriate institution
	.4	Adhering to institution's confinement procedures

16964

STEPS	KEY POINTS
	7.5 Having necessary commitment documents
	.6 Supplying necessary information
	.7 Searching arrestee:
	.1 In presence of custodial officer
	.2 Removing all property
	.3 Giving property to custodial officer
	.4 Retaining possession of evidence
	.5 Giving receipt for evidence taken
	.6 Accounting with custodial officer for arrestee's property
	.8 Signing required forms
	.9 Removing handcuffs
	.10 Keeping constantly alert:
	.1 Against personal attack
	.2 Attempt to escape

16965

Training Procedure No. 10

TESTIFYING IN COURT

INTRODUCTORY INFORMATION:

The arrest of a suspect after the investigation of a crime does not necessarily close the case or end the officer's responsibility.

Under our system of government, any case involving an arrest may be put to a test. This test is a court trial, which is the right of any person charged with a crime. A trial is the examination of evidence by a jury, the evidence being presented through witnesses by the attorneys for both sides of an action, according to the rules of law as interpreted by the judge. The officer must handle every case, in all its aspects, with this ultimate test in mind, since he connot foretell which investigation will result in an arrest and which of these will result in a trial.

Due to the fact that the officer is neither judge nor jury, he will not pass on legal matters nor determine the guilt or innocence of the defendent. The officer is not an attorney, therefore, he will not defend or prosecute the accused. This leaves the officer but one role in the court trial, that of a witness.

As a witness the officer is sworn to present his testimony to the court concerning his personal knowledge regarding the case. The purpose of this procedure is to assist the officer in testifying truthfully, objectively, and effectively, thereby contributing to the impartial administration of justice.

EQUIPMENT NEEDED:

Appropriate notes
Notebook, Pocket

GENERAL CAUTIONS IN TESTIFYING:

Assuming the public prosecutor's responsibilities must be avoided
Have confidence in the public prosecutor's handling of the case
Follow the public prosecutor's instructions
The officer's bearing and physical appearance must be above reproach
Testify impartially
Maintain an impersonal attitude
Tell the truth
Avoid guessing
Avoid arguing with the defense attorney
Be courteous
Sit erect

16966 ~~82~~/83

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS	
1. Prepare for court appearance	1.1	Reviewing case reports
	.2	Placing only pages pertinent to case in notebook
	.3	Checking personal appearance
	.4	Wearing proper uniform (or conservative business suit and accessories)
	.5	Avoiding the wearing of any fraternal insignia on civilian clothes
	.6	Nothing in breast pocket of civilian coat
	.7	Contacting public prosecutor, if prosecutor has not contacted officer, to discuss case and coordinate activities
	.8	Assembling physical and documentary evidence
	.9	Providing for transportation of physical evidence
2. Proceed to courthouse	2.1	With evidence and notebook
	.2	Attending correct court on day and at time specified
	.3	Arriving early
	.4	Maintaining respectful demeanor at all times
	.5	Checking with appropriate court personnel, as required
	.6	Discussing case privately only with authorized persons
	.7	Directing all other persons wanting to discuss the case to the public prosecutor
3. Confer with public prosecutor	3.1	Regarding changes
	.2	Receiving instructions
	.3	Providing physical and documentary evidence
	.4	Avoid the borrowing of prosecutor's copy of the case reports
	.5	Reviewing last minute details

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STEPS		KEY POINTS	
4.	Attend court	4.1	Taking no items not relevant into the courtroom
		.2	Giving bailiff Sam Browne belt and revolver in accordance with court policy
		.3	Selecting seat which affords easiest and most direct route to witness stand
		.4	Seating self before judge arrives
		.5	Avoiding all talk
		.6	Writing note when necessary to communicate with prosecutor
		.7	Paying attention to proceedings
		.8	Noting friends and associates of defendant
5.	Take the witness chair	5.1	When summoned
		.2	Be calm
		.3	Maintaining erect posture, dignified carriage, and impersonal attitude
		.4	Standing at attention and raising right arm when being sworn in
		.5	Looking at person giving the oath
		.6	Sitting erect in witness chair
		.7	Avoiding unusual mannerisms or gestures
6.	Answer questions	6.1	Asked by public prosecutor, defense attorney, and judge
		.2	Maintaining an impersonal attitude
		.3	Listening to, hearing, and understanding the question
		.4	Requesting that a question be repeated when not understood
		.5	Thinking about the question
		.6	Formulating the answer mentally and logically before replying
		.7	Answering only the question
		.8	Telling the truth
		.9	Avoid guessing
		.10	Confining testimony to relevant matters

16968

UNIT IX — SHEET METAL DRAWING

General Information

Sheet metal is a very useful material. Many of the products used in industry today depend upon this metal.

Sheet metal was first flattened by hand. We know it was made in Bohemia before 1620. A machine for rolling metal into sheets was invented in South Wales in 1865. Today giant machines roll hot metal (ingots) into large sheets.

Sheet metal comes in flat sheets from the rolling mills. In the case of steel, it may be black or galvanized.

The many useful articles constructed of sheet metal are made from patterns. The sheet metal draftsman makes the patterns. He must have a clear picture of the finished project in order to make the sheet metal pattern. This pattern, or "development" as the draftsman calls it, must be actual size with an extra allowance for hems and laps.

A development drawing is a one-view drawing showing the object spread out into one flat sheet. A "development" of a box shows the bottom of the box with the sides and ends attached. An additional amount of space must be provided for the "hems" (turned-over edges) and for the "laps" (the amount needed to fasten the sides and ends together) if needed.

The projects used in this unit of work are often made in the school metal shop as a part of the sheet metal unit.

STEPS		KEY POINTS
	6.11	Volunteering no other information
	.12	Choosing words carefully
	.13	Repeating conversations verbatim
	.14	Avoiding use of technical law enforcement terms, criminal jargon, and slang
	.15	Looking at the judge or jury, as appropriate, when replying
	.16	Speaking clearly in a conversational voice
	.17	Using plain and direct language
	.18	Answering "I don't know", as appropriate
	.19	Answering one question at a time
	.20	Stating "I cannot answer that question with a 'Yes' or 'No' ", as appropriate
	.21	Referring to notes, as required
	.22	Refreshing memory by using notes
	.23	Avoiding arguments
7. Leave the courtroom	7.1	When excused
	.2	Receiving Sam Browne belt and revolver from bailiff
	.3	Avoiding the expression of any opinions concerning the trial
	.4	Refusing to discuss case with unauthorized persons
	.5	Avoid loitering about the courthouse
	.6	Leaving courthouse when dismissed

16969

Training Procedure No. 11

FIREARMS SAFETY AND NOMENCLATURE

INTRODUCTORY INFORMATION:

Safety in handling firearms is fundamental to the protection of life. There is no margin for error in determining whether or not a firearm is loaded. These statements are particularly true in a training situation. Too often we read or hear about the officer inadvertently shot by a brother officer or see the department floor or ceiling with a bullet hole in it. Each officer must strictly adhere to all safety rules concerning firearms.

Every officer should know, generally, the names of the most important parts of firearms. By doing this an understanding of the mechanical operation is more easily achieved. Knowing the parts and their function in the operation of the weapon better prepares the officer to detect a possible malfunction or unsafe condition. To detect a malfunction or unsafe condition and subsequently repair it ensures dependable operation.

EQUIPMENT NEEDED:

Departmental or personal weapon used on duty - sidearm
Revolver cleaning kit
Shotgun 12 gauge, riot
Shotgun cleaning kit

Training Procedure No. 11

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
1. Learn Safety Rules	Treat all guns as though they are loaded.
	Point a firearm only at a person you are justified in killing.
	Allow only an expert to repair your weapon.
	All firearms training must be properly and adequately supervised by someone in authority. All safety precautions must be adhered to and enforced.
	Strictest discipline must be maintained. Carelessness and thoughtlessness cannot and must not be tolerated during firearms training.
	Immediately on picking up a firearm, open the cylinder or action and check to see that it is unloaded--check it again.
	A firearm is given to or received from another person only when the cylinder or action is open.
	Never anticipate a command.
	Check for obstruction in barrel of a firearm before loading.
	Load only after position is taken at the firing point and the command to load has been given.
	Unload when and as instructed.
	Keep the firearm pointed down range at all times.
	Draw a revolver from the holster or reholster with the finger outside the trigger guard.
	When shooting single-action, place your finger on the trigger only after the firearm is pointed toward the target and the cocking action has been completed.

16971

STEPS	KEY POINTS
	No smoking on the firing line.
	No talking on the firing line or to shooters on the firing line, except by instructors.
	Always keep the muzzle of a firearm from touching the ground.
	Place thumb in front of the hammer before releasing the trigger when letting hammer down on a live cartridge.
	In case of a misfire, keep the firearm pointed down range at least ten seconds before opening the cylinder.
	After a malfunction unload and check the barrel for obstructions before firing a succeeding shot.
	Unload firearm before leaving the firing line.
	Leave firing line only when command is given.
	A loaded firearm is allowed only on the firing line.
	Dry fire on the range only under the supervision of an instructor.
	Pay strict attention to the range officer. He will instruct you as to exactly what you are to do.

16972

Training Procedure No. 11

FIREARMS SAFETY AND NOMENCLATURE

STEPS

2. Learn Parts of Revolver

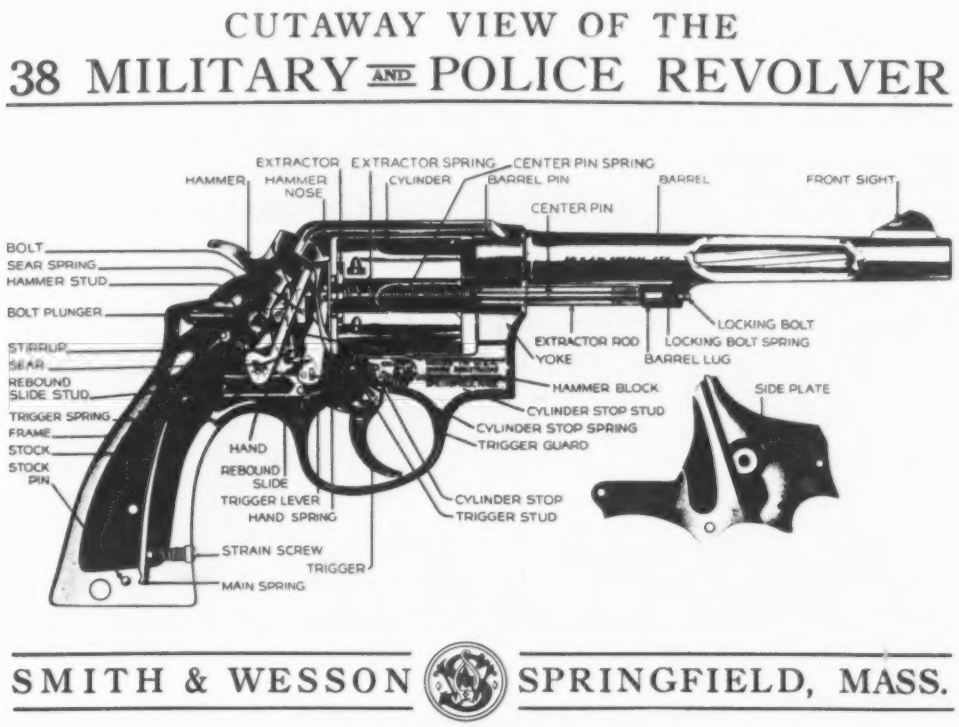

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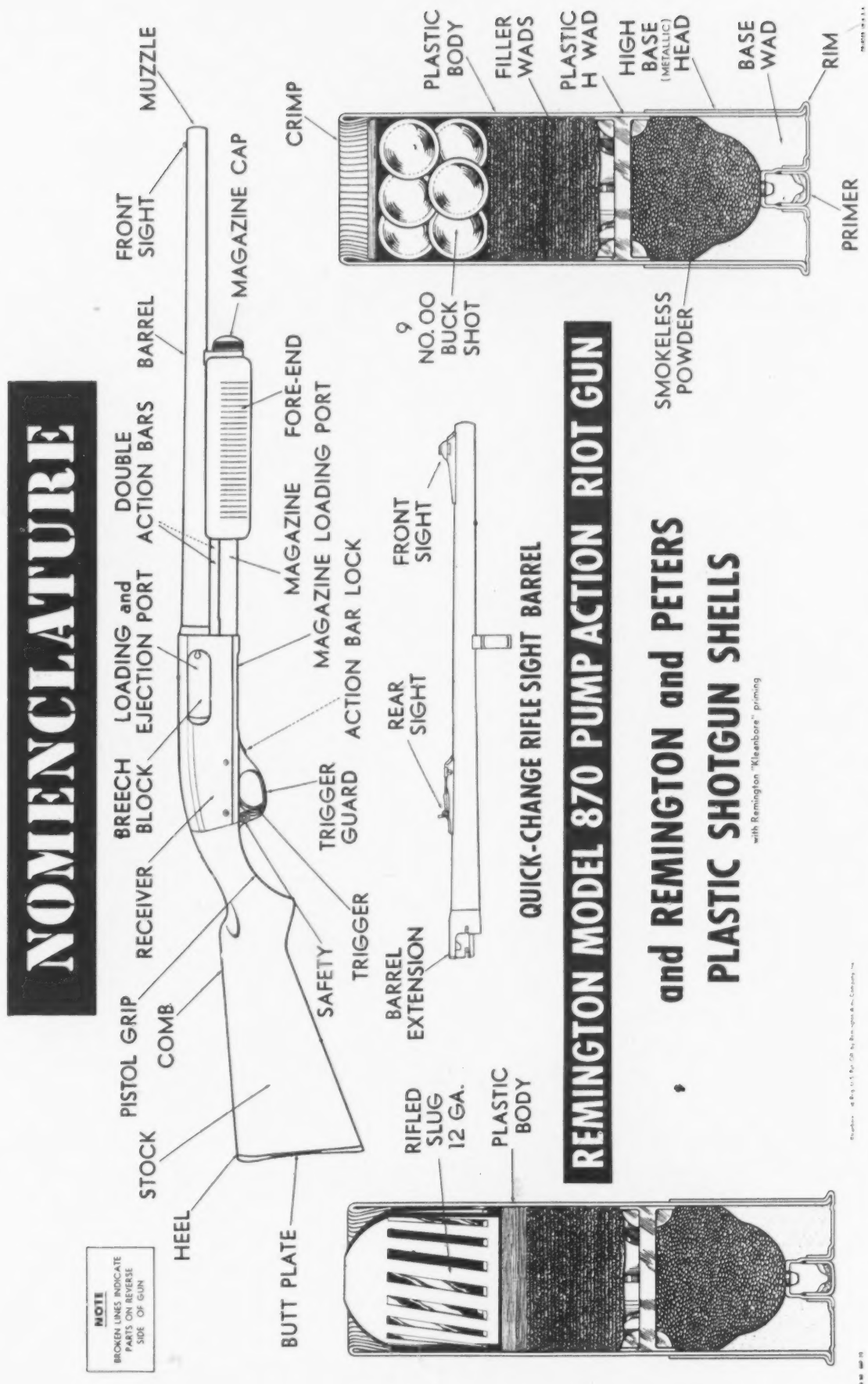

3. Learn Parts of Shotgun

16974

Training Procedure No. 12

REVOLVER SHOOTING - TARGET - COMBAT

INTRODUCTORY INFORMATION:

Target shooting offered through an organized training situation by a qualified instructor provides the best method to learn the fundamentals of revolver shooting. The use of a revolver as a weapon requires expert training and regular practice. Expert training is necessary to acquire the basic knowledge and skill necessary to develop proficiency in handling the weapon and regular practice is required to maintain and increase proficiency.

Once the officer acquires the basic knowledge and skill of handling the revolver he must then proceed to develop as much skill as possible in reacting to a combat situation. Combat shooting requires firing rapidly and accurately.

Concomitant with skillful use of the weapon is the equally important criterion of determining the justifiable use of the weapon. Not knowing under what circumstances the weapon may be used places the officer at a decided disadvantage. Use of the weapon in any situation must be based on sound judgment with the ever present thought that hanging in the balance of a decision is life or death.

EQUIPMENT:

Revolver Cleaning Kit .38 Caliber:
- Bore Brush, Brass wire
- Bore Cleaner
- Carwax, fine grade
- Cloth, Polishing
- Coarse cloth or extra fine steel wool
- Cylinder Brush, Nylon or Bristle
- Gun Grease, Fine Grade
- Lightweight Oil, Fine Grade
- Patches, Cleaning
- Rod, Cleaning with detachable tip

Screwdriver, small

Toothbrush or 1/2" to 1" Bristle Paint Brush

Sidearm, Departmental issue or personal

Target, Silhouette

Target, Pasters, Black & White

Uniform of the Day

16975

LAW ENFORCEMENT OFFICER TRAINING

GENERAL SAFETY PRACTICES:

Review Safety Practices Training Procedure No. 11

REVOLVER SHOOTING - SINGLE ACTION BULLSEYE TARGET

STEPS	KEY POINTS
1. Assume offhand stance	1. Any one of three positions: 1.1 Face target 1.2 Blade target 1.3 45° angle to target 2. Feet 12" to 18" apart 3. Weight evenly distributed 4. Stance should be practiced till it becomes natural

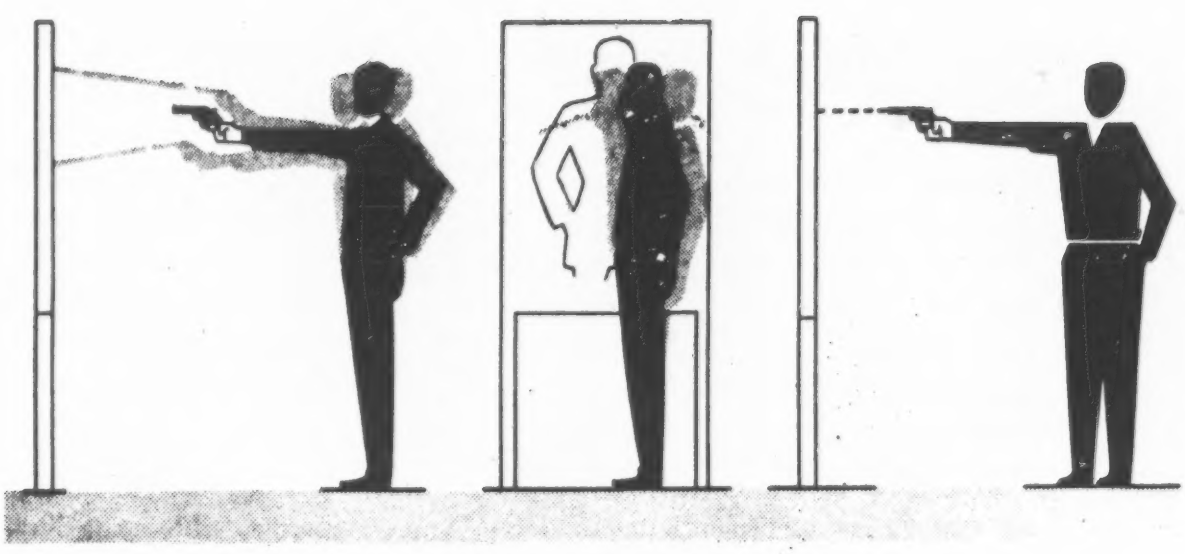

Stances, left to right: facing target directly; "blading" target; compromise position at 45 degree angle to target.

16976

STEPS		KEY POINTS	
2. Draw Revolver	:	2.1	Face target
	:	.2	Place strong hand on butt of weapon
	:	.3	Grip firmly
	:	.3.1	Place webbing between thumb and forefinger high on back strap
	:	.3.2	Keep trigger finger out of guard.
	:	.3.13	Thumb high on frame, no pressure
	:	.3.14	Maintain grip
	:	.4	Snap weapon out of holster

16977

STEPS		KEY POINTS
3. Load Revolver	3.1	Keep weapon pointed down range
	.2	Place revolver in palm of weak hand
	.3	Releasing cylinder latch with thumb of strong hand
	.4	Push cylinder out with middle two fingers
	.5	Obtain six cartridges
	.6	Lower muzzle to 45° angle
	.7	Hold cartridges in palm of strong hand
	.8	Grasp rim of cartridge with tips of thumb, index and middle finger
	.9	Insert cartridge into cylinder chamber
	.10	Revolve cylinder with thumb of weak hand
	.11	Bringing empty cylinder to the top
	.12	Load all cylinders
	.13	Close cylinder, gently

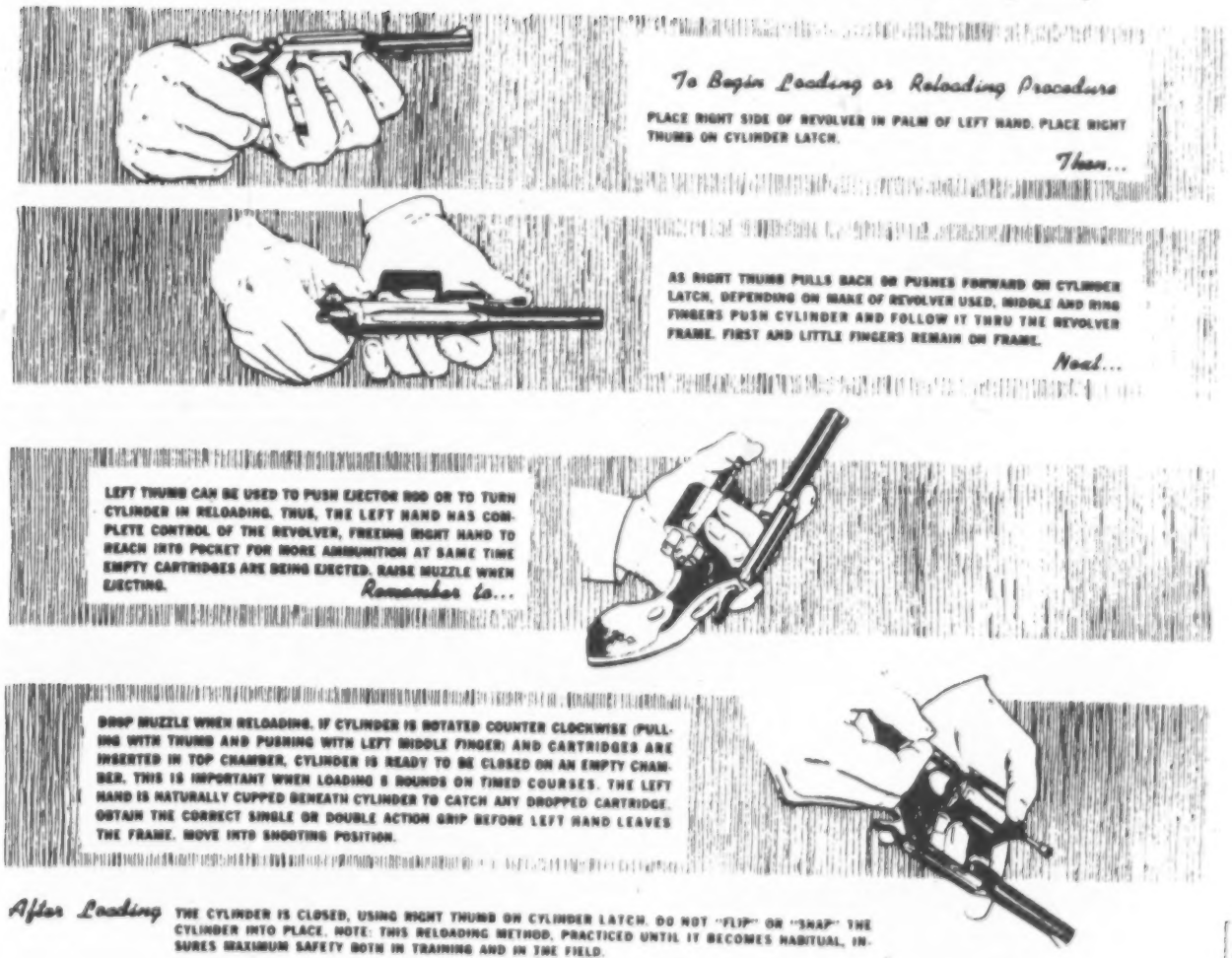

PROCEDURES IN LOADING AND RELOADING THE REVOLVER

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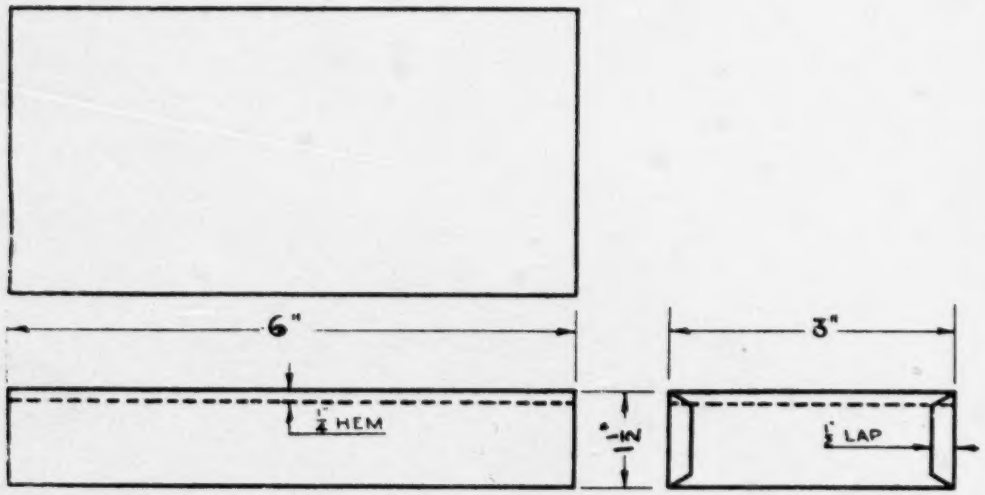

BOX

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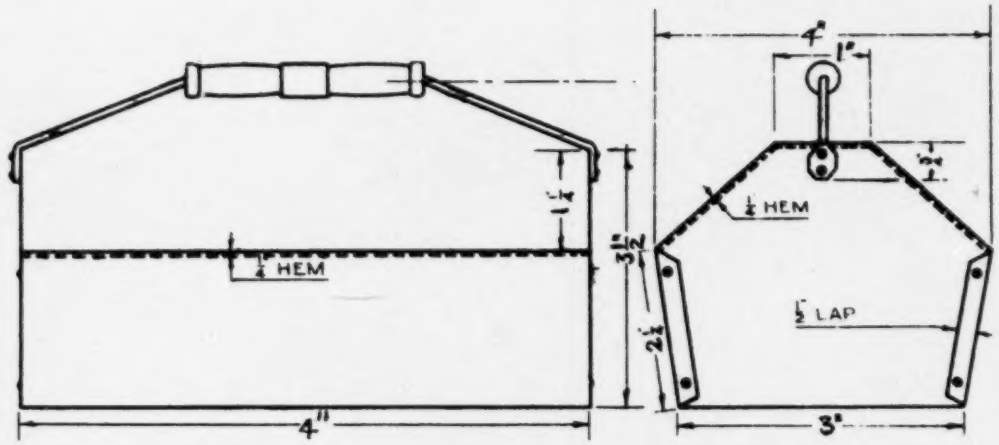

PARTS TRAY

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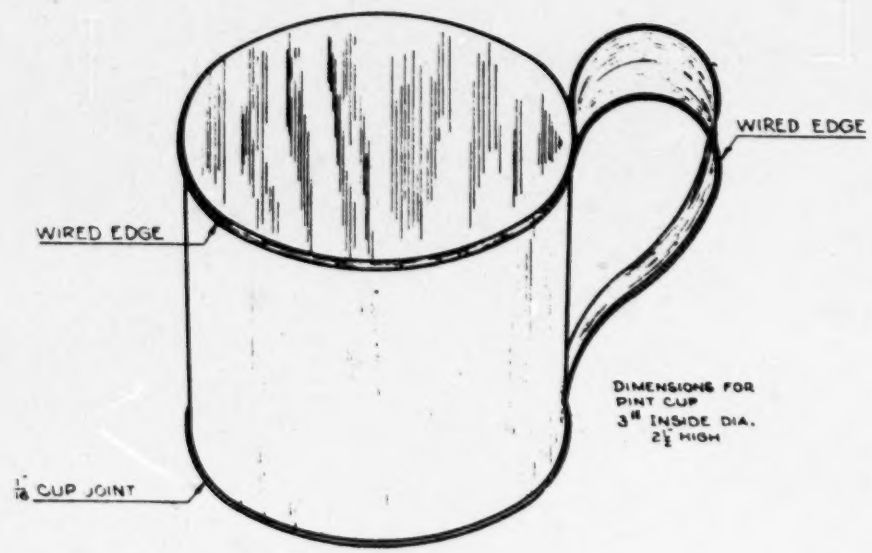

TIN CUP

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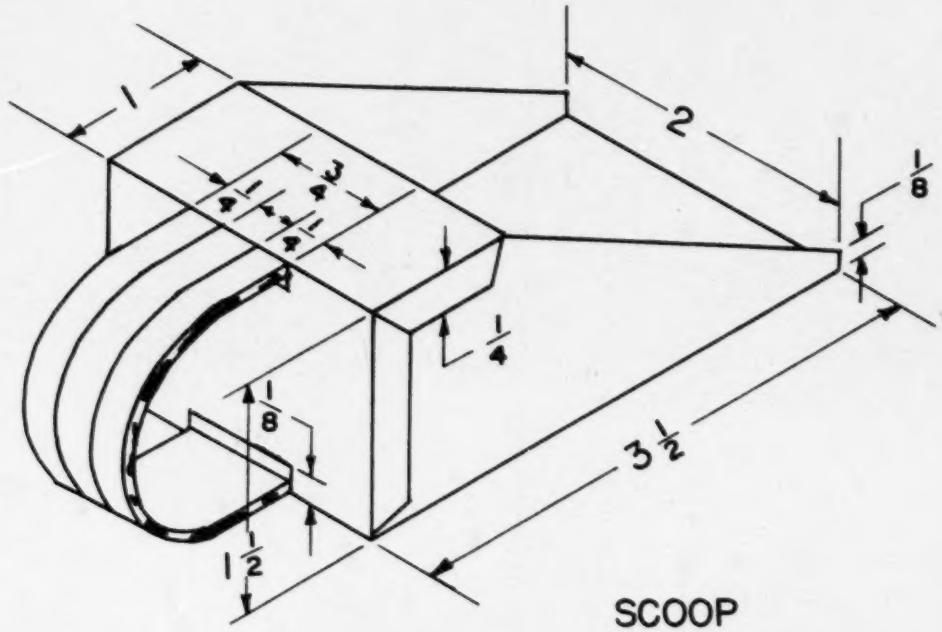

SCOOP

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ILLUSTRATION SHEET 32

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
4. Sight on Target	4.1	Extend arm and revolver at shoulder level toward target
	.1.1	Lock shoulder-elbow-wrist in position
	.2	Concentrate vision on revolver sights
	.2.1	Top of front sight even with top of rear sight an equal amount of light on either side of front blade
	.2.2	Target should appear fuzzy or gray, sights clear and sharp

6:00 O'CLOCK HOLD
BULLSEYE TARGET

16979[97]

Training Procedure No. 12

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
5. Fire at target	:	5.1	Cock revolver
	:	.1.1	Use tip of thumb on spur of hammer
	:	.1.2	Do not relax grip
	:	.2	Recheck for correct sight picture
	:	.3	Take a breath, exhale some air, hold rest
	:	.4	Squeeze trigger
	:	.4.1	Centering pad of end joint of index finger on trigger
	:	.4.2	Squeezing straight back
	:	.4.3	Maintaining constant even pressure on trigger
	:	.5	Repeat for number of shots required

WEAK HAND - SINGLE ACTION

STRONG HAND - SINGLE ACTION

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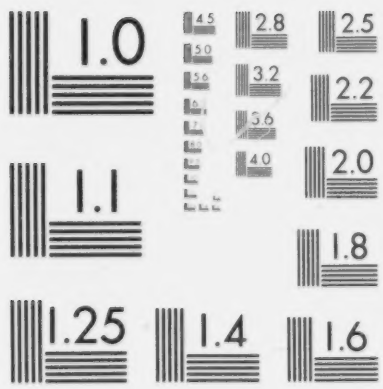

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

LAW ENFORCEMENT OFFICER TRAINING

REVOLVER SHOOTING - COMBAT - DOUBLE ACTION

STEPS		KEY POINTS	
1. Assume Position	:	1.1	The position best suited to the situation
	:	1.1.1	Crouch-hip or point shoulder shooting
	:	.1.2	Standing - offhand or barricade shooting
	:	.1.3	Kneeling - Point shoulder shooting
	:	.1.4	Sitting - using knee as rest
	:	.1.5	Prone - using free hand as rest

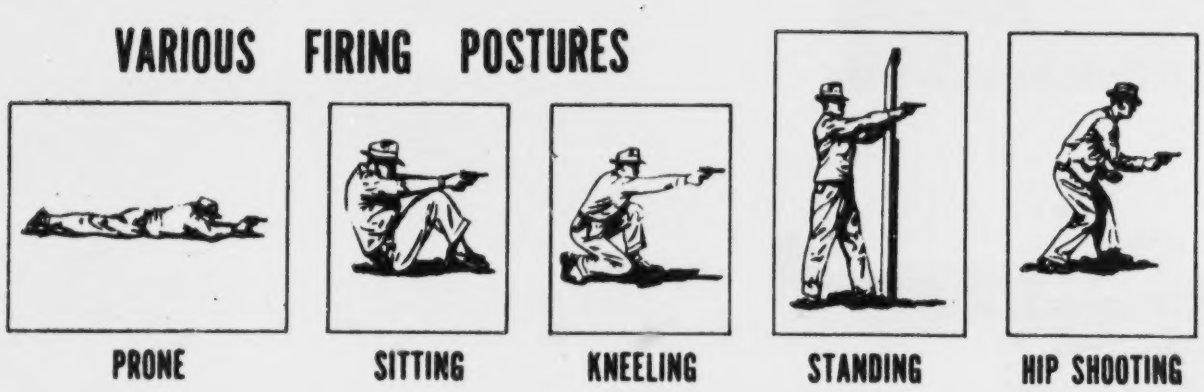

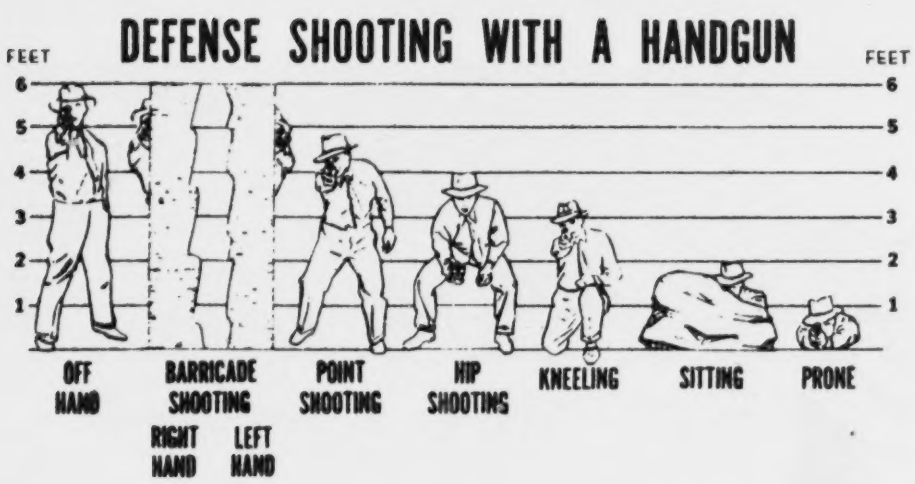

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Training Procedure No. 12

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
2. Draw Revolver	2.1	While assuming position
	.2	Lock hand on butt thumb down
	.2.1	Keep trigger finger out of trigger guard
	.3	Snap revolver out of holster
	.3.1	Insert trigger finger when revolver clears holster
	.4	Maintain firm grip

WEAK HAND - DOUBLE ACTION

STRONG HAND - DOUBLE ACTION

16982

Training Procedure No. 12

REVOLVER SHOOTING - TARGET - COMBAT

STEPS		KEY POINTS	
3. Fire at target	3.1	Concentrate vision on target at distances 0 to 15 yards.
A. Hip shooting	3.a.1	Point revolver at target as you would index finger
	a.2	Upper arm 45° angle, forearm and hand parallel to ground
	a.3	Elbow in front of body (tucked in)
	.2	Trigger finger inserted to first joint or further
	.3	Stroke trigger back, smoothly
	.4	Maintaining firm grip

CROUCH POSITION

16983

STEPS		KEY POINTS
b. Standing or offhand	b.1	In the open or from behind object
	.2	Feet 12" to 18" apart or best balanced position
	.3	Holding revolver straight out at shoulder height
	.4	Locking shoulder, elbow, wrist
	.5	Focusing vision on revolver sights so target appears fuzzy or gray
	.6	Stroke trigger back, smoothly
	.7	Maintaining firm grip

STANDING POSITIONS
WITHOUT SUPPORT

OFF-HAND

16984

STEPS		KEY POINTS
c. Kneeling	:	3.c.1 Dropping down to strong knee
	:	.2 Holding revolver straight out at shoulder height
	:	.3 Locking shoulder, elbow and waist
	:	.4 Focusing vision on revolver sights so target appears fuzzy or gray
	:	.5 Stroke trigger back, smoothly
	:	.6 Maintaining firm grip

KNEELING POSITION

16985

STEPS		KEY POINTS
d. Sitting	3.d.1	Place weak hand behind back and sit down
	.2	Extend revolver straight out from shoulder
	.3	Lock shoulder, elbow and wrist
	.4	Focus vision on sights so target appears fuzzy or gray
	.5	Stroke trigger back, smoothly
	.6	Maintaining firm grip

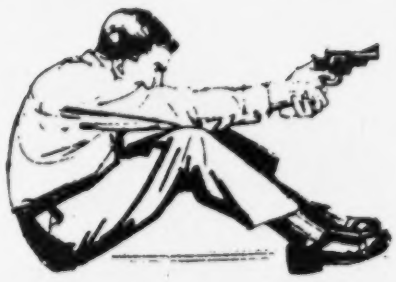

SITTING POSITION

16986

Training Procedure No. 12

REVOLVER SHOOTING - TARGET - COMBAT

STEPS		KEY POINTS	
e. Prone	:	e.1	Fall to knees and then rest of way down
	:	.2	Use weak hand to break fall
	:	.3	Extend revolver arm out and lock in position
	:	.4	Use palm of weak hand to rest revolver butt (optional)
	:	.5	Focus vision on revolver sights so target appears fuzzy or gray
	:	.6	Stroke trigger back, smoothly
	:	.7	Maintain firm grip

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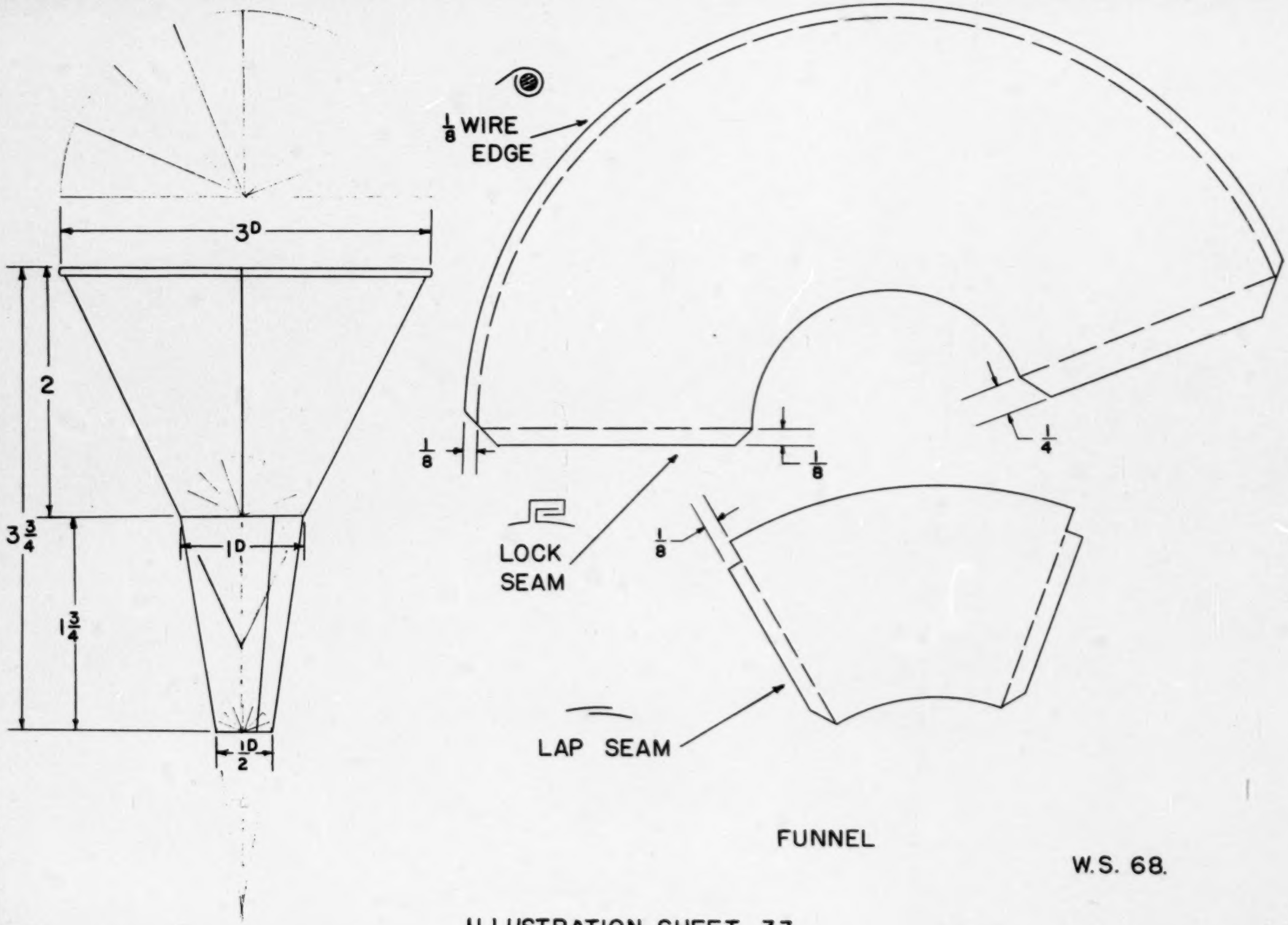

FUNNEL

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ILLUSTRATION SHEET 33.

1696

FIREARMS, SHOTGUN SHOOTING (12-GAUGE)

INTRODUCTORY INFORMATION:

The shotgun is a versatile weapon that commands a tremendous psychological respect because of its effectiveness. At close range, loaded with shot, the shotgun is formidable. Actual aiming is not required and the officer can literally spray any given area. Loaded with the rifled slug and at ranges to 100 yards its penetration and stopping power is more than adequate in most instances. It lends itself well to a law enforcement combat situation both psychologically and through effective firepower.

The law enforcement officer who resorts to the use of a shotgun by assignment or choice must be trained in its use. Placed in the hands of an untrained officer the shotgun is dangerous to all involved and its effectiveness is doubtful.

EQUIPMENT NEEDED:

Riot Shotgun, 12-Ga. Pump or Automatic
Shells, 12-Ga. 00 Buck Shot
Shells, 12-Ga. Rifled slug
Shotgun, 12 Ga. Cleaning kit
Target, Bobber

GENERAL SAFETY PRACTICES:

Make certain safety is on at all times other than actual firing
Never load until instructed to load
Keep shotgun pointed down range at all times
Check shotgun shells to make certain they are proper gauge and load - pellet - slug
Visually check barrel and receiver for obstruction

16988

Training Procedure No. 13

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS	
1. Assume stance		1.1	Facing target
a. Hip		2.	Lock stock against side just above hip
		3.	Use forearm parallel to stock for locking
		4.	Pointing shotgun at target
		5.	Using peripheral vision to line up barrel and target
		6.	Place weak hand on fore-end
b. Shoulder		1.b.1	Bring shotgun to shoulder height
		.2	Fit stock tight against shoulder on muscular portion
		.3	Point shotgun at target
		.4	Place weak hand on fore-end
2. Load shotgun		2.a.1	Make certain safety is in "on" position
a. Pump		a.2	Turn shotgun over so trigger guard is up
		a.3	Check shells for damage, proper gauge, proper load
		a.4	Insert shells in magazine loading port
		a.5	Start shell in by using thumb, index and middle finger
		a.6	Use thumb on base of shell to push shell in rest of way
		a.7	After magazine loaded return shotgun to firing position
		a.8	Pull back quickly and firmly on fore-end to load shell in firing chamber
b. Automatic		2.b.1	Follow above procedure except pull back on operating handle to load shell in firing chamber

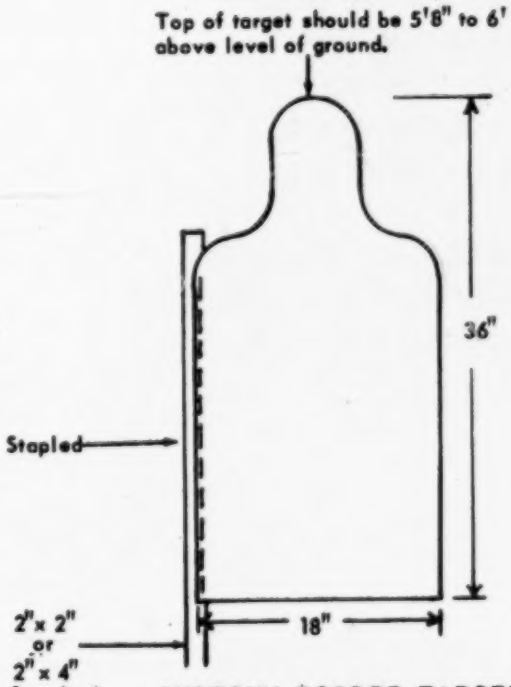

SHOTGUN BOBBER TARGET
(cardboard or similar material)

16989

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
3. Fire shotgun	3.1 Release safety with index finger
	.2 Recheck sight alignment
a. pump	.3 Squeeze trigger back firmly and rapidly
	.4 Release trigger completely
	.5 Readjust shotgun on target if necessary
	.6 Pull back quickly and firmly on fore-end to reload chamber
	.7 Repeat trigger squeeze and reloading as often as necessary
b. Automatic	b.1 Trigger may be squeezed till all rounds are expended then reloaded.

16990

Training Procedure No. 14

CIVIL COMPLAINTS, DEALING WITH

INTRODUCTORY INFORMATION:

Ministering to the needs of the public is an integral part of an officer's duties. The "need," as identified by a person, usually is in the form of a complaint, request for assistance, or protection. Often these complaints or requests are totally unrelated to the primary or secondary responsibilities of law enforcement. Yet, they must be dealt with because the individual has indicated a "need." The nature of the complaint or request, may at times, be vague thereby requiring personal response or contact by an officer. On the other hand the "need" may be resolved by the person receiving the information via telephone or personal contact at the agency. Either instance necessitates the proper disposition by the officer. The proper disposition can be satisfactorily accomplished when the officer learns how to effectively deal with this "need."

Acceptable performance by the officer helps to create the public support of law enforcement which is absolutely necessary if law enforcement is to fulfill its primary and secondary responsibilities.

EQUIPMENT NEEDED:

Notebook, Pocket Field
Pen, Ball Point

GENERAL SAFETY PRACTICES:

Avoid taking sides in any issue
Entering all premises and approaching all persons and things with caution

STEPS		KEY POINTS	
1. Receive assignment or information	:	1.1	From dispatcher
	:	.2	Acknowledging call immediately
	:	.3	Identifying unit and location
	:	.4	From citizen, notifying dispatcher
	:	.5	Stopping patrol car before writing
	:	.6	Recording on patrol car desk pad:
	:	.6.1	Location of scene
	:	.2	Type of complaint
	:	.3	Person to be contacted and/or complainant and address.

16991

STEPS		KEY POINTS
	.6.4	Time received
	.7	Repeating location to dispatcher for verification
	.8	Acknowledging receipt of transmission
	.9	Requesting required information
	.10	Understanding assignment
2. Proceed to scene	2.1	As soon as possible, unless otherwise instructed
	.2	Using most expeditious route
	.3	Driving safely
	.4	Obeying all traffic laws
	.5	Planning operations within known information
	.6	Notifying dispatcher of personal knowledge
3. Arrive at scene	3.1	Parking safely
	.2	Giving dispatcher exact location
	.3	Signalling dispatcher "Out of Service"
	.4	Recording time
	.5	Removing ignition key
	.6	Taking required equipment
	.7	Alighting from patrol car with caution
	.8	Locking patrol car
	.9	Entering onto all premises with caution
	.10	Approaching all persons and things with caution
4. Observe scene and situation	4.1	Appearing and keeping calm
	.2	Determining personal safety
	.3	Gathering information
	.4	Determining future action
	.5	Noting:
	.5.1	Mood and state of participants or complainant
	.2	Physical and mental conditions of participants or complainant
	.6	Scanning area for potential weapons

16992

STEPS	KEY POINTS
5. Preserve the peace	5.1 Greeting complainant or participants with a smile
	.2 Asking, "May I be of service?"
	.3 Speaking in soft conversational tone
	.4 Quieting persons present
	.5 Removing participants to secluded area
	.6 Separating participants
	.7 Rendering personal service impartially
6. Identify participants or complainant	6.1 Contacting complainant first, by name
	.2 Contacting witnesses in logical order
	.3 Requesting participants to identify witnesses
	.4 Recording in notebook:
	.1 Name
	.2 Age
	.3 Address
	.4 Telephone number
	.5 Occupation
	.6 Employer:
	.1 Address
	.2 Telephone number
7. Interview participants	7.1 Individually and privately
	.2 Obtaining accurate information
	.3 Allowing interviewees to tell own version of event
	.4 Asking as few questions as possible
	.5 Recording required notes at completion
	.6 Repeating interviewees' statements for verification
	.7 In logical order, depending on circumstances
8. Verify cause of complaint	8.1 Those against government
	.2 When possible and within capabilities
	.3 Determining that complaint is civil

16993

STEPS		KEY POINTS	
9.	Take corrective action	9.1	Those against government
		.2	When possible and within capabilities
		.3	Writing memorandum to department concerned when unable to correct cause
		.4	Addressing memorandum to department head
		.5	Routing it through supervisor
		.6	Completing memorandum before going off duty
		.7	Keeping a copy for reference
		.8	Making recommendation when advisable
10.	Explain jurisdiction limitations	10.1	Regarding civil matters
		.2	Between local government departments
		.3	Concerning law enforcement agency's regulations and policies
		.4	In a courteous manner
11.	Inform and direct complainant	11.1	Avoid taking sides in any issue
		.2	Avoid giving legal advice
		.3	Of possible courses of action
		.1	Avoiding the suggestion of any possible results
		.4	Regarding the name, address, and business hours of the proper agency to contact
		.5	Stating what officer can or will do to assist
		.6	What complainant can do to assist in solution of complaint
		.7	Asking if instructions and directions are understood
		.8	Writing them out, if necessary
		.9	Thanking the complainant

16994

Training Procedure No. 15

FIRE SCENES, HANDLING

INTRODUCTORY INFORMATION:

Fire fighting is a fireman's task but many times the law enforcement officer is first on the scene. Some of the problems which involve an officer at a fire scene are usually spectators, vehicular traffic congestion and emotional instability. If the officer knows and identifies the problems which may arise and then takes effective measures to prevent or handle them, this materially assists the fire service and citizens of the community. On the other hand, when these problems are not effectively handled, fire fighting efforts may be hindered, personal injury and death multiplied and additional property damage incurred. Through effective handling lives may be saved and government service is definitely improved.

EQUIPMENT NEEDED:

Blanket	Flashlight, Safety Approved
Fire Extinguisher, CO_2	Notebook, Pocket Field
Fusees	Rope

GENERAL SAFETY PRACTICE:

Do not enter a burning structure except to save lives

STEPS		KEY POINTS
1. Receive assignment	1.1	From dispatcher
	.2	Acknowledging initial call immediately
	.3	Identifying unit and giving location
	.4	Stopping patrol car before writing
	.5	Recording on patrol car desk pad:
	.1	Location of scene
	.2	Person to be contacted
	.3	Time received
	.6	Noting situation at scene
	.7	Noting actual or potential hazards to persons involved
	.8	Noting personal hazards
	.9	Noting avenues of approach
	.10	Understanding assignment
	.11	Requesting required information

16995

STEPS		KEY POINTS
	.12	Repeating location of scene for verification by dispatcher
	.13	Ascertaining if fire department has been notified
2. Proceed to scene	2.1	Promptly
	.2	Driving safely
	.3	Using most expeditious route
	.4	Considering avenues of approach
	.5	Avoiding use of patrol car siren and beacon unless otherwise instructed
	.6	Planning operations within known information
	.7	Requesting information and/or assistance--as required
	.8	Notifying dispatcher of personal knowledge
	.9	Observing traffic problems in vicinity of scene
	.10	Watching for persons leaving the immediate scene
	.11	Watching for fire apparatus responding to scene
	.12	Yielding right-of-way to fire apparatus
3. Observe scene and situation	3.1	While approaching
	.2	Gathering information
	.3	Determining personal safety
	.4	Noting vehicles blocking fire lane
	.5	Determining presence of fire fighting apparatus
	.6	Noting color and amount of flames and smoke
	.7	Noting number of fires
	.8	Noting rapidity of flame spread
	.9	Detecting flammable odors
	.10	Noting direction of wind
	.11	Determining if neighboring structures are in danger

16996

STEPS		KEY POINTS	
4.	Arrive at scene	4.1	Noting time
		.2	Turning on patrol car beacon
		.3	Parking safely
		.4	Avoiding interference with fire fighting apparatus
		.5	Using patrol car as barricade
		.6	Keeping calm
		.7	Extinguishing incipient fire
		.8	Notifying dispatcher of state of fire
		.9	Giving exact location
		.10	Notifying dispatcher of presence of fire fighting apparatus
		.11	Alighting from patrol car with caution
		.12	Locking patrol car
		.13	Determining if there are occupants in burning structure
		.14	Determining if there are occupants in neighboring structures
		.15	Determining if anyone has been killed or injured
		.16	Directing fire fighting apparatus to scene
		.17	Removing parked vehicles only upon request of fire service officer-in-charge
		.18	Requesting assistance--as required
5.	Rescue occupants	5.1	Only if fire fighters are not present and conditions permit
		.2	Warning inhabitants by use of siren and horn
		.3	Assisting occupants physically
		.4	Preventing exposure
		.5	Deter occupants from re-entering burning structure

16997

PROJECT DESIGN

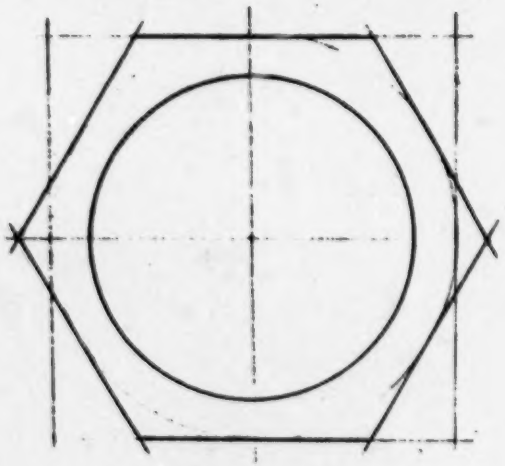

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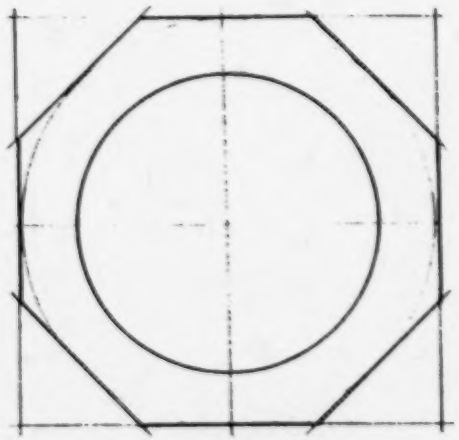

OCTAGON

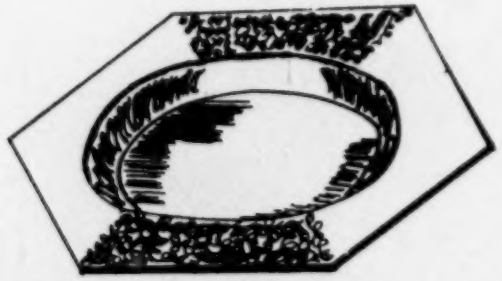

HAMMERED COPPER TRAY: DRAW 4 OR MORE POSSIBLE DESIGNS FOR A TRAY, SIZES COMMONLY USED ARE 4" & 6".

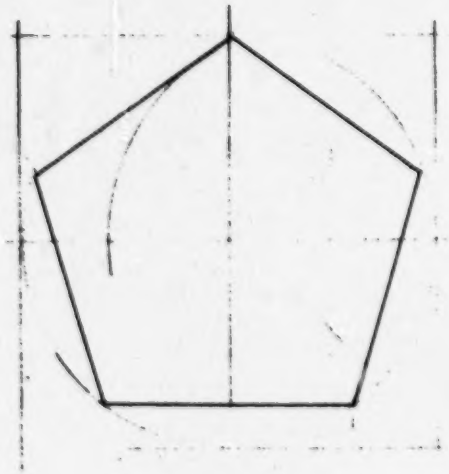

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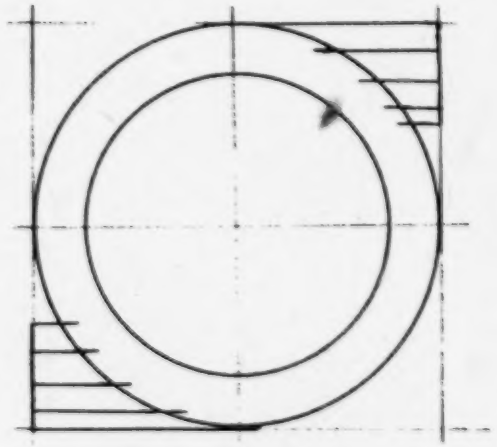

SELF DESIGNED

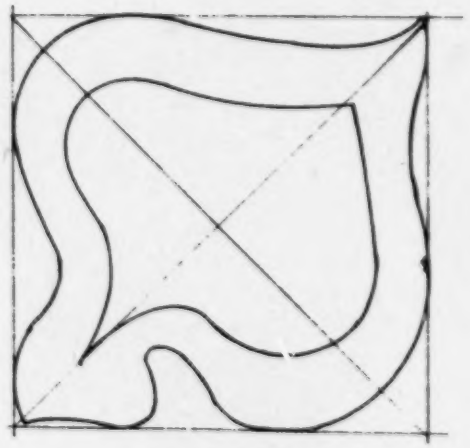

FREEFORM

W.S. 69.

ILLUSTRATION SHEET 34.

1697

STEPS		KEY POINTS	
		.6	Determining if all occupants have escaped
		.7	Avoid the wearing of raingear into burning structure
		.8	Using wet blanket for protection
		.9	Covering nose and mouth with wet hankerchief
		.10	Entering burning structures with extreme caution
		.11	Feeling door to determine heat
		.12	Opening door only if hand can withstand heat
		.13	Opening door wide, standing to one side
		.14	Closing door after passing through
		.15	Stooping to knee height
		.16	Remembering hot and toxic gases rise fast
		.17	Realizing entrance route may not be safe exit route
		.18	Avoiding the use of flashlight not safety approved
6.	Care for victims	6.1	Promptly
		.2	Requesting appropriate assistance
		.3	Notifying dispatcher
		.4	Arranging for care of homeless
		.5	Contacting appropriate service agency or relatives
7.	Control traffic	7.1	Vehicular and pedestrian
		.2	Keeping fire lane open
		.3	Until properly relieved
		.4	Courteously and firmly
		.5	Preventing damage to fire fighting apparatus
		.6	Preventing interference with fire fighting operations

16998

STEPS		KEY POINTS	
		.7	Removing those vehicles indicated by fire service officer-in-charge
		.8	Warning and diverting vehicular traffic
		.9	Selecting and directing to alternate route
		.10	Setting up fire lines
		.11	Using patrol car, barricades, and lighting
		.12	Using bystanders temporarily for assistance
		.13	Permitting authorized vehicles only inside vehicle fire line
		.14	Permitting fire fighting personnel only inside pedestrian fire line
		.15	Facing crowd to control bystanders
		.16	Checking with fire service officer-in-charge prior to opening additional lanes of traffic at scene
		.17	Allowing and assisting traffic to regain normal flow when emergency is ended
		.18	Assisting fire fighting apparatus in leaving scene
		.19	Leaving scene after securing clearance from fire-service officer-in-charge
8.	Guard property	8.1	Until arrival of claimant
		.2	Until arson investigation is completed
		.3	Until properly relieved
		.4	Keeping unauthorized persons away
		.5	Securing building
		.6	Barricading area
		.7	Placing all property in one place
		.8	Determining ownership

16999

STEPS		KEY POINTS	
		.9	Segregating according to ownership
		.10	Identifying claimant
		.11	Releasing property to owner or authorized claimant only
		.12	Recording time property released and identification of claimant
		.13	Receiving receipt for released property
		.14	Informing, if requested, claimant of available security arrangements
9.	Assist fire service	9.1	Looking for evidence of incendiarism and/or other offense
		.2	Arranging for photographing scene and spectators, in color preferably
		.3	Noting and observing spectators
		.4	Identifying habitual fire spectators
		.5	Checking with fire fighting personnel
		.6	Notifying supervisor of suspected offense
10.	Submit reports	10.1	Whenever incendiarism and/or evidence of other offense is indicated or when fire department did not respond
		.2	Promptly
		.3	Using appropriate forms
		.4	Constituting permanent record
		.5	Completing at headquarters
		.6	Submitting to supervisor

17000

Training Procedure No. 16

DISASTER SCENE, HANDLING

INTRODUCTORY INFORMATION:

Natural disasters are oftentimes predictable, for example, those created by weather. Consequently, operations can be pre-planned by law enforcement so that this type of disaster may be effectively handled. On the other hand, another type of disaster, the unpredictable occurs as a result of violent forces erupting to create destruction of life and property. Even though this type of disaster seldom occurs, law enforcement must still pre-plan for it.

The primary role of law enforcement is coordination of all efforts at the disaster scene. Control exercised by law enforcement at the scene will most effectively achieve the necessary coordination.

The first officer upon the scene will be the key to the successful implementation of the departments pre-planned disaster operation. Among other duties, he will provide vital information to the communications center so that any emergency or rescue operation can be undertaken promptly and efficiently. Because of the very nature of a disaster it is extremely easy for an officer to be caught-up in the panic. The officer must know the duties at the scene and fulfill them. Above all he cannot become a part of or party to the panic.

EQUIPMENT NEEDED:

Blanket
Flashlight, Safety Approved
Fusees
Notebook, Pocket Field
Rope, Polyproplyene or nylon

GENERAL SAFETY PRACTICES:

Be calm
Be constantly alert for potential personal hazards

STEPS		KEY POINTS
1. Receive assignment and information	1.1	From dispatcher
	.2	Acknowledging initial call immediately
	.3	Identifying unit and giving location

17001

STEPS		KEY POINTS
	.4	Stopping patrol car before writing
	.5	Recording on patrol car desk pad:
	.1	Location of scene
	.2	Person to be contacted
	.3	Time received
	.6	Noting situation at scene
	.7	Noting affected and potential affected area
	.8	Noting avenues of approach
	.9	Noting actual or potential hazards to persons involved
	.10	Noting personal hazards
	.11	Understanding assignment
	.12	Requesting required information
	.13	Ascertaining what other emergency service units have been dispatched
	.14	Repeating location of scene for verification by dispatcher
2. Proceed to scene	2.1	Promptly
	.2	Driving safely
	.3	Considering avenues of approach
	.4	Using most expeditious route
	.5	Avoiding use of patrol car beacon and siren unless otherwise instructed
	.6	Planning operations within known information
	.7	Requesting information and/or assistance--as required
	.8	Notifying dispatcher of personal knowledge
	.9	Watching for and yielding right-of-way to other emergency vehicles responding
	.10	Exercising care when driving in danger areas

17002

STEPS		KEY POINTS	
3.	Make reconnaissance	3.1	Rapidly and calmly
		.2	Gathering accurate information
		.3	Determining perimeter of Theater of Operations:
		3.3.1	Immediate disaster area
		.2	Potential disaster area
		3.4	Determining serious damage to:
		.1	Trafficways
		.2	Public utilities
		.3	Sewer systems
		.4	Buildings
		.5	Determining number of persons:
		.1	Killed
		.2	Injured
		.3	Homeless
		.4	Panic stricken
		.6	Determining law enforcement hazards which afford possibilities of looting
		.7	Determining number, location, and stage of fires
		.8	Determining direction of wind
		.9	Obtaining information desired by dispatcher
		.10	Determining emergency vehicle lanes
		.11	Locating and identifying unexploded ordinance
		.12	Working in towards center of Theater of Operations
4.	Report information	4.1	To dispatcher
		.2	Immediately and calmly
		.3	When radio is free for transmission
		.4	Identifying unit and location
		.5	Indicating results of reconnaissance
		.6	Labeling statements that are opinions
		.7	Keeping transmissions brief
		.8	Breaking long transmissions periodically

17003

STEPS		KEY POINTS	
5.	Arrive at scene	5.1	Observing while approaching
		.2	Stopping siren, if used, leaving on patrol car beacon
		.3	Parking properly
		.4	Watching for toppling buildings, street cave-ins, and downed wires
		.5	Requesting assistance
		.6	Alighting from patrol car with caution
		.7	Avoiding interference with emergency apparatus
		.8	Locking patrol car
		.9	Rescuing victims
		.10	Administering first aid
6.	Observe scene and situation	6.1	Gathering further information
		.2	Determining personal safety
		.3	Determining number and degree of personal injuries
		.4	Determining amount and degree of property damage
		.5	Noting type and amount of emergency and/or rescue equipment and personnel required
		.6	Noting danger to neighboring property
7.	Establish law enforcement lines	7.1	As ordered by supervisor or dispatcher
		.2	Preventing further injury and damage
		.3	Keeping unauthorized vehicles and pedestrians away from scene
		.4	Keeping emergency vehicle lanes open
		.5	Preventing interference with rescue operations
		.6	Using patrol car as barricade
		.7	Controlling traffic

17004

	STEPS		KEY POINTS
		.8	Selecting and directing traffic to alternate routes
		.9	Maintaining lines until emergency is ended or until properly relieved
		.10	Assisting traffic in returning to normal flow
8.	Guard property	8.1	Preventing looting
		.2	Keeping unauthorized persons away
		.3	Issuing receipt for found property to finder
		.4	Turning in found property to property officer
		.5	Determining and identifying owner
		.6	Recording information learned
		.7	Until properly relieved

17005

Training Procedure No. 17

UNLAWFUL GATHERING, HANDLING

INTRODUCTORY INFORMATION:

The beat officer will occasionally be called upon to handle various types of public gatherings. These assignments may range from school-aged children playing in the street, to thousands of adults rioting in a community. A riotous mob is an example of what a community would be like without law enforcement services. The law exists prohibiting such conduct; but it is not effective without the officer's enforcement.

Any public gathering is a potentially explosive situation. Unfortunately it is extremely difficult to determine who or what will light the fuse. Certain elements that are clues to a potential mob or riot can be detected. When these are recognized and handled it may well be that a potentially explosive situation can be controlled.

EQUIPMENT NEEDED:

Baton, Riot
Form, Field Interrogation Report
Form, Preliminary Investigation Report
Form, Request to Disperse
Gas Masks
Grenades, Tear Gas
Helmet, Safety
Riot Statute, Prepared Copy in Pocket Notebook
Shotgun, Riot

GENERAL SAFETY PRACTICES:

Be calm, firm, and objective
Concentrate on dispersal
Maintain vigilance
Wearing safety helmet properly secured at all times
Watch for objects thrown from behind front ranks of gathering
Avoid encirclement
Maintain position in formations
Guard officers and other departmental equipment
Riot equipment must be in good order
Remove wrist watch, badges, glasses, and neckties

17006

126/

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
1. Receive assignment and information	1.1	From dispatcher
	.2	Acknowledging call immediately
	.3	Identifying unit and giving location
	.4	Stopping patrol car before writing
	.5	Recording on patrol car desk pad:
	.1	Location of scene
	.2	Type of offense
	.3	Person to be contacted
	.4	Time received
	.6	Noting situation at scene
	.7	Noting actual or potential hazards to persons involved
	.8	Noting estimated number of persons involved
	.9	Noting kind and number of weapons involved
	.10	Noting personal hazards
	.11	Noting avenues of approach
	.12	Understanding assignment
	.13	Requesting required information
	.14	Repeating location of scene for verification by dispatcher
2. Proceed to scene area	2.1	Quickly as possible
	.2	Driving safely
	.3	Using most expeditious route
	.4	Considering avenues of approach
	.5	Using patrol car beacon and/or siren--as required
	.6	Planning operations within known information
	.7	Notifying dispatcher of personal knowledge
	.8	Observing traffic problems in vicinity of scene
	.9	Stopping patrol car at selected vantage point
	.10	Allowing avenues of escape for crowd
	.11	Turning off patrol car beacon and stopping siren

17007

Assignment

WS. 64. Box: Refer to Illustration Sheet 32, page 113. Make a "development" or pattern of the box showing necessary hems and laps. Make your pattern full size. Dimension your drawing. Letter-in your title strip. After your drawing has been graded, your teacher may want you to cut out the pattern and fold it to make the box. Fold the hems to the outside of the box. Use drafting tape to hold the sides and ends together. Show the completed box to the instructor.

WS. 65. Parts Tray: Refer to Illustration Sheet 32, page 113. Make a "development" or pattern of the sheet metal part of the parts tray showing necessary hems and laps. Make your pattern full size. Dimension your drawing. Letter-in your title strip. After your drawing has been graded, your teacher may want you to cut out the pattern and fold it to make the parts tray. Fold the hems to the outside of the tray. Use drafting tape to hold the sides and ends together. Show the completed tray to the instructor.

WS. 66. Cup: Refer to Illustration Sheet 32, page 113. Make a pattern of the body, bottom, and handle of the cup showing necessary hems and laps. Make your pattern full size. On a piece of practice paper, design your own curves for the handle. To find the length of the handle when it is stretched out flat, measure it in small units such as $\frac{1}{4}$" so that the stretch-out will be more accurate. The handle on the sketch tapers from 3/4" at the large end to 1/4" at

STEPS		KEY POINTS	
3.	Observe scene and situation	3.1	From selected vantage point
		.2	Keeping out of sight
		.3	Keeping calm
		.4	Gathering information
		.5	Determining personal safety
		.6	Determining mood and state of gathering
		.7	Noting type and direction of movement
		.8	Scanning group for weapons or potential weapons
		.9	Scanning area for avenue of departure for crowd
		.10	Identifying leaders
		.11	Noting offenses and identifying perpetrators
		.12	Determining future action
4.	Request assistance	4.1	As required
		.2	Using radio
		.3	Notifying dispatcher of:
		.1	Situation at scene
		.2	Number of persons involved
		.3	Weapons being or liable to be used
		.4	Asking that supervisor be sent
		.5	Designating sufficient personnel, weapons, and equipment to insure success
		.6	Designating assembly point
		.7	Designating routes of approach
		.8	To photograph for other units, scene and participants
5.	Plan tactics	5.1	With supervisor, dispatcher, and assisting personnel
		.2	Selecting avenues of officer's approach and escape for crowd
		.3	Selecting formations (See App. 28, 29, 30, 31)
		.4	Designating positions, weapons, and equipment

17008

STEPS		KEY POINTS
	.5	Assigning duties
	.6	Assigning guard to law enforcement agency's equipment
	.7	Selecting method of handling prisoners and injured
	.8	For removing cause of dissension
6. Request dispersal	6.1	From discreet distance
	.2	Protecting speaker
	.3	Keeping calm
	.4	Maintaining military bearing
	.5	Remaining courteous but firm
	.6	Speaking in conversational and understandable tone
	.7	Request cooperation (See Appendix 32)
	.8	Explaining reasons for request
	.9	Avoiding arguments
	.10	Thanking participants for cooperation
	.11	Notifying gathering of:
	.1	Actual and potential offenses
	.2	Possible injury
	.3	Allotted time and avenues of departure
	.12	Using loudspeaker to insure hearing
7. Order dispersal	7.1	At end of allotted time
	.2	Keeping calm
	.3	According to law (See Appendix 33)
	.4	Identifying self as a law enforcement officer, by name and agency
	.5	Reading the riot statute
	.1	Placing an officer on opposite perimeter of assembly to test and insure hearing
	.6	Designating time alloted for compliance

17009

	STEPS		KEY POINTS
8.	Approach assembly	8.1	At expiration of allotted time
		.2	To physically disperse crowd
		.3	Removing wrist watch, shoulder strap, glasses, tie, and badges
		.4	Wearing prescribed equipment
		.5	Carry prescribed weapons
		.6	Fearlessly
		.7	Keeping calm
		.8	In prescribed formation
		.9	Maintaining position in formation
		.10	Advancing at slow, steady pace
		.11	Avoiding conversation
		.12	Listening for commands
		.13	Being alert to potential hazards
		.14	Using peripheral vision
		.15	Watching for objects thrown from behind front ranks of assembly
		.16	Executing orders with snap, confidence, and precision
		.17	Caring for injured officers
9.	Arrest violators	9.1	Objectively and impartially
		.2	Selecting leaders and agitators
		.3	Removing them quickly from view and scene
		.4	Protecting arresting officers
		.5	Guarding against escape or liberation attempts
		.6	Gathering physical evidence
		.7	Protecting weapons and/or evidence
		.8	Using only necessary force
10.	Follow-up	10.1	To prevent recurrence
		.2	Gathering information and evidence for reports and prosecution
		.3	Determining cause, instigators, and method of operation
		.4	Identifying participants
		.5	Breaking up large segments into ever smaller groups

17010

STEPS		KEY POINTS	
11.	Submit reports	11.1	Completing Preliminary Investigation Report Form
		.2	At headquarters
		.3	To supervisor
		.4	Recording injury to persons and damage to property

17011

Training Procedure No. 18

TRAFFIC CONGESTION, HANDLING

INTRODUCTORY INFORMATION:

The motoring public expects to travel the trafficways with a minimum of interruption. Should an interruption occur it usually creates an irritated driver. The irritated driver can easily become an accident going somewhere to happen.

An officer handling traffic congestion can and must rapidly and effectively restore traffic to its normal flow. This is best accomplished by identifying the problem and correcting it. A system of distinct gestures and signals make drivers respond, thereby, providing for a minimum of interruption which the motoring public appreciates.

EQUIPMENT NEEDED:

Whistle, Traffic
*Baton, Traffic, Red
*Flashlight, Clear lens
Gloves, White or Yellow Cloth

* To be used at night

GENERAL SAFETY PRACTICES:

Being constantly alert to moving traffic and pedestrians
Always selecting best position to see and to be seen
Using Traffic Baton at night or during adverse weather conditions

	STEPS		KEY POINTS
1.	Observe scene and situation	1.1	After parking properly
		.2	Selecting safe position while standing or walking
		.3	Quickly scanning area to determine:
		.1	Cause of congestion
		.2	Urgent matters requiring immediate action
		.3	Course of Action
2.	Relieve cause of congestion	2.1	Taking action to:
		.1	Remove obstruction
		.2	Effect temporary or permanent repairs
		.2	Route traffic around cause temporarily

17012

STEPS		KEY POINTS	
		.3	Replace signal control with officer control
3.	Direct traffic	3.1	Before or after relieving cause
		.2	Selecting officer control point: (See Appendix 34)
		.1	Safest
		.2	Clearly seen
		.3	BEING CONSTANTLY ALERT TO MOVING VEHICLES AND PEDESTRIANS
a.	Assume ready position	a.1	Standing erect
		.2	Keeping feet 8" to 10" apart
		.3	Letting arms hang naturally
		.4	Balancing weight on both feet
		.5	Having traffic whistle ready
b.	Start traffic using hand gesture	b.1	Standing parallel or at slight angle to traffic
		.2	Attracting drivers attention by:
		.1	Pointing index finger at driver from shoulder height
		.2	Blowing two (2) short blasts of traffic whistle only if necessary
		.3	Turning wrist so palm is up after pointing
		.4	Using elbow as pivot point
		.5	Swinging forearm in an upward arc
		.6	Bringing hand to position in front of chin, palm down, forearm parallel to ground
		.7	Repeating if driver does not respond

17013

STEPS	KEY POINTS
	.8 Making movement of arm deliberate
c. Start traffic using traffic baton 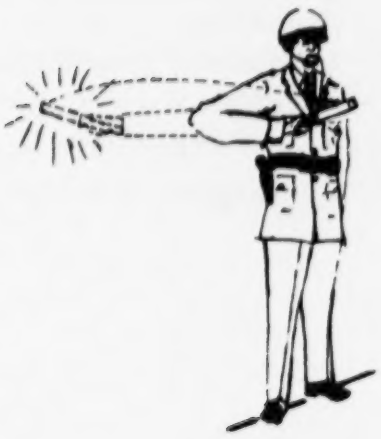	c.1 Positioning body at slight angle facing traffic .2 Pointing traffic baton at driver from shoulder height .3 Using elbow for pivot .4 Arcing traffic baton upward and across to front of body
d. Stop traffic using hand gesture	d.1 Standing parallel to moving traffic .2 Looking right and left carefully .3 Thrusting one arm or both upward so hands are slightly above head .4 Palm (s) facing approaching traffic fingers joined .5 Repeating for stopping traffic in all directions
e. Stop traffic using Traffic Baton	e.1 Facing traffic to be stopped .2 Keeping firm grip on traffic baton with strong hand .3 Upper arm parallel to ground .4 Forearm vertical to ground .5 Arc baton across body. slightly above head, from shoulder to shoulder

17014

STEPS	KEY POINTS
f. Turn traffic using hand gesture	f.1 Stopping opposing traffic .2 Moving back towards stopped traffic .3 Allowing room in front of you for turn .4 Keeping arm and hand at stop gesture .5 Using free arm and hand to point at driver to make turn .6 Lower arm in arc across body .7 Pointing in direction of turn

g. Turn traffic using traffic baton	g.1 Stop opposing traffic (see Step 3e.) .2 Reposition body at slight angle facing traffic to turn .3 Point traffic baton at driver from shoulder height .4 Use straight arm motion .5 Arc baton downward, about stomach height .6 Point to area driver will turn to

17015

STEPS		KEY POINTS
	.2	Accurately after understanding question
	.3	Referring to proper authority or agency if answer is not known
	.4	Giving directions most easily understood
	.5	Saying "I don't know but will find out for you" or "help you to find the answer"
	.6	Following up answer by showing the way, according to departmental policy
	.7	Refraining from selling a person, place or thing.

17017

the small end. Dimension your drawing. Letter-in the title strip. After your drawing has been graded, your teacher may want you to cut out the patterns and fold them to make the cup. Use drafting tape to hold the parts together. Show the completed cup to the instructor.

WS. 67. Scoop: Refer to Illustration Sheet 32, page 113. Make patterns of the body and handle of the scoop showing necessary hems and laps. Make the pattern full size. On a piece of practice paper, design your own curves for the handle. To find the length of the handle when it is stretched out flat, measure it in small units such as $\frac{1}{4}$" so that the stretch-out will be more accurate. Dimension your drawing. Letter-in your title strip. After your drawing has been graded, your teacher may want you to cut out the patterns and fold them to make the scoop. Use drafting tape to hold the parts together. Show the completed scoop to the instructor.

WS. 68. Funnel: Refer to Illustration Sheet 33, page 115. Make a front view of the funnel as shown on the Illustration Sheet. Use this front view to obtain your measurements and make patterns of the two parts of the funnel, showing necessary hems and laps. Make the drawing full size. Dimension your drawing. Letter-in the title strip. After your drawing has been graded, your teacher may want you to cut out the patterns and tape them together to make the funnel. Show the completed scoop to the instructor.

Training Procedure No. 20

MENTALLY ILL PERSON, HANDLING

INTRODUCTORY INFORMATION:

Mentally ill persons come to the attention of law enforcement officers usually because of their actions. Their behavior is unpredictable. The officer handling the situation acts accordingly but must resort to persuasion first. A technique to handle various behavioral patterns must be devised by the officer. This is not an easy task. Duty requires that the public be protected, at the same time the officer must safeguard his own life while also treating the mentally ill person as being sick. The technique which provides for the greatest margin of safety to all concerned, and assures the safe arrival of the mentally ill person at the designated facility, is the one officers must strive towards.

An officer can help himself in becoming better equipped to handle mentally ill persons by acquiring a knowledge of the various types of mental illness. Mental and physical action or reaction vary with type and person. A better understanding of mentally ill persons may provide the officer with the necessary forewarning to successfully accomplish handling the task.

EQUIPMENT NEEDED:

Restraint device (commercial) (See Appendix 39)

GENERAL SAFETY PRACTICES:

Be constantly alert
Notify dispatcher and give exact location when leaving patrol car
Approach all persons and things with caution
Isolate person or re-position potential weapons
Be careful to use only necessary amount of force to bring person under control
Use appropriate restraint device for mentally ill

	STEPS		KEY POINTS
1.	Receive assignment and information	1.1	From dispatcher
		.2	From supervisor
		.3	From observation, notifying dispatcher or supervisor
		.4	Recording on patrol car desk pad:
		.1	Date and time received or observed
		.2	Location

17018

	STEPS		KEY POINTS
		.3	Person to be contacted or complainant and address
		.5	Requesting repeat of information not understood
2.	Proceed to scene	2.1	Arranging for pick-up of restraint equipment
		.2	Driving safely
		.3	Avoiding use of red light and siren unless otherwise instructed
		.4	Planning personal operations from known information
3.	Arrive at scene	3.1	Selecting parking place
		.2	Parking properly
		.3	Giving dispatcher exact location
		.4	Signalling "out-of-service"
		.5	Recording time of arrival
		.6	Removing ignition key
		.7	Taking required equipment
		.8	Carrying restraint equipment in weak hand behind back
		.9	Entering all premises with caution
		.10	Approaching all persons and things with caution
4.	Observe scene and situation	4.1	From a selected safe location
		.2	Noting:
		.1	Actions of mentally ill person and others
		.2	Potential weapons
		.3	Exits
		.4	Conversation (s)
		.3	Determining and calling for assistance, as required
		.4	Planning future action
		.5	Watching mentally ill person constantly

17019

STEPS		KEY POINTS
	.6	Taking immediate action to protect life or preserve the peace
5. Gather information	5.1	To assist in planning approach
	.2	Watching mentally ill person constantly
	.3	Talking to:
	.1	Persons present
	.2	Relatives or friends having personal knowledge
	.3	Mentally ill person
	.4	Using gentle voice and calm approach
	.5	Avoiding controversy
	.6	Finding out who-what-when-where-how and why
	.7	Determining, when possible if physical injury or illness is cause of mental illness
	.8	Requesting person (s) not involved to leave
	.9	Keeping strong hand side (weapon side) away from person being spoken to
	.10	Isolating mentally ill person from:
	.1	Potential weapons
	.2	Exits
	.3	Other persons, as appropriate
6. Take into custody	6.1	Searching for weapons
	.2	Using gathered information to plan approach
	.3	Having assistance from female officer or trusted adult woman for females
	.4	Using restraining devices as needed
	.5	PERSUASION FIRST - FORCE LAST

17020

LAW ENFORCEMENT OFFICER TRAINING

STEPS	KEY POINTS
a. Persuasion	a.1 Approaching slowly, cautiously and calmly
	.2 Taking position out of arm and leg reach
	.3 Using gentle voice
	.4 Watching constantly
	.5 Avoiding sudden movements
	.6 Assuring person you will help
	.7 Answering questions honestly
	.8 Ignoring insults, profanity, or actions, that will not do bodily harm
	.9 Refraining from use of words such as, hospital, crazy, nuts, looney, etc.
	.10 Requesting that he or she accompany you
	.11 Showing kindness and understanding
	.12 Keeping restraining device out of sight
b. Force	b.1 Using ONLY that amount necessary to bring person under control
	.2 Maneuvering person into best position to apply physical restraint
	.3 Using take down hold (See Appendices 35, 36, 37, 38)
	.4 Securing with restraining device (See Appendix 38)
	.5 Handcuffing as a last resort or until able to get appropriate restraint device
	.6 Using blankets, sheets, rugs, stretchers to hold violent persons
	.7 Indicating type of physical action used and reason on appropriate report form

17021

	STEPS		KEY POINTS
7.	Remove mentally ill person from scene	7.1	After searching for weapons
		.2	Transporting to appropriate facility or authority
		.3	Placing person in safest location in vehicle:
		.1	Front seat when alone
		.2	Rear seat if safety screen provided
		.3	Right rear seat next to brother officer if accompanied
		.4	Requesting relative or friend who is trusted by mentally ill person to accompany you if alone
		.5	Removing purse and spike heeled shoes from females
		.6	Having sedative administered by doctor when person is violent and great distance to be traveled
		.7	Keeping constantly alert against personal attack
8.	Process person	8.1	Watching person constantly
		.2	Being careful when alighting from patrol car
		.3	Holding or watching, as appropriate, person after removal from patrol car
		.4	Escorting to proper authority:
		.1	Committing magistrate
		.2	Admitting office of appropriate facility
		.5	Detaining at jail facility only as last resort or according to departmental procedure
		.6	Transporting to facility designated by magistrate
		.7	Following procedures of facility
		.8	Having necessary commitment or admission papers, as required
		.9	Providing information and signing forms as appropriate

17022

STEPS		KEY POINTS
	.10	Acquiring necessary forms for return to department or committing magistrate
	.11	Accompanying attendant to assist, as needed
	.12	Recording all personal property removed
	.13	Having person removing property, sign list
9. Submit reports	9.1	To supervisor as required
	.2	Before going off duty
	.3	Including all required documents and information

17023

Training Procedure No. 21

THE SERVICE AND RETURN OF COURT DOCUMENTS, HANDLING

INTRODUCTORY INFORMATION:

The courts in order to function in accordance with our system of jurisprudence use various documents. These documents either notify or have brought before the court persons or things for the purpose of administering justice.

Court documents issued for service are either criminal or civil in context. The documents are varied and the handling procedure is based on the type of document. Once the document is drawn by the court it then, usually, is an assignment for an officer to "serve and return" it. State statute governs the document from its inception. It also fixes responsibility and provides the penalty for improper service.

Special knowledge and certain skills are required to properly handle this assignment. When this knowledge and these skills are acquired, the officer is then better prepared to handle the assignment. Proper service reflects the efficiency of the officer and aids in the smooth functioning of the court in its administration of justice.

EQUIPMENT NEEDED:

Directory, City and/or County	Pen
Handcuffs	Pencil
Map, City and/or County	Uniform of the day
Notebook, Pocket	

GENERAL SAFETY PRACTICES:

Being certain all documents are executed in accordance with the law and departmental procedure.
Be constantly alert for potential personal hazards
Approach all persons and things with caution
Notifying dispatcher before leaving patrol car
Keeping arrestee under control and in view at all times
Constantly watching person being served document
Park properly

17024

LAW ENFORCEMENT OFFICER TRAINING

	STEPS		KEY POINTS
1.	Receive assignment and information	1.1	From supervisor or person in charge of document service
		.2	Asking if there are any special instructions
		.3	Recording date and time assignment received
2.	Identify document (s) and type of service	2.1	Criminal or civil (See App. 40)
		.2	Personal or residential service (See App. 41)
		.3	Check for:
		.1	Name of person to serve and return
		.2	Proper signature
		.3	Proper seal of court
		.4	All blanks are properly filled in
3.	Plan service	3.1	Using county or city directory, phone book and Post Office as sources for checking addresses
3.a	criminal	a.1	Gathering necessary information about person named in warrant, such as:
.1	warrant to arrest	.1.1	Name and alias if used
		.1.2	Physical description from head to toe
		.1.3	Location of arrestee:
		.1.3.1	Residence
		.1.3.2	Place of employment
		.1.3.3	Places often frequented
		.1.3.4	Relatives or friends homes
		a.2	Background information
		.2.1	Past record and arrests
		.2.2	Behaviorial pattern
		a.3	Requesting assistance as needed
		a.4	Consulting with proper authority when in doubt

17025

STEPS		KEY POINTS	
.b	civil	b.1	Selecting and arranging documents to save miles and time on the basis of:
		.1.1	Priority
		.1.2	Location to be served
		.2	Arranging for necessary assistance
4.	Execute service	4.1	After checking validity of document
		.2	According to document being served
		.3	Greeting recipient courteously
		.4	Being constantly alert to personal attack
		.5	Answering questions politely and referring to proper authority when answers not known
		.6	Using persuasion first to obtain compliance with court document, force only as last resort
		.7	Handcuffing as appropriate
.a	Personal	4.a.1	Establishing identity of recipient
		.a.2	Following instructions according to type of document, EXAMPLES:
		.a.2.1	Reading injunction clauses
		.a.2.2	Padlocking establishment
		.a.2.3	Attaching property
		.a.2.4	Collecting monies
		.a.3	Handing document to person named therein
		.a.4	Recording:
		.a.4.1	Time - E.S.T. - D.S.T. or other
		.a.4.2	Date
		.a.4.3	Place if different than address listed
		.a.5	Selecting safe place to stand
		.a.6	Avoiding legal advice

17026

STEPS		KEY POINTS	
.b	Residential	4.b.1	Establishing if person named actually resides at the address listed on document, by:
		.b.1.1	Checking with neighbors
		.b.1.2	Checking with person answering door
		.b.2	Recording data according to State Statute and departmental procedure
5.	Record and return data	5.1	According to State Statute and departmental procedure
		.2	Including:
		.1	Date served
		.2	Time served
		.3	Address (if different)
		.4	Mileage
		.5	Service by whom
		.3	Returning all information and records to appropriate person
		.4	Including information useful to department

17027

WS. 69. Copper Tray: Refer to Illustration Sheet 34, page 117. Some suggested designs are given for shapes often used in copper trays. Lay out on your Work Sheet, spaces for four trays. Make your own design for each of the trays and draw them on the shapes you have selected. Make sketches and have them approved before making your final drawing.

Training Procedure No. 22

CRIME PREVENTION PROCEDURES, HANDLING

INTRODUCTORY INFORMATION:

A fundamental objective of every police agency is that of crime prevention. The procedures developed, adopted, and implemented to attain this objective helps to partially contain the crime problem facing our nation. Crime has shown an insidiously steady increase down through the years. Combating it is a tremendous task requiring the efforts and resources of all persons. However, the law enforcement officer is directly charged with this task. Subsequently, the aid of persons and things, enlisted by the officer, will contribute substantially to making his task a little easier. Education of the public in safeguarding each other and their property by reporting any incident which may be criminal will contribute most to this combat. Therefore, it can be readily noted that ach officer must strive to convince the public, that law enforcement is concerned with their welfare and property. Furthermore, that through cooperation, life, liberty, and the pursuit of happiness will have more meaning. The criminal element of our society will soon realize that total war has been declared, when crime prevention procedures are employed by the public as advocated by law enforcement.

EQUIPMENT NEEDED:

Brochures, pamphlets, etc., crime prevention techniques (see App. 42)
Card, Business (officers)
Log, Field Notebook
Report, Security Survey
Report, Unoccupied Home

GENERAL SAFETY PRACTICES:

Be certain that information is offered only to reputable persons

Making certain any quotes of the law are correct and clearly understood

17028

LAW ENFORCEMENT OFFICER TRAINING

	STEPS		KEY POINTS
1.	Learn techniques (See App. 42)	1.1	Studying specific crime and literature concerning it
		.2	Devising ways and means of preventing or deterring the criminal act
		.3	Referring to the law to substantiate technique for prevention
		.4	Utilizing all available resources for already prepared materials (See App. 42)
		.5	Committing technique to memory or recording step-by-step procedure
		.6	Discussing with brother officer (s)
2.	Approach person (s)	2.1	Greeting courteously
		.2	Speaking confidently
		.3	Explaining "why" you're there
		.4	Offering to meet with them another time if too busy
		.5	Determining their interest by questioning
		.6	Allowing person to offer their views
3.	Advocate technique	3.1	According to departmental procedure
		.2	After obtaining necessary clearance from supervisor
		.3	Offering ONLY to reputable persons
		.4	Motivating person to want to participate
		.5	Including detailed discussion so that it is clearly understood

17029

STEPS		KEY POINTS
	.6	Including any civil or physical dangers involved.
	.7	Learning necessary printed information, material, etc.
	.8	Recording name, address, telephone number, of person, date contacted and technique advised.
	.9	Using appropriate departmental forms.
4. Follow-up	4.1	Returning periodically to person advised.
	.2	Advising of any new ideas or changes in technique.
	.3	Checking on any items that may need replacement.

17030

Training Procedure No. 23

SUSPICIOUS PERSONS, HANDLING

INTRODUCTORY INFORMATION:

Prevention of crime is one of the primary responsibilities facing a law enforcement officer. Ideally, the lack of crime on the beat is the goal towards which the officer strives. One of the yardsticks of measuring an officer's ability in patrolling is the incidence of crime on his beat.

A method of suppressing crime on the beat is to handle suspicious persons. Many times the so called "routine stop" will deter the commission of a criminal act. However, it must be remembered that the individual enjoys the freedom of coming and going as he chooses. The determination of whether the individual is suspicious or not is critical. It must be based on sound procedure from the standpoints of legality and personal safety.

EQUIPMENT NEEDED:

Flashlight
Notebook, Field
Pen, Ballpoint
Pencil, Mechanical
Report, Persons (See App. 44)

GENERAL SAFETY PRACTICES:

Assume defensive stance while talking
Keep alert to movements of person
Keep hands free
Watch for associates

17031 152/

LAW ENFORCEMENT OFFICER TRAINING

STEPS		KEY POINTS
1. Approach person	1.1	As soon as possible
	.2	Unfastening holster flap or strap
	.3	Scanning area
	.4	Selecting spot for interview
	.5	Moving in from rear and/or side
	.6	Constantly watching for movements
	.7	Using peripheral vision to detect approach of associate
	.8	Using available cover to protect back or side
	.9	Watching for objects person may discard
	.10	Noting:
	.1	Dress, for identification
	.2	Physical and mental condition
	.3	Personal physical characteristics
2. Stop person	2.1	Addressing courteously as "Sir" or "Ma'am"
	.2	Stating "I would like to talk to you"
	.3	Using only enough voice volume to be heard
	.4	Standing to the right of and slightly sideways
	.5	Keeping out of arms or legs reach
	.6	Assuming defensive stance
	.7	Isolating person by moving to doorway, around corner, etc.
	.8	Identifying self by rank, name, and department
	.9	Explaining "I would like you to identify yourself"
	.1	Requesting person verbally give name, address, also to spell name
	.2	Asking for identification documents
	.3	Noting any discrepancies from verbal to document
	.10	Keeping constantly alert to personal attack
	.11	Noting any unusual appearance or action

17032

STEPS		KEY POINTS
	.12	Having person assume spread-eagle position against vertical surface if dangerous or known felon
3. Question person	3.1	Politely
	.2	Determining:
	.1	Why person is in area
	.2	Method of travel: walking, riding
	.3	How long in area
	.4	Coming from where and going where
	.5	Employed by whom and where
	.3	Maintaining defensive stance
	.4	Keeping hands free
	.5	Obtaining character check from dispatcher, as appropriate at the time
4. Record information	4.1	After or during interview, as appropriate
	.2	Being certain all information on Persons Report is obtained
	.3	Using form contained in field notebook when necessary
	.4	Location of interview including date, time, day of week
	.5	Using notebook log if satisfied person is law abiding
5. Submit report (s)	5.1	To supervisor
	.2	Using supplemental report for further explanation
	.3	Being certain reports are detailed and correct

17033

Training Procedure No. 24

DEAD ON ARRIVAL, HANDLING

INTRODUCTORY INFORMATION:

Death reported to a law enforcement agency must be investigated. The handling of a death by an officer is a task that leaves no margin for error. There are facts and determinations to be made that will present a serious challenge to the officer's ability to reconstruct what happened. The officer shall investigate by patient inquiry, observation and examination. Facts surrounding any death must be ascertained and oftentimes further corroborated by the coroner and/or a pathologist before it is listed in one of the following categories of death: Natural causes, accidental, suicide or homicide.

EQUIPMENT NEEDED:

Bags, Evidence
Camera
Clipboard
Compass
Containers
Crayon, Marking (yellow lumber)
Flashlight
Handcuffs
Knife, pocket
Notebook (with forms)
Paper, graph
Pen, Ballpoint
Pencil, Mechanical
Ruler
Tape 100' - Metal Reinforced cloth
Tape 10' - White Surface Spring steel tape

GENERAL SAFETY PRACTICES:

Be calm
Be constantly alert for personal hazards
Keep dispatcher properly informed
Be sure that you understand and are understood

STEPS		KEY POINTS
1. Receive assignment and information	1.1	From dispatcher
	.2	Acknowledging call immediately
	.3	Identifying unit and give location
	.4	From citizen, notifying dispatcher
	.5	Stopping patrol car before writing
	.6	Recording on patrol car desk pad:
	.1	Time call received
	.2	Location of scene
	.3	Person to be contacted and/or complainant and address
	.7	Requesting additional information

17034

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STEPS		KEY POINTS
	.8	Repeating location of scene for verification by dispatcher
	.9	Acknowledge receipt of transmission
2. Proceed to scene	2.1	Immediately
	.2	Driving safely
	.3	Using most expeditious route
	.4	Using beacon light and siren as instructed
	.5	Planning personal operations based on known information
	.6	Watching for persons or vehicle fleeing scene
3. Arrive at scene	3.1	Park properly
	.2	Identifying cars parked near the scene-record license number (s)
	.3	Giving dispatcher exact location
	.4	Signaling dispatcher "Out of Service"
	.5	Recording time of arrival
	.6	Removing ignition key from patrol car
	.7	Taking required equipment
	.8	Unfastening holster flap
	.9	Alighting from patrol car with caution
	.10	Locking patrol car, as appropriate
	.11	Approaching and entering scene with caution
	.12	Being alert to personal safety hazards
	.13	Requesting everyone to remain at scene
	.14	Identifying self if in plain clothes
	.15	Determining if medical help has been summoned

17035

	STEPS		KEY POINTS
4.	Observe scene and situation	4.1	Appearing and keeping calm
		.2	Noting:
		.1	Unusual conditions or activities in area
		.2	Physical and mental condition of persons present
		.3	Weapons in the area
		.4	Being alert to conversations
		.5	Determining course of action
5.	Take action	5.1	Determining if victim is apparently dead:
		.1	Feeling for pulse or heart beat
		.2	Observe for breathing
		.3	Looking for obvious apparent cause of death
		.2	Remembering to preserve the scene
		.3	Summoning Coroner:
		.1	By notifying Dispatcher
		.1	By radio
		.2	By public service
		.3	Selecting person to call dispatcher
		.4	Standing by till coroner arrives, if death appears natural
		.5	Arresting perpetrator if on scene and evidence warrants
		.6	Continuing action if death appears unnatural continue action by:
		.1	Photographing scene
		.2	Sketching scene
		.3	Collecting and preserving evidence
		.4	Interviewing persons at scene
		.5	Requesting bystanders to leave
		.6	Recording data about witnesses
		.7	Requesting witnesses to write account of incident

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	STEPS		KEY POINTS
6.	Follow-up	6.1	Completing unfinished details
		6.1.1	Being certain next of kin has been notified
		.2	Locating and arresting perpetrator after warrant issued
		.3	Gathering additional facts
		.4	Leads furnished or discovered
		.5	Recording exact cause learned from coroner or pathologist, as appropriate
7.	Submit reports	7.1	According to departmental procedure
		.2	To supervisor
		.3	Including all pertinent information
		.4	Using Report of Death form (See App. 46)
		.5	Editing and reviewing before submitting

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Training Procedure No. 25

EMERGENCY CARE - FIRST AID

INTRODUCTORY INFORMATION:

A law enforcement officer administers emergency care usually because he is the first person of authority to arrive at the scene. The officer should be able to give proper care until such time as professional medical help is acquired.

Emergency care procedures require special skills, techniques and knowledge. When these are learned and practiced the officer in certain instances may be able to restore breathing or heart beat, check the loss of blood and prevent shock. The saving of a human life by an officer administering proper care will win the admiration of all concerned.

EQUIPMENT NEEDED:

Blankets
First aid kit
Tourniquets
Compresses
Airways (infant and adult)

GENERAL SAFETY PRACTICES:

Keep calm
Be alert for potential personal hazards.

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LAW ENFORCEMENT OFFICER TRAINING

CONTROL OF BLEEDING

STEPS		KEY POINTS
1. Examine injured person	1.1	Look for obvious bleeding
	.2	Check for blood stains on clothing
2. Identify type of bleeding	2.	Each type of bleeding has symptoms which identify the type
a. Arterial	2.a.1	Blood spurting
	a.2	Bright red in color
b. Venous	b.1	Blood flows steadily from wound
	b.2	Dark red in color
c. Capillary	c.1	Blood oozes from wound
3. Stop Bleeding	3.a.1	Select pressure point between heart and wound
a. Arterial digital pressure	a.2	Exert pressure with fingers or on one of the following pressure points as appropriate to location of bleeding:
	3.a.2.1	Temporal
	2.2	Facial
	2.3	Carotid
	.4	Subclavian
	.5	Axillary
	.6	Brachial
	.7	Brachial at bend of elbow
	.8	Radial and ulnar
	.9	Femoral - groin (heel of hand)
	.10	Femoral - thigh
	.11	Popliteal - back of knee

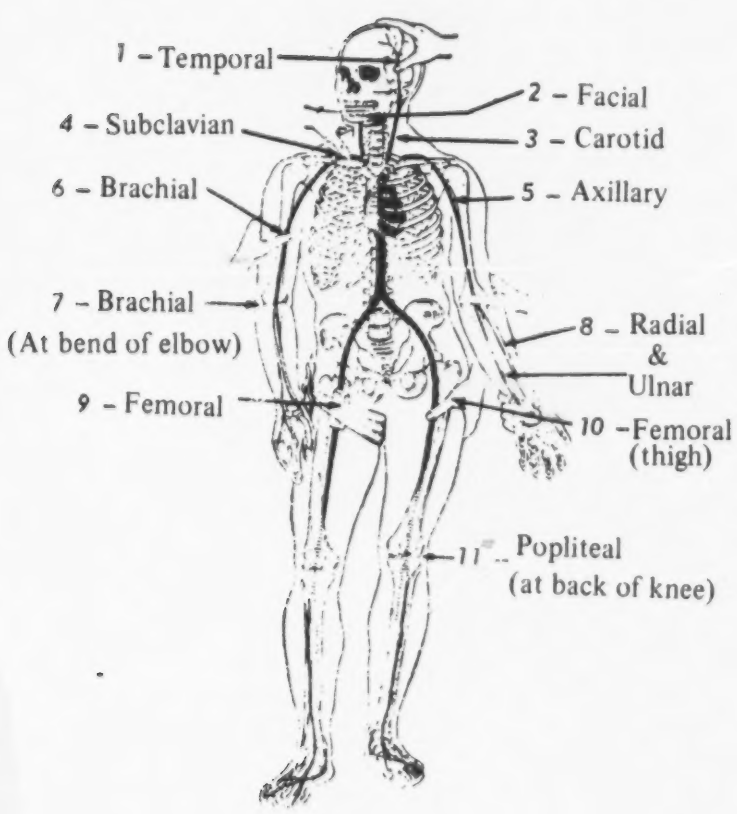

FIGURE 1
Course of Arteries: Pressure Points

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LAW ENFORCEMENT OFFICER TRAINING

CONTROL OF BLEEDING

STEPS		KEY POINTS	
3.b	Direct arterial compress pressure	3.b.1	Use sterile compress if available
		.2	Use clean folded cloth if compress is not available
		.3	Place directly over wound
		.4	Apply pressure with hand or tie compress over wound
		.5	Exceptions -- not over fractures, eyes, nose or mouth
3.c	Apply tourniquet (only as last resort)	3.c	Any of the following:
		c.1	Neckties
		c.2	Belts
		.3	Handkerchiefs
		.4	Towels
		.5	Suspenders
		.6	Rubber tubing
		.7	Commercial
		.8	Other
		3.c.2	Encircle arm or leg with tourniquet at pressure point
		.3	Place hard pad or object of suitable size over the artery at pressure point
		.4	Apply pressure by tightening tourniquet
		.5	Once tourniquet is applied and tightened it should not be loosened or removed until victim is under proper medical care
		.6	Tag victim indicating a tourniquet has been applied, time and place of tourniquet
4.	Venous Bleeding		
	a. Direct pressure	4.a.1	Use sterile compress if available
		.2	Use cleanest cloth available
		.3	Place directly over wound
		.4	Apply pressure with hand or tie knot directly over wound

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LAW ENFORCEMENT OFFICER TRAINING

CONTROL OF BLEEDING

STEPS	KEY POINTS
b. Elevation	4.b.1 Elevate injured portion of body by placing rolled blanket or any article at hand under head, arm or leg depending on location of injury
c. Cold applications	4.c.1 Apply to body in region of injury .2 Not into the wound .3a Use ice bag if available .b Cold pack - commercial item, comes in plastic bag that when squeezed causes chemicals to mix and bag becomes cold .c Cloth soaked in cold water .d Any cold object - metal, etc., wrapped in cloth

17041

LAW ENFORCEMENT OFFICER TRAINING

PHYSICAL SHOCK

STEPS		KEY POINTS
1. Look for symptoms of shock	1.1	Face pale, with anxious or dull expression
	.2	Eyelids droop if open; eyes are dull and pupils dilated
	.3	Patient may be partly or totally unconscious
	.4	Skin is cold and covered with clammy sweat, particularly hands and forehead
	.5	Patient feels cold and may have a chill; temperature subnormal
	.6	Pulse is weak and rapid
	.7	Breathing is shallow and may be irregular
	.8	Patient is stupid and takes little interest in things about him
	.9	If internal bleeding is present, patient will be restless; if conscious, he complains of clouded vision, dizziness and thirst
	.10	He may answer questions slowly or apparently fail to understand
	.11	Nausea and vomiting often occur
2. Treat usual form of shock	2.1	Position victim:
	.1.1	Place victim in a comfortable position
	.2	Lying down if possible
	.3	Head level with rest of body
	.4	Elevate feet of victim
	.5	Remove all foreign bodies from the victim's mouth, false teeth, gum, etc.
	.6	Loosen tight clothing from neck, chest and waist

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STEPS	KEY POINTS
	2.2 Conserve body heat: .1 Cover victim with blanket or other material, placing blanket under victim as well as over him
	2.3.1 Use stimulants: .1 Aromatic spirits of ammonia .2 Coffee or tea if possible and victim is conscious .3 Oxygen if available
2.a Skull fracture or hemorrhage	2.a.1 Note bleeding or swelling of: .1 Nose .2 Ears .3 Mouth .4 Eyes .5 Other part of head 2. Elevate head above level of feet 3. Apply cold compress to swelling or internal bleeding
.b Sunstroke or heat prostration	2.b.1 Examine victim by: .1 Observing to see if face is flushed .2 Feel forehead for abnormal temperature .2 Place in shade or cooler location .3 Apply cold application to body

17043

LAW ENFORCEMENT OFFICER TRAINING

MOUTH TO MOUTH RESUSCITATION

STEPS	KEY POINTS	
1. Check Breathing	1.1	Victim unconscious and not breathing
	.2	Victim gasping for breath
	.3	Choking and blocked air passage
2. Position victim	2.1	Move victim cautiously
	2.1.1	Place on back if possible,
	1.2	Turn face up
3. Clean victim's throat	3.1	Turn head to side
	.2	Insert finger(s) in mouth
	.3	Scoop matter out (see figure 1)
	.4	Grasp hard object with fingers to remove
4. Open air passage (preferred method)	4.1	Place head in sniffing position, as far back as possible so the neck is extended
	.2	Hold lower jaw up
	.3	Insert thumb between the victim's teeth and grasp the lower jaw at the midline (see figure 2)
	.4	Lift lower jaw forcefully upward so that the lower teeth are higher than upper teeth
	.5	Hold the jaw in this position as long as victim is unconscious
5. Open air passage (alternate method)	5.1	Place head in sniffing position as far back as possible so the neck is extended
	.2	With both hands grasp the angles of the lower jaw just beneath the ear lobes (see figure 3)
	.3	Lift lower jaw forcefully upward so the lower teeth are higher than the upper teeth

FIGURE 1

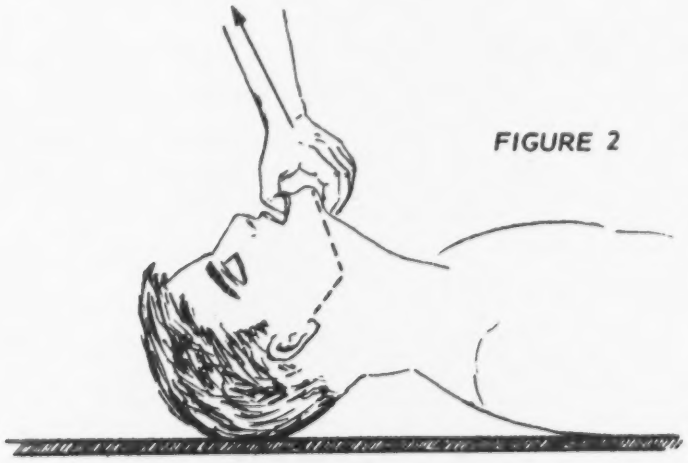

FIGURE 2

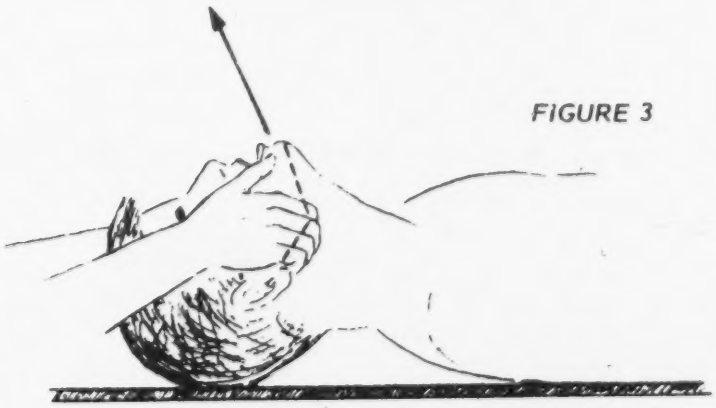

FIGURE 3

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LAW ENFORCEMENT OFFICER TRAINING

MOUTH TO MOUTH RESUSCITATION

STEPS	KEY POINTS	
	5.4	If the lips are shut, push the lower lip down gently with the thumbs, but never drop the chin
	.5	Hold the jaw in this position as long as victim is unconscious
6. Administer mouth to mouth breathing (preferred method)	6.1	Make certain the passageway is open
	.2	Squeeze nostrils shut
	.2.1	Use thumb and index finger of free hand (see figure 4)
	.3	Take a deep breath
	.4	Place your mouth over victim's mouth
	.5	Exhale your air into victim's mouth
	.6	Watch victim's chest to make certain it rises
	.6.1	Stop forcing air into victim's mouth when chest rises
	.6.2	Quickly remove your mouth and let victim exhale
	.7	Repeat inflations 15 to 20 times per minute
7. Administer mouth to mouth breathing (Method for infants)	7.1	Make certain air passageway is open
	.2	Place your mouth over victim's nose and mouth (see figure 5)
	.3	Take a shallow breath
	.4	Gently exhale air into victim's mouth
	.4.1	Be careful not to force air too hard
	.5	Repeat inflations 15 to 20 times per minute

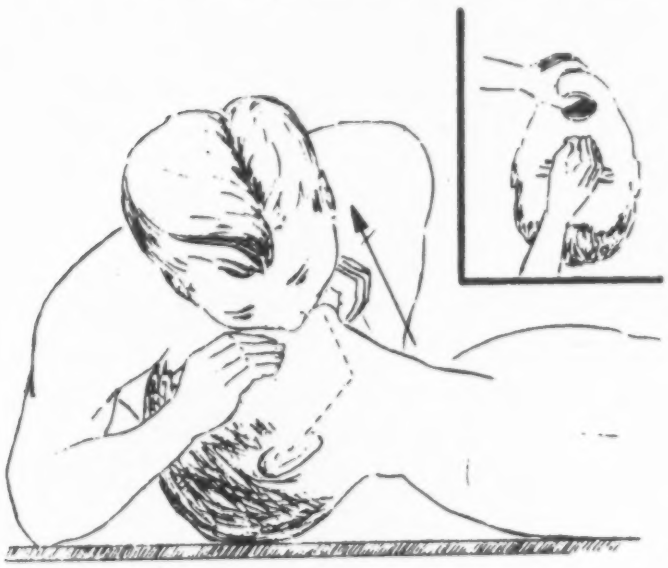

FIGURE 4

FIGURE 5

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LAW ENFORCEMENT OFFICER TRAINING

MOUTH TO MOUTH RESUSCITATION

STEPS	KEY POINTS
7.a Insert Breathing Tube	7.a.1 Infant, child or adult as appropriate (see figure 6)
	.2 Take position behind the victim's head
	.3 Tilt head back (sniffing position)
	.4 Open victim's mouth
	.5 Check mouth for any obstructions and clear
	.6 Pull tongue to lower lip with thumb and index finger and hold while inserting breathing tube
	.7 Insert breathing tube with contour following roof of mouth
	.7.1 Adult victim, long end of breathing tube
	.2 Infant or child, short end of breathing tube
	.3 Flange resting on victim's lips
	.8 Press victim's nostrils (see figure 7) together with large part of thumbs
	.9 Seal victim's mouth by pressing down on flange of breathing tube with fingers or thumbs
7.b Administer mouth to tube breathing	7.b.1 Take deep breath
	.2 Place your mouth over breathing tube
	.3 Blow your air into breathing tube
	.1 Forcefully for adults
	.2 Gently for children
	.3 Small puffs from cheeks for infants
	.4 watch for chest rise
	.5 Repeat inflations 15 to 20 times per minute

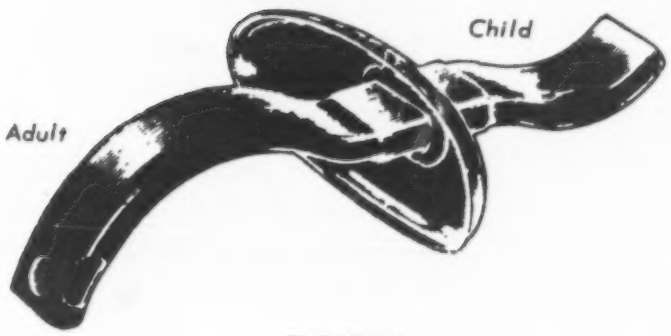

FIGURE 6

FIGURE 7

FIGURE 8

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Training Procedure No. 12

LAW ENFORCEMENT OFFICER TRAINING

CLOSED CHEST HEART COMPRESSION

STEPS	KEY POINTS
1. Examine victim	1.1 Check for breathing and/or pulse by:
	.1 Place hand on diaphragm to detect motion
	.2 Feel carotid artery on neck for pulse (see figure 1)
	2. Check pupils of eyes for dilation and reaction to light (see figure 2)
2. Position victim	2.1 Place victim on a hard surface:
	.1 Floor
	.2 Ground
	.3 Backboard if available
3. Open air passage	3.1 Place one hand under back of neck and lift
	.2 Place other hand on forehead and tilt the head backward to maintain fully extended position
4. Inflate lungs	4.1 Use mouth to mouth resuscitation (see figure 3)
	4.2 Make two or three inflations
5. Locate victim's heart	5.1 Place index finger of one hand top of chest bone. (Sternum)
	.2 Place index finger of other hand at bottom of chest bone. (Sternum)
	.3 The heart is located directly under the lower half of chest bone. (Sternum) (see figure 4)

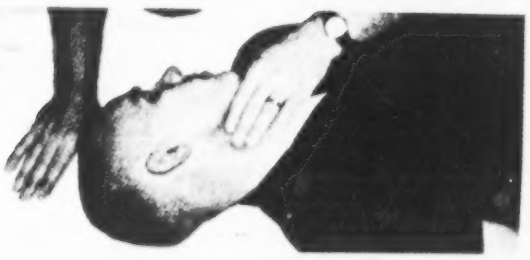

FIGURE 1

FIGURE 2
Examining for pupil action.

FIGURE 3

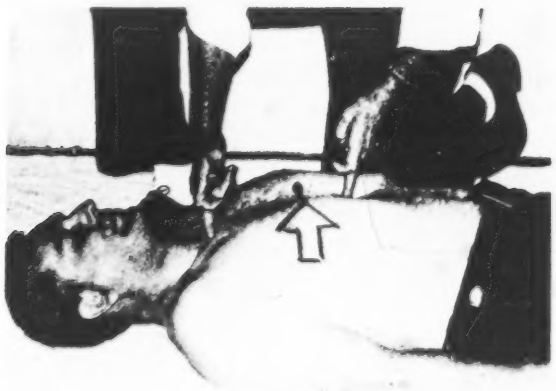

FIGURE 4
Measuring the sternum, or chest bone.

(Photos courtesy Sharon Twp. F.D., Worthington, Ohio)

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Training Procedure No. 12

LAW ENFORCEMENT OFFICER TRAINING

CLOSED CHEST HEART COMPRESSION

STEPS	KEY POINTS	
6. Position hands	6.1	Kneel beside victim
	.2	Place butt or heel of one hand on lower half of chest bone
	.3	The butt of hand should be along chest bone with fingers extending toward the ribs
	.4	Fingers should be extended up and not touching the ribs
	.5	Place second hand on top of first hand
7. Apply pressure a. one man operation	7.a.1	Position hands
	a.2	Keep elbows straight
	.3	Bend forward til shoulders are directly over hands
	.4	Use weight of upper body to exert pressure
	.5	Depress chest bone one and a half to two inches
	.6	Release pressure as soon as chest bone is depressed
	.7	Repeat 15 times
	.8	Administer two (2) mouth to mouth inflations after every 15 compressions
	.9	Maintain rate of 60 compressions per minute
b. two man operation	7.b.1	Same procedure as step 7 except one man administers mouth to mouth, the other closed chest compression
	.2	Maintain cycle of 5 compressions and 1 mouth to mouth inflation
	.3	Mouth to mouth should be started immediately during release of 5th compression

FIGURE 5
Placing the hands.

FIGURE 6

(Photos courtesy Sharon Twp. F.D., Worthington, Ohio)

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LAW ENFORCEMENT OFFICER TRAINING

CLOSED CHEST HEART COMPRESSION

STEPS	KEY POINTS
c. Infant or child	7.c.1 Same as step 7 except use one hand or finger for compression
	.2 Compress chest at rate of 80 to 100 times per minute
	.3 Maintain cycle of 5 compressions to 1 mouth to mouth inflation or 15 to 1 if alone

17049

REVIEW AND EXAMINATION GUIDE

THE EXAMINATION WILL COVER ALL THE MATERIAL INCLUDED IN THIS MANUAL .

CLASS TIME WILL BE PROVIDED FOR REVIEW. AT THAT TIME YOU ARE ENCOURAGED TO ASK ALL QUESTIONS ON ANY OF THE MATERIAL COVERED IN THIS MANUAL.

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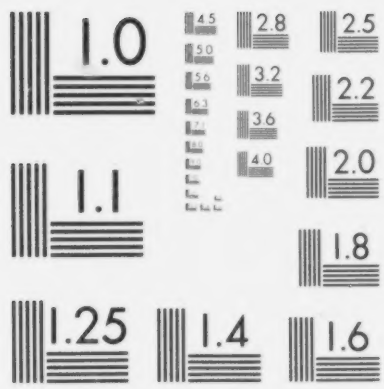

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

APPENDICES

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THE BILL OF RIGHTS

Original Ten Amendments to the Constitution with Preamble

We the people of the United States, in order to form a more perfect Union, establish justice, insure domestic tranquility, provide for the common defense, promote the general welfare, and secure the blessings of liberty to ourselves and our posterity, do ordain and establish this Constitution for the United States of America.

ARTICLE I. Freedom of Religion, Speech, and the Press; Right of Assembly and Petition. Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble, and to petition the Government for a redress of grievances.

ARTICLE II. Right to Keep and Bear Arms. A well regulated militia, being necessary to the security of a free State, the right of the people to keep and bear arms, shall not be infringed.

ARTICLE III. Quartering of Soldiers. No soldier shall, in time of peace be quartered in any house, without the consent of the owner, nor in time of war, but in a manner to be prescribed by law.

ARTICLE IV. Right of Search and Seizure Regulated. The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

ARTICLE V. Rights of the Accused in Criminal Proceedings. No person shall be held to answer for a capital, or otherwise infamous crime, unless on a presentment or indictment of a Grand Jury, except in cases arising in the land or naval forces, or in the militia, when in actual service in time of war or public danger; nor shall any person be subject for the same offense to be twice put in jeopardy of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation.

ARTICLE VI. Right to Speedy Trial, Witnesses, Etc. In all criminal prosecutions, the accused shall enjoy the right to a speedy and public trial, by an impartial jury of the State and district wherein the crime shall have been committed, which district shall have been previously ascertained by law, and to be informed of the nature and cause of the accusation; to be confronted with the witnesses against him; to have compulsory process for obtaining witnesses in his favor, and to have the assistance of counsel for his defense.

ARTICLE VII. Right of Trial by Jury. In suits at common law, where the value in controversy shall exceed twenty dollars, the right of trial by jury shall be preserved, and no fact tried by a jury shall be otherwise re-examined in any court of the United States, than according to the rules of the common law.

ARTICLE VIII. Protection Against Excessive Bail and Punishments. Excessive bail shall not be required, nor excessive fines imposed, nor cruel and unusual punishment inflicted.

ARTICLE IX. Rights Retained by the People. The enumeration in the Constitution, of certain rights, shall not be construed to deny or disparage others retained by the people.

ARTICLE X. Rights of States Under Constitution. The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

17053

APPENDIX 2

LAW ENFORCEMENT CODE OF ETHICS

As a Law Enforcement Officer, my fundamental duty is to serve mankind; to safeguard lives and property; to protect the innocent against deception, the weak against oppression or intimidation, and the peaceful against violence or disorder; and to respect the Constitutional rights of all men to liberty, equality and justice.

I will keep my private life unsullied as an example to all; maintain courageous calm in the face of danger, scorn, or ridicule; develop self-restraint; and be constantly mindful of the welfare of others. Honest in thought and deed in both my personal and official life, I will be exemplary in obeying the laws of the land and the regulations of my department. Whatever I see or hear of a confidential nature or that is confided to me in my official capacity will be kept ever secret unless revelation is necessary in the performance of my duty.

I will never act officiously or permit personal feelings, prejudices, animosities, or friendships to influence my decisions. With no compromise for crime and with relentless prosecution of criminals, I will enforce the law courteously and appropriately without fear or favor, malice or ill will, never employing unnecessary force or violence and never accepting gratuities.

I recognize the badge of my office as a symbol of public faith, and I accept it as a public trust to be held so long as I am true to the ethics of police service. I will constantly strive to achieve these objectives and ideals, dedicating myself before God to my chosen profession....law enforcement.

17054

APPENDIX 3

CANONS OF POLICE ETHICS

ARTICLE 1. PRIMARY RESPONSIBILITY OF JOB

The primary responsibility of the police service, and of the individual officer, is the protection of the people of the United States through the upholding of their laws; chief among these is the Constitution of the United States and its amendments. The law enforcement officer always represents the whole of the community and its legally expressed will and is never the arm of any political party or clique.

ARTICLE 2. LIMITATIONS OF AUTHORITY

The first duty of a law enforcement officer, as upholder of the law, is to know its bounds upon him in enforcing it. Because he represents the legal will of the community, be it local, state or federal, he must be aware of the limitations and proscriptions which the people, through the law, have placed upon him. He must recognize the genius of the American system of government which gives to no man, groups of men, or institution, absolute power, and he must insure that he, as a prime defender of that system, does not pervert its character.

ARTICLE 3. DUTY TO BE FAMILIAR WITH THE LAW AND WITH RESPONSIBILITIES OF SELF AND OTHER PUBLIC OFFICIALS

The law enforcement officer shall assiduously apply himself to the study of the principles of the laws which he is sworn to uphold. He will make certain of his responsibilities in the particulars of their enforcement, seeking aid from his superiors in matters of technicality or principle when these are not clear to him; he will make special effort to fully understand his relationship to other public officials, including other law enforcement agencies, particularly on matters of jurisdiction, both geographically and substantively.

ARTICLE 4. UTILIZATION OF PROPER MEANS TO GAIN PROPER ENDS

The law enforcement officer shall be mindful of his responsibility to pay strict heed to the selection of means in discharging the duties of his office. Violations of law or disregard for public safety and property on the part of an officer are intrinsically wrong; they are self-defeating in that they instill in the public mind a like disposition. The employment of illegal means, no matter how worthy the end, is certain to encourage disrespect for the law and its officers. If the law is to be honored, it must be honored by those who enforce it.

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ARTICLE 5. COOPERATION WITH PUBLIC OFFICIALS IN THE DISCHARGE OF THEIR AUTHORIZED DUTIES

The law enforcement officer shall cooperate fully with other public officials in the discharge of authorized duties, regardless of party affiliation or personal prejudice. He shall be meticulous, however, in assuring himself of the propriety, under the law, of such actions and shall guard against the use of his office or person, whether knowingly or unknowingly, in any improper action. In any situation open to question, he shall seek authority from his superior officer, giving him a full report of the proposed service or action.

ARTICLE 6. PRIVATE CONDUCT

The law enforcement officer shall be mindful of his special identification by the public as an upholder of the law. Laxity of conduct or manner in private life, expressing either disrespect for the law or seeking to gain special privilege, cannot but reflect upon the police officer and the police service. The community and the service require that the law enforcement officer lead the life of a decent and honorable man. Following the career of a policeman gives no man special perquisites. It does give the satisfaction and pride of following and furthering an unbroken tradition of safeguarding the American republic. The officer who reflects upon this tradition will not degrade it. Rather, he will so conduct his private life that the public will regard him as an example of stability, fidelity and morality.

ARTICLE 7. CONDUCT TOWARD THE PUBLIC

The law enforcement officer, mindful of his responsibility to the whole community, shall deal with individuals of the community in a manner calculated to instill respect for its laws and its police service. The law enforcement officer shall conduct his official life in a manner such as will inspire confidence and trust. Thus, he will be neither over-bearing nor subservient, as no individual citizen has an obligation to stand in awe of him nor a right to command him. The officer will give service where he can, and require compliance with the law. He will do neither from personal preference or prejudice but rather as a duly appointed officer of the law discharging his sworn obligation.

ARTICLE 8. CONDUCT IN ARRESTING AND DEALING WITH LAW VIOLATORS

The law enforcement officer shall use his power of arrest strictly in accordance with the law and with due regard to the rights of the citizen concerned. His office gives him no right to prosecute the violator nor to mete out punishment for the offense. He shall, at all times, have a clear appreciation of his responsibilities and limitations regarding detention of the violator; he shall conduct himself in such a manner as will

Page

TOPIC: MACHINE DRAWING 103

WS. 60. Bottle Opener 109
WS. 61. Cold Chisel 109
WS. 62. Machinist's Punch 109
WS. 63. Screw Driver 110

TOPIC: SHEET METAL DRAWING 111

WS. 64. Box 119
WS. 65. Parts Tray 119
WS. 66. Cup 119
WS. 67. Scoop 120
WS. 68. Funnel 120
WS. 69. Copper Tray 121

minimize the possibility of having to use force. To this end he shall cultivate a dedication to the service of the people and the equitable upholding of their laws whether in the handling of law violators or in dealing with the law-abiding.

ARTICLE 9. GIFTS AND FAVORS

The law enforcement officer, representing government, bears the heavy responsibility of maintaining, in his conduct, the honor and integrity of all government institutions. He shall, therefore, guard against placing himself in a position in which any person can expect special consideration or in which the public can reasonably assume that special consideration is being given. Thus, he should be firm in refusing gifts, favors, or gratuities, large or small, which can, in the public mind, be interpreted as capable of influencing his judgment in the discharge of his duties.

ARTICLE 10. PRESENTATION OF EVIDENCE

The law enforcement officer shall be concerned equally in the prosecution of the wrong-doer and the defense of the innocent. He shall ascertain what constitutes evidence and shall present such evidence impartially and without malice. In so doing, he will ignore social, political, and all other distinctions among the persons involved, strengthening the tradition of the reliability and integrity of an officer's word.

The law enforcement officer shall take special pains to increase his perception and skill of observation, mindful that in many situations his is the sole impartial testimony to the facts of a case.

ARTICLE 11. ATTITUDE TOWARD PROFESSION

The law enforcement officer shall regard the discharge of his duties as a public trust and recognize his responsibility as a public servant. By diligent study and sincere attention to self-improvement he shall strive to make the best possible application of science to the solution of crime and, in the field of human relationships, strive for effective leadership and public influence in matters affecting public safety. He shall appreciate the importance and responsibility of his office, hold police work to be an honorable profession rendering valuable service to his community and his country.

17057

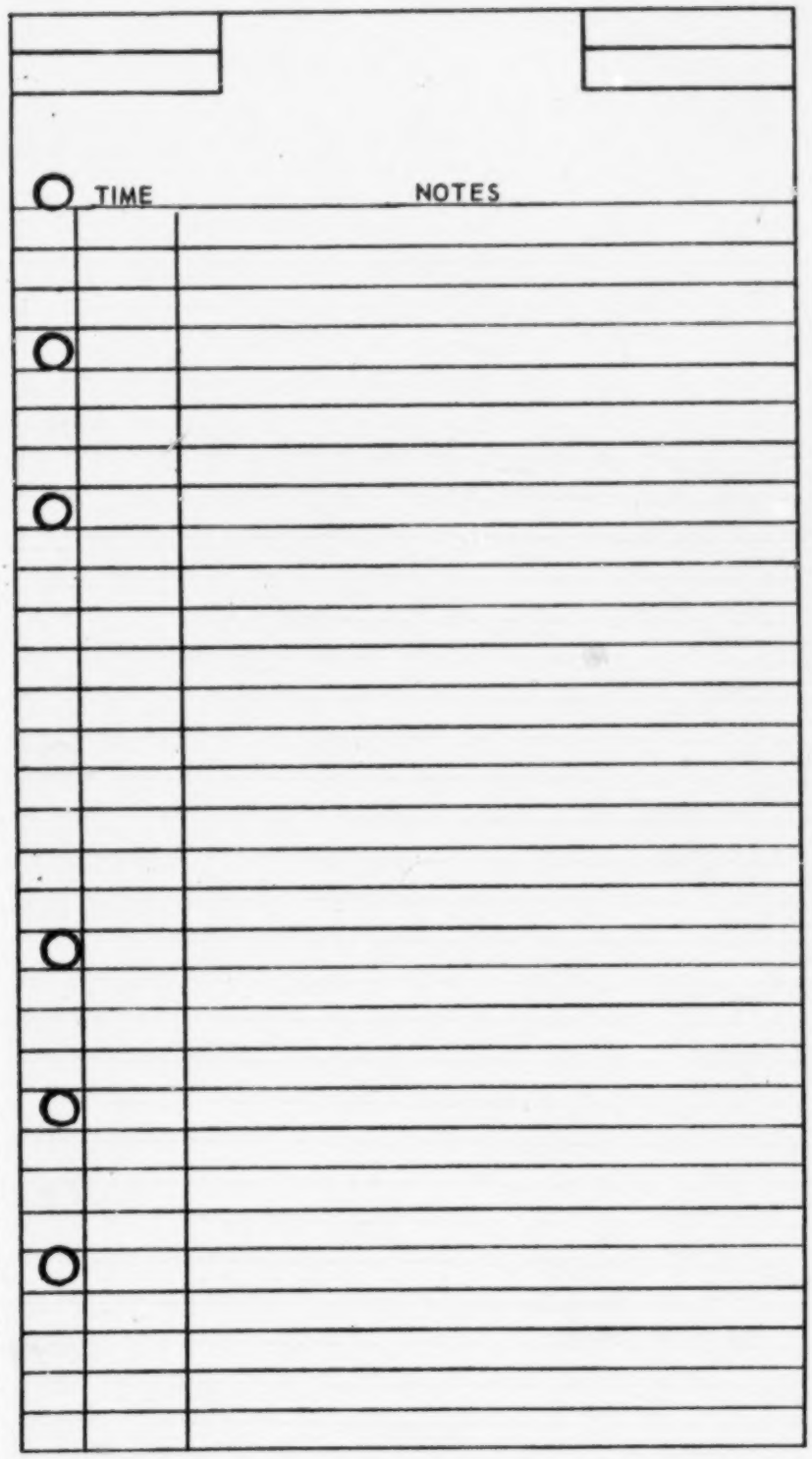

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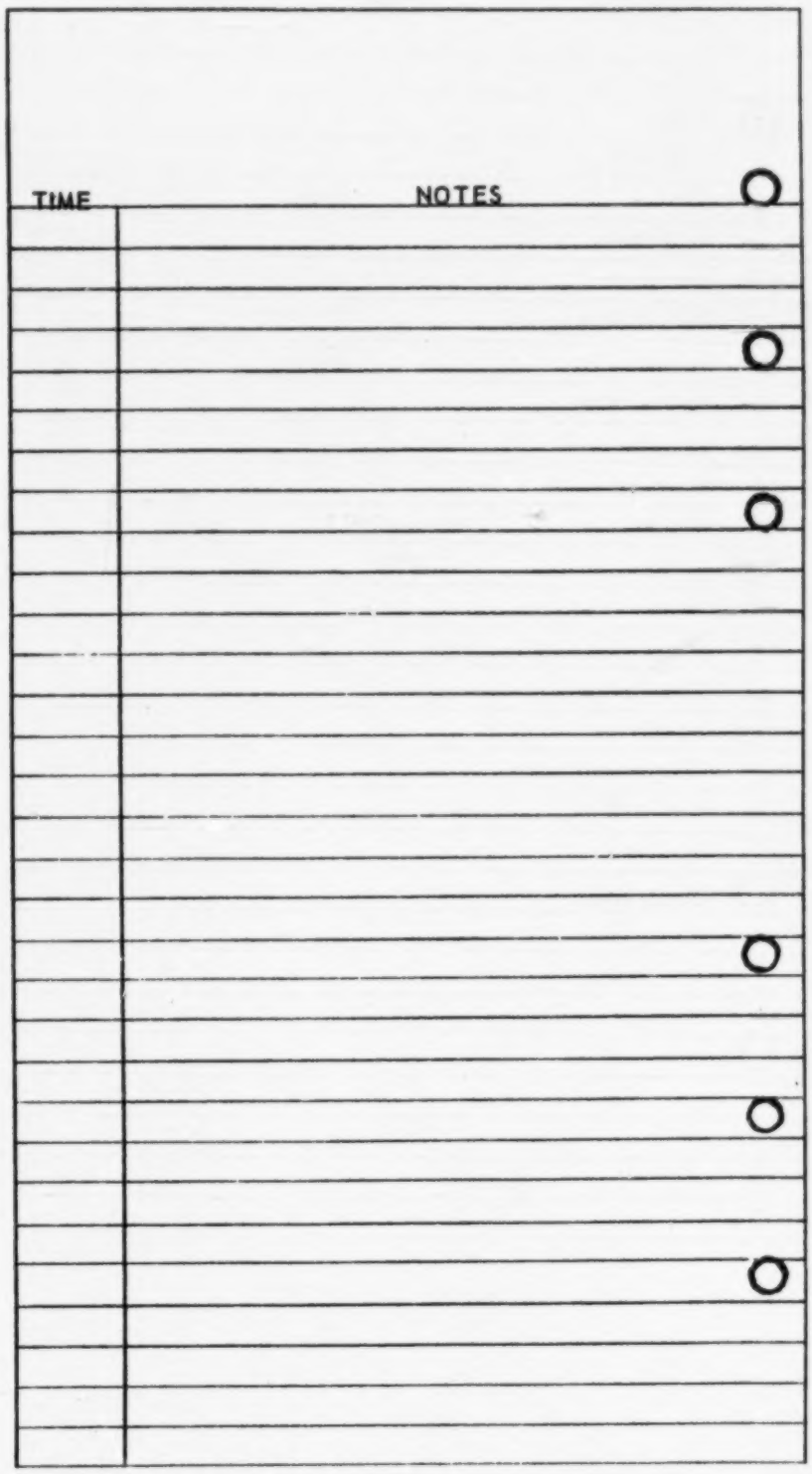

Back Side

FIELD NOTEBOOK LOG

17058

APPENDIX 5

PERSONS REPORT

Suspicious Wanted Missing

Name-
Alias-
Address-
City- State-
Telephone-

PERSONAL:
Sex- Color-
Nationality-
Birthdate-
Birthplace-
Height- ' " Weight- lbs.
Build-
Hair-
Eyes-
Complexion-
Beard-
Characteristics-

Occupation-
Employer-

Hangout-

Front Side

DRESS:
Headdress-
Mask-
Outer Garment-
Neckwear-
Upper Garment-
Lower Garment-
Gloves-
Stockings-
Footwear-
Jewelry-

VEHICLE:
Make-
Model-
Body-
Year-
Color-
License-
State-
Characteristics-

REMARKS:

Back Side

PERSONS REPORT

17059

*Armed ○ ○ ○ ○ ○ ○ # Felony

A	B	C	D	E	F	G	H	I	J	K	L	M

N	O	P	Q	R	S	T	U	V	W	X	Y	Z

Front Side

WANTED VEHICLE LIST

17060

APPENDIX 6 (cont.)

* Armed		WANTED VEHICLE LIST		# Felony
0	1	2	3	4

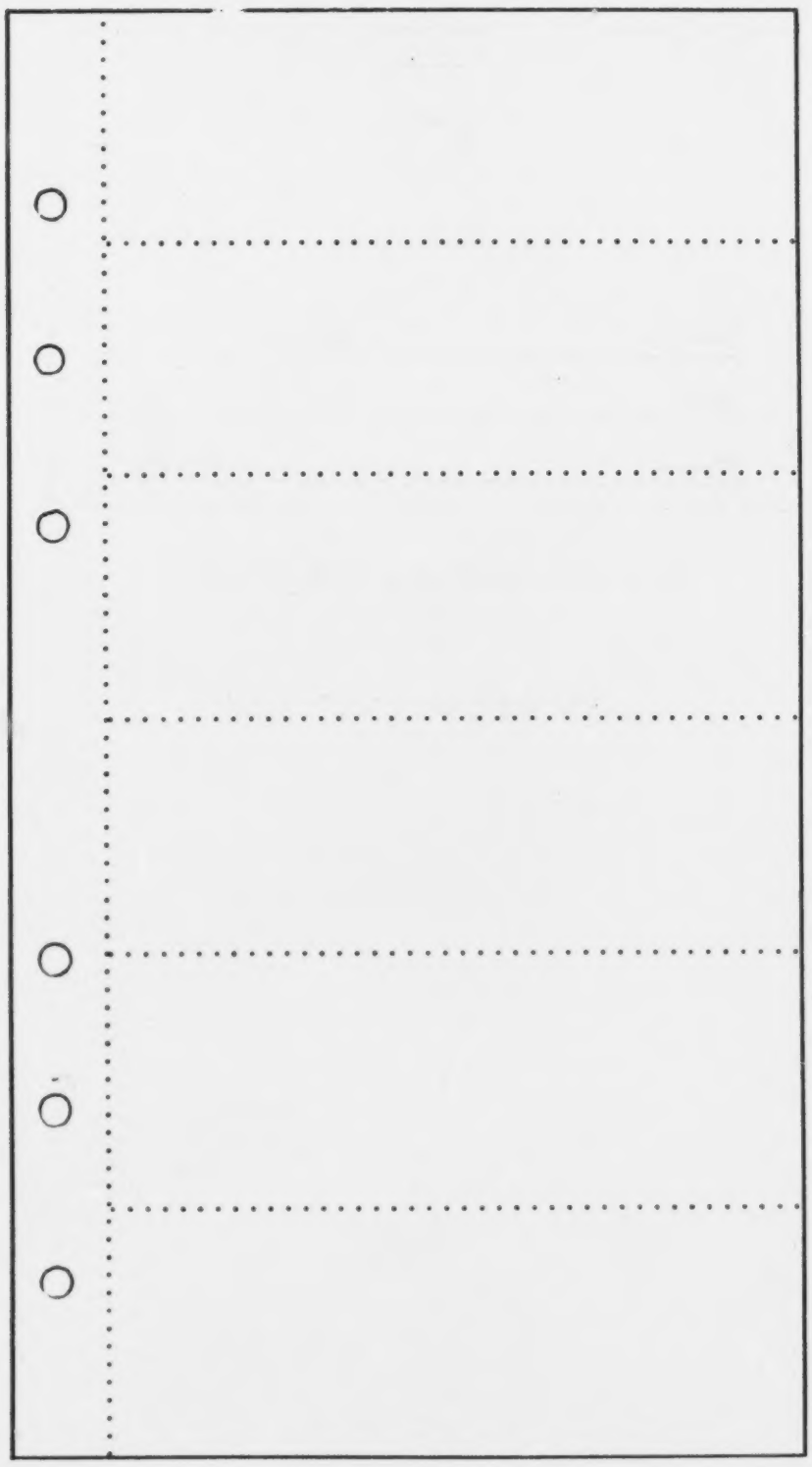

PERFORATED MEMO

17062

APPENDIX 8

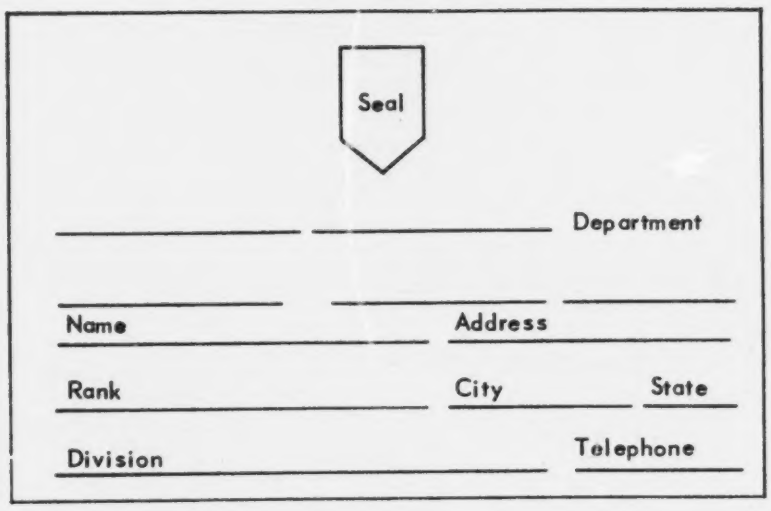

(Recommended size 2" x 3-1/2")

SAMPLE BUSINESS CARD

17063

BUSINESS SECURITY SURVEY REPORT

Business Name:

Address:

Telephone:

Manager:

Residence:

Telephone:

Assistant Manager:

Residence:

Telephone:

Kind of Business:

PHYSICAL SECURITY INSPECTION

Designate: ✓ OK, x - Defective, N - S - E - W	None	Rear	Side	Front	Roof
Doors: Locks					
Bars					
Hasps					
Windows: Locks					
Bars					
Other Entries: Security					
Accessibility					
Night Light: Safe					
Exterior					
Interior					
View: Shades					
Displays					

Safe: None ☐

Visible- easily ☐ poorly ☐ concealed ☐

Can officer easily reach all means of entry without climbing fences, etc.? Yes ☐ No ☐

Front Side

Location of interior light switches on ground floor:

Night Watchman: Name-

None ☐ Private Patrol ☐

Alarm System:

Other Protective Devices:

Precautions taken against holdup:

Did you make personal investigation of points covered? Yes ☐ No ☐ If not, why?

SUGGESTIONS MADE:

Doors-

Windows-

Roof-

Safe-

Night Light-

Shop Lifters-

Check Passers-

Hold Ups-

Other-

Did you give manager copies of Department's brochures? Yes ☐ No ☐

Will your suggestions be followed?

Yes ☐ No ☐ Doubtful ☐

Officer: Date:

Back Side

BUSINESS SECURITY SURVEY REPORT

17064

APPENDIX J

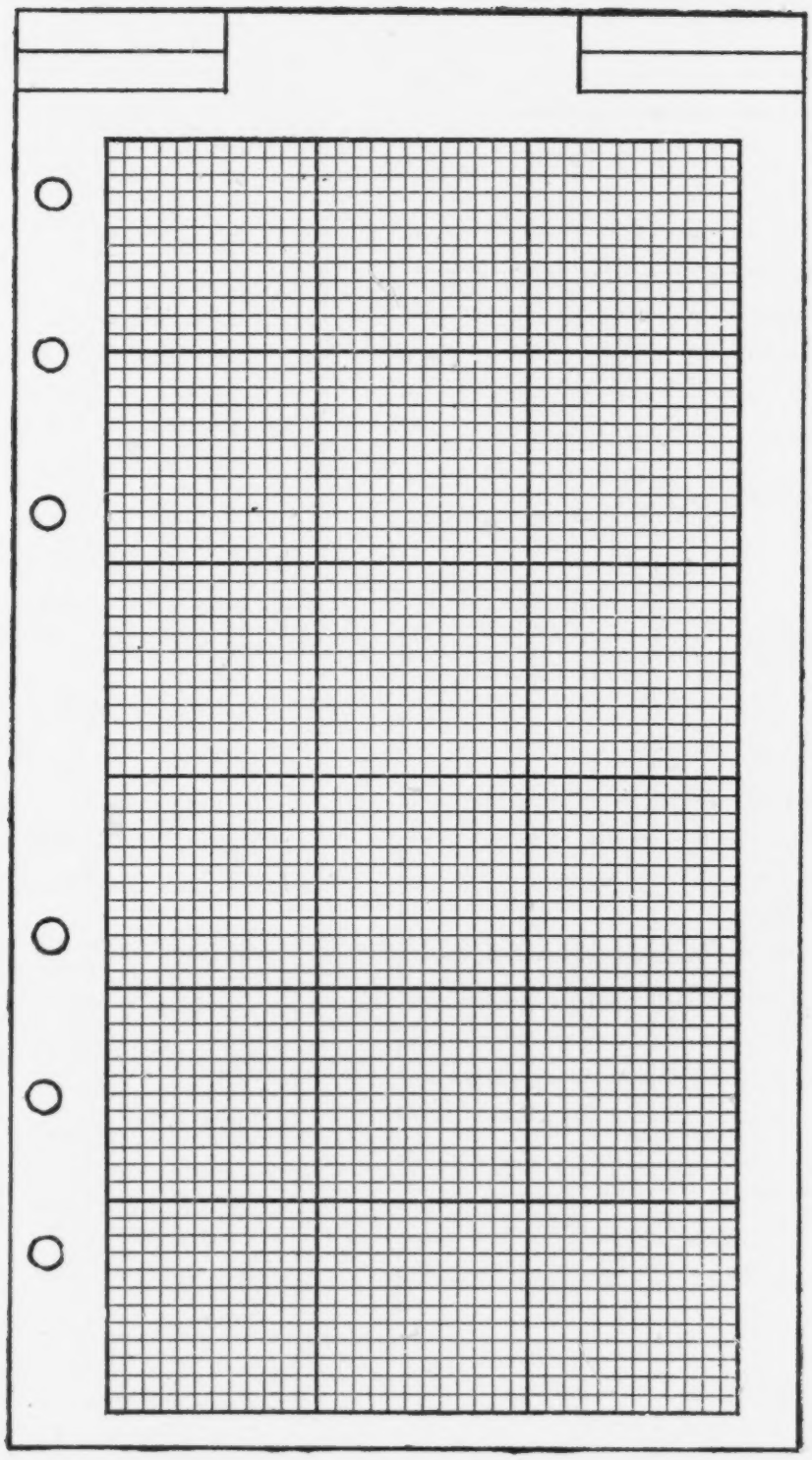

FIELD SKETCH SHEET

17065

INFORMATION ON PERSONALITIES

TR.MK. REG. U.S. PAT. OFF.

Name.....

Address.....

.....

.....

Telephone.....

Date of Birth.....

Birth Place.....

Marital Status.....

Date Married.....

Education.....

Business.....

.....

Hobby.....

.....

Likes.....

.....

Dislikes.....

.....

Special Talent.....

.....

Where Introduced.....

.....

Remarks.....

.....

.....

.....

.....

.....

.....

.....

.....

(Over)

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SPEC. FORM L-1132.

Front Side

Name of Spouse.....

Address.....

.....

.....

Telephone.....

Date of Birth.....

Birth Place.....

Education.....

Business.....

.....

Hobby.....

.....

Likes.....

.....

Dislikes.....

.....

Special Talent.....

.....

Where Introduced.....

.....

Remarks.....

.....

.....

.....

.....

.....

.....

Names of Children	Birth Date	Birth Place

Back Side

Courtesy Lefax

INFORMATION ON PERSONALITIES

17066

VT 011 363
Industrial Arts Curriculum Guide for the State of Wyoming Grades K-12.

Wyoming Research Coordinating Unit in Vocational-Technical Education, Cheyenne.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - Aug69 82p.

DESCRIPTORS - *CURRICULUM GUIDES; *INDUSTRIAL ARTS; *PROGRAM DESCRIPTIONS; INDUSTRIAL ARTS TEACHERS; *STATE CURRICULUM GUIDES; SECONDARY GRADES; *COURSE DESCRIPTIONS; PREVOCATIONAL EDUCATION; ELEMENTARY GRADES; CURRICULUM PLANNING

ABSTRACT - Prepared by members of the Wyoming State Industrial Arts Curriculum Committee, this guide is intended to aid Wyoming industrial arts teachers in planning and conducting improved programs on both the elementary and secondary levels. Following brief information on the philosophy of the program, goals, organizational plans, safety, personnel and shop management, and policy regarding special students, nine content areas are outlined, including: (1) drafting, (2) woodworking, (3) metalworking, (4) plastics, (5) basic electricity, (6) power mechanics and transportation, (7) home maintenance, (8) graphic arts, and (9) crafts, such as ceramics, leathercraft, and art metals. Program evaluation guidelines and an appendix containing eye safety legislation, safety color coding, and a content area bibliography are also included. (AW)

VT 011 363

APPENDIX 12

OFFICERS WATCH ACTIVITY REPORT

_____ _____ Department

To _____ Date _____ Day _____ Vehicle No. _____
(Supervisors title and name)

Officer _____ Watch: From _____ To _____ Odometer: In _____
and
Officer _____ Assignment _____ Out _____

TIME DISTRIBUTION			LOCATION AND ACTIVITY	SUMMARY		NO.
FROM	TO	HOURS		TOTAL MILEAGE		
				CASES		
					ARRESTS	
				TRAFFIC VIOLATORS CITED	HAZARDOUS	
				TIME - WHOLE OR 1/2 HOURS		
				SELECTED CLASSIFICATION		

17067 OFFICER'S WATCH ACTIVITY REPORT Actual size 8-1/2" x 11"

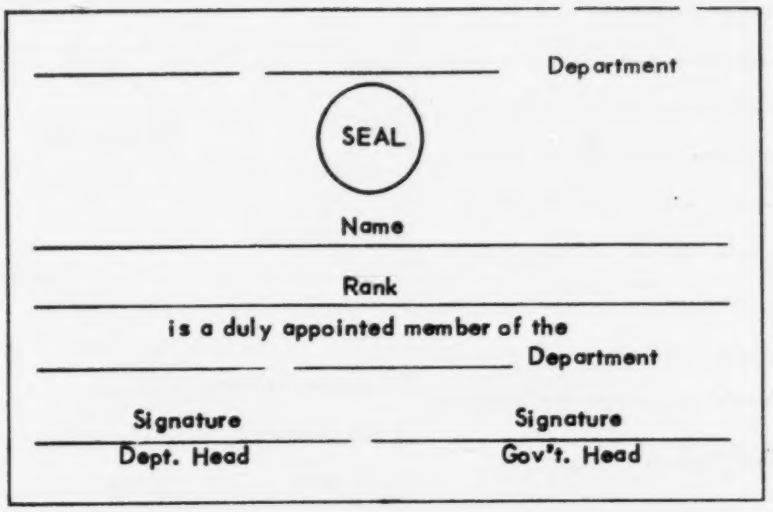

Front Side

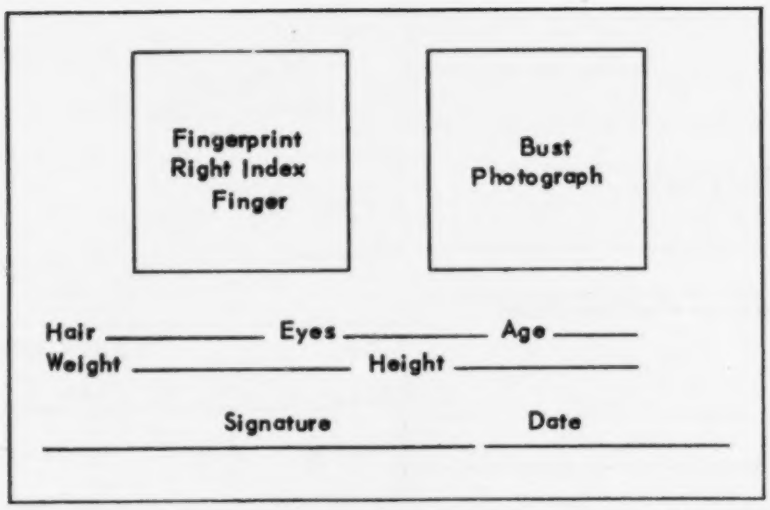

Back Side

IDENTIFICATION CARD

17068

APPENDIX 14

PRELIMINARY INVESTIGATION REPORT

Beat No. _____ Census Tract _____ Report Area _____ Case No. _____

_____ _____ Department

City-County Police-Sheriffs

Type of Crime: _____

Name of Victim (or Firm) _____

Address _____

City _____ State _____

Phone _____

Reported by _____

Home Address: _____

Phone _____

Date & Time Report Rec'd. _____

Reported To _____

Assigned To _____

Date Committed _____

Time Committed _____

Person Attacked _____
(Race-Sex-Age-Type of Occupation)

What was victim doing at time of attack? _____

Property Attacked _____
(Type of Premises and/or Location)

How Attacked _____

Means of Attack _____
(Weapons or Tools Used)

Object of Attack _____
(What Was Taken or Why Committed)

Trademark _____

Vehicle Used _____
(Give Available Description)

SUSPECT AND DESCRIPTION

Name _____ Nationality _____

Alias _____

Address _____

Color Sex Age Eyes Hair Height Weight

Build Complexion Scars or Marks

Characteristics _____

DRESS

Headdress _____

Disguise or Mask _____

Outer Garment _____

Neckwear _____

Upper Garment _____

Lower Garment _____

Gloves _____

Stockings _____

Footwear _____

Jewelery _____

OTHER IDENTIFICATION

Occupation _____

Employer _____

Hangout _____

Remarks _____

PERSON ARRESTED

Name _____ Age _____

Address _____ D.O.B. _____

By Officer _____

Date _____

Officer Making Report _____
(Sign in ink)

Date _____ Time _____

PRELIMINARY INVESTIGATION REPORT Actual size 8-1/2" x 11"

17069

PATROL CAR AND AUXILIARY EQUIPMENT FIELD CHECK LIST

Patrol Car No.: Date:

Previous Driver:

Check: ✓ - OK x - Defective	OPERATION Before	During	After
1. Cleanliness			
2. Damage			
3. Identification			
4. Leaks			
5. Tires			
6. Auxiliary Equipment			
7. Safety Seat Belts			
8. Weapons and Security			
9. Instruments			
10. Speedometer Check			
11. Fuel, Oil, Water			
12. Lubrication & Service			
13. Siren			
14. Lights & Reflectors			
15. Engine Operation			
16. Unusual Noises			
17. Brakes			
18. Clutch			
19. Steering			
20. Radio			
Officer:			
Supervisor			

Remarks: (Con't. on back)

PATROL CAR AND AUXILIARY EQUIPMENT FIELD CHECK LIST

17070

APPENDIX 16

UNOCCUPIED HOME REPORT

Date of Departure: Return:

Name:

Address:

Telephone:

Forwarding Address

Reported By:

Address:

Reported To: Date:

In emergency, notify:

Address:

Telephone:

Department brochure:

HAZARDS UNCORRECTED:

Doors- Front ☐ Rear ☐ Side ☐ Garage ☐

Other

Windows- Front ☐ Rear ☐ Side ☐ Garage ☐

Other

Services discontinued- Yes ☐ No ☐

Deliveries discontinued- Yes ☐ No ☐

Lawn care- Yes ☐ No ☐

Pet care- Yes ☐ No ☐

Night light- Yes ☐ No ☐

Shades- Yes ☐ No ☐

Neighbor contacted:

Address-

Persons authorized on premises:

Remarks: (Con't. on back)

UNOCCUPIED HOME REPORT

17071

PROPERTY TAG NO. _____ **CASE NO.** _____

Property: Evidence ☐ Found ☐ Per sonal ☐ Recovered ☐

Owner: _____

Address: _____

Claimed by: _____ Date: _____

Address: _____

Method of Disposal: _____

To: _____

Address: _____

Turned in by: _____

Turned in to: _____ Date: _____ Time: _____

DETACH HERE

PROPERTY RECORD CARD NO. _____ **CASE NO.** _____

Property: Evidence ☐ Found ☐ Per sonal ☐ Recovered ☐

Owner: _____

Address: _____

Claimed by: _____ Date: _____

Address: _____

Method of Disposal: _____

To: _____

Address: _____

Turned in by: _____

Turned in to: _____ Date: _____ Time: _____

Front Side

PROPERTY TAG

17072

APPENDIX 17 (cont.)

ITEM	QUANTITY	DESCRIPTION	STORED

ITEM	QUANTITY	DESCRIPTION	STORED

Back Side

PROPERTY TAG

STORT 17073

MFG. BY WEBER GOVERNMENTAL SYSTEMS, 117 W. SHIAWASSEE ST., LANSING 1, MICH. (11)

UNIFORM TRAFFIC TICKET AND COMPLAINT

DOCKET No._____ DIVISION_____

STATE OF _____
COUNTY OF _____ } SS.
CITY OF _____

No. 4103

COMPLAINT - AFFIDAVIT

IN THE _____ **COURT OF** _____

THE UNDERSIGNED, BEING DULY SWORN, UPON HIS OATH DEPOSES AND SAYS:

ON_____THE_____DAY OF_____, 19_____, AT_____M.,

NAME_____ (Please Print)

STREET_____

CITY-STATE_____

BIRTH DATE_____ RACE_____ SEX_____ WT._____ HT._____

CH. LIC. # _____ (PARK)

OP. LIC. #_____, DID UNLAWFULLY (OPERATE)

VEH. LIC. #_____ STATE_____ YEAR_____

MAKE_____ YR._____ EMPL. AT_____

UPON A PUBLIC HIGHWAY, NAMELY AT (LOCATION)_____

LOCATED IN THE CITY, VILLAGE OR TOWNSHIP, COUNTY AND STATE AFORESAID AND DID THEN AND THERE COMMIT THE FOLLOWING OFFENSE:

Leading Causes of Accidents

SPEEDING (over limit) (_____m.p.h. in_____m.p.h. zone)	☐ 5-10 m.p.h.	☐ 11-15 m.p.h.	☐ over 15 m.p.h.
Improper LEFT TURN	☐ No signal	☐ Cut corner	☐ From wrong lane
Improper RIGHT TURN	☐ No signal	☐ Into wrong lane	☐ From wrong lane
Disobeyed TRAFFIC SIGNAL (When light turned red)	☐ Past middle intersection	☐ Middle of intersection	☐ Not reached intersection
Disobeyed STOP SIGN	☐ Wrong place	☐ Walk speed	☐ Faster
Improper PASSING AND LANE USAGE	☐ At intersection	☐ Cut in	☐ Wrong side of pavement
	☐ Between Traffic	☐ On right	☐ On hill
	☐ Lane Straddling	☐ Wrong lane	☐ On curve

Other Violations: in violation of Sec._____ of ☐ State Statute ☐ Local Ordinance in such case made and provided.

PARKING: Meter No._____ ☐ Overtime ☐ Prohibited area ☐ Double parking ☐ Other parking violation (describe)_____

Conditions that Increased Seriousness of Violation

SLIPPERY PAVEMENT	☐ Rain ☐ Snow ☐ Ice	CAUSED PERSON IN ACCIDENT TO DODGE	☐ Pedestrian ☐ Driver
DARKNESS	☐ Night ☐ Fog ☐ Snow	JUST MISSED ACCIDENT	☐ Close ☐ Very Close
OTHER TRAFFIC PRESENT	☐ Cross ☐ Oncoming ☐ Pedestrian ☐ Same Direction		

Type Accident: ☐ PD ☐ PI ☐ Fatal ☐ Ped. ☐ Vehicle ☐ Intersection ☐ Right Angle ☐ Head on ☐ Sideswipe ☐ Rear end ☐ Ran off Roadway ☐ Hit Fixed Object

AREA: ☐ Business ☐ Industrial ☐ School ☐ Residential ☐ Rural

HIGHWAY TYPE: ☐ 2 lane ☐ 3 lane ☐ 4 lane ☐ 4 lane divided

THE UNDERSIGNED FURTHER STATES THAT HE HAS JUST AND REASONABLE GROUNDS TO BELIEVE, AND DOES BELIEVE, THAT THE PERSON NAMED ABOVE COMMITTED THE OFFENSE HEREIN SET FORTH, CONTRARY TO LAW.

SWORN TO AND SUBSCRIBED BEFORE ME

THIS_____DAY OF_____, 19_____

_____ (Name and title)

_____ (Signature and identification of officer or other complainant)

COURT APPEARANCE:_____DAY OF_____, 19_____, AT_____M.

ADDRESS OF COURT _____ BAIL POSTED_____

I promise to appear in said Court or Bureau at said time and place.

Signature_____

NAME

No. 4103

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Courtesy American Bar Association

UNIFORM TRAFFIC TICKET AND COMPLAINT

Quadruplicate form Actual size 4-1/8" x 8"

17074

APPENDIX 19

PRELIMINARY
INVESTIGATION FIELD REPORT

Type of Crime:

Beat: CT: RA:

VICTIM:

Address-

City- State-

Phone-

REPORTED BY:

Address-

City- State-

Phone-

Date Reported: Time:

Reported To:

Date Committed:

Time Committed:

Person Attacked:

Property Attacked:

How Attacked:

Means of Attack:

Object of Attack:

Trademark:

Vehicle Used:

PRELIMINARY INVESTIGATION FIELD REPORT

17075

_____ _____ Department
City, State

Location
Date
Time

I *(first, middle initial, last name)*, make the following statement to *(rank, name of recorder)*, known to me to be a member of the *(name of department)*. I have been advised that prior to time of confinement, or removal from the county, I have the right to communicate with an attorney, or with a relative or other person, for the purpose of obtaining counsel or arranging bail; that thereafter I have the right to confer with my attorney privately, or with another person to arrange bail; and that I have a right to communicate with my attorney, or other person, for purpose of obtaining counsel by a reasonable number of telephone calls. I have been advised that the police, or other arresting officer, may not require me to make a statement, but that if I do, it may be used in evidence against me.

My name is *(first, middle, last name)*. I am *(number)* years old, live at *(number and street address)* in *(city)*, *(state)*. I attend *(number)* grade at *(name)* school. I am employed as a *(occupation)* by *(name of firm)* at *(number and street address)* in *(city)*, *(state)*.

(Write details in chronological order.)

I have read this statement which consists of *(number)* pages, initialed all corrections which have been made, and signed each page. I have given this statement freely and voluntarily. No threats or promises of any kind have been made to or used against me to make this statement and it is the truth. I have nothing further to add.

Signed: *(first, middle, last name)*
Date: Time:

Witnessed by:
(Signed—first, middle initial, last name—rank)
(Two)

SAMPLE FORMAT FOR STATEMENT

17076

ED0 56238

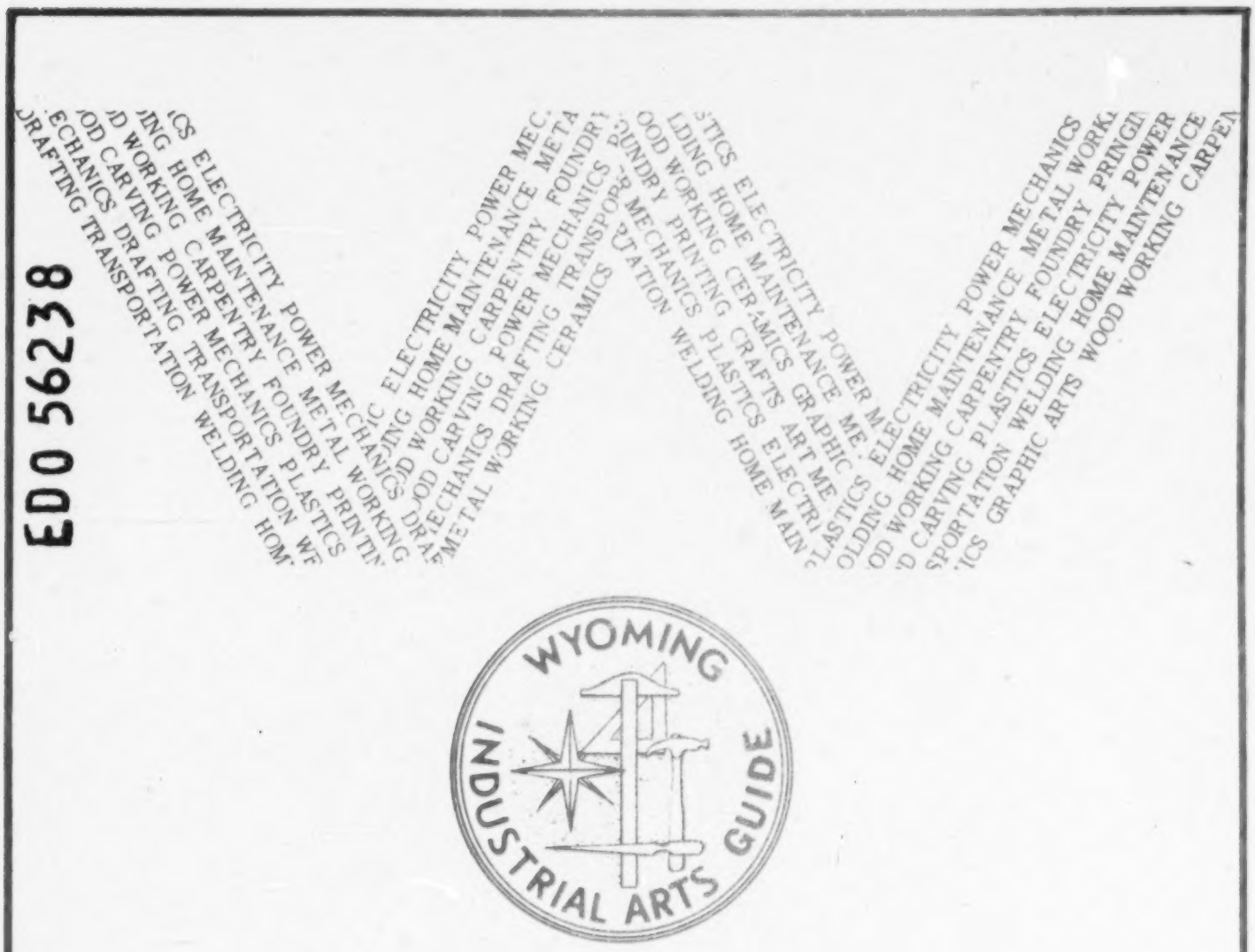

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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WYOMING INDUSTRIAL ARTS CURRICULUM GUIDE GRADES K-12

VT011363

APPENDIX 21

GUIDELINES FOR DETERMINING WHO, WHAT, WHY, WHERE, WHEN AND HOW

1. Who?

   Who was the victim?
   Who made the report?
   Who discovered the crime?
   Who saw or heard something of importance?
   Who had a motive for committing the crime?
   Who committed the crime?
   Who helped him?
   Who will sign the complaint?
   Who was talked to?
   Who worked on the case?
   Who marked the evidence?
   Who received the evidence?

2. What?

   What was the nature of the crime committed?
   What actions were taken by the suspect?
   What happened?
   What do the witnesses know about it?
   What evidence was obtained?
   What was done with the evidence?
   What tools were used?
   What action did the officer take?
   What further action is needed?
   What knowledge, skill, or strength was needed to commit the crime?
   What other agencies were notified?
   What was reported but did not occur?
   What witnesses were not contacted?
   What time was the crime committed?
   What time was the crime reported?
   What was the time of your arrival?
   What time did you contact witnesses?

3. Where?

   Where was the crime discovered?
   Where was the crime committed?
   Where were the tools or weapons obtained?
   Where was the victim?
   Where was the suspect seen?
   Where was the witness?
   Where did the criminal live?
   Where did the criminal hang out?
   Where is he now?

17077

Where would he most likely go?
Where was he apprehended?
Where was the evidence marked?
Where was the evidence stored?

4. When?

When was the crime committed?
When was the crime discovered?
When were the authorities notified?
When did the authorities arrive at the scene?
When was the guilty party arrested?
When was the victim last seen?
When did help arrive?
When will the complaint be signed?

5. How?

How was the crime committed?
How did the criminal get to the scene?
How did the criminal get away?
How did the criminal obtain information in order to commit the crime?
How was the crime discovered?
How were the tools obtained?
How did you get your information regarding the crime?
How did you manage the arrest?

6. With What?

With what tools was the crime committed?
With what weapons was the crime committed?
With what means did the criminal travel to and from the scene?

a. Auto
b. Bicycle
c. Train
d. Bus
e. On foot
f. etc.

With what trade or profession are the tools associated?
With what other crime is this crime associated?

17078

MARK [X] NOT [✓]. PRINT, DON'T WRITE

District

SHERIFF'S DEPARTMENT • TRAFFIC COLLISION REPORT

COUNTY OF • TOWNSHIP OF • STATE OF OHIO

Report Number

ACTIVE		INACTIVE		PENDING		ARREST MADE		CITATION ISSUED	
FATALITY INV.		HIT-SKIP INV.		FELONY INV.		PUB. PROP. INV.		PERSONAL PROP. HELD	

TOTAL UNITS INVOLVED		TOTAL DRIVERS INVOLVED		TOTAL PEDESTRIANS INVOLVED		TOTAL NUMBER KILLED		TOTAL NUMBER INJURED		TOTAL NOT INJURED	

POSITION OF UNITS PRIOR TO COLLISION

UNIT 1	Headed	On-Name/Number of Highway	Stated Speed MPH
UNIT 2	Headed	On-Name/Number of Highway	Stated Speed MPH
IS ☐ VEH ☐ PED	If A Pedestrian, Crossing or Entering?	Going From-Side or Corner	To-Side or Corner

EVENT

Interstate Hwy?	State Hwy?	County Road?	Twsp. Road or Street?

ON- Name and Number of Street or Highway

AT- Name and Number of Intersecting Road or Distance From

Hour ☐EST ☐DST /M	Day of the Week	Date	Month	19

UNIT-1

Driver-Print Full Name (Last-First-Middle)	Address-Number and Street	City and State	

Sex	Race	Age	Driver License Number	Type	State Issued By	Date Expires	Restrictions	Birthdate (Mo-Day-Yr.)

Employed By	Address-City and State	Occupation	Bus. Phone X	Res. Phone X

Vehicle-Color	Year	Make	Model	Registration No.	State Issued By	Valid?	Date Expires

Serial or Motor Number	P.U.C.O. or I.C.C. NO.-If Any	Driver/Owner Insured By	Currently Under Financial Responsibility? ☐Driver ☐Owner

Registered Owner (Last-First-Middle)	Address-Number and Street	City and State	Residence Phone

If above vehicle was towing a trailer, give description here. Include registration data. ☐ Loaded ☐ Empty

Disposition of Vehicle (Name of wrecker and where taken)	Part of Vehicle Damaged.	☐ Minor	☐ Moderate
		☐ Major	☐ Total

PASSENGERS

	Center Front-Name (Last-First-Middle)	Address-Number and Street	City and State	Residence Phone	Sex	Age
	Right Front					
	Left Rear					
	Center Rear					
	Right Rear					

UNIT-2

Driver/Pedestrian-Print Full Name (Last-First-Mid.)	Address-Number and Street	City and State	

Sex	Race	Age	Driver License-Number	Type	State Issued By	Date Expires	Restrictions	Birthdate (Mo-Day-Yr.)

Employed By	Address-City and State	Occupation	Bus. Phone X	Res. Phone X

Vehicle-Color	Year	Make	Model	Registration No.	State Issued By	Valid?	Date Expires

Serial or Motor Number	P.U.C.O. or I.C.C. NO.-If Any	Driver/Owner Insured By	Currently Under Financial Responsibility? ☐Driver ☐Owner

Registered Owner (Last-First-Middle)	Address-Number and Street	City and State	Residence Phone

If above vehicle was towing a trailer, give description here. Include registration data. ☐ Loaded ☐ Empty

Disposition of Vehicle (Name of Wrecker and where taken)	Part of Vehicle Damaged.	☐ Minor	☐ Moderate
		☐ Major	☐ Total

PASSENGERS

	Center Front-Name (Last-First-Middle)	Address-Number and Street	City and State	Residence Phone	Sex	Age
	Right Front					
	Left Rear					
	Center Rear					
	Right Rear					

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APPENDIX V (cont.)

MARK [X] NOT [✓]. PRINT, DON'T WRITE

Property Damaged	Nature of Damage	Owner–Name and Address

NOTE- The catagories of injuries follow the Manual of Uniform Definitions of Motor Vehicle Accidents.
K–Deceased before report completed. A–Bleeding wound, distorted member, carried from scene.
B–Other visible injuries such as bruises, abrasions, swelling, or limping. C–Complaint of Pain without visible injury.

INJURED WAS			IN VEHICLE		Sex	Age	Ext. Of Injury				FIRST AID BY	TAKEN BY	TAKEN TO	PHYSICIAN ATT.
Driv.	Pass.	Ped.	No.	Place			K	A	B	C				

1	2	KIND OF ROAD	WEATHER	ROAD SURFACE	LIGHTING	ROAD DEFECTS	LOCALE
		One-way Road or Alley	Clear	Dry	Daylight	Holes–Deep Ruts	Manufacturing-Industrial
		One Lane Each Direction	Cloudy	Wet	Dawn	Loose Material on Road	Shopping–Business
		Two Lanes Each Directn.	Raining	Snow Covered	Dusk	Obstruction	Residential
		Three or More Lanes	Snowing	Ice Covered	Dark–No Illumination	Construction–Repair	School–Playground
		Divided Road–Any Width	Fog	Slippery–Other	Dark–Illuminated	Reduced Road Width	Not Developed–Open
		Freeway-Interstate	Other-	Other-	Other-	Other-	Other-
		Unpaved–Any Type					

ROAD CONTOUR	TYPE COLLISION	TRAFFIC CONTROL	PEDESTRIAN ACTIONS	1	2	PHYSICAL CONDITIONS
Level	Motor Vehicle And:	No Control Present	Crossing at Signalized I/S			Had Been Drinking-Obviously Intoxicated
On Grade-up	Other Motor Vehicles	2-Phase Signal	Crossing at I/S-No Signal			Had Been Drinking-Ability Impaired
On Grade-down	Pedestrian	3-Phase Signal	Crossing-Not at I/S			Had Been Drinking-Ability Not Impaired
Hill Crest	Railroad Train	Flashing Signal	Walking in Road-With Traffic			Had Not Been Drinking
Straight	Animal	R.R. Gates-Signals	Walking in Road-Against			Sobriety Unknown
Curve	Bicycle	Police Officer	Standing in Road			Illness-Sudden While Driving
Sharp Curve	Fixed Object	School Patrol Guard	Working-Playing in Road			Fatigue-Fell Asleep at Wheel
Merging Lanes	Other Object	Stop Sign	Other-In Road			Disability-Arms, Legs, Hands or Feet
Bridge	Overturned-Road	Yield Sign	Getting On-off Vehicle			Eye Sight-Poor
Tunnel	Ran Off Road	Other-	Not in Road			Other-
Cloverleaf Ramp	Other Non-collision		In Violation / No Violation			

1	2	PRIMARY	1	2	CAUSE	1	2	OTHER	1	2	VIOLATIONS	UNIT 1 LF	UNIT 1 RF	UNIT 1 LR	UNIT 1 RR	UNIT 2 LF	UNIT 2 RF	UNIT 2 LR	UNIT 2 RR	SEAT BELTS
		Exceeded Stated Speed			Followed too Closely			Registration Imp.			Length Rules									None Installed
		Exceeded Safe Speed			Unsafe Passing			OL Improper			Obscured Plates									Anchors Only
		Driving While Intoxicated			Improper Lane Change			False Information			School Bus Vio.									Not Fastened
		Failed to Yield Rgt.-of-way			Improper Parking			Driv. Under Susp.			Drag-Racing									Fastened-Snug
		Failed to Stop at Stop Sign			Defective Vehicle			Driv. Under Revoc.			Other Violations									Fastened-Loose
		Failed to Obey Traffic Lgt.			Reckless Operation			Hit and Run			Unknown-If Any									Two Under One Belt
		Made Improper Turn			Inadequate Lights			Trf. Manslaughter			Used in Felony									Failed-Webbing
		Failed to Signal			Inadequate Brakes			Towing Rules			No Violations									Failed-Buckle
		Drove Wrong Way			Other-			Loading Rules			Other-									Failed-Anchors
		Left of Center						Weight Rules												Trapped by Belts

• COLLISION CAUSE DUE TO • ☐ USER ☐ VEHICLE ☐ ROADWAY OR STREET

DESCRIBE WHAT HAPPENED • REFER TO UNITS BY NUMBER

REPORT MADE BY (Rank and Name)	Badge	Shift	Assignment	District Assigned	Report Made At

Time Received	Time Dispatched	Time Arrived	Time Cleared	Total Time Expended	Assisted By

ENF	Print Full Name (Last-First-Middle)	Charge and Section Number		Number
			Citation / Arrest / Warrant	
			Citation / Arrest / Warrant	
			Citation / Arrest / Warrant	

Supervisor Approving Report	Rank	Date	TRF	Tabulated by	RD No.	Case File No.	Date Opened

REC	Record Clerk	Date Received	Carded	Other

BMV	Acc. Nr.	Co. Name	Code	Pouch No.	Report Number

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WITNESSES	Name	Sex	Age	Address	Res. Phone	Bus. Phone	Statement?

VEHICLE CONDITION	MARK ALL APPLICABLE BOXES	1	2	3
	Mechanical Failure of Steering			
	Inadequate Brakes or Mechanical Failure			
	Power Failure			
	Tire Failure–Blow Out Before Collision			
	Coupling or Trailer Hitch Failure			
	Headlight Failure–Broken or Burnt Out			
	Tail Light Failure			
	Stop Light Failure			
	Dimensions Too Great			
	Load Fell Off, Shifted, or Projected			
	Load Obstructed View			
	Load Distracted Operator			
	Part of Vehicle Obstructed View From Within			
	Part of Vehicle Distracted Operator			
	Other Vehicle Obstructions or Distractions			
	Other (explain)			
ROADWAY CONDITIONS	Slippery Surface			
	Ruts, Holes, or Lips			
	Signs or Signals Obscured, Down, or Missing			
	Defaced Signs or Signals			
	No Passing Lines Obscured or Worn Away			
	Weak or Missing Guard Rail			
	Part of Surface Gave-way			
	View Obstructed by Crest or Dip			
	Blind Curve			
	Blind Intersection			
	Low Visibility Due to Fog, Rain, etc.			
	Dark Pockets Between Lighted Locations			
	Unlighted Obstructions			
	Sun Glare			
	Glare at Night From Road or Headlights			
	Reflected Glare From Glass or Water			
	Overhead Clearance Inadequate			
	Marginal Clearance Too Narrow			
	Sudden Narrowing			
	Obstacles or Obstructions in Road			
	Outside Distractions–Road, Scenery			
	Other (explain)			
DRIVER/PEDESTRIAN CONDITIONS	Seeing Defects–Not Corrected			
	Hearing Defects–Not Corrected			
	Lacks Intelligence Applying Knowledge to Situation			
	Impaired Body Coordination or Control			
	Handicapped by Stature			
	Handicapped by Weight			
	Lack of Limbs or Their Use			
	Other Infirmity or Physical Defect			
	Lack of Strength			
	Low Vitality, Sluggishness			
	Lacks Knowledge of Vehicle			
	Lacks Knowledge of Roads			
	Lacks Knowledge of Laws			
	Lacks Knowledge of Safety Rules, Not In Laws			
	Lacks Skill to Manipulate Vehicle			
	Lacks Skill to Recognize Road Situations			
	Lacks Skill to Judge & Anticipate Other Traffic			
	Lacks Attention Maintaining Habits			
	Lacks Habits to Resist Distractions			
	Impatience–Hurrying Unnecessarily			
	Doing Stunts–Racing			
	Showing Off–Impressing or Scaring Passengers			
	Overdoing–As on Long Trips			
	Slighting–Either Laziness or Carelessness			
	Taking Chances–Knowingly Doing Risky Things			
	Willful Violations			
	Depending on Other Users			
	Preoccupation–Thinking of Other Things			
	Impulsive Acts–Suicidal or Homicidal			
	Other Faulty Attitudes–Explain			
	Under Influence of Alcohol			
	Under Influence of Narcotics–Non-medicinal			
	Carbon Monoxide Poisoning			
	Under Medication–Prescribed or Patent Drugs			
	Sudden Illness–Heart Attack, Stroke, etc.			
	Fatigue, Exhaustion, etc.			
	Asleep			
	Other (explain)			

HIT & RUN INV INFO

Wanted Driver–Name | Address

Sex | Race | Age | How Dressed

Other Identifying Features

Color(s)	Year	Make	Model	License No.	State/Color(s)

Damage & Other Distinguishing Features

Did Any Conversation Take Place Between Suspect & Plaintiff? What Was Said?

Suspect Last Seen Going (Direction) | On What Road?

FOLLOW-UP INFO

Case Closed–Date | By Officer(s)

Reason | Approved By

Remarks | Report Number

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MARK ☒ NOT ☑. PRINT, DON'T WRITE

☐ Photos Taken	Taken By	Assisted By	Supervisor at Scene	Remarks
☐ Measurements				

SURFACE MARKS LEFT BY UNITS				SURFACE	UNIT 1	UNIT 2	UNIT 3
LEFT BY	UNIT 1	UNIT 2	UNIT 3	Type			
LF Tire				Width			
RF Tire				Condition			
LR Tire				Drag Factor Range			
RR Tire				Number of Lanes			
Oth. Left				Type Center Divider			
Oth. Right				View Obstruction			

Unit	Distance Danger of Collision Was First Noticed-In Feet	Estimated Speed at That Point	Estimated Speed at Time of Impact	Distance Unit Traveled After Impact-In Feet	Lawful Speed	Maximum Safe Speed Under Existing Cond.	Speed Estimates Were Determined By
1							
2							
3							

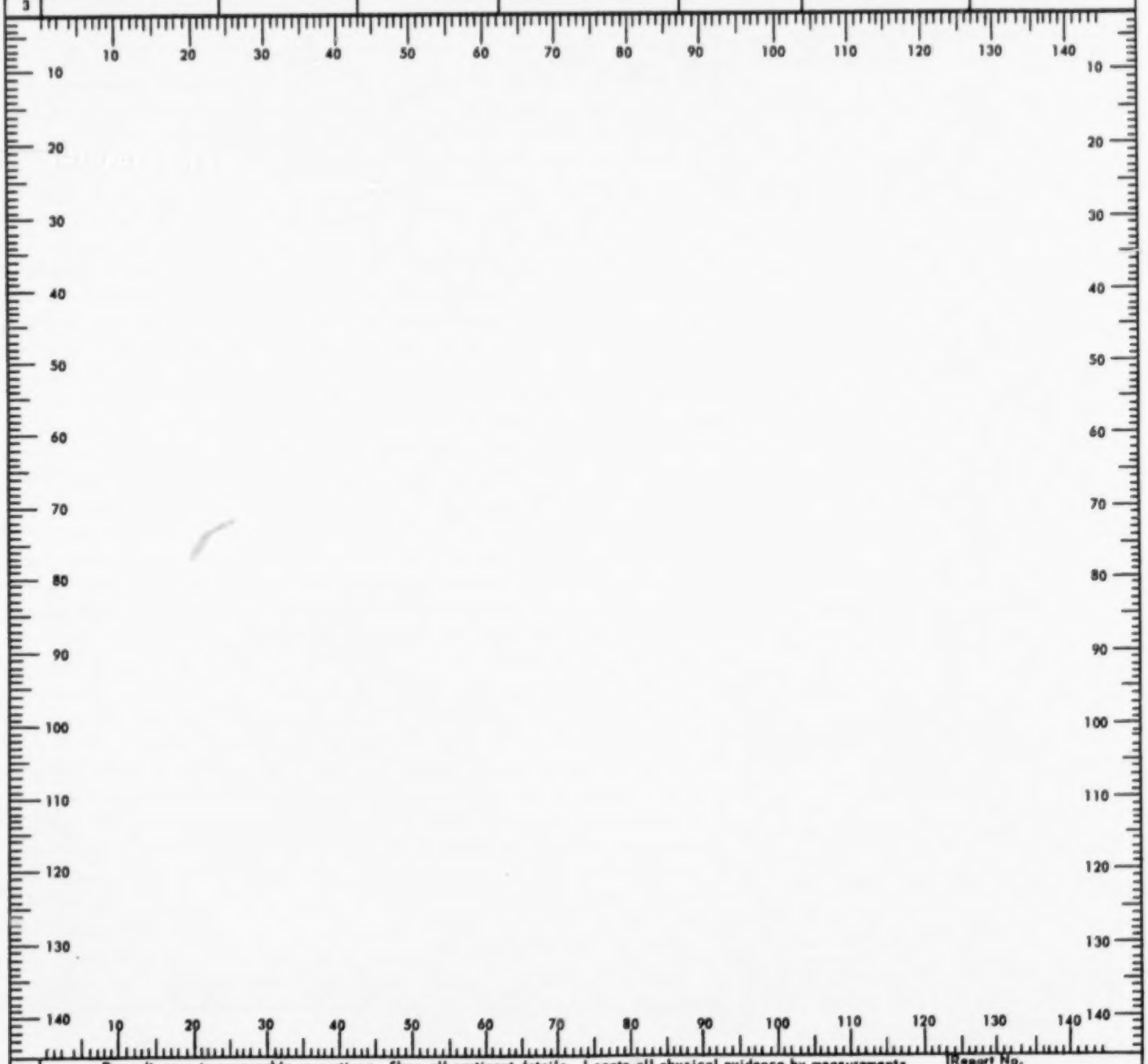

Draw diagram in reasonable proportions. Show all pertinent details. Locate all physical evidence by measurements. Show path each unit took before, during, and after the collision. Diagram can be drawn to scale by using the printed scale on this form. Scale is 1 inch = 20 ft. Show North by arrow.

Report No.

BSSA FORM ARS-3-INV

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STATE OF OHIO — **MOTOR VEHICLE ACCIDENT REPORT** — DEPARTMENT OF HIGHWAY SAFETY

LOCATION

PLACE OF ACCIDENT County..... City.....

If accident was outside city, show distance from nearest city or village corporation line..... .....miles N. ☐ S. ☐ E. ☐ W. ☐ of .....
Name of city, town, village or other reference point

ACCIDENT OCCURRED ON .....AT INTERSECTION OF.....
Name of street or highway number (US or State) — *Intersecting street or highway*

IF NOT AT INTERSECTION.....feet N. ☐ S. ☐ E. ☐ W. ☐ of .....
Name or otherwise identify the nearest intersecting street or highway, railroad crossing, bridge or other landmark.

TIME OF ACCIDENT — DATE..... DAY OF WEEK..... HOUR..... AM..... PM — LIGHT CONDITIONS.....
month day year — *day, night, dusk or dawn*

VEHICLE No. 1 — *In remarks and on accident diagram, refer to this vehicle as No. 1.*	VEHICLE No. 2 — *Refer to this vehicle as No. 2*
DRIVER.....Age..... Sex.....	DRIVER.....Age..... Sex.....
Street Address.....	Street Address.....
City and State.....	City and State.....
Driver's License..... *State Number Type (Operator, Chauffeur, etc.)*	Driver's License..... *State Number Type (Operator, Chauffeur, etc.)*
Vehicle going..... Speed.....MPH.....MPH *East, west turning north, parked, etc. stated estimated*	Vehicle going..... Speed.....MPH.....MPH *East, west turning north, parked, etc. stated estimated*
OWNER.....	OWNER.....
Street Address.....	Street Address.....
City and State.....	City and State.....
VEHICLE..... *Year Make Type (Sedan, truck, taxi, etc.)*	VEHICLE..... *Year Make Type (Sedan, truck, taxi, etc.)*
License..... *Vehicle License Plate State of Registration PUCO or ICC Number*	License..... *Vehicle License Plate State of Registration PUCO or ICC Number*
Damage.....	Damage.....
.....Estimate $.....	.....Estimate $.....
Vehicle removed to..... By..... *Name of Wrecking Co. Driver, owner, etc.*	Vehicle removed to..... By..... *Name of Wrecking Co. Driver, owner, etc.*

DAMAGE TO PROPERTY OTHER THAN VEHICLES .....
Name object, state nature of damage
.....Estimate $.....
Name and address of owner of damaged property

NAMES AND ADDRESSES OF KILLED AND INJURED	Car 1, 2	Age	Sex	Driver, Pass., Ped.	K-Killed I-Injured	Nature of Injuries

Number of Persons Killed and Injured in This Accident..... Injured taken to..... By.....
Hospital, physician, etc.

COLLISION OF MOTOR VEHICLE WITH ☐ Other motor vehicle(s) ☐ Pedestrian ☐ Non-collision ☐ Other .....
Train, bicycle, animal, fixed object, etc.

NAMES AND ADDRESSES OF WITNESSES

Form HP3 (Rev. 1-1-55)

Front Side — MOTOR VEHICLE ACCIDENT REPORT — Actual size 8-1/2" x 11"

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INDICATE ON THIS DIAGRAM WHAT HAPPENED

INSTRUCTIONS

1. Number each vehicle and show direction of travel by arrow.
2. Use solid line to show path of vehicle before accident.
3. Use dotted line to show path of vehicle after accident.
4. Show pedestrian by:
5. Show railroad crossing by:
6. Indicate north by arrow, as:

INDICATE

NORTH BY ARROW

Street name or highway number

Street or highway

Street or highway

WEATHER *(Check one)*

- ☐ Clear
- ☐ Cloudy
- ☐ Rain
- ☐ Snow
- ☐ Fog
- ☐ ..... *specify other condition*

ROAD CONTOUR *(Check two)*

- ☐ Straight
- ☐ Curve
- ☐ Level
- ☐ On grade
- ☐ Hill crest

ROAD CONDITION *(Check one)*

- ☐ Dry
- ☐ Wet
- ☐ Snow or ice
- ☐ ..... *specify other condition*

TRAFFIC CONTROL *(Check one or more)*

- ☐ Warning sign
- ☐ Stop sign
- ☐ Stop-and-go signal
- ☐ Railroad flasher
- ☐ ..... *specify other control*
- ☐ No control present

CONDITION OF DRIVER AND PEDESTRIAN *(Check one or more for each driver)*

Driver 1	2	3	Ped.	
☐	☐	☐	☐	Had not been drinking
☐	☐	☐	☐	Had been drinking
☐	☐	☐	☐	Body defects (eyes, etc.)
☐	☐	☐	☐	Apparently asleep
☐	☐	☐	☐	Illness
☐	☐	☐	☐	Apparently normal

VIOLATIONS OF DRIVER *(Check one or more for each driver)*

Driver 1	2	3	
☐	☐	☐	Exceeding speed limit
☐	☐	☐	Speed excessive for road and weather
☐	☐	☐	Did not grant right-of-way to vehicle
☐	☐	☐	Following too closely
☐	☐	☐	Passing on curve or hill
☐	☐	☐	Other improper passing
☐	☐	☐	Wrong side of road — not overtaking
☐	☐	☐	Failed to give turn signal
☐	☐	☐	Improper turn
☐	☐	☐	Disregarded stop sign
☐	☐	☐	Disregarded stop-and-go signal
☐	☐	☐	Other improper action (explain below)
☐	☐	☐	No improper action indicated

.....

.....

ACTIONS OF PEDESTRIAN *(Check one)*

- ☐ Crossing at intersection
- ☐ Crossing at other locations
- ☐ Crossing from behind parked cars
- ☐ Walking in road — with traffic
- ☐ Walking in road — against traffic
- ☐ Getting on or off other vehicle
- ☐ Playing in roadway
- ☐ Working in roadway
- ☐ Not in roadway
- ☐ Other action (explain below)

.....

.....

.....

.....

DESCRIBE WHAT HAPPENED
(Refer to vehicles by number)

Time Notified of Accident.....AM.....PM Arrived at Scene.....AM.....PM Time on Investigation.....

ARRESTS 1. ..... *Name* *and* *address* *Charge*

2. .....

PERSON SUBMITTING REPORT ..... *Name of investigating officer* *Department*

Date of Report ..... *Month* *Day* *Year*

Back Side MOTOR VEHICLE ACCIDENT REPORT Actual size 8-1/2" x 11"

17085

INJURED ARRESTEE FIELD REPORT

Arrestee:

Alcoholic breath?

Nature and extent of injuries:

Treatment Given

In your opinion is the physical condition of this Arrestee such that he may be held in custody in jail without endangering his life or health? Yes ☐ No ☐

Signed:

(M.D.-Interne)

Hospital:

Time Entered Hospital:

Date-

Brought In By Officer:

Nurses in Attendence

Time Discharged:

Date-

Officer:

17086

INDUSTRIAL ARTS CURRICULUM GUIDE
FOR
THE STATE OF WYOMING
GRADES K–12

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APPENDIX 24

C - Complainant

V - Victim

W - Witness (when used alone or with #)

W - White (only when used with another letter designating sex)

♂ M - Male

♀ F - Female

N - Negro

n - north

s - south

e - east

w - west

← l - left

→ r - right

f - front

|| - parallel to

⊥ - perpendicular

└ - right angle

" " - stated

- Number

S - Suspect

"—" - exact words used

↑ - up (or raise)

↓ - down (or lower)

+ - together with (intersection) plus

— - without (or removed) less

& - and

@ - at

c/a - carried away

c/t - carried to

c/u - carried up

c/d - carried down

ea - each

SAMPLE ABBREVIATION CHART

UCUTI 17087

A - Adam	N - Nora
B - Boy	O - Ocean
C - Charles	P - Paul
D - David	Q - Queen
E - Edward	R - Robert
F - Frank	S - Sam
G - George	T - Tom
H - Henry	U - Union
I - Ida	V - Victor
J - John	W - William
K - King	X - X-Ray
L - Lincoln	Y - Young
M - Mary	Z - Zebra

PHONETIC ALPHABET CHART

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LAWS OF SEARCH AND SEIZURE

B. NECESSITY; SEARCH WITHOUT WARRANT

§ 8. Generally.—A search warrant is not necessary to the legality of searches in all cases.[18] Police officers acting in good faith and upon information which induces in them an honest belief that a person is in the act of violating the law may make a search and seizure without a warrant.[19] An officer may, without a search warrant, seize contraband goods which he sees.[20]

16. RC § 2933.31 (GC § 13430-1).

17. RC § 2933.30 (GC § 13430-10).

18. United States v Pierce, 124 F Supp 264, 56 O Ops 44, 70 OL Abs 140, affd 224 F2d 281.

Annotation: Search and seizure, without warrant on suspicion or information as to unlawful possession of weapons. 92 ALR 490.

—Search of automobile without warrant by officers relying on description of persons suspected of crime. 60 ALR 299.

—Right to search or seize vehicle containing contraband as affected by the fact that it was stationary at the time. 61 ALR 1002.

—Entry and search of premises for purpose of arrest without search warrant. 5 ALR 263.

19. Houck v State, 106 OS 195, 140 NE 112; Porello v State, 121 OS 280, 168 NE 135; Walsh v State (App) 35 OLR 216, 11 OL Abs 28; Hartenstine v State, 24 ONP NS 1[illegible]; Cincinnati v Wagner, 27 ONP NS 445.

In Houck v State, supra, the court notes the similarity between the statutes authorizing an arrest without a warrant (see 5 O Jur 2d 31, ARREST §§ 19 et seq) and those relating to search and seizure.

Annotation: Accused's right to, and prosecution's privilege against, disclosure of identity of informer where issue is legality of search without warrant. 76 ALR2d 327.

20. Podner v State, 19 O App 82, 3 OL Abs 228, m c o 20 OLR 611, dismd for want of debat q 107 OS

Courtesy The Lawyers Co-operative Publishing Company

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Where property held illegally is not in sight of the officer, however, there must be probable cause for the search.[1] In the absence of such probable cause, the search is illegal,[2] even though it results in the discovery of contraband. An officer cannot act on a mere venture or exaggerated suspicion,[3] and after-acquired knowledge cannot legalize a search which was unlawful when made.[4] There must be such suspicious circumstances or such surrounding conditions that a reasonably prudent man would believe the person passing guilty of crime.[5] Officers without previous knowledge and without any information that would induce an honest belief that the defendant was violating the law cannot seize and search a person unless they have a search warrant and have previously arrested him.[6]

632, 141 NE 92; Dunning v Cincinnati, 21 ONP NS 468, 29 ODNP 472, affd by ct of app, m c o, m d p err sustained 18 OLR 24.

1. § 15, infra.

2. Bock v Cincinnati, 43 O App 257, 10 OL Abs 436, 183 NE 119, error dismd 124 OS 667, 181 NE 888.

The search of a person without probable cause or reasonable ground to believe that the person searched was committing a violation of law is unlawful unless the requirements of the statute, regulating the issuance of a search warrant have been complied with. State v Chick, 31 ONP NS 313, 15 OL Abs 529.

3. Cincinnati v Wagner, 27 ONP NS 445. In this case, the view is taken that the act of an officer, upon seeing a person under the influence of liquor and staggering and with the proverbial "bulge," in taking hold of his arm and feeling of the "bulge," which proves to be intoxicants, is not on probable cause.

4. Cincinnati v Fay, 27 ONP NS 520.

5. Rasey v Ciccolino, 1 O App 194, 18 OCC NS 331, 34 OCC 294. In this case, it appeared that the officers were warned that a certain fugitive was expected to get off of a train, and a police officer subsequently saw a man peaceably walking along the railroad track, but who did not answer the description of the fugitive, and there was nothing suspicious about him, and no indication that he even got off the train, and the court held that the police officer had no authority to stop him.

6. Cincinnati v Fay, 27 ONP NS 520, wherein it appeared that the officers entered a cigar store and saw the defendant talking with several men, and after he left them they seized him and searched his pockets and found a memorandum of a wager upon a horse race, without having previously placed him under arrest and without intending to place him under arrest unless they found the slip of paper, and wherein it appeared that they had no previous knowledge of the fact that he was carrying a race horse slip or any information that would induce an honest belief that the defendant was in the act of violating the law.

An officer is not entitled to search a person or premises without a search warrant unless he has information concerning a violation of law or sees the violation, and where officers arrest a person who had not violated any statute, law, or ordinance, or done anything which would give a reason to make an arrest, the arrest and search are unlawful. State v Mendel (Mun) 5 O Ops 311.

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The legality of a search without a warrant must be raised in the trial court.[7]

Searches for dead bodies without a warrant, but with the same power as officers executing a warrant, are authorized by statute under certain conditions.[8]

§ 9. Search Incident to Arrest.—Often, a search warrant is used for the purpose of procuring evidence of crime only and at a time when the offender is in custody,[9] and the right, without a search warrant, to search a person after a valid arrest, is well recognized.[10] Officers who have lawfully arrested a person may remove contraband property from his person, and if police officers find a person in possession of that which constitutes a violation of law and he puts the things unlawfully possessed in his pocket, they may, upon arresting him, forcibly take such property from his possession.[11] Thus, officers who have arrested one on the charge of carrying a concealed weapon may remove a revolver from his person.[12] Likewise, a person arrested without a warrant for having in his possession horse-racing slips, may be searched and the forbidden papers seized.[13] Intoxicating liquors on the person of one lawfully arrested may be seized without a search warrant.[14] However, it seems that the search of the person of one unlawfully arrested is illegal.[15]

§ 10. Search of Vehicles and Persons in Control Thereof.—If officers see a person in or about a motor vehicle illegally possessing contraband goods, they may search him and his automobile with-

7. Manley v State (App) 7 OL Abs 45.

8. § 7, supra.

9. Kovacs v State, 24 ONP NS 1.

10. Cardinal v United States, 79 F2d 825; United States v Pierce, 124 F Supp 264, 56 O Ops 44, 70 OL Abs 140, affd 224 F2d 281.

Annotation: Right of search and seizure incident to lawful arrest, without a search warrant. 32 ALR 680, s. 51 ALR 424, 74 ALR 1387, 82 ALR 782.

—Illustrations of distinction, as regards search and seizure, between papers or other articles which merely furnish evidence of crime, and the actual instrumentalities of crime. 129 ALR 1296.

11. Dunning v Cincinnati, 21 ONP NS 468, 29 ODNP 472, affd by ct of app, m c o, m d p err sustained 18 OLR 24; Cincinnati v Bush, 24 ONP NS 81.

12. Walsh v State (App) 35 OLR 216, 11 OL Abs 28.

13. 25 O Jur 2d 660, GAMBLING § 45.

14. Phillips v State, 105 OS 541, 138 NE 54. See also Hartenstine v State, 24 ONP NS 124.

15. State v Smith (CP) 19 O Ops 454, 33 OL Abs 272.

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out a search warrant.[16] An officer acting in good faith and upon information which he believes to be true may lawfully search an automobile or other vehicle without first obtaining a search warrant therefor, and having found property the possession of which is a violation of law, he is warranted in confiscating the goods and arresting the person in charge.[17] Such a search is authorized, even though the officer has no previous knowledge of such violation, provided he acts in good faith and upon such information as induces an honest belief that the person in charge of the automobile is in the act of violating the law; the search and seizure under such circumstances is not unreasonable and does not transgress Article 1, § 14 of the Ohio Constitution.[18]

§ 11. Search of Buildings.—Ordinarily, a search of a building cannot be lawfully made without a warrant,[19] and this includes

16. Decker v State, 113 OS 512, 150 NE 74, 42 ALR 1151; United States v Hilsinger, 284 F 585, 1 OL Abs 324.

With reference to violation of federal laws relating to taxation of intoxicating liquor, it has been held that where circumstances present facts within the personal knowledge of investigating officers, sufficient to lead a reasonably discreet and prudent man to believe that liquor is illegally possessed in an automobile, a search and seizure of such automobile, although without warrant, is not unlawful. Scher v United States, 95 F2d 64, affd 305 US 251, 83 L ed 151, 59 S Ct 174.

17. Houck v State, 106 OS 195, 140 NE 112; Porello v State, 121 OS 280, 168 NE 135; Frazier v Semoff, 21 O App 6, 4 OL Abs 701, 152 NE 780.

Where it appeared that the person whose automobile was searched without a warrant had the reputation of being a bootlegger and had attempted to conceal his identity and that of his automobile, and the officer knew of his alleged persistent violations of the law in transporting and selling liquor, and knew the license number of his automobile, and where at the time of the search he was in the act of transporting liquor for sale contrary to law—a search under such circumstances is not unreasonable and does not violate the constitutional provision. Houck v State, 16 O App 209, affd 106 OS 195, 140 NE 112.

In a case in which officers stopped a person driving a truck, thinking that he was transporting slot machines, and he was found to be transporting intoxicating liquor in violation of law, the court said that the seizure of contraband liquor was justifiable. Dworken v State (App) 29 OLR 52, 7 OL Abs 218.

18. Houck v State, 106 OS 195, 140 NE 112.

19. Hendershot v State, 14 O App 430; Knipp v Cincinnati, 29 ONP NS 209.

It has thus been held generally, and without referring to the existence of probable cause, that a police officer without a warrant has no authority to search a junk shop for stolen goods. Neifeld v State, 3 OCC NS 551, 23 OCC 246.

Annotation: Searches and seizures by health officers without warrant. 13 ALR2d 969.

—Premises temporarily unoccupied as dwelling within provision

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a closed garage in the rear of the defendant's home.[20] However, there may be circumstances under which the search of a building without a warrant is permissible. If police officers are fairly certain that a house is being used for unlawful purposes, they may enter it, by force, if necessary, and make arrests therein without first securing a search warrant.[1]

If an officer is informed that there is a disturbance at a particular residence and he goes there and is admitted and finds therein contraband property, which he confiscates, the residence ceases to be a bona fide private residence, and the fact that the officer did not have a search warrant is not fatal to the proceeding.[2] Officers lawfully in a house for a particular purpose may arrest for other crimes they see being committed and seize the evidence of crime which they see,[3] but they have no authority to search the whole house, without a warrant, for evidence of other crimes.[4]

In a number of cases decided under a former intoxicating liquor statute, the opinion was expressed that when a house had lost its character as a bona fide residence it might be searched without a warrant.[5] Prohibition officers under the former intoxicating liquor laws were held justified in entering, without a warrant, a brewery engaged, under a permit from internal revenue, in the manufacture of near beer, a taxable product, and also in searching

forbidding unreasonable search of dwelling. 33 ALR2d 1430.

20. Antoszewski v State (App) 5 O Ops 264, 21 OL Abs 345, 31 NE2d 881.

The constitutional guaranty is not limited to dwelling houses proper; it extends to a garage on the residence property. Antoszewski v State, supra; United States v Slusser, 270 F 818.

1. Davis v State (App) 35 OLR 194, 10 OL Abs 550.

2. Podner v State, 19 O App 82, 3 OL Abs 228, m c o 20 OLR 611, and dismd for want of debat q 107 OS 632, 141 NE 92.

3. Cincinnati v Mills, 27 ONP NS 473.

4. Cincinnati v Mills, supra.

Where an officer was lawfully in one room of a residence for the purpose of executing a warrant of arrest of a person for disorderly conduct he has no right, upon smelling the odor of beer in the house, to search other rooms thereof without a warrant. Cincinnati v Mills, supra.

Officers at a residence for the purpose of investigating a particular crime have no authority to search the residence for intoxicating liquor. Nekruta v State (App) 31 OLR 320, 8 OL Abs 11.

5. Hornack v State, 39 O App 203, 10 OL Abs 113, 177 NE 244; Hamerick v Youngstown (App) 7 OL Abs 251; Wade v State (App) 31 OLR 104, 8 OL Abs 95; Florea v Cleveland (App) 34 OLR 484, 9 OL Abs 459; Alderman v Lakewood (App) 11 OL Abs 163.

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for contraband, and in seizing any contraband they found there.[6] But premises cannot be searched without a warrant and without circumstances indicating illegal trafficking in liquor merely because at a prior date the occupant of such premises was found guilty of unlawfully possessing intoxicating liquor on such premises.[7]

§ 12. Consent to Search.—An officer may search premises without a warrant if it is done with the owner's consent[8] or if the owner assists in conducting the search.[9] The fact that a search warrant was based upon an insufficient affidavit is immaterial where the officers did not enter the building in question by reason of the search warrant, but were admitted by the occupant,[10] and a suspected person waived his constitutional rights by telling

6. United States v Hilsinger, 284 F 585, 1 OL Abs 324.

7. Strauss v Cleveland (App) 11 OL Abs 268, wherein the court said that merely because the owner of a residence had been found guilty of unlawfully possessing intoxicating liquor in such residence did not mean that the residence had perpetually lost its bona fide character.

8. Gilmore v State, 15 O App 432; Podner v State, 19 O App 82, 3 OL Abs 228, m c o 20 OLR 611, dismd for want of debat q 107 OS 632, 141 NE 92; Veal v State, 32 OCA 281, 45 OCC 744.

Agents and employees of the Department of Liquor Control are exempt from the provisions relative to search warrants in connection with violations of the liquor laws. Moreover, if it could be said that a liquor permittee's constitutional rights were invaded, it is such a constitutional right as could be waived, and by securing a permit and electing to operate under the Liquor Control Act, he has waived the constitutional protection, if any, of the Ohio Constitution as to the right to search his premises and seize property if found to be in violation of law. Hurless v Department of Liquor Control (App) 73 OL Abs 161, 136 NE2d 736, dismd for want of debat q 164 OS 492, 58 O Ops 331, 132 NE 2d 107, and reh den 75 OL Abs 70, 142 NE2d 667.

In Hahn v State, 38 O App 461, 176 NE 164, error dismd 123 OS 675, 177 NE 585, a prosecution for murder, where the defendant, before the jury was impaneled, moved the court to require the sheriff and prosecuting attorney to return to him certain property which they had seized at or about the time of his arrest, the property seized consisting of parts of the automobile in which it was claimed by the State that the murdered man was conveyed to a creek, and where it was shown that the automobile belonged to the defendant's father and was seized upon a search by the officers with the consent of the owner of the premises on which the automobile was found, it was held that there was no error in overruling the motion for the return of the property taken, the court stating that the defendant certainly would not have the right to demand the return to him of articles which he did not own, and which were not in his possession at the time of seizure.

9. Carmosino v State (App) 27 OLR 623, 6 OL Abs 688 (gambling machines).

10. Renda v State (App) 14 OL Abs 639.

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the officers to search him and his car if they so desired as he had nothing illegal in his possession.[11] But the mere failure to resist the officer does not show consent.[12] For example, the statement of the owner, when told by the officers that they were there to search his premises, to "go ahead," is not a waiver of the owner's rights, but a peaceful submission to officers of the law.[13]

Consent of one person, such as an employee, does not waive the necessity of a warrant as against another person, for example, the employer.[14] Also, even assuming that a wife in the absence of her husband may waive his constitutional immunity against search of his dwelling as granted by § 14, Article 1, of the Constitution of Ohio, such waiver cannot be said to have occurred where the testimony as to the wife's assent is conflicting, and there is a probability that any assent given was by reason of the coercive influence of an officer or officers of the law.[15]

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FORMATION TO DISPERSE GATHERING

Squad Wedge

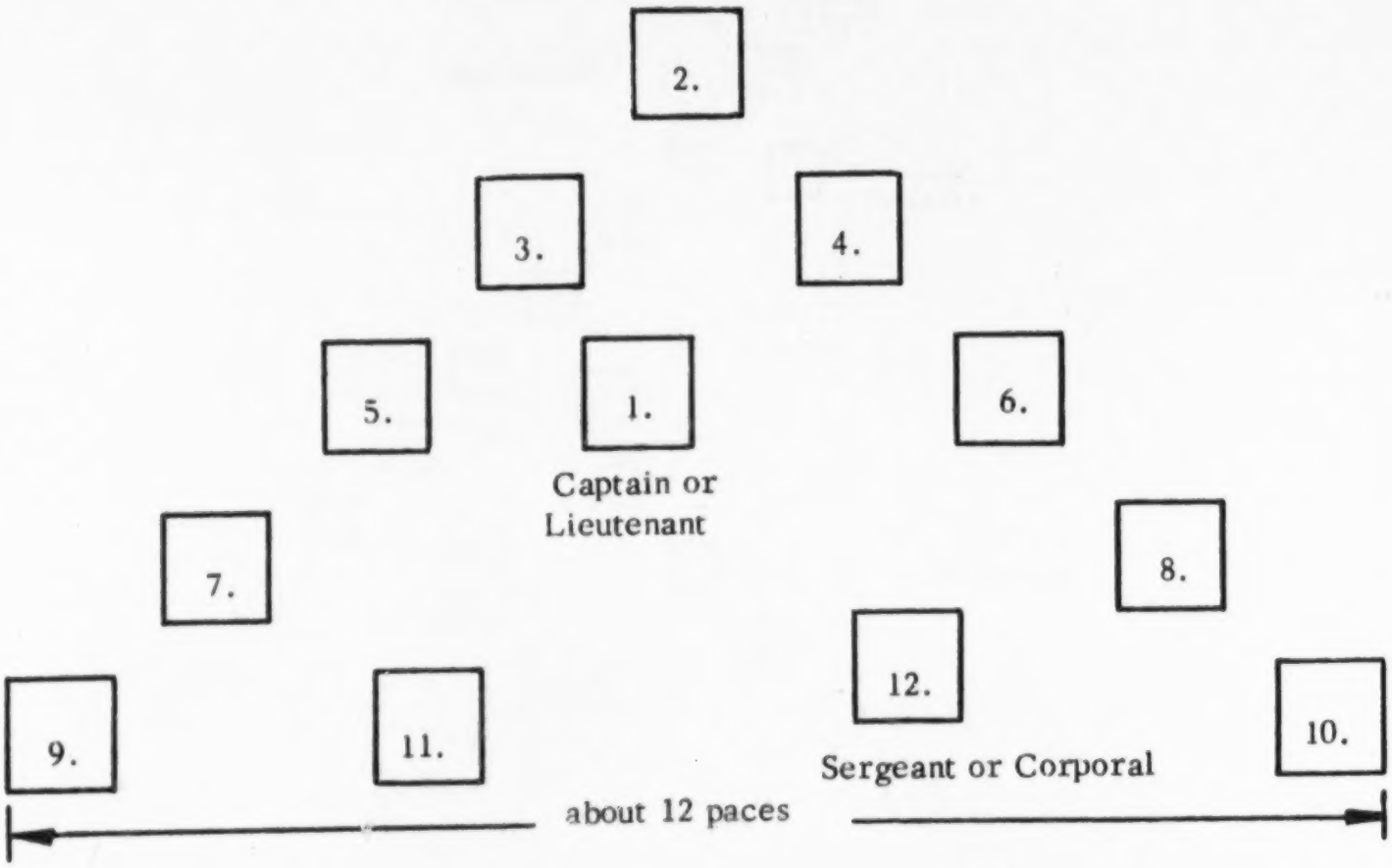

The squad wedge should be used when the gathering is small enough not to require more than a squad. This is used in splitting a gathering to apprehend a ringleader or just to split into smaller groups.

Squad = 12 officers - 1 command officer - 1 supervisor - (Sgt.-Cpl.) 10 Ptl.

Space between men - 1 pace to right or left - 1 pace rear - odd numbers to left - even numbers to right.

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The Committee is grateful for the advice and information received from other state departments of education regarding the progress that they have made in the field of industrial arts education.

Acknowledgement must also be given to those persons who have contributed so much of their time in the preparation and publication of this document.

A special acknowledgement is also due the Wyoming Research Coordinating Unit, State Department of Education, which provided the necessary funds and encouragement for the development and publishing of this guide. The original stimulus for the development of this guide was provided by Larry Erickson, Industrial Arts teacher, Torrington, Wyoming schools, via his project development proposal to the RCU.

The Curriculum Committee is extremely grateful to Donald L. Jeanroy, project coordinator, and RCU graduate research assistant, who provided the direct organizational structure, initial to accomplish the development of this guide.

FOREWORD

The Occupational Education Section of the State Department of Education is currently developing a Comprehensive Occupational Education Model for the State of Wyoming. This model includes a world of work attitude phase at the elementary school level; a career orientation phase at the junior high school level; a career exploration phase at the upper junior and lower senior high school; and a career development phase at the upper senior high and community college levels.

This Industrial Arts Guide is a working paper developed by a committee of Industrial Arts Teachers last year and will be used as a study to develop a portion of the career exploration phase.

Dr. Dean Talagan
Coord. Occupational Education
State Department of Education

APPENDIX 28

FORMATION TO DISPERSE GATHERING

Squad Diagonal Right or Left

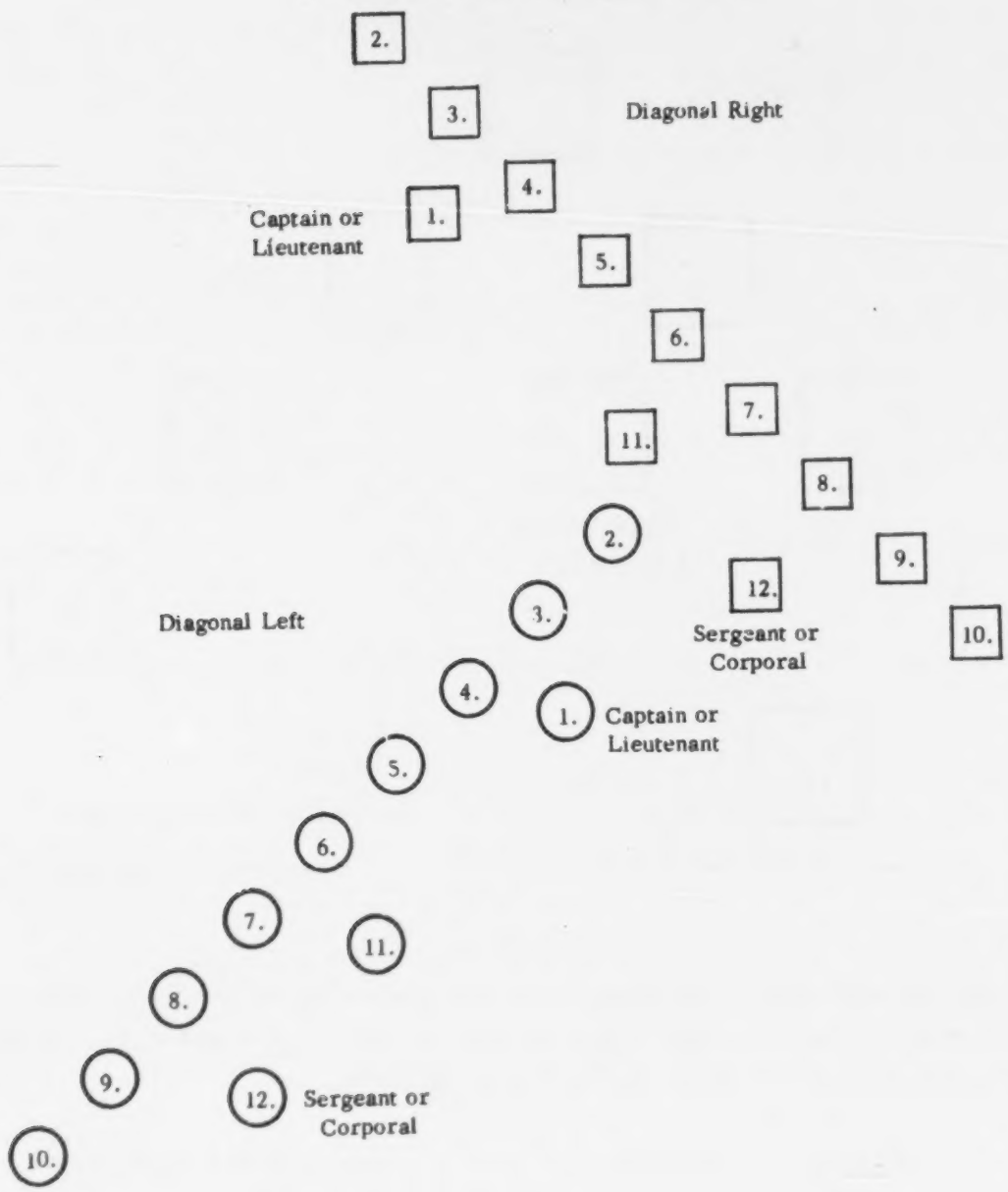

The squad diagonal is to be used for dispersing small gatherings. Its purpose is to move people away from a wall, building or to clear a street.

17097

FORMATION TO DISPERSE GATHERING

Squad Side Wedge

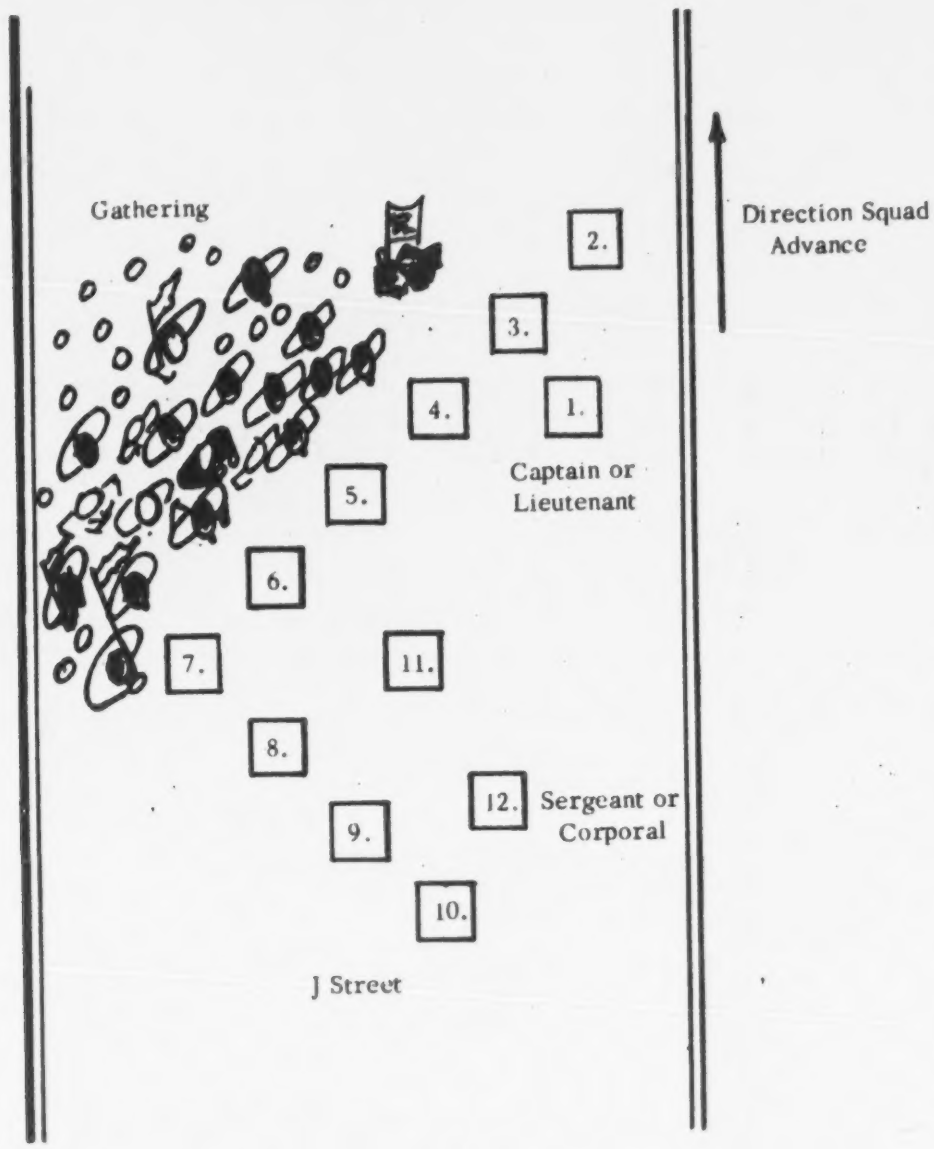

This movement will prevent people from closing inside and in rear of squad. It is a variation of the squad wedge and diagonal.

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APPENDIX 30

FORMATION TO HOLD - DEFENSIVE

Squad Skirmish

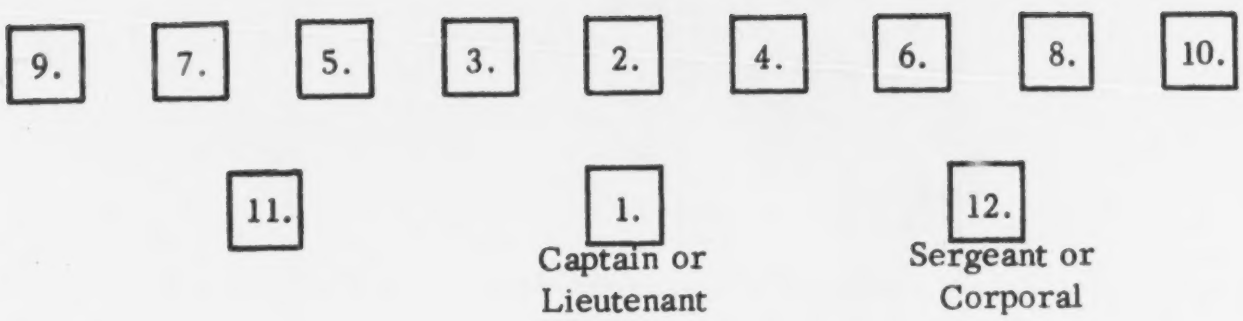

The purpose of the squad skirmish deployment is to hold an objective taken. It is used strictly as a defensive measure.

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APPENDIX 31

SAMPLE FORMAT FOR REQUEST FOR DISPERSAL

This is officer_____of the_____
(name) (Police-Sheriff's Dept.)
_____ may I have your attention and cooperation. This gathering is requested to disperse so as to avoid possible injuries or arrests to any or all persons involved. You have been participating in a gathering which is in violation because it is no longer a peaceful assembly. Serious injury or a crime may result from your actions. You have_____minutes
(number)
to leave. You may leave by_____
(Name(s) of streets-exits)
I wish to thank you for your cooperation.

APPENDIX 32

SAMPLE FORMAT FOR ORDER FOR DISPERSAL

"I, officer_____ of the_____
(name) (Police-Sheriff's Dept.)
acting under authority of Section 3761.14 of the Ohio Revised Code, do command you in the name of the State of Ohio to disperse and depart to your several homes or lawful employment." You have_____minutes to disperse. (number)

ANY PERSONS REMAINING ARE SUBJECT TO ARREST.

17100

APPENDIX 33

INTERSECTIONS & OTHER TYPE TRAFFICWAY CONTROL POINTS

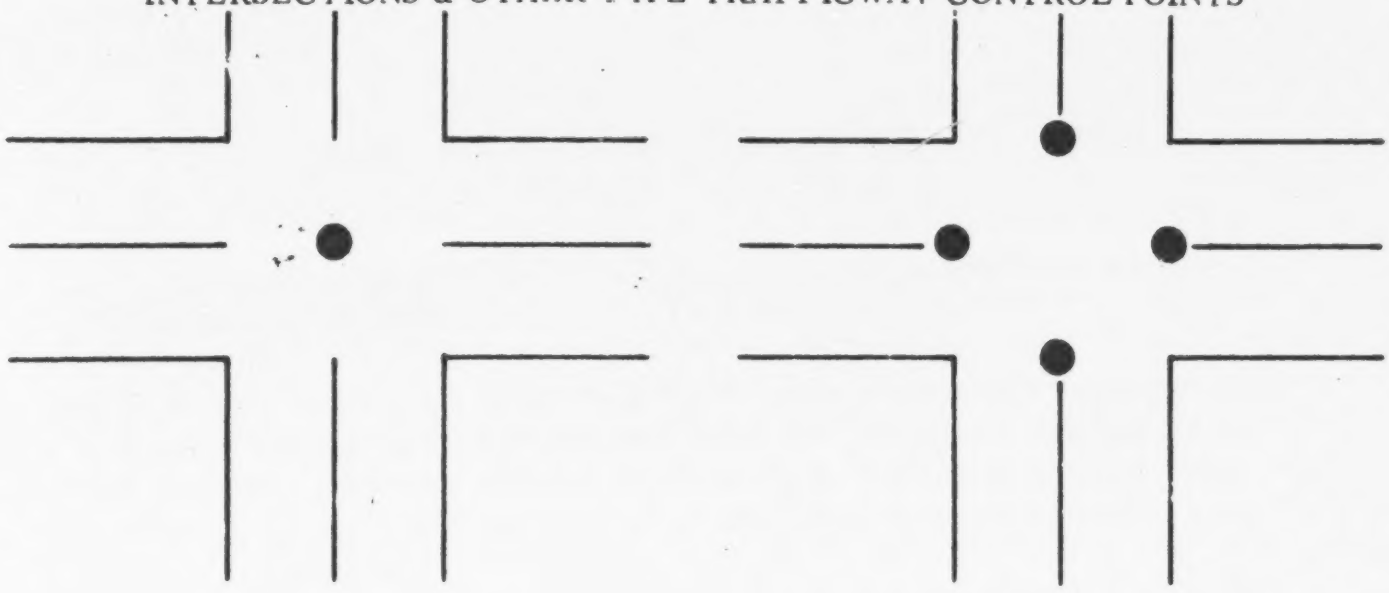

INTERSECTION TRAFFIC CONTROL POINT FOR OFFICER

● - OFFICER OR ASSISTANT

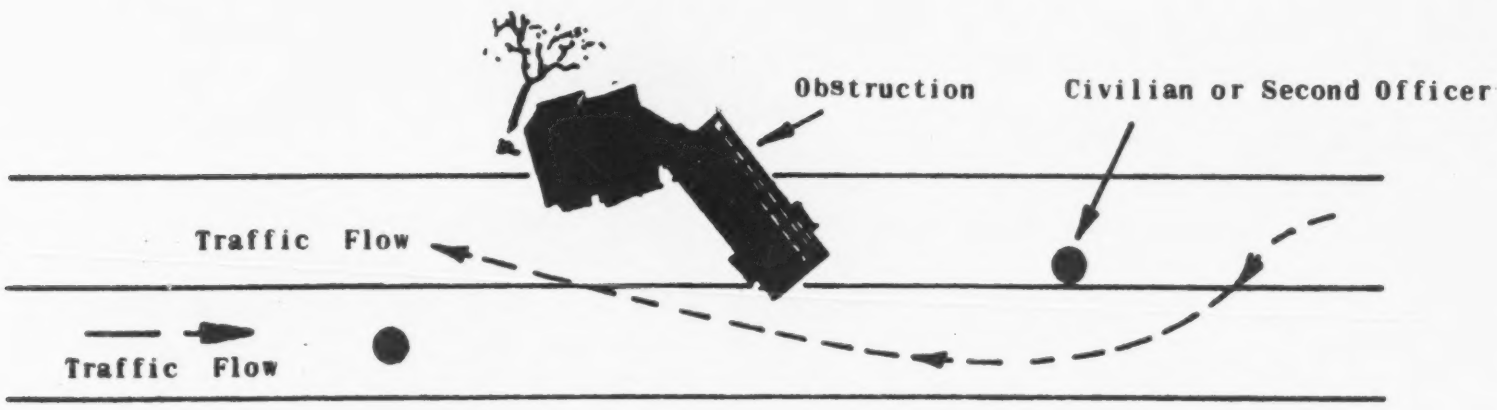

POSITION FOR STRAIGHT-AWAY CONTROL BY OFFICER

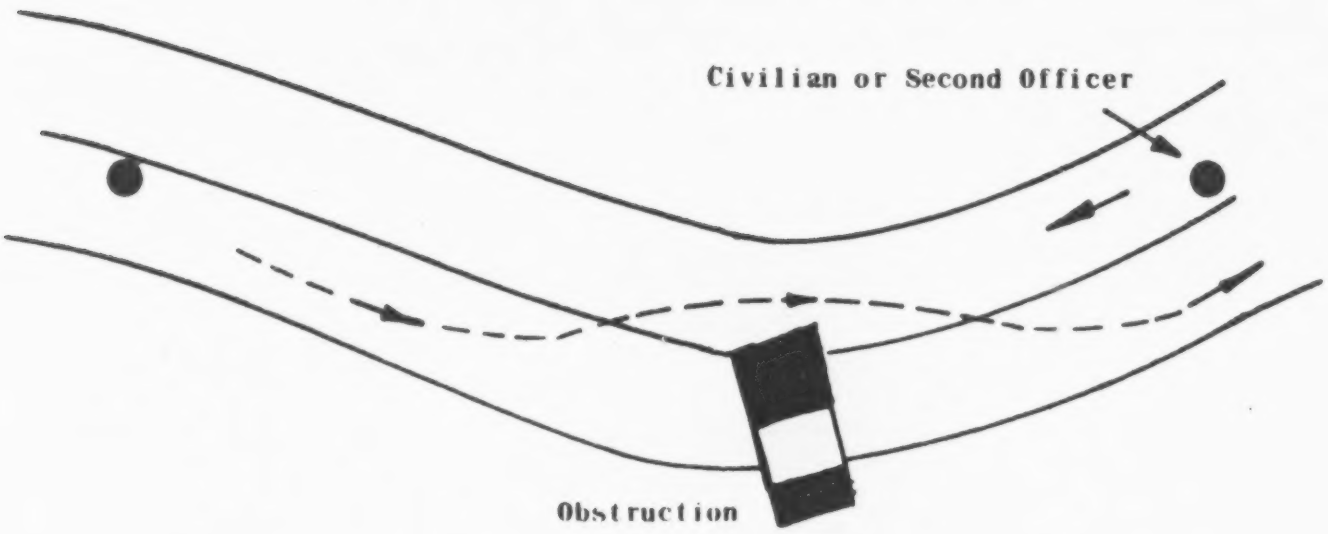

TRAFFIC CONTROL POINT FOR OFFICER ON GRADE OR CURVE

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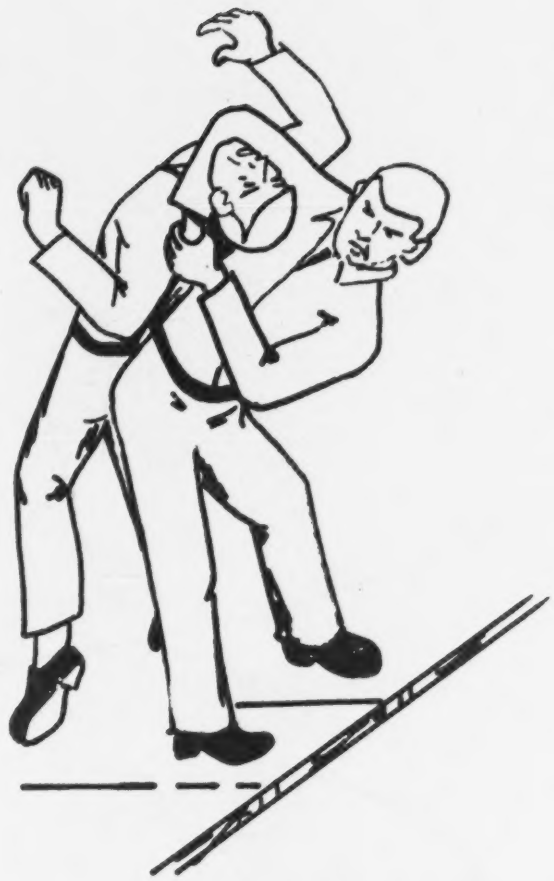

Rear Strangle Lock - Take Down

1. Get behind person
2. Place forearm around throat
3. Strike sharp blow with palm of free hand to kidney (if necessary)
4. Lock hands
5. Step forward
6. Jerk person backward onto hip and small of back
7. Flex muscles of lower and upper arm around throat
8. Hold till under control
9. Take down to floor or ground
10. Apply restraint device

WARNING: Blood circulation is blocked from this hold thereby causing a blackout or death if held too long.

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APPENDIX 35

Hands to Heel and Knee - Take Down

1. Feign blow to head
2. Drop quickly to one knee
3. Grasp ankle or heel with strong hand
4. Place weak hand on kneecap
5. Jerk ankle or heel towards you
6. Push knee away

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Rear Kick to Knee - Take Down

1. Grasp shoulders or arms
2. Kick back of knee
3. Pull backward and downward
4. Stepping back and to side opposite foot used
5. Continuing pull backwards and downwards to ground or floor

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APPENDIX 37

VULNERABLE POINTS OF ATTACK

This chart shows some of the vital nerve and pressure point areas used in self-defense

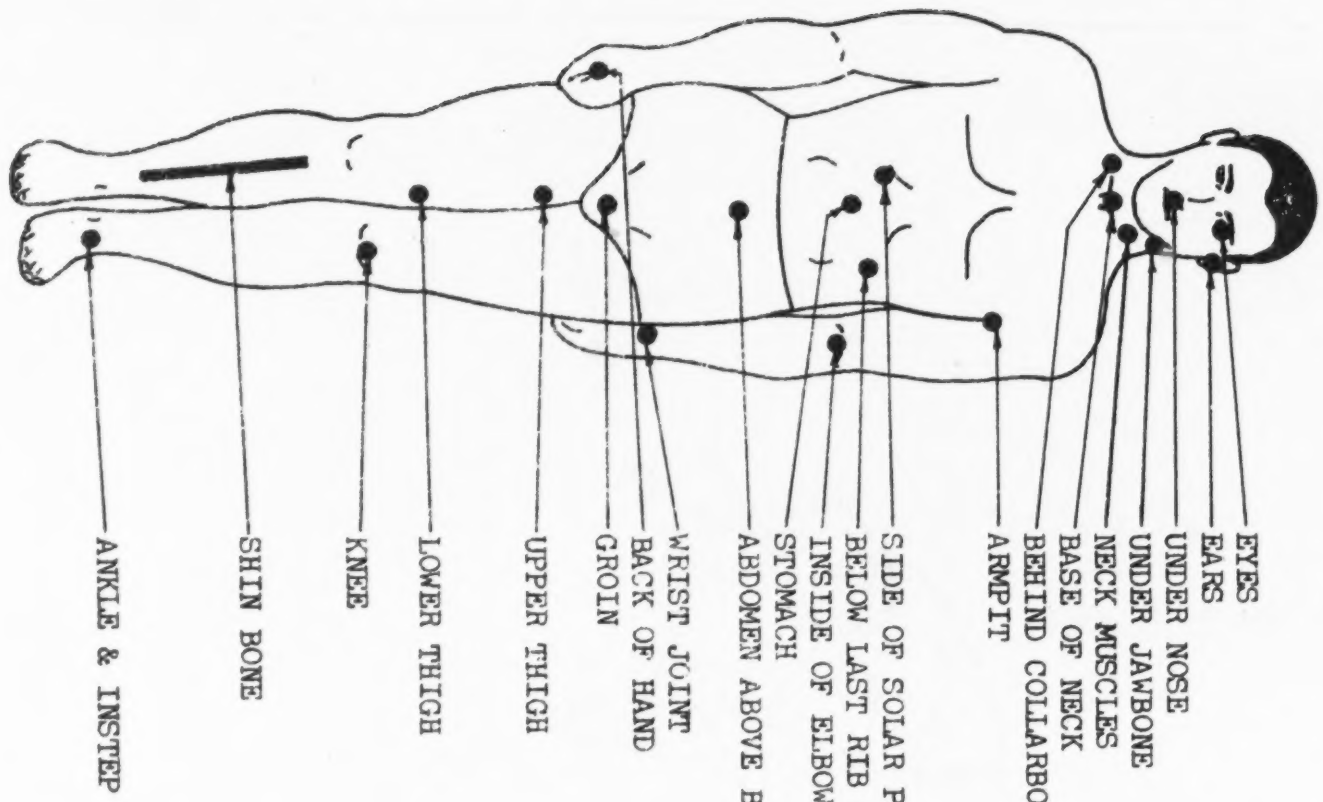

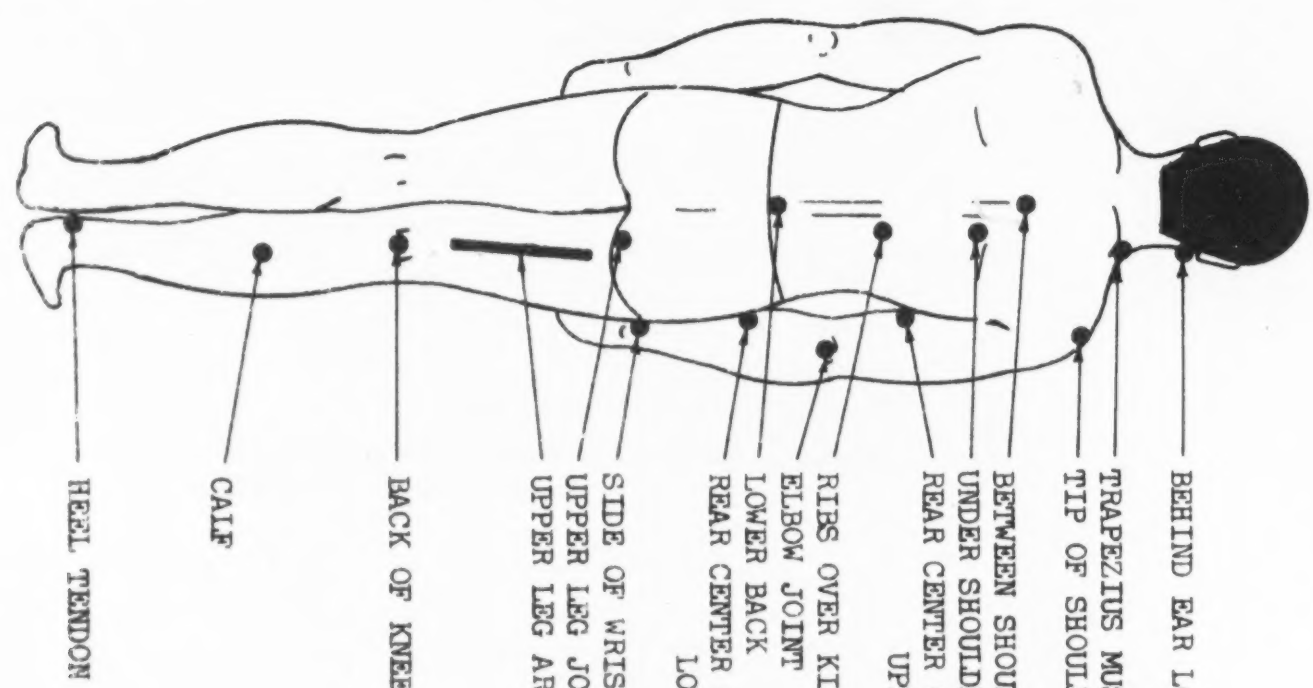

17105

COMMERCIAL RESTRAINT DEVICES

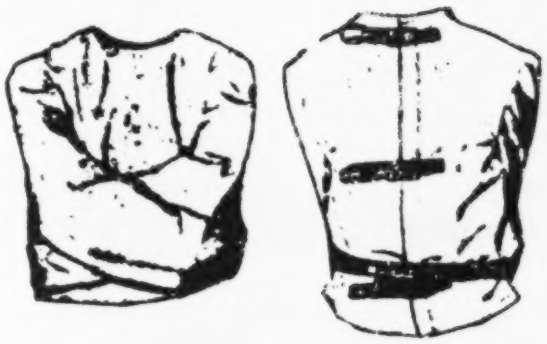

STRAIT JACKET

ANKLETS WITH LOCK ON EACH CUFF

WAIST STRAP WITH BUCKLE LOCK

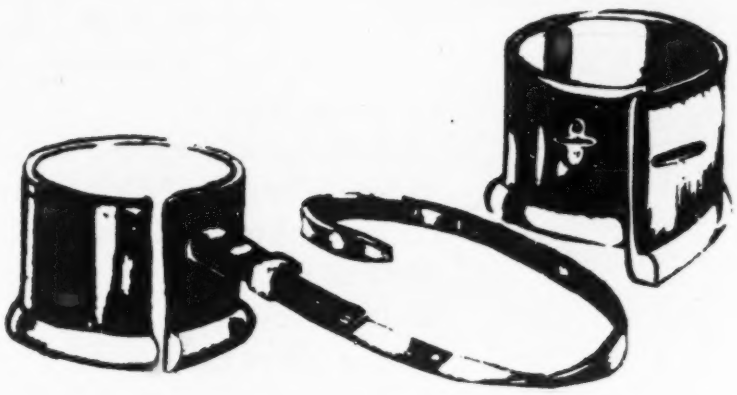

ANKLETS WITH LOCK STRAP

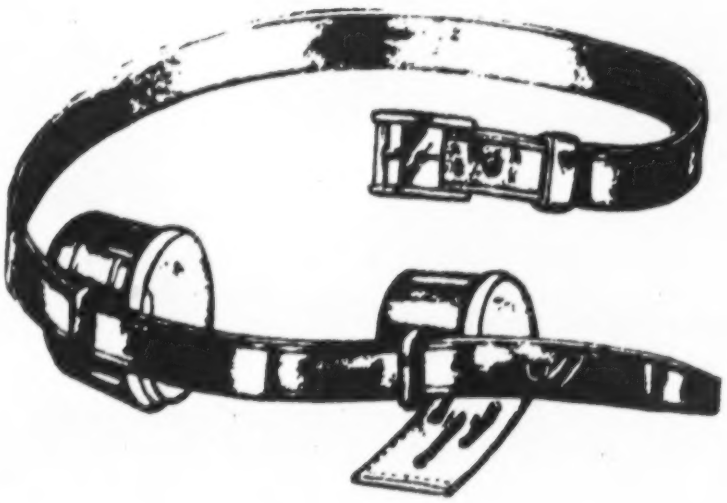

WRISTLETS WITH WAIST STRAP

ALL PURPOSE LOCK STRAPS

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ACKNOWLEDGEMENTS

This first edition of the Industrial Arts Curriculum Guide for the State of Wyoming has been prepared primarily to assist the industrial arts teacher in improving the quality of industrial arts instruction. It has been designed to be flexible in its scope and broad in its treatment of industrial arts content, yet limited in detail. It is intended to serve as a guide for the teacher in the preparation of instructional materials suitable for his particular situation.

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APPENDIX 39

PARTIAL LIST OF COURT DOCUMENTS

Summons - Money Only
Summons - On Answer and Cross-Petition
Summons - In Action for Divorce and Alimony
Summons - On Answer and Cross Petition in Divorce
Notice to Petit Juror
Subpoena - Grand Jury
Subpoena - Duces Tecum
Subpoena - Petit Jury
Subpoena - Criminal Case
Order of Attachment
Inventory and Appraisement of Property Attached
Affidavit for Order of Delivery - In Replevin
Verdict - For Plaintiff - In Replevin
Verdict - For Defendant - In Replevin
Order of Sale
Certificate of Release and Satisfaction of Mortgage
Journal Entry. Order Approving Appraisement and for Bond
Order of Appraisement
Writ of Partition
Writ of Dower
Notice (General Form)
Warrant to Arrest on Indictment
Warrant to Arrest on Information
Warrant to Arrest
Bench Warrant
Indictment for - - - - - - - -
Petition for Habeas Corpus
Writ of Habeas Corpus - in custody
Writ of Habeas Corpus - not in custody
Notice of Application for Temporary Alimony
Praecipe for Subpoena. Civil Case
Praecipe for - - - - - - - - -
Waiver of Notice or Summons and Appearance
Waiver of Summons and Appearance - civil action
Summons - Probate Court
Subpoena - Probate Court

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Civil Process Service - Terms Commonly Used.

GLOSSARY:

1.	Amercement -	usually monetary penalty imposed by a court upon its own officers for neglect of duty, or failure to pay over moneys collected. In particular, the remedy against the sheriff for failing to levy an execution or make return of proceeds of sale.
2.	Answer -	in pleading, under the Codes of Civil Procedure, the answer is the formal written statement made by a defendant setting forth the grounds of his defense.
3.	Attachment -	The act or process of taking, apprehending, or seizing persons or property, by virtue of a writ, summons, or other judicial order, and bringing the same into the custody of the law; used either for the purpose of bringing a person before the court, of acquiring jurisdiction over property seized, to compel an appearance, to furnish security for debt or costs, or to arrest a fund in the hands of a third person who may become liable to pay it over.
4.	Bench Warrant -	Process issued by the court itself, or "from the bench," for the attachment or arrest of a person; either in case of contempt, or where an indictment has been found, or to bring in a witness who does not obey a subpoena.
5.	Capias - Latin	"That you take." The general name for several species of writs, the common characteristic of which is that they require the officer to take the body of the defendant into custody; they are writs of attachment or arrest.

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Civil Process Service - Terms Commonly Used.

6.	Constructive service of process -	Any form of service other than actual personal service: notification of an action or of some proceeding therein, given to a person affected by sending it to him in the mails or causing it to be published in a newspaper.
7.	Defendant -	the person defending or denying: the party against whom relief or recovery is sought in an action or suit.
8.	Demurrer -	the formal mode of disputing the sufficiency in law of the pleading of the other side. An objection made by one party to his opponent's pleading, alleging that he ought not to answer it, for some defect in law in the pleading.
9.	Duces Tecum - Latin "to bring with you"	the name of a certain species of writs, of which the subpoena duces tecum is the most usual, requiring a party who is summoned to appear in court to bring with him some document, piece of evidence, or other thing to be used or inspected by the court.
10.	Habeas Corpus -	(you have the body) The name given to a variety of writs, (of which these were anciently the emphatic words,) having for their object to bring a party before a court or judge.
11.	Indictment -	An accusation in writing found and presented by a grand jury, legally convoked and sworn, to the court in which it is impaneled, charging that a person therein named has done some act, or been guilty of some omission, which, by law, is a public offense, punishable on indictment.

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Civil Process Service - Terms Commonly Used.

12.	Injunction -	A prohibitive writ issued by a court of equity, at the suit of a party complainant, directed to a party defendant in the action, or to a party made a defendant for that purpose, forbidding the latter to do some act, or to permit his servants or agents to do some act, which he is threatening or attempting to commit, or restraining him in the continuance thereof, such act being unjust and inequitable, injurious to the plaintiff, and not such as can be adequately redressed by an action at law.
13.	Mandamus -	We command. This is the name of a writ which issues from a court of superior jurisdiction, and is directed to a private or municipal corporation, or any of its officers, or to an executive, administrative or judicial officer, or to an inferior court, commanding the performance of a particular act therein specified, and belonging to his or their public, official, or ministerial duty, or directing the restoration of the complainant to rights or privileges of which he has been illegally deprived.
14.	Personal service -	Personal service of a writ or notice is made by delivering it to the person named, in person, or handing him a copy and informing him of the nature and terms of the original.
15.	Plaintiff -	a person who brings an action: the party who complains or sues in a personal action and is so named on the record.

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Civil Process Service - Terms Commonly Used.

16.	Praecipe -	An original writ, drawn up in the alternative, commanding the defendant to do the thing required, or show the reason why he had not done it. Also an order, written out and signed, addressed to the clerk of a court, and requesting him to issue a particular writ.
17.	Replevin -	A personal action from a delict, tort, fault, crime or misfeasance brought to recover possession of goods unlawfully taken.
18.	Residential Service -	leaving the writ or notice at the usual residence of the person named therein only after diligent effort has been put forth to establish that the person named therein does actually reside at the residence.
19.	Rule to Show Cause -	A rule commanding the party to appear and show cause why he should not be compelled to do the act required, or why the object of the rule should not be enforced.
20.	Subpoena -	The process by which the attendance of a witness is required is called a "subpoena." It is a writ or order directed to a person, and requiring his attendance at a particular time and place to testify as a witness.
21.	Summons -	A writ, directed to the sheriff or other proper officer, requiring him to notify the person named that an action has been commenced against him in the court whence the writ issues, and that he is required to appear, on a day named, and answer the complaint in such action.

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Civil Process Service - Terms Commonly Used.

22. Warrant -

1. A writ or precept from a competent authority in pursuance of law, directing the doing of an act, and addressed to an officer or person competent to do the act, and affording him protection from damage, if he does it.
2. Particularly a writ or precept issued by a magistrate, justice, or other competent authority, addressed to a sheriff, constable, or other officer, requiring him to arrest the body of a person therein named, and bring him before the magistrate or court, to answer, or be examined, touching some offense which he is charged with having committed.

23. Writ -

A precept in writing, couched in the form of a letter, running in the name of the king, president, or state, issuing from a court of justice, and sealed with its seal, addressed to a sheriff or other officer of the law, or directly to the person whose action the court desires to command, either as the commencement of a suit or other proceeding or as incidental to its progress, and requiring the performance of a specified act, or giving authority and commission to have it done.

(Courtesy of West Publishing Company, Black's Law Dictionary)

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APPENDIX 41

POTENTIAL SOURCES FOR PREPARED CRIME PREVENTION MATERIALS

This is not a comprehensive list of all available sources. It should be born in mind that this also provides a guide to sources of information and safety materials.

Automobile Club
Bankers Association
Better Business Bureau
Chamber of Commerce
Civil Defense
Federal Bureau of Investigation
Federal Post Office Department
Federal-State-Local Departments of Health
Federal Treasury Department
Insurance Companies
National Auto Theft Bureau
National Safety Council
Police and Sheriffs Departments
Publishers - Newspaper and others
State Bureau of Motor Vehicles
State Department of Agriculture
State Department of Commerce
State and Federal Narcotics Bureau
State Fire Marshal
State Highway Department
State Department of Liquor Control
State Department of Natural Resources
Telephone Company
Utilities

17113

SUGGESTED LIST OF CRIMES FOR WHICH PREVENTION SHOULD BE LEARNED AND ADVOCATED

This is not an exhaustive list but rather one that includes those crimes usually occurring most often. You may add your list to these.

Auto Theft
Bogus Check
Burglary
Child Molestation
Confidence Rackets
Counterfeit Money
Employee Theft
Larceny
Robbery
Shoplifting
Till-tapping

17114

APPENDIX 43

PERSONS REPORT

Suspicious Wanted Missing

Name-
Alias-
Address-
City- State-
Telephone-

PERSONAL:
Sex- Color-
Nationality-
Birthdate-
Birthplace-
Height- ' " Weight- lbs.
Build-
Hair-
Eyes-
Complexion-
Beard-
Characteristics-

Occupation-
Employer-

Hangout-

Front Side

DRESS:
Headdress-
Mask-
Outer Garment-
Neckwear-
Upper Garment-
Lower Garment-
Gloves-
Stockings-
Footwear-
Jewelry-

VEHICLE:
Make-
Model-
Body-
Year-
Color-
License-
State-
Characteristics-

REMARKS:

Back Side

PERSONS REPORT

17115

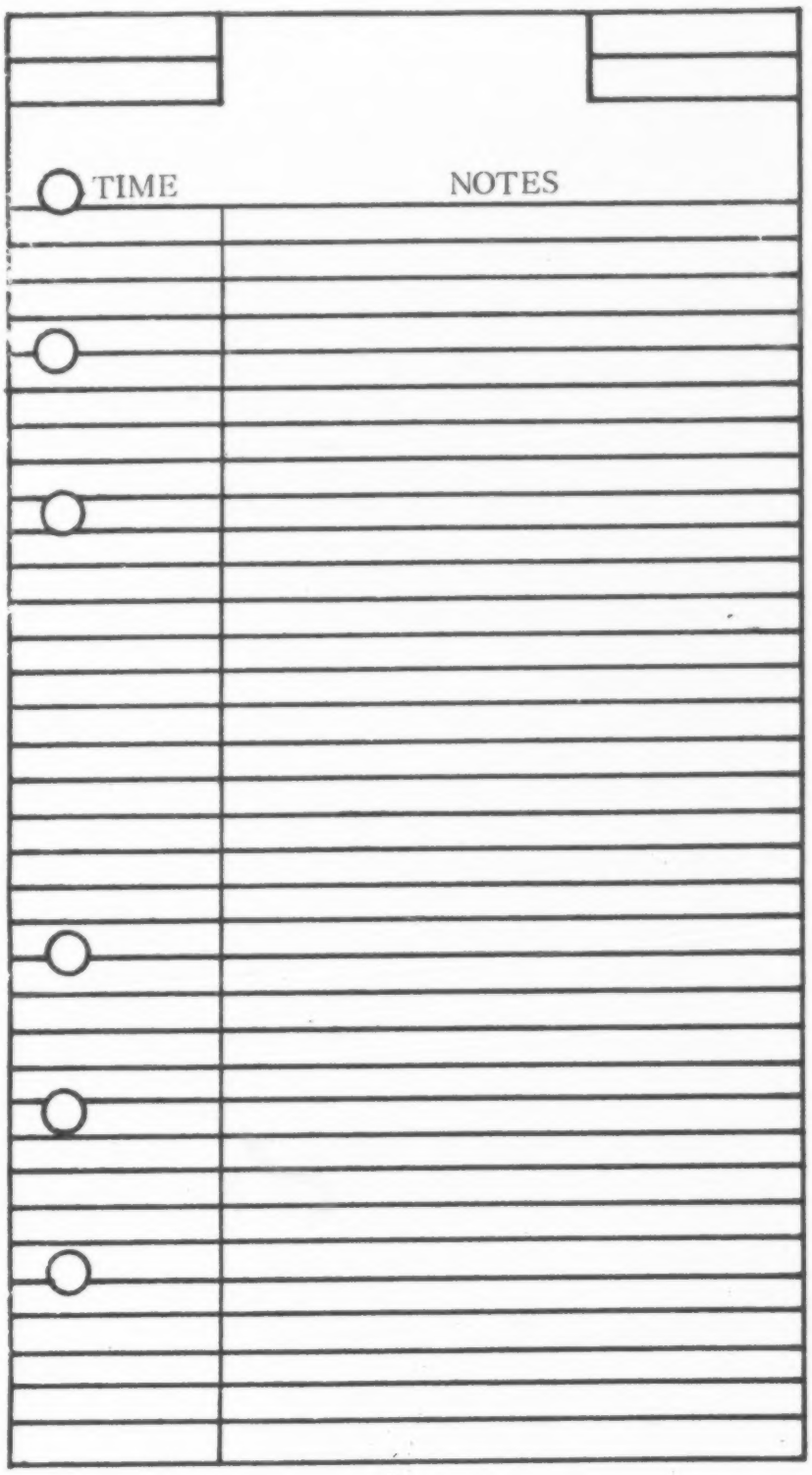

Front Side

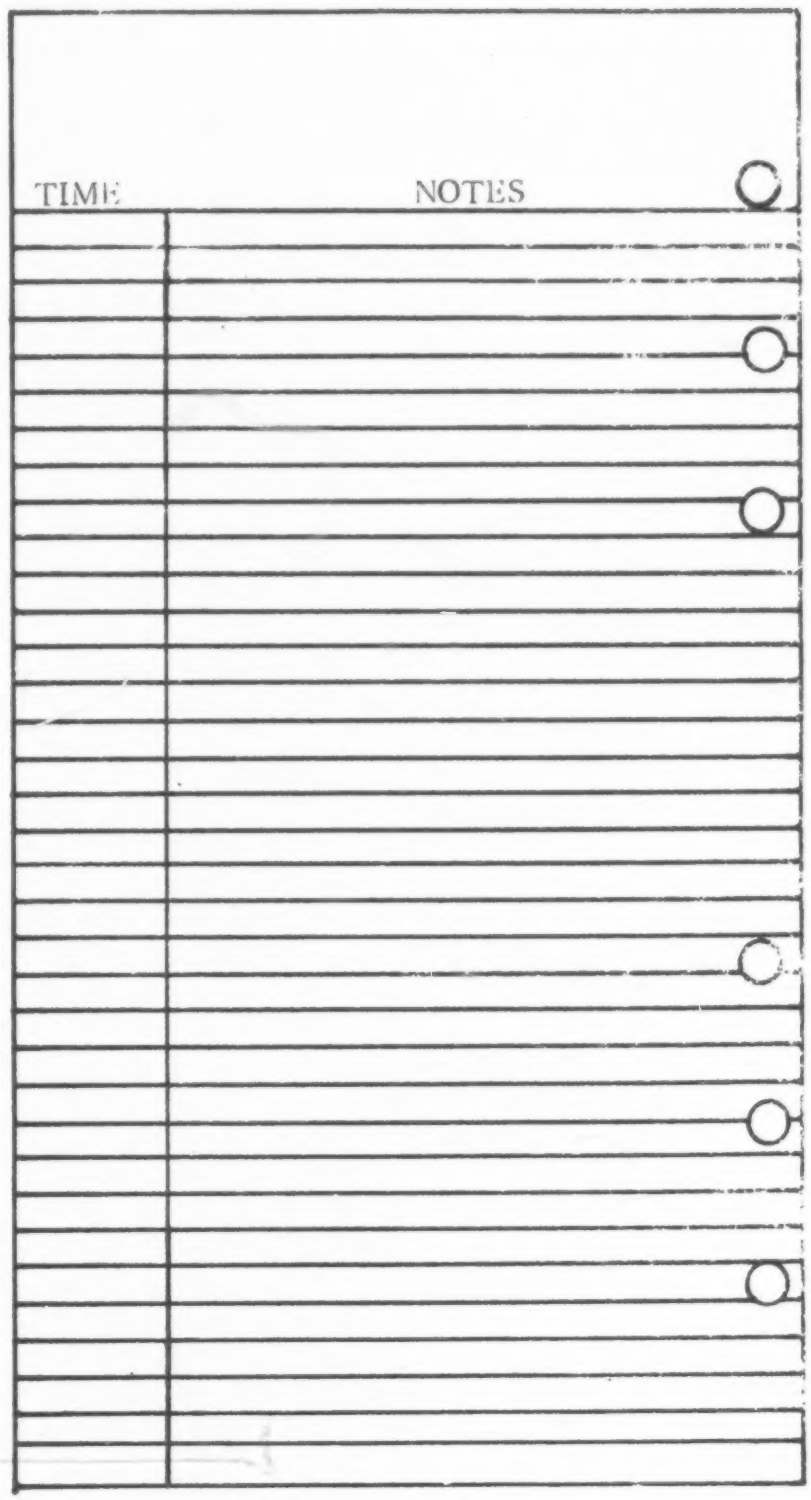

Back Side

FIELD NOTEBOOK LOG

17116

CURRICULUM PLANNING GUIDE IN INDUSTRIAL ARTS

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II. THE PHILOSOPHY FOR A DYNAMIC INDUSTRIAL ARTS PROGRAM 1
III. INDUSTRIAL ARTS AS A SEGMENT OF GENERAL EDUCATION 2
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APPENDIX 45

(FRONT)

REPORT OF DEATH

Natural Accidental Suicide Homicide

Name:
Alias:
Address:
City: State:

PERSONAL:
Sex: Color:
Nationality:
Birth Date:
Birth Place:
Height: ' " Weight:
Build:
Hair:
Eyes:
Complexion:
Beard:
Characteristics:

Occupation:
Employer:

Dress:
Headdress:
Outer Garments:

Upper Garments:

(BACK)

Lower Garments

Neckwear:

Gloves:
Stockings:
Footwear:
Jewelry:

Personal Belongings:

Coroner or Doctor:

Ruling of Cause of Death:

Circumstances:

REPORT OF DEATH

17117

61151

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17118

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VT 013 123
Auto Mechanics Course. Book 1: The Brake System.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 138p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *AUTO MECHANICS; *STUDY GUIDES; *WORKBOOKS; INDUSTRIAL ARTS; SKILL DEVELOPMENT; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the brake system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of remedial materials developed by Basic Systems, Inc. (GB)

VT 013 123

17120

246 OF 327

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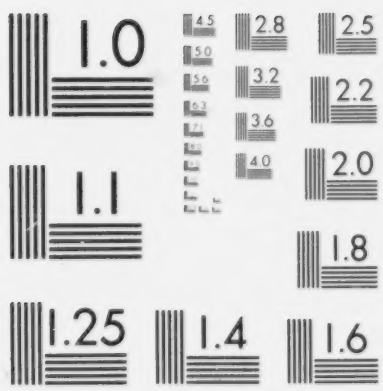

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

ED0 56238

BOOK 1

To Be Used With
PANEL BOOK 1

C1

AUTO MECHANICS COURSE

BOOK 1: THE BRAKE SYSTEM

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
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A BASIC SYSTEMS PROGRAM

VT013123

Curriculum Report Reference
Page 14

Task Analysis Reference
35.1

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246

AUTO MECHANICS COURSE

BOOK 1: THE BRAKE SYSTEM

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

17122

PANEL BOOK 1

To Be Used With
BOOK 1

AUTO MECHANICS COURSE

PANEL BOOK 1: THE BRAKE SYSTEM

A BASIC SYSTEMS PROGRAM

17123

1

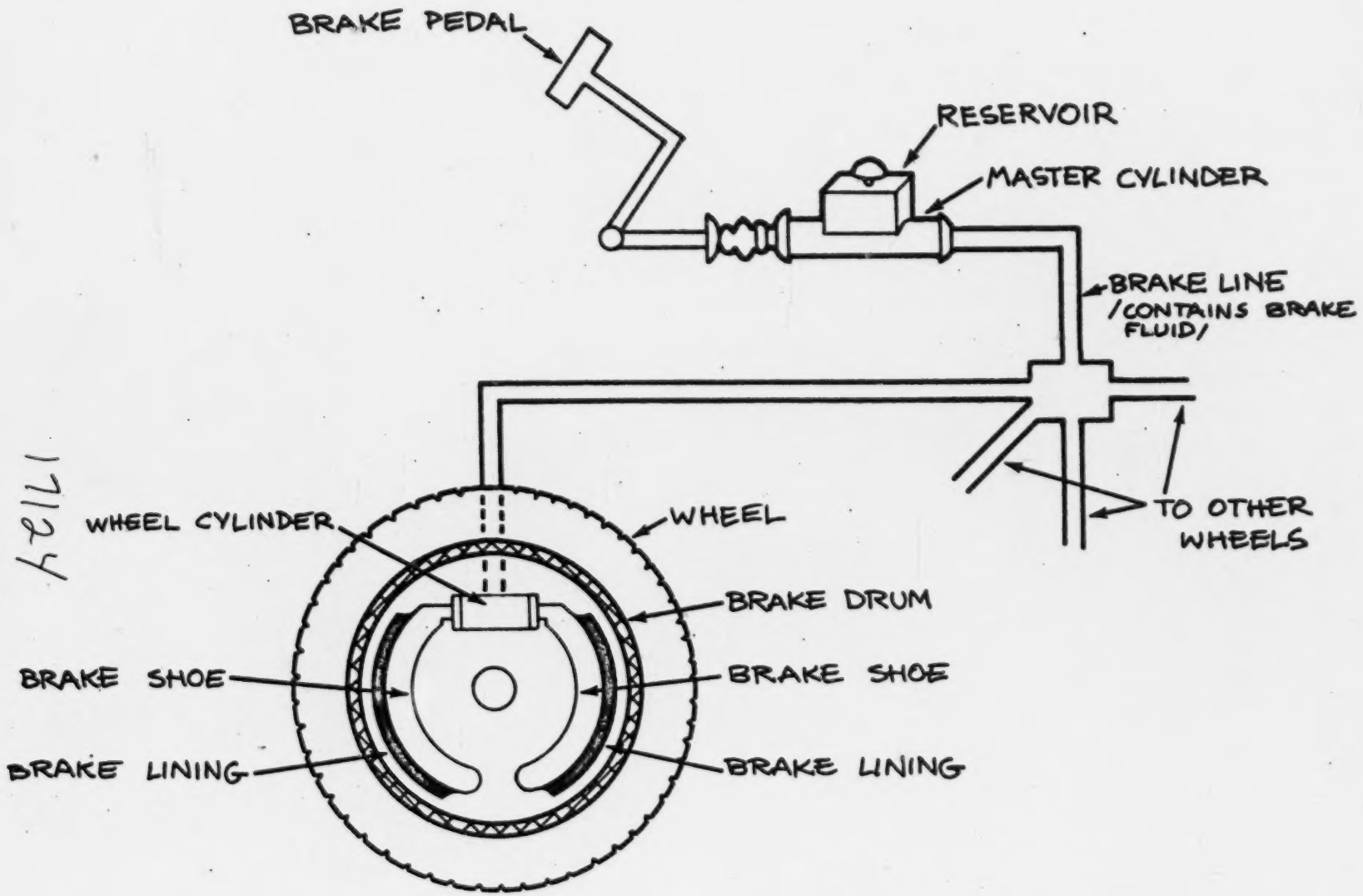

PANEL 1

42171

Book 1

1

The fluid distributor is used to:

- ☐ connect the master cylinder to the brake pedal
- ☐ divide the brake fluid among the four wheels
- ☐ increase the braking power
- ☐ store the brake fluid

2

CHECK the two things the master cylinder does:

- ☐ gets the stopping force from the brake pedal and gives it to the brake fluid
- ☐ makes the stopping force greater
- ☐ makes the stopping force smaller
- ☐ does the same thing the wheel cylinders do

17125

INTRODUCTION

Twentieth century America is dominated by industry. The educated man of today must be informed regarding the effect of this and all other elements of his environment. Industrial Arts is that part of the total educational program which provides the opportunity for the study of man and industry through participation in the experiences of industrial processes and techniques. It enriches other educational fields such as mathematics, science, and language arts by bringing theory and practice closer together through illustrations and examples which are industrial in nature. It leads to the development of personal aptitudes, interests, abilities, good judgment and resourcefulness through problem solving and self expression in an environment related to industry. Industrial arts education is designed to help prepare individuals to meet the requirements of today's culture.

It is intended that this publication will provide guidelines to foster continued growth and success of industrial arts education in the State of Wyoming.

THE PHILOSOPHY FOR A DYNAMIC INDUSTRIAL ARTS PROGRAM

The application of technology affects the pattern of our living and the place of the individual within our society. The interpretation of technology through applied learning is a unique contribution of industrial arts to the general education of young people.

Industrial arts provides an opportunity to satisfy a student's need to know himself and the world about him. Our nation's economic structure uses human resources, machines and materials. The inter-relationship of knowledge and skills to societal needs is necessary if society is to continue its technological advances. A well-designed program of industrial arts education provides the student with the opportunity to assemble ideas, knowledge and techniques. He experiences, through meaningful activity, the problems of applied technology.

The range of instruction in industrial arts, as presented in this curriculum guide, exposes the student to a series of instructional areas grouped to provide realistic programming and efficient arrangment of facilities. The instructional content is planned to remain a constant regardless of the school size or organization. To this end the curriculum guide for a dynamic industrial arts program for the State of Wyoming is provided.

1171

1710

3

The brake pedal is used to take the stopping force from the:

- ☐ master cylinder and give it to the wheel cylinder
- ☐ wheel cylinder and give it to the master cylinder
- ☐ driver and give it to the master cylinder

4

The power booster is between the:

- ☐ brake pedal and the master cylinder
- ☐ master cylinder and the brake line
- ☐ master cylinder and the brake shoe

5

The brake drum is used to connect the:

- ☐ brake line to the rest of the brake system
- ☐ wheel to the wheel cylinder
- ☐ wheel to the rest of the brake system

17126

6

The brake lining is used to:

- ☐ hold the wheel cylinder to stop the wheel
- ☐ push the master cylinder against the brake pedal and stop the wheel
- ☐ push against the brake drum and stop the wheel

7

The brake fluid is used to:

- ☐ carry the stopping force from the brake lining to the brake drum
- ☐ carry the stopping force from the master cylinder to the wheel cylinder
- ☐ make the brake lining turn slower

8

The brake lining is mounted on the part called the _____ .

9

When the driver steps on the brake pedal, the brake shoes are moved by the _____ .

17127

10

Brake fluid flows through the brake system in the _____.

11

The master cylinder reservoir is used to:

- ☐ make the stopping force greater
- ☐ make the stopping force smaller
- ☐ store the brake fluid

12

What part of the brake system divides the brake fluid coming from the master cylinder among the four wheels? _____

17/28

13-15

NAME the parts that the arrows point to:

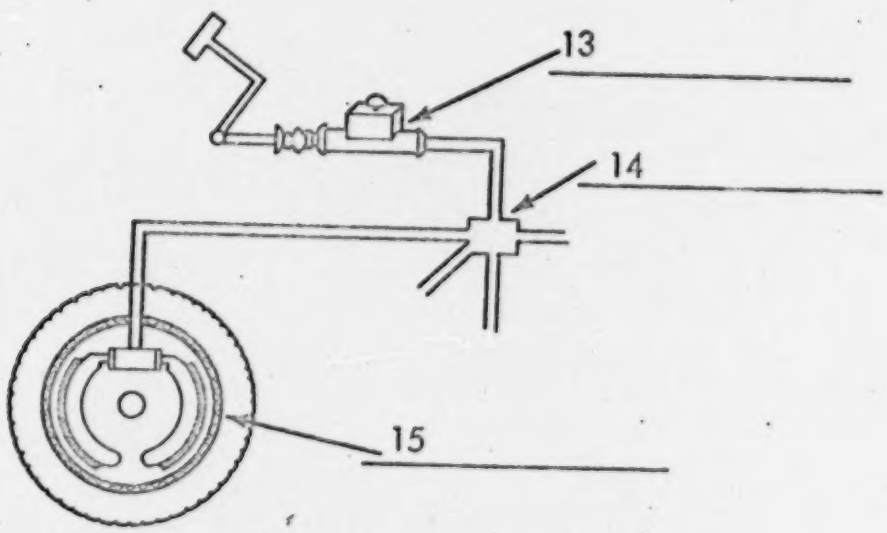

17129

1

PREVIEW

This part of the program will tell you about the parts used to stop a car. These parts are called the brake system.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

17130

1

NO ANSWER NEEDED

2

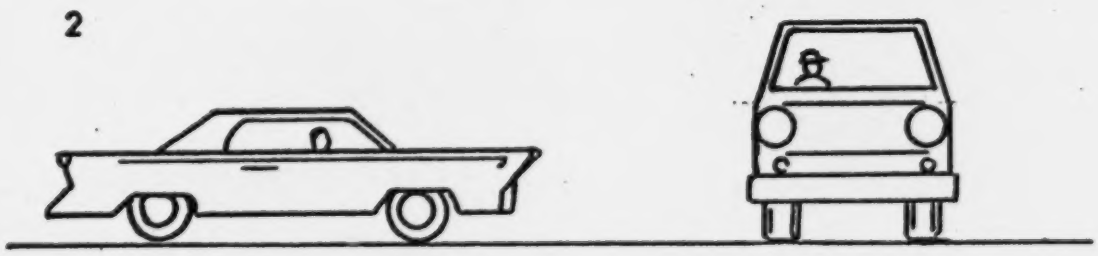

You are driving the car.

The truck pulls in front of you.

What should you do?

- ☐ keep going
- ☐ stop

17131

2

stop

3

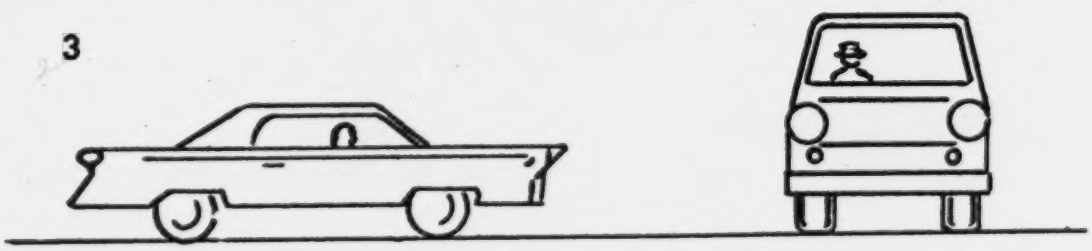

When you see the truck in front of you, you should:

- ☐ step on the brake
- ☐ step on the gas

17/32

3

step on the brake

4

Which car got into an accident?

- ☐ car A
- ☐ car B

Why didn't the other car get into an accident?

_____

17132

4

car B

driver stepped on the brake
(or similar answer)

5

You step on the brake and the car stops.

This is because the wheels:

- ☐ keep turning
- ☐ stop turning

17133

5

stop turning

6

If your brakes are working, the wheels stop when you step:

- ☐ on the brake
- ☐ on the clutch
- ☐ on the gas

17134

INDUSTRIAL ARTS AS A SEGMENT OF GENERAL EDUCATION

As each individual wisely learns to accept, use and appreciate the products of industry and to bolster this with humanitarian principles, he elevates his personal standards of living. When all the individuals lift themselves, the result is an advancement in all of society.

In this world where it is the business of industry to make usable for mankind the marvelous things that science creates, it is imperative that the education of each child include some interpretation of industry to him. The industrial arts of today and tomorrow should be designed to fulfill this mission. To the hordes of energetic, young personalities who daily stream through our public schools, the industrial arts must emphasize its relationship to general education. Everyone needs to sample its offerings, everyone needs to have industry interpreted to him both manipulatively and informationally, because there is no escaping the fact that modern peoples live in an industrial culture. However, industrial arts reaches even further than this. From the large group of humans engaged in the business of learning, many will desire more than a sampling of the atmosphere of industry. There are phases of the practical arts geared to meet their needs also. Industrial arts penetrates the industrial fields and affords opportunities for greater exploration, application and interpretation of industry for those who desire it. Here one major point of emphasis emerges. Industrial arts must never be considered a 'special' subject taught by a 'special' teacher.

In the language of our present generation, such terms as fiberglas, television, geiger counter, transistor and space satellite are commonplace. Technical as these items may be in fact, they are all fabricated from the raw materials of the earth through the efforts of science and industry. In short, industrial arts is the study of the basic products, processes, operations, materials and problems of industry and today's world. Industrial arts is the study of the factors within our present society.

1711

0151

6

on the brake

7

You push your hand against a bicycle wheel that is turning.

The wheel will:

- ☐ keep turning
- ☐ stop

17135

7

stop

8

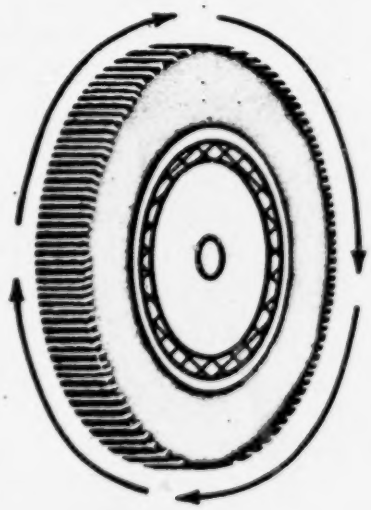

This is a car wheel. It is turning.

To stop it, something has to:

- ☐ keep away from it
- ☐ push against it

17136

8

push against it

9

The arrows are pointing to two pieces of metal. If they pushed against the wheel, the wheel would:

- ☐ go faster
- ☐ keep going
- ☐ stop

17/37

9

stop

10

The force that lets you grab a wheel is put into your hand by:

- ☐ your eyes
- ☐ your muscles
- ☐ your feet

17138

10

your muscles

11

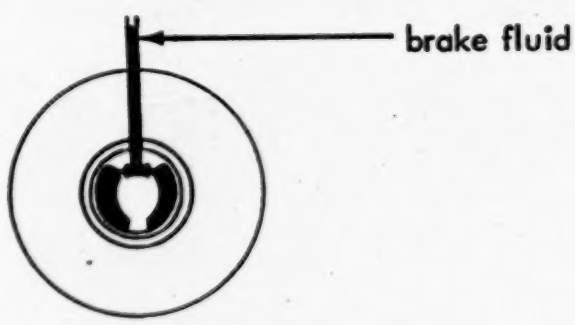

Brakes use brake fluid instead of muscles.

The brake fluid makes the pieces of metal push against the:

- ☐ inside of the wheel
- ☐ outside of the wheel

17139

11

inside of the wheel

12

A carrier of "muscle force" in the brake system is:

- ☐ brake fluid
- ☐ the wheel
- ☐ your hand

17140

12

brake fluid

13

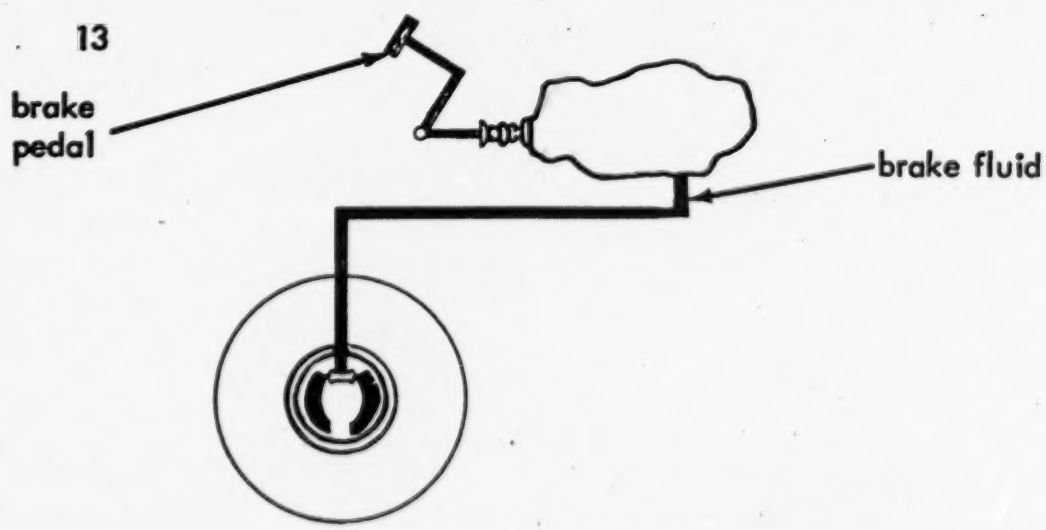

Brake fluid is used to get the force from the:

- ☐ brake pedal to the wheel
- ☐ wheel to the brake pedal

17141

14

car B

The car hit the truck.
(or similar answer)

15

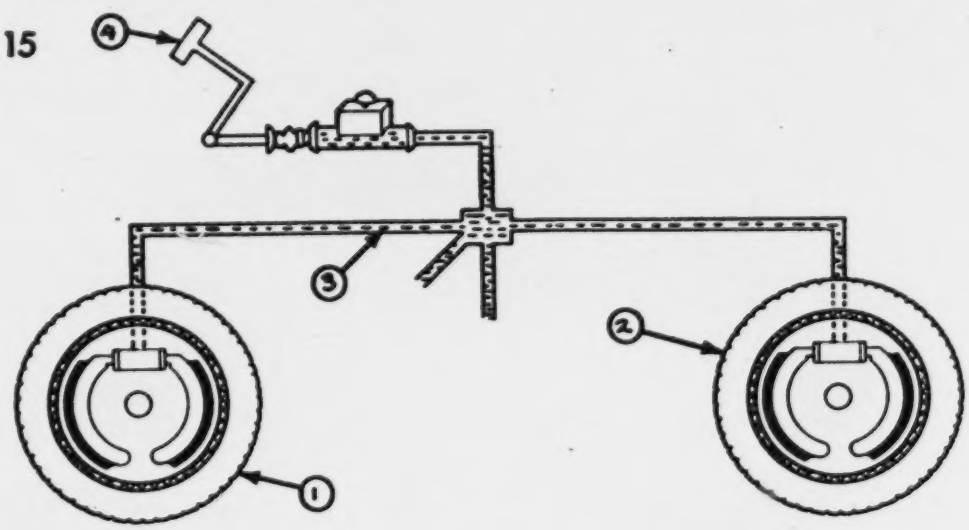

MATCH the numbers with the names:

_____ brake fluid

_____ brake pedal

_____ wheel

_____ wheel

17143

15

3

4

1 or 2

2 or 1

16

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

17144

GENERAL GOALS OF INDUSTRIAL ARTS

Goal I.

To develop an insight and understanding of industry and its place in our culture.

Properly conceived, experiences relating to industry and opportunities for each student to better understand the society in which he lives are part of the common learning and total development of the learner.

Goal II.

To discover and develop talents, aptitudes, interests, and potentialities of individuals for the technical pursuit and applied sciences.

Opportunities for students to discover abilities and develop to their fullest are essential to the basic education of all youth. Efforts should be made to allow for differences in abilities, interests, and needs, and to ascertain which learning experiences are the most significant for the success of each individual.

Goal III.

To develop an understanding of industrial processes and the practical application of scientific principles.

The field of industrial arts is concerned with the study of integration of physical, chemical, and other forces with the materials and processes of industry, coupled with an active interest in the creative use of design. A program of industrial arts fosters experiments, research, exercises, and opportunities for solving various types of technical problems as well as project making.

Goal IV.

To develop basic skills in the proper use of common industrial tools, machines and processes.

Industrial arts provides students with basic skills which are relevant to industrial occupations and later may assist the individual in successful occupational adjustment. This segment of industrial arts instruction provides opportunities for developing manipulative skills, the very vehicle which students use to achieve their goals, understand industry, and discover abilities to develop to their fullest in the industrial fields.

Goal V.

To develop problem-solving and creative abilities involving the materials, processes, and products of industry.

The problem-solving approach in industrial arts involves creative thinking and allows students to define and determine logical solutions to problems and to evaluate both visually and intellectually the effectiveness of their solutions. The very nature of our laboratory setting makes possible a concrete, understandable approach to teaching problem-solving and critical thinking.

Condensed form:

A Guide to Improving Instruction In Industrial Arts, American Vocational Association, Washington, D.C.

1712

16

NO ANSWER NEEDED

17

LOOK AT PANEL 1

The brake pedal is the part of the brake system that the driver:

- ☐ steps on
- ☐ turns

17145

17

steps on

18

LOOK AT PANEL 1

When you stop a car, brake fluid in the master cylinder is pushed.

The part that pushes the brake fluid is the:

- ☐ brake pedal
- ☐ brake wheel
- ☐ master cylinder

17146

18

brake pedal

19

LOOK AT PANEL 1

From the master cylinder, the "stopping" force is carried through the brake lines by:

- ☐ the brake pedal
- ☐ the brake fluid
- ☐ the wheel

17147

19

the brake fluid

20

LOOK AT PANEL 1

When you step on the brake pedal, the master cylinder pushes brake fluid to the four wheel cylinders.

Brake fluid reaches the wheel cylinders through the:

- ☐ brake lines
- ☐ brake pedal
- ☐ master cylinder

17148

20

brake lines

21

LOOK AT PANEL 1

What carries the "stopping" force through the brake lines?

- ☐ brake fluid
- ☐ brake pedal
- ☐ master cylinder

17149

21

brake fluid

22

LOOK AT PANEL 1

The wheel cylinder gives the "stopping" force to the brake shoe.

To do this, the wheel cylinder:

- ☐ pushes against the brake shoe
- ☐ pulls against the brake shoe

17150

22

pushes against the brake shoe

23

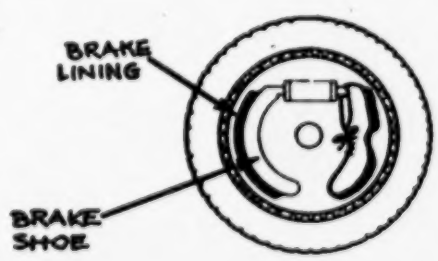

The brake shoe is something like a real shoe.

What part on the brake shoe is like the sole on a real shoe?

_____ _____

If the brake shoe moves, the brake lining:

- ☐ moves with the shoe
- ☐ does not move with the shoe

17151

23

brake lining

moves with the brake shoe

24

LOOK AT PANEL 1

The brake drum turns with the wheel, but the brake lining does not turn with the wheel.

A turning brake drum rubs against the brake lining if the brake drum and the brake lining are:

- ☐ not touching
- ☐ touching

17152

24

touching

25

LOOK AT PANEL 1

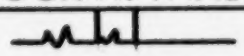

If the brake lining and brake drum touch each other:

- ☐ nothing will happen
- ☐ they will rub together

17153

25

they will rub together

26

LOOK AT PANEL 1

The brake drum is connected to the wheel.

One good way to stop the wheel from turning is to stop the:

- ☐ brake drum from turning
- ☐ brake lining from turning
- ☐ brake shoes from turning

17154

PLANS OF ORGANIZATION

In planning an industrial arts program for a particular school, consideration must be given to the potential enrollment of each individual class section. Under no circumstances, in either the junior or senior high schools, should there be enrolled more than a miximum of 21 student per class section. Depending upon the types of students involved, the type of courses being offered and the physical facilities of the school shop, the number of students may even be reduced considerably.

The junior high school industrial arts program must be exploratory in nature. It should be open to both boys and girls alike. It should include a wide variety of both vocational and avocational experiences that have been selected from a number of basic industrial fields. The course that would normally be considered a part of the junior high school industrial arts curriculum would include: introduction to drafting; hand woodworking; introductory bench and sheet metals; plastics; basic electricity-electronics; power mechanics; home maintenance; graphic arts; and a variety of craft areas. Many of the above programs can be expanded depending upon the interests and the number of students involved in the program and the shop facilities available.

It is suggested that one of the areas be developed into a production technology unit to be presented at the end of the 8th grade.

The senior high school industrial arts program must be more specialized in nature, It must give greater stress upon the vocational aspects of the curriculum being offered. The courses that would normally be considered a part of the senior high school industrial arts program would include all the aspects of the following areas; drafting; woodworking; metal working; plastics; electricity-electronics; power mechanics and transportation; home maintanence; graphic arts; and crafts. The full scope of such a program depends upon the interests and the number of the students involved in the program and the shop facilities available.

TEACHER LIABILITY

As programs expand and new equipment is available, the possibility of accidents will increase. What responsibilities does an instructor have in preventing accidents?

AA. Two kinds of accidents are likely to occur. First a pure accident is one considered to be beyone the power of the instructor to prevent. Second, a negligent accident is one that should have been prevented and may be considered as willful negligence.

Because the latter type of accident can easily occur, a high degree of supervision is always necessary. This is particularily true when consideration is given to the fact that a minor student is not considered to have the same reasoning power as an adult, and therfore his actions are not judged by adult standards.

BB. An industrial arts shop teacher must assume the responsibility for the safety of the students in his shop. The teacher has a legal responsibility to provide safety instruction to the students, to instruct them in the proper use of tools and equipment and to supervise them at all times while they are in the shop.

An industrial arts teacher is always in a vulnerable position. He must protect the students at all times from potential danger. He must anticipate hazardous conditions and when a hazardous condition is evident, he must report it immediately in writing to the school administration. Then take appropriate steps to correct the condition.

When an accident occurs, it is the instructor who receives the criticism. Threefore, safety rules and regulations must be meaningful, reasonable and always enforced. Safety is not a one hour lecture. It must be emphasized constantly in the shop. A teacher must be enthusiastic about teaching safety.

26

brake drum from turning

27

LOOK AT PANEL 1

For the brake lining to touch the brake drum, what must move against the brake drum?

- ☐ brake fluid
- ☐ brake shoes
- ☐ master cylinder

17155

27

brake shoes

28

LOOK AT PANEL 1

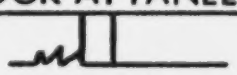

The name of the system shown in this panel is:

- ☐ the brake system
- ☐ the suspension system
- ☐ the steering system

17156

28

the brake system

29

The brake system is used to:

- ☐ start the car
- ☐ steer the car
- ☐ stop the car

17157

29

stop the car

30

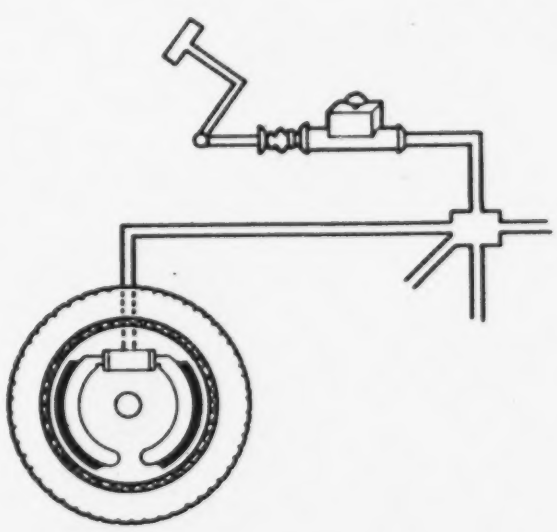

What is the name of the system shown in this drawing?

_____

17158

30

brake system

31

What is the brake system used for? _____

17159

31

to stop the car

32

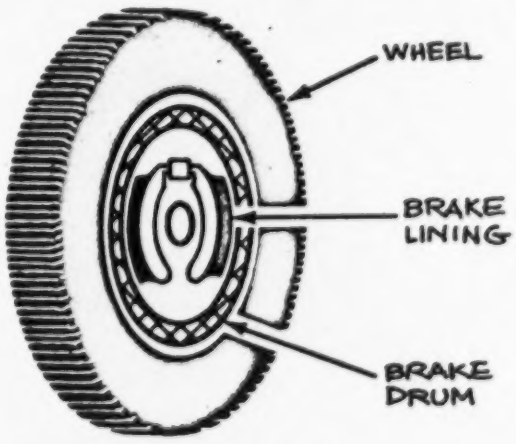

The wheel is connected to:

- ☐ the brake drum
- ☐ the brake lining

17160

32

the brake drum

33

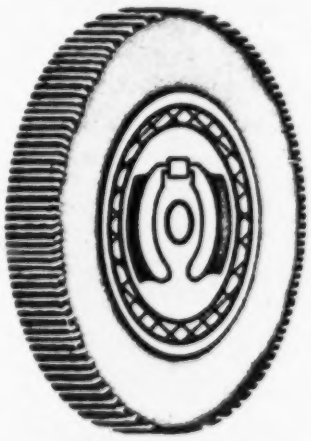

What stops turning when you stop the brake drum?

- ☐ brake lining
- ☐ wheel

17161

33

wheel

34

The part of the brake system that turns with the wheel is the _____.

17162

34

brake drum

35

DARKEN the brake drum in the drawing below:

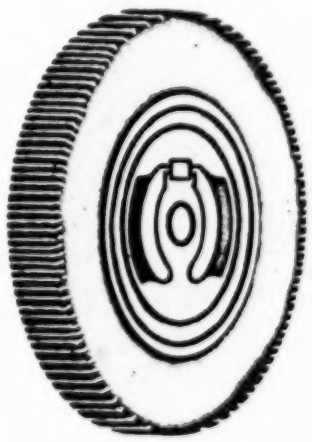

17163

35

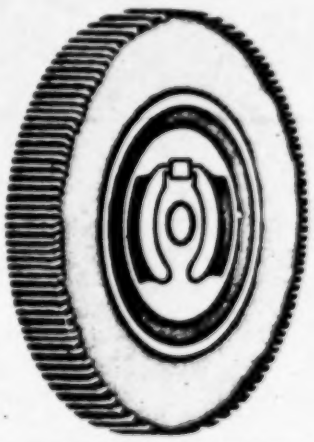

36

To stop the car, something must _____ against the brake drum.

17164

CC. A few general practices that would help avoid a negligent situation would include:

Never be absent from the classroom when the students are in attendance.

Never allow students to use tools and equipment in the shop that have not been provided by the school administration unless the teacher has written permission to do so from the school authorities.

Check the construction features of the shop. They must be safe. Lighting and ventilation facilities must be adequate.

Check the location of the machines. There must be no interference between the operators of the different machines. A safety zone, properly marked is essential.

Check the storage of materials and supplies. They must be properly stored.

DD. Remember that a civil jury is not made up of a professional people. The jury may not look at a situation as you would want them to do. Therefore, what are some of the questions you may have to answer in the case of an accident.

Did the instructor fail to act to protect the person injured?

Did the instructor fail to carefully evaluate the situation before hand in order to prevent the accident?

Was it possible for him to foresee that an accident would occur?

Was good supervision provided and good safety instruction taught?

Was proper care given to the tools and equipment?

Was the conduct of the instructor considered proper?

Was the instructor absent from the shop when the accident occurred?

Was the machine or tool used beyone its limitations?

Did the instructor neglect to provide safe working conditions?

Did the instructor fail to provide guards on the machines?

Did the instructor fail to obtain prompt medical care for the injured student?

The above section was compiled by:

Mr. Ernest Sones, director
Vocational Education and Practical Arts
Casper-Midwest School System

SAVE HARMLESS LEGISLATION

Wyoming Statutes Annotated (1957)

Section 44. The board of trustees of each school district within the state may save harmless and protect board members, teachers, and other personnel from financial loss arising out of any claim, demand, suit or judgment by reason of alleged negligence or other act resulting in accidential bodily injury or death to any person within or without the school building; provided, such board member, teacher, or other personnel at the time of the accident was acting in the discharge of his duties within the scope of his employment...

Section 45. The board of trustees of each school district within the state may procure a policy or policies of comprehensive liability insurance shich would save the school district harmless from financial loss arising out of any claim, deman, suit, or judgment for personal injury or death occasioned by the alleged tort of any officer, employee, or agent of the school district...

36

push

37

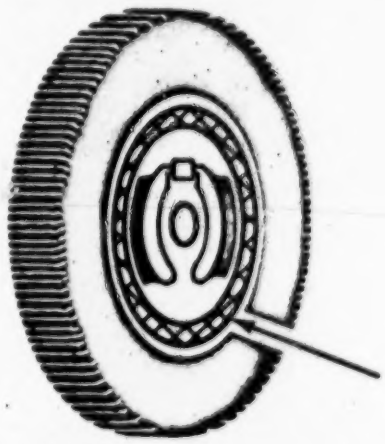

In this drawing, the arrow is pointing to the part of the brake system called the _____ _____.

17165

37

brake drum

38

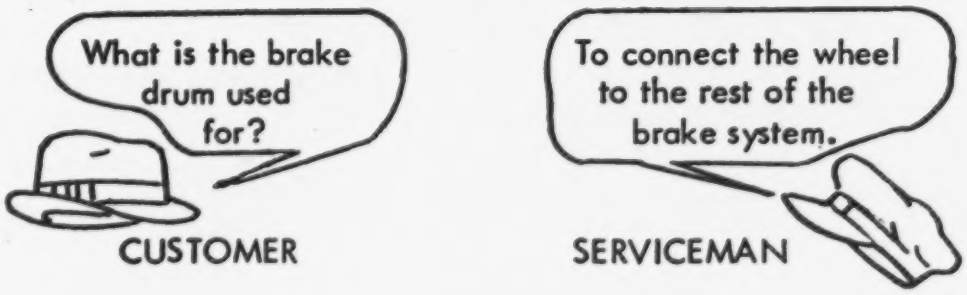

The customer asked the serviceman a question.

Did the serviceman give the right answer?

- ☐ yes
- ☐ no

17166

38

yes

39

The brake drum is used to connect the _____ with the rest of the brake _____.

17167

39

wheel

system

40

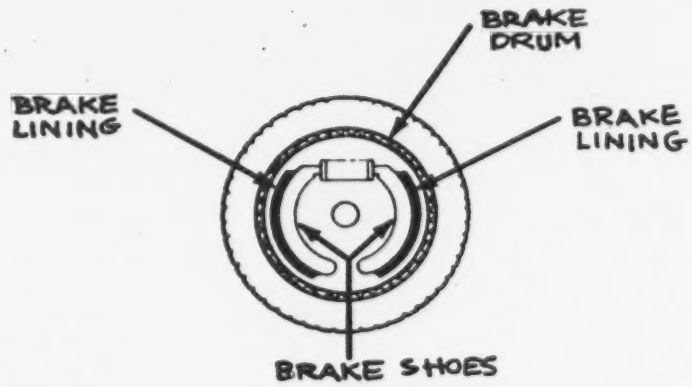

When you want to stop the car, the brake shoe should move so that the brake lining will rub against the:

- ☐ brake drum
- ☐ brake pedal
- ☐ wheel

17168

40

brake drum

41

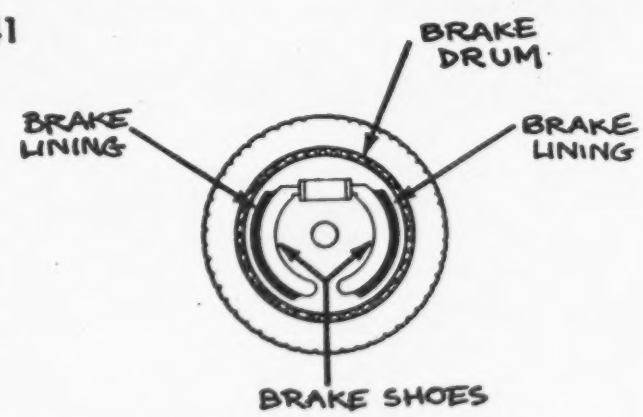

The car will stop if the brake lining:

- ☐ pulls the brake drum
- ☐ rubs the brake drum
- ☐ rubs the brake shoe

17169

41

rubs the brake drum

42

A

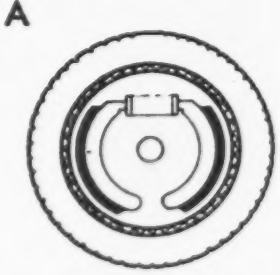

B

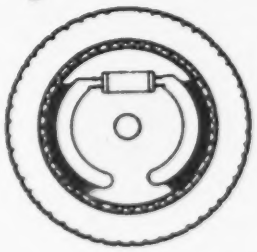

The brake lining is rubbing against the brake drum in:

- ☐ car A
- ☐ car B

Which car is stopping?

- ☐ car A
- ☐ car B

17170

42

car B

car B

43

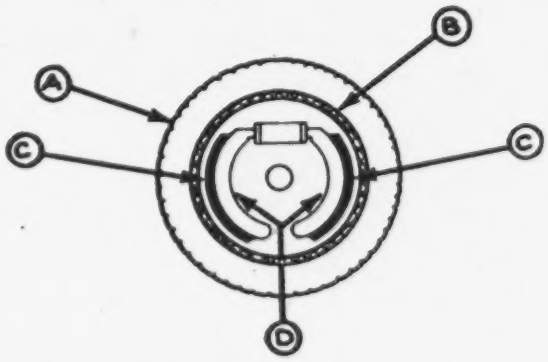

MATCH the letters with the names of the parts:

_____ brake lining

_____ brake shoe

_____ drum

_____ wheel

17171

43

C

D

B

A

44

When the driver steps on the brake pedal, the brake lining pushes against the:

- ☐ brake drum
- ☐ brake shoe
- ☐ wheels

17172

44

brake drum

45

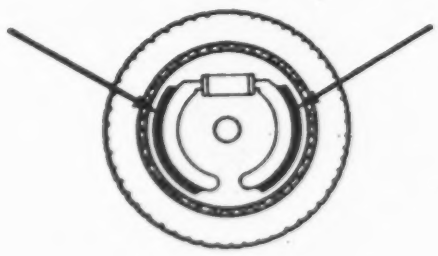

In the drawing, the arrows are pointing to the

_____ _____.

17173

45

brake lining

46

MATCH the parts with the job they do:

A. brake lining

B. brake drum

C. wheels

_____ connects wheel to rest of the brake system

_____ does the pushing to stop the car

17174

PERSONNEL/SHOP MANAGEMENT

The challenge of the increasing size of classes, the selection of course content from such a broad field, the supplies problem and the need for maintaing equipment in working condition have made shop teachers aware of the advantages of a personnel system wherein the class becomes essentially a self-governing unit. The teacher becomes an advisor, coordinator and source of information, while much of the responsibility of routine shop management is taken over by the students.

In addition to allowing more time for instruction, proper administration of the pupil personnel system offers an unusual opportunity to develop leadership qualities and desirable personal-social traits.

Two basic types of organization are commonly used by shop teachers. They include:

1. The teacher acts as general manager and delegates responsibility to various student leaders.
2. The teacher allows the students to elect, through a democratic process, those who will assume the responsibility of leadership in the maintenance of cleanliness of the shop.

Under either type of plan common duties that usually are delegated to students include:

1. Ventilation and lights
2. Shop maintenance and cleanliness
3. Stock room care
4. Area foreman
5. Tool checking
6. Finishing room care
7. Shop library supervision
8. Monitoring and assisting other students

Procurement of Supplies

Each school system has its own method of requisitioning supplies. It is the responsibility of the industrial arts teacher to familiarize himself with the method in his system in order that he may do his part in avoiding delays in delivery which may cause irritating interruptions in his program.

Issuing Materials to Students

There are many methods for issuing materials and collecting money for payment. Regardless of the method used, it is generally agreed that the teacher should not be required to handle money.

Methods employed are:

1. Punch cards purchased by the student as necessary.
2. Central office collects all fees.
3. Enrollment fee - student pays fee upon enrolling.

46

brake drum

brake lining

47

The job of brake lining is to push against the _____.

What will this do to the car's motion? _____

17175

47

brake drum

stop it

48

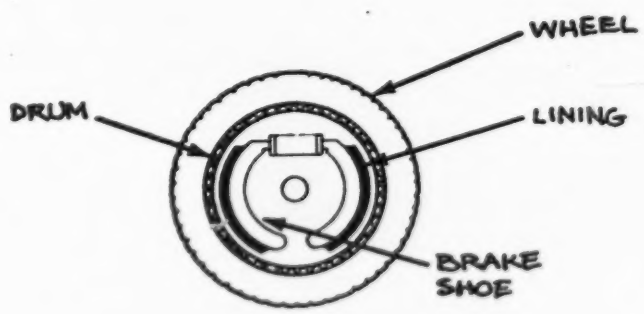

The brake lining is mounted on the brake shoe. In stopping the car, the brake lining is pushed against the drum by the:

- ☐ hub
- ☐ brake shoe
- ☐ wheel

171 76

48

brake shoe

49

DRAW two arrows pointing to the brake shoes.

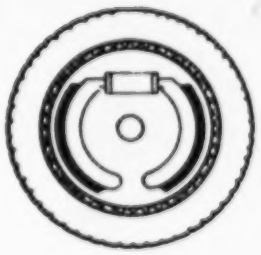

17/77

49

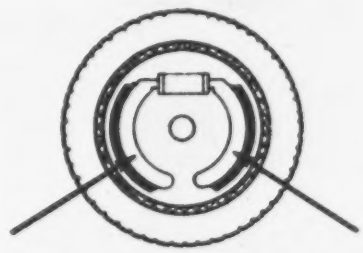

50

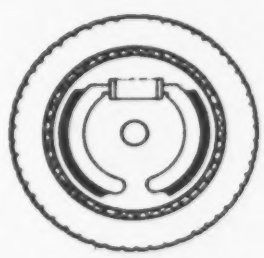

The stopping force gets to the brake lining through the:

- ☐ brake shoe
- ☐ vibration damper
- ☐ wheel

17178

50

brake shoe

51

When a shoe's sole wears out, you replace the soles.

What do you replace when a brake shoe's linings wear out?

_____

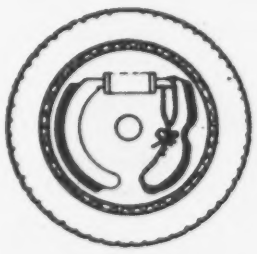

17179

51

brake linings

52

Which part of the brake system connects the wheel to the rest of the brake system? _____

Which part of the brake system rubs against the brake drum when you step on the brake pedal? _____

What is the brake lining fastened on to? _____

17180

52

brake drum

brake lining

brake shoes

53

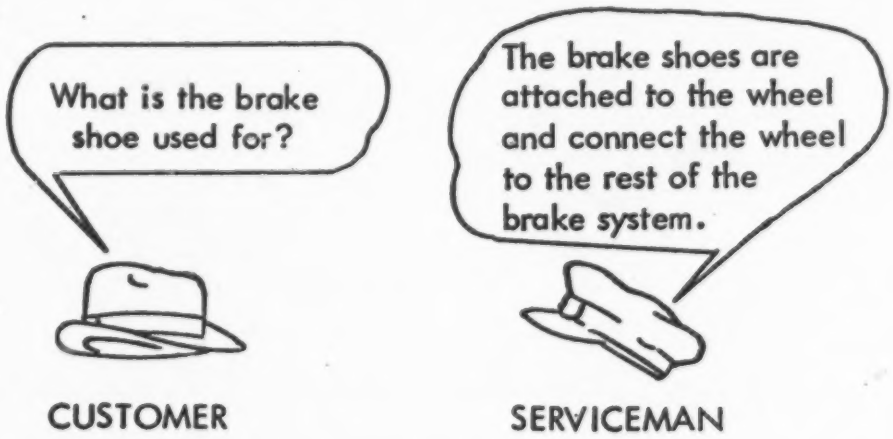

Did the serviceman give the correct answer?

- ☐ yes
- ☐ no

17181

53

no (The brake linings are mounted on the brake shoes. The brake shoe pushes the brake lining against the brake drum. This stops the wheel.)

54

The job of the brake shoe is to push the b_____ l_____ against the d_____.

What will this do to the car's motion? _____

17182

54

brake

lining drum

stop it

55

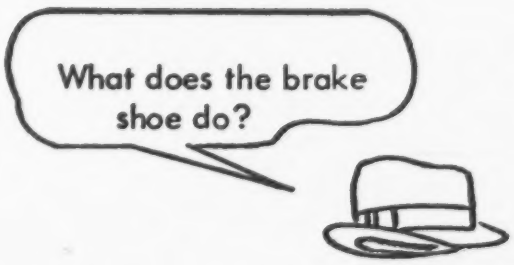

Now you be the serviceman and WRITE an answer to the customer's question below.

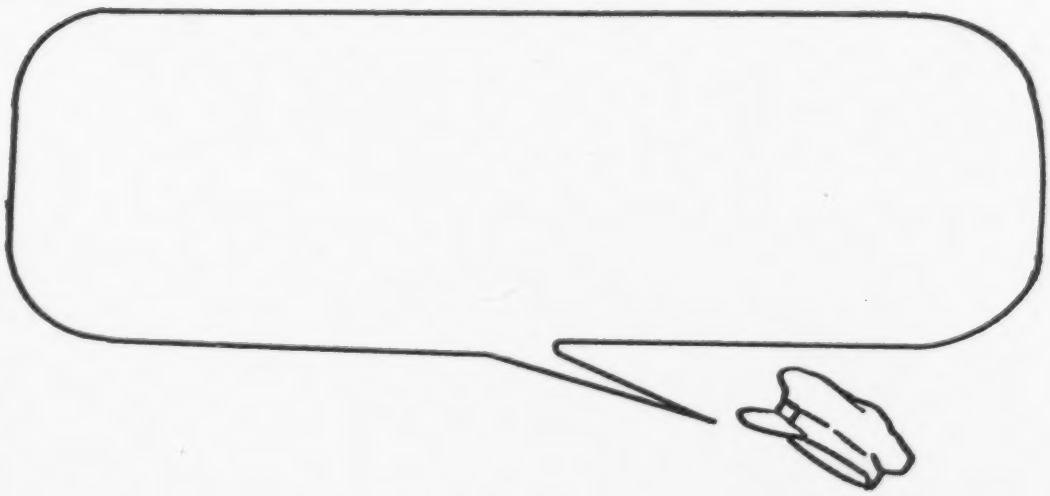

17183

55

The brake linings are on the brake shoes. The brake shoes push the linings against the brake drum and stop the wheel.

56

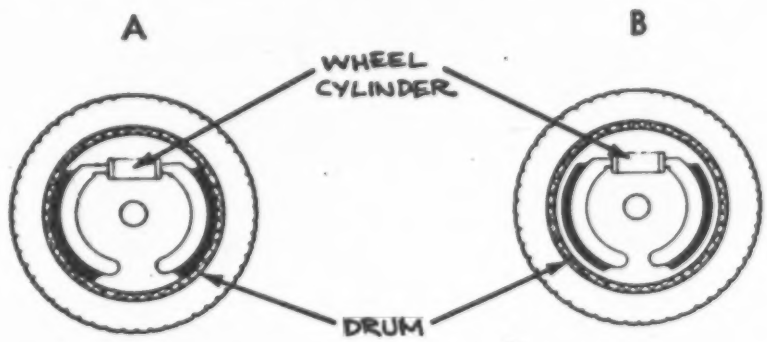

When the driver steps on the brake pedal, the wheel cylinder pushes the brake shoe.

Which car is stopping?

- ☐ car A
- ☐ car B

17184

Equipment Considerations

A. Use color coding/dynamics
B. Refinish benches, cabinets and machines when necessary
C. Arrange furniture and equipment for instructional efficiency and appearance
D. Keep machinery in safe working condition
E. Provide safety zones

Storage

A. Store projects in a safe place
B. Provide controlled access to materials
C. Provide effective tool storage facilites

To do a creditable job of instruction and justify the public funds expended in his department, it is necessary that the teacher maintain a tight organization in every area of the shop. It would be superfluous to describe in detail all methods used to maintain such an organization. Excellent material of this kind may be found in books and journals. Each situation requires a unique solution depending on the personality of the teacher, the existing regulations within the school administration ahd the facilities available. An effec tive procedure is for the teacher to make an inventory listing all the pertinent elements of his situation. With this in mind, the available material on shop and personnel organization should be reviewed. With this background of information the teacher can organize a program tailored to meet his and the students' needs.

SAFETY IN THE SCHOOL SHOP

Safety is not a subject that can be considered alone. In a broad sense safety must be an important and integral part of living. Considerations of safety must be foremost when choosing or adapting to an environment, when making plans for the future and in every detail of carrying out hese plans. Thus, school shop safety must not be merely a 'safety program,' but must be an important consideration in everything which goes into making the total shop program from choosing the location, building and equipment, to the everyday routine of conducting and supervising classes.

The two general causes of school shop accidents are unsafe environmental factors and unsafe human behavior.

Environmental Factors

Environmental factors include buildings, machines, tools, storage agencies, protective equipment, sanitary facilities, clothing, etc.

Buildings housing industrial arts shops should be inspected and carefully evaluated from the standpoint of safety. Hazards such as improper lighting, inadequate ventilation and poor sanitary facilities should be reported to the proper authorities. Until adequate repairs or remodeling is made, stringent rules must be adopted to reduce the possibilities of accidents from this source.

56

car A

57

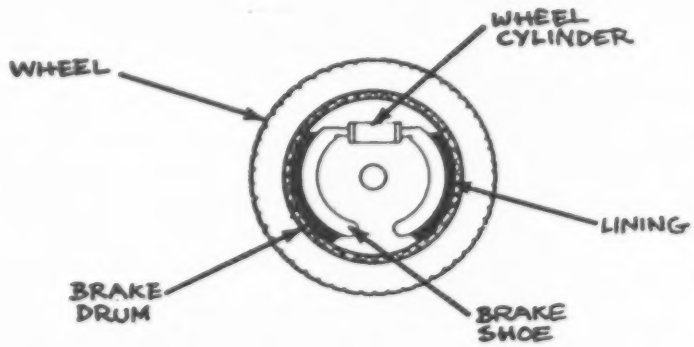

When the driver steps on the brake pedal, the brake shoes and linings are pushed against the drum by the:

- ☐ driver
- ☐ wheel
- ☐ wheel cylinder

1 7185

57

wheel cylinder

58

CIRCLE the wheel cylinder in this diagram:

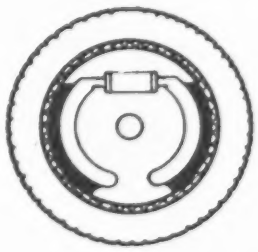

17186

58

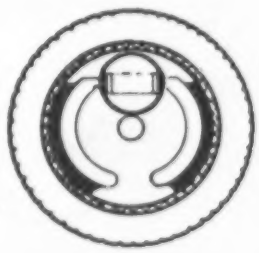

59

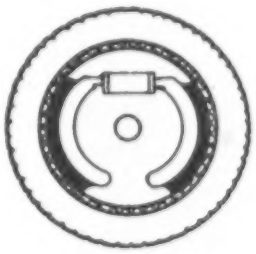

The wheel cylinder pushes against the brake shoe. This happens because the brake fluid gives the "stopping" power to:

- ☐ the brake shoe
- ☐ the wheel
- ☐ the wheel cylinder

17187

59

the wheel cylinder

60

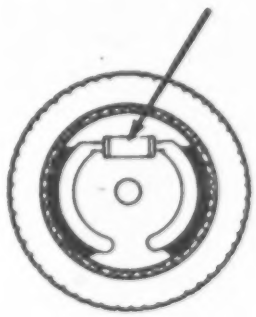

NAME the part that the arrow is pointing to:

_____ _____

12188

60

wheel cylinder

61

When you step on the brake, the wheel cylinder pushes against the _____ _____.

17189

247 OF 327

ED

056 238

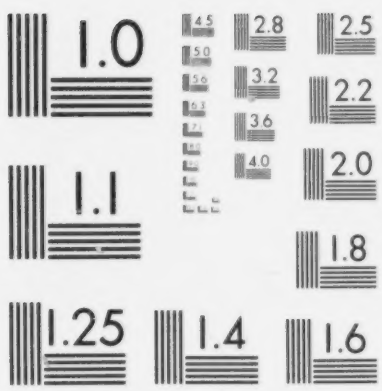

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

61

brake shoes

62

Brake shoes move against the drum when they are pushed by the _____.

17190

62

wheel cylinder

63

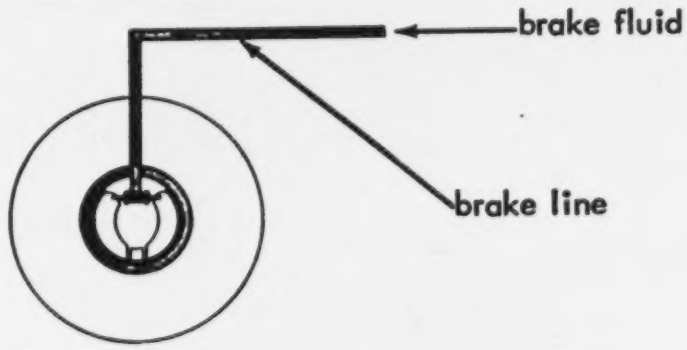

The wheel cylinder gets its force from the liquid inside the brake line.

This liquid is _____ _____.

17191

63

brake fluid

64

Force is carried from the master cylinder to the wheel cylinders by _____ _____.

17192

64

brake fluid

65

MATCH each part with the job it does:

A. brake fluid

B. brake drum

C. brake lining

D. wheel cylinder

1._____ pushes against the brake shoes to stop the car

2._____ carries stopping force from the brake pedal to the wheel cylinder

3._____ rubs against the drum to stop the car

17193

Shop and storage areas must be kept clean and uncluttered at all times and heavy material must be stored in a safe manner. Hazards that cannot be eliminated must be safeguarded by the use of effective guards, safety zones and other devices. Proper and adequate personal protective equipment such as goggles and respirators should be provided where needed. All safety equipment must be inspected frequently to see that it is in proper working order.

Human Behavior

Shop teachers must also accept the responsibility of giving safety instruction and developing safety consciousness to insure against the second general cause of accidents, unsafe human behavior. Unsafe human behavior includes improper attitudes on the part of students or teacher, lack of knowledge or skill and physical or mental defects. A competent, alert teacher can reduce accidents from these causes by careful instruction in the use of tools and equipment, insistence upon the use of safety equipment at all times and by maintaining good housekeeping for the total shop area.

A well disciplined, well managed shop where there is a genuine will on the part of both teacher and student to work so as to avoid accidents, will be a safe shop. Complete safety is possible only when everyone involved adheres to certain simple rules and, above all, exercises good judgement.

General shop safety rules that apply equally well in all areas are listed below while those peculiar to a given activity may be found under their respective areas.

General Safety Rules

A. Report all injuries to your instructor immediately.
B. Report any equipment not functioning properly.
C. Caution any student violating a safety rule. Wilful violation will result in suspension.
D. Appropriate clothing and appearance in the shop will be determined by the teacher. Loose sleeves and shirt tails must be corrected. Hair length shall be determined by the teacher.
E. Adequate eye protection equipment must be worn in the shop at all times. (see appendix)
F. Ask for help when in becomes necessary to carry large, heavy or long objects.
G. Place oil rags in covered, metal containers.
H. Keep floor clean of scraps, shavings, chips and other litter.
I. Clean up spilled liquids immediately.
J. Refrain from projecting tools or materials beyond the edge of the benches.
K. Know the location of fire extinguishers, first aid equipment and electrical power switches.

POLICY REGARDING SPECIAL STUDENTS

Special students are hereby indentified as those students who have acute emotional, mental and/or physical handicaps that do not afford them the opportunity to participate, on an equal basis, in the regular school curriculum with the other students in the school.

Regarding the activities of such special students in the industrial arts program, it is recommended that only after considerable consultation between the student's parents, the school's administrative and counseling units and the industrial arts teachers involved, and only after obtaining the approval of all the above parties, shall the student be enrolled in the industrial arts program. If at any time after admittance into the program, the teacher feels that the student's abilities and attitudes are not suited for the program, then the teacher alone has the right and responsibility to refuse the student further admission into the shop environment.

The reasons for this recommendation are:

1717

65

1. D
2. A
3. C

66

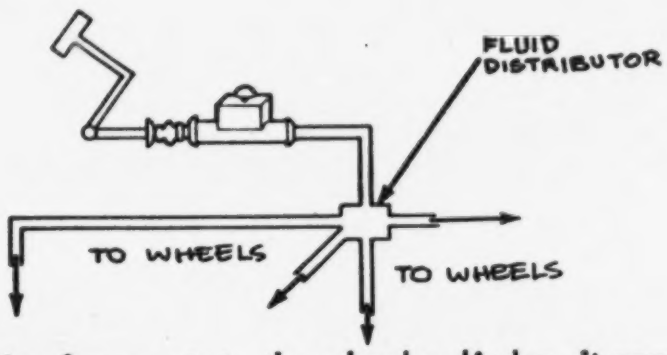

Before the braking force gets to the wheel cylinder, it passes through the fluid distributor.

The fluid distributor allows the brake fluid to go to how many wheels? _____

17194

66

4

67

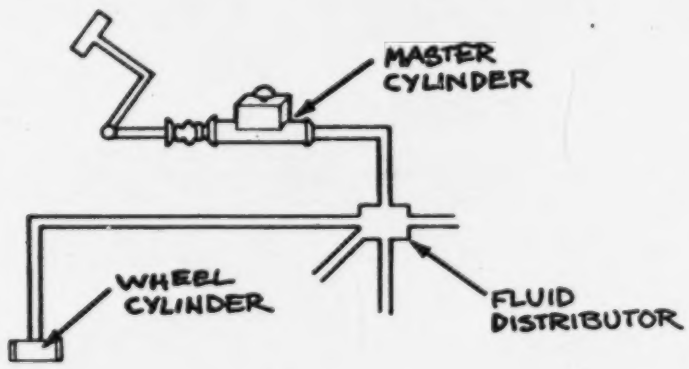

Brake fluid carries the braking force to all the wheels. This happens because the fluid is split up by the:

- ☐ fluid distributor
- ☐ wheel cylinder

17195

67

fluid distributor

68

CIRCLE the fluid distributor in the diagram:

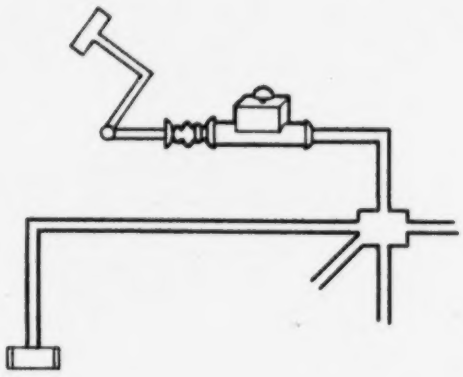

17196

68

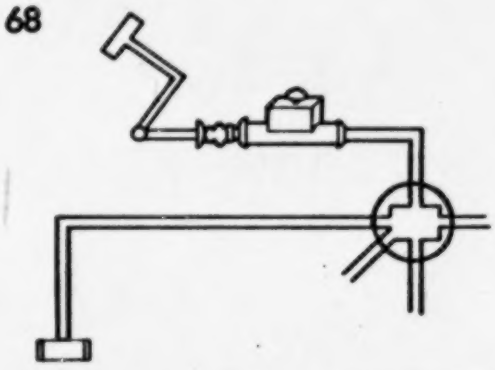

69

The fluid distributor is used to:

- ☐ divide the brake fluid among the four wheels
- ☐ store the brake fluid

17197

69

divide the brake fluid among the four wheels

70

DARKEN the brake lines in the drawing:

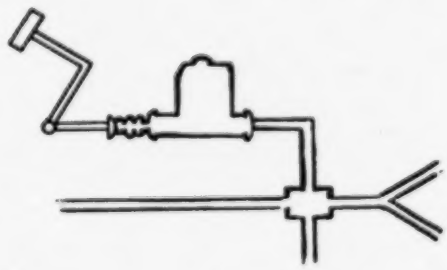

17198

70

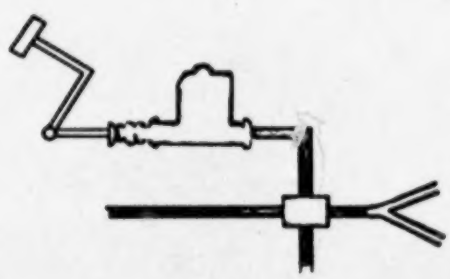

71

One part of the brake system that contains brake fluid is:

- ☐ the brake lines
- ☐ the brake lining

17199

71

the brake lines

72

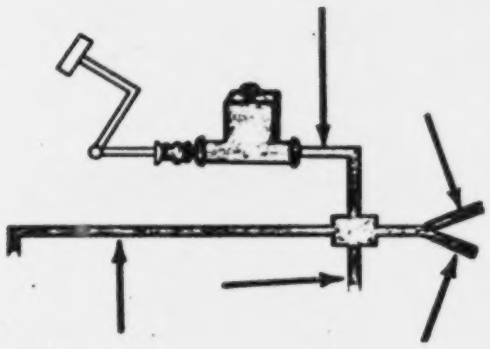

The arrows point to the part of the brake system called the _____ _____.

17200

72

brake lines

73

The brake lines are used to hold brake _____.

17201

73

fluid

74

What are the brake lines used for? _____

17202

74

to hold the brake fluid

75

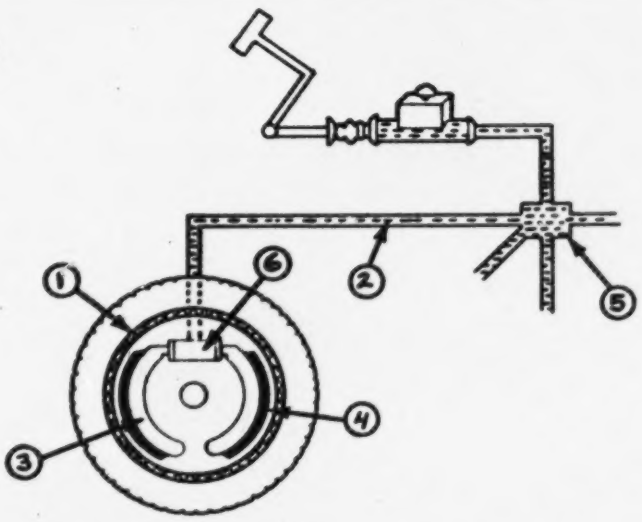

NAME the part that each arrow points to:

1: _____

2: _____

3: _____

4: _____

5: _____

6: _____

17203

1. The industrial arts teachers are not trained to handle the peculiar needs of the special student in a normal school shop situation.

2. The industrial arts shop facilities are not designed to accomodate the peculiar needs of the special student.

3. The general welfare and safety of the other students in the program are often endangered.

ELEMENTARY PROGRAM

Elementary school Industrial Arts is that phase of the elementary school curriculum which provides the child with opportunities for exploration, manipulation, experimentation, and the planned use of tools, materials, and techniques appropriate to converting these materials to serve some useful purpose. Planned activities and experience include (1) the construction of projects related to and reinforcing the elementary school subject matter content and projects related to recreational and personal purposes, and (2) a study of industry with emphasis on its organization, materials, processes, occupations, products, and problems and their effect on man's cultural past and present.

General Objectives

To help children develop confidence in their ability to make useful things with their hands.

To develop avocational interest and to understand the use of leisure time.

To encourage and develop an attitude of investigation, experimentation, and creation by providing opportunities to think through problems.

To encourage children to plan and organize so that their work becomes more precise and accurate, and so that greater levels of achievement may be reached.

To provide opportunities to develop muscular coordination and to release emotional tension.

To develop an understanding of the industrial nature of society.

To develop safety values in the work and play habits of the children.

To provide the means and experiences by which children create coupled with the growing ability to accomplish something with materials and to experience the accompanies joy of accomplishment.

To develop an appreciation of good workmanship, which involves social development including dependability, self control, willingness to cooperate and work with others.

GENERAL INTRODUCTION

Purpose

Many desirable habits and attitudes should result from an intelligently planned and administered program of industrial arts. Such a program furnishes opportunities for necessary social adjustments and for the perfecting of desired manipulative skills. It also enables the teacher to observe and evaluate the interests and abilities of the child.

75

brake drum

brake line

brake shoe

brake lining

fluid distributor

wheel cylinder

76

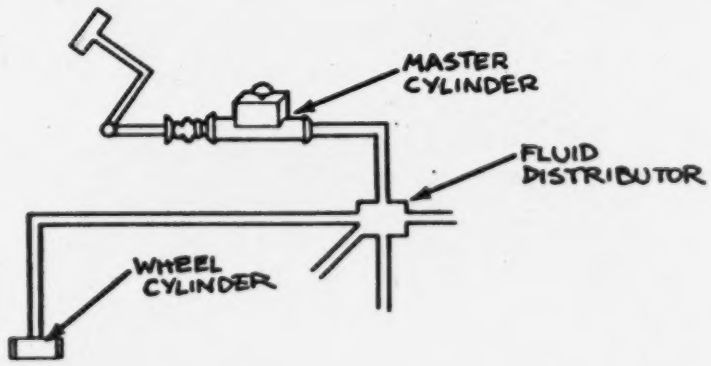

The part that connects the brake pedal to the brake lines is the:

- ☐ wheel cylinder
- ☐ fluid distributor
- ☐ master cylinder

17204

77

before the force gets to the brake lines

78

CIRCLE the master cylinder in the drawing:

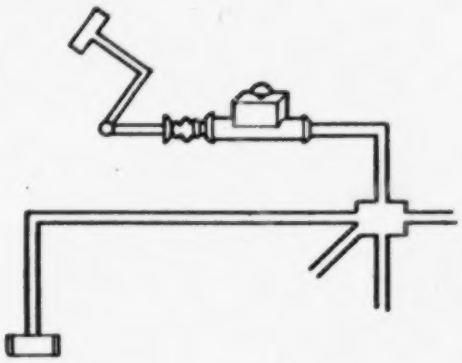

17206

78

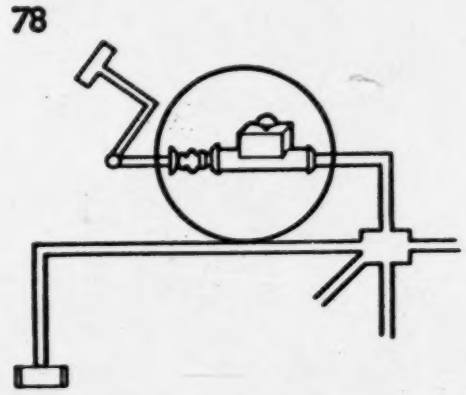

79

The arrow is pointing to the _____.

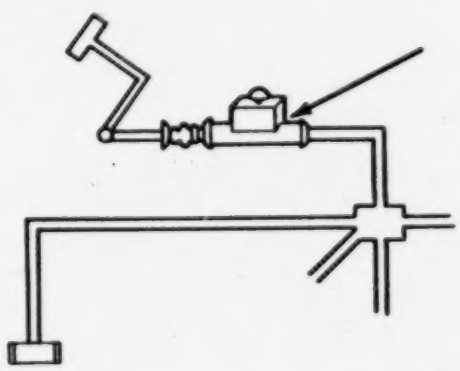

17207

79

master cylinder

80

The force from the brake pedal is increased before it gets to the brake lines.

What is the name of the part that increases the force?

_____

17208

80

master cylinder

81

The master cylinder gets the force from the brake pedal and gives it to the:

- ☐ brake drum
- ☐ brake fluid
- ☐ wheel cylinder

17209

81

brake fluid

82

CHECK the two things that the master cylinder does:

- ☐ gets the force from the brake fluid and gives it to the brake pedal
- ☐ gets the force from the brake pedal and gives it to the brake fluid
- ☐ makes the force greater
- ☐ makes the force smaller

17210

82

gets the force from the brake pedal and gives it to the brake fluid

makes the force greater

83

What part of the brake system does the driver step on?

_____

What part of the brake system builds up the force that the driver applies? _____

What carries the force to the wheel cylinders?

_____

17211

83

brake pedal

master cylinder

brake fluid

84

The job of the master cylinder is to make the driver's force on the brake pedal:

- ☐ greater
- ☐ less
- ☐ stay the same

17212

84

greater

85

What does the master cylinder do? _____

17213

Specific Objectives

A. To give each child varied opportunities to satisfy the urge to create and to feel the joy of accomplishment.

B. To give each child experiences that will help develop social understanding and the ability to work effectively with others either as a leader or as a member of the group.

C. To promote interesting activities that will lead to more effective use of leisure time.

D. To introduce the student to some of the changes that have been and can be made in the raw materials of his industrial world.

E. To develop independent thinking and orginality.

F. To correlate projects and ideas with specific subject areas.

Suggested Content

A. Manipulative and technical

1. Identification of common tools
2. Correct use and care of tools
3. Identification of common materials - wood, metal, etc.
4. Methods of cutting and fastening common materials.
5. Correct use of measuring devices
6. Filing common materials smooth
7. Sanding common materials smooth
8. Simple finishing procedures
   a. Shellacking
   b. Paint (water base paint)
   c. Coloring with crayons and other materials
9. Cleaning and care of brushes
10. Cutting with a knife

B. Related information

1. How tools, materials, and other supplies are manufactured
2. The selection of hand tools and materials
3. Use of various skills in industry
4. Good work habits and attitudes
5. Responsibility for clean-up and the orderly storage of tools and materials
6. Proper planning procedures
7. Safety to one's self and to others
8. Use of various skills for leisure enjoyment

Suggested Tools and Equipment

A. Hand tools

1. Claw hammers - various sizes
2. Back saws
3. Coping saws
4. Crosscut saws
5. Files - assorted
6. Compass
7. Screwdrivers
8. Pliers
9. Wood clamps
10. Knives
11. Rulers
12. Bench vises
13. File cards
14. mitre box
15. Auger bits
16. Hand drills
17. Twist drills
18. Ratchet brace
19. Try square
20. Drawing boards
21. T-squares
22. Triangles
23. Scales
24. Paint brushes
25. Eye shields

85

makes the driver's force on the brake pedal greater

86

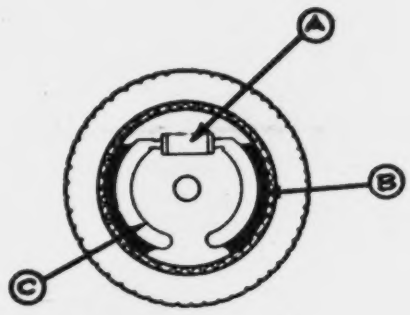

Which arrow in the drawing points to each of the following?

1. _____ brake lining
2. _____ brake shoe
3. _____ master cylinder
4. _____ wheel cylinder

17214

86

1. B
2. C
3. —
4. A

87

The master cylinder gets its force from the _____.

17215

87

the brake pedal

88

CIRCLE the brake pedal:

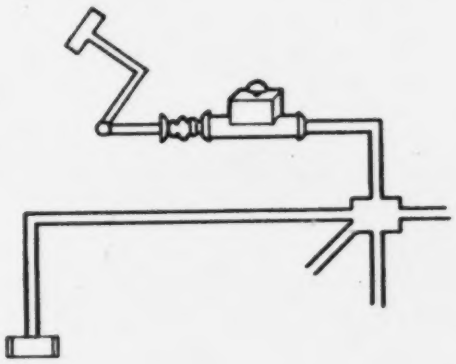

17216

88

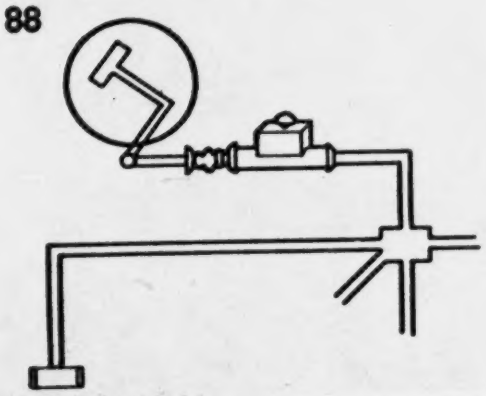

89

What is the name of the part of the brake system that the driver steps on? _____ _____

17217

89

brake pedal

90

The brake pedal is used to take the force from the driver and give it to the _____ _____.

17218

90

master cylinder

91

The brake pedal takes force from the _____ and gives it to the _____.

17219

91

brake pedal

master cylinder

92

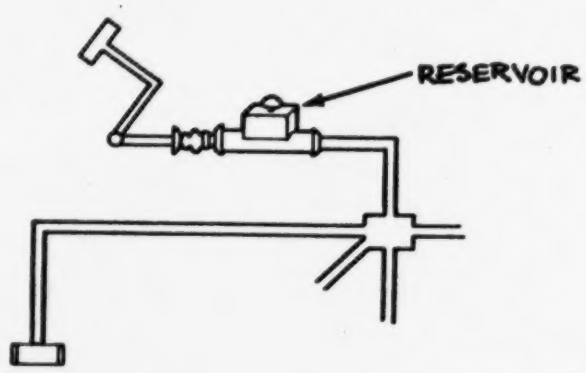

Brake fluid is kept in a brake reservoir.

The brake reservoir is on top of the _____.

17220

92

master cylinder

93

DARKEN the brake reservoir in the diagram:

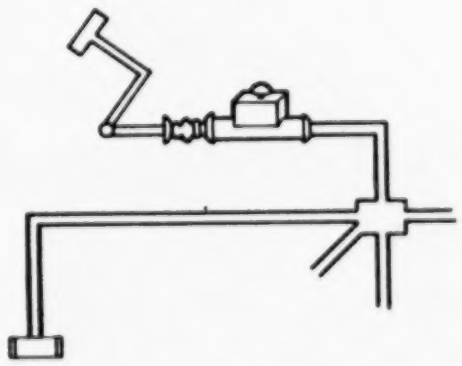

17201

93

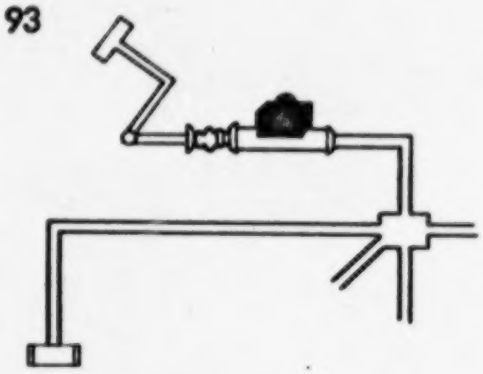

94

The part used to store brake fluid is the:

- ☐ brake lines
- ☐ master cylinder
- ☐ master cylinder reservoir
- ☐ wheel cylinder

17222

94

master cylinder reservoir

95

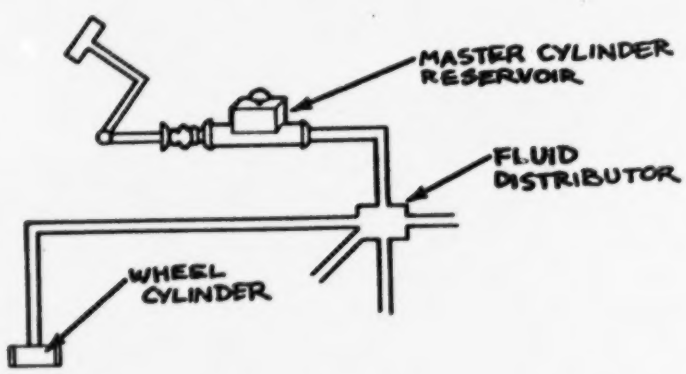

Which part stores brake fluid for the master cylinder?

- ☐ fluid distributor
- ☐ master cylinder reservoir
- ☐ wheel cylinder

17223

B. Power tools and equipment

1. Jig saw
2. Grinder
3. Saber saw
4. Drill press
5. Portable drill

Materials

A. Soft woods - assorted sizes
B. Sheet metal - assorted sizes
C. Plastics - assorted sizes
D. Nails and screws
E. Glue
F. Finishing materials

1. Abrasive sandpaper
2. Plastic crack filler
3. Linseed oil
4. Shellac
5. Paints (water color base)
6. Steel wool
7. Paste wax

G. Leather

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criterial to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations withing ability of student
3. Good design
4. Within means of student
5. Within shop facilities

Safety Precautions

A. Pupils should notify the teacher if they notice any unsafe conditions in the working area.
B. Pupils should not attempt to lift heavy materils.
C. Playing or scuffling is extremely dangerous and often results in personal injury.
D. Sharp-edged and pointed tools must not be carried in pockets or allowed to protrude when placed on a bench.
E. Any injury, no matter how slight, should be reported to the teacher immediately.
F. When using a sharp-edged tool, always cut away from the body.
G. Oil, scraps of wood, and other foreign matter must be kept off the floor.
H. Be considerate of one's fellow worker.

Suggested Equipment Organization

A. The Industrial Arts laboratory

A room especially equipped for Industrial Arts activities, with supplies, tools, equipment, and working space available, similar to a craft room or a small shop, is advisable. The classes would come to this room for their Industrial Arts work and activities. Here classes have the proper atmosphere and all the materials necessary to fill individual and collective needs.

95

master cylinder reservoir

96

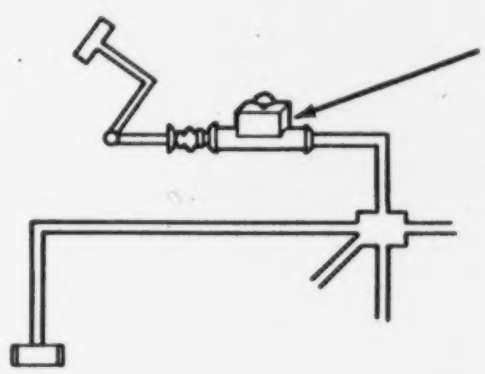

The arrow is pointing to the:

- ☐ brake shoe
- ☐ fluid distributor
- ☐ master cylinder reservoir

17224

96

master cylinder reservoir

97

What is the master cylinder reservoir used for? _____

17225

97

to store brake fluid

98

Some cars have parts added to the brake system to give the brakes extra power. This makes it easier to stop the car.

These cars have parts that:

- ☐ decrease the power of the brake force
- ☐ increase the power of the brake force
- ☐ remove the power of the brake force

17226

98

increase the power of the brake force

99

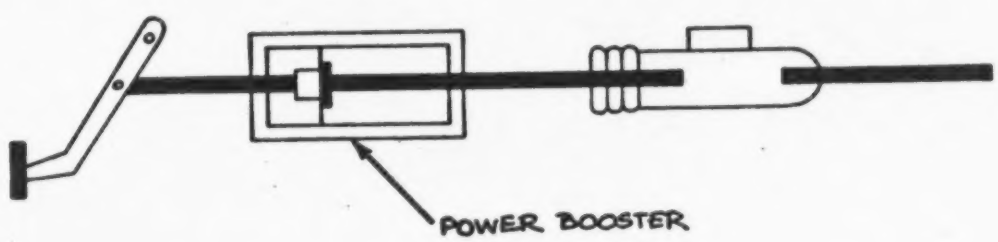

The power booster increases the force in the brake system.

The part which increases force is between the _____ and the _____.

17227

99

brake pedal

master cylinder

100

CIRCLE the power booster:

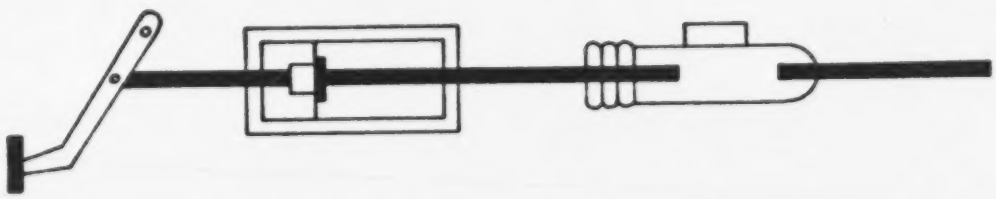

17228

100

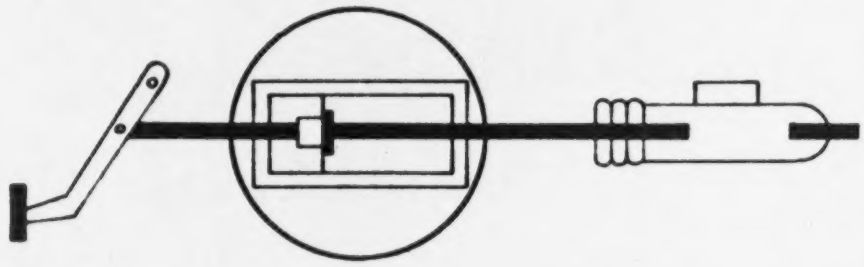

101

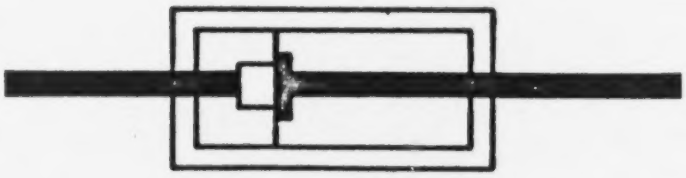

The part shown above is the:

- ☐ master cylinder
- ☐ power booster
- ☐ wheel cylinder

17229

101

power booster

102

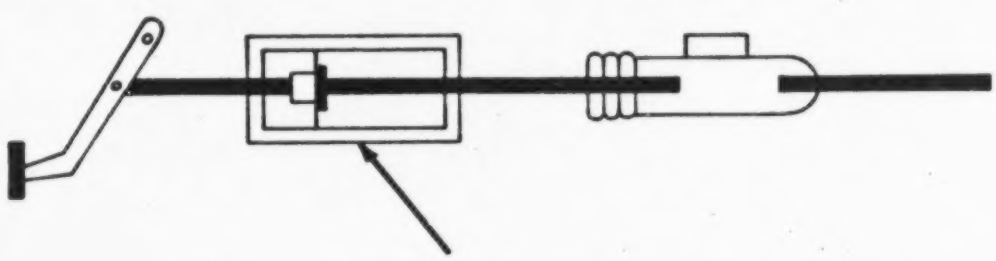

What is the job of the part that the arrow is pointing to?

_____

17230

102

to increase the power of the brake system

103

Cars with a part to increase the "stopping" force have power brakes.

To have power brakes, a car must have a:

- ☐ master cylinder
- ☐ power booster
- ☐ wheel cylinder

17231

103

power booster

104

A car with a power booster in the brake system has:

- ☐ no brakes
- ☐ power brakes
- ☐ regular brakes

17232

104

power brakes

105

When a car has a power booster, it has _____ brakes.

17233

B. Portable laboratory

A bench and equipment built on wheels or casters may be used. This method requires a minimum of space and expense and the teachers may borrow the portable laboratory when needed in the classroom. This unit may be kept in a storage room or the library when not in use. A suggested plan for the portable laboratory includes such features as; a work bench top of 2-inch Maple, storage space under the table, vises on the corners, tool panel that closes into the table for storage, retractable casters, and accomodations for 4 to 6 pupils at one time.

1721

105

power

106

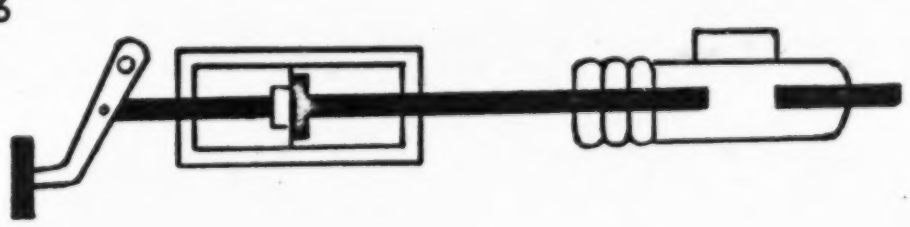

What kind of brake system does this car have?

_____

17234

106

power brake system

107

Which car will be easier to stop? A car with:

- ☐ no brakes
- ☐ regular brakes
- ☐ power brakes

l 7235

107

power brakes

108

How do power brakes affect stopping a car? _____

17236

108

they make it easier
(or similar answer)

109

What part is added to the brake system to make it a power brake system? _____

17236

109

a power booster

110

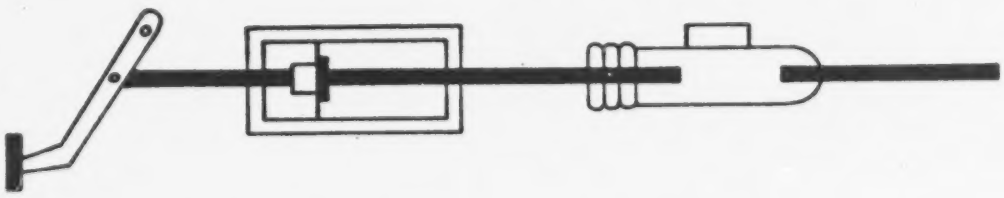

The power booster is between the _____ and the _____.

17237

110

brake pedal

master cylinder

111

The master cylinder and the power booster (☐ are ☐ are not) the same thing.

17238

111

are not

112

COMPLETE the serviceman's answer:

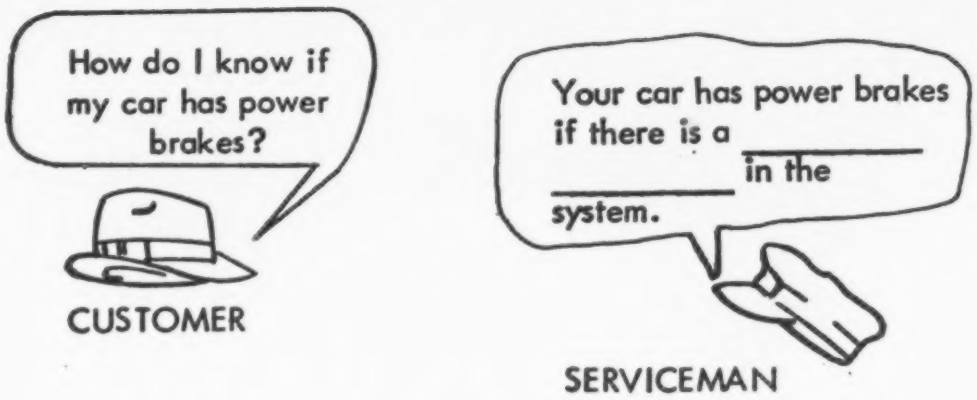

L 7239

112

power booster

113

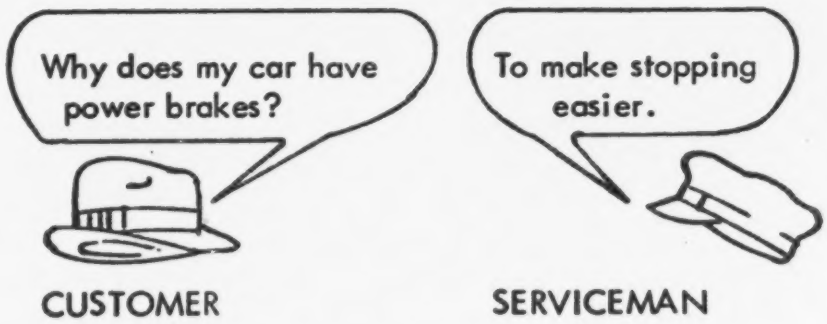

Did the serviceman give the correct answer?

- ☐ yes
- ☐ no

17240

113

yes

114

Why does a car have power brakes? _____

17244

114

to make stopping easier

115

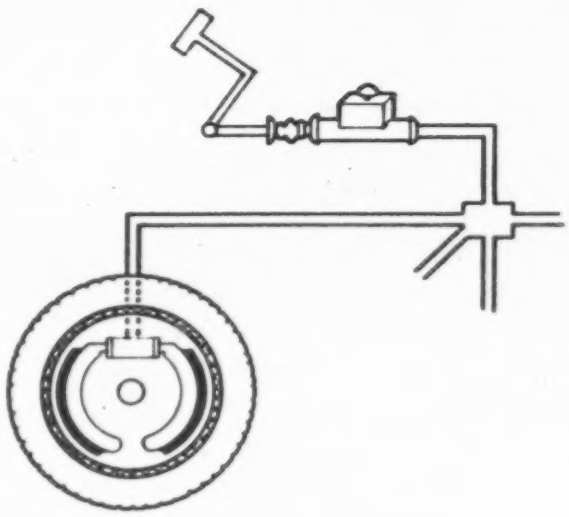

Does the picture show a regular brake system?

- ☐ yes
- ☐ no

How do you know this? _____

17242

DRAFTING

Drafting, the universal graphic language, is of greatest importance in such areas as engineering, construction, manufacturing, and industrial processing. Drafting skills are used extensively in a variety of occupations such as; engineering, designing, technical illustration, etc. However, one need not be engaged in one of these vocations in order to benefit from experiences in the drafting field. The ability to read and understand drawings that are concerned with the assembly, installation, and operation of applicances, mechanical devices, and many common household products is necessary today. Drafting in the secondary school must be appropriate to the consumer as well as to the producer of industrial products.

General Objectives

To develop the ability to visualize and represent on paper what one sees.

To develop the ability to make working drawings in keeping with modern practices.

To give the student with an engineering or technical interest a basic experience in the universal language of industry.

To develop the ability to interpret working drawings.

INTRODUCTION TO DRAFTING

Purpose

This is intended to be an exploratory course in general drafting. Good working habits and informational topics concerning industrial practices, materials, and machines should be considered along with the manipulative aspects of drafting. The suggested material should be considered the minimum outline for a school year of 36 weeks. Shorter courses may be organized by selecting a limited number of learning units from the course.

Specific Objectives

A. To develop the habit of using drafting as a tool in the planning process involving problems of a technical nature.
B. To apply the theory of related views - orthographic projections.
C. To teach the basic skills needed in freehand sketching.
D. To introduce the use of pictorial drawing in describing objects.
E. To develop an appreciation of contour maps and their uses.

Suggested Content

A. Manipulative and technical
1. Use and care of instruments
2. Alphabet of lines
3. Acceptable norms of accuracy
4. Good dimensioning practices
5. Proper lettering techniques
6. Applied geometry in drafting
7. Methods of illustrating objects
8. Reading and construction of contour maps
9. Processes involving the planning of small buildings
10. Tracing techniques
Reproducing drawings
12. Shape description
13. Orthographic projection
14. Pictorial drawing
15. Sketching
16. Sections andConventions
17. Auxiliary views
18. Sheet metal layout
19. Working drawings
20. Detail drawings
21. Schematics
22. Charts and graphs

115

yes

It has no power booster.
(or similar answer)

116

LOOK AT PANEL 1

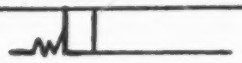

The panel shows a diagram of the _____ _____.

17243

116

brake system

117

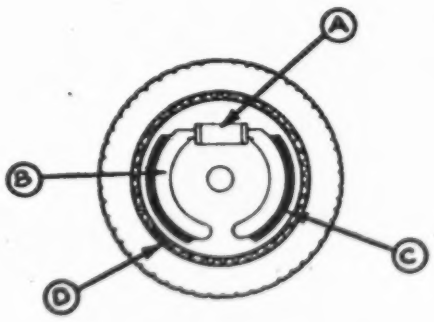

What part does each arrow point to?

arrow A: _____

arrow B: _____

arrow C: _____

arrow D: _____

17244

117

wheel cylinder

brake shoe

brake lining

brake drum

118

The part of the brake system that is connected to each wheel is a:

- ☐ brake pedal
- ☐ brake shoe
- ☐ brake drum

17245

118

brake drum

119

MATCH each part with the job it does:

A. brake fluid

B. brake lining

C. master cylinder

D. wheel cylinder

1. _____ builds up the driver's force on the brake pedal

2. _____ carries force from the master cylinder to the wheel cylinders

3. _____ moves the brake shoes toward the brake drum

4. _____ rubs against the drum to stop the car

17246

119

1. C
2. A
3. D
4. B

120

The brake lining is mounted on a _____.

17247

120

brake shoe

121

Brake shoes are moved by the _____.

Force is carried through the brake system by the _____.

17248

121

wheel cylinder

brake fluid

122

Brake fluid is carried through the brake system in the

_____ _____.

The driver steps on the _____ _____.

17249

122

brake lines

brake pedal

123

The driver's force on the brake pedal is built up by the

_____ _____.

17250

123

master cylinder

124

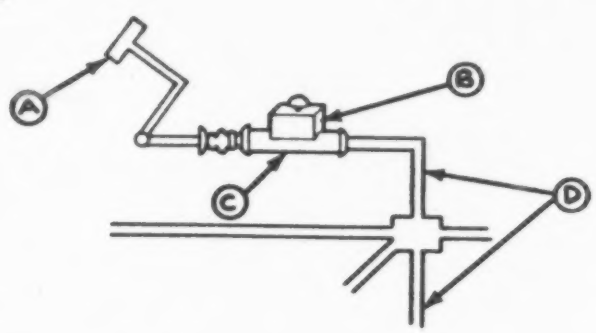

To what part does each arrow point?

arrow A: _____

arrow B: _____

arrow C: _____

arrow D: _____

17251

124

brake pedal

fluid reservoir

master cylinder

brake lines

THIS IS THE END OF BOOK 1

17252

B. Related information

1. The importance of drafting
2. The relationship between the draftsman and the craftsman
3. Occupations that use dr fting
4. Employment opportunities
5. The selection of instruments
6. Types of tools used by the draftsman
7. Mathematics as applied to drafting

Suggested Tools and Equipment

A. Drawing Board
B. T-square
C. 30-60 degree triangle
D. 45 degree triangle
E. Architects scale (suitable scale or ruler)
F. Drafting set
G. Irregular curve
H. Draftsman's pencil sharperner
I. Lettering guide
J. Erasing shield
K. Assorted templates
L. Drafting machine

Safety Precautions

A. Provide adequate lighting and ventilation within the drafting area.
B. Handle all pointed drafting equipment appropriately.

Materials

A. Drawing paper (size, color, and quality - optional)
B. Drawing pencisl (number and grades - optional)
C. Eraser (non-grit)
D. Drafting tape
E. Sandpaper for pointing pencils
F. India ink (optional)
G. Tracing paper

Suggested Projects

This assignment of lettering and drawing plates is left to the discretion of the individual instructor. Assignments may come from the following sources: (1) actual objects, (2) textbook projects and problems (3) workbook sheets, (4) instructor-assigned drawings.

1723

post Test
page 1
Book 1

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

When a driver steps on the brake pedal, what rubs against the brake drum? _____

2

One brake line comes out of the master cylinder. It goes into a part that divides brake fluid among the four wheels. This part is the _____.

3

The power booster is between the:

- ☐ brake pedal and the master cylinder
- ☐ master cylinder and the brake line
- ☐ master cylinder and the wheel cylinder

17253

4

CHECK the two jobs of the master cylinder:

- ☐ gets stopping force from the brake pedal and gives it to the master cylinder
- ☐ gets stopping force from the master cylinder and gives it to the brake fluid
- ☐ makes the stopping force greater
- ☐ makes the stopping force smaller
- ☐ does the same thing that the wheel cylinder does

5

When the driver steps on the brake pedal, the brake shoes are moved by the _____ .

6

Force is carried to the wheel cylinders in _____ .

7

The brake linings are mounted on the _____ .

17254

8

The wheel is connected to the rest of the brake system by the _____.

9

If brake fluid leaks out of a brake line, the car will not stop because _____ is not being carried to the wheel cylinders.

10

What is stored in the master cylinder reservoir? _____

11

What is mounted to the brake shoes to move when the brake shoes move? _____

17255

12-15

LABEL each of the following parts:

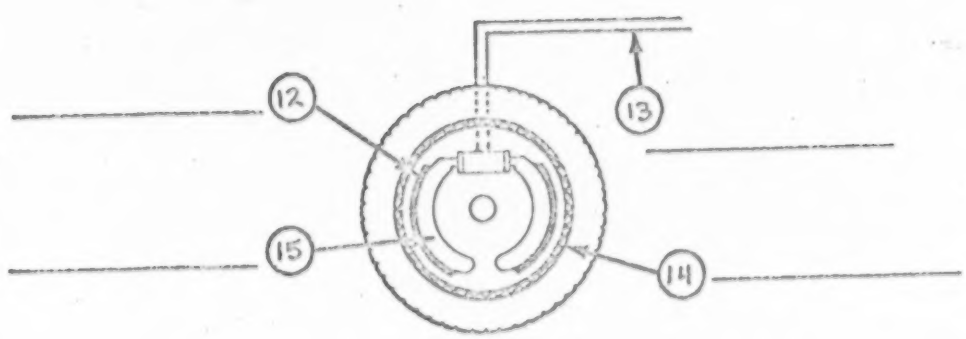

17256

VT 013 124
Auto Mechanics Course. Book 2: Simple DC Circuits.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 75p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *ELECTRIC CIRCUITS; ELECTRIC BATTERIES; ELECTRICITY; MECHANICS (PROCESS); INDUSTRIAL ARTS
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on simple DC circuits was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 124

ED0 56238

BOOK 2

C1

AUTO MECHANICS COURSE

BOOK 2: SIMPLE DC CIRCUITS

A BASIC SYSTEMS PROGRAM

VT013124

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OFFICE OF EDUCATION
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Curriculum Report Reference
Page 11

Task Analysis Reference
6.3

17258

248 OF 327

ED

056 238

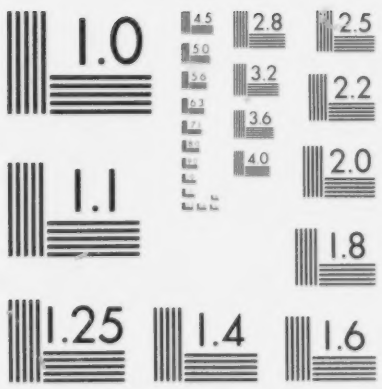

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

AUTO MECHANICS COURSE

BOOK 2: SIMPLE DC CIRCUITS

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

2xc

17259

1-4

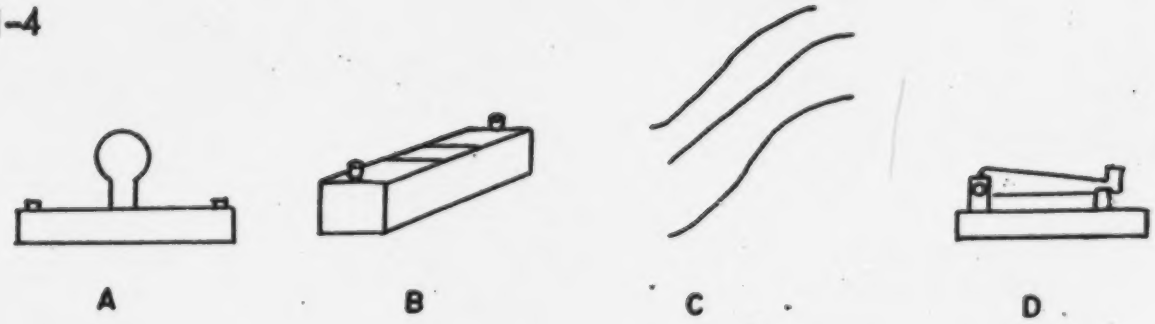

Next to each letter below, WRITE the name of the part that it represents in the picture above:

A: _____

B: _____

C: _____

D: _____

17260

5-7

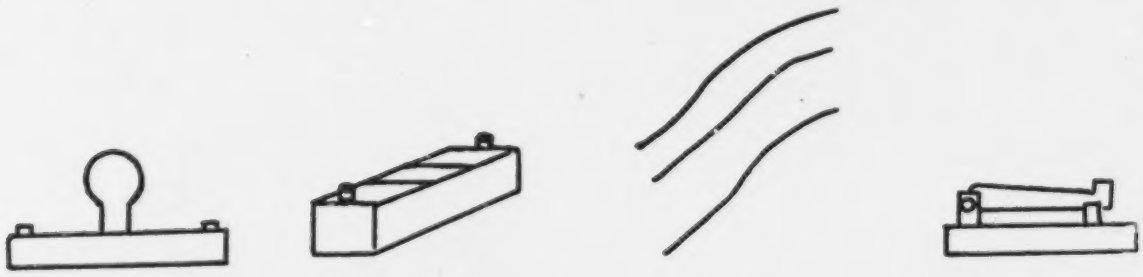

Using the parts shown above, DRAW a picture of a closed circuit:

8

NAME the part that stores and gives off electricity. _____

17261

MACHINE DRAFTING

Purpose

This outline is designed for the advanced student who is interested in becoming more proficient in mechanical drafting. It is especially helpful to the person who may be interested in mechnaical engineering, the metal trades, or drafting as a vocation. This material is planned to be covered in one semester.

Special Objectives

A. To give the student further instruction in drafting and the techniques of good drawing.
B. To increase one's power of visualization and constructive thinking.
C. To provide the opportunity for specialization in the area of detail and asembly drawing.
D. To introduce the student to metal fabrication processes and material use.

Suggested Content;

A. Manipulative and technical
   1. Review orthographic projection
   2. Review pictorial drawing
   3. Detail dimensioning
   4. Gears and cams
   5. Mechanical symbols
   6. Jigs and fixtures
   7. Standard bolts and nuts
   8. Standard screw threads
   9. Keys and Keyways
   10. Miscellaneous fasteners
   11. Chucks
   12. Dies
   13. Assembly drawing
      a. Detail
      b. Exploded
      c. Sections

B. Related Information
   1. Casting processes
   2. Machining processes - fillets, shrinks, machine choice
   3. Drafting and the mechanical engineer
   4. Limits and tolerances
   5. Mathematics of machine drafting
   6. Basic heat treating processes

Suggested Tools and Equipment

A. Drawing Board
B. T-square
C. 30-60 degree triangle
D. 45 degree triangle
E. Mechanical engineer's scale
F. Drafting set
G. Irregular curve
I. Erasing shield
J. Lettering guide
K. Assorted templates
L. Drafting machines

Safety Precautions

A. Provide adequate lighting and ventilation within the drafting area.
B. Handle all pointed drafting equipment appropriately.

1724

9

NAME the part that turns electricity on and off. _____

10

Electricity will <u>not</u> pass through an _____ switch.

17262

Name _____

Date _____

Starting time _____

Finishing time _____

17263

1

PREVIEW FRAME

This section of the program tells you how electrical parts are connected.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

17264

1

NO ANSWER NEEDED

2

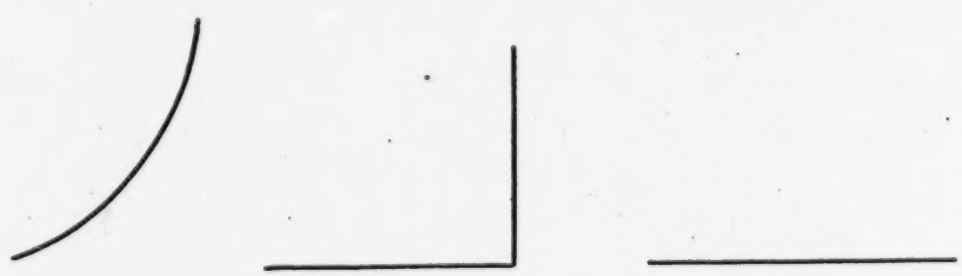

A line is used to represent a wire.

How many wires are shown above?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

17265

2

3

3

In electricity, the above line represents a:
(CHECK ONE)

- ☐ lamp
- ☐ piece of wire
- ☐ battery

17266

3

piece of wire

4

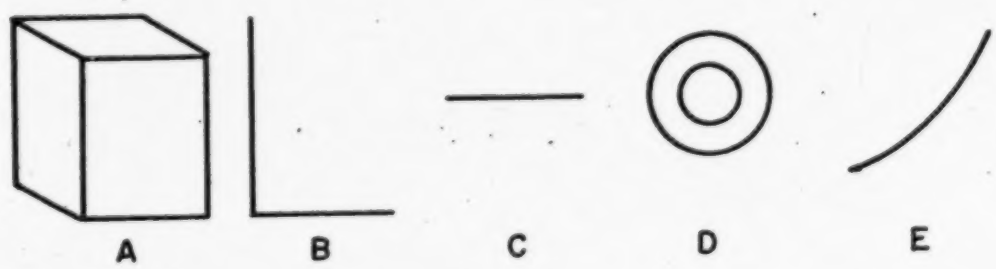

Wires can be drawn in many shapes.

CHECK all of the above shapes that represent pieces of wire:

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E

17267

5

A

B

6

Wires are used to carry _____ .

17269

6

electricity

7

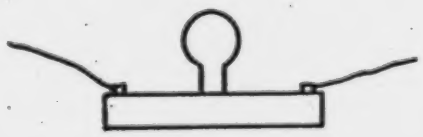

The drawing shows a lamp.

A lamp gives off:

- ☐ air
- ☐ flames
- ☐ light

17270

7

light

8

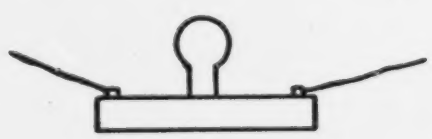

The picture represents a:

- ☐ battery
- ☐ lamp
- ☐ switch

It uses:

- ☐ electricity
- ☐ gasoline

17271

Materials

A. Drawing paper (size, color, and quality - optional)

B. Drawing pencisl (number and grade - optional)

C. Eraser

d. drafting tape

E. Sandpaper for pointing pencils or a pencil pointer

F. Tracing paper

G. India ink (optional)

H. Lettering pens

Suggested Projects

The assignment of plates is left to the discretion of the individual instructor. Asignments may come from the following sources: (1) actual objects, (2) textbook projects and problems, (3) workbood sheets, (4) instructor-assigned drawings.

1725

8

lamp

electricity

9

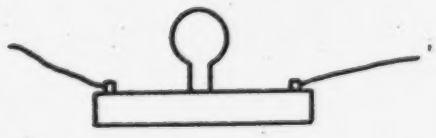

The lamp:

- ☐ burns up the wires
- ☐ has a round socket
- ☐ uses electricity to give off light

17272

9

uses electricity to give off light

10

The part that uses electricity to give off light is called a _____ .

17273

10

lamp

11

A wire is connected to one side of the lamp.

DRAW a wire so that it is connected to the other side of the lamp:

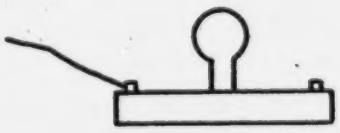

17274

11

12

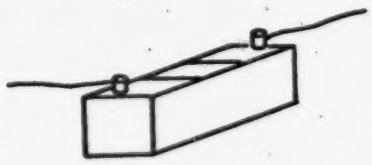

The picture shows a BATTERY.

How many wires are connected to it? ____

17275

12

2

13

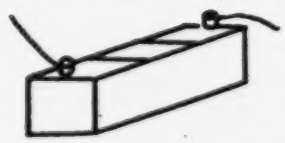

The wires are connected to a:

- ☐ lamp
- ☐ battery
- ☐ pipe

17276

13

battery

14

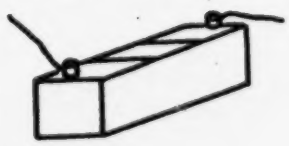

The place where each wire is connected to the battery is called a TERMINAL.

The terminals are located:

- ☐ at each end of the battery
- ☐ in the middle of the battery
- ☐ underneath the battery

17287

14

at each end of battery

15

Wires are connected to a battery's:

- ☐ casing
- ☐ top
- ☐ terminal

Now DRAW two wires to the correct part of the battery:

17278

15

terminal

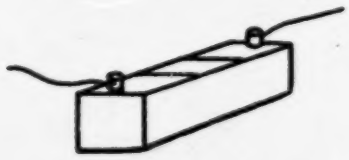

16

CIRCLE the object below that stores and gives off electricity:

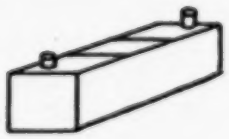

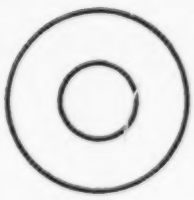

17279

16

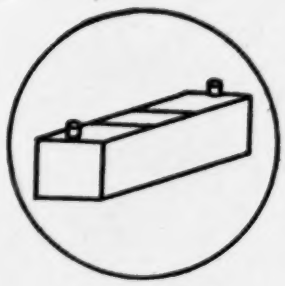

17

You need a part that stores and gives off electricity.

CHECK the name of the part you should buy:

- ☐ headlight
- ☐ switch
- ☐ battery

17280

17

battery

18

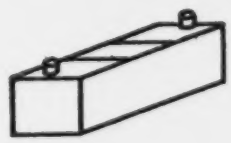

The part in the drawing above is used to:

- ☐ destroy electricity
- ☐ hold a switch
- ☐ store and give electricity

1728

ARCHITECTURAL DRAFTING

Purpose

This course is designed for the advanced student who is interested in a specialized area of drafting. Architectural drafting is fascinating and valuable whether it is pursued as a vocation or for personal use as a future home owner. Although the suggested content is sufficient for a full year's course, the usual one semester course can be organized by selecting a limited number of units from the suggested content.

Specific Objectives

A. To teach good house planning principles to the future home owner.
B. To develop the ability to interpret drawings of building construction.
To increase the mechanical skills of the prospective architect, engineer, draftsman, or tradesman.
D. To introduce the student to construction material and methods of construction.
E. To make students aware of building codes and their importance in planning a residence.

Suggested Content

A. Manipulative and technical
1. Architectural lettering
2. Architectural styles
3. Architectural symbols
4. Footings and foundations
5. Sill construction
6. Wall construction
a. Frame
b. Masonry
c. Brick Veneer
7. Cornices
8. Roof construction
9. Stair details
10. Fireplace and chimney details
11. Utilities
a. Electrical
b. Plumbing fixtures
12. Preliminary sketches
13. Floor plan
14. Elevations
16. Kitchen and bathroom arrangements
17. Plat plan
18. Perspective
19. Models
20. Landscaping

B. Related information
1. Lumbering
2. Masonry products
3. Heating and air conditioning systems
4. New building materials
5. Plumbing problems
6. State and local building codes
7. The architect and his work
8. Pre-fabrication processes
9. Vocational opportunities (types of architectural occupations)
10. FHA standard
11. Estimating

18

store and give electricity

19

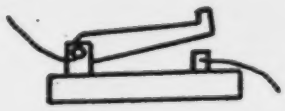

A SWITCH is shown in the drawing.

A switch has:

- ☐ one wire connected to it
- ☐ two wires connected to it
- ☐ three wires connected to it

17282

19

two wires connected to it

20

Two switches are shown above.

The arrows show that:

- ☐ electricity cannot flow through a switch
- ☐ electricity only flows through a closed switch
- ☐ electricity only flows through an open switch

17283

20

electricity only flows through a closed switch

21

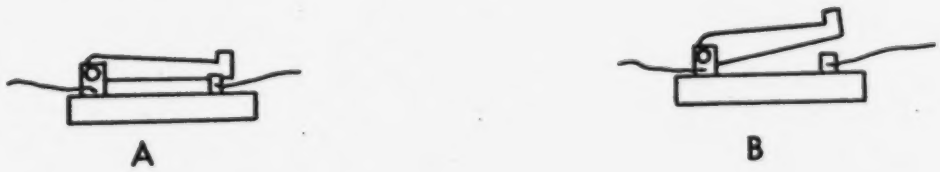

The switch in the drawing above is shown in two positions.

In drawing B the switch is:

- ☐ open
- ☐ closed
- ☐ disconnected

17284

21

open

22

Electricity can pass through this switch: CLOSED

Electricity can <u>not</u> pass through this switch: 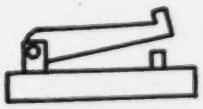 OPEN

Electricity can pass through:

- ☐ a closed switch only
- ☐ an open switch only
- ☐ both a closed switch and an open switch

17285

22

a closed switch only

23

CIRCLE the switch that electricity can <u>not</u> pass through:

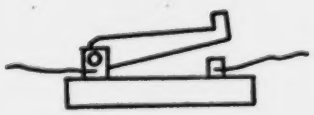

17286

23

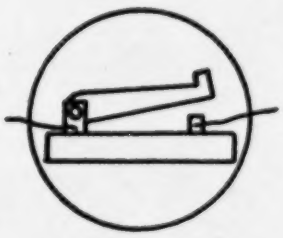

24

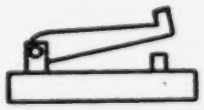

The picture shows the part called a _____ .

Is it open or closed? _____

17287

24

switch

open

25

DRAW the switch ARM on the wired part to show a closed switch:

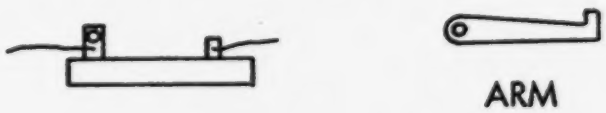

17288

25

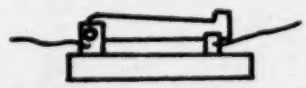

26

A switch is ON when electricity passes through it.

CIRCLE the switch below that is in the ON position:

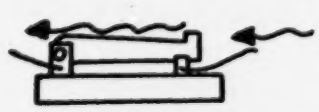

17289

26

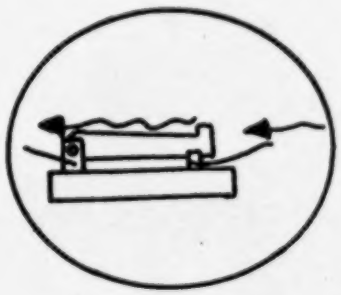

27

A switch has two positions to:

- ☐ make electricity hot or cold
- ☐ turn the flow of electricity on or off
- ☐ store electricity

17290

27

turn the flow of electricity on or off

28

MATCH the following:

A. lets electricity pass through it

B. stops electricity from passing through it

C. stores electricity

1. _____ closed switch

2. _____ open switch

17291

Suggested Tools and Equipment

A. Drawing board
B. T-square
D. 45 degree tra
D. 45 degree triangle
E. Architect's scale
F. Drafting set
G. Irregular curves
H. Draftsman's pencil sharpener
I. Erasing shield
J. House plan templates (1/4 inch scale)
K. Lettering guide
L. Drafting machine

Safety Precautions

A. Provide adequate lighting and ventilation within the drafting area.
B. Handle all pointed drafting equipment appropriately.

Materials

A. Drawing paper (size, color, and quality - optional)
B. Drawing pencils (number and grade - optional)
C. Eraser
D. Drafting tape
E. Sandpaper or pencil pointer
F. Tracing paper
G. India ink (optional)
H. Lettering pens

Suggested Projects

A complete set of house plans, designed and drawn by each student. Models may be required.

28

1. A

2. B

29

MATCH the following:

A. battery

B. lamp

C. wire

1. _____ stores and gives electricity

2. _____ uses electricity to produce light

17292

29

1. A

2. B

30

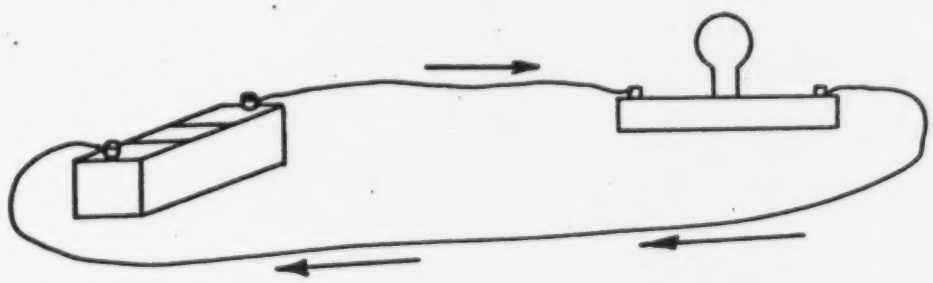

LOOK at the picture above.

Electricity goes to the lamp from the _____ .

17293

30

battery

31

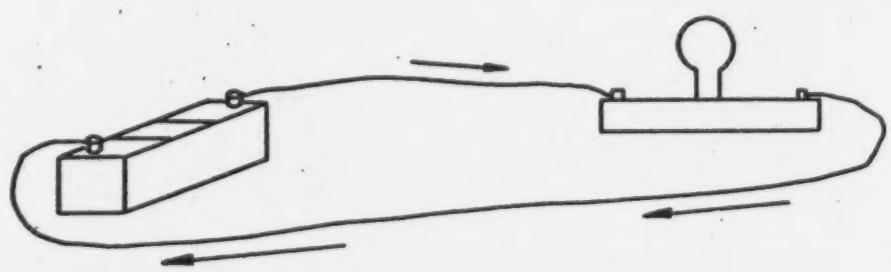

Electricity gets from the battery to the lamp and back to the battery again through:

- ☐ signals
- ☐ pipes
- ☐ wires

17294

31

wires

32

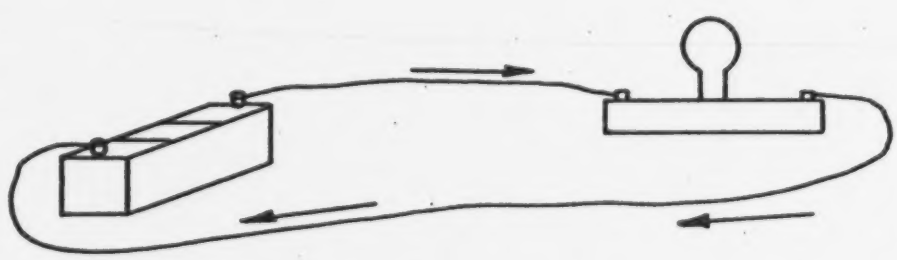

When electricity passes through the lamp, the lamp will

_____.

17295

32

light

33

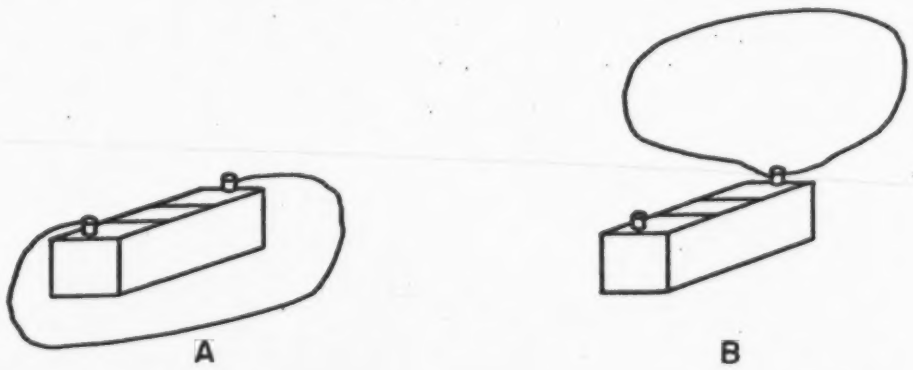

The electricity always leaves the battery at one terminal and returns to the battery at the other terminal.

In which of the above drawings is the wire correctly connected to the battery?

- ☐ A
- ☐ B

17296

33

A

34

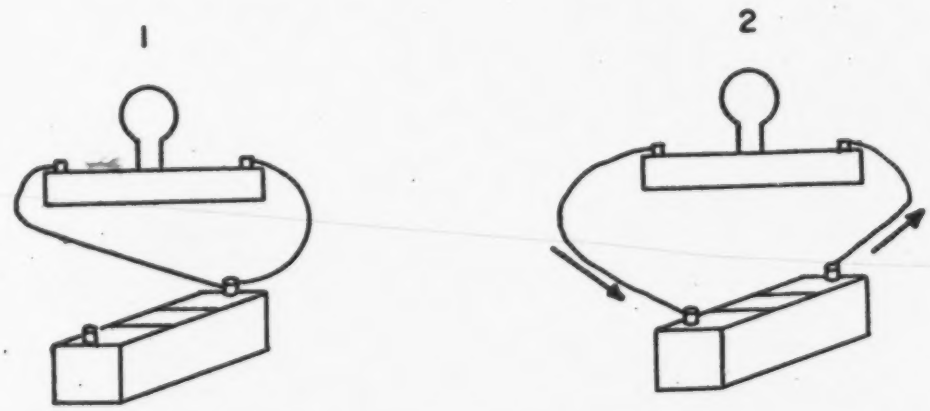

Which drawing shows that the electricity leaves one terminal of the battery and returns to the other terminal?

- ☐ 1
- ☐ 2

Which of the above lamps will light?

- ☐ 1
- ☐ 2

34

2

2

35

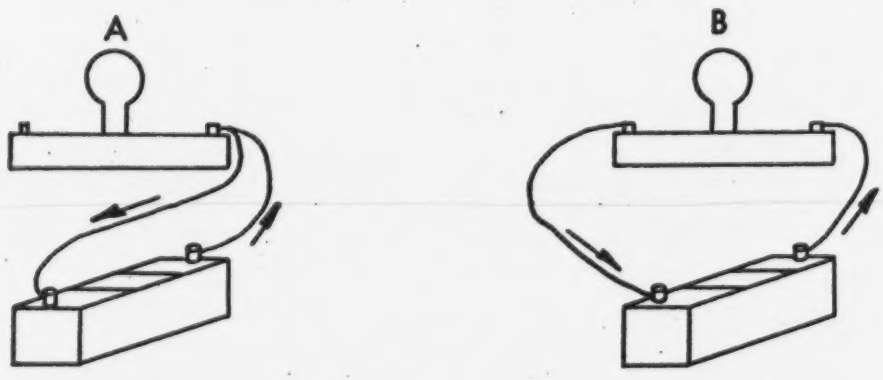

A lamp can be lighted only when electricity passes through the lamp.

Which of the pictures above shows that electricity passes through the lamp?

- ☐ A
- ☐ B

17298

35

B

36

In the picture above, does electricity leave the battery at one terminal and return to the battery at the other terminal?

- ☐ yes
- ☐ no

Will the lamp light?

- ☐ yes
- ☐ no

17299

36

no

no

37

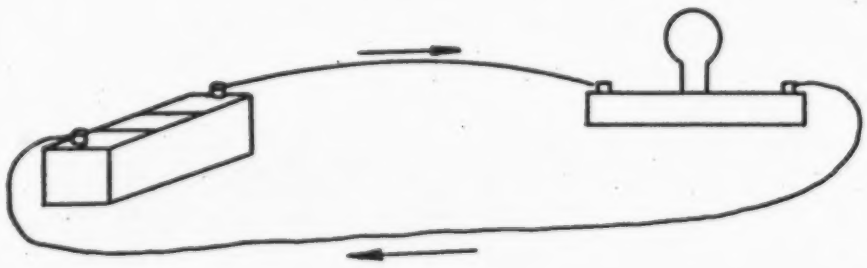

Does electricity pass through the lamp?

- ☐ yes
- ☐ no

Should the lamp light?

- ☐ yes
- ☐ no

17300

37

yes

yes

38

To light a lamp:

1) electricity must leave the battery at one terminal and return to the battery at the _____ (same/other) terminal;

2) electricity must enter the lamp at one end and leave the lamp at the _____ (same/other) end.

17301

WOODWORKING

Woodworking is one of the oldest safe activities involving common material that can be easily fashioned into useful objects. Although it began as a handicraft, woodworking now involves power-driven machines in addition to the more traditional hand tools.

Woodworking has always been of considerable interest to young people and much personal satisfaction accrues to one who constructs attractive and useful projects.

General Objectives

To develop a degree of skill in the use and care of the common tools and machines used in woodworking.
To develop an appreciation of the importance of the forest industry in our society.
To develop an appreciation of good design in products made of wood.
To develop an awareness of the occupational opportunities in the woods industries.
To encourage the development of hobby interests with wood as the medium.
To teach the student how to make and use a working drawing, compute a bill of materials and plan an orderly procedure.
To develop a consumer's or homeowner's literacy to the extent that the student can wisely select, buy, use and care for products of the woods industry.
To develop safe working practices.
To familiarize the students with modern processes and conditions encountered with the resource of wood.

Purpose

To initiate woodworking experiences at the junior high school level in shop class restricted to the use of hand tools. This area has been developed on hand tools. However, if students are given permission to proceed to the power machines in the first courses, these items should be done in the order and sequence that follows the objectives.

A. To develop a degree of skill in the use and care of the common hand tools in woodworking.
B. To develop an awareness of the principles of good design.
C. To develop the ability to identify a variety of common woods and have a knowledge of their appropriate uses.
D. To develop the ability to carry out an orderly procedure in a logical sequence.
E. Familiarization with the processes and procedures of the woodworking industry.

Suggested Content

A. Manipulative and technical
1. Identification of common tools.
2. Correct use and care of hand tools.
3. Characteristics and classification of the common hardwoods.
4. Methods of cutting and milling wood on lathes.
5. Appropriate saws for the common woods.
6. Nominal and actual sizes of lumber.
7. Kiln and air drying processes.
8. Gluing, nailing, hardware and other items.
9. Board measure and other applied mathematics.
10. Characteristics of good design.
11. Working drawings.
12. Computing a bill of materials.
13. Planning an orderly work procedure.

1729

1728

38

other

other

39

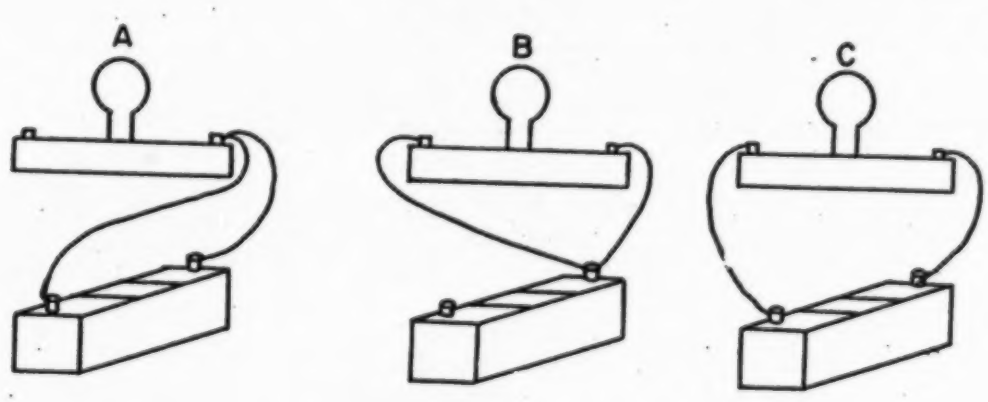

Which of the above lamps will light?

- ☐ A
- ☐ B
- ☐ C

17302

39

C

40

COMPLETE the drawing to show the wires needed to light the lamp:

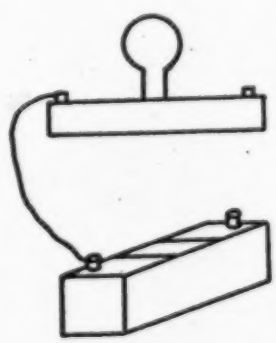

17303

40

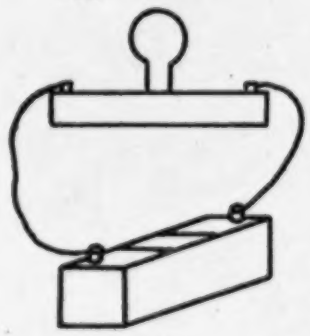

41

DRAW in the parts needed to make the lamp light up:

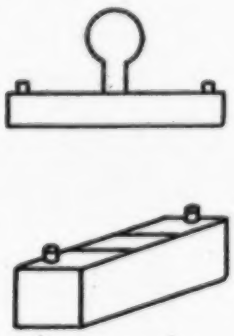

17304

41

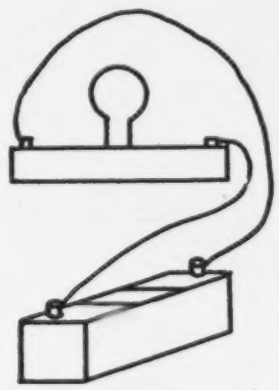

or

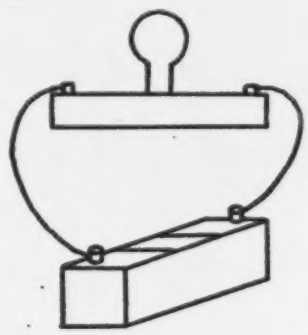

42

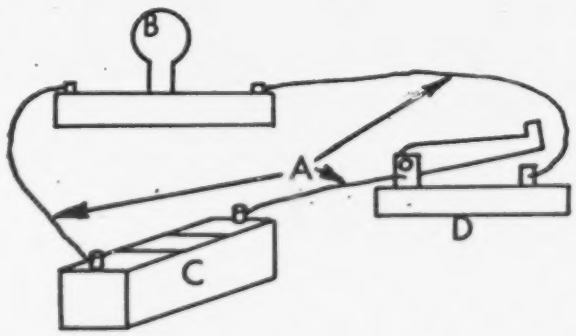

Next to each letter below, WRITE the name of the part that it represents in the picture above:

A: _____

B: _____

C: _____

D: _____

17305

42

wires

lamp

battery

switch (or open switch)

43

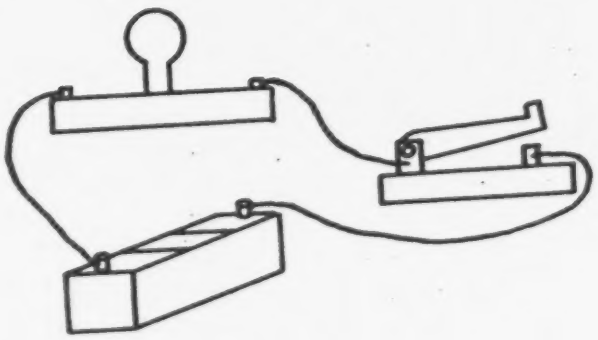

Electricity does not go from the lamp back to the battery because the switch is:

- ☐ open
- ☐ closed
- ☐ broken

17306

43

open

44

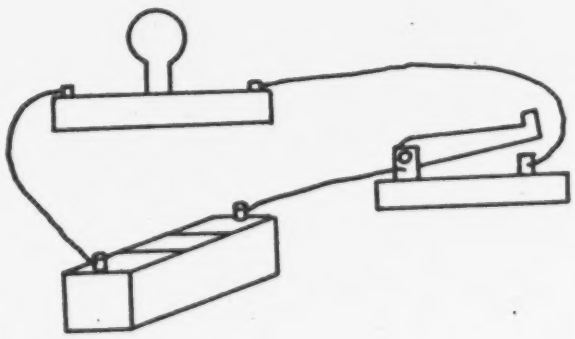

The electricity does not flow through the lamp because the electricity is cut off by the _____ (closed/open) switch.

17307

44

open

45

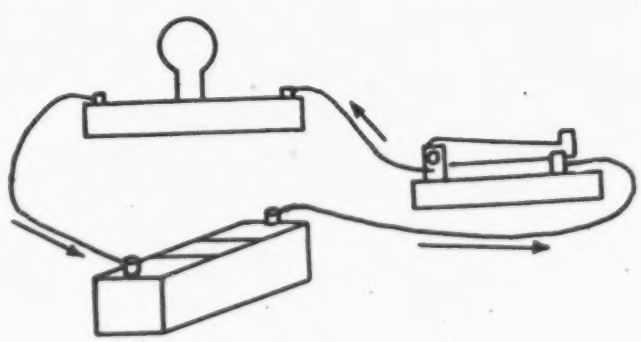

LOOK at the above illustration.

The electricity leaves the _____ and is carried to the switch by a _____.

Will the electricity pass through the switch?

- ☐ yes
- ☐ no

45

battery

wire

yes

46

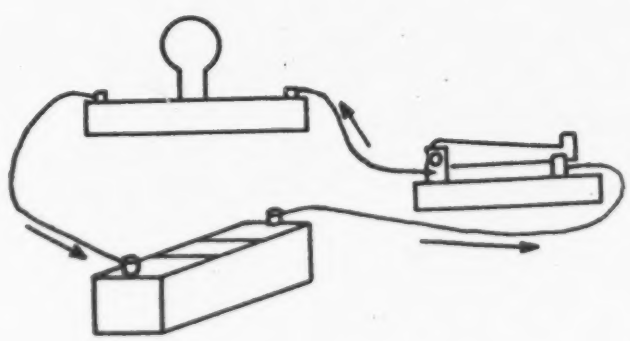

The electricity goes through the switch because the switch is

_____.

17309

46

closed

47

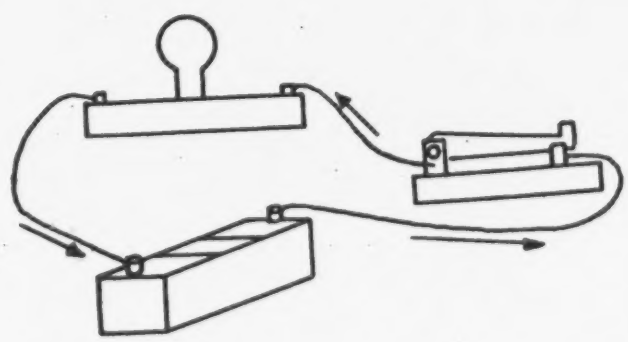

The electricity is carried from the switch to the lamp by a

_____.

17310

47

wire

48

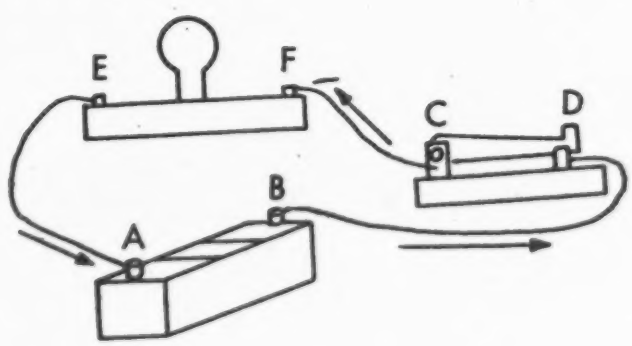

Where does the electricity enter the lamp? (CHECK letter)

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

Where does the electricity leave the lamp? (CHECK letter)

☐ A ☐ B ☐ C ☐ D ☐ E ☐ F

17311

14. Common joints and their uses.

15. Adheasives and jointing processes

16. Metal fasteners for wood.

17. Finishing materials and basic procedures.

18. Cabinet hardware.

B. Related information

1. Occupations in the woodworking industry,
2. Employment opportunities
3. The manufacture of fastenera, finishing materials and other supplies
4. The selection of hand tools and materials
5. Period furniture and its present status
6. Products derived from trees
7. Manufacture of plywood, pressed wood, etc.

Suggested Tools and Equipment

A. Hand tools

1. Claw hammer
2. Coping saws
3. Compass saw
4. Spokeshaves
5. Block planes
6. Smoothing planes
7. Jack planes
8. Jointer planes
9. Rabbet plane
10. Router plane
11. Dividers
12. Trammel points
13. Rules
14. Ratchet braces
15. Auger bits
16. Hand drills
17. Twist drills
18. Countersinks
19. Expansive bits
20. Forstner bits
21. Screwdrive bits
22. Awls
23. Carving tools
24. Wood chisels
25. Bar clamps
26. C-clamps
27. Handscrews
28. Bench brushes
29. Doweling jig
30. Mallets
31. Back saws
32. Crosscut saws
33. Rip saws
34. Cabinet scrapers
35. Hand scrapers
36. Burnisher
37. Framing squares
38. Combination squares
39. Try squares
40. Sliding T bevel
41. Marking gauge
42. Mortise gauge
43. Level
44. Oil stones
45. Files and rasps
46. Glass cutter
47. Nail sets
48. Oil cans
49. Pliers
50. Screwdrivers
51. Putty knife
52. Drawing boards
53. T-squares
54. Triangles
55. Scale or rule
56. Compass
57. Eye shields
58. Miter box
59. Picture frame vise

1728

1729

48

F

E

49

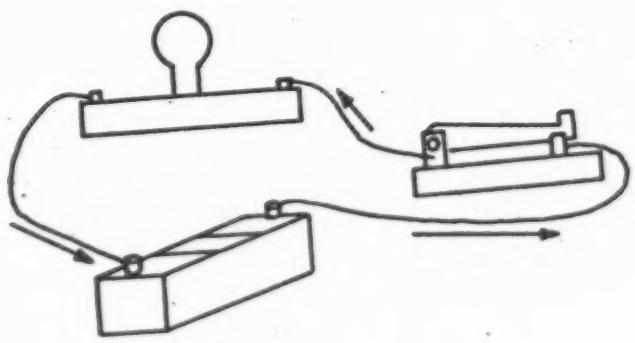

A wire carries electricity from the lamp to the _____ .

17312

49

battery

50

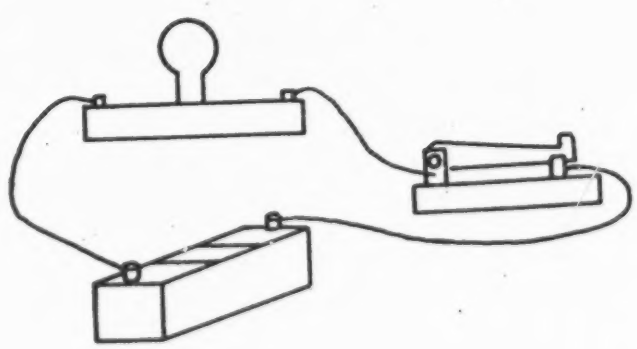

Does the electricity leave the battery at one terminal and return to the battery at the other terminal?

- ☐ yes
- ☐ no

What will happen to the lamp? _____

50

yes

The lamp will light up.
(or similar answer)

51

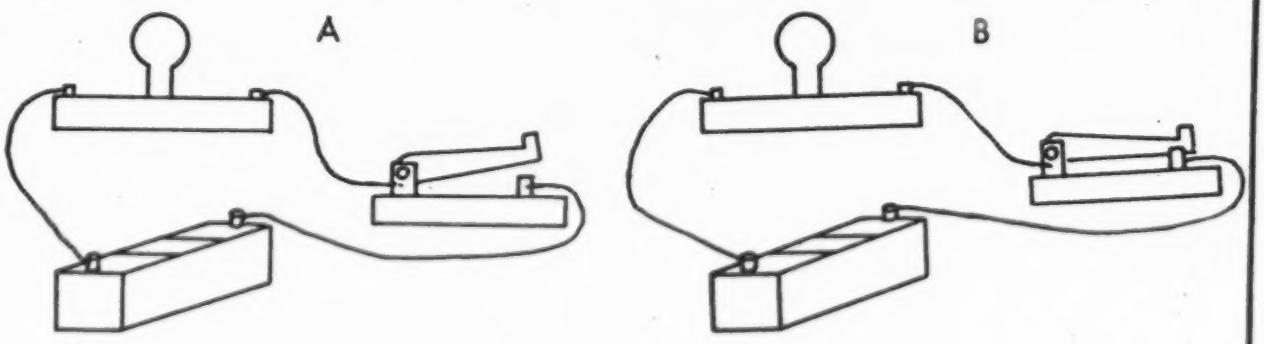

Which of the above lamps will light?

☐ A

☐ B

This lamp lights because _____ passes through it.

51

B

electricity

52

COMPLETE the picture to show a lamp that will light by:

1. DRAWING in the missing wire
2. DRAWING in the switch arm

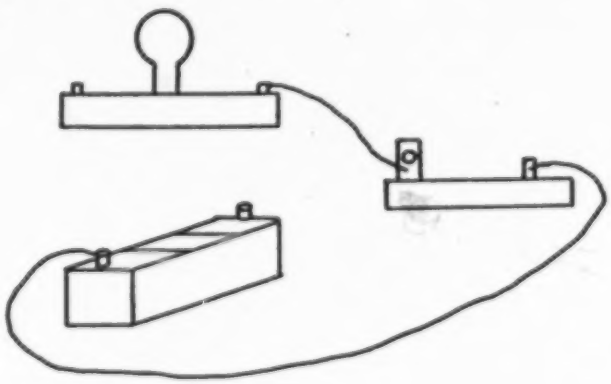

17315

52

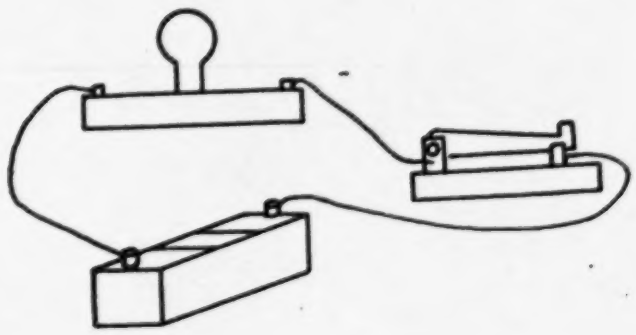

53

DRAW in the parts needed to make the lamp light:

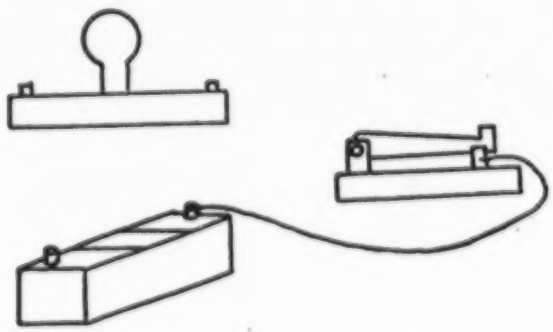

17316

53

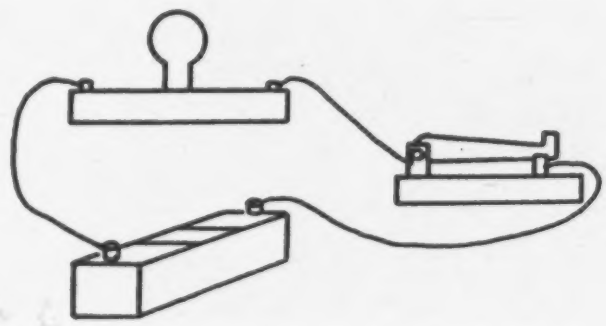

54

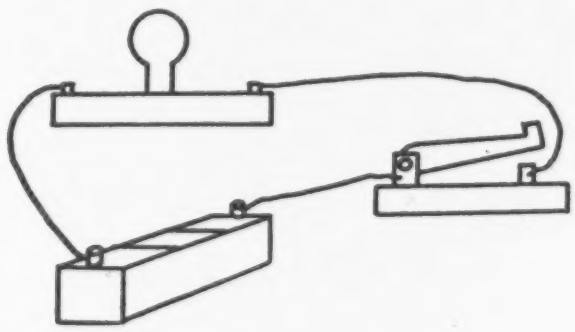

A CIRCUIT is a series of parts connected to an electric power source.

The power source for the circuit above is the:

- ☐ lamp
- ☐ wires
- ☐ battery

17317

54

battery

55

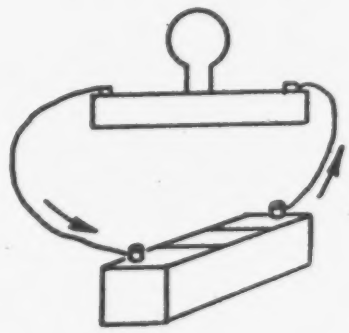

There are three parts to the circuit in the drawing.

COMPLETE the list below:

1. wires
2. l _____
3. b _____

17318

55

lamp

battery

56

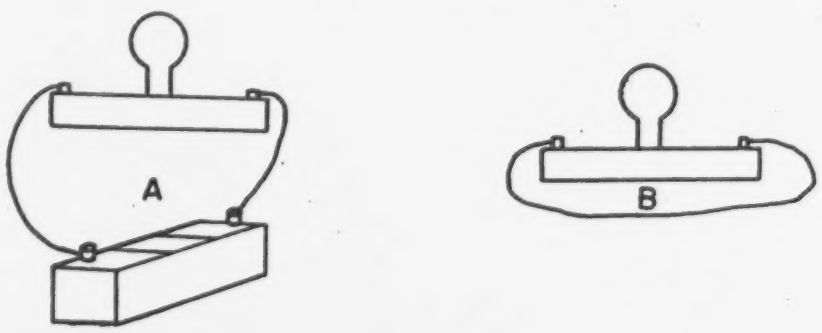

Which drawing shows parts that are <u>not</u> a circuit? ____

17319

56

B

57

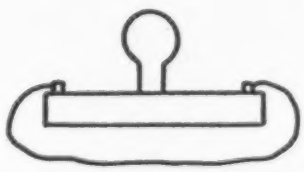

You can make a circuit with the parts in the drawing by adding another part called a _____ :

17320

57

battery

58

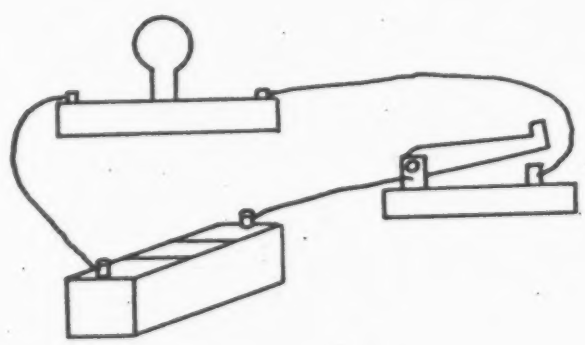

A CLOSED CIRCUIT has electricity flowing through it.

To make a closed circuit above you should:

- ☐ add a wire
- ☐ put the switch over the battery
- ☐ close the switch

17321

Materials

A. Hardwoods and soft woods
B. Plywood
C. Masonite, pegboard, etc.
D. Dowels
E. Nails
F. Screws
G. Glue
H. Cabinet hardware
I. Finishing materials
   1. Abrasives
   2. Paste filler
   3. Plastic crack filler
   4. Linseed oil
   5. Stains
   6. Shellac
   7. Varnish
   8. Brushing lacquer
   9. Wipe-on finish
   10. Paste wax
   11. Appropriate thinners
   12. Steel wool
J. Brushes
K. Small mouldings
L. Vaneers

Safety Precautions

A. Sharp-edged and pointed tools must not be carried in pockets nor allowed to protrude when placed on a bench
B. Hand tools must be carried so as to avoid injury to the user or a fellow student.
C. Dull tools are dangerous; therefore, all tools must be kept sharp and in good condition.
D. Files must be used with handles.
E. Scraps of wood must be kept off of the floor.
F. Avoid blocking aisles with stock or projects.
G. Check tool handles regularly to make sure they are fastened securely.
H. Store finishing rags in a covered metal container.
I. Provide adequate ventilation during all finishing procedures. Particular attention must be directed to the ventilation of sanding dust.
J. Adequate eye protection equipment must be worn in the shop at all times.

Suggested Projects

Rather than supplying a list of the usual racks, lamps, holders, etcl, the teacher is urged to search for ideas in the suggested references and in project books. Criteria to be considered in project selection include:

1. Contributes to attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of students
4. Good design
5. Inexpensive
6. Within shop facilities

58

close the switch

59

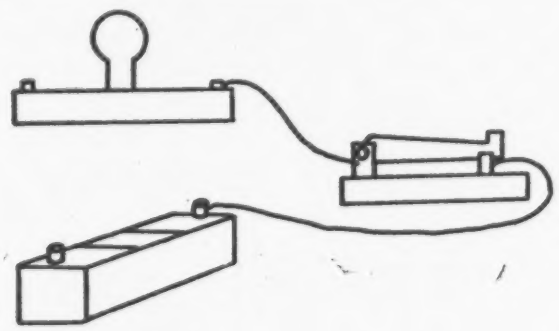

An OPEN CIRCUIT is any circuit that does not have electricity flowing through it.

The circuit above is open because:

- ☐ the switch is open
- ☐ a wire is missing
- ☐ the battery needs a termianl

17322

59

a wire is missing

60

DRAW a wire in the picture below to make a closed circuit:

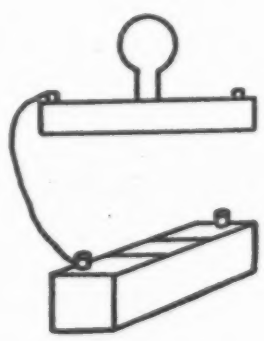

17323

60

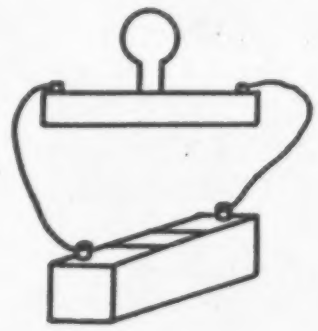

61

DRAW <u>two</u> wires in the picture below to make a closed circuit:

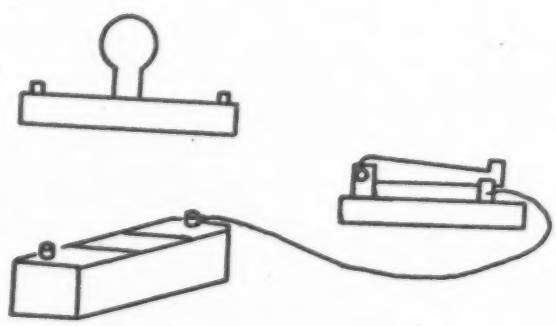

17324

61

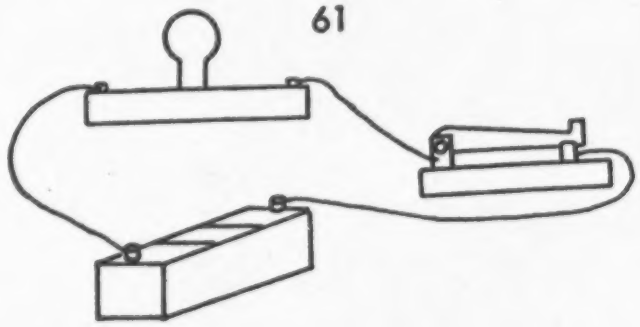

62

DRAW an arrow to the part below that keeps the circuit open:

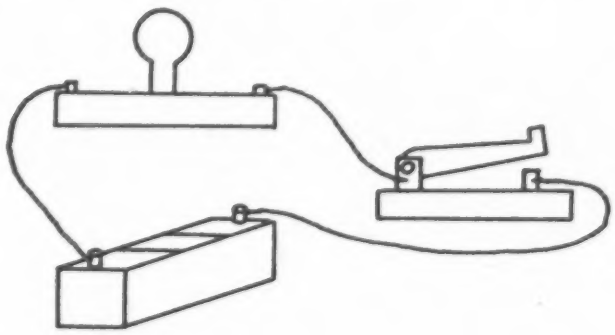

17325

62

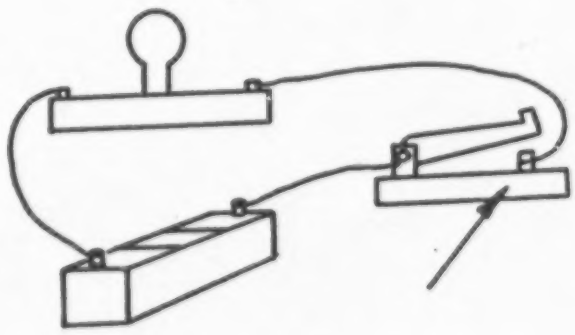

63

DRAW the parts needed to make a closed circuit, and show the flow of electricity by DRAWING arrows on each wire:

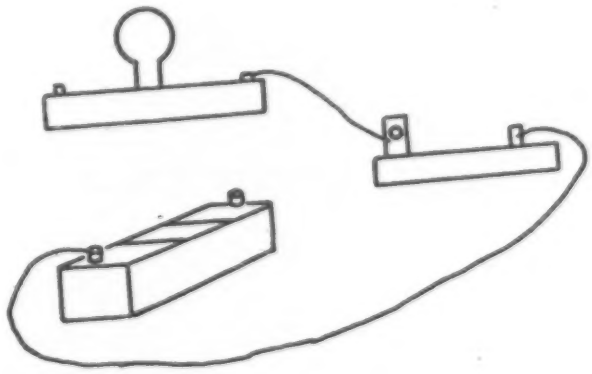

17326

63

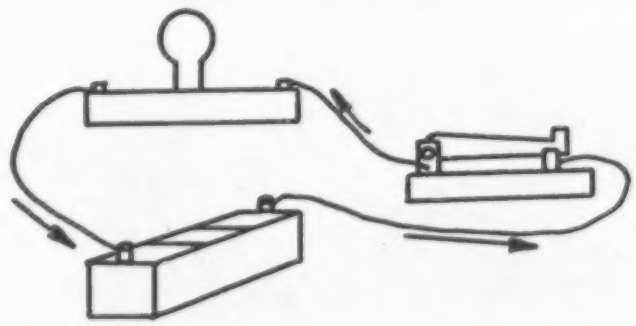

64

If a lamp is lighted you know that it is part of a _____ circuit.

17327

64

closed

65

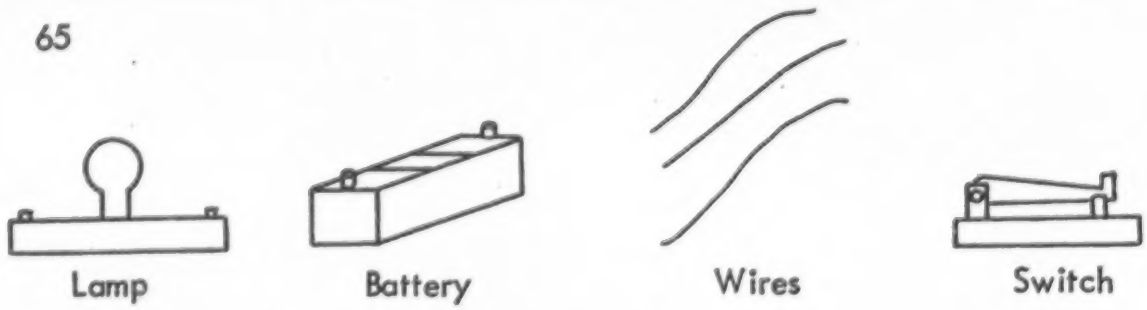

Using the parts shown above, DRAW a picture of a closed circuit:

17328

249 OF 327

ED

056 238

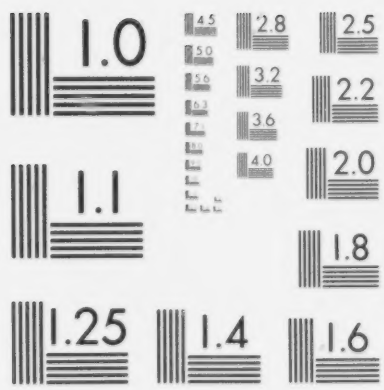

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

65

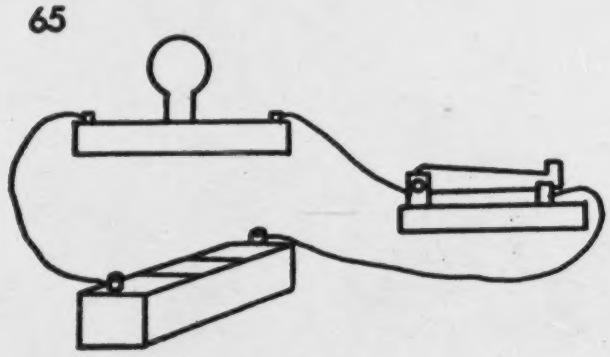

66

THIS IS THE END OF BOOK 2

17329

249

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1-4

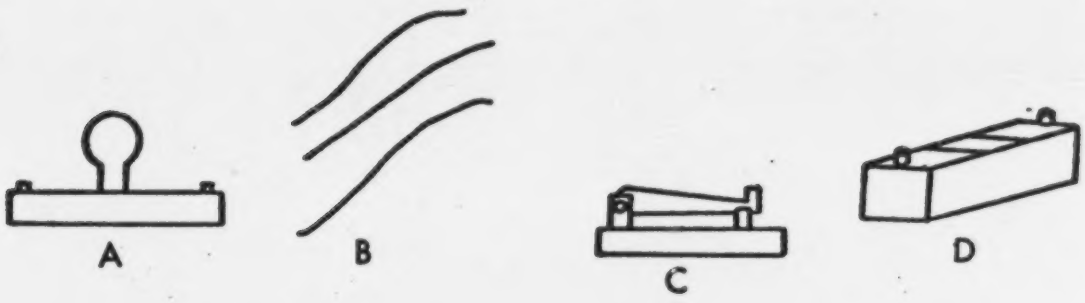

Next to each letter below, WRITE the name of the part that it represents in the picture above:

A: _____

B: _____

C: _____

D: _____

17330

Purpose

It is assumed that the student enrolled in advanced woodworking has developed a reasonable amount of skill in the use of hand tools and has discovered the joy and personal satisfaction of making beautiful and useful things of wood.

Specific Objectives

A. To develop a degree of skill in the use and care of the common woodworking machines.

B. To develop an appreciation of good design and workmanship in products made of wood.

C. To develop the ability to apply mathematics, science, and drawing to practical situations in the woodshop.

D. To develop an awareness of the requirements and opportunities in the woodworking trades and industries.

Suggested Content

A. Manipulative and technical

1. Review uses and care of hand tools
2. Review project planning and applied mathematics
3. Review characteristics and identification of the common cabinet woods.
4. Review elements and principles of design.
5. Correct use and care of power equipment
6. Identification of machine components and accessories.
7. Fundamental operations of power equipment.
8. Finishing and laminating procedures

B. Related information

1. Occupations in the woodworking industry
2. Employment opportunities
3. The selection of woodworking tools and equipment
4. The manufacture and use of plywood and veneers
5. Cutting and milling of lumber
6. Forest conservation
7. The manufacture of nails, screws, etc.
8. The manufacture of finishes and their characteristics
9. Trends in furniture design
10. Grading of lumber and plywood

Suggested Tools and Equipment

A. Hand tools

1. Hand tools listed in Hand Woodworking

B. Equipment

1. Circular saw
2. Jigsaw
3. Radial saw
4. Jointer
5. Band saw
6. Thickness planer
7. Wood lathes
8. Drill press
9. Shaper
10. Sanders
11. Portable drill
12. Portable router
13. Saber saw
14. Grinder
15. Spraying facilities
16. Portable electric equipment

1731

1730

7

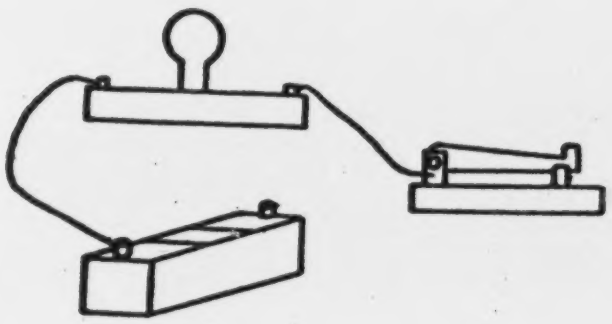

Will the lamp light up?

- ☐ yes
- ☐ no

8

EXPLAIN your answer. _____

9

NAME the part that opens and closes circuits: _____

10

BATTERY LAMP SWITCH

What else would you need to make a complete circuit? _____

17332

VT 013 125
Auto Mechanics Course. Book 3: Simple Schematic Diagrams.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
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IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on simple schematic diagrams was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 125

17333

ED0 56238

BOOK 3

AUTO MECHANICS COURSE

BOOK 3: SIMPLE SCHEMATIC DIAGRAMS

A BASIC SYSTEMS PROGRAM

Curriculum Report Reference
Page 12

Task Analysis Reference
7.1, 7.2, 7.3

17334

VT013125

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AUTO MECHANICS COURSE

BOOK 3: SIMPLE SCHEMATIC DIAGRAMS

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

17335

 Book 3

1-7

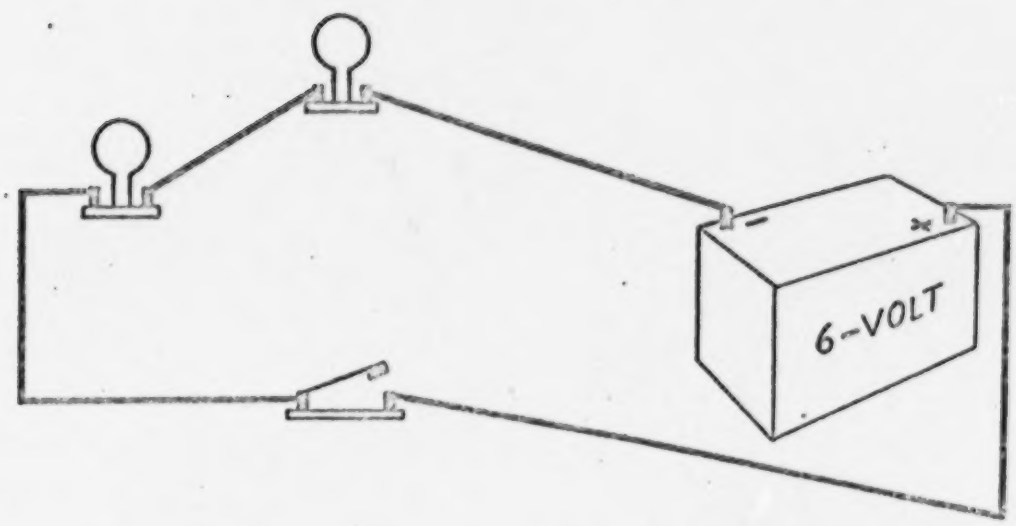

In the space below, DRAW a schematic diagram of the circuit shown above:

8-10

NAME the electrical parts in the circuit below:

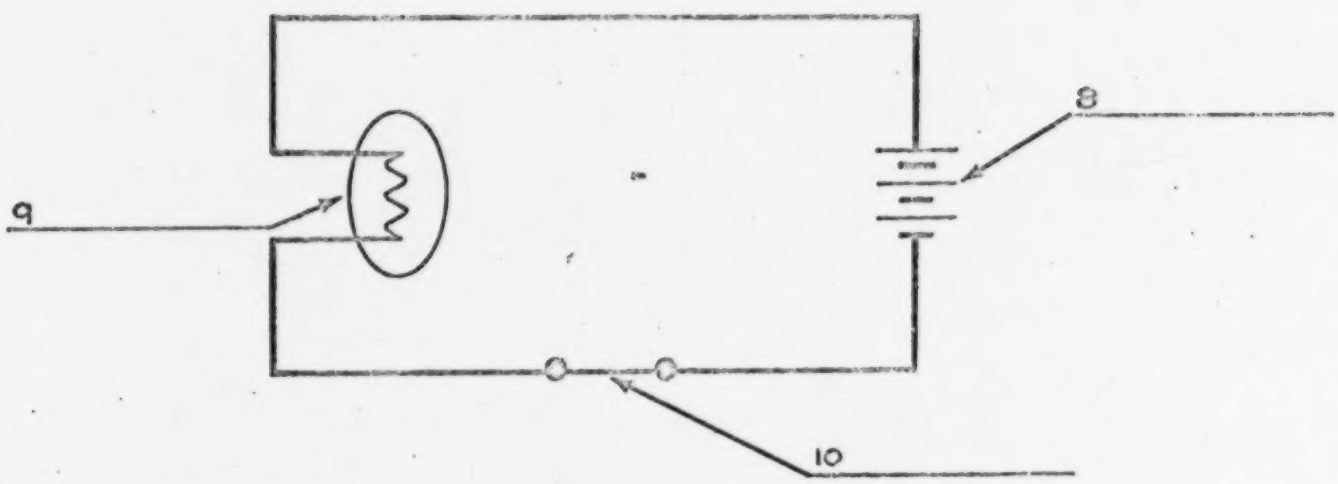

11

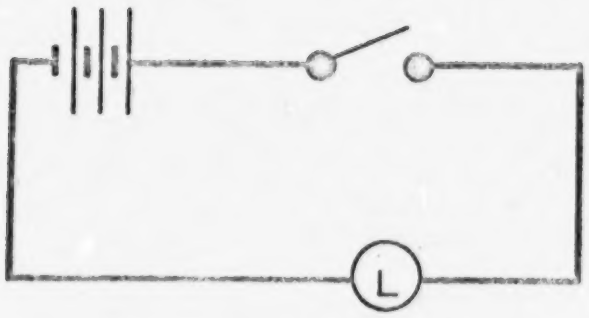

Will the lamp in the circuit light up?

- ☐ yes
- ☐ no

12

EXPLAIN your answer. _____

Name _____

Date _____

Starting time _____

Finishing time _____

17339

1

Industry uses "electrical schematic diagrams" to show actual electrical circuits.

This section will teach you how symbols are used to show actual electrical circuits.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

Materials

A. Materials listed in Hand Woodworking
B. Lacquer sealer
C. Lacquer
D. Rubbing compound
E. Laminating

Safety Precautions

Woodworking machines are always a potential source of danger, particularly if effective guards have not been installed. Many of the precautions to be observed around woodworking machines are common to other machine-equipped areas. Therefore, the following list includes safety precautions that apply equally well to other areas.

A. Machines are not to be operated without instructor's permission.
B. Neckties and sleeves must be removed and rolled up, respectively, when operating machinery.
C. Do not distract a student operating a machine.
D. The operator's work zone around machines must be observed.
E. Machines must be stopped before oiling, cleaning, or adjusting.
F. Appropriate aids (push sticks, push shoe, featherboard, etc.) must be kept free of excess stock.
G. Machines must be kept free of excess stock
H. Check adjustment before turning on the machine.
I. Stand clear when turning on the power.
J. Allow machine to reach full speed before using.
K. Never leave an operating machine unattended.

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of pupils increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

CARPENTRY

Purpose

although carpentry is normally considered a trade-vocational course, an elementary treatment has been included for shop classes in communities where the needs may not be met by the usual course in woodworking.

Specific Objectives

A. To develop a degree of skill in the use and care of the common tools used by the carpenter.
B. To develop the ability to plan and carry out basic carpentry construction techniques.
C. To develop consumer literacy to the extent that the pupil can identify and select appropriate building materials for a given job.

1732

1

NO ANSWER NEEDED

2

	Actual Part	Symbol
Switch		
Lamp	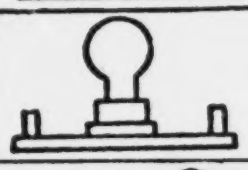	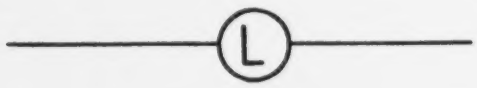
Battery	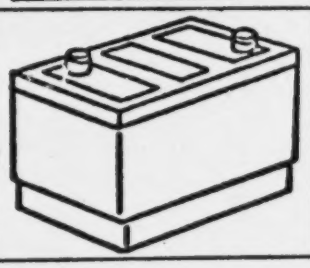	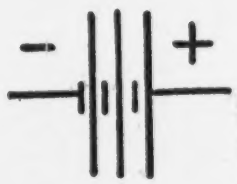

Symbols are easy ways to show acutal parts.

DRAW the symbol for the following parts:

LAMP SWITCH

17341

2

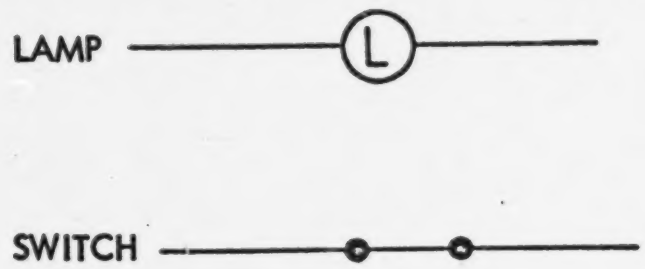

3

Symbols are:

- ☐ different from actual parts
- ☐ the same as actual parts

An easy way to show an electrical part is to draw its
s_____.

17342

3

different from actual parts

symbol

4

Diagrams of automotive electrical systems always have:

- ☐ pictures of the parts
- ☐ symbols for the parts

This is done to make reading diagrams:

- ☐ easier
- ☐ harder

17343

4

symbols for the parts
easier

5

What is never shown on an electrical diagram?

- ☐ actual parts
- ☐ symbols

How would you compare symbols to actual parts?

- ☐ different
- ☐ the same

17344

5

actual parts
different

6

Symbols for electrical parts are used on:

- ☐ a running automobile
- ☐ diagrams of electrical systems
- ☐ pictures of real parts

17345

6

diagrams of electrical systems

7

In order to read diagrams of auto electrical systems, you must know how to read:

- ☐ make-believe parts
- ☐ make-believe symbols
- ☐ parts
- ☐ symbols

17346

7

symbols

8

GROUP A

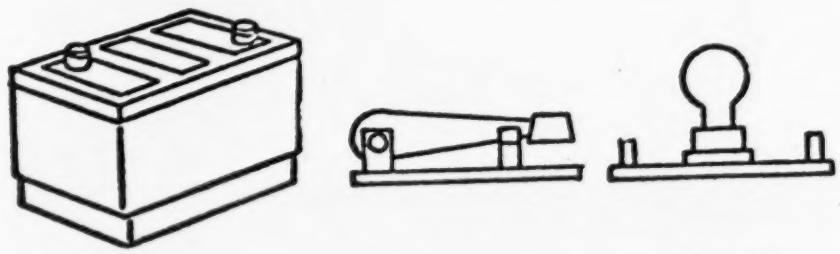

GROUP B

Which group shows symbols?

- ☐ group A
- ☐ group B

What would you call the other group? _____

17347

8

group B

actual parts

9

The two symbols shown above are used in electrical diagrams to represent an electrical part that gives off light.

The two symbols stand for a l_____.

9

lamp

10

Figure 1

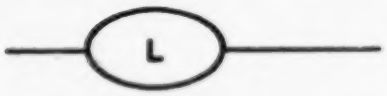

Figure 2

Figure 1 is the symbol for a _____.

What does Figure 2 stand for? _____

10

lamp

a lamp

11

A B C

Which of the above are symbols for a lamp?

- ☐ A
- ☐ B
- ☐ C

Which is a picture of a lamp?

- ☐ A
- ☐ B
- ☐ C

Suggested Content

A. Manipulative and technical

1. Identification of common tools
2. Correct use and care of hand tools and machines
3. Characteristics and identification of the common construction woods and other building materials.
4. Methods of cutting, drying, and milling lumber
5. Appropriate uses of common building materials
6. Nominal and actual sizes of lumber
7. Estimating and ordering lumber and other building materials
8. Unit measure and other applied mathematics
9. Reading and making working drawings
10. Computing bill of materials
11. Planning orderly work procedures
12. Laying out foundation for small building
13. Foundation forms
14. Mixing, pouring and finishing concrete
15. Rough framing
16. Sheathing and flooring
17. Cutting studs, plates, joists, headers and rafters
18. Exterior finishing
19. Roofing materials
20. Applying metal fasteners and hinges
21. Hanging doors
22. Setting windows
23. Modern industrial application
24. Glass care and glazing

B. Related information

1. Occupations in the carpentry business
2. Employment opportunities
3. The selection of tools and machines
4. The manufacture of fasteners, finishing materials and other supplies
5. The manufacture of plywoods, pressed wood, etc.
6. Lumbering
7. Knowledge of related fields

Suggested Tools and Equipment

A. Hand tools

1. Hand tools listed in Hand Woodworking

B. Equipment

1. Equipment listed in Advanced Woodworking

C. Portable electric equipment

Materials

There is usually little need to carry an extensive inventory of materials since the projects undertaken determine the types and amount needed and usually all supplies are readily available locally.

11

A

C

B

12

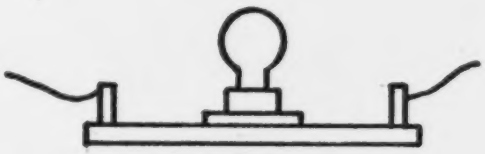

What actual part does the picture show? _____

CIRCLE the symbols for the picture:

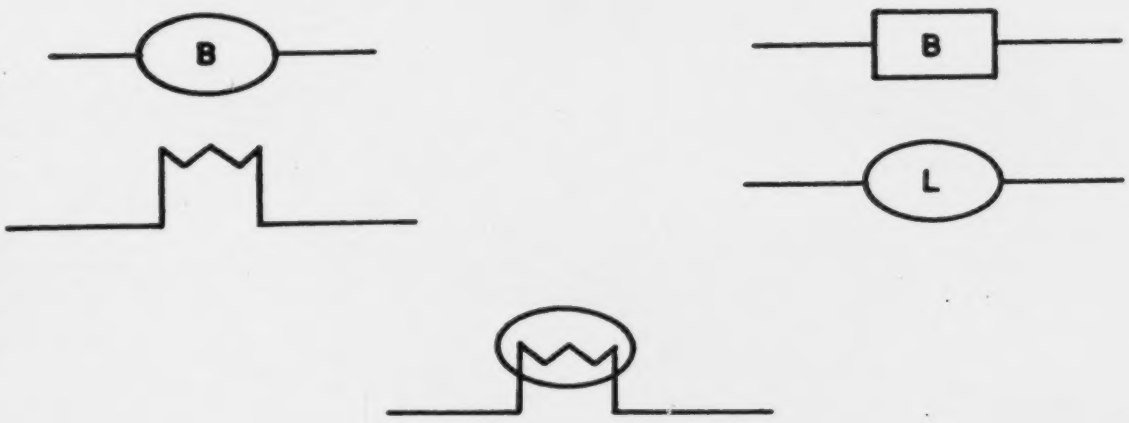

17351

12

a lamp

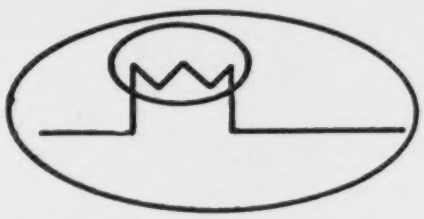

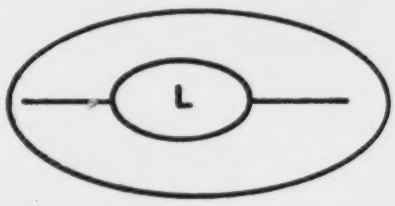

13

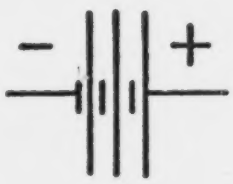

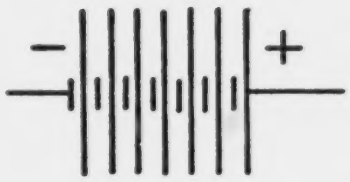

The three symbols above stand for an electrical part that stores and gives electricity.

They are symbols for a _____.

17352

13

battery

14

CIRCLE the figure that is not a symbol for a battery:

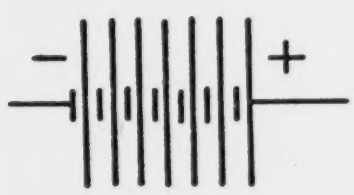

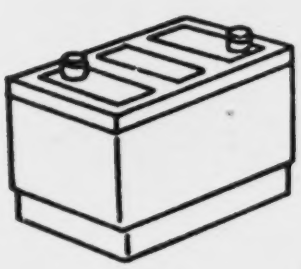

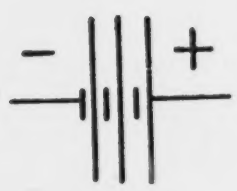

17353

14

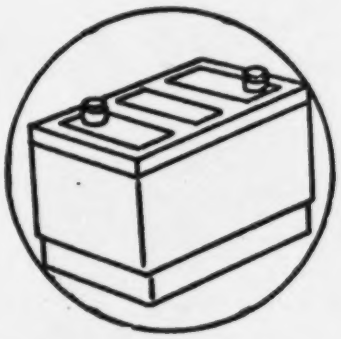

15

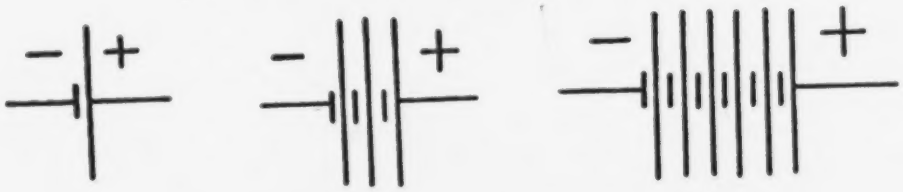

2 volts 6 volts 12 volts

The "size" of the symbol tells you how many volts the battery has.

A 12-volt battery has:

- ☐ more lines than a 6-volt battery
- ☐ less lines than a 6-volt battery

15

more lines than a
6-volt battery

16

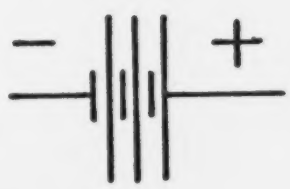

The symbol above stands for a 6-volt battery because it has:

- ☐ 1 pair of short and long lines
- ☐ 2 pairs of short and long lines
- ☐ 3 pairs of short and long lines

17355

16

3 pairs of short and long lines

17

Each pair of lines stands for 2 volts.

Under each symbol, WRITE the number of volts that the battery has:

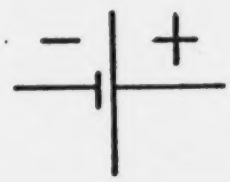

A. ____ volts

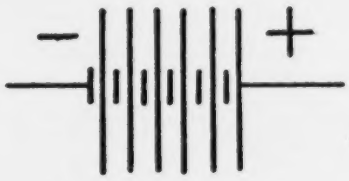

B. ____ volts

17

A. 2

B. 12

18

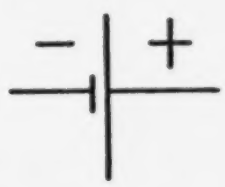

The pair of lines above stand for a _____ -volt battery.
(how many)

18

2

19

In symbols for batteries of all sizes, two volts are shown by:

- ☐ a short line and a long line
- ☐ two long lines
- ☐ two short lines

19

a short line and a long line

20

CIRCLE the symbol for a 6-volt battery:

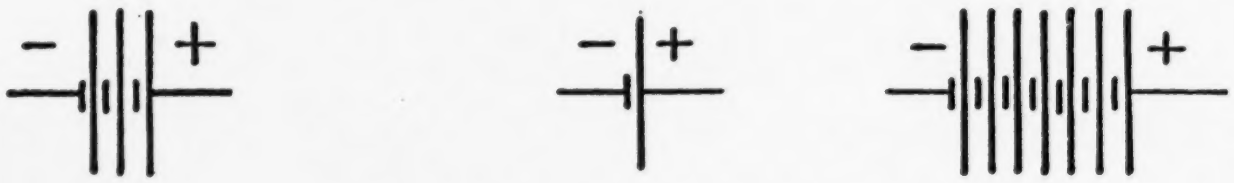

20

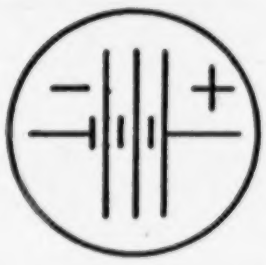

21

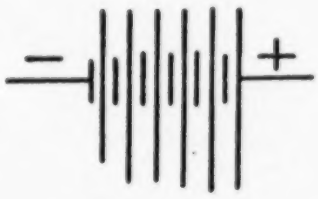

12 volts

The symbol above stands for a 12-volt battery.

DRAW a 2-volt battery:

Safety Precautions

General safety precautions covered in Hand Woodworking and Advanced Woodworking are appropriate for a course in carpentry.

Suggested Projects

It is reasonable to expect that most projects will consist of the construction of small structures such as feeders and portable animal shelters. The selected references and farm shop books contain suggestions for projects that will meet the needs of rural as well as urban youth.

21

22

DRAW the symbol for a 6-volt battery.

22

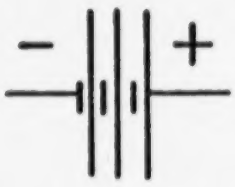

23

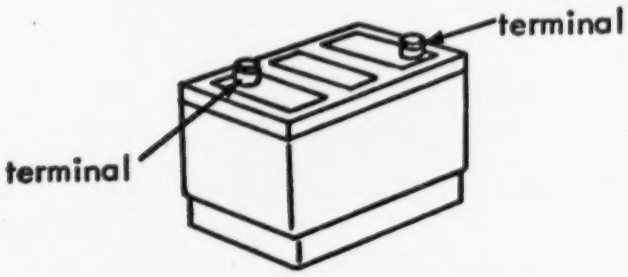

Electricity always leaves a battery from one terminal and goes back into the battery at the:

- ☐ other terminal
- ☐ same terminal

23

other terminal

24

The plus sign (+) and the minus sign (-) are used in electrical diagrams to show the direction in which the electricity "flows."

CIRCLE the symbols that tell you the direction in which the electricity "flows."

17363

24

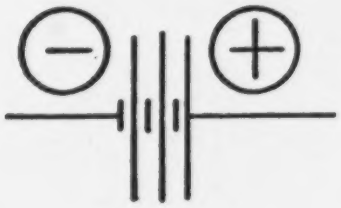

25

Electricity leaves a battery from the end marked with a plus sign.

In the symbol below, CIRCLE the end from which the electricity leaves:

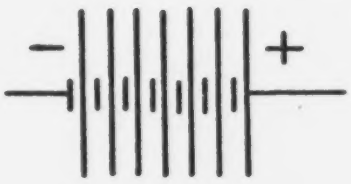

17364

25

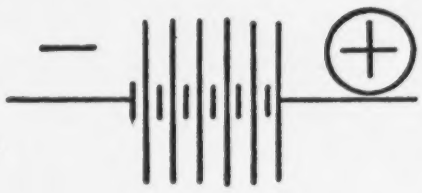

26

The plus sign (+) is next to the:

- ☐ short line
- ☐ long line

Electricity leaves the battery at the end that has a:

- ☐ long line
- ☐ short line

17365

26

long line

long line

27

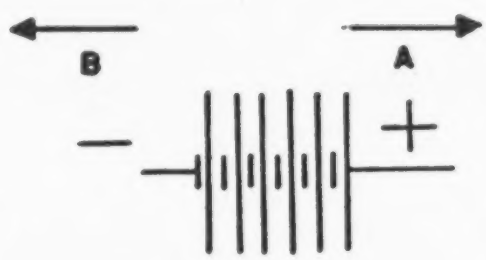

Which arrow shows the direction in which the electricity flows:

☐ A

☐ B

27

A

28

DRAW an arrow under the battery to show the direction in which the electricity flows:

17367

28

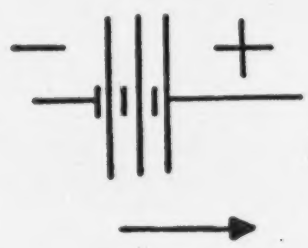

29

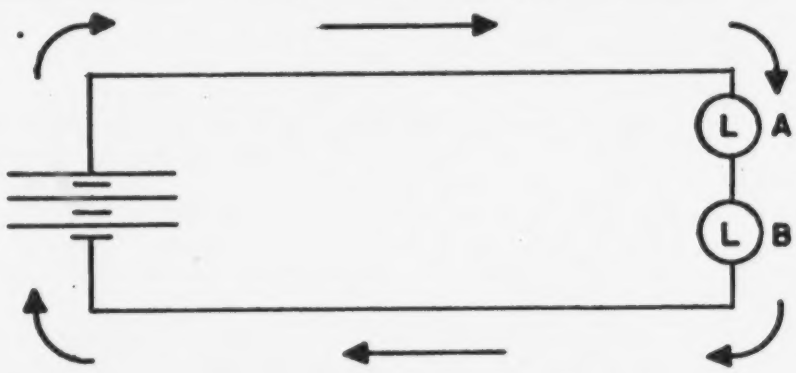

The arrows show the direction in which electricity flows.

The electricity leaves one end of the battery, flows around the circuit, and goes back to the battery at the:

☐ other end

☐ same end

WRITE a plus sign (+) next to the terminal where the electricity leaves the battery.

WRITE a minus sign (–) next to the terminal where the electricity returns to the battery.

17368

29

other end

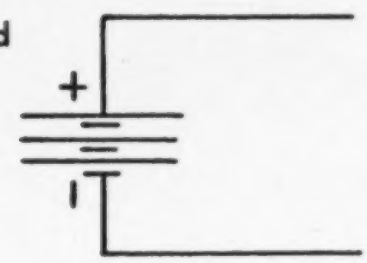

30

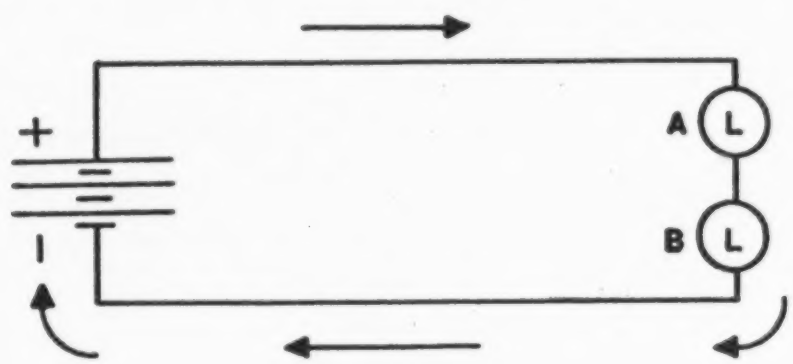

After the electricity leaves the battery, it will first pass through:

- ☐ lamp A
- ☐ lamp B

17369

30

lamp A

31

DRAW arrows around the diagram to show the direction in which the electricity flows:

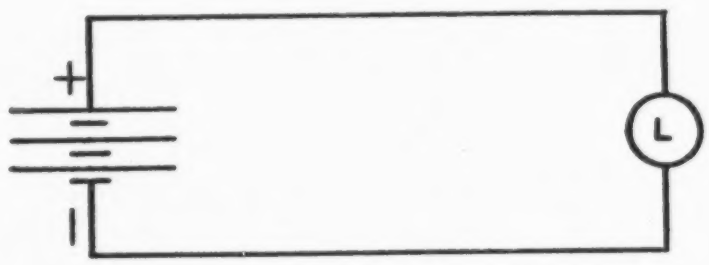

26 OF 327

ED

056 238

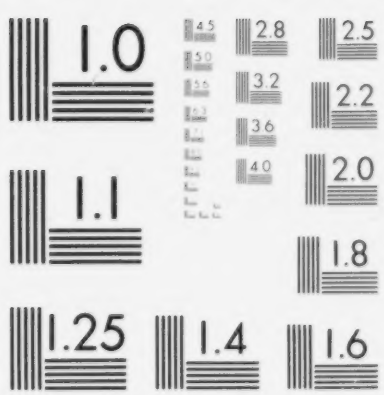

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

31

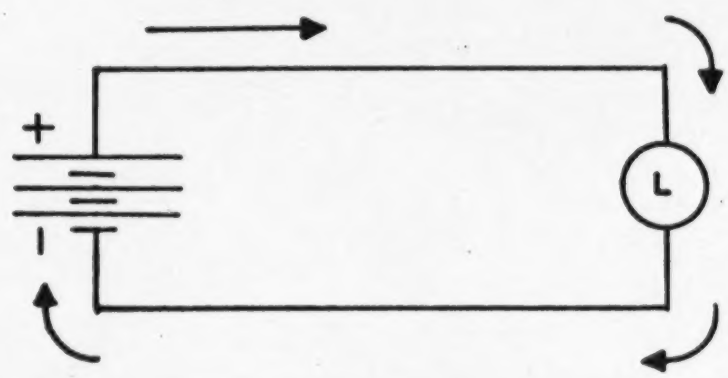

32

CIRCLE the 6-volt battery.

MARK an X through the 12-volt battery.

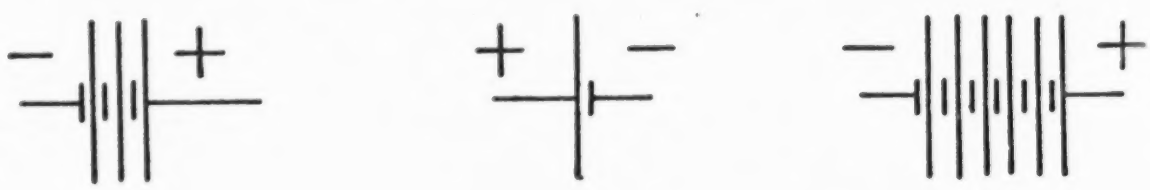

17371

32

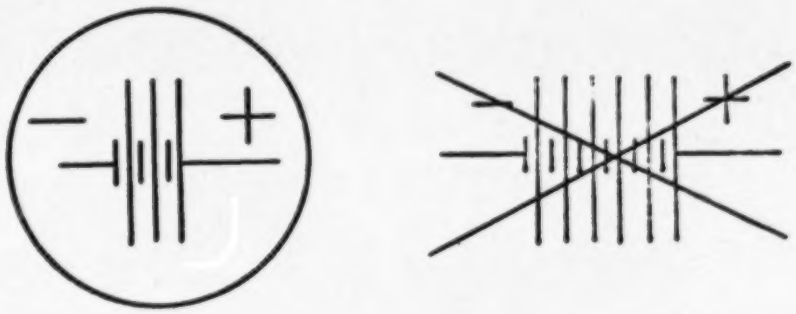

33

MATCH the following:

A. 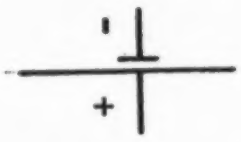

B. 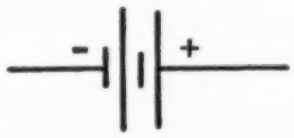

C.

D. 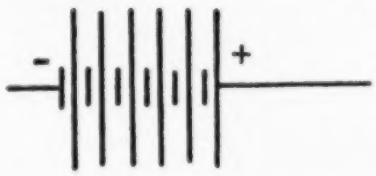

1. ____ 2-volt battery

2. ____ 6-volt battery

3. ____ 12-volt battery

17372

33

1. A
2. C
3. D

34

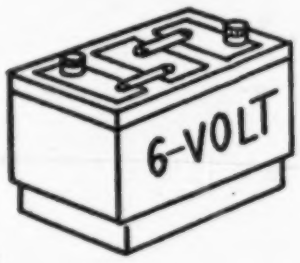

The picture shows a _____ with _____ volts.

DRAW the symbol for the picture:

17373

34

battery 6

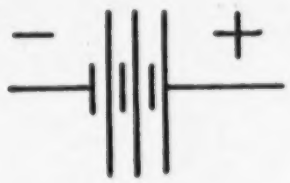

35

The diagram represents a circuit that has a battery and a lamp.

The lamp cannot be easily turned on and off because there is no:

- ☐ extra wire
- ☐ heater
- ☐ switch

35

switch

36

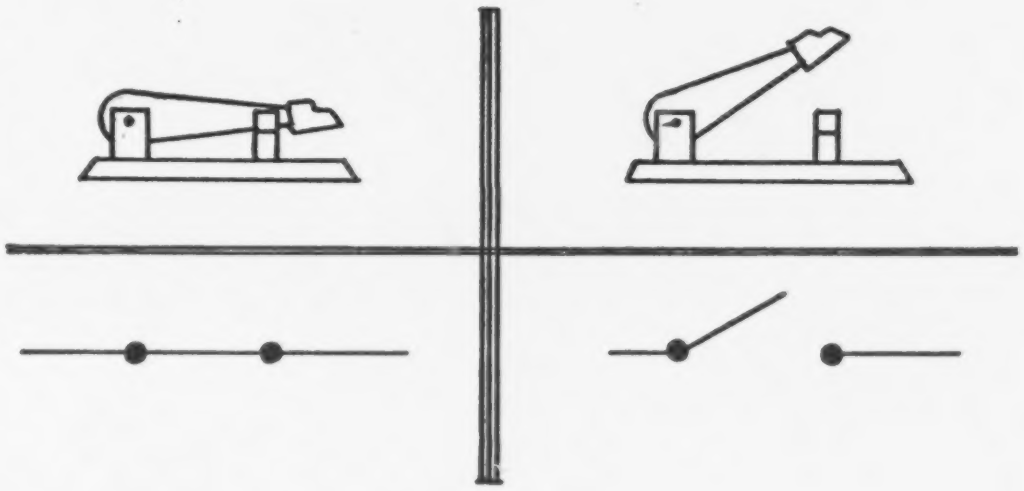

The above figures show pictures of switches and symbols for switches.

DRAW the symbol for an open switch:

17375

36

37

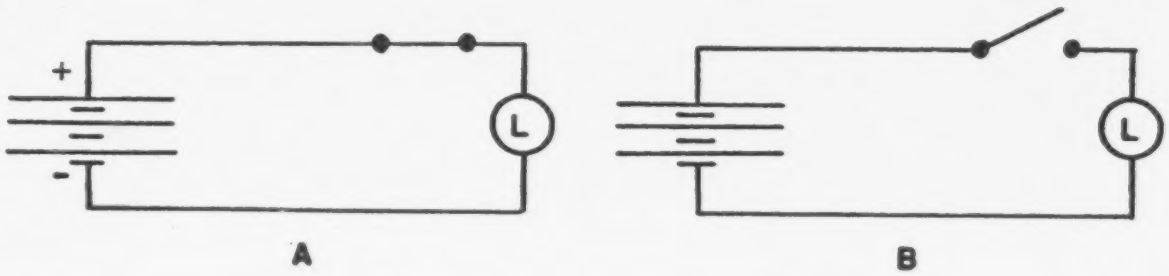

The lamp in circuit A is turned on.

The lamp in circuit B is turned off.

The switch is closed in:

- ☐ circuit A
- ☐ circuit B

37

circuit A

38

CIRCLE the symbol for a closed switch:

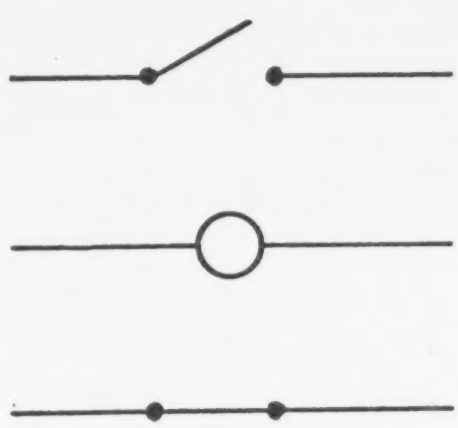

17377

38

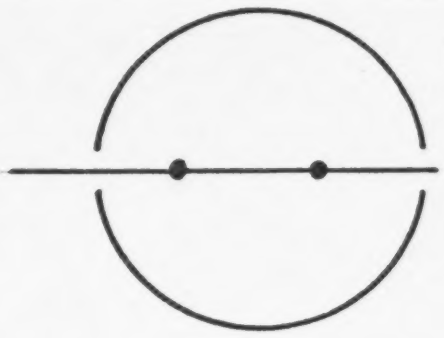

39

MATCH the following:

A.

B.

C.

1. ____ 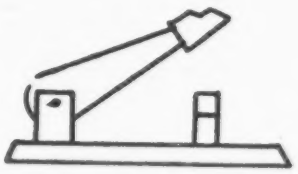

2. ____ 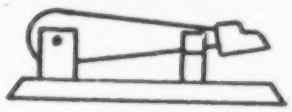

39

1. C

2. A

40

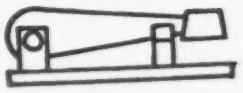

The picture shows a _____ switch.

DRAW the symbol for this electrical part:

40

closed

41

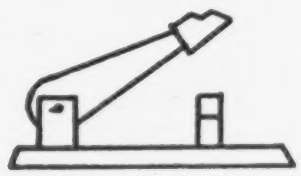

The picture shows an _____ switch.

DRAW its symbol:

17380

METALWORKING

Metalworking has become more important daily to man and to his society since the discovery of metal thousands of years ago. Today the American people are enjoying more comforts than any other nation in the world. These comforts include the modern home and all of its conveniences, transportation, with its luxurious vehicles, including the automobile, streamlined trains and jet airliners and communications which are becoming more extensive, practical and workable.

All of this, not to mention the future that exists in space, is very dependent on the metals now available. There are more people employed in the metalworking industries than in any other industrial field. It is quite important, therefore, that this area of industry be included as a part of the industrial arts program.

General Objectives

To develop an appreciation of the importance of the metals industry in our society.
To develop a knowledge of the characteristics of metals.
To develop an interest in the occupational opportunities pertaining to the metal-working industry.
To develop procedures with regard to the fabrication of metals.
To develop an understanding of the fundamental characteristics of good design in metal products.
To develop a degree of skill in the use and care of metal-working tools and machines.
To develop repair and maintenance procedures which will be helpful to the consumer.
To teach the student how to plan an orderly procedure, and to make and read metalworking drawings.
To encourage the development of hobby activities with metal as the medium.

INTRODUCTORY BENCH & SHEET METAL

Purpose

Bench and sheet metal is basically a program of hand operations serving as a basis or prerequisite for other areas of metal fabrication. It is a basic activity allowing for exploration and experimentation. Rather than teaching it as a composite of the two, this unit may be separated into bench metalworking and sheet metalworking. Generally, students should be encouraged to participate in this activity before enrolling in other metalworking areas.

Specific Objectives

A. To develop the ability to identify metals and appreciate the metal processes of industry.
B. To develop a degree of skill in the operation and care of common metalworking tools.
C. To develop an appreciation of good design in metalworking.
D. To develop an awareness of the occupational opportunities in the metal industry.

Suggested Content

A. Manipulative and technical

1. Identification of tools and machines
2. Using measuring and layout tools
3. Making and reading working drawings
4. Using patterns and templates
5. Planning a project
6. Identification of metals through spark tests
7. Heat treatment
8. Cutting metals
9. Drilling, reaming and punching
10. Filing
11. Threads, and thread cutting
12. Bending, twisting and forming
13. Preparing, decorating and finishing metals
14. Removing metal by grinding
15. Care and maintance of hand tools
16. Identification of cutting fluids and compounds
17. Identification of abrasives
18. Use of metal fasteners
19. Characteristics of metal

41

open

42

The symbol used to show an electrical wire is a:

- ☐ broken line
- ☐ solid line
- ☐ striped line

42

solid line

43

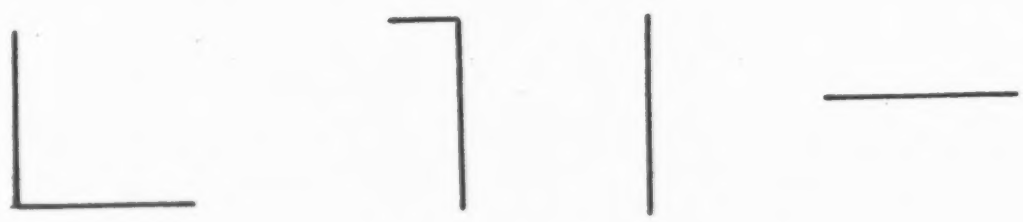

In electricity, the symbols above represent _____.

43

wires

44

MATCH the following:

A.

B.

C. 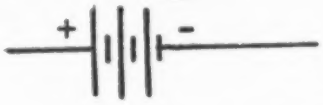

D.

1. _____ 6-volt battery
2. _____ closed switch
3. _____ lamp

44

1. C

2. D

3. B

45

MATCH the following:

A.

B.

C.

D.

1. ____ lamp

2. ____ open switch

3. ____ wire

45

1. D

2. B

3. A

46

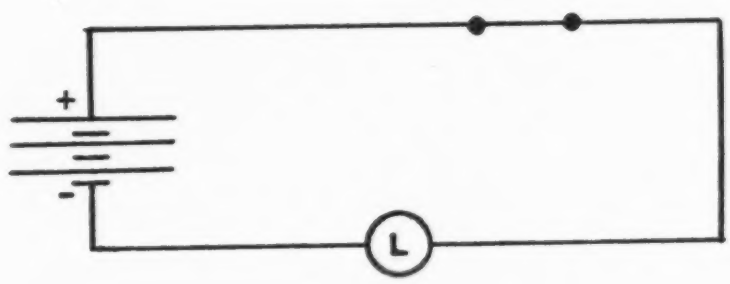

LOOK at the diagram above.

When electricity leaves the battery, it flows first through:

- ☐ the lamp and then the switch
- ☐ the switch and then the lamp

46

the switch and then the lamp

47

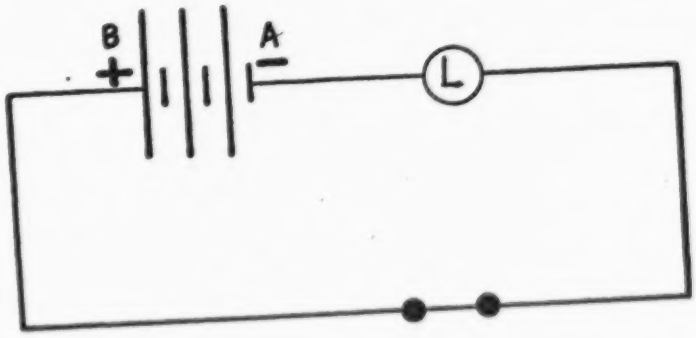

Current leaves the battery at:

☐ side A

☐ side B

This is the (☐ plus ☐ minus) side.

Electricity returns to the battery at:

☐ side A

☐ side B

47

side B

plus

side A

48

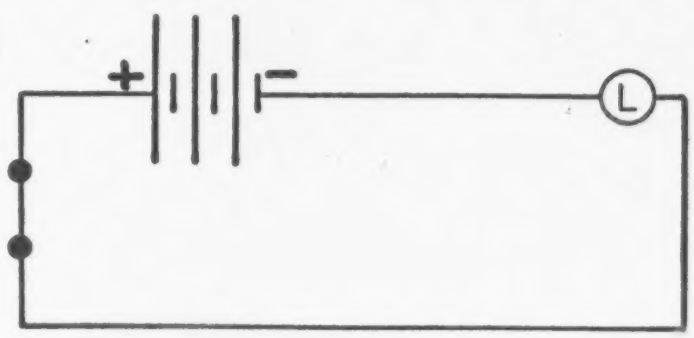

In this circuit, the current leaves the battery to flow first through the _____ and then through the _____.

17387

48

switch

lamp

49

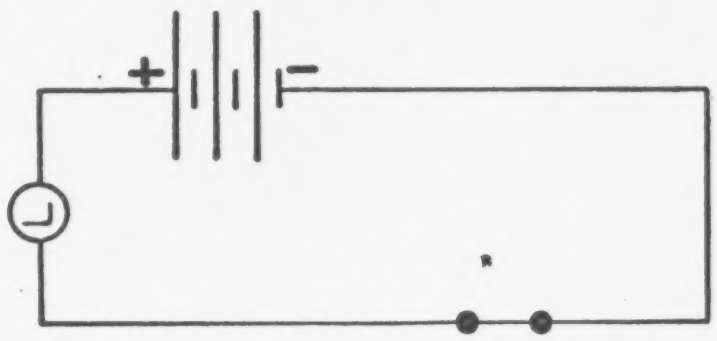

In this circuit, the current flows first through the _____ and then through the _____.

49

lamp

switch

50

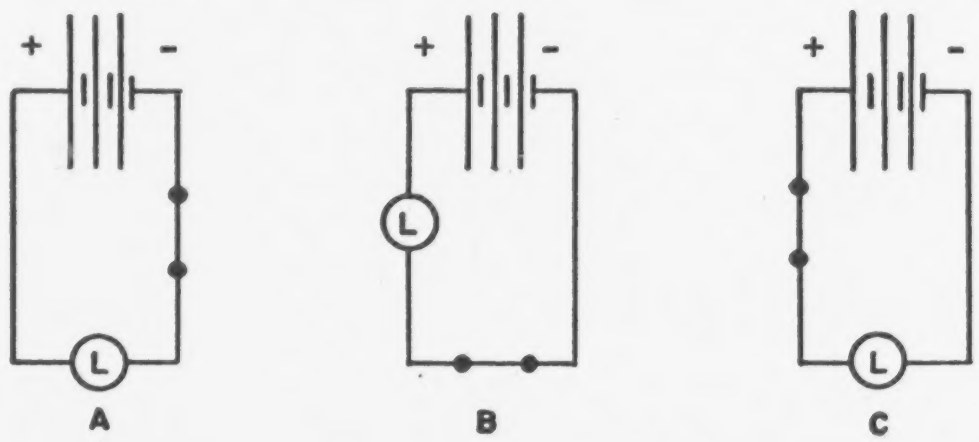

In which two electrical circuits does the current flow first through the lamp and then through the switch?

- ☐ A
- ☐ B
- ☐ C

17389

50

A

B

51

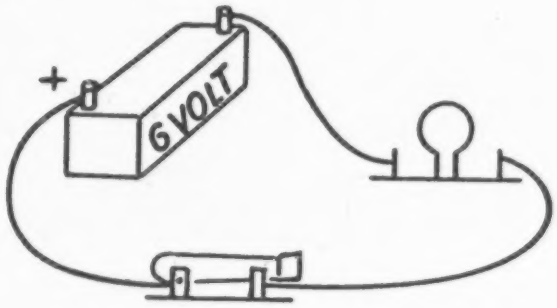

A

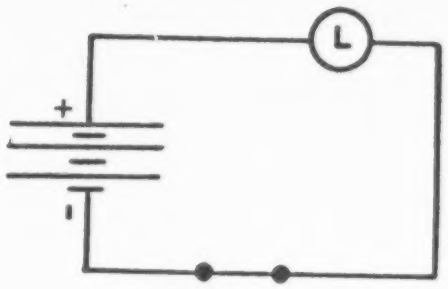

B

In figure A, current flows first through the _____ and then through the _____ .

In figure B, current flows first through the _____ and then through the _____ .

B. Related information

1. Occupational information
2. Consumer information
3. The manufacture of abrasives
4. Special thread forms and their application
5. Manufacturing process in the metal industry
6. Fabrication of metals in industry
7. Alloys in the metalworking industry
8. Assembly techniques

Suggested Tools and Equipment

A. Hand tools

1. Ball-pein hammers
2. Plastic mallets
3. Vise grips
4. Steel rules
5. Prick punches
6. Center punches
7. Scribes
8. Calipers
9. Spring dividers
10. Surface plate
11. Height gauge
12. Hacksaws
13. Chisels
14. Set of reamers
15. Rivet set
16. Pliers
17. File cards
18. Phillips screwdrivers
19. Hand drill
20. Twist drills
21. Set of pipe dies
22. Plastic eye shields
23. Screw pitch gauge
24. Twist drill gauge
25. Soldering coppers
26. Riveting hammers
27. Setting hammers
28. Bolt cutters
29. Hand reamer
30. Tubing or pipe benders
31. Pipe and adjustable wrenches
32. Micrometer combination
33. Tin snips or hand and bench shears
34. Combination, solid and steel squares
35. Set of socket or combination box and open end wrenches
36. Set of taps and die ational course and national fine.

B. Equipment

1. Machinist vises with pipe jaw accessory
2. Anvils
3. Stakes
4. Bench plate
5. Bending machine, bending jig or folks
6. Grinder
7. Wire brush
8. Buffer
9. Drill press
10. Bar folder
11. Rotary machine, combination
12. Square shear
13. Slip roll forming machine
14. Box and pan brake

Safety Precautions

A. Do not press the treadle of cutting shears when others are not clear of the machine
B. Handles must be kept on all files, hacksaws and other tools requiring them.
C. Hold work in a holding device when drilling, cutting, filing, chiseling or cutting threads.
D. Removing chips by hand is dangerous.
E. Mushrommed heads and chipped or cracked tools are very dangerous.
F. Loose hammer heads and split handles are dangerous.
G. Keep hands at a respectful distance from hammer blows.

1736

51

switch

lamp

lamp

switch

52

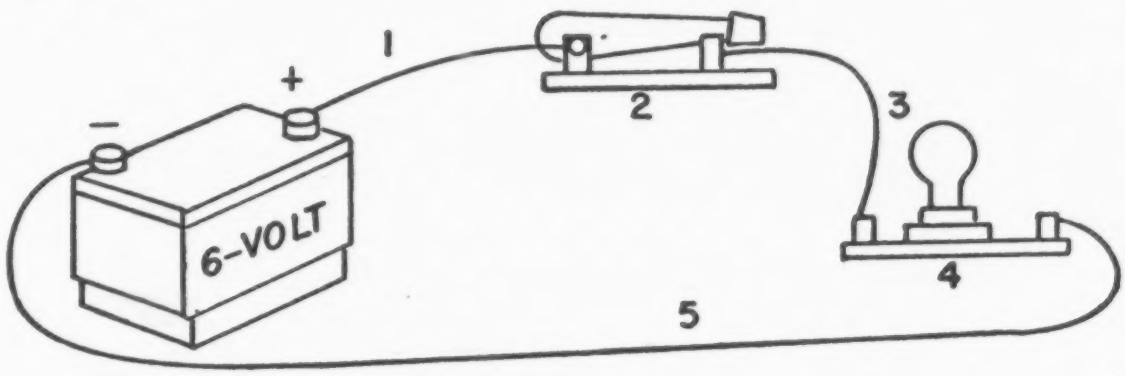

The diagram shows the path of electrical current.

When the electricity leaves the battery, it passes through:

1. a wire
2. _____
3. a wire
4. _____
5. _____
6. and then returns to the _____

52

(1. a wire)

2. the switch

(3. a wire)

4. the lamp

5. a wire

6. battery

53

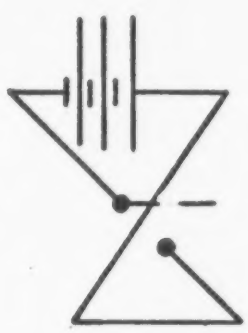

A

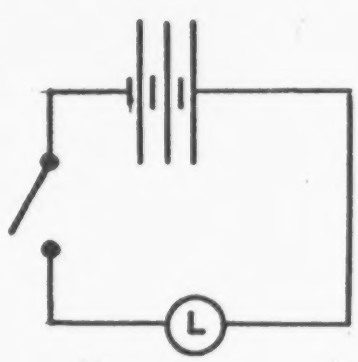

B

Which of the above is the clearest and simplest diagram?

☐ A

☐ B

53

B

54

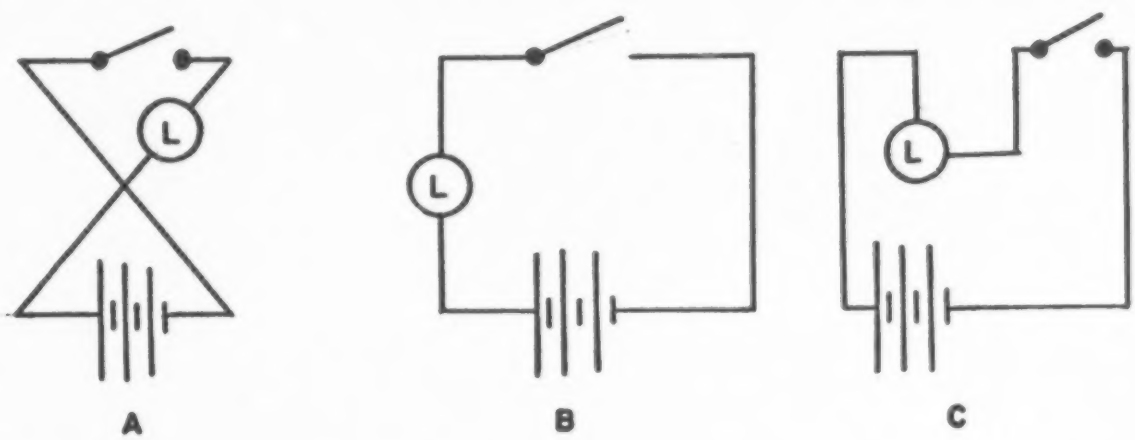

Which of the above shows the right way to draw a diagram of an electrical circuit?

- ☐ A
- ☐ B
- ☐ C

54

B

55

You should draw a diagram so that it is: (CHECK TWO)

- ☐ clear
- ☐ complicated
- ☐ confusing
- ☐ simple

55

clear

simple

56

Diagrams should show all parts of the actual circuit.

If a circuit has four lamps, how many lamps should the diagram show?

_____

If a circuit had two switches, how many switches should be shown in the diagram? _____

17395

57

one lamp is missing

58

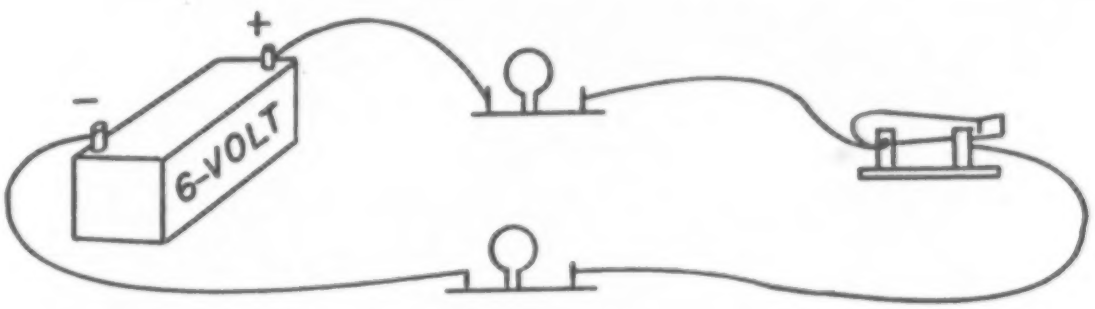

COMPLETE the diagram below so that it correctly represents the above circuit:

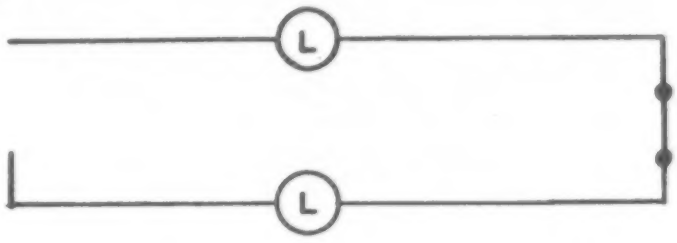

17397

58

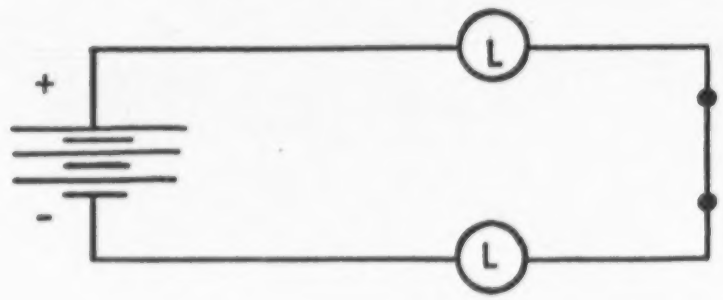

59

Lamps will light only if the complete circuit is closed.

Can a lamp in a circuit with an open switch light up?

☐ yes

☐ no

17398

250 OF 327

ED

056 238

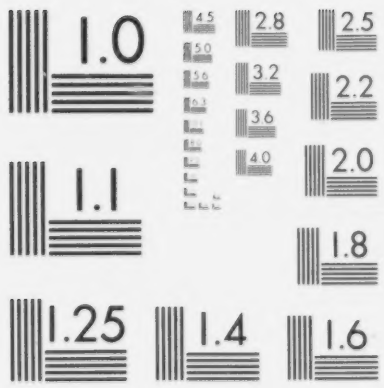

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

59

no

60

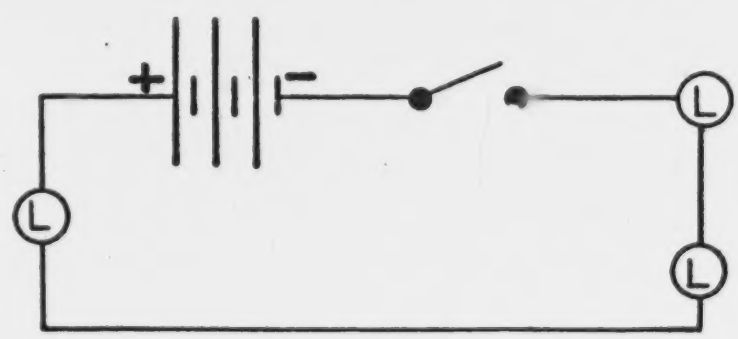

Will the lamps in the circuit light up? _____

EXPLAIN your answer. _____

Materials

A. Brass pipe
B. Sheet brass
C. Black iron
D. Angle iron
E. Drill rod
F. Layout dye
G. Soft iron rivets
H. Hacksaw blades
I. Solder
J. Solder flux
K. Abrasives
l. Cutting fluids
M. Hot rolled mild steel flat stock
N. Hot rolled mild steel round stock
O. Hot rolled mild steel square stock
P. Black iron or galvinized pipe
Q. Finishing materials
R. Nuts, bolts, washers and metal screws
S. Expanded materials

Suggested Projects

There are unlimited projects in this area that may be created with a wide variety of finishing materials available. However, instead of supplying a list of the usual racks, holders, tools, etc., the teacher is urged to search for ideas in the suggested references and in project books. Criteria to be considered in project selection include:

1. Contributes to attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of students
4. Good design
5. Inexpensive
6. Within shop facilities

FOUNDRY

Purpose

Since primitive man first discovered that copper could be cast in many shapes, man has depended upon the foundry industry in its various forms. Foundry is a basic industry on which most of the other industries depend either directly or indirectly. One has only to look about his surroundings to discover the importance castings play in our industrial society. All industrial arts students should be provided with an opportunity to acquaint themselves with this very important industry.

Specific Objectives

A. To develop an appreciation of the importance of founding in industry.
B. To develop an awareness of the relationship between the foundry area and the other areas of the industrial arts curriculum.
C. To develop a degree of skill in the use of special tools and equipment used in the foundry area.
D. To develop an awareness of the strength, weight and other characteristics of common metals used in founding.

60

no

switch is open
(or similar answer)

61

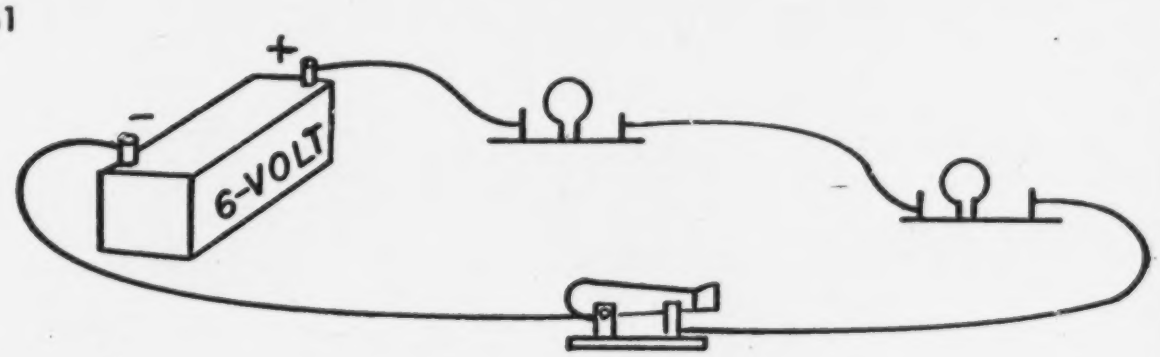

Now COMPLETE the diagram of the circuit:

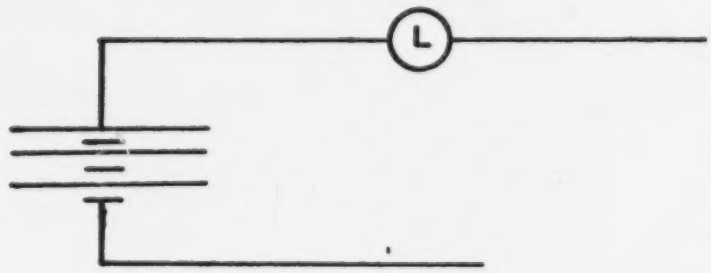

17400

61

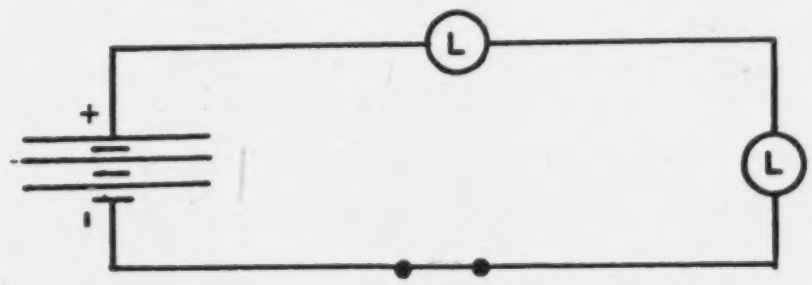

62

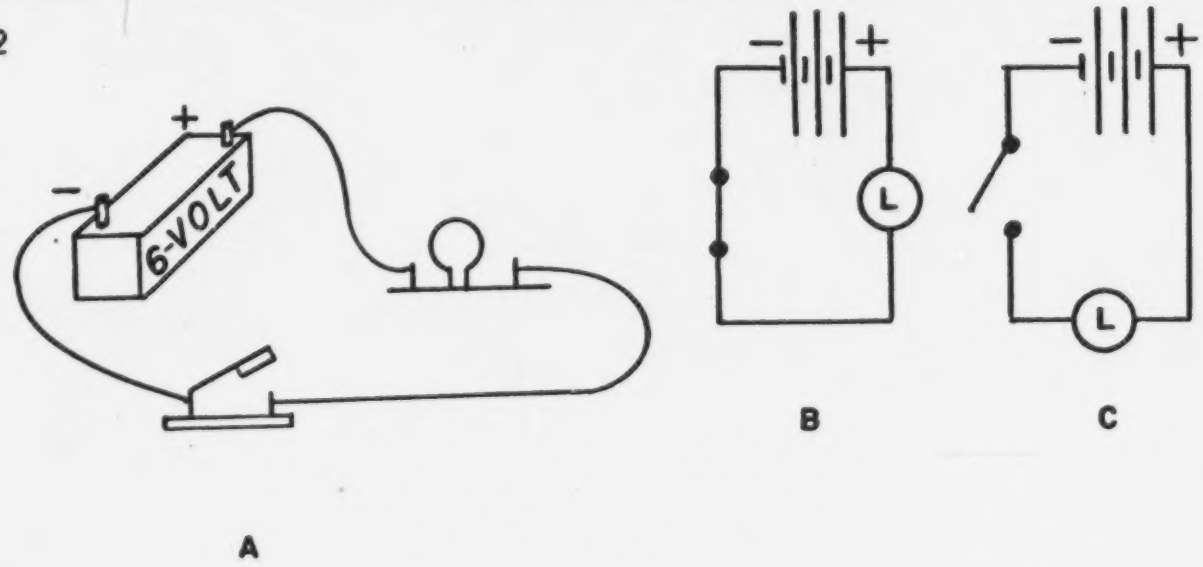

The correct diagram of circuit A is shown in picture:

☐ B

☐ C

17401

62

C

(B is not correct because the switch is closed)

63

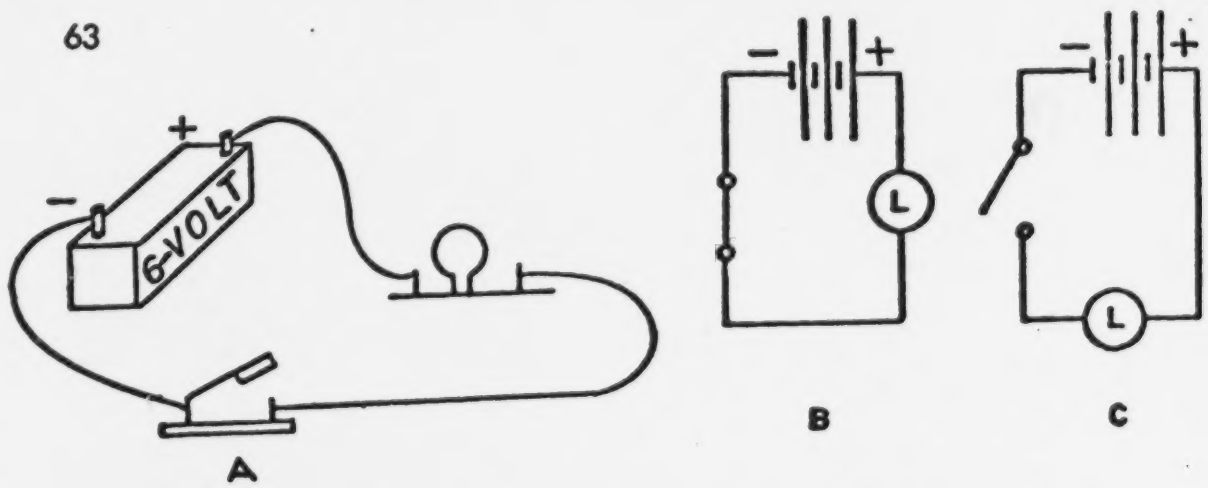

Why is picture B NOT a correct diagram of the circuit?

_____

17402

63

switch is closed

(or similar answer)

64

MATCH the following:

A

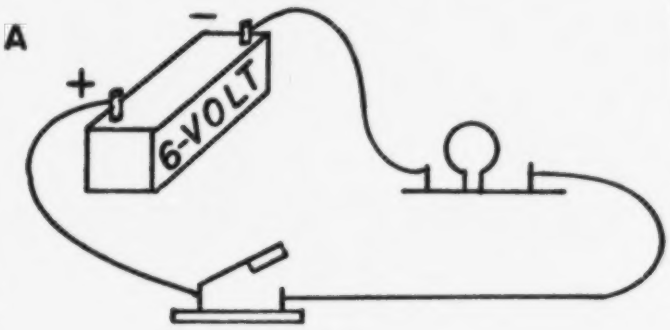

B

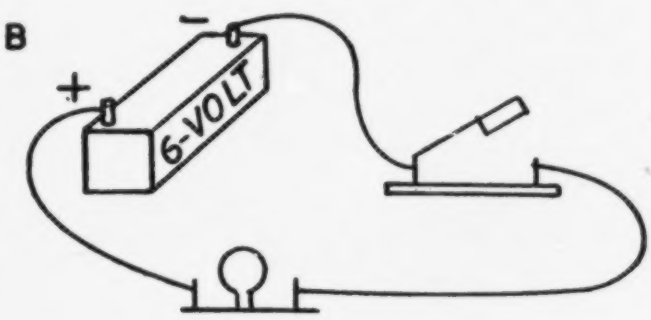

1 ____

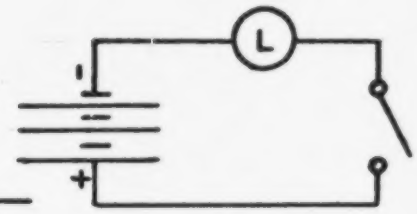

2 ____

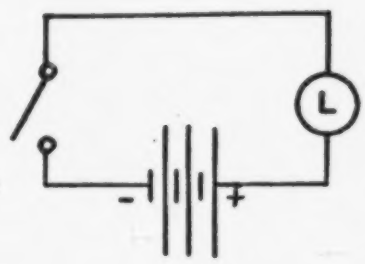

17403

64

1. A

2. B

65

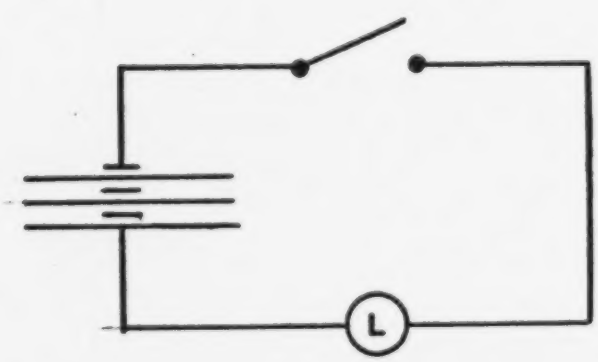

The diagram for an electrical circuit is used to show: (CHECK ONE)

☐ a real electrical circuit

☐ an electrical circuit on paper

17404

65

an electrical circuit on paper

66

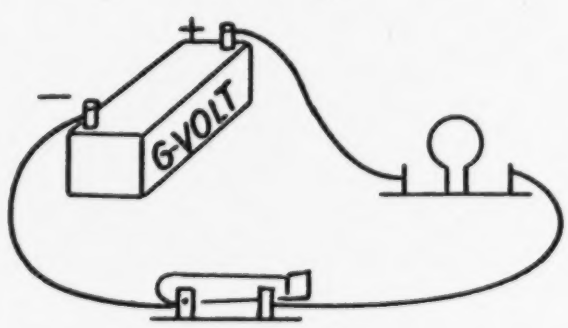

DRAW a diagram of the above circuit:

17405

66

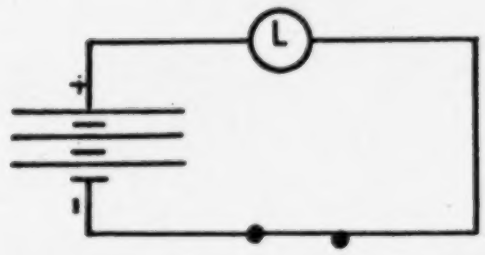

67

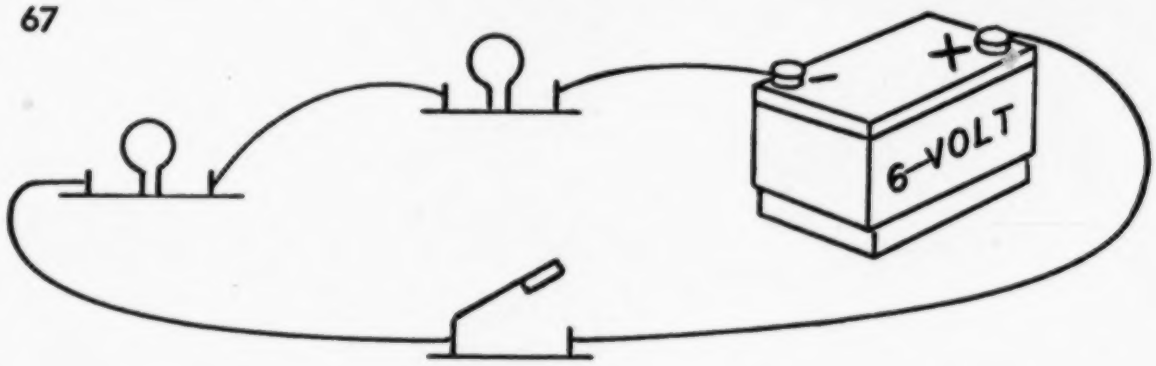

DRAW a diagram of the above circuit:

17406

67

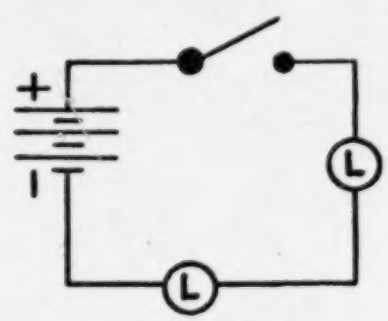

68

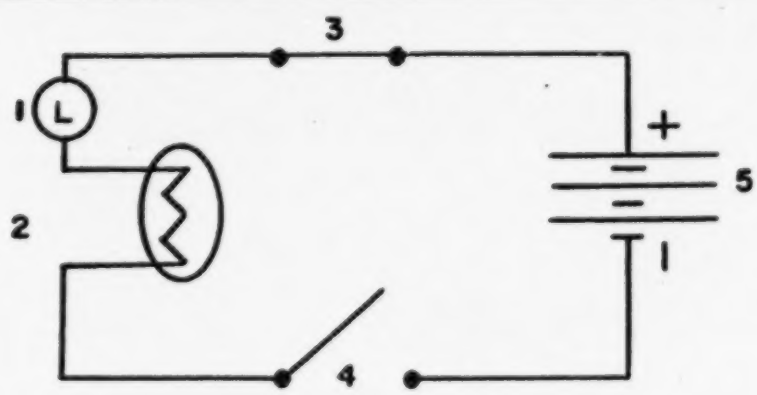

Next to each number, WRITE the name of the electrical part that it represents in the above diagram:

1: _____

2: _____

3: _____

4: _____

5: _____

17407

68

lamp

lamp

closed switch

open switch

battery (6-volt)

THIS IS THE END OF BOOK 3

17408

AUTO MECHANICS COURSE

POST-TEST BOOK 3: SIMPLE SCHEMATIC DIAGRAMS

A BASIC SYSTEMS PROGRAM

17409

Suggested Content

A. Manipulative and Technical

1. Glossary of foundry terms
2. Identification of tools and machines
3. Patternmaking
4. Types of patterns, their uses and care
5. Identification and characteristics of foundry metals
6. Construction of ingate, runners and sprue with regard to patterns.
7. Types of sand and binders
8. Preparing sand
9. Preparing a cavity in a mold
10. Size of riddles
11. Ramming a pattern in a flask
12. Aiding in removing gases from mold
13. Swabbing, rapping and removing a pattern from mold
14. Clamping or weighting a mold
15. Lighting and preheating the furnace
16. Placing the crucible and charging the furnace
17. Determining the temperature of the molten metal
18. Removing crucible, placing in shank, skimming and pouring in molds
19. Determining cooling periods of the metal in molds
20. Removing a casting from the sand
21. Preparing a casting for finishing
22. Finishing a casting
23. Identification of cores and their uses
24. Making sand cares
25. How to place core in mold
26. Identification of casting defects

B. Related information

1. Types of casting in industry
2. Occupational information
3. Pattern allowances and drafts
4. Alloying of metals
5. Laboratory tests of sand
6. Crucible types and sizes
7. History of the casting industry
8. Consumer knowledge of foundry products

Suggested Tools and Equipment

A. Hand Tools

1. Molder's trowel
2. Slicks and spoons
3. Lifters
4. Struje-off bar
5. Draw pins
6. Vent wire
7. Gate cutters
8. Bulb swab
9. Files
10. Tongs
11. Square-blade foundry shovel

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1-7

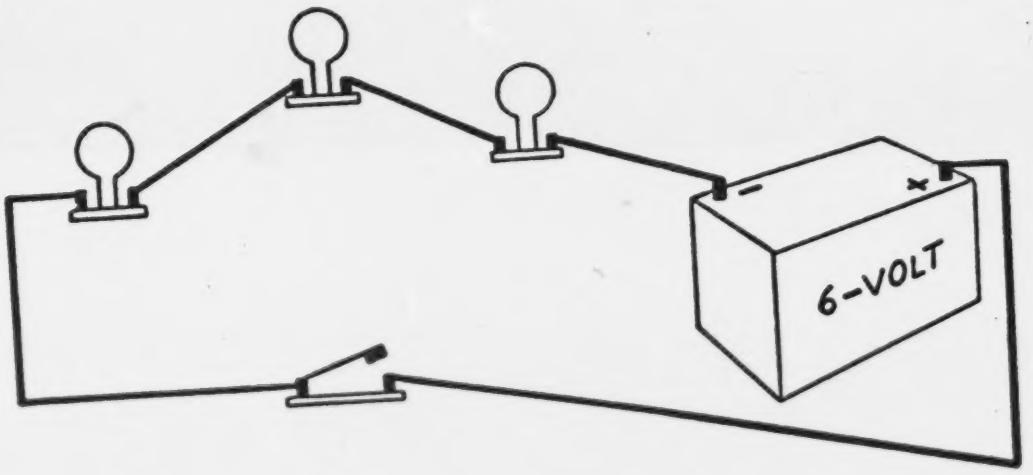

In the space below, DRAW a schematic diagram of the above circuit:

17410

8-10

NAME the electrical parts in the circuit below:

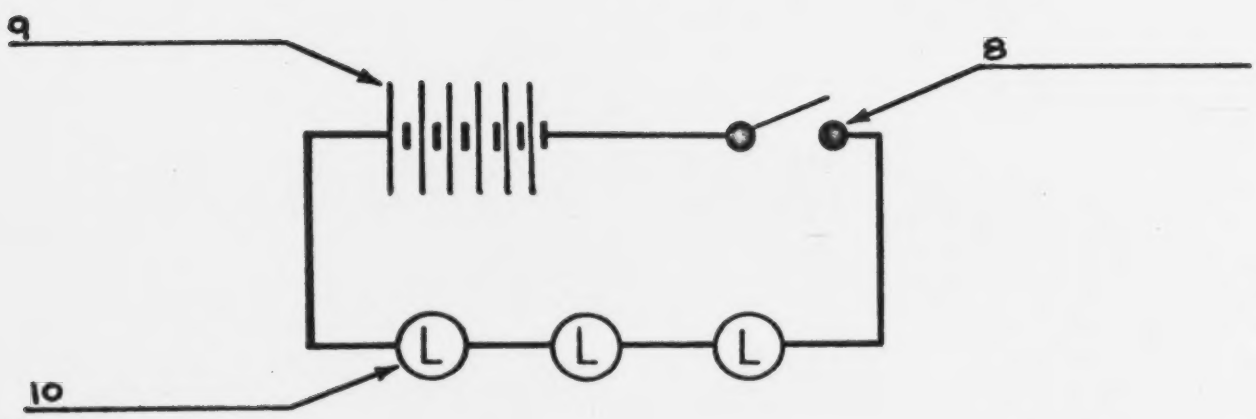

17411

11

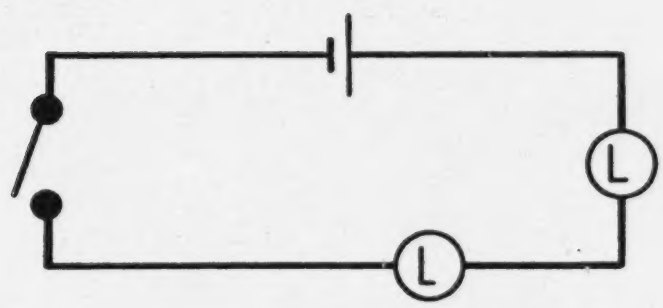

Will these lamps light up?

- ☐ yes
- ☐ no

Why did you choose this answer? _____

17412

VT 013 126
Auto Mechanics Course. Book 4: Automotive Electrical Systems, Part I.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 174p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; MECHANICS (PROCESS); *ELECTRICAL SYSTEMS; ELECTRICITY; ELECTRIC CIRCUITS
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on automotive electrical systems, Part I, was developed under the Manpower Development and Training Act of 1962. Contents are presented in very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 126

ED0 56238

BOOK **4**

(C1)

To Be Used With
PANEL BOOK 4

AUTO MECHANICS COURSE

BOOK 4: AUTOMOTIVE ELECTRICAL SYSTEMS

PART I

A BASIC SYSTEMS PROGRAM

VT013125

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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Curriculum Report Reference
Page 13

Task Analysis Reference
11

17414

AUTO MECHANICS COURSE

BOOK 4: AUTOMOTIVE ELECTRICAL SYSTEMS

PART I

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

17415

Name _____

Date _____

Starting time _____

Finishing time _____

17416

Book 4

1

What part of the electrical system stores and gives off electricity?

_____

2

Low-voltage electricity is changed to high voltage by the _____ _____.

3

Electricity is made by the _____.

4

The flow of electricity into the battery is regulated by the _____ _____.

5

The job of the starter motor switch is to close the circuit to the _____ _____.

6

When the ignition key is on the "off" position, electricity (☐ does ☐ does not) flow to the ignition coil.

7

The part that starts the engine running is the _____ .

8

The generator circuit and the starter circuit are both _____ voltage.

9

A battery that is low in electricity should be _____ .

10

When a battery gives off more electricity than it receives, we say that the battery is _____ .

1

The following three books will teach you how electricity is used in an automobile.

These books will teach you which parts use electricity and how electricity gets around in the automobile.

NO ANSWER NEEDED

GO ON TO NEXT FRAME

B. Equipment

1. Shake bag
2. Crucible or ladle
3. Grinder
4. Wire buffer
5. Pyrometer
6. Riddle
7. Flasks
8. Bellows
9. Sqrue and riser pins
10. Moulding bench
11. Mold weight
12. Patterns
13. Foundry letters
14. Crucible furnace
15. Single shank or duouble end shank

Safety Precautions

A. Wear clothing suitable for protection around the foundry furnaces.

B. Be sure work area is well ventilated.

C. Temper molding sand properly to eliminate 'blows' when metal is poured into molds.

D. Molds rammed too hard will 'blow' when they are poured

E. Do not attempt to lift excessive weight. Ask for assistance when lifting or rolling a heavy mold.

F. Stack flasks, boards and weights in an orderly manner so they will not fall.

G. Wear safety goggles when tapping furnaces, handling molton metal, or chipping a casting.

H. Keep the area around the furnace dry.

I. Damp or wet metal thrown into molten metal will cause an explosion that will make metal spatter.

J. Blow air through crucible furnace before attempting to light it.

K. Before using crucibles check them for flaws or cracks.

L. Store crucibles in a warm dry place.

M. Use properly fitted tongs and shanks when handling crucibles of molten metal.

N. Wedging pieces of metal into a crucible when charging it may crack it when metal expands.

O. Do not walk backwards when carrying molten metal.

P. Keep feet a safe distance from the mold when pouring in case of a run-out.

Q. Placing one's face over a sprue or riser may cause injury.

R. When moving molten metal, set the container down rather than dropping it in cases of emergency.

Materials

A. Foundry sand

B. Binder sand

C. Parting compound

D. Facing sand

E. Core paste

F. Core sand

G. Foundry metals

1. Aluminumable -- care must be taken when mixing different alluminum as the results are not wholly satisfactory
2. Brass
3. Lead

H. Flux

I. Buffing compound

NO ANSWER NEEDED

2

What is needed to start a car and keep it going? _____

What else is it needed for? _____

17420

2

electricity

extras

3

Electricity is used when:

1. the heater is working
2. the lights are turned on
3. the radio is playing

These three ways of using electricity are part of:

- ☐ keeping the car running
- ☐ starting the car
- ☐ the extras

17421

3

the extras

4

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

17422

4

NO ANSWER NEEDED

5

LOOK AT PANEL 1

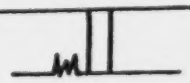

The panel shows a diagram of the _____ .

17423

5

Automotive Electrical System

6

LOOK AT PANEL 1

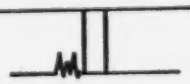

An automobile is much more complicated than the diagram shows. This book will teach you about the main circuits in an automobile.

NAME the two circuits shown in the diagram:

1. _____

2. _____

17424

6

1. primary circuit

2. secondary circuit

7

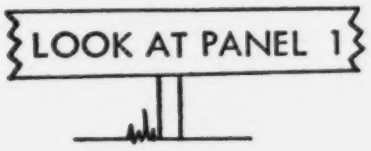

You have learned which part of a circuit stores and gives off electricity.

The part that gives off electricity is the _____ .

17425

7

battery

8

LOOK AT PANEL 1

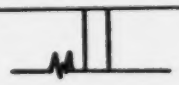

Electricity leaves the battery and goes to the _____ .

17426

8

starter motor switch

9

LOOK AT PANEL 1

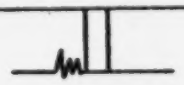

The starter motor switch is mounted onto the _____ .

9

starter motor

10

LOOK AT PANEL 1

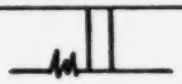

The starter gets electricity to start the car from the _____ .

10

starter motor switch

11

LOOK AT PANEL 1

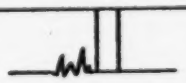

Electricity from the starter motor switch goes to the starter motor.

Besides the wire from the battery and the wire to the starter motor, wires also go from the starter motor switch to the _____ and the _____ .

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the student increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

MACHINE METAL WORKING

Purpose

Machine shop is an important part of the total industrial arts program since machines through the ages have greatly increased the productive capacity of man. Although most industrial arts shops concerned with metals are equiped to work only in such activities as bench work, drilling and metal turning, consideration should also be given to the other important metalworking operations - shaping, milling and grinding. This unit may be used for any other or all of the activities listed and is considered an addition or extension of the unit on bench metalwork.

Specific Objectives

A. To develop an understanding of an an appreciation for metal machining processes and practices.

B. To develop in each student a degree of skill in the use and care of machine shop tools and equipment.

C. To develop an understanding of the metallurgical factors involved in the machine shop area.

D. To provide the opportunity for exploration into various aspects of the metal machining industry.

E. To develop an understanding of an appreciation for precision measurement demanded in the machining of metals and an appreciation of the machine tool industry in the industrial trades.

Suggested Content

A. Manipulative and Technical

1. Identification of tools and machines
2. Planning a project
3. Identification and characteristics of relevant metals
4. Glossary of machine ship terms
5. Layout of stock
6. Operating precision measuring instruments
7. Operating the drill press
8. Sharpening drills and cutting tools
9. Boring and reaming
10. Making set-ups on the lathe
11. Rough and finish turning on the lathe
12. Face-off, bore, knurl, thread, taper and cut-off operations on the lathe.
13. Filing and using abrasives on the lathe.

11

ammeter ignition switch

12

LOOK AT PANEL 1

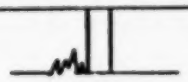

The fan belt connects the engine to the _____ .

12

generator

13

LOOK AT PANEL 1

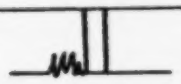

The turning fan belt turns the generator.

When electricity leaves the generator, it goes through the _____ .

17431

13

voltage regulator

14

LOOK AT PANEL 1

When electricity leaves the voltage regulator, it goes through the _____ .

17432

14

ammeter

15

LOOK AT PANEL 1

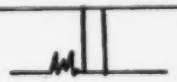

For electricity to get to the battery from the ammeter, it must first pass through the _____ .

17433

15

starter motor switch

16

LOOK AT PANEL 1

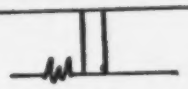

Many wires are connected to the ignition switch.

The ignition switch is connected by wires to the: (CHECK ALL CORRECT ANSWERS)

- ☐ ammeter
- ☐ generator
- ☐ ignition coil
- ☐ starter motor switch
- ☐ voltage regulator

16

ammeter

ignition coil

starter motor switch

17

LOOK AT PANEL 1

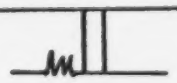

The ignition switch gets electricity from the:

- ☐ generator
- ☐ starter motor switch
- ☐ voltage regulator

17

starter motor switch

18

LOOK AT PANEL 1

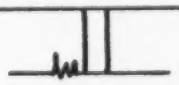

Electricity leaves the ignition switch and goes up to the

_____.

18

ignition coil

19

LOOK AT PANEL 1

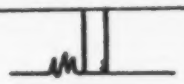

Electricity is stored and given off by the _____ .

19

battery

20

LOOK AT PANEL 1

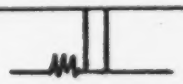

How many circuits are shown in the diagram? ____

Which circuit is low voltage? _____

20

2

primary (circuit)

21

LOOK AT PANEL 1

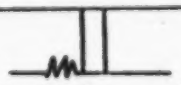

The starter motor is in the:

- ☐ high voltage circuit
- ☐ low voltage circuit

The generator is in the:

- ☐ high voltage circuit
- ☐ low voltage circuit

14. Identification of various cutting tools
15. Setting up work in the shaper
16. Adjusting the strole and position of the shaper
17. Squaring rectangular stock in the shaper
18. Planing irregular surfaces with a shaper
19. Making set-ups in the milling machine
20. Milling flat surfaces
21. Squaring up stock in a milling macine
21. Squaring up stock in a milling machine
22. Operating a dividing head
23. Machining stock with the aid of the dividing head
24. Setting up material on the surface grinder
25. Squaring up stock on the surface grinder
26. Care and maintenance of machines
27. Cutting off stock with a metal-cutting saw
28. Theory and application of cutting tangents
29. Cutting fluids
30. Kinds of metals and how to identify them
31. Mathematics related to cutting speeds, feeds, tapering and measuring, simple and compound cutting and belting.
32. Theory and application of cams and gears.

B. Related information

1. History of the machine shop and its varous machines
2. The theory of cutting metal with various tools
3. Mechanics of machines
4. Types and uses of the various threads
5. Types of tapers
6. Machine accessories
7. The manufacture of abrasives
8. Grinding wheels and their characteristics
9. Job opportunities in the machine shop trades
10. Union activities in the metal trades

Suggested Tools and Equipment

A. Hand tools

1. Hand tools listed in Introductory Bench & Sheet Metal
2. Center gage
3. Screw pitch gage
4. Dial indicator
5. Center head
6. Surface gage
7. V-block and clamps
8. High speed twist drills
9. Tool bit blanks
10. Diamond wheel dresser
11. Combination center drill and countersink
12. Testing equipment

21

low voltage circuit

low voltage circuit

22

LOOK AT PANEL 1

When electricity is generated, it is _____ voltage.

When the starter motor starts the engine, it uses _____ voltage electricity.

22

low

low

23

LOOK AT PANEL 1

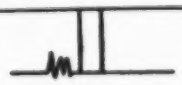

The ignition coil distributor and spark plugs are all part of the _____ circuit.

What kind of voltage goes through the secondary circuit?

_____

23

secondary

high (voltage)

24

LOOK AT PANEL 1

The primary circuit and the secondary circuit come together at the:

- ☐ distributor
- ☐ ignition coil
- ☐ voltage regulator

24

ignition coil

25

LOOK AT PANEL 1

The ignition coil changes low voltage to high voltage.

Which part changes the primary circuit electricity to secondary circuit electricity? _____

25

ignition coil

26

LOOK AT PANEL 1

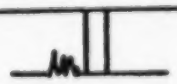

The panel shows the Automotive _____ System.

26

Electrical

27

LOOK AT PANEL 1

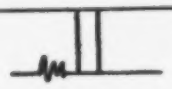

When electricity goes into the ignition coil, it is low voltage.

When electricity leaves the ignition coil, it is (☐ high ☐ low) voltage.

17445

27

high

28

LOOK AT PANEL 1

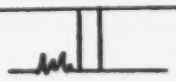

When electricity leaves the ignition coil, it goes to the

_____ .

28

distributor

29

LOOK AT PANEL 1

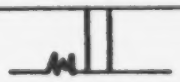

What kind of voltage does the distributor get? _____

When electricity leaves the distributor, it goes to the _____.

17447

29

high voltage

spark plugs

30

LOOK AT PANEL 1

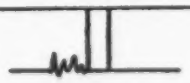

The different parts of the electrical system are connected by:

- ☐ more parts
- ☐ solid bars
- ☐ wires

30

wires

31

LOOK AT PANEL 1

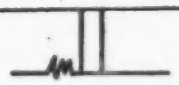

NAME the part that is in BOTH the primary circuit and the secondary circuit:

_____

B. Equipment

1. Metal lathes
2. Metal lathe accessories
   a. Taper attachment
   b. Spindle sleeves
   c. Collect attachment
   d. Universal and independent chucks
   e. Lathe dogs
   f. Drill chuck, Jacobs
   g. Drill pad
   h. Crotch center
   i. Boring bar and holder
   j. Hand reamer set
   k. Knurling tools
   l. Follower rest
   m. Steady rest
   n. Mandrel set
   o. Tool holders
   p. Face plates
   q. Tool post grinder
3. Surface plate
4. Drill press
5. Drill press vise
6. Shaper with accessories
7. Milling machine, vertical and/or horizontal, with accessories
8. Surface grinder with chuck
9. Hold down clamps
10. Metal-cutting power saw
11. Grinder, bench or pedestal

Safety Precautions

A. Place all heavy objects, such as angle plates, surface plates and workpieces so they cannot drop off the bench and injure the worker.

B. Use a brush to clean metal filings from the vise or the work.

C. Leaving a chuck key in the chuck may cause an accident.

D. Wear eye protection in the machine shop.

E. Measuring work in a machine while it is moving is dangerous.

F. Care should be used to keep a lathe carriage from going into the head stock.

G. All work must be clamped tightly in a machine.

G. Use proper cutting speeds for all machines in the machine shop.

J. Keep hands away from all moving cutters.

K. Sleeves should always be rolled up in a machine shop.

L. It is dangerous to sue improperly fitted cutters.

M. It is dangerous to use rags, cotton waste, or cleaning brushes near a moving cutter.

N. Heavy attachments must not be handled alone.

O. Make sure the cutting tool is clear of the work before starting a machine.

P. Avoid grasping metal that may be hot.

Q. Use caution when removing chips from machines.

Materials

Material needed in the machine shop unit will depend upon the choice of projects. Some of these generally on inventory in a machine shop are:

A. Hot rolled carbon steel

B. Cold rolled carbon steel

C. Tool steel

D. Aluminum stock

E. Brass and bronze

F. Lubricants

G. Abrasive paper and cloth

H. Case hardening material

31

ignition coil

32

LOOK AT PANEL 1

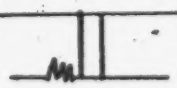

CHECK all the parts that are in the secondary circuit:

- ☐ distributor
- ☐ generator
- ☐ ignition coil
- ☐ spark plugs
- ☐ voltage regulator

32

distributor

ignition coil

spark plugs

33

LOOK AT PANEL 1

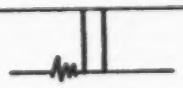

CHECK each of the parts below that are in the primary circuit:

- ☐ distributor
- ☐ ignition coil
- ☐ ignition switch
- ☐ spark plugs
- ☐ starter motor
- ☐ starter motor switch

33

ignition coil

ignition switch

starter motor

starter switch motor

34

LOOK AT PANEL 1

Low voltage gets the car started and keeps the battery charged up.

This is the job of the _____ circuits.

34

primary (circuit)

35

LOOK AT PANEL 1

High voltage keeps the car going.

This is the job of the _____ circuits.

Which part changes low voltage to high voltage? _____

35

secondary

ignition coil

36

LOOK AT PANEL 1

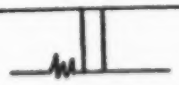

NAME three parts of the secondary circuit:

1. _____

2. _____

3. _____

17454

36

1. ignition coil
2. distributor
3. spark plugs

37

LOOK AT PANEL 1

MATCH the following:

A. high voltage

B. low voltage

1. _____ primary circuit
2. _____ secondary circuit

37

1. B

2. A

38

LOOK AT PANEL 1

CHECK each job done by the primary circuit:

- ☐ keeps the battery charged up
- ☐ keeps the engine running
- ☐ starts the car

38

keeps the battery charged up

starts the car

39

LOOK AT PANEL 1

Unless the battery is charged up, it will soon run out of electricity. The job of the generator is to put electricity into the battery.

The job of the generator is to charge the _____ with electricity.

39

battery

40

LOOK AT PANEL 1

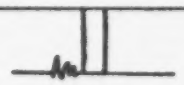

When electricity flows through the voltage regulator, it is registered on a meter.

NAME the meter that shows the flow of electricity from the generator and voltage regulator:

_____

17458

40

ammeter

41

LOOK AT PANEL 1

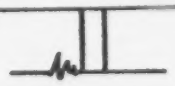

After the flow of electricity is shown on the ammeter, which part must it go through to get to the battery? _____

17459

41

starter motor switch

42

LOOK AT PANEL 1

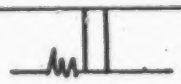

Electricity for an automobile's electrical system comes from the

_____ .

NAME the part that makes electricity for the battery to store:

_____

17460

42

battery

generator

43

LOOK AT PANEL 1

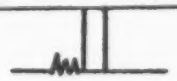

Which of the following are parts of the system that gets electricity into the battery?

- ☐ distributor
- ☐ generator
- ☐ voltage regulator

43

generator

voltage regulator

44

LOOK AT PANEL 1

A battery is used to: (CHECK ALL CORRECT ANSWERS)

- ☐ give off electricity
- ☐ make electricity
- ☐ store electricity

A generator is used to:

- ☐ destroy electricity
- ☐ make electricity
- ☐ store electricity

17462

44

give off electricity

store electricity

make electricity

45

LOOK AT PANEL 1

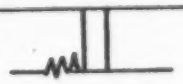

The job of the starter motor is to start the car.

Electricity gets to the starter motor from the _____ .

17463

45

starter motor switch

46

LOOK AT PANEL 1

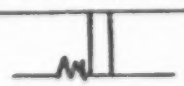

Where does the starter motor switch get its electricity from?

_____

For electricity to get to the parts that keep the engine running, electricity must flow through the _____ .

17464

46

battery

ignition coil

47

LOOK AT PANEL 1

Parts that help to start the car are in the _____ circuit.

Parts that make, regulate and store electricity are also in the _____ circuit.

17465

47

primary

primary

48

LOOK AT PANEL 1

The generator circuit and the starter circuit are both in the _____ circuit.

17466

48

primary

49

LOOK AT PANEL 1

CHECK each part that helps to start the engine:

- ☐ battery
- ☐ distributor
- ☐ ignition switch
- ☐ starter motor switch
- ☐ starter motor
- ☐ voltage regulator

17467

49

battery

ignition switch

starter motor switch

starter motor

50

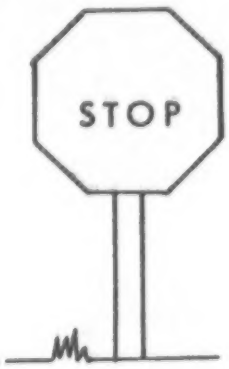

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

17468

251 OF 327

ED

056 238

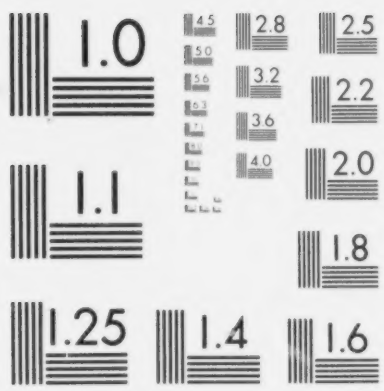

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

B. Related information

1. Manufacturing of welding oxygen and acetylene gas
2. Occupational information
3. Consumer information
4. Welding in industry

Suggested Tools and Equipment

A. Hand Tools

1. T-handle wrench
2. Regulator wrench
3. Tip cleaner
4. Ball pein hammers
5. Vise-grip pliers
6. Wire brushes

B. Equipment

1. Welding cart
2. Regulators
3. Welding goggles
4. Friction lighters
5. Leather gloves
6. Welding clamps
7. Anvil
8. Machine vise
9. Grinder
10. Bench shears
11. Wire wheel
12. Safety eyeshield
13. Welding first aid kit
14. Welding hoses and connections
15. Cutting attachment with tips
16. Welding blowpipe and tips
17. Welding tables with fire bricks
18. Fire blanket and extinguisher

Safety Precautions

A. Exercise extreme care when handling cylinders and store in proper place.
B. Using lubricating oil on welding equipment is very dangerous.
C. Acetylene pressure greater than 15 lbs. in hose is very dangerous.
D. Guard against leaks in acetylene equipment
e. check all connections to see if they are tight.
F. Always make sure the torch is pointing away from other or materials that will burn.
G. Wear colored eye protection when welding or cutting.
H. Always use regulation gloves when welding or cutting.
I. Loose clothing and cuffs are vey dangerous around the welding area.
J. Inflammable material should not be in the welding area.
K. Open acetylene pressure valve only one-half turn when using.
L. Keeping acetylene wrench on valve stem when operating welder.
M. Welding on containers which have held combustible or inflammable materials is dangerous.
N. Weld in areas with adequate ventilation.
O. Consider all metals in the welding area as being potentially hot.
P. Keep cap on tanks when moving.
Q. Keep hose away from sparks.
R. Cylinders should always be fastened securely.
S. Turn cylinder valves off at bottle source.

50

NO ANSWER NEEDED

51

The primary circuit includes the starter circuit and the generator circuit.

The job of the generator circuit is to make _____ .

The job of the starter circuit is to _____ .

17469

51

electricity

start the engine running

52

In any electrical circuit, electricity (☐ will ☐ will not) flow if the switch is open.

An open switch is the same as a switch that is:

☐ on

☐ of

When a switch is "on," it means that the switch is:

☐ open

☐ closed

52

will not

off

closed

53

The picture shows the ignition switch in the position that keeps the primary circuit open.

The primary circuit is open when the key is at the:

- ☐ off position
- ☐ on position
- ☐ start position

Electricity (☐ will ☐ will not) flow through the ignition switch to the ignition coil.

17471

53

off position

will not

54

The picture shows the key pointing to the "on" position.

The primary circuit is:

☐ open

☐ closed

Electricity (☐ will ☐ will not) flow through the ignition switch to the ignition coil.

54

closed

will

55

When the key is turned to the start position, the starter motor starts the engine running.

You turn the key to the "start" position when you want to:

- ☐ get the engine running
- ☐ keep the engine running
- ☐ stop the engine from running

55

get the engine running

56

Once the engine starts running, the key stays on the:

- ☐ off position
- ☐ on position
- ☐ start position

To stop the engine from running, you turn the key to the:

- ☐ off position
- ☐ on position
- ☐ start position

56

on position

off position

57

The key is on the "on" position only when:

- ☐ you are starting the engine
- ☐ you are turning off the engine
- ☐ the engine is running

57

the engine is running

58

MATCH the following key positions to the way each affects the primary circuit:

A. key on

B. key off

1. _____ circuit open

2. _____ circuit closed

58

1. A

2. B

59

MATCH the following:

ENGINE	KEY POSITION
A. engine running	1. _____ start
B. engine not running	2. _____ off
C. engine starting	3. _____ on

59

1. C

2. B

3. A

60

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

Materials

A. Mild steel welding rod
B. Brazing rod
C. Cast iron rod
D. Brazing flux
E. Cast iron flux
F. Flints for lighters
G. Welding metals

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criterial to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

ARC WELDING

Purpose

Welding is now used as a major means of fabrication and repair. Arc welding and oxyacetylene welding are two of the most common types of welding now being used. Arc welding is generally more economical than oxyacetylene welding when it is available and it has wider application. Many homeowners now own arc welding machines for general maintenance problems and for do-it-yourself projects.

Specific Objectives

A. To develop the ability to identify, understand and appreciate the fabrication of metals in industry through the medium of arc welding.

B. To develop a degree of skill inthe

B. To develop a degree of skill in the operation and care of arc welding equipment.

C. To provide the opportunity to explore the various aspects of the welding industry for future employment possibilities.

D. To develop the ability to maintain machinery and equipment by use of the arc welder.

Suggested Content

A. Manipulative and technical
   1. Theory of arc welding
   2. Types of arc welding machines
   3. Identification, setting-up and care of equipment
   4. Identification and characteristics of metals as applied to welding
   5. Identification, characteristics and care of electrodes
   6. Glossary of welding terms
   7. Planning welding projects
   8. Identification and welding principles of different types of joints and their purposes
   9. Manipulation of electrodes

60

NO ANSWER NEEDED

61

LOOK AT PANEL 1

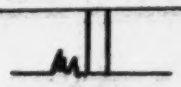

When the key is turned on, the ignition switch is:

- ☐ off
- ☐ on

Electricity can then get to the _____ .

61

on

ignition coil

62

LOOK AT PANEL 1

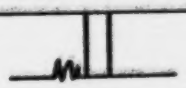

Electricity reaches the ignition coil when the primary circuit is closed.

Which switch closes the primary circuit?

- ☐ ignition switch
- ☐ starter motor switch
- ☐ voltage regulator

62

ignition switch

63

When the key is turned to the "on" position, the _____ switch is on and electricity reaches the _____ .

63

ignition (switch)

ignition coil

64

LOOK AT PANEL 1

Which circuit is closed and opened by the ignition switch?

_____

64

primary

65

What does the ignition switch do? _____

65

opens and closes the primary circuit

66

LOOK AT PANEL 1

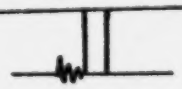

When the key in the ignition switch is turned to the "start" position, the starter motor circuit is closed.

Electricity will then flow to the starter motor _____ .

66

switch

67

The starter motor switch closes the circuit to the:

- ☐ generator
- ☐ ignition coil
- ☐ starter motor

67

starter motor

68

The starter motor switch is in the:

- ☐ ignition circuit
- ☐ generator circuit
- ☐ starter circuit

17486

68

starter circuit

69

The job of the starter motor switch is to close the circuit to the

_____ .

17487

69

starter motor

70

What kind of voltage goes through the starter motor switch?

_____

10. Welding in the various positions
11. Preparing metals for welding
12. Testing and inspecting various welds
13. Controlling and correcting distortion
14. Striking an arc
15. Cutting with the arc welder
16. Operating the carbon arc torch
17. Hard surfacing
18. Metal resurfacing

B. Related information
1. Industrial processes of welding
2. Consumer information pertaining to welding
3. Occupational opportunities in welding
4. Research in welding electrodes

Suggested Tools and Equipment

A. Hand tools
1. Wire Brushes
2. Chipping Hammers
3. Forging Tongs

B. Equipment
1. Arc welding units, AC and/or DC
2. Power lines
3. Electrode holders
4. Ground clamps
5. Arc shields or helmets
6. Gaunlet gloves, leather
7. Metal welding tables
8. Grinder
9. Wire wheel
10. Safety goggles
11. Bench shears
12. Protective clothing
13. Tungston inert gas welding equipment
14. Magnesium inert gas welding equipment

Safety Precautions

A. Wear a welding helmet whenever welding or watching others weld.
B. Avoid skin exposures.
C. Wear eye protection when in the welding shop.
D. Wear gloves for all welding operations.
E. Roll trouser cuffs down.
F. Shut off welding machine before changing polarity.
G. Touching both contact points at the same time is dangerous.
H. Everyting should be considered potentially hot in the welding area.
I. Avoid exposing welding flashes to others.
J. Weld only in a well-ventilated area.
K. Laying electrode holder on the table is a dangerous practice.
L. Wear long sleeves and leqther or rubber apron.
M. Welding directly on concrete is very dangerous.

70

low voltage

71

Can the starter motor start the engine running if the starter motor switch is not working?

- ☐ yes
- ☐ no

For the starter motor to start the engine running, the starter motor switch must:

- ☐ close the starter circuit
- ☐ open the starter circuit

17489

71

no

close the starter circuit

72

When the starter circuit is closed, electricity flows from the starter motor switch to the _____.

72

starter motor

73

LOOK AT PANEL 1

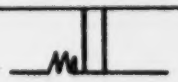

The starter circuit is closed by the:

- ☐ ignition switch
- ☐ strater motor switch
- ☐ voltage regulator

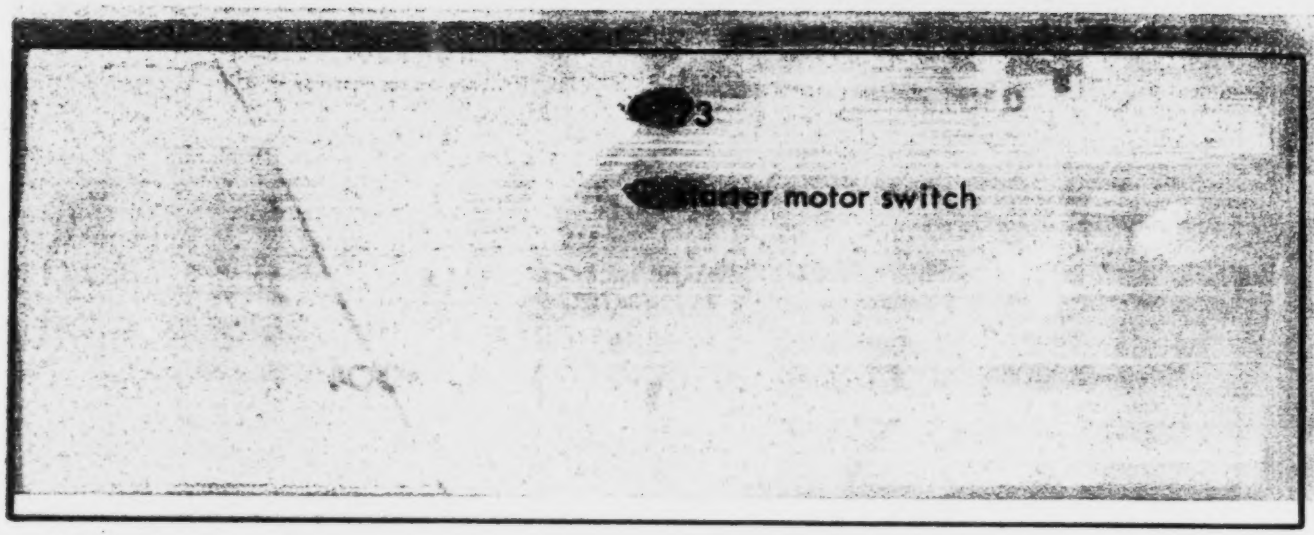

74

LOOK AT PANEL 1

When the starter circuit is closed, the starter motor starts the engine.

On which position is the key in the ignition switch?

- ☐ on
- ☐ off
- ☐ start

74

start

75

LOOK AT PANEL 1

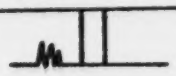

NAME the part that closes the circuit to the starter motor:

_____

17493

75

starter motor switch

76

What does the starter motor switch do? _____

17494

76

closes the starter circuit

77

The job of the starter motor switch is to close the starter circuit.

When the starter circuit is closed, the starter motor will:

- ☐ start the engine running
- ☐ not start the engine running
- ☐ stay the same as before

77

start the engine running

78

The starter motor, starter motor switch and the ignition switch are part of the _____ circuit.

17496

78

primary

79

The starter motor is used to:

- ☐ charge the battery of an automobile
- ☐ start the engine running
- ☐ stop the engine from running

17497

79

start the engine running

80

The starter circuit is:

- ☐ high voltage
- ☐ low voltage

The starter circuit is part of the:

- ☐ primary circuit
- ☐ secondary circuit

17498

Materials

A. Electrodes

B. Extra lens for welding helmet

C. Welding metals

D. Carbon tips for arc torch

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributions to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

80

low voltage

primary circuit

81

What kind of voltage does the starter circuit use?

_____

17499

81

low voltage

82

The starter motor _____ the engine of an automobile.

17500

82

starts

83

MATCH the following:

A. ignition switch

B. starter motor

C. starter motor switch

1. _____ closes and opens the starter motor circuit

2. _____ starts the engine of an automobile

17501

83

1. C

2. B

84

Which part starts the engine running? _____

17502

84

starter motor

85

What is the job of the starter motor? _____

17503

85

starts the engine

86

A battery is used to: (CHECK TWO)

- ☐ destroy electricity
- ☐ give off electricity
- ☐ remove electricity
- ☐ store electricity

17504

86

give off electricity

store electricity

87

The battery is part of the _____ circuit.

The battery stores and gives off _____ .

17505

87

primary

electricity

88

What kind of voltage does the battery give off? _____

88

low (voltage)

89

A battery _____ and _____ off electricity.

17507

89

stores gives

90

A battery stores and gives off electricity.

NAME the part that makes electricity: _____

17508

PLASTICS

Purpose

Due to the ever increasing demands of modern living, the plastics industry has grown tremendously. It has a growth rate of 4 to 5 times greater than that of any other single industry. Due to this rapid growth, we can no longer afford to treat plastics as a sub-unit within the crafts area. Instead, we must treat plastics as a separate curriculum area.

Specific Objectives

A. To develop a knowledge of the history of the plastic industry.
B. To instill an appreciation for the increasing importance of the plastic industry.
C. To develop a knowledge of the classifications, types and kinds of plastics
D. To introduce an ability of the various industrial processes, included design and safety procedures.

Suggested Content

A. Introduction to plastics
   1. History of plastics
   2. Types of plastics
      a. Thermo-forming
      b. Thermod-setting

B. Hand operations
   1. Lay out
   2. Cutting and squaring
   3. Internal carving and dies
   4. Finishing and buffing

C. Molding and forming
   1. Thermo-forming
   2. Injection molding
   3. Rotational molding
   4. Extrusion
   5. Compression
   6. Blow molding

D. Bonding
   1. Cements
   2. Plastic welding

E. Color plastics
   1. Cold dip
   2. Hot dip
   3. Carving dies
   4. Paints

F. Casting and Embedding
   1. Simple casting
   2. Fiberglass
   3. Plastical casting

1748

90

generator

91

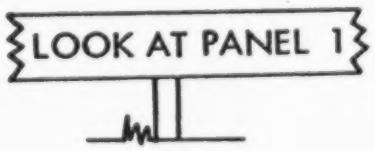

What connects the engine to the generator? _____

17509

91

fan belt

92

LOOK AT PANEL 1

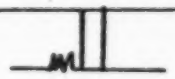

When the engine turns the fan belt, the fan belt will turn the _____.

17510

92

generator

93

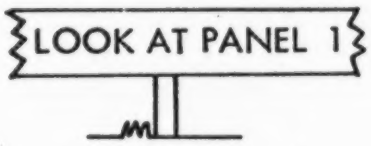

What is connected to both the engine and the generator?

_____

17511

93

fan belt

94

What does the fan belt turn? _____

17512

94

generator

95

When the generator turns, electricity is made.

What turns the generator? _____

17513

95

fan belt

96

A working generator makes:

- ☐ electric power
- ☐ gasoline power
- ☐ water power

What kind of voltage is this? _____

17514

96

electric power

low voltage

97

Electricity is made by the _____ .

17515

97

generator

98

What kind of voltage is in the primary circuit? _____

What kind of voltage does the generator make? _____

17516

98

low voltage

low voltage

99

When the generator turns, what kind of power is made?

_____

17517

99

electric power <u>or</u> low voltage

100

For the generator to make electricity, the fan must turn the generator.

Will the fan do this if the engine is NOT running?

- ☐ yes
- ☐ no

What must the engine be doing for the generator to make electricity? _____

17518

Suggested Tools and Equipment

A. Hand Tools

1. Coping saw
2. Back saw
3. Try square
4. Combination square
5. Rulers
6. Files
7. Bench vises
8. Jewlers' saws
9. Scratch awl
10. Chisels
11. Block planes
12. Smooth planes
13. Hand scrapers
14. Set of twist bits
15. Hammers
16. File cleaners
17. Needle nose pliers
18. Counter-sink
19. Tap and die set
20. Dividers
21. Compass
22. Internal carving drills
23. Internal carving burrs
24. Molds, plastic and aluminum

B. Power Tools and Equipment

1. Flexible shaft machine
2. Drill press
3. Disc sander
4. Belt sander
5. Jig saw
6. Oven
7. Buffer
8. Bench grinder
9. Lathe
10. Propane torch
11. Engraving tool
12. C-clamps
13. Hand screws
14. Spring clamps
15. Vaccum former
16. Injection molder
17. Strip heater and oven
18. Flextruder
19. Welding unit
20. Laminating press
21. Rotational molder

Materials

A. Supply of plastics
   1. Sheet plastic - various thicknesses and colors
   2. Plastic rod - cylinders, tubes, and special shapes
B. Laminating dyes
C. Laminating cement
D. Household cement
E. Internal carving drills
F. Small twist bits
G. Carving burrs
H. Muslin and flannel buffing wheel
I. Internal carving dyes
J. Abrasives
K. Tripoli compound (Buffing)
L. White final compound (Buffers)
M. Jewelry findings and accessories
N. Casting plaster
O. Fiberglass cloth
P. Hardener for resin
Q. Mold release solution
R. Acetone
S. Polyethylene
T. High impact styrene
U. Soft vinyl
V. Polypropylene
W. Wetting agent
X. Polystyrene
Y. Cellulose vaccumforms
Z. Polynightglows

100

no

be running

101

When the engine is running, the _____ will make electricity.

17519

101

generator

102

What is the job of the generator? _____

17520

102

makes electricity

103

Electricity is stored and given off by the _____ .

17521

103

battery

104

A dead battery is a bad battery.

A bad battery gives off:

- ☐ lots of electricity
- ☐ no electricity

17522

105

dead battery

high battery

106

A LOW battery gives just a little electricity.

CHECK the low battery:

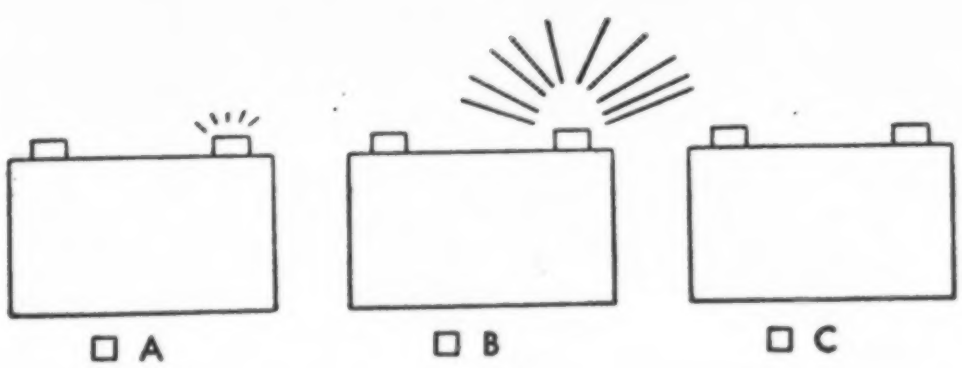

17524

106

A

107

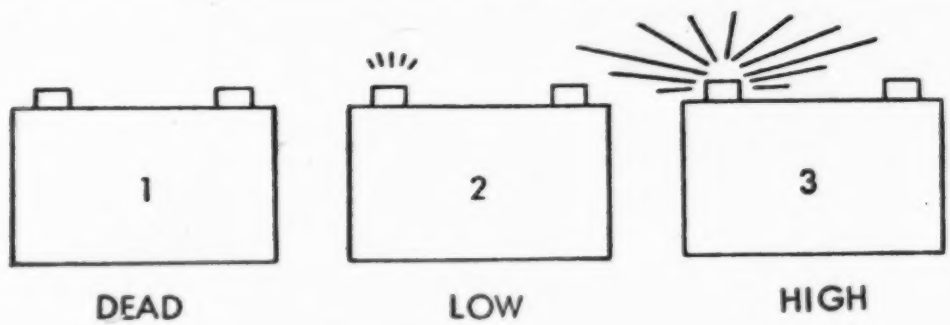

A low battery can still be used if it is REFILLED with electricity.

Putting electricity into a battery is called CHARGING a battery.

Battery 2 (☐ needs ☐ does not need) to be charged.

Battery 3 (☐ needs ☐ does not need) to be charged.

17525

107

needs

does not need

108

Putting electricity into the battery is called:

- ☐ advancing the battery
- ☐ charging the battery
- ☐ weakening the battery

17526

108

charging the battery

109

The part that makes electricity, also puts the electricity into the battery.

What part is this? _____

17527

109

generator

110

The generator:

- ☐ charges the battery
- ☐ kills off the battery
- ☐ weakens the battery

17528

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributions to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

BASIC ELECTRICITY

Purpose

Electricity, possibly the greatest benefactor of mankind, has always been a mystery to the average person. In this course, the student will become acquainted with the basic laws and circuits involved in the production and consumption of electrical current. Relationship of basic electricity to the expanding electronics industry in considerable. Although intended to cover a period of 18 weeks, the content may be adjusted to meet the needs of a short unit in a comprehensive general shop.

Specific Objectives

A. To develop an understanding of how electricity affects our social and economic life.

B. To develop a degree of skill in the use and care of tools and equipment used in the electricity area.

C. To develop desirable attitudes and practices with respect to health and safety when working around electricity.

D. To develop the ability to detect minor troubles in electrical circuits in the home and to take safe measures to correct them.

E. To develop the ability to judge the value of electrical products, appliances, and installations.

F. To develop wholesome leisure-time interests and an awareness of occupational opportunities in field of work related to electricity and electronics.

Suggested Content

A. Manipulative and technical

1. Identification of tools and instruments
2. Correct use and care of tools and instruments
3. Electrical symbols
4. Sources of electricity
5. Drawing and reading schematics
6. Magnetism
7. Electromagnetism
8. Electron theory
9. Static electricity
10. Current electricity
11. The simple cell
12. The dry cell
13. The storage cell
14. The generator, alternator, and motor
15. Parallel circuits
16. Series circuits
17. Conductors and insulators
18. Fuses and breakers
19. Transformer function
20. OHM'S Law
21. Series and parallel resistors
22. Communicating with electricity
23. National and local electrical codes
24. Computing cost of electrical service
25. Single and three phase electricity

110

charges the battery

111

Which part charges the battery? _____

17529

111

generator

112

What does a generator do to the battery? _____

17530

112

charges the battery

113

A high battery is fully charged.

A charged battery has enough electricity for the starter motor to start the engine running.

Does the generator really have to charge a fully charged battery?

- ☐ yes
- ☐ no

113

no

114

When a battery is low, it must be _____ .

Which part does this job? _____

17532

114

charged

generator

115

What kind of voltage does the generator make? _____

17533

115

low voltage

116

Some cars have a part that does the same job as the generator.

It is called the ALTERNATOR.

The alternator:

- ☐ makes electricity
- ☐ stores electricity
- ☐ uses electricity

17534

116

makes electricity

117

CHECK the parts below that make electricity:

- ☐ alternator
- ☐ battery
- ☐ generator
- ☐ starter motor

17535

117

alternator

generator

118

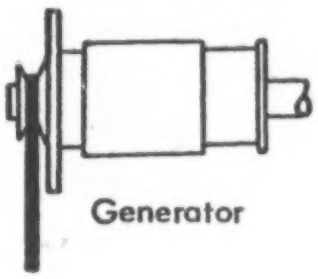

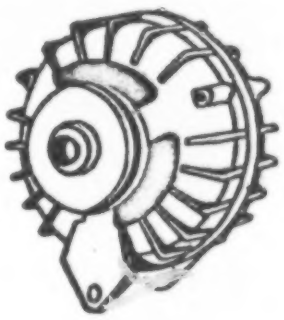

The diagrams show two parts that make electricity in a car.

One part is called a generator and the other part is called an _____ .

17536

118

alternator

119

Both the alternator and the generator make the same kind of electricity that the battery gives off.

Alternators produce:

- ☐ high voltage
- ☐ low voltage

17537

119

low voltage

120

In some cars electricity is made by a generator.

In others electricity is made by:

- ☐ an alternator
- ☐ the battery
- ☐ the turbine

17538

B. Related information

1. Occupations and requirements in the electrical and electronics field
2. Applications of electricity in the home and industry
3. The manufacture of electrical supplies and appliances
4. History of artificial illumination
5. Communications and the space age
6. Factors affecting rates of electrical service
7. Opportunities in the Armed Services

Suggested Tools and Equipment

A. Tools

In addition to the tools normally available in a general shop, the following are required:

1. Needle-nose pliers
2. Lineman's pliers
3. Basic meter assortment
4. Watt-hour meter
5. Transformers
6. Circuit testers
7. Relays
8. Magnets
9. Hydrometer
10. Direct current power supply
11. Compasses
12. Battery charger
13. Storage battery
14. Dry cells
15. Switches
16. Surface mount light fixtures
17. Small AC and DC motors
18. Resistor and capacitor assortment
19. Receptacles
20. Glass and hard rubber rod
21. Buzzers and bells
22. Switchboard
23. Rectifier

Materials

A. Wire, various sizes and types
B. Screws and nuts
C. Battery clips
D. Alligator clips
E. Solder, rosin core
F. Solderless connections
G. Staples
H. Electrician's tape
I. Bulbs, assorted
J. Fuses, assorted
K. Wool cloth
M. Fahnestock clips

Safety Precautions

Electricity is a potentially lethal force and must, therefore, be treated with the utmost respect. All high voltage terminals should either be thoroughly insulated or difficult in access. Students should be thoroughly grounded in safety practices, and they should be restricted to experiments involving less than 50 volts until they show by their actions that they have developed a respectful attitude toward electricity. The following precautions are peculiar to this activity and must be observed in the shop and at home.

A. Portable heating appliances must be disconnected before leaving them.
B. Observe first aid procedures when handling victims of electrical shock.
C. Determine the cause of a blown fuse or open circuit breaker before replacing the fuse or resetting breaker.
D. Be aware of conditions that cause electrical accidents.
E. Observe safety rules when testing circuits. When working on a circuit, turn the power off.

1751

252 OF 327

ED

056 238

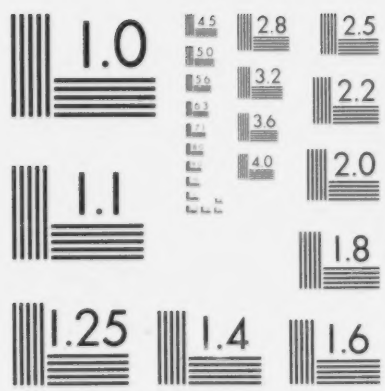

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

120

an alternator

121

An alternator makes _____ .

17539

258

121

electricity

122

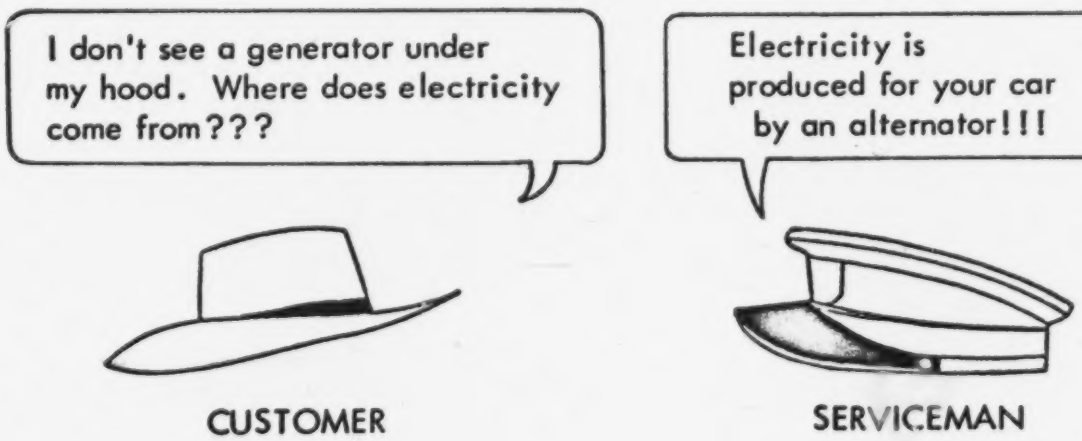

Do you think the serviceman's answer could be correct?

- ☐ yes
- ☐ no

17540

122

yes

123

When the battery is low, it:

- ☐ must be charged
- ☐ need not be charged

17541

123

must be charged

124

Which battery should be charged?

- ☐ a dead battery
- ☐ a high battery
- ☐ a low battery

17542

124

a low battery

125

When the engine turns the fan belt, the fan belt turns the generator.

When the engine runs slowly, the fan belt slowly turns the

_____ .

17543

125

generator

126

The engine turns the fan belt.

The fan belt turns the:

- ☐ battery
- ☐ generator
- ☐ voltage regulator

126

generator

127

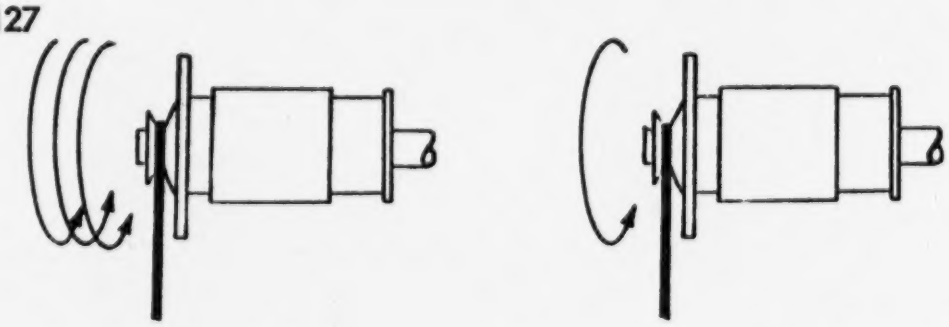

A B

The generator shown in picture A produces more electricity than the generator in picture B.

Which generator makes more electricity?

- ☐ a fast generator
- ☐ a slow generator

17545

127

a fast generator

128

When the generator turns fast, it produces a:

- ☐ strong electric current
- ☐ weak electric current

128

strong electric current

129

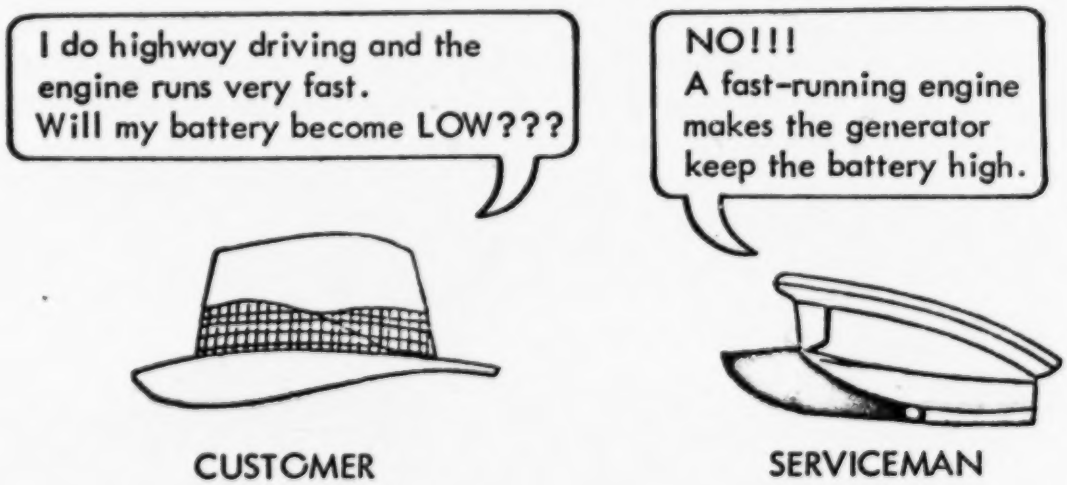

Is the serviceman giving the customer correct information?

- ☐ yes
- ☐ no

17547

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the student increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

POWER MECHANICS AND TRANSPORTATION

Purpose

This course in power mechanics involves an exploration of engines which convert fuel or heat into useful power. Experiences are divided between laboratory-type and live jobs. Although planned as an industrial arts course for general education purposes, it also serves as a prevocational experience for boys seeking a vocational interest. The suggested material should be considered the minimum outline for a school year of 36 weeks. Shorter courses may be organized by selecting a limited number of learning units from this content.

Specific Objectives

A. To develop a degree of skill in the use and care of common and special hand tools, instruments, and equipment used in the power laboratory.

B. To explore the construction and operating principles of all power engines, including steam, rocket, jet, diesel and gas.

C. To explore and develop a degree of skill in the diagnosis, maintenance, repair, and rebuilding of units, with emphasis of small gas engines.

D. To make the student aware of the important contributions power has made in the development of our country.

E. To develop an appreciation of the contributions of allied industries.

Suggested Content

A. Manipulative and technical

1. Identification of common tools
2. Correct use and care of precision instruments
3. Correct use and care of tools
4. Identification of engine components
5. Basic operating principles
6. Various power applications
7. Characteristics and functions of:
   a. Heat engines
   b. Fuel systems
   c. Intake system
   d. Exhaust system
   e. Lubrication system
   f. Cooling system
   g. Ignition system
   h. Electrical system
8. Techniques of identifying engine malfunction
9. Making job estimates
10. Planning orderly work procedures
11. Correcting engine malfunctions
12. Selecting replacement parts
13. Causes of lubricating oil contamination
14. Types and purposes of thrust and anti-friction
15. Electron theory or electrical current flow
16. Various starting systems
17. Testing compression

129

yes

130

A car is run at high speed for long distances.

This means the battery will probably be:

- ☐ high
- ☐ low

17548

130

high

131

LOOK AT PANEL 1

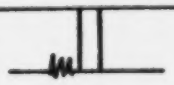

Wires go from the generator to the _____ .

17549

131

voltage regulator

132

LOOK AT PANEL 1

What connects the voltage regulator to the generator?

_____

17550

132

(2) wires

133

If the battery is fully charged, it:

- ☐ does not need the electricity made by the generator
- ☐ needs the electricity made by the generator

17551

133

does not need the electricity made by the generator

134

The voltage regulator has points inside of it.

The points act just like a switch.

When the points touch each other, the circuit is closed and electricity:

- ☐ will flow through the voltage regulator
- ☐ will not flow through the voltage regulator

17552

134

will flow through the voltage regulator

135

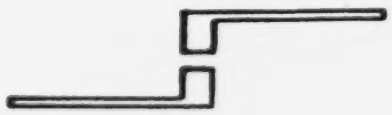

open contact point

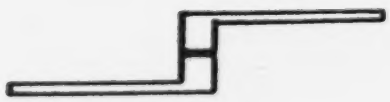

closed contact point

A contact point works like a switch inside the voltage regulator.

When the contact point is open, the electricity (☐ will ☐ will not) pass through the contact point.

17553

135

will not (pass)

136

closed contact point

The electricity (☐ will pass ☐ will not pass) through the contact point shown above.

17554

136

will pass

137

Electricity from the generator goes through the voltage regulator when the regulator's contact points are:

- ☐ open
- ☐ closed

17555

137

closed

138

Battery	Voltage Regulator
low	closes
high	opens

When the battery is high, the voltage regulator automatically _____ .

17556

138

opens

139

When the battery is low, the voltage regulator:

- ☐ opens
- ☐ closes

and the electricity:

- ☐ flows to the battery
- ☐ does not flow to the battery

17557

B. Related information

1. Occupations in the power industries
2. Employment opportunities
3. Principles of public relations
4. The selection of hand tools
5. The selection of power tools
6. Production processes
7. Rebuilt parts and units
8. Kinds of lubricants
9. Fuel refining processes
10. Kinds of fuels
11. Purpose of lubricants
12. Lubricant refining processes
13. Principles of science applied by:
    a. The air cooling system
    b. The water cooling system
    c. The fuel system

<u>Suggested Tools and Equipment</u>

A. Hand Tools

1. Calipers
    a. Inside diameter, 6"
    b. Outside diameter, 6"
    c. Vernier, combination, 8"
    d. Vernier, combination, 4"
2. Chisel set
3. Flaring tool for tubing
4. Guages
    a. Thickness, .002 to .035
    b. Wire, spark plug
5. Hammers
    a. 12 oz. ball peen
    b. 24 oz. ball peen
    c. Small brass head
    d. Soft faced head
6. Files
7. Putty knives
8. Micrometers
    a. Outside diameter, sizes 0-1",1-2"3-4",4-5"
    b. Inside diameter, range 2-9 1/2"
    c. Taper
9. Oiler, 5 oz., plunger type
10. Oil stone
11. Oil measure
12. Oil can opener-dispenser
13. Oil suction gun

139

closes

flows to the battery

140

The voltage regulator closes when the battery is:

- ☐ high
- ☐ low

The battery will then:

- ☐ be charged by the generator
- ☐ be discharged by the generator
- ☐ go dead

17558

140

low

get charged by the generator

141

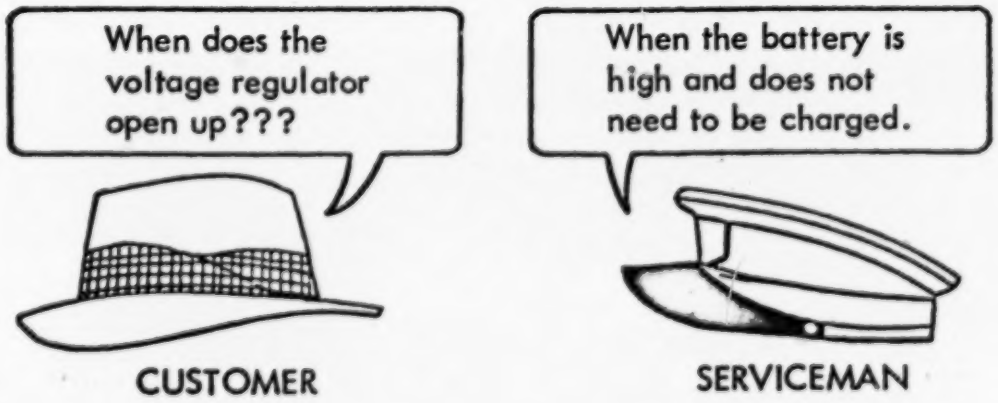

Is the serviceman's answer correct?

- ☐ yes
- ☐ no

17559

141

yes

142

A voltage regulator:

- ☐ charges the generator
- ☐ stops and starts the flow of electricity from the generator to the battery

17560

142

stops and starts the flow of electricity from the generator to the battery

143

The flow of electricity from the generator to the battery is regulated by the _____ _____ .

17561

143

voltage regulator

144

What does the voltage regulator do to the flow of electricity?

- ☐ nothing
- ☐ regulates it

17562

144

regulates it

145

To keep the battery at the proper charge, the voltage regulator controls the flow of _____ .

145

electricity

146

A voltage regulator is used to control the _____ of _____ .

17564

146

flow

electricity

147

Electricity going through the voltage regulator is:

- ☐ high voltage
- ☐ low voltage

The generator, voltage regulator and the battery are part of the _____ circuit.

147

low voltage

primary

148

CHECK the circuits below that are in the primary circuit:

- ☐ generator circuit
- ☐ spark plug circuit
- ☐ starter circuit

17566

148

generator circuit

starter circuit

149

The voltage regulator opens and closes the circuit coming from the _____ .

The starter motor switch opens and closes the circuit going to the _____ .

The circuit going to the ignition coil is opened and closed by the _____ .

17567

14. Pliers
    a. Utility
    b. Tapered flat nose (duck bill)
    c. Channel-lock type
    d. Diagonal cutter mechanics
    e. Pointed nose
    f. Vise-grip
    g. Lick-ring expander
15. Punches
    a. Drive pin, 8' set
    b. Center, assortment
16. Pules, machinist
17. Hack saws
18. Scredrivers, blade assortment
19. Screw extractor, set
20. Tin snips
21. Electric soldering iron
22. Taps and dies
    a. Machine screw
    b. National course
    c. National fine
    d. Standard pipe, 1/8, 1/4, 3/8'
23. Wrenches
    a. Adjustable open end set
    b. Pipe, 10'
    c. Box hexagonal, offset, 3/16 through 7/16'
    d. Box hexagonal, offset, 1/4 through 1 1/4'
    e. Open end, 1/4 through 1'
    f. Combination box and open end, 3/8 through 1'
    g. Ignition, open end, 13/64 through 5/16'
    h. Socket set, including sliding 'T', flex, and speed handles, rachets, short, medium, and long drive extensions, and universal joints:
        (1) 1/2' square drive, 7/16 through 1 1/4'
        (2) 3/8' square drive, 3/8 through 3/4'
        (3) 1/4' square drive, (optional)
        (4) 3/4' square drive, (optional)
    i. Torque, 1/2' square drive
    j. Tappet, 7/16 x 1/2', 1/2 x 9/16', 9/16 x 5/8'
    k. Socket set, spark plug
    l. Socket set, deep 1/2' square drive
    m. Magnetic finger, 1 short and 1 long
    n. Allen wrenches, set

B. Equipment
    1. Air compressor
    2. Aligning jig for connecting rods
    3. Arbor press
    4. Battery equipment
        a. Battery, storage 6 volt
        b. Battery, storage 12 volt
        c. Battery charge, tube rectifier type, 6 amp

149

generator

starter motor

ignition switch

150

CHECK every part that is in the primary circuit:

- ☐ battery
- ☐ distributor
- ☐ generator
- ☐ spark plugs
- ☐ starter motor
- ☐ starter motor switch
- ☐ voltage regulator

150

battery

generator

starter motor

starter motor switch

voltage regulator

151

NAME the part that stores and gives off electricity:

_____

17569

151

battery

152

A battery that has lots of electricity is said to be:

- ☐ a low battery
- ☐ a dead battery
- ☐ fully charged

152

fully charged

153

A battery that is low must be _____ .

The part that does this job is the _____ .

17571

153

charged

generator

154

If a battery is fully charged, it:

- ☐ should be recharged
- ☐ should not be charged

The part that controls the flow of electricity from the generator into the battery is the _____ .

17572

154

should not be charged

voltage regulator

155

NAME the part that makes electricity:

_____

The part that stops the flow of electricity to the battery when the battery is fully charged is the _____ .

17573

155

generator

voltage regulator

156

The part that starts the engine running is the _____ .

156

starter motor

157

The part that closes the circuit to the starter motor is the

_____ .

17575

157

starter motor switch

158

The primary circuit and the secondary circuit come together at the:

- ☐ distributor
- ☐ ignition coil
- ☐ generator

158

ignition coil

159

Electricity coming out of the ignition coil is high voltage.

Electricity going into the ignition coil is _____ voltage.

17577

d. Battery charge, fast charge type
e. Battery hydrometer
f. Battery cell tester
g. Battery carrier strap
h. Battery water dispenser
i. Battery storage rack with rubber or plastic mat

5. Benches
   a. Permanent with vises
   b. Portable
   c. Test equipment
6. Containers
   a. Safety gasoline can
   b. Oil drain pan
   c. Covered waste can
   d. Drain
7. Cleaning equipment
   a. Air blow gun
   b. Air-kerosene spray gun
   c. Air-hot water spray gun
   d. Ring groove cleaner
   e. Parts vat
   f. Carburetor vat
   g. Spark plug cleaner and tester
8. Creepers
9. Drills
   a. Electric portable
   b. Drill press
   c. Twist drill set, high speed
10. Engine lifting equipment
    a. Chair hoist with overhead trolley and monorail
    b. Portable engine life
11. Engine support stands
12. Guages
    a. Cylinder, dial indicator
    b. Compressor
13. Bench grinders
14. Growler, armature
15. Honers
    a. Cylinder
    b. Bushing (piston, etc.)
    c. Brake cylinder hone
16. Jacks
    a. Floor, hydraulic type (3 to 5 ton)
    b. Hand, hydraulic type (2 to 5 ton)
    c. Bumper, hydraulic
17. Meters
    a. Starter load
    b. Volt, (12-20 volt rating)
    c. Ammeter, (40-50 amp capacity)

159

low

160

The circuit going to the ignition coil is opened and closed by the:

- ☐ ignition switch
- ☐ starter motor switch
- ☐ voltage regulator

17578

160

ignition switch

161

When the ignition switch is turned to the "on" position, electricity reaches the _____ .

17579

161

ignition coil

162

When the ignition key is turned to the "start" position, the circuit is closed to the _____ switch.

When this happens, what will the starter motor do?

_____

162

starter motor

start the engine running

163

THIS IS THE END OF BOOK 4

17581

AUTO MECHANICS COURSE

POST-TEST BOOK 4: AUTOMOTIVE ELECTRICAL SYSTEMS
PART I

A BASIC SYSTEMS PROGRAM

17582

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

The low-voltage circuit is separated from the high-voltage circuit by the _____ _____.

Low voltage goes through the (☐ primary ☐ secondary) circuit.

2

Electricity is stored and given off by the _____.

3

When electricity leaves the generator, it first flows through the _____ _____.

4

When the ignition key is turned to the "on" position, electricity (☐ will ☐ will not) reach the ignition coil.

5

If you want to start the engine running, you should turn the ignition key to the _____ position.

6

The part that starts the engine running is the _____ _____ .

7

When the battery is fully charged, the points in the voltage regulator (☐ open ☐ close) and stop the flow of electricity to the battery.

8

The generator and the starter are both in the (☐ primary ☐ secondary) circuit.

9

The starter motor switch closes the circuit to the _____ _____ .

10

When the ignition key is turned to the "off" position, electricity (☐ will ☐ will not) reach the ignition coil.

17585

PANEL BOOK 4

To Be Used With
BOOK 4

AUTO MECHANICS COURSE

PANEL BOOK 4: AUTOMOTIVE ELECTRICAL SYSTEMS

PART I

A BASIC SYSTEMS PROGRAM

17586

18. Ring compressors and expanders
19. Ridge reamers
20. Spring tension scales, brush and point
21. Stands
    a. Engine build-up
    b. Vehicle stands
    c. Live engine
22. Testers
    a. Coil
    b. Condenser
    c. Power light (synchroscope)
    d. Valve spring
23. Trouble lights and cord assemblies
24. Valve reconditioning equipment
    a. Valve sorfacer
    b. Valve and seat grinder
    c. Valve spring compressor for L head engines
    d. Valve spring compressor for overhead valve assemblies
25. Puller
    a. Gear, combination set
    b. Bushing driver set, small
    c. Bearing
    d. Bushing driver set, camshaft

<u>Materials</u>

A. Blades, hack saw, 12'
B. Brushes
    1. Flat, parts cleaning
    2. Steel, hand
    3. Steel, 6' diameter, power
    4. Bench
C. Cleaning cloths
D. Cleaning solvent
    1. Parts
    2. Carburetor
E. Cleaning compound
F. Aluminum oxide cloth
G. Floor sweep and cleaner
    1. Dry saw dust
    2. Commercial oil spot romover
    3. Blade scraper
H. Gasoline
I. Gasket cement

VT 013 127
Auto Mechanics Course. Book 5: Automotive Electrical System, PartII.

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YMCA of Greater New York, Brooklyn, N.Y.
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IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on automotive electrical systems, Part II, was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 127

ED0 56238

BOOK 5

To Be Used With
PANEL BOOK 5

(C)

AUTO MECHANICS COURSE

BOOK 5: AUTOMOTIVE ELECTRICAL SYSTEM
PART II

A BASIC SYSTEMS PROGRAM

VT013127

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Curriculum Report Reference
Page 13

Task Analysis Reference
11

17589

AUTO MECHANICS COURSE

BOOK 5: AUTOMOTIVE ELECTRICAL SYSTEM

PART II

Developed under the Manpower Development and Training Act of 1962 (PL 87-416), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

17590

1

Electricity is stored and given off by the _____.

2

NAME the part that is in both the primary circuit and the secondary circuit. _____

3

The part of the ignition system that sparks the gasoline is called the _____.

4

Electricity reaches the ignition coil when the key is turned to the _____ position.

5

The starter circuit is closed by the _____ _____ switch.

6

What kind of voltage do the spark plugs use? _____ _____

7

The part that distributes electricity to the spark plugs is called the _____.

8

NAME the part that makes electricity. _____

9

When the battery is getting more electricity than it is giving out, we say that the battery is being _____.

10

Which parts of the electrical system are screwed into the engine?

_____ _____

Name _____

Date _____

Starting time _____

Finishing time _____

17593

1

Electricity is stored and given off by the _____.

17594

1

battery

2

Parts in the primary circuit:

- ☐ keep the car running
- ☐ make electricity
- ☐ start the engine

17595

2

make electricity

start the engine

3

The starter motor switch closes the circuit to the:

- ☐ generator
- ☐ ignition coil
- ☐ starter motor

What will then happen to the engine? _____

17596

3

starter motor

It will start running.

4

A battery that has little electricity in it must be:

- ☐ charged
- ☐ discharged
- ☐ left alone

HOME MAINTENANCE

Purpose

Fundamentals learned in other areas of industrial arts are easily adapted to home mechanics. The difference is in the emphasis. Home mechanics, as the name implies, emphasizes the solution of problems found in and around the home. It points to the non-vocational nature of industrial arts and accents its place in general education. Segments of this course could be beneficially used for a course in 'industrial Arts for Girls'.

Specific Objectives

A. To develop in boys and girls the interest and ability to solve problems common to home maintenance and repair.

B. To develop the ability to use and care for common household tools.

C. To develop in the student a feeling of pride and responsibility concerning his home and its equipment.

D. To develop a better understanding of the physical environment in the home.

E. To develop the ability to select, purchase, and care for materials used in the home.

F. To develop an appreciation for good habits of health and safety in the home.

Suggested Content

A. Manipulative and Technical

1. Planning
   a. Sketch and reading detailed drawings
   b. Building codes and regulations
   c. Estimating building costs
   d. Kinds of construction
2. Carpentry
   a. Repair windows and doors
   b. Repair and refinish floors
   c. Install caulking, insulation and weather stripping
   d. Roof repairs
3. Electricity
   a. Low voltage bell, buzzers, and thermostats
   b. Repair and replace light switches
   c. Repair and replace extension and appliance cords
   d. Fuses and circuit breakers
   e. Transformers
   f. Maintaining electric motors
   g. Reading a watt-hour meter and computing costs
   h. City and state electrical codes
   i. Replacing heating elements
   j. Series and parallel lighting circuits
4. Plumbing
   a. Plumbing codes and regulations
   b. Repairing faucets, valves and drains
   c. Pipes and fittings
   d. Reading water meters and computing costs
5. Finishing and decorating
   a. Exterior and interior finishes

4

charged

5

NAME the part that charges the battery: _____

17598

5

generator

6

Electricity does not flow into the battery when the battery is fully charged. The part that stops the flow of electricity to the battery is the _____.

17599

6

voltage regulator

7

When the battery is low, the voltage regulator closes and electricity

- ☐ flows into the battery
- ☐ does not flow into the battery
- ☐ stays where it is

7

flows into the battery

8

For electricity to get to the ignition coil, it must first flow through the _____.

This will happen when the key is turned to the

- ☐ on position
- ☐ off position
- ☐ start position

8

ignition switch

on position

9

NAME the part that closes the starter circuit:

_____

When this happens, what will the starter motor do?

_____

9

starter motor switch

It will start the engine running.

10

For the starter motor switch to close the starter circuit, the key in the ignition switch must be turned to the _____ position.

10

start

11

The generator circuit and the starter circuit are both:

- ☐ high voltage
- ☐ low voltage

11

low voltage

12

Low voltage is carried by the primary circuit. High voltage is carried by the _____.

12

secondary circuit

13

What kind of voltage does the generator make?

_____

When electricity goes into the battery, it is _____ voltage.

17606

13

low voltage

low

14

The primary circuit ends at the ignition coil.

Where does this circuit begin? _____

17607

b. Application of finishes
c. Removers, sealers and bleaches
d. Mixing colors
e. Care of brushes and other equipment
f. Cutting and glazing glass
g. Hanging wall paper

6. Masonry
a. Building forms
b. Mixing concrete, mortar, and plaster
c. Laying brick, block and stone
d. Repairing plaster
e. Repairing and replacing tile

B. Related Information
1. Lumber grades and prices
2. Preserving and protecting wood
3. Common fasteners
4. Common abrasives
5. Cost considerations
6. Basic first aid
7. Effects of moisture on materials
8. Manufacture of plywood
9. Manufacture of electrical and plumbing materials
10. General up-keep and neatness of a home

Suggested Tools and Equipment

Lists of necessary tools and equipment for many of the sub-units in home mechanics will be found in the corresponding units in the Guide. Supplementary information will be available in selected references for this unit. The following are lists of suggested tools and equipment for sub-units not included elsewhere in the Guide.

A. Plumbing
1. Pipe vise
2. Peip wrenches, 10", 12", and 14"
3. Adjustable wrenches, 12", 14"
4. Propane torch
5. Screw drivers
6. So;dering coppers
7. Hole saws
8. Pipe cutters, #1, #2
9. Valve seat dressing tool
10. Plumber's friend
11. Tubing cutter
12. Tube flanging tool

B. Masonry
1. Mortar Box
2. Mortar Board
3. Sand Screen
4. Mixing hoe
5. Hod

1758

14

battery

15

The primary circuit is opened and closed by the _____ switch.

17608

253 OF 327

ED

056 238

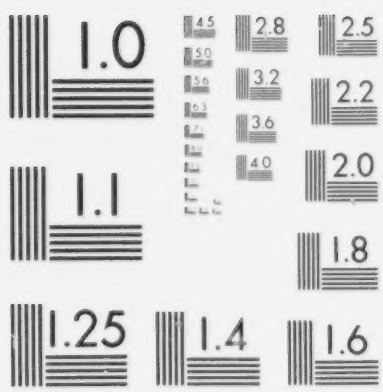

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

15

ignition

16

What part does the starter motor switch turn on and off?

_____

17609

16

starter motor

17

When the ignition switch closes the starter circuit, does electricity reach the starter motor switch?

- ☐ yes
- ☐ no

17610

17

yes

18

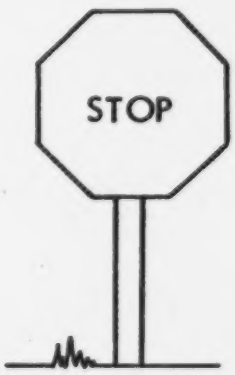

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

17611

18

NO ANSWER NEEDED

19

LOOK AT PANEL 1

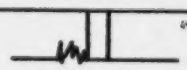

Electricity made by the generator goes through the voltage regulator.

It then flows through the _____.

17612

19

ammeter

20

A battery that is very low will have:

- ☐ much electricity flowing into it
- ☐ little electricity flowing into it
- ☐ no electricity flowing into it

17613

20

much electricity flowing into it

21

LOOK AT PANEL 1

Before electricity flows into the battery, it flows through a meter. This meter is called the _____.

17614

21

ammeter

22

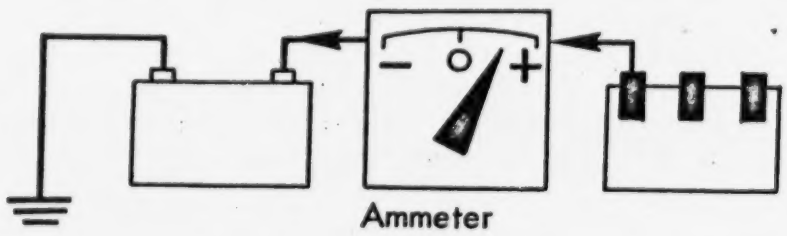

Electricity goes through the ammeter.

Where does it come from?

- ☐ battery
- ☐ voltage regulator

17615

22

voltage regulator

23

When more electricity is flowing out of the battery than is being put into the battery, you say that the battery is:

- ☐ charging
- ☐ discharging
- ☐ resting

17616

6. Brick trowel
7. Plastering trowel
8. Cement finishing trowel
9. Pointed trowel
10. Plumb rule, 48"
11. Brick hammer
12. Jointer tools
13. Terra-cotta chisels
14. Line blocks
15. Line
16. Steel rule
17. Steel square
18. Hawk
19. Tile nipper
20. Tile cutter
21. Rubbing stone
22. Straight edge

Safety Precautions

A. Use machines only after proper instruction.
B. Wear safety goggles or face guard when using cutting or grinding tools.
C. Keep safety devices on machines at all times.
D. Use sharp edged tools properly and with caution.
E. Protect the hands, feet, face, and body when using hot tools or materials.
F. Check all scaffolding before using.
G. Keep shop work area free from scraps and debris.
H. When making electrical repairs be sure to turn off the electrical power.

Materials

As in the case of tools and equipment, materials for many sub-units in home mechanics are included in corresponding units elsewhere in the Guide. Exceptions follow:

A. Plumbing
   1. Pipe and fittings
   2. Copper tubing and fittings
   3. Solder
   4. Flux
   5. Pipe joint compound
   6. Faucet washers and packing
B. Masonry
   1. Brick, concrete blocks, field stone
   2. Cement
   3. Sand and gravel
   4. Lime or prepared mortar mix
   5. Plaster of Paris
   6. Gypsum plaster
   7. Plaster or ceramic tile
   8. Tile mastic
   9. Grout, white

23

discharging

24

When more electricity is flowing <u>into</u> the battery than out of it, you say that the battery is being:

- ☐ charged
- ☐ discharged
- ☐ rested

24

charged

25

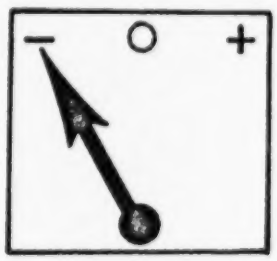

AMMETER

The job of the ammeter is to show if electricity is flowing into or out of the battery.

When the battery is discharging, the needle on the ammeter points to the minus (–) side.

When the battery gets charged, the needle will:

- ☐ go to the plus (+) side
- ☐ go to the zero (0) position
- ☐ stay at the minus (–) side

17618

25

go to the plus (+) side

26

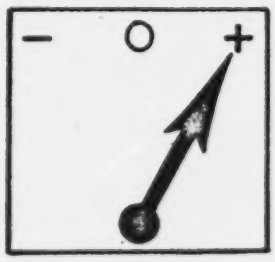

AMMETER

Which position is the ammeter needle pointing at?

- ☐ plus (+) side
- ☐ minus (−) side
- ☐ zero (0) position, off

This means that the battery is being:

- ☐ charged
- ☐ discharged

17619

26

plus (+) side

charged

27

Electricity leaving the voltage regulator goes through which meter?

_____

The needle on this meter will point to which side? _____

17620

27

ammeter

plus <u>or</u> +

28

The battery is fully charged and does not need the electricity made by the generator. The points in the voltage regulator open up and electricity:

- ☐ will flow through to the battery
- ☐ will not flow through to the battery

28

will not flow through to the battery

29

NAME the meter that shows the flow of electricity in and out of the battery. _____

29

ammeter

30

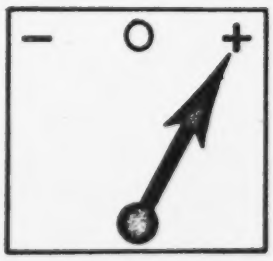

A

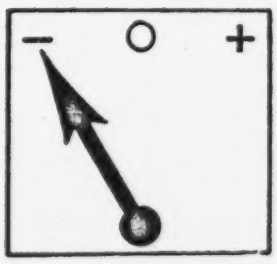

B

Which ammeter shows the battery being charged? _____

Which ammeter shows the points in the voltage regulator open? _____

Which ammeter shows the battery discharging? _____

17623

30

A

B

B

31

When the battery is getting weaker, the ammeter needle points to the:

- ☐ + side
- ☐ - side
- ☐ 0

When this happens, the battery is:

- ☐ charging
- ☐ discharging

17624

31

- side

discharging

32

A charging battery becomes:

☐ stronger

☐ weaker

Which side will the ammeter needle then point to? _____

17625

32

stronger

plus <u>or</u> +

33

An ammeter shows if a battery is getting stronger or weaker.

A charging battery is getting _____.

A battery that is getting weaker is said to be _____.

Suggested Projects

Working drawings
Bill of materials and cost estimating
Make and fit handles in tools
Repair a window screen
Hand or repair a door
Repair a floor or a roof
Window box
Garden trellis
Wire push button and buzzer in series
Wire push button and buzzer in parallel circuit
Wirt two push buttons and one buzzer
Repair and replace a heating unit
Install a bell transformer
Repair a faucet
Clean a drain trap
Figure a water bill
Set forms and pour concrete
Repair concrete sidewalk or steps
Concrete flags
Repoint a brick or block wall
Brick incinerator
Patch a plastered wall
Replace a loose brick
Plaster a block wall

1760

33

stronger

discharging

34

An ammeter is used to show if a battery is _____ or _____.

17627

34

charging

discharging

35

What shows a battery charging or discharging? _____

17628

35

ammeter

36

What is the job of an ammeter? _____

36

to show if a battery is charging
or discharging

37

Voltage going through the ammeter is _____ voltage.

17630

37

low

38

Which part makes electricity for the battery? _____

17631

38

generator

39

Electricity is stored and given off by the _____.

39

battery

40

The part that controls the flow of electricity into the battery is the

_____.

The flow of electricity into and out of the battery is shown on the

_____.

17633

40

voltage regulator

ammeter

41

MATCH the following:

A. ammeter

B. battery

C. generator

D. voltage regulator

_____ controls the flow of electricity

_____ makes electricity

_____ shows if battery is charging or discharging

_____ stores and gives off electricity

41

D

C

A

B

42

The starter circuit and the generator circuit are:

- ☐ high voltage
- ☐ low voltage

17635

42

low voltage

43

CHECK the jobs of the primary circuit:

- ☐ keep the engine running
- ☐ make electricity
- ☐ start the engine running

17636

GRAPHIC ARTS

Graphic arts is a broad term used widely in industry to describe printing and allied crafts. Graphic arts, one of the ten leading industries in theUnited States, is offered in industrial arts programs in a variety of combinations. In this guide the units are confined to three of the most common areas -- bookbinding, letterpress printing, and screen process printing.

General Objectives

To develop an understanding of the contributions made to business, industry, education, and the professions by the grapphic arts field.

To provide an opportunity to develop a background of knowledge and skills leading to the intelligent selection of an avocational interest.

To develop an awareness of the many occupational opportunities in the graphic arts and allied fields.

To develop the ability to recognize and appreciate good typo-graphical design, a well-printed product, and the craftsmanship involved in the producing of the product.

To develop the ability to plan in an intelligent manner and produce work that meets accepted standards.

To become familiar with the related graphic arts process of screen process printing, bookbinding, rubber stamp making, and their application in business and industry.

Purpose

The most common type of printing taught in the public schools today is letterpress or relief printing. The printing is accomplished from a raised surface. The common rubber stamp is a typical example of this type of printing.

Specific Objectives

A. To develop the student's ability to use the technical terms of the printer.
B. To develop the ability to recognize and appreciate good typographical design and a well-printed product.
C. To develop safe work habits
D. To develop the ability to plan, to design, and to follow copy.

Suggested Content

A. Manipulative and Technical
   1. Lay of the type cases
   2. Layout and design of jobs
   3. Setting type
   4. Proofreaders' marks
   5. Use of spacing material
   6. Typing forms
   7. Proofing and correcting a form
   8. Distributing type and spacing material
   9. Setting various types of indentions
   10. Inposing and locking up a form
   11. Press maintenance

43

make electricity

start the engine running

44

The primary circuit ends at the:

- ☐ distributor
- ☐ ignition coil
- ☐ starter motor

44

ignition coil

45

LOOK AT PANEL 1

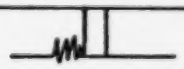

Which circuit begins at the ignition coil? _____

17638

45

secondary circuit

46

Parts in the secondary circuit keep the engine running.

To keep the engine running, _____ voltage is needed.

17639

46

high

47

The primary circuit ends and the secondary circuit begins at the

_____.

17640

47

ignition coil

48

Low voltage goes into the ignition coil and _____ voltage comes out of it.

17641

48

high

49

By going through the ignition coil, voltage is:

- ☐ made larger
- ☐ made smaller
- ☐ kept the same

17642

49

made larger

50

Which part of the automobile's electrical system makes voltage higher? _____

17643

50

ignition coil

51

The ignition coil changes _____ voltage to _____ voltage.

51

low

high

52

The engine needs high voltage to keep running. This is made by the _____.

17645

52

ignition coil

53

Which switch closes the circuit to the ignition coil?

_____

In what position will it be?

- ☐ off
- ☐ on
- ☐ neither

12. Inking, making ready, feeding and cleaning presses
13. Cutting paper
14. Thermographic printing
15. Design of type faces
16. Balance and symmetry
17. Basic sizes and weights of paper
18. Processes of line casting machines
19. Comparison of various printing processes
20. Designing and making rubber stamps
21. Wage scales of various operations in a printing shop
22. Processes of stereotyping, mat-making, and other forms of plate making.

B. Related Information

1. Occupations and requirements in the graphic arts industry
2. Employment opportunities
3. Labor unions in the graphic arts industry
4. Selection of equipment
5. History of paper, ink, printing, presses, etc.
6. Multicolor printing
7. The printing of newspapers and periodicals.

Suggested Tools and Equipment

A. Line gauges
B. Composing sticks
C. Benzine cans
D. Galleys
E. Quoins
F. Quoin key
G. Assorted cases (type, rule, space)
H. Rawhide mallet
I. Type and proof planners
J. Proof press brayer
K. Font of wooden furniture
L. Font of reglets
M. Font of brass rule
N. Fonts of leaders
O. Platen presses of various sizes (complete)
P. Imposing stone with galley and furniture storage
Q. Proof press
R. Assorted wrenches, screw drivers and other hand tools
S. Type high gauge
T. Thermography equipment
U. Type cabinets
V. Lead and slug rack
W. Vulcanizing press

1762

53

ignition switch

on

54

Will electricity reach the ignition coil if the ignition switch is off?

- ☐ yes
- ☐ no

What kind of voltage flows through the ignition switch? _____

17647

54

no

low voltage

55

What does the ignition coil do? _____

17648

55

It changes low voltage to high voltage.

56

LOOK AT PANEL 1

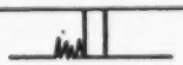

When high voltage comes out of the coil, it first reaches the:

- ☐ distributor
- ☐ spark plugs

57

high voltage

58

LOOK AT PANEL 1

The distributor sends the high voltage to the six _____ _____.

58

spark plugs

59

LOOK AT PANEL 1

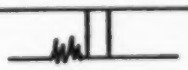

The distributor gets the high-voltage electricity from the

_____.

17652

59

ignition coil

60

For high voltage to get to the spark plugs from the ignition coil, it must go through the _____.

17653

60

distributor

61

The distributor: (CHECK TWO)

- ☐ gets electricity from the ignition coil
- ☐ makes high-voltage electricity
- ☐ sends electricity to the spark plugs
- ☐ sends electricity to the ignition switch

61

gets electricity from the ignition coil

sends electricity to the spark plugs

62

LOOK AT PANEL 1

How many wires go from the ignition coil to the distributor?

_____

How many wires go from the distributor to the spark plugs?

_____

17655

62

2

6

63

LOOK AT PANEL 1

To "distribute" means to split up and give something.

What does the distributor distribute? _____

What does it distribute it to? _____

17656

Safety Precautions

A. Avoid distractions when operating the press.

B. Keep both hands on the lever when operating the paper cutter.

C. Check grippers for clearance before turning on press.

D. Be aware of and know the dangers of working with volatile liquids.

E. Store soiled rags in a closed metal can.

F. The vulcanizing press is hot--exercise care when removing stamps.

Materials

a. gauge pins

B. Assorted sizes and styles of foundry type

C. Assorted sizes of spaces and quads

D. Various sizes, colors and weights of paper

E. Assorted colors of inks

F. Varnishes, reducers, etc., for inks

G. Chip board

H. Padding compound

I. Thermographic powder

K. Tympan paper

L. Sealing wax

M. String

N. Makeready paste

O. Type cleaner

P. Rubber stamp kits

Q. Ink pads and suitable ink

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributions to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

SCREEN PROCESS PRINTING

Purpose

Screen process printing is a fast growing, versatile phase of the graphic arts field. An introduction to this stencil technique of printing can be accomplished with inexpensive equipment.

Specific Objectives

A. To develop an awareness of the importance of screen process printing in industry.

B. To provide an opportunity for the students to work with the media that is incorporated into screen process printing.

C. To develop an appreciation of good design in screen process printing.

63

electricity or high voltage

spark plugs

64

The job of the distributor is to _____ high _____ electricity to the spark plugs.

17657

64

distribute <u>or</u> split up

voltage

65

What does the distributor give high-voltage electricity to?

_____

17658

65

spark plugs

66

NAME the part that distributes electricity to the spark plugs.

_____

Where does it get the electricity from? _____

17659

66

distributor

ignition coil

67

What does the distributor do? _____

17660

67

It gives high-voltage electricity to the spark plugs.

68

The primary circuit starts the car and makes electricity. The engine needs the electricity of the secondary circuit to keep running.

What kind of voltage keeps the engine running? _____

17661

68

high voltage

69

LOOK AT PANEL 1

The parts that have threads on them are screwed into the engine.

Which parts have threads? _____

17662

69

spark plugs

70

The last parts of the secondary circuit are the _____.

17663

70

spark plugs

71

Just as a person uses "muscle" to get a job done, an automobile uses gasoline to keep the engine running.

A person burns up food when he uses energy.

An automobile engine burns up gasoline when it is running.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

71

NO ANSWER NEEDED

72

What kind of fuel does an automobile engine use?

_____

17665

72

gasoline

73

Gasoline must be burned in an automobile engine in order to keep the engine running.

You can light gasoline with a match or a spark.

Can you guess what part of the electrical system sparks the gasoline in an automobile engine? _____

17666

Suggested Content

A. Manipulative and technical
   1. Layout and design
   2. Materials and their effective use
   3. Mixing colors
   4. Method of screening design:
      a. Paper stencil method
      b. Tusche and glue method
      c. Direct photographic method
      d. Indirect photographic method
      e. Reverse color method
      f. Lacquer film stencil method
   5. Adhering design to silk screen
   6. Use and care of squeege
   7. Use and care of cutting knives
   8. Construction screen frames
   9. Blocking out:
      a. Paper
      b. Water soluble filler
      c. Shellac
   10. Cleaning frame and screen
   11. Making register guides
   12. Multicolor printing
   13. Preparing frame for printing
   14. Paper harmony
   15. Sketching appropriate designs for screen process
   16. Paper sizes, weights, and substances
   17. Paper cutting
   18. Material costs
   19. Color chart or wheel

B. Related Information
   1. Industrial uses of screen process printing
   2. Chemistry of substances used in screen process printing
   3. Commercial equipment
   4. Occupational information

Suggested Tools and Equipment

A. Cutting Knives
   1. Circle cutter
   2. Swivel cutter
   3. Bi-line cutter
   4. Film line cutter
   5. Straight stencil knife
B. Frames of various sizes
C. Rubber squeeges of various sizes
D. Stapler
E. Spatulas
F. India slipstone

73

spark plug

74

Spark plugs light the gasoline in the:

- ☐ engine
- ☐ ignition system
- ☐ primary circuit

This will keep the engine:

- ☐ from running
- ☐ running
- ☐ still

17667

74

engine

running

75

Spark plugs help keep the engine running by:

- ☐ giving it energy
- ☐ lighting the gasoline
- ☐ working it

17668

75

lighting the gasoline

76

If high voltage did NOT reach the spark plugs, there would be no spark.

In this event, which of the following are correct?

- ☐ then the engine could not run
- ☐ then the engine could not stop running

17669

76

then the engine could not run

77

When the spark plug makes a spark, the gasoline:

- ☐ will burn
- ☐ will not burn

17670

77

will burn

78

Gasoline in the engine will burn when it gets a:

- ☐ flame
- ☐ match
- ☐ spark

NAME the part that gives it. _____

17671

78

spark

spark plugs

79

The spark plugs give:

- ☐ a spark to burn gasoline
- ☐ electric current to the engine
- ☐ low voltage to the distributor

79

a spark to burn gasoline

80

Sparks from the spark plugs burn _____ in the engine.

17673

80

gasoline

81

Why are sparks from the spark plugs needed by the engine?

_____

17674

81

to burn gasoline

82

What do spark plugs do? _____

17675

82

They make a spark to burn gasoline.

83

Where do the spark plugs get electricity from? _____

What kind of voltage is this? _____

17676

G. Triangle
H. French curve
I. Art brushes
J. Rulers
K. Pieces of glass to be used as base for cutting stencil

Materials

A. Silk - general purpose, such as 12XX
B. Blocking-out agents
C. Inks of several colors
D. Various bases to add to ink for special effects
E. Solvents for stencil films
F. Clean cloths
G. Newspapers for cleaning up
H. Stencil film
I. Paper or cloth tape
J. Shellac
K. Masking tape
L. Showcard water colors
M. Scotch tape - regular
N. Scotch tape - two-sided adhesive
O. Liquid tusche
p. Lithographic pencils and crayons
Q. Drawing and art materials

Safety Precautions

A. Observe caution when using cutting tools.
B. Be aware of and know the dangers present when using a volatile fluid.

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributes to the attainment of caourse objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

83

distributor

high voltage

84

The distributor gets electricity from the _____ and gives it to the _____.

17677

84

ignition coil

spark plugs

85

The ignition coil changes _____ voltage to _____ voltage.

It then gives it to the _____.

17678

254 OF 327

ED

056 238

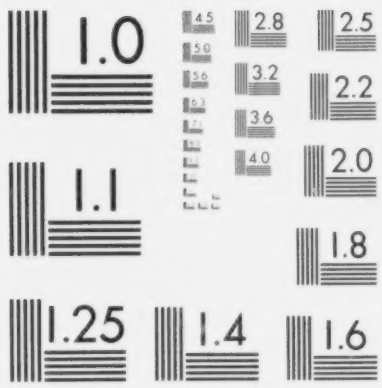

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

85

low

high

distributor

86

Where does the high-voltage electricity go to from the distributor?

_____

What do the spark plugs do? _____

17679

86

spark plugs

make a spark (to burn the gasoline)

87

Electricity reaches the ignition coil when the key in the ignition switch is turned to the _____ position.

87

on

88

Which is the only part of the automotive electrical system that is in both the primary circuit and the secondary circuit? _____

17681

88

ignition coil

89

What part changes low voltage to high voltage? _____

What kind of voltage goes through the ignition switch? _____

17682

89

ignition coil

low voltage

90

Electricity for the automotive electrical system starts out in the

_____.

17683

90

battery

91

When you want to start the engine running, you turn the key in the ignition switch to the _____ position.

17684

91

start

92

When you turn the key in the ignition switch to the start position, you are closing the circuit to the _____ _____ switch.

What will the starter motor then do? _____

17685

Suggested Content

A. Manipulative and technical
   1. Layout and design
   2. Materials and their effective use
   3. Mixing colors
   4. Method of screening design:
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      b. Tusche and glue method
      c. Direct photographic method
      d. Indirect photographic method
      e. Reverse color method
      f. Lacquer film stencil method
   5. Adhering design to silk screen
   6. Use and care of squeege
   7. Use and care of cutting knives
   8. Construction screen frames
   9. Blocking out:
      a. Paper
      b. Water soluble filler
      c. Shellac
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   19. Color chart or wheel

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   1. Circle cutter
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   4. Film line cutter
   5. Straight stencil knife
B. Frames of various sizes
C. Rubber squeeges of various sizes
D. Stapler
E. Spatulas
F. India slipstone

1766

92

starter motor

It will start the engine running.

93

The starter motor switch closes the circuit to the _____.

17686

93

starter motor

94

The starter circuit uses _____ voltage.

17687

94

low

95

Does a battery MAKE electricity?

- ☐ yes
- ☐ no

17688

95

no

96

NAME the part that does make electricity. _____

17689

96

generator

97

The flow of electricity from the generator to the battery is regulated by the _____ _____.

97

voltage regulator

98

If the battery is fully charged, it needs no more electricity.

The points in the voltage regulator will then:

- ☐ close
- ☐ open

When this happens:

- ☐ electricity will flow into the battery
- ☐ electricity will not flow into the battery

98

open

electricity will not flow into the battery

99

A battery that has much electricity:

- ☐ does not have to be charged
- ☐ has to be charged

When this happens, the flow of electricity will be stopped by the

_____ _____.

17692

99

does not have to be charged

voltage regulator

100

A battery that has very little electricity is said to be:

- ☐ charged
- ☐ discharged

100

discharged

101

A battery that is low must be _____.

Which part does this job? _____

17694

101

charged

generator

102

When the needle on an ammeter is facing to the minus (-) side, you know that the battery is:

- ☐ charging
- ☐ discharging

17695

G. Triangle
H. French curve
I. Art brushes
J. Rulers
K. Pieces of glass to be used as base for cutting stencil

Materials

A. Silk - general purpose, such as 12XX
B. Blocking-out agents
C. Inks of several colors
D. Various bases to add to ink for special effects
E. Solvents for stencil films
F. Clean cloths
G. Newspapers for cleaning up
H. Stencil film
I. Paper or cloth tape
J. Shellac
K. Masking tape
L. Showcard water colors
M. Scotch tape - regular
N. Scotch tape - two-sided adhesive
O. Liquid tusche
p. Lithographic pencils and crayons
Q. Drawing and art materials

Safety Precautions

A. Observe caution when using cutting tools.
B. Be aware of and know the dangers present when using a volatile fluid.

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributes to the attainment of caourse objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

102

discharging

103

When the battery is being charged, the needle on the ammeter will be facing to the _____ side.

17696

103

plus <u>or</u> +

104

The ammeter shows the flow of electricity into and out of the

_____.

17697

104

battery

105

CHECK every part that is in the secondary circuit:

- ☐ battery
- ☐ distributor
- ☐ ignition coil
- ☐ ignition switch
- ☐ spark plugs
- ☐ starter motor

105

distributor

ignition coil

spark plugs

106

CHECK the parts that are in the primary circuit:

- ☐ battery
- ☐ distributor
- ☐ generator
- ☐ ignition switch
- ☐ spark plugs
- ☐ starter motor switch

106

battery

generator

ignition switch

starter motor switch

107

The part that changes low voltage to high voltage is the _____.

17700

107

ignition coil

108

CHECK the parts that are in the primary circuit:

- ☐ ammeter
- ☐ distributor
- ☐ starter motor
- ☐ voltage regulator

17701

108

ammeter

starter motor

voltage regulator

109

CHECK the jobs done in the primary circuit:

- ☐ keep the engine running
- ☐ make electricity
- ☐ start the engine

17702

109

make electricity

start the engine

110

CHECK the job done by the secondary circuit:

- ☐ keep the engine running
- ☐ make electricity
- ☐ start the engine running

17703

110

keep the engine running

111

You have just completed BOOK 4 and BOOK 5.

These books taught you about the electrical circuits that:

- ☐ keep the engine running
- ☐ make electricity
- ☐ start the engine running

111

keep the engine running

make electricity

start the engine running

112

THIS IS THE END OF BOOK 5

17705

CRAFTS

Through the crafts area the student is introduced to several areas of industry. Knowledge and skills developed in working with crafts are transferable to other areas of industrial arts. Through these experiences the student will be a much better informer-consumer of the many products by industry that are a part of his daily life.

Ceramics, leather, art metals and wood carving are the areas included under the general heading of CRAFTS. Each could be offered separately, but a more desirable arrangement is to offer a general course permitting students to explore several of the areas.

General Objectives

To develop an appreciation of good design and craftsmanship in the crafts.

To create an avocational interest for leisure-time activities.

To give the student a general knowledge of the crafts products from a consumer's standpoint.

To acquaint the student with present day industrial methods.

To develop a degree of skill in working with tools, materials, and equipment used in crafts.

To develop a desire for creativity within the student.

CERAMICS

Purpose

Ceramics provides an ideal situation for experimentation and creative thinking at a small cost to the student. With little equipment and a creative mind, much can be accomplished in the way of originality of design.

Specific Objectives

A. To develop an avocational interest in the ceramics area
B. To develop an awareness of the materials and processes in the ceramics field
C. To develop an appreciation of good design, creative, and commercial in ceramics
D. To develop a degree of skill in the procedures and processes used in the ceramics area.

Suggested Content

A. Manipulative and Technical
   1. Terminology
   2. Working with clay
   3. Basic designs in ceramics
   4. Formulas for mixing clay bodies and glazes
   5. Making and using the plastic mold
   6. The potter's wheel and its techniques
   7. Creativity
   8. Operating the ceramic kiln
      a. Bisque
      b. Glaze ware
   9. Mixing, wedging, and preparing clay
   10. Jiggering

1768

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

Which part changes low voltage electricity to high voltage electricity?

_____ _____

2

What kind of voltage does the distributor get? _____ _____

3

The flow of electricity is shown on the _____.

4

Gasoline is exploded in the engine by _____ _____.

5

A battery that is low in electricity is said to be _____.

17707

6

The part that distributes electricity to the spark plugs is called the _____.

7

The starter motor circuit is closed by the _____ _____ switch.

8

What kind of voltage do the spark plugs use to explode the gasoline?

_____ _____

9

What part makes high voltage out of low voltage electricity?

_____ _____

10

The flow of electricity into the battery is regulated by the _____ _____.

PANEL BOOK 5

To Be Used With
BOOK 5

AUTO MECHANICS COURSE

BOOK 5: AUTOMOTIVE ELECTRICAL SYSTEM
PART II

A BASIC SYSTEMS PROGRAM

AUTOMOTIVE ELECTRICAL SYSTEM

17709

VT 013 128
Auto Mechanics Course. Book 6: Automotive Electrical Systems, Part III.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
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IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on automotive electrical systems, Part III, was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 128

17710

ED0 56238

BOOK 6

(C1)

AUTO MECHANICS COURSE

BOOK 6: AUTOMOTIVE ELECTRICAL SYSTEMS
PART III

A BASIC SYSTEMS PROGRAM

VT013128

Curriculum Report Reference
Page 13
Task Analysis Reference
11

17711

AUTO MECHANICS COURSE

BOOK 6: AUTOMOTIVE ELECTRICAL SYSTEMS
PART III

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

17712

AUTO MECHANICS COURSE

PRE-TEST BOOK 6: AUTOMOTIVE ELECTRICAL SYSTEMS

PART III

A BASIC SYSTEMS PROGRAM

17713

1

To turn on the low beam, how far out should you pull the headlight switch? _____

2

When parked at night at the side of the road, you should have your _____ lights turned on.

3

To change your low beam to the high beam, step on the _____ switch.

4

Cars behind you know that you are stopping your car when they see your _____ lights go on.

5

When you step on the brake pedal, which lights will go on? _____

17714

Name _____

Date _____

Starting time _____

Finishing time _____

17716

11. Dry press forming
12. Turning
13. Decorating ceramic pieces
    a. Colored slip
    b. Underglaze
    c. Overglaze
    d. Decals
    e. Raised and carved designs
14. Applying glazes
15. Making and using the one-and two-piece plaster molds
16. Using student-made and commercial molds

B. Related Information
1. Local clay deposits
2. Commercial uses of clay
3. History of the ceramics industry
4. Types of commonly used clays and their uses
5. Methods used in the ceramics industry
6. The glass industry
7. The portland cement industries

Suggested Tools and Equipment

A. Ceramic Kiln
B. Potters wheel
C. Metal containers for storing dry clay
D. Rust proof containers for storing wet clay
E. Containers for slip casting clay
F. Spray booth and stilts
G. Kiln shelves, supports and stilts
H. Purometric cones
I. Modeling wheels
J. Wedging board
K. Plaster bats
L. Plaster molds, mostly one piece
M. Scales
N. Sieves
O. Tables with waterproof tops
P. Sink facilities with hot/cold water and dirt trap
Q. Face masks
R. Steel and wooden modeling tools
S. Palette knives
T. Turning tools for potter's wheel
U. Small sponges
V. Wooden rollers for rolling clay
W. Wire and brush tools
X. Brushes
Y. Flexible scrapers
Z. Grindstones

Materials

A. Local clays, when possible
B. Modeling clay
D. Molding plaster
E. Matt and gloss glaze
F. Underglaze colors
G. Overglaze colors
H. Ceramic pencils
I. Decal pages
J. Stencils
k. kiln wash
L. Sandpaper and steel wool

1769

1

BOOK 4 and BOOK 5 taught you about the electrical system of an automobile.

CHECK the parts that were not taught in these books:

- ☐ ammeter
- ☐ fuses
- ☐ heater
- ☐ generator
- ☐ lights
- ☐ starter motor
- ☐ windshield wipers

1

fuses

heater

lights

windshield wipers

2

This book will teach you about the "extras" that use electricity in an automobile.

The automobile extras that you will learn about get electric power from the _____ .

17718

2

battery

3

Headlights are on the:

- ☐ back of the car
- ☐ front of the car

and tail lights are on the:

- ☐ back of the car
- ☐ front of the car

17719

3

front of the car

back of the car

4

To help you see while driving at night:

- ☐ headlights are used
- ☐ taillights are used

To help the cars in back of you to see your car:

- ☐ headlights are used
- ☐ taillights are used

17720

4

headlights are used

taillights are used

5

You use taillights and headlights while driving:

- ☐ at night
- ☐ during the day

17721

5

at night

6

To see what is in front of you while driving at night, you use the car's _____ .

When you drive at night, the drivers behind you can see your car if you turn on the _____ .

17722

6

headlights

taillights

7

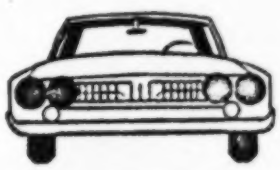

High Beam

Low Beam

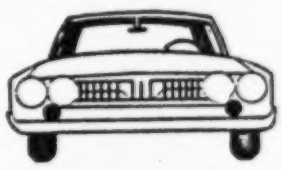

Parking Light

The shaded lights can be used at night.

The parking lights should not be used while driving.

NAME the two beams that can be used at night:

_____

_____

7

high beam

low beam

8

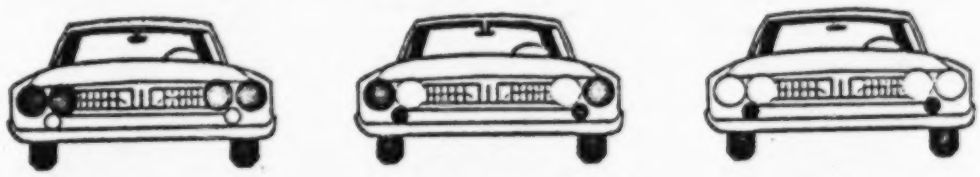

High Beam Low Beam Parking Light

The parking lights should not be used while driving.

You CAN use parking lights when:

- ☐ the car is parked on the side of the road
- ☐ you are moving on the highway
- ☐ you are going through city streets

17724

8

the car is parked on the side of the road

9

You use the low beam when driving in the city and you use the _____ when you are driving on the highway.

17725

9

high

10

If you are driving on the Thruway, which beam you should you use? _____

If you pull the car off the road to one side, change the lights to your _____ lights.

17726

Safety Precautions

A. Be aware of the extreme heat in the kiln

B. Do not open kiln unless authorized to do so

c. Beware of sharp ceramic edges

D. Use grindstone to smooth sharp edges

E. Guard against lead poison when spraying glaze

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criterial to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

LEATHERCRAFT

Purpose

Leathercraft is taught as a leisure time activity. The main purposes being: the development of a worthwhile hobby, to develop a measure of manipulative skill, and to learn and care for leather products.

Specific Objectives

A. To create an interest in leather.

B. To develop an appreciation of good design in leather.

C. To develop an awareness of the importance of leather and its uses.

D. To develop a working knowledge of the processes used in leathercraft.

Suggested Content

A. Manipulative and Technical

1. Terminology
2. Decorating leather
3. Creative possibilities
4. Lacing and stitiching
5. Operating machines used in leatherwork
6. Transferring designs
7. Marking leather for tooling
8. Preparing leather for tooling
9. Tooling outlines with modeling tools
10. Stamp designs
11. Raised designs
12. Creasing edges
13. Splice lacing
14. Punch lacing holes
15. Attaching hardware
16. Types of lacing
17. Carved leather designs
18. Assembly processes
19. Dyeing and applying finish

1771 1770

10

high

parking

11

Low beams are used in the _____ .

High beam lights are used on the _____ .

17727

11

city

highway

12

Which lights should you use when you are parked at the side of the road? _____

When you pull back onto the highway, change your lights to the _____ _____ beam.

17728

12

parking lights

high

13

MATCH the following:

A. high beam

B. low beam

C. parking lights

1. _____ driving on city streets

2. _____ driving on highways

3. _____ standing on the side of the road

17729

13

1. B

2. A

3. C

14

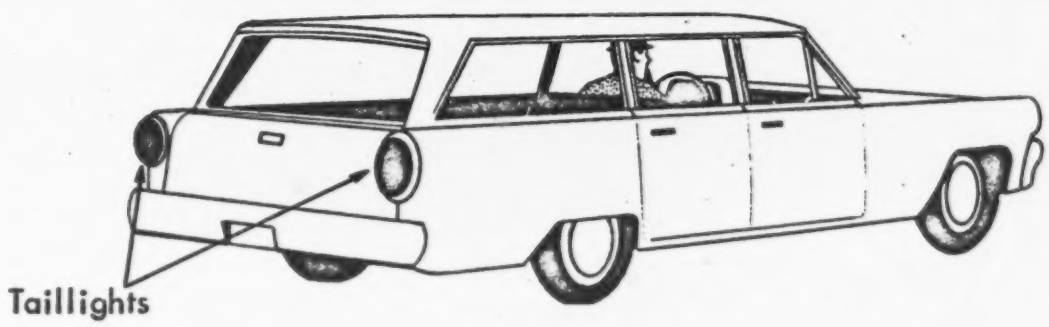

Whenever you turn on the headlights, the taillights also go on.

Taillights are on the:

- ☐ back of the car
- ☐ front of the car

17730

14

back of the car

15

You have learned that electrical circuits are opened and closed by a:

- ☐ battery
- ☐ lamp
- ☐ switch

15

switch

16

The headlights and the taillights are both on the same switch.

When the headlights are turned on, what will taillights do?

_____

16

go on

17

Whenever you turn on the headlights <u>or</u> the parking lights, the taillights will also go on.

This is because they are both controlled by one _____ .

17733

17

switch

18

When you turn on the headlights, what other lights will go on? _____

When you put on the parking lights, what other lights will go on? _____

17734

18

taillights

taillights

19

If headlights, taillights and parking lights are turned on and off by the same switch, they are:

- ☐ in the same electrical circuit
- ☐ not in the same electrical circuit

19

in the same electrical circuit

20

CHECK all the items below that are in the light circuit:

- ☐ high beam
- ☐ generator
- ☐ low beam
- ☐ parking lights
- ☐ starter motor
- ☐ taillights

B. Related Information

1. Types of leather and their uses
2. Tanning processes of leather
3. Kinds of leather
4. The leather industry
5. Types of hardware and finishes

Suggested Tools and Equipment

A. Steel rule
B. Mallets
C. Modeling tools
D. Basic stamping tools
E. Swivel knives
F. Marble slab
G. Revolving punch
H. Snap set
I. Edge creaser
J. Edge trimmer
k. Draw knife
L. Shears
M. Leather knife
N. Oilstones
O. Sewing machine
P. Skiving machine
Q. Sewing awl
R. Belt awl
S. Steel square
T. Dividers
U. Spacing wheel
v. lacing chisel
W. Commercial templates
X. Lacing needles

Materials

A. Various types of leather
B. Assorted threads
C. Tracing paper
D. Finishing materials
E. Dye
F. Rubber cement
G. Thread wax
H. Sponges
I. Lacing, assorted colors
J. Lacing needles
K. Assorted hardware
L. Assorted buckles
M. Belt snaps
N. Assorted dye brushes
O. Oxalic acid

0771 1771

20

high beam

low beam

parking lights

taillights

21

The headlight switch controls all the lights in the _____ circuit.

17737

21

light

22

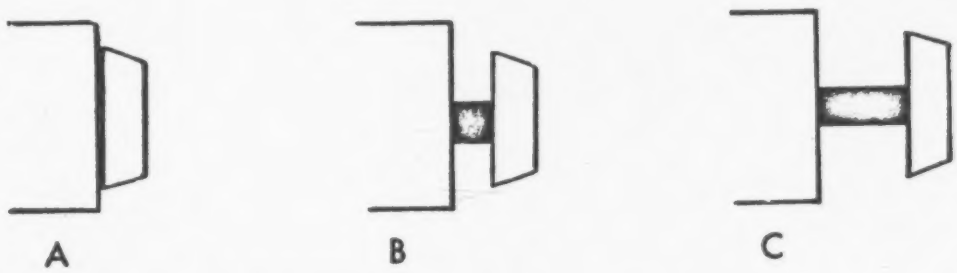

You know how switches that go "up and down" work.

Headlights switches are turned on when you pull them.

The switch position above that is NOT turned on is switch _____ .

Which switch positions will turn lights on?

- ☐ switch A
- ☐ switch B
- ☐ switch C

17738

22

A

switch B

switch C

23

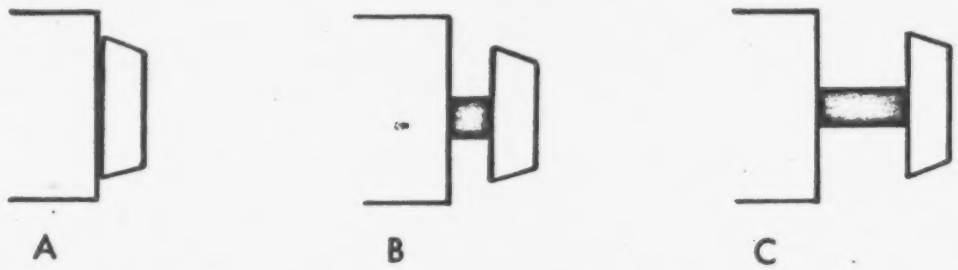

Switch C is pulled all the way out. The taillights and the headlights will go on.

Switch B is pulled halfway out and the taillights and the _____ lights will go on.

17739

23

parking

24

Parking lights and taillights go on when you pull the light switch:

- ☐ halfway out
- ☐ all the way out

Headlights and taillights go on when you pull the light switch:

- ☐ halfway out
- ☐ all the way out

17740

24

halfway out

all the way out

25

When the light switch is pulled all the way out: (CHECK TWO)

- ☐ low beams are on
- ☐ parking lights are on
- ☐ taillights are on
- ☐ taillights are off

17741

25

low beams are on

taillights are on

26

When the light switch is pulled halfway out the: (CHECK TWO)

- ☐ low beams are on
- ☐ parking lights are on
- ☐ taillights are off
- ☐ taillights are on

17742

26

parking lights are on

taillights are on

27

When you pull the light switch halfway out, the taillights and the _____ go on.

You use these lights when you are:

- ☐ driving in the city
- ☐ driving on the highway
- ☐ parked at the side of the road

17743

27

parking lights

parked at the side of the road

28

When you pull the light switch all the way out, the taillights and the _____ go on.

This is the low headlight beam.

You use it when:

- ☐ driving in the city
- ☐ driving on the highway
- ☐ parked at the side of the road

17744

28

headlights (or low beam)

driving in the city

29

The light circuit is opened and closed by the _____ switch.

17745

29

headlight

30

You are driving and leave the city. Which beam should you have used while driving in the city? _____

Which beam should you switch to when you go onto the highway?

_____

17746

Safety Precautions

A. Keep cutting tools sharp

B. Handle cutting tools with extreme care

C. Cutting tools should be pushed away from body

D. Use caution when working with inflammable materials and acids

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the student increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

ART METALS

Purpose

Lapidary and jewelry making present an apportunity for industrial arts students to express themselves freely and creatively in an interesting craft activity.

Specific Objectives

A. To develop an avocational interst in semi-precious stones and jewelry.

B. To develop a degree of skill in finishing stones and making jewelry

C. To develop creativity and originality of good design.

D. To develop the ability to select appropriate materials for jewelry.

Suggested Content

A. Manipulative and Technical

1. Terminology
2. Names and descriptions of commonly used stones
3. Polishing stones
4. Fashioning jewelry items
5. Soft soldering
6. Collecting and identifying local and commercial stones
7. Cutting and polishing stones
8. Attaching dop sticks
9. Operating and maintaing equipment
10. Making original patterns for projects
11. Designing and making mountings for stones
12. Laying out design or material
13. Silver soldering
14. Pickling soldered pieces
15. Doming work
16. Engraving

1772

30

low (beam)

high (beam)

31

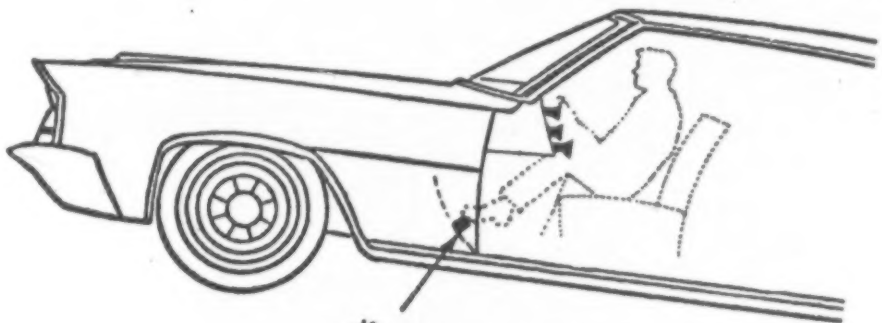

dimmer switch

To put on the high beam, you step on the DIMMER switch.

You put on the high beam with your:

- ☐ foot
- ☐ hand

You use this beam when you are:

- ☐ in the city
- ☐ on the highway

17747

31

foot

on the highway

32

Before the high beam goes on, the low beam must first be on.

The low beam goes on when you pull the headlight switch:

- ☐ all the way out
- ☐ halfway out

The high beam goes on when you step on the:

- ☐ dimmer switch
- ☐ headlight switch
- ☐ stop light switch

17748

32

all the way out

dimmer switch

33

Once the low beam is on, you can put on the high beam by stepping on the:

- ☐ dimmer switch
- ☐ headlight switch
- ☐ night switch

17749

255 OF 327

ED

056 238

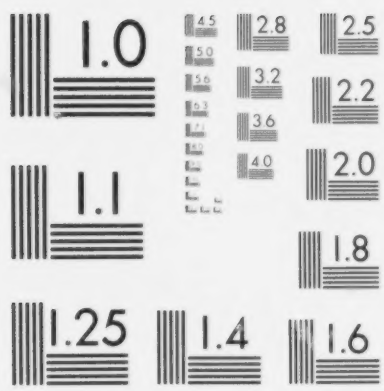

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

33

dimmer switch

34

When you step on the dimmer switch, the _____ beam will go on.

You should use this beam when driving on the _____ .

17750

34

high

highway

35

How do you put on the high beam? _____

35

by stepping on the dimmer switch

36

In order to put on the high beam, the _____ beam must first be put on.

You do this by:

- ☐ leaving the light switch alone
- ☐ pulling the light switch halfway out
- ☐ pulling the light switch all the way out

36

low

pulling the light switch all the way out

37

MATCH the following:

A. low beam

B. high beam

C. parking light

1. _____ light switch halfway out

2. _____ light switch all the way out

3. _____ step on the dimmer switch

17753

37

1. C
2. A
3. B

38

To stop a moving car, you step on the _____ .

When you do this, cars behind you know you are stopping because your BRAKE LIGHT lights up.

This is shown in:

- ☐ picture A
- ☐ picture B

38

brake pedal

picture A

39

Cars behind you know that you are stopping when your car's brake light goes on. This happens when you step on the

_____ .

17. Stamping
18. Setting of stones
19. Polishing and finishing projects
20. Copper enameling

B. Related Information
1. Local sources for materials
2. The commercial value of various stones
3. The lapidary and jewelry making industry
4. Metals used in jewelry making
5. The economics of custom jewelry making

Suggested Tools and Equipment

A. Hand Tools
1. Templates
2. Hand drill
3. Twist drill set
4. Borax slate
5. Charcoal blocks
6. Electric soldering iron
7. Electric soldering gun
8. Soldering coppers
9. Chasing tools
10. Pitch pan
11. Dapping block & punches
12. Stakes
13. Forming hammers
14. Flasks
15. Mallets
16. Ring & bracelet mandrels
17. Ring sizers
18. Crucibles
19. Jewelers Saw Frames
20. Tin snips
21. Gravers
22. Bench pins
23. Hand vise
24. Ring clamp
25. Jewelers pliers
26. Tweezers
27. Burnishing tool
28. Bottled gas torch

B. Equipment
1. Slabbing saw
2. Trim saw
3. 100 grit grinding unit
4. 220 grit grinding unit

STTI 1773

39

brake pedal

40

When you step on the brake pedal the:

- ☐ brake light goes on
- ☐ brake light goes off
- ☐ taillight goes on
- ☐ taillight goes off

In this way cars behind you know that your car is _____ .

17756

40

brake light goes on

stopping

41

A switch on the master cylinder turns the _____ light on when you step on the _____ pedal.

17757

41

stop

brake

42

The switch on the master cylinder is called the STOP LIGHT SWITCH.

This switch closes the circuit to the brake light and the brake light will:

- ☐ go on
- ☐ go off

The stop light switch will go off when you:

- ☐ step on the brake pedal
- ☐ take your foot off the brake pedal

42

go on

take your foot off the brake pedal

43

The stop light switch is controlled by the:

- ☐ brake pedal
- ☐ clutch pedal
- ☐ gas pedal

Stepping on this pedal is like turning the switch:

- ☐ on
- ☐ off

Taking your foot off the pedal is like turning the switch:

- ☐ on
- ☐ off

43

brake pedal

on

off

44

The brake pedal controls the:

- ☐ dimmer switch
- ☐ headlight switch
- ☐ stop light switch

When this circuit is closed, the _____ lights go on.

44

stop light switch

stop <u>or</u> brake

45

When you step on the brake pedal, the _____ switch closes the circuit to the brake lights.

The brake lights go off when you take your foot off the _____ .

17761

45

stop light

brake pedal

46

MATCH the following:

A. dimmer switch

B. headlight switch

C. stoplight switch

1. _____ closes the brake light circuit

2. _____ turns on the low beam

3. _____ turns on the parking light

4. _____ turns on the high beam

17762

46

1. C

2. B

3. B

4. A

47

The cars behind you should know when you want to make a turn to the left or to the right.

You signal that you are changing direction by using:

- ☐ driving lights
- ☐ directional lights
- ☐ parking lights

47

directional lights

48

Directional lights are used to let other cars know:

- ☐ that you are stopping the car
- ☐ that you are leaving the city
- ☐ in which direction you are going to turn

17764

48

in which direction you are going to turn

49

Cars know you are turning to one side or the other when your:

- ☐ brake light goes on
- ☐ directional lights start flashing
- ☐ taillights go off

17765

5. Drum sander
6. Disc sander
7. Polishing wheel
8. Stone grinder
9. Drill press
10. Buffers
11. Melting furnace
12. Crucibles
13. Flasks
14. Bench vises
15. Asbestos table tops
16. Anvil
17. Face shields
18. Bunsen burner
19. Alcohol lamp
20. Hot Plate
21. Gregory kilm

Materials

A. Collection of rough stones
B. Commercial gemstones
C. Assortment of polishing oxides
D. Dopping wax and sticks
E. Rubber cement
F. Jewelry cement
G. Rubber gloves
H. Abrasive materials
I. Soluble oil
J. Sheet brass, copper, and sterling silver
K. Nickle silver
L. Assortment of sterling silver wire
M. Assortment of bezel wire
N. Necklace findings
O. Earring findings
P. Cuff link findings
Q. Tie clasp findings
R. Pins and broaches
S. Iron binding wire
T. Sparex #2 for pickling
U. Jewelers rouge
V. Tripoli compound
W. Soft solder
X. Liver of solder

1774

49

directional lights start flashing

50

When turning your car to the left, the left directional light should be turned on.

When turning to the right, the _____ directional light should be turned on.

17766

50

right

51

When you are going to make a turn, which lights should be flashing? _____

17767

51

directional lights

52

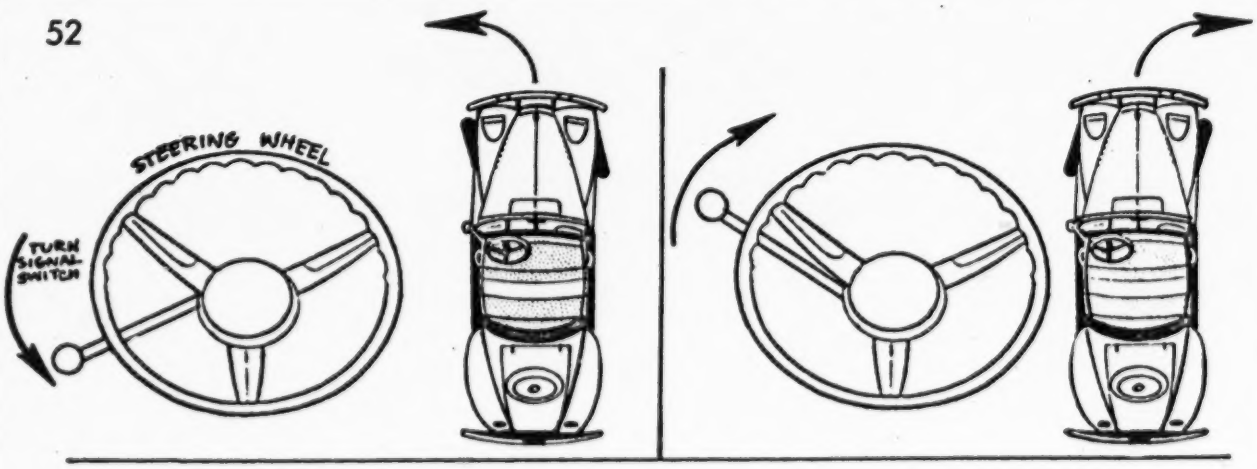

The TURN SIGNAL SWITCH lets you flash the taillights.

When this switch is down the:

- ☐ left signal flashes
- ☐ right signal flashes

17768

52

left signal flashes

53

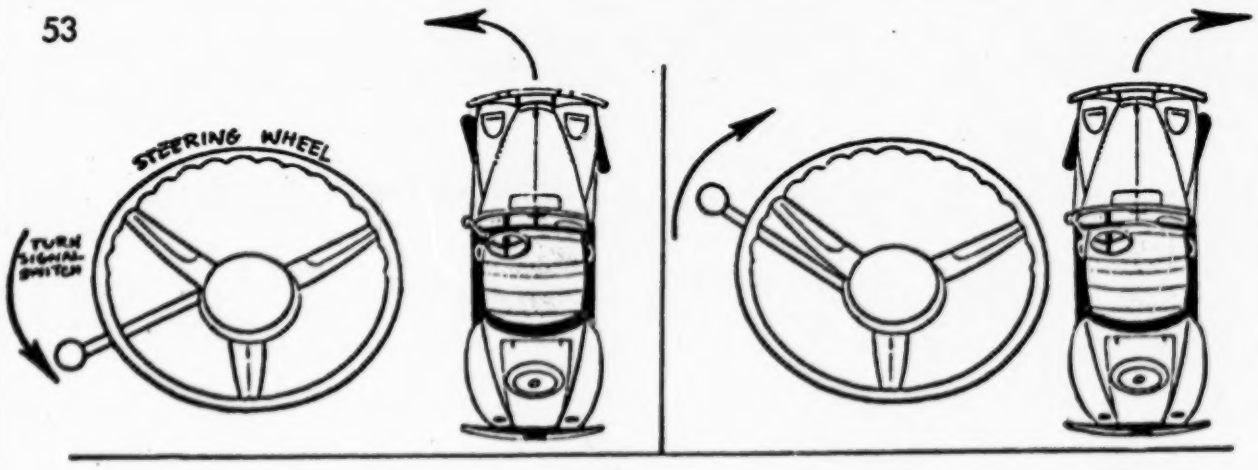

When you are going to turn in one direction or another, you move the turn signal switch either:

- ☐ up or down
- ☐ in or out
- ☐ back and forth

53

_____ up or down

54

To let other cars know you are going to change direction, you use the:

- ☐ brake light switch
- ☐ dimmer switch
- ☐ turn signal switch

54

turn signal switch

55

The turn signal switch is used when you want other cars to know you are:

- ☐ changing direction
- ☐ stopping
- ☐ undecided about turning or stopping

55

changing direction

56

To show that you are going to make a turn, use the _____ _____ switch.

17772

56

turn signal

57

MATCH the following:

A. dimmer switch

B. headlight switch

C. stop light switch

D. turn signal switch

1. _____ puts on brake lights
2. _____ puts on directional lights
3. _____ puts on low beam
4. _____ puts on high beam

17773

57

1. C
2. D
3. B
4. A

58

NAME the switch used to show that you are changing directions: _____

58

turn signal switch

59

When you drive in the rain or snow, can you see well out of the window?

- ☐ yes
- ☐ no

17775

Materials

A. Sheet copper (16 - 18 gauge)

B. Copper wire - 22 gauge

C. Enamels

1. Opaque
2. Transparent
3. Crackle

D. Gum tragacanth or baby oil

E. Lump enamel assortment

F. Counter enamels

G. Solder and paste

H. Emery paper

I. Jewelry findings

J. Permacoat or metal lacquer

K. String

L. Steel wool

M. Nitric acid or sulphuric acid

Safety Precautions

A. Treat all pieces of copper in the cooling off area as being potentially hot.

B. Wear asbestos gloves when placing or removing enameled pieces in a large kiln

C. Add acid to water when making a pickling solution

D. When carrying hot firings, be careful of fellow students.

Suggested Projects

The instructor is urged to search for ideas in the suggested references and project books. As the ability of the pupil increases, more challenging projects or other activities should be suggested. Criteria to be considered include:

1. Contributes to the attainment of course objectives
2. Involves appropriate processes and operations
3. Within ability of student
4. Good design
5. Within means of student
6. Within shop facilities

PROGRAM EVALUATION FOR INDUSTRIAL ARTS

Purpose

The need and demand for more intensive evaluation of industrial arts programs in Wyoming has presented many complex problems, the answers to which are not readily soluble through ordinary means. Industrial arts programs, teachers, and evaluations have been quite diverse and may be classified in quality from traditional to progressive and from excellent to poor. This divergence has left much to be desired with respect to a framework of consistent standards from which to base evaluation comparisons.

The following evaluation guidelines have been established and are presently being used in a number of states to evaluate present industrial arts programs. These guidelines can be used as a frame of reference at least in five different ways:

59

no

60

To make driving safe in rain or snow, the front window should be:

- ☐ covered with rain or snow
- ☐ forgotten about
- ☐ kept clear of rain or snow

17776

60

kept clear of rain or snow

61

To keep the windshield clear of rain and snow, the windshield must be cleaned off.

The part that cleans the front window is called the:

- ☐ window holder
- ☐ windshield cover
- ☐ windshield wiper

62

front window

63

Rain and snow are wiped from the windshield by the _____ _____ .

17779

63

windshield wiper

64

In order to make the windshield wipers work, you must turn on the switch that closes the windshield wiper circuit.

Can you guess which of the following switches does this job?

- ☐ dimmer switch
- ☐ stop light switch
- ☐ windshield wiper switch

17780

64

windshield wiper switch

65

MATCH the following.

A. dimmer switch

B. stop light switch

C. windshield switch

D. turn signal switch

1. _____ turns on the brake light

2. _____ turns on the high bean

3. _____ turns on the windshield wipers

17781

65

1. B

2. A

3. C

66

Almost every automobile has a heater.

The heater is used to:

- ☐ cool the inside of an automobile
- ☐ warm the inside of an automobile

66

warm the inside of an automobile

67

To warm the inside of an automobile, you turn on the

_____.

17783

67

heater

68

A switch turns the heater on and off.

When the heater switch is turned to the "on" position the car gets:

- ☐ warmer
- ☐ colder

17784

68

warmer

69

MATCH the following.

A. heater switch

B. dimmer switch

C. windshield wiper switch

1. _____ turns on the heater

2. _____ turns on the high beam

3. _____ turns on the windshield wiper

17785

1. by the teacher as a self evaluation,
2. by the supervisor to become better acquainted with the program,
3. by the administrator to become more familiar with the standards of a quality program,
4. by teacher-educators to give guidance in the planning of pre-service and in-service program developments, and,
5. by the State Department of Education to become better acquainted with the strengths and needs of the total program across the State.

Although this document is written as a set of guidelines and not specifically as an evaluation instrument, it can be used as such by placing numerical values beside each guideline in the space provided. The following value system could be followed:

5 --- Excellent
4 --- Very good
3 --- Good
2 --- Fair
1 --- Poor

Organization

A. Availability of industrial arts courses to all students:

———— An industrial arts course is available to each student at some time during his or her secondary educational program.

B. Schedules, time allotments, and class sizes:

———— Each class group should have a total of 250 classroom minutes per week.
———— Separate classes are provided for beginning and advanced students in grades 7-9 and grades 10-12
———— A 2,000-3,000 sq. ft. lab accommodates a maximum of 20 students with one teacher per period of instruction.
———— A non-teaching period is provided daily for planning and student conferences.

C. Financial support:

———— Differentiation is made between materials and supplies. Materials defined as items identifiable in student projects which students should pay for. Supplies defined as consumables.
———— Provisions are made for adding and replacing tools and equipment as needed.

Nature of Offerings

A. Industrial arts program related to modern industry

———— Industrial growth and expansion from the home unit to the nature and operation of modern industry, including labor and industrial organizations, are emphasized in each area of the program.
———— Students gain an over-view of representative workers and working conditions in a wide range of industrial information, in a variety of fields, is suitable interspersed with other instruction.
———— Program is characterized with student awareness of technological developments in American industry.

69

1. A

2. B

3. C

70

A way for people to be entertained while driving is to turn on the:

- ☐ heater
- ☐ lights
- ☐ radio

70

radio

71

People riding in a car can be entertained by listening to the _____ .

17787

71

radio

72

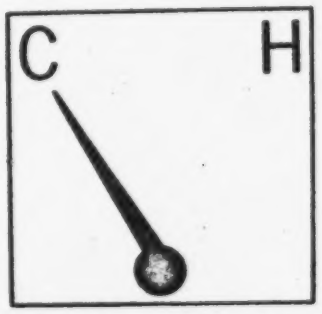

TEMPERATURE GAUGE

The arrow on the gauge is pointing to the "C" and tells you that the engine is cold.

When the arrow points to the "H," it means that the engines is _____ .

17788

72

hot

73

You can tell if an engine is hot or cold by looking at the:

- ☐ ammeter
- ☐ speedometer
- ☐ temperature gauge

17789

73

temperature gauge

74

A temperature gauge tells you if the engine is _____
or _____ .

17790

74

hot

cold

75

You can tell what an engine's temperature is by looking at a car's _____ .

75

temperature gauge

76

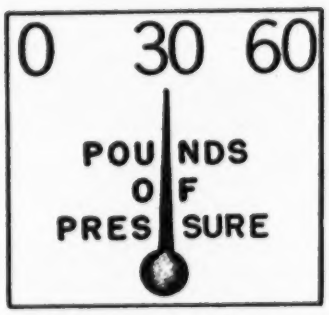

Oil Pressure Gauge

The oil pressure gauge tells how much oil pressure there is in the engine.

0 is for low pressure.

30 is for average pressure.

60 is for:

- ☐ empty
- ☐ high pressure
- ☐ normal pressure

17792

76

high pressure

77

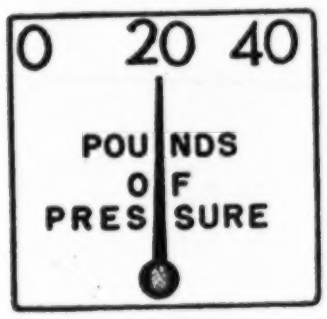

The picture shows:

- ☐ an ammeter
- ☐ an oil pressure gauge
- ☐ a temperature gauge

17793

77

an oil pressure gauge

78

OIL PRESSURE GAUGE

You should NEVER drive an automobile if there is no oil pressure in the engine.

Could you drive a car when the oil pressure reads as shown above?

- ☐ yes
- ☐ no

17794

78

no

79

Most modern cars have warning lights instead of gauges.

When a red warning light goes on, on the dashboard, it means danger!!!

If the red warning light for a car's temperature goes on, it means the car is too hot.

If the warning light goes on for the oil pressure, it means there (☐ is ☐ is no) oil pressure.

17795

B. Program related to interests and needs of the students

---------- Through a variety of carefully planned experiences, students explore their abilities and personal traits, attitudes and values, and gain a better understanding of themselves.

---------- Problems are closely related to the student's world of experiences: student interests are recognized and activities simulating real-life situations are used.

---------- Experiences are provided in each industrial arts area so that a degree of skill in the use of common tools and machines may be developed commensurate with the student's interest, ability, and the scope of the program.

---------- Industrial arts projects are not considered by teachers to be the most important outcome in themselves but as mediums used in the teaching-learning situation to stimulate more complete and effective pupil learning.

---------- Specific efforts are directed toward the development of an orderly, systematic procedure for the intelligent planning of any task.

---------- Basic skills such as reading, writing, arithmetic, speaking, and listening are continually re-emphasized and made part of the instructional program.

---------- Students play an active part in the safety program through the use of student safety supervisors, through inducing safety problems, and the safety tests.

---------- Students are provided with opportunities that allow them to participate in various roles of industrial organizations within the industrial arts program.5

Physical Plan and Services

It is suggested that professional consultants be used whenever possible to determine appropriateness of physical plant and services.

A. Architectural features and services

------- Location: Industrial arts laboratories are centrally located as a unit such as a separate building in a campus plan. Labs are conveniently located for students as well as for adult evening classes. Outside entrance is provided for delivery of supplies and equipment.

------- Size: Floor area, excluding office, finishing room, storage room, and other special-purpose rooms approximates the following formula: class size x 100 sq. ft. - area of the lab.

------- Shape: Lab proportions are to be either square or 1 to 1 1/2 rectangle: minimum width should be 30 feet. All areas of the lab are visible to the teacher at all times.

------- Lighting: Natural light is effectively controlled to eliminate glare. Sufficient supplemental, artificial light, properly diffused and distributed, 100 footcandle of light at bench height throughout the labs.

------- Floors: Floors are in good condition and are suited to the area in which they are located: precautions are taken against slippery floors, machine areas receive special attention.

------- Heating-Ventilation: Adequate controlled heat and ventilation commensurate with best working conditions is provided: Exhaust ventilation is available in areas producing excessive heat, fumes, and gases.

------- Utilities: Where applicable, adequate and properly located gas, water, electrical, and compressed air facilities are provided.

------- Entrances-Exits: Lab has a minimum of two entrance-exit doors with a width of 36 inches or more. Large outside entrance is probided where it is needed. Outside door is constructed so that it can be unlocked from the inside without a key. All main exit doors have panic-bars inside in place of knob handles.

79

is no

80

If a battery is discharging and the car has a warning light instead of an ammeter, what color will be seen? _____

17796

80

red

81

When the engine gets too hot:

- ☐ a red light will go on
- ☐ a red light will go off
- ☐ nothing will happen

17797

81

a red light will go on

82

A red temperature light means the engine has gotten too

_____ .

17798

82

hot

83

If the oil pressure light is red it means that there is no _____ _____.

17799

83

oil pressure

84

A red light on the battery light means the battery is _____ .

17800

84

discharging

85

Red warning lights go on when: (CHECK THREE)

- ☐ there is no oil pressure
- ☐ there is oil pressure
- ☐ the battery is getting charged
- ☐ the battery is getting discharged
- ☐ the engine is at the right temperature
- ☐ the engine is too hot

17801

85

there is no oil pressure

the battery is getting discharged

the engine is too hot

86

Warning lights are used instead of:

- ☐ a battery
- ☐ gauges
- ☐ oil
- ☐ water

17802

86

gauges

87

What do many modern cars use instead of gauges? _____

What color are they? _____

17803

87

warning lights

red

88

Red warning lights are used instead of _____.

When any of them go on it means _____.

17804

88

gauges

danger

89

In your home, too much electricity in wires will start a fire and burn everything out.

Too much electricity in an automobile's wires will also make them burn out.

FUSES are put in circuits to avoid "burn out" dangers.

Fuses are a:

- ☐ danger for the car
- ☐ safeguard for the car

17805

——— Ceilings: Ceiling height is appropriate, i.e., between 12' and 24' in all labs and drawing rooms: ceilings are constructed of a material having a high coefficient of sound absorption.

——— Storage of combustible materials: Ventilated fire-resistant cabinet is provided for the storage of combustible materials. Metal, self-closing container is provided for soiled rags.

——— Background surfaces: Walls are durable, easily cleaned, and have a texture that is adaptable to other considerations from the floor to door height. Sound-absorbing materials are provided on upper walls.

——— Washing facilities: Washing facilities and drinking fountain are provided: size and location are desirable.

——— Health precautions: Air conditioning, adequate fume and dust control systems are provided.

——— Eye safety: Industrial quality eye protection devices are provided for each student, teacher, and visitor and are stored in sanitizing cabinets.

B. Physical features related to program planning

——— Exhibit space: Display area is provided, sufficient in size, properly lighted, and appropriately located.

——— Teacher's office: Separate, convenitent office or instructor area is provided. Privacy is possible for work or conferences during part of the day.

——— Tool and supply ceated: Lab contains a convenient and centrally located tool and supply center and, where applicable, an adequate number of well laid out tool panels in areas for special tools.

——— Color treatment: Color coding as recommended by theNational Safety Council is followed in the coding of dangerous parts and machines. Safety zones are provided around all machines and restricted areas.

——— Supply storage: Adequate and safe storage is provided for all supplies: storage area accommodates full length stock as needed and cares for all appropriate materials.

——— Project storage: Adequate storage is provided for projects under construction and those being finished. Floors in the vicinity of all working areas are kept free of clamped materials and projects in the process of being assembled.

——— Student lockers: Proper distribution is provided for student lockers: lockers are adequate in number and size and dispersed so as to avoid ganging and crowding.

——— Equipment arrangement: Equipment is arranged with reference to the sequence of operations and their relations to other areas. Adequate clearance, commensurate with the function of the machine, is provided around all equipment.

——— Student work stations: An adequate number of work stations are provided free from interference, approximately one-third more than class enrollment. Ample aisle space, four feet desirable, is provided between all areas and point of common usage.

——— Instructional areas: Instructional areas are arranged in relation to one another so that a maximum working relationship exists: areas are also arranged from clean to dirty and from noisy to quiet.

——— Finishing area: Finishing area with the following characteristics is provided: adequate in size, appropriately located, properly lighted and ventilated, easily supervised, and relatively free of dust.

——— Lecture assembly area Ample demonstration and discussion area is provided with a comfortable seat and writing area provided for each student.

——— Planning area: Convenient resource library and/or planning facilities are located away from major machine noises and/or dirty areas. Adequate space is provided for the storage of books, magazines, and idea folders.

89

safeguard for the car

90

It is easier to change fuses than it is to change wires and electrical parts.

It also costs less to change _____ than it does to change wires and electrical parts.

When a fuse burns out, you should _____ it.

17806

90

fuses

change

91

Fuses are put in electrical circuits because they: (CHECK TWO)

- ☐ are easier to change than wires and parts
- ☐ cost less to change than wires and electrical parts
- ☐ were first used in homes
- ☐ will never burn out

17807

91

are easier to change than wires and parts

cost less to change than wires and electrical parts

92

LIGHTS

HEATER

RADIO

The parts listed above have fuses in their circuits. These fuses are put into the circuits to:

- ☐ burn out the circuit
- ☐ keep the wires burning
- ☐ keep the wires from burning out

92

keep the wires from burning out

93

Fuses will burn out (☐ faster than ☐ slower than) wires.

When the fuse burns out, what sl uld you do? _____

17809

93

faster than

change it

94

When a fuse burns out, the circuit is open.

Will a radio play if the circuit has a burned out fuse?

- ☐ yes
- ☐ no

17810

94

no

95

Which would create the smallest problem in a radio?

- ☐ burnt tubes
- ☐ burnt wiring
- ☐ a burnt fuse

17811

95

a burnt fuse

96

When too much electricity goes through a circuit, the fuse will burn out and the circuit will become:

- ☐ closed
- ☐ open

Will parts in that circuit then work?

- ☐ yes
- ☐ no

17812

96

open

no

97

What burns out when too much electricity goes through a circuit?

_____

17813

97

fuses

98

A fuse will burn out when too much electricity goes through a _____ .

This keeps the important wires and parts in that circuit from _____ .

17814

98

circuit

burning out

99

A fuse _____ to save wires and parts from damage.

It will do this by _____ the circuit to stop the flow of too much electricity through the circuit.

17815

Visual aid facilities: Appropriate and convenient film showing facilities are provided within the school; area is well-ventilated, easily darkened, and efficiently managed. Comfortable student seating is provided.

C. Tools and Equipment

——— Tools and equipment selection: Good judgment prevails on all requests for tools and machines; justification of tools and machines is made first on their instructional avlue in meeting student needs.

——— Hand tools and machines: An adequate quantity and variety of tools, instruments, and equipment for the usual types of students' experiences and activities are found in each area of the indstrial arts program.

——— Machine size and type: Unit type machines with self-contained motors are used throughout the industrial arts program; equipment adapted to the size and maturity of the students, i.e., height from the floor to the working surface of the machine, size of a machine, horse-power, speed, capacity, etc.

——— Safety guards and devices: All power machines and manually operated equipment are provided with effective guards and devices. Guards are in place and are used by the operators at all times.

——— Location and identification of controls: Conveniently located and appropriately painted switches and/or control boxes are provided on all power machines. Control boxes are easily accessible from the position of the operator.

——— Electrical safety devices: Master electrical panel is conveniently and centrally located in the lab. all machines, wired in with building, are provided with disconnect switches and have controls providing under-voltage and overload protection. All machines are properly grounded.

——— Tools and equipment maintenaces: All tools and equipment are properly managed; repairs are mwde as soon as the damaged condition is noticed; allcutting surfaces are kept sharp.

Direction of Learning -- Instructional Staff

A. Philosophy

——— Well-defined philosophy of education is held by the industrial arts teachers. Staff members are able to direct, intelligently, their own thinking in clarifying and refining the basic purposes or functions of education, as well as more specific day-to-day teaching goals in their instructional program.

——— Industrial arts program emanates from the needs and interests of boys and girls living in our culture and based upon presently known data about the learning process, the characteristics of adolescents, and developmental tasks.

——— Industrial arts staff members subscribe to the philosophy that a modern, defeasible industrial arts program makes adjustments as new situations demand and as better insights and understanding are achieved in the teaching-learning process.

B. Qualifications of Staff

——— Teachers hold as a minimum requirement the collegiate professional teaching certificate and are endorsed in industrial arts.

——— Graduate work and/or certificate renewal has been in field of industrial arts education.

——— Teachers strive to keep abreast of professional literature.

——— Teachers show competence in a variety of teaching approaches and methods.

99

burns out

opening

100

When fuses burn out, they open _____ .

This happens when too much _____ is going through the _____ .

17816

100

circuits

electricity

circuit

101

What happens to the fuses in a circuit? _____

17817

101

They burn out (when too much electricity goes through a circuit).

102

Which other lights will go on when you turn on the parking lights?

_____

17818

102

taillights

103

When driving on city streets, you use the _____ beam and when driving on the highway you turn on the _____ beam.

17819

256 OF 327

ED

056 238

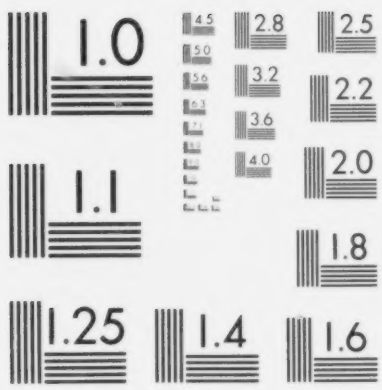

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

103

low

high

104

You put on the parking lights by pulling the headlight switch _____ way out and you put on the low beam by pulling the headlight switch _____ the way out.

17820

256

104

half (way)

all

105

You change the low beam to high beam by stepping on the _____ switch.

105

dimmer

106

Your stop lights will go on when you step on the _____ pedal.

17822

106

brake

107

Your brake lights will go on when the stop light circuit is closed by the _____ _____ switch.

17823

107

stop light

108

The windshield is kept clear of rain and snow by the

_____ _____.

17824

C. Teaching Methodology

——— Industrial arts teachers possess satisfactory and comparable competence in a variety of teaching methods and are prepared to utilize one or several ways or techniques in developing meaningful experiences in their instructional program.

——— Methods of instruction used in the industrial arts program focus attention on student-teacher participation, with each playing important roles in the teaching-learning activities.

——— Democratic teacher-pupil and pupil-pupil relationships are fostered as teachers and pupils share variety of real-life democratic experiences in the industrial arts program.

——— Student participation in the evaluation procedures ks made a part of a natural learning situation; teacher and student set up goals and frequently evaluate progress toward the.

——— Primary attention is focused upon concepts of growth, and physical and emotional development of adolescents, as well as an optimum time when certain types of experiences will be most meaningful to students.

——— Recognizing the value of pupil questions, staff members use instructional techniques which encourage pupil inquiry; all student contributions are treated with dignity and sincerity and are utilized in the teaching-learning process.

——— Activities in the industrial arts program are organized so that provisions are made for significant group activities and projects which revolve around problem type situations. These are suitable interspersed with individual enterprises.

——— Information and instructional materials are timely and are presented in a manner that arouses in students an awareness of the importance and need of these data for the solution of problems.

——— Most students undertake appropriate research problems which pertain to the area of science and industry, as a part of their industrial arts experience.

——— Emphasis is placed on a variety of initiatory contacts and experiences in several industrial arts arts areas during the initial phase of the student's program in the industrail arts.

——— Awide variety of suitable materials and techniques of instruction, e.g., self-evaluation by students student plan sheets, experimentation, operation sheet, pupil demonstrations, etc., are used in the program.

------- students are encouraged to draw upon supplementary sources of information and to bring to class material of interest in areas within the scope of the program.

——— Teachers are prompt in meeting their responsibilities, e.g., where is important to keep records, they are maintained in an accurate, concise, and up-to-date manner, starting time of meetings and due-dates on reports are observed.

——— Industrial arts teachers keep their labs clean and neat, good organization is in evidence, there is a place for everything and everything is in its place.

Direction of Learning -- Instructional Activities

——— After establishing their basic goals, most industrial arts teachers organize their instructional plans around activities designed to bring about desired behavior changes in students.

------- Field trips are frequently planned and executed. Community persons are asked to contribute their experiences. Students are often asked to bring in illustrative material. All uses of community resources are carefully planned.

——— Recognition is made of the value of extra-curricular experiences as provisions are made for sutdents to identify themselves with several areas of interest akin to the industrial arts; activities are organized where greatest interest is shown.

108

windshield wipers

109

People in a car can be entertained by turning on the _____ .

People in your car can be kept warm if you turn on the _____ .

17825

109

radio

heater

110

Cars behind you will know if you are going to turn to the left or to the right if you use the _____ lights on your car.

17826

110

directional

111

When a red warning light goes on, on your dashboard, it means

_____ .

111

danger

112

When the red temperature light goes on, it means that the engine is too _____ .

When the red warning light for oil pressure goes on, it means that there is no _____ _____ .

When the red battery light goes on, it means that the battery is being _____ .

17828

112

hot

oil pressure

discharged

113

THIS IS THE END OF BOOK 6

17829

AUTO MECHANICS COURSE

POST-TEST BOOK 6: AUTOMOTIVE ELECTRICAL SYSTEMS
PART III

A BASIC SYSTEMS PROGRAM

17830

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

When you put on your parking lights or your headlights, which lights will also go on? _____

2

Cars behind you know that you are stopping when they see your _____ go on.

3

When you step on your dimmer switch, the low beam will change to _____ beam.

4

You use the _____ to be entertained. To keep warm in a car you turn on the _____ .

5

What is put in electrical circuits as a safety device? _____

6

If there is no oil pressure in an engine, the red _____ _____ will go on.

7

When the ammeter reading is minus (-), it means that the battery is (☐ charging ☐ discharging).

8

The stop light switch opens and closes the circuit for the _____ _____ .

9

When you pull the light switch all the way out, the _____ beam will go on.

10

What can you use to keep your windshield clear of rain? _____

_____

VT 013 129
Auto Mechanics Course. Book 7: The Fuel System.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 92p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *FUELS; MOTOR VEHICLES; ENGINES; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the fuel system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available as VT 013 123-VT 013 146, and part of a series of programed remedial materials develcped by Basic Systems, Inc. (GB)

VT 013 129

——— In developing each phase of the industrial arts program, teachers recognize student ability levels and plan or adjust appropriate learning experiences with students, so that all members of a class may show growth within their area of competency.

——— Evidence is shown of an adequate eye protection program in which all students, teachers, and visitors participate in compliance with Wyoming's eye safety law.

——— Industrial arts teachers work closely with other school areas as they plan their instructional program in an effort to weave together the learnings of various phases of the school's program and provide meaningful, practical applications to what some students may believe to be isolated and unimportant bits of information.

Instructional and Reference Materials

——— Recently published quality textbooks are provided for unit courses along with an adequate resource library within the lab.

——— Up-to-date primary resource materials from industry as well as reference books and/or textbooks are readily available within the lab, for general industrial arts programs.

——— Learning aids, e.g., films, models, mock ups, transparencies, etc., are provided in all industrial arts areas.

——— Reference materials are available describing recent commercial materials, processes, products, occupational trends and monographs.

Direction of Learning

A. Methods of Evaluation

——— Staff members employ a continuous program of evaluation to determine the extent to which pupils approach established goals or objectives in the industrial arts program.

——— Evaluation is considered to be an integral part of the teaching-learning activities by members of the industrial arts teaching staff.

——— Industrial arts teachers carefully record objective data.

——— At periodic intervals, teachers use the most objective means available to determine the reactions of parents and laymen to the order and degree of emphasis that shoul be given various kinds of growth and development experiences.

——— Evaluation includes surveying student reactions to shop experiences near the end of courses and at specified times following graduation, e.g., a year following the student's departure from a junior or senior high school.

——— Industrial arts equipment and facilities are inspected periodically by fire prevention, industrial inspectors, and safety experts.

Outcomes

The student development is measure in terms of meeting the overall objectives of the program and by obtaining the specific behavioral changes that were expected. There is evidence that they have:

——— developed understanding of the broad scope of industry and its place in American culture,

——— discovered their abilities and aptitudes related to the industrial-technical fields,

——— developed a reasonable amount of skill in the safe use of tools and machines, and

——— developed problem-solving abilities related to the materials, processes, and products of industry.

Compiled From:

Evaluation Guidelines For Industrial Arts Programs, STATE DEPARTMENT OF EDUCATION, RICHMOND, VIRGINIA

ED0 56238

BOOK 7

To Be Used With
PANEL BOOK 7

(C1)

AUTO MECHANICS COURSE

BOOK 7: THE FUEL SYSTEM

A BASIC SYSTEMS PROGRAM

VT013129

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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Curriculum Report Reference
Page 14

Task Analysis Reference
22.1

17835

AUTO MECHANICS COURSE

BOOK 7: THE FUEL SYSTEM

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

17936

Name _____

Date _____

Starting time _____

Finishing time _____

17897

Book 7

1

Gasoline is stored in a _____ _____.

2

The fuel burned in the engine is made up of two things.
What are the two things? _____ .

_____

3

Gasoline gets from the gas tank to the carburetor
through _____ _____.

4

Air is mixed with gasoline in the _____.

5

The mixture of air and gasoline gets into the engine through the _____ _____.

6

Gasoline is pushed up to the carburetor by the _____ _____.

7

When gasoline flows through the fuel system, it goes through gas _____.

17589

1

For a person to have lots of energy, he must eat lots of:

- ☐ food
- ☐ water
- ☐ wood

17840

1

food

2

Food:

- ☐ gives a person energy
- ☐ makes a person tired
- ☐ never affects a person

17941

3

gasoline

4

Gasoline gives the engine the e _____ it needs.

17943

4

energy

5

Gasoline burns in the car's:

- ☐ gas tank
- ☐ engine
- ☐ brake system

17844

APPENDIX

STATE DEPARTMENT OF EDUCATION
Capitol Building
Cheyenne, Wyoming 82001

MEMORANDUM
'Eye Safety Legislation'
the Wyoming State Board of Education, in its meeting of June 12-13, 1967, resolved that:

'It shall be the responsibility of each school district to establish rules and regulations to implement Chapter 100, Session Laws of Wyoming, 1967, which relates to protective eye devices for pupils and teachers.'

CHAPTER 100

Original House Bill No. 80

SCHOOLS--PROTECTIVE EYE DEVICES

AN ACT to require the public schools of the state to supply protective eye devices to pupils and teachers participating in certain courses and to require pupils and teachers desiring protective-corrective eye devices to secure such devices at their own expenses.

Ch. 100 SESSION LAWS OF WYOMING, 1967
Be It Enacted by the Legislature of the State of Wyoming:

Courses Where Protective Eye Devices Required; Trustees to Furnish Devices; Protective-Corrective Devices Responsibility of Individual; Definition

Section 1. Every pupil and teacher in any public school participating in any of the following courses:
(a) Vocational or industrial art shops or laboratories involving use of or exposure to: (1) hot molten metals; (2) milling, sawing, turning, shaping, cutting, or stampting of any solid materials; (3) heat treatment tempering, or kiln firing of any metal or other materials; (4) gas or electric arc welding; (5) repair or servicing of any vehicle; (6) caustic or explosive materials;
(b) Chemical or combined chemical-physical laboratories involving caustic or explosive chemical or hot liquids or solids;

is required to wear industrial quality eye protective devices at all times while participating in such courses or laboratories. The trustees of each school district shall purchase and cause such plano protective eye devices to be placed in such public schools for the eye protection of pupils, teachers and visitors to such classrooms or laboratories.

5

engine

6

If a person gets no food he will not be able to work.

If an engine gets no gasoline it:

- ☐ will run
- ☐ will not run
- ☐ makes no difference

17945

6

will not run

7

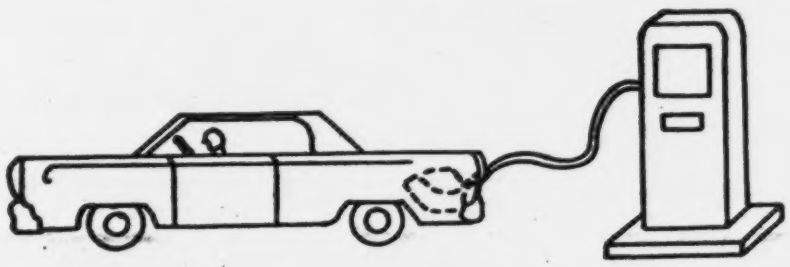

Gasoline is being pumped into a car's GAS TANK.

The job of the gas tank is to:

- ☐ add air to the fuel supply
- ☐ store fuel
- ☐ warm up the engine

17846

7

store fuel

8

The fuel system supplies gasoline for the engine.

The fuel supply comes from the:

- ☐ rear axle
- ☐ gas tank
- ☐ gas gauge

17847

8

gas tank

9

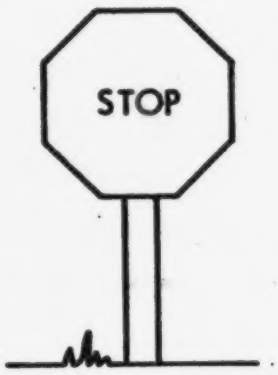

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

17848

9

NO ANSWER NEEDED

10

LOOK AT PANEL 1

The fuel system and the engine are shown in the panel.

The gas tank stores the fuel:

- ☐ next to the engine
- ☐ under the fuel pump
- ☐ away from the engine

17849

10

away from the engine

11

LOOK AT PANEL 1

In which part of the fuel system is the fuel stored?

- ☐ gas lines
- ☐ gas tank
- ☐ gas station

11

gas tank

12

LOOK AT PANEL 1

Fuel is carried through the fuel system by the parts that look like small pipes.

These parts are called _____ _____.

12

gas lines

13

LOOK AT PANEL 1

The arrows show the direction in which fuel flows through the gas lines.

Fuel flows from the:

- ☐ gas tank toward the engine
- ☐ fuel pump toward the gas tank
- ☐ engine toward the gas tank
- ☐ intake manifold toward the fuel pump

17852

13

gas tank toward the engine

14

LOOK AT PANEL 1

The FUEL PUMP pushes gasoline through the fuel system.

The fuel pump is connected to:

- ☐ one gas line
- ☐ two gas lines
- ☐ double carburetors

14

two gas lines

15

LOOK AT PANEL 1

Both gas lines are connected to the:

- ☐ engine
- ☐ gas tank
- ☐ fuel pump

17854

(c) Any person desiring protective-corrective lenses instead of plano protective devices supplied by the school trustees shall at his own expense procure and equip himself with industrial quality eye protective devices.

(d) The phrase 'industrial quality eye protective devices', as used in this section, means devices meeting the standards of the American Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1-1959 promulgated by the American Standards Association, Incorporated.

Approved February 16, 1967.

THE STATE OF WYOMING
Department of Education
Cheyenne

MEMORANDUM

DATE: January 29, 1969
TO: Industrial Arts Instructors
FROM: Charles M. Burke, Industrial Arts Consultant
SUBJECT: Safety Color Code

Accident prevention programs, over the past forty years, have been helping save the lives, limbs and sight of thousands of people at work in industrial plants throughout the country. The use of color in these programs has played a very important part in indentifying hazards detrimental to safe working conditions.

In 1953, the Safety Color Code was approved by the American Standards Association. The Code defines the application of color to specific purposes in connection with accident prevention and recommends the specific colors to be used as markings of physical hazards, the location of safety equipment, and the identification of fire and other protective equipment. ASA recommends Red, Orange, Yellow, Purple, Blue, Green, Black and White for Safety Painting, Pipe Coding and Safety Signs.

SAFETY PAINTING

Red -- Fire Protection Equipment and Apparatus
Fire Alarm Boxes
Fire Blanket Containers
Fire Extinguishers
Fire Hose Cabinets
Fire Hydrants
Fire Exit Signs
Fire Pumps
Fire Sirens
Stand Pipes
Post Indicator Valves
Sand Pails
Hose Reels

15

fuel pump

16

LOOK AT PANEL 1

The CARBURETOR is at one end of a gas line.

The part of the fuel system at the end of the other gas line is the:

- ☐ gas tank
- ☐ exhaust manifold
- ☐ intake manifold

17855

16

gas tank

17

The arrows show that gasoline is pumped through the gas lines to the:

- ☐ fan
- ☐ carburetor
- ☐ generator

17856

17

carburetor

18

LOOK AT PANEL 1

The INTAKE MANIFOLD gets a mixture of gasoline and air from the carburetor.

The intake manifold is part of what system? _____

18

fuel system

19

LOOK AT PANEL 1

The gas tank is at one end of the fuel system.

The part next to the engine at the other end is called the:

- ☐ engine block
- ☐ intake manifold
- ☐ fuel pump

17958

19

intake manifold

20

LOOK AT PANEL 1

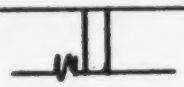

The part mounted on the intake manifold is called the c _____ .

17859

20

carburetor

21

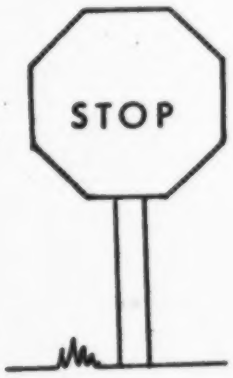

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

17860

21

NO ANSWER NEEDED

22

The carburetor mixes air and gasoline to make a VAPOR.

This vapor mixture should be called a:

- ☐ fuel vapor
- ☐ water vapor
- ☐ spark vapor

17861

22

fuel vapor

23

One kind of vapor you have seen is steam.

Steam is a vapor made of:

- ☐ air and dust
- ☐ air and exhaust
- ☐ air and water

17862

23

air and water

24

CIRCLE the vapor that results when boiling water is mixed with air:

steam smoke soda

17863

24

steam

25

Steam is a vapor of air and water.

Fuel vapor burned in a car's engine is made of air and:

- ☐ oil
- ☐ lighter fluid
- ☐ gasoline

17864

Danger -- Use RED to identify cans and other containers used for the storage of flammable liquids, and identify contents in large white letters.

Red Lights warn of danger. Use on barricades and on temporary construction.

Stop bars on hazardous machines. Stop buttons on electrical switches. Use RED

Orange -- emphasizes hazardous parts of machines or energized equipment which could possibly cut, crush or shock. Following is a partial list of applications:

Interior of gear guards
Exterior of switch boxes on machines
Interior of transmission guards for gears, pulleys
Interior of switch and fuse boxes
Guards over power blades; guards at cutting or crushing points
Exposed parts (edges only) pulleys, gears, rollers, power jaws

Yellow -- demands caution. Use it to warn of physical hazards such as those that a worker my strike against, stumble, fall, trip, or be 'caught in-between.'

Use alternating Yellow and Black striping where extra emphasis to stationary hazards is required.

The following is a partial list of suggestions for the application of Yellow:

Construction Equipment
Moving parts of machines
Moving objects
Handrails, guardrails
Platform edging
Floor zone marking
Caution signs
Markings for low projections

Green -- designates safety. GREEN with a WHITE cross is generally used to mark medical-aid areas. The following is a partial list of suggestions for the application of Green.

First aid dispensary
Stretcher equipment or containers
Safety bulletin boards
First aid kits

Blue -- denotes caution, limited to warning against starting machinery or equipment that is under repair. Warnings, such as a Blue tag, markers, etc., with White lettering reading 'Do Not Start' should be displayed conspicuously on the starting switch or power source of machinery.

25

gasoline

26

The carburetor:

- ☐ mixes air and gasoline
- ☐ separates air from gasoline

17865

26

mixes air and gasoline

27

A mixture of air and gasoline is called:

- ☐ steam
- ☐ fuel vapor
- ☐ water vapor

17866

27

fuel vapor

28

What happens inside a carburetor?

- ☐ gasoline is mixed with air
- ☐ gasoline is mixed with oil
- ☐ gasoline is turned to steam

17867

28

gasoline is mixed with air

29

CHECK the two jobs of the carburetor:

- ☐ makes an air-gasoline liquid
- ☐ makes an air-gasoline vapor
- ☐ puts the air-gasoline liquid into the engine exhaust
- ☐ puts the air-gasoline vapor into the intake manifold

17868

29

makes an air-gasoline vapor

puts air-gasoline vapor into the intake manifold

30

LOOK AT PANEL 1

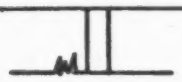

The carburetor is mounted on the _____ _____ .

The part of the fuel system that is mounted on the engine is the:

- ☐ carburetor
- ☐ fuel tank
- ☐ intake manifold

What is mounted on to the intake manifold? _____

The carburetor and the intake manifold (☐ are ☐ are not) two different parts.

17869

30

intake manifold

intake manifold

carburetor

are

31

In the diagram below, CIRCLE the part that puts the air-gasoline vapor into the intake manifold.

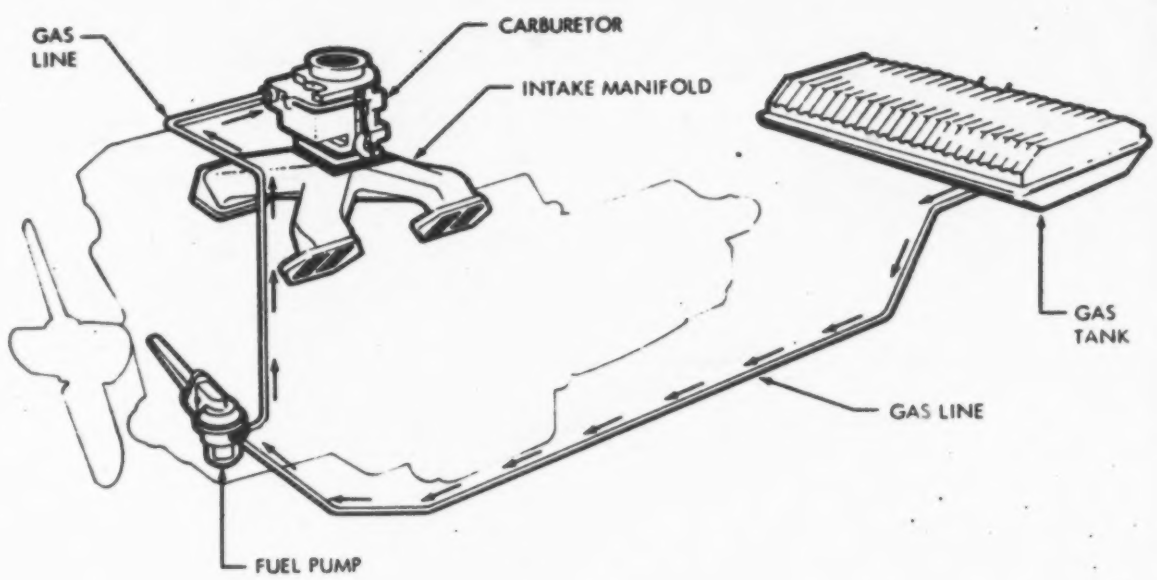

17870

31

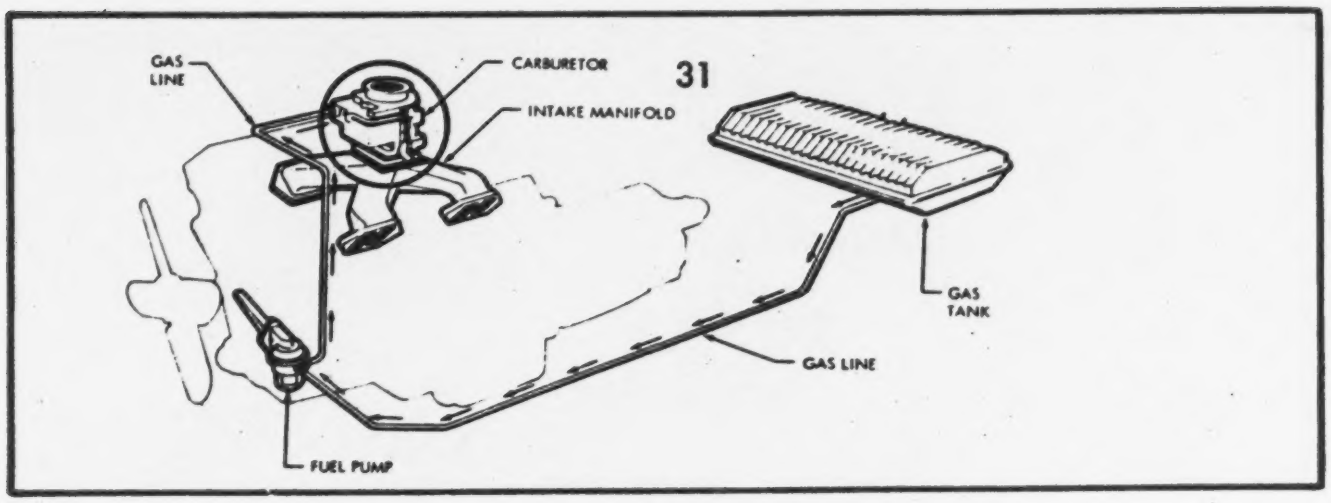

32

The carburetor mixes _____ and _____.

It then puts this mixture into the _____ _____.

32

air (and) gasoline

intake manifold

33

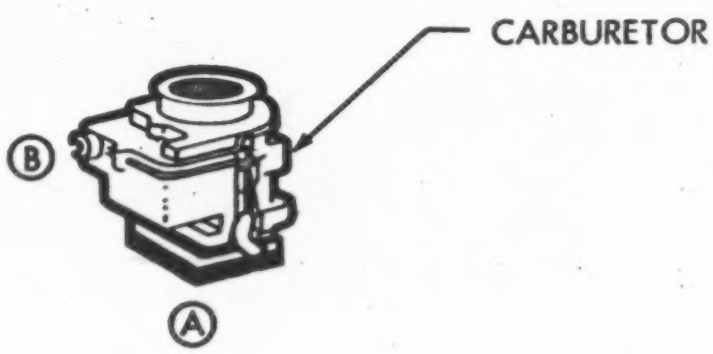

The carburetor is connected to the intake manifold at point A.

Fuel comes into the carburetor at B through the:

- ☐ gas tank
- ☐ fuel pump
- ☐ gas line

17872

33

gas line

34

LABEL the carburetor in the diagram below.

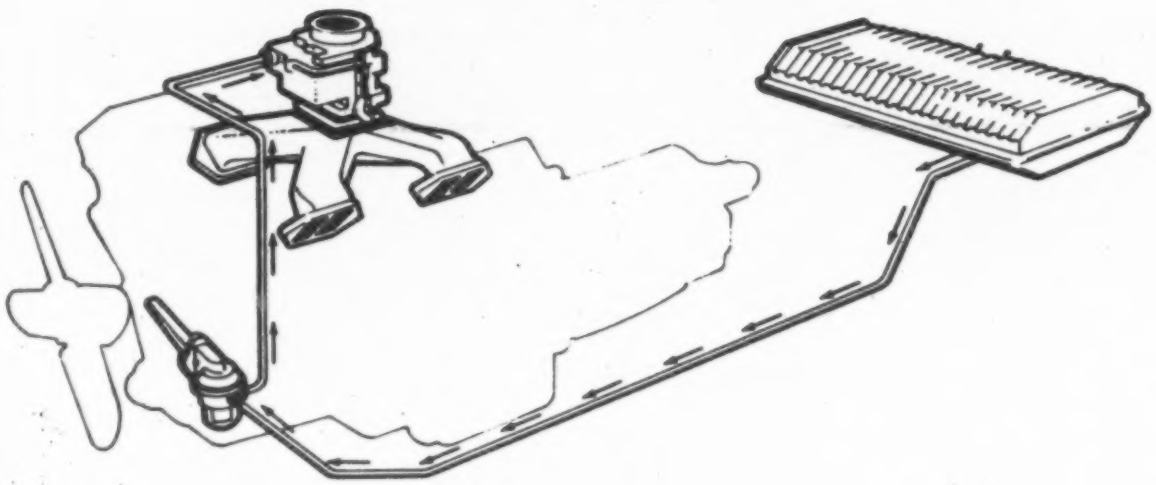

17873

34

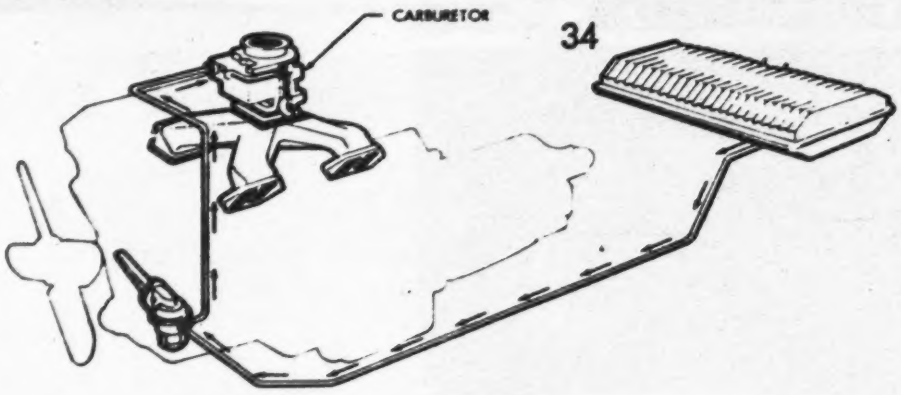

35

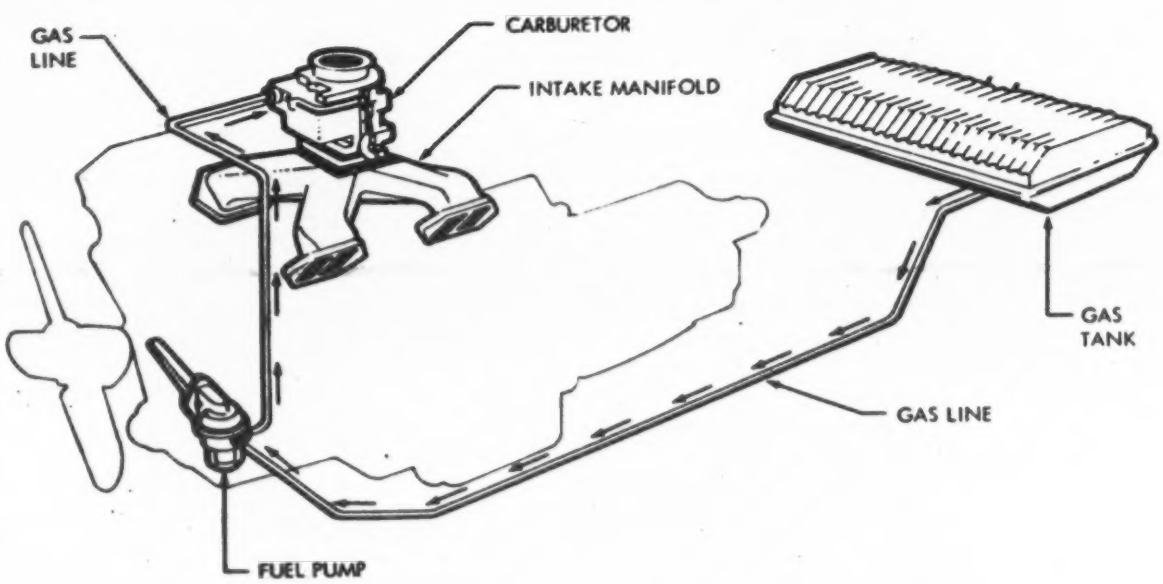

The carburetor gives the fuel vapor (air-gasoline mixture) to the _____ _____ .

17874

Black , White, or a Combination of Black and White -- Black, white, or a combination of these colors is generally used for traffic, zone, and housekeeping markings. Black and White stripes are often applied on barricades and crosswalks.

SAFETY SIGNS

Safety colors gain added visual impact when used in conjunction with safety signs in industrial plants. The American Standards Associations color recommendations for these signs are as follows:

Danger Signs --

Upper portion: Red oval background with letters reading 'Danger'.

Lower portion: White background with Black letters spelling out the particular danger.

Caution Signs--

Upper panel: Yellow letters with Black background reading 'Caution'.

Lower panel: Yellow background with Black letters giving the reason for the caution.

Safety Instruction Signs --

Upper panel; Green with white lettering reading: s : 'safety Instructions', or other suitable wording.

Lower panel: White background with instruction lettered in Black.

General Instruction Signs --

Acceptable in any color, except Red or Yellow

35

intake manifold

36

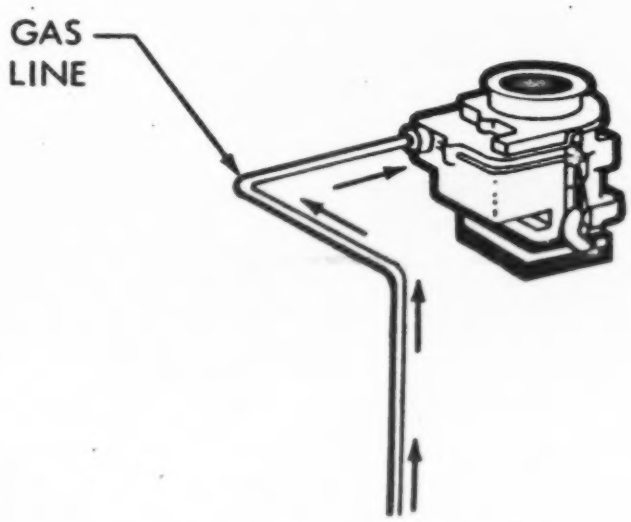

The gas line gives:

- ☐ gasoline to the carburetor
- ☐ the fuel vapor to the intake manifold

17875

36

gasoline to the carburetor

37

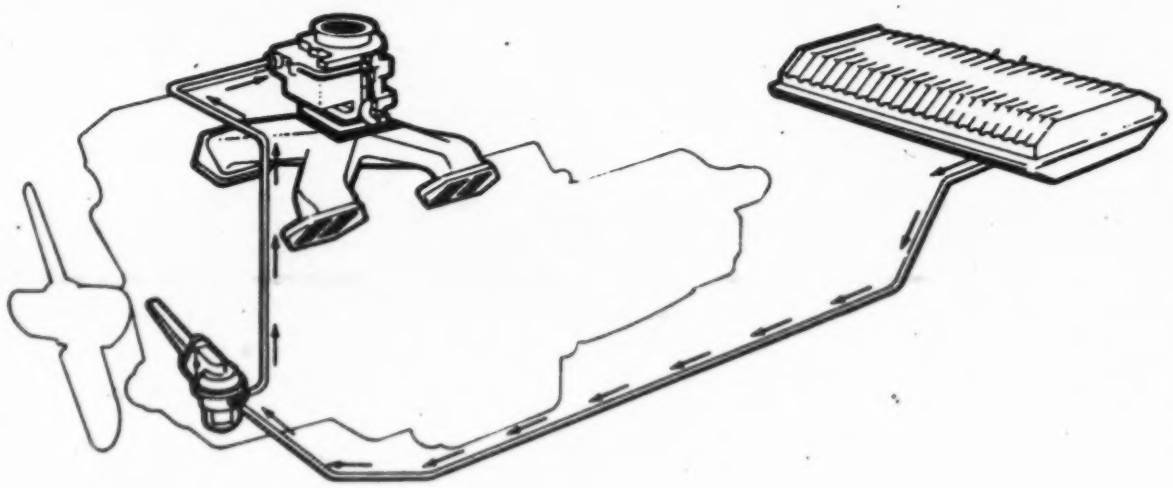

Gasoline reaches the carburetor through the:

- ☐ gas lines
- ☐ gas tank
- ☐ intake manifold

17876

37

gas lines

38

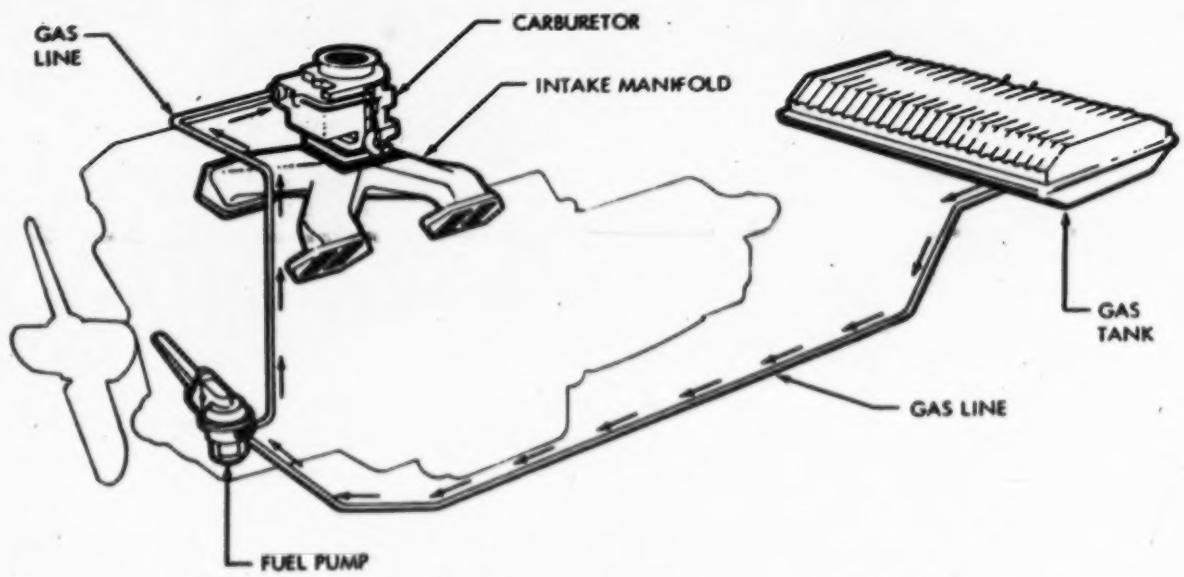

A gas line connects the: (CHECK ALL CORRECT ANSWERS)

- ☐ gas tank directly to the fuel pump
- ☐ gas tank directly to the carburetor
- ☐ carburetor directly to the fuel pump

17877

38

gas tank directly to the fuel pump

carburetor directly to the fuel pump

39

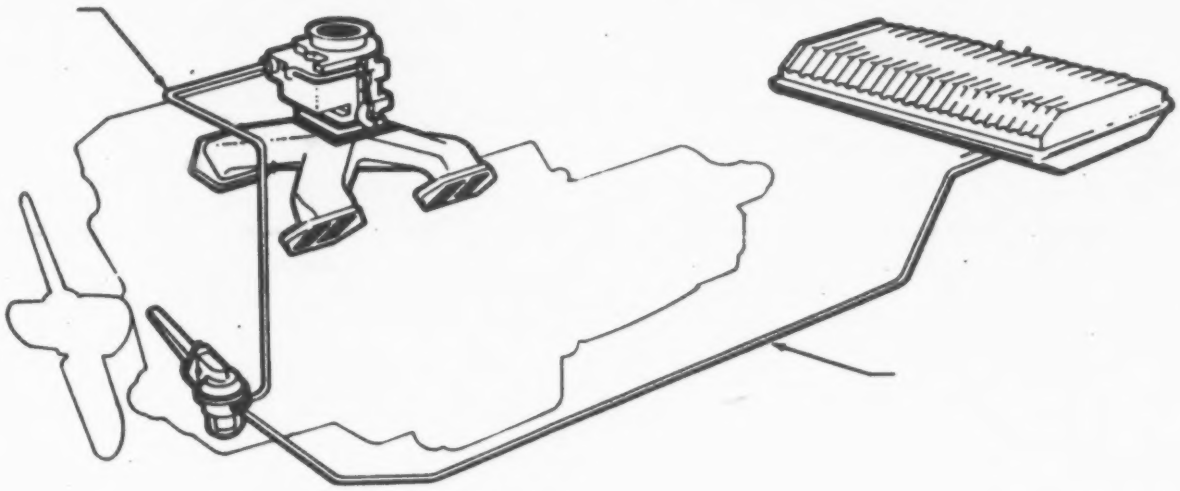

To what parts of the fuel system are the arrows pointing?

_____

17878

39

gas lines

40

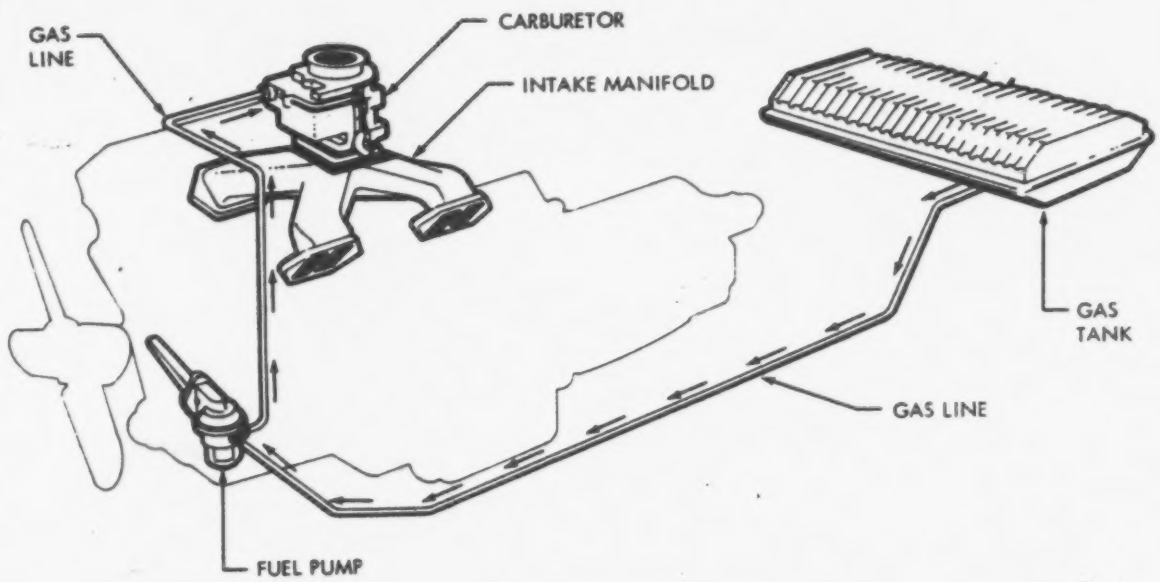

Which of the following best describes how gasoline flows through the fuel system?

- ☐ gas tank → gas line → carburetor → fuel pump → intake manifold
- ☐ gas tank → fuel pump → gas line → carburetor → gas line
- ☐ gas tank → gas line → fuel pump → gas line → carburetor

40

gas tank → gas line → fuel pump → gas line → carburetor

41

Gasoline flows from the gas tank to the fuel pump and from the fuel pump to the carburetor through _____ _____ .

17880

41

gas lines

42

CIRCLE the gas lines.

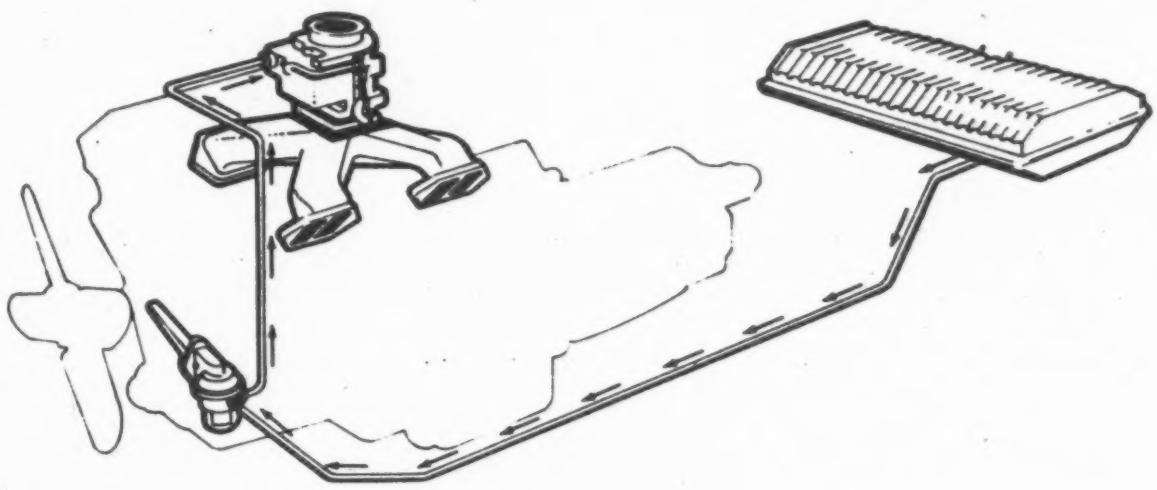

17881

42

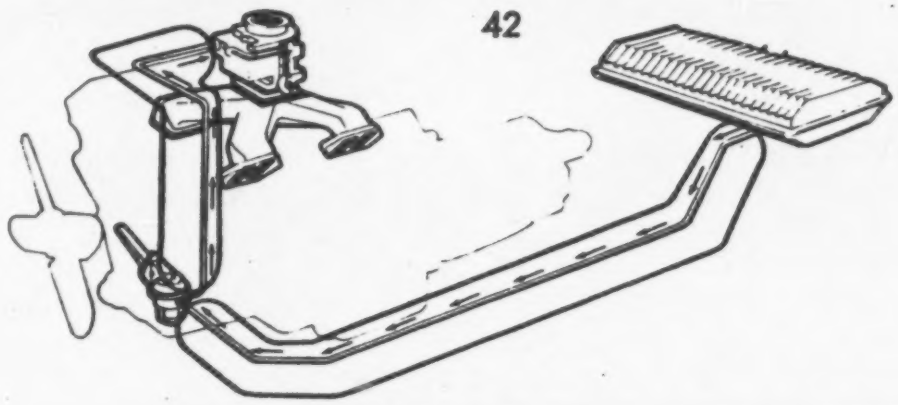

43

LABEL the part connected to the gas lines.

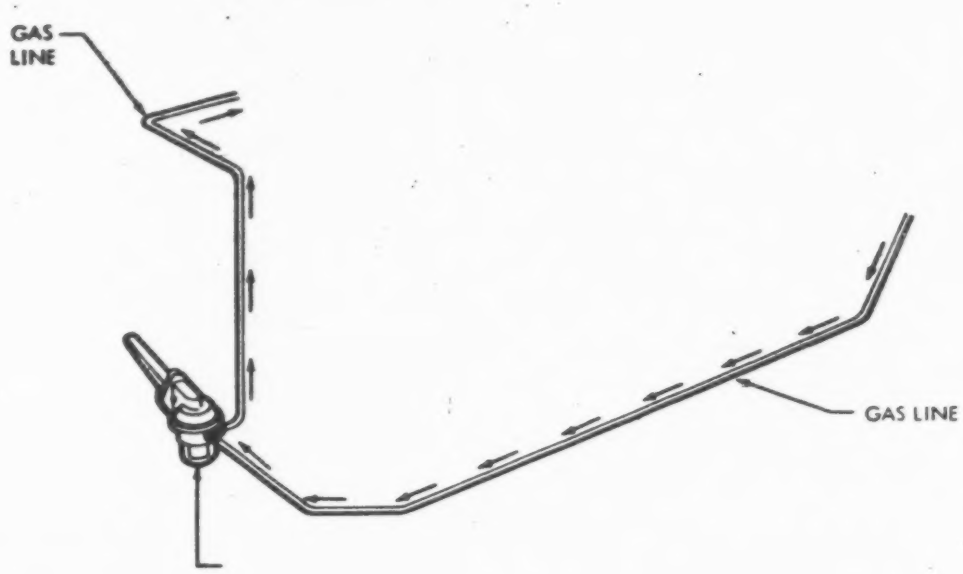

43

fuel pump

44

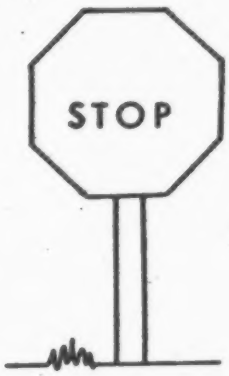

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

17883

44

NO ANSWER NEEDED

45

The carburetor is:

- ☐ higher than the gas tank
- ☐ lower than the gas tank

17884

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1786

45

higher than the gas tank

46

LOOK AT PANEL 1

The fuel pump is needed to pump gasoline:

- ☐ downhill to the carburetor
- ☐ uphill to the carburetor
- ☐ into the intake manifold

17885

46

uphill to the carburetor

47

LOOK AT PANEL 1

What pumps gasoline up to the carburetor? _____ _____

17886

47

fuel pump

48

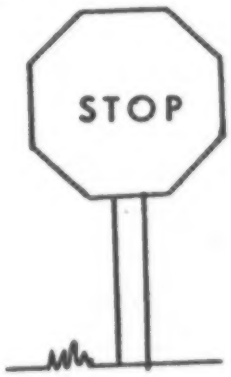

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

17887

48

NO ANSWER NEEDED

49

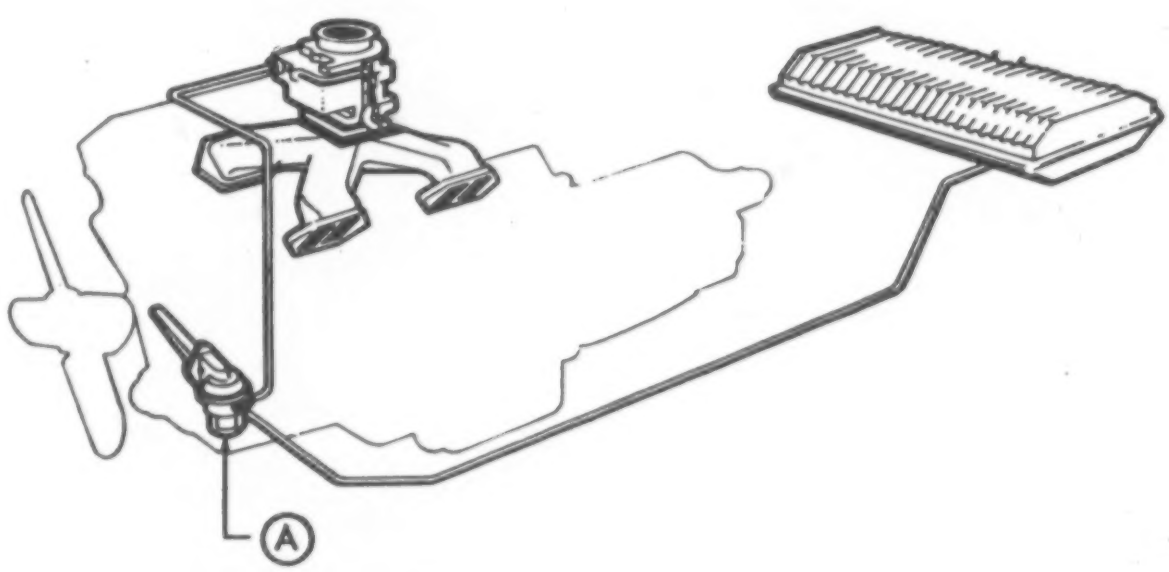

The arrow is pointing to the part that:

- ☐ burns gasoline
- ☐ mixes gasoline
- ☐ pumps gasoline

17588

49

pumps gasoline

50

CIRCLE the fuel pump in the drawing below.

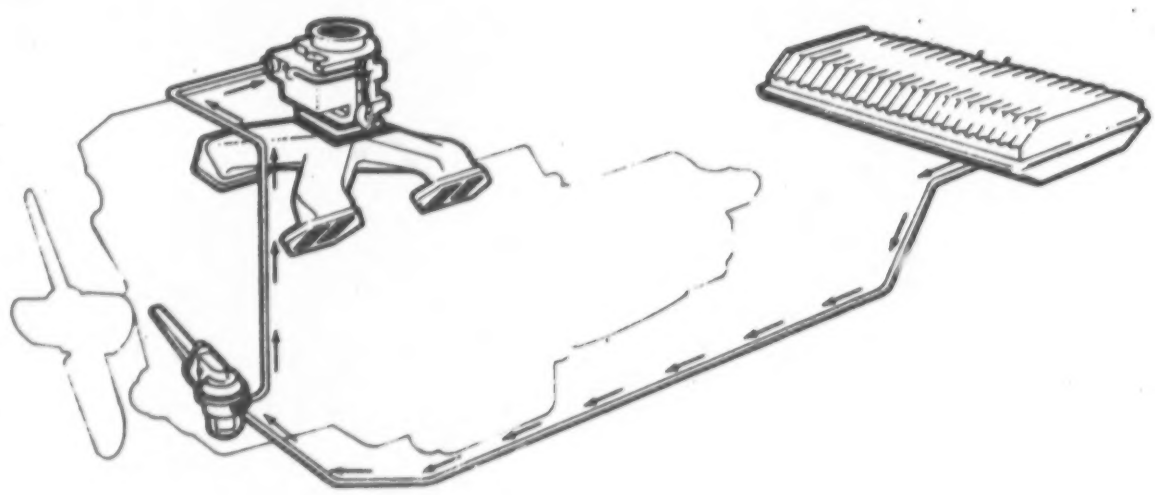

17889

257 OF 327

ED

056 238

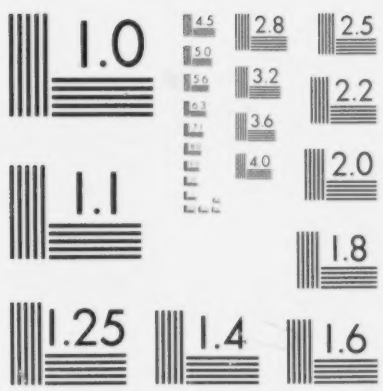

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

50

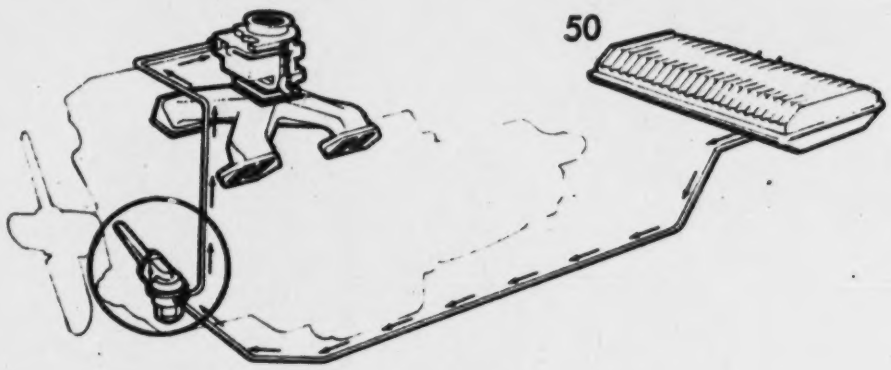

51

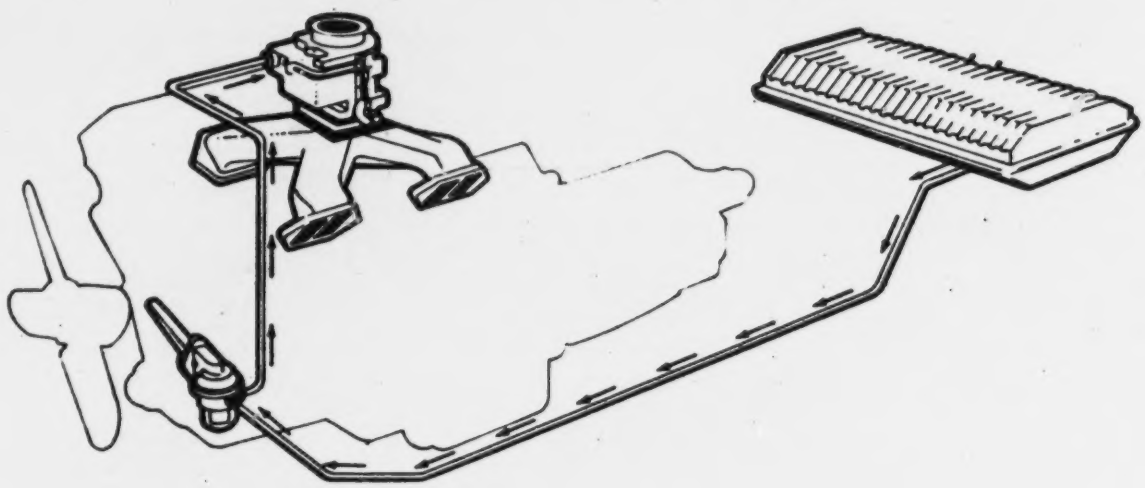

The fuel pump pumps gasoline from the _____ to the _____ .

257

17890

51

gas tank (to the) carburetor

52

NAME the part that pumps gasoline from the gas tank up to the carburetor: _____

17891

52

fuel pump

53

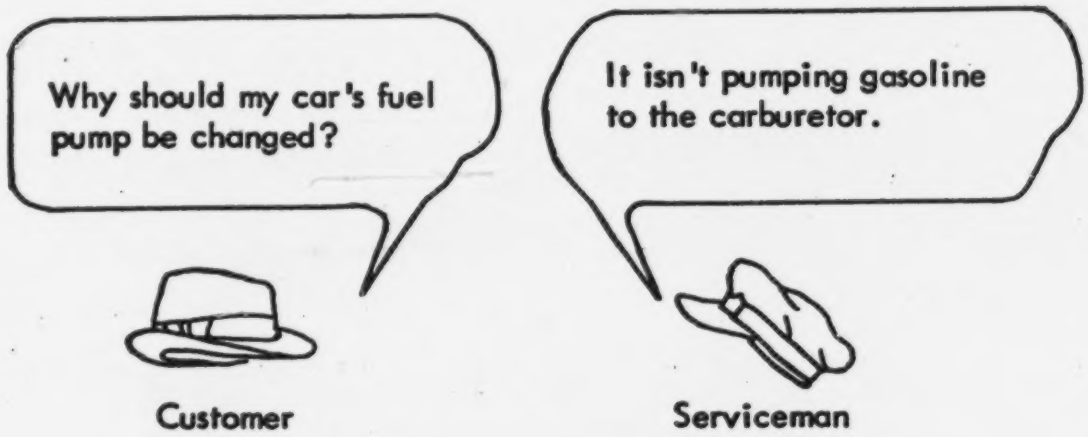

Did the serviceman give a good reason to change a fuel pump?

- ☐ yes
- ☐ no

53

yes

54

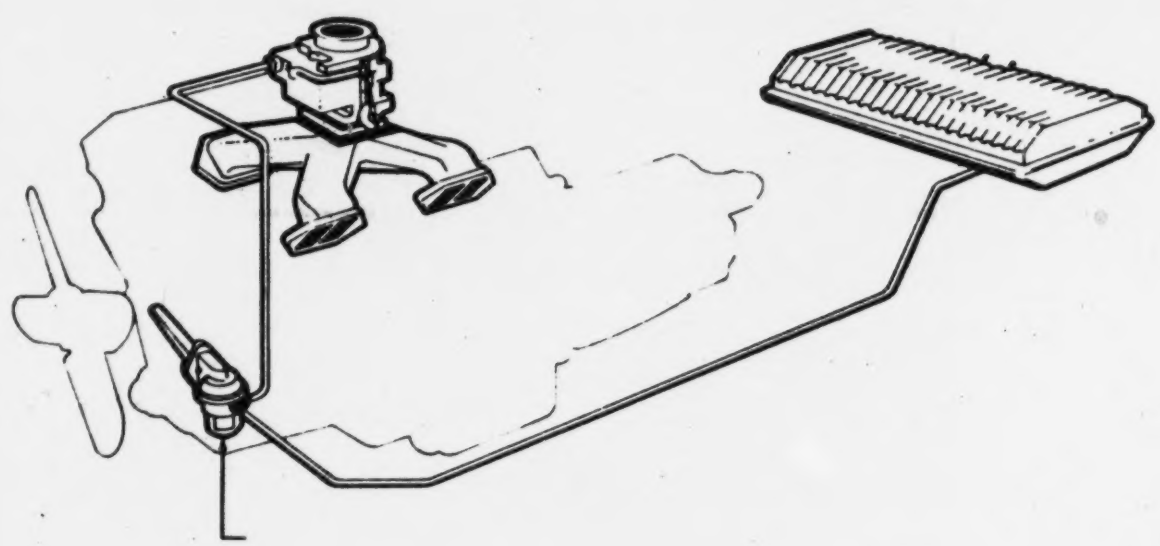

What is the arrow pointing to? _____

17893

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54

fuel pump

55

What does the fuel pump do? _____

17594

55

It pumps gasoline from the gas tank to the carburetor.

56

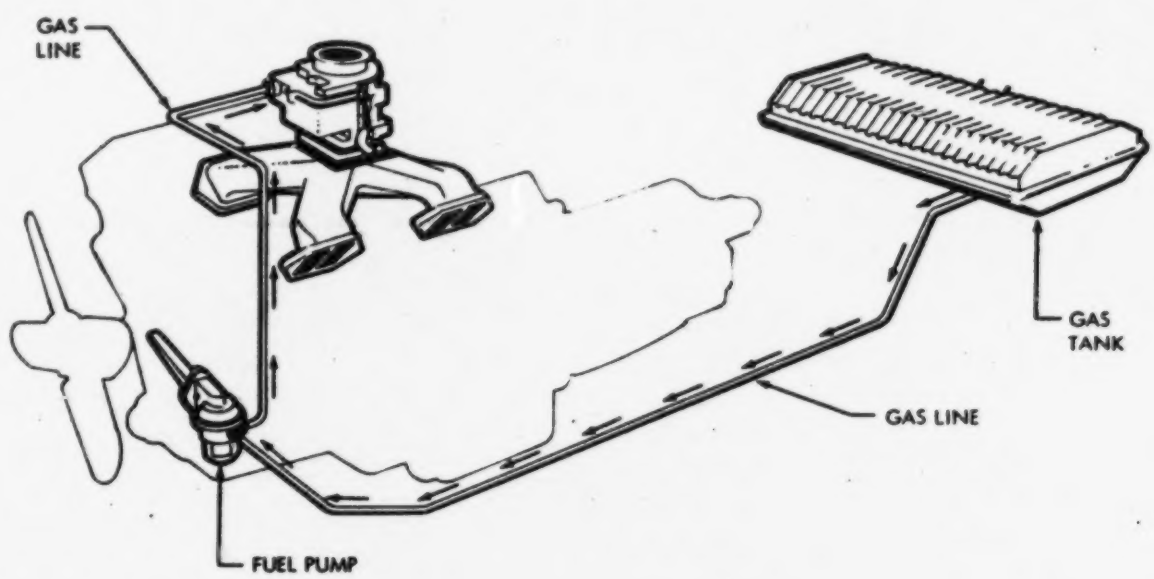

The gas tank is connected to the fuel pump by a _____ _____.

17895

56

gas line

57

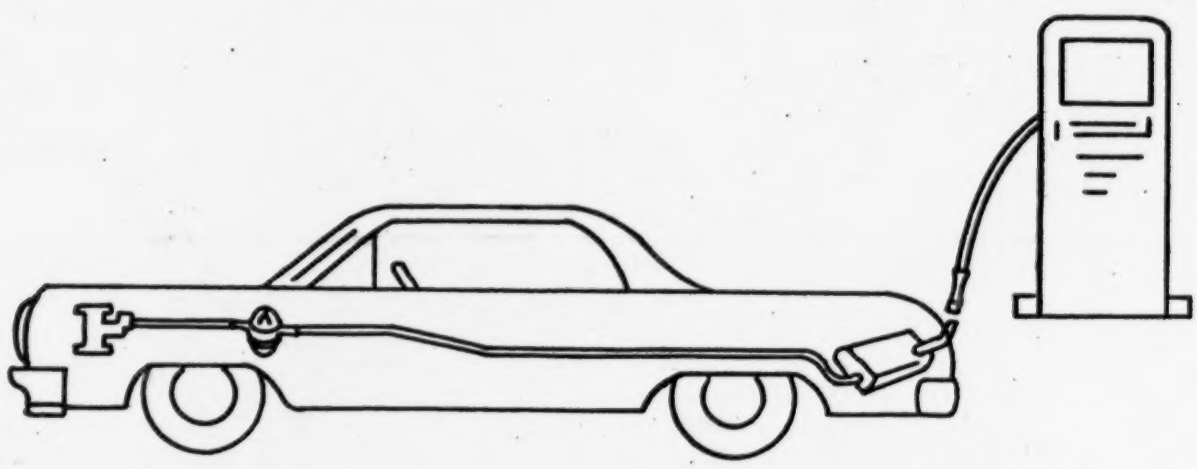

Gasoline in the fuel system is stored in the _____.

17896

57

gas tank

58

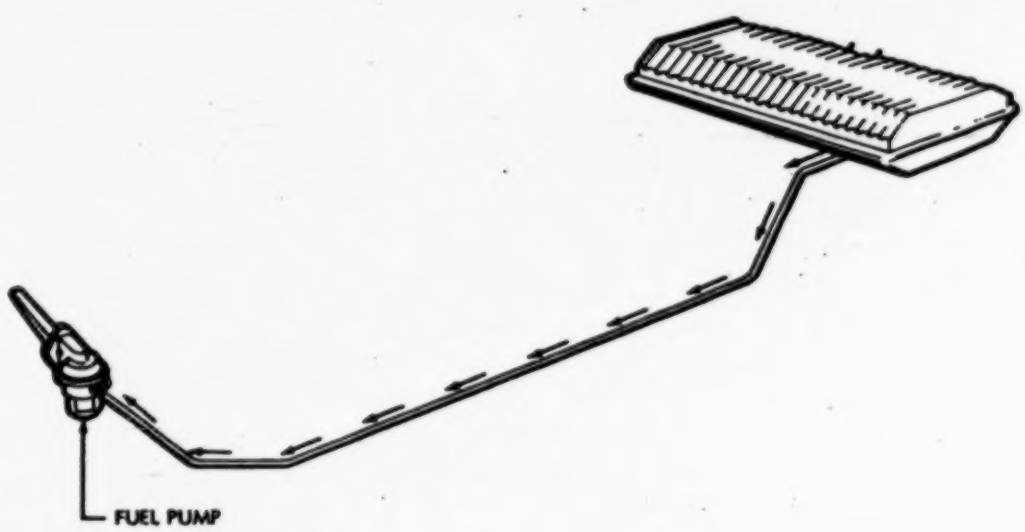

Gasoline reaches the fuel pump through the _____ .

17897

58

gas line

59

The gas tank and the fuel pump are connected by a _____ _____.

17898

59

gas line

60

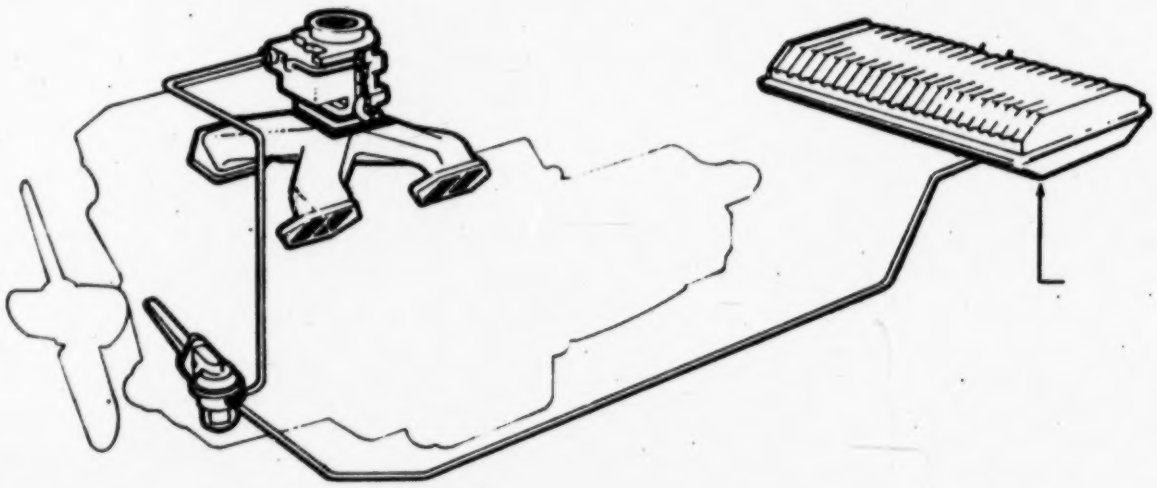

What is the arrow pointing to? _____

17899

60

gas tank

61

The fuel pump gets gasoline from the _____ and pumps the gasoline to the _____ .

61

gas tank

carburetor

62

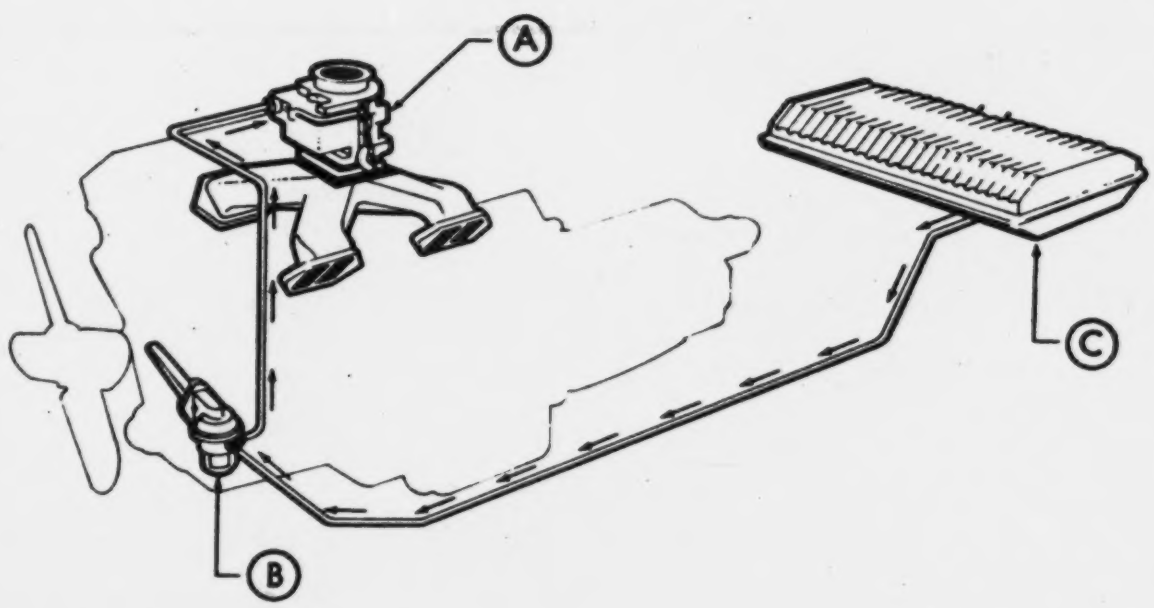

Which letter shows the part that stores gasoline? _____

This part is called the _____ _____.

17901

62

C

gas tank

63

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

17902

63

NO ANSWER NEEDED

64

LOOK AT PANEL 1

The carburetor makes a mixture of _____ and _____.

This fuel vapor enters the engine through the:

- ☐ exhaust manifold
- ☐ fuel pump
- ☐ intake manifold

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1788

64

air (and) gasoline

intake manifold

65

NAME the two things that are mixed to make an automobile's fuel vapor.

_____

_____

NAME the part that makes this mixture. _____

66

the intake manifold

67

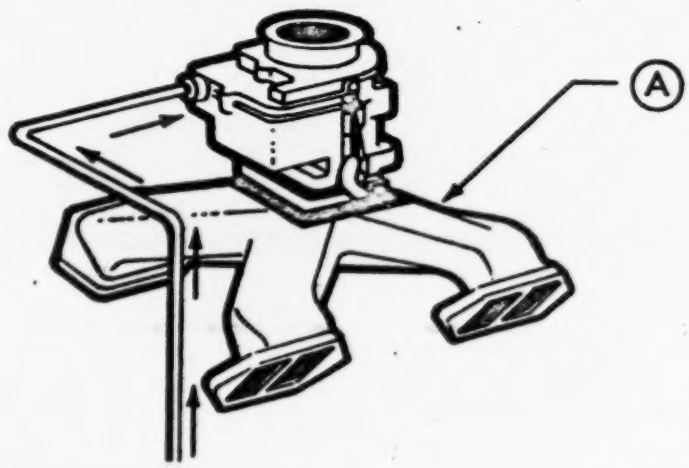

Arrow A is pointing to the:

- ☐ intake manifold
- ☐ water lines
- ☐ gas lines

What goes through the part that arrow A points to?

- ☐ air
- ☐ air-gasoline mixture
- ☐ gasoline

17906

67

intake manifold

air-gasoline mixture

68

LOOK AT PANEL 1.

After the air-gasoline mixture goes through the intake manifold, it enters the _____ .

17907

68

engine

69

LOOK AT PANEL 1

After the air-gasoline mixture leaves the carburetor, how does it get into the engine? _____

17908

69

goes through the intake manifold

70

LOOK AT PANEL 1

What is the job of the intake manifold? _____

70

to get the air-gasoline mixture into the engine

71

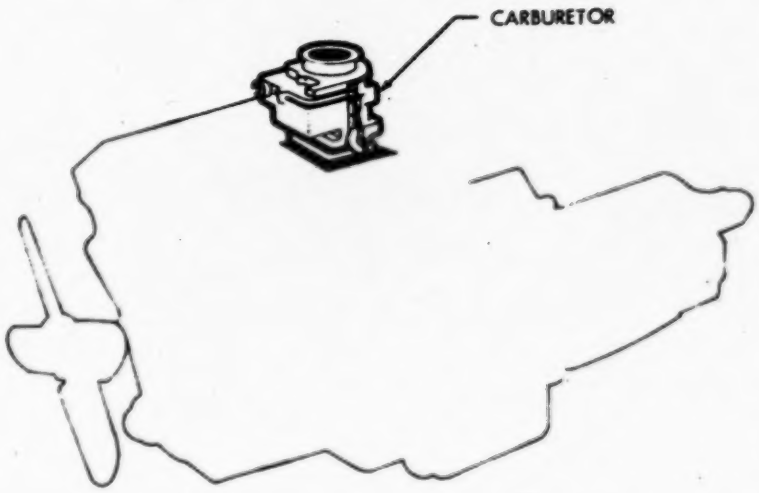

NAME the part that goes between the two parts shown in the above diagram. _____

71

intake manifold

72

The intake manifold connects the _____ and the _____.

72

carburetor (and the) engine

73

WRITE the name of the part to which each arrow points:

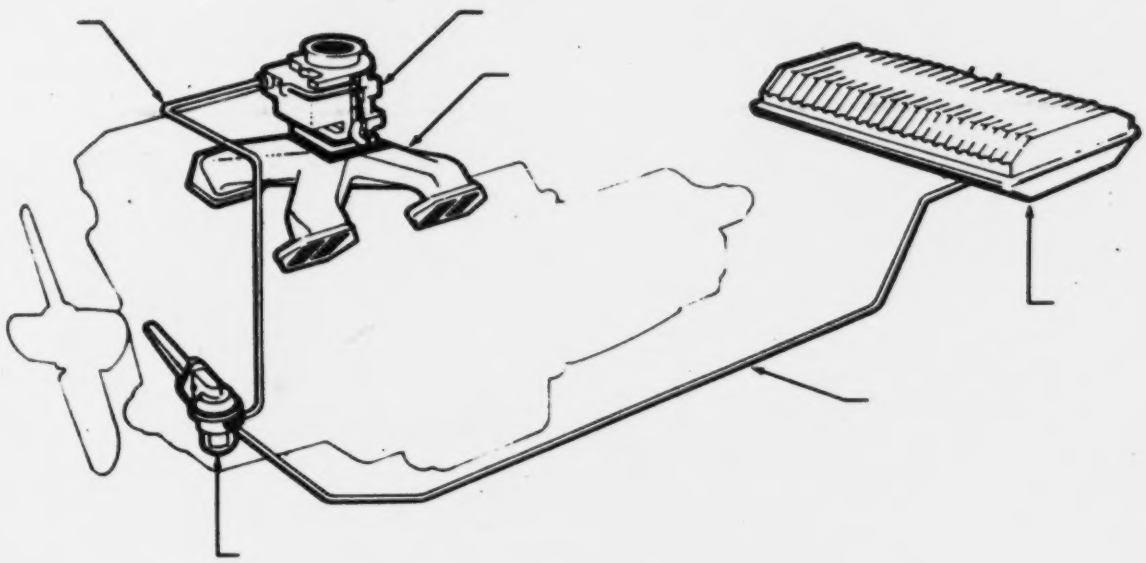

17912

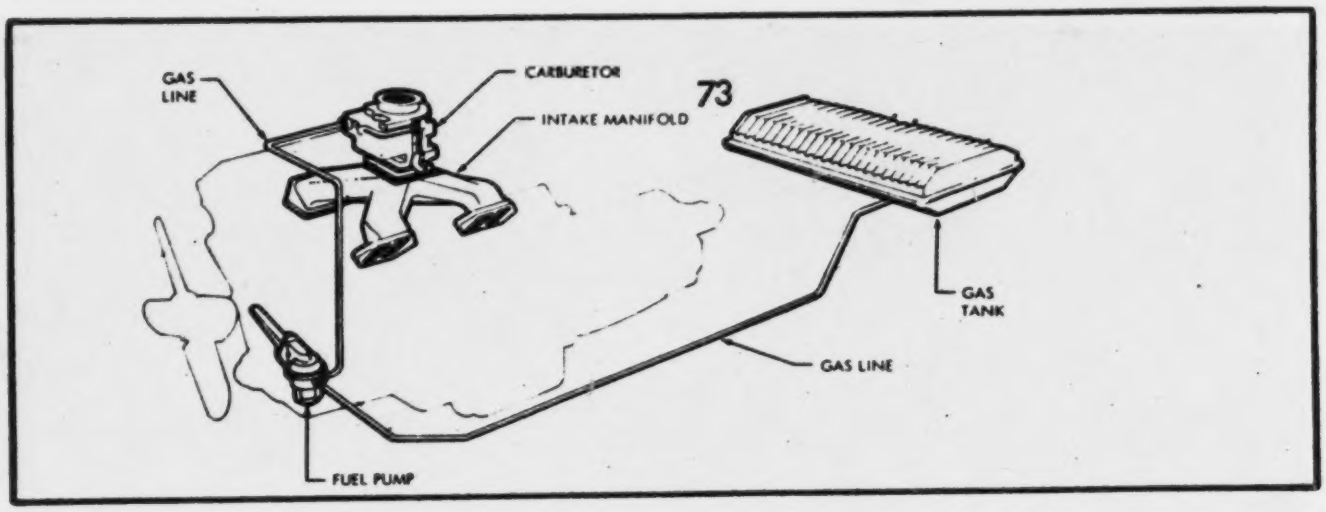

73

74

The carburetor is fastened on top of the:

- ☐ gas lines
- ☐ intake manifold
- ☐ fuel pump

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74

intake manifold

75

Air–gasoline vapor enters the intake manifold from the

_____.

17914

75

carburetor

76

What does the carburetor do? _____

76

mixes air and gasoline to form vapor

77

The picture shows a _____ _____.

What does it do? _____

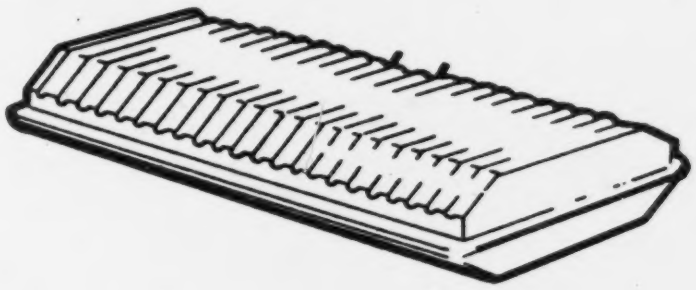

17916

77

gas tank

stores gasoline

78

NAME the part that gets gasoline up to the carburetor.

_____

What does gasoline flow through to get to the carburetor?

_____

What does gasoline flow through when it leaves the gas tank?

_____

17917

78

fuel pump

gas line

gas line

79

Where is gasoline stored in an automobile? _____

17918

79

gas tank

80

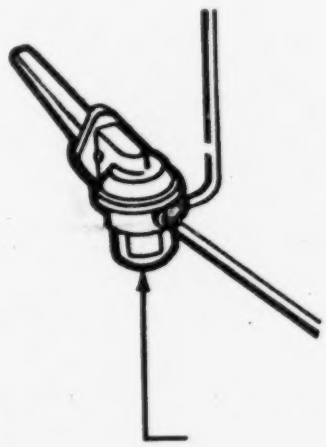

The arrow points to the _____ _____.

17919

80

fuel pump

81

What does the fuel pump do? _____

17920

81

pumps gasoline from the gas tank to the carburetor

82 THIS IS THE END OF BOOK 7

17921

AUTO MECHANICS COURSE

POST-TEST BOOK 7: THE FUEL SYSTEM

A BASIC SYSTEMS PROGRAM

17922

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

Gasoline gets through the fuel system by flowing through _____.

2

Since the carburetor is higher than the gas tank, gasoline must be moved upwards by the _____.

3

Where is gasoline stored? _____

4

17922

The carburetor is mounted onto the _____.

VT 011 497
Williams, Edgar, And Others
Safety in the Auto Shop. Unit No. 1--LAP No. 1.

Hughson Union High School, Calif.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 18p.

DESCRIPTORS - *INDUSTRIAL ARTS; *LEARNING ACTIVITIES; HIGH SCHOOL STUDENTS; MANUALS; *AUTOINSTRUCTIONAL AIDS; INSTRUCTIONAL MATERIALS; EDUCATIONAL OBJECTIVES; *AUTO MECHANICS; *LABORATORY SAFETY; SAFETY EDUCATION
IDENTIFIERS - *ELEMENTARY SECONDARY EDUCATION ACT TITLE III; ESEA TITLE III; LEARNING ACTIVITY PACKAGE; LAP

ABSTRACT - Developed with Elementary and Secondary Education Act (ESEA) Title III funds, this learning activity package is on safety in the high school auto shop. Designed as a self-instructional unit, it contains: (1) Rationale, (2) Primary Idea, (3) Secondary Idea, (4) Objectives, (5) Pretest, (6) Activities, and (7) Eight Instructional Sheets. A pretest answer sheet and bibliography are included. (GR)

VT 011 497

5

An automobile engine uses a mixture of _____ and _____.

6

What does the carburetor do? _____

7

A car will stop running if the fuel pump is broken because no _____ will get to the carburetor.

17924

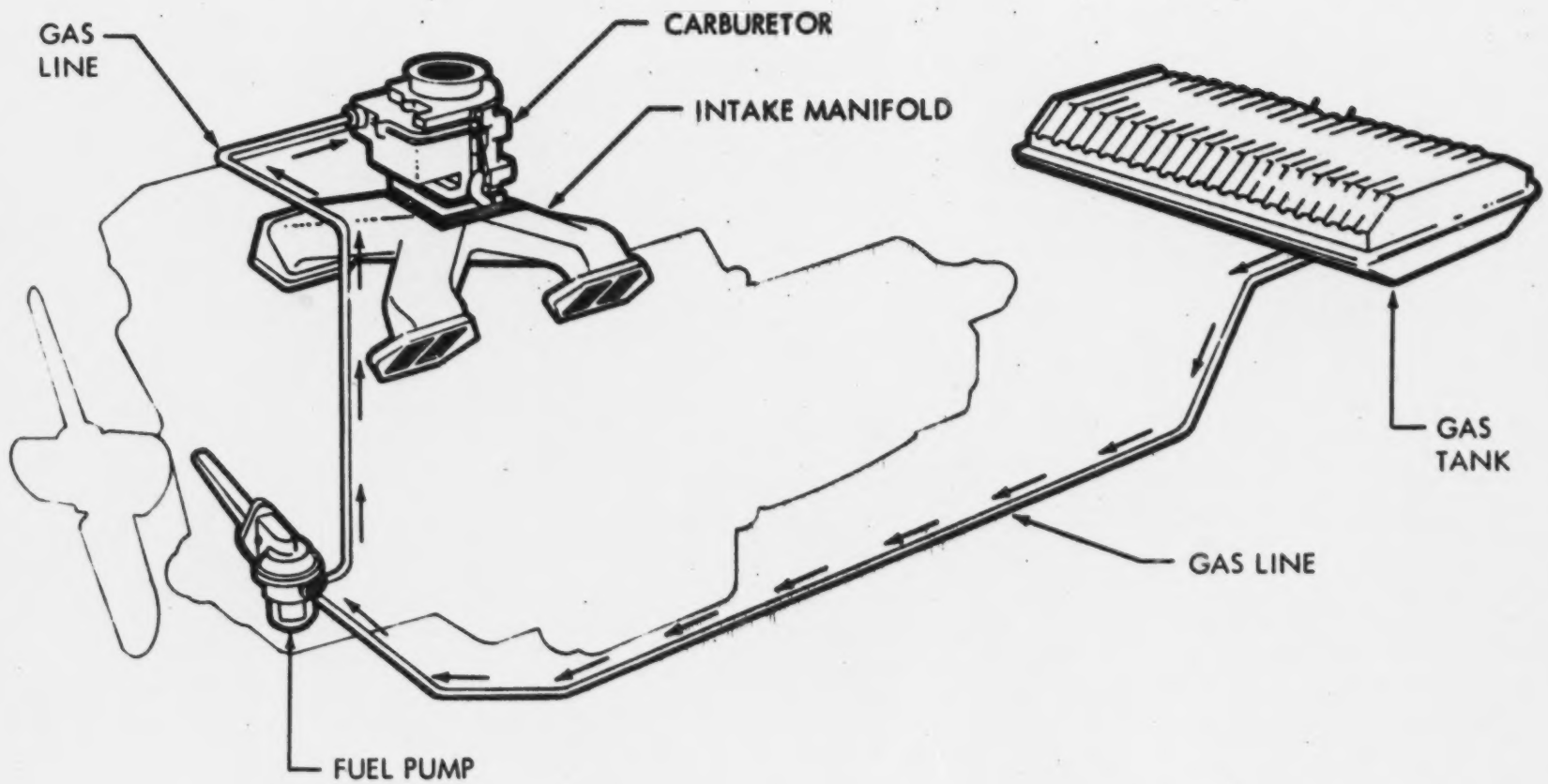
GAS
LINE
CARBURETOR
INTAKE MANIFOLD
GAS
TANK
GAS LINE
FUEL PUMP

PANEL 1

VT 013 130
Auto Mechanics. Book 8: The Cooling System.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 121p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *ENGINES; MOTOR VEHICLES; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the cooling system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 130

ED0 56238

BOOK **8**

(1)

To Be Used With
PANEL BOOK 8

AUTO MECHANICS

BOOK 8: THE COOLING SYSTEM

A BASIC SYSTEMS PROGRAM

VT013130

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EDUCATION & WELFARE
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Curriculum Report Reference
Page 14

Task Analysis Reference
29.1

17926

AUTO MECHANICS

BOOK 8: THE COOLING SYSTEM

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

17927

Name _____

Date _____

Starting time _____

Finishing time _____

17928

AUTO MECHANICS COURSE

PRE-TEST BOOK 8: THE COOLING SYSTEM

A BASIC SYSTEMS PROGRAM

17929

1

For an engine to run at the right temperature, the cooling system must be filled with:

- ☐ gasoline
- ☐ ice
- ☐ water

2

The fan is used to:

- ☐ pull air through the radiator
- ☐ pull air through the water pump
- ☐ push air through the radiator
- ☐ push air through the water pump

3

Water gets through the cooling system because it is pumped by the _____.

4

Water in the cooling system must cool off when it takes heat away from the engine. This happens when the water is in the _____.

5

Hoses are used to get water:

- ☐ to the engine where is stays
- ☐ to the radiator where it stays
- ☐ back and forth between the engine and the radiator

6

The water jacket is inside the _____.

7

When water goes through an engine, it goes from the:

- ☐ bottom to the top
- ☐ top to the bottom
- ☐ back to the front

8

When you put water into the cooling system, you pour it into the:

- ☐ engine
- ☐ radiator
- ☐ thermostat
- ☐ water pump

9

The thermostat will:

- ☐ close if the engine is too cold
- ☐ push water through the cooling system
- ☐ open if the engine is too warm

10

When water flows around the hot spots in the engine, it is flowing through the _____.

11

A car is left standing in very cold weather. The thermostat will be:

- ☐ open
- ☐ closed

ED056238

SAFETY IN THE AUTO SHOP

UNIT #1

LAP #1

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OFFICE OF EDUCATION
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E.S.E.A.

TITLE III

HUGHSON UNION HIGH SCHOOL
WRITTEN BY:
EDGAR WILLIAMS
REX HAYHURST
CHARLES VAUGHN

VT011497

12

A car is left standing in below freezing weather. What must you add to the radiator to keep the water in the cooling system from freezing?

- ☐ antifreeze
- ☐ antiknock
- ☐ oil
- ☐ water

13

Water in the radiator is cooled off by the turning motion of the _____.

1

If a running engine gets too hot, the engine parts will stick together and the engine will stop running.

In the automobile trade, this is called a SEIZED ENGINE.

If an engine gets too hot, it will:

- ☐ continue running
- ☐ stay the same as before
- ☐ stop running

17934

1

stop running

2

Because of small explosions of gasoline in auto engines, the engines can get very hot.

An automobile engine should be:

- ☐ as hot as possible
- ☐ cooled off in some way

2

cooled off in some way

3

If the engine gets too hot, the car can't run the way it should.

So there must be a way to:

- ☐ put heat into the engine
- ☐ take heat out of the engine

17936

3

take heat out of the engine

4

The COOLING SYSTEM of a car uses water to cool the hot engine.

Will an engine run well without water?

- ☐ yes
- ☐ no

17937

4

no

5

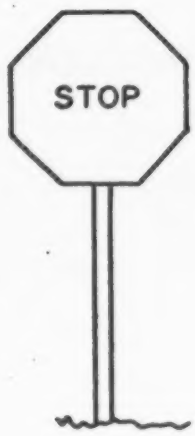

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

17938

5

NO ANSWER NEEDED

6

LOOK AT PANEL 1

Engine B is getting water into its RADIATOR from a water hose.

The radiator is part of a car's:

- ☐ brake system
- ☐ cooling system
- ☐ exhaust system

6

cooling system

7

LOOK AT PANEL 1

The water flowing in engine A was put into the cooling system at the:

- ☐ hose
- ☐ engine
- ☐ radiator

7

radiator

8

LOOK AT PANEL 1

If the water flows between the radiator and the engine, how would it get back and forth?

- ☐ through the water hose
- ☐ through the two hoses on the engine

8

through the two hoses on the engine

9

Why would water flow back from the engine to the radiator?

- ☐ to put heat into the engine
- ☐ to take heat out of the engine

17942

TABLE OF CONTENTS

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SECONDARY IDEA	1
OBJECTIVES	2
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INSTRUCTIONAL SHEETS	7, 8, 9, 10, 11, 12, 13, 14
PRETEST ANSWERS	15
BIBLIOGRAPHY	16

9

to take heat out of the engine

10

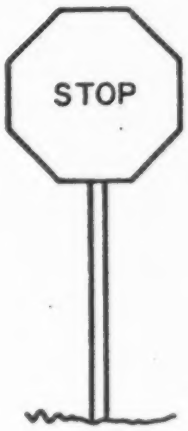

CLOSE THE PANEL BOOK

THEN TURN THE PAGE AND GO ON

17943

10

NO ANSWER NEEDED

11

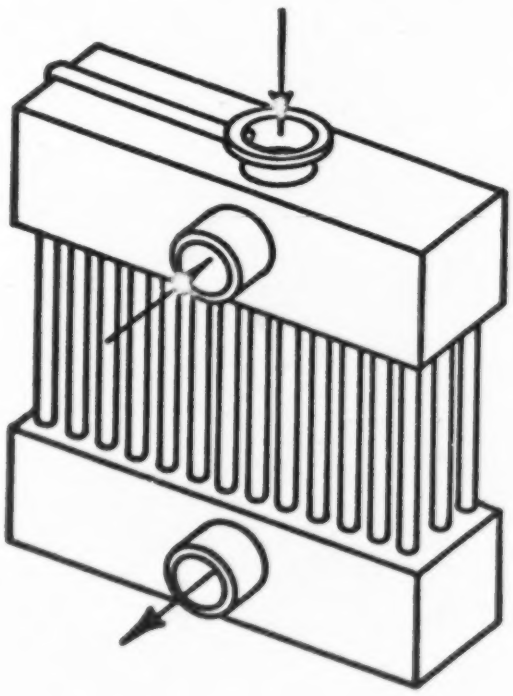

The radiator has small pipes to hold the _____.

17944

11

water

12

Water to cool the engine is stored in the:

- ☐ crankcase
- ☐ gas tank
- ☐ radiator

17945

12

radiator

13

CIRCLE the radiator in the drawing below:

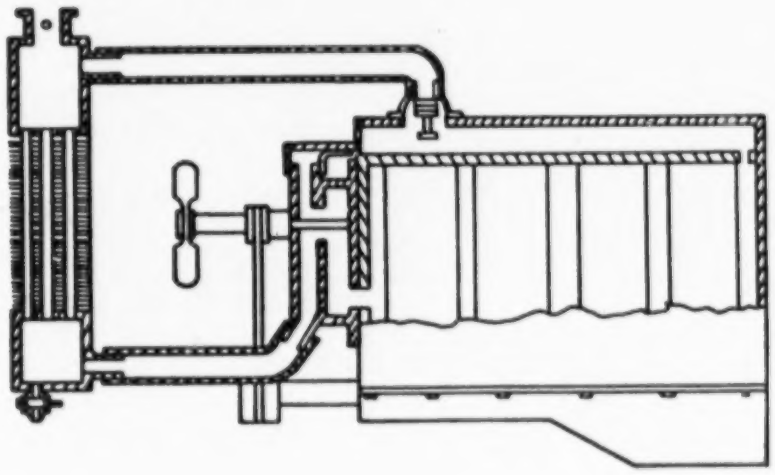

17946

13

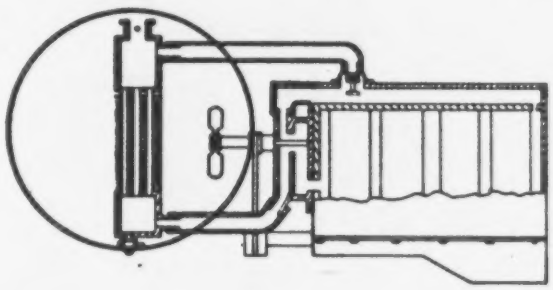

14

MATCH the parts at the left with the actions at the right:

A. brake line

B. engine

C. radiator

1. _____ gets very hot and needs cooling

2. _____ holds water for cooling

17947

14

1. B
2. C

15

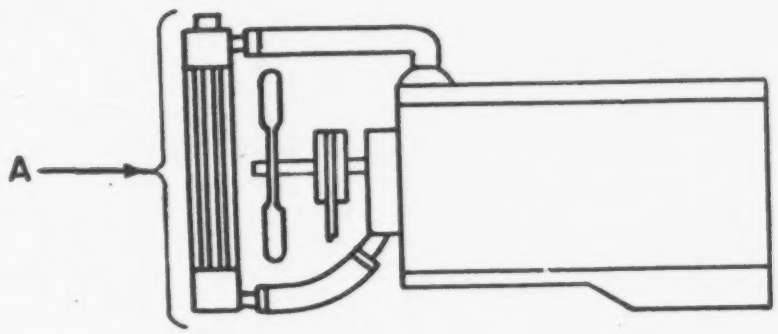

Arrow A points to the _____

17948

15

radiator

16

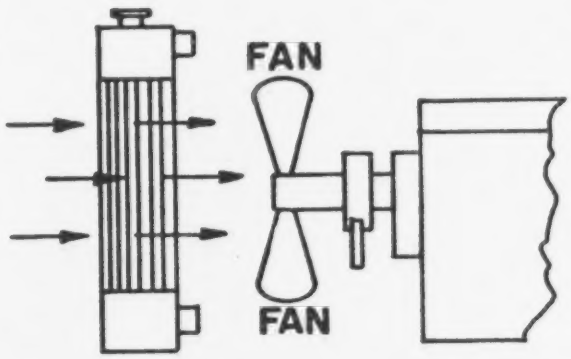

In the drawing above the heavy arrows show how air flows through the radiator.

The fan is:

- ☐ pulling the air
- ☐ pushing the air

17949

16

pulling the air

17

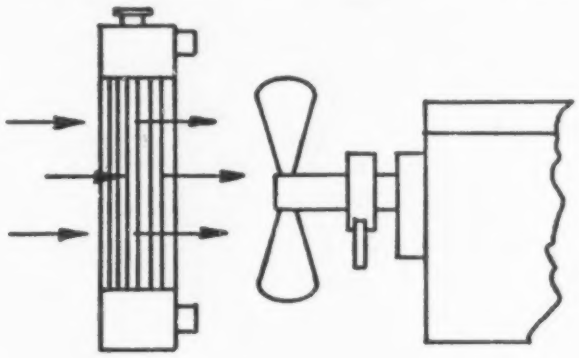

The water in the radiator is cooled by:

- ☐ quick freezing
- ☐ overflow valves
- ☐ air flow

17950

17

air flow

18

The fan is used to pull air through the:

- ☐ engine
- ☐ radiator
- ☐ radiator hoses

17951

18

radiator hoses

19

Water in the cooling system cools the engine.

What cools the water?

- ☐ air
- ☐ gas
- ☐ oil

RATIONALE

On the following pages is a program that will help the student become familiar with shop safety, proper use of hand tools, and machine hazards.

PRIMARY IDEA

Auto Shop Safety

SECONDARY IDEAS:

1. General Auto Shop Safety
2. Safety in Using Hand Tools
3. Safety in Using Machine Tools

19

air

20

What makes the air flow through the radiator?

- ☐ the engine
- ☐ the fan
- ☐ the radiator

17953

20

the fan

21

Does the fan push or does it pull the air through the radiator?

- ☐ it pulls the air through
- ☐ it pushes the air through

17954

21

it pulls the air through

22

CIRCLE the fan in the drawing below:

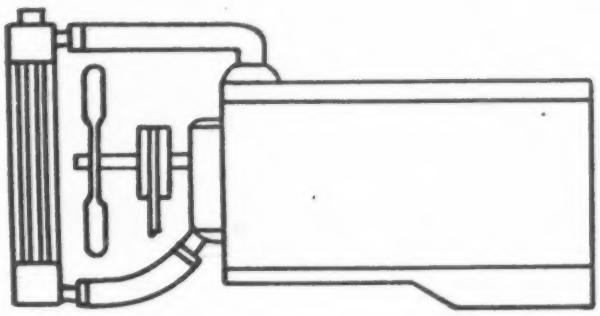

17955

22

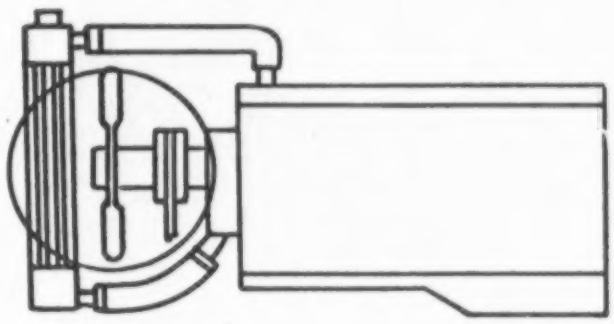

23

MATCH the parts at the left with the actions at the right.

A.	engine	1. _____	holds water for cooling
B.	fan	2. _____	pulls air through for cooling water
C.	radiator		

17956

23

1. C
2. B

24

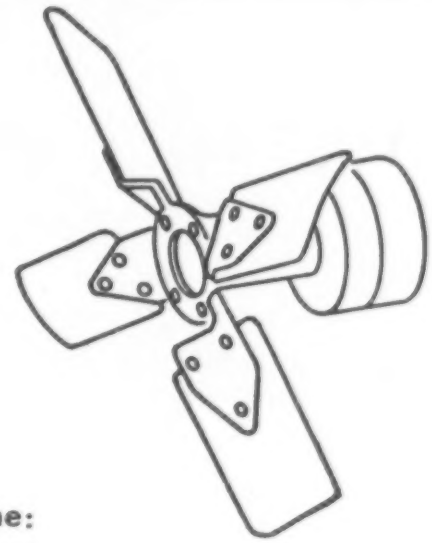

The auto part in the picture is the:

- ☐ flywheel
- ☐ fan
- ☐ radiator

24

fan

25

DANGER

ALWAYS BE CAREFUL WHEN YOU ARE WORKING ANYWHERE NEAR THE FAN ON A CAR ENGINE.

YOUR HAND OR YOUR CLOTHING MAY GET CAUGHT IN THE FAN, AND YOU COULD BE SERIOUSLY INJURED.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

258 OF 327

ED

056 238

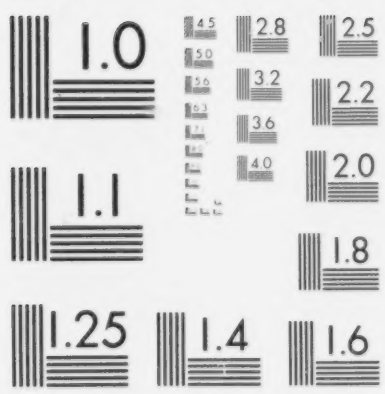

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

25

NO ANSWER NEEDED

26

TOP OF THE ENGINE

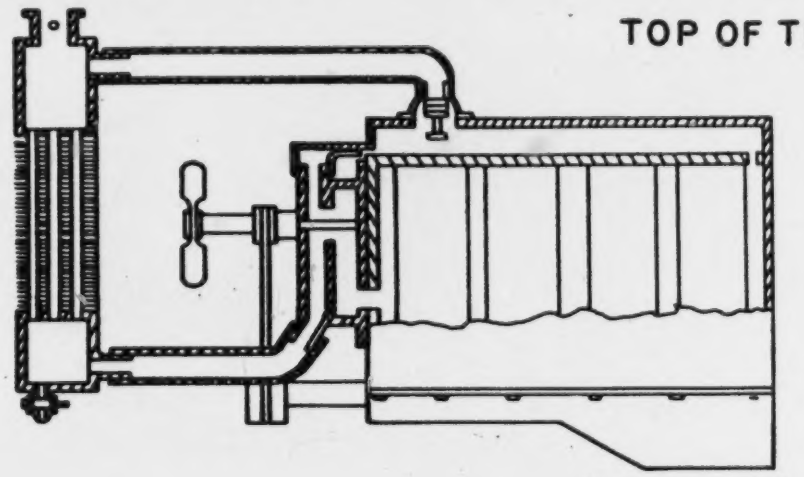

BOTTOM OF THE ENGINE

From this picture you can see that:

- ☐ all parts of the engine are on the same level
- ☐ some parts are higher than other parts

17959

358

26

some parts are higher than other parts

27

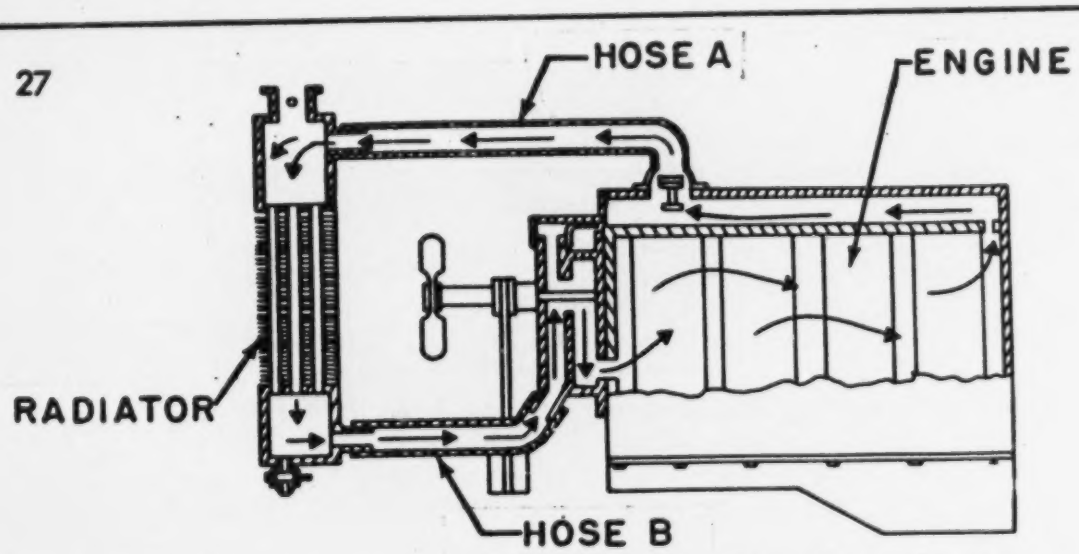

Water flows from Hose A at the bottom to Hose B at the top because:

- ☐ water in the system is always cool
- ☐ water is pumped through the cooling system
- ☐ water flows uphill by itself

17961

27

water is pumped through the cooling system

28

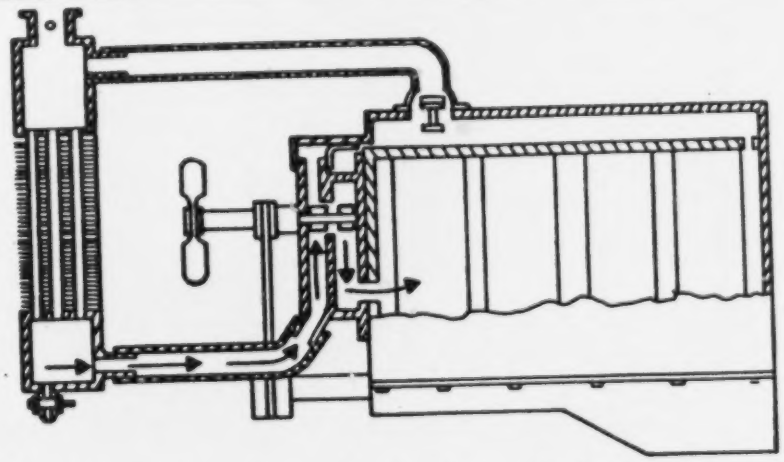

Water goes into the engine from the bottom of the radiator.

Water gets to the top of the engine because:

- ☐ the water will flow uphill by itself
- ☐ a pump pushes the water through the engine
- ☐ the car moves forward at high speed

17962

INSTRUCTIONAL OBJECTIVES

When completed with this package you will be able to:

1. List at least ten typical auto shop safety accidents.
2. Know how to respond in case of an accident that might occur in the auto shop
3. Pass a safety test with 100% score.
4. You will be expected to demonstrate that you understand by practicing shop safety at all times.
5. You will be expected to follow any school safety or fire drill.

1794

28

a pump pushes the water through the engine

29

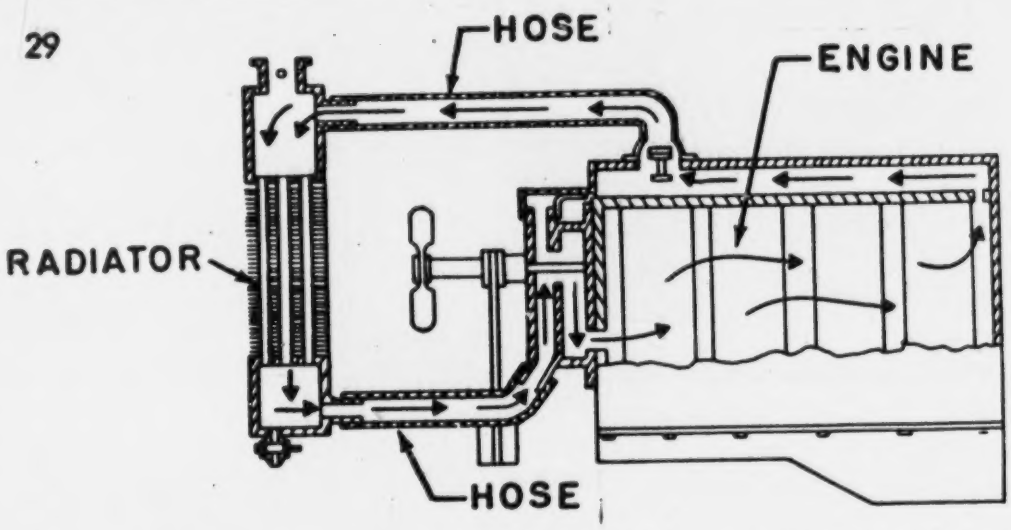

The cooling system has a WATER PUMP to push water through the system (see arrows).

Water flows from the radiator to the engine:

- ☐ through the hose at the top
- ☐ through the hose at the bottom
- ☐ through the radiator pipes

17963

29

through the hose at the bottom

30

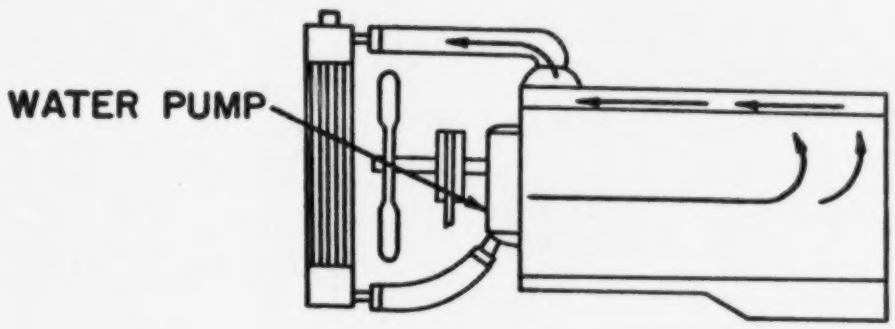

When the car's engine is running, the water pump pushes the water:

- ☐ from the engine to the radiator
- ☐ from the radiator to the engine

17964

30

from the engine to the radiator

31

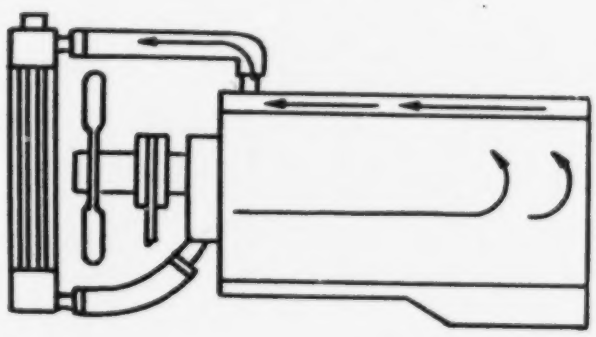

CIRCLE the water pump in the drawing above.

17965

31

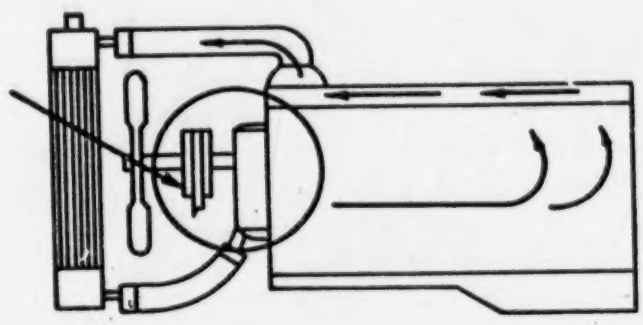

32

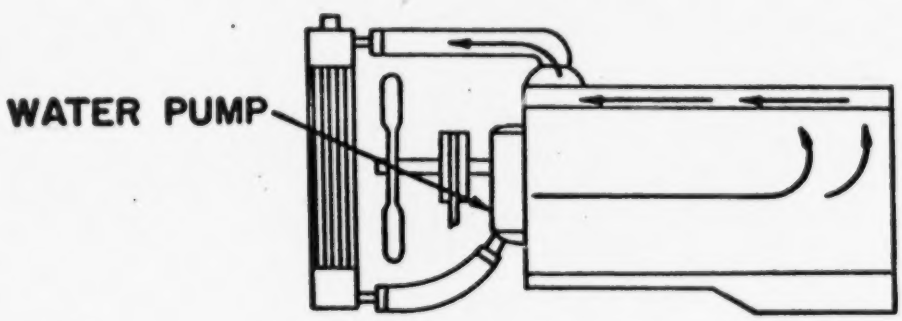

CIRCLE the radiator.

17966

32

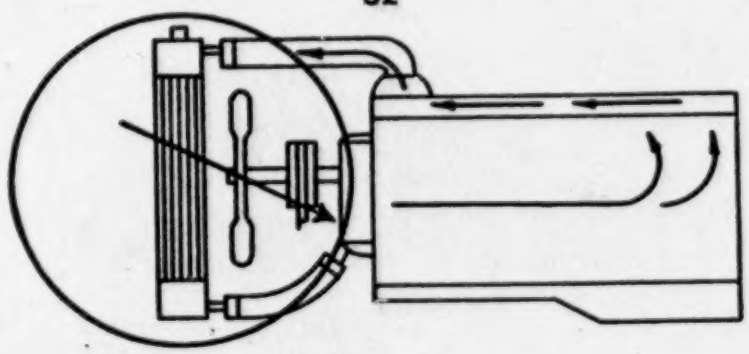

33

NAME the system that the water pump pushes water through.

_____

17967

33

cooling system

34

Can water go through the cooling system without the water pump?

- ☐ yes
- ☐ no

17968

35

pushes water through the cooling system

36

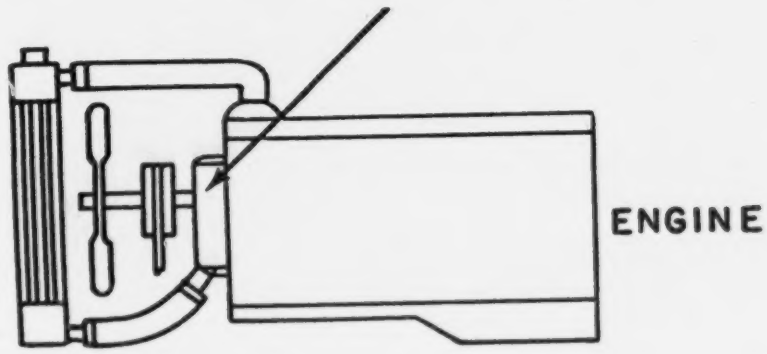

The arrow is pointing to the _____ _____ of the cooling system.

17970

36

water pump

37

fan	radiator	water pump
hose	water jacket	

Using the parts listed above, COMPLETE the following sentences.

The part that holds water is called the _____.

Air is pulled through the radiator by the _____.

Water in the cooling system is pushed by the _____.

17971

37

radiator

fan

water pump

38

If water is going into the engine it means that:

- ☐ the fan is not working
- ☐ the water pump is not working
- ☐ the water pump is pushing the water through

17972

This is a pre-test for you. Answer the following questions before going on to the activities listed. If you can pass this test with a score of 100%, you may be exempt from this LAP.

PRETEST

Complete test as explained

TRUE- FALSE (Write T for true, F for false.)

____ 1. The shop needs to be clean if it is going to be safe.

____ 2. Grease and oil that is spilled on the floor should be cleaned up at the end of the period.

____ 3. When the fire drill bell rings you should run to the nearest exit.

____ 4. It is permissible to short circuit a battery for testing purposes.

____ 5. The wire buffer should not be used without eye protection.

____ 6. Sharp tools should not be carried in the pockets.

____ 7. Lift with your legs instead of your back.

____ 8. Screwdrivers make good pry bars.

____ 9. Guards can be removed from grinders if eye protection is worn.

____ 10. It is a good practice to stand to one side of the grinding wheel when starting it.

____ 11. When welding with the arc welder, safety goggles designed for gas welding may be used.

____ 12. Throwing things in the shop is not permitted.

____ 13. Students should test fire extinguishers at least twice a year.

____ 14. Prior to running an engine, be sure that it is fastened securely to its stand.

____ 15. It is necessary to report to the teacher any equipment that is not operating correctly.

ae1795

38

the water pump is pushing the water through

39

DRAW an arrow pointing to the water pump in the picture below:

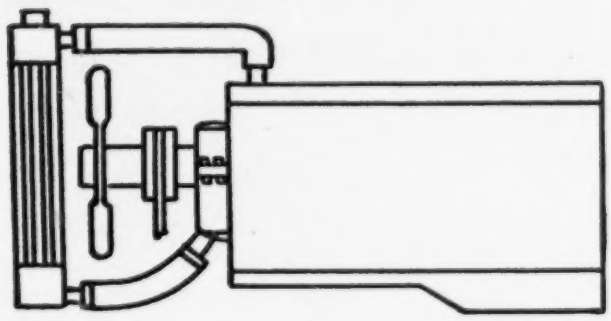

17973

39

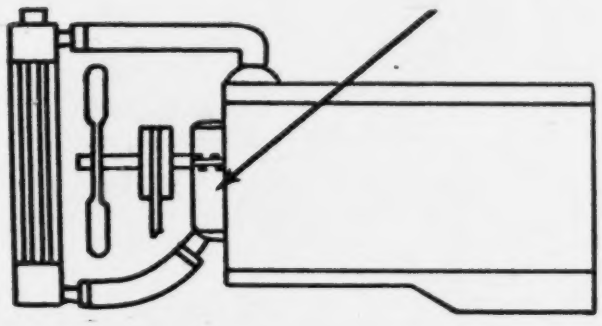

40

PICK UP THE PANEL BOOK

FIND PANEL 1 AGAIN

THEN TURN THE PAGE AND GO ON

17974

40

NO ANSWER NEEDED

41

LOOK AT PANEL 1

For each engine, how many hoses are there between the radiator and the engine? _____

17975

41

2 or two

42

LOOK AT PANEL 1

Water gets to the engine and back to the radiator by going:

- ☐ around the hoses
- ☐ out of the cooling system
- ☐ through the hoses

42

through the hoses

43

LOOK AT PANEL 1

The bottom hose takes water from the radiator into the engine. (See arrows, Engine A)

The top hose takes the water:

- ☐ from the engine to the radiator
- ☐ from the radiator to the engine

43

from the engine to the radiator

44

LOOK AT PANEL 1

Water going <u>from</u> the engine <u>to</u> the radiator flows through the (see arrows, Engine A):

- ☐ bottom hose
- ☐ top hose

44

top hose

45

LOOK AT PANEL 1

Water goes from the radiator to the engine and back again by going:

- ☐ out of the cooling system
- ☐ through the fan
- ☐ through through the hoses

17979

45

through the hoses

46

LOOK AT PANEL 1

The bottom hose takes water to the _____ .

The top hose takes water back to the _____ .

17980

46

engine

radiator

47

LOOK AT PANEL 1

The water in the radiator is cool.

It enters the engine through the bottom hose.

Will the water get hot in the engine?

- ☐ yes
- ☐ no

47

yes

48

CLOSE THE PANEL BOOK

THEN TURN THE PAGE AND GO ON

17982

____ 16. Small tools can be dangerous if they are left on the floor.

COMPLETION (Write correct answers in spaces provided.)

1. When working on an automobile engine, make sure that the battery is _____.
2. _____ should not be used for cleaning parts.
3. _____ clothing should not be worn in the shop.
4. There should be only _____ operators to each machine.
5. All injuries should be reported to the _____.
6. Batteries contain _____ which is dangerous.
7. Battery chargers should be _____ when connecting or disconnecting a battery.
8. _____ is used for putting out gasoline and oil fires.
9. Exhaust gases are _____.
10. Sharp tools should not be carried in _____.

MULTIPLE CHOICE (Write letter of correct statement.)

____1. When using a buffer or wire wheel, the material should be held:

(a) above and behind the center of the wheel
(b) below and behind the center of the wheel
(c) below and in front of the center of the wheel
(d) above and in front of the center of the wheel

____2. When lifting a heavy object up from the floor:

(a) keep your legs bent and lift with your arms
(b) keep your back straight and lift with your legs
(c) keep your back and legs bent, and lift with your legs
(d) keep your legs straight and lift with your back

____3. Select the best staement about creepers.

(a) Creepers can be used for moving engines as well as people.
(b) Always leave a creeper just where you get off of it.
(c) Keep creepers where no one can step on them.
(d) Standing on a creeper is a good practice.

96L92

48

NO ANSWER NEEDED

49

When water goes from the radiator to the engine and back again, the water passes through the two _____ .

17983

49

hoses

50

The two hoses on the radiator carry water:

- ☐ from the radiator to the engine and back again
- ☐ to the engine where it stays
- ☐ to the radiator where it stays

17984

50

from the radiator to the engine and back again

51

SHADE in the hoses in the picture below.

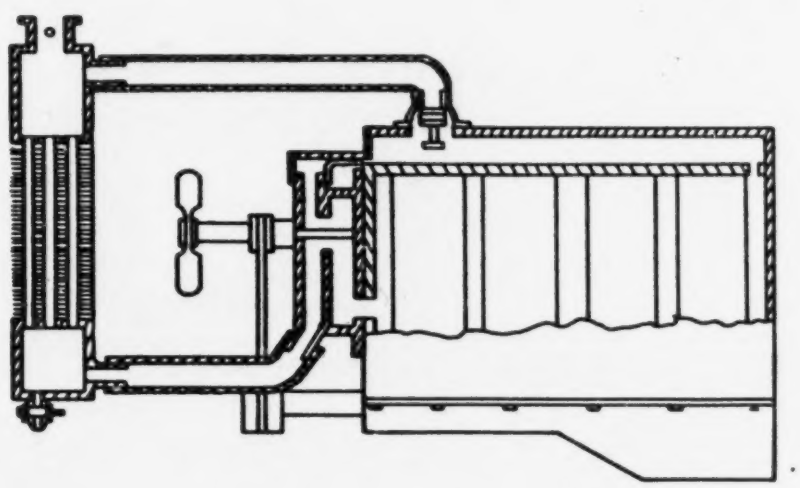

17985

51

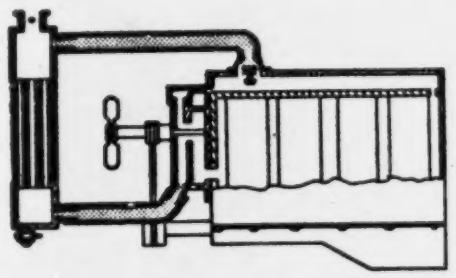

52

The water pump is pushing water through the cooling system.

The water is going through the:

- ☐ bottom hose only
- ☐ top hose only
- ☐ both hoses

17986

52

both hoses

53

PREVIEW FRAME

Now you will learn how water gets to the hot places in the engine.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

53

NO ANSWER NEEDED

54

Some parts of the engine are hotter than others.

To cool the engine correctly, the water should go to the:

- ☐ cool spots
- ☐ hot spots

17988

54

hot spots

55

If you are very hot and take a shower, water flows all around you.

Cool water flowing around you will:

- ☐ cool you off
- ☐ make you feel the same
- ☐ warm you up

17989

55

cool you off

56

Cool running water lowers your body temperature.

Cool flowing water will:

- ☐ make the engine run hot
- ☐ make the engine run cooler
- ☐ not change how hot or cool the engine is

17990

56

make the engine run cooler

57

If you are very hot and take a shower, what will this do to your temperature?

- ☐ lower it
- ☐ keep it high

57

lower it

58

A running engine has many explosions in it.

HEAT made by the constant explosions is taken away by:

- ☐ flowing water
- ☐ water that stays in the engine
- ☐ water that stays in the radiator

17992

____4. Carbon monoxide gas comes from the exhaust of automobile engines. It is:

(a) a poison
(b) light blue in color
(c) lighter than air
(d) easy to smell

____5. Gasoline:

(a) can be used for cleaning parts.
(b) will not burn unless it is under pressure inside of the engine
(c) vapors are highly explosive
(d) should be stored in open containers

ESSAY

1. List three rules for using hand tools.

2. Why should oil or grease be cleaned up immediately after it is spilled on the floor?

3. Explain how a heavy object should be lifted.

4. List the kinds of fire extinguishers that are available in the shop and explain how they are used.

5. Give several reasons why accidents happen.

Now check your answers on Page 15 of this LAP. If you passed this test with a score of 100% and you feel you can pass the final test, see your instructor. If you don't feel you are ready for the final exam, go on to the activities of this package.

58

flowing water

59

Water flows around the parts of the engine where there are explosions and heat. It surrounds these _____ spots like a jacket of water.

17993

59

hot

60

The cylinders and pistons are the hottest spots in the engine.

A jacket of water flows around the engine to keep the engine:

- ☐ hot
- ☐ cool
- ☐ wet

This jacket of water is called the _____ JACKET.

17994

60

cool

WATER

61

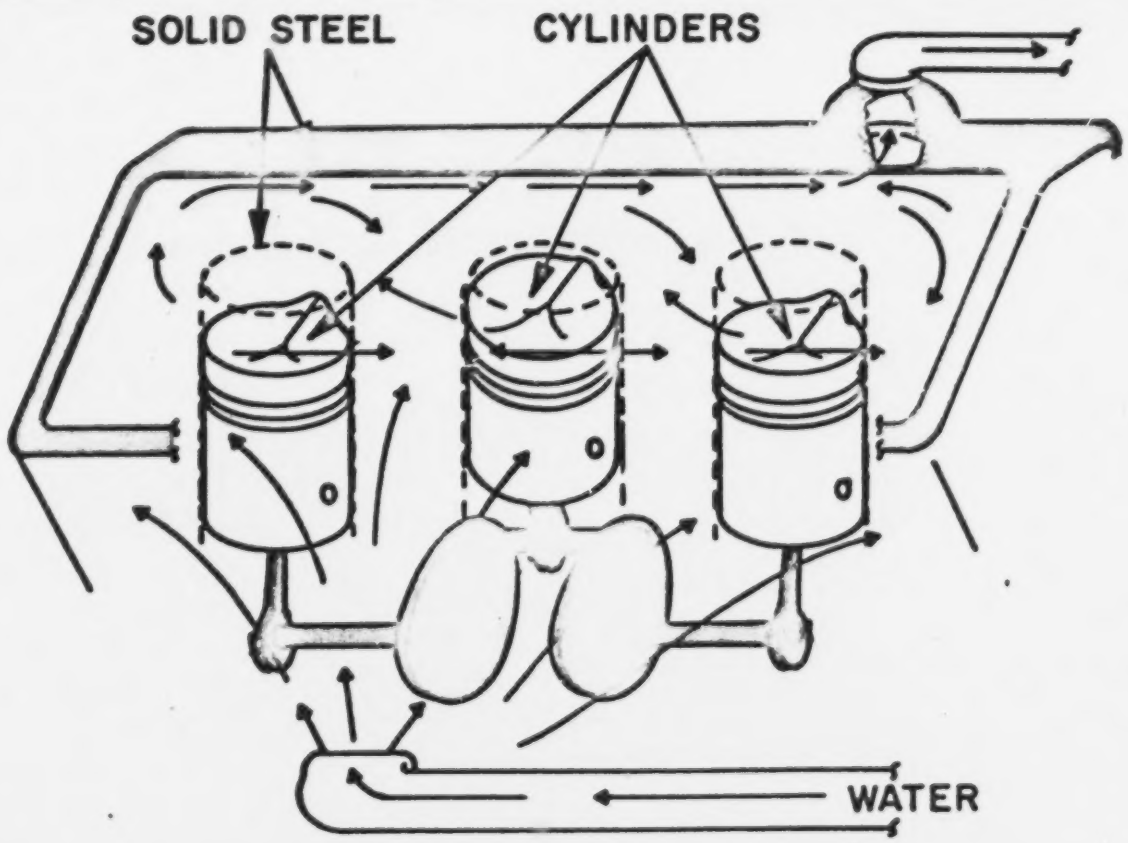

The water jacket surrounds the pistons and cylinders. Water flows through it, keeping the engine cool. PUT check marks in the water jacket above.

17995

61

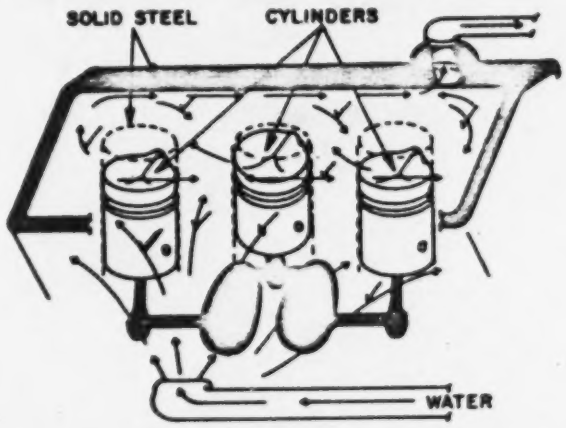

62

PICK UP THE PANEL BOOK

FIND PANEL 2

THEN TURN THIS PAGE AND GO ON

17996

62

NO ANSWER NEEDED

63

LOOK AT PANEL 2

Water flows from the bottom of the engine to the top of the engine and takes away the extra engine heat.

It flows in the engine's:

- ☐ crankcase
- ☐ cylinders
- ☐ water jacket

63

water jacket

64

LOOK AT PANEL 2

The water jacket keeps water flowing:

- ☐ around the pistons and cylinders of the engine
- ☐ next to the radiator
- ☐ around the fan belt

17998

64

around the pistons and cylinders of the engine

65

The part that directs the cooling water around the hot spots in the engine is called the w_____ j_____.

17999

65

water jacket

66

CLOSE THE PANEL BOOK
THEN TURN THIS PAGE AND GO ON

18000

66

NO ANSWER NEEDED

67

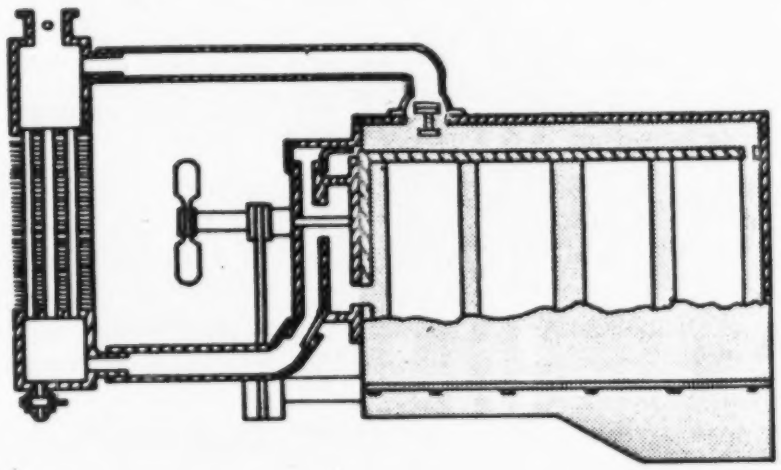

This is a diagram of the cooling system.

NAME the shaded part.

_____ _____

18001

67

water jacket

68

fan radiator water pump

hoses water jacket

Using the parts listed above, COMPLETE the following sentences.

Cooling air is pulled through by the _____.

Water is held for cooling in the _____.

Water in the cooling system is pushed by the _____.

REQUIRED ACTIVITIES

1. Read the class text book on general safety practices.

2. Read safety instructions in activity package.

3. See safety film "Primitive Pete" (This will be shown to the class by the instructor.)

4. Sign up for small group and tour the auto shop and list 10 possible safety hazards.

5. Write down in order, the things you would do if an engine of a car caught fire.

6. Demonstrate to the instructor the correct and safe procedure for use of the power grinder.

7. On assignment from instructor, get the assigned extinguisher and give a mock demonstration of how you would use it.

1798

68

fan

radiator

water pump

69

fan radiator water pump

hoses water jacket

Using the parts listed above, COMPLETE the following sentences.

Water is carried from the radiator to the engine and back to the radiator by the _____ .

Hot spots in the engine are cooled by water in the _____ .

69

hoses

water jacket

70

WINTER NOTE

In very cold weather, water in the cooling system can freeze. Next, you will learn how the cooling system is protected against freezing up.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

70

NO ANSWER NEEDED

71

If a car is running, the water in the cooling system:

- ☐ stops flowing
- ☐ is heated by the engine
- ☐ is cooled by the engine

71

is heated by the engine

72

When the engine stops running, the water pump:

- ☐ continues running
- ☐ stops running

When an engine is not running, the water in the cooling system:

- ☐ continues flowing
- ☐ stops flowing

18006

72

stops running

stops flowing

73

A car is parked on the street overnight. The temperature drops to 22° (below freezing).

The water in the cooling system:

- ☐ freezes and becomes ice
- ☐ is raised to a higher temperature
- ☐ stays the same

73

freezes and becomes ice

74

20° Temperature

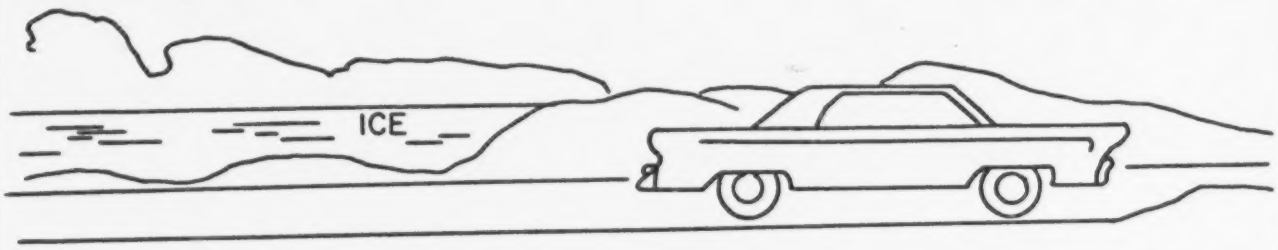

The lake is frozen. The engine is not running.

Will the water in the radiator and in the water jacket freeze?

- ☐ yes
- ☐ no

18008

74

yes

75

If the water in the cooling system freezes, it will cause damage and may crack the engine block.

To keep the engine from freezing you should:

- ☐ keep the heater going at all times
- ☐ put something into the water so that it will not freeze

75

put something into the water so that it will not freeze

76

Antifreeze is a liquid that mixes with water to keep it from freezing.

Antifreeze should be used:

- ☐ in the winter
- ☐ only in the summer

18010

76

in the winter

77

When antifreeze mixes with water, the mixture will not

- ☐ freeze
- ☐ cool the engine
- ☐ flow through the water pump

18011

77

freeze

78

Where would the serviceman put in the antifreeze?

In the:

- ☐ fan belt
- ☐ front seat
- ☐ radiator

18012

INSTRUCTIONAL SHEET #1

GENERAL SAFETY RULES

1. The automotive laboratory should be kept clean.

2. No one should use the machines unless he has had proper instruction in their use.

3. Scuffling, playing,throwing,loud talking, and running is ABSOLUTELY FORBIDDEN!

4. The floor should be kept clear of all scrap materials,parts, and tools.

5. All injuries,even a small scratch or cut, must be reported to the teacher immediately.

6. If automotive parts, hoses,jacks, extension cords, and other objects are carelessly left on the floor, they may cause bad falls. These items should be kept out of walkways.

7. All students should be familiar with the location and use of all fire fighting equipment in the shop.

8. All students must be familiar with the emergency exits.

9. It is most important that proper ventilation be maintained in the automotive laboratory at all times and especially when running gasoline engines.

10. It is dangerous to work in semi-darkness.

11. When working under a car, protect your eyes.

12. It is dangerous to talk to an operator of a machine which is running.

13. The power must be OFF when oiling or cleaning any type of equipment.

14. Observe good housekeeping at all times. Wipe up grease,water, oil, etc., immediately,or cover with sawdust or sand.

15. Be careful with sharp pointed oil cans. Do not leave them where someone may fall on them.

16. Heavy parts, such as transmissions or differential assemblies, must be securely blocked to prevent rolling when on a bench.

17. When carrying rods,pipes ,or strap iron, always hold the ends in front of you . . . low.

GO ON TO PAGE 8

1799
BEST

78

radiator

79

The _____ is mixed with water in the radiator.

Will it then get into the rest of the cooling system?

- ☐ yes
- ☐ no

18013

79

antifreeze

yes

80

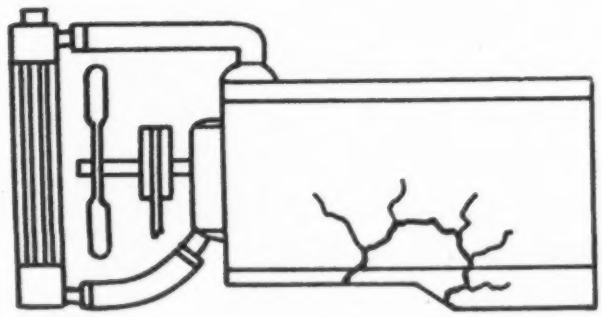

The engine above is seriously damaged. The cold weather froze the water. The water turned to ice and cracked the lower part of the engine.

Was antifreeze put into the radiator?

- ☐ yes
- ☐ no

80

no

81

A mixture of water and antifreeze will:

- ☐ freeze
- ☐ not freeze

81

not freeze

82

It is winter. The car has been outside all night.

When the car is first started, the engine will be:

- ☐ cold
- ☐ hot
- ☐ warm

82

cold

83

Water circulating in the cooling system keeps the engine:

- ☐ warm
- ☐ cool

If water doesn't flow from the engine to the radiator and back, the engine will:

- ☐ warm up slowly
- ☐ warm up fast
- ☐ stop running

83

cool

warm up fast

84

To warm up a cold engine, you must warm up the water.

To warm up a cold engine, you want the water to:

- ☐ stay in the engine and warm up
- ☐ flow back to the radiator before it warms up

84

water to stay in the engine and warm up

85

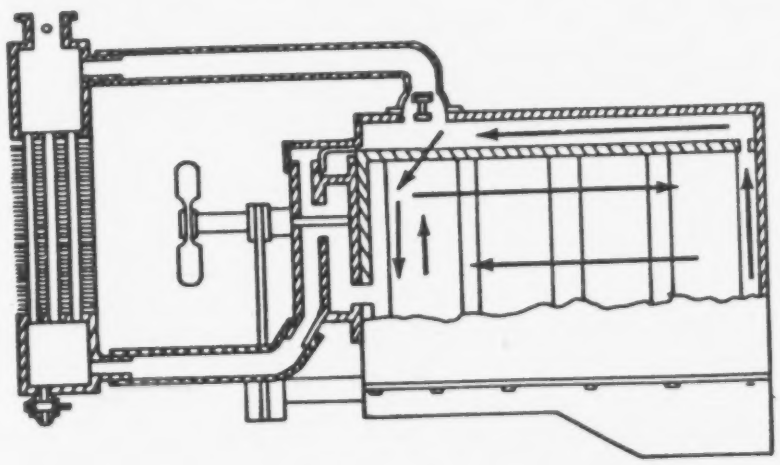

The water in this engine will warm up quickly because the water is:

- ☐ going through the radiator
- ☐ staying in the engine

18019

85

staying in the engine

86

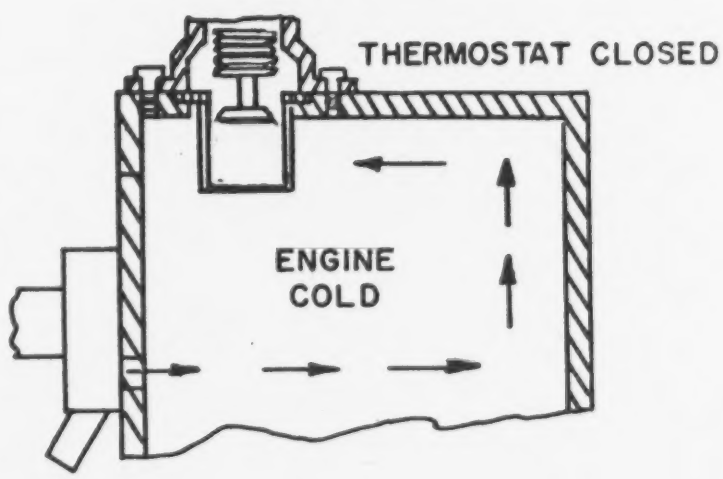

A valve called a thermostat is located where the top hose meets the water jacket.

When the thermostat is closed, water:

- ☐ flows to the radiator and cools off
- ☐ stays in the engine and warms up

86

stays in the engine and warms up

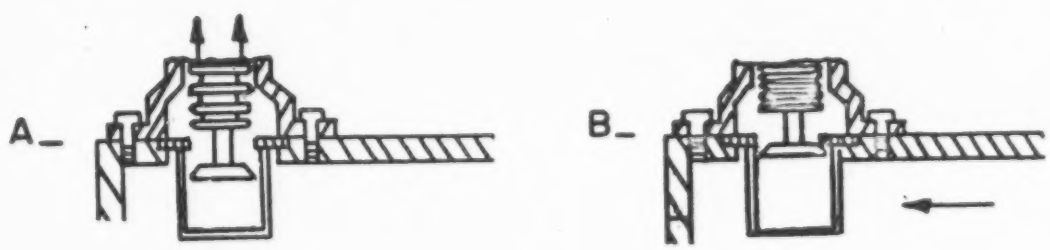

A spring controlled THERMOSTAT opens or closes to control the flow of water through the top hose.

The thermostat is open in drawing: ☐ A ☐ B

18021

87

A

88

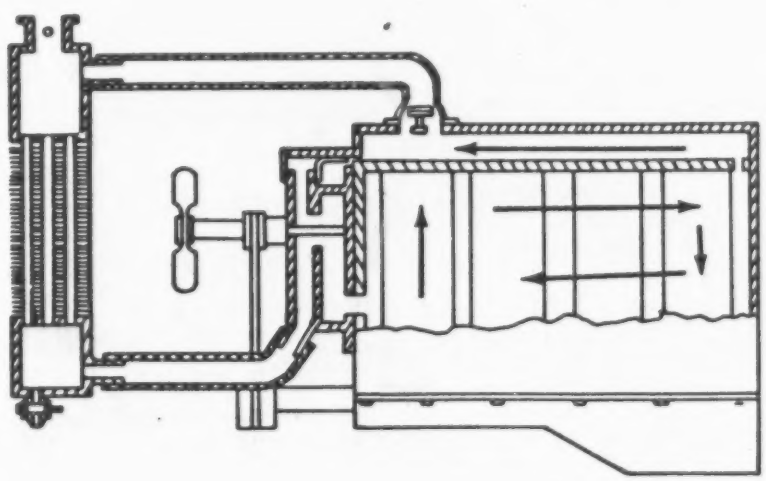

The water is <u>not</u> going from the engine to the radiator and back.

This is because the thermostat is:

- ☐ closed
- ☐ open

INSTRUCTIONAL SHEET #2

18. The motion involved in striking objects or cutting materials, must be done away from yourself and other students.

19. The transmission should be out of gear before starting and engine.

20. Handle brake fluid carefully. Keep it away from your eyes.

21. Do not use the mouth to start a siphon from a gasoline tank. Certain gasoline contains poisonous TETHAETHYL LEAD.

22. Never consider a job complete until a check has been made to make sure that all lock washers, cotter pins, or other locking devices are in place. Be sure cotter pin ends do not protrude.

23. Keys are not to be left in ignition switches.

24. No student is to be inside an automobile unless he is doing an assigned job and working on the job.

25. Distrubing another student while he is working is dangerous.

26. Walk, DO NOT RUN, in the automotive laboratory.

27. Students must get permission before test running an engine.

28. When in doubt as to the safety of any operation of job being performed in the laboratory, ask the teacher before proceeding further.

29. Cultivate personal caution al all times. This is one of the big lessons to be learned in this laboratory.

AIR LINES

1. Don't play with the compressed air hose. The air=hose must be turned so as not to be aimed at anyone.

2. Air pressure must not be used to clean one's person or clothing.

3. When cleaning out steel chips or carbon, goggles must be worn.

4. Hoses are to be coiled and stored when not in use.

BATTERIES AND BATTERY CHARGERS

1. Handle batteries with care. Wash hands after handling.

2. Never stand over a battery when working on it. An explosion may spray acid into your eyes.

88

closed

89

A_

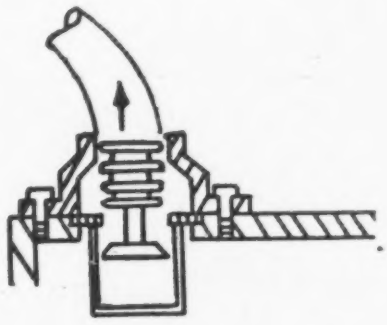

B_

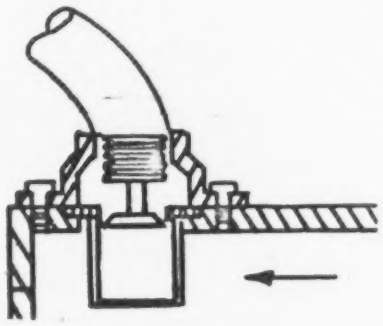

The thermostat closes to stop water flow.

Which thermostat above is closed?

- ☐ A
- ☐ B

In which picture is the water flowing through the top hose?

- ☐ A
- ☐ B

89

B

A

90

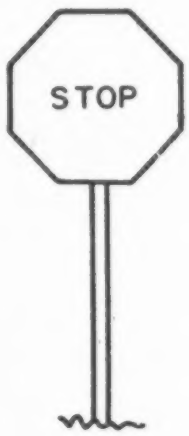

PICK UP THE PANEL BOOK

FIND PANEL 3

THEN TURN THE PAGE AND GO ON

18624

90

NO ANSWER NEEDED

91

LOOK AT PANEL 3

In which engine is the water going to the radiator and back?

- ☐ A
- ☐ B

This is because the thermostat is:

- ☐ closed
- ☐ open

91

A

open

92

LOOK AT PANEL 3

The water stays in the water jacket in engine:

- ☐ A
- ☐ B

18026

92

B

93

When the engine is cold, the thermostat closes:

- ☐ so the water in the engine can warm up
- ☐ to keep the water in the engine cold

18027

93

so the water in the engine can warm up

94

The thermostat:

- ☐ closes when the engine is cold
- ☐ opens when the engine is cold
- ☐ opens when the radiator is cold

18028

94

closes when the engine is cold

95

LOOK AT PANEL 3

In engine B the water is not leaving because the thermostat is:

- ☐ closed
- ☐ open

Engine B is cold now. Will it heat up?

- ☐ yes
- ☐ no

18029

259 OF 327

ED

056 238

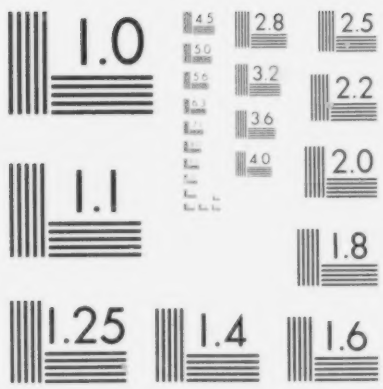

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

95

closed

yes

96

After the engine heats up, the thermostat will open. This will:

- ☐ keep the water in the engine
- ☐ let the water flow from the engine to the radiator and back again

18030

259

96

let the water flow from the engine to the radiator and back again

97

The thermostat will open when the engine is:

- ☐ cold
- ☐ hot

INSTRUCTIONAL SHEET #3

3. Get help when lifting large batteries. Don't hold battery in your arms. Use battery strap or carrier.

4. Don't short circuit a battery to test it.

5. If there is a short circuit, do not touch shorted wires with bare hands.

6. When doing work on transmissions,clutch,or engine, disconnect the cable from the battery to starter.

7. In handling batteries, avoid splashing acid. Should acid contact eyes or skin,flush immediately with large quantities of fresh water or baking soda water.

8. Keep open flames away from batteries.

9. When using the battery charger, you must first check the charging instructions on the battery and then receive permission from the teacher.

10. Before connecting or disconnecting the battery from the charger, always turn the switch OFF.

11. The power must be shut off when checking a battery for charge.

BREATHING HAZARDS

1. Internal combustion engines must not be run in a closed area unless vented to the outside.

2. Avoid breathing carbon monoxide fumes. These fumes are oderless, colorless,tasteless, and deadly poison.

3. First Aid: If a person has inhaled too much carbon monoxide,his skin will start to darken. If this occurs get the person to open air immediately, open his clothing, and apply artificial respiration if necessary. In advanced stages, the skin will be black.

BURNS

1. Keep clear of hot exhaust manifolds.

2. Severe burns can result from wearing metal rings,bracelets,chains or metal watch bands while working on electrical circuits. Remove all jewelery of this type when working with electrical circuits.

3. Keep hands away from battery acid. . . it will burn.

4. Do not pick up drill bits with bare hands after heavy cutting, allow them to cool.

THERE IS MORE ON NEXT PAGE

1801 0081

98

opened

99

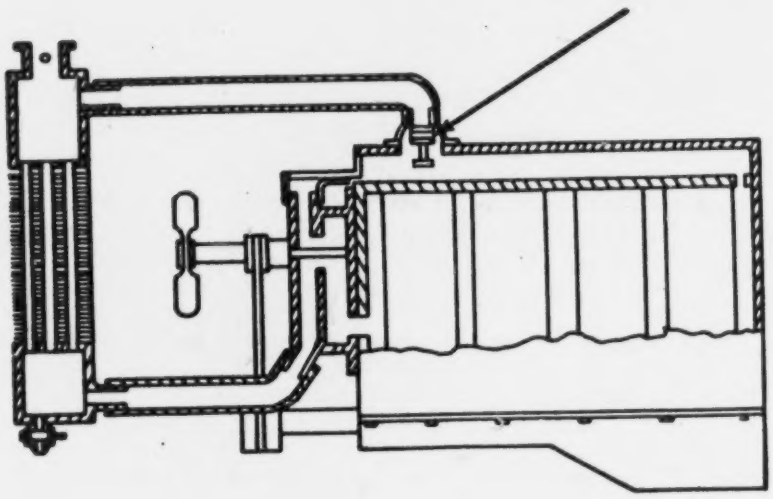

What is the arrow pointing to in the picture above?

- ☐ the radiator
- ☐ the thermostat
- ☐ the water jacket

99

the thermostat

100

The part of the cooling system that closes for the engine to heat up is the:

- ☐ hose
- ☐ thermostat
- ☐ water pump

100

thermostat

102

CIRCLE the list below that only names parts of the cooling system:

1. fan	1. radiator	1. center link
2. water pump	2. hoses	2. hoses
3. fuel pump	3. water pump	3. spark plugs
4. radiator	4. water jacket	4. radiator
5. antifreeze	5. fan	5. thermostat

101

radiator

hoses

water pump

water jacket

fan

102

MATCH the names with the jobs:

A. antifreeze

B. fan

C. thermostat

D. water jacket

1. _____ closes to heat up cold engine

2. _____ keeps cooling system from freezing

3. _____ takes water to engine hot spots

102

1. C
2. A
3. D

103

The water pump is used to pump the _____ through the _____ system.

The hoses are used to carry water back and forth between the _____ and the _____ .

103

water

cooling (system)

radiator (and the) engine

104

The fan's job is to pull air through the _____ .

What does this do to the water in it? _____

18038

104

radiator

cools it

105

Water is carried to the hot spots in the engine by the

_____ _____.

105

water jacket

106

The radiator holds the water that is used to _____ the engine.

The name of the part that pulls air through the radiator is the _____ .

Water travels back and forth between the engine and the radiator through the _____ .

18040

106

cool

fan

hoses

107

The part that pumps the water through the cooling system is the _____ _____.

The water is cooled as it goes through the _____.

INSTRUCTIONAL SHEET #4

5. Be careful about handling metal in a welding area, it could be hot.

6. Do not leave hot metal unattended.

7. Report all burns to the teacher immediately.

CLOTHING

1. Wear tight-fitting coveralls or other appropriate clothing. It is dangerous to wear loose clothing around machinery.

2. Coveralls should be cleaned periodically keeping them free of accumulated oil and grease.

CRANKING

1. When cranking a motor with crank or starter, be certain that all persons and materials are clear of turning parts.

2. When cranking an engine, be prepared for an emergency. If trouble develops, turn the ignition switch off immediately.

CREEPERS

1. Creepers are not playthings! Playing with them will not be tolerated.

2. Creepers should not be left on the floor where they may cause someone to fall. Stand the creepers up.

ELECTRIC HAND DRILL

1. When the hand drill is being used, hold it straight and steady.

2. After inserting or removing a drill from the chuck of the drill, the chuck key must be removed.

3. The electric drill and its cord must not be allowed to get wet.

ELECTRIC EQUIPMENT

1. All electrical equipment must be on a 3-wire grounded circuit.

2. Any cut or frayed insulation should be reported to the teacher at once.

3. If an unusual flash occurs while plugging in equipment, notify the teacher immediately.

NOT YET - TURN PAGE

107

water pump

radiator

108

INFORMATION

Modern antifreezes can be left in the cooling system for the whole year. Antifreeze keeps water from freezing during the winter. Antifreeze will also keep the cooling system cooler during the hot weather.

THIS IS THE END OF BOOK 8

18042

AUTO MECHANICS COURSE

POST-TEST BOOK 8: THE COOLING SYSTEM

A BASIC SYSTEMS PROGRAM

18042

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

Antifreeze is used in a cooling system:

- ☐ instead of water
- ☐ to do away with the need for water
- ☐ to be mixed with water

2

NAME the part that moves water through the cooling system. _____

3

A car comes into your service station and its engine is overheating. If a fan belt ripped, which part stopped turning?

- ☐ fan
- ☐ radiator
- ☐ thermostat

4

It is winter and a customer complains that it takes too long for his engine to warm up. Which of the following is a possible reason?

- ☐ The radiator is full.
- ☐ The thermostat is staying open.
- ☐ The water pump is working.

5

It is summer and a customer comes into your service station. Water is leaking because the hose on top of the engine is not properly connected. You will connect it to the:

- ☐ fan
- ☐ radiator
- ☐ thermostat
- ☐ water pump

6

The water jacket is used to:

- ☐ keep the water from getting cold
- ☐ keep the water from getting hot
- ☐ get the water to cold spots in the engine
- ☐ get the water to hot spots in the engine

7

Water in the cooling system cools off when it is in the _____.

8

In order to get water going back and forth in the cooling system, which part must be working?

- ☐ water jacket
- ☐ water pump
- ☐ water reserve

9

Water or antifreeze is poured directly into the:

- ☐ fan
- ☐ radiator
- ☐ water jacket
- ☐ water pump

10

The thermostat will:

- ☐ close if the engine is too cold
- ☐ push water through the cooling system
- ☐ open if the engine is too cold
- ☐ pull water through the cooling system

11

An engine has a water jacket in it to:

- ☐ get water out of the cooling system
- ☐ get water away from the hot spots in the engine
- ☐ get water to hot spots in the engine
- ☐ keep the water from getting cold

12

Water enters the engine through the _____ hose and returns to the engine through the _____ hose.

VT 013 131
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IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the exhaust system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 131

ED0 56238

BOOK 9

To Be Used With
PANEL BOOK 9

(d)

AUTO MECHANICS COURSE

BOOK 9: EXHAUST SYSTEM

A BASIC SYSTEMS PROGRAM

VT013131

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Curriculum Report Reference
Page 17

Task Analysis Reference
49.1

18049

AUTO MECHANICS COURSE

BOOK 9: EXHAUST SYSTEM

Developed under the manpower development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

18050

Name _____

Date _____

Starting Time _____

Finishing Time _____

18051

INSTRUCTIONAL SHEET #5

4. Electrical cords lying on the floor should not be run over. A break might be caused in the insulation making a faulty circuit.

5. When operating electrical equipment be sure you are on a dry surface and that the equipment is not wet.

6. Never turn a switch "on" or "off" without knowing what is at the other end of the circuit.

ELECTRICAL SHOCKS

1. Treat any wire as if it were"hot."

2. If a slight shock is received while operating any piece of equipment, notify the teacher immdiately. -DO NOT CONTINUE TO OPERATE THE MACHINE.

3. Wearing of metal rings,bracelets, or chains while working on or near an electrical circuit is forbidden.

4. Circuits should not be checked with the fingers to see if they are "hot."

ENGINES

1. Before starting any engine, always obtain the teacher's permission.

2. When working on or around live engines in the shop,excise extreme care when making any adjustments on a running engine(tappet,carburetor, timing,etc.)

3. It is dangerous to work around running belts, gears,etc. Keep your hands clear!

4. If you are not directly involved in the operation of any engine, KEEP CLEAR AND DO NOT TALK TO THE OPERATOR.

FIRES

1. Gasoline should NEVER be used as a cleaning agent.

2. Keep all oily and gasoline soaked rags in a fireproof container.

3. Learn the location and use of all fire extinguishers.

4. When starting or operating an automotive engine, a fire extinguisher must be readily accessable.

KEEP GOING

Pre Test
Page 1
Book 9

1

The part of the exhaust system that is mounted on the engine is called the _____ _____ .

2

The part that quiets engine noise is called the _____ .

3

The exhaust system takes _____ and _____ away from the car.

4

The exhaust manifold is connected to the engine and to the _____ _____ .

5

What part of the exhaust system is the tailpipe connected to?

_____

18052

6

Which part of the exhaust system is between the exhaust pipe and the tailpipe? _____

7-10

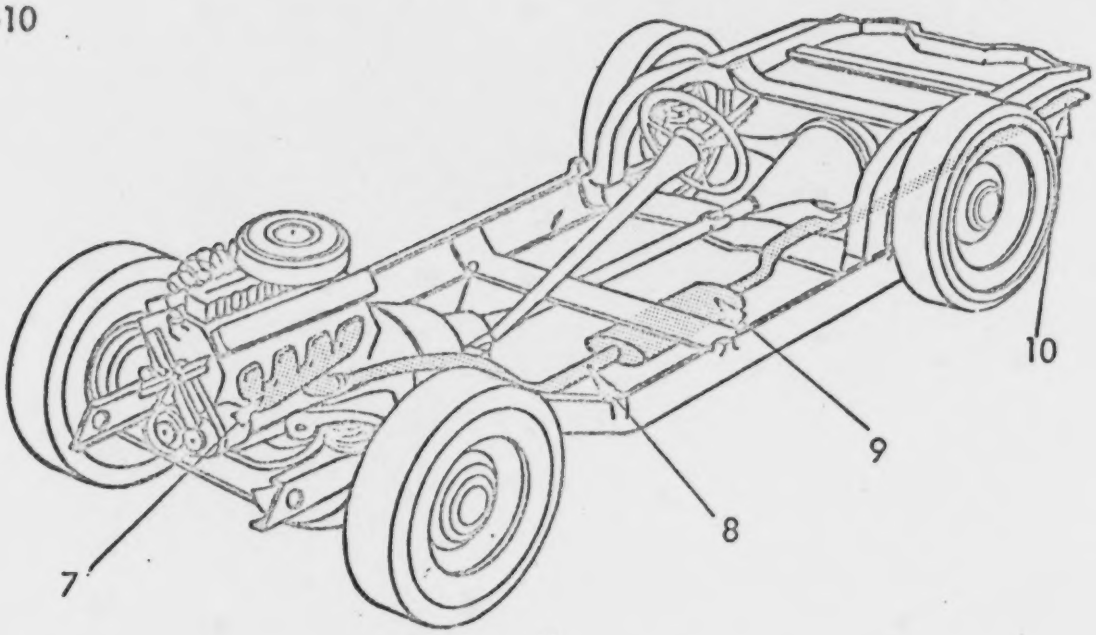

NAME the part each arrow points to:

7: _____

8: _____

9: _____

10: _____

18053

1

Automobiles use a mixture of _____ and _____ for fuel.

18054

1

air

gasoline

2

The air-gasoline mixture is exploded when it is sparked by the _____ _____ .

18055

2

spark plugs

3

An explosion makes: (CHECK TWO)

- ☐ noise
- ☐ no noise
- ☐ smoke
- ☐ no smoke

18056

3

noise

smoke

4

Smoke and noise are made when there are explosions in an automobile's _____ .

18057

4

engine

5

Smoky, noisy engines are dangerous and annoying to drivers.

For the drivers' comfort and safety, noise and smoke should be:

- ☐ kept in the car
- ☐ left alone
- ☐ taken out of the car

18058

5

taken out of the car

6

The parts of an automobile that quiet engine noise belong to the EXHAUST SYSTEM.

The exhaust system also takes _____ out of the car.

18059

6

smoke

7

Noise and smoke are taken out of the engine by the:

- ☐ cooling system
- ☐ exhaust system
- ☐ fuel system

18060

7

exhaust system

8

What does the exhaust system do? (CHECK ALL CORRECT ANSWERS)

- ☐ feeds gasoline to the engine
- ☐ quiets the engine
- ☐ takes burned gas fumes out of the car

18061

INSTRUCTIONAL SHEET #6

GRINDER AND BUFFER

1. Goggles or a face shield must be worn when grinding or buffing. Keep the glass clean.

2. The tool rest on the grinder should be 1/8" from the grinding wheel. Excessive clearance permits work to jam between the wheel and tool rest.

3. Be sure that the tool rest is secure and tight.

4. Always turn the grinder off before leaving it.

5. Excessive pressure against the grinding wheel causes overheating of the work and may cause breakage of the wheel.

6. Be careful of fingers when using the buffer or wire wheel.

7. Keep the grinder running at full motor speed. Avoid slowing the wheel by use of excessive pressure.

8. Small pieces of metal must not be ground on a grinding wheel.

9. When starting the grinder, do not stand in line with the wheel.

10. Stand to one side while grinding.

11. Allow no one to watch who is not wearing goggles or a face shield.

12. Grinding wheels that do not run true must not be used.

13. The work should always be held below center and to the front of the buffing wheel.

HOIST CHAIN

1. Stand clear of any weight being lifted with a chain hoist.

2. The hoist or lifting device should never be overloaded, know the capacity of the hoist and use it wisely.

3. Working under an engine or car held up by a hoist is forbidden.

4. After lifting, block the car and take the weight off of the hoist.

5. Lift straight up. Do not pull the chain to one side. This may cause the load to shift.

6. Do not play with the chain hoist.

TURN TO NEXT PAGE

8

quiets the engine

takes burned gas fumes out of the car

9

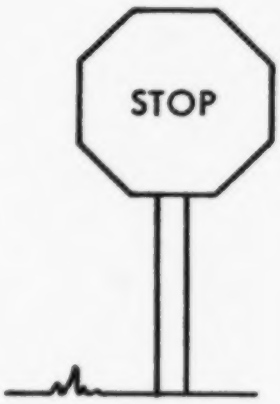

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

18062

PANEL BOOK 9

To Be Used With
BOOK 9

AUTO MECHANICS COURSE

PANEL BOOK 9: EXHAUST SYSTEM

A BASIC SYSTEMS PROGRAM

18063

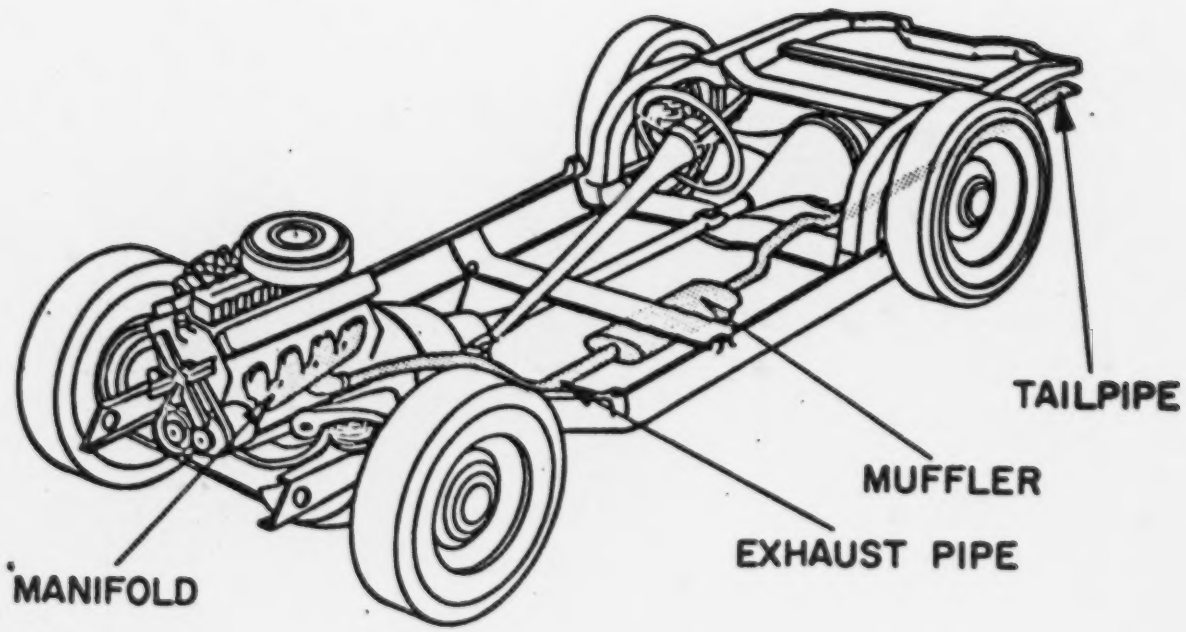

18064

PANEL 1

53

enters the muffler

54

If a car had a broken muffler or no muffler at all, the engine noise would:

- ☐ increase
- ☐ decrease
- ☐ remain the same

18065

54

increase

55

As exhaust gases and engine noise pass through the muffler, the noise is _____ .

18066

55

quieted

56

MATCH the following:

A. engine

B. exhaust manifold

C. exhaust pipe

D. muffler

1. _____ gets noise and fumes from the engine

2. _____ gets noise and exhaust fumes into the muffler

3. _____ makes noise and fumes

4. _____ quiets engine noise

18067

56

1. B
2. C
3. A
4. D

57

The job of the muffler is to _____ .

18068

57

quiet the engine noise

58

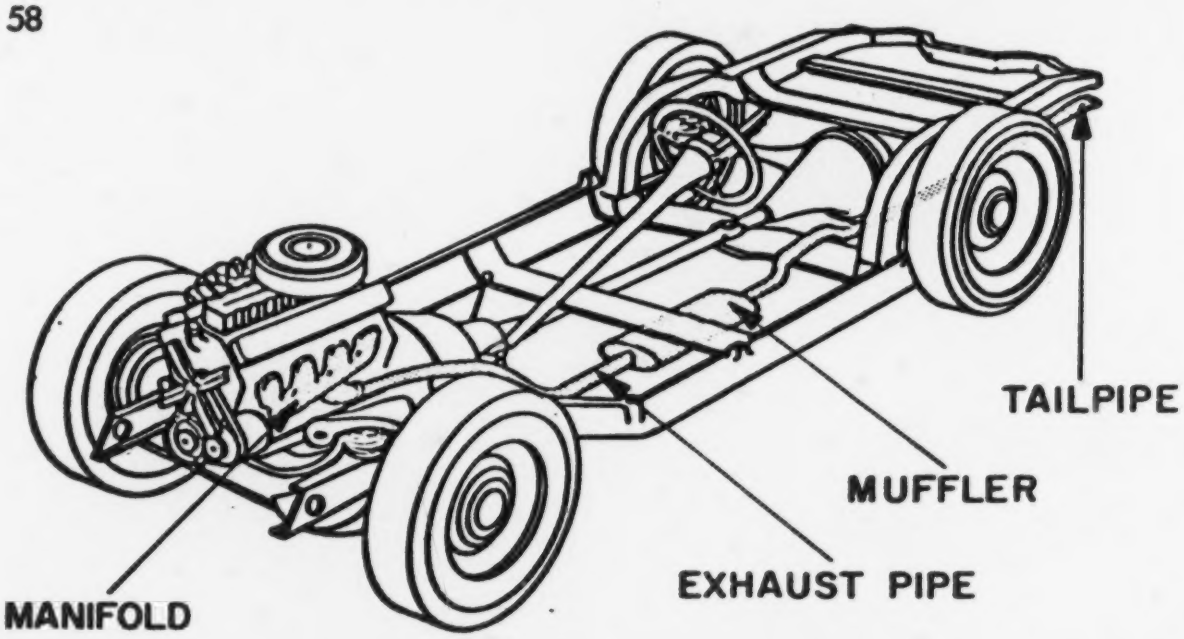

Exhaust fumes and engine noise leave the car through the back part of the exhaust system.

This part is called the _____ .

18069

58

tailpipe

59

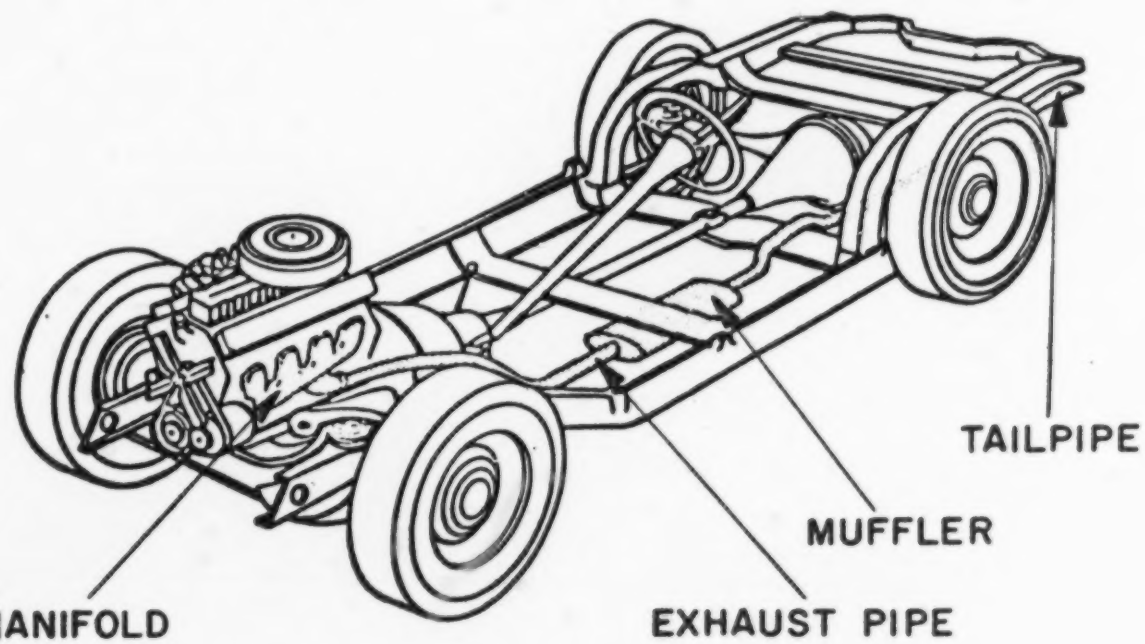

The tailpipe gets exhaust fumes and engine noise directly from the _____ .

18070

59

muffler

60

What two things escape from the car through the tailpipe?

_____

_____

18071

27 OF 327

ED

056 238

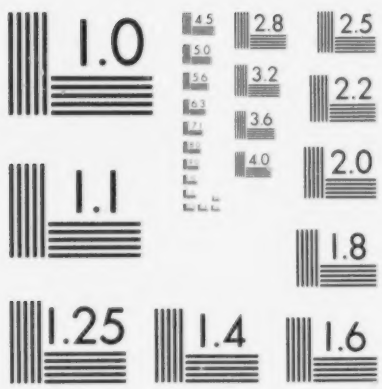

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

60

noise or engine noise

exhaust fumes

61

Exhaust fumes and engine noises leave the car through the:

- ☐ exhaust pipe
- ☐ muffler
- ☐ tailpipe

61

tailpipe

62

The job of the tailpipe is to get _____ and _____ _____ out of the car.

18073

62

noise <u>or</u> engine noise

exhaust fumes

63

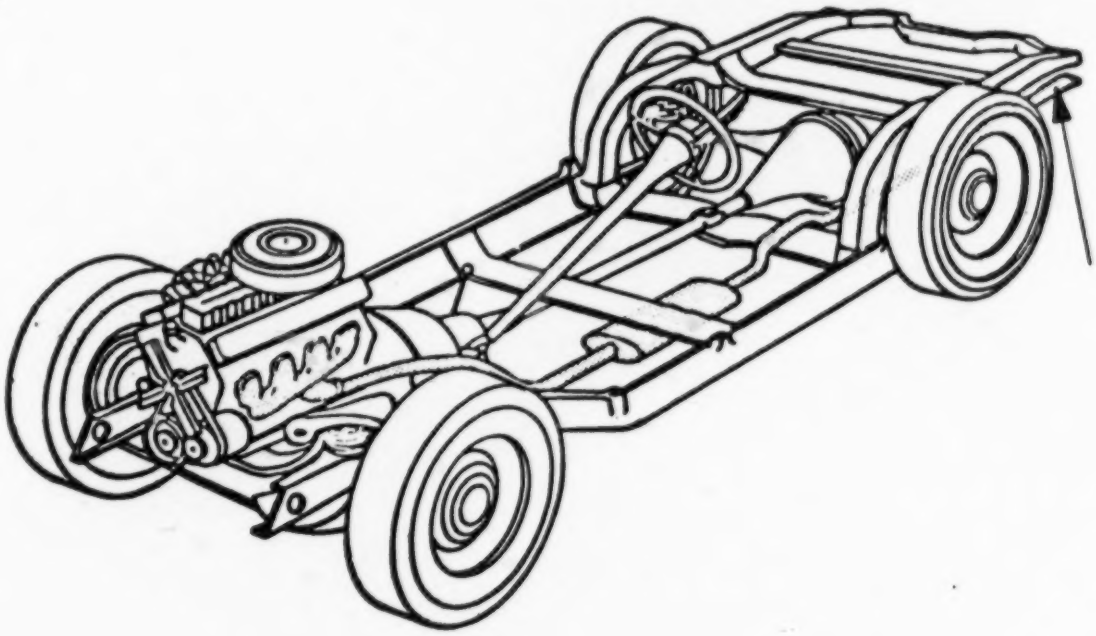

The arrow is pointing to a part called the _____ .

18074

63

tailpipe

64

What does the tailpipe do? _____

18075

64

gets engine noise and exhaust fumes out of the car

65

Noise and gases are made when an air-gasoline mixture is exploded in the _____ .

The noise and exhaust fumes then enter the:

- ☐ exhaust manifold
- ☐ exhaust pipe
- ☐ muffler

18076

65

engine

exhaust manifold

66

Engine noise and exhaust fumes enter the muffler directly from the _____ _____ .

What does the muffler do to the engine noise? _____

18077

66

exhaust pipe

quiets it

67

Engine noise and exhaust fumes leave the car through the back part of the exhaust system.

NAME this part:

_____

67

tailpipe

68

The exhaust system:

- ☐ gets engine noise and exhaust fumes out of the car
- ☐ keeps engine noise and exhaust fumes in the car
- ☐ never affects a car's engine noise and exhaust fumes

18079

68

gets engine noise and exhaust fumes out of the car

69

Which system gets engine noise and exhaust fumes out of a car? _____

18080

69

exhaust system

THIS IS THE END OF BOOK 9

18081

7. When through using the chain hoist, put it away.

HAND TOOLS

1. Always use the correct size and type of tool for the job.
2. Do not carry sharp tools in your pockets.
3. A slipping wrench may cause a serious injury; therefore,never use a wrench with cracked or worn jaws.
4. Hammer, mallet, or sledge heads should be kept tight on their handles.
5. Cracked handles must be replaced.
6. Mushroom ends on chisels and punches must be ground off before using.
7. Chisels will not be used for screwdrivers and screwdrivers will not be used for chisels.
8. When using a chisel, you should hold the work in a vise or clamp.
9. A ratchet handle is not to be used as a hammer.
10. When additional leverage is needed to loosen a nut, use a bigger tool. Do not add an extension to the handle for more leverage.
11. When using a screwdriver on small objects, the object must be held in a vise or clamp.
12. Keep screwdrivers out of your pockets.
13. Hammers should not be hit together.
14. Never use a file without a handle.
15. Never use a file for a pry bar.
16. Do not hit a file with a hammer.
17. Return all broken or damaged tools to the teacher.
18. Hardened material must never be struck with a hard-surface hammer.
19. Vise handles and control knobs are to be tightened by hand.

HYDRAULIC FLOOR JACKS

1. Do not use a jack if there is any doubt about its safe operation.

CONTINUED ON NEXT PAGE

1605

9

NO ANSWER NEEDED

10

LOOK AT PANEL 1

The panel shows a picture of the exhaust system.

Every part is labeled.

How many parts are there in the exhaust system? _____

10

4

11

LOOK AT PANEL 1

Noise and smoke are produced by explosions in the

_____.

The part of the exhaust system connected to the engine is called the _____ _____.

18085

11

engine

exhaust manifold

12

Exhaust smoke is called "exhaust fumes."

Exhaust fumes leave the car through the back part of the exhaust system.

The exhaust fumes go out through the part called the _____ .

12

tailpipe

13

The back part of the exhaust system is called the tailpipe because a tail is always at the:

- ☐ front
- ☐ back

18087

13

back

14

LOOK AT PANEL 1

Before exhaust fumes can excape through the tailpipe, they must first pass through the exhaust manifold, the exhaust pipe and the _____.

18088

14

muffler

15

LOOK AT PANEL 1

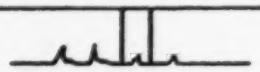

The part that connects the exhaust manifold to the muffler is called the _____ _____ .

15

exhaust pipe

16

LOOK AT PANEL 1

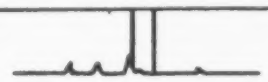

The two pipes connected to the muffler are called the:

_____

_____

18090

16

exhaust pipe

tailpipe

17

LOOK AT PANEL 1

The exhaust pipe is connected to the muffler and the

_____ _____ .

18091

17

exhaust manifold

18

LOOK AT PANEL 1

The exhaust manifold is connected to the exhaust pipe and the _____ .

18092

18

engine

19

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

18093

INSTRUCTIONAL SHEET #8

2. Do not work under any car or object supported by a jack alone. Use axle stands for safety.

3. When the floor jacks are not being used,they should be placed out of the way where no one will fall over them.

4. Never lift or lower a car or object if someone is working underneath.

LIFTING HEAVY OBJECTS

1. When lifting any object, be sure to grasp it firmly so it will not fall and hit your feet.

2. Lift with your legs and not your back.

3. Keep your back as nearly vertical as possible while lifting

4. Use assistance for lifting a heavy object. Lifting objects which are too heavy can cause serious injury.

TIRES

1. Inflate tires only to recommended pressure.

2. If gauge appears to be faulty, notify the teacher.

3. Avoid looking directly at a tire or valve while inflating. A blast of air could blind you.

4. Stand as far to one side as possible when putting air in tires and protect face with fender in case the tire blows.

IF YOU ARE READY FOR FINAL TEST SEE THE INSTRUCTOR-

REMEMBER - YOU MUST SCORE 100% - BE CERTAIN THAT YOU ARE WELL PREPARED.

19

NO ANSWER NEEDED

20

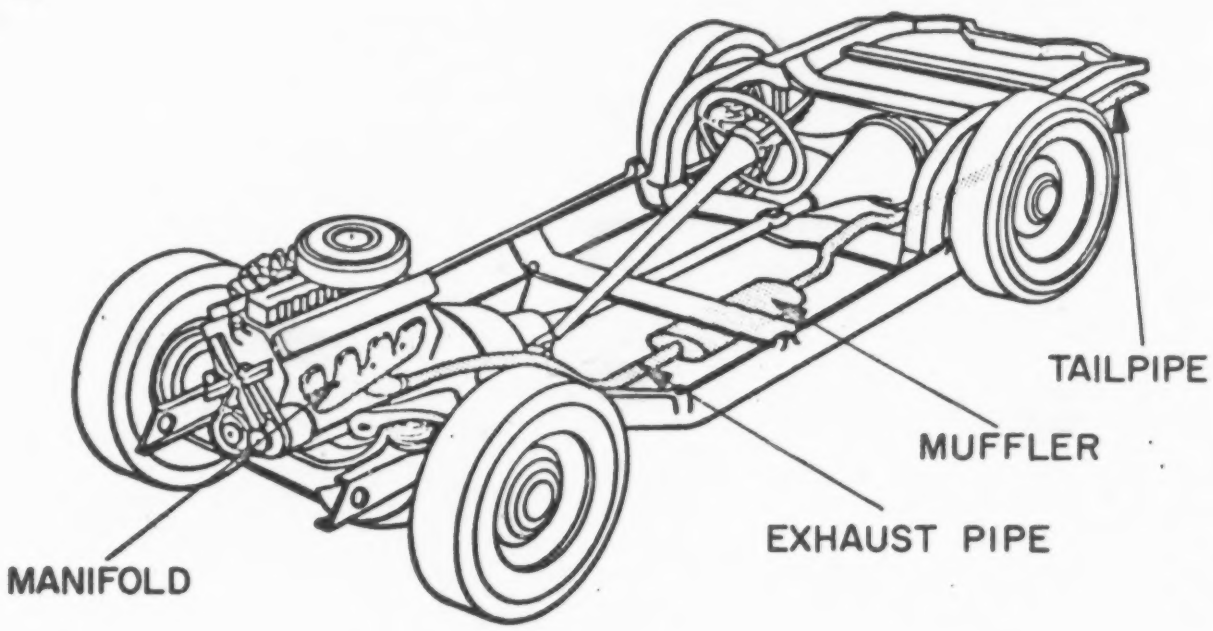

Noise and exhaust fumes are made in the:

- ☐ engine
- ☐ muffler
- ☐ tailpipe

18094

20

engine

21

When the exhaust fumes and noise leave the engine, the first part of the exhaust system that they enter is the:

- ☐ exhaust manifold
- ☐ manifold
- ☐ tailpipe

21

exhaust manifold

22

The exhaust manifold gets noise and exhaust fumes from the _____ .

22

engine

23

The exhaust manifold gets _____ and _____ fumes from the engine.

18097

23

noise exhaust

24

Noise and exhaust fumes leave the engine and go into the _____ manifold.

18098

25

engine

noise exhaust fumes

engine

26

The job of the exhaust manifold is to _____ .

18100

26

take noise and exhaust fumes
out of the engine

27

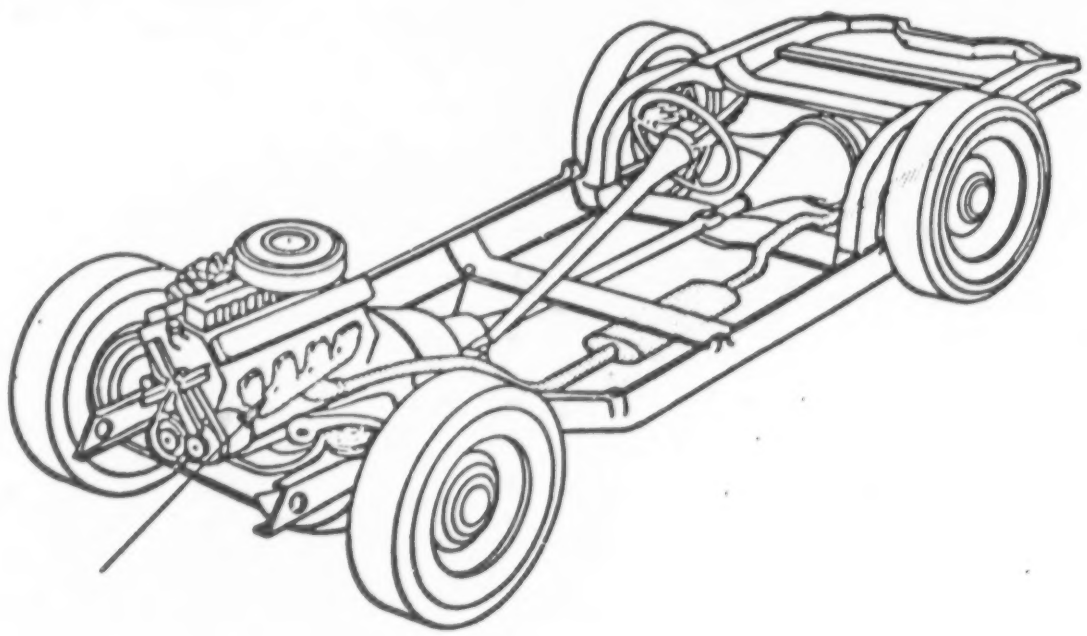

NAME the part the arrow points to.

_____

18101

260 OF 327

ED

056 238

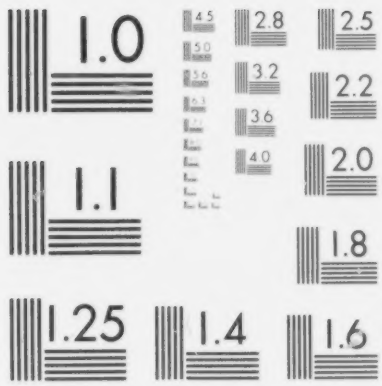

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

27

exhaust manifold

28

Why is the exhaust manifold mounted on an engine?

- ☐ to make an engine look streamlined
- ☐ to take noise and exhaust fumes out of the engine
- ☐ to take exhaust out of the engine

18102

PRE-TEST ANSWER SHEET

TRUE AND FALSE

1. True
2. False
3. False
4. False
5. False
6. True
7. True
8. False
9. False
10. True
11. False
12. True
13. False
14. True
15. True
16. True

MULTIPLE CHOICE

1. C
2. B
3. C
4. A
5. C

COMPLETION

1. disconnected
2. Gasoline
3. loose
4. one
5. instructor
6. acid
7. turned off
8. CO_2
9. poisonous
10. in pockets

IF YOU PASSED THE PRE-TEST WITH A SCORE OF NO LESS THAN 100% SEE THE INSTRUCTOR FOR A FINAL TEST. IF NOT GO TO ACTIVITIES AND PROCEED.

28

to take noise and exhaust fumes
out of the engine

29

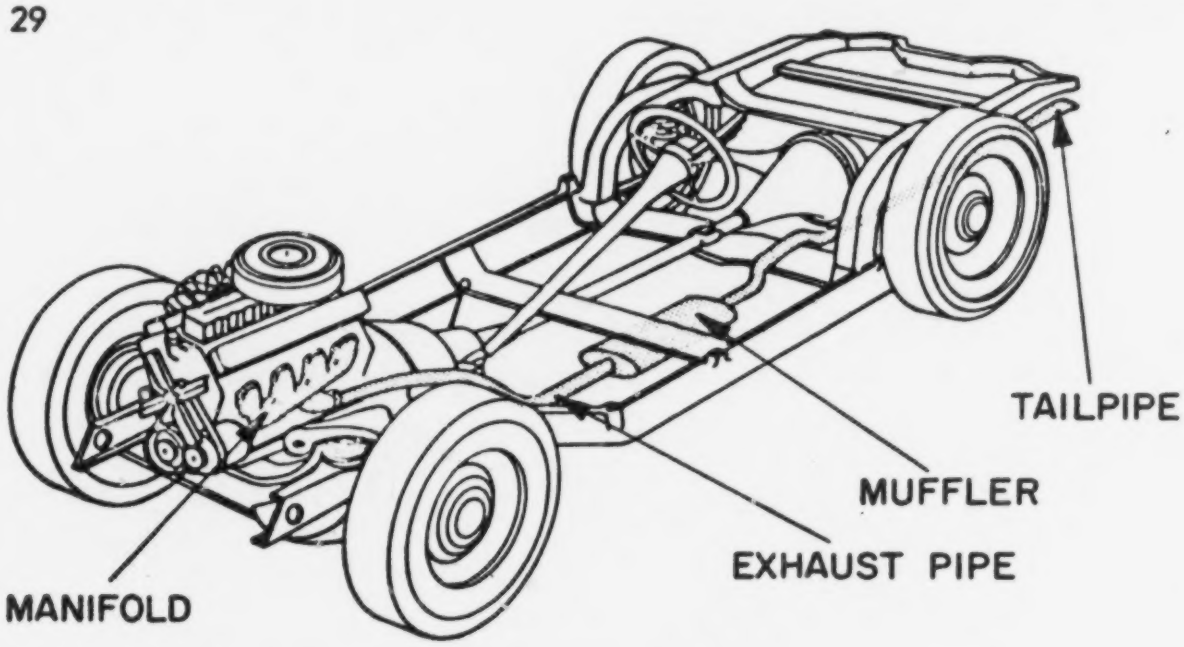

After engine noise and exhaust fumes have passed through the exhaust manifold, they enter a pipe called the _____ .

29

exhaust pipe

30

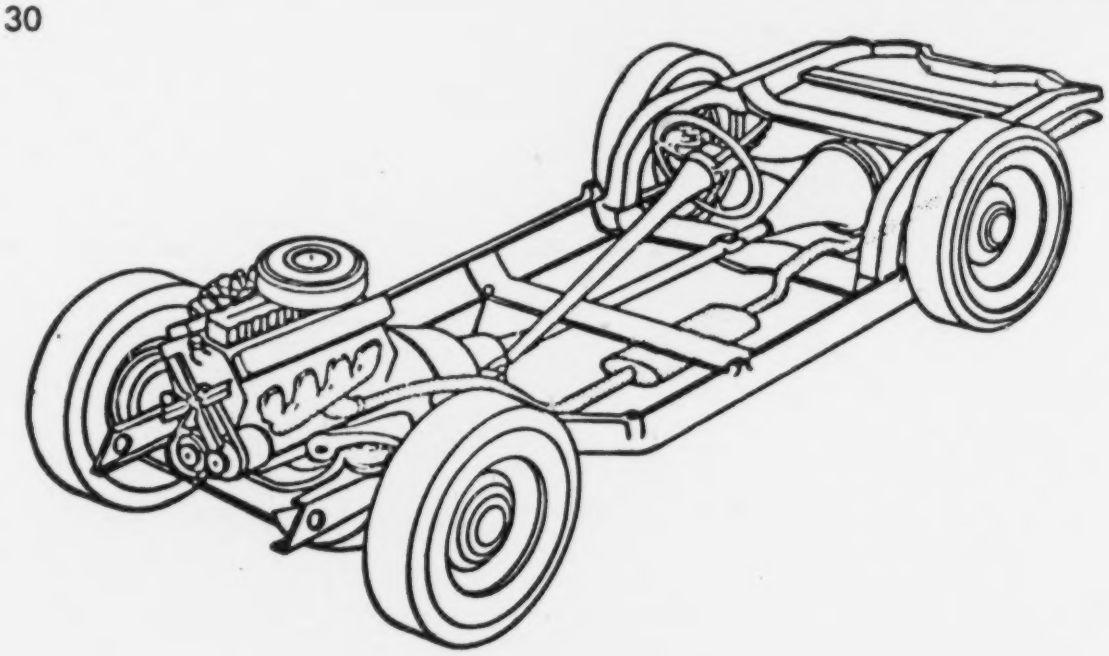

Engine noise and exhaust fumes enter the exhaust pipe from the

_____ _____

18104

30

exhaust manifold

31

NAME two things that enter the exhaust pipe from the exhaust manifold.

_____

_____

31

noise

exhaust fumes

32

Noise and exhaust fumes enter the exhaust pipe directly from the:

- ☐ engine
- ☐ exhaust manifold
- ☐ tailpipe

18106

32

exhaust manifold

33

Exhaust fumes and noise are made in the _____ .

The first part of the exhaust system that they enter is called the _____ _____ .

33

engine

exhaust manifold

34

The exhaust manifold gives noise and smoke directly to the

_____ _____ .

34

exhaust pipe

35

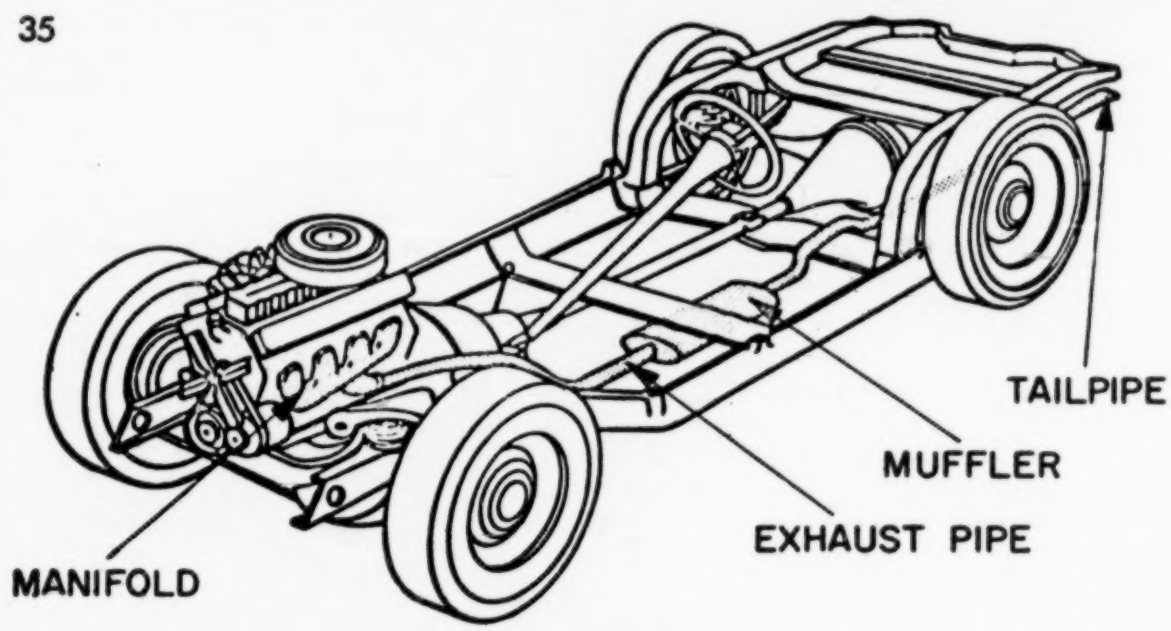

When noise and smoke leave the exhaust pipe on their trip to the back of the car, they then enter a part called the _____ .

35

muffler

36

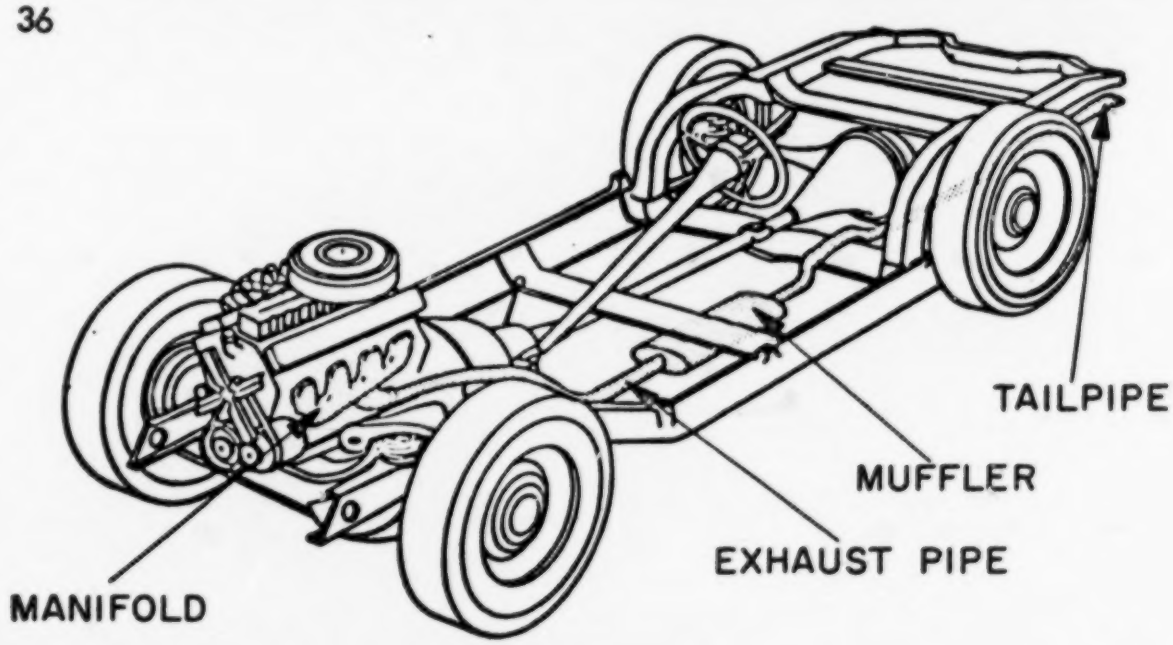

The muffler gets noise anu smoke directly from the:

- ☐ engine
- ☐ exhaust manifold
- ☐ exhaust pipe

18110

36

exhaust pipe

37

NAME two things that enter the muffler directly from the exhaust pipe.

_____

_____

37

noise

exhaust fumes

38

The job of the exhaust pipe is to carry noise and exhaust fumes from the _____ _____ to the muffler.

18112

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6. Text

38

exhaust manifold

39

The exhaust manifold and the muffler are connected by the

_____ _____ .

39

exhaust pipe

40

The exhaust pipe connects the _____ _____ and the _____ .

40

exhaust manifold

muffler

41

Noise and exhaust fumes enter the muffler directly from the _____ _____ .

41

exhaust pipe

42

The exhaust pipe gets _____ and _____ _____ from the exhaust manifold into the _____.

42

noise exhaust fumes

muffler

43

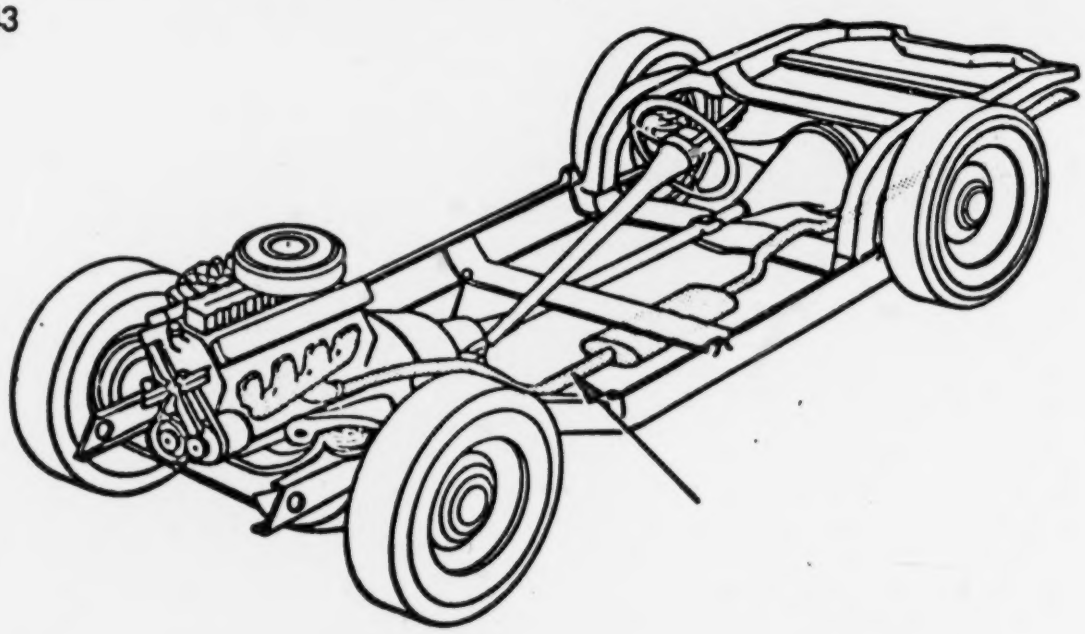

NAME the part the arrow points to.

_____

43

exhaust pipe

44

What does the exhaust pipe do? _____

44

gets noise and exhaust fumes from the exhaust manifold to the muffler

45

MATCH the following:

A. engine

B. exhaust manifold

C. exhaust pipe

1. _____ gets noise and exhaust fumes from the engine

2. _____ gets noise and exhaust fumes into the muffler

3. _____ makes noise and exhaust fumes

45

1. B

2. C

3. A

46

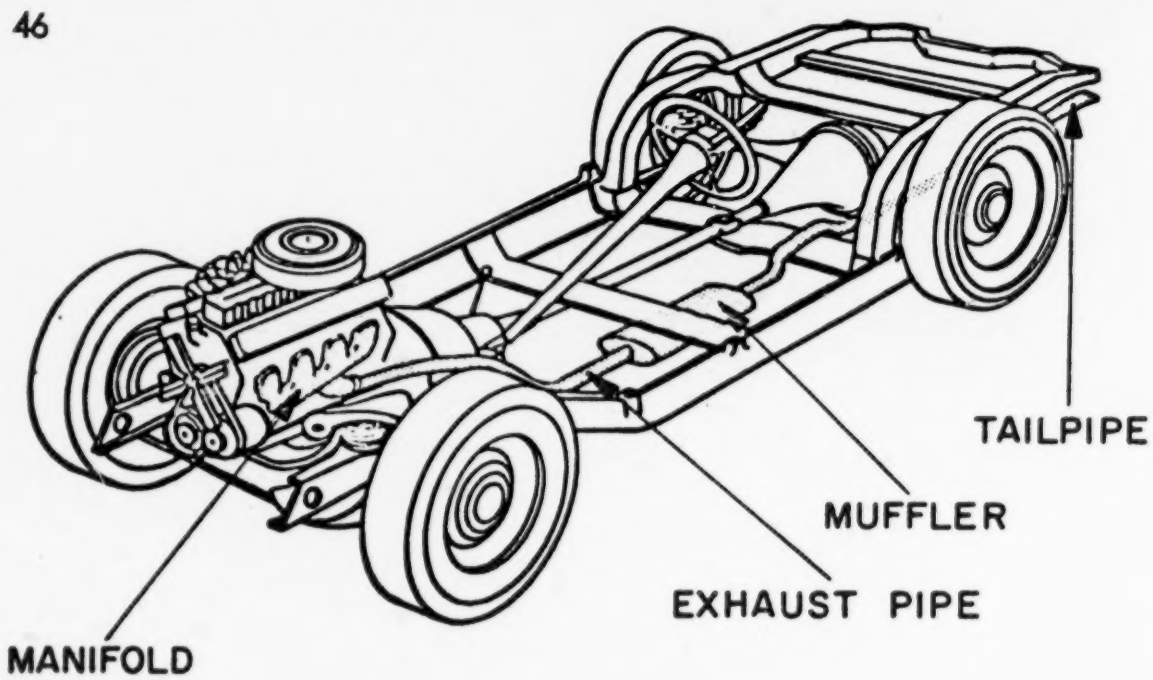

The part between the exhaust pipe and the tailpipe is called the _____ .

46

muffler

47

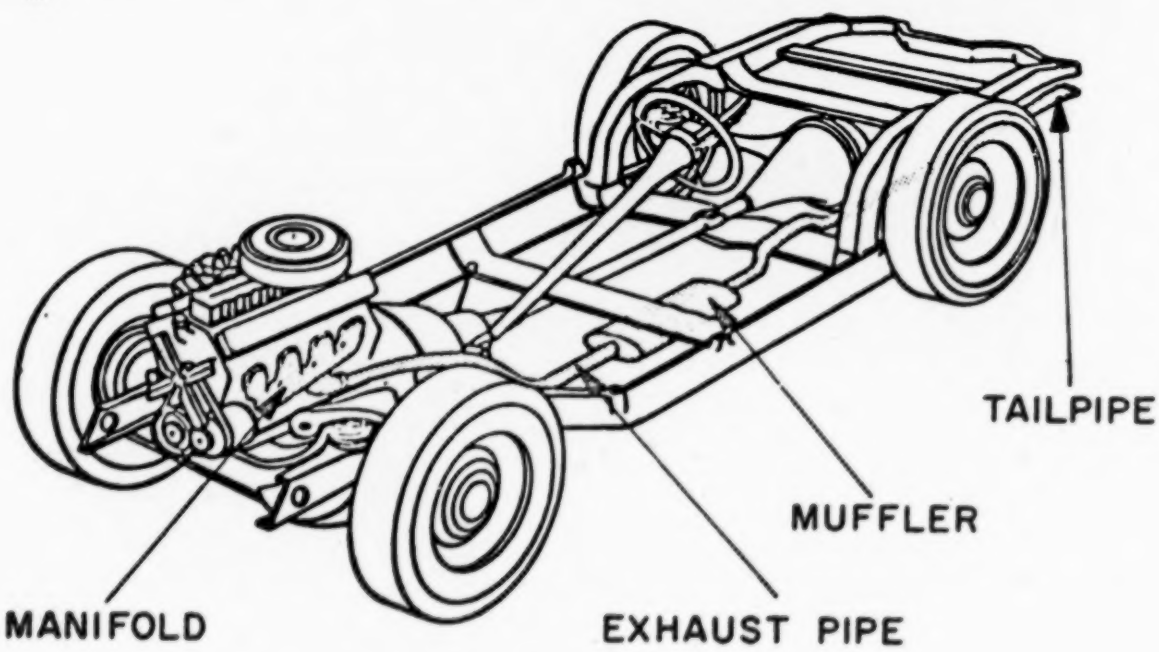

The muffler gets noise and exhaust fumes from the

_____.

47

exhaust pipe

48

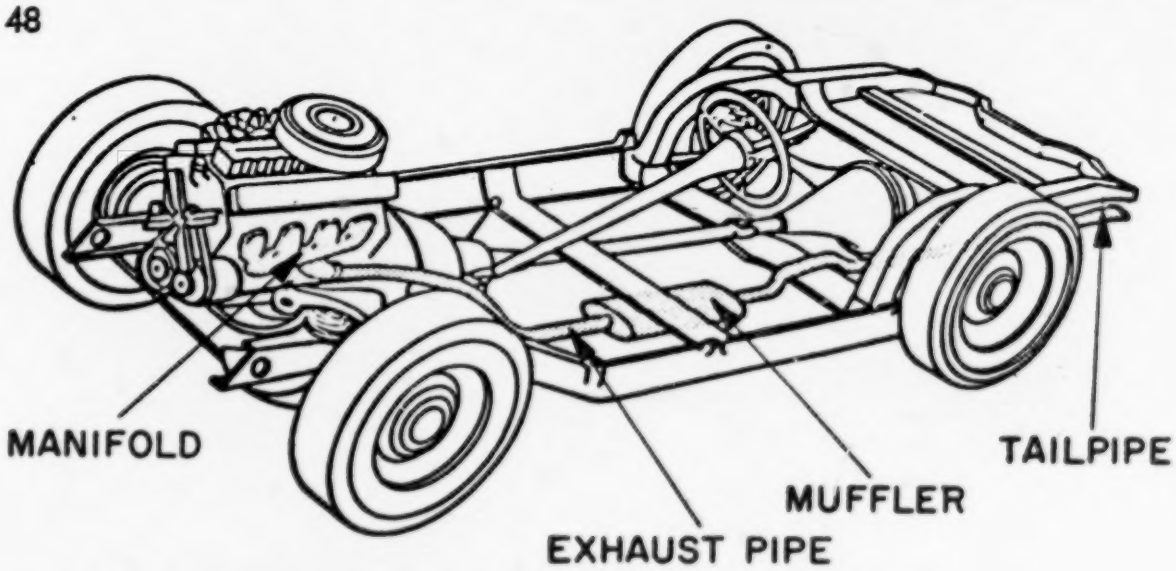

After noise has gone through the muffler, it is not as loud as it was when it entered.

Therefore, the muffler:

- ☐ increases noise
- ☐ decreases noise
- ☐ maintains same amount of noise

VT 011 498
Peterson, L.C.
Geometry of Drawing, Drafting.--Universal Language of Industry. LAP No. 6.

MF AVAILABLE IN VT-ERIC SET.
PUB DATE - Jul68 32p.

DESCRIPTORS - *INDUSTRIAL ARTS; *LEARNING ACTIVITIES; MANUALS; *AUTOINSTRUCTIONAL AIDS; INSTRUCTIONAL MATERIALS; EDUCATIONAL OBJECTIVES; *DRAFTING; GEOMETRIC CONCEPTS; ENGINEERING DRAWING; *ORTHOGONAL PROJECTION; HIGH SCHOOL STUDENTS
IDENTIFIERS - *ELEMENTARY SECONDARY EDUCATION ACT TITLE III; ESEA TITLE III; LEARNING ACTIVITY PACKAGE; LAP

ABSTRACT - Developed with Elementary and Secondary Education Act (ESEA) Title III funds, this learning activity package teaches certain geometrical constructions needed in drafting. Designed as a self-instructional unit for high school students, it contains: (1) rationale, (2) geometric applications, (3) primary ideas, (4) student objectives, (5) pretest terms, (6) key to pretest terms, (7) pretest drawing, (8) required and optional activities, (9) instructions following completion of activities, and (10) 12 drawings. A bibliography is included. (GR)

VT 011 498

48

decreases noise

49

Since noise from the engine is decreased inside the muffler, you hear less noise:

- ☐ before it goes into the muffler
- ☐ after it comes out of the muffler

49

after it comes out of the muffler

50

The job of the muffler is to:

- ☐ increase engine noise
- ☐ decrease engine noise
- ☐ maintain the same amount of engine noise

18124

50

decrease engine noise

51

The part that quiets engine noise is called the _____ .

18125

51

muffler

52

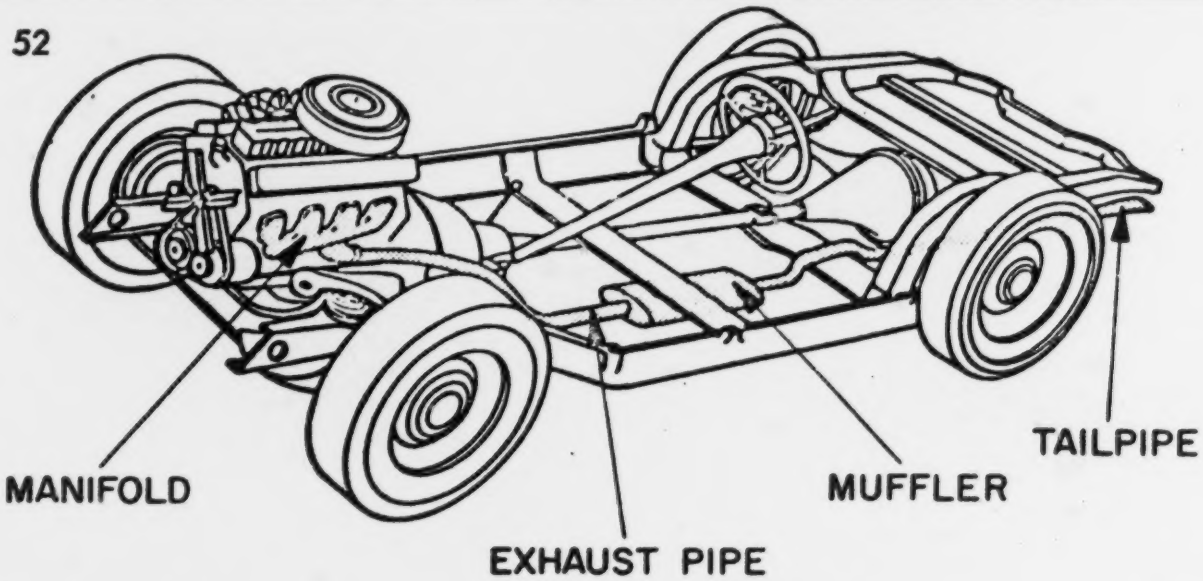

The part that has less engine noise going through it is the:

- ☐ exhaust pipe
- ☐ tailpipe

because it comes:

- ☐ after the muffler
- ☐ before the muffler

18126

52

tailpipe

after the muffler

53

Noise is louder when it:

- ☐ enters the muffler
- ☐ leaves the muffler

18127

post Test page 1 Book 4

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

The part of the exhaust system that is connected to the engine is called the _____ _____.

2

Exhaust fumes leave the exhaust system at the back of the car through the _____ _____.

3

Engine noise is quieted by the _____.

4

The tailpipe is connected to a part of the exhaust system called the _____.

5

NAME the part that builds up the driver's force on the steering wheel: _____

6

What part of the steering system does the driver turn? _____

7

The steering column connects the steering wheel to the _____ _____ assembly.

8

The idler arm is connected to the center link and to the _____.

9

The steering gear arm, the idler arm and the _____ _____ are connected to the center link.

10

What part of the steering system moves the front wheels? _____

18129/30

PANEL BOOK 9

To Be Used With
BOOK 9

AUTO MECHANICS COURSE

PANEL BOOK 9: EXHAUST SYSTEM

A BASIC SYSTEMS PROGRAM

18131

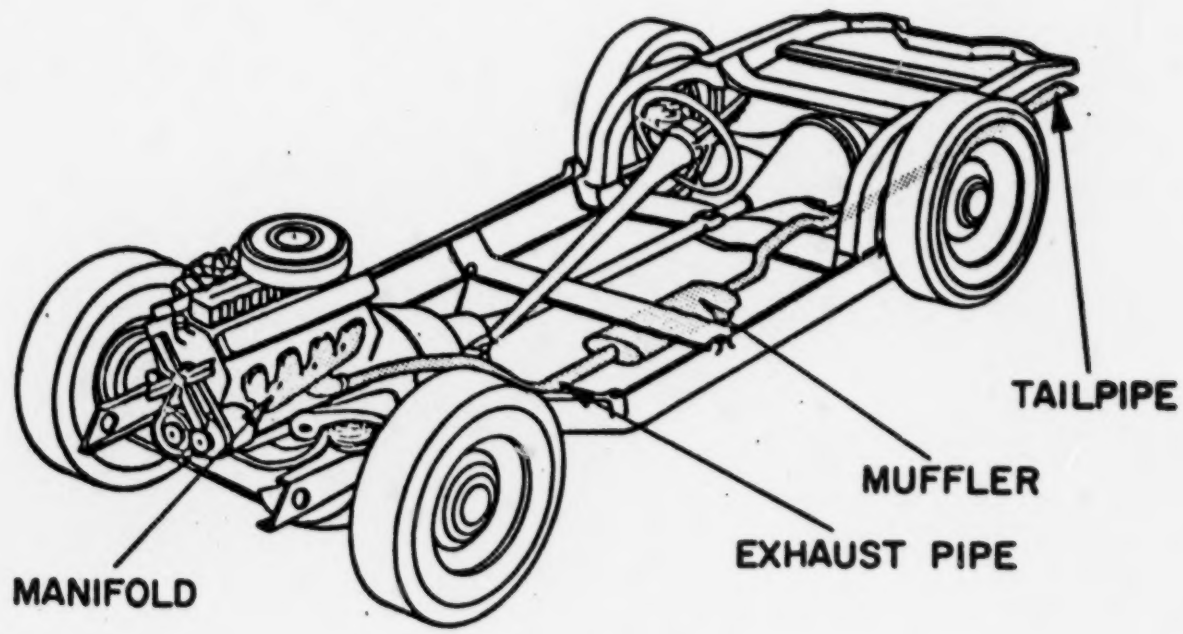

PANEL 1

18133

VT 013 132
Auto Mechanics Course. Book 10: The Power Transmission System.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 120p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *POWER MECHANICS; MOTOR VEHICLES; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the power transmission system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 132

4356

ED0 56238

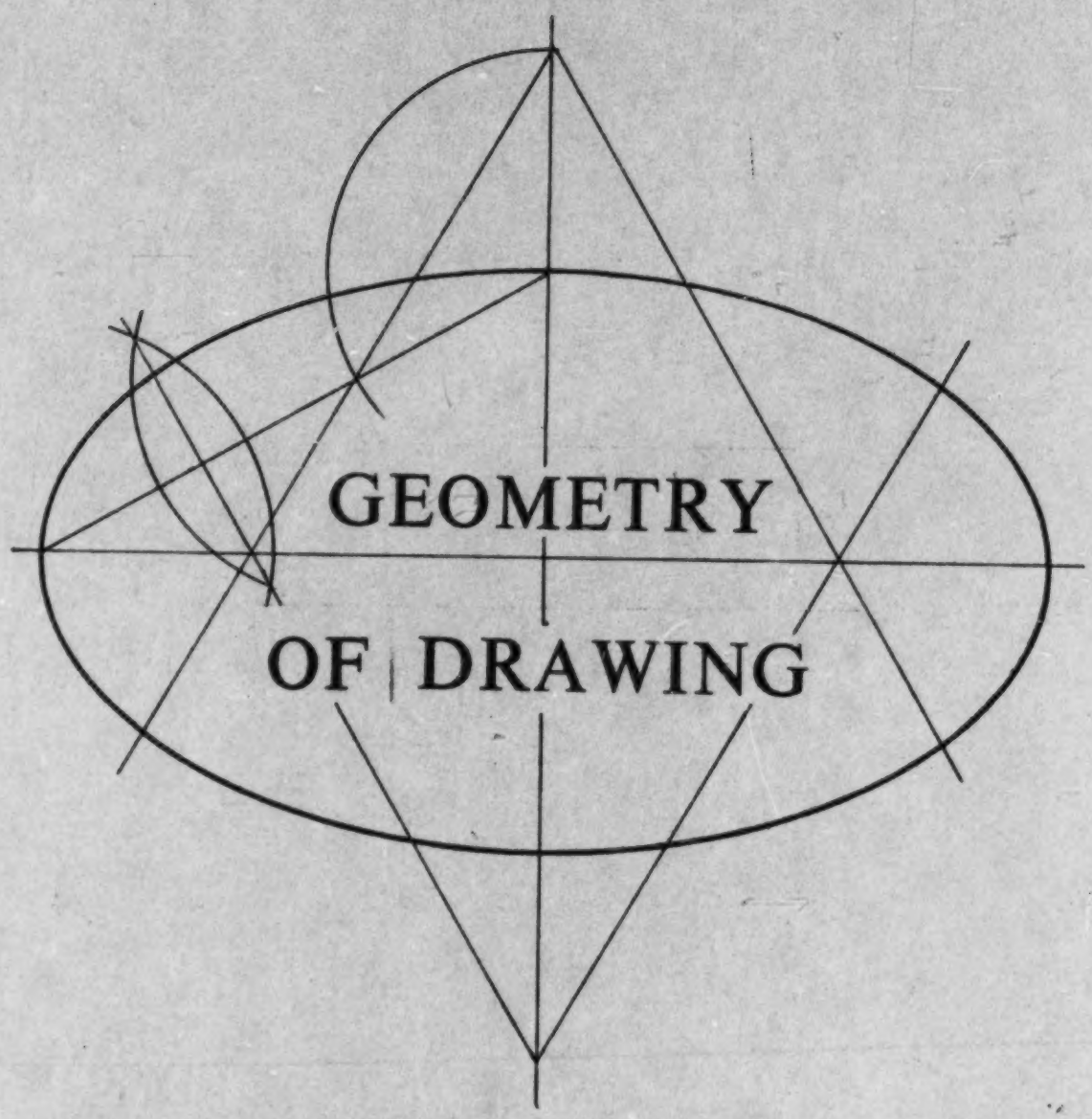

GEOMETRY OF DRAWING

* DRAFTING - UNIVERSAL LANGUAGE OF INDUSTRY *

For use by:
Modesto Junior College
Feeder Schools

E.S.E.A. Title III
Project No. 04401

L.A.P. No. 6

Basic Drafting

Prepared by
L. C. Peterson

July 1968

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VT011498

1810

ED0 56238

BOOK **10**

To Be Used With
PANEL BOOK 10

CV

AUTO MECHANICS COURSE

BOOK 10: THE POWER TRANSMISSION SYSTEM

A BASIC SYSTEMS PROGRAM

VT013132

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Curriculum Report Reference
Page 13

Task Analysis Reference
25, 26

18134

AUTO MECHANICS COURSE

BOOK 10: THE POWER TRANSMISSION SYSTEM

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

18135

Name _____

Date _____

Starting time _____

Finishing time _____

18136

Book 10

1

The drive wheels of a car are the:

- ☐ front wheels
- ☐ rear wheels

2

Power reaches the drive wheels from the _____ _____.

3

Power reaches the differential assembly through the _____ _____.

4

The part of the power transmission assembly between the clutch assembly and the drive shaft is called the _____ _____ assembly.

5

The muffler and the exhaust manifold are connected by the _____ _____.

6

Two pipes connected to the muffler are the:

_____

_____

7-10

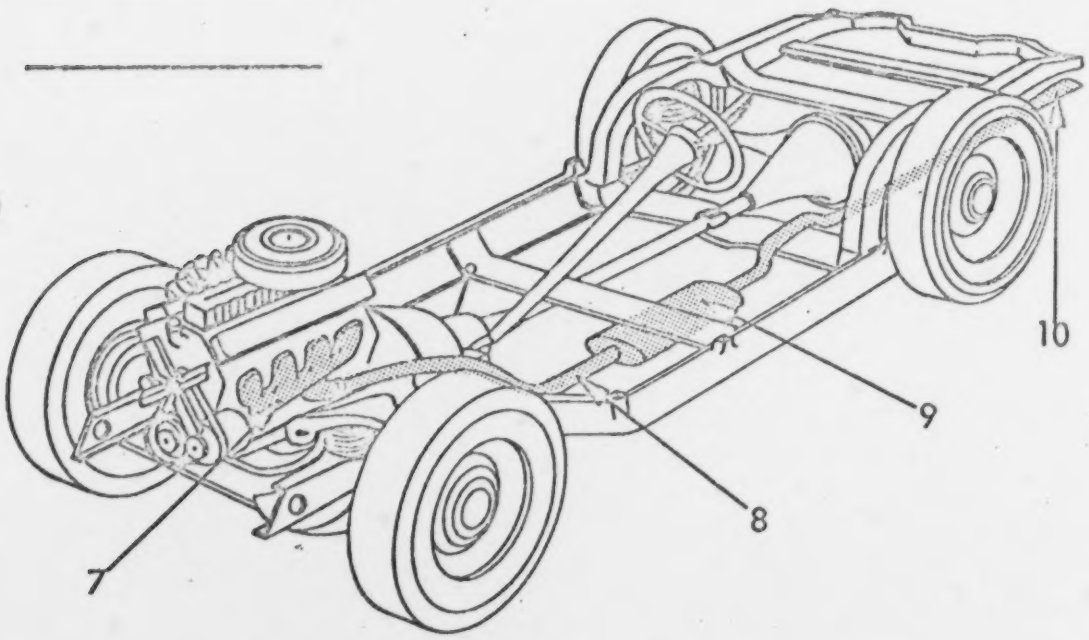

NAME the part each number points to:

7: _____

8: _____

9: _____

10: _____

18138

1

This section of the program will teach you how power gets from the engine to the wheels.

This part will answer the question:

- ☐ What steers the front wheels?
- ☐ What starts the engine?
- ☐ What makes the wheels turn?

18139

1

What makes the wheels turn?

2

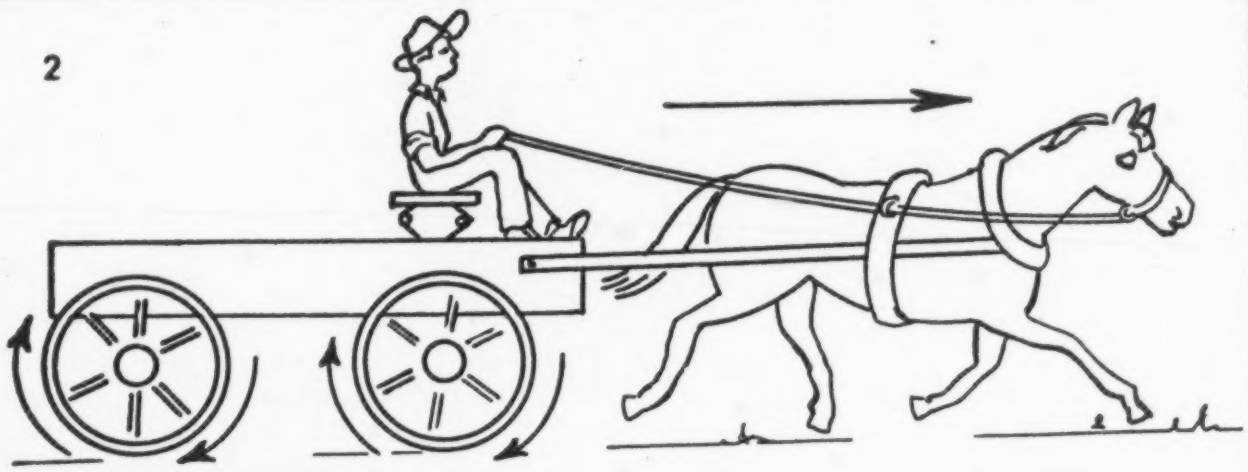

A horse and wagon are shown in the drawing.

Where does the power come from?

- ☐ the wheels
- ☐ the wagon
- ☐ the horse

18140

2

the horse

3

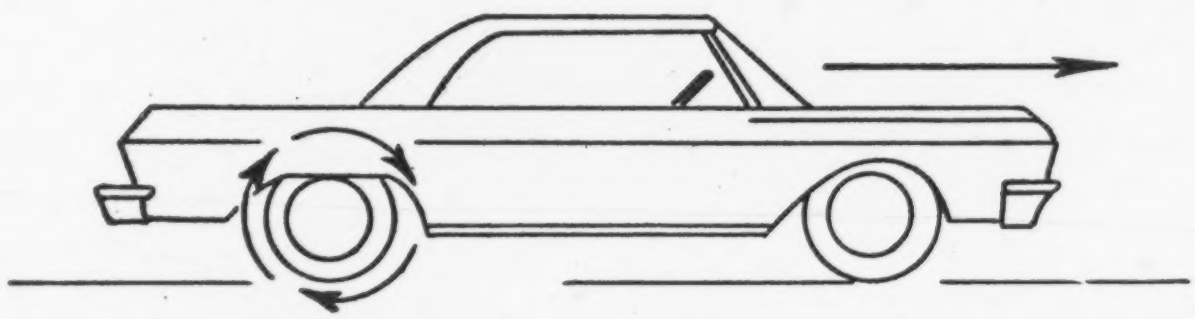

A car has power in the engine (think of "horsepower").

The arrows show that the car moves because:

- ☐ power turns the rear wheels
- ☐ the front wheels make their own power
- ☐ energy comes from the road

18141

3

power turns the rear wheels

4

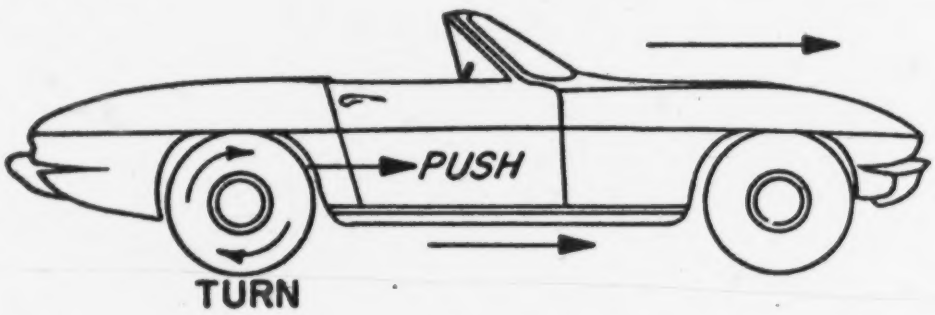

A horse pulls a wagon.

The drawing shows that a car moves because the rear wheels _____ the car.

18142

4

push

5

The rear wheels push a car because they:

- ☐ are larger than the front wheels
- ☐ stick to the road
- ☐ get power from the engine

18143

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Geometric Application	3
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Key - Pre-Test Terms	8-10
Pre-Test Drawing	11
Procedure Following Pre-Test	12
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Instructions Following Completion of Activities	15
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Octagons - Hexagons	G-3
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Tangents	G-5
Tangents	G-5A
Arcs & Tangents	G-6

5

get power from the engine

6

The power transmission system of a car sends power from the engine to the rear wheels.

The words that best describe transmission are:

- ☐ battery — power — rear wheels
- ☐ engine — power — rear wheels
- ☐ starter — battery — engine

6

engine — power — rear wheels

7

The rear wheels on a car get power from the:

- ☐ starter
- ☐ road
- ☐ engine

18145

7

engine

8

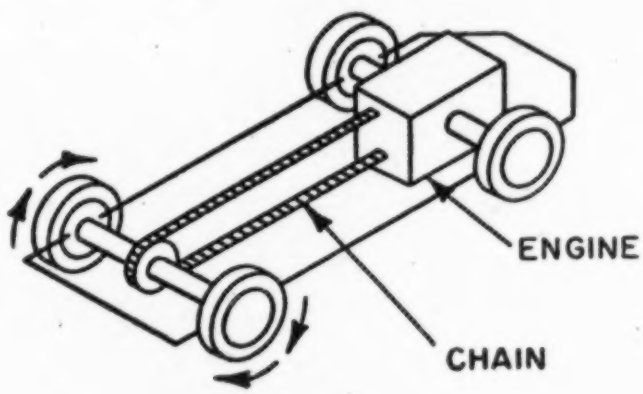

The drawing shows a "homemade" car.

The CHAIN carries power from the engine to the rear w _____ .

18145

8

wheels

9

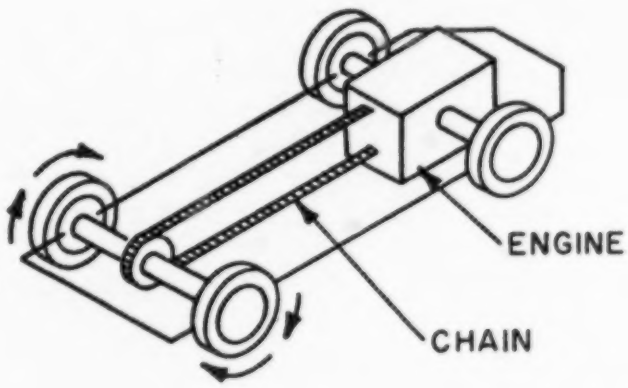

The drawing shows a simple "homemade" car.

CIRCLE the part below that transmits (carries) power to the rear wheels:

chain engine wheel

DS147

9

chain

10

The parts of a car that carry or transmit power from one place to another – just like a chain – are called the POWER TRANSMISSION SYSTEM.

The power transmission system:

- ☐ sends power from the gas tank to the gas pedal
- ☐ stops the engine power
- ☐ sends power from the engine to the rear wheels to turn the rear wheels

18140

10

sends power from the engine to the rear wheels to turn the rear wheels

11

Which system connects the engine to the rear wheels?

- ☐ exhaust system
- ☐ power transmission system
- ☐ steering system

18149

11

power transmission system

12

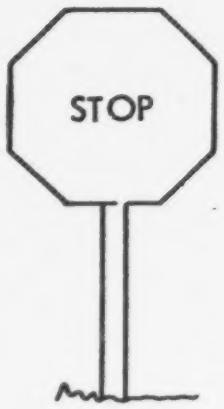

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

12

NO ANSWER NEEDED

13

The rear wheels on a car are called the DRIVE WHEELS.

Do the drive wheels steer the car? ☐ yes ☐ no

Do the drive wheels move the car? ☐ yes ☐ no

18151

13

no

yes

14

LOOK AT PANEL 1

CIRCLE the location of the drive wheels on a car:

front of the car

beside the steering wheel

around the drive shaft

back of the car

18152

14

back of the car

15

LOOK AT PANEL 1

The rear wheels are called:

- ☐ steering wheels
- ☐ drive wheels
- ☐ shaft wheels

18153

TOPIC	PAGE
Ellipse	G-7
Arcs	G-8
Conveyer Link	G-9
Gasket	G-10
Cushioning Base	G-11
Bibliography	16

15

drive wheels

16

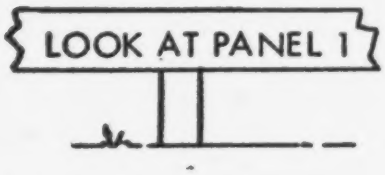

You can see from the drawing that the power transmission system parts are located:

- ☐ in the front of the car
- ☐ in the middle and the rear of the car
- ☐ only between the drive wheels

18154

16

in the middle and the rear of the car

17

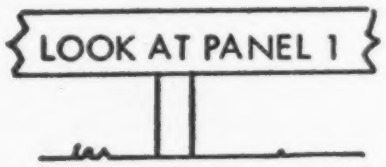

All the parts of the power transmission system are labeled.

The engine is at one end of the power transmission system, and the drive wheels are at the other end.

NAME the power transmission system parts that are between the engine and the drive wheels:

1. _____

2. _____

3. _____

4. _____

18155

17

clutch assembly

transmission gear assembly

drive shaft

differential assembly

18

What job do the power transmission system parts do?

- ☐ send power from the engine to the drive wheels
- ☐ stop the wheels from turning
- ☐ carry power from the drive wheels to the engine

18156

18

send power from the engine to the drive wheels

19

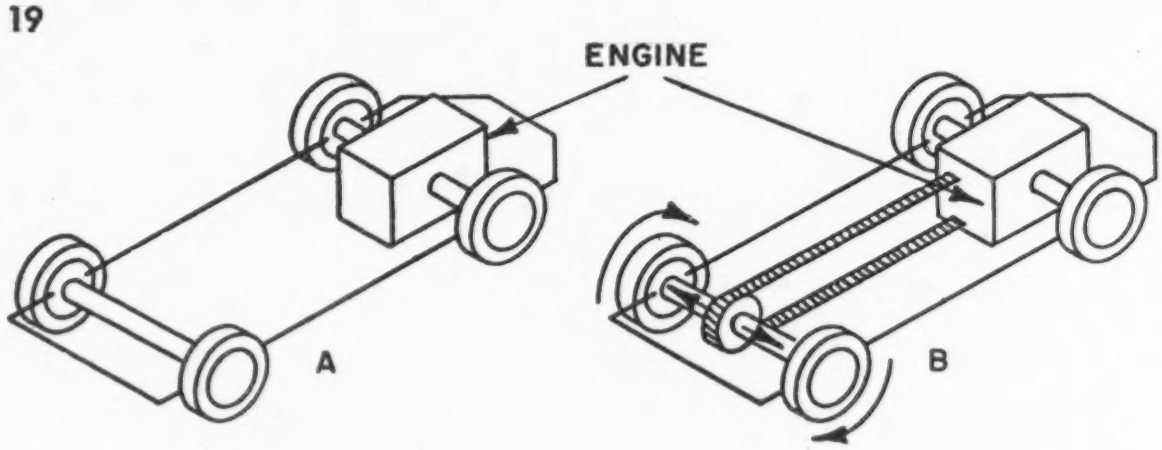

The power transmission system sends power from the engine to both drive wheels.

Which drawing above shows the complete flow of power through the power transmission system?

☐ A

☐ B

18157

19

B

20

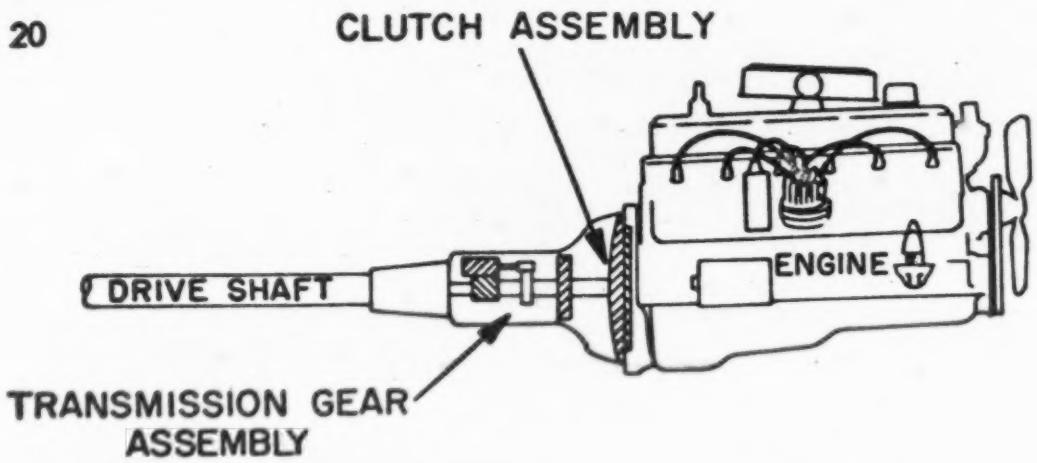

The first part of the power transmission system is the CLUTCH ASSEMBLY.

The clutch assembly gets power directly from the:

- ☐ drive shaft
- ☐ transmission gear assembly
- ☐ engine

18158

20

engine

21

LOOK AT PANEL 1

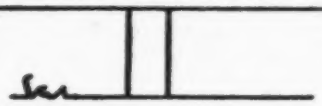

The engine makes the power in a car.

After the power is made in the engine it goes directly to the:

- ☐ drive shaft
- ☐ clutch assembly
- ☐ differential assembly

18159

21

clutch assembly

22

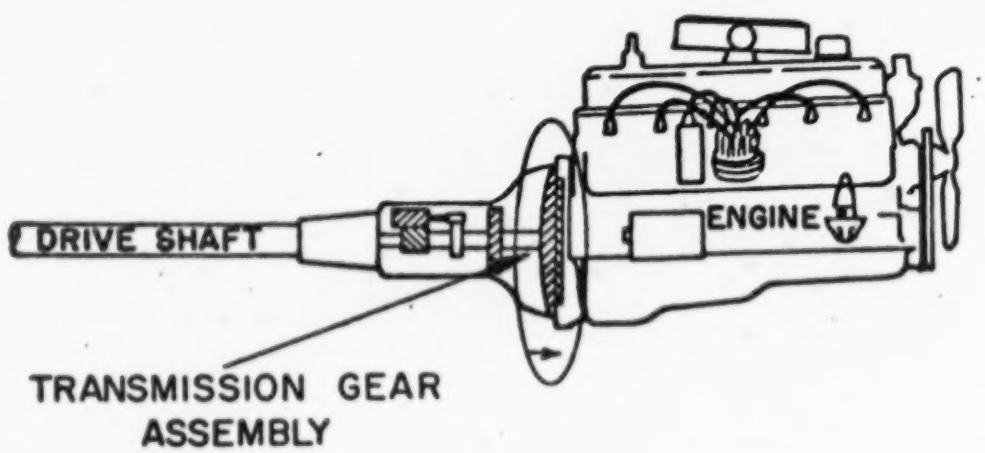

The drawing shows how the inside of the clutch assembly looks when the driver steps on the clutch pedal.

You can see that the clutch has:

- ☐ one main bearing that powers the engine
- ☐ four contact points
- ☐ two plates that go together and come apart

18160

22

two plates that go together and come apart

23

LOOK AT PANEL 1

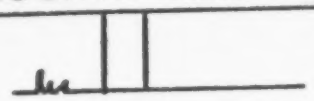

The second part of the power transmission system is the TRANSMISSION GEAR ASSEMBLY.

Power goes to the transmission gear assembly directly from the:

- ☐ rear wheels
- ☐ clutch assembly
- ☐ drive shaft

18161

23

clutch assembly

24

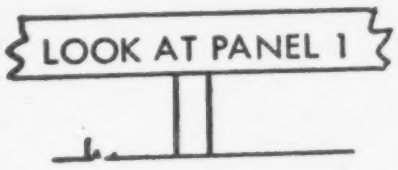

One end of the clutch assembly is bolted onto the engine.

What is the other end attached to?

- ☐ crankshaft
- ☐ transmission gear assembly
- ☐ rear axle

18162

24

transmission gear assembly

25

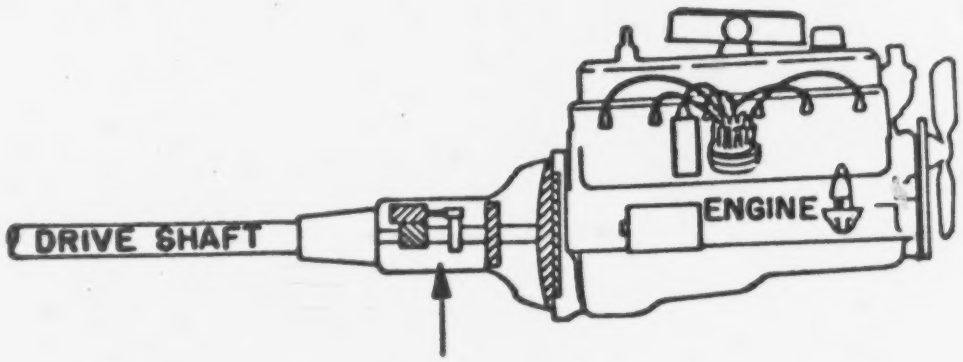

The arrow points to the:

- ☐ engine
- ☐ clutch assembly
- ☐ transmission gear assembly

18163

25

transmission gear assembly

26

CIRCLE one drawing below that looks like a clutch assembly and transmission gear assembly unit:

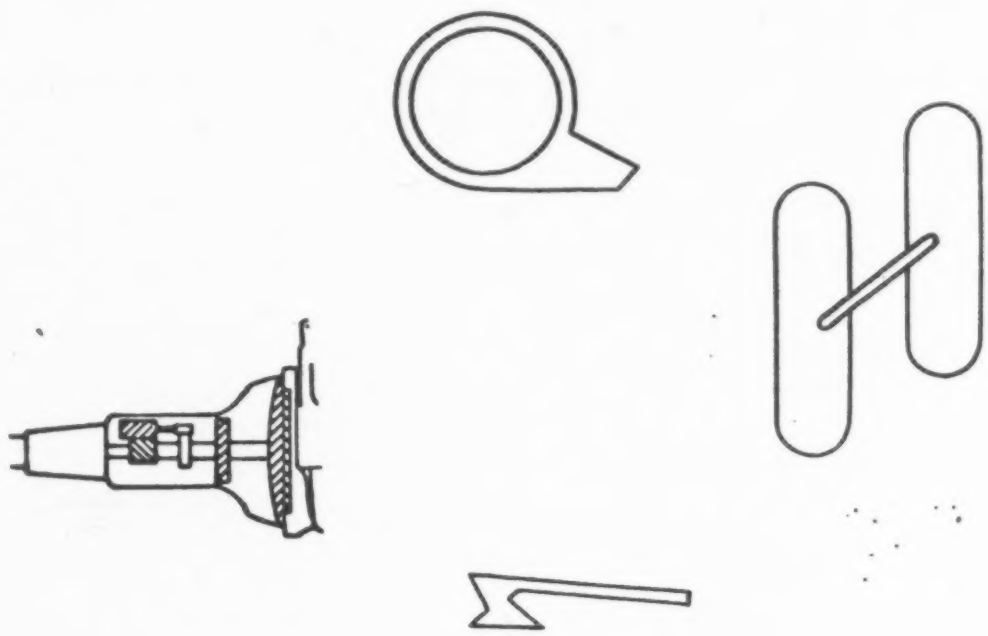

18164

26

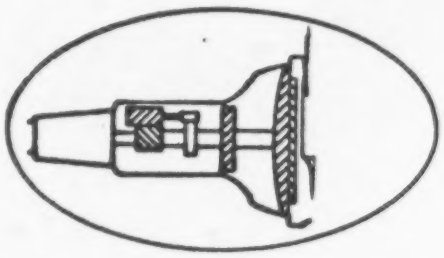

27

LOOK AT PANEL 1

After power has traveled through the clutch assembly, it goes directly to the:

- ☐ rear axle
- ☐ drive shaft
- ☐ transmission gear assembly

18165

27

transmission gear assembly

28

LOOK AT PANEL 1

The third part of the power transmission system (and the longest part) is the DRIVE SHAFT.

CROSS OUT the drawing below that shows what the drive shaft looks like:

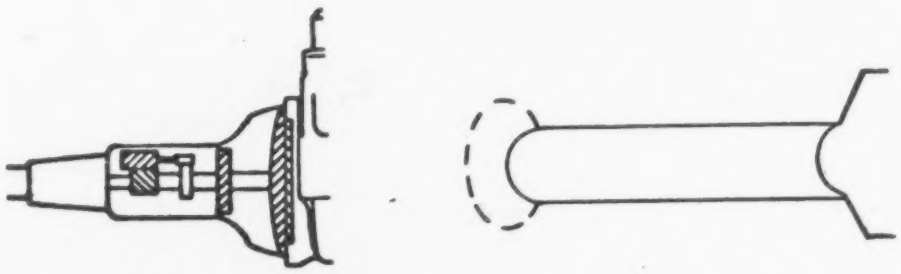

A B

28

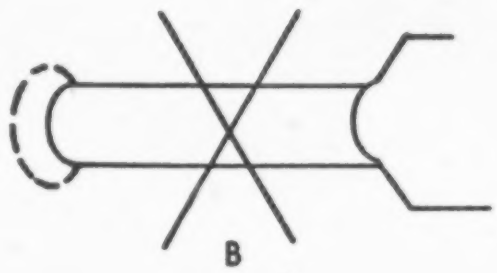

B

29

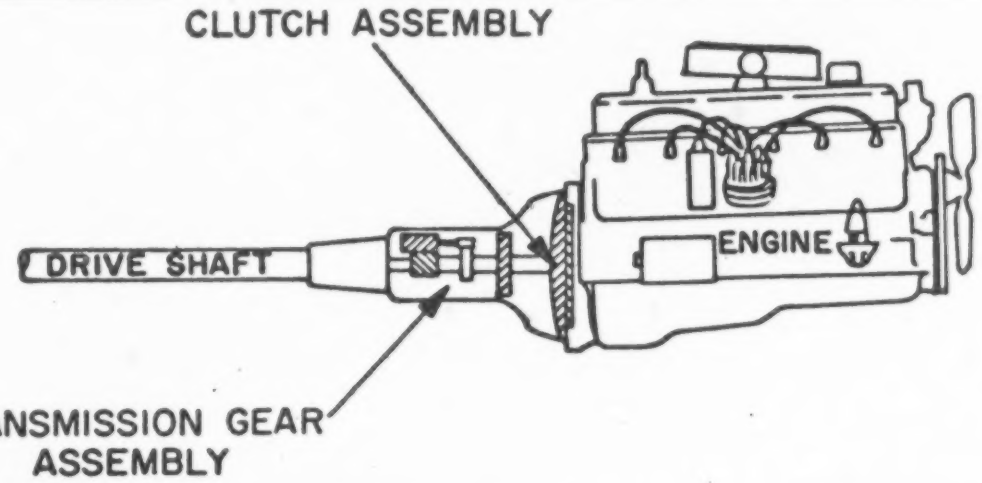

The drawing above shows that the drive shaft is connected to one side of the transmission gear assembly.

The part connected to the other side of the gears is the c_____ a_____.

29

clutch assembly

30

LOOK AT PANEL 1

The transmission gear assembly is connected to two parts.

What are the names of these parts? (CHECK TWO)

- ☐ the clutch assembly
- ☐ the differential assembly
- ☐ the engine
- ☐ the drive shaft

30

the clutch assembly

the drive shaft

31

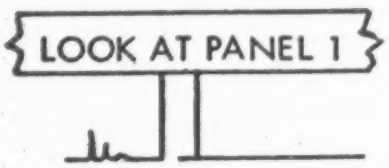

You can see from the drawing that the drive shaft is a long straight part that extends back to the:

- ☐ end of the tailpipe
- ☐ middle of the car
- ☐ part between the drive wheels

18169

31

part between the drive wheels

32

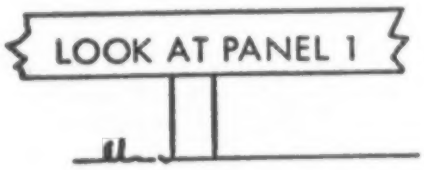

The part located between the rear axles is called the DIFFERENTIAL ASSEMBLY.

The differential assembly is connected to the:

- ☐ drive shaft
- ☐ transmission gear assembly
- ☐ drive wheels

18170

32

drive shaft

33

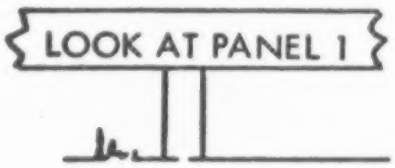

The transmission gear assembly is attached to one end of the **drive shaft.**

What part is connected to the other end of the drive shaft?

- ☐ the differential assembly
- ☐ the drive wheels
- ☐ the rear axles

33

the differential assembly

34

LOOK AT PANEL 1

The differential assembly is located:

- ☐ between the rear wheels
- ☐ exactly in the middle of the drive shaft
- ☐ on the drive shaft near the engine

18172

261 OF 327

ED

056 238

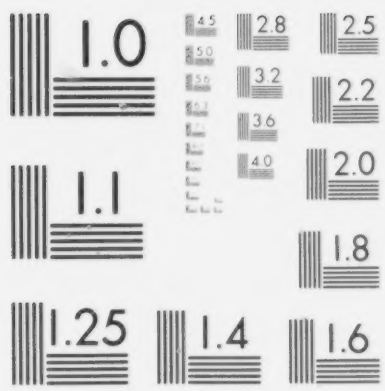

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

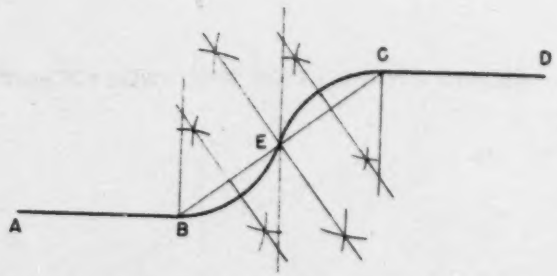

TO CONSTRUCT AN EQUAL OGEE CURVE

PLATE G-6

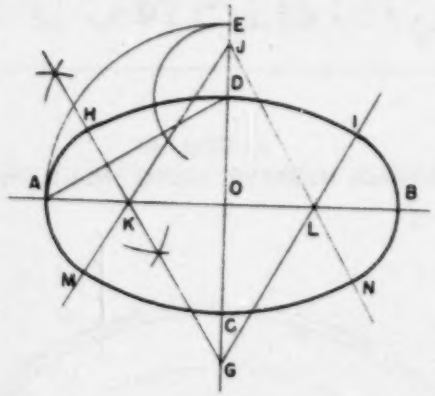

TO CONSTRUCT AN APPROXIMATE ELLIPSE BY THE FOUR CENTER METHOD

PLATE G- 7

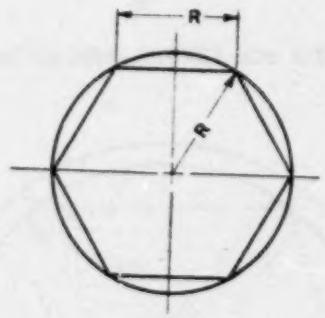

TO INSCRIBE A HEXAGON BY THE RADIUS METHOD

PLATE G - 3

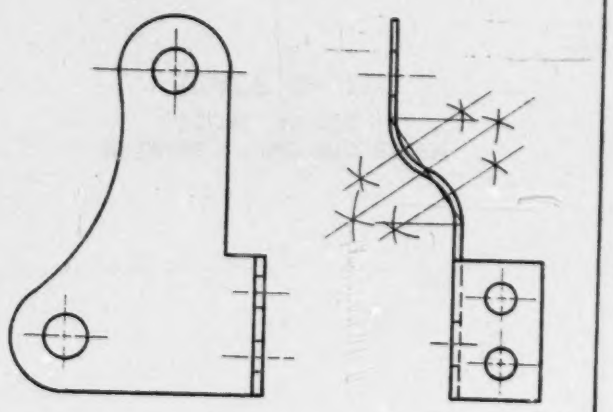

APPLICATION - SUPPORT

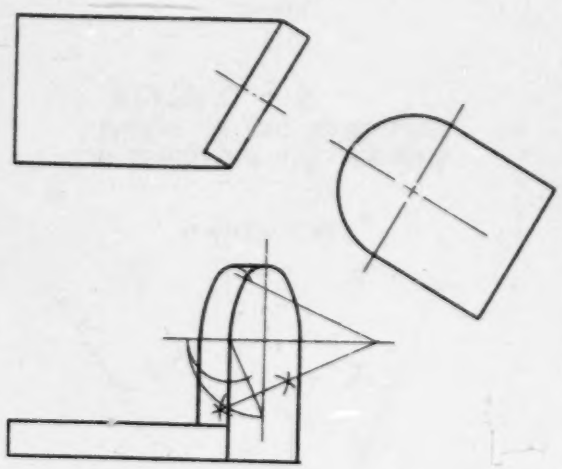

APPLICATION - ANGLE SUPPORT

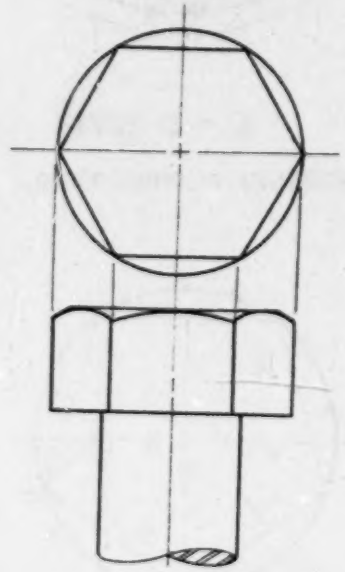

APPLICATION - HEXAGON BOLT HEAD

GEOMETRIC CONSTRUCTIONS

1812 (2)
1814
4360

34

between the rear wheels

35

LOOK AT PANEL 1

The parts connecting the rear wheels to the differential gear assembly are called the REAR AXLES.

The rear axles are located:

- ☐ between the rear wheels and the differential gear assembly
- ☐ between the rear wheels and the front wheels
- ☐ on the side of the drive shaft

35

between the rear wheels and the differential gear assembly

36

LOOK AT PANEL 1

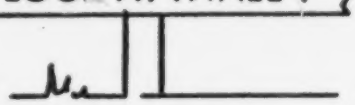

Which of the following parts is connected to the differential assembly?

- ☐ transmission gear assembly
- ☐ rear axles
- ☐ drive wheel
- ☐ steering wheel

18174

36

rear axles

37

LOOK AT PANEL 1

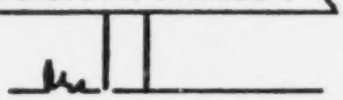

On the outside end of each rear axle, there is a:

- ☐ drive wheel
- ☐ transmission gear assembly
- ☐ very small differential gear assembly

18175

37

drive wheel

38

The power transmission system gets power from the engine and transmits (sends) this power to:

- ☐ both drive wheels
- ☐ the differential assembly only
- ☐ only the drive wheel on the driver's side

18176

38

both drive wheels

39

LOOK AT PANEL 1

Power is made in the engine.

WRITE 1 for the first part power goes to after leaving the engine.

WRITE 2 for the part power goes to next.

WRITE 3 for the part power goes to last.

clutch assembly _____

drive shaft _____

transmission gear assembly _____

39

1

3

2

40

LOOK AT PANEL 1

Power goes from the engine to the rear of the car.

CIRCLE the parts that are written in the order in which power goes to them:

transmission gear assembly—drive shaft—clutch assembly

clutch assembly—transmission gear assembly—drive shaft

drive shaft—clutch assembly—transmission gear assembly

40

clutch assembly → transmission

gear assembly → drive shaft

41

LOOK AT PANEL 1

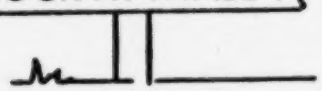

WRITE the name of the transmission part that is located between the two parts named below:

1. clutch assembly
2. _____ _____ _____
3. drive shaft

41

transmission gear assembly

42

LOOK AT PANEL 1

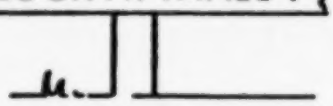

Remember, the engine makes power that travels back to the rear wheels.

Power from the drive shaft goes directly to the:

- ☐ rear axles
- ☐ drive wheels
- ☐ differential assembly

18180

42

differential assembly

43

LOOK AT PANEL 1

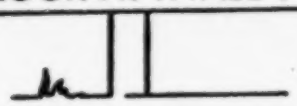

Power goes from the drive shaft to the _____ _____.

43

differential assembly

44

LOOK AT PANEL 1

Power goes through the drive shaft.

WRITE 1 for the first part power goes to after leaving the drive shaft.

WRITE 2 for the part power goes to next.

WRITE 3 for the part power goes to last.

differential assembly _____

drive wheels _____

rear axles _____

1815

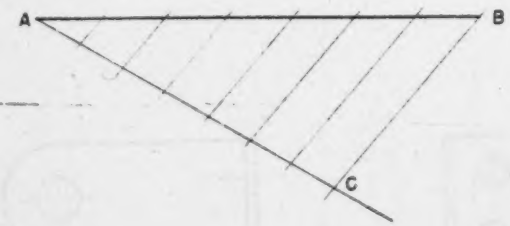

TO DIVIDE A LINE INTO SEVEN EQUAL SPACES

PLATE G- 1

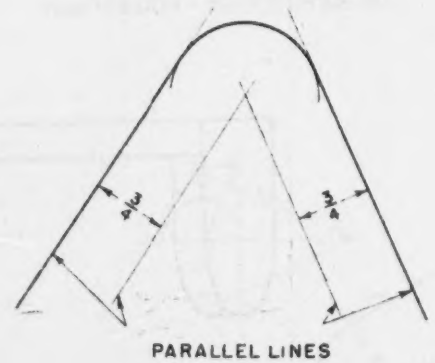

PARALLEL LINES

TO CONSTRUCT A $\frac{3}{4}$-IN. RADIUS TANGENT TO TWO GIVEN LINES

PLATE G - 5

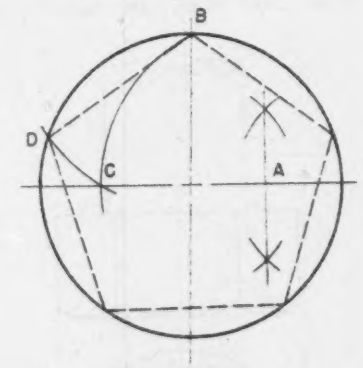

TO CONSTRUCT A PENTAGON

PLATE G - 3

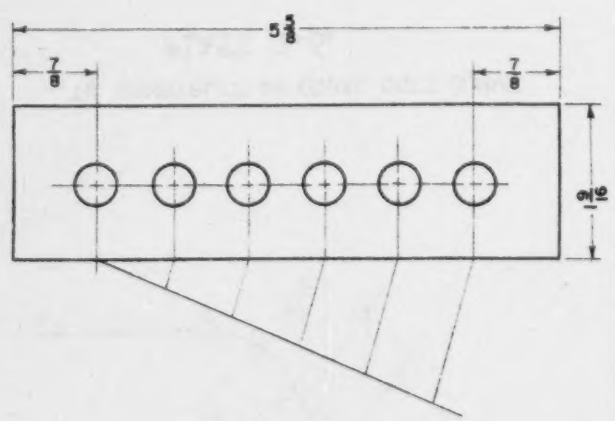

APPLICATION- SIX HOLES EQUALY SPACED

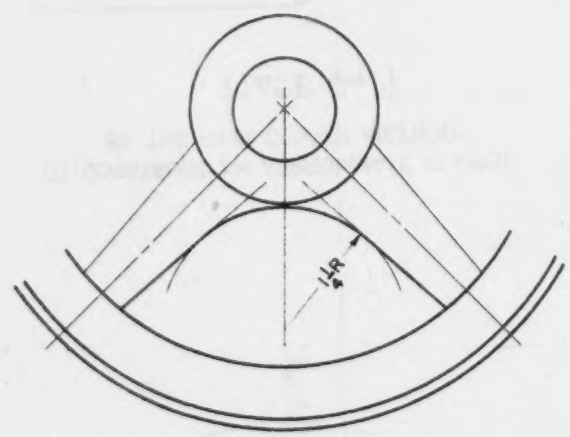

APPLICATION- RADIUS BETWEEN SPOKES OF PULLEY

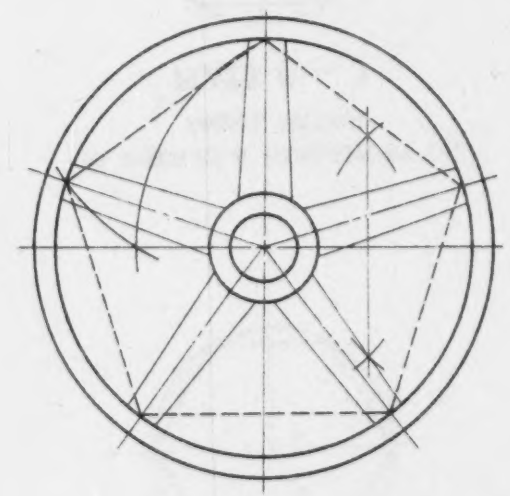

APPLICATION - SPOKES FOR PULLEY

GEOMETRIC CONSTRUCTIONS

1815 (3)

(3)

4361

44

1

3

2

45

LOOK AT PANEL 1

The power transmission system gets power from the engine to the road.

Just before power gets to the road it is:

- ☐ at the clutch assembly
- ☐ in the drive wheels
- ☐ in the transmission gear assembly

45

in the drive wheels

46

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

18184

46

NO ANSWER NEEDED

47

DRAW an arrow from the words DRIVE WHEEL (below) to the actual drive wheel on the car in the drawing:

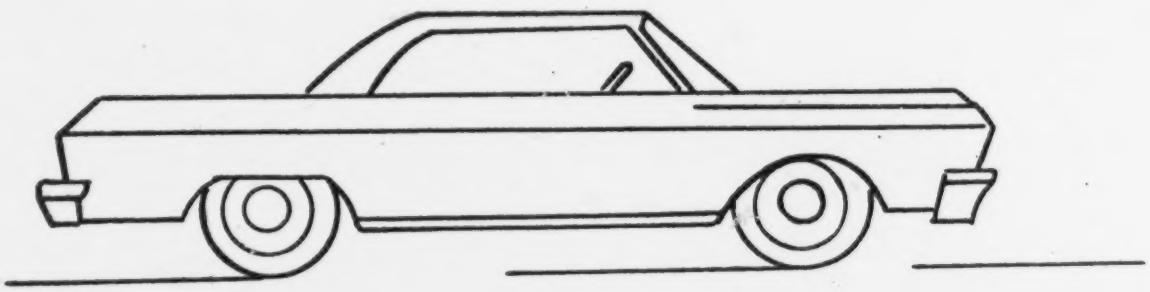

DRIVE WHEEL

18185

47

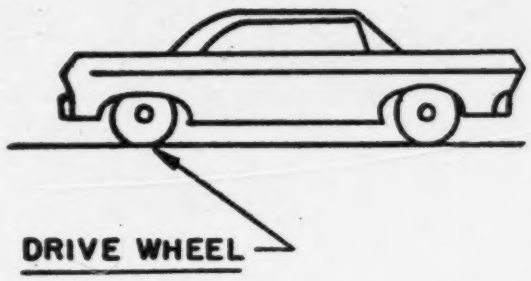

48

SHADE IN the rear axles below:

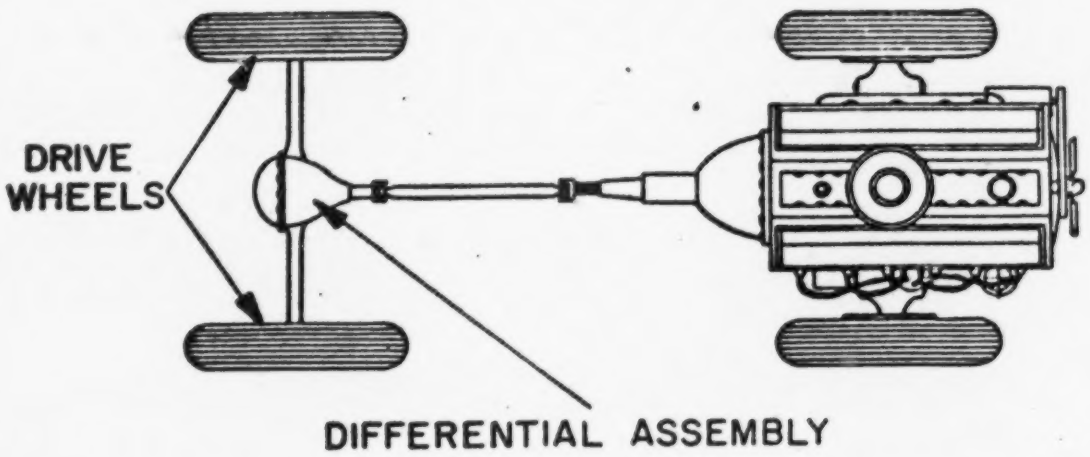

48

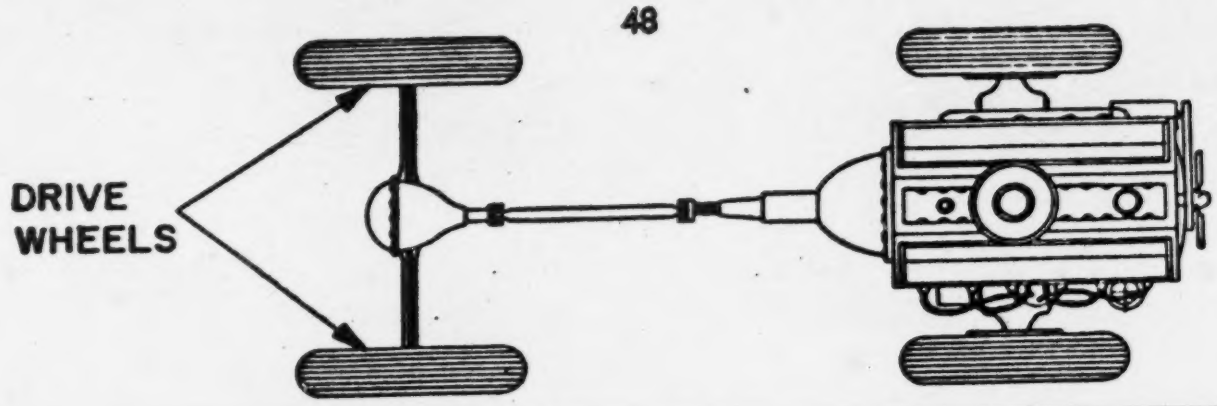

49

CROSS OUT the differential assembly below:

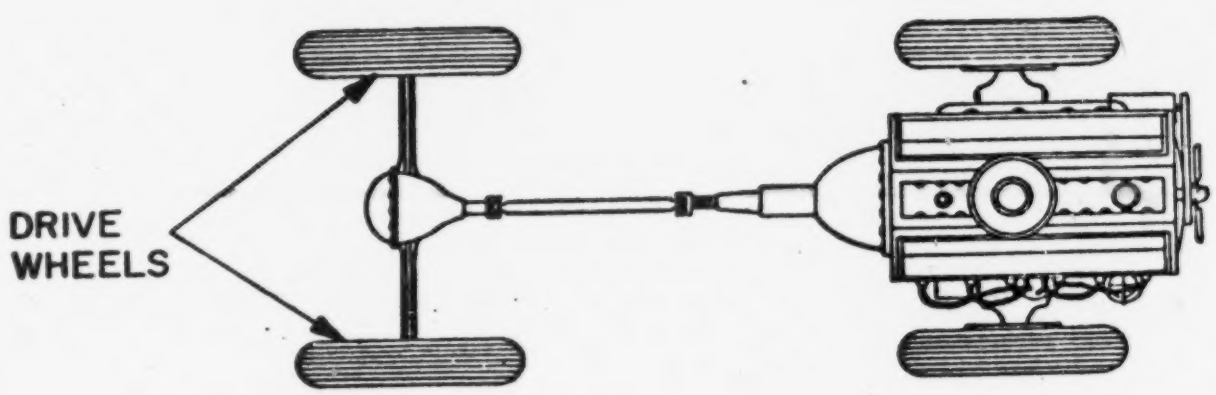

18187

49

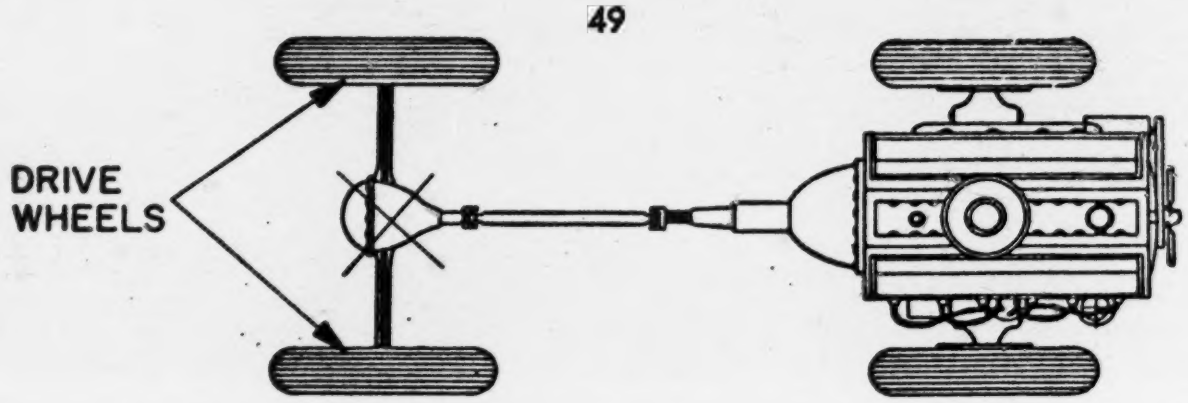

50

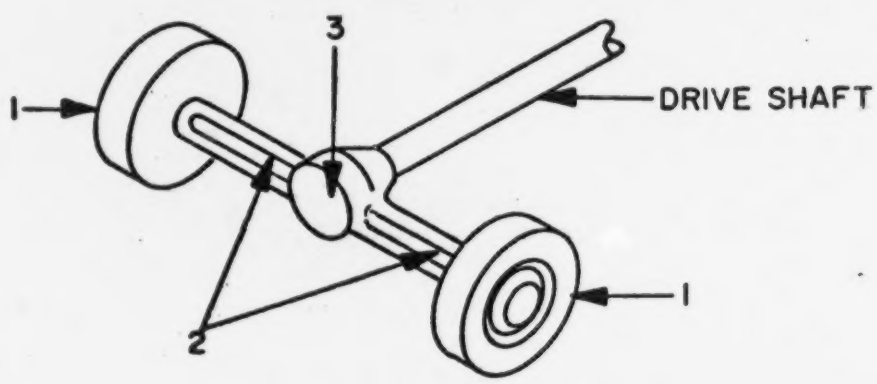

Next to each part name below, WRITE the number that identifies it in the picture:

differential assembly _____

drive wheels _____

rear axles _____

18188

50

3

1

2

51

WRITE the missing part names in the boxes below:

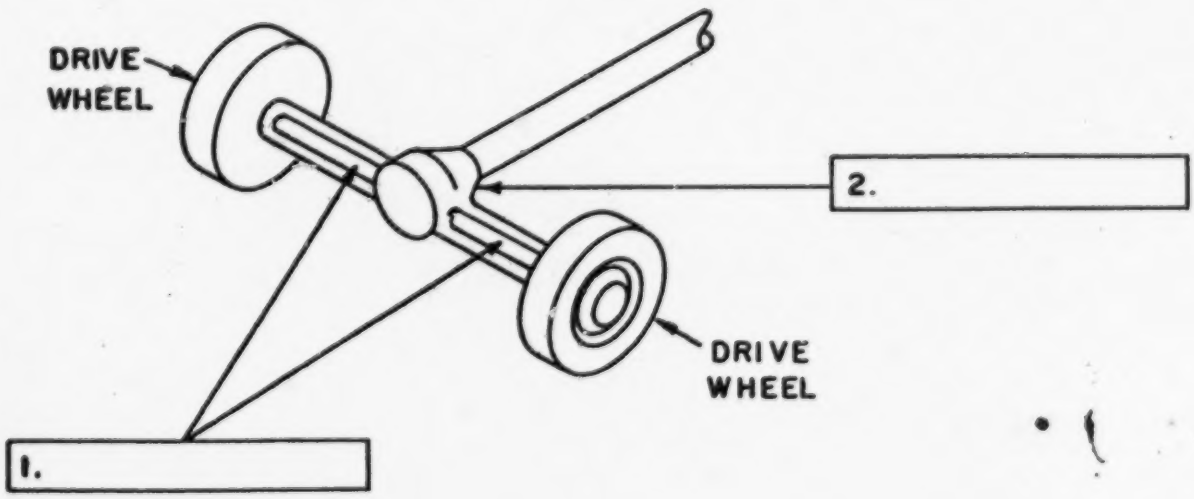

18189

51

1. rear axles

2. differential assembly

52

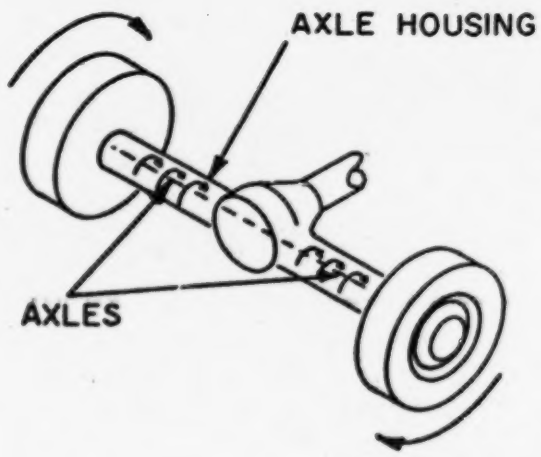

The drawing shows that the turning parts are the axles and the:

- ☐ drive wheels
- ☐ axle housing
- ☐ differential housing

52

drive wheels

53

The axle housing protects the rear axles. It does not turn.

The turning axles are located:

- ☐ around the drive shaft
- ☐ inside the axle housing
- ☐ inside the wheels

53

inside the axle housing

54

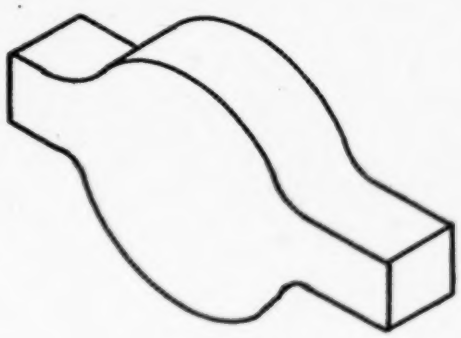

A

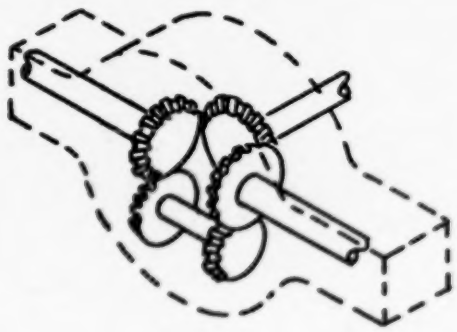

B

Which of the two drawings shows the working (moving) parts of a differential assembly?

- ☐ A
- ☐ B

18192

PRIMARY IDEA - GEOMETRIC CONSTRUCTION

STUDENT OBJECTIVES

The following terms relate to Geometrical Construction. Given a symbol, drawing, or term, you will be able to explain through an oral or written statement, and by drawing an illustration or symbol, the following:

Vertex of an Angle	Angle
Hypotenuse	Cube
Quadrant of Circle	Prism
Sector of Circle	Cylinder
Segment of Circle	Pyramid
Concentric Circles	Cone
Eccentric Circles	Sphere
Semi-Circle	Parallelogram
Center Line	Ellipse
Construction Line	Polygon
Isosceles Triangle	Major Axis
Scalene Triangle	Minor Axis
Perpendicular	Cord
Tangent-Point	Arc

54

B

55

Like the axles, the differential assembly has moving parts inside a housing.

The differential assembly housing:

- ☐ turns with the gears
- ☐ protects the gears
- ☐ steers the front wheels

55

protects the gears

56

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

18194

56

NO ANSWER NEEDED

57

LOOK AT PANEL 1

16

In the panel drawing, you can see:

- ☐ the moving parts of the axles and differential assembly
- ☐ the housings for the axles and differential assembly
- ☐ all the parts of the differential assembly

18195

57

all the parts of the differential assembly

58

LOOK AT PANEL 1

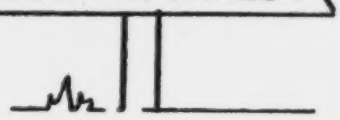

The parts labeled in the panel drawing are all:

- ☐ important for the safety of the driver
- ☐ parts of the power transmission system
- ☐ parts that make the car stop quickly

58

parts of the power transmission system

59

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

18197

59

NO ANSWER NEEDED

60

The differential gear assembly is between the:

- ☐ drive shaft
- ☐ front axle
- ☐ two rear axles

18198

60

two rear axles

61

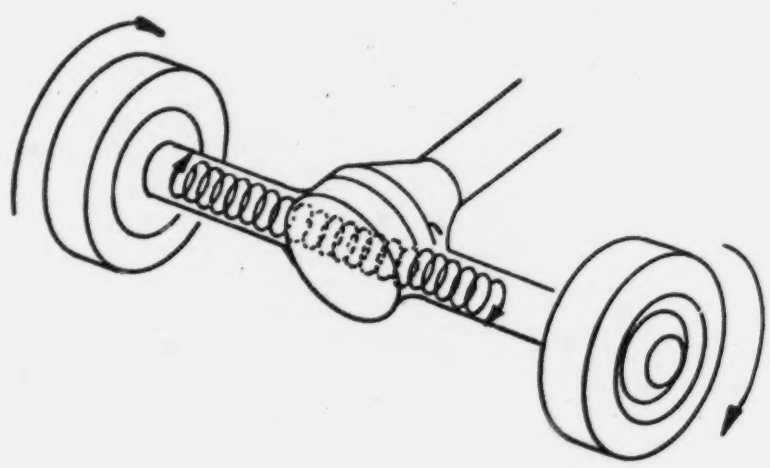

The drawing shows that the parts of the differential assembly send turning power:

- ☐ only to the left drive wheel
- ☐ only to the right drive wheel
- ☐ to both drive wheels

18199

61

to both drive wheels

62

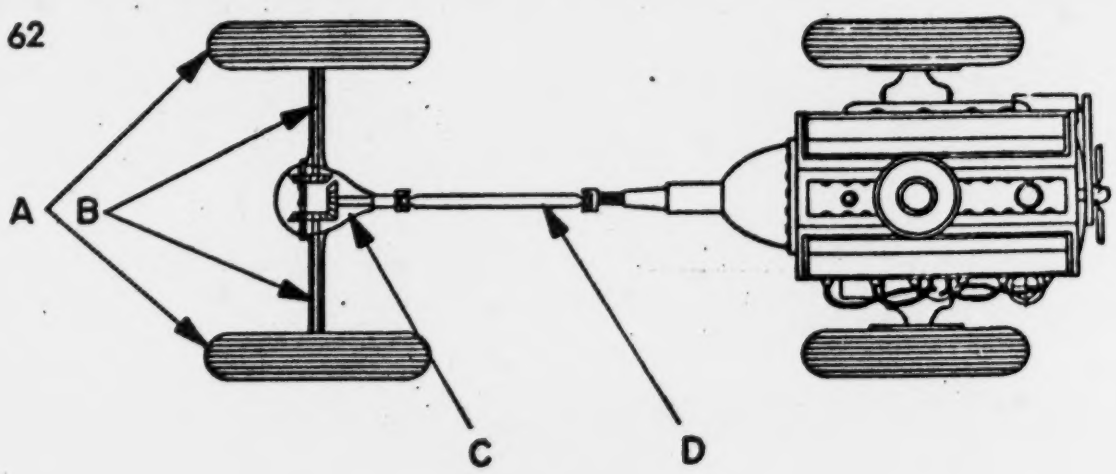

IDENTIFY the parts that each arrow points to:

Arrow A: _____

Arrow B: _____

Arrow C: _____

18200

62

drive wheels

rear axles

differential assembly

63

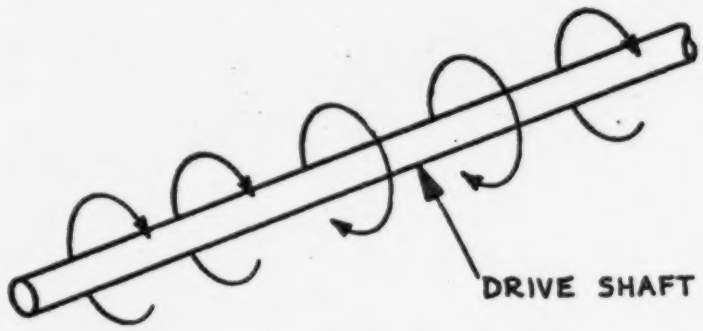

The drawing shows that the drive shaft:

- ☐ never moves
- ☐ is a part that can turn
- ☐ is supported by three mounts

18201

63

is a part that can turn

64

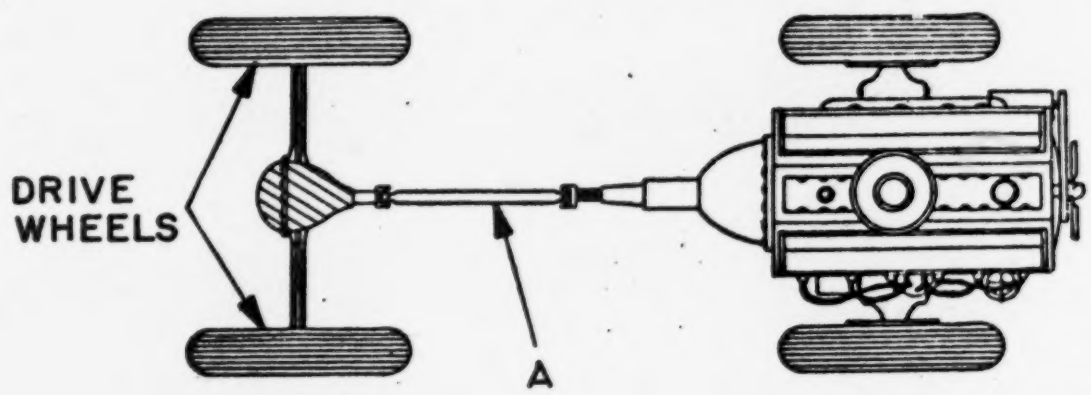

Arrow A points to:

- ☐ the drive shaft
- ☐ the drive wheels
- ☐ the transmission gear assembly

The striped part in the diagram is the:

- ☐ clutch assembly
- ☐ drive shaft
- ☐ transmission gear assembly

18202

STUDENT OBJECTIVES

Given a selected set of activities, the student will develop an ability to understand and accurately perform the following:

1. Divide lines and angles into segments.
2. Draw a tangent from a point outside a circle to a circle and show construction for points of tangency.
3. Draw an arc of designated radius tangent to a given line and an arc showing points of tangency.
4. Draw an arc of designated radius to two given lines showing construction for points of tangency.
5. Draw an arc of designated radius tangent to two given arcs showing the construction for the points of tangency.
6. Draw a circle through 3 predetermined points.
7. Draw an ogee curve connecting two given points and passing through a third.
8. Given a line segment, construct a right triangle whose sides have given proportions.
9. Erect a perpendicular to a line from a point outside a line.
10. Erect a perpendicular at a point on a line.
11. Draw hexagons, octagons, and pentagons.
12. Reduce a figure by triangulation.
13. Draw an arc of designated radius tangent to the arc of another radius.
14. Draw an exterior common tangent to two circles.
15. Draw an interior common tangent to two circles.
16. Draw various types of an ellipse.
17. Draw selected objects using the geometric construction you have learned.

64

the drive shaft

transmission gear assembly

65

The drive wheels can move the car only if the:

- ☐ brake shoes are turning
- ☐ drive shaft is turning
- ☐ rear springs are turning

18203

65

drive shaft is turning

66

The drive shaft turns the:

- ☐ front wheels
- ☐ differential assembly
- ☐ steering wheel

18204

66

differential assembly

67

Transmission turning power goes from the drive shaft to the

(☐ transmission gear assembly ☐ differential assembly)

and then to the rear axles.

18205

67

differential assembly

68

CROSS OUT the parts listed below that do <u>not</u> belong to the power transmission system:

drive shaft

camshaft

differential assembly

front axle

rear axles

68

~~camshaft~~

~~frontaxle~~

69

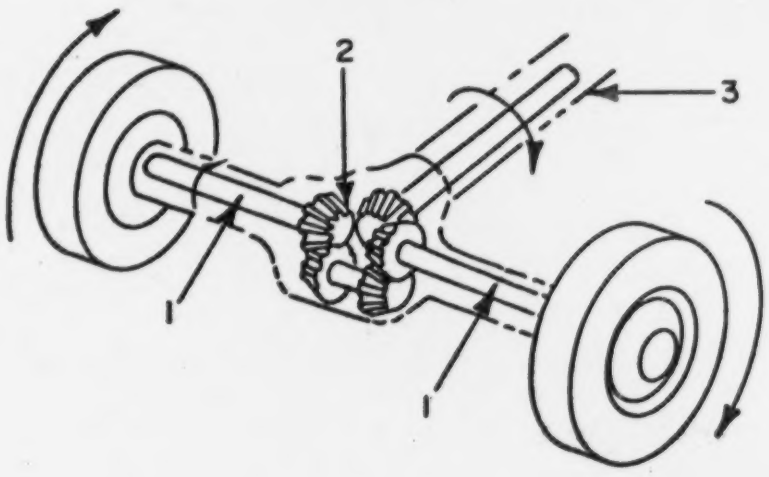

Next to each part name, WRITE the number of the arrow that points to it in the picture:

differential gear assembly _____

rear axles _____

18207

69

2

1

70

WRITE the missing part names in the boxes below:

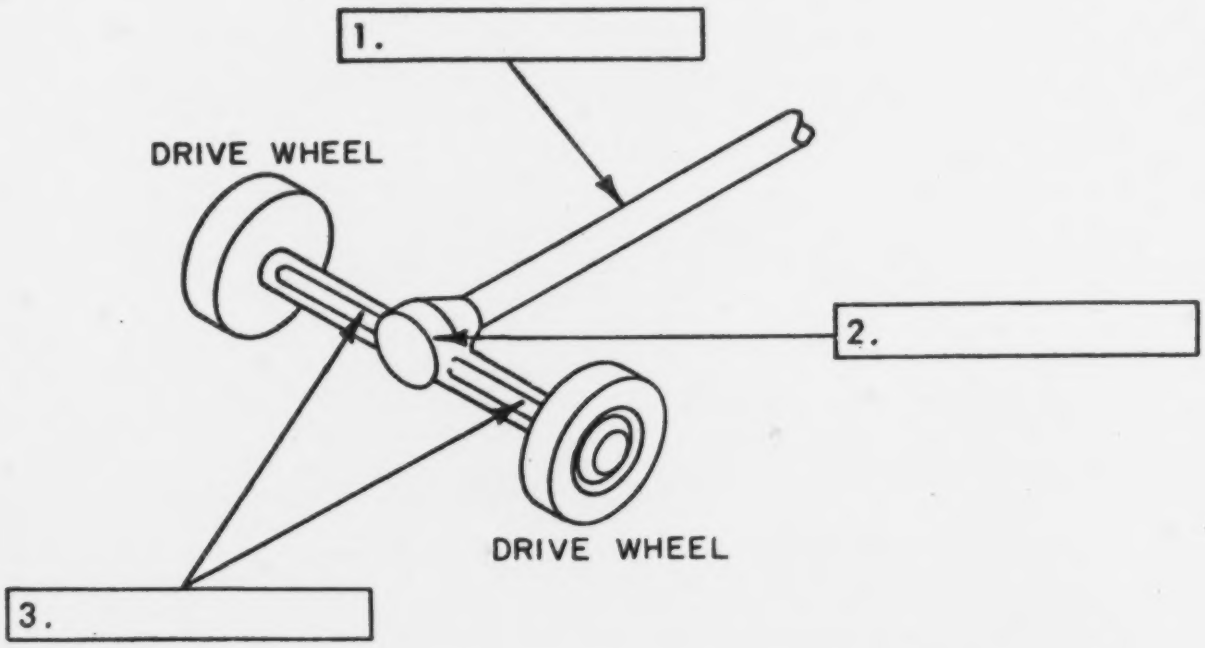

18208

70

1. drive shaft
2. differential assembly
3. rear axles

71

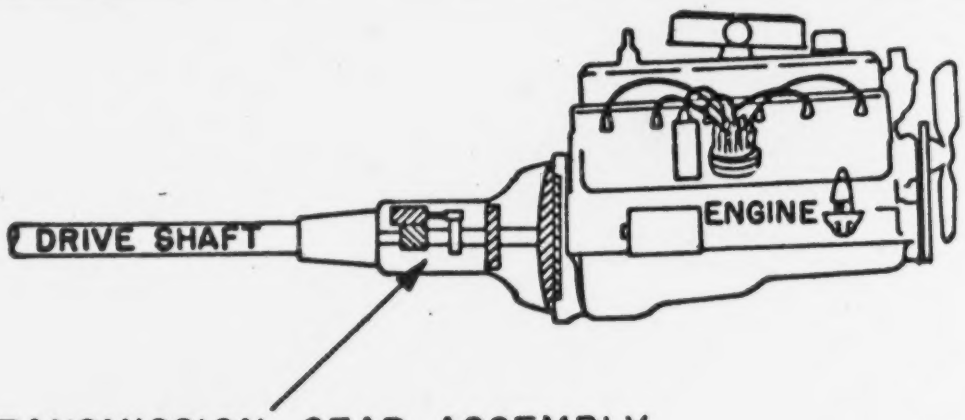

TRANSMISSION GEAR ASSEMBLY

The drive shaft is connected to the transmission gear assembly.

What part is between the transmission gear assembly and the engine? _____

18209

71

clutch assembly

72

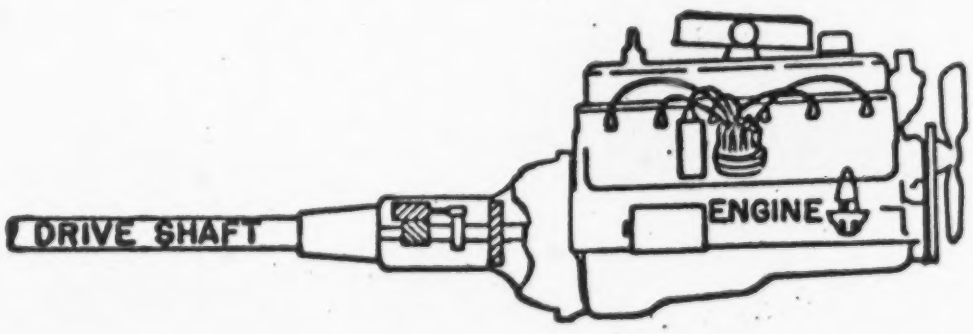

The transmission part shown in detail above is the:

- ☐ transmission gear assembly
- ☐ drive shaft
- ☐ rear axles

18210

72

transmission gear assembly

73

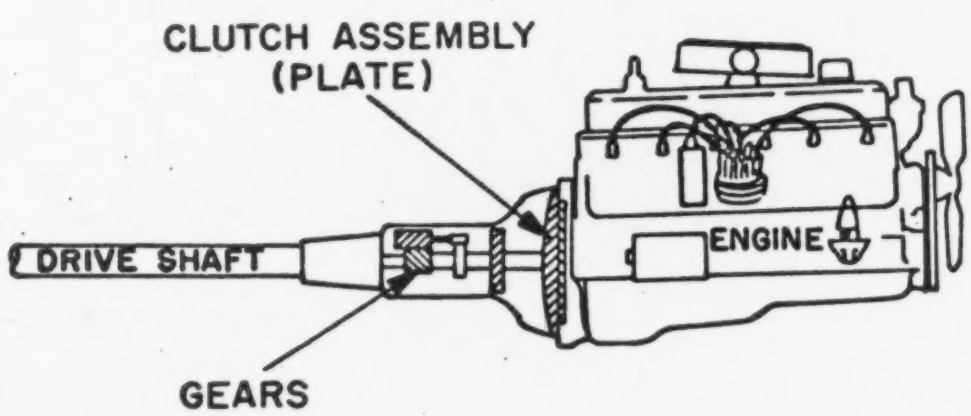

You can see from the drawing that the transmission gear assembly is connected to the clutch assembly and the:

- ☐ differential assembly
- ☐ drive shaft
- ☐ drive wheels

18211

73

drive shaft

74

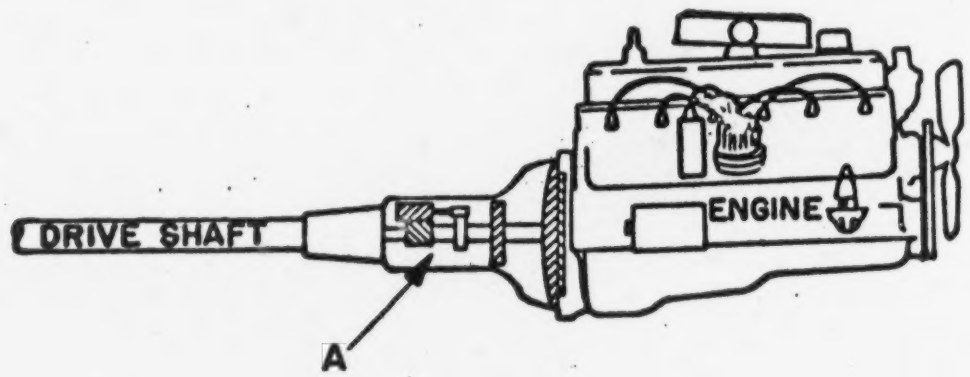

Part A is called the t_____ g_____
a_____.

18212

IF YOU THINK YOU CAN MEET THESE OBJECTIVES TURN TO PAGE 6 FOR THE PRE-TEST.

IF YOU DO NOT THINK YOU CAN MEET THESE OBJECTIVES TURN TO PAGE 13 AND BEGIN THE ACTIVITIES.

74

transmission gear assembly

75

The clutch assembly is between the engine and the transmission gear assembly.

Turning power goes to the transmission gear assembly directly from the:

- ☐ clutch assembly
- ☐ drive shaft
- ☐ front wheels

75

clutch assembly

76

The correct order of power transmission from the engine is:

- ☐ clutch assembly ⟶ transmission gear assembly ⟶ drive shaft
- ☐ clutch assembly ⟶ drive wheels ⟶ transmission gear assembly
- ☐ clutch assembly ⟶ transmission gear assembly ⟶ rear axles

18214

76

clutch assembly → transmission gear assembly → drive shaft

77

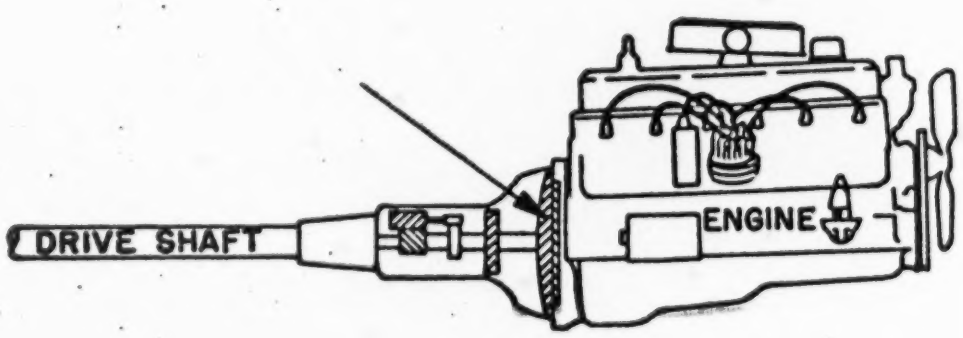

What does the arrow point to?

- ☐ the clutch assembly
- ☐ the differential assembly
- ☐ the transmission gear assembly
- ☐ the rear axles

77

the clutch assembly

78

WRITE the missing part names in the boxes below:

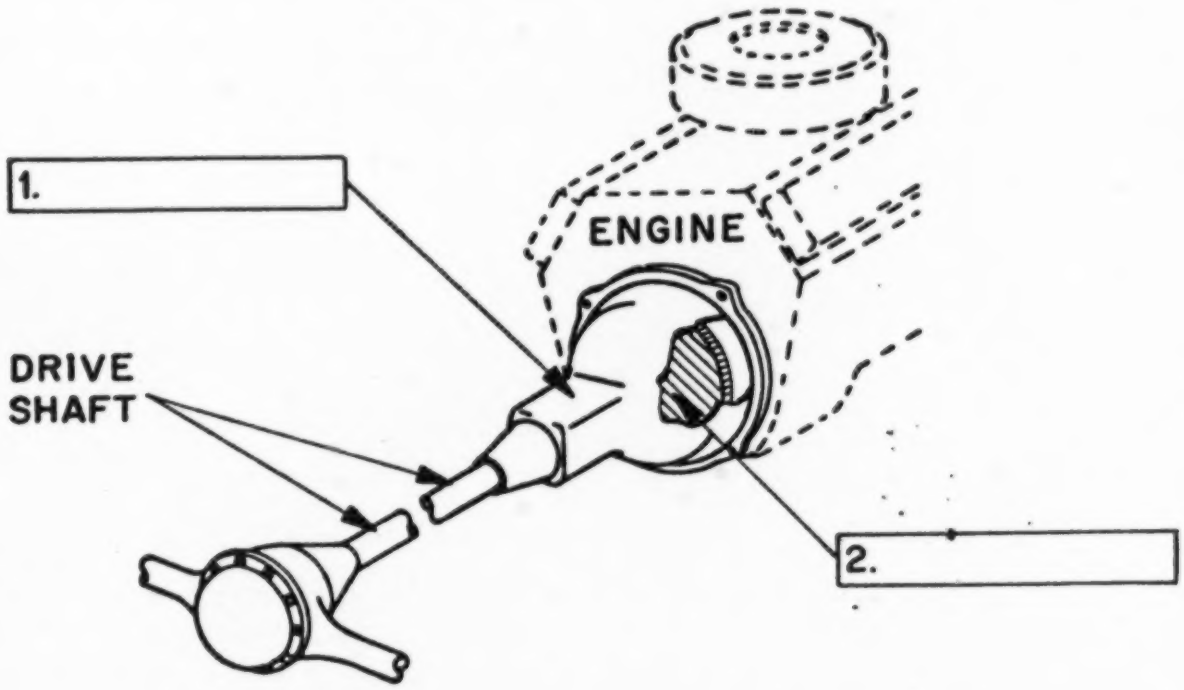

18216

78

1. transmission gear assembly
2. clutch assembly

79

Power goes to the drive wheels directly from the:

- ☐ drive shaft
- ☐ rear axles
- ☐ differential assembly

79

rear axles

80

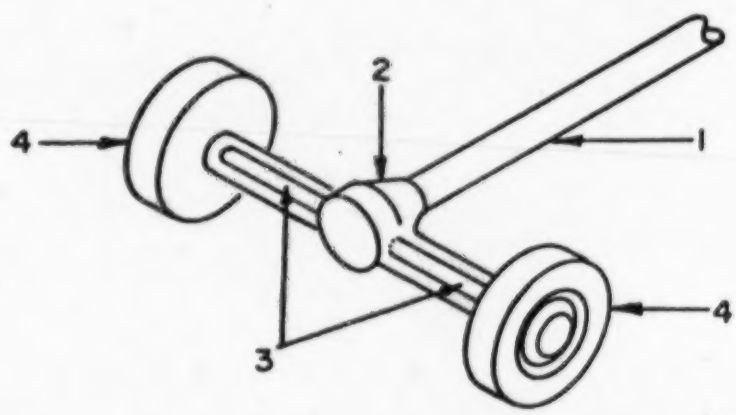

Next to each part name, WRITE the number that identifies it in the picture:

drive shaft _____

drive wheels _____

rear axles _____

80

1

4

3

81

WRITE the missing part names in the boxes below:

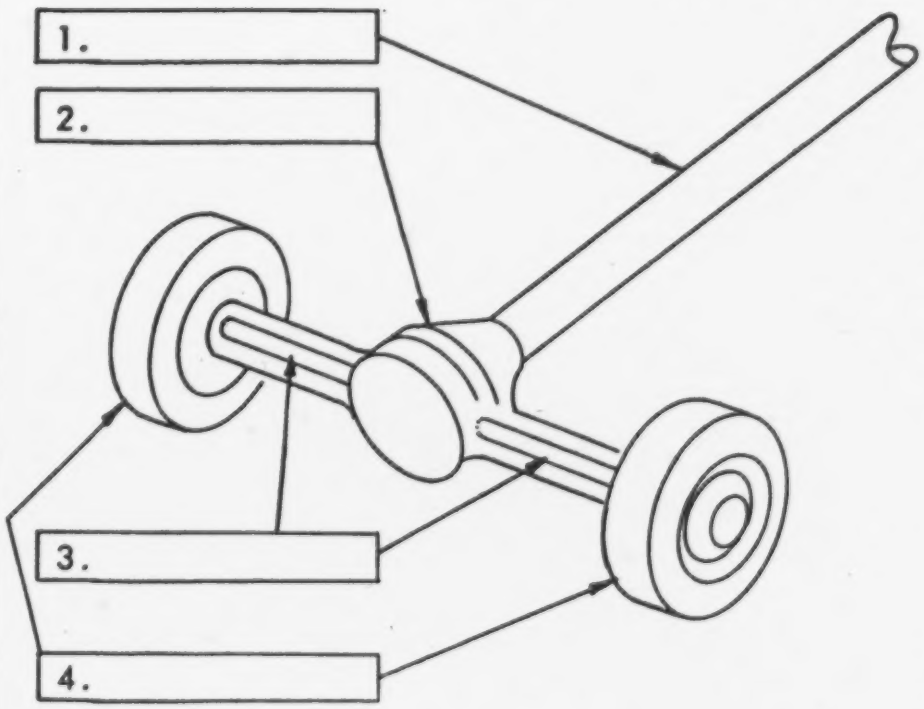

18219

81

1. drive shaft
2. differential assembly
3. rear axles
4. drive wheels

82

CIRCLE the list below that includes <u>all</u> the transmission parts between the engine and the rear axles:

1

engine
clutch assembly
transmission gear assembly
differential assembly

2

clutch assembly
transmission gear assembly
drive shaft
differential assembly

3

transmission gear assembly
drive shaft
rear axles
drive wheels

18220

82

2

clutch assembly
transmission gear assembly
drive shaft
differential assembly

83

In the blanks below, WRITE the number that identifies each part in the picture:

clutch assembly _____

differential assembly _____

drive shaft _____

transmission gear assembly _____

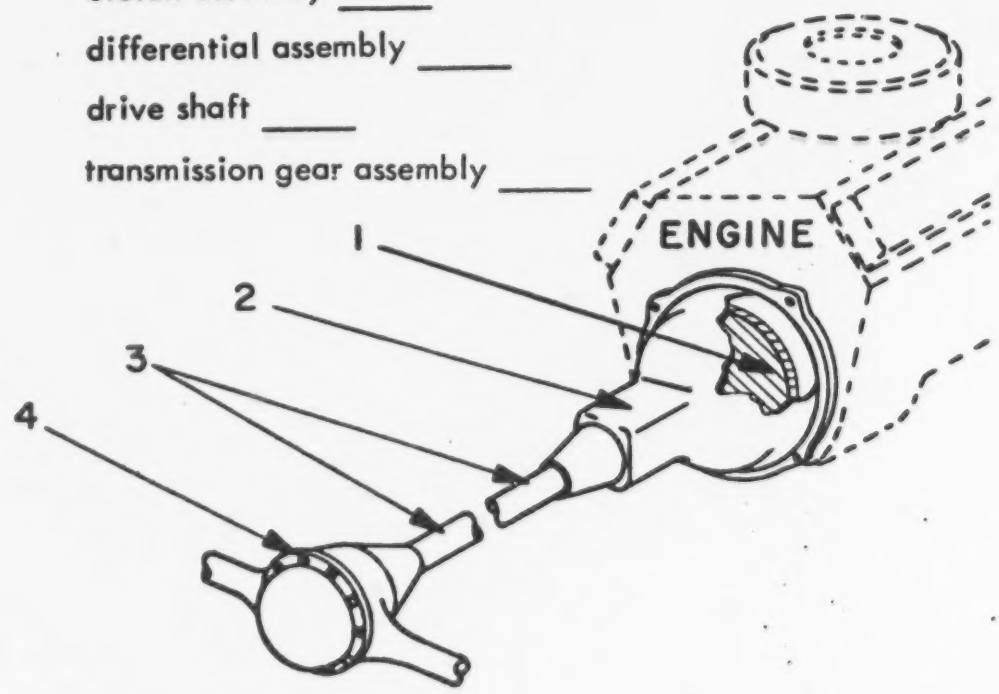

83

1

4

3

2

84

WRITE the missing part names in the boxes below:

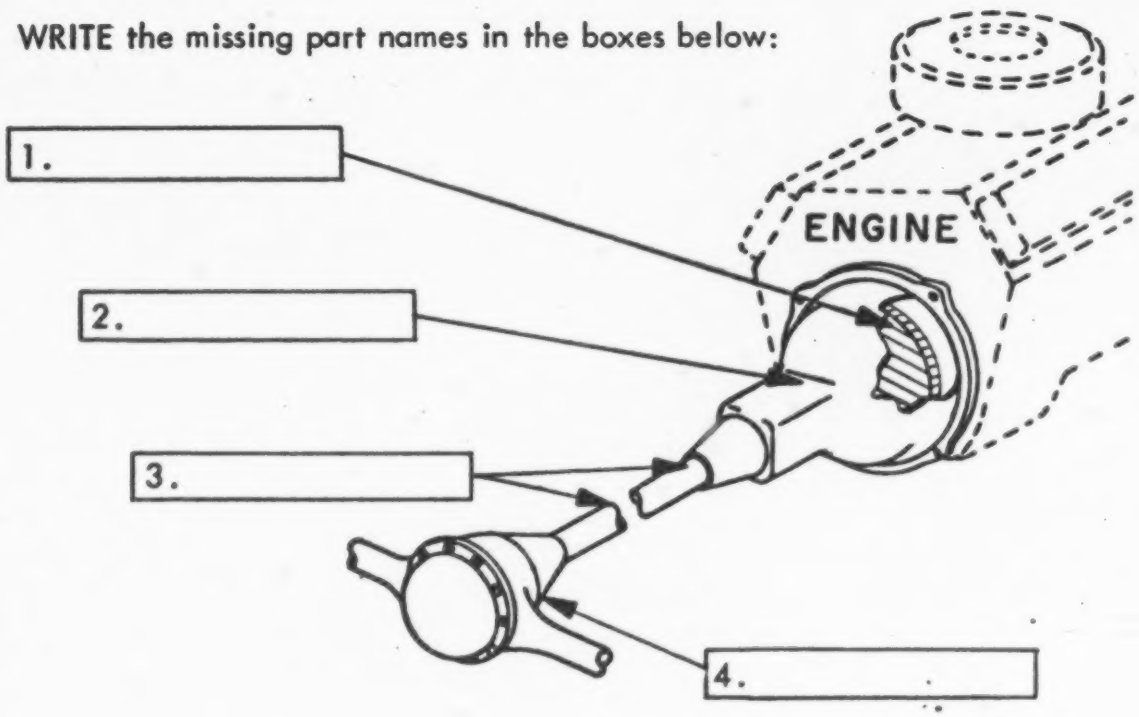

18222

PRE-TEST TERMS

DIRECTIONS - GET A COPY OF THIS TEST FROM YOUR INSTRUCTOR. WRITE A DEFINTION OR MAKE A DRAWING OF EACH OF THE FOLLOWING:

1. Vertex
2. Tangent
3. Segment
4. Perpendicular
5. Semi-circle
6. Quadrant
7. Sector of Circle
8. Concentric Circle
9. Eccentric Circle
10. Construction Line
11. Isosceles
12. Scalene Triangle
13. Angle
14. Cube
15. Prism

84

1. clutch assembly
2. transmission gear assembly
3. drive shaft
4. differential assembly

85

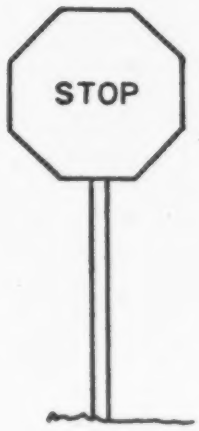

PICK UP THE PANEL BOOK

FIND PANEL 2

THEN TURN THIS PAGE AND GO ON

18223

85

NO ANSWER NEEDED

86

LOOK AT PANEL 2

NAME the parts power travels through when it goes from the engine to the drive wheels:

A. engine

B. _____ _____

C. _____ _____

D. _____ _____

E. _____ _____

F. _____ _____

G. drive wheels

86

B. clutch assembly

C. transmission gear assembly

D. drive shaft

E. differential assembly

F. rear axles

87

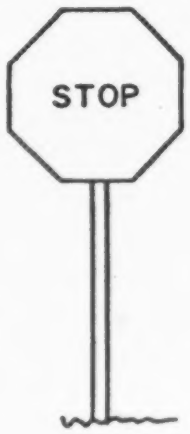

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

87

NO ANSWER NEEDED

88

When a car goes over a bump, the rear wheels go up and down.

If the drive shaft could not move with the rear wheels, it would probably:

- ☐ be all right
- ☐ break

89

goes up

90

The UNIVERSAL JOINTS allow the drive shaft to move up and down.

If a car did not have universal joints the drive shaft would:

- ☐ be all right
- ☐ break

18228

90

break

91

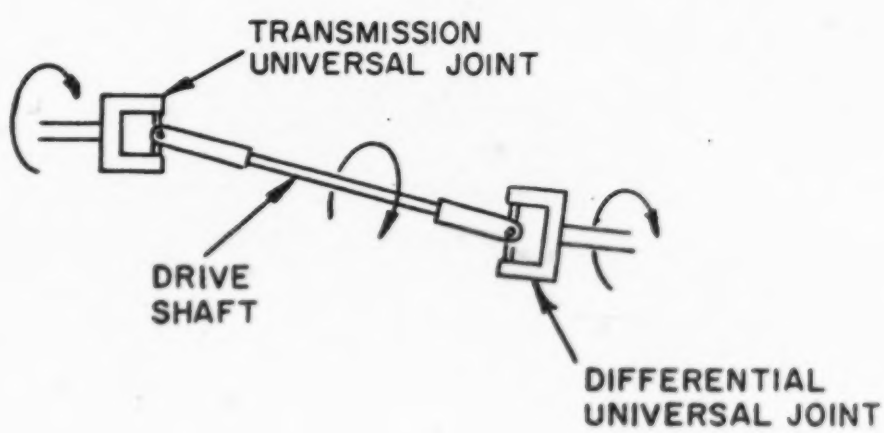

There is a universal joint:

- ☐ only at the back of the drive shaft
- ☐ only at the front of the drive shaft
- ☐ at both the back and the front of the drive shaft

91

at both the back and the front of the driver shaft

92

CROSS OUT the universal joints below:

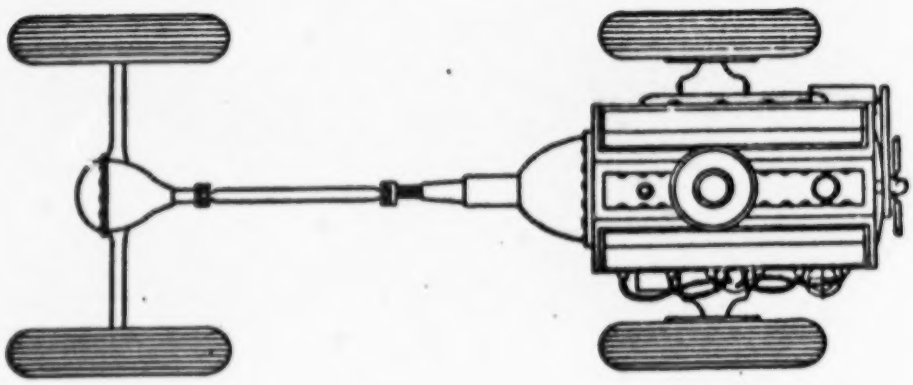

18230

92

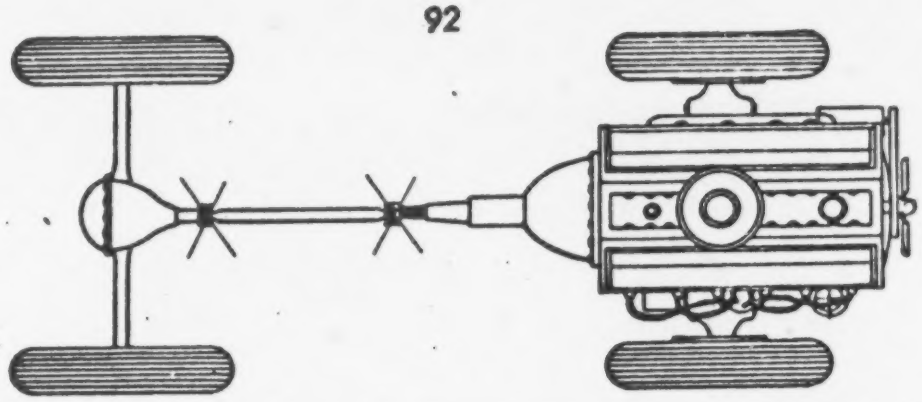

93

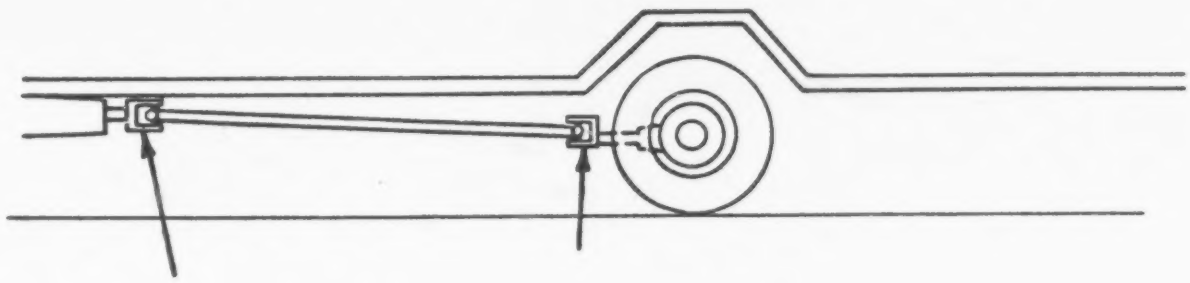

What do the arrows point to? _____ _____

18231

93

universal joints

94

The universal joint:

- ☐ corrects the drive shaft
- ☐ lets the drive shaft move up and down
- ☐ transmits brake power to the drive wheels

18232

PRE-TEST (con't)

16. Cylinder

17. Cone

18. Parallelogram

19. Ellipse

20. Cord

21. Tangent Point

22. Arc

Check your answers with the key. (pages 8,9,10) Correct all answers and bring your pre-test to the instructor.

If you wish to continue with the Pre-Test, turn to page 11.

IF YOU DO NOT WISH TO CONTINUE THE PRE-TEST, TURN TO PAGE 13 AND START THE ACTIVITIES.

94

lets the drive shaft move up and down

95

Which part lets the drive shaft move up and down?

- ☐ the drive shaft mover
- ☐ the drive joint
- ☐ the universal joint

18233

95

the universal joint

96

What is the job of the universal joint? _____

18234

96

to let the drive shaft move up and down

97

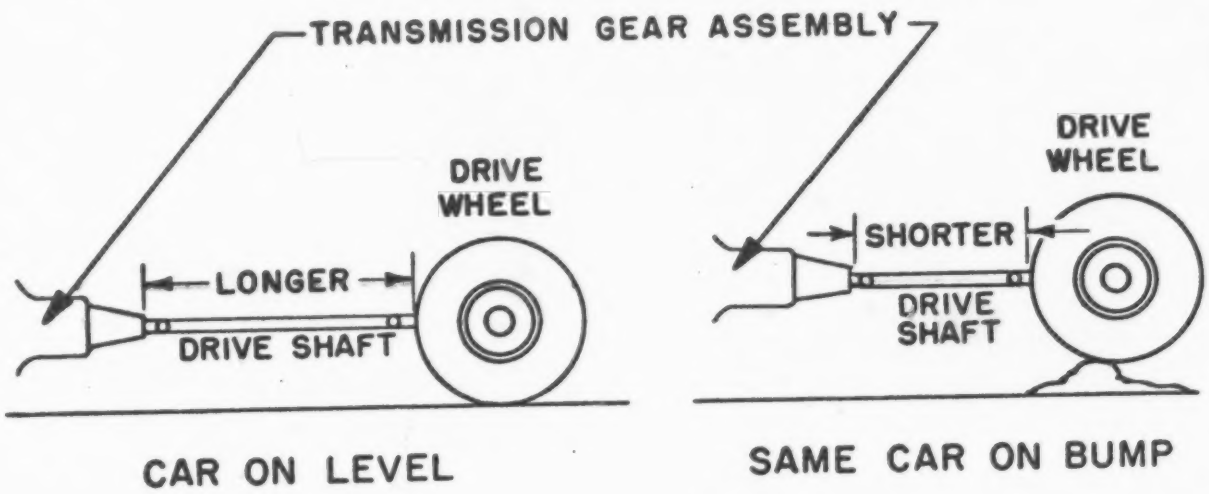

CAR ON LEVEL

SAME CAR ON BUMP

When a car goes over a bump which part gets shorter?

- ☐ the drive shaft
- ☐ the drive wheels
- ☐ the transmission gear assembly

18235

97

the drive shaft

98

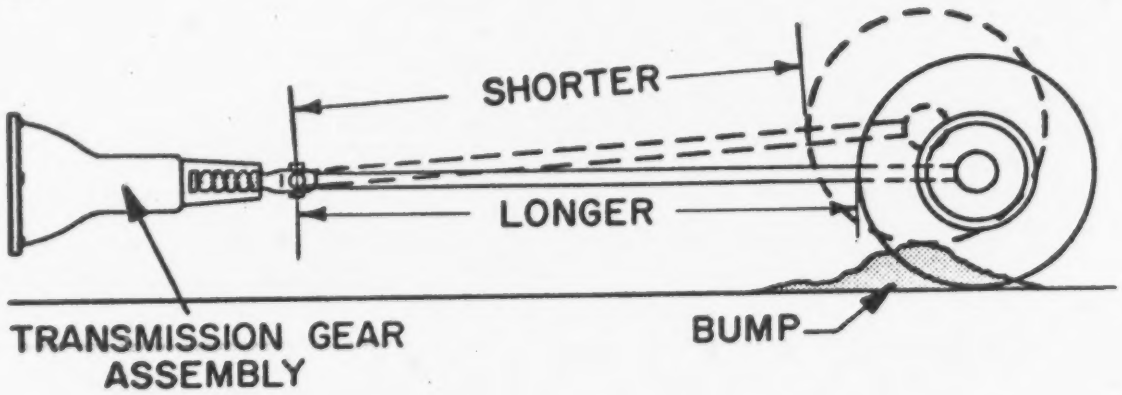

When a car goes over a bump the drive shaft:

- ☐ stays the same
- ☐ slides a bit and looks a little longer
- ☐ slides a bit and looks a little shorter

98

slides a bit and looks a little longer

99

The part that lets the drive shaft slide is called the SLIP JOINT.

The slip joint is located at the front of the drive shaft and goes into the t_____ g_____ a_____.

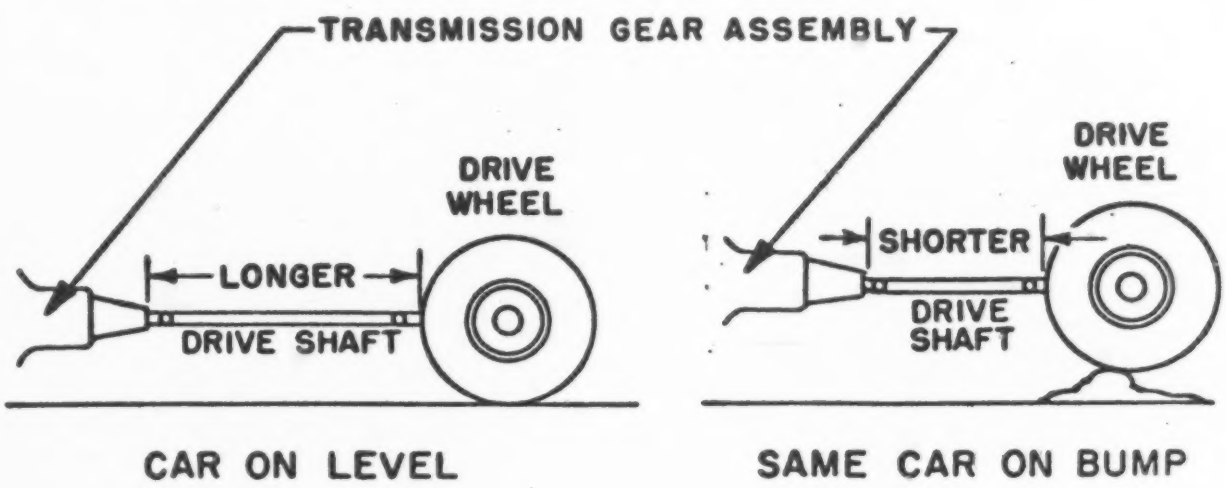

18237

99

transmission gear assembly

100

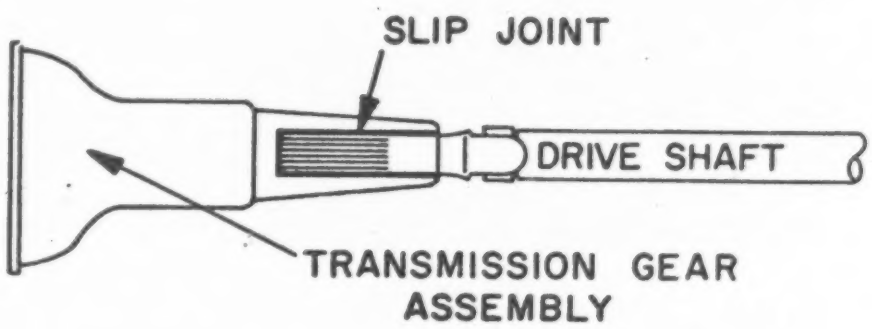

A special part at the front of the drive shaft lets the drive shaft get longer or shorter.

What is it called? _____ _____

100

slip joint

101

The SLIP JOINT lets the drive shaft:

- ☐ fall apart
- ☐ slide a bit in the transmission gear assembly
- ☐ move up and down as the car is moving

18239

101

slide a bit in the transmission gear assembly

102

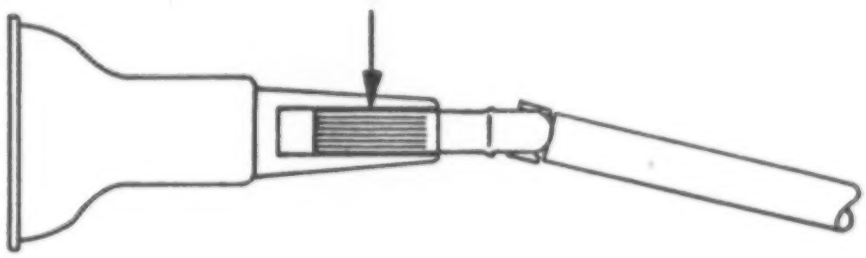

What does the arrow point to? _____

18240

102

slip joint

103

CIRCLE the slip joint below.

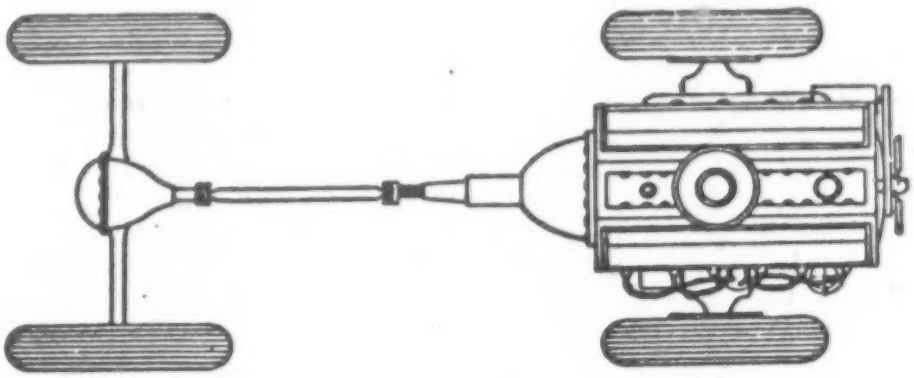

18241

103

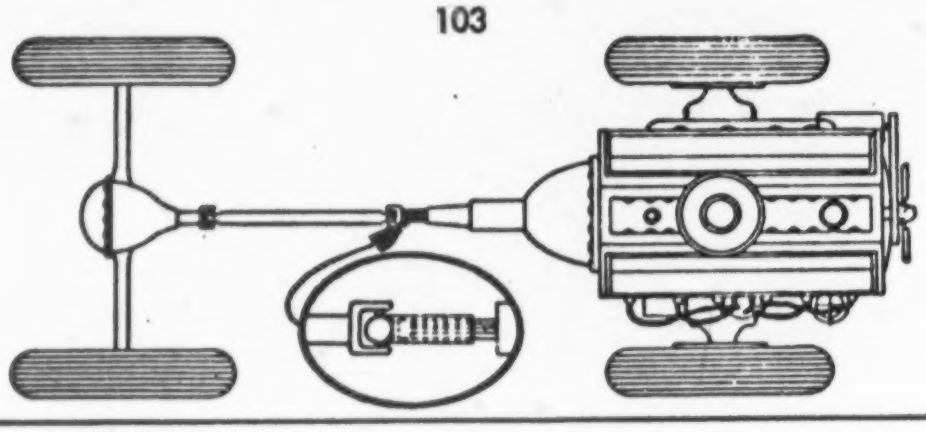

104

MATCH the parts with their jobs:

A. slip joint

B. universal joint

1. _____ lets drive shaft slide in or out
2. _____ lets drive shaft move up or down
3. _____ lets drive shaft turn

18242

KEY - PRE - TEST: TERMS, DEFINITIONS AND SYMBOLS

Vertex of an angle - the termination or intersection of the sides of the angle.

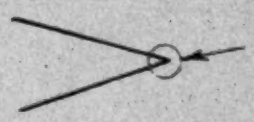

Hypotenuse - the side of a right angle triangle that is opposite the right angle.

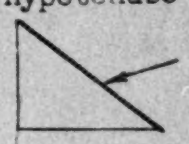

Quadrant of circle - an arc of 90° that is one quarter of a circle.

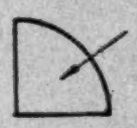

Sector of circle - a geometrical figure bounded by two radii and the included arc of a circle.

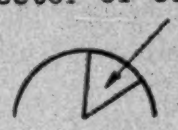

Segment of circle - the part of a circular area bounded by a chord and an arc of that circle.

Concentric circles - circles having a common center.

Eccentric circle - circles not having the same center.

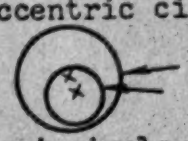

Semi-circle - half a circle.

Center line - a thin dark line consisting of alternate short and long dashes.

——— - ———

Construction line - a light thin gray line drawn preliminary to the finish object line of a drawing.

Isosceles triangle - a triangle having two sides equal.

1821

262 OF 327

ED

056 238

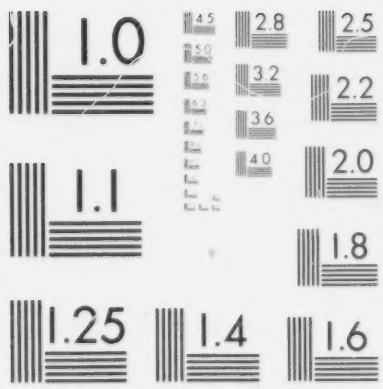

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

104

1. A

2. B

3. —

105

Which part slides in and out in the transmission gear assembly?

- ☐ the clutch assembly
- ☐ the slip joint
- ☐ the universal joint

18243

262

105

the slip joint

106

What is the job of the slip joint? _____

106

to let the drive shaft slide in
the transmission gear assembly

107

MATCH the following:

A. slip joint

B. universal joint

1. _____ lets the drive shaft slide in the transmission

2. _____ lets the drive shaft move sideways

3. _____ lets the drive shaft move up and down

107

1. A

2. —

3. B

108

THIS IS THE END OF BOOK 10

18246

AUTO MECHANICS COURSE

POST-TEST BOOK 10: THE POWER TRANSMISSION SYSTEM

A BASIC SYSTEMS PROGRAM

18247

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

The clutch assembly gets power from the _____ .

2

In order for the car to move, which wheels must get power?

_____

3

The drive shaft carries power to the _____ assembly.

4

The transmission gear assembly is between the clutch assembly and the _____ _____ .

5

The rear wheels get power from the _____ _____.

6

NAME the part located at each end of the drive shaft: _____

7

The part that slides to lengthen or shorten the drive shaft is called the _____ _____.

8

Power goes to the rear axles from the _____ assembly.

9

What part of the power transmission system is between the clutch assembly and the drive shaft? _____

10

The differential assembly gets power from the drive shaft and gives it to the _____ _____ .

PANEL BOOK 10

To Be Used With
BOOK 10

AUTO MECHANICS COURSE

PANEL BOOK 10: THE POWER TRANSMISSION SYSTEM

A BASIC SYSTEMS PROGRAM

18251

KEY-PRE-TEST (continued)

Scalene triangle - a triangle having unequal length sides.

Perpendicular - being at right angles to a given line or plane.

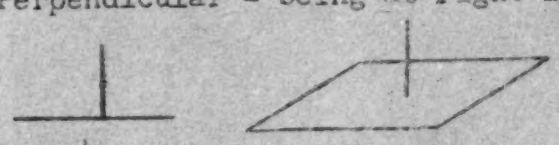

Angle - the figure formed by two lines meeting at the same point.

Tetrahedron - a regular solid of four faces.

Cube - a regular solid of six equal square sides.

Prism - a solid with two faces that are polygons in parallel planes and the other faces parallelograms.

Cylinder - a solid bounded by a curved surface and two opposite faces called bases.

Pyramid - a solid whose base is a polygon and whose faces are triangles meeting at a common point.

Cone - a solid, one of whose surfaces tapers to a point and whose base is a closed curve.

Sphere - a solid bounded by a curved surface, every point of which is equally distant from the center.

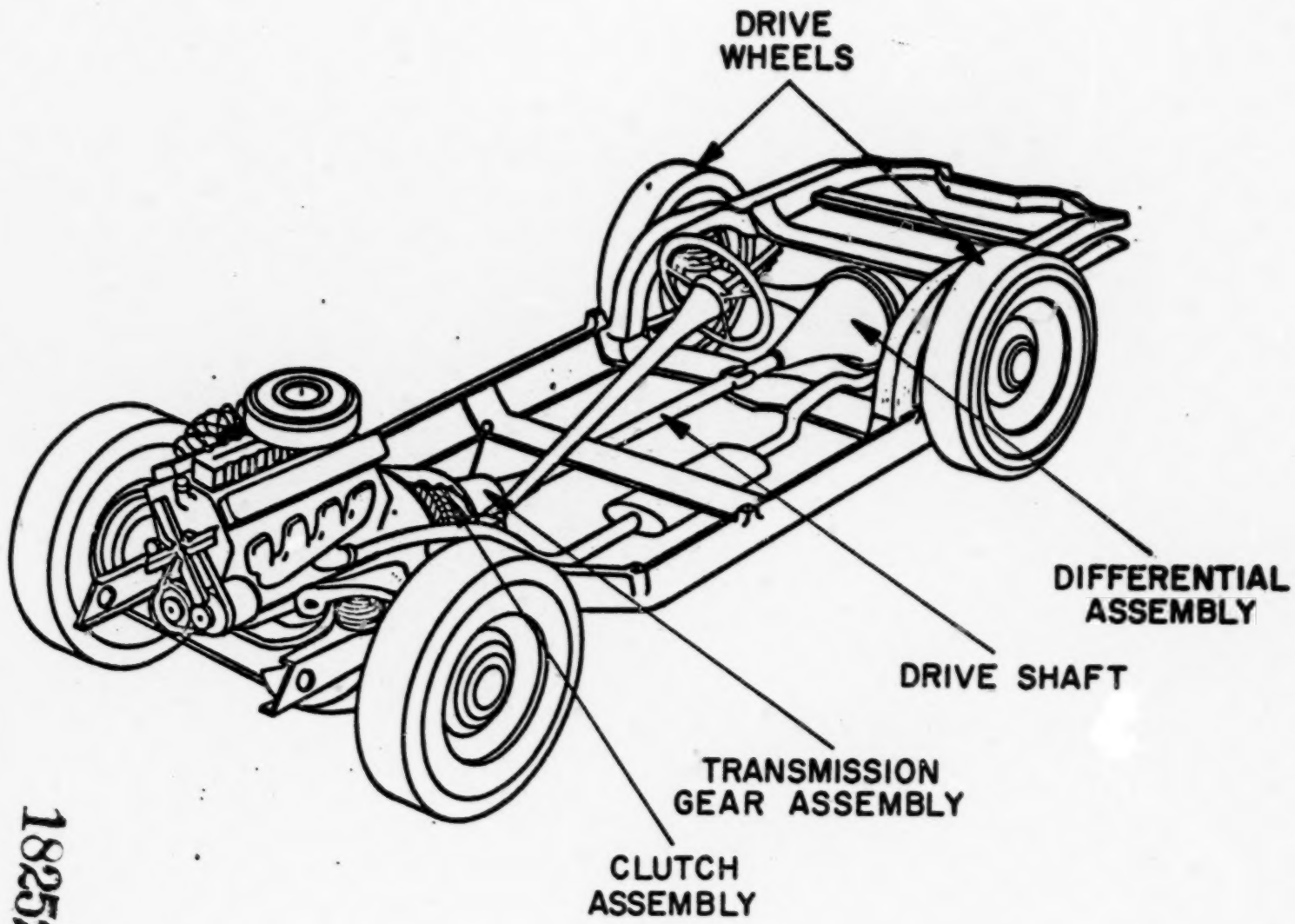

18252

PANEL 1

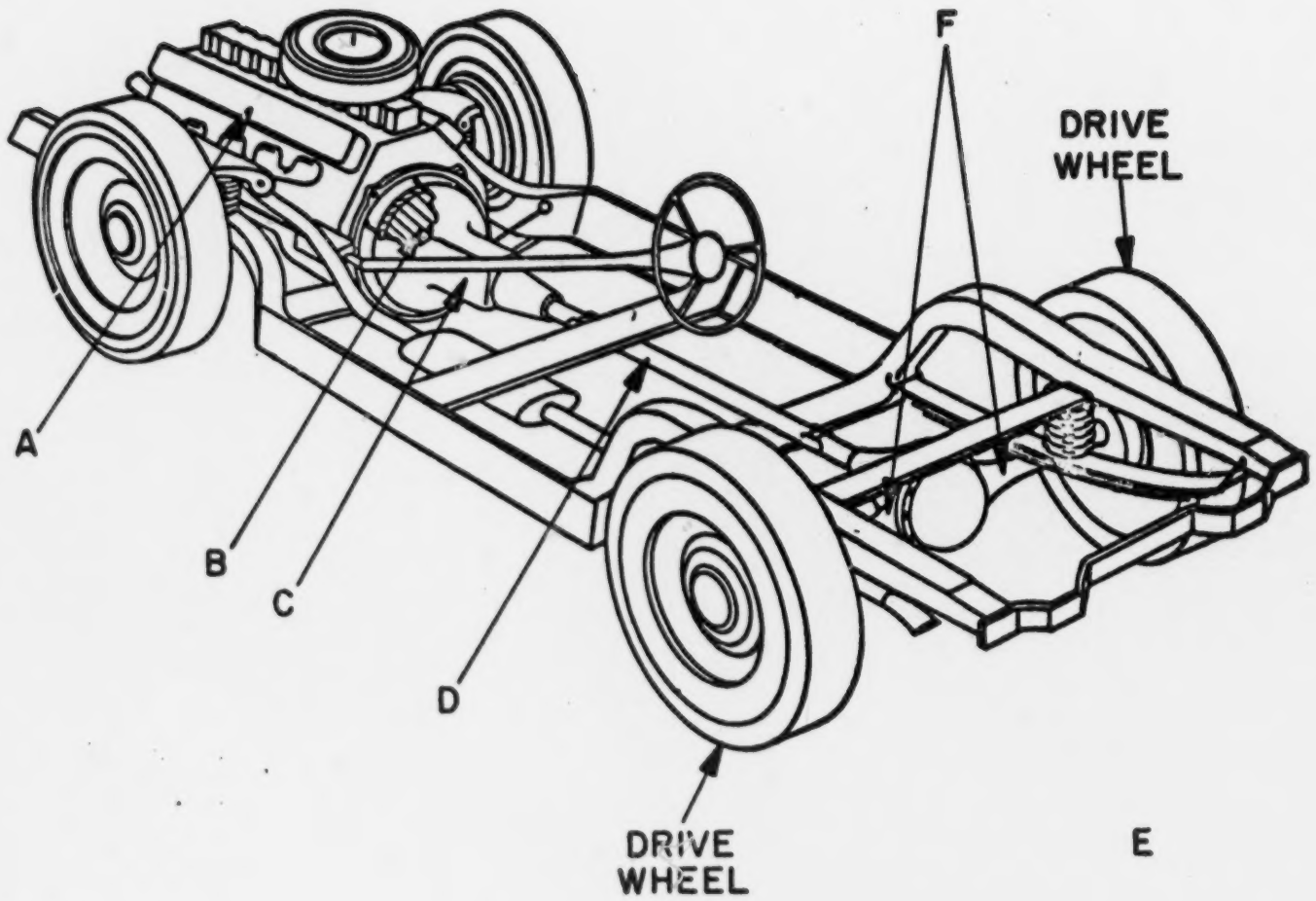

PANEL 2

18259

VT 013 133
Auto Mechanics Course. Book 11: The Steering System.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.

PUB DATE - ND 139p.

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IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the steering system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 133

ED0 56238

BOOK 11 post

(C1)

To Be Used With
PANEL BOOK 11

AUTO MECHANICS COURSE

BOOK 11: THE STEERING SYSTEM

A BASIC SYSTEMS PROGRAM

VT013133

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OFFICE OF EDUCATION
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Curriculum Report Reference
Page 14

Task Analysis Reference
31.1, 31.2

18255

AUTO MECHANICS COURSE

BOOK 11: THE STEERING SYSTEM

Developed under the Manpower Development and Training Act of 1962 (PL- 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

18256

1

The part of the steering system that reduces vibration is called the _____ _____.

2

Each front wheel is mounted onto a _____ _____.

3

What part of the steering system does the driver turn? _____

4

The steering gear arm moves the _____ _____.

5

The parts between the steering knuckle and the center link are called _____ _____.

6

What moves the steering gear assembly? _____ _____

7

The part between the front wheel and the tie rod is called the
_____ _____.

8

NAME the part of the steering system that is connected to the chassis:
_____ _____

9

The center link gets power from the _____ _____ _____.

10

The idler arm is connected to the chassis and to the _____ _____.

Name _____

Date _____

Starting time _____

Finishing time _____

18259

1

This part of the program will teach you about the steering system of an automobile.

You will lear how a car:

- ☐ goes
- ☐ stops
- ☐ turns

18260

1

turns

2

The steering system is made up of the steering wheel, the front wheels and the parts that connect them together.

CHECK the parts that belong to the steering system.

- ☐ back wheels
- ☐ front wheels
- ☐ steering wheel

18261

KEY PRE -TEST (continued)

Parallelogram - a four sided figure whose opposite sides are equal and parallel.

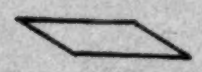

Ellipse - a foreshortened circle, a figure that is formed by cutting a cylinder or cone at any angle other than a right angle to the axis.

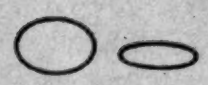

Regular Polygon - a figure that has any number of sides all of which are equal.

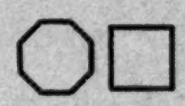

Major axis - the main straight line about which a body or a geometric figure rotates or may be supposed to rotate. In an ellipse: the largest measurement.

Minor Axis - the secondary straight line about which a body or a geometric figure rotates or may be supposed to rotate. In an ellipse: the smaller measurement of the two axis.

If you have corrected and restudied any answers missed, you are now ready to proceed to the drawing portion of the self test.

Turn the page and continue

2

front wheels

steering wheel

3

The purpose of the steering system is to make the car:

- ☐ go faster or slower
- ☐ start or stop
- ☐ turn or go straight

18262

3

turn or go straight

4

What is operating when the driver turns the steering wheel to the left or right?

- ☐ the cooling system
- ☐ the steering system
- ☐ the valve system

18263

4

the steering system

5

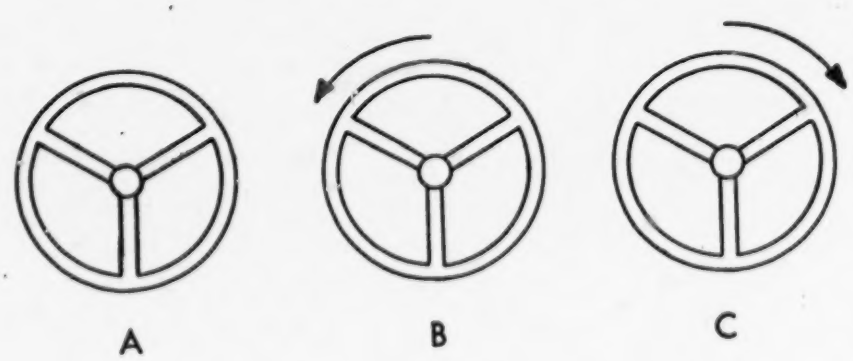

Steering wheel "A" is NOT being turned.

Steering wheel "B" is being turned to the left.

Steering wheel C is being turned to the _____.

18264

5

right

6

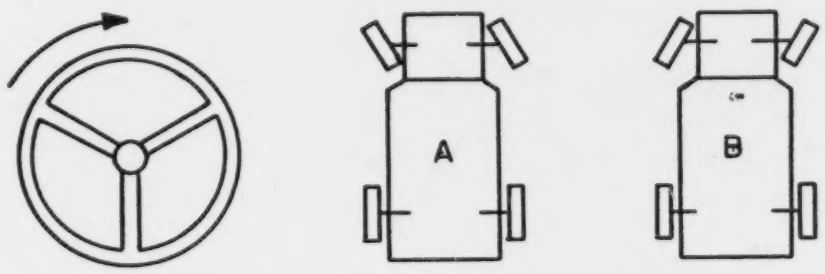

Which car is going in the direction that the steering wheel is being turned?

- ☐ car A
- ☐ car B

When the steering wheel turns, this car will turn to the:

- ☐ left
- ☐ right

18265

6

car B

right

7

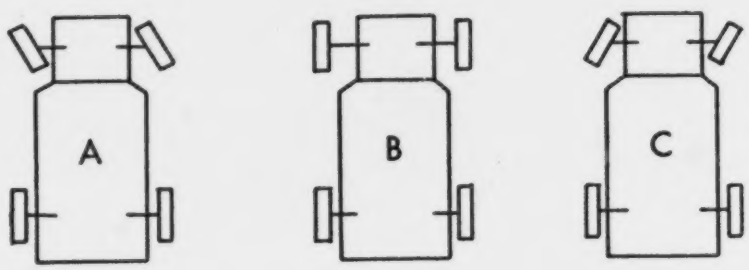

WRITE the direction (left, right, straight) in which each car's steering wheel is being turned:

car A: _____

car B: _____

car C: _____

18266

7

left

straight

right

8

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

18267

8

NO ANSWER NEEDED

9

LOOK AT PANEL 1

Cars change direction because the front wheels turn to the left or right.

When a driver turns the steering wheel, which parts of the car change the car's direction? _____

18268

9

the front wheels

10

LOOK AT PANEL 1

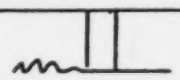

This diagram shows that the steering wheel is being turned to the:

- ☐ left
- ☐ right

The steering gear assembly moves the center link to the:

- ☐ left
- ☐ right

18269

10

right

left

11

The movement of the center link:

- ☐ does nothing to the tie rods
- ☐ pushes and pulls the tie rods
- ☐ twists and turns the tie rods

18270

11

pushes and pulls the tie rods

12

LOOK AT PANEL 1

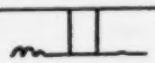

When the steering wheel is turned, the tie rods move the two

_____ _____.

18271

PRE-TEST DRAWING

The drawing pre-test consists of plates G-1 and G-10. You may get them from your instructor after you have passed the test on terms.

Do not use the references to complete these drawings.

THIS IS A TEST

STAY IN YOUR SEAT

TALK TO NO ONE

You have 3 periods for the two tests.

When finished, the instructor will grade the plates.

Turn to page 12.

12

steering knuckles

13

LOOK AT PANEL 1

The steering knuckles are connected to the:

- ☐ steering wheel
- ☐ front wheels
- ☐ rear wheels

The movement of the steering knuckles:

- ☐ turns the front wheels to the left or right
- ☐ moves the car to the front or rear

18272

13

front wheels

turns the car to the left or right

14

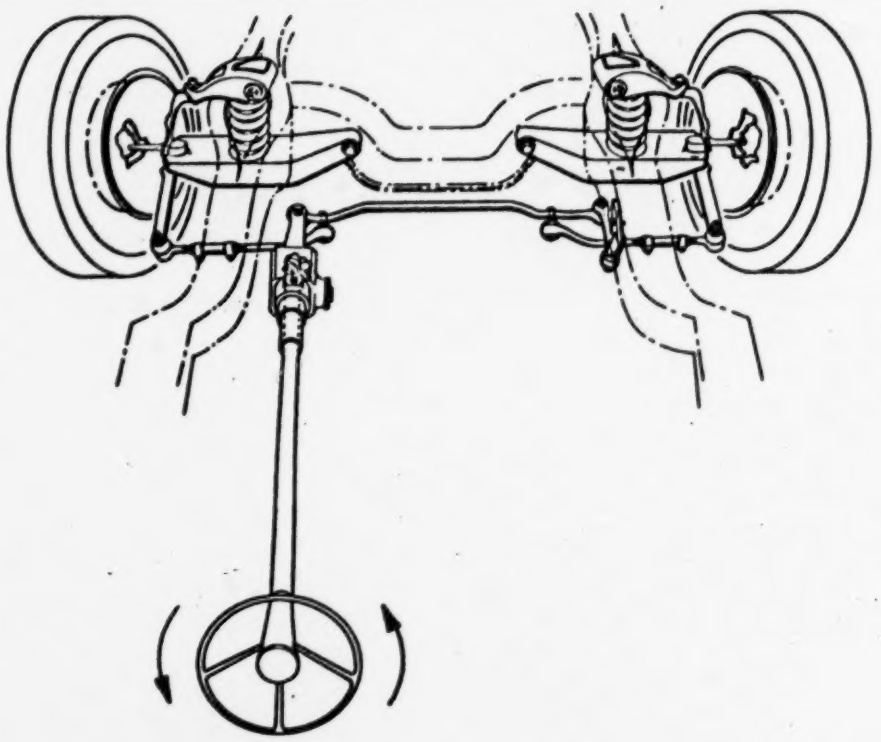

The steering wheel is being turned.

In which direction will the front wheels turn? _____

18273

14

left .

15

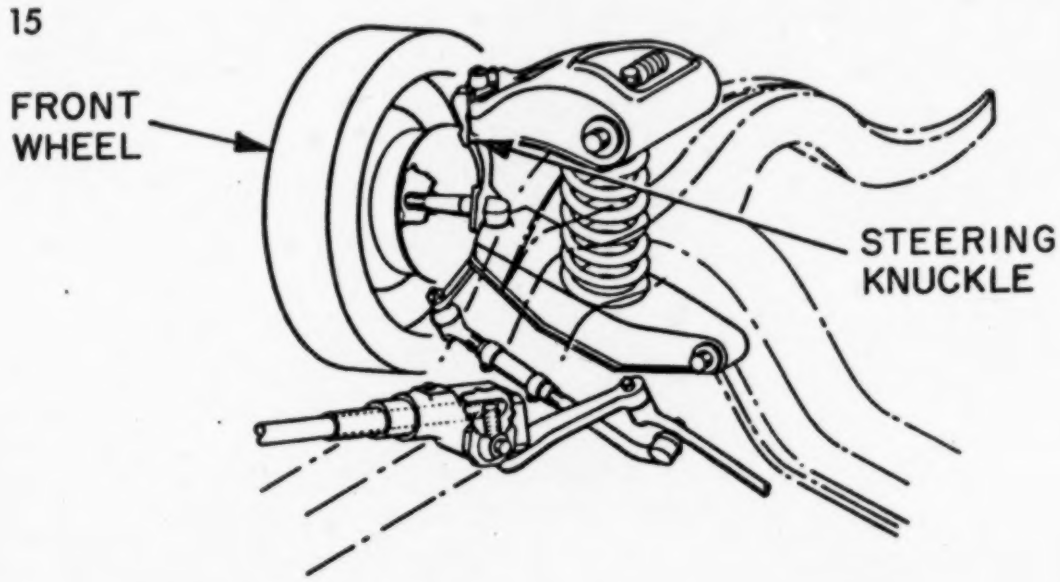

Each front wheel is mounted on a _____ .

18274

15

steering knuckle

16

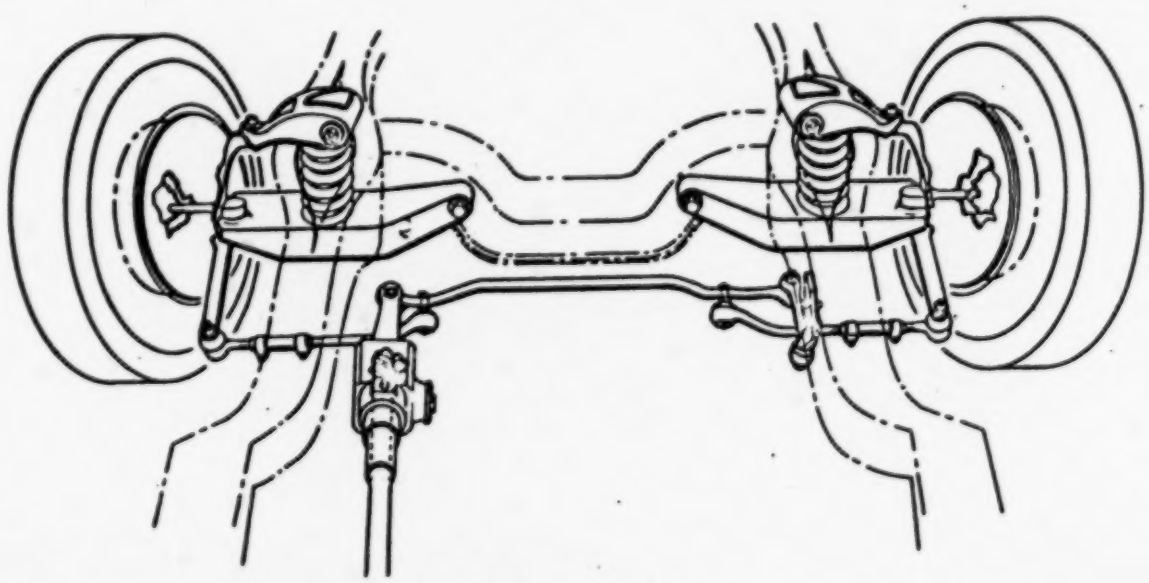

To make a car turn to the left or right:

- ☐ the driver must move
- ☐ the steering knuckles must move
- ☐ nothing must move

18275

16

the steering knuckles must move

17

The purpose of the steering knuckle is to: (CHECK ALL CORRECT ANSWERS)

- ☐ pull against the wheel
- ☐ push against the wheel
- ☐ bend the front wheel

18276

17

pull against the wheel

push against the wheel

18

CIRCLE the steering knuckle in the drawing below:

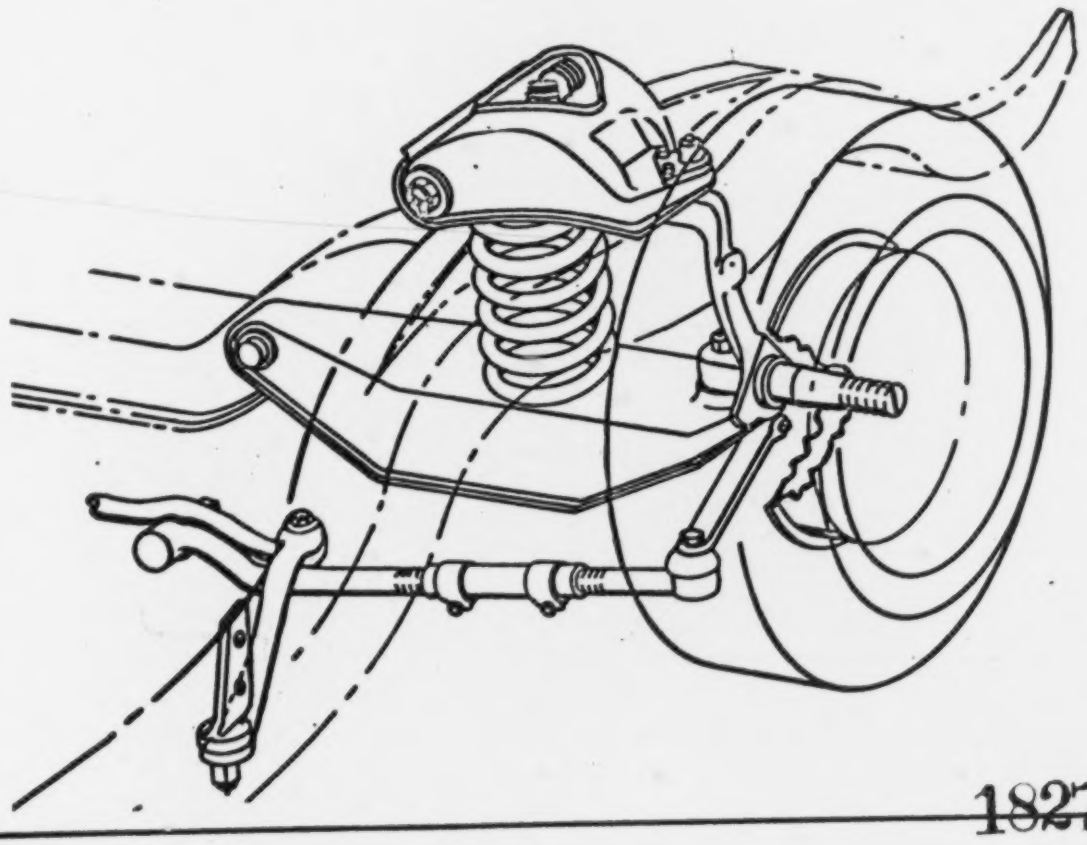

18277

18

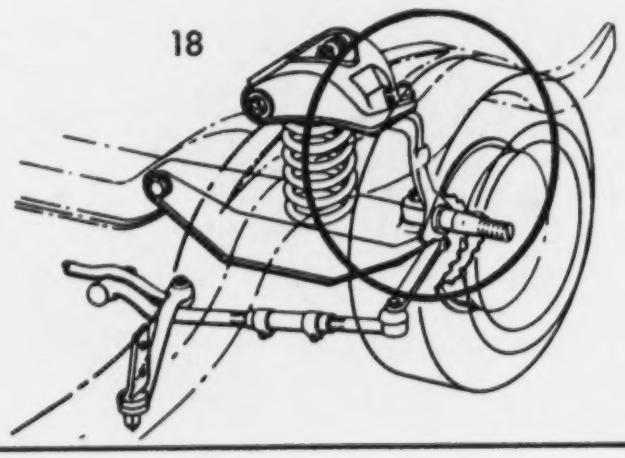

19

When a turn is being made, the steering knuckles _____ and _____ against the front wheels.

18278

19

pull (and) push

20

What do the steering knuckles pull or push against? _____

18279

20

the front wheels

21

The purpose of the steering knuckles is to change the direction of the car by: (CHECK ALL CORRECT ANSWERS)

- ☐ pulling against
- ☐ pushing against

the car's:

- ☐ front wheels
- ☐ rear wheels

18280

21

pulling against

pushing against

front wheels

22

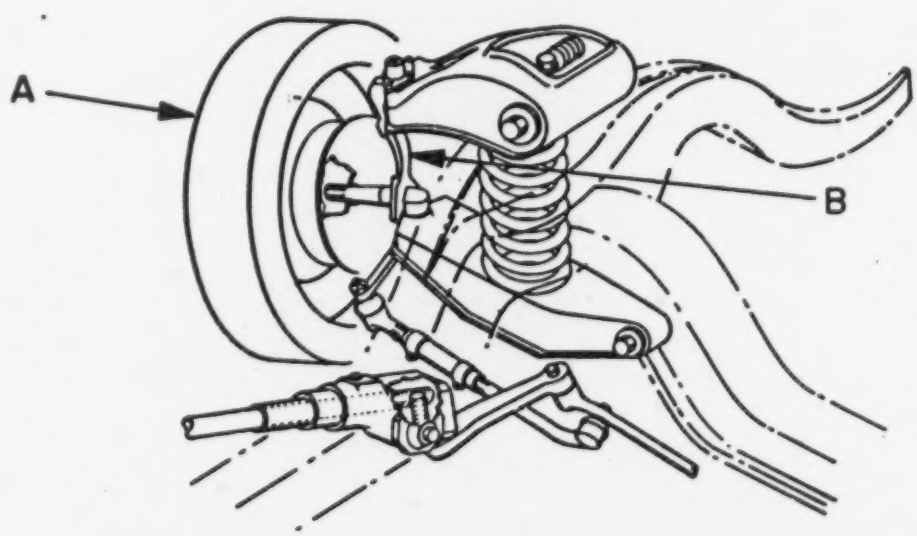

What is arrow "A" pointing to? _____

What is arrow "B" pointing to? _____

18281

PROCEDURE FOLLOWING SELF-TEST

If you passed the pre-test, with your instructor's permission you may start work on the ORTHOGRAPHIC DRAWING L.A.P. 7.

If you did not pass, turn to page 13 and start the activities listed there.

22

the front wheel

the steering knuckle

23

What do the steering knuckles do to the front wheels? _____

This will change the d_____ the car is going.

18282

23

push or pull against them

direction

24

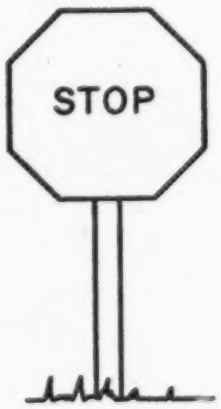

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

18283

24

NO ANSWER NEEDED

25

LOOK AT PANEL 1

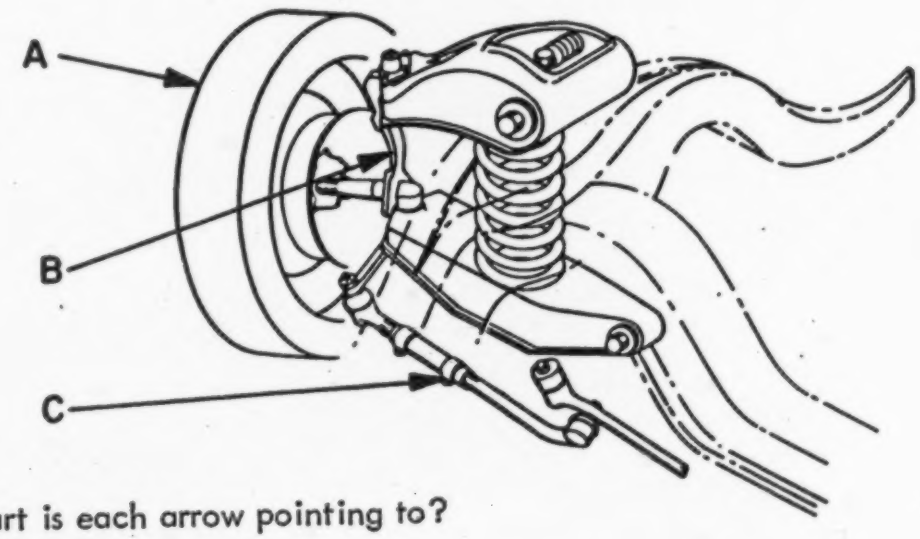

What part is each arrow pointing to?

arrow A: _____

arrow B: _____

arrow C: _____

18284

25

front wheel

steering knuckle

tie rod

26

What does the steering knuckle do? _____

18285

26

pushes or pulls the front wheels and makes the wheels turn the car to the left or right

27

front wheel

steering knuckle

tie rod

Using the words above, LABEL the parts in the picture below:

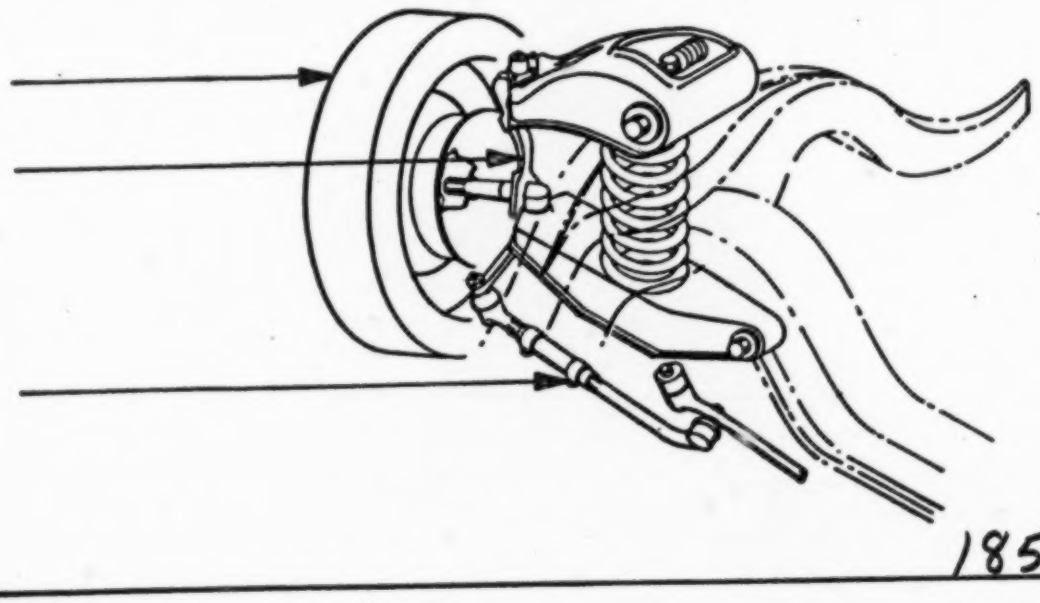

18586

27

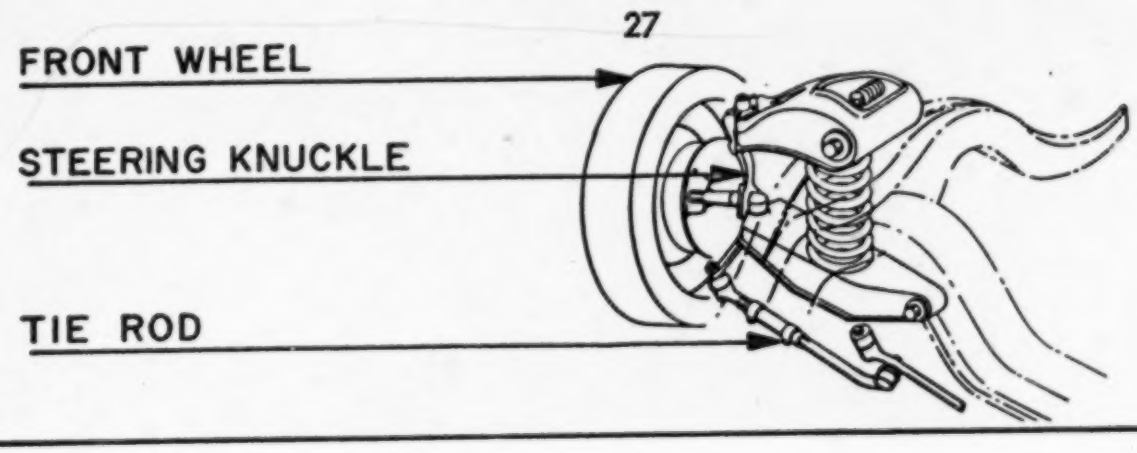

28

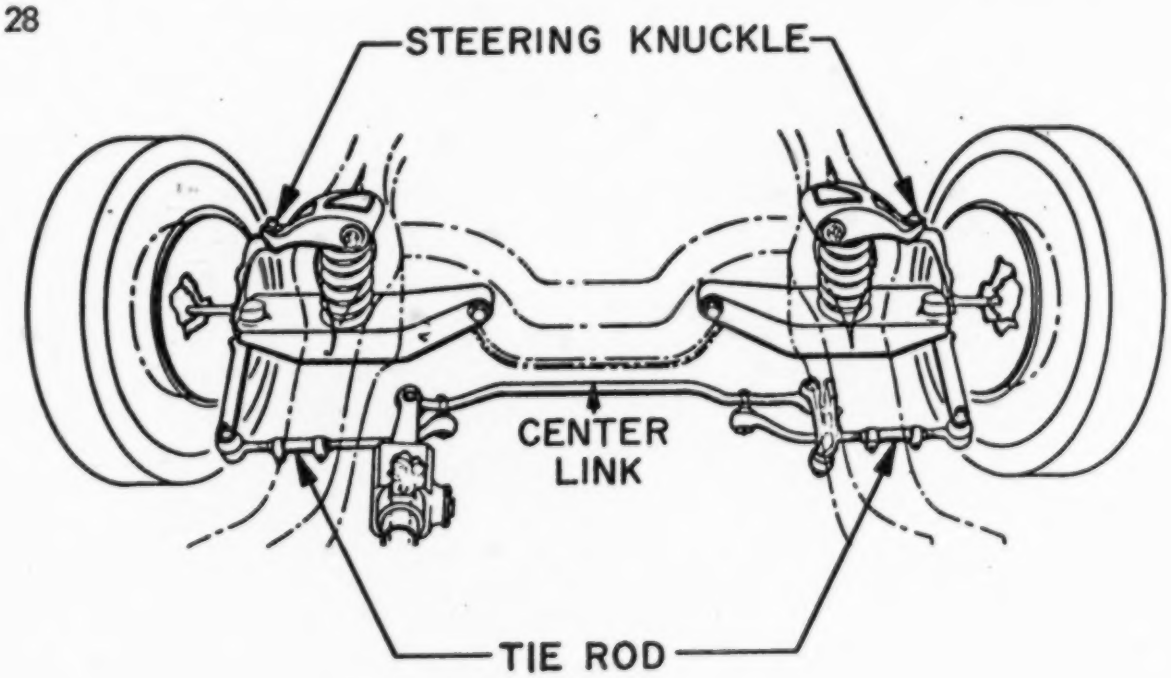

Each steering knuckle is connected to a _____ _____.

18587

28

tie rod

29

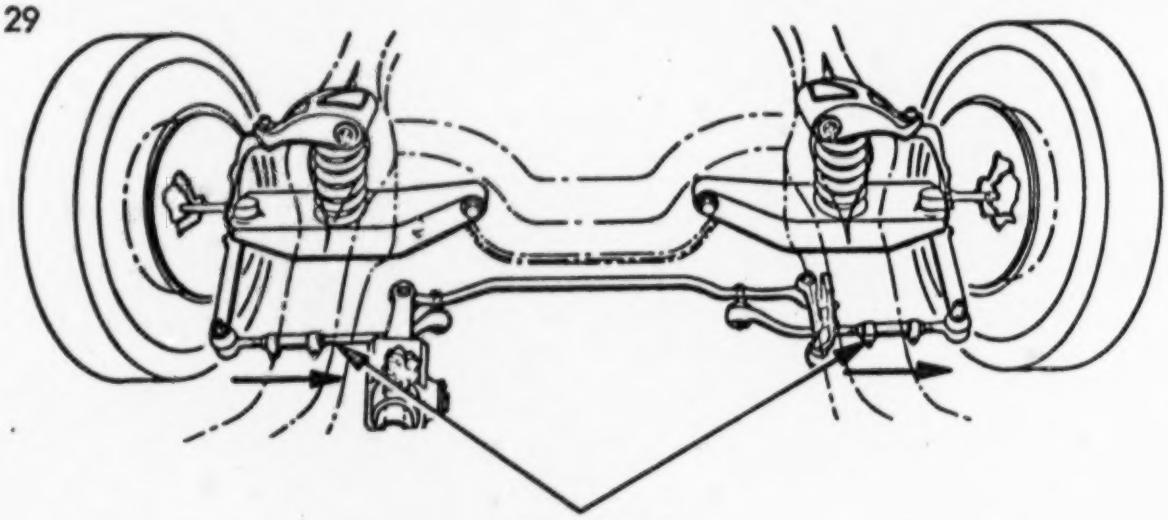

TIE ROD

Which parts do the tie rods push and pull against? _____

How many tie rods does a car have? _____

18588

29

steering knuckles

2

30

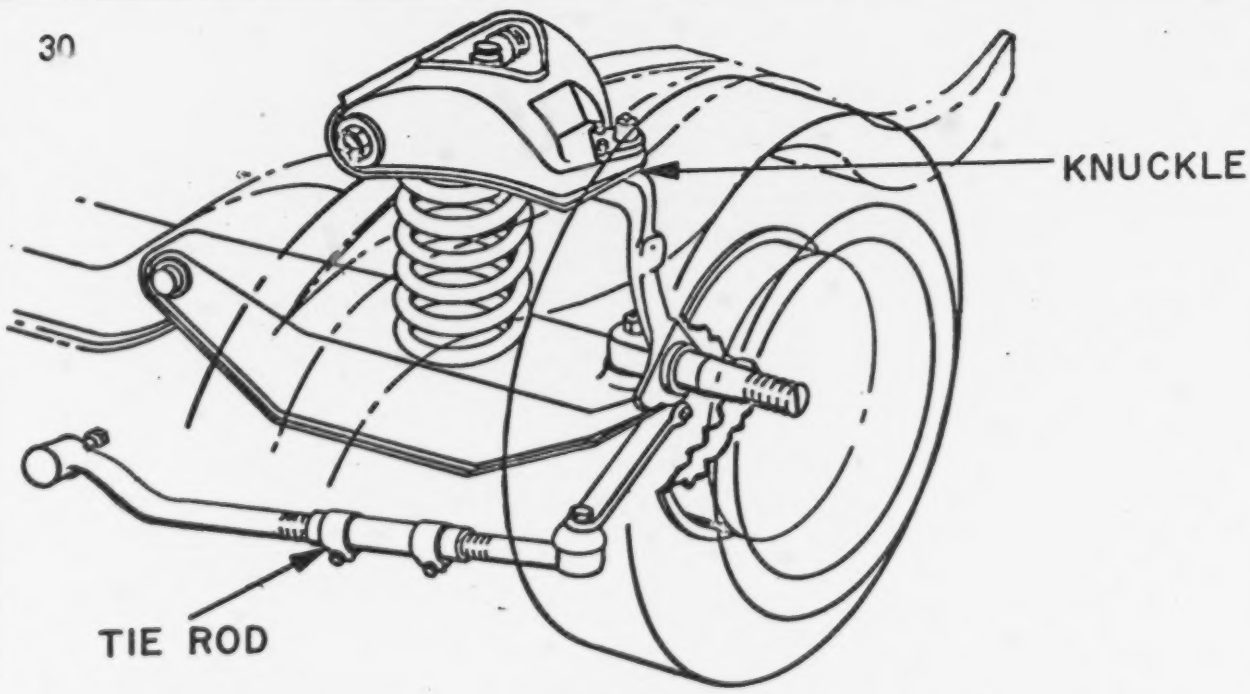

To make the front wheel turn to the left or right, the tie rod must push or pull:

- ☐ the knuckle
- ☐ directly on the wheel
- ☐ the steering wheel

18589

30

the knuckle

31

Each steering knuckle is connected to a front wheel and to a:

- ☐ tire iron
- ☐ tie rod
- ☐ tire housing

18590

GEOMETRICAL CONSTRUCTION

A. Required Activities - These activities have been developed to aid you in accomplishing the objectives on page 4. Start these activities by getting plate G-1 from your instructor.

READ

The assignment is on the plate.
The references are:

MD 6 Mechanical Drawing, French & Svensen 6th Ed.

MD 7 Mechanical Drawing, French & Svensen 7th Ed.

USE these references to complete the drawing.

ACCURACY AND NEATNESS are important! When you have finished the plate check it with the overlay. If correct, ask the instructor to grade the plate. If it is satisfactory he will give you the next plate.

Draw the plates in the order listed.

Plate	Title
1. G-2	Segments
2. G-2	Perpendiculars
3. G-3	Octagons-Hexagons
4. G-4	Geometric Problems
5. G-5	Tangents
6. G-5a	Tangents
7. G-6	Arcs and Tangents
8. G-7	Ellipses
9. G-8	Arcs
10. G-9	Conveyer Link

32

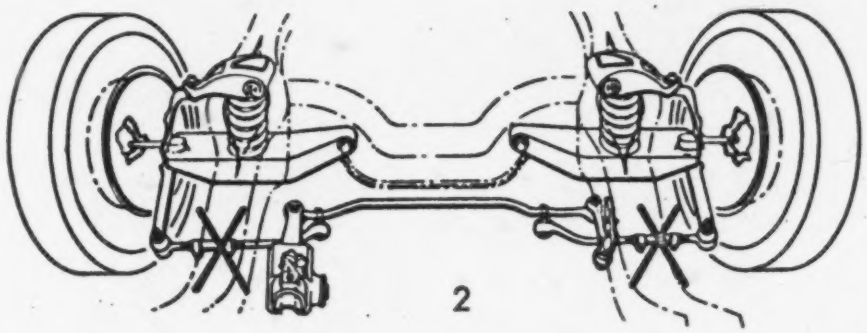

2

33

What pushes the steering knuckle? _____

18592

33

the tie rod

34

What part does a tie rod push against? _____

18593

34

the steering knuckle

35

What do the tie rods do? _____

18594

35

push or pull the steering knuckles

36

steering knuckles

tie rods

center link

Using the words above, LABEL the picture below:

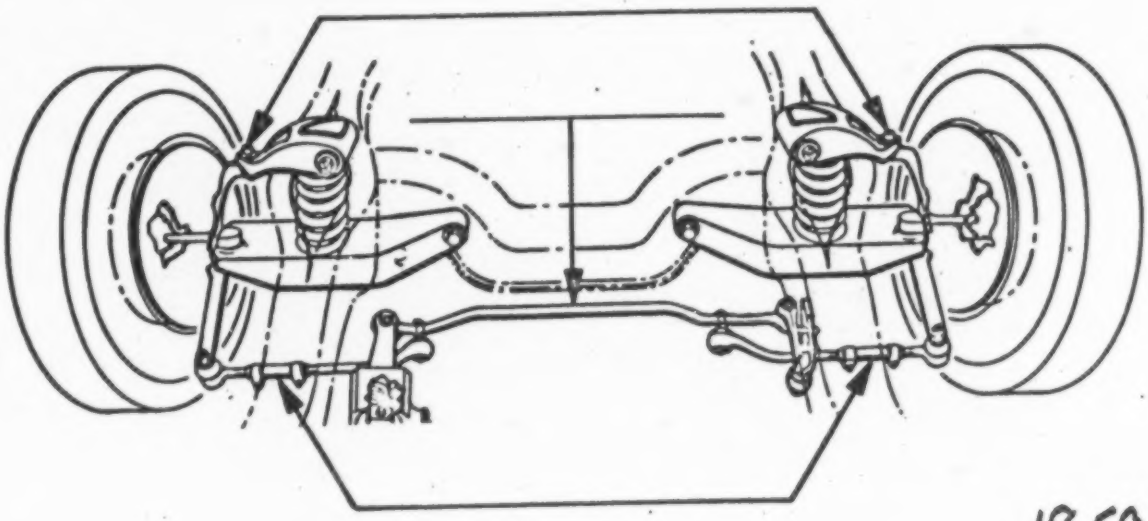

18595

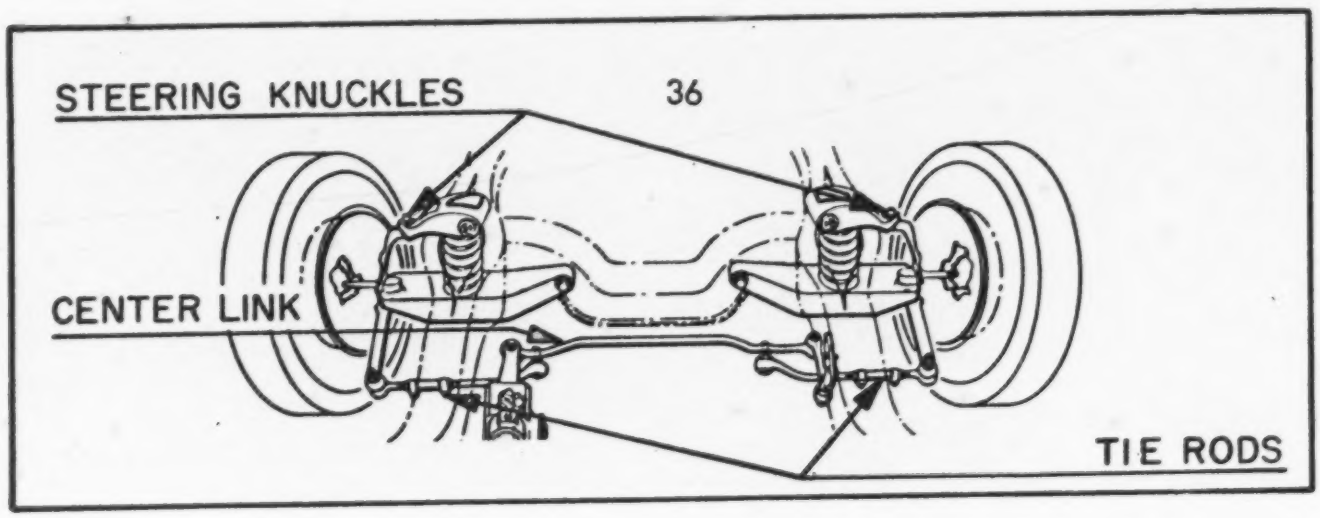

37

What do the tie rods do? _____

18596

37

push or pull the steering knuckles
to the left or right

38

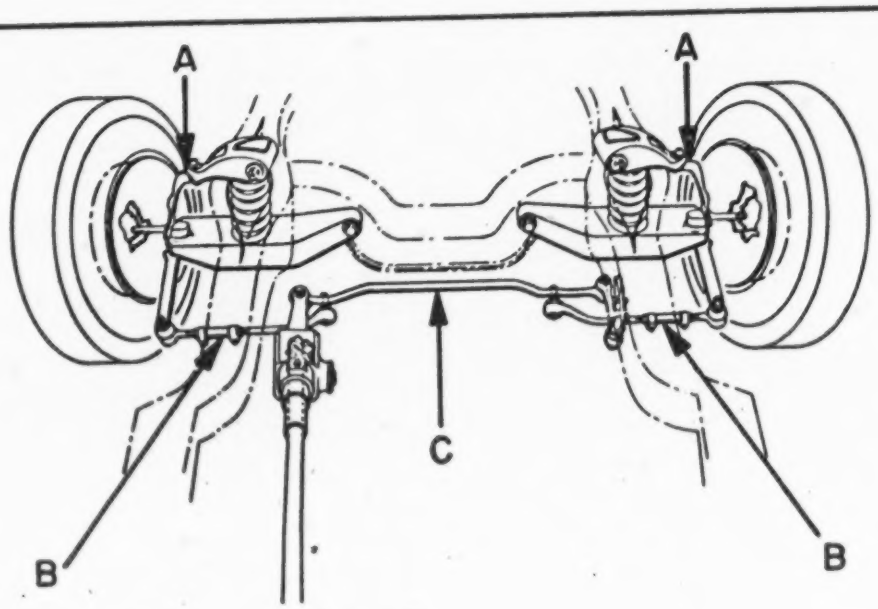

What part does each arrow point to?

arrow A: _____

arrow B: _____

arrow C: _____

18597

38

steering knuckles

tie rods

center link

39

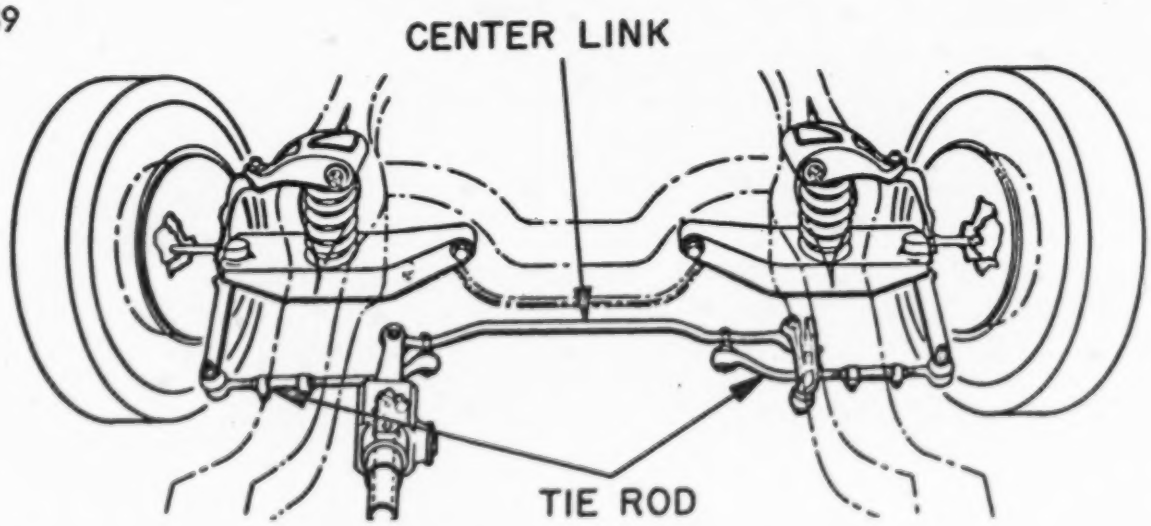

The tie rods are pushed or pulled to the left or right by the:

- ☐ center link
- ☐ driver
- ☐ front wheels

18598

39

center link

40

How many tie rods are connected to the center link? _____

How many center links does a car have? _____

18599

40

2

1

41

Both tie rods are connected to one _____ .

18600

41

center link

42

MARK an X through the center link in the diagram below:

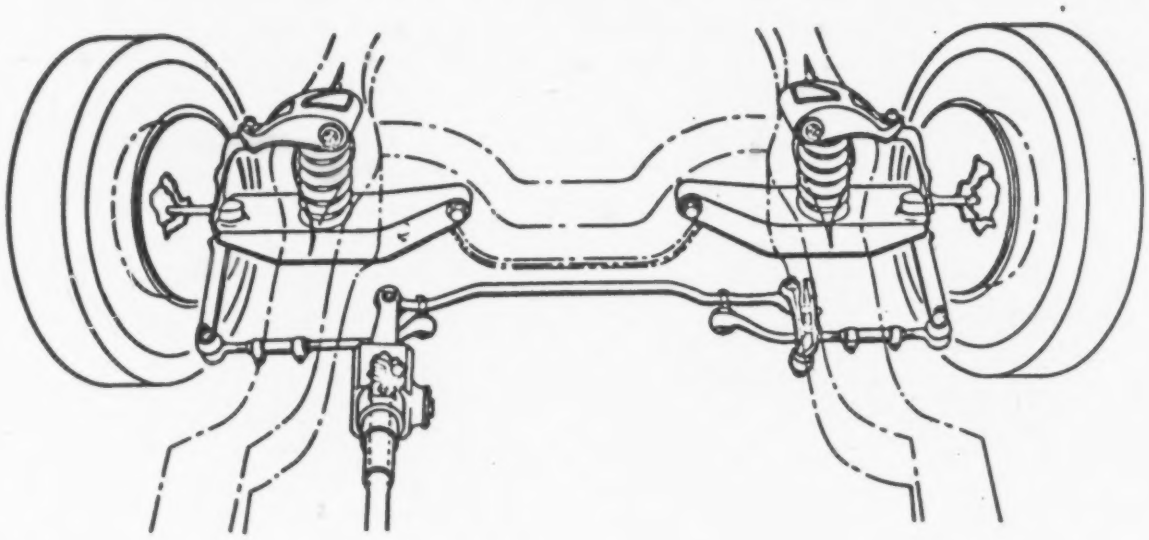

18601

Activities (con't)

B. Optional Activities - The optional plates are designed to improve your skill. These plates require the application of the skills you learned in the previous plates.

Plate	Title
1. G-10	Gasket
2. G-11	Cushioning Plate

42

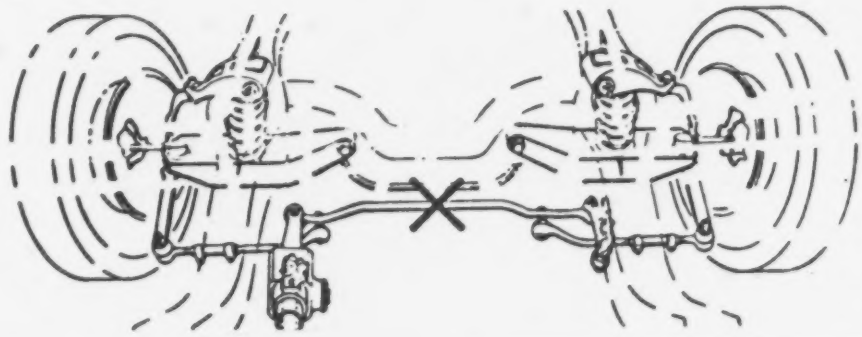

43

Which parts are connected to a tie rod? (CHECK ALL CORRECT ANSWERS)

- ☐ front wheel
- ☐ steering knuckle
- ☐ center link

18602

43

steering knuckle

center link

44

The parts connected to a tie rod are a _____ _____ and a _____ _____.

18603

44

center link

steering knuckle

45

When the center link moves, the _____ _____ are moved to the left or right.

18604

45

tie rods

46

On the diagram below, LABEL the tie rods and the center link:

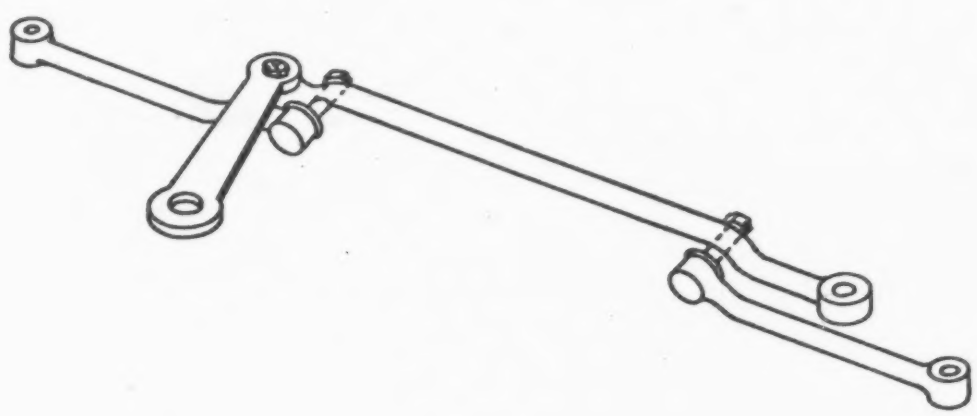

18605

46

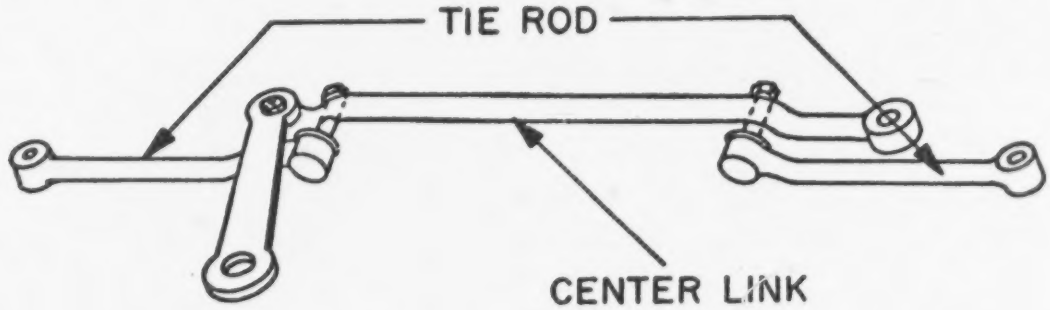

47

What does the center link do? _____

18606

47

pushes or pulls the tie rods to the left or right

48

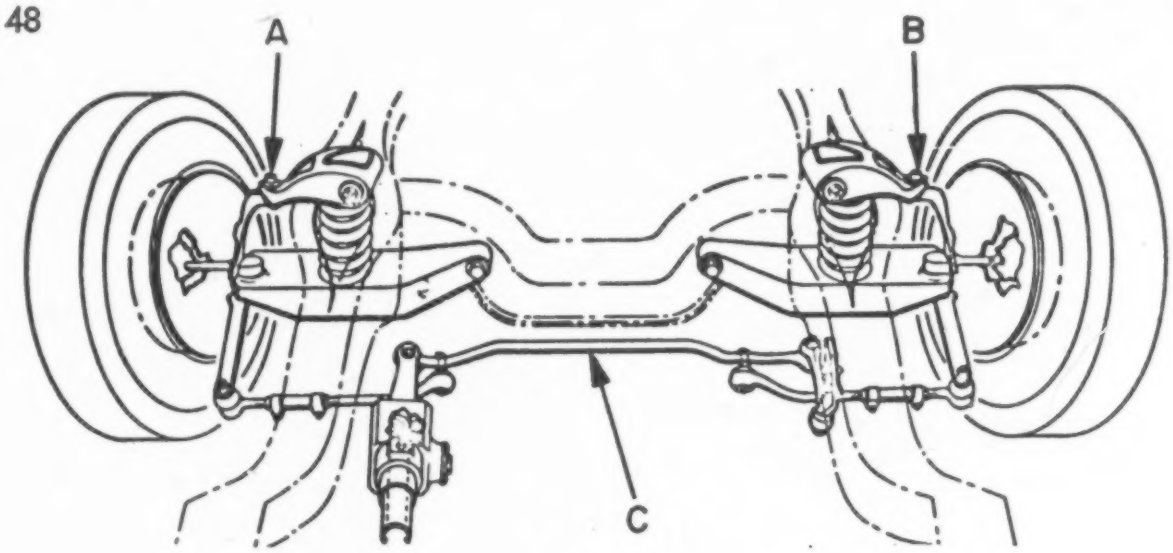

What is each arrow pointing to?

arrow A: _____

arrow B: _____

arrow C: _____

18607

48

steering knuckle

steering knuckle

center link

49

LOOK AT PANEL 1

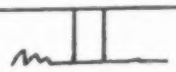

When the steering gear arm moves, the car:

- ☐ will turn to the left or right
- ☐ will not turn to the left or right

To make the car turn to the left or right, the steering gear arm must:

- ☐ move the center link
- ☐ move the driver
- ☐ move over

18608

49

will turn to the left or right

move the center link

50

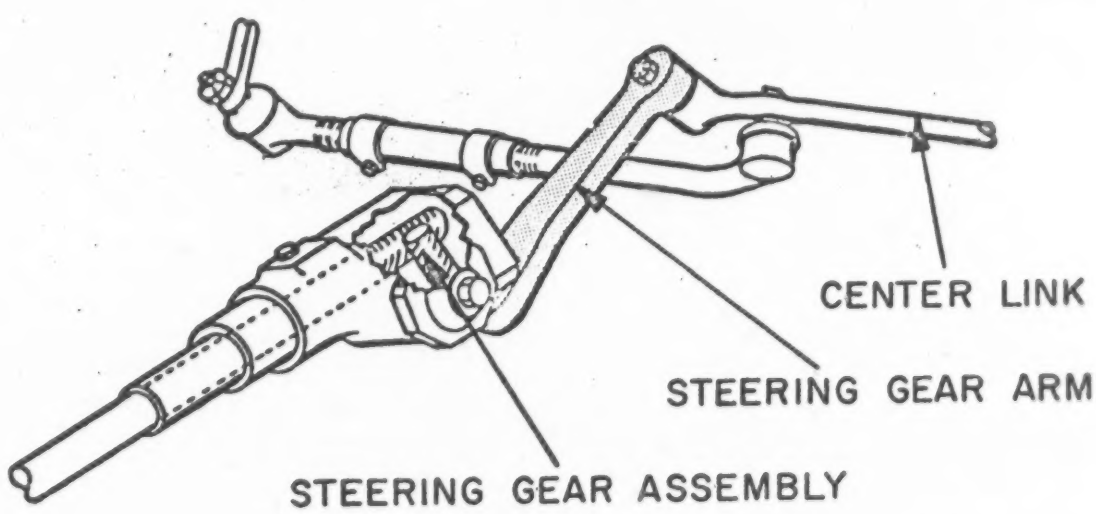

The center link is moved by the _____ .

18609

50

steering gear arm

51

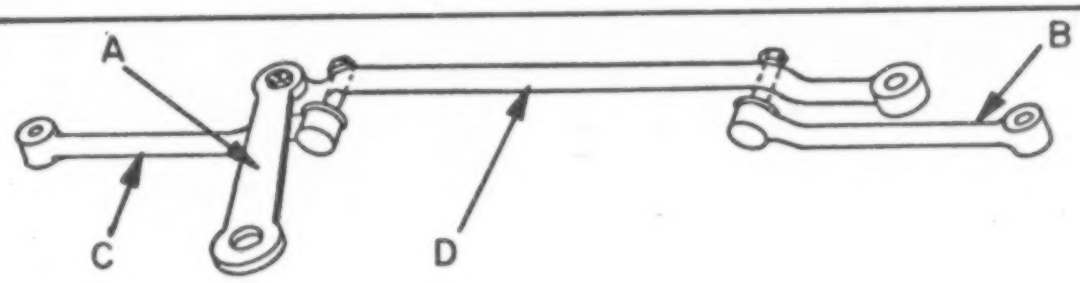

The part that moves the center link is labeled:

- ☐ A
- ☐ B
- ☐ C
- ☐ D

Arrow A is pointing to the:

- ☐ center link
- ☐ front wheel
- ☐ tie rod
- ☐ steering gear arm

18610

51

A

center link

52

The steering gear arm moves the _____ _____.

18611

INSTRUCTIONS FOLLOWING COMPLETION OF ACTIVITIES

You have been learning the basic geometric constructions and using the terms that describe their construction. You have applied these constructions to draw the conveyer link and the optional plates. If your drawings have been correct you should be ready for the teacher test.

REVIEW THE TERMS AND THE PLATES G-1 THROUGH G-9

The teacher test is divided into two parts:

Part 1. Definition of terms.

Part 2. Geometrical constructions.

Get these tests from the instructor.

YOU ARE ALLOWED THREE PERIODS FOR THE TEST

When finished turn them in to the instructor. If the test is satisfactory you will be given permission to start L.A.P. 7.

52

center link

53

CIRCLE the steering gear arm in the diagram below:

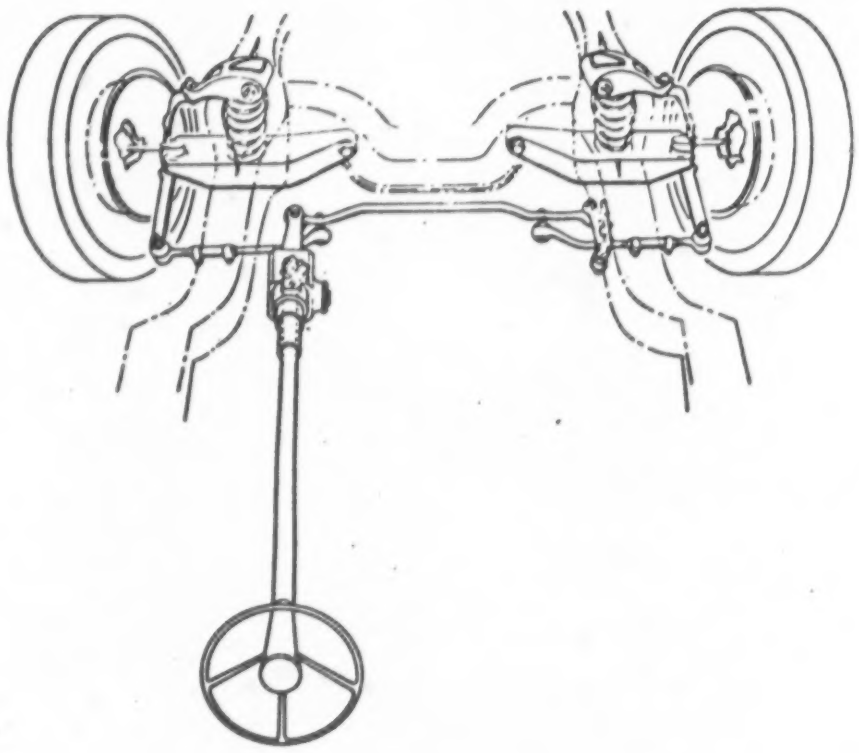

18612

263 OF 327

ED

056 238

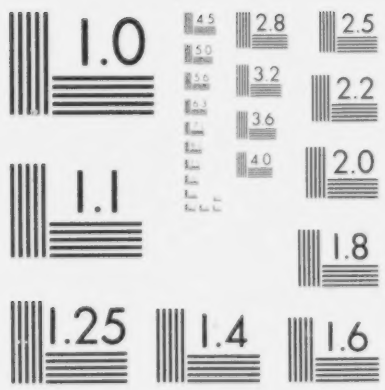

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

53

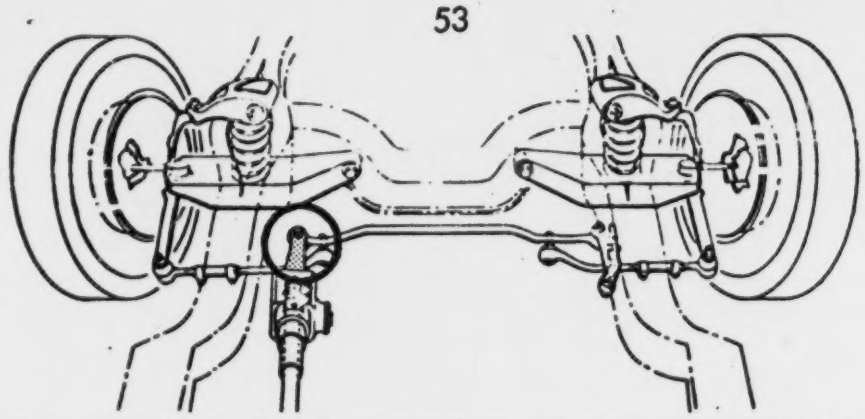

54

The center link is moved by the:

- ☐ front wheels
- ☐ steering gear arm
- ☐ steering knuckle assembly

18613

54

steering gear arm

55

What does the steering gear arm do? _____

18614

55

moves the center link

56

One end of the center link is connected to the steering gear arm.

What else is connected to the center link? _____

18615

56

the tie rods

57

NAME two parts connected to the center link:

_____

_____

18616

57

tie rods

steering gear arm

58

The steering gear arm is moved by the steering gear assembly.

On the diagram, LABEL the steering gear arm and the steering gear assembly:

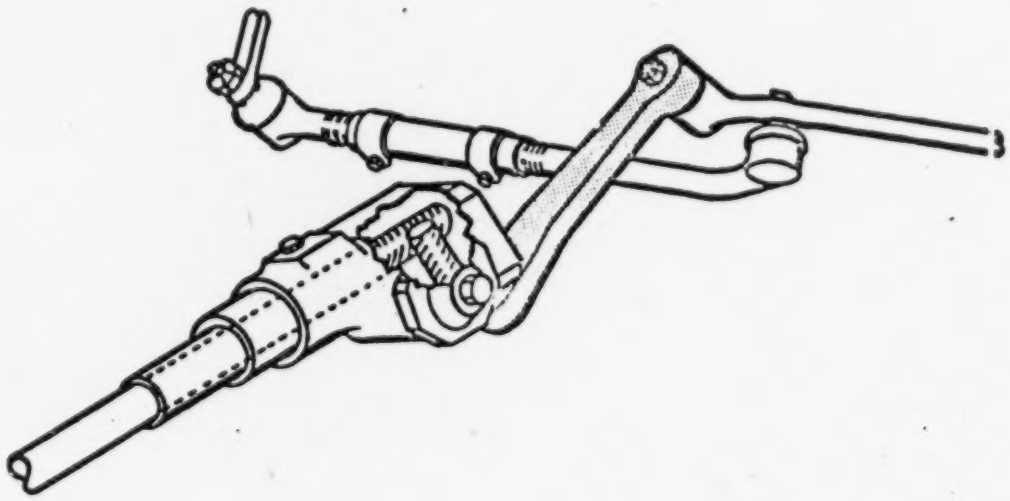

18617

58

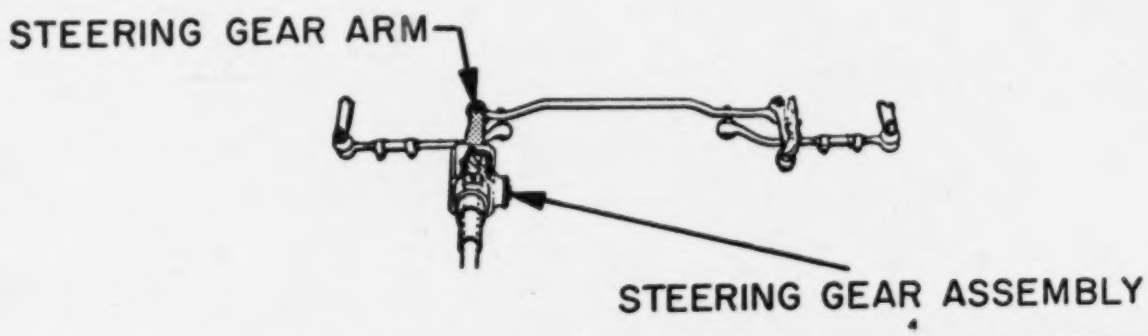

59

What does the steering gear arm do? _____

18618

59

moves the center link

60

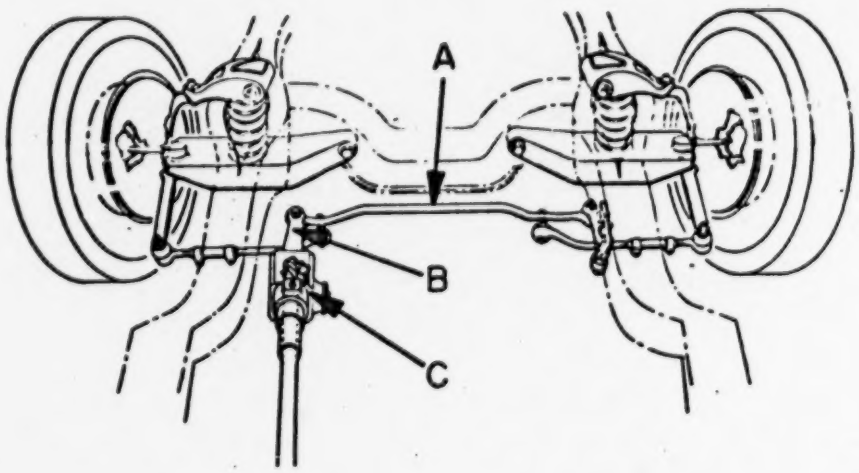

NAME the part that each arrow points to?

arrow A: _____

arrow B: _____

arrow C: _____

18619

60

center link

steering gear arm

steering gear assembly

61

The front wheels of a car are mounted on the:

- ☐ tie rods
- ☐ steering knuckles
- ☐ center link

18620

BISECT A STRAIGHT LINE

REF. MD 7 Art. 4.2 Fig. 4.2a
MD 6 Art. 4.2 Fig 4.1

DIVIDE A LINE INTO 7 EQUAL PARTS

MD7 Art. 4.6 Fig. 4.6b
MD6 Art. 4.6 Fig. 4.7

BISECT AN ANGLE

REF. MD 7 Art. 4.2 Fig. 4.2d
MD 6 Art. 4.9 Fig. 4.11

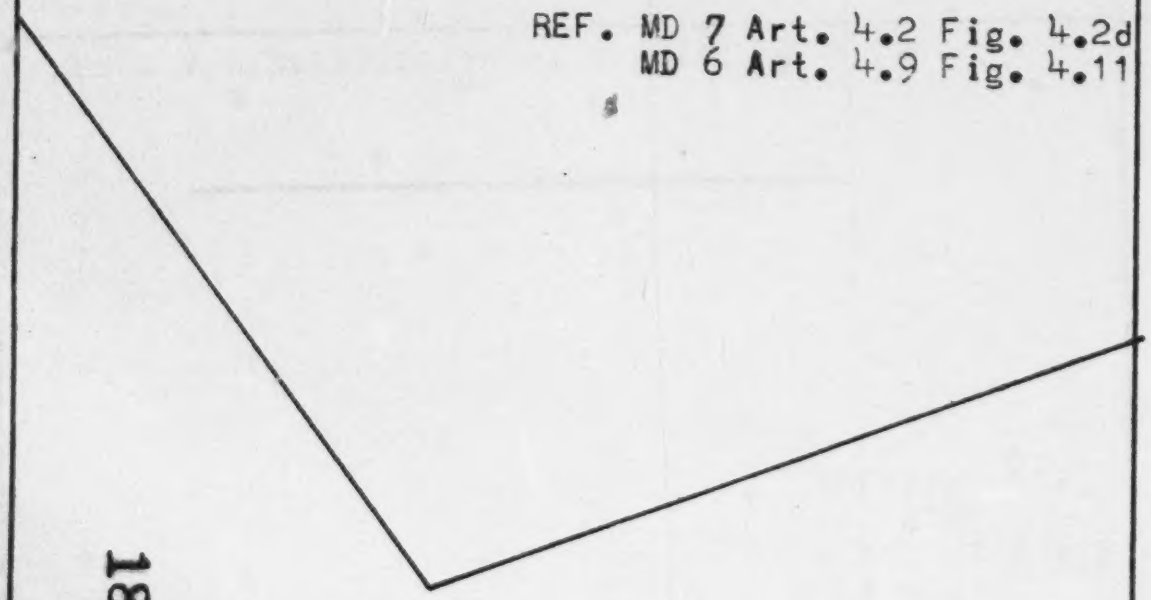

BISECT AN ARC

REF. MD 7 Art. 4.2 Fig 4.2b
MD 6 Art. 4.2

1829

4374

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61

steering knuckles

62

Which parts push or pull against the steering knuckles?

_____

18621

62

the tie rods

63

CHECK the parts connected to the center link:

- ☐ front wheels
- ☐ tie rods
- ☐ steering gear arm

18622

63

tie rods

steering gear arm

64

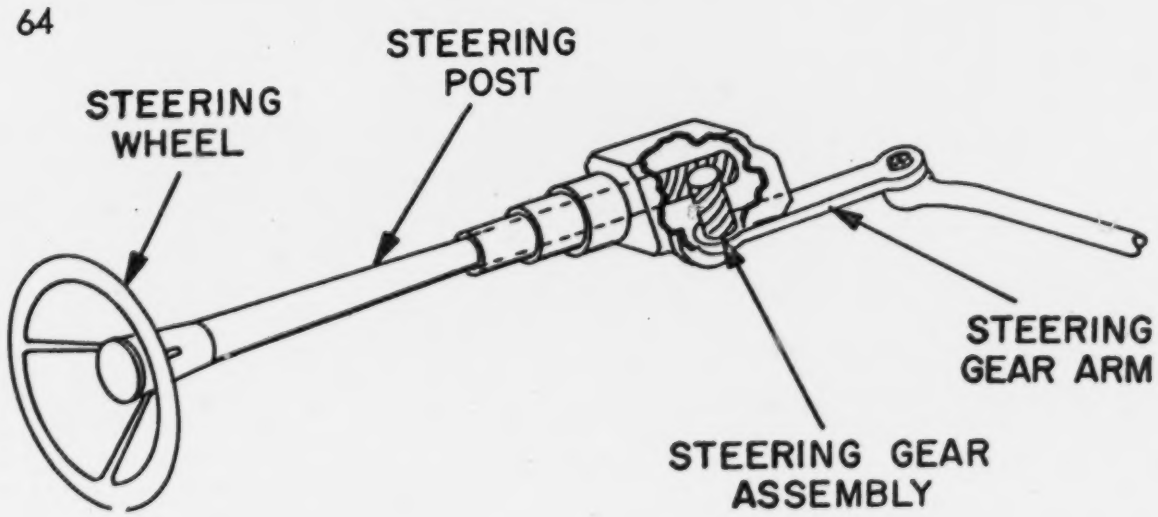

When the driver turns the steering wheel, the steering gear arm moves.

The steering gear arm is moved by gears in the:

- ☐ steering gear assembly
- ☐ steering post

18623

64

steering gear assembly

65

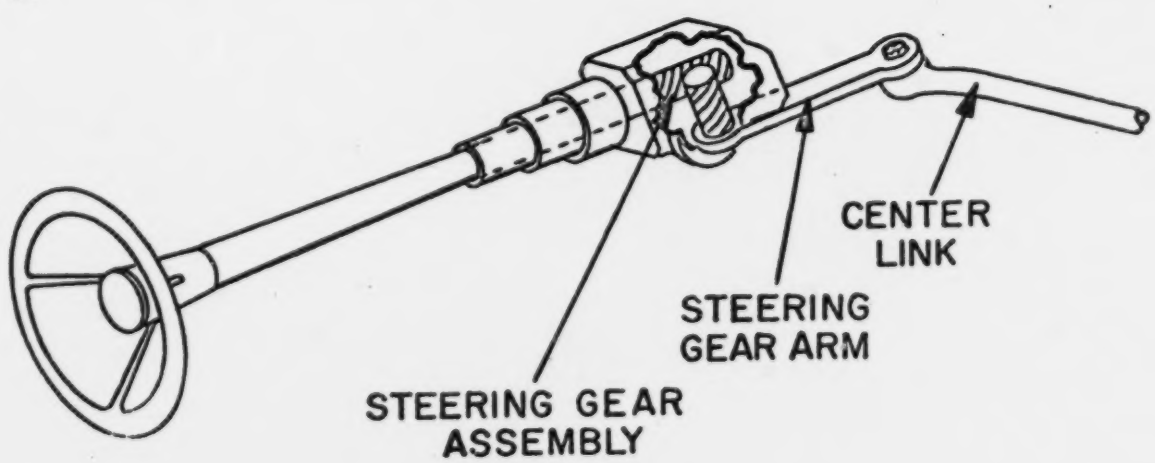

The steering wheel is being turned.

The gears in the gearbox will move the:

- ☐ steering gear arm
- ☐ steering wheel

18624

65

steering gear arm

66

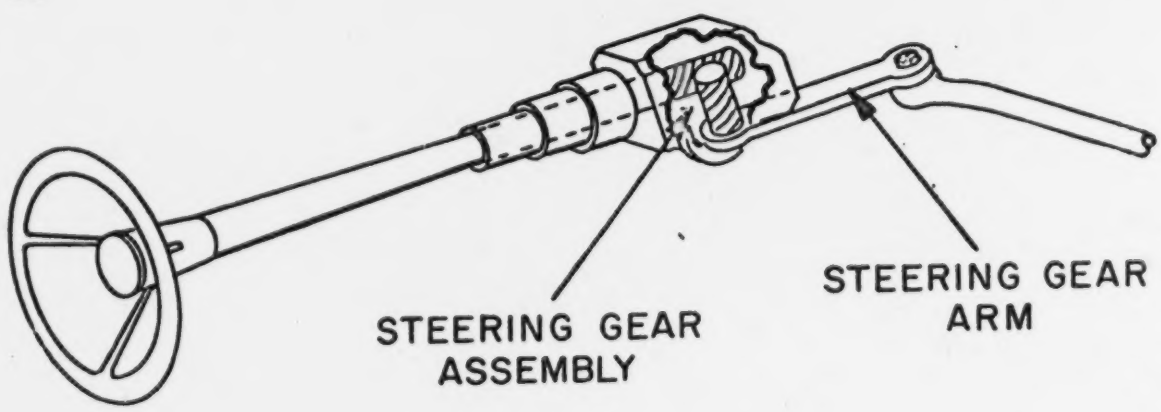

The steering gear arm is moved by:

- ☐ gears in the gearbox
- ☐ the steering knuckle
- ☐ the center link

18625

66

gears in the gearbox

67

A driver cannot turn the steering wheel hard enough to move the steering system parts. His force on the steering wheel must be built up in order to move the front wheels.

A driver's force on the steering wheel should:

- ☐ be increased
- ☐ be decreased
- ☐ remain the same

18626

67

be increased

68

A steering gear assembly gives the driver enough force on the steering wheel to make the front wheels turn to the left or right.

A driver's force is built up by the steering _____ _____.

18627

68

gear assembly

69

The steering gear assembly:

- ☐ builds up the driver's force on the steering wheel
- ☐ decreases the driver's force
- ☐ does not change the driver's force

18628

69

builds up the driver's force on the steering wheel

70

DRAW an arrow pointing to the part that builds up the driver's force on the steering wheel:

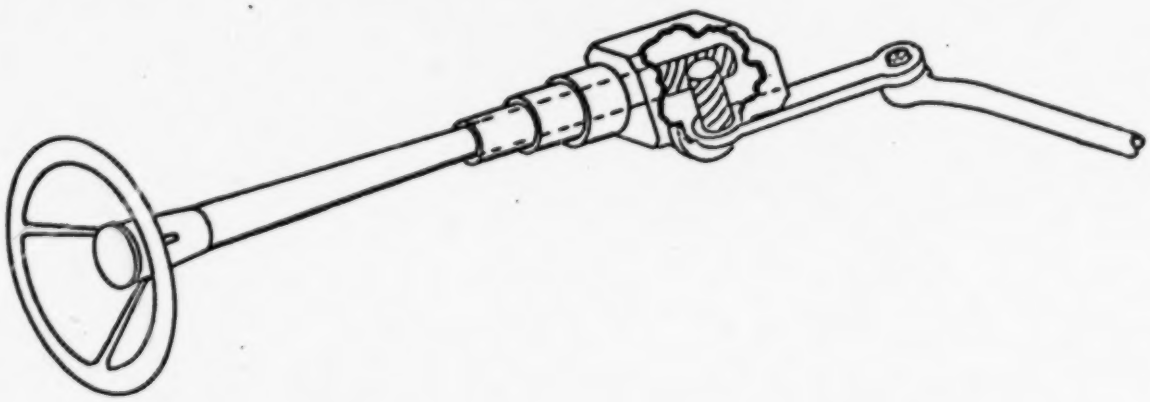

This part is the _____ _____ _____.

18629

70

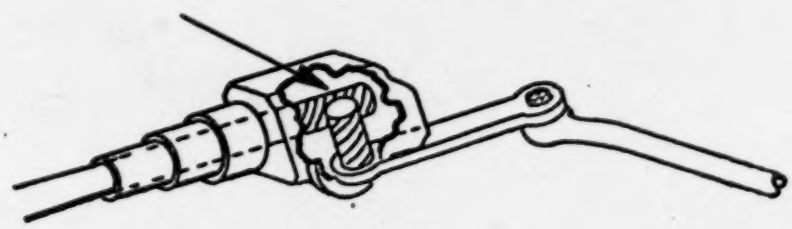

steering gear assembly

71

What does the steering gear assembly do to a driver's force on the steering wheel? _____

18630

185a

REF. MD7
A 4.3 F. 4.3 B
M.D6
A.4.3 F. 4.3

ERECT A PERPENDICULAR AT A POINT ON A LINE

MD7 4.4 Fig. 4.4a B
MD6 A.4.4 Fig. 4.5

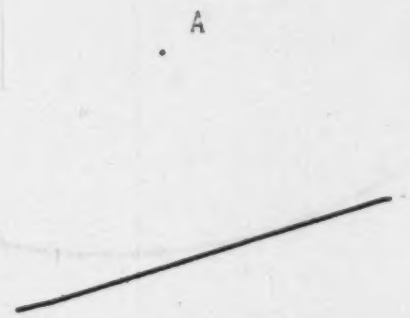

ERECT A PERPENDICULAR TO A LINE FROM A POINT (A)

MD774.3 Fig. 4.3A
MD6 4.3 Fig. 4.2

ERECT A PERPENDICULAR AT A POINT ON A LINE

MD7 Fig. 4.4c&a
MD6 A4.3 Fig. 4.2

DRAW A PERPENDICULAR WITHTRIANGLE AND
T- SQUARE

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4375

71

builds it up

72

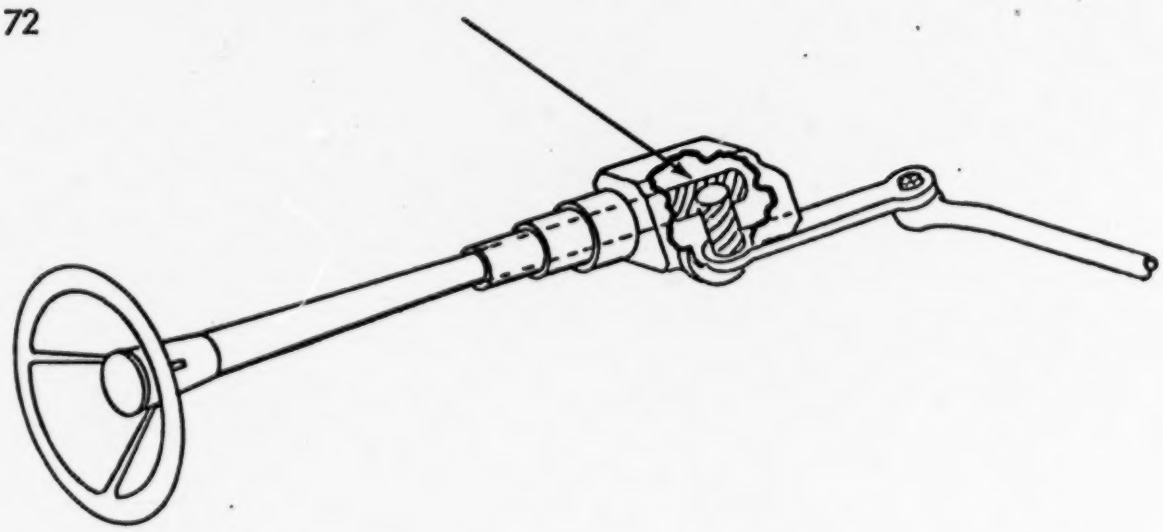

The arrow is pointing to the _____ .

18631

72

steering gear assembly

73

Which parts are connected to the steering gear arm?

_____

_____

18632

73

center link

steering gear assembly

74

On the diagram below, LABEL each of the following parts:

steering gear arm

steering gear assembly

steering post

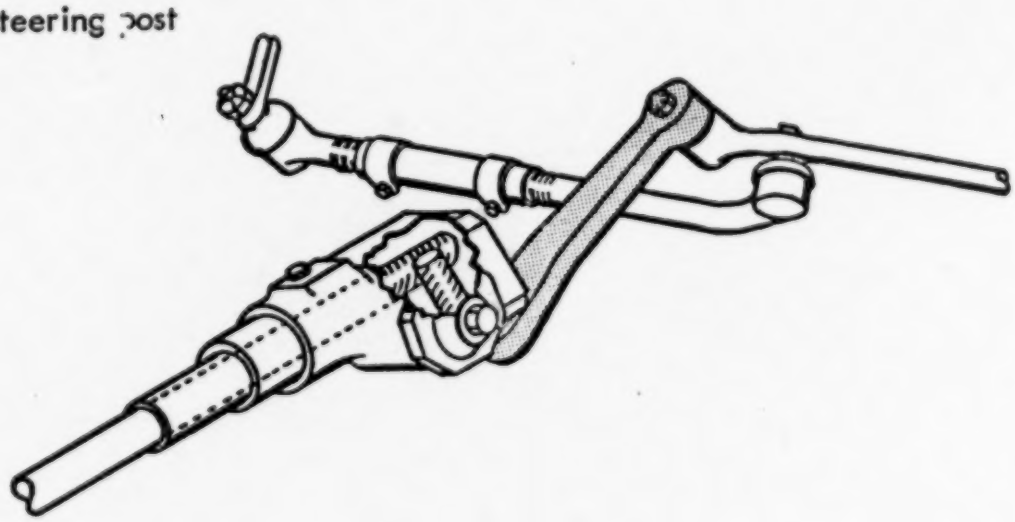

18633

74

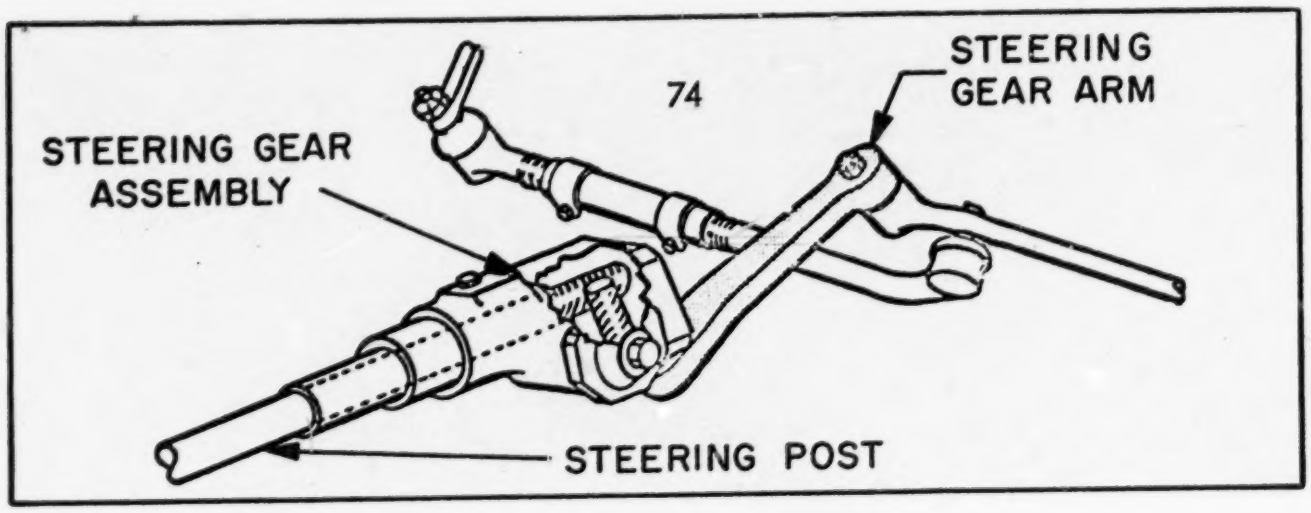

75

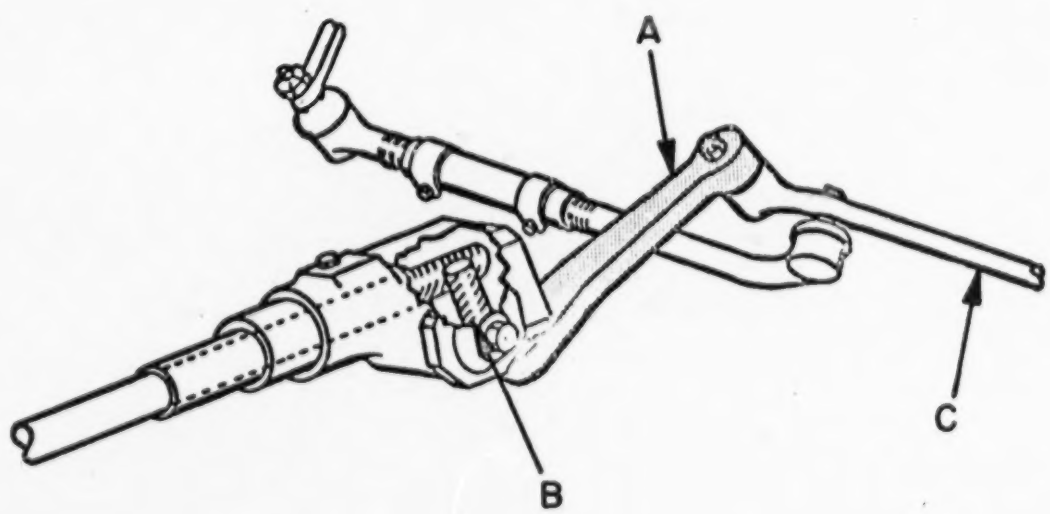

The steering gear arm is connected to the steering gear assembly and the _____ .

18634

75

center link

76

Besides moving the steering gear arm, what does the steering gear assembly do? _____

18635

76

builds up the driver's force on the steering wheel

77

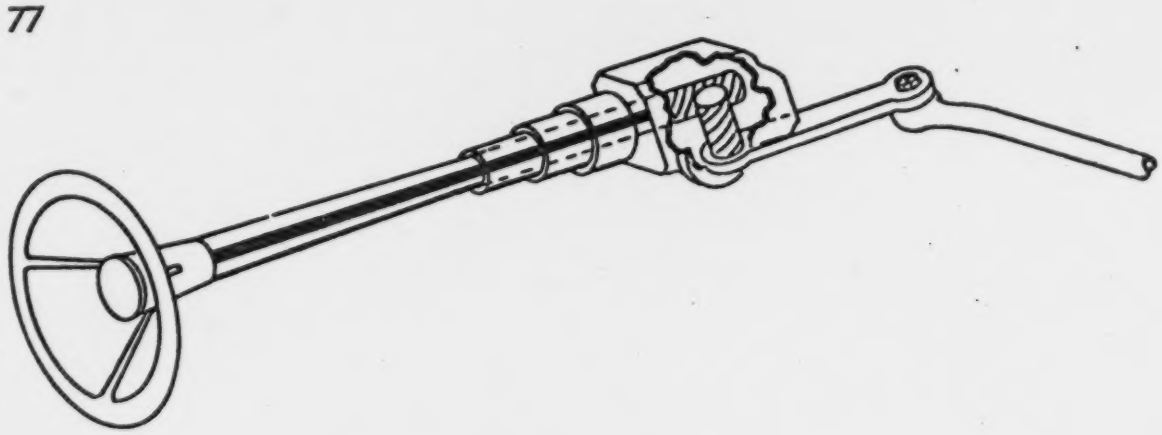

When the driver turns the steering wheel, force reaches the steering gear assembly through the steering post.

The column in the steering post:

- ☐ turns the steering gears
- ☐ moves to one side
- ☐ does not move

18636

77

turns the steering gears

78

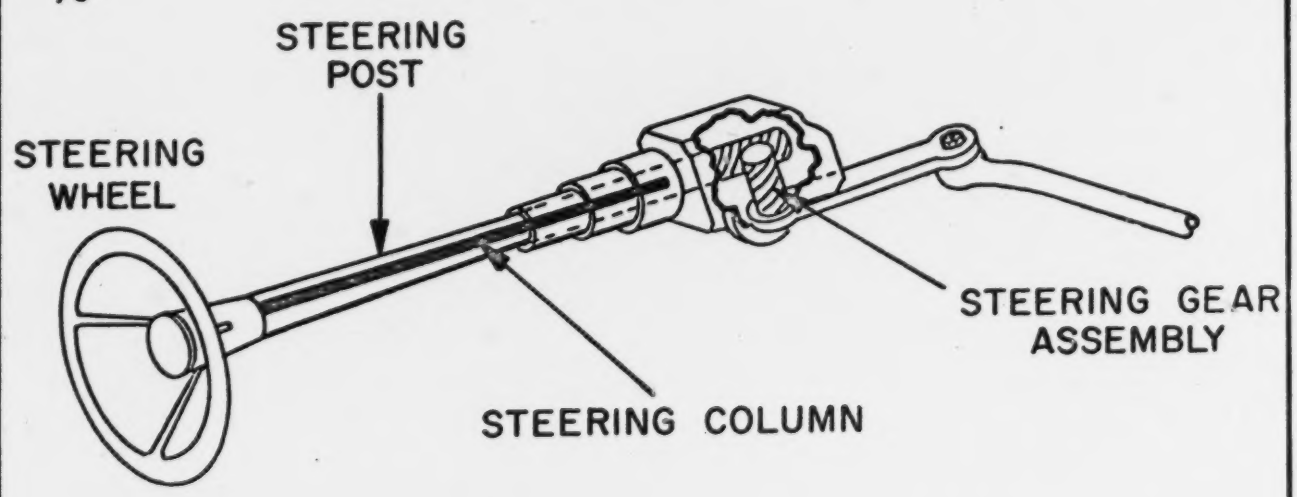

The steering column is in the:

- ☐ steering wheel
- ☐ steering post
- ☐ steering gear assembly

18637

78

steering post

79

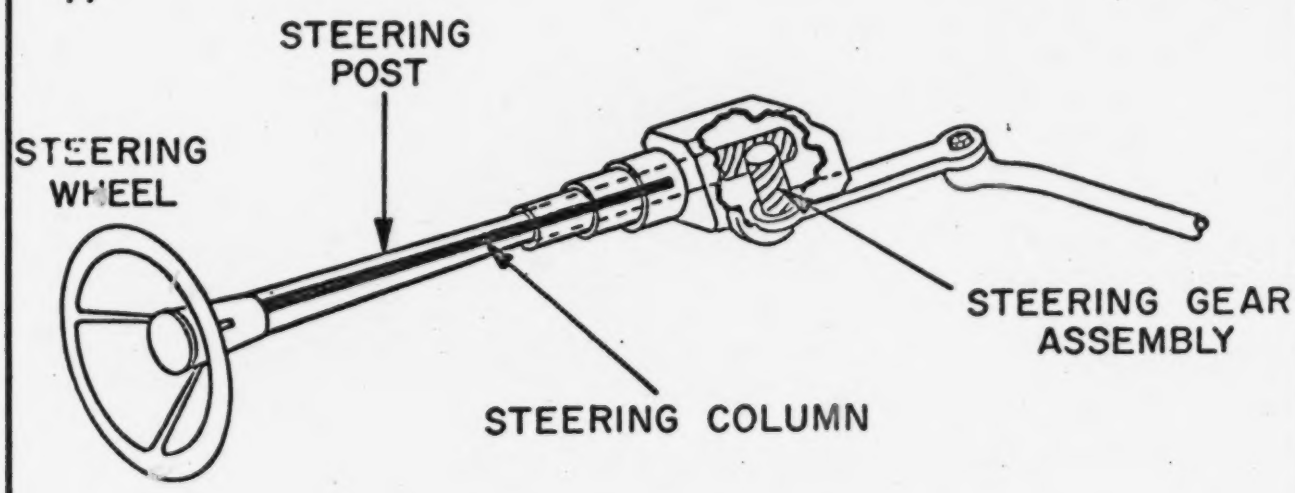

The steering gears are turned by the:

- ☐ steering column
- ☐ steering post
- ☐ tie rods

18638

79

steering column

80

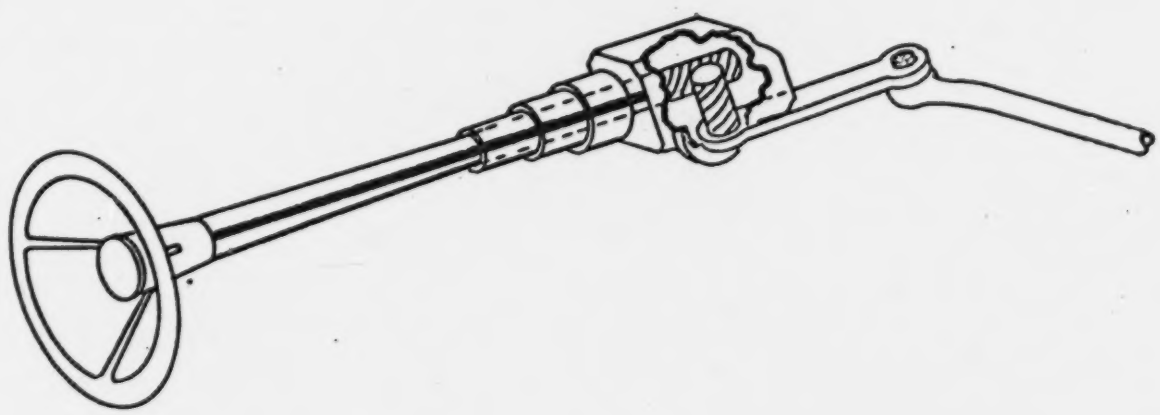

The steering wheel is being turned to the right.

What will be the first part to turn?

- ☐ the steering column
- ☐ the steering post
- ☐ the tie rods

18639

80

the steering column

81

The steering column turns the:

- ☐ steering gear assembly
- ☐ tie rods

18640

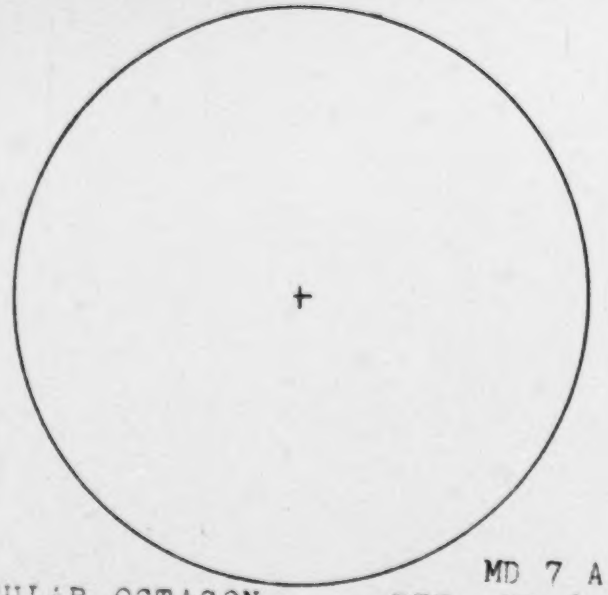

4.22a
MD 7 Art.4.22Fig.
DRAW A REGULAR OCTAGON REF. MD 6 Art. 4.15

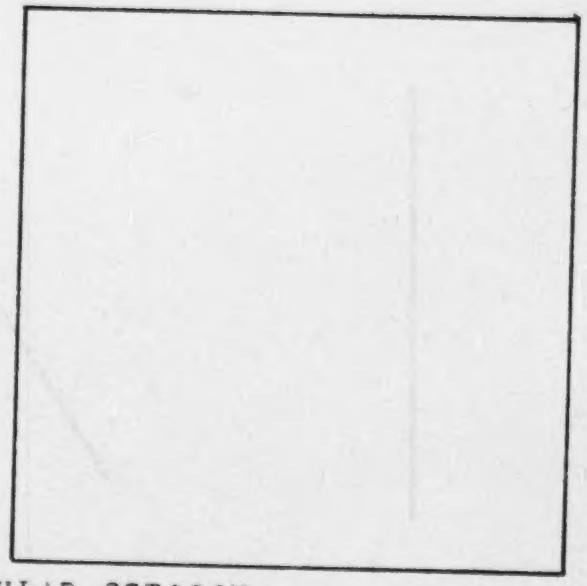

REF.
MD7 Art.
4.21
Fig. 4.21
MD6
DRAW A REGULAR OCTAGON A 4.15 F 4

DRAW A REGULAR HEXAGON REF. Art. 4.19 F. 4.19
MD6 Art.4.13 F. 4.20

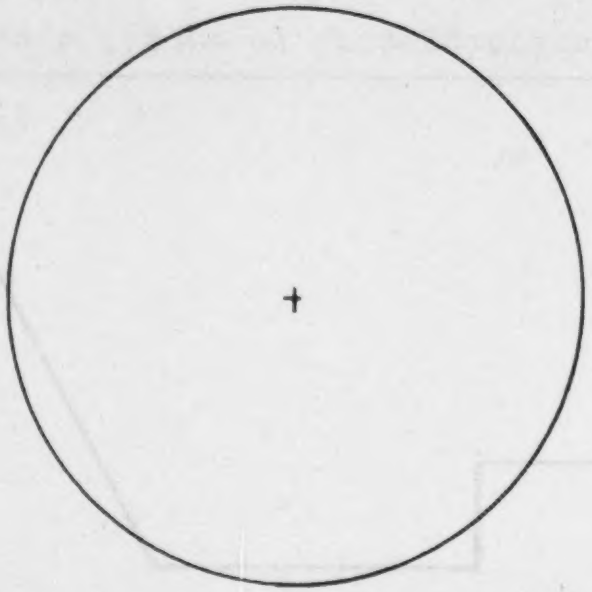

DRAW A PENTAGON REF. MD7 Art. 4.17 Fig. 4
MD6 Art.4.14 Fig. 4.21

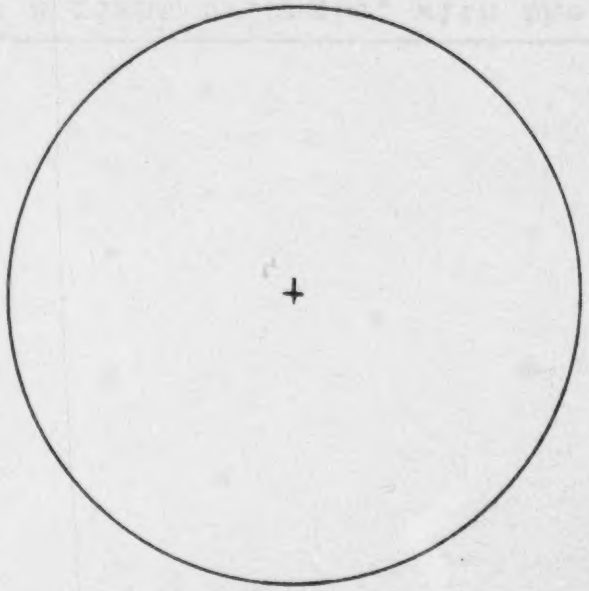

1831

18.5

4376

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81

steering gear assembly

82

The steering column is in the:

- ☐ steering wheel
- ☐ steering post

18641

82

steering post

83

DRAW an arrow pointing to the steering column:

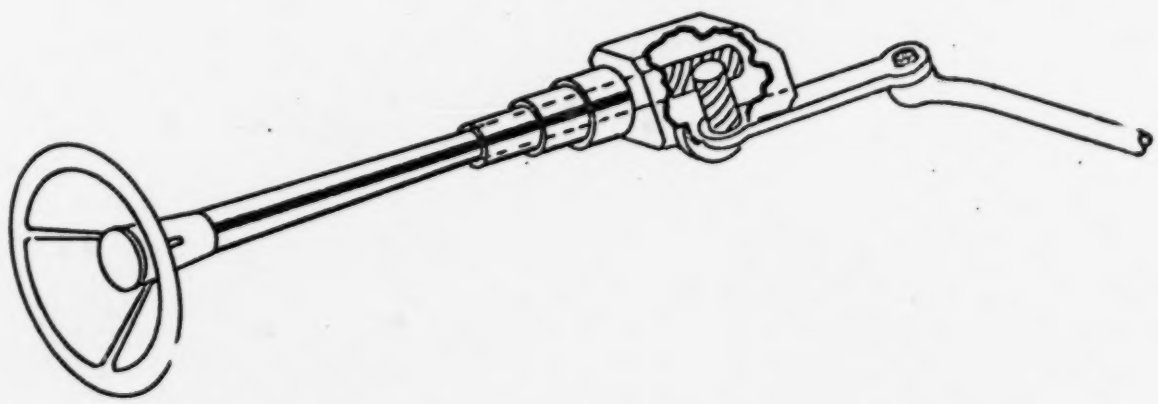

18642

83

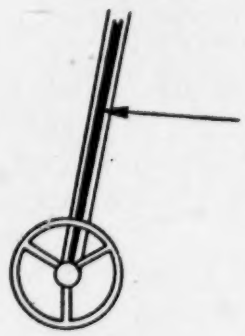

84

The steering column turns the steering _____ _____ .

18643

84

gear assembly

85

The steering column is turned by the steering _____ .

18644

85

wheel

86

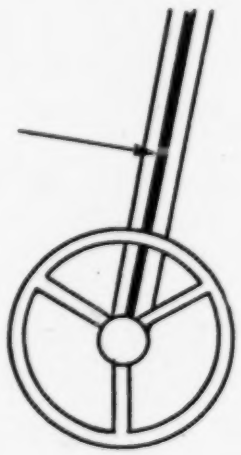

The arrow in this drawing is pointing to the _____

18645

86

steering column

87

What does the steering wheel turn? _____

18646

87

the steering column

88

The steering column turns when the driver of the car turns the

_____ .

18647

88

steering wheel

89

The steering column is connected to the: (CHECK ALL CORRECT ANSWERS)

- ☐ steering gear arm
- ☐ steering gear assembly
- ☐ steering wheel
- ☐ tie rods

18648

89

steering wheel

steering gear assembly

90

The steering post:

- ☐ turns
- ☐ does not turn

18649

90

does not turn

91

The steering column is in the _____ .

18650

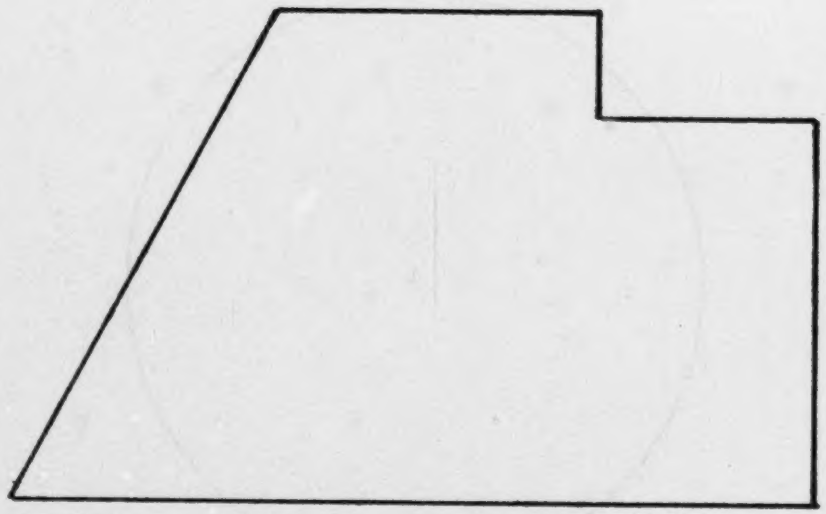

Reduce a figure by triangulation MD7 4.7
Fig. 4.7b

Construct a right triangle, with the line below as a base, by the 3-4-5 method MD 7 4.1, 4.13 Fig 4.1

Draw a circle through the three points
MD 7 4.23 Fig 4.23
MD 6 4.16 Fig 4.23

Transfer an Angle MD 7 4.8 Fig 4.8
MD 6 410 Fig. 4.12

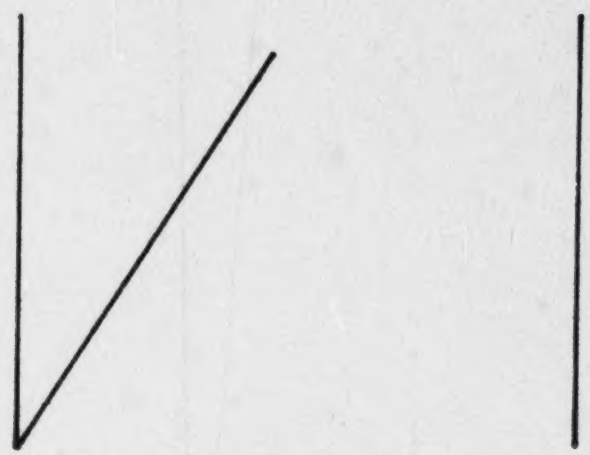

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1831

4377

91

steering post

92

On the diagram below, LABEL each of the following parts:

steering gear assembly

steering post

steering wheel

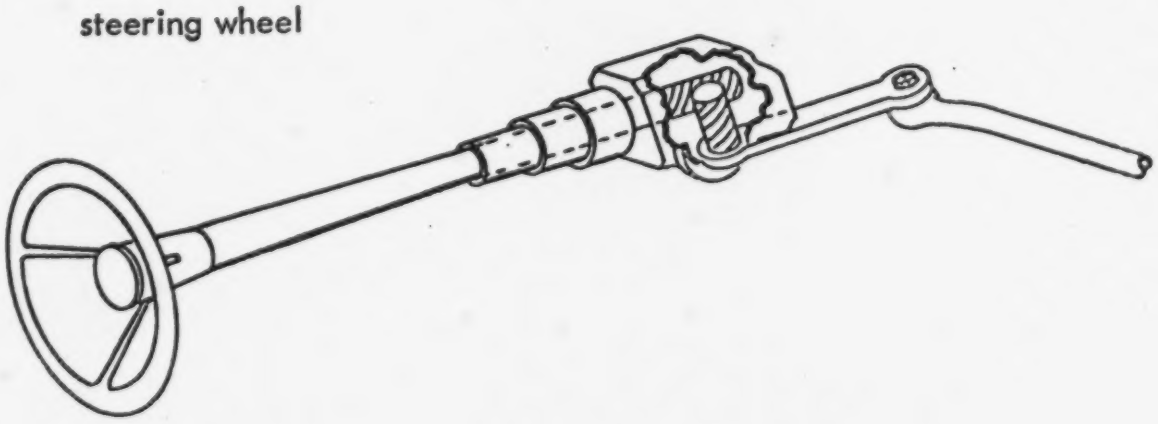

18651

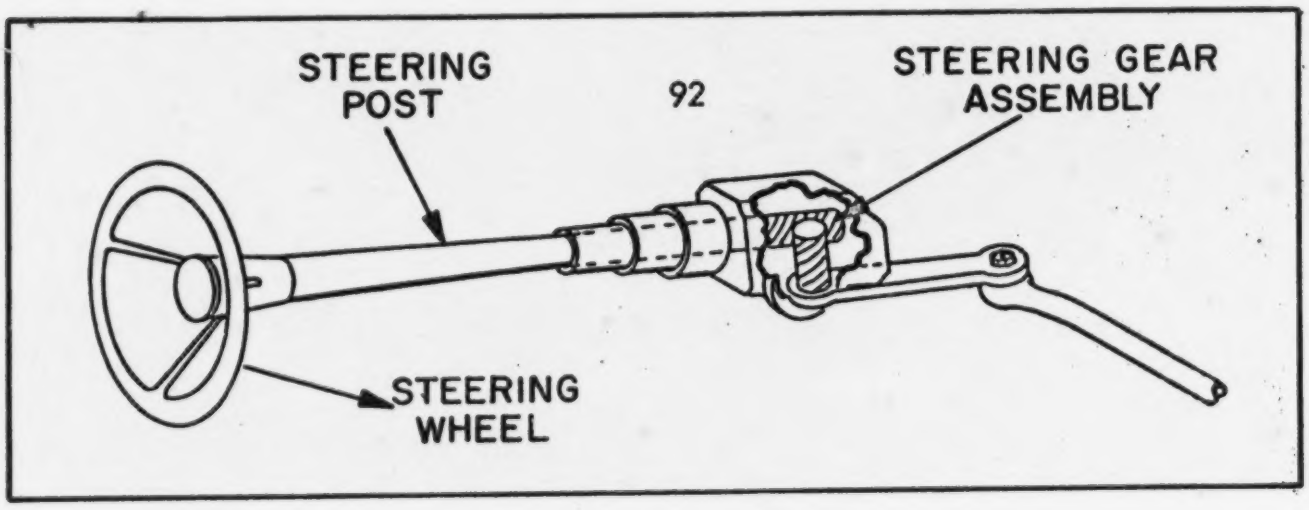

93

The force the driver uses to turn the steering wheel is (☐ greater than ☐ less than) the force exerted on the steering gear arm.

18652

93

less than

94

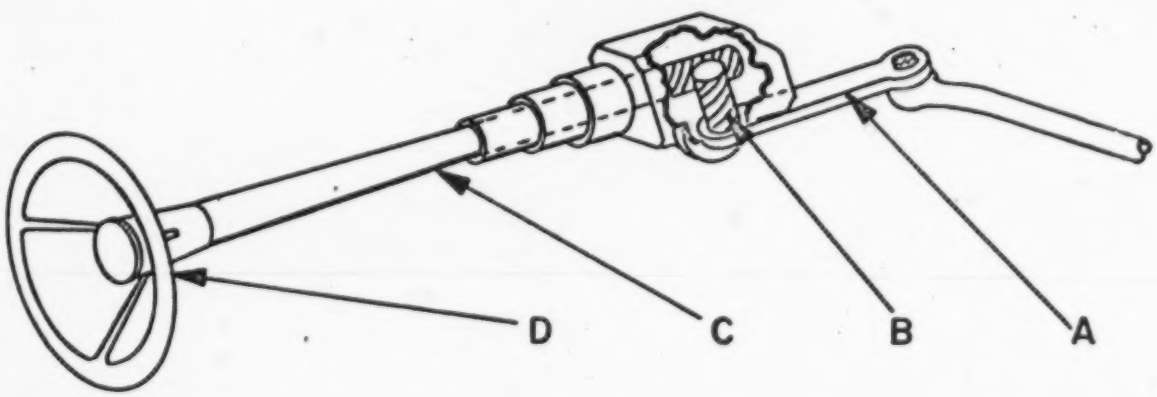

What is each arrow pointing to?

arrow A: _____

arrow B: _____

arrow C: _____

arrow D: _____

18653

95

steering gear assembly

96

The driver of the car turns the:

- ☐ steering post
- ☐ steering wheel

18655

96

steering wheel

97

The steering wheel turns the:

- ☐ steering column
- ☐ steering post

18656

97

steering column

98

What part of the steering system does the driver turn?

_____

18657

98

the steering wheel

99

On the diagram below, LABEL each of the following parts:

steering wheel

steering post

steering column

18658

99

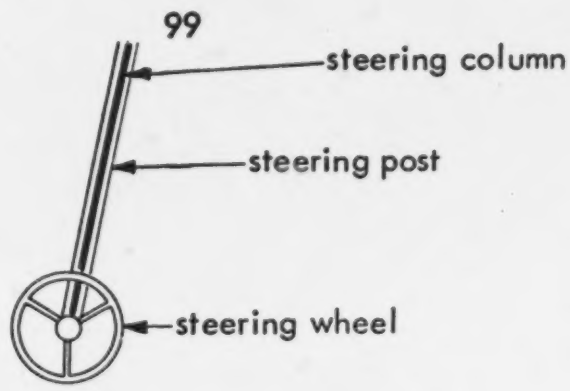

100

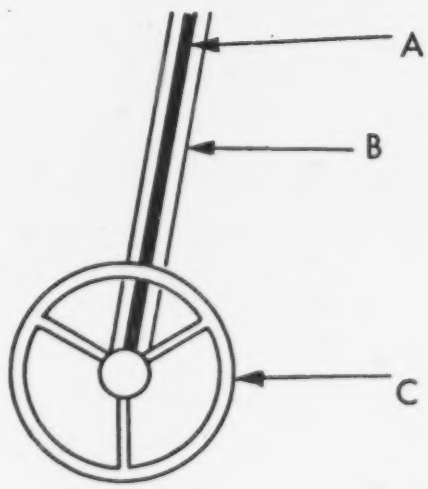

What part is each arrow pointing to?

arrow A: _____

arrow B: _____

arrow C: _____

18659

100

steering column

steering post

steering wheel

101

What does the steering wheel do? _____

18660

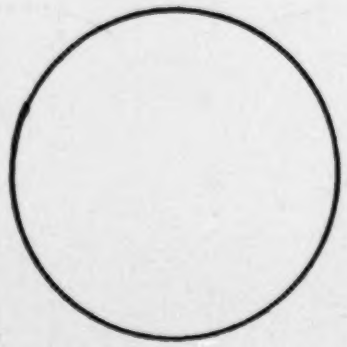

Draw a tangent to the Circle from a point outside the circle MD 7 425 Fig. 425a

1833

Draw a 3/4" arc tangent to the two sets of lines MD 7 4.26 Fig. 426b MD 6 4.18 Fig 4.25

Draw a 1" arc tangent to the two lines
MD 7 Fig 4.26d
MD 6 Fig 4.27

Draw tangent arcs at each corner of the figure with the radius indicated. Mark center and tangent points.

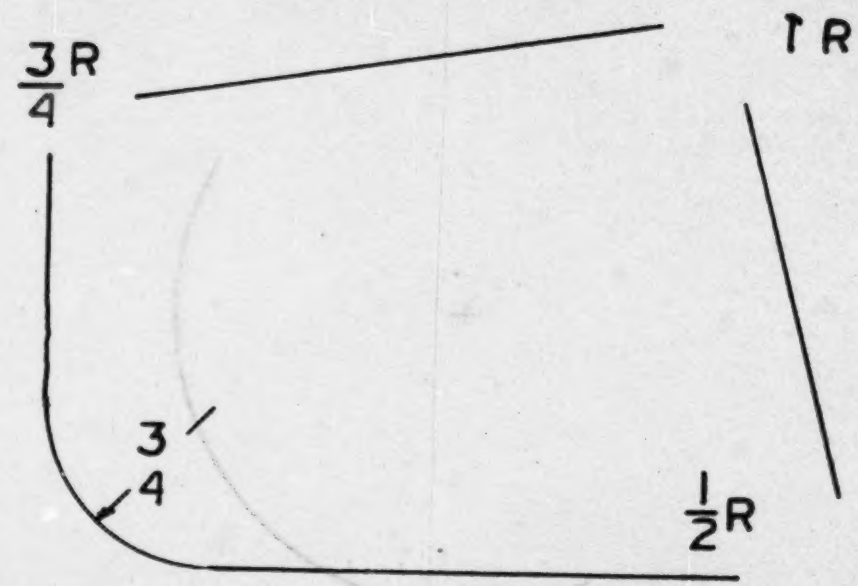

1834

4378

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DATE / /

No. G-5

101

turns the steering column

102

CHECK the parts that move when the driver of the car turns the steering wheel:

- ☐ the steering gear assembly
- ☐ the steering post
- ☐ the steering knuckle

18661

102

the steering gear assembly

the steering knuckle

103

CHECK each part that moves when the driver of the car turns the steering wheel:

- ☐ the front wheels
- ☐ the tie rods
- ☐ the steering gear arm

18662

103

the front wheels

the tie rods

the steering gear arm

104

Which part has <u>not</u> yet been talked about?

- ☐ the center link
- ☐ the idler arm
- ☐ the steering gear arm

18663

104

the idler arm

105

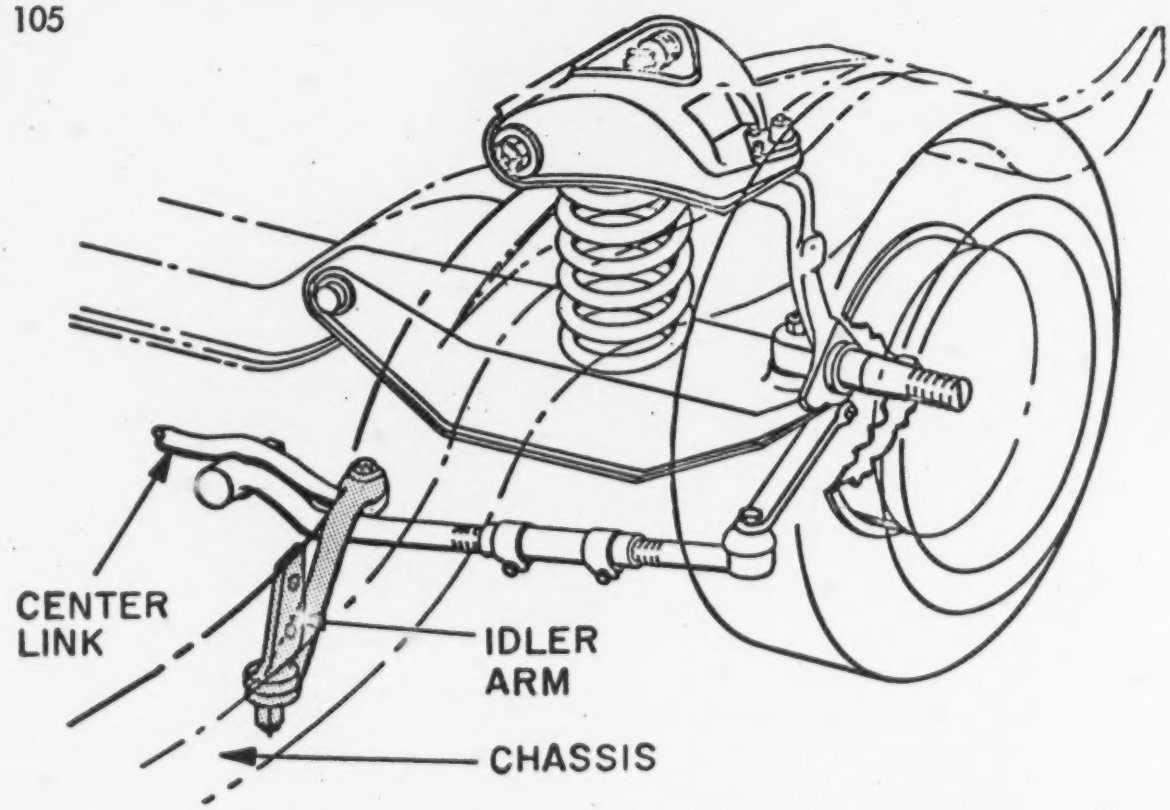

To reduce vibration in the steering system, the idler arm is bolted onto the _____ .

18664

105

chassis

106

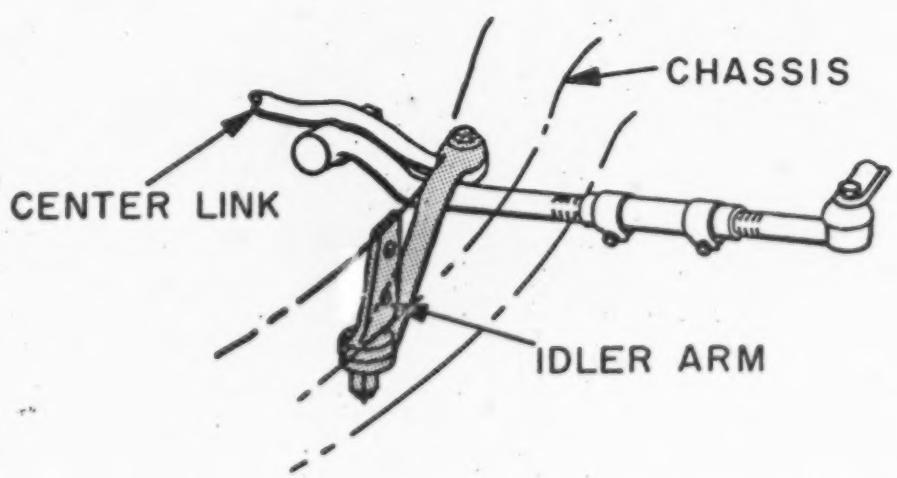

The idler arm is connected to the chassis and to the _____ _____.

18665

106

center link

107

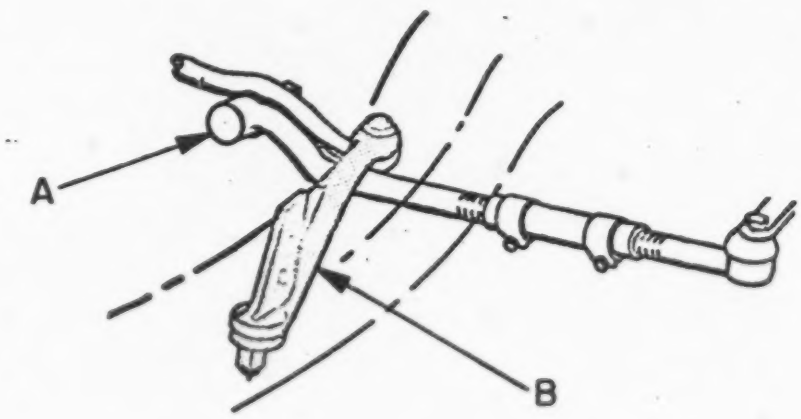

Arrow B points to the:

- ☐ center link
- ☐ idler arm

186666

107

idler arm

108

The purpose of the idler arm is to reduce:

- ☐ gas consumption
- ☐ tire wear
- ☐ vibration

18667

108

vibration

109

CIRCLE the idler arm in the drawing below:

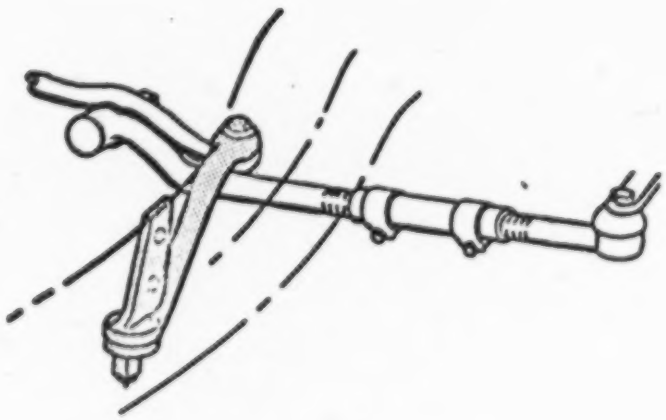

18668

109

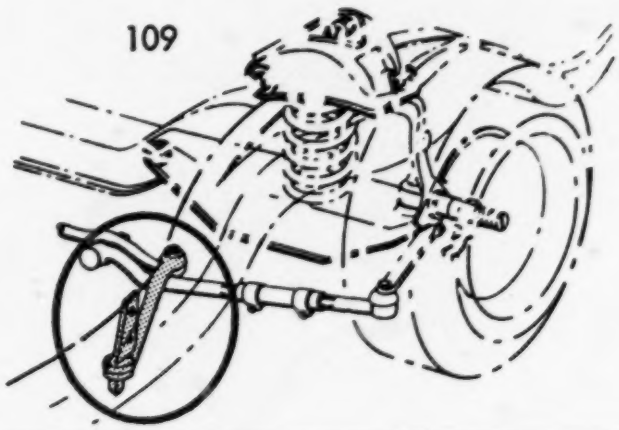

110

The idler arm is connected to the center link and to the

_____ .

18669

110

chassis

111

The idler arm does <u>not</u> help turn a car to the left or right.

The purpose of the idler arm is to reduce _____ .

18670

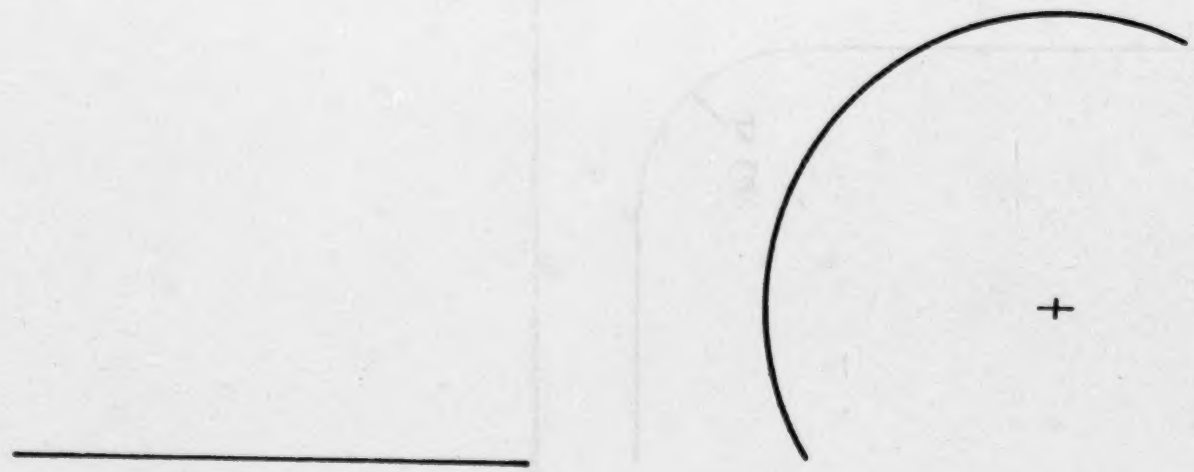

1834

DRAW A 1 INCH ARC TANGENT TO AN ARC AND A LINE
MD7 4.29 Fig. 4.29A

DRAW A 1 INCH ARC TANGENT TO AN ARC AND A LINE
MD 7 4.29 Fig. 4.29

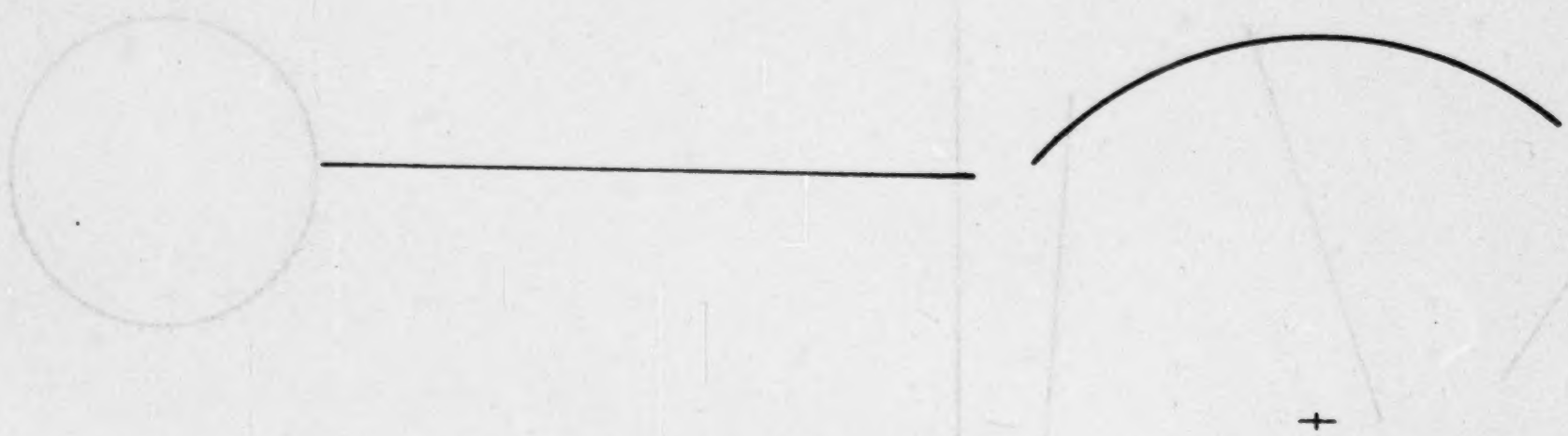

1833

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4379

111

vibration

112

One end of the idler arm is connected to the _____ .

The other end of the idler arm is connected to the _____ .

18671

112

center link

chassis

113

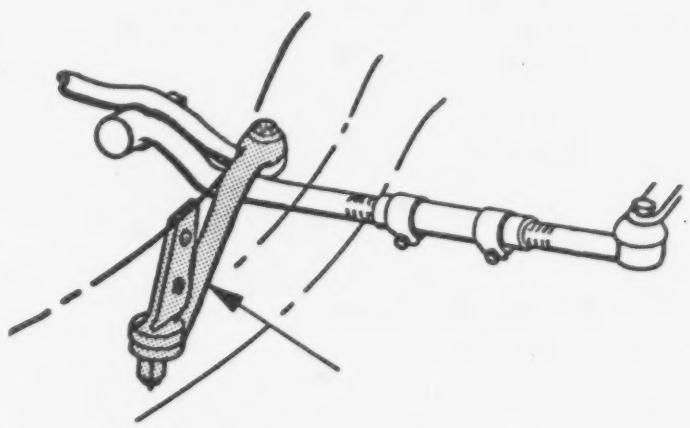

Which part is the arrow pointing to? _____

18672

113

the idler arm

114

On the diagram below, LABEL the following parts:

center link

idler arm

chassis

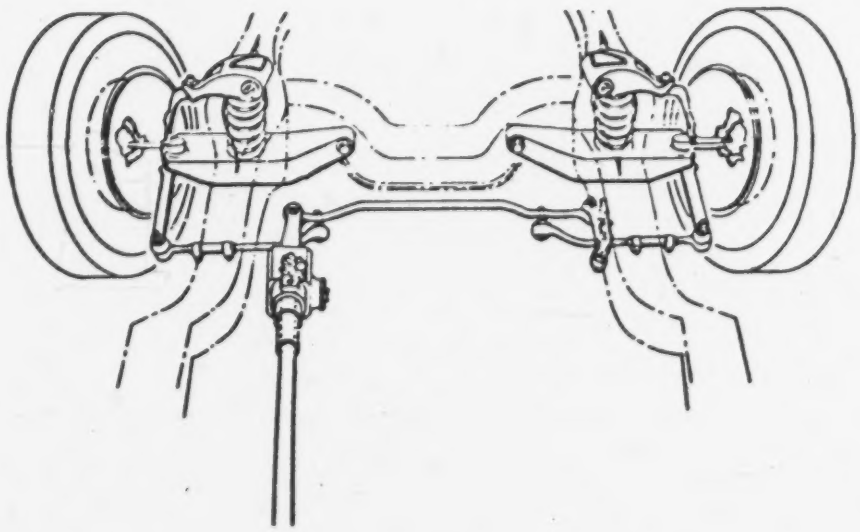

18673

114

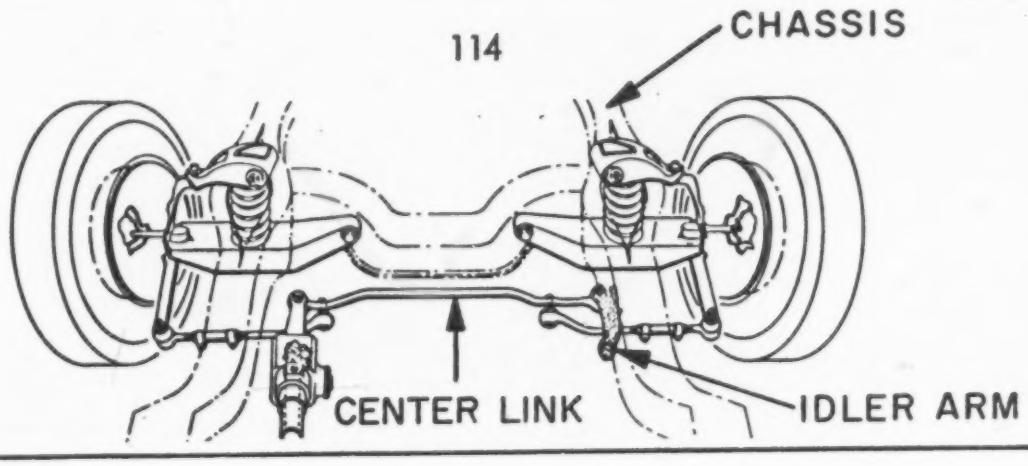

115

What does the idler arm do? _____

18674

115

reduces vibration

116

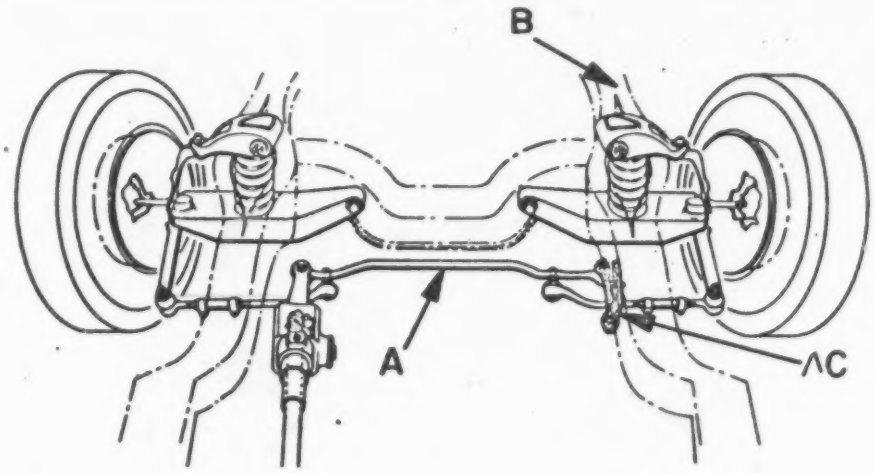

What is each arrow pointing to?

arrow A: _____

arrow B: _____

arrow C: _____

18675

116

center link

chassis

idler arm

117

What does the idler arm do? _____

18676

117

reduces vibration in the steering system

118

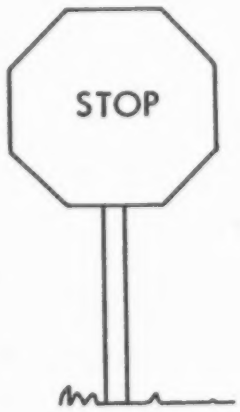

PICK UP THE PANEL BOOK

FIND PANEL 2

THEN TURN THIS PAGE AND GO ON

18677

118

NO ANSWER NEEDED

119

LOOK AT PANEL 2

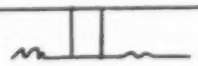

What do we call the system shown in this diagram?

_____

18678

119

the steering system

120

LOOK AT PANEL 2

LABEL the following parts in the panel drawing:

idler arm

steering wheel

tie rods

steering post

18679

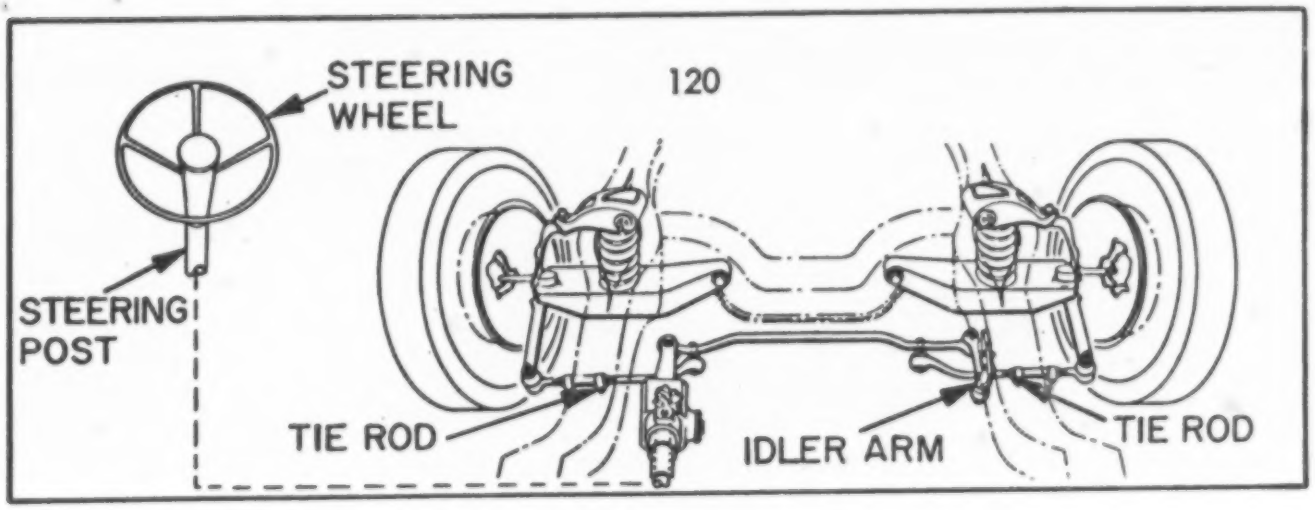

121

LOOK AT PANEL 2

LABEL the following parts in the panel drawing:

steering knuckle

steering gear assembly

front wheels

steering gear arm

center link

~~18679~~
18686

1836

Draw a reverse ogee curve MD 7 4.27 Fig 4.27
MD 6 4.19 Fig 4.28

Draw the arcs tangent to one another
MD 7 4.29 Fig 429b ,D 6 Prob. A-6

Draw exterior common tangent to two circles
MD 7 4.30 Fig. 4.30

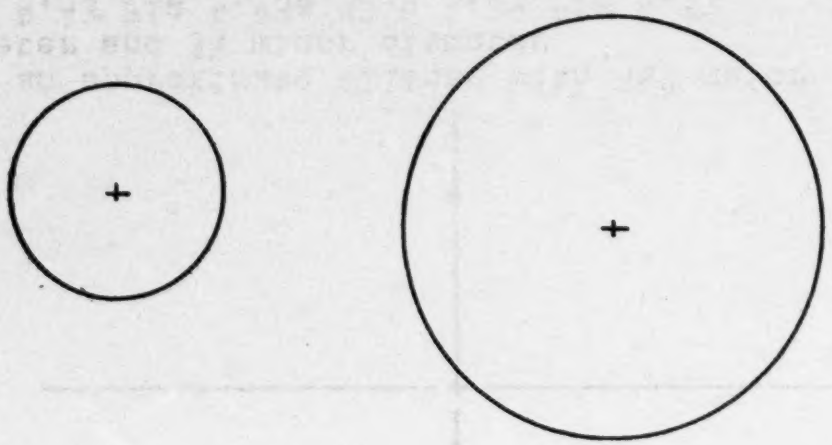

Draw an interior common tangent to the two circles
MD 7 4.31 Fig 4.31

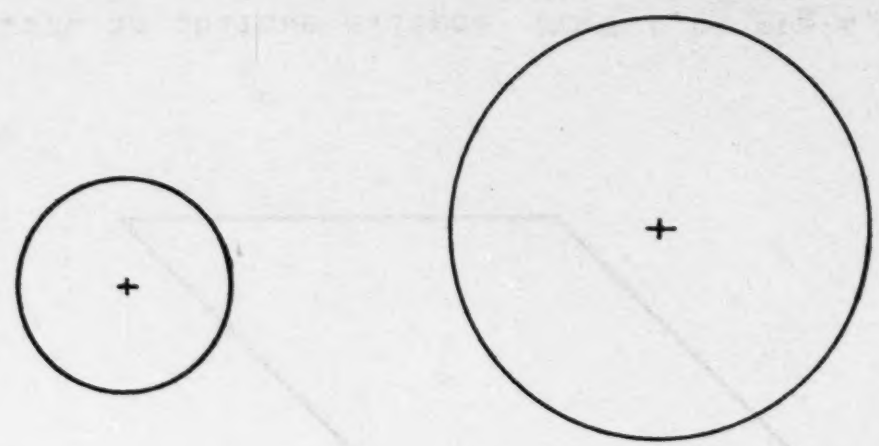

1835

4380

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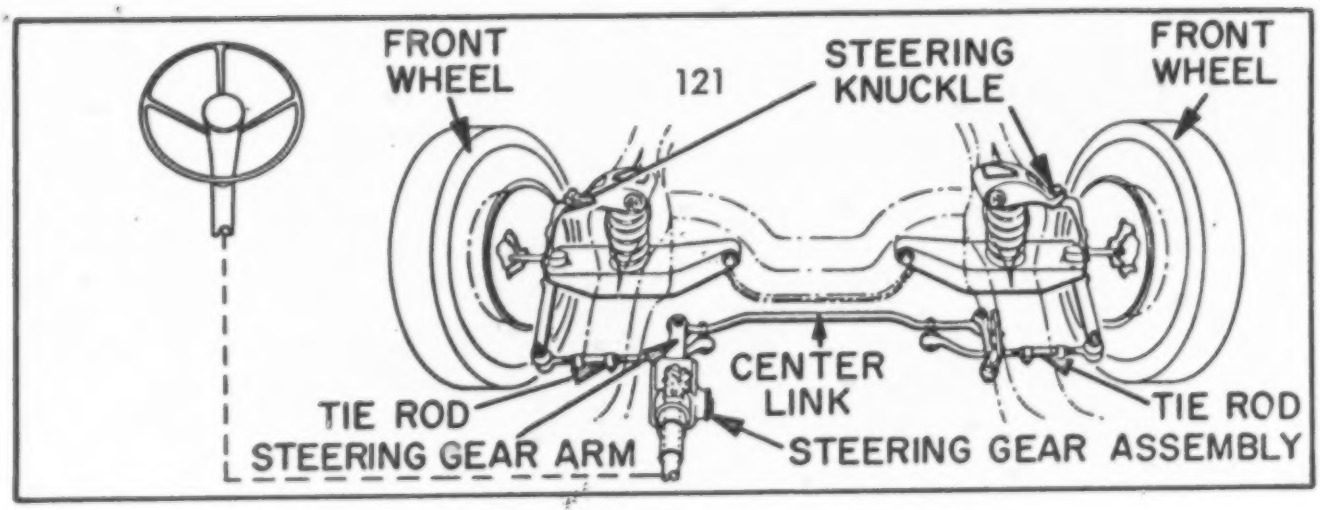

122

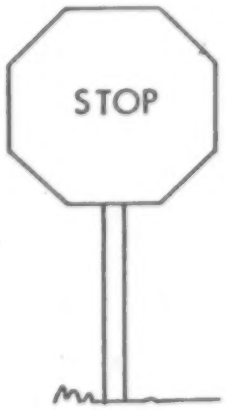

PICK UP THE PANEL BOOK

FIND PANEL 3

THEN TURN THIS PAGE AND GO ON

18681

122

NO ANSWER NEEDED

123

LOOK AT PANEL 3

In the blanks below WRITE the names of the parts that are labeled with the following letters in the panel drawing:

A: _____

B: _____

C: _____

D: _____

18682

264 OF 327

ED

056 238

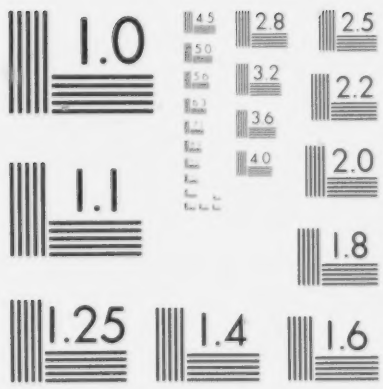

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

123

front wheels

tie rods

center link

steering gear arm

124

LOOK AT PANEL 3

NAME the parts that are labeled with the following letters in the panel drawing:

E: _____

F: _____

G: _____

H: _____

I: _____

264

18683

124

idler arm

steering post

steering wheel

steering knuckles

steering gear assembly

125

DESCRIBE what the following parts do:

steering knuckles _____

idler arm _____

center link _____

18684

125

push the front wheels and make them turn the car to the left or right.

cuts down or reduces vibration in the steering system

pushes or moves the tie rods to the left or right

126

DESCRIBE what the following parts do:

tie rods _____

steering wheel _____

steering column _____

18685

126

push or turn the steering knuckles to the left or right

turns the steering column in the steering post

turns the steering gear assembly

127

Two other parts of the steering system are listed below. What does each of them do?

steering gear assembly _____

steering gear arm _____

18686

127

builds up the force of the steering wheel

is moved or pushed by the steering gear assembly and moves or pushes the center link to the left or right

128

THIS IS THE END OF BOOK 11

18687

Book 11 POST TEST 1

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

NAME the part of the steering system that is mounted on a steering knuckle: _____ _____

2

What moves the steering knuckle? _____ _____

3

The steering gear arm gives power to the _____ _____.

4

Which part of the steering system reduces vibration? _____ _____

18688

5

The part that lets the drive shaft slide in the transmission gear assembly is called the _____ _____.

6

The parts at the ends of the drive shaft that let the drive shaft move up and down are called _____.

7

The differential assembly is connected to the rear axles and to the _____ _____.

8

Which part of the power transmission assembly is between the engine and the transmission gear assembly? _____

18689

1832

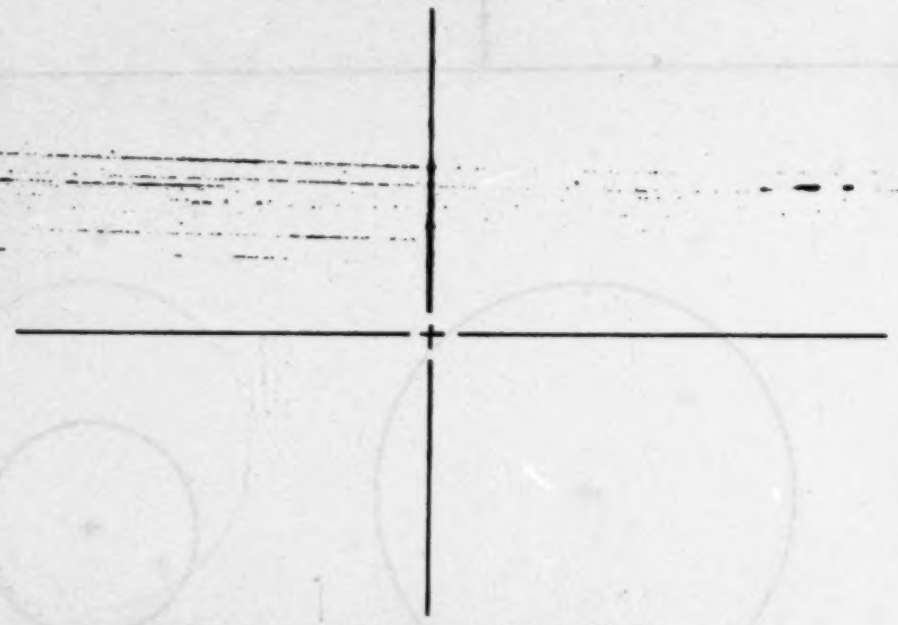

Draw an approximate ellipse with 4½" major diameter and 3¼ minor diameter
MD 7 4.43 Fig 4.43a MD 6 4.29 Fig 4.39

Draw an oblique ellipse MD 7 4.43 Fig 4.43c
,D 6 ;4/6 Fig 14.8

Draw an isometric ellipse MD 7 4.43 Fig 4.43c
MD 6 14.6 Fig 14.8

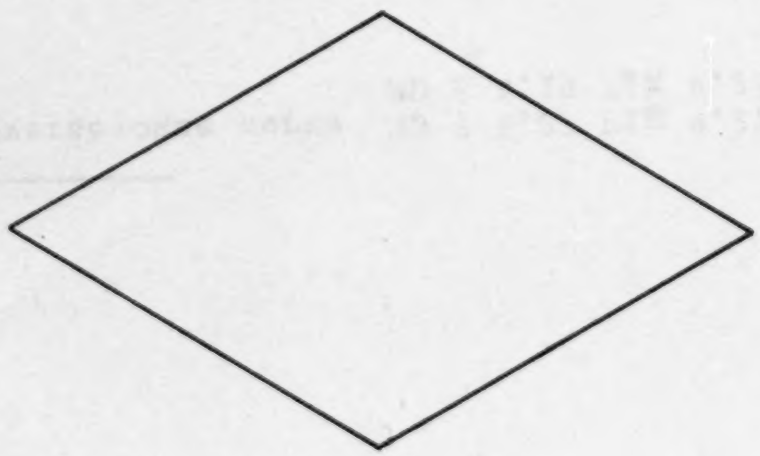

Draw an ellipse on the face of each surface of the cube MD 7 14.7 Fig 14.7a
,D 6 ;4/6 Fig 14.8

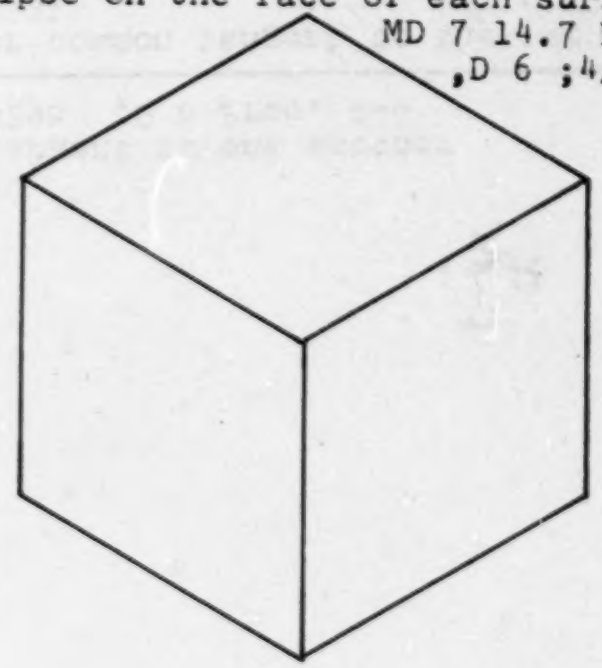

1836

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PANEL BOOK **11**

To Be Used With
BOOK 11

AUTO MECHANICS COURSE

PANEL BOOK 11: THE STEERING SYSTEM

A BASIC SYSTEMS PROGRAM

18690

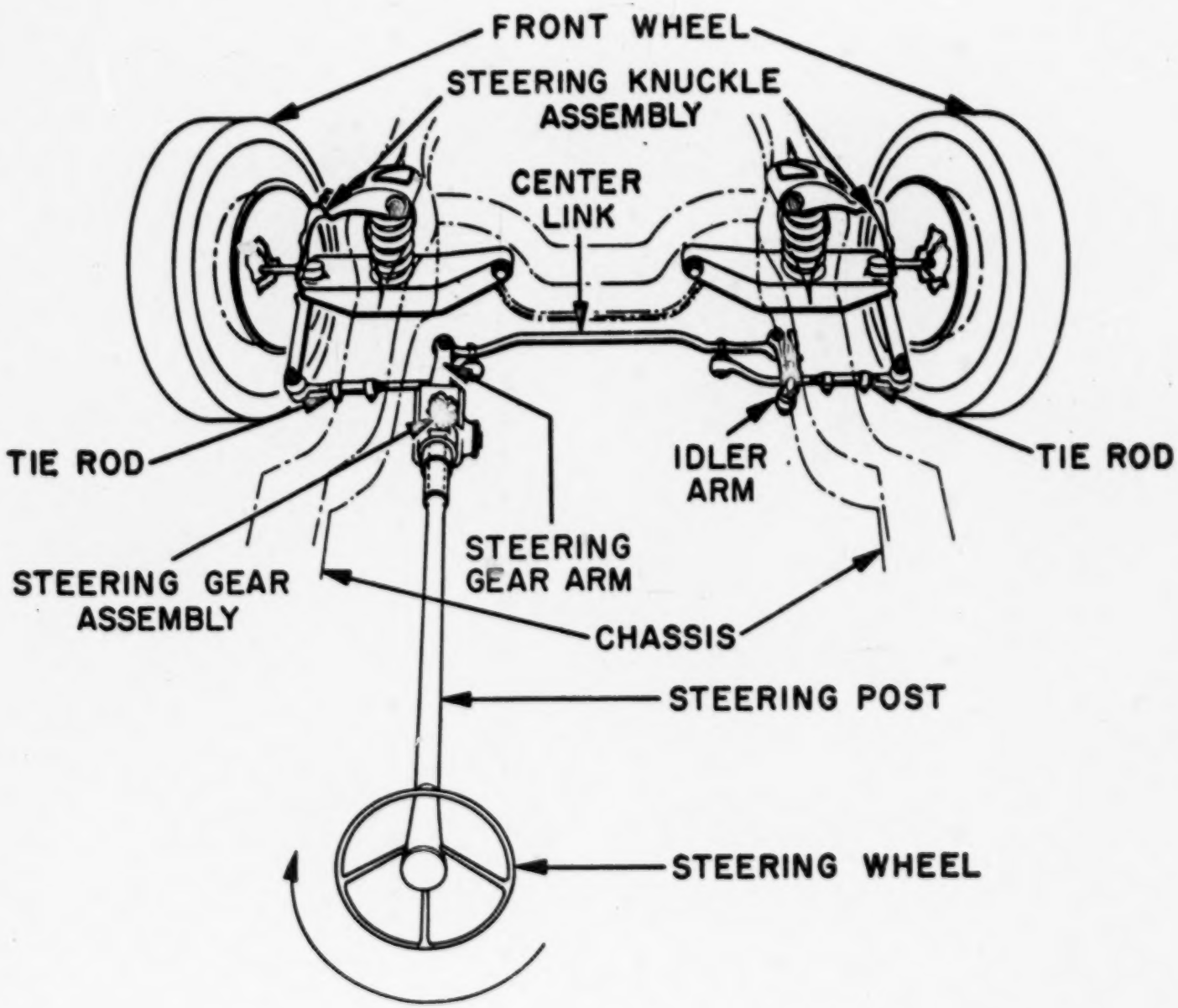

PANEL 1

16981

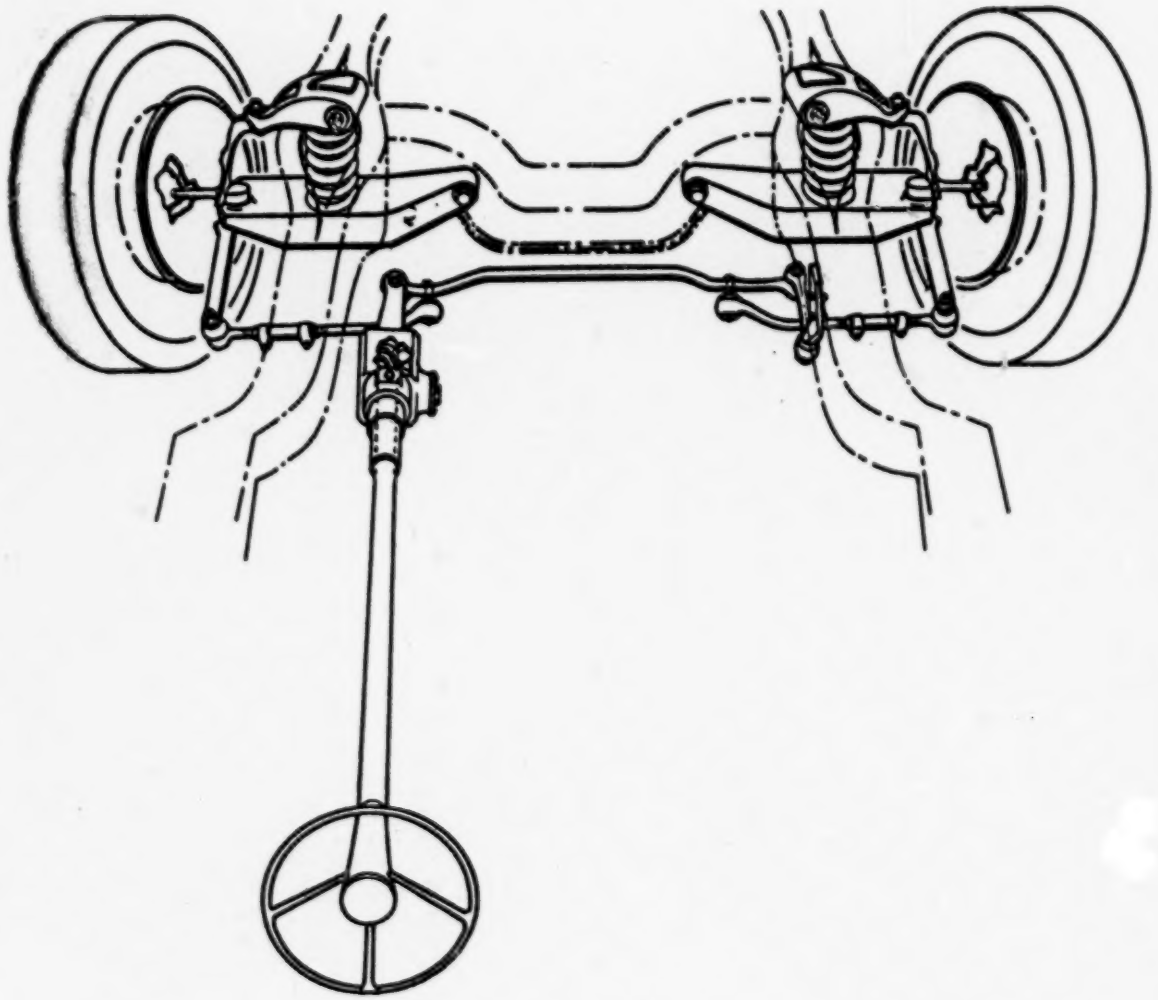

PANEL 2

18692

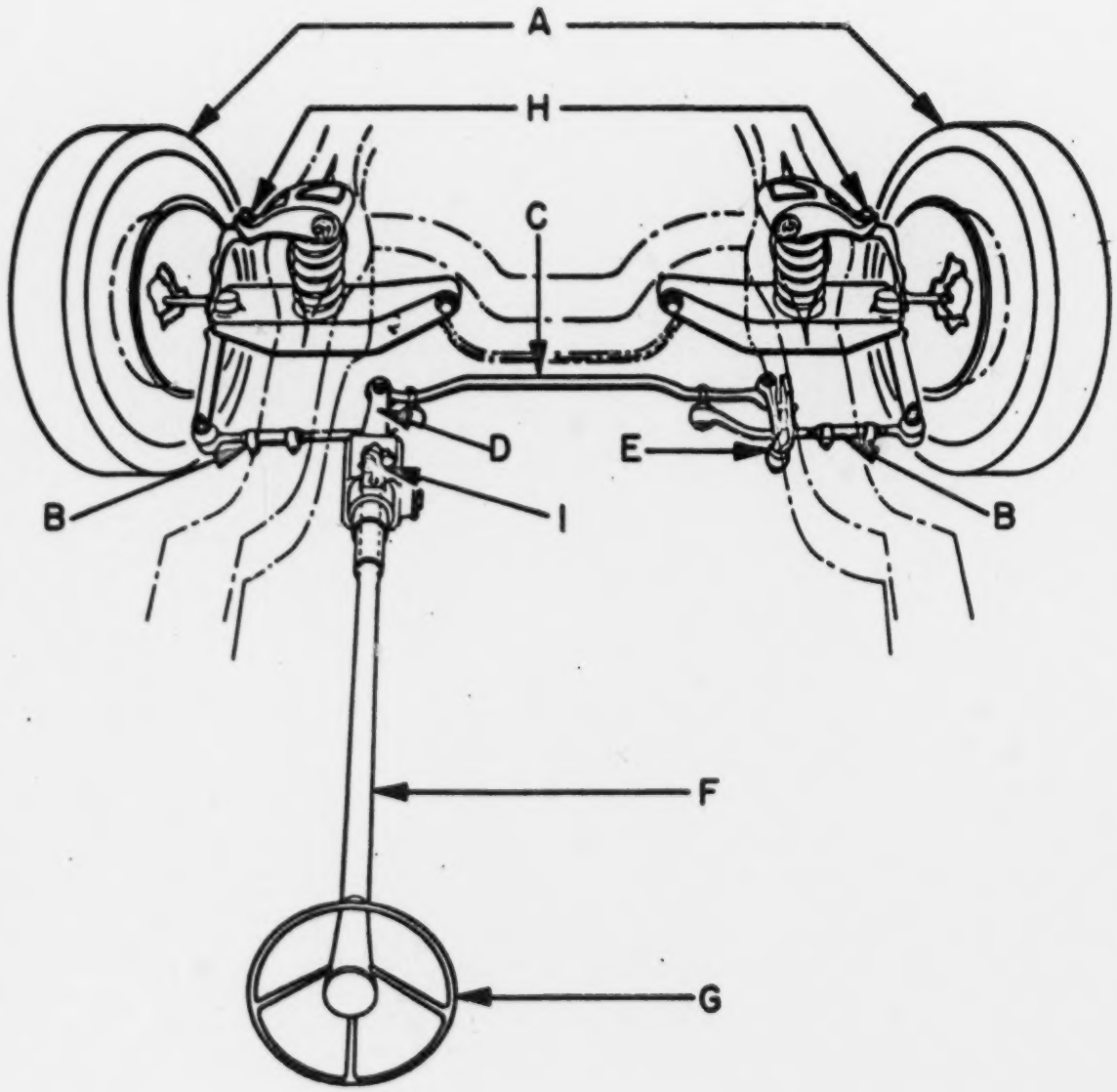

PANEL 3

18693

VT 013 134
Auto Mechanics Course. Book 12: Front End Geometry.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 107p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; MECHANICS (PROCESS); *MOTOR VEHICLES
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on front end geometry was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

18694

VT 013 134

ED0 56238

BOOK 12

(C1)

AUTO MECHANICS COURSE

BOOK 12: FRONT END GEOMETRY

A BASIC SYSTEMS PROGRAM

VT013134

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Curriculum Report Reference
Page 14

Task Analysis Reference
32.1, 32.2, 32.3, 32.4

18695

AUTO MECHANICS COURSE

BOOK 12: FRONT END GEOMETRY

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

1

A front end that needs to be aligned can make tires:

- ☐ wear fast
- ☐ wear evenly
- ☐ wear slowly
- ☐ wear evenly

2

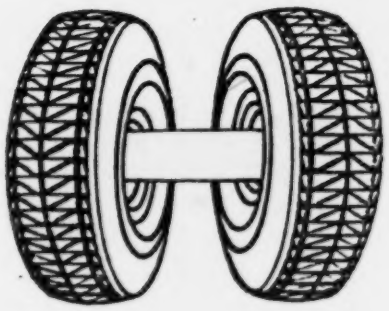

These wheels are:

- ☐ toed-in
- ☐ toed-out

3

Front wheel's camber is changed by tilting the:

- ☐ top of the front wheel to the inside or outside of the car
- ☐ front of the wheels closer together or farther apart
- ☐ top of the front wheels to the front or back of the car

18697

4

Caster adjustments are made by tilting the:

- ☐ top of the front wheel to the inside or outside of the car
- ☐ fronts of the wheels closer together or farther apart
- ☐ tops of the front wheels to the front or back of the car

5

Toe-in is changed to toe-out by tilting the: (CHECK TWO)

- ☐ fronts of the wheels closer together
- ☐ fronts of the wheels further apart
- ☐ tops of the wheels to the outside of the car
- ☐ tops of the wheels to the inside of the car

6

Which of the following pictures show wheels that have positive camber?

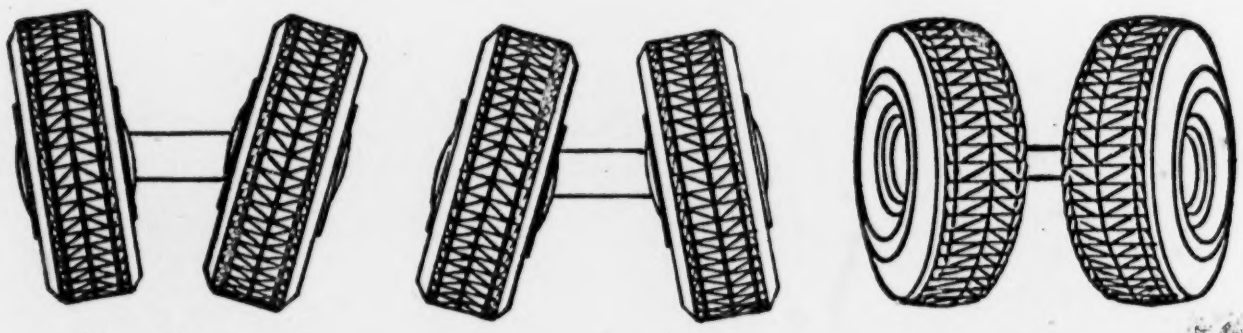

A B C

18698

7

Which of the following pictures shows a wheel that has negative caster?

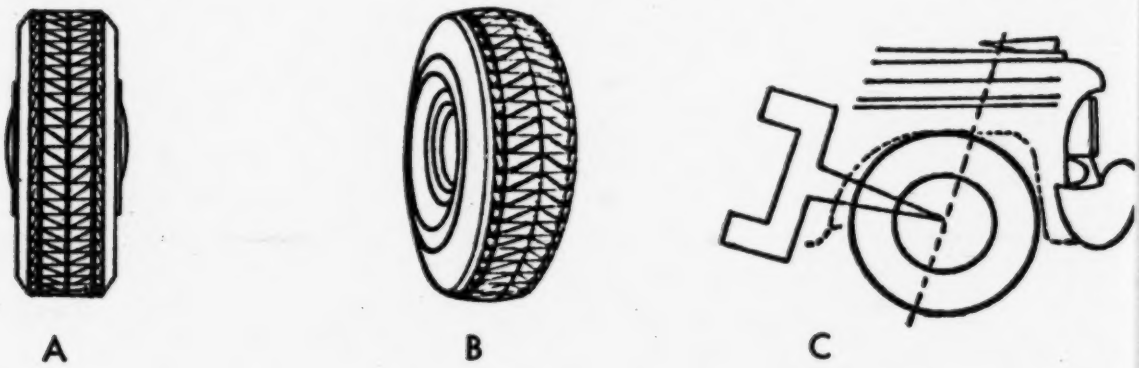

8

To give front wheels positive camber, you should tilt them to look like which of the following sets of wheels?

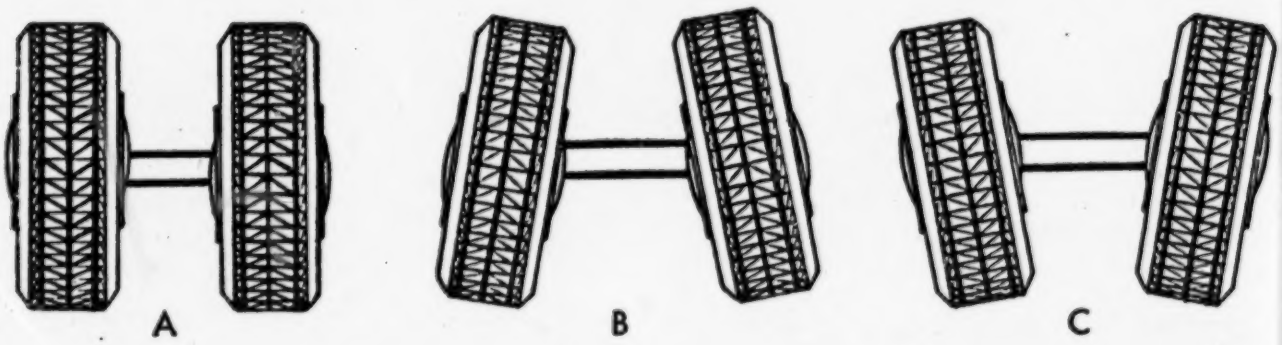

9

Cars that are not correctly aligned will:

- ☐ make steering easy
- ☐ make steering hard
- ☐ make the car go straight
- ☐ make the car pull to one side of the road

18699

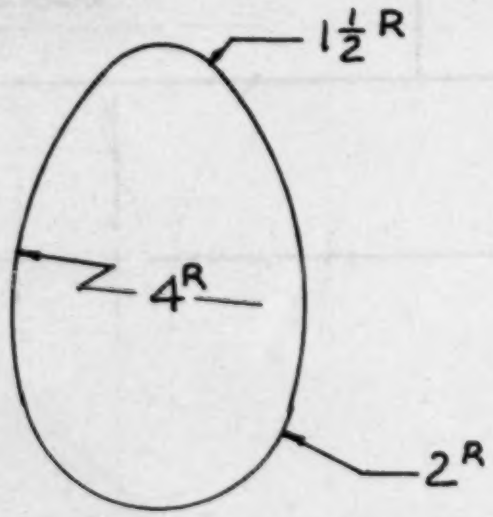

Draw the tangent arcs to complete the figure as shown in the left top corner. MD 7 4.28 Fig. 4.28c

DR. BY		SCALE	NO. G-8
		DATE / /	PER.

1837
1838
4382

Name _____

Date _____

Starting time _____

Finishing time _____

18700

1

BOOK 11 told you about the steering system.

This program will teach you about different adjustments made to the front end.

This program also teaches why adjustments are needed.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

18701

1

NO ANSWER NEEDED

2

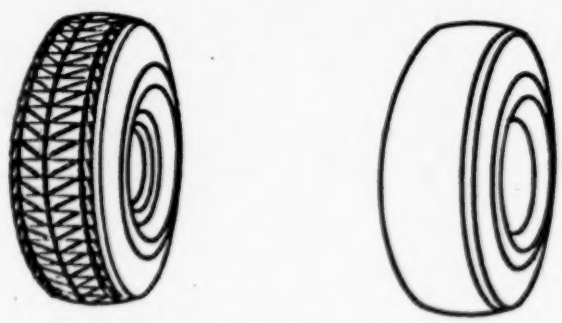

A B

Which picture shows a tire with the threads worn off?

- ☐ picture A
- ☐ picture B

18702

2

picture B

3

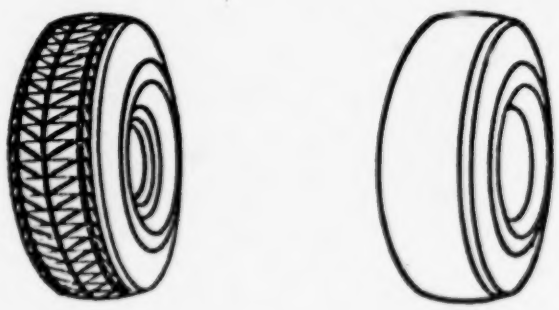

A B

When all the treads are worn off, the tire should be replaced.

Which tire can still be used?

- ☐ tire A
- ☐ tire B

18703

3

tire A

4

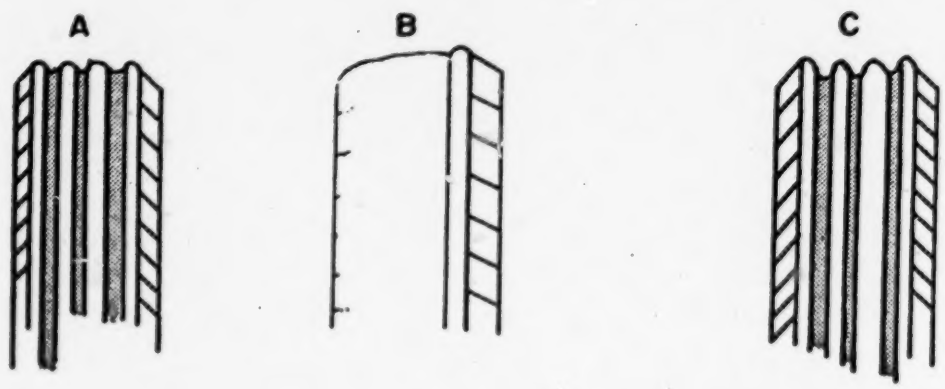

GOOD front ends wear treads evenly.

Which tire comes from a car with a BAD front end.

- ☐ tire A
- ☐ tire B
- ☐ tire C

18704

4

tire B

5

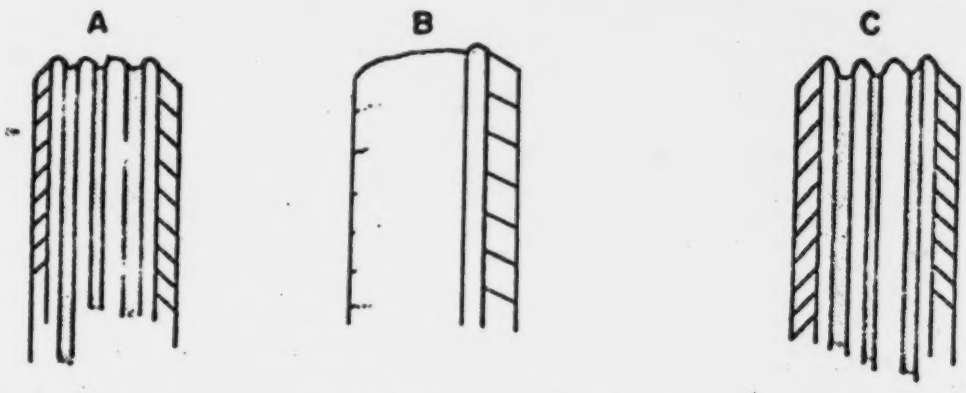

Front ends that are correctly adjusted will make tires wear evenly.

Which tire comes from a car with a front end that is not correctly adjusted?

- ☐ tire A
- ☐ tire B
- ☐ tire C

18705

5

tire B

6

These tires have:

- ☐ no wear
- ☐ even wear
- ☐ uneven wear

18706

6

uneven wear

7

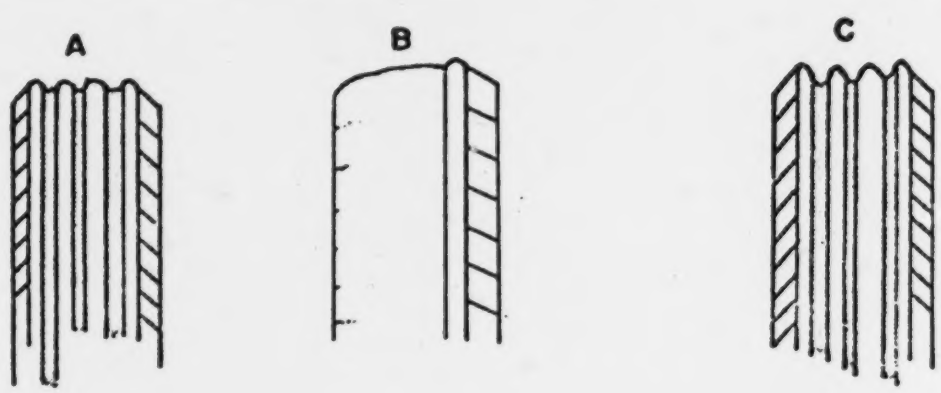

Tires that wear evenly last longer than tires that wear unevenly.

Which tire will not last very long?

- ☐ tire A
- ☐ tire B
- ☐ tire C

18707

7

tire B

8

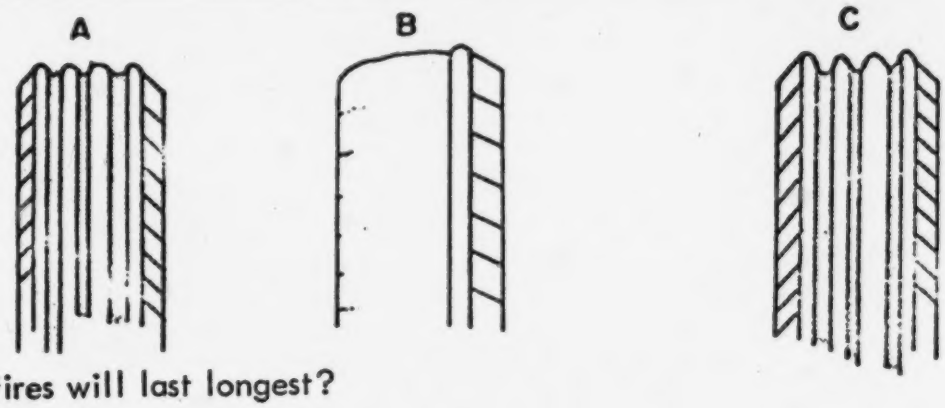

Which tires will last longest?

- ☐ tire A
- ☐ tire B
- ☐ tire C

Which tire comes from a car with a bad front end?

- ☐ tire A
- ☐ tire B
- ☐ tire C

18708

8

tire A

tire C

tire B

9

A front end that needs adjusting will make tires:

- ☐ wear evenly
- ☐ wear out faster
- ☐ wear out slower
- ☐ wear out unevenly

18709

COMPLETE THIS DRAWING
SCALE FULL

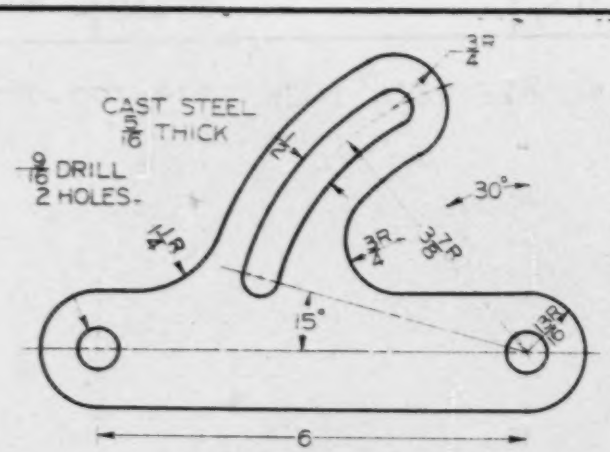

Conveyor Link.

NAME OF SCHOOL

Drawn by:

Date:

G-9
PER

4383

1836

1836

9

wear out faster

wear out unevenly

10

To repair a car that makes front tires wear out quickly and unevenly., you must:

- ☐ adjust the front end
- ☐ adjust the rear end
- ☐ remove the front end
- ☐ remove the rear end

18710

10

adjust the front end

11

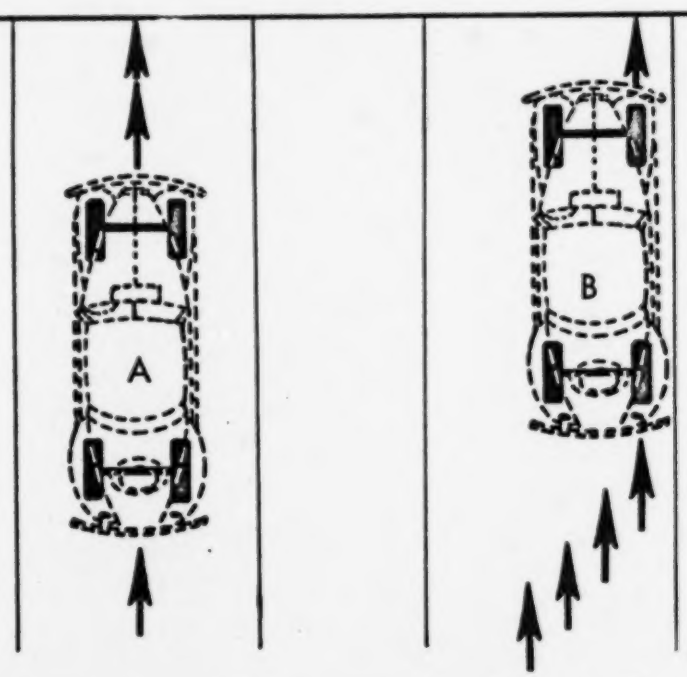

When the front end of a car is not properly adjusted, the car will be hard to steer and will pull to one side.

Which car has a correctly adjusted front end?

- ☐ car A
- ☐ car B

18711

11

car A

12

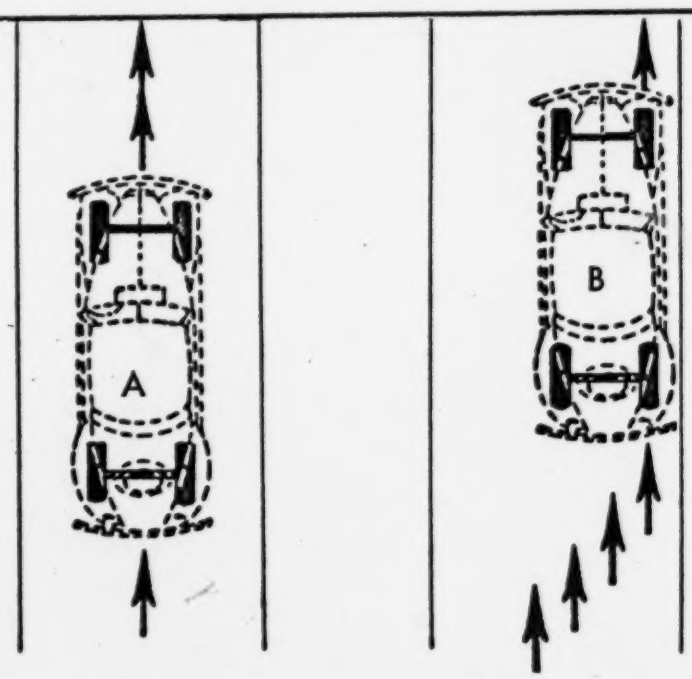

A car may pull to one side or be hard to steer for the same reason that will cause:

- ☐ even tire wear
- ☐ uneven tire wear
- ☐ wasted tire wear

12

uneven tire wear

13

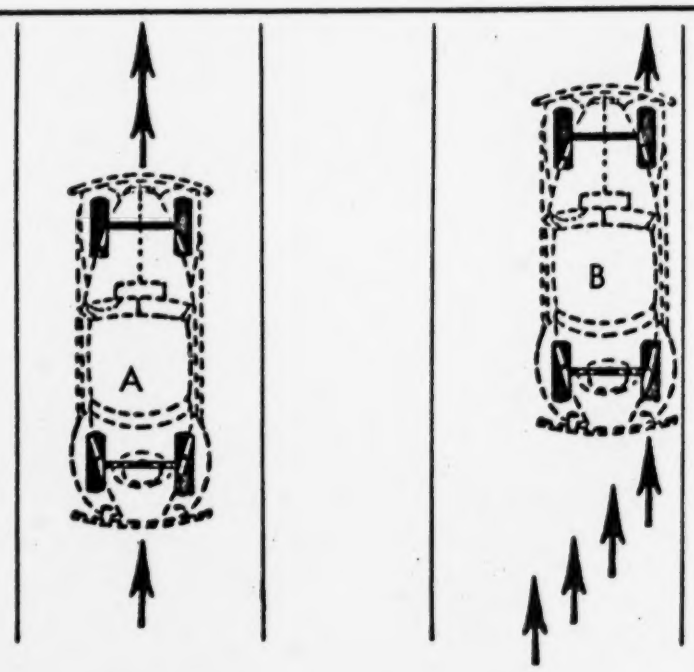

Car B is pulling to one side because the front end:

- ☐ is correctly adjusted
- ☐ has no adjustment
- ☐ is not correctly adjusted

18713

13

is not correctly adjusted

14

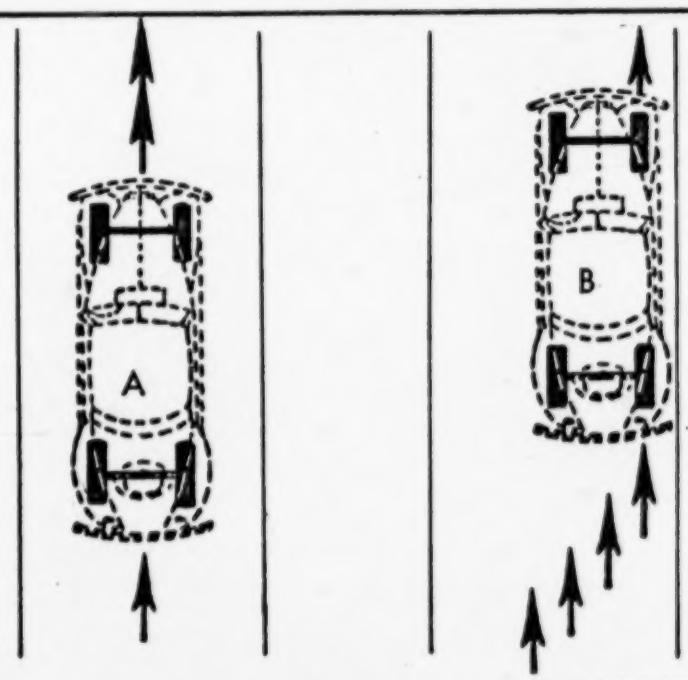

Adjustments made to the front end of a car are called FRONT END ALIGNMENT.

Which car needs a front end alignment?

- ☐ car A
- ☐ car B

18714

14

car B

15

Adjustments made to the front end are called:

- ☐ alignments
- ☐ alliances
- ☐ changes

18715

15

alignments

16

What causes tires to wear unevenly?

- ☐ correct alignment
- ☐ no alignment
- ☐ poor alignment

18716

16

poor alignment

17

A car's front end is not correctly aligned.

What will happen to the car? (CHECK TWO)

- ☐ The tires will wear evenly.
- ☐ The tires will wear fast.
- ☐ The tires will wear slowly.
- ☐ The tires will wear unevenly.

18717

18

make it go straight

make steering easy

19

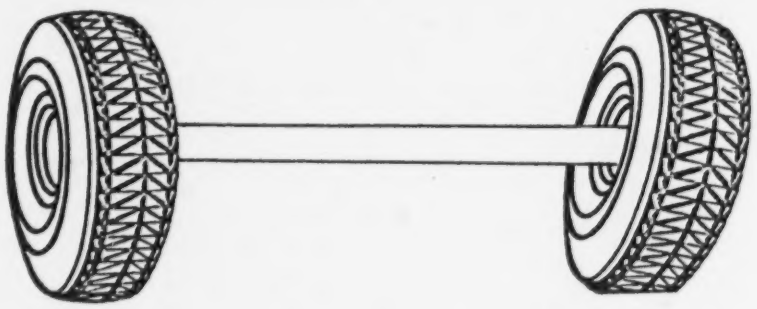

A B

Which front tire is tilted to one side?

- ☐ tire A
- ☐ tire B

Which tire will probably wear evenly?

- ☐ tire A
- ☐ tire B

18719

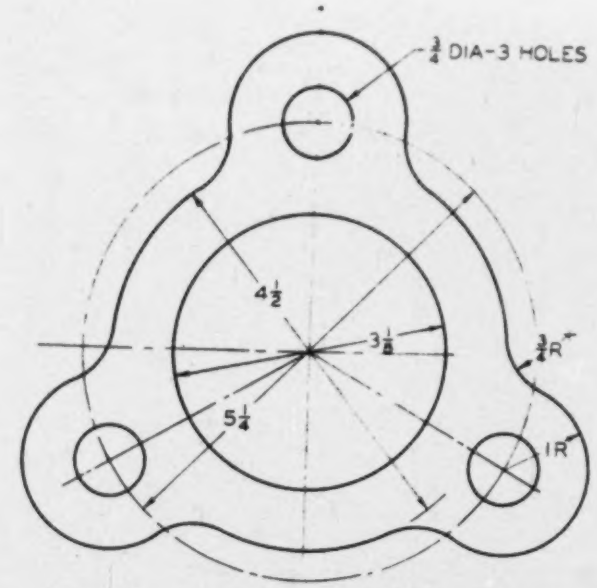

Draw the view of the gasket. Scale: full size. Show construction with light, thin lines.

DR.BY.		SCALE DATE / /	G-10 PER

1839
4384

19

tire B

tire A

20

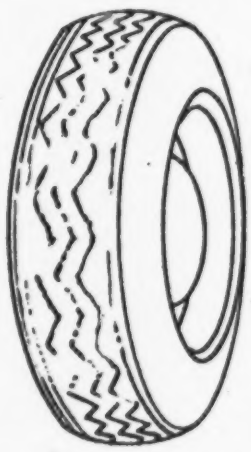

This tire has worn:

- ☐ evenly
- ☐ not at all
- ☐ unevenly

Was the alignment correct?

- ☐ yes
- ☐ no

18720

20

unevenly

no

21

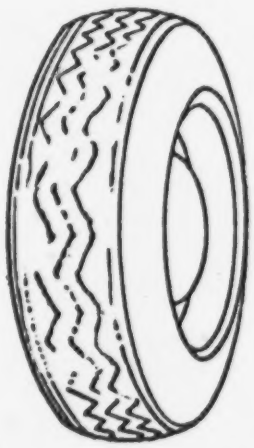

This tire comes from a car that has a:

- ☐ correctly aligned front end
- ☐ poorly aligned front end
- ☐ unaligned front end

18721

21

poorly aligned front end

22

DRAW an arrow pointing to the part of the tire that shows that it comes from a car with a poorly aligned front end:

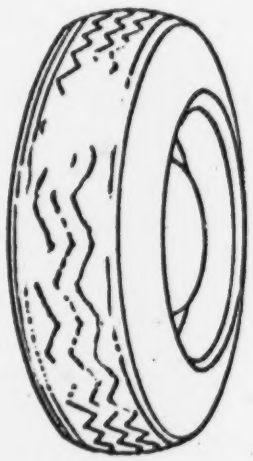

18722

22

23

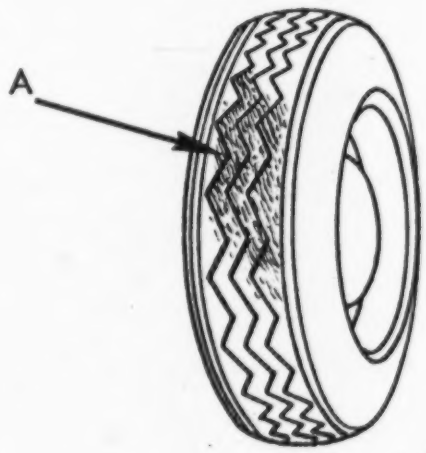

To correct a car that does this (see arrow A above) to the tires, you should:

- ☐ adjust the brake system
- ☐ align the front end
- ☐ avoid all changes in the front end

18723

23

align the front end

24

Alignment means:

- ☐ adjusting the front end
- ☐ leaving the front end alone
- ☐ looking over the front end

18724

24

adjusting the front end

25

Aside from wearing tires unevenly, what else does a poorly aligned front end do?

- ☐ makes the car go straight
- ☐ makes the car pull to one side
- ☐ makes steering easy
- ☐ makes steering hard

18725

25

makes the car pull to one side

makes steering hard

26

A

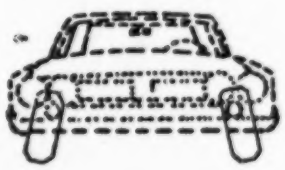

B

Which car will be hard to steer?

- ☐ car A
- ☐ car B

Which car will wear tires unevenly?

- ☐ car A
- ☐ car B

18726

26

car B

car B

27

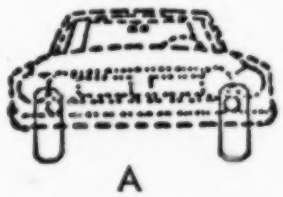

A

B

Which car did the tire come from?

- ☐ car A
- ☐ car B

18727

27

car B

28

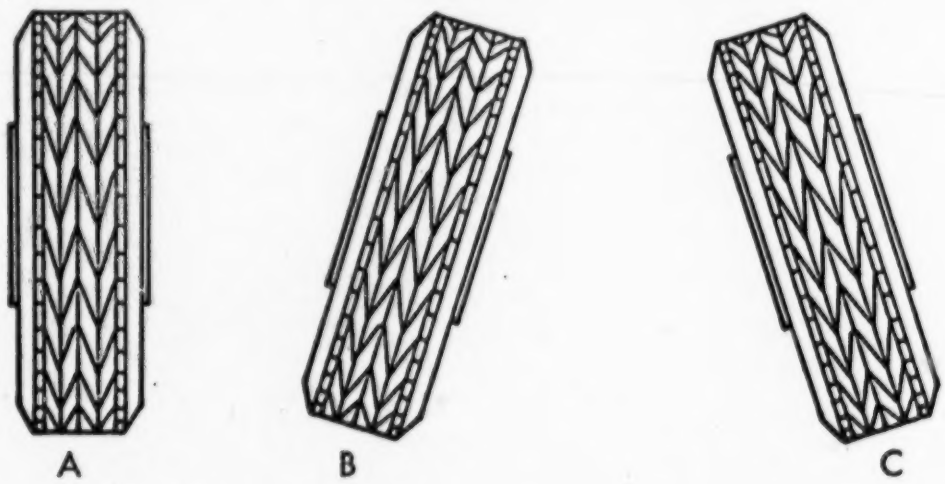

Which tires will wear out faster?

- ☐ tire A
- ☐ tire B
- ☐ tire C

This can be corrected by_____.

18728

28

tire B

tire C

alignment

29

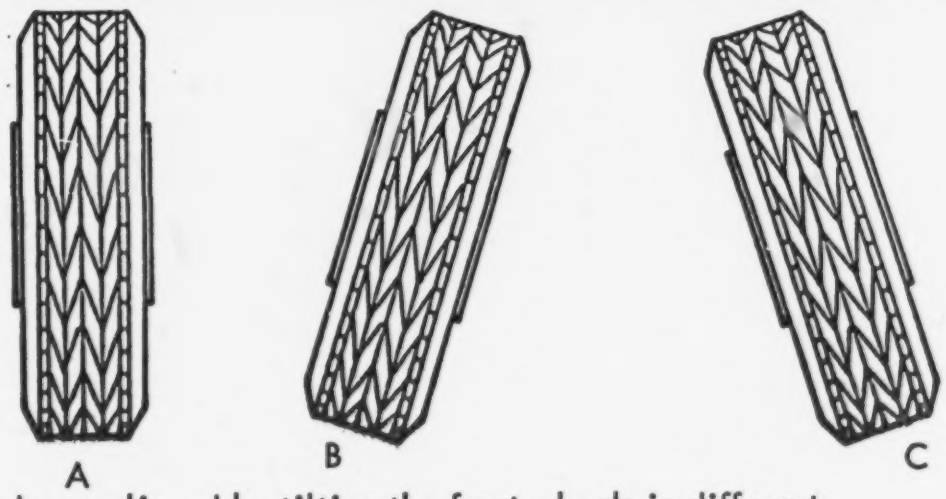

Front ends are aligned by tilting the front wheels in different ways.

Which wheels should be tilted to get good alignment?

- ☐ wheel A
- ☐ wheel B
- ☐ wheel C

18729

PLATE G- 11 Cushioning Base

MD 6 Prob. A.11 P. 368

MD 7 Prob. 2.12 P. 406

1. Follow the instructions in the text.
2. The order of drawing the lines is very important.
3. Use standard plate layout.
4. Locate all tangent points.
5. Leave all construction lines.

YOU HAVE HAD ALL THE CONSTRUCTIONS NECESSARY TO COMPLETE THIS PLATE.

Check with the overlay when finished then call the instructor.

29

wheel B

wheel C

30

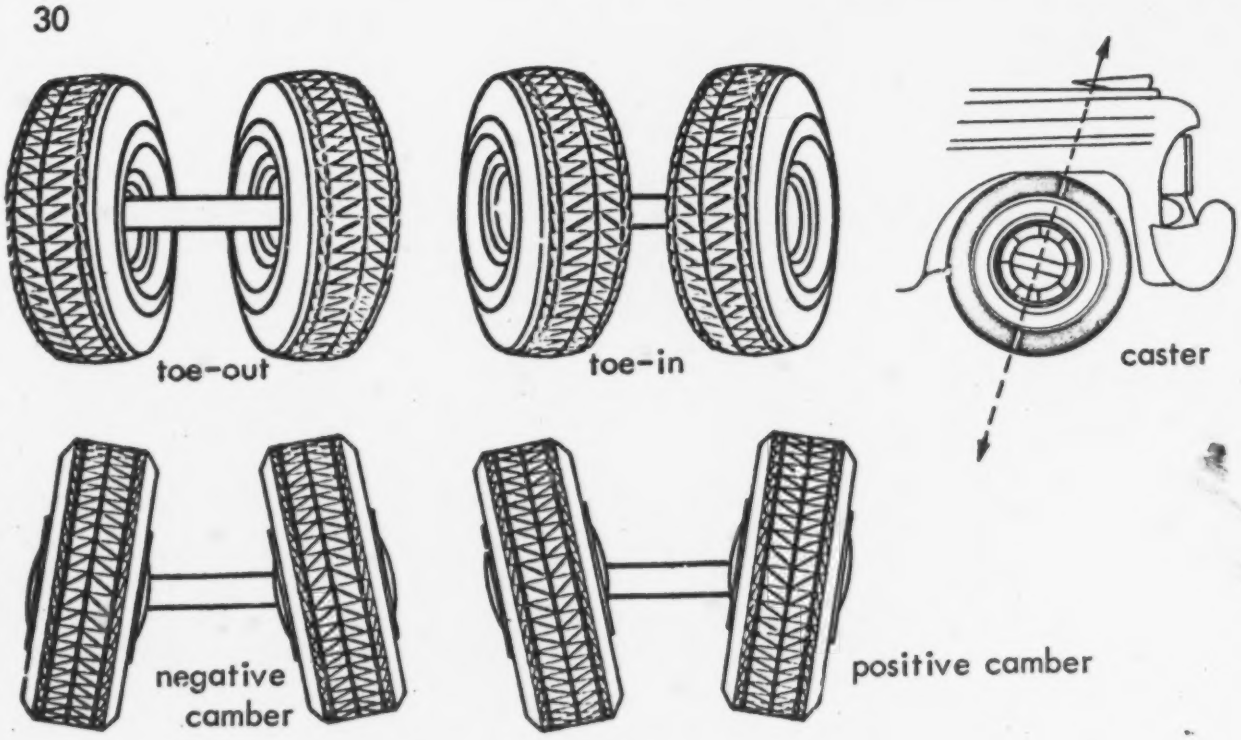

The pictures show the different ways in which front wheels can be tilted to get correct alignment.

How many different kinds of alignments are shown? _____

18730

30

5

31

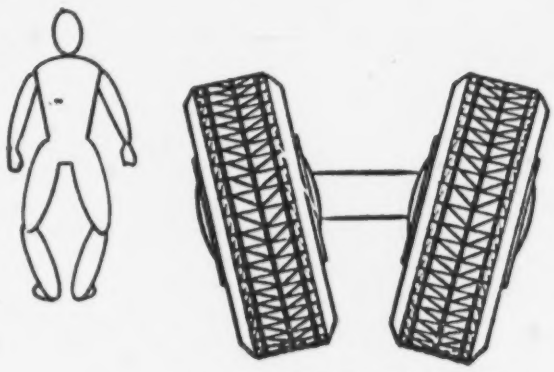

POSITIVE CAMBER

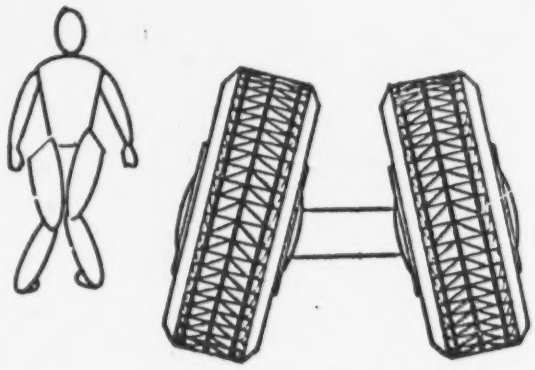

NEGATIVE CAMBER

Front wheels with positive camber look like a person who is:

- ☐ bowlegged
- ☐ knock-kneed

The tops of the wheels are tilted:

- ☐ inward
- ☐ outward

18731

31

bowlegged

outward

32

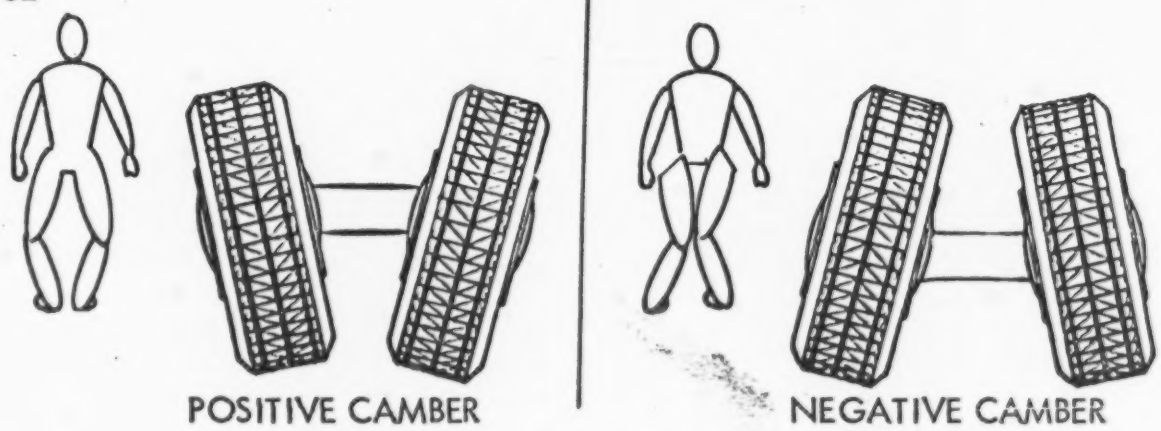

When the tops of the front wheels are tilted outward, the wheels have:

- ☐ positive camber
- ☐ negative camber

18732

32

positive camber

33

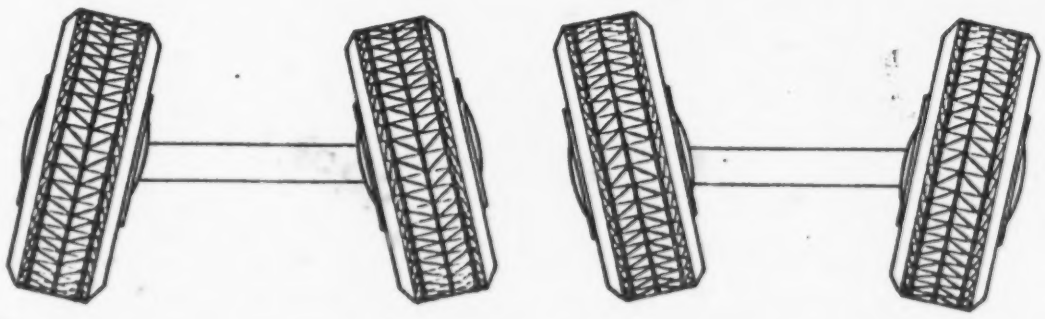

In order to change the camber of front wheels, you should:

- ☐ lower or raise the front wheels
- ☐ tilt the tops of the front wheels in or out
- ☐ turn the front wheels to the front or rear

18733

33

tilt the tops of the front wheels in or out

34

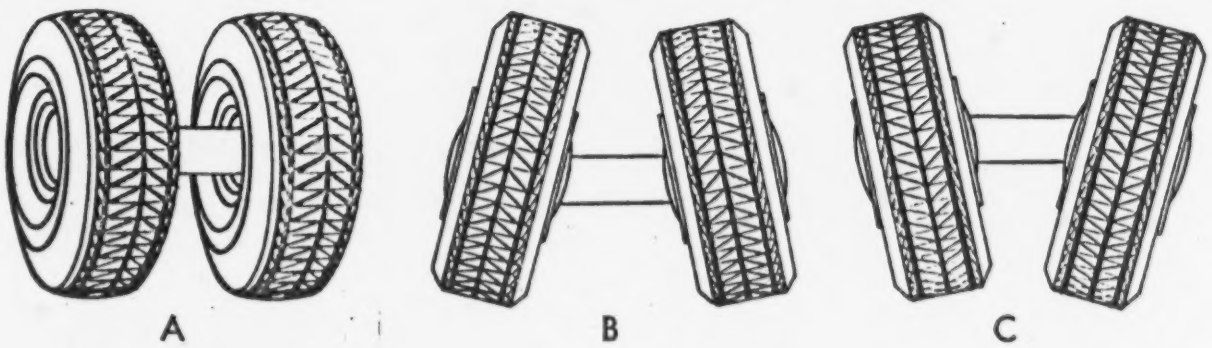

Front wheels that do not have positive camber or negative camber have ZERO camber.

Which picture shows wheels that have zero camber?

- ☐ picture A
- ☐ picture B
- ☐ picture C

18734

34

picture A

35

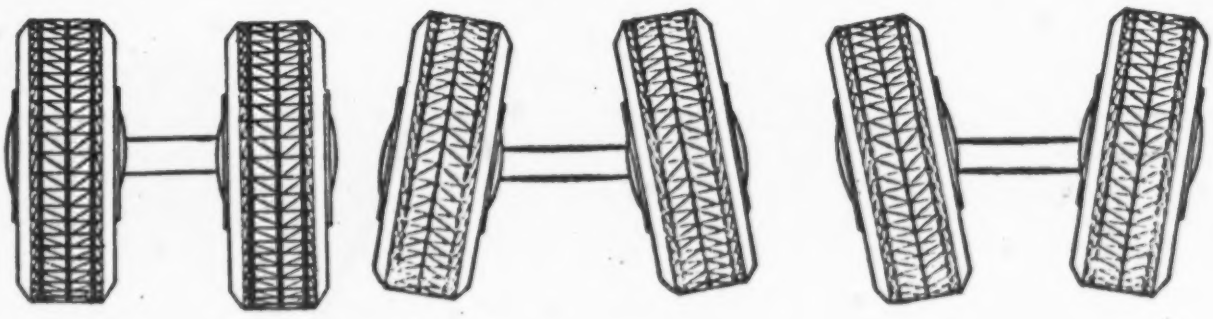

To change wheels with zero camber to positive camber, you should:

- ☐ tilt the tops of the front wheels outward
- ☐ tilt the tops of the front wheels inward
- ☐ reverse the wheels to the rear of the car

18735

35

tilt the tops of the front wheels outward

36

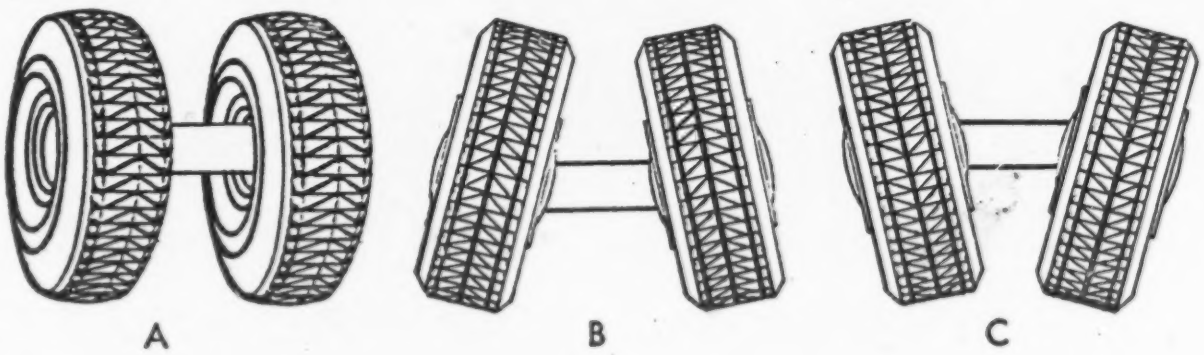

Which wheels have negative camber?

- ☐ wheels A
- ☐ wheels B
- ☐ wheels C

This is because the wheels are tilted:

- ☐ inward
- ☐ outward
- ☐ straight up and down

18736

36

wheels C

inward

37

When the tops of the front wheels are closer together than the bottoms of the wheels, we say that the wheels have:

- ☐ negative camber
- ☐ positive camber
- ☐ zero camber

18737

37

negative camber

38

When wheels have positive camber, the:

- ☐ tops of the wheels are closer together
- ☐ tops of the wheels are farther apart
- ☐ wheels are straight up and down

18738

38

tops of the wheels are farther apart

39

When wheels have zero camber the:

- ☐ wheels are straight up and down
- ☐ tops of the wheels are closer together than the bottoms of the wheels
- ☐ tops of the wheels are farther apart than the bottoms of the wheels

18739

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1. French and Svendsen, Mechanical Drawing, Webster - McGraw-Hill, Sixth Edition

2. French and Svendsen, Mechanical Drawing, Webster - McGraw-Hill, Seventh Edition

3. Spencer, Henry, Basic Technical Drawing, Macmillan Company

39

wheels are straight up and down

40

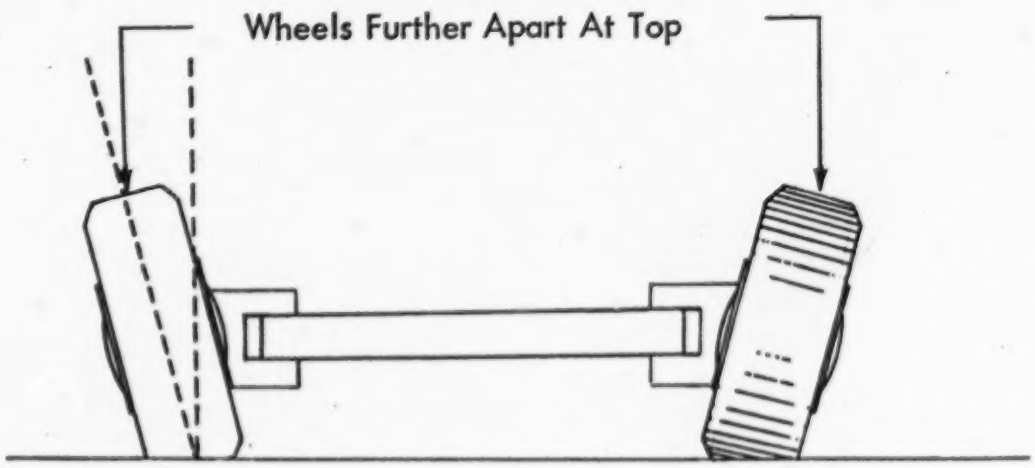

These front wheels have:

- ☐ positive camber
- ☐ negative camber
- ☐ zero camber

18740

40

positive camber

41

For a mechanic to make camber adjustments, he should:

- ☐ tilt the tops of the front wheels in or out
- ☐ twist the tops of the front wheels back or forth
- ☐ turn the wheels around to the rear of the car

18741

41

tilt the tops of the front wheels in or out

42

MATCH the following:

A.

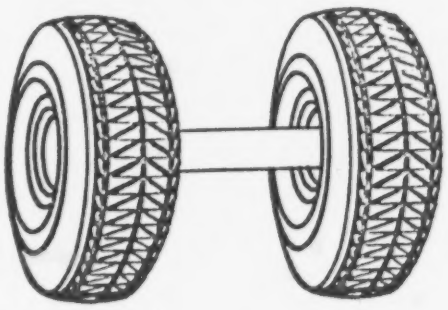

1. _____ positive camber

2. _____ negative camber

3. _____ zero camber

B.

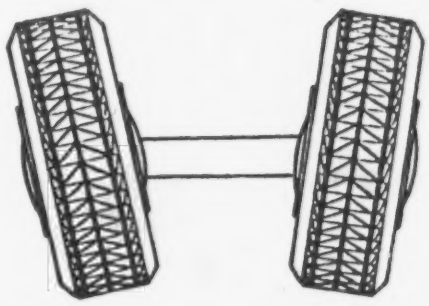

C.

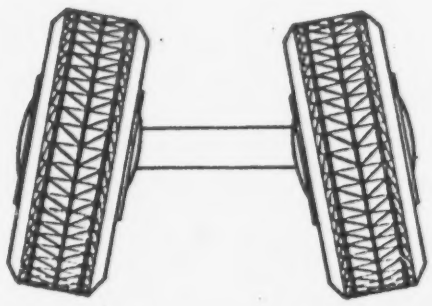

18742

42

1. B

2. C

3. A

43

Adjustments made to a front end are called:

- ☐ abatement
- ☐ advancement
- ☐ alignment

18743

43

alignment

44

Front wheels are aligned to make:

- ☐ tires last longer
- ☐ tires wear out faster
- ☐ steering easy
- ☐ steering hard

18744

44

tires last longer

steering easy

45

Incorrectly aligned front ends will:

- ☐ make the car go straight
- ☐ make the car pull to one side
- ☐ wear tires evenly
- ☐ wear tires unevenly

18745

45

make the car pull to one side

wear tires unevenly

46

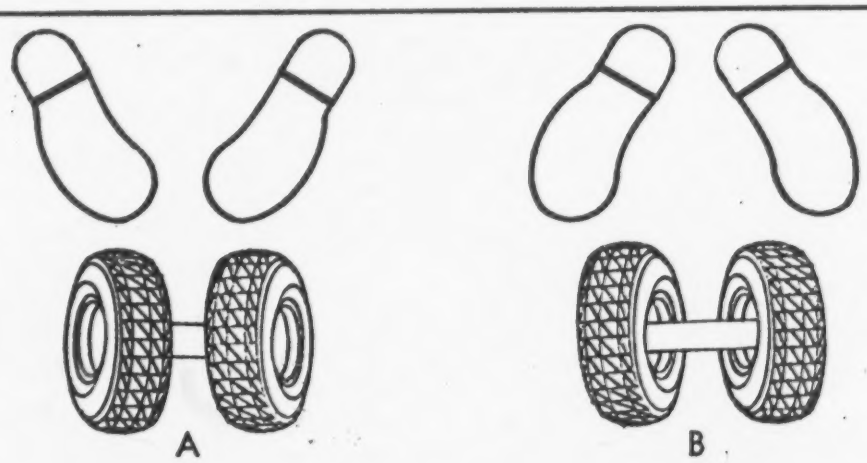

Aside from camber adjustment, wheels can also be TOED-IN or TOED-OUT.

Which set of wheels look like they would be called toed-in?

- ☐ wheels A
- ☐ wheels B

This is because toed-in wheels look like toes that are:

- ☐ pointing toward each other
- ☐ pointing away from each other

18746

46

wheels A

pointing toward each other

47

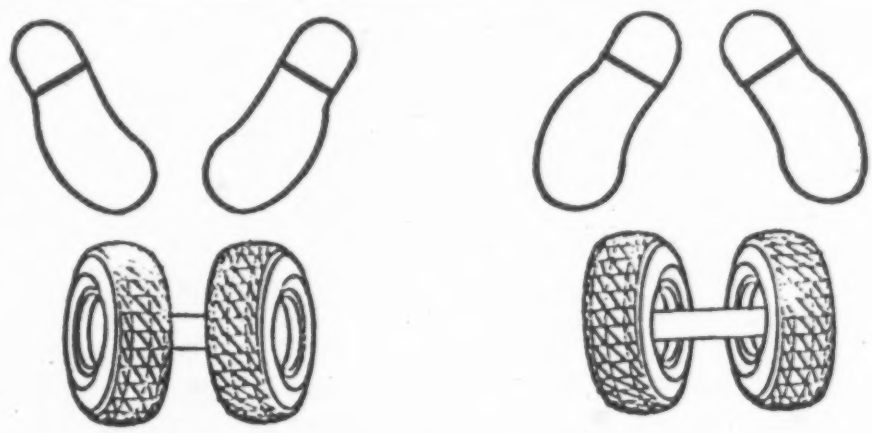

When the fronts of the wheels are closer together than the backs of the wheels, you say that the wheels are:

- ☐ toed-in
- ☐ toed-out

18747

47

toed-in

48

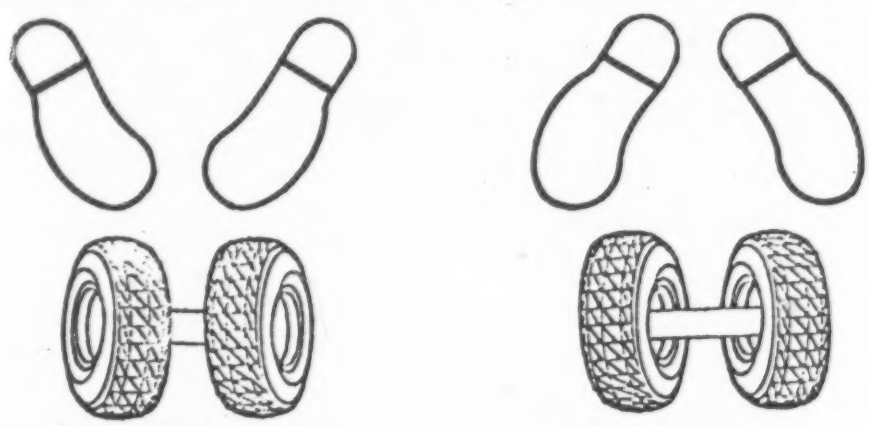

To adjust front wheels for toe-in or toe-out, the fronts of the wheels are moved: (CHECK ALL CORRECT ANSWERS)

- ☐ away from each other
- ☐ closer to each other
- ☐ to the inside of the car
- ☐ to the outside of the car

18748

48

away from each other

closer to each other

49

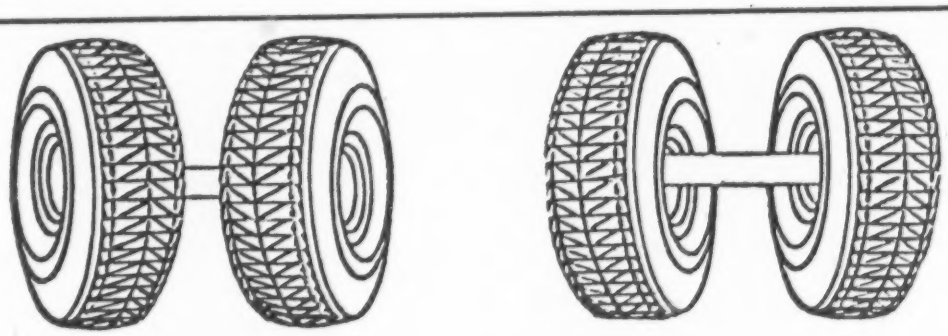

When a person's toes are facing outward, the heels are:

- ☐ closer together than the toes
- ☐ farther apart than the toes

Which set of wheels look like they are toed out?

- ☐ wheels A
- ☐ wheels B

18749

VT 011 502
Hames, Dan
Dimensioning Rules and Principles. LAP No. 11.

Hughson Union High School, Calif.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 68 12p.

DESCRIPTORS - *LEARNING ACTIVITIES; *AUTOINSTRUCTIONAL AIDS; *DRAFTING; *GUIDELINES; INDUSTRIAL ARTS; HIGH SCHOOL STUDENTS; MANUALS; INSTRUCTIONAL AIDS
IDENTIFIERS - ELEMENTARY AND SECONDARY EDUCATION ACT TITLE III; ESEA TITLE III; LEARNING ACTIVITY PACKAGE; LAP

ABSTRACT - This learning activity package, developed under a grant from Elementary Secondary Education Act (ESEA) Title III, describes dimensioning rules and principles of drafting. Designed as a self-instructional unit for individual learning, it contains: (1) Rationale, (2) Primary Ideas, (3) Secondary Ideas, (4) Pretest Instructions, and (5) Five Secondary Ideas. Each secondary idea includes the stated objective and activities. A bibliography is given. Additional Learning Activity Packages (LAP) are available. (GR)

VT 011 502

49

closer together than the toes

wheels B

50

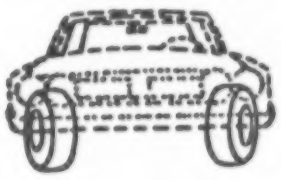

This car's front wheels are:

- ☐ toed in
- ☐ toed out

18750

50

toed in

51

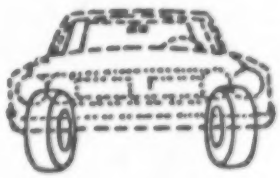

LOOK at the picture above.

The fronts of the car's wheels are facing:

- ☐ away from each other
- ☐ toward each other

These wheels are:

- ☐ toed in
- ☐ toed out

18751

51

away from each other

toed out

52

MATCH the following:

A.

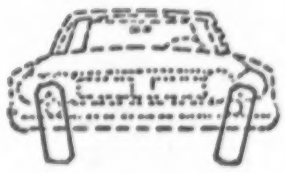

B.

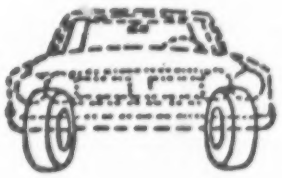

C.

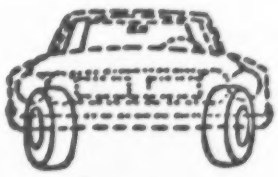

1. _____ fronts of the wheels closer than the backs of the wheels

2. _____ fronts of the wheels farther apart than the backs of the wheels

3. _____ tops of the front wheels farther apart than the bottoms of the wheels

18752

265 OF 327

ED

056 238

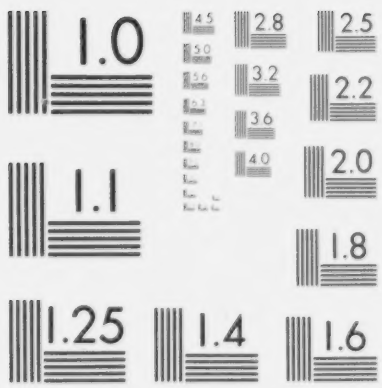

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

52

1. C

2. B

3. A

53

MATCH the following:

A.

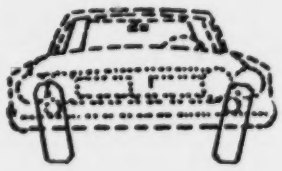

B.

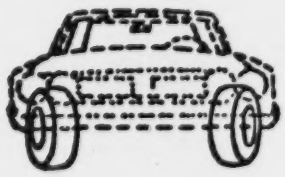

C.

1. _____ toe-in

2. _____ toe-out

3. _____ positive camber

18753

246

53

1. C

2. B

3. A

54

If the tops of front wheels are farther apart than the bottoms of the wheels, the wheels are said to have:

- ☐ positive camber
- ☐ negative camber

When the fronts of the wheels are closer together than the backs of the wheels, we say that the wheels are:

- ☐ toed in
- ☐ toed out

54

positive camber

toed in

55

Camber adjustments tilt the tops of the front wheels in or out.

In toe-in and toe-out adjustments the fronts of the wheels are tilted toward each other or away from each other.

Are toe-in and toe-out adjustments the same as camber adjustments?

- ☐ yes
- ☐ no

18755

55

no

56

Moving the tops of the front wheels closer together or farther apart shows that:

- ☐ camber adjustments are being made
- ☐ toe-in adjustments are being made
- ☐ toe-out adjustments are being made

56

camber adjustments are being made

57

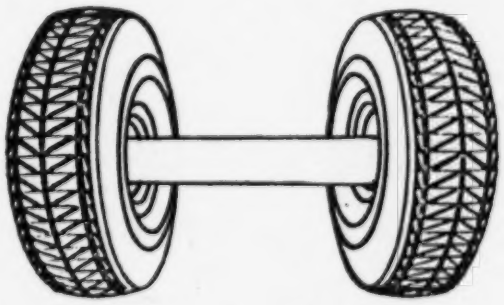

A

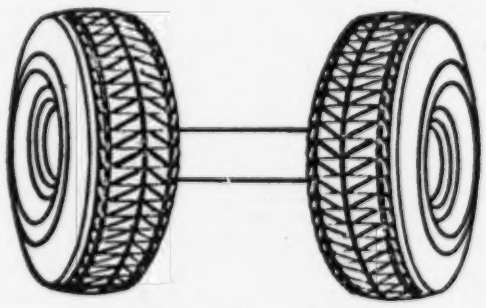

B

Which picture shows front wheels toed-in?

- ☐ picture A
- ☐ picture B
- ☐ picture C

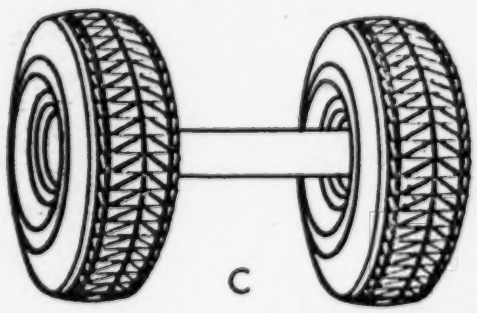

C

18757

57

picture B

58

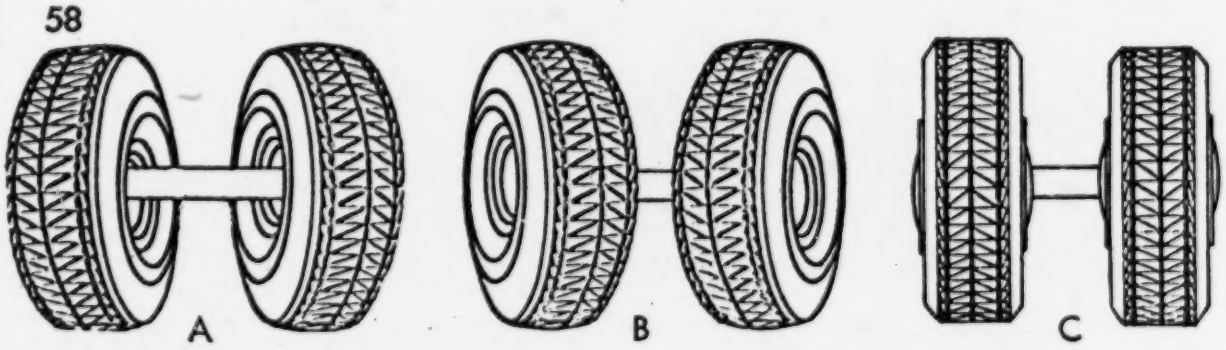

To change toed-in wheels to toed-out wheels, you should make them look like:

- ☐ wheels A
- ☐ wheels B
- ☐ wheels C

18758

10451

(4)

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Dimensioning Rules and Principles

VT011502

Hughson Union High School
E.S.E.A. Title III
Project No. 04401

1843

LAP No. 11
Prepared by
Dan Hames
Summer 1968

58

wheels A

59

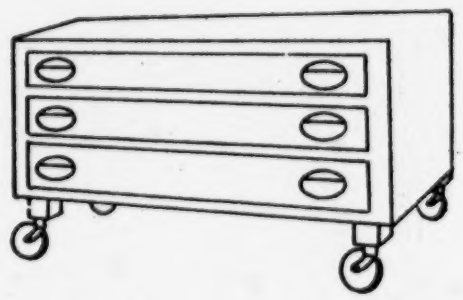

Many pieces of furniture can roll around on wheels that are called CASTERS.

How many casters does the dresser have? _____

18759

59

4

60

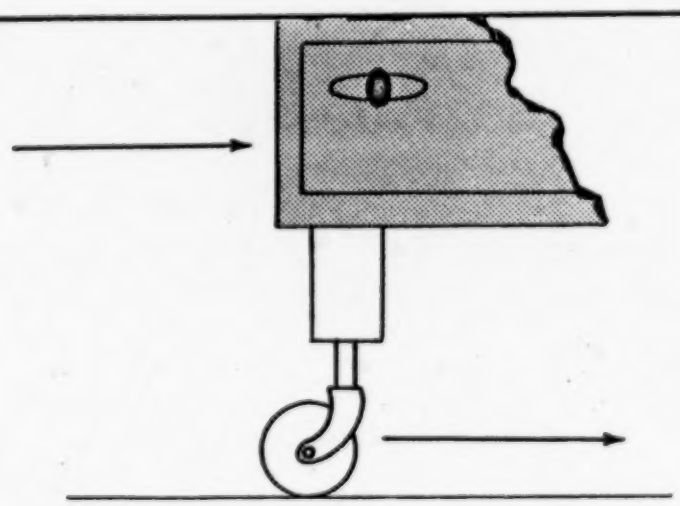

This piece of furniture is being rolled on the floor.

The caster is a little bit:

- ☐ ahead of the piece of furniture
- ☐ behind the piece of furniture

18760

60

behind the piece of furniture

61

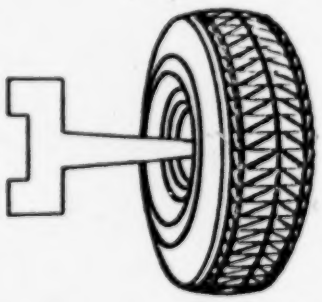

Each front wheel is mounted onto a:

- ☐ center link
- ☐ tie rod
- ☐ steering knuckle

18761

61

steering knuckle

62

When you tilt the top of the steering knuckle, the front wheel will:

- ☐ also be tilted
- ☐ not be affected
- ☐ stay the same

18762

62

also be tilted

63

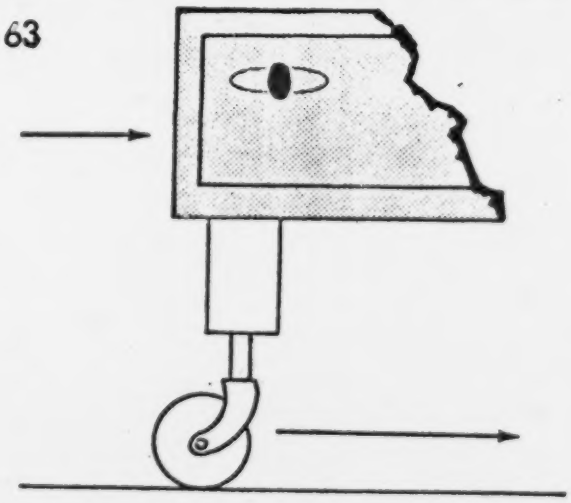

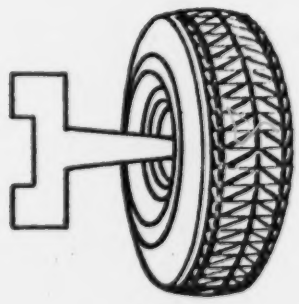

The furniture caster is behind the piece of furniture.

The car wheel is tilted a little behind the:

- ☐ center link
- ☐ steering knuckle
- ☐ steering wheel

18763

63

steering knuckle

64

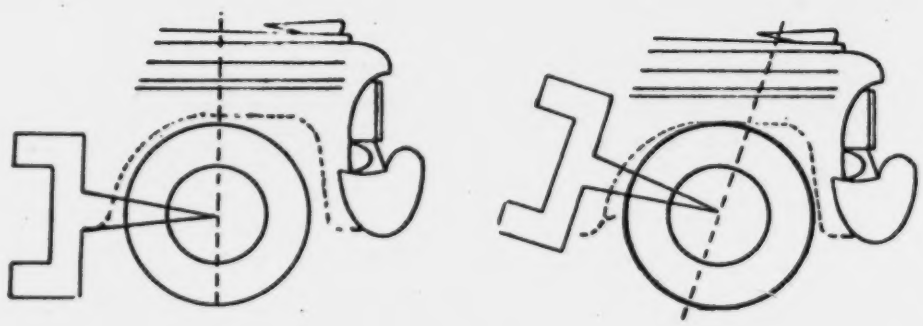

Tilting the top of the steering knuckle to change the tilt of the front wheel is called making a "caster adjustment."

To tilt the top of the wheel to the front of the car, you should:

- ☐ leave the steering knuckle alone
- ☐ tilt the steering knuckle up
- ☐ tilt the steering knuckle down

18764

64

tilt the steering knuckle up

65

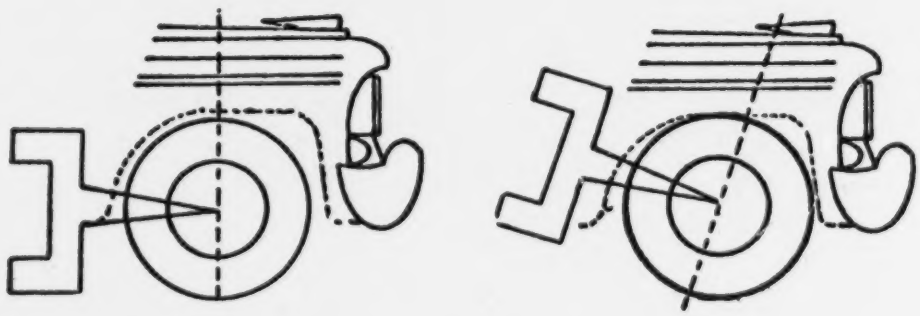

If you tilt the steering knuckle up, the top of the front wheel will:

- ☐ move to the front of the car
- ☐ move to the rear of the car
- ☐ stay the same

18765

65

move to the front of the car

66

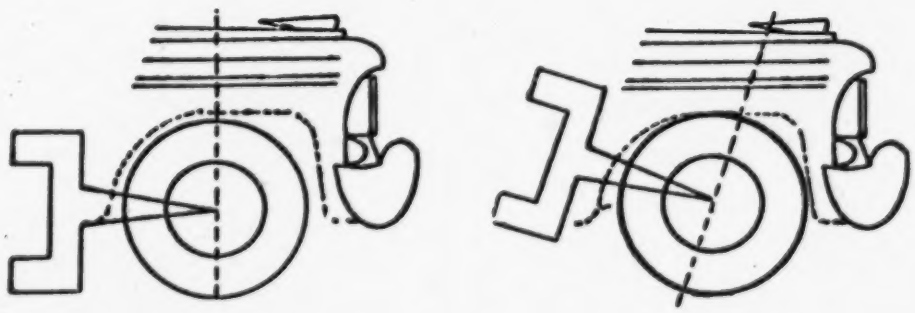

Tilting the top of the front wheel to the front or rear of the car is called:

- ☐ camber adjustment
- ☐ caster adjustment
- ☐ toe-in adjustment
- ☐ toe-out adjustment

18766

66

caster adjustment

67

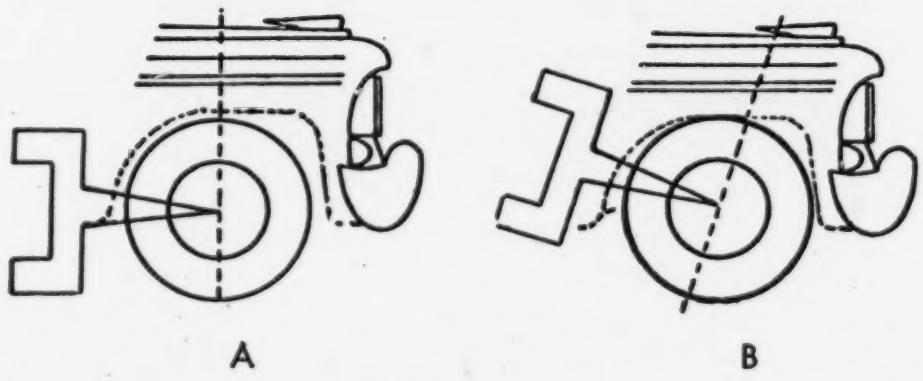

Which wheel shows a caster adjustment?

- ☐ wheel A
- ☐ wheel B

18767

67

wheel A

68

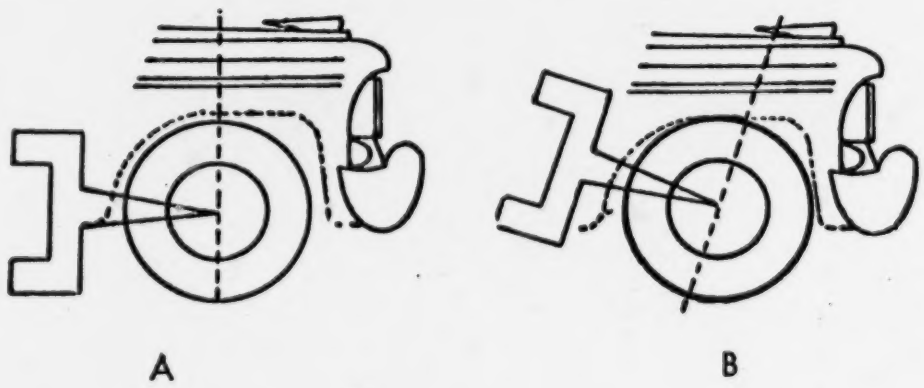

When the top of the front wheel is tilted to the front of the car, the caster is negative.

Which picture shows a wheel with ZERO caster?

- ☐ picture A
- ☐ picture B

18768

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68

picture A

69

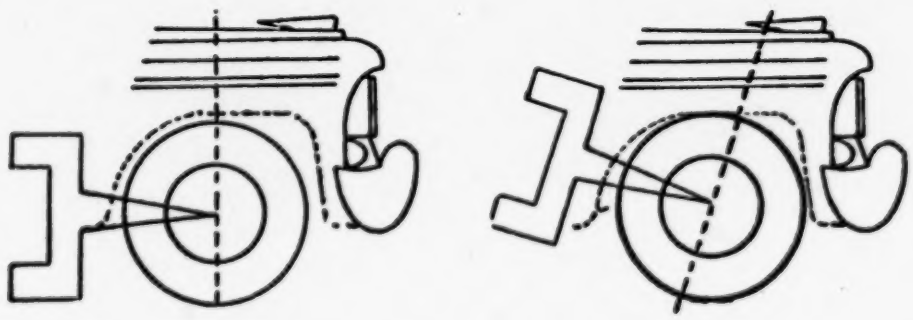

Which wheel shows negative caster?

- ☐ wheel A
- ☐ wheel B

18769

69

wheel B

70

Tilting the tops of the front wheels so that the tops are farther apart than the bottoms of the wheels is called a:

- ☐ camber adjustment
- ☐ caster adjustment
- ☐ toe-in adjustment

18770

70

camber adjustment

71

Tilting the top of the front wheel toward the front of the car is called a:

- ☐ camber adjustment
- ☐ caster adjustment
- ☐ toe-in adjustment

18771

71

caster adjustment

72

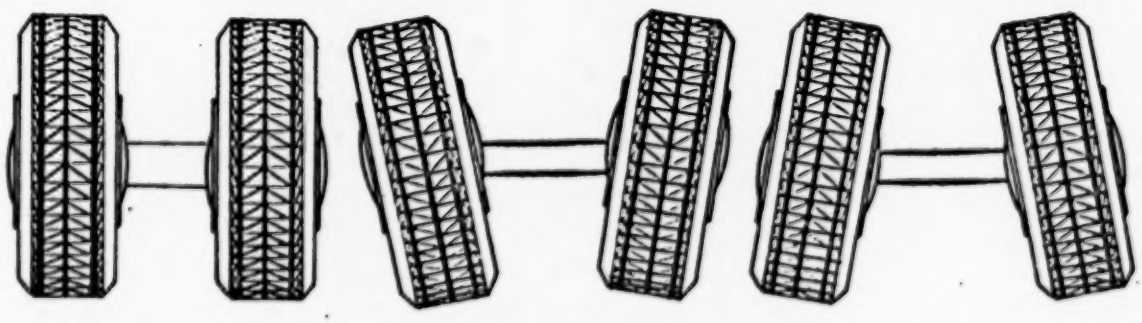

Making the front of the wheels closer to each other than the rear of the wheels is changing the car's:

- ☐ camber
- ☐ caster
- ☐ toe-in

18772

72

toe-in

73

MATCH the wheels with the different types of alignment?

A.

1. _____ camber

2. _____ caster

3. _____ toe-out

B.

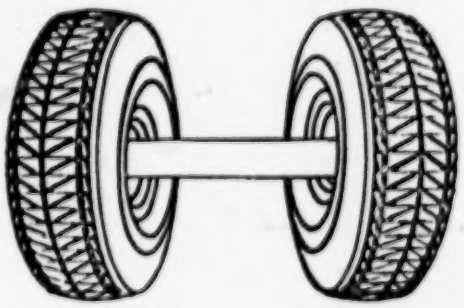

C.

18773

73

1. A

2. C

3. B

74

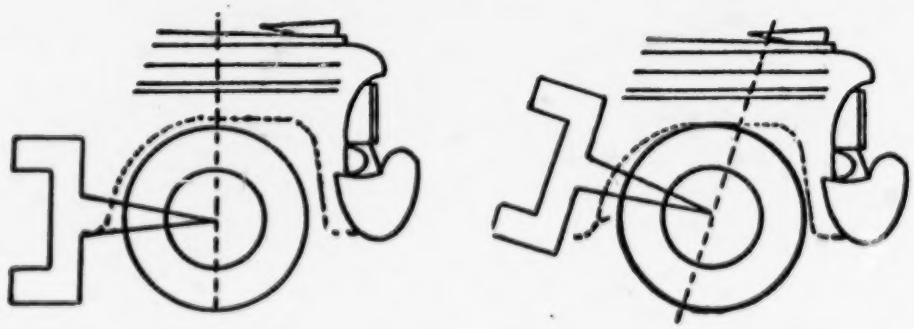

When you tilt the steering knuckle up, you are moving the top of the steering knuckle and the top of the front wheel to the:

- ☐ front of the car
- ☐ rear of the car

18774

74

front of the car

75

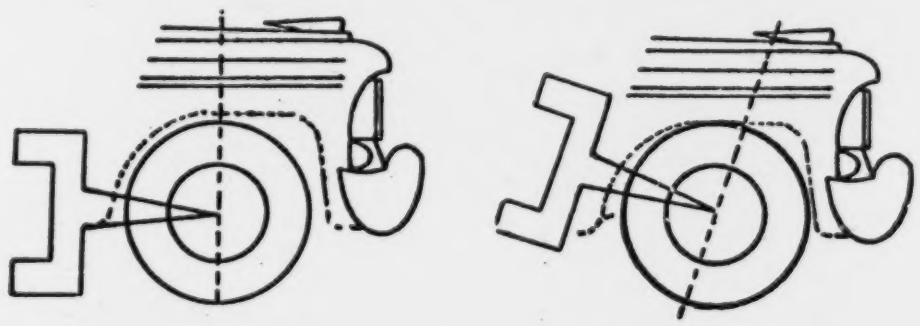

The top of the steering knuckle and the top of the front wheel is tilted to the front of the car when the top of the steering knuckle is tilted:

- ☐ up
- ☐ down

18775

75

up

76

Tilting the top of the steering knuckle to the front of the car is done in:

- ☐ camber adjustments
- ☐ caster adjustments
- ☐ toe-in and toe-out adjustments

18776

76

caster adjustments

77

MATCH the following:

A. camber

B. caster

C. toe-in

1. _____ moving the top of the steering knuckle to the front or back of the car

2. _____ moving the top of the wheel to the inside or outside of the car

3. _____ moving the fronts of the wheels closer or farther apart

77

1. B

2. A

3. C

78

MATCH the following:

A. positive camber

B. negative caster

C. toe-out

D. toe-in

1. _____ moving the fronts of the wheels farther apart than the rears of the wheels

2. _____ tilting the top of the steering knuckle to the front of the car

3. _____ moving the fronts of the wheels closer together than the rears of the wheels

Why Study Dimensioning?

If the draftsman or designer is to produce a drawing so an object can be made accurately from it by a workman on the job, it must tell two complete stories. It tells these by means of:

1. VIEWS, describing shape of object.
2. DIMENSIONS and NOTES, giving sizes and other shop information.

The dimensions on a drawing must be the actual dimensions of the completed object. The job of the workman is to produce the object exactly as shown on the drawing. If the dimensions are wrong on the drawing, the object will be made wrong. Many pieces of this object would be mass produced before the error is caught resulting in a large expense and may cost the draftsman his job. It is very important to follow the basic rule of dimensioning:

1. ACCURACY
2. SIMPLICITY
3. CLEARNESS

DO NOT make the mistake of simply giving the dimensions you use to make the drawing.

GIVE the dimensions you want the workman to use in making the part.

78

1. C

2. B

3. D

79

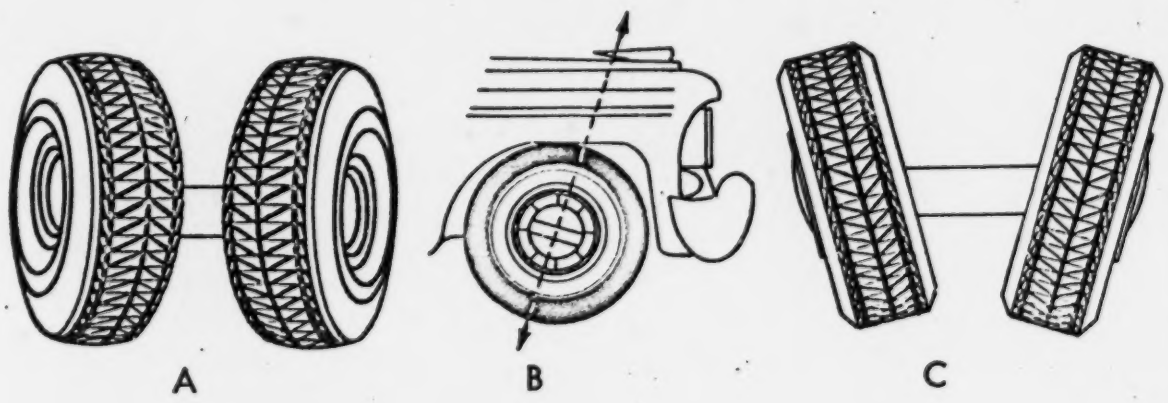

Which picture shows wheels that are toed-in?

- ☐ picture A
- ☐ picture B
- ☐ picture C

Which picture shows wheels that have positive camber?

- ☐ picture A
- ☐ picture B
- ☐ picture C

18779

79

picture A

picture C

80

Which front end adjustment looks like the rollers on a piece of furniture?

- ☐ camber
- ☐ caster
- ☐ toe-in
- ☐ toe-out

18780

81

alignments

82

Tilting the top of the front wheels to the front or back of the car is one way of aligning the front end.

CHECK the picture that shows a front wheel that has this kind of adjustment:

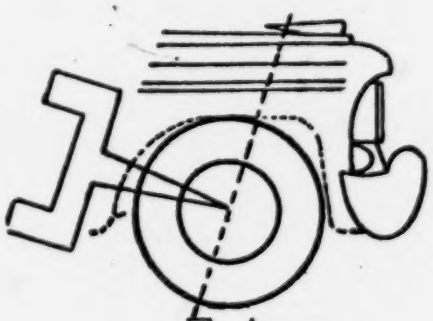

☐ A

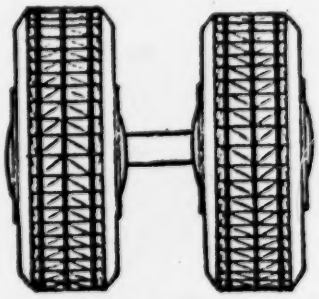

☐ B

This is a:

☐ camber adjustment

☐ caster adjustment

18782

82

A

caster adjustment

83

Caster adjustments tilt the tops of the front wheels:

- ☐ to the front of the car
- ☐ to the back of the car
- ☐ in and out

18788

83

to the front of the car

to the back of the car

84

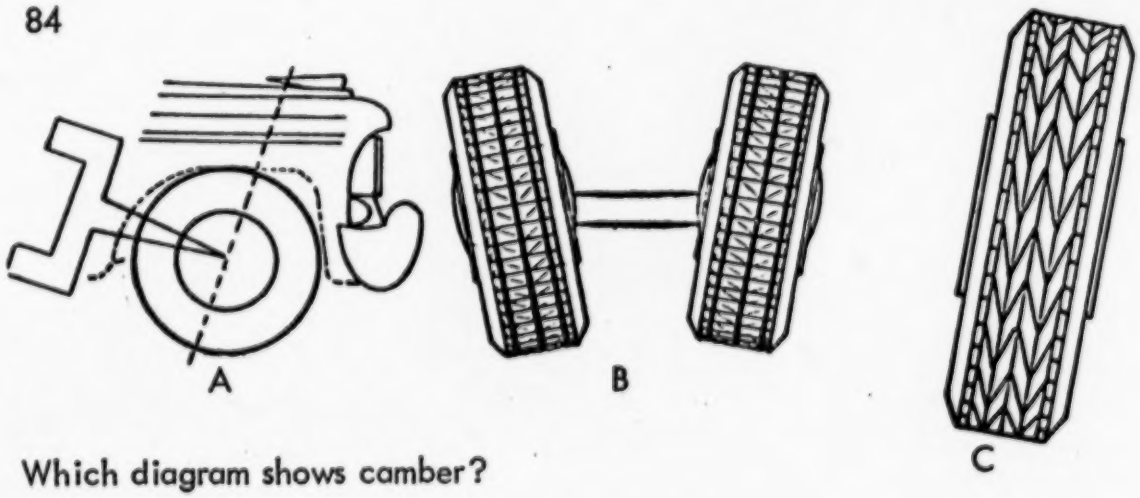

Which diagram shows camber?

- ☐ A
- ☐ B
- ☐ C

Which diagram shows caster?

- ☐ A
- ☐ B
- ☐ C

18784

84

C

A

85

How can you align the front end?

- ☐ by adjusting the camber
- ☐ by adjusting the valves
- ☐ by adjusting the caster

18785

85

by adjusting the camber

by adjusting the caster

86

The purpose of camber and caster adjustments is to:

- ☐ increase tire life
- ☐ make tires wear faster
- ☐ make a car pull to one side
- ☐ make a car go straight

18786

86

increase tire life

make a car go straight

87

The tops of the front wheels are tilted outward.

This sentence describes a:

- ☐ caster tilt (negative)
- ☐ camber tilt (positive)

The tops of the front wheels are tilted inward.

This sentence describes a:

- ☐ caster tilt (negative)
- ☐ camber tilt (positive)

87

camber tilt (positive)

camber tilt (positive)

88

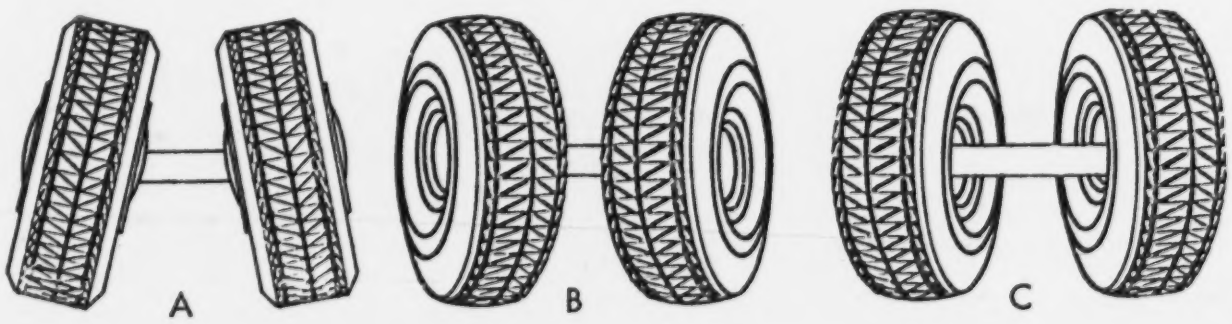

Which tires show each of the following alignments?

camber ☐ A ☐ B ☐ C

toe out ☐ A ☐ B ☐ C

18788

PRIMARY IDEA

Dimensioning Rules and Procedures

SECONDARY IDEAS

The student will be able to:

1. Gain a basic understanding of the principle of shape description.

2. Develop a skill in the construction and use of dimension and extension lines, arrowheads, numerals and notes.

3. Learn the proper construction and use of finish marks and leaders.

4. Develop an understanding of the selection and placing of dimensions.

5. Understand the various systems of dimensioning.

1846

88

A

C

89

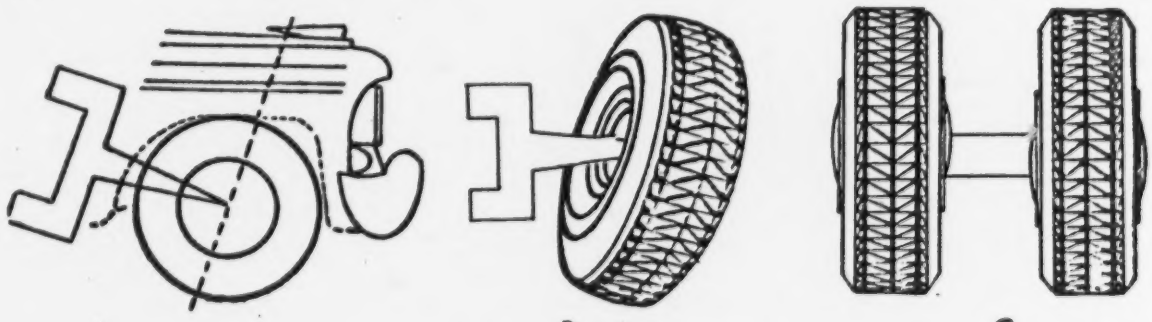

A B C

Which tires show each of these alignments?

camber _____

caster _____

18789

89

B

A

90

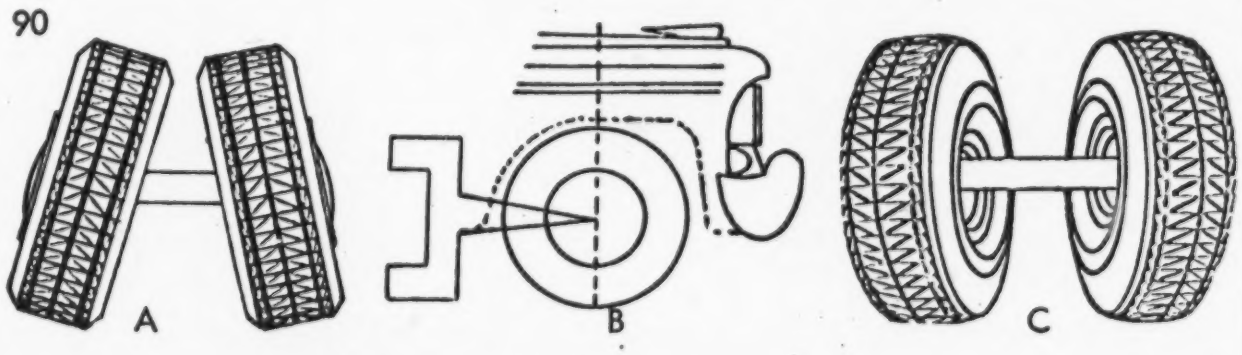

Which tires show each of the following alignments?

camber _____

toe-out _____

90

A

C

91

Which sentence below describes camber?

- ☐ The tops of the front wheels are tilted to the outside or inside of the car.
- ☐ The fronts of the wheels are closer together than the backs of the wheels.

18791

91

The tops of the front wheels are tilted to the outside or inside of the car.

92

Which of the following phrases describes caster?

- ☐ The tops of the front wheels are tilted to the front or rear of the car.
- ☐ The tops of the steering knuckles are tilted to the outside or inside of the car.
- ☐ The tops of the front wheels are tilted out.

18792

92

The tops of the front wheels are tilted to the front or rear of the car.

93

Front wheels are toed in by having the fronts of the wheels:

- ☐ closer together than the backs of the wheels
- ☐ farther apart than the backs of the wheels
- ☐ the same distance apart as the backs of the wheels

93

closer together than the backs of the wheels

94

Front wheels are toed out by moving the fronts of the wheels:

- ☐ closer together than the backs
- ☐ farther apart than the backs
- ☐ the same distance apart as the backs

94

farther apart than the backs

95

Front ends are aligned to make: (CHECK ALL CORRECT ANSWERS)

- ☐ tires last longer
- ☐ steering easier
- ☐ a car go straight

18795

95

tires last longer

steering easier

a car go straight

96

Adjusting a front end is called:

- ☐ aligning
- ☐ braking
- ☐ steering

18796

96

aligning

THIS IS THE END OF BOOK 12

18797

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

Cars that are correctly aligned will:

- ☐ steer easy
- ☐ steer hard
- ☐ go straight
- ☐ pull to one side

2

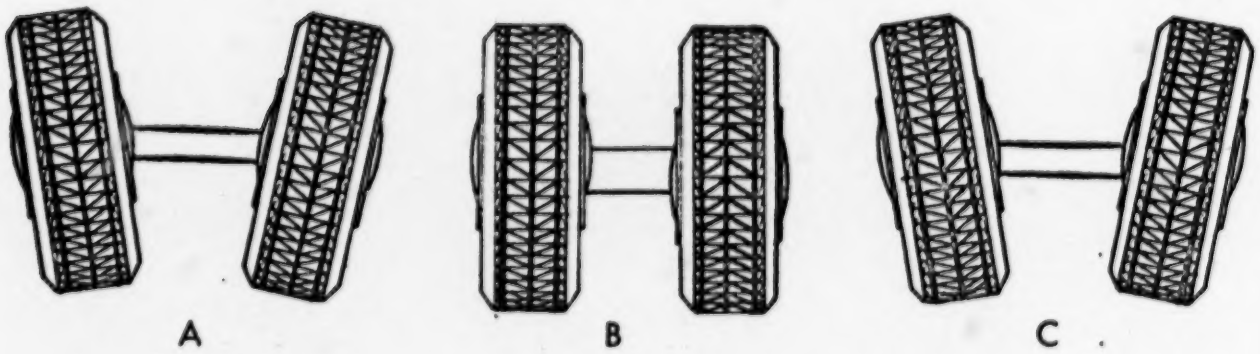

Which of the above diagrams show wheels that have zero camber? ____

After reading the secondary ideas, if you feel you can pass the pre-test on dimensioning, see your instructor for the pre-test . . .

NOW:

After you have completed your pre-test, bring the test to your instructor.

1847

3

Front ends that are correctly aligned will:

- ☐ wear tires ever
- ☐ wear tires faster
- ☐ wear tires slowly
- ☐ wear tires unevenly

4

Tilting the tops of the front wheels to the inside or outside of the car makes a:

- ☐ camber adjustment
- ☐ caster adjustment
- ☐ toe-in or toe-out adjustment

5

Tilting the tops of the front wheels to the front or rear of the car makes a:

- ☐ camber adjustment
- ☐ caster adjustment
- ☐ toe-in or toe-out adjustment

18799

6

Tilting the fronts of the front wheels closer together or further apart makes a:

- ☐ camber adjustment
- ☐ caster adjustment
- ☐ toe-in or toe-out adjustment

7

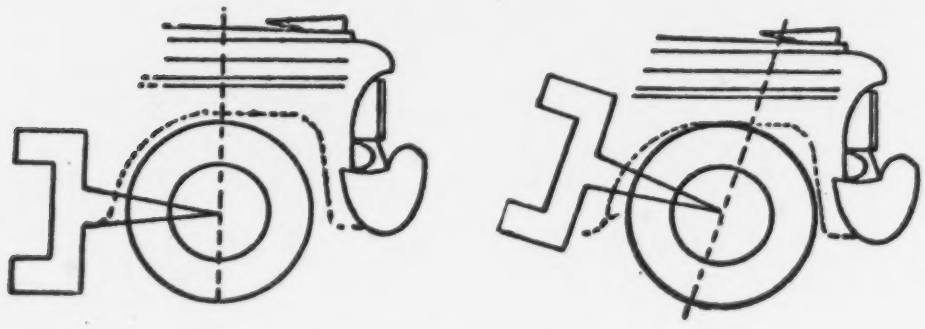

A B

This wheel was adjusted for caster to give the wheel a negative caster. The adjustment was done by tilting the top of the steering knuckle:

- ☐ up (or forward)
- ☐ down (or backward)
- ☐ so that it is straight up and down

8

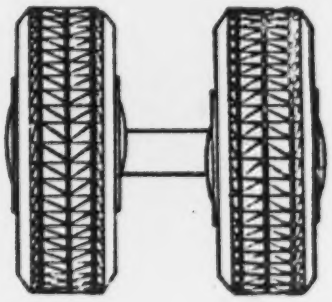

These front wheels have ZERO camber.

To adjust these wheels to positive camber the top of the wheels should be:

- ☐ tilted inward
- ☐ tilted outward
- ☐ left straight up and down

9

Adjustments made to a car's front end are called _____ .

VT 013 135
Auto Mechanics Course. Book 13: Suspension System.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
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IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the suspension system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 135

BOOK 13

To Be Used With
PANEL BOOK 13

(1)

ED0 56238

AUTO MECHANICS COURSE

BOOK 13: SUSPENSION SYSTEM

A BASIC SYSTEMS PROGRAM

Curriculum Report Reference
Page 15

Task Analysis Reference
33.1,33.2,33.3,33.4

VT013135

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18803

AUTO MECHANICS COURSE

BOOK 13: SUSPENSION SYSTEM

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

18804

1

Shock absorbers:

- ☐ hold the wheel on the axle
- ☐ smooth out spring bounce
- ☐ tie springs onto the axle

2-6

MATCH the letters with the pictures:

A. air spring
B. coil spring
C. leaf spring
D. torsion bar
E. shock absorber

2.____ 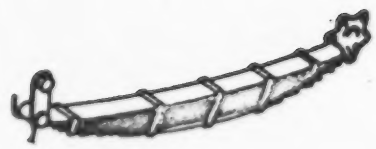

3.____

4.____

5.____

6.____

18805

7

The job of an automobile spring is to:

- ☐ keep the wheels steady while the car bounces
- ☐ let the car bounce with the wheels
- ☐ keep the car steady while the wheels bounce

8

What does the suspension system do?

- ☐ holds the axis on the chassis
- ☐ makes the frame jiggle
- ☐ smooths out the car's ride
- ☐ stops the car

9-10

Which of the following are part of the suspension system?

- ☐ the axle
- ☐ the chassis
- ☐ the shock absorbers
- ☐ the springs

1

This section will teach you which parts make a car drive smoothly over a bumpy road.

After you have finished this part of the course, which question should you be able to answer?

- ☐ How does a car stop?
- ☐ What gives a more level ride?
- ☐ When do you put gas in?

18807

1

What gives a more level ride?

2

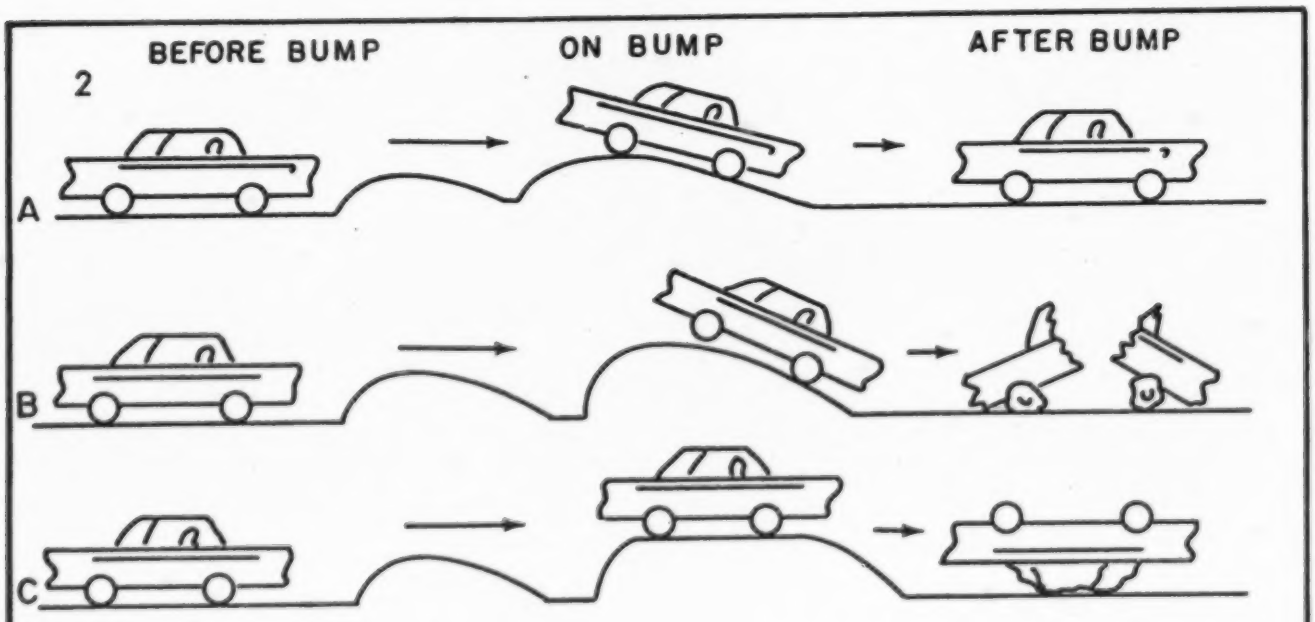

Which car is driving smoothly after the bump?

- ☐ car A
- ☐ car B
- ☐ car C

18808

Secondary Idea #1:

To gain a basic understanding of the principles of shape description.

Student Objective #1

Given the text and available reference material, the student will read these to gain an understanding of size description.

Activities for Student Objective #1:

A. Required:

1. Read Chapter 11, "Size Description", page 130 *Mechanical Drawing*.

B. Optional:

1. Read Chapter 9, "Dimensioning", page 122, *Basic Technical Drawing*.

OR

Read Chapter 3, "Dimensions", page 29, *Drafting Rules and Principles*.

2

car A

3

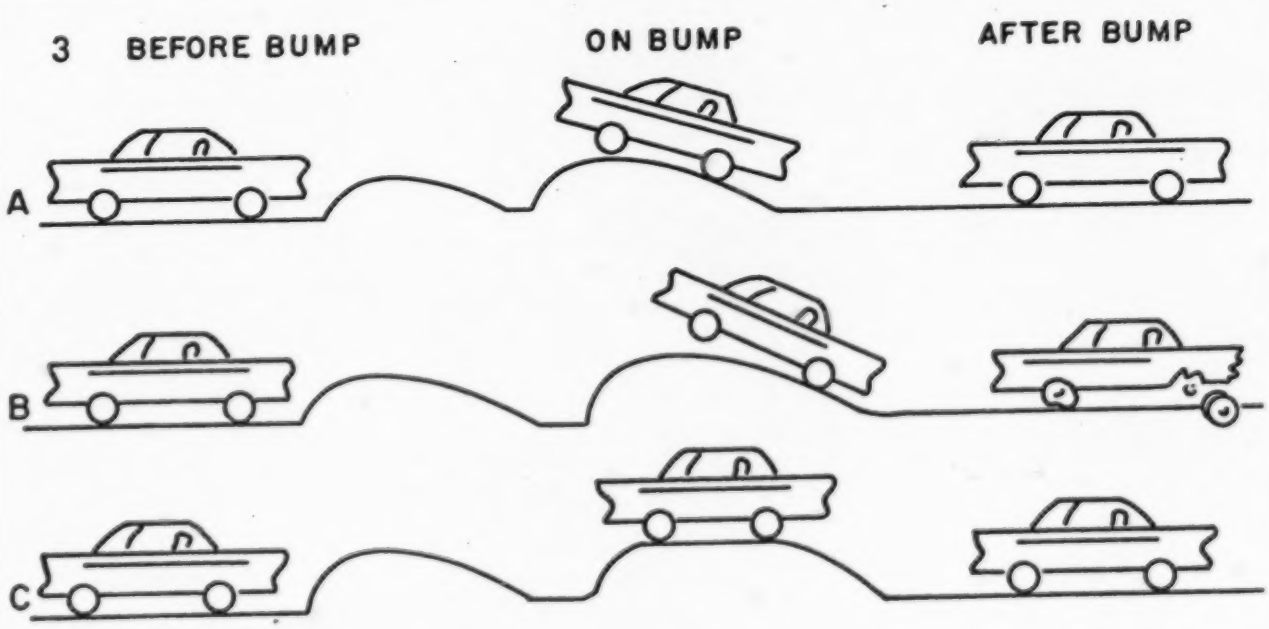

Which car is in bad shape after the bump?

- ☐ car A
- ☐ car B
- ☐ car C

18809

3

car B

4

A smooth-driving car goes over a bump.

After it is over the bump the:

- ☐ car shakes apart
- ☐ wheels are crushed
- ☐ wheels hold the car up

18810

4

wheels hold the car up

5

If a car that drives smoothly goes over a bump the:

- ☐ bump will break the car
- ☐ car can take the bump
- ☐ wheels will be crushed

18811

5

car can take the bump

6

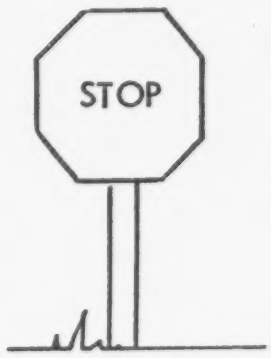

OPEN THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

18812

6

NO ANSWER NEEDED

7

Automobile springs are connected to the car's chassis.

How many springs does this car have? ____

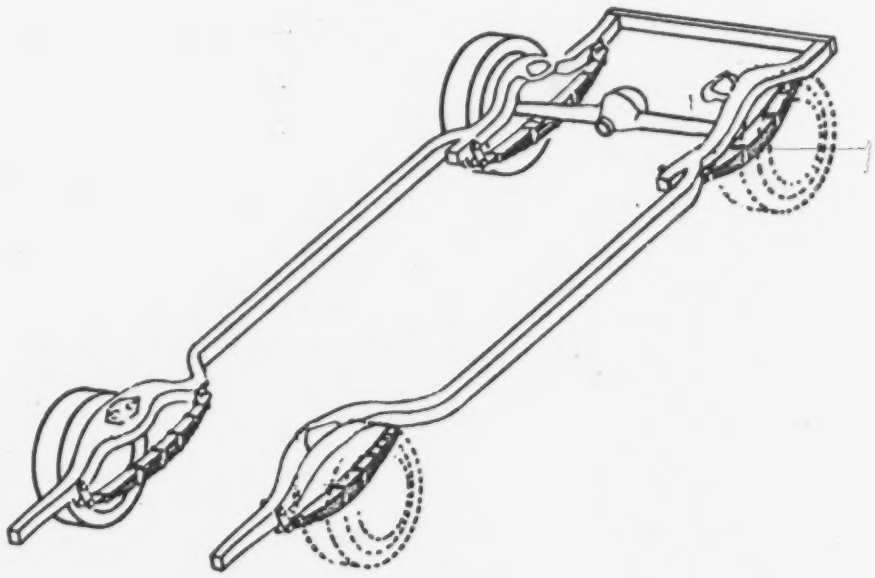

18813

7

4

8

LOOK AT PANEL 1

For each car shown in the panel, the springs are always connected to the:

- ☐ chassis
- ☐ drive shaft
- ☐ transmission

18814

8

chassis

9

When a car goes over a bump, the wheels will:

- ☐ go up and down
- ☐ go up
- ☐ stay on the bump

18815

9

go up and down

10

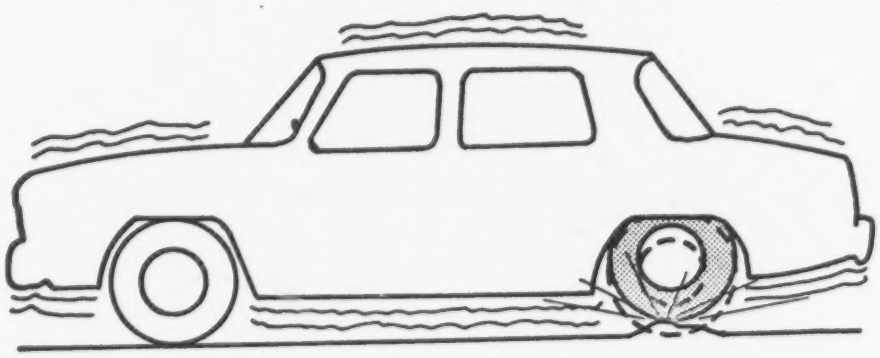

This car is bouncing up and down because:

- ☐ it is on a smooth road
- ☐ it went over a bump on the road
- ☐ the driver is bouncing up and down

18816

10

it went over a bump on the road

11

To give people a smooth ride, the car has special parts called the SUSPENSION SYSTEM.

Suspension-system parts make the ride smooth by:

- ☐ letting the wheels go up and down
- ☐ making the wheels bounce harder
- ☐ smoothing the up-and-down bounce of the car

18817

11

smoothing the up-and-down
bounce of the car

12

COIL SPRING

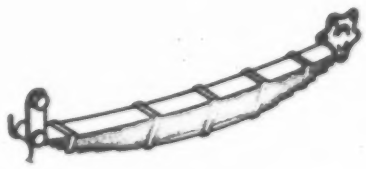

LEAF SPRING

SHOCK ABSORBER

Parts that stop a car from bouncing and smooth out the ride are all parts of the SUSPENSION SYSTEM.

Suspension-system parts are springs and:

- ☐ chassis
- ☐ frames
- ☐ shock absorbers

18818

Secondary Idea #2:

To learn the proper construction and use of dimension and extension lines, arrowheads, numerals, and notes.

Student Objective #1:

Given the necessary drawing plates, the student will be able to develop an ability to accurately construct dimension and extension lines, arrowheads, numerals and shop notes.

Activities for Student Objective #1:

A. Required:

1. Using the figures shown on the top of plate D-1, dimensions and extension lines so they are spaced to provide clearness. DO NOT DRAW ARROWHEADS ON YOUR DIMENSION LINES.

2. Using Figure 11-5 on page 131 in your text, *Mechanical Drawing*, as a guide, practice the use of arrowheads on plate D-2.

3. Using your previously drawn dimension lines on plate D-1, draw in the necessary arrowheads.

4. Complete plate D-5 titled "Dimensioning Practice."

5. Refer to Art. 11-7, "Numerals and Notes", page 130 in the *Mechanical Drawing* text while completing plate D-3.

6. Refer to Art. 11-7, "General Rules of Dimensioning", page 137 in *Mechanical Drawing* text while completing plate D-6.

B. Optional:

1. Complete plate D-4

OR

Bring a blueprint to class showing the dimensioning practices used by a professional draftsman.

12

shock absorbers

13

Parts that stop a car from bouncing up and down are all parts of the:

- ☐ power transmission system
- ☐ steering system
- ☐ suspension system

18819

13

suspen: n system

14

The suspension system: (CHECK TWO)

- ☐ keeps the car from bouncing around
- ☐ makes the ride bumpy
- ☐ smooths out the ride
- ☐ carries bumps to the driver of the car

18820

14

keeps the car from bouncing around

smooths out the ride

15

COIL SPRING

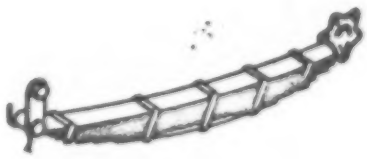

LEAF SPRING

SHOCK ABSORBER

These are parts of the:

- ☐ brake system
- ☐ exhaust system
- ☐ suspension system

18821

15

suspension system

16

If a car had no springs or shock absorbers, the ride would be:

- ☐ bumpy
- ☐ smooth
- ☐ the same as with springs and shock absorbers

18822

266 OF 327

ED

056 238

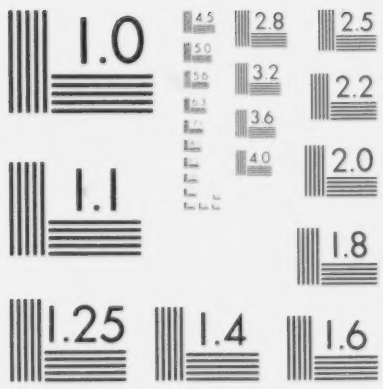

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

16

bumpy

17

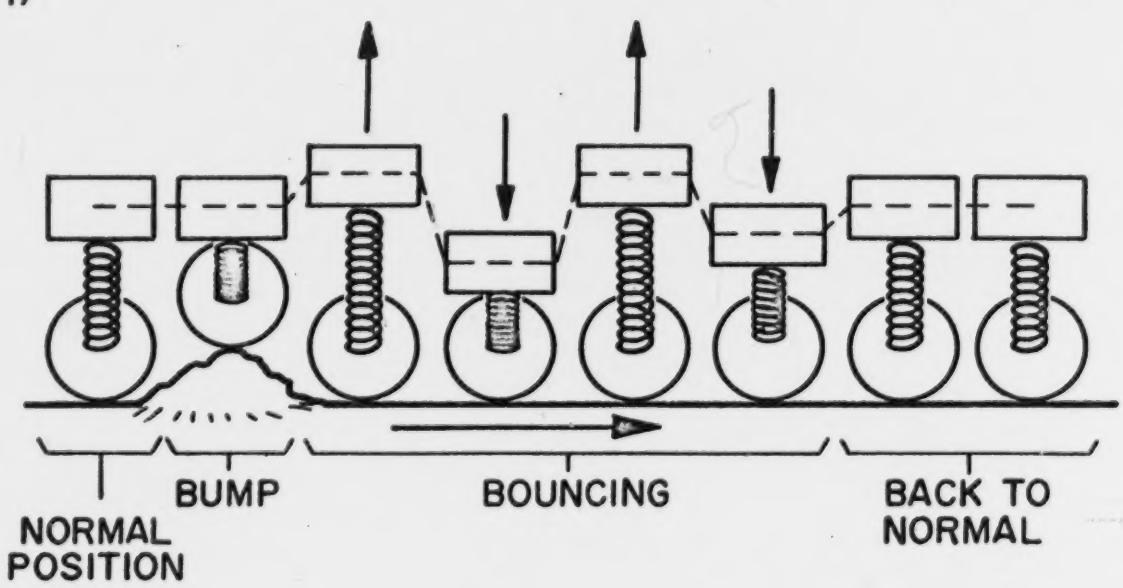

When a car goes over a bump, to keep the car steady the springs must:

- ☐ not move
- ☐ bounce up and down without stopping
- ☐ bounce up and down and then stop bouncing

18823

26

17

bounce up and down and then stop bouncing

18

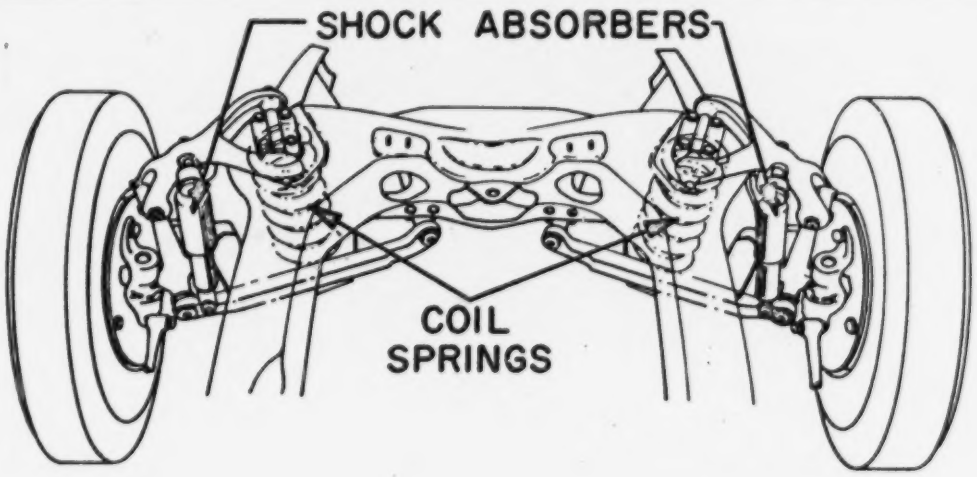

Another part is built into the suspension system to keep the car steady while the springs bounce.

This part is the:

- ☐ center link
- ☐ tie rod
- ☐ shock absorber

18824

18

shock absorber

19

If a car had only springs in its suspension system:

- ☐ it would bounce a lot
- ☐ bouncing would stop
- ☐ it would not bounce

18825

19

it would bounce a lot

20

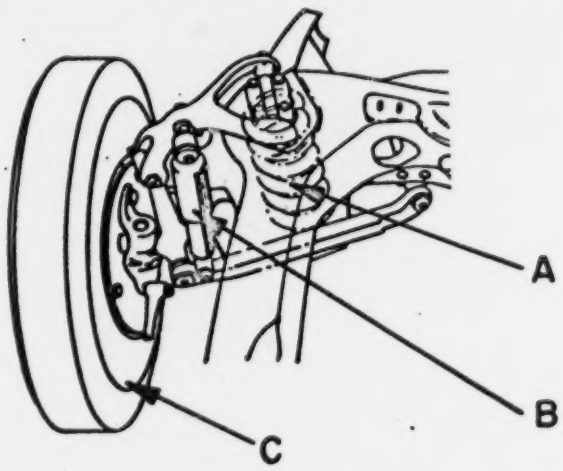

Which arrow is pointing to the part that keeps springs from bouncing too much?

- ☐ arrow A
- ☐ arrow B
- ☐ arrow C

18826

20

arrow B

21

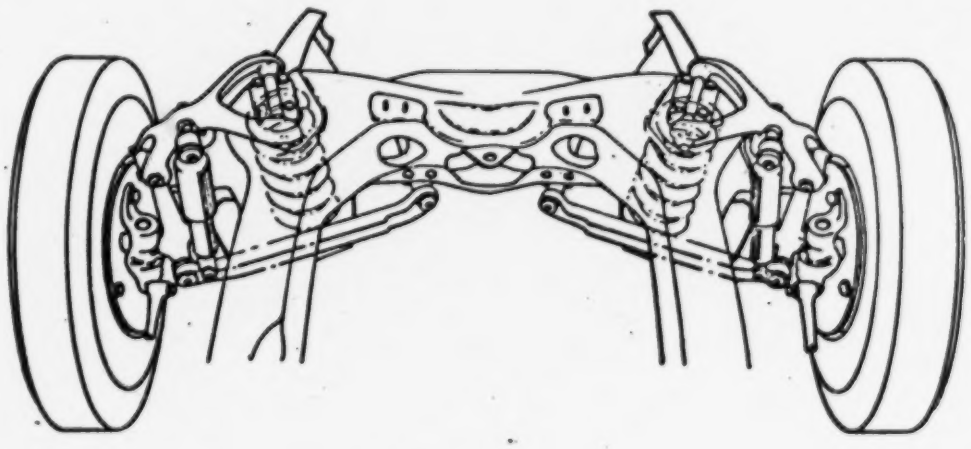

The springs are mounted on the:

- ☐ chassis
- ☐ ground
- ☐ wheels

18827

Secondary Idea #3:

Learn the proper construction and use of finish marks and leaders.

Student Objective #1:

Given the necessary drawing plates, the student will be able to show, in detail, surfaces to be machined by the use of finish mark symbols. Leader lines will also be drawn from a note or dimensions to the place where it applies.

Activities for Student Objective #1:

A. Required:

1. Refer to page 130 in the *Mechanical Drawing* text while completing plate D-7.

21

chassis

22

The body of the car is mounted on the:

- ☐ chassis
- ☐ springs
- ☐ wheels

18828

22

chassis

23

To keep the body of the car from bouncing when the wheels go up and down:

- ☐ the chassis should be kept steady
- ☐ the driver should be kept steady
- ☐ the wheels should be kept steady

18829

23

the chassis should be kept steady

24

Parts that keep the chassis steady are the:

- ☐ power transmission system
- ☐ steering system
- ☐ suspension system

18830

24

suspension system

25

The job of the suspension system is to:

- ☐ keep the car smooth and steady
- ☐ keep the car bouncing up and down
- ☐ keep the driver on the alert

18831

25

keep the car smooth and steady

26

Suspension-system parts connect which part of the car to the steering knuckle assembly?

- ☐ chassis
- ☐ steering wheel
- ☐ transmission gear assembly

18832

26

chassis

27

When driving a car, you want the car to go:

- ☐ forward
- ☐ up
- ☐ down

The system that keeps the car from doing what you do not want it to do is called the:

- ☐ brake system
- ☐ electrical system
- ☐ suspension system

18833

27

foward

suspension system

28

The job of the suspension system is to:

- ☐ bring the car to a halt
- ☐ let the car make a turn to the left or right
- ☐ smooth out the car's ride

18834

28

smooth out the car's ride

29

Parts that smooth out a car's ride are the:

- ☐ distributor
- ☐ shock absorbers
- ☐ springs
- ☐ wheels

18835

29

shock absorbers

springs

30

What do springs and shock absorbers do?

- ☐ align the front wheels
- ☐ let the car steer
- ☐ smooth out the ride

18836

30

smooth out the ride

31

CHECK the parts below that are in the suspension system:

- ☐ brake lines
- ☐ shock absorbers
- ☐ snap rings
- ☐ springs
- ☐ wheels

18837

Secondary Idea #4:

To develop an understanding of the selection and placing of dimensions.

Student Objective #1:

The student will be able to select and place the necessary size and location dimensions on various views of an object.

Activities for Student Objective #1:

A. Required:

1. Read the following information about size and location dimensions.

SELECTION OF DIMENSIONS

All necessary dimensions should be shown.

Dimensions are classified into two groups: (a) size dimensions and (b) location dimensions, both of which are needed to show the necessary details of parts.

An object and its details have three dimensions in space, all of which must be shown on the drawing. The methods of construction should be understood, for all dimensions which are needed in making an object should be given.

Dimensions which would make assembly drawings too complicated are sometimes omitted. However, these dimensions must be given in detail drawings.

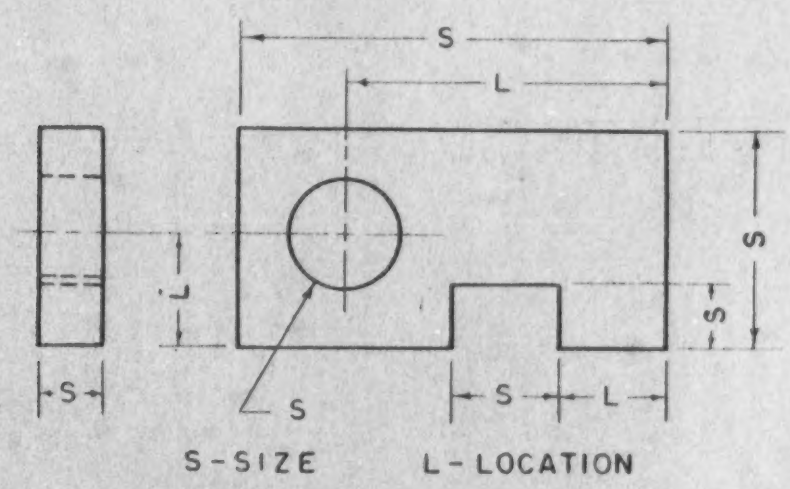

31

shock absorbers

springs

32

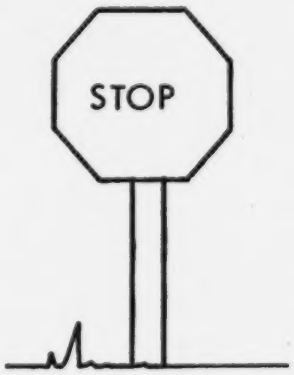

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

18838

32

NO ANSWER NEEDED

33

LOOK AT PANEL 1

This panel shows pictures of several different kinds of:

- ☐ engines
- ☐ shock absorbers
- ☐ springs
- ☐ wheels

How many different kinds are shown? _____

18839

33

springs

4

34

LOOK AT PANEL 1

Which cars below have coil springs?

☐ A

☐ B

☐ C

☐ D

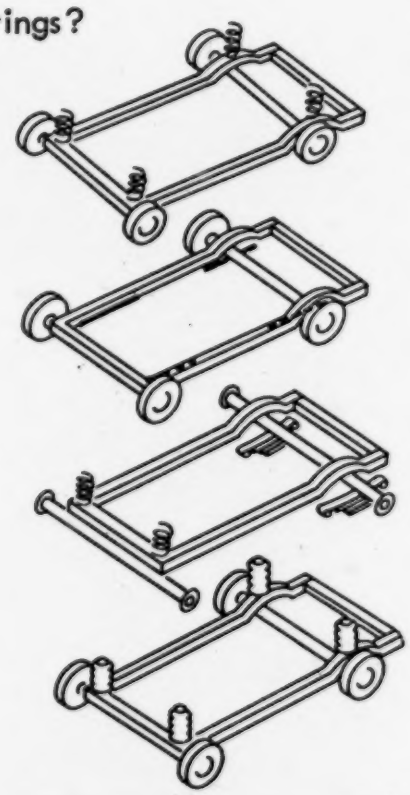

18840

34

A

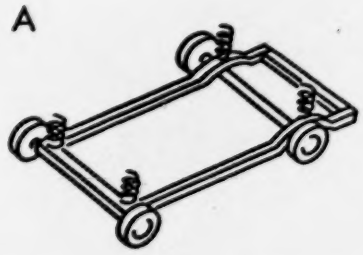

C

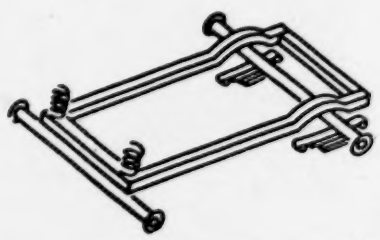

35

LOOK AT PANEL 1

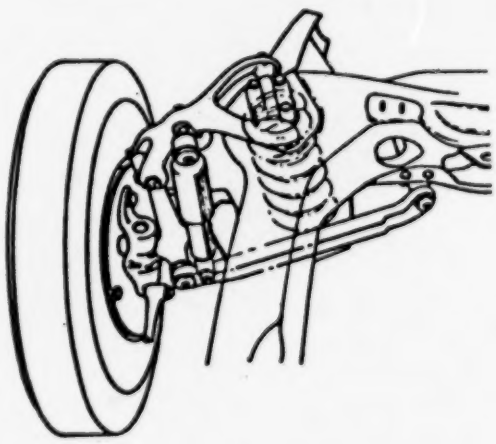

A

B

Picture "A" shows a coil spring and picture "B" shows:

- ☐ an air spring
- ☐ a leaf spring

18841

35

an air spring

36

LOOK AT PANEL 1

On the car below, CIRCLE the leaf springs and MARK an X through the coil springs:

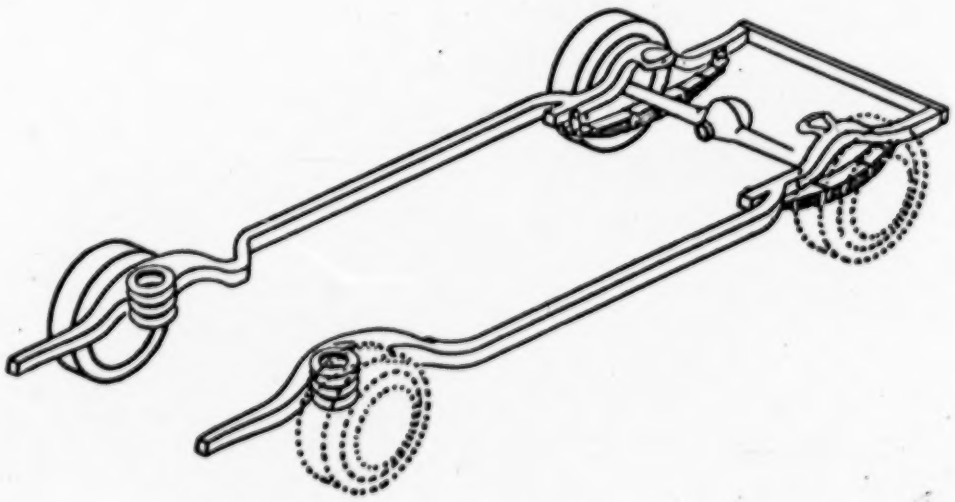

18842

36

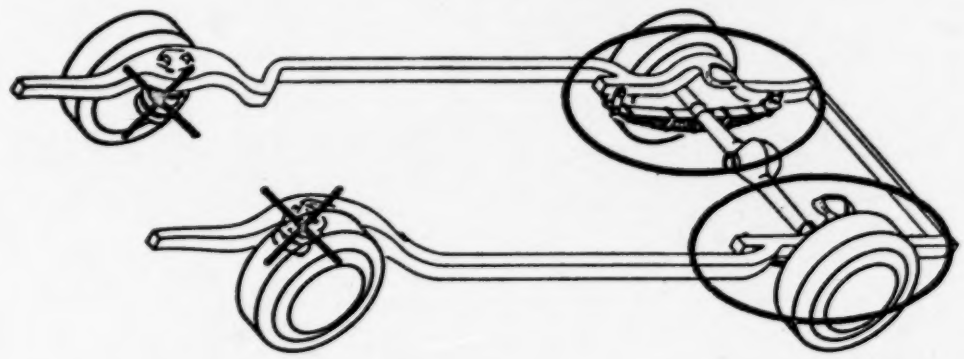

37

LOOK AT PANEL 1

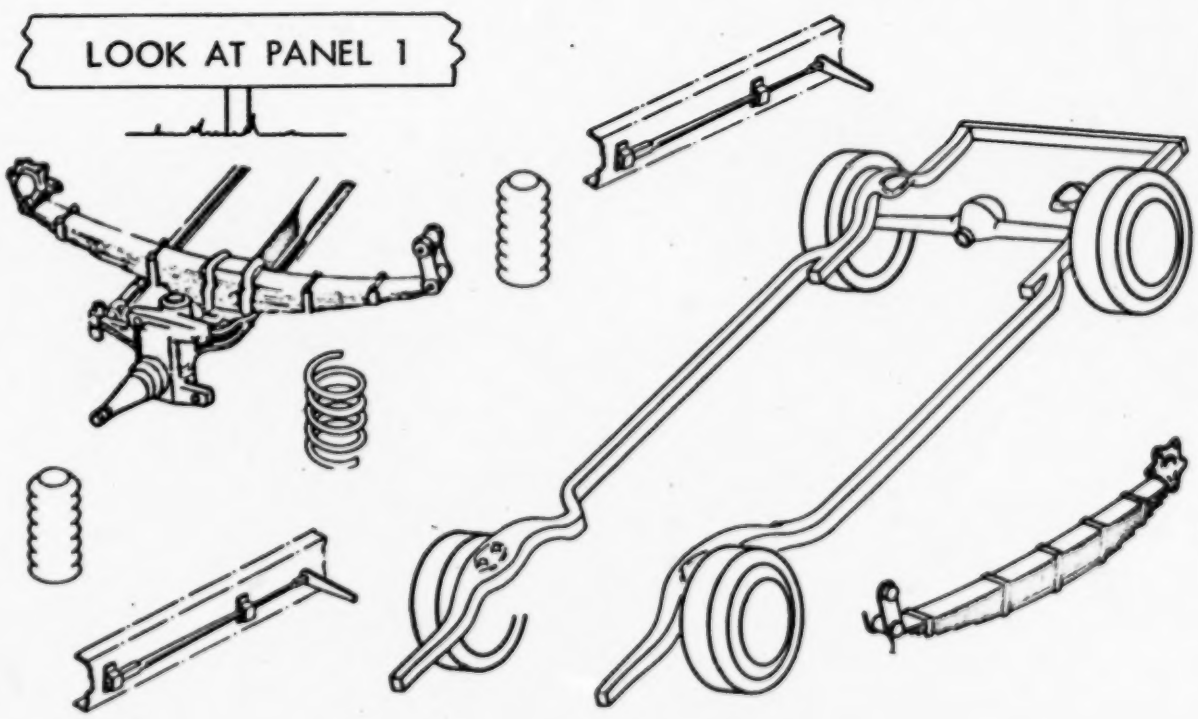

How many leaf springs are there in the picture above? ____

How many coil springs are there? ____

18843

37

2

1

38

MATCH the pictures with the names:

1. _____ coil spring

2. _____ leaf spring

A

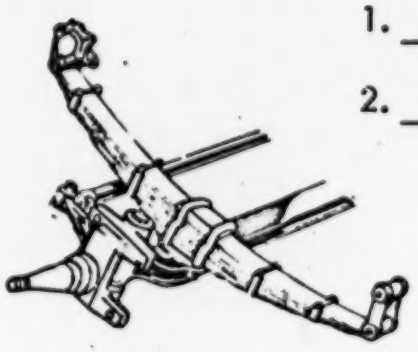

B.

C.

18844

39

2

40

LOOK AT PANEL 1

CHECK the air springs below:

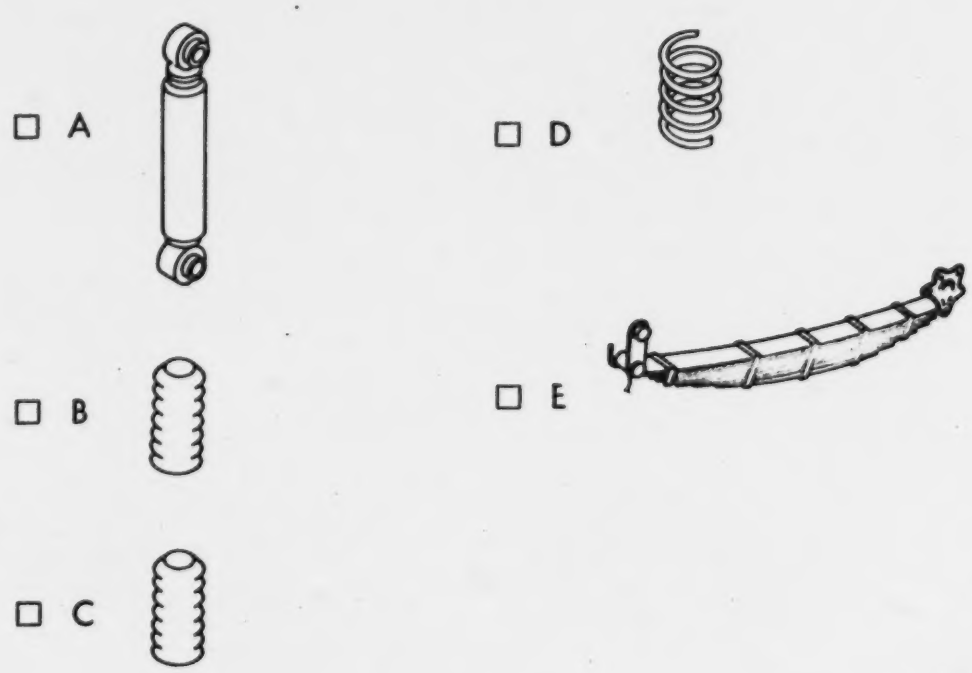

18846

40

B

C

41

MATCH the names with the pictures:

A. air spring

B. coil spring

C. leaf spring

1. ____

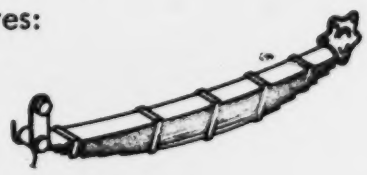

2. ____

3. ____

4. ____

18847

A. Required Activities Continued:

2. Refer to Arts. 11-4 and 11-5, "Size Dimensions" and "Location Dimensions" on pages 134-136 in *Mechanical Drawing* text while completing plate D-8.

B. Optional:

1. Select plate D-9 or D-10 as an option.

1852

41

1. C
2. A
3. —
4. B

42

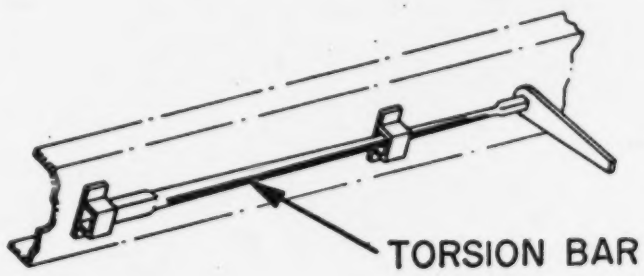

This is a picture of a TORSION BAR.

The torsion bar does the same job as the:

- ☐ coil springs
- ☐ shock absorbers
- ☐ wheel cylinders

18848

42

coil springs

43

LOOK AT PANEL 1

On the car below, CIRCLE the torsion bar springs and MARK an X through the coil spring:

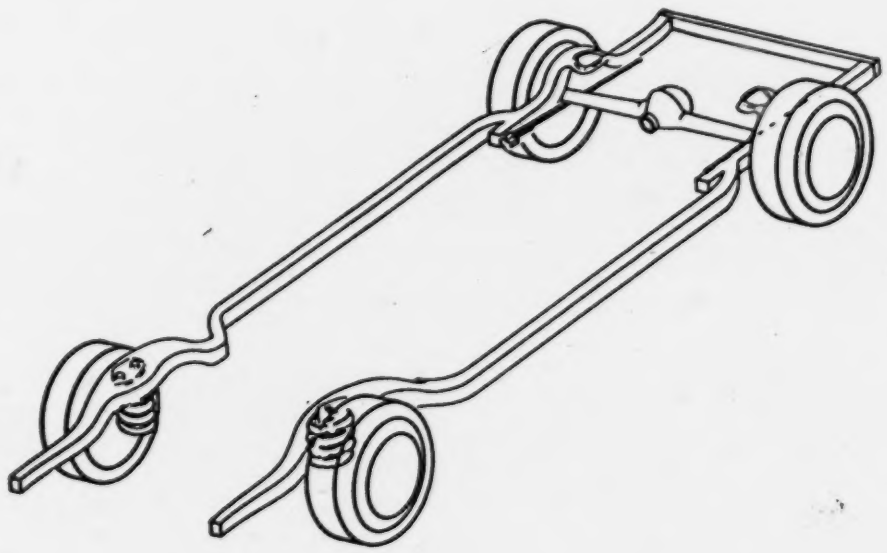

18849

43

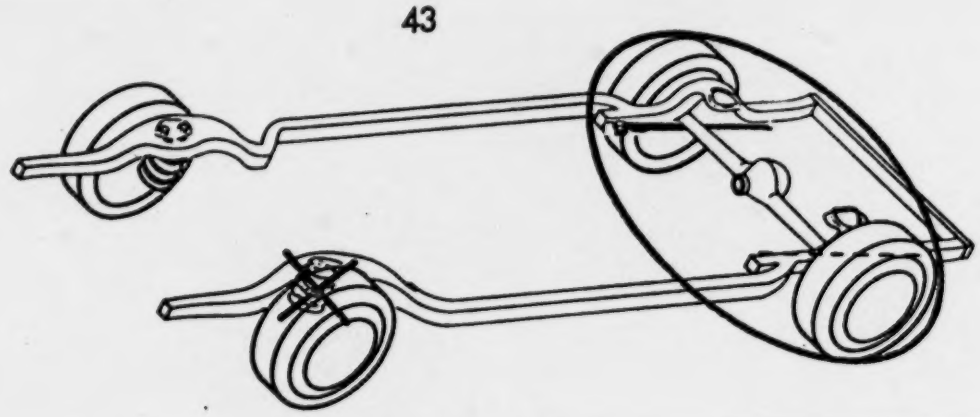

44

LOOK AT PANEL 1

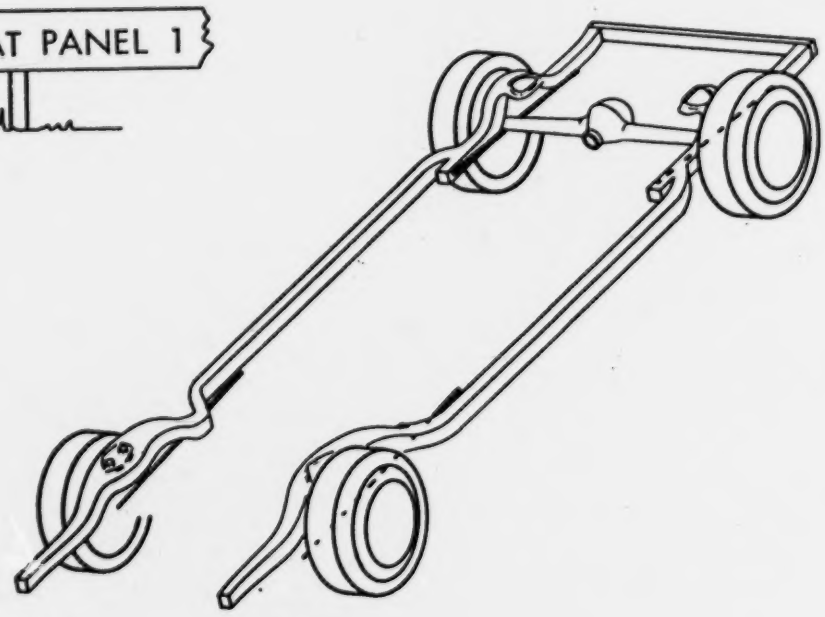

How many torsion bar springs are on this car? _____

How many coil springs are there? _____

18850

44

4

0

45

LOOK AT THE PICTURE BELOW

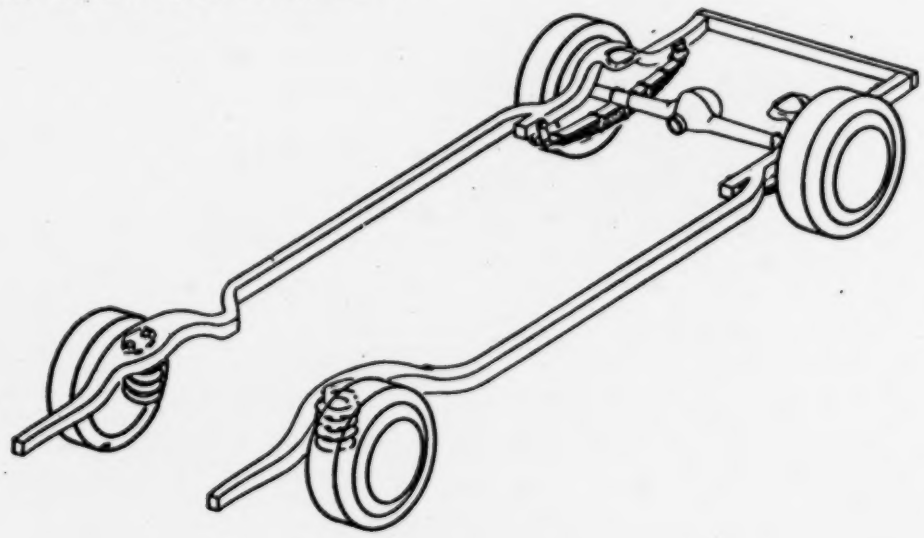

What kind of springs are on the front wheels?

- ☐ air springs
- ☐ coil springs
- ☐ leaf springs

18851

45

coil springs

46

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

18852

46

NO ANSWER NEEDED

47

Suspension-system parts:

- ☐ let the body of the car go smoothly while the wheels bounce
- ☐ make the body of the car bounce with the wheels

Different kinds of springs:

- ☐ can do this job
- ☐ cannot do this job

18853

47

let the body of the car go smoothly while the wheels bounce

can do this job

48

MATCH the names with the pictures:

A. air springs

B. coil springs

C. leaf springs

1. ____

2. ____

3. ____

4. ____

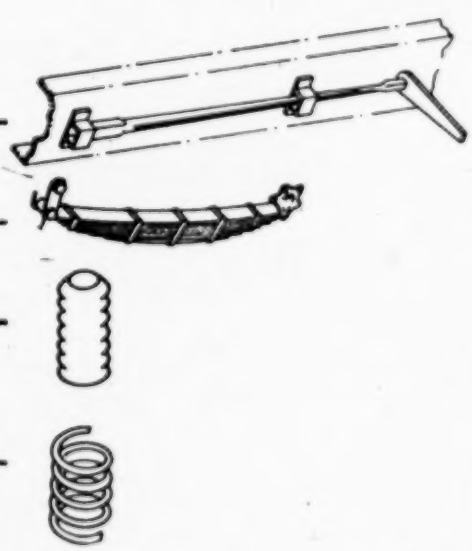

18854

48

1. —
2. C
3. A
4. B

49

MATCH the pictures with the names:

A.

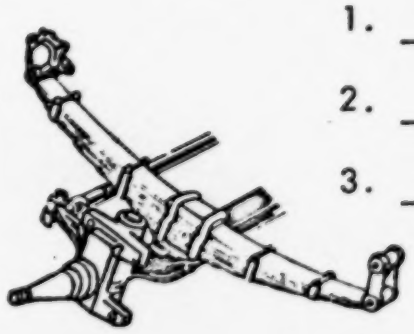

B.

C

D

1. _____ air spring
2. _____ leaf spring
3. _____ torsion bar spring

18855

49

1. D
2. A
3. C

50

For a car to ride smoothly, it must have springs and shock absorbers.

A car with shock absorbers and a broken spring will give:

- ☐ a bumpy ride
- ☐ a smooth ride
- ☐ the same ride as before

18856

50

a bumpy ride

51

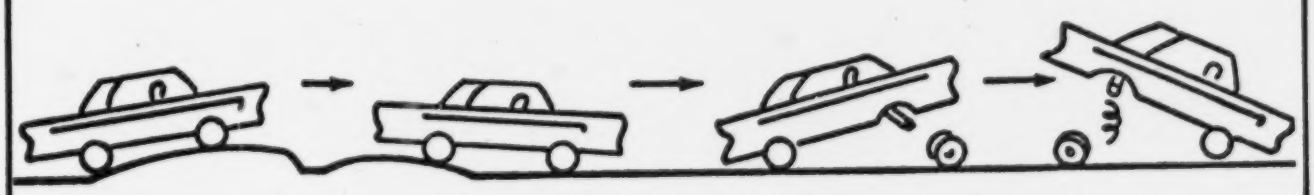

A suspension system with springs alone and no shock absorbers will:

- ☐ keep bouncing after going over a bump
- ☐ stop bouncing at once after going over a bump
- ☐ stay the same after going over a bump

18857

Secondary Idea #5:

To understand the various systems of dimensioning.

Student Objective #1:

Given the necessary drawing plates, the student will be able to develop an ability to accurately dimension views by the aligned and unidirectional system.

Activities for Student Objective #1:

A. Required:

1. Refer to Art. 11-12, "Placing Dimensions for Reading", on page 133 in the *Mechanical Drawing* text while completing the following:

   a. The Cone Gland on the upper half of plate D-11 using the aligned system of dimensioning.

   b. Complete the Sleeve on the lower half of plate D-11 using the unidirectional system of dimensioning.

B. Optional:

1. Locate a blueprint from the automotive or aircraft industry showing unidirectional system of dimension.

2. Define the following terms:

   a. Fillet
   b. Round
   c. Leader
   d. Finish Mark
   e. Radius

3. Complete plate D-12 using the unidirectional system of dimensioning.

51

keep bouncing after going over a bump

52

Which car will give a smoother ride?

- ☐ a car that has springs
- ☐ a car that has springs and shocks

18858

52

a car that has springs and shocks

53

Shock absorbers smooth out a spring's bounce.

Using shock absorbers with springs:

- ☐ has no effect on the ride
- ☐ gives a smooth ride
- ☐ gives a rough ride

18859

53

gives a smooth ride

54

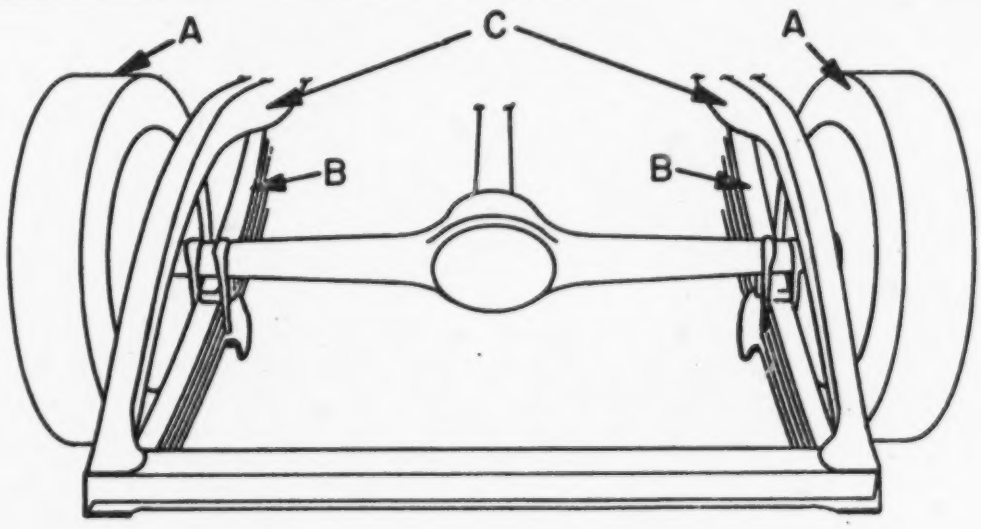

MATCH the correct letter to each of the following parts:

chassis _____

leaf springs _____

rear wheels _____

18860

54

C

B

A

55

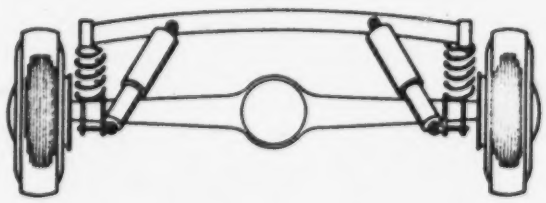

What kind of springs are shown here?

- ☐ air springs
- ☐ coil springs
- ☐ leaf springs

What other part of the suspension system is shown in this picture?

_____ _____

18861

55

coil springs

shock absorbers

56

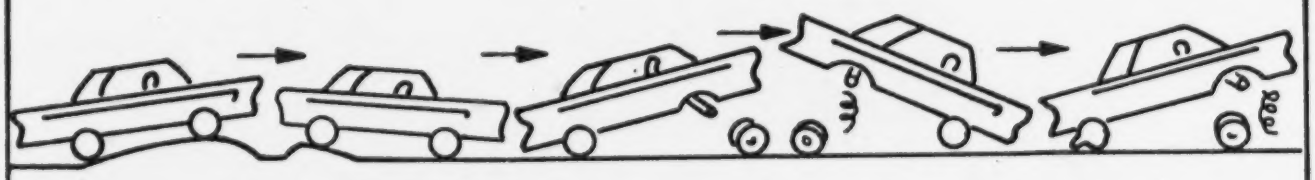

What part of the suspension system is missing from this diagram?

- ☐ springs
- ☐ shock absorbers

18862

56

shock absorbers

57

CIRCLE the shock absorber:

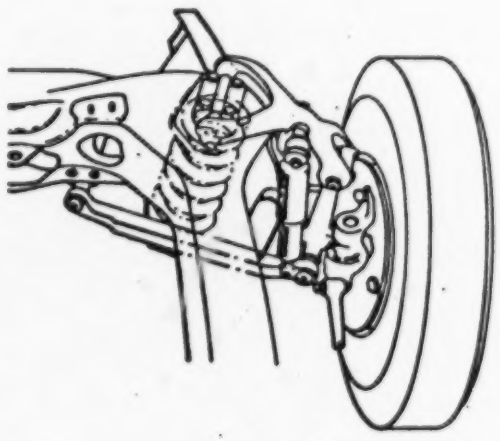

18863

57

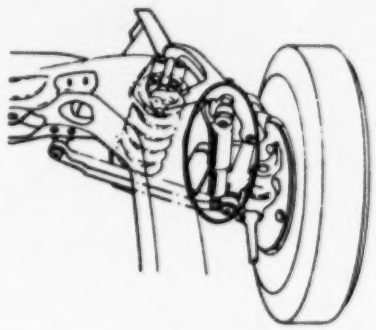

58

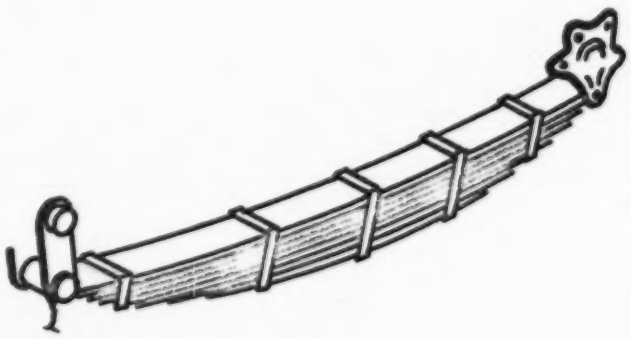

These are pictures of a leaf spring and:

- ☐ an air spring
- ☐ a coil spring
- ☐ a torsion bar

18864

58

an air spring

59

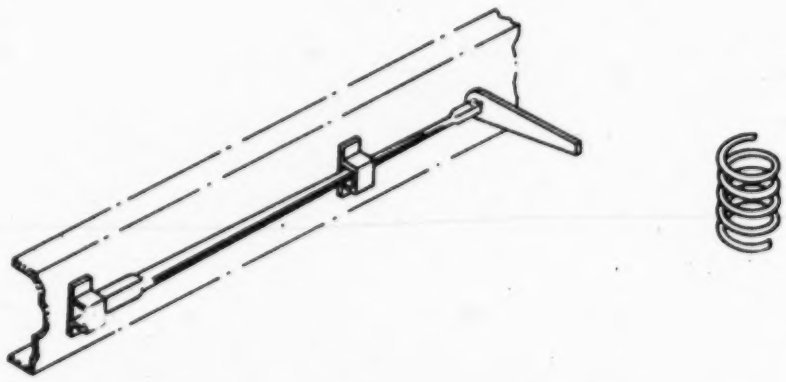

These are pictures of a coil spring and:

- ☐ an air spring
- ☐ a leaf spring
- ☐ a torsion bar spring

18865

59

a torsion bar spring

60

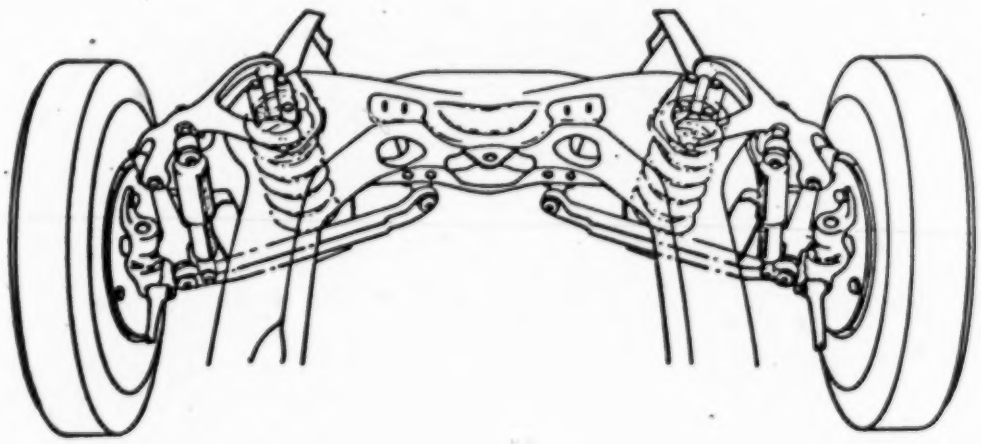

To get a smooth ride, you must:

- ☐ use springs alone
- ☐ use shocks alone
- ☐ use shocks and springs togethers

18866

60

use shocks and springs together

61

What are the shock absorbers used for?

- ☐ to hold the wheel on the axle
- ☐ to smooth out the spring bounce
- ☐ to hold the springs on the axle

10067

BIBLIOGRAPHY

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3. French and Svensen, *Mechanical Drawing*, Webster-McGraw-Hill, Sixth Edition.

4. Nelson, Howard C., *Drafting Rules and Principles*, McKnight and McKnight.

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61

to smooth out the spring bounce

62

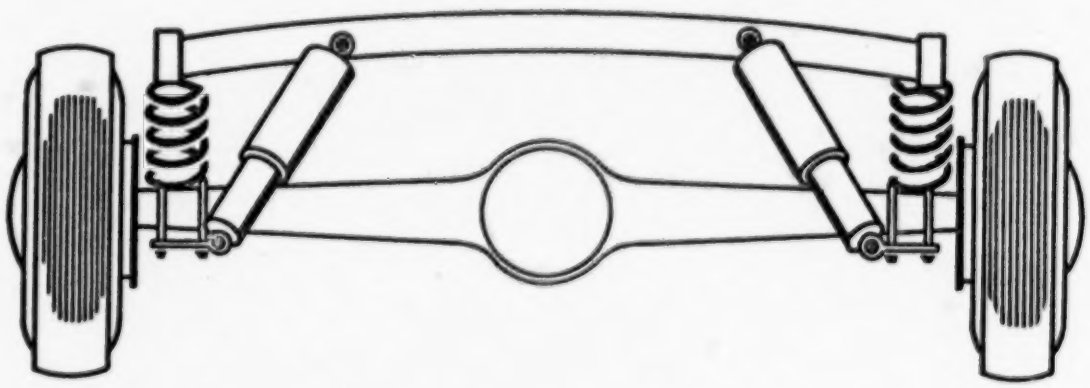

How many different parts are there in a car's suspension system?

_____

18868

62

2

63

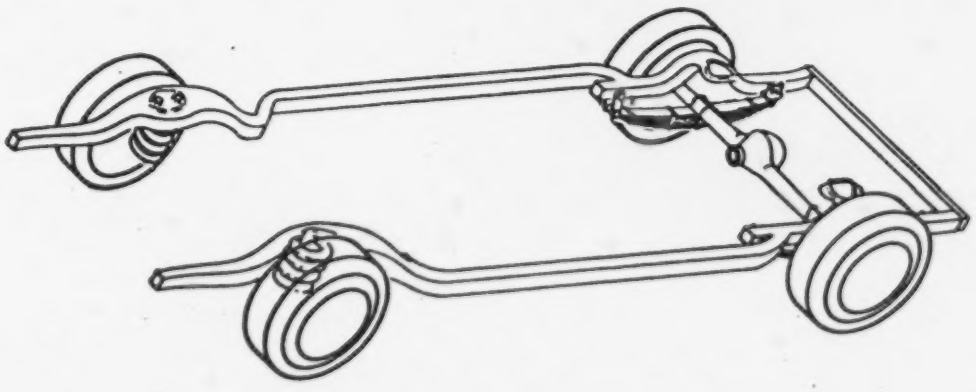

What kind of springs are there in front of the car?

- ☐ air springs
- ☐ coil springs
- ☐ leaf springs

What kind of springs are at the rear of the car?

- ☐ air springs
- ☐ coil springs
- ☐ leaf springs

18869

63

coil springs

leaf springs

64

A car's suspension system may use different types of springs at the front and at the rear of the car.

Which of the following statements are correct? (CHECK TWO)

- ☐ Some cars have the same type of springs at the front and at the rear of the car.
- ☐ Some cars have different types of springs at the front and at the rear of the car.
- ☐ Vehicles never have different types of springs at the front and at the rear of the car.

18870

64

Some cars have the same type of springs at the front and at the rear of the car.

Some cars have different types of springs at the front and at the rear of the car.

65

Must a car always have the same kind of springs at the front and at the rear of the car?

- ☐ yes
- ☐ no

Is it possible to have the same kind of springs at the front and at the rear of the car?

- ☐ yes
- ☐ no

65

no

yes

66

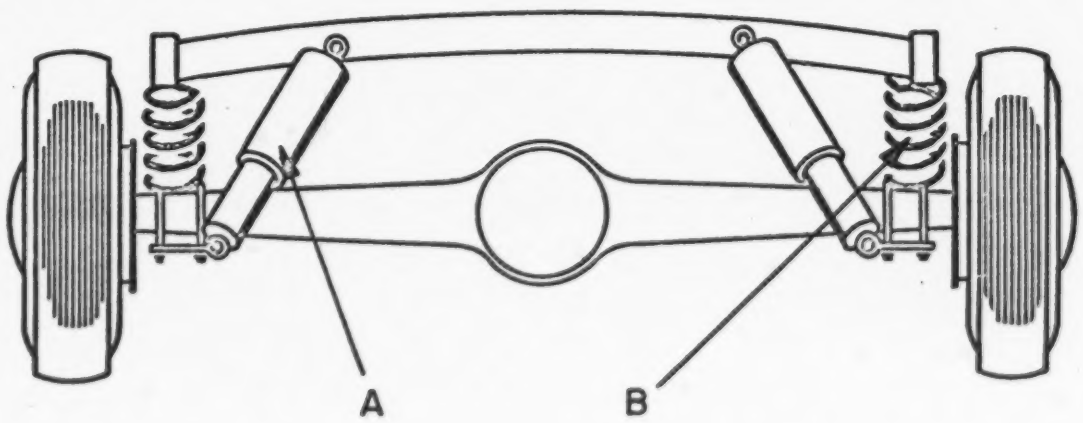

The arrow that points to the shock absorber is:

- ☐ arrow A
- ☐ arrow B

18872

66

arrow A

67

MATCH the parts with the jobs:

A. springs

B. shock absorbers

1. _____ support the chassis

2. _____ stop the car's bounce

18873

67

1. A
2. B

68

MATCH the names with the pictures:

A. chassis
B. shocks
C. springs

1. ____
2. ____
3. ____
4. ____

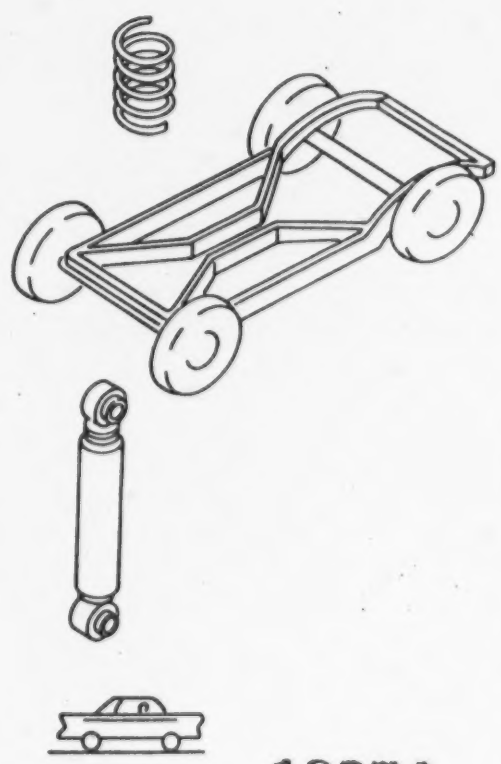

18874

68

1. C
2. A
3. B
4. —

69

MATCH the names with the pictures:

A. air springs
B. coil springs
C. leaf springs
D. torsion bar springs

1. ____
2. ____
3. ____
4. ____
5. ____

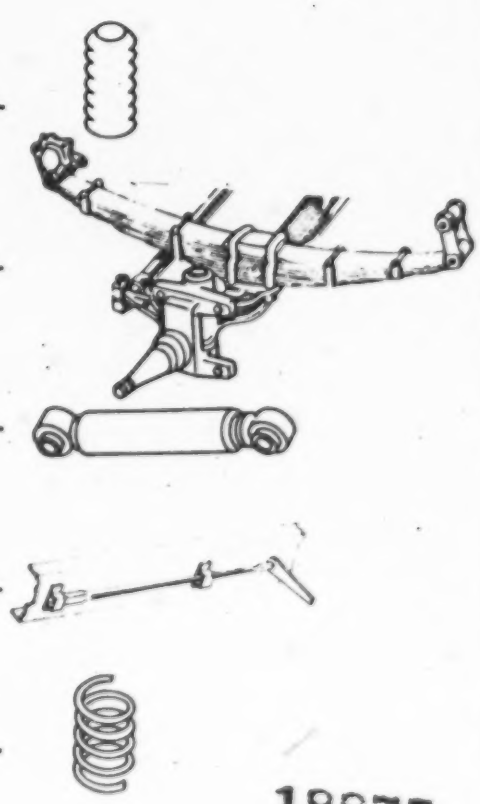

18875

69

1. A
2. C
3. —
4. D
5. B

70

What do springs do?

- ☐ let the car bounce off the wheels
- ☐ keep the car steady while the wheels bounce
- ☐ keep the wheels steady while the car bounces

18876

70

keep the car steady while the wheels bounce

71

What are shock absorbers used for?

- ☐ to hold the wheel on the axle
- ☐ to smooth out spring bounce
- ☐ to tie the springs onto the axle

18877

VT 011 561
Selected Advances in Metalworking Technology.
Technology Utilization.

Small Business Administration, Washington, D.C.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 70 49p.

DESCRIPTORS - *RESOURCE MATERIALS; TECHNICAL REPORTS; *TECHNOLOGY; *METAL INDUSTRY; METAL WORKING OCCUPATIONS; *TECHNICAL EDUCATION; PATENTS; METALLURGY

ABSTRACT - This publication of the Small Business Administration (SBA) presents a number of innovative processes and devices selected and intended to be of interest and use to small businesses concerned with metalworking technology. Developed through government space, nuclear energy, and defense programs, the material is presented in the form of brief digests from three major sources: NASA/AEC Tech Briefs, government-owned patents, and reports from the Clearinghouse for Federal Scientific and Technical Information. Brief general information is given on the Technology Utilization program of the SBA , as well as procedures for obtaining the full reports from which the digests are taken, followed by more than 125 digests covering: (1) forming, (2) heat treating and cleaning, (3) instrumentation, (4) joining, (5) machining, (6) metals, (7) new products, and (8) seals, coatings, and lubricants. Order forms for all three categories of sources are also provided. (AW)

VT 011 561

71

to smooth out spring bounce

THIS IS THE END OF BOOK 13

18878

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

Springs and shock absorbers are in the:

- ☐ cooling system
- ☐ power transmission system
- ☐ suspension system

2

The job of an automobile's suspension system is to:

- ☐ hold the axis on the chassis
- ☐ make the frame shaky
- ☐ smooth out the car's ride
- ☐ stop the car

3

Automobile springs:

- ☐ bounce the car while the wheels remain steady
- ☐ let the car bounce with the wheels
- ☐ keep the car steady while the wheels go up or down

4-8

MATCH the letters with the pictures:

A. air spring
B. coil spring
C. leaf spring
D. torsion bar
E. shock absorber

4. ____

5. ____ 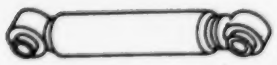

6. ____

7. ____

8. ____

9

If a car had no shock absorbers, the:

- ☐ car would not bounce
- ☐ springs would not bounce
- ☐ springs would bounce too much

10

An automobile:

- ☐ can have different springs at the front and at the rear
- ☐ cannot have different springs at the front and at the rear

PANEL BOOK **13**

To Be Used with
BOOK 13

AUTO MECHANICS COURSE

PANEL BOOK 13: SUSPENSION SYSTEM

A BASIC SYSTEMS PROGRAM

18882

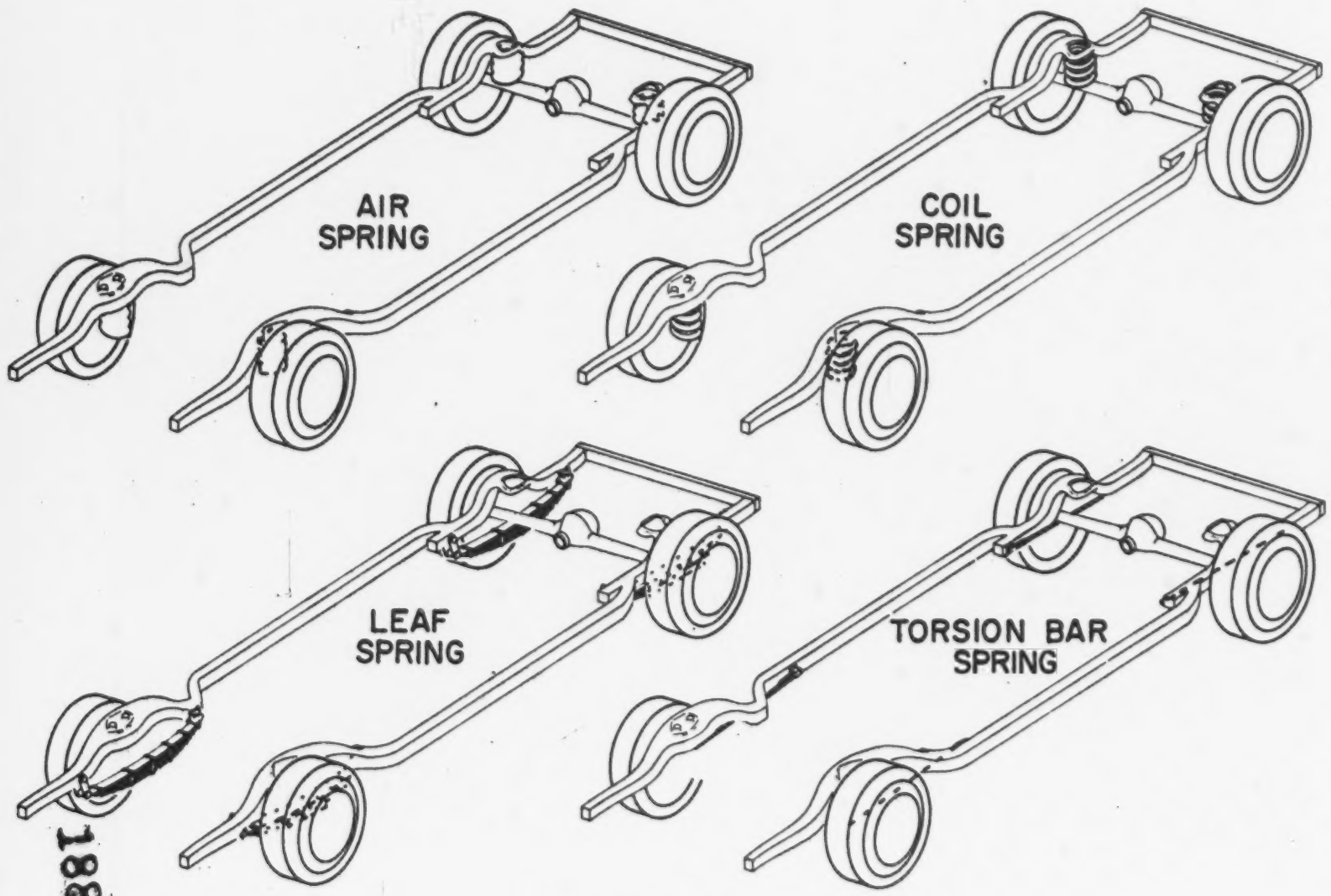

PANEL 1

18883

VT 013 136
Auto Mechanics Course. Book 14: Major Parts of An Engine, Part I.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 121p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *ENGINES; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the major parts of an engine was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 103 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

12884

VT 013 136

ED0 56238

BOOK 14

(C1)

AUTO MECHANICS COURSE

BOOK 14: MAJOR PARTS OF AN ENGINE

PART I

A BASIC SYSTEMS PROGRAM

VT013136

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Curriculum Report Reference
Page 13

Task Analysis Reference
15.1, 15.2

18885

AUTO MECHANICS COURSE

BOOK 14: MAJOR PARTS OF AN ENGINE

PART I

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

18886

AUTO MECHANICS COURSE

PRE-TEST BOOK 14: MAJOR PARTS OF AN ENGINE

PART I

A BASIC SYSTEMS PROGRAM

18887

SMALL
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Washington, D.C.

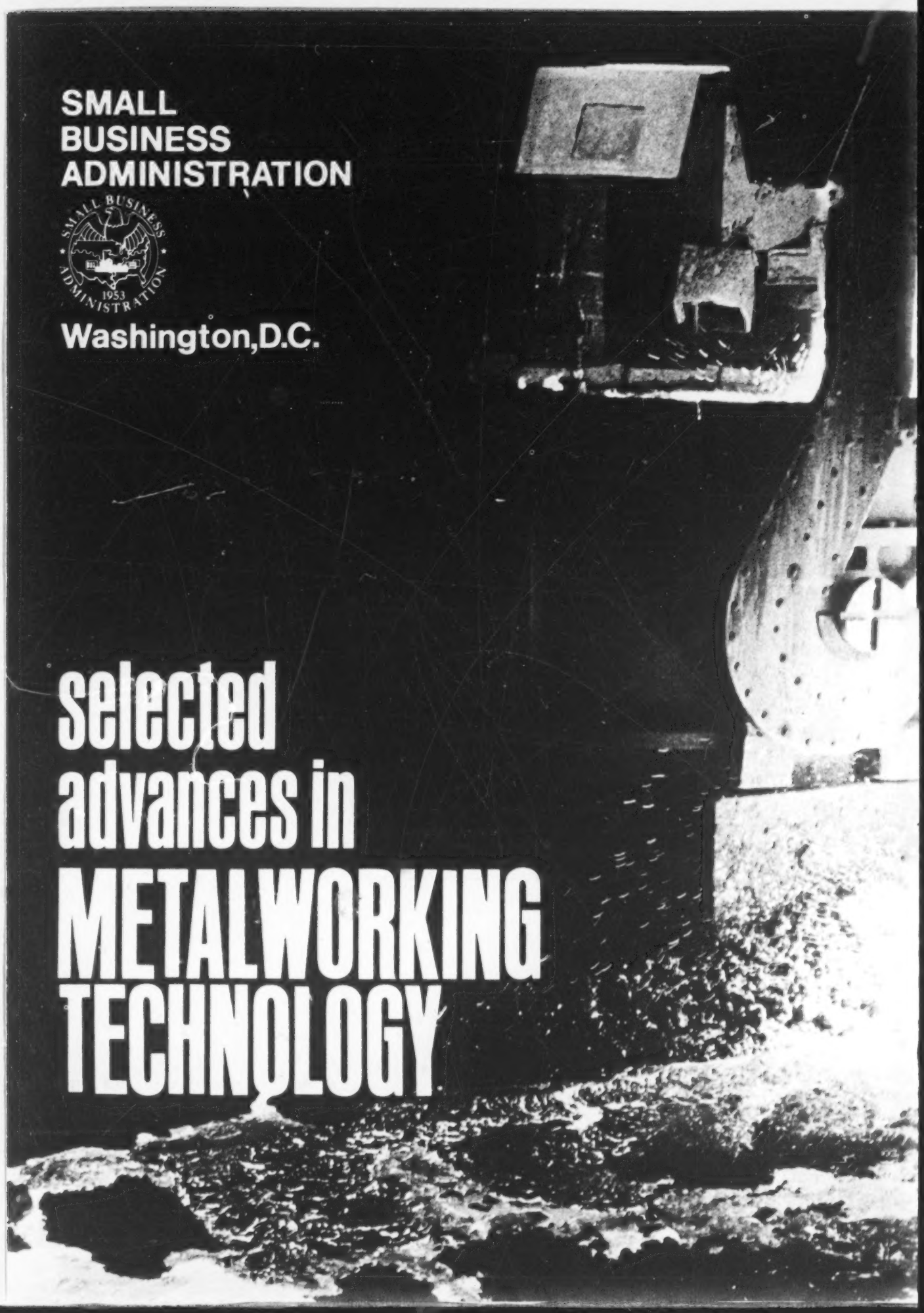

selected advances in METALWORKING TECHNOLOGY

1

An automobile's fuel is a mixture of _____ and _____.

2

In which part of the fuel system is the engine's fuel mixed?

_____

3

NAME the part that causes the spark to explode the fuel mixture:

_____ _____

4

The fuel mixture is exploded in the _____ _____.

5

NAME the part that is pushed down by explosions in the engine:

_____

6

NAME the part that connects the piston to the crankshaft:

_____ _____

18888

7

NAME the part of the engine that gives power to the Power Transmission System: _____

8

Pistons go up and down in openings in the engine. NAME these openings:

_____

9

The cylinder head goes on the:

- ☐ top of the engine
- ☐ bottom of the engine

10

NAME the part that goes around the pistons and seals the spaces between the piston and the cylinder walls:

_____

11

NAME the part that smooths out the uneven turning motion of the crankshaft: _____

12

The large part of the engine that holds the cylinders is called the cylinder _____.

Name _____

Date _____

Starting time _____

Finishing time _____

18891

1

You have learned that an automobile's fuel is a mixture of _____ and _____ .

18892

267 OF 327

ED

056 238

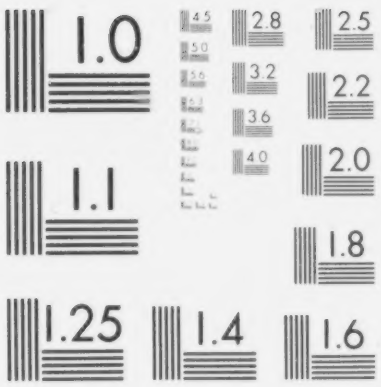

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

1

air gasoline

2

The power to move an automobile comes from the engine.

The parts that move an automobile forward are the:

- ☐ differential assembly gears
- ☐ transmission gear assembly
- ☐ rear wheels

18893

2

rear wheels

3

Power to move the car gets from the engine to the rear wheels through the:

- ☐ brake system
- ☐ cooling system
- ☐ power transmission system

3

power transmission system

4

The power transmission system gets the power to move the car from the:

- ☐ brakes
- ☐ engine
- ☐ radiator

18895

4

engine

5

The automobile engine gives the _____ that moves the car.

18896

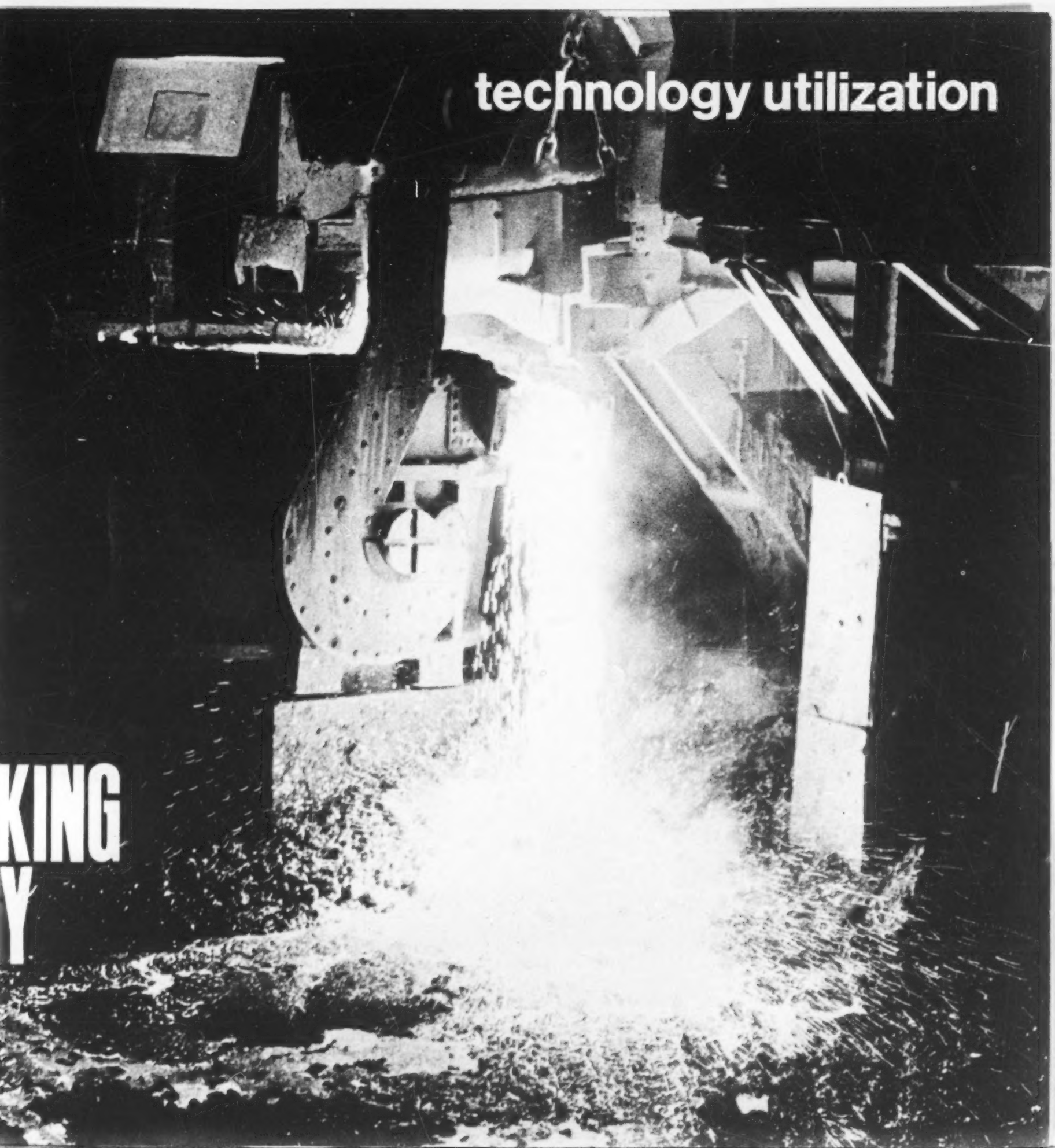

technology utilization

KING
Y

5

power

6

This book will teach you about the parts of the engine that make power for the car.

This book will also teach you how power from the engine gets to the Power Transmission System.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

18897

6

NO ANSWER NEEDED

7

The parts of the electrical system that are screwed into the engine are the:

- ☐ distributors
- ☐ coils
- ☐ spark plugs

18898

7

spark plugs

8

The carburetor makes a mixture of air and gasoline.

This mixture enters the engine through the:

- ☐ intake manifold
- ☐ exhaust manifold
- ☐ manifold heat control valve

18899

8

intake manifold

9

At the same time that the air-gasoline mixture enters the engine, the spark plugs that are screwed into the engine make a spark.

When the spark plugs spark the mixture of air and gasoline:

- ☐ an explosion will happen
- ☐ they will mix together
- ☐ there will be no change at all

9

an explosion will happen

10

The part that causes the air-gasoline mixture to explode is the

_____ _____.

18901

10

spark plug

11

The job of the spark plug is to _____ the air-gasoline mixture.

This will happen inside the:

- ☐ engine
- ☐ ignition coil
- ☐ master cylinder

11

explode

engine

12

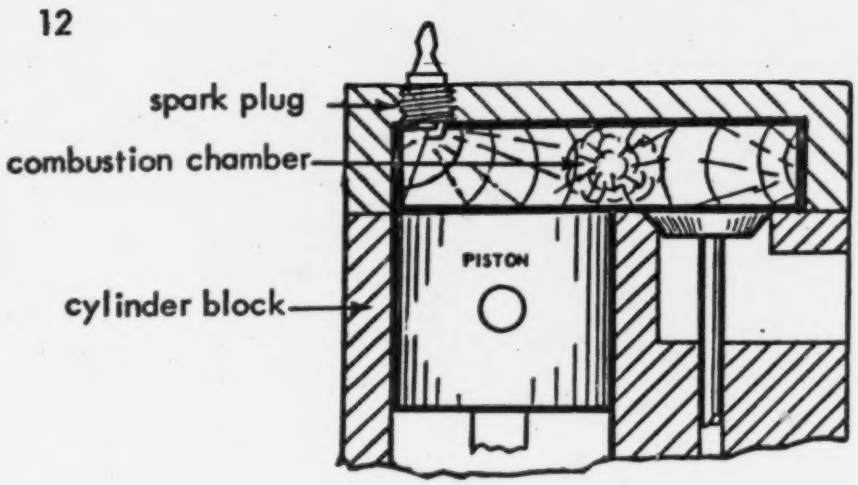

The spark is made in the bottom of the spark plug.

The bottom of the spark plug is screwed into a part of the engine called the _____ _____.

18903

12

combustion chamber

13

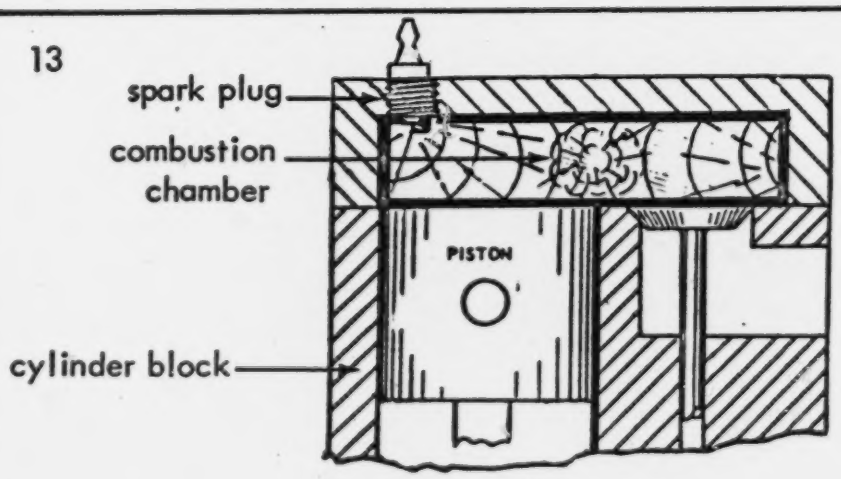

In the combustion chamber, there is an explosion of _____ and _____ .

18904

13

air gasoline

14

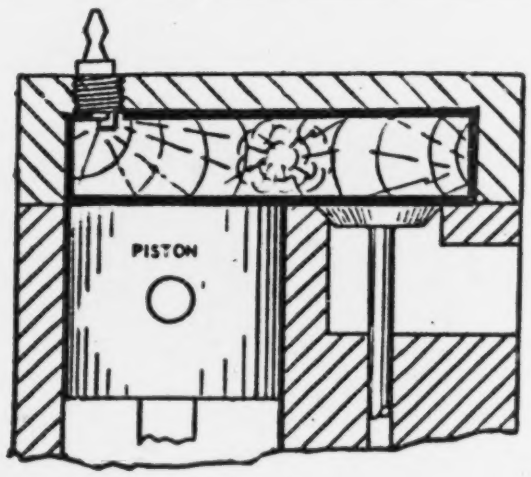

The spark explodes a mixture of air and gasoline.

This happens in the c_____ c_____.

18905

14

combustion chamber

15

The combustion chamber is really a small space at the top of the engine.

When explosions take place in a very small space:

- ☐ a lot of pressure builds up
- ☐ no pressure builds up
- ☐ little pressure builds up

18906

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15

a lot of pressure builds up

16

Pressure builds up in the combustion chamber when an _____ takes place.

18907

17

spark

18

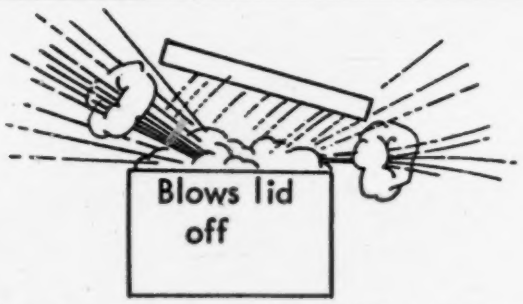

If there is an explosion in a can and the lid is not on tight, the pressure of the explosion will blow the _____ off.

What will happen to any moveable part when it is near an explosion?

- ☐ It will be pushed away from the explosion.
- ☐ It will stay where it is.
- ☐ It will blow into the explosion.

18909

18

lid

It will be pushed away from the explosion.

19

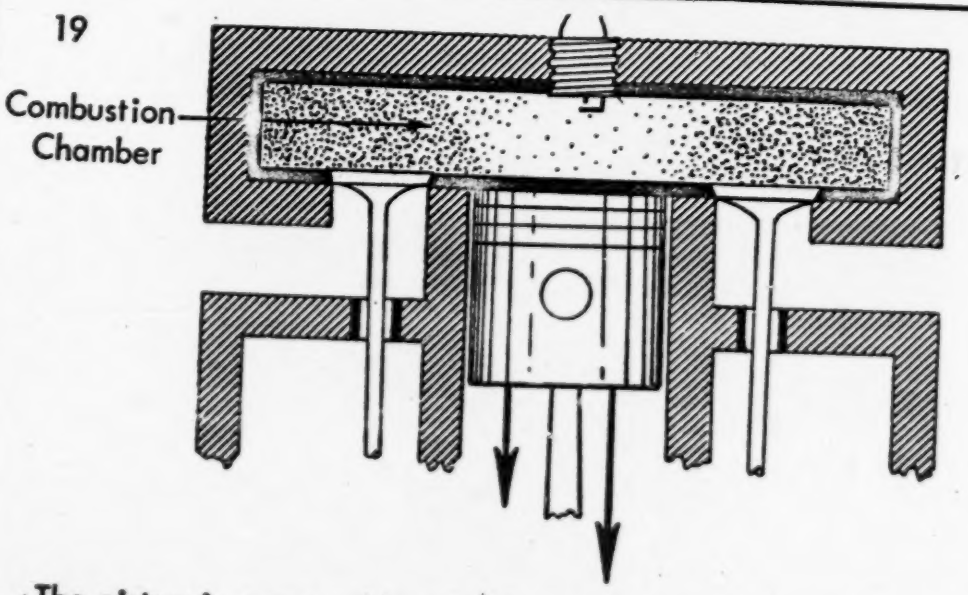

The piston is a moveable part that goes up and down in the cylinder.

When there is an explosion in the combustion chamber above the piston, the pressure of the explosion will:

- ☐ force the piston down
- ☐ not touch the piston
- ☐ move the piston up

19

force the piston down

20

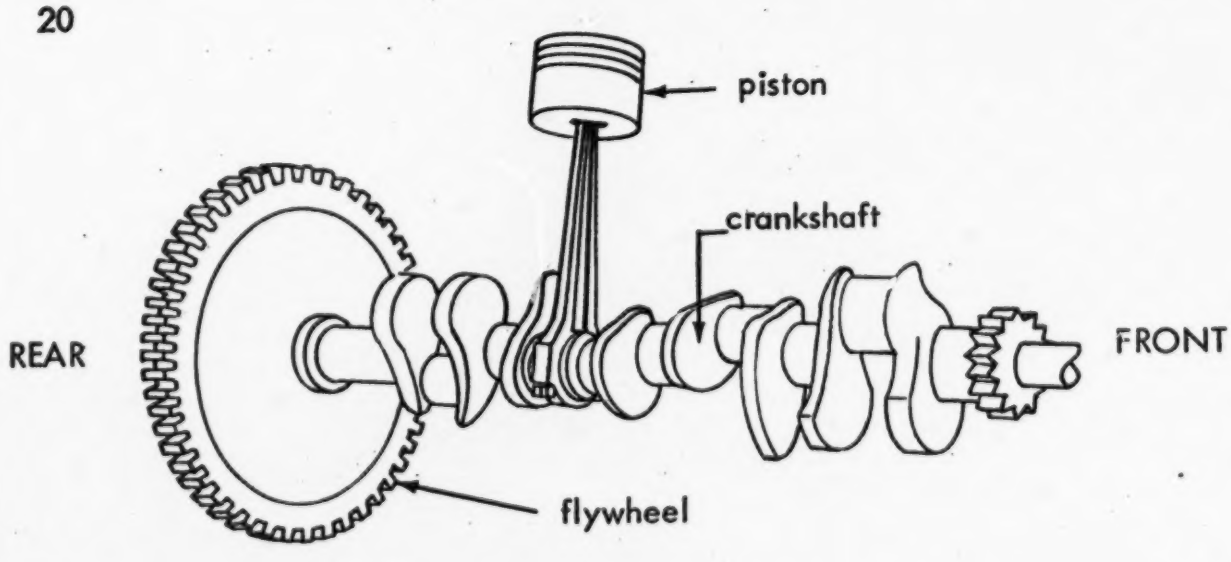

When the force of the explosion pushes the piston down, the piston forces a shaft to turn which shaft? _____

18911

20

crankshaft

21

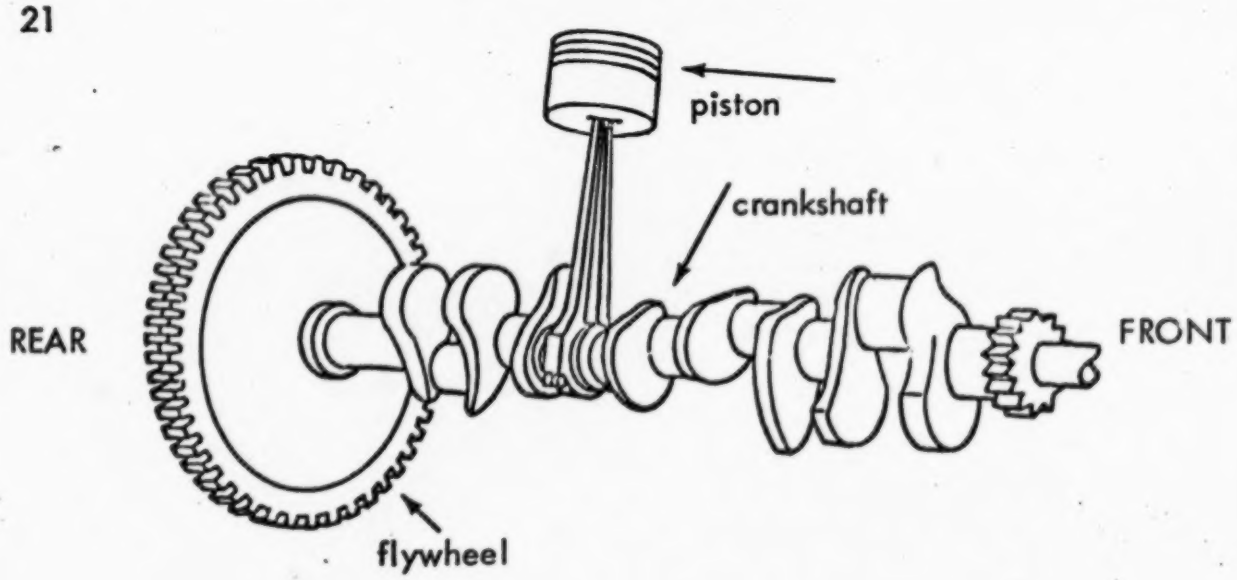

When the crankshaft turns, which large part at the rear of the crankshaft is made to turn? _____

18912

21

flywheel

22

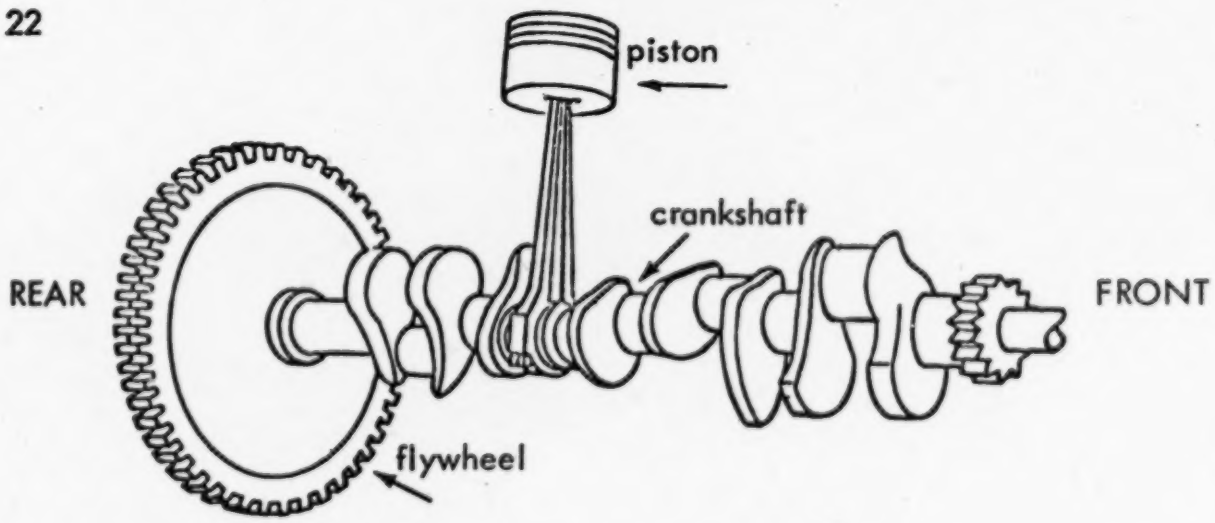

When the flywheel turns, it gives force to the Power Transmission System.

NAME the part of the engine that transmits power to the Power Transmission System: _____

18913

22

flywheel

23

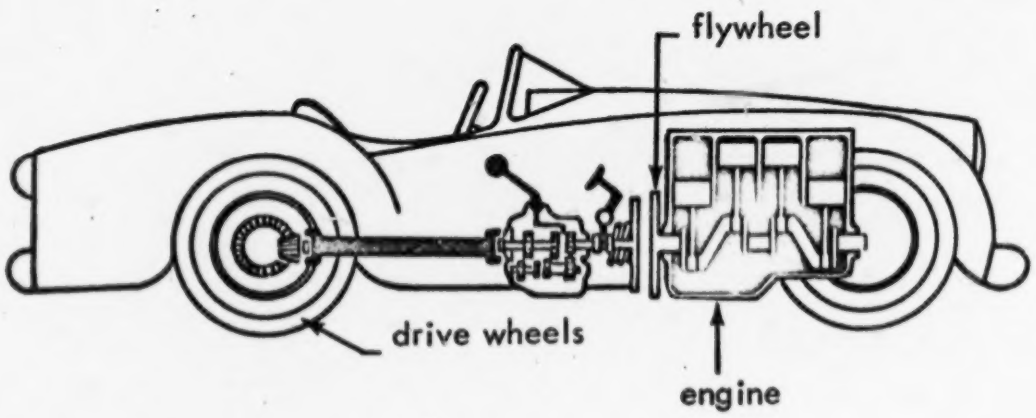

When the flywheel turns, it gives power to the _____ _____ system.

18914

23

power transmission

24

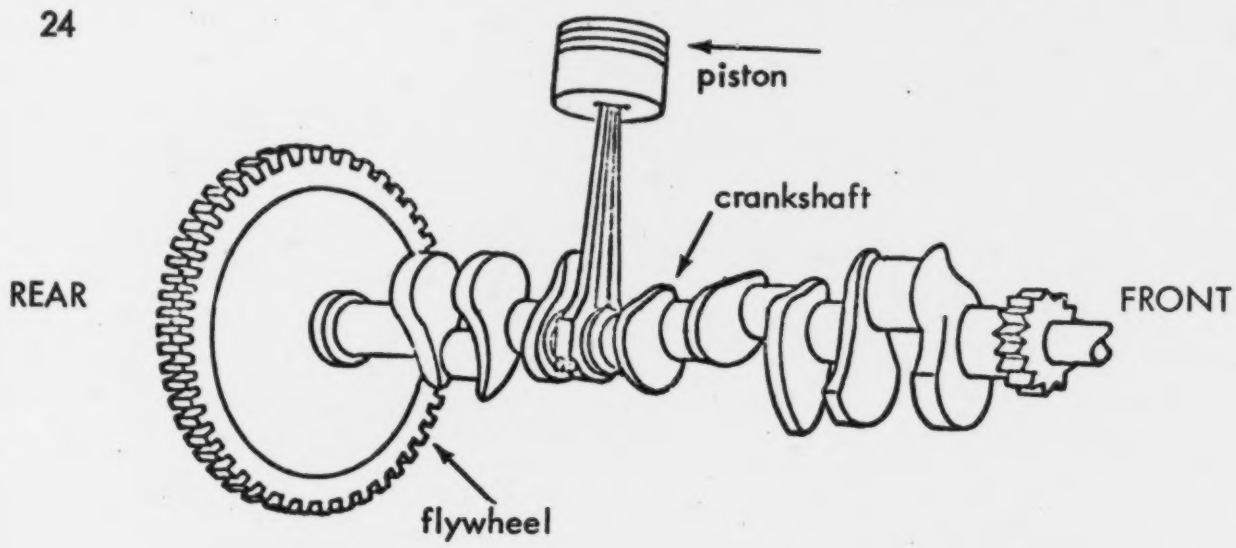

The car moves forward when the flywheel:

- ☐ moves up and down
- ☐ stays still
- ☐ turns

18915

24

turns

25

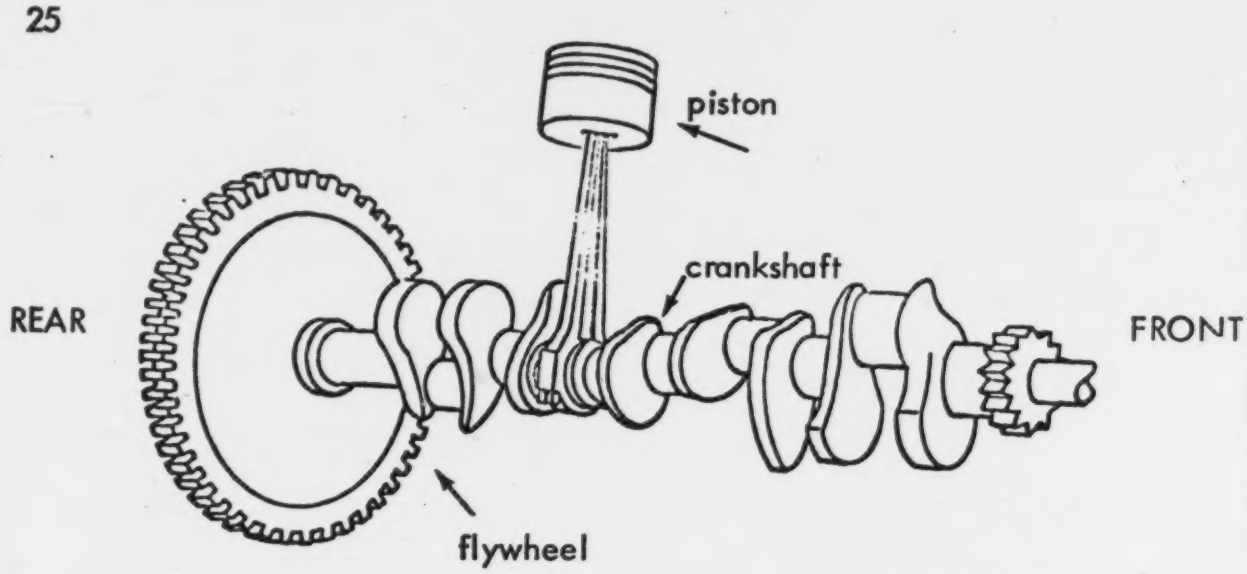

NAME the part that turns the flywheel: _____

18916

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A 200 TON CAPACITY LADLE CRANE in Keystone Steel & Wire Co.'s open hearth pit, courtesy Broderick & Bascom Rope Co., St. Louis, Mo.

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METAL LATHE, courtesy International Association of the Machinists and Aerospace Workers, Washington, D.C.

ARMCO HOT-ROLLED STEEL PRODUCTS, courtesy ARMCO Steel Corp., Middletown, Ohio.

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25

the crankshaft

26

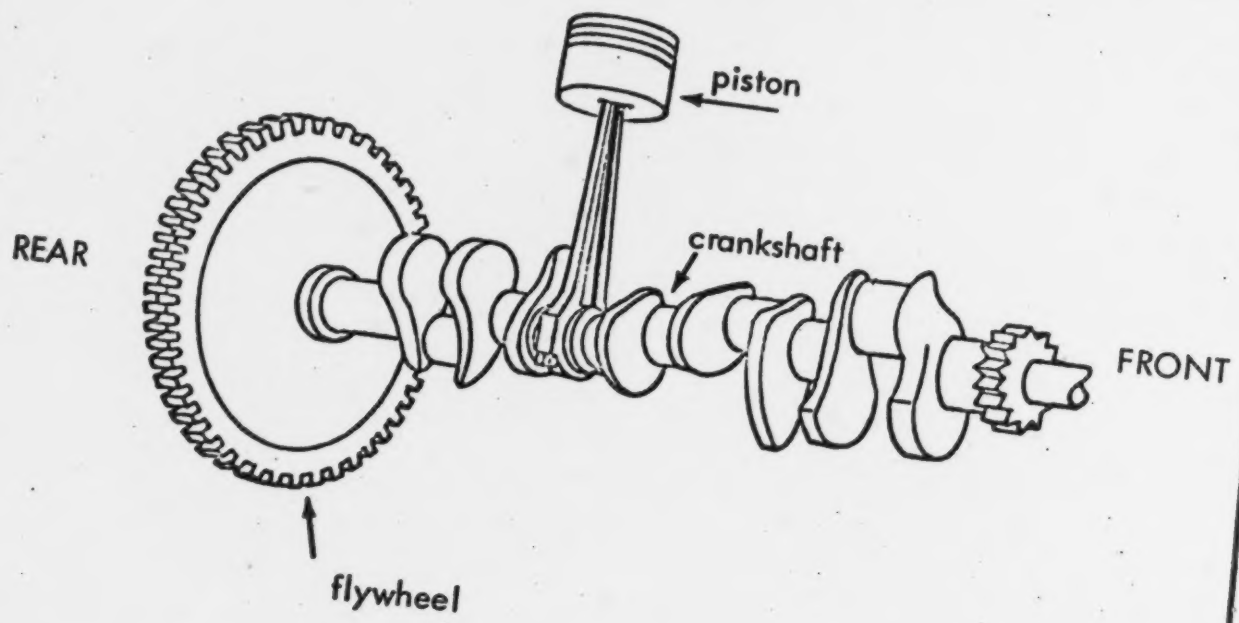

The crankshaft turns when the _____ moves up and down.

18917

26

piston

27

The piston is forced down when there are _____ in the combustion chamber.

18918

27

explosions

28

Explosions in the combustion chamber take place when the air-gasoline mixture is ignited by the _____ plugs.

18919

28

spark

29

An automobile engine's fuel is a mixture of _____
and _____ .

18920

29

air

gasoline

30

The _____ _____ give the spark that explodes the mixture of air and gasoline in the _____ _____.

18921

30

spark plugs

combustion chamber

31

What do the spark plugs do? _____

18922

31

The spark plugs give the spark that explodes the air-gasoline mixture.

32

LABEL and DRAW an arrow to the place where the mixture of air and gasoline explodes:

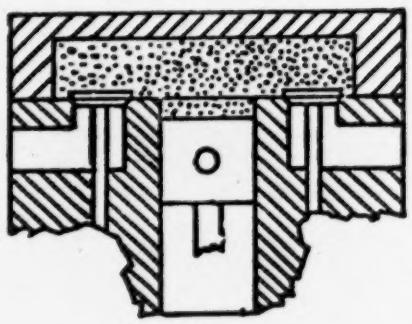

18923

32

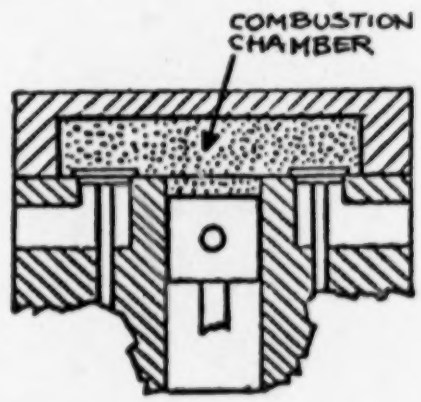

33

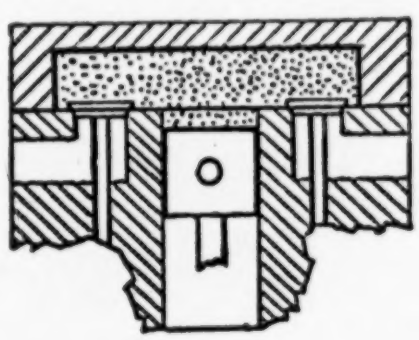

When explosions take place, the explosions:

- ☐ push the piston down
- ☐ push the piston up
- ☐ push the piston sideways

18924

33

push the piston down

34

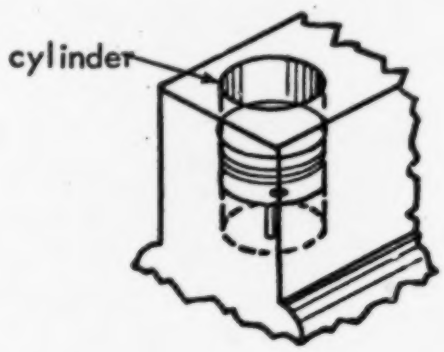

The piston go up and down in openings in the engine called

_____.

18925

34

cylinders

35

Each piston goes up and down in a cylinder.

If a car has 6 cylinders, how many pistons would it have? _____

18926

techn

selected advances in METALWORKING TECHNOLOGY

SMALL BUSINESS ADMINISTRATION 1953

35

6

36

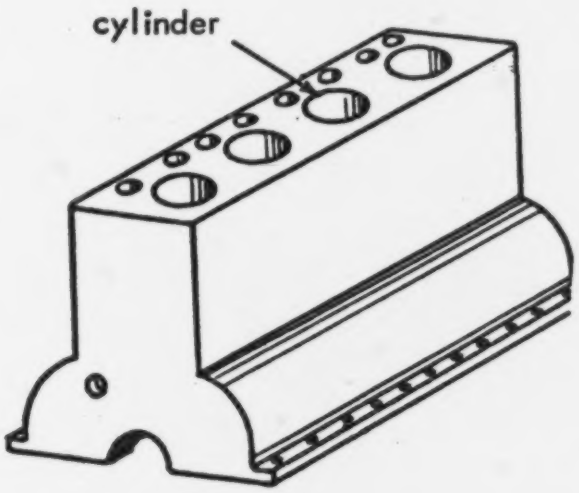

How many cylinders does this engine have? _____

18927

36

4

37

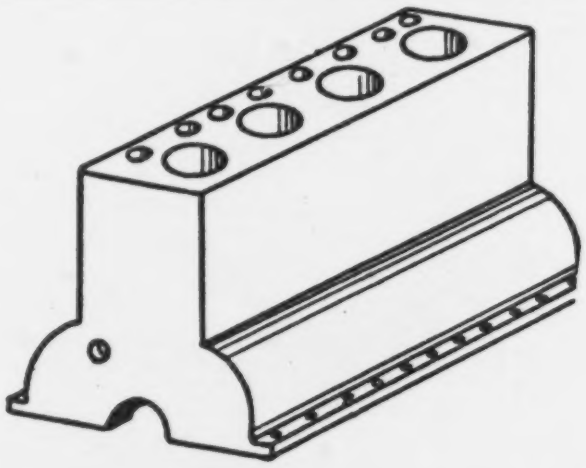

Cylinders are large open shafts in the _____ _____.

18928

37

cylinder block

38

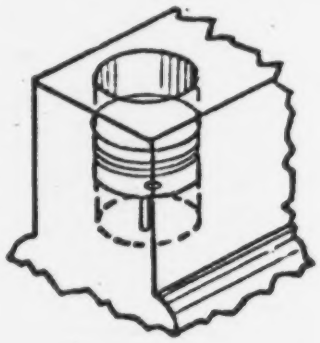

What goes up and down in the cylinders? _____

18929

38

pistons

39

When the air-gasoline mixture _____, the pistons are pushed down in the _____.

18930

39

explodes

cylinders

40

Cylinders are located in the:

- ☐ cylinder block
- ☐ cylinder head
- ☐ cylinder openings

18931

40

cylinder block

41

The flywheel is connected to the:

- ☐ combustion chamber
- ☐ crankshaft
- ☐ pistons

18932

41

crankshaft

42

What is the name for the openings in the cylinder block where the pistons go up and down? _____

18933

42

cylinders

43

Where are cylinders located? _____

18934

43

in the cylinder block

44

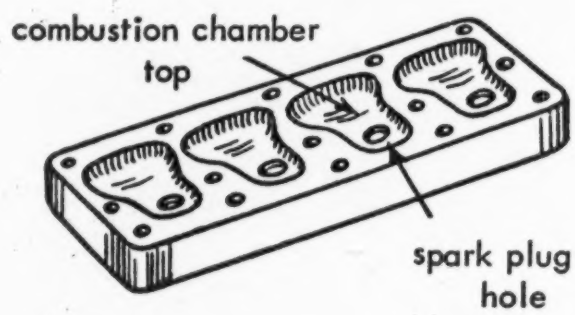

The picture shows a CYLINDER HEAD.

Heads are:

- ☐ on top of the combustion chamber
- ☐ on the bottom of the combustion chamber

18935

44

on top of the combustion chamber

45

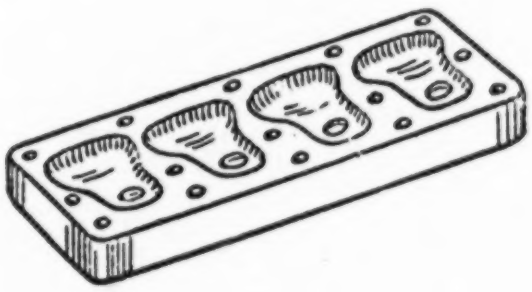

NAME the part that is on top of an engine: _____ _____ .

18936

1970
technology utilization

RKING
GY

SMALL BUSINESS ADMINISTRATION 1953

45

cylinder head

46

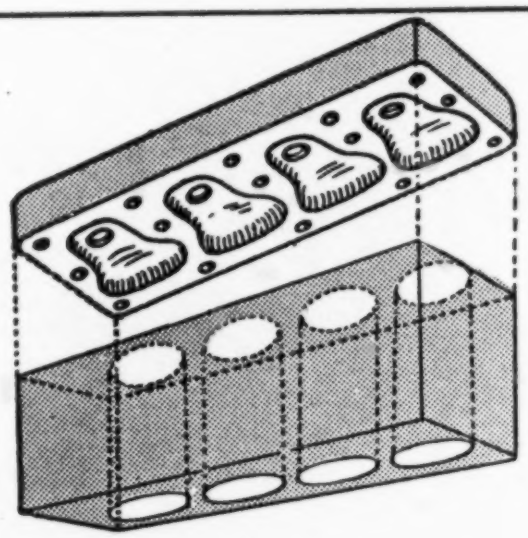

By looking at this cylinder head, you can see that the engine has _____ (how many) cylinders.

18937

46

4

47

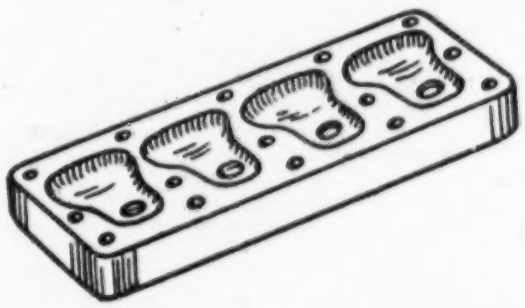

The cylinder head goes on top of the _____ _____.

18938

47

cylinder block

48

Openings in the cylinder block where the pistons go up and down are called _____ .

18939

48

cylinders

49

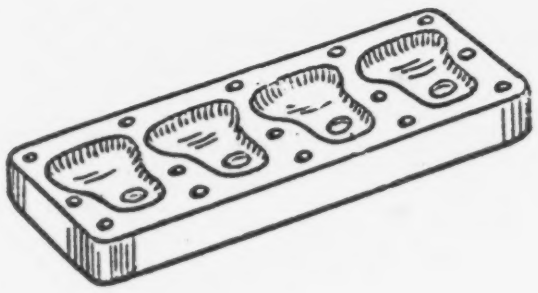

Spark plugs are screwed into the:

- ☐ cylinder block
- ☐ cylinder head
- ☐ cylinder bolts

18940

49

cylinder head

50

Explosions take place in the _____ chamber.

18941

50

combustion

51

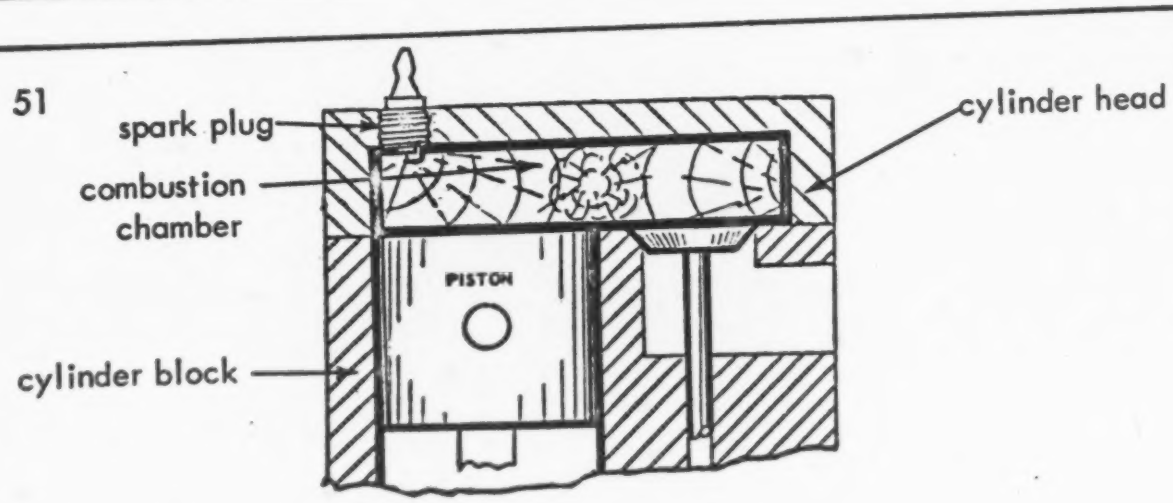

The combustion chamber is a space between the _____ _____ and the _____ _____.

18942

51

cylinder block

cylinder head

52

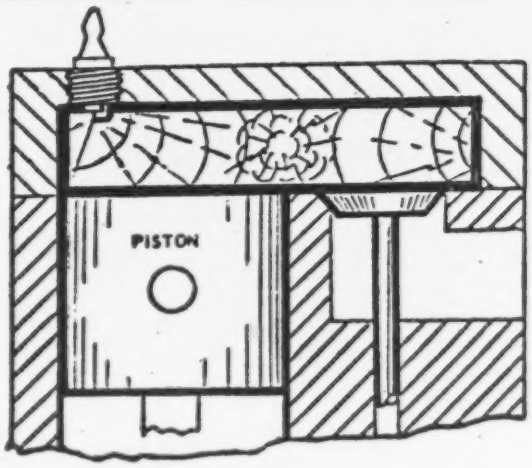

SHADE IN the place where explosions take place.

This space is called the _____ _____.

18943

52

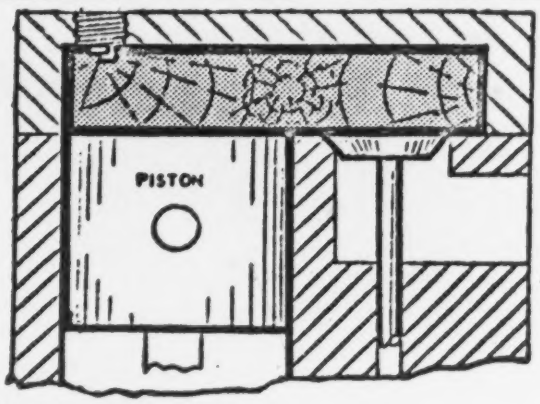

combustion chamber

53

What happens inside the combustion chamber? _____

18944

53

The spark plugs spark the air-gasoline mixture and an explosion takes place.

54

MATCH the following:

A. combustion chamber

B. cylinders

C. cylinder head

D. cylinder block

1. _____ explosions take place there
2. _____ cylinders are there
3. _____ pistons go up and down there
4. _____ is on top of the cylinder block

18945

54

1. A
2. D
3. B
4. C

55

MATCH the following:

A. spark plugs

B. pistons

C. fuel mixture

D. cylinder block

1. _____ sparks the fuel mixture
2. _____ made up of air and gasoline
3. _____ is pushed down by the explosions
4. _____ holds the cylinders

18946

Hilary Sandoval, Jr.,

Administrator,
Small Business Administration

55

1. A
2. C
3. B
4. D

56

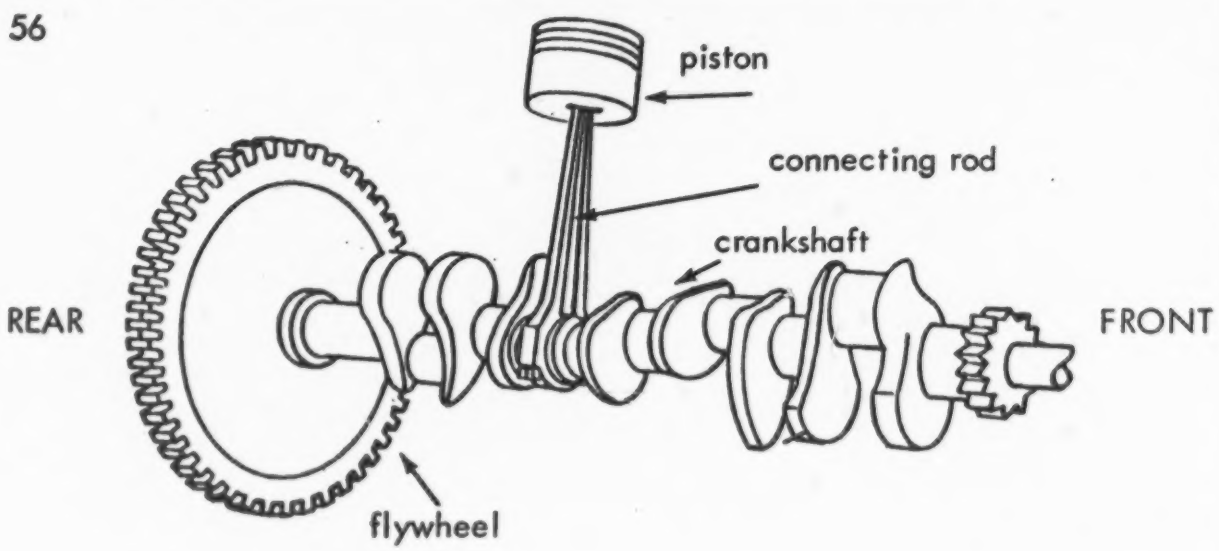

The pistons:

- ☐ go up and down
- ☐ go round and round
- ☐ go sideways

18947

56

go up and down

57

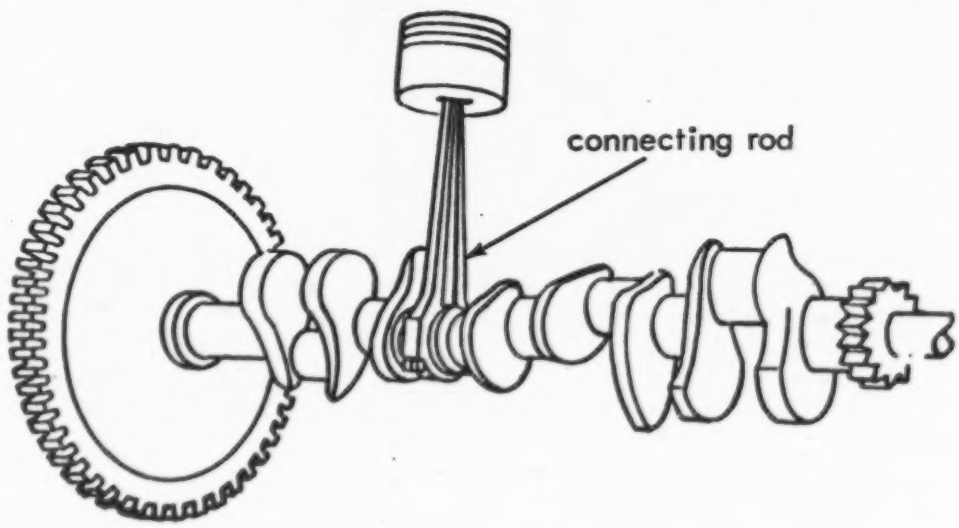

The crankshaft:

- ☐ goes up and down
- ☐ goes sideways
- ☐ turns

18948

57

turns

58

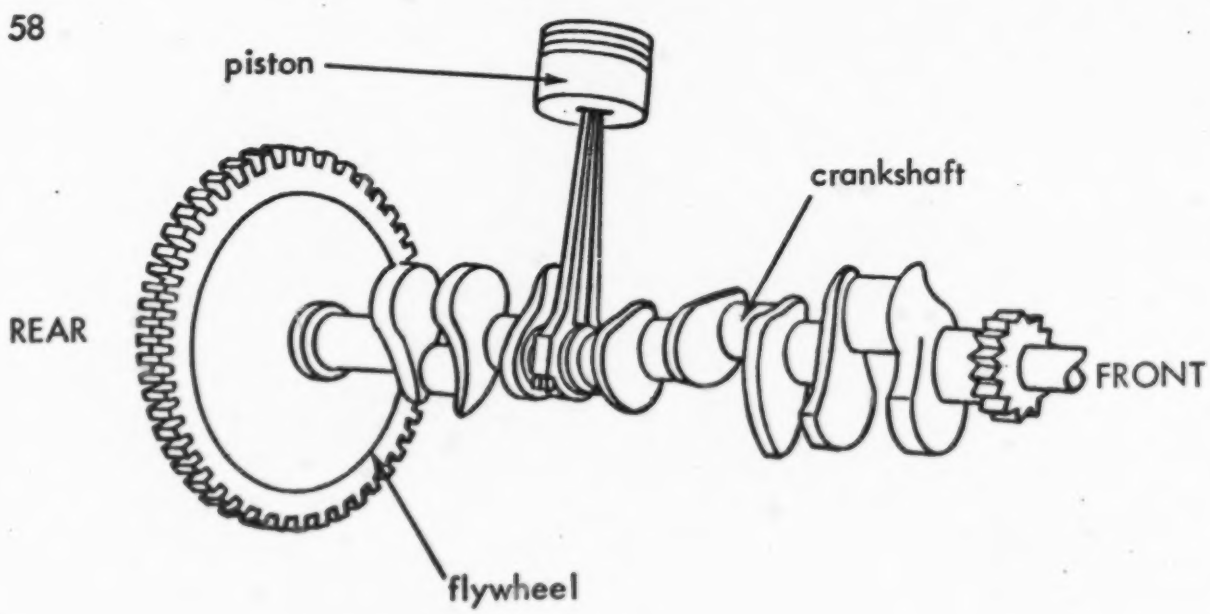

The piston is connected to the crankshaft by the

_____ _____.

18949

58

connecting rod

59

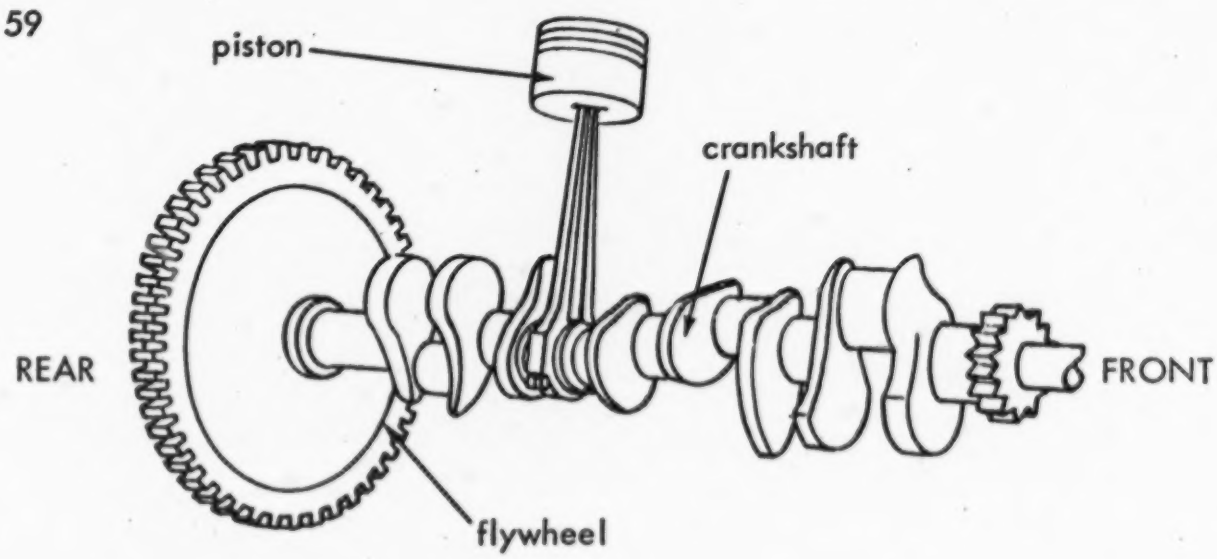

The top of the connecting rod is connected to the _____ .

The bottom of the connecting rod is connected to the _____ .

18950

59

piston

crankshaft

60

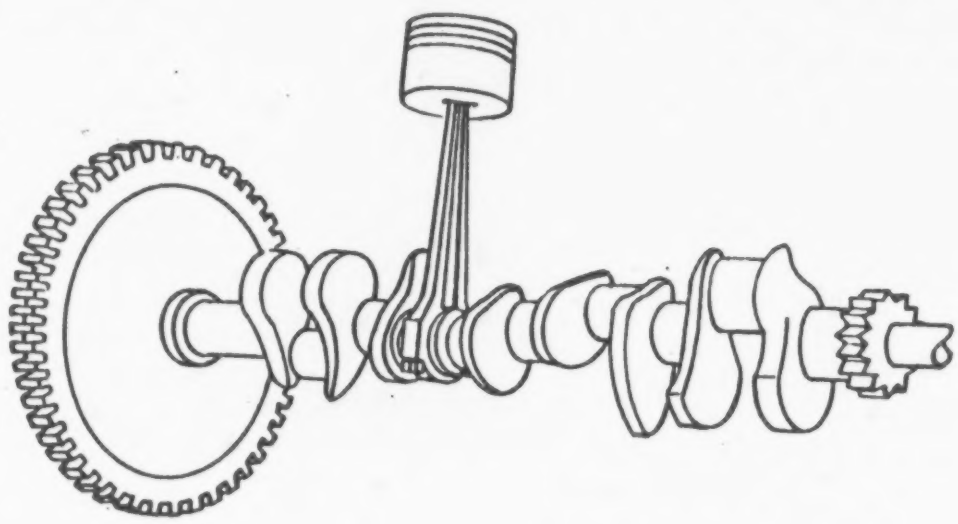

The force of the explosion in the combustion chamber pushes down on the piston.

The piston pushes down on the _____ _____ to turn the crankshaft.

18951

60

connecting rod

61

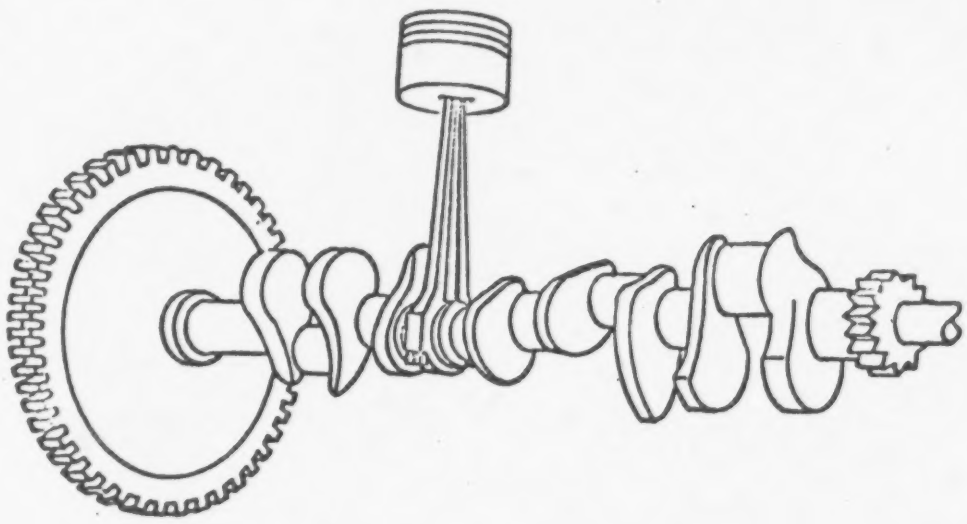

What part that is at the end of the crankshaft turns when the crankshaft turns? _____

18952

61

flywheel

62

If a car has eight cylinders, how many pistons does it have? _____

How many connecting rods does this car have? _____

18953

62

8

8

63

As the connecting rods push down on the crankshaft, the crankshaft:

- ☐ goes up and down
- ☐ turns
- ☐ stays still

18954

63

turns

64

MATCH the following:

A. goes up and down

B. turns

1. _____ connecting rods
2. _____ crankshaft
3. _____ flywheel
4. _____ pistons

18955

64

1. A
2. B
3. B
4. A

65

What part is pushed down by explosions in the combustion chamber? _____

18956

FOREWORD

The benefits of unclassified Government-sponsored research and development are available to the Nation's business community. The Small Business Administration, through its Technology Utilization program, brings these benefits to the attention of small manufacturers, research and development concerns, and other potential users. Small businesses, to remain competitive and to assure future growth and profitability, must provide for technological growth in their planning.

This publication, *Selected Advances in Metalworking Technology*, identifies a number of selected innovative processes and devices in forming, joining, machining, heat treating and cleaning, coating metals, and related instrumentation which have evolved from Government space, nuclear energy, and Defense programs. We believe that there are industrial and commercial possibilities among them. In any case, we hope they will stimulate the inventiveness and ingenuity that characterize the small businessman.

Changing a process of production, or adding to an existing line of production, may call for far-reaching administrative decisions, often requiring managerial, technical, or financial guidance and assistance. SBA's programs are geared to provide these and other services.

When additional innovations become available, they will be reported in future issues of this and similar SBA publications.

HILARY SANDOVAL, JR.,
Administrator.

65

piston

66

What does the connecting rod do? _____

18957

66

connects the piston to the crankshaft

<u>or</u>

pushes down on the crankshaft

67

Explosions take place inside the _____ _____.

18958

67

combustion chamber

68

In order to get lots of power in the engine, the explosions must push down:

- ☐ gently on the piston
- ☐ very hard on the piston
- ☐ without touching the piston

18959

68

very hard on the piston

69

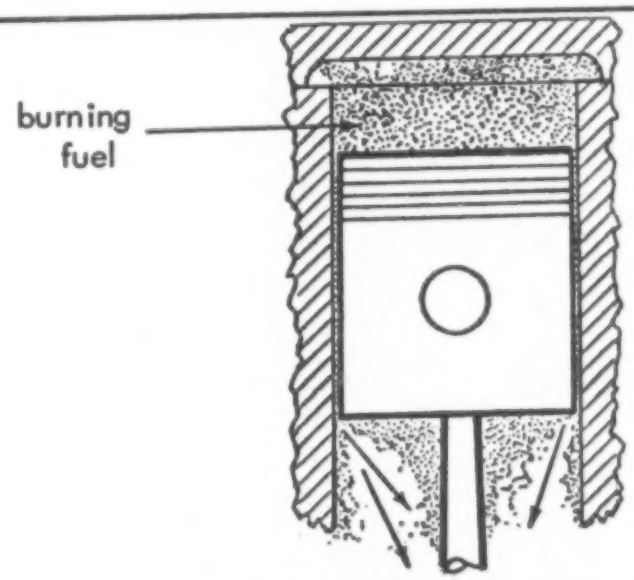

exploding fuel escapes by piston

If there were a space between the sides of the piston and the cylinders:

- ☐ the force from the combustion chamber explosions would go into the empty space
- ☐ the force from the combustion chamber explosions would still push down <u>only</u> on the piston

18960

69

the force from the combustion chamber explosions would go into the empty space

70

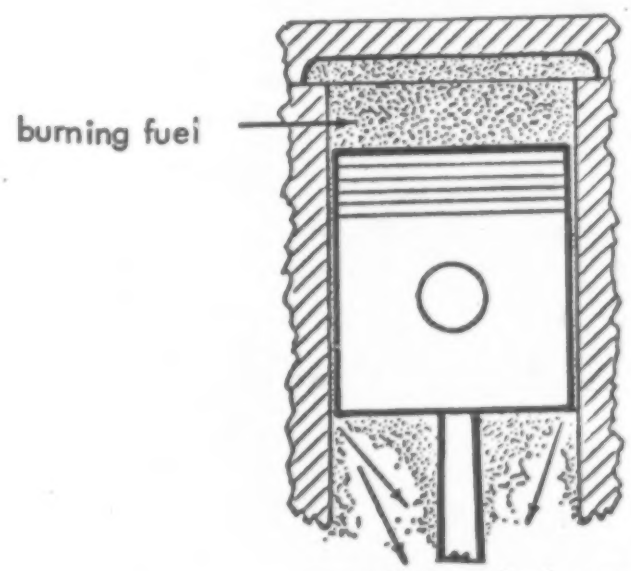

exploding fuel escapes by piston

To get the most force from the combustion chamber explosions, the space between the piston and the cylinder walls should be:

- ☐ open
- ☐ sealed tight
- ☐ left the same

18961

70

sealed tight

71

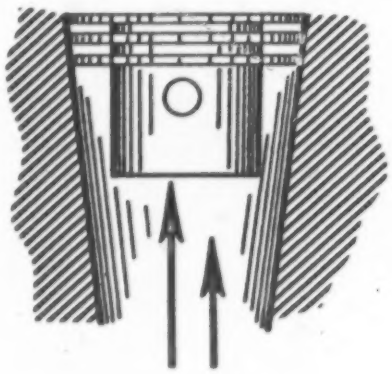

Rings fit around the piston to seal the space between the piston and the cylinder walls.

Piston rings:

- ☐ keep all the power pushing only on the top of the piston
- ☐ open a space between the piston and the cylinder walls
- ☐ do not affect the space between the piston and the cylinder walls

18962

268 OF 327

ED

056 238

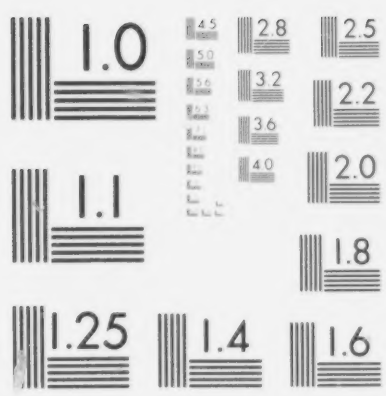

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

71

keep all the power pushing only on the top of the piston

72

The above part seals the space between the piston and the cylinder wall.

What part does it go around? _____

18963

72

the piston

73

Parts that go around a piston to seal space between the cylinder walls and the piston are called:

- ☐ connecting rods
- ☐ flywheels
- ☐ piston rings

18964

73

piston rings

74

Piston rings go around _____ .

Piston rings _____ the space between the pistons and the cylinder walls.

18965

CONTENTS

Foreword ..... *iii*

Small Business and Technology Transfer 1

Sources of Technology—NASA/AEC Tech Briefs, NASA Special Publications, Government-Owned Patents, and Clearinghouse Reports 1

Selected Advances in Metalworking:

- **Forming: Casting, Extruding, Forging** 2
- **Heat Treating and Cleaning: Alloys, Effects on Surfaces** 3
- **Instrumentation: Testing Procedures, Results, Related Instruments** 4
- **Joining: Bonding, Brazing, Soldering, Welding** 11
- **Machining: Electro Discharge, Drilling, Milling, Boring, Grinding** 17
- **Metals: Refractory, Hot and Cold Working, Processing** 22
- **New Products** 23
- **Seals, Coatings, Lubricants, Miscellaneous** 37

74

pistons

seal

75

Where are piston rings found? _____.

Piston rings seal the space between the _____ and the _____ _____.

18966

75

around pistons

piston

cylinder walls

76

NAME the part that is pushed down by combustion chamber explosions: _____

18968

76

piston

77

A six cylinder engine has _____ pistons.

How many connecting rods are connected to the piston and the crankshaft in a six cylinder engine? _____

18969

77

6 or six

6 or six

78

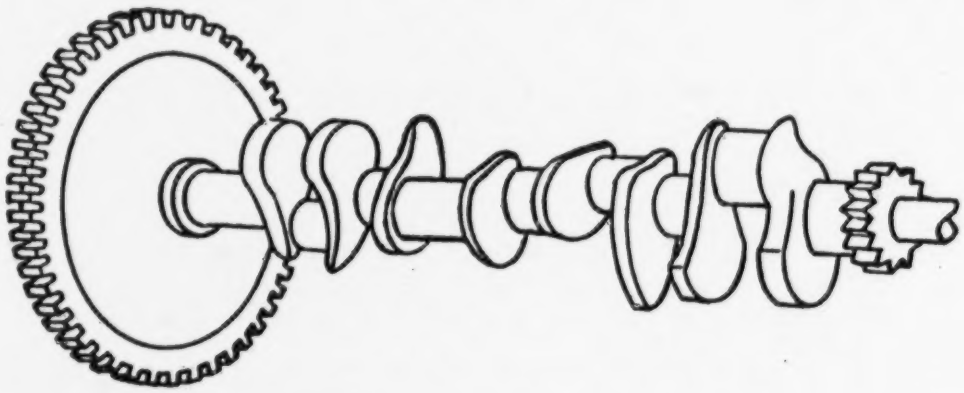

The pistons push the connecting rods down, one at a time.

A running 6 cylinder engine has 6 _____ pushing down on the connecting rods.

This will:

- ☐ keep the crankshaft turning
- ☐ stop the crankshaft from turning
- ☐ not affect the turning of the crankshaft

18970

78

pistons

keep the crankshaft turning

79

Combustion chamber explosions do not all take place at one time. They happen one at a time in a defined order. The explosions happen very quickly.

The rapid series of explosions keeps the crankshaft turning:

- ☐ not at all
- ☐ quickly
- ☐ slowly

18971

79

quickly

80

When many connecting rods are pushing down on the crankshaft at different times, the _____ will turn unevenly or in a bumpy way.

Because each _____ happens at a different time, the crankshaft will turn unevenly.

18972

81

flywheel

82

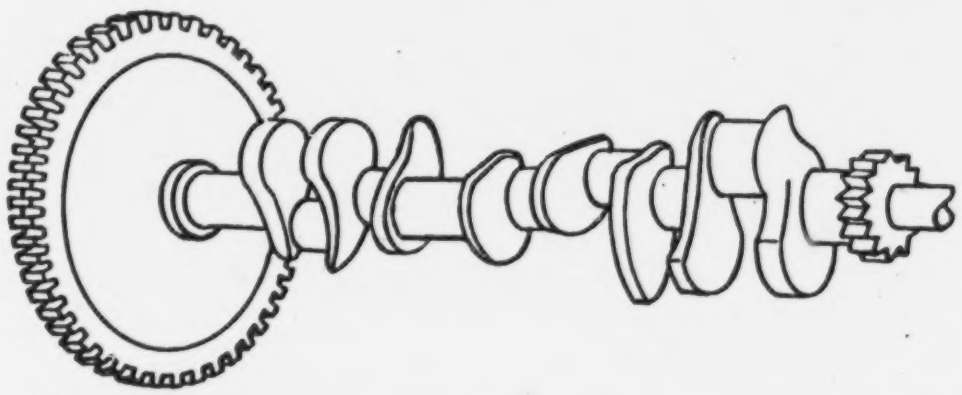

Without a flywheel, the crankshaft would turn in:

- ☐ uneven motion (or "bumpy" motion)
- ☐ no motion
- ☐ smooth motion

18974

82

uneven motion (or "bumpy" motion)

83

The job of the flywheel is to smooth out the uneven turning of the _____ .

18975

83

crankshaft

84

NAME the part that smooths out the uneven turning of the crankshaft: _____

18976

SMALL BUSINESS AND TECHNOLOGY TRANSFER

Technology transfer involves the use of technology developed for one purpose to fulfill a need elsewhere. It requires the knowledge that an advance has occurred in one field, the recognition of its significance in related or different fields, and the capability to make the required adaptations.

During the past few years, more emphasis has been given to the commercial utilization of new technology emerging from Federally sponsored research and development programs. The reason for this emphasis is Government's concern that the Nation gain the maximum return on its investment in research and development. The space program has already made significant contributions in advancing such technical areas as aerodynamics, electronics, materials, metalworking, communications, navigation, and meteorology. These advances, in turn, have served to improve the economy. Intelligent use of Government sources of technology can be especially important to small manufacturers who do not have research and development capabilities.

Technical information from Government R. & D. is disseminated through such media as conferences, seminars, and workshops, U.S. Government Research and Development reports, U.S. Government-owned patents, NASA/AEC Tech Briefs, NASA special publications, trade and technical journals, and by counseling.

SBA hopes, through this publication and future similar issues, to transfer information on selected innovations to a
of the "Selected Advances" have been on
and soldering technology; tools, dies, jigs
technology, and computer technology.

SBA initiates, or cosponsors with educ
organizations, seminars on technological
manufacturers. The speakers present va
technology to meet problems, pinpoint the
industrial sectors, and discuss the impact
of various segments of the economy.

SBA also cosponsors workshops relati
logical advances to solve industry proble
The cosponsors for such workshops are us
associations.

Another effective method of accompli
case, individual situations. To this end, S
phone, or personal interview at its field o
businessman's plant. The counselor advis
accelerate the profitability and growth of
expert counseling SBA will recommend
consultants.

NASA/AEC TECH BRIEFS, GOVERNMENT-OWNED PATENTS, AND CLEARINGHOUSE REPORTS

The new processes and devices described in the following digests are from abstracts of reports of research and development funded by the U.S. Government during 1968. The digests are grouped into three broad categories: NASA and AEC Tech Briefs, Government-owned Patents, and Reports from the Clearinghouse.

SBA believes this selection of digests should be of more than average interest and use to small businesses concerned with metalworking technology. Some of the digests may suggest profitable ideas or lead to the solution of certain problems, or, at least, help to keep abreast of the state-of-the-art.

NASA/AEC Tech Briefs

The aerospace and nuclear energy programs conducted by the National Aeronautics and Space Administration (NASA) and the Atomic Energy Commission (AEC) continue to generate enormous volumes of scientific and technical knowledge. Both Agencies select those innovations considered to have commercial value and briefly describe them in the form of a Tech Brief. The Small Business Administration (SBA) cooperates with NASA and AEC in disseminating technical advances through this Technology Utilization booklet and similar industry-oriented publications. Copies of the full reports, or other back-up material from which the digests of the Tech Briefs are drawn, may be obtained by circling the appropriate key number on the Reader Service Card (see insert card) and sending it to your nearest SBA field office listed on the inside back cover.

Government-Owned Patents

The patents on the following pages we
nology Utilization Division of the Small
Government-owned and may be used on a
selected appear to have potential comme
full patent may be obtained at a cos o
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20231. These patents also may be reviwe
inside front cover of this publication. Fu
to get licenses for their use may be oltai
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from your nearest SBA office.

Reports From Clearinghouse

The Clearinghouse for Federal Scienti
is a central source of information abut
U.S. Government-sponsored program U
tions prepared by many Governmet
nounced, and sold by CFSTI. With C
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reports, paper ($3 each) or microfich (
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on the Clearinghouse Document Car (
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field, Va. 22151.

84

the flywheel

85

The flywheel smooths out the _____ turning of the _____.

18977

85

uneven

crankshaft

86

What is the job of the flywheel? _____

18978

86

to smooth out the uneven turning of the crankshaft

87

Pistons and connecting rods give their up and down motion to the c _____ .

18979

87

crankshaft

88

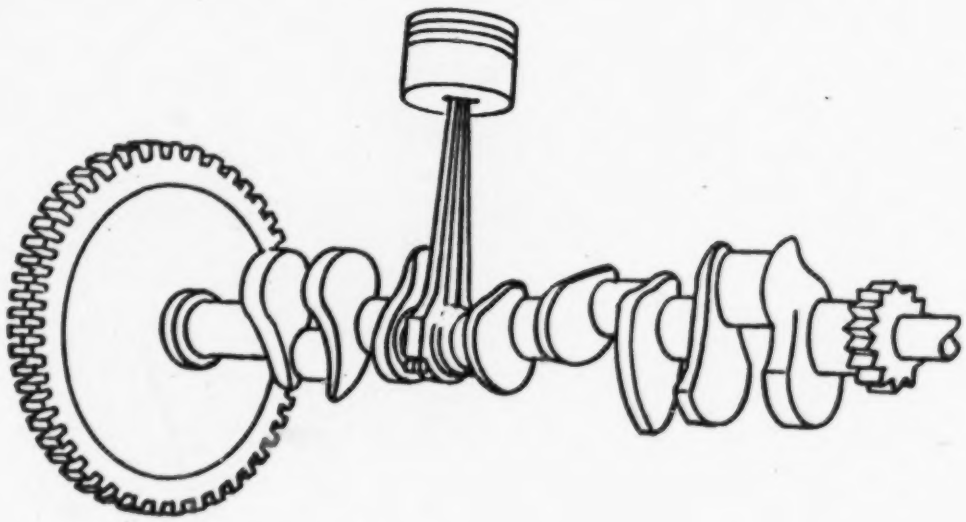

The piston is joined to the crankshaft by the _____ _____.

18980

88

connecting rod

89

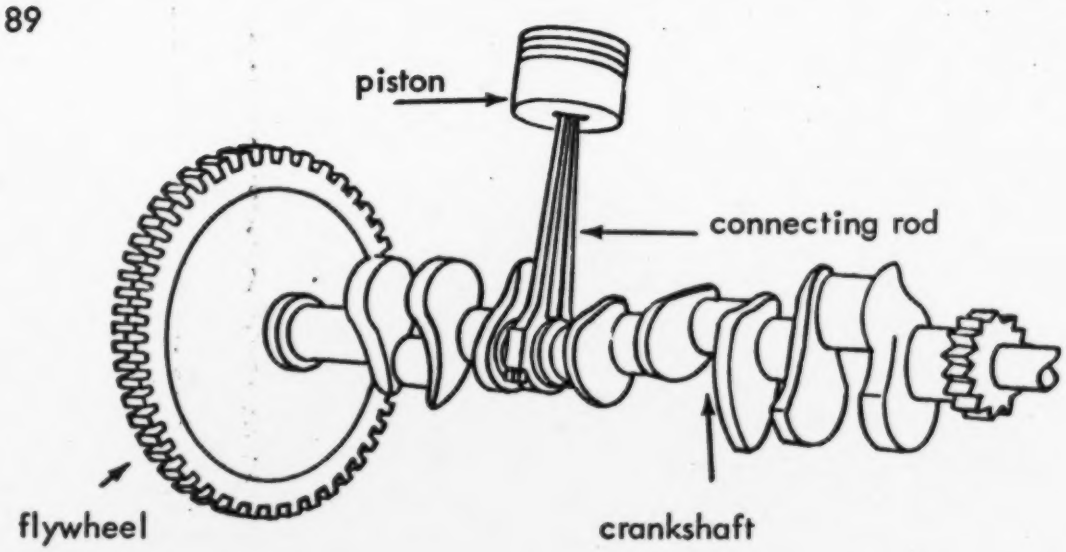

The piston and connecting rod have up and down motion.

The motion of the crankshaft and flywheel is:

- ☐ turning
- ☐ up and down

18981

89

up and down

90

Where does the crankshaft get the up and down motion from?

_____

18982

90

pistons (and/or) connecting rods

91

What does the crankshaft do? _____

18983

91

changes up and down motion to turning motion

92

The crankshaft gives the turning motion to the _____ .

18984

92

flywheel

93

From what part of the engine does the Power Transmission System get the power to turn the rear wheels? _____

18985

93

the flywheel

94

The part of the ignition system that is screwed into the engine and makes a spark for the explosion is the

_____ _____.

18986

TECHNOLOGY TRANSFER

of technology developed for one purpose
knowledge that an advance has occurred
icance in related or different fields, and
ations.

hasis has been given to the commercial
from Federally sponsored research and
this emphasis is Government's concern
on its investment in research and devel-
ady made significant contributions in
dynamics, electronics, materials, metal-
nd meteorology. These advances, in turn,
ntelligent use of Government sources of
o small manufacturers who do not have

ent R. & D. is disseminated through such
rkshops, U.S. Government Research and
owned patents, NASA/AEC Tech Briefs,
chnical journals, and by counseling.
and future similar issues, to transfer

S, GOVERNMENT-OWNED RINGHOUSE REPORTS

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A) and the Atomic Energy Commission
s volumes of scientific and technical
novations considered to have commercial
rm of a Tech Brief. The Small Business
NASA and AEC in disseminating techni-
tilization booklet and similar industry-
reports, or other back-up material from
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rvice Card (see insert card) and sending
the inside back cover.

information on selected innovations to all small manufacturers. Previous issues of the "Selected Advances" have been on electrical technology; welding, brazing, and soldering technology; tools, dies, jigs and fixtures technology; instrumentation technology, and computer technology.

SBA initiates, or cosponsors with educational institutions and other nonprofit organizations, seminars on technological subjects for groups of interested small manufacturers. The speakers present various examples of the effective use of technology to meet problems, pinpoint the need for modern technology in specific industrial sectors, and discuss the impact of technology on the profit and growth of various segments of the economy.

SBA also cosponsors workshops relating to the application of specific technological advances to solve industry problems for groups of small manufacturers. The cosponsors for such workshops are usually universities, or industry and trade associations.

Another effective method of accomplishing technology transfer is in single case, individual situations. To this end, SBA provides direct counseling by mail, phone, or personal interview at its field offices or during onsite visits to the small businessman's plant. The counselor advises on the effective use of technology to accelerate the profitability and growth of the firm. For cases requiring continuing expert counseling SBA will recommend the use of outside help, such as private consultants.

Government-Owned Patents

The patents on the following pages were selected for abstracting by the Technology Utilization Division of the Small Business Administration. They are U.S. Government-owned and may be used on a royalty-free, nonexclusive basis. Those selected appear to have potential commercial application. A printed copy of the full patent may be obtained at a cost of $0.50 each by listing it on the Patent Order Card (insert) and sending it to the U.S. Patent Office, Washington, D.C. 20231. These patents also may be reviewed at one of the depository libraries listed inside front cover of this publication. Further information about patents and how to get licenses for their use may be obtained from the administering agency cited in each patent description. Advice about using these patents may be requested from your nearest SBA office.

Reports From Clearinghouse

The Clearinghouse for Federal Scientific and Technical Information (CFSTI) is a central source of information about science and technology emerging from U.S. Government-sponsored programs. Unclassified technical reports and translations prepared by many Government Agencies are collected, catalogued, announced, and sold by CFSTI. With CFSTI's cooperation, the digests on the following pages were screened, selected, and prepared. Copies of the complete reports, paper ($3 each) or microfiche ($0.65 each), may be purchased from the Clearinghouse. To order these reports, list the document number (for example, PB–178 570, AD–670 921, LA–3759, or N67–36554) in the spaces provided on the Clearinghouse Document Card (insert) and check appropriate blocks to indicate either paper copy (PC) or microfiche (MF), and mail with your check or money order payable to Clearinghouse, U.S. Department of Commerce, Springfield, Va. 22151.

94

spark plug

95

An automobile engine's fuel is a mixture of _____ and _____ .

18987

95

air

gasoline

96

When there is a spark in a mixture of air and gasoline, an _____ will take place.

This happens in a part of the engine called the:

- ☐ cylinder
- ☐ combustion chamber
- ☐ connecting rod

96

explosion

combustion chamber

97

When explosions take place in the combustion chamber, which part is pushed down? _____

18989

97

the piston

98

Pistons go up and down in openings in the engine called

_____.

18990

98

cylinders

99

The large part of the engine in which the cylinder openings are located is called the cylinder _____ .

18991

99

block

100

The part that goes on top of the cylinder block is called the cylinder _____ .

18992

100

head

101

Parts that go around the pistons to seal the space between the pistons and the cylinder walls are called piston _____.

18993

101

rings

102

The part that connects the piston to the crankshaft is called a _____ _____.

18994

102

connecting rod

103

What part changes up and down motion to turning motion?

_____

18995

103

crankshaft

104

The crankshaft gives the turning motion to the _____ .

TECH BRIEF 68–10184—STRESS-CORROSION CHARACTERISTICS OF ALUMINUM CASTING ALLOY M–45

Aluminum foundries and shops casting aluminum alloy M–45 will be interested in this study by NASA of the stress-corrosion characteristics of the alloy. In particular, the study describes the best practices to follow in the casting and aging cycle to obtain optimum use of this alloy, which has unusually high strengths under cryogenic conditions. For example, normal aging processes most definitely degrade the alloy.

For additional information, circle Key No. 1 on Reader Service Card.

PROCESS OF CASTING A REACTIVE METAL (PAT. NO. 3,380,508)

By using molds of graphite powder, betonite, and water carefully mixed and cured, this patent permits reactive metals, such as magnesium and magnesium alloys, to be cast without any need for inhibitors which always degrade casting production. This molding material permits castings to be made which are impossible in sand molds regardless of the inhibitors used. Lithium and lithium-magnesium alloys are examples of such castings. The basic mixture of the mold is 92 to 95 percent graphite powder (20 to 60 mesh, acording to needs), and 5 to 8 percent of betonite and water. Any carbonaceous foundry material may be used instead of graphite. The mold material can readily be used for other metals, for example, aluminum, cast iron, and steel. It is relatively inexpensive. Moreover, it can be prepared into molds by using standard foundry equipment, thereby considerably reducing the operating costs of a reactive metal foundry.

Administering Office: Department of the Army, Office of the Judge Advocate General, Chief, Patents Division, Washington, D.C. 21315.

PRESSURE CASTING IN INVESTMENT MOLDS (AD–451 230)

Foundries and machine shops trying to improve their castings may find this study helpful. It is a report on methods for pressure casting nonferrous alloys into investment molds by Frankford Arsenal, Philadelphia, Pa. Experimental methods were compared with standard suction casting practices, and the best appeared to be the direct pressure diaphragm method. In this process, metal is forced into the mold in an upward direction with a high degree of control of metal stream velocity, turbulence, and casting pressure. Tests showed improved filling of the casting section and reduced defects in the casting cross-section because of lowered metal turbulence.

INTERACTION BETWEEN THE METAL AND THE MOLD DURING THE CASTING OF TITANIUM (AD–675 245)

Studies of the reactions between titanium (Ti) and various refractory oxides and materials used in connection with casting of titanium were translated from a Russian report at Wright-Patterson AFB, Ohio. Various mold and binding materials were used, with teeming temperatures from 1,790 to 1,950°. The maximum hardness and depth of hard zone rise considerably with the increased pouring temperature. The most satisfactory material investigated was zirconium oxide (ZrO_2) plus 15 atomic percent titanium with zirconium nitrate binder, since the optimum teeming temperature for Ti is 1,760°. Good results were obtained by using shell molds of ZrO_2 and Al_2O_3 on ethyl silicate.

INVESTIGATION OF SOLIDIFICATION OF HIGH-STRENGTH STEEL CASTINGS (AD–676 235)

The morphology, size, and distribution of sulfide inclusions are studied in vacuum melted and solidified AISI 4330 low alloy steel. The steel was

104

flywheel

105

Power to run an automobile comes from the:

- ☐ engine
- ☐ steering gear assembly
- ☐ radiator

18997

105

engine

106

The part that gives the engine's power to the power transmission assembly is the _____ .

18998

106

flywheel

107

Without a flywheel, the engine would run unevenly because of the:

- ☐ uneven turning of the crankshaft
- ☐ bumpy roads that cars travel on
- ☐ poor balance outside the engine

18999

107

uneven turning of the crankshaft

108

The crankshaft turns unevenly because:

- ☐ the power transmission turns unevenly
- ☐ many connecting rods are pushing down on the crankshaft at different times
- ☐ there is poor balance in the engine

108

many connecting rods are pushing down on the crankshaft at different times

109

The part that smooths out the uneven turning of the crankshaft is the _____ .

109

flywheel

THIS IS THE END OF BOOK 14

19002

AUTO MECHANICS COURSE

POST-TEST BOOK 14: MAJOR PARTS OF AN ENGINE

PART I

A BASIC SYSTEMS PROGRAM

19003

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

The Power Transmission System gets the engine's power from the _____.

2

The pistons and the connecting rods give their up and down motion to the _____.

3

Pistons are connected to the crankshaft by the _____ _____.

4

The fuel used by an automobile engine is a mixture of _____ and _____.

5

The fuel mixture explodes when the _____ _____ make a spark.

6

In what part of the engine do the explosions take place?

_____

7

Pistons go up and down in openings in the engine. NAME these openings:

_____

8

To seal the spaces between the pistons and the cylinder walls,
_____ _____ go around the pistons.

9

Cylinders are openings in the engine _____.

10

The part located at the top of the engine is called the cylinder
_____.

11

NAME the part that smooths out the uneven turning motion of
the crankshaft: _____

12

NAME the part that is pushed down by the explosions in the combustion chamber: _____

TRESS-CORRO-
OF ALUMINUM

ops casting alu-
ed in this study by
aracteristics of the
describes the best
g and aging cycle
oy, which has un-
ogenic conditions.
ocesses most defi-

cle Key No. 1 on

A REACTIVE
08)

powder, betonite,
cured, this patent
agnesium and mag-
t any need for in-
asting production.
astings to be made
molds regardless
and lithium-mag-
such castings. The
95 percent graph-
ing to needs), and
water. Any carbo-
be used instead of
readily be used for
um, cast iron, and
. Moreover, it can
standard foundry
reducing the oper-
dry.

nt of the Army,
eral, Chief, Patents
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PRESSURE CASTING IN INVESTMENT MOLDS (AD–451 230)

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INVESTIGATION OF SOLIDIFICATION OF HIGH-STRENGTH STEEL CASTINGS (AD–676 235)

The morphology, size, and distribution of sulfide inclusions are studied in vacuum melted and solidified AISI 4330 low alloy steel. The steel was deoxidized with various elements, such as aluminum, silicon, and manganese, used individually or in combinations, and boron, zirconium, and cerium. Types 1, 2, and 3 inclusions are investigated in detail. The effects of chemistry (Al, Si, Mn) on inclusion type is quantitatively determined. This report by the Massachusetts Institute of Technology, Department of Metallurgy and Materials Science, Cambridge, Mass., should be of interest to foundries.

EXTRUSION OF TOOL STEEL WITHOUT PRESS RESIDUES (AD–674 155)

This report, a translation from Russian by Wright-Patterson AFB, Ohio, describes a technique of butt-free hot extrusion of solid and hollow shapes from structural and high-alloy tool steels. The principle of the method, materials used, and auxiliary benefits are related. Small manufacturers may be interested in this extrusion process. The principle is as follows: an intermediate link or "insert" is placed between the punch and the forging; the height of the insert is not lower than that of the die. The material of the insert must withstand considerable loads without a change in its properties, its strength should be lower than the strength of the extruded metal, and it should display the qualities of a lubricant. Toward the end of the extrusion the material passes through the die and disintegrates into powder, which facilitates its removal for reuse. This technique also improves the conditions for automating the process of hot extrusion.

TOOL FOR COLD EXTRUSION OF PIPES FROM ALUMINUM ALLOYS (AD–675 235)

A possible new machine for cold forging of aluminum alloy pipes is described in this report translated from Russian at Wright-Patterson AFB, Ohio. Schematics of the machine parts are shown. Tabulations of the composition of various machine parts and test results of machine performance during manufacture of different size pipes are included. This development will be of interest to machine builders and users of extrusion equipment.

VT 013 137
Auto Mechanics Course. Book 15: Major Parts of an Engine, Part II.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 156p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *ENGINES; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the major parts of an engine. Part II, was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 137

ED0 56238

BOOK 15 (21)

AUTO MECHANICS COURSE

BOOK 15: MAJOR PARTS OF AN ENGINE

PART II

A BASIC SYSTEMS PROGRAM

VT013137

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Curriculum Report Reference
Page 13

Task Analysis Reference
15.1, 15.2

19008

AUTO MECHANICS COURSE

BOOK 15: MAJOR PARTS OF AN ENGINE
PART II

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19009

AUTO MECHANICS COURSE

PRE-TEST BOOK 15: MAJOR PARTS OF AN ENGINE
PART II

A BASIC SYSTEMS PROGRAM

19010

1

The fuel mixture must go through the _____ _____ to get to the combustion chamber.

2

Burned gases go through the _____ _____ when they leave the combustion chamber and go to the exhaust system.

3

In order for the fuel mixture to get into the combustion chamber, the _____ _____ must open.

4

In order for the burned gases to get out of the combustion chamber, the _____ _____ must open.

5

When the valves are closed, they sit on a part called the valve _____.

6

A part goes around the valve to keep it from wobbling. This part is called the valve _____.

7

The shaft that moves the valves up is called the _____.

8

The shaft that is turned by the up and down motion of the pistons is called the _____.

9

NAME the gears that keep the two shafts working together:

_____

10

What part on the valve is squeezed together for the valve to open up?

_____ _____

11

Valves are lifted up by _____ _____.

12

The part of the camshaft that lifts the valve lifter is called the _____.

Name _____

Date _____

Starting time _____

Finishing time _____

19014

1

You have learned that explosions take place in the:

- ☐ combustion chamber
- ☐ crankshaft
- ☐ connecting rod

19015

1

combustion chamber

2

An engine's power comes from pushing the piston down with:

- ☐ great force
- ☐ little force
- ☐ no force at all

19016

Forming: Casting, Extruding, Forging (continued)

REVIEW OF RECENT DEVELOPMENTS, METALWORKING (AD–453 480)

This report is a review of the following three developments in metalworking made by the Metals Information Center, Battelle Memorial Institute, Columbus, Ohio: (1) Molybdenum-forging process for producing close-die forgings of TZM molybdenum alloy to aircraft and missile requirements. The new procedure results in shorter transfer and forging times which prevent heat losses and excessive oxidation, and show that MoS_2 performs satisfactorily as a die lubricant. (2) Precision forging of gears and turbine wheels with integral blades. It is now feasible to use radial-extrusion to produce high quality RENE–41, Waspalloy, A–286 alloy turbine wheels, and A1S1 9310 steel and 18-percent nickel maraging steel gears. The process involves continuous grain-flow patterns and improves the dimensional and surface quality of the products. (3) The development of a 2400° F. forging die system to determine the upper temperature limit of forging dies cast from INCONEL 713C alloy, and to minimize the required forging sequence for steel by using the hot-die system.

SELECTION OF DIE STEELS FOR HIGH-SPEED METAL-FORMING TOOLS (AD–673 821)

Tool manufacturers may be interested in this report translated from Russian by Wright-Patterson AFB, Ohio. Three tool steels were tested for their suitability as die materials in high energy rate of aluminum, steel, titanium, and nickel based alloys.

FORGING OF LARGE FORGED PIECES (CHAPTER II) (AD–674 039)

This report is a translation from Russian at Wright-Patterson AFB, Ohio, and may be of interest to manufacturers using the processes described. Tables and diagrams illustrate the following: heating of billets and blanks for forging using structural carbon and alloy steels, and the mechanical properties of discs forged at various temperatures. Also, the tables and charts illustrate a new method for forging pieces of turbine and compressor discs and lids on floating blocks under hydraulic presses, and the technological factors determining the deformation of metal during rolling of forged lead, aluminum, and steel blanks.

ANALYSIS OF CRACKING IN SWAGED 7075–T6 ALUMINUM ALLOY TUBING (AD–673 954)

This report from the Naval Research Laboratory, Washington, D.C., might interest shops forming and/or using swaged aluminum tubing in their products. It discusses intergranular fractures caused by stress-corrosion mechanism failure. Microstructural examination by electron microscopy showed that a significant short transverse-type grain orientation existed in the fracture plane.

EXPERIMENTAL DETERMINATION OF THE BASIC PARAMETERS OF A HIGH-SPEED HAMMER (AD–674 342)

Wright-Patterson AFB, Ohio, translated a Russian report which might be useful to manufacturers or users of high-speed hammers. It describes the method and results of determining the velocities and collision energies of the counter-moving parts of a high-velocity press hammer. It has a maximum impact energy of 8,900 kg-m which is represented by a frame and a ram, plus accessories.

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STRENGTHENING MECHANISMS DURING THE HEAT TREATMENT OF THREE TITANIUM ALLOYS (AD–675 464)

Firms involved with heat treating of titanium alloys will be interested in this report from the Army Materials and Mechanics Research Center, Watertown, Mass. It discusses the effects of solution and aging treatments on three alloys, Ti–6Al–4V, Ti–6Al–6V–2Sn, and Ti–8Al–1Mo–1V. The following

2

great force

3

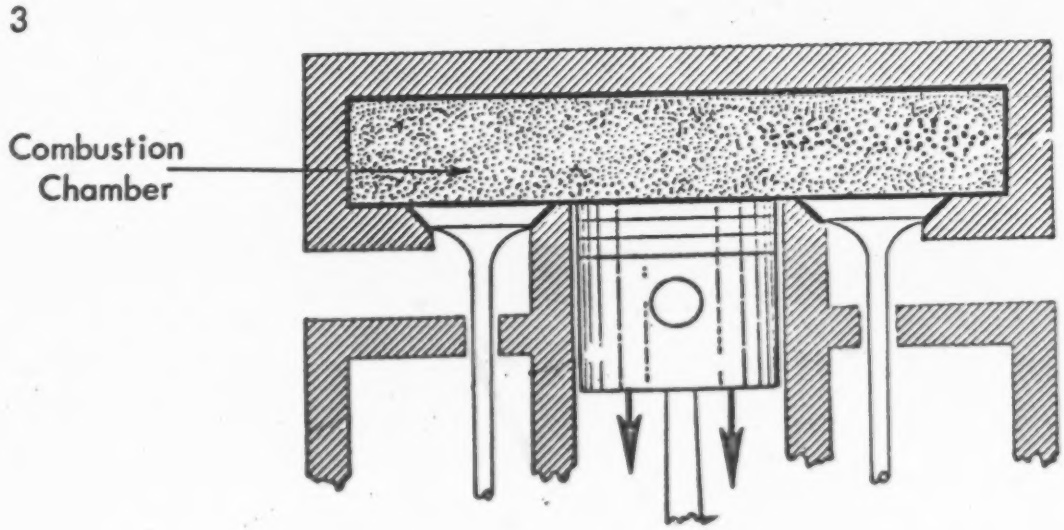

To get the greatest force out of combustion chamber explosions, the force should:

- ☐ only push down on the piston
- ☐ partly go away from the top of the piston
- ☐ not be allowed to happen at all

19017

3

only push down on the piston

4

The carburetor makes a mixture of _____ and _____.

This mixture first goes through which part before entering the combustion chamber?

- ☐ exhaust manifold
- ☐ intake manifold
- ☐ neutral manifold

19018

4

air

gasoline

intake manifold

5

When the spark ignites the air-gasoline mixture, there is an explosion.

This explosion makes power and also makes burned gases.

You have learned that burned gases leave the engine through the:

- ☐ cooling system
- ☐ exhaust system
- ☐ power transmission system

19019

5

exhaust system

6

The part of the exhaust system that is connected to the engine is the:

- ☐ exhaust manifold
- ☐ muffler
- ☐ tailpipe

19020

6

exhaust manifold

7

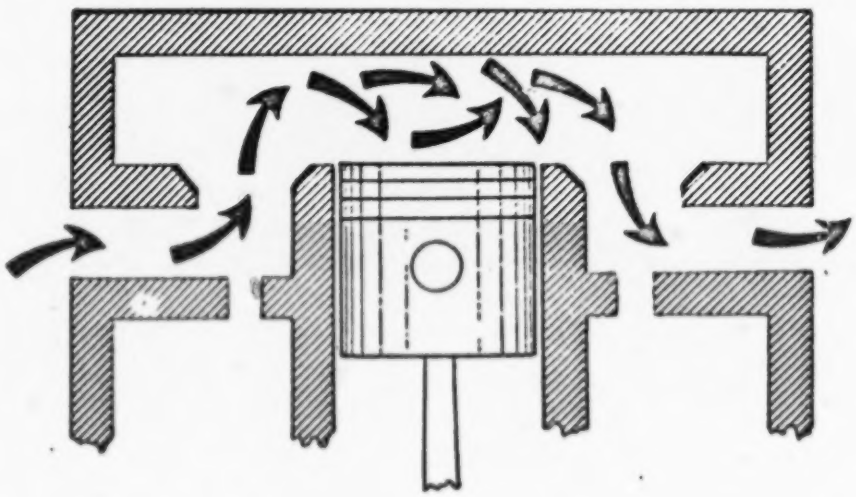

There is an opening for the air-gasoline mixture to get into the combustion chamber, and, in the same way, there is also an opening for the burned gases to _____ of the combustion chamber.

19021

7

get out

(or similar answer)

8

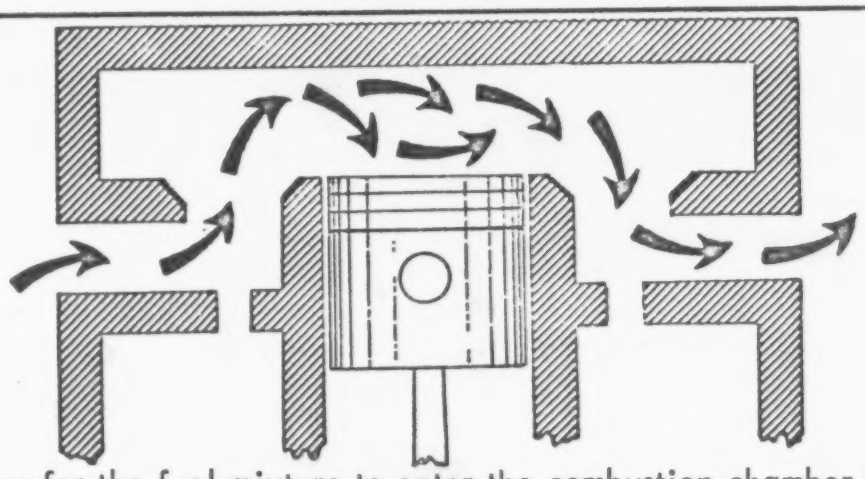

Openings for the fuel mixture to enter the combustion chamber and openings for the burned gases to leave the combustion chamber are:

- ☐ on the same side of the combustion chamber
- ☐ on opposite sides of the combustion chamber
- ☐ on the inside of the combustion chamber

8

on opposite sides of the combustion chamber

9

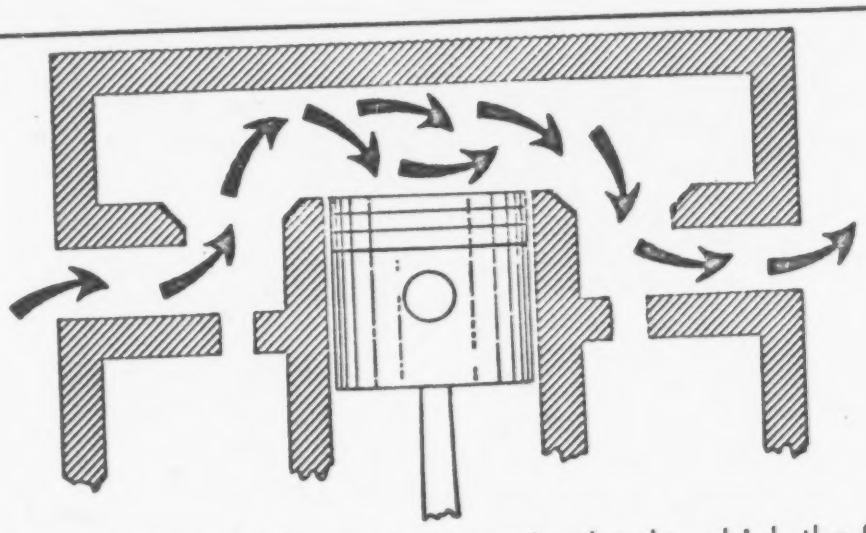

The opening at the side of the combustion chamber by which the fuel mixture enters the combustion chamber is called the INTAKE PORT.

DARKEN the intake port.

19023

9

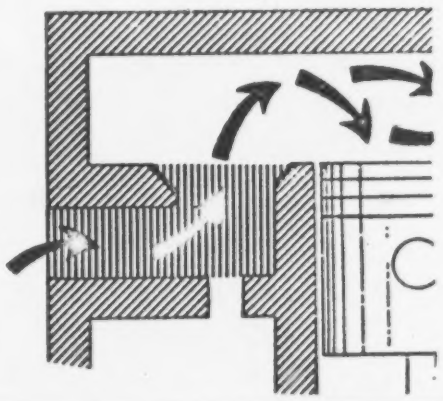

10

SHADE IN the valve port where exhuast gases leave the combustion chamber:

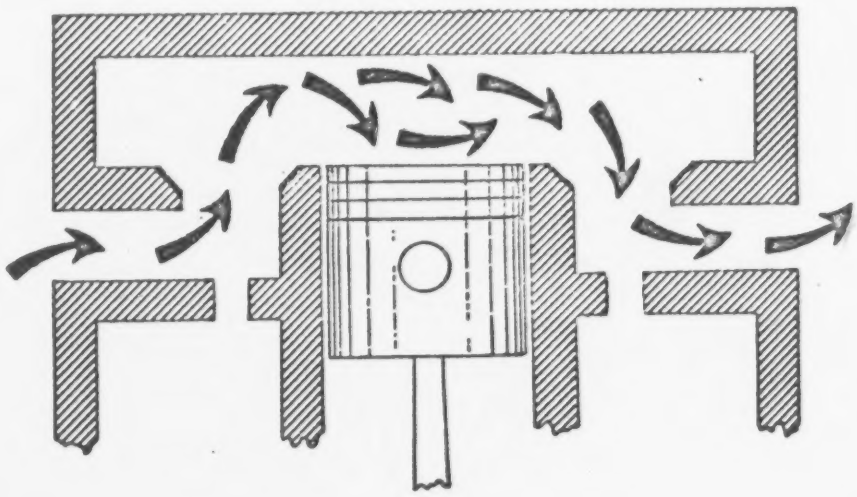

This is the:

- ☐ exhaust port
- ☐ intake port

19024

10

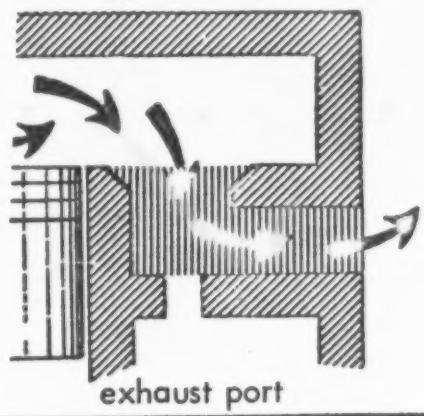

11

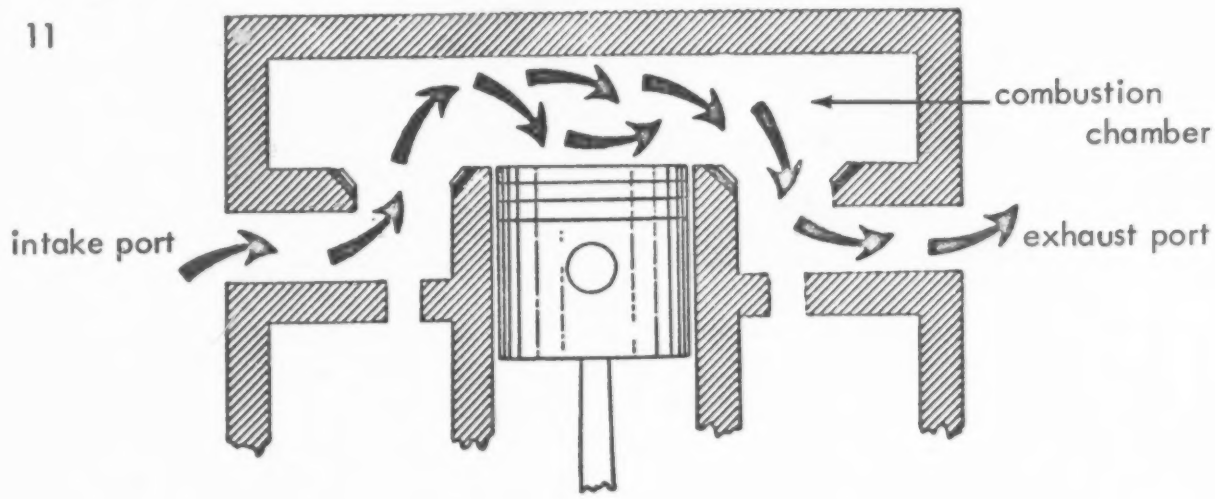

The automobile's fuel mixture enters the combustion chamber and the burned gases leave the combustion chamber through:

- ☐ valve harbors
- ☐ valve ports
- ☐ valve wharves

19025

11

valve ports

12

What goes through the valve ports of an engine?
(CHECK two correct answers)

- ☐ air-gasoline mixture
- ☐ burned gases
- ☐ raw gasoline
- ☐ unburned gasoline

19026

carbon and alloy steels, and the mechanical properties of discs forged at various temperatures. Also, the tables and charts illustrate a new method for forging pieces of turbine and compressor discs and lids on floating blocks under hydraulic presses, and the technological factors determining the deformation of metal during rolling of forged lead, aluminum, and steel blanks.

ANALYSIS OF CRACKING IN SWAGED 7075–T6 ALUMINUM ALLOY TUBING (AD–673 954)

This report from the Naval Research Laboratory, Washington, D.C., might interest shops forming and/or using swaged aluminum tubing in their products. It discusses intergranular fractures caused by stress-corrosion mechanism failure. Microstructural examination by electron microscopy showed that a significant short transverse-type grain orientation existed in the fracture plane.

EXPERIMENTAL DETERMINATION OF THE BASIC PARAMETERS OF A HIGH-SPEED HAMMER (AD–674 342)

Wright-Patterson AFB, Ohio, translated a Russian report which might be useful to manufacturers or users of high-speed hammers. It describes the method and results of determining the velocities and collision energies of the counter-moving parts of a high-velocity press hammer. It has a maximum impact energy of 8,900 kg-m which is represented by a frame and a ram, plus accessories.

STRENGTHENING MECHANISMS DURING THE HEAT TREATMENT OF THREE TITANIUM ALLOYS (AD–675 464)

Firms involved with heat treating of titanium alloys will be interested in this report from the Army Materials and Mechanics Research Center, Watertown, Mass. It discusses the effects of solution and aging treatments on three alloys, Ti-6Al-4V, Ti-6Al-6V-2Sn, and Ti-8Al-1Mo-1V. The following characteristics were investigated: hardness measurements, electron microscopy, resistance measurements at the aging temperatures, and X-ray diffraction. Relatively small changes in alloy content have a marked effect on the strengths attainable by heat treatment. Two hardening mechanisms which account for all the observed responses to heat treatment are described. The changes in strength as the result of heat treatment are correlated with the equilibrium alloy contents of the phases present at the solution temperature.

TECH BRIEF 68–10285—PREWELD HEAT TREATMENT IMPROVES WELDS IN RENÉ 41

Shops and laboratories using René 41 have found the alloy seriously troubled by cracking during the post-weld heat treatment. Because most cracking seemed related to "strainage," NASA has determined that controlled cooling of the alloy (40° F./min.) from the solution-annealing temperature would eliminate 90 percent of the serious cracking. This technique, with modifications, should apply equally well to Waspalloy, U500, and other nickel-base alloys.

For additional information, circle Key No. 2 on Reader Service Card.

OPTIMUM CONDITIONS FOR BLAST CLEANING OF STEEL PLATE (AD–670 623)

The blast cleaning process and how it affects the surface of steel plate is described in this report by Collins Radio Co., Newport Beach, Calif. Exploratory tests showed that removing rust from steel plate and cleaning welds are best accomplished by blasting perpendicular to the surface. Small grain size abrasives achieve higher rates of cleaning. This process may be of interest to companies now using centrifugal machines since test results showed somewhat higher values for blast cleaning.

12

air-gasoline mixture

burned gases

13

Openings at the side of the combustion chamber are called valve

_____.

19027

13

ports

14

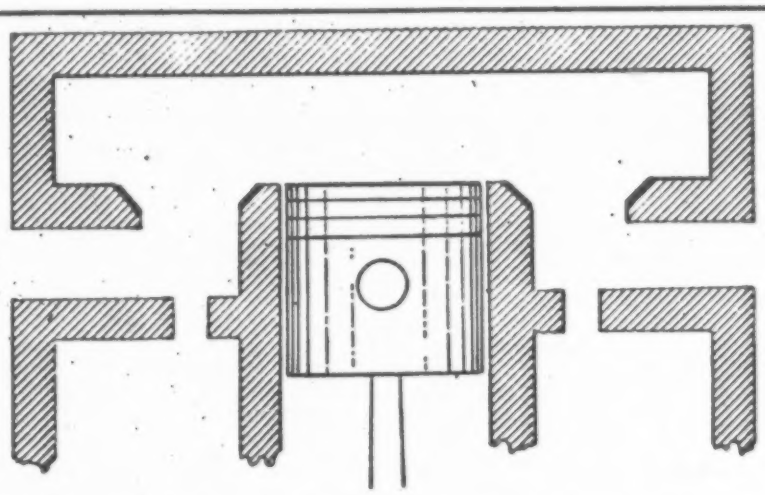

If the valve ports were left open when the explosions happened, the force would:

- ☐ partly go out of the valve ports
- ☐ only go on the top of the piston
- ☐ go out by the spark plugs

This would make the engine's power:

- ☐ great
- ☐ less
- ☐ the same

19028

14

partly go out of the valve ports

less

15

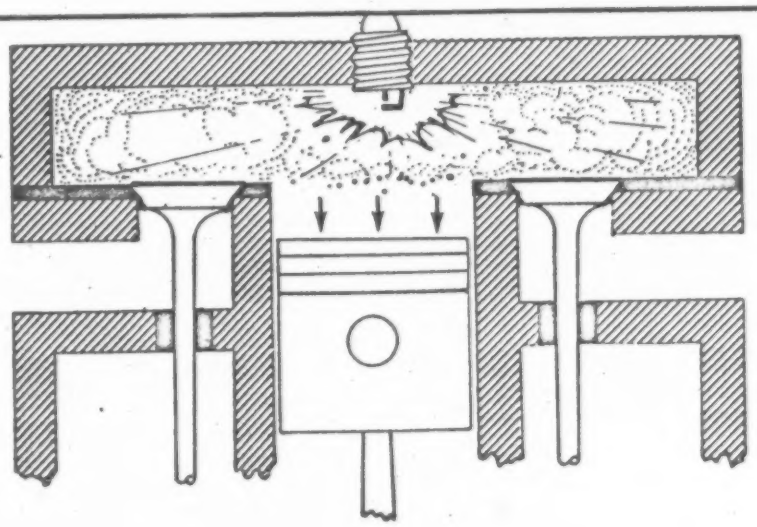

When the explosion takes place, parts inside the valve ports close the combustion chamber.

When this happens, all the power will:

- ☐ blow out of the valve ports
- ☐ push down on the top of the piston
- ☐ return to the spark plugs

19029

15

push down on the top of the piston

16

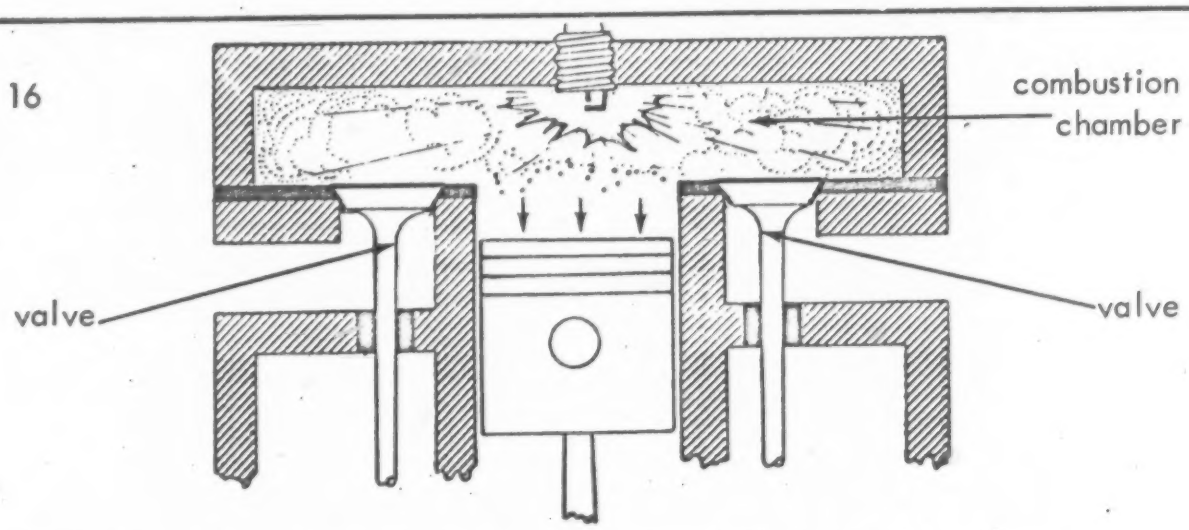

The parts in the valve ports that seal the combustion chamber are called _____.

19030

16

valves

17

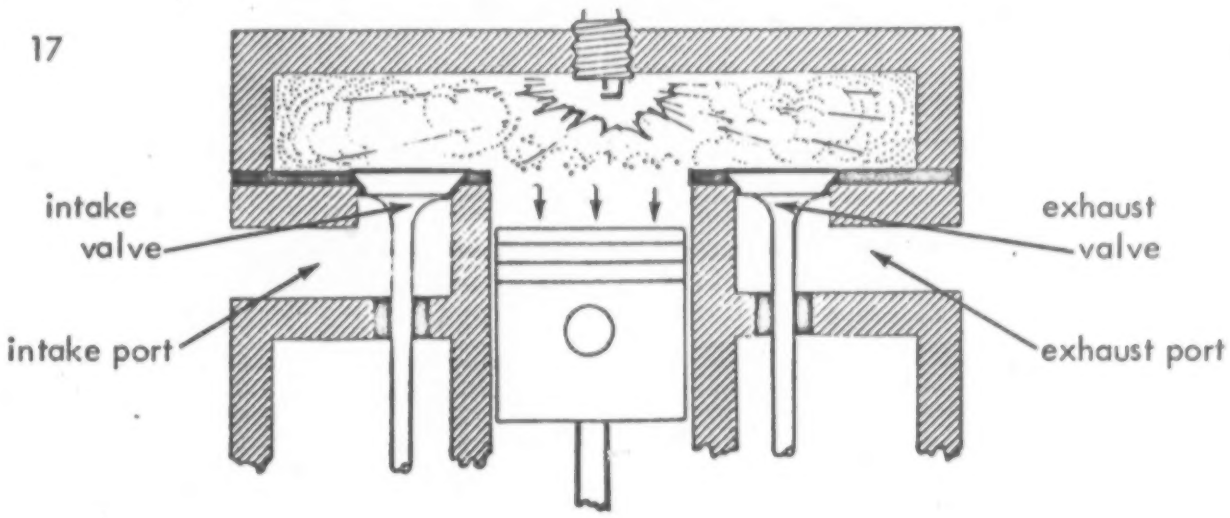

The air-gasoline mixture enters the compression chamber through the intake port and the burned gases leave the combustion chamber through the _____ port.

19031

17

exhaust

18

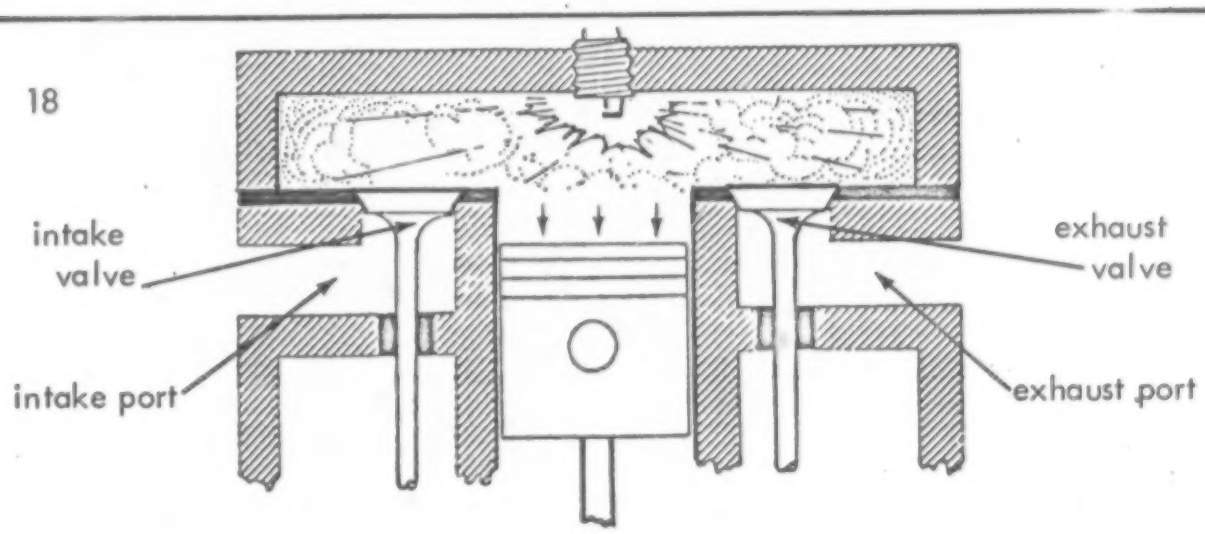

Which valve port does the air-gasoline mixture go into?

_____

19032

18

intake port

19

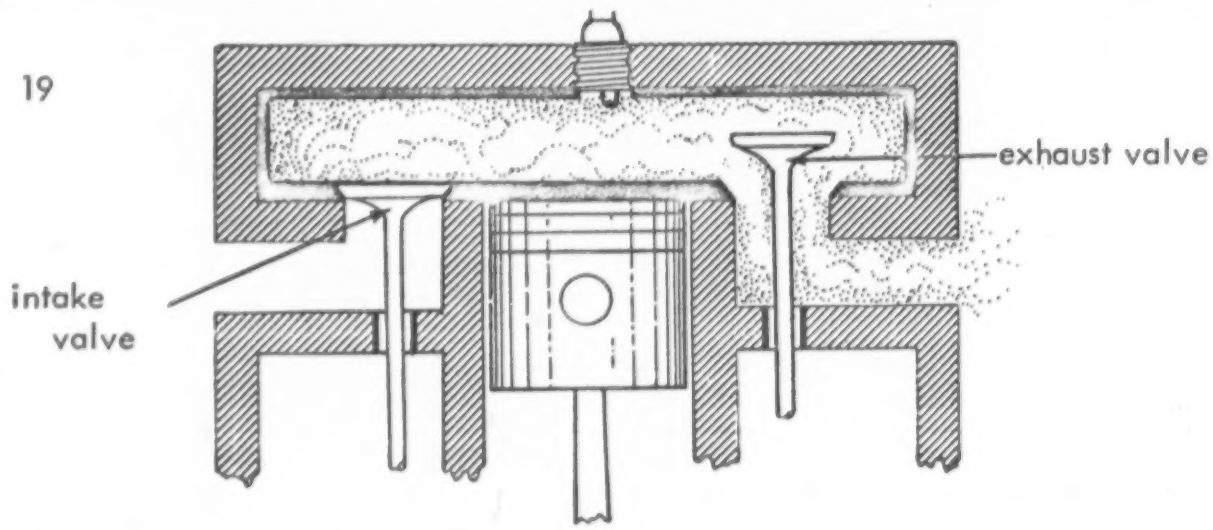

After the explosion, the _____ opens and burned gases leave the combustion chamber.

19033

270

269 OF 327

ED

056 238

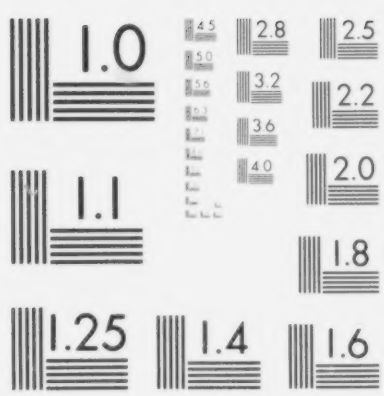

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

19

exhaust

20

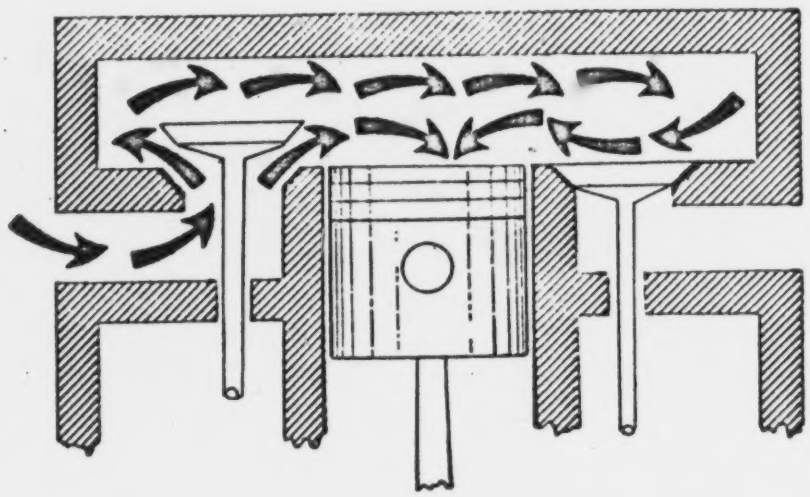

Which valve opens up to let the air-gasoline mixture into the combustion chamber? _____

19034

20

intake valve

21

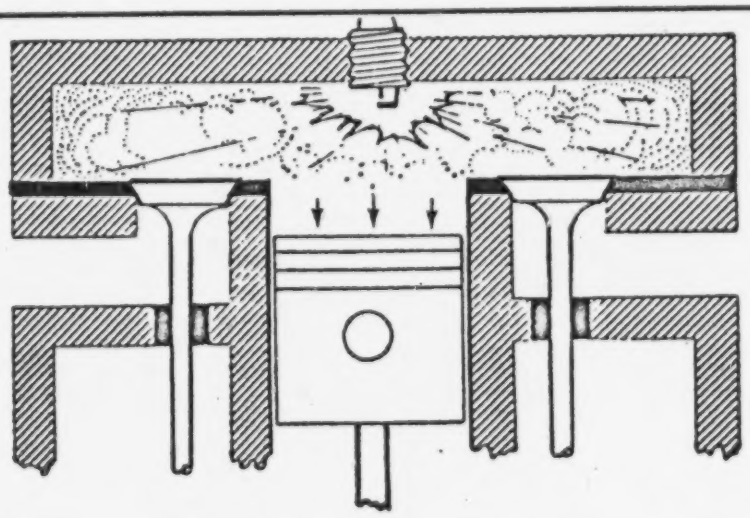

When the explosion in the combustion chamber takes place:

- ☐ both valves are closed
- ☐ both valves are open
- ☐ one valve is open

19035

A LIBERAL EDUCATION IN NONDESTRUCTIVE TESTING

How can you test the tank under pressure without blowing it to smithereens? How can you test all manner of items, fittings, instruments, and the like to the ultimate limits of what is required without destroying or damaging them? What can you do when nondestructive testing is a requirement of the contract?

What you can do is learn about nondestructive test techniques. These techniques are sometimes expensively learned, and very frequently hard to obtain—remember the Vanguard and the Tacoma Narrows Bridge.

NASA at Huntsville has attacked the problem of acquiring this knowledge and has assembled a series of 15 volumes. Each is described in the following abstracts, N68–28776 through N68–28790. They contain a mint of information covering the entire field of nondestructive test techniques. These books are much more than just an encyclopedia of the subject; in each of the special areas they can be your engineer's handbooks. They are written in a self-study, programed instruction format. Hard cover editions are $3 each, or $45 for the set. You can try them out, if you wish, in the low cost microfilm version at 65 cents apiece.

INTRODUCTION TO NONDESTRUCTIVE TESTING (N68–28776)

Meeting the entire subject for the first time, the reader finds that nondestructive testing can be best introduced by a discussion of those things for which tests are made. They are flaws, discontinuities and weaknesses that occur in welding, tubing, pipes, extruded materials, forgings, castings, seams, laminations, and the complete gamut of materials and processes that may create undesirable conditions. This report shows how these methods disclose conditions that otherwise might not be detected with destructive test techniques. A wide variety of metal and formed materials are discussed in terms o sources of flaws or discontinuities. The need fo and the value of nondestructive testing is made ev dent for all of the materials, machinings, and pro cesses discussed.

LIQUID PENETRANT TESTING (N68–28777)

This is the first of the volumes dealing with specific nondestructive testing technique. It disclose the discontinuities by using the Oil and Whitin method, by using various penetrant materials, an by wet and dry developers. The techniques used, th materials and equipment required, and the pro cedure are discussed fully. Inspection is presente carefully, with many notes on the limitations of liqui penetrant testing. A chapter covers the use of wate washables, emulsificants, and solvent-removabl penetrants, together with the washing and dryin processes needed.

MAGNETIC PARTICLE TESTING (N68–28778)

Both theory and practice of magnetic partic testing are covered thoroughly in the programed in struction in this volume. The technique, studyin the particle formation after magnetization, require complete demagnetization first. This and the theor of the test are fully explained. Then the variou techniques are described fully, including circul longitudinal fields, cables, prods, and yokes. Curren are covered by type and load requirements, an special emphasis is given to general safety in al pro cedures. Residual field inspection is discussed, as the set-up, equipment, and procedures for each the testing methods.

EDDY CURRENT, VOLUME 1: BASIC PRI CIPLES (N68–28779)

22

intake valve

23

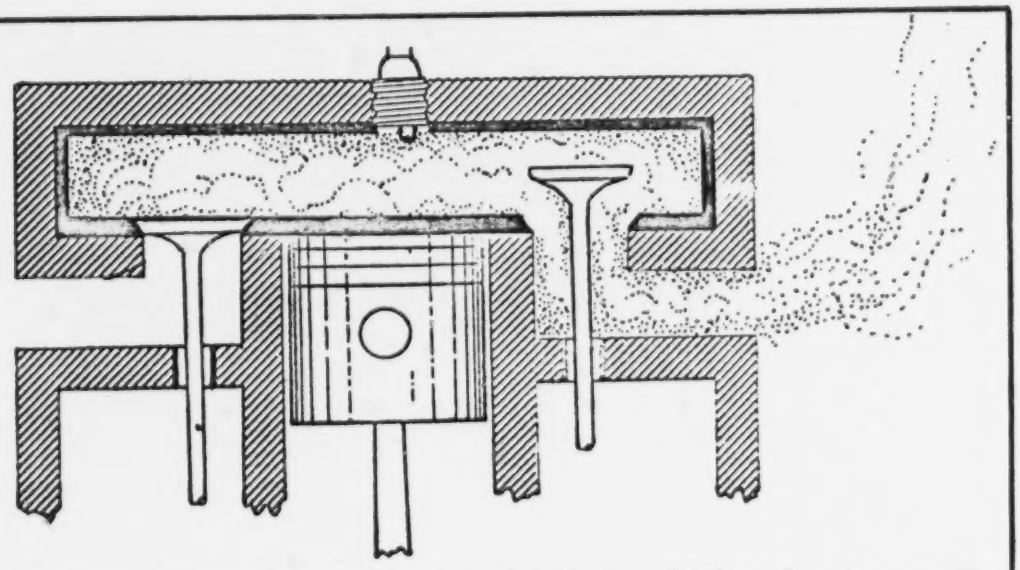

When the burned gases leave the combustion chamber, which valve is open?

- ☐ control valve
- ☐ exhaust valve
- ☐ intake valve

Which valve port do the burned gases go through?

- ☐ exhaust port
- ☐ intake port

19037

23

exhaust valve

exhaust port

24

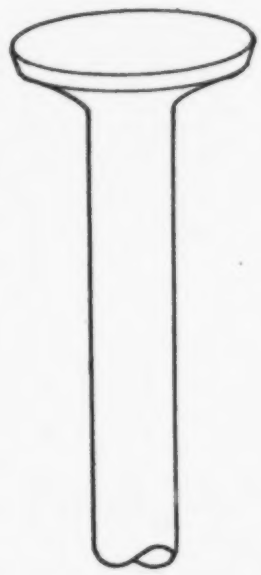

This is a picture of a:

- ☐ flywheel
- ☐ piston ring
- ☐ valve

19038

24

valve

25

The job of the intake valve is to let the air-gasoline mixture go into the _____ _____.

This happens when the intake valve:

- ☐ opens
- ☐ closes

19039

25

combustion chamber

opens

26

When the exhaust valve opens, b_____ g_____ leave the combustion chamber.

19040

26

burned gases

27

NAME the part that controls the flow of the fuel mixture into the combustion chamber.

_____ _____

19041

27

intake valve

28

Which part controls the flow of burned gases out of the combustion chamber? _____

19042

28

exhaust valve

29

The job of the intake valve is to control the flow of _____ into the _____.

This happens when the intake valve _____.

19043

29

fuel or air-gasoline mixture

combustion chamber

opens

30

The job of the exhaust valve is to control the flow of burned gases _____ of the _____ _____.

This happens when the exhaust valve _____.

30

out

combustion chamber

opens

31

The fuel mixture goes through the _____ port to get to the combustion chamber.

The burned gases go through the _____ when it leaves the combustion chamber.

19045

UCATION IN VE TESTING

under pressure without How can you test all struments, and the like at is required without m? What can you do is a requirement of the

n about nondestructive niques are sometimes ry frequently hard to uard and the Tacoma

ttacked the problem of and has assembled a is described in the fol- 6 through N68–28790. ormation covering the test techniques. These ust an encyclopedia of special areas they can s. They are written in truction format. Hard or $45 for the set. You , in the low cost micro- e.

ONDESTRUCTIVE

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EDDY CURRENT. VOLUME 1: BASIC PRINCIPLES (N68–28779)

EDDY CURRENT. VOLUME 2: EQUIPMENT, METHODS, AND APPLICATIONS (N68–28780)

These two volumes, both programed texts, provide the reader with the theory, the state-of-the-art, and the practical know-how to develop expertise in performing eddy current test procedures. The first volume deals with the generation and distribution of eddy currents, their behavior and value to material testing, the relationship of magnetic and electrical effects to the eddy current, and electrical concepts required for such testing. Permeability, flux density, magnetizing force, saturation, and hysteresis are included, as are impedance testing, phase and modulation analysis.

Volume 2 discusses physical and electrical design of various coils in relation to electromagnetic testing systems. Encircling, inside, and surface coils are considered, and single, double, and differential arrangements noted. Impedance, reactance, and feedback controlled testing; vector point, ellipse, and linear time-base methods, and modulation analysis are treated under methods and indications for use of eddy currents. A chapter on applications reviews conductivity, permeability, discontinuity, and thickness testing.

TECH BRIEF 68–10257—INSPECTION CRITERIA ENSURE QUALITY CONTROL OF PARALLEL GAP SOLDERING

Firms engaged in parallel gap soldering of electrical connections will profit from NASA's investigation of process control and inspection criteria of all commercially used connectors. The recommendations, when followed, will improve production, reduce scrap, and minimize damage to other components. They cover technique, amount of solder, heat dwell time, and material preparation.

For additional information, circle Key No. 3 on Reader Service Card.

31

intake

exhaust

32

MATCH the following:

A. control valve

B. intake valve

C. exhaust valve

1. _____ controls the flow of burned gases out of the combustion chamber

2. _____ controls the flow of the fuel mixture into the combustion chamber

19046

32

1. C

2. B

33

MATCH the following:

A. deposit port

B. intake port

C. exhaust port

1. _____ burned gases leave from the combustion chamber

2. _____ fuel mixture enters the combustion chamber

19047

33

1. C

2. B

34

What is the job of the intake valve? _____

19048

34

It controls the flow of the fuel mixture into the combustion chamber.

35

What is the job of the exhaust valve? _____

19049

35

It controls the flow of burned gases from the combustion chamber.

36

In order for the greatest possible power to push down on the top of the piston, there should be:

- ☐ many openings around the parts
- ☐ no openings around the parts
- ☐ some small openings around the parts

19050

36

no openings around the parts

37

The parts that seal the space between the piston and the cylinder walls are the:

- ☐ piston bearings
- ☐ piston pins
- ☐ piston rings

19051

37

piston rings

38

Piston rings go around the piston.

This is to assure that there are no leaks between the piston and the:

- ☐ combustion chamber
- ☐ cylinder walls
- ☐ valve ports

19052

38

cylinder walls

39

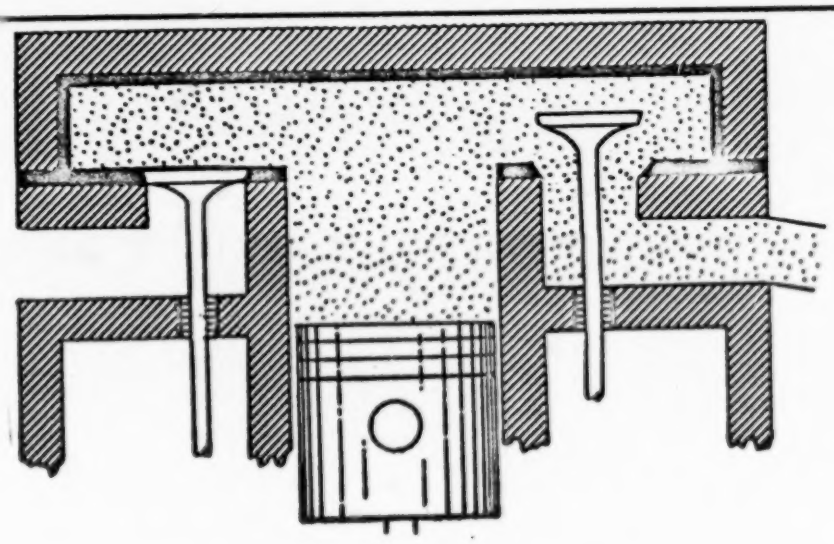

In the same way that the space between the piston and the cylinder walls must be sealed, so the space between the valve and the cylinder block must be sealed also.

This is important because it keeps all the power from the explosions:

- ☐ pushing down on the top of the piston
- ☐ leaking past the valves
- ☐ leaking past the piston

19053

39

pushing down on the top of the piston

40

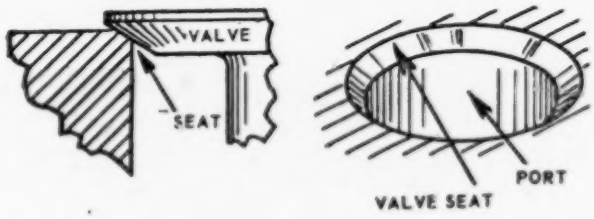

When the valves close, they sit on a part in the engine called the:

- ☐ valve guide
- ☐ valve seat
- ☐ valve spring

19054

40

valve seat

41

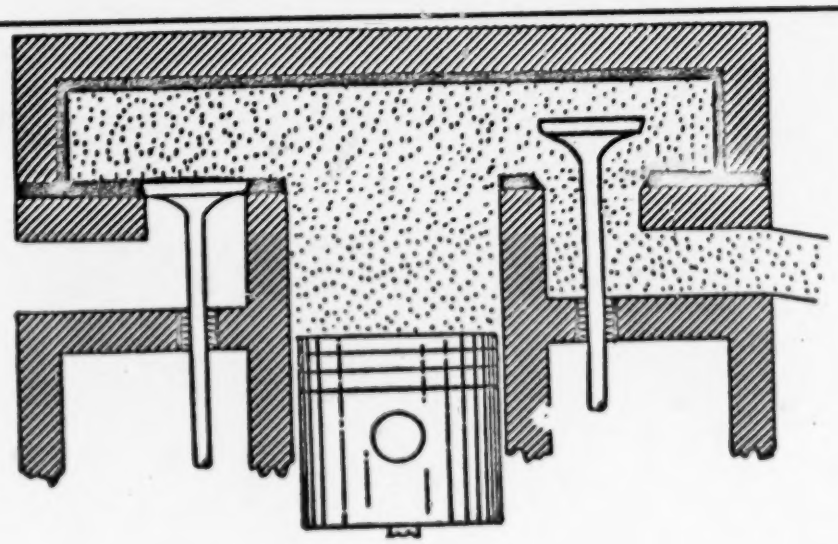

The valve seat has a surface that matches the edge of the valve.

When the valve closes, it rests on the seat.

This makes a seal between the cylinder block and the _____.

19055

TECH BRIEF 68–10394—NONDESTRUCTIVE TESTING OF BRAZED ROCKET ENGINE COMPONENTS

Manufacturers who employ welding or brazing in the fabrication of components which must withstand temperature excesses, vacuums, or high pressures will be interested in this NASA compendium of nondestructive testing of welded or brazed joints. Carefully prepared, the report fully covers the radiographic, ultrasonic, thermographic, and leak test methods used to inspect and ensure the quality of welds and brazes. Well illustrated, the report covers the set-up, jigs, equipment, and procedures of the various tests and carefully defines the advantages and limitations of each technique.

For additional information, circle Key No. 4 on Reader Service Card.

MAGNETIC PARTICLE TESTING: CLASSROOM TRAINING MANUAL (N68–28789) ULTRASONIC TESTING: CLASSROOM TRAINING MANUAL (N68–28790)

Firms investing in these two unusual testing techniques may wish to train their personnel as a group before and during their on-the-job experiences with the new equipment. These two manuals are guides to the teachers and they presume only that they have already completed the programed instruction manuals (N68–28778 and N68–28781, 82, and 83). While essentially the same material is covered as in the parent volumes, these manuals will provide great support to the teacher in a class situation where the material can be more effectively presented than in programed instruction.

METHOD OF DETERMINING ELASTIC PROPERTIES OF A METAL SAMPLE (PAT. NO. 3,416, 365)

Metallurgical and material quality control laboratories have now available to them a system for nondestructive testing of the elastic properties of metal. The tests are both rapid and accurate and are not influenced by variations in the thickness of the metal. The test equipment also can be used to establish the effects upon elasticity of known impurities in the metal. Elasticity is measured by pulsed ultrasonic waves according to their time-of-passage through the sample material. The test equipment includes transmitter and heads, gating circuit, amplifiers, coincidence and pulse shaping circuits, a time-to-voltage converter, and a recording machine. As originally designed, the equipment was able to determine the presence of hydride in zirconium at levels of a few hundred parts per million. When parameters are established, similar detections can be made for other impurities in other metals.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

ULTRASONICS. VOLUME 1: BASIC PRINCIPLES (N68–28781)

ULTRASONICS. VOLUME 2: EQUIPMENT (N68–28782)

ULTRASONICS. VOLUME 3: APPLICATIONS (N68–28783)

In recent years ultrasonic testing has received tremendous attention from NASA and Defense and its growth as a scientific test discipline has been astounding. Because of NASA's success, a plateau in ultrasonics has been reached. Now is an opportune time to survey all that has been done in all areas of ultrasonic testing. These three volumes completely cover today's abilities in this field.

886-408 O - 70 O - 8

41

valve

42

Valve seats and piston rings both help to prevent power from leaking out because they:

- ☐ help power to leak for the combustion chamber
- ☐ reduce the engine's power
- ☐ seal the spaces between parts

19056

42

seal the spaces between parts

43

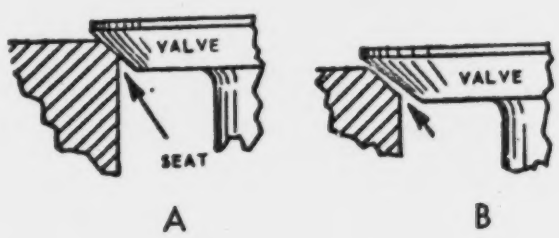

Which picture shows an open valve?

- ☐ picture A
- ☐ picture B

When the valve is closed it sits on the valve _____.

19057

43

picture B

seat

44

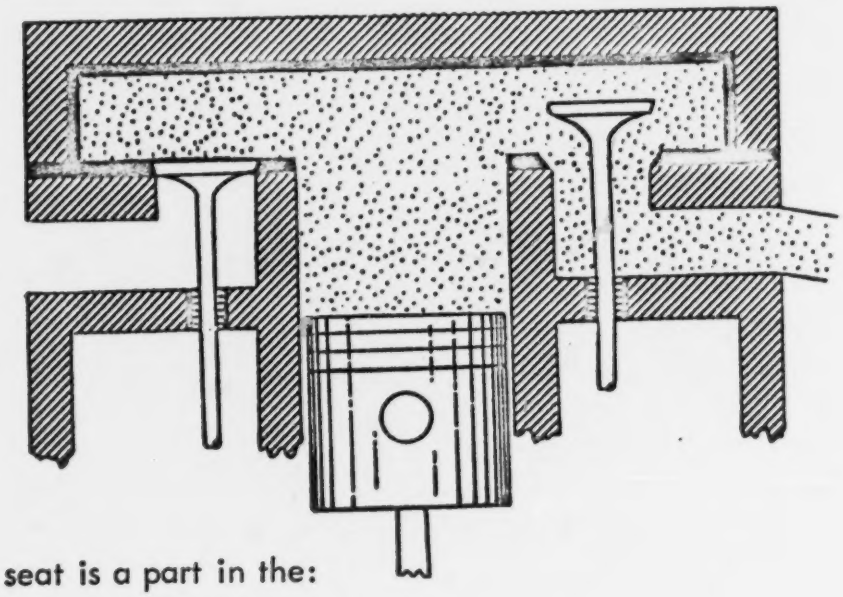

The valve seat is a part in the:

- ☐ cylinder block
- ☐ valve

It does not move:

- ☐ This statement is true.
- ☐ This statement is false.

19058

44

cylinder block

This statement is true.

45

NAME the parts that move toward and away from the valve seat.

_____

19059

45

valves

46

If the valves were loose, as they went up and down they would:

- ☐ stay straight
- ☐ wobble
- ☐ go true

If they wobbled, they would not make a perfect seal on the valve seat.

- ☐ true
- ☐ false

19060

46

wobble

true

47

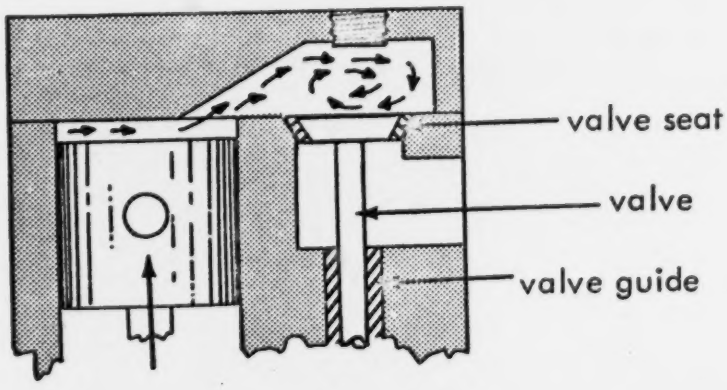

Just like the steering post goes around the steering column, a part goes around the valve to keep the valve from wobbling.

This part is called the valve _____.

The job of this part is to keep the valve going:

☐ from side to side

☐ straight up and down

19061

47

guide

straight up and down

48

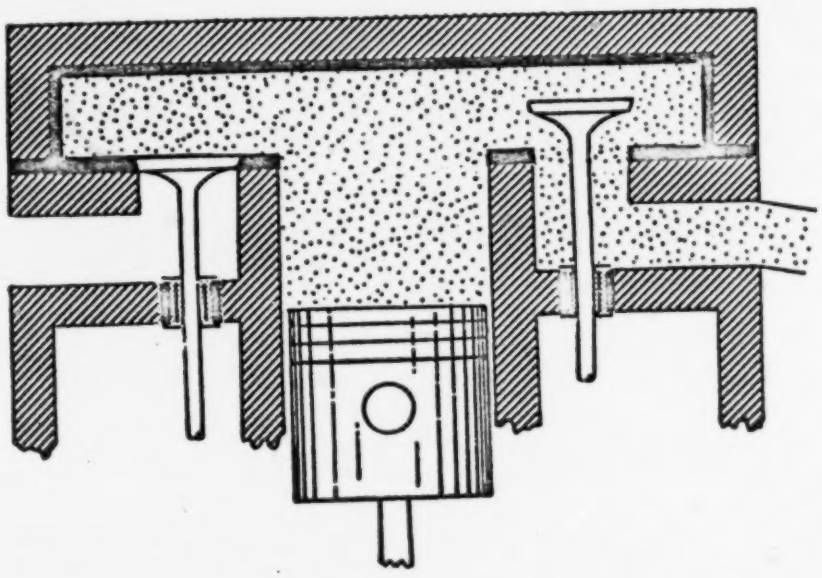

Valve guides go:

- ☐ around part of the valve
- ☐ on the bottom of the valve
- ☐ on the top of the valve

19062

48

around part of the valve

49

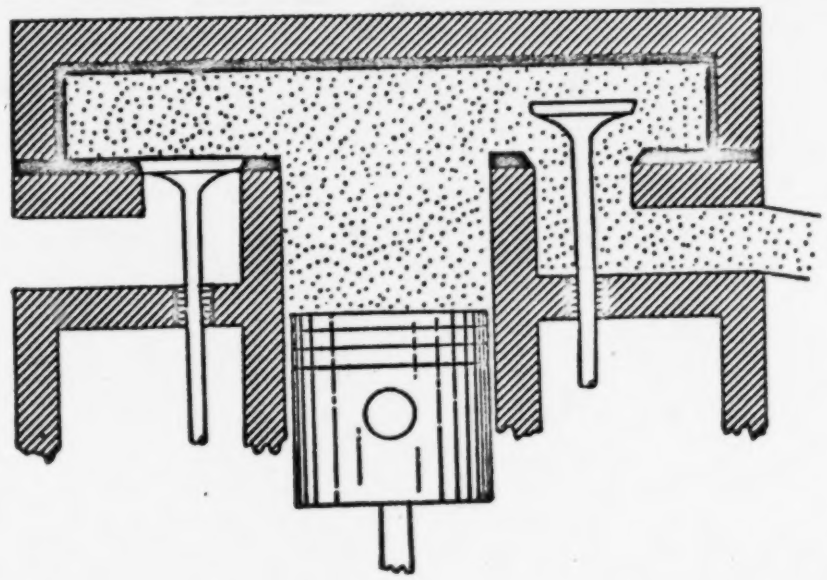

The job of the valve guides is to:

- ☐ keep the valves going straight up and down
- ☐ keep the valves from moving
- ☐ keep the valves going from side to side

19063

49

keep the valves going straight up and down

50

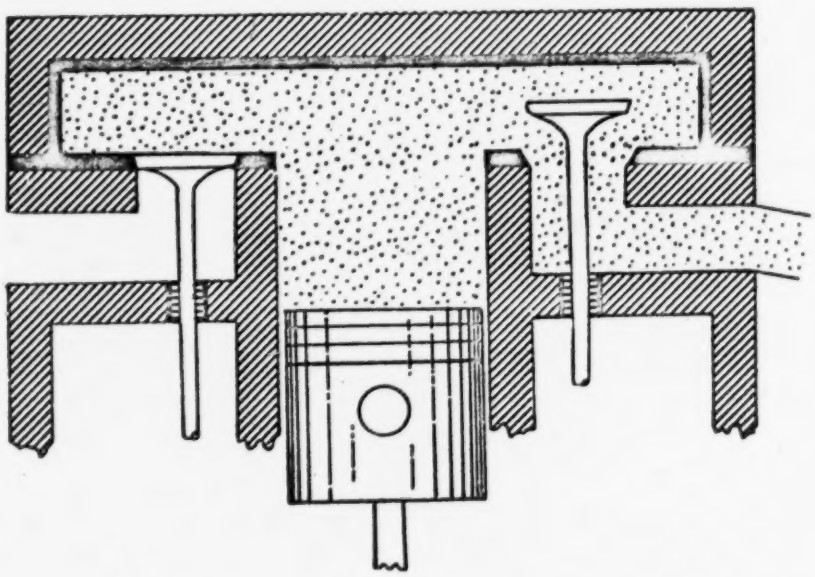

CIRCLE the valve guides in the diagram above.

19064

50

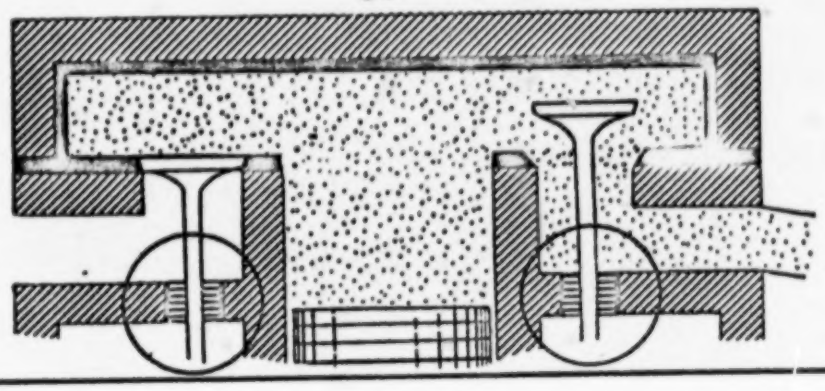

51

Valve guides keep the valves going straight _____ and _____.

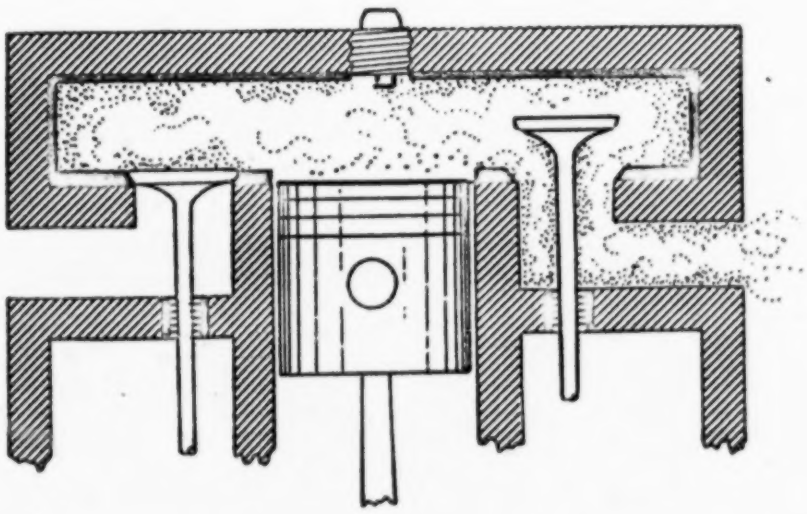

19065

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Key No. 4 on

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N68–28789)
CLASSROOM
790)

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METHOD OF DETERMINING ELASTIC PROPERTIES OF A METAL SAMPLE (PAT. NO. 3,416, 365)

Metallurgical and material quality control laboratories have now available to them a system for nondestructive testing of the elastic properties of metal. The tests are both rapid and accurate and are not influenced by variations in the thickness of the metal. The test equipment also can be used to establish the effects upon elasticity of known impurities in the metal. Elasticity is measured by pulsed ultrasonic waves according to their time-of-passage through the sample material. The test equipment includes transmitter and heads, gating circuit, amplifiers, coincidence and pulse shaping circuits, a time-to-voltage converter, and a recording machine. As originally designed, the equipment was able to determine the presence of hydride in zirconium at levels of a few hundred parts per million. When parameters are established, similar detections can be made for other impurities in other metals.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

ULTRASONICS. VOLUME 1: BASIC PRINCIPLES (N68–28781)

ULTRASONICS. VOLUME 2: EQUIPMENT (N68–28782)

ULTRASONICS. VOLUME 3: APPLICATIONS (N68–28783)

In recent years ultrasonic testing has received tremendous attention from NASA and Defense and its growth as a scientific test discipline has been astounding. Because of NASA's success, a plateau in ultrasonics has been reached. Now is an opportune time to survey all that has been done in all areas of ultrasonic testing. These three volumes completely cover today's abilities in this field.

The first volume defines how and why ultrasonics can work as a test and evaluation instrument. Various test systems, methods, techniques, and displays are covered under the general heading of transducers. The generation of ultrasonic sound, wave propagation and characteristics in different media, and resonance and harmonic frequencies are included. A chapter deals with pulse echo through transmission and resonance, contact and immersion testing, and A, B, C scans. Surface conditions, beam incidence, grain structure, porosity effects, discontinuity orientation, and angular discontinuities are also covered. It relates the technique to the tested materials and the information that can be gained from testing.

Test equipment and accessories used in ultrasonic testing are reviewed in the second volume. Piezoelectric materials for transducers as well as transducer sensitivity, resolution, size, and frequency are treated. Contact, immersion, and straight and angle beam transducers are discussed, as are water column, wheel-type, and double transducers. Acoustical lenses and collimators are mentioned, and couplants for connecting the transducer to the test surface are considered. Attention is given to standard reference and calibration blocks; the C-scan recorder, automatic scanning equipment, carriage, manipulator, and scan tube are covered. A chapter on generator/indicator equipment describes both the pulse echo/through transmission instruments, and the resonance instruments.

Procedures for the solution of test equipment, and methods and techniques for ultrasonic testing are detailed in this third volume. Advantages and limitations of ultrasonic testing as well as contact and immersion testing are considered. Pulse echo/through transmission testing, using both the contact and immersion methods, is described. Castings, forgings, bar stock, rolled sheet and plate, pipe and tubing, and welds are discussed in relation to the application of contact testing. Discontinuity evaluation, rolled sheet and plate, cylindrically shaped specimens, off-center scanning, welds, and bonded and honeycomb materials are treated in a chapter on the application of immersion testing. Resonance testing advantages and disadvantages are reviewed.

51

up

down

52

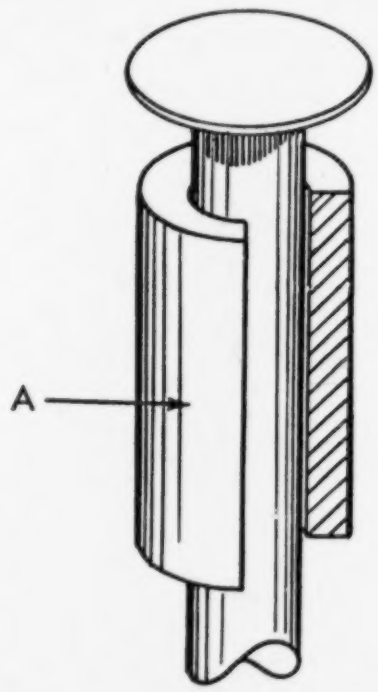

NAME the part that arrow A is pointing to: _____

19066

52

valve guide

53

What do the valve guides do? _____

19067

53

They stop the valves from wobbling.
or They keep the valves going straight up and down.

54

MATCH the following:

A. exhaust valve

B. valve guide

c. valve seat

1. _____ lets the burned gases leave the combustion chamber

2. _____ keeps the valve going straight up and down

3. _____ place where the valve sits when it is closed

54

1. A

2. B

3. C

55

MATCH the following:

A. combustion chamber

B. cylinders

C. exhaust port

1. _____ burned gases pass through it on their way to the exhaust system

2. _____ where the pistons go up and down

3. _____ where the fuel mixture is exploded

19069

55

1. C

2. B

3. A

56

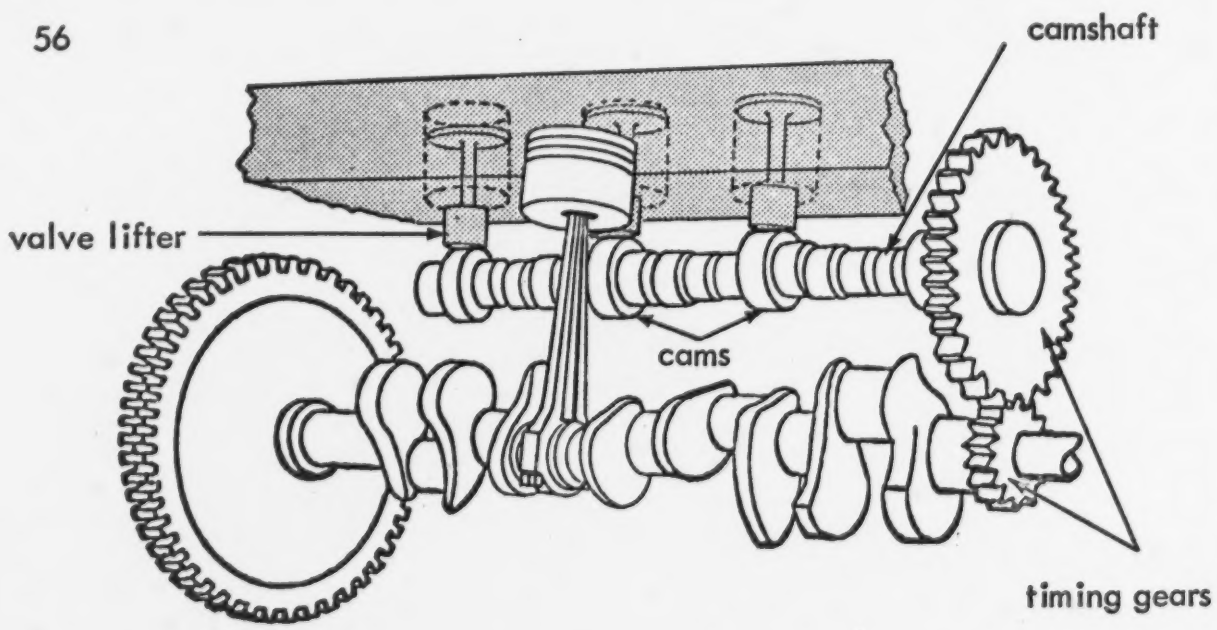

The piston is connected to the crankshaft by the:

- ☐ cams
- ☐ camshaft
- ☐ connecting rod

19070

56

connecting rod

57

In order for the fuel mixture to get into the combustion chamber, the intake valve must:

- ☐ open
- ☐ close

When explosions take place in the combustion chamber, both valves are:

- ☐ open
- ☐ closed

19071

57

open

closed

58

In order for the burned gases to get out of the combustion chamber, the exhaust valve must be:

- ☐ open
- ☐ closed

19072

58

open

59

The intake valve and the exhaust valve must work together with the piston so that they open and close at the right times.

This means that the valves and the pistons are:

- ☐ connected by some parts
- ☐ not connected by any parts

19073

59

connected by some parts

60

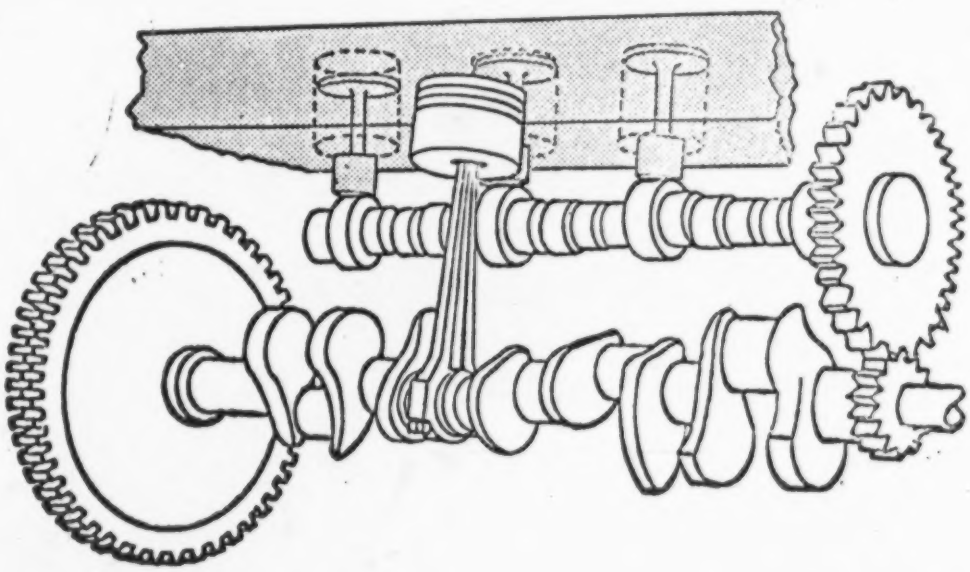

When explosions push down on the top of the piston, the piston and the connecting rod make which part turn?

- ☐ crankshaft
- ☐ valve guide
- ☐ valve seat

19074

60

crankshaft

61

The large heavy part at the rear of the crankshaft where the power transmission systems gets it power from is called the:

- ☐ connecting rod
- ☐ flywheel
- ☐ valve guide

19075

28 OF 327

ED

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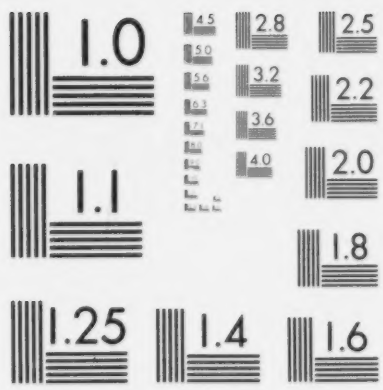

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

61

fly

62

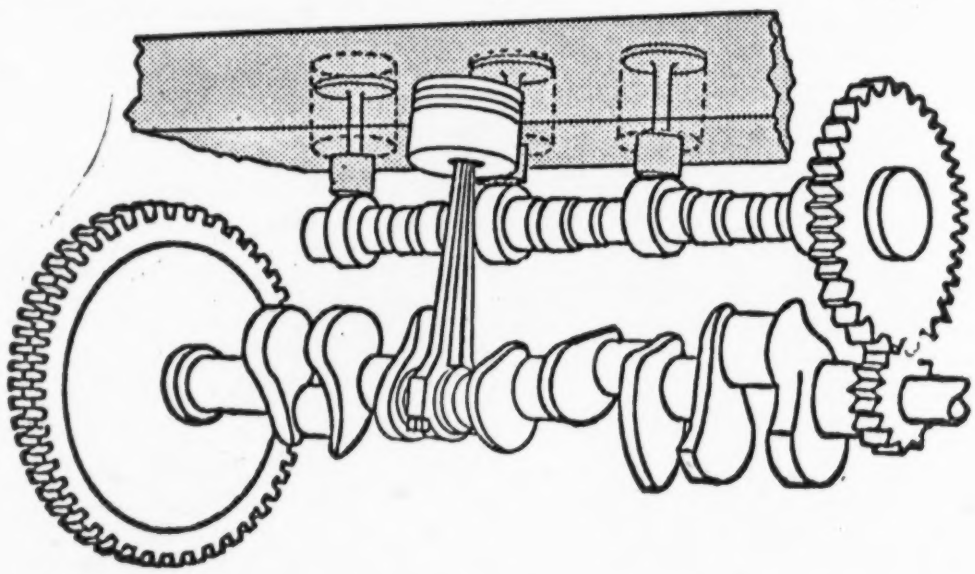

When the crankshaft is made to turn because of the up and down motion of the pistons, the timing gear to the FRONT of the crankshaft:

- ☐ will turn also
- ☐ will stay still

19076

62

will turn also

63

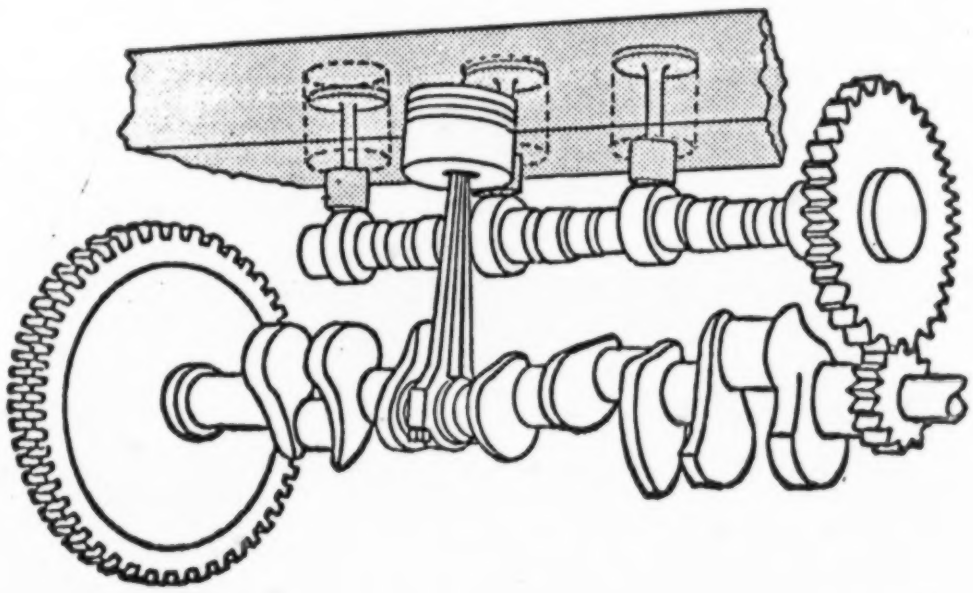

When the timing gear at the front of the crankshaft turns, what will it do to the large gear that is connected to it?

- ☐ turn it
- ☐ leave it alone
- ☐ rip it apart

19077

63

turn it

64

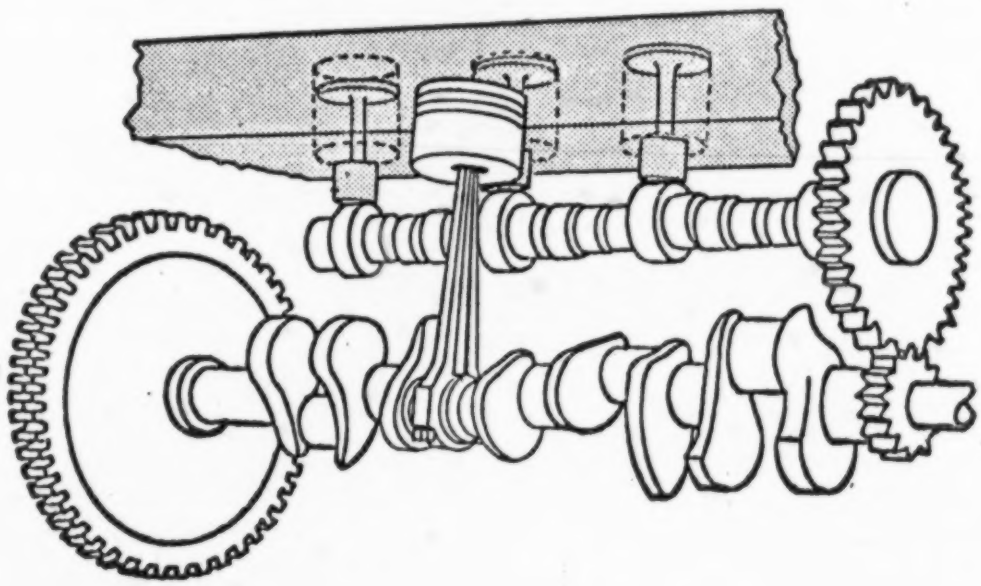

The large gear is connected to the:

- ☐ camshaft
- ☐ crankshaft

When this gear is turned by the small gear, what will it do to the shaft that it is connected to?

- ☐ turn it
- ☐ leave it alone

19078

64

camshaft

turn it

65

Which parts keep the camshaft and the crankshaft working together?

- ☐ connecting rods
- ☐ timing gears
- ☐ valve guides

19079

65

timing gears

66

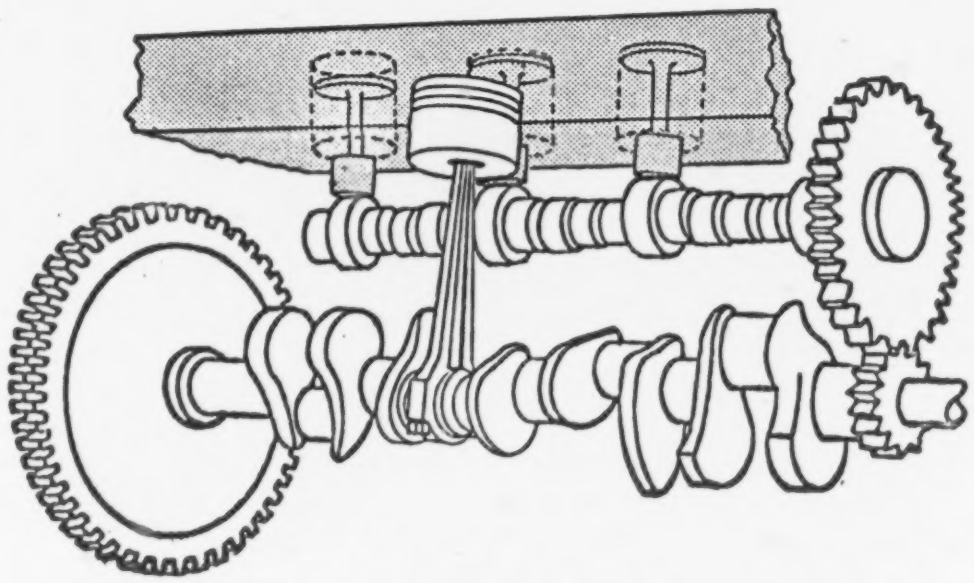

The valves move up and down on the:

- ☐ camshaft
- ☐ crankshaft

19080

66

camshaft

67

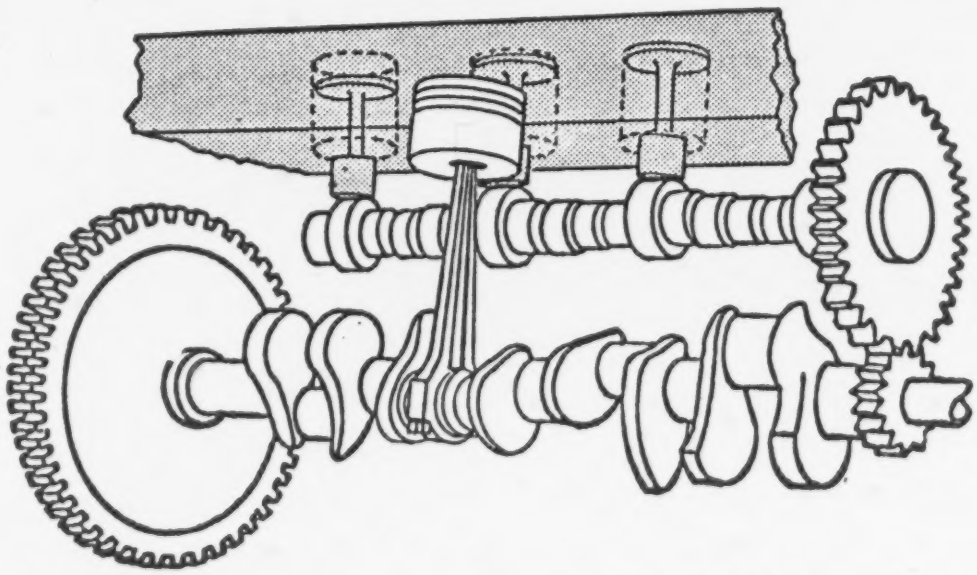

The parts that connect the camshaft and the crankshaft are the:

- ☐ gears at the front of the shafts
- ☐ parts that move up and down on the shafts
- ☐ parts at the rear of the shafts

19081

67

gears at the front of the shafts

68

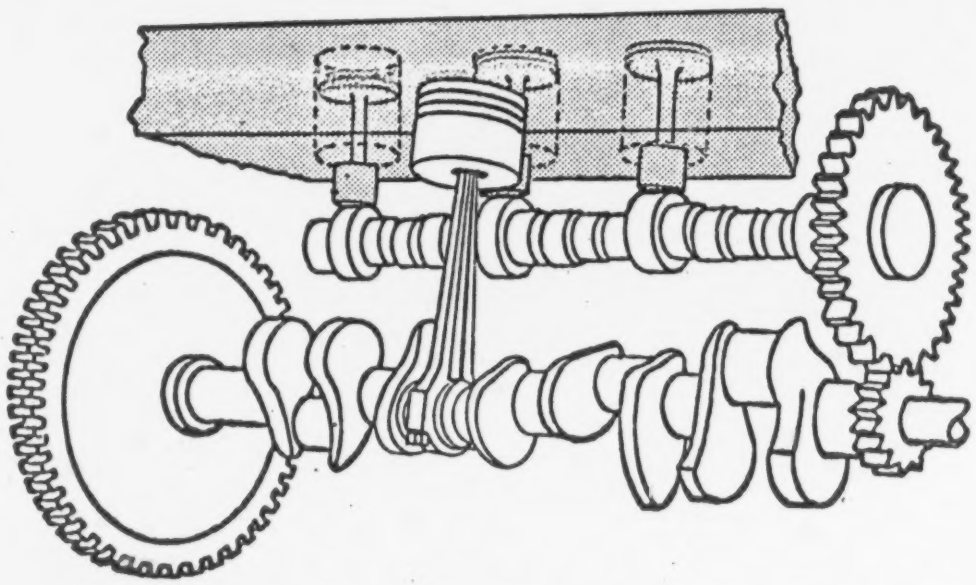

The gears that keep the timing of the valves and the pistons working in order so that the valves open and close at the right times are called the TIMING GEARS.

Timing gears are:

- ☐ at the front of the shafts
- ☐ at the rear of the shafts
- ☐ in the middle of the shafts

19082

68

at the front of the shafts

69

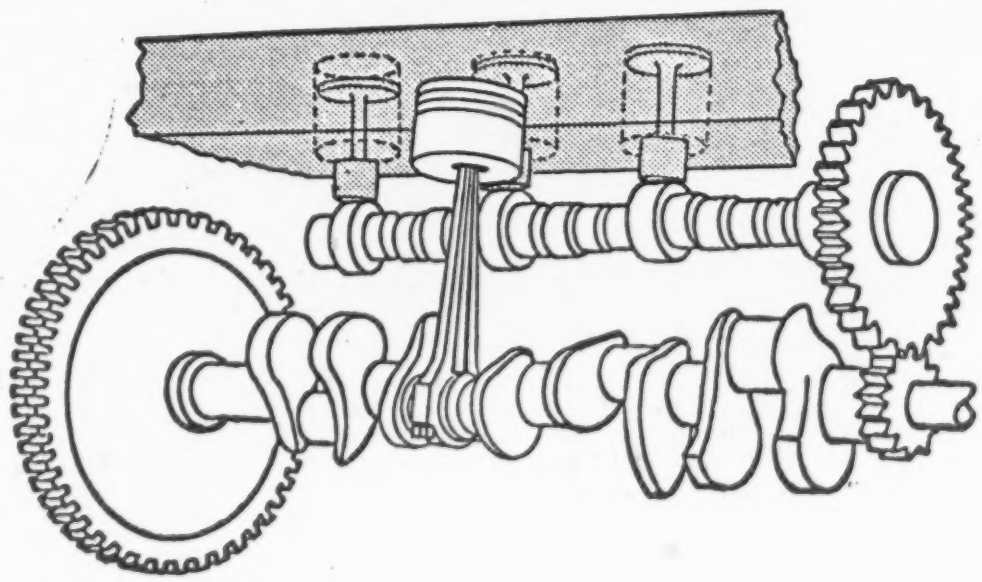

The gears that keep the crankshaft and the camshaft working together are called the:

- ☐ drive gears
- ☐ power gears
- ☐ timing gears

19083

69

timing gears

70

Which shafts are kept working together by the timing gears?

- ☐ camshaft
- ☐ crankshaft
- ☐ drive shaft
- ☐ torque shaft

19084

70

camshaft

crankshaft

71

NAME the parts that keep the crankshaft and the camshaft working together.

_____ _____

19085

TECH BRIEF 68–10004—DEVELOPMENT OF MECHANIZED ULTRASONIC SCANNING SYSTEM

A mechanized ultrasonic scanner that can inspect welds at speeds of more than 1 inch per second has been developed. It is available to firms whose weldments require more than radiographic inspection. The scanner incorporates a water-column probe which eliminates any need for submerging the weld or flushing the inspection surface. It also includes a recording system, the tooling needed to move the probe over the work surface, the probe which receives instructions and transmits data, and the flaw detection equipment and oscilloscope.

For additional information, circle Key No. 5 on Reader Service Card.

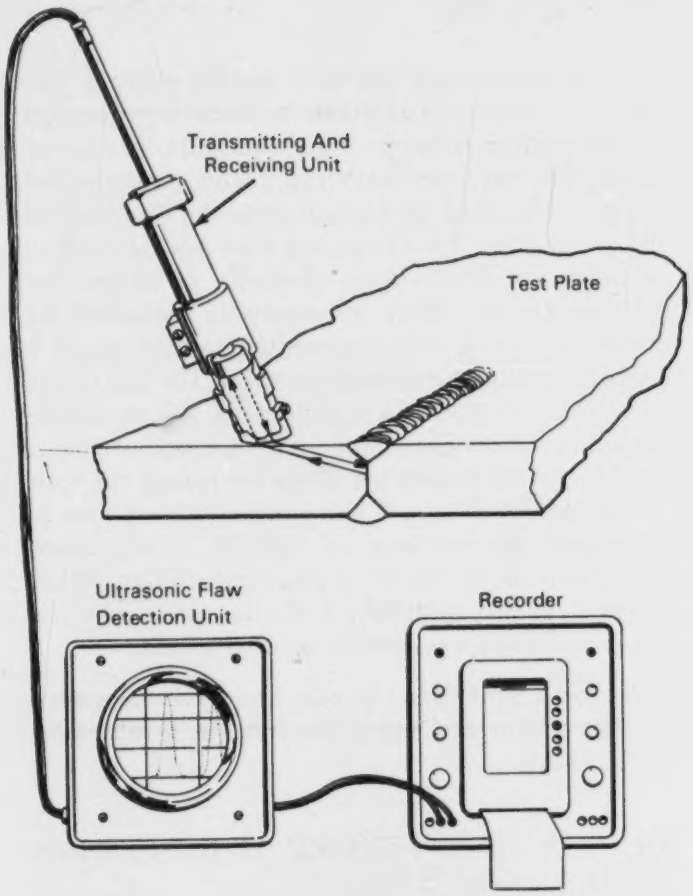

To order Clearinghouse reports (numbers prefixed AD, LA, PB, or N) and patents, list numbers on Reader Service Cards.

ULTRASONIC INSPECTION SYSTEM AND APPARATUS FOR RESISTANCE WELDS AND THE LIKE (PAT. NO. 3,384,733)

This equipment may fill a long-established need for on-the-line inspection of production welding which is nondestructive. Inspection and test of a weld is accomplished by spaced high-frequency pulses of ultrasonic energy which pass through the weld zone and are picked off by an electrode. They are processed for display on a cathode ray tube and then shown on the cathode ray screen, which may have marked out on it the acceptable limits of a good weld. Acceptance and rejection therefore does not require a skilled operator. Two ultrasonic transducers are mounted with the electrodes and test the weld almost immediately. Manufacturers of production welding equipment should not overlook the improvements inherent in this system.

Administering Office: Department of the Army, Office of the Judge Advocate General, Chief, Patents Division, Washington, D.C. 21315.

71

timing gears

72

Which shafts do the timing gears keep working together?

_____

_____

19086

72

camshaft

crankshaft

(any order)

73

DRAW an X through the timing gear on the crankshaft, and DRAW a line through the timing gear on the camshaft.

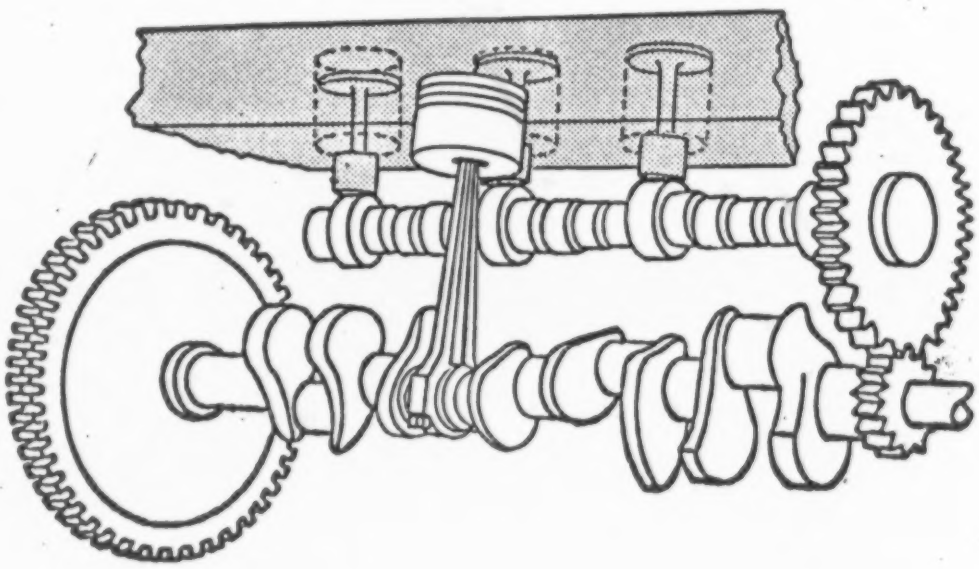

19087

73

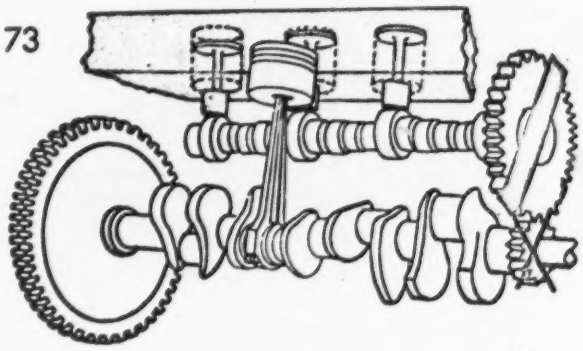

74

Which shaft turns the timing gears? _____

Which shaft gets turned by the timing gears? _____

19088

74

the crankshaft

the camshaft

75

What do the timing gears do? _____

19089

75

They keep the camshaft and the crankshaft working together.

76

When the camshaft and the crankshaft are working together, what will happen to all the parts connected to these two shafts?

- ☐ They will work together also.
- ☐ They will work separately.
- ☐ They will not be affected by the shafts.

19090

76

They will work together also.

77

Parts connected to the camshaft and the crankshaft are kept working together by the:

- ☐ drive gears
- ☐ power gears
- ☐ timing gears

77

timing gears

78

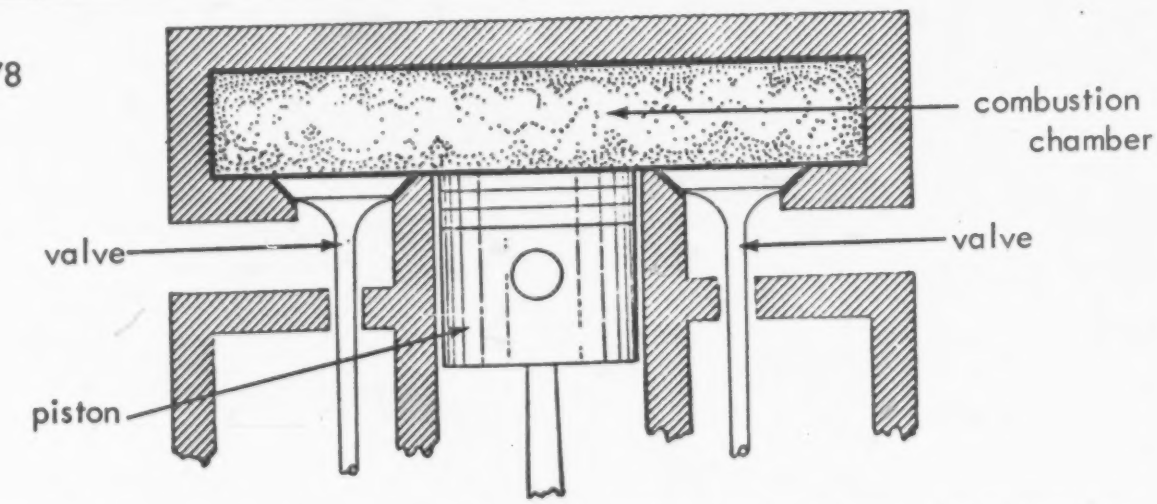

When the explosions in the combustion chamber take place, the piston is:

- ☐ at the top of the cylinder
- ☐ at the bottom of the cylinder
- ☐ in the middle of the cylinder

Both valves are:

- ☐ open
- ☐ closed

19092

78

at the top of the cylinder

closed

79

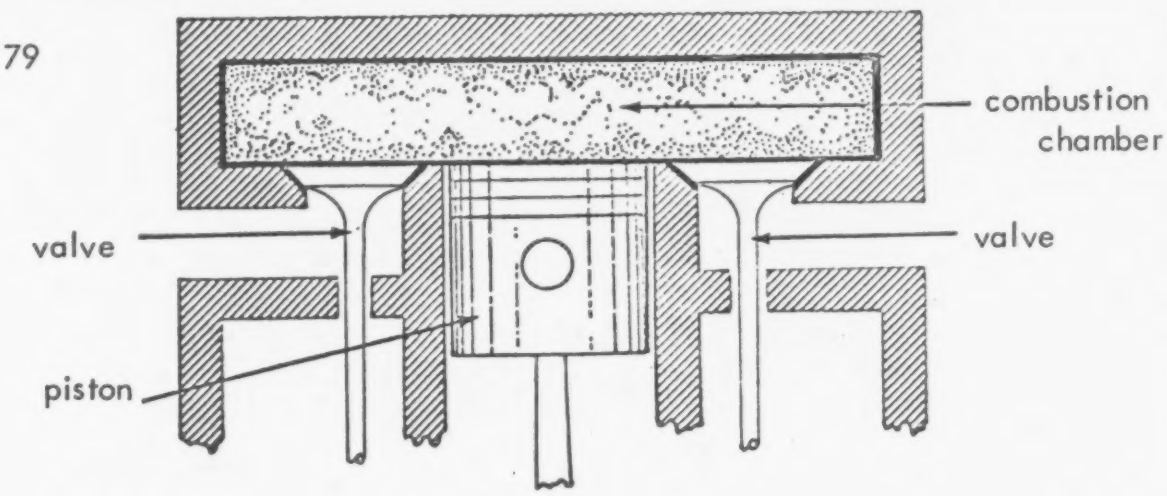

When explosions in the combustion chamber take place, the valves and the pistons:

- ☐ are working together
- ☐ are working separately

19093

79

are working together

80

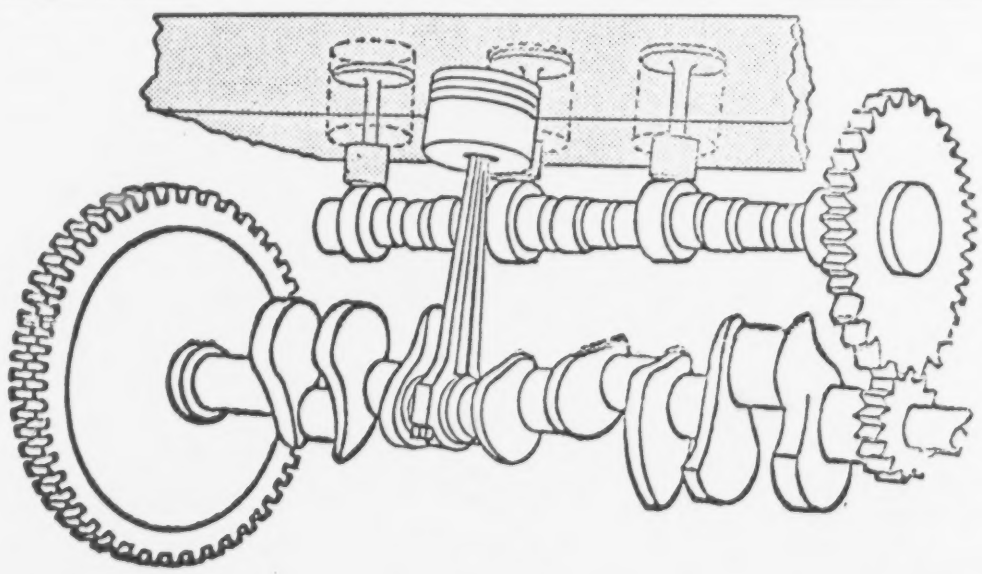

The parts that make the valves and the pistons work together are the _____ _____.

19094

80

timing gears

81

For the fuel mixture to get into the combustion chamber, which valve must open up?

_____ _____

For the exhaust gases to get out of the combustion chamber after the explosion, which valve must open up?

_____ _____

19095

ELOPMENT
C SCANNING

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d to move the
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Key No. 5 on

STEM AND
CE WELDS
4,733)

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Chief, Patents

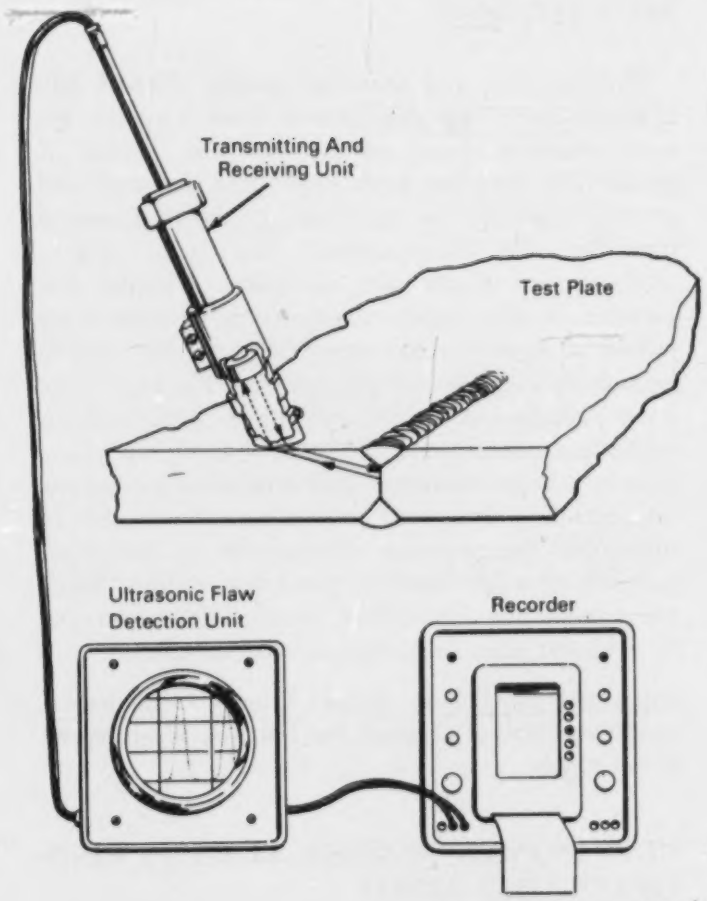

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DEVELOPMENT OF THE ULTRASONIC DELTA TECHNIQUE FOR ALUMINUM WELDS AND MATERIALS (FINAL REPORT) (N69–14207)

Applications of ultrasonics to welds of aluminum and its alloys may be measurably improved through use of the delta arrangement. The technique is described in this report from the Research Division, Automation Industries, Inc., Boulder, Colo. Designed for use with automated equipment, and also applicable to nonautomated shops, the delta technique both improves and refines the ultrasonic testing of these materials.

TECH BRIEF 68–10115—METHOD FOR REINFORCING TUBING JOINTS

Of almost universal attractiveness is a NASA-developed technique for repairing leaks, especially in restricted areas, and reinforcing small tubing used in hydraulic and pneumatic systems. This method applies equally well to the tubing used in a wide variety of transfer systems such as fuel lines, refrigerant, and air conditioning systems. The technique involves a split, threaded aluminum shield fitting over the joint ferrule and adjacent tubing. Interior surfaces of the shield are coated with an epoxy resin to establish a tight bond between shield and tube. Open nuts are used to secure the shield in place. This technique may be used effectively and economically in a majority of industries.

For additional information, circle Key No. 6 on Reader Service Card.

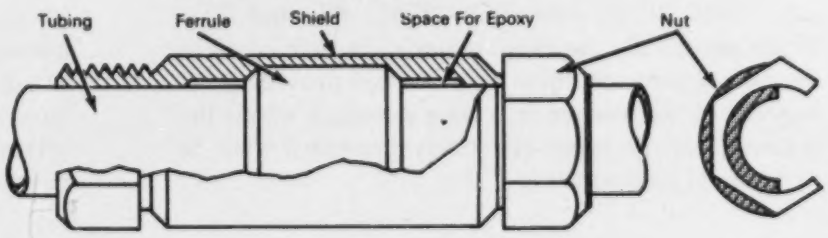

81

the intake valve

the exhaust valve

82

When the camshaft and the crankshaft work together, the valves open at the right time.

Which parts make the intake valve and the exhaust valve open and close at the right time?

_____ _____

19096

82

the timing gears

83

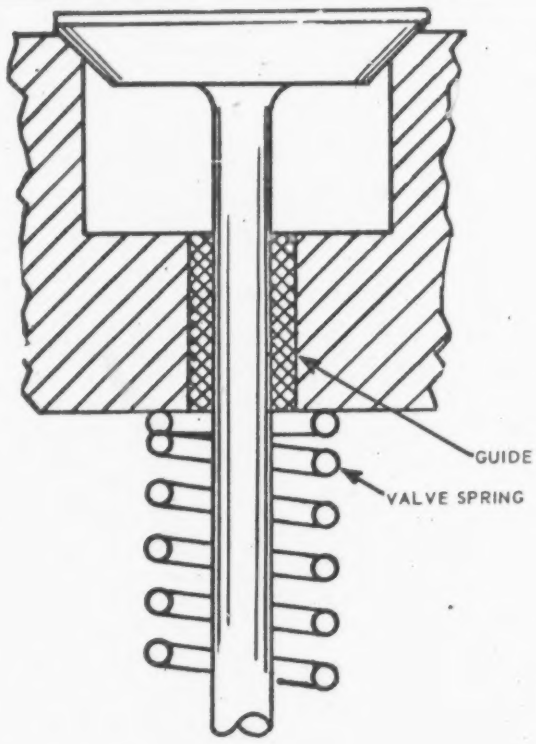

NAME the part that goes around the lower part of the valve.

_____ _____

19097

83

valve spring

84

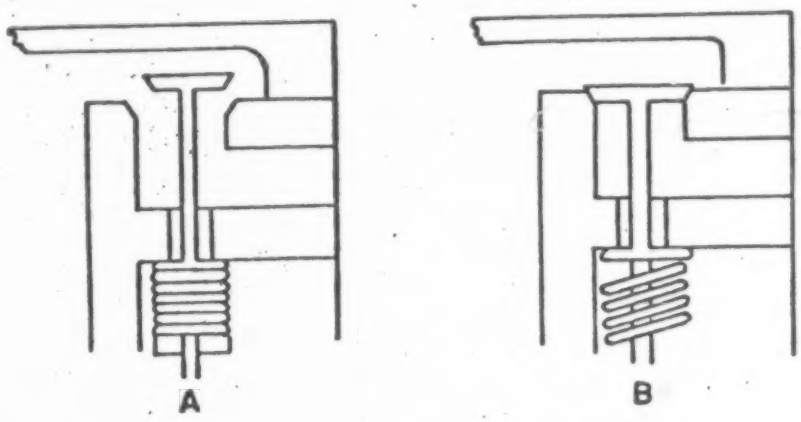

The valve spring is pushed together when the valve is:

- ☐ open
- ☐ closed

19098

84

open

85

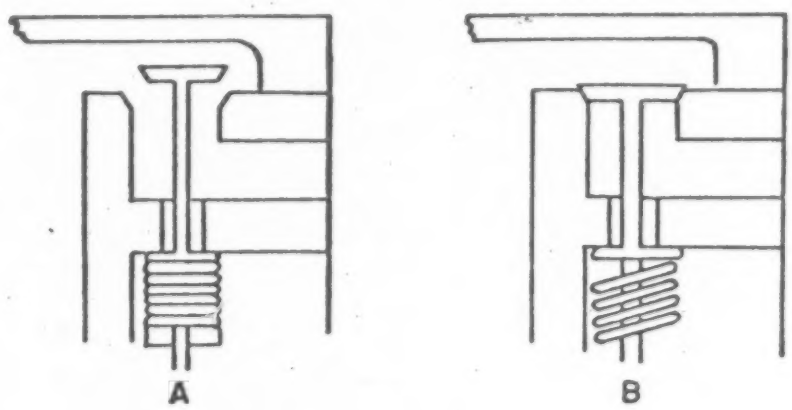

The valve opens when the valve spring is:

- ☐ pushed together
- ☐ left alone

19099

85

pushed together

86

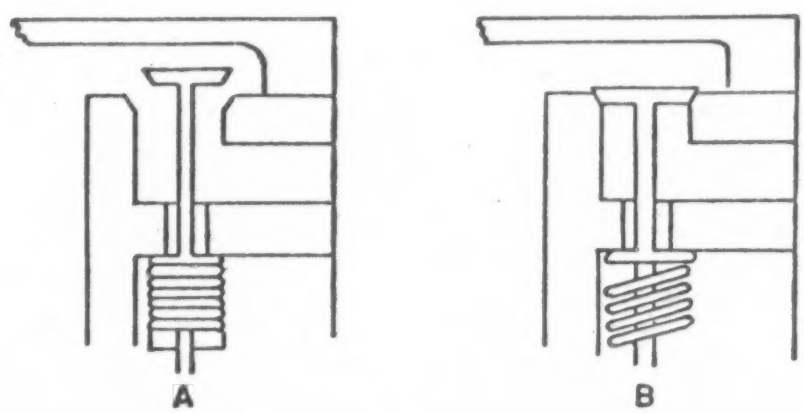

When the valve spring is left alone the valve:

- ☐ stays open
- ☐ stays closed

19100

87

the spring is pressed together or left alone

88

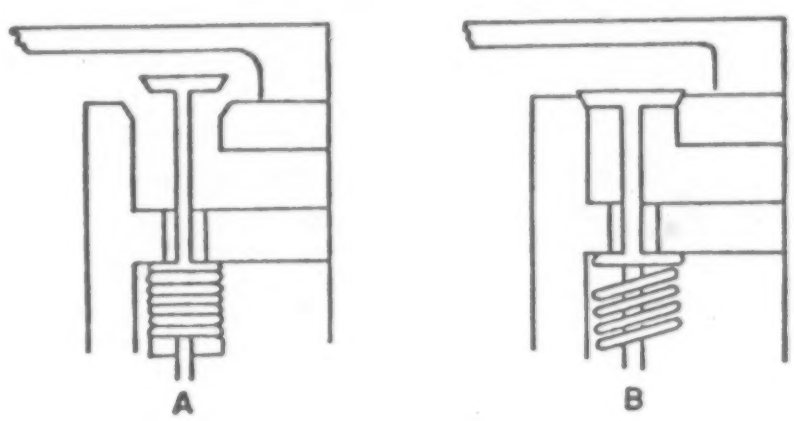

The top of the valve stays on the valve seat when the valve spring is:

- ☐ left alone
- ☐ pressed together

19102

88

left alone

89

Valves are closed when they are:

- ☐ on the valve seat
- ☐ off the valve seat

19103

270 OF 327

ED

056 238

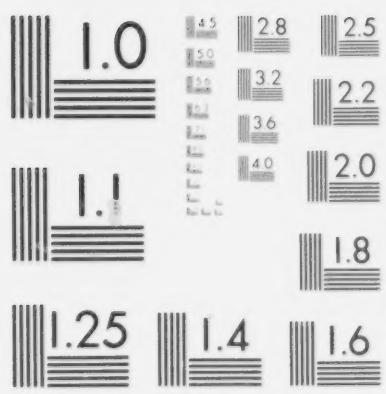

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

89

on the valve seat

90

Valves stay closed when the spring is:

- ☐ pressed together
- ☐ left alone

19104

270

TECH BRIEF 68-10134—SHALLOW GROOVES IN JOURNAL IMPROVE AIR BEARING PERFORMANCE

While air bearings see application with lightly-loaded rotors or journals, the operation is not stable as the rotor tends to precess and eventually to seize. The instability is self-excited, but NASA research has discovered that helical or herringbone grooves on the journal or rotor will dampen the tendency to instability and greatly improve the bearing performance. These shallow grooves act somewhat as air pumps and achieve a pressure distribution similar to that of a hydrostatic gas bearing. Tests at speeds over 60,000 r.p.m. have been run successfully. This type of bearing might be used in hand tools, machine tools, or other types of equipment to reduce friction.

For additional information, circle Key No. 7 on Reader Service Card.

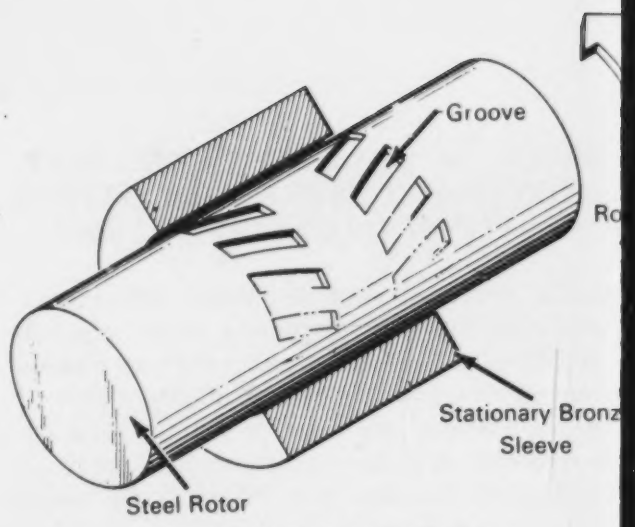

PARTIALLY GROOVED ROTOR

MEASURING TOOLS AND DEVICES (NASA SP-5912(01))

Included in this publication are 13 abstracts of measuring devices, fixtures, tools, and accessories primarily for machine shops. Section 1, *Measuring Tools and Devices,* includes a gage which considerably increases the accuracy of flared tubing thickness readings, and a weld shrinkage gage for measuring shrinkage at circumferential ring weld joints of storage tanks. There is a clamp selector to wrap around tubing or wire harness to permit simultaneous determination of their diameters and clamp size which eliminates loose installation and related vibration; and a dimensional checking tool and fixture capable of fast, efficient, close tolerance checking of mass produced machined parts of two different lengths. Also included in this section are a layout tool, made from stock items, which accurately marks cone and cylindrical shaped thin sheet metal wo pieces without marring or bending them; an T-square location tool for marking layout dim sions on assembly workpieces in hard to reach ar There is also an optical fixture which permits curate alinement of equipment by rotating wi the circular opening of a large tank and locating exact center, allowing accessory equipment in around the tank to be alined with the center.

Section 2, *Measuring Systems and Fixtures,* cludes an automatic contour checking system usi microwave unit to provide quick and accurate r outs of any deviation from the nominal contou large tank bulkheads; a concentricity inspection ture that checks shaft journals, splines, pitch d eter of gears, and the taper of threads with minin setup time and effort; and a measuring fixture large, tape controlled boring mills which permit curate measurements during operations.

90

left alone

91

When a valve spring is pressed together or left alone, the valves will _____ and close.

19105

91

open

92

Valves are held on to the valve seat by the v_____ s_____.

19106

92

valve springs

93

The job of the valve spring is to keep the _____ on the valve _____.

19107

93

valve

seat

94

What do the valve springs do?

_____

19108

94

They keep the valves on the valve seats.

95

MATCH the following:

A. valve guide

B. valve key

C. valve seat

D. valve spring

1. _____ valve sits on this to keep the combustion chamber sealed

2. _____ keeps the valve from wobbling

3. _____ keeps the valve closed on the valve seat

19109

95

1. C

2. A

3. D

96

The gears that keep the valves and the pistons working together are called the _____ _____ .

19110

96

timing gears

97

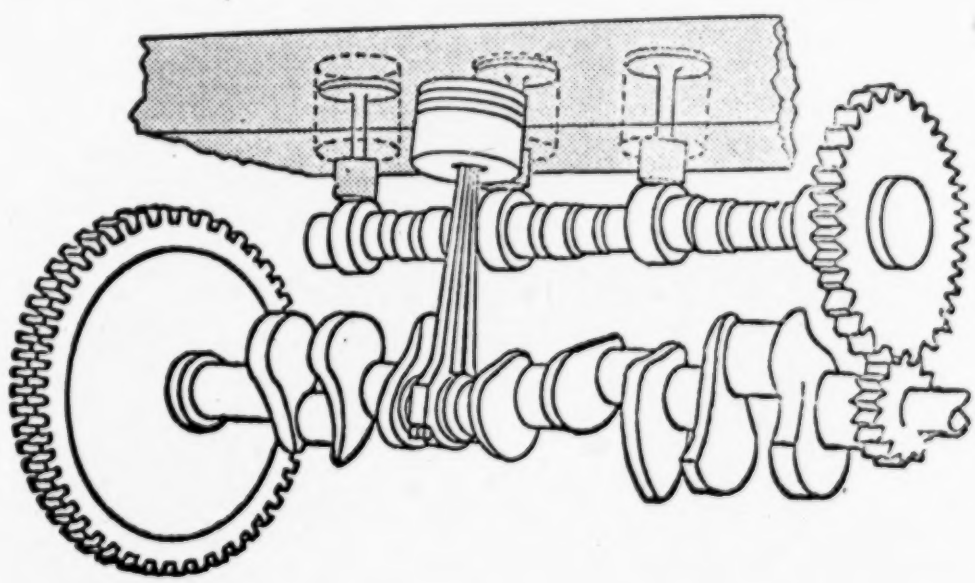

When the crankshaft turns, it makes the timing gears turn the _____ shaft.

19111

97

camshaft

98

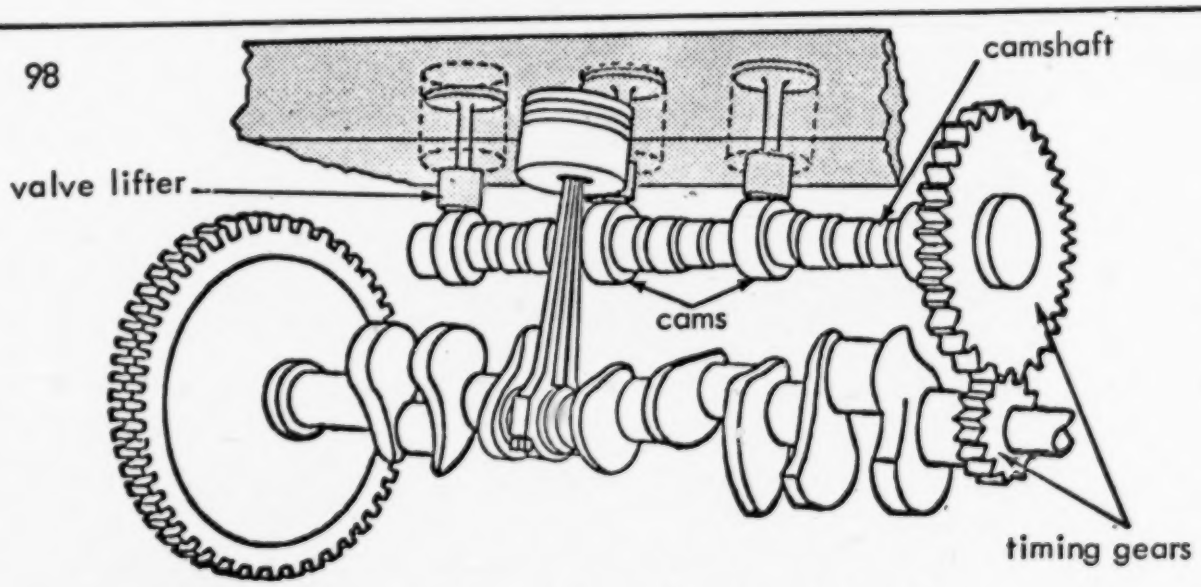

CHECK any of the following parts that ride up and down the camshaft:

- ☐ connecting rods
- ☐ pistons
- ☐ valves
- ☐ valve lifters

98

valves

valve lifters

99

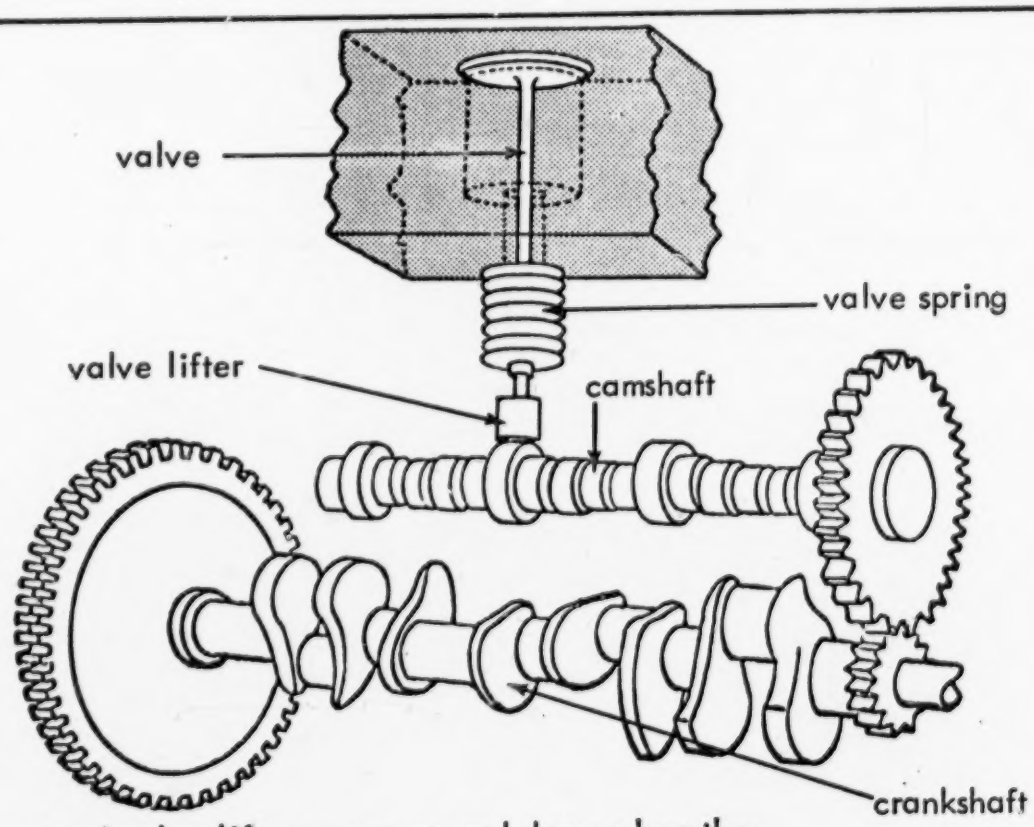

Valves and valve lifters move up and down when the:

- ☐ camshaft turns
- ☐ driveshaft turns

19113

99

camshaft turns

100

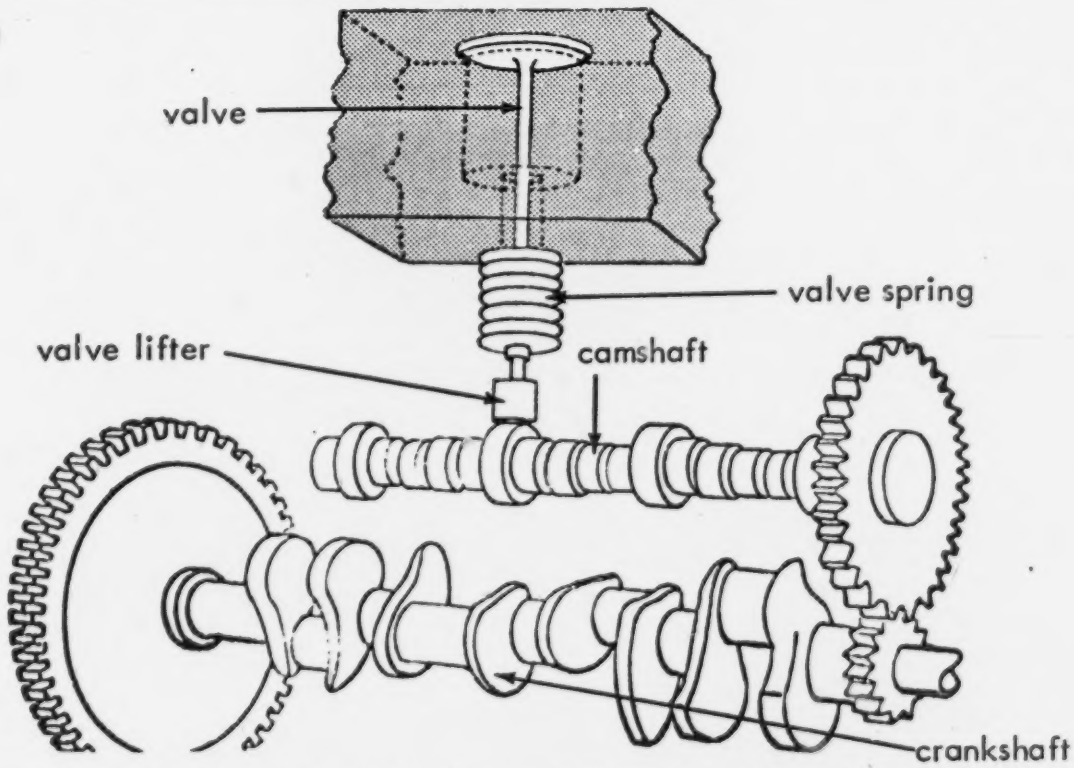

When the camshaft turns, the valves and the valve lifters:

- ☐ move up and down
- ☐ also turn
- ☐ are not affected

19114

SHALLOW ROVE AIR

with lightly-
n is not stable
ually to seize.
ASA research
bone grooves
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ring perform-
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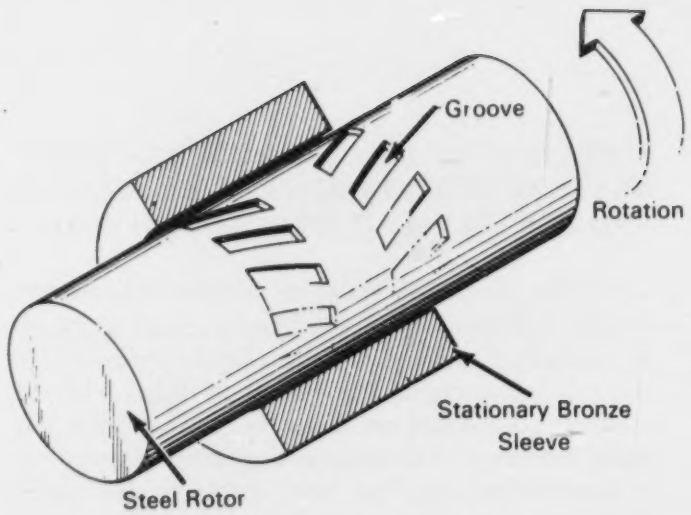

PARTIALLY GROOVED ROTOR

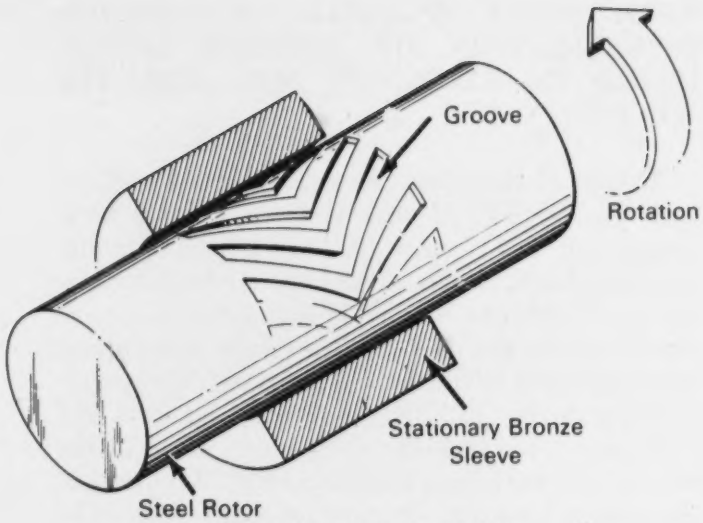

FULLY GROOVED ROTOR

CES (NASA

3 abstracts of
nd accessories
1, *Measuring*
hich consider-
bing thickness
for measuring
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ector to wrap
mit simultane-
and clamp size
related vibra-
ol and fixture
ce checking of
two different
n are a layout
curately marks

cone and cylindrical shaped thin sheet metal workpieces without marring or bending them; and a T-square location tool for marking layout dimensions on assembly workpieces in hard to reach areas. There is also an optical fixture which permits accurate alinement of equipment by rotating within the circular opening of a large tank and locating the exact center, allowing accessory equipment in and around the tank to be alined with the center.

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In section 3, *Measuring Aids and Accessories,* are a tape rule magnetic retaining device for measuring distances beyond a person's reach which can be rotated 90° to permit right angle measurements, *e.g.,* between a floor and wall; a vacuum retaining device for tape rules suitable for use on nonmagnetic metal surfaces to measure distances beyond a person's reach; and a device which permits inside and outside diameters to be measured more quickly and accurately on large rings that have corners and surfaces which are not perpendicular to each other. 1968. 11 pp. CFSTI $0.20.

100

move up and down

101

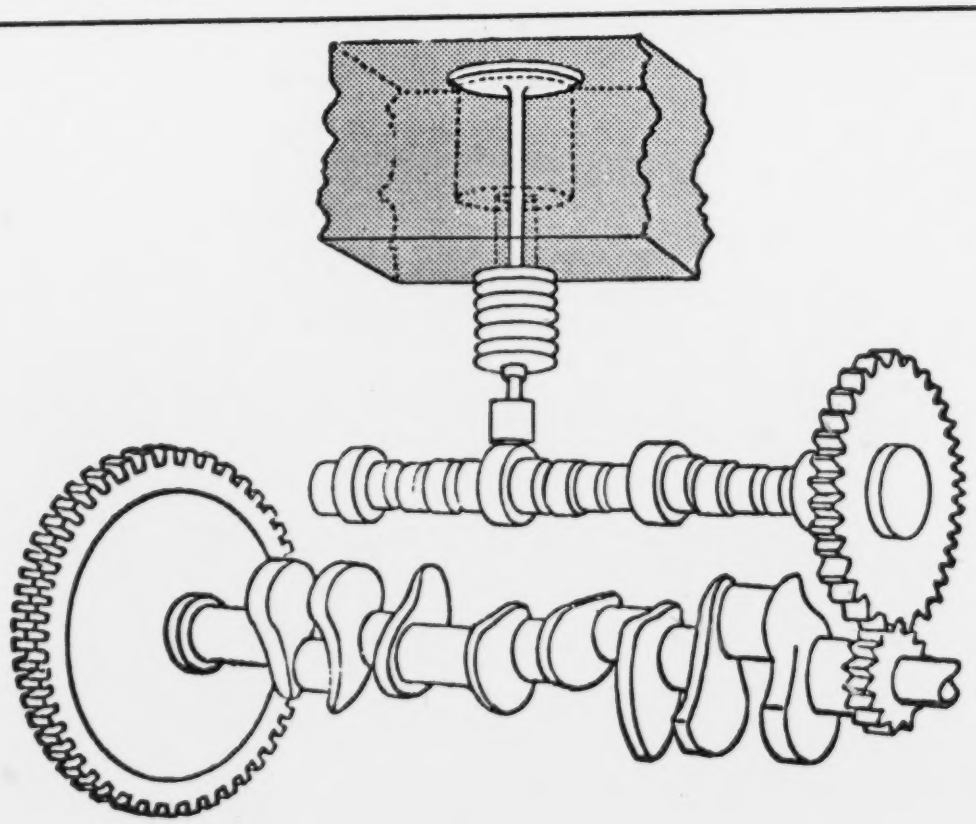

The up and down motion of the valves and the valve lifters is controlled by the _____shaft_____.

19115

101

camshaft

102

When the camshaft moves the valves up and down, the valves:

- ☐ open and close
- ☐ twist and turn
- ☐ move from side to side

19116

102

open and close

103

Which shaft controls the opening and closing of the valves?

_____

19117

103

camshaft

104

The job of the camshaft is to control the opening and closing of the _____ .

19118

104

valves

105

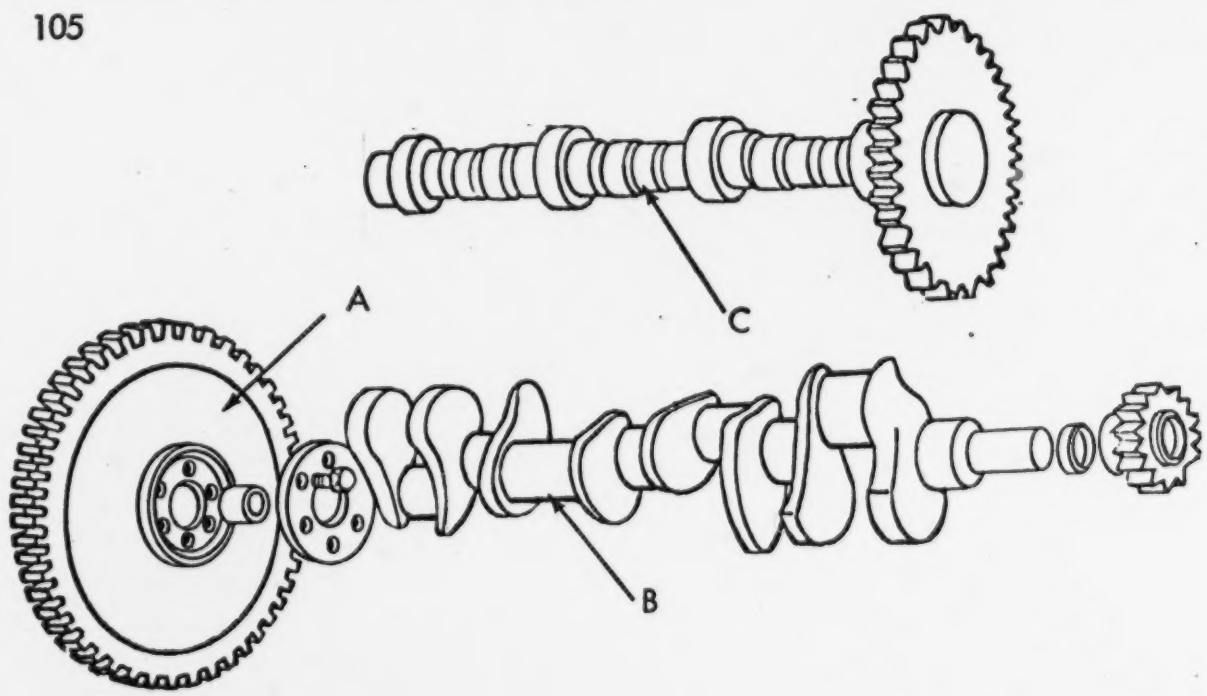

Arrow A points to the flywheel.

Arrow B points to the _____.

Arrow C points to the _____.

19119

105

crankshaft

camshaft

106

An open valve:

- ☐ sits on the valve seat
- ☐ is off the valve seat

19120

106

is off the valve seat

107

Valves are lifted on and off the valve seat by the turning of the _____ .

19121

107

camshaft

108

What does the camshaft do? _____

19122

108

It controls the opening and closing of the valves.

or Lifts the valves on and off the valve seat.

109

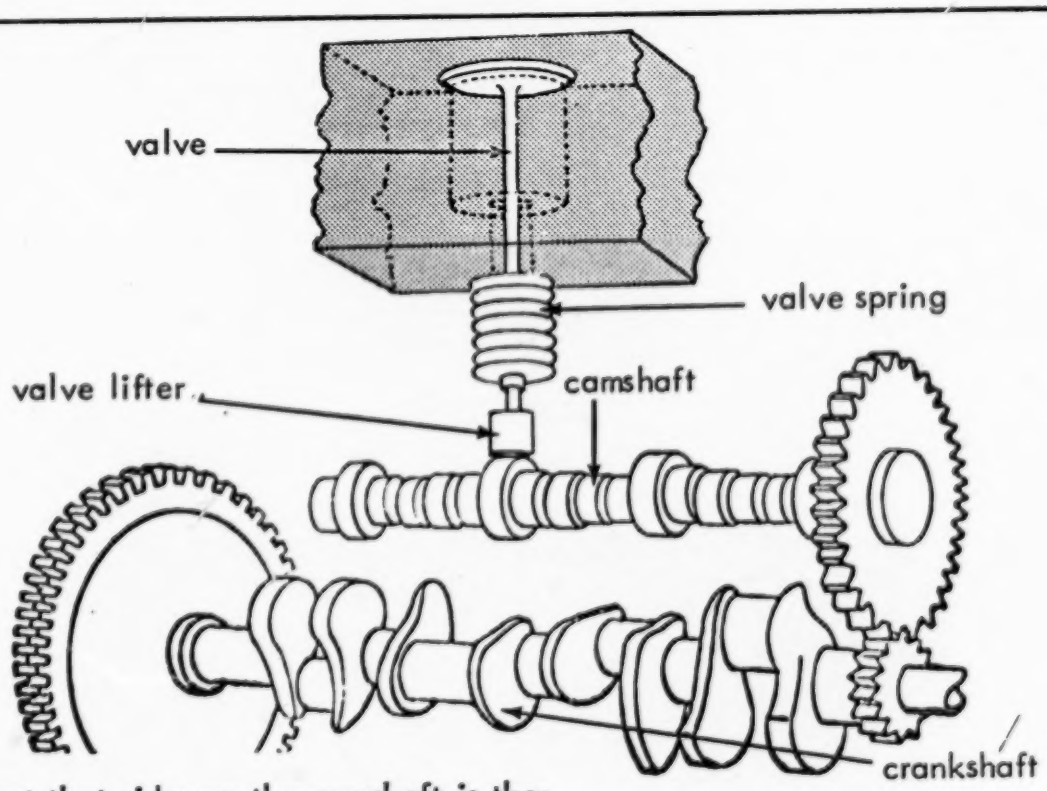

The part that rides on the camshaft is the:

- ☐ valve
- ☐ valve lifter
- ☐ valve spring

19123

109

valve lifter

110

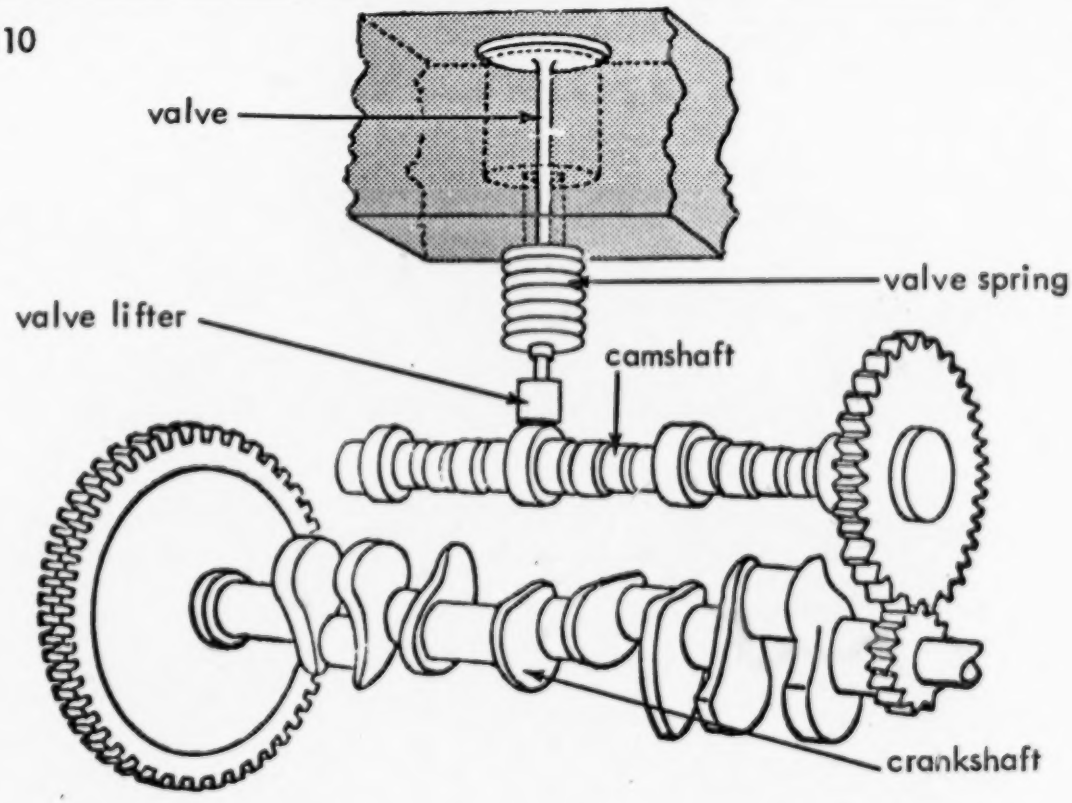

The valve lifter is between the valve and the _____ .

19124

TECH BRIEF 68–10334—MICROPROBE INVESTIGATION OF BRITTLE SEGREGATES IN ALUMINUM MIG AND TIG WELDS

Welders of aluminum pieces who use MIG (Metal Inert Gas) or TIG (Tungsten Inert Gas) weld techniques will find their work may be substantially improved by the results of this microprobe investigation by NASA into the brittle segregates and intermetallic compound particles. The results indicate that there are about 10 different kinds of particles, corresponding to the 10 different (binary, tertiary, and quaternary) intermetallic compounds. Only in the MIG welds were binary $CuAl_2$ observed. Also, copper rich phases tended to be more frequently located in the MIG welds. Metastable ternary phases were found more frequently in the TIG weld. The differences between the MIG and TIG welds appear to be related to the individual cooling rates of these welds.

For additional information, circle Key No. 8 on Reader Service Card.

TECH BRIEF 68–10352—MACHINING TECHNIQUE PREVENTS UNDERCUTTING IN TENSILE SPECIMENS

Metallurgical laboratories and quality-control facilities can use this NASA-developed machining technique to provide a precise and standardized production of tensile test specimens. Equipment required is a milling machine with a contour-controlled vertical-travel table. NASA can provide full instructions on the tool set, the definition of the stylus and template, and the machining operation. This technique can both simplify and improve the validity of tensile test procedures, and insure that the test specimens will fail at the center of the reduced section.

For additional information, circle Key No. 9 on Reader Service Card.

A REVIEW OF METALLOGRAPHIC PREPARATION PROCEDURES FOR BERYLLIUM AND BERYLLUM ALLOYS (AD–674 066)

Battelle Memorial Institute, Metals Information Center, Columbus, Ohio, prepared a report on grinding, polishing, etching, and thinning for transmission electron microscopy. The results of this review of existing procedures are listed in tabular form for ready reference. A considerable amount of previously unpublished data has been included also which may interest metallurgical laboratories.

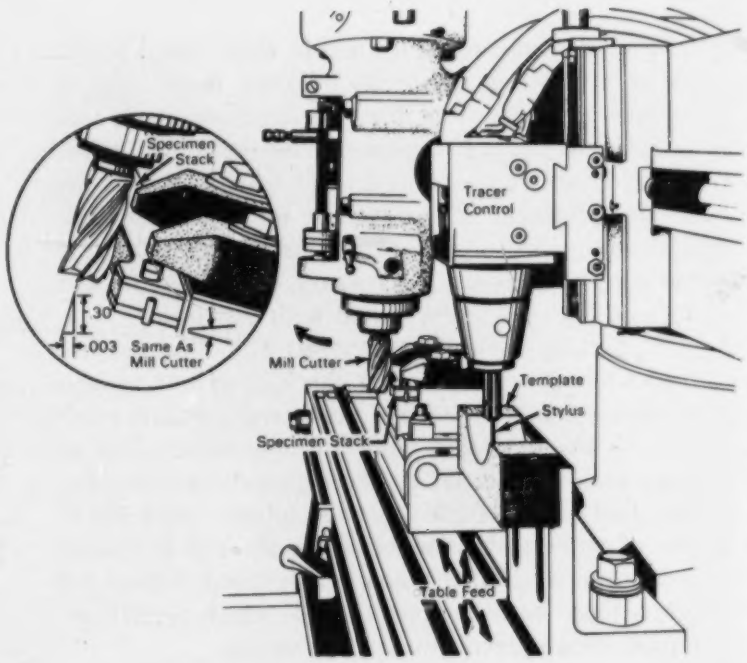

110

camshaft

111

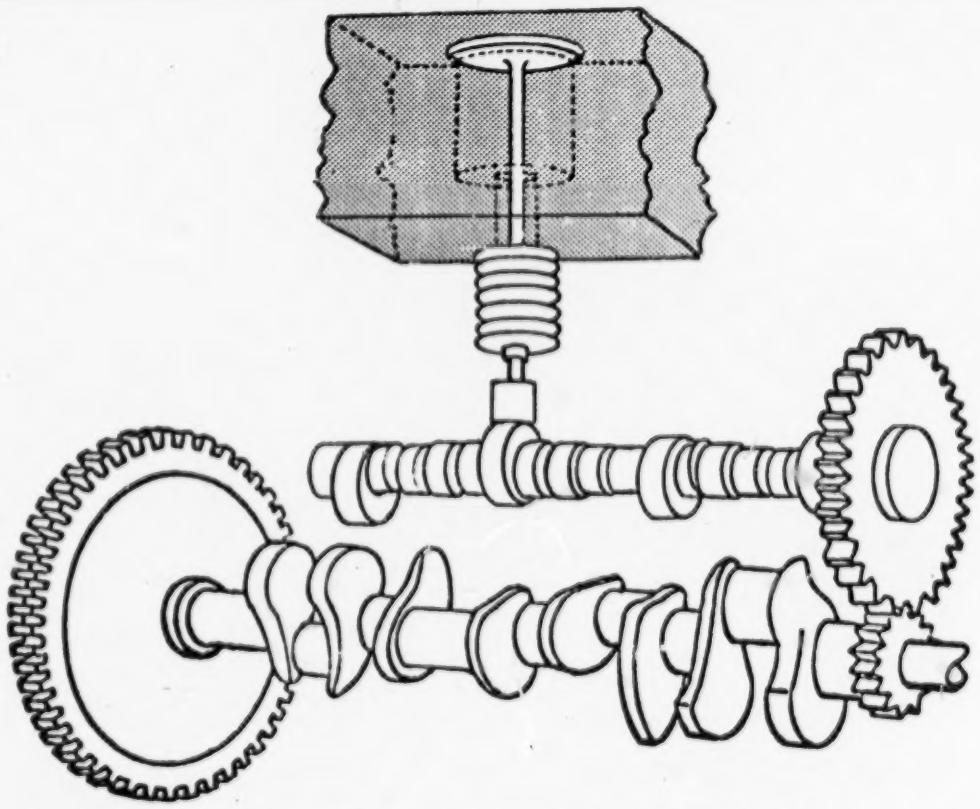

The turning of the camshaft pushes up the valve lifter.

When this happens, the valve lifter lifts up the _____.

19125

111

valve

112

The job of the valve lifter is to:

- ☐ hold on to the valves
- ☐ lift up the valves
- ☐ push down on the valves

19126

112

lift up the valves

113

The valve lifters are between the _____ and the _____ .

19127

113

camshaft

valves

114

What do valve lifters do? _____

19128

114

They lift up the valves.

115

When the valve lifters are pushed up by the _____shaft_____, the valves will:

- ☐ open
- ☐ close

19129

115

camshaft

open

116

The valve lifters lift the valves up when the _____shaft_____ pushes the lifters up.

19130

116

camshaft

117

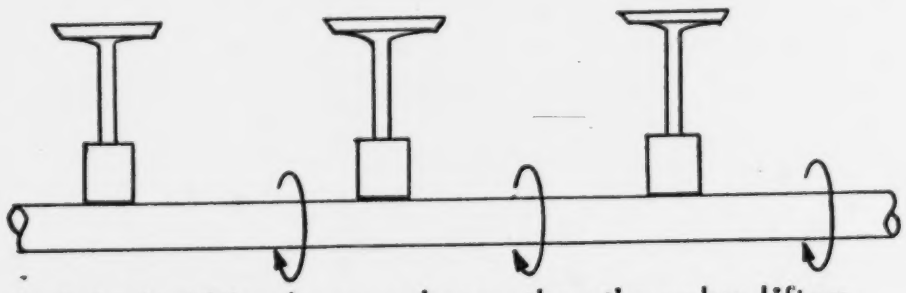

If the camshaft looked like the one above, then the valve lifters would not lift up the valves because the shaft is smooth and does not have bumps.

With a camshaft like the one above, the valves:

- ☐ could never open and close
- ☐ would open and close
- ☐ would still work

19131

117

would never open and close

118

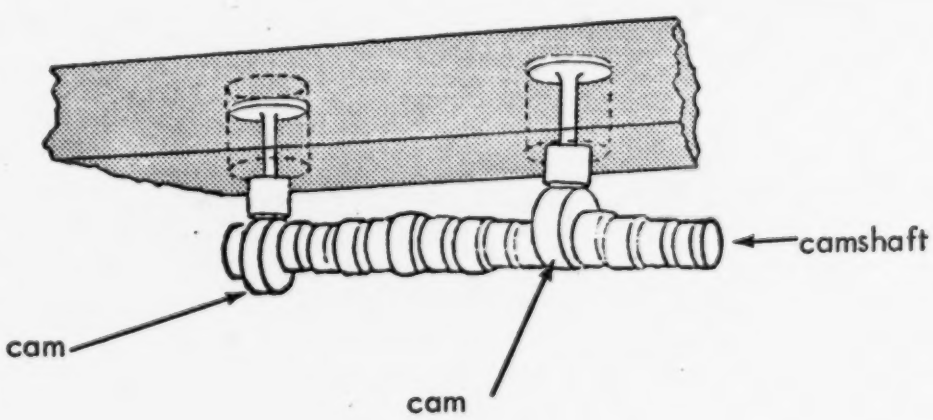

A real camshaft has bumps on which the valve lifters ride.

These bumps are called _____ .

19132

118

cams

119

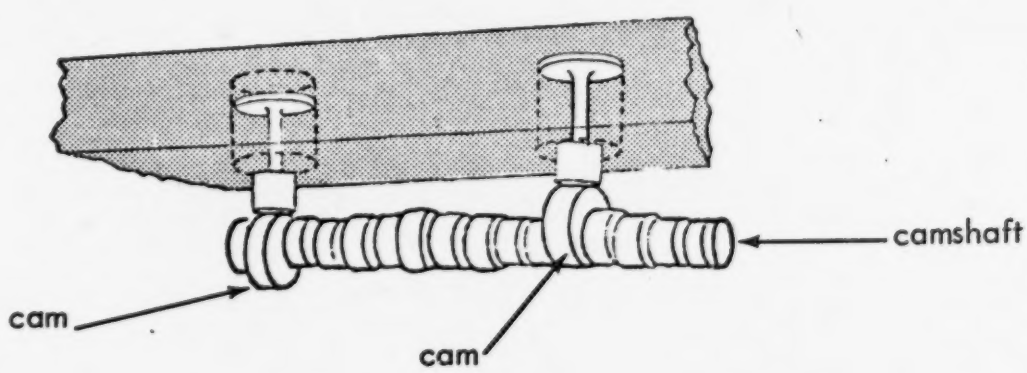

As the camshaft turns, the cams will push the valve lifters:

- ☐ up
- ☐ down
- ☐ to the side

19133

119

up

120

Cams are parts of the:

- ☐ camshaft,
- ☐ crankshaft
- ☐ driveshaft

19134

-MICROPROBE
TTLE SEGRE-
MIG AND TIG

no use MIG (Metal
rt Gas) weld tech-
y be substantially
croprobe investiga-
gregates and inter-
results indicate that
of particles, corre-
nary, tertiary, and
unds. Only in the
erved. Also, copper
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phases were found
d. The differences
ppear to be related
f these welds.

cle Key No. 8 on

—MACHINING
NDERCUTTING

quality-control fa-
veloped machining
d standardized pro-
Equipment required
ur-controlled verti-
de full instructions
the stylus and tem-
ion. This technique
e validity of tensile
the test specimens
uced section.

cle Key No. 9 on

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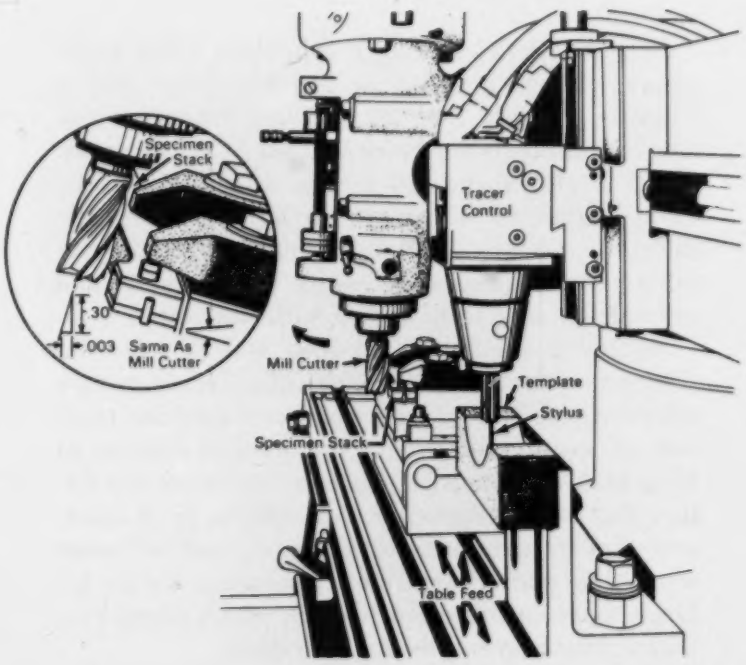

A METHOD OF MEASURING THE TENSIONS IN BOLTS (PB–178 739)

A method of measuring bolt tension has been developed in which the bolt is fitted with an internal rod which remains unstressed when the bolt is loaded by tightening the nut. As the bolt extends under load, relative movement occurs between the free end of the rod and a reference plane on the bolt head. This movement may be measured and related to bolt tension by calibrating the bolt against a suitable load cell. This method was developed by Road Research Laboratory, Crowthorne, England, and may be of interest to machine shops and testing laboratories.

FURTHER DEVELOPMENTS OF THE INVESTIGATIONS ON Al–Zn–Mg WELDABLE ALLOYS (AD–676 107)

Investigations were conducted by the Italian Metal Institute at Milan on four ternary alloys with Cr, Mn, and Zr additions. Two of the sample alloys were rolled and two were extruded. Complete experimental results are given and the conclusions are reported in the following relationships: (1) stress corrosion resistance to quench rate and heat treatment cycle; (2) ductility to quench rate, and (3) composition to fatigue strength. An explanation for the changes in stress-corrosion resistance and ductility is offered in terms of the precipitate distribution in the microstructure. Welding shops may find this report useful.

A LABORATORY METHOD OF MEASURING SLIP IN BOLTED CONNECTIONS (PB–179 704)

A gage designed to measure slip in bolted connections was developed which measures the movement and is unaffected by the strain induced in the plates by the applied load. The gage is applied as a unit, and avoids tedious setting-up procedures. It allows repeated measurements of movements to within 5 percent. The bolts tested were corrosion-resistant and have a high-strength friction grip. The report on this development by Road Research Laboratory, Crowthorne, England, will be of interest to manufacturers using bolted joints.

120

camshaft

121

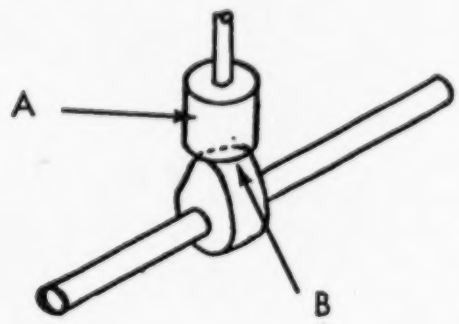

The part of the camshaft that raises the valve lifter is called the _____ .

Which arrow is pointing to it?

- ☐ arrow A
- ☐ arrow B

19135

121

cam

arrow B

122

DRAW an arrow that points to the cam of the camshaft.

DRAW an X through the valve lifter.

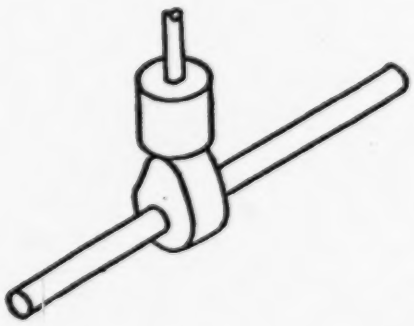

19136

122

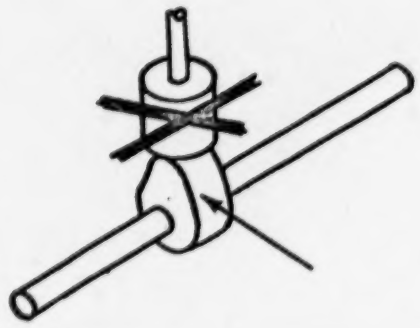

123

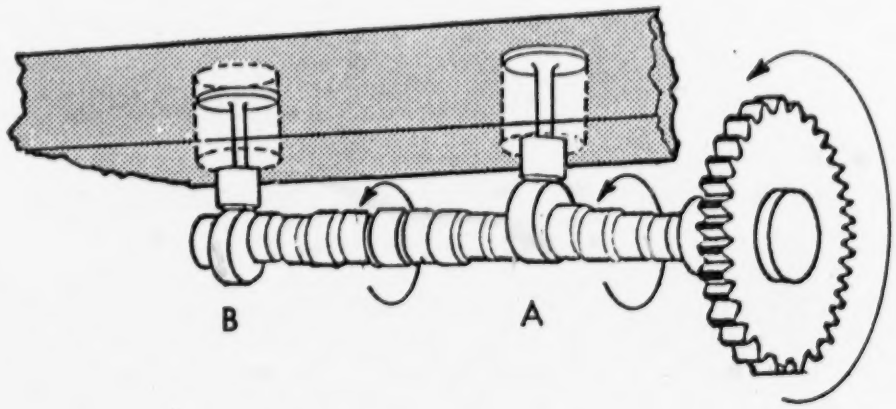

Which letter shows the valve lifter raised by the cam?

- ☐ letter A
- ☐ letter B

Which letter shows the position of the cam and the valve lifter when the valve is open?

- ☐ letter A
- ☐ letter B

19137

123

letter A

letter A

124

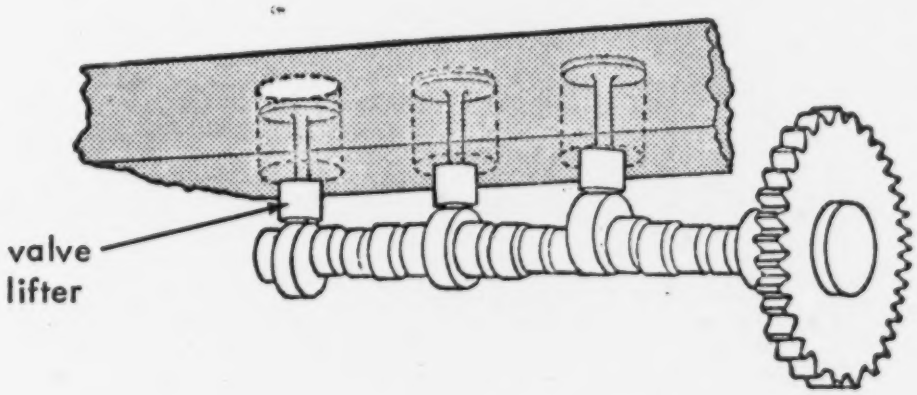

Valves open when the valve lifter:

- ☐ is on the top of the cam
- ☐ is not on the top of the cam

19138

124

is on the top of the cam

125

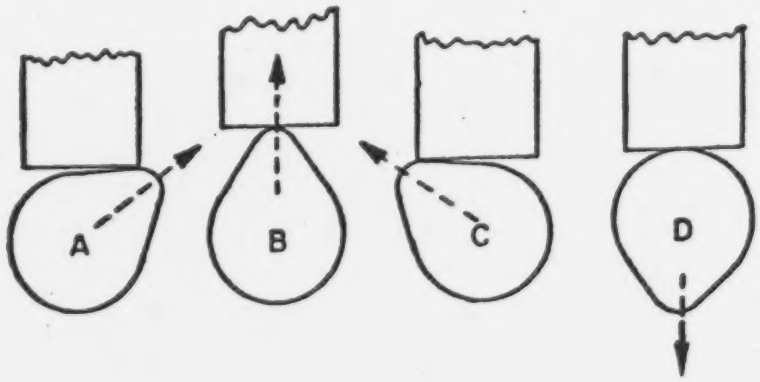

Which picture shows when the valve will open?

- ☐ picture A
- ☐ picture B
- ☐ picture C
- ☐ picture D

19139

125

picture B

126

The camshaft opens and closes the _____ by raising and lowering the valve lifters.

19140

126

valves

127

Valve lifters raise the valves on and off the:

- ☐ valve guide
- ☐ valve spring
- ☐ valve seat

19141

127

valve seat

128

The job of the valve lifter is to _____ the valve.

19142

128

lift

129

What do valve lifters do? _____

19143

129

They lift the valves off the valve seats.

130

When the camshaft turns the cam raises the valve _____ .

This will:

- ☐ open the valve
- ☐ close the valve

19144

TECH BRIEF 68–10002—GAGE MONITORS QUALITY OF CROSSWIRE RESISTANCE WELDS

Companies engaged in wire fabricating may find numerous applications for this gage which measures the relative embedment of the crosswires during the welding process. Before developing the gage, NASA studies had proved a direct relationship between embedment and both weld strength and consistency. The dial reading is a statement of displacement between the fixed and movable electrodes. During the weld, the movable tip is in contact with the workpiece and follows the depth of the embedment. The device can be modified to fit other types of welding heads, such as the press type which uses opposed electrodes.

For additional information, circle Key No. 10 on Reader Service Card.

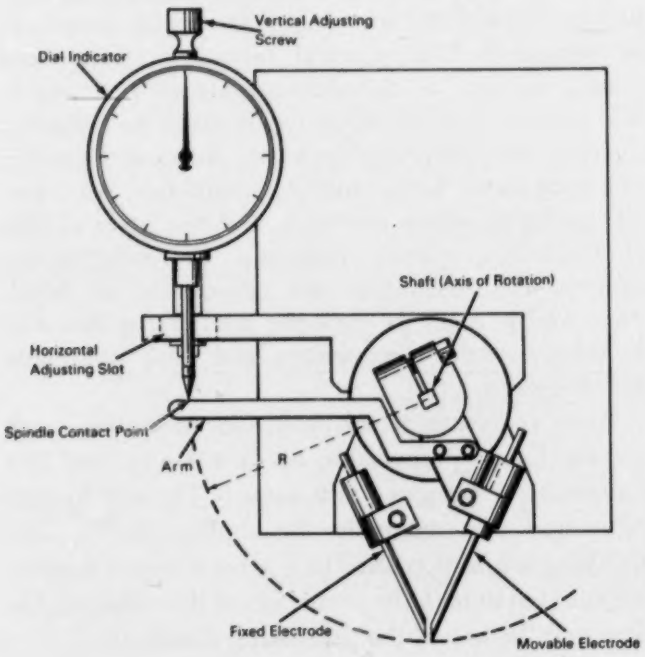

TECH BRIEF 68–10242—WELDER ANALYZER

Manufacturers of welding equipment, as well as users of welders in production work, will be able to analyze and certify the performance of resistance welders. NASA has recently developed an analyzer circuit which can test the machine either on the job or with a precision shunt load for evaluation. Measurements include peak power, peak current, peak voltage, total energy, and first pulse energy. Of special importance, the analyzer can optimize performance in a production shop.

For additional information, circle Key No 11 on Reader Service Card.

METHOD AND STRUCTURE FOR TESTING THE WELDABILITY OF HIGH-STRENGTH STEELS (PAT. NO. 3,410,133)

Welding shops can improve their output by using this technique to detect steels which are prone to hot cracking in the welding process and to reject them before they produce much unsuitable work. In this test, a steel sample is placed in the test rack and a welding bead applied. Then, while it is still hot, the steel is subjected to controlled stresses that are much greater than any expected in normal service. Under this test, cracks, voids, and inclusions will become apparent if the steel is unsuitable. This applies not only in the weld deposit but also in the metal pieces that are being spanned by the weld material. Any welding shop which has either a requirement or a reputation for quality work will appreciate this rapid and inexpensive test technique.

Administering Office: Department of the Air Force, Office of the Judge Advocate General, Chief, Patents Branch, Washington, D.C. 20333.

130

lifter

open the valve

131

The job of the cam is to _____ the valve lifter.

19145

131

raise <u>or</u> lift

132

What do the cams do? _____

19146

132

They raise <u>or</u> lift the valve lifters.

133

MATCH the following:

A. cams

B. valve guide

C. valve lifter

D. valve seat

1. _____ keeps the valve going straight up and down

2. _____ raise the valve lifters

3. _____ where the top of the valve sits

4. _____ lifts the valves

133

1. B

2. A

3. D

4. C

134

NAME the part that keeps the valve from wobbling as it goes up and down? _____

NAME the part that lifts the valve: _____

134

valve guide

valve lifter

135

GIVE the NAME for the bumps on the camshaft that raise the valve lifters: _____

When the valve is closed, it sits on the valve _____ .

19149

135

cams

seat

136

MATCH the following:

A. camshaft

B. crankshaft

C. flywheel

D. timing gears

1. _____ changes the up and down motion of the pistons to a turning motion

2. _____ gives the engine's power to the power transmission system

3. _____ is turned by the timing gears

4. _____ keeps the valves and pistons working together

19150

136

1. B

2. C

3. A

4. D

137

Timing gears keep the _____ and the _____ working together.

The timing gears are turned by the motion of the _____.

19151

137

pistons valves

or

camshaft crankshaft

crankshaft

138

The timing gears turn the _____ .

The power transmission system gets its power from what part of the engine? _____

19152

138

camshaft

flywheel

139

MATCH the following:

A. connecting rod

B. exhaust valve

C. intake valve

D. piston

1. _____ connects the piston to the crankshaft

2. _____ is pushed down by explosions in the combustion chamber

3. _____ lets the fuel mixture into the combustion chamber

4. _____ lets the exhaust gases out of the combustion chamber

139

1. A

2. D

3. C

4. B

140

Connecting rods connect the _____ to the _____.

The exhaust valve opens to let burned gases out of the _____ _____.

19154

GE MONI-
E RESIST-

ing may find
ich measures
es during the
gage, NASA
between em-
consistency.
lacement be-
. During the
th the work-
edment. The
es of welding
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y No. 10 on

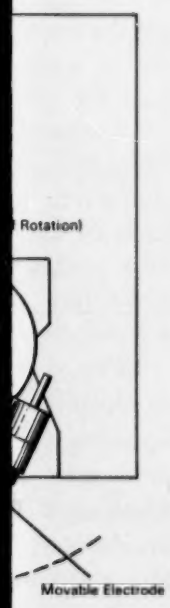

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Administering Office: Department of the Air Force, Office of the Judge Advocate General, Chief, Patents Branch, Washington, D.C. 20333.

ELECTRODE CENTERING MECHANISM FOR VACUUM ARC MELTING (PAT. NO. 3,391,239)

Metallurgical shops and laboratories which have the need to supply ingots of pure tungsten will appreciate a rod-centering device for the vacuum-arc furnace. This technique will improve the homogeneity of the ingot and reduce the risk of burn-through in the mold. The rods of sintered tungsten used as the source material are not perfectly shaped, therefore, some means is needed to keep the electrode end of the rod in perfect alinement with the mold without breaking the vacuum. This equipment accomplishes the centering with a pair of cam elements, one within the other, which allow the electrode to be moved transversely so that perfect centering may be had. The rod movements are controlled externally to the furnace in accordance with visual observations made through quartz windows. While this device has a limited use, it may well be valuable to those shops and companies needing these advantages.

Administering Office: Department of the Air Force, Office of the Judge Advocate General, Chief, Patents Branch, Washington, D.C. 20333.

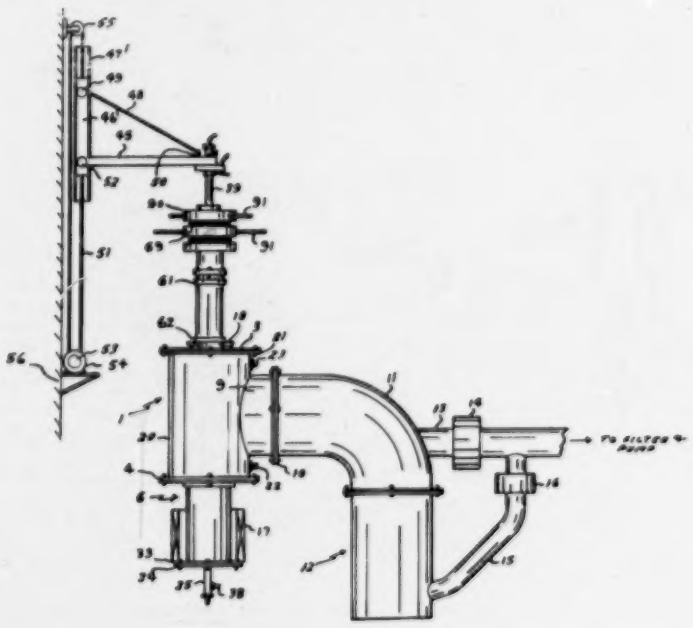

140

piston

crankshaft

combustion chamber

141

NAME the valve that opens to let the air-gasoline mixture into the combustion chamber: _____ _____

The part of the engine that is pushed down by explosions in the combustion chamber is the _____ .

19155

141

intake valve

piston

142

MATCH the following:

A. combustion chamber

B. exhaust port

C. air-gasoline mixture

D. intake port

1. _____ automobile fuel mixture

2. _____ where the burned gases go through on the way to the exhaust system

3. _____ where the fuel mixture goes through on the way to the combustion chamber

4. _____ where explosions take place

19156

142

1. C

2. B

3. D

4. A

143

A car's fuel is a mixture of _____ and _____.

This fuel mixture is exploded in the _____ _____.

19157

143

air

gasoline

combustion chamber

144

The fuel mixture is sparked in the combustion chamber by the

_____ _____.

19158

144

spark plugs

THIS IS THE END OF BOOK 15

19159

AUTO MECHANICS COURSE

POST-TEST BOOK 15: MAJOR PARTS OF AN ENGINE
PART II

A BASIC SYSTEMS PROGRAM

19160

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

The camshaft and the crankshaft are kept working together by the _____ _____.

2

Valves are lifted up and down by _____ _____.

3

To keep the valves from wobbling from side to side, there are _____ _____ that go around the valves.

4

When valves are closed, they sit on a part called the _____ _____.

5

The part of the camshaft that moves the valve lifter up is called the _____ of the camshaft.

6

The part that must be squeezed together for the valve to open is called the _____ _____.

7

In order for the fuel mixture to get into the combustion chamber, the _____ _____ must open.

8

In order for the burned gases to get out of the combustion chamber, the _____ _____ must open.

9

To get into the combustion chamber, the fuel mixture must pass through the _____ _____.

10

In order for the burned gases to get out of the combustion chamber, they must pass through the _____ _____.

11

The shaft that moves the valve lifters up is called the _____.

12

The shaft that turns the timing gears is called the _____.

VT 013 138
Auto Mechanics Course. Book 16: The Combustion Cycle.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 108p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *ENGINES; FUELS; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the combustion cycle was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 138

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EDUCATION & WELFARE
OFFICE OF EDUCATION
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BOOK 16

(c1)

To Be Used With
PANEL BOOK 16

ED0 56238

AUTO MECHANICS COURSE

BOOK 16: THE COMBUSTION CYCLE

A BASIC SYSTEMS PROGRAM

VT013138

Curriculum Report Reference
Page 12
Task Analysis Reference
16.1, 16.2, 16.3, 16.4, 16.5

19165

AUTO MECHANICS COURSE

BOOK 16: THE COMBUSTION CYCLE

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19166

AUTO MECHANICS COURSE

PRE-TEST BOOK 16: THE COMBUSTION CYCLE

A BASIC SYSTEMS PROGRAM

19167

1-4

WRITE in the name of each stroke:

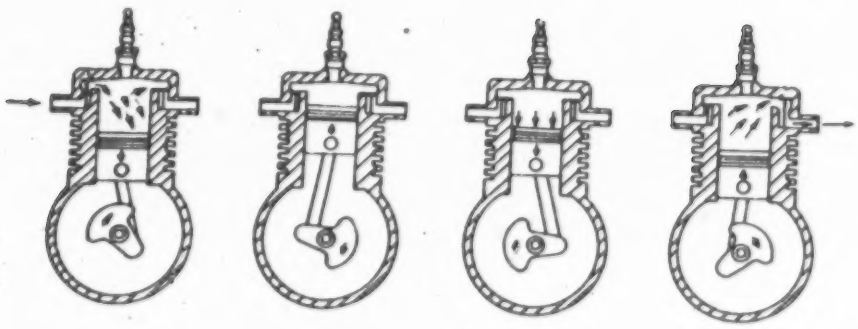

1. _____ 2. _____ 3. _____ 4. _____

5

What fuel is used in the engine? _____-_____ mixture

6-7

During what two strokes are both valves closed?

_____ stroke

_____ stroke

8

Which way does the piston move during the power stroke? _____

9-12

MATCH the following:

A. compression stroke

B. exhaust stroke

C. intake stroke

D. power stroke

9. _____ burns the fuel

10. _____ lets burned gas out of the cylinder

11. _____ squeezes the fuel

12. _____ takes the fuel in

Name _____

Date _____

Starting time _____

Finishing time _____

19170

1

A car gets its power from the:

- ☐ engine
- ☐ exhaust system
- ☐ wheels

10171

1

engine

2

Fuel is burned to get power.

The fuel used in an automobile engine is:

- ☐ carbon deposits
- ☐ gasoline
- ☐ oil
- ☐ water

19172

2

gasoline

3

Gasoline must be mixed with air before it will burn.

The carburetor mixes gasoline with air so that burning will take place in the car's:

- ☐ electrical system
- ☐ engine
- ☐ gas tank

271 OF 327

ED

056 238

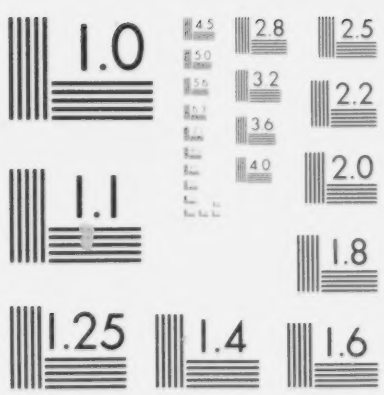

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SPEED CON-
914)

will maintain a
of the contours,
workpiece. It can
, or an accessory
d be helpful par-
work to extremely
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Aeronautics and
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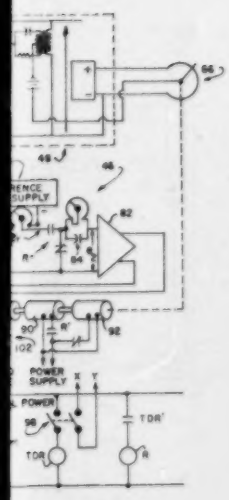

RADIOGRAPHY. VOLUME 1: ORIGIN AND NATURE OF RADIATION (N68–28784)

RADIOGRAPHY. VOLUME 2: RADIATION SAFETY (N68–28785)

RADIOGRAPHY. VOLUME 3: RADIOGRAPHIC EQUIPMENT (N68–28786)

RADIOGRAPHY. VOLUME 4: MAKING A RADIOGRAPH (N68–28787)

RADIOGRAPHY. VOLUME 5: FILM HANDLING AND PROCESSING (N68–28788)

These five volumes present a complete and detailed coverage of industrial radiography starting with the nature of gamma and X-radiation and continuing through test practices and film handling. Radiography is a technique of great value in testing. There are many important findings that can be determined in no other way. Any firm with a present or possible requirement for radiographic testing should obtain these volumes.

The origin and nature of X-radiation and gamma radiation are treated in the first volume. Atomic and mass numbers are discussed; and radioactive materials are treated under the general headings of isotopes, radioisotopes, decay, activity and specific activity, and half life. Electromagnetic spectrum, wavelength, frequency, energy, intensity, and photons are covered for both X-rays and gamma rays. Absorption and scattering are considered, including penetration, ionization, and photoelectric effect. Compton effect, bremsstrahlung, and half-value layer are included. Alpha, beta, and neutron radiation are also covered.

Overshadowing all others in importance is the second volume on safety. Because the hazard is great and never detectable without special equipment, this volume is mandatory reading before radiographic equipment is even unpacked. The contents of this book are directed to nondestructive test radiography users and the material is presented as programed instruction. The important areas of detection, dosage, and limits are explored thoroughly and one chapter is given to the effect of radiation on human tissue and life. Every available monitoring and metering device is described and correct operation is explained.

Basic theory of X-ray generation is considered in volume 3. A chapter dealing with the X-ray machine covers ratings, types, and selection of equipment; the X-ray tube and its cooling, anode and cathode, the duty cycle, and focal spot. Transformers, controls, tube current and voltages, grounding, and rectification are among the topics treated under power supplies. Isotope radiography, requirements, and equipment; energy and equivalent energy; and characteristics and merits of isotopes are described for gamma ray sources. A chapter on other facilities and equipment covers screens, film holders and cassettes, penetrometers, the step wedge, filter and collimator, and densitometers. Isotope source changing equipment and radiographic rooms are discussed. Attention is given to fluoroscopy, xeroradiography, flash radiography, stereoradiography, and microradiography.

Radiographic image formation, sensitivity, and exposure calculations are among the topics presented in volume 4. Mathematical formulas, charts, and graphs required by the radiographer are included in this volume. Specific attention is given to radiation quantity and intensity, exposure, X-ray and gamma ray reciprocity laws, inverse square law, film density and type versus exposure, and two types of film characteristic curves. Selection of radiographic sources and techniques are considered in detail. Step wedge analysis, latitude analysis, a two-film technique, and penetrometers and their placement are described.

Basic requirements of darkroom procedure, such as cleanliness, preparation for processing, and film handling are discussed in volume 5. The step-by-step procedure for manually developing, fixing, and finishing a film is treated in a general way. Chapters are devoted to both the properties of the radiographic film and the use of the processing chemicals.

3

engine

4

Before going into the engine, gasoline is mixed with air in the:

- ☐ carburetor
- ☐ fuel pump
- ☐ gas tank

19173

4

carburetor

5

The air-gasoline mixture is burned in the engine to give the car:

- ☐ driving power
- ☐ proper lubrication
- ☐ wheel balance

19174

5

driving power

6

FILL IN the correct answer that the serviceman should give:

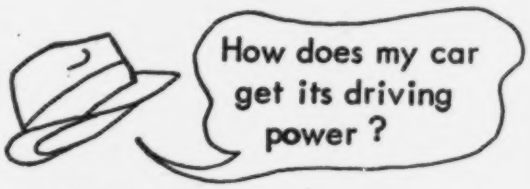

CUSTOMER

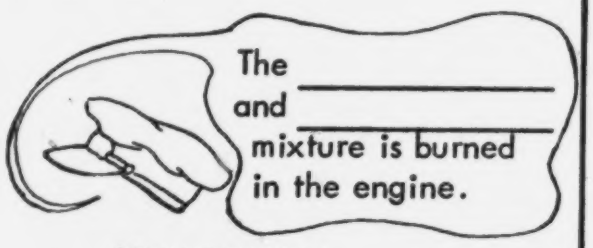

SERVICEMAN

19175

6

gasoline (and) air

7

LOOK AT PANEL 1

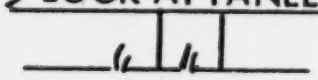

To produce the driving power each cylinder in the engine goes through four steps or strokes.

The four strokes are called the c_____ c_____.

19176

7

combustion cycle

8

LOOK AT PANEL 1

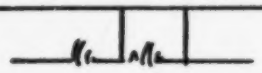

Each cylinder must do the following jobs:

1. Let the gasoline-air mixture in.
2. Get the gasoline-air mixture ready to explode (burn).
3. Explode the gasoline-air mixture.
4. Let the exhaust gases out.

Each job is done in a different s_____.

19177

8

stroke

9

LOOK AT PANEL 1

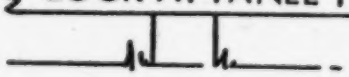

The panel shows the strokes in the combustion cycle.

How many strokes are there? _____

19178

9

4

10

LOOK AT PANEL 1

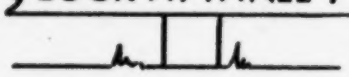

The first stroke in the combustion cycle is the Intake Stroke.

In the Intake Stroke the air-gasoline mixture is:

- ☐ compressed in the cylinder
- ☐ pulled into the cylinder
- ☐ pushed out of the cylinder

19179

10

pulled into the cylinder

11

LOOK AT PANEL 1

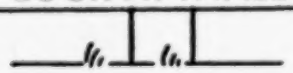

Intake means to take in.

The Intake Stroke is the:

- ☐ 1st stroke
- ☐ 2nd stroke
- ☐ 3rd stroke
- ☐ 4th stroke

19180

11

1st stroke

12

The next job of the cylinder is to get the air-gasoline mixture ready to explode.

This is done in the _____ stroke.

19181

12

compression

13

To compress means to squeeze together. In the Compression Stroke the air-gasoline mixture is:

- ☐ exploded
- ☐ let out of the cylinder
- ☐ squeezed together in the cylinder

19182

TECH BRIEF 68–10146—LAMINATED SHEET COMPOSITES REINFORCED WITH MODULAR FILAMENT SHEET

NASA has developed an extremely simple method of producing these laminates by diffusion bonding and explosive bonding procedures. Laminated sheet, roll, or plate material made with reinforcing modular filament sheets is considerably less expensive to produce than the wire-enforced laminates. Further, it is superior in many applications, particularly those where compressive axial loads and hoop stresses are met. The filament laminates are easier to work with in flat plane applications and can accept conventional fastenings.

For additional information, circle Key No. 12 on Reader Service Card.

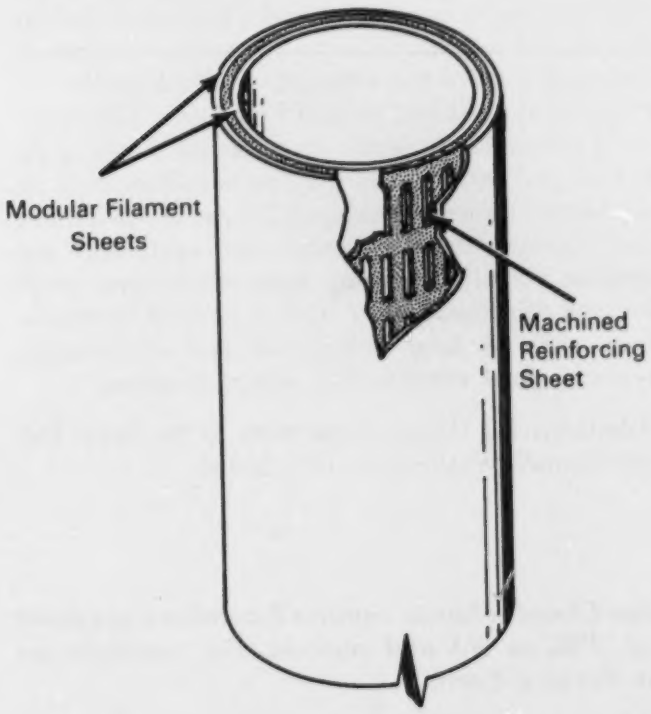

TECH BRIEF 68–10161—ROLL DIFFUSION BONDING OF TITANIUM ALLOY PANELS

NASA has reported fully upon the present state-of-the-art of roll diffusion bonding as it has applied to their efforts to fabricate T-stiffened panel assemblies. The results have value to any fabricator of integral construction who would value the weight/strength ratio of titanium alloys. The report discusses 12 major conclusions together with five obstacles that must be overcome before this process can become a standard production technique. Metallurgists and metal-fabricating shops may find this report useful.

For additional information, circle Key No. 13 on Reader Service Card.

DIFFUSION BONDING OF TITANIUM ALLOYS (AD–670 940)

Using Ti–6Al–4V, as a representative titanium alloy, Atomics International, Canoga Park, Calif., performed tests to determine shear, tensile, and bend strength of bonded joints for a wide range of bonding conditions. The tests indicated that the order of events in bonding are: (1) Surface contaminants diffuse into the bulk alloy leaving clean surfaces; (2) plastic flow occurs closing the voids at the bond line and brazing the surfaces of the joint into intimate contact; (3) the bond attains its final strength through nucleation and growth of grains across the bond interface. A number of specific conclusions emerged: (1) Shear tests coupled with metallographic examination give an effective index of bond quality; (2) ultra-high vacuum is not required to produce good bonds; (3) the strength of the diffusion bond approaches that of the parent metal; (4) the bonding process does not weaken the parent alloy; (5) the principal variables correlated with bond quality are time, surface finish, and permanent deformation, and (6) the relative independence of bond quality from pressure and temperature permits a wide choice of bonding conditions.

DIFFUSION
ALLOYS (A

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POLYETHY
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13

squeezed together in the cylinder

14

LOOK AT PANEL 1

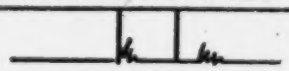

The compression stroke comes (☐ after ☐ before) the intake stroke.

19183

14

after

15

LOOK AT PANEL 1

The third step in the combustion cycle is to explode (burn) the air-gasoline mixture.

This happens in the _____ stroke.

19184

15

power

16

The burning of the air-gasoline mixture in the power stroke gives the car:

- ☐ driving power
- ☐ lubrication
- ☐ wheel balance

19185

16

driving power

17

In addition to producing driving power, burnt gases are also made during the _____ stroke.

19186

17

power

18

LOOK AT PANEL 1

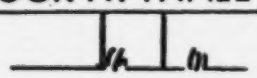

The two strokes that come before the power stroke are the _____ stroke and the _____ stroke.

19187

18

intake

compression

19

LOOK AT PANEL 1

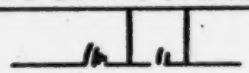

After the power stroke, the burnt gases must be:

- ☐ pulled into the cylinder
- ☐ pushed out of the cylinder

This is done in the _____ stroke.

19188

19

pushed out of the cylinder

exhaust

20

LOOK AT PANEL 1

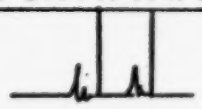

The exhaust stroke is the (☐ first ☐ last) stroke of the combustion cycle.

How many strokes are there in the combustion cycle ?

_____

19189

20

last

4

21

LOOK AT PANEL 1

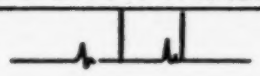

The first two strokes of the Combustion Cycle are the _____ Stroke and the _____ Stroke.

19190

21

Intake

Compression

22

LOOK AT PANEL 2

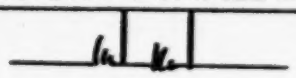

What strokes come after the compression stroke?

_____ Stroke

_____ Stroke

19191

22

Power

Exhaust

23

When the engine is running, the Combustion Cycle happens over and over again in the cylinder.

When the engine is running, which stroke follows the exhaust stroke?

- ☐ the intake stroke
- ☐ the power stroke
- ☐ no stroke follows, the car stops

6—LAMINATED FORCED WITH ET

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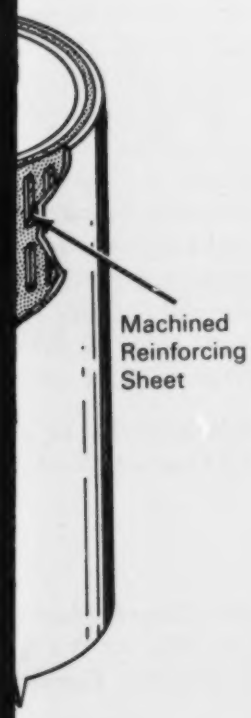

TECH BRIEF 68–10161—ROLL DIFFUSION BONDING OF TITANIUM ALLOY PANELS

NASA has reported fully upon the present state-of-the-art of roll diffusion bonding as it has applied to their efforts to fabricate T-stiffened panel assemblies. The results have value to any fabricator of integral construction who would value the weight/strength ratio of titanium alloys. The report discusses 12 major conclusions together with five obstacles that must be overcome before this process can become a standard production technique. Metallurgists and metal-fabricating shops may find this report useful.

For additional information, circle Key No. 13 on Reader Service Card.

DIFFUSION BONDING OF TITANIUM ALLOYS (AD–670 940)

Using Ti–6Al–4V, as a representative titanium alloy, Atomics International, Canoga Park, Calif., performed tests to determine shear, tensile, and bend strength of bonded joints for a wide range of bonding conditions. The tests indicated that the order of events in bonding are: (1) Surface contaminants diffuse into the bulk alloy leaving clean surfaces; (2) plastic flow occurs closing the voids at the bond line and brazing the surfaces of the joint into intimate contact; (3) the bond attains its final strength through nucleation and growth of grains across the bond interface. A number of specific conclusions emerged: (1) Shear tests coupled with metallographic examination give an effective index of bond quality; (2) ultra-high vacuum is not required to produce good bonds; (3) the strength of the diffusion bond approaches that of the parent metal; (4) the bonding process does not weaken the parent alloy; (5) the principal variables correlated with bond quality are time, surface finish, and permanent deformation, and (6) the relative independence of bond quality from pressure and temperature permits a wide choice of bonding conditions.

DIFFUSION BONDING OF TITANIUM ALLOYS (AD–670 941)

This report, by Atomics International, Canoga Park, Calif., further discusses methods and results of shear tests and metallography in addition to AD–670 940. Information is presented on the effects of finish and bonding time, the need to modify the bonding dies to eliminate radial constraint, and how shear test data can be fitted to a third order polynomial by means of a least squares program. This last item may be worked into the reliability figures of all firms using diffusion bonding. The report also contains data on diffusion of 15 elements in titanium including aluminum, vanadium, oxygen, nitrogen, and carbon.

POLYETHYLENE BONDING TO METAL FOR CABLE PENETRATION OF PRESSURE HULLS AND COMMUNICATIONS APPLICATIONS (AD–676 608)

Bonding polyethylene to all kinds of metals can create new and unexpected product possibilities. Using the process described in this report, low-cost polyethylene insulated, or jacketed, cables which are water resistant can be produced. This report was prepared by the United States Underseas Cable Corp., Washington, D.C.

23

the intake stroke

24

MATCH the stroke with the correct combustion cycle step:

A. Power Stroke

B. Compression Stroke

C. Exhaust Stroke

D. Intake Stroke

1. ____ lets the air-gasoline mixture into the cylinder

2. ____ gets the air-gasoline mixture ready to explode

3. ____ explodes the air-gasoline mixture

4. ____ lets the exhaust gases out

19193

24

1. D

2. B

3. A

4. C

25

PREVIEW FRAME

The four strokes of the combustion cycle happen very fast in each cylinder of the car. Now you will learn what happens during each stroke of the combustion cycle.

NO ANSWER NEEDED
GO ON TO NEXT FRAME

25

NO ANSWER NEEDED

26

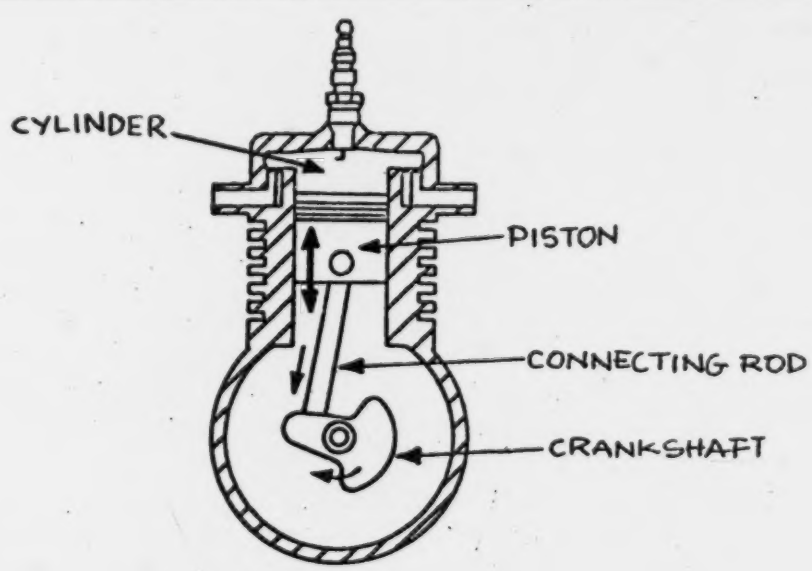

The part that moves straight up and down inside the cylinder is the _____.

19195

26

piston

27

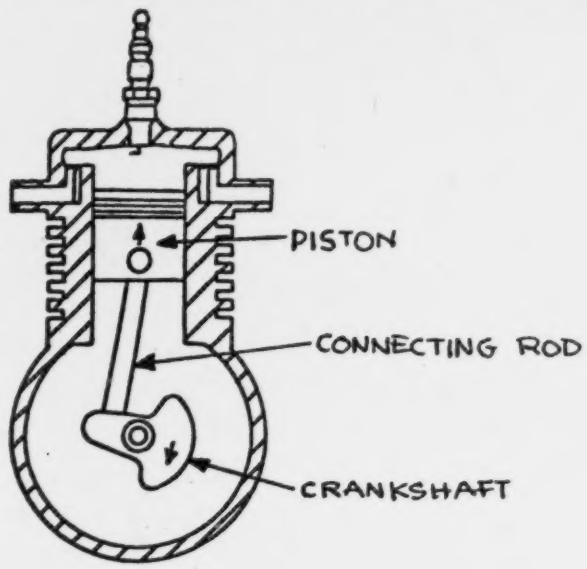

The connecting rod connects the piston to the _____.

19196

27

crankshaft

28

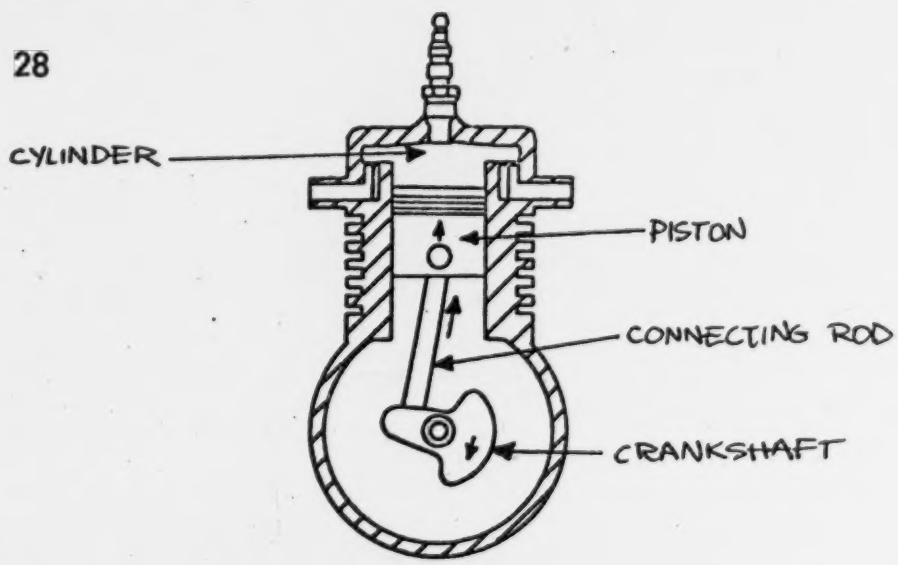

If the crankshaft is moving, what other parts must be moving also?
(CHECK ALL CORRECT ANSWERS)

- ☐ connecting rod
- ☐ cylinder
- ☐ piston

19197

28

connecting rod

piston

29

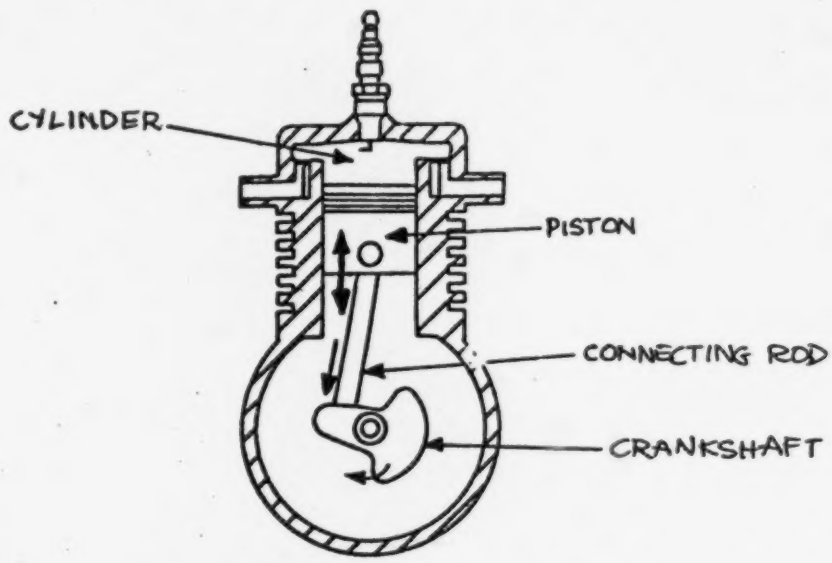

The connecting rod connects the piston and the crankshaft.

When the piston moves, does the crankshaft turn?

☐ yes

☐ no

19198

29

yes

30

During every stroke of the combustion cycle, the piston moves.

What else happens in <u>every</u> stroke?

- ☐ the crankshaft stops
- ☐ the crankshaft turns
- ☐ both valves are open

19193

30

the crankshaft turns

31

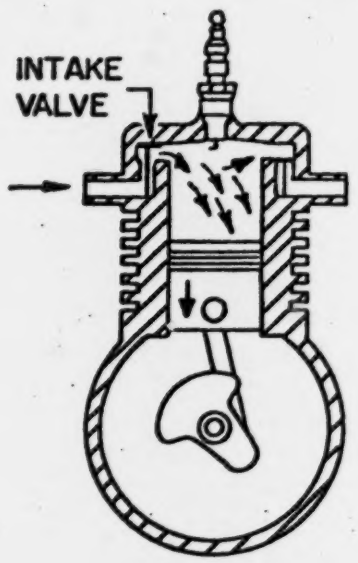

INTAKE
STROKE

During the Intake Stroke the piston:

- ☐ moves up
- ☐ moves down
- ☐ stays still

19200

31

moves down

32

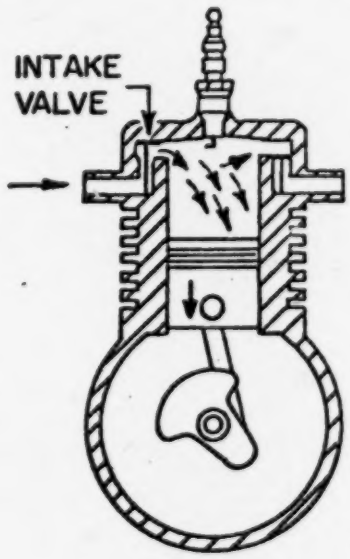

INTAKE
STROKE

The downward movement of the piston in the Intake Stroke draws the air-gasoline mixture (☐ into ☐ out of) the cylinder.

19201

32

into

33

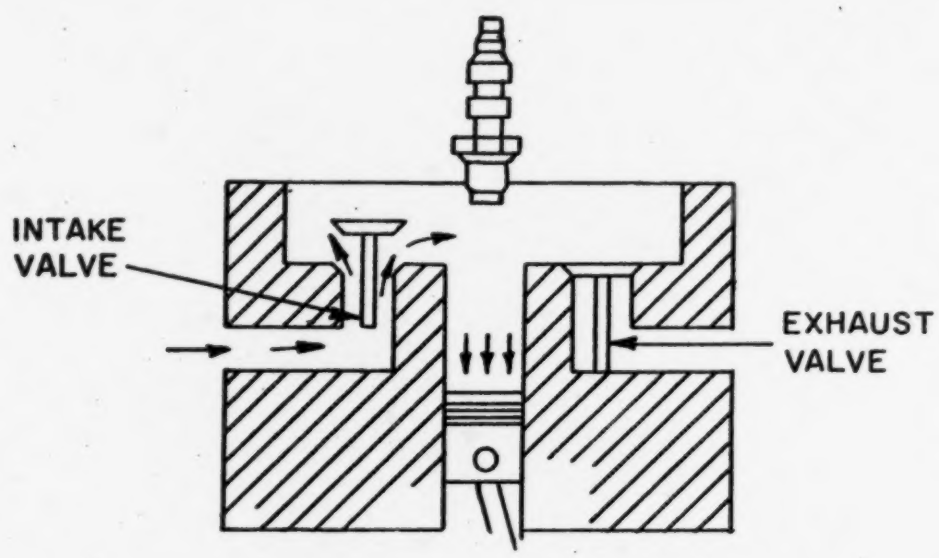

The air-gasoline mixture comes into the cylinder through the _____ valve port.

19202

METHOD OF BRAZING ALUMINUM TO STAINLESS STEEL FOR HIGH-STRESS-FATIGUE APPLICATIONS (NASA SP–5040)

When dissimilar metals and alloys are used to fabricate a structure, various unfavorable reactions occur in joints between the metals. A prime example is the formation of intermetallic compounds which reduce the strength and ductility of the joint. The Rocketdyne Division of North American Aviation, Inc., developed for NASA a procedure for minimizing formation of these compounds in aluminum-stainless steel joints. The procedure has potential in fabricating transition joints in piping systems containing both materials and for tube-to-tube sheet joints where the tubes are of one material and the tube sheet of another. It also has potential in fabricating extended surfaces for heat exchangers where both stainless steel and aluminum are used, and in applying cladding to complex shapes. The process uses a coating of titanium on stainless steel to act as a diffusion barrier and to minimize compound formation. This technique has been successfully used in brazing other dissimilar metal joints, such as beryllium and stainless steel, copper and stainless steel, copper and alloy steel, columbium and stainless steel, molybdenum and graphite, and titanium with alloy steel. 1968. 11 pp. GPO $0.15.

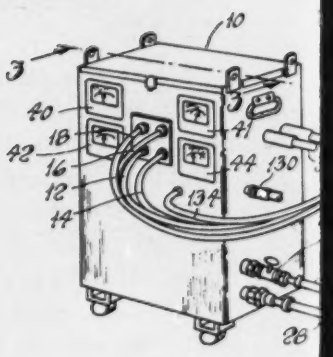

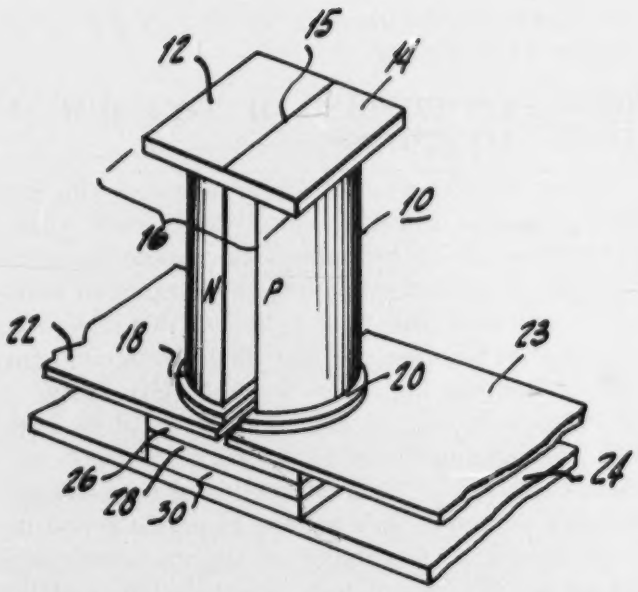

ALUMINUM BRAZING (PAT. NO. 3,391,446)

Current techniques of bonding aluminum to other metals are quite satisfactory at low temperatures, but the bonds are mechanically weak and deteriorate in temperatures over 250° C. All plants and shops fabricating critical items which require aluminum brazing can profit from this new technique. The non-aluminum surface is coated with a rhodium film and then the aluminum body is brazed in place on the rhodium coating by conventional methods. The bond has already proven to be mechanically strong, less affected by time and temperature, and highly conductive both thermally and electrically. The employment of this technique in making a stacked ceramic-tungsten-aluminum thermoelectric generator suggests a number of possible electronic and semiconductive uses.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

33

intake

34

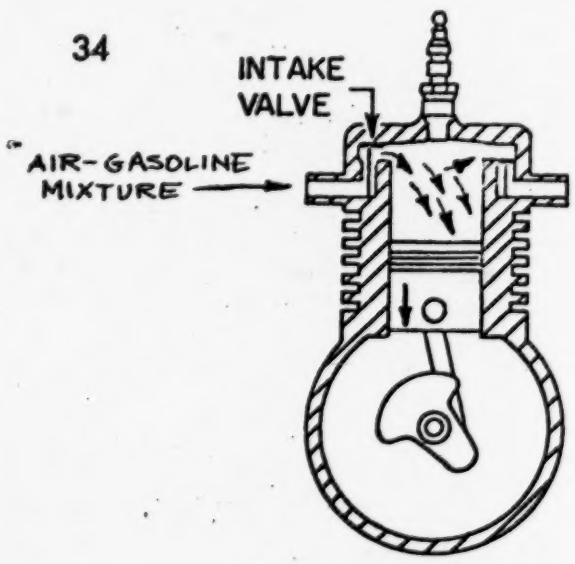

INTAKE
STROKE

In order for the air-gasoline mixture to be pulled into the cylinder during the Intake Stroke, the intake valve must be:

- ☐ closed
- ☐ open

19203

34

open

35

The intake valve is open during the _____ stroke.

19204

35

intake

36

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

19205

36

NO ANSWER NEEDED

37

LOOK AT PANEL 1

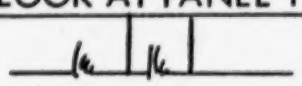

For the burnt gases to leave the cylinder during the Exhaust Stroke, the exhaust valve must be (☐ open ☐ closed).

19206

37

open

38

LOOK AT PANEL 1

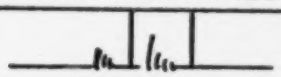

Burnt gases leave the cylinder through the _____ valve port.

19207

38

exhaust

39

How many valves does each cylinder have? _____

The valves are used to: (CHECK TWO)

- ☐ let the air-gasoline mixture into the cylinder
- ☐ let the burnt gases out of the cylinder
- ☐ lubricate the cylinder

19208

39

2

let the air-gasoline mixture into the cylinder

let the burnt gases out of the cylinder

40

WRITE IN the names of the two valves in the cylinder:

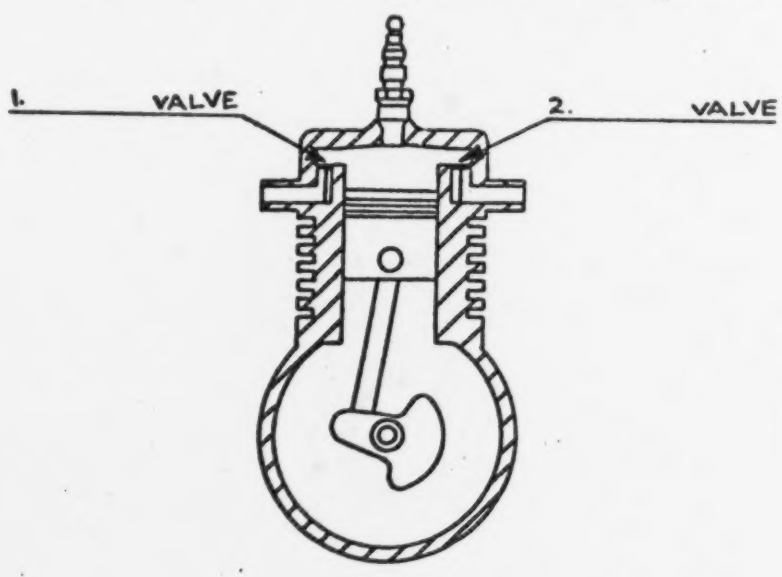

Each valve does (☐ a different ☐ the same) job.

19209

40

1. intake valve

2. exhaust valve

a different

41

LOOK AT PANEL 1

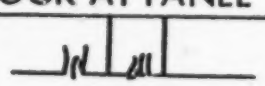

The compression stroke comes (☐ after ☐ before) the intake stroke.

During the compression stroke both valves are (☐ open ☐ closed).

41

after

closed

42

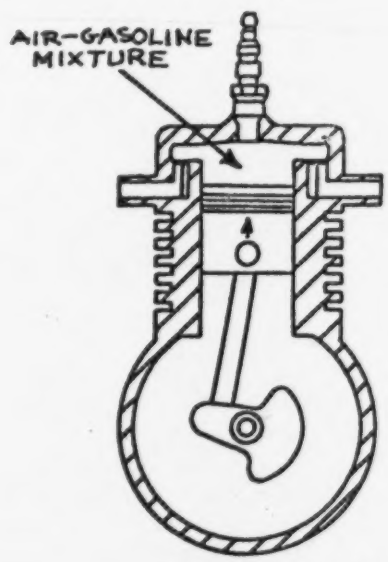

COMPRESSION
STROKE

Because both valves are closed in the compression stroke the air-gasoline mixture:

- ☐ cannot leave the cylinder
- ☐ burns in the cylinder
- ☐ moves out of the cylinder

19211

42

cannot leave the cylinder

43

SHADE IN the part of the cylinder where the air-gasoline mixture is contained during the compression stroke:

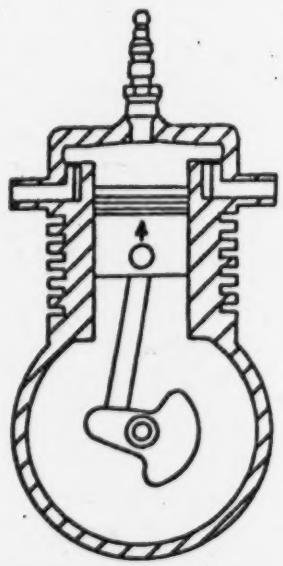

COMPRESSION STROKE

19212

ALUMINUM TO
HIGH-STRESS-
(NASA SP–5040)

l alloys are used to
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American Aviation,
procedure for mini-
compounds in alu-
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It also has potential
for heat exchangers
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er dissimilar metal
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l alloy steel, colum-
denum and graphite,
58. 11 pp. GPO $0.15.

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All plants and shops
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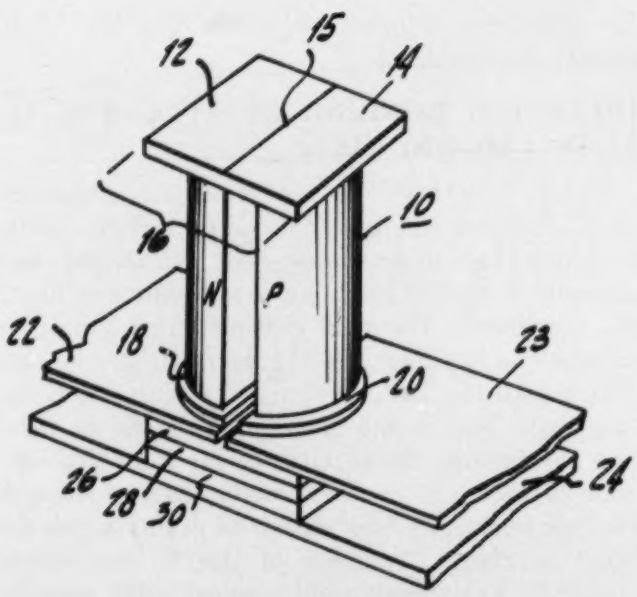

affected by time and temperature, and highly conductive both thermally and electrically. The employment of this technique in making a stacked ceramic-tungsten-aluminum thermoelectric generator suggests a number of possible electronic and semiconductive uses.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

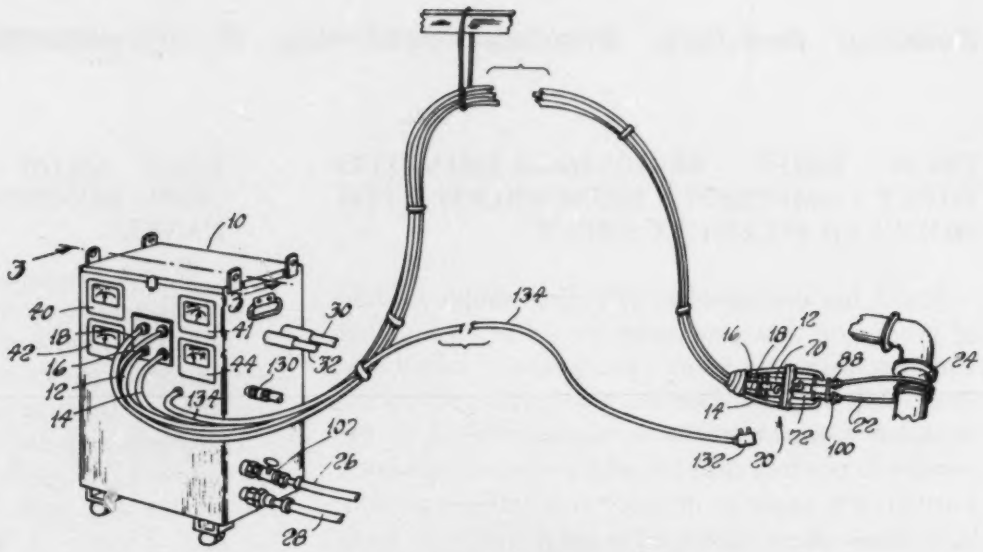

PORTABLE REMOTE INDUCTION BRAZING STATION WITH FLEXIBLE LEAD (PAT. NO. 3,403,240)

Conventional induction brazing equipment is bulky and ill-suited to portability to any degree, yet induction is far superior to torch brazing in quality and ease of joining. Induction brazing, for example, does not require the removal of all materials that might be ignited or damaged by a torch. The equipment solves the problems of supplying power to the brazer and water to be used as a coolant in a recirculating system. Developed for use in the interior construction of submarines, the equipment has genuine potential in many fields where torch welding and brazing are now used in spite of shortcomings, such as large refrigerant and conditioning systems, plant construction, silver, et cetera.

Administering Office: Department of the Navy, Patent Counsel, Washington, D.C. 20360.

To order Clearinghouse reports (numbers prefixed AD, LA, PB, or N) and patents, list numbers on Reader Service Cards.

43

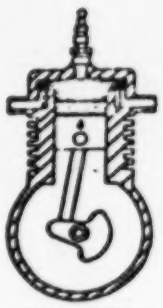

COMPRESSION

44

LOOK AT PANEL 1

During the compression stroke, the piston:

- ☐ moves up
- ☐ moves down
- ☐ stays still

19213

44

moves up

45

At the end of the compression stroke, the piston has moved up as far as it can go.

CIRCLE the drawing which shows the end of the compression stroke:

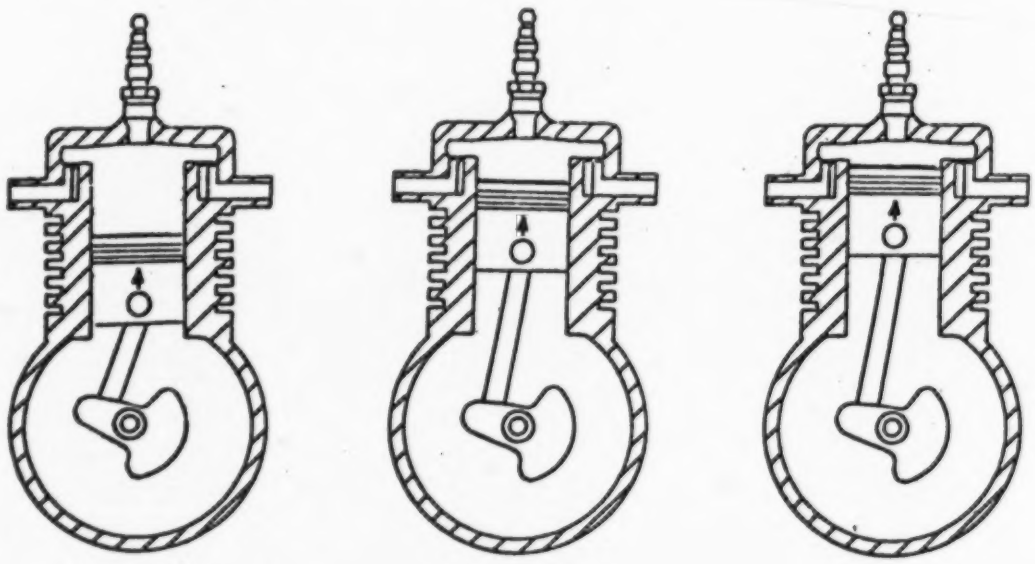

19214

45

46

The space in the cylinder which contains the air-gasoline mixture at the end of the compression stroke is called the combustion chamber.

SHADE IN the combustion chamber in the cylinder below:

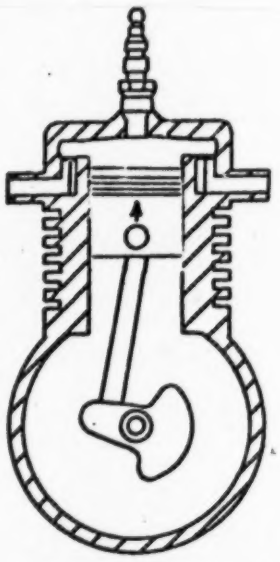

COMPRESSION
STROKE

19215

46

COMPRESSION

47

The air-gascline mixture is now ready to be turned into driving power and burnt gases by being:

- ☐ cooled off
- ☐ exploded or burned
- ☐ lubricated

19216

47

exploded or burned

48

In order for the air-gasoline mixture to burn in the power stroke there must be:

- ☐ cool air
- ☐ oil pressure
- ☐ a spark

19217

48

a spark

49

A spark is used to burn the air-gasoline mixture in the _____ stroke.

19218

49

power

50

LOOK AT PANEL 1

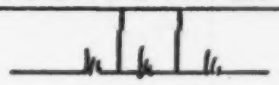

The spark used in the power stroke is made by the

_____.

19219

50

spark plug

51

When the spark plug makes a spark, then the air-gasoline mixture will burn with a force great enough to be called:

- ☐ an explosion
- ☐ a fire
- ☐ a jerk

19220

51

an explosion

52

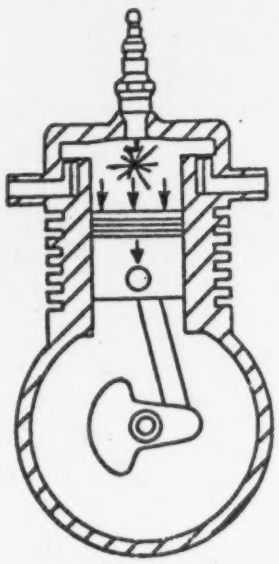

POWER
STROKE

The explosion made by the air-gasoline mixture burning in the power stroke pushes the piston:

- ☐ down
- ☐ up

19221

52

down

53

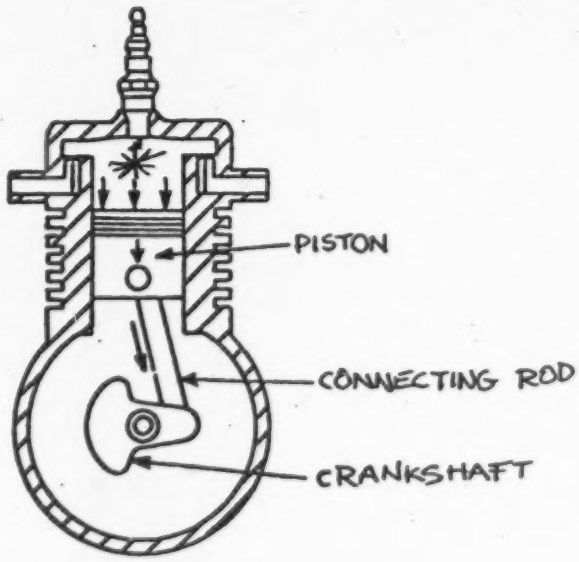

POWER
STROKE

The downward movement of the piston transfers the force of the explosion through the connecting rod to the _____.

19222

TECH BRIEF 68–10157—THERMAL RESISTANCES OF SOLDER-BOSS/POTTING COMPOUND COMBINATIONS

Engineers and designers of electronic cordwood modules will be able to apply the thermal resistance formulas developed by NASA when the work involves stacked modules over a heat sink. The heat transfer to the sink is highly important. The formulas in this study can materially simplify some knotty calculations and eliminate potentially serious errors. They can be used as a design tool to calculate the thermal resistances of the combinations for depths of solder bosses varying between 0.020 and 0.50 inch for the same or similar electronic applications.

For additional information, circle Key No. 14 on Reader Service Card.

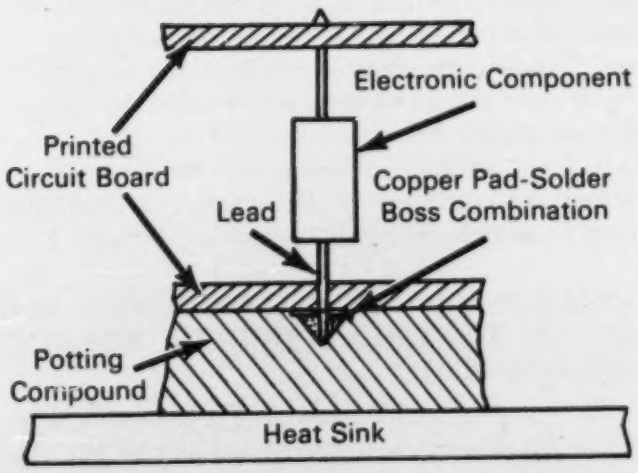

SOLDERING NONMETALS TO METALS (PAT. NO. 3,391,447)

Many manufacturers may find both economy and improvement in an unusual technique of bonding a nonmetallic object to a metal surface. A paste of fine metallic silver and silver fluoride is applied to the nonmetalic surface which, after it dries, becomes silver subfluoride and on heating, a thin bonded layer of metallic silver. This can be easily soldered by a variety of standard techniques. The method works best with nonmetallic materials which contain metal or mineral salts. The technique is ideal when working with objects that must be formed of nonmetallic materials such as sodium chloride, bromide, quartz, baked clay, silica-based common glass, et cetera, which seriously limit the designer in fabrication methods. A solder bond is particularly desirable in the construction of certain instruments, for example, radiation sample cells.

Administering Office: Department of Agriculture, Office of the General Counsel, Washington, D.C. 20250.

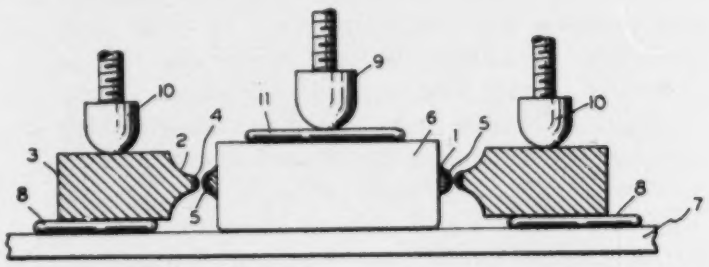

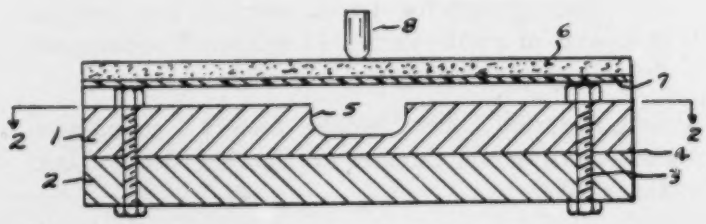

53

crankshaft

54

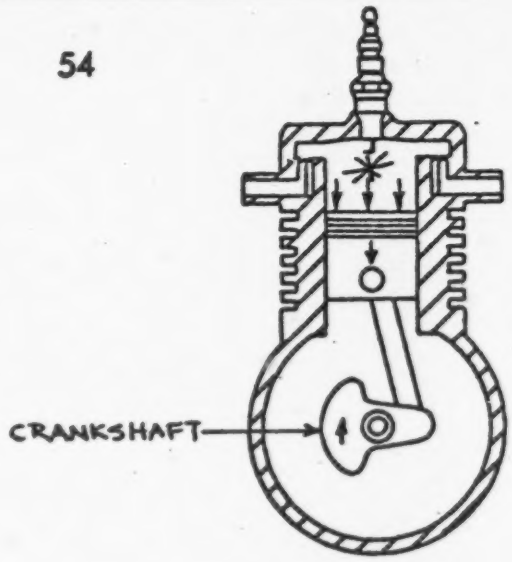

POWER
STROKE

The turning crankshaft gives the car:

- ☐ brake power
- ☐ driving power
- ☐ engine cooling

19223

54

driving power

55

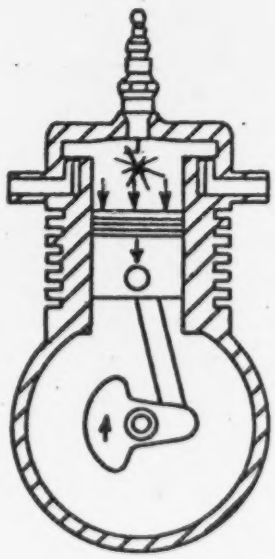

The crankshaft is given turning force every time that there is an explosion during the _____ stroke.

19224

55

power

56

LOOK AT PANEL 1

In the power stroke, both valves are _____.

19225

56

closed

57

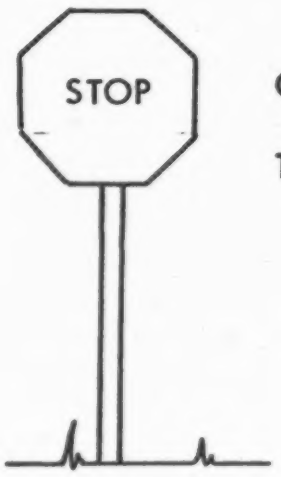

CLOSE THE PANEL BOOK

THEN TURN THIS PAGE AND GO ON

19226

58

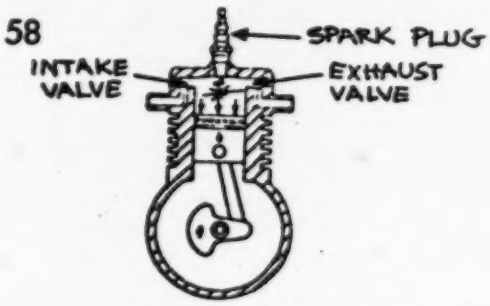

power stroke

59

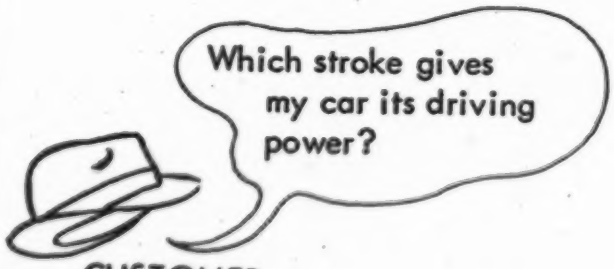

CUSTOMER

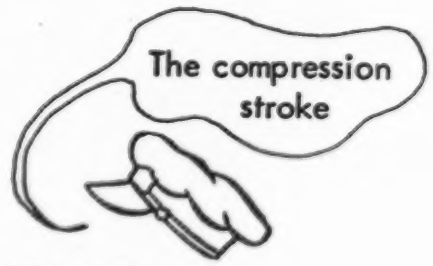

SERVICEMAN

Is the serviceman right?

☐ yes

☐ no

19228

59

no

60

The car gets its driving power from the _____ stroke.

19229

60

power

61

Let's see what happens in the cylinder so far.

The intake stroke lets the _____ - _____ mixture into the cylinder.

19230

61

air-gasoline

62

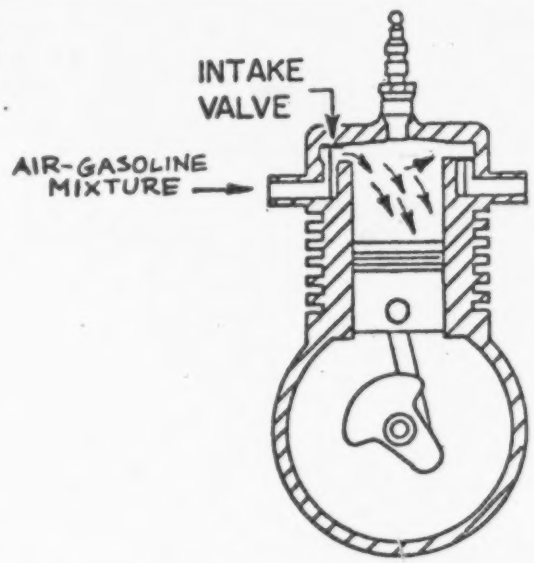

INTAKE
STROKE

Which valve is open to let the air-gasoline mixture into the cylinder?

_____ _____

Which way does the piston move during the Intake Stroke? _____

62

intake valve

down

63

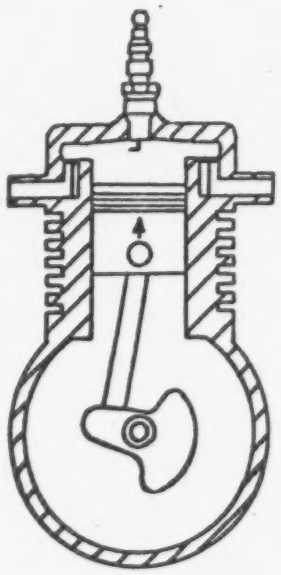

During the compression stroke, the piston moves up and squeezes the air-gasoline mixture into the c_____ c_____.

19232

THERMAL RE-
OSS/POTTING
S

ctronic cordwood
thermal resistance
hen the work in-
eat sink. The heat
portant. The for-
lly simplify some
potentially serious
gn tool to calculate
combinations for
between 0.020 and
similar electronic

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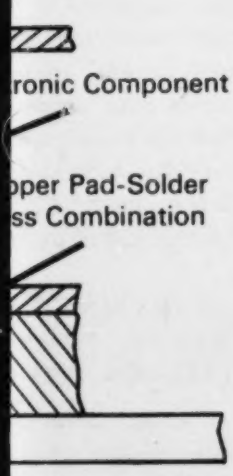

TO METALS

both economy and
nique of bonding
l surface. A paste

of fine metallic silver and silver fluoride is applied to the nonmetalic surface which, after it dries, becomes silver subfluoride and on heating, a thin bonded layer of metallic silver. This can be easily soldered by a variety of standard techniques. The method works best with nonmetallic materials which contain metal or mineral salts. The technique is ideal when working with objects that must be formed of nonmetallic materials such as sodium chloride, bromide, quartz, baked clay, silica-based common glass, et cetera, which seriously limit the designer in fabrication methods. A solder bond is particularly desirable in the construction of certain instruments, for example, radiation sample cells.

Administering Office: Department of Agriculture, Office of the General Counsel, Washington, D.C. 20250.

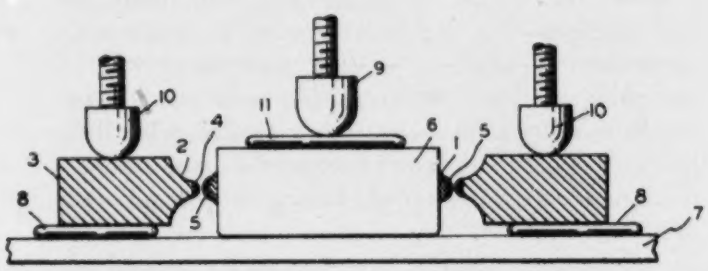

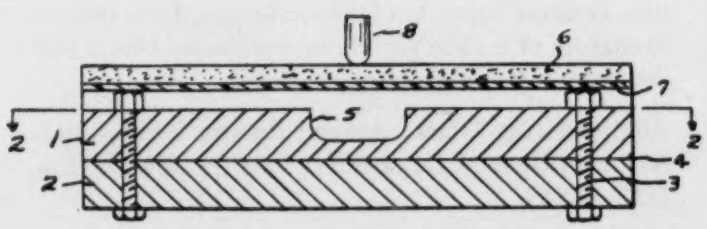

RESISTANCE WELDING (PAT. NO. 3,415,977)

Fabricators of metal tubing may be able to employ this resistance welding technique to effect a positive seal in a length of tubing without severing or weakening the tubing. The electrodes serve as jaws to deform and flatten the tubing and then pass current to weld the walls of the tubing together. The technique adjusts the sealing pressure and the welding current to deal with different sizes of tubing and different wall thicknesses. This arrangement can form hermetic seals in any weldable metal tube.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

WELDING BY HIGH-ENERGY STRESS FRONT (PAT. NO. 3,409,975)

This improvement in explosive welding processes removes the most common limitation in making a sound weld, oxide, and surface contamination. In this technique, the plates are tightly clamped together and a thin layer of explosive applied in such a fashion as to direct the resulting shock wave across the interface at a steep angle. The intensity of the shock wave creates considerable atom agitation on the interfacing plates and leads to a fusion weld. This technique could be useful in many areas of construction and service. It has limitations but its use in a large variety of spot welding operations has not been exploited.

Administering Office: Department of the Air Force, Office of the Judge Advocate General, Chief, Patents Branch, Washington, D.C. 20333.

63

combustion chamber

64

During the compression stroke both valves are _____.

19233

64

closed

65

At the end of the compression stroke the air-gasoline mixture is ready to be exploded.

What is needed to explode the air-gasoline mixture?

_____

19234

65

a spark

66

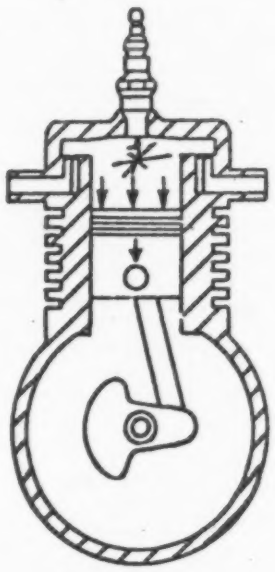

POWER
STROKE

A spark is made by the spark plug.

What happens to the air-gasoline mixture? _____

66

it explodes (or it burns)

67

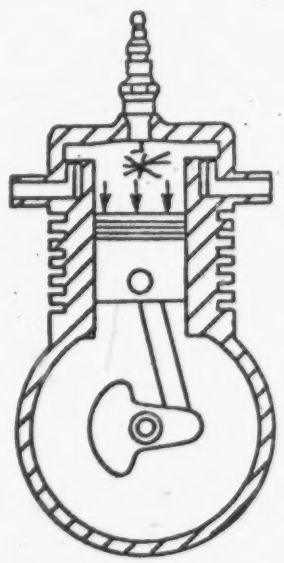

POWER
STROKE

The explosion of the air-gasoline mixture in the power stroke pushes the piston _____ (which way).

19236

67

down

68

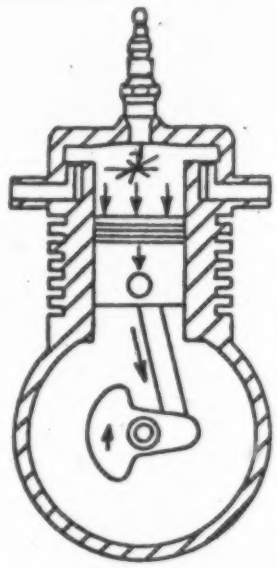

POWER
STROKE

When the piston moves down during the power stroke, the driving power goes through the _____ _____ to the _____.

19237

68

connecting rod

crankshaft

69

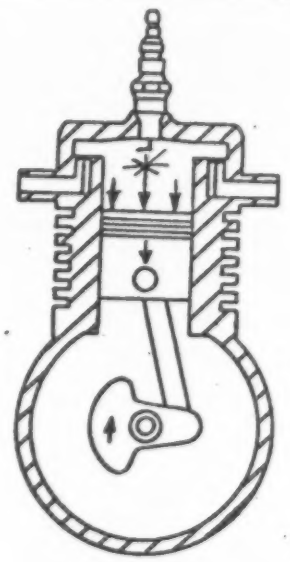

POWER
STROKE

During the power stroke the intake valve and the exhaust valve are _____.

69

closed

70

WRITE in the names of the three strokes that we have been talking about.

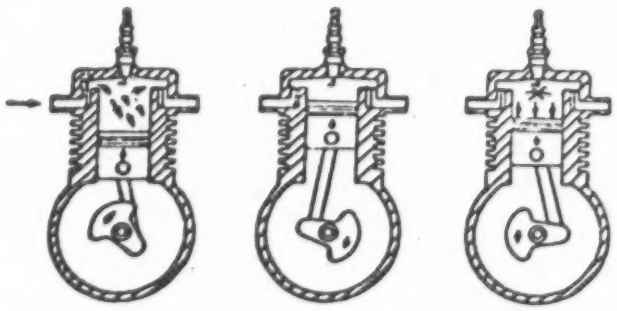

_____ stroke _____ stroke _____ stroke

19239

70

intake (stroke)

compression (stroke)

power (stroke)

71

Driving power and burnt gases are made during the _____ stroke.

19240

71

power

72

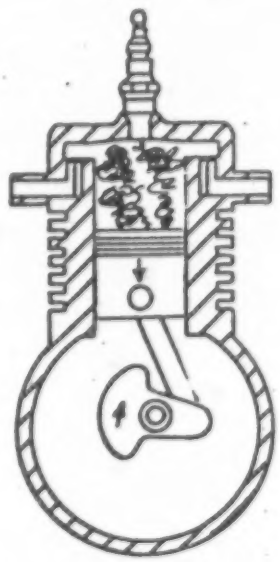

POWER
STROKE

At the end of the power stroke the cylinder is full of b_____ g_____.

19241

72

burnt gases

73

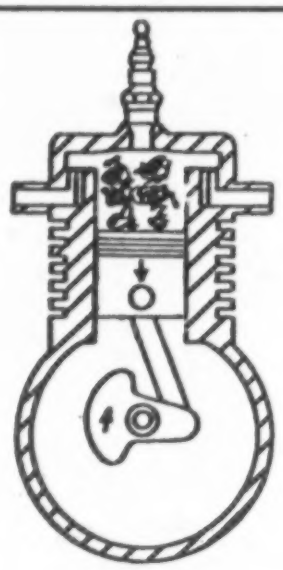

POWER
STROKE

The burnt gases are still in the cylinder at the end of the power stroke and the piston is at the (☐ bottom ☐ top) of the cylinder.

19242

EXPLOSIVE WELDING (PAT. NO. 3,417,455)

Explosive welding has seen little use in many areas of repair and construction work where such a technique would be valuable. The new technique, using standard detonators and C–3 plastic explosive, simplifies the welding by providing metal plates formed into a V-shape and faced with the explosive and buffer material. On detonation, the plates are forced towards each other at such velocity and under such pressure that the surfaces of the plates behave as a liquid and give a fusion welding of the parts. The development of techniques and expertise in this field might be a profitable enterprise. The materials require safety and handling precautions to be observed much as with blasting materials. This technique joins dissimilar metals by surface jet welding and permits in-the-field welding where conventional equipment is not available.

Administering Office: Department of the Navy, Patent Counsel, Washington, D.C. 20360.

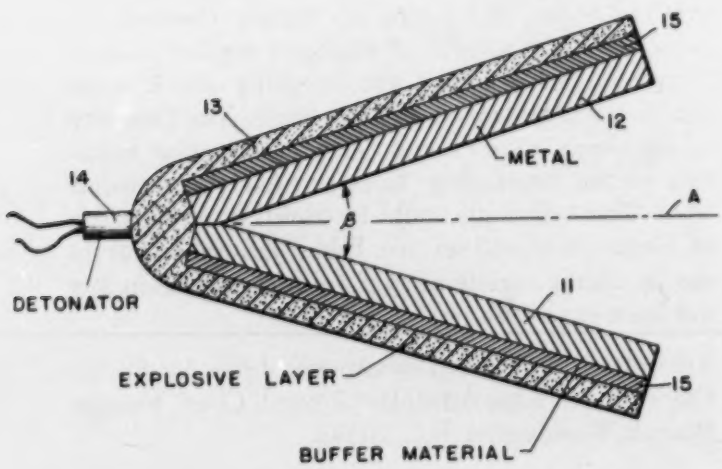

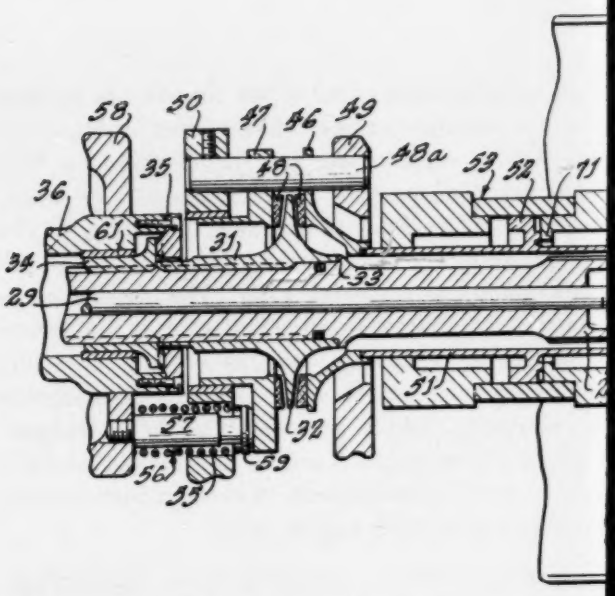

FRICTION WELDER (PAT. NO. 3,396,89

Metal fabrication shops working with mater and products that can be improved or made m profitable by friction welding techniques will interested in this friction welding machine. It g erates heat by high-speed rotary motion with li pressure applied, and can be stopped almost insta to allow the weld to be made before the heat beco dissipated. The higher contact pressures used earlier friction welders have frequently created wanted deformation of the piece being welded. T welding machine contains a motor, the necess drive mechanism to rotate, and a highly sophistica braking system to stop the rotation and posi the piece accurately for welding. The brake is to stop rotation of 10,000 r.p.m. within one rev tion. Braking capacity of that order may have inte to makers of a wide variety of equipment where den damping of high speed is needed.

Administering Office: Atomic Energy Commiss Assistant General Counsel for Patents, Washing D.C. 20545.

272 OF 327

ED

056 238

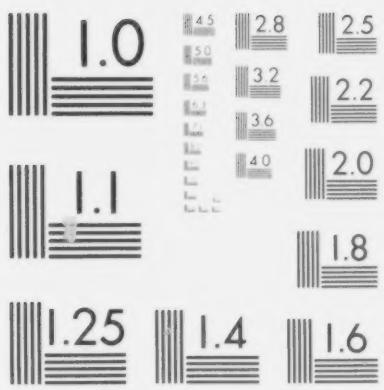

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

73

bottom

74

LOOK AT PANEL 1

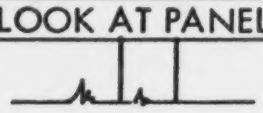

The burnt gases are pushed out of the cylinder during the _____ stroke.

19243

272

74

exhaust

75

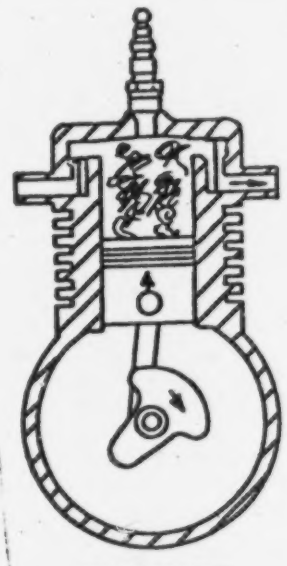

EXHAUST
STROKE

During the exhaust stroke the _____ valve is open.

19244

75

exhaust

76

DRAW an arrow to show the direction in which the piston moves during the exhaust stroke.

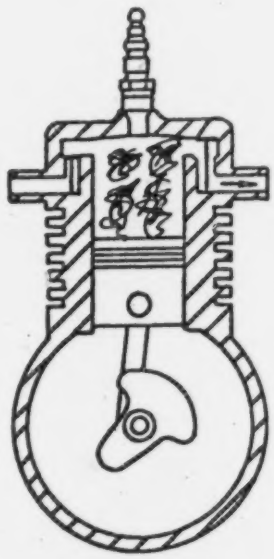

EXHAUST
STROKE

19245

76

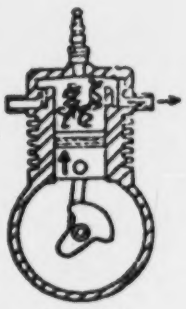

EXHAUST

77

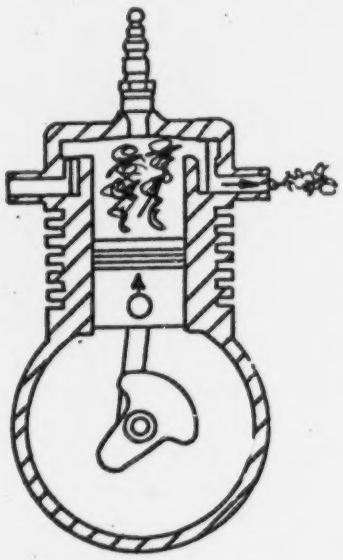

EXHAUST
STROKE

What is forced out of the cylinder by the upward movement of the piston in the exhaust stroke? _____ _____

19246

77

burnt gases

78

In order for the burnt gases to be let out during the exhaust stroke:

the exhaust valve is _____

the piston moves _____

the intake valve is _____

19247

78

open

up

closed

79

At the end of the exhaust stroke the combustion cycle starts all over again.

You remember the main job of the combustion cycle is to give the car d_____ p_____.

79

driving power

80

The fuel used in the combustion cycle to give the car driving power is a mixture of _____ and _____.

19249

80

air (and) gasoline

81

MATCH what happens to the air-gasoline mixture with each stroke:

A. power stroke

B. compression stroke

C. intake stroke

D. exhaust stroke

1. _____ air-gasoline mixture is pulled into the cylinder

2. _____ air-gasoline mixture is squeezed into the combustion chamber

3. _____ air-gasoline mixture burns

4. _____ burnt gases are pushed out of the cylinder

81

1. C

2. B

3. A

4. D

82

The flow of the air-gasoline mixture and burnt gases into and out of the cylinder is controlled by two valves called the _____ valve and the _____ valve.

azing, Soldering,

AT. NO.

little use in many
ction work where
valuable. The new
tonators and C–3
elding by providing
ape and faced with
ial. On detonation,
each other at such
re that the surfaces
l and give a fusion
velopment of tech-
l might be a profit-
require safety and
rved much as with
ue joins dissimilar
l permits in-the-field
equipment is not

nent of the Navy,
C. 20360.

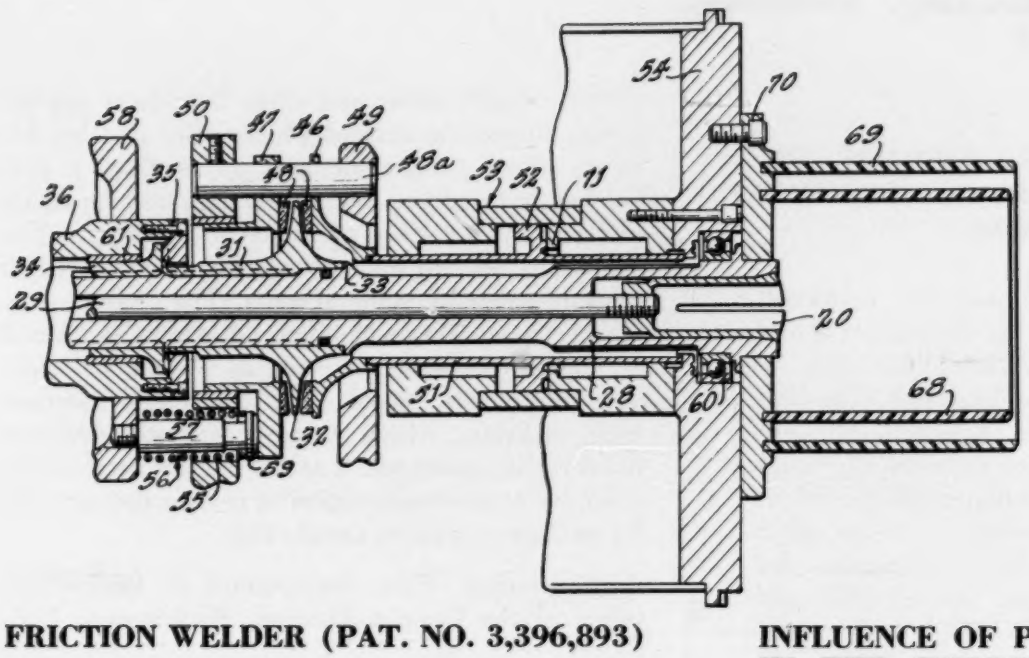

FRICTION WELDER (PAT. NO. 3,396,893)

Metal fabrication shops working with materials and products that can be improved or made more profitable by friction welding techniques will be interested in this friction welding machine. It generates heat by high-speed rotary motion with little pressure applied, and can be stopped almost instantly to allow the weld to be made before the heat becomes dissipated. The higher contact pressures used in earlier friction welders have frequently created unwanted deformation of the piece being welded. This welding machine contains a motor, the necessary drive mechanism to rotate, and a highly sophisticated braking system to stop the rotation and position the piece accurately for welding. The brake is able to stop rotation of 10,000 r.p.m. within one revolution. Braking capacity of that order may have interest to makers of a wide variety of equipment where sudden damping of high speed is needed.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

INFLUENCE OF PLASTIC DEFORMATION IN THE WELDING PROCESS ON THE STRENGTH OF WELDED JOINT CONNECTIONS (AD–673 412)

Potentially worthwhile improvements in the mechanical indices of welded joints in alloy steels are suggested by this study of the plastic deformation occurring in metals during the welding process. Careful investigation of the various common welds over a span of steel alloys seems to indicate that the plastic deformation can be turned to advantage by a welding processor who understands the deformation as it occurs. This study is a translation from Russian by Wright-Patterson AFB, Ohio.

ANALYSIS OF THERMAL STRESSES AND METAL MOVEMENT DURING WELDING (AD–676 830)

Studies at Marshall Space Flight Center on three-dimensional movement during welding of flat plate specimens are summarized in this report. The conclusions are that local metal movement apparently is caused by bending moment, and that general metal movement is caused by buckling. Welding operators may find this information useful. This report was prepared by Batelle Memorial Institute, Columbus, Ohio.

82

intake

exhaust

83

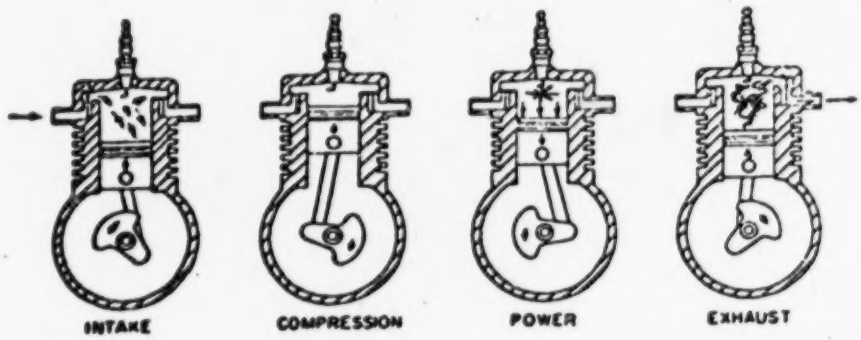

During the intake stroke, the _____ valve is open.

During the exhaust stroke the _____ valve is open.

During what strokes are both valves closed?

_____

_____

19252

83

intake

exhaust

compression stroke

power stroke

84

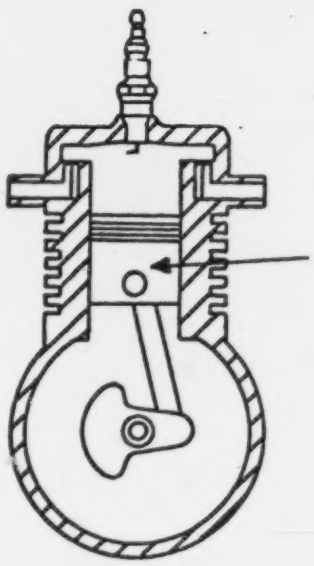

The arrow point to the part that moves straight up or down in the cylinder during each stroke.

The name of this part is the _____.

84

piston

85

LOOK AT PANEL 1

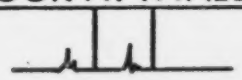

The piston does a different job during each stroke.

MATCH the piston job with the correct stroke:

A. piston squeezes air-gasoline mixture into combustion chamber

B. piston pushes burnt gases out of cylinder

C. piston transfers driving power to crankshaft

D. piston pulls air-gasoline mixture into cylinder

1. _____ intake stroke

2. _____ compression stroke

3. _____ power stroke

4. _____ exhaust stroke

19254

85

1. D

2. A

3. C

4. B

86

What happens during the power stroke ?

The intake and exhaust valves are _____.

The spark explodes the _____-_____ mixture.

The piston moves (☐ up ☐ down) transferring the driving power through the connecting rod to the c_____.

86

closed

air-gasoline

down

crankshaft

87

What stroke follows the power stroke? _____ _____

19256

87

exhaust stroke

88

What happens during the exhaust stroke?

The intake valve is _____.

The exhaust valve is _____.

The burnt gases are pushed out of the cylinder as the piston moves _____.

88

closed

open

up

89

Since the combustion cycle repeats itself over and over, what stroke will come after the exhaust stroke?

_____

89

the intake stroke

90

What happens during the intake stroke?

The intake valve is _____.

The exhaust valve is _____.

The piston moves _____ pulling the _____-_____ mixture into the cylinder.

19259

90

open

closed

down

air-gasoline

91

The intake stroke is followed by the _____ stroke.

19260

91

compression

92

During the compression stroke:

the intake valve is _____

the exhaust valve is _____

the piston moves up squeezing the air-gasoline mixture into the
c_____ c_____

19261

TECH BRIEF 68–10251—WELD MICROFISSURING IN INCONEL 718 MINIMIZED BY MINOR ELEMENTS

Welders of Inconel 718 can profit from NASA's research into the causes of microfissuring in the weld heat-affected areas. Past experience suggested that the microfissures were markedly influenced by trace elements. The addition of 20 p.p.m. of manganese and 25 p.p.m. of silicon greatly reduces microfissuring in Inconel 718. The addition of 20 p.p.m. of magnesium will significantly improve the standard alloy, except with electron-beam welding.

For additional information, circle Key No. 15 on Reader Service Card.

TECH BRIEF 68–10302—EFFECTS OF SURFACE PREPARATION ON QUALITY OF ALUMINUM ALLOY WELDMENTS

In research towards improving the quality of aluminum alloy welds, NASA has done a complete study on the effects of surface preparation on the weld, using aluminum alloy 2014 as the sample material. It was found that "as-machined" surfaces give the best welds and that all conventional surface cleanings, degreasings, rinsings, anodizings, and silicon coatings are highly detrimental to good work. Shops concerned with high-quality aluminum welds may be interested in this report.

For additional information, circle Key No. 16 on Reader Service Card.

TECH BRIEF 68–10383—EFFECTS OF HIGH FREQUENCY CURRENT IN WELDING ALUMINUM ALLOY 6061

Metal fabricators working with aluminum alloy 6061 have often seen cracking after tungsten inert gas (TIG) welding with a.c. current. To reduce the incidence of this defect, NASA has performed a careful study of the welding technique and has proven conclusively that uncontrolled high frequency current is the malefactor in the welding process. Of special importance is the set of tests which can help the fabricator to establish the limits and adjust the current for the best possible weld.

For additional information, circle Key No. 17 on Reader Service Card.

CAPACITOR DISCHARGE CIRCUIT FOR STARTING AND SUSTAINING A WELDING ARC (PAT. NO. 3,376,470)

Welding equipment manufacturers and welding shops doing inert gas atmosphere welding will be interested in this simple and reliable circuit. It can establish and maintain a d.c. arc for sufficient time to permit the normal power source to take over the voltage and current supply. The high voltage needed to establish the arc is not needed to maintain it and this device provides the surge by capacitor discharge. The circuit requires less power than is needed by presently available d.c. starters. It is inexpensive and rugged in design, and is connected in series with an inductor to the welding electrodes.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

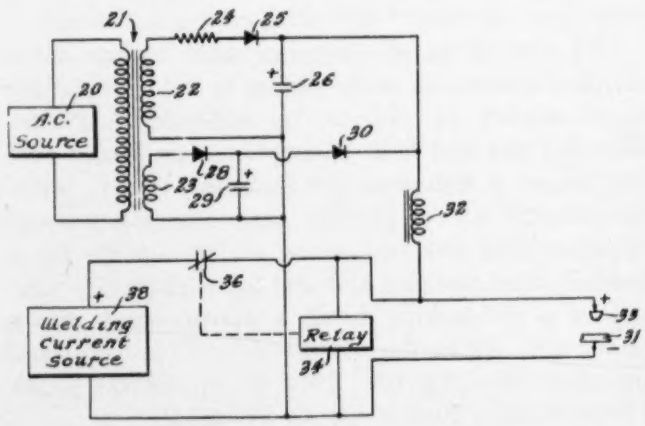

92

closed

closed

combustion chamber

93

The air-gasoline mixture in the combustion chamber is exploded by the s_____ p_____ which starts the p_____ stroke.

93

spark plug

power

94

Now, you know what happens during the four strokes of the
c_____ c_____.

19263

94

combustion cycle

95

NAME the four strokes of the combustion cycle:

_____ stroke

_____ stroke

_____ stroke

_____ stroke

19264

95

intake

compression

power

exhaust

96

What is the main job of the combustion cycle? _____

19265

96

It gives the car driving power.

(or equivalent response)

THIS IS THE END OF BOOK 16

19266.

AUTO MECHANICS COURSE

POST-TEST BOOK 16: THE COMBUSTION CYCLE

A BASIC SYSTEMS PROGRAM

19267

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1-4

NAME the four strokes of the combustion cycle:

1. _____ stroke

2. _____ stroke

3. _____ stroke

4. _____ stroke

5

The _____-_____ mixture is exploded during the _____ stroke.

6

Which way does the piston move during the compression stroke? _____

7-10

MATCH the following:

A. compression stroke

B. exhaust stroke

C. intake stroke

D. power stroke

7. _____ burns the fuel

8. _____ lets burned gas out of the cylinder

9. _____ squeezes the fuel

10. _____ takes the fuel in

11-12

During the power stroke both the _____ valve and the _____ valve are closed.

PANEL BOOK 16

To Be Used With
Book 16

AUTO MECHANICS COURSE

PANEL BOOK 16: THE COMBUSTION CYCLE

A BASIC SYSTEMS PROGRAM

18270

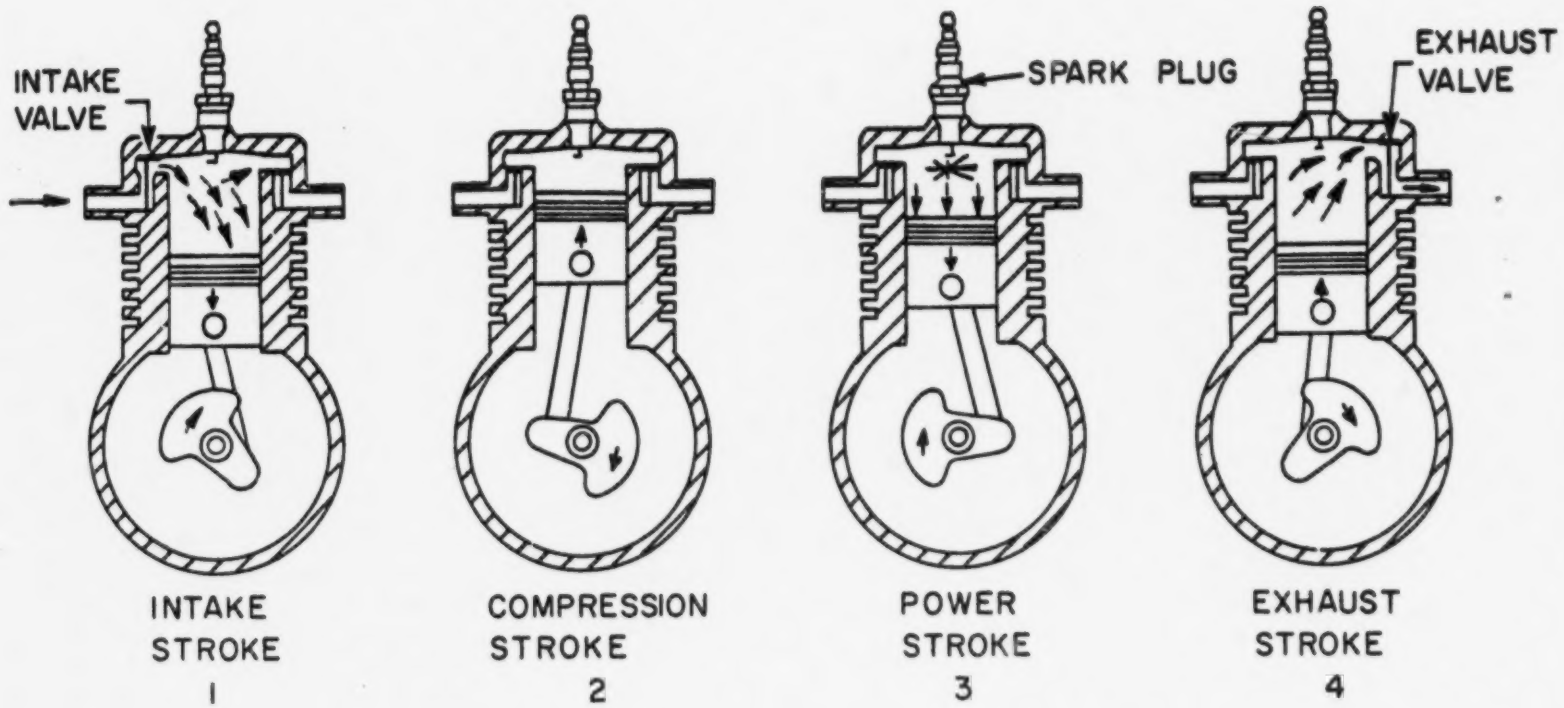

COMBUSTON CYCLE

PANEL 1

19271

WELD MICRO-
718 MINIMIZED

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20 p.p.m. of man-
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The addition of 20
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ron-beam welding.

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—EFFECTS OF
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61

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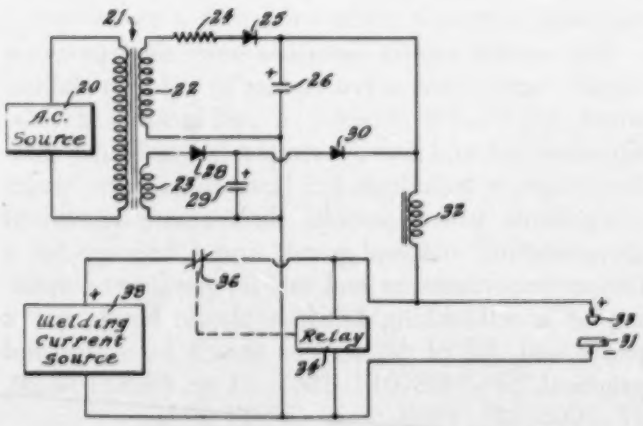

WELDING CORE FOR TUBES (PAT. NO. 3,411,688)

Makers of magnesium aluminum silicate ceramic materials may find a new source of activity in fabricating ceramic cores that may be used in welding tubes to a plate or container wall, as in a steam boiler. These cores or ferrules are sized to fit the piping and flanged to fit the plate or container wall. They simplify the welding process, making the weld more uniform, and do away with the need for after-drilling. After welding, the ceramic is shattered and removed. Ceramic cores can be produced at a moderate cost, thus providing economy in time and work, and an improved quality in the welding shop fabrication.

Administering Office: Department of the Navy, Patent Counsel, Washington, D.C. 20360.

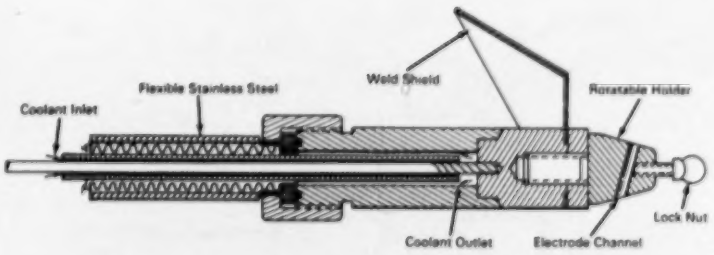

TECH BRIEF 68–10041—IMPROVED TORCH INCREASES WELD QUALITY IN REFRACTORY METALS

In welding refractory materials, the normal commercial welding torches tend to degrade the weld atmosphere by contamination. NASA has developed a new torch that is impermeable and contributes almost no contamination to the weld box. The torch holds the welding cable inside a coolant chamber; the head rotates so that strain is avoided at the cable. This torch could become increasingly important as refractory materials see wider application.

For additional information, circle Key No. 18 on Reader Service Card.

VT 013 139
Auto Mechanics Course. Book 17: Functions of Lubricating Oil.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 85p.

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IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on functions of lubricating oil was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 139

ED0 56238

BOOK 17

(C1)

AUTO MECHANICS COURSE

BOOK 17: FUNCTIONS OF LUBRICATING OIL

A BASIC SYSTEMS PROGRAM

VT013139

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OFFICE OF EDUCATION
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Curriculum Report Reference
Page 14

Task Analysis Reference
40.1

19273

AUTO MECHANICS COURSE

BOOK 17: FUNCTIONS OF LUBRICATING OIL

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19274

AUTO MECHANICS COURSE

PRE-TEST BOOK 17: FUNCTIONS OF LUBRICATING OIL

A BASIC SYSTEMS PROGRAM

19275

1

Pistons, rings and valves are examples of parts that are lubricated by _____.

2

How does motor oil affect the heat of moving engine parts?

_____

3

Spaces between moving engine parts are sealed by _____ _____.

4

When large amounts of dirt, sludge and acids get into the motor oil, the motor oil should be _____.

5

When motor oil gets between two moving engine parts, we say that the parts are _____.

6-8

MATCH the following:

A. dust, carbon and bits of metal	1. _____ form(s) acids
B. unburned gasoline	2. _____ make(s) oil dirty
C. water	3. _____ make(s) oil weaker

9

Motor oil lets close-fitting moving parts:

- ☐ burn up
- ☐ slide more easily
- ☐ stick together

10

If a running engine had no motor oil, it would:

- ☐ burn out
- ☐ run cooler
- ☐ make no difference

1

PREVIEW

This section will tell you about lubricating oil, how it works and what it does.

NO ANSWER NEEDED

GO ON TO NEXT FRAME

19278

1

NO ANSWER NEEDED

2

Pistons move up and down in the:

- ☐ cylinders
- ☐ keys
- ☐ valve guides

Valves move up and down in the:

- ☐ cylinders
- ☐ keys
- ☐ valve guides

19279

2

cylinders

valve guides

3

The pistons and connecting rods:

- ☐ go up and down
- ☐ turn

The crankshaft:

- ☐ goes up and down
- ☐ turns

19280

3

go up and down

turns

4

CHECK ALL of the moving parts:

- ☐ the combustion chamber
- ☐ the connecting rods
- ☐ the crankshaft
- ☐ the pistons
- ☐ the valve ports
- ☐ the valves

19281

TECH BRIEF 68–10022—MECHANICAL SHIELDING REDUCES WELD SURFACE CRACKING IN 6061 T6 ALUMINUM

Welders of aluminum 6061 T6 have experienced heat check cracking when working with high frequency AC tungsten arc equipment. NASA has developed a simple mechanical shield of high-melting-point material which protects the parent metal from the arc and eliminates heat check cracks. An 0.020-inch sheet of tungsten plate was used first in the tests, but other materials were also tried. Columbium No. 752 gave the best protection.

For additional information, circle Key No. 19 on Reader Service Card.

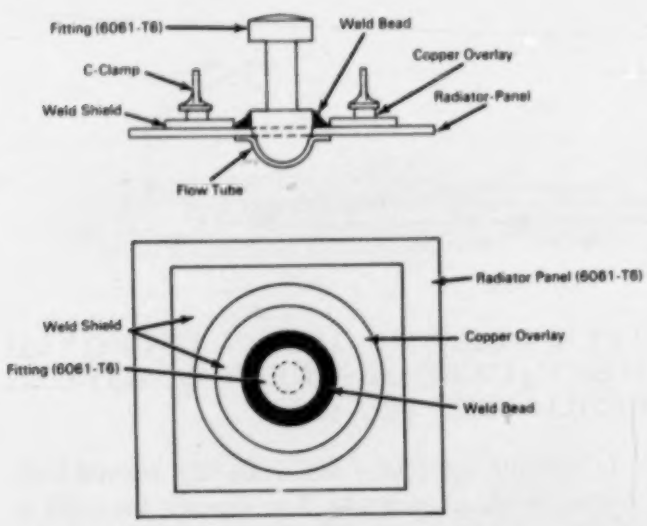

TECH BRIEF 68–10566—WELDING SKATE WITH COMPUTERIZED CONTROLS

Firms that have had problems in precision welding of contoured and double-contoured metal joints may be interested in a NASA-developed welding skate using computer controls. The computer is programed for TIG welding. On the basis of input information, it can compute the best torch angle and position both the torch and the cold-wire guide-angle manipulator. In addition, the optimum speed is computed and supplied through control of the welding skate motor speed. This management of the welding process is maintained without contact with the working surface by electrical, electromechanical, and photoelectric transducers which supply the desired inputs to the computer.

For additional information, circle Key No. 20 on Reader Service Card.

FASTENERS AND FASTENING TECHNIQUES (NASA SP–5906 (01) AND (02))

These two reports cover innovations in fastening devices and techniques developed by NASA and its contractors to solve fastening problems. Fasteners for sheet metal, plastics, wire, and cables are described. Clamp, clip, and strap devices include: a stop-clip fastener applicable to enclosures that must suppress both conducted and radiated radiofrequency energy, a device used to secure spliced sections of tubular containers, two types of cup-shaped washers which will prevent roll-pins from vibrating loose, and a thermal insulation clamp, among others. Also described are a new, quick-release fastener, and a simple self-locking device which is inexpensive and can be made of different materials. There are also protective fastening devices, such as a support and attach mechanism for mounting electrical equipment on inner or outer surfaces of cylinders, and a vibrator isolator assembly designed to minimize vibration when used with a gyroscope.

The second report describes such devices as: a simple countersunk screw holder to aid in installing wood screws in objects; a self-locking double-threaded nut and bolt; a simple spring-loaded rolling hinge; a technique for fastening display panel components which permits their removal without disconnecting attached wires, and a concept for a tamper-proof fastener and seal for packages consisting of a self-locking head, a plastic band, and a paper seal. All of the devices should be useful and practical. SP–5906(01). 1967. 14 pp. CFSTI $0.20. SP–5906(02). 1968. 6 pp. CFSTI $0.15.

4

the connecting rods

the crankshaft

the pistons

the valves

5

Connecting rods, pistons and valves move up and down:

- ☐ very fast
- ☐ very slowly

Pistons and valves:

- ☐ rub against other parts
- ☐ do not rub against other parts

19282

5

very fast

rub against other parts

6

When fast-moving parts rub against each other, the parts wear out quickly and get very hot.

As a result, the engine will: (CHECK TWO CORRECT ANSWERS)

- ☐ burn out
- ☐ last a long time
- ☐ not last very long
- ☐ run cool

6

burn out

not last very long

7

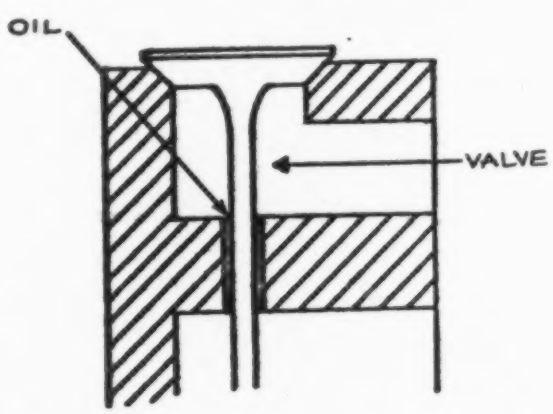

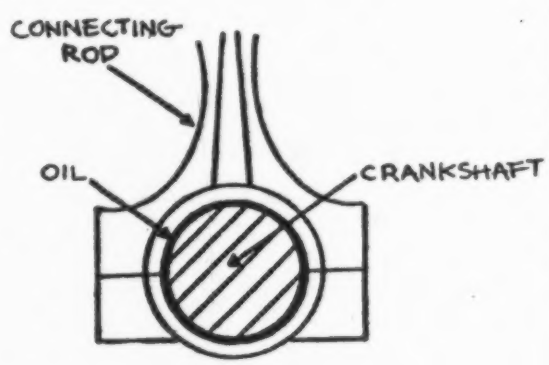

The pictures show moving parts that are separated by a thin coat of _____ .

19284

7

oil

8

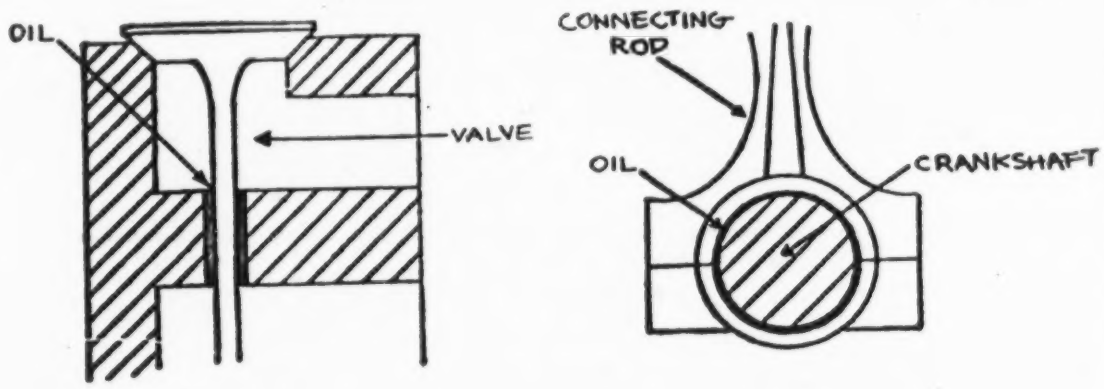

The oil used in an automobile is called MOTOR OIL.

Motor oil is a lubricant, that is, it makes surfaces slippery.

When motor oil gets between moving parts, they will:

- ☐ slide easily
- ☐ stick together

8

slide easily

9

Parts that fit closely together and rub against each other will get very hot.

The close-fitting moving parts in an engine are cooled by:

- ☐ air
- ☐ gasoline
- ☐ oil

9

oil

10

When moving parts rub against each other, they can get very:

- ☐ hot
- ☐ cold

Motor oil between moving parts makes the moving:

- ☐ easier
- ☐ more difficult

19287

10

hot

easier

11

Motor oil makes surfaces:

- ☐ dry
- ☐ slippery
- ☐ gritty

19288

11

slippery

12

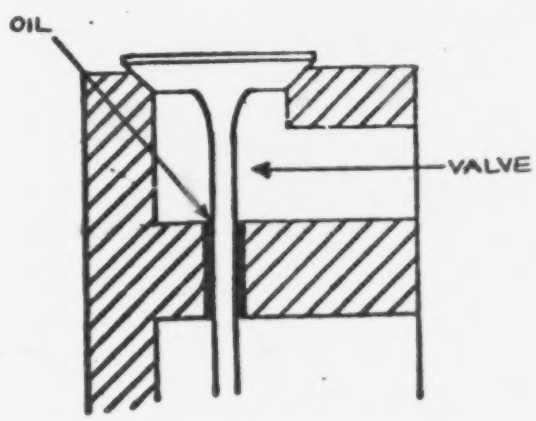

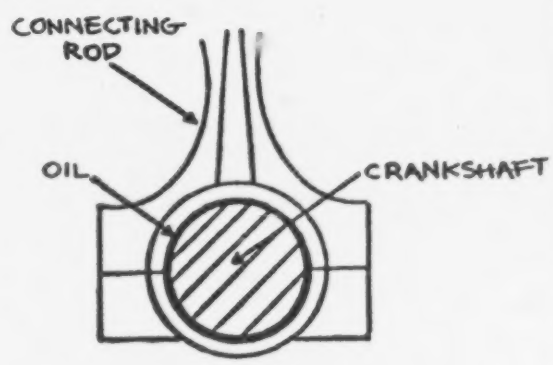

Motor oil goes between parts that:

- ☐ move very slowly
- ☐ move very fast
- ☐ rub together
- ☐ do not rub together

19289

12

move very fast

rub together

13

To keep engine parts moving easily, m _____
o _____ is added to the engine.

19290

zing, Soldering,

–MECHANICAL
ELD SURFACE
MINUM

have experienced
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nt. NASA has de-
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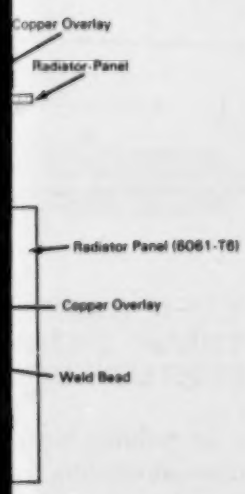

6—WELDING
ERIZED CON-

in precision weld-
oured metal joints
developed welding
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FASTENERS AND FASTENING TECHNIQUES (NASA SP–5906 (01) AND (02))

These two reports cover innovations in fastening devices and techniques developed by NASA and its contractors to solve fastening problems. Fasteners for sheet metal, plastics, wire, and cables are described. Clamp, clip, and strap devices include: a stop-clip fastener applicable to enclosures that must suppress both conducted and radiated radiofrequency energy, a device used to secure spliced sections of tubular containers, two types of cup-shaped washers which will prevent roll-pins from vibrating loose, and a thermal insulation clamp, among others. Also described are a new, quick-release fastener, and a simple self-locking device which is inexpensive and can be made of different materials. There are also protective fastening devices, such as a support and attach mechanism for mounting electrical equipment on inner or outer surfaces of cylinders, and a vibrator isolator assembly designed to minimize vibration when used with a gyroscope.

The second report describes such devices as: a simple countersunk screw holder to aid in installing wood screws in objects; a self-locking double-threaded nut and bolt; a simple spring-loaded rolling hinge; a technique for fastening display panel components which permits their removal without disconnecting attached wires, and a concept for a tamper-proof fastener and seal for packages consisting of a self-locking head, a plastic band, and a paper seal. All of the devices should be useful and practical. SP–5906(01). 1967. 14 pp. CFSTI $0.20. SP–5906(02). 1968. 6 pp. CFSTI $0.15.

TECH BRIEF 68–10091—AUTOMATIC CONTOUR WELDER INCORPORATES SPEED CONTROL SYSTEM

NASA has developed an electrical device than can ensure constant torch speed regardless of contours or other irregularities in shape. Production welders and welding shops already know how the quality of work improves when the torch is maintained at a constant speed. The innovation is in the motor-driven rate generator which is controlled by a separate feedback amplifier loop and the motor clutch-brake arrangement for controlling the electronic governor. Speed and contour are sensed by a speed pickup wheel and the information is translated into control data for the welder. The movement of the workpiece is adjusted automatically to maintain constant speed at the torch.

For additional information, circle Key No. 21 on Reader Service Card.

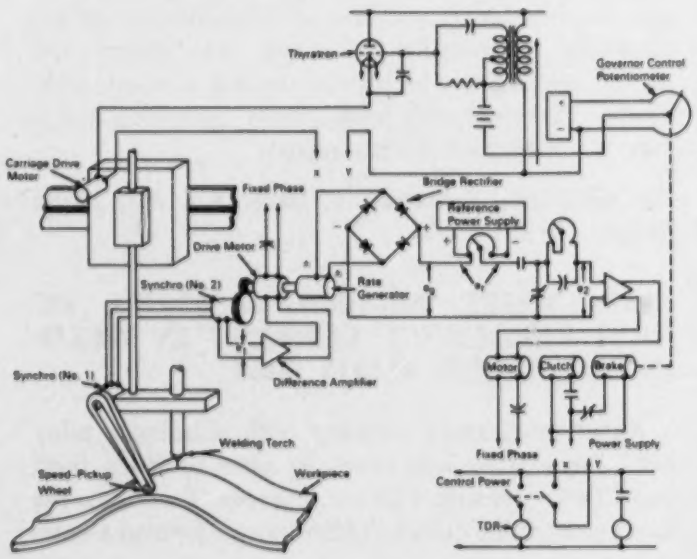

14

do not get too hot

slide easily

15

What is poured into an engine to lubricate the engine's moving parts? _____ _____

19292

15

motor oil

16

When close-fitting parts are covered with a coat of motor oil, the parts will move easily and will not burn up.

These parts are l_____ .

19293

16

lubricated

17

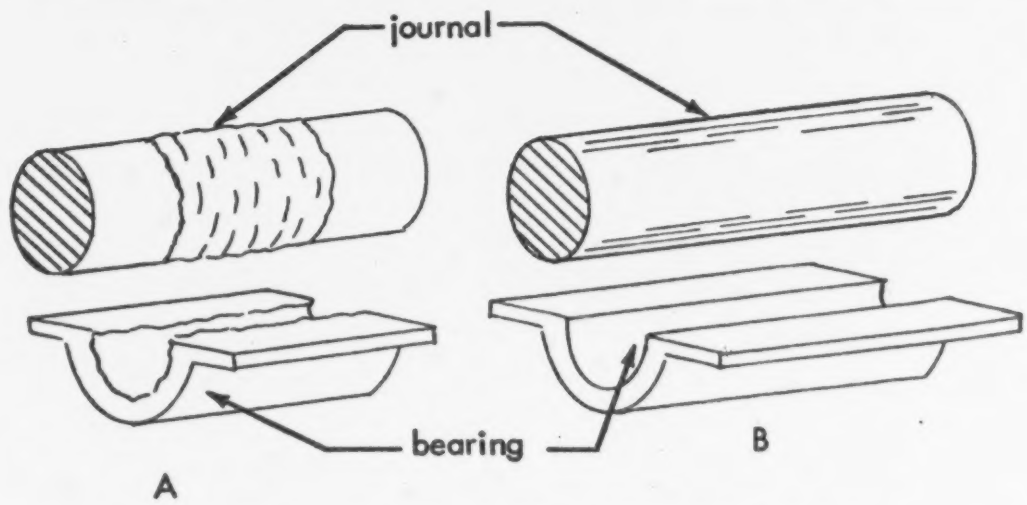

If engines were run without oil, the parts would get so hot that they would swell, tear bits of metal from each other, and then stick together.

Which picture above shows an engine that has been run without oil?

- ☐ picture A
- ☐ picture B

19294

17

picture A

18

Once the parts of an engine have become stuck or "welded" together the engine is burnt out.

An engine becomes burnt out usually because it has been run without:

- ☐ air
- ☐ gasoline
- ☐ oil

18

oil

19

Failure to use oil in an engine will cause moving parts to heat, swell, and then:

- ☐ slide over each other
- ☐ stick together

Once this happens, the engine has been b_____ out.

19

stick together

burnt (burned)

20

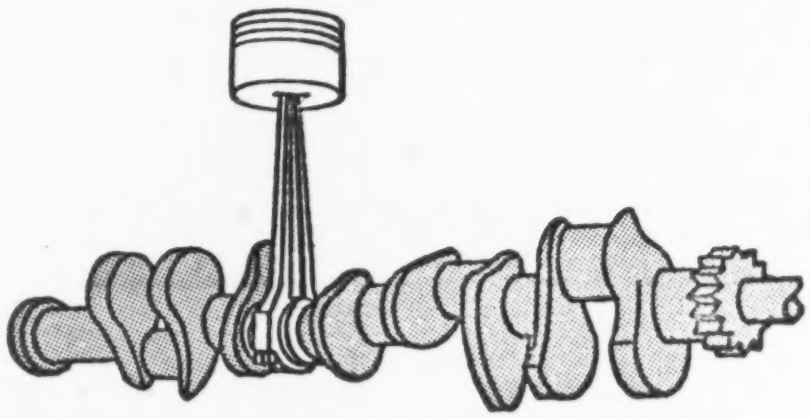

The picture shows the bearing that fits between the connecting rod and the crankshaft.

The surface of this bearing is very:

- ☐ rough
- ☐ smooth

20

smooth

21

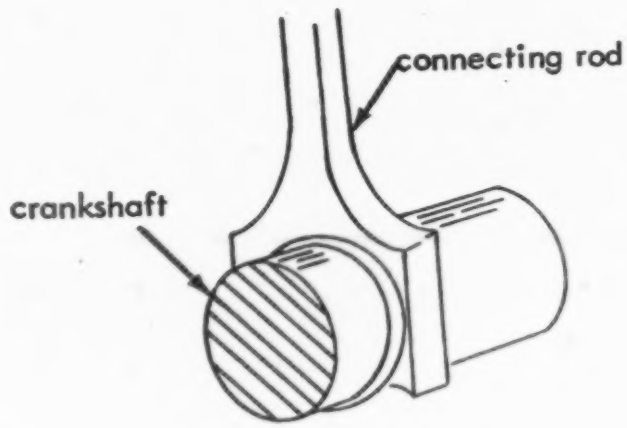

The picture shows the surface of the crankshaft.

Is the surface of the crankshaft very smooth?

- ☐ yes
- ☐ no

21

yes

22

Engine parts can slide past each other more easily because they are very smooth.

They can slide very easily when they have a thin coat of

_____ _____.

19299

22

motor oil

23

Wear is caused when two moving parts:

- ☐ rub together
- ☐ stick together

19300

23

rub together

24

Putting a thin film of oil between moving parts will cause:

- ☐ more wear
- ☐ less wear

19301

TECH BRIEF 68–10522—METHOD FOR REMOVING SURFACE-DAMAGED LAYERS FROM NICKEL ALLOYS

Metalworking shops which use electrical discharge machining (EDM) have experienced problems with degradation of nickel alloys caused by the brittle layer of redeposited material on the machined surface. Serious losses in yield strength, ductility, and ultimate strength have been observed. Electropolishing of the completed work at room temperature in a water solution of sulphuric and phosphoric acids, with a current density of $5A/in^2$, has proven to be the best removal method. Abrasive grit blasting will remove the deposits but it causes a number of detrimental side-effects.

For additional information, circle Key No. 22 on Reader Service Card.

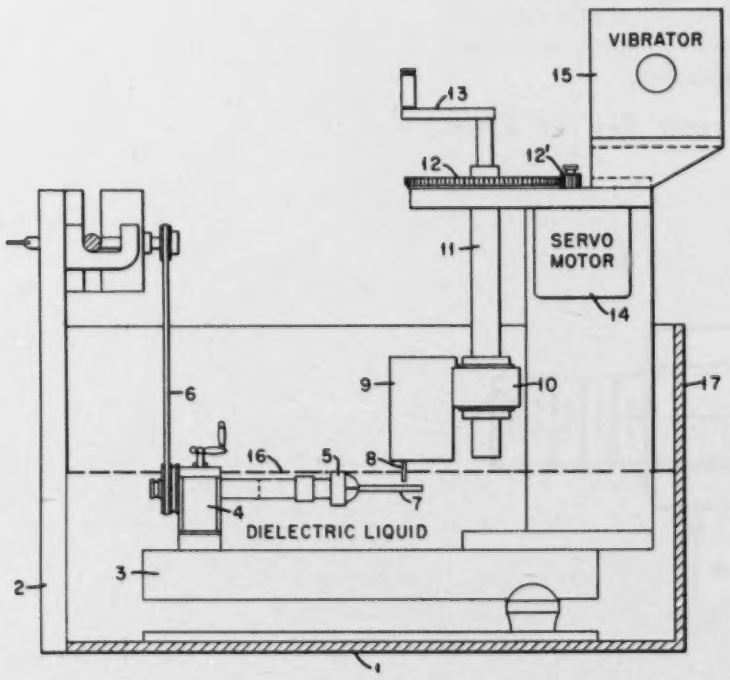

USE OF NUMERICALLY CONTROLLED MACHINE TOOLS IN RAE WORKSHOPS (AD–688 352)

Firms contemplating the purchase or installation of numerically controlled machine tool equipment will find interest in this carefully detailed report. It covers the use of such equipment in the workshops of Great Britain's Royal Artillery Establishment. The installation of this equipment was carefully planned in advance, yet the problems met were generally unforeseen. Their solutions may be as useful to the American businessman as to the British ordnance engineer.

METHOD FOR ELECTRODISCHARGE MACHINING (PAT. NO. 3,396,259)

Firms manufacturing or machine shops using electrodischarge machining (EDM) equipment may find the technique disclosed in this patent quite profitable. It has a mechanism at the cutting tool of the EDM equipment to vibrate the tool and impart high frequency, low-amplitude movement to the tool. The increased cutting rate resulting from this method was surprising, ranging from 900 to several thousand percent depending on the material. The equipment includes the necessary electronic circuitry to control the EDM operation plus a vibrator unit, together with the controls over amplitude and frequency. The tool wear rate on the cutting head is substantially reduced on materials like tantalum and stainless steel, but is slightly increased on the softer materials such as brass. This technique, then, increases the cutting rate and permits low-wear tools to be used which yield good machine stability.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

ROTAR
3,371,5

Any r
drilling
rotary d
work. T
the bit t
holds th
friction
and lets
traction
and resu
drill all
decide t
Manufac
in guide
vices ma

Adminis
Assistan
D.C. 20

24

less wear

25

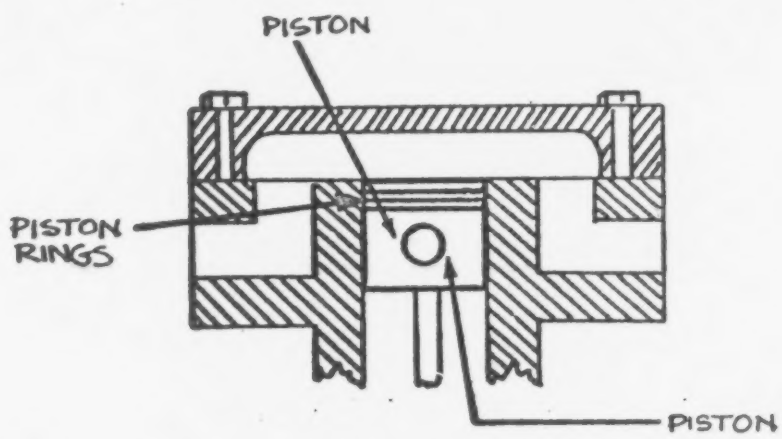

You have learned that the space between the piston and the cylinder walls are sealed by _____ _____ .

19302

25

piston rings

26

Even though there are rings around pistons, some power can still blow past the rings instead of pushing down on the pistons.

In this way, the engine could:

- ☐ gain power
- ☐ lose power
- ☐ not have its power affected

26

lose power

27

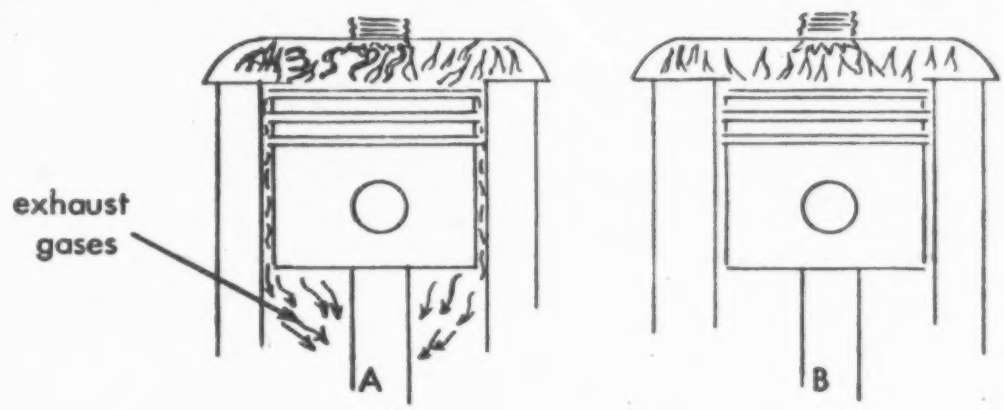

Motor oil seals the rings so that no power is lost in the engine.

In which picture is there a sealed space between the piston rings and the cylinder walls?

- ☐ picture A
- ☐ picture B

19304

27

picture B

28

Motor oil in an engine: (CHECK ALL CORRECT ANSWERS)

- ☐ makes moving parts slide more easily
- ☐ makes moving parts stick together
- ☐ seals the spaces between moving parts
- ☐ stops parts from moving

28

makes moving parts slide more easily

seals the spaces between moving parts

29

Motor oil lubricates the rings in the piston.

If there is no oil in the ring grooves, the rings will:

- ☐ keep on working
- ☐ stick in the ring grooves or break
- ☐ shrink into the crankcase

29

stick in the ring grooves or break

30

Piston rings will stick in the ring grooves if:

- ☐ the engine is warm
- ☐ there is no oil in the ring grooves
- ☐ there is lots of oil in the ring grooves

19307

30

there is no oil in the ring grooves

31

If the engine is properly lubricated, exhaust gases cannot get into the crankcase. One reason for this is that:

- ☐ the rings are stuck in the ring grooves and help to seal the space between the piston and cylinder
- ☐ the rings are not stuck in the ring grooves; they are pushed out from the grooves and help to seal the space

19308

31

the rings are not stuck in the ring grooves; they are pushed out from the grooves and help to seal the space

32

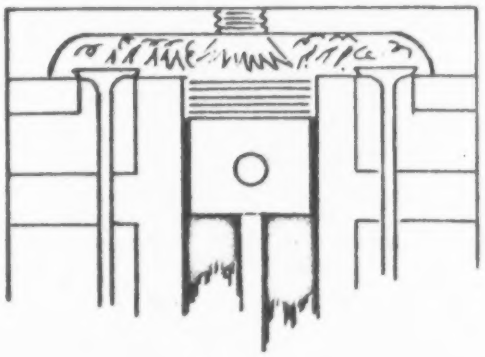

In the picture above, exhaust gases cannot get into the crankcase, because the: (CHECK TWO)

- ☐ cylinder walls have a coat of oil
- ☐ cylinder walls do not have a coat of oil
- ☐ rings are stuck in the grooves
- ☐ rings are not stuck in the grooves

32

cylinder walls have a coat of oil

rings are not stuck in the grooves

33

BLOW-BY occurs when exhaust gases get past the piston into the crankcase.

Blow-by cannot happen if the space between the rings and the cylinder walls are sealed with _____ .

33

(motor) oil

34

Oil between the cylinder walls and the piston prevents:

- ☐ blow-by
- ☐ blowups
- ☐ explosions

ETHOD FOR
GED LAYERS

e electrical dis-
xperienced prob-
lloys caused by
material on the
n yield strength,
e been observed.
work at room
f sulphuric and
ensity of 5A/in²,
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Key No. 22 on

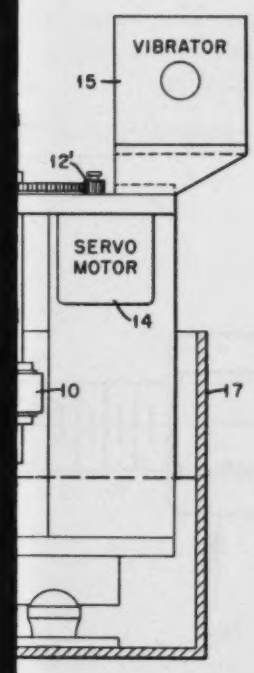

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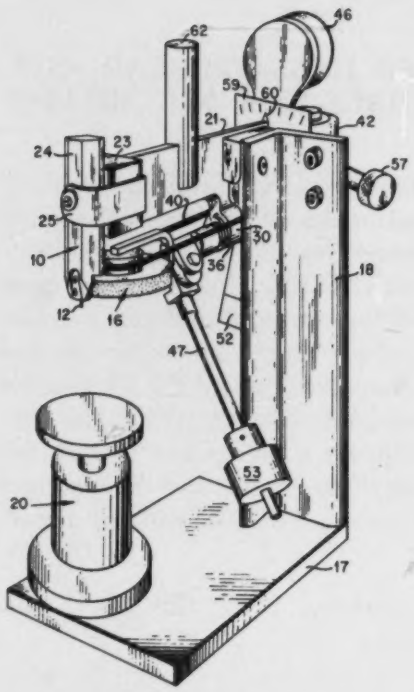

ROTARY DRILLING DEVICE (PAT. NO. 3,371,558)

Any machine shop with the need to do accurate drilling in sizes of 0.002- to 0.030-inch can use this rotary drill to improve the accuracy and speed of its work. This device has a novel method of mounting the bit to eliminate wobble or waver. The mounting holds the bit in the exact orientation desired by a friction grip. This permits higher speeds of rotation and lets the operator control advancement and retraction during drilling operations. Bit breakage and resulting work stoppage can be prevented. This drill allows the skilled operator a better chance to decide the condition of the bit by its performance. Manufacturers of components for instruments used in guided missiles, radar, aircraft, and timing devices may find this drill useful.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

34

blow-by

35

Oil prevents blow-by.

To prevent blow-by, what must oil do to the space between the cylinder wall and the piston rings? _____

273 OF 327

ED

056 238

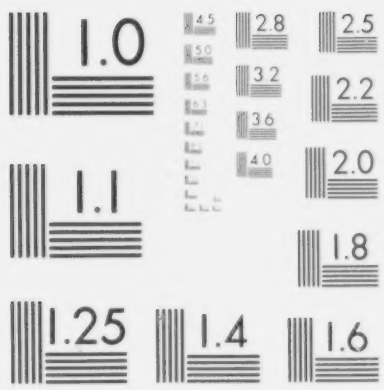

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

35

seal it

36

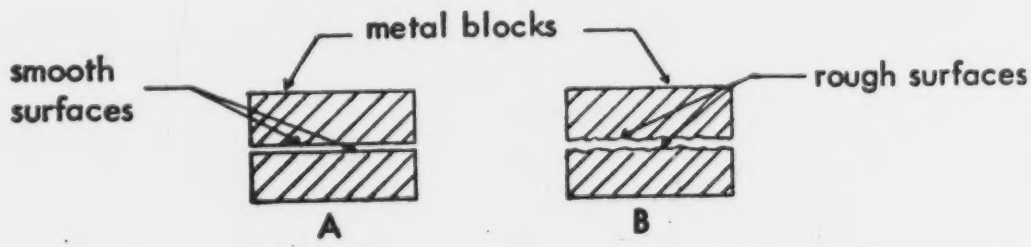

Parts with rough surfaces take more power to move.

In the pictures above, which two metal blocks will take more power to move?

- ☐ A
- ☐ B

19313

273

36

B

37

Some engine power must be used to make the different parts of a car move. This power is wasted or "lost." Otherwise, it could be used to make the car go.

Oil reduces power loss by making it:

- ☐ easier for parts to move
- ☐ harder for parts to move

37

easier for parts to move

38

Power used just to make the parts of an engine move is wasted or lost.

If it is very hard to move engine parts:

- ☐ more power will be lost
- ☐ less power will be lost

38

more power will be lost

39

When a thin film of oil is placed between moving parts, these parts will move easily.

In this way, oil:

- ☐ adds to power loss
- ☐ reduces power loss

39

reduces power loss

40

When you rub your hands very fast and very hard against something, your hands will get:

- ☐ cool
- ☐ hot

When fast moving parts rub against each other, they will get:

- ☐ cool
- ☐ hot

40

hot

hot

41

Motor oil seals and lubricates.

Motor oil also carries off engine heat to keep the engine from burning out.

Motor oil helps engines to run well by:

- ☐ burning up engine parts
- ☐ carrying off the heat of rubbing parts
- ☐ making moving parts slide easier
- ☐ making parts stick together

19318

41

carrying off the heat of rubbing parts

making moving parts slide easier

42

What carries off the heat of moving engine parts?

_____ _____

19319

42

motor oil

43

Besides sealing and lubricating, what else does motor oil do?

_____

19320

TECH BRIEF 68–10055—THREAD CUTTING WITH THREE-AXIS N/C MILLING MACHINES

Shops with a three-axis N/C milling machine equipped to respond to the APT numerical control system can avail themselves of a special thread-cutting macro known as TAPDIE. This macro has been developed by NASA for cutting threads on oversize stock or on pieces which cannot be cut by conventional means. It is compatible with APT III Version 7 and is totally independent. The TAPDIE addendum to the APT encyclopedia contains instructions for using the macro, sample programs, and the punched card decks for the macro. TAPDIE will cut almost any type of thread.

For additional information, circle Key No. 23 on Reader Service Card.

TECH BRIEF 68–10318—COMPRESSIBLE SLEEVE PROVIDES AUTOMATIC CENTERING FOR GRINDING OR TURNING OF CYLINDERS

Most machine shops have experienced lost time in setting up a rough casting for grinding or turning. NASA has developed an elastomeric sleeve on a threaded mandrel that permits the machinist to set up a rough casting without delay. The mandrel can be secured by a collet or held between centers. The elastomer, as it is tightened up, yields to find the average inside diameter of the casting and the rough cast thicknesses become almost equal across the diameter. The equipment can be easily made and the elastomers molded without difficulty. The method was first used to grind hollow cylindrical magnets. Machine tool builders may find it useful for grinding spindle outside diameters concentric with the inside diameters.

For additional information, circle Key No. 24 on Reader Service Card.

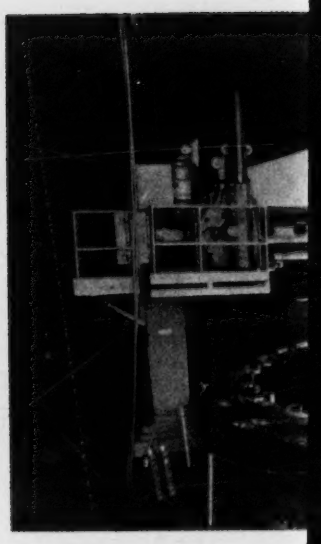

TECH BRIEF 68–10530–
ING MILL CAPACITY IS

Operators of vertical borin
workpiece capacity is 27 feet
in-shop NASA modification o
36-foot workpiece diameters.
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as a greater size of workpie
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For additional information,
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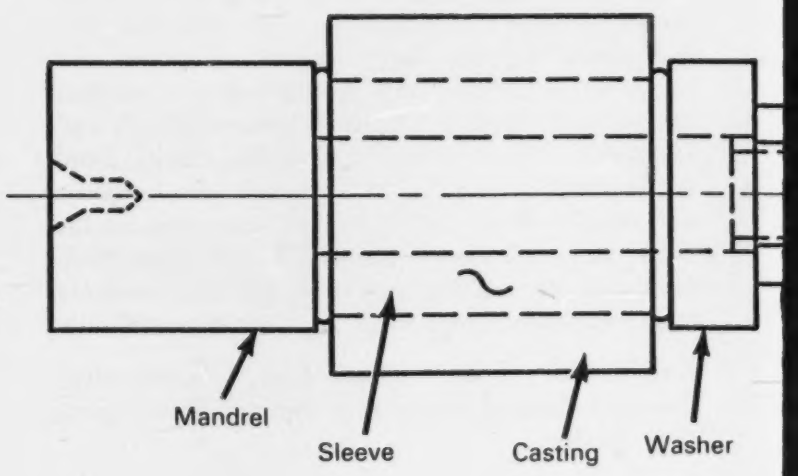

43

It carries off heat.

44

What is added to an automobile engine to lubricate it?

_____ _____

19321

44

motor oil

45

Parts that are lubricated will:

- ☐ slide easily
- ☐ stick together
- ☐ wear fast
- ☐ wear slowly

19322

45

slide easily

wear slowly

46

How does motor oil affect the wear of engine parts?

_____

19323

46

It slows down wear or makes parts last longer.

47

Motor oil cuts down the loss of engine power by forming a _____ between the piston rings and the cylinder walls.

47

seal

48

What does motor oil do to the heat caused by engine parts rubbing together? _____

19325

48

Motor oil carries the heat away.

49

Motor oil seals the spaces between parts and carries off engine heat.

Another job that motor oil does is to:

- ☐ make parts stick together
- ☐ make parts slide more easily
- ☐ make parts fall apart

49

make parts slide more easily

50

The different jobs that motor oil does are to: (CHECK ALL CORRECT ANSWERS)

- ☐ carry off engine heat
- ☐ make parts slide easier
- ☐ stop engine movement
- ☐ seal spaces between close-fitting parts
- ☐ wear out engine parts

19327

50

carry off engine heat

make parts slide easier

seal spaces between close-fitting parts

51

New oil is clean oil.

When an engine has been running for a while, dirt, dust and tiny bits of metal will get into the oil.

When this happens, the oil is:

- ☐ clean
- ☐ dirty

51

dirty

52

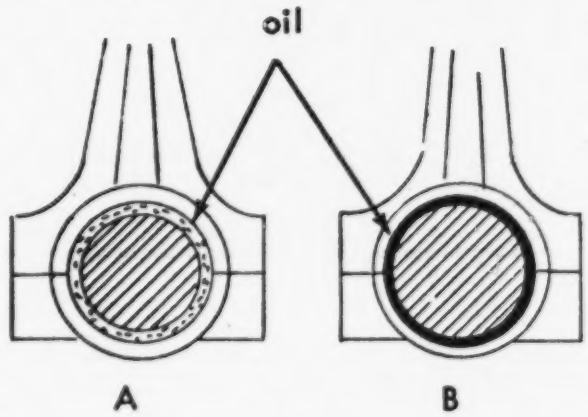

Which picture shows motor oil with particles of dirt and dust in it?

- ☐ picture A
- ☐ picture B

52

picture A

53

Dust, carbon, and bits of metal can dirty oil. For this reason, oil should be changed often.

Changing the oil often keeps it:

- ☐ clean
- ☐ dirty

19330

harge, Drilling, (continued)

**HREAD CUT-
N/C MILLING**

milling machine
umerical control
pecial thread-cut-
s macro has been
eads on oversize
e cut by conven-
APT III Version
PDIE addendum
instructions for
and the punched
E will cut almost

Key No. 23 on

**MPRESSIBLE
TIC CENTER-
TURNING OF**

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The mandrel can
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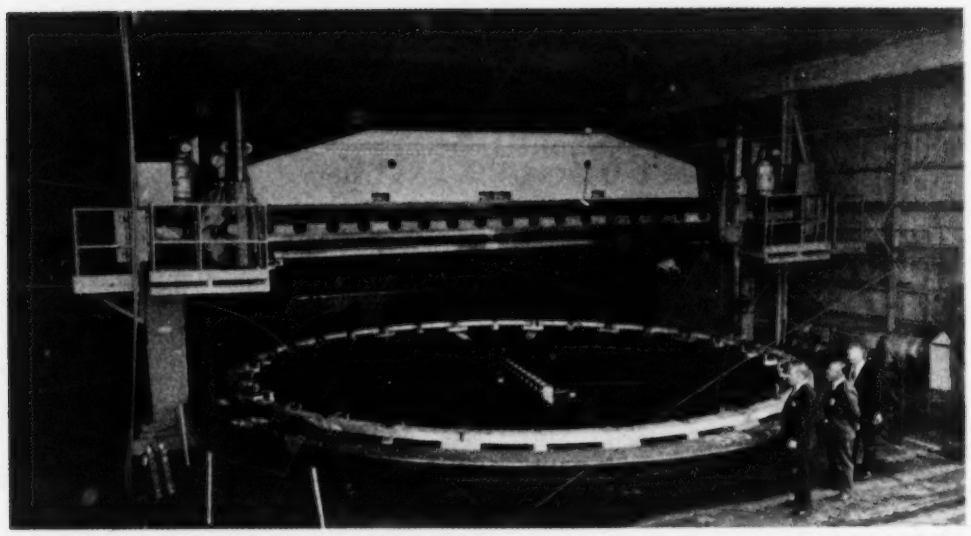

TECH BRIEF 68–10530—VERTICAL BORING MILL CAPACITY IS INCREASED

Operators of vertical boring mills whose nominal workpiece capacity is 27 feet may be able to use an in-shop NASA modification of the machine to permit 36-foot workpiece diameters. By adding extension saddles to the mill suport columns, the modification provides a wider traverse for the drillheads as well as a greater size of workpiece. The basic concepts might be applied to other types of machines which might benefit from this modification.

For additional information, circle Key No. 25 on Reader Service Card.

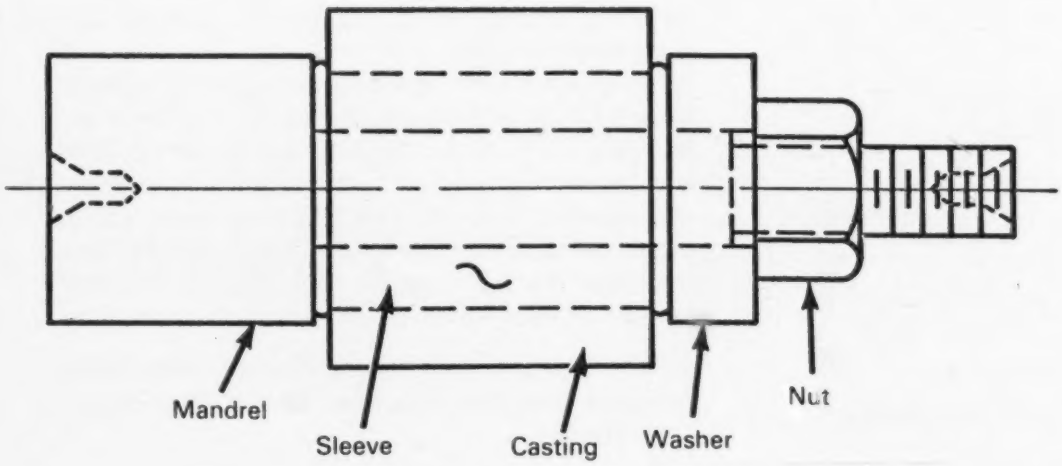

53

clean

54

If a carburetor does not work properly, unburned gases can get into the motor oil and make it weak.

If the oil gets too weak, it cannot do its job.

Should weak motor oil be changed?

- ☐ yes
- ☐ no

19331

54

yes

55

Dust, carbon, and bits of metal can dirty oil. For this reason, oil should be changed often.

Changing the oil often keeps it:

- ☐ clean
- ☐ dirty

55

clean

56

Motor oil should be changed when it gets too dirty.

Oil should be changed when: (CHECK ALL CORRECT ANSWERS)

- ☐ dirt gets into it
- ☐ dust gets into it
- ☐ metal particles get into it

56

dirt gets into it

dust gets into it

metal particles get into it

57

As dirt, dust and tiny metal particles collect in the engine, motor oil washes them away.

This keeps the engine:

- ☐ clean
- ☐ dirty

57

clean

58

Anything that enters the engine lubricating system besides motor oil will make the motor oil weak.

Weak motor oil is:

- ☐ bad for the engine
- ☐ good for the engine

19335

58

bad for the engine

59

Unburned gasoline can get into oil and make it:

- ☐ strong
- ☐ weak

19336

59

weak

60

Dust, carbon, and bits of metal make oil:

- ☐ clean
- ☐ dirty

19337

60

dirty

61

What makes oil dirty?

- ☐ bits of metal
- ☐ dust
- ☐ time

19338

61

bits of metal

dust

62

What makes oil weak?

- ☐ carbon
- ☐ dirt
- ☐ unburned gasoline

62

unburned gasoline

63

Motor oil should be changed when it gets too dirty.

Oil should be changed when: (CHECK ALL CORRECT ANSWERS)

- ☐ dirt gets into it
- ☐ dust gets into it
- ☐ metal particles get into it

19340

A METHOD OF GRINDING AND FINISHING DIAMOND CONES (AD–674 044)

The method described in this translated Russian report from Wright-Patterson AFB, Ohio, may interest diamond tool grinders. The diamond is rotated around an axis perpendicular to the plane of the grinding disc. This speeds up the machining and allows the finish to be more exact. The rotation specified is superposed on the conventional rotation of the diamond, *i.e.*, round the axis of the cone.

MACHINE TOOLS AND FIXTURES (NASA SP–5910(01))

This summary of selected novel machine tools and fixtures, and unusual uses for existing standard tools, includes four sections: (*1*) *Drilling Machine Fixtures and Adapters;* (*2*) *Engine Lathe Fixtures* (*3*) *Measurement and Layout Fixtures;* (*4*) *Milling Machine Fixtures and Adapters.* Included in section 1 are abstracts on a sensitive drilling feed attachment; improvement of drill press clamp; a post indexing fixture which saves considerable time in drilling complex hole patterns where interrelationship between holes is critical; and a pressure feed unit for a 90° drill which will result in less operator fatique, fewer broken bits, greater personal safety, higher quality work, and increased production. Section 2 deals with self-alining, tilting chuck jaws; honeycomb cylinder doming and facing machine, and a honeycomb cylinder planer. In section 3, the abstracts describe a gage block comparator, antifriction modification; precision angle grid plate; simple tool and procedure for laying out internal locations; and an alinement device for precision butt fitting. Abstracts included in section 4 are on a continuous feed milling fixture; vertical milling head adapter; collet adapter for Cincinnati dividing head; and a pneumatic machining fixture which extends drill travel. All the tools are believed to be useful and practical. 1968. 9 pp. CFSTI $0.20.

To order Clearinghouse reports (numbers AD, LA, PB, or N) and patents, list nu Reader Service Cards.

TECH BRIEF 68–10239—MANUAL OF INDUSTRIAL DIAMONDS PLUS DRESSING AND GRINDING CRITERIA FOR MACHINING SUPERALLOYS

Because there is no single source of information available about the selection and best use of diamond wheels, NASA has prepared and published a compendium of currently available information. The manual is accurate, extensive, and written for use by the machine shop. It covers every normal and many exceptional uses of the diamond wheel in shop production. Machine shops may find this publication extremely useful.

For additional information, circle Key No. 26 on Reader Service Card.

METHODS OF TREATMENT OF COMPLEX SURFACES ON METAL CUTTING MACHINES (CHAPTERS 1 AND 12) (AD–670 945)

This study of the best use of equipment in forming complex surfaces may be helpful to engineers concerned with machining and machine shops engaged in complex profile work. Attention is given to the formation of complicated surfaces and the analysis of motion that must be executed in the machine tools to produce such surfaces. Of particular interest are the methods by which both general purpose and special profiling lathes can be used for finishing such surfaces. The author has organized his material for easy adaptation into automated or mechanically controlled shop systems.

MACHINE T SP–5910(02

All of the by NASA and are believed to of 16 abstract to crimp stai sleeves, espec or peeling the with an adju countersunk parts and rew be applied to Included also machining ra gage plates to movement of sembly; hold and which qu a tensile testi

This collec that facilitate hydrogen ins pneumatic lif control in lif parator so tha an optical sco permits a lar to be drilled The last thre collet which requiring a ti out flexing s covered stabi file to be pla small extensi savings in tin close to shoul counterbores.

63

dirt gets into it

dust gets into it

metal particles get into it

64

When dirt, dust and metal particles get into the motor oil, should it be changed?

- ☐ maybe
- ☐ yes
- ☐ no

19341

64

yes

65

If oil is weak or dirty, what should be done to it? _____

19342

65

It should be changed.

66

When gasoline is burned in the combustion chamber, it forms water on the cylinder walls.

This water gets into the oil and forms acids that rust and corrode engine parts.

Acids:

- ☐ harm engine parts
- ☐ help engine parts

66

harm engine parts

67

A mechanic starts taking apart an engine.

He sees that some parts are rusted and corroded.

Therefore, he knows that the motor oil has been mixed with:

- ☐ unburned gasoline
- ☐ water

19344

67

water

68

When water mixes with oil, engine parts will rust and corrode because:

- ☐ acids were formed
- ☐ oil increases rust
- ☐ water cooled the engine

19345

68

acids were formed

69

MATCH the following:

A. form(s) acids

B. make(s) the oil dirty

C. make(s) the oil weaker

D. make(s) the oil stronger

1. _____ dust, carbon, bits of metal

2. _____ water

3. _____ unburned gasoline

19346

69

1. B

2. A

3. C

70

When water, dirt and oil get all churned up, they make a creamy, black "goo" that is called SLUDGE.

Besides sludge, what else does water cause in the oil?

_____

19347

70

water causes acids to form

71

Sludge and acids are caused by:

- ☐ oil in the crankcase
- ☐ water in the crankcase

19348

71

water in the crankcase

72

The creamy, black "goo" that forms in the crankcase is called:

- ☐ acid
- ☐ sludge
- ☐ varnish

What causes this "goo" to form? _____

72

sludge

water

73

When an automobile is driven at high speeds, the engine may get so hot that some oil is burned.

This burned oil forms a sticky gum called varnish that coats engine parts and clogs oil passages.

Varnish:

- ☐ harms engine parts
- ☐ helps engine parts

19350

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TECH BRIEF 68–10239—MANUAL OF INDUSTRIAL DIAMONDS PLUS DRESSING AND GRINDING CRITERIA FOR MACHINING SUPERALLOYS

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MACHINE TOOLS AND FIXTURES (NASA SP–5910(02))

All of the machine tools and fixtures developed by NASA and its contractors described in this report are believed to be useful and practical. This selection of 16 abstracts consists of a lathe staking tool used to crimp stainless steel over inserted bearings or sleeves, especially in limited space, without galling or peeling the staked metal; an offset countersinker with an adjustable stop which allows holes to be countersunk with precision, eliminating scrapped parts and rework; and a titanium router which can be applied to stainless steel and other materials. Included also are various fixtures that increase machining radii; permit multiple milling; allow thin gage plates to be held without embossing; arrest the movement of miniature bearing balls during assembly; hold recorder stylus heads for machining; and which quickly adapt a standard brake press into a tensile testing machine.

This collection also includes a mechanical seal that facilitates the proof pressure testing of liquid hydrogen insulation honeycomb test coupons; a pneumatic lifting device that permits accuracy and control in lifting the spindle of a gage block comparator so that only one reading need be taken; and an optical scope mounted on an SIP jig borer which permits a large number of accurately spaced holes to be drilled in printed circuit boards, and the like. The last three of the 16 abstracts include a nylon collet which can be used in almost any application requiring a tight grip on a small diameter rod without flexing splits; an extension shaft and plastic covered stabilizing handle which permits a rotary file to be placed wherever filing is required; and a small extension collet which has realized sizable savings in time and material in drilling small holes close to shoulder trunions or in the bottom of deep counterbores. 1968. 11 pp. CFSTI $0.20.

73

harms engine parts

74

Varnish is formed when:

- ☐ gasoline is burned
- ☐ oil is burned

19351

74

oil is burned

75

Oil keeps engine parts free of acids, dirt, and sludge.

In this way, oil helps to: (CHECK ONE)

- ☐ clean engine parts
- ☐ cool engine parts

75

clean engine parts

76

Piston rings and connecting rod bearings are examples of parts that are lubricated by _____ _____ .

19353

AUTO MECHANICS COURSE

POST-TEST BOOK 17: FUNCTIONS OF LUBRICATING OIL

A BASIC SYSTEMS PROGRAM

19355

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1-3

MATCH the following:

A. dust, carbon and bits of metal
B. unburned gasoline
C. water

1. _____ form(s) acids in the motor oil
2. _____ forms(s) sludge in the motor oil
3. _____ make(s) the oil weaker

4

If you ran a car's engine without motor oil:

- ☐ the engine would burn out
- ☐ the engine would run better
- ☐ the engine parts would never burn out

5

When motor oil gets between close-fitting moving parts:

- ☐ the parts will slide and move easily
- ☐ the engine gets so hot that it stops running
- ☐ the parts will stick together

19356

6

Engine parts are lubricated by _____ _____.

7

Spaces between moving engine parts are sealed by a thin coat of _____ _____.

8

When large amounts of sludge, acids and water get into the motor oil, the motor oil should be _____.

9

When two moving parts are oiled and slide easily, we say that the parts are _____.

10

What does motor oil do to the heat made by moving parts?

_____

VT 013 140
Auto Mechanics Course. Book 18: Engine Lubricating System.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 133p.

DESCRIPTORS - *TRADE AND INDUSTRIAL

EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; *LUBRICANTS; ENGINES; MECHANICS (PROCESS)
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the engine lubricating system was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 140

ED0 56238

BOOK **18**

To Be Used With
PANEL BOOK 18

AUTO MECHANICS COURSE

BOOK 18: ENGINE LUBRICATING SYSTEM

A BASIC SYSTEMS PROGRAM

VT013140

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EDUCATION & WELFARE
OFFICE OF EDUCATION
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Curriculum Report Reference
Page 16

Task Analysis Reference
42.1, 42.2

19359

AUTO MECHANICS COURSE

BOOK 18: ENGINE LUBRICATING SYSTEM

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19360

WHAT ABOUT MACHINE TOOL CHATTER?

American machine designers and tool machine operators have argued chatter from time to time, but there has not been any really firm work done about the problem, even to seeing whether it is a problem. Recently some German machine designers have taken a critical look at machine chatter. Five of their reports, plus a report of a similar but independent investigation of the same problem in England, are available to you. Machine tool shops, machine designers, and production machine shops will find material of interest, of use, and of value in these studies. Theoretical as these reports are, the results can point toward better work from your tool machines.

CHATTER BEHAVIOR OF HEAVY MACHINE TOOLS (AD–671 541)

The chatter behavior of a medium-sized vertical milling machine has been subjected to detailed investigation after careful preliminary research into the validity and reproducibility of the measured data concerning the machine. The first important result showed that the static and dynamic behavior of the machine cannot be accurately expressed in terms of medium values. Electromagnetic excitation was used for taking dynamic values at the spindle. This report relates the results of dynamic tests, and in particular demonstrates that dynamic behavior is seriously influenced by plate vibrations. Measurements of damping coefficients are discussed, together with the possibility of damping techniques.

CHATTER BEHAVIOR OF HEAVY MACHINE TOOLS (AD–671 542)

Continuing the investigations of the previous report (AD–671 541), a digital computer program is described that will allow exact analysis of the stability of the cutting process on the vertical milling machine. This technique applies six degrees of freedom in accounting for the coupling between vibration modes and cutting stiffness. Inde the program, tests on another mill proved the influence of machine posit critical depth of cut. This data was fed computed program to reduce the calcu tional determinations were made of natural frequencies, and mode shapes.

EFFECT AND CONTROL OF VIBRATIONS IN MACHINE TO ESSES (AD–671 543)

Having shown that a vertical milling systematic errors in frequency-respo ments caused by power and cross-powe report looks into the errors from e signals as they are introduced into the setup. It also examines the ways in w measurements can be used to compute responses. Improvements in wave-on operations are shown as strongly dep phase angle between the two contour and its resultant frequency response.

EFFECT AND CONTROL OF VIBRATIONS IN MACHINE TO ESSES (AD–671 544)

Continuing the studies on the vertic chine, this report covers the evaluatio mic test results. Compliance frequenc two degrees of freedom) are determin ing conditions for the machine. The developed random noise theory is ap variety of milling conditions, static feeds. The results are discussed in th which deal with the interdependence force components.

EFFECT AND CONTROL OF VIBRATIONS IN MACHINE TO ESSES (AD–671 549)

The previous four reports provide all the needed ingredients for a "cl

AUTO MECHANICS COURSE

PRE-TEST BOOK 18: ENGINE LUBRICATING SYSTEM

A BASIC SYSTEMS PROGRAM

19361

1-3

Three uses of the oil in an engine are:

1. _____

2. _____

3. _____

4

In the lubricating system, the oil enters the filter (☐ after ☐ before) it goes through the pump.

5

The lower part of the oil pan is called the _____ .

6

The part that controls the flow of oil in the lubrication system is the
p_____ r_____ v_____ .

7

Which of the following describes the correct way oil flows?

- ☐ main bearing to main line to connecting rod bearing
- ☐ connecting rod bearing to main bearing to mainline
- ☐ main line to main bearing to connecting line bearing

8

Oil from the spit hole lubricates the:

- ☐ oil pan
- ☐ piston
- ☐ walls of the cylinder

9

Which engine parts are lubricated by oil from the rocker shaft? (CHECK ALL CORRECT ANSWERS)

- ☐ the push rod
- ☐ the rocker arm
- ☐ the valve guide
- ☐ the valve lifter

Name _____

Date _____

Starting time _____

Finishing time _____

19364

1

PREVIEW

This section will teach you how oil flows through the engine lubrication system and what the oil does inside the engine.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

19365

1

NO ANSWER NEEDED

2

Oil does many important things inside an engine.

Oil carries dirt, dust and sludge to the crankcase.

One use of oil is to:

- ☐ clean engine parts
- ☐ make engine parts stick together

19366

2

clean engine parts

3

In addition to keeping engine parts clean, oil carries heat away from hot spots and keeps moving parts from sticking together.

CHECK the things oil does in the engine:

- ☐ cleans parts
- ☐ cools hot spots
- ☐ provides fuel
- ☐ lubricates parts

19367

3

cleans parts

cools hot spots

lubricates parts

4

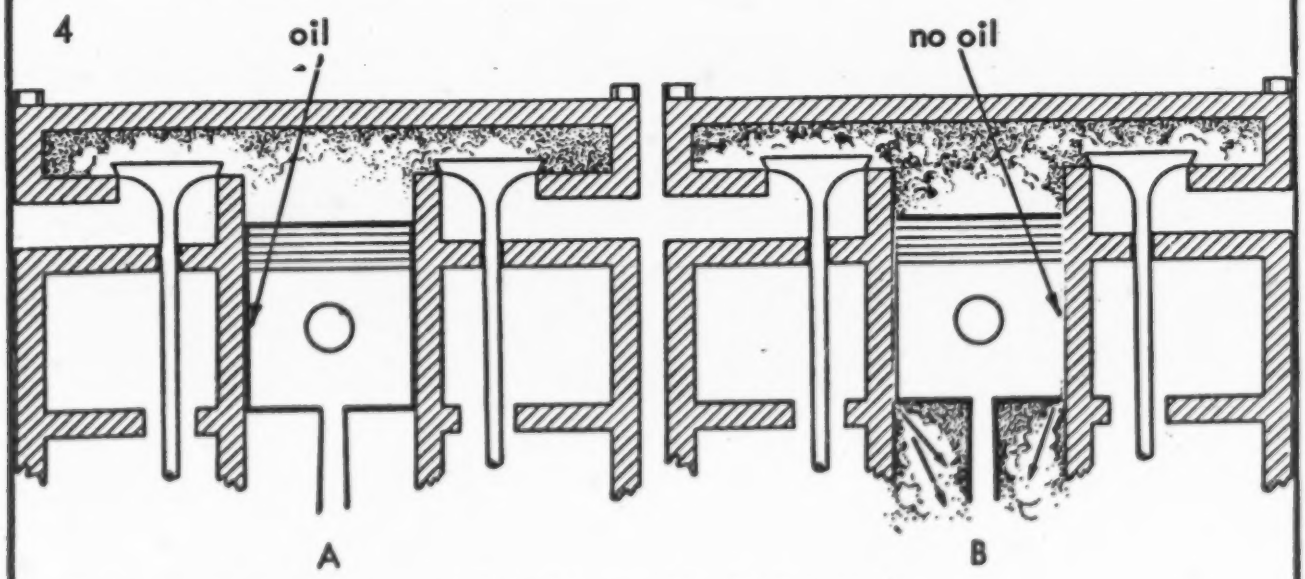

By forming a seal between the piston and cylinder walls, oil prevents exhaust gases from escaping from the combustion chamber.

Which picture above shows exhaust gases escaping?

- ☐ picture A
- ☐ picture B

What is used to prevent this? _____

19368

4

picture B

oil

5

Oil works hard in a car. The oil between the piston and cylinder walls keeps hot gases in.

In this way, oil acts as a:

- ☐ coolant
- ☐ lubricant
- ☐ seal

Oil also carries heat away from the engine.

By doing this, it keeps the engine:

- ☐ clean
- ☐ cool
- ☐ tight

19369

5

seal

cool

6

Oil in the engine: (CHECK ALL CORRECT ANSWERS)

- ☐ cleans
- ☐ cools
- ☐ lubricates
- ☐ seals

Oil does:

- ☐ different jobs in the engine
- ☐ only one job in the engine

19370

HINE TOOL

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tion modes and cutting stiffness. Independently of the program, tests on another milling machine proved the influence of machine position upon the critical depth of cut. This data was fed back into the computed program to reduce the calculations. Additional determinations were made of response loci, natural frequencies, and mode shapes.

EFFECT AND CONTROL OF CHATTER VIBRATIONS IN MACHINE TOOL PROCESSES (AD–671 543)

Having shown that a vertical milling machine has systematic errors in frequency-response measurements caused by power and cross-power spectra, this report looks into the errors from external noise signals as they are introduced into the measurement setup. It also examines the ways in which resulting measurements can be used to compute subfrequency responses. Improvements in wave-on-wave cutting operations are shown as strongly dependent on the phase angle between the two contours of the chip and its resultant frequency response.

EFFECT AND CONTROL OF CHATTER VIBRATIONS IN MACHINE TOOL PROCESSES (AD–671 544)

Continuing the studies on the vertical milling machine, this report covers the evaluation of the dynamic test results. Compliance frequencies (given for two degrees of freedom) are determined from working conditions for the machine. Then the already-developed random noise theory is applied under a variety of milling conditions, static preloads, and feeds. The results are discussed in theoretical terms which deal with the interdependence of the cutting force components.

EFFECT AND CONTROL OF CHATTER VIBRATIONS IN MACHINE TOOL PROCESSES (AD–671 549)

The previous four reports provide the reader with all the needed ingredients for a "classical" mathematical model of the medium-sized vertical milling machine whose performance has been measured with extreme accuracy over the normal mode of excitation. This report explains how the information can be transferred into the operation of another milling machine of similar design, synthesizing the mobility transfer functions for four pairs of positions. Measurements on the second mill are made by exciter and pickup devices and show fair correlation. This could be unusual considering the irregularities that may be expected between any two milling machines that have seen regular use.

The previous five reports are heavily theoretical but do point strongly to improved machine tool performance through the understanding and control of only a few conditions of the working environment. In addition to these reports, which were prepared in Germany using precision German milling machines, there is a more practical study done in England dealing with lathes.

CHATTER ANALYSIS OF MEDIUM-SIZE MACHINE TOOLS. VOLUME I. PRIMARY CHATTER OF LATHE TOOLS (AD–671 551)

This study begins with a standard work process, an orthogonal cut, which is considered without reference to chatter, regenerative effect, or mode coupling. With single-pass cutting, allowing the tool 1 degree of freedom, measurable instability occurred wherein chip thickness exceeded the critical depth of the cut. Then these measured conditions were used to establish a damping capacity and to control the directional variation of tool flexibility. Control over the total cutting force, as it applied to the direction of flexibility, was then easily determined and the results plotted. Plots of the work are given in terms of cutting energy, cutting speed, and the depth of the cut.

6

cleans

cools

lubricates

seals

different jobs in the engine

7

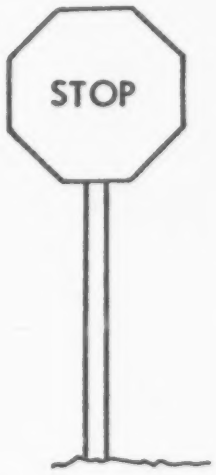

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

19371

7

NO ANSWER NEEDED

8

LOOK AT PANEL 1

The panel shows a lubrication system.

This system carries oil to the parts that:

- ☐ do not move and do not need lubrication
- ☐ move and need lubrication

19372

8

move and need lubrication

9

LOOK AT PANEL 1

The arrows show that oil:

- ☐ flows around in the engine
- ☐ stays in the bottom of the engine

19373

9

flows around in the engine

10

LOOK AT PANEL 1

Let's follow the path of the oil as it flows around the engine.

Oil starts out in the OIL PAN which is:

- ☐ at the top of the engine
- ☐ in the bottom of the engine

19874

10

in the bottom of the engine

11

LOOK AT PANEL 1

From the oil pan, oil goes first to the OIL INTAKE.

The oil intake:

- ☐ puts oil into the oil pan
- ☐ takes oil out of the oil pan
- ☐ takes oil out of the pump

19375

11

takes oil out of the oil pan

12

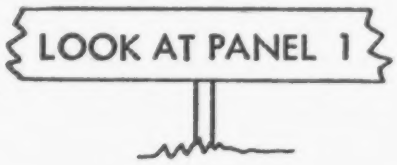

From the oil pan, the oil goes through the oil intake to the PUMP which:

- ☐ drains the oil out of the system
- ☐ pushes the oil around in the system
- ☐ takes the oil back to the oil pan

19376

12

pushes the oil around in the system

13

LOOK AT PANEL 1

The part of the lubrication system that pushes the oil around the engine is called the _____.

19377

13

pump

14

LOOK AT PANEL 1

The oil enters the FILTER to be cleaned right after it leaves the:

- ☐ oil intake
- ☐ oil pan
- ☐ pump

19378

14

pump

15

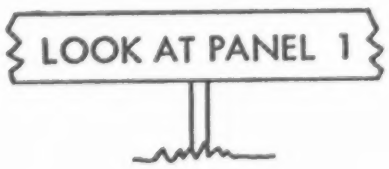

The filter squirts the clean oil into the LINES.

The oil lines carry the oil to the c_____ and the c_____.

19379

15

crankshaft

camshaft

16

LOOK AT PANEL 1

Oil flows from the filter to the crankshaft and camshaft by going through the _____ _____.

19380

What Does It Point To?

Possibly to greatly improved machine tools, and even more possibly to greatly improved tool operating conditions. The machine tool designer should have the entire package.

DETERMINATION AND ANALYSIS OF MACHINING COSTS AND PRODUCTION RATES USING COMPUTER TECHNIQUES (AD–675 340)

All metalworking companies will find this report by the Air Force Machinability Data Center, Cincinnati, Ohio, of interest and use. It presents equations for determining the cost per piece and production rate for machining operations such as turning, milling, drilling, reaming, and tapping. These equations require tool life data for the actual machining conditions to be used. A Fortran program for an IBM 1130 has been written to calculate and printout the cost per piece and the production rate for these operations. A detailed cost breakdown also is printed out to facilitate analysis of the total cost per piece. In addition, equations are developed for calculating the optimum cutting speeds and tool life corresponding to minimum costs and maximum production assuming that the tool life cutting speed follows the simplified Taylor equation. The optimized equations enable one to interpolate and extrapolate the cost and production determinations.

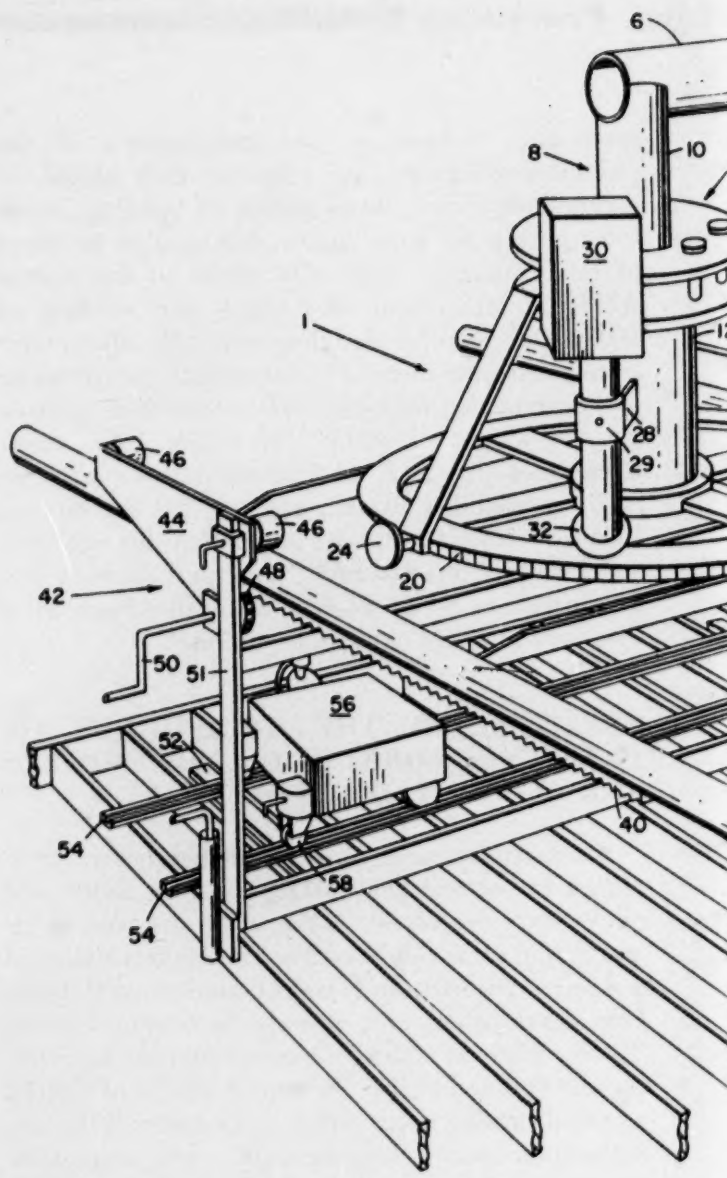

PLATE CUTTING APPARATUS (PAT. NO. 3,388,902)

This improved plate cutting apparatus has a high degree of versatility, adjustability, durability, and precision as compared to conventional devices. The cutting head can be easily positioned for cutting along straight and/or circular lines. The support structure for the cutter head may be rotated through 360°, and the head may be additionally moved in several different directions. The cutting machine is adapted for rolling along a track wherein the machine may be set for automatic operation and may be remotely controlled. The cutting apparatus also allows a number of cutting heads and machines

16

oil lines

17

The oil lines carry oil to different engine parts where the oil does which of the following jobs? (CHECK ALL CORRECT ANSWERS)

- ☐ cleans the parts
- ☐ cools hot spots
- ☐ provides fuel
- ☐ lubricates the parts

19381

17

cleans the parts

cools hot spots

lubricates the parts

18

After the oil has cooled, cleaned and lubricated the engine, it drips back into the oil pan. Then the trip starts all over again.

The next part of the program will tell you about some of the jobs oil does and the places it goes along the way.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

19382

274 OF 327

ED

056 238

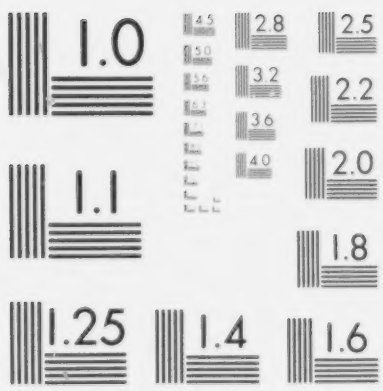

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

18

NO ANSWER NEEDED

19

The oil pan is at the:

- ☐ bottom of the engine
- ☐ top of the engine

19383

19

bottom of the engine

20

Some oil moves around in the engine. The rest of the oil is at the bottom of the engine in the o_____ p_____.

19384

20

oil pan

21

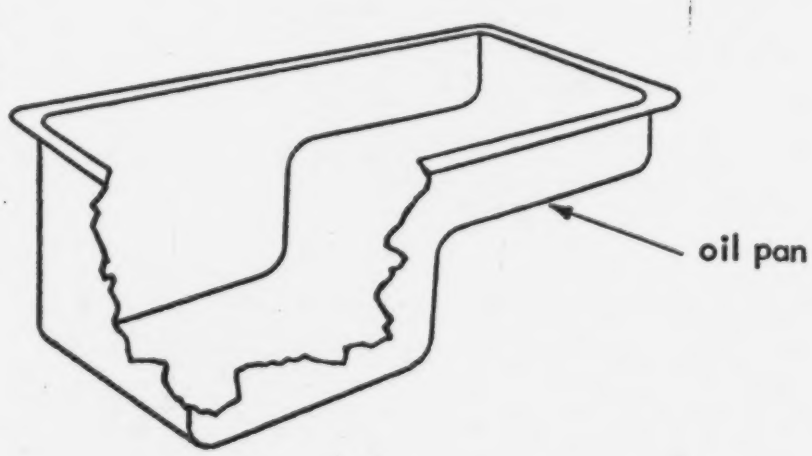

The picture above shows a side view of the oil pan.

The bottom of the oil pan has:

- ☐ one level
- ☐ two levels
- ☐ three levels

19385

21

two levels

22

The lower level of the oil pan holds oil that is not moving through the engine.

In the picture below, DRAW an arrow to the level holding the oil that is not moving through the engine:

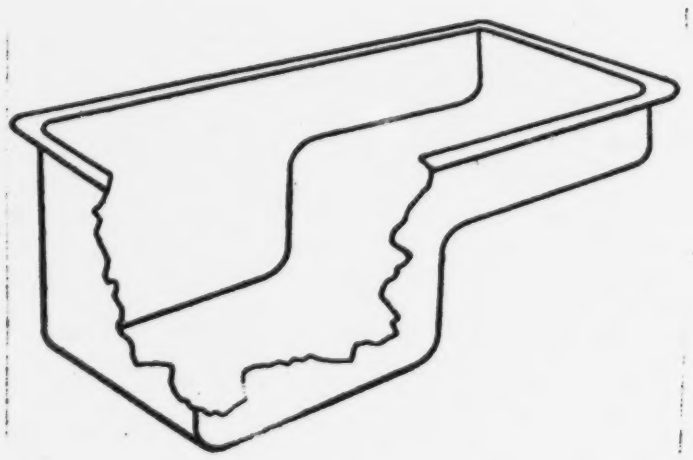

19386

22

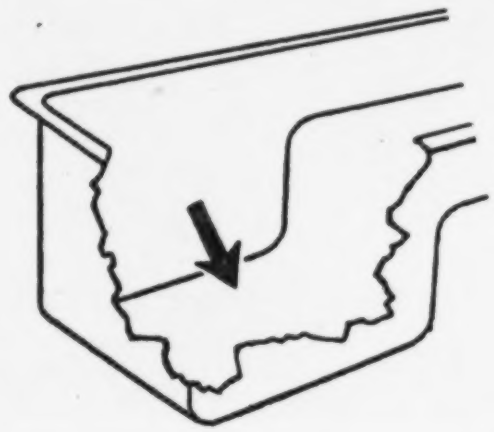

23

The lower level of the oil pan is called the SUMP.

The sump holds oil that is:

- ☐ moving through the engine
- ☐ not moving through the engine

19387

23

not moving through the engine

24

At the bottom of the sump is a plug called the drain plug.

In the blanks below, WRITE the letter of the arrow that points to the part:

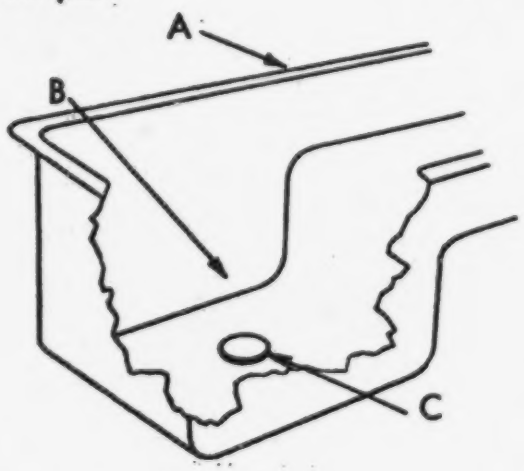

1. _____ drain plug

2. _____ sump

19388

24

1. C

2. B

25

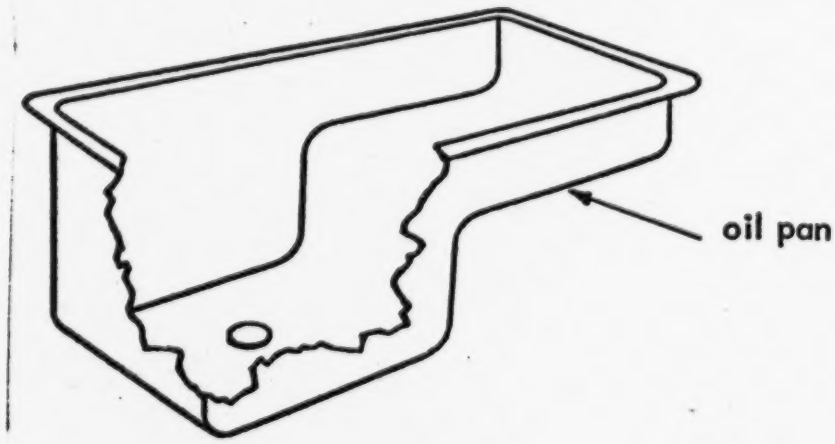

The drain plug is at the bottom of the s _____.

19389

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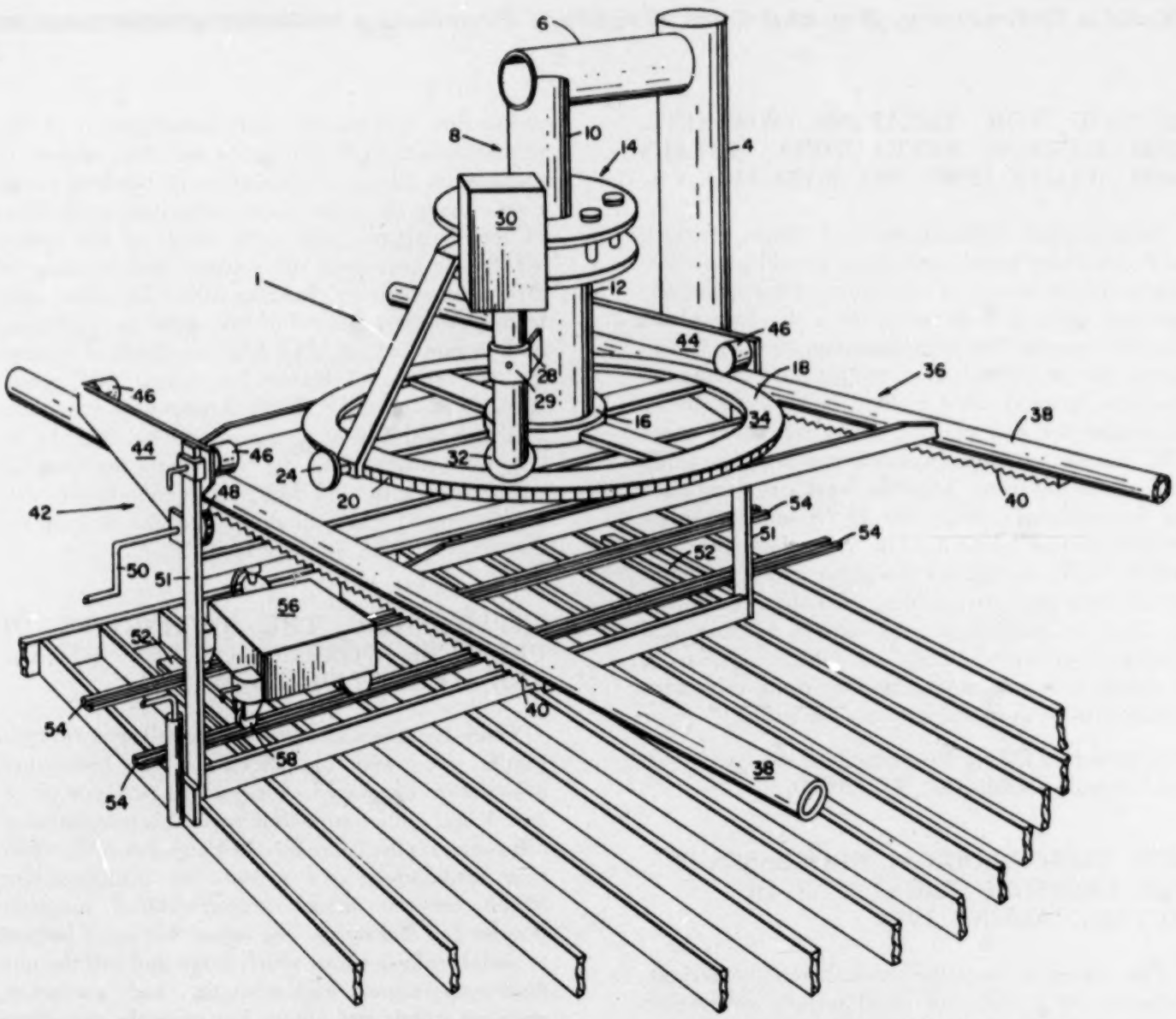

cutting head can be easily positioned for cutting along straight and/or circular lines. The support structure for the cutter head may be rotated through 360°, and the head may be additionally moved in several different directions. The cutting machine is adapted for rolling along a track wherein the machine may be set for automatic operation and may be remotely controlled. The cutting apparatus also allows a number of cutting heads and machines to be used interchangeably with it. Any factory, shop, depot, or metal supplier faced with a requirement for exact cutting of metal plates may find this device quite helpful. It can cut other structures such as thrust and adapter rings, and motor heads for missile and rocket assemblies.

Administering Officer: Department of the Army, Office of the Judge Advocate General, Chief, Patents Division, Washington, D.C. 21315.

25

sump

26

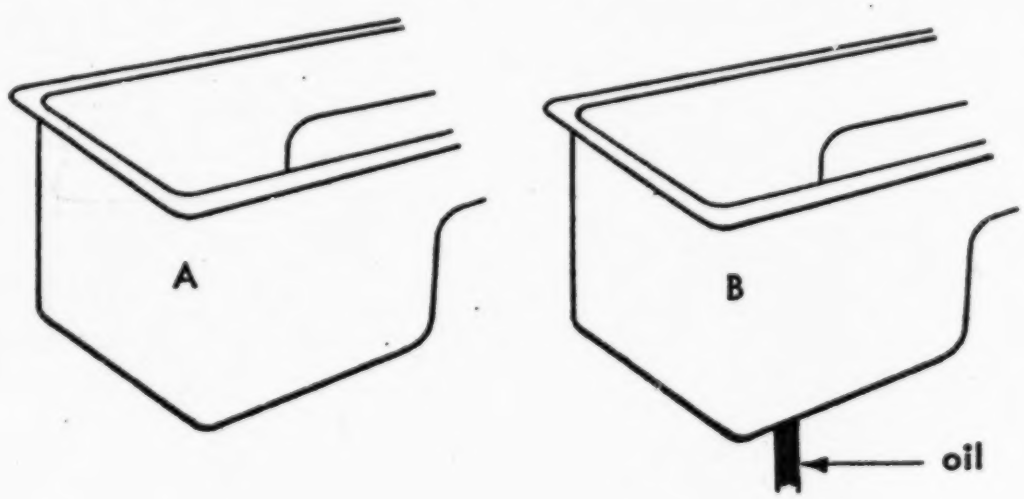

To drain oil from the pan, the drain plug is opened.

In which picture above is the drain plug open?

- ☐ picture A
- ☐ picture B

19390

26

picture B

27

To remove oil from the oil pan, you must open the d_____ P_____.

19391

27

drain plug

28

In most oil pans, a steel plate is welded to the bottom. This plate prevents oil from splashing around in the sump.

In the picture below, CIRCLE the part that stops oil from splashing:

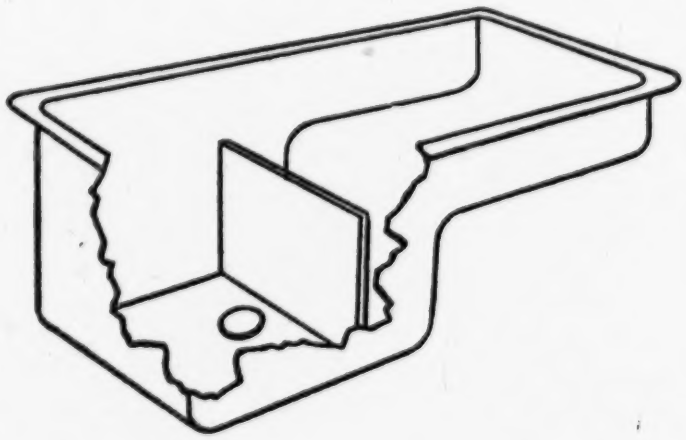

19392

28

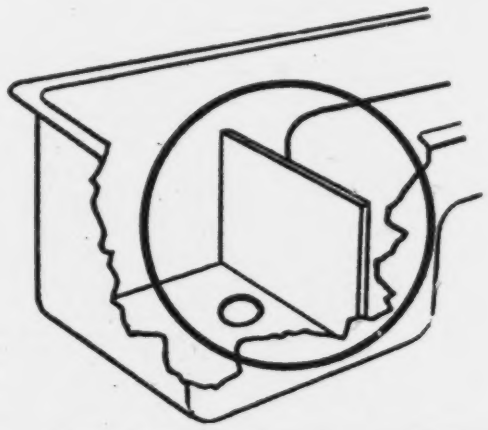

29

The steel plate in the oil pan is called the BAFFLE.

The baffle:

- ☐ keeps oil from splashing around in the oil pan
- ☐ lets oil drain out of the sump
- ☐ splashes the oil around in the oil pan

19393

29

keeps oil from splashing around in the oil pan

30

If oil is allowed to splash around, it will foam up. To prevent this, oil pans have:

- ☐ baffles
- ☐ sumps

30

baffles

31

The sump, baffle and drain plug are all parts of the:

- ☐ oil pan
- ☐ oil pump

19395

31

oil pan

32

MATCH the following:

A. baffle
B. drain plug
C. main lines
D. sump

1. _____ hold(s) oil not in use
2. _____ is/are opened to let oil flow out
3. _____ prevent(s) oil from splashing and foaming

19396

32

1. D
2. B
3. A

33

The lower part of the oil pan is called the:

- ☐ baffle
- ☐ drain plug
- ☐ sump

19397

33

sump

34

Which of the following is welded to the oil pan to prevent oil from splashing and foaming?

- ☐ the baffle
- ☐ the drain plug
- ☐ the sump

19398

34

the baffle

35

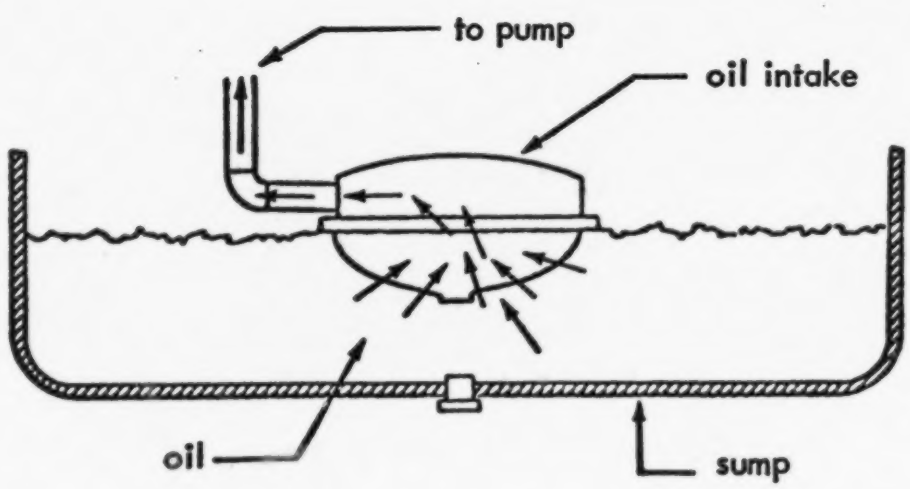

The oil INTAKE takes oil:

- ☐ from the pump to the sump
- ☐ from the sump to the pump

METHOD FOR TREATING, WORKING, AND BONDING REFRACTORY METALS AND ALLOYS (PAT. NO. 3,416,342)

Metallurgical laboratories and shops working with refractory metals and alloys should give attention to this technique of cold working the refractory material while it is embedded in a titanium/nickel (Ti/Ni) matrix. The processing temperature is held above the recrystallization temperature of the refractory material. This method not only improves the processing and working of the refractory materials, but also provides an effective means of bonding and protecting them. After the work has been done on the refractory piece, the Ti/Ni matrix can be melted away at 1,310° C. The molten matrix leaves a thin Ti/Ni coating on the piece which serves as an excellent protective coating. This procedure may be used in forming a wide variety of sizes and shapes of refractory metals, *e.g.* tubing rods, strips, et cetera. It is also used in cold working refractory metals directly from the arc cast condition.

Administering Office: Department of the Navy, Patent Counsel, Washington, D.C. 20360.

NEW TECHNOLOGICAL PROCESSES IN THE PRESSURE TREATMENT OF METALS (AD–673 197)

This report is an edited translation by Wright-Patterson AFB, Ohio, of developments undertaken by the Aviation Technological Institute, Moscow. Some of the subjects covered are: the distribution of metallic mobility rates, deformation, and stresses along a billet cross section in rolling of aluminum alloys; the problem of anoxidative heating of billets in a protective atmosphere with lithium vapors; preparation of bimetallic rods and wires from aluminum alloys; the possibility of utilizing sodium stearate and its substitutes as technological lubricants in the extrusion of light alloys; die casting of thin-walled parts from molten metal; development of production technology and investigation of the physico-mechanical properties of thin sheets of magnesium alloys; investigation of bonding conditions during the joint plastic deformation of alloys of the duralumin type with alloys of the system AlMg; improvement of contact spot welding of D16 alloy sheets by cladding with AMg alloy; electron-microscope method of investigating SAP using carbon replicas; cladding SAP; methods of increasing the weight of blanks for rolling SAP sheet; strength of clad SAP sheet; comparative evaluation of the weldability of clad and nonclad SAP by resistance welding methods; technology for spot and roller welding of clad SAP; structural changes during heating of SAP; the problem of the character of distribution of the oxide phase in SAP.

ESTABLISHING THE TECHNIQUES OF PRESSURE WORKING OF NEW METALS AND ALLOYS (AD–674 912)

Extensive research was conducted before techniques of hot and cold working of new metals and alloys were developed. A report on the type of research and some results of it are in this translation of a Russian report from Wright-Patterson AFB, Ohio. One development is a process for manufacturing 30–50 microns thick vacuum-sintered tungsten-powder foil and strips. The report will be of interest to metalworking shops which forge and roll the new high-temperature, high-strength, and corrosion-resistant metals and alloys. For example, the effects of force parameters; plasticity and its dependence on temperature, deformation rate, structural transformations, and stressed state; and the kinematics of change in shape are described.

METALLOGRAPHY AND METALS TESTING TECHNIQUES (NASA SP–5911(01))

This publication presents a selection of 14 innovations developed by NASA and its contractors.

35

from the sump to the pump

36

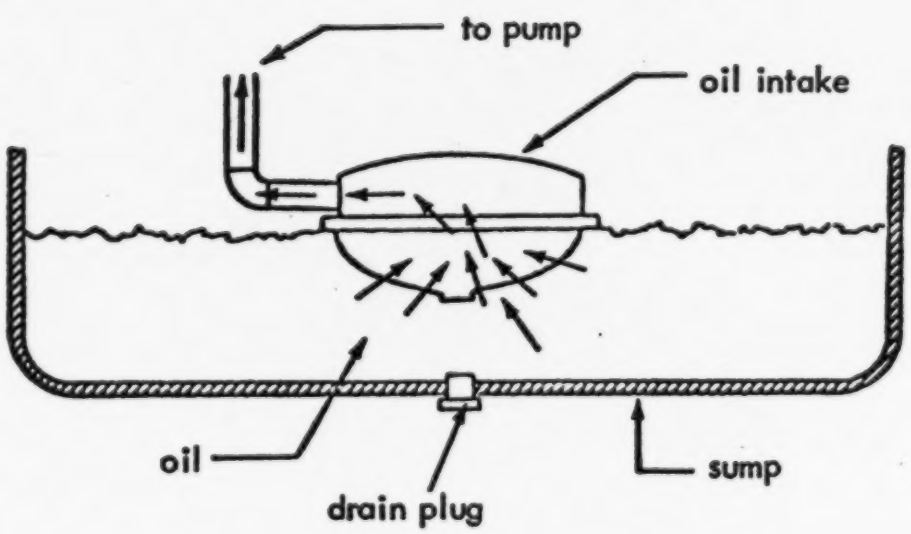

Which part draws up the oil from the sump? _____

19400

36

oil intake

37

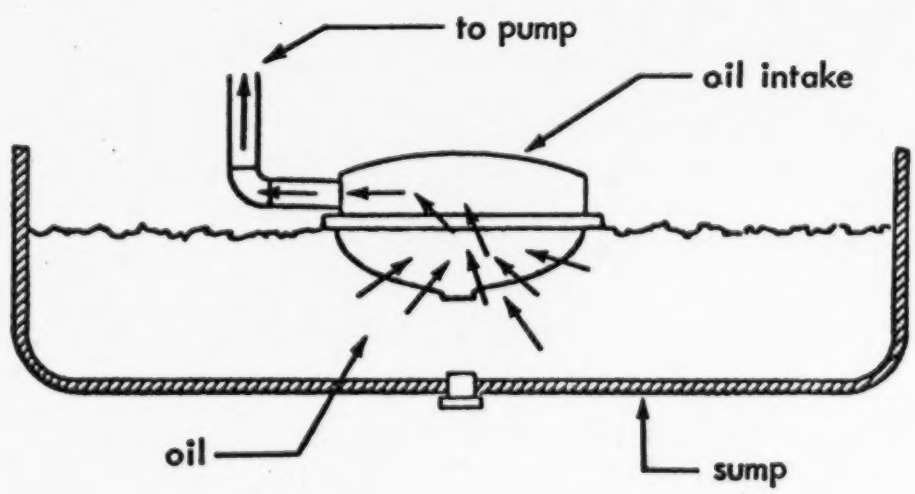

The picture shows that the oil intake:

- ☐ rests at the bottom of the sump
- ☐ floats on top of the oil
- ☐ is connected to the sump

19401

37

floats on top of the oil

38

Dirt, dust and bits of metal in the oil sink to the bottom of the sump.

This means that the cleanest oil is found at the:

- ☐ bottom of the sump
- ☐ top of the sump

19402

38

top of the sump

39

The oil intake floats on top of the oil.

It picks up the:

- ☐ clean oil
- ☐ dirty oil

19403

39

clean oil

40

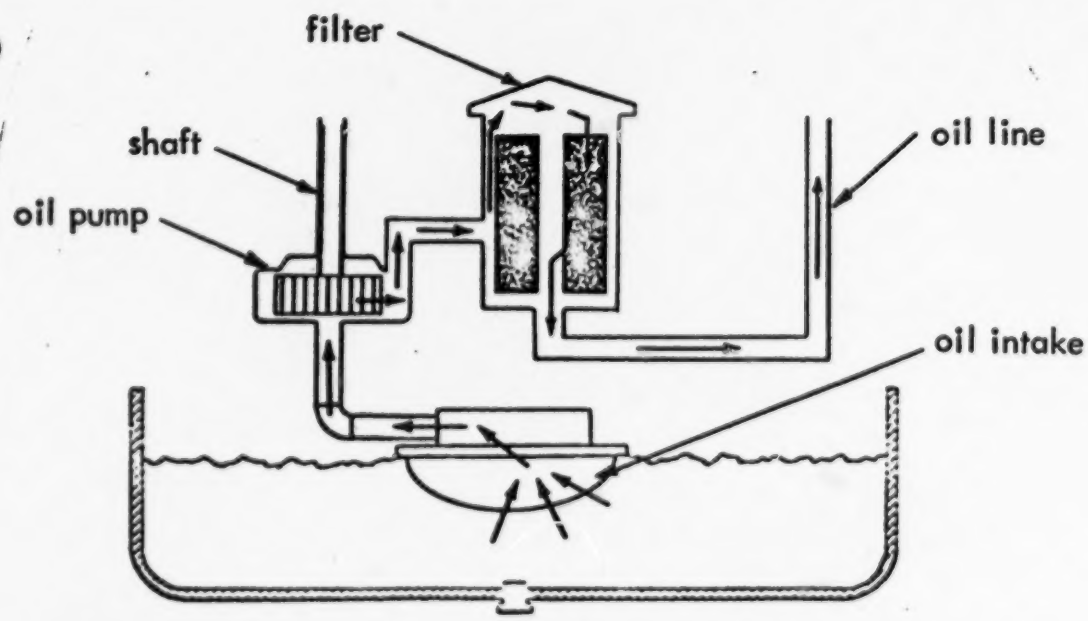

Before the oil gets to the oil pump, it goes through the:

- ☐ oil intake
- ☐ oil filter

19404

40

oil intake

41

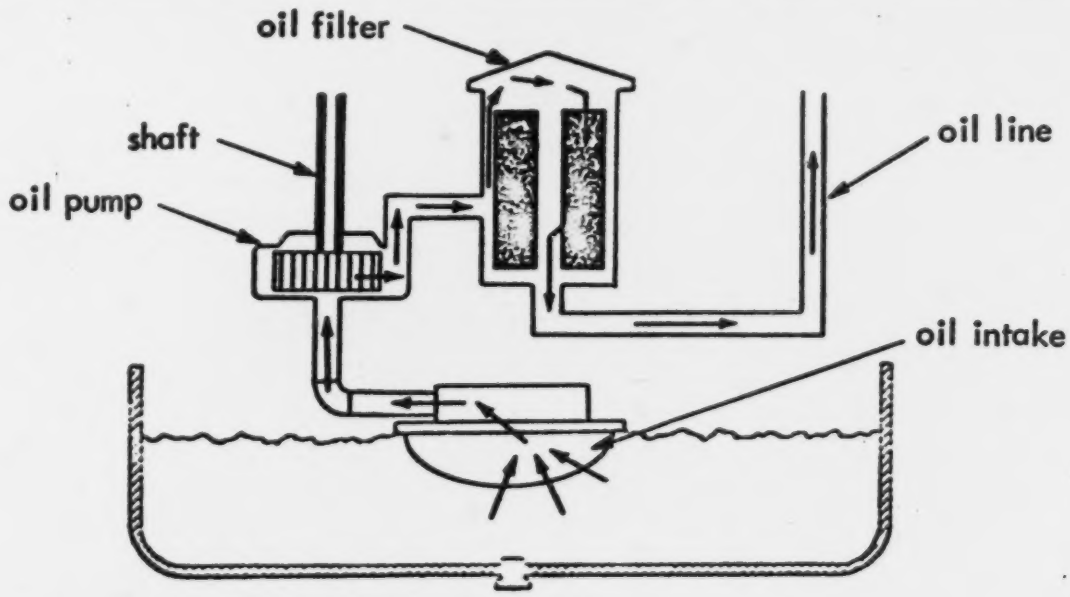

The oil is taken up by the oil intake.

Where does the oil intake send it?

- ☐ to the oil pump
- ☐ to the sump

19405

41

to the oil pump

42

The oil pump pumps oil to all the engine parts that need lubrication.

CIRCLE the part that gets oil to the engine parts where it is needed:

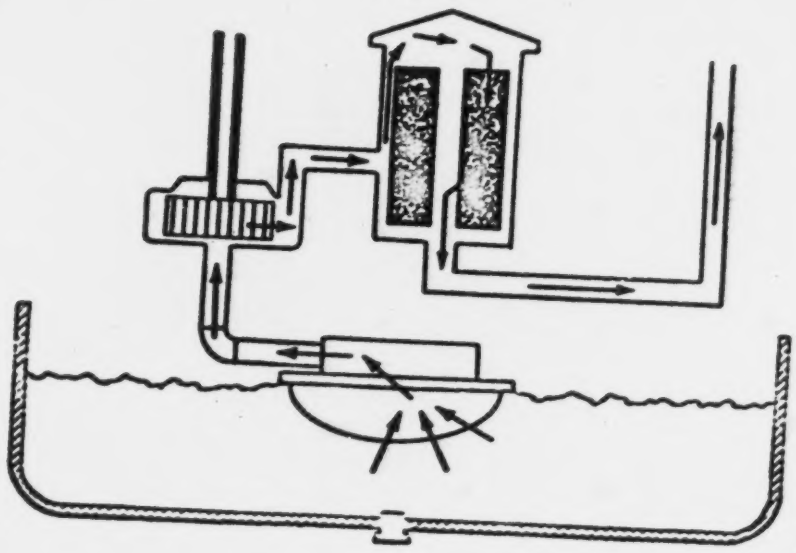

19406

42

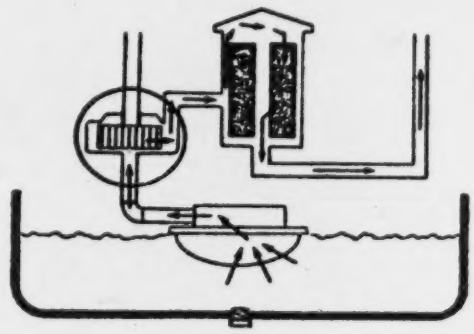

43

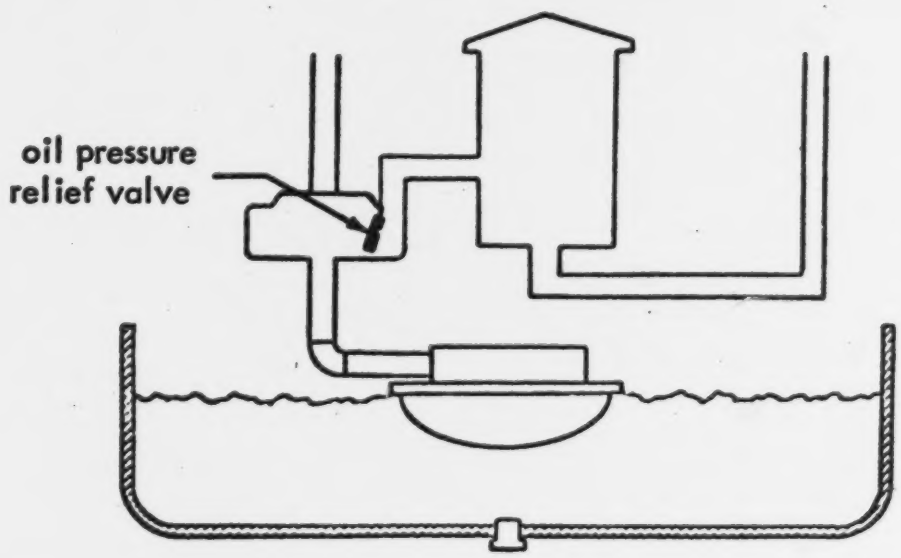

The OIL PRESSURE RELIEF VALVE is next to the:

- ☐ pump
- ☐ sump

19407

43

pump

44

The oil pressure relief valve includes a ball and a spring.

In the picture below, CIRCLE the oil pressure relief valve:

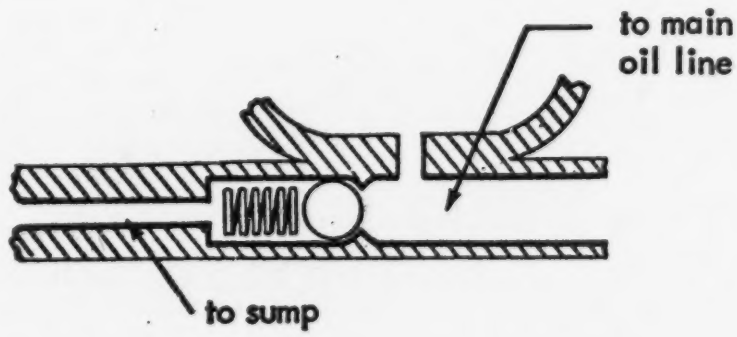

19408

44

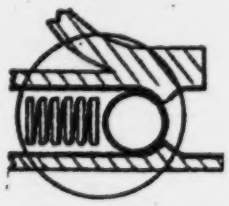

45

If the oil pressure is too high, the oil pressure relief valve opens and lets oil return to the sump.

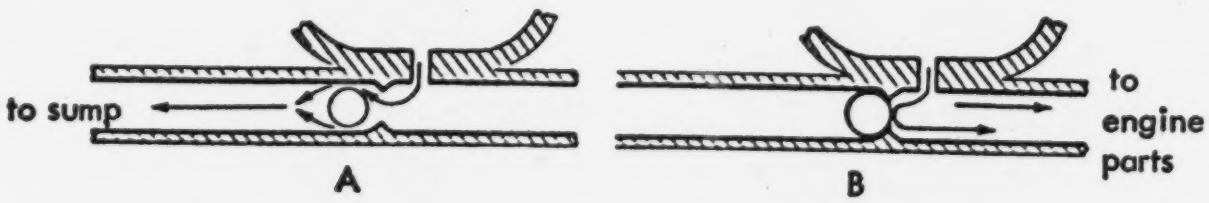

The oil pressure relief valve is open in picture:

- ☐ A
- ☐ B

19409

, WORKING, ORY METALS ,416,342)

l shops working should give atten- ing the refractory a titanium/nickel mperature is held rature of the re- ot only improves refractory mate- means of bonding rk has been done Ni matrix can be lten matrix leaves e which serves as is procedure may iety of sizes and ubing rods, strips, orking refractory ondition.

of the Navy, Pat- 360.

OCESSES IN NT OF

lation by Wright- ments undertaken institute, Moscow. the distribution of tion, and stresses lling of aluminum e heating of billets lithium vapors; wires from alumi- utilizing sodium ological lubricants die casting of thin- ; development of production technology and investigation of the physico-mechanical properties of thin sheets of magnesium alloys; investigation of bonding conditions during the joint plastic deformation of alloys of the duralumin type with alloys of the system AlMg; improvement of contact spot welding of D16 alloy sheets by cladding with AMg alloy; electron-microscope method of investigating SAP using carbon replicas; cladding SAP; methods of increasing the weight of blanks for rolling SAP sheet; strength of clad SAP sheet; comparative evaluation of the weldability of clad and nonclad SAP by resistance welding methods; technology for spot and roller welding of clad SAP; structural changes during heating of SAP; the problem of the character of distribution of the oxide phase in SAP.

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METALLOGRAPHY AND METALS TESTING TECHNIQUES (NASA SP–5911(01))

This publication presents a selection of 14 innovations developed by NASA and its contractors. The collection is offered in the hope that industrial concerns may find useful some of the implements and techniques described. Section 1, *Stress-Corrosion and Tensile Testing*, includes seven abstracts: a U-shaped frame for stress corrosion testing of metal samples which eliminates the nonuniform bonding characteristics of former wedge-type designs; and various fixtures which can be used on practically any bonded or brazed tensile testing machine that permits dumbbell specimens to be attached to pull rods and base plates of tensile testing machines. One on biaxially stressing metal tube specimens prior to performing stress corrosion tests on them; and to hold a tensile specimen of sheet material in a constant strained position while it undergoes stress-relaxation tests in a furnace. The collection also includes a device for conducting tensile tests under special environments, particularly potentially dangerous atmospheres; and a planimeter to measure the cross section reduction-of-area of a broken tensile specimen after tensile test.

Section 2 on *Metallography* includes seven abstracts covering a more reliable and less-time-consuming method to differentiate between microfissures and heavy grain boundaries in welded Inconel 718; techniques for preparing metallographic samples of tantalum and its alloys, tungsten and its alloys, vanadium alloys, Inconel X718 and X750, pyrolytic graphite foil, and for the 300 series stainless steel. 1968. 9 pp. CFSTI $0.20.

INCREASING THE TOUGHNESS OF AFC 77 BY CONTROL OF RETAINED AUSTENITE CONTENT, AUSFORMING, AND STRAIN AGING (AD–675 668)

Metallurgists and shops using martensitic stainless steel (AFC 77) may be interested in this report by Boeing Co., Renton, Wash. It describes the following three methods of improving toughness without loss of strength in the steel: (1) control of retained austenite content, (2) strain aging, and (3) ausforming. AFC 77 is subject to low fracture toughness in its highest strength conditions produced by tempering at 800° F. to 1,100° F.

45

A

46

When the oil pressure is normal, the oil pressure relief valve is closed and the oil flows to the engine parts.

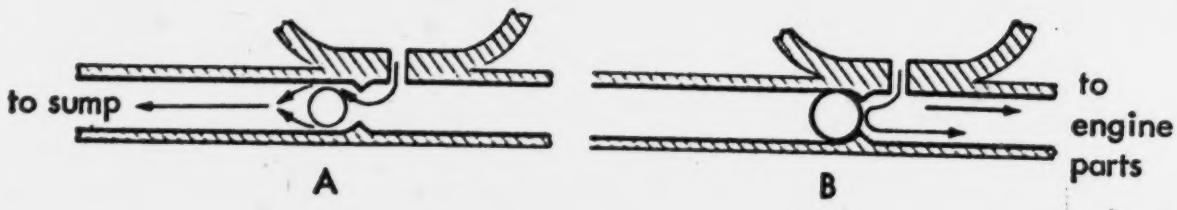

The oil pressure relief valve is closed in picture:

- ☐ A
- ☐ B

19410

46

B

47

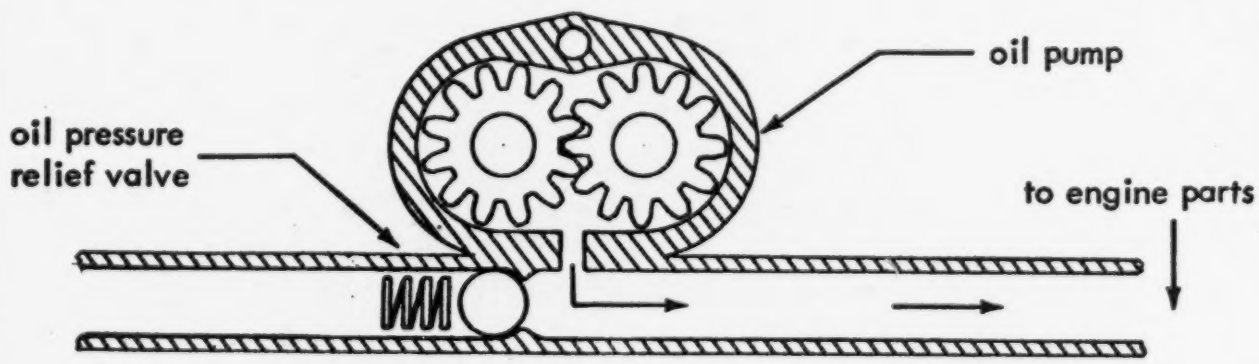

In the drawing, the oil pressure relief valve is:

- ☐ open
- ☐ closed

19411

47

closed

48

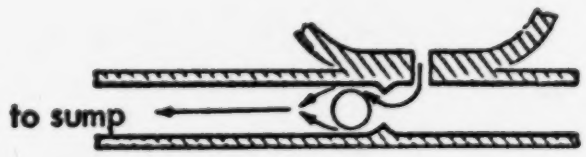

To control oil flow, the oil pressure relief valve lets the oil return to the sump when the valve is:

- ☐ closed
- ☐ open

19412

48

open

49

An oil pressure relief valve controls the flow of oil from the oil pump.

MATCH the following:

A. fuel pump

B. oil pump

C. oil pressure relief valve

1. _____ controls the flow of oil

2. _____ moves the oil

49

1. C

2. B

50

Oil is moved through the engine by the:

- ☐ oil pan
- ☐ oil pump

This oil is drawn up from the sump by the:

- ☐ oil filter
- ☐ oil intake

19414

50

oil pump

oil intake

51

Which part lets oil flow back to the sump?

- ☐ the oil intake
- ☐ the oil pump
- ☐ the oil pressure relief valve

19415

51

the oil pressure relief valve

52

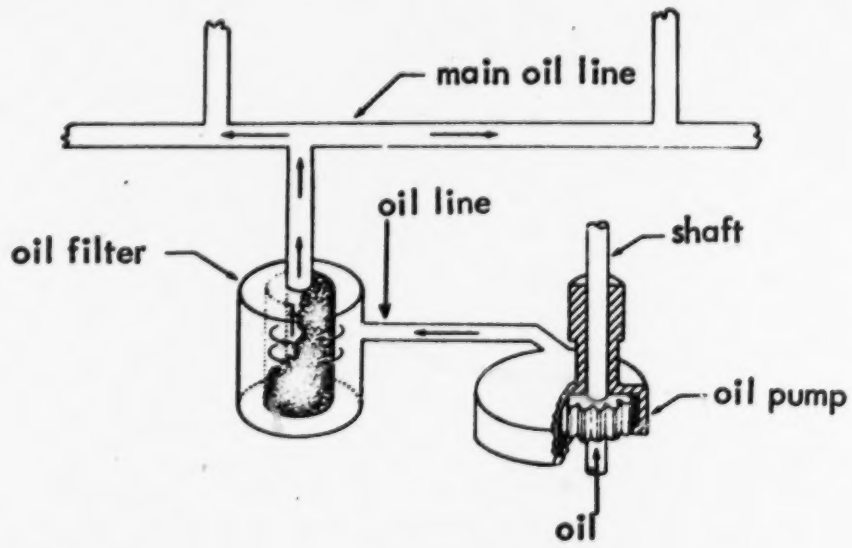

Oil flows from the pump to the FILTER through:

- ☐ an oil line
- ☐ the shaft
- ☐ the main oil line

19416

52

an oil line

53

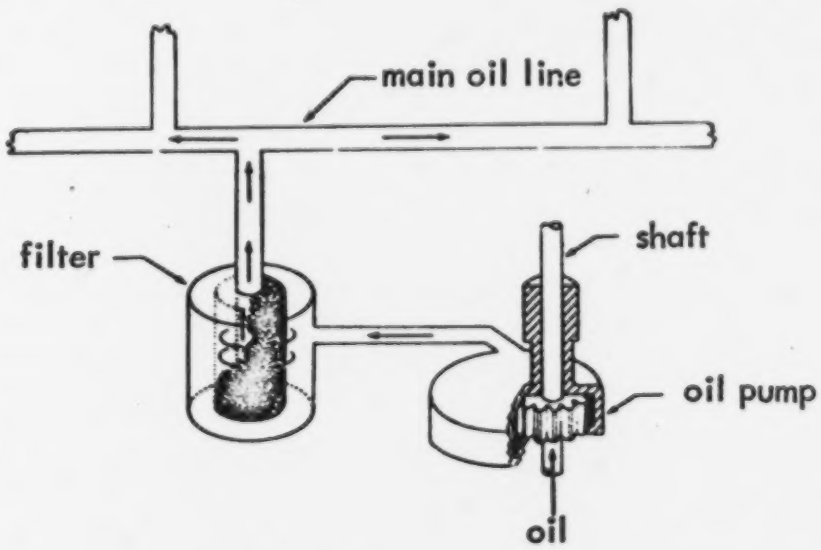

Before going to the MAIN OIL LINE, the oil passes through the

_____.

19417

54

main oil line

55

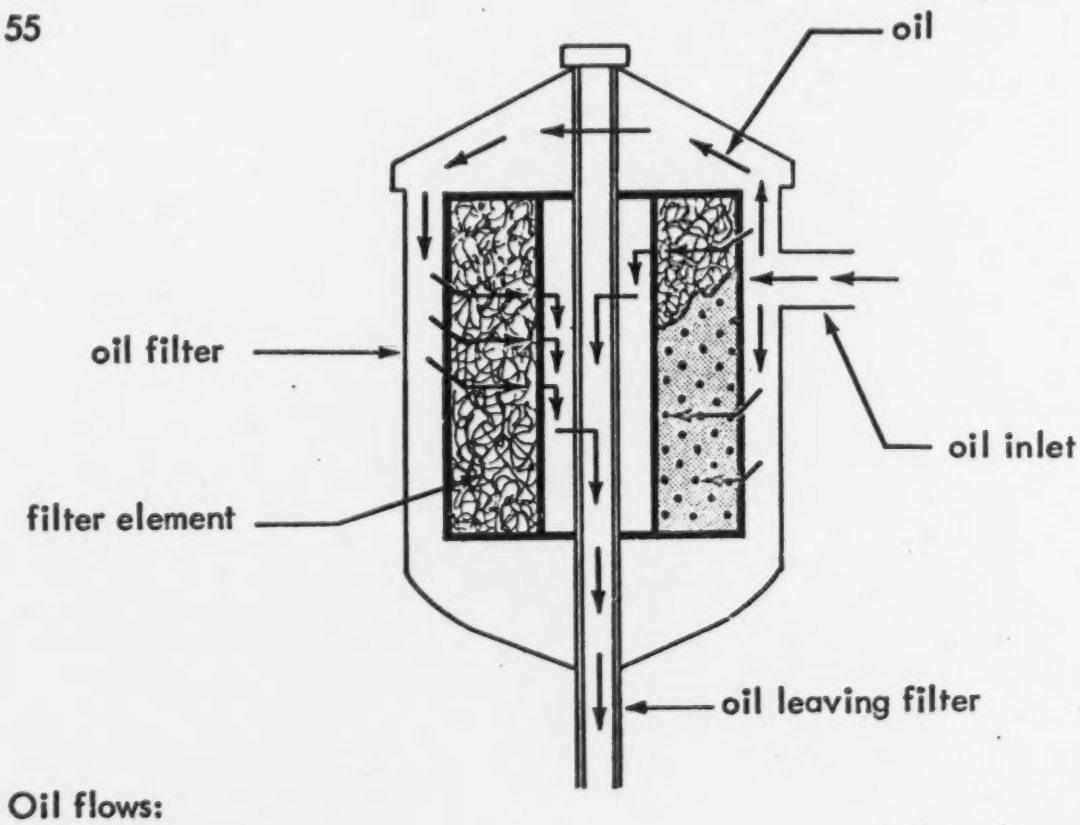

Oil flows:

- ☐ around the filter
- ☐ through the filter

19419

The following abstracts describe fixtures, devices, tools, and accessories which were developed to solve specific technical problems in the Government. These problems demanded innovations which were subsequently designed, developed, tested, and produced, in-house or with industry. The resulting products successfully met existing work requirements.

These selections are brought to your attention because the products may have commercial and industrial potential for metalworking businesses.

A market survey or analysis generally goes hand-in-hand with the introduction of a new product on the market. If help is needed in this area, the Small Business Administration has pertinent assistance programs and can provide counseling and literature, if desired. Please see list of SBA field offices, inside back cover, for office nearest you.

TECH BRIEF 68–10135—ANTECHAMBER FACILITATES LOADING AND UNLOADING OF VACUUM FURNACES

More efficient use of vacuum furnaces, freeze chambers, freeze driers, hot presses, and chemical reactors can be realized by using a NASA-designed antechamber for vacuum furnaces which can be easily adapted to other uses. The chamber holds a vacuum to 10^{-6} torr and allows the furnace to be loaded and unloaded without exposing its contents to air. Toxic materials can be transferred into and out of the furnace without exposing operators to contamination hazards. The antechamber also allows the furnace to be operated to the fullest degree, and protects all air-sensitive materials during the transfer process. The antechamber has glove ports, an access door, back-filling ability, and a motor-driven platform. Such an antechamber may be useful in conjunction with many types of pressure, vacuum, or controlled-atmosphere chambers.

For additional information, circle Key No. 27 on Reader Service Card.

TECH BRIEF 68–10064—FLEXIBL BAFFLES FOR DAMPING LIQUID S

Makers of liquid transport equipment users of liquid handling equipment who h problems in siphoning or decanting, or ma flow during motion, may be interested in th invention. Buoyant, flexible ring baffles h developed which break up the movement p the liquid and supply a high degree of Made up in another configuration, the h act as structural stiffeners for the containe configurations, the baffles will substantia aeration of the transported liquids.

For additional information, circle Key N Reader Service Card.

(a) Self Positioning Flexibl Configuration

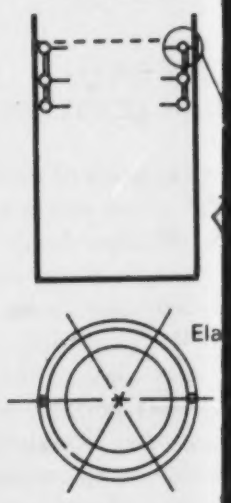

55

through the filter

56

As oil circulates through the filter, the filter traps dirt, dust and sludge.

In this way, the oil filter helps to keep the oil:

- ☐ clean
- ☐ cool
- ☐ dirty

19420

56

clean

57

baffle oil filter oil intake oil pump sump

LABEL the parts with the names listed above:

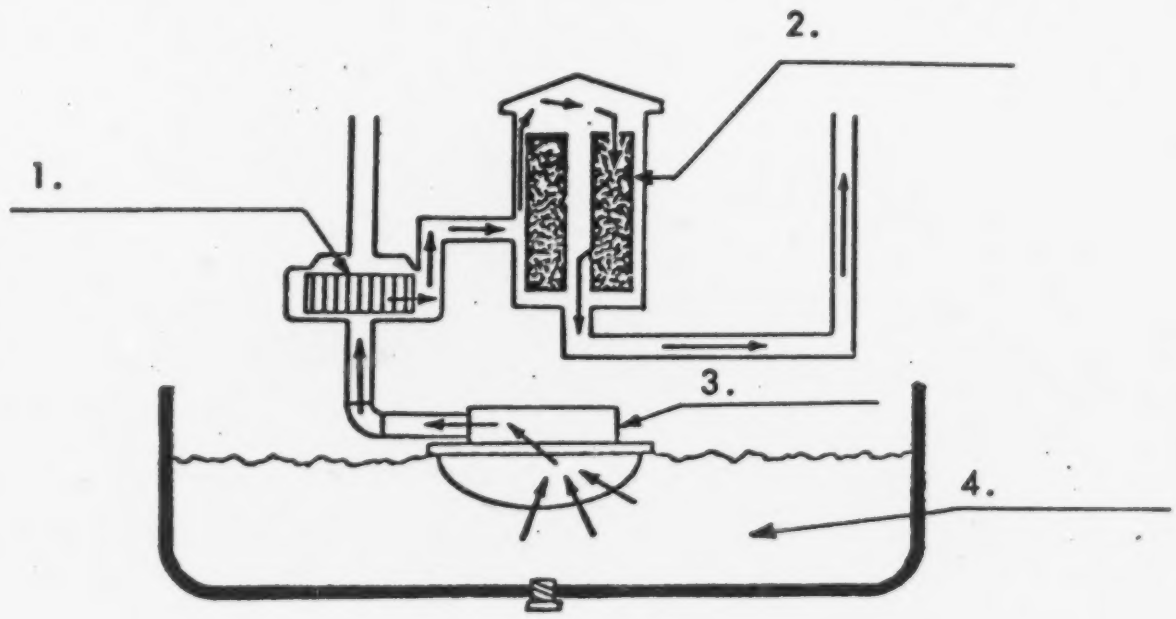

19421

57

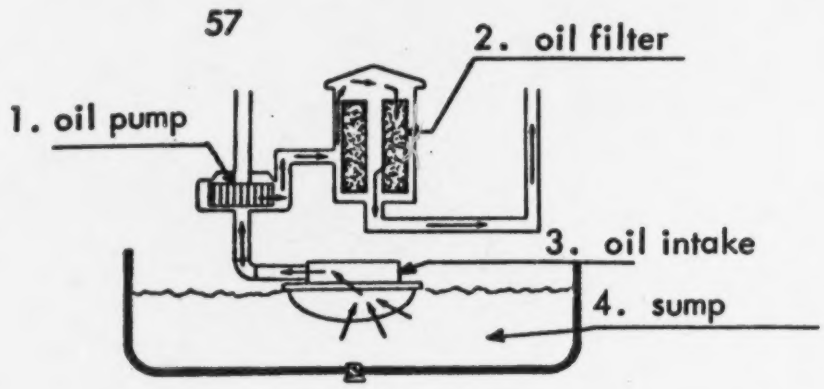

58

MATCH the following:

A. oil filter

B. oil inlet

C. oil pump

1. ____ cleans oil

2. ____ moves oil

19422

58

1. A

2. C

59

Sludge, dust and dirt are trapped by the:

- ☐ oil filter
- ☐ oil intake
- ☐ oil pump

19423

59

oil filter

60

MATCH each arrow letter with the name of the part pointed to:

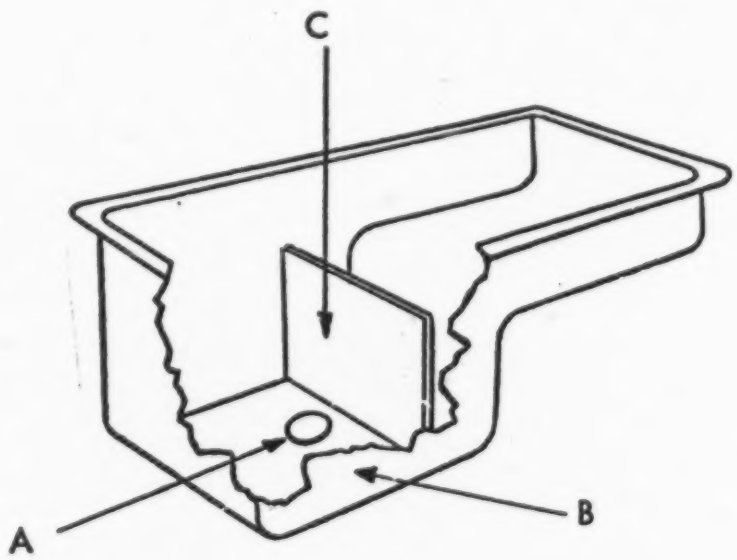

1. ____ baffle

2. ____ drain plug

3. ____ sump

4. ____ seal

60

1. C
2. A
3. B
4. –

61

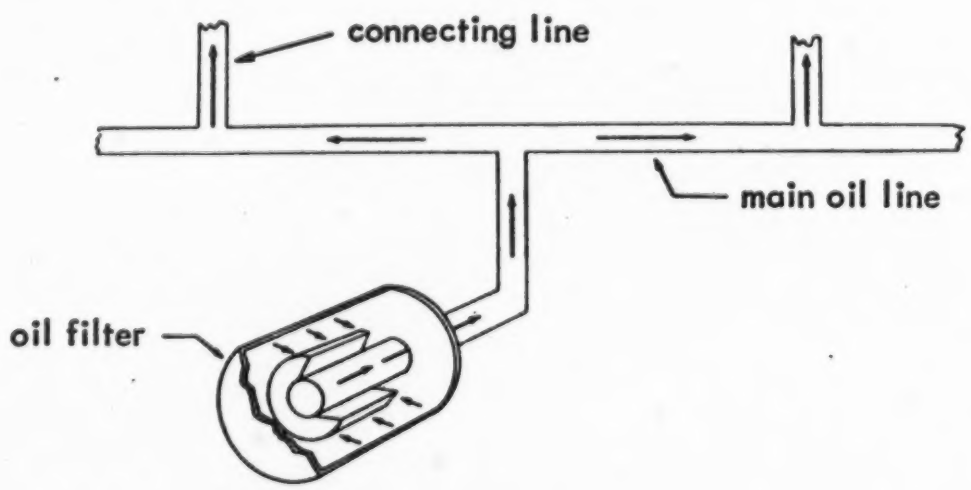

The main oil line gets oil from the:

- ☐ connecting line
- ☐ oil filter

19425

61

oil filter

62

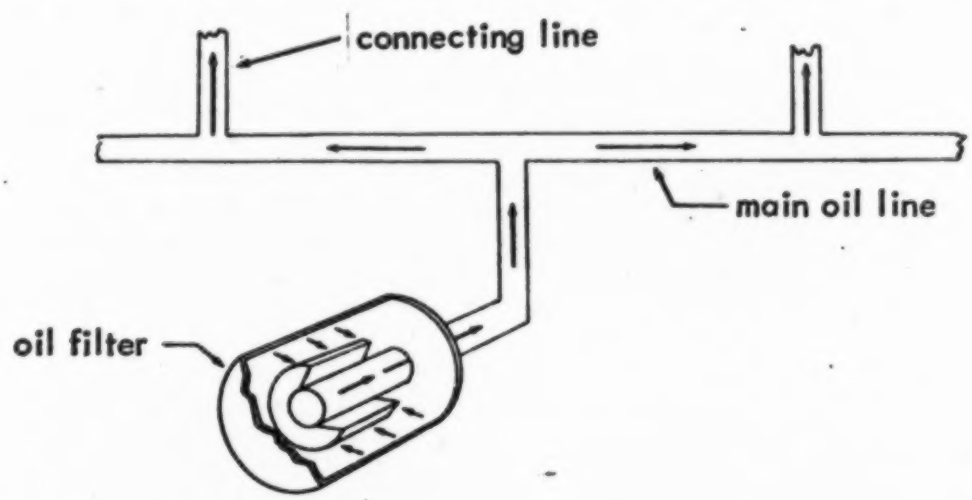

The main oil line is a large metal tube that runs the length of the cylinder block.

Does the main oil line have lines branching from it?

- ☐ yes
- ☐ no

19426

62

yes

63

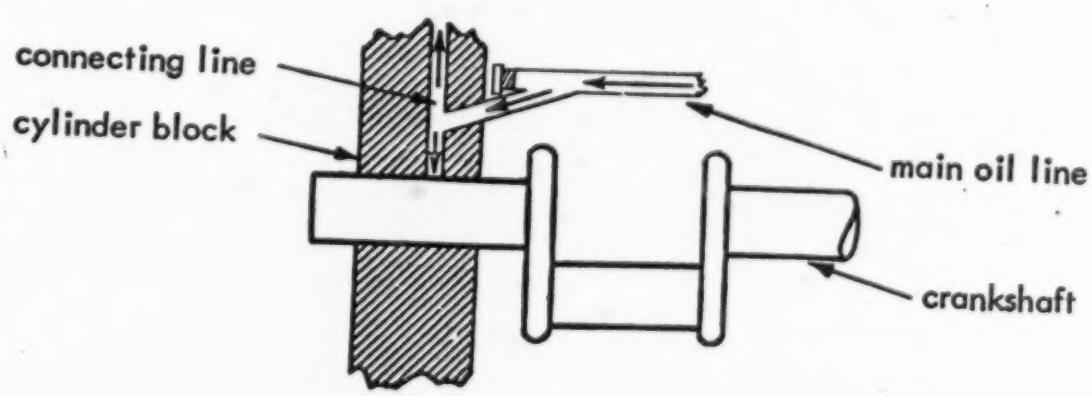

Oil from the main oil line flows into connecting lines.

The picture above shows that these lines are drilled in the:

- ☐ cylinder block
- ☐ crankshaft

63

cylinder block

64

The connecting lines carry oil to the crankshaft main bearings.

MATCH the following:

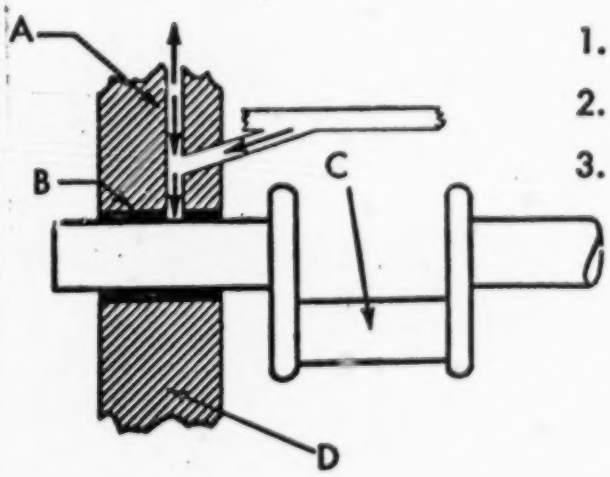

1. _____ connecting line
2. _____ crankshaft
3. _____ crankshaft main bearing

19428

64

1. A

2. C

3. B

65

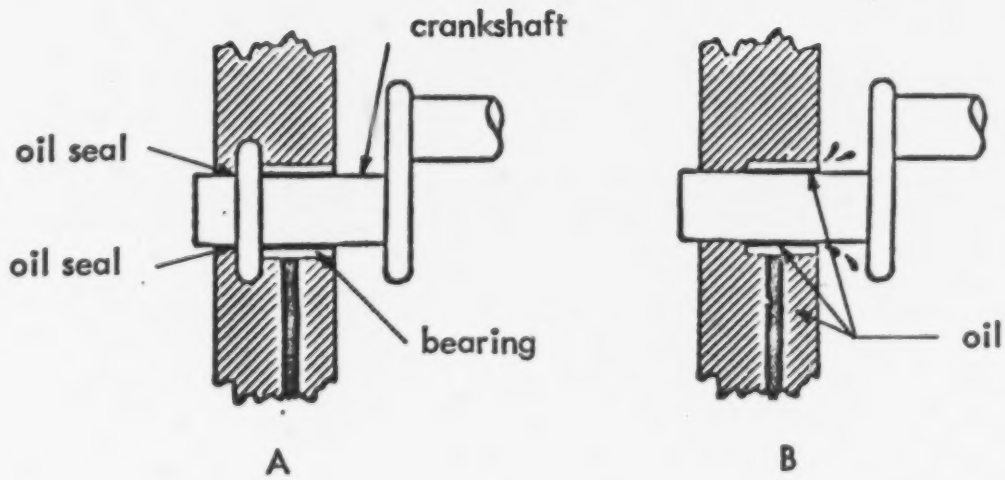

Oil is leaking in engine:

- ☐ A
- ☐ B

OIL SEALS:

- ☐ help the engine to leak faster
- ☐ stop the leak

19429

devices,
to solve
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TECH BRIEF 68–10064—FLEXIBLE RING BAFFLES FOR DAMPING LIQUID SLOSH

Makers of liquid transport equipment and all users of liquid handling equipment who have slosh problems in siphoning or decanting, or maintaining flow during motion, may be interested in this NASA invention. Buoyant, flexible ring baffles have been developed which break up the movement patterns of the liquid and supply a high degree of damping. Made up in another configuration, the baffles can act as structural stiffeners for the container. In both configurations, the baffles will substantially reduce aeration of the transported liquids.

For additional information, circle Key No. 28 on Reader Service Card.

(a) Self Positioning Flexible Baffle Configuration

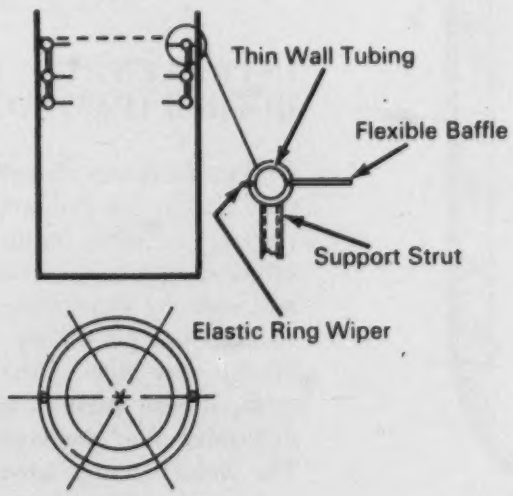

(b) Flexible Baffle and Structural Stiffener Configuration

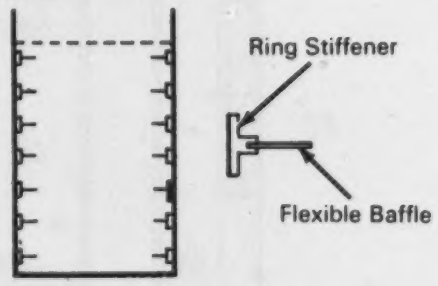

65

B

stop the leak

66

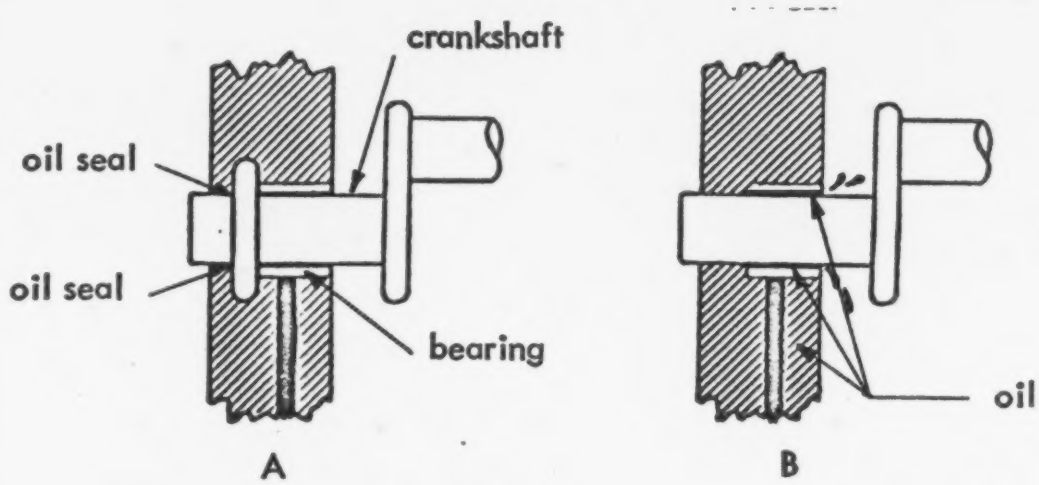

Since the oil is under pressure, there is always the chance that some oil will leak past the main bearing and be lost from the engine.

What will stop the oil from leaking? _____

19430

66

oil seals

67

Oil seals are made of leather or rubber.

The purpose of these seals is to:

- ☐ allow oil leaks
- ☐ stop oil leaks

19431

67

stop oil leaks

68

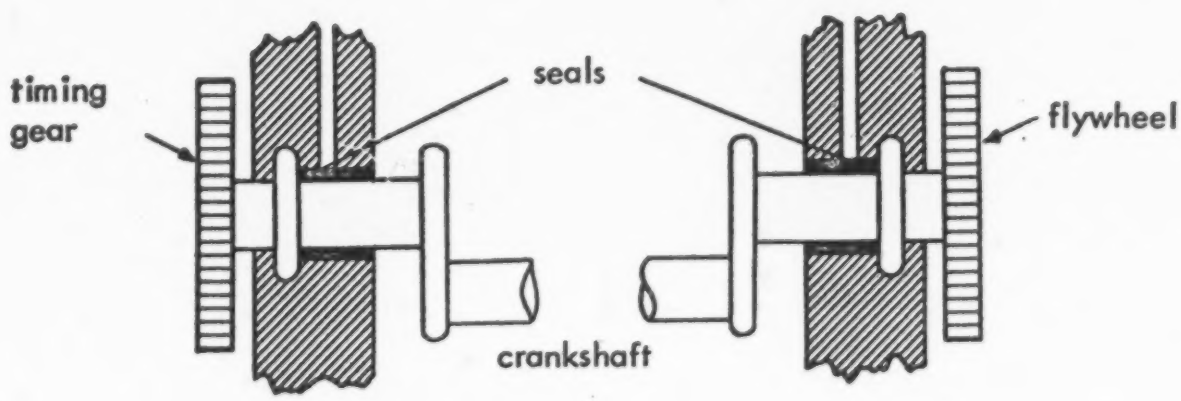

The pictures above show the two seals used to prevent oil from leaking around the crankshaft. These seals are:

- ☐ at the ends of the crankshaft
- ☐ in the middle of the crankshaft

19432

68

at the ends of the crankshaft

69

What is used to prevent oil from leaking out of the engine? _____

19433

69

seal(s)

70

If there were no seals at both ends of the crankshaft, oil would:

- ☐ flow back to the sump
- ☐ leak out of the engine

19434

70

leak out of the engine

71

MATCH the following:

A. oil filter	1. ____	move(s) oil
B. oil lines	2. ____	clean(s) oil
C. oil pump	3. ____	take(s) oil to engine parts
D. sump	4. ____	store(s) oil

19435

71

1. C

2. A

3. B

4. D

72

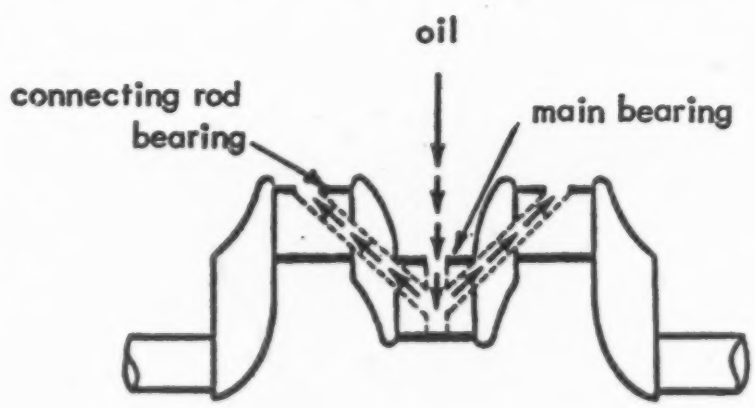

The picture above shows that there are holes drilled in the crankshaft.

Oil flows:

- ☐ around these holes
- ☐ through these holes

19436

72

through these holes

73

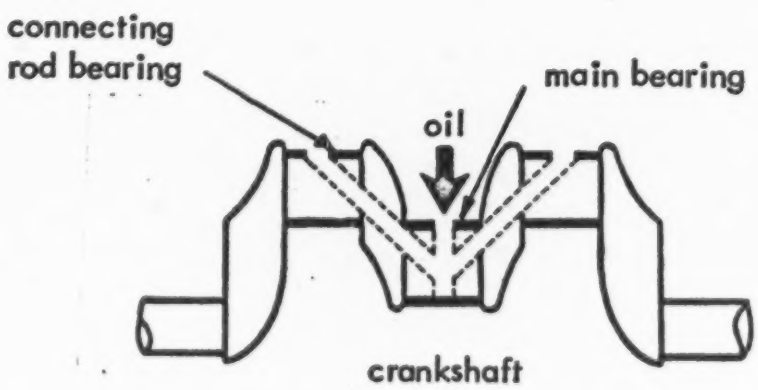

The heavy arrow shows oil going into the:

- ☐ connecting rod bearing
- ☐ main bearing

19437

73

main bearing

74

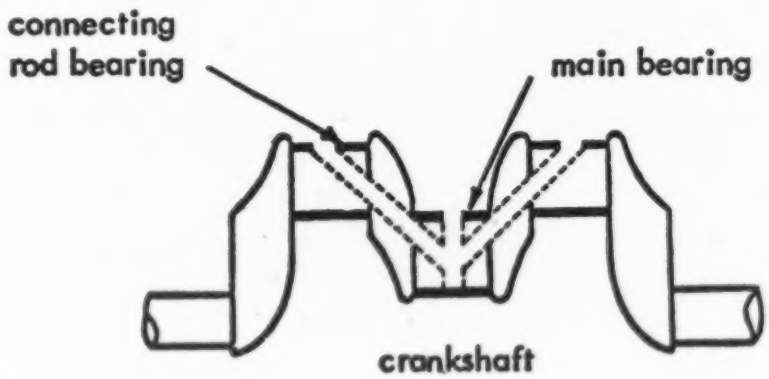

The dotted lines show holes that go through the crankshaft.

The main bearing and the connecting rod bearing:

- ☐ are not part of the crankshaft
- ☐ are part of the crankshaft

74

are part of the crankshaft

75

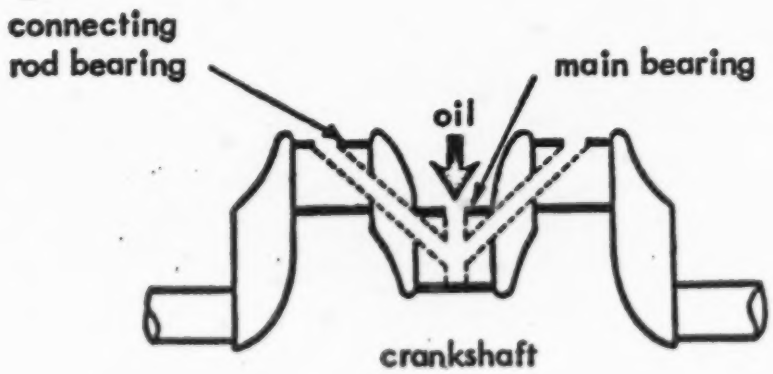

Which bearing gets the oil first? _____ _____

19439

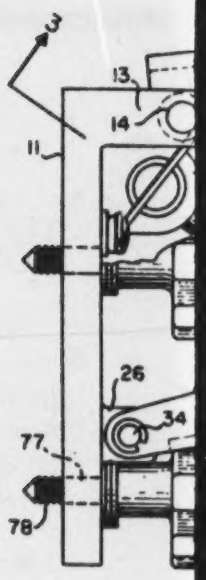

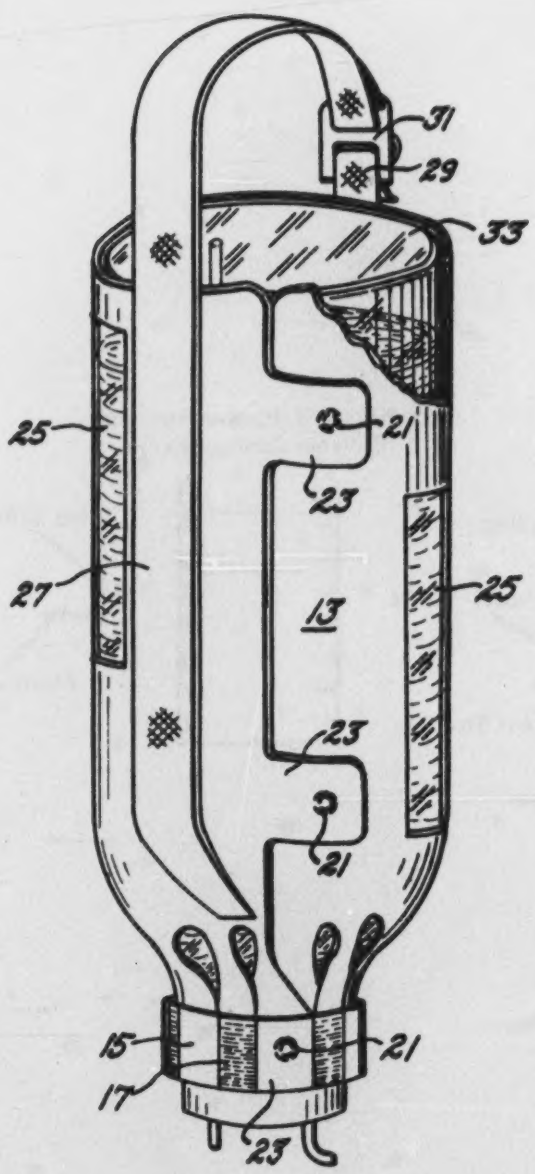

INTRAVENOUS INFUSION BOTTLE HOLDER (PAT. NO. 3,395,882)

Manufacturers of medical and laboratory supplies may find a new product in this simple, reliable, and rugged infusion bottle holder. Designed for use under emergency circumstances, such as ambulances and casualty evacuation aircraft, this holder greatly reduces the possibility of accidental breakage. Allowing easy view of the infusion bottle and its contents, it also permits medical personnel to rapidly determine that the right rate of flow is occurring. The holder wraps around the infusion bottle and snaps into a closed position. It can be made from any of a number of materials without expensive fabrication.

Administering Office: Department of the Air Force, Office of the Judge Advocate General, Chief, Patents Branch, Washington, D.C. 20333.

75

the main bearing

76

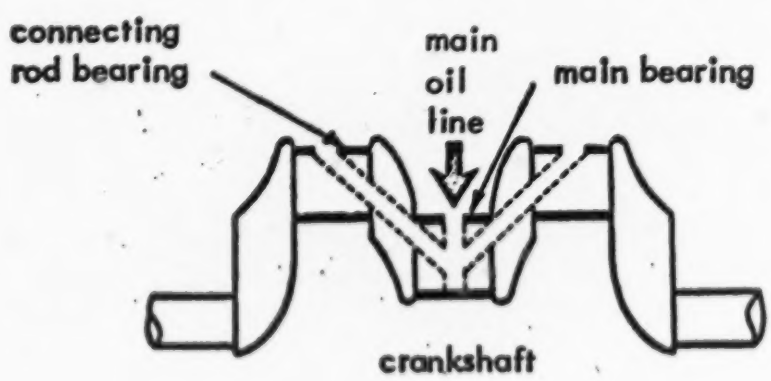

Oil flows from the main bearing to the connecting rod bearings by going through holes in the _____.

19440

76

crankshaft

77

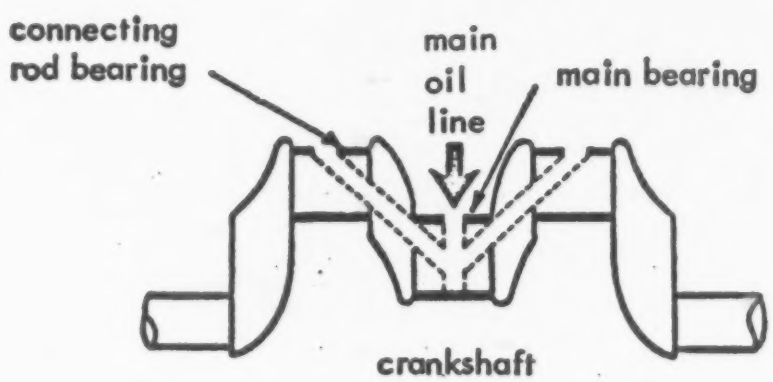

The correct order of oil flow is:

- ☐ main bearing → main line → connecting rod bearing
- ☐ connecting rod bearing → main bearing → main line
- ☐ main line → main bearing → connecting rod bearing

19441

77

main line ⟶ main bearing ⟶
connecting rod bearing

78

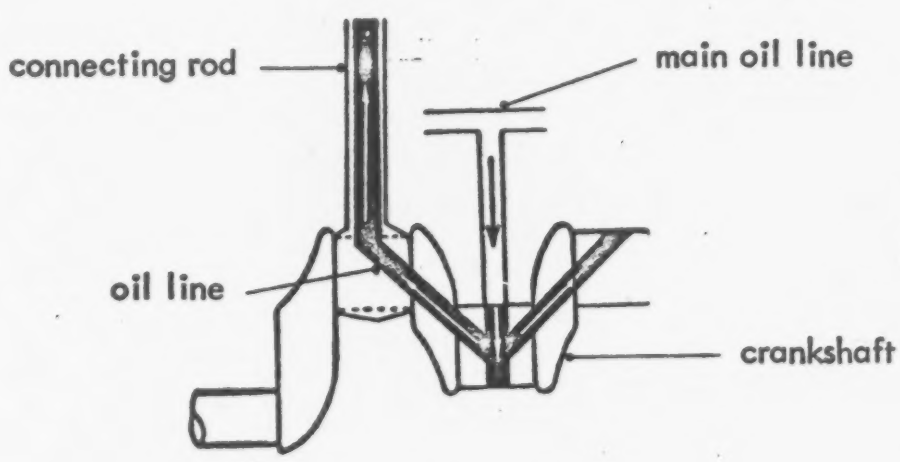

The picture above shows oil entering a hole drilled in the connecting rod. Oil entering the connecting rod comes from the:

- ☐ crankshaft
- ☐ main oil line

19442

78

crankshaft

79

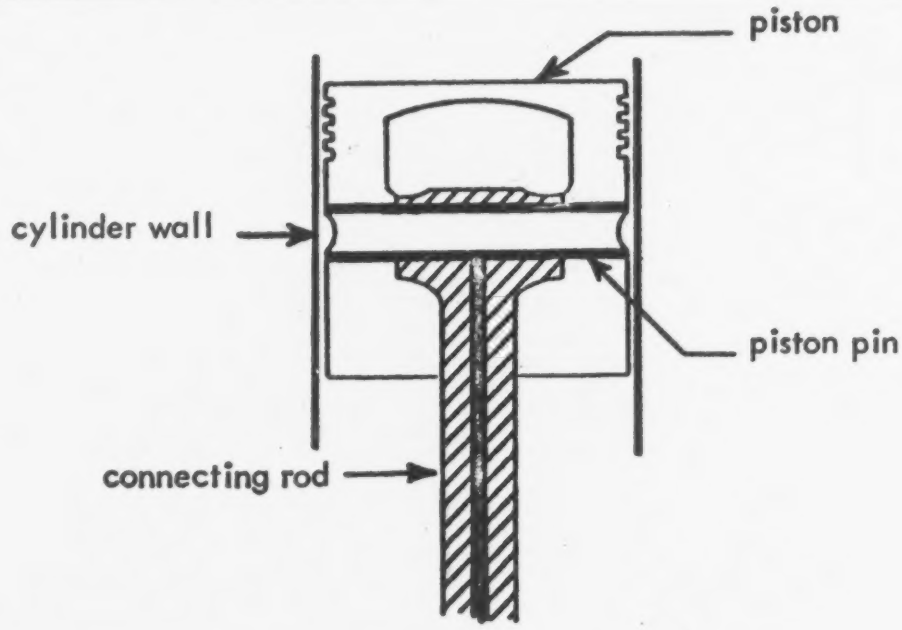

The connecting rod is connected to the:

- ☐ cylinder wall
- ☐ piston
- ☐ piston pin

19443

79

piston pin

80

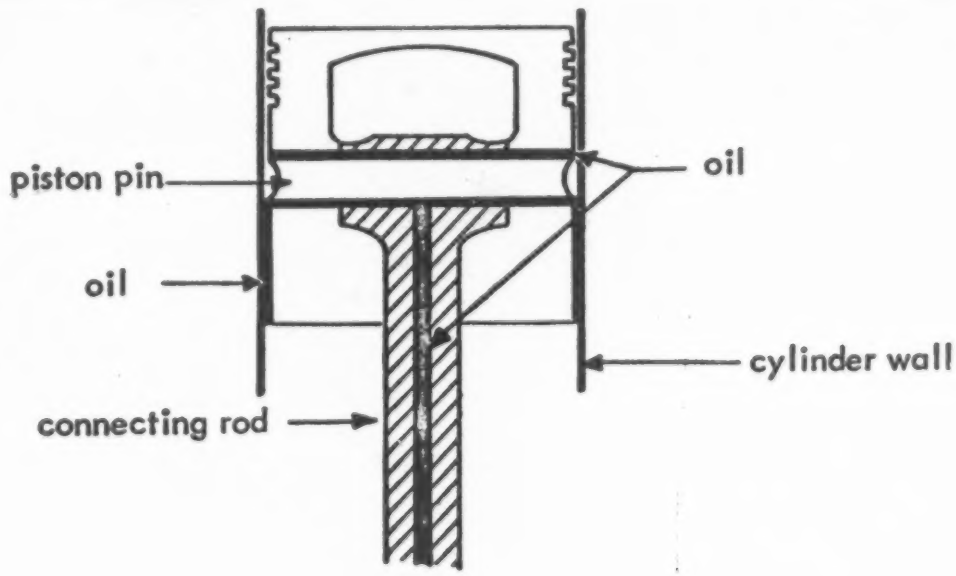

When oil comes up the connecting rod, it lubricates:

- ☐ only the piston pin
- ☐ only the cylinder wall
- ☐ both the piston pin and the cylinder wall

19444

80

both the piston pin and the cylinder wall

81

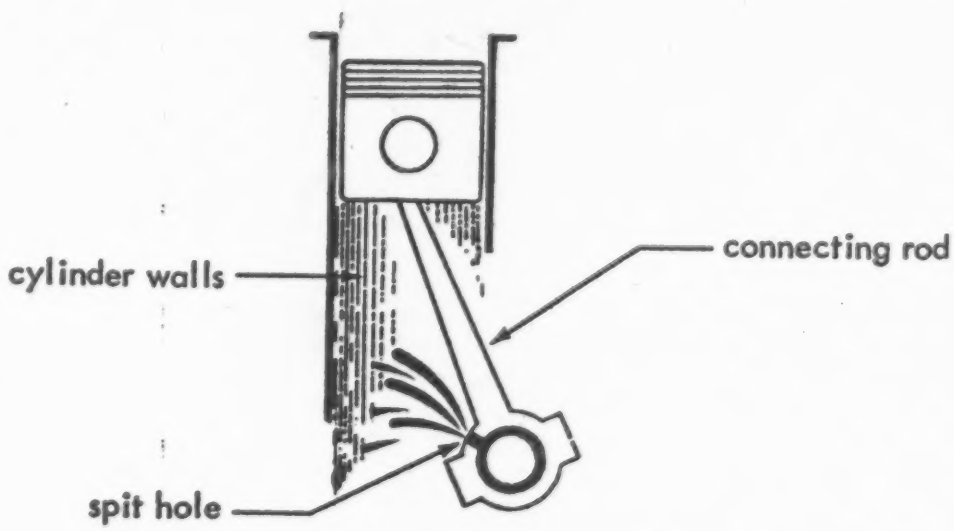

Most connecting rods have a hole in their side called a "spit" hole. As the crankshaft turns, oil is forced out of this hole in a fine spray.

The picture above shows that this oil spray lubricates the:

- ☐ walls of the cylinder
- ☐ piston

19445

81

walls of the cylinder

82

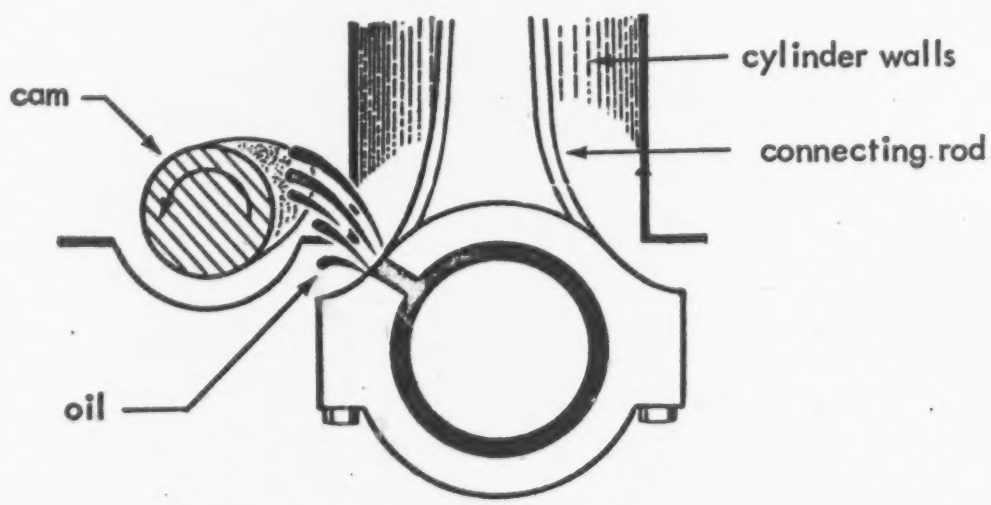

The oil from the connecting rod spit hole lubricates both the cylinder walls and the _____.

19446

82

cam

83

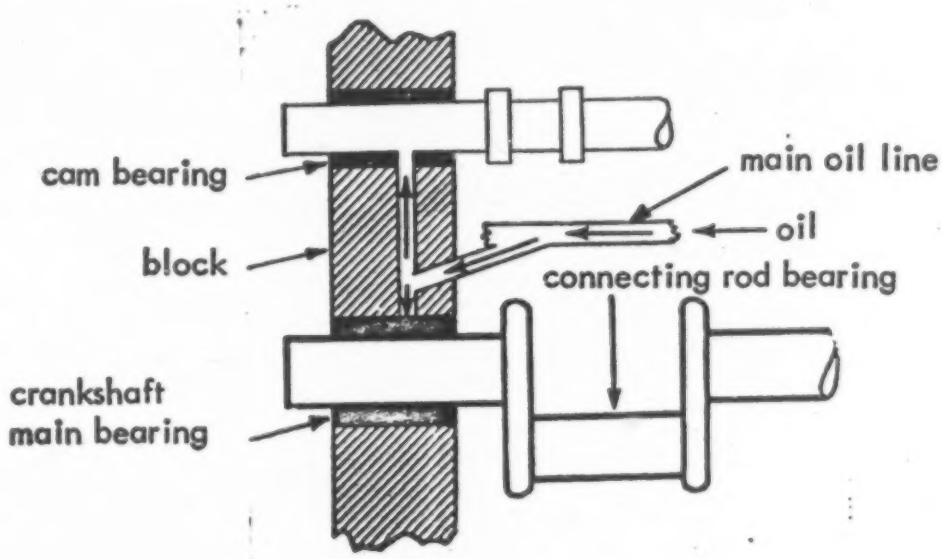

The picture above shows that the cam bearings are lubricated by lines drilled in the block.

These lines also carry oil to the:

- ☐ connecting rod bearings
- ☐ crankshaft bearings

19447

83

crankshaft bearings

84

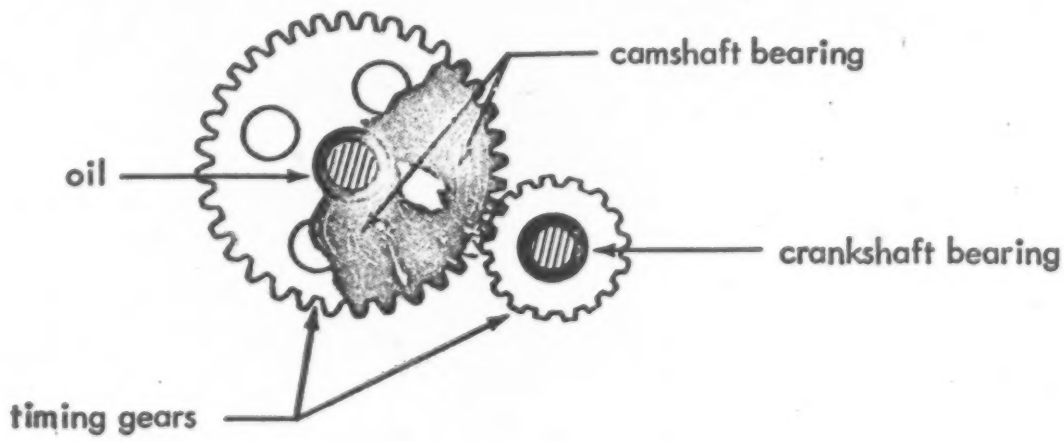

The picture above shows that the timing gears are lubricated by oil from the:

- ☐ camshaft bearing
- ☐ crankshaft bearing

19448

84

camshaft bearing

85

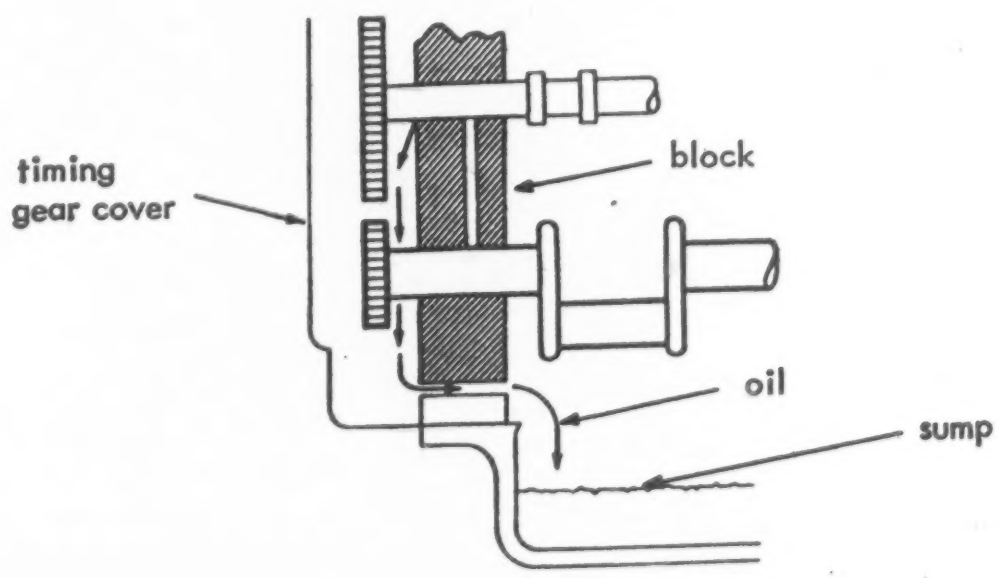

The picture above shows that once oil has been used to lubricate the timing gears, it flows back to the _____.

19449

ued)

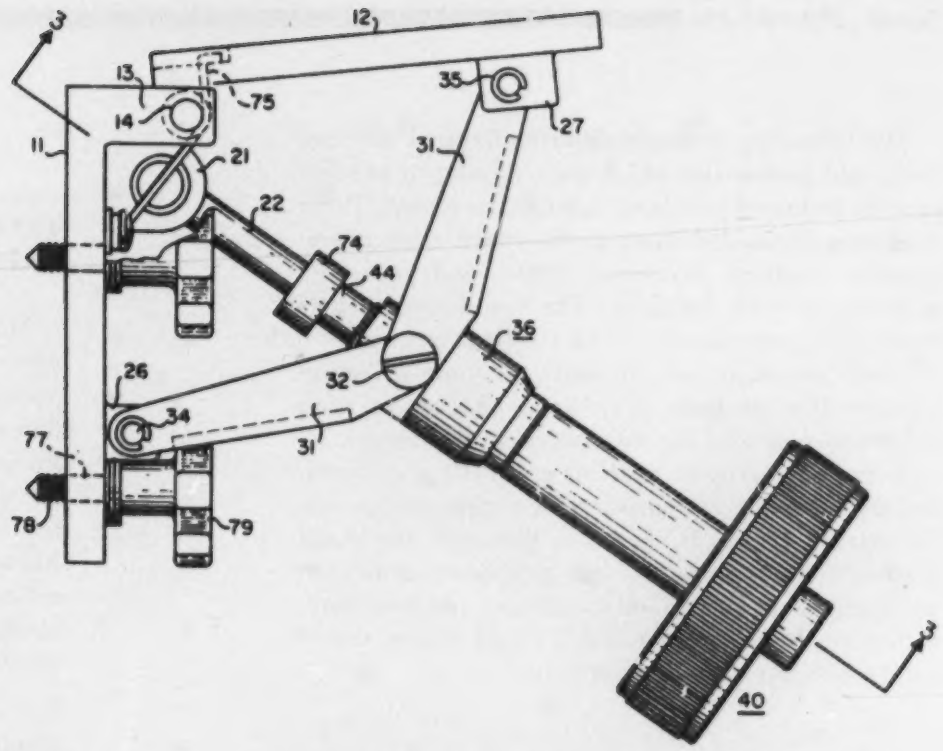

INTRAVENOUS INFUSION BOTTLE HOLDER (PAT. NO. 3,395,882)

Manufacturers of medical and laboratory supplies may find a new product in this simple, reliable, and rugged infusion bottle holder. Designed for use under emergency circumstances, such as ambulances and casualty evacuation aircraft, this holder greatly reduces the possibility of accidental breakage. Allowing easy view of the infusion bottle and its contents, it also permits medical personnel to rapidly determine that the right rate of flow is occurring. The holder wraps around the infusion bottle and snaps into a closed position. It can be made from any of a number of materials without expensive fabrication.

Administering Office: Department of the Air Force, Office of the Judge Advocate General, Chief, Patents Branch, Washington, D.C. 20333.

VARIABLE PITCH BRACKET (PAT. NO. 3,392,951)

This device was developed as a camera holder for an astronaut in orbit to take pictures at different angles. Because astronauts are kept busy and work in confined quarters, the instrument should require as little work and operational time as possible and require minimum storage space. This bracket, manually operated and locked into place by spring loaded latches, meets such requirements. A hand operated handle rotates the plates more or less than an angle of 90°. The handle has a finger operated button which releases a pair of pawls that hold the shaft in place to automatically fold the base plates into a compact assembly by spring action. This bracket will be of interest and use to manufacturers and users of fixtures, tripods, weld positioners, sensors, detectors, photograph equipment and accessories, and the like.

Administering Office: Department of the Navy, Patent Counsel, Washington, D.C. 20360.

85

sump

86

In an engine, oil goes to the: (CHECK ALL CORRECT ANSWERS)

- ☐ camshaft bearings
- ☐ cotter pin line
- ☐ crankshaft main bearings
- ☐ cylinder walls
- ☐ valve lifters

19450

86

camshaft bearings

crankshaft main bearings

cylinder walls

87

In an engine, oil goes to the: (CHECK THREE)

- ☐ connecting rod bearings
- ☐ cylinder head
- ☐ piston pins
- ☐ timing gears
- ☐ valve stems

19451

87

connecting rod bearings

piston pins

timing gears

88

The picture below shows a rocker arm. The rocker arm rides on a rod called the rocker shaft.

MATCH the following:

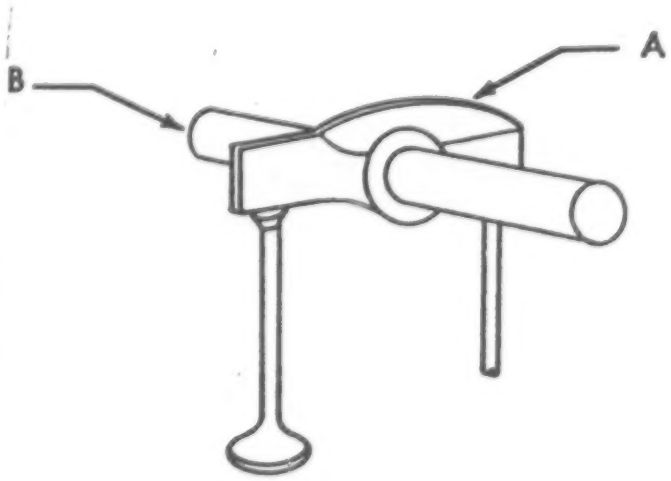

1. _____ rocker arm

2. _____ rocker shaft

19452

275 OF 327

ED

056 238

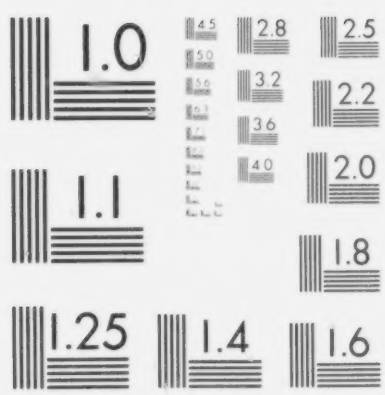

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

88

1. A

2. B

89

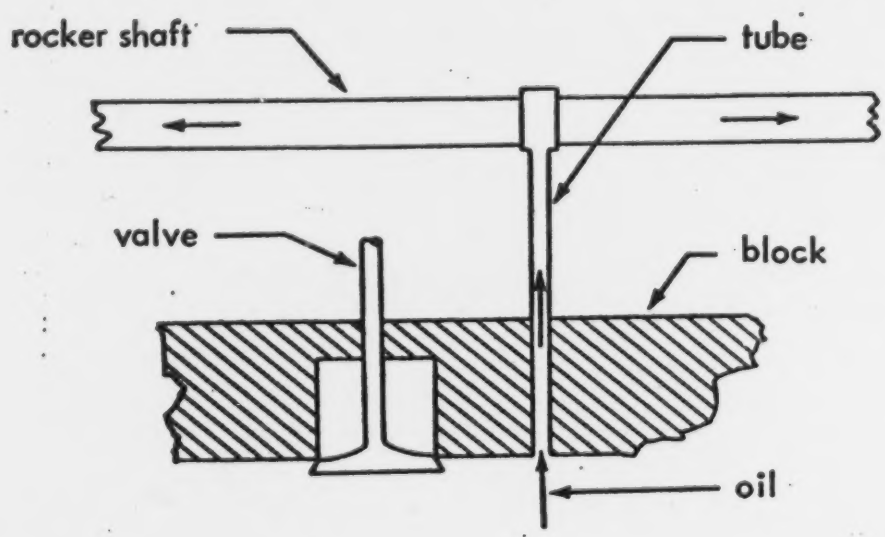

The picture above shows that a metal tube carries oil from the block to the: (CHECK ONE)

- ☐ rocker shaft
- ☐ valve

19453

89

rocker shaft

90

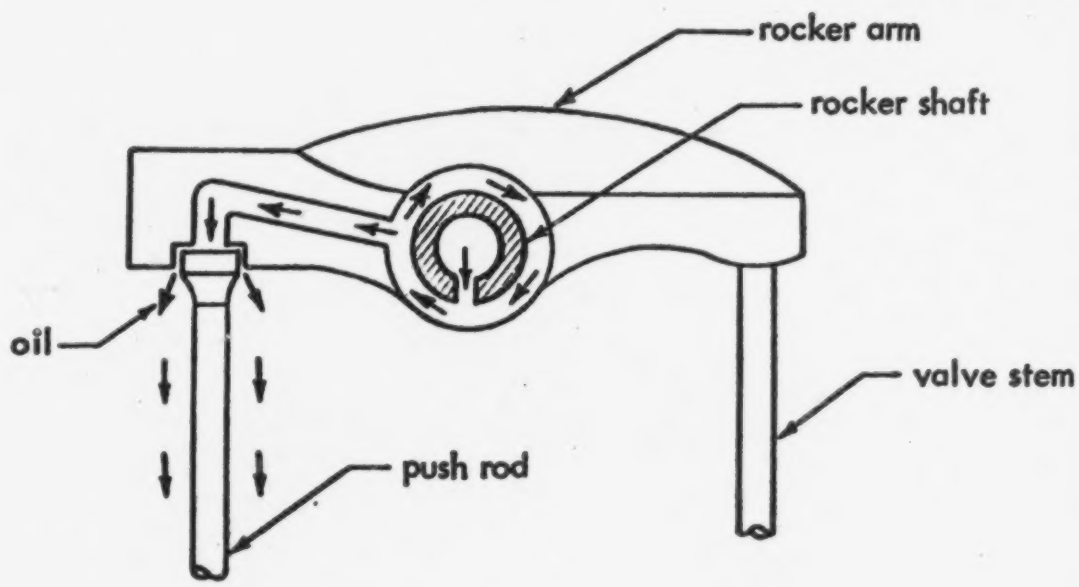

The PUSH ROD pushes and moves the:

- ☐ rocker arm
- ☐ rocker shaft

19454

90

rocker arm

91

This is a picture of the rocker arm and shaft in side view:

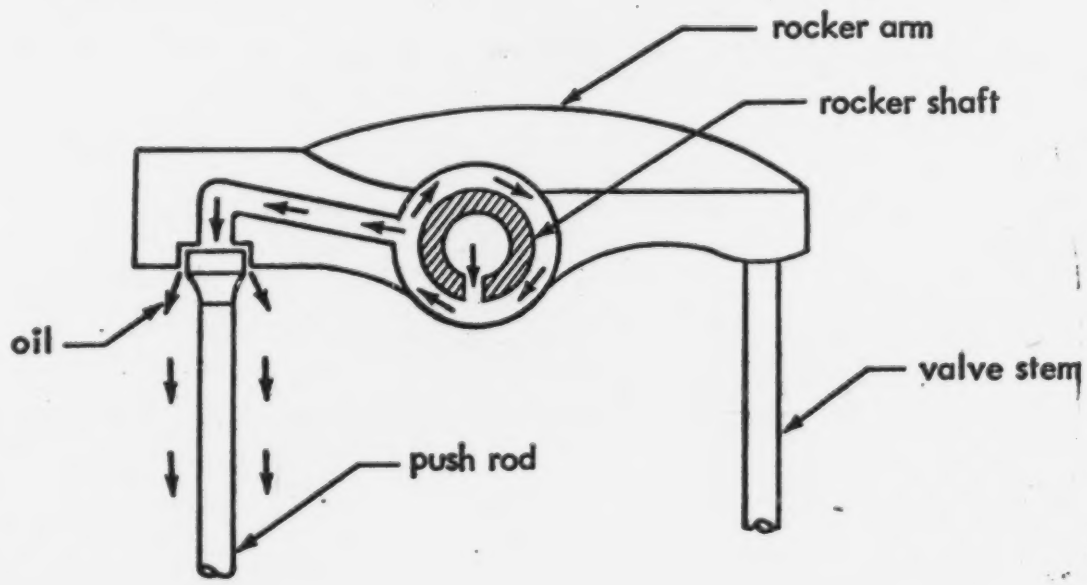

You can see that some oil from the rocker shaft flows down the sides of the:

- ☐ push rod
- ☐ valve stem

19455

91

push rod

92

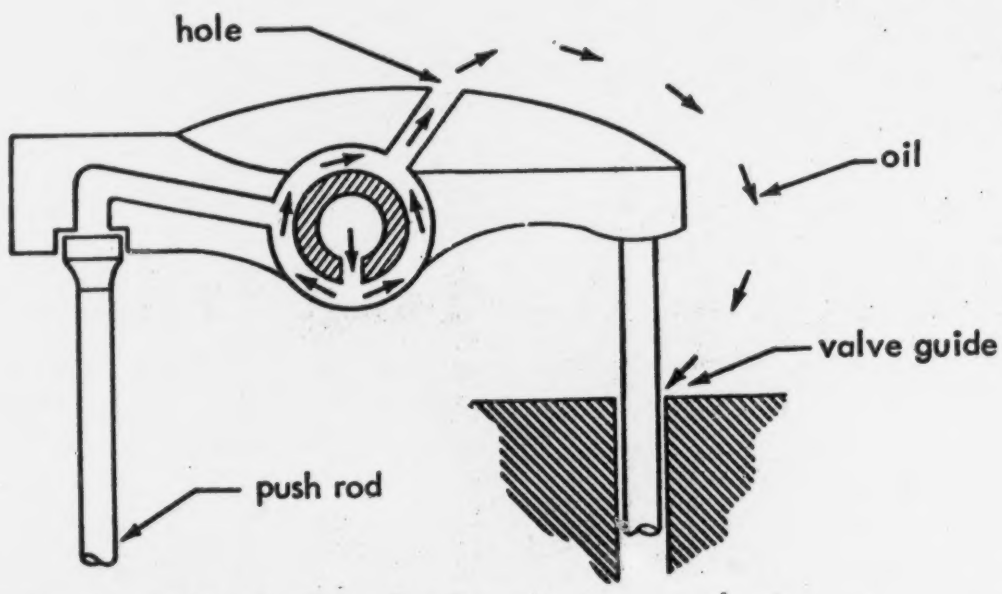

The oil moving in the rocker shaft is also forced out of a hole in the top of the rocker arm.

The picture above shows that this oil is used to lubricate the:

- ☐ push rod
- ☐ valve guide

19456

92

valve guide

93

Which engine parts are lubricated by oil from the rocker shaft? (CHECK ALL CORRECT ANSWERS)

- ☐ the push rod
- ☐ the rocker arm
- ☐ the valve guide
- ☐ the valve lifter

93

the push rod

the rocker arm

the valve guide

94

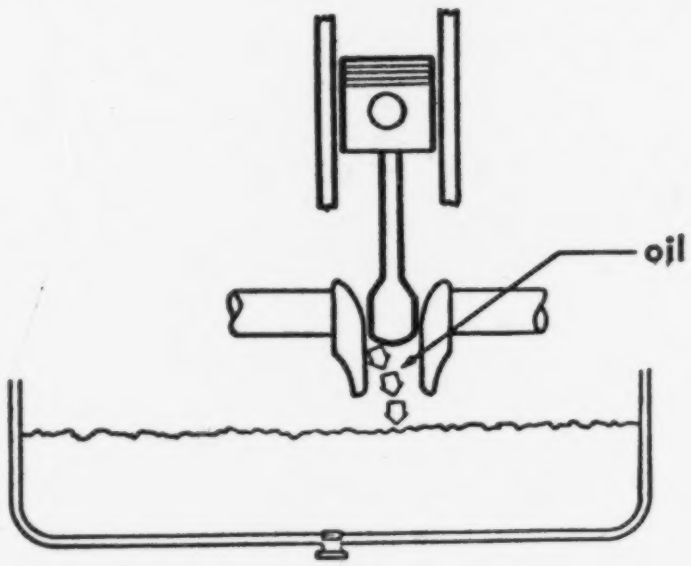

The picture above shows that oil returns to the:

- ☐ oil lines
- ☐ oil sump

TECH BRIEF 68–10250—QUICK-ATTACH CLAMP

A fast-acting, positive, sliding-jaw cable clamp has been devised by NASA that can be used by every manufacturer of cable and rope equipment and by every industry and trade using cables, halyards, or lines. This new clamp can be easily triggered by a flip action and remotely triggered with little additional trouble, needing only an extra line. In the case of heavy, moving cable, this new clamp is both safer and less awkward than presently available clamps. It is faster and at least as positive in its action in all other applications.

For additional information, circle Key No. 29 on Reader Service Card.

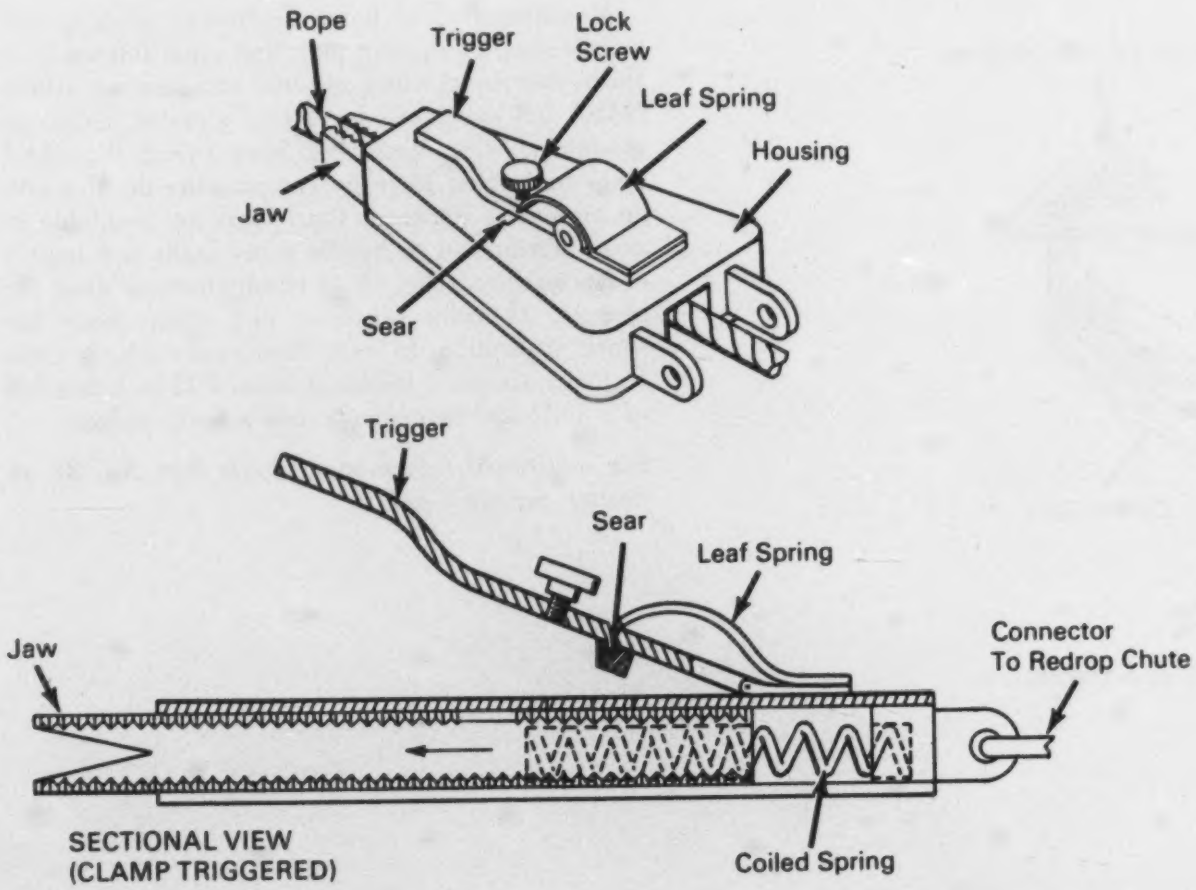

SECTIONAL VIEW (CLAMP TRIGGERED)

94

oil sump

95

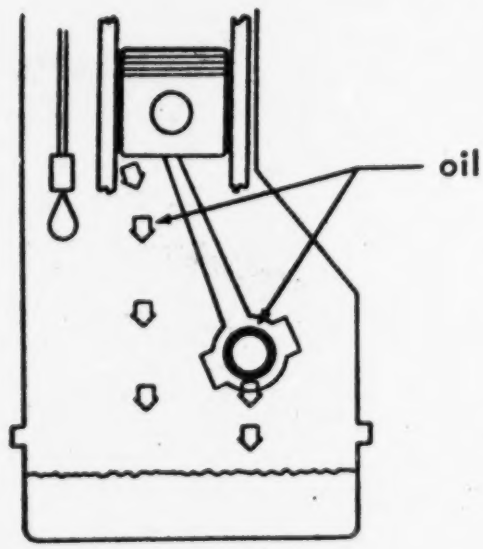

The oil that drops into the sump comes from the connecting rod bearing and the p_____.

19459

95

piston

96

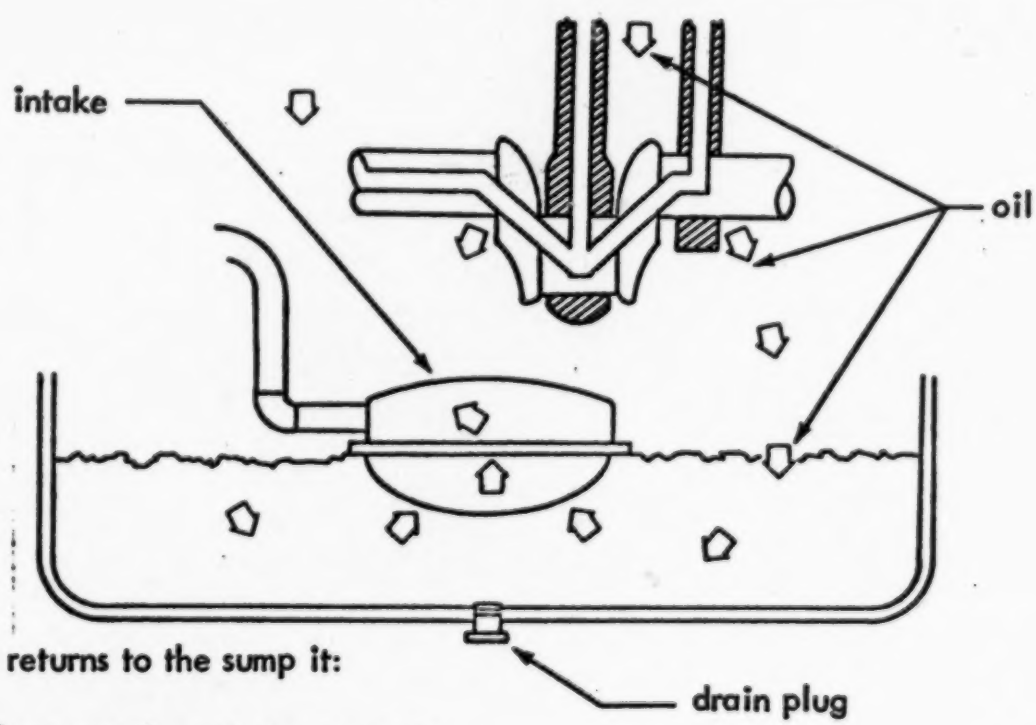

After oil returns to the sump it:

- ☐ flows out through the drain plug
- ☐ re-enters the oil intake

19460

96

re-enters the oil intake

97

Once the oil re-enters the oil intake, it is:

- ☐ thrown away
- ☐ used again

19461

97

used again

98

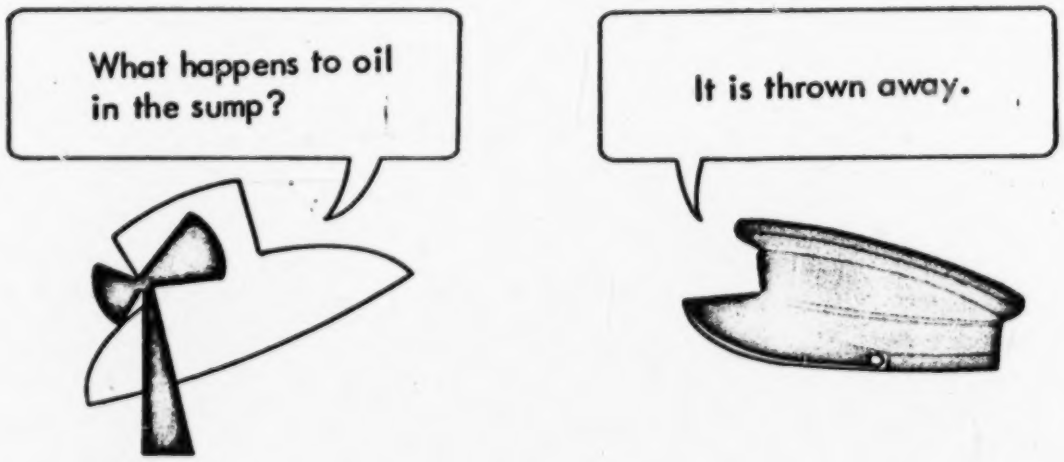

The serviceman is:

- ☐ right
- ☐ wrong

98

wrong (The oil is put back into the engine.)

99

After oil goes through the lubricating system, it: (CHECK TWO)

- ☐ flows into the sump
- ☐ flows onto the ground
- ☐ is thrown away
- ☐ is used again

10463

99

flows into the sump

is used again

100

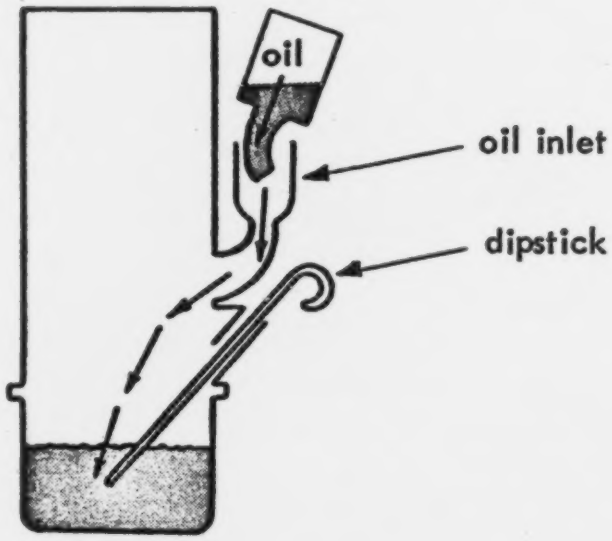

What is pouring into the sump through the OIL INLET? _____

19464

100

oil

101

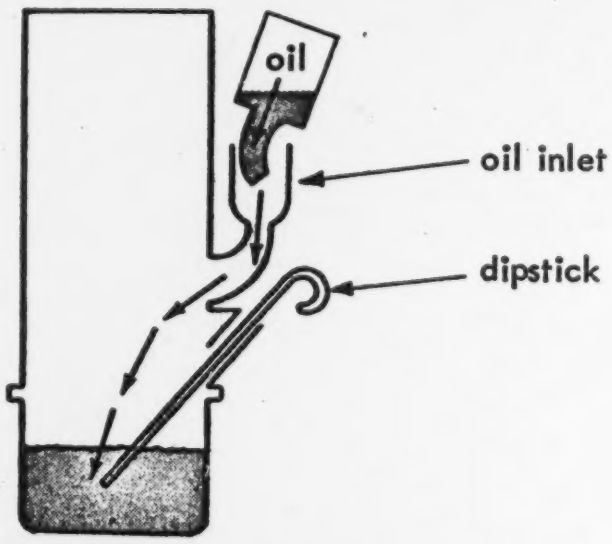

In the picture above, oil is being poured into the engine. The oil enters the engine through the:

- ☐ dipstick
- ☐ oil inlet

19465

101

oil inlet

102

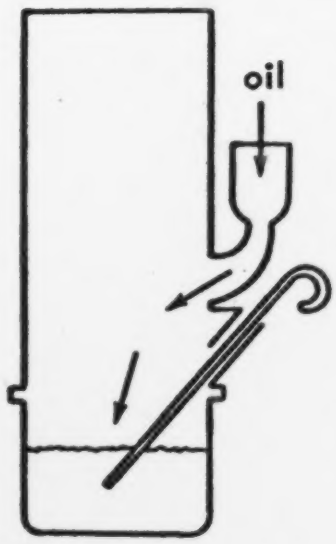

When oil is poured into the oil inlet, it flows into the:

- ☐ dipstick
- ☐ main oil lines
- ☐ sump

19466

102

sump

103

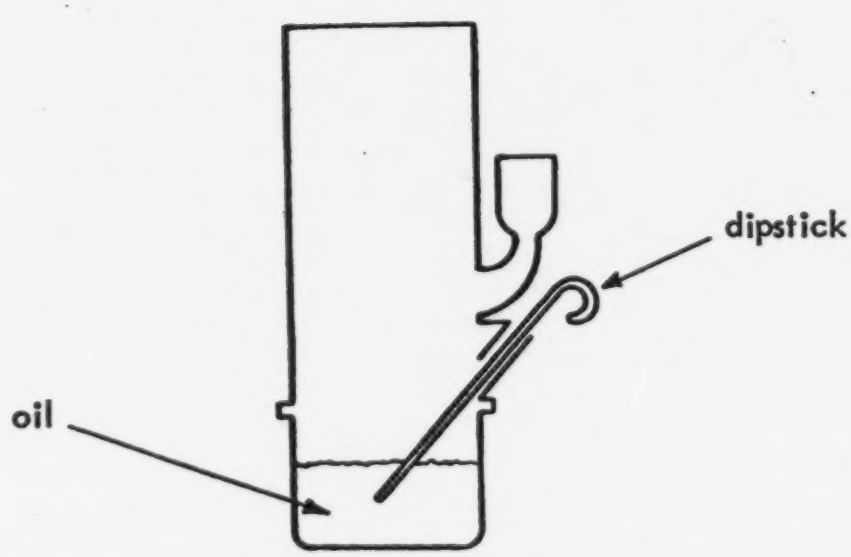

The long metal rod below the oil inlet is called a dipstick.

The DIPSTICK is:

- ☐ entirely in the oil
- ☐ partly in the oil
- ☐ totally out of the oil

19467

103

partly in the oil

104

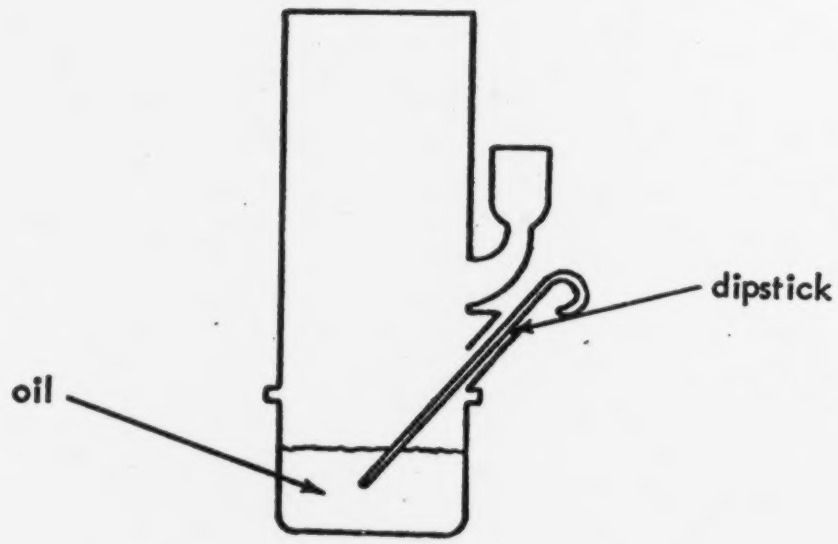

The dipstick measures how much oil there is in the engine.
It measures the oil level in the:

- ☐ cylinder
- ☐ oil pump
- ☐ sump

19468

H

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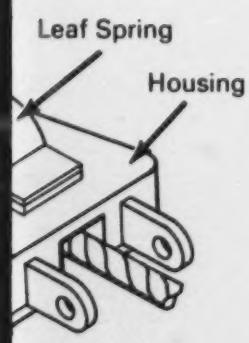

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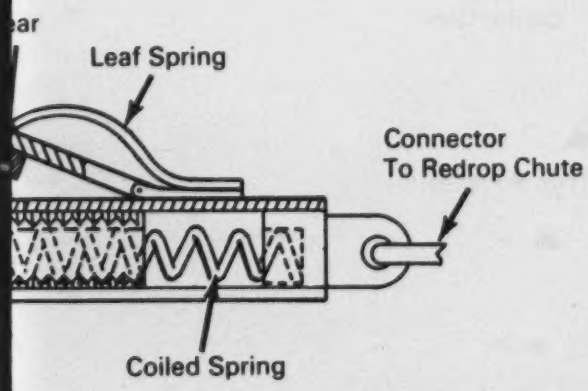

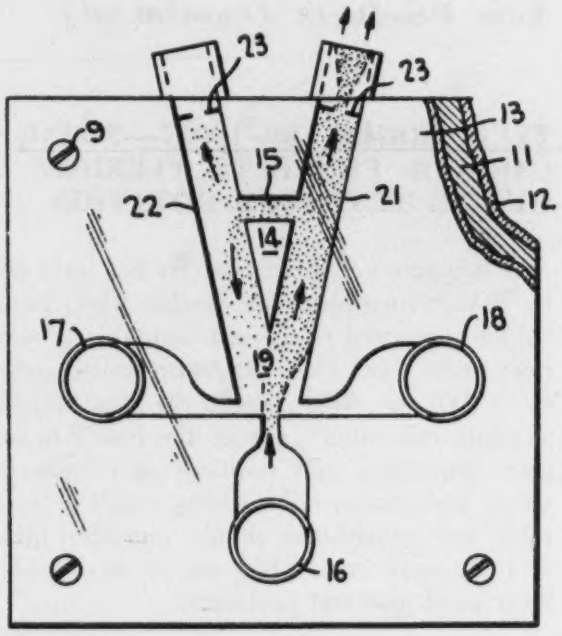

FEEDBACK DIVIDER FOR FLUID AMPLIFIER (PAT. NO. 3,397,713)

Manufacturers of fluidic devices may find considerable improvement in their product with the inclusion of this feedback divider. It will improve stability, implant reliability to the memory functions, and assist in boundary layer lock-on. The divider will also reduce the counterflow or even eliminate it in some functions. It also maintains momentum in the feedback flow so that there will be no interruption in its value as a control signal. The combined advantages of this innovation should measurably improve the performance of any system in which this fluid amplifier can work. The design functions equally well with liquids or gases and can be made of any material compatible with the fluid used.

Administrative Office: Department of the Army, Office of the Judge Advocate General, Chief, Patents Division, Washington, D.C. 21315.

104

sump

105

The dipstick shows the oil level in the sump.

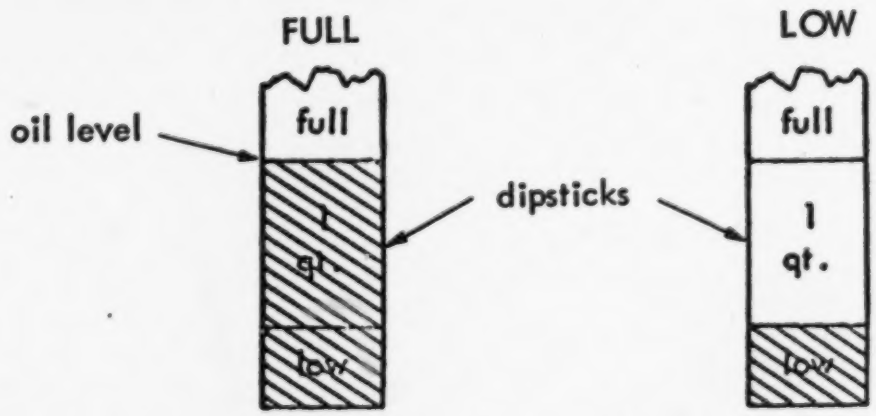

CROSS OUT the dipstick that shows a full sump:

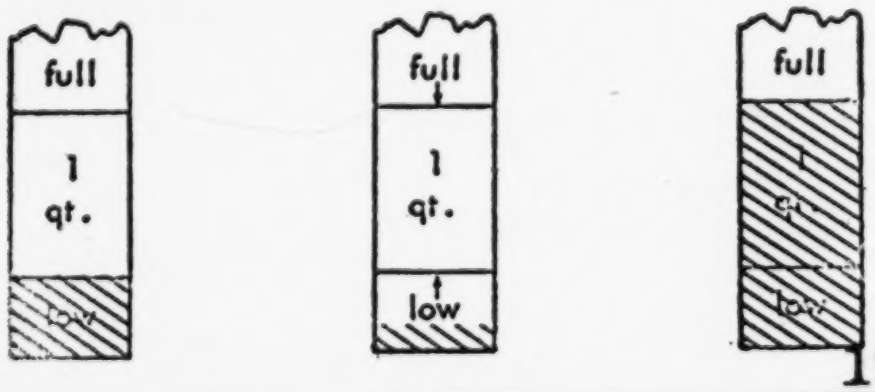

19469

105

106

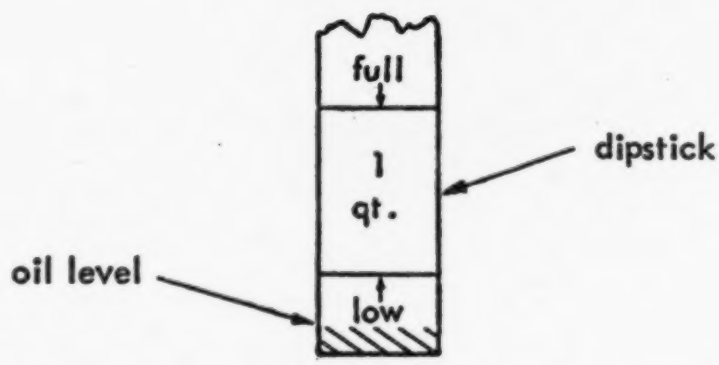

In the picture above, the dipstick shows that the engine is:

- ☐ full of oil
- ☐ low on oil

19470

106

low on oil

107

MATCH the following:

A. dipstick

B. oil inlet

C. sump

1. _____ lets oil into the engine

2. _____ shows amount of oil in the engine

19471

107

1. B

2. A

108

To check the amount of oil in the sump, you look at the:

- ☐ dipstick
- ☐ oil inlet

108

dipstick

109

When adding oil to the engine, you pour the oil into the:

- ☐ oil inlet
- ☐ oil intake

19473

109

oil inlet

110

When you pour oil into the engine, it goes down to the:

- ☐ oil filter
- ☐ piston
- ☐ sump

19474

110

sump

111

After a car has been driven a few hundred miles, dirt, dust and sludge begin to collect in the oil.

Most of this dirt, dust and sludge is trapped by the:

- ☐ oil filter
- ☐ oil pump

111

oil filter

112

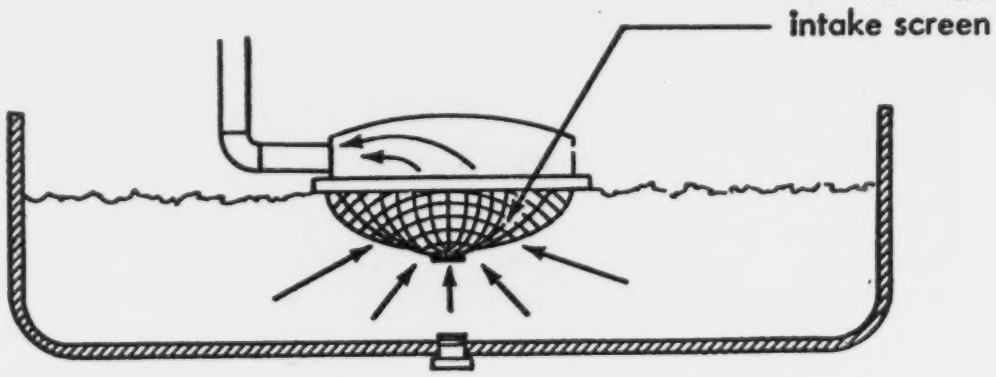

The oil intake has a screen which also filters the oil.

The picture above shows that this screen traps the dirt and dust in the oil coming from the _____ .

19476

112

sump

113

Engines have two parts that keep oil clean.

They are the:

- ☐ oil filter
- ☐ oil pump
- ☐ intake screen

19477

113

oil filter

oil screen

114

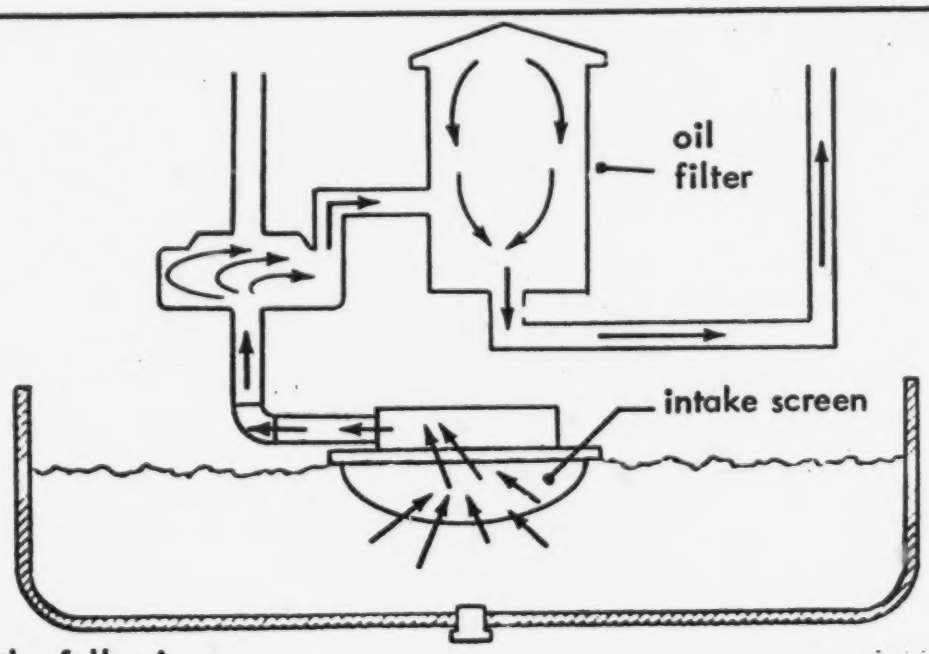

MATCH the following:

A. intake screen

B. oil filter

1. _____ filters oil going to the lines

2. _____ filters oil going to the sump

3. _____ filters oil going to the pump

19478

TECH BRIEF 68–10037—SWING ARM CARRIER PROTECTS FLEXIBLE LINES DURING TEST ITEM ROTATION

A five-gate swing arm carrier has been developed by NASA to protect the flexible lines, tubing, and cables connected to the test turntable to supply the item under test. The swing arm easily accepts arcs of +180° to –180°, keeps the line lengths to an absolute minimum, reduces the bends to one common centerline, and requires very little time for set-up and disassembly. Firms which perform turntable test procedures should consider this device and the ways in which it can be easily adapted to their particular test problems.

For additional information, circle Key No. 30 on Reader Service Card.

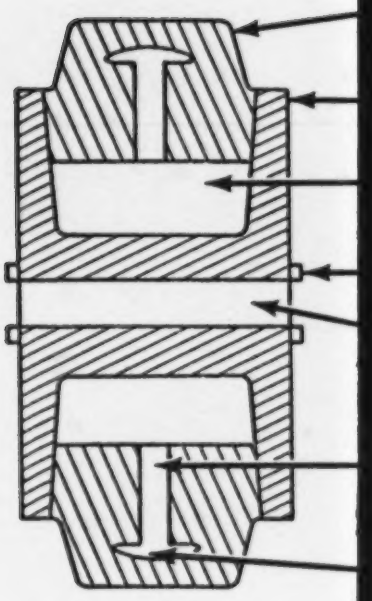

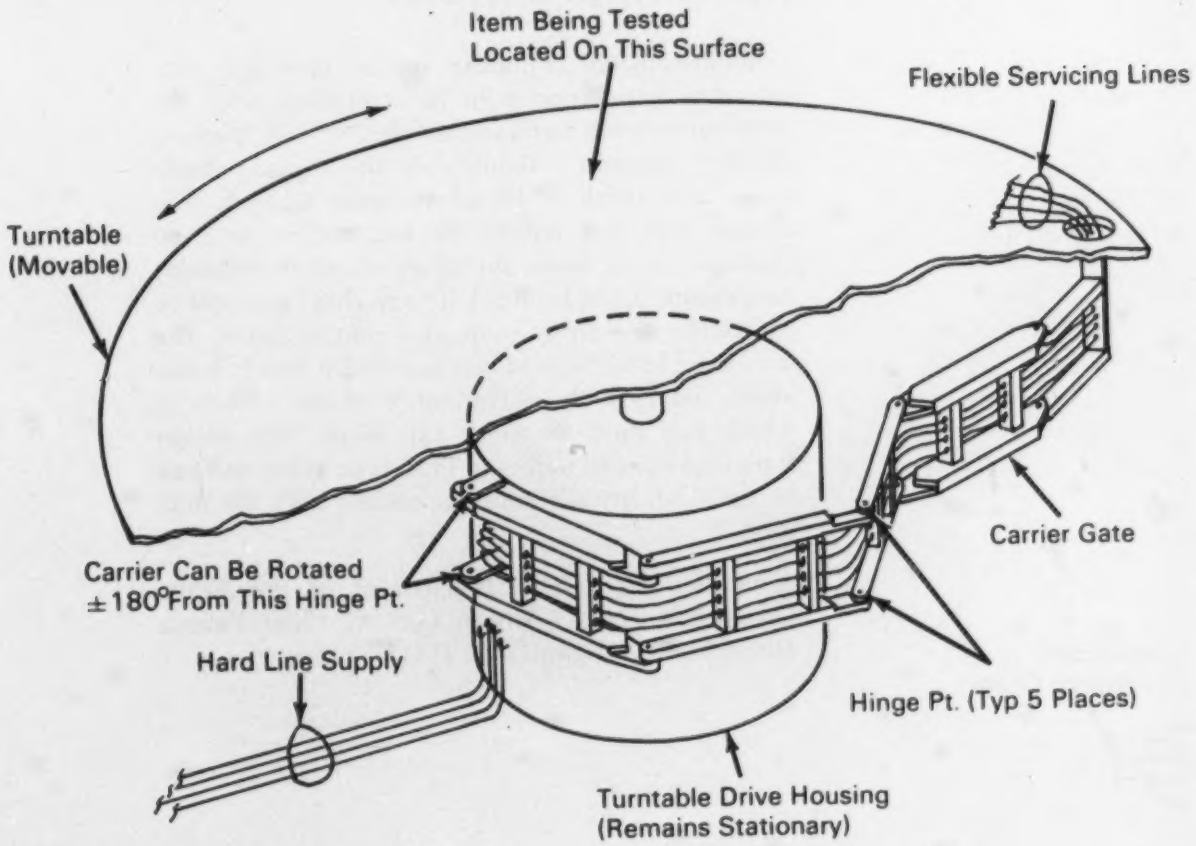

114

1. B

2. —

3. A

115

Before oil goes to the oil pump, it must first go through the:

- ☐ oil filter
- ☐ oil intake

19479

115

oil intake

116

After oil goes up through the oil intake to the pump, it is filtered.

The oil goes next to the:

- ☐ oil lines
- ☐ oil pump

117

drain plug

118

What traps dirt and dust in the oil?

- ☐ the drain plug
- ☐ the oil filter
- ☐ the oil pump

19482

118

the oil filter

119

What must be opened to remove oil from the sump?

- ☐ the drain plug
- ☐ the oil filter
- ☐ the intake screen

19483

119

the drain plug

120

NAME three things oil does in the engine:

1. _____

2. _____

3. _____

19484

120

1. cleans parts

2. cools hot spots

3. lubricates parts

121

WRITE IN the name of the parts pointed to:

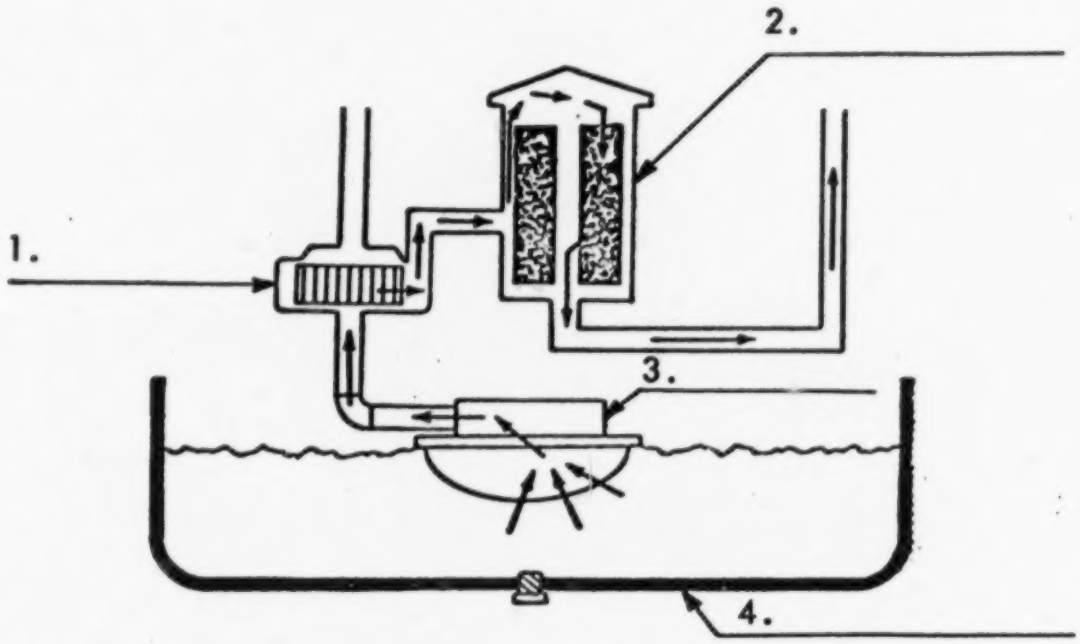

19485

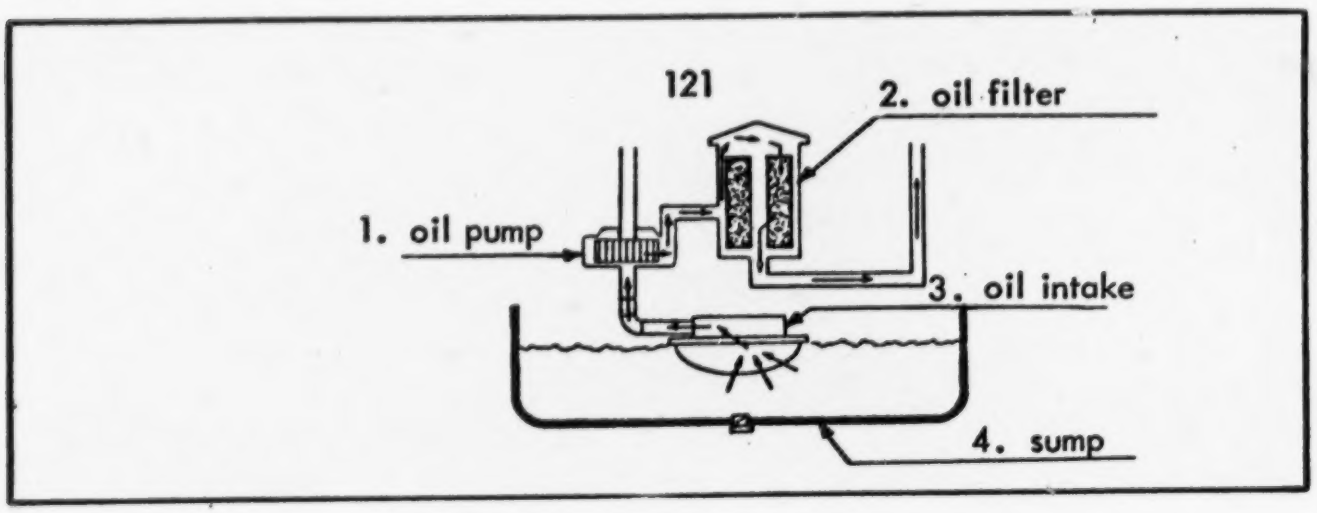

THIS IS THE END OF BOOK 18

19486

AUTO MECHANICS COURSE

POST-TEST BOOK 18: ENGINE LUBRICATING SYSTEM

A BASIC SYSTEMS PROGRAM

19487

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1-4

WRITE IN the name of the parts pointed to:

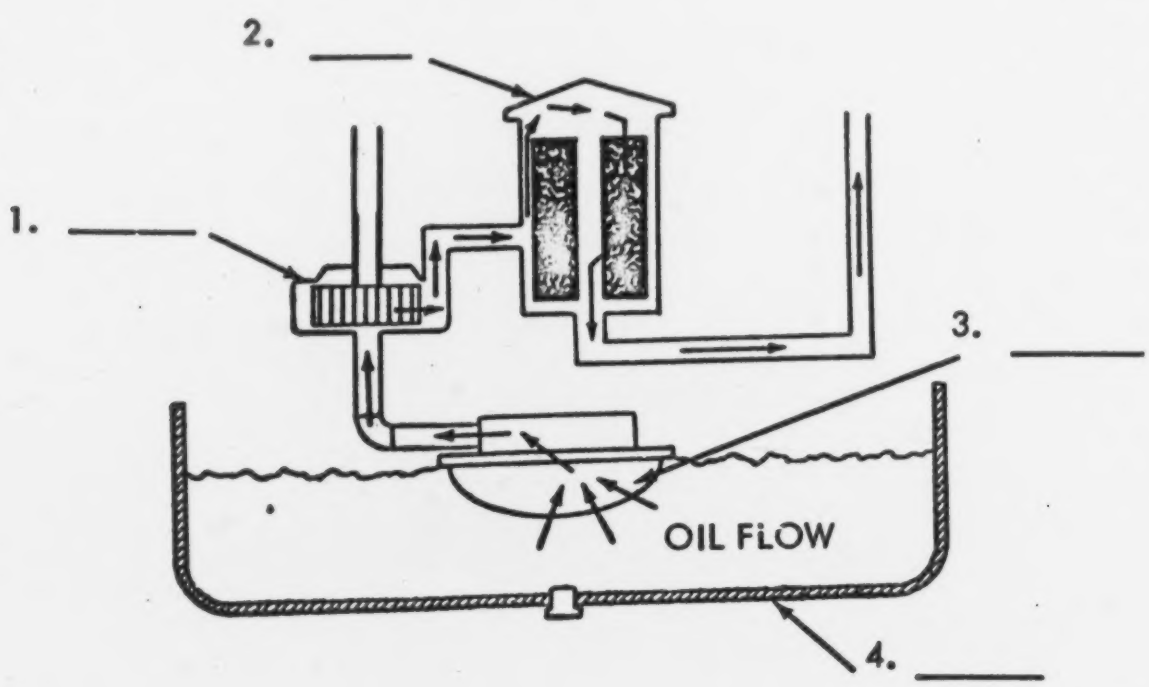

tinued)

37—SWING ARM FLEXIBLE LINES OTATION

ier has been developed ible lines, tubing, and urntable to supply the rm easily accepts arcs the line lengths to an he bends to one com- s very little time for s which perform turn- consider this device n be easily adapted to s.

circle Key No. 30 on

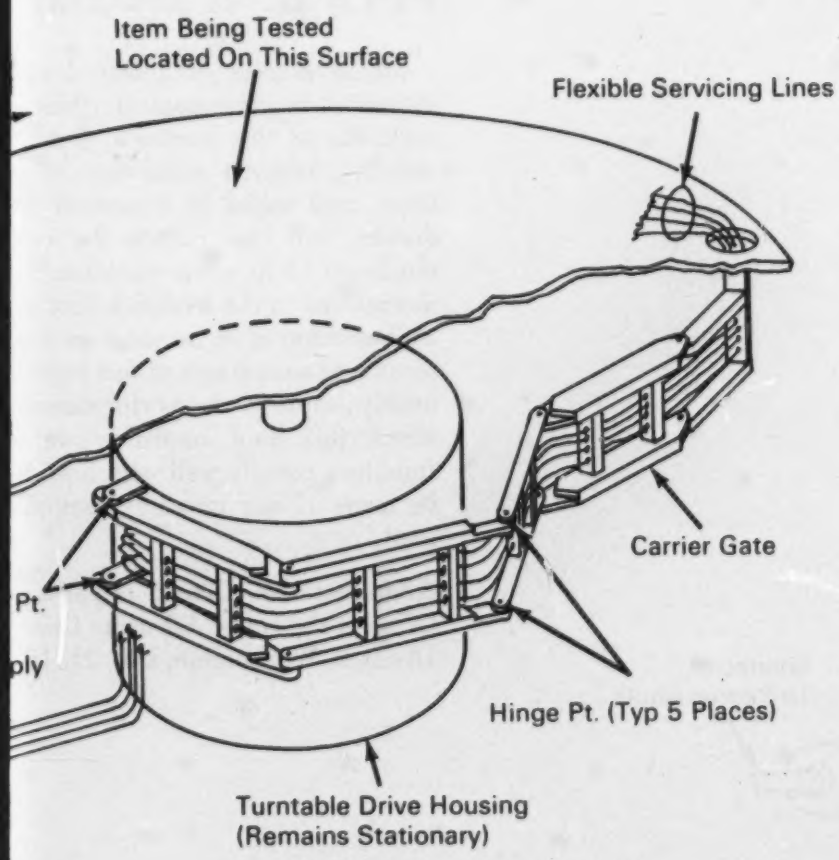

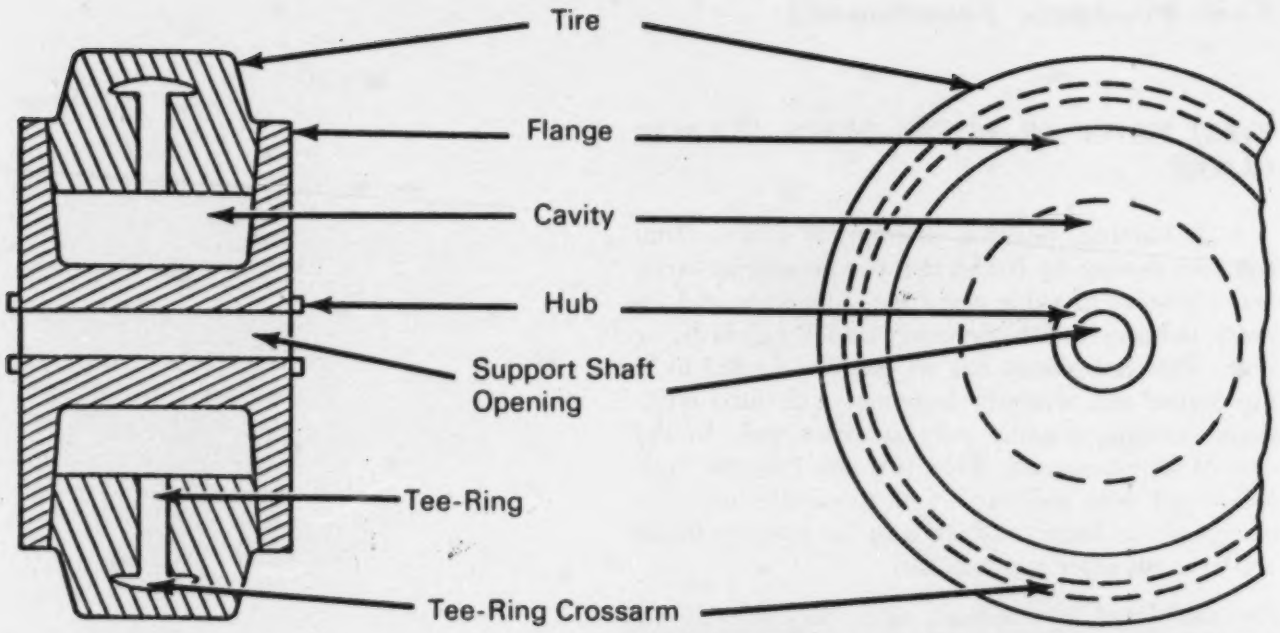

TECH BRIEF 68–10266—SHOCK-ABSORBING CASTER WHEEL IS SIMPLE AND COMPACT

Manufacturers of home appliances, garage, and mobile shop equipment may find great interest in a shock-absorbing wheel-and-tire arrangement which NASA has developed for use as a caster. Using an elastomeric tire reenforced by a T-ring, the wheel takes up impact force by compressing the tire into an air cavity under it. Elastomers are available in many hardnesses to handle many loads and impact characteristics. The wheel eliminates any need for springs, Belleville washers, and other items for shock absorption. In tests, these caster wheels satisfactorily absorbed the shock from a 12-inch free fall of a dolly and its contents onto a hard surface.

For additional information, circle Key No. 31 on Reader Service Card.

5

What job does the oil pressure relief valve do in the lubrication system?

_____

6-7

WRITE IN the name of the two bearings being lubricated:

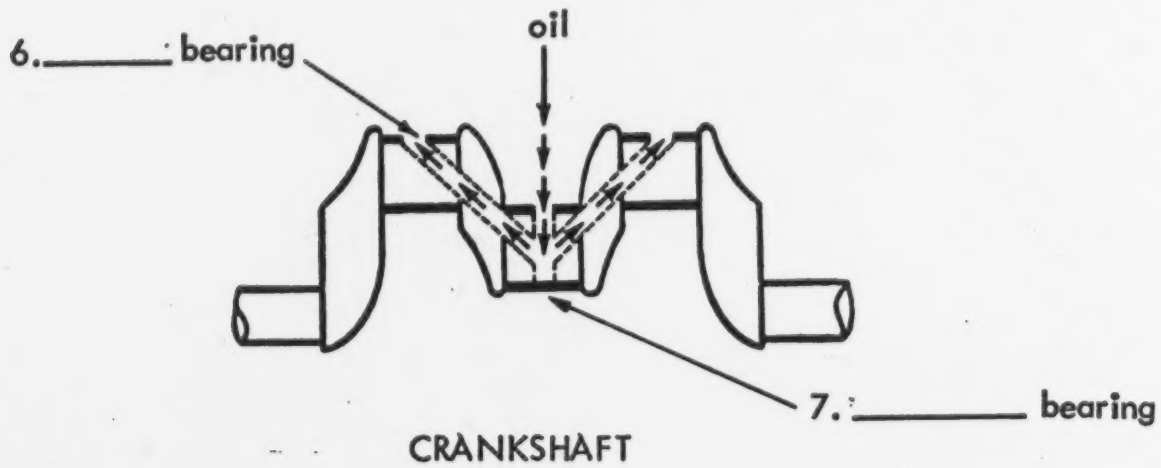

CRANKSHAFT

8-9

NAME TWO engine parts that are lubricated by oil from the rocker shaft:

8. _____

9. _____

PANEL BOOK 18

To Be Used With
BOOK 18

AUTO MECHANICS COURSE

PANEL BOOK 18: ENGINE LUBRICATING SYSTEM

A BASIC SYSTEMS PROGRAM

19490

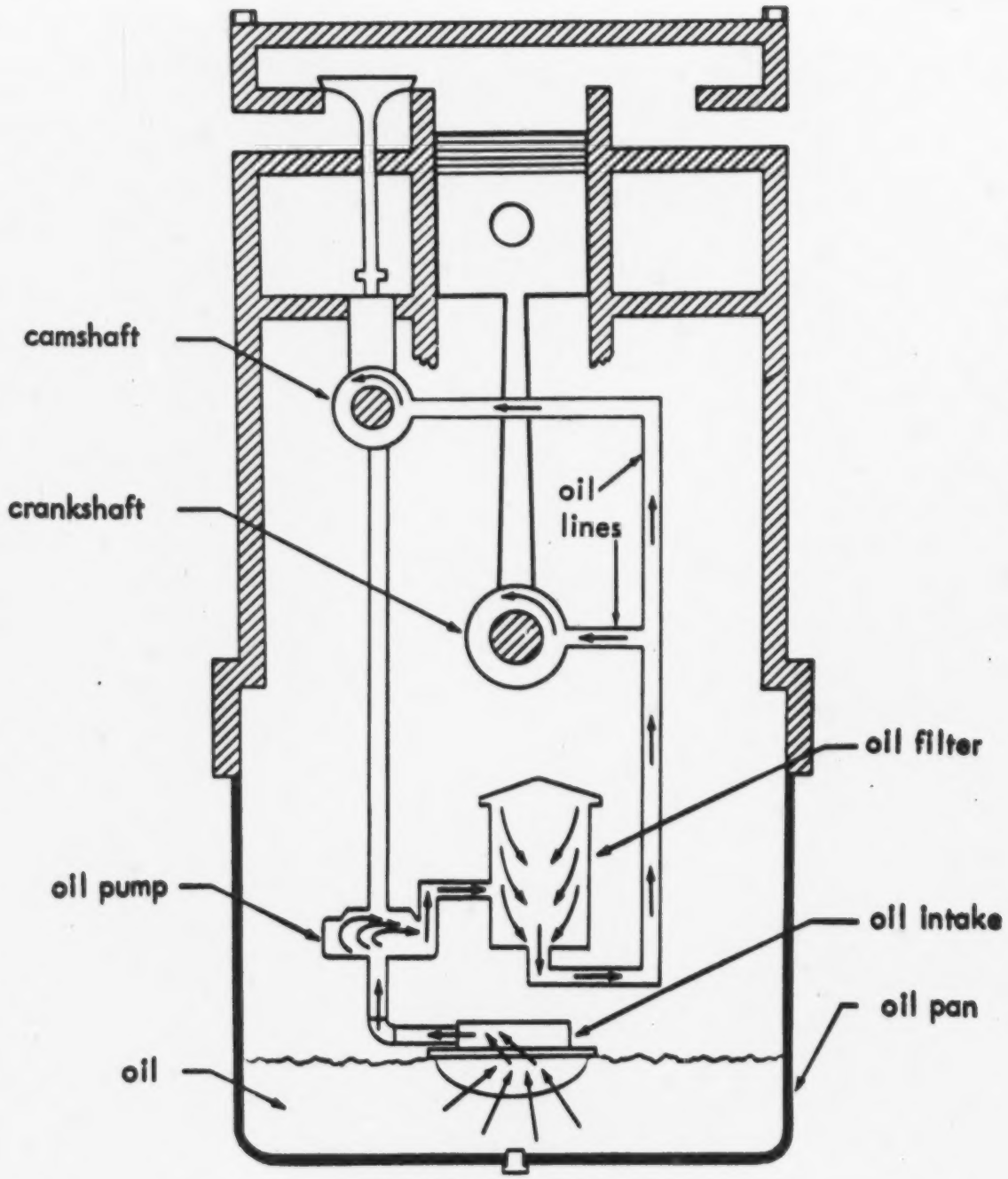

LUBRICATION SYSTEM

PANEL 1

19491

VT 013 141
Auto Mechanics Course. Book 19: Recommending Oil Changes.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 96p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; MECHANICS (PROCESS); *LUBRICANTS
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on oil changes was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 141

ED0 56238

BOOK 19

(C1)

AUTO MECHANICS COURSE

BOOK 19: RECOMMENDING OIL CHANGES

A BASIC SYSTEMS PROGRAM

VT013141

Curriculum Report Reference
Page 15

Task Analysis Reference
41.1, 41.2

19493

AUTO MECHANICS COURSE

BOOK 19: RECOMMENDING OIL CHANGES

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19494

AUTO MECHANICS COURSE

PRE-TEST BOOK 19: RECOMMENDING OIL CHANGES

A BASIC SYSTEMS PROGRAM

19495

1

An engine's motor oil can be changed according to a car manufacturer's recommendations when driving conditions are _____.

2-4

Which of the following are considered perfect driving conditions?

- ☐ city driving
- ☐ cross-country trips
- ☐ stop-and-go traffic
- ☐ summer driving
- ☐ higher speeds for long distances

5-7

CHECK the parts below that affect the amount of time between oil changes:

- ☐ the crankcase ventilator
- ☐ the crankshaft
- ☐ the oil filter
- ☐ the oil vent
- ☐ the oil pump

8

If a customer's car is driven under perfect driving conditions, how often should he change the oil? _____

9

The extreme heat of summer and the extreme frost of winter are:

- ☐ good for motor oil
- ☐ bad for motor oil

10

A customer uses his car for local stops in the city. Should he change his motor oil very often?

- ☐ yes
- ☐ no

11

A customer just came back from a winter trip to Alaska. What should you recommend for his car? _____

Name _____

Date _____

Starting time _____

Finishing time _____

19498

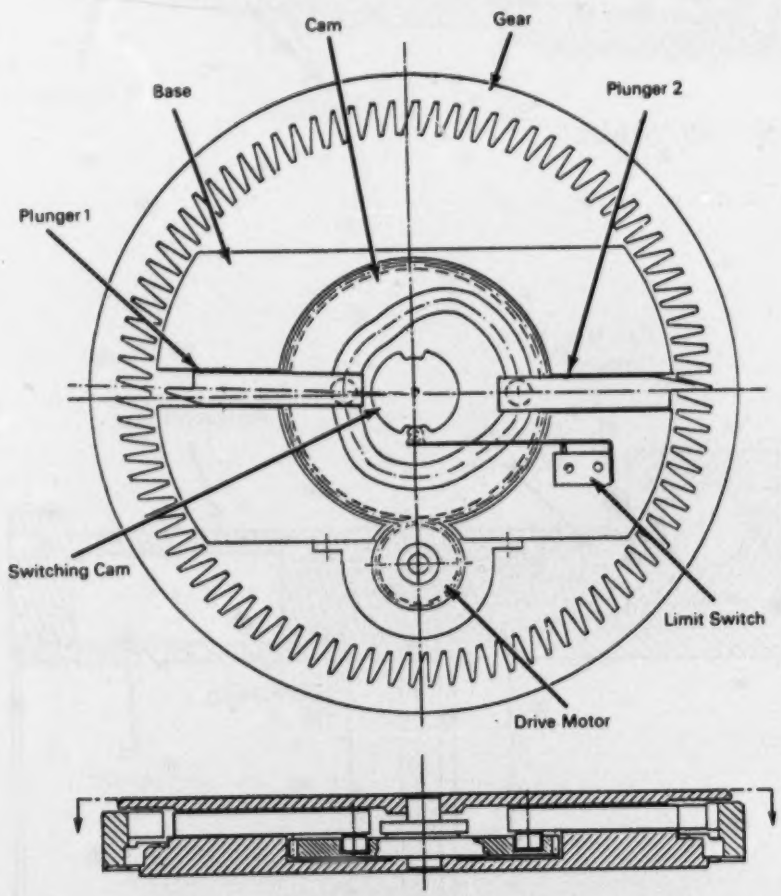

TECH BRIEF 68–10549—HIGH-TORQUE PRECISION STEPPING DRIVE

Laboratories and shops which require objects, such as antennas, optical units, and instruments, to be precisely positioned about a horizontal axis will be able to use this stepping drive mechanism developed by NASA for accurate transmission measurements. The tooth cut on the outer gear determines the increments. They provide precise 2-degree positionings which are locked in by plungers cut to mesh exactly with the gear teeth. Rotation of the cam drive will lock and unlock the plungers and advance the base by the desired angular amount. This design might also be applied to rotary tables and fixtures used in positioning parts for machining.

For additional information, circle Key No. 33 on Reader Service Card.

TECH BRIEF 68–10359—REMOTELY OPERATED GRIPPER PROVIDES VERTICAL CONTROL ROD MOVEMENT

Designers and manufacturers of automated production equipment may find use in a remotely operated gripper whose movement provides a vertical control function. Its primary function is to effect engagement between a drive shaft and the control rod by remote actuation of the gripper shaft. The secondary function is remote indication of the positive completion of the gripping or ungripping operation. Originally designed to operate in an atomic reactor, the gripper might be simplified for reliable use in overhead material handling systems, transport systems requiring remote control of the hook, and as a pickup and release device on helicopters.

For additional information, circle Key No. 32 on Reader Service Card.

1

This book will teach you about recommending oil changes.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

1

NO ANSWER NEEDED

2

The best driving conditions for operating a car are long trips at high and steady speeds in warm weather.

CHECK the conditions that are not the best driving conditions:

- ☐ city driving and short trips
- ☐ cross-country trips
- ☐ driving on parkways
- ☐ stop and go traffic
- ☐ winter frosts

19500

2

city driving and short trips

stop and go traffic

winter frosts

3

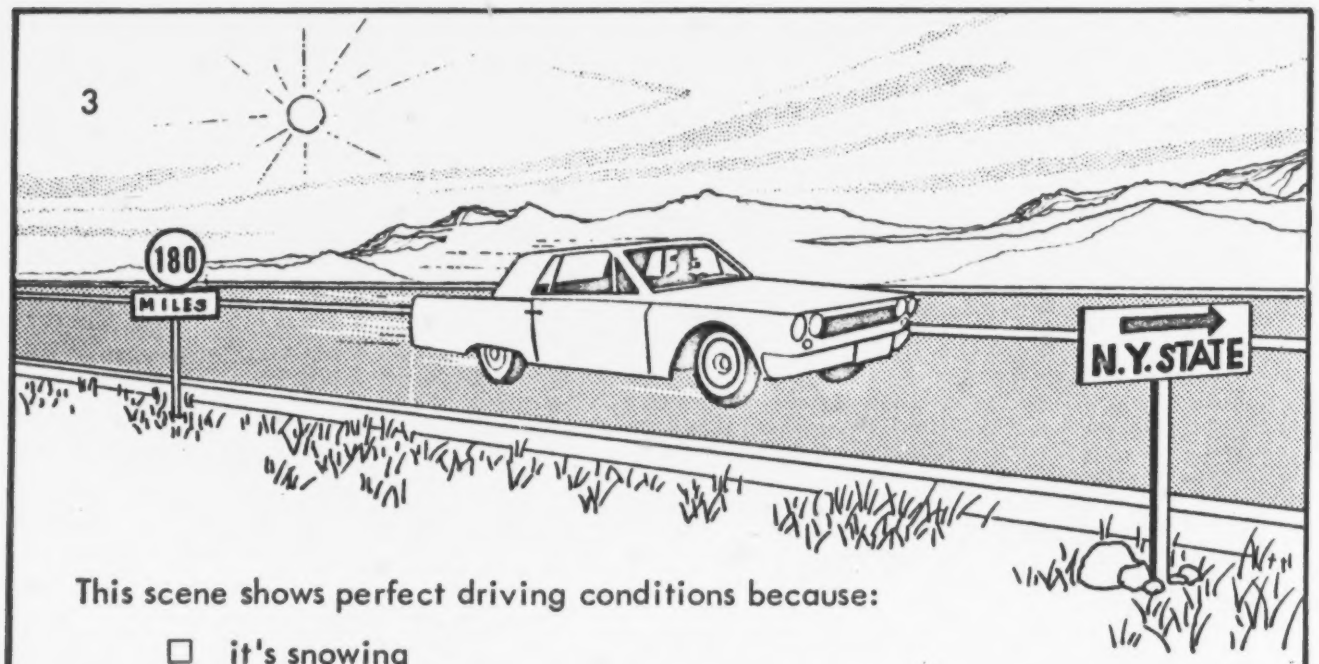

This scene shows perfect driving conditions because:

- ☐ it's snowing
- ☐ it's summertime
- ☐ the car is going at a high speed
- ☐ the car is traveling on a highway
- ☐ the car is tied up in city traffic

19501

3

it's summertime

the car is going at a high speed

the car is traveling on a highway

4

What is the perfect season for driving? _____

19502

4

summer

5

At what kind of speeds is it best to drive a car? _____

19503

5

high (speeds)

6

It is better for a car to be driven on:

- ☐ city streets
- ☐ highways

19504

6

highways

7

At what kind of speeds do cars operate best? _____

19505

7

high speeds

8

Where is most stop-and-go driving done?

- ☐ on the highways
- ☐ in city traffic

19506

8

in city traffic

9

Perfect driving conditions are warm weather, high speed and long distance.

Which one of the places below has the poorest driving conditions?

- ☐ a Florida city
- ☐ a Florida highway
- ☐ an Alaskan city
- ☐ an Alaskan highway

19507

9

an Alaskan city

10

When dirt, dust, carbon, and bits of metal build up in the engine's motor oil, they are trapped by the oil filter.

Which of the following parts keeps the oil clean?

- ☐ oil filter
- ☐ oil pan
- ☐ oil plug

19508

TECH BRIEF 68–10359—REMOTELY OPERATED GRIPPER PROVIDES VERTICAL CONTROL ROD MOVEMENT

Designers and manufacturers of automated production equipment may find use in a remotely operated gripper whose movement provides a vertical control function. Its primary function is to effect engagement between a drive shaft and the control rod by remote actuation of the gripper shaft. The secondary function is remote indication of the positive completion of the gripping or ungripping operation. Originally designed to operate in an atomic reactor, the gripper might be simplified for reliable use in overhead material handling systems, transport systems requiring remote control of the hook, and as a pickup and release device on helicopters.

For additional information, circle Key No. 32 on Reader Service Card.

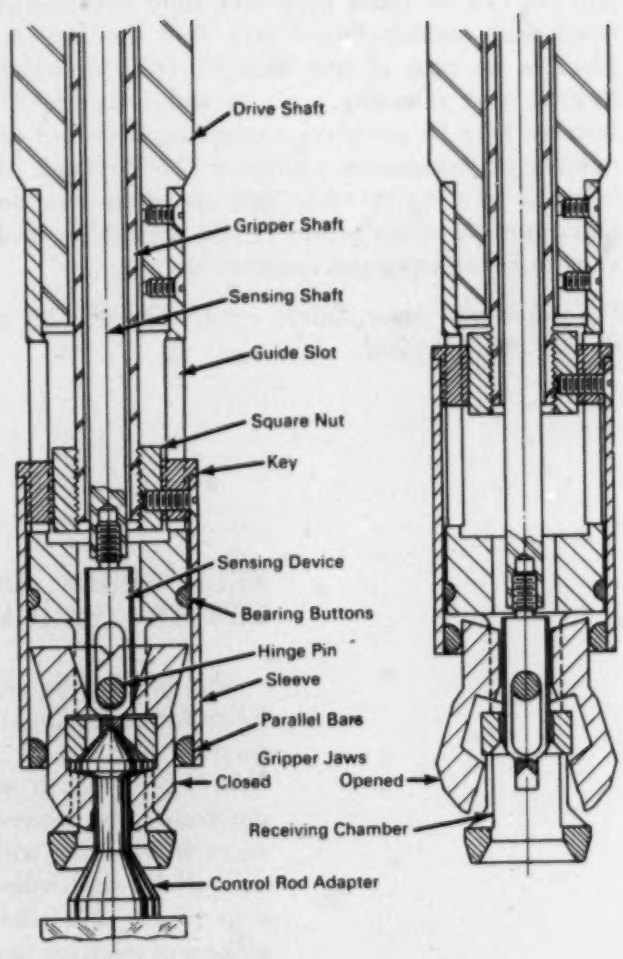

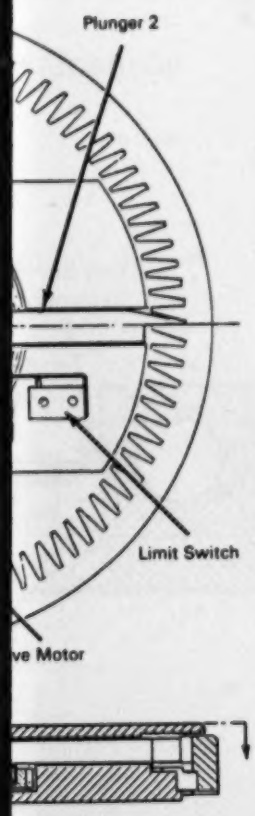

GH-TORQUE

equire objects, instruments, to zontal axis will mechanism de- ission measure- gear determines

the increments. They provide precise 2-degree positionings which are locked in by plungers cut to mesh exactly with the gear teeth. Rotation of the cam drive will lock and unlock the plungers and advance the base by the desired angular amount. This design might also be applied to rotary tables and fixtures used in positioning parts for machining.

For additional information, circle Key No. 33 on Reader Service Card.

10

oil filter

11

When water gets into the oil, sludge forms. Sludge, dirt, dust, and bits of metal are all trapped by the:

- ☐ air filter
- ☐ oil filter

19509

11

oil filter

12

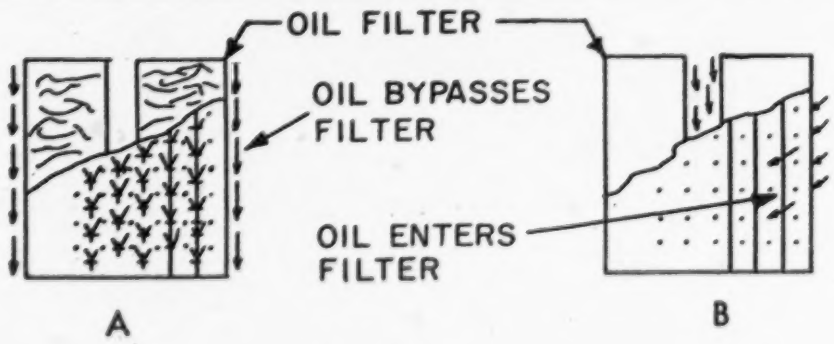

If the oil filter is not changed regularly, it will become clogged.

Which picture shows a filter that was not changed regularly?

- ☐ picture A
- ☐ picture B

19510

12

picture A

13

The condition of the car is improved by having the oil filter:

- ☐ clogged
- ☐ working

19511

13

working

14

Oil works best under perfect driving conditions.

Oil does its best job when you drive:

- ☐ long distances at fairly high and steady speeds
- ☐ short distances in which there is a lot of stopping and starting

14

long distances at fairly high and steady speeds

15

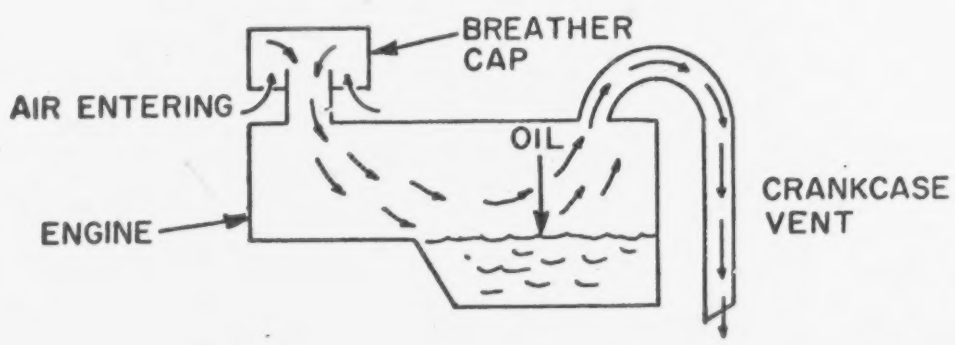

This is a picture of the crankcase ventilation system.

The BREATHER CAP lets:

- ☐ air in
- ☐ oil out
- ☐ air out

15

air in

16

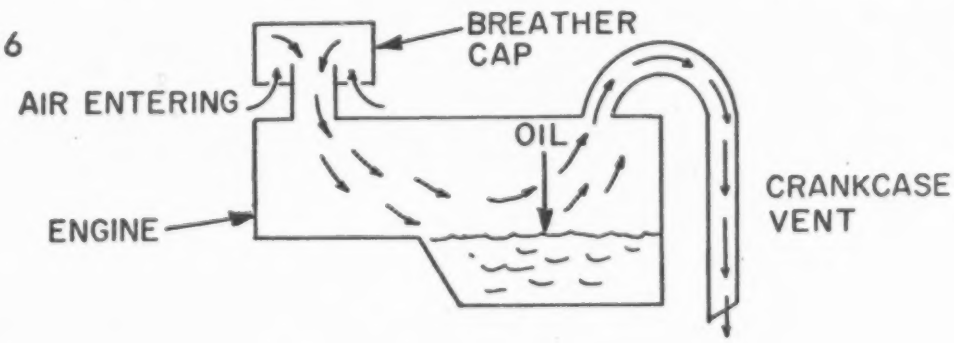

This is a diagram of a crankcase ventilation system.

Air enters the crankcase through the:

- ☐ breather cap
- ☐ crankcase vent

19514

16

breather cap

17

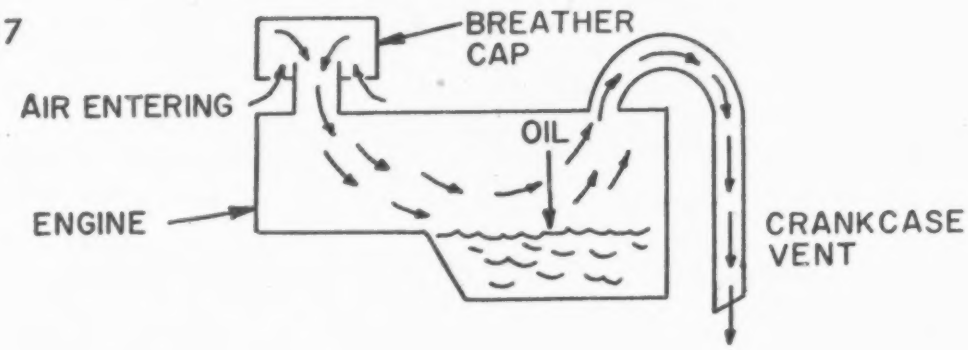

The crankcase VENT lets:

- ☐ air in
- ☐ air out
- ☐ oil in
- ☐ oil out

19515

17

air out

18

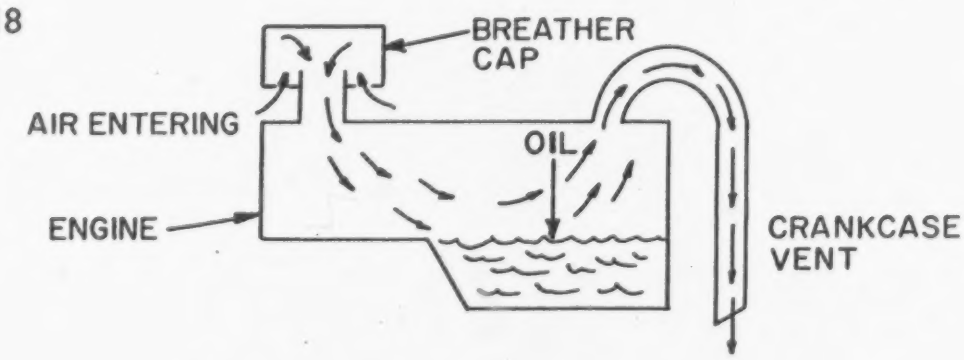

Air leaves the crankcase through the crankcase _____.

19516

18

vent

19

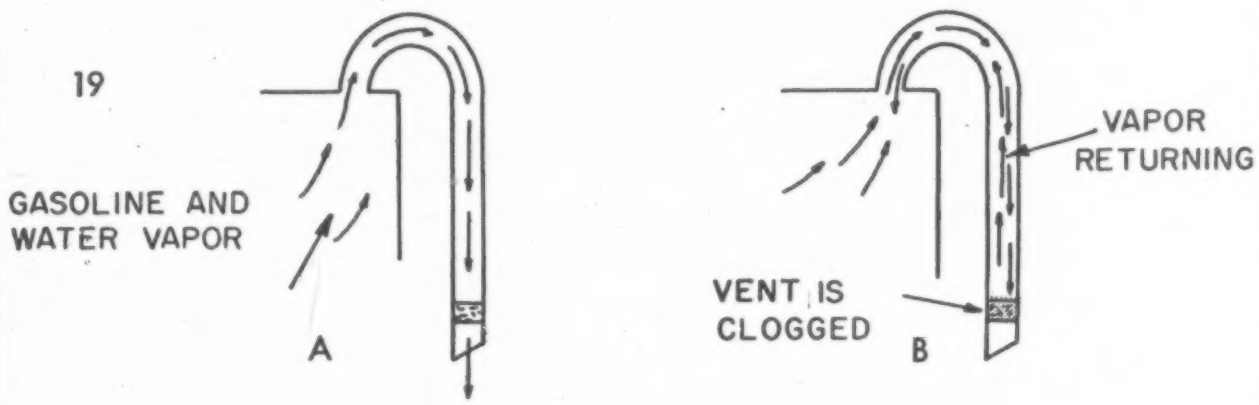

When water and gasoline get into the crankcase, they are turned to vapor. This vapor escapes through the crankcase vent.

In which picture above is the vapor escaping?

- ☐ picture A
- ☐ picture B

19517

19

picture A

20

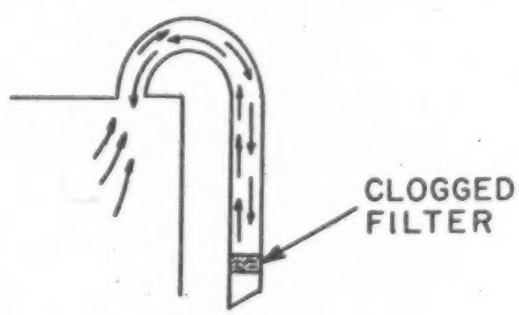

In the picture above, the crankcase vent is clogged.

Can gasoline and water vapor escape?

- ☐ yes
- ☐ no

TECH BRIEF 68–10512—BOYDBOLT, A POSITIVE-LATCH, SIMPLE-RELEASE FASTENER

The Boydbolt, a newly designed NASA fastener, will hold under extremely high dynamic preloads and yet can be freed with very little effort. Many equipment manufacturers may find the Boydbolt ideal in its ease of use, security from accidental locking and releasing, and overall strength. The fastener may be useful as a coupling device in any number of commercial products. The Boydbolt can be made in a variety of lengths and diameters, and its large-scale manufacture should present no problems to a well-equipped machine shop.

For additional information, circle Key No. 34 on Reader Service Card.

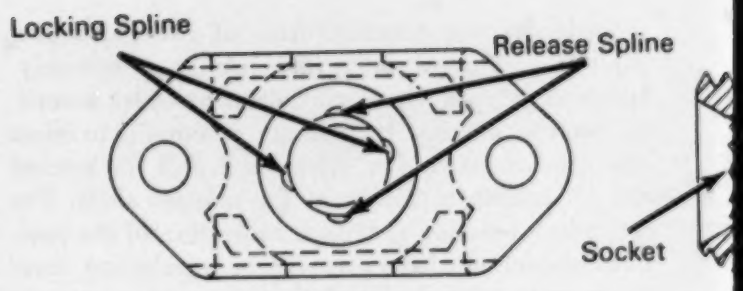

RECEPTACLE

TECH BRIEF 68–10261—DYNAMIC-RESERVOIR LUBRICATING DEVICE

This lubricating device, which meters the flow of lubricant according to the angular velocity of the rotating element, is now available as a result of NASA research. It will operate equally well with inner-race and outer-race running bearings. It insures lubrication without introducing friction, as with wicks, and without wasting oil, as with some drip feeds. This oiler should be interesting to the makers of machine tools and a wide variety of industrial equipment and heavy-duty driven machinery manufacturers. The oiler ensures the optimum supply of lubricant for the maximum operating life of the bearing.

For additional information, circle Key No. 35 on Reader Service Card.

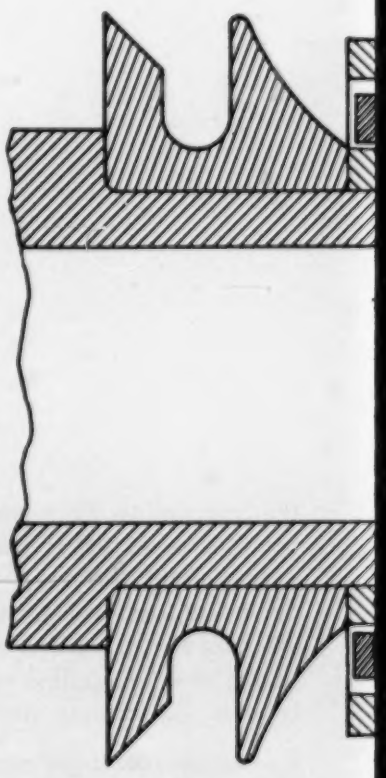

20

no

21

Oil works best if the car is in perfect condition. It will not work very well if the: (CHECK ONE OR MORE)

- ☐ crankcase vent is clogged
- ☐ crankcase vent is working
- ☐ oil filter is clogged
- ☐ oil filter is working

19519

21

crankcase vent is clogged

oil filter is clogged

22

To keep the car in perfect driving condition, the oil filter and c _____ vent should be working.

In addition, the car should be driven:

- ☐ at fairly high speeds
- ☐ at fairly low speeds
- ☐ for long distances
- ☐ for short distances

22

crankcase

at fairly high speeds

for long distances

23

After a few hundred miles, dust and bits of metal get into the oil and make it:

- ☐ cool
- ☐ dirty
- ☐ lubricate better

19521

23

dirty

24

If it rains very hard, or the car goes through a river, acids and sludge form in the oil.

What causes the acids and sludge to form?

- ☐ dirt
- ☐ gasoline
- ☐ water

276 OF 327

ED

056 238

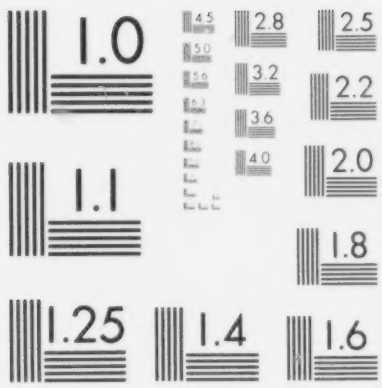

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

24

water

25

MATCH the following:

A. dust and bits of metal

B. gasoline

C. water

1. _____ form(s) acids and sludge

2. _____ make(s) oil dirty

19523

25

1. C

2. A

26

CHECK every item that helps driving conditions:

- ☐ a clean crankcase vent
- ☐ a dirty breather cap
- ☐ frost and ice
- ☐ short trips in the city
- ☐ highway traveling from city to city
- ☐ warm weather

19524

26

a clean crankcase vent

highway traveling from city to city

warm weather

27

WRITE the letter "B" next to the bad driving conditions.

WRITE the letter "G" next to the good driving conditions.

_____ a clean oil breather

_____ a clogged crankcase vent

_____ driving to the corner market

_____ an oil filter filled with sludge

_____ using the car for long summer vactions

27

G

B

B

B

G

28

Engines work best when they are warm.

When an engine is cold, it works:

- ☐ poorly
- ☐ well

19526

28

poorly

29

Engines work best when they are:

- ☐ cold
- ☐ warm

19527

OLT, A
SE FAS-

A fastener,
c preloads
ort. Many
Boydbolt
accidental
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No. 34 on

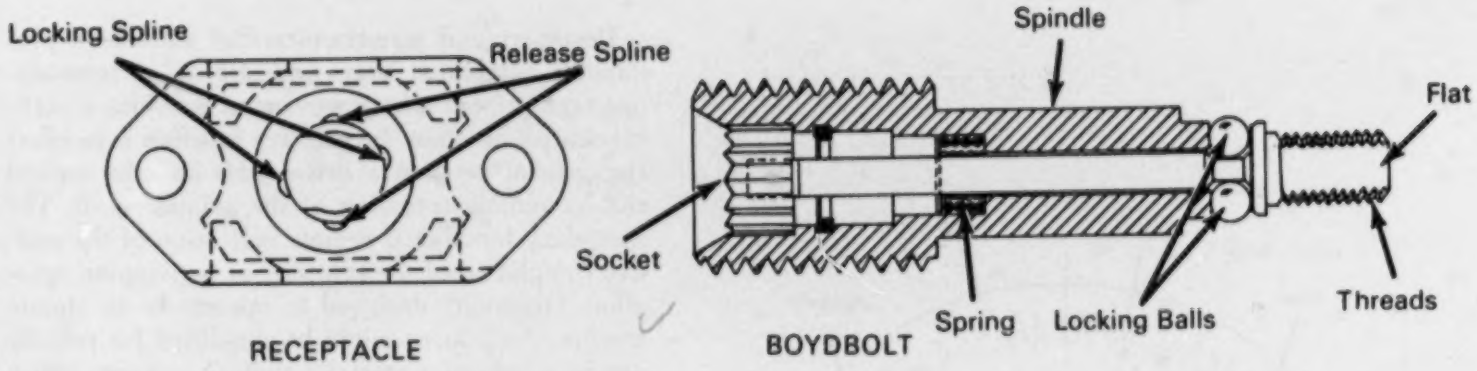

IEF 68–10261—DYNAMIC-RES-
UBRICATING DEVICE

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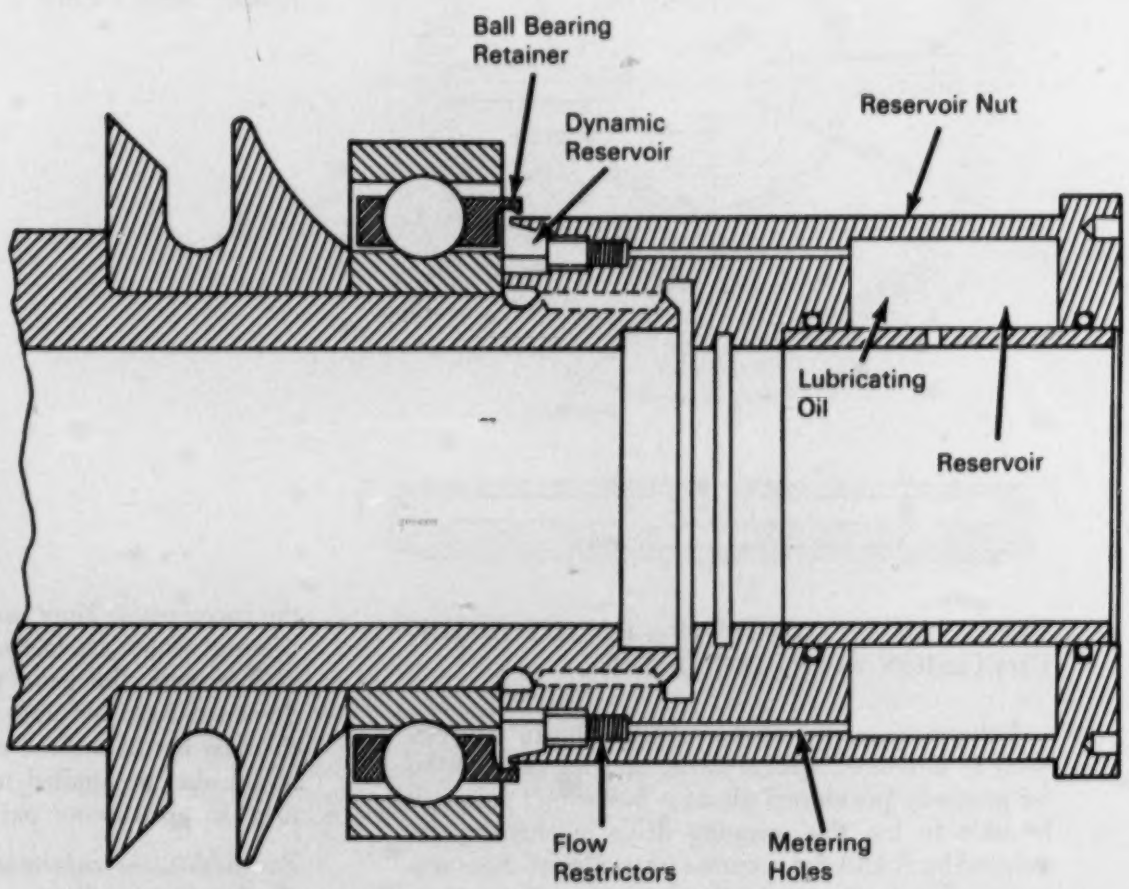

29

warm

30

Engines need time to warm up.

An engine will be warmer in:

- ☐ long-distance driving
- ☐ stop-and-start driving

19528

30

long-distance driving

31

Most short-distance driving is done in the city. In this kind of driving the driver does:

- ☐ a lot of stopping and starting
- ☐ little stopping and starting

Under these conditions, will the engine have time to warm up properly?

- ☐ yes
- ☐ no

19529

31

a lot of stopping and starting

no

32

When the engine is cold, water forms on the cylinder walls. This water gets into the oil and forms sludge.

Which driving condition will cause the most sludge?

- ☐ using the car for many very short trips
- ☐ cross-country traveling
- ☐ using the car for vacation trips

32

using the car for many very short trips

33

When too much sludge, dirt and acid accumulate in the motor oil, the motor oil should be drained and fresh oil added to the engine.

The oil should be:

- ☐ changed
- ☐ kept
- ☐ re-used

19531

33

changed

34

Motor oil should be changed when:

- ☐ it gets dirty
- ☐ it stays in the automobile
- ☐ sludge and acids accumulate
- ☐ it is still clean

34

it gets dirty

sludge and acids accumulate

35

When the conditions for driving are perfect, an engine's motor oil will last for a long time.

CHECK the conditions under which oil will <u>not</u> last for a very long time:

- ☐ a clogged crankcase vent
- ☐ an oil filter filled with sludge
- ☐ highway driving
- ☐ stop-and-go city driving
- ☐ using a car only during the summer

35

a clogged crankcase vent

an oil filter filled with sludge

stop-and-go city driving

36

An engine's motor oil can be used for a long time when the:

- ☐ crankcase vent and oil breather are clean
- ☐ car is used for long-distance driving
- ☐ car is used for short trips in the city
- ☐ car is driven in warm weather
- ☐ car is driven in the winter time

19534

36

crankcase vent and oil breather are clean

car is used for long-distance driving

car is driven in warm weather

37

Which of the following are considered perfect driving conditions?

- ☐ driving in warm weather
- ☐ driving in cold weather
- ☐ long-distance driving
- ☐ stop-and-go driving
- ☐ a clean oil filter, crankcase vent and oil breather
- ☐ a clogged oil filter, crankcase vent and oil breather

37

driving in warm weather

long-distance driving

a clean oil filter, crankcase vent and oil breather

38

Since perfect driving conditions mean few oil changes, motor oil should be changed often when:

- ☐ the car is used in city traffic
- ☐ the crankcase vent and oil breather are working properly
- ☐ using the car for lots of highway driving
- ☐ the oil filter is clogged
- ☐ using the car during the winter

19536

38

the car is used in city traffic

the oil filter is clogged

using the car during the winter

39

MATCH the following:

A. perfect driving conditions

B. poor driving conditions

1. _____ city driving
2. _____ highway driving
3. _____ summer road conditions
4. _____ winter road conditions

19537

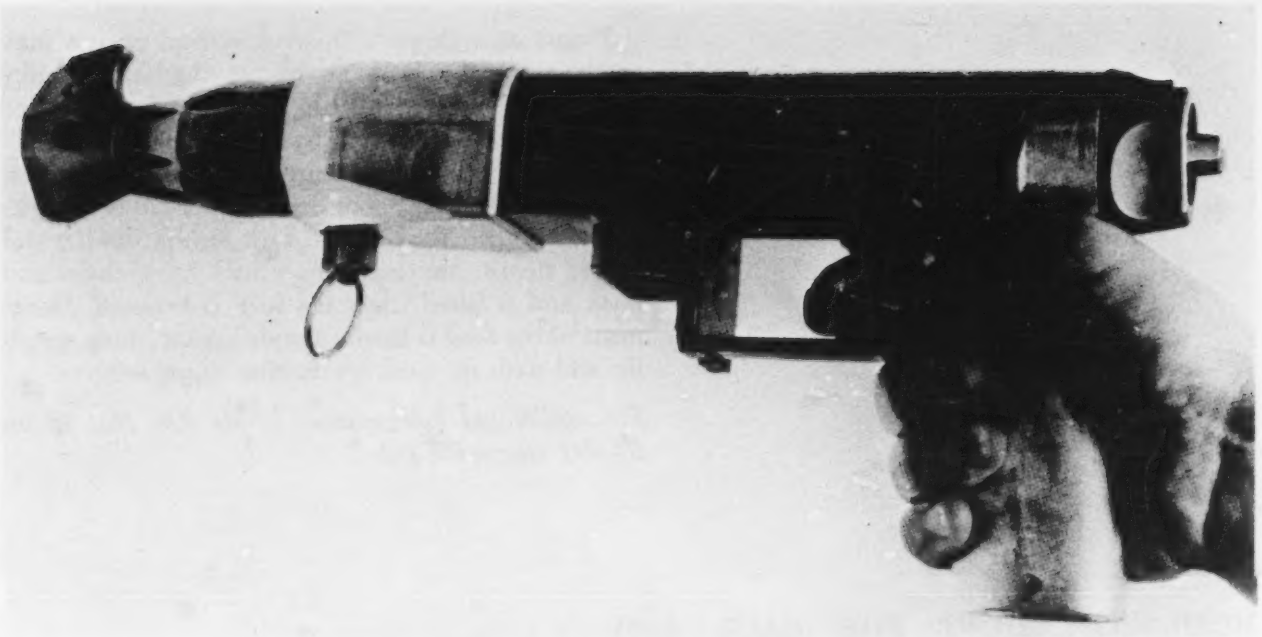

TECH BRIEF 68–10371—VERSATILE IMPACT HANDTOOL

When an extremely powerful impact is needed from a handtool for driving, punching, hammering, or shearing, this cartridge-actuated tool developed by NASA may provide an ideal answer. Equipped with easily interchangeable attachments for the four functions, the tool is hand held. Cartridges are fed into the tool from a magazine to allow rapid repetition when needed. An I-clamp locks the tool to the work surface to reduce recoil, and the impact power can be adjusted within limits. The tool could be very useful in the construction and renovation trades, and in the maintenance departments of most plants.

For additional information, circle Key No. 36 on Reader Service Card.

39

1. B

2. A

3. A

4. B

40

MATCH the following:

A. frequent oil changes

B. few oil changes

1. _____ high speeds for long trips

2. _____ low speeds for short trips

3. _____ winter driving

4. _____ summer driving

19538

40

1. A

2. B

3. A

4. B

41

Most automobile manufacturers recommend that the oil be changed every 2000 miles depending on driving conditions.

If a person changes his oil every 2000 miles, is he following manufacturers' recommendations?

- ☐ yes
- ☐ no

19539

41

yes

42

BOB

JOE

Who changes his oil more often?

- ☐ Bob
- ☐ Joe

Automobile manufacturers recommend changing your oil every:

- ☐ 2000 miles
- ☐ 500 to 1000 miles
- ☐ 10,000 miles

19540

42

Joe

2000 miles

43

After 2,000 miles, it is recommended that your oil be _____.

19541

43

changed

44

How often you change your motor oil depends on:

- ☐ driving conditions
- ☐ life of the car
- ☐ wear on the filter

19542

44

driving conditions

45

When driving conditions are perfect, motor oil can be changed every:

- ☐ 200 miles
- ☐ 2,000 miles
- ☐ 20,000 miles

19543

45

2,000 miles

46

Frequent oil changes are necessary when driving conditions are:

- ☐ perfect
- ☐ poor

19544

47

2,000 miles

48

Car manufacturers' recommendations for changing oil should be followed when driving conditions are:

- ☐ perfect
- ☐ poor

19546

48

perfect

49

When a car is driven at fairly high speeds for long distances and during warm weather, the oil needs to be changed less often.

This is because these driving conditions are:

- ☐ perfect
- ☐ poor

19547

ed)

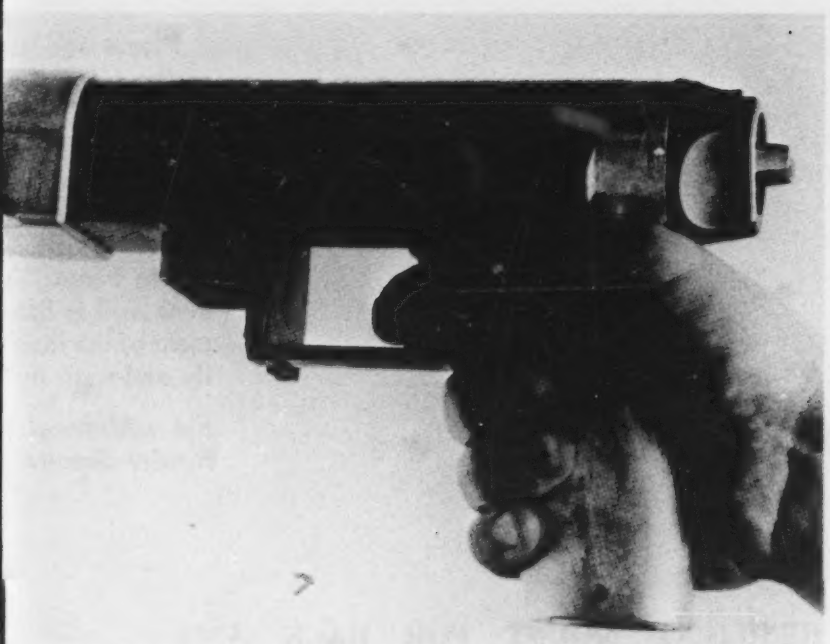

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ditional information, circle Key No. 36 on Service Card.

To order Clearinghouse reports (numbers prefixed AD, LA, PB, or N) and patents, list numbers on Reader Service Cards.

METHOD OF MAKING HEAT EXCHANGERS (PAT. NO. 3,340,588)

Manufacturers concerned with heat exchangers either as a primary product or as a component of other equipment will be interested in this novel method of making a spiral heat exchanger. The elements of the heat exchanger, especially unusually large units, are first assembled in proper relative proportions and then the unit is fed into a brazing furnace of ordinary size. After the brazing operation is completed the unit is wound in a spiral form to any desired size. The fluid coolant carrying tube has corrugated fins brazed on both sides. Filler blocks are inserted in alternate recesses to prevent collapse of the fin members. Separating strips prevent meshing of fins of adjacent spirals. The simple construction and efficient operation of this heat exchanger will appeal to many users, especially in the chemical and food-processing fields.

Administering Office: Department of the Air Force, Office of the Judge Advocate General, Chief, Patents Branch, Washington, D.C. 20333.

49

perfect

50

Perfect driving conditions are those in which the weather is warm, you drive long distances, and you travel at fairly high speeds.

Are driving conditions better during summer or winter?

- ☐ summer
- ☐ winter

Driving conditions are better:

- ☐ in city traffic
- ☐ on the highways

19548

50

summer

on the highways

51

If a car stops and starts often and needs frequent oil changes, it is being operated under conditions that are:

- ☐ perfect for driving
- ☐ poor for driving

The oil should be changed:

- ☐ every 2,000 miles
- ☐ more often than every 2,000 miles

19549

51

poor for driving

more often than every 2,000 miles

52

Driving conditions and the CONDITION OF THE CAR will affect the same thing.

The condition of the car will determine:

- ☐ changing weather
- ☐ how often you change the oil
- ☐ the condition of the roads

19550

52

how often you change the oil

53

Driving conditions affect how often you must change oil.

What other condition will also determine how often the oil must be changed?

- ☐ the condition of the car
- ☐ the condition of the driver
- ☐ the condition of the steering system

19551

53

the condition of the car

54

To get rid of dirt, dust, and sludge, the oil should be _____ regularly.

19552

54

changed

55

People who do a lot of short-distance, stop-and-start driving should change their car's oil:

- ☐ more often
- ☐ less often

This is because short-distance, stop-and-start driving does not give the engine a chance to:

- ☐ cool off
- ☐ warm up

19553

55

more often

warm up

56

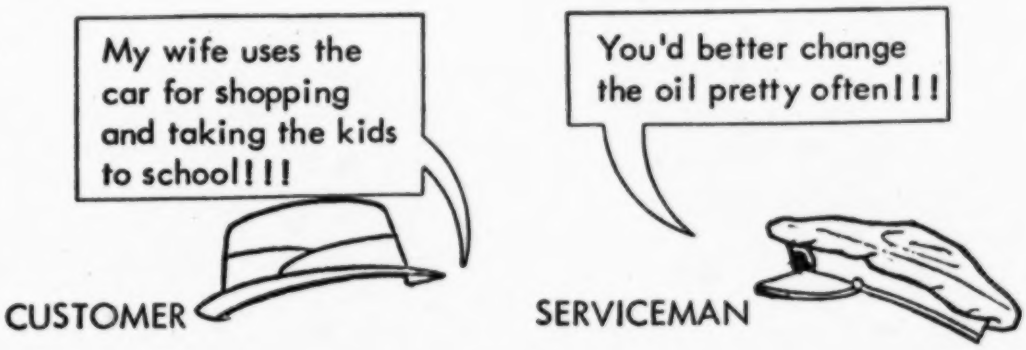

The serviceman suggested frequent oil changes because the customer's car is used for:

- ☐ city stop-and-go driving
- ☐ long-distance highway driving

19554

56

city stop-and-go driving

57

Any extreme temperature is bad for running an automobile.

Which of the following are extreme temperatures?

- ☐ high summer heat
- ☐ mild spring weather
- ☐ severe winter frost

19555

57

high summer heat

severe winter frost

58

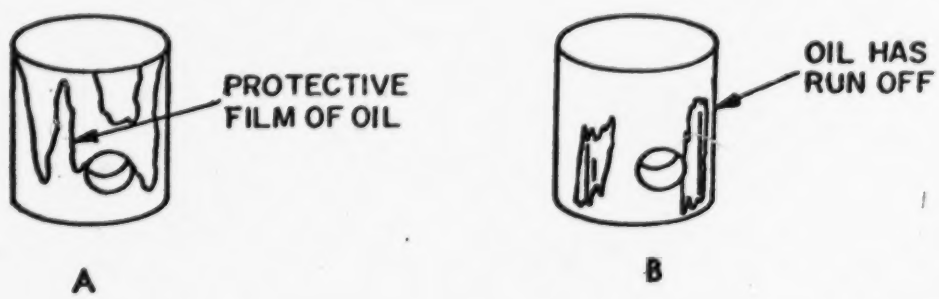

If the engine gets too hot, the oil will become so thin that it will be unable to protect engine parts.

Which picture above shows oil that is too hot?

- ☐ picture A
- ☐ picture B

19556

58

picture B

59

Oil tends to thin more during the:

- ☐ extreme heat of summer
- ☐ extreme cold of winter

19557

TECH BRIEF 68–10370—WATER-COOLED MOUNT FOR MINIATURE PRESSURE TRANSDUCERS

Pressure measurements taken from hot enclosures, such as ovens and furnaces, can be facilitated by a water-cooled mounting for miniature pressure transducers. For the first time it was possible to measure the pressure fluctuations in an axial-flow engine compressor. The mounting has already been used by NASA in a variety of installations where gas temperatures exceeded 1,000° F. Performance was rated excellent and the responses taken covered several hundred Hertz. The mount can be fabricated and assembled by any well-equipped laboratory with shop facilities available, or by a machine shop.

For additional information, circle Key No. 37 on Reader Service Card.

RESILIENT MOUNT FOR RACK PANEL-TYPE ELECTRICAL CONNE (PAT. NO. 3,363,218)

Resilient mountings for drawer, rack, a connectors have caused trouble in the pas alinement, open connections, and by need plexity in design and maintenance. This nique provides a resilient mount for c subject to impact as might come from slidi ming, pushing, and other motions common t rack, or panel installations. The mount as combining of the telescoping connector elen will be complete until definite actions to the connectors are made. The mount is si signed and easily manufactured; it needs maintenance. The patent should be attracti equipment manufacturers for garage, han gine test racks, and other areas where int able electronic units get rough handlin normal operations.

Administering Office: Department of th Office of the Judge Advocate General, Chie Division, Washington, D.C. 21315.

59

extreme heat of summer

60

The oil film on engine parts, such as the piston, valves, and cylinder walls, will burn if the engine is run when it is too:

- ☐ hot
- ☐ cold

19558

60

hot

61

Burnt oil collecting in the crankcase forms harmful gums and varnish that coat engine parts and clog oil passages.

If a car is run during the extreme heat of summer:

- ☐ more oil will be burned
- ☐ less oil will be burned

61

more oil will be burned

62

Engines run during extremely hot weather should have their oil changed:

- ☐ more often
- ☐ less often

19560

62

more often

63

If a car is run during dusty weather, some of the dust will get into the oil. To prevent this dust from clogging the oil filter, the oil should be

_____.

19561

63

changed

64

Should the oil be changed after a car is driven across the Arizona desert?

- ☐ yes
- ☐ no

19562

64

yes

65

In dusty weather, oil should be changed more often because the oil filter may get _____.

19563

65

clogged

66

What gets clogged in dusty weather? _____

19564

66

the oil filter

67

When oil filters become clogged, they should be:

- ☐ by-passed to avoid filtering
- ☐ ignored for oil filters are a nuisance
- ☐ replaced with a clean oil filter

67

replaced with a clean oil filter

68

During extremely cold weather the engine does not have time to warm up. Water gets into the oil and forms acids and sludge.

Under these conditions the oil should be changed:

- ☐ more often
- ☐ less often

19566

68

more often

69

Oil should be changed more often if the car is driven in: (CHECK ONE OR MORE)

- ☐ extremely cold weather
- ☐ extremely hot weather
- ☐ warm, but not hot, weather

Should the oil be changed if the car is driven in a dust storm?

- ☐ yes
- ☐ no

19567

d)

TER-COOLED
PRESSURE

m hot enclosures,
facilitated by a
e pressure trans-
sible to measure
flow engine com-
y been used by
here gas temper-
nance was rated
covered several
fabricated and
laboratory with
chine shop.

Key No. 37 on

TECH BRIEF 68-10575—HOISTING FRAME FACILITATES HANDLING OF LARGE OBJECTS

Plants and shops without overhead cranes may easily solve the problem of moving large, bulky objects by using a hoisting frame and a standard 5-ton forklift. Developed by NASA for moving 33-foot spreaders, the hoist rig has a counterweight on the long end of its boom that accepts the twin forks of the forklift. Raising the fork lowers the lift end of the boom; the load is secured by a chain and hook and is lifted when the fork is lowered. Movement of the load is then a simple matter, done speedily and with no need for further equipment.

For additional information, circle Key No. 38 on Reader Service Card.

RESILIENT MOUNT FOR RACK AND PANEL-TYPE ELECTRICAL CONNECTORS (PAT. NO. 3,363,218)

Resilient mountings for drawer, rack, and panel connectors have caused trouble in the past by misalinement, open connections, and by needless complexity in design and maintenance. This new technique provides a resilient mount for connectors subject to impact as might come from sliding, slamming, pushing, and other motions common to drawer, rack, or panel installations. The mount assures the combining of the telescoping connector elements and will be complete until definite actions to disengage the connectors are made. The mount is simply designed and easily manufactured; it needs little in maintenance. The patent should be attractive to test equipment manufacturers for garage, hangars, engine test racks, and other areas where interchangeable electronic units get rough handling during normal operations.

Administering Office: Department of the Army, Office of the Judge Advocate General, Chief, Patents Division, Washington, D.C. 21315.

69

extremely cold weather

extremely hot weather

yes

70

This section has told you about recommending:

- ☐ oil changes
- ☐ oil filters

19568

70

oil changes

71

When the crankcase vent, oil breather and oil filter are working properly, you should change your oil:

- ☐ according to the car manufacturer's recommendations
- ☐ more often than the intervals recommended by the car manufacturer

71

according to the car manufacturer's recommendations

72

You may change your motor oil as often as the manufacturer recommends when you drive at high _____, for long d_____.

What should be working?

1. the oil f_____
2. the crankcase v_____

19570

72

speeds

distances

filter

vent

73

The perfect conditions for motor oil are:

speed

- ☐ fast
- ☐ slow

distance

- ☐ long
- ☐ short

oil filter

- ☐ is working
- ☐ is not working

crankcase vent

- ☐ is clogged
- ☐ is not clogged

19571

73

fast

long

is working

is not clogged

74

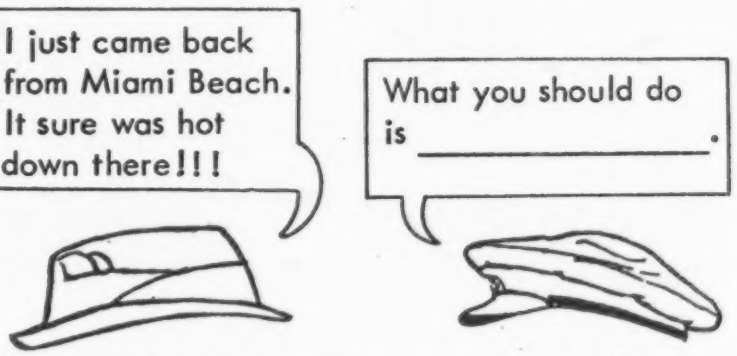

What do you think the serviceman told the customer?

- ☐ "change your motor oil"
- ☐ "junk the car"
- ☐ "return to Florida"

19572

74

"change your motor oil"

75

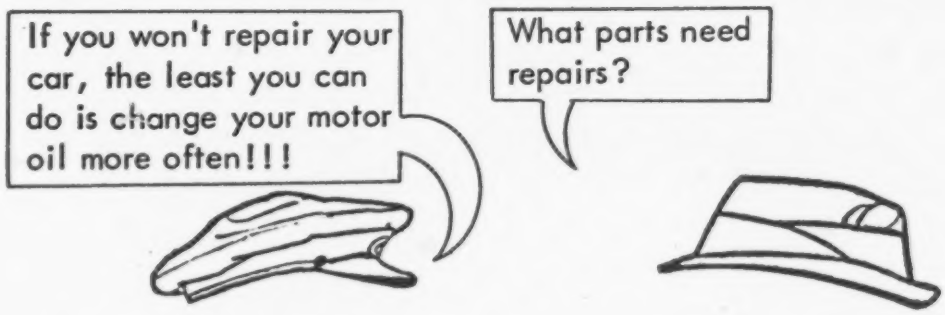

NAME the parts that could need servicing:

- ☐ the oil filter
- ☐ the crankcase breather
- ☐ the oil vent
- ☐ the gas filter

19573

75

the oil filter

the crankcase breather

the oil vent

76

If driving conditions are perfect, how often should you change an engine's motor oil? _____

19574

76

every 2,000 miles

77

If a car is driven under conditions that are <u>not</u> perfect, the motor oil should be changed:

- ☐ every 2,000 miles
- ☐ more often than every 2,000 miles
- ☐ less often than every 2,000 miles

19575

77

more often than every 2,000 miles

78

The amount of time between oil changes depends upon:

- ☐ the condition of the car
- ☐ driving conditions
- ☐ road conditions

19576

78

condition of the car

driving conditions

79

Motor oil should be changed _____ often when the car is used for city driving.

19577

DEVICE FOR TAKING FLUID SAMPLES FROM CLOSED SYSTEMS (PAT. NO. 3,412,613)

Chemical laboratories, the chemical and pharmaceutical industry, and a variety of other manufacturers may find great value in this newly designed probe to be used for pulling liquid samples from sealed containers or systems without any danger of contaminating. As with other devices of this kind, a sealing block or plug of special design must already be installed in the system of the container. Such a block permits passages to be made and resealed after use. It also affords the passage of a long probe-like device for collecting the fluid sample from any depth inside the container or system. The block has the means to reseal the passage once the probe has been withdrawn. This device can be easily connected into existing vacuum or purging systems. It also can be easily modified to meet the requirements of specific listing conditions and goals.

Administering Office: Department of the Interior, The Solicitor, Patents Branch, Washington, D.C. 20242.

TECH BRIEF 68–10387—MINIATURE PAINT-SPRAY GUN FOR RECESSED AREAS

Standard commercial paint-spray equipment cannot do an acceptable job when used in recesses or other hard-to-get-into areas. NASA has developed a miniature spray gun for paint and other liquids which is hand held and has individual controls for regulating air pressure and fluid flow. The small spray head can be extended 13 inches, rotated 360°, and very easily cleaned and maintained. The spray nozzle can work as close as ½-inch from the surface without overspray to other areas. This miniature paint-spray gun should find applications in almost any manufacturing shop.

For additional information, circle Key No. 39 on Reader Service Card.

79

more

80

Cars used on long-distance trips can have their motor oil changed _____ often.

19578

80

less

81

A car does not have time for the engine to get warm because the car is used for very short trips.

This means the motor oil should be changed _____ often.

81

more

82

How do dusty driving conditions affect the amount of time between oil changes? _____

19580

82

The oil should be changed more often.
(or similar answer)

83

If a car is used during the extreme heat of the summer or extreme winter frosts, how does this affect the amount of time between oil changes?

_____

19581

83

The oil should be changed more often.
(or similar answer)

84

How would you describe the conditions in which an engine's motor oil can be changed at longer intervals? _____

19582

84

perfect

85

Which of the following can be considered perfect driving conditions?

- ☐ the crankcase vent, oil breather and oil filter are working
- ☐ the car is used for city driving
- ☐ the car is used for highway driving
- ☐ the car is used in warm weather
- ☐ the car is used in extreme frosts and heat

85

the crankcase vent, oil breather and oil filter are working

the car is used for highway driving

the car is used in warm weather

86

Good automobile operation depends on changing motor oil:

- ☐ as often as is necessary
- ☐ as little as possible
- ☐ never at all

19584

86

as often as is necessary

THIS IS THE END OF BOOK 19

19585

AUTO MECHANICS COURSE

POST-TEST BOOK 19: RECOMMENDING OIL CHANGES

A BASIC SYSTEMS PROGRAM

19586

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

You can change your motor oil according to the manufacturer's recommendations when driving conditions are _____.

2-4

CHECK ALL of the conditions below that are not considered perfect driving conditions:

- ☐ city driving
- ☐ highway driving
- ☐ low speed stop-and-go driving
- ☐ driving in warm weather
- ☐ driving during winter frosts

5-7

To change oil according to the manufacturer's recommended intervals, which of the following parts must be working properly?

- ☐ the crankcase vent
- ☐ the crankshaft
- ☐ the oil filter
- ☐ the oil vent
- ☐ the oil pump

19587

DEVICE FOR TAKING FLUID SAMPLES FROM CLOSED SYSTEMS (PAT. NO. 3,412,613)

Chemical laboratories, the chemical and pharmaceutical industry, and a variety of other manufacturers may find great value in this newly designed probe to be used for pulling liquid samples from sealed containers or systems without any danger of contaminating. As with other devices of this kind, a sealing block or plug of special design must already be installed in the system of the container. Such a block permits passages to be made and resealed after use. It also affords the passage of a long probe-like device for collecting the fluid sample from any depth inside the container or system. The block has the means to reseal the passage once the probe has been withdrawn. This device can be easily connected into existing vacuum or purging systems. It also can be easily modified to meet the requirements of specific listing conditions and goals.

Administering Office: Department of the Interior, The Solicitor, Patents Branch, Washington, D.C. 20242.

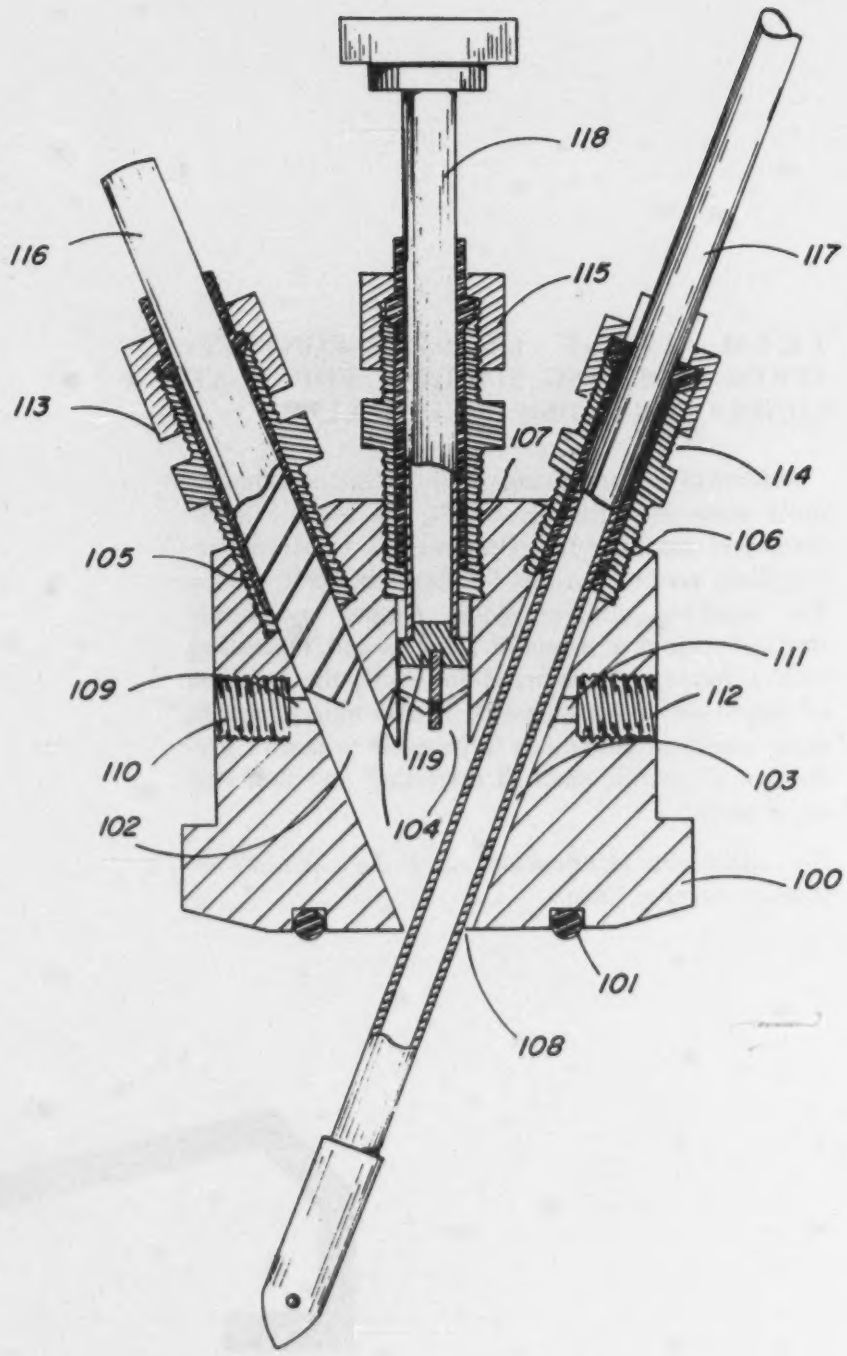

INIATURE RECESSED

uipment can-
n recesses or
as developed
other liquids
controls for
y. The small
rotated 360°,
d. The spray
n the surface
is miniature
ns in almost

y No. 39 on

8

If your customer's car is driven under perfect driving conditions, how often should his car's motor oil be changed? _____

9

If the customer uses his car during the extreme heat of the summer, you should recommend that he change his oil:

- ☐ more often than the manufacturer recommends
- ☐ less often than the manufacturer recommends

10

A customer keeps his car near a sandy, dusty beach. What should you recommend? _____

11

A woman customer uses her car for shopping and taking her little girl to and from school. How does this affect the length of time between oil changes? _____

VT 013 142
Auto Mechanics Course. Book 20: Use of Lubrication Chart.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; MECHANICS (PROCESS); *LUBRICANTS
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on the use of lubrication charts was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 023-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 142

ED0 56238

BOOK 20

(C1)

To Be Used With
PANEL BOOK 20

AUTO MECHANICS COURSE

BOOK 20: USE OF LUBRICATION CHART

A BASIC SYSTEMS PROGRAM

VT013142

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EDUCATION & WELFARE
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19590

AUTO MECHANICS COURSE

BOOK 20: USE OF LUBRICATION CHART

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19591

AUTO MECHANICS COURSE

PRE-TEST BOOK 20: USE OF LUBRICATION CHART

A BASIC SYSTEMS PROGRAM

19592

277 OF 327

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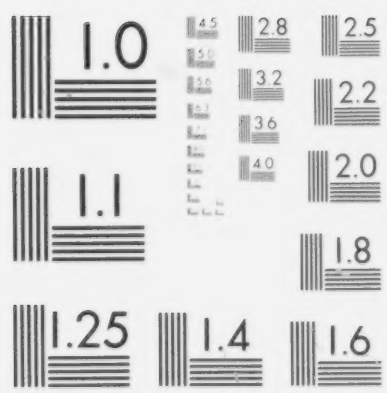

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

1

LIST two ways in which the serviceman uses the Lubrication Service Chart:

1. _____

2. _____

2

The Lubrication Service Chart shows that you (☐ would ☐ would not) service a Buick the same way you would service a Pontiac.

3

On a Lubrication Service Chart, a car is classified by:

1. _____

2. _____

3. _____

277

4

By using the Lubrication Service Chart, you can find: (CHECK ALL CORRECT ANSWERS)

- ☐ where parts are located
- ☐ how to do a lube job
- ☐ battery serial numbers
- ☐ the weight of a car

5

The Lubrication Service Chart will tell you about a car's:

1. o _____ capacity
2. g _____ capacity
3. w _____ capacity
4. a _____ t _____ capacity

6

Will you find front suspension and steering linkage information on the Lubrication Service Chart?

- ☐ yes
- ☐ no

Name _____

Date _____

Starting time _____

Finishing time _____

19595

1

In this program you will learn how to make extra sales by knowing what service every car needs and how often this service should be given.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

19596

TECH BRIEF 68–10550—CONTACT-SPRING FORMING MACHINE FOR FLAT CONDUCTOR CABLE RECEPTACLES

Makers of contact springs, spring clips, and similar small parts may find profitable use for a NASA-developed machine tool designed to form copper-beryllium contact springs for flat conductor cables. The machine receives stock, forms, and ejects finished springs at a rate of 1 per second. Operating with a four-step punch-and-die cycle, the machine is simple and inexpensive. It is also able to accept many small modifications in its cycle to permit production of a wide span of three-step and four-step small parts.

For additional information, circle Key No. 40 on Reader Service Card.

Contact Spring

1

NO ANSWER NEEDED

2

Every make of car must be serviced:

- ☐ a different way
- ☐ the same way

19597

2

a different way

3

Should you service a Chevrolet the same way as you would a Ford?

☐ yes

☐ no

19598

3

no

4

A Dodge might be serviced the same way as:

- ☐ a Chrysler
- ☐ a Plymouth
- ☐ another Dodge

19599

4

another Dodge

5

Since there are so many different makes of cars, the serviceman must use a SERVICE MANUAL to do work on them.

What would you find in the service manual?

- ☐ automobile needs
- ☐ manuals
- ☐ servicemen

19600

5

automobile needs

6

The best way for the serviceman to become familiar with the ways in which the different makes of cars are serviced is to:

- ☐ ask the customer
- ☐ refer to a service manual
- ☐ trust his luck

19601

6

refer to a service manual

7

This book tells you how each car should be serviced:

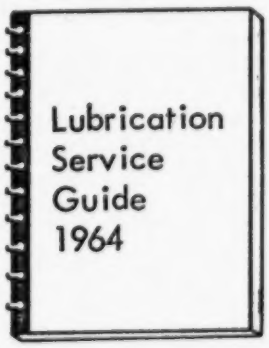

Look in the lubrication service guide when you:

- ☐ do a front end alignment
- ☐ change the oil in a car
- ☐ clean the windshield

19602

7

change the oil in a car

8

A lubrication service manual tells you how to:

- ☐ do a lube job
- ☐ repair an automobile engine
- ☐ service a brake system

19603

8

do a lube job

9

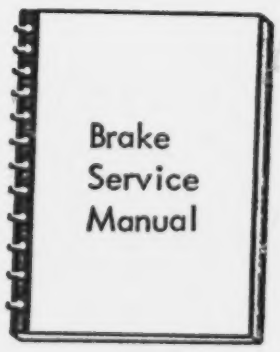

1

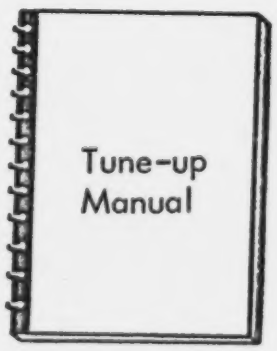

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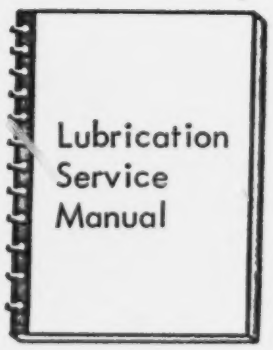

3

Which book will help you to do a good lube job?

- ☐ Book 1
- ☐ Book 2
- ☐ Book 3

19604

9

Book 3

10

To do a complete lube job, the serviceman should look at the:

- ☐ brake service manual
- ☐ lubrication service manual
- ☐ wheel alignment munual

19605

10

lubrication service manual

11

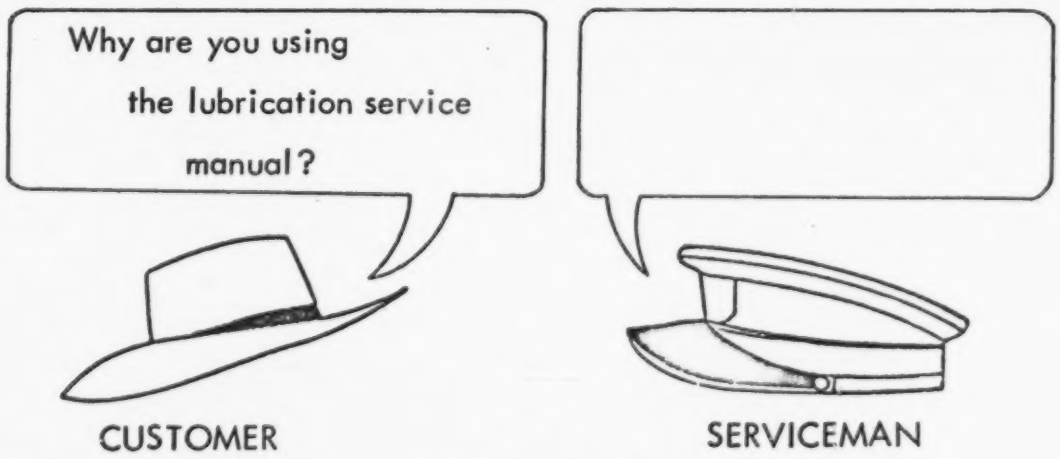

The serviceman should answer:

- ☐ "To do a proper lube job."
- ☐ "To find the part number of the battery."
- ☐ "To hold the hood up."

19606

tinued)

-10550—CONTACT-
CHINE FOR FLAT
ECEPTACLES

spring clips, and similar
able use for a NASA-
signed to form copper-
r flat conductor cables.
ck, forms, and ejects
l per second. Operating
die cycle, the machine
It is also able to accept
its cycle to permit pro-
three-step and four-step

circle Key No. 40 on

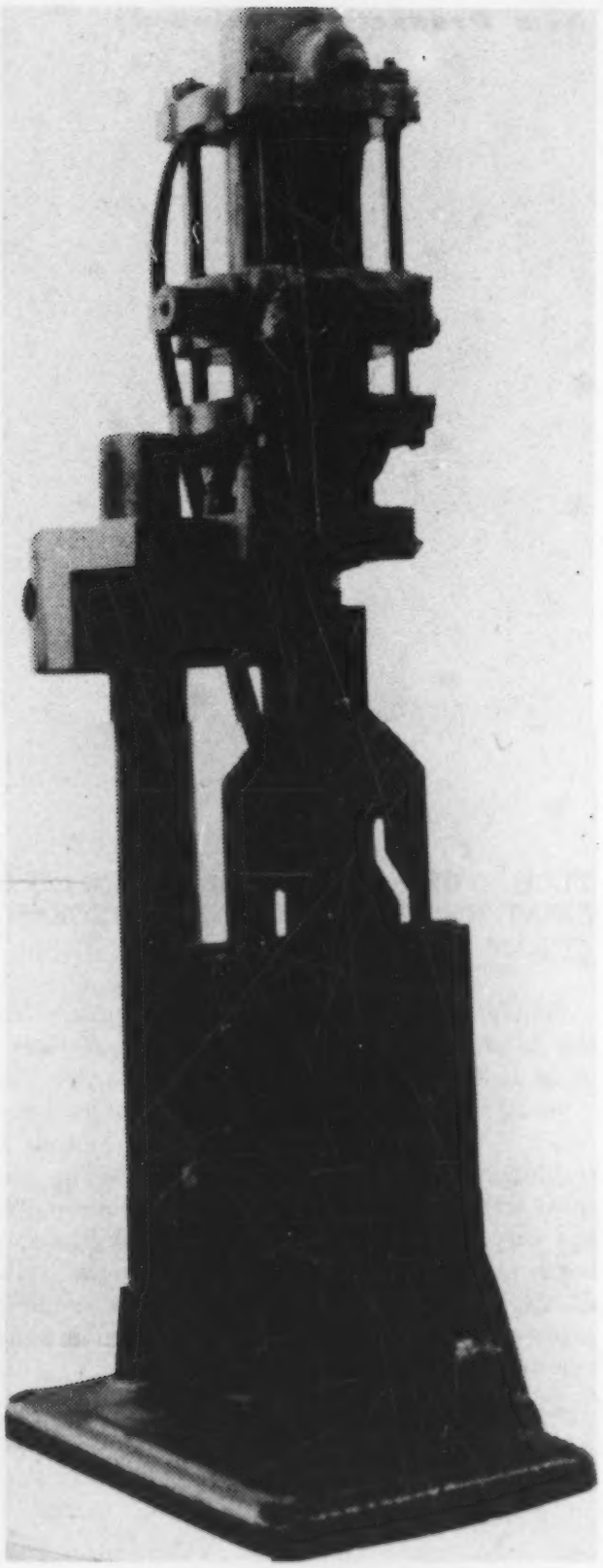

Contact Spring

11

"To do a proper lube job."

12

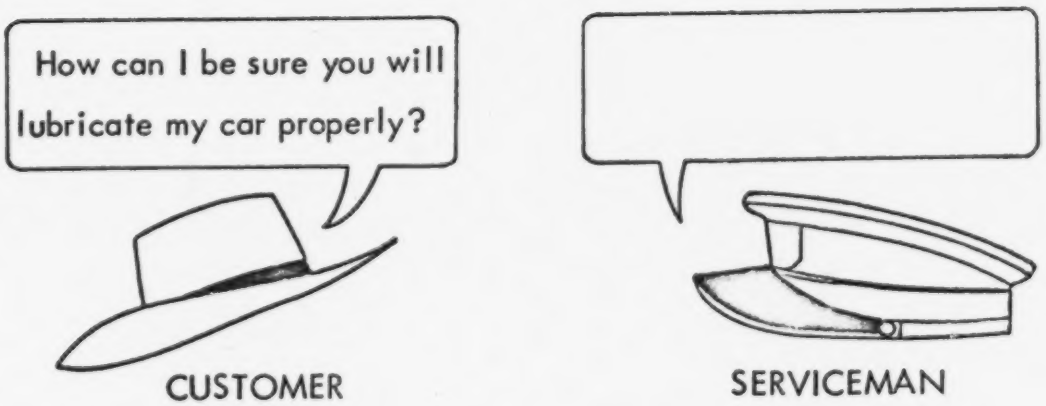

The serviceman's answer should be:

- ☐ "I did a car like yours last month."
- ☐ "I remember each step as I go along."
- ☐ "I use the lubrication service manual."

19607

13

complete lube job

14

CHECK the reason for using a lubrication service manual:

- ☐ to avoid doing a complete lube job
- ☐ to be sure you are doing a complete lube job
- ☐ to spend lots of time doing the lube job

19609

14

to be sure you are doing a complete job

15

In a service manual:

an Austin comes before a Buick

a Cadillac comes before a Ford

a Dodge comes before a Pontiac

How are cars listed in the service manuals?

- ☐ in alphabetical order
- ☐ by size
- ☐ by weight
- ☐ in numerical order

15

in alphabetical order

16

In a service manual, cars are listed in alphabetical order.

Therefore, an Austin comes:

- ☐ after a Buick
- ☐ before a Buick

16

before a Buick

17

Which car will be listed first in a lubrication service manual?

- ☐ Ford
- ☐ Buick
- ☐ Pontiac

19612

17

Buick (because B comes before F and P)

18

Which car will be found toward the back of a lubrication service manual?

- ☐ Cadillac
- ☐ Valiant
- ☐ Dodge

18

Valiant (because V comes after C and D)

19

Cars are listed in service manuals according to:

- ☐ alphabetical order
- ☐ how large they are
- ☐ how much they cost

19

alphabetical order

20

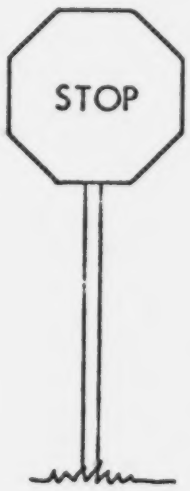

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

20

NO ANSWER NEEDED

21

LOOK AT PANEL 1

The panel shows a simple chart for an automobile called a KARR.

What year is this KARR? _____

What model is it?

- ☐ Extra
- ☐ Regular
- ☐ Special

TECH BRIEF 68–10248—TENSILE TESTING GRIPS ENSURE UNIFORM LOADING OF BIMETAL TUBING SPECIMENS

Stress distribution on bimetal tubing is very poor when standard grips are used in tensile tests. NASA has designed grips which distribute the stress evenly on the inner and outer surfaces of the tubing. The inner grip is made with an expansion grip and cone, while the outer grip is effected with a compression nut. Simple and versatile, the grips can be used with any type of tubing and will improve both the test procedure and the uniformity of its results. A chuck based on the design of this grip could be used for chucking tubes of various diameters without distorting them.

For additional information, circle Key No. 41 on Reader Service Card.

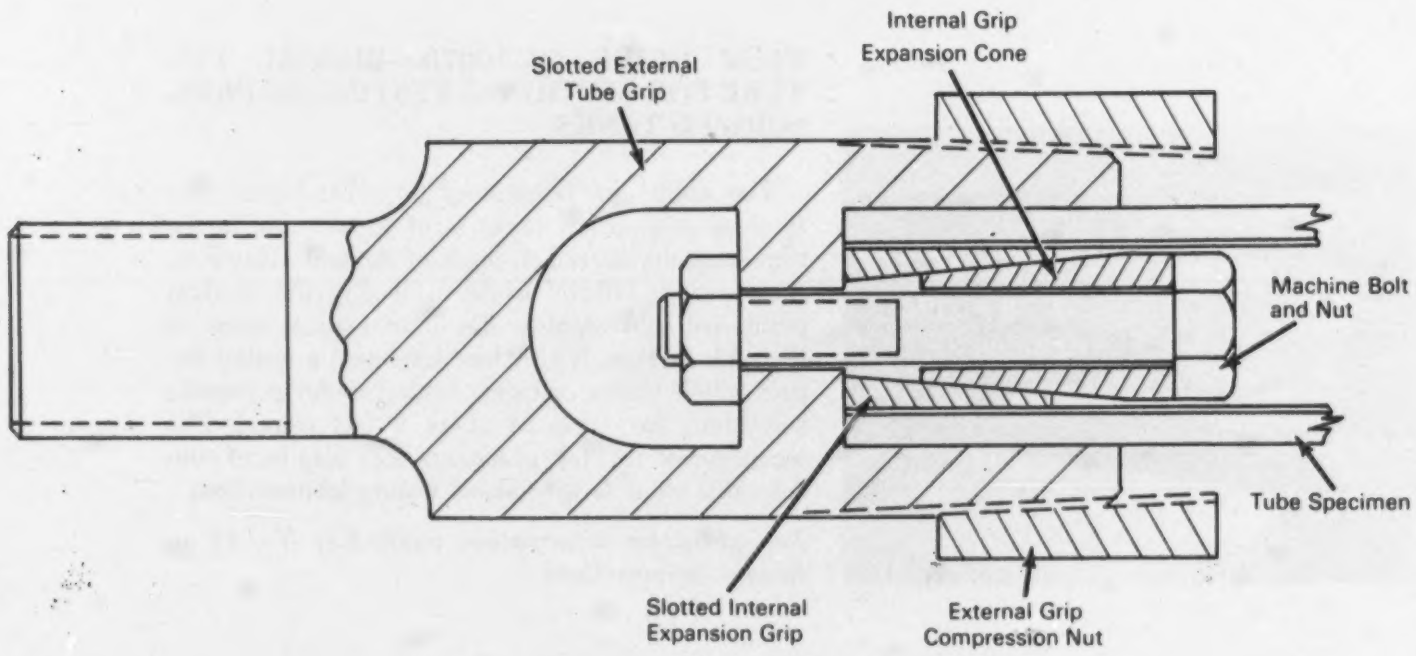

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Reader Se

20

NO ANSWER NEEDED

21

LOOK AT PANEL 1

The panel shows a simple chart for an automobile called a KARR.

What year is this KARR? _____

What model is it?

- ☐ Extra
- ☐ Regular
- ☐ Special

19617

21

1964

Regular

22

On the lubrication service chart a car is classified according to make, year and:

- ☐ model
- ☐ size
- ☐ weight

19618

22

model

23

Service manuals classify automobiles according to: (CHECK ALL CORRECT ANSWERS)

- ☐ make
- ☐ model
- ☐ size
- ☐ year

23

make

model

year

24

The amount of gas, oil, and water that a car takes is called the car's CAPACITY.

The capacity of oil is usually measured in quarts.

The capacity of gasoline is usually measured in:

- ☐ pints
- ☐ quarts
- ☐ gallons

24

gallons

25

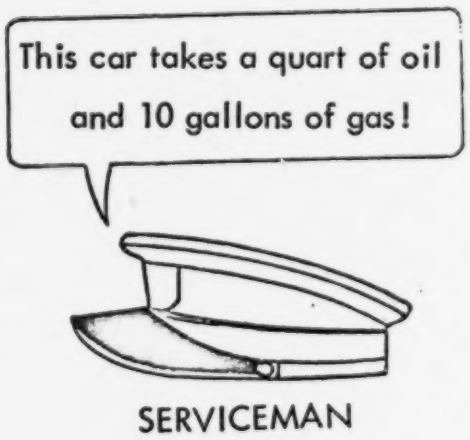

This serviceman is talking about different:

- ☐ capacities
- ☐ contents
- ☐ volumes

19621

25

capacities

26

The best wc / for the serviceman to become familiar with the capacities of all makes and models of cars is to:

- ☐ ask the customer what the capacities are
- ☐ guess at the different capacities
- ☐ look at a chart that shows capacities

19622

26

look at a chart that shows capacities

27

LOOK AT PANEL 1

Panel 1 shows gas, oil, and water capacities on a chart called the

L _____ S _____ C _____.

19623

27

Lubrication Service Chart

28

LOOK AT PANEL 1

Besides the gas, oil, and water capacities, the Lubrication Service Chart also tells you about:

- ☐ front suspension and steering linkage
- ☐ the oil pump
- ☐ windshield wipers

19624

28

front suspension and steering linkage

29

LOOK AT PANEL 1

How many fittings does the front suspension and steering linkage have?

_____

What is the cooling system capacity? _____

What is the KARR's crankcase capacity? _____

19625

29

12

16 quarts

4 quarts

LOOK AT PANEL 1

30

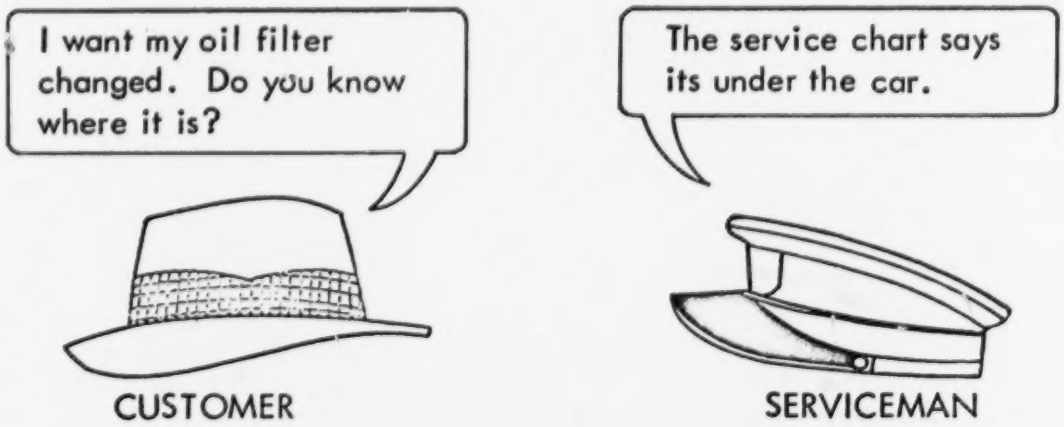

Did the serviceman give the customer a correct answer?

☐ yes

☐ no

19626

TEST-
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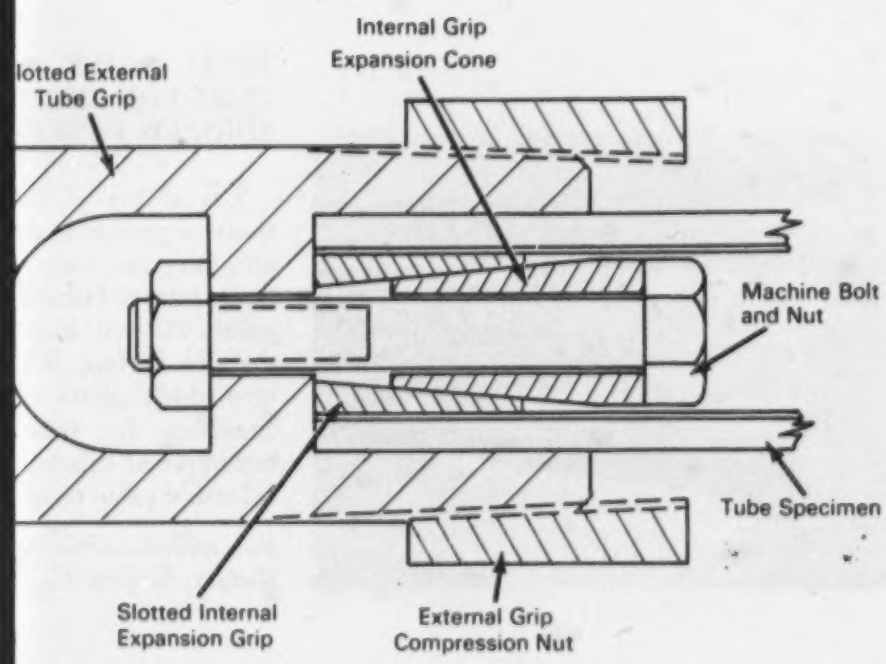

TECH BRIEF 68–10509—ROTARY-KNIFE STRIPPER FACILITATES REMOVAL OF X-RAY FILM FROM PACK

Hospitals and manufacturing plants using large quantities of X-ray film have been troubled by techniques of stripping the film prior to development. Using the common thin-blade knife has led to frequent scratching of the film and working by hand has occasioned film flaws. It also can create a troublesome electrostatic charge. NASA has developed a rotary-knife stripper which is power-driven and has self-sharpening blades. It both strips the film and trims $1/16$ inch from the edge and is designed to be mounted on the film processor apron.

For additional information, circle Key No. 42 on Reader Service Card.

30

yes

31

Lubrication Service Charts tell the serviceman: (CHECK TWO CORRECT ANSWERS)

- ☐ about cars' capacities
- ☐ about prices
- ☐ where parts are located

31

about cars' capacities

where parts are located

32

PICK UP THE PANEL BOOK

FIND PANEL 2

THEN TURN THIS PAGE AND GO ON

19628

32

NO ANSWER NEEDED

33

LOOK AT PANEL 2

PANEL 2 is an actual Lubrication Service Chart.

How would you describe this chart as compared to the first one that you saw?

- ☐ It has less information.
- ☐ It has more information.
- ☐ It has the same amount of information.

33

It has more information.

34

LOOK AT PANEL 2

This page of the lubrication service manual describes:

- ☐ a Buick
- ☐ a Cadillac
- ☐ an Oldsmobile

What year is this car? _____

What model is this car? _____

19630

34

a Buick

1962

Special V-6

35

LOOK AT PANEL 2

In what part of the chart are the make, model, and year of a car found?

- ☐ the bottom
- ☐ the middle
- ☐ the top

35

the top

36

LOOK AT PANEL 2

LOOK at the left-hand column and FIND "Front Suspension and Steering Linkage."

How many fittings does this car have? _____

FIND the line marked "Gas Tank."

How many gallons does this gas tank hold? _____

36

17

16

37

LOOK AT PANEL 2

The information found in the upper right-hand side of the page tells you the oil capacity of the crankcase.

How many quarts of oil does this car hold? _____

37

4

38

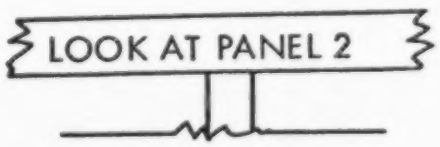

LOOK at the line marked "Oil Filter" on the right-hand side of the page.

The "4" to the right of the line is in a:

- ☐ box
- ☐ circle

19634

38

box

39

LOOK AT PANEL 2

Lubrication service manuals also tell you how often parts should be changed.

LOOK AT the column labeled "service as shown."

FIND the number 4 in the box.

Number 4 tells you to replace the oil filter every _____ miles.

19635

39

4000

40

LOOK in the right-hand column for the words "TRANSMISSION, Automatic."

What is the automatic transmission's capacity? _____

What number is in a box to the right? _____

Now LOOK at the bottom of the page.

This number means:

Every _____ miles drain and refill _____.

19636

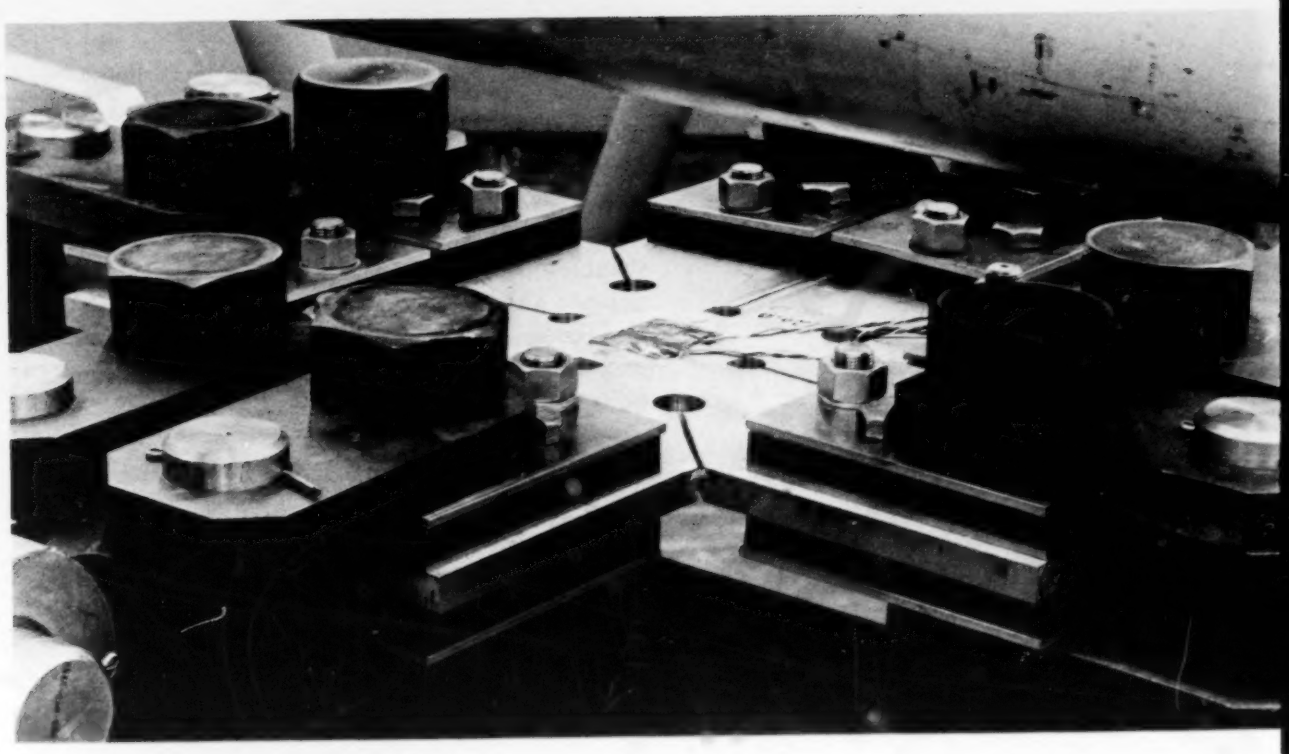

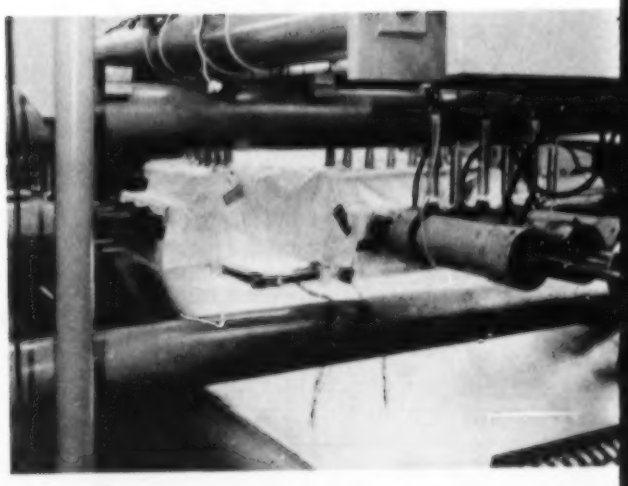

40

6 quarts

25

25,000 miles

automatic transmission

41

LOOK AT PANEL 2

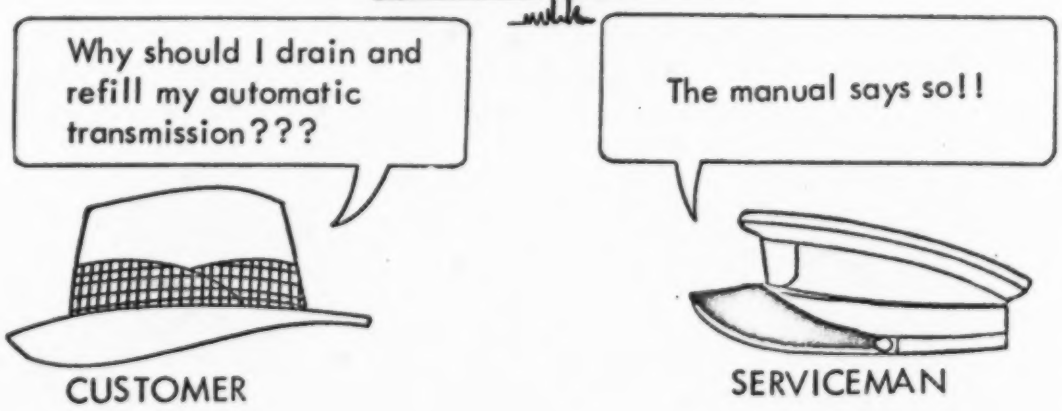

What does the manual say about the intervals between changing automatic transmission oil?

- ☐ drain and refill every 4,000 miles
- ☐ drain and refill every 10,000 miles
- ☐ drain and refill every 25,000 miles

19637

41

drain and refill every 25,000 miles

42

The lubrication service manual helped the serviceman make a sale by telling him when to:

- ☐ change the water in the radiator
- ☐ drain and refill the automatic transmission
- ☐ lubricate the drive shaft

19638

41

drain and refill every 25,000 miles

42

The lubrication service manual helped the serviceman make a sale by telling him when to:

- ☐ change the water in the radiator
- ☐ drain and refill the automatic transmission
- ☐ lubricate the drive shaft

19639

42

drain and refill the automatic transmission

43

The lubrication service manual:

- ☐ does not affect sales
- ☐ helps the serviceman to make a sale
- ☐ prevents the sale of a transmission oil change

19640

43

helps the serviceman to make a sale

44

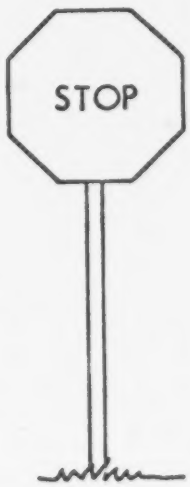

PICK UP THE PANEL BOOK

FIND PANEL 3

THEN TURN THIS PAGE AND GO ON

19641

44

NO ANSWER NEEDED

45

LOOK AT PANEL 3

The chart describes a:

- ☐ Dodge 6
- ☐ Dodge V-8

Which years get the same servicing?

- ☐ 1956
- ☐ 1957
- ☐ 1958
- ☐ 1959
- ☐ 1960

19642

45

Dodge 6

1957

1958

1959

46

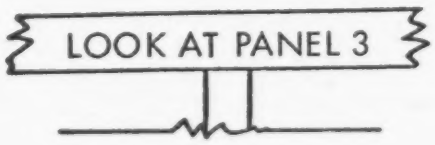

What is the crankcase capacity of a 1958 Doge 6?

How often should an air cleaner be cleaned? _____

How often should the air cleaner element be replaced? _____

19643

45

Dodge 6

1957

1958

1959

46

LOOK AT PANEL 3

What is the crankcase capacity of a 1958 Doge 6?

How often should an air cleaner be cleaned? _____

How often should the air cleaner element be replaced? _____

19644

46

5 quarts

every 2,000 miles

every 10,000 miles

47

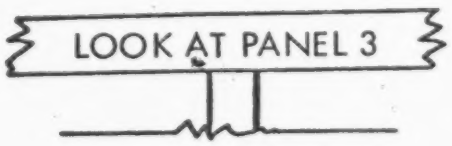

What is the gas tank capacity of a 1959 Dodge 6? _____

The front suspension and steering linkage have _____ fittings.

How often should universal joints be repacked? _____

19645

47

20 gallons

8

every 20,000 miles

48

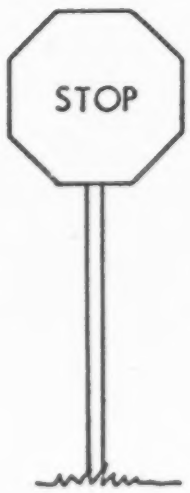

FIND PANEL 4

THEN TURN THIS PAGE AND GO ON

19646

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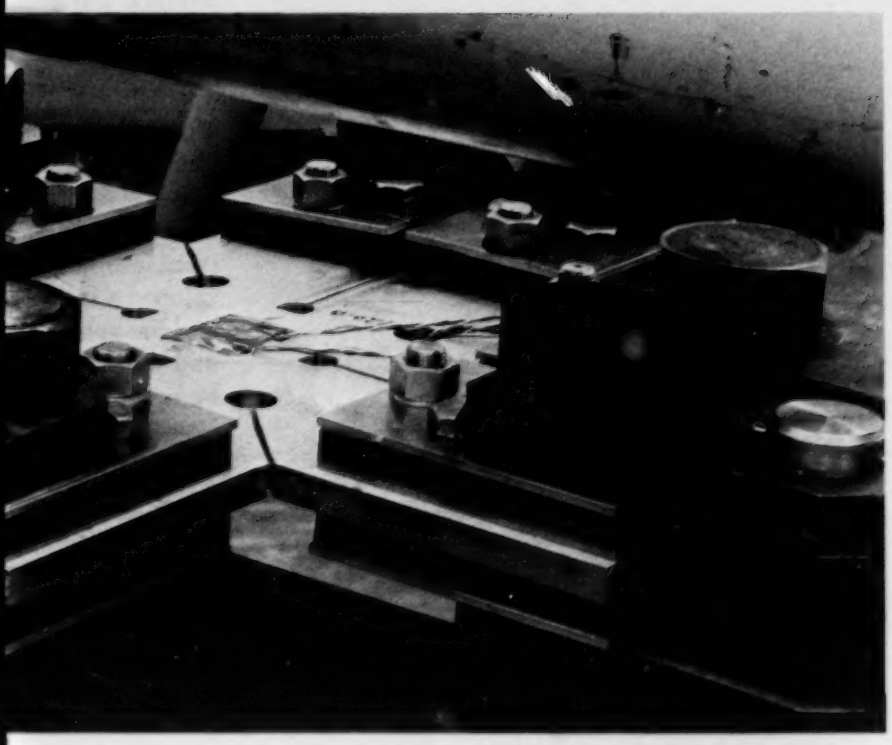

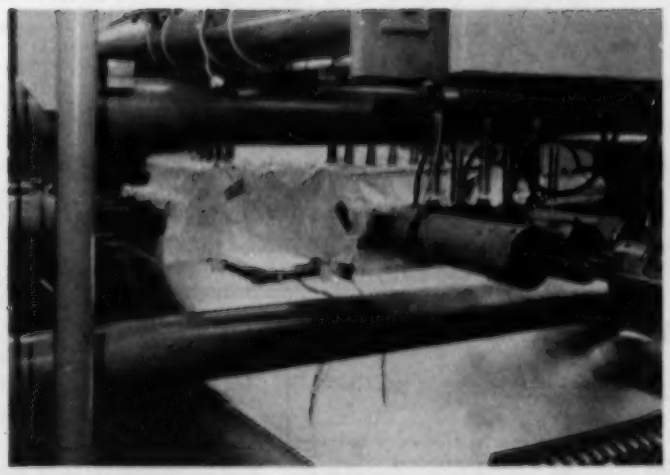

TECH BRIEF 68–10070—BIAXIAL FIXTURE FOR SECTIONAL TESTING OF PRESSURIZED TANKS

The ability of fabricators to test-to-failure sections of pressurized tanks is of great value in determining the overall strength of the tank. However, these tests-to-failure, while disclosing the weakest point, will not identify the other critical areas of the tank surface. NASA has developed a testing fixture which allows sectional testing under cryogenic conditions for areas of about 2 feet square. The technique of this test procedure may also be of considerable value to specialized testing laboratories.

For additional information, circle Key No. 43 on Reader Service Card.

48

NO ANSWER NEEDED

49

LOOK AT PANEL 4

The chart describes a:

- ☐ Dodge 6
- ☐ Dodge V-8

Which years get the same servicing?

- ☐ 1961
- ☐ 1962
- ☐ 1963
- ☐ 1964

19647

49

Dodge V-8

1962

1963

50

LOOK AT PANEL 4

What is a Dodge V-8's crankcase capacity? _____

Where is the oil filter located?

- ☐ under car
- ☐ under hood
- ☐ under wheels

How often should the oil filter be replaced? _____

19648

50

4 quarts

under car

every 4,000 miles

51

LOOK AT PANEL 4

How often should the front wheel bearings be cleaned and repacked?

_____

What is the capacity of the differential? _____

19649

51

every 10,000 miles

4 pints

52

FIND PANEL 5

THEN TURN THIS PAGE AND GO ON

19650

52

NO ANSWER NEEDED

53

LOOK AT PANEL 5

The lube chart describes a:

- ☐ Ford 6
- ☐ Ford V-8

For which model Ford would you NOT use this chart?

- ☐ 1956
- ☐ 1957
- ☐ 1958
- ☐ 1959

53

Ford 6

1956

54

LOOK AT PANEL 5

The front suspension and steering linkage have _____ or _____ fittings.

The crankcase has a capacity of _____ quarts.

The oil filter should be changed every _____ miles.

19652

54

9 (or) 11

4

4,000

55

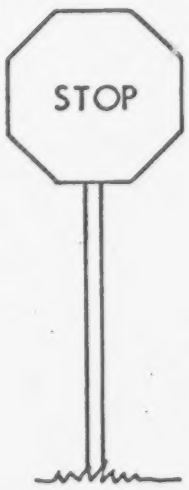

FIND PANEL 6

THEN TURN THE PAGE AND GO ON

19653

55

NO ANSWER NEEDED

56

LOOK AT PANEL 6

What is the crankcase capacity of a 1957 Oldsmobile? _____

What is the crankcase capacity of a 1958 Oldsmobile? _____

19654

56

5 quarts

4 quarts

57

LOOK AT PANEL 6

The serviceman lubricated 10 grease fittings (front suspension and steering linkage).

How many fittings are left to be lubricated? _____

The serviceman is changing the differential oil.
He put in 4 pints.
How many more pints should he add? _____

19655

56

5 quarts

4 quarts

57

LOOK AT PANEL 6

The serviceman lubricated 10 grease fittings (front suspension and steering linkage).

How many fittings are left to be lubricated? _____

The serviceman is changing the differential oil.
He put in 4 pints.
How many more pints should he add? _____

TECH BRIEF 68–10036—TUBE DIMPLING TOOL ASSURES ACCURATE DIP-BRAZED JOINTS

Manufacturers and repairers of equipment containing small diameter metal tubing can simplify their work and improve their product with this new dimpling tool. It ensures accurate placement when tubes of different diameters are brazed together in a series-flow arrangement. By controlled dimpling of the larger tube, the smaller tube will be perfectly centered, the flow pattern will be improved, and the brazing will be easier and stronger. The tool, developed just for this purpose by NASA, is hand held and includes a dial to register the depth of the dimple.

For additional information, circle Key No. 44 on Reader Service Card.

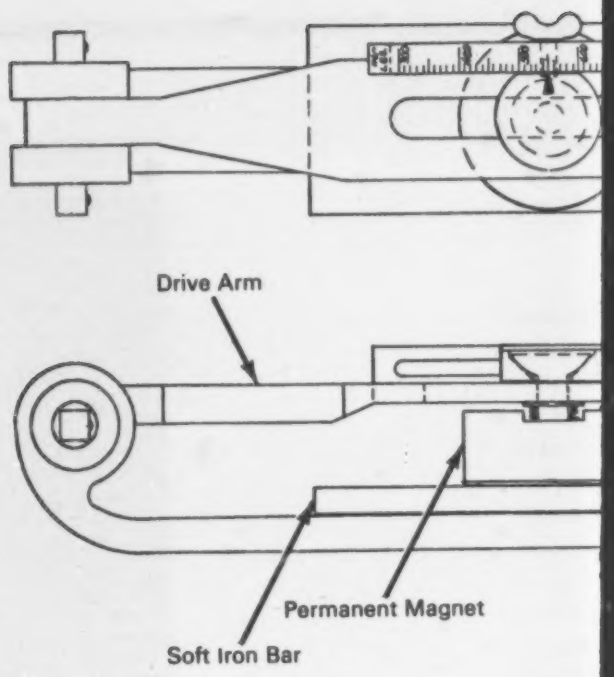

Note: Permanent Magnet Type Only; Electromagnetic

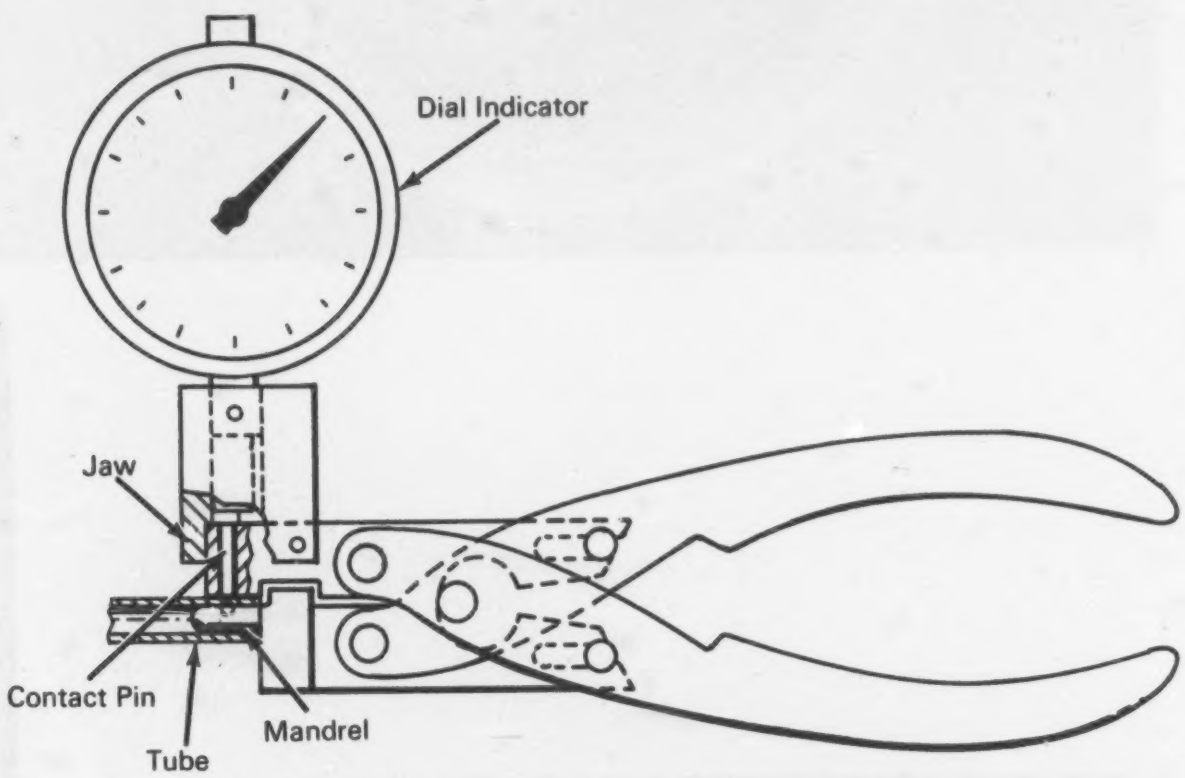

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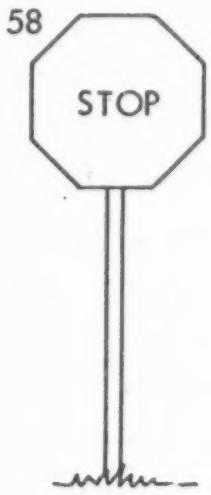

FIND PANEL 7

THEN TURN THIS PAGE AND GO ON

19657

58

NO ANSWER NEEDED

59

LOOK AT PANEL 7

The cars described have _____ lube fittings.

The crankcases hold _____ quarts.

After how many miles should you recommend that the front wheel bearings be cleaned and repacked? _____ miles

19658

59

21 (lube fittings)

5 (quarts)

10,000 (miles)

60

NOW LOOK AT PANEL 8

COMPLETE the following chart:

make, model year	# of fittings	crankcase capacity	differential capacity
Buick, Super 1958			

19659

60

# of fittings	crankcase capacity	differential capacity
17	5 quarts	6 pints

61

Automobiles are listed in lubrication service manuals according to:

- ☐ length
- ☐ make
- ☐ model
- ☐ size
- ☐ year

60

# of fittings	crankcase capacity	differential capacity
17	5 quarts	6 pints

61

Automobiles are listed in lubrication service manuals according to:

- ☐ length
- ☐ make
- ☐ model
- ☐ size
- ☐ year

19661

61

make

model

year

62

A lubrication service manual tells the serviceman: (CHECK ALL CORRECT ANSWERS)

- ☐ about different capacities
- ☐ when parts should be changed
- ☐ where lube points are located

19662

278 OF 327

ED

056 238

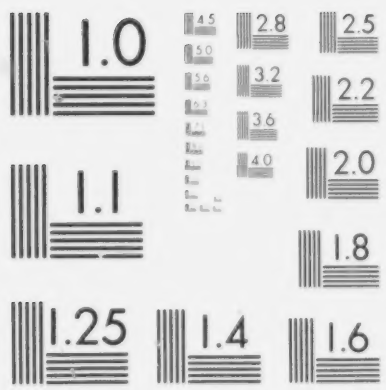

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

62

about different capacities

when parts should be changed

where lube parts are located

63

By using a lubrication service chart, you can find out: (CHECK ALL CORRECT ANSWERS)

- ☐ the number of lube fittings a car has
- ☐ when to change certain parts
- ☐ the cooling system capacity
- ☐ the weight of a car

19663

278

63

the number of lube fittings a car has

when to change certain parts

the cooling system capacity

64

The experienced serviceman always uses lubrication service charts to:

- ☐ do a thorough job
- ☐ show the customer he is new on the job
- ☐ take up extra time

64

do a thorough job

65

THIS IS THE END OF BOOK 20

19665

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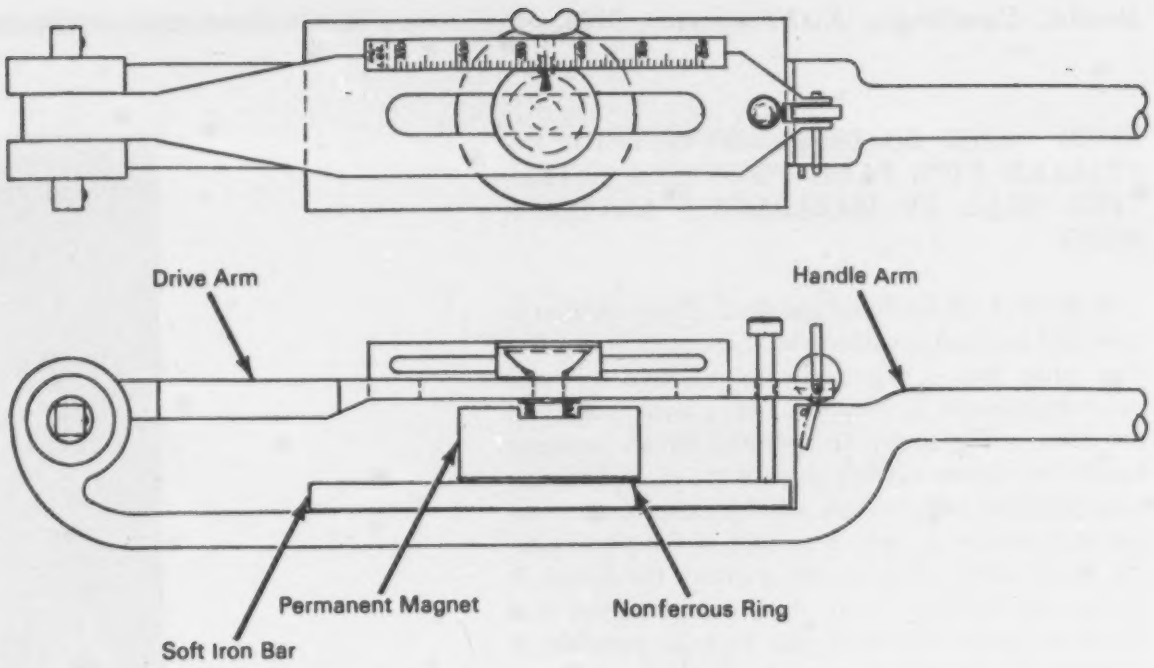

Note: Permanent Magnet Type Only; Electromagnetic Type Not Shown

TECH BRIEF 68–10209—MAGNETICALLY CONTROLLED TORQUE WRENCH PREVENTS OVERTORQUING

A torque wrench that releases its grip as soon as the specified torque is exceeded has been developed by NASA. This control is effected by equating the torque force with a magnetic force to free the drive arm from the handle. It can be made up with either permanent or electromagnets. Permanent magnets allow easy portability but the electromagnetic type is capable of much wider control. The torque wrench can be used in any application where accurate torquing is required. The same principle might be incorporated in equipment as a safety device to limit both torsion and torsion loads.

For additional information, circle Key No. 45 on Reader Service Card.

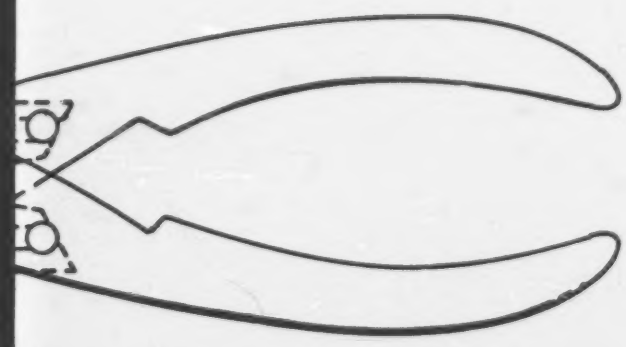

AUTO MECHANICS COURSE

POST-TEST BOOK 20: USE OF LUBRICATION CHART

A BASIC SYSTEMS PROGRAM

19666

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

What are the two ways in which a serviceman uses the Lubrication Service Chart?

1. _____

2. _____

2

How are cars classified on the Lubrication Service Chart?

1. _____

2. _____

3. _____

3

By using the Lubrication Service Chart, you can find: (CHECK ALL CORRECT ANSWERS)

- ☐ the make of a car
- ☐ when to change parts
- ☐ motor serial numbers
- ☐ how to do a lube job

4

The Lubrication Service Chart shows that you (☐ would ☐ would not) service a Buick the same way you would service a Pontiac.

5

The Lubrication Service Chart will tell you about a car's:

1. o _____ capacity
2. g _____ capacity
3. w _____ capacity
4. a _____ t _____ capacity

6

19668

You (☐ would ☐ would not) find front suspension and steering linkage information on the Lubrication Service Chart.

PANEL BOOK 20

To Be Used With
BOOK 20

AUTO MECHANICS COURSE

PANEL BOOK 20: USE OF LUBRICATION CHART

A BASIC SYSTEMS PROGRAM

19669

LUBRICATION SERVICE CHART

KARR, 1964
model "REGULAR"

Cooling System
capacity 16 quarts

Crankcase capacity
4 quarts

Oil Filter
under the car

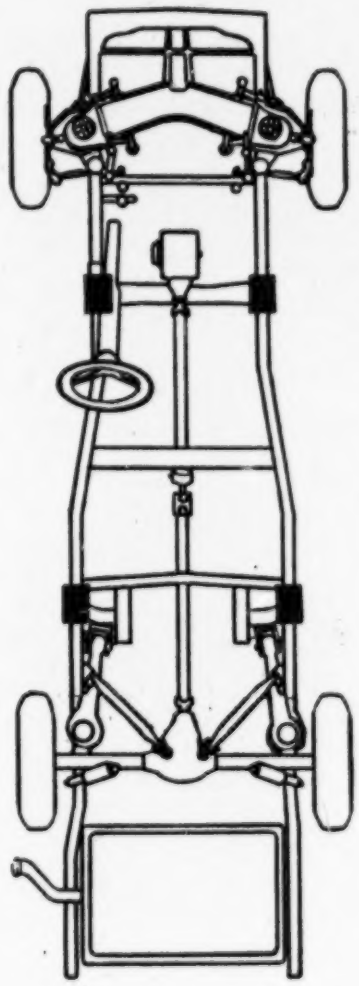

Front Suspension
and Steering
Linkage
12 Fittings

Transmission capacity
3 pints

Differential capacity
4 pints

Gas tank capacity
16 gallons

PANEL 1

19670

BUICK

1962 Special V-6

HOOD RELEASE: Front

CAR CHECK SERVICE EVERY 1,000 MILES EXCEPT AT MILEAGE ■ SYMBOLS SHOWN

COOLING SYSTEM ..... Quarts

	~~With Heater~~	~~Without Heater~~
All models	~~12~~	10½

Cooling system pressure, 15 pounds

Fuel Filter ..... Clean glass bowl
Air conditioned models only

10 Air conditioned models .... Replace element

10 All other models ..... Clean element

Power Steering Reservoir ..... ATF
Fill to FULL mark on dipstick, when oil is warm

Manual Steering Gear (plug) ..... 90 MP

Crankcase Dipstick ..... Check level
Fill to Add 1—1 qt.

2 **Oil Fill Cap** ..... Wash and oil MO

Brake Master Cylinder (cap) ..... GHDB
Fill to ⅛ inch below top of fill hole

Chek-Chart

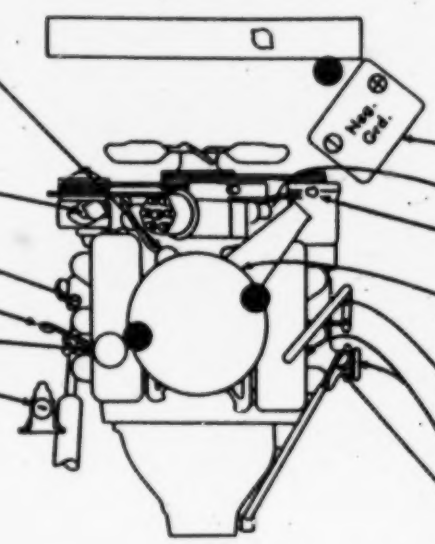

CRANKCASE ..... MS

Above +32°	20/20W or 10W/30
+32° to 0°	10W or 10W/30

CAPACITY 4 quarts

Battery ..... Test and fill

Oil Filter (under car) ..... Replace 4

Generator (oil cup) ..... 10W MO
Add only 8 to 10 drops

Air Cleaner Element ..... Service
Polyurethane ..... 20/20W or 10W/30 MO 5
Wash and oil

Positive Crankcase Ventilator ..... CC 10
Check operation every 5,000 miles. Clean or replace if necessary

Manifold Heat Control Valve Shaft ..... GK

TRANSMISSION, Automatic ATF
Check level, engine idling, PARK position
CAPACITY 8 quarts, refill approx. 2 quarts
Do not overfill
DRAIN and REFILL 25
Remove oil pan

Front Suspension and Steering Linkage ..... (17 fittings) GX

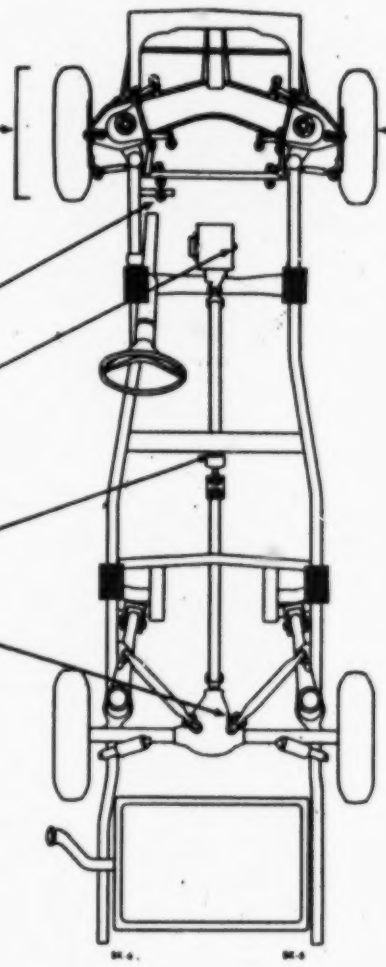

Front Wheel Bearings ..... Clean and repack GX 10
Initial torque, 19 ft. lb.; back off until bearing is loose; second torque, 11 ft. lb.; back off ¼ to ¼ turn and insert cotter pin

Clutch Release Equalizer Shaft ..... GX

TRANSMISSION, Manual MP, MO
90MP, or 40 or 50 MO
Maintain level to fill plug hole
CAPACITY 3-speed, 2¼ pints; 4-speed, 2½ pints
10 DRAIN and REFILL

10 **Propeller Shaft Spline** (plug) .....
Requires special lubricant and special procedure. Refer owners to car dealer

DIFFERENTIAL ..... 90 MP
When consistently below —10°, 80 may be used
Maintain level to ¼ inch below fill plug hole
CAPACITY 2 pints
10 DRAIN and REFILL
POSITIVE TRACTION IDENTIFICATION:
Metal tag under fill plug

GAS TANK ..... Gallons
All models 18

TIRES ..... Pressure

	Front	Rear
6.00-15	22	22*
6.50-13	22	22*
7.00-13	22	22*

* Estate Wagon and heavily loaded cars, 26
For temperatures below +32° increase pressure 2 pounds

5 Rotate tires

■ Position for lift adapter
• Lubrication fitting
● Cooling system drain

SERVICE AS SHOWN

2 **Every 2,000 miles**
Wash and oil the oil fill cap

4 **Every 4,000 miles**
Replace oil filter, add extra quart oil

5 **Every 5,000 miles**
Rotate tires, balance wheels
Wash and oil polyurethane air cleaner element

10 **Every 10,000 miles**
Replace fuel filter element on air conditioned models and clean element at carburetor inlet on all other models
Drain and refill manual transmission
Lubricate propeller shaft spline. Requires special lubricant and special procedure. Refer owners to car dealer
Drain and refill differential
Clean or replace positive crankcase ventilator valve and exhaust line
Clean and repack front wheel bearings

25 **Every 25,000 miles**
Drain and refill automatic transmission

PANEL 2

19671

Charts for Panels 2-8 by permission of The Chek-Chart Corporation.

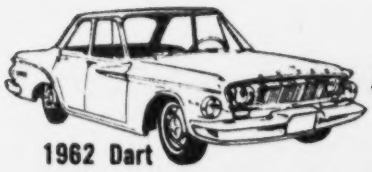
1962 Dart

1962 Polara "500"

HOOD RELEASE: Front

1963

DODGE V-8

1962-63 All Models

CAR CHECK SERVICE EVERY 1,000 MILES EXCEPT AT MILEAGE ■ SYMBOLS SHOWN

COOLING SYSTEM.....Quarts

	With Heater	Without Heater
361-, 383-cu. in. engines	17	16
318-cu. in. engine	21	20

Cooling system pressure, 14 pounds; with air conditioning, 16 pounds

Battery.....Test and fill
Caution: Do not ground positive terminal

Power Steering Reservoir.....10W MO
Fill to base of filler neck if cold, halfway when hot

2 **Oil Fill Cap**.....Wash and oil 30 MO

30 **Automatic Trans. Filter** (under car).....Replace
Replace at time of transmission drain

Air Cleaner Element.....Service
2 Dry type .....Clean
10 Dry type .....Replace

Manual Steering Gear (plug).....90 MP

Brake Master Cylinder (cover).....GHDB
Fill to ¼ inch below top of reservoir

Distributor Shaft (oil cup).....10W MO
383- and 361-cu. in. engines, right side at front
10 Wick under rotor..... Sparingly 10W MO

5 **Crankcase Ventilator Valve**.....CC
1962 cars having this equipment and all 1963 cars clean or replace valve; also clean hose and carburetor, if passages are clogged

2 **Crankcase Breather Outlet Element 1962**.....Wash and oil 30 MO

C **Front Suspension**.....(4 plugs) GX
Semi-permanently prelubricated at the factory. Plugs provided for relubrication. Check seals for damage at each oil change. Relubricate as required using special adapter. Fill until grease flows from upper ball joint bleed holes or lower joint seal lower lip. Do not rupture seals. Reinstall plug

C **Steering Linkage**.....(4 sealed bearings)
Inspect seals for damage at each oil change; replace if damaged or worn

30 **Torque Shaft**.....GX
Disassemble, clean and repack both ends
Qualified Mechanic only

TRANSMISSION, Manual....ATF
Maintain level to fill plug hole
CAPACITY 880, 4½ pints; refill approx. 3½ pints; all others, 5 pints
10 DRAIN and REFILL

30 **Gearshift Lever** 880.....MO
Remove rubber boot from floor panel, apply lubricant to pivot points and yoke selector mechanism

30 **Universal Joints**..... Repack GX
Use only 2 ounces in front joint
Must be disassembled. Qualified Mechanic only
1963, inspect seals for leaks, replace if necessary

DIFFERENTIAL..... 90 MP
Maintain level to ½ inch below fill plug hole
CAPACITY 4 pints
10 DRAIN and REFILL
SURE-GRIP IDENTIFICATION:
Metal tag attached to housing near fill plug

GAS TANK.....Gallons

	880	All others
Station wagon	21	21½
All other models	23	20

TIRES.....Pressure

	Front	Rear
7.00-14, 7.50-14, 8.00-14	24	22*
6.70-15	24	24**
8.50-14 880 station wagon	22	24**

* Station wagon, 26; with heavy load, 28
** Station wagon with heavy load, 28

5 Rotate tires

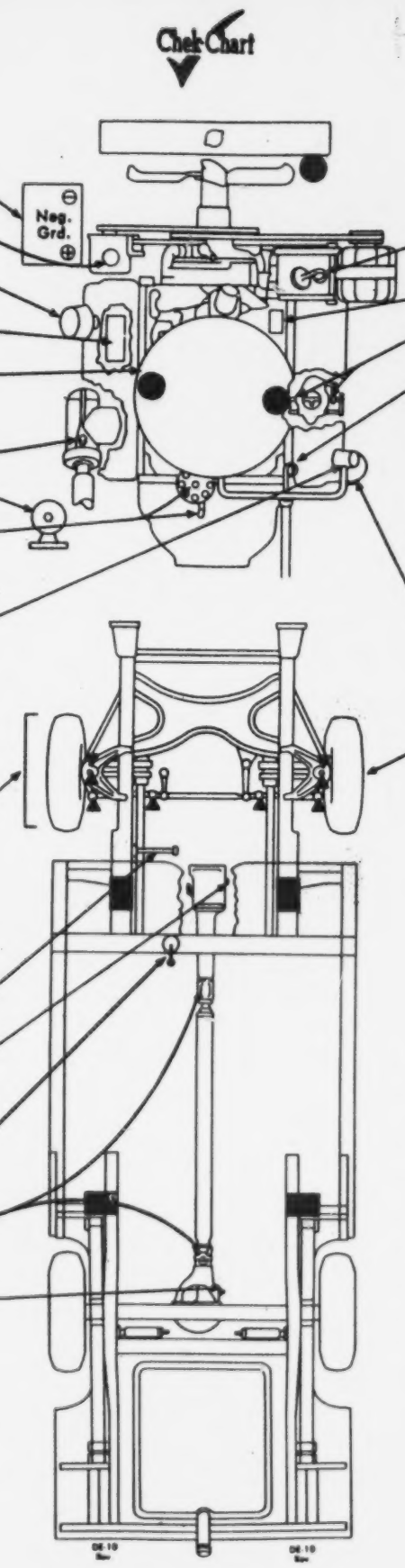

■ Position for lift adapter
▲ Prepacked bearing
● Cooling system drain

CRANKCASE.....MS

Above +32°	30 or 10W/30
+32° to 0°	20/20W or 10W/30

CAPACITY [redacted] 4 quarts

Crankcase Dipstick.....Check level
383- and 361-cu. in. engines, left side
Full to Add—1 qt.

Fuel Filter.....Replace 15

Manifold Heat Control Valve Shaft.....GK

TRANSMISSION, Automatic.ATF

Check level, engine idling and thoroughly warm, NEUTRAL position

CAPACITY, quarts	Initial Refill	Total Refill
All models	5	9

DRAIN and REFILL.....30
Remove 1 converter plug, transmission plug and parking sprag cavity plug; also, remove oil pan on 1963 without transmission plug
Drain more frequently under severe service
Replace transmission filter at time of drain

Oil Filter (under car).....Replace 4
383- and 361-cu. in. engines, left side, front

Front Wheel Bearings....Clean and repack GX 10
Tighten front wheel adjusting nut to 90 in. lb., position lock nut over adjusting nut so that one set of slots on lock nut aligns with drilled hole in axle spindle. Back off adjusting and lock nuts one slot and install cotter key
1963, final adjustment should be 0, no preload to .003" end play

SERVICE AS SHOWN

2 Every 2,000 miles
Wash and oil the oil fill cap
Clean dry type air cleaner element
1962, wash and oil crankcase breather element

4 Every 4,000 miles
Replace oil filter, add extra quart oil

5 Every 5,000 miles
Clean or replace crankcase ventilator valve
Rotate tires, balance wheels

10 Every 10,000 miles
Replace dry type air cleaner element
Lubricate distributor wick under rotor
Drain and refill manual transmission
Drain and refill differential
Clean and repack front wheel bearings

15 Every 15,000 miles
Replace fuel filter

30 Every 30,000 miles
1962, replace automatic trans. filter
Disassemble, clean and repack torque shaft
Lubricate gearshift lever
Repack universal joints
Drain and refill automatic transmission

C Conditional service
Relubricate front suspension as required
Replace steering linkage joints and seals if damaged or worn

15678

FORD 6

1957-59 All Models

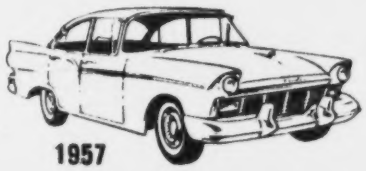
1957

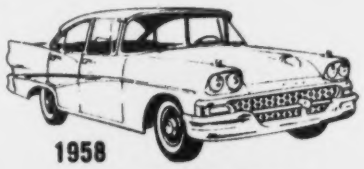
1958

1959

HOOD RELEASE: Inside

CAR CHECK SERVICE EVERY 1,000 MILES EXCEPT AT MILEAGE ■ SYMBOLS SHOWN

COOLING SYSTEM ..... Quarts

	With Heater	Without Heater
All models	16	15

Cooling system pressure, 12-15 pounds

Power Steering Reservoir ..... ATF
Fill to ¼ inch from top of reservoir

25 **Power Steering Res. Filter Element** .... Replace

5 **Generator** (oil cup) ..... Sparingly 10W MO
Late 1959, no lubrication

Crankcase Dipstick ..... Check level
Full to mark between Full and Add Oil—1 qt.

Air Cleaner Element ..... Service
2 Dry type ..... Clean
10 Dry type ..... Replace

Manifold Heat Control Valve Shaft ..... GK

Steering Gear (plug) ..... 90 MP
1958-59 models, turn wheels to left, remove fill plug and housing cover lower capscrew. Fill thru plug hole until lubricant comes out capscrew hole

Brake Master Cylinder (plug) ..... GHDB
Fill to ½ inch below top of fill hole

Gearshift Levers (1 or 2 fittings) ..... GX

Front Suspension and Steering Linkage ..... (9 or 11 fittings) GX

Clutch Release Equalizer ..... GX

TRANSMISSION, Manual . 80 MP
Maintain level to fill plug hole
CAPACITY 3 pints with or without overdrive
10 DRAIN and REFILL
Overdrive, check level and drain thru separate plug hole. Fill slowly thru transmission

10 **Parking Brake Shaft** ..... GX

25 **Universal Joint Spline** ..... Coat 1 oz. GX
On 1959 models with automatic transmission

20 **Universal Joints** ..... Repack GX
Must be disassembled. Qualified Mechanic only

10 **Parking Brake Cables** ..... Coat GX

DIFFERENTIAL ..... 90 MP
Maintain level to fill plug hole
CAPACITY 4½-5½ pints
10 DRAIN and REFILL
EQUA-LOCK IDENTIFICATION:
Metal tag stamped with letter "L" attached to left side of carrier housing

GAS TANK ..... Gallons
All models 20

TIRES ..... Pressure

	Front	Rear
7.50-14, 8.00-14	24	22
Station wagon, Ranchero, sedan delivery	24	26

All tire pressures: For extensive high-speed driving and heavy loading, add 4 to 6 pounds

5 Rotate tires

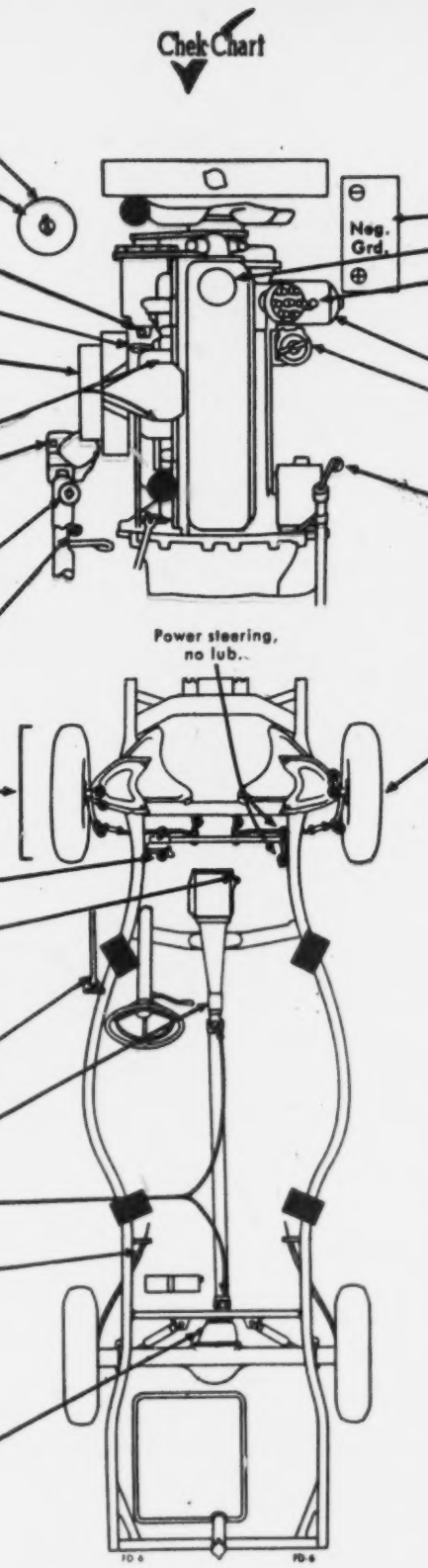

CRANKCASE ..... MS

Above +32°	20/20W or 10W/30
+32° to 0°	10W or 10W/30

CAPACITY 4 quarts

Battery ..... Test and fill

Oil Fill Cap ..... Wash 2

Distributor Shaft (oil cup) ... Sparingly 10W MO

Oil Filter ..... Replace 4

Fuel Filter Element ..... Replace 5

TRANSMISSION, Automatic . ATF
Check level, engine idling, PARK position

CAPACITY, quarts	Initial Refill	Total Refill
1957-58	5	9
1959	5	10

DRAIN and REFILL 25
Remove 2 converter plugs and disconnect fill pipe, except 1959, remove transmission plug

Front Wheel Bearings .... Clean and repack GX 10
Initial torque, 11½-12½ ft. lb.; final adjustment, loosen ⅛ but not more than ⅓ turn

SERVICE AS SHOWN

2 Every 2,000 miles
Clean dry type air cleaner element
Wash the oil fill cap

4 Every 4,000 miles
Replace oil filter, add extra quart oil

5 Every 5,000 miles
Lubricate generator
Rotate tires, balance wheels
Replace fuel filter element

10 Every 10,000 miles
Replace dry type air cleaner element
Drain and refill manual transmission
Lubricate parking brake shaft
Coat parking brake cables
Drain and refill differential
Clean and repack front wheel bearings

20 Every 20,000 miles
Repack universal joints

25 Every 25,000 miles
Replace power steering reservoir filter element
1959, coat universal joint spline
Drain and refill automatic transmission

■ Position for lift adapter
• Lubrication fitting
● Cooling system drain

T-9674

1957

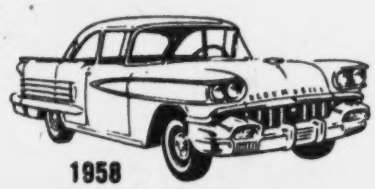

1958

OLDSMOBILE

1957-58 All Models

HOOD RELEASE: Front

CAR CHECK SERVICE EVERY 1,000 MILES EXCEPT AT MILEAGE ■ SYMBOLS SHOWN

Chek-Chart

COOLING SYSTEM.....Quarts

	With Heater	Without Heater
1957	21	19½
1958	21	20

Cooling system pressure, 13 pounds; with air conditioning, 15 pounds

Battery..... Test and fill

Power Steering Reservoir..... **ATF**
Fill to level mark with fluid at operating temperature. New-Matic Air Suspension models with special cover, use only synthetic fluid GM Part No. 577080. Do not service these cars with ATF. Replace special cover between bolt head and lock washer

Air Cleaner Element.....Service
2 Dry type .....Clean
10 Dry type .....Replace
2 Oil bath .....Wash and fill **MO**
Above +32°, 40; below +32°, 20/20W
2 Wire gauze.....Wash and oil 40 **MO**

Manual Steering Gear (plug)..... 90 **MP**

Brake Master Cylinder (plug)..... **GHDB**
Fill to ½ inch below top of fill hole. Power brake models, fill until level shows on dipstick. With air conditioning, service thru access opening in fender splash shield back of wheel

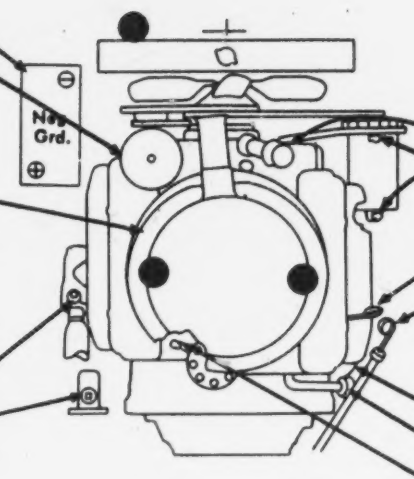

CRANKCASE..... **MS**

Above +32°	20/20W* or 10W/30
+32° to 0°	10W or 10W/30

* Above +90°, 30 or 10W/30 may be used

CAPACITY 1957, 5 quarts; 1958, 4 quarts

Oil Fill Cap.....Wash and oil **MO** 2

Generator (2 oil cups).....10W **MO**

Crankcase Dipstick.....Check level
Full to Add 1—1 qt.

TRANSMISSION, Automatic. **ATF**
Check level, engine idling, PARK position

CAPACITY, quarts	Initial Refill	Total Refill
All models	8	11

DRAIN and REFILL..... 25
Remove 1 torus cover plug and transmission plug

Oil Filter (under car).....Replace 4

Crankcase Breather Outlet Element.....Wash 2

Distributor Shaft (oil cup) 10W **MO**

New-Matic Suspension Separator 1958...Drain
Open cock to drain condensation. Close immediately. When temperature is +32° or lower, leave cock open to expel all air from system. Using rubber hose inserted into cock, inject 8 ounces of Gulf ColdFlo Antifreeze into separator tank and close cock. CAUTION: Do not use permanent type antifreeze
4 Filter (under hood).....Wash

Front Suspension and Steering Linkage.....(17 fittings) **GX**

Auxiliary Clutch Shaft (2 felts).....**MO**

Pedal Shaft (1 or 2 fittings).....**GX**
Power brake models, no lubrication

25 **Speedometer Cable** .....Coat **GX**

TRANSMISSION, Manual..80 **MP**
Maintain level to fill plug hole
CAPACITY 2½ pints
10 **DRAIN and REFILL**

4 **Universal Joint Spline** (plug).....**GX**
Install fitting. Lubricate until lubricant appears at nut at rear of front propeller shaft. Reinstall plug

20 **Universal Joints** .....Repack **GX**
Must be disassembled. Qualified Mechanic only

10 **Parking Brake Cables**.....Coat **GX**

DIFFERENTIAL .....90 **MP**
Maintain level to fill plug hole
CAPACITY 5 pints
10 **DRAIN and REFILL**
ANTI-SPIN IDENTIFICATION:
Letter "L" stamped with gear ratio code on pad below fill plug

25 **Air Spring Piston Strut Seats** Both sides.. ..**GX**
Disassemble, clean and lubricate with ¼ ounce. Qualified Mechanic only

New-Matic Suspension High Pressure Tank 1958.....Drain
Depress valve core to expel all water

GAS TANK .....Gallons
All models 20, 21

TIRES .....Pressure Front Rear

8.50-14	22*	20◆
9.00-14, 1957	22	20◆
9.00-14, 1958	22*	20◆

* With air conditioning, 24
◆ Fiesta models, 22

4 Rotate tires

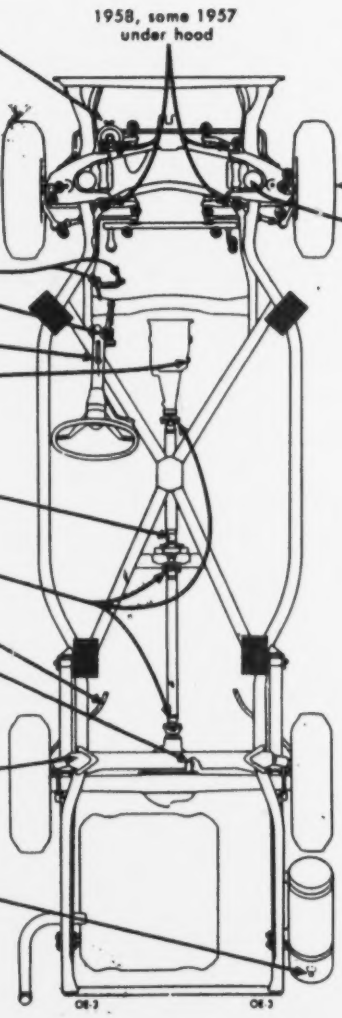

Front Wheel Bearings.....Clean and repack **GX** 10
Initial torque, 17 ft. lb.; final adjustment, 4 ft. lb.

Air Spring Piston Strut Seats Both sides....**GX** 25
Disassemble, clean and lubricate with ¼ ounce. Qualified Mechanic only

■ Position for lift adapter
• Lubrication fitting
● Cooling system drain

SERVICE AS SHOWN

2 Every 2,000 miles
- Clean dry type air cleaner element
- Wash and fill oil bath air cleaner
- Wash and oil wire gauze air cleaner element
- Wash and oil the oil fill cap
- Wash crankcase breather outlet element

4 Every 4,000 miles
- Wash New-Matic suspension separator filter
- Lubricate universal joint spline
- Rotate tires
- Replace oil filter, add extra quart oil

10 Every 10,000 miles
- Replace dry type air cleaner element
- Drain and refill manual transmission
- Coat parking brake cables
- Drain and refill differential
- Clean and repack front wheel bearings

20 Every 20,000 miles
- Repack universal joints

25 Every 25,000 miles
- Coat speedometer cable
- Clean and lubricate both front and rear air spring piston strut seats
- Drain and refill automatic transmission

19675

TECH BRIEF 68–10053—REMOTELY INSTALLED PIPE PLUG PROVIDES EFFECTIVE SEAL IN HAZARDOUS ENVIRONMENT

Makers of oil field and chemical plant equipment may find particular value in this remotely controlled pipe plug that can provide an effective gas seal against pressures of 75 p.s.i under a wide variety of conditions. The sealer is operated by an actuator handle and firmly clamps itself to the pipe. The pipe plug provides the gas-tight seal by expanding a rubber seal against the inside surface of the pipe opening. Intial turns of the actuator clamp the device in place, and further turns then compress the seal firmly in place. This seal also may be valuable in underwater operations, biological work, pressure systems, et cetera where hazardous conditions prescribe remote manipulation techniques.

For additional information, circle Key No. 46 on Reader Service Card.

TECH BRIEF 68–10270—SPIRAL-GROOVED SHAFT SEALS SUBSTANTIALLY REDUCE LEAKAGE AND WEAR

Seals on most rotating shafts are unsuitable for long term operation unless maintenance can be performed regularly. There is an additional problem when the seals must hold against pressure or thermal differentials, or must retain pumped fluids such as caustics or desiccants. NASA has developed a spiral-grooved seal that overcomes these problems by countering the centrifugal forces (as would displace fluids outwards) and maintaining separation of the seal faces to prevent wear. These spiral seals will be useful in a number of applications such as pumps, compressors, blowers, and others.

For additional information, circle Key No. 47 on Reader Service Card.

PONTIAC

1955-57 All Models

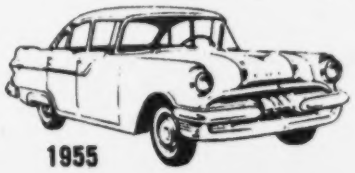

1955

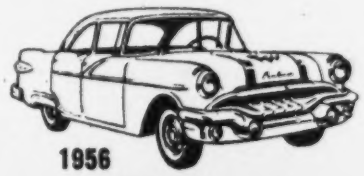

1956

HOOD RELEASE: Front

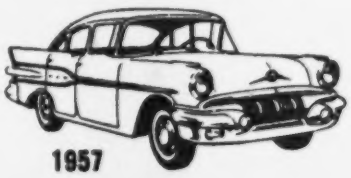

1957

CAR CHECK SERVICE EVERY 1,000 MILES EXCEPT AT MILEAGE ■ SYMBOLS SHOWN

Chek-Chart

COOLING SYSTEM ..... Quarts

	With Heater	Without Heater
1955, with air conditioning	25	23
1955, all other models	24½	22¾
1956, with Strato-Flight Hydra-Matic	25	23½
1956, all other models	24¼	22¾
1957, with air conditioning	23¾	22¼
1957, all other models	23	21½

Cooling system pressure: 1955-56, 7 pounds, with air conditioning, 15 pounds; 1957, 14 pounds

Battery ..... Test and fill

Power Steering Reservoir ..... ATF
Fill to level mark

Air Cleaner Element ..... Service
10 Dry type ..... Replace
2 Oil bath ..... Wash and fill MO
Above +32°, 40; below +32°, 20/20W
2 Wire gauze ..... Wash and oil MO

Steering Gear (plug) ..... 90 MP
1956-57 power steering models, no lubrication

Brake Master Cylinder (plug) ..... GHDB
Fill to ⅞ inch below top of fill hole. Power brakes, ½ inch

Distributor Shaft (oil cup) ..... 10W MO
10 1955-56: Wick under rotor . Sparingly 10W MO
10 Felt under plate . . Sparingly 10W MO

Front Suspension and Steering Linkage ..... (21 fittings) GX

Clutch Shaft Felts and Linkage ..... MO

Pedal Shaft (1 or 2 fittings) ..... GX
Hydra-Matic models with power brakes, no lubrication

TRANSMISSION, Manual . . 80 MP
Maintain level to fill plug hole
CAPACITY 1955, 1¾ pints; 1956-57, 2½ pints
10 DRAIN and REFILL

25 **Universal Joints** ..... Repack GX
Must be disassembled. Qualified Mechanic only

DIFFERENTIAL ..... 90 MP
Maintain level to fill plug hole
CAPACITY 1955-56, 3¼ pints; 1957, 5 pints
10 DRAIN and REFILL

10 **Parking Brake Cables** ..... Coat GX

GAS TANK ..... Gallons

All models, ex. station wagons	20
Station wagons:	
1955	18
1956-57: 2 seat	17
3 seat	16

TIRES ..... Pressure

	Front	Rear
7.10-15	24*	24
7.50-14	22■	22
7.60-15, ex. station wagons	22*	20
7.60-15, station wagons	26◆	26◆
8.00-14	20*	22
8.50-14, ex. Safari	20*	20
8.50-14, Safari	24▲	24▲

* With air conditioning, except station wagons, add 2 pounds
◆ Safari, 24
■ With Hydra-Matic, 24
▲ Star Chief Safari, 22

4 Rotate tires

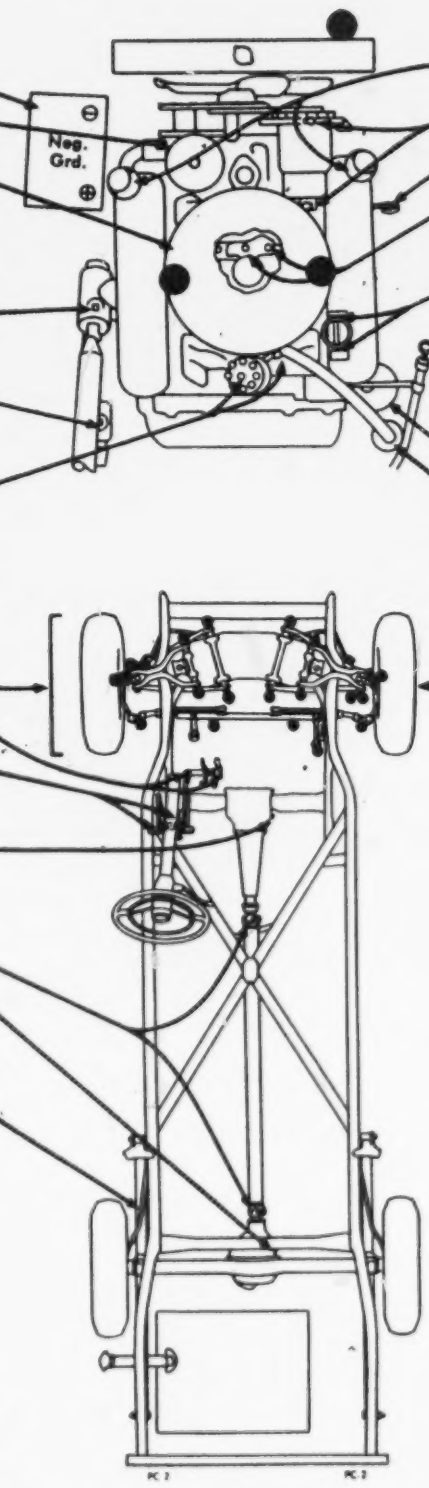

• Lubrication fitting
● Cooling system drain

CRANKCASE ..... MS
Above +32° ..... 20/20W* or 10W/30
+32° to 0° ..... 20/20W* or 10W/30
* Use one grade heavier for sustained speed, or severe operation
CAPACITY 5 quarts

Oil Fill Caps ..... Wash and oil MO 2

Generator (2 oil cups) ..... 10W MO

Crankcase Dipstick ..... Check level
Full to Add Oil—2 qts.

Carburetor Accelerating Pump Shaft . . 10W MO 10
Carter carburetor: 1955-56 two-barrel, fill 1 screw hole on top and 1 hole under cover; 1955 four-barrel, fill 2 oil holes under cover

Manifold Heat Control Valve ..... GK C
Lubricate if shaft is not free

TRANSMISSION, Automatic . ATF
Check level, engine idling: Strato-Flight PARK position; others, NEUTRAL

CAPACITY, quarts	Initial Refill	Total Refill
1955-56 ex. Strato-Flight	8	9½
1956 Strato-Flight	8	10½
1957	8	9

DRAIN and REFILL 25
Remove 1 torus cover plug and transmission plug

Oil Filter (under car) ..... Replace 4

Crankcase Breather Outlet Element ..... MO 2
Wash and oil

Front Wheel Bearings .... Clean and repack GX 10
Initial torque, 200 in. lb.; final adjustment, 45-50 in. lb.

SERVICE AS SHOWN

2 Every 2,000 miles
- Wash and fill oil bath air cleaner
- Wash and oil wire gauze air cleaner element
- Wash and oil the oil fill caps
- Wash and oil crankcase breather outlet element

4 Every 4,000 miles
- Rotate tires, balance wheels
- Replace oil filter, add extra quart oil

10 Every 10,000 miles
- Replace dry type air cleaner element
- 1955-56, lubricate distributor wick under rotor
- 1955-56, lubricate distributor felt under plate
- Drain and refill manual transmission
- Drain and refill differential
- Coat parking brake cables
- Lubricate carburetor pump shaft
- Clean and repack front wheel bearings

25 Every 25,000 miles
- Repack universal joints
- Drain and refill automatic transmission

C Conditional service
- Lubricate manifold heat control valve if shaft is not free

19676

BUICK

1957-58 All Models

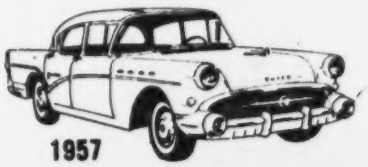

1957

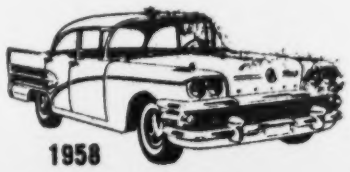

1958

HOOD RELEASE: Front

CAR CHECK SERVICE EVERY 1,000 MILES EXCEPT AT MILEAGE ■ SYMBOLS SHOWN

Chek-Chart

COOLING SYSTEM ..... Quarts

	With Heater	Without Heater
1957	18	16½
1958	19	16½

Cooling system pressure, 15 pounds

Battery ..... Test and fill

Power Steering Reservoir ..... ATF
Fill to level mark

Air Cleaner Element ..... Service

[2] Dry type ..... Clean

[10] Dry type ..... Replace

[2] Oil bath ..... Wash and fill 40 MO

Manual Steering Gear (plug) ..... 90 MP

Brake Master Cylinder (plug) ..... GHDB
Fill to ½-1 inch below top of fill hole

[5] **Carburetor Accelerating Pump Shaft** ... 10W MO
Carter carburetor: Series 40, fill 1 screw hole on top and 1 hole under cover

Air Suspension Tank Cock ..... Drain
Drain condensation. Close drain cock, finger tight, immediately. Where temperature is below +32° for long period of time, open cock and exhaust air supply. Remove core from valve on top of tank and pour ½ pint of Gulf ColdFlo Antifreeze thru opening. Reinstall valve core and run engine to recharge system. CAUTION: Do not use permanent type antifreeze

Front Suspension and Steering Linkage ..... (17 fittings) GX

Clutch Release Equalizer Shaft ..... GX

TRANSMISSION, Manual .. 90 MP
When consistently below −10°, 80 may be used
Maintain level to fill plug hole
CAPACITY 2½ pints
[10] DRAIN and REFILL

[5] **Propeller Shaft Spline** ..... GX
Remove plug, rotate shaft until fitting appears

DIFFERENTIAL ..... 90 MP
When consistently below −10°, 80 may be used
Maintain level ¼ to ⅜ inch below fill plug hole
CAPACITY 6 pints
[10] DRAIN and REFILL

LIFTING CAUTION — AIR SUSPENSION

Before jacking or placing car on hoist or lift, PULL MANUAL LIFT CONTROL KNOB, located under instrument panel, right of center, all the way out. Push knob all the way in after lowering

GAS TANK ..... Gallons

All models	20

TIRES ..... Pressure Front Rear

7.10-15, 7.60-15, 8.00-15	24	24

For temperatures below +32° increase pressure 2 pounds

[5] Rotate tires

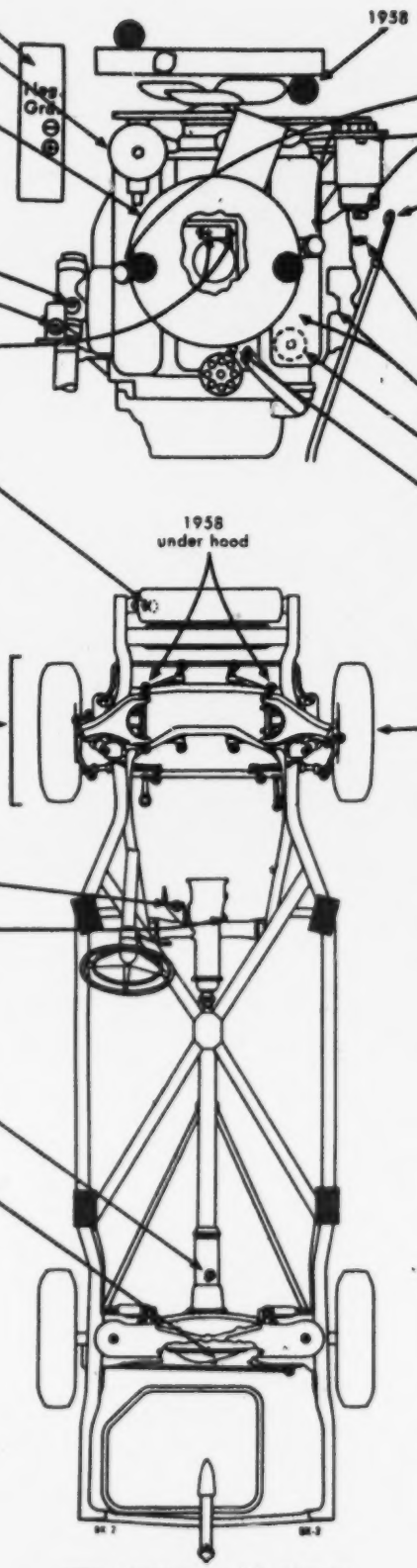

■ Position for lift adapter

• Lubrication fitting

● Cooling system drain

CRANKCASE ..... MS

Above +32°	20/20W or 10W/30
+32° to 0°	10W or 10W/30

CAPACITY 5 quarts

Oil Fill Caps ..... Wash and oil MO [2]

Generator (2 oil cups) ..... 10W MO

TRANSMISSION, Automatic . ATF
Check level, engine idling, PARK position

CAPACITY, quarts	Initial Refill	Total Refill
1958 Flight Pitch	3	12½
All other models	3	12

DRAIN and REFILL ..... [25]
Remove 2 converter plugs and disconnect fill pipe

Crankcase Dipstick ..... Check level
1957, Full to Add—1 qt.; 1958, Full to 1 qt.—1 qt.

Manifold Heat Control Valve Shaft ..... GK

Oil Filter (under car) ..... Replace [4]

Distributor Shaft (oil cup) ..... 10W MO

Front Wheel Bearings .... Clean and repack GX [10]
Initial torque, 30 ft. lb.; final adjustment, 12½ ft. lb.

SERVICE AS SHOWN

[2] **Every 2,000 miles**
Clean dry type air cleaner element
Wash and fill oil bath air cleaner
Wash and oil the oil fill caps

[4] **Every 4,000 miles**
Replace oil filter, add extra quart oil

[5] **Every 5,000 miles**
Lubricate carburetor pump shaft
Lubricate propeller shaft spline
Rotate tires, balance wheels

[10] **Every 10,000 miles**
Replace dry type air cleaner element
Drain and refill manual transmission
Drain and refill differential
Clean and repack front wheel bearings

[25] **Every 25,000 miles**
Drain and refill automatic transmission

19677

VT 013 143
Auto Mechanics Course. Book 21: Ordering Replacement Parts.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 108p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; MECHANICS (PROCESS); *MOTOR VEHICLES
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on ordering replacement parts was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 143

ED0 56238

BOOK 21

To Be Used With
PANEL BOOK 21

(C1)

AUTO MECHANICS COURSE

BOOK 21: ORDERING REPLACEMENT PARTS

A BASIC SYSTEMS PROGRAM

VT013143

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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Curriculum Report Reference
Page 17

Task Analysis Reference
47.3

19679

AUTO MECHANICS COURSE

BOOK 21: ORDERING REPLACEMENT PARTS

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19680

AUTO MECHANICS COURSE

PRE-TEST BOOK 21: ORDERING REPLACEMENT PARTS

A BASIC SYSTEMS PROGRAM

19681

1-3

NAME the three things you should tell a parts salesman about a car when ordering parts:

_____

_____

_____

4-5

When ordering replacement parts on the telephone, what else should you tell the parts salesman?

_____

_____

6

Manufacturers list the parts they make in books called _____.

7

Parts are listed according to _____ order.

8

To identify a part, every manufacturer gives the part a _____.

9-11

"Send me a coil for a Buick Super."

NAME the three things that should have been added to the order for the part to be delivered:

_____

_____

_____

Name _____ ___

Date _____

Starting time _____

Finishing time _____

19684

1

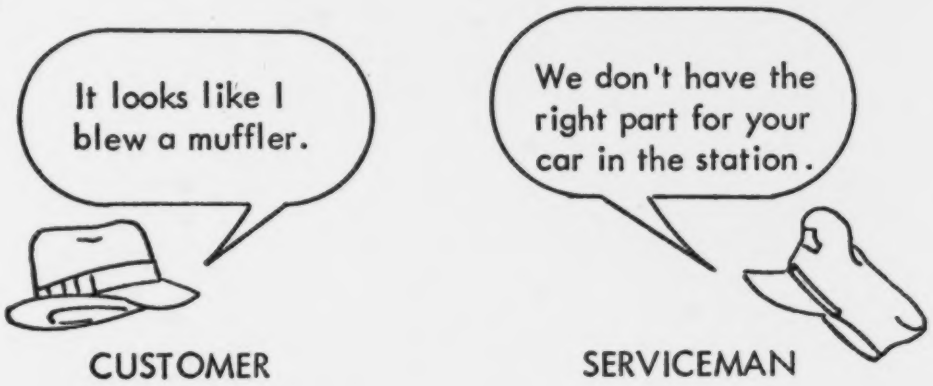

What should the serviceman do?

- ☐ call up a parts dealer and order a new part
- ☐ tell the customer to take his business somewhere else
- ☐ try to sell the customer a tailpipe

—REMOTELY IN- ROVIDES EFFEC- DOUS ENVIRON-

nical plant equipment is remotely controlled an effective gas seal der a wide variety of rated by an actuator to the pipe. The pipe by expanding a rub- ace of the pipe open- r clamp the device in n compress the seal may be valuable in gical work, pressure rdous conditions pre- chniques.

ircle Key No. 46 on

H BRIEF 68-10270—SPIRAL- OVED SHAFT SEALS SUBSTAN- LY REDUCE LEAKAGE AND WEAR

ls on most rotating shafts are unsuitable for erm operation unless maintenance can be per- d regularly. There is an additional problem the seals must hold against pressure or ther- fferentials, or must retain pumped fluids such stics or desiccants. NASA has developed a grooved seal that overcomes these problems ntering the centrifugal forces (as would dis- fluids outwards) and maintaining separation seal faces to prevent wear. These spiral seals e useful in a number of applications such as , compressors, blowers, and others.

dditional information, circle Key No. 47 on Service Card.

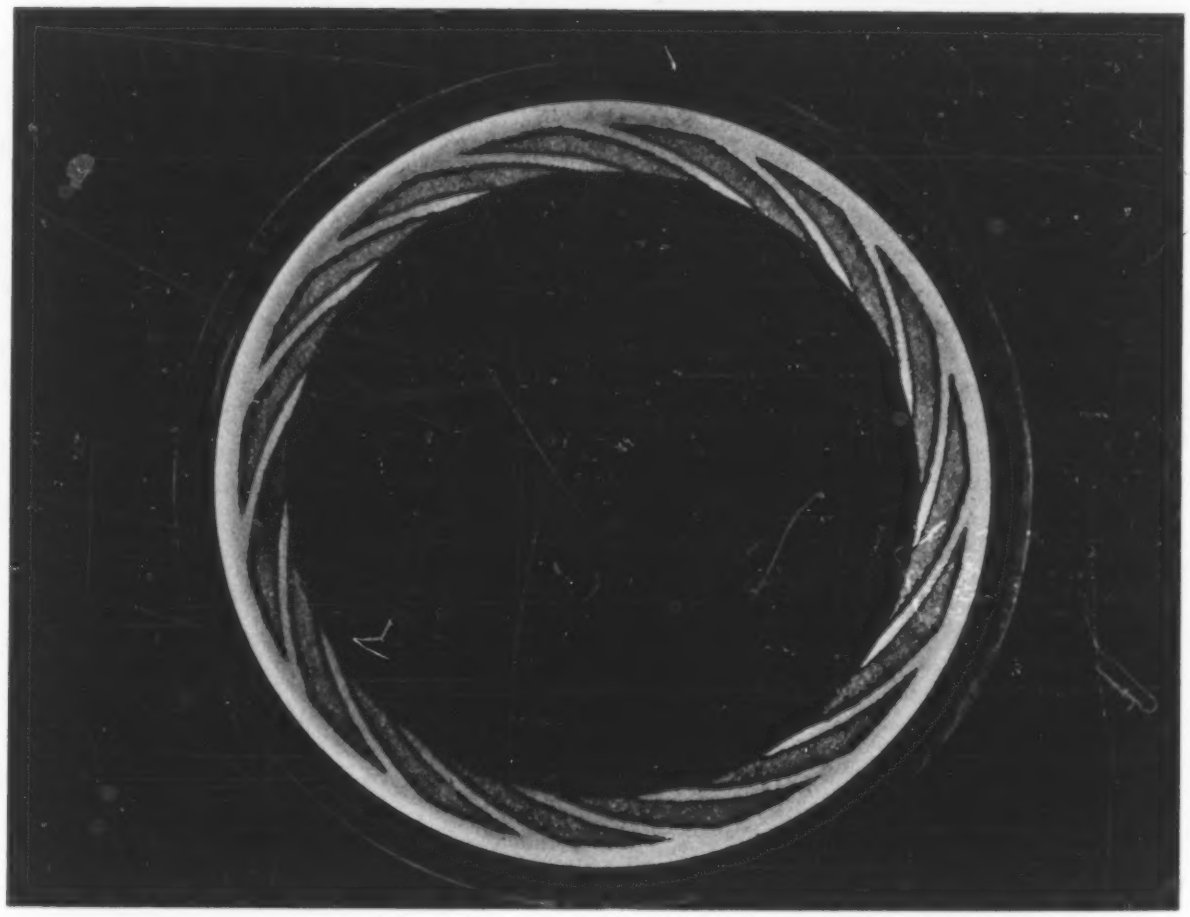

1

call up a parts dealer and order a new part

2

This part of the program will teach you how to order parts from parts dealers.

NO ANSWER NEEDED
GO ON TO NEXT PAGE

19686

2

NO ANSWER NEEDED

3

Parts are replaced in an automobile when: (CHECK ALL CORRECT ANSWERS)

- ☐ they are broken
- ☐ the car owner is tired of them
- ☐ they are not working

19687

3

they are broken

they are not working

4

Parts that are broken, worn out or not working should be:

- ☐ replaced
- ☐ left in a car

19688

4

replaced

5

Auto repair shops and gasoline filling stations:

- ☐ have every part for all automobiles
- ☐ must buy replacement parts for automobiles

19689

5

must buy replacement parts for automobiles

6

A Pontiac fuel pump will not fit in a Dodge.

A Valiant radiator hose will not fit in a Lincoln.

Different makes of cars take parts that are:

- ☐ the same
- ☐ not the same

19690

6

not the same

7

Will a Plymouth tailpipe fit an Oldsmobile?

- ☐ yes
- ☐ no

19691

7

no

8

A carburetor that fits a Ford (☐ will ☐ will not) fit a Chrysler.

19692

8

will not

9

Ford, Plymouth and Pontiac are all different makes of cars.

CHECK the different makes of cars listed below:

- ☐ Cadillac
- ☐ Chevrolet
- ☐ 1959
- ☐ 4-door sedan
- ☐ Mercury

19693

9

Cadillac

Chevrolet

Mercury

10

Parts must be ordered according to the make of the car that is being worked on.

What information can help you to order the correct part? (CHECK ALL CORRECT ANSWERS)

- ☐ car is dirty
- ☐ car is a Corvair
- ☐ car needs repairs

19694

10

car is a Corvair

11

When ordering parts from a parts salesman, you must tell him the m_____ of the car.

19695

SEALS AND SEALING TECHNIQUES (NASA SP–5905(01))

This report on seals and techniques developed by NASA and its contractors to solve problems may be useful to many businesses. Some special purpose seals and gaskets which were developed are a vented gasket for liquid hydrogen valves which reduces leakage into a vacuum chamber; a soft metal seal with serrated top and bottom which seals conical surfaces; a reusable tear-strip hermetic seal, and a glass-to-metal seal of thermoplastic material for a nickel-cadmium battery. The sealing and packaging techniques include a simplified orifice seal assembly of Teflon, and a restrained, pressure-balanced plastic rubbing ring used under high-fluid-pressure conditions. Two general techniques have been developed to standardize packaging specifications for spiral wound gaskets, pressure actuated seals, disks, rings, and similar materials. Four seal installation tools are described: one facilitates installing O-rings over sharp external threads, and another protects O-rings from damage caused by thread edges. An electrically heated hand cutter and sealer for nylon and fiberglass, which can be modified to use on wood, leather, fiberboard, plastic film, and other materials, appears useful. 1967. 14 pp. CFSTI $0.25.

SEALING ARRANGEMENT FOR PISTON-CYLINDER PRESSURE VESSEL (PAT. NO. 3,415,170)

Shops concerned with isostatic hot presses will be interested in this sealing arrangement which has the ability to hold 200,000 p.s.i. at room temperature and 4,000 p.s.i. at 300° F. without seal failure. This device provides a seal with a capacity to increase with increasing pressure and yet does not extrude between the piston and the die at any point in the pressure cycle. In this arrangement, the seal is made of soft copper but can be made of polyvinyl chloride. Once pressure is release
in removing the piston from
releases at the same time. Thi
broaden the scope of isostat

Administering Office: Atomi
Assistant General Counsel f
D.C. 20545.

METHOD OF PROVID METALS WITH PROT (PAT. NO. 3,362,842)

Companies which make
metals for operation at elev
find this coating process o
method prevents oxidation
the elimination of both su
oxygen ion diffusion throu
ductors, when used as coatin
of the substrate to diffuse t
oxidize at the coating air i
when used as metal coating
diffuse inwardly through th
moting oxidation at the met
then, an N conductor is appli
to the metal and a P conduct
layer, metal and oxygen io
through the coating. The
must be selected with care
expensive nor difficult to us
objects of almost any size an

Administering Office: Dep
Patent Counsel, Washington

METALLURGICAL AS BILITY FOR SMALL (N68–34248)

Useful statistical and met
nitriding process for harde
sented in this report from
Center, Greenbelt, Md. It
great value in clarifying the
viously assigned to the nitrid
using the technique may fi
both OC and reliability num

11

make

12

To order the correct part, who has to know the make of the car?

- ☐ the manufacturer
- ☐ the parts salesman
- ☐ the customer

19696

12

the parts salesman

13

What must a parts salesman know to give you the right part? _____

19697

13

the make of the car

14

Parts that fit a 1949 Chevrolet may not fit a 1959 Chevrolet.

Parts that fit a 1954 Ford may not fit a 1964 Ford.

Parts that fit a 1950 Pontiac:

- ☐ may fit a 1960 Pontiac
- ☐ may not fit a 1960 Pontiac

19698

14

may not fit a 1960 Pontiac

15

When ordering parts, you must tell the parts salesman the year of the car.

Which information can help you get the correct part?

- ☐ The car is a 1958 Mercury.
- ☐ The car is an old Mercury.
- ☐ The car is a new Mercury.

19699

15

The car is a 1958 Mercury.

16

Aside from telling the parts salesman the make of a car, when you order parts, you must also tell him the y_____ of the car.

19700

16

year

17

Knowing the make and the year of the car helps in:

- ☐ filling the gas tank
- ☐ ordering replacement parts
- ☐ putting air in the tires

17

ordering replacement parts

18

NAME two things that you must tell a parts salesman when you are ordering replacement parts for a car:

1. _____

2. _____

19702

18

1. the make of the car

2. the year of the car

19

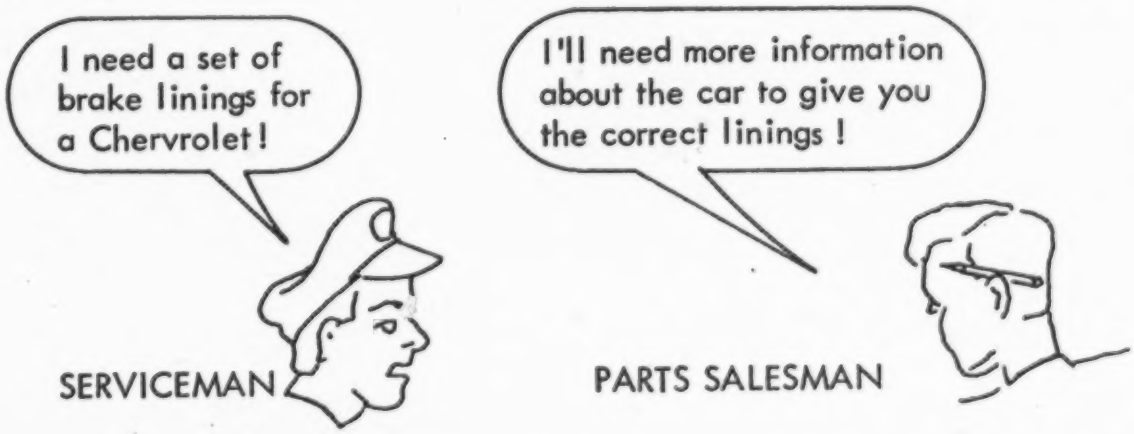

What else should the serviceman tell about the Chevrolet? _____

19703

19

the year of the car

20

The Buick Super, Buick Special and Buick Roadmaster may not all use the same tires.

The Plymouth Belvedere and Plymouth Fury may not always use the same parts.

Must a Mercury Montclair and a Mercury Monterey always use the same clutch?

- ☐ yes
- ☐ no

19704

20

no

21

The same make of car comes in different MODELS.

CHECK the different models of Chevrolet:

- ☐ 1954
- ☐ Biscayne
- ☐ Impala

19705

ride. Once pressure is released, there is no difficulty in removing the piston from the cylinder as the seal releases at the same time. This sealing technique may broaden the scope of isostatic hot press equipment.

Administering Office: Atomic Energy Commission, Assistant General Counsel for Patents, Washington, D.C. 20545.

METHOD OF PROVIDING REFRACTORY METALS WITH PROTECTIVE COATINGS (PAT. NO. 3,362,842)

Companies which make products of refractory metals for operation at elevated temperatures will find this coating process of interest and use. The method prevents oxidation of the coated articles by the elimination of both substrate metal ion and oxygen ion diffusion through the coating. P conductors, when used as coatings on metals, allow ions of the substrate to diffuse through the coating and oxidize at the coating air interface. N conductors, when used as metal coating, permit oxygen ions to diffuse inwardly through the coating thereby promoting oxidation at the metal coating interface. If, then, an N conductor is applied as a coating adjacent to the metal and a P conductor is applied as a second layer, metal and oxygen ions cannot easily diffuse through the coating. The specific semiconductors must be selected with care. The technique is not expensive nor difficult to use. It can be applied to objects of almost any size and shape.

Administering Office: Department of the Navy, Patent Counsel, Washington, D.C. 20360.

METALLURGICAL ASPECTS OF RELIABILITY FOR SMALL NITRIDED PARTS (N68–34248)

Useful statistical and metallurgical aspects of the nitriding process for hardening small parts is presented in this report from Goddard Space Flight Center, Greenbelt, Md. It contains information of great value in clarifying the reliability figures previously assigned to the nitriding process. Metal shops using the technique may find the report useful in both OC and reliability number assignments.

21

Biscayne

Impala

22

Chrysler New Yorker and Chrysler Saratoga are both different m_____ of the same make.

19706

22

models

23

Besides the make and year of a car, you should also know the _____ of the car.

19707

23

model

24

When getting the correct part to do a job, you must know the m _____ , y _____ and m _____ of the car.

19708

24

make, year (and) model

25

You should know the make, model and year to be sure you get the right:

- ☐ customer
- ☐ part
- ☐ price

19709

25

part

26

What must you know about a car to be sure you will get the right parts?

_____

_____

_____

19710

26

the make

the year

the model

27

Each part is given a special number by the company that makes the part. You should try to give the exact number when ordering parts.

Ordering parts by numbers helps to get:

- ☐ any old part
- ☐ the right part
- ☐ the wrong part

19711

27

the right part

28

Parts can be ordered by telling the parts salesman the part n _____ .

19712

28

number

29

Besides telling the salesman the make, year and model of a car, in what other way can you order a part?

_____

19713

29

by the part number

30

CHECK all of the things you tell a parts salesman when ordering parts:

- ☐ the make of the car
- ☐ the model of the car
- ☐ the year of the car
- ☐ the part number
- ☐ the size of the part

19714

30

the make of the car

the model of the car

the year of the car

the part number

31

Companies that manufacture parts make books that list the number of each part. These books are called parts CATALOGS.

Parts catalogs tell you:

- ☐ the number of a part
- ☐ how to use the part

19715

METHOD FOR SPRAY FORMING OF TUBULAR BODIES (PAT. NO. 3,397,732)

This invention is a novel way of making tubular sections by spraying molten metal onto a removable form. It will be of great value to plants and shops working with unusual sizes of tubular bodies or which have tubular size and shape requirements not easily available commercially. A collapsible mandrel supports the form. The mechanism for doing this is similar to a lathe. The mandrel is rotated and the device for spraying the molten metal is moved along the axis of the mandrel by a lead screw. Tubular sections made this way are seamless, may have extremely thin walls, and can be formed from layers of different metals. Repeated sprayings increase the thickness of the tubular section. After the tube is formed, the mandrel is simply collapsed and removed. This method of spraying, followed by shear extrusion, or hot or cold working, may be repeated for any required number of cycles to achieve the desired dimensions or other necessary characteristics.

Administering Office: Department of the Army, Office of the Judge Advocate General, Chief, Patents Division, Washington, D.C. 20360.

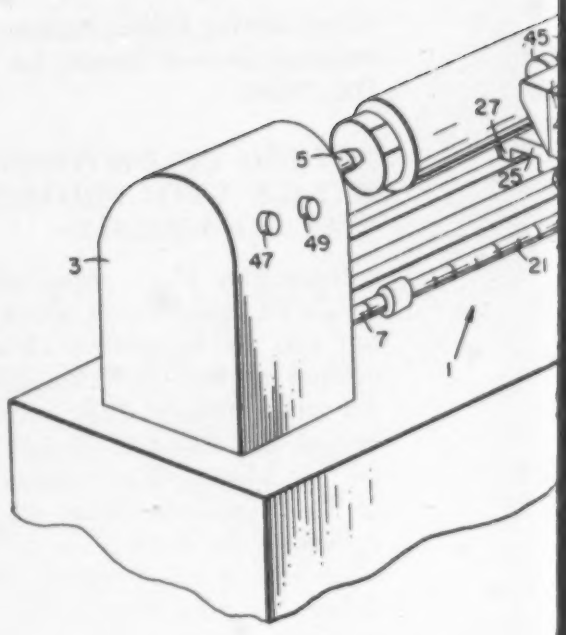

TECH BRIEF 68–10249—HIGH-T TURE BEARING LUBRICANTS

Proper lubrication of a bearing is a successful operation and endurance a design and material selection. Yet today are generally incapable of protecting temperatures over 450° F., while bearin called upon for operation at increasing peratures (500° to 700° F.). NASA rese problem has led to a synthetic paraffi cant that will assure operation at 600° than the catalog life of the bearing. Bo finic base oil and the additives are available; only antiwear and antifoam used. This lubricant should be valuable ing installation where heat is a problem

For additional information, circle Ke Reader Service Card.

31

the number of the part

32

You can find the number of a part in a:

- ☐ catalog
- ☐ telephone book
- ☐ customer's automobile

19716

32

catalog

33

A parts catalog gives you the catalog n _____ of the part.

19717

33

number

34

Where can you find a part number? _____

19718

34

(in a) parts catalog

35

What does a parts catalog tell you? _____

19719

35

part numbers

36

To find part numbers, you need to know MAKE, MODEL and YEAR.

If you know the make, model and year, look in the:

- ☐ catalog
- ☐ part number book
- ☐ yearbook

19720

36

catalog

37

You want to find the part number in a catalog.

What do you have to know?

_____

_____

_____

19721

37

the make

the model

the year

38

Does the parts salesman really need this information?

- ☐ yes
- ☐ no

19722

38

yes

39

SERVICEMAN

PARTS SALESMAN

What did the serviceman tell the parts salesman that makes it easy to find the part number?

_____

_____

_____

19723

39

the year of the car

the make of the car

the model of the car

40

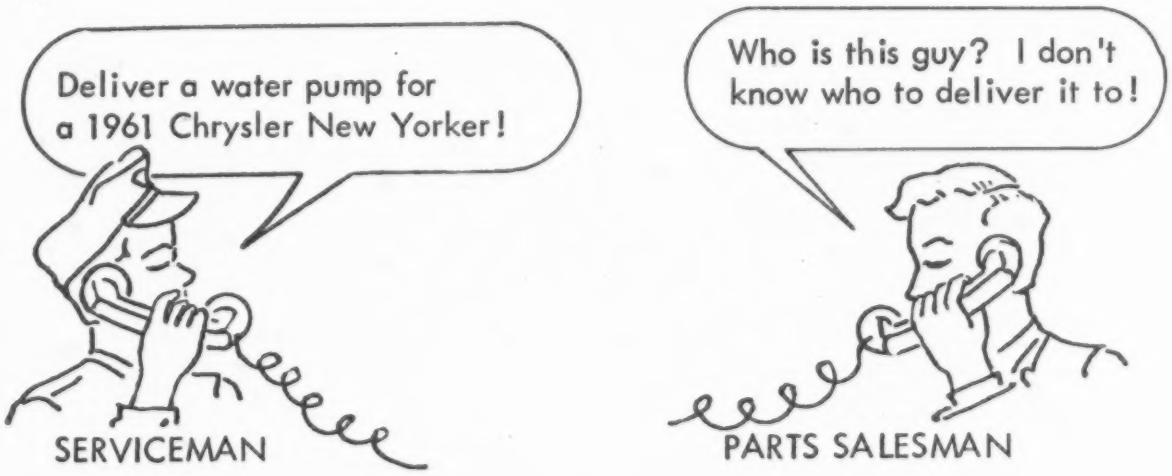

The parts salesman cannot deliver because he does not know: (CHECK TWO)

- ☐ what a water pump is
- ☐ where to deliver the part
- ☐ whom to deliver it to

19724

40

where to deliver the part

whom to deliver it to

41

When the serviceman asked for the water pump to be delivered, he forgot to: (CHECK TWO)

- ☐ ask for the part by make, model and year
- ☐ give his name and address

19725

nts,
ed)

ING OF TUBU-
7,732)

f making tubular
onto a removable
plants and shops
ubular bodies or
requirements not
llapsible mandrel
for doing this is
s rotated and the
metal is moved
a lead screw. Tu-
amless, may have
rmed from layers
rayings increase
. After the tube is
collapsed and re-
followed by shear
may be repeated
es to achieve the
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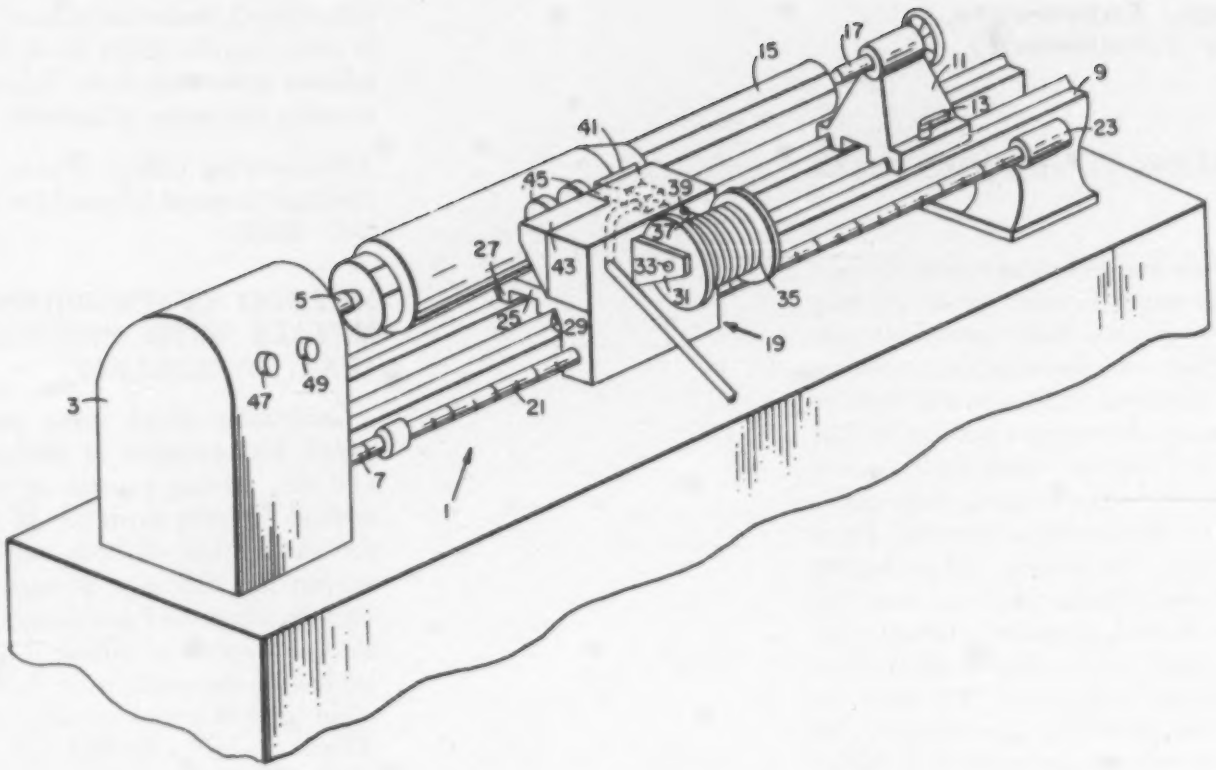

TECH BRIEF 68–10249—HIGH-TEMPERATURE BEARING LUBRICANTS

Proper lubrication of a bearing is as vital to its successful operation and endurance as is proper design and material selection. Yet today's lubricants are generally incapable of protecting a bearing at temperatures over 450° F., while bearings are being called upon for operation at increasingly high temperatures (500° to 700° F.). NASA research into this problem has led to a synthetic paraffin base lubricant that will assure operation at 600° F. for longer than the catalog life of the bearing. Both the paraffinic base oil and the additives are commercially available; only antiwear and antifoam additives are used. This lubricant should be valuable in any bearing installation where heat is a problem.

For additional information, circle Key No. 48 on Reader Service Card.

CHEMICAL VAPOR DEPOSITION OF THIN FILM DIELECTRICS (AD–674 020)

Chemical vapor deposition (CVD) is a technique for forming a thin film of TiO_2 with the desirable dielectric properties. It uses the reaction of tetraisopropyl titanate in an oxidizing atmosphere containing water vapor. CVD yields the widest range of technological possibilities for forming dielectrics with good control of variables and products. Dielectric constants range from 50 to 100 with a breakdown strength of 200,000 volts/cm. The thickness of the film ranges from 1,200 to 3,000 angstroms. The dissipation factor varies from 4 percent to 30 percent, with the average near 10 percent. This technique was developed at Texas University Electronics Research Center, Austin, Tex., and may interest electronic manufacturers.

41

give his name and address

42

Who must know the name and address of the service station for parts to be delivered?

- ☐ the customer
- ☐ the parts salesman
- ☐ the serviceman

19726

42

the parts salesman

43

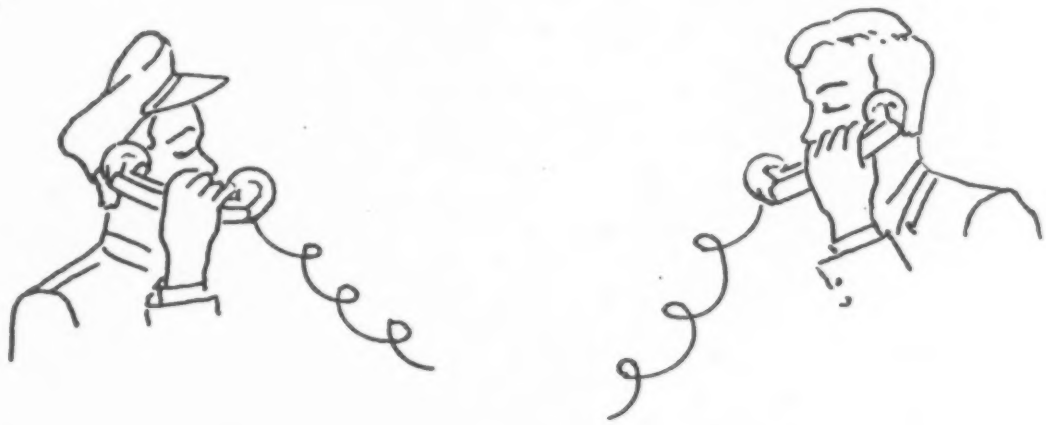

The parts salesman cannot deliver the water pump because he does not:

- ☐ argue with servicemen
- ☐ know the address of the serviceman
- ☐ know the name of the serviceman
- ☐ know the part that was ordered

19727

43

know the address of the serviceman

know the name of the serviceman

44

When ordering parts by telephone, the name and address of the service station must be given by the:

- ☐ customer
- ☐ parts salesman
- ☐ serviceman

19728

44

serviceman

45

In order to get parts delivered, the serviceman must give his name and address to the _____ _____.

19729

45

parts salesman

46

In order to deliver parts, the parts salesman must know the serviceman's _____ and _____.

19730

46

name (and) address

47

Don't forget, besides his name and address, the serviceman must also give the m_____, m_____ and y_____ of the car.

19731

47

make, model (and) year

48

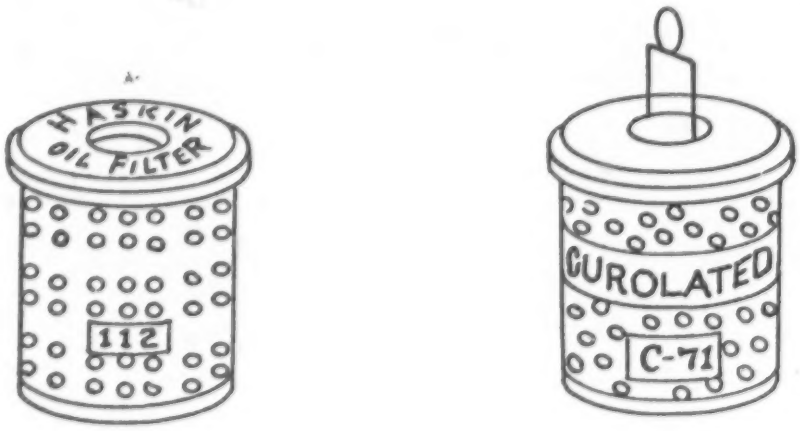

The filters shown above have:

- ☐ different names
- ☐ different numbers
- ☐ the same names
- ☐ the same numbers

19732

279 OF 327

ED

056 238

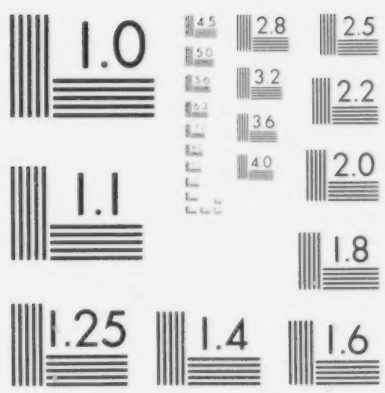

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

48

different names

different numbers

49

Different parts manufacturers use:

- ☐ different parts numbers
- ☐ the same parts numbers

19733

279

49

different parts numbers

50

To be sure that you get the right part, you must tell the parts salesman the right number and the:

- ☐ condition of the part
- ☐ manufacturer of the part
- ☐ weight of the part

19734

TECH BRIEF 68–10062—PYROTECHNIC DEVICE PROVIDES ONE-SHOT HEAT SOURCE

A small, light pyrotechnic heater has been developed by NASA to solve the temperature control problem for localized packages and small areas. Consisting of two mating aluminum tubes, an initiator section, and a heater section, the device can provide 850 to 900 B.T.U.'s per pound and supply temperatures of about 600° F. if needed. Heat is created by an exothermic reaction between an active element, such as boron or magnesium, and an oxygen-supplying compound, such as barium chromate or molybdenum trioxide. The device is safe, reliable, and incapable of reacting until the tubes are joined together and electrically fired. It could be included in a repair kit for welding items in places inaccessible to regular welding equipment.

For additional information, circle Key No. 49 on Reader Service Card.

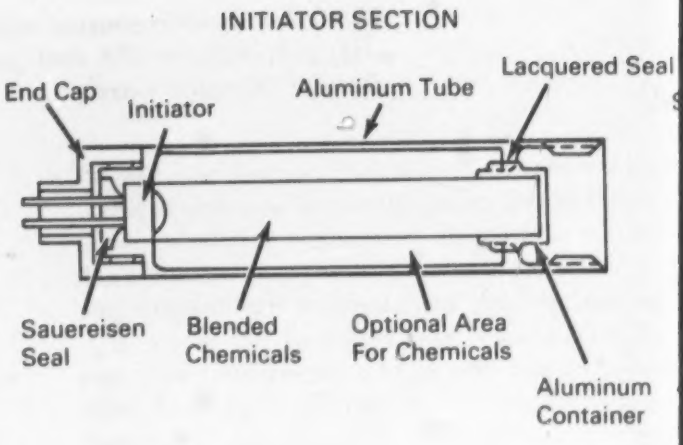

TECH BRIEF 68–10340—APPLICAT OF THE SOLID LUBRICANT MOLYB NUM DISULPHIDE BY SPUTTERING

To take fullest advantage of the lubricant q ties of molybdenum disulphide (MoS_2), the l cant film of MoS_2 must be bonded to the surfa the material requiring lubrication. Under thos cumstances, MoS_2 will function well in all condi including high temperature and high vacuum ronments. NASA studies have shown that can best be bonded to a surface by a three-elect sputtering system. The bonding is continuous, form, and strongly adherent; the equipmen quired is not difficult to assemble or operate. report gives instructions in sputtering and desc the use of MoS_2 in lubricating bearing surfac environments containing chemicals that woul stroy most bonding agents.

For additional information, circle Key No. 5 Reader Service Card.

51

number

52

When a parts salesman is asked for a part by its number, he must also know the maker of the part.

The maker of the part is the:

- ☐ manufacturer
- ☐ salesman
- ☐ user of the part

19736

52

manufacturer

53

You can order parts by the make, model and year of the car.

Or you can tell the parts salesman the _____ and _____ of the part.

19737

53

number

manufacturer

54

You do not have a catalog.

You call the parts salesman and say, "This is William from Joe's Service Station. Send me a water pump."

You forgot to tell the parts salesman:

- ☐ the make of the car
- ☐ the model of the car
- ☐ the year of the car
- ☐ what part you need

19738

54

the make of the car

the model of the car

the year of the car

55

carburetor

1964

Ford

Fairlane

Name: Karr

Address: Karr's Fixit Quick

USE the information above to complete the order:

This is Karr from Karr's Fixit Quick. Send me a carburetor for:

(make) _____

(model) _____

(year) _____

19738

55

Ford

Fairlane

1964

56

fan belt

1960

Dodge

Dart

Name: Pete

Address: The Place

Send me a fan belt for a Dodge Dart 1960. This is _____ (name) from _____ (address).

19740

56

Pete

The Place

57

fuel pump

Chevrolet 6

Bel Air

1959

Name: Barry

Address: Super Service Station

USE this information to complete the parts order below:

This is Barry from the Super Service Station. Send me a fuel pump for

_____.

19741

57

a 1959 Chevrolet Bel Air

58

top radiator hose

1960

Mercury

Montclair

Name: Craig

Address: Economy Service Station

USE the above information to complete the order below:

This is Craig from Economy Service Station. Send me a _____.

19742

58

top radiator hose for a 1960 Mercury Montclair

59

You do not have a parts catalog.

USE your own name and address and WRITE an order for a fan belt for a 1957 Buick Special:

_____

_____

_____

19743

59

This is (your name) from (your address). Send me a fan belt for a 1957 Buick Special.

60

You do not have a catalog and you want to order 4 tires.

CHOOSE a car and WRITE a complete order.

_____

_____

_____

19744

cants,
ued)

-PYROTECHNIC
E-SHOT HEAT

ater has been devel-
emperature control
s and small areas.
inum tubes, an ini-
ion, the device can
pound and supply
if needed. Heat is
n between an active
esium, and an oxy-
s barium chromate
vice is safe, reliable,
he tubes are joined
t could be included
s in places inacces-
ent.

cle Key No. 49 on

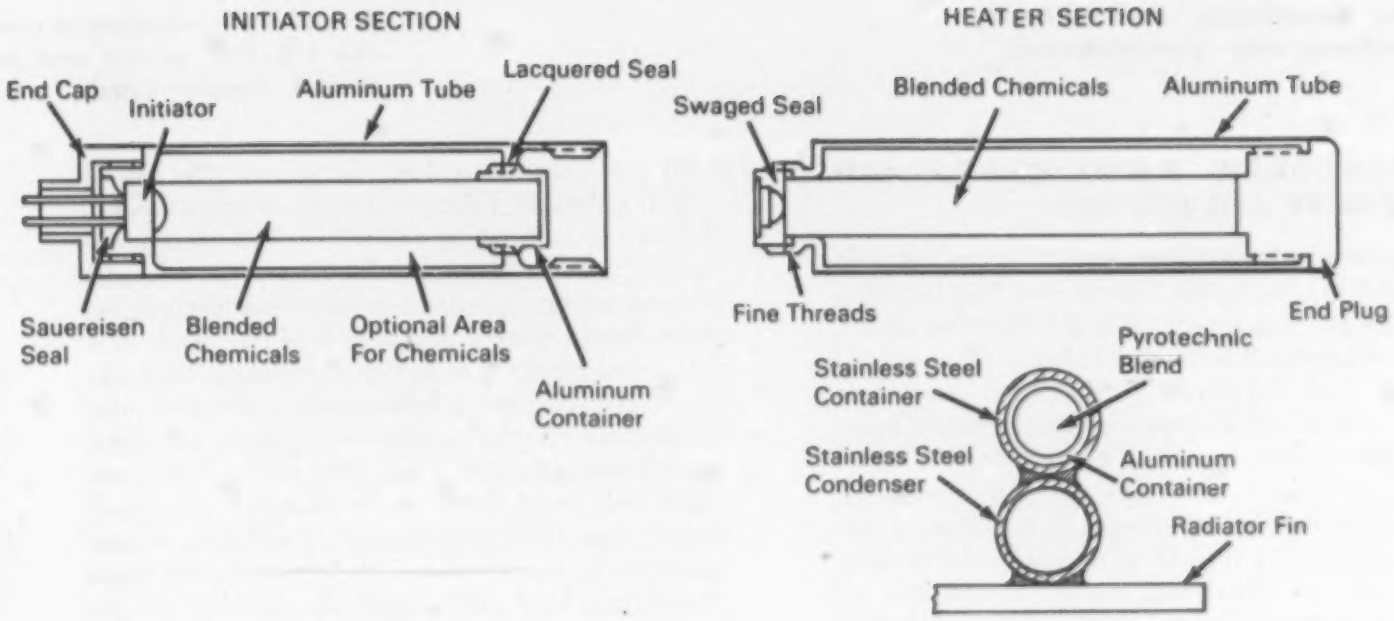

TECH BRIEF 68–10340—APPLICATION OF THE SOLID LUBRICANT MOLYBDENUM DISULPHIDE BY SPUTTERING

To take fullest advantage of the lubricant qualities of molybdenum disulphide (MoS_2), the lubricant film of MoS_2 must be bonded to the surface of the material requiring lubrication. Under those circumstances, MoS_2 will function well in all conditions including high temperature and high vacuum environments. NASA studies have shown that MoS_2 can best be bonded to a surface by a three-electrode sputtering system. The bonding is continuous, uniform, and strongly adherent; the equipment required is not difficult to assemble or operate. This report gives instructions in sputtering and describes the use of MoS_2 in lubricating bearing surfaces in environments containing chemicals that would destroy most bonding agents.

For additional information, circle Key No. 50 on Reader Service Card.

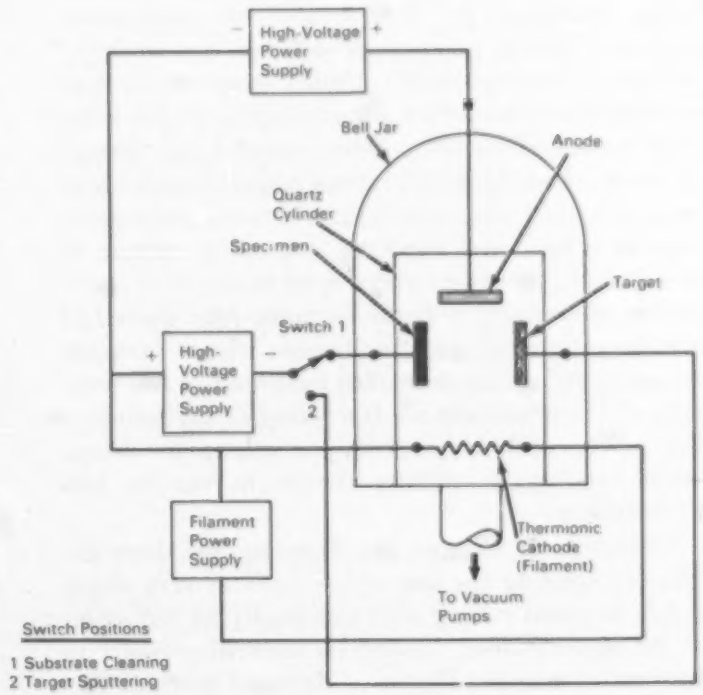

60

THIS IS A SAMPLE ANSWER:

This is Barry from Karr's Service Station. Send me 4 tires for a 1962 Ford Falcon.

61

The next part of this program will show you sample pages from parts catalogs and show you how to use them.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

19745

61

NO ANSWER NEEDED

62

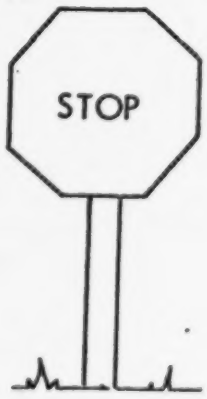

PICK UP THE PANEL BOOK

FIND PANEL 1

THEN TURN THIS PAGE AND GO ON

19746

62

NO ANSWER NEEDED

63

LOOK AT PANEL 1

The top of this chart tells you that two kinds of filters are listed. They are:

_____

_____

19747

63

oil filters

air filters

64

LOOK AT PANEL 1

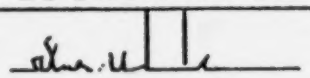

Which car is first on the list? _____

Which cars are listed last? _____

Cars are listed:

- ☐ any old way
- ☐ in alphabetical order
- ☐ in reverse

19748

64

Buick

Studebaker & Packard

in alphabetical order

65

LOOK AT PANEL 1

FIND the box that is labeled "Cadillac."

CHECK the filters listed for this car:

- ☐ air
- ☐ gas
- ☐ oil
- ☐ water

19749

65

air

oil

66

LOOK AT PANEL 1

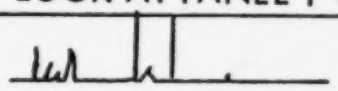

The left-hand column lists the:

- ☐ year
- ☐ part number

The right-hand column lists the:

- ☐ year
- ☐ part number

19750

66

year

part number

67

LOOK AT PANEL 1

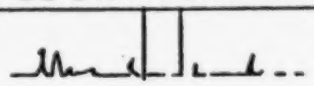

Catalog numbers are to the (☐ left ☐ right) of the year, make and model.

19751

67

right

68

LOOK AT PANEL 1

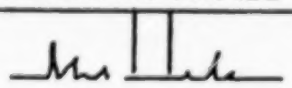

You find the car's make and model:

- ☐ in the middle column
- ☐ in the left-hand column
- ☐ in the right-hand column

19752

68

in the middle column

69

LOOK AT PANEL 1

FIND the box that is labeled "Cadillac."

Oil filters for Cadillacs from 1960 to 1964 all have:

- ☐ the same number
- ☐ different numbers

Oil filters for a 1959 and a 1960 cadillac are:

- ☐ the same
- ☐ different

19753

69

the same number

different

70

LOOK AT PANEL 1

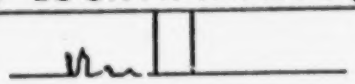

FIND the box that is labeled "Cadillac."

LOOK AT the line marked "1960-64 All Models."

Then, FOLLOW the dotted line to the number column.

What is the number of the filters for these cars?

- ☐ PER-5
- ☐ P-51
- ☐ P-124

19754

METALWORKING PROCESSES AND EQUIPMENT (AD–675 784)

A coordinated committee report (Army-Navy-Air Force-NASA), under the Government Metalworking Processes and Equipment Program, identifies salient factors which limit metal deformation processes. At the same time, the committee sponsored research to extend these limits to improve manufacturing capabilities. This final report will be of interest to metal forming shops and researchers, designers, and builders of metalworking equipment. It contains 34 recommendations for R. & D. in various metalworking areas such as: vibrational energy, hydrostatic extrusion, superplasticity, ductile fracture, application of computers to deformation processing, and others.

METAL FABRICATION (NASA SP–5915 (01))

This publication includes 12 techniques and devices, developed by NASA and its contractors, covering cutting, machining, shaping, and forming. Section 1, *Cutting and Machining*, contains abstracts on minimizing burr formation by filling drilled holes with a nonferrous alloy before machining, instead of hand deburring which is time consuming and may raise rejection rate; and the use of paradichlorobenzene as a filler and rigidizer to prevent collapse of the core of brazed or bonded steel honeycomb sandwiches during roll or brake forming. Also described are the separation of brazed tubes with a tungsten heated probe under controlled temperature and pressure which minimizes the fracturing or annealing of the tubes; and a linear-shaped explosive charge which enables a cutting device to cut in two directions.

In section 2, *Shaping and Forming*, are three abstracts depicting the use of ice to form very sharp bends in metal tubing with practically no reduction of the internal area; to provide internal pressure to prevent cave-in or collapse of flattened tubes of uniform cross section and which permits the use of welded and drawn tubing instead of seamless tubing; and also as a form to fabricate a spherical metal container. The remaining five abstracts include a set of programing tools to determine the distance between bends, planes, and angles of the bends in a preformed master tube so that the configuration can be programed into a numerically controlled tube bending machine for production purposes; a dimpled sheet forming process which permits 0.004-inch and 0.006-inch metal sheets to be dimpled in various shapes; and the application of an adhesive backed spacer to the surface of a workpiece to protect raised channeling from deforming during roll-forming operations. Also included are the use of titanium wire as corner fillets in diffusion bonded structures which produces better structural integrity, fatigue life, and crack resistance; and a forming technique for end closure rings which are used to transfer a uniform load to a sandwich structure. 1968. 8 pp. CFSTI $0.20.

FABRICATION OF TITANIUM CUPOLA PROTOTYPE FOR COMMANDER CAR XM21 (XM13) (AD–676 167)

The fabrication of two titanium alloy gun mounts is described in this report by Watertown Arsenal, Mass. Two alloys (Ti-6Al-4V and Ti-4Al-4V) were selected. Hot working procedures were developed, including the design and construction of special forming dies for titanium plate and closed dies for forging massive components of complicated geometry. Tape-controlled automatic reproduction machining of titanium parts having unusually complex shapes was successfully carried out. Techniques and invaluable shop skills were developed for the successful forming and welding of titanium alloy plates into precisely constructed structures. The two titanium cupolas were assembled by welding, machining, and hand fitting. These procedures may be of interest to fabricators of titanium components.

70

PER-5

71

LOOK AT PANEL 1

FIND the box that is labeled "DeSoto."

All DeSotos from 1958 to 1961 use:

- ☐ a different oil filter
- ☐ no oil filter
- ☐ the same oil filter

19755

71

the same oil filter

72

LOOK AT PANEL 1

What oil filter does a 1950 Oldsmobile 6 cylinder use?

- ☐ 206 or P-206
- ☐ PER-5
- ☐ P-124

19756

72

P-124

73

LOOK AT PANEL 1

What oil filter would a 1961 Buick V-8 use? _____

19757

73

PER-5

74

LOOK AT PANEL 1

What number oil filter does a 1957 6 cylinder Dodge use? _____

What number <u>air filter</u> does this car use? _____

19758

74

P-70FF

AFP-4

75

LOOK AT PANEL 1

What kind of air filter does a 1963 6 cylinder Studebaker use? _____

19759

75

AFP-58

76

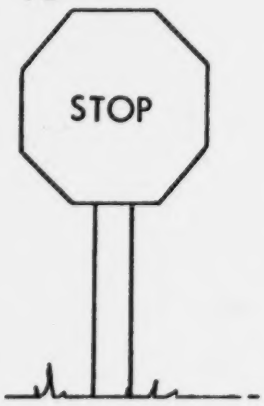

NOW FIND PANEL 2

THEN TURN THIS PAGE AND GO ON

19760

76

NO ANSWER NEEDED

77

LOOK AT PANEL 2

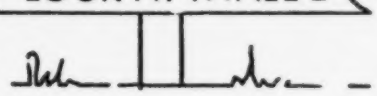

What kind of filter does this chart tell about? _____

19761

77

gasoline (filter)

78

LOOK AT PANEL 2

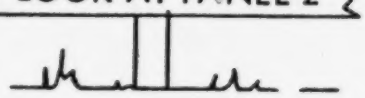

The part numbers are on the (☐ left ☐ right).

19762

78

right

79

LOOK AT PANEL 2

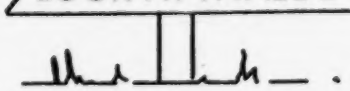

FIND the box that is labeled "Buick."
Now, FIND the line for 1958 Buicks.

FOLLOW the dotted line to the right.

What number gasoline filter does this car use? _____

19763

79

GF-11-8

80

LOOK AT PANEL 2

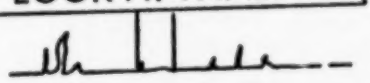

FIND the box that is labeled "Dodge."

Which gasoline filter goes into a 1960 V-8 Dodge Coronet? _____

19764

ts,
)

SES AND

rmy-Navy-Air
Metalworking
lentifies salient
n processes. At
red research to
facturing capa-
terest to metal
ers, and build-
ontains 34 rec-
metalworking
ydrostatic ex-
re, application
ocessing, and

A SP–5915

niques and de-
s contractors,
, and forming.
tains abstracts
g drilled holes
hining, instead
ming and may
radichloroben-
ent collapse of
neycomb sand-
Also described
ith a tungsten
ature and pres-
or annealing of
plosive charge
o cut in two

, are three ab-
rm very sharp
y no reduction
nal pressure to
d tubes of uni-

To order Clearinghouse reports (numbers prefixed AD, LA, PB, or N) and patents, list numbers on Reader Service Cards.

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HAND TOOLS (NASA SP–5908 (01) AND (02))

A selection of novel tools, modifications, or unusual uses for existing tools have been compiled in these two special publications under three sections: (1) Electronic and Electrical Tools, (2) Portable Tools, and (3) Assembly and Special Tools.

In the first report under section 1 are: a new printed circuit board extractor that prevents uneven pull and twisting which causes damage to mounted components; a set of three tools that disengage Cannon Connectors quickly and cleanly without damage to the connector or connecting cable; a harness and tubing clamp holding tool, and a helical wrapping device. In section 2, a template and sheet metal line scribe, a sealing tool, a tube beading tool, one for reversing countersinks in sheet metal, and debraze knockoff tools are described. Section 3 includes a safety wire twister, blind bolt handtool, and a spanner wrench for umbilicals.

The second report contains the following: Section 1, an electronic card puller, the use of which results in fewer twisted or dropped circuit boards than when pliers or wire hooks are used; a tool that permits many component leads to be sheared off simultaneously in uniform lengths or tapered at varying lengths; a bending jig for transistor leads, a method of making cutting pliers safer, and a tool for applying potting compounds in hard to reach areas. Section 2 has abstracts on a ferrule puller, flange trimming, sleeve machinery, honeycomb cutter, and clearance measuring tools. Included in section 3 are abstracts on a torque wrench attachment, an adapter which allows handling of tools with one master slave manipulator, a flexible line compression tool, an insert for a T-wrench, and a gear nut and spanner wrench. All of the tools are believed to be useful and practical. NASA SP–5908(01). 1968. 12 pp. CFSTI $0.25; NASA SP–5908(02). 1968. 8 pp. CFSTI $0.20.

U. S. GOVERNMENT PRINTING OFFICE : 1970 O - 359-918

80

GF-11

81

LOOK AT PANEL 2

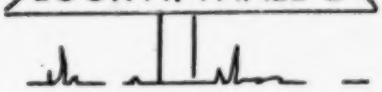

What gasoline filter is used in a 1963 Ford Falcon? _____

19765

81

P-111-5

82

LOOK AT PANEL 2

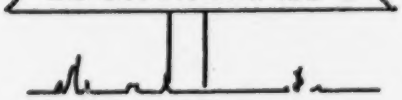

What gasoline filter is used in a 1962 Rambler? _____

19766

82

EP-221

83

LOOK AT PANEL 2

Which gas filter is used in a 1956 Chrysler V-8 Windsor? _____

19767

83

GF-11-1

84

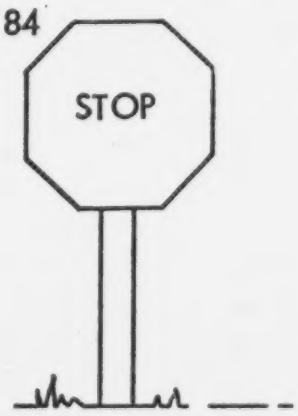

FIND PANEL 3

THEN TURN THIS PAGE AND GO ON

19768

84

NO ANSWER NEEDED

85

LOOK AT PANEL 3

The top of this page tells you that it lists l _____ n _____.

19708

85

lamp numbers

86

LOOK AT PANEL 3

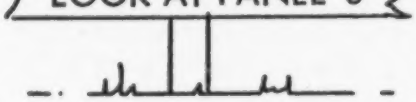

Each column shows numbers for:

- ☐ different kinds of light bulbs
- ☐ no light bulbs
- ☐ the same kind of light bulbs

19770

86

different kinds of light bulbs

87

LOOK AT PANEL 3

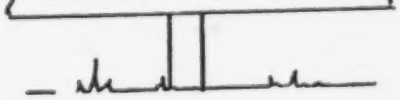

FIND the line for a 1960 Lincoln.

Then, FOLLOW the dotted line to the right for three columns.

This column is for:

- ☐ dome lights
- ☐ parking lights
- ☐ taillights

What number bulb does it call for? _____

19771

87

parking lights

1034

88

LOOK AT PANEL 3

FIND the box that is labeled "Plymouth."

Then LOOK AT the line for 1953.

What is the number of the parking light bulb for this car? _____

What bulb number can be used for the directional lights? _____

19772

88

63

1154

89

LOOK AT PANEL 3

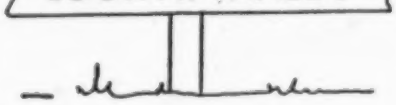

A 1960 Mercury stoplight bulb is number _____.

This car's taillight uses bulb number _____.

The instrument light is bulb number _____.

19773

89

1034

1034

57

90

LOOK AT PANEL 3

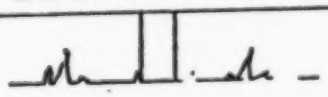

What headlight bulb number is used in a 1957 Pontiac? _____

What is the number of its license plate bulb? _____

19774

29 OF 327

ED

056 238

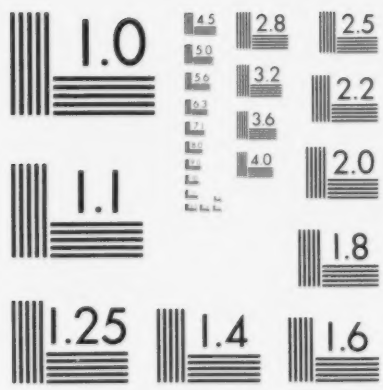

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

90

6012

67

91

LOOK AT PANEL 3

What is the number of the headlight bulb used in a 1954 Packard? _____

What number bulb would you use for the parking light?

_____

What bulb is used for the license plate light? _____

19775

91

6006

1154

63

92

Catalogs list parts according to:

1. _____

2. _____

3. _____

19776

92

1. make
2. model
3. year

93

When you call a parts salesman, never forget to give the make, model and year of the car and your _____ and _____.

19777

93

name (and) address

94

To identify different parts, manufacturers give each part a special _____.

19778

94

(parts) number

95

THIS IS THE END OF BOOK 19

19779

AUTO MECHANICS COURSE

POST-TEST BOOK 21: ORDERING REPLACEMENT PARTS

A BASIC SYSTEMS PROGRAM

19780

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE CORRECT ANSWERS.

1-3

You call your parts dealer to order a replacement part. What should you tell him about the car you are working on?

_____

_____

_____

4-5

For the parts salesman to be able to deliver the part you order, he must know your _____ and _____.

6

Manufacturers list the parts they make in books called _____.

7

Parts are listed according to _____ order.

8

To identify a part, every manufacturer gives the part a _____.

9-11

"Send me a water pump for a Chevrolet Impala."

NAME the three things that should have been added to the parts order for the correct part to be delivered:

_____

_____

_____

PANEL BOOK **21**

To Be Used Wfth
BOOK 21

AUTO MECHANICS COURSE

PANEL BOOK 21: ORDERING REPLACEMENT PARTS

A BASIC SYSTEMS PROGRAM

19783

OIL AND AIR FILTER SPECIFICATIONS / PASSENGER CARS

BUICK & SPECIAL

OIL FILTERS

1959-64	All Models	PER-5
1953-58	V-8 All Models	P-124
1949-52	All Models, also 1953 Model 40	P-125

AIR FILTERS

1964	V-8† (with 2 or 4 bbl. carb.) (except Riviera)	AFP-44
1964	V-8 (with dual 4 bbl. carb.)	AFP-23
1963-64	Riviera (except dual 4 bbl. carb.)	AFP-30
1963	Skylark with 4 bbl. and all '60 with 2 bbl.†	AFP-31
1962-64	All Models† (with V-8 eng.)	AFP-59
1960-63	V-8† (with 2 bbl. carb.)	AFP-47 or AFP-44
1958-62	V-8 (except 1958-62 with 2 bbl.)	AFP-19

† Models with Polyurethane oil-wetted air filters can be replaced with Purolator Dry Type air filter.

CADILLAC

OIL FILTERS

1960-64	All Models	PER-5
1956-59	All Models (except 1957-58 Eldorado)	P-51
1957-58	Eldorado Brougham	P-124

AIR FILTERS

1961-64	All Models	AFP-19
1960	All Models (except with 3-2 bbl. carbs.)	AFP-30
1958-60	All Models (with 3-2 bbl. carbs.)	AFP-23
1959	All Models (with 4 bbl. carb.)	AFP-30
1958	All Models (with 4 bbl. carb.)	AFP-19

CHEVROLET, CHEVELLE, CHEVY II & CORVAIR

OIL FILTERS

1962-64	Chevy II, Chevelle (with 6 cyl. eng.)	PER-11
1962-64	Chevy II (with 4 cyl. eng.)	PER-12
1958-64	V-8 (except Chevy II with V-8 283 eng.)	P-141
1964	Chevy II (with V-8 283 eng.)	PER-11
1960-64	All Corvair Models	PER-14
1963-64	Chevrolet 6 cyl. Models	PER-11
1940-62	6 cyl. Chevrolet Models* and 1955 V-8* (except 1962 Chevy II)	P-51
1956-57	V-8 Models	P-131

AIR FILTERS

1962-64	Chevy II All Models†	AFP-59
1962-64	All Models with 6 cyl. 230 or 235 eng.†	AFP-59
1959-64	V-8 except 409 eng. with dual 4 bbl.	AFP-31
1961-64	Corvair (except 1964 without air cond.)††	AFP-55K
1964	Corvair (without air conditioning)†	AFP-67
1960	Corvair†	AFP-46
1962-64	Models (with 409 eng. and 2-4 bbl. carb)	AFP-23
1958-61	Corvette (with fuel injection)	AFP-26
1958	All Models (with fuel injection) (race)	AFP-25
1958-61	All Models (with 3-2 bbl.)	AFP-23
1958-60	All with Fuel Injection (except Corvette)	AFP-24

† Models with Polyurethane oil-wetted air filters can be replaced with Purolator Dry Type air filter.
†† Models with separate, optional oil bath air cleaner use AFP-58K.
* If factory equipped.

CHRYSLER & IMPERIAL

OIL FILTERS

1959-64	All Models	PER-1
1957-58	All Models (early '57 Imperial uses P-82)	P-70FF
1946-56	All Models	P-82

AIR FILTERS

1963-64	All (except Newport or Police & 300 series with 4 bbl. or 2-4 bbl. carb.)	AFP-62
1963-64	Newport, Police and 300 (with 4 bbl. carb.)	AFP-14
1963-64	All 300 series (with 2-4 bbl. carb.)	AFP-44
1959-62	All (except 1958-62 C-300 series)	AFP-14
1962	All 300 series	AFP-15 (2)
1960-61	C-300 Models	AFP-44
1958-59	C-300 Models	AFP-15 (2)
1957-58	Models (except 1958 C-300)	AFP-2

COMET, MERCURY, LINCOLN

OIL FILTERS

1957-64	All Models (incl. 1960-63 Comet)	PER-1
1952-56	All Models (also 1952-53 Lincoln)	P-48
1938-53	All Models (except 1952-53 Lincoln)	P-34

AIR FILTERS

1963-64	Lincoln, Continental	AFP-13
1963-64	All 6 cyl. Models	AFP-45
1964	Comet (with V-8 eng.)	AFP-57
1963-64	Monterey*** (with 300 eng. except Police)	AFP-61
1963-64	Police Car	AFP-8
1964	Mercury (with 427 dual 4 bbl. eng.)	AFP-66
1962-63	V-8 Meteor	AFP-57
1961-63	Police Interceptor	AFP-8
1961-62	V-8 (except 1962 Meteor and Police Car)	AFP-40
1961-62	6 cyl. Mercury	AFP-13
1959-60	Lincoln	AFP-13
1960-62	Comet and 1962 6 cyl. Meteor	AFP-45
1958-60	Mercury Models (1958-59 Marauder uses AFP-22)	AFP-13
1957-58	Lincoln and Mercury Turnpike Cruiser	AFP-7
1957	Mercury Models	AFP-5

*** Models produced before October 15, 1962 use AFP-40.

DE SOTO

OIL FILTERS

1958-61	All Models	PER-1
1952-57	V-8 Models (from eng. 7057)	P-70FF
1952-54	6 cyl. Models*	PER-½
1952	V-8 Models (thru eng. 7056)	P-82

AIR FILTERS

1958-61	Models (with 2 bbl. and 4 bbl. carb.)	AFP-14
1960-61	All (with dual 4 bbl. carb.)	AFP-44
1958-59	Adventurer (with dual 4 bbls.)	AFP-15
1958	Models (with air conditioning)	AFP-2
1957	All Models (except Firesweep S-27)	AFP-2
1957	Firesweep S-27	AFP-1

DODGE, DART & LANCER

OIL FILTERS

1963-64	All V-8 Models	PER-1
1960-64	6 cyl. Models (except optional)	PER-1
1961-64	6 cyl. Models (optional)	P-76-2
1958-62	V-8 Dodge and '60 Dart with "B" eng.	PER-1
1960-62	V-8 Dart (with "A" eng.)	P-76-1
1959-60	V-8 Dodge Models (with "A" eng.)	P-76-1
1953-58	V-8 Models (except with "B" eng.)	P-70FF
1946-59	6 cyl. Models*	P-70FF

AIR FILTERS

1963-64	330, 440, Polara V-8 318 eng.	AFP-4
1963-64	330, 440, Polara V-8 383 eng. 2 bbl. carb.††	AFP-62
1963-64	Polara 500, 880, Custom 880††	AFP-62
1960-64	6 cyl. Dodge, Dart, 1960-62 Lancer	AFP-52
1964	Dart (with V-8 eng.)	AFP-4
1961-62	Polara and Dart V-8 (with "B" eng.)	AFP-14
1960-62	Dart V-8 with "A" eng. except '61 D-500	AFP-4
1961	Models (with 4 bbl. high performance eng.) and 1958-59 Police Car	AFP-10
1961	D-500	AFP-44
1958-60	V-8 Models with "B" eng. (with 4 bbl. carb. except D-500)	AFP-14
1960	All Models with dual 4 bbl. carb.	AFP-44
1958-59	D-500 (with 4 bbl. carb.)	AFP-15
1958	V-8 Models	AFP-1
1959	V-8 (with 2 bbl carb. except D-500)	AFP-4
1957	Model Super D-500	AFP-2
1957-58	V-8 Models with "B" eng. and Air Cond.	AFP-1
1957-59	6 cyl. and 1958 V-8 (2 bbl. carb.)	AFP-4

†† High performance 413 4 bbl. carb., 383 4 bbl. carb. or Police Car use AFP-14. Maximum performance 426B dual 4 bbl. carb. uses AFP-30(2). High performance 426A 4 bbl. carb. use AFP-62.

FORD, FALCON & THUNDERBIRD

OIL FILTERS

1957-64	Ford, Thunderbird (early '57's use P-48)	PER-1
1960-64	All Falcon Models	PER-1
1954-56	V-8 and 1952-56 6 cyl. Models	P-48
1942-53	V-8 Models, 1942-52 6 cyl. Models	P-34

1954-58 Crankcase vent filter Puro Part No 61905-1.

AIR FILTERS

1963-64	All 6 cyl. Models	AFP-45
1963-64	Falcon, Galaxie (with V-8 260 or 289 eng.)	AFP-57
1963-64	Falcon Sprint (with V-8 260 eng.)	AFP-8
1963-64	Galaxie*** (with 352 or 390 eng. exc. Police)	AFP-61
1962-63	Galaxie (with 406 eng. 3-2 bbl. carb.)	AFP-22
1963-64	Galaxie (with 427 dual 4 bbl. carb.)	AFP-66
1963-64	Fairlane (with V-8 260 eng. 4 bbl. carb.)	AFP-8
1962-64	Fairlane V-8 221, 260 2 bbl. or 289 eng.	AFP-57
1961-63	Police Interceptor and 1957 T-Bird	AFP-8
1964	Thunderbird	AFP-61
1963	Thunderbird‡	AFP-40
1960-62	V-8 (except Fairlane, '60 T-Bird & Police)	AFP-40
1960-62	6 cyl. except '62 Fairlane and '60 T-Bird	AFP-13
1961-62	Falcon and 1962 Fairlane 6	AFP-45
1960	Falcon (with closed housing)	AFP-45
1960	Falcon (with open housing)	AFP-10
1958-59	All (except Police Interceptor) (361 eng.)	AFP-13
1959	Police Interceptor (361 eng.)	AFP-18
1958-59	Taxi & Fleet Cars with Governors	AFP-8
1957	V-8 & '58 V-8's with 2 bbl. 292 eng.	AFP-5
1957	6 cyl. Models	AFP-10

*** Models produced before October 15, 1962 use AFP-40.
‡ Models with 3-2 bbl. carb. use AFP-22.

EDSEL

OIL FILTERS

1958-60	All Models	PER-1

AIR FILTERS

1960	All Models	AFP-40
1959	Models (except 361 eng.) & '58 Corsair, Citation	AFP-13
1959	361 eng. models and '58 Pacer, Ranger	AFP-18

PLYMOUTH & VALIANT

OIL FILTERS

1963-64	All V-8 Models	PER-1
1960-64	6 cyl. Plymouth Models (except optional)	PER-1
1960-64	All Valiant Models (except optional)	PER-1
1961-64	Valiant & Plymouth 6 cyl. (optional)	P-76-2
1958-62	V-8 Plymouth Models (with "B" eng.)	PER-1
1956-62	V-8 Plymouth Models* (with "A" eng.)	P-76-1
1953-59	6 cyl. Models*	P-70FF
1949-58	6 cyl. Models*	PER-½
1953	V-8 Models	P-70FF

* On 1956 models where filter points upward use P-70FF. On 1956 models where filter points downward use P-76-1.
* If factory equipped.

PLYMOUTH & VALIANT (Cont.)

AIR FILTERS

1963-64	All Models (with V-8 301 "B" eng.)	AFP-62
1963-64	Models†† incl. Police (w/383 4 bbl. carb. eng.)	AFP-14
1960-64	Models (with V-8 318A or 273A eng.)	AFP-4
1957-64	6 cyl.	AFP-52
1960-62	All Models (with V-8 301 "B" eng.)	AFP-14
1960-61	Models (with 2-4 bbl. carb.)	AFP-44
1961	Model (with Golden Commando eng.)	AFP-10
1959	V-8 Models (2 and 4 bbl. carb.)	AFP-4
1958-59	Fury (with Commando eng.)	AFP-15
1958	V-8 Models & '59 Fury with 4 bbl. carb.	AFP-14
1957-58	V-8 Models (with 2 bbl. carb.)	AFP-4
1957	V-8 Models (with 4 bbl. carb.)	AFP-1
1957	Fury (with dual 4 bbl. carb.)	AFP-2

†† High performance 413 4 bbl. carb., 383 4 bbl. carb. or Police Car use AFP-14. Maximum performance 426B dual 4 bbl. carb. uses AFP-30(2). High performance 426A 4 bbl. carb. use AFP-62.

OLDSMOBILE & F-85

OIL FILTERS

1959-64	All Models (with vertical filter)	PER-5
1949-58	(also early 1960) with horizontal filter	P-124

AIR FILTERS

1964	F-85, Cutlass, Jetfire, Jetstar, 88, (V-8 eng.)	AFP-49
1963-64	Super 88, 98, Starfire	AFP-32
1963	Dynamic 88 and F-85 Models	AFP-49
1964	F-85 (with V-8 eng.)	AFP-59
1962	High performance eng. (except F-85)	AFP-30
1961-62	All Models (except F-85)	AFP-32
1961-62	F-85† (with 2 bbl carb.)	AFP-50
1961-62	F-85† (with 4 bbl. carb.)	AFP-49
1959-60	All Models (with 2 bbl. carb.)	AFP-32
1959-60	All Models (with 4 bbl. carb.)	AFP-30
1958	All Models (except 3-2 bbl. carb.)	AFP-20
1958	All Models (with 3-2 bbl. carb.)	AFP-23

PONTIAC & TEMPEST

OIL FILTERS

1964	Tempest (with 6 cyl. eng.)	PER-11
1960-64	All Models (except 1964 6 cyl. models)	PER-5
1955-59	All Models	P-124

AIR FILTERS

1964	Tempest (with 6 cyl. eng.)	AFP-59
1961-63	Models† (with 4 cyl. eng.)	AFP-47 or AFP-44
1962-64	Models† (except 4 & 6 cyl. Tempest)	AFP-31
1958-64	Models (with 3-2 bbl. carb.)	AFP-23
1958-61	Models (with 4 bbl. carb.)	AFP-19
1959-60	Models (with 2 bbl. carb.)	AFP-31
1958	Models (with fuel injection)	AFP-27

† Models with Polyurethane oil-wetted air filters can be replaced with Purolator Dry Type air filter.

RAMBLER • HUDSON • WILLYS

OIL FILTERS

1959-64	V-8 Models (late 1959 only)	PER-5
1961-64	6 cyl. (with alum. block eng.)	PER-5
1958-64	6 cyl. Rambler (except alum. block eng.)	PER-3
1958-59	V-8 Rambler Models (early 1959 only)	PER-1
1958-62	Metropolitan*	MF-21
1955-57	V-8 Hudson Models	P-34
1946-63	All Willys Models*	P-70FR
1962-64	All Willys Models (with 230 eng.)	PER-1
1964	All Willys (except 230 eng.)	PER-3

AIR FILTERS

1964	All Models* (with V-8 eng.)	AFP-14
1964	Models (with 6 cyl. except L head eng.)	AFP-45
1964	Models (with 6 cyl. L head eng.)	AFP-58
1958-63	V-8 All Models	AFP-5
1962-63	All 6 cyl. Models (with 1 bbl. carb.)	AFP-58
1961-63	All 6 cyl. Models (with 2 bbl. carb.)	AFP-48
1955-61	All 6 cyl. Models (if equipped)	AFP-21
1957	V-8 Rambler	AFP-5

* Early models use AFP-5.

STUDEBAKER & PACKARD

OIL FILTERS

1962-64	All Models‡*	PER-5
1959-62	All Models including Lark*** *	PER-3
1961-62	Models (with replaceable element type)	P-34W
1957	President (to January 1957)	P-34
1957-59	All Packard Models	PER-3
1955-56	V-8 Packard Models	P-34

*** To April 15, 1962. ‡ Beginning April 15, 1962.
* If factory equipped.
‡ Car with optional filter use P-48.

AIR FILTERS

1964	All Models (with 6 cyl. eng.)	AFP-45
1964	Avanti & Lark V-8 (Super Eng.—no supercharger)	AFP-8
1964	Avanti & Lark V-8 (Super Eng.—supercharged)	AFP-58 (2)
1964	Lark V-8 (w/o Jet Thrust eng.)	AFP-48
1963	Avanti, Hawk, Lark V-8 (supercharged)	AFP-58 (2)
1963	Avanti (without supercharger)	AFP-8
1962-63	6 cyl. Models	AFP-58
1961-63	V-8 Lark and Hawk (1963—no supercharger)	AFP-48
1961	6 cyl. Lark	AFP-21
1959-60	Lark, Hawk (2 bbl. carb.)	AFP-21
1957-58	All Models (with 2 bbl. carb.)	AFP-21
1957-58	All V-8 Models (with 4 bbl. carb.)	AFP-11
1953-56	All Models (with dry type filter)	AFP-21

19784

PANEL 1

Charts for Panels 1 and 2 by permission of Purolator Products, Incorporated.

FOR FURTHER INFORMATION

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37	38	39	40	41	42	43	44	45	46	47	48
49	50										

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Total amount of this order ---------- $ _____

Company (Print) _____

Name _____

Street _____ City _____

State _____ (Zip Code) _____ Phone _____

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GASOLINE FILTER SPECIFICATIONS

BUICK & SPECIAL

1963-64	Models (without air conditioning) (except V-6)	GF-11-11
1963-64	V-6 and 1948-57 — All Models	GF-11-1
1957-62	All Models (without air conditioning)	EP-124
1961-62	All Models (with air conditioning)	EP-226
1958-62	All Models	GF-11-8

CADILLAC

1963-64	All (without air conditioning)	EP-124
1959-64	All Models (with air conditioning)	EP-226
1950-62	All Models	EP-124-1
1953-62	(Heavy duty filter)	GF-11-1

CHEVROLET, CHEVELLE, CHEVY II & CORVAIR

1957-64	V-8, 1948-62 6 cyl.	GF-11-1
1963-64	Models (with V-8 409 eng.)	EP-226
1957-58	V-8 Models (with AC BF-124)	EP-124
1959	Corvette (without fuel injection)	EP-124
1962-64	Chevy II & 1964 Chevelle with 6 cyl. eng.	GF-11-7

CHRYSLER & IMPERIAL

1939-64		GF-11
1958-59**		P-111-5
1946-58		GF-11-1

** Early Models

COMET, MERCURY, LINCOLN

1963-64	Comet, Mercury, 1963 Meteor	P-111-5
1962	Comet	GF-11-10
1962	Mercury, Meteor	P-111-5
1960-64	Lincoln	GF-11-4
1960	Mercury and Comet	GF-11-4
1961	Mercury, Comet	GF-11

Purolator recommends "GF-11" series gasoline filters as replacements for limited capacity original equipment filters ("EP" series). Both are listed above

COMET, MERCURY, LINCOLN (Cont.)

1958-59	Lincoln (with 430 eng.)	EP-124
1958-59	Mercury (with 383 or 430 eng.)	EP-124
1957-59	Mercury (with 312 eng.)	EP-124
1958-59	Lincoln	GF-11-8
1954-59	Mercury, 1952-57 Lincoln	GF-11-1

DE SOTO

1959-61	All Models	GF-11
1958-59	Early 1959 Models	P-111-5
1955-59	Some Models	EP-134
1946-61	All Models	GF-11-1

DODGE, DART & LANCER

1960-64		GF-11
1955-59	Models equipped with Carter fuel filter	EP-134
1946-59	All Models	GF-11-1

FORD, FALCON & THUNDERBIRD

1962-64	All Models (except 1962 Falcon)	P-111-5
1962	Falcon	GF-11-10
1961	All Models	GF-11-1
1960	All Models except Falcon	GF-11-3
1960	Falcon	GF-11-4
1955-59	All Models	EP-142
1955-59	V-8 and 1952-59 6 cyl.	GF-11-1
1955-59	Thunderbird (filter next to fuel pump)	EP-142
1955-59	T-Bird (filter separate from fuel pump)	EP-124

EDSEL

1960	All Models	GF-11-3
1958-59	All (with 223, 332 & 361 eng.)	EP-142
1959	All (with 282 eng.)	EP-142
1958-59	All Models	GF-11-1

PLYMOUTH & VALIANT

1959-64		GF-11
1948-58		GF-11-1

OLDSMOBILE & F-85

1963-64	All (except F-85 & Jetstar)	EP-226
1963-64	F-85 & Jetstar	GF-11-1
1957-62	(except F-85)	EP-124
1961-62	F-85	EP-226
1961-62	(with rubber hose) also 1950-60 models	GF-11-1

PONTIAC & TEMPEST

1964	All (except 3-2 bbl. carb.)	GF-11-8
1964	All (with 3-2 bbl. carb.)	GF-11-11
1960-63	w/o air cond. (exc. Tempest & '63 2 bbl. carb.)	GF-11-11
1957-58	also early '59	EP-124-1
1961-62	Tempest (also 1948-57 models)	GF-11-1

RAMBLER • HUDSON • WILLYS

1962-64	All Models	EP-221
1956-58	(equipped with Carter fuel filter)	EP-134
1954-59	Willys (6-226 eng.) also 1948-61 models	GF-11-1
1946-58	Willys (except 6-226 eng.)	GF-11-7

STUDEBAKER & PACKARD

1964	All Models (with V-8 eng.)	EP-226
1963	Hawk & Lark (with V-8 supercharged)	EP-226
1963	Avanti (w/o supercharger)	GF-11
1959-64	6 cyl. Models	EP-142
1961-62	All V-8 Models	GF-11-1
1946-58	6 cyl.	GF-11-7
1946-58	Supercharged Golden Hawk	GF-11-8

CHEVROLET OIL FILTERS

1963-64	Models with 230 or 292 eng.	PER-11
1962-64	V-8 283, 348 & 327 (except optional)	P-141
1962-64	Diesel 4-53 or 6-53 eng.	EP-78
1961-64	Corvair	PER-14
1963-64	Models with 4 cyl. 153 eng.	PER-12
1962-63	Model 327 eng. (optional)	EP-78
1962-64	Models with V-8 409 eng.	EP-78
1959-62	Models with 6 cyl. 261 eng. (optional)	P-141 EP-78
1962	Models with 6 cyl. 235 eng.	P-51
1958-61	Models with V-8 eng.	P-141
1956-61	6 cyl. if factory equipped except 261 eng.	P-51
1940-58	Models except COE with 6 cyl eng.	Kit 428E
1955-57	Models with V-8 eng.	P-131
1940-55	6 cyl. 261 eng. if factory equipped	P-51

CHEVROLET AIR FILTERS

1963-64	Models with 6 cyl. 230 eng.	AFP-59
1961-64	Corvair	AFP-55K

GMC FILTERS

1954-61	6 cyl. oil filter pipe refill	AF-3
1959-64	Models V-6 and V-12 eng.	AF-13
1960-64	Models with 305B, 305C, 351, 401, 478 or 702 eng.	EP-78
1963	Models with 351, 401 or 478 eng.	P-111-5
1956-64	4-71, 6-71, 6V-71, 8V-71 diesel eng. *	EP-78
1960-63	Models with 305A* or 305B eng.	P-124
1955-61	Models with 6 cyl. 270 eng. (Partial)	P-37 or P-50
1955-58	Models with V-8 eng.	P-124
1949-58	Models with 6 cyl 248 eng. (Partial)	P-37 or P-50
1949-58	Models with diesel 4-71, 6-71 eng.	P-38

* 305A engine obsolete in 1962
Plus 10954 2 gasket P-36 used with P-92 on 413 BB eng
(Optional PER 1)
** P-92 & 10954 2 gasket optional on 1951-52

FORD OIL FILTERS

1960-64	Econoline, P-100 with 144 and 170 eng.	PER-1
1963-64	Models with 223, 262, 292 or '64 330 HO eng.	P-49*
1964	Models (with 330 HO, 361, 391 eng.)	P-48
1958-62	Models with V-8 292 eng.	P-49*
1954-63	Models with V-8 302 or 332 eng.	P-48
1952-59	Models with 215 or 223 eng.	P-48
1960-62	Models with 223 eng.	P-49
1958-63	V-8 401, 477 or 534 eng.	P-169
1940-53	Models with 239 or 254 eng.	P-34
1953	Models with V-8 278 & 312 eng.	P-48

FORD AIR FILTERS

1960-62	Econoline Truck	AFP-45
1957-61	Models with EBT 223 eng.	AFP-10
1960	Models with EBR 223 eng.	AFP-18
1960	EEH 292 or EEJ 292 eng. (Partial)	AFP-5
1960	EEJ 292 or EEK 292 eng. (Partial)	AFP-33
1960	With ECS 302 or ECT 332 eng.	AFP-34
1958-60	Models with 401, 477, 534 eng.	AFP-16
1957-59	V-8 272, 292, 312 eng. & 6 cyl. 223 eng.	AFP-5
1957-58	V-8 Heavy Duty 302 & 332 eng.	AFP-50

FORD GASOLINE FILTERS

1964	All Models with 223, 292 2 bbl. carb.	EP-221
1962-64	Models with 144 or 170 eng.	GF-11-10
1957-64	All (except 144, 170, 223, 292 2 bbl. carb.)	P-111-5
1958-64	401, 477, 534	P-485

DODGE OIL FILTERS

1963-64	With 6 cyl. 170, 225 or 251 eng.	P-76-2
1959-64	Models with V-8 318A eng.	P-76-1††
1961-64	With V-8 361B & 413BB eng.	P-92†
1959-62	WM-3 (6 cyl. 251 eng.)	P-70FF
1960-62	With Cummins eng.	PT-750 & 61474-1
	Fuel Filter	PER-15
1939-58	Models	PER-½
1946-60	Over ½ ton (Partial)	P-90, T-1 or T-1P

DODGE AIR FILTERS

1960-62	C-5, C-6, D-1, D-2, D-3, D-4, D-5, D-6, S-6, W-1, W-2, W-3, W-5	AFP-43
1961-64	D-1, D-2, D-3	AFP-14
1964	D-1, D-2, D-3 (Optional), C-5, C-6, D-4, D-5, D-6 (Standard)	AFP-43
1961-63	C-6, C-7, C-8, C-9, C-10, CT-7, CT-8, CT-9, D-7	AFP-42

DODGE GASOLINE FILTERS

1959-63	C-5, C-6, C-7, C-8, C-9, C-10, CT-7, CT-8, CT-9, D-4, D-5, D-6, P-4, W-3, W-5	P-111-5
1964	C-5, C-6, D-4, D-5, D-6, D-7, W-3, W-5	P-111-5

INTERNATIONAL OIL FILTERS

1961-64	Models with 4 cyl. 152 eng.	EP-135
1957-60	Models with BD-220 or B-240 eng.	EP-135
1961-64	Models with BD-220, BD-240 or BD-264 eng.	EP-206
1961-64	Models with D-301 eng. (Diesel)	EP-118
	(Fuel)	P-71
1958-64	Models with V-266, V-304 or V-345 eng.	EP-135
1958-64	Models with BD-282 or BD-308 eng.	EP-135
Late 1959-64	RD-372, RD-406, RD-450, RD-501 eng.	EP-137
1958-64	Models with V-401, V-461, V-549 eng.	EP-137
1958-64	Models with Cummins eng.	
	Air Filter	AF-1012
	Oil Filter	PT-750 & 61474-1
	Fuel Filter	PER-15 or P-485
1958-59	(Only late model '58's)	EP-119-1
1956-57	Models with V-401, V-461 or V-549	T-66
1950-58	Series A, L, R, S except diesel & V-8	T-66

INTERNATIONAL AIR FILTERS

1960-63	Models with Cummins eng.	AF-1012
1957-60	Models with BD-220, BD-240, BD-264, BD-282, BD-308 (Partial)	AFP-9
1957-59	COE Models with V-8 eng.	AF-41
1958-59	ACO-195, 200, 220 (V-8 eng.)	AFP-17

ALFA-ROMEO

1956-64	Giulietta Berlina, Giulietta Sprint, Giulietta Spyder, Romeo Diesel	P-10-L

AUSTIN

1959-64	A-40	MF-39
1960-64	New Seven	MF-39
1957 on	A-50, A-55	MF-21
1957-58	A-40 B Series	MF-21
1956 on	A-35	MF-39
1952-56	A-30	MF-6103
1947-54	A-40, Devon, Dorset, Somerset	P-4L

AUSTIN HEALEY

1954-64	100, 100 Six, 3000	MF-52A
1959-64	Sprite	MF-39

BORGWARD

. . . . .	Isabella, Isabella TS Series	P-70FR

FIAT

1959-64	1800B, 2100, 2300S	PER-3
. . . . .	600	AFP-37I
To 1959	1100/103 Series	AFP-36I
1960-62	1100	AFP-21I
. . . . .	600	EP-140
. . . . .	1100, 1200, 1300	P-70FR

FORD (ENGLISH)

1963-64	Consul Cortina	MF-139A
1960-64	Anglia, Prefect, Capri	MF-139A
1951-64	Zephyr 6, Consul 4	MF-35
1954-59	Anglia, Prefect	MF-21

HILLMAN

1954-64	Minx, Super Minx, New Husky	MF-52A
1955-61	De Luxe, Convertible, Sedan MK VIII	MF-52A
1934-50	Minx	MF-23

HUMBER

. . . . .	Hawk, Saipa	P-37

JAGUAR

1957-64	XK-E, XK-150, 2.4, 3.4, 3.8, Mark V, Mark X	P-10-L
1952 on	XK-120, -140, Mark VII, VIII, IX	MF-67A
1944-51	XK-120, 100 Models	MF-66A

M.G.

. . . . .	All Models (except 1961-64 Midget)	MF-21
1961-64	Midget	MF-39

MERCEDES-BENZ

1960-64	220B, 220SB	AFP-27I
1960-64	190B, 190, 190SL, 220B, 220S, 220SE, 300SE, 1964 230SL	EP-178
1962-64	1900	P-51†
1952-59	180A, 190, 190SL, 219, 220A, 220S, 300	0-98-100MI

MORGAN

. . . . .	Plus 4	MF-52A

MORRIS

1960-64	Mini-Minor	MF-39
1956-64	Minor 1000	MF-39
1953-54	Minor Series II (with Austin A-30 eng.)	MF-6103
1948-50		MF-23
1954-56	Oxford Traveler, Oxford	MF-21

NISSAN-DATSUN

1962-64	Cedric, Nissan Patrol, SPL-310	MF-52A
1962-64	All Models (with 1000 or 1200 cc eng.)	MF-21

NSU

. . . . .	Prinz, Prinz 4 (Partial)	0-98-100MI

PORSCHE

. . . . .	Sports Model	P-70FR

RENAULT

1962-64	Dauphine, Gordini, Early Caravelles	PER-3

RILEY

1957-64	1.5	MF-21
1957-61	2.5	MF-52A

SIMCA

1962-63	V-8 Models	P-34

SINGER

. . . . .	Midget	P-4-L
1955	Roadster, Hunter	MF-52A

STANDARD

1950-64	Vanguard, Ensign Models	MF-52A
1947-50	Vanguard	MF-52B
1953-on	Eight, 1954-on Ten	MF-6103

SUNBEAM

1955-64	Rapier Series, Alpine	MF-52A

TRIUMPH

1963-64	Herald 1200, Spitfire	PER-17*
1960-63	Herald, 948, 950, TR-10	MF-6103
. . . . .	TR-2, TR-3, TR-4	MF-52A
Before 1950	2000	MF-52B

VAUXHALL

1957-64	Cresta, Victor, Velox	EP-141
1954-55		P-70AC
1951-53		P-4-L

VOLKSWAGEN

. . . . .	All Models including Trucks and Bus	Kit 493**

VOLVO

1959-62	PV-444L, P-1200, PV-44400 (with B18B eng.)	AFP-41KI
1962-64	All Models	PER-18
1961	P-1800 (with B eng.)	PER-18
1957 on	PV-444L, PV-544, P-1200, 1225, (Amazon), PV-44400 (with B18B eng.)	EP-125
1956	PV-44400 (with B14A eng.)	EP-126

** Use P-70FF refill * If conversion has not already been completed, purchase #170809/2A adapter from Triumph dealer. Then service car with PER-17. The PER-17 cannot be used without adapter. † Install handle end down.

E Air Filter

19785

PASSENGER CARS—1953-1960

WESTINGHOUSE LAMP NUMBERS

CAR & MODEL**	CIRCUIT VOLTS	HEAD LIGHT*	PARKING	DIRECTION SIGNAL FRONT	DIRECTION SIGNAL REAR	TAIL	STOP	LICENSE PLATE	INSTRUMENT	DOME	STEP or COURTESY	UNDER HOOD
HUDSON												
'53	6	6006[3]	63	1154	1154	1154	1154	63	55	81-87[11]	87[11]	87[11]
'54	6	6006[3]	63	1154	1154	1154	1154	63	55	81-87[11]	87[11]	87[11]
'55	6	6006[3]	1154	1154	1154	1154	1154	63	55	81	.....	.....
'56	12	6012	1034	1034	1034	1034	1034	67	57	89	89	.....
'57	12	6012	1034	1034	1034	1034	1034	67	57[10]	89	.....	.....
IMPERIAL												
'56	12	6012	1034	1034	1034	1034	1034	67	57-67	1004	1004	1004
'57	12	6012[10]	1034	1034	1034	1034	1034	67	57-67	1004	1004	1003
'58	12	4001-4002	1034	1034	1034	1034	1034	67	1816-89	1004	1004	1003
'59	12	4001-4002	1034	1034	1034	1034	1034	67	57	1004	1004	1003
'60	12	4001-4002	1034	1034	1034	1034	1034	67	.....	1004	.....	.....
LINCOLN												
'53	6	6006[3]	1154	1154	1154	1154	1154	63	55	63-209	63	87[11]
'54, '55	6	6006[3]	1154	1154	1154	1154	1154	63	55	63-209	63	87[11]
'56	12	6012	67	1073	1034	1034	1034	67	57	1003	89	93[10]
'57	12	6012[11]	67-1034	1034	1034	1034	1034	67	57	1003	89	93[10]
'58	12	4001-4002	1034	1034	1034	1034	1034	67	57	1003	67-89	93[10]
'59	12	4001-4002[11]	1034	1034	1034	1034	1034	67	57	1003	67-89	93[10]
'60	12	4001-4002	1034	1034	1034	1034	1034	67	57-1816	1003	67-89	93[10]
MERCURY												
'53, '54, '55	6	6006[3]	1154	1154	1154	1154	1154	63	55	63-209	63	87[11]
'56	12	6012	1034	1034	1034	1034	1034	67	57	1003	89	93[10]
'57	12	6012[10]	1034	1034	1034	1034	1034	67	57	1003	89-1003	93[10]
'58	12	4001-4002	1034	1034	1034	1034	1034	67	57	1003	89	93[10]
'59	12	4001-4002[10]	1034	1034	1034	1034	1034	67	57	1003	89	93[10]
'60	12	4001-4002[10]	1034	1034	1034	1034	1034	67	57	1003	89	93[10]
OLDSMOBILE												
'53, '54, '55	12	6012	1034	1034	1034	1034	1034	67	57	1004	90	89
'56	12	6012	1034	1034	1034	1034	1034	67	57	1004	90	89
'57	12	6012	1034	1034	1034	1034	1034	67	57	90-1004	68-90	89
'58	12	4001-4002	1034	1034	1034	67-1034	1034	67	57	90-1004	68-90	89
'59	12	4001-4002[11]	1034	1034	1034	1034	1034	67	53-57[7]	90-1004	68-90	89
'60	12	4001-4002[11]	1034	1034	1034	1034	1034	67	53-57[7]	90-1004	68-90	89
PACKARD												
'53	6	6006	1154	1154	1154	1154[11]	1154	63	55	210	82	87[11]
'54	6	6006	1154	1154	1154	1154[11]	1154	63	55	210	.....	.....
'55	12	6012	1034	1034	1034	1034	1034	67	57	67-1004	90	.....
'56	12	6012	1034	1034	1034	1034	1034	67	57	1004	1004	.....
'57	12	6012	1034	1034	1034	1034	1034	67	57	1004	.....	67
'58	12	4001-4002[11]	1034	1034	1034	1034	1034	67	57	1004	.....	67
PLYMOUTH												
'53	6	6006[3]	63	1154	1154	1154	1154	63	55	210	.....	87[11]
'54	6	6006[3]	63	1154	1154	1154	1154	63	55	88[11]	210	.....
'55	6	6006[3]	63	1154	1154	1154	1154	63	55	210	.....	87[11]
'56	12	6012	67-1034	1034	1034	1034	1034	67	57	1004	.....	1003
'57	12	6012	1034	1034	1034	1034	1034	67	57	1004	90	1003
'58	12	4001-4002	1034	1034	1034	1034	1034	67	57	1004	.....	1003
'59	12	4001-4002	1034	1034	1034	67-1034	1034	67	57	1004	.....	1003
'60	12	4001-4002	1034	1034	1034	1034	1034	67	57	1004	.....	.....
PONTIAC												
'53, '54	6	6006[3]	63-1154	1154	1154	1154	1154	63	55	82-210	82	87[11]
'55	12	6012	67-1034	1034	1034	1034	1034	67	57	90-1004	89	93[10]
'56	12	6012	1034	1034	1034	1034	1034	67	57	90-1004	89	93[10]
'57	12	6012	1034	1034	1034	1034	1034	67	57	90-1004	89	93[10]
'58	12	4001-4002	1034	1034	1034	1034	1034	67	57	90-1004	89	93[10]
'59	12	4001-4002[10]	1034	1034	1034	67-1034	1034	67	53-57	90-1004	89	93[10]
'60	12	4001-4002[10]	1034	1034	1034	67-1034	1034	67	53-57	90-1004	89	93[10]
RAMBLER												
'53, '54	6	6006[3]	1154	1154	1154	1154	1154	63	51[3]-55	81	55	.....
'53, '54 (Nash)	6	6006[3]	1158	1158	1154	1154	1154	63	51	81	55	.....
'55	6	6006[3]	1154	1154	1154	1154	1154	63	51	81	.....	.....
'55 (Nash)	6	6006[3]	1154	1154	1154	1154	1154	63	51	81	.....	.....
'56, '57	12	6012	1034	1034	1034	1034	1034	67	57	89	.....	.....
'56 (Nash)	12	6012	1034	1034	1034	1034	1034	67	57	89	.....	.....
'57 (Nash)	12	4001-4002	1034	1034	1034	1034	1034	67	57[10]	89	.....	.....
'58, '59	12	4001-4002[10,11]	1034	1034	1034	1034	1034	67	57	1003	.....	.....
'60	12	4001-4002[10,11]	1034	1034	1034	1034	1034	67	57	1004	1004	.....
STUDEBAKER												
'53	6	6006[3]	63-1158	1158	1154	1154	1154	63	51	88[11]	88[11]	87[11]
'54	6	6006[3]	63-1158	1158	1154	1154	1154	63	51	88[11]	.....	87[11]
'55	6	6006[3]	63-1158	1158	1154	1154	1154	63	51	.....	.....	87[11]
'56	12	6012	1034	1034	1034	1034	1034	67	57	1004	.....	67
'57	12	6012	1034	1034	1034	1034	1034	67	57	1004	.....	67
'58	12	4001-4002[11]	1034	1034	1034	1034	1034	67	57-1445	1004	.....	67
'59	12	6012[10]	1034	1034	1034	1034	1034	67	57-1445	1004	.....	67
'60	12	6012	1034	1034	1034	1034	1034	67	1445	1004	.....	.....
VALIANT												
'60	12	4001-4002	1034	1034	1034	67-1034	1034	67	57	1004	.....	.....
WILLYS												
'53	6	6006[3]	63	1158	1129	1154	1154	63	51[3]-55	81-88[11]	.....	.....
'53 (STA. WAG.)	6	6006[3]	63-1158	1158	1158	1158	1158	63	55	87[11]	.....	.....
'54	6	6006[3]	63-1158	1158	1158[11]	1158[11]	1158[11]	63	51[3]-55	81-87[11]	81	.....
'54 (STA. WAG.)	6	6006[3]	63-1158	1158	1158	1158	1158	63	55	87[11]	.....	.....
'55	6	6006	63-1158	1158	1154	1154	1154	63	55	87[11]	.....	.....
'55 (STA. WAG.)	6	6006	63-1158	1158	1129	1158	1158	63	55	87[11]	.....	.....

*Though most cars are equipped with either 5040S (6 volt) or 5400S (12 volt), it is recommended that for better see-ability the 6006 (6 v) or 6012 (12 v) be used for replacement in pairs.

PANEL 3

19788

Chart for Panel 3 by permission of Westinghouse Electric Corporation.

VT 013 144
Auto Mechanics Course. Book 22: Salesmanship and Good Customer Relations.

Basic Systems, Inc., New York, N.Y.
Department of Labor, Washington, D.C.
YMCA of Greater New York, Brooklyn, N.Y.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 124p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; INDUSTRIAL ARTS; *AUTO MECHANICS; *STUDY GUIDES; WORKBOOKS; MECHANICS (PROCESS); *SALESMANSHIP; AUTO PARTS MEN; MOTOR VEHICLES
IDENTIFIERS - *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS; MDTA PROGRAMS

ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on salesmanship and good customer relations was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 144

ED0 56238

BOOK 22

(C1)

AUTO MECHANICS COURSE

BOOK 22: SALESMANSHIP AND GOOD CUSTOMER RELATIONS

A BASIC SYSTEMS PROGRAM

VT013144

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Curriculum Report Reference
Page 17

Task Analysis Reference
46.1

19788

AUTO MECHANICS COURSE

BOOK 22: SALESMANSHIP AND GOOD CUSTOMER RELATIONS

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19789

AUTO MECHANICS COURSE

PRE-TEST BOOK 22: SALESMANSHIP AND GOOD CUSTOMER RELATIONS

A BASIC SYSTEMS PROGRAM

19780

1

Service station attendants should always look c_____ and n_____.

2

You should never tell a customer about:

- ☐ the cost of repairs on his car
- ☐ service station profits and expenses
- ☐ the different services sold by the station

3

When pumping gasoline, the service station attendant should never _____ (one word).

4

Whenever making a gasoline sale at the pump island, what service should you be sure to give the customer? _____

5

To build your customer's confidence in your service station, you should sell only the things his car _____.

6

When making a gasoline sale, you should always check three things under the hood.

These three things are:

_____

_____

_____

7

Whenever you see that a car needs a quart of motor oil, you should try to sell the customer an _____ _____.

8

When working in the service station at night, you should think of selling _____.

~~19799~~
19792

9

When cleaning a car's windshield, think of selling _____ _____.

10

How should you always treat customers? _____

Name _____

Date _____

Starting time _____

Finishing time _____

19794

Metalworking Technology."

I am interested in SBA assistance programs:

☐ Technological ☐ Management ☐ Procurement ☐ Financial

☐ I have a technical problem and would like your help. Please contact me.

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Street City State ZIP Code

1

This part of the program will teach you how to sell automobile parts and service in a service station.

It will also teach you how to get along with service station customers.

NO ANSWER NEEDED

GO ON TO NEXT PAGE

1

NO ANSWER NEEDED

2

A station that sells gasoline is often called a SERVICE STATION because:

- ☐ many things can be done for cars at a service station
- ☐ hundreds of gallons of gasoline are sold every day
- ☐ a service station has a supply of spare parts for cars

2

many things can be done for cars at
a service station

3

The attendant in the drawing is:

- ☐ checking the level of the car's motor oil
- ☐ cleaning the windshield of the car
- ☐ taking a coffee break

19797

3

cleaning the windshield

4

The attendant in the drawing is:

- ☐ greasing the car
- ☐ checking the level of the car's motor oil
- ☐ filling the car's gas tank

19798

4

checking the level of the
car's motor oil

5

In this picture the attendant is:

- ☐ putting air in a tire
- ☐ filling the gas tank
- ☐ adjusting the brakes

19799

6

picture B

7

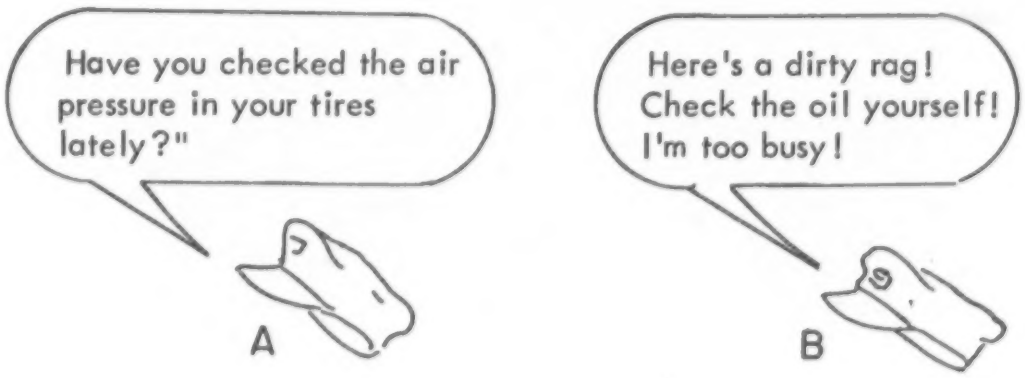

Which attendant is offering a customer SERVICE for the customer's car?

- ☐ attendant A
- ☐ attendant B

19801

7

attendant A

8

Service station customers like to see an attendant wearing:

- ☐ a clean uniform
- ☐ a dirty uniform
- ☐ his best street clothes

281

19802

280 OF 327

ED

056 238

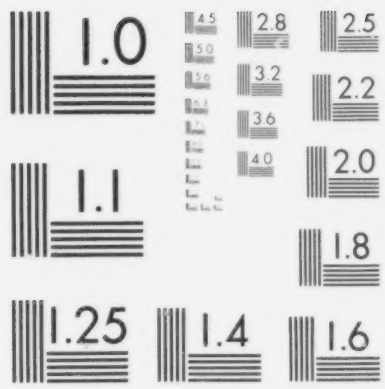

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

8

a clean uniform

9

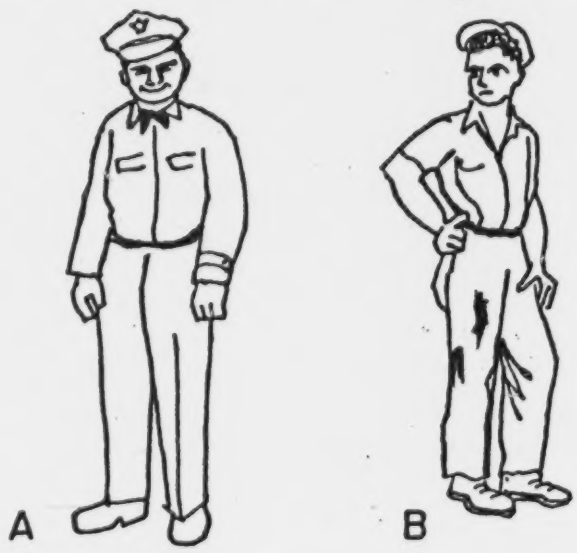

Neat service station attendants give a service station a neat and businesslike appearance.

Which man is properly dressed for working in a service station?

- ☐ attendant A
- ☐ attendant B

19803

280

Place
Stamp
Here

SMALL BUSINESS ADMINISTRATION

_____

_____

_____

Please mail this order form with your payment to Clearinghouse, U.S. Department of Commerce, Springfield, Va. 22151

Please mail this order form with your payment to U.S. Patent Office, Washington, D.C. 20231

9

attendant A

10.

CIRCLE the man who should change his work uniform.

19804

10

11

A neat service station attendant:

- ☐ changes his work uniform when it's dirty
- ☐ makes sure his uniform lasts for the month
- ☐ never changes his working clothes

19805

11

changes his work uniform when it's dirty

12

Clean and neat service station attendants are usually:

- ☐ disliked by customers
- ☐ laughed at by customers
- ☐ liked by customers

19806

12

liked by customers

13

Customers like a service station where the attendants are: (CHECK TWO)

- ☐ clean and neat
- ☐ dirty and need to shave
- ☐ not too dirty
- ☐ still greasy from the last job they did
- ☐ wearing a clean service station uniform
- ☐ unshaven once in a while

19807

13

clean and neat

wearing a clean service station uniform

14

A clean and neat service station attendant is:

- ☐ an experienced man who takes pride in his job
- ☐ an attendant who does not know how to dress for the job
- ☐ a service station attendant who does not care how he looks

14

an experienced man who takes pride in his job

15

An experienced service station attendant should look c' _____ and n _____.

19809

15

clean (and) neat

16

One reason why an experienced service station attendant looks clean and neat is:

- ☐ he never cleans up before going home
- ☐ he wears old soiled work clothes
- ☐ he wears a clean uniform
- ☐ he tries to stay away from grease and dirt

16

he wears a clean uniform

17

CIRCLE two words below that tell you how you want to look when you work at a service station:

tough clean tired

beat scared neat

19811

17

clean

neat

18

Nobody expects a service station attendant to smile all the time, but the attendant should always be:

- ☐ loud-mouthed.
- ☐ late for work
- ☐ polite
- ☐ dirty

19812

18

polite

19

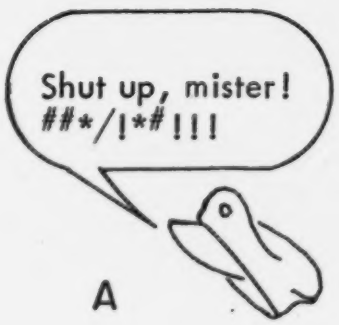

A

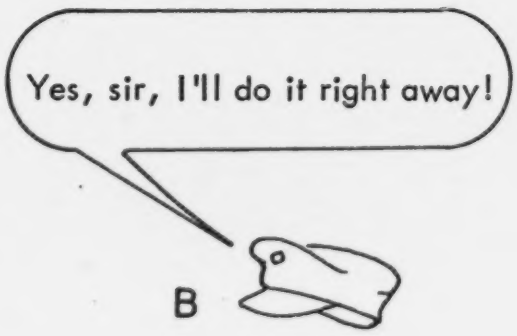

B

Which attendant is being polite to his customer?

- ☐ attendant A
- ☐ attendant B

19813

SMALL BUSINESS ADMINISTRATION
FIELD OFFICES

For addresses and telephone numbers of the field offices, consult the appropriate telephone directories.

Albuquerque, N. Mex. 87101
Anchorage, Alaska 99501
Atlanta, Ga. 30303
Augusta, Maine 04330
Baltimore, Md. 21201
Birmingham, Ala. 35205
Boise, Idaho 83701
Boston, Mass. 02203
Buffalo, N.Y. 14203
Casper, Wyo. 82601
Charlotte, N.C. 28202
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Philadelphia, Pa. 19107
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San Antonio, Tex. 78205
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San Francisco, Calif. 94102
Seattle, Wash. 98104
Sioux Falls, S. Dak. 57102
Spokane, Wash. 99210
Syracuse, N.Y. 13202
Washington, D.C. 20417
Wichita, Kans. 67202

Bold face listing indicates offices with Technology Utilization Officers, as follows:

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L. W. Foster, tel. 617–223–7761
Cleveland, Ohio
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Denver, Colo.
L. W. Palmer, tel. 303–297–3686
Detroit, Mich.
Arthur Kraft, tel. 313–226–7935
Jackson, Miss.
Ray Love, tel. 601–948–2519
Los Angeles, Calif.
John Lang, tel. 213–688–2946
Minneapolis, Minn.
M. K. Pass, tel. 612–334–2340
New York, N.Y.
Arthur Gilmore, tel. 212–264–4304
Philadelphia, Pa.
John May, tel. 212–597–3234
San Francisco, Calif.
J. O. Hannauer, tel. 415–556–5232

19

attendant B

20

A service station attendant should be:

- ☐ friendly and polite
- ☐ loud-mouthed and vulgar
- ☐ careless and rude

19814

20

friendly and polite

21

When you are dealing with customers, you should behave in a _____ way.

Should you ever curse at a customer?

- ☐ yes
- ☐ no

19815

21

polite or friendly

no

22

An experienced service station attendant should be:

- ☐ dirty
- ☐ friendly
- ☐ neat
- ☐ polite

22

friendly

neat

polite

23

A customer who gets service for his car expects you to look

_____ and _____.

19816

23

clean (and) neat

24

How would you describe the appearance of an experienced attendant who takes pride in his appearance? _____

19817

24

looks clean and neat

25

Car owners are often in a hurry when they buy gasoline.

Because of this, they:

- ☐ like to wait while you finish a lube job
- ☐ want service to be as fast as possible
- ☐ ask if they can leave the car and walk around

19818

25

want service to be as fast as possible

26

When a car pulls up to the gasoline pumps, you should:

- ☐ take plenty of time to get to the pumps
- ☐ tell the customer to help himself
- ☐ get to the pumps right away

19819

26

get to the pumps right away

27

A service station attendant gets to the gas pumps quickly because many customers expect f_____ s_____.

19820

27

fast service

28

You should listen to customers when they complain about service because: (CHECK TWO CORRECT ANSWERS)

- ☐ all customers are rich
- ☐ customers have a right to complain
- ☐ customers who complain are nuts
- ☐ customers never complain when you are wrong
- ☐ customers may be right about their complaints

19821

28

customers have a right to complain

customers may be right about their complaints

29

Customers have a right to complain if they want to, so you should:

- ☐ listen to the customers
- ☐ ask complaining customers to leave
- ☐ make up a funny story about the complaining customers

19822

VT 011 775
Steeb, Ralph V.; Geil, John J.
Safety in Industrial Arts Laboratories.
Bulletin 76H-1.

Florida State Dept. of Education,
Tallahassee.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - May69 86p.

DESCRIPTORS - *INDUSTRIAL ARTS; SAFETY EDUCATION; *LABORATORY SAFETY; ACCIDENT PREVENTION; SAFETY EQUIPMENT; SAFETY; *INSTRUCTIONAL MATERIALS

ABSTRACT - A really effective safety program is practiced regularly and naturally as part of the daily work. This manual was developed by industrial arts consultants to help the teacher develop within each student an awareness of safety that will carry through school and into postschool work and recreation. The purpose of safety education is: (1) to protect the student from injury while in the school shop or laboratory, and (2) to develop habits, attitudes, and perceptions which will help insure his safety throughout his lifetime. Major topics include: (1) Safety and Liability, (2) Causes of Accidents, (3) Providing for Safety, and (4) Safety Rules, covering all areas of industrial arts. Appended materials include a national standard safety inspection checklist, accident form, a selected bibliography, and listings of posters, charts, films and filmstrips, and catalogs and directories. A selected bibliography is appended. (GR)

VT 011 775

29

listen to the customers

30

Would you say that this customer had a right to complain about the work being done on his car?

- ☐ yes
- ☐ no

19823

30

yes

31

As an experienced attendant, you should listen to complaints because: (CHECK TWO)

- ☐ you want to know how to improve service
- ☐ some of them are funny
- ☐ you like to keep customers satisfied with service
- ☐ you know the customer is never right

19824

31

you want to know how to improve service

you like to keep customers satisfied with service

32

You should listen to a complaining customer because:

- ☐ he never gets what he wants anyway
- ☐ you may find out that he is complaining for a good reason
- ☐ there is no such thing as poor service at your service station

19825

32

you may find out that he is complaining for a good reason

33

When a customer complains, an experienced service station attendant _____.

19826

33

listens (or pays attention)

34

Service station operators are in business to make sales and profits. You should NEVER tell customers about these things.

This means that you can:

- ☐ brag about how much your boss clears on a job
- ☐ tell the customer only what the repairs will cost
- ☐ tell the customer how much you make on the repairs done to his car

19827

34

tell the customer only what the repairs will cost

35

An experienced service station attendant never talks with customers about:

- ☐ driving conditions and traffic
- ☐ sports and entertainment
- ☐ service station profits and costs
- ☐ different kinds of cars

19828

35

service station profits and costs

36

A customer wants to talk about:

1. repairs his car needs
2. service his car needs
3. what repairs and service will cost

Example A

A customer wants to talk about:

1. the station's profits
2. the station's costs
3. the station's expenses

Example B

It is "OK" to talk with a customer about the things listed in:

- ☐ example A
- ☐ example B
- ☐ neither example A nor example B

19529

36

example A

37

You should NEVER talk with a customer about: (CHECK TWO)

- ☐ new products for cars
- ☐ the station's profits
- ☐ the importance of car maintenance
- ☐ the wholesale cost of gasoline

19830

37

the station's profits

the wholesale cost of gasoline

38

A = profits

B = costs

C = expenses

You should talk with customers about:

- ☐ A and B
- ☐ B and C
- ☐ A, B, and C
- ☐ neither A, B, nor C

19831

38

neither A, B, nor C

39

When the cigarette spark is falling into the can (see picture):

- ☐ the gas in the can will spill over
- ☐ the spark will go out
- ☐ the gasoline will explode

19832

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SAFETY IN INDUSTRIAL ARTS LABORATORIES

Bulletin 76H—1, May, 1969

PREPARED BY

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DEPARTMENT OF EDUCATION
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FLOYD T. CHRISTIAN
COMMISSIONER

CARL W. PROEHL
ASSISTANT COMMISSIONER
DIVISION OF VOCATIONAL, TECHNICAL,
AND ADULT EDUCATION

1958

39

the gasoline will explode

40

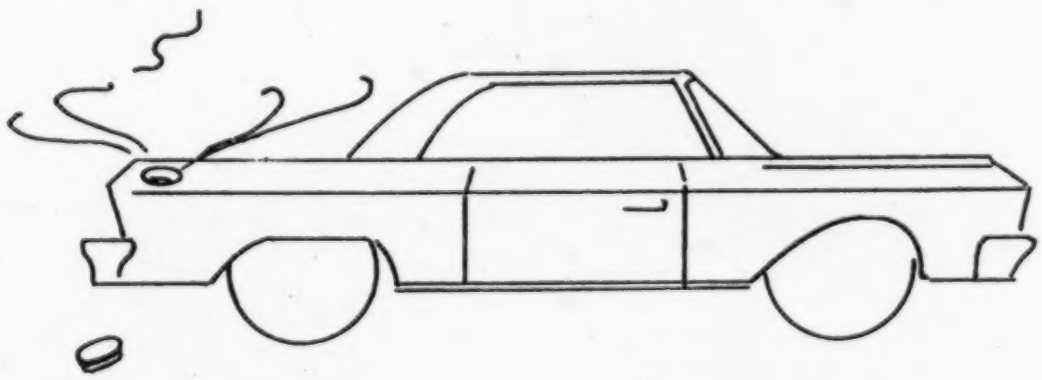

LOOK AT the picture above.

There are gasoline fumes in the air because the gas cap is off.

Can this gasoline vapor explode?

- ☐ yes
- ☐ no

19833

40

yes

41

Gasoline fumes are very explosive.

CIRCLE the things named below that will make gasoline explode:

cigarette sparks	hot weather	burning matches	noise

19834

41

cigarette sparks

burning matches

42

Dangerous sparks can come from:

- ☐ worn-out tires
- ☐ gasoline and oil
- ☐ radio static
- ☐ cigars, cigarettes, and pipes

42

cigars, cigarettes, and pipes

43

What should <u>not</u> be in the picture? _____

19836

43

the pipe

44

When pumping gasoline, you should never _____.

19837

44

smoke

45

Whenever a customer pulls up to the gasoline pumps, you should _____.

19838

45

wipe the windshield

46

When do you wipe the windshield on a car?

- ☐ after the car pulls away from the gas pumps
- ☐ when the customer agrees to buy 10 gallons of gas
- ☐ whenever a car pulls up to the gas pumps

19839

46

whenever a car pulls up to the gas pumps

47

You clean the windshields on the cars that come to your service station because:

- ☐ customers deserve this service
- ☐ it keeps the customer waiting on the service station
- ☐ you want to annoy the driver of the car

1940

47

customers deserve this service

48

Which cars should have their windshields cleaned?

- ☐ only small sports cars
- ☐ only large expensive cars
- ☐ all cars that pull up to the gas pumps

19841

48

all cars that pull up to the gas pumps

49

What should you do to every car that drives up to the gas pumps? _____

19842

EMERGENCY ACTION

BE PREPARED: Think through what you will do in event of injury before the emergency occurs. Discuss emergency procedures with your department head and/or principal. Arrange communications, first aid, transportation, and other details before an accident occurs.

In Event of Injury, Take the Following Steps Immediately:

1. Have someone notify department head and/or principal.

2. First aid, if needed, should be administered by a qualified person only (nurse or person with Red Cross training).

3. If injury is serious:

   a. Give no medication
   b. Notify parents. They should contact family doctor.
   c. If unable to contact parents, contact family doctor direct.
   d. If above fails, call local doctor or hospital.
   e. Contact parents as soon as possible.
   f. Stanch profuse bleeding with antiseptic compress. Do not use tourniquet unless trained.
   g. Do not move victim if bone fracture is likely (falls, collisions, etc.).
   h. Keep victim warm.

4. District superintendent should be notified of any serious injury as soon as possible after the injury occurs.

0301 1959

49

clean the windshield

50

The attendant in the drawing is cleaning the windshield of the car. He should tell the customer about:

- ☐ the weather
- ☐ the broken windshield wiper
- ☐ the rear-view mirror

19843

50

the broken windshield wiper

51

The thing to do when you see a broken windshield wiper on a car is:

- ☐ suggest to the customer that he should buy a new wiper
- ☐ remove the wiper without telling the customer anything
- ☐ wrap a piece of cloth around the wiper

51

suggest to the customer that he should buy a new wiper

52

When you clean a car's front window, you should look for a chance to sell:

- ☐ new tires
- ☐ a car wash
- ☐ windshield wipers
- ☐ seat covers

52

windshield wipers

53

When cleaning the windshield, you should look for a chance to sell _____.

19846

53

windshield wipers

54

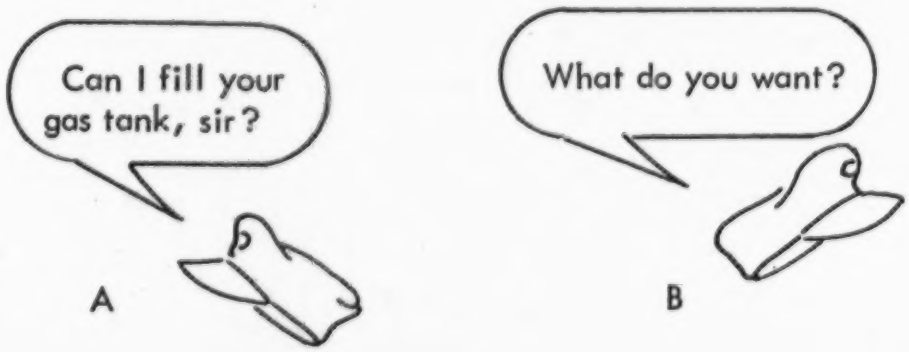

Which serviceman is being polite to the driver?

- ☐ serviceman A
- ☐ serviceman B

Which serviceman will probably sell more gasoline?

- ☐ serviceman A
- ☐ serviceman B

19847

54

serviceman A

serviceman A

55

CIRCLE the words you should say to a customer when he drives up to the gas pumps:

"Can I fill the gas tank, sir?"

"Your windshield sure is dirty!"

"What's your problem, mister?"

"You'll get a full tank of gas, if you wait."

19848

55

"Can I fill the gas tank, sir?"

56

Which of these men sounds like an experienced service station attendant?

- ☐ attendant A
- ☐ attendant B

What will he probably sell the customer? _____

56

attendant B

a tankful of gasoline

57

Trying to sell a tankful of gasoline is the sign of:

- ☐ a beginning service station attendant
- ☐ an experienced service station attendant

57

an experienced service station attendant

58

The serviceman is checking the motor oil with a:

- ☐ clean wiper
- ☐ dirty rag

19851

58

clean wiper

59

The serviceman is adding water to the car's:

- ☐ crankcase
- ☐ radiator
- ☐ transmission

19852

THE FIVE "E'S" OF SAFETY EDUCATION

ENGINEERING: Control of physical conditions

EDUCATION: A planned, positive approach to learning rules and behavior

ENFORCEMENT: Constant insistence that safety rules be followed

EXAMPLE: The teacher as leader

ENTHUSIASM: The essential ingredient

(Adapted from Teacher Liability in School-Shop Accidents, Denis J. Kigin, Prakken Publications, Inc., Ann Arbor, Michigan, 1963)

1960 1929

59

radiator

60

The attendant is adding water to the car's:

- ☐ battery
- ☐ gas tank
- ☐ radiator

19853

60

battery

61

Unless a customer is in a big hurry, you should check the car's motor oil, cooling system water, and battery water.

To do this, you must:

- ☐ jack up the front end of the car
- ☐ raise the hood
- ☐ roll up the windows

By doing this, you can:

- ☐ make sales to the customer
- ☐ never make a sale to a customer

19854

61

raise the hood

make sales to the customer

62

By selling a customer the things his car needs, you are:
(CHECK TWO CORRECT ANSWERS)

- ☐ making sales and profits for your service station
- ☐ letting the customer know you are interested in his car
- ☐ sticking him with things his car can never use
- ☐ helping your service station to go broke

62

making sales and profits for your service station

letting the customer know you are interested in his car

63

The service station attendant must raise the hood to check the battery.

When the hood is raised, the serviceman also checks:
(CIRCLE TWO)

the radiator the tires the oil the axle

63

the radiator

the oil

64

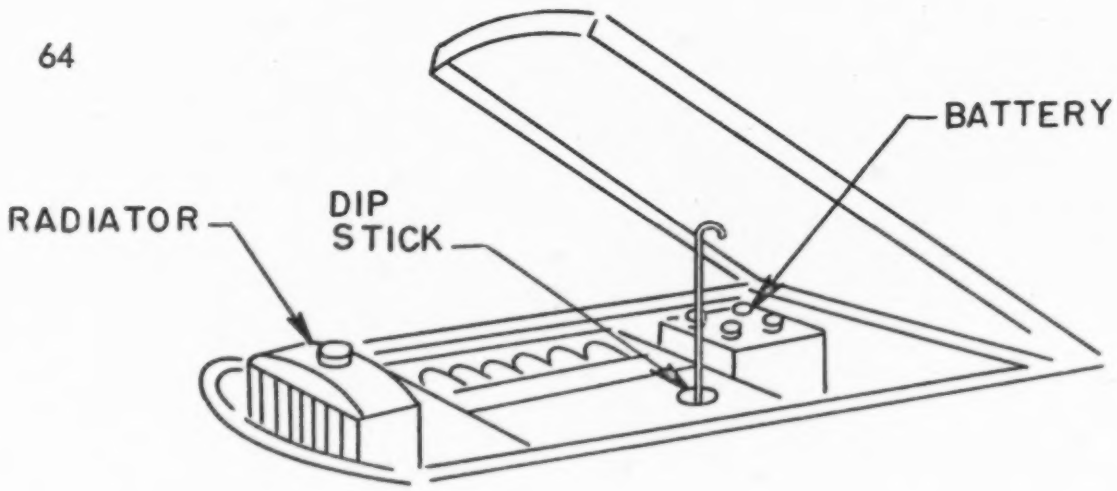

The picture shows three check points under the hood. An experienced service station attendant looks at:

- ☐ the radiator only
- ☐ the radiator, battery, and oil level in the engine
- ☐ the oil level in the engine or the battery

19857

64

the radiator, battery, and oil level in the engine

65

Almost all customers expect you to look under the hood and check: (CIRCLE THREE)

the battery the fuel pump the motor oil level

the piston rings the radiator the spark plugs

By checking these three things, you show that you are:

- ☐ a beginning service station attendant
- ☐ an experienced service station attendant

65

the battery

the motor oil level

the radiator

an experienced service station attendant

66

Three things an experienced service station attendant always checks are:

b _____

r _____

motor o _____

This will make a s _____ customer.

19859

66

battery

radiator

(motor) oil

satisfied

67

The service station attendant is:

- ☐ careful not to let oil drip on the fender
- ☐ letting oil drip on the fender
- ☐ cleaning the fender

67

careful not to let oil drip on the fender

68

The experienced attendant never spills water on a car's body.

Would you call this attendant experienced?

- ☐ yes
- ☐ no

19861

68

yes

69

You check a car's oil level. If you see that there is a quart of oil missing, try to sell the customer an oil change.

You can do this by: (CHECK TWO)

- ☐ asking the customer how long it's been since his last oil change
- ☐ letting the customer know you only sell oil changes
- ☐ showing the customer that the car needs one quart of oil
- ☐ just going ahead and changing the oil

69

asking the customer how long it's been since his last oil change

showing the customer that the car needs one quart of oil

70

If you cannot sell the customer an oil change, you should:

- ☐ get out of the service station business
- ☐ run the customer out of the station
- ☐ sell the customer the quart of oil that he needs

19863

70

sell the customer the quart of oil that he needs

71

You should try to sell oil changes:

- ☐ if you think you can get away with it
- ☐ when the oil level shows that oil has been used up
- ☐ when the service station is overstocked with oil

19864

71

when the oil level shows that oil has been used up

72

The experienced serviceman knows that few cars use a lot of oil.

Before selling the quart of oil, you should: (CHECK TWO)

- ☐ ask the customer how long it's been since the last oil change
- ☐ show the customer the dipstick if the oil on it is dirty
- ☐ spill a little oil on the fenders

19865

72

ask the customer how long it's been since the last oil change

show the customer the dipstick if the oil on it it dirty

73

You check a car's oil level and see that the engine needs one quart of oil.

What should you do?

- ☐ Add two quarts of motor oil right away.
- ☐ Don't tell the customer because he'll be angry.
- ☐ Ask the customer how long it's been since the last oil change.

73

Ask the customer how long it's been since the last oil change.

74

You have a good chance to sell a customer an oil change:

- ☐ if you write a note that says "change oil" and give it to the customer
- ☐ if you check the oil, see that it is dirty, and show the dipstick to the customer
- ☐ if you add more oil than the amount needed to fill the crankcase

19867

74

if you check the oil, see that it is dirty, and show the dipstick to the customer

75

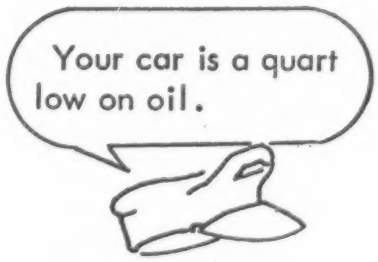

SERVICEMAN

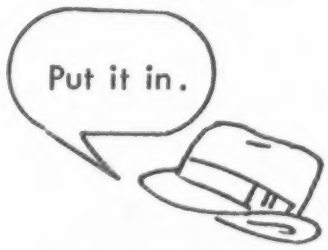

CUSTOMER

Is this serviceman likely to sell an oil change for the customer's car?

☐ yes

☐ no

The serviceman (☐ was ☐ was not) really interested in his customer's needs.

19868

75

no

was not

76

Before you sell a customer a quart of oil, find out if you can sell him:

- ☐ a new oil filter
- ☐ an oil change
- ☐ an oil can for the trunk of the car

76

an oil change

77

When checking the oil in a car, you should think about selling an _____.

1980

77

oil change

78

It is winter.

You check a radiator and see that the water-antifreeze mixture in the radiator is low.

You should:

- ☐ add water without telling the customer
- ☐ just forget about the problem
- ☐ sell the customer more antifreeze

19871

281 OF 327

ED

056 238

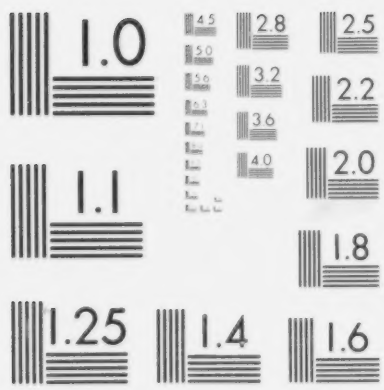

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ACKNOWLEDGEMENTS

The original State Department of Education guide for safety in school shops, published in November, 1953, served well for many years the needs of Florida's industrial arts teachers and students. With the modernization of laboratories, new and different types of equipment, and increasing student enrollment, it has become necessary for the guide to be rewritten to accommodate these changes. The original publication was the work of:

Dr. G. W. Neubauer, University of Florida (now with the Division of Vocational, Technical, and Adult Education, Florida State Department of Education).

Dr. Wayne B. Hughes, National Safety Council, Chicago

Dr. Walter R. Williams, Jr., Director of Vocational Education and Consultant for Industrial Arts, Florida State Department of Education (now retired).

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Prakken Publications, Inc. (Teacher Liability in School-Shop Accidents, by Dennis J. Kigin)

1962

78

sell the customer more antifreeze

79

You have a good chance to sell antifreeze:

- ☐ when the weather is cold
- ☐ when customers tell you they are going south for the winter
- ☐ when winter servicing has already been done by another station

19872

79

when the weather is cold

80

The attendant in the picture is checking: (CIRCLE ONE)

battery power air pressure oil level

1987

80

air pressure

81

Tires should be kept at the correct air pressure.

You should check:

- ☐ all four tires
- ☐ just the front tires
- ☐ only a low tire

19874

81

all four tires

82

You check the air pressure of all four tires on a car because:

- ☐ the customer should buy whitewall tires
- ☐ each tire should have the correct air pressure
- ☐ each tire must have different air pressure

19875

82

each tire must have the correct air pressure

83

When checking tires for correct air pressure, you should look for: (CHECK TWO)

- ☐ dirt on the tires
- ☐ tires that look worn out
- ☐ rips or breaks in the tires

83

tires that look worn out

rips or breaks in the tires

84

What does the experienced attendant think of selling when he checks air pressure? (CIRCLE ONE)

new cars new taillights new tires new hubcaps

By checking his customer's needs, he will:

- ☐ make satisfied customers
- ☐ lose customers

84

new tires

make satisfied customers

85

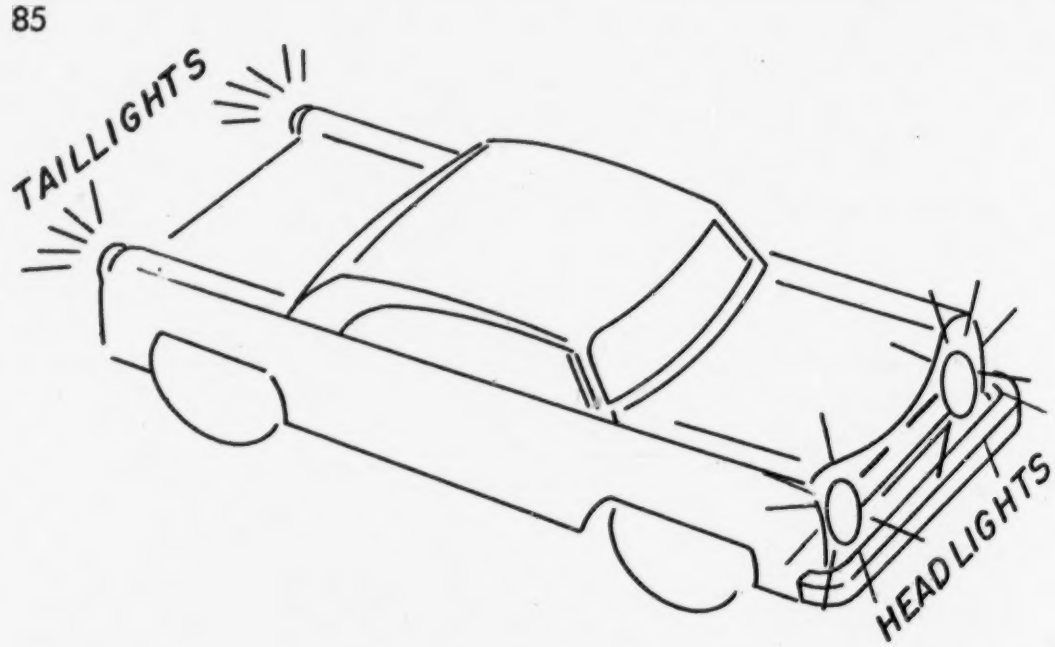

CIRCLE the time when you can easily check
a car's headlights and taillights:

daytime noon on Sunday nighttime

1978

85

nighttime

86

When you work at a gas station at night, you should check each car's:

- ☐ differential assembly and driveshaft
- ☐ headlights and taillights
- ☐ wheel alignment and brakes

19879

86

headlights and taillights

87

When you see a burned-out headlight on a car, you should:

- ☐ sell the customer replacement bulbs
- ☐ tell the customer not to drive at night
- ☐ not bother the customer about it

This shows that you are:

- ☐ an experienced service station attendant
- ☐ an inexperienced service station attendant

19880

87

sell the customer replacement bulbs

an experienced service station attendant

88

You tell the customer if his car has a burned-out light because:
(CHECK TWO)

- ☐ the customer will buy a new light
- ☐ lights cost more than any other part for the car
- ☐ it is unsafe to drive with a burned-out light
- ☐ burned-out lights wear out the battery

INTRODUCTION

When an industrial arts teacher accepts a teaching position, he shoulders a great responsibility for the education and welfare of students in his classes. While he is dependent upon a hieracy of administrators, supervisors, and representatives of the people, the teacher nevertheless is the principal organizer and director of educational experiences and activities. The content, outcomes, and indeed the success or failure of that part of the educational program resides with the teacher. The professional teacher welcomes this responsibility and employs the latitude and trust invested in him to carefully select curricular materials and activities that will further the objectives of the school and departmental program. He will organize and conduct his classes in such a manner as to promote desirable outcomes and attitudes in his students.

In any industrial arts education program, one topic which the professional teacher will include is that of safety--not as a isolated or unrelated lecture but as an integral part of the total instructional program. This manual is intended to serve as a guide in helping the teacher accomplish this vital task. While intended primarily for the teacher, industrial arts supervisors, principals, superintendents, board members and others will find it a source of useful information.

Safety, or, more properly, a safety attitude or safety consciousness, is not something with which we are born or something which is "picked up" as an incidental part of education or experience. The human instinct for self preservation is, unfortunately, not a very strong instinct when everyday safety is considered, and almost everyone falls victim to "it can't happen to me" attitudes. The student must be educated in safety, generally and specifically, just as he receives education in other areas of endeavor. Obviously, the purposes of safety education are twofold: (1) to protect the student from injury while in the school shop or laboratory, and (2) to develop habits, attitudes, and perceptions which will help insure his safety throughout his lifetime.

This guide is not an entire safety program, nor does it pretend to tell the teacher much about how to teach safety. Rather, several general and specific rules and practices are presented in an effort to achieve a certain minimum coverage. The teacher is encouraged to use this manual as an aid in developing a comprehensive, integrated, safety program. A truly effective safety program is practiced regularly and naturally as part of the daily work.

The teacher will want to gloss through the manual prefatory to planning his safety program, but "shotgun" coverage is to be avoided. Instruction should be given when it is most timely and meaningful to the student. The program of safety must be tailored to the equipment, facilities, and students in each particular shop. Basic safety rules should be developed and posted for each machine and activity.

Student participation greatly increases the effectiveness of a safety education program. Students can and should be actively involved in planning and presenting programs, demonstrations, and other activities. If a pupil personnel system is employed, a safety "engineer" and committee can be of great help in promoting compliance with safety rules and procedures. This manual can be used by students as an educational aid, and teachers are encouraged to reproduce it in whole or in part for these purposes.

Finally, in addition to helping the teacher establish safe working conditions and develop safety knowledges, habits, and attitudes in his students, this manual is intended to provide the teacher with ideas for protection from liability. Due to the nature of the environment, some accidents will happen. The teacher can protect himself from suit by following the suggestions in this manual.

1963

88

the customer will buy a new light

it is unsafe to drive with a burned-out light

89

You will see when it is time to sell lights if you work at the service station during the:

- ☐ day shift
- ☐ morning shift
- ☐ evening shift

19882

89

evening shift

90

When you work in a gas station, you should:

- ☐ be alert for any chance to sell service or a part
- ☐ never help to build the station's sales and profits
- ☐ stay away from selling that will mean extra work

19863

90

be alert for any chance to sell service or a part

91

You are checking a car's oil and water.

CIRCLE TWO other parts you could check at the same time:

radio tone control sparkplug wires

fan belt steering gear

91

sparkplug wires

fan belt

92

You can easily make a quick check of the sparkplug wires and fan belt, but the three main things you check under the hood are: (CIRCLE THREE)

fan belt	oil level	battery
oil level	radiator water	horn
sparkplugs	battery	fan belt

19885

92

oil level

radiator water

battery

93

Which serviceman is doing something that should make a customer satisfied?

- ☐ serviceman A
- ☐ serviceman B

93

serviceman A

94

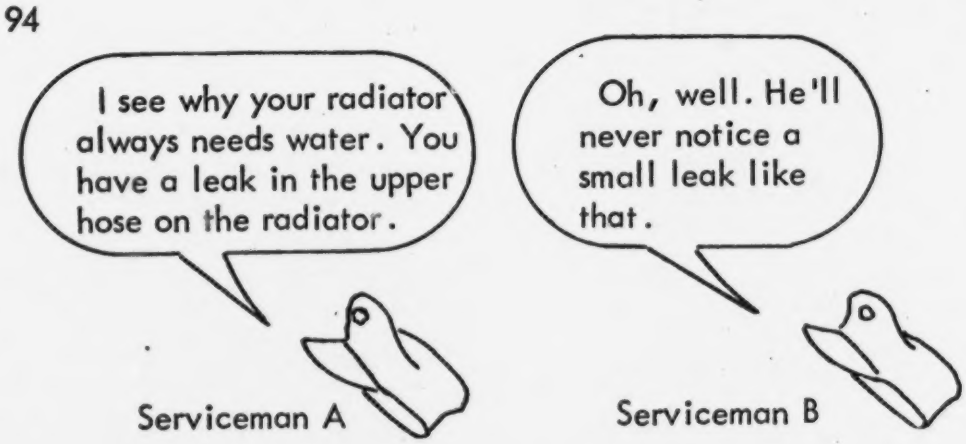

Serviceman A should make a customer satisfied because:

- ☐ he notices what a car needs
- ☐ he tries to avoid extra work
- ☐ he wastes the customer's time

94

he notices what a car needs

95

If something is wrong with a car, you should: (CHECK TWO CORRECT ANSWERS)

- ☐ just make a joke out of it
- ☐ tell the customer what is wrong
- ☐ mind your own business
- ☐ sell the customer the needed repairs

19888

95

tell the customer what is wrong

sell the customer the needed repairs

96

FAN BELT

RADIATOR AND RADIATOR HOSE

OIL LEVEL

SPARKPLUG WIRES

TIRE PRESSURE

BATTERY

When an attendant checks all of the above things carefully, he will make a s_____ customer.

19889

96

satisfied

97

An experienced service station attendant improves business at his gas station by:

- ☐ making wisecracks about the customers
- ☐ making a list of unusual complaints
- ☐ making extra sales of parts or service

19890

97

making extra sales of parts or service

98

A service station attendant should wear a:

- ☐ red shirt
- ☐ clean uniform
- ☐ tight uniform

19891

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C321
1963
1964

98

clean uniform

99

A service station attendant does not wear a dirty uniform because he wants to look cl _____ and n _____ on the job.

19892

99

clean neat

100

Service station attendants are always polite, but one thing they don't discuss with their customers is:

- ☐ roads and traffic
- ☐ cars and motors
- ☐ profits and costs
- ☐ sports

100

profits and costs

101

If a customer complains about the work being done on his car, you should:

- ☐ ignore what he is saying
- ☐ listen to what he is saying
- ☐ run him out of the station

101

listen to what he is saying

102

A service station attendant cleans a car's windshield:

- ☐ whenever he can find the time
- ☐ when the customer says, "...my windshield is dirty"
- ☐ every time a car pulls up to the gas pumps

19895

102

every time a car pulls up to the gas pumps

103

What should you do to a car when it pulls up to the gas pumps?

_____

19896

103

clean the windshield

104

An experienced service station attendant takes care of car needs for:

- ☐ every customer at the sation
- ☐ rich customers only
- ☐ customers who buy a full tank of gas

19897

104

every customer at the station

105

You should make each customer a satisfied customer by selling him the things his car _____.

19898

105

needs

106

When a service station attendant cleans a car's windshield, he should look for a chance to sell _____ _____ (what part).

19899

106

windshield wipers

107

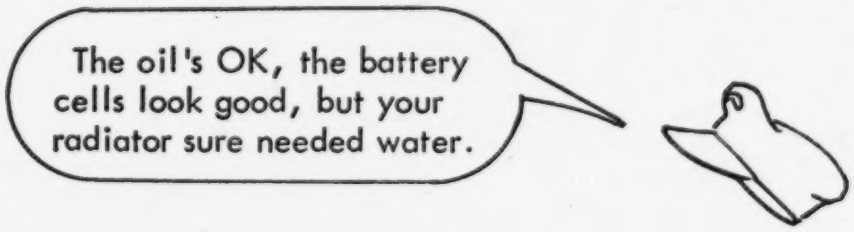

The attendant told the customer about things he checked when he looked:

- ☐ in the lube chart
- ☐ under the car
- ☐ under the hood

19900

107

under the hood

108

Three things an experienced attendant checks under the hood of every car are:

_____

_____

_____

19901

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the oil level

the radiator

the battery

109

When checking the motor oil level, a service station attendant should think about selling an o _____ ch _____.

12902

109

oil change

110

An experienced service station attendant is always a salesman. When working at a station at night, he looks for a chance to sell _____.

19903

110

bulbs

111

Extra sales are made by service station attendants who:

- ☐ don't listen to the station manager
- ☐ stay alert
- ☐ complain to the customers

19904

111

stay alert

112

If you are an alert attendant, you can find ways to make

_____.

19905

112

sales

113

Being a good salesman causes you to get:

- ☐ a raise or promotion from the owner
- ☐ fired
- ☐ nothing at all

19906

113

a raise or promotion from the owner

114

THIS IS THE END OF BOOK 22

19907

AUTO MECHANICS COURSE

POST-TEST BOOK 22: SALESMANSHIP AND GOOD CUSTOMER RELATIONS

A BASIC SYSTEMS PROGRAM

19908

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE CORRECT ANSWERS.

1

You should always be _____ to service station customers.

2

The experienced service station attendant always sells the customer the things his car _____.

3

When wiping a car's windshield, you should think of selling _____ _____.

4

The experienced service station attendant always looks _____ and _____.

5

Never tell a customer about:

- ☐ station costs and expenses
- ☐ the cost of repairs to his car
- ☐ services the station offers

6

Experienced service station attendants never _____ when filling a gas tank.

7

Three things to be checked every time you make a gasoline sale are:

_____

_____

_____

8

When checking a car's oil, you see that a quart of motor oil should be added. Before selling the one quart of oil, try to sell the customer a _____ _____.

19910

9

Experienced service station attendants working at night always try to sell _____.

10

Every time you sell a customer gasoline, what other service should you give to his car? _____

PART I

SAFETY AND LIABILITY

1. Safety--Who's Responsible?

Scope of Responsibility

The responsibility for safety in industrial arts programs rests with many people, but most of this responsibility, both moral and legal, falls upon the teacher. The teacher's role is not, however, to be construed as a passive one, accepting whatever conditions he is given. Rather, as a professional person, he must not only provide a safety education program, but he must also keep his supervisors and administrators advised of the needs of his shop and program. Deficiencies, unsafe conditions, etc., should be reported in a professional manner, as a matter of written record, to the proper authorities. Unsafe equipment or conditions should cause that portion of the instructional program to be suspended until corrective action is taken. Written reporting does not excuse the teacher from liability in tort--it does, however, serve as evidence of his concern and good intentions.

Responsibility of the Parents

Parents should begin the safety education of their children at home, but their responsibility does not end there. It is also their responsibility, as taxpayers and parents, to concern themselves with the enactment of good school laws and to provide qualified personnel and quality equipment and facilities. The teacher should capitalize on the influence of the parents on the development of their children, and involve them in the safety programs of the school. Parent cooperation and interest are of the utmost importance.

Responsibility of the School Board

Legally, the school board is an instrumentality of the government and enjoys sovereign immunity--that is, it is immune to tort action. Nevertheless, the board should provide the financial support required for an effective program and then hire the most competent instructional personnel available to carry it out. Safety in industrial arts programs begins with an efficient facility, safe equipment, and proper materials. The provision of these items is the responsibility of the school board. Safety should never be subrogated to economy.

An interesting provision in the Florida School Law allows school boards to provide legal services for employees being sued, but cannot pay any damages awarded (230.234 Florida School Law).

Responsibility of the Administration

Administrative responsibility for school shop safety rests with all persons concerned with administration or supervision of the industrial arts program, from the state commissioner of education, the state consultants for industrial arts, district superintendents, industrial arts supervisors, to principals. The responsibility of these people is that of supporting the teacher with the information, facilities, tools, and equipment needed to conduct an on-going safety program and create a safe working environment in the industrial arts laboratory. The teacher, being closest to the student and the certificated subject specialist, is the one most responsible, not only for

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ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on driving regulations, part I, was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 145

ED0 56238

BOOK 23

(C1)

AUTO MECHANICS COURSE

BOOK 23: DRIVING REGULATIONS, PART I

A BASIC SYSTEMS PROGRAM

VT013145

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1

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AUTO MECHANICS COURSE

BOOK 23: DRIVING REGULATIONS, PART I

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

19914

AUTO MECHANICS COURSE

PRE-TEST BOOK 23: DRIVING REGULATIONS, PART I

A BASIC SYSTEMS PROGRAM

19915

1

What is the definition of a "motor vehicle" under New York State law?

- ☐ a gas-driven vehicle only
- ☐ a diesel-powered vehicle only
- ☐ a vehicle operated by any power other than muscular power
- ☐ a vehicle that has the motor up front only

2

In New York State, which motor vehicles are subject to the periodic inspection laws?

- ☐ all vehicles
- ☐ all vehicles over 1 year of age
- ☐ all vehicles over 4 years of age; and all vehicles recently transferred
- ☐ only vehicles that were transferred

3

When do registrations expire for passenger cars?

- ☐ January 1
- ☐ January 15
- ☐ January 31
- ☐ February 1

4

Why does New York State demand that every driver be licensed?

- ☐ because the law requires it
- ☐ because New York State needs money to build roads
- ☐ for the protection of the public
- ☐ to see that everybody that drives can read

19917

5

Who must accompany you when you practice driving under a learner's permit?

- ☐ a New York State licensed driver at least 18 years of age
- ☐ a licensed driver at least 18 years of age
- ☐ a duly licensed instructor in New York State
- ☐ a police officer from your precinct

6

How many total hours of practice driving should you have before you take your road test?

- ☐ at least 4 hours
- ☐ at least 10 hours
- ☐ exactly 12 hours
- ☐ at least 20 hours

19918

7

For what period of time are drivers' licenses normally issued?

- ☐ six months
- ☐ 1 year
- ☐ 2 years
- ☐ three years

8

In what county, outside New York City, is a Junior Operator's license not valid?

- ☐ Nassau County
- ☐ Suffolk County
- ☐ Sullivan County
- ☐ Westchester County

9

What is the application fee for a driver's license?

- ☐ $1.00
- ☐ $2.00
- ☐ $3.00
- ☐ $5.00

10

When applying for a license, who must bring proof of date of birth?

- ☐ people of all ages
- ☐ only those people under 21 years of age
- ☐ only those people over 21 years of age
- ☐ only those people applying for a junior operator's license

Name _____

Date _____

Starting time _____

Finishing time _____

19921

safety but for other aspects of the students' education. In order to carry out these large responsibilities, the teacher needs the unqualified support of the school administration.

The State Department of Education has the responsibility of providing leadership and direction to assist school districts in the development of practical safety programs. This leadership is expressed in bulletins, newsletters, and consultive services. The state consultant for industrial arts is to coordinate and promote the state-wide industrial arts safety program.

District superintendents and their administrative personnel must give their wholehearted cooperation in the establishment and continuance of a viable safety program. Procedures and county "machinery" to develop, maintain, and evaluate safety programs should be provided. Some items to be provided by the county are special individual equipment, adequately guarded and maintained power equipment, safe facilities, and the leadership required to motivate teaching personnel to maintain a successful safety program.

The county supervisor of industrial arts is part of the administration and has the specific task of directing safety programs through his teachers in shops and laboratories. Supervisors should provide guides, accident report forms, in-service education, equipment maintenance procedures, in-service information, and direct supervision of the safety program.

Responsibility of the Teacher

The main burden of responsibility for school shop safety and liability for accidents rests on the industrial arts teacher. The reasons for this are:

A. The teacher has a moral responsibility, dictated by his profession, to protect the welfare of his students and provide instruction and measures to create a safe working environment and safety consciousness.
B. The teacher is not a public school officer, and therefore is not protected by sovereign immunity. In fact, teachers may be held more closely accountable than ordinary laymen due to accepting, by virture of employment, professional responsibilities.
C. The teacher is governed by the common-law obligation that every person must so act, or use what he controls, so as not to injure another. The law requires that teachers exercise that care and prudence any reasonably prudent person would exercise in the same or similar situation.
D. Teachers are more closely involved with pupil activities than any other school staff members and are, therefore, named as defendants in cases alleging negligence. Persons held legally responsible are subject to payment of damages. It must be proven, however, that the negligence of the teacher was the proximate cause of the injury.
E. The teacher stands in loco parentis, which means "in the place of the parent." Teachers are parents pro tem and have some of the rights and duties of the parents--those related to education and training of pupils. Thus the teacher has the added requirement to act as a reasonable and prudent parent would.

The possibility of claims against the teacher for negligent action is great, due to the nature of pupil activities. Adequate pupil supervision and a planned safety program are necessary to escape the charge of negligence. Specific recommendations are presented in paragraph 3, below.

1967

1

INTRODUCTION

BEFORE YOU CAN DRIVE IN NEW YORK STATE YOU MUST PASS A WRITTEN TEST AND A ROAD TEST FOR A DRIVER'S LICENSE.

WHEN YOU TAKE THE ROAD TEST, DRIVING SKILL IS WHAT COUNTS. WHEN YOU TAKE THE WRITTEN TEST, YOU NEED TO KNOW THE RIGHT ANSWERS TO MANY QUESTIONS.

THIS BOOK AND BOOK 24 WILL PREPARE YOU FOR THE WRITTEN TEST.

NO ANSWER NEEDED

GO ON TO THE NEXT PAGE

1

NO ANSWER NEEDED

2

These are
MOTOR VEHICLES:

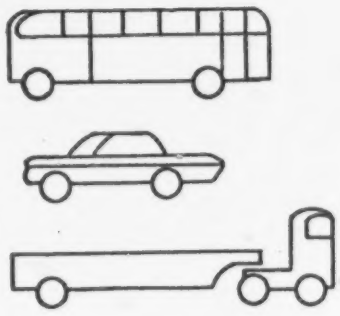

These are
NOT motor vehicles:

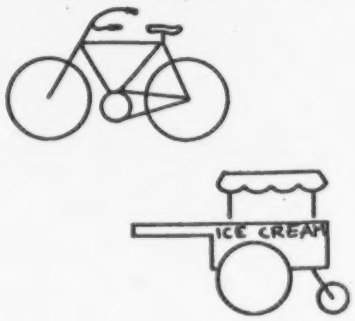

Everything on the road that is <u>not</u> a motor vehicle is operated by:

- ☐ gasoline
- ☐ muscle power
- ☐ special diesel fuel

19923

2

muscle power

3

In New York State, a motor vehicle must be operated by motor power.

CIRCLE the motor vehicle below:

19924

3

4

A vehicle operated by any power other than muscle power is called a m_____ vehicle.

19925

5

a vehicle operated by any power other than muscle power

6

In New York State all motor vehicles four years old or older must be inspected for safety.

Your five-year-old Pontiac could fail inspection because of a: (CHECK ALL CORRECT ANSWERS)

- ☐ broken spring in the back seat
- ☐ cracked windshield
- ☐ burned-out headlight bulb
- ☐ broken radio antenna

19927

6

cracked windshield

burned-out headlight bulb

7

A car or any vehicle with a cracked windshield, burned-out headlight or other serious defects fails safety inspection.

If you drive a car that has failed inspection you are:

- ☐ an experienced mechanic
- ☐ breaking the law
- ☐ assisting the law

*19928

7

breaking the law

8

The New York State law states that motor vehicles:

- ☐ are unsafe if more than four years old
- ☐ must be inspected for safety if they are more than four years old
- ☐ must never be sold

19929

8

must be inspected for safety if they are more than four years old

9

Your car fails inspection because the steering knuckles are worn out.

You pay to have new steering knuckles put in because:

- ☐ the owner of a car must keep it in safe operating condition
- ☐ you are ready to sell the car
- ☐ cars with new parts do not need to be inspected

19930

9

the owner of a car must keep it
in safe operating condition

10

Cars four years old or older must be inspected every year for:

- ☐ paint durability
- ☐ safety
- ☐ speed

19931

. Responsibility of the Student

The student himself bears a responsibility for his own safety. It is for him that all has been planned and provided. The program of safety education should be such that he comes to realize that it is his duty and responsibility to cooperate and develop sound safety habits.

While the philosophy of the safety education program should be such that students will come to realize that they are responsible for their own safety, in school and out, the teacher is not excused from liability if a student commits an act he (the student) knows to be unsafe. The reason for this is that the teacher, being a professional educator, is expected to know the vagaries of his pupils' minds. The teacher is not actually responsible for what happens to his pupils, but he is responsible for the reasonable consequences of his own acts with regard to pupils. The students immaturity must also be taken into account. He may realize that a particular act is dangerous, but he may not appreciate the amount of danger or realize the consequences of committing an unsafe act. For these reasons, contributory negligence on the part of the pupil is seldom a factor in releasing the teacher of liability.

2. Philosophy of Safety Education

The fundamental purpose of a safety program is to insure safety and prevent pupils from being injured. The teacher has a moral, professional responsibility to safeguard and educate those who have been placed in his trust. Students cannot be expected to act and behave with concern for their safety and that of others since they lack experience and maturity. The teacher, in accepting employment, accepts the responsibility for seeing that a safe working environment is created and that safety instruction and evaluation are an integral part of the instructional program.

A second purpose concerns the economic factor, both for the teacher and his pupils. Injuries to pupils may impair their future earning power and restrict the avenues for employment or personal enterprise which they could normally expect. This would create a hardship not only for the individual but also for his family. The teacher must protect himself and his family and prevent loss due to litigation or judgment. Even though the teacher may be exonerated of liability, legal services can be very costly.

3. Liability

The central purpose of a safety program is to protect and educate students and provide a safe working environment. An adequate safety program will not only result in a low accident rate, however, but will also serve to protect the teacher from judgment in the event of a law suit. The following fundamental rules should be religiously followed by the teacher:

A. Provide adequate supervision at all times. Never leave a class unattended. If it is absolutely necessary to be out of the room, shut off power to machines and try to have a qualified person watch the class for you. Check with your principal on what to to before this need arises.

B. Behave as a reasonable and prudent person would under the same or similar circumstances.

C. Develop a sound safety education program as an integral part of the course of instruction. Formulate clear, basic rules and

CACI 1968

10

safety

11

Who is responsible for the safe operating condition of your motor vehicle?

- ☐ your mechanic
- ☐ you
- ☐ your father
- ☐ the Department of Motor Vehicles

19932

11

you

12

You must have a car inspected if if has just changed owners or if it is 4 years old or older.

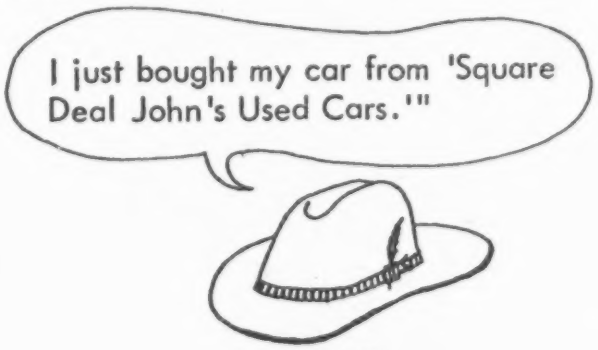

BERNIE

Does Bernie need to have his car inspected? ☐ yes ☐ no

A 1963 Impala must be inspected in:

☐ 1966

☐ 1967

☐ 1968

19933

12

yes

1967

13

When the owner of a car sells it to another person, we say that the car has been transferred.

A car is transferred when it is:

- ☐ bought
- ☐ destroyed
- ☐ repaired

19934

13

bought

14

If a car is 4 years old or has just been transferred, it must be:

- ☐ bought
- ☐ inspected
- ☐ repaired

19935

14

inspected

15

In New York State, what motor vehicles are subject to the periodic inspection laws?

- ☐ all vehicles
- ☐ all vehicles over 1 year of age
- ☐ all vehicles over 4 years of age or those recently transferred
- ☐ only vehicles that have been transferred

19936

15

all vehicles over 4 years of age or those recently transferred

16

A policeman stops your car and says to you, "Let me see your registration."

You show him:

- ☐ a copy of the safety regulations for drivers
- ☐ your ownership papers
- ☐ the serial number on the engine

19937

16

your ownership papers

17

All vehicles in New York State are registered with the Motor Vehicle Bureau.

If you own a motorcycle and a car, you must:

- ☐ register either the car or the motorcycle
- ☐ keep the motorcycle in Connecticut
- ☐ register both the car and the motorcycle

19938

17

register both the car and the motorcycle

18

Every year cars must be registered before January 31.

If it is January 9, 1964, the year on your car registration should be:

- ☐ 1962 or 1963
- ☐ only 1964
- ☐ 1963 or 1964

19939

18

1963 or 1964

19

Registration (ownership papers) for a car must be renewed every year.

The final date for getting a new registration is:

- ☐ January 31
- ☐ February 31
- ☐ July 4
- ☐ your birthday

19940

19

January 31

20

After January each year, every car owner in New York should have a:

- ☐ new car
- ☐ new registration
- ☐ parking regulation notice

19941

regulations and enforce them rigidly.

D. Give adequate instruction in the proper, safe use of all machines, tools, and equipment. Supervise student use of all such items closely to make certain your instruction has been effective.

E. Insist that guards be provided which meet industrial standards. Insist that guards be used.

F. Insist that eye protective devices be worn as prescribed by Florida law.

G. Provide protective clothing for special hazards and insist that it be used. Regular personal clothing should be proper for the particular job or situation (e.g. ties, rings, etc. should not be worn around machinery).

H. Maintain the entire facility (plant and equipment) in proper condition. Items beyond the scope of repair by the teacher should be reported in writing to the proper authority. Copies of all such reports should be preserved. Danger signs or "out of order" signs should be posted until repairs are made.

I. Toxic and flammable materials must be clearly labeled and properly stored.

J. Continue to develop a professional understanding of your students, with regard to maturity level, health, background, personality, coordination, attitude, etc. Check the cumulative records of each student as early as possible in the school year. Physical or behavior problems should be taken up with the proper school personnel and with parents. Insist that you be consulted before any students with handicaps are assigned to you (epileptics, hard of hearing, partially sighted, behavior problems, etc.)

K. Activities should be carefully selected to suit the students with regard to maturity level, coordination, etc.

L. Teach by example--by word and by deed.

4. Liability Insurance

Liability insurance can be obtained at low cost from the American Industrial Arts Association or the Florida Education Association. In addition to these group plans, individual companies offer liability insurance which the teacher may want to investigate.

The question of whether taking out liability insurance is tantamount to admitting liability should not be of concern, because teachers are named in suits whether they are insured or not. In view of the reasonable cost of most insurance policies, no teacher should be without the protection they afford. A finding against the teacher as the result of a negligence suit could be a financial disaster. As previously stated, Florida School Law (230.234) authorizes school boards to provide legal services to employees being sued, but does not allow payment of damages.

282 OF 327

ED

056 238

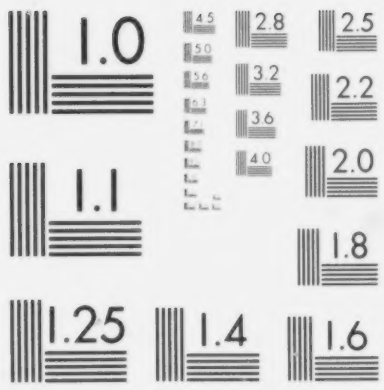

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

20

new registration

21

When do registrations expire for passenger cars?

- ☐ January 1
- ☐ January 15
- ☐ January 31
- ☐ February 1

19942

287

21

January 31

22

ALL MOTOR VEHICLES IN NEW YORK MUST BE REGISTERED.

THE LAW ALSO STATES THAT ANY DRIVER OF A MOTOR VEHICLE MUST HAVE A DRIVER'S LICENSE OR A LEARNER'S PERMIT.

NO ANSWER NEEDED

GO ON TO THE NEXT PAGE

19943

22

NO ANSWER NEEDED

23

If one did not need a driver's license to drive in New York, this is probably what would happen:

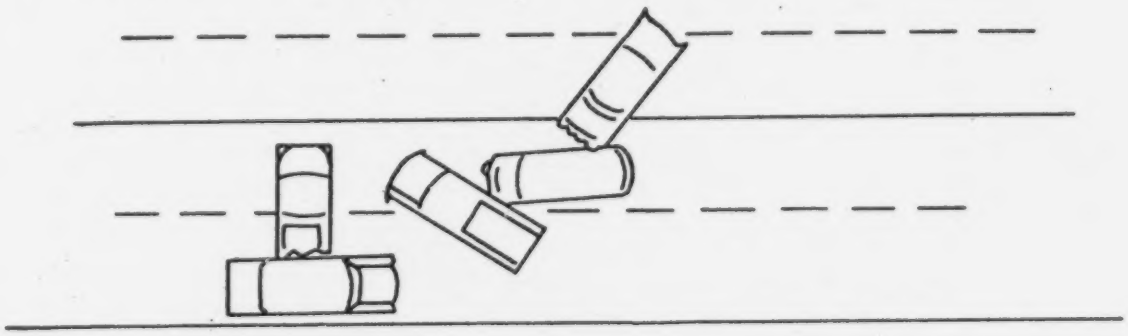

State law requires drivers to have licenses to increase:

- ☐ accidents
- ☐ safety
- ☐ highway taxes

19944

23

safety

24

To drive a motor vehicle you must have a driver's license or a learner's permit.

CROSS OUT the name of the vehicle in the list below that can be operated without a license:

truck

taxi

car

motorcycle

bicycle

19945

24

~~bicycle~~

25

To get a driver's license you must take a written test and a road test.

You get a driver's license if:

- ☐ you are old enough and pass the tests
- ☐ you write the Motor Vehicle Bureau a letter
- ☐ you get a perfect score on the written test

19946

25

you are old enough and pass the tests

26

Licensed drivers:

- ☐ are the fastest drivers on the road
- ☐ know something about good driving
- ☐ don't care about other drivers

19947

26

know something about good driving

27

Bad drivers do not get licenses, which means that:

- ☐ there are too many taxi drivers
- ☐ the public is protected against bad drivers
- ☐ bad drivers get police protection

19948

27

the public is protected against
bad drivers

28

Drivers licenses protect the public because:

- ☐ license fees pay police salaries
- ☐ only good drivers can get and keep drivers' licenses
- ☐ women are not allowed to drive in New York City

19949

28

only good drivers can get and
keep drivers' licenses

29

Why does New York State demand that every driver be licensed?

- ☐ because it needs money to build roads
- ☐ for the protection of the public
- ☐ to get everyone's picture in the state files

19950

PART II

CAUSES OF ACCIDENTS

There is an old saying which still applies--accidents don't just happen, they are caused. A conscientious teacher will endeavor to write and teach a "water tight" safety program, but in spite of his best efforts, accidents may still occur. Part of the job of teachers and supervisors is to discover causative factors before they produce accidents and take whatever corrective action may be necessary.

There are three major categories of hazards which contribute to accidents:

(1) Unsafe physical facilities
(2) Unsafe practices
(3) Unsafe personal factors[1]

While an element in any one of these categories could be responsible for an accident, two or more categories are generally involved. The following checklists will help to identify items needing correction. Changing enrollments, course offerings, new materials, pupil differences, equipment additions, etc., dictate that the total enviornment be under constant scrutiny.

1. Physical Facilities Checklist

A. Building
(1) Ceiling height
(2) Floor type and condition
(3) Adequacy of illumination
(4) Plumbing and heating pipes and equipment
(5) Windows: protection from breakage; opening, closing, and holding devices
(6) Doors: size, swing, operation
(7) Stairways and balconys: railings, non-slip treads
(8) Adequacy of ventilation
(9) Adequacy of storage facilities
(10) Adequacy and condition of electrical distribution system
(11) Space allocations
(12) Personal facilities (restrooms, drinking fountains, wash-up facilities, etc.)
(13) Traffic flow
(14) Emergency exits
(15) Alarms and communications systems
(16) Fire prevention and extinguishing devices
(17) Interior color scheme
(18) Noise absorption factor
(19) Maintenance and cleanliness

B. Machinery and Equipment
(1) Placement and clearance
(2) Safety zones marked

[1]Kigin, Denis J., Teacher Liability in School Shop Accidents, Prakken Publications, Ann Arbor, Michigan, 1963. p. 74.

1970

29

for the protection of the public

30

DRIVING IN NEW YORK AND ALL OTHER STATES IS LEGAL ONLY IF YOU HAVE A DRIVER'S LICENSE.

DRIVING WITHOUT A LICENSE IS AN OFFENSE THAT CAN COST YOU A BIG FINE OR EVEN A JAIL SENTENCE.

NO ANSWER NEEDED
GO ON TO THE NEXT FRAME

19951

30

NO ANSWER NEEDED

31

Suppose YOU are 18 years old and have just been issued your driver's license.

Your 14 year-old brother Willie says: "Hey, I can drive a car. Let me borrow your license."

Should you lend Willie your new license?

- ☐ yes
- ☐ no

19952

31

no

32

May your driving license be used by another person?

- ☐ only if he has the same name
- ☐ no
- ☐ only if he has paid half the fee
- ☐ only on weekends

19953

32

no

33

A driver's license can only be used by the owner of the license — the person who passed the tests.

A man says to you: "I can sell you a driver's license for $5.00." The so-called license he is trying to sell is:

- ☐ a temporary license
- ☐ a learner's permit
- ☐ an illegal license

19954

33

an illegal license

34

CIRCLE the vehicles in the list below that must have a New York State registration and safety inspection:

automobile motorcycle bicycle sled

19955

34

automobile motorcycle

35

According to the New York State Bureau of Motor Vehicles, a motor vehicle is any vehicle that:

- ☐ can carry three or more persons
- ☐ has a V-8 engine only
- ☐ does not run by muscle power

19956

35

does not run by muscle power

36

A vehicle operated by any power other than muscle power is called a:

- ☐ primary vehicle
- ☐ diesel tractor
- ☐ motor vehicle

19857

36

motor vehicle

37

You have a job and have just bought your first car.

WRITE the name of the person who is reponsible for the safe operating condition of the car:

_____

19958

37

_____

(Your own name should be written down because you are responsible for the car you own!)

38

You just bought a car that is five years old.

This car:

- ☐ doesn't need inspection because you are only the second owner
- ☐ can be inspected anytime because you got it from a dealer
- ☐ must be inspected right away because it has just been transferred

19959

38

must be inspected right away
because it has just been transferred

39

Motor vehicles that are transferred (sold) or are more than four years old must be inspected for:

- ☐ safety
- ☐ engine performance
- ☐ manufacturing standards

(3) Non-skid floors around machines
(4) All pulleys, belts, gears, blades, and cutters guarded with approved devices in excellent condition (See "Regulation for Guarding Machine Points of Operation", Chapter 1855-11, and "Regulation for Guarding Mechanical Power Transmission Apparatus" Chapter 1855-9, Rules of the Florida Industrial Commission)
(5) All cutting blades and knives sharp and secure
(6) All machines in good condition, properly maintained and lubricated
(7) All switches guarded. Magnetic type switches on all major machines
(8) All machines properly wired and grounded
(9) All hand and portable power tools in good condition and grounded
(10) All machines are of the highest quality available consistent with financial resources
(11) Adequate local illumination
(12) Safety precautions and rules conspicuously posted near each machine

C. Housekeeping
(1) Care of floors, stairs, aisles
(2) Care of rags and waste
(3) Storage and handling of oils, solvents, and other flammables
(4) Effectiveness of clean-up methods or procedures
(5) Storage of raw stock
(6) Project storage
(7) Cleanliness of light fixtures and windows
(8) Effectiveness of tool storage methods
(9) Adequacy of dust and fume removal equipment

2. Unsafe Practices Checklist

A. Unsafe Teacher Practices
(1) Teacher lacks knowledge of certain tools and machines
(2) Preliminary instruction is inadequate
(3) Follow-up is inadequate
(4) Students are inadequately supervised
(5) There are gaps in safety instruction and/or testing
(6) Students are allowed to play in shop
(7) Students or others work unsupervised in the shop after normal hours
(8) Teacher is not aware of or does not enforce eye-safety and other laws and regulations
(9) Teacher does not set a "safety example"
(10) Machines are not checked before allowing operation
(11) Teacher does not keep administrators aware of safety needs
(12) Teacher does not maintain adequate safety records

B. Unsafe Student Practices
(1) Students engage in "horseplay" or other nonsense
(2) Students do not heed instruction
(3) Students fail to develop a positive attitude toward safety
(4) Students do not dress properly

1971

39

safety

40

In New York State, which motor vehicles are subject to the periodic inspection laws?

- ☐ all vehicles
- ☐ all over 1 year of age
- ☐ all vehicles over 4 years of age; or those recently transferred
- ☐ only vehicles which are transferred

19961

40

all vehicles over 4 years of age; or those recently transferred

41

Registrations for passenger cars expire in the first month of each year.

Your registration expires:

- ☐ on December 31
- ☐ on January 31
- ☐ on February 1

19962

41

on January 31

42

All passenger car registrations expire on January 31 every year.

Your car is legal in New York:

- ☐ if you keep it in safe parking garages
- ☐ if you register it in someone else's name every year
- ☐ if it has an up-to-date registration

42

if it has an up-to-date registration

43

Registrations for passenger cars expire every year on:

- ☐ your birthday
- ☐ January 1
- ☐ January 31
- ☐ February 1

19964

43

January 31

44

In New York, if you own a motor vehicle you must have a registration.

Driving a motor vehicle in New York requires:

- ☐ a vote registration card to show residence
- ☐ a license
- ☐ high school graduation certificate
- ☐ knowledge of traffic

19965

44

a license

45

MATCH the following:

A. driver's license	1. _____ one-way streets
B. reckless driving	2. _____ protection of public
	3. _____ accidents

19966

45

1. -

2. A

3. B

46

The law in New York states that all drivers must be licensed because:

- ☐ outlaws from other states can be arrested
- ☐ licensed driving protects the public of New York
- ☐ license fees pay for the construction of highways

19967

46

licensed driving protects the public of New York

47

A licensed driver in New York can never:

- ☐ drive late at night in rural areas
- ☐ lend his driver's license to someone else
- ☐ lend his automobile to someone else
- ☐ transport furniture in an automobile

19968

47

lend his driver's license to someone else

48

May your driving license be used by another person?

- ☐ only if he has the same name
- ☐ only if he pays you for the license
- ☐ yes, if driving conditions are safe
- ☐ no

19969

48

no

49

Before you can get a driver's license, you get a LEARNER'S PERMIT.

When you have a learner's permit, a licensed New York driver who is 18 years old or older can help you with:

- ☐ parking problems
- ☐ practice driving
- ☐ an application for a license

19970

(5) Students take short cuts or hurry too much
(6) Students lack normal judgment
(7) Students are absent too much
(8) Students sometimes omit use of guards
(9) Students achieve poorly on safety tests

3. Unsafe Personal Factors Checklist

A. Each student should be observed carefully and records checked for indications of problems involving:

(1) Sight
(2) Hearing
(3) Coordination
(4) Strength and range of motion
(5) Epilepsy
(6) Nervousness
(7) Hypertension
(8) Disease or contagion
(9) Mental aberration
(10) Poor attitude

B. The Teacher should apply the same checklist to himself and obtain a yearly basic physical examination.

1972

49

practice driving

50

With a learner's permit, you can do practice driving for your road test.

The road test and the written test must be passed:

- ☐ to get a high school diploma
- ☐ before you are 21 years old
- ☐ to get a driver's license

19971

50

to get a driver's license

51

A learner's permit allows you to:

- ☐ drive out of state but not in New York
- ☐ drive with a qualified driver accompanying you
- ☐ drive cars and motorcycles only

19972

51

drive with a qualified driver accompanying you

52

MATCH the following:

A. requires registration

B. requires learner's permit

1. _____ practice driving

2. _____ motor vehicle

3. _____ license renewal

52

1. -

2. B

3. A

53

Before you start practice driving you must have:

- ☐ an old car
- ☐ a learner's permit
- ☐ a high school diploma

19974

53

a learner's permit

54

When you get behind the wheel and start practice driving you must:

- ☐ ask a policeman to help you
- ☐ be with a New York licensed driver who is 18 or older
- ☐ be with someone from your family who is at least 21 years of age

19975

54

be with a New York licensed driver who is 18 or older

55

A driver with a New York license who is at least 18 years old:

- ☐ can take the road test for you
- ☐ must accompany you when you do your practice driving
- ☐ must sit in the back seat while you drive

19976

55

must accompany you when you do your practice driving

56

Who must accompany you when you are practicing driving under a learner's permit?

- ☐ a New York State licensed driver at least 18 years of age
- ☐ a licensed driver at least 18 years of age
- ☐ a duly licensed instructor in New York State
- ☐ a police officer from your precinct

19977

56

a New York State licensed
driver at least 18 years of age

57

When you go to take the road test, you must be with a licensed driver 18 years old or older.

This driver must have a license from:

- ☐ Pennsylvania
- ☐ New Jersey
- ☐ New York

19978

57

New York

58

A New York State licensed driver must go with you when you take:

- ☐ the road test
- ☐ the written test
- ☐ the traffic signal test

19979

58

the road test

59

Who must be with you when you appear for the road test for your driver's license?

- ☐ your parent or guardian
- ☐ your high school teacher
- ☐ a New York State licensed driver at least 18 years of age
- ☐ a licensed driver from any state at least 18 years of age

19980

PART III

PROVIDING FOR SAFETY

1. Safety Instruction

A planned, approved program of safety instruction involving general shop safety and specific safety instruction is necessary. Further, the plan must be implemented--taught and evaluated. The best time to teach safety is when the operation or skill is taught. Safety should be an integral part of all instruction. Repetition and reinforcement are necessary to build habits. In planning and teaching for safety, review the "5 E'S" of safety in the front of this manual.

Safety regulations should be developed for each shop, each machine and each hazardous operation. Merely handing out or posting these regulations cannot, however, replace proper and adequate instruction. The teacher must set an example by following regulations and safe practices zealously and cheerfully.

A safety pledge, while legally worthless in a lawsuit, is nonetheless a worthwhile medium for emphasizing the students role in safety. Even minors tend to respect the obligations inherent in a pledge and signature.

Pledge cards, safety test results, anecodatal records and similar information should be maintained in a student file system. This sort of information provides a constant source of evaluative material to assess the effectiveness of instruction and is a source of evidence of sincere intent in the event of a suit following a student injury.

A regular shop safety report or letter is indispensible in maintaining a safe shop. The proper supervisor or administrator should be informed of strengths, weaknesses and needs. File copies should be maintained chronologically. Any machine, device, or area that is unsafe to use should be blocked off or otherwise secured and a statement to this effect made in the report. Teachers should flatly refuse to use, or permit to be used, any unsafe item, such as a circular saw with a broken guard, etc.

Depending upon the size of the school and the extent of industrial arts activities, a safety coordinator may be in order. This will simplify and refine channels of communication for the department.

A safety foreman and/or a safety squad should be a part of the pupil personnel system. This helps to make the students realize their responsibility for their own safety. Students can also, in addition to observing the work of others and inspecting equipment, take charge of the safety bulletin board, safety displays, and other related activities.

2. Organizing the Laboratory

The success of industry lies in organization. Random movement, uncoordinated action, lost motion, and so forth, spell loss and danger. The school industrial arts laboratory should be reflective of industry with regard to organization. Several factors are to be considered:

a. The general arrangement of the shop should suggest orderliness and neatness. Material flow directions should be apparent.

b. Students should be assigned to work stations.

1973

59

a New York State licensed driver at least 18 years of age

60

A New York State licensed driver at least 18 years of age must be with you: (CHECK ALL CORRECT ANSWERS)

- ☐ when you are repairing your car
- ☐ when you are practicing driving under a learner's permit
- ☐ when you appear for the road test for your driver's license
- ☐ to prove to the Motor Vehicle Bureau that you are old enough to drive

19981

60

when you are practicing driving
under a learner's permit

when you appear for the road
test for your driver's license

61

You take a road test to show that you have:

- ☐ a smooth running car
- ☐ driving endurance
- ☐ driving skill
- ☐ experience in driving in heavy traffic

19982

61

driving skill

62

Driving skill is demonstrated when you take:

- ☐ an eye examination
- ☐ a safety quiz
- ☐ a road test

19983

62

a road test

63

What is required in the road test for a driver's license?

- ☐ knowledge of the English language
- ☐ one-handed driving
- ☐ driving skill
- ☐ dodging any tricks the examiner pulls

19984

63

driving skill

64

Driving skill is needed to pass the road test.

The best way for you to get driving skill is to:

- ☐ ride the bus and watch traffic
- ☐ read "Road and Track" magazine
- ☐ practice driving

19985

64

practice driving

65

Practice driving is the best way to learn to drive.

You must do your practice driving: (CHECK ALL CORRECT ANSWERS)

- ☐ after dark
- ☐ after you get a learner's permit
- ☐ before the winter months when the weather is bad
- ☐ with a New York licensed driver at least 18 years of age

19986

65

after you get a learner's permit

with a New York licensed driver
at least 18 years of age

66

You should do twenty (20) hours of practice driving:

- ☐ before you take the road test
- ☐ after you take the road test
- ☐ if you want to become a taxi driver

66

before you take the road test

67

New York State recommnds that 20 hours of practice driving be done to:

- ☐ get more cars on the road
- ☐ keep traffic speed under 35 mph
- ☐ get learners to improve their driving skill

19988

67

get learners to improve their driving skill

68

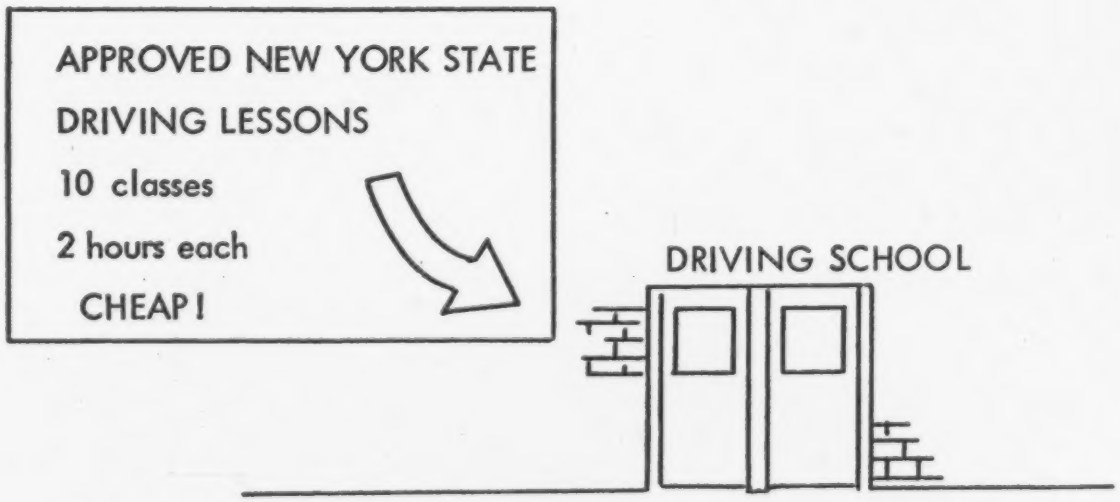

The sign shows that practice driving with a driving school instructor will take at least:

- ☐ 10 hours
- ☐ 15 hours
- ☐ 20 hours
- ☐ 25 hours

19989

c. Material storage, distribution, and handling should be routinized for efficiency and safety.

d. Decentralized tool storage should be employed. Centralized storage areas, supply areas, locker areas, project storage areas, etc. should be observed closely for accident hazards due to crowding. Certain procedures, such as time staggering, may reduce congestion.

e. Time-use plans should be established for heavily used machines to avoid students having to stand around and wait for a particular machine.

f. An emergency warning and communication procedure is essential. The warning may be a bell, whistle, horn, or other device, but students must be trained to pay absolute attention when it sounds. Procedures for fire, explosion, storm, injury, and other events should be established and practiced.

3. Teaching Aids

A safety education program must be "spiced" with a variety of audio-visual aids to maintain its appeal. The National Safety Council, the state industrial commission, insurance companies, industries, and others provide many free items. The following types of aids should be included in presenting safety instruction:

a. Posters: Choose carefully and change regularly. Don't "wallpaper" the lab with posters--they become meaningless this way.

b. AV materials: Films, filmstrips, slides, photographs, recordings, viedotape, etc.

c. Tests and Quizzes: Not only as a check on understanding of safety instruction, but also as a learning device.

d. Instruction sheets and project sheets: Written procedural materials should always include pertinent safety precautions.

e. Suggestion box: Encourages student participation in safety. Suggestions should be considered by the class, not by the teacher alone. Suitable recognition should be given for adopted suggestions. This can be an industrial arts club project.

4. Facilities Organization

The arrangement, organization, and maintenance of the physical plant and its equipment is of inestimable importance in the total safety program. Good "housekeeping" and "a place for everything and everything in its place" are basic to safety. The Physical Facilities Checklist on page 5 will assist in identifying potential problems.

5. Pupil Personnel System

While many teachers debate the efficacy of student personnel systems, the fact remains that an effective safety program cannot be had without student involvement. Regardless of what method or system is used, students should be made to feel that shop cleanup and housekeeping are for reasons of safety and are the workmanlike thing to do. Organizations such as the following can be utilized to advantage:

69

driving practice

70

How many total hours of practice driving should you have before you take your road test?

- ☐ 4 hours
- ☐ 10 hours
- ☐ 20 hours
- ☐ 12 hours

19991

70

20 hours

71

When you go to take the road test for your driver's license, you must:

- ☐ be with a New York licensed driver at least 18 years old
- ☐ throw away your learner's permit
- ☐ show that you own your own car

19992

71

be with a New York licensed driver at least 18 years old

72

Driving licenses are issued for three years to New York State residents who:

- ☐ pass a written test or a road test
- ☐ pass a written test and a road test
- ☐ pass a driving course in high school

19993

72

pass a written test and a road test

73

Drivers' licenses are issued for three years.

If you get a license when you are 18 years old, you must have the license renewed:

- ☐ when you drive to another state
- ☐ before January 31 on alternate years
- ☐ when you are 21 years old

19994

73

when you are 21 years old

74

MATCH the following:

A. car registration renewal

B. driver's license renewal

1. _____ October 1

2. _____ January 31

3. _____ every three years

74

1. -

2. A

3. B

75

For what period of time are drivers' licenses issued?

- ☐ 3 months
- ☐ 6 months
- ☐ 1 year
- ☐ 3 years

19996

75

3 years

76

A special driver's license called a JUNIOR LICENSE is issued to younger drivers who pass the tests.

Drivers with junior licenses are:

- ☐ twelve year-old boys with a lot of money
- ☐ boys under fifteen who must drive to school
- ☐ girls and boys sixteen or seventeen years old

76

girls and boys sixteen or seventeen years old

77

In New York most drivers who are sixteen or seventeen get a special license called:

- ☐ a junior instructor's license
- ☐ a private driving permit
- ☐ a junior license

77

a junior license

78

How old must you be before you can obtain a junior operator's (driver's) license?

- ☐ eighteen
- ☐ twenty-one
- ☐ sixteen
- ☐ seventeen

19999

78

sixteen

79

Joe has a Junior Operator's License.

He CAN use a car at night:

to drive to math class

if he needs a car to drive to trade school

He CANNOT use a car at night:

to drive to the movies

to take his girl for a ride

When can a junior operator drive at night?

- ☐ never
- ☐ only to go to school
- ☐ when there isn't much traffic

20000

Foreman or supervisor
Safety engineer
Sanitary engineer
Tool manager

Other duties to be assigned on some sort of rotating basis include:

Care of benches and vises
Care of specific machines
Care of personal items (books, clothing, etc.)
Storage of projects, stock, etc.
Scrap and waste handling

The duties of students assigned to these responsibilities should be clear. Check sheets should be posted or passed out.

6. Color

The effect of color on safety and efficiency is well known, and, in addition, an attractively painted facility improves the appearance and engenders interest in housekeeping. Proper color contrast reduces eye fatigue and tension and promotes better vision. The following is suggested by the American Standards Association:

RED - To identify fire protection equipment, danger, and emergency stops on equipment. Use on fire alarm boxes, fire extinguishers, fire hose connections, safety cans.

ORANGE - Used to alert and is the basic color for designating hazardous parts of machines or electrical equipment that might shock, cut, crush or otherwise injure. Use on exposed edges of cutting devices, pulleys, gears, interior surfaces of guards, transmission cases, fuse boxes.

YELLOW - Designates caution and is used to indicate hazards from stumbling, falling, tripping, bumping, and collision. Use for aisle markings, handrails, guardrails, barricades, protruding parts, low overhead projections, approach to stairs, and floor areas near open pits.

GREEN - Used in combination with WHITE, to identify first aid and safety equipment. Use on first-aid kits, safety bulletin boards, stretchers, personal protective equipment supply or storage areas.

BLUE - Indicates precaution and is used to mark equipment controls. Use for signs indicating that equipment is not to be used, electrical controls, valves, brakes, kilns, etc.

PURPLE - Denotes radiation hazards. Use for radiation warning lights and containers for radioactive material.

BLACK and WHITE - Use separately or in combination as strips or checks to indicate housekeeping areas. Use to denote location of waste containers, stair risers, white corners for rooms or passageways.

The interior of the laboratory and the machines and equipment can be painted in accordance with the suggestions offered by various paint manufacturers. There is no "standard" color coding system beyond that specified above, but judicious use of color can emphasize certain areas, reduce glare, improve

1975

79

only to go to school

80

Joe can drive alone to school at night if he has:

- ☐ a learner's permit
- ☐ a junior operator's license
- ☐ permission from the owner of the car

20001

80

a junior operator's license

81

When may a driver with a junior license drive at night?

- ☐ when accompained by a licensed driver over 18 years of age
- ☐ if he is a member of the National Guard
- ☐ never
- ☐ to go to school

20002

81

to go to school

82

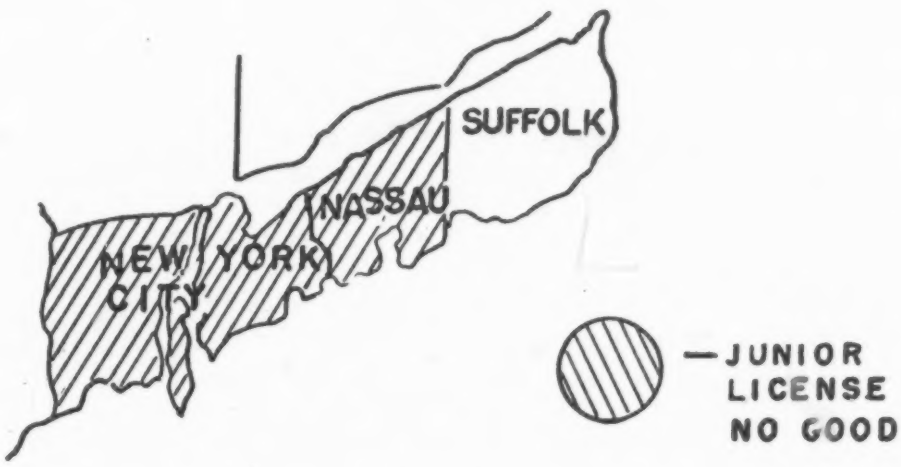

This map shows where you can NOT use a junior operator's license, day or night.

One place is NASSAU county.

What is the other? _____

20003

82

New York City

83

In New York City and in Nassau County:

- ☐ a junior operator's license is not valid
- ☐ a regular learner's permit is not valid

20004

83

a junior operator's license is not valid

84

In what county, outside New York City, is a junior operator's license not valid?

- ☐ Westchester
- ☐ Nassau
- ☐ Suffolk
- ☐ Sullivan

20005

84

Nassau

85

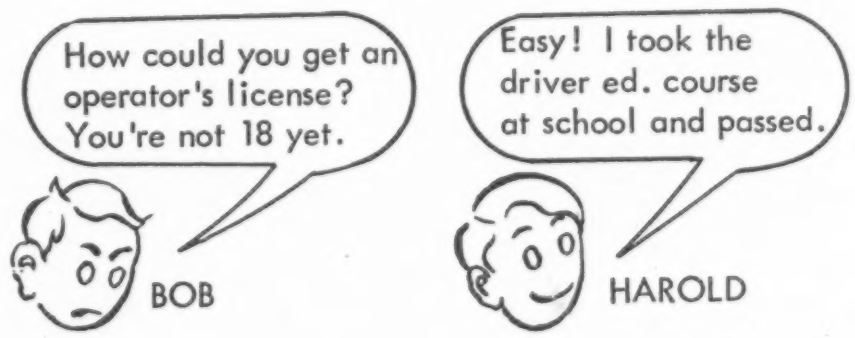

If Harold did not take the driver education course, he would have to wait until he was _____ (how old).

20006

85

18 (years old)

86

If you pass an approved driver's education course in high school, you can:

- ☐ drive without insurance
- ☐ get an operator's license under 18
- ☐ get an operator's license under 21

20007

86

get an operator's license under 18

87

To obtain a regular operator's license a person under 18 years of age must:

- ☐ write a letter to the Commissioner of Motor Vehicles
- ☐ show that he has above average skills
- ☐ pass an approved driver training course at a junior or senior high school that he attends
- ☐ pass the driving test the first time

20008

87

pass an approved driver training course at a junior or senior high school that he attends

88

Before you take the road test for a driver's license you should practice driving for at least:

- ☐ ten days in winter and ten days in summer
- ☐ 20 hours
- ☐ 48 hours
- ☐ two years

88

20 hours

89

You do at least twenty hours of practice driving:

- ☐ before you can get a learner's permit
- ☐ after you get a learner's permit
- ☐ after you pass the written test at the License Bureau

20010

illumination, and generally create more pleasant working conditions.

7. Fire Prevention and Extinguishment

Fire may seem a remote possibility, but it has been responsible, together with explosion, for the nation's worst school disasters. Those responsible for the school should seek the help of the local fire department, insurance carrier, state fire marshall, and others in eliminating the cause of fires and assessing extinguishment methods. Much of the work in school shops involves the use of fire, heat, and flammable materials. Three factors are necessary to cause fire: (1) oxygen (2) fuel (3) temperature high enough to cause ignition. To prevent or extinguish fire, one or more of these three factors must be controlled or eliminated.

There are four general classifications of fires based on the types of extinguishing media necessary. The chart on the following page lists the classes of fires, the types of materials, and the methods to be used for extinguishing fires.

The following factors should receive close attention in planning a fire prevention program:

Gas - All types of gases, oxygen, acetylene, natural, propane, butane, etc., represent a hazard. All equipment, piping, regulators, and ignitors should receive periodic and careful inspection by a qualified person. Students must receive thorough instruction before using these types of equipment. Matches should not be used for igniting gas-fired equipment.

Housekeeping - Rubbish, waste, and other debris must be cleaned up and removed from the shop daily and disposed of in suitable containers outside of the shop.

Electrical Equipment - Motors and other devices should be kept clean and properly maintained. All wiring should be done by a qualified person. All electrical equipment should be included in periodic inspections.

Matches and Smoking - Although it may be assumed that students do not smoke in class, teachers, custodians, adult students and visitors might. Smoking in laboratories should be strictly prohibited.

Spontaneous Combustion - This is probably the most prevalent cause of school shop fires. Oily or paint-soaked rags or clothing left in student lockers are a great hazard. Dust, lint, and oil collecting in ducts and flues can also ignite spontaneously. Safety containers should be provided for rags and waste and they should be emptied daily. Students must be instructed and supervised closely to prevent these types of fires.

Open Flames - Open flames are involved in welding, forging, forming and other heating operations. Fireproof materials around the work area and suitable clothing will aid in the prevention of most fires. However, the use of portable equipment involves high fire danger and all precautions should be taken, including having an extinguisher of the proper type ready at hand.

Heated Surfaces - Heated surfaces on furnaces, flues, heating devices

 1978 ۱۹۷۸

89

after you get a learner's permit

90

How many total hours of practice driving should you have before you take your road test?

- ☐ at least 4 hours
- ☐ at least 10 hours
- ☐ no more than 10 hours
- ☐ at least 20 hours

283 OF 327

ED

056 238

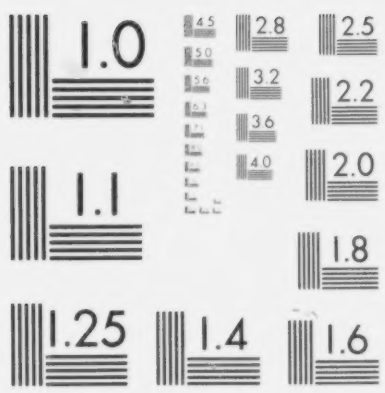

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

90

at least 20 hours

91

When you drive to the place where you take your road test you should bring along:

- ☐ paper and pencil
- ☐ a N. Y. licensed driver at least 18 years old
- ☐ a New York State Driver's Manual

20012

91

a N.Y. licensed driver at least 18 years old

92

A New York State licensed driver at least 18 years old should be in your car: (CHECK TWO)

- ☐ when you are making repairs on the car
- ☐ when you appear for the road test
- ☐ after you get your driver's license
- ☐ when you drive using a learner's permit

20018

92

when you appear for the road test

when you drive using a learner's permit

93

Who must accompany you when you are practicing driving under a learner's permit?

- ☐ a New York State licensed driver at least 18 years of age
- ☐ any licensed driver at least 18 years of age
- ☐ a duly licensed instructor in New York State
- ☐ a police officer from your precinct

93

a New York State licensed driver at least 18 years of age

94

When you are trying to get a license, you show your driving skill:

- ☐ by driving through heavy traffic
- ☐ when your reaction speed is tested
- ☐ when you take the road test

20015

94

when you take the road test

95

The written test for a license requires correct answers.

The road test requires:

- ☐ fast reflexes
- ☐ a fast car
- ☐ driving skill
- ☐ courage

20016

95

driving skill

96

The road test must be taken by:

- ☐ all women applying for drivers' licenses
- ☐ everyone who wants to get a driver's license
- ☐ people who live in the country where there are only a few cars

20017

96

everyone who wants to get a driver's license

97

What is required in the road test for a driver's license?

- ☐ knowledge of the English language
- ☐ one-handed driving
- ☐ driving skill
- ☐ dodging any tricks the examiner pulls

20018

97

driving skill

98

A learner's permit costs 50¢.

An application for a driver's license costs $2.00.

A driver's license costs:

- ☐ twice as much as a learner's permit
- ☐ three times as much as a learner's permit
- ☐ four times as much as a learner's permit

20019

FIRE CLASSES AND EXTINGUISHING AGENTS

Class	Types of Materials	Extinguishing Agents
A	Ordinary materials, such as wood, paper, excelsior, rags, rubbish	Water, for its quenching and cooling effect. Hose, pump, or soda-acid extinguishers, or multi-purpose dry chemical extinguishers
B	Flammable liquids, such as gasoline, oil, kerosene, grease, paints, thinners	Limit air supply through the use of dry chemical, multi-purpose dry chemical, CO^2, or foam. Water fog nozzles may be used in certain circumstances. Do not use solid streams of water.
C	Fires in or near electrical equipment	Non-conducting agents must be used, such as dry chemical, CO^2, compressed gas
D	Combustible metals, such as magnesium, titanium, zirconium, lithium, sodium	Specialized techniques and equipment are necessary. If you use these materials, consult your fire department or the fire marshall.

NOTE: Do Not Use Carbon Tetrachloride Extinguishers. Fumes From Carbon Tetrachloride Are Deadly.

1977

98

four times as much as a learner's permit

99

In New York State you must pay a fee for:

- ☐ a learner's permit but not a driver's license
- ☐ a learner's permit and a driver's license
- ☐ only a driver's license, provided you pass the tests

20020

99

a learner's permit and a driver's license

100

What document costs less than $1.00?

- ☐ a driver's license application
- ☐ a learner's permit
- ☐ a diploma from a driving school

20021

100

a learner's permit

101

Your learner's permit cost 50¢.

Your driver's license application cost $2.00.

You passed the tests, and got a driver's license!

The total cost to you of getting a license was:

- ☐ $1.50
- ☐ $2.00
- ☐ $2.50
- ☐ $3.00

101

$2.50

102

In some states (New Jersey, Pennsylvania) drivers must pay each time they are issued a new license, but this is not the case in New York.

In New York, you only pay for your license:

- ☐ if you fail the tests and have to take them again
- ☐ when it is first issued to you
- ☐ when you change your address

102

when it is first issued to you

103

In New York you have your license renewed (every three years) without paying, but you must pay for a brand new license.

You'll need a brand new license if:

- ☐ you get taller and gain weight
- ☐ you lose the old one
- ☐ you buy a car

20024

103

you lose the old one

104

DON'T LOSE YOUR LICENSE!

THE COST OF REPLACING A LOST LICENSE IS $3.00.

The cost of a replacement license is:

- ☐ less than the cost of a learner's permit
- ☐ more than the cost of an original license
- ☐ the same as a license application fee

104

more than the cost of an original license

105

Your learner's permit cost you 50¢.

Your driver's license application cost you $2.00.

You don't have to pay the state more money unless:

- ☐ you drive outside of New York City
- ☐ you lose your license and have to get a new one
- ☐ you move to a new address in the city

20026

105

you lose your license and have to get a new one

106

25¢

50¢

$2.00

$3.00

$5.00

From the list of prices above, WRITE IN the cost of the permit and of the license below:

A driver's license application costs _____

A learner's permit costs _____

A replacement license costs _____

106

$2.00 (driver's license application)

50¢ (learner's permit)

$3.00 (replacement license)

107

After you get a driver's license, you will not have a renewed license issued to you for three years.

If you get a license in 1965, you must renew this license before:

- ☐ 1967
- ☐ 1968
- ☐ 1970

107

1968

108

What is the fee for a learner's permit?

- ☐ fifty cents
- ☐ seventy-five cents
- ☐ one dollar
- ☐ two dollars

What is the application fee for a driver's license?

- ☐ $1.00
- ☐ $2.00
- ☐ $3.00
- ☐ $5.00

and light bulbs can be the cause of fires if flammable or combustible materials are close enough to absorb sufficient heat to cause combustion. Care should be taken to insure that all such devices are properly installed, especially with respect to clearances and barrier materials.

Molten Metal -Molten metal will ignite any flammable material with which it comes in contact. Precautions should be taken to provide a flame-proof environment in foundry areas and also to provide flame-proof clothing. Additional precautions are to be found in the section dealing with foundry operations.

Volatile Liquids - Paints, varnishes, lacquers, petroleum products, solvents and similar volatile materials are frequent sources of fire and/or explosion. The liquid itself does not burn, but heat causes vaporization, and the vapors of these liquids are easily ignited by sparks from electrical devices, static electricity, or metal objects striking together or, or course, open flames. Vapors are generally heavier than air and may travel along the floor for considerable distance before they are ignited and flash back to the source. Tight metal containers, flameproof cabinets, color coding, and strict storage and handling procedures are necessary. See also, "Fire Prevention: Flammable or Combustible Liquids," Chapter 5A-16 of the Rules of the State Fire Marshall.

In addition to the foregoing, it is necessary that all persons in the shop or laboratory know exactly what to do in case of fire. The general rules established by the principal should, of course, be followed. In addition, students should be given instruction on the following:

A. How and when to turn in a fire alarm.

B. How to extinguish fires and how to determine whether extinquishment should be attempted.

C. What to do in the event of alarm, such as turn off all machines, disconnect power at main switch, turn off gas values and torches, etc.

D. How to leave the building.

8. Controlling Electrical Hazards

Everyone is familiar with electricity, but few people really understand it. Consequently, many misconceptions are prevalent with regard to the changes associated with the use of electrical devices. The most common misconception is that voltage kills. Actually, while a certain amount of voltage is required, it is current (electron flow, measured in amperes) that does the damage. The amount of current that flows is governed by the applied voltage, the resistance of the body, and the nature of the ground. The amount of current required to kill is very small--generally less than one-half ampere. Cases are on record of deaths resulting from one-tenth ampere or even less. That this is not a great amount of current can be seen by comparing it to that which an ordinary 100 watt light draws--nearly one ampere.

The part of the body through which the current flows determines whether death or injury results. A leg to leg circuit, for example, would probably not be as damaging as an arm to leg or head to arm circuit. If the current passes through one or more of the vital organs, severe shock

1978

108

fifty cents

$2.00

109

In New York State you must have your driver's license renewed:

- ☐ every three years
- ☐ after thirty years
- ☐ eventually

20030

109

every three years

110

COMPLETE this jingle:

"Renew your license every three years for free,

But don't lose your license or you'll have to pay _____"

20031

110

three ($3.00)

111

For what period of time are drivers' licenses issued?

- ☐ 6 months
- ☐ 1 year
- ☐ 2 years
- ☐ 3 years

111

3 years

112

What is the fee for a new license if you lose your license?

- ☐ $1.00
- ☐ $3.00
- ☐ $5.00
- ☐ $6.00

20033

112

$3.00

113

When you apply for a driver's license you must bring $2.00 <u>and</u> a baptismal certificate or birth certificate.

A baptismal certificate or birth certificate is written evidence of:

- ☐ only your last name
- ☐ your place of birth but not your name
- ☐ your place of birth, full name and age

113

your place of birth, full name and age

114

One good reason why the Department of Motor Vehicles wants to see evidence of age is:

- ☐ old people make better drivers than young people
- ☐ no person under sixteen years of age can get a regular license
- ☐ applicants who are twenty-one or older take an easier test than younger applicants

20035

114

no person under sixteen years of age can get a regular license

115

When applying for a license, who must bring proof of date of birth?

- ☐ people of all ages
- ☐ only those people under twenty-one years of age
- ☐ only those people over twenty-one years of age
- ☐ only those people applying for a Junior Operator's license

20036

115

people of all ages

116

How old must you be before you can obtain a junior operator's license?

- ☐ eighteen
- ☐ twenty-one
- ☐ sixteen
- ☐ seventeen

116

sixteen

117

A junior license holder can drive <u>any</u> <u>time</u> during the day, but at night he can only drive:

- ☐ if his father is in the car
- ☐ to go to work
- ☐ to go to school

117

to go to school

118

A junior operator can drive at night only if he must drive to school.

Ordinarily a junior operator only drives:

- ☐ early in the morning before sunrise
- ☐ during daylight hours
- ☐ to and from night school

20039

damage or death is certain.

The severity of shock will be determined by several factors:

(1) the rate of current flow as mentioned above
(2) the path of current flow, also mentioned
(3) the frequency of the current
(4) the phase of the heart cycle at the moment of shock.
(5) the physical and psychological condition of the victim

In addition to nerve shock, the victim may sustain burns, tissue and nerve destruction, or other injury due to falling or other secondary effects.

Causes of electrical accidents are generally due to : (1) defective equipment, (2) unsafe work practices, and (3) lack of knowledge. Most accidents involving electricity can be prevented by:

(1) Obtaining quality electrical equipment
(2) Inspecting regularly and maintaining all electrical equipment, wiring, and devices
(3) Grounding all motors and portable tools
(4) Using isolation transformers in electronic work
(5) Teaching safe and proper work practices
(6) Teaching the rudiments of electricity and electrical safety to all students

9. Protecting eyesight

Our one single most valuable asset is undoubtedly our eyesight. But we take sight so much for granted and treat it so carelessly that many states have seen fit to pass special legislation to protect eyesight in schools. Florida's eye safety law is reproduced on the following page. Note that it is still the responsibility of the teacher to make certain that protective devices are worn where hazards exist. While the principal purpose of the law is to preserve sight, it should be obvious that a teacher who does not rigidly enforce the law in his shop will be virtually defenseless if an eye injury occurs.

Sometimes, as in pouring metals, it is advisable to wear two types of protection--spectacle type safety glasses and a plastic face shield. Plastic goggles or face shields alone cannot be relied upon to stop flying drops of molten metal.

A procedure for periodic disinfection of eye protective devices is recommended. One method is to wash all parts with soap and water then rinse well to remove all soap. Swab thoroughly or completely immerse all parts for 10 minutes in a solution of germicidal deodorant fungicide. Air dry all parts to retain the germicidal residue which will retain its effectiveness for some time. A germicidal cabinet can also be used.

The ideal practice is for each student to have his own safety glasses which he can use throughout his school career in shop and chemistry courses. Each shop, however, must have available a sufficient type and quantity of devices to protect the largest number of students (and visitors) who may be engaged in performing or observing the activities indicated in the law.

1979

118

during daylight hours

119

When may a junior operator drive at night?

- ☐ when accompanied by a licensed driver over 18 years of age
- ☐ if he's a member of the National Guard
- ☐ never
- ☐ for credit-bearing classes or activities at school

20040

119

for credit-bearing classes or activities at school

120

When does a junior license holder ordinarily operate a motor vehicle?

- ☐ only in New York City, or within Nassau County limits
- ☐ only when driving for compensation
- ☐ only between the hours of sunrise and sunset
- ☐ only going to and from school

20041

120

only between the hours of sunrise and sunset

121

If you live in New York City you might as well forget about getting a junior operator's license because:

- ☐ only one hundred junior licenses are issued in the city each year
- ☐ driving in New York City is dangerous
- ☐ junior licenses are not valid in New York city and Nassau County

20042

121

junior licenses are not valid in New York City and Nassau County

122

When you apply for a junior license you must:

- ☐ show proof that you own a safe car
- ☐ show proof of your date of birth
- ☐ show that you are a skillful driver

20043

122

show proof of your date of birth

123

In what county outside New York City is a junior driver's license not valid?

- ☐ Nassau
- ☐ Suffolk
- ☐ Sullivan
- ☐ Westchester

123

Nassau

124

Drivers who drive for commercial reasons (to make money) need a special license called a CHAUFFEUR'S LICENSE.

CROSS OUT the driver on the list below who does not need a chauffeur's license:

taxi driver

Sunday driver

bus driver

20045

124

Sunday driver

125

Can Drive With Operator's License

MOTORCYCLE

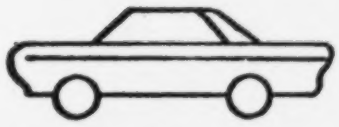

PASSENGER CAR

Can Drive With Chauffeur's License

MOTORCYCLE

PASSENGER CAR

TAXI CAB

Which vehicle cannot legally be driven with an operator's license?

- ☐ motorcycle
- ☐ passenger car
- ☐ taxi

20046

125

taxi

126

To operate a motorcycle and a passenger car, you only need:

- ☐ an operator's license
- ☐ an unclassified chauffeur's license

20047

126

an operator's license

127

If you only have an operator's license, what vehicles can you legally drive?

- ☐ commercial tractor trailers
- ☐ buses
- ☐ regular passenger cars and motorcycles
- ☐ regular passenger cars only

20048

127

regular passenger cars and motorcycles

128

To drive a taxi, you need:

- ☐ an operator's license
- ☐ a chauffeur's license
- ☐ a taxi license

20049

Revision of Eye Protection Device Law as Passed
by Legislature

(Major Changes Underlined)

CHAPTER 67-181

House Bill No. 754

AN ACT relating to public schools; revising and amending sections 228.002, 230.302(3), 231.361, 231.40(1), 232.45, 233.09(5)(b), 236.071(1) and 237.17, Florida Statues.

Section 5. Section 232.45, Florida Statutes, is amended to read:

232.45 Eye protection devices required in certain vocational and chemical laboratory courses--

(1) Eye protective devices shall be worn by students, teachers, and visitors in courses including, but not limited to, vocational or industrial arts shops or laboratories and chemistry, physics or chemical-physical laboratories, at any time at which the individual is engaged in or observing an activity or the use of hazardous substances likely to cause injury to the eyes.

(a) Activity or the use of hazardous substances likely to cause injury to the eye includes:

1. Working with hot molten metals;

2. Milling, sawing, turning, shaping, cutting, grinding or stamping on any solid material using power equipment;

3. Heat treatment; tempering or kiln firing or any metal or other materials;

4. Gas or electric arc welding;

5. Caustic or explosive materials;

6. Working with hot liquids or solids including chemicals which are flammable, caustic, toxic or irritating.

(2) The boards of public instruction of the several counties may furnish plano safety glasses or devices for students and teachers and shall furnish such equipment for all visitors to such classrooms or laboratories, or may purchase such plano safety glasses or devices in large quantities and sell them at cost to students and teachers, but shall not purchase, furnish or dispense prescription glasses or lenses.

(3) To implement and carry out the purpose of this act the boards of public instruction of the several counties are hereby given authority to promulgate rules and regulations to accomplish the purpose of the law.

(4) "Industrial quality eye protective devices" as used in this act means devices meeting the requirements of the American standard safety code for head, eye, and respiratory protection Z2, 1-1959, promulgated by the American Standards Association, Incorporated.

1665
1980

128

a chauffeur's license

129

What vehicles can you operate legally with a chauffeur's license?

- ☐ airplanes
- ☐ taxis and all vehicles for which an operator's license is required
- ☐ zeppelins
- ☐ frieght trains

20050

129

taxis and all vehicles for which an operator's license is required

130

THE NEXT FRAMES WILL REVIEW WHAT YOU HAVE LEARNED IN THIS BOOK.

NO ANSWER NEEDED

GO ON TO THE NEXT FRAME

20051

130

NO ANSWER NEEDED

131

What is the definition of a "motor vehicle" under New York State law?

- ☐ a gas-driven vehicle only
- ☐ a diesel-powered vehicle only
- ☐ a vehicle operated by any power other than muscle power
- ☐ a vehicle that has the motor up front

20052

132

you

133

In New York State, what motor vehicles are subject to the periodic inspection laws:

- ☐ all vehicles
- ☐ all vehicles over 1 year of age
- ☐ all vehicles over 4 years of age or those recently transferred
- ☐ only vehicles that have been transferred

20054

133

all vehicles over 4 years of age or those recently transferred

134

When do registrations expire for passenger cars?

- ☐ January 1
- ☐ January 15
- ☐ January 31
- ☐ February 1

20055

134

January 31

135

Why does New York State demand that every driver be licensed?

- ☐ because the law requires it
- ☐ because it needs money to build roads
- ☐ for the protection of the public
- ☐ to see if everybody who drives can read

20056

135

for the protection of the public

136

May your drivers'license be used by another person?

- ☐ only if he has the same name
- ☐ no
- ☐ only if he has paid half the fee
- ☐ only on weekends

20057

136

no

137

Who must accompany you when you are practicing driving under a learner's permit?

- ☐ a New York State licensed driver at least 18 years of age
- ☐ a licensed driver at least 18 years of age
- ☐ a duly licensed instructor in New York State
- ☐ a police officer from your precinct

20058

137

a New York State licensed driver at least 18 years of age

138

Who must be with you when you appear for the road test for your driver's license?

- ☐ your parent or guardian
- ☐ your high school teacher
- ☐ a New York State licensed driver at least 18 years of age
- ☐ a licensed driver from any state at least 18 years of age

PART IV

SAFETY RULES

On the following pages are general and specific rules for the use of the types of equipment commonly found in industrial arts laboratories. Each set of rules is on a separate sheet so that they can be easily reproduced and made available to students, posted, etc. Changes and additions should be made by the individual teacher, if necessary, in order to meet the needs of particular situations. Schools with graphic arts equipment may wish to print rules on heavy stock for posting by each machine or area.

Certain organizations and manufacturers have safety operation rules which are either free or available at nominal cost. Since safety must be "sold" to students, the most effective ways available should be used.

1981
0861

138

a New York State licensed driver at least 18 years of age

139

What is required in the road test for a driver's license?

- ☐ knowledge of the English language
- ☐ one-handed driving
- ☐ driving skill
- ☐ dodging any tricks the examiner pulls

20060

139

driving skill

140

How many total hours of practice driving should you have before you take your road test?

- ☐ 4 hours
- ☐ 10 hours
- ☐ 12 hours
- ☐ 20 hours

20061

140

20 hours

141

For what period of time are drivers' licenses normally issued?

- ☐ 3 months
- ☐ 6 months
- ☐ 1 year
- ☐ 3 years

20062

141

3 years

142

How old must you be before you can obtain a junior operator's license?

- ☐ sixteen
- ☐ seventeen
- ☐ eighteen
- ☐ twenty-one

20083

142

sixteen

143

In what county, outside New York City, is a junior operator's license not valid?

- ☐ Nassau
- ☐ Suffolk
- ☐ Sullivan
- ☐ Westchester

20064

143

Nassau

144

To obtain a regular operator's license a person under 18 years of age must:

- ☐ write a letter to the Commissioner of Motor Vehicles
- ☐ show that he has above average skills
- ☐ pass an approved driver training course at a junior or senior high school that he attends
- ☐ pass the driving test the first time

20065

144

pass an approved driver training course at a junior or senior high school that he attends

145

What is the fee for a learner's permit?

- ☐ fifty cents
- ☐ seventy-five cents
- ☐ one dollar
- ☐ two dollars

What is the application fee for a driver's license?

- ☐ $1.00
- ☐ $2.00
- ☐ $3.00
- ☐ $5.00

145

fifty cents

$2.00

146

When applying for a license, who must bring proof of date of birth?

- ☐ people of all ages
- ☐ only those people under twenty-one years of age
- ☐ only those people over twenty-one years of age
- ☐ only those people applying for a Junior Operator's license

20067

146

people of all ages

147

END OF BOOK 23 DRIVING REGULATIONS, PART I

20068

AUTO MECHANICS COURSE

POST-TEST BOOK 23: DRIVING REGULATIONS, PART I

A BASIC SYSTEMS PROGRAM

20069

General Safety Rules for All Industrial Arts Areas

1. Secure approval from your teacher for all work that you plan to do.
2. Report all injuries to your teacher, however slight.
3. Wear proper eye protection as required by Florida law.
4. Wear appropriate clothing. Clothes should not be loose to catch in moving parts. Roll up sleeves, take off or tuck in ties, remove rings, watches and jewelry.
5. Keep hair away from moving parts. Wear a hair net if hair is longer than conventional length.
6. Observe limit lines around machines and traffic lanes.
7. Be alert to help others spot safety hazards and improper procedures.
8. Report to your teacher any equipment that does not work properly, makes odd noises, etc.
9. Be careful in handling and storing materials.
10. Keep your work area and machines you use clean, but don't use your hand to brush away chips. Brushes are available for all jobs.
11. Do not allow chips and litter to collect on the floor.
12. Wipe up spilled liquids at once and use an absorbent material if necessary to prevent slipping.
13. Keep doors and drawers closed.
14. Place oily rags and other combustible materials in safety containers.
15. Get help in handing long or heavy pieces of material.
16. Learn and follow instructions to follow in case of fire, hurricane, or other emergency.
17. Develop a receptive attitude toward safety instruction and cooperate in all matters related to safety in the school shop and elsewhere.

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

The amount you must pay when you apply for a driver's license is:

- ☐ $1.00
- ☐ $2.00
- ☐ $3.00
- ☐ $4.00

2

Before you take your road test you should take time for practice driving.

The recommended time is:

- ☐ ten hours
- ☐ a maximum of twelve hours
- ☐ twenty hours
- ☐ twenty-four hours at intervals during one week

3

If you own a car, your registration expires:

- ☐ every ten years, or when you sell the car
- ☐ every year on January 1
- ☐ every year on January 31
- ☐ every three years

4

You can not apply for a driver's license unless:

- ☐ you supply evidence of car ownership
- ☐ you show ability to handle a car in heavy traffic
- ☐ you show proof of date of birth
- ☐ you are 21 years of age, or older

5

Drivers' licenses are normally issued for a time period of:

- ☐ 1 year
- ☐ 2 years
- ☐ 3 years
- ☐ 4 years

6

It is a New York State law that every driver must be licensed:

- ☐ because cars are powerful and difficult to handle safely
- ☐ because driving courses are required in high school
- ☐ for the protection of the public
- ☐ for additional state money that comes from license fees

7

According to New York State law, a "motor vehicle" is:

- ☐ any vehicle that is manufactured in a factory
- ☐ only gas and diesel powered vehicles
- ☐ any vehicle operated by power that is not muscle power
- ☐ only vehicles with the motor located up front

8

A junior driver's license can not be used in New York City or:

- ☐ counties near New York City
- ☐ Nassau County
- ☐ Rochester, Syracuse, and Albany
- ☐ Westchester County

9

When you are practicing driving under a learner's permit, there must be someone in the car with you.

This person must be:

- ☐ a member of your family
- ☐ a licensed driver at least 18 years of age
- ☐ a driver with a New York license who is at least 18 years old
- ☐ a licensed instructor from a driving school

10

What motor vehicles in New York State must be inspected periodically?

- ☐ all vehicles regardless of age
- ☐ all vehicles more than two years old
- ☐ all vehicles over 4 years of age; or those recently transferred
- ☐ only vehicles which are transferred

VT 013 146
Auto Mechanics Course. Book 24: Driving Regulations, Part II.

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ABSTRACT - This combination study guide and workbook for a basic auto mechanics course on driving regulations, Part II was developed under the Manpower Development and Training Act of 1962. Contents are presented in a very simple programed format providing questions and answers for students. Illustrations, diagrams, a pre-test, and a post-test are included. This document is one in a series of related documents available in this issue as VT 013 123-VT 013 146, and part of a series of programed remedial materials developed by Basic Systems, Inc. (GB)

VT 013 146

ED0 56238

BOOK 24

(C1)

AUTO MECHANICS COURSE

BOOK 24: DRIVING REGULATIONS, PART II

A BASIC SYSTEMS PROGRAM

VT013145

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Task Analysis Reference
1

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AUTO MECHANICS COURSE

BOOK 24: DRIVING REGULATIONS, PART II

Developed under the Manpower Development and Training Act of 1962 (PL 87-415), contract No. MDS 24-64 between the Secretary of Labor and Young Men's Christian Association of Greater New York, by Basic Systems Incorporated.

20077

AUTO MECHANICS COURSE

PRE-TEST BOOK 24: DRIVING REGULATIONS, PART II

A BASIC SYSTEMS PROGRAM

20078

1

The length of time it takes to stop a car is always determined by:

- ☐ the New York Bureau of Vehicle Standards
- ☐ brakes, road surface and weather
- ☐ the time since your car was last inspected
- ☐ a clean windshield

2

If you are following a car that is going 40 mph, your car should be:

- ☐ as close to the car ahead as possible
- ☐ as far away as the traffic allows
- ☐ closer than two car lengths from the car ahead
- ☐ at least four car lengths from the car ahead

3

When you are following a car on a highway or turnpike, the rule to remember is:

- ☐ drive faster than trucks and buses
- ☐ look out for litterbugs
- ☐ never lose sight of the car ahead
- ☐ don't follow close behind the car ahead — don't "tailgate"

20079

Safety Rules for Lifting and Handling Materials

1. Do not lift objects beyond your strength. Get help or use a lifting device. Do not risk back and abdominal injuries.

2. Check your footing before lifting. Feet should be placed firmly, not more than about 12" apart, with the weight of the body directly over the soles of the feet. The object to be lifted must be kept as close to the center of gravity of the body as possible. Keep arms and body straight. Lift with the legs, not the back.

3. Long objects should be carried with the front end down. Preferred practice is to have a person on each end.

4. Be careful of slivers when handling lumber, and get medical aid if you get a sliver in your hand. Wear gloves to handle rough materials.

5. Be careful not to set heavy objects down on your toes.

6. Pile or stock materials so that they do not slip, crush, or fall.

1983

4

If you must signal for help on the New York State Thruway, you should:

- ☐ flash your headlights on and off
- ☐ flash your brake lights on and off
- ☐ tie a white cloth to the left door handle of the car
- ☐ use a red cloth to flag down a passing car

5

What does it mean when the line in the middle of a highway is a broken line?

- ☐ the painting job isn't finished yet
- ☐ never drive over the line
- ☐ you may cross the line to pass if traffic permits
- ☐ the road is an interstate highway

6

Taillights on a car must be bright enough to be seen at night from a distance of:

- ☐ 400 feet
- ☐ 500 feet
- ☐ 600 feet
- ☐ up to one mile

7

At intersections, the rule about right of way is:

- ☐ trucks have the right of way before cars at all times
- ☐ all vehicles must stop at intersections
- ☐ vehicles making turns have the right of way
- ☐ cars on the right have the right of way

8

What is the distance needed to stop a car going sixty miles an hour?

- ☐ 100 feet
- ☐ 400 feet
- ☐ 500 feet
- ☐ 527 feet

20081

284 OF 327

ED

056 238

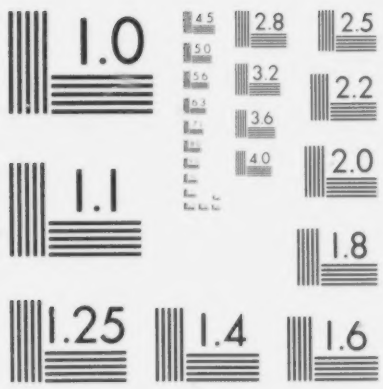

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

9

When you are overtaking a car at night, switch your headlights to low beam:

- ☐ when the car is twenty feet away
- ☐ if the car ahead slows down
- ☐ when the car ahead is 200 feet away
- ☐ when you can see the taillights on the car ahead

10

The headlights on a car must light up the road for a distance of:

- ☐ at least one mile
- ☐ about 250 feet
- ☐ at least 350 feet
- ☐ 1,000 feet

284

20082

1

IN BOOK 23 YOU LEARNED ABOUT LICENSES, REGISTRATIONS, AND FEES.

NOW YOU ARE GOING TO LEARN SOME FACTS ABOUT DRIVING A CAR THAT WILL HELP YOU PASS THE WRITTEN TEST AND THE ROAD TEST.

NO ANSWER NEEDED
GO ON TO NEXT PAGE

20083

1

NO ANSWER NEEDED

2

You are driving this car:

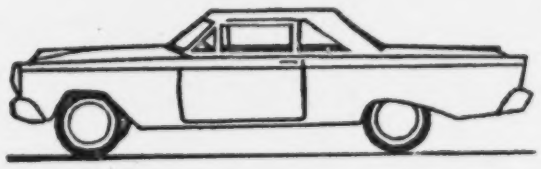

To make the car stop, you press the brake.

The brakes work well, but your stopping time might be affected by other things such as: (CHECK TWO)

- ☐ radio reception
- ☐ road surface
- ☐ daylight
- ☐ weather conditions

20084

2

road surface

weather conditions

3

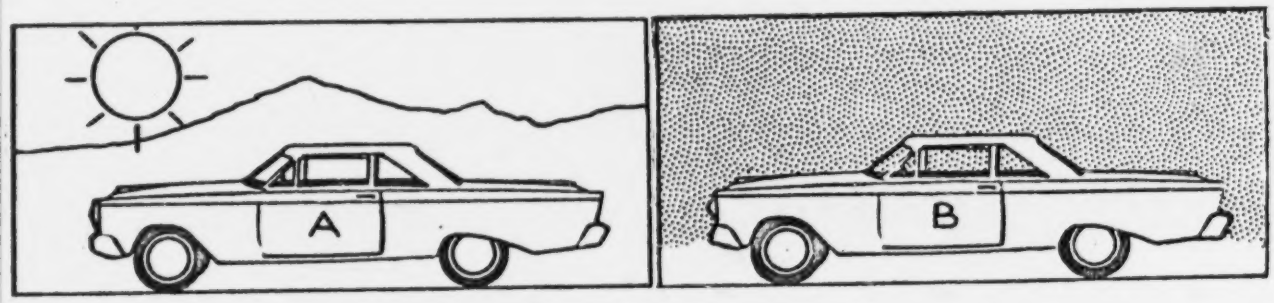

The brakes on both cars are good.

Which car will take less time to stop?

- ☐ car A
- ☐ car B

20085

3

car A

4

When the road you are driving on is slippery, you need:

- ☐ less time to stop your car
- ☐ more time to stop your car
- ☐ power brakes to stop your car without skidding

20086-*

4

more time to stop your car

5

What conditions determine the length of time in which you can stop your car?

- ☐ windshield should be clean
- ☐ brakes, road surface and weather
- ☐ driver may get sleepy
- ☐ car must be periodically inspected

20087

5

brakes, road surface and weather

6

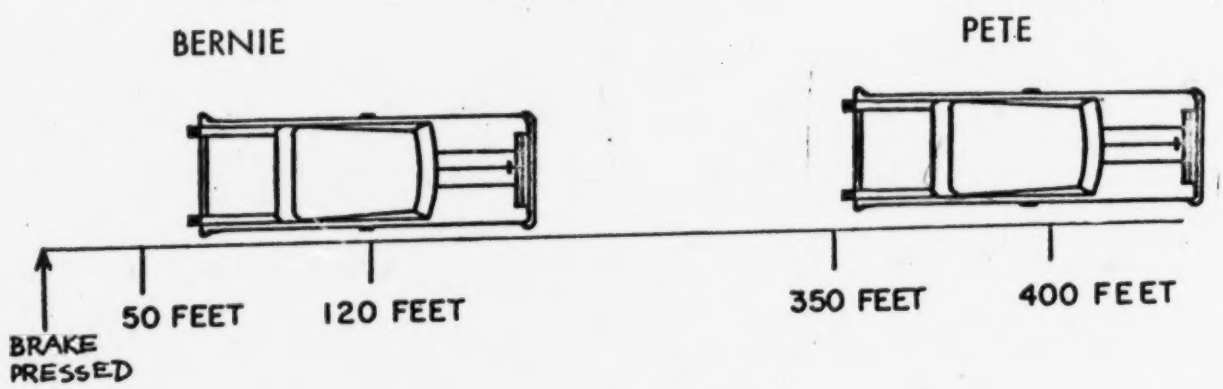

Bernie was going 40 miles per hour.

Pete was going 60 miles per hour.

Both drivers put on their brakes at the arrow (BRAKE PRESSED).

How far did Bernie's car at 40 mph go before it stopped? _____ feet

Pete's car at 60 mph went _____ feet.

20088

General Safety Rules for Hand Tools

1. Select the proper size and type of tool for the job.
2. Make sure cutting tools are sharp and that all tools are in good condition.
3. Keep your hands clean.
4. Handle edged and pointed tools with care. Point edges away from yourself and others while carrying and using.
5. Secure small work with a vise or clamp.
6. Never carry cutting tools in your pocket.
7. Lay tools near the center of the bench to keep them from rolling off or being knocked off.
8. Do not use tools for other than the purposes for which they were intended.
9. Know and follow the correct way to use each tool.
10. Wear eye protection when eye hazards exist.

6

120 (feet)

400 (feet)

7

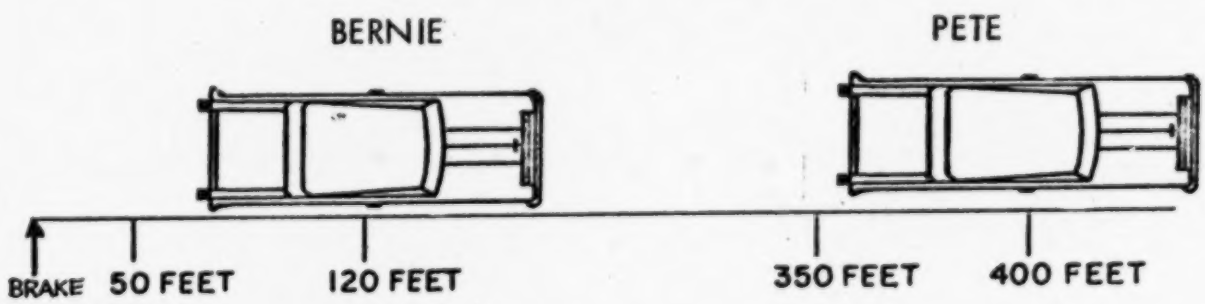

Both drivers put on their brakes at the arrow.

Was Pete going faster than Bernie?

- ☐ yes
- ☐ no

Which car stopped first?

- ☐ Pete's car
- ☐ Bernie's car

20089

7

yes

Bernie's car

8

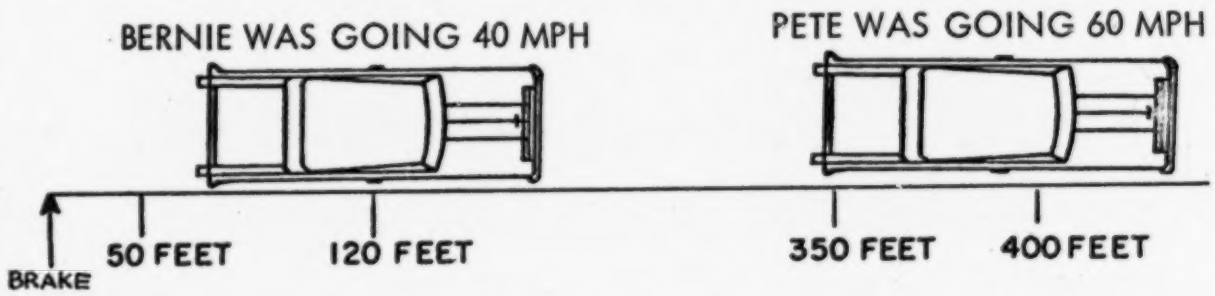

MATCH the following:

A. Bernie's car

B. Pete's car

1. _____ stopped after 50 feet
2. _____ stopped after 400 feet
3. _____ stopped after 120 feet

20090

8

1. —

2. B

3. A

9

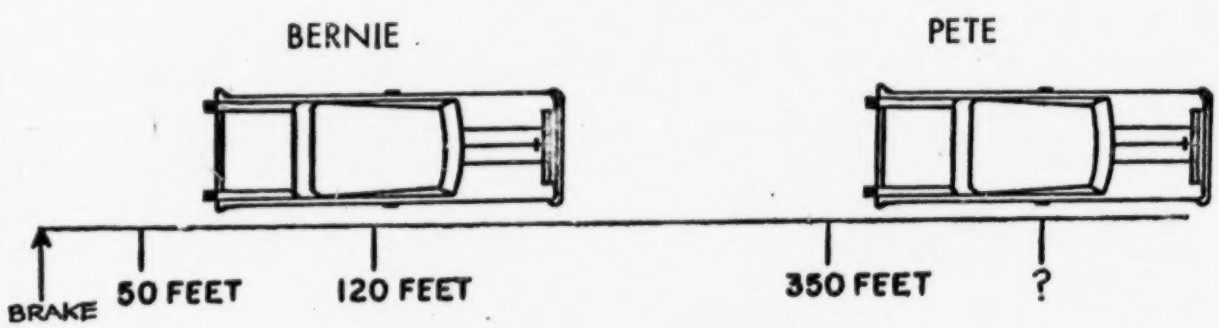

Bernie was going 40 mph and stopped after 120 feet.

Pete was going 60 mph and stopped after:

- ☐ 400 feet
- ☐ 500 feet
- ☐ 600 feet

9

400 feet

10

at 40 mph: you stop after 120 feet

at 60 mph: you stop after 400 feet

You are driving down the street and see a stalled pie truck blocking the street 300 feet ahead.

Your car is going to be covered with pie if you're driving:

- ☐ 20 mph
- ☐ 40 mph
- ☐ 60 mph

20092

10

60 mph

11

MATCH the following:

A. 40 mph

B. 60 mph

1. _____ 120 feet to stop

2. _____ 400 feet to stop

3. _____ 500 feet to stop

20093

11

1. A

2. B

3. —

12

Your car is going 60 mph. You put on the brakes. How far will your car go before it stops? _____

If you are doing 40 mph, you need _____ feet to stop.

20094

12

400 feet

120 (feet)

13

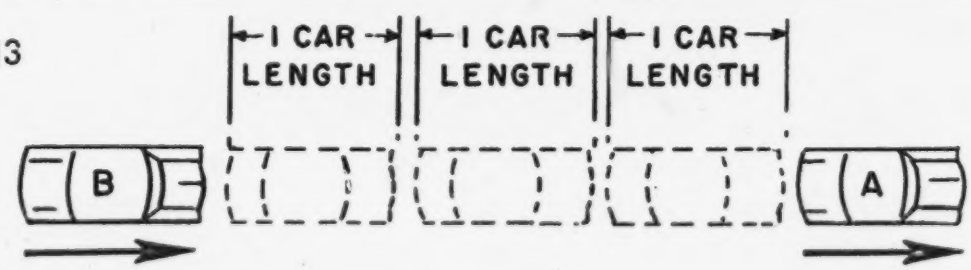

Car B is 3 car lengths behind car A.

Which diagram below shows that car B is 4 car lengths behind car A? ____

1 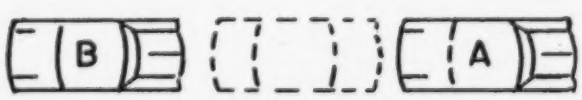

2 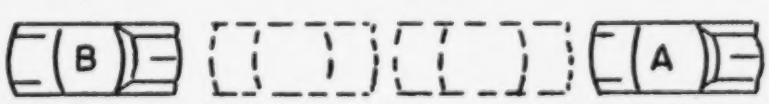

3 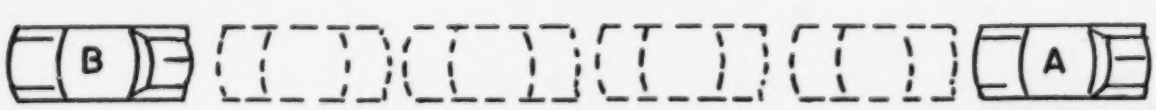

20095

13

3

14

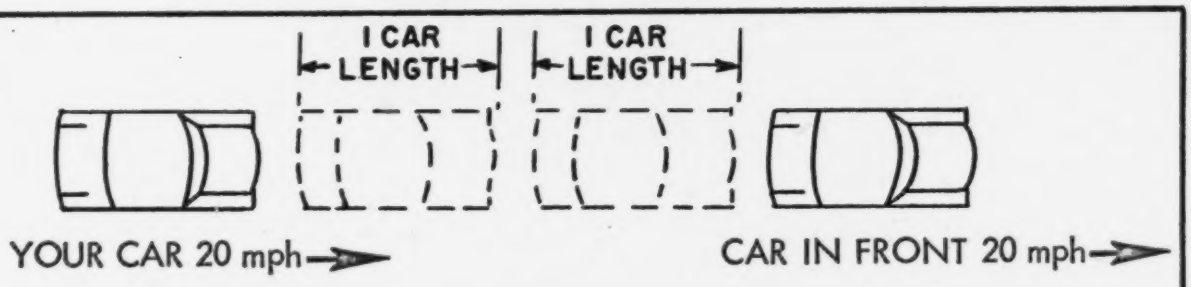

When you are driving at a speed of 20 mph, you should stay at least:

- ☐ one car length behind the car in front of you
- ☐ two car lengths behind the car in front of you
- ☐ three car lengths behind the car in front of you

20096

14

two car lengths behind the car in front of you

15

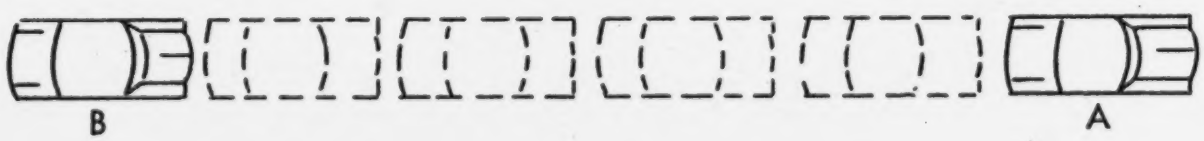

Car A is going 40 mph. Car B is going the same speed.

CIRCLE the number of car lengths that should be between car A and car B:

1

2

3

4

5

10

20097

15

4

16

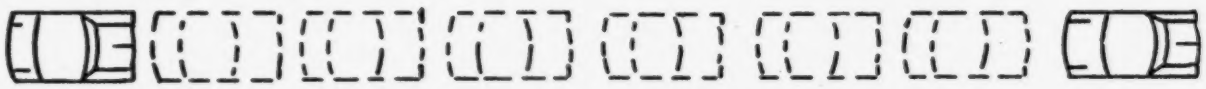

Both cars are doing 60 mph. How many car lengths are between the two cars? _____

200988

General Safety Rules for Power Tools

1. Do not use any machine until you receive instruction in its use and have received the teacher's permission.

2. Ask your teacher to check your setup.

3. Check adjustments before applying power.

4. Make sure others are clear before applying power.

5. Make sure guards are in place and functioning properly.

6. Start and stop your own machine. Remain with the machine until it has come to a dead stop.

7. Stay clear of machines being operated by others. Do not help unless asked.

8. Notify your teacher of improper operation, breakage, etc.

9. Disconnect power before oiling, cleaning, or adjusting.

10. Allow a minimum of 4" between your hands and saws, cutters, or moving parts.

11. Keep machine tables clear of tools, stock, and other items.

12. Keep the floor area around machines clear of scrap and chips.

13. Give the machine your absolute undivided attention while you are using it. Do not talk to others.

14. Never lean or lounge against any machine.

15. Know and obey all the safety rules for each machine.

16. Wear eye safety devices for all power machine operations. Require all observers to wear eye protection.

17. All power machines must be grounded.

18. If extension cords are used with portable power tools, use only cords with a ground wire.

1985

16

6

17

SPEED	CAR LENGTHS BETWEEN CARS
30 mph _____	3
40 mph _____	4
50 mph _____	5
60 mph _____	6

This chart shows the number of car lengths that you should keep between your car and the car in front of you.

The rule is that the distance should be:

- ☐ 1 car length for every 10 mph
- ☐ 1 car length for every 30 mph
- ☐ 2 car lengths for every 10 mph
- ☐ 2 car lengths for every 30 mph

20099

17

1 car length for every 10 mph

18

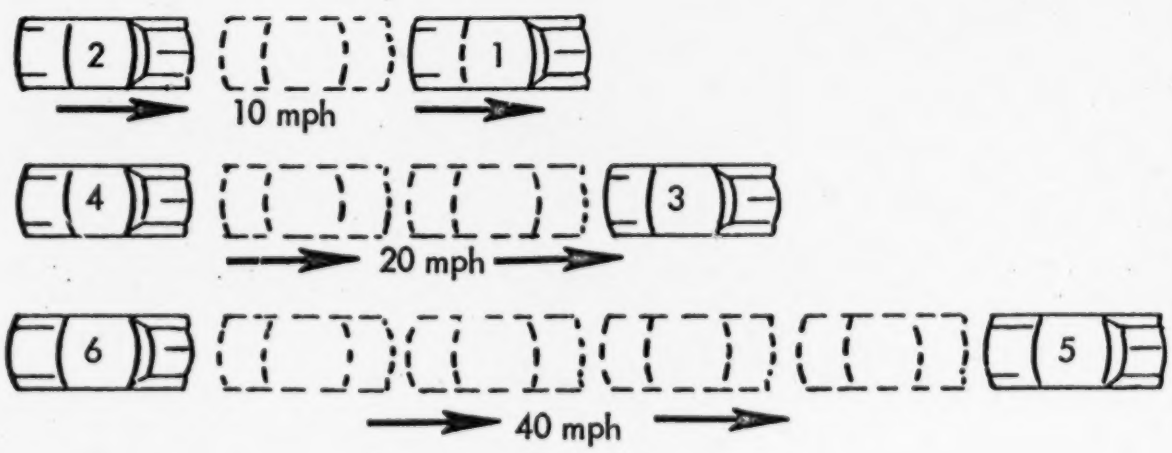

These drivers are keeping the correct distance apart.

Car number 6 is:

- ☐ three lengths behind car 5
- ☐ four lengths behind car 5
- ☐ five lengths behind car 5

20100

18

four lengths behind car 5

19

When you are driving, you should stay at least 1 car length behind the car in front of you for every _____ (how many) mph of your speed.

19

10

20

How many car lengths should you keep between you and the car in front of you if you are going 40 mph?

- ☐ one
- ☐ two
- ☐ four
- ☐ eight

20102

20

four

21

At least how far behind the car in front of you should you drive?

- ☐ 1 car length for every 10 mph
- ☐ 1 car length for every 40 mph
- ☐ 2 car lengths for every 10 mph
- ☐ 2 car lengths for every 40 mph

20103

21

1 car length for every 10 mph

22

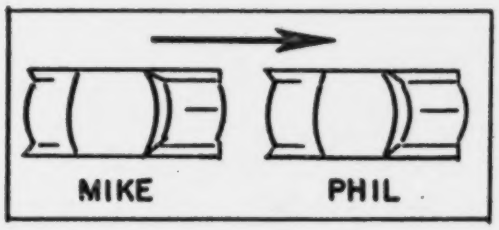

A

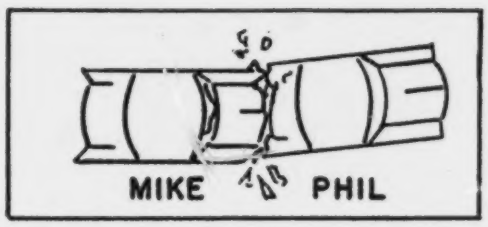

B

Picture A shows Mike following Phil on the highway.

Picture B shows what happened when Phil had to stop suddenly.

Mike crashed into Phil because Mike was too:

- ☐ close
- ☐ far away
- ☐ sleepy

20104

22

close

23

Following too closely to the car in front of you is called TAILGATING.

ALL CARS ARE GOING 20 MPH

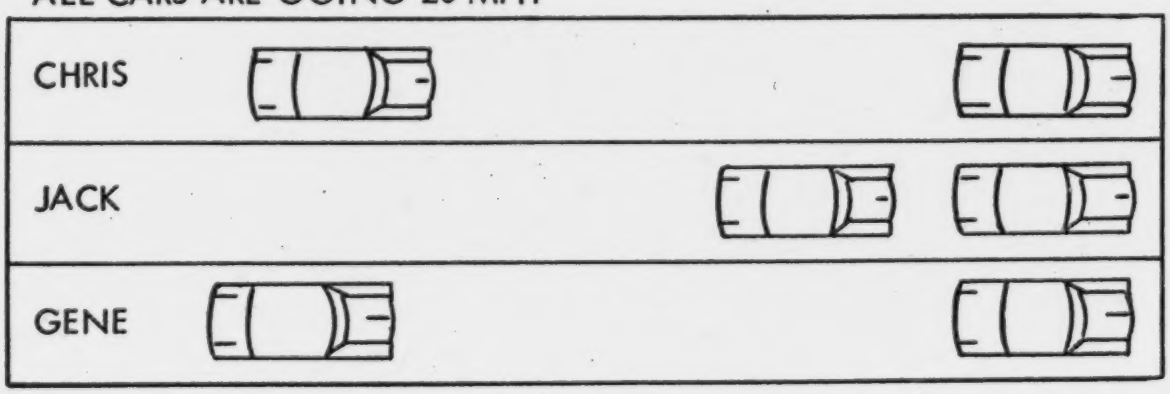

Which of the above drivers is guilty of tailgating?

- ☐ Chris
- ☐ Jack
- ☐ Gene

20105

23

Jack

24

Most highway accidents are caused by drivers who drive too closely to the car in front of them.

The cause of most accidents on the highway is:

- ☐ driving while intoxicated
- ☐ no headlights
- ☐ tailgating

24

tailgating

25

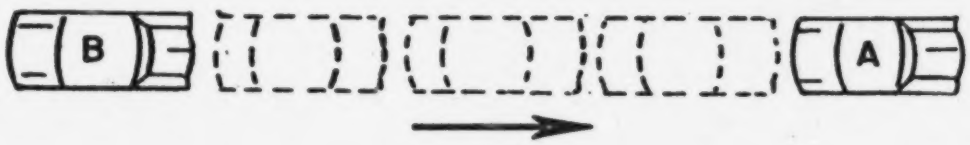

The cars in the drawing are going 60 mph on the New York Thruway.

Which car is tailgating? _____

How many car lengths should be between the two cars? _____

20107

25

car B

6

26

What should you consider when you are following another car on a highway?

- ☐ do not follow too closely; in other words, do not "tailgate"
- ☐ try to follow at exactly the same speed
- ☐ watch out for littering
- ☐ make sure you don't lose sight of the car

20108

Safety Rules for the Drill Press

1. Select the correct size and type of drill and be sure it is sharp.
2. Select the correct speed for the size drill and type of material. POWER OFF
3. Tighten drill securely in the chuck.
4. Remove the chuck key
5. Locate work carefully and clamp it securely in place or use a drill press vise if appropriate.
6. Determine whether a coolant should be used.
7. Double check setup before applying power.
8. Operate feed handle so that drill cuts evenly into the work.
9. Ease up on feed pressure when drill begins to break through.
10. Back drill out of the hole immediately.
11. Stop the drill press before attempting to remove chips. Use a brush, not your hand.
12. If the work comes loose or is seized by the drill, step quickly away. Shut off power if you can do so without danger to yourself. Summon your teacher.
13. Do not leave the machine until it has stopped.
14. Clean up the work table and the floor and return drills, coolants, clamps, etc. to their proper places.

1986

26

do not follow too closely; in other words, do not "tailgate"

27

A

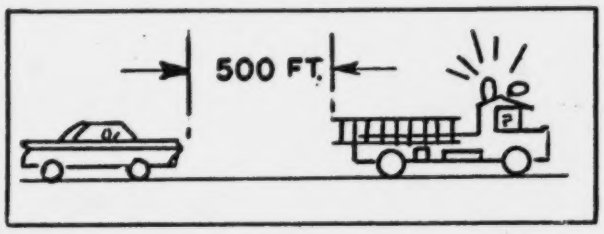

B

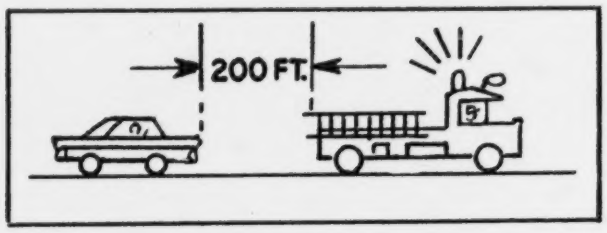

If you follow a fire engine in the city, you should keep at least 200 feet behind it. In rural areas, you should keep 500 feet between your car and the fire engine.

In which picture is the driver keeping the correct distance behind a fire engine for a rural (country) area?

☐ picture A

☐ picture B

20109

27

picture A

28

"200 feet in the city; 500 feet in rural areas"

The above statement tells how far you must:

- ☐ park from fire hydrants
- ☐ stay in front of police cars
- ☐ stay behind fire engines

20110

28

stay behind fire engines

29

You are driving in Brooklyn. A fire engine is speeding ahead of you.

How far should you stay behind the engine?

- ☐ 200 feet
- ☐ 500 feet

20111

29

200 feet

30

"200 feet in the city; 500 feet in rural areas"

If you follow a fire engine, you must stay farther back:

- ☐ in the city
- ☐ in the country
- ☐ in an emergency

20112

30

in the country

31

A fire engine is on its way to a fire in a rural area.

How far behind the engine should you stay? _____ feet

When following a fire engine in the city, you should keep _____ feet behind it.

31

500 (feet)

200 (feet)

32

How closely may you follow a fire engine on its way to a fire?

- ☐ 200 feet in both city and rural areas
- ☐ 500 feet in both city and rural areas
- ☐ 200 feet in the city; 500 feet in rural areas
- ☐ 500 feet in the city; 200 feet in rural areas

20114

32

200 feet in the city; 500 feet in rural areas

33

There's no law that says you must follow a fire engine, but you must give a fire engine the right of way.

Right of way gives a fire engine:

- ☐ a police escort to all fires
- ☐ a clear lane through traffic
- ☐ clearance to drive on the sidewalk

20115

33

a clear lane through traffic

34

Official emergency vehicles have the right of way on any highway or street.

CIRCLE the emergency vehicles in the list below:

taxicab

bicycle

ambulance

moving van

fire engine

police squad car

35

pull over and stop so an emergency vehicle can pass

36

Who must give an emergency vehicle right of way?

- ☐ only truck drivers
- ☐ all drivers except politicians
- ☐ all drivers
- ☐ only pedestrians and taxicab drivers

20118

Safety Rules for the Wood Lathe

1. Ask your teacher to check your stock before your mount it in the lathe. Glued-up material should be closely inspected.

2. On larger pieces, remove corners (arrises) to reduce turning time and make turning safer.

3. Mount stock properly in the lathe and adjust tool rest.

4. Rotate the stock by hand before applying power.

5. Set lathe at slowest speed (See note 1 below)

6. Have your teacher check your setup.

7. Select proper turning tools and make sure they are sharp.

8. Stand to one side when starting the motor.

9. Stop frequently to check your work and move the tool rest to within 1/8" of work.

10. Never caliper or touch stock when rotating.

11. Remove tool rest when sanding or finishing.

12. Use only small rags folded into pads for finishing and polishing--never use long pieces of cloth.

13. When finished working, set the machine at its slowest speed, clean up the area and return all tools and accessories to their places.

Special Instructions for Spindle Turning

14. Make sure centers are properly imbedded in the stock.

15. Use oil or beeswax on the dead center.

16. Make sure tailstock is clamped firmly.

17. Rough stock down to cylindrical form at slow speed.

18. Check tail stock frequently for overheating.

19. Remove live center when finished.

(Note 1: The spindle speed of lathes with continuously variable speed can be changed only when the lathe is running. Such machines should be returned to the lowest speed before stopping. Change speeds slowly. Abrupt speed changes can throw the work out of the lathe or cause the faceplate to come off of the spindle.)

(more)

1987

36

all drivers

37

When you see or hear a vehicle with a flashing red light on, siren blowing or bell ringing, what should you do?

- ☐ give it the right of way
- ☐ speed up and drive on
- ☐ stop in your lane
- ☐ stop and direct traffic, if there is no police officer

20119

37

give it the right of way

38

What conditions determine the length of time in which you can stop your car?

- ☐ windshields should be clean
- ☐ brakes, road surface and weather
- ☐ driver may get sleepy
- ☐ car must be periodically inspected

20120

38

brakes, road surface and weather

39

You can stop your car in 400 feet when you go 60 mph.

You can stop in 120 feet when you go:

- ☐ 20 mph
- ☐ 30 mph
- ☐ 40 mph
- ☐ 50 mph

20121

39

40 mph

40

You should stay at least 1 car length behind the car in front of you for every:

- ☐ 5 mph
- ☐ 10 mph
- ☐ 15 mph
- ☐ 20 mph

20122

40

10 mph

41

200 feet in a city and 500 feet in a rural area are the distances you must:

- ☐ stay behind an ambulance
- ☐ stay in front of an ambulance
- ☐ stay behind a fire engine
- ☐ stay in front of a fire engine

20123

41

stay behind a fire engine

42

If you are driving and hear a siren from an emergency vehicle:

- ☐ give the vehicle the right of way
- ☐ speed up to stay close behind the fire engine
- ☐ speed up and drive home
- ☐ stop and direct traffic

20124

42

give the vehicle the right of way

43

It will take you 400 feet to stop your car if you are going:

- ☐ 40 mph
- ☐ 60 mph
- ☐ any speed over the speed limit

20125

43

60 mph

44

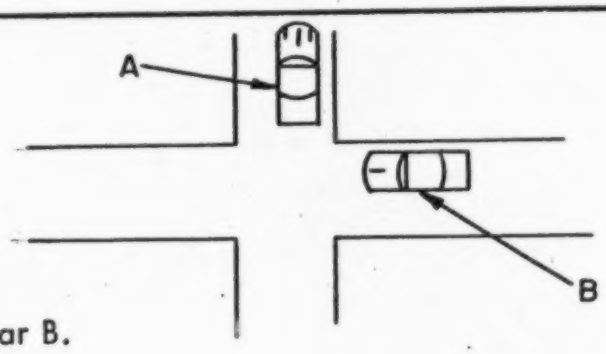

Car A is on the right of car B.

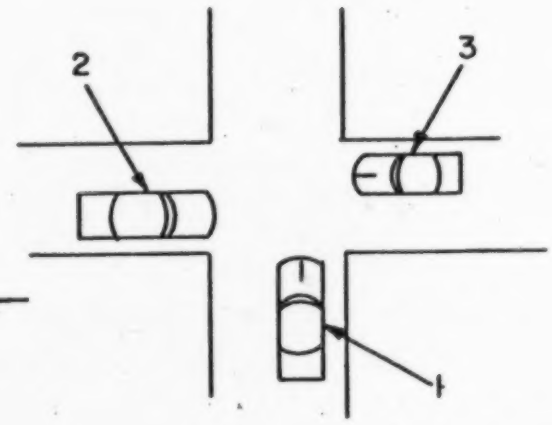

Which car is on the right of car 1? ____

20126

44

car 3

45

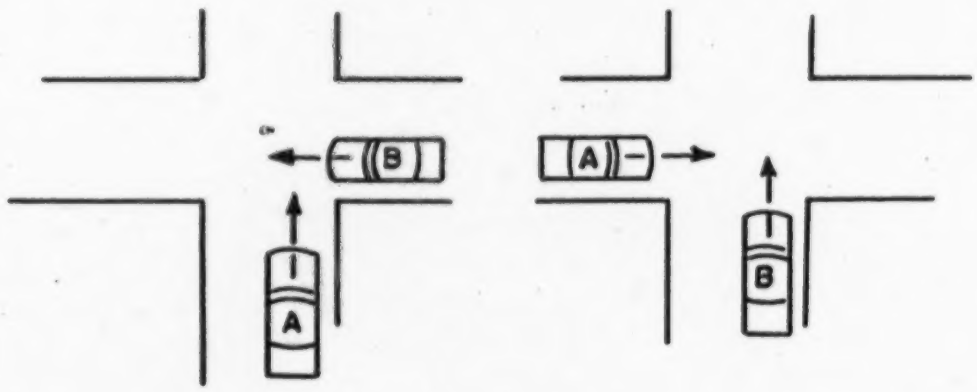

The cars labeled "B" have the right of way in the pictures above.

When you're driving, you give right of way to:

- ☐ cars to your left
- ☐ cars to your right
- ☐ cars that speed through intersections

20127

45

cars to your right

46

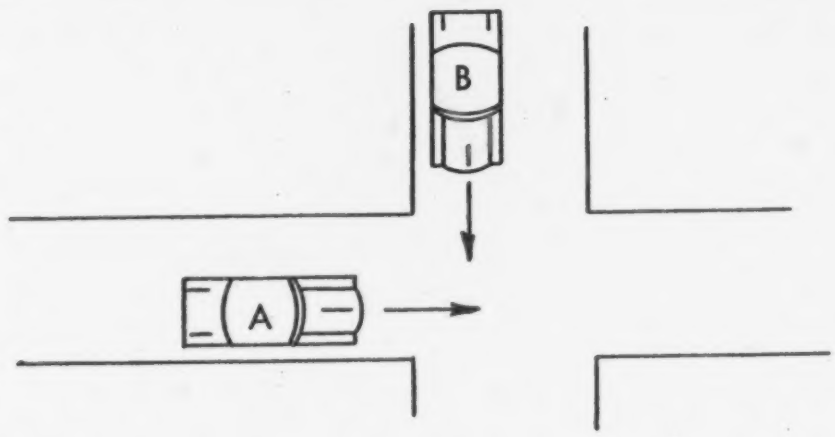

Which car has the right of way here?

- ☐ car A
- ☐ car B

20128

Special Instructions for Faceplate Turning

20. Stock should be cut to circular form on handsaw or jig saw.

21. Select proper size and style of faceplate.

22. Select proper size and number of screws.

23. Drill the correct size holes and set screws in tight.

24. Ask teacher to double check faceplate mounting.

25. Work should be rotated by hand after mounting and should not be off center.

26. Start at slowest speed.

27. Keep an accurate check on depth to avoid running the tool into the mounting screws.

28. Inspect mounting screws and backing block frequently.

29. If you are turning outboard with an outboard turning stand, be careful not to kick or bump the stand.

30. Never turn large diameter work at high speed.

46

car A

47

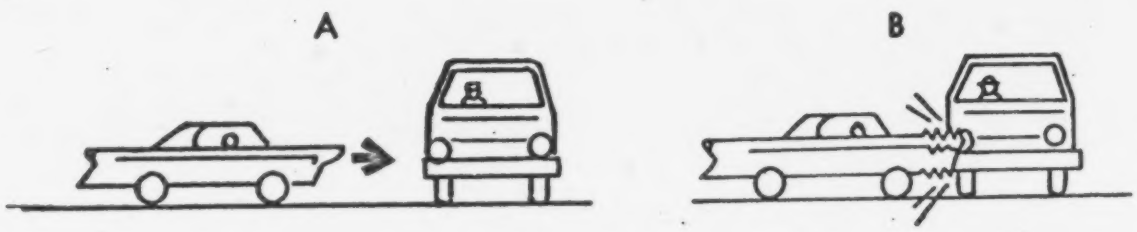

At intersection A the truck driver is letting the car (on his right) pass.

At intersection B there's an accident because the truck driver forgot about:

- ☐ turning on his lights
- ☐ right of way
- ☐ making a right turn

20129

47

right of way

48

What is the general rule with regard to right of way at intersections?

- ☐ The car going straight ahead has the right of way.
- ☐ The car on the main road has the right of way.
- ☐ The car on the right has the right of way.
- ☐ The car making a turn has the right of way.

20130

48

The car on the right has the right of way.

49

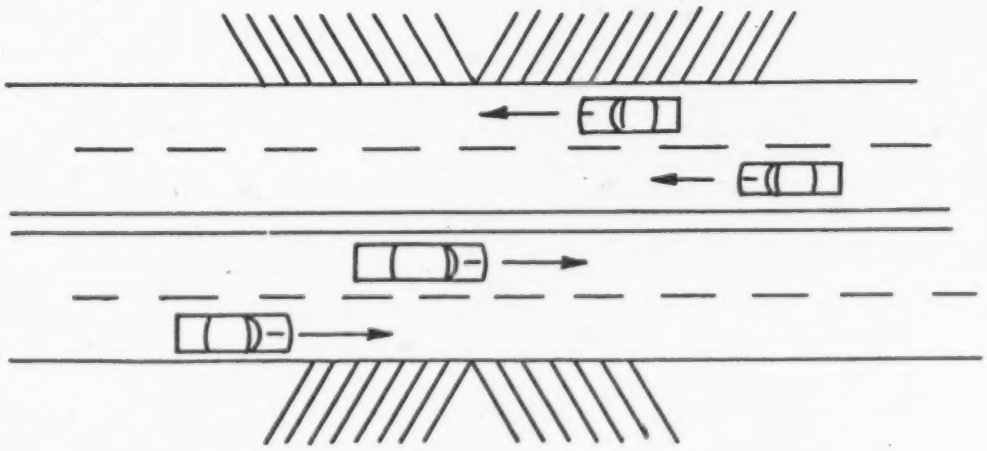

Above is a picture of a four-lane highway.

Which line should <u>never</u> be crossed by a car?

☐

☐

20131

49

50

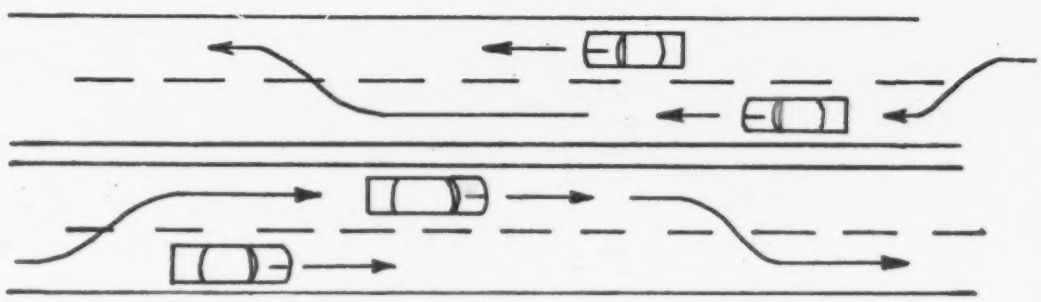

A broken line:

- ☐ may be crossed when traffic permits
- ☐ should never be crossed

20132

50

may be crossed when traffic permits

51

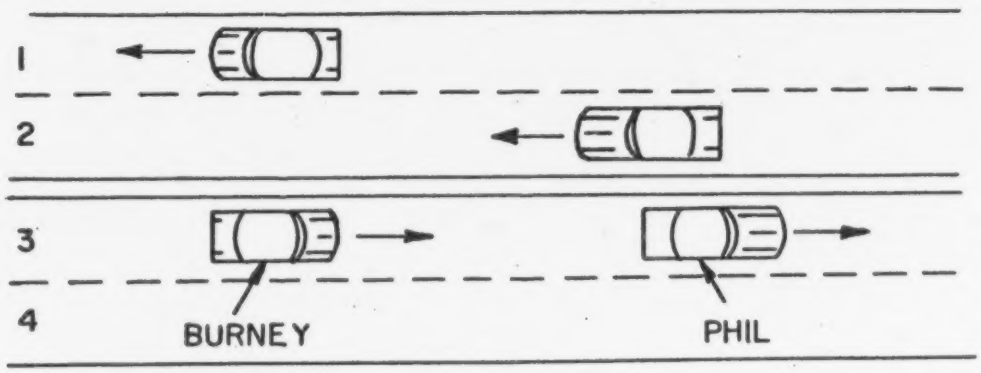

Burney wants to drive in lane 4. Is this OK?

- ☐ yes
- ☐ no

Phil would like to drive into lane 2. May he do that?

- ☐ yes
- ☐ no

20133

51

yes

no

52

MATCH the following:

A. broken line

B. double solid line

C. garage line

1. _____ may be crossed when traffic permits

2. _____ should never be crossed

20134

52

1. A

2. B

53

1. a double solid line

2. a broken line

The line on a highway that may never be crossed is line number _____ .

20135

53

1

54

What does a broken line painted on the highway mean?

- ☐ You must not cross it at any time.
- ☐ You may cross it to pass, provided traffic permits.
- ☐ You may cross it to pass, even on hills.
- ☐ You must not cross it on weekends.

54

You may cross it to pass, provided traffic permits.

55

What does it mean when the painted line on the highway is a double solid line?

- ☐ You may cross it at any time.
- ☐ You may cross it only if you are on the main road.
- ☐ You must never cross it.
- ☐ You must never cross it, unless traffic permits.

20137

55

You must never cross it.

56

A blowout can be dangerous, especially if you are driving fast.

Blowouts can cause:

- ☐ accidents
- ☐ dim taillights
- ☐ higher speeds

20138

Safety Rules for Disc and Belt Sanders (Non-Portable)

1. Make sure that disc and/or belt is not torn or loose.
2. Make any adjustments before turning on the power.
3. Don't attempt to sand pieces which are too small to hold safely.
4. Sand only on the "down" side of the disc.
5. Keep work moving across the disc or belt.
6. Use moderate pressure to avoid burning the work and possibly having the work slip out of your hands.
7. Keep hands away from the abrasive surfaces.
8. Make sure dust pickup is working if machine is so equipped.
9. Allow machine to stop before leaving it.
10. Clean up the area.

1989

56

accidents

57

When a tire blows out, you should take your foot OFF the gas and hold the steering wheel STEADY.

Which driver is doing the things he should after a blowout?

- ☐ Barrie
- ☐ George

57

George

58

If you get a blowout when you are driving your car, you should:
(CHECK TWO)

- ☐ step on the gas
- ☐ take your foot off the gas
- ☐ hold the steering wheel steady
- ☐ turn the steering wheel

20140

58

take your foot off the gas

hold the steering wheel steady

59

You should: 1. take your foot off the gas

2. hold the steering wheel steady

when you have:

- ☐ an accident
- ☐ a blowout
- ☐ a tire change

20141

59

a blowout

60

How should you handle your car to prevent an accident when you have a blowout?

- ☐ Blink your lights to warn other drivers.
- ☐ Slam on your brakes to stop.
- ☐ Take your foot off the gas and hold the steering wheel steady.
- ☐ Warn other drivers by blowing your horn.

20142

60

Take your foot off the gas and hold the steering wheel steady.

61

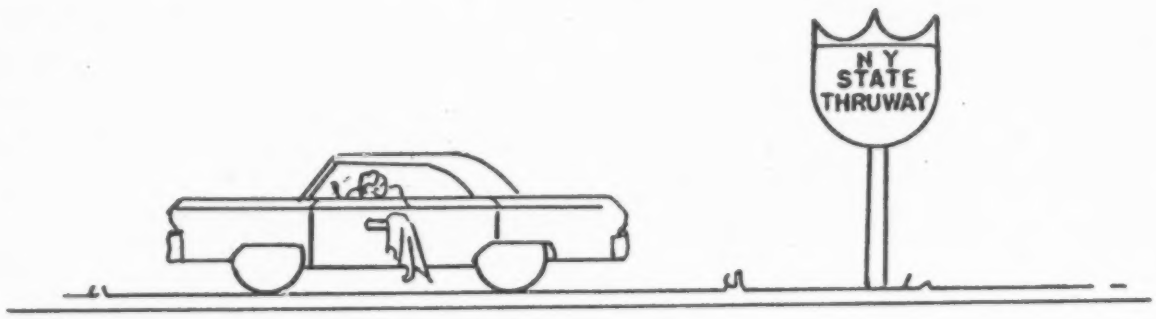

If you have an accident or need help, there is a way to signal for help.

The driver shown above has signaled for help by:

- ☐ putting a flare behind his car
- ☐ tying a white cloth onto the left door handle
- ☐ turning on his parking lights

61

tying a white cloth onto the left door handle

62

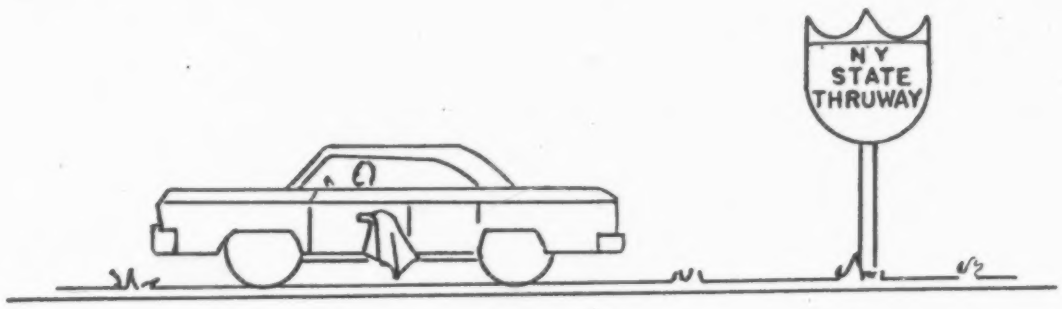

This driver has tied a white cloth onto his left door handle to signal:

- ☐ for help
- ☐ that he is taking a nap

The sign in the picture tells you that this way of signaling is used on:

- ☐ Route 46
- ☐ the New York Thruway
- ☐ the Penn-Can highway

20144

62

for help

the New York Thruway

63

To signal for help on the New York Thruway, you should:

- ☐ blink your lights
- ☐ put a flag over the trunk
- ☐ put a flare behind the car
- ☐ tie a white cloth to the left door handle of your car

20145

63

tie a white cloth to the left door handle of your car

64

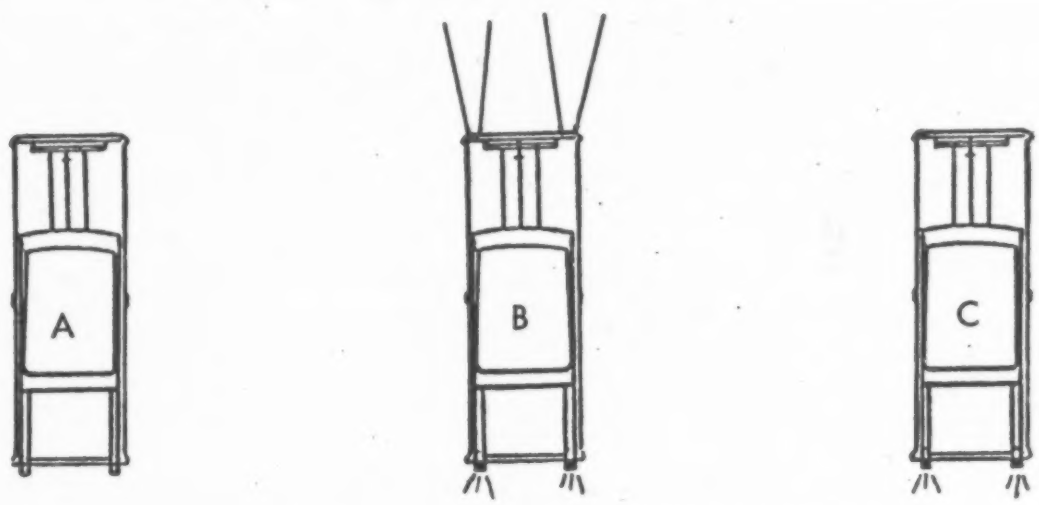

Which car is ready for night driving? _____ (WRITE LETTER)

When driving at night, you can see ahead if you:

- ☐ follow another car closely
- ☐ have your headlights on
- ☐ have your taillights on

20146

64

B

have your headlights on

65

Sunset is at 5:00 p.m. You turn on your headlights at 5:30 p.m. because the law requires that headlights be turned on one half-hour:

☐ after sunset

☐ before sunset

20147

65

after sunset

66

The law requires that you turn on your headlights one half-hour after the sun sets.

If sunset is at 6:30 p.m., then you should turn on your headlights at:

- ☐ 5:30
- ☐ 6:00
- ☐ 6:30
- ☐ 7:00

Safety Rules for the Woodworking Jointer

1. Do not attempt to joint stock less than 1/4" x 4" x 12" - check with your teacher.
2. Make adjustments before applying power.
3. Check the operation of the guard.
4. Use pushblock for small stock.
5. Ask your teacher to check setup for stop-cuts, beveling, tapering, and rabbeting.
6. Check depth-of-cut setting prior to starting the machine. Limit cuts to 1/8" or less.
7. Whenever possible, allow two fingers to ride along the top of the fence.
8. Feed stock slowly while holding it firmly. Consider grain direction.
9. Do not attempt to plane end grain without special permission.
10. Push stock far enough on each pass to allow the guard to close.
11. Be careful of your stance--as you feed the stock, do not lean forward and lose your balance or slip.
12. Allow the machine to stop before leaving it.
13. Return all adjustments to "normal" and clean up the area.

reel 25 1990

66

7:00

67

When does the law require that you turn on your headlights?

- ☐ one half-hour after sunset
- ☐ one half-hour before sunset
- ☐ one hour after sunset
- ☐ one hour before sunset

20149

67

one half-hour after sunset

68

One half-hour after sunset, you should turn on your:

- ☐ headlights
- ☐ parking lights

20150

68

headlights

69

Which car is not ready for night driving? _____

Parking lights are used for:

- ☐ overtime parking
- ☐ parking at night
- ☐ parking near intersections

20151

285 OF 327

ED

056 238

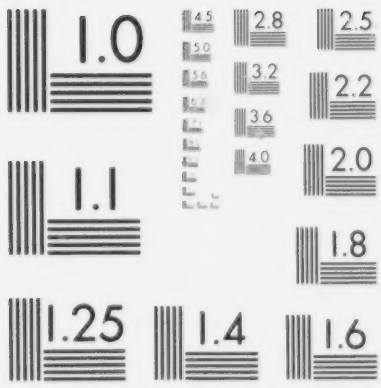

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

69

B

parking at night

70

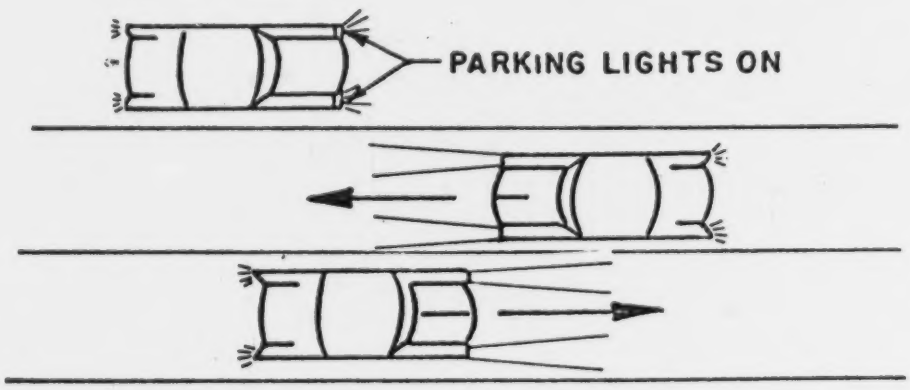

This picture shows when you use your parking lights alone.

Parking lights are on when you:

- ☐ drive in a well lighted area
- ☐ park on a road going with the traffic
- ☐ park on a road facing traffic
- ☐ stop at a toll booth

20152

70

park on a road facing traffic

71

When you are parked facing traffic, turn on your:

- ☐ headlights
- ☐ parking lights
- ☐ taillights

20153

71

parking lights

72

You should use your parking lights only when:

- ☐ parked in a parking lot
- ☐ parked on the road facing traffic
- ☐ parked on the road going with the traffic
- ☐ entering a four-lane divided highway

20154

72

parked on the road facing traffic

73

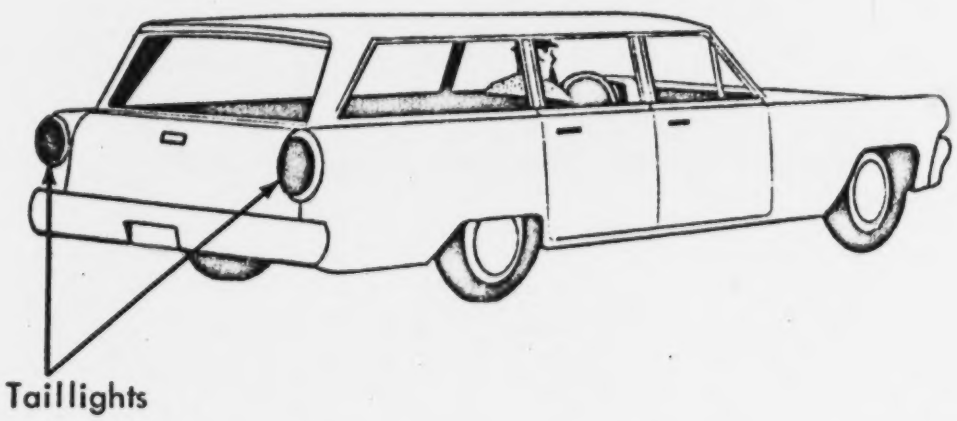

At night your taillights must be visible from 500 feet away.

You should be able to see the taillights on a car:

- ☐ 420 feet in front of you
- ☐ 501 feet in front of you
- ☐ 598 feet in front of you
- ☐ 629 feet in front of you

20155

73

420 feet in front of you

74

When you are not more than 500 feet behind a car at night, you should be able to see its:

- ☐ headlights
- ☐ parking lights
- ☐ taillights

74

taillights

75

For what distance must your taillights be visible at night?

- ☐ only 50 feet
- ☐ only 300 feet
- ☐ 500 feet
- ☐ 650 feet

20187

Safety Rules for the Planer (Surfacer)

1. Use only clean, nail-free lumber.
2. Make sure stock is about 1" longer than the distance between infeed and outfeed rolls. Never attempt to surface shorter stock.
3. Make adjustments only when machine is stopped (except for normal depth-of-cut adjustments between passes).
4. Adjust first cut to measurements taken at the thickest part of the board.
5. Limit cuts to 1/16" on wide stock to 1/8" on narrow stock.
6. Run thin stock (less than 1/4") through planer on top of a thicker, surfaced board.
7. Stand to one side of the throat when feeding or receiving.
8. Never look into the throat while machine is running.
9. Keep hands away from feed rolls and away from boards already gripped by feed rolls.
10. Never change depth-of-cut adjustment while a board is in the planer.
11. If a board gets stuck, turn off power and summon your teacher.
12. Work with a helper to receive stock and pass it back for further cuts.
13. Loose knots should be removed prior to surfacing.
14. If stock is wet, lubricate tables with wax or kerosene.

0681 1991

75

500 feet

76

Taillights let people behind you see your car.

Which lights let you see the road in front of your car?

_____

20158

76

headlights

77

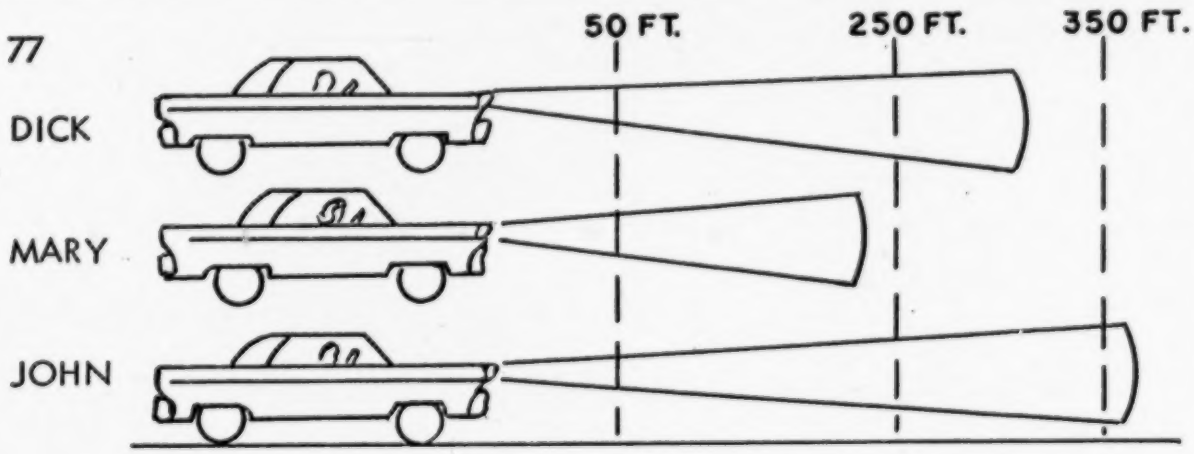

At night your headlights should light up the road in front of you by at least 350 feet. Which of the above cars have headlights that are lighting up the right distance for night driving?

- ☐ Dick's car
- ☐ Mary's car
- ☐ John's car

20158

77

John's car

78

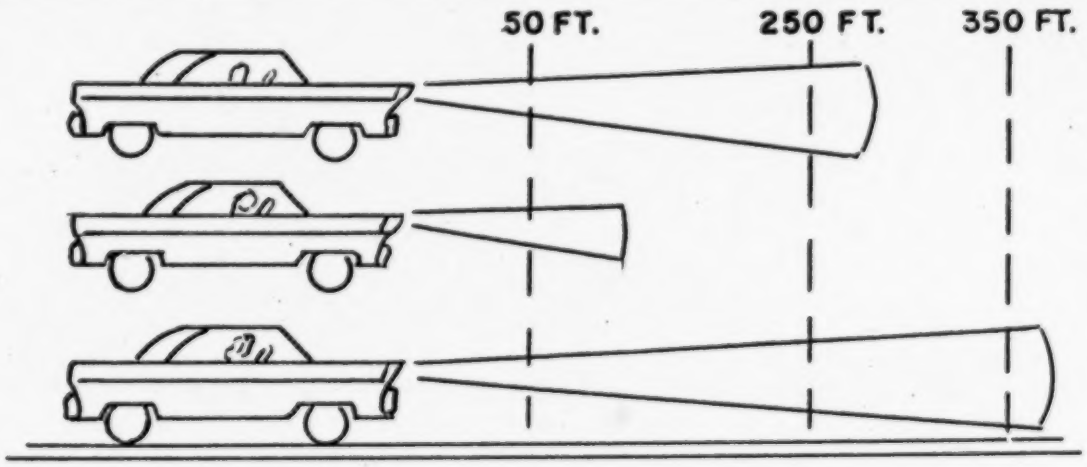

If your headlights are working, you should be able to see all objects on the road ahead up to a distance of:

- ☐ 150 feet
- ☐ 250 feet
- ☐ 350 feet
- ☐ 450 feet

78

350 feet

79

MATCH the following:

A. 350 feet

B. 400 feet

C. 500 feet

1. _____ headlights should light at night

2. _____ taillights should be visible at night

79

1. A

2. C

80

What is the distance that should be lighted by your headlights at night?

- ☐ 100 feet
- ☐ 250 feet
- ☐ 350 feet
- ☐ 500 feet

80

350 feet

81

When your headlights are on high beam, they look very bright and can "blind" other drivers who are coming toward you. This can cause accidents.

When another car is coming toward you, you should:

- ☐ blink your lights
- ☐ be sure your lights are on high beam
- ☐ dim your lights so you won't blind the other driver

81

dim your lights so you won't "blind" the other driver

82

Which car below has its headlights on low beam, or "dimmed":

- ☐ car A
- ☐ car B

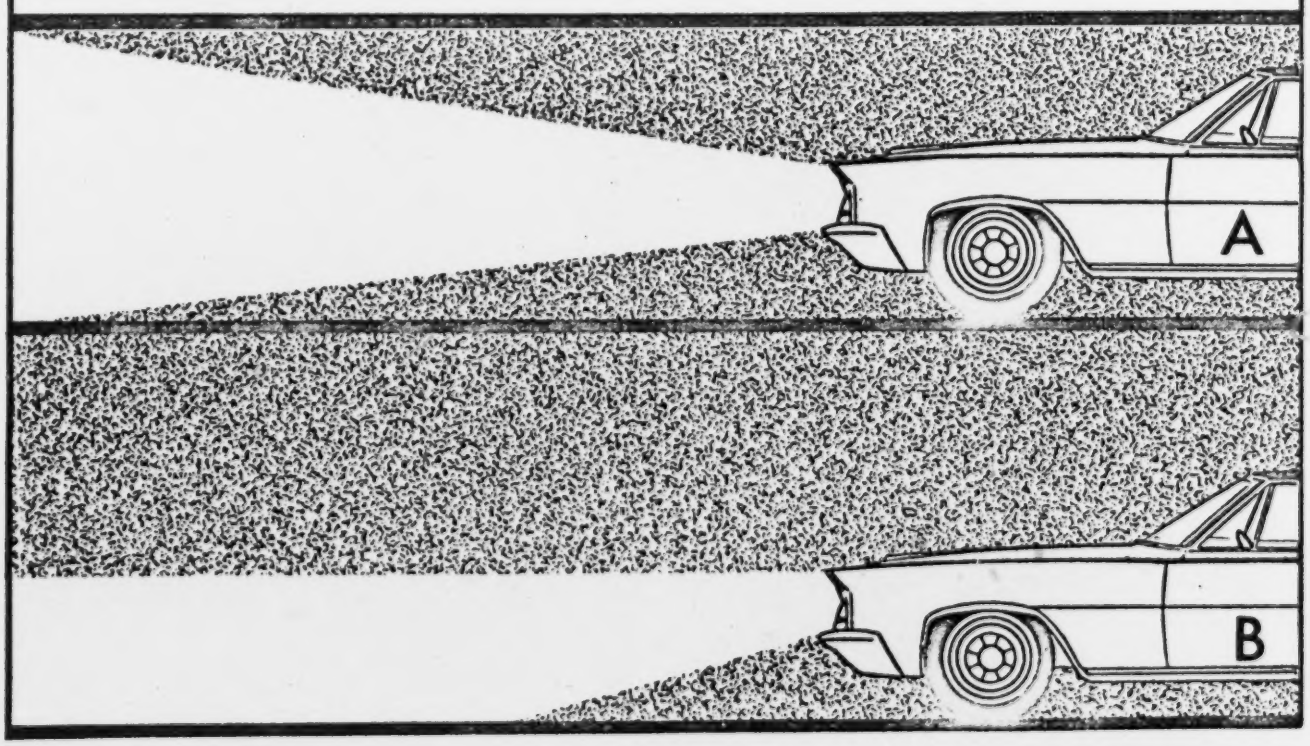

82

car B

83

Drivers must dim headlights when 500 feet from an approaching vehicle.

You should switch your headlights to low beam when you are:

- ☐ 250 feet in back of a car
- ☐ 250 feet from a car coming toward you
- ☐ 500 feet from a car coming toward you
- ☐ 500 feet in back of a car

20165

83

500 feet from a car coming toward you

84

Dim your headlights when you are 500 feet from:

- ☐ an approaching car
- ☐ a car you are overtaking
- ☐ a car overtaking you

84

an approaching car

85

How close to an oncoming vehicle should you be before switching your headlights to low beam?

- ☐ 250 feet
- ☐ 350 feet
- ☐ 500 feet
- ☐ 520 feet

20167

Safety Rules for the Band Saw

1. Stock to be cut should have a flat surface.
2. Adjust blade guide to about 1/8" above surface of work.
3. Plan cuts to avoid backing out of kerf, if possible.
4. If necessary to back out of kerf, do so with saw stopped.
5. Feed material at a moderate speed, being careful to keep hands and fingers clear of blade.
6. Avoid pinching blade by turning too sharply.
7. If blade breaks, shut off power and summon your teacher.
8. Clear scraps from table only with saw stopped.
9. Have your teacher check resawing and other special setups before proceeding.

85

500 feet

86

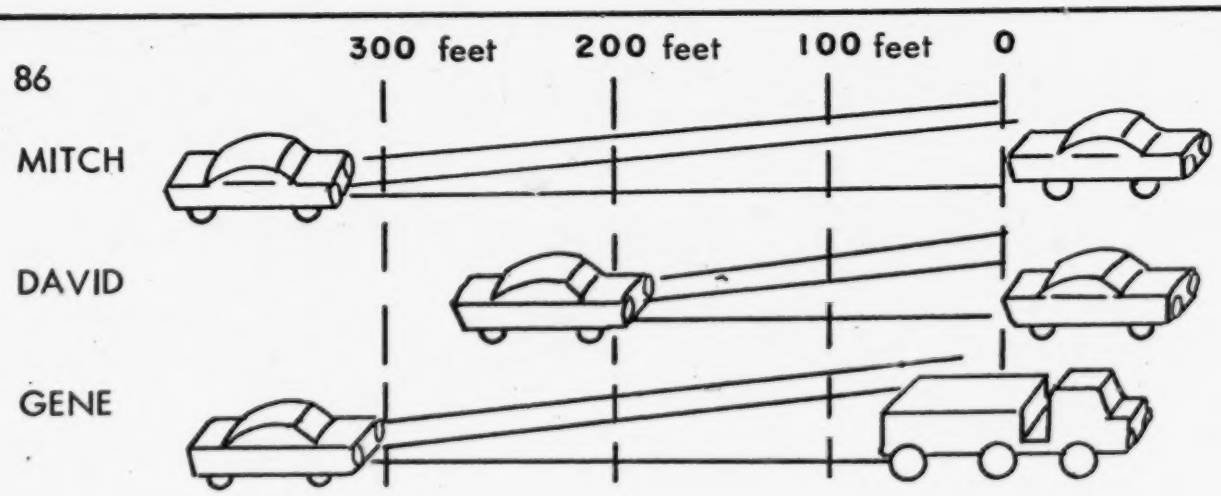

You should switch your headlights to low beam when you are 200 feet from the car in front of you. Which of the above drivers should switch his lights to low beam?

- ☐ David
- ☐ Gene
- ☐ Mitch

20168

86

David

87

MATCH the following:

A. 200 feet

B. 350 feet

C. 500 feet

1. _____ low beam when overtaking a car

2. _____ low beam for an oncoming car

20169

87

1. A

2. C

88

How close should you be to a vehicle you are overtaking before switching your headlights to low beam?

- ☐ 200 feet
- ☐ 300 feet
- ☐ 400 feet
- ☐ 500 feet

20170

88

200 feet

89

Headlights should light up the road ahead by 350 feet.

Taillights should be seen for 150 feet farther.

How far should taillights be seen? _____

20171

89

500 feet

90

MATCH the following:

A. 200 feet

B. 350 feet

C. 500 feet

1. _____ taillights should be seen

2. _____ should be lit by headlights

20172

90

1. C

2. B

91

How far from an approaching car should you be before you dim your headlights? _____ feet

20173

91

500 (feet)

92

When two cars are approaching each other and are 500 feet apart, the headlights should be switched to low beam. This means that:

- ☐ both drivers should put their lights on low beam
- ☐ only the one driver should put his lights on low beam

20174

92

both drivers should put their lights on low beam

93

When you meet a car that has blinding lights:

1. look toward the right
2. keep your car near the right side
3. slow down

If you are moving at 40 mph, you should:

☐ go 60 mph so you won't have to see the lights as long

☐ go 30 mph to be safe

20175

93

go 30 mph to be safe

94

When you meet a car with very bright lights, look toward the right side of the road so that you:

- ☐ can see any signs that may be there
- ☐ can see the middle of the road
- ☐ won't be blinded by the bright lights

20176

94

won't be blinded by the bright lights

95

You meet a car with very bright lights. You should keep your car toward the right side of the road so that your car:

- ☐ will be in the middle of the road
- ☐ won't hit the other car

20177

Safety Rules for the Circular Saw

1. Saw only clean, nail-free lumber.
2. Select proper blade, make sure it is sharp, clean, and properly installed.
3. Check operation of guards. Ask your teacher for assistance if setup requires removal of guards.
4. Use ripping fence or miter gage. Do not use both except with a clearance block as directed by your teacher.
5. Never saw "freehand"--that is, without some guiding device.
6. Stand to one side rather than in line with the blade.
7. Use push sticks for stock under 6" in width.
8. Push stock yourself. Use a helper to bear off, but instruct him to only support the stock, not pull it.
9. Blade should not project over 1/8" above work.
10. Use support stands for long boards.
11. Use a featherboard as instructed.
12. Never reach over the saw.
13. Feed rapidly enough to make saw work. Don't jam stock into blade. Don't feed so slowly as to cause burning.
14. Return adjustments to normal and clean up the saw and area after the machine has stopped.

1993

95

won't hit the other car

96

You should slow down when you approach a car with blinding lights so that:

- ☐ you can see the lights longer
- ☐ you won't miss a turn-off
- ☐ you have better control of your car
- ☐ the other driver will see your lights longer

20178

96

you have better control of your car

97

When you meet a car with blinding lights, you should do three things.

You should look toward the:

- ☐ left
- ☐ right

and you should keep the car toward the:

- ☐ right side of the road
- ☐ left side of the road

and you should also:

- ☐ speed up
- ☐ slow down

20178

98

look toward the right side of the road, stay near it, and slow down

99

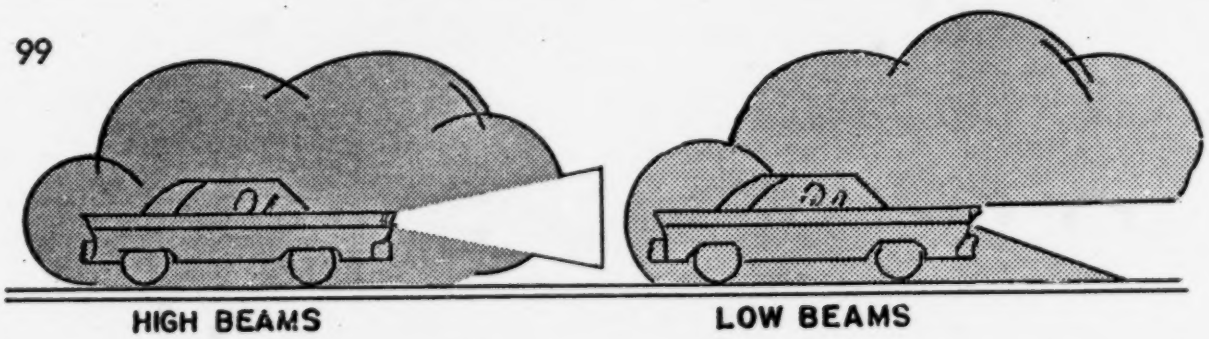

Low beams should be used when you are driving in fog because the low beams:

- ☐ do not blind other drivers
- ☐ do not let you see as far
- ☐ get rid of the fog
- ☐ let you see better

20181

99

let you see better

100

If you are driving in the fog, you should use:

- ☐ high beams
- ☐ low beams
- ☐ parking lights
- ☐ taillights

20182

100

low beams

101

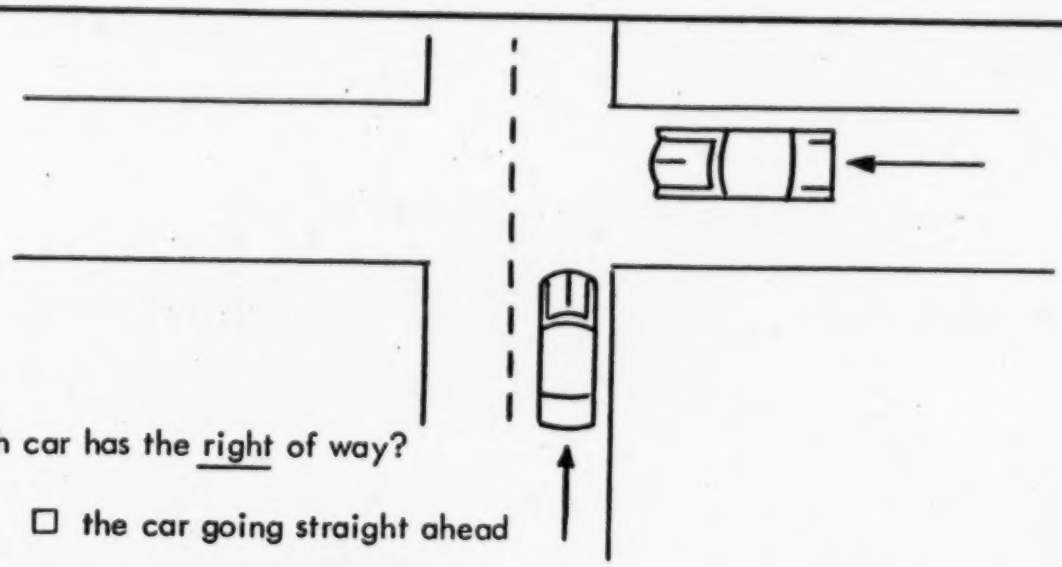

Which car has the right of way?

- ☐ the car going straight ahead
- ☐ the car on the right
- ☐ the car turning to the left

20183

101

the car on the right

102

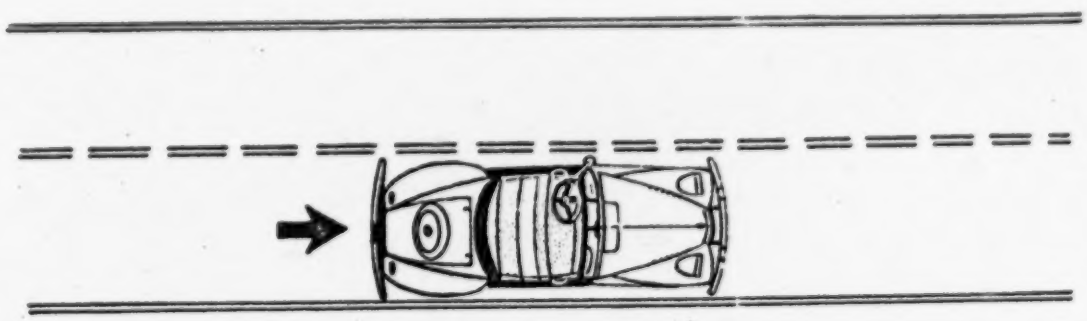

The broken line:

- ☐ must not be crossed at any time
- ☐ may be crossed at any time
- ☐ may not be crossed at night
- ☐ may be crossed to pass if traffic permits

20184

102

may be crossed to pass if traffic permits

103

SHADE IN the line on the highway that must never be crossed:

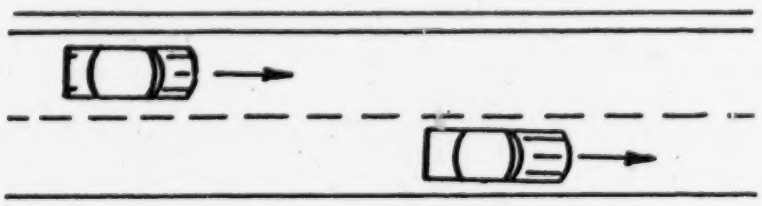

20185

103

a double solid line

104

When must you turn on your headlights?

- ☐ an hour after sunset
- ☐ a half-hour after sunset
- ☐ a half-hour before sunset

20186

104

a half-hour after sunset

105

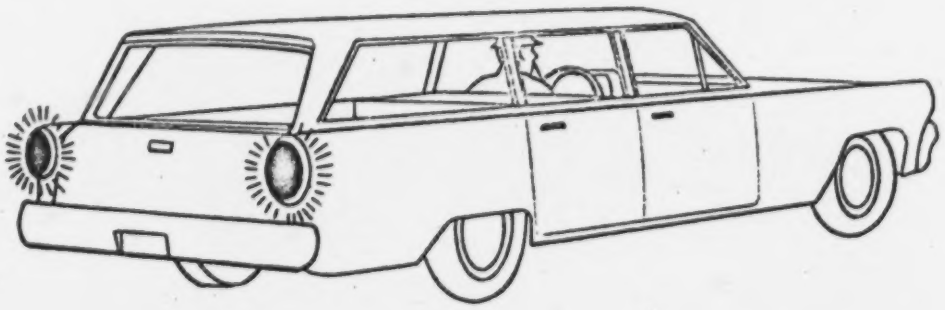

The lights that you can see on the car in the drawing must be visible at night from a distance of:

- ☐ fifty feet
- ☐ one hundred feet
- ☐ five hundred feet
- ☐ half a mile

20187

Safety Rules for the Mortiser

1. Select and install proper size bit.
2. Clamp stock in place.
3. Make necessary adjustments for depth and lateral travel.
4. Keep hands away from chisel when power is on.
5. Feed rate should allow machine to cut easily.
6. Lift bit clear of work before moving table.
7. Check with your teacher if cutting is difficult or chisel burns.
8. When finished, remove bit and clean up the area.

105

five-hundred feet

106

When you tie a white cloth to the left door handle of your car on the New York State Thruway, you are:

- ☐ reporting a theft
- ☐ signaling for help
- ☐ signaling to pass

20188

106

signaling for help

107

If a tire blows out while you're driving, you can prevent an accident by:

- ☐ signaling for help
- ☐ taking your foot off the gas and holding the wheel steady
- ☐ stopping as quickly as possible
- ☐ driving on to the nearest gas station

107

taking your foot off the gas and holding the wheel steady

108

You should use your parking lights alone when:

- ☐ parked in a parking lot
- ☐ parked on the road facing traffic
- ☐ parked on the road going with the traffic
- ☐ entering a four-lane divided highway

20190

108

parked on the road facing traffic

109

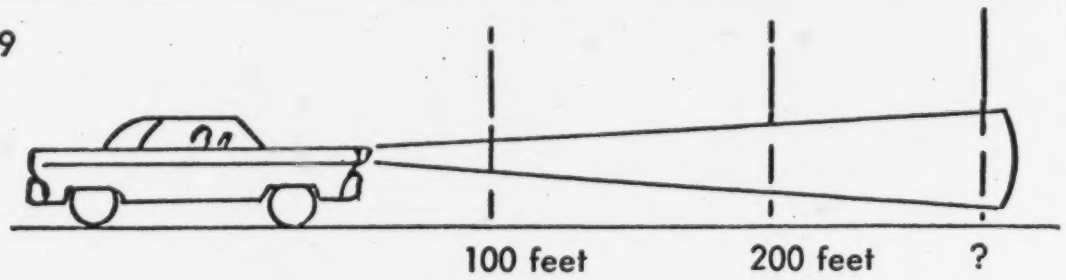

At night the headlights on a car should light up the road for at least:

- ☐ 100 feet
- ☐ 250 feet
- ☐ 300 feet
- ☐ 350 feet

20191

109

350 feet

110

How close to an oncoming vehicle should you be before switching your headlights to low beam?

- ☐ 250 feet
- ☐ 350 feet
- ☐ 500 feet
- ☐ 520 feet

20192

110

500 feet

111

How close should you be to a vehicle you are overtaking before switching your headlights to low beam?

- ☐ 200 feet
- ☐ 300 feet
- ☐ 400 feet
- ☐ 500 feet

20193

111

200 feet

112

At night when you meet a vehicle with very bright, blinding lights, what is the safest action to take?

- ☐ put on your high beams to counteract his
- ☐ close your eyes so that you won't be blinded
- ☐ look toward the right side of the road, stay near it, and slow down
- ☐ turn on your left-turn signal to tell the driver to dim his lights

20194

112

look toward the right side of the road,
stay near it, and slow down

113

If you must drive in a heavy fog, be sure to use:

- ☐ your horn
- ☐ high beam on your headlights
- ☐ low beam on your headlights
- ☐ parking lights only, to save the battery

20195

113

low beam on your headlights

114

What conditions determine the length of time in which you can stop your car?

- ☐ windshields should be clean
- ☐ brakes, road surface and weather
- ☐ driver may get sleepy
- ☐ car must be periodically inspected

20196

114

brakes, road surface and weather

115

How far will it take you to stop if you are traveling at 40 mph?

- ☐ 30 feet
- ☐ 67 feet
- ☐ 120 feet
- ☐ 190 feet

20197

Safety Rules for the Radial Arm Saw

1. Make sure proper blade is installed and that it is sharp.

2. Set up for the type of cut you need to make and ask teacher to check setup.

3. Hold stock firmly, keeping hand well out of the way of the blade.

4. Pull saw smoothly across board. Maintain firm control so that saw does not pull itself into the work.

5. When crosscutting, make sure saw returns to the starting position before advancing board for the next cut.

6. Cut only one piece of stock at a time.

7. When finished, lock saw in starting position and clean up area.

1995

115

120 feet

116

How many feet will it take you to stop your car when driving at 60 mph?

- ☐ 67 feet
- ☐ 120 feet
- ☐ 190 feet
- ☐ 400 feet

20198

116

400 feet

117

How many car lengths should you keep between you and the car in front of you if you are going 40 mph?

- ☐ one
- ☐ two
- ☐ four
- ☐ eight

20199

117

four

118

How far behind the car in front of you should you drive?

- ☐ 1 car length for every 10 mph
- ☐ 1 car length for every 40 mph
- ☐ 2 car lengths for every 10 mph
- ☐ 2 car lengths for every 40 mph

20200

118

1 car length for every 10 mph

119

What should you consider when you are following another car on a highway?

- ☐ do not follow too closely; in other words, do not "tailgate"
- ☐ try to follow at exactly the same speed
- ☐ watch out for littering
- ☐ make sure you don't lose sight of the car

20201

119

do not follow too closely; in other words, do not "tailgate"

120

How closely may you follow a fire engine on its way to a fire?

- ☐ 200 feet in both city and rural areas
- ☐ 500 feet in both city and rural areas
- ☐ 200 feet in the city; 500 feet in rural areas
- ☐ 500 feet in the city; 200 feet in rural areas

20202

120

200 feet in the city; 500 feet in rural areas

121

When you see or hear a vehicle with a flashing red light on, siren blowing or bell ringing, what should you do?

- ☐ give it the right of way
- ☐ speed up and drive on
- ☐ stop in your lane
- ☐ stop and direct traffic, if there is no police officer

20203

121

give it the right of way

122

What is the general rule with regard to right of way at intersections?

- ☐ The car going straight ahead has the right of way.
- ☐ The car on the main road has the right of way.
- ☐ The car on the right has the right of way.
- ☐ The car making a turn has the right of way.

20204

122

The car on the right has the right of way.

123

What does a broken line painted on the highway mean?

- ☐ You must not cross it at any time.
- ☐ You may cross it to pass, provided traffic permits.
- ☐ You may cross it to pass, even on hills.
- ☐ You must not cross it on weekends.

20205

123

You may cross it to pass, provided traffic permits.

124

What does it mean when the painted line on the highway is a double solid line?

- ☐ You may cross it at any time.
- ☐ You may cross it only if you are on the main road.
- ☐ You must never cross it.
- ☐ You may cross it only if traffic permits.

124

You must never cross it.

125

How should you handle your car to prevent an accident when you have a blowout?

- ☐ Blink your lights to warn other drivers.
- ☐ Slam on your brakes to stop.
- ☐ Take your foot off the gas and hold the steering wheel steady.
- ☐ Warn other drivers by blowing your horn.

20207

Safety Rules for the Portable Router

1. Stock should be firmly fastened with a vise or clamp.
2. Change cutters and make adjustments only when cord is disconnected. Do not rely on the switch alone.
3. Make sure cutters are tight in the chuck and that adjustments are locked.
4. Ask your teacher to check your setup.
5. Before plugging in the electric cord, make sure switch is off and that machine is on its side.
6. Hold the machine firmly with both hands.
7. Practice on scrap stock.
8. Feed cutters slowly into the material.
9. When cut is finished, turn off switch, allow machine to stop, and lay it on its side, away from the edge of the bench.
10. Disconnect cord, remove cutter, clean machine, and store it properly.

125

Take your foot off the gas and hold the steering wheel steady.

126

To signal for help on the New York Thruway, you should:

- ☐ blink your lights
- ☐ put a flag over the trunk
- ☐ put a flare behind the car
- ☐ tie a white cloth to the left door handle of your car

20208

126

tie a white cloth to the left door handle of your car

127

When does the law require that you turn on your headlights?

- ☐ one half-hour after sunset
- ☐ one half-hour before sunset
- ☐ one hour after sunset
- ☐ one hour before sunset

20209

127

one half-hour after sunset

128

Parking lights are used alone when you:

- ☐ drive in a well lighted area
- ☐ park on a road going with the traffic
- ☐ park on a road facing traffic
- ☐ stop at a toll booth

20210

128

park on a road facing traffic

129

Taillights on a car must be visible for a distance of:

- ☐ only 50 feet
- ☐ only 300 feet
- ☐ 500 feet
- ☐ 650 feet

20211

129

500 feet

130

What is the distance that should be lighted by your headlights at night?

- ☐ 100 feet
- ☐ 250 feet
- ☐ 350 feet
- ☐ 500 feet

20212

130

350 feet

131

How close should you be to an oncoming vehicle before switching your headlights to low beam?

- ☐ 500 feet
- ☐ 350 feet
- ☐ 200 feet
- ☐ 100 feet

20213

131

500 feet

132

How close should you be to a vehicle you are overtaking before switching to low beams?

- ☐ 100 feet
- ☐ 200 feet
- ☐ 250 feet
- ☐ 500 feet

20214

132

200 feet

133

At night when you meet a vehicle with very bright, blinding lights, what is the safest action to take?

- ☐ Put on your high beams to counteract his.
- ☐ Close your eyes so that you won't be blinded.
- ☐ Look toward the right side of the road, stay near it, and slow down.
- ☐ Turn on your left-turn signal to tell the driver to dim his lights.

133

Look toward the right side of the road, stay near it, and slow down.

134

In a heavy fog, always use your:

- ☐ high beams
- ☐ low beams
- ☐ parking lights

20216

134

low beams

135

You now know some of the important driving rules of New York State.

This will help you to be safe on the road and pass the written test.

You will find them all plus many more in the New York State DRIVER'S MANUAL. Read it.

NO ANSWER NEEDED

THIS IS THE END OF BOOK 24

20217

Safety Rules for Portable Sanders

1. Arrange work so that it is held securely.

2. Inspect sander and abrasive belt, pad, or disc.

3. Be certain switch is off before connecting power cord. Belt sander should be laid on its side.

4. Check tracking of belt sander before starting work.

5. Do not "force" any sander. Use only the weight of the machine.

6. Avoid inhaling dust. Use mechanical dust pickup or wear respirator.

8. Keep abrasive surface clean.

9. When finished, disconnect power cord and clean machine prior to storage. Always empty dust collection bag.

80997

AUTO MECHANICS COURSE

POST-TEST BOOK 24: DRIVING REGULATIONS, PART II

A BASIC SYSTEMS PROGRAM

20218

TRY THE FOLLOWING QUESTIONS TO SEE HOW WELL YOU HAVE MASTERED THE MATERIAL IN THIS UNIT. YOUR INSTRUCTOR HAS THE ANSWERS.

1

What conditions determine the length of time in which you can stop your car?

- ☐ windshield should be clean
- ☐ brakes, road surface, and weather
- ☐ driver may get sleepy
- ☐ periodically inspected

2

How many feet will it take you to stop your car when driving at 60 mph?

- ☐ 67 feet
- ☐ 120 feet
- ☐ 190 feet
- ☐ 400 feet

3

At 40 mph, how many car lengths should you allow between your car and the one ahead?

- ☐ four
- ☐ eight
- ☐ twelve
- ☐ sixteen

4

What should you consider when you are following another car on a superhighway?

- ☐ do not follow too closely; in other words, do not "tailgate"
- ☐ try to follow at the same speeds
- ☐ watch out for littering
- ☐ make sure you do not lose sight of it

5

What is the general rule with regard to right of way at intersections?

- ☐ the car going straight ahead has the right of way
- ☐ the car on the main road has the right of way
- ☐ the car on the right has the right of way
- ☐ the car making a turn has the right of way

6

What does a broken line painted on the highway mean?

- ☐ you must not cross it at any time
- ☐ you may cross it to pass, provided traffic permits
- ☐ you may cross it to pass, even on hills
- ☐ you must not cross it on weekends

286 OF 327

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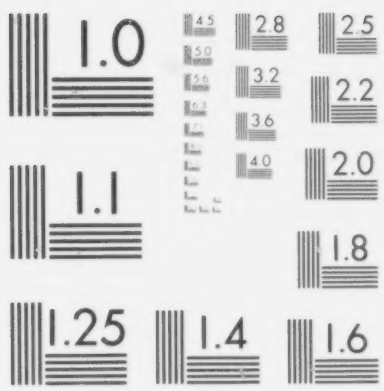

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

7

How should you signal for help on the New York State Thruway?

- ☐ flash your headlights on and off
- ☐ flash your brake lights on and off
- ☐ tie a white cloth to the left door handle of the car
- ☐ stand on the road and flag down the first oncoming car

8

For what distance must your taillights be visible at night?

- ☐ 200 feet
- ☐ 350 feet
- ☐ 400 feet
- ☐ 500 feet

9

What is the distance that should be lighted by your headlights at night?

- ☐ 100 feet
- ☐ 250 feet
- ☐ 350 feet
- ☐ 500 feet

10

How close should you be to a vehicle you are overtaking before switching your headlights to low beam?

- ☐ 100 feet
- ☐ 200 feet
- ☐ 250 feet
- ☐ 350 feet

20223

VT 013 275
Carraway, Byrle M.; Spitler, William L.
Smith and Wesson TDS Computer (Time--Distance--Speed). Operating Instructions and Trial Guide.

Stephenson, Red Bank, N.J. Smith and Wesson Law Enforcement Group.
MF AVAILABLE IN VT-ERIC SET.

PUB DATE - ND 76p.

DESCRIPTORS - *ELECTRONIC EQUIPMENT; *LAW ENFORCEMENT; *MANUALS; *JOB TRAINING; *TRAFFIC CONTROL; TRAFFIC REGULATIONS; INSTRUCTIONAL MATERIALS; COMPUTERS; MOTOR VEHICLES; POLICE

ABSTRACT - Intended for the law enforcement officer involved in traffic control, this training manual describes the theory and operation of the Time-Distance-Speed (TDS) Computer used to calculate the speed of motor vehicles. Operating procedures are detailed, including methods of clocking speeders from various moving and parked positions. Initial calibration and subsequent checks are explained. A trial guide is included to prepare the TDS operator for cross-examination in court. (BH)

VT 013 275

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SMITH AND WESSON

TDS COMPUTER

OPERATING INSTRUCTIONS AND TRIAL GUIDE

By

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North Carolina Department of Community Colleges

William L. Spitler
Supervisor, Law Enforcement Training
North Carolina Department of Community Colleges

20226

Safety Rules for the Scroll (Jig) Saw

1. Do not attempt to saw stock that does not have a flat surface. Other shapes may be sawn if a suitable support or rest is fashioned.
2. Check for proper blade size and type.
3. Check for correct blade tension.
4. Adjust hold-down so that spring fingers bear on work.
5. Set correct machine speed.
6. Adjust dust blower, if so equipped.
7. Holding material firmly, feed into machine at a moderate rate.
8. Keep hands and fingers away from the blade.
9. If blade breaks, turn off machine and summon your teacher.
10. Stop machine before brushing scrap pieces from work table.
11. When finished, stop machine and clean up the area.

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20228

CHAPTER I

INTRODUCTION TO THE TDS COMPUTER

1. The Traffic Problem

The objective of traffic management is to move the greatest number of vehicles as rapidly as possible and hold accidents to an irreducible minimum. In conventional traffic management, these objectives have been strived for by four separate approaches: enforcement, engineering, education and enactment. This approach is commonly referred to as the "4 E Concept." Those in enforcement compose the group which has most direct contact with the traffic problem. The remaining groups use the findings of enforcement to guide their actions. The engineer determines from accident reports that a particular location has an unusually high number of accidents. Attempts are then made to change the physical environment of that location to reduce the decisions that the driver must make. The educator, using these findings, attempts to educate the public in the new methods and techniques as they are developed. The legislators also use these findings to guide them in enacting laws, the enforcement of which will presumably reduce accidents. Utilizing this approach, there appears to be no problem; however, over the years the traffic accident picture has constantly deteriorated. All of the agencies involved in the 4 E concept have consistently increased their efforts; yet they have been unsuccessful in reducing the number of accidents, deaths and injuries that occur on our highways. It has long been assumed that there is no magical solution.

In fact, a great deal of effort has gone into the solution of the problem, only to find a consistent and predictable rise in traffic accidents. In an attempt to maintain control of the situation, a constant search for better methods, techniques and equipment must be perpetuated.

2. The Role of Speed in Traffic Accidents

It is recognized that speed on streets and highways is one of the major contributors to traffic accidents; consequently, speed must be one of the problems on which a great deal of effort should be expended. This could be accomplished by saturating the streets and highways with traffic enforcement officers. However, the American people would consider enforcement to this degree far too costly and, at the same time, a far too agressive act. Therefore, methods and equipment must be developed that will make each officer more effective and efficient and, in turn, greatly increase his influence on the public.

3. The TDS Computer

The TDS Computer is an electronic time-distance speed measuring device used in conjunction with an enforcement car to determine the vehicle speed of potential traffic violators. It computes average speed by recording the distance traveled by a violating vehicle and also recording the elapsed time of the violating vehicle over that distance.

With the TDS Computer, a properly trained operator while driving his patrol car can determine the speed of any other vehicle on the same highway or street. The violating vehicle may

be traveling in the same or opposite direction and can be either in front of, behind, or passing the operator's patrol car.

The TDS Computer can also be used to check vehicle speed from a parked patrol car in many configurations. This combined capability tends to increase the enforcement officer's effectiveness many times over. Based on these principles, it may safely be assumed that properly trained enforcement officers, equipped with a TDS Computer, can significantly reduce the frequency of speeding violations. By taking enforcement action against the violator at any location on a roadway and changing locations frequently, he can produce the psychological effect of saturating the roads with enforcement. Therefore, the officer equipped with the TDS Computer reduces both the probability of speeding and the possibility of traffic accidents occurring.

The TDS Computer consists of a readout unit, the main computer and switching panel, and the distance pickup. The distance pickup is located at the transmission end of the speedometer cable. The readout unit can be placed in any convenient location, usually on the dashboard. Both connect by cable to the rear panel on the main computer. In the configuration shown, (See Figure I.1), the main computer is pedestal mounted on the center hump between the front seat and dashboard. However, if desired, the switching panel can be removed from the main computer and remotely located, allowing the main computer to be placed under the seat or on the floorboard.

20231

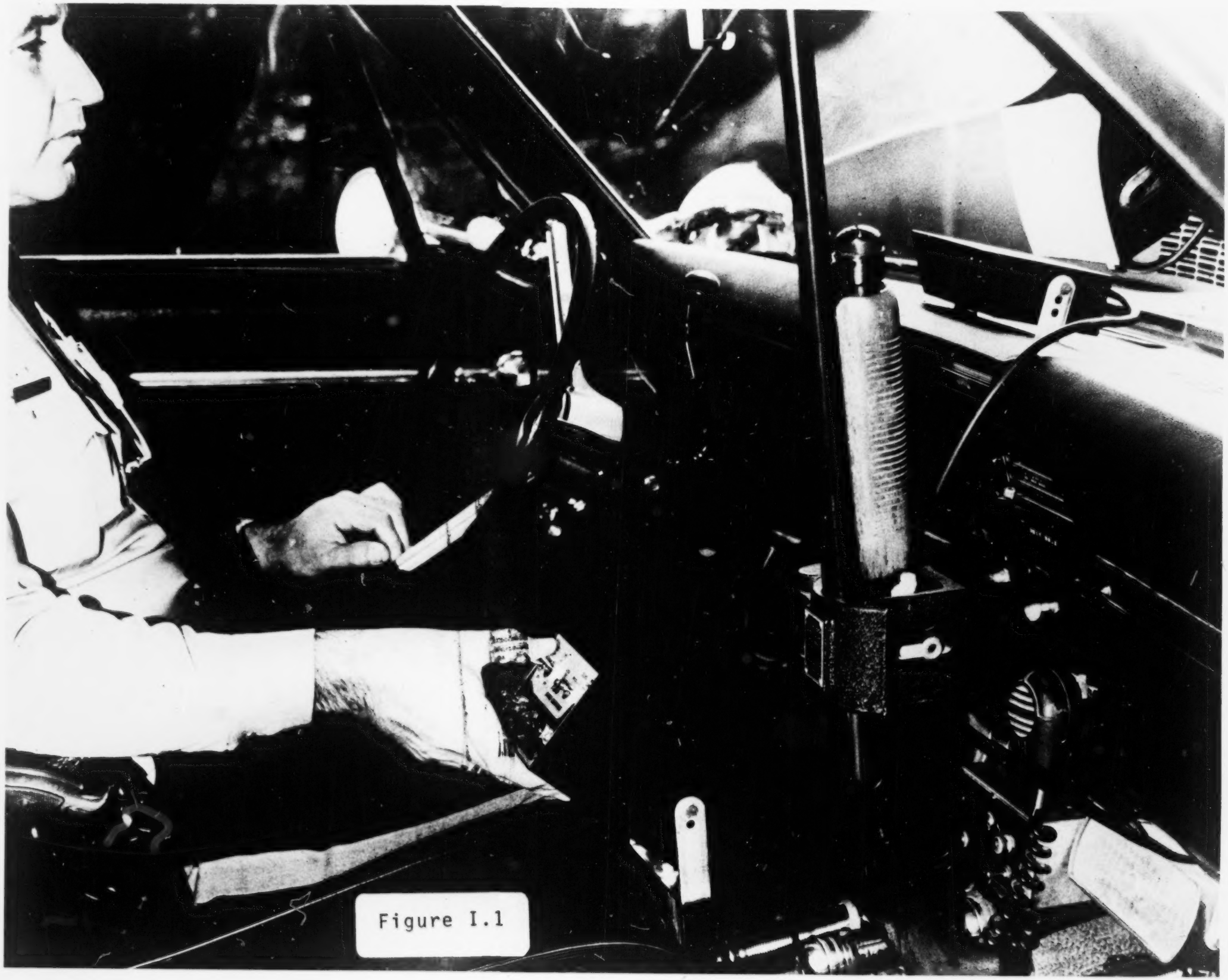

Figure I.1

20232

CHAPTER II

PRINCIPLES OF THE TDS COMPUTER

1. Formula for Speed

The basic principle on which the TDS Computer functions is an age-old mathematical formula. This function is the formula* for speed; Speed = $\frac{\text{Distance}}{\text{Time}}$. In other words, speed can be determined by dividing elapsed time (T) into the distance traveled (D). If elapsed time (T) is stated in hours or portions thereof and is divided into distance (D) stated in miles, the results would be in Miles Per Hour (S). This function is demonstrated in the following examples:

a. If a car travels 80 miles in 2 hours, the resultant average speed would be 40 MPH (80 miles ÷ 2 hours = 40 MPH)

b. If a car travels 30 miles in 1/2 hour (0.5 hours), the resultant average speed would be 60 MPH (30 miles ÷ 0.5 hours = 60 MPH)

As the distance traveled and elapsed time shorten, the time may be measured in minutes. If this is done, the first function must be a conversion from minutes to hours. A simple method for this conversion is to divide the elapsed time by 60 (the number of minutes in an hour). After this is done, simply apply this in the manner given earlier. These combined functions

---

* Actually, from a scientific standpoint, this formula is the basic definition of speed.

20233

are demonstrated in the following examples:

a. If a car travels 2 miles in 3 minutes, the resultant average speed would be 40 MPH (3 minutes ÷ 60 = 0.05 hours). Now, continue the function as given in the other example. (2 miles ÷ 0.05 hours = 40 MPH)

b. If a car travels 1 mile in 1.2 minutes (1 minute, 12 seconds), the resultant average speed would be 50 MPH (1.2 minutes ÷ 60 = 0.02 hours), continuing (1 mile ÷ 0.02 hours = 50 MPH).

As the time and distance continue to shorten, the time may more conveniently be measured in seconds. The conversion of seconds to hours is done in the same manner that minutes are converted to hours except for a factor of 3600 instead of 60. This is demonstrated in the following example:

a. If a car travels 1/4 mile (0.25 miles) in 18 seconds, the resultant average speed would be 50 MPH (18 seconds ÷ 3600 = 0.005 hours), continuing (0.25 miles ÷ 0.005 hours = 50 MPH).

2. The XY Graph

A quick and simple method to calculate speed when the elapsed time and traveled distance are known is by plotting these factors on an XY graph. Let X = Distance and Y = Time, as shown in Figure II.1.

If X = Distance in Miles and Y = Time in Minutes, and the graph is calibrated in equal one-mile and one-minute increments,

20234

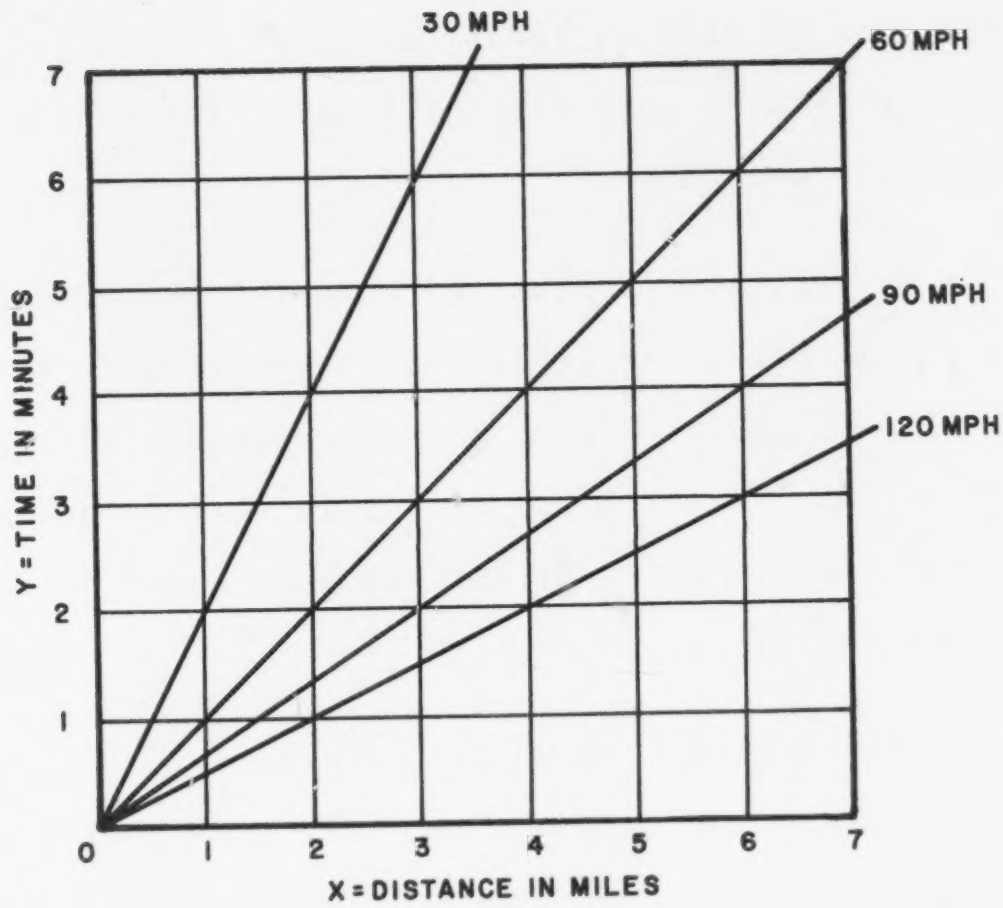

Figure II.1

20235

then 60 MPH will represent 1/2 of the graph (one mile in one minute, two miles in two minutes, etc.). 30 MPH would represent 1/4 of the total graph and 120 MPH would represent 3/4 of the total graph.

3. Time Measurement by the TDS Computer

The TDS Computer determines elapsed time by using an electronic crystal made of quartz. This type crystal, similar to those used in radios, radar, etc., will function at a precise frequency depending upon its thickness. The frequency is given in cycles per second.

The crystal used in the TDS Computer has a natural frequency of one megacycle or 1,000,000 cycles per second with a tolerance of ± .05%. The cycles per second are then divided by 100,000 (1,000,000 ÷ 100,000 = 10), so that 10 counts per second of elapsed time is put into the computer when the "Time" switch is in the "On" position.

4. Distance Measurement by the TDS Computer

The distance measurement is made by a specially designed attachment placed at the odometer cable outlet on the transmission of the vehicle. This device, a photo-electric pick-up, counts the revolutions of the transmission and allows approximately 4000 impulses to be entered into the computer per mile traveled when the "Distance" switch is in the "On" position. The number of impulses allowed by the distance pick-up head is adjustable to permit absolute calibration of the system. (The 4000 pulses are divided by 4 within the computer so that precisely 1000 pulses per mile are entered into the distance storage register.)

20236

Safety Rules for the Woodworking Shaper

1. Do not attempt to use the shaper on stock having knots, cracks, or other defects.

2. Do not attempt to shape small pieces without special holding jigs. Consider the use of the router. Check with your teacher.

3. Make sure that knives are correctly seated and that the locknut is tightened securely.

4. Arrange to use the fence whenever possible.

5. Use a fixed collar whenever possible.

6. Use spring guard whenever possible.

7. Use push stick if needed.

8. Practice feeding with power off. Enter all work opposite to the direction of the rotation of the cutter.

9. Have your teacher check your setup and supervise your first cuts.

10. Test setup on scrap stock of safe size.

11. Turn off power, remove cutters and clean up the area.

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5. Time and Distance Data Storage

The TDS Computer has separate storage banks for time and distance data. Both information storage banks are conventional binary counter systems that receive, count and store the conditioned signals coming from the time and distance measuring devices. The time storage bank is capable of storing 54 minutes of elapsed time, and the distance storage bank is capable of storing 32 miles of distance. A maximum of 999.9 seconds can be displayed (16.6 minutes) a maximum of 9.999 miles can be displayed.

6. Computing the Speed

When the "Time" and "Distance" switches are returned to the "Off" position and the selector switch is set on "MPH", the computer receives a "Ready to Compute" signal. Upon receipt of this signal, the Time and Distance Data Storage Banks transfer the data into separate Shift Registers on a non-destruct basis. In other words, the stored data is utilized but will be retained by both Data Storage Banks.

The actual computation, $S = \frac{D}{T}$ (division of elapsed time into traveled distance), is done by "Repetitive Subtraction" on a bit-by-bit basis. The number of subtractions that take place are counted and displayed on the digital readout as "MPH". When it becomes necessary to borrow to complete a subtraction, the computation is complete.

After the miles per hour are computed, distance traveled

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and the elapsed time can be displayed on the digital read-out simply by changing the selector from "MPH" to "Time" and "Distance". The time and distance data will remain in the Data Storage Banks until the "Erase" switch is pushed.

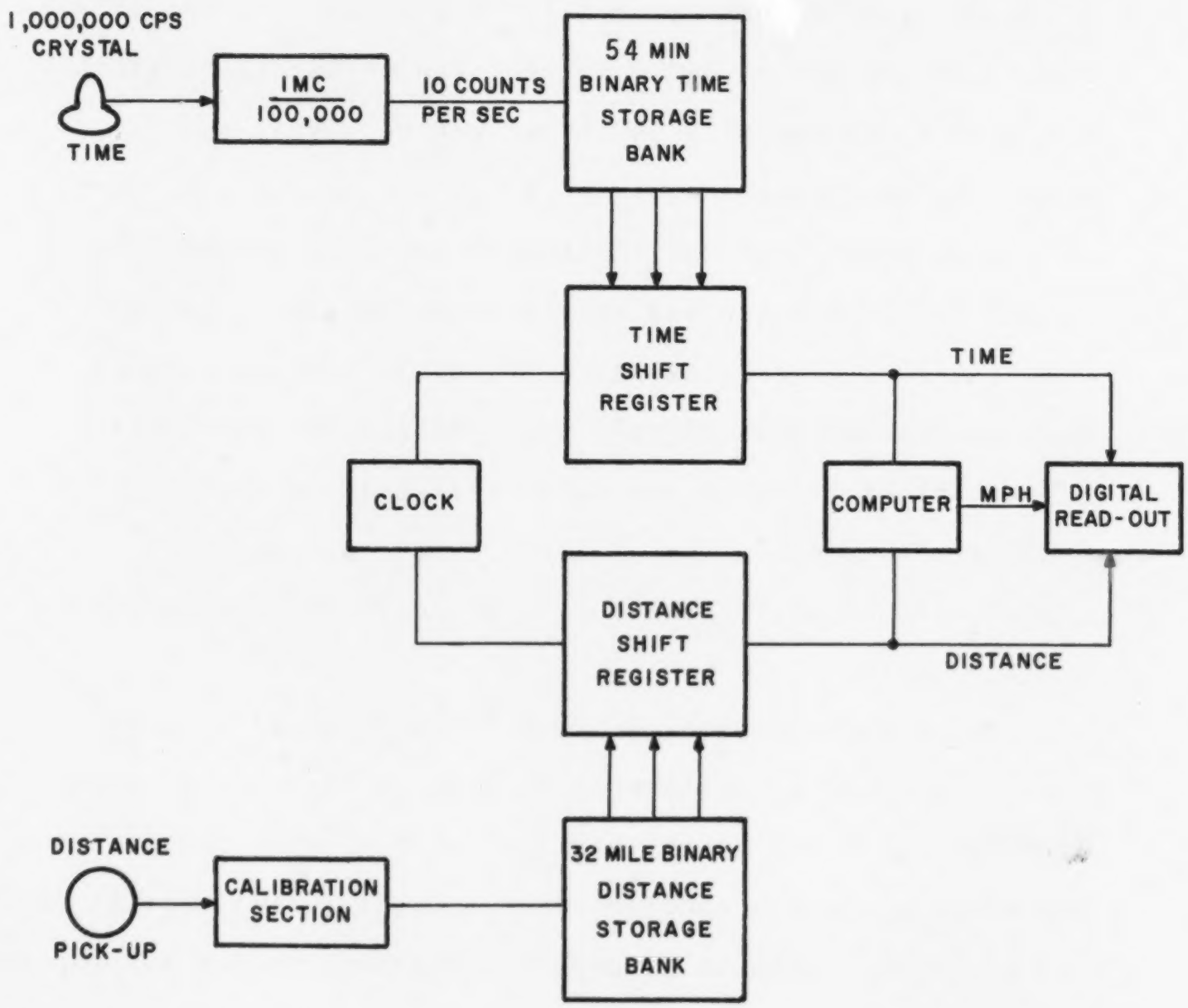

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CHAPTER III

OPERATIONAL PROCEDURES OF THE TDS COMPUTER

1. CONTROL SWITCHES

The following named and described control switches are located as shown in the front panel photograph of Figure III.1.

POWER SWITCH (ON-OFF). Controls power input to the device from the patrol car's 12-volt electrical power system.

DISTANCE SWITCH (ON-OFF). Allows the distance traveled by the patrol car while the switch is on to be accurately measured and entered into the distance storage register. The distance measurement is independent of the patrol car's speed.

DISTANCE LOCK SWITCH (NORMAL-LOCK). In the lock position it locks whatever distance measurement is in the distance storage register by disabling the distance switch and distance storage reset circuits.

TIME SWITCH (ON-OFF). Allows counts from an accurate crystal oscillator time base to enter the time storage register while the switch is on.

READOUT SWITCH (MPH, TIME, DISTANCE). In the time position the time stored in the time storage register is displayed on the readout. In the distance position the distance stored in

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Figure III.1

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the distance storage register is displayed on the readout. In the MPH position the miles per hour corresponding to the stored time and distance is computed and displayed on the readout.

ERASE SWITCH (PUSH BUTTON). Pushing the erase switch clears the time and distance storage registers in preparation for a new set of readings.

NIXIE* TURN-OFF SWITCH (PUSH BUTTON). Pushing this switch will completely turn off the NIXIE readouts. They will automatically re-light when a readout is required. (This switch is located on the readout unit.)

2. Operating Modes

In the normal mode of operation the erase switch will prepare the device to accept a new set of time and distance readings. (The time and distance switches are in the OFF position when the erase button is pushed.) The NIXIE turn-off switch may be pushed at this time. The position of the readout switch is immaterial, however, MPH will be the usual position since this is the first desired reading. Time and distance measurements are taken by respectively turning the time and distance switches ON then OFF. This may be done in any sequence. When both time and distance have been entered into their respective storage registers

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* A registered trademark of the Burroughs Corp.

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a readout will automatically appear corresponding to the position of the readout switch (usually MPH). The readout switch may then be set to the other positions with a corresponding readout of those quantities. Since the time and distance storage register are non-destructive the readout switch can at will be switched to any position resulting in a re-calculation and readout of that quantity until such time as the erase button is pushed.

If the distance lock switch is placed in the lock position when a distance measurement is stored in the distance register, this distance measurement will be locked and will not be affected by the erase button. The device will operate essentially as described above with only the time position being sequenced.

3. The Functional Requirements of a TDS Computer Operator

The TDS Computer is a tool of the officer--alone it does absolutely nothing. When manipulated by an officer, its limits are a reflection of the officer's ability as an operator.

In order to become an expert TDS Computer operator, the officer must possess three qualities: the first is concentration; the second, the ability to anticipate; and the third, ingenuity. There are four functions that the officer must perform with expertise.

- He must be expert in starting and in stopping the time switch when the violating vehicle reaches a

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reference point on the roadway in front of the operator.

- He must be expert in starting and in stopping the time switch when a violating vehicle, which is approaching from the rear, reaches a reference point on the roadway. He must utilize the rear view mirror for this type of clock.
- He must be expert in simultaneously starting the time switch and stopping the distance switch, or vice versa, when the violating vehicle is directly abreast of the enforcement vehicle.
- He must be expert in starting and stopping the distance switch when the enforcement vehicle reaches a reference point on the roadway.

Before the operator masters the above functions, the following terms and definitions must be thoroughly understood:

- <u>Reference points</u>

  Reference point defined: a reference point is anything on the roadway that is foreign to the surface of the road. Reference points are created by a change in light density.
- <u>Reference points during daylight hours</u>

  There are two types of reference points created by daylight. One is the moving shadow of the violator's vehicle. Depending on the direction of the sun, the shadow may be cast on either side of the vehicle;

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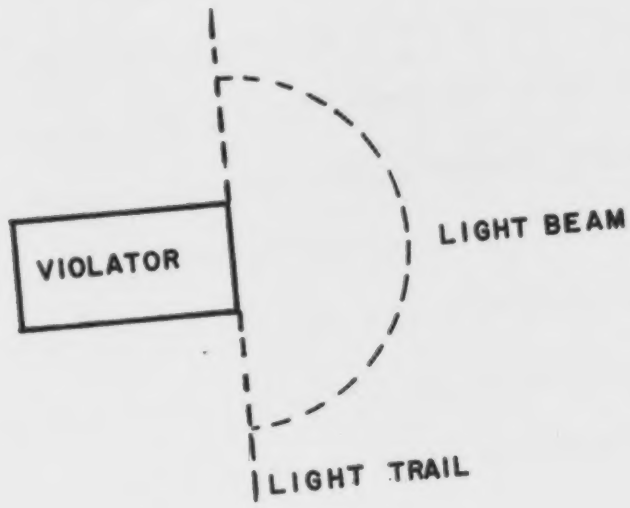

Figure III.2

For purposes of this discussion, the line that is created at a right angle to the vehicle's head-lamps will be called a <u>light trail</u>. When the light trail passes a mail box, a reflective road sign, the beginning or ending of a guard rail or bridge, or any other large object on the roadway, the object goes black. This change of light density can be easily seen from a great distance and the operator can be sure that the front of the violator's vehicle is at a right angle to the object observed. Note, however, that the lights from the operator's vehicle will obstruct the light density change if the operator's vehicle is following closely behind the violator's vehicle. When the operator follows closely behind the violating vehicle, he can easily observe the light trail as it moves forward on the road shoulder.

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He may use as a reference point, in this case, anything that is foreign to the road shoulder. Examples of these reference points are: the post used for road signs or mail boxes, bottles, cans, any debris, the beginning or ending of driveways, roads or bridges, and any other object that can be seen as the light trail touches it and which remains visible for the duration of the clock.

- Precision in the use of reference points

  A qualified operator is able to start or stop the distance or time switch when the violator's vehicle or the enforcement vehicle is within four (4) feet of a reference point. The operator employs anticipation in the use of reference points. Anticipation involves the action taken when an expected event occurs. The effect of anticipation can easily be seen, as it is in fact a countdown. The operator observes the shadow cast by the violating vehicle traveling along the roadway, selects a reference point in front of the violating vehicle, and then observes and anticipates the moving shadow as it proceeds to and touches the reference point, at which time the switch is turned on.

- The role of reaction time and depth perception in the use of reference points

Safety Rules for the Grinder

1. Check the condition of the grinding wheels. They should be free of chips and cracks.

2. Make sure tool rest is not over 1/8" away from wheel. Adjust clearance and angle if necessary.

3. Check guards and wipe off safety glass. Check spark arrester position.

4. Stand to one side of the wheels when you turn on the power.

5. Hold work with your hands. Do not use gloves. Do not use pliers. Check with your teacher for instructions on grinding small work.

6. Use the face of the wheel only.

7. Keep work in motion across the face of the wheel. Use only enough pressure to cause the wheel to cut.

8. Do not allow work to overheat. Quench frequently.

9. Allow the wheels to stop before leaving the grinder.

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Reaction time is not involved. Reaction time is that amount of time elapsed between the perception of an unexpected event and action taken. By using anticipation to an expected event, this element is reduced to the point of insignificance. Neither is depth perception involved, because the shadow cast by a violating vehicle actually touches the reference point on the roadway. Depth perception involves the lining up of two objects in a spatial relationship and thus is not used.

4. TDS Computer Clocking Configurations

There are five basic configurations in which a violating vehicle may be clocked. They are:

- The enforcement vehicle clocks a violating vehicle from a parked position.
- The enforcement vehicle clocks a violating vehicle which is approaching from the rear.
- The enforcement vehicle, which is approaching an intersection, clocks a violating vehicle which is crossing its path.
- The enforcement vehicle clocks a violating vehicle while following it in the same direction.
- The enforcement vehicle clocks a violating vehicle which is approaching in an opposing lane.

5. Methods for Clocking Violating Vehicles

There are many variations of each configuration; thus

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the number of ways a vehicle may be clocked is dependent upon the ingenuity of the operator. The following is an explanation of each configuration. Several variations of each will be given:

- <u>The enforcement vehicle clocks a violating vehicle from a parked position</u>.

  (A) The enforcement vehicle parks and clocks passing violators. The operator selects two reference points on the roadway that he can see clearly from a selected location off the roadway. The operator then measures the distance between the two reference points. By turning the distance lock toggle switch on, the distance is locked into the computer. The time switch is turned on when the violating vehicle reaches the first reference point. The time switch is turned off when the violating vehicle reaches the second reference point. Since the distance has been locked into the computer, the computer can be reset and still retain the distance for additional clocks between the same two points.

  PROCEDURE: (See Figure III.3)

  (1) The TDS operator locates two reference points, then puts the distance in the computer, locks the distance into the computer and locates the enforcement vehicle off the roadway such that both reference points are clearly visable.

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(2) The time switch is turned on when a violating vehicle reaches the first reference point.

(3) The time switch is turned off when the violating vehicle reaches a second reference point.

*Note: In using this method the computer is cleared, after each clock, of the time only. The distance between the two reference points is locked into the computer. When the reference points extend across the roadway, traffic may be clocked in either direction.

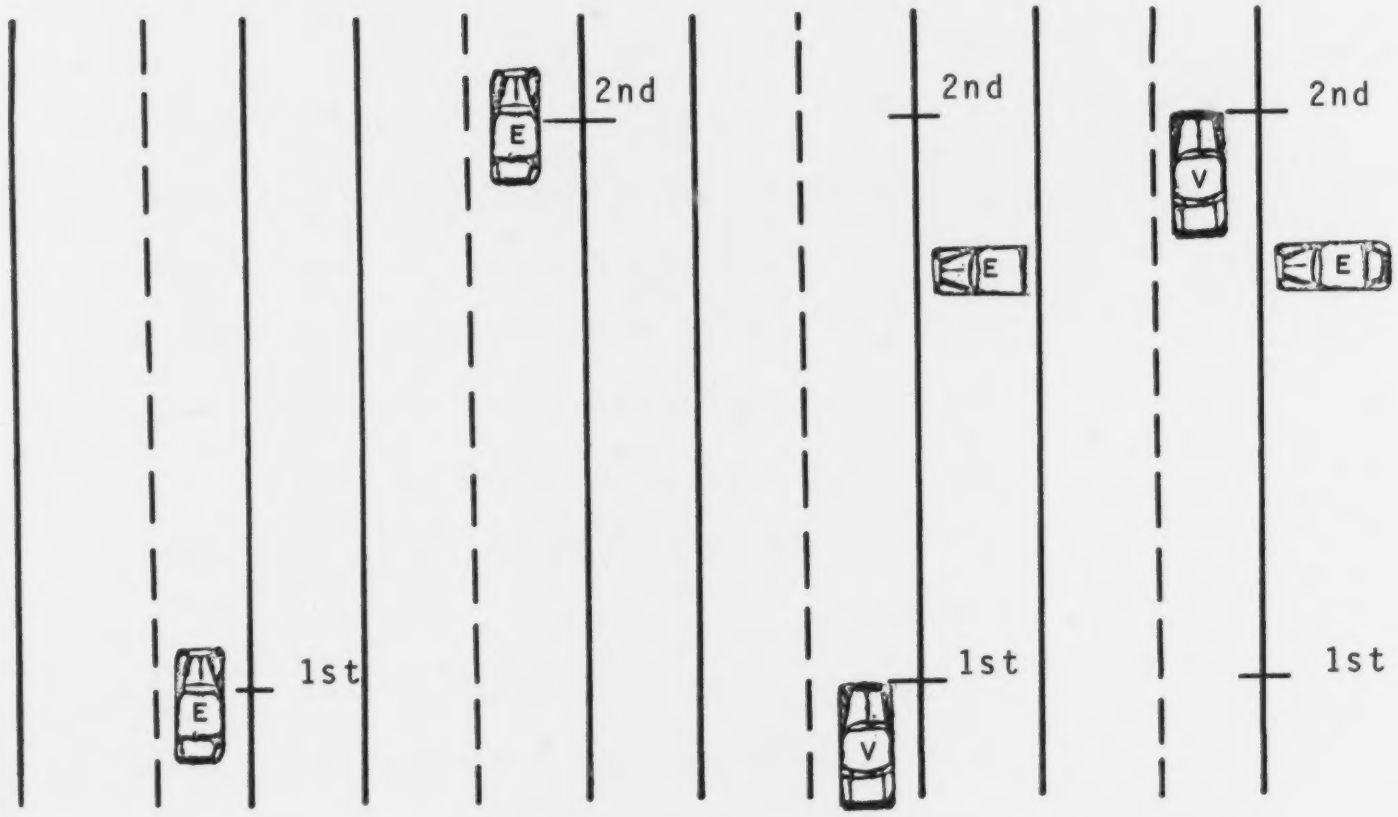

Figure III.3

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(B) The enforcement vehicle parks, using itself as the second reference point. The operator turns on the distance switch and travels for some distance. He then parks alongside the road and turns the distance switch off and locks distance into the computer. The time switch is turned on when a violating vehicle reaches the reference point. The time switch is turned off when the violating vehicle is abreast of the enforcement vehicle. The computer may be reset and used continuously, utilizing the same reference points.

PROCEDURE: (See Figure III.4)

(1) The TDS operator locates a reference point and turns on the distance switch.

(2) The TDS operator proceeds to a point one-tenth of a mile away or more. He then parks the enforcement vehicle such that the first reference point is clearly visible and locks the distance into the computer.

(3) The time switch is turned on when a violating vehicle reaches the first reference point.

(4) The time switch is turned off when the violating vehicle reaches a point directly abreast of the enforcement vehicle.

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*Note: Traffic can be clocked in either direction when the first reference point extends across the roadway.

(C) The TDS operator uses one reference point on the roadway, parks the enforcement vehicle and uses the vehicle as the second reference point in clocking one violating vehicle. The enforcement vehicle is being followed by a violating vehicle. The distance switch is turned on when the enforcement vehicle reaches a reference point. The time switch is turned on when the violating vehicle reaches the same reference point. The enforcement vehicle then pulls off the road and turns off the distance switch. The time switch is turned off when the violating vehicle is abreast of the enforcement vehicle.

PROCEDURE: (See Figure III.4)

(1) The distance switch is turned on when the enforcement vehicle reaches the first reference point.

(2) The time switch is turned on when the violating vehicle reaches the same reference point.

(3) The enforcement vehicle then pulls off the road and parks.

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(4) Both the time and distance switches are turned off when the violating vehicle is abreast of the enforcement vehicle.

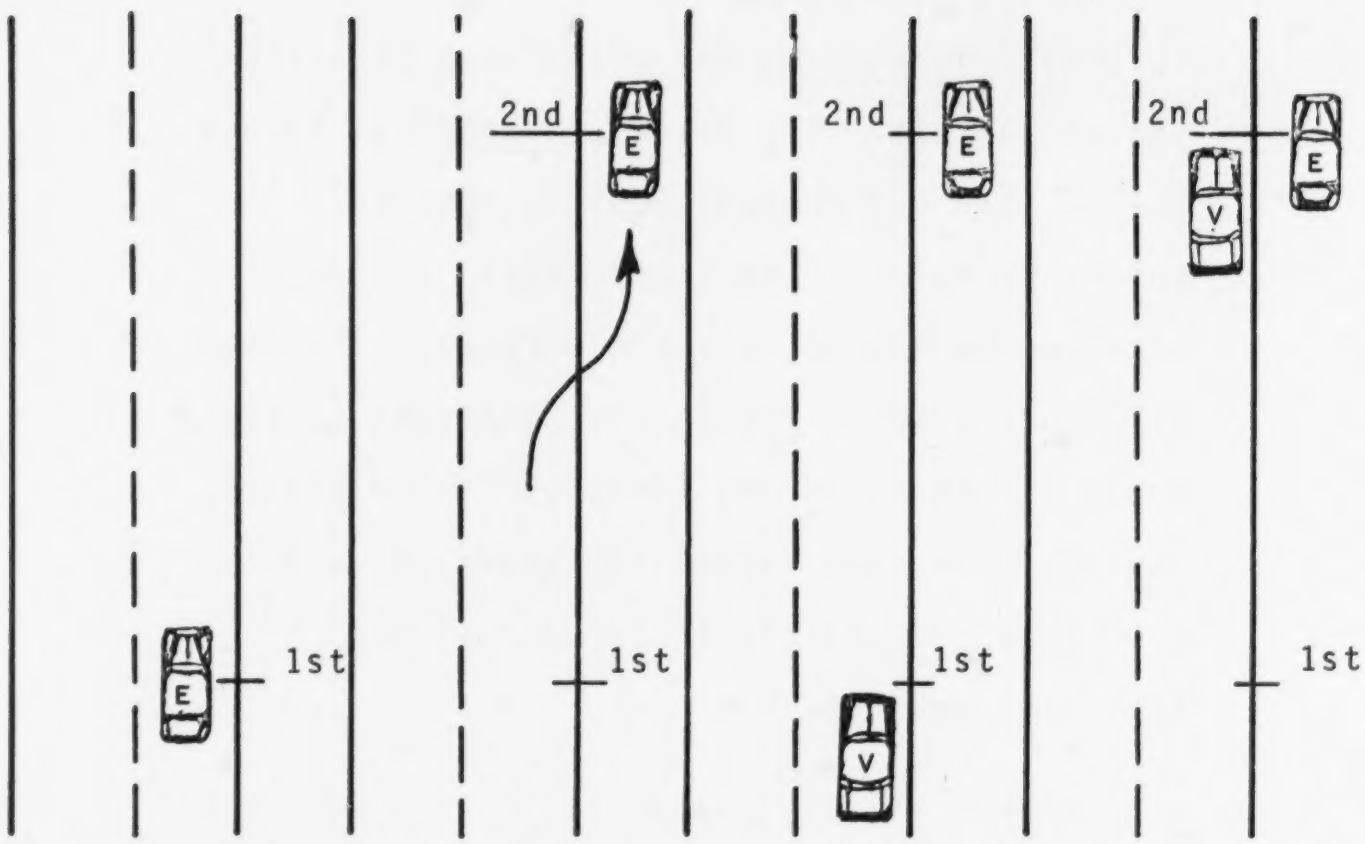

Figure III.4

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(D) The TDS operator uses triangulation in locating reference points. He then measures the distance between the reference points and locks it into the computer. The enforcement vehicle parks and measures the time consumed by the violating vehicle between the same two points.

PROCEDURE: (See Figure III.5)

(1) The TDS operator locates a natural triangular situation or creates his own. He may paint his marks on the road and use them for measuring distance. (Note: This situation, once created, may be used from day to day.)

(2) The time switch is turned on when a violating vehicle reaches the first reference point.

(3) The time switch is turned off when the violating vehicle reaches the second reference point.

*Note: The use of this reference point situation is the same in theory as sighting down the sights of a rifle. The many uses of this situation are limited only to the ingenuity of the operator.

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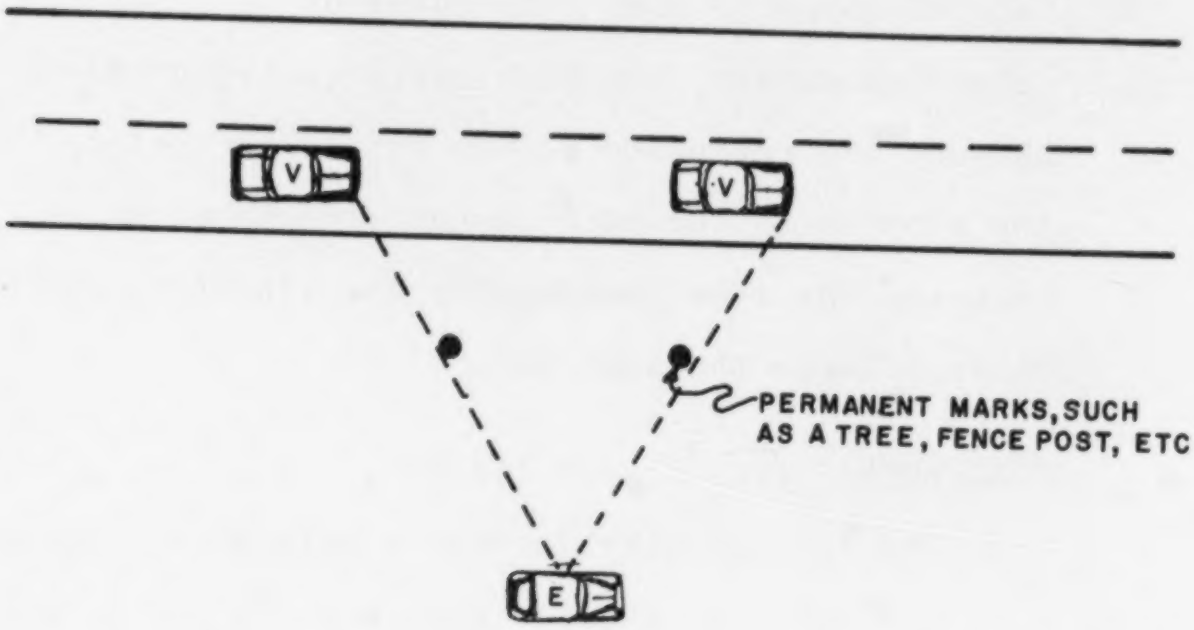

Figure III.5

- <u>The enforcement vehicle clocks the violating vehicle which is approaching from the rear</u>.

  (A) In this clock, the distance switch is used first. Utilizing the rear view mirror, the operator observes a violating vehicle approaching at a high rate of speed. The distance switch is turned on when the enforcement vehicle reaches a reference point. The time switch is turned on when the violating vehicle reaches the same reference point. The distance switch is turned off when the enforcement vehicle reaches the second reference point. The time switch is turned off when the violating vehicle reaches the second reference point.

PROCEDURE: (See Figure III.6)

(1) The TDS operator locates a first reference point and turns on the distance switch.

(2) The time switch is turned on when the violating vehicle reaches the first reference point.

(3) The TDS operator locates a second reference point and turns off the distance switch.

(4) The time switch is turned off when the violating vehicle reaches the second reference point.

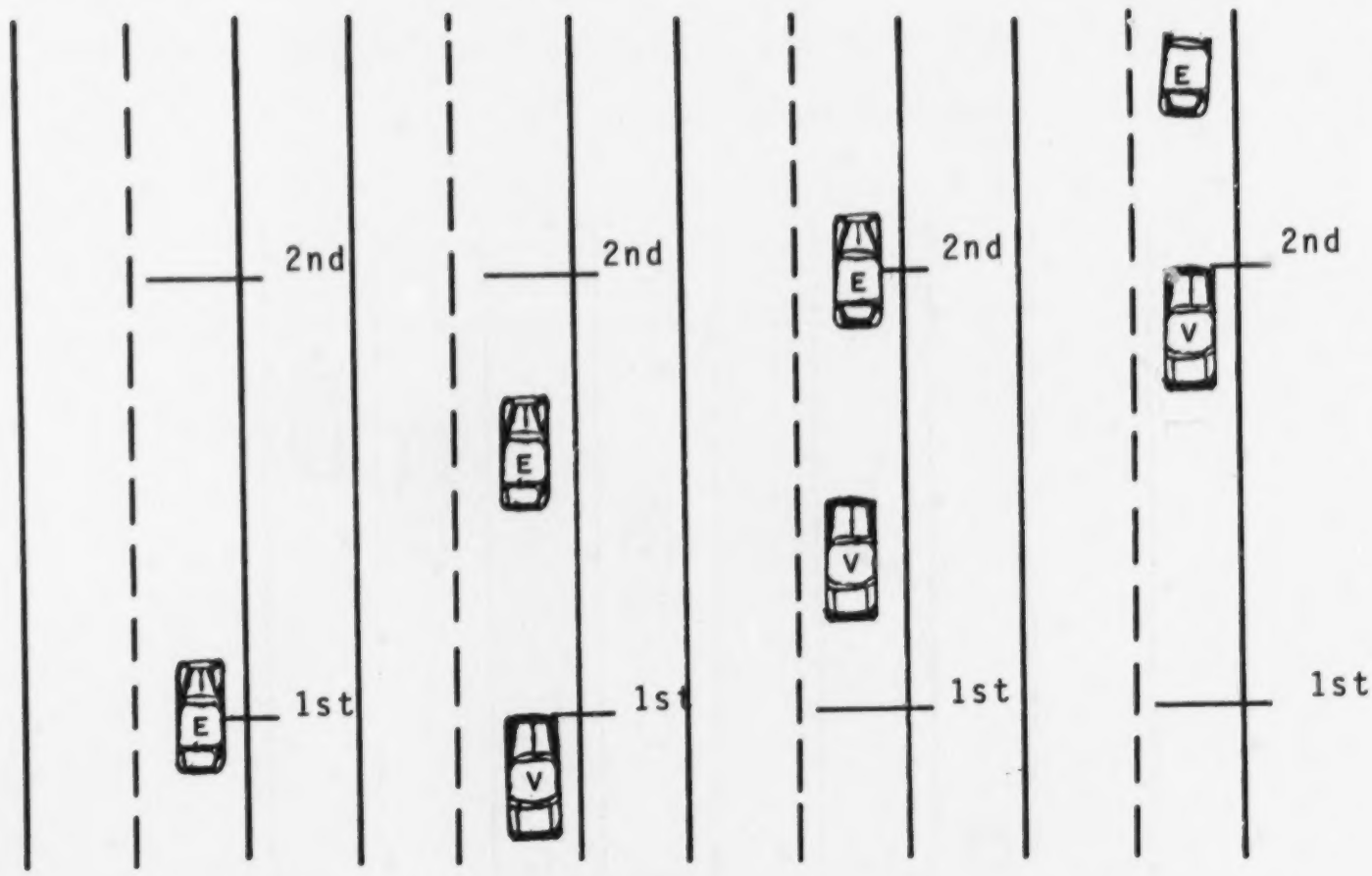

Figure III.6

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(B) The enforcement vehicle clocks a violating vehicle approaching from the rear, using one reference point on the roadway and using as the second reference point where the violating vehicle passes abreast of the enforcement vehicle.

PROCEDURE: (See Figure III.7)

(1) The TDS operator locates the first reference point and turns on the distance switch.

(2) The time switch is turned on when the violating vehicle reaches the first reference point.

(3) Both the time and distance switches are turned off when the violating vehicle gets abreast of the enforcement vehicle.

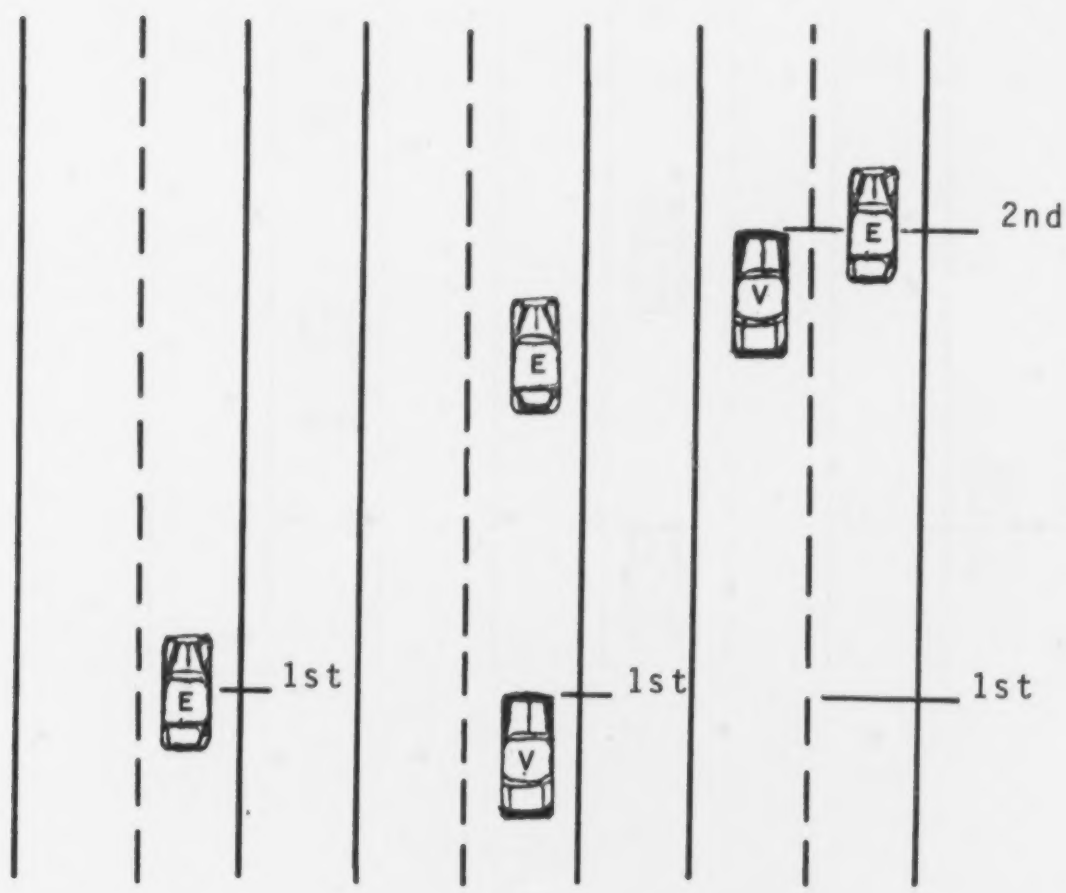

Figure III.7

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Safety Rules for Portable Electric Drills

1. Select the proper size drill bit and drill motor. Make sure the bit is sharp.

2. Before plugging in the power cord, insert the drill in the chuck and tighten the chuck securely with the key. Remove the key.

3. Making sure the ground connection is in place, plug in the power cord.

4. Secure the work with clamps or in a vise.

5. Keep hands away from chuck and drill.

6. Hold drill firmly and turn on. Both hands are usually needed on the drill.

7. Apply straight and steady pressure.

8. Ease up on the pressure before the drill breaks through.

9. Remove drill from hole. Do not touch the drill bit--it may be very hot.

10. Remove the bit and return everything to the proper place after cleaning up.

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- <u>The enforcement vehicle, which is approaching an intersection, clocks the violating vehicle which is crossing its path</u>.

  This method may be used when the enforcement vehicle pulls up to an intersection and the operator sees a violator going past, but he is unable to pull out into traffic and obtain a clock. The time switch is turned on when the violating vehicle reaches a reference point past the intersection. The time switch is turned off when the violating vehicle reaches a second reference point. Thus, time has been recorded in the computer. The TDS operator pulls out of the intersection and measures distance while in pursuit.

  PROCEDURE: (See Figure III.8)

  (1) The time switch is turned on and the enforcement vehicle starts the time measure when the violating vehicle reaches a reference point at the end of the intersection or a point past the intersection.

  (2) The time switch is turned off when the violating vehicle reaches a second reference point.

  (3) The enforcement vehicle pulls out and turns on the distance switch at the first reference point, while in pursuit.

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(4) The enforcement vehicle reaches the second reference point and turns off the distance switch.

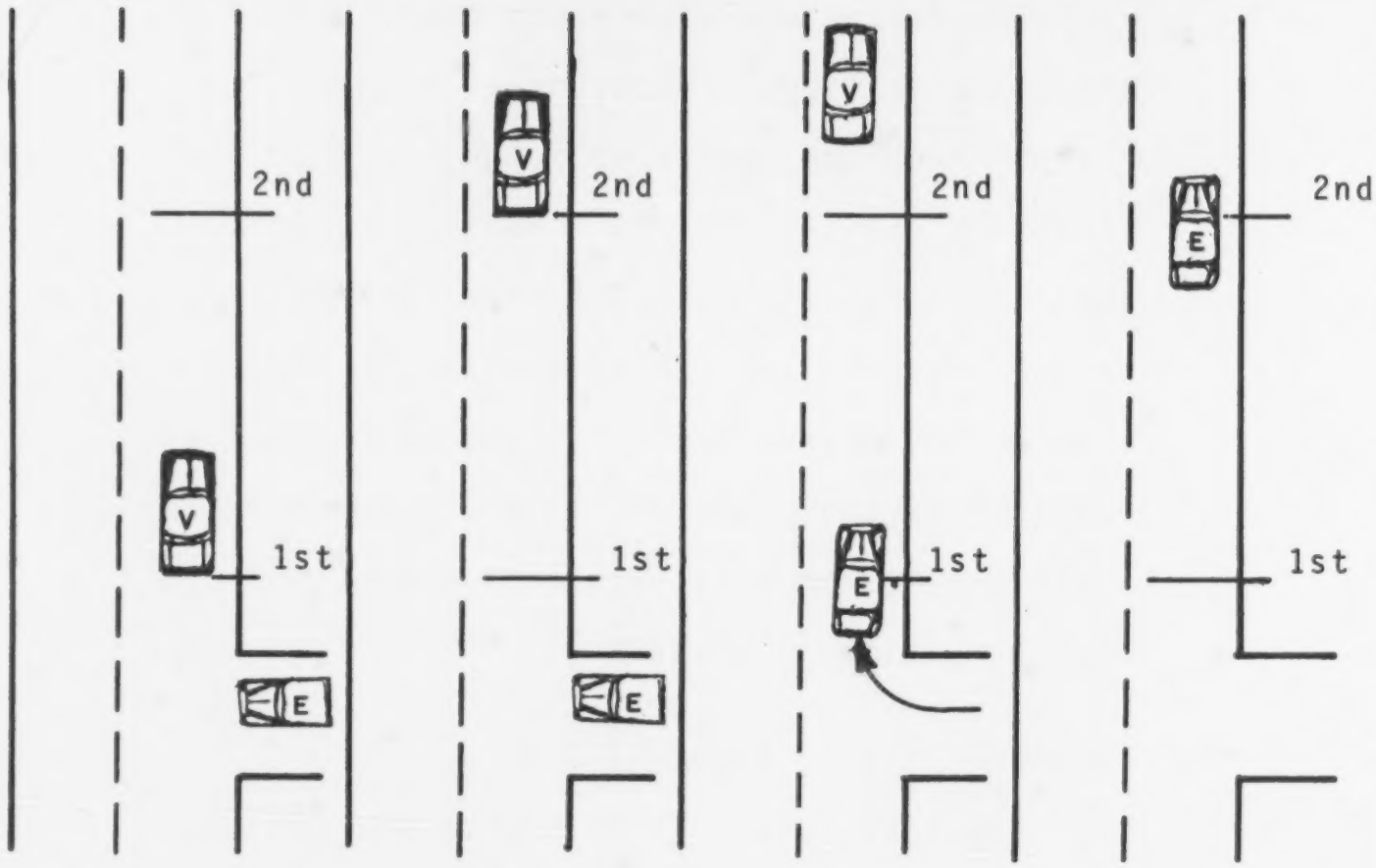

Figure III.8

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- <u>The enforcement vehicle follows the violating vehicle in the same direction</u>.

(A) The TDS Computer may be used in regular pacing just as the regular speedometer method. In this method, the time and distance switches are turned on simultaneously and turned off simultaneously. No reference points are used. The distance between the violating vehicle and the enforcement vehicle at the beginning of the clock and at the finish of the clock must be approximately the same. The TDS Computer gives the average speed of the enforcement vehicle. Since the distance between the two vehicles was the same at the beginning and end of the clock, the two vehicles were traveling at the same average rate of speed.

PROCEDURE: (See Figure III.9)

(1) The enforcement vehicle gets in a relative position behind the violating vehicle and turns on the distance and time switches simultaneously.

(2) The enforcement vehicle obtains the same relative position behind the violating vehicle after one-tenth of a mile or more and turns off the time and distance switches

simultaneously, thus computing the average speed of both vehicles.

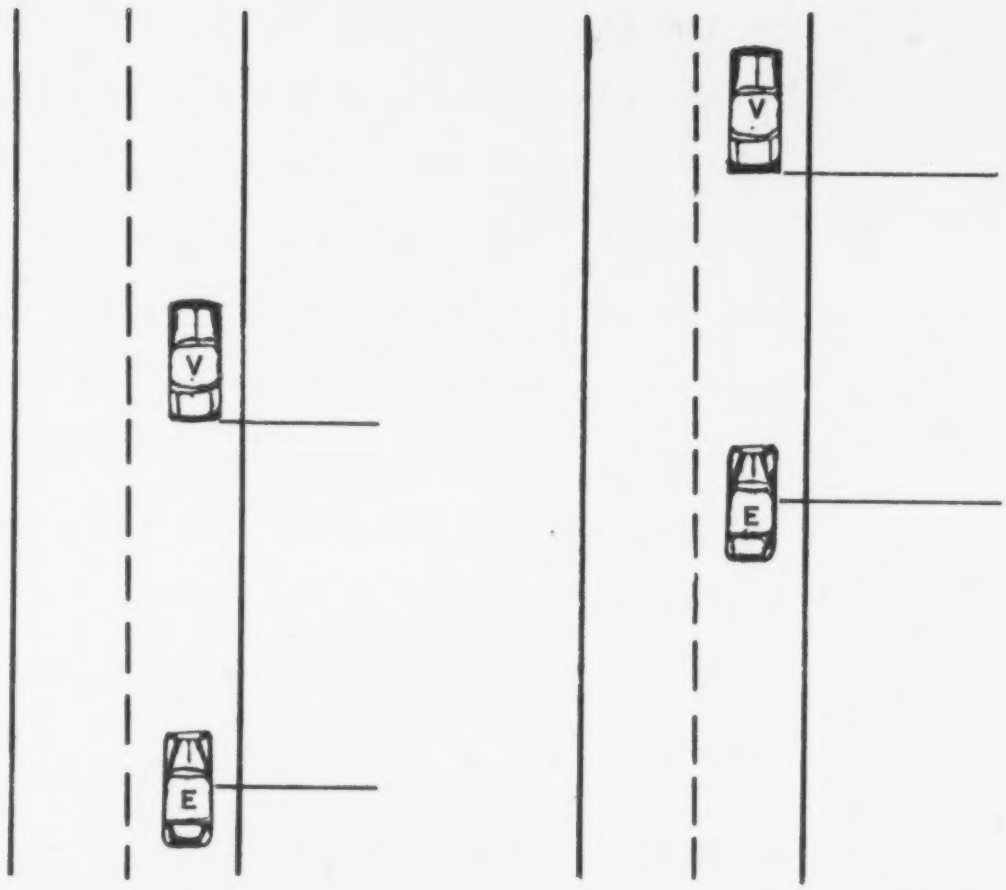

Figure III.9

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(B) The enforcement vehicle follows the violating vehicle, using two reference points. The time switch is turned on when the violating vehicle reaches the first reference point. The distance switch is turned on when the enforcement vehicle reaches the same reference point. The time switch is turned off when the violating vehicle reaches the second reference point. The distance switch is turned off when the enforcement vehicle reaches the second reference point. It might be noted that the distance between the two vehicles need not be maintained. The speed of the two vehicles need not be the same. It is necessary to be consistent when using the front or rear of the violating vehicle as it crosses the reference points. The same holds true for the enforcement vehicle.

PROCEDURE: (See Figure III.10)

(1) The time switch is turned on when the violating vehicle reaches the first reference point.

(2) The distance switch is turned on when the enforcement vehicle reaches the first reference point.

(3) The time switch is turned off when the

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violating vehicle reaches the second reference point.

(4) The distance switch is turned off when the enforcement vehicle reaches the second reference point.

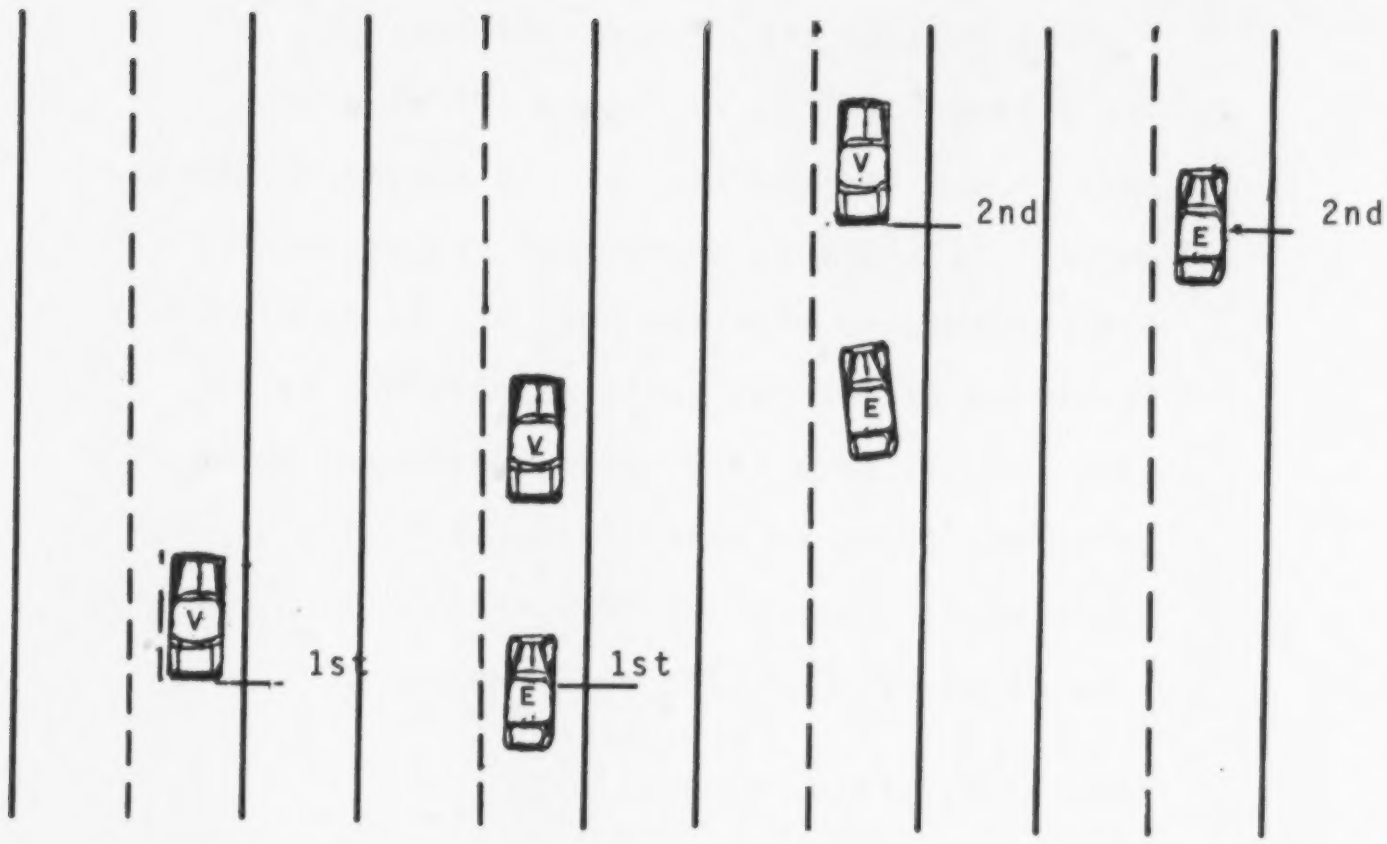

Figure III.10

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(C) This method is identical with number B above except that the time is measured completely before the distance is measured. In all cases, the time is determined by the violating vehicle and the distance is measured by the enforcement vehicle.

PROCEDURE: (See Figure III.11)

(1) The time switch is turned on when the violating vehicle reaches the first reference point.

(2) The time switch is turned off when the violating vehicle reaches the second reference point.

(3) While in pursuit, the distant switch is turned on when the enforcement vehicle reaches the first reference point.

(4) While in pursuit, the distance switch is turned off when the enforcement vehicle reaches the second reference point.

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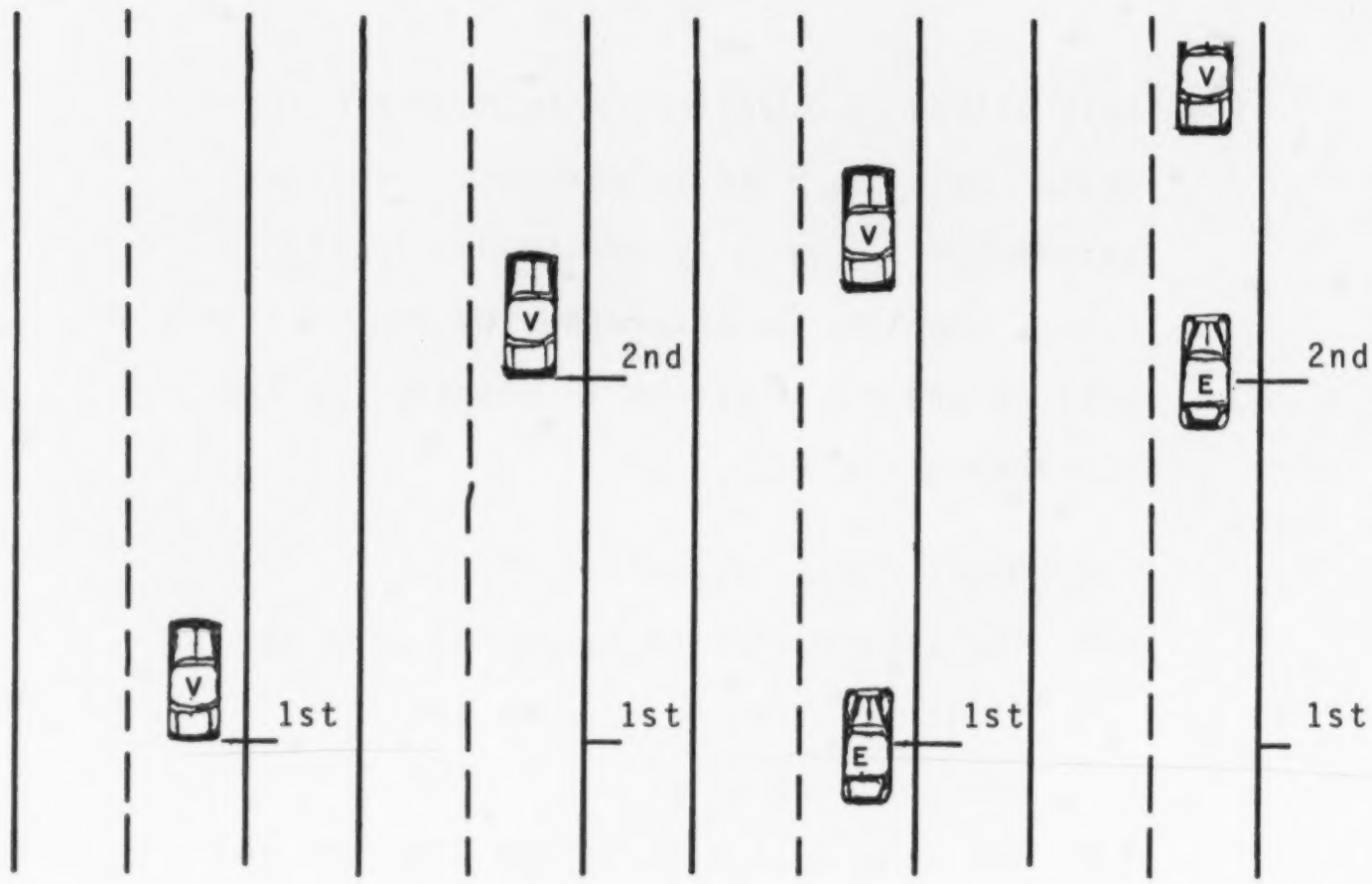

Figure III.11

- <u>The enforcement vehicle clocks a violating vehicle which is approaching in an opposing lane</u>.

  (A) The enforcement vehicle begins the time measure first and uses itself as the second reference point. The TDS operator sees an approaching vehicle and turns on the time switch when the violating vehicle reaches a reference point. The violating vehicle and the enforcement vehicle continue toward each other and, as they are abreast, the time switch is turned off and the distance switch is turned on simultaneously. The enforcement vehicle continues to the first

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reference point, where he turns off the distance switch.

PROCEDURE: (See Figure III.12)

(1) The time switch is turned on when the violating vehicle reaches the first reference point.

(2) The time switch is turned off and the distance switch is turned on when the violating vehicle and the enforcement vehicle are abreast of each other.

(3) The enforcement vehicle proceeds to the first reference point and turns the distance switch off. He then turns around in pursuit.

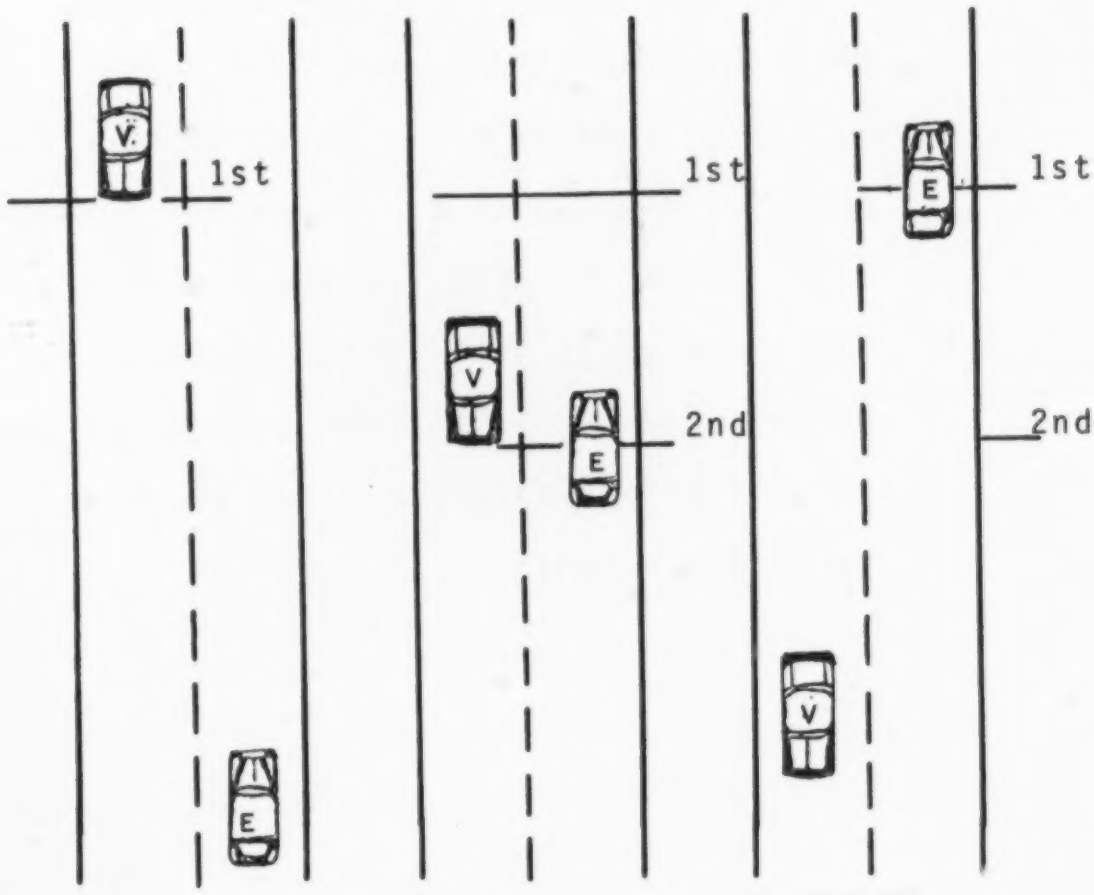

Figure III.12

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(B) The enforcement vehicle begins measuring distance first and uses itself as the second reference point. The enforcement vehicle reaches a reference point and the distance switch is turned on. The two vehicles meet and the distance switch is turned off and simultaneously the time switch is turned on. The violating vehicle continues to the first reference point, at which time the TDS operator turns off the time switch.

PROCEDURE: (See Figure III.13)

(1) The distance switch is turned on when the enforcement vehicle reaches a reference point.

(2) When the enforcement vehicle and the violating vehicle are abreast of each other, the distance switch is turned off and the time switch is turned on simultaneously.

(3) The enforcement vehicle turns around in pursuit and turns the time switch off when the violating vehicle reaches the first reference point.

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Safety Rules for the Bar Folder and Box and Pan Brake

1. Remove sharp burrs and edges from sheet metal before attempting to handle it in machines.

2. Do not attempt to bend metal which is heavier than the capacity of the machine.

3. Check machine and adjust it as necessary. Ask your teacher to check your setup.

4. Keep hands clear of moving parts.

5. Do not bend more than one thickness of metal.

6. Do not slam or drop handles.

7. Make sure moving parts do not strike anyone.

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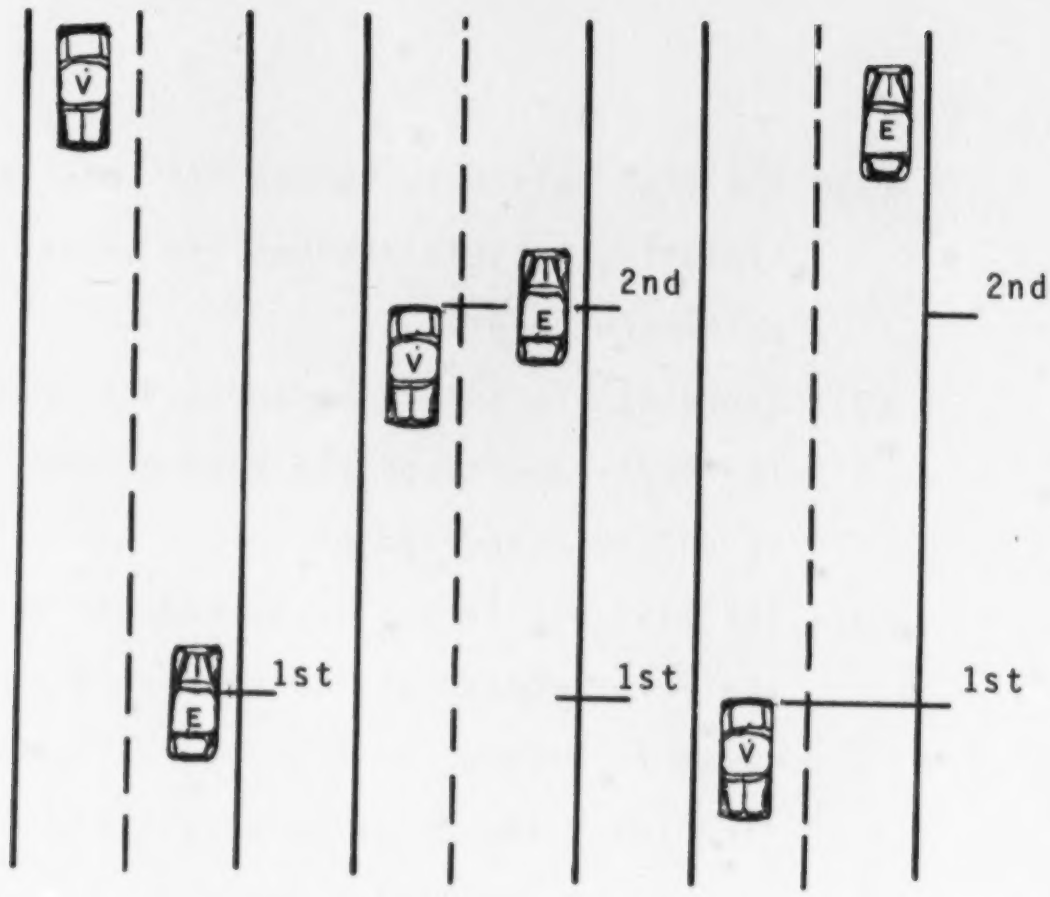

Figure III.13

(C) The enforcement vehicle measures the time completely; then the distance is measured. The time switch is turned on when the violating vehicle reaches a reference point on the roadway. The time switch is turned off at a second reference point. The distance switch is turned on when the enforcement vehicle reaches the second reference point. The distance switch is turned off when the first reference point is reached.

PROCEDURE: (See Figure III.14)

(1) The time switch is turned on when the violating vehicle reaches the first reference point.

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(2) The time switch is turned off when the violating vehicle reaches the second reference point.

(3) The distance switch is turned on when the enforcement vehicle reaches the second reference point.

(4) The distance switch is turned off when the enforcement vehicle reaches the first reference point. The TDS operator then turns the enforcement vehicle and pursues the violating vehicle.

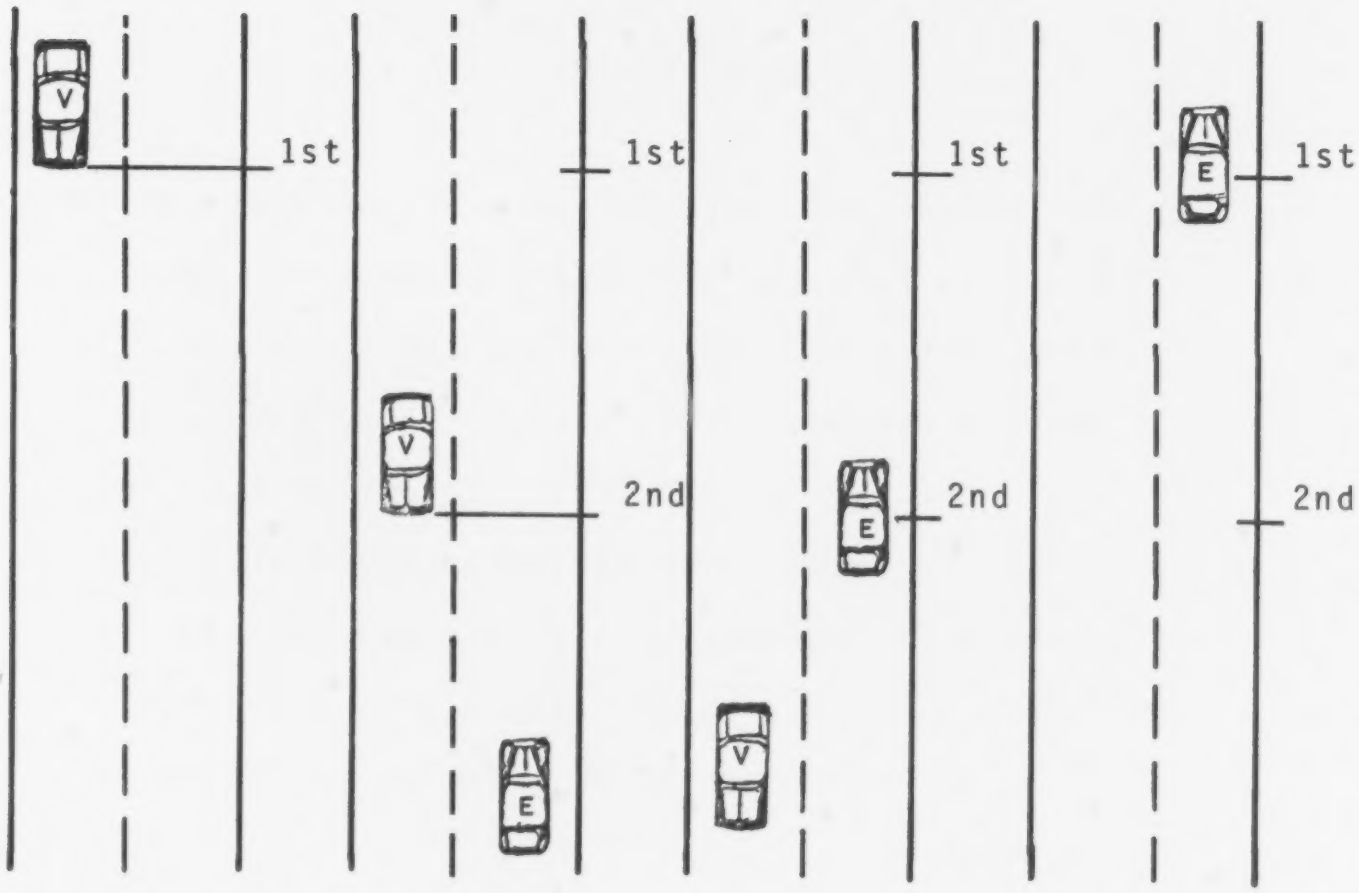

Figure III.14

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(D) The enforcement vehicle measures the distance completely and then measures the time. This method is the reverse of method C.

PROCEDURE: (See Figure III.15)

(1) The distance switch is turned on when the enforcement vehicle reaches the first reference point.

(2) The distance switch is turned off when the enforcement vehicle reaches the second reference point.

(3) The time switch is turned on when the violating vehicle reaches the second reference point.

(4) The time switch is turned off when the violating vehicle reaches the first reference point.

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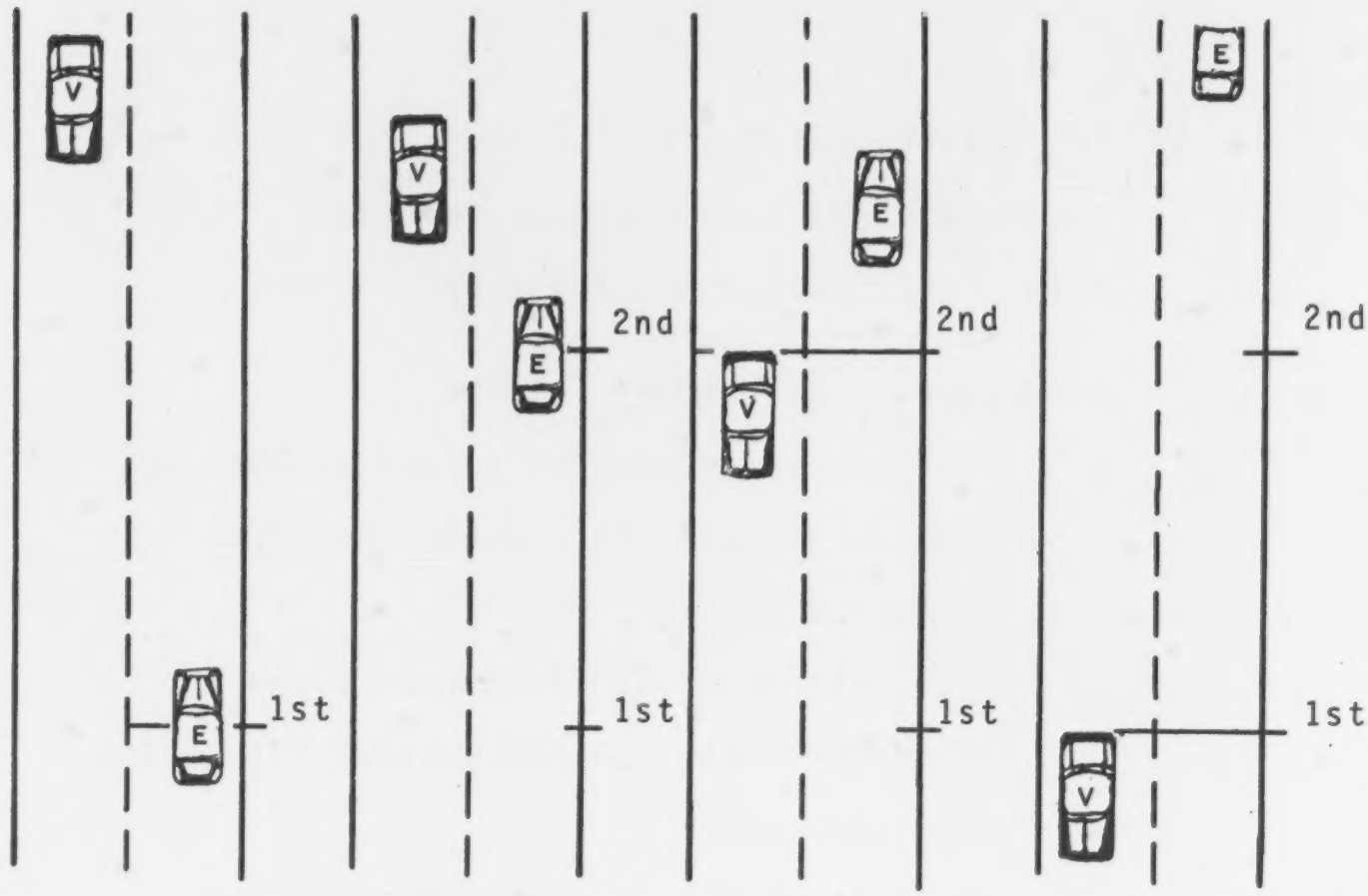

Figure III.15

(E) The enforcement vehicle begins measuring the time, then turns around and completes the clock. Thus, the time switch is turned on when the violating vehicle reaches a reference point. The two vehicles meet and the enforcement vehicle continues until it is past the first reference point; it then makes a "U" turn and proceeds in the same direction as the violating vehicle. The distance switch is turned on when the enforcement vehicle reaches the reference point. The time switch is turned off as the violating vehicle reaches the second reference point. The distance switch is turned off at the second reference point.

PROCEDURE: (Figure III.16)

(1) The time switch is turned on when the violating vehicle reaches the first reference point.

(2) The enforcement vehicle turns around and pursues the violating vehicle. The TDS operator turns on the distance switch when his enforcement vehicle reaches the first reference point.

(3) The time switch is turned off when the violating vehicle reaches the second reference point.

(4) The distance switch is turned off when the enforcement vehicle reaches the second reference point.

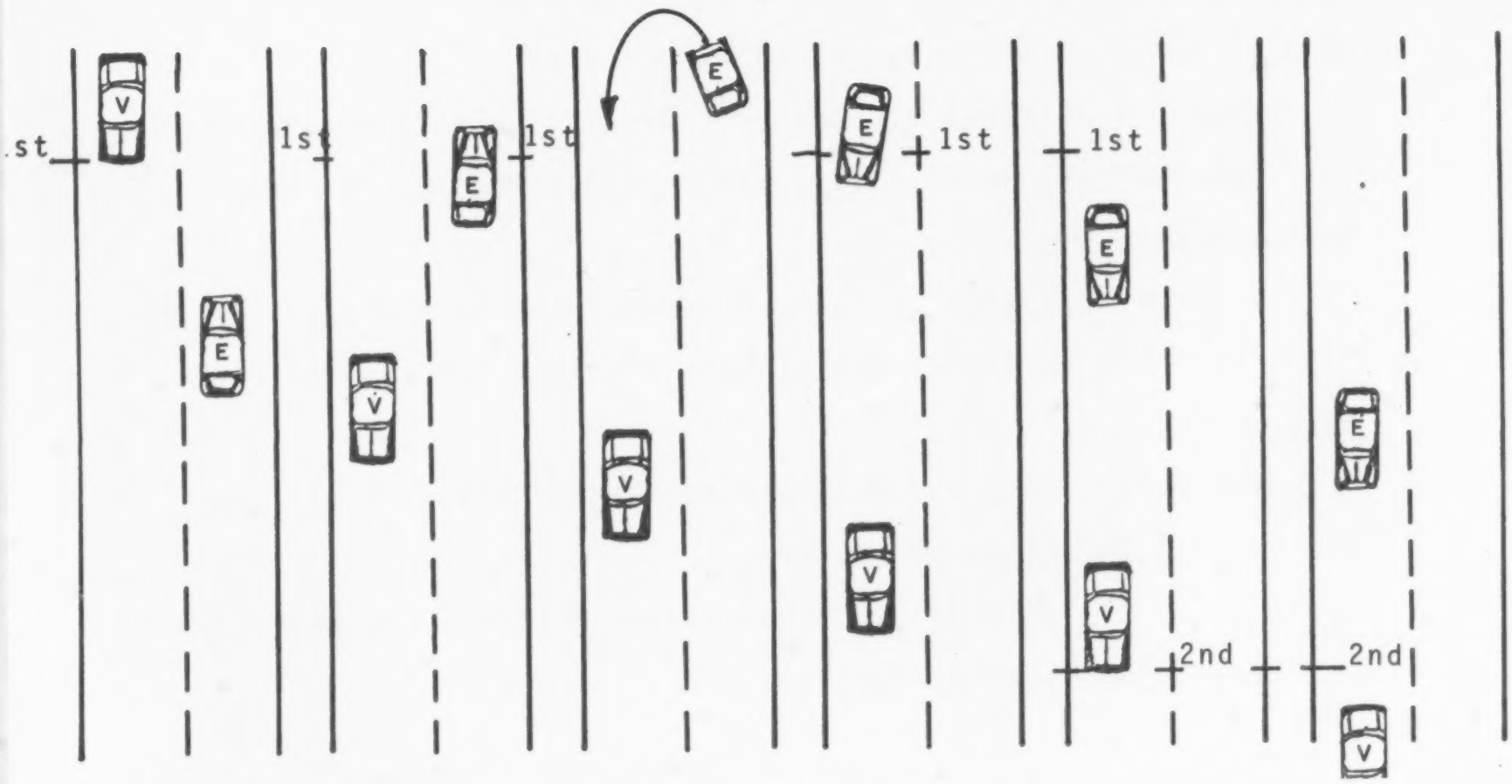

Figure III.16

6. Calibrating the TDS

The TDS has provision for allowing the correct entry of distance into the Distance Storage Register despite:

1. Differences in tire and wheel sizes of various automobiles.
2. Changes in tire pressure, wear, load, or any other factor that could cause a change in the wheel diameter of an automobile.

The calibration of the TDS is accomplished with the aid of six slide switches located on the left hand side of the main computer, near the front panel and beneath the small plate provided for covering the switches. The cover is held on by two screws, one of which can be removed and the plate swung aside for easy access to the calibration switches.

In order to more clearly understand the calibration procedure, the following discussion is offered as an aid. The discussion will be based on the measurement of one exact mile.

When all switches are pushed rearward toward the rear of the TDS (the "ON" position) the lowest possible reading for one measured mile will result.

When all switches are pushed forward toward the front of the TDS (the "OFF" position) the highest possible reading for one measured mile will result.

EXAMPLES: With all switches forward ("OFF") one mile may read 1,200 miles on the TDS.

With all switches rearward ("ON") one mile may read .640 miles on the TDS.

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The idea is to get a combination of switch positions, that will accurately indicate one exact mile on the TDS display, for one exact mile measured. However, each switch affects the reading by a different amount.

The switches are numbered 1 through 6 from bottom to top. The top switch, #6, affects the reading by twice the amount of the second switch from the top, #5, and #5 affects the reading by twice as much as #4 and so on.

EXAMPLES: A one mile reading with all switches "ON" may be .640 miles on the TDS.

If the top switch, #6, is moved "OFF" and the mile rerun, the reading will be about .900 miles, a difference of .260 from the .640 mile reading above. If the #6 switch is moved "ON" and the #5 switch is moved "OFF" and the mile rerun, the new reading will be .770 miles, a difference of .130 from the .640 mile reading above and half the difference of .260 caused by the #6 switch.

From the foregoing discussion, it can be seen that moving a switch rearward, ("ON"), subtracts from the reading, moving a switch forward, ("OFF"), adds to the reading. Furthermore the switches have the following approximate values over a one mile distance:

Switch Number	Value
6	.256
5	.128
4	.064
3	.032
2	.016
1	.008

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Over a one quarter mile distance the switches will give one fourth of the above changes as follows:

Switch Number	Value
6	.064
5	.032
4	.016
3	.008
2	.004
1	.002

In order to add or subtract any given number to a distance reading, it will be necessary to move at least one switch and perhaps two or more. The next part of Section 6 on Initial Calibration is given as a guide to calibrating.

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6A. Initial Calibration

The initial calibration procedure must be carried out when the computer is first installed and at any subsequent time when a routine calibration check shows the calibration to be out of tolerance (as set forth in the calibration check procedure). The initial calibration is carried out as follows:

a. Open the calibration switch cover located on the left hand side of the main computer near the front panel. Inside will be six slide switches numbered one through six from bottom to top, respectively. Initially, set the switches as follows:

Switch Number	Position *
6	OFF
5	ON
4	ON
3	OFF
2	OFF
1	OFF

b. With the calibration switches set in the above positions, run a measured quarter-mile in the following manner: With the computer erased and ready

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*Note: "OFF" is the forward position of the switch
"ON" is the rearward position of the switch

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to accept a set of readings, stop well ahead of the beginning quarter-mile mark. Start the car and bring it up to approximately 25 MPH. Turn on the distance switch when abreast of the beginning quarter mile mark. Drive approximately 25 MPH speed to the end mark and stop. Turn OFF the distance switch. With the readout selector switch in the distance (MILES) position, sequence the time switch ON then OFF so that the distance readout will appear. Record the distance reading.

c. From the Calibration Table (See Figure III.17), re-position the calibration switches as shown in the column corresponding to the distance reading obtained above.

d. The computer is now ready for a calibration check.

NOTE: To use a measured half-mile or measured mile for calibration, divide the obtained distance reading by two for the half-mile reading or by four for the mile reading, and use the resulting number with the calibration table.

Safety Rules for the Metal Shear

1. Check setup of machine.
2. Do not attempt to cut metal heavier than capacity of machine.
3. Cut narrow strips of metal crosswise only.
4. Stand directly in front of machine.
5. Feed metal from the front (operator's position)
6. Keep your fingers away from the pressure bar and the blade.
7. Keep the foot that is not being used on the treadle back out of the way.
8. Do not catch small pieces--let them drop.
9. Use care in handling trimmings--they may be sharp.

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CALIBRATION TABLE
(Page 1 of 2)

SWITCH NUMBER \ READING	203	206	209	212	215	218	221	224	227	230	233	236	239
1	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON
2	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF	ON	ON
3	OFF	OFF	ON	ON	ON	OFF	OFF	ON	ON	ON	OFF	OFF	OFF
4	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	OFF	OFF	OFF
5	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

SWITCH NUMBER \ READING	204	207	210	213	216	219	222	225	228	231	234	237	240
1	ON	OFF	OFF	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF
2	OFF	ON	OFF	ON	OFF	OFF	ON	OFF	ON	ON	OFF	ON	OFF
3	OFF	OFF	ON	ON	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	ON
4	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF
5	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

SWITCH NUMBER \ READING	205	208	211	214	217	220	223	226	229	232	235	238	241
1	ON	ON	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF
2	OFF	ON	OFF	ON	OFF	ON	ON	OFF	ON	OFF	OFF	ON	OFF
3	OFF	OFF	ON	ON	OFF	OFF	OFF	ON	ON	OFF	OFF	OFF	ON
4	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	OFF	OFF	OFF	OFF
5	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON
6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

Figure III.17

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CALIBRATION TABLE
(Page 2 of 2)

SWITCH NUMBER	READING	242	245	248	251	254	257	260	263	266	269	272	275
	1	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	ON	OFF	ON
	2	OFF	ON	ON	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF
	3	ON	ON	ON	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF
	4	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	OFF	OFF
	5	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	OFF	OFF
	6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON

SWITCH NUMBER	READING	243	246	249	252	255	258	261	264	267	270	273	276
	1	ON	OFF	OFF	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF
	2	OFF	ON	OFF	OFF	ON	ON	OFF	ON	ON	OFF	OFF	ON
	3	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	OFF	OFF	OFF
	4	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF
	5	ON	ON	ON	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF
	6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON

SWITCH NUMBER	READING	244	247	250	253	256	259	262	265	268	271	274	277
	1	ON	ON	OFF	ON	OFF	OFF	ON	OFF	ON	OFF	ON	OFF
	2	OFF	ON	OFF	OFF	ON	OFF	OFF	ON	ON	OFF	OFF	ON
	3	ON	ON	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF
	4	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF
	5	ON	ON	ON	ON	ON	ON	ON	ON	ON	OFF	OFF	OFF
	6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON

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7. Calibration Check

Before each tour of duty, a routine calibration check must be performed. This is done as follows: With the computer erased and ready to accept a set of readings, stop well ahead of the beginning measured quarter-mile mark (a measured half-mile or mile may also be used). Bring the car up to approximately 25 MPH. Turn ON the distance switch, when abreast of the beginning quarter-mile mark. Drive at approximately 25 MPH speed to the end mark and turn OFF the distance switch. Using an accurate watch, enter 15 seconds into the time register (enter 30 seconds for a measured half-mile or 60 seconds for a measured mile).

To be within tolerance the distance reading must agree with the measured distance within 1/4 of 1%. (i.e. .250 ± .001, .500 ± .002, or 1.000 ± .004) It has been found that an experienced operator can enter time into the computer usually within two-tenths of a second. If the time is not within two-tenths of a second (i.e. 15.0 ± 0.2, 30.0 ± 0.2, or 60.0 ± 0.2), turn ON the distance lock, erase, and re-enter the required time.

(Note: The time generation technique used in the TDS Computer is highly stable and accurate. Any small difference between the watch reading and the computer time reading is due solely to the operator's inability to obtain absolute synchronization in starting and stopping the time devices.)

If the distance reading is not within the required

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1/4 of 1%, re-calibrate the distance as outlined in Section 6 of this chapter. A small time difference due to the reason given above (usually less than ± 0.2 seconds) is normal for an experienced operator. A large time difference (which is very unlikely) indicates a failure in the computer's clock circuit and, in this event, the device must be taken in for repair.

With the time and distance properly entered and in tolerance, the following charts showing the resulting miles-per-hour reading for given time and distance are used to verify that the computer is indeed computing properly.

Distance = 0.249

Time	MPH
14.8	60.1
14.9	59.7
15.0	59.3
15.1	59.0
15.2	58.6

Distance = 0.250

Time	MPH
14.8	60.5
14.9	60.1
15.0	59.6*
15.1	59.3
15.2	59.0

Distance = 0.251

Time	MPH
14.8	60.8
14.9	60.4
15.0	60.0
15.1	59.6
15.2	59.2

COMPUTATION CHECK - QUARTER-MILE CALIBRATION

* The MPH reading for a quarter-mile and 15 seconds is 59.6 rather than 60.0 due to automatic error compensation within the computer.

Distance = 0.498

Time	MPH
29.8	60.0
29.9	59.8
30.0	59.6
30.1	59.4
30.2	59.2

Distance = 0.499

Time	MPH
29.8	60.1
29.9	59.9
30.0	59.7
30.1	59.5
30.2	59.3

Distance = 0.500

Time	MPH
29.8	60.2
29.9	60.0
30.0	59.8
30.1	59.6
30.2	59.4

COMPUTATION CHECK -

HALF-MILE CALIBRATION

Distance = 0.501

Time	MPH
29.8	60.4
29.9	60.2
30.0	60.0
30.1	59.8
30.2	59.6

Distance = 0.502

Time	MPH
29.8	60.5
29.9	60.3
30.0	60.1
30.1	59.9
30.2	59.7

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Distance = .996

Time	MPH
59.8	59.9
59.9	59.8
60.0	59.7
60.1	59.6
60.2	59.5

Distance = .997

Time	MPH
59.8	59.9
59.9	59.8
60.0	59.7
60.1	59.6
60.2	59.5

Distance = .998

Time	MPH
59.8	60.0
59.9	59.9
60.0	59.8
60.1	59.7
60.2	59.6

Distance = .999

Time	MPH
59.8	60.0
59.9	59.9
60.0	59.8
60.1	59.7
60.2	59.6

Distance = 1.000

Time	MPH
59.8	60.1
59.9	60.0
60.0	59.9
60.1	59.8
60.2	59.7

Distance = 1.001

Time	MPH
59.8	60.2
59.9	60.1
60.0	60.0
60.1	59.9
60.2	59.8

Distance = 1.002

Time	MPH
59.8	60.2
59.9	60.1
60.0	60.0
60.1	59.9
60.2	59.8

Distance = 1.003

Time	MPH
59.8	60.3
59.9	60.2
60.0	60.1
60.1	59.9
60.2	59.8

Distance = 1.004

Time	MPH
59.8	60.3
59.9	60.2
60.0	60.1
60.1	59.9
60.2	59.8

COMPUTATION CHECK -

ONE MILE CALIBRATION

8. Error Analysis

Due to the digital nature of the TDS Computer, the time and distance readings can be in error by plus-or-minus one count. The TDS Computer gives the traffic violator the benefit of doubt by automatically subtracting the worst case error. The miles-per-hour reading of the TDS Computer is always within ± 1 MPH of the slowest possible speed corresponding to the time and distance readings. Some examples are:

a. Distance Reading = 0.100 miles

Time Reading = 3.2 seconds

MPH Reading = 109.0 MPH

MPH corresponding to time and distance readings is

$$\text{MPH} = \frac{0.100 \text{ miles}}{3.2 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 112.5 \text{ MPH}$$

Worst case error yields

$$\text{MPH} = \frac{0.099 \text{ miles}}{3.3 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 108.0 \text{ MPH}$$

b. Distance Reading = 1.000 miles

Time Reading = 60.0 seconds

MPH Reading = 59.9 MPH

MPH corresponding to time and distance readings is

$$\text{MPH} = \frac{1.000 \text{ miles}}{60.0 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 60.0 \text{ MPH}$$

Worst case error yields

$$\text{MPH} = \frac{0.999 \text{ miles}}{60.1 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 59.8 \text{ MPH}$$

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c. Distance Reading = 0.250 miles

Time Reading = 15.0 seconds

MPH Reading = 59.6 MPH

MPH corresponding to time and distance readings is

$$\text{MPH} = \frac{0.250 \text{ miles}}{15.0 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 60.0 \text{ MPH}$$

Worst case error yields

$$\text{MPH} = \frac{0.249 \text{ miles}}{15.1 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 59.4 \text{ MPH}$$

d. Distance Reading = 0.100 miles

Time Reading = 6.0 seconds

MPH Reading = 59.0 MPH

MPH corresponding to time and distance readings is

$$\text{MPH} = \frac{0.100 \text{ miles}}{6.0 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 60.0 \text{ MPH}$$

Worst case error yields

$$\text{MPH} = \frac{0.099 \text{ miles}}{6.1 \text{ seconds}} \times \frac{3600 \text{ seconds}}{\text{hour}} = 58.4 \text{ MPH}$$

Figure III.18 shows the worst case error and readout compensation versus speed for various clocking distances.

Since the device automatically compensates for its internal error, the only error to be considered by the enforcement officer is the error in judging coincidence between the violator's vehicle and the reference point. The Error Factor Chart of Figure III.19 gives the error in MPH versus the error in distance (i.e. error in coincidence), as a function of measured speed and total clocking distance. This is calculated from the formula:

$$\text{MPH ERROR} = \frac{\text{DISTANCE ERROR}}{\text{CLOCKING DISTANCE}} \times \text{MEASURED MPH}$$

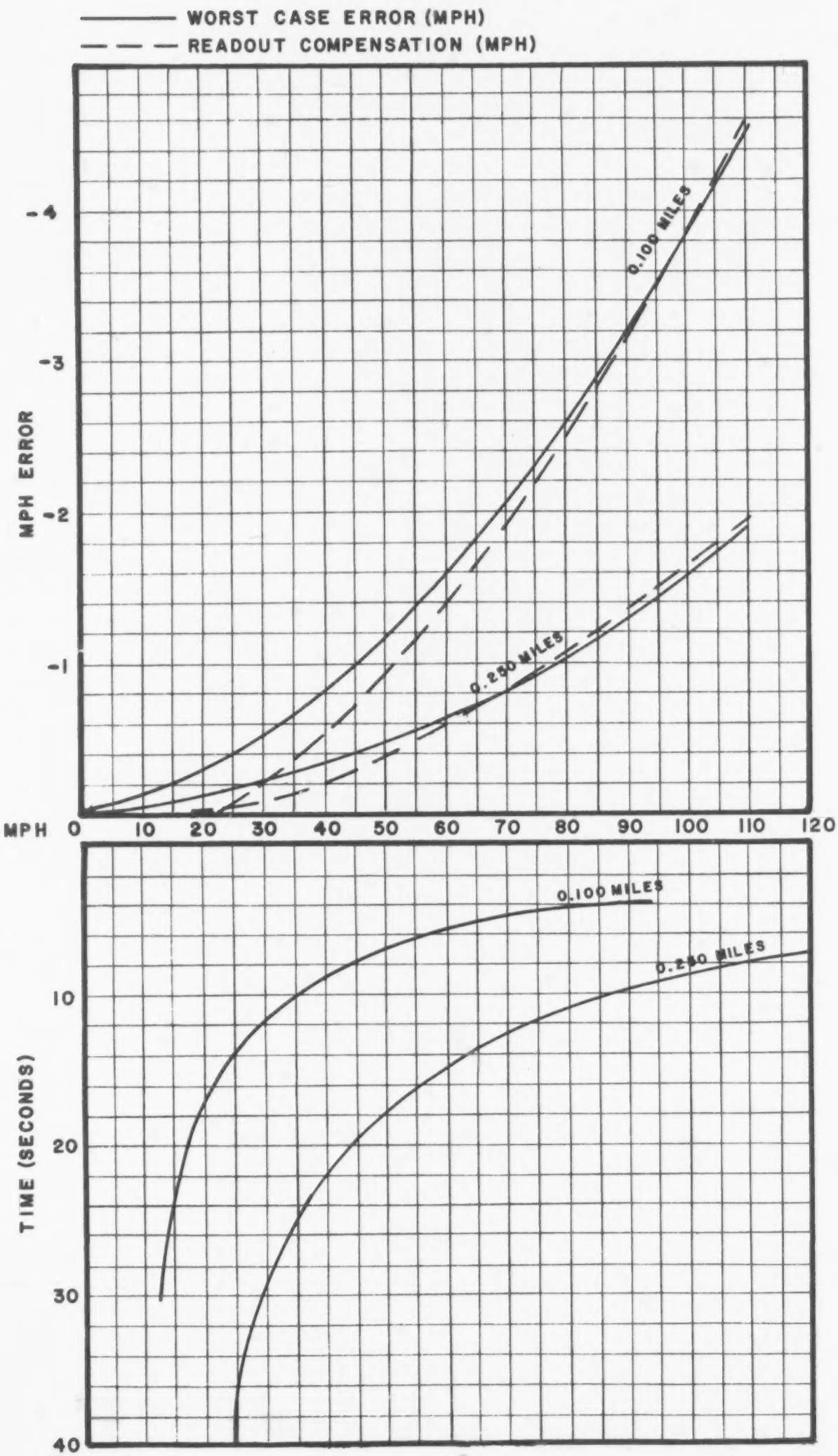

Figure III.18

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ERROR FACTOR CHART

Figure III.19

AMOUNT OF ERROR	CLOCKING DISTANCE	30 MPH	40 MPH	50 MPH	60 MPH	70 MPH	80 MPH	90 MPH	100 MPH
2 FT.	1/10	.11	.15	.19	.23	.27	.30	.34	.38
	1/4	.05	.06	.08	.09	.11	.12	.14	.15
	1/2	.02	.03	.04	.05	.05	.06	.07	.08
	1	.01	.02	.02	.02	.03	.03	.03	.04
4 FT.	1/10	.23	.30	.38	.50	.53	.61	.68	.76
	1/4	.09	.12	.15	.18	.21	.24	.27	.30
	1/2	.05	.06	.08	.09	.11	.12	.14	.15
	1	.02	.03	.04	.05	.05	.06	.07	.08
8 FT.	1/10	.46	.61	.76	.91	1.10	1.21	1.36	1.52
	1/4	.18	.24	.30	.36	.42	.48	.55	.61
	1/2	.09	.12	.15	.18	.21	.24	.27	.30
	1	.05	.06	.08	.09	.11	.12	.14	.15
10 FT.	1/10	.57	.76	.95	1.14	1.33	1.52	1.71	1.89
	1/4	.23	.30	.38	.45	.53	.61	.68	.76
	1/2	.11	.15	.19	.23	.27	.30	.34	.38
	1	.06	.08	.10	.11	.13	.15	.17	.19
20 FT.	1/10	1.14	1.52	1.89	2.27	2.65	3.03	3.41	3.79
	1/4	.45	.61	.76	.91	1.06	1.21	1.36	1.52
	1/2	.23	.30	.38	.46	.53	.61	.68	.76
	1	.11	.15	.19	.23	.27	.30	.34	.38
30 FT.	1/10	1.71	2.27	2.84	3.41	3.98	4.55	5.11	5.68
	1/4	.68	.91	1.14	1.36	1.59	1.82	2.05	2.27
	1/2	.34	.46	.57	.68	.80	.91	1.02	1.14
	1	.17	.23	.28	.34	.40	.46	.51	.57
40 FT.	1/10	2.27	3.03	3.79	4.55	5.30	6.06	6.82	7.58
	1/4	.91	1.21	1.52	1.82	2.12	2.42	2.73	3.03
	1/2	.46	.61	.76	.91	1.06	1.21	1.36	1.52
	1	.23	.30	.38	.46	.53	.61	.68	.76
50 FT.	1/10	2.84	3.79	4.74	5.68	6.63	7.58	8.52	9.47
	1/4	1.14	1.52	1.89	2.27	2.65	3.03	3.41	3.79
	1/2	.57	.76	.95	1.14	1.33	1.52	1.71	1.89
	1	.28	.38	.47	.57	.66	.76	.85	.95
60 FT.	1/10	3.41	4.55	5.68	6.82	7.96	9.09	10.23	11.36
	1/4	1.36	1.82	2.27	2.73	3.18	3.64	4.09	4.55
	1/2	.68	.91	1.14	1.36	1.59	1.82	2.05	2.27
	1	.34	.46	.57	.68	.80	.91	1.02	1.14
70 FT.	1/10	3.98	5.30	6.63	7.96	9.28	10.60	11.93	13.26
	1/4	1.59	2.12	2.65	3.18	3.71	4.24	4.77	5.30
	1/2	.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65
	1	.40	.53	.66	.80	.93	1.06	1.19	1.33
80 FT.	1/10	4.55	6.06	7.58	9.09	10.61	12.12	13.64	15.15
	1/4	1.82	2.42	3.03	3.64	4.24	4.85	5.45	6.06
	1/2	.91	1.21	1.52	1.82	2.12	2.42	2.73	3.03
	1	.46	.61	.76	.91	1.06	1.21	1.37	1.52
90 FT.	1/10	5.11	6.82	8.52	10.23	11.93	13.64	15.34	17.05
	1/4	2.05	2.73	3.41	4.09	4.77	5.45	6.14	6.82
	1/2	1.02	1.36	1.71	2.05	2.39	2.73	3.07	3.41
	1	.51	.68	.85	1.02	1.19	1.36	1.53	1.71
100 FT.	1/10	5.67	7.58	9.47	11.36	13.26	15.15	17.05	18.94
	1/4	2.27	3.03	3.79	4.55	5.30	6.06	6.82	7.58
	1/2	1.14	1.52	1.89	2.27	2.65	3.03	3.41	3.79
	1	.57	.76	.95	1.14	1.33	1.52	1.71	1.89

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Safety Rules for the Forge

1. Do not light forge without special permission.

2. Keep flammable materials away from forge area.

3. Read manufacturer's instructions or follow this procedure to light the forge:
   - A. Wear appropriate eye protection.
   - B. Run air for about two minutes.
   - C. Turn off air.
   - D. Place lighted piece of paper in the forge.
   - E. Create draft by turning on air slowly.
   - F. Turn on gas slowly.
   - G. Adjust valves to confine all flame within the forge.

4. Practice handling work with appropriate pliers or tongs <u>before</u> heating it.

5. Be careful in handling long or heavy pieces.

6. Be careful when carrying hot metal. Warn others by calling out, "Hot metal!"

7. Consider all metal around the furnace and the furnace itself as being hot.

8. If it is necessary to leave hot work, mark it "HOT" with chalk or soapstone or use a special sign.

9. Inspect hammer faces and handles before using.

10. Never strike hammer on hammer or hammer on anvil. Hardened faces may fracture and send chips of metal flying.

11. Protect your face when quenching metal.

12. To turn off furnace, shut off Gas <u>first</u>, then the air.

13. Quench hot tongs before returning to their storage place.

CHAPTER IV

TDS COMPUTER TRIAL GUIDE

The following "Trial Guide" is made a part of this manual with the hope that it may prove to be of assistance to the prosecuting attorney in the preparation of speeding cases where the TDS Computer was used to determine the speed of the violator. It is recognized that some of the questions may be objectionable and that the questions are not necessarily presented in the most logical order. However, review of these questions and answers before such a case is presented may assist in the formulation of more suitable questions. In speeding cases the problem of proof ultimately resolves itself into two general categories: (1) the reliability and accuracy of the method or device used, and (2) the skill and credibility of the officer. Keep in mind that the fact situations are given for illustration purposes only. The specific facts of any case may make some of the examples inapplicable and may require the formulation of additional questions.

1. Direct Examination of the TDS Operator

Q. What is your name?

A. John Robertson.

Q. What is your occupation?

A. I am a trooper on the State Highway Patrol.

Q. How long nave you been a member of the State Highway Patrol?

A. Nine years.

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Q. On July 3, 1968, were you so employed?

A. Yes, sir.

Q. What sort of duty were you engaged in on that date?

A. I was on routine patrol.

Q. What area were you working on that date?

A. I was working U.S. 24 in Forrest County from the airport to the Westville City Limits.

Q. On that date, was your patrol car equipped with any devices designed and used to measure the speed of your vehicle or other vehicles?

A. Yes, sir. My car was equipped with a speedometer and a TDS Computer.

Q. Have you had any training in the use of either of these devices?

A. Yes, sir. I have.

Q. Please describe this training.

A. I attended a course of instruction at the Police Academy. This course included lectures on the operation of the TDS Computer and a 15-day practice period. I then underwent a series of certification tests.

Q. Did you successfully complete this training and the certification tests?

A. Yes, sir. I did.

Q. Do you have a certificate or other evidence of proficiency in the use of the TDS Computer?

A. Yes, sir, I have. After successfully completing the training and passing the qualification test, I received a Certificate of Proficiency as a TDS Computer Operator from the Director of the Police Academy.

Q. Please explain to the jury what a TDS Computer is.

A. A TDS Computer is an electronic computer which automatically computes speed in miles per hour when quantities of time and distance are fed into it.

Q. How does a TDS Computer operate?

A. The TDS Computer is equipped with two toggle switches, one of which controls the time measuring protion of the computer and one which controls the distance measuring mechanism. These switches are manually turned on and off by the operator of the computer. The time switch is used to measure the elapsed time of a violating vehicle between two reference points on the highway. The distance switch is used to measure the distance between the same two points.

Q. Is the principle of the TDS Computer based on any scientific facts or principles?

A. Yes. It is based on the mathematical formula for determining speed; Speed = Distance divided by Time, or $S = \frac{D}{T}$.

Q. How is the TDS Computer used to measure the speed of another automobile?

A. The suspected violator is timed between two reference points on the highway. This is done by the operator of the computer. He turns on the time switch when some part of the violating vehicle is directly abreast of one reference point, and he turns the time switch off when some part of the violating vehicle is directly abreast of the second reference point. The operator measures the distance by passing the same reference points and turning the distance switch on and off when the enforcement vehicle is in the same relative position to the reference points. The computer then has both the necessary quantities, time and distance. The speed is indicated on a digital readout. The violating vehicle is always timed between two points and the distance is always measured by the enforcement vehicle. There is no sequence in which time and distance are measured. The TDS Computer can measure either time or distance first, or it can measure both at the same time.

Q. What sort of reference points may be used by the computer operator?

A. Nearly any object foreign to the surface of the highway may be used as a reference point, provided that it can be clearly seen by the TDS operator at the beginning and end of the clock. Examples are: Lines painted on the highway, cracks in the surface of the roadway, rocks, shadows, etc.

Q. How can the computer operator tell when the violating vehicle passes such a location point?

A. During the day shadows may be used to determine when the violating vehicle passes any given point. As the violating vehicle moves along the highway, it casts a shadow, either directly underneath the car or to one side or the other. The operator can watch this shadow as it approaches a preselected reference point. As the shadow strikes the reference point the time switch is turned on, and as the shadow strikes the second reference point the operator turns off the time switch. Stationary shadows cast upon the highway can also be used as reference points. The operator watches as the violating vehicle approaches the shadow and he turns the time switch on just as the violating vehicle passes into the shadow. He turns the time switch off when the car passes a second reference point. In either case, there is a noticeable change in light density when the shadow touches an object on the roadway or when the violating vehicle is touched by a shadow cast by a foreign object. Night use of the TDS Computer involves headlight reflections on stationary objects in much the same manner as daytime shadows are used.

Q. Is depth perception an important factor affecting the accuracy of measurement?

A. No, depth perception is not a factor because the shadow actually strikes the reference point, or the violating vehicle is touched by a shadow. When the violating vehicle's shadow touches an object on the roadway, it causes a definite change of light density. When the violating

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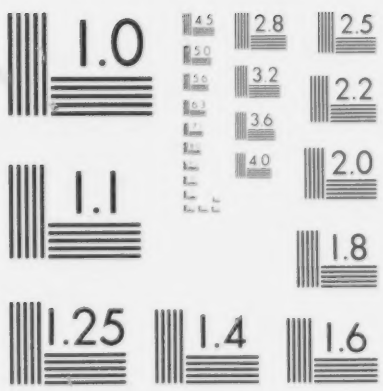

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

vehicle is touched by a shadow cast by a fixed object, there is also a distinct change in light density. This is entirely different from the problem of attempting to align two objects some distance away which do not actually touch each other.

DEFINITION: DEPTH PERCEPTION - the ability to judge the distance of objects and the spatial relationship of objects at different distances.

Q. Is reaction time an important factor in using the TDS Computer?

A. No, reaction time is not an important factor because the computer operator is able to watch the shadow of the violating vehicle as it approaches the reference point, or the violating vehicle as it approaches a stationary shadow used as a reference point, and the operator can anticipate the time when the two will come in contact. This is very similar to a race track official's anticipating the time when a runner breaks the tape at the end of a race when the runner is being timed with a stopwatch. Therefore, true reaction time, which is a reaction to an unexpected event, is not involved.

DEFINITION: REACTION TIME - the time elapsed between perception and action.

DEFINITION: ANTICIPATION - the act of looking forward, i.e. Expectation.

Q. Does the TDS Computer display the top speed of a violating vehicle at any given instant?

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A. No, it computes the average speed; that is, the average speed for the amount of distance involved between the two reference points used. The average speed can never be greater than the top speed.

Q. What are the time and distance capacities of the TDS Computer?

A. The computer is designed to measure up to 15 minutes in time and up to 32 miles in distance.

Q. How is the time and distance information stored in the computer?

A. Both the time and distance are stored in separate electronic circuitries within the computer. These sections of the computer are commonly referred to as Data Storage Banks.

Q. Is the TDS Computer operator able to read out the amount of time elapsed and distance measured from the computer?

A. Yes, this information is stored in two separate memory units of the computer and the computer will display this information upon request. The distance is displayed in miles or portions thereof and time, in seconds or portions thereof.

Q. Can the TDS Computer be checked for accuracy?

A. Yes, it can be checked for accuracy very easily.

Q. How is this done?

A. One method is to feed a pre-measured distance into the computer. This is done by driving the computer-equipped

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enforcement vehicle over the measured distance, turning the distance switch on at one reference point and off at the other. After the known distance is fed into the computer, the operator can feed a known time into the computer by turning the time switch on and off simultaneously with a stopwatch. If he feeds 15 seconds into the computer, having already fed one-fourth mile into the computer, the result will be sixty miles per hour if the computer is properly calibrated.

Q. Why would the result be sixty miles per hour in that case?

A. At sixty miles per hour a car travels one mile in one minute. Therefore, if a car travels one-fourth mile in one-fourth minute it travels at sixty miles per hour.

Q. Can the TDS Computer be spot checked for accuracy by any other means?

A. Yes, the computer can be checked against the enforcement vehicle speedometer. The enforcement vehicle speedometers are calibrated and certified as correct. By very carefully maintaining a constant speed, the computer operator can turn on and off both the time and distance switches at the same time. If the speed of the enforcement vehicle has been held constant, the average speed reading of the computer should be the same as the speed indicated by the speedometer during the test.

Q. What can be done if the computer does not give the correct speed when a known time and a known distance are fed into it?

A. The computer can be calibrated to correct the error by correcting the distance imput into the computer.

Q. What factors would make calibration necessary?

A. Tire size is one factor. As a tire wears, it becomes smaller, thus requiring more revolutions of the wheel to measure a unit of linear distance. Tire wear is a very gradual change; however, it affects the distance measuring capability of the computer to a very insignificant degree. Another factor which makes calibration necessary is the changing of the computer from one enforcement vehicle to another, for the reason of differences in tire sizes.

Q. What is the policy of your department concerning the frequency of checking the accuracy of the TDS Computer?

A. The accuracy must be checked every day.

Q. How long have you had a TDS Computer in your enforcement vehicle?

A. I have had it in my car for six months.

Q. Have you checked the accuracy of the computer in your enforcement vehicle as required by Department policy?

A. Yes, sir. I have.

Q. How often have you found it necessary to calibrate and correct the computer?

A. In six months the accuracy of the computer in my enforcement vehicle has not changed significantly. (Be prepared to present your log of accuracy checks.)

Safety Rules for the Bench Furnace

1. Before attempting to light furnace, make sure gas valves are OFF.

2. If furnace does not have a pilot light, use this procedure to light:
   - A. Place a lighted piece of paper in the furnace
   - B. Slowly turn on the gas.
   - C. Adjust the flame so that all fire is contained within the furnace.

3. Place soldering copper on an prescribed rest when not in use.

4. Do not overheat coppers. Test for proper heat by touching the copper to a piece of solder.

5. Do not inhale fumes from soldering fluxes.

6. Use care in wiping excess solder from copper.

7. Wipe up spilled flux immediately.

8. When finished, turn off furnace and place "HOT" sign on it.

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Q. While on patrol on July 3, 1968, did you have occasion to observe an automobile being driven by the defendant?

A. Yes, sir.

Q. What kind of car was he driving?

A. He was driving a 1967 Ford.

Q. What, if anything, attracted your attention to the automobile that the defendant was driving?

A. The car appeared to be traveling at a speed greater than the normal flow of traffic.

Q. In what direction was the defendant going and in what direction were you going?

A. The defendant was going east and I was traveling west.

Q. Were you able to determine the speed of the defendant's car?

A. Yes, sir.

Q. What method or device did you use to make this determination?

A. I used the TDS Computer.

Q. How did you accomplish this?

A. As the defendant's car approached me, it passed over a patch in the roadway. The patch is asphalt and the pavement is concrete; therefore, a great contrast in color existed, supplying a very prominent reference point. The time switch was turned on at that point. When the defendant's car came abreast of the enforcement car, I turned off the time switch and started measuring distance. As the enforcement vehicle passed over the

asphalt patch, I turned off the distance switch. The computer then calculated the speed of the defendant's car.

Q. Do you know how much distance and time was fed into the computer, and if so, how much?

A. Yes, sir. The distance from the asphalt patch to the point where we passed was 0.5 mile and the elapsed time for the defendant to travel that distance was 20 seconds.

Q. How were these time and distance figures determined?

A. I queried the time and distance memory sections of the computer. These are the figures that were displayed on the digital readout screen.

Q. How were you able to remember the reference points and all of these figures?

A. Immediately after issuing the citation, I made notes, and I reviewed these notes prior to this court appearance.

Q. Is it true that the longer the clock, the more accurate it will be?

A. This is not necessarily true, although the longer the distance traveled , the more insignificant any error becomes in missing a reference point and, of course, since this method measures average speed, the longer the clock, the more benefit of the doubt is given the defendant should he deviate from his peak speed.

Q. How close do you think you can "call" a reference point when the violating vehicle is a tenth of a mile away?

A. Based on my training and experience with the TDS Computer and the tests which I have passed, I would estimate that I can come within four feet of the exact spot from a distance of one-tenth of a mile, under good conditions.

Q. Have you been furnished any material indicating what the error would be, if any, if you should misjudge a location point by four feet in a speed range of 90 miles per hour over, say, a half-mile clock?

A. Yes, sir. If I missed a reference point by four feet in a speed range of 90 miles per hour over a half-mile clock, the error would be 0.136 of a mile per hour.

Q. Now, if you missed a reference point by four feet each time you turned on and off the time and distance switches, there would be an error of four times this 0.136 of a mile per hour in this speed range, is this not true?

A. Yes, sir. If I missed it four feet each time I turned on and off the two switches, there would be an error of 0.544 miles per hour.

Q. What makes you think that you can call the reference points as closely as plus or minus four feet?

A. I feel that I can do this consistently because my training and testing for certification as a TDS Computer operator indicated that I am able to clock the speed of the violating vehicle twenty-five different and consecutive times with an

average error of less than one-half of one mile per hour.

Q. Based on your experience as a police officer, when you clock the speed of another car using the conventional speedometer method, how close do you think you can gauge speed?

A. I don't think anyone, including myself, can call a speedometer clock any closer than to the nearest whole mile per hour under the best possible conditions.

Q. Officer Robertson, are there any speed signs on U.S. 24 in Forrest County?

A. Yes, sir.

Q. Did you observe these signs on the date of the arrest?

A. Yes, sir.

Q. Are these official highway speed control signs?

A. Yes, they are.

Q. Are there any such signs located in the area in which this clock was made?

A. Yes.

Q. What is the speed indicated on the signs?

A. 60 miles per hour.

Q. Officer Robertson, you have passed a rigid training program and you are a Certified TDS Computer Operator. How can you assure the court that the clock you made on the defendant is accurate?

A. I was sure of my reference points and I was careful with my clock. Based on my experience and tests, I know that the speed indicated is correct within two miles per hour. Also, I would be glad to demonstrate my ability as a TDS Computer operator for the court, if the court deems this necessary.

Q. What did the TDS Computer indicate as the speed of the vehicle which the defendant was driving?

A. The TDS Computer indicated that he was traveling 90 miles per hour.

VT 013 276
An Instructors Manual for a Three Week Course in Administration and Supervision of a Periodic Motor Vehicle Inspection.

Northwestern Univ., Evanston. Traffic Inst.
American Association of Motor Vehicle Administrators, Washington, D.C.
Automotive Safety Foundation, Washington, D.C.
Highway Users Federation for Safety and Mobility
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DESCRIPTORS - *VOCATIONAL EDUCATION; *TEACHING GUIDES; *MANUALS; EDUCATIONAL OBJECTIVES; INSTRUCTIONAL MATERIALS; RESOURCE MATERIALS; ANNOTATED BIBLIOGRAPHIES; TEACHING TECHNIQUES; *MOTOR VEHICLES; *INSPECTION; SUPERVISORS

ABSTRACT - Prepared by the Traffic Institute at Northwestern University, this instructor's manual should be useful in a training program in Periodic Motor Vehicle Inspection (PMVI). As times change and PMVI programs develop, there will be need for updating the information in the manual. Therefore, instructors who use the manual should be constantly on the alert for supplementary material to improve this basic work. To adequately treat the 15 units in this source it is recommended that three weeks or 85 hours of instruction time be set aside. Covered by the 15 units are such topics as (1) Federal Programs, (2) Selection and Training of Supervisors, (3) Field Supervision and Enforcement, (4) Records and Information, (5) Planning--A Function of Management, and (6) Budgeting--A Function of Management. This loose-leaf notebook is arranged in outline format and provides (1) objectives for each unit, (2) suggested teaching time, (3) suggested teaching techniques, (4) references, (5) exhibits and illustrations, and (6) an annotated bibliography. (Author/JS)

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AN INSTRUCTORS MANUAL for a THREE WEEK COURSE in ADMINISTRATION AND SUPERVISION OF PERIODIC MOTOR VEHICLE INSPECTION

Prepared by
Traffic Institute,
Northwestern University
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1970

under contract with the
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and the
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for Safety and Mobility

Cooperating Agency:
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FOREWORD

The Automotive Safety Foundation and the Highway Users Federation for Safety and Mobility have long sought to improve and expand highway safety programming through the funding of manpower research and development projects. The sponsorship of this manual is a further effort to increase the supply of fully prepared highway safety workers through the development of instructional resources.

The Foundation was indeed fortunate to have the Traffic Institute, Northwestern University, and the American Association of Motor Vehicle Administrators serve as contractors for developing and reviewing this instructors manual. We are indebted to them for their valuable technical competence and experience, productive organizational talent and dedication to the field of traffic safety.

D. Grant Mickle
President
Highway Users Federation
for Safety and Mobility

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PREFACE

Public Law 89-563 was passed by the 89th Congress and then approved by Lyndon B. Johnson on September 9, 1966. The opening paragraph of Public Law 89-563 states: "Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that Congress hereby declares that the purpose of this act is to reduce traffic accidents and deaths and injuries to persons resulting from traffic accidents. Therefore, Congress determines that it is necessary to establish motor vehicle safety standards for motor vehicles and equipment in interstate commerce; to undertake and support necessary safety research and development; and to expand the national driver register." Following this opening pre-amble is Title I - Motor Vehicle Safety Standards.

Public Law 89-564 was also passed and was subsequently approved by President Johnson on September 9, 1966. This law is a sequel to the National Traffic and Motor Vehicle Safety Act of 1966 (Public Law 89-563) and is identified as the "Highway Safety Act of 1966."

Section 401 of the Highway Safety Act (Public Law 89-564) directs and authorizes the Secretary of the Department of Transportation to assist and cooperate with other federal agencies,

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state and local governments, private industry and other interested parties in increasing highway safety. The Congress then, in Section 402 of the same law, says in part:

> "(a) Each state shall have a highway safety program approved by the Secretary, designed to reduce traffic accidents and deaths, injuries, and property damage resulting therefrom. Such programs shall be in accordance with uniform standards promulgated by the Secretary. Such uniform standards shall be expressed in terms of performance criteria. . . . In addition, such uniform standards shall include, but not be limited to, . . . vehicle registration, operation and <u>inspection</u>." (emphasis added)

The passing of these acts and the subsequent organizing of the National Highway Safety Bureau gave emphasis and impetus to the States' Periodic Motor Vehicle Inspection Programs. At the time of this writing there are 31 states with a periodic motor vehicle inspection program, 8 states are operating random spot inspection programs, and 11 states are still without such a program.

The National Highway Safety Bureau (NHSB), in releasing its first 13 standards, identified Periodic Motor Vehicle Inspection as Standard 4.4.1. The purpose of this standard, according to the NHSB, is to increase the likelihood that every vehicle operated on the public highways is properly equipped and is being maintained in reasonable safe working order.

Safety Rules for the Crucible Furnace

1. Always use care in the foundry area. Crucibles, equipment, flasks, and castings may be hot.

2. Ask your teacher to check your mold before closing it. Make sure it is not too damp or too dry before pouring.

3. Keep molds covered until ready for pouring.

4. Before handling molten metal don protective clothing, including face shield, apron, leggings, and gloves.

5. Keep flammable materials away from the foundry area.

6. Practice lifting and pouring with a cold, empty crucible. Run through the entire procedure several times.

7. Light furnace only when and as directed by your teacher. Follow the manufacturer's directions or the following:
   - A. Purge the furnace by running air for two minutes with gas off.
   - B. Turn off air.
   - C. Place a lighted piece of paper in the furnace.
   - D. Create draft by turning on air slowly.
   - E. Turn on gas slowly. If flame is blown out, go back to A.
   - F. Adjust flame so that all fire is contained within the furnace.

8. Preheat metal to remove moisture before placing it in a crucible containing molten metal.

9. Preheat skimmer before using it.

10. Shut off GAS FIRST, then the air, when finished.

11. Carry ladles and crucibles close to the floor to reduce danger.

12. Mold should be placed only on the floor, never on a bench.

13. If floor is concrete, have someone standing by to shovel foundry sand on spills. Concrete explodes violently when heated.

14. Keep water and wet items away from the foundry area.

15. Allow castings to cool before breaking them out of molds.

16. Two precautions in using polystyrene (Styrofoam) patterns.
    - A. Once pouring is started, keep sprue basin filled to prevent polystyrene from firing back through the sprue.
    - B. Do not breathe the fumes from the burning polystyrene.

17. Completely empty crucible. Solidfied metal will crack the crucible when reheated. Use ingot molds rather than pouring a puddle in the sand.

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The Automotive Safety Foundation (ASF), which subsequently combined its operation with Auto Industries Highway Safety Committee and the National Highway Users Conference to form "The Highway Users Federation for Safety and Mobility", recognized that the NHSB Standard for Periodic Motor Vehicle Inspection re-emphasized the need for supervisory and management training in the PMVI field. ASF approached the Northwestern University Traffic Institute and the American Association of Motor Vehicle Administrators (AAMVA) offering to underwrite the cost of developing a manual for instruction in "Administration and Supervision of Periodic Motor Vehicle Inspection." The Traffic Institute and AAMVA agreed to develop the manual. Under the terms of the agreement the Traffic Institute staff would assemble the material and prepare the manual. AAMVA agreed to provide material and consulting service. Louis Spitz, AAMVA Executive Director, Preston Poore and Arthur Tritsch of the AAMVA staff were most cooperative in providing this service. Our completed work was reviewed by AAMVA staff.

No work of this magnitude could be completed without the contributions of many people. There were a number of organizations and officials with an interest in motor vehicle inspection who provided material for this project.

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TEACHING & TESTING

The purpose of teaching is to bring about a certain desired behavioral change in an individual. The purpose of testing is to measure the extent and duration of the desired behavioral changes. Learning is said to have occurred when the desired behavioral change is observable or measurable. Thus, we may say that a teacher has taught when he helps his students to learn.

In any teaching situation, then, the teacher's job is to get the student to make the desired behavioral change. This may best be accomplished through the following steps:

1. Identify the terminal behavioral objective[1];

2. Help the student achieve the desired terminal behavior by presenting him with related information, encouraging the necessary physical and mental activity, requiring a particular response to a given stimulus and reinforcing the correct response;

3. Test the student's ability to perform a given behavioral task; and

4. Recognize the student's attainment of the desired terminal behavioral objective.

Perhaps the two greatest challanges to the teacher are, (1) clearly identifying the desired behavioral objectives of a lesson, or the terminal behavioral objectives of a course, and

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[1] Terminal behavioral objectives are those competencies which the learner is expected to acquire as a consequence of successfully completing the entire instructional sequence.

(2) measuring the student's achievement of the desired behavioral objectives.

To aid the instructor in his efforts to achieve the purposes of this Three Week Course in Administration and Supervision of Periodic Motor Vehicle Inspection, the Federation commissioned Dr. Henry H. Walbesser and his staff at the Bureau of Educational Research, University of Maryland to analyze the instructional purposes of this manual and write appropriate behavioral objectives and measurement criteria.

To effectively utilize Dr. Walbesser's work in the teaching of this course, the instructor should know that in addition to the course terminal behavioral objectives, three distinct classes of intermediate behavioral objectives are given. They are:

a) Process Objectives - those competencies in which the learner acquires a series of actions that constitute a procedure.

b) Product Objectives - those competencies in which the learner constructs a tangible item.

c) Management Objectives - those competencies in which the learner acquires organizing, directing, or controlling skills.

Process, product, and management objectives all mediate to the terminal objectives. The instructional model embedded in the lessons can be depicted by the following schematic:

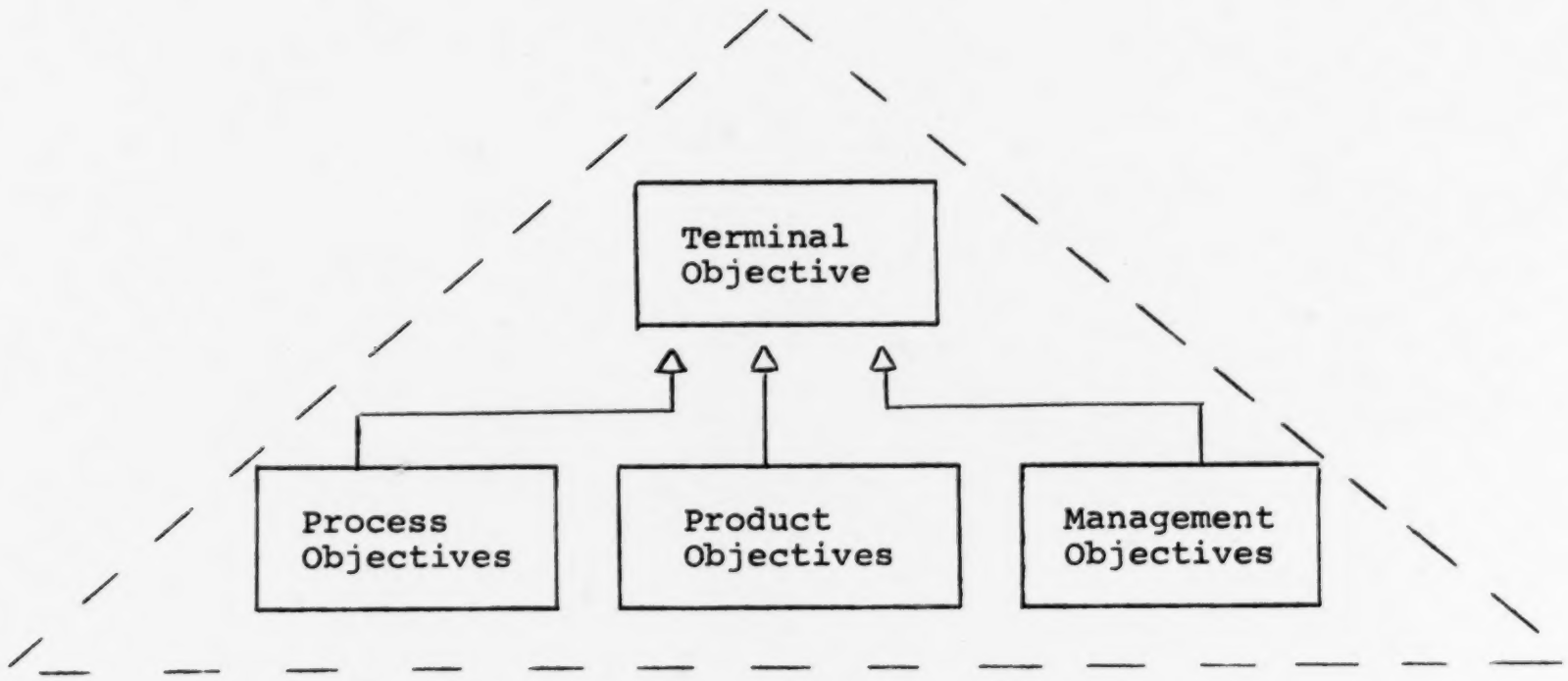

Because of the interlocking nature of the instructional materials in this course, specific lesson by lesson behavioral objectives were deemed inappropriate. However, general objectives containing the related elements of each class of objective are given in the introduction of each instructional unit.

Behavioral Objectives and Measurement Criterion

To gain maximum results from each instructional unit, the teacher should relate the general objective given for each subject to one or more of the following intermediate or terminal behavioral objectives. Once the relationship has been clearly established, the teacher may employ the criterion measures given under those specific objectives to determine the student's success in achieving the desired behavior.

Intermediate Objectives

PROCESS OBJECTIVES

A. Upon completion of the lessons the course participant will be able to distinguish inter-dependency from independence of a vehicle inspection program and other highway safety activities.

B. Upon completion of the lessons the course participant will be able to identify missing legal or operational components in a given PMVI system and describe the reasons why each identified component is needed.

C. Upon completion of the lessons the course participant will be able to distinguish among the types of motor vehicle inspection according to a given set of functions.

D. Upon completion of the lessons the course participant will be able to demonstrate the use of selection procedures for obtaining supervisors.

E. Upon completion of the lessons the course participant will be able to demonstrate procedures for obtaining public and governmental support for a motor vehicle inspection program.

PRODUCT OBJECTIVES

A. Upon completion of the lessons the course participant will be able to describe the rationale and the data supporting each component of a motor vehicle inspection program.

B. Upon completion of the lessons the course participant will be able to describe federal programs related to motor vehicle inspection and the particular contributions of each.

C. Upon completion of the lessons the course participant will be able to describe the 20th century history of motor vehicle inspection.

D. Upon completion of the lessons the course participant will be able to identify and name the various functions of a motor vehicle inspection program in a state level highway safety program.

E. Upon completion of the lessons the course participant will be able to describe the components of a training program for supervisors and the reasons in support of each component.

F. Upon completion of the lessons the course participant will be able to describe the components of a state owned and operated motor vehicle inspection program and the reasons in support of each component.

G. Upon completion of the lessons the course participant will be able to describe the advantages and disadvantages of a state owned and operated motor vehicle inspection program.

MANAGEMENT OBJECTIVES

A. Upon completion of the lessons the course participant will be able to demonstrate management procedures related to training functions.

B. Upon completion of the lessons the course participant will be able to demonstrate management procedures related to planning and direction functions.

C. Upon completion of the lessons the course participant will be able to demonstrate management procedures related to the delegation of responsibility and control functions.

D. Upon completion of the lessons the course participant will be able to demonstrate management procedures related to budget construction and monitoring.

E. Upon completion of the lessons the course participant will be able to apply the enforcement rules to a given collection of situations within a specific PMVI system.

F. Upon completion of the lessons the course participant will be able to distinguish between appropriate and inappropriate management decisions given a list of problem-management action pairs.

Terminal Objectives

A. Upon completion of the three week course, the course participants will be able to demonstrate procedures for the administration and supervision of a motor vehicle inspection program at the state level or for a political subdivision of a state, given the description of the components of an existing PMVI system.

Criterion Measure - Present the learner with two administrative decisions and two supervisory decisions to be made within a specific PMVI system. The learner should be asked to show what decisions and actions he would take. An acceptable response requires four decisions that would resolve the problems for that particular system.

B. Upon completion of the three week course, the course participant will be able to construct an operational system of motor vehicle inspection for a state or political subdivision of the state, given sufficient demographic and highway information.

Criterion Measure - Give the learner the description of a state or local government with all of the necessary demographic and highway information and ask him to construct an operational motor vehicle inspection system. An acceptable response requires the creation of a PMVI system that is feasible within the information provided.

Periodic Motor Vehicle Inspection is an essential element in the total highway safety program. To successfully carry out this element of the program, administrative and supervisory personnel must be trained that can direct and manage the people, equipment, facilities, and other resourses needed to perform the inspection tasks.

The teacher charged with the responsibility for training PMVI personnel plays a vital role in the total highway safety effort. Through this manual, the Highway Users Federation hopes to provide instructional materials and guidelines that will enable the teacher to bring about the desired behavioral change in each of his students.

Jack K. Weaver, Ph. D.
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Highway Users Federation

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THREE-WEEK COURSE

ADMINISTRATION AND SUPERVISION OF
PERIODIC MOTOR VEHICLE INSPECTION

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	TOTAL	85

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Safety Rules for the Metal Lathe

1. General

   A. Dress properly. Remove tie and jewelry and roll sleeves up.
   B. Make adjustments only when machine is completely stopped.
   C. Make sure all guards are in place.
   D. Ask your teacher to check your setup.
   E. Always remove chuck key or wrench immediately after using it.
   F. Be sure all parts of the carriage will clear any rotating part during full-length of cut.
   G. Set tool on center of work to be turned.
   H. Keep your hands on the controls or at your sides except when filing and polishing. Don't lean or lounge on the machine.
   I. Do not pull chips or brush chips away with your hands.
   J. Finish cuts that are close to chuck or against a shoulder by hand feed.
   K. Allow lathe to stop before reversing. Do not "jog" the reverse button to stop lathe.
   L. Remove tool holder or tool post before filing or polishing.
   M. Do not leave lathe while it is running.
   N. Chatter indicates that something is wrong. Check!
   O. Regulate feed, speed, and depth of cut according to size and type of material.
   P. Use proper coolant.
   Q. Make sure tool bit and tool post are secure.
   R. File and polish with right arm arching over work.

2. Between-Centers Turning

   A. Use only safety-type dogs to drive work
   B. Clamp tailstock securely
   C. Adjust & lubricate dead center.
   D. Use properly ground tools.
   E. Use steady or follower rest if needed.

3. Chuck and Faceplate Turning

   A. Place a board under chuck or faceplate during installation or removal. Keep your fingers clear.
   B. Make sure work is securely mounted.
   C. Counterbalance work if needed to prevent vibration.
   D. Turn through one complete revolution to check clearances.
   E. Stand to one side of revolving faceplate.

0004007

SUBJECT: PURPOSES AND OBJECTIVES OF MOTOR VEHICLE INSPECTION

HOURS: 4

OBJECTIVES: To acquaint the student with the historical development of motor vehicle inspection programs; develop an understanding of the various types of inspection programs; create an awareness of the role of vehicle inspection in a balanced highway safety program, and the inter-relationships and inter-dependencies of vehicle inspection and other functional highway safety activities.

METHODS OF INSTRUCTION: The primary method of instruction for this unit is lecture. Because the students are actively engaged in motor vehicle inspection programs, the instructor should stimulate class participation to the fullest extent.

Several of the references, especially numbers 1 and 7, contain charts and tables that can easily be utilized as visual aids by the instruction.

INSTRUCTOR'S GUIDE

(PURPOSES AND OBJECTIVES OF MOTOR VEHICLE INSPECTION)

I. INTRODUCTION

A. Instruction should provide the students with an understanding of the growth and development of vehicle inspection programs in this country. The student should be made aware of the various types of existing programs and the reasons why jurisdictions adopted one program in favor of another or in some cases why no inspection program exists.

The importance of motor vehicle inspection in a balanced highway safety program should be emphasized. The students should understand how vehicle inspection can support other accident prevention measures and conversely, how other preventive measures support vehicle inspection.

20317

	REFERENCES
II. PRESENTATION	
A. <u>Historical Development of Motor Vehicle Inspection</u> - Vehicle inspection has been a part of our society as an accident prevention measure since the late 1920's.	Ref. #1 - pp. 1-18 Ref. #2 - p. 23 Ref. #3 - pp. 1-6 Ref. #5 - pp. 11-29
1. Voluntary inspection programs were initiated in 1926 in Massachusetts, and the next year in New York and Maryland. In 1928 and 1929 Pennsylvania, New Jersey and Delaware also instituted voluntary programs.	
2. The first legislation requiring compulsory inspection of motor vehicles was enacted in 1929 and 1930 by Pennsylvania, Maryland and Massachusetts. By 1940, sixteen additional states adopted compulsory inspection legislation. However, two states, Arkansas and Nebraska, repealed the legislation shortly thereafter.	
3. During World War II several inspection programs were abandoned or sharply curtailed. In some states, such as Connecticut, Maryland and Washington, the programs were never revived.	

	REFERENCES
4. The development of compulsory inspection programs between 1945 and 1967 was somewhat slack in that only nine states enacted legislation during that period. One, Arizona, discontinued its program after two years. By 1967, 21 states and the District of Columbia had compulsory motor vehicle inspection programs.	
5. In 1967 the U. S. Department of Transportation, under the authority of the Highway Safety Act of 1966, issued a standard calling for each state to institute a vehicle inspection program. During 1967, 11 additional states enacted legislation which established a compulsory, periodic inspection of motor vehicles. As of January 1969, 31 states and the District of Columbia had motor vehicle inspection programs that required inspection of virtually all registered motor vehicles in their jurisdictions.	

20319

	REFERENCES
B. Types of Motor Vehicle Inspection Programs - There are basically three types of vehicle inspection programs in existence in the U. S. today.	Ref. #1 - pp. 7-18 Ref. #2 - pp. 15-16 Ref. #6 - pp. 1-3 Chapter IV Ref. #7 - pp. 35-54
1. State owned and state operated. New Jersey and Delaware, and the District of Columbia have adopted this type of inspection system. Under this system the state buys or leases land and buildings, purchases or leases equipment, employs supervisors and inspectors and has complete responsibility for and control of the entire operation.	
a. Some of the advantages of this type of system are:	
(1) Re-inspection provides a quality check on vehicle repairs.	
(2) Inspectors do not personally benefit from any repairs that may have to be made.	
(3) Uniformity of inspections throughout the state is facilitated.	

	REFERENCES
(4) Training of inspectors and supervision of inspections is made easier.	
(5) Collection of accurate and uniform motor vehicle inspection data is facilitated.	
b. Disadvantages	
(1) High cost of implementing and maintaining equipment and facilities.	
(2) Limited number of stations can cause excessive inconvenience to the public due to excessive driving distances and waiting times due to over-crowded facilities.	
(3) State unable to adequately compete with private enterprise for inspection personnel.	
(4) Has only been proven satisfactory and immediately feasible in places with small geographical areas and dense populations	

20321

	REFERENCES
and motor vehicle registration rates.	
2. Private Owned and State Supervised - 29 states have instituted this type of inspection system. Under this system the state licenses and certifies private garages, service stations, automobile dealers, etc., to conduct motor vehicle inspections in accordance with regulations established by the state. The state in turn supervises the inspection activities of the private stations.	
a. Some advantages of this type of system are:	
(1) Large number of stations may be authorized, which provides the motorists with greater convenience by reducing travel and waiting time.	
(2) Programs can be quickly implemented due to facilities, equipment and personnel already being in existence. Also this eliminates the need to select	

	REFERENCES
and train a large inspection force.	
(3) Repairs can be made immediately.	
b. Disadvantages	
(1) Adequate supervision of large numbers of stations is extremely difficult.	
(2) A lack of confidence by motorists because the inspection stations may benefit from repairs.	
(3) Lack of uniformity of inspections between stations because of their large numbers.	
3. Random or Spot Inspections - Under this system state law enforcement personnel set up temporary roadside testing equipment and stop passing motorists and perform vehicle inspections. Eight states have adopted this type of system.	
a. Some of the advantages of this system are:	
(1) Costs will be low because there	

	REFERENCES
is no need to purchase buildings and train large numbers of inspection personnel.	
(2) Motorists will voluntarily keep their vehicles in a safe condition due to the possibility of being subjected to an inspection at any time.	
(3) Provides an opportunity for other official activities relating to drivers, such as checking driver licenses.	
b. Disadvantages	
(1) Only a small percentage of the registered vehicles can be inspected.	
(2) The motorist may be subjected to delays and other inconveniences because he does not know when his vehicle may be inspected.	
(3) Inspections are not as thorough or complete as those done in garages.	

20324

	REFERENCES
4. Combination of Systems - Under this system the best of each type program would be drawn together to overcome the weaknesses of any one type. The state owned and state operated system would be utilized in the heavily populated metropolitan areas and the privately owned and state supervised would be utilized in the less populated areas. Both of these programs would be supplemented with a random or spot inspection system which would help insure voluntary maintenance of vehicles at all times rather than just when it is time for an inspection.	
C. Vehicle Inspection and Accident Prevention - A balanced highway safety program must deal with the highway, the vehicle, and the human element. Motor vehicle inspection is the primary means currently available to government to deal with the vehicle.	Ref. #1 - pp. 36-60 Ref. #1 - pp. 5-14 Ref. #4 - All Ref. #7 - pp. 63-68
1. It can generally be said that the primary objective of motor vehicle inspection is to prevent accidents and reduce deaths and injuries resulting therefrom by detecting and requiring correction of	

Safety Rules for the Milling Machine

1. Make setup and adjustments only when machine is stopped.
2. Make certain work is properly mounted. Use soft hammer or mallet to seat work against parallels.
3. Ask your teacher to approve your setup.
4. Make sure cutters are sharp. Handle them carefully.
5. Set proper feed, speed, and depth of cut.
6. Disengage handles when on automatic feed.
7. Be sure cutter is turning in the proper direction. Feed against the cutter--not with it.
8. Use a brush to remove chips with machine off.
9. Use proper coolant.
10. When finished, turn off machine, release automatic feed controls and clean up.

C002008

	REFERENCES
vehicles with mechanical defects that impair safe operation.	
2. A vehicle inspection program must depend on and receive support from other highway safety functional programs if it is to be effective.	
a. Police traffic services. Vehicle equipment regulations must be enforced by state and local police agencies. Data gathered by the police at accident scenes should reflect to the extent possible the role that vehicle defects played in the accident. The police, through their enforcement powers, must ensure that vehicles have valid inspection stickers, properly displayed, etc.	
b. Traffic courts. The judiciary must be willing and able to prosecute and adjudicate vehicle equipment violations and violations of other regulations pertaining to the inspection of motor vehicles.	
c. Vehicle registration. The vehicle	

	REFERENCES
registration function assists and supports the vehicle inspection program by providing information on vehicle density; geographical distribution; vehicle make, model, age, identification number; and names and addresses of vehicle owners. Registration can be an extremely valuable adjunct to motor vehicle inspection if it requires that a vehicle must have a valid inspection sticker before it can be registered.	
d. Traffic records. Traffic records, especially accident and enforcement reports, provide the information needed to evaluate and upgrade the motor vehicle inspection function. Record systems capable of providing comparisons between such things as vehicle equipment failures resulting in accidents and inspection data can provide quality checks on the inspection program.	

20327

REFERENCES

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4. Insurance Institute for Highway Safety. Background Report: Motor Vehicle Inspection. Washington, D.C., 1967

5. "States Requiring Official Motor Vehicle Inspection of All Vehicles." A chart prepared by the Auto Industries Highway Safety Committee, April 1, 1970

20329

SUBJECT: DEVELOPING SUPPORT FOR VEHICLE INSPECTION

HOURS: 4

OBJECTIVES: Improve the student understanding of the need for gaining and maintaining official and public support for motor vehicle inspection programs and improve his understanding of techniques for obtaining or improving support.

METHODS OF INSTRUCTION: The primary method of instruction should be class discussion with the instructor serving as the discussion leader. Students from jurisdictions where inspection legislation failed several times before passage and/or from jurisdictions where there have been attempts to repeal the inspection program should report on who opposed the legislation, why it was opposed, and the reasons behind the eventual success.

Students should be required to develop case histories of the emergence and growth of vehicle inspection in their states with emphasis on the success or failure of public support activities. These cases should be reproduced for the benefit of all students.

INSTRUCTOR'S GUIDE

(DEVELOPING SUPPORT FOR MOTOR VEHICLE INSPECTION)

I. INTRODUCTION

A. Instruction should provide the students with a basic understanding of the need for planned public support activities. Students should be made aware of the controversial nature of compulsory inspection programs and the potential sources of opposition.

The importance of enlisting the support of government officials, news media and organizations should be stressed, including techniques that have been utilized in gaining and maintaining this support.

20221

	REFERENCES
II. PRESENTATION	
A. <u>Need for Public Support</u> - Whether a state will have a motor vehicle inspection program and how effective it will be depends largely on the acceptance and support it receives from drivers and vehicle owners.	Ref. #3 - All Ref. #8 - All
1. In contrast to many other domestic problems, there has not been a great public outcry for more and better highway and traffic safety programs. This is especially true of compulsory vehicle inspection.	
2. Vehicle inspection is the type of program that a large number of people feel they could easily do without. Lack of support for motor vehicle inspection is illustrated by the following:	
a. Several states instituted inspection programs that were later abandoned and never revived.	
b. Prior to the Federal standard requiring state motor vehicle inspection programs, less than half of the states had inspection programs.	

	REFERENCES
c. Even with the Federal standard, only 11 of the 29 non-inspection states instituted inspection programs.	
d. Bills to repeal or modify inspection programs are regularly introduced in the legislative sessions of several states.	
e. The inspection programs in many states frequently come under attack by the news media.	
f. Elected officials in several states feel that to support vehicle inspection would be political suicide.	
B. <u>Developing Public Support</u> - The degree of public support for vehicle inspections is entirely dependent on the quality of the inspection program. The best organized support program cannot overcome the failures of a poorly planned, understaffed, and inadequately financed program. In short, public support is 90 percent dependent on what you do and 10 percent dependent on what you say you did.	Ref. #5 - pp. 5-6

20333

	REFERENCES
1. The first step toward public support is understanding. The public must be provided with information concerning the need for vehicle inspection.	
2. Responsibility for collecting and disseminating information to the public concerning vehicle inspection is shared three ways. a. By government officials with highway transportation responsibilities. b. By the news media, including newspapers, radio and television, industrial, trade and other publications, outdoor advertising, etc. c. By organizations interested in the motor vehicle and its use, including safety councils, professional, civic, religious, fraternal, civil rights and women's groups, and business and industrial organizations.	
3. The Governor's office should play the key role in coordinating the public	Ref. #4 - pp. 15-19

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	REFERENCES
support activities of these groups. The governor or his representative should establish a fact-gathering or study committee. The committee should have representatives from each group (governmental, public media, and organizations). a. The group should gather all available information about motor vehicle inspection. This should include: (1) The number of accidents in which defective vehicles were a contributing factor. (2) Facts concerning vehicle defects that were detected in voluntary inspection programs. (3) Accident and fatality rates of states with inspection programs as compared to those without. (4) Previous unsuccessful attempts to institute inspection programs -- who supported those efforts, who was opposed, why the attempts failed, etc.	

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Safety Rules for the Metal Shaper

1. Make adjustments only with machine stopped.
2. Set work against parallels with soft hammer or mallet. Clamp securely.
3. Select and insert properly ground tool in holder.
4. Be sure that ram and head will clear the work and holding devices.
5. Start motor with control lever in neutral.
6. Keep hands away from cutting tool and moving parts.
7. Flying chips can be controlled by rigging a screen.
8. Use proper coolant.
9. Do not leave machine while it is running.
10. When finished, remove tool and clean up the area.

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	REFERENCES
b. The study committee should also gather data as to the type of program that would be most suitable for and acceptable to the motorists of the state.	
(1) The two most important factors in this regard are <u>motorist convenience</u> and <u>program costs</u>.	
4. States that have a motor vehicle inspection program should establish an advisory committee to serve as a sounding board for and a support group to the inspection program administrator.	
a. This committee should consist of representatives from each group and should be kept informed of any proposed changes in the program.	
b. Their advice should be sought on proposed changes in inspection regulations.	
C. <u>Developing Official Support</u> - To operate effectively, a vehicle inspection program must have the understanding and support of public officials with highway safety responsibilities at the state and local level.	

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	REFERENCES
1. Public officials who play a significant role in the success or failure of the program include: highway and traffic engineers, police, driver educators, judges, prosecutors, health officers and driver license officials. a. The public generally considers these officials "in the know" on highway safety matters, and derogatory remarks about the inspection program by them can curtail public support.	
2. Oftentimes these officials are not personally convinced of the value or need for an inspection program. Also, an inspection program is or will be another competing force for the tax dollar.	
3. To help overcome apathy or resistence, officials should be: a. Provided with facts concerning the need for an inspection program in the state. b. Asked for counsel and guidance in determining the best type of program including who will inspect,	

	REFERENCES
where, when, how often, what items, etc.	
c. Kept informed throughout the planning implementation stages on decisions that are being made or considered.	
d. Should be asked to serve on committees that are developed to study motor vehicle inspection in the state.	
D. <u>Developing Media Support</u> - Since an effective motor vehicle inspection program depends to a large extent upon a public that is informed of the problem and understanding of the needs, it is extremely important that the program have the support and backing of the news media.	Ref. #4 - pp. 25-26
1. Media people can make or break the inspection program.	
a. There have been several cases illustrating how a hostile news media can turn public opinion against motor vehicle inspection. This is especially true where they were not provided facts on the	

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	REFERENCES
need for inspection or information on how the program would operate. (1) A good working relationship must be developed with the media. A frequent complaint by the media is that they are only consulted when something is wanted. (2) The media should be involved in the planning of the program and their advice on such matters as to what type of inspection program should be adopted, how it should be operated, what items will be inspected, etc., should be sought. ASK THEM FOR HELP, DON'T TELL THEM. (3) The media should also be provided with information after a program has been instituted. This should include information concerning any changes that are being made or considered in the operation of the program as well as possible changes in items to be inspected.	

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	REFERENCES
They should also be provided with the reasons for the proposed changes.	
b. Where the media are not in support of inspection, it is not uncommon for reporters to take a vehicle to several inspection stations within a state to show that inconsistencies between inspection stations exist. The media should not be discouraged from doing this, but they should be asked to provide officials with their findings before airing them to the public.	
(1) The state in turn must be prepared to conduct swift investigations of these complaints and take necessary action when justified.	
(2) This activity by the state will build confidence in the integrity of the program.	
2. The National Safety Council, in their publication, "How to Promote Motor Vehicle	Ref. #4 - p. 26

	REFERENCES
Inspection in Your State," offers the following suggestions for utilizing the resources of radio and television. a. See that the news departments of your radio and television stations are included in the distribution of news releases about the inspection program. b. Take advantage of the growing trend toward editorializing in radio and television. Much of this editorial activity has been in the traffic safety area. This provides opportunity for promotion of the vehicle inspection program. c. Provide local stations with spokesmen who can be interviewed or participate in talks over the air, and provide the local stations with information about the inspection program. 3. Because of the special expertise of the media people their assistance should be	

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	REFERENCES
sought in developing special pamphlets, flyers and posters that are necessary supplements to regular channels of communication. a. Innovative ways of distributing this type of information should be explored. (1) The groups which are supporting the inspection program may include items with their regular mailings. (2) May be able to include in mailings of vehicle registration notices. (3) Supply of flyers and brochures can be put in such places as police stations, doctors' offices, barber shops, and other places where people are likely to be. (4) May be taken as a special project for organizations, such as Boy Scouts or Girl Scouts.	

	REFERENCES
E. Developing Organization Support - Every state has several organizations or groups that play a significant role in influencing public opinion.	Ref. #1 - All Ref. #2 - All Ref. #4 - p. 22 Ref. #6 - p. 8
1. Every effort must be made to identify all of the organizations in the state whose cooperation and support is needed.	
a. These organizations should be given all of the available facts concerning the need for a vehicle inspection program.	
b. Their advice and counsel should be sought concerning the best type of inspection program, how it should operate, what items should be inspected, etc.	
2. The organizations should be invited to actively participate in the public support program.	
3. It is important to identify those groups that are most likely to oppose a vehicle inspection program.	
a. A concerted effort must be made to swing these people over to your side.	

	REFERENCES
One of the most successful ways to accomplish this is to involve them as much as possible.	
b. Opposing groups should be invited to participate in the overall planning of the program, to participate in discussions on the pros and cons of the various types of inspection programs, etc.	
c. Recent experiences in some states have identified the types of organizations or groups that frequently oppose vehicle inspection.	Ref. #7 - pp. 76-77
(1) Farm Organizations - Their support is a "must" for political success in many states. Farmers and ranchers are used to having a great deal of freedom when it comes to the type and condition of equipment they operate on public highways. Any regulation that is likely to impose added restrictions on this freedom is likely to be opposed.	

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	REFERENCES
(2) Civil Rights Organizations - In recent years the political clout of civil rights organizations has grown tremendously. These groups frequently view vehicle inspection as discrimination against the poor. The case that is usually made is that inspection provides no inconvenience to the upper and middle-income groups because they are likely to drive newer vehicles that easily meet inspection standards. The lower income groups, however, drive older vehicles that are frequently in need of repairs and least likely to meet inspection standards. Because of inadequate public transportation, lower income wage earners often have no way to get to work except in older vehicles which, in order to pass minimum inspection standards, would require prohibitive repair costs.	

Safety Rules for the Arc Welder

1. Wear approved welding helmet or face shield. Do not use gas welding goggles for arc welding!

2. Wear treated gauntlet gloves, leather apron and leather jacket.

3. Wear safety glasses under welding hood if intermittently chipping and welding.

4. Do not breathe fumes. Make sure exhaust is working.

5. Keep flammable materials away from welding area.

6. Use a welding screen to prevent flashing others.

7. Report to your teacher if electrode holder, ground clamp, connections, or cables get hot.

8. Hang up electrode holder. Do not lay it on grounded bench.

9. Use "HOT" sign on work and table.

10. Be careful of others when welding and chipping.

11. Dispose of rod ends in the proper container. Do not allow them to get on the floor.

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	REFERENCES
d. In public support programs the two organizations described above should be given the utmost consideration. Facts should be gathered and presented in a manner that will demonstrate what inspection will do FOR these people rather than TO them. (1) The quickest way to alienate these groups is by making inspection procedures too strict at the onset of the program.	
4. There are numerous activities that groups and organizations can engage in which will help develop and maintain public support for vehicle inspection. *a. Supporting resolutions - the organizations should be asked to go on record in support of vehicle inspection by adopting a resolution so stating.	

*Sample - Resolution, Open letter, Press release, and Speech are attached.

	REFERENCES
(1) Copies of the resolution should be sent to legislators, news media, other organizations and various other public officials.	
(2) The resolution as well as the organization's reason for supporting the program should be published in the organization's publication.	
b. Individual members should be urged to write personal letters to the governor and appropriate state legislators.	
(1) It should be noted that form letters <u>should not</u> be used for this purpose. Mass produced letters carry little weight with public officials.	
5. The administrator can stay alert to public attitudes toward his program by establishing a simple reporting procedure in which mechanics and station operators could easily report on the types of complaints and comments that they hear about the	

	REFERENCES
inspection program. a. This technique will enable the administrator to discover unpopular policies before they develop into full fledged problems. b. It also provides guidelines on those things that need to be clarified to the motorist. This provides a good basis for news releases and training bulletins.	

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4. "Some States Dispute Washington on Value of Auto Inspection". Wall Street Journal, June 16, 1969.

SUBJECT: FEDERAL PROGRAMS

HOURS: 3

OBJECTIVES: To develop an understanding of the various federal programs that relate to new and used vehicle standards; how these programs relate to state vehicle inspection programs; the objectives, requirements and benefits of the federal programs.

METHODS OF INSTRUCTION: Instruction should consist of combination lecture and class discussion. Students should be encouraged to explore and explain how their inspection programs may have to change as a result of the Federal standards.

INSTRUCTOR'S GUIDE

(FEDERAL PROGRAMS)

I. INTRODUCTION

A. Instruction should provide the student with a working knowledge of the various Federal programs that both directly and indirectly relate to state motor vehicle inspection programs. Students should understand the objectives of Federal programs and the role that state periodic motor vehicle inspection plays in assuring the attainment of these objectives.

Emphasis should be placed on the inter-relationships and inter-dependencies of Federal and State programs designed to insure that motor vehicles are equipped and maintained in a safe operating condition.

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	REFERENCES
II. PRESENTATION	
A. <u>The Federal Role in Vehicle Inspection</u>	
1. Prior to the 1960's, it was generally felt that governmental responsibility for traffic and highway safety was almost entirely vested at the state and local level.	
2. During the 1960's, the Federal role in highway and traffic safety has been more clearly defined and expanded.	
a. The Federal responsibility for improving the safety qualities of motor vehicles and vehicle equipment is an area of particular concern.	
3. In 1966, the President of the United States signed two pieces of safety legislation into law -- the Highway Safety Act and the National Traffic and Motor Vehicle Safety Act. Both Acts require a coordinated Federal/State effort in developing and implementing vehicle safety performance standards for both new and used vehicles.	
a. These two laws give the U. S. Department of Transportation the authority	

	REFERENCES
and the responsibility to assume a leadership role in the national traffic safety effort.	
4. The National Traffic and Motor Vehicle Safety Act states that "in order to assure a continuing and effective national safety program, it is the policy of Congress to encourage and strengthen the enforcement of state inspection of used motor vehicles."	Ref. #1 - All
a. The Act further directs the Secretary of Transportation to "conduct a thorough study and investigation to determine the adequacy of motor vehicle safety standards and motor vehicle inspection requirements and procedures applicable to used motor vehicles in each state, and the effect of such programs authorized by this title upon such standards, requirements, and procedures for used motor vehicles."	

	REFERENCES
b. The role that states should play in the formulation of Federal programs under the Act is delineated. (1) The Secretary of Transportation is authorized to cooperate with the states in the planning and development of motor vehicle safety standards and the methods for inspecting and testing to determine compliance. (2) The Secretary is directed to consult with the Vehicle Equipment Safety Commission (which is made up of state officials) in developing motor vehicle safety standards. (3) The Secretary of Transportation is required to establish a "National Motor Vehicle Safety Advisory Council, a majority of which shall be representatives of the general public, including representatives of state and local governments." The Secretary	

Safety Rules for the Oxyacetylene Welder

1. Inspect equipment before using. Make sure tanks are chained or otherwise restrained from falling. Inspect hoses, connections, and valves. Report defects to your teacher.

2. Before changing tanks, place protective cap over valves.

3. Keep equipment clean and free of oil and grease. NEVER oil or grease threads.

4. Make sure ventilation is adequate.

5. Keep flammable materials away from the work area.

6. Wear the proper type of goggles.

7. Release regulator pressure screws. Open cylinder valves gradually.

8. Open acetylene cylinder valve not more than 1/4 turn. Keep wrench in place on the valve so that valve may be shut off quickly.

9. Acetylene pressure in the hose should never exceed 15 pounds per square inch.

10. Use a friction lighter to ignite the torch--never use a match or other lighter.

11. Close acetylene valve first if torch backfires.

12. Point torch away from yourself and others.

13. Keep sparks and flame away from cylinders, hoses, and regulators.

14. Close cylinder valves when finished, release pressure on regulators, and drain lines by opening torch valves. Reclose torch valves.

15. Quench hot metal or mark "HOT" with chalk, soapstone, or a special sign.

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	REFERENCES
must consult with this Council on motor vehicle safety standards.	
5. The Highway Safety Act declares that "Each state shall have a highway safety program approved by the Secretary, designed to reduce traffic accidents and deaths, injuries and property damage resulting therefrom." Among other things, the Act calls for the development of uniform standards by the Secretary in the areas of "vehicle registration, operation, and inspection."	Ref. #2 - All
a. The act delineates the role that states should play in formulating Federal programs.	
(1) The Secretary must develop standards in cooperation with the states and their political subdivisions.	
(2) A National Highway Safety Advisory Committee is created. Members are appointed by the President and must include representatives of state and local government including state legislators. This	

	REFERENCES
Committee is responsible for advising, consulting with and making recommendations to the Secretary on matters relating to the highway safety activities of the Department of Transportation. In addition, the Committee is authorized to (1) review research projects and/or programs and make recommendations concerning those having merit and (2) to review and make recommendations on standards prior to their issuance.	
6. The two Acts clearly give the Secretary of Transportation authority to improve the safety qualities of used motor vehicles. Under the National Traffic and Motor Vehicle Safety Act he has the power to issue uniform Federal standards applicable to all motor vehicles in use. Under the Highway Safety Act he has the authority to implement and enforce the used motor vehicle standards by requiring states to institute motor vehicle inspection programs.	

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	REFERENCES
B. Federal Influence on State Inspection Programs	Ref. #3 - pp. 2-3
1. The most immediate impact on state vehicle inspection programs will result from the periodic motor vehicle inspection standard issued under the Highway Safety Act.	
a. The motor vehicle inspection standard requires that each state have a periodic vehicle inspection program for all registered vehicles or an experimental or pilot program approved by the Secretary. To be in compliance with the standard, the program must:	
(1) Require each vehicle registered in the state to be inspected, either at the time of initial registration and at least anually thereafter, or at such other time as may be designated under an experimental, pilot or demonstration program approved by the Secretary.	
(2) Insure that the inspection is performed by competent personnel specifically trained to perform	

	REFERENCES
their duties and certified by the state. (3) Require inspections to cover systems, sub-systems and components having substantial relation to safe vehicle performance. (4) Establish inspection procedures to equal or exceed criteria issued or endorsed by the National Highway Safety Bureau. (5) Require each inspection station to maintain records in a form specified by the state, which would include at least the following information: (a) Class of vehicle (b) Date of inspection (c) Make of vehicle (d) Model year (e) Vehicle identification number.	

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	REFERENCES
(f) Defects by category (g) Identification of inspection (h) Mileage or odometer reading. (6) Publish summaries of records of all inspection stations at least annually, including tabulations by make and model of vehicle.	
b. The motor vehicle inspection standard is supplemented by a Highway Safety Program Manual which provides additional guidance to the states in implementing or improving motor vehicle inspection programs. Specifically, the Manual provides insight into: (1) The purpose of vehicle inspection. (2) The legal authority of the Department of Transportation	Ref. #4 - All

	REFERENCES
to establish motor vehicle inspection program standards. (3) The Department of Transportation's general and specific policies regarding vehicle inspection programs. (4) Methods of developing and operating state inspection programs. (5) Methods of evaluating the quality of vehicle inspection programs. (6) The types and uses of various records and reports. c. Since the passage of the Highway Safety Act, the Department of Transportation has clearly indicated that it will utilize its authority and resources to see that each state institutes a periodic motor vehicle inspection program. Any program that will not result in <u>all</u>	

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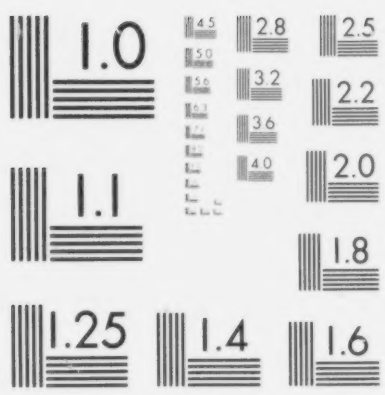

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

	REFERENCES
registered vehicles being inspected at least annually is less than satisfactory.	Ref. #6 - All
(1) The Federal Highway Administration, U. S. Department of Transportation, in FHWA Order 7-3 outlines the policies and conditions that must be met by a state if they wish to have an inspection program approved which deviates from the one described in the standard.	
(a) The order will make it difficult, if not impossible, for any program other than a PMVI program to meet the necessary requirements.	
2. The National Traffic and Motor Vehicle Safety Act, while not having an immediate impact on state vehicle inspection programs, will eventually have an effect.	
a. While the department has the authority under this Act to establish uniform Federal standards for used motor	

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	REFERENCES
vehicles, it has not done so. In December, 1969, the National Highway Safety Advisory Committee reported on a study of the present status of the Department's standards-making program for used vehicles. The Committee stated, "we express our utter dismay at the present stagnation of the Highway Safety Bureau's program to implement the intention of Congress in the matter of used car standards and motor vehicle inspection. We conclude that not one single used car standard can be expected under present conditions for at least several years." The Committee also urged the Secretary of Transportation to sponsor a conference of used vehicle inspection and maintenance which would bring state and federal officials and experts together in order to promote the ideas and techniques of inspection.	Ref. #7 - Resolution on Used Vehicle Safety
b. Once the Secretary starts to exercise the authority vested in him under the	

	REFERENCES
Act, the Federal influence on state inspection programs will be greatly expanded. Where the states currently establish the performance standards that used vehicles must meet, and then enforce these standards through inspections, the Federal government will be establishing the performance standards and the state will retain the enforcement responsibility.	
(1) The Secretary, in his report to Congress, Safety for Vehicles in Use, indicated that the following systems and components are being considered for initial standards for used vehicles:	Ref. #5 - p. 32
(a) Brake systems, including brake lines, service brake system, emergency brake system, and parking brake system.	
(b) Steering and suspension systems.	

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Safety Rules for Lifts, Hoists, Cranes, and Jacks

1. Be sure you know how to operate the equipment and know the limitations.
2. Ask your teacher to approve your setup.
3. Check all equipment, chains, hooks, cables, ropes, etc., for condition. Report defects to your teacher.
4. Position crane or hoist directly over item to be lifted.
5. Double check attachment to object.
6. Make sure object is balanced after picking it up a few inches.
7. Keep unnecessary persons away from objects on hoists, lifts, or cranes.
8. Automobiles must be supported on approved stands or blocks before doing work under the car or removing the wheels. JACKS CANNOT BE TRUSTED!
9. Avoid walking under hoisted objects.

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	REFERENCES
(c) Tires, wheels and rims.	
(d) Lamps, reflective devices and associated equipment.	
(e) Glazing	
(f) Windshield wiping, washing, defrosting and defogging.	
(g) Occupant restraint systems.	
(h) Horns	
(i) Rear view mirrors.	
(j) Body, doors, fenders, moldings and bumpers.	
(k) Fuel supply system.	
(l) Exhaust system.	
(m) Wheel nuts, wheel discs and hub caps.	
c. The setting of standards for used vehicles will not be an entirely new experience for the Federal Government. The Department of Transportation currently establishes standards of	Ref. #5 - p. 33

	REFERENCES
inspection and maintenance as well as general safety requirements for commercial vehicles operating in interstate and foreign commerce under the authority of the Interstate Commerce Act and the Explosives and Combustibles Act. (1) Regulations developed as a result of these Acts are enforced by the Department's Motor Carrier Safety Bureau. Many states have adopted all or part of these regulations and applied them to intra-state motor carriers. (a) One of the primary reasons for some states not adopting these regulations for intra-state carriers is the states' lack of sufficient resources to enforce the regulation. (b) The Secretary is currently studying the feasibility of providing funds to states "to increase the State/ Federal commercial motor	

	REFERENCES
vehicle inspection and safety enforcement capability for intra-state commercial motor vehicles operated by both for-hire and private motor carriers."	
3. In addition to the Department of Transportation, the Department of Health, Education and Welfare also had certain responsibilities in motor vehicle inspection as a result of the Clean Air Act of 1967. Under the Act, the Secretary of HEW has the responsibility for setting standards relating to vehicle exhaust system emissions. As with safety standards, the eventual enforcement to assure compliance will rest with states.	Ref. #5, p. 54
a. Title II of the Act also authorizes the Secretary of HEW to make grants to state agencies with respect to costs incurred to inspect and test emission control devices.	
b. Before making such grants the Secretary of HEW must have the Department of	

	REFERENCES
Transportation certify that the emission inspection program is consistent with the highway safety inspection program carried out under the Highway Safety Act.	

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REFERENCES

1. Public Law 89-563, National Traffic and Motor Vehicle Safety Act of 1966, 9 September 1966

2. Public Law 89-564, Highway Safety Act of 1966, 9 September 1966

3. United States Department of Transportation. Highway Safety Program Standards. Washington, D. C.: National Highway Safety Bureau Documentation Center, U. S. Department of Transportation, 1968

4. United States Department of Transportation. Highway Safety Program Manual, Volume I: Periodic Motor Vehicle Inspection. Washington, D. C.: Government Printing Office, 1969

5. United States Department of Transportation. Safety for Vehicles in Use. A report to the Congress from the Secretary of Transportation. Washington, D. C.: Government Printing Office, 1968

6. United States Department of Transportation. Federal Highway Administration Order 7-3. Washington, D. C.: Department of Transportation, January 17, 1969

7. United States Department of Transportation. "Transcript of the National Highway Safety Advisory Committee Meeting," December 16, 1969. Washington, D. C.: U. S. Department of Transportation

20369

SUBJECT: LEGAL ASPECTS OF MOTOR VEHICLE INSPECTION

HOURS: 4

OBJECTIVE: To develop an understanding of the legal framework in which a motor vehicle inspection program must operate, including the legislation creating the function and the legal authority granted the administrator to establish and enforce administrative rules and regulations; acquaint the student with appellate court decisions regarding administrative enforcement and civil liability; and to discuss the relationship of the federal and state standards relating to vehicles and vehicle equipment.

METHODS OF INSTRUCTION: The primary method of instruction for this unit is lecture combined with full class discussion and participation. Because the students are actively engaged in vehicle inspection programs, the instructor should attempt to stimulate and encourage full class participation and discussion.

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	REFERENCES
II. PRESENTATION	
A. Creating the Agency	
1. Every governmental agency, bureau, department, division, etc., must point to some law establishing or creating the agency and setting forth the powers and duties to be performed. The Uniform Vehicle Code (1968) recommends the Department of Motor Vehicles be assigned the function of inspection of motor vehicles. The law creating the agency and specifying the duties and powers is a legal framework around which the administrator adopts rules and regulations for the administration and enforcement of the motor vehicle inspection law. This power to make rules and regulations is a very important and necessary aspect of government. The statute establishes guidelines and leaves the details of the operation to the administrator.	Ref. #4, Secs. 2-301 et seq. and 13-101 et seq. Ref. #4, Sec. 13-112
B. Duties of Department	
1. Establish inspection stations (if law provides for state owned and operated	Ref. #4, Secs. 13-105, 13-106, and 13-107

	REFERENCES
stations) or appoint official inspection stations (if law provides for privately owned and operated inspection stations).	
2. Establish list of items to be inspected on vehicles. Some items of equipment are set forth in the statutory law -- brakes, lights, horns, mufflers, mirrors, etc.	Ref. #4, Sec. 13-104; Ref. #3, Exhibit II List of Inspection items; Ref. #2 - All Ref. #4 - Chapt. 12
3. Statute normally establishes the fee charged for each inspection.	Ref. #4, Sec. 13-107
4. Department normally issues or approves all signs, posters, inspection certificates, etc.	Ref. #4, Secs. 13-111 and 13-107
5. Other administrative duties.	
C. Duties of Motorists	
1. It is unlawful to drive or move on any highway any motor vehicle, etc., unless the equipment on such vehicle is in good working order and adjustment and unless the vehicle is in such safe mechanical condition as not to endanger the driver or other occupant or any person or property.	Ref. #4, Sec. 13-101 Ref. #5, pp. 436-441 Ref. #6, Sec. 166

	REFERENCES
2. Unlawful for owner or driver to refuse to submit a vehicle to any inspection and test that is authorized or required.	Ref. #4, Sec. 13-103
3. Every motor vehicle must be inspected periodically, but at least annually, is provision of Uniform Vehicle Code. Some states make it more frequently. Others have adopted random inspection by teams of inspectors who establish roadblocks along the highway.	Ref. #4, Sec. 13-104 Ref. #1, pp. 26-29
D. Administrative Law	
1. For every administrative agency there is a body of law known as administrative law which governs many of the activities of the administrative process.	
2. The work of an administrative agency can be divided into three functions:	
a. Making of rules and regulations -- both for internal operation of the organization and for the general public which it serves.	
b. Regulation or enforcement -- both of statutory law as well as rules	

Safety Rules for the Paper Cutter

1. Be certain that the handle or lever controlling the blade is in its proper position and that the safety lock is engaged before setting back gage.

2. Keep hands clear of blade at all times.

3. Do not overload the cutter--work with smaller batches that cut easily.

4. Use care in jogging stock against the back gage. Paper can cut!

5. Keep both hands on the cutting lever or handle during the cut and return stroke.

6. Be sure handle or lever is in the proper position before reaching for cut stock.

7. Engage safety lock after using the cutter.

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	REFERENCES
and regulations made by agency -- done by inspection and investigation.	
c. Adjudication -- determining when a statutory law or rule and regulation has been violated.	
3. Many states have adopted an "Administrative Procedure Act" which sets forth the procedures by which most administrative agencies adopt rules and regulations. Such laws normally require that the agency give the public notice that a certain rule is being proposed, and sometimes must hold a public hearing. Interested persons can then submit their views either orally at a public hearing, or in writing. When the proposed rule is adopted, the agency must then publish such fact, and in many states file it with some office such as Secretary of State or Attorney General.	Ref. #7, Vol. 4 pp. 397-408
4. The process called adjudication or determining if there has been a violation of a statutory law or rule and regulation normally provides for judicial review of the decision in a court of law. The	

	REFERENCE
appeal from an administrative decision requires: a. That the person must have standing to appeal -- that is, he must have been personally affected or aggrieved by the action of the administrator. b. That the decision of the administrator is final -- there are no other administrative remedies available such as a hearing before an appeal board. There is no such provision in the Uniform Vehicle Code for motor vehicle inspections. The appeal would be directly from the agency to the courts. c. That such appeal will not consider the wisdom of an administrator's decision as long as he has not violated some statutory or constitutional provision, or acted beyond his authority. The administrator's decision must be based on some evidence -- the standard normally used is "substantial evidence". In other words, he cannot be arbitrary or capricious and abuse his discretion.	

	REFERENCES
d. Courts will set aside an administrative decision if the administrator has not followed his own rules and regulations- even if he was not required to make such a rule in the first instance. If he does issue a rule, he must follow it. Vitarelli v. Seaton, 359 U. S. 535, 79 S. Ct. 968 (1959).	
E. Inspection by Police Officers	
1. In addition to the periodic inspection of vehicles, the Uniform Vehicle Code, and many states, provide that police officers "may at any time upon reasonable cause to believe that a vehicle is unsafe or not equipped as required by law, or that its equipment is not in proper adjustment or repair, require the driver of such vehicle to stop and submit such vehicle to an inspection and test..."	Ref. #4, Sec. 13-102 Ref. #1, pp. 42-53
2. If a vehicle is found to be in an unsafe condition or is not in proper repair and adjustment, the officer may issue a written notice to the driver and send copies to the motor vehicle department. In most states	Ref. #4, Sec. 13-102

	REFERENCES
this action requires that the vehicle be repaired and inspected within 10 days. If in the reasonable judgment of the officer the further operation of the vehicle would be hazardous, he can require that it not be operated <u>or</u> that it be driven to the nearest garage or place of safety.	
F. Motor Vehicle Inspection and Constitutional Issues	
1. Arguments that motor vehicle inspection violates the "due process" clauses of both the state and U. S. Constitution (14th Amend.) because inspections are arbitrary, harsh, and an unreasonable exercise of the police power, has been rejected by the courts. City of Evanston v. Wazau, 364 Ill. 198, 4 N.E.2d 78 (1936); Miami v. Slone, 190 So. 810 (Fla. 1939).	
2. Arguments that the creation of a motor vehicle inspection system was an unconstitutional delegation of legislative authority has also been rejected by the courts. City of Evanston v. Wazau, <u>supra</u>. "It is true that while a legislative body cannot divest itself of its proper function	

	REFERENCES
by determining what the law shall be, it may nevertheless authorize others to do those things which it might properly, but cannot understandingly or advantageously, do itself. ... This doctrine is sound and has been adhered to for many years, for the obvious reason that government could not be carried on if nothing were left to the judgment and discretion of administrative officers. ... A clear distinction exists, however, between the power to legislate -- to grant the permit under certain specified conditions -- and the power to administer or regulate its exercise, once granted." See also Brattleboro v. Norwicki, 117A.2d 258 (Vt. - 1955).	
3. Arguments that inspection of vehicles places an unreasonable burden on interstate commerce has been rejected by the courts. Mayer v. Ames, 133 Ohio St. 458, 14 N.E.2d 617 (1938), cert. denied 305 U. S. 621 (1938).	
4. At least eight states have established a random inspection program which involves stopping motorists at a roadblock to check	

	REFERENCES
equipment alongside the highway. Such road-blocks were held to be constitutional in People v. DeLaTorre, 64 Cal. Rptr. 804 (Cal.App.-1967).* The court held it is not a denial of an individual's right of mobility.	
G. Preemption of Vehicle Equipment by Federal Government	
1. In 1966 the U. S. Congress entered the field of motor vehicle equipment by passing the "National Traffic and Motor Vehicle Safety Act of 1966" (15 U.S.C.A. 1381 et seq.). This act provided for the issuance of federal standards concerning motor vehicle performance and equipment.	
2. In Sec. 1392 of that Act it provides for supremacy of federal standards as follows: "(d) Whenever a Federal motor vehicle safety standard established under this subchapter	

*For additional cases on roadblocks, see Fisher, Edward C., Laws of Arrest, Traffic Institute, Northwestern University, 1967, with current supplement, Sec. 38, "Stopping Vehicle to Inspect License, Equipment, or Load," pp. 79-85.

	REFERENCES
is in effect, no State or political subdivision of a State shall have any authority either to establish, or to continue in effect, with respect to any motor vehicle or item of motor vehicle equipment any safety standard applicable to the same aspect of performance of such vehicle or item of equipment which is not identical to the Federal Standard. ..."	
3. This supremacy of the federal standard has been narrowly construed by the federal courts. Examples are the cases dealing with the Chrysler "Super Lite" which is an additional light to the other lighting equipment required by the federal standard. The states of Vermont, New Hampshire and New York found that this super lite was hazardous and prohibited its use under the state equipment standards. Chrysler Corporation brought suite to prevent the states from issuing regulations prohibiting such lights on the ground that the federal standard had preempted the field.	

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The federal courts held that the federal preemption was limited and it did not bar the states from regulating equipment not covered by the federal standard. The super lite did not impair the effectiveness of the lighting requirements of the federal standards and hence would be regulated by the states. Chrysler Corp. v. Rhodes, 294 F. Supp. 665 (D.C.-N.H.-1968) affirmed 416 F.2d 319 (C.A. 2d-1969); Chrysler Corp. v. Malloy, 294 F. Supp. 524 (D.C.-Vt.-1968) and Chrysler Corp. v. Tofany, 305 F. Supp. 971 (D.C.N.D.-N.Y.-1969) both reversed by 419 F.2d 499 (C.A.2d-1969).	
H. Civil Liability for Motor Vehicle Inspection	
1. The question arises, what if the vehicle is inspected, passed, and a few days later an accident is caused or contributed to by some defective part which has been inspected? Does this give rise to an action for damages against the governmental agency and/or the person who did the inspecting?	
2. First, let us consider the department's liability. As a general rule the government is immune from a lawsuit for torts	Ref. #8, Sec. 125

	REFERENCES
committed by its employees. However, in recent years this doctrine of governmental tort immunity has been changed in a few states. For example, the Federal Government has enacted a "Federal Tort Claims Act" under which a person who has been injured by some negligent act on the part of a Federal employee can sue in the federal courts. Unless the law has been changed by court decision or statute in the particular state, the general rule is that a lawsuit cannot be brought against the motor vehicle department or other government agency. Employees of governmental agencies who perform what is called ministerial acts are liable for their own personal acts which are negligent. (For example, a state employee, driving a motor vehicle in the course of his duties, runs a stop sign, and as a result of his negligent act, another person is injured or property is damaged. The employee would be liable for such acts). However, employees are not liable, generally, if their duties are what the courts call discretionary. That is, the duties involve discretion and	

	REFERENCES
judgment. No court decisions directly in point were found concerning the liability of employees of a state owned and operated motor vehicle inspection station. However, it is likely the courts would hold the employee personally liable if he was negligent in the manner of conducting the inspection and the negligence was the proximate cause of injury to another.	
3. As for a privately owned and operated inspection station which has been officially designated by the state motor vehicle department to conduct motor vehicle inspections, it has been held that where an inspection was negligently done and this was the proximate cause of injury to another, the station is liable. In Buszta v. Souther, 232 A.2d 396 (1967) the Supreme Court of Rhode Island held a service station liable. The vehicle had been inspected and passed. About a month later the daughter of the vehicle's owner was involved in an accident in which she was injured. Suit was brought against the service station on the	Ref. #6, Sec. 166

Safety Rules for the Platen Press

1. Make sure form is securely locked in the bed.
2. Apply ink only when press is at a dead stop.
3. Have your teacher check your setup and supervise your feeding.
4. Make sure guards are in place and functioning.
5. Start at slowest speed. Increase speed only as your skill increases.
6. Never attempt to retrieve a misfed sheet! Use throw-off lever, stop machine and open platen.
7. Stop press before attempting to retrieve paper picked up by the ink rollers.
8. Never leave the press while it is running.
9. When finished, stop press and clean up according to directions.

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	REFERENCES
grounds the brakes were in defective condition. The court held there was a legal cause of action and that the liability of the inspection station extended to anyone injured.	

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REFERENCES

1. Inspection Laws Annotated, 1969, National Committee on Uniform Traffic Laws and Ordinances, Washington, D. C.

2. Highway Safety Program Standard 4.4.1, Periodic Motor Vehicle Inspection, U. S. Department of Transportation, National Highway Safety Bureau, Washington, D. C., issued June 27, 1967.

3. Highway Safety Program Manual, "Periodic Motor Vehicle Inspection," Vol. 1, U. S. Department of Transportation, National Highway Safety Bureau, Washington, D. C., January 1969.

4. Uniform Vehicle Code, 1968, National Committee on Uniform Traffic Laws and Ordinances, Washington, D. C., Chapter 13, "Inspection of Vehicles."

5. Fisher, Edward C., Vehicle Traffic Law, Traffic Institute, Northwestern University, 1961, with current supplement, Chapter XIX, Part 7, "Offenses Involving Equipment of Vehicles," pp. 436-441.

6. 7 Am.Jur.2d, Automobiles and Highway Traffic, Sec. 166 "Inspection of Vehicles."

7. Davis, Kenneth Culp, Administrative Law Treatise, West Publishing Co., 1958, 4 volumes.

8. Prosser, William L., Handbook of the Law of Torts, West Publishing Co., 1964, Sec. 125 "Governmental Immunity," and Sec. 126 "Public Officers."

SUBJECT: INTRODUCTION TO ORGANIZATION

HOURS: 6

OBJECTIVE: To develop an understanding of some basic principles of management as they apply to the part that organization plays in achieving the goals of a motor vehicle inspection program.

METHODS OF INSTRUCTION: The primary method of instruction for this unit is lecture.

Because the students will be actively engaged in motor vehicle inspection programs the instruction should stimulate class participation to the fullest. This should be done by discussing the organizational structure in which the students now operate and have the class suggest improvements. The students should also be required to participate in practical organizational exercises.

The syllabus highlights management theories which go into an effectively operating organization and which will be recognizable to those students who have been exposed to formal management training. Three attachments are included which should further assist the instructor in preparing for this phase of the training program.

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INSTRUCTOR'S GUIDE

(INTRODUCTION TO ORGANIZATION)

I. INTRODUCTION

A. Instruction should provide an understanding of management principles involved in the allocation of functions and responsibilities within an effective motor vehicle inspection program.

It should be emphasized to the student that the motor vehicle inspection segment of state government is big business and must be operated as such under the guidance of knowledgeable administrators and within an organizational structure designed to facilitate the accomplishment of set goals.

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	REFERENCES
II. PRESENTATION	
A. An Overview of the Theory of Organization	
1. In order for a periodic motor vehicle inspection program to be successful it must operate within an organization which lends itself to the carrying out of its objectives. This does not mean that vehicle inspection can be the responsibility of a unit of government that is entirely independent of the assistance and cooperation of other agencies, but rather that vehicle inspection should operate within an organizational structure that fits the needs of the program while embodying accepted theories of administration. In organizing a vehicle inspection program, the objective should be to establish an organizational structure within which various degrees of responsibility and authority for making decisions and taking actions are delegated. The objective is to establish responsibility and authority where action can or must be accomplished. The level to which these various degrees of authority and responsibility are	Ref. #1 - par. 2.7.1.

	REFERENCES
assigned establishes the principal echelons within the structure. The lateral division of responsibility or authority establishes the functional organization. This does not mean that the head of an organization can delegate final responsibility. It is a well-established principle of management that the top executive alone is responsible for all that his organization does or fails to do, and that he can best discharge his responsibility through an established chain of command which assists him in this function. The head of a motor vehicle inspection department, working within the framework of an effective organizational structure, should have subordinates that present to him that information which he requires to keep abreast of the current situation and to form the basis of sound decisions. Staff personnel receive information from personal observation, from the head administrator, from other staff employees, from research of files,	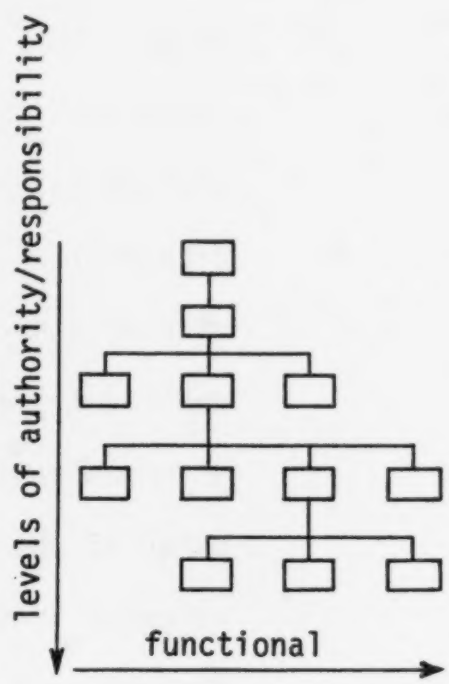

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records, and studies available, and from reports received from subordinates. They analyze and condense this information in order to present only significant facts. If this is done, the head of the motor vehicle inspection program will not be burdened by undigested or irrelevant information and he will have more time for field trips and personal observation of operating conditions in order to enable him to better guide the program.	
B. Departmentation	
1. It would be impractical to outline an organizational chart to encompass a vehicle inspection program and to expect it to be utilized by every lecturer using this syllabus. The differences in programs, i.e., state-owned, state-appointed, spot-check, combination, now in operation or being adopted by state legislatures, require different organizations. However, an effective organizational structure is necessary to carry out effective programs in order to meet highway safety needs.	Ref. #4 - Chap. IV - p. 4

	REFERENCES
With this in mind, some suggestions can be made.	
2. When placing vehicle inspection activities within an organizational structure, the administrator should consider two management theories of organization charting, namely mechanical (structural) and behavioral. Under the mechanical theory the functions to be performed are decided upon and a chart is drawn placing these functions, in detail, within the structural authority. The premise here is that the functions will be satisfactorily performed, regardless of the personnel involved, and the result will be an efficient organization. The behavioral theory is based on the relationships between humans. This theory suggests that guidelines are not needed -- that it is the individual who is important. As can be seen, an intelligent combination of the two theories should be worked into the organization chart.	
3. When we talk of departmentation we mean any unit, regardless of size, set up for the	

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	REFERENCES
purpose of performing a function within proper limits of supervision. Relationships between activities should be considered when grouping units, as should specialization of activity or knowledge required to perform a particular function. Although it is difficult to stress uniformity when dealing with many different political jurisdictions, it is necessary to define some basic terms when discussing organization planning. a. Accountability - is the requirement that the individual answer to his senior for his success or failure in the execution of the duties for which he has responsibility and authority. b. Authority - is the right of power connected with a rank or position to make a decision in fulfillment of a responsibility, and to act, command, or require action by others. c. Delegation - is the granting or conferring of both responsibility and authority from one organizational unit to another.	

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	REFERENCES
d. Duties - refer to the tasks which contribute to functions and which a single individual is required to perform.	
e. Formal Organization - is the formal structure and the formally assigned functions/duties.	
f. Function - is one of the processes which, taken together, are designed to accomplish an objective.	
g. Informal Organization - refers to the friendships, group relationships, and customs that grow when people are brought together on a job.	
h. Mission - is the purpose for which the organization exists; the sum of all the more detailed goal formulations.	
i. Organizational Goals - refers to the results an organization desires to attain. The over-all goal is achieved by sub-goals. When talking about goals it is necessary to know if you are talking about the ultimate goal of	

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General Safety Rules for Electricity/Electronics Laboratories

1. Consider all wires and terminals as live and "HOT" until proven otherwise by a safe method of testing.

2. Resist the temptation to throw a switch just to see what happens.

3. Turn off power before replacing fuses.

4. Locate and correct the cause of a blown fuse or tripped circuit breaker before replacing fuse or resetting breaker.

5. Experimental circuits and wiring practice boards should be fused properly.

6. Make wiring changes only with power OFF.

7. Make sure wire size and insulation is appropriate for the job.

8. Disconnect or unplug appliances and equipment before attempting repairs.

9. Make it a habit to inspect cords, plugs, etc.

10. Make sure portable electrical devices are properly grounded.

11. Never attempt to use a piece of electrical equipment known to be faulty.

12. Chassis of AC-DC radios should be kept clear of any grounded conductors. Use an isolation transformer if available, otherwise determine polarity and reverse plug if necessary.

13. Make sure capacitors are discharged before touching. Experimental power supplies should incorporate "bleeder" resistors.

14. Disconnect power cord before touching anything behind front panel of transmitter.

15. Remove headphones before working on equipment.

16. Make it a habit to keep one hand in your pocket or behind your back when using a test probe.

17. Wear gloves and a face shield when handling cathode-ray tubes. Old CRT's should be smashed in a large steel barrel by dropping a heavy metal rod through a hole in the top of the barrel. Never have CRT's setting around as "curiosities."

18. Metal jewelry, watches, rings, chains, etc. should not be worn when working on electrical equipment.

19. Always wear safety glasses when soldering.

20. Follow instructions when handling and charging storage batteries. Wear safety glasses.

21. Keep sparks and flame away from storage batteries, especially when being charged.

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	REFERENCES
the organization or goals of the various sub-divisions within the organization.	
j. Responsibility - it is the obligation of the individual to perform the duties assigned to him to the best of his abilities. In another sense, a responsibility may be regarded as the same as duty.	
The following terminology for identification of levels of groupings of activity within the organization is suggested. These terms are commonly used by governmental employees and can be used to advantage in a discussion of governmental organization or functions. (References to parts of existing organizations must, of course, make use of the terms officially adopted to designate them.)	

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REFERENCES

Name of Part of Organization	Identification of Level	Example
Department	The basic functional part of the organization in its entirety.	Department of Public Safety
Division	The major, formal, functional parts of a department.	Motor Vehicle Inspection Division
Bureau	The principal, established, functional parts of a division.	Field Operations Staff Operations Services
District	Geographic sub-division of the organization. The principal areas under one command or control.	Western District District #1 Troop A
Section	Any recognized permanent or semi-permanent specialization in a bureau.	Special Investigations
Unit	Further specialization, often temporary, within a section.	Undercover Investigations
Detail	Temporary assignment or project in relation to a specific matter.	Spotcheck Detail

Section, Unit, or Detail may temporarily apply directly under Department or Division.

	REFERENCES
4. When preparing an organizational arrangement for the motor vehicle inspection program, specialization, span of control, centralization, de-centralization, line and staff functions are matters which require consideration by the administrator. Once an organization has been finalyzed and implemented, these same matters should always be under consideration by the administrator so that the organizational structure will be a "living" thing and will be able to adjust to the needs of the times. Too often this is not the case. a. Specialization must be considered so that the specialized efforts can be integrated toward organizational goals. As it concerns the operational levels of a vehicle inspection program, specialization can be graphically illustrated at least three different ways depending on decisions made as to the classes of inspection to be included in the program and the degree of supervision to be included within each class.	

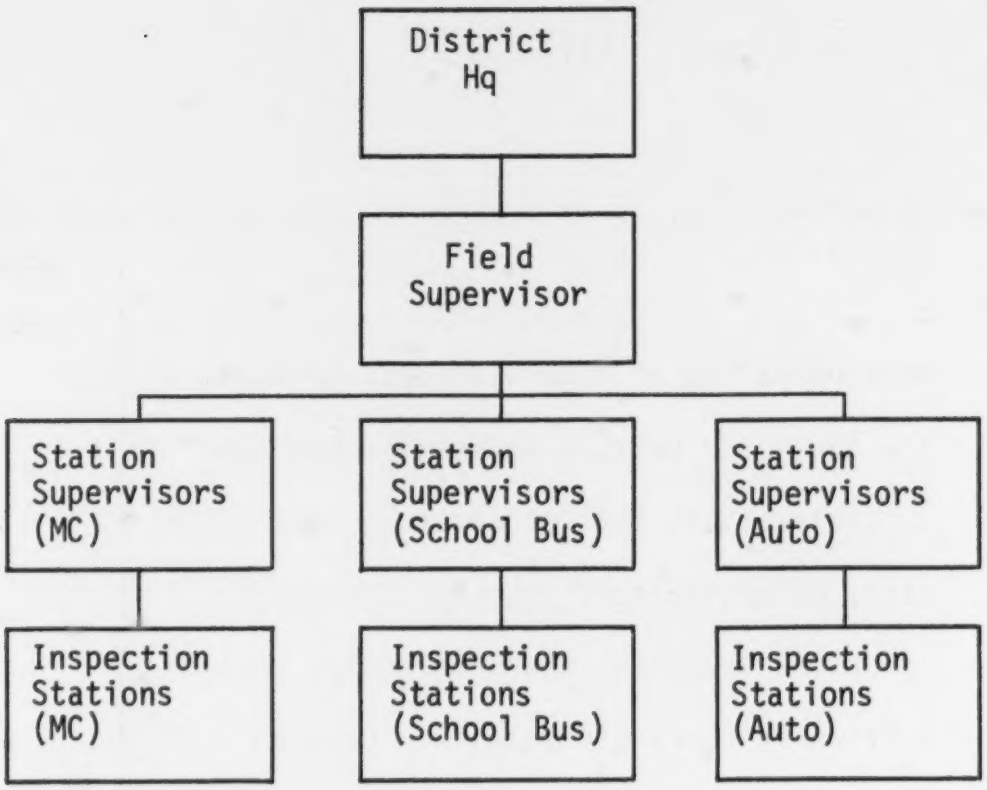
District Hq
Field Supervisor
Station Supervisors (MC)
Station Supervisors (School Bus)
Station Supervisors (Auto)
Inspection Stations (MC)
Inspection Stations (School Bus)
Inspection Stations (Auto)

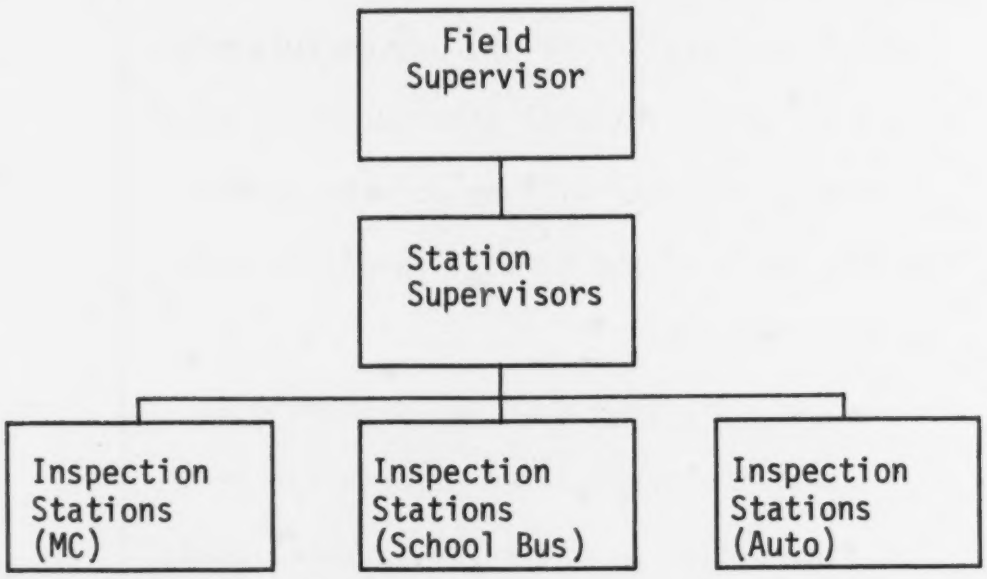
Field Supervisor
Station Supervisors
Inspection Stations (MC)
Inspection Stations (School Bus)
Inspection Stations (Auto)

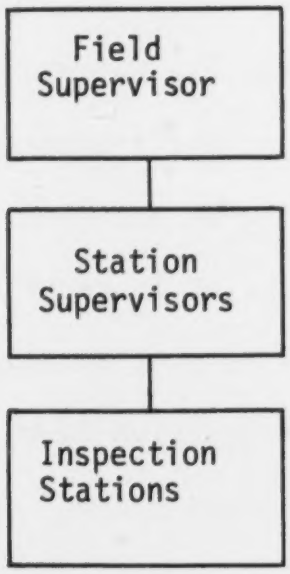
Field Supervisor
Station Supervisors
Inspection Stations

20398

	REFERENCES
b. Span-of-Control refers to the theoretical or practical limit to the number of units or subordinate personnel who can be effectively supervised or controlled by one individual. Conversely, it is the number of units or subordinate personnel reporting to a single person. In programs where inspections are conducted in state-owned stations, span-of-control will mainly be concerned with personnel. In the state-appointed programs the theory of span-of-control deals with personnel within the governmental agency administering the program and must also take into consideration the number of inspection stations which will be assigned to a Station Supervisor. Factors that should be taken into consideration concerning this aspect of organization are competency and geographical location (dispersion) of subordinates and supervisors, personal authority of subordinates to make decisions, type and amount of	

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	REFERENCES
work being performed, relationships among the management group, and acceptance of the vehicle inspection program by inspection station personnel and the public.	
c. <u>Centralization and De-centralization</u> must be considered in vehicle inspection programs due to the geographical dispersion of the involved activities. The administrator must assign personnel and activities on the basis of need in relation to time and area to effectively equalize workloads and responsibilities. Factors entering into this are geographical dispersion, size and complexity of the organization, ability of superiors and subordinates, management philosophy of the administrator, economics, and lines of communication. The degree of decentralization will differ among states, but the administrator must be made aware that as he decentralizes the need of controls is increased in	

20400

	REFERENCES
order to maintain consistency of/with policy and technological competence in order that objectives of the program may be obtained.	
d. Line refers to those functions and activities which are basically concerned with fulfillment of the primary responsibility of the vehicle inspection program, the translating of plans and policies into action in the field. In state-owned programs it would be generally characterized by direct contact with the public. In state-appointed operations it still is concerned with direct contact with the public. The public in this case including inspection station personnel. In determining the background and training desirable in line personnel, the administrator of the vehicle inspection program must first decide upon the functions they are to perform. A check of existing programs shows that some favor line personnel to	Ref. #1 - par. 2.9.2.

	REFERENCES
have mechanical training and others favor law enforcement experience.	
e. Staff refers to those non-line functions and activities which serve the purpose of developing personnel and the agency to most effectively meet their responsibilities. The functions generally include those activities which provide technical, special, and other supportive activities necessary for the organization to accomplish its mission. When deciding upon an organizational structure for the vehicle inspection program, the administrator must first decide upon the staff assistance which will be required by the line operation and which of this assistance can be obtained form outside the agency. He then needs to place the internal staff functions into logical groupings for the purpose of including them in his organizational structure.	

	REFERENCES
5. The Insurance Institute for Highway Safety, in its Management Manual for Motor Vehicle Inspection, suggests organizational structures for both state-appointed and state-operated systems which the National Highway Safety Bureau considered sufficiently appropriate to include as examples in the Highway Safety Program Manual, Volume I - Periodic Motor Vehicle Inspection. These charts serve the purpose of graphically representing the arrangement and inter-relationships of the functions and sub-divisions of a motor vehicle inspection program, and are included in this syllabus so that the instructor can have a basis on which to formulate his presentation. (It is emphasized that these charts are not meant to represent the optimum organizational arrangement for a vehicle inspection system, but are included here so that the lecturer can have a starting point for developing, with the class, an organization chart that will meet the needs of a motor vehicle inspection program.)	Ref. #1 - par. 2.10.14 and 2.11.10. Ref. #4 - Chap. IV - p.5

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SAMPLE ORGANIZATION CHART FOR STATE-APPOINTED MVI SYSTEM

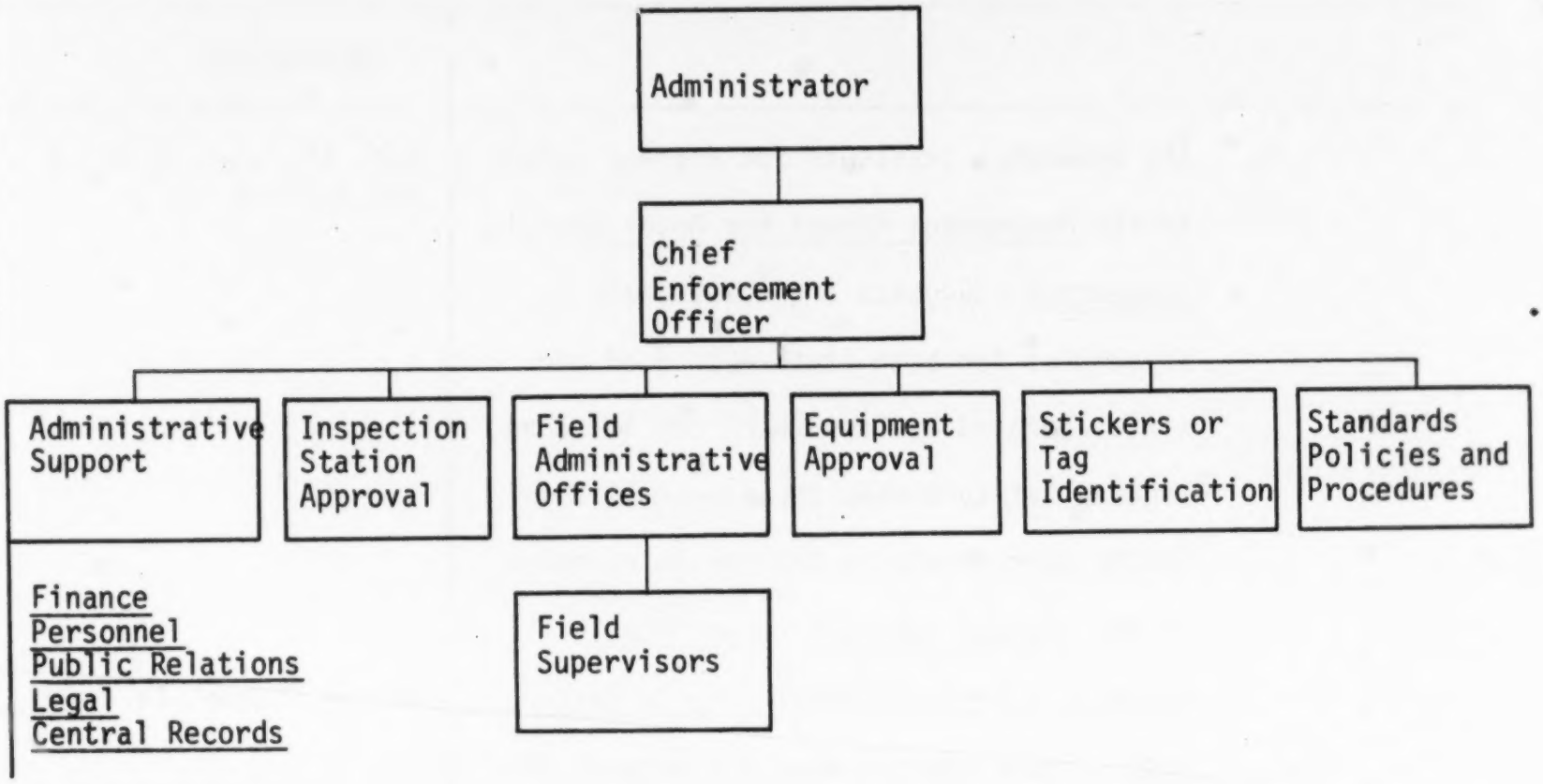

SAMPLE ORGANIZATION CHART FOR STATE-OPERATED MVI SYSTEM

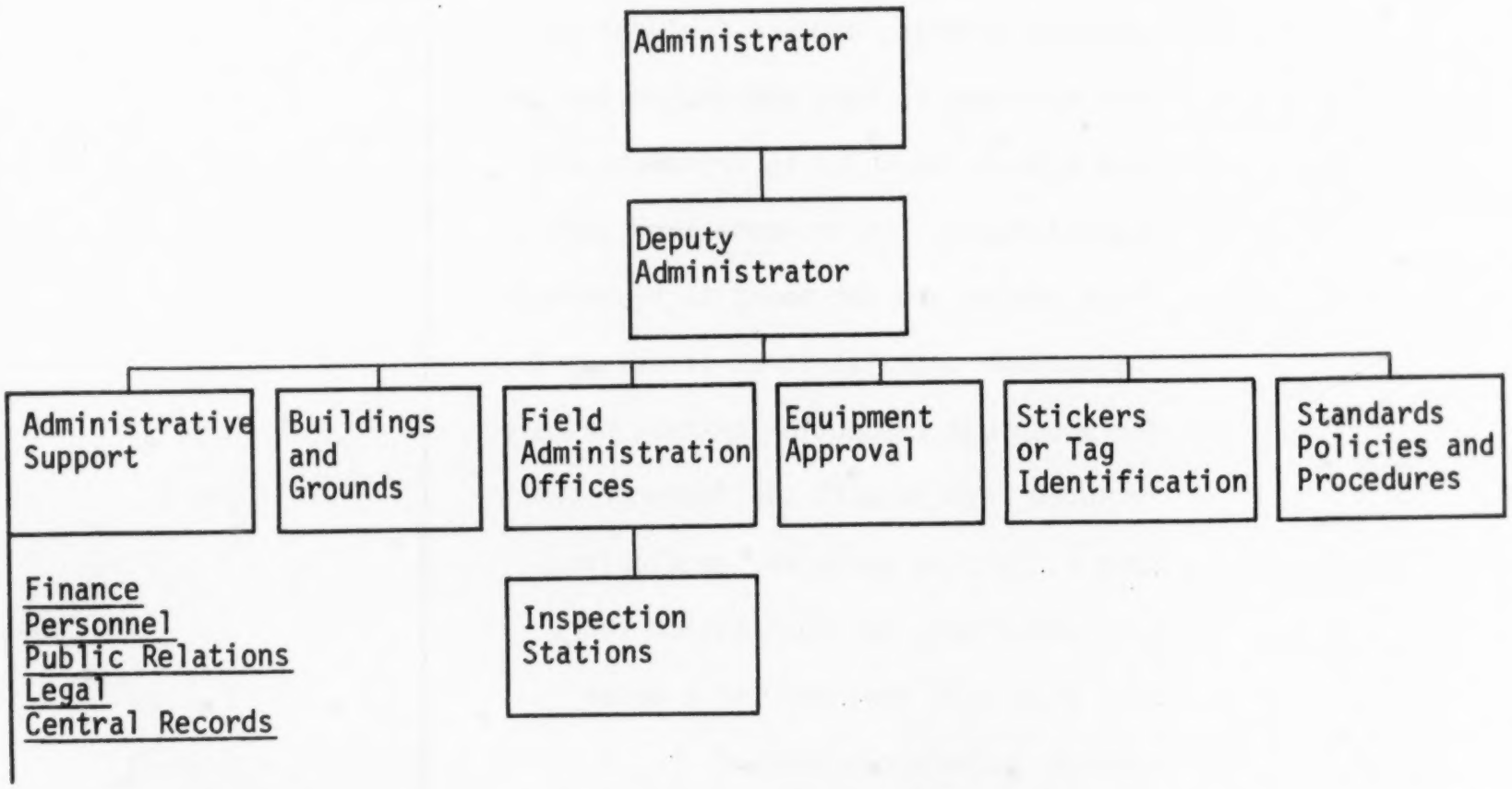

20404

Safety Rules for Engines

1. Use care in handling engines. See safety rules for lifting and handling and for hoists and cranes.

2. Check fuel system for leaks. Never start an engine which is leaking fuel.

3. Vent exhaust to the outside of the building.

4. Engine must be securely fastened to the bench or test stand.

5. Make sure electrical connections are tight.

6. Double check for loose parts, wrenches, etc. before starting.

7. Keep hands away from moving parts.

8. Keep a CO_2 extinquisher handy.

2016

	REFERENCES
C. Administrative and Managerial Responsibilities 1. The task of guiding, leading and controlling the cooperative functions of a vehicle inspection program towards a common goal involves many processes and areas of activity which are usually only alluded to in an organizational chart. The degree of success that a program attains, however, will often depend on the ability of the administrator to integrate these processes and activities into the framework of his organization. It is axiomatic that three basic administrative processes vital to the achievement of the goals of an organization are: (1) planning the operation; (2) implementing the plan; and (3) controlling the results. This syllabus is built on that premise and includes pertinent blocks of instruction. 2. It is easy, however, to become entwined with administrative terminology. When discussing organizational charts it must be remembered that the chart can only	

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	REFERENCES
"make provisions for" but cannot guarantee anything. The chart itself can, and should, be used to assure provisions for:	Ref. #2 - p. 20
a. Allocation of responsibility.	
b. Equitable distribution of workloads.	
c. Clear lines of authority.	
d. Proper delegation of authority.	
e. Reasonable spans of control.	
f. Unity of command.	
g. Coordination of effort.	
h. Administrative control.	
But the "chart" is just that -- a "chart" -- unless the right men are found for the right job. When discussing organization, this refers to men who have an understanding of various functional elements of work that go into making a "chart" come to life and assist the organization it represents to accomplish its mission. The work that the administrators and managers must be able to do can be referred to as POSDCORB, which is a made	Ref. #3 - p. 97

20406

	REFERENCES
up word which has been used since 1937, but which is still meaningful today when talking about organizational structures. It stands for: a. Planning - working out in broad outline the things that need to be done and the methods for doing them to accomplish the purpose set for the enterprise. b. Organizing - the formal structure of authority through which work subdivisions are arranged, defined and coordinated for the defined objective. c. Staffing - the whole personnel function. d. Directing - the continuous task of making decisions and embodying them in orders and instructions. e. Co-ordinating - the all important duty of interrelating the various parts of the work. f. Reporting - keeping everyone informed.	Ref. #3 - p. 13

20407

	REFERENCES
g. Budgeting - with all that goes with budgeting in the form of fiscal planning, accounting and control.	
D. Summary	
1. In order for the periodic motor vehicle inspection program to achieve its mission it must operate within a philosophy which exists to assist in the accomplishment of objectives. This philosophy needs to recognize the part that organization plays in achieving goals by taking into consideration areas of specialization, levels of command, span of control, grouping of activities, delegation of authority and centralization. The leadership of a vehicle inspection program should be aware of the importance of properly organizing the various functions involved into an organizational structure which remains sufficiently simple and flexible to facilitate the accomplishment of objectives while embodying a teamwork approach to other agencies who have as their goal the motoring safety of the public.	

20408

REFERENCES

1. Insurance Institute for Highway Safety. Management Manual for Motor Vehicle Inspection. Washington, D. C. 20037, January 1, 1968.

2. International City Management Association. Municipal Police Administration - Sixth edition. 1140 Connecticut Avenue, N.W., Washington, D. C. 20036, 1969.

3. Luther Gulick and L. Urwick, Papers on the Science of Administration. Institute of Public Administration, Columbia University, New York, New York, 1937.

4. United States Department of Transportation. Highway Safety Program Manual, Volume I: Periodic Motor Vehicle Inspection. Government Printing Office, Washington, D.C., 1969.

ADDITIONAL SOURCES OF INFORMATION

1. Terry, Roy M., "An Overview of a Successful Motor Vehicle Inspection Program," an unpublished paper prepared for the Traffic Institute, Northwestern University, Evanston, Illinois, 1969.

2. Godsey, Wiley W., "A Model Vehicle Inspection Program," an unpublished paper prepared for the Traffic Institute, Northwestern University, Evanston, Illinois, 1969.

3. "Organizational Structure - Charts and Chart Construction," a training publication prepared by the Traffic Institute, Northwestern University, Evanston, Illinois.

20409

SUBJECT: SELECTION AND TRAINING OF FIELD SUPERVISORS

HOURS: 3

OBJECTIVES: To develop an understanding of the qualities and attributes desirable in supervisors; to create an understanding of the problems involved in the selection and training of supervisors, and suggested ways and means of solving them.

METHODS OF INSTRUCTION: The primary method of instruction for this unit is lecture.

References 1 and 2 contain much information which the lecturer can utilize in developing the supervision aspect of his presentation. References 3 through 6 should be referred to when connecting supervision to the motor vehicle inspection program.

20410

INSTRUCTOR'S GUIDE

(SELECTION AND TRAINING OF SUPERVISORS)

I. INTRODUCTION

A. Instruction should provide the student with an understanding of the function and importance of supervision by examining the relationships which underlie the supervisor's duties and responsibilities. The student should be made aware of the importance of selecting and training supervisors with the desirable qualities and attributes.

The important role of the Field Supervisor in a successful vehicle inspection program should be emphasized. The student should understand that violations of the intent of an inspection program can largely be eliminated if Field Supervisors properly fulfill their function.

20411

	REFERENCES
II. PRESENTATION	
A. Needs of Field Supervision	
1. A fundamental requirement for making periodic motor vehicle inspection accomplish its purpose of enhancing highway safety is controlling improprieties of inspection personnel. Close supervision of inspection stations is necessary to maintain high quality inspections and to create public confidence in the program. While this is important when the stations are owned and operated by the regulatory authority, it is even more important when they are appointed and licensed by them.	Ref. #3 - P. 23 Ref. #4 - p. 7 Ref. #5 - p. 7 Ref. #6 - p. 4 - Chap. IV
2. In order to allow a constant exchange of information about the motor vehicle inspection program and to provide for close observation and evaluation of its effectiveness, in-the-field supervision of the Station Supervisors should be a primary function of the Field Supervisors. The Field Supervisor should periodically make unannounced visits to inspection stations and personal reinspection of some recently inspected vehicles.	Ref. #3 - p. 26

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	REFERENCES
a. This results in better evaluation of the station supervisors and a more effective motor vehicle inspection program.	
3. It is unfortunate but true that field supervisors who have many responsibilities in addition to motor vehicle inspection do not always give their inspection responsibilities the priority they deserve. This emphasizes the need of a proper selection and training program.	
B. What is a Supervisor?	
1. When attempting to define "supervision" it is helpful to go to the Latin origin of the word: "super" meaning over and "vision" meaning sight or seeing. In management, then, supervision indicates someone who is watching from above, but goes further and indicates that this someone is looking down with authority. This is the heart of supervision - the presence of someone up above to look to for assistance and guidance - and the realization that this same someone, the supervisor, is watching to	Ref. #1 - p. 3

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	REFERENCES
make sure assignments are carried out properly. a. A supervisor is anyone whose working relationship is such that he is directly responsible for the assignment, supervision and/or evaluation of the performance of at least one other employee. This emphasizes that the function of supervision must operate at all levels within the organization. 2. The success of an organization often depends on the ability of its supervisors, for it is to his supervisor that an employee looks for most guidance in determining the detailed requirements of his job; the supervisor is the key figure in developing competence in the employee, and studies have shown that the satisfaction an employee derives from his work depends more on the kind of leadership and motivation provided by his supervisor than on such material values as wages and hours.	

APPENDIX

	REFERENCES
C. Importance of Planning in the Selection and Training of Supervisors 1. When speaking of the selection and training of supervisors it is important not to separate these into two distinct functions, but to consider them as one process which is continuous. Training of potential supervisors should always be going on even under circumstances of which the person being trained is not aware. For example, giving assignments which call for decision-making is a part of the training process which allows observation of potential supervisory talent. Selection occurs at intervals during this training process, and what the "student" has been undergoing in an informal situation becomes a formal program. By having selection and training be interdependent and interwoven functions, going on all the time, supervisory ability which otherwise may have gone unnoticed may become apparent and/or training needs may be shown by the weaknesses in the man after he is supervising.	

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	REFERENCES
2. Planning increases the awareness of the need for supervisory training, for it recognizes that the efficiency of an operation is dependent on the quality of supervision. When the planning phase takes an objective look at the supervision program it should recognize that the basis for appointment to a supervisory position should be the potential supervisory ability of the individual under consideration, and not just such things as: a. Satisfactory performance of a lower job. b. Seniority - reward for length of service. c. Politics - pressure groups. d. Tested knowledge of non-supervisory areas - technical know-how. 3. A planned program should provide a reservoir of potential supervisors by providing a system for obtaining, recording, filing and using information concerning them. This recognizes the need for the	

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	REFERENCES
selection and training process to start long in advance of the actual appointment to a supervisory job and emphasizes the fact that low level supervisors are recognized as the source from which future administrative personnel are selected.	
D. Basic Elements of the Selection Program	
1. A basic philosophy in personnel management is that each employee should be utilized in a manner which will make the greatest contribution to the total enterprise. It may be difficult to achieve this to a degree approaching perfection, but within the realm of practicality and within the authority of the department head to assign and transfer, this philosophy must be considered. To increase the probability of success of a motor vehicle inspection program while providing the necessary guidance to the professional growth of subordinates, one must base the selection of inspection supervisors on more important considerations and factors than whim, opportunity and convenience. Factors which should have bearing on the selection	

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	REFERENCES
of the supervisor are: a. Personal interests and motivation. b. Special aptitudes, with or without developed skills. c. Experience and training - general background of work. d. General skills or proficiency, as demonstrated in service. e. Special skills or proficiency or any special qualifications in any way related to his possible use. f. Ultimate potential, as well as this can be appraised. g. Need for and importance of the service the individual can contribute. (1) No one factor is mentioned as necessarily more important than any other, since the special circumstance of <u>this</u> assignment in <u>this</u> organization should determine the importance of a factor.	

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	REFERENCES
2. To assist him in selecting supervisors the administrator should give consideration to: a. Merit rating which covers areas important to the level of supervision. b. Intelligence tests which measure the ability of the supervisor to think and make decisions which his level of supervision will require. c. Job knowledge tests which will indicate to what degree the supervisor knows the tasks which he will be supervising. d. Personality tests which should indicate to what degree the supervisor will be able to lead and motivate. e. Interviews by qualified superior officers who have displayed the ability to fill the position for which the supervisor is being chosen. f. Medical tests to ensure the continued employment of the supervisor so that the investment in him can be recouped.	

	REFERENCES
3. In order to assign the appropriate amount of weight to the factors mentioned above, and to decide on appropriate selection procedures to employ, the administration of an organization should first study the job to be filled by the supervisor. After analyzing the job content and requirements, the duties should be put in writing. This is also true of the responsibilities and relationships of this supervisory position. This should make it easier to determine the qualifications needed for a person to successfully fill the position and the methods to use to uncover those who may have those qualifications.	
E. Basic Elements of the Training Program	
1. In many organizations training is "something we do" - an activity, or a process - rather than a program designed and used to solve problems and fill needs. Like vitamins we buy without a prescription, most training is "good." But training must be more than just good; it must be based on the job requirement of the trainee; it must be built around the identified problems and needs of	

	REFERENCES
the trainee; and it must, in fact, produce some change in attitude, in understanding, or in performance. This is particularly important when the training is aimed at taking a person out of the operational level of an organization and inserting him into the management stream. The nature and purposes of training programs vary a great deal, but for the purposes of this presentation they can be grouped into three categories:	Ref. #2 - p. 268
a. Developing job knowledge and skills. This becomes particularly important within the motor vehicle inspection program, for in addition to the knowledge necessary for the supervisor to be effective to the over-all purpose of his organization, he will need specific knowledge and skills of a mechanical nature. Skills, as used here, covers manual skills necessary to the motor vehicle inspection program and interpersonal relations skills necessary to supervise people.	

	REFERENCES
b. Transmitting Information. This training program is directed toward transmitting general information about the organization, its purposes, policies, rules, etc.	
c. Modifying Attitudes. This program is of particular importance to a new level of supervisors. Its intent is to develop more favorable attitudes toward and appreciation for the position of supervisor, and to increase the supervisor's ability to motivate subordinates to perform in the manner desired.	
It is readily apparent that all three types of programs need to be meshed into one when deciding on a training program for supervisors.	
2. Supervisory training must have the endorsement and participation of top management of the organization. Management must set the climate for training effectiveness through its insistence that procedures and knowledge taught in a training course be	

	REFERENCES
utilized. With this in mind, supervisory training must be designed to meet the needs of the organization concerned. Guidance from other organizations can be helpful, but for the program to be more meaningful to the students, management policy, philosophy, and organization of the supervisor's own department must be incorporated into the program. Supervisory training should include, and probably should start with, top management. This can be achieved through their participation in the planning and defining of the policies, philosphy and contents of the training program. This should not eliminate other levels from consideration when the training program is being developed. The supervisors themselves should be involved in defining their problems and approaches to the solutions of these problems.	
3. Once the objectives of a supervisory training program have been decided upon, it is necessary to determine what method of training is best suited to accomplish the objective. Some techniques might be in-	

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	REFERENCES
dividual coaching, group conferences, classroom lectures, rotating assignments, case studies, on-the-job and/or off-the-job training. To the maximum extent possible, subordinate supervisors should be trained by their supervisors with the advise and assistance of staff personnel as necessary. This does not mean that the supervisor would do all the teaching, but rather that his knowledge would be used to the fullest with some teaching required. Supervisory training should be dynamic in character. That is, subject to adaptation and progressive improvement. As changes in supervisory techniques are suggested they should be included in the training program. As changes in periodic motor vehicle inspection standards and requirements come about the supervisor should be notified and the changes should be made clear to him so that he, in turn, can so instruct his subordinates, the station supervisors. Performance of supervisors and potential supervisors in the training situation should be an important consideration in making selections for	

NATIONAL STANDARD SCHOOL SHOP SAFETY INSPECTION CHECK LIST

Prepared by the Joint Safety Committee of the
AMERICAN VOCATIONAL ASSOCIATION — NATIONAL SAFETY COUNCIL

_____ Date _____

_____

INTRODUCTION

A safe environment is an essential part of the school shop safety education program. The safe environment will exist only if hazards are discovered and corrected through *regular* and *frequent* inspections by school personnel—administrators, teachers and students. Safety inspections are to determine if everything is satisfactory.

Inspections may be made at the request of the board of education, the school administration or upon the initiative of the teacher. Some communities have drawn upon the cooperative service of professional safety engineers, inspectors of state labor departments, insurance companies and local safety councils to supplement and confirm inspections by school personnel.

The National Standard School Shop Safety Inspection Check List, recommended by the President's Conference on Industrial Safety is an objective inspection procedure for the school shop.

DIRECTIONS

WHO INSPECTS?

This will depend upon local policies. It is recommended, however, that shop teachers, and students—the student safety engineer and/or student safety committee—participate in making regular inspections. This not only tends to share responsibility but stimulates a broader interest in the maintenance of a safe school shop.

WHEN TO INSPECT?

As a minimum, a safety inspection should be made at the beginning of every school term or semester. More frequent inspections may be advisable.

HOW TO INSPECT?

Inspections should be well planned in advance.

Inspections should be systematic and thorough. No location that may contain a hazard should be overlooked.

Inspection reports should be clear and concise, but with sufficient explanation to make each recommendation for improvement understandable.

FOLLOW-UP

The current report should be compared with previous records to determine progress. The report should be studied in terms of the accident situation so that special attention can be given to those conditions and locations which are accident producers.

Each unsafe condition should be corrected as soon as possible in accordance with accepted local procedures.

A definite policy should be established in regard to taking materials and equipment out of service because of unsafe conditions.

The inspection report can be used to advantage as the subject for staff and class discussion.

CHECKING PROCEDURE

Draw a circle around the appropriate letter, using the following letter scheme:

S — Satisfactory (needs no attention)
A — Acceptable (needs some attention)
U — Unsatisfactory (needs immediate attention)

Recommendations should be made in all cases where a "U" is circled. Space is provided at the end of the form for such comments. Designate the items covered by the recommendations, using the code number applicable (as B-2).

In most categories, space is provided for listing of standards, requirements or regulations which have local application only.

A. GENERAL PHYSICAL CONDITION

1. Machines, benches, and other equipment are arranged so as to conform to good safety practices ..... S A U
2. Condition of stairways ..... S A U
3. Condition of aisles ..... S A U
4. Condition of floors ..... S A U
5. Condition of walls, windows, and ceiling ..... S A U
6. Illumination is safe, sufficient, and well placed ..... S A U
7. Ventilation is adequate and proper for conditions ..... S A U
8. Temperature control ..... S A U
9. Fire extinguishers are of proper type, adequately supplied, properly located and maintained ..... S A U
10. Teacher and pupils know location of and how to use proper type for various fires ..... S A U
11. Number and location of exits is adequate and properly identified ..... S A U
12. Proper procedures have been formulated for emptying the room of pupils and taking adequate precautions in case of emergencies S A U
13. Lockers are inspected regularly for cleanliness and fire hazards. S A U
14. Locker doors are kept closed ..... S A U
15. Walls are clear of objects that might fall ..... S A U
16. Utility lines are properly identified ..... S A U
17. Teachers know the procedure in the event of fire including notification of the fire department and the evacuation of the building. S A U
18. Air in shop is free from excessive dust, smoke, etc. ..... S A U
19. _____ S A U
20. _____ S A U
21. _____ S A U
22. _____ S A U
23. Evaluation for the total rating of A. GENERAL PHYSICAL CONDITION ..... S A U

Reproduced through courtesy of the National Safety Council.

	REFERENCES
higher supervisory positions. This should be made clear to the student-supervisor so that there will be no doubt in his mind that the intent of the training program is to have a more qualified supervisory level of personnel. It must be recognized by management, training personnel and the student-supervisors that training should not be expected to compensate for poor selection. Training is a further continuation of the selection process and if it is found that a person has been selected to be a supervisor but he cannot comprehend the new requirements of his position, or cannot perform to the level required of supervisors of his position, procedures should be present which provide for this to be called to the attention of the appointing authority so that corrective measures can be taken. Mediocrity breeds mediocrity. If personnel are to remain effective and if the motor vehicle inspection program is to accomplish its goals, field supervisors must be able to supervise people - and to effectively control the function to which their subordinates are assigned.	

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	REFERENCES
F. Summary 1. In order for a periodic motor vehicle inspection program to meet the planned for success it is necessary to have knowledgeable, dedicated station supervisors monitoring the program in the field. To ensure the effectiveness of a level of command, the next higher level of supervisors must be properly trained in the techniques of supervision and the program being monitored. The purpose behind properly selecting and training field supervisors is to have levels of supervisors who are able to motivate subordinates to do their best for the organization they represent, both in furthering the image of the organization and in functioning in the manner for which the organization is in existence.	

REFERENCES

1. Pfiffner, John M. and Fels, Marshall. The Supervision of Personnel - Third Edition. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964.

2. Tiffin, Joseph and McCormick, Ernest J. Industrial Psychology - Fifth Edition. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1965.

3. American Petroleum Institute. Periodic Motor Vehicle Inspection Programs - Part 2 - Organization Guidelines. 1271 Avenue of the Americas, New York, N. Y. 10020, August 1968.

4. United States of America Standards Institute. American Standard D7.2-1968, Station Requirements for Inspection of Motor Vehicles, Trailers and Semi-Trailers in Stations Owned and Operated By Regulatory Authority. 10 East 40th Street, New York, N. Y. 10016.

5. United States of America Standards Institute. American Standard D7.3-1968, Station Requirements for Inspection of Motor Vehicles, Trailers and Semi-Trailers in Stations Appointed and Licensed By Regulatory Authority. 10 East 40th Street, New York, N. Y. 10016.

6. United States Department of Transportation. Highway Safety Program Manual, Volume I: Periodic Motor Vehicle Inspection. Washington, D. C.: Government Printing Office, 1969.

20427

SUBJECT: FIELD SUPERVISION AND ENFORCEMENT

HOURS: 4

OBJECTIVE: To develop an understanding of the role of field supervision and enforcement in a motor vehicle inspection program with emphasis on management's responsibility to the vehicle owner and the inspection station.

METHODS OF INSTRUCTION: The primary method of instruction for this unit is lecture. Extensive use should be made of training aids and handout material when discussing the various types of forms used during initial application, inspection and enforcement.

In addition to the noted reference material, three states with programs which the lecturer could refer to when preparing for his presentation are:

Georgia: Department of Public Safety
Motor Vehicle Inspection Division
PO Box 1456
Atlanta, Ga. 30301

Texas: Texas Department of Public Safety
5805 N. Lamar Blvd.
Box 4087, North Austin Station
Austin, Texas 78751

Virginia: Commonwealth of Virginia
Department of State Police
PO Box 1299
Richmond, Virginia 23210

INSTRUCTOR'S GUIDE

(FIELD SUPERVISION AND ENFORCEMENT)

I. INTRODUCTION

A. Instruction should provide the student with an understanding of the function and importance of field supervision and enforcement in the motor vehicle inspection program. The student should be made aware that inspection stations and mechanics, whether state employed or state appointed, must be under close and positive supervision by the state. It should be emphasized to the student that enforcement of laws, rules and regulations governing the operation of the motor vehicle inspection program is necessary to ensure compliance with the program objectives and acceptance of these objectives by the motoring public.

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	REFERENCES
II. PRESENTATION	
A. The Need of Field Supervision and Enforcement.	
1. An aim of motor vehicle inspection programs is for every vehicle owner to have his vehicle voluntarily inspected and repaired in the interest of safety because he believes that everyone with whom he comes in contact on the public streets and highways has done likewise. As this aim comes closer to reality the number of collisions caused by vehicle defects should be correspondingly reduced. In order to achieve this aim, however, it is necessary for administrators to include in their inspection programs enforcement procedures which will ensure that defective vehicles are repaired, but only when justified, and that inspection stations are accurately and honestly complying with prescribed standards and procedures. Conversely, the absence of sound enforcement procedures can result in a breakdown of the inspection program and the loss of the public confidence and support which is necessary for success.	Ref. #5 - p. 37 Ref. #1 - p. 7

	REFERENCES
2. Field supervision and enforcement, in the present context, refers to those functions necessary to ensure an "honest" operation of the motor vehicle inspection program.	
B. Investigation of Applicants.	
1. A segment of the field supervision and enforcement aspects of inspection programs has to do with the investigation of applicants who desire to have their stations certified as inspection facilities. It is axiomatic that state owned and operated inspection facilities would meet the requirements of the program but in those states where the inspection stations are not owned by the state but are licensed by them, basic requirements for approval and licensing should be imposed. Then, when an application is received requesting certification of an inspection station, a part of the qualifying process should be a field investigation of the applicant and his facility to ascertain if the basic requirements are met.	Ref. #1 - p. 27
2. Success of an inspection program depends	Ref. #1 - p. 29

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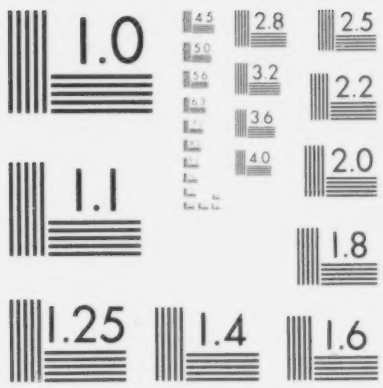

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

	REFERENCES
heavily upon the caliber and adequacy of the people who inspect the vehicles. Basic requirements which mechanic-inspectors must meet should be set forth and, as with the stations, when an application for certification is received a part of the qualification process should be a field investigation of the applicant to determine if he meets the basic requirements. This procedure should be adhered to whether or not the inspection program is state-owned or state-licensed.	
C. Supervision of Inspection Stations and Mechanics.	
1. Both state-owned and state-operated and state-licensed stations must be regularly inspected to ensure that policies and procedures are followed. As a general rule, it would be desirable to have sufficient station supervisors to allow each station to be visited at least monthly on a regular basis. In order for the inspection program to accomplish its purpose the station supervisor should be allowed sufficient time to properly inspect the facility, its records and employees, and should have a form setting forth the items to be checked with space to note the results.	Ref. #3 - par. 2.9.1.

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	REFERENCES
The inspection form should be in sufficient copies to give the station management a copy and to have copies placed in the administering agency's files. In addition, when the station supervisor is filling the role of investigator, he should also visit the stations to help the station personnel perform more effectively by clarifying the legislative and administrative intent of rules and regulations, and to provide a channel of communication for feedback from the public and station personnel to the program administrator.	
2. A program of undercover spot-checks should also be a part of field supervision and enforcement. This should be done by having agency personnel who are unknown to a particular geographic area drive vehicles with known defects in for inspection. The actions of the inspector in these situations should be governed by the reason for this spot-check, i.e., routine, because of complaints against the station; because of suspicions that the station is "winking" at	

B. HOUSEKEEPING

1. General appearance as to orderliness..... S A U
2. Adequate and proper storage space for tools and materials. S A U
3. Benches are kept orderly..... S A U
4. Corners are clean and clear..... S A U
5. Special tool racks, in orderly condition, and provided at benches and machines ..... S A U
6. Tool, supply, and/or material room is orderly..... S A U
7. Sufficient scrap boxes are provided..... S A U
8. Scrap stock is put in scrap boxes promptly..... S A U
9. Materials are stored in an orderly and safe condition.. S A U
10. A spring lid metal container is provided for waste and oily rags. S A U
11. All waste materials and oily rags are promptly placed in the containers ..... S A U
12. Containers for oily rags and waste materials are frequently and regularly emptied ..... S A U
13. Dangerous materials are stored in metal cabinets..... S A U
14. Machines have been color conditioned..... S A U
15. Safety cans are provided for flammable liquids. ..... S A U
16. Bulk storage of dangerous materials is provided outside of the main building ..... S A U
17. A toe-board or railing around a mezzanine used for storage or washing facilities ..... S A U
18. Materials are stored in an orderly and safe condition on this mezzanine ..... S A U
19. Flammable liquids are not used for cleaning purposes S A U
20. Floors are free of oil, water and foreign material..... S A U
21. Floors, walls, windows, and ceilings are cleaned periodically. S A U
22. _____ S A U
23. _____ S A U
24. _____ S A U
25. _____ S A U
26. Evaluation for the total rating for B. HOUSEKEEPING S A U

C. EQUIPMENT

1. Machines are arranged so that workers are protected from hazards of other machines, passing students, etc..... S A U
2. Danger zones are properly indicated and guarded..... S A U
3. All gears, moving belts, etc., are protected by permanent enclosure guards ..... S A U
4. All guards are used as much as possible..... S A U

C. EQUIPMENT (continued)

5. All equipment control switches are easily available to operator. S A U
6. All machines are "locked off" when instructor is out of the room. S A U
7. Brushes are used for cleaning equipment..... S A U
8. Nonskid areas are provided around machines..... S A U
9. Machines are in safe working condition..... S A U
10. Machines are guarded to comply with American Standards Association and local state code..... S A U
11. Adequate supervision is maintained when students are using machines and dangerous tools..... S A U
12. Tools are kept sharp, clean and in safe working order S A U
13. All hoisting devices are in safe operating condition... S A U
14. Machines are shut off while unattended..... S A U
15. Adequate storage facilities for tools, equipment, etc., not in immediate use ..... S A U
16. _____ S A U
17. _____ S A U
18. _____ S A U
19. _____ S A U
20. Evaluation for the total rating for C. EQUIPMENT.. S A U

D. ELECTRICAL INSTALLATION

1. All switches are enclosed..... S A U
2. There is a master control switch for all of the electrical installations ..... S A U
3. Electrical outlets and circuits are properly identified.. S A U
4. All electrical extension cords are in safe condition and are not carrying excessive loads..... S A U
5. All machine switches are within easy reach of the operators. S A U
6. Electrical motors and equipment are wired to comply with the National Electric Code..... S A U
7. Individual cut-off switches are provided for each machine. S A U
8. Machines are provided with overload and underload controls by magnetic pushbutton controls..... S A U
9. No temporary wiring in evidence..... S A U
10. _____ S A U
11. _____ S A U
12. _____ S A U
13. _____ S A U
14. Evaluation for the total rating for D. ELECTRICAL INSTALLATION ..... S A U

	REFERENCES
inspection program is an on-going process.	
D. Field Enforcement	
1. By field supervision and enforcement we also mean efforts aimed at assuring that the public comply with the periodic motor vehicle inspection laws, rules and regulations. To facilitate this an easy means of identifying those vehicles which have not been currently inspected needs to be developed by the program administrator. In this regard the administer should not be governed only by tradition or by what others are doing. He should solicit ideas from line personnel who enforce the inspection statute as to the easiest means of identifying non-inspected vehicles.	Ref. #4 - p. 15
a. For example, while it is the usual practice to place inspection stickers on the auto windshield, it may, for enforcement purposes, serve a better purpose on the rear window.	

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	REFERENCES
2. Agencies which have the authority to enforce the motor vehicle inspection requirements must then cooperate to have a united front to confront violators with this aspect of the motor vehicle laws. No one agency can accomplish this alone -- and cooperation among the many police agencies in a state should be the rule rather than the exception. Cooperation in this function is not a one-way street. The agency in charge of the motor vehicle inspection program should keep other enforcement agencies informed as to the aims and accomplishments of the program and changes which are made within it. These other agencies should comply to their utmost with the valid requests of the administrator of the motor vehicle inspection program.	Ref. #2 - p. 10
E. Summary	
1. The success of periodic motor vehicle inspection programs depends upon the systematic enforcement of safety equipment requirements uniformly applied to all.	Ref. #1 - p. 2

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	REFERENCES
To accomplish this there must be continuous, impartial field supervision of inspection stations and personnel, and sustained enforcement action taken against those who refuse to comply with regulations.	

20437

REFERENCES

1. American Petroleum Institute. Periodic Motor Vehicle Inspection Programs - Part 2 - Organization Guidelines. 1271 Avenue of the Americas, New York, N. Y. 10020, August 1968.

2. Coverdale & Colpitts, Consulting Engineers. Report on Recommendations Regarding Motor Vehicle Inspection. 120 Wall Street, New York, N. Y. 10005, May 4, 1967.

3. Insurance Institute for Highway Safety. Management Manual for Motor Vehicle Inspection. Washington, D. C. 20037, January 1, 1968.

4. United States Department of Transportation. Highway Safety Program Manual, Volume I: Periodic Motor Vehicle Inspection. Washington, D. C.: Government Printing Office, 1969.

5. United States Department of Transportation. Safety for Motor Vehicles in Use. A Report to the Congress from the Secretary of Transportation. Washington, D. C., December 1968.

SUBJECT: RECORDS AND INFORMATION

HOURS: 8

OBJECTIVES: To improve the student's understanding of the need for complete and accurate records within the periodic motor vehicle inspection program. To make the student aware of the types of information on which a successful program can be evaluated and the procedure for receiving and processing this information into meaningful data. To develop an understanding in the student of the need for a well planned management information system.

METHODS OF INSTRUCTION: The primary method of instruction for this unit is lecture, supplemented by classroom project discussions. Maximum use should be made of forms and reports now in use within the students' jurisdictions.

INSTRUCTOR'S GUIDE

(RECORDS AND INFORMATION)

I. INTRODUCTION

A. Instruction should identify the importance of the records function and should familiarize the student with the information which a vehicle inspection program should produce in order for management to fulfill its responsibilities to the organization and to the public that organization serves.

It should be emphasized to the student that periodic motor vehicle inspection data does not exist merely for the gathering agency, but is part of a total information gathering system which must be integrated if the aims of traffic safety and vehicle inspection programs are to be met.

The student should be shown the need for his functional input to the total management information system, and how management benefits from effective inputs from his level.

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	REFERENCES
II. PRESENTATION	
A. The Need for Records and Information	
1. The successful vehicle inspection organization accomplishes its mission by moving forward within well-developed programs. These programs, to be effective, must be created and continued on the basis of factual information. Appropriate records, properly maintained and carefully analyzed, are the means for making this factual information available to the program administrator. By records we mean all the documentary materials, regardless of physical form or content, which are produced in connection with the vehicle inspection program and filed to be available for reference as the need arises. Information is the content of those records.	Ref. #4 - p. 1
2. Reliable records data should serve many valuable purposes. They should be the official memory of the agency and should assist it in accounting upward and outward for its activities and for the justification of its programs. They should provide	Ref. #5 - par. 5.1.1.

	REFERENCES
information to other agencies which share responsibilities in vehicle safety. They should fill the void that now exists as to documentary proof of the effectiveness of vehicle inspection in highway traffic safety.	Ref. #1 - p. 5
3. The concept of management's use of data recognizes that, essentially, records-keeping and information processing are performed for the purpose of providing management with information to plan and control agency activity. In order to efficiently use information from the records system the various levels of management within the vehicle inspection organization should be identified and their decision-making responsibilities clearly understood. Then the managers at the various levels can ask for the data necessary on which to base decisions.	
a. To a large extent the primary responsibility of the supervisory level of management is the motivation of subordinates. Planning and organizing activities at this level largely	

	REFERENCES
concern the effective utilization of subordinate personnel on a day-to-day, or at least short-range basis. Informational needs of this level usually correspond to geographical areas of assignment of first line supervisors and often are restricted to the goals of sub-units within the vehicle inspection organization.	
b. Top and middle management's responsibility, on the other hand, is not as much in the area of motivation of subordinates as it is in the development of long-range plans, evaluating progress towards organizational goals, and coordinating efforts within the inspection agency and with other organizations. This level's informational needs encompass the whole organization and the total highway safety program as pertains to vehicles.	
4. The National Highway Safety Bureau has focused attention on sixteen program areas to be coordinated into a unified attack on	

E. GAS

1. Gas flow to appliances is regulated, so that when appliance valve is turned on full, the flames are not too high..... S A U

2. Gas appliances are properly insulated with asbestos or other insulating material from tables, benches, adjacent walls, or other flammable materials ..... S A U

3. No gas hose is used where pipe connections could be made. S A U

4. Gas appliances have been adjusted so that they may be lighted without undue hazard..... S A U

5. Students have been instructed when lighting gas appliances to light the match first before turning on the gas..... S A U

6. There are no gas leaks, nor is any odor of gas detectable in any part of the shop..... S A U

7. Shop instruction has been given concerning the lighting of gas furnaces operating with both air and gas under pressure.. S A U

8. When lighting the gas forge, goggles are worn..... S A U

9. When lighting the gas furnace, the following procedure is used: (a) light the match; (b) turn on the gas; (c) drop the match in the hole in top of the furnace..... S A U

10. In shutting down the gas furnace, the gas valve is closed before the air valve..... S A U

11. _____ S A U

12. _____ S A U

13. _____ S A U

14. _____ S A U

15. Evaluation for the total rating for E. GAS..... S A U

F. PERSONAL PROTECTION

1. Goggles or protective shields are provided and required for all work where eye hazards exist..... S A U

2. If individual goggles are not provided, hoods and goggles are properly disinfected before use..... S A U

3. Shields and goggles are provided for electric welding.. S A U

4. Rings and other jewelry are removed by pupils when working in the shop..... S A U

5. Proper kind of wearing apparel is worn and worn properly for the job being done..... S A U

6. Leggings, safety shoes, etc., are worn in special classes such as foundry, etc., when needed..... S A U

7. Respirators are provided for dusty or toxic atmospheric conditions such as when spraying in the finishing room..... S A U

8. Provisions are made for cleaning and sterilizing respirators. S A U

9. Students are examined for safety knowledge ability.. S A U

10. Sleeves are rolled above elbows when operating machines. S A U

11. Clothing of students is free from loose sleeves, flopping ties, loose coats, etc. ..... S A U

12. _____ S A U

F. PERSONAL PROTECTION (continued)

13. _____ S A U

14. _____ S A U

15. _____ S A U

16. Evaluation for the total rating for F. PERSONAL PROTECTION. S A U

G. INSTRUCTION

1. Shop Safety is taught as an integral part of each teaching unit. S A U

2. Safety rules are posted particularly at each danger station. S A U

3. Printed safety rules are given each student..... S A U

4. Pupils take a safety pledge..... S A U

5. Use of a safety inspector..... S A U

6. Use of a student shop safety committee..... S A U

7. Use of safety contests..... S A U

8. Motion and/or slide films on safety are used in the instruction. S A U

9. Use of suggestion box..... S A U

10. Use of safety tests..... S A U

11. Use of safety posters..... S A U

12. Talks on safety are given to the classes by industrial men. S A U

13. Tours are taken of industrial plants as a means of studying safety practices ..... S A U

14. Periodic safety inspections of the shop are made by a student committee ..... S A U

15. Men from industry make safety inspections of the shop S A U

16. Student shop safety committee investigates all accidents S A U

17. A proper record is kept of safety instructions which are given, preferably showing the signature of student on tests given in this area ..... S A U

18. Rotate students on the Shop Safety Committee so that as many students as possible have an opportunity to participate... S A U

19. _____ S A U

20. _____ S A U

21. _____ S A U

22. _____ S A U

23. Evaluation for the total rating of G. INSTRUCTION S A U

H. ACCIDENT RECORDS

1. There is a written statement outlining the proper procedure when and if a student is seriously hurt..... S A U

2. Adequate accident statistics are kept..... S A U

3. Accidents are reported to the proper administrative authority by the instructor ..... S A U

	REFERENCES
traffic accident causes. These areas have been reduced to Highway Safety Program Standards, and it is expected that additions will be made to them. Each of these Standards is supplemented by a Highway Safety Program Manual. The Manual dealing with Traffic Records emphasizes that agencies which operate in any of the Standard areas, of which one deals with periodic motor vehicle inspection, can expect many federal, state, local and private organizations to be requesting information about their activities. Realizing that vehicle inspection data is part of an overall information system, the program administrator must adopt techniques and practices which further the aims of the total program while enhancing his own operations.	Ref. #6 - Chap. IV
B. A Management Information System	
1. The Federal Bureau of the Budget has defined management information as "That information required by managers to evaluate and control their organization's progress and to substantiate their formulation of judgments for	

	REFERENCES
executing their decision-making and management responsibilities." The Bureau defines system as "A set of interdependent elements arranged to interact harmoniously and effectively to serve one or more specific purposes. The elements include (1) people and organizations; (2) software, methods, processes, procedures, techniques; (3) hardware equipment and facilities; and (4) an integrated and regulating mechanism for effective operation." Therefore, it can be said that a management information system is the people, equipment, and techniques which secure, file and retrieve information which managers need to plan, operate and evaluate activities. Viewed functionally, management information systems are three distinct but highly related management activities. Planning - Operations - Evaluations - linked by a constant flow of information. All during these activities the three functions are continually supported by reports and records derived from a data base. a. For the most part this data base consists of the information normally used	

	REFERENCES
or accumulated in the organization's operations. It should also include related data from other agencies, i.e., number of registered vehicles, census information which may have a bearing on programs, accident causes, police enforcement pertaining to vehicle defects, etc.	
b. This is important when measuring the impact of particular programs, or when identifying specific problem areas toward which new programs need to be directed.	
An overview of a management information system can be as follows:	Ref. #3 - p. 4

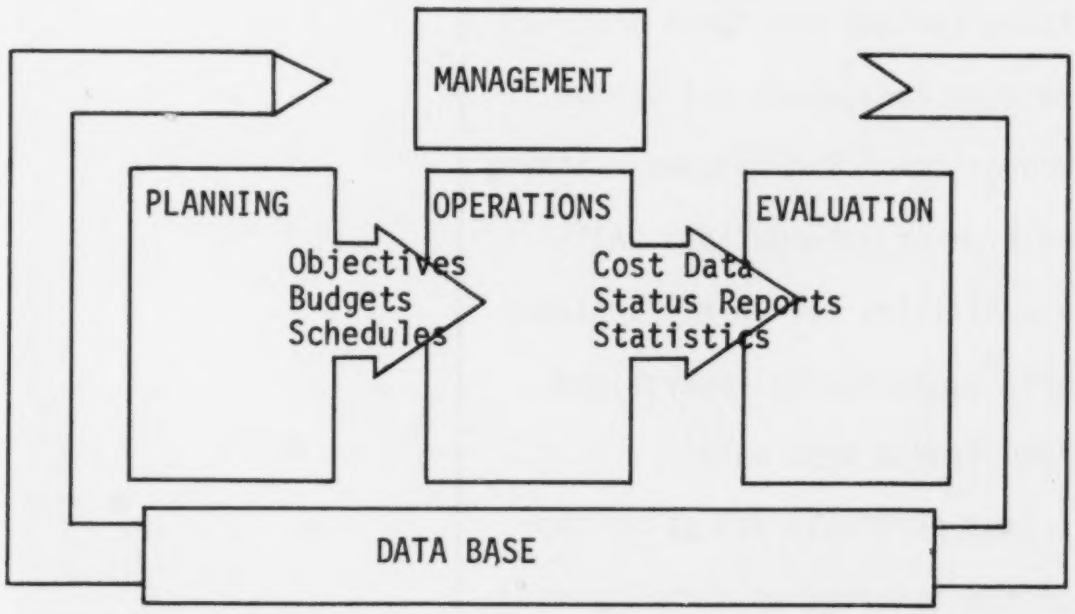

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	REFERENCES

C. Scope of This Presentation

1. Vehicle inspection records connect with and overlap records relating to other internal programs and activities which have a bearing on the agency's mission.

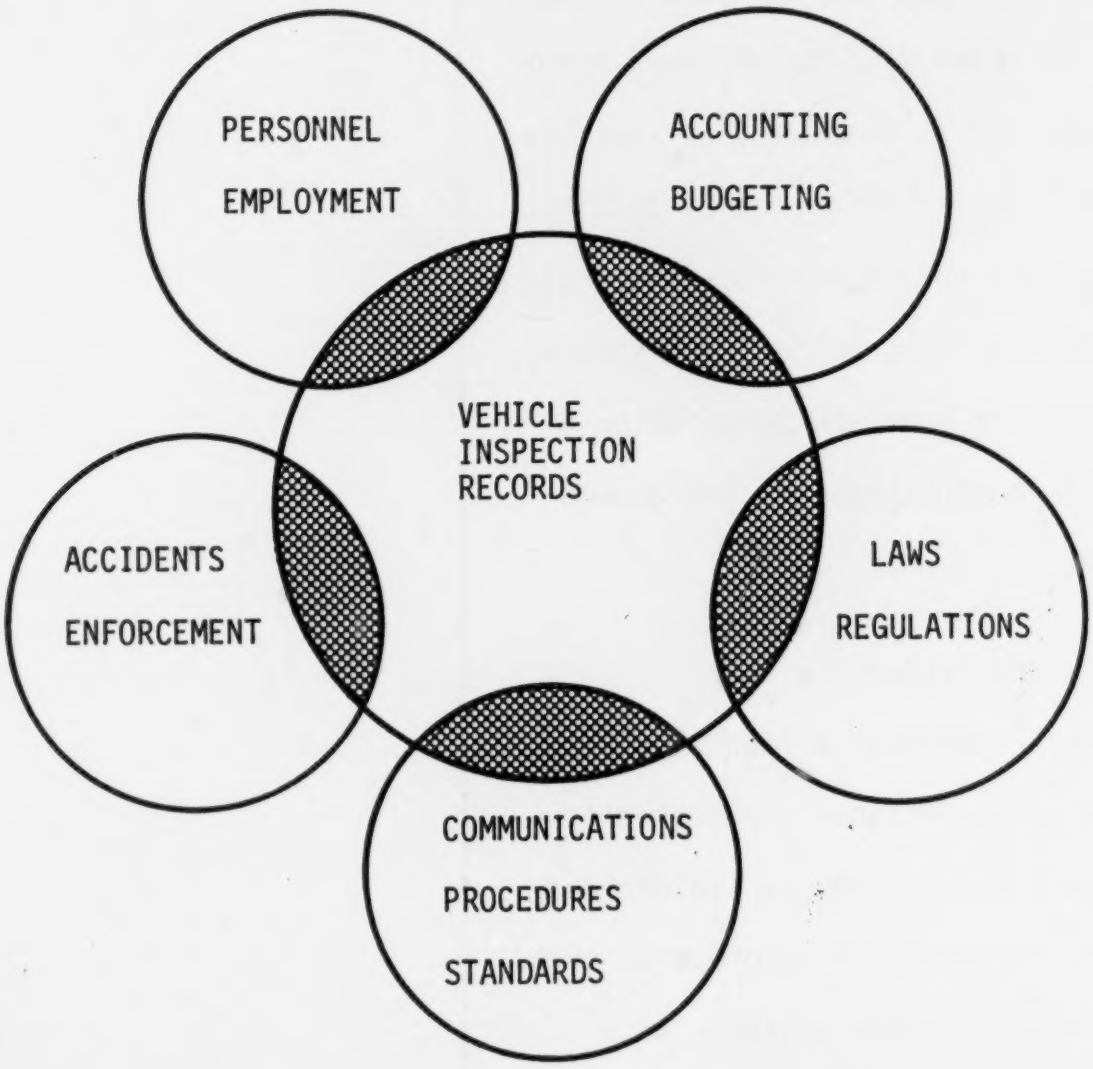

This block of instruction will be concerned with only those records which directly refer to the inspection of vehicles, the people doing the inspection, and the establishments

	REFERENCES
where the inspections are conducted. (It is difficult, in a syllabus of this nature, to suggest one set of informational requirements that will satisfy the needs of all motor vehicle inspection programs. So that the lecturer may extract that information which is meaningful to his particular group, inputs and outputs will be suggested later in this presentation. They consist of data required or suggested by the National Highway Safety Bureau, guides published by agencies like the American Association of Motor Vehicle Administrators, and common sense.)	
D. Outputs of the Record System	
1. A problem that sometimes arises when record systems are being designed or updated is that equipment and procedures are decided upon only on the basis of information that is to be placed into the system. As a result, it is not unusual for files to become filled with records that are never used, and for expensive electronic equipment to never reach its potential for use.	

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	REFERENCES
To overcome this pitfall of economy and efficiency, the administrator should decide what the records system is expected to produce before he decides on methods or equipment. Generally speaking, outputs of a motor vehicle inspection records system are of five kinds: a. Facts relating to a specific past event. The inspection of a vehicle or the certifying of an establishment to be a vehicle inspection station are examples of this. b. Descriptions of a specific inspection station, mechanic-inspector, or vehicle; for example, the class of vehicles a particular station or mechanic is certified to inspect, the age and odometer reading of a vehicle at the time of inspection. The description may be a single item, or it may include all the information in the record. c. Periodical summaries of events during a period and in an area. This output totals data by categories for groups of	

	REFERENCES
events, such as vehicles inspected and passed, or vehicles inspected and failed.	
d. Periodical inventories of characteristics of individual stations, inspectors, and vehicles. This totals data by categories. Such inventories may include rejected vehicles by make and model, mechanic-inspectors by scope of certification, and stations by classes of vehicles authorized to inspect.	
e. Special summaries and inventories which may be required by authorities from time to time. These may include data from other sources such as accident records and vehicle recall notices. Special reports are usually for research and exploratory purposes. The vehicle inspection administrator should anticipate these requests, for it can be expected that the effect motor vehicle inspection has on vehicle involvement in crashes will be a matter of interest in highway safety for a long time.	

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	REFERENCES
2. In addition to taking in, digesting and giving out data as described in preceding paragraphs, the system should also provide for the following special services: a. Comparisons between various output reports and data obtained from other sources. (1) Rates are a form of such comparisons. Examples would be the number of vehicles inspected per the number of vehicles registered in a state; citations for uninspected vehicles per number of uninspected vehicles; number of vehicles found with serious defects per number of vehicles inspected. (2) Trends are changes in numbers or rates from time period to time period. Trends may include comparisons of accident experience before and after a change in the vehicle inspection program. Trends of the numbers of inspections conducted may be used as a	

	REFERENCES
basis for projecting future facility and personnel needs.	
(3) Relative experience of classes of vehicles within the requirements of the vehicle inspection program.	
b. "Sounding an alarm" to call attention to a condition which needs correction. This is the records aspect of management by exception which should come into play when some standard of guide is not matched, when trends become unusual, and/or when conditions or performances deviate considerably from the average or mean. Management by exception will be discussed more fully later in this presentation.	
c. Routine operations which enhance the effectiveness of the vehicle inspection program and which the records system can do economically and efficiently. Examples of this would be (1) notification to people and establishments to renew and update	

	REFERENCES
their certification and (2) follow-up on vehicles which were rejected to make sure they have been resubmitted for another inspection within the time specified.	
3. The justification of vehicle inspection records is support for vehicle inspection programs. It is important that records system outputs and services match programs. Inadequate records will hamper development of programs; superfluous records will waste money and effort. It is necessary, therefore, for records system personnel to work closely with administrators of the programs in planning the reports managers want, especially for decision-making. As a basis for reaching agreement as to what outputs will be included, each output and each specific information item considered for that output should be considered according to whether it is (1) necessary; (2) useful, but not necessary; (3) nice or impressive, but not especially useful; and (4) something somebody imagined ought to be included, but might never be used. All of number 1 should	

H. ACCIDENT RECORD (continued)

4. A copy of each accident report is filed with the State Department of Education ..... S A U

5. Accident reports are analyzed for instructional purposes and to furnish the basis for elimination of hazards..... S A U

6. _____ S A U

7. _____ S A U

8. _____ S A U

9. _____ S A U

10. Evaluation for the total rating of H. ACCIDENT RECORDS. S A U

I. FIRST AID

1. An adequately stocked first aid cabinet is provided... S A U

2. The first aid is administered by a qualified individual S A U

3. The school has individuals qualified to administer first aid. S A U

4. _____ S A U

5. _____ S A U

6. _____ S A U

7. _____ S A U

8. Evaluation for the total rating of I. FIRST AID.... S A U

RECOMMENDATIONS

Code No.	

For additional copies in packets of 50 send $1.00 to National Safety Council, 425 North Michigan Avenue, Chicago, Ill. 60611

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	REFERENCES
be produced; none of number 4 should be. Whether 2 or 3 are produced will depend on the availability of resources and the relative importance of different programs.	
4. Exhibits 1 through 14 of this unit are output reports which the Traffic Institute has suggested should be produced in connection with a vehicle inspection program. For each output, three elements are listed: a. Title (what the report concerns). b. Identifying data (time, area, group of people, group of vehicles). c. Information reported or summarized. The sheets are designed so that they can be used by the instructor for project assignments or classroom participation. In this regard the second section of each sheet leaves space for the class to evaluate the need for the particular output report, whether the existing report is sufficient and, if not, what changes are required. There is also space for the class to make an estimate as to the number of individual	

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	REFERENCES
output reports to be prepared in one year. Codes which could be used are:	

Sufficiency

- [ ] Not now available
- [/] Important improvements needed
- [X] Needs some additions or adjustments
- [■] Satisfactory as is

Requirements

A: Form design or form standardization

B: Data collection improvements

C: Data processing and storage

D: Funds, management decisions

The instructor should also consider having the class assign priorities of importance to the listed outputs. Codes which could be used for this are:

	REFERENCES
Priority a. Immediate attention required. This information is necessary for a successful program. b. Prompt attention suggested. This information is important to the program and is economically and operationally sensible to produce now. c. Future attention required. Other recommendations need adoption before this information can be accommodated. d. Future attention suggested. This information is part of a complete program but unnecessary for a successful one. E. Inputs to the Records System 1. A records system can produce output records only to the extent that input data have been provided. If unavailable information is repeatedly requested from the system, program managers should arrange to provide the necessary input -- if the records system can handle it.	

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	REFERENCES
2. A unit of input is not a piece of paper, but a piece of information. Usually the input is on a paper arranged as a form for convenience. A single paper form may include many inputs. For example, a report from an inspection station may show, one to a line, the results of inspecting 20 vehicles; this is not one but twenty unit inputs, each relating to a different inspection. Or a single form may include a mechanic's application for certification as an inspector as one input and the investigator's approval or disapproval as another from a separate source. These two could be on separate forms, or they could be at different locations on the same sheet. There is advantage in making each form serve as many purposes as possible. It reduces the number of forms and it makes transcribing data from them a more standardized process.	
3. It once again must be emphasized that periodic motor vehicle inspection is part of a total highway safety program and that the information gathered within the inspection	

	REFERENCES
program must be made available to other agencies who have need of it. Furthermore, the vehicle inspection program may require information gathered by other agencies. The importance of these types of information to the various programs should guide the administrators regarding the methods of transmission to be used. This can best be explained by illustrations: a. Several traffic agencies in a state keep records of people. Most of these expect or require reports of any change of name or address but, in practice, people often forget to make those reports. Any agency receiving information about such a change should at once make it known to all others. This means that if, during a vehicle inspection, it is found that the operator or owner of the vehicle being inspected is no longer living at the address noted on the operator's license or vehicle registration certificate, the appropriate agency should be notified.	

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	REFERENCES
(1) Field supervisors should constantly be reminding mechanic-inspectors to check on the correctness of addresses.	
b. In order for a vehicle to be registered it should first have passed an inspection within a specified time. Coordination between vehicle inspection and vehicle registration records should provide the means of enforcing this requirement.	
c. Mechanic-inspectors are usually required to be licensed drivers. If such a person's drivers license is suspended or revoked, he is also disqualified as an inspector. Therefore, it is important that suspension information reach the vehicle inspection agency. To do this effectively the records system should be so designed that appropriate notations are made in an operator's license file when he is certified as a mechanic-inspector.	

	REFERENCES
4. A common experience of management consultants in reviewing communication procedures is the discovery that the majority of forms and reports in use are no longer fulfilling the purpose for which they were intended. In accomplishing what is being suggested in this section, the administrator must be wary of over communicating through forms. The volume of information being processed within and through the vehicle inspection program, a volume of which will most surely increase before it levels off, suggests emphatically the need for electronic data processing. The lack of EDP in the majority of existing vehicle inspection programs has hindered the evaluation of the overall effectiveness of the programs in the past. However, even those states making use of EDP find that it introduces a delay. It is the time required to transcribe data from the data collection forms to punched cards or tapes so that the automatic machinery can digest it. If an agency is now using EDP, or is contemplating its use, the administrators, records analysts, and system programmers should consult on the	Ref. #2 - p. 18

	REFERENCES
information to be recorded so that waste in effort and money will be kept at a minimum. Fewer kinds of forms, forms with data always in the same place, and forms with precoded data all help. In a repetitive type of operation such as noting vehicle defects, input instruments should be considered which can be optical scanned with the data automatically encoded into the system. a. This once again emphasizes the importance of the field supervisors' properly performing their functions of inspecting and training. 5. The next page contains a schematic diagram of processing information connected with the inspection of a vehicle. It should be used by the instructor to solicit suggestions from the class as to the ideal, or the realistic, procedure which should be adopted locally. Similar flow charts should be developed for the processing of information concerned with the certifying of inspection stations and the inspectors.	

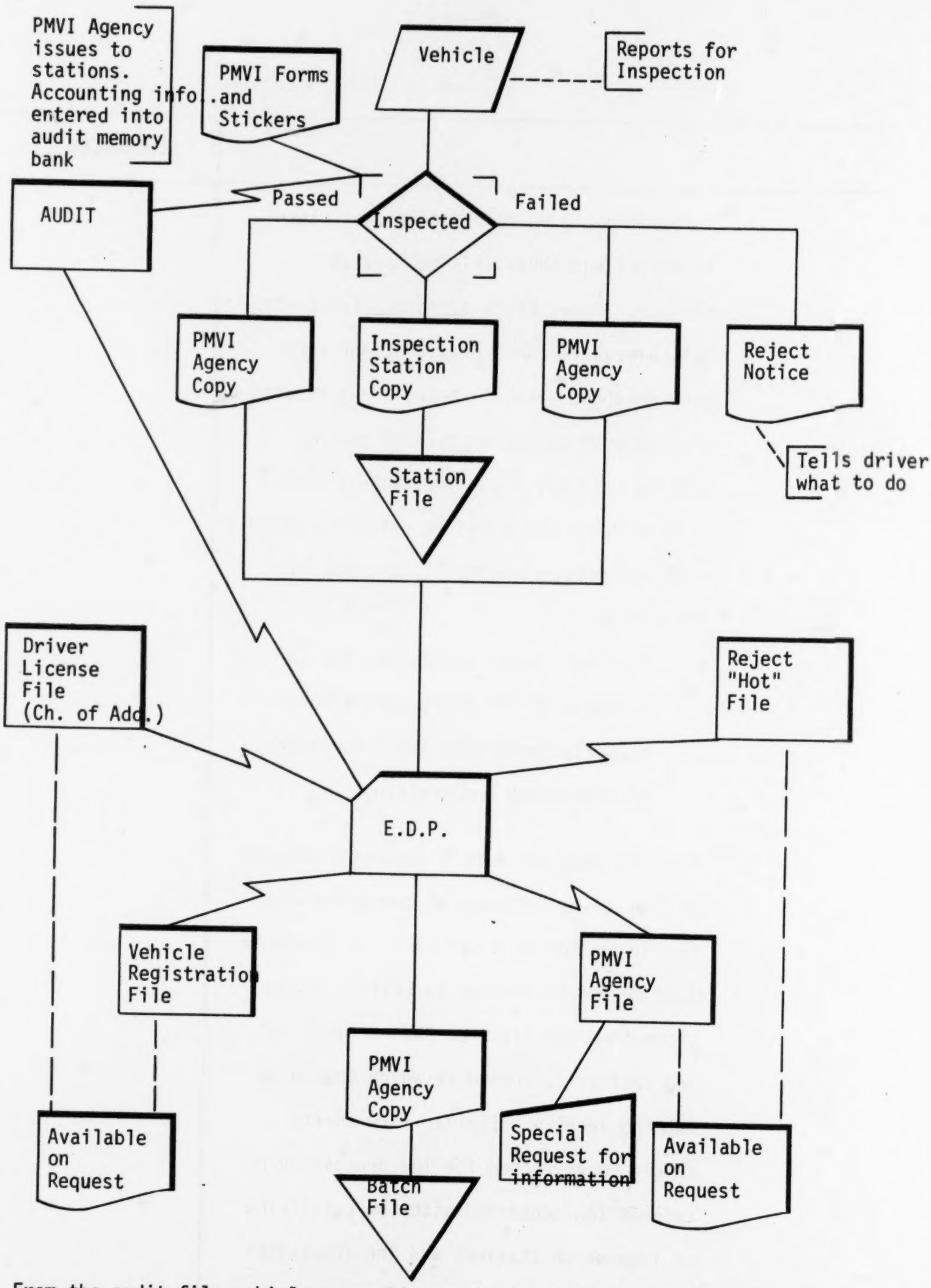

From the audit file vehicle ownership can be identified through inspection sticker number. Also, statistical reports as to serial numbered forms may be compiled.

	REFERENCES
6. Exhibits 15 - 35 of this unit are input reports which the Traffic Institute has suggested should be a part of a periodic motor vehicle inspection records system. As with the previously listed output records, these input sheets are designed so that they can be used by the instructor for project assignments or classroom participation. The second section of each sheet has space for the class to note whether or not the agency now is gathering this input information and the estimated number of such inputs each year. There is also space for the evaluation of the existing input data, and if a deficiency is noted, space for suggested requirements for improvement. Codes which could be used for this evaluation are:	

Sufficiency

- ☐ Not now available
- ⧄ Important improvements needed
- ☒ Needs some additions or adjustments
- ■ Satisfactory as is

20463

STANDARD STUDENT ACCIDENT REPORT FORM

Part A. Information on ALL Accidents

1. Name: _____ Home Address: _____
2. School: _____ Sex: M ☐; F ☐. Age: _____ Grade or classification: _____
3. Time accident occurred: Hour _____ A.M.; _____ P.M. Date: _____
4. Place of Accident: School Building ☐ School Grounds ☐ To or from School ☐ Home ☐ Elsewhere ☐

5. NATURE OF INJURY

Abrasion	____	Fracture	____
Amputation	____	Laceration	____
Asphyxiation	____	Poisoning	____
Bite	____	Puncture	____
Bruise	____	Scalds	____
Burn	____	Scratches	____
Concussion	____	Shock (el.)	____
Cut	____	Sprain	____
Dislocation	____		
Other (specify)	____		

PART OF BODY INJURED

Abdomen	____	Foot	____
Ankle	____	Hand	____
Arm	____	Head	____
Back	____	Knee	____
Chest	____	Leg	____
Ear	____	Mouth	____
Elbow	____	Nose	____
Eye	____	Scalp	____
Face	____	Tooth	____
Finger	____	Wrist	____
Other (specify)	____		

DESCRIPTION OF THE ACCIDENT

How did accident happen? What was student doing? Where was student? List specifically unsafe acts and unsafe conditions existing. Specify any tool, machine or equipment involved. _____

6. Degree of Injury: Death ☐ Permanent Impairment ☐ Temporary Disability ☐ Nondisabling ☐
7. Total number of days lost from school: _____ (To be filled in when student returns to school)

Part B. Additional Information on School Jurisdiction Accidents

8. Teacher in charge when accident occurred (Enter name): _____
   Present at scene of accident: No: _____ Yes: _____

9. IMMEDIATE ACTION TAKEN

First-aid treatment	____	By (Name): _____
Sent to school nurse	____	By (Name): _____
Sent home	____	By (Name): _____
Sent to physician	____	By (Name): _____
		Physician's Name: _____
Sent to hospital	____	By (Name): _____
		Name of hospital: _____

10. Was a parent or other individual notified? No:__ Yes:__ When: _____ How: _____
    Name of individual notified: _____
    By whom? (Enter name): _____
11. Witnesses: 1. Name: _____ Address: _____
    2. Name: _____ Address: _____

12. LOCATION

	Specify Activity		Specify Activity
Athletic field	____	Locker	____
Auditorium	____	Pool	____
Cafeteria	____	Sch. grounds	____
Classroom	____	____ shop	____
Corridor	____	Showers	____
Dressing room	____	Stairs	____
Gymnasium	____	Toilets and washrooms	____
Home Econ.	____	Other (specify)	____
Laboratories	____		

Remarks

What recommendations do you have for preventing other accidents of this type? _____

Signed: Principal: _____ Teacher: _____

Reproduced through the courtesy of The National Safety Council.

8208 2022

	REFERENCES
Requirements A: Form design or form standardization B: Adaptation to new processing method C: Adapt to local or broader use D: Funds, administrative decisions The instructor should consider having the class rate the information listed in the identification and description columns according to its importance to the overall program. Codes which can be used for this are: " This is a must piece of information ' This is a should have piece of information No mark is a nice-to-have piece of information F. Management by Exception 1. Earlier it was said that management by exception is one of the services which a records system can perform. Now that the student has an idea of the amount of	

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	REFERENCES
information which will be put into the vehicle inspection record system, it is time to again suggest that supervisors, at all levels of the management heirarchy must know what decisions they are allowed to make and should ask the records system to alert them to situations which require their attention. In practice, management by exception usually means referring minor unusual developments to supervisors and middle management; but if the exceptional situation persists or becomes aggravated, it is referred to the chief administrator or "top management".	
2. The records system, however competent, cannot make plans and set goals; it should not establish standards. These are duties of the people who use reports put out by records systems. But the records system can and should call attention to deviations from norms or averages and sharp or prolonged changes in trends.	
3. Exceptions are usually related to one or more of four bases of comparison. Supervisors should be aware of these so that	

20465

	REFERENCES
they will be able to ask the records personnel to channel meaningful information to their level of operation. a. Plans, goals, time schedules intended or hoped for. The administrator must know if plans are not being carried out, but does not need to be repeatedly told that all operations are according to plan. A goal of vehicle inspection programs is to correct vehicles which are not safe as determined by an inspection. If this control is to be effective there should be some way to know what "failed" vehicles continue to be operated without ever passing an inspection. Likewise, supervisors should know if a station in their area is constantly passing vehicles which had been rejected elsewhere. b. Standards and guides. Standards of motor vehicle safety are established within the inspection program in the belief that adherence to them will be	

	REFERENCES
beneficial. It is important to discover instances in which the standards are not being met, and to take necessary corrective steps. The motor vehicle inspection program should be helpful in determining whether manufacturing standards are being met by alerting the administrator to unusual numbers of defects being noted within one model of vehicles. (1) To do this the administrator would first have to decide when defects become unusual or exceptional and so notify the system. c. Trends. It may not be practical to say that a vehicle inspection program of certain magnitude will definitely reduce traffic accidents by "X" percent a year for the next "X" years, but we can watch the number of accidents occurring and get some idea if vehicle inspection is having any effect on the problem. Trends in work performance and trends in the rate at which a problem is responding to control or	

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	REFERENCES
continues to grow are especially important to an administrator; they tell him if he is gaining or losing in his efforts to meet standards. Trends are extremely important as guides when management personnel must intervene and seek to correct lack of satisfactory progress toward meeting standards or achieving goals. In order to make the most efficient use of trends, the user should tell the records system when it is to consider the trend unusual so that the records system may then notify the user that his attention is required.	
d. Deviation from norms. Norms are related to standards; a standard represents a kind of "normal" situation. Then non-conformance is a deviation from this norm. Norms also represent the mean or average of observed experience. The supervisor should be concerned when one of several units performing the same functions under his direction proves to be "different" in some way or another. As an example: it may be that a vehicle	

	REFERENCES
inspection station never shows any repairs required by vehicles which are inspected.	
4. When asking the records system to alert him to an exceptional condition warranting his attention, the supervisor should make sure that he is not getting changes which are due to chance or which have no real statistical significance. An example would be the supervisor who asks to be notified if any station in his area shows a 25% increase or decrease in its monthly reject rate. This supervisor is notified of a 50% change in one of his stations, and on investigation finds that the station, for an isolated reason, inspected and passed one vehicle during the first time period, and during the second time period inspected two vehicles and rejected one of them. If a change such as this is reported it should be clearly marked as not being a significant or reliable change. The same rule applies in reporting before and after accident experience to indicate the effect of vehicle inspection.	

20469

	REFERENCES
5. There are procedures for determining whether or not percent changes are statistically significant. One such procedure is on the next page.	

20470

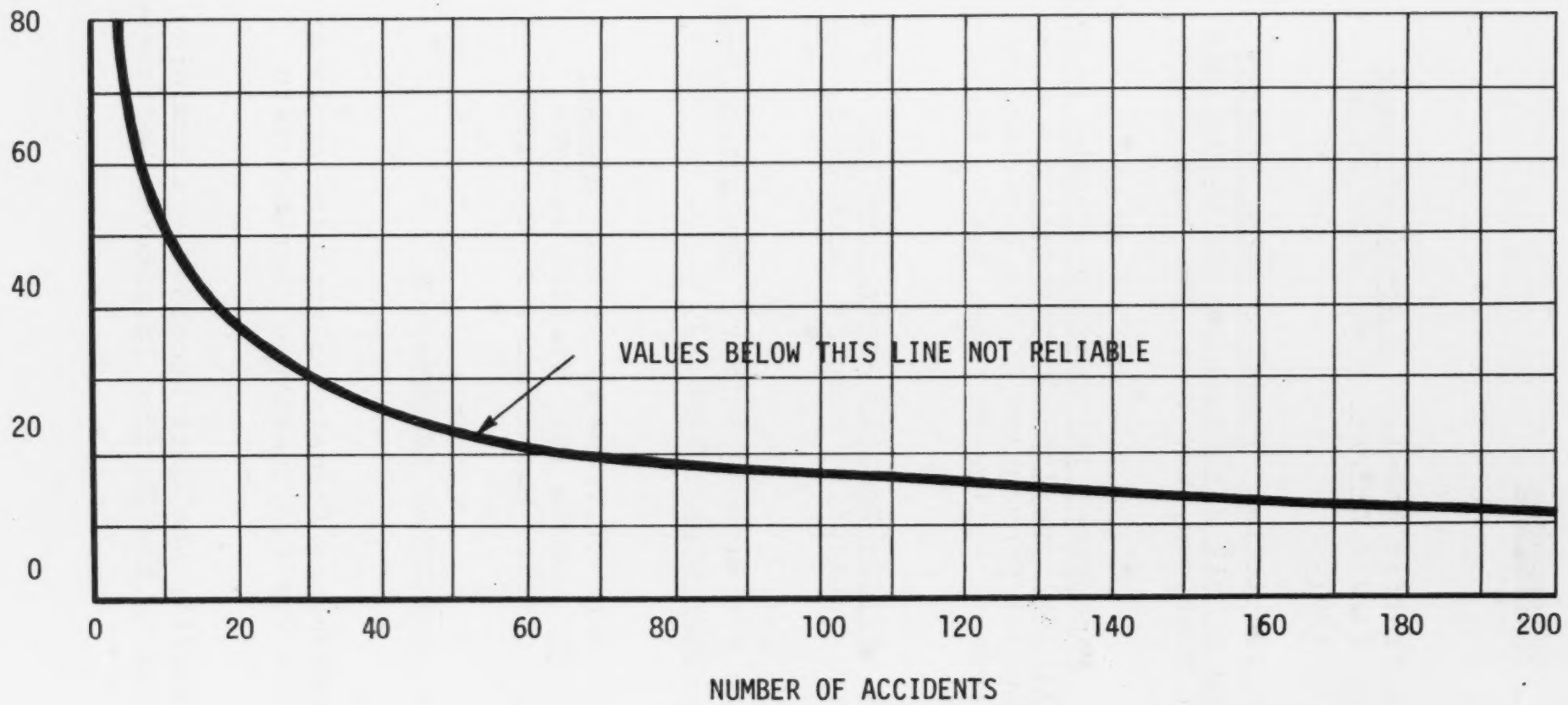

It is important not to become excited about changes which are probably due to chance. There are statistical tests to evaluate the probability that a change is due to chance. The chart above illustrates such a test. If the percent change related to the number of accidents or other events is below the curve, the probability is greater than 1 in 20 that the change is due to chance. (From Michaels, Richard M., "Two Simple Techniques for Determining the Significance of Accident-reducing Measures" in Traffic Safety Research Review, June 1960)

-20471

REFERENCES

1. AAA Foundation for Traffic Safety. A Study of Motor Vehicle Inspection, 1712 G Street, N.W., Washington, D. C. 20006, April, 1967.

2. American Petroleum Institute. Periodic Motor Vehicle Inspection Programs - Part 2 - Organization Guidelines. 1271 Avenue of the Americas, New York, New York 10020, August, 1968.

3. Dirksen, James R. Management Information Systems in Law Enforcement and Criminal Justice Administration. A paper presented at the Annual Convention of the International Association of Chiefs of Police in Miami Beach, Florida, October, 1969.

4. Hewitt, William H. Police Records Administration. The Lawyers Co-operative Publishing Company, Rochester, New York., 1968.

5. Insurance Institute for Highway Safety. Management Manual for Motor Vehicle Inspection. Washington, D. C. 20037, January 1, 1968.

6. United States Department of Transportation. Highway Safety Program Manual, Volume 10: Traffic Records. Government Printing Office, Washington, D. C., 1969.

SOURCES OF ADDITIONAL INFORMATION

1. "Check List for Evaluating Forms" - a training publication prepared by the Traffic Institute, Northwestern University.

2. "Form Design for Traffic Accident Records" - a training publication prepared by the Traffic Institute, Northwestern University.

20472

EXHIBIT 1

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning: MVI Inspector's certification

Needed by: NHSB Manual 1, P.M.V.I. Agency, MVI Station, Police

Needed when: Periodically

Identifying or limiting data: Name, address of inspector, driver license number - (social security number)

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Description of inspector:

Number of certificate:

Date of issuance:

Date of expiration:

Type:

30 OF 327

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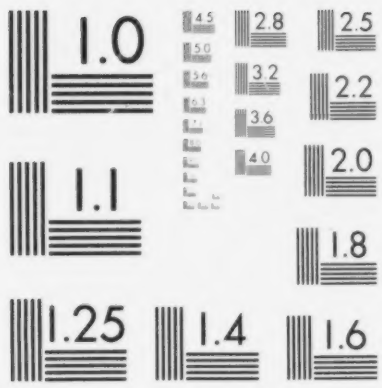

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

EXHIBIT II

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning: Status of MVI Inspector

Needed by: NHSB Manual 1, P.M.V.I. Agency, Police, Public

Needed when: On request

Identifying or limiting data: Inspector's name, address, certification number (could be driver license or social security number)

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Date originally certified:

Certification under suspension, date, reason:

Revoked, cancelled - date:

Complaints:

Kind of training:

Employing station:

Date of expiration of certification:

20474

EXHIBIT III

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning:	Updating information MVI inspector's certification
Needed by:	P.M.V.I. Agency
Needed when:	Periodically on expiration
Identifying or limiting data:	Expiration date, name of inspector, number of certificate

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Expiration date of present certificate:

Changes required (name, address, description, type):

EXHIBIT IV

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning:	Recapitulation of licensed MVI inspectors
Needed by:	P.M.V.I. Agency, Public
Needed when:	Periodic (monthly, yearly)
Identifying or limiting data:	All vehicle inspectors, time period

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

A1	Inspectors active at beginning of period:	= A8 previous period:
A2	Plus approved during period:	= B3:
A3	Minus suspensions by reason:	
A4	Plus reinstatements:	
A5	Minus revocations or cancellations by reason:	
A6	Minus withdrawals:	
A7	Minus lapses:	
A8	Equals total active at end of period:	= A1 next period:
B1	Applications pending beginning of period:	= B5 previous period:
B2	Plus received during period:	
B3	Minus approved during period:	= A2:
B4	Minus applications rejected during period:	
B5	Equals pending at end of period:	= B1 following period:

EXHIBIT V

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning:	Inventory - MV Inspectors
Needed by:	P.M.V.I. Agency
Needed when:	Periodic (yearly)
Identifying or limiting data:	All certified MV inspectors, date of inventory

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Total number of certified MV inspectors:

Number approved for each type vehicle:

Number currently under suspension by reason:

EXHIBIT IV

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning: Work of certifying inspectors

Needed by: P.M.V.I. Agency

Needed when: Periodic (Yearly)

Identifying or limiting data: All transactions connected with certification of MV inspectors, time period

---

Existing report: Yearly report:

Sufficiency:

Requirements:

Specific Information Items Required

Applications received by type of vehicle requesting to inspect:

Certificates issued by type of vehicle authorized to inspect:

Official action taken against an inspector by type (warning, suspension, revocation, etc.):

Recertification after lapse, revocation, cancellation, termination:

Duplicates (lost certificates - corrected certificates):

Requalifications:

Reinstatements:

EXHIBIT VII

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning: Certification of VI Station

Needed by: NHSB Manual 1, P.M.V.I. Agency, Police, MVI Station

Needed when: Periodic (yearly)

Identifying or limiting data: Station name, address, number

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Date issued:

Date of expiration:

Vehicles equipped to inspect:

EXHIBIT VIII

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning: Status of VI Station

Needed by: P.M.V.I. Agency, Public

Needed when: On request

Identifying or limiting data: Station name, address (including county), number, zip code for area location

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Status (OK, suspended, revoked, probation, out-of-business, not renewed):

Name of proprietor:

Complaints since specified time:

Date of original licensing (date established):

What vehicles inspected (motorcycle, school bus, etc.):

Facilities: Number and capacity of brake testing equipment, same for headlight equipment:

Number of certified mechanics available:

EXHIBIT IX

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning:	Updating information - MV Inspection Station
Needed by:	P.M.V.I. Agency
Needed when:	Periodic (yearly)
Identifying or limiting data:	Expiration date, all VI stations

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Expiration date present certificate:

Changes required (address, name, description):

20481

EXHIBIT X

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning: Recapitulation - VI Stations

Needed by: NHSB Manual 1, P.M.V.I. Agency, Public

Needed when: Periodic (monthly, yearly)

Identifying or limiting data: Time period

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

A1	Stations active at beginning of period:	= A8	previous period:
A2	Approved during period:	= B3	
A3	Minus suspensions by reason:	= D2	
A4	Plus reinstatements:	= D3	
A5	Minus revocations or cancellations by reason:		
A6	Minus withdrawals		
A7	Minus lapses:		
A8	Equals total active at end of period:	= A1	next period:
B1	Applications pending beginning of period:	= B5	previous period:
B2	Plus received during period:		
B3	Minus approved during period:	= A2	
B4	Minus applications rejected during period:		
B5	Equals pending end of period:	= B1	following period:
C1	Stations on probation beginning of period:	= C4	previous period:
C2	Plus placed on probation during period by reason:		
C3	Minus removed from probation during period:		
C4	Equals on probation at end of period:	= C1	following period:
D1	Stations suspended at beginning of period:	= D4	previous period:
D2	Plus suspended during period:	= A3	
D3	Minus reinstatements during period:	= A4	
D4	Equals suspended at end of period:	= D1	following period:

EXHIBIT XI

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning:	Inventory - VI Stations
Needed by:	P.M.V.I. Agency, Public
Needed when:	Periodic (yearly)
Identifying or limiting data:	All VI Stations, date of inventory

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

---

1. List of certified MVI stations (directory):

   a. Name of station and number
   b. Address
   c. Person in charge
   d. Type of vehicles inspected

2. Totals:

   a. By cities and counties
   b. By types of vehicles inspected

GENERAL DIRECTIONS FOR GIVING FIRST AID

Courtesy American National Red Cross

KEEP THE INJURED PERSON LYING DOWN **DO NOT GIVE**

LIQUIDS TO THE UNCONSCIOUS **CONTROL BLEEDING BY PRESSING ON**

THE WOUND **RESTART BREATHING WITH MOUTH-TO-MOUTH ARTIFICIAL**

RESPIRATION **DILUTE SWALLOWED POISONS** **KEEP BROKEN BONES**

FROM MOVING **COVER BURNS WITH THICK LAYERS OF**

CLOTH **KEEP HEART-ATTACK CASES QUIET**

FAINTING: KEEP HEAD LOWER THAN HEART **COVER EYE INJURIES WITH**

GAUZE PAD

ALWAYS CALL A DOCTOR

TAKE A RED CROSS FIRST AID COURSE

THE AMERICAN NATIONAL RED CROSS

2023

EXHIBIT XII

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning:	Production - MVI Stations
Needed by:	NHSB Manual 1, P.M.V.I. Agency, Public
Needed when:	Periodic (monthly, yearly)
Identifying or limiting data:	Each and all inspections conducted in period, time period

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

Passed first inspection:

Failed first inspection by reason:

Passed first reinspection:

Failed first reinspection by reason:

Passed second reinspection:

Failed second reinspection by reason:

Etc.:

By station - by major types of vehicles:

20484

EXHIBIT XIII

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning:	Percent of vehicles inspected
Needed by:	NHSB Manual 1, P.M.V.I. Agency
Needed when:	Periodic (yearly)
Identifying or limiting data:	Vehicle registration total, vehicles inspected total, time period, types of vehicles

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

---

1. Number of vehicles registered)
2. Number of vehicles inspected) By type of vehicle
3. Percent of vehicles inspected)

NOTE: Could be done by sampling procedures on road. This might be combined with enforcement.

EXHIBIT XIV

INFORMATION NEEDED FROM RECORDS

(Unit Output Report)

Concerning: Mileage of vehicles

Needed by: NHSB Manual 1, Indeterminate at present
(No suggestion as to use by NHSB)

Identifying or limiting data: Inspection period - specific vehicles types or all vehicles

---

Existing report: Yearly reports:

Sufficiency:

Requirements:

Specific Information Items Required

---

a.	Mileage between inspections	Each vehicle
b.	Time between inspections	
c.	Mileage per year = a/b	
d.	Total mileage per year	By type of vehicle
e.	Total accidents per year	
f.	Mileage rate = d/e	

Similar data by make and model

20486

EXHIBIT XV

DATA FOR RECORDS

(Unit Input)

Title: MV inspection report

Obtained: Periodically (annually) when owner presents vehicle for inspection

Initiated by: Inspector in inspection station

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Motor vehicle	Manufacturer, division* Registration number* ID Number	Model year Odometer reading
Inspector	Signature ID Number Station Number	
Approved	Date Place Number of sticker	Yes, No Yes, after repair
If disapproved, why		List of items rejected
Attempts to qualify		Number of previous disapprovals

May be as a list, one line per vehicle, or as individual reports

NHSB MANUAL 1, IV, 9b(2)(b)

20487

EXHIBIT XVI

DATA FOR RECORDS

(Unit Input)

Title: Vehicle mileage

Obtained: When vehicle is inspected

Initiated by: Inspector

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Vehicle	Manufacturer, division* Registration number* ID Number	Model year Body style
Mileage		Odometer to nearest 100 miles

NHSB MANUAL 1, IV, 9b(2)(b)8

20488

EXHIBIT XVII

DATA FOR RECORDS

(Unit Input)

Title: Original application for MV inspector

Obtained: When person wants to become MV inspector

Initiated by: Applicant (or station on his behalf)

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Application	Date	4-tired vehicle Motorcycle Truck (6 or more tires) Tractor and trailer Bus School bus
Applicant	Full name Residence address DL Number - SS Number Signature	Sex Date of birth
To work in	Name of establishment Address	
Education (highest grade completed)	Name of school City or town Date (year)	Elementary Secondary College Technical Other
Previous application	Date of last Place	How many previous Last approved or disapproved
Previous approval		Revoked Lapsed

The description above of the classes of vehicles applied for is suggestive. Program requirements in any state would dictate the exact classification for which the MV inspector is applying.

20489

EXHIBIT XVIII

DATA FOR RECORDS

(Unit Input)

Title: Approval original application MV inspector

Obtained: When application received

Initiated by: Examiner, inspector, reviewer

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Applicant	Name Number	
Examiner	Signature ID Number Department	Title
Basis of judgment		Information from application Supporting documents Tests Recommendations Work record
Approved	Date Place	Yes, No
If disapproved, why		Training, experience Failed tests Personal record*
Examination	Date Place	
Attempts to qualify		Number of previous disapprovals

A list of documents supporting approval or disapproval should appear on the form but are not entered in the working record.

NHSB MANUAL 1, IV, 9b(1)(c)

20499

EXHIBIT XIX

DATA FOR RECORDS

(Unit Input)

Title: Application for scope change MV inspector

Obtained: When additional qualification is desired

Initiated by: MV inspector

Existing form: Yearly number:

Sufficiency:

Requirements:

Elements	Identification	Description
Application	Date	Change desired
Inspector	Name Current address DL Number - SS Number Signature	

This input is unnecessary if every inspector is qualified to inspect all kinds of vehicles, in other words, if there is only one kind of inspector.

EXHIBIT XX

DATA FOR RECORDS

(Unit Input)

Title: Approval of scope change, MV Inspector

Obtained: When application for scope change received or to approval reinstatement after suspension

Initiated by: Examiner, inspector, reviewer

Existing form: Yearly number:

Sufficiency:

Requirements:

Elements	Identification	Description
Inspector	Name DL Number - SS Number	
Examiner	Signature ID Number Department	Title
Approval	Date Place	Yes, No
Basis of judgment		Information from applicant Supporting documents Recommendations Tests Driver record
If disapproved, why		Physical condition Education, experience Personal record Failed tests Driver record
Attempts to qualify		Number of previous disapprovals

A list of documents supporting approval or disapproval should appear on the form but are not entered in the working record. Input not necessary if all inspectors are fully qualified to inspect all vehicles.

EXHIBIT XXI

DATA FOR RECORDS

(Unit Input)

Title: Renewal (updating) MV inspector

Obtained: Periodically before expiration (annually)

Initiated by: Inspector or station on his behalf in response to request from PMVI printout

---

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Application	Date of expiration	
Inspector	Name Current address DL Number - SS Number Signature	
To work in	Name of station Address	
Changes from	Former name Former address Former station	
Desire to continue		Yes, No

SAVING A LIFE

BY ARTIFICIAL RESPIRATION

THE AMERICAN NATIONAL RED CROSS

If victim is not breathing, begin some form of artificial respiration at once. Wipe out quickly any foreign matter visible in the mouth, using your fingers or a cloth wrapped around your fingers.

MOUTH-TO-MOUTH (MOUTH-TO-NOSE) METHOD

Tilt victim's head back. (Fig. 1). Pull or push the jaw into a jutting-out position. (Fig. 2).

If victim is a small child, place your mouth tightly over his mouth and nose and blow gently into his lungs about 20 times a minute. If victim is an adult (see Fig. 3), cover the mouth with your mouth, pinch his nostrils shut, and blow vigorously about 12 times a minute.

If unable to get air into lungs of victim, and if head and jaw positions are correct, suspect foreign matter in throat. To remove it, suspend a small child momentarily by the ankles or place child in position shown in Fig. 4, and slap sharply between shoulder blades.

If the victim is adult, place in position shown in Fig. 5, and use same procedure.

1

2

3

4

5

Courtesy American National Red Cross

2024

EXHIBIT XXII

DATA FOR RECORDS

(Unit Input)

Title: Notification of change of address or name of MV inspector

Obtained: When MV inspector changes address or name

Initiated by: Inspector, employer, police

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Inspector	Name Current Address DL Number - SS Number Signature	
Changes from	Former name Former address	

20494

EXHIBIT XXIII

DATA FOR RECORDS

(Unit Input)

Title: Application for duplicate MV inspector's certificate

Obtained: As requested by inspector

Initiated by: MV inspector

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Inspector	Name Current address DL Number - SS Number Signature	
Changes from	Former name Former address	

20495

EXHIBIT XXIV

DATA FOR RECORDS

(Unit Input)

Title: MV inspector, warning - probation

Obtained: When record reaches certain level or inspector is put on probation

Initiated by: Investigator, inspector

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Inspector	Name DL Number - SS Number ID Number	
Authority	Date effective Signature ID Number Department	Title
Subsequent action anticipated		Suspension Revocation Restriction Other
Circumstances requiring subsequent action	Date of termination if fixed	Failure to qualify Additional offenses
Reasons for warning		Complaints Inspection

NHSB MANUAL 1, IV, 9b(1)(h)

20496

EXHIBIT XXV

DATA FOR RECORDS

(Unit Input)

Title: Suspension - revocation of vehicle inspector

Obtained: When record develops or qualifications no longer met

Initiated by: Records system, inspector, examiner

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Inspector	Name Address DL Number - SS Number	
Authorization	Date effective Place Signature of agent ID Number	Mandatory Discretionary Automatic Title
Type		Suspension Revocation Cancellation
Basis for action		Unethical procedure Accumulated record Serious offense Failed tests Mental
Circumstances of restoration of privilege		Conditions met New application after (date)

NHSB MANUAL 1, IV, 6(h)3

EXHIBIT XXVI

DATA FOR RECORDS

(Unit Input)

Title: Termination of MV inspector

Obtained: Revocation, lapse, return of certificate upon licensing elsewhere, request of inspector, death

Initiated by: Records system - inspector himself

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Termination	Date	Revocation Death notice Request Lapse Resignation Left state
Inspector	Name DL Number - SS Number	

Termination input will be in several forms depending upon the circumstances, for example, revocation notice, death certificate....

20498

EXHIBIT XXVIII

DATA FOR RECORDS

(Unit Input)

Title: Approval original application MV inspection station

Obtained: When original application for MV inspection station received

Initiated by: Inspector, examiner

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Establishment	Name Address	
Approving individual	Signature ID Number Department	Title
Basis of judgment		Information from applicant Supporting documents Recommendations Inspection of plant Interview of people
Approved	Date Place	Yes, No
If disapproved, why		Inadequate facilities Inadequate inspectors Unfavorable reports
Attempts to qualify		Number of previous disapprovals

A list of documents supporting approval or disapproval should appear on the form, but are not entered in the working record.

20500

EXHIBIT XXIX

DATA FOR RECORDS

(Unit Input)

Title: Application for scope change MV inspection station

Obtained: When additional qualification is desired or new equipment to be approved

Initiated by: Proprietor, owner

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Application	Date	Change desired
Inspection station	Name Address Number	
Responsible official	Name Signature	Title

Unnecessary if all stations are qualified to inspect all kinds of vehicle from motorcycles to school buses.

NHSB MANUAL 1, IV, 9b(1)(n)

290 OF 327

ED

056 238

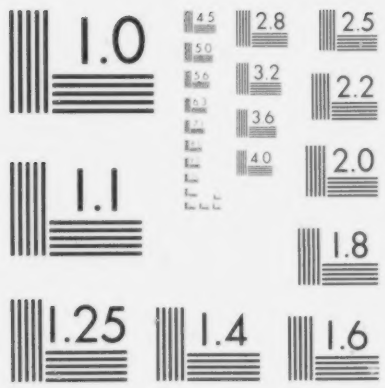

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

EXHIBIT XXX

DATA FOR RECORDS

(Unit Input)

Title: Approval for scope change MV inspection station

Obtained: When application for scope change received or to approve reinstatement after suspension

Initiated by: Inspector, examiner

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Inspection station	Name Address Number	
Inspector, examiner	Signature ID Number Department	Title
Approval	Date Place	Yes, No
Basis of judgment		Information on application Supporting documents Inspection of station Data in file
If disapproved, why		Inadequate facilities Inadequate inspectors Unfavorable reports
Attempts to qualify		Number of previous disapprovals

A list of documents supporting approval or disapproval should appear on the form, but are not entered in the working record.

290

KNOW YOUR FIRE EXTINGUISHERS

	WATER TYPE				FOAM	CARBON DIOXIDE	DRY CHEMICAL	
	STORED PRESSURE	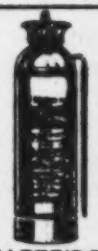 CARTRIDGE OPERATED	WATER PUMP TANK	SODA ACID	FOAM	CO2	CARTRIDGE OPERATED	STORED PRESSURE
CLASS A FIRES WOOD, PAPER, TRASH HAVING GLOWING EMBERS	YES	YES	YES	YES	YES	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	NO (BUT WILL CONTROL SMALL SURFACE FIRES)
CLASS B FIRES FLAMMABLE LIQUIDS, GASOLINE, OIL, PAINTS, GREASE, ETC.	NO	NO	NO	NO	YES	YES	YES	YES
CLASS C FIRES ELECTRICAL EQUIPMENT	NO	NO	NO	NO	NO	YES	YES	YES
CLASS D FIRES COMBUSTIBLE METALS	SPECIAL EXTINGUISHING AGENTS APPROVED BY RECOGNIZED TESTING LABORATORIES							
METHOD OF OPERATION	SQUEEZE HANDLE OR TURN VALVE	TURN UPSIDE DOWN AND BUMP	PUMP HANDLE	TURN UPSIDE DOWN	TURN UPSIDE DOWN	PULL PIN SQUEEZE LEVER	RUPTURE CARTRIDGE-SQUEEZE LEVER	PULL PIN-SQUEEZE LEVER
RANGE	30'–40'	30'–40'	30'–40'	30'–40'	30'–40'	3'–8'	5'–20'	5'–20'
MAINTENANCE	CHECK AIR PRESSURE	WEIGH GAS CARTRIDGE ADD WATER IF REQUIRED	DISCHARGE AND FILL WITH WATER ANNUALLY	DISCHARGE ANNUALLY -RECHARGE	DISCHARGE ANNUALLY -RECHARGE	WEIGH SEMI-ANNUALLY	WEIGH GAS CARTRIDGE-CHECK CONDITION OF DRY CHEMICAL	CHECK PRESSURE GAUGE AND CONDITION OF DRY CHEMICAL

5054
60
2025

EXHIBIT XXXI

DATA FOR RECORDS

(Unit Input)

Title: Renewal (updating) MV inspection station

Obtained: Periodically before expiration (annually)

Initiated by: Owner, proprietor in response to request from PMVI agency

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Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Application	Date of expiration	
Station	Name Address Station number	
Responsible official	Name Signature	Title
Changes from	Former name Former address Former responsible official	Equipment previously listed Number certified mechanics available

EXHIBIT XXXII

DATA FOR RECORDS

(Unit Input)

Title: Requalification MV inspection station

Obtained: Intermittently (monthly) or when complaints or other records develop

Initiated by: Inspector, PMVI Agency

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Station	Name Address Number	
Inspector	Signature Employee number	Title
Approval	Date	Yes Probation No(suspension)
If disapproved, why		Inadequate facilities Inadequate inspectors Other

NHSB MANUAL 1, IV, 9b(1)(a)

EXHIBIT XXXIII

DATA FOR RECORDS

(Unit Input)

Title: MV inspection station, warning - probation

Obtained: When complaints accumulate or station is put on probation

Initiated by: Investigator, inspector

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Station	Name Address ID Number	
Authority	Date effective Signature ID Number Department	Title
Subsequent action anticipated		Suspension Revocation Other
Circumstances requiring subsequent action	Date of termination, if fixed	Failure to qualify Additional offenses Investigation
Reasons for warning		Complaints Inspection

NHSB MANUAL 1, IV, 9b(1)(h)

20505

EXHIBIT XXXIV

DATA FOR RECORDS

(Unit Input)

Title: Suspension - revocation MV inspection station

Obtained: When record develops or qualification no longer met

Initiated by: Inspector

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Station	Name Address Number	
Authorization	Date effective Place Signature of agent ID Number	Title
Type		Revocation Suspension
Basis for action		Inadequate facilities Inadequate personnel Unethical procedures Accumulated record Bond not in effect
Circumstances for reinstatement		Conditions met New application after (date)

NHSB MANUAL 1, IV, 9b(1)(j,k)

20506

EXHIBIT XXXV

DATA FOR RECORDS

(Unit Input)

Title: Termination of MV inspection station

Obtained: Revocation, lapse after failure to update

Initiated by: Request of owner, station official, department, records system

Existing form: Yearly number:

Sufficiency:

Requirements:

Element	Identification	Description
Station	Name Address Number	
Termination	Date effective	Lapse Revocation Request
Authority	Signature Department ID Number	

SUBJECT: TRAINING - A FUNCTION OF MANAGEMENT

HOURS: 8

OBJECTIVE: To develop the student's understanding of management responsibility to up-grade personnel performance through training; to increase ability to implement training programs; and to acquaint the student with the responsibility of training to provide staff service to management.

METHOD OF INSTRUCTION: This presentation is designed to be given by the lecture method. Students may be divided into groups for the purpose of designing a training program for field supervisors and station supervisors. They should also develop criteria for evaluating such a training program.

INSTRUCTOR'S GUIDE

(TRAINING - A FUNCTION OF MANAGEMENT)

I. INTRODUCTION

A. Training is an essential part of personnel management. "Personnel Management" is an integral part of "administration."* Due to the placement of the function of motor vehicle inspection within the organizational structure of a state government, it is assumed that the processes of training for PMVI will be part of a larger program directed toward training of employees of a number of divisions within the motor vehicle or public safety department of a state. Instruction should emphasize that this in no way reduces the need for training, nor does it affect the management role in training.

*Ref. #1, Sec. 3.5.1 through 3.5.5

20509

	REFERENCES
II. PRESENTATION	
A. What is Training?	
1. Training is a process used to help employees acquire the attitudes, knowledge, skill or experience needed to carry out the specific tasks to which they are or may be assigned. Training is concerned with motivation, morale, cooperation, obedience to procedures, compliance with orders and acceptance of policies and many other facets of operation which cause an organization to carry on its commitments.	
III. ESTABLISHING A CLIMATE FOR TRAINING	
A. The Administrator must Create an Atmosphere for the Acceptance of Training.	
1. Members of his organization must be aware of his support of training and his belief in the value of the process of training.	
a. Training is often thought of as a "stooge" activity for management.	
2. The administrator must be willing and able to convey the same attitude to his superiors for:	
a. Budgetary reasons	

	REFERENCES
b. To justify personnel assignment to training section.	
c. To justify in-service and "up-grading" training.	
B. The Administrator Must Formulate and Publish a General Policy Statement Relating to the Need for Training and the Value of it.	
1. Such a policy gives the training function a recognized "status" structure within the "staff" functions of the organization.	
a. This is extremely important in PMVI programs because a large portion of the budget is personnel. Therefore, an administrator can obtain the greatest return on his money through improvement of human resources. In addition, employees derive necessary job satisfaction by being able to perform well.	
C. The Administrator Must Provide for a Realistic Training Budget. Realistic in Cost, Time, Number of People to be Trained and Re-trained.	
1. The important categories in a training budget are:	
a. Provisions for space, materials, equip-	

	REFERENCES
ment and training personnel.	
b. Who is to be trained and:	
(1) Salary considerations of training staff.	
(2) Salaries of personnel while in training (if Performance Budgeting).	
c. Provisions for guest instructors.	
d. Cost of housing students.	
e. Cost of meals and travel.	
f. Without a program and adequate budget, training becomes a "step-child" of other functions and often is seriously neglected for lack of money and direction.	
D. The Administrator Should Require a Formalized Schedule of Training.	
1. Training formally scheduled permits supervisors to plan their personnel schedules in such a way as to be able to assign personnel to training without having to establish "emergency" measures to cover the tasks to be done while their people are away in training.	

20512

(S A M P L E)

Industrial Arts Safety Test Record

_____ School

_____ County

Subject _____

School year _____

Student's Name _____ Age _____

Teacher _____

Date	Test Number	Title or Topic	Score	Pass-Fail	Repeat Required Yes - No

2026

	REFERENCES
2. A further purpose is to allow field personnel to advise non-departmental people when training will be scheduled so that they -(the non-personnel) can schedule their appearance in training sessions. (In PMVI the agency may conduct mechanic-inspector training for new licensees or refresher training for mechanic-inspectors who are licensed.)	
3. A training schedule may be made up as little as three months in advance or for as long as the budget period, which may be two years.	
E. Training, as a Staff Function, Should be so Structured in the Department that there is Adequate Means for Coordination and Communications with those Division within the Agency that use the Training Services. This Positioning of the Training Function is an Administrator's Responsibility.	
1. The Periodic Motor Vehicle Inspection function is normally a section or function of a larger agency, and training of PMVI personnel may require special emphasis in coordination.	

	REFERENCES
F. The Organization of the Training Section is a Matter of Concern for the Administrator. 1. Must be so organized that all elements using the service have emphasis placed on their training needs in proper proportion to their needs. A training section that is staffed with specialists from the driver license field or state police might well display less zeal for PMVI than for their own speciality. This will result in a down-grading of the PMVI function.	
G. A Training Advisory Committee can be Particularly Helpful to the Administrator. 1. An advisory committee composed of persons responsible for and interested in the inspection program can assist in identifying and evaluating training. 2. Because of the nature of most inspection programs the committee should consist of representatives from within the organization such as a field supervisor and a station supervisor. In addition, an owner or manager of an authorized inspection station and an inspector-mechanic should be on the committee.	

	REFERENCES
a. Each of these people have a personal stake in the success of the inspection program.	
IV. THE PMVI ADMINISTRATOR'S RESPONSIBILITIES FOR TRAINING	
A. Administering the Training Program.	
1. Planning	
a. Develop policies for training.	
b. Draw up rules and regulations relating to training.	
c. Set objectives and broad programs for training.	
d. Determine personnel needs.	
e. Determine facility needs.	
2. Organizing	
a. Assigning personnel and facilities.	
b. Allocating functions to personnel.	
c. Establishing the training function in the departmental organization. (In determining the position of training within the organization the size of the PMVI section, its positioning	

20515

	REFERENCES
within a larger parent organization and the role that the parent organization plays in providing training for all branches of the parent organization are factors for consideration.)	
3. Staffing	
a. Selection and assignment of instructors.	
b. Improving instructors through consultation, indicating problem areas and training needs.	
c. Improve instructors through recommending courses of action and by providing supervision.	
4. Directing	
a. Directing the activities of subordinates, non-technical staff, in-house instructors, counselling "outside" instructors.	
b. Directing the student body. (Often aided by written rules, particularly on short-term training sessions.)	
5. Coordinating	
a. Assigning personnel and facilities for most effective use.	

20516

	REFERENCES
b. Training activities with staff and command activities. (The implication here is that there must be a willingness of organizational staff to keep training informed of needs and programs which may create scheduling problems; of departmental programs which will have a direct bearing on the training function. (1) A method for keeping training informed of needs occurs in the control processes of the organization; staff conferences, inspection processes and other techniques used in Control, point up training needs. The problem of program operations which may interfere with training schedules can be resolved in proper staff functioning. As programs are scheduled concurrence from interested divisions can be obtained on the basis of manpower available and time scheduling.	

20517

	REFERENCES
c. Coordinating departmental employee training schedules with training department has scheduled for others. It is not unusual in PMVI for the station supervisor to have established a program of retraining for inspection mechanics. It would be possible for that station supervisor to be scheduled for departmental "in-service" training during the same period unless coordination existed.	
6. Reporting - without an adequate system for reporting the organization loses much in the needed exchange of information.	
a. The administrator must seek ways to be sure the information concerning operations is reaching him. This reporting to the administrator is accomplished through a number of management techniques; some of these are: inspection, statistical reporting, summaries of activities, staff conferences, staff visits, and control techniques.	
At the same time the administrator is seeking ways to be informed of operations,	

	REFERENCES
the organization's operations are being "explained in the field." In large organizations such a flow of information may be in the form of bulletins, training flyers, or other brief news releases. The general staff conference also provides the opportunity for exchange of information but often the press of the total business causes omissions and lack of complete communications.	
7. Budgeting for training. a. The administrator interprets training costs and justifies them. b. He attempts to assure the best use of funds. c. He works toward assuring adequate training materials and facilities. (It is often said that when competition for the budget dollar gets keen, training and training facilities get short shrift.)	

20519

	REFERENCES
B. The Administrator Should Designate one Person as being Responsible for Development of Courses and Curriculum...Hereafter Designated as Training Director. (The Training Function Does not Necessarily have to be a Separate Unit or Division.) 1. Identifying training needs. (This requires a constant communication with other staff, a review of operations, a study of departmental evaluation and inspection reports.) 2. Establishing attainable objectives. (In PMVI as in any other governmental organization budget, time and manpower limitations will be a factor in determining to what degree training will be carried on.) 3. Selecting and organizing course content that can be used to attain objectives. 4. Developing student activities that will assist in attaining objectives. 5. Creating the evaluation device that will aid in determining how nearly training objectives have been attained. (The examination, the demonstration, an analysis of field performance, etc.)	

	REFERENCES
C. The Training Director Provides Course Direction	
1. Schedules course operational details, types of programs, hours, subjects, objectives, etc.	
2. Assures availability of facilities, equipment, etc.	
3. Selects instructors, explains objectives, plans for alternates in case of emergency.	
4. Arranges for preparation of student and instructor reference material.	
5. Establishes rules for course operation and conduct of students.	
6. Keeps program on schedule, introduces instructors, monitors their work.	
7. Keeps superiors informed on progress.	
8. Records deficiencies in operations in order to correct for "next time around."	
D. The Training Director Evaluates Results of Instruction.	
1. Determines extent of learning by students.	
a. As course progresses.	
b. At conclusion of the course.	20521

	REFERENCES
2. Follows up training (job performance). If training is directly related to job performance. a. Establishes S.O.P.'s for reports from the field. b. May make an on-the-job review. c. Review findings as reported by supervisors, inspection officers and management.	
E. Administrator sees that there is a System for Reporting and Recording Training Information. 1. Abilities of personnel, developed through training and subsequently reported, need to be at management's fingertips. A good technique is for the training division to submit a written report to the administrator on each student in training, outlining his performance, his abilities and limitations, and itemizing any special talents or traits that management may need to know. It is well for management to know who can perform and who cannot. The larger the organization the less top management is likely to know about individual abilities in lower echelons.	

VISUAL AIDS

Films and Filmstrips

Inspirational

Attitude for Safety. 20 min., 16 mm., sd., color and b & w, Job Corps, Staff Resources Div., 1200 - 19th Street, N.W., Washington, D.C. 1965
Summary: Designed to alert Job Corps conservation staff to accident potentials.

Be a Pro. 14 min., 16 mm., sd., color. Industrial Accident Prevention Association, 90 Harbour Street, Toronto 1, Ontario, Canada. 1965.
Summary: Portrays necessity of learning and adhering to safety procedures in industrial operation. Especially for Canadian audiences.

Everything to Lose. 26 min., 16 mm., sd., color. Caterpillar Tractor Co., Peoria, Ill. 1965.
Summary: Dramatizes consequences of taking chances in typical shop situations.

It's Your Accident. 23¾ min., 16 mm., sd., color. Association of Mill and Elevator Mutual Insurance Cos., 2 North Riverside Plaza, Chicago 60611. 1965.
Summary: Points out how emotions and attitudes can affect safety.

Instructional

Always on the Job. 20 min.,.35 mm. film strip, sd., b & w, 1953. Air Reduction Sales Co., 60 E. 42nd Street, New York 10017.
Summary: Basic approach to safety in electric arc welding shown in cartoon style.

Automotive Shop Safety. 23 min., 16 mm., sd., b & w, 1963. U.S. Army Pictorial Center, 35-11 35th Avenue, Long Island City, New York 11001.
Summary: Illustrates common automotive shop situations in military operations, explaining safe procedures.

Be a Pro. 14½ min., 16 mm., sd., b & w, 1965. Chetwind Films, Ltd., 21 Greenville Street, Toronto 5, Ontario, Canada.
Summary: Just as professional athletes protect themselves with good equipment and attitudes, workers too should develop professional attitudes toward their work. Several spectacular sports scenes.

Breathing for Others. 14 min., 16 mm., sd., color. British Admiralty., U.S. Contact-International Film Bureau, Inc., 332 South Michigan Ave., Chicago 60604. 1965.
Summary: Demonstrates situations requiring mouth-to-mouth resuscitation. 1966

Courtesy National Safety Council. Used with Permission

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	REFERENCES
2. Comparison of performance with training is essential to successful personnel management. a. This comparison can be made through supervisory techniques. Example: Study of activity reported, evaluation of reports submitted, analysis of employee evaluation forms, review of letters of condemnation and commendation, etc. 3. Supervision of personnel can be aided by information reported by the training division. a. Supervisor's review of training's evaluation of a student can provide clues as to the special areas where special attention may need to be directed. An example of this technique: "The Training Division reports that the new employee has shown some ineptitude in report writing. The suggestion is that special attention needs to be directed to this phase of the employees work. Similarily, training may note that an employee should be good in public speaking. In either case the employee's supervisor, then, has a better understanding of his subordinate's abilities.	

	REFERENCES
4. Without adequate "feed-back" from the field, errors can be perpetuated. a. The failure on the part of supervision to report inadequacy of performance on the part of employees, as it is related to his training, leaves training with no idea that certain concepts they are teaching are either not practical, or are in error.	
5. Records provide useful information for future use in: a. Reporting what was done this time. b. Appraisal for consideration in next presentation. c. Shortening preparation time. d. Guide future planning. e. To preserve data on personnel, individual achievement, etc.	
V. TRAINING AND SELECTION A. Training Complements the Selection of, and the Evaluation of Employees. 1. The selection process determines who is to be trained. At the same time it defines the	

	REFERENCES
basic qualities needed. Training, then, has the obligation to refine these basic qualities so that the beginner can function at his best.	
2. The desirable traits, skills and abilities needed are first defined through a job description process. a. By establishing job descriptions, training has a better guide for determining what the individual must do and what he must know in order to do it.	Ref. #3, pp. 21-58
3. Administrator - management has obligation to provide job description.	Ref. #1, Sec. 3.6.1 pp. 1-32
4. Training provides management with added refinement in determining candidate qualification. It can: a. Reveal employee's special abilities or lack of same. (1) Memory (2) Initiative (3) Enthusiasm for job (4) Ability to get along with others.	

	REFERENCES
b. Close observation by training staff allows for screening out those who are obviously not suited. In the training sessions the instructors can often detect a lack of initiative, an inability to work with others, over-aggressiveness, poor grammar, diction, and ability to express ideas. (Instructor: question class about employment procedures and what qualities the usual detection process can reveal.) (1) Employment procedures in many instances are not designed to disclose candidate abilities. (2) Stress situations will often bring out the true measure of the employee (some training directors plan stress situations in order to observe student reaction). The instructors may do this by inserting obviously difficult questions into the class or by playing the role of the "devil's advocate" to determine how the student reacts.	

	REFERENCES
(a) Role playing within the class can also aid in measuring the student's abilities. A classic example of this in PMVI is the situation with which the station supervisor is often confronted. The citizen who complains about the inspection process in general, then about a particular inspecting station, a specific inspector-mechanic, and finally about an inspection item within the inspection standards.	
(3) Traits which can be detected by training personnel must be carefully considered before final judgment is rendered. Examples:	
(a) Laziness may be due to temporary illness.	
(b) An apparently sharp individual may be, for the moment, in a field where he has had ample opportunity for experience and learning.	

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	REFERENCES
(c) The caution here is for training personnel to compare notes, make sound evaluations.	
5. Training provides orientation for the employees.	
a. The employee performs better when he understands his organization; the objectives; its regulations; what is expected of him; what he can expect from others; etc.	
b. The employee develops confidence in his ability to do the job -- to perform.	
6. Training can provide clues for identifying employees who may display qualities desirable in higher positions, or in other positions within the organization.	
a. The Director of Training, and other training personnel, are constantly on the alert for outstanding students.	
7. Training can provide service to employee who is changing to a different job.	
a. In motor vehicle inspection many of the new station supervisors may be men whose work experience was not in the inspection field.	

	REFERENCES
b. Obviously these new supervisors must be "brought up" to an acceptable level of understanding of their jobs and all facets of same.	
8. Training plays an important role in providing education for men who are "moving up" within the organization.	
a. Supervisory and management training.	
b. Involves not only the technical aspects of the job but attitude changes.	
c. Recognition of added responsibilities and added authority.	
9. An analysis of merit ratings can identify areas in which personnel need improvement. Training may be able to meet this need.	
10. Training provides a principal source of "upgrading" of personnel in order that the individual's rating may be better.	
a. If an individual improves as a result of training - education, it strengthens his belief in the system.	
b. His job is better understood, easier to perform and more satisfying.	

20529

	REFERENCES
11. Training serves as an example of personnel management policies of the department in operation.	
a. Well operated school involves good management; indicates management's interest in employee welfare.	
VI. TYPES OF TRAINING (To Provide Training for PMVI)	
A. Basic Training Considerations	Ref. #2, pp. 16-33
1. In most situations the motor vehicle inspection program would not be of sufficient size to justify a basic training school of its own.	
2. The training that is needed by station supervisors is very similar in many respects to that needed by law enforcement officers. This is especially true of such areas as report writing, case preparation, rules of evidence, investigative techniques, etc. Therefore, the administrator should take advantage of the training program of the state police or highway patrol.	
a. However, the administrator should not consider this training sufficient. He must include additional in-depth instruction on the inspection rules, procedures,	

	REFERENCES
testing of equipment, etc.	
3. The availability of training elsewhere:	
a. American Association of Motor Vehicle Administrators training.	
b. Regional training seminars.	
c. Training conducted by the parent organization. Examples: the Department of Transportation, a Department of Public Safety; - have an academy and all training is conducted there.	
d. In PMVI the manufacturers of testing equipment can provide training.	
e. The automobile manufacturers should not be overlooked as a source of specialized training on functions of component parts.	
4. Course content is an obvious management consideration. Management must consider what is essential; what would be needed for improvement beyond basic needs; and what is needed for the future.	
5. The time available to be allocated to PMVI, if in a course being conducted for personnel	

	REFERENCES
whose first assignment may not be in PMVI, as an example:in state police academies the PMVI function is a part of the total job responsibilities, and limited time on teaching this subject may be assigned. If the new employee is to go directly into PMVI, then greater time should be allocated to his training.	
6. Staff and assistance available are important in establishing recruit training programs.	
7. Budget money and facilities are essentially a management consideration in establishing any type training.	
8. Delegating responsibility for the training is a consideration. Must be done before almost any other consideration, in order that coordination and planning can proceed in an orderly fashion.	
9. Selection of program type is a consideration. a. Number of hours and days in classroom. b. Classroom vs field time vs combination of same in order to best prepare the student.	

Case of the Cluttered Corner. 10 min., 16 mm., sd., b & w, 1958. Associated Films, Inc., 347 Madison Avenue, New York 10017.
Summary: Broken leg leads to finding out how and why the corner got cluttered.

Cause and Effect. 15 min., 35 mm., film strip, sd., b & w, 1957. Zurich Insurance Company, 111 West Jackson Blvd., Chicago 60604.
Summary: Typical occupational accident prevention.

Close Shaves. 15 min., 35 mm., film strip, sd., b & w, Zurich Insurance Co., 111 West Jackson Blvd., Chicago 60604.
Summary: Near accidents are warnings of danger.

Communication for Safety Series. (4 films). National Safety Council, 425 North Michigan Avenue, Chicago, 60611.
No. 1. *Let's Talk About Safety.* 10 min., 16 mm., sd., b & w, 1959.
Summary: Talking about safety can be a helpful habit.
No. 2. *Take a Talkie–Brief.* 10 min., 16 mm., sd., b & w, 1959.
Summary: Ten minutes a day devoted to safety talks.
No. 3. *Setting 'Em Straight.* 10 min., 16 mm., sd., b & w, 1959.
Summary: How to correct worker's unsafe habits without causing hurt feelings.
No. 4. *Let Everybody Help.* 10 min., 16 mm., sd., b & w, 1959.
Summary: Cooperation comes when workers know their ideas are wanted.

Current Facts. 22 min., 35 mm., film strip, sd., 1961. Liberty Mutual Insurance Co., 175 Berkeley Street, Boston, Mass. 02117.
Summary: Causes of electric shock accidents from cords, appartus, and portable devices.

Don't Take Chances. 13½ min., 16 mm., sd., color, 1963. International Film Bureau, Inc., 332 South Michigan Avenue, Chicago 60604.
Summary: Dramatization of the fatal result of chance taking.

Easy Does It. 15 min., 35 mm., film strip, sd., b & w, 1951. Zurich Insurance Company, 111 West Jackson Blvd., Chicago 60604.
Summary: Handling materials–includes a photo quiz.

Electricity–Principles of Safety. 11 min., 16 mm., sd., color, 1960. Coronet Instructional Films, 65 East South Water Street, Chicago 60601.
Summary: Points out common hazards of electricity and their causes.

Everybody's Job. 15 min., 35 mm., film strip, sd., b & w, 1953. Zurich Insurance Co., 111 West Jackson Blvd., Chicago 60604.
Summary: How a safety committee works.

Falls. 5 min., 16 mm., sd., b & w, Contemporary Films, Inc., 267 West 25th Street, New York 10001.
Summary: Spotlights most common cause of industrial falls.

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	REFERENCES
c. In the recruit or beginner class the degree of training, the number of hours, the practical training versus classroom training will be based on the exact position the new employee will fill. It is generally assumed that the beginner will have to understand how to use inspection equipment, what it can do, and cannot do; the reasons for inspecting the component parts; the use and functions of calibrating equipment. He should be given practical field experience in: (1) Inspecting vehicles. (2) Inspecting the work of inspector-mechanics and inspection station operations. (3) In general those things departmental experience indicated are essential for an employee who is just entering the department's service. Future training can be handled at the in-service level.	

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10. Is basic training to be followed by probationary period? The degree to which you go to determine qualities of beginner will be affected by whether or not you can eliminate him if he proved unworthy during the earliest period of his employment. a. In those departments that operate under a system which allows the administrator to place a man on probation for a specified period of time after his initial employment, the administrator has an opportunity to review the man's abilities, and if he doesn't measure up, he can be eliminated. b. In those agencies where the employee enters the department with tenure immediately after the completion of the recruit school, the administrator must ascertain as best he can whether the new employee is going to be satisfactory. Therefore, the training must provide a deeper insight into the man's abilities and future potential.	

	REFERENCES
B. Regularly Scheduled Refresher Courses: 1. Refresher courses scheduled well in advance to provide management with an opportunity to communicate ideas, new programs, changing objectives, etc. a. Especially important in PMVI because of changing legislation, revision of rules, court opinions, etc. b. Supervisors must be equipped with the latest information and understand the reasons for any changes in rules. 2. Should provide increased uniformity of operation. 3. Provides for upgrading in areas of deficiency. 4. Identifies new policies, procedures and techniques. 5. Problems of conducting annual refresher courses are: a. Decentralization of PMVI personnel creates expense in assembling students. b. Continuity of instruction and instructors may be difficult if a number of sessions are planned.	

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	REFERENCES
c. If sessions are planned in which all personnel attend at one time, then station supervision and field operations come to a halt.	
d. Payment for time spent in training, if student attends night sessions, etc. If overtime must be paid for special sessions, then budgetary considerations arise.	
e. Keeping all levels of management informed on exactly what is covered and how covered in the in-service school. (1) Often after an in-service school, line management finds that changes in procedures have been made without their superior's being informed.	
f. Preparing meaningful agendas for discussion.	
g. Nothing kills the quality of in-service training quicker than the presentation of material over and over again. The material must be of sufficient importance to warrant in-service training or none should be held.	

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	REFERENCES
C. Continuous In-service Training: 1. Is not practical for decentralized operations such as occurs in PMVI. 2. Would have merit if personnel were within easy commuting distance of training source.	
D. Continuous Training via Training Bulletins: 1. Training bulletins are particularly well suited for inspection training. Employees are decentralized and hard to reach for brief periods of instruction. The bulletin can also serve the dual purpose of an in-house training device and at the same time provide information to inspection stations and mechanics. a. The preparation and publication of meaningful training bulletins requires considerable effort. The material must be meaningful and deal with operations where added information is needed. This added information need is determined by the departmental "feed-back" system, i.e., inspection, activity reports, staff discussions, supervisory reporting, analysis of performance through direct supervision and through study of trends, etc. The	20537

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reader of such bulletins will ignore the material if it constantly deals in trite subjects for which there is little need for clarification.	
b. They are a good tool when standard format is used in presenting information. Often bulletins are, or become, policy (rules and/or regulations). A bulletin, per se, should never become a policy, or a rule, unless it is so identified and then it should be taken out of the classification of a bulletin and written in the format the department uses for whatever it is to be, i.e., policy, rule or procedure.	
c. The principal purpose is to inform, but when the information is no longer valid then procedures are necessary to see that changes or cancellations occur. (An example of a good training bulletin, prepared by the state of Oklahoma, is attached).	
d. Generally such bulletins are considered to be "how-to-do" information, but can well be used to keep employees informed.	

	REFERENCES
E. Coach-pupil Method of Training: 1. Because of the relatively small number of new station supervisors entering the program at any one time, an effective training technique is to assign a new station supervisor with a field supervisor. a. Provides supplement to formal training. b. Gives student immediate re-enforcement of learning process by reason of coach's guidance. 2. The selection of personnel to act as coach often has a salutary effect on the man selected, (the field supervisor). He will often improve his own performance in order to coach his new pupil. He may thrive on recognition. He teaches, observes, discusses and counsels. On the opposite side of the coin a man selected as a coach who is disgruntled, or not motivated to improve his pupil will do little to improve the pupil. There is need, therefore, for close supervision of the coach-pupil process to determine whether or not the coach is, in fact, doing what he is assigned to do.	

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3. Coach evaluates and reports on his pupil. Provides good "feed-back" on other training and allows management to decide whether to retain pupil in the job for which he has been selected. The coach should be reporting the student's ability to do the job.	
4. The time element for the coach-pupil status will be related to the amount of previous training and experience the pupil has. Too often the time element is only related to how badly the organization needs a "warm body" in a job.	
a. A rejection of a pupil after two months training can leave a position open until another man is trained and ready to go. If the need is critical the pupil may be approved, although not qualified.	
F. The Training Conference as a Training Technique.	
1. This technique has particular application to the training of inspector-mechanics by the station supervisor. In cases where this technique is used the administrator should provide the station supervisor with written	

	REFERENCES
guidelines on how the training should be conducted. (Sample from Louisiana attached.) This will greatly aid the station supervisor and help to insure uniformity of instruction throughout the state.	
2. The training conference also can work well as a supervisory personnel training technique.	
a. Allows for exchange of views.	
b. Analysis of procedures and concepts.	
c. Stimulates thinking.	
d. Creates awareness of similarities and/or differences in problems, etc.	
e. Instills sense of participation for source of new information and experience.	
3. Group size should be limited to a maximum of 25 men.	
4. Requires skill in discussion leading.	
5. Objectives of the training conference:	
a. Provide inspiration; to engender enthusiasm.	

	REFERENCES
b. To exchange experiences and thusly add new information for participants.	
c. To conduct problem solving sessions; adds expertise to the staff; provides management with insight into problem areas that they may have missed.	
G. Other types of training:	
1. Pre-promotional	
a. Preparatory training for men eligible for promotion.	
b. May include men from a civil service eligibility list; men who have the necessary senority; proven ability, etc.	
c. The question of who attends and who is not permitted to attend can be a morale factor in a department. The personnel of the department should have a clear understanding of the eligibility for pre-promotional training, i.e., in the cases of civil service list there may be an inclusion of the top men on the list and exclusion of others lower on the list.	

Falls Are No Fun. 10 min., 16 mm., sd., b & w, 1957. Associated Films, Inc., 347 Madison Avenue, New York, 10017.
Summary: Cartoon treatment of situations resulting in falls.

First Aid. 29 min., 16 mm., sd., b & w, American Red Cross, 615 North Asaph Street, Alexandra, Va., 22314 or inquire of local chapter.
Summary: Basic life-saving and related skills taught in revised standard first aid course of American Red Cross.

The Guy Behind Your Back. 20 min., 35 mm. filmstrip., sd., b & w, 1953. Air Reduction Sales Co., 60 East 42nd Street, New York 10017.
Summary: The fundamental approach to safety for operators of oxyacetylene welding and cutting equipment. Cartoon style.

Heads You Win. 15 min., 35 mm. filmstrip, sd., b & w, 1954. Zurich Insurance Company, 111 West Jackson Blvd., Chicago 60604.
Summary: Safety in the small shop.

Here's How. 15 min., 35 mm. film strip, sd., b & w, 1950. Zurich Insurance Company, 111 West Jackson Blvd., Chicago 60604.
Summary: Shows how to do various industrial jobs safely and efficiently.

How to Avoid Muscle Strains. 15 min., 16 mm., sd., b & w, Bray Studies, Inc., 729 Seventh Avenue, New York 10019.
Summary: For industrial, school and general public. Basics of lifting and handling for prevention of back and muscular injury.

How to Have an Accident at Work. 8 min., 16 mm., sd., color, 1960. Walt Disney Productions, 16 mm Film Division, 350 S. Buena Vista, Burbank, Calif. or 545 Cedar Lane, Teaneck, N.J.
Summary: Donald Duck disregards all rules on the job and blames fate for his troubles.

Human Factors in Safety. (series of 4). 10 min. each, 16 mm., sd., color, and b & w. National Safety Council, 425 North Michigan Avenue, Chicago, 60611, 1965.
Summary: Teaches fundamental concepts of human behavior as related to accidents.

The Key Man Series. (4 films) Associated Films, Inc., 347 Madison Avenue, New York 10017.
No. 1. *Point of No Return.* 10 min., 16 mm., sd., b & w, 1961.
Summary: Study of consequences of an accident.
No. 2. *You're the Key Man.* 10 min., 16 mm., sd., b & w, 1961.
Summary: Decisions and attitudes of foreman can result in greater safety consciousness in workers.
No. 3. *It's the Little Things that Count.* 10 min., 16 mm., sd., b & w, 1961.
Summary: Editor of plant magazine finds out who was most responsible for the winning of top safety award.
No. 4. *People are the Puzzle.* 10 min., 16 mm., sd., b & w, 1961.
Summary: Knowing your people is the key to accident prevention.

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	REFERENCES
(1) If civil service lists are not a factor in the selection/exclusion process, it may be based on an employee evaluation system or "senority" although senority, per se, is not a valid reason for promotion.	
(2) If the number of men for pre-promotional training is small it might be wise (morale-wise) to include all men in the training who are eligible for promotion.	
d. Pre-promotional training giv es management a final opportunity for evaluating eligible personnel before promotion, for in this training situation management can again evaluate the individual.	
2. Post-promotional training	
a. Management's opportunity to see that new station supervisors, field supervisors, or staff personnel are adequately trained to meet the demands of their new position.	
b. Course content can, in part, be determined by an analysis of past performances	

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	REFERENCES
of new supervisors. In PMVI, with a wide decentralization of personnel, personal responsibility must be stressed.	
3. Supervisory training - training for men in the supervisory capacity, but who are not necessarily newly promoted supervisors.	
a. Periodic retraining tends to keep the supervisor alert to his job responsibilities and should improve his operations.	
b. The supervisor is the link between operations and management. The time and effort expended in improving supervision will "pay off" in improved operations at the operational level and a smoothing out of management problems as the supervisor gets management's desires implemented at the operational level.	
4. Command training - headquarters staff level training.	
5. Management level training	
a. For personnel who have potential for upward movement into managerial positions.	

	REFERENCES
6. Technical training, both within and outside the department. a. In PMVI, automotive mechanics would be an example. b. Functions of inspection equipment. c. Complete understanding of motor vehicle standards.	

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REFERENCES

1. Management Manual for Motor Vehicle Inspection. Insurance Institute for Highway Safety, Washington, D. C. 20037

2. American Society for Training and Development. Training and Development Handbook, New York: McGraw-Hill Book Co., 1967

3. Bennet, C. L., Defining the Manager's Job, New York: American Management Association, Inc. 1958

SUBJECT: PLANNING - A FUNCTION OF MANAGEMENT

HOURS: 12

OBJECTIVES: To develop a student's understanding of the need for planning; of levels and types of plans; of steps in the planning process. To identify factors which influence the reliability of planning.

METHODS OF INSTRUCTION: Recommended instructional procedure includes project work in developing a plan. Principal instructional method is lecture presentation.

In this presentation special emphasis needs to be placed on the project work in order to get the student involved in the actual processes of planning. Classroom projects or assignments outside the classroom should provide the student with the dual opportunity of preparing plans as well as developing work that has value in broadening his ability to administer or supervise periodic motor vehicle inspection.

Suggested areas of assignment of project work may include planning for:

1. Changing from once a year inspection program to a six months program.

2. The addition of added inspection requirements, i.e., component parts to be inspected.

3. Presentation of a program to the legislature for the purpose of restoring certain elements of the program which have been lost.

4. Future needs of the inspection program based on anticipated growth and/or legislative or administrative action.

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INSTRUCTOR'S GUIDE

(PLANNING - A FUNCTION OF MANAGEMENT)

I. INTRODUCTION

A. Purpose of this session

1. Planning is an essential element of all phases of administration and at all levels of operation within an organization. The primary differences in planning that exist from one level of management to another are those of scope and time.

2. The student should develop an understanding of the necessities of planning and how the successful accomplishment of an organization's objectives are inter-related to that organization's ability to plan for contingencies, both short-term and long-range in scope.

3. Planning occurs at all levels in an organization. These levels may be defined as administrative, supervisory and operational.

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	REFERENCES
II. PRESENTATION (Planning position in management)	
A. Definition of planning	Ref. #5, pp. 15-81
1. Planning is basically deciding in advance what is to be done and how it is to be done. A plan is a projected course of action.	
2. Planning involves ends and means -- ends inevitably involve values (results).	
a. Means involve resources and availability of personnel.	
3. Normally involves at least these considerations:	
a. Awareness of an action needed.	
b. Investigation of those factors which have or will create the need and an analysis of action and alternatives to meet the needs.	
c. A proposal for action.	
d. A final decision.	
B. Relationship of plans to other activities of management.	Ref. #5, pp. 15-17
1. Plans and planning are an integral part of all activities of management.	

	REFERENCES
a. The separation of the planning function into a separate unit still does not eliminate the necessity of all units of the operation from participation. (Charts or slides showing organizational structure where (1) planning section is a separate unit, and (2) where it is a part of each operation.)	
b. Staff personnel must provide statistics, information, judgments. (Consulting service to the planning section.)	
c. Suggest techniques.	
2. In a successful operation, planning must be a continuing activity.	
a. Operational overview is a responsibility of planning. Once a plan is implemented and a program on-going, future needs then need reviewing.	
(1) In PMVI it can be expected that vehicle design change will create need for constant re-evaluation of inspection procedures and/or addition or deletion of component parts inspection. (Example: change in front	

	REFERENCES
end suspension could require major change in techniques; elimination of internal combustion engine to affect exhaust emission control, etc.)	
C. Kinds of plans needed	
1. The plans designed to accomplish major goals and/or objectives of the PMVI program. (The implementation of policy.)	
a. Examples: Safe motor vehicle equipment on the highways as an objective.	
b. Efficient, effective operation of the PMVI program as a whole.	
c. The implementation of a major change in inspecting techniques.	
2. Single use plans (non-repetitive type function).	
a. May be used to accomplish major goals; often are more clearly related to the accomplishment of a single facet of operation. Examples:	
(1) A plan for adopting a new technique.	
(2) A change in or adoption of new equipment.	

Lucky. 18½ min., 16 mm., sd., color, 1959. Union Carbide Nuclear Co., P.O. Box 1410, Paducah, Ky. 42202.
Summary: Shows how attitudes can affect worker and his job.

Matter of Degree. 13 min., 35 mm. film strip, sd., color, 1957. Crown Zellerbach Corporation, One Bush Street, San Francisco 94119.
Summary: Outlines program for prevention of employer accidents.

Mind Your Back. 13¼ min., 16 mm., sd., color, 1965. Australian News and Information Bureau, 636 Fifth Avenue, New York 10020.
Summary: Demonstrates right and wrong methods of lifting/handling objects.

Painting Safely. 22 min., 35 mm. film strip, sd., color, 1958. California State Compensation Insurance Fund, 525 Golden Gate Avenue, San Francisco 94101.
Summary: Teaches safe practices in the painting trade.

Safety for Sure. 11 min., 16 mm., sd., b & w, U.S. Department of Agriculture, Motion Picture Service, Washington, D.C. 20250 or loan from nearest U.S. Forest Service Office.
Summary: Presents four key points to be taught on any job.

Safety in the Shop. 10 min., 16 mm., sd., b & w, Mogul's, 112 West 48th Street, New York 10019.
Summary: Emphasizes the supervisor's responsibility in teaching and maintaining safe practices.

Safety Management Films Series. (8 films) each: 10 min., 16 mm., sd., b & w, 1963. National Safety Council, 425 North Michigan Avenue, Chicago 60611.
Summary: Series deals with several elements of safety management for supervisors and foremen.

No. 1. *Run the Team*
No. 2. *Plan for Prevention*
No. 3. *Let Them Know*
No. 4. *Mind over Matter*
No. 5. *Safety is in Order*
No. 6. *Bare Minimum*
No. 7. *Guard Duty*
No. 8. *Sell Safety*

School Shop Safety. 14¾ min., 16 mm., sd., color, 1968. Film Associates, 11559 Santa Monica Blvd., Los Angeles 90025.
Summary: Covers the problem of developing safety consciousness in the industrial arts shop.

Shadow of Doubt. 5 min., 16 mm., sd., color, 1965. Pacific Telephone, Room 507, 620 C Street, San Diego, Calif.
Summary: Covers supervisors role in preventing accidents.

So You're New Around Here. 10 min., 16 mm., sd., b & w, 1955. Associated Films, Inc., 347 Madison Avenue, New York 10017.
Summary: Indoctrination of new employees in safe shop.

Stop, Look and Beware. 15 min., 35 mm. film strip, sd., b & w, 1951. Zurich Insurance Co., 111 West Jackson Blvd., Chicago 60604.
Summary: The importance of observing warning signs.

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	REFERENCES
3. Plans for routine activities (repetitive operations).	
a. Plans of this type should end up in a procedural type manual or file, in order that there is an understanding of action intended, how to implement it and carry it through.	
b. By placing routine operations in a procedural manual, an organized body of information about PMVI, or any operation, is collected and published so it is at the fingertips of any person within the organization needing it.	
D. Executive must decide: (involves)	
1. What type of plan to be used, to be most useful. (How he will plan.)	Ref. #4, Sec. 6
2. How far will it pay to go in preparing plan. (Cost of planning as benefit to be accrued).	Ref. #4, Sec. 6.21
3. Procedures to be followed in making decisions.	
a. Staff conferences. (Considerations: manpower available; budget considerations.)	
b. Individual staff review of plan. (Importance of objective of plan to	

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overall objective of the PMVI program.)	
c. Operational level - field supervision concurrence and inputs.	
d. Means available to determine accomplishment of plan objectives.	
III. PLANNING FOR GOALS OR OBJECTIVES (First type of plan).	
A. Levels of planning	
1. In state PMVI operations there are at least three levels at which planning takes place. They are:	
a. The administrative level - at this level major programs are planned; plans which normally are concerned with the overall operations of the department.	
b. The supervisory level - plans at this level generally involve the implementation of procedures that are handed down from the administrator of PMVI. At this level planning may involve such things as improving existing operations; getting better performance through more efficient use of manpower and equipment.	

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c. The operational level - in PMVI the operational level planning involves the day-to-day performance of the inspection task. Scheduling of manpower, preventitive maintenance of equipment, distribution of reporting falls, etc., fall within this classification.	
B. Necessity for setting up objectives.	
1. Planning must be directed toward stated and understood goals.	
a. In PMVI major goal is reduction of accidents through improvement in condition of vehicles.	Ref. #4, Sec. 1.2.1
b. Must decide what the end product will be.	Ref. #2 - All
2. In planning, the goals will vary with level for which plans are being developed.	
a. Overall objectives of organization is major goal.	
b. The improvement of a record system within PMVI in order to simplify and make the system more efficient is an important goal, but not at the same level as the overall objective.	

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	REFERENCES
c. Goals may be simple or complex, generally, depending on the level at which the plans are being developed and the complexities of the program or function being planned.	
C. Factors requiring consideration in setting up goals or objectives.	
1. Budget requirements and/or budget limitations.	
a. A major factor - administrator must consider sources of revenue and logical placement of expenditures to keep a balanced program.	
2. Time deadlines (time requirements to do each part. Critical path method).	
a. Critical path method will set up time estimates for completion of steps in the overall operational scheme of accomplishing the objectives of the plan. The critical path method, when used, then allows the administrator to know from day-to-day where his organization stands in completing the objective. (Ways of setting up critical path method charts differ, but the format is not as important as scheduling operations and	Ref. #1, pp. 21-22

	REFERENCES
then checking on progress through visually related references.)	
b. Generally there are time deadlines for each part.	Ref. #3 - All
(1) Often in PMVI major objectives are identified by legislation or by administrative procedures which identify what should be done by a specific time.	
(2) An example: The legislature passes a statute requiring that all vehicles be equipped with exhaust emission control devices one year after the passing of the legislation. This time designation then sets the limit for completion of development, testing, securing and installing proper testing equipment. To accomplish these objectives there must be established specific time deadlines for each phase, in order that the final time deadline is met. The use of a PERT or other charting method is recommended. With such	

	REFERENCES
a system the administrator can depict where a program stands and more readily determine the reasons for delay, if a delay occurs. c. The various function plans must be coordinated. Examples: (1) Record systems must be ready when inspection procedures start. (2) Equipment must be ready to meet deadline, and training in its use complete. (3) Procedures for inspection routine written and understood before inspection starts. d. Plans and time must allow for station supervisor, field supervisor and operational level personnel to "tool up" for the objective of the plan. 3. In planning objectives there must be recognition of reasonable delays. a. Coordination with other agencies within state government takes time, i.e., a plan and operation that requires that	

	REFERENCES
a vehicle be inspected prior to registration which is being newly implemented would require adequate time for detailed planning on records, forms to be used, training of vehicle inspection personnel and, possibly, tax personnel, etc. (A plan which requires hasty implementation will often disclose glaring difficulties because of lack of coordination.)	
b. Some planning cannot be completed until certain milestones are passed. Examples:	
(1) Legislature decrees that there will be PMVI. Later budget appropriations are made, administrator may find limitations will preclude performing some action he had anticipated.	
(2) Decision to start state-owned inspection operations. Administrator cannot plan buildings, personnel and total budget needs until he determines equipment needs, cost and space requirements, etc.	

	REFERENCES
4. In setting objectives there must be consideration of performance levels or standards to be expected. What can you reasonably expect to do? Other commitments must also be considered. a. Availability of resources and potential resources important. (Manpower, money). b. Reasonable (attainment) goals essential. c. Priorities for performance. (In what order and how do all factors affect this?) d. There will be an adverse effect on quality and possibly quantity if these limitations are not considered. e. Public acceptance can force a major revision in some operations. (1) Example to illustrate this point can be found in a number of states where the administration developed well designed PMVI programs and had to "back off" because of pressures. (Missouri; Oklahoma; North Carolina; Arizona).	

	REFERENCES
D. Planning for objectives is broadest at the top and becomes narrower in scope and more specific at each subordinate layer. 1. Administrator plans overall program. 2. Field supervisor plans to implement administrator's program as it relates to operations, line or staff function. (Each level is vital to the accomplishment of the end result.) 3. Station supervisor plans routine procedures to meet specific supervision requirement. (Each subordinate level plans to implement or carry on his phase of the overall program.)	
E. Benefits from the use of objectives or goals in planning. 1. There can be no real planning if final objectives are not well identified. 2. Planning is easier and more purposeful when "end product" is identified and attainable. 3. Much unproductive work can be avoided as unrelated goals or unreachable or impractical objectives are eliminated. 4. The goals or objectives of each level of planning are directed toward and in support	Ref. #5, pp. 72-73

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	REFERENCES
of the ultimate goal or objective which is a safer highway transportation system.	
a. The success of the PMVI program is based on a fine balancing of proper planning and performance at each level of operations. (See attached drawing depicting this balance.)	
5. The establishment of goals serves in direction and control.	
6. The establishment of goals are important to employee motivation and morale.	
IV. SINGLE USE PLANS (Second type)	Ref. #5, pp. 30-40
A. A course of action to fit a special situation which may be non-recurring, but may be applicable for more than one use.	
B. Uses of single use plans.	
1. Setting up major programs.	
a. Parts of a single use plan of this type may become, in fact, operational policies or procedures, but the plan as a whole is intended only to develop a program. Example: Planning for the adoption of the Diagnostic Center	

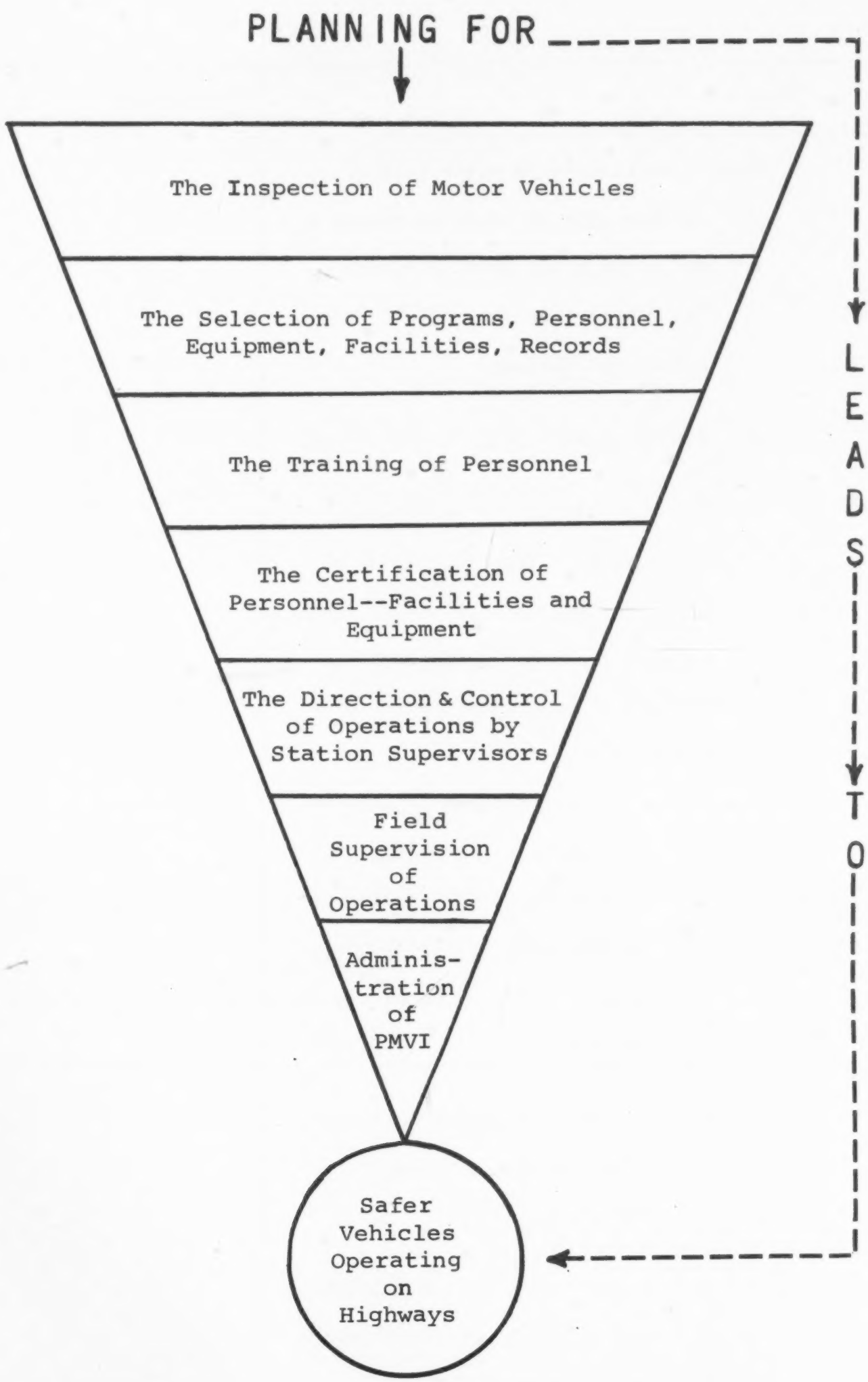
PLANNING FOR
The Inspection of Motor Vehicles
The Selection of Programs, Personnel, Equipment, Facilities, Records
The Training of Personnel
The Certification of Personnel--Facilities and Equipment
The Direction & Control of Operations by Station Supervisors
Field Supervision of Operations
Adminis-tration of PMVI
Safer Vehicles Operating on Highways
LEADS TO

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	REFERENCES
Inspection concept in major cities. (1) Planner sets up steps or stages by which the goals will be reached. The PERT or Critical Path techniques are useful systems. (2) Timing of each step is identified. (3) Planner attempts to anticipate bottlenecks. (Bottleneck may be the location and cost of training as well as selection or maybe a failure of supplier to provide equipment.) (a) Example: Problem of selecting and training employees, with consideration of salaries to be commanded by skilled personnel needed to operate such equipment. (b) Possible need to develop public understanding and support for the new system. (c) Prepare arguments to counteract political pressures which may be brought to bear.	

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	REFERENCES
(d) Anticipate pressures and prepare to deal with them from the present "in" group who are doing inspection.	
b. A proper major single use plan will include plans for coordinating with whatever other organizations or functions are involved:	
(1) Budgetary considerations.	
(2) Record keeping.	
(3) Supervision or administrative problems which may be factors.	
2. A second type of single use plan (planning for projects.)	
a. Not as broad as major plans, but deals with a one-time, non-repetitive program which may call for some special study: such as a study to determine training needs; to analyze the success or failure of a special inspection technique; or to do a cost study on a procedure.	
b. May include planning for special programs. Research activities will often call for	

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some special information gathering, or setting up control groups, etc.	
3. The third type of single use plan (for detail planning).	
a. Such plans are used when special operations are needed in carrying out portions of a major program. The element of timing of each special operation becomes a factor and detail planning will include the time factors involved in each detail to be carried out.	
(1) Example: In arranging to set up and test a new type of inspection equipment subsequent to purchasing same, or authorizing the equipment's use in the state. Detail planning for each phase of the test and the timing of each phase are important. Considerations in this example are: securing test sites; securing and setting up equipment; conducting test; releasing equipment. (See (b) below).	
b. Can be used in picturing every step in a series of operations which are	

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contemplated, but which may only be a "one-time" operation. (1) There are limits on this series of steps, based on how well you can predict or forecast future events and the end result of each step in the series. C. Benefits of single use plans. 1. Integrated and purposeful action more readily achieved when total actions are considered in advance. Review of actions anticipated can disclose possible points of conflict, or need for coordination, etc. 2. Crisis and delays can be avoided as planning will reveal weaknesses, and remedies can be applied before the fact rather than after the fact. 3. More efficient and practical methods can be developed, replacing customary or old "we always did it this way" methods, if such replacement proves to be warranted. 4. Delegation of authority and general control of the operation is improved by allocating	

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time for needed communications. a. Explanation and clarification being made in advance of actual implementation. 5. Such planning provides guidelines for future planning, for as the plan is implemented the weaknesses and/or strengths in planning are revealed. V. THIRD TYPE OF PLAN - Plans for routine operations - often called Standard Operating Procedures (S.O.P.) also include repetitive use plans and plans for emergencies. (A well organized operation will have a set of written procedures for repetitive operations.) A. S.O.P. defined - using the same decision over and over again in guiding actions. 1. Such plans establish uniformity of action where more than one department or section are performing an operation. 2. Establishes a "normal" pattern of action. Planner can then concentrate on only those phases within the plan that need changing as a need develops. 3. S.O.P.'s have essential application in three main areas: (These three to be	

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discussed more fully in this text.) a. Developing and maintaining policy. b. Establishing and maintaining uniform operating procedures (S.O.P.). c. Ascertaining and prescribing best methods and/or techniques. B. Policies 1. Definition - a general plan of action which guides members of the enterprise in the conduct of its operation. Policies should be designed so that they do not constrict action adversely. They should not be so arbitrary as to leave no room for personal judgment to operate. 2. Policies are needed to: a. Provide uniformity of action. b. Relieve executive or his subordinate from constant decision-making. (1) The danger here is that neither the executive or his subordinate will look for or recognize need for change. May even resent change because of long established use of an S.O.P. or policy.	

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c. Policy is likened to a highway; the motor vehicle operator has considerable latitude in traveling over the highway toward his objective. The same operator, however, may be restricted by certain basic laws (rules) as to his driving behavior. These rules do not limit the operator from reaching his objective, but they do limit his manner of doing so. Finally, policy states an objective, and this statement of objective should keep the personnel in the PMVI organization aware of the direction which the program should be going to meet that objective.	
C. Standard Operating Procedures (most state manuals on PMVI are made up of S.O.P.'s).	
1. Definition: an approved step-by-step detailed delineation of process in handling or dealing with a certain operation or procedure.	
a. S.O.P.'s are usually spelled out. Generally quite detailed.	
b. An S.O.P. is distinguished from policy or broader planning concept in that the	

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detailed instructions do limit actions or decisions necessary. (1) In good administration, review of S.O.P.'s are routinely done. In addition, employees are encouraged to analyze and recommend changes. 2. Benefits from S.O.P. a. Should assure that all essential things are accomplished at right time, place, in correct order, in uniform manner. b. Less direct supervision and direction will be needed. c. May have a direct relationship to the amount of training which is needed. (1) Specifics are more clearly set forth. Steps in procedures identified, and end objective stated. d. Speeds up performance by establishing well designed routines which eliminate wasted motions and which employ most efficient procedures.	

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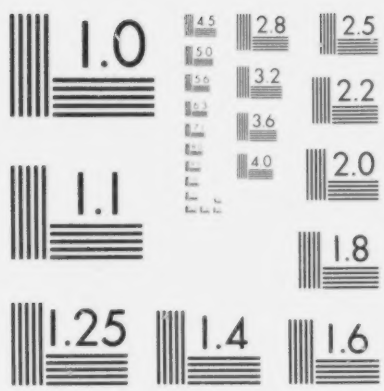

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

One to a Customer. 11 min., 16 mm., sd., b & w, 1955. Aetna Life Affiliated Co., 151 Farmington Avenue, Hartford, Conn. 06115.
Summary: Demonstrates how protective equipment should be used in a wide variety of jobs.

Safety Shoes, Postively our Most Neglected Article of Clothing. 22 min., 16 mm., sd., color. Lehigh Safety Shoe Company, Emmaus, Pa., 1965.
Summary: Satirical treatment of use of foot protection in industry.

Take Your Choice. 12½ min., 16 mm., sd., color, 1964. Detroit Society for the Prevention of Blindness, 51 W. Warren Avenue, Detroit, Mich. 48201.
Summary: Eye protection in high school chemistry laboratory.

Tools: Hand and Power

A New Approach to Saw Safety. 12 min., 16 mm., sd., color, 1958. Brett-Guard Corporation, 100 South Van Buren Street, Englewood, N.J. 07631.
Summary: Features sponsors see-through guard.

Design for Safety. 26 min., 16 mm., sd., b & w, 1952. U.S. Department of Labor, Bureau of Labor Standards, Washington, D.C.
Summary: Safety integrated in engineering courses. Deals with machine guarding and other safety materials.

Don't Drop your Guard. 10 min., 16mm., sd., b & w, 1951. Aetna Life Affiliated Cos., 151 Farmington Avenue, Hartford, Conn. 06115.
Summary: Demonstrates protection provided by different types of machine guards.

The Grinding Wheel. 20 min., 16 mm., sd., color, 1964. Norton Co., Publicity Department, Worcester, Mass. 01606.
Summary: Care, use, storage, and dressing procedures.

Grinding Wheel Safety. 20 min., 16 mm., sd., color. Norton Co., Publicity Department, Worcester, Mass. 01606.
Summary: Principal causes of wheel breakage. Need for proper guarding. Care and selection based on ASA standard safety code.

It Didn't Have to Happen. 14 min., 16 mm., sd., b & w, 1953. International Film Bureau, Inc. 332 South Michigan Avenue, Chicago 60604.
Summary: Careless or self-assured worker who scorns use of guards and safety devices on woodworking machines endangers life.

Lock and Tag. 23 min., 16 mm., sd., color, 1957. Calvin Company, 1105 Truman Road, Kansas City, Mo. 64106.
Summary: Dramatizes isolation of equipment being repaired.

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	REFERENCES
VI. LIMITATIONS TO PLANNING	
A. It is difficult to plan long-range programs when planner is unable to forecast accurately.	
1. Unanticipated change in vehicle design can negate an otherwise successful plan for carrying on inspection.	
2. Economics can alter budgetary "guesses".	
3. Political changes can make decided changes in programs in some jurisdictions.	
4. Inability to negotiate long-term contracts and leases affect economy of operation. (Some states have very short-term leasing ability.)	
5. A plan is only useful as long as the assumption on which it is based will prevail. (See items above.)	
6. Planner must predict on the basis of sound data, good analysis, consideration of all factors. He may need to propose alternatives when and if certain uncertain variables should occur, such as:	
a. Budget cuts.	
b. Legislated changes.	

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7. Planner may need to show ways to surmount problem areas for which there is the least degree of predictability.	
B. Planning is limited when there is little repetitive operation. This is not a problem in PMVI, for most operations, once organized, are highly repetitive.	
1. When establishing a procedure for an operation for which there is no past precedent, the planning is based on "best judgment" concepts. Example: In PMVI there might be an added inspection procedure for checking all vital chassis metals for fatigue using some type of advanced radiological instrumentation.	
2. Planner as in case above might have to borrow and/or analyze experiences from some related field. A related field in the case above might be the aircraft industry or the auto racing field.	
3. Being unable to forecast and having no previous experience points up the necessity for testing plans before final adoption.	
C. Status quo is a limitation to planning.	

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1. Reluctance to change is a psychological factor which permeates most organizations.	
2. Adoption and use of someone else's plans limits planning, too.	
3. The need to meet current demands for service can stifle a plan to increase service or change operations for fear that what is being done will be altered.	
4. Planning requires supervisory and administrative energy. An administrator that is complacent or satisfied with things as they are is not likely to plan to change and/or improve them.	
D. Planning costs money in manpower and time. The improvement in results may not warrant the cost of planning to make the change.	
1. Planner might, as an example, spend many hours in study of inspection station "layouts." He then proposes some minor rearrangement which may not materially affect the quality of the inspection. The cost of the planning would not warrant the time spent considering the benefits received from the change.	

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2. Cost is not always in money. It may show up in loss of use of equipment, manpower, services, or neglect of other needs.	
E. Time in which to plan is a deterrent to planning.	
1. Planning is time-consuming and organization must budget executive time and money to meet the needs.	
2. Deadlines to be met often do not allow time for planning.	
a. Assume that the legislature decrees that within 90 days the inspection section shall check speedometer calibration, which is a new program. The administrator is limited to planning and implementing a major change in much too little time.	
3. The lack of time calls attention to the need for having advanced planning for "eventualities" whenever there is any forseeable possibility of an emergency (eventuality). This may involve starting preliminary planning once a strong suggestion arises from an authoritative source that some changes may	

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be "in the wind".	
a. Legislative lobbyist often may give clues.	
b. A legislator's inquiry may give administrator a hint.	
c. Changes in neighboring states may presage a change in the "home" state.	
F. Limitation detailed planning may place on individual initiative.	
1. S.O.P.'s do restrict decision-making on a particular problem. There must be some administrative recognition of need for individual judgment in emergency situations.	
2. Planners should, where practical, get subordinate participation in formulation of plans in order that plan acceptance is better, and to make certain they have all the facts.	
VII. STEPS IN PLANNING	
A. Clarify the problem.	
1. What is anticipated? What is reason for needed change?	
2. What do you expect to accomplish?	

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B. Determine objective and identify key factors or reasons for selecting procedures designed to meet objectives. Consider alternatives.	
C. Analyze facts, sifting, combining and relating them to problem at hand. The planner at this stage must be critical, often almost negative in thinking, looking for all possible roadblocks.	
D. Decide on action to be taken, giving consideration to others who have an interest or concern in the plan and its operation.	
E. Arrange for execution of the plan. This involves the issuance of administrative orders and the development of time tables for performance.	

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REFERENCES

1. American Petroleum Institute, Periodic Motor Vehicle Inspection Programs - Part 2 - Organization Guidelines, New York, New York, 1968

2. Automotive Safety Foundation, A Fact-Gathering Guide to Assist States in Developing a Highway Safety Program - Chapter 8, Washington, D. C., 1968

3. Gunaris, E. Theodore, "Planning a Vehicle Inspection Program". Unpublished speech at AAMVA Vehicle Inspection Training Program in St. Louis, Missouri, August 1-3, 1967

4. Insurance Institute for Highway Safety, Management Manual for Motor Vehicle Inspection, Section 6, Washington, D.C., 1968

5. Newman, William H., Administrative Action, second edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1963

6. Reed, D. W., "Administrative Planning for Inspection Programs". Unpublished speech at AAMVA Vehicle Inspection Training Program in St. Louis, Missouri, August 1-3, 1967

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SUBJECT: DIRECTION - A FUNCTION OF MANAGEMENT

HOURS: 6

OBJECTIVE: To create an understanding of the function of directing and how the proper use of directives can aid in the administering of a motor vehicle inspection program.

METHODS OF INSTRUCTION: The primary method of instruction is lecture, supplemented by classroom projects and discussions. Students should be required to bring a copy of their organization's orders, rules, manuals, etc., which contain directives pertaining to vehicle inspection. This material should form the basis for classroom discussion and projects.

INSTRUCTOR'S GUIDE

(DIRECTION - A FUNCTION OF MANAGEMENT)

I. INTRODUCTION

A. Instruction should provide the student with understanding as to the role direction plays within a periodic motor vehicle inspection program. The student should be made aware that directives may be written or oral and that both types require planning and preparation.

The importance of a system of directives to the coordinated efforts of a vehicle inspection program should be emphasized to the students. It should also be emphasized that written policy which documents the mission and intent of the vehicle inspection agency should be the basis on which directives are formulated. The student should be made aware that directives not only refer to persons employed by the vehicle inspection agency, but also include people who are licensed to operate inspection stations, mechanics who are certified as inspectors, and the vehicle owner who is required to have his vehicle inspected.

Instruction should emphasize the need for uniform inspection procedures throughout the state if the program is to be successful. To accomplish this the administering agency must incorporate procedures which assist in achieving success rather than impede it.

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II. PRESENTATION A. What we mean by Direction 1. Directing is the process which is concerned with the way management issues instructions and otherwise indicates what is to be done. It is the continuous task of making decisions and implementing the decision through instructions. This task is extremely important to the success of a vehicle inspection program, for it embodies the function of guiding and controlling efforts, state-wide, toward hoped for goals. a. The term Directive as used in this unit of instruction refers to any and all types of instructions which require action on the part of the person or persons receiving such instructions. Webster's Seventh New Collegiate Dictionary defines Directive as "something that serves to direct, guide, and usually to impel toward an action, attainment or goal; an authoritative instrument issued by a high-level official body or competent official.	

Machines. 7 min., 16 mm., sd., b & w. Contemporary Films, Inc., 267 West 25th Street, New York 10001 or 614 Davis Street, Evanston, Ill. 60201.
Summary: Reconstructs the steps that led to fatal accident caused by carelessness and handling machinery.

Safe in Hand. 20 min., 35 mm. film strip, sd., b & w, 1946. Associated Films, Inc., 347 Madison Avenue, New York 10017.
Summary: How to pick and use right tool safely.

Safety Depends on You. 13½ min., 16 mm., sd., b & w or color, 1959. Public Service Films, Inc., 6626 Romain Street, Hollywood, Calif. 90038.
Summary: Covers all general hand tool safety precautions.

Sharp as a Razor. 15½ min., 16 mm., sd., b & w or color, 1959. Public Service Films, Inc., 6626 Romain Street, Hollywood, Calif. 90038.
Summary: Sharp cutting tools are safe when used properly.

Fire Prevention and Fire Safety

Extinguish that Fire. 25 min., 16 mm., sd., color, 1965. Los Angeles City Fire Department, 217 South Hill Street, Los Angeles, Calif.
Summary: Shows classes of fires and how to handle appropriate types of extinguishers.

Are You Sure. 14½ min., 16 mm., sd., color, 1962. Associated Films, Inc., 347 Madison Avenue, New York 10017 or regional office.
Summary: Fire employees think they caused serious industrial fires. Each reviews his careless acts.

Cause for Alarm. 13 min., 16 mm., sd., b & w, 1950. Associated Films, Inc., 347 Madison Avenue, New York 10017 or regional office.
Summary: What to do in case of fire.

Flammables Engineering. 26½ min., 16 mm., sd., color, 1960. The Protectoseal Company, 1920 South Western Avenue, Chicago 60608.
Summary: Flammable liquids and their use. Also fire prevention principles applied to handling.

Know Your Fire Extinguishers. 20½ min., 16 mm., sd., color, 1950. Factory Mutual Engineering Corporation, 1151 Boston-Providence Turnpike, Norwood, Mass. 02062.
Summary: Which extinguishers suitable for different types of fires.

Waterfog, Master of Fire. 37 min., 16 mm., sd., color, Rockwood Sprinkler Company, 38 Harlow Street, Worcester, Mass.
Summary: How waterfog controls flammable liquid and the principle and operation of equipment.

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2. The vehicle inspection agency should publish an administrative manual. This manual should contain sufficient guidelines and instructions so that each person involved in the program will know what is expected of him and how he is expected to function in his particular job capacity. This manual should be issued to all agency employees with management or supervisory responsibilities. In those jurisdictions where inspections are conducted by state-appointed stations, an appropriate manual should be published and issued to each station and to each certified mechanic-inspector. In those jurisdictions where inspections are conducted by state employees, each employee should be issued a manual. There must be a system of numbering or identifying each item in the manual in order that revisions, deletions and additions can be made easily and correctly. The format of this identifying system is not critical as long as the recipient of the material can identify its purpose and make the proper insertions,	

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deletions and/or changes of the material into the manual.	
3. Methods of distributing inspection directives and information:	
a. General orders - issued to announce adoption of/or revision of policy; to identify changes in organizational objectives; to set forth responsibilities of the levels of command within the organizational structure. It is not expected that General Orders would be subject to everyday changes, but be of a more permanent nature.	
b. Special orders - issued to announce policies or direct procedures concerning a specific circumstance or event. An example in PMVI could be found in setting up and conducting a special inspection program on a limited area basis to test a new type of equipment (dynamometer, as an example).	
Special orders can also be those that by their nature will not be applicable after	

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the subject to which they apply is no longer in existence, or needed. Example, in above paragraph, after the test of the dynamometer is completed the special orders no longer apply.	
c. Operational orders - orders designed to give detailed instructions on how to perform specific functions. These orders are found in all state inspection manuals where instructions are set forth for inspection of component parts of motor vehicles.	
d. Personnel orders - are concerned with the personnel function within the vehicle inspection agency. They cover the appointment of new personnel; the assignment or transfer of members from one unit to another; the promotion, demotion, suspension, dismissal and restoration to duty, and termination by resignation or retirement of a member of the organization.	

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e. Bulletins - may be issued for the following purposes: (1) To disseminate information or instructions which do not warrant a formal order. (2) To direct the actions of subordinates in specific situations or circumstances under a level of command not authorized to issue General or Special Orders. (In motor vehicle inspection a field supervisor may have information which interprets orders for station supervisors; such information may fall in the "bulletin" category. Such information must not deviate from or conflict with established policies and procedures as documented by higher authority.) (3) To inform members of actions or policies of other agencies.	
4. When it becomes necessary to issue a general or special order, responsibility for format and content of the order should be vested in	

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one of the staff officers of the organization. This responsibility should include the obligation to review previous orders to see that duplications and/or conflicts do not exist. Where practical such orders should be so written as to make them self-cancelling when their use is no longer applicable.	
a. The staff officer assigned this responsibility should maintain master files of all departmental orders. He should review all orders periodically to determine if they still represent management's thinking.	
B. Consideration before issuing Directives	
1. Direction defined:	
a. The essence of direction is assignment. Literally, direction consists of ordering someone to do something; to take an action; to cease an action; or combinations of both. The person ordered to perform may or may not be a subordinate, depending on the type of action which is to be taken.	
Direction in Motor Vehicle Inspection takes place, as an example, when the Administrator of the PMVI program tells his Field	

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Supervisors to assign more men to field vehicle spot checks; direction is at work when the Field Supervisor orders Station Supervisors to alter station inspection procedures. The same is true when the Station Supervisor advises a mechanic inspector to use a new inspection form. Regardless of the management level which initiates a directive, the initiator needs to make sure that he clearly understands the problem that brought about the need for it. He should then look at alternative procedures available to him and select the procedure that most effectively fits the particular situation.	
2. To be considered is whether or not the directive should be in writing. In arriving at this decision the initiator of the direction or directive must know the policy of his agency as to written and verbal directives. It may well be that agency policy will decide this question for him. If not, the initiator should consider the importance of the matter under consideration. Is the problem that caused the need for	

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this directive sufficiently important that written documentation may later be needed? Does the expense of putting the directive in writing outweigh the results of what is to be expected? As an example, the cost of writing and distribution of a directive calling for block printing on an inspection form far exceeds any monetary gain which could be expected from such a procedure. Is the person to whom this is directed the type that needs instructions in writing? Is this directive going to be repeated to many people at different times and locations? How complicated and/or technical is the subject matter of this directive? Does it make sense to put this particular directive in writing? These are the type of questions which should be considered when deciding if a directive should be written or oral. a. When deciding if a directive should be written or oral, it should be remembered that the success of a vehicle inspection program depends heavily on the honesty with which it is run and the acceptance of the program by the public. Because of	

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this, some directives should be in writing so that there can be no doubt as to the meaning contained therein. Also, written directives can be used as part of a public information program aimed at gaining public support for vehicle inspection by documenting the intent, procedures and administrative controls of the overall program.	

C. Characteristics of good directives

1. Directives, to be beneficial to the program, must contribute to making the procedure or policy effective. They must be complete enough to secure and maintain uniformity of action, but at the same time leave room for flexibility. They must seem reasonable to the person who is to carry out the direction. Considerations here are:

   a. Do the personnel involved here have the necessary ability and experience to carry it out? For example, it would be ridiculous to direct station supervisors to test headlight aiming equipment without first providing them the necessary

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training on how to conduct the testing.	
b. Do we have the necessary facilities and equipment to carry the directive out? This might be a consideration when deciding upon the type of an inspection program to be conducted and whether vehicles are to be inspected annually, semi-annually, etc.	
c. Can the quality of performance desired be achieved within the time stated? For example, in determining how frequently inspection stations will be contacted by station supervisors, the administrator must consider the number of stations to be inspected, the length of time needed per station, and their geographical dispersion.	
2. A directive must be clear and understandable to the person receiving it. To satisfy this characteristic, the initiator should place himself in the position of the person receiving the directive to see what questions he would ask about it.	

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a. If directives are written covering a complicated process, the administrator may consider first developing a sampling procedure in which a limited number of persons receive the directive. This group of persons then "live" with it to determine whether or not it meets the administrators proposed objectives for it. Constructive comments from this trial run can then be incorporated in the official directive which then is distributed throughout the organization.	
3. The system through which directives flow should be designed so that the new directive starts at the highest affected level within the vehicle inspection agency and moves down the organizational heirarchy by level. In this manner each level becomes aware of the content of the directive prior to the next subordinate level. This should provide each lev el the opportunity to understand the intent and the "why" of a directive in order to be able to properly explain it to the next group in the organization. This system should result in field and station supervisors being	

Flammable Liquid Fire Safety. 20 min., 16 mm., sd., color, 1956. Factory Mutual Engineering Corporation, 1151 Boston-Providence Turnpike, Norwood, Mass. 02062.
Summary: Shows right way to handle liquids and importance of using safety containers and approved equipment.

POSTERS AND CHARTS

Poster Directory. National Safety Council, 425 North Michigan Avenue, Chicago 60611. 1966-67
Summary: Miniatures of all posters available from the Council, 58 p.

Safety Graphs. National Safety Council.
Summary: Illustrated safety talks on 22 occupational safety subjects.

Safety in Shops. Industrial Arts Packet No. 3. 3M Company, Box 3100, St. Paul, Minn. 55101.
Summary: Packet of 25 charts for overhead projection.

CATALOGS AND DIRECTORIES

American Medical Association, "Disaster Medical Care Films." The Association, 535 North Dearborn Street, Chicago 60610. 46 p.

Associated Films, Inc., "Free Loan Films–Sales and Rental Subjects." Associated Films, Inc., 347 Madison Avenue, New York 10017. 70 p.

Coronet Films, "Coronet Films." Coronet Films, Sales Department, Coronet Building, Chicago 60601, 128 p.

Encyclopedia Britannica Films, Inc., "Catalog," 425 North Michigan Avenue, Chicago 60611.

3M Company, "Visual Products, School Catalog." Visual Products Department, 2501 Hudson Road, St. Paul, Minn. 55119. 23 p.

Modern Talking Picture Service, Inc., "A Catalog of Business and Professional Films." Modern Talking Picture Service, Inc., 3 East 54th Street, New York 10022. 12 p.

National Safety Council, "National Directory of Safety Films," (annual). 425 North Michigan Avenue, Chicago 60611.

	REFERENCES
better able to clarify directives to state-appointed personnel when the directive affects their operations. A system such as this should result in directives being implemented in the field with the same intent with which they were published.	
D. Follow-up as a technique in Direction	
1. In order for directives to achieve their purpose, supervisors must, on a continuing basis, visit with those levels in the inspection program who have the responsibility for implementation. These visits are necessary to make sure that directions are being followed and that operations are being conducted in the manner and within the time desired. This does not mean that such inspections are only for the purpose of discovering persons who are willfully winking at requirements of the directives but, rather, that supervisors are constantly checking to make sure that the contents of directives are understandable and realistic.	
2. The importance of follow-up as a technique in direction is emphasized in motor vehicle	

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inspection programs by the wide decentralization of operation levels of personnel involved. In state-owned operations, directives must be channeled to appropriate offices and locations in order to keep programs progressing forward. When one realizes that these programs have to do with such varied functions as personnel, finances, and the inspecting of vehicles, the importance of clear, understandable and reasonable instructions, arriving in time to be implemented on schedule, is better understood. a. In state-appointed programs the above is still true, but now personnel not employed by the state become involved. They usually are less knowledgeable in the vehicle inspection agency's terminology and internal requirements, and need closer supervision to ensure their proper compliance with the intent of directives. However, it is not unusual for these same non-agency people to be the source of intelligent suggestions which can lend to the efficiency of vehicle inspection. They, along with all recipients of directives, should be allowed an avenue of	

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communication to accommodate feedback information connected with program operations. The follow-up visits of supervisors should and could supply this channel of communications.	
3. Follow-up can assist in another important element of good direction. This is the need to countermand directives which are no longer in force. In those systems which are designed to be self-cancelling it would be nice if all the users of the directives would recognize that the directive is no longer in force and cease to use it. Practical experience indicates that this doesn't happen and follow-up is necessary. This is particularly important in vehicle inspection programs where administrative rules often carry the weight of law. It emphasizes the importance of the vehicle inspection agency keeping abreast of the state statutes that control, or allow its operation, so that directives issued by the agency comply with legal requirements.	

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E. The Use of Standard Operating Procedures 1. Standard Operating Procedures are used for operations which are repetitive in nature. Once they are properly set up the task of directing is eased. A good supervisor, at whatever level he may be, will create a set of attitudes that will lead subordinates to perform in the manner he desires. The natural conclusions, if the above is true, is that the more standard operating procedures you have, the less direction you'll need to exercise. Some operations within vehicle inspection programs which could be guided by standard operating procedures are: a. The requesting of inspection stickers by using stations, and the issuing of them by the governing agency. b. The periodic inspections of station facilities and mechanics by station supervisors. c. The inspection of a vehicle by the mechanic-inspector. d. The handling of complaints from motorists concerning operations of an inspection facility.	

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	REFERENCES
F. The Function of Training in Direction	
1. The training program of the vehicle inspection agency should be based, in part, on the departments directives and standard operating procedures. The training personnel can direct their teaching activities toward developing a student understanding of the departments policies, its standard operating procedures and other departmental guidelines which are used in directing the organization's functions. A thorough understanding of the wishes of management assist in the student's learning and performing his job. When this learning takes place it is simpler to direct activities, for the subordinate knows more about his task.	
2. All training does not take place at the agency's training school. The many changes taking place within the vehicle inspection field suggests that training should be a continuing function. Therefore, some portion of training will take place in the field away from the training school environment. Under these conditions there is an evident need for good supervision and supervisors in seeing that "in the field" training continues.	

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Because of the decentralized nature of the motor vehicle inspection operation, much of the updating of personnel will take place away from the training academy. In the field training supplements the formalized academy training and aids management in directing the organization's operation.	
3. Direction of persons not in the employ of the state motor vehicle inspection agency is aided by the development of training for such persons. In the state appointed inspection systems the operational type employee, i.e., the mechanic-inspector, is not subject to the direct orders of the state's official station supervisor. The mechanic-inspector must, therefore, be regulated by specific rules but in addition, he can be motivated and educated by proper training.	
a. When talking about the "why" of directives, it is proper to once more mention state-appointed operations and the fact that many persons involved in vehicle inspection programs are not employed by the vehicle inspection agency. These	

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people are the ones who talk with the public and who are in a position to further the aims of vehicle inspection and highway safety.	
b. A subject area which should not be overlooked when explaining "why" is the changes which have been brought about by the National Highway Safety Bureau through its standards, particularly the one dealing with PMVI. The reason for recording of the odometer reading, for example, is one item of explanation which could be given to these people so that they could be prepared to tell the public to what use this information is to be put within the overall highway safety program.	
G. The Use of Consultation in Direction	
1. When appropriate and practical, those people who will be responsible for the execution of a directive should be consulted about it. These people usually are in the best position to know if a proposed directive is workable, reasonable, or even needed. Often times they	

	REFERENCES
can suggest alternate means which accomplish the same ends, but much easier and perhaps less expensively. This advice and counsel should not include only agency personnel but should take into consideration inspection station personnel who may actually be the ones that will have to perform the function described in the directive.	
2. The method of consultation, when used in a motor vehicle inspection agency, may vary according to the urgency and/or complexity of the subject. The telephone, a letter, a questionnaire, or a staff conference may be used. Regardless of the method used, there are benefits to be had in discussions before directives are formulated. Some of these benefits are:	
a. The performance of employees is improved when they have had the opportunity to be heard or to aid you in deciding what or how a job is to be done.	
b. The directive - finally adopted - will have the benefit of the thinking of a number of people and may well be better	

	REFERENCES
suited to the task than one which was developed by only considering the opinions of one person.	
c. Better understanding of why the directive is needed and the steps needed to implement it will occur at all levels of execution.	
H. Briefings as a Part of Direction	
1. Once a directive has been decided upon, supervisors often hold briefings in order to explain the directive to subordinates. This occurs throughout the chain-of-command and will often end when the station supervisor briefs station owners and mechanic-inspectors. Briefings are useful in direction for they give the person doing the briefing a chance to sell the reason behind a particular directive. If the directive results in a person having to do more work to accomplish what appears to him to be the same end, a briefing should clarify this and explain the change in procedure. An example of this would be when a vehicle inspection agency adopts electronic data processing	

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techniques with the resultant change in forms which are filled out by the mechanics when inspecting vehicles. At first the new forms and procedures may seem overly time-consuming, but once the complete procedure is explained the mechanic should better understand what is being done, and why.	
2. In order to be effective the person conducting a briefing should be aware of some requirements for them to be a success.	
a. It is necessary to analyze the briefing. To whom is it going to be presented? What do they actually have to know? Where is the briefing to be given? Why was it decided to hold a briefing on this particular directive? These are all questions which should be answered before the start of the session.	
b. Preparation for the briefing is necessary if you expect the listener to take it seriously. The speaker should prepare an easy to follow outline of what he wants to get across. He should have sufficient graphic material to emphasize points he	

Society for Visual Education, Inc., "Educational Film Strips." The Society, 1345 Diversey Parkway, Chicago 60614. 64 p.

United States Atomic Energy Commission, "16 mm Film Catalog." The Commission, Washington, D.C. 20545. 63 p.

U.S. Department of Agriculture, "Films." Agriculture Handbook No. 14. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20241. 86 p.

University of Illinois, "Safety and Driver Education Films." The University, Champaign, Ill. 26 p.

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	REFERENCES
is going to make, but not so much material that he will overwhelm the listeners. He should rehearse his presentation so that it will be effective.	
c. When making his presentation he should make sure he identifies himself, if there are those present who have never met him. The purpose of the briefing should be explained and when he has completed his presentation he should answer legitimate questions. If he doesn't know the answer to a question, he should say so. If he knows the answer, but for some reason cannot divulge it, he should say so.	
I. Policy in Direction	
1. Policy is a "code" by which all people in an organization are guided in making decisions and in taking action in a given situation.	Ref. #2, pp. 40, 42, 108
It identifies the direction action should take. Policy provides a common guideline to enhance uniformity of action. It displays what the administrator stands for and what he wants his organization to accomplish. Policy	Ref. #1, Sec. 4

	REFERENCES
stipulates the objectives in the broadest sense. The authority to take action presupposes that the doer will function within the boundaries of the policy. Policy, being broad, encourages thinking and permits discretion on the part of subordinates.	
2. A rule differs from policy. A rule is a prescribed guide for conduct. It is not nearly as flexible as policy. Rules usually leave no latitude for decision-making. They describe who is to act, when, how much, and exactly how.	
3. Policy must conform to statutes, economic principles, governmental operating restrictions, and must be compatible with the public interest. In order to avoid misunderstandings, the policy of the vehicle inspection agency should be reduced to writing. This allows all to know the aims of the program and of the vehicle inspection agency itself. It also results in more effective direction, for all employees of the inspection agency must know the boundaries within which they operate.	

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	REFERENCES
J. Conclusion 1. The management of the vehicle inspection agency can, through the proper use of directives, develop a set of beliefs and attitudes beneficial to the success of agency programs. Some basic concepts around which the agency is built and functions, and which directives help promote, deal with: a. Ethics: This is extremely important to vehicle inspection because every vehicle owner is being forced to do something that he might not otherwise have done - get his vehicle inspected. He has to be convinced that the program and its administration is completely honest. b. Loyalty: Loyalty to management and the organization is a management objective. Directives show employees and others for what and on what the organization stands. Directives should form a basis for employees and state-appointed personnel to want to be loyal to the organization and its objectives.	

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	REFERENCES
c. Public Relations: Directives should leave nothing to the imagination as to the importance of each contact between a vehicle inspection agency employee and the public whom that employee serves. These directives should not omit station owners and mechanics in the state-appointed operations.	
2. Management's attitudes should filter down through the organization. All personnel connected with the program should sense the principles under which the agency operates.	

REFERENCES

1. Insurance Institute for Highway Safety, Management Manual for Motor Vehicle Inspection, Washington, D. C., 1968

2. Newman, William H., Administrative Action, Second Edition, Prentice-Hall, 1963

ADDITIONAL SOURCES OF INFORMATION

1. Pigors, Paul and Faith. "Let's Talk Policy." A student reference used by the Traffic Institute, Northwestern University

2. "Policy Guides" - a training publication prepared by the Traffic Institute, Northwestern University

3. "Formulation of Executive Policy" - excerpts from Chapter XII, Government Administration, by Charlesworth. A student reference used by the Traffic Institute, Northwestern University

4. "Orders Establishing a Directive System" - prepared by the Evanston, Illinois Police Department. Used as a student reference by the Traffic Institute, Northwestern University.

SUBJECT: DELEGATION - A FUNCTION OF MANAGEMENT

HOURS: 6

OBJECTIVE: To improve the student's ability to direct activities in administering a Periodic Motor Vehicle Inspection Program by acquainting him with the processes of delegation.

To provide the student with substantive knowledge of the process of delegation in order that he can recognize the need for applying sound delegation principles.

METHODS OF INSTRUCTION: The principal method of instruction is a lecture presentation. Supplemental reading in the area of management principles may be assigned. Recommended readings are:

1. Albers, Henry H., Principles of Management, third edition, John H. Wiley & Sons, Inc., New York 1969

2. Hutchinson, John G., Organization: Theory and Classical Concepts, Holt, Rinehart and Winston, Chicago 1967

3. Koontz, Harold and O'Donnell, Cyril, Principles of Management, third edition, McGraw-Hill Book Company, New York 1964

The instructor may present an organization chart depicting the placement of the PMVI function within the structure state government. A second chart, or a continuation of the first may then be used to show how the organizational structure tends to establish areas of responsibility, span of control and chain of command. Sample organizational

charts can be found in the unit of instruction on "Introduction to Organization."

In this subject area the role of the staff officer should be stressed, with emphasis placed on the staff officer as an aide to the administrator and who acts, not for himself, but for the administrator.

The fine line between staff counselling of a subordinate, not under his direct command, and staff directing that same subordinate contrary to the dual subordination principle should be identified.

Project work in this area can best be done after the student has studied Direction and Policy. Once this is accomplished the student should be ready to play the role of management in delegating tasks. This can be done in written form with the requirement that the limits of authority and objectives of the assignment will be identified.

Suggested areas of assignment for project work may include: Writing Policy; Issuing Orders; and Delegating Authority to subordinates for:

1. Developing and implementing a records system.
2. Adding additional components to the inspection system.
3. Preparing new inspection manual.
4. Defining levels of authority and responsibility within the PMVI section and showing how the PMVI section relates to the organizational structure of motor vehicle administration.

INSTRUCTOR'S GUIDE

(DELEGATION - A FUNCTION OF MANAGEMENT)

I. INTRODUCTION

A. Purpose of this session

1. In management many administrators are unwilling to free themselves of tasks which should and could be done by subordinates. The administrator burdens himself with so many jobs that he does not have time for tasks which only he can accomplish.

The purpose of this subject is to have the student:

a. Recognize the need for delegation.

b. Understand the relationship between authority-responsibility and accountability.

c. Comprehend how an administrator builds and molds his organization by delegating to responsible subordinates those tasks which they can perform and which permit them to develop administrative skills in their own right.

d. Be aware of the problems of dual subordination and how dual subordination can adversely affect line supervision.

e. See the value of manuals, policy and rules in delegation, particularly as these devices aid in establishing limits of authority, clarify organizational responsibility and help in resolving jurisdictional problems.

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	REFERENCES
II. PRESENTATION - (Delegation as a tool of management) Introductory Remarks: Delegation takes place, even in the smallest organization. Administrative organization creates the executive-subordinate relationship. The executive delegates the authority for subordinates to perform portions of the organizations function. The delegation of authority creates a responsibility on those authorized to perform. An unwillingness to delegate is a serious problem for an executive.	Ref. #4, p. 183
A. Definition of Authority	Ref. #4, pp. 180-183
1. As used in the context of this lecture, it does not refer to legal or technical authority, although this is important to PMVI administration.	
a. Legal authority is that given by law.	
b. Technical authority is that authority which is derived from expertise in specialized fields of endeavor.	
c. In public administration and, therefore, in PMVI, the ULTIMATE authority rests with the people.	

	REFERENCES
2. In our discussions we are referring to <u>operational authority</u>. a. Operational authority means that someone is authorized or permitted to perform certain acts. b. Accompanying the delegation of operational authority is or should be an indication of how that authority is to be used and the limitations on same. As an example: The Administrator delegates to a subordinate the task of evaluating a new type of testing device. He is told to perform exhaustive tests to determine whether or not the device will improve the inspection of motor vehicles. At the same time, he is instructed to analyze the cost of the instrument or instruments and if his report is favorable, to do the necessary staff work to set up the necessary procedures for purchasing such equipment. A limitation is placed on him, however, in that he is advised: (1) not to proceed with	

Sources of Help-
National Organizations

American Insurance Association, Engineering and Safety, 85 John Street, New York City 10038

Educational, statistical, and engineering service organization. Materials include inspection blanks for checking fire hazards, standards, and recommended practices.

American Medical Association, 535 N. Dearborn Street, Chicago, 60610

Concerned with industrial nursing, workmen's compensation and rehabilitation, occupational dermatoses and industrial opthalmology. Published materials.

American Mutual Insurance Alliance, Accident and Fire Prevention Department, 20 North Wacker Drive, Chicago, 60606

Technical safety data and materials.

American National Red Cross, 17th and E Streets, N.W., Washington, D.C. 20006

First aid texts and courses, instructor's manuals, charts and other teaching materials. Visual aids, such as films and posters available through local chapters.

American Petroleum Institute, Safety and Fire Protection Services, 1271 Avenue of Americas, New York City 10020

Safety and fire protection manuals related to petroleum industry.

American Society of Safety Engineers, 5 North Wabash Avenue, Chicago, 60602

Professional society for safety specialists. Many local chapters have active assistance programs for schools.

American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103

Sponsors research in the properties of engineering materials and develops standards, including specifications and test methods.

American Welding Society, 345 East 47th Street, New York City 10017

Materials dealing with proper and safe use of welding by industry.

Courtesy National Safety Council. Used with Permission

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	REFERENCES
purchase until administration approval is had; (2) not to give any indication to the equipment supplier as to his decision as to the feasibility of adopting the equipment; (3) to report the results of his work.	
B. The Nature of Delegation	
1. Delegation exists in any organization where there is more than one employee.	
a. It takes place when one man takes a helper.	
b. Delegation does not relieve the delegator of his ultimate responsibility for the function.	
c. Delegation requires risk-taking. The risks are these:	
(1) The delegator permits the subordinate to exercise judgment on how to proceed. The risk in this delegation is that the subordinate may misconstrue the intent and "take off on a tangent". (Good management calls for the administrator	

	REFERENCES
to be sure the subordinate knows what is wanted and the general guidelines for proceeding).	
(2) There is a risk too that where exacting limitations are placed on the subordinate he will not accomplish the task in as competent a manner as he would have if he had been permitted wider latitude of power to make decisions.	
(3) The administrator must, therefore, be aware of the risks, weigh them, know his personnel and then be willing to accept their actions.	
C. Three Aspects of Delegation	Ref. #4, p. 186
1. The assignment of duties by an administrator to his immediate subordinates:	
a. Who does what and who eventually performs the operation may require further delegation, down the line. In organizational structure this redelegation or assignment of duties may stop only at the lowest level of operations within the organization.	

	REFERENCES
2. AUTHORITY must be granted to take such actions as are delegated. a. Authority is defined as power to influence, to command, to perform or to require performance. b. Delegating responsibility without giving commensurate authority is ineffective management. 3. Delegation creates an obligation or responsibility on the part of the subordinate for satisfactory performance of the duty delegated. D. Establishing the Limits of Authority Delegated 1. A failure to clearly define limitations of authority causes vagueness of authority. Administrator may "fall back" on the "but that is not what I meant" technique. a. For example: It is extremely important for an inspection station supervisor to clearly understand the nature and extent of his authority in taking action for violations of the inspection station rules.	

	REFERENCES
2. Policy defines the broad limits within which operations take place; procedures are more explicit. The limits must not be vague. It is the responsibility of the delegator to make the general limits of desired performance (behavior) clear. a. An analogy exists between policy and procedure and a football game. The football field (policy) represents the area of performance. The quarterback is permitted a latitude in judgment in running plays in order to reach the goal line. He can do so as long as he keeps his team moving forward within the boundary lines of the field. The plays he calls (procedures) determine whether or not he accomplishes his objective. 3. Where delegation is a constant process in an organization, the organizational chart and/or the organizational structure establishes limits of authority. 4. There are some inherent limits on authority	

	REFERENCES
over employees. a. In PMVI departmental policies and rules establish certain limits. b. State statutes and civil service rules stipulate others. c. Organizational structure dictates others. d. In actual practice the only authority held by the executive is that which his subordinates are willing for him to exercise. (1) Subordinates can defeat him, unless he removes them or finds means to remotivate them. (2) Some authority is accomplished by negotiation and/or inducements within the organization. Authority to issue instructions can be delegated. If employee objects to instructions he can: (a) Resign - as the most drastic step. (b) Go through the motions of complying but accomplish little.	

	REFERENCES
(c) Be induced through proper personnel relations, supervision and training to follow instructions.	
(d) Employee willingness to comply falls within his zone of acceptance.	
e. The authority to deal with people or processes outside the enterprise must be clearly defined in the process of delegation.	Ref. #2, Sec. 4.4.4
(1) Liaison lines with other agencies within the government often grow unofficially. Eventually differences may arise which can only be corrected through "top-level" intervention. Such intervention may break the Delegation-Authority-Responsibility processes, for it may be necessary for the "top-level" authority to take actions countermanding some orders given by a subordinate who supposedly had authority to issue such orders	

	REFERENCES
but who has exceeded the limits of his authority. This may arise as the result of a lack of a clear definition of the limits of authority.	
(2) In PMVI liaison occurs in many areas:	
(a) Enforcement, records, licensing, accident statistic compilation, etc.	
(b) Outside the governmental area in motor vehicle equipment and accessory supplies, safety organizations, etc.	
E. Principles of Delegation of Authority	
1. There must be a real desire to delegate.	
a. The "boss" that is swamped with work eventually finds he must delegate. If he is uncertain of subordinates, or of himself, he attempts then to regulate too strongly and thusly fails to grant authority to perform. In effect he hasn't delegated.	

	REFERENCES
2. Care must be taken that not too much authority is delegated. a. The administrator must retain for himself the elements of control. b. If complete authority is handed down, the administrator may find he is simply rubber-stamping efforts of subordinates, or even worse, having them "second guess" what he wants done.	Ref. #5, - All
3. Responsibility cannot be delegated, but when delegation takes place there is created a responsibility on the part of the person receiving delegation to perform. (Delegation creates responsibility to the recipient of the delegation). a. In all organizations the responsibility for a function and the resultant accountability lies ultimately with the administrator. b. As the administrator delegates he creates responsibility and accountability for his subordinates. The subordinate then has the responsibility with commensurate	

	REFERENCES
authority to perform, and an obligation of accounting for his performance.	
4. Dual subordination should be avoided.	
a. Employee cannot serve two masters well.	
(1) In PMVI where decentralization occurs, there is a firm need for the maintaining of the "chain of command" in order that a station supervisor is not held directly accountable to two, three, or four levels of command.	
(2) Where dual subordination occurs, employee will tend to set his behavior to please the higher echelons of command.	
(3) In state licensed PMVI the inspection-mechanic may be subjected to a dual role when a PMVI station supervisor conducts a review of his operation. In cases of this kind the inspection-mechanic is in a position of being subject to	

	REFERENCES
the orders of his employer and at the same time may find he is being directed to perform differently by the PMVI station supervisor, for whom he does not work.	
(4) Within PMVI the dual subordination situation can lead to morale problems when a conflict arises between directives from two sources which do not agree, and employee is uncertain as to what to do.	Ref. #4, pp. 191-192
b. Staff activity, properly used, does not need to result in dual subordination.	
(1) Staff man, acting for the administrator, may inspect, counsel and review operations of persons not under his control.	
(2) He must not, except in emergencies, direct the activities, nor issue orders to persons not under his control. He can only do this	

Association of Casualty and Surety Companies, Accident Prevention Department, 110 William Street, New York City 10038

Pamphlets covering a wide range of subjects to meet needs of specific industries and job categories.

Department of Labor, 14th Street and Constitution Avenue, N.W., Washington, D.C. 20216

Wide variety of publications dealing with occupational safety. List of publications available.

Factory Mutual, Division of Associated Factory Mutual Fire Insurance Companies, 1151 Boston-Providence Turnpike, Norwood, Mass. 02062

Tests and lists fire protection equipment for approval, assists in development of better standards, conducts research in industrial fire protection, conducts courses on fire safety in industry.

Illuminating Engineering Society, 345 E. 47th Street, New York City 10017

The scientific and engineering stimulus in the field of lighting. Materials on all phases of lighting.

Industrial Hygiene Foundation of America, Inc., 4400 Fifth Avenue, Pittsburgh, Pa. 15231

Gives direct professional help to member companies. Assists companies in development of health programs. Contributes to technical advancement of industrial health and hygiene through research, investigation and allied activities.

International Acetylene Association, 205 East 42nd Street, New York City 10017

Technical publications dealing with calcium carbide, acetylene and allied products.

Manufacturing Chemists' Association, Inc., 1825 Connecticut Avenue, N.W., Washington, D.C. 20036

A trade organization for the chemical industry; publishes valuable information on chemical safety.

National Commission on Safety Education, National Education Association, 1201–16th Street, N.W. Washington, D.C. 20036

Magazines, bulletins, pamphlets, checklists, posters for all levels of education and all aspects of safety education.

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	REFERENCES
through that subordinate's line operation or chain of command. This assures that dual subordination does not occur and that the subordinate's superiors are in control and aware of "what is going on." (a) As an example of an "emergency situation" - a staff officer might be obligated to countermand an order of a station supervisor to a station operator when it was obvious that the station supervisor's order was contrary to established procedures and was going to produce difficulties for the station operator. In the event such an emergency arises the staff officer must immediately notify the station supervisor and his superiors of his, the staff officer's, actions and the reason for them.	

	REFERENCES
(3) In PMVI, which by its nature is a decentralized operation, it is difficult for a headquarters staff man to visit a field area without observing some operation which is not going according to procedure. The lower management procedures involve noting the deficiency and the probable causes for same. The staff man can then arrange for corrective action through channels. The staff officer must exercise caution in that a subordinate must not be allowed to believe that an improper inspection technique is correct, simply because a staff officer observed it and did not take corrective action. A simple procedure for alerting subordinate to an improper operation is to open the operation to review and discussion with the subordinate, with the staff officer indicating and/or producing the correct information. This, then, is followed	

	REFERENCES
up with a review of the operation with the subordinate's superiors.	
c. Direct contacts between the PMVI executive and the lower ranks, i.e., persons at a level who normally do not report directly to the PMVI executive, does not need to lead to dual subordination; if the executive is careful not to issue orders to that person directly.	
If the executive has orders for subordinates at the second level below him, he should relay the instructions down the chain of command. He can communicate at these levels primarily to learn and get a "first hand" view of the operation.	
(1) By-passing down the line, i.e., by-passing a level of command, may make an employee indifferent to the wishes of his superior. This can seriously weaken that superior's control over line operations.	

	REFERENCES
(2) By-passing also allows by-passed superior the opportunity to deny responsibility as he was unaware of orders handed down past him.	
5. Authority must equal responsibility in delegation. (If a responsibility is created by delegation then there must be also granted adequate authority to meet that responsibility.)	
a. A subordinate cannot be held accountable for results unless he is permitted to guide activity according to his best judgment. If his best judgment is not adequate this is a risk the delegator must face. If the delegator is aware of the subordinates inability to perform then he must take other measures to get the task accomplished. This may take the form of replacing the subordinate. Such a measure is harsh and can create a morale problem if the administrator does not exercise restraint in acting. (The makings of a supervisor or administrator are founded in this statement.) In PMVI the widespread area of operation necessitates a wider latitude of authority	

	REFERENCES
Identify Relationships Further Through Organizational Structure Charts. (See unit on Introduction to Organization, for Charts).	
1. Position descriptions.	Ref. #2, Sec. 3.6.1 Ref. #3 - All Ref. #4, pp. 302-305
a. Quite often are short and denote the lines of authority with main duties of the position described.	
2. Job descriptions.	Ref. #1 - All
a. A broader view of what employee must do, his area of responsibility, etc.	
b. Should define essential requirements of job.	
c. Should be prepared for each level of management, and for each key group or groups of similar jobs.	
d. Specifications should clearly define:	
(1) Functions of job	
(2) Objectives	
(3) Responsibilities	
(4) Relationship to other job	

	REFERENCES
(5) Limits of authority	
(6) Jurisdiction, if applicable	
(a) Territorial, legal, etc.	
e. The job specs or description should then serve as basis for:	
(1) Training	
(2) Merit ratings	
(3) Salary evaluation	
(The more clearly the lines of responsibility are set forth the better delegation can work. The process of describing jobs and positions in advance cuts down on the necessity for added comments and orders when delegation takes place).	
3. Advantages of a formalized description of the organization.	
a. The executive usually prepares the description and establishes his organization accordingly. (This requires analysis of the organization and can lead to improvement.)	

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	REFERENCES
b. Unclear lines of authority can be cleared up.	
c. Overlapping interest and areas of responsibility become more clearly defined.	
d. S.O.P.'s (Standard Operating Procedures) may be agreed upon.	
e. Major duties and responsibilities are emphasized.	
f. Needs for change should be more evident.	
g. A broad overview of the operation materializes which leads to further analysis and possible repositioning, reorganization, etc.	
4. Some limitations to using fully finalized statements of descriptions:	
a. Difficult to draft to cover all needs, and once drafted hard to revise.	
b. The more detailed it is the more frequent changes may be needed.	

	REFERENCES
c. Where descriptions are extensive frictions may be created as employees begin to think "this is not my job", etc.	
d. Charts tend to over simplify relationships.	
e. Inflexibility develops and when changes are made it is often difficult to get acceptance of the changes.	

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REFERENCES

1. American Association of Motor Vehicle Administrators, Job Qualifications for Inspection Supervisory Personnel, Washington, D. C. 1969

2. Insurance Institute for Highway Safety, Management Manual for Motor Vehicle Inspection, Washington, D. C. 1968

3. Louisiana State Police, Job Description, Administrator M.V.I. Section, Rank of Captain, Baton Rouge, Louisiana 1969

4. Newman, William H., Administrative Action, second edition, Prentice-Hall, Inc., 1963

5. Northwestern University, Traffic Institute, Delegating Authority and Responsibility, Pub. No. 7065T&F, Rp 1970, Evanston, Illinois

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National Fire Protection Association, 60 Batterymarch Street, Boston, Mass. 02110

Clearing house for information on fire protection and fire prevention. Technical standards are widely accepted by state and municipal governments.

National Safety Council, 425 North Michigan Avenue, Chicago, 60611

Accident prevention programs, materials and technical assistance. Wide variety of materials for all aspects of accident prevention. Books, pamphlets, data sheets, technical releases, films, posters, etc. Conducts National Safety Congress each October.

National Society for the Prevention of Blindness, 16 East 40th Street, New York City 10016

Materials, consultation and technical service for conservation and utilization of eyesight in industry. Sponsors conferences and courses for lay and professional groups. Sponsors "Wise Owl Club of America."

New York University, Center for Safety Education, Washington Square, New York City 10003

Courses, research and materials on all phases of safety education and accident prevention.

Public Health Service, Department of Health, Education, and Welfare, Washington, D.C. 20202

Division of Accident Prevention offers materials and consultation service on accident prevention programs.

Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, 60611

Maintains laboratories for examination and testing of devices, systems, and materials to determine their safety. Safety engineers regard the Underwriters' label as a requisite when they purchase fire, electrical, and other equipment.

United States of America Standards Institute, 10 East 40th Street, New York City 10016

The national standards body in the United States. Prime purpose is to provide the machinery for an orderly and voluntary method of establishing recognized United States of America Standards. Standards are generally accepted as minimum requirements by safety engineers.

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SUBJECT: CONTROL - A FUNCTION OF MANAGEMENT

HOURS: 3

OBJECTIVE: To develop student managerial skill by identifying specific administrative devices and tactics used to control the operations of an organization. To improve student's understanding of how control techniques are an integral part of the total management process.

METHODS OF INSTRUCTION: A lecture presentation. The instructor may set up a hypothetical PMVI organization or use an example of an existing program. Have students identify the control factors that are being used or that could be used in the operation. A sample organizational structure chart appears in Volume 1, Highway Safety Program Manual, "Periodic Motor Vehicle Inspection."

INSTRUCTOR'S GUIDE

(CONTROL - A FUNCTION OF MANAGEMENT)

I. INTRODUCTION

A. Control is a major function of good management. The essence of control involves the establishment of criteria for performance and the setting up of "listening" or observational posts along the operational path in such a way that management can determine whether operations are going according to schedule. The post or control also will inform management whether or not operations are following acceptable procedures and accomplishing desired results. The overall purpose of Control being to see that objectives are being met efficiently and on time.

In this session the student should discover how important it is to design and/or build into the operational system control points and techniques which permit managment to evaluate and direct activities which are on-going.

In management, Control is a consideration in Direction, Delegation and Budgeting. The student should become aware of this as he progresses in the management area.

	REFERENCES
II. PRESENTATION	
A. Introduction: Administration has been defined as a continuing cycle of Planning, Organizing, Assembling Resources, Supervising and Controlling.	Ref. #3, pp. 419-466
1. Directing and Controlling are identified as major categories of administrative or managerial work.	
2. Control consists in seeing that all operations are carried out in accordance with the plans which have been adopted and the orders which have been issued. It further consists of determining if planned objectives are being met.	
a. A PMVI organization must develop and adopt <u>controls</u> to help assure compliance with departmental programs designed to accomplish its objectives.	
b. Control mechanisms must function within an organization to protect it from its own elements. The administrator must discover and eliminate individual and group conduct which hampers the organization from successfully completing its programs and meeting its objectives.	

	REFERENCES
Within the organization the competition for personal recognition, for personnel and the budget dollar, necessitates administrative control.	
c. Whenever authority is delegated, some form of control must be initiated to determine if authority is properly exercised.	Ref. #2, Sec. 5.4.3
B. Control as a basic process	
1. Control is an essential and basic process and is an integral part of other activities of management. (Particularly is this true of Direction and Delegation.) For controls to function there must be:	
a. Objectives and goals clearly outlined and understood. (Where you are headed must be known, in order that control techniques can determine if you are actually going that way.) The objective of the control method should be defined. An example of a statement of objectives for motor vehicle inspection is found in Chapter 1, Paragraph 3 of Volume 1, Motor Vehicle Inspection	

	REFERENCES
of the National Highway Safety Bureau.	
b. Procedures for installing control methods and assurances that the procedures will be used.	
c. Appraisals of performance. The principal objective of PMVI is assuring safe vehicles on the roadways of the state. The measure of the success of the program is the quality of the work being done. As a control measure the administrator must regularly test the quality of the inspections being performed. This testing is routinely done by that station supervisor's visits and inspection of the inspecting stations. The unscheduled stopping and checking of vehicles in roadchecks will also give the administrator a test of the performance of his program.	Ref. #2, Sec. 5.4.2
d. Corrective action which originates when control techniques disclose deviation from desired results. (Control techniques which disclose irregularities but which do not prompt remedial action	Ref. #2, Sec. 5.4.1

	REFERENCES
are useless. By the same token, where superior performance is disclosed the control technique should allow for recognition and subsequent improvement in operation.)	
2. The feed-back process provides the administrator with another means for determining whether or not the program objectives and criteria are being met.	
a. Feed-back in motor vehicle inspection is found, in part, through routine reports that are designed to show how many vehicles are being inspected, and their condition. Since the implicit purpose of PMVI is to improve the mechanical condition of vehicles, a study of trends in vehicle defects, i.e., either upward or downward, would indicate whether or not the inspection program is, in fact, improving the mechanical condition of vehicles on the road.	
Some unofficial feed-back comes to the administrator through sources not directly related to reports within the	

	REFERENCES
PMVI records system. The administrator gets a "reading" on how things are doing by reading the complaints received; by noting letters of commendation and/or condemnation; by news media interest and reaction to the program; by the activities of organized groups within the state that have an interest in motor vehicle inspection, such as the Auto Dealers Association; the Automobile Association; Safety Councils, etc.	
3. Types of Control	
a. Organizational structure is designed to provide "span of control" and chain of command.	
b. Staff and line units assume responsibility for and control of functional activities. Position descriptions as found in a number of state personnel operations describe the functional control by staff. Oklahoma has, in part, the following in their position descriptions for motor vehicle inspection personnel.	

	REFERENCES
(1) Director - will be responsible for all operations of the motor vehicle inspection division. He will serve as liaison officer with (independent organization). He will work closely with (other branches of state government). He will conduct all hearings in regard to violations of inspection laws.	
(2) Assistant Director - will be in charge of records, training of troop inspectors, training of mechanics. He will see that all complaints are investigated, be in charge of all office personnel. He will check all reports and will select random samples of inspection station reports for proper evaluation.	
(3) The field supervisor's and trooper inspector's responsibilities are similarly set forth.	
(4) In the above examples in Oklahoma, the administrator has set forth	

	REFERENCES
the areas of performance for his subordinates. Such descriptions provide control by defining areas of responsibility and along with proper reporting procedures should provide the administrator with feed-back on the functions which fall within the scope of activity of the subordinates.	
c. Records and reports are designed and used to provide the administrator with information. Statistical summaries, daily reports of activity, unusual activity reporting, and many other such reports are used to provide information on objective accomplishments and the status of the operations as of the reporting time ... feed-back, in other words.	
d. Staff conferences often are used to gather information. They are also used in directing an organization's activity.	
(1) During staff conferences the administrator can and will determine	

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whether certain objectives are being met. He can inquire in great detail as to why or why not programs are functioning. Such inquiry constitutes a form of control.	
e. Controls are exercised by the appointment and removal of staff (while this seems drastic, the inability or failure of a subordinate to perform causes a breakdown in operations and removal of the offender may be the answer. For morale reasons, the administrator should consider alternatives to removal). The addition of an assistant may be warranted.	Ref. #3, p. 200
f. Departmental policies and rules provide guidelines for performance. They set standards by which the administrator can determine whether the expected performance is being met. These policies and rules then are the criteria against which the administrator weighs performance procedures of his subordinates. They become, in the control process, an evaluating tool.	

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Acknowledgment of Safety Instruction and Pledge

I have received the SAFETY INSTRUCTIONS regarding the operation of the following power driven machines. I fully understand the importance of these rules and regulations and I am fully aware that the violation of any one of them may endanger myself and others.

My teacher has demonstrated to me the proper methods of using each machine listed below and has pointed out the safety precautions necessary to avoid injury.

I have demonstrated my ability to use each machine listed below in the presence of my teacher. I understand the safety precautions involved and understand how to insure my safety through the proper use of the machines. I am confident that I can operate these machines safely. When in doubt about the operation of any machine, or other equipment, I will consult the teacher before proceeding.

(Name of each machine to be written in *by the pupil* only after he has passed the safety tests and demonstrated his ability to use it.)

Name of Machine	Date	Student's Signature	Teacher's Initials
1			
2			
3			
4			
5			
6			

I have passed the tests covering safety in the shop and the use of the above listed machines.

I promise to observe the SAFETY INSTRUCTIONS and to follow the instructions given in the demonstration. I may use the machines only after I have been properly instructed in their safe use, and have had the approval of the teacher. I understand that the use of machines in this shop is voluntary on my part.

School _____ Signed _____
Pupil

Date _____ _____
Teacher

Courtesy National Safety Council. Used With Permission.

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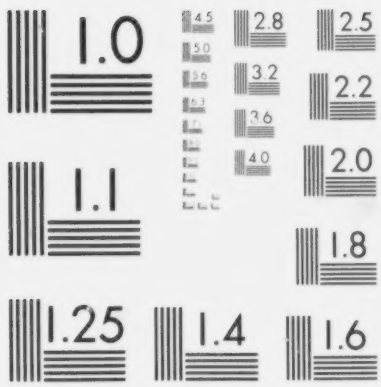

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

	REFERENCES
g. Control is exercised through adequate field and station supervision. The use of random inspection of motor vehicles in a broad sampling basis can disclose the quality of inspections and provide clues to management as to how well inspecting stations are complying with departmental guidelines.	Ref. #1, p. 32
h. Standard Operating Procedures provide concise guidelines. These guidelines establish criteria for performance and here, as in Section f above, the administrator has a tool for exercising control. In motor vehicle inspection the instructions for conducting component parts inspection set forth procedures and end results desired. A failure on the part of an inspector-mechanic to carry out the correct procedures or to correct a defect, when observed by a station supervisor, provides that supervisor with a control measure in that the inspection is not meeting its	

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objective and the reason why not is disclosed.	
C. Methods by which a PMVI administrator controls	
1. Control over personnel	Ref. #1, p. 9
a. Through the recruitment and selection process.	
(1) This area of control is often affected by civil service regulations, state personnel regulations, and political ramifications.	
b. By the placement and transfer of personnel.	
c. Through training.	
d. By promotions and demotions. (The promotional processes and demotional processes of a state civil service system have a material effect on the administrator's control.)	
e. By use of disciplinary authority.	Ref. #3, p. 400
2. Control over records and control through records system.	
a. Control is the backbone of a vehicle inspection program. If the administrator	

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is to maintain the public trust he must see that the inspection function is correctly carried out. (The records system must be designed to provide feed-back on performance.) R. M. Terry identifies some reports which aid control in his paper, "An Overview of a Successful Motor Vehicle Inspection Program," which is in the unit "Introduction to Organization." These reports are, in part, records on active stations and inactive stations; those stations that are suspended or rejected; records on inspection stickers issued for strict fiscal control as well as subsequent checks on mis-use of the inspection sticker; summaries of inspections for required statistical information as well as indicators of trends. Records on expenditures, records on mechanic training and retraining are maintained.	Ref. #4, pp. 17-20
b. By properly placing the records system within the organization.	

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c. By establishing accountability for critical report and/or accounting forms. (Numbering of forms, etc.)	
d. By the development of follow-up procedures.	
e. By form design - what information to be reported.	
f. By development of a records flow system and processing system which allows for interpretation of operations at key points. (Management by exception can be mentioned here.) In this concept the records reveal an unusual pattern which is not the norm. When such a pattern is disclosed by the record system, management is immediately advised of the abnormal situation and corrective actions are started. An example of this principle might be found in PMVI when the records indicate that in a given area there is a sudden decrease in vehicle rejections. Such a decrease should alert management to look for the reasons,	

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	REFERENCES
3. Financial controls	
a. Budgetary controls - the comparison of use of budgetary items versus the predicted usage identifies deviation from planned progress. An example of this type of budgetary control can be found in the PMVI departmental automotive cost. An overdrawn account in departmental vehicle repair and replacement account provides the administrator with information on trends. One; vehicle costs are going up more rapidly than anticipated; two; there may be vehicle operating policies needing review; three; the demands of the service are creating excessive travel and there may be need for a general review of manpower assignment and/or need for increased personnel.	Ref. #3, pp. 441-455
b. Purchasing control - in governmental operations limits are often placed on maximum dollar purchases without bids in order that the "people" and/or state administration sees that the state gets the most for its dollar.	

	REFERENCES
(1) One of the purposes of purchasing control is to "hold the line" within the budget on items which must be purchased. The acquisition of office supplies, inspection stickers, inspection equipment, motor equipment, etc., is controlled by budget and by sound purchasing practices.	
c. Audits - internal auditing provides positive control of expenditures, purchases and financial transactions. (Handling of inspection decal money, licensing fees, etc.) Generally audits are arranged for by law in a governmental operation - but additional are being made through routine review of financial actions (bookkeeping).	
D. Inspection as a control technique. (Inspection, as used in this section, refers not to the inspection of motor vehicles, but to the administrative inquiry into operations - operations in its broadest sense.)	
1. Purpose of inspection is to keep management adequately informed of all pertinent facts -	

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it is related to people, programs, progress, conditions and techniques, and can provide the administrator with answers to key questions. a. It can provide analysis of operations outside the routine reporting and control techniques. It tends to provide unbiased reporting in that the reporting does not normally come from the people who are involved in the operation.	
2. Line inspection and its uses a. Line inspection is conducted by second echelon management and/or supervisors of all the work under his charge. A management control device for determining for himself how his people are performing - as such it provides a control in that subordinates are aware that they are going to have to account for their operations. (1) Line inspections in motor vehicle inspection may be conducted through direct observation of the performance of subordinates. Other techniques, of course, are to spot-	

	REFERENCES
check performances of inspection mechanics and make routine station inspections to check on accuracy of station supervisor's reports. All of this is done to see that performances are producing desired results.	
3. Staff inspections and their uses	
a. Generally staff inspections are conducted for the administrator and relate to department-wide operations. As a control technique they are:	
(1) Usually conducted as a routine and continuing function.	
(2) Fundamentally to provide the administrator with the assurance that things are going as planned. Such assurance then comes from staff which is a source outside the operations system and the assurance is not necessarily dependent upon the people who are doing the work.	

	REFERENCES
(3) Almost invariably conducted without taking corrective action which may be indicated as being needed. (This is done to avoid the dual subordination role.)	
(4) Used to check on line inspection. The exception to the rule of not taking corrective action is when circumstances indicate the organization's mission or the reputation of the organization is in danger.	
E. Summary	
1. All inspections are only a means to an end. The end product being to make certain that the quality and quantity of PMVI service is meeting the department's objectives.	

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SUBJECT: BUDGETING - A FUNCTION OF MANAGEMENT

HOURS: 8

OBJECTIVES: To acquaint student with the principles of budgeting; to identify types of budgets and how budgeting serves as a tool of management in accomplishing the organization's goals.

METHODS OF INSTRUCTION: This unit of instruction is designed to be presented by the lecture method. It should be supplemented with a project which requires the student to formulate a budget time schedule for the operation of a Motor Vehicle Inspection agency. Students should be encouraged to study existing budgets of PMVI agencies in order that they may get a broader picture of the types of need which occur within the field of PMVI.

INSTRUCTOR'S GUIDE

(BUDGETING - A FUNCTION OF MANAGEMENT)

I. INTRODUCTION

A. This presentation is designed to acquaint the student with the budgetary processes in a state government in which the PMVI agency is a sub-branch of a larger organization. In every state in the United States where PMVI takes place, the PMVI agency is organizationally at least three levels, and possibly four levels, below cabinet level in government. These levels are:

1. Department of Transportation, within which there is:

   a. A Division of Motor Vehicles, within which there is:

      (1) A Bureau of State Police, within which there is:

         (a) A PMVI agency.

In some states the PMVI function may be at the third level.

It is suggested that the instructor encourage students to obtain and study and discuss budgets which are published by their respective states.

Emphasis is placed, in this presentation, on the effects of the "political climate" on the success or failure of getting budget approvals. The instructor should emphasize and re-emphasize the importance of good public relations activities in PMVI in selling and reselling the PMVI program.

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	REFERENCES
II. PRESENTATION	
A. Definition	
1. A budget is a comprehensive fiscal plan for a jurisdiction over an established period of time.	
a. To be comprehensive it should be all inclusive of both revenue and expenditures.	
(1) Revenues for PMVI can come from such sources as:	
(a) Sale of inspection stickers.	
(b) Direct charge for inspection of motor vehicles.	
(c) Inspection station licensing fees.	
(d) Mechanic-Inspector licensing fees.	
(e) Indirect charge based on vehicle registration fee.	
(2) Appropriations by legislature are not in a true sense revenue, but	

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such appropriation is a major factor in determining monies available for expenditures.	
b. PMVI agencies are generally placed in governmental organizational structure so as to make competition for the budget dollar quite severe.	
2. The time factor will vary from one state to another although most PMVI states operate on a two-year fiscal budgeting cycle.	
a. Fiscal year may begin on a scheduled basis, usually immediately after the ordinarily scheduled end of a legislative year. A fiscal year is of twelve months duration, but most often does not start on January 1 of any given year. July 1 seems to be the usual starting time for governmental fiscal years.	
b. A calendar year is January 1 to December 31.	
c. There is nothing "sacred" about the time period when a fiscal year starts.	

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There is, however, some problem with carrying projects over from one fiscal period into the next. This is usually handled by allocating or encumbering funds to meet the anticipated projects which are started in one fiscal period and which will be ended in the next. (1) Generally, operating budgets are designed to allocate expenditures during a fixed period of time and within the fiscal period, while: (2) Capital improvement budgets may require pay-off over a longer period of time and the obligation will be carried over from one fiscal period to the next. In these cases the actual amount needed for any one fiscal period is included in the operating budget for that period. (a) An example of this in PMVI might be as follows: Management decided to conduct a	

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five year building program to modernize area supervisors headquarters. Construction plans are drawn with a time-table for completion of all projects within a five year span. The total cost of this program to be $2,000,000.00, of which $750,000.00 will be expended within the next fiscal year for planning and property acquisition. The operating budget would reflect the need for the $750,000.00 for the fiscal period and the Capital Improvement Budget would show the total cost and what percentage of the funds would be needed and what part of the project would be completed in the various fiscal periods up to the time of completion.	

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3. A budget is, in itself, not the authority for spending money but it does provide the guidelines for the legislative body to appropriate funds to meet the budgetary needs and it is from this appropriation that money will be allocated. a. In PMVI agencies the funds appropriated are often a part of funds allocated to the bureau within which the PMVI agency is located. Example: In Wisconsin, the Department of Transportation is the major governmental department in which the Division of Motor Vehicles is found, and within the Division of Motor Vehicles is located the Bureau of Policing, or the State Patrol, and Motor Vehicle Inspection (random spot inspection in Wisconsin) is under the jurisdiction of the Patrol. B. Why is a budget necessary? 1. In government there seems to be a scarcity of funds in almost every administration. Therefore, the wise PMVI administrator budgets his money, manpower and resources to	

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produce the most efficient and productive operation possible. a. Limitations of funds are created by state laws in some cases. (Maximum indebtedness is stipulated.) 2. The proportion of state revenues allocated or appropriated to each branch of the government is dependent on a number of factors. a. The need (absolute) for the service being rendered. b. The available monies. c. The political expediency. (In some cases - pressure being brought to bear on the legislators.) d. The quality of the budget. (Reasonableness, demonstrated or expressed need for the service being proposed, the justification for expenditures, etc. e. The ability of the administrator of the "parent" organization, i.e., department or cabinet level administrator, to convince the legislature	

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of the needs.	
3. The competition for funds then requires the administrator to wisely conceive his budget, intelligently prepare the budget, and astutely present it to the legislature in order that funds become available.	
a. In PMVI the PMVI administrator has the same obligation to design his budget so as to meet the requirements set forth above. There are instances where the PMVI administrator may have to appear before the legislative committees to justify his portion of his department's total budget.	
4. Legal requirements make a budget necessary.	
a. The format used, the procedures for presenting a budget, and the time for presentation of a budget for approval may be based on law, administrative order, or both.	
b. Within the PMVI agency departmental rules will establish the format, procedure and timing of the budget.	

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	REFERENCES
Generally the agency budget must be submitted considerably ahead of the time that the department's budget is completed in order that the PMVI agency's section of the budget can be incorporated into the overall departmental budget. *Instructor: At this point samples of PMVI budgets may be shown along with those of the department to which PMVI is attached, to show the relationship between the PMVI budget and that of the department as a whole.	
C. The budget as a master (managerial) plan	
1. Provides for a continual evaluation of services and needs.	
a. The budget guides operations.	
b. Provides for continual evaluation of services rendered and needs - (a comparison of what is needed to do the job and what is being spent to accomplish that need. In addition, it allows a comparison of the accomplishment of the objectives of the organization against the cost of so doing).	

	REFERENCES
c. Budget assures that funds are provided for the most important services and needs first - (priorities). (1) In PMVI priority must be given to adequate inspection of motor vehicles which entails proper supervision of the inspectors and inspecting stations. Secondary priority then may be such functions as the record system, the quality of housing facilities, training, etc.	
d. A budget will highlight the cost of personnel as being one of the principal costs. (1) Management, therefore, has the obligation to get maximum efficiency from that personnel.	
e. The budget helps to sell the PMVI program to the appropriating authority. It should also strengthen the department administrators opinion and evaluation of the PMVI program. (It is assumed that the PMVI agency is a section within a larger organization.)	

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D. The budget acts as a fiscal control 1. Provides PMVI administrator and others (auditors and department administrator) with fiscal checks and balances. a. Money spent for specific items, services or needs must have been appropriated and expenditures must be kept within the amounts allocated. 2. Budget is a tool for decision-making. a. When expenditures are exceeding monies allocated, management must make adjustments. (1) To slow down expenditures. (2) To adjust to meet increased spending if priorities warrant the adjustments. 3. The budget provides and calls for a review of actions before they are taken, i.e., if PMVI agency administrator plans a function he must, as a part of his planning, determine if monies are av ailable and budgeted for. If the action planned is not within the planned budget then adjustments and location of funds is essential.	

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4. The fiscal control that is found in PMVI budgets and, in fact, in most all budgets is often not primarily exercised by the administrator. The departmental auditor, state auditor, or budget control officer (title is not significant for such a person may be at staff level) maintains the records. He informs the administrator of expenditures and balances. If the process of informing the administrator is slow or the procedures for authorizing expenditures before actual spending are poor the administrator may find accounts overspent before he is aware of it. a. To circumvent this problem in PMVI agencies it is recommended that record-keeping procedures be adopted so that the budget source of funds for expenditures is indicated before expenditure is authorized.	
E. The Budget Process 1. The Budget directive. a. A budget directive is a device in which the chief administrator sets forth the anticipated performance of his organization during the period covered by the	

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budget. He states his justification for making the expenditures for which money is being requested and in general"sets the stage" for consideration of his budget by the legislature. (1) The administrator, before preparing his budget directive, will have called for needs for budget items from his organization. It is well at this point for the student to again recognize the position of the PMVI agency in the organizational structure of government. (a) To start with, by law, the governor will call for a submission of a budget. This call is transmitted to the department administrator (generally a cabinet level person). The departmental administrator then charges each of his divisions to prepare divisional budgets. The division directors will then advise bureau chiefs to prepare	

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their budget requests. The bureau chiefs will call upon section or agency heads to set forth their needs for the coming budget year or years. The agency head may then ask his subordinates to estimate their budgetary needs and these persons often will ask the field supervisors and operational employees to outline needs for the next budget period. It is evident, then, that the call for the submission of a budget may, in some manner, involve nearly everyone in the organization. PMVI agencies are no exception to this concept. (2) The executive budget directive (call for budget submission) (a) Should set forth a general budget policy.	

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(b) May stipulate that there must be justification for all requests. (c) Demand necessary supporting information and the type of data needed. (d) May ask for specifics such as: (1) Personnel needs (2) Capital outlays (3) Exact figures on equipment needs. b. Require detailed information on procedures (justification on basis of 'best-possible-way'). This makes PMVI personnel cost conscious. 2. The budget calendar is a prerequisite to good budgeting. a. The governor has a specific date for submitting budget to legislature..usually far enough in advance to allow legislative committees time to probe and decide, but not so long in advance of time of	

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actual need as to allow legislators an opportunity to kill the budget entirely. (This can happen and the Governor would have to call emergency sessions of administrators to re-submit). Timing to the Governor and legislature is important, therefore. Budgets are often one of the last items on a legislative agenda before adjournment. b. After the Governor's call the departmental administrator sets up the time for the submission of the division budgets. The division establishes the bureau's budget and the bureau sets a time for submission of budget items from sub-bureaus or agencies within the PMVI agency. The PMVI agency may call for submission of items from the "field". The whole process, therefore, must be well-timed with each of the levels allowing adequate time for them to assemble their budget facts and to	

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submit them, through channels, to their immediate superiors. *Instructor: A portrayal of this time span can be either drawn on the board or shown graphically with overhead projector or slides, or have students estimate a budget calendar as a project. It is estimated that there may be as much as eight months between origination of first line budget considerations until the budget is finally approved by the legislative body.	
3. Budgetary phases a. Preparation phase (1) The flow-up and feed-back continuum. Everyone in the organization should have an opportunity to suggest budgetary needs and at the same time management should request this type information. As a matter of procedure in PMVI operations management will aid this flow if they can keep subordinates informed on why certain budgetary proposals are not incor-	

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porated into the budget. An example of this flow-up and feed-back continuum is shown in the following situation: A station supervisor, in a routine visit to a neighboring state, observes a new type of calibration device which he believes is more efficient than those being used by his state. At budget time the station supervisor proposes the state acquire x-number of these instruments. Management is informed of this item. Management has already considered this item and has concluded that they will replace the existing calibration devices with another type when the present ones are due for replacement. This decision is then returned down to the originator of the item.	
(2) Definition of goals - in the budgetary process it is essential that management at all levels define, in terms of budgetary items, what their	

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goals are -- what they expect to accomplish, what new or different operations they plan.	
(3) Analysis of needs - throughout the PMVI agency there should be a constant evaluation of what is needed to perform the agency's function. In addition to determining what routine needs are, management should through planning be considering future needs.	
(4) Development of plans - as plans are made for future operations, budgetary needs are indicated and as budget "time" comes due these needs are included in the budget .	
(5) Estimation of cost - in estimating cost in PMVI as in any other organization management has to consider future cost as opposed to current cost. Labor, as an example, has a constant rise in cost. Most materials used in PMVI, i.e., forms,	

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stickers, equipment, motor vehicles, etc., cost more each year. Management may consider trends in rising cost over the last few years and using these trends as guidelines, estimate future cost.	
(6) Compilation of the budgetary document.	
(a) After the person preparing the budget has assembled the necessary information, the actual preparation of the budgetary document requires that it meets the legal requirements, if applicable, and the requirements as established by the administration and/or the legislative body.	
(b) The format of the budgetary document will be dictated normally by at least these considerations:	
(1) Requirements of the administration.	

	REFERENCES
(2) The legislative committee use of the document. In most cases the format will have been established by prior experience and acceptance. (7) Submission and adoption of the budget. (At this point it is assumed that the compilation of the budgetary document of the "parent" department has gone through the process of bureau, division and agency compilations and that it has been accepted by the administrator of the department for submission to the Governor and/or the legislature and their sub-committees.) (8) The administrator prepares a budget message which accompanies the submission of the budget to the legislature. The context of this message will include a statement of proposed programs, the needs for the programs and what it will cost	

	REFERENCES
to perform them, and the cost of service to be rendered. (9) The budget is then assigned to a committee within the legislature for review and consideration. 4. The final approval of or acceptance of a budget by the legislature is affected by relationships which, while unofficial, have a bearing on the willingness of the responsible people to accept the budget request. These in PMVI are: the working relationship between the PMVI agency head and his immediate superiors. The better the communications, the better the acceptance of the proposed budget may be. The wise department administrator recognizes the need for cultivating key people in the legislature. In fact, in some cases the administrator becomes his own best, or worst, lobbyist depending on his understanding of the political climate.	

	REFERENCES
The administrator also must take cognizance of pressure groups who can effect his budget request. In PMVI it is reasonably certain that support for PMVI will come from garages and agencies who can expect financial gain from the inspection operation. Opposition to inspection may not be as well organized, but a few irate citizens writing to key legislative members can create problems for the PMVI agency in getting funds allocated. In PMVI the administrator and the PMVI agency head must constantly be aware of the need for good public relations in order to combat negative pressures on the program. This good PR work will "pay-off" at budget time. 5. The administrator, in making his presentation before the legislative committees, should: a. Place emphasis on the objectives of his organization.In PMVI this is the reduction of death and injuries in accidents as the result of motor vehicle traffic accidents.	

	REFERENCES
b. Be able to support factually any request he makes in the budget message or body of the budget.	
c. Have considered alternatives to his proposals and be prepared to defend the proposals. He must also be willing to accept alternatives if he cannot get acceptance of his original proposals.	
d. He must relate cost to the activity proposed.	
e. Prepare necessary exhibits, visual aids, charts, etc., to present his factual information.	
f. Be prepared to acknowledge when he is estimating needs or cost for lack of any experience which can give him a "handle" on actual costs.	
g. Prepare and handout a legislator's information kit. He must avoid, in this area, however, the idea that the kit was an expensive undertaking.	

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	REFERENCES
6. In summary - the success of presenting a budget and getting acceptance of it is dependent on:	
a. Good staff work in assembling information.	
b. Good planning for future operations.	
c. Successful performance in the past.	
d. Determining needs	
e. Building proper rappaport with legislature, administrators, pressure groups and interested citizens.	
F. Execution of the budget (use of)	
1. Once the budget is approved and the legislature allocates the funds, the administrator:	
a. Makes an analysis of the accepted budget to determine exactly what he has to work with in terms of dollars, manpower and other resources.	
b. Makes plans to perform based on availability of resources and allocates these resources throughout the organization.	
c. May have to re-evaluate operations on	

	REFERENCES
the basis of changes made by the legislature. This requires further staff work, planning and setting priorities for performance.	
2. The expenditure process from budgeted items will follow a pattern similar to the following:	
a. Request for budget item expenditure is made. Example: Field supervisor needs a new car.	
b. Staff personnel reviews request, determines need and approves purchase.	
c. Audit at this point may be made to determine if money is available and if contract meets legal requirements. If so:	
d. Money is encumbered, and:	
e. Purchase order is made up, following which the car is:	
f. Delivered and acceptance is noted. This is called:	

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	REFERENCES
g. Certification of purchase and delivery, which, when received in finance office is the order for:	
h. Payment for the car.	
3. In the accounting process of PMVI organizations there should be a "running inventory" of how much has been expended in each account and what the balances are.	
a. When management is informed that expenditures are running ahead of budget expectations, they should review the operations to determine corrective measures.	
G. Types of Budgets	Ref. #1 - pp. 11-14
1. Introduction	
a. The choice of the type of budget to be used by an administrator in presenting his budget to the legislature will vary from one jurisdiction to another. There are three principal types of budgets in use today.	
(1) Line Item Budget, sometimes referred to as an Object Budget.	

	REFERENCES
(2) Program Budget (3) Performance Budget The differences between the three budgets may be indicated by the following simple examples: (1) A Line Item Budget itemizes the individual cost for personnel, equipment, material and services for the PMVI agency to perform its overall task. No special attention is given as to what it costs to perform the individual functions within the agency. (2) The program budget indicates the cost of conducting various phases of the PMVI agency without showing the cost of doing the individual unit performance of that task. An example is: A program budget will stipulate x-number of dollars for licensing of inspector-mechanics, but this will be no indication of the cost to license an individual	

State Superintendent of Public Instruction. Eye Safety in Arizona Education: A Manual of Rules and Regulations. Phoenix: The Superintendent, 1968.

*U. S. Department of Health, Education, and Welfare. A Guide to Safety Education Programs in School Shops. Washington, D. C.: Office of Education, 1960, (OE-84004).

_____. School Shop Safety, (OE-84004), Washington, D. C.: Office of Education, 1959.

_____. "School Shop and Laboratory Safety: Report of a National Conference," Washington, D. C.: Office of Education, 1964.

*Utah State Board for Vocational Education. Industrial Arts Safety Guide. Salt Lake City: The Board, 1968.

*Volusia County Schools. Safety Handbook: A Guide for Volusia County Instructors of Industrial Education. Deland, Fla.: The Schools, 1963.

Weaver, Gilbert G. Shop Organization and Management. New York: Pitman Public Schools, 1955.

Webster, Richard G. "Modernize Your Instruction in Accident Prevention," School Shop, (September, 1968), 80-82.

*Williams, William A. An Accident Prevention Programs for School Shops and Laboratories. Chicago: National Safety Council (undated).

_____. "Health Hazards in the School Shop," School Shop, (September, 1964), 34-35.

_____. Study Guide for Accident Prevention Manual for Shop Teachers. Chicago: American Technical Society, 1966

* Zimmerman, Earl R. "State Guidelines for Industrial Arts Safety." Unpublished paper presented at NDEA Institute for State Supervisors of Industrial Arts, Washington, D. C., August, 1968.

	REFERENCES
mechanic. On this basis the administrator has budgeted x-dollars for licensing and projected what his total cost will be.	
(3) In performance budgeting the administrator establishes his programs and then computes the cost of performing each individual function. On this basis he submits a budget request which is based on units of activity. An example of this: The PMVI agency will license y-number of inspection mechanics in the coming budget year. The cost for licensing one mechanic inspector is x-dollars. Therefore, xy dollars are needed to license mechanic-inspectors for the coming budget period.	

In summary - a simplification of the above - Line Item Budgets itemize individual object cost without specific regard to the unit programs; Program Budgets deal with cost of programs with minimal reference to item cost or performance cost; Performance Budgets compute cost on numbers of units of activity

	REFERENCES
to be performed at a cost per unit.	
2. The Line Item Budget	
a. The Line Item Budget is the traditional approach to budgeting.In this form of budget submission the administrator itemizes the cost of performing the services of the organization in terms of quantities, i.e., people, supplies and contractural services. He then computes the cost to provide these items. (A sample type budget accompanies this unit of instruction.)	Ref. #3 - All
b. The advantage of the Line Item Budget is its simplicity. The department using this form of budget can operate it with a minimum of budgetary expertise.	
(1) The Line Item system can be operated with a non-complex type of accounting. The fact that it itemizes expenditures makes it fairly simple to keep track of cost vs expenditure.	

	REFERENCES
(2) The Line Item Budget allows for easy statistical comparisons from one year to the next.	
(3) Legislatures like the Line Item Budget approach for it is easy to understand and simple to evaluate and pare.	
c. The disadvantage of the Line Item Budget approach:	
(1) The preparation of the budget becomes so involved in computing unit cost that sight is lost of the full objectives of the organization. There is more attention to dollars, units of personnel, equipment and supplies than to the unit or organizational objectives. Less attention is paid to the amount of work the dollars are accomplishing.	
(2) The Line Item Budget creates a problem in evaluating the cost of programs within the PMVI function. Example: In a department using the Line Item Budget the administrator	

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	REFERENCES
may know that personnel is costing x-number of dollars but without making some special studies he cannot determine what it costs to conduct an investigation of a station for licensing purposes. (In Performance Budgeting he would know this cost.)	
(3) In Line Item Budgeting the administrator loses some flexibility in adjusting to meet contingencies,for he is held accountable to a fixed cost for each specific item of expense. Management, therefore, loses some element of decision-making to the "sharp pencil" of the accountant.	
d. The Line Item Budget can be used in conjunction with adequate accounting procedures to determine program cost or performance cost. This is often what is done in the PMVI service. Example: The agency will extract from the budgetary cost the exact cost of personnel, supplies, equipment, material, space,	

	REFERENCES
etc., to conduct training. This would involve computing the cost for only the personnel, time, materials, etc., when such costs were directly related to the training. The PMVI agency can cover program costs by coding expenditures on the basis of type of service performed in order that analysis can be made of the program cost at some later date. With this type of accounting the administrator can be kept informed of program and/or performance costs. 3. The Program Budget a. The Program Budget is designed to show the cost of programs being carried on within the organization. Examples in PMVI are: (1) Licensing of mechanic-inspectors. (2) Licensing of inspection stations. (3) Training of mechanic-inspectors. (4) Supervision of stations and inspectors.	

	REFERENCES
(5) Training of departmental personnel.	
(6) Management of PMVI function.	
(7) Calibration of equipment.	
(8) Research	
(9) Etc.	
b. Advantages of the Program Budget	
(1) This budget allows the administrator to have a better understanding of the relative cost of each of the programs carried on within the organization.	
(2) Trends in program costs can be better followed.	
(3) The administrator is not held to the fine degree of accounting as is found in Line Item Budgeting and, therefore, there is more flexibility in adjusting expenditures within the program.	
c. Disadvantages of the Program Budget	
(1) In Program Budgeting cost distributions within sub units of the	

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	REFERENCES
organization tend to be lost (not accounted for). Example in PMVI: The licensing of mechanic-inspectors would involve the training unit, the field supervision unit, accounting unit and supplies, while the cost of licensing all inspector-mechanics would be known, the ratio of cost per sub-unit would not be known. Program Budgeting doesn't allow for exact costing of management or supervisory overhead.	
(2) In presenting Program Budgets to the legislature, some factors which affect cost may not be clearly identified. (The budget directive and justification for cost estimates may cover this, but when this is done the budget process becomes partially a Line Item Budget.)	
(3) Another disadvantage of the Program Budget is the need for greater expertise in staff work in computing the cost of programs.	

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	REFERENCES
4. The Performance Budget a. A Performance Budget is designed to show the cost of each unit of activity within a PMVI program. As an example: The Performance Budget for PMVI in the program of licensing mechanic-inspectors would show the individual cost of licensing one mechanic-inspector and then project the total cost for performing that service. In computing these costs the administrator considers: (1) Departmental manhours per each license for: (a) Background investigation. (b) Departmental training for applicant before licensing. (c) On-the-job testing of applicant, etc. (2) Cost of certificate. (3) Accounting cost - supplies, etc. b. Advantages of the Performance Budget (1) The Performance Budget more clearly permits management to determine the	

	REFERENCES
relationship between resource input and the service output. As an example: If it cost $139.00 to conduct the investigation and to license one inspector-mechanic, and the license fee collected is $5.00, there is no doubt that management will begin to look for more efficient ways to accomplish the licensing. (a) Another advantage is that the legislative committee can see exactly what costs are for individual services rendered. (b) This type of budgeting places greater responsibility on program managers (management) to render their service within the cost estimate. c. Disadvantages (1) In PMVI the Performance Budget concept requires a more detailed accounting system and qualified budget personnel.	

VT 011 868
Quantity Food Preparation; A Suggested Guide.

Office of Education (DHEW), Washington, D.C.
Div. of Manpower Development and Training.
MF AVAILABLE IN VT-ERIC SET.
Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (FS5.282:82015, $.35).
PUB DATE - 67 43p.

DESCRIPTORS - *OCCUPATIONAL HOME ECONOMICS; TRADE AND INDUSTRIAL EDUCATION; *FOOD SERVICE INDUSTRY; *FOODS INSTRUCTION; *EDUCATIONAL PROGRAMS; *TEACHING GUIDES; INSTRUCTIONAL AIDS; FOOD SERVICE WORKERS; SAFETY EDUCATION; SECONDARY EDUCATION; POST SECONDARY EDUCATION

ABSTRACT - Developed by the Education Department of the National Restaurant Association, this guide is for instructor use in developing a training program in quantity food preparation. Topics are: (1) Basic Principles of Quantity Food Preparation, (2) Science Related to Food Preparation, (3) Mathematics Related to Food Preparation, (4) English Related to Food Preparation, and (5) Safety Instruction. The content suggested for each subject area has been outlined under the three phases of instruction which include essential learnings, scope of instruction (suggested content), and technical and related information. The curriculum outline may be adapted to a 2- or 3-year course as part of a high school program or a specialized trade program. Job descriptions, teaching materials, and supplementary teaching materials are appended. (SB)

VT 011 868

	REFERENCES
3. Performance Budgeting requires greater expertise in preparation and in use than do the other two types of budgets. It provides management with a closer evaluation of the exact cost and benefit from each individual action within the programs of the organization. A disadvantage of Performance Budgeting in PMVI is that there are functions in the operation which cannot be "broken down" into individual performance cost; public relations operation as an example.	
4. A budget is a tool of management and should be used as a guideline, not as an objective in itself, i.e., run an operation to stay within the budget as opposed to meeting the operational objective.	

20691

REFERENCES

1. Moak & Killian - "Operating Budget Manual," Municipal Finance Officers Association of the United States and Canada, 1313 East 60th Street, Chicago, Illinois 60637, pp. 11-14

2. Public Administration Review, November/December 1969. "Implementation and Use of PPB in Sixteen Federal Agencies." The American Society for Public Administration, 1225 Connecticut Ave., N.W., Washington, D. C. 20036

3. State Periodic Motor Vehicle Inspection Budget, 1969-70 Copy Attached

20692

Form 2-SP

ESTIMATE OF RECEIPTS AND EXPENDITURES
SPECIAL REVENUE COLLECTORS
FOR FISCAL YEAR ENDING JUNE 30, 1970

DEPT. OR INSTITUTION Department of Public Safety DATE SUBMITTED May 1, 1969

ACCOUNT NAME Current Expense ACCOUNT NO. 8350

	Source of Income and Item of Expenditure	Actual 1967-68	Budget for 1968-69	Estimated 1969-70
	RECEIPTS: (All Sources)			
1	Sale of Stickers	198,474.75	200,000.00	400,000.00
2				
3				
4				
5				
6				
7	Total Receipts	198,474.75		
8	Balance Beginning of Year	135,496.00	76,457.45	72,457.45
9	Total Receipts and Balance	333,875.71	276,457.45	472,457.45
	EXPENDITURES:			
1	Personal Service*			
2	Total Expenditures (8350-53)	159,179.87	135,000.00	230,000.00
3	8355-05 (Building Account)	83,338.69		100,000.00
4	8357-07 (Building Account)	8,637.94		
5	8358-08 (Building Account)	5,845.01		100,000.00
6	Refunds	416.75		
7	8356-06 (Building Account)		69,000.00	
8				
9				
10				
11				
12				
13				
14				
15	Total Expenditures	257,418.26	204,000.00	430,000.00
16	Balance End of Year	76,457.45	72,457.45	42,457.45

*If any amounts for Personal Services are to be paid from this account include totals here and submit separate list, (Using form 2A for regular budget allotments) showing name of employee, rate of pay and duties of each.

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PERSONAL SERVICES

FOR FISCAL YEAR ENDING JUNE 30, 1970

SPENDING UNIT: Department of Public Safety

(1) POS. NO. 1969-70	(2) POS. NO. 1968-69	(3) EMPLOYEES NAME AND TITLE (DOUBLE SPACE)	(4) TEN-URE	(5) EMOLU-MENTS	(6) ANNUAL SALARY 1968-69	(7) LEGISLATIVE DIGEST 1969-70	PROPOSED SALARY FOR 1969-70 RATE OF PAY PER MONTH (8)	TOTAL FOR YEAR (9)
1	1				7,200.		772.	9,264.
				1	7,200.	9,264.		9,264.
2	2				6,156.		642.	7,704.
3	3				6,156.		642.	7,704.
4	4				6,156.		642.	7,704.
5	5				6,156.		642.	7,704.
6	6				6,156.		642.	7,704.
7	7				6,156.		642.	7,704.
8	8				6,156.		642.	7,704.
9	9				6,036.		642.	7,404.
10	1				6,036.		642.	7,404.
11	1				5,916.		592.	7,104.
12	1				5,916.		592.	7,104.
13	1				5,916.		592.	7,104.
14	1				5,916.		592.	7,104.
15	1.				5,916.		592.	7,104.
16	16				5,916.		592.	7,104.
17	17				5,916.		592.	7,104.
18	18				5,916.		592.	7,104.
				17	102,492.	125,568.		125,568.
				18	109,692.	134,832.		134,832.
21	21				4,920.		435.	5,220.
22	22				4,440.		390.	4,680.
23	23				4,200.		370.	4,440.
24	24				3,720.		330.	3,960.
25	25				1,330.		250.	3,000.
				5	18,610.	21,300.		21,300.
				23	128,302.	156,132.		156,132.

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PAGE NO. _____

8350-01

CURRENT EXPENSES ACCOUNT

FOR FISCAL YEAR ENDING JUNE 30, 1970

SPENDING UNIT: Department of Public Safety Inspection Fees DIVISION:

ITEM NO.	ITEM	LEGISLATIVE DIGEST 1969-70	ESTIMATED EXPENDITURES FOR 1969-70 FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	TOTAL FOR YEAR
010	Office Supplies & Subscriptions		250.	250.	250.	250.	1,000.
011	Medical, Scientific, & Ed. Expense		150.	150.	150.	150.	600.
012	Clothing, & Household Supplies		250.	250.	250.	250.	1,000.
013	Heat & Electricity		250.	250.	250.	250.	1,000.
014	Water, Ice, Sewage & Garbage		75.	75.	75.	75.	300.
015	Telephone & Telegraph		500.	500.	500.	500.	2,000.
016	Postal, Freight, Express & Drayage		500.	500.	500.	500.	2,000.
017	Travel Expense		500.	500.	500.	500.	2,000.
018	Subsistence		2,585.	2,585.	2,585.	2,585.	10,340.
019	Members Insurance		1,000.				1,000.
	Printing & Binding		500.	500.	500.	500.	2,000.
021	Association Dues						
022	Civil Service Fees						
023	Pension & Retirement Plan Contribution		2,500.	2,500.	2,500.	2,500.	10,000.
024	Manufacturing Supplies						
025	Debt Service						
026	Food Products		125.	125.	125.	125.	500.
027	Athletic Supplies						
028	Farm Expense						
029	Professional Services		92.	92.	93.	93.	370.
030	Workmen's Compensation						
031	Fire Insurance						
032	Automobile Insurance		150.	150.	150.	150.	600.
033	Bonds		125.	125.	125.	125.	500.
	Advertising						
035	Vehicle Expense		1,250.	1,250.	1,250.	1,250.	5,000.
036	Merchandise For Resale		15,000.				15,000.
037	Maintenance Contracts						
038	Rental Expense- (Machine)		250.	250.	250.	250.	1,000.
039	Rental Expense- (Building)		250.	250.	250.	250.	1,000.
	TOTAL CURRENT EXPENSES	57,210.	26,302.	10,302.	10,303.	10,303.	57,210.

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Form 4-A

PAGE NO. 4

ACCT. NO. 8350-02

REPAIRS AND ALTERATION ACCOUNT

FOR FISCAL YEAR ENDING JUNE 30, 1970

SPENDING UNIT: Department of Public Safety Inspection Fees

ITEM NO.	ITEM	LEGISLATIVE DIGEST 1969-70	FIRST QUARTER	ESTIMATED EXPENDITURES FOR 1969-70 SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	TOTAL FOR YEAR
040	Labor (Contractual)						
041	Office Equipment Repairs		125.	125.	125.	125.	500.
042	Medical Equipment Repairs						
043	Educational & Scientific Equip. Repairs						
044	Household Equipment & Furnishings, Shop & Custodial, Communications		188.	188.	187.	187.	750.
045	Building Repairs		125.	125.	125.	125.	500.
046	Vehicle Expense		625.	625.	625.	625.	2,500.
047	Athletic Equipment & Repairs						
048	Ground Improvements						
049	Farm & Construction Equip. Repairs						
0'	OtherEquipment Repairs		150.	150.	150.	150.	600.
051							
							20636
	TOTAL REPAIRS & ALTERATIONS	4,850.	1,213.	1,213.	1,212.	1,212.	4,850.

EQUIPMENT ACCOUNT

FOR FISCAL YEAR ENDING JUNE 30, 1970

SPENDING UNIT: Department of Public Safety Inspection Fees

ITEM NO.	ITEM	LEGISLATIVE DIGEST 1969-70	FIRST QUARTER	ESTIMATED EXPENDITURES FOR 1969-70* SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	TOTAL FOR YEAR
052	Office & Communications Equipment						
053	Medical						
054	Educational & Scientific						
055	Household Equipment & Furnishings						
056	Building						
057	Vehicles*		9,800.				9,800.
058	Farm & Construction						
059	Livestock						
060	Books						
061	Athletic						
062	Shop & Custodial						
064	~~Small Tools and Other~~ Other Equipment		300.	250.	250.	250.	1,050.
	TOTAL EQUIPMENT	10,850.	10,100.	250.	250.	250.	10,850.

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ACCT. NO. 8350-06

Unclassified Account

FOR FISCAL YEAR ENDING JUNE 30, 1970

SPENDING UNIT: Department of Public Safety Inspection Fees DIVISION:

ITEM NO.	ITEM	LEGISLATIVE DIGEST 1969-70	FIRST QUARTER	ESTIMATED EXPENDITURES FOR 1969-70 SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER	TOTAL FOR YEAR
	PERSONAL SERVICES*						
	Social Security Matching Fund		240.	240.	239.	239.	958.
	TOTAL	958.	240.	240.	239.	239.	958.

*If any amounts for Personal Services are to be paid from this account include totals here and submit separate list, (Using form 2A for regular budget allotments) showing name of employee, rate of pay.

20698

SUBJECT: MANAGEMENT PROBLEM-SOLVING SEMINAR

HOURS: 4

OBJECTIVE: To provide the student with current information in selected areas of motor vehicle inspection program management; to provide the student with a means of discussing supervisory and management problems with recognized experts in the motor vehicle inspection field.

METHODS OF INSTRUCTION: Instruction in this unit should be based on questions which the students would like to have discussed by a panel of experts.

Each student should be requested to submit a series of questions. The questions should be collated and submitted to panel members at least a week in advance of the discussion.

Panel members should consist of people who are recognized authorities in one or more phases of vehicle inspection. The course coordinator should serve as a panel member.

SELECTED READINGS ON MOTOR VEHICLE INSPECTION

A bibliography prepared by
Transportation Center Library
at Northwestern University

Evanston, Illinois

April 1970

20700

ED0 56238

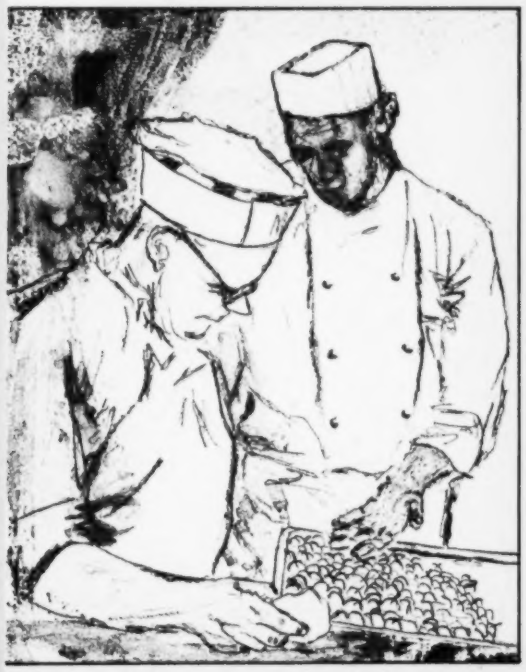

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EDUCATION & WELFARE
OFFICE OF EDUCATION
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QUANTITY FOOD PREPARATION /A SUGGESTED GUIDE

2045

AAA Foundation for Traffic Safety. A study of motor vehicle inspection: final report, conducted by...and Arizona State University Division of Industrial Design & Technology. Washington, Apr.1967. 70p.+ charts, form, tables, bibl.

Contents: Introduction.- Summary.- History of motor vehicle inspection.- State-of-the-art of motor vehicle inspection.- Probable future trends in motor vehicle inspection.- Effectiveness of motor vehicle inspection in preventing accidents.

A separate summary issued for this report also updates information on individual state programs to July 1, 1967.

American Association of Motor Vehicle Administrators. Motor vehicle inspection reference guide, by...and Auto Industries Highway Safety Committee. Washington, 1964. 2pts. charts, tables.

pt.1. Motor vehicle inspection in perspective.- pt.2. The answerfinder.

"The purpose...is to provide in a readily applicable format (a) basic information about periodic motor vehicle inspection, (b) pointers on organizing and working for MVI, (c) pointers on administering an inspection program in the first 24 months of operation, and (d) pointers on upgrading an established MVI program." - Outline.

American Association of Motor Vehicle Administrators. Vehicle inspection reciprocity agreement. [Washington, 1967?] 2p.

Text of agreement granting reciprocity on vehicle inspection.

American Petroleum Institute. Periodic motor vehicle inspection programs, pt.1. Procedure guidelines. New York, May 1967. 21p. Publ.1571. $.35.

This report makes recommendations to help state petroleum organizations and the oil industry work effectively with state motor vehicle inspection agencies. The report presents the consensus of oil companies and dealers who have had experience with existing programs. It seeks to answer these questions: "What items should be included in a good inspection? What requirements should be met to pass? What equipment the inspector should have?"

American Petroleum Institute. Periodic motor vehicle inspection programs, pt.2. Organization guidelines. New York, Aug.1968. 40p. bibl. Publ.1572. $.50.

"These Organization Guidelines pinpoint the essential components needed for sound administration, supervision, and enforcement of a state's periodic motor vehicle inspection program."

Arizona. Motor Vehicle Division. Motor vehicle safety inspection in perspective. [Phoenix, 1966?] 73p. tables.

The program and its repeal in Arizona including general discussion on essential requirements for PMVI systems and a detailed cost analysis of state programs. A recommended plan for periodic vehicle inspection in Arizona is presented.

Automobile Club of Missouri. Used car safety standards (vehicle safety status): final report, by F.B. Oldham, prepared for U.S. National Highway Safety Bureau, Contract no.FH-11-6915. St.Louis, July 31, 1969. 2v.in 4. charts, tables. Distributed by CFSTI (PB 187658-61).

Reports of defects found during examination of 8000 cars in the Auto Club's inspection center. Total defects and potentially dangerous defects as well as data on car use, servicing, storage and mileage are tabulated by make, model and year. Discussion includes information on most common defects, required inspection equipment and procedure and research needed to establish relationship of vehicle condition to accidents. The author concludes that "brakes, tires and steering geometry should be inspected twice annually, while the remainder of those items normally included in State inspections should be examined only once a year".

Automobile Club of Southern California. Compulsory periodic motor vehicle inspection. [Los Angeles] Sep.1966. 24p.+

Review of types of systems, arguments for and against inspection, research on efficacy. Recommendations that the Club oppose compulsory periodic motor vehicle inspection and support the inspection program as presently conducted by the California Highway Patrol.

Automobile Manufacturers Association. Inspection handbook for passenger cars and station wagons, trucks and buses, motorcycles, school buses, foreign vehicles through 1969 models with manufacturers' recommendations, prepared by...in cooperation with the American Association of Motor Vehicle Administrators. [Detroit] Jan.1970. var.paged. diagrs., tables.

Contents: Registration.- Wheels and tires.- Steering alignment and suspension.- Brakes.- Lighting and electrical.- Glazing.- Body and sheet metal.- Exhaust and fuel systems.- Vehicle emission control systems.

"This handbook is...a guide for both the individual inspector and for the person responsible for planning and implementing a meaningful program based on sound engineering principles." - Introduction.

Automobile Manufacturers Association. Subject summaries of...state legislation. Detroit. annual.
Section 8. Vehicle inspection.

Automotive Safety Foundation. A fact-gathering guide to assist states in developing a highway safety program. Washington, 1968. var. paged. bibl.
Periodic motor vehicle inspection, p.8.1-8.14.
Presents study outline covering legal authority, rules and regulations, selection and training of inspection personnel, statistical data for state inspection programs.

Automotive Safety Foundation. Highway safety program management [v.2] Transcripts of regional safety program management seminars conducted for the U.S. National Highway Safety Bureau under Contract FH-11-6537. Washington, Aug.1968. 125p. illus., charts, diagrs., maps, tables, bibl.
Motor vehicle inspection, p.47-53.
Discusses research which tends to correlate vehicle inspection with accident reduction and describes random and periodic inspection procedures among the states. Suggestions are given on basic elements for a state inspection statute and administrative rules and regulations. Significant program problems presently encountered are outlined.

Automotive Safety Foundation. Maryland's highway safety needs in periodic motor vehicle inspection, by Anthony Antony [for Maryland State Roads Commission] Washington, 1969. 92p.
Maryland's past, present, and future program of motor vehicle inspection as related to NHSB requirements.

Automotive Service Industry Association. The reasons for periodic motor vehicle inspection. Rev. Chicago, Dec.1964. 85p. tables.
Partial contents: Comparison of motor vehicle fatality rates, with and without PMVI.- Registration and percent rejections in PMVI states.- Comparison of PMVI state by state.- Typical defect analysis in PMVI states.- PMVI system in detail (Massachusetts).-Rules & regulations concerning PMVI - Massachusetts.- Inspection station requirements.- Sample cost analysis of a state PMVI.- Uniform Vehicle Code on PMVI.- Sample of state PMVI bill.

Boodman, David M. Safety and systems analysis, with applications to traffic safety. Law and Contemporary Problems, Summer 1968, p.488-511.

"The systems analysis approach to the traffic safety problem requires careful consideration of a variety of programs intended to reduce the hazards of the system as they exist in the vehicle, the driver, the environment, or the legal and regulatory features of the system." - Summary.

Booz-Allen and Hamilton. Safety specialist manpower, prepared for U.S. National Highway Safety Bureau, Contract no.FH-11-6496. Washington, Oct.14, 1968. 4v. forms, tables. Distributed by CFSTI (PB 182068-71).

v.1. Manpower requirements.- v.2. Manpower resources.- v.3. Manpower training.- v.4. Conclusions and recommendations.

Brenner, Robert. Some trends and views on new car and used car safety performance standards [presented at] Society of Automotive Engineers Detroit section, April 15, 1968. New York, Soc.of Auto.Eng. 5p.

"The safety of motor vehicles is discussed in relation to: the development and application of new and used car safety standards; the improvement and standardization of motor vehicle inspection programs; and comprehensive engineering and economic studies to guide the application and development of standards themselves." - Abstract.

Burnstine, Murray. Some defective vehicle conditions in traffic death cases. Aspects Tech.de la Sec.Routiere, Mar.1965, p.3.1-3.30. illus.

Reprinted from Research on fatal highway collisions (Harvard Medical School).

Study indicates the ineffectiveness of the Massachusetts vehicle inspection program. Thirty-two vehicles involved in collisions were analyzed for defects. The observations reported are not exclusively collision-causal defects; however, ascribing cause to the driver or the road without fully analyzing the vehicle may result in misinterpretations of cause.

Buxbaum, Robert C. Relationship of motor vehicle inspection to accident mortality, by...and Theodore Colton. J.of the Am.Med.Assn., July 4, 1966, p.31-36. charts, tables, bibl.

"The role of mechanical failure in automobile accidents is examined by comparing motor vehicle mortality among men, age 45 to 54, in states which do and do not require motor vehicle inspection. Inspection is associated with lower mortality, and this association prevails under varying economic, geographic, and demographic conditions. Furthermore, comparison of white to nonwhite death rates reveals that nonwhites are at consistently greater risk." - Abstract.

Criticism of variables used in this study appears in report: Safety Research Manpower (North Carolina University Highway Safety

Research Center, June 1968) developed for traffic safety research personnel training.

California. Legislature. Assembly. Committee on Transportation and Commerce. Motor vehicle inspection; report of the..., January 7, 1963. [Sacramento] 71p. charts, map, tables, bibl.

Background report on the need for vehicle inspection in California describing advantages and disadvantages of state and private systems, past and present programs in other jurisdictions and a review of inspection legislation in California. From its study and hearings the committee recommended that investment in increased traffic law enforcement and current inspection procedures (random, brake and light) would be more effective than investment in PMVI.

California Traffic Safety Foundation. Opinion poll of California licensed drivers, by Earl F. Campbell, J. Arthur Rude and Royal A. Neilson; survey conducted...in cooperation with California Department of Motor Vehicles. San Francisco, Jan.1965. 180p. tables, map.

Tabulation of replies to 34 questions relating to traffic laws and driving. Question 12: Do you believe there should be a law requiring periodic inspection of all motor vehicles for safe mechanical condition? Answers were substantially affirmative.

Carmichael, Glenn V. Periodic motor vehicle inspection. Washington, AAMVA [1964?] var.paged.

This report concludes that PMVI programs have been successfully conducted on a state-wide basis for more than thirty years. Selection of a system should be made only after a full survey and study of the special needs and circumstances of the particular state. An important element in a successful MVI program is a thorough public information effort.

Chayet, Neil L. Motor vehicle inspection. (in Curran, William J., ed. Trauma and the automobile. Cincinnati, W.H. Anderson, 1966) p.66-88. illus., tables.

Statistics, though not conclusive, appear to indicate that compulsory MVI has reduced accidents. The author recommends state-operated systems as opposed to private inspection.

Cline, E.L. Development of techniques and equipment to improve reliability of automotive diagnosis [presented at] Society of Automotive Engineers midyear meeting, Chicago, May 15-19, 1967. New York, Soc.of Auto.Eng. 15p. illus., charts, diagrs. 670517. $1.

"Findings obtained through mass diagnosis provide a practical insight, useful in the development of: multiple personnel work procedures, efficient facility layout, testing techniques that answer field service problems, equipment and personnel education that implement these techniques, and solutions to novel architectural problems inherent with indoor vehicle operation." - Abstract.

Colton, Theodore. Motor vehicle inspection and motor vehicle accident mortality, by...and Robert C. Buxbaum. Am.J.of Pub.Health, June 1968, p.1090-1099. charts, map, tables, bibl.

An extension of the authors' earlier study (published in the Journal of the American Medical Association July 4, 1966) to consider accident deaths for all ages, both sexes and whites and non-whites by inspection and non-inspection states with covariance adjustment for other accidents, population density and per capita income. "...results support the hypothesis of an effect of inspection on motor accident mortality, but its magnitude is considerably smaller than that suggested by our previous report."

Cornell Aeronautical Laboratory. A program plan for developing safe handling standards for motor vehicles, by Fred Dell'Amico, prepared for U.S. National Highway Safety Bureau, Contract no.FH-11-6529. Buffalo, Sep.1967. 175p. illus., charts, diagr., tables, bibl. CAL Rpt.no.VJ-2494-V-1. Distributed by CFSTI (PB 177617).

"State-of-the-art reviews have been conducted in motor vehicle handling qualities, handling qualities evaluation procedures, driver skill demands, braking system technology, and the relationship between vehicle handling and safety... There is no general body of objective evaluation technique." - Summary.

Coucke, Edouard. Vehicle fitness, pt.1-2. Aspects Tech.de la Sec. Routiere, Mar.1965, p.4.1-4.39; June 1965, p.3.1-3.29. charts, tables, bibl.

Motor vehicle inspection in Belgium and abroad. Gives a classification of and statistics on defects of vehicles, based on a study done in Belgium. Includes discussion of "type approval", or fitness of a definite model of vehicle in relation to design and construction, as applied in Belgium.

Coverdale & Colpitts. Report on an evaluation of motor vehicle inspection. New York, Apr.14, 1967. 48p. charts, tables.

Existing MVI programs are evaluated, based on "interviews with manufacturers of inspection equipment, the supervisors of inspection programs, observations of inspections being made, and [Coverdale & Col-

pitts] reading of the rules under which the programs are conducted." Transmittal letter.

Coverdale & Colpitts. Report on recommendations regarding motor vehicle inspection. New York, May 4, 1967. 18p. tables.
Follow-up to the authors' Report on an evaluation of motor vehicle inspection. The study recommends inspection by licensed agencies (garages or diagnostic centers) equipped to carry out necessary maintenance, inspection of vehicles twice yearly but with the program scheduled throughout the year rather than at specific time periods, with supervision of the program under the director of the state police or his equivalent.

Coverdale & Colpitts. [Recommendations for a preferred statewide periodical motor vehicle inspection program, submitted to Office of Traffic Operations, U.S. Bureau of Public Roads] New York, July 5, 1967. 7p.+ table.
Recommendations on provisions of inspection laws, program administration and enforcement.

Eagles, Joseph E. Legislator outlines steps taken to win vehicle inspection bill for North Carolina. Traf.Dig.and Rev., Mar.1966, p.16-18.
Political considerations which influenced passage of new inspection legislation in North Carolina.

Frey, Thomas J. Private vehicle inspection operates as an arm of the municipal garage in Cincinnati, Ohio. Am.City, Apr.1969, p.112-113. illus.
Description of inspection lane operations, facilities, fees and costs.

Fuchs, Victor R. Motor accident mortality and compulsory inspection of vehicles, by...and Irving Leveson. J.of the Am.Med.Assn., Aug. 28, 1967, p.657-661. tables.
A follow-up of the Burbaum-Colton study published in Journal of the American Medical Association (July 4, 1966). In this report, age-adjusted death rates by states are regressed on inspection and other variables such as population density, age of drivers and alcohol consumption. The authors conclude inspection can reduce highway deaths by 5-10 percent but cost-benefit analysis does not indicate effectiveness of inspection over other traffic safety measures.

George Washington University. State-Local Finances Project. Planning-programming-budgeting for city, state, county objectives, PPB note 10. Program objectives, effectiveness criteria and program structure; an illustration for highway safety. Washington, July 1968. 17p. tables.

Note developed by Jack Cotton as a special project for the State College of Arkansas and the Rockefeller Brothers Fund.

Suggested elements of state highway safety program include inspection as a minimum standard in maintenance/improvement of vehicle safety characteristics.

George Washington University. State-Local Finances Project. Planning-programming-budgeting for city, state, county objectives, PPB note 11. A first step to analysis: the issue paper. Washington, July 1968. 22p. tables.

A useful guide to PPBS.

Houck, L.H. Mo. inspection law likely to stir woes, pt.1-4. Auto. News, Nov.18, 1968, p.40; Dec.9, 1968, p.14; Jan.20, 1969, p.35; Mar.10, 1969, p.23.

pt.2. Inspection started under new Missouri law.- pt.3. Car inspections stir tempest in Missouri.- pt.4. Mo. revising inspection law.

Criticisms of program administration and lack of profit for dealers performing inspections. Response of State Highway Patrol officials. Repeal introduced, but defeated; House of Representatives committee working to improve present law.

Huddleston, Bert. Oklahoma's compulsory vehicle inspection program. Law and Order, May 1969, p.40-41+

Reviews complaints against the inspection law as too stringent and requiring too many repairs. Suggested modifications of the law were: (1) deletion of all areas wherein the judgment of the individual inspector was involved; (2) modification of standards for shock absorbers, brakes, wheels, exhaust systems, lights, horns, windshields and tires; (3) extending time allowed for repairs.

Insurance Institute for Highway Safety. Management manual for motor vehicle inspection. Washington, Jan.1, 1968. var.paged. charts, diagrs., forms, tables.

Contents: Purpose, objective, and need for periodic inspection programs.- Development of a motor vehicle inspection program.- MVI resource requirements.- Operating policies and procedures.- Report requirements.- Program development management plan.

Keene, Jenness M. Rx 'clinic' goes to the fleet [new concept in diagnostic centers for Pacific Telephone and Telegraph] Fleet Owner, July 1969, p.72-75. illus.
Mobile diagnostic unit used in San Francisco Bay area.

Klaus, Robert L. The day my car took its physical. Our Sun, Summer 1968, p.8-10. illus.
The Sunoco Car Care diagnostic center.

Little (Arthur D.) The state of the art of traffic safety; a critical review and analysis of the technical information on factors affecting traffic safety, prepared for the Automobile Manufacturers Association. [Cambridge, Mass.] 1966. 2pts.in 1 (624p.) charts, tables, bibl.
Compulsory vehicle inspection, p.274-285.
Contents: Introduction.- Information reviewed.- Views of official bodies.- Legislative attitudes.- Administration of inspection.- Findings of inspections.- Evaluation of compulsory inspection.- Vehicle deterioration as a factor in accident causation.- Summary and evaluation.

Little, Joseph W. Highway safety programs and the public trust. Traf.Q., Oct.1968, p.469-477.
"...PMVI can serve the public good but...its implementation should be accompanied by realistic scientific research to establish the value of PMVI; the evaluation of alternate programs such as check-lanes; and continual program review to insure sympathetic response to the demands of the public, quality inspections, and honesty."

Little, J.W. Politics and vehicle inspection in the United States. Aspects Tech.de la Sec.Routiere, no.35, 1968, p.4.1-4.17. tables.
Acceptance by the states of federal standards on motor vehicle inspection. The authors surveyed state PMVI authorities on their programs for the influence of the Highway Safety Act, public reaction, effect on traffic safety and evaluation. Non-PMVI states were queried on the outlook for legislation.
The study was also issued as University of Michigan Highway Safety Research Institute report PuF-8 (September 1968).

Lowrey, Francis P. Vehicle condition and periodic safety inspections. (in Association for the Aid of Crippled Children. Passenger car design and highway safety. New York, 1962) p.109-122. Includes discussion.
Brief review of vehicle condition as a factor in accidents, inspection programs and trend toward recognition of inspection as a factor in accident prevention.

Michigan State University. Highway Traffic Safety Center. Public opinion in Michigan on traffic accident prevention: preliminary report. [East Lansing] Jan.1966. 39p.+ tables.

"This study was conducted to obtain precise estimates of how serious Michigan residents judge the state's traffic and accident problem and what they think should be done about the situation."

Section F: Car safety and vehicle inspection, p.30-33.

Michigan State University. Highway Traffic Safety Center. Study report and plan for periodic vehicle inspection in Michigan. [East Lansing] Dec.1964. 59p. maps, tables.

Partial contents: Essential features of a good periodic motor vehicle inspection program.- Financing of periodic motor vehicle inspection.- Recommended plan for periodic vehicle inspection in Michigan.

Michigan. University. Highway Safety Research Institute. The influence of periodic motor vehicle inspection on mechanical condition, by Robert W. McCutcheon and Harold W. Sherman. [Ann Arbor] July 1968. 68p. illus., charts, forms, tables, bibl. Rpt.PhF-1. Distributed by CFSTI.

Observations at inspection sites in four cities "indicate that vehicle populations subject to periodical inspection are in substantially better mechanical condition than populations not subject to inspection..., that the mechanical condition of a vehicle population is substantially improved as the frequency of inspections increases, and that the number of defects per rejected vehicle decreases as the frequency of inspection increases." - Abstract.

A revised version of this study was published in Journal of Safety Research, December 1969.

Michigan. University. Highway Safety Research Institute. Motor vehicle inspection administration: a critical review, by Joseph W. Little. Ann Arbor, June 1967. 51p. charts, form. Distributed by CFSTI (PB 174919).

Surveys administrators of state inspection programs. Problem areas of internal administration and public relations are discussed, with recommendations for administrative organization, inspection organization and procedures, and enforcement.

Michigan. University. Highway Safety Research Institute. Two-month survey of motor vehicle inspection: report, by Joseph W. Little. [Ann Arbor] Dec.24, 1966. 26p. bibl.

Problems and trends in motor vehicle inspection programs with suggestions for research.

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QUANTITY FOOD PREPARATION

A Suggested Guide

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
JOHN W. GARDNER, *Secretary*

Office of Education
HAROLD HOWE II, *Commissioner*

Manpower Development and Training Program

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Motor vehicle inspection. Police Chief, Sep.1967, p.25-39.
Contents: Virginia's mandatory program, by R.M. Terry.- California's random program, by W. Eugene Beck.
Beck's article also appears in Journal of California Law Enforcement, July 1967.

National Committee on Uniform Traffic Laws and Ordinances. Inspection laws annotated. Washington, 1969. 304p.
A special issue of the Traffic Laws Commentary series covering Uniform Vehicle Code provisions and state legislation on motor vehicle inspection. The issue will be updated by pocket supplements.
pt.1. Development of Code provisions and state laws.- pt.2. Text of UVC Chapter 13: Inspection of vehicles.- pt.3. Inspection laws annotated.- pt.4. Texts of state inspection laws.- pt.5. Text of Highway Safety Program Standard 1.- pt.6. Text of Highway Safety Program Manual, volume 1.

National Safety Council. Multiple regression study of the effects of safety activities on the traffic accident problem, by J.L. Recht. Chicago, Dec.1965. 84p.+ tables.
In this study the association of motor vehicle inspection programs (types of vehicle inspection systems and percent of vehicles inspected) with death rates, property damage rates and bodily injury rates was analysed to determine the contribution of this activity to the total traffic safety program. Results indicate significant association of the accident rates with percent of vehicles inspected.

National Safety Council. Traffic Education and Training Committee. Highway safety manpower and training; a report on highway safety manpower and training needed to implement U.S. National Highway Safety Bureau standards. Chicago, 1968. 28p.
Recommended training programs and time schedules geared to meet NHSB standards.

Nevada. Department of Motor Vehicles. Periodic motor vehicle inspection: a review, prepared by A. Wayne Tetrault. Carson City, Mar.1968. 81p. diagrs., forms, tables, bibl.
Contents: Highway Safety Program Standard 4.4.1.- Motor vehicle inspection - the public trust.- History of motor vehicle inspection.- Traffic safety.- What PMVI does.- Public awareness and acceptance of PMVI.- Outline - typical PMVI program.- Pilot program - State of Wisconsin.- Periodic motor vehicle inspection survey.

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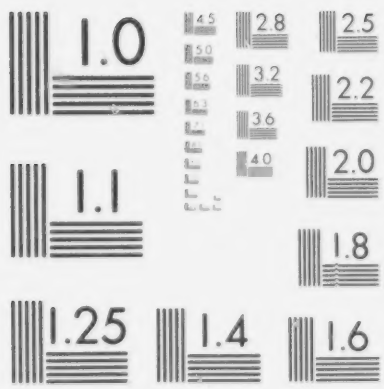

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

New Jersey. Legislature. General Assembly. Subcommittee on Transportation. Compulsory periodic motor vehicle inspection in New Jersey. [Trenton] Jan.1964. 71p. charts, tables, bibl.

Study of New Jersey state-operated PMVI program with recommendations to continue the program but institute modifications to exempt vehicles less than two years old, and shorten the re-inspection period for defective vehicles.

Appendices: motor vehicle inspection in the U.S., scope and costs of the New Jersey program, motor vehicle inspection and accident research.

Newman, John. Vehicle inspection a success in New Jersey. Hwy.User, Dec.1965, p.21-23.

New Jersey's state owned and operated system.

North Carolina. University. Highway Safety Research Center. Periodic motor vehicle inspection in North Carolina: a descriptive study, by Donald W. Reinfurt and Edward A. Pascarella. Chapel Hill, Nov.1969. 47p. charts, tables.

Data on failure rates and repair charges for inspected vehicles in North Carolina. Their relationship to vehicle age, mileage and presumed driving environment is charted.

O'Day, James. The breakdown of periodic motor vehicle inspection, by... and Jay S. Creswell; paper prepared for presentation at the 14th annual conference of the Canadian Highway Safety Council, Victoria, B.C., May 6-8, 1968. Ann Arbor, Univ.of Mich.Hwy.Saf.Res.Inst. var.paged. charts. In English and French.

Description of "a generalized model...to consider the effectiveness of inspection systems (as measured by the number of faulty vehicles on the road) as a function of the expected lifetime of a component (like a taillight), the expected time for the owner to detect and repair a fault, and the kind of inspection system in being."

O'Day, James. A modeling approach to motor vehicle inspection, by... and Jay S. Creswell, Jr. [prepared] for presentation at the Winter annual meeting and Energy systems exposition, Pittsburgh, Pa., November 12-17, 1967 of the American Society of Mechanical Engineers. New York, Am.Soc.of Mech.Eng. 9p. chart. 67-WA/BHF-3. $1.50.

"An attempt to define systematically the parameters needed to evaluate inspection systems." The authors discuss factors determining vehicle condition and costs (administrative and owner) vs. inspection program levels and describe a study comparing defective vehicle lights in two cities, one with and one without an inspection program.

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O'Day, James. Periodic motor vehicle inspection and predictive analytical modeling, by...and Jay S. Creswell, Jr. HSRI Res., Oct. 1968 [entire issue] charts, table, bibl.

Extension of the authors' earlier works with model test and validation. Application to programs may indicate (1) emphasis on inspection of components which fail quickly and are repaired slowly, (2) consideration of "trade-offs between frequency and inspection efficiency", (3) improvement of vehicle condition through defect-detection devices which can alert owner to repair need or improved component reliability.

Operations Research. An investigation of used car safety: final report, by H. Eisner [and others] prepared for U.S. National Highway Safety Bureau, Contract FH-11-6522. Silver Spring, Md., June 30, 1968. 5v. charts, tables, bibl. Distributed by CFSTI (PB 179712-6).

v.1. Summary and program plan.- v.2. Qualitative evaluation.- v.3. Quantitative evaluation, pt.1. Technical considerations.- v.4. Quantitative evaluation, pt.2. Economic considerations.- v.5. Appendices.

"The basic approach adopted by ORI in this study can be summarized by the following brief set of steps: (a) Systems analysis and modeling to structure the problems, develop effectiveness and cost measures, establish and assess alternatives to determine the elements of an approved safety program, (b) Data collection to estimate the parameters defined in the preceding, (c) Description and assessment of the adequacy of current practices, including strengths and weaknesses, gaps to be filled, and problems in implementing NTMVS and NHS Act requirements."

Peat, Marwick, Livingston & Company. Highway safety management guidelines for state governments, prepared for U.S. National Highway Safety Bureau, Contract no.FH-11-6627. Washington, June 1968. 144p. charts, tables. Distributed by CFSTI (PB 179019).

Contents: Why guidelines?- The highway safety program structure.- Organizing for highway safety.- The management process in highway safety.- Measuring program efficiency and effectiveness.- Management information.

Appendix: Suggested program structure.- Suggested highway safety program structure.- Model legislation and executive order.

The periodic technical inspection of motor vehicles: an international survey. Intl.Rd.Saf.and Traf.Rev., Summer 1965, p.17-20+

Survey of nineteen countries with compulsory or voluntary motor vehicle inspection programs. Three detailed tables give information on types of inspection stations, categories of cars inspected, parts examined, and enforcement.

RCA Service Company. A design for periodic motor vehicle inspection. Camden, N.J. [1968?] 9p.
RCA proposal to conduct statewide PMVI program.

Reports of three state motor vehicle inspection programs. Traf.Dig. and Rev., May 1968, p.4-15.
Contents: Random motor vehicle inspection in California, by H.A. Duryea.- Periodic, compulsory motor vehicle inspection in Virginia, by H.W. Burgess.- Random motor vehicle inspection in Michigan, by Matt P. Hrebec.

Southwest Research Institute. Alternative inspection policies for collision damaged vehicles and inspection of special purpose vehicles: final report, by Roy W. Hull, J. Robert Cromack and Raymond G. Ward, prepared for U.S. National Highway Safety Bureau, Contract no.FH-11-6886. San Antonio, June 1, 1969. 2v. illus., charts, diagrs., tables, bibl. SwRI Project no.11-2389. Distributed by CFSTI (PB 185452).
v.1. Alternative inspection policies for collision damaged vehicles.- v.2. Special vehicle inspection.
Analyzes existing policies and surveys cars damaged in accidents, concluding that reinspection of a more stringent nature than in normal MVI programs is desirable for collision-damaged vehicles. Discussion of policies and problems for inspection of vehicles other than passenger cars.

State police to begin tough new auto inspection program. La.Peace Officer, June 1967, p.2-3.
Describes the program for roadside spot checks of vehicles in Louisiana. The state program has been revised to meet requirements of National Highway Safety Bureau standards.

Svensk Bilprovning. Motor vehicles: points to watch; periodic inspections during the first half of 1968. Aspects Tech.de la Sec.Routière, June 1969, p.4.1-4.10. charts, tables.
"A statistical report on the results of the compulsory traffic safety inspections carried out by...The Swedish Motor Vehicle Inspection Company....
"More than 575,000 of the 775,000 private cars inspected...were found defective in one or more respects, collecting a total of 1.6 million remarks.... Only about 25o/o of the vehicles inspected were approved without remarks. As previously, headlights were...most frequently remarked on - more than one car in five being criticized in this respect." - Abstract.

TRW Systems Group. Automated diagnostic systems - vehicle inspection: final report, phase 1, prepared for U.S. National Highway Safety Bureau, Contract no.FH-11-6538. Redondo Beach, Calif., Mar.26, 1968. var. paged. charts, diagrs., tables, bibl. Distributed by CFSTI (PB 178230).

Contents: Introduction.- The mathematical models.- TRW inspection requirements.- The TRW ADVISE inspection systems.- Personnel requirements.- Statistical and reliability analysis.- Suggested future research.- Study bibliography.

A summary of this report has been issued in a separate volume (PB 178229).

TRW Systems Group. Automated diagnostic systems - vehicle inspection: final report, phase 2, prepared for U.S. National Highway Safety Bureau, Contract FH-11-6538. Redondo Beach, Calif., Nov.28, 1968. 2v. charts, diagrs., tables, bibl. Distributed by CFSTI (PB 180040-1).

"The purpose...is to improve the motor vehicle inspection process by documenting and evaluating the present procedures, cost, and effectiveness of automated diagnostic equipment, and to develop an appropriate cost model of the increasingly extensive use of such equipment. The cost model is to be exercised for sensitivity analysis of cost data and other parameters, and the various inspection systems hypothesized during the study are to be evaluated for cost-effectiveness." - Executive summary.

U.S. Department of Transportation. Estimate of the cost of carrying out the provisions of the Highway Safety Act of 1966; a report to the U.S. Congress from the Secretary of Transportation. Washington, Oct.1968. 112p. charts, maps, tables.

Periodic motor vehicle inspection, p.13-17.

Program activities and needs with map indicating state inspection status and chart showing estimated expenditures (funded and unfunded) required by state and local governments 1967-1976.

U.S. Department of Transportation. Requirements for motor vehicle and highway safety research and test facilities; a report to the U.S. Congress from the Secretary of Transportation. Washington, Oct.1968. 2v. charts, maps, tables, bibl.

v.1. Summary of investigations and determinations made to date.- v.2. Expanded descriptions of summary information.

"The report summarizes the results of the extensive investigations to date of the program requirements that generate the array of tests and measurements for which general and special purpose facilities must be available to the Government and its contractors." - Transmittal letter.

U.S. Department of Transportation. Safety for motor vehicles in use; a report to the Congress from the Secretary of Transportation. Washington, June 1968. 139p. charts, tables, bibl.

Motor vehicle inspection, p.35-61.

Contents: Introduction.- Current motor vehicle inspection programs in the states.- State motor vehicle inspection programs under the Highway Safety Act of 1966.- Periodic versus random motor vehicle inspection.- Consolidated motor vehicle inspection.- Capital requirements for motor vehicle inspection facilities.

U.S. National Highway Safety Bureau. Federal motor vehicle safety standards and regulations. Washington, GPO, 1969. lv. (loose-leaf) $8.

Kept up-to-date by supplementary paging.

"The revised publication contains the technical, engineering versions of the Federal vehicle safety standards, plus all regulations and interpretations issued under the National Traffic and Motor Vehicle Safety Act of 1966 through September 25, 1969." - FHWA release.

U.S. National Highway Safety Bureau. Highway safety program manual, v.1. Periodic motor vehicle inspection. Washington, Jan.1969. var.paged. chart, gloss., table, bibl.

Based on the standard for motor vehicle inspection, this volume provides guidelines for state and local motor vehicle inspection programs.

Washington University. Institute for Continuing Education in Engineering and Applied Science. Papers presented during conference on inspection testing of automobiles: its prospects for accident reduction, in cooperation with Missouri Auto Club, St.Louis, Missouri, January 25-26, 1968. St.Louis. var.paged. $5.

Partial contents: The national highway safety agency standards for vehicle inspection, by G.V. Carmichael.- State compulsory inspection systems: Michigan system and data summary, by M.P. Hrebec; the New Jersey system, by A.J. Sherwood; The Pennsylvania system, by H.M. Brainerd.- The Missouri Auto Club diagnostic testing center, by F.B. Oldham.

Wayne State University. Institute for Regional and Urban Studies. Motor vehicle inspection: a report on current information, measurement, and research, by Albert J. Mayer and Thomas F. Hoult. Detroit, Wayne State Univ., Jan.1963. 66p. diagrs., tables, bibl.

Includes comparison of average mileage death rates for 1948-1960 with state "inspection-status" for all the states and for the states on a regional basis.

Westwick, Emerson H. Kentucky gears for MVI. Traf.Saf., Feb.1967, p.12-13.
Review of passage of Kentucky's inspection law with discussion of preparation, organization and public information necessary for an effective program.

Wisconsin. Division of Motor Vehicles. Feasibility studies for state owned vehicle inspection centers. [Madison] 1969. var.paged. charts, diagrs., maps, tables.
"...pertinent costs and operation factors of four variations of the state owned inspection center concept." Includes investment and operating costs, station layout, organization and manpower requirements for program.

Wisconsin. Division of Motor Vehicles. Motor vehicle inspection: report of activities, July 1, 1968 to December 31, 1968. [Madison, July 1969] 99p.+ illus., charts, forms, tables.
Contents: Summary discussion and conclusions.- Legislative background.- Random motor vehicle inspection.- Voluntary motor vehicle inspection.- Pilot and research project utilizing private garages.- Self inspection motor vehicle inspection program.

Wisconsin. Legislative Reference Bureau. Compulsory motor vehicle inspection. Madison, Oct.1966. 15p. tables, bibl. Inf.Bull.66-4.
Status of state compulsory motor vehicle inspection programs including items inspected and costs.
Table 5. History of compulsory motor vehicle inspection in Wisconsin.

Further recommended reading can be found in state inspection manuals, state summaries of inspection results, and national standards for motor vehicle inspection.

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Learner's Manual.

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ABSTRACT - Ohio State staff personnel
prepared this manual to assist school bus
drivers in the State of Ohio to become
familiar with the transportation laws, to
acquaint them with the best known techniques
of school bus driving, and to impress upon
them the magnitude of their responsibilities.
Ten units include: (1) Introduction to School
Bus Driver Education, (2) Public Relations,
(3) Pupil Transportation Laws and Regulations
in Ohio, (4) Digest of Motor Vehicle Laws of
Ohio, (5) Bus Maintenance, (6) Driving
Fundamentals, (7) Defensive Driving, (8)
Safety and Emergency Procedures, (9) First
Aid, and (10) The Special Child. Most
sections in the units provide content,
orientation material, presentation
suggestions, and a summary. A glossary and
bibliography are included. (GEB)

VT 013 277

ED0 56238

SCHOOL BUS DRIVER TRAINING

BASIC COURSE LEARNER'S MANUAL

OHIO TRADE AND
INDUSTRIAL EDUCATION SERVICE
Division of Vocational Education
State Department of Education
Columbus, Ohio

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SCHOOL BUS DRIVER TRAINING

Basic Course
Learner's Manual

OHIO TRADE AND INDUSTRIAL EDUCATION SERVICE

DIVISION OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF EDUCATION
COLUMBUS, OHIO

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Columbus, Ohio

Revised - 1971

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PREFACE

The purpose of this manual is (1) to assist the school bus drivers in the State of Ohio to become familiar with the transportation laws enacted by the Ohio General Assembly and the transportation rules and regulations adopted by the State Board of Education, (2) to acquaint the drivers with the best known techniques of school bus driving and (3) to impress upon the drivers the magnitude of their responsibilities and the necessity to observe every safety precaution.

A combined effort by the personnel of the Transportation Section of the Division of School Finance and the Trade and Industrial Education Section of the Division of Vocational Education made the writing and publishing of this manual possible.

Special acknowledgment is given to the following individuals for their contributions:

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UNIT I

INTRODUCTION TO SCHOOL BUS DRIVER EDUCATION

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UNIT I

I. TOPIC

Introduction To School Bus Driver Education Program

II. ORIENTATION

A. The content in this unit will include course objectives, class rules and regulations, history of Ohio Driver Education Program, national and Ohio school transportation history, Ohio's program for organization and line of responsibility for transportation, and the ten commandments of transportation safety.

B. It is important to become familiar with the above mentioned items, using them as a foundation to proceed.

III. PRESENTATION

A. Purposes and Objectives of Program

1. Improve the quality and efficiency of school bus driving in Ohio
2. Improve and promote safety procedures
3. Reduce fleet maintenance costs by proper inspection and use of equipment
4. Cause the bus driver to realize his extensive responsibilities and duties
5. Provide adequate training for every bus driver in Ohio

B. Class Rules and Regulations

1. One hundred per cent attendance is required during this training course

   a. Make-up of a missed class is possible in case of an emergency
   b. This must be done through special arrangements with the instructor

2. Score of 75% or better is required on final written examination to pass the course
3. Certificates will be issued upon successful completion of the course based on the above regulations.

   a. A certificate for display in the bus
   b. A billfold certificate will be issued

4. If a class member does not successfully complete the course; he may re-take the training when it is offered.

   a. If he holds a valid Ohio school bus driver's license, the unsuccessful completion of this course does not invalidate said license.
   b. A new driver must successfully complete the Basic Course sometime within the first year of driving.

5. Class sessions will start and end on time.

   a. Ten minute break each hour if schedule permits
   b. Smoking regulations of host institution shall be followed.
   c. Class members are to bring manuals and supplies to each meeting.
   d. Intervals between class sessions should be used for study, review, and practice.

C. History of Ohio's School Bus Driver Education Program

The first historical facts, that can be located, dealing with school bus driver education occurred at Ohio State University in May of 1949. These facts grew from a conference conducted by Dr. Robert Reese and his aide, George Brandon, from the Ohio State University of Trade and Industrial Education.

The main topics discussed at the conference were vehicle maintenance, rules and regulations of the road, and driver education. The conference participants were selected from personnel who had a keen interest as well as experience in school transportation. The participants consisted of School Administrators, Safety Engineers, Driver Education Consultants, and Law Enforcement Officers.

The program remained in a discussion phase with no record of additional conferences or planning until January of 1963 when Trade and Industrial Services in conjunction with Ohio State University and the State Department of Education, established the job classification of School Bus Driver Education Consultant. The State Department of Education had this to say:

> "A few short years ago pupil transportation was a small auxiliary service to be tacked on the school budget and easily administered by spending a few hours with some of the drivers. Today the cost of transportation is a major item in the school budget and administrators spend many hours struggling with the problems that accompany this growth."

School district reorganization and consolidation plus the migration of masses of people to the suburbs have created problems of larger rural school attendance areas. To the bus driver, this means more students to transport, more daily miles

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to travel, and more daily time to devote to the transportation program. No longer should a person be employed to do this job unless some training in the skills and knowledge of driving a school bus has been acquired. The bus driver is hauling truly a most precious cargo.

With the above mentioned thoughts in mind the State Department of Education hired James Provost on February 1, 1963, as transportation consultant under the Division of Vocational Education. Mr. Provost had experience in bus driving, driver education, bus fleet supervision, and school administration.

After studying programs in other states and placing into operation an advisory committee, material and literature were reviewed and an outline, composed of units that the committee thought should be included in Ohio's manual of instruction, were developed.

Mr. Provost completed the final pre-publication copy of the manual and it was used in two pilot programs to test the instruction time involved and the value of the material. A pilot program was held first in a large city school, then one in a predominately rural school to determine if the content was practical for all types of schools. Necessary revisions to the manual were then made, based on the results of the pilot programs, and the manual went to press late in 1963. While the manual was being printed, an instructor's guide was developed to aid the instructors in the sequence of instruction and in timing the units of instruction. The first official classes began early in January of 1964 at Bedford City School in Cuyahoga County and Willoughby-Eastlake School in Lake County. From this date forward Ohio could offer a practical program for the school bus driver.

1. Pre-Employment Course consisting of 36 hours
2. Basic Course consisting of 18 hours
3. Advanced Course consisting of 30 hours

D. History of Pupil Transportation in The United States and Ohio

The first laws governing the transportation of children to school in the United States were enacted in the year 1869. The city of Quincy, Massachusetts provided the first transportation facilities for students in 1874.

Figure 1

Ohio's pupil transportation program was initiated in Ashtabula County in 1892, with a proposal to consolidate some of the school districts. Kingsville Township, Ashtabula County, and other small districts in the area decided to transport their students to a village school rather than build a new school building.

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FOREWORD

The food service industry has undergone changes as far reaching as those experienced by other industries. Improved refrigeration and freezing processes have introduced new ideas in food production and service. The trend is toward centralized food service through use of the commissary and assembly line techniques, microwave ovens, and rapid steam-cooking equipment. Automation has placed new demands on food preparation personnel. These changes, coupled with an ever-expanding population, have given the food service industry a new look.

Food preparation and service, at present, call for a greater degree of skill and a more technical knowledge. Schools at the secondary level and post high school programs must provide the education and training prerequisite for entry into the industry.

The purpose of this manual is to provide a suggested plan to be used by school officials in developing a training program in quantity food preparation. The guide is designed for use by instructors as an aid in developing a course of study. It is *not* for student use. It is a tool to be used only by persons charged with the responsibility of planning the program.

The original guide under this title was published as Circular No. 526 by the U.S. Office of Education in 1958. This revised edition was developed by the Education Department of the National Restaurant Association under contract with the U.S. Office of Education. The manuscript was prepared by John J. MacAllister, Director, School of Hotel and Restaurant Administration, Oklahoma State University.

Consultants who reviewed the manuscript and suggested many improvements were: Kathryn Bruce, Education Department, National Restaurant Association, Chicago; Hilda Watson Gifford, Council on Hotel, Restaurant and Institutional Education, San Francisco; Vincent Galvin, Director, Food Service Course, Edison Technical School, Seattle; and Edward Martin, Director, Educational Services, Chicago and Illinois Restaurant Association, Chicago.

The Division of Vocational and Technical Education expresses appreciation for the cooperation and the assistance of the food service industry in the modernizing of this publication.

WALTER M. ARNOLD
Assistant Commissioner for Vocational and Technical Education

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In order to legalize this procedure, a bill was introduced into the General Assembly of Ohio, and it became a law on April 17, 1894. The first state-wide law providing for pupil transportation was passed by the General Assembly on April 5, 1898.

Ohio's pupil transportation program has undergone many significant changes. The first type of vehicles to be used were horse drawn and, in some cases, the board owned the wagon and hired a driver with a team. The most common practice, however, was to contract with an individual for the service of a driver, conveyance, and team of horses.

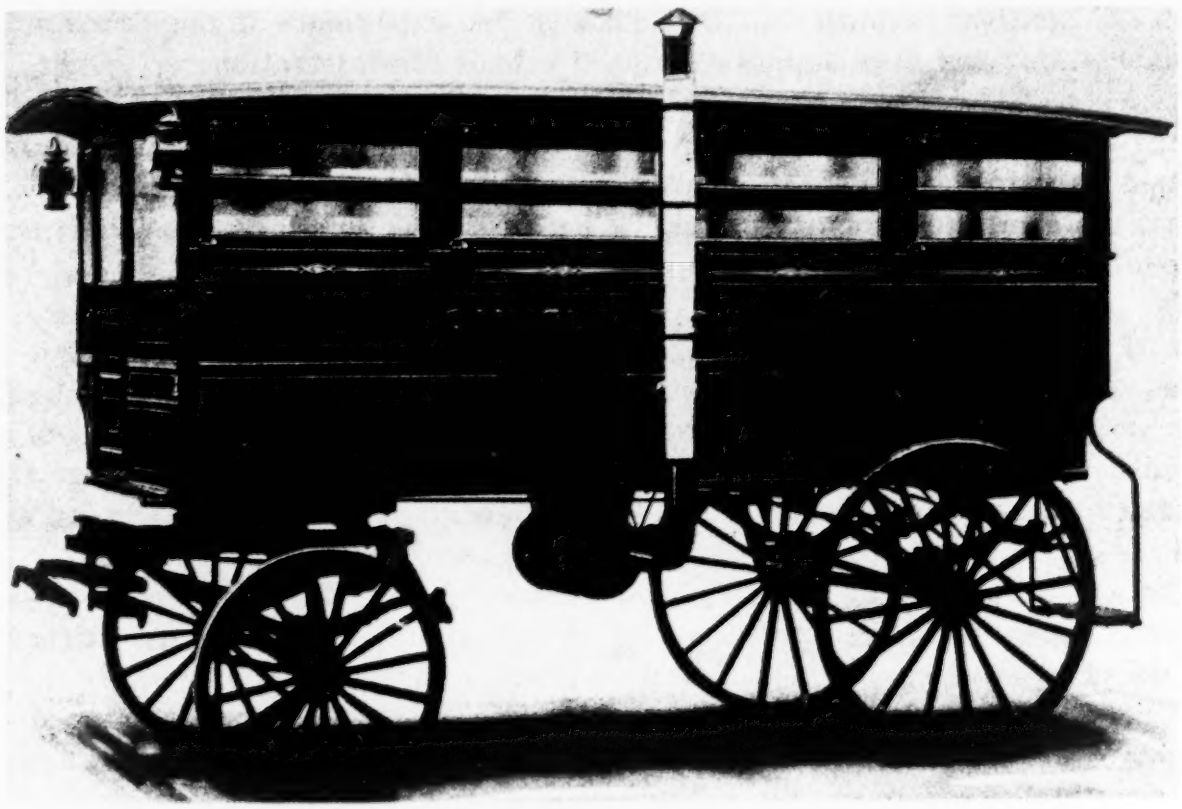

Figure 2

The above vehicle is approximately a 1903 Wayne school car. It was 12 feet long and transported 12 passengers. This vehicle was heated by a corn cob heater.

From these early horse-drawn vehicles to our most modern buses, there has been a constant increase in the number of students being transported to school for their education. The most rapid growth, however, came with the development of the automobile and the building of hard-surfaced roads. At the present time in the State of Ohio, the implementation of the Fair Bus Bill, the reorganization of school districts, people moving to the outlying suburbs, the manufacturing of larger buses, and the building of better roads have all expanded the transportation area of our school districts.

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With the increased square miles of area to be covered, and the use of larger buses, the responsibilities of the school officials and particularly the school bus drivers have grown tremendously.

Some interesting growth patterns can be revealed by comparing the data listed in Table 1:

	School Year 1941-42	School Year 1961-62	School Year 1968-69
1. No. of Buses	6,800	8,908	10,864
2. No. of Pupils Transported	290,000	795,411	1,211,651
3. Total Cost for Ohio	6,998,150	23,309,583	40,554,879

The growth of the total transportation program has brought about many changes in the state, county, and local school's educational programs. Bus service can no longer be classified as an auxiliary service but has become an integral part of the total school program. The number of people involved and the amount of money expended greatly increases the demand for better trained transportation supervisory personnel and school bus drivers. Throughout the years of pupil transportation five general objectives have emerged in the organization and administration of pupil transportation. These are:

a. Safety
b. Economy
c. Adequacy
d. Efficiency
e. Equality

E. Sample School Organizational Chart

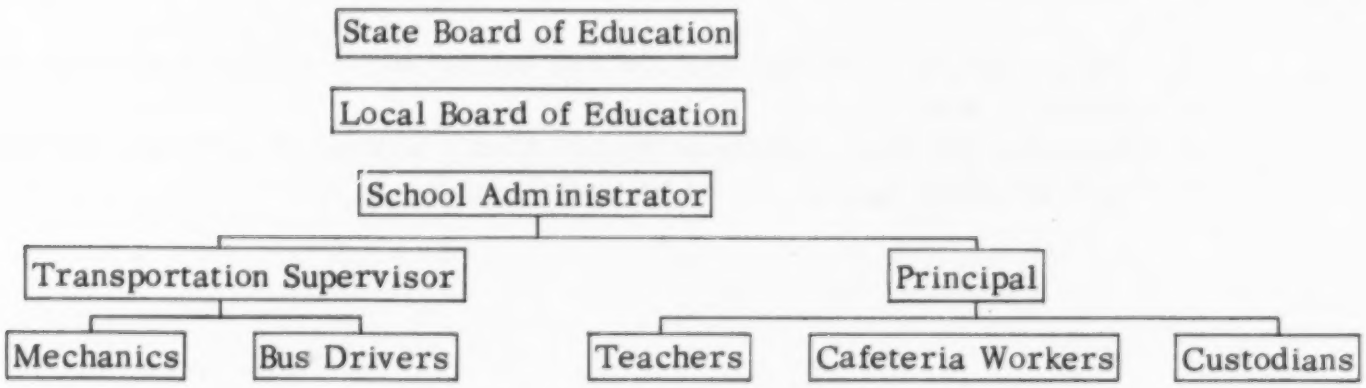

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1. The bus driver should evaluate his position within the program.
2. Teamwork is the only answer.

F. **The Bus Drivers' Ten Commandments of Safety:**

1. Know and obey the traffic laws and regulations set forth in "Ohio Rules and Regulations."
2. Obey all traffic control devices as though they were an actual flesh-and-blood officer.
3. Know that the STOP sign means stop.
4. Do not cross railroad tracks when warning lights, bell, or other warning devices indicate the immediate approach of a train. A slow freight may screen a fast passenger train. The driver must be certain that all tracks are clear before he proceeds.
5. Stay in the correct lane of traffic and heed the yellow line no-passing zones.
6. Be positive that the vehicle is mechanically safe.
7. Drive defensively, always expect the other driver or pedestrian to do the unexpected.
8. Avoid sudden starts and stops.
9. Never take undue risks.
10. Always be courteous in the respect for the rights, lives, and property of others.

IV. SUMMARY

A. Objectives of the program should constantly be kept in mind.
B. The school bus driver should objectively evaluate himself.
C. The necessary action to correct shortcomings or weaknesses should be taken by the driver.
D. Drivers should ask questions as the program moves along.

1. There is no such thing as a stupid question.
2. If any driver doesn't know he should ask.

E. Drivers should know the laws and regulations, and Ten Commandments; and abide by them.
F. Everyone will learn something if each driver's attitude is such that he will give the ideas that are to be presented a try.

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UNIT II

PUBLIC RELATIONS

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UNIT II

I. TOPIC

Public Relations

II. ORIENTATION

"No man is an island unto himself." There are few occupations left in our world which permit a person to work independently. Certainly the business of education recognizes that only when human beings work together can they hope to do a satisfactory job in educating the young people of our nation.

A. Cooperation Is A Must!

1. Parent with teachers.
2. Teachers with administrators.
3. Administrators with supervisors.
4. Bus drivers with all of the above.
5. Professional ethics are a must!

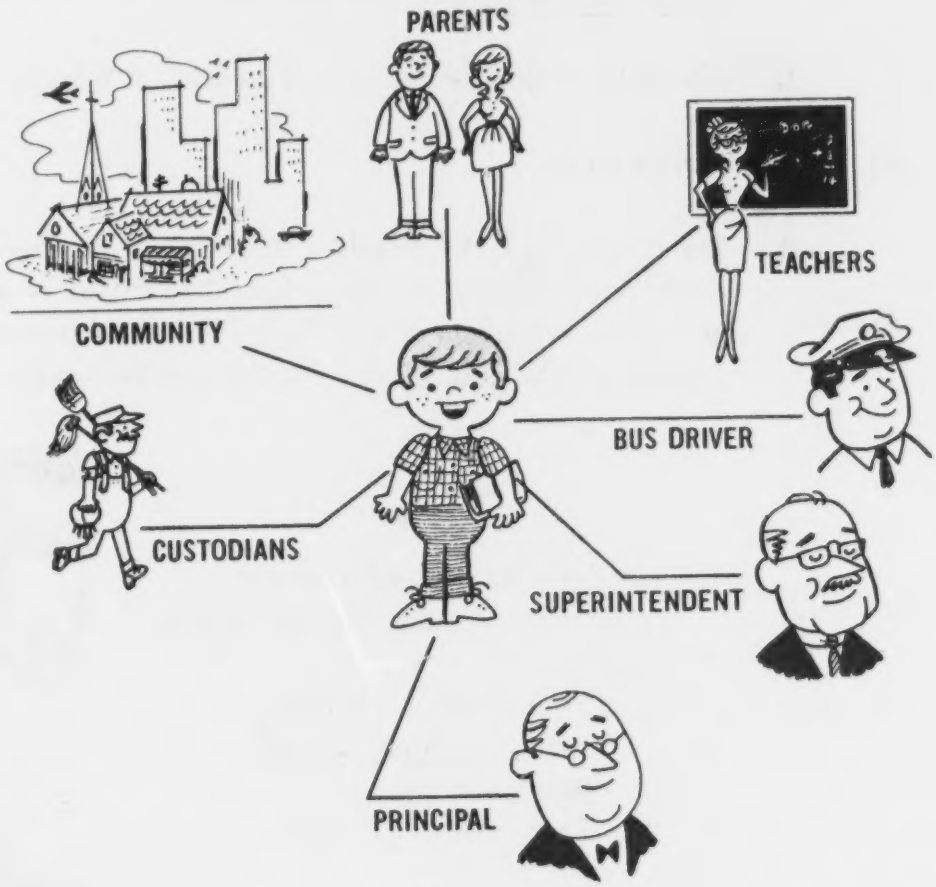

Figure 3

B. Working Together - How well we work together, one with another, depends to a large extent on our relations with other human beings. Human relations is that vital key which can unlock the doors of:

1. Cooperation
2. Effective communication
3. Success of the job to be done

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C. **Bus Driver's Relationship to the Total School Program**

The transportation of pupils to and from school is a far more important part of the total school program than many people would realize. The driver's duties, for example, necessitate that he work in close harmony with:

1. Pupils
2. Fellow school officials
3. Parents
4. Members of the community

D. **Successful Relationships** - His success in these relationships with the people of each of these above areas can have a tremendous effect upon the continued support of the community for its schools. The driver is, then, a public relations agent for the schools.

E. **The School Bus Driver Is a Teacher on Wheels**

III. **PRESENTATION**

A. **The Driver and the Pupils** - Although it is generally understood that the chief responsibility of the school bus driver is to transport the pupils to and from school in a safe and effecient manner, there are other important aspects of the job which should not be overlooked.

1. He can "set the educational tone" of the day for the student.

   a. First contact student has with a school official in the morning.
   b. Last contact at night.

Figure 4

2. He must maintain good control of the students while they ride the bus. This is a must for safe school bus operation. Some guiding principles for the driver which will assist him in maintaining good student behavior and control are:

   a. Recognize his responsibilities and identify himself as a staff member of the school system.

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b. Know the policies and regulations relating to his duties.
c. Explain to the pupils at beginning of school term the rules which govern their conduct on the bus.
d. Conscientiously obey rules governing drivers; setting a good example will create respect.
e. Teach respect by showing respect.

(1) Students should address the driver by proper name; such as, Mr. Brown.
(2) The bus driver should address the student by proper name.

f. Let students know obedience is expected; correct in positive terms, such as "Do this!"
g. Take a personal interest in each pupil.
h. Listen and observe carefully for trouble making situations.
i. Prevention forestalls real trouble when conditions causing trouble are found, correct them as soon as possible.
j. Assigning seats aids student control and in cases of vandalism, aids in the investigation.
k. Delay punishment when angered and upset.
l. A problem child on the bus may be a problem in the classroom; a talk to teacher or principal might help. (Check board policy for procedure.)
m. Give authorized punishment where it is merited; in most cases, a warning is sufficient buy don't threaten unless prepared to carry out the threat.
n. Private personal contact or discussion with problem student may help - do not humiliate.
o. Accept each child as he is and try to help him to greater achievements.

3. The three "F's" in dealing with pupils are:

a. Be friendly but not familiar
b. Be firm but not unduly strict.
c. Be fair and not partial.

4. Be courteous to all students; a "good morning", a "goodbye", and a smile go a long way.
5. Word of warning, however, friendliness can be carried too far; the driver should never joke with students to the extent that he becomes overly familiar.

a. The driver is not a student; the student does not expect him to act like a student.
b. Pupils will not respect the adult who tries to be "one of the crowd."

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6. Proper behavior is learned; not inherited. Teach pupils proper school bus behavior at the beginning of the school year. "As the twig is bent, so grows the tree."

   a. Orientation by classroom teacher.
   b. Orientation through school assemblies.

B. The Driver and Other School Officials

1. As a member of the educational team for a given school district, it is extremely important that cooperation and mutual respect exist between all members of the team.

   a. Classroom teachers
   b. Bus drivers
   c. Supervisors
   d. Custodians
   e. Administrators
   f. Secretaries

   } all have an important job to be done.

2. Respect other school officials' positions and responsibilities.
3. Avoid criticizing other school personnel to students, parents, other drivers, and to the public.
4. Utilize resources of fellow team members.

   a. Problem child on bus

      (1) Talk with his classroom teacher; she may be having the same problem.
      (2) A guidance counselor may have been working with the child and can give some valuable suggestions as to how to correct this pupil.

   b. Possible handicap pupils - the deaf, partially blind, epileptic, other emotional problems, see Unit X.

      (1) See principal's or supervisor's advice (Board policy).
      (2) Classroom teacher or health nurse may help.

   c. The bus driver may have discovered some health or emotional problems which should be shared with other school personnel.
   d. No one team member sees the whole child; but together, a far better picture is obtained.

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C. **The Driver and Parents** - "Each morning I loan you my most precious possession. Please drive carefully and do everything you can to insure he will come home at night; well and healthy." A MOTHER'S PRAYER

1. Parents of pupil passengers on each bus expect a safe trip to and from school each day for their children. (World's most precious cargo)

2. *Driver should create a feeling of security in the minds of these parents by establishing and maintaining safe driving procedures and effective pupil control on his bus.*

Figure 5

3. Parents hear pupils talk about their experiences on the school bus, and all too often, may form opinions as to the driver and the school on this basis.
4. The driver should become acquainted with as many parents as possible.

   a. Driver should get to know parents under pleasant conditions-- it may help later when he needs their cooperation and help on a disciplinary matter.
   b. Driver should make parents feel that he is genuinely interested in their comments and suggestions.

5. Time schedules are important to parents.
6. Pitfalls to be avoided for all school personnel.

   a. Never argue with parents.
   b. Never lose temper when discussing matters with parents.
   c. Never attempt to discuss or handle pupil problems with a parent through the open door of the bus.

      (1) Make arrangements to have the parents contacted.
      (2) Refer the parent to the person in charge of the transportation program for a conference.

7. If the driver has built good human relations with the parents of his passengers, much can be accomplished when the driver needs parental help and cooperation.

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D. **The Driver and the Community** - Every business and industry is constantly concerned about its "public image." Any company which prints the name of the firm on the side of a truck, trailer, or auto must realize that the company's image is created in the minds of thousands of motorists on the highways each day. So it is with a school bus.

A school bus driver is moving a yellow and black sign, thirty-five feet long and eight feet wide, down the community's highways each morning and evening.

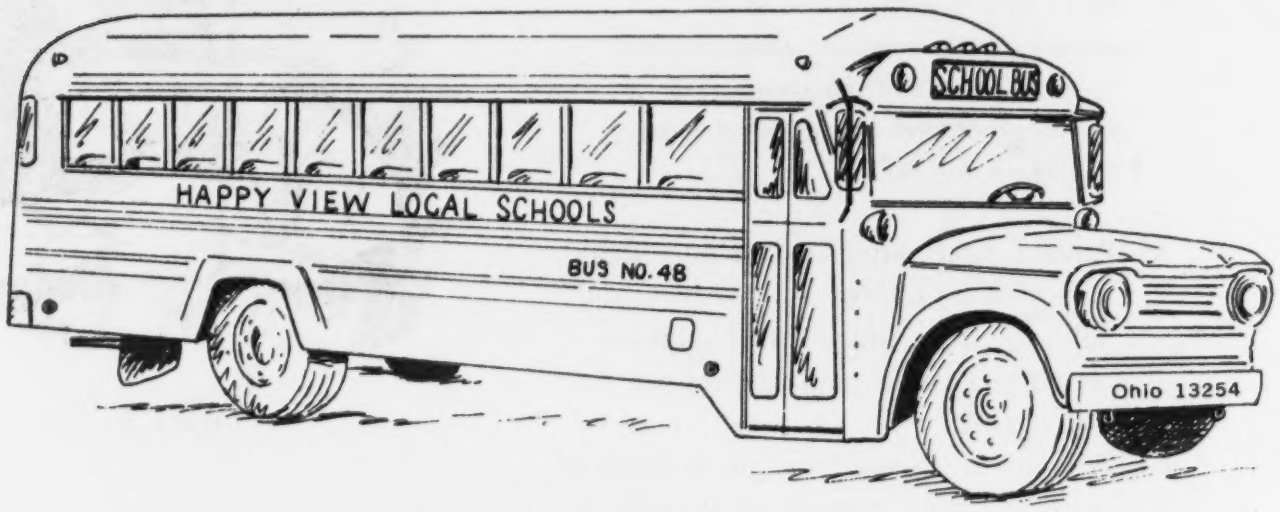

Figure 6
Do you advertise well?

1. The driver must create a favorable image for the school district by:

   a. Being a careful and alert driver.
   b. Observing courtesy on the highways.
   c. Observing local and state traffic laws and regulations on the streets and highways.
   d. Driving a clean "sign" (bus). The vehicle may not be new, but it must be clean, well-kept, and in good mechanical condition.

2. Some citizens in a community have no other contact with the local school except the school bus, which they see each day as it travels up and down their street or road. The driver, the vehicle, and the pupils on that particular bus route are their only bases to judge the school system.

IV. SUMMARY

It is difficult to over-emphasize the importance of human relations. A good over-all school system must have a good transportation program. A poor transportation program will penalize an otherwise sound educational system. The school bus driver plays a key role in the success or failure of the transportation program. He must be constantly aware of his human relations with:

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UNIT III

PUPIL TRANSPORTATION LAWS AND REGULATIONS IN OHIO

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PUPIL TRANSPORTATION LAWS AND REGULATIONS IN OHIO

Introduction

Pupil transportation in Ohio is governed by the Revised Code of Ohio, by Regulations adopted by the State Board of Education, and by policy adopted by school district boards of education.

A Board of Education is limited to powers expressly granted by statute and those necessary to carry into effect the powers expressly granted. Where discretionary powers are vested by statute in a Board of Education, such discretion is limited only by Judicial Review in case of fraud or abuse of discretion (1928 OAG 1714).

These Regulations have been adopted by the State Board of Education with the advice and consent of the Director of Highway Safety.

UNIT III

SECTION ONE

I. TOPIC

Transportation Responsibilities of the State Agencies

II. STATE DEPARTMENT OF EDUCATION

A. Construction and Design of School Buses (Sec. 4511.76(A) O.R.C.)

The State Department of Education shall adopt and enforce standards of construction, design and equipment of all school buses owned and/or operated by public school districts or under contract with a public school district. (See Ohio School Bus Minimum Standards)

NOTE: All other buses are regulated by the Director of Highway Safety. (See Sec. 4511.76(B) O.R.C.)

B. Operating Regulations (Sec. 4511.76(A) O.R.C.)

The State Department of Education shall adopt and enforce regulations which govern pupil transportation administration and operation procedures.

NOTE: All other buses are regulated by the Director of Highway Safety. (See Sec. 4511.76(B) O.R.C.)

C. Fiscal Responsibilities (Sec. 3317.051 O.R.C.)

1. The State Board of Education shall determine by formula the total amount of money approved for each district in which the transportation meets the regulations prescribed by it to secure an efficient and economical program of pupil transportation. (Sec. 3327.012 O.R.C.)
2. The State Board of Education shall adopt a formula for assistance to eligible districts for the purchase of school buses. (Sec. 3317.07 O.R.C.)

D. Area Coordinator (Transportation)

1. The Area Coordinator (Transportation) has the following responsibilities:

   a. Designate collection points (Sec. 3327.01 O.R.C.)
   b. Establish routes, schedules, and utilization of equipment that has been recommended by each board of education to whatever extent is feasible. (Section 3327.011 O.R.C.)

III. COUNTY BOARD OF EDUCATION, CITY AND EXEMPTED VILLAGE SUPERINTENDENTS

A. The County Board or City or Exempted Village Superintendent shall provide annual physical examinations for school bus drivers. (Sec. 3327.10 O.R.C.)

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B. The County Board or City or Exempted Village Superintendent shall issue a drivers' certificate upon determining that each school bus driver and substitute driver has met the requirements as established by the Ohio Revised Code and these regulations. (See School Bus Driver)

C. The County Board of Education or City or Exempted Village Superintendent may revoke such certificate:

1. When the school bus driver fails to meet the requirements established by these regulations. (See School Bus Driver)
2. When a driver is found guilty of improper conduct or has failed to notify the authorities of all traffic violations and convictions; or has failed to comply with any laws of the State of Ohio, Regulations of the State Board of Education, or policies of the school district of employment.

D. The county, city or exempted village superintendent shall provide at least one (1) annual safety workshop for transportation personnel.

IV. LOCAL, CITY AND EXEMPTED VILLAGE SCHOOL BOARD RESPONSIBILITIES

A. District Boards of Education:

1. Are responsible for the operation of the school transportation program. The Board of Education may delegate the authority for direct control to the superintendent or other administrative employee.
2. Shall provide transportation for all pupils so crippled that they are unable to walk regardless of the distance to a school where the State Board of Eduction prescribes minimum standards. (Sec. 3327.01 O.R.C.)
3. Shall provide transportation for all resident elementary children who live more than two miles from the public school to which they are assigned or to the non-public school to which they attend. (Sec. 3327.01 O.R.C.)
4. Shall recommend to the Area Coordinator (Transportation) routes, schedules, and utilization of transportation equipment. (Sec. 3327.011 O.R.C.)
5. Shall adopt a time schedule and put in force no later than ten days after the beginning of the school term. (Sec. 3327.01 O.R.C.)

B. District Boards of Education may:

1. Provide transportation for high school pupils. (Sec. 3327.01 O.R.C.)
2. Provide transportation for any elementary or high school pupils residing any distance. (Sec. 3327.01 O.R.C.)
3. Pay a parent or guardian in lieu of transporting an eligible pupil when the board deems such transportation impractical. (Sec. 3327.01 O.R.C.)
4. Procure accident insurance on school buses. When carried by the Board, the amount of liability insurance shall not exceed five hundred thousand dollars. (Sec. 3327.09 O.R.C.)

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5. Designate depots to gather pupils for transportation purposes. If the board designates such a depot, they shall provide a shelter. (Sec. 3327.03 O.R.C.)
6. Maintain turn-around points. (Sec. 3327.12 O.R.C.)
7. Make cooperative agreements with recreation commissions for the use of school buses to transport students taking part in summer recreation programs. (OAG 67-081-1967)
8. Assess a fee, not to exceed the actual cost, for transportation to and from established educational exhibits and programs during summer months, Saturdays, and holidays.
9. Use buses for summer or auxiliary service programs for resident pupils sponsored by district boards of education.

NOTE: Transportation operational expense records must be maintained for sections 8 and 9 above. Such expenses are not reimbursable through state foundation monies.

10. Permit the use of school buses in the event of civil emergency.

C. **Boards of Education shall not:**

1. Transport pupils to or from any school which practices discrimination against any person on the grounds of race, color, religion, or national origin. (Sec. 3327.01 O.R.C.)
2. Pay a parent more than the state average cost per pupil for transporting pupils in the previous school year, when the board pays the parent or guardian in lieu of transporting a pupil eligible for such service. (Sec. 3327.01 O.R.C.)
3. Transport pupils residing within another district without that school district's written consent. (Sec. 3327.05 O.R.C.)
4. Transport pupils to a school which does not meet the minimum standards prescribed by the State Board pursuant to Division (D) of Section 3301.07 of the Revised Code. (Sec. 3321 O.R.C.)

D. **District Boards of Education Are Not Required to Provide Transportation For:**

1. Non-public pupils who attend a school which requires more than 30 minutes of direct travel time as measured by a school bus from the collection point to the pupil's school of attendance. (Sec. 3327.01 O.R.C.)
2. Pupils where it is impractical to provide such service with a school bus. (Sec. 3327.01 O.R.C.)
3. Pupils, when in the judgment of such board of education and confirmed by the State Board of Education, such transportation is unnecessary or unreasonable. In determining the necessity for transportation, availability of facilities and distance to school shall be considered. (Sec. 3327.01 O.R.C.)

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UNIT III

SECTION TWO

I. TOPIC

Transportation Personnel Responsibilities

II. THE TRANSPORTATION ADMINISTRATOR (SUPERINTENDENT OR SUPERVISOR)

A. A transportation administrator may be the superintendent, local superintendent, principal, transportation supervisor or any other person designated by the Board of Education to administer the transportation program. The Board of Education may delegate the administration, but not its legal responsibilities for, pupil transportation.

B. The transportation administrator shall provide safe school buses by:

1. Assuring that all school buses meet or exceed the "Ohio School Bus Minimum Standards" in effect at the time of purchase.
2. Providing a quality, continuing maintenance program.
3. Providing for the pre-inspection and completion of Form T-30 (O.D.E.) for all school buses before the annual Ohio State Highway Patrol inspection.
4. Assuring that all school buses are presented for inspection.
5. Providing for regular safety inspections and correcting immediately all deficiencies noted.

C. Is responsible for recommending to the Board of Education the names of qualified applicants for employment.

D. Shall see that all school bus drivers are instructed as to routes, time schedules, duties, laws, regulations, and school district policies related to pupil transportation.

E. Is responsible for seeing that all drivers meet the requirements of the laws of Ohio and Ohio Department of Education regulations before driving a bus with pupils on board. He shall make arrangements for the basic school bus driver's education program. (See School Bus Driver)

F. He shall maintain a school district map or route description system indicating all routes, pick-up points, names of students by bus by stop, the grade and school of attendance, and a route time schedule.

G. He shall administer the transportation policies and procedures relating to pupil behavior.

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H. He shall, in the case of city and exempted village school districts, provide for one (1) annual safety workshop for transportation personnel. Local school district transportation administrators shall require the transportation personnel to attend one (1) annual county sponsored safety workshop.

I. He shall be responsible for maintaining accurate records of:

1. Vehicle inventory
2. Daily miles traveled
3. Students transported
4. Annual operating costs by vehicles for the regularly scheduled trips.

J. He shall maintain accurate record of annual miles and costs for non-routine use of school buses.

K. He shall provide all information as required by the Ohio Department of Education.

III. THE SCHOOL BUS DRIVER

A. To be employed as a school bus driver the following requirements must be met:

1. Be at least 21 years of age.
2. Be of good moral character.
3. Be physically qualified as determined by an annual physical examination meeting the criteria established by Ohio Department of Education Form T-8.
4. Prior to testing by the Ohio State Highway Patrol, be trained in the operation of a school bus and have a knowledge of the Transportation Laws and Regulations.
5. Hold a current Ohio Chauffeur's License marked "School Bus Operator".
6. Hold a current bus driver's certificate issued by the County Board of Education or City or Exempted Village Superintendent.
7. Shall be required to satisfactorily complete the State Department of Education's Basic School Bus Driver Education Program within the first year of employment as a school bus driver.
8. Attend all safety workshops and meetings as required by district administration.

B. It is recommended that boards of education not employ any person as a school who has passed his 65th birthday.

C. No person shall be employed as a bus driver who is addicted to alcohol, narcotics or other drugs of a sedative nature.

D. The bus driver shall not use or permit the use of tobacco while pupils are on the bus.

E. The use of stimulants, sedatives or any other substance which will affect the bus driver's judgment and driving ability during his routes is prohibited.

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UNIT III

SECTION THREE

I. TOPIC

Operational Regulations

II. SCHOOL BUS OPERATIONS AND DRIVING PROCEDURE

A. The school bus driver shall make a daily inspection to determine if the bus is in safe operating condition.
The following items should be checked:

1. Air Brakes - (a) Drain water from air reservior tanks
   (b) Air pressure indicators
2. Brake Pedal - Travel on hydraulic brake systems
3. Steering
4. Tires and Wheel Lugs
5. Engine Oil Level - Must not be below "add" mark
6. Radiator Coolant Level
7. Emergency Equipment
8. Heaters and Defrosting Equipment (seasonal)
9. Lights
10. Instruments and Gauges
11. Horn
12. Windshield Wipers and Washers
13. Interior Cleanliness
14. Glass Areas - Clear vision to front, sides and rear

B. All items checked and found deficient shall be reported to responsible authority. Mechanical defects shall be reported in writing.

C. In no event shall a bus be driven backward on school grounds while children are being loaded or unloaded.

D. When departing from the loading area, buses shall maintain a safe interval. No passing shall be permitted in the loading area.

E. Bus drivers shall maintain a distance of 300 feet behind any preceding moving vehicle while traveling on the highway at normal speed.

F. School buses operating on divided highways or highways with four or more traffic lanes shall receive and discharge all school children on their residence side of the highway. (Sec. 4511.75(C) O.R.C.)

G. Before receiving and discharging pupils on the highway, the bus shall be driven to the right side of the paved or traveled portion of the roadway and brought to a full stop.

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H. The bus driver shall be the only operator of the service entrance door. The door shall not be opened to load or unload pupils until traffic has cleared the bus or come to a complete stop in all directions.

I. Warning flasher lights shall be used to prewarn other motorists of the intention of the bus to stop for the singular purpose of loading or unloading pupils. The lights shall remain in operation during the total time the bus remains stationary.
Warning flasher lights shall not be used:

(1) When stopped for railroad grade crossings
(2) While stopped on traveled highway used for loading and unloading pupils at school locations
(3) At turn arounds

J. Driver shall not use service door control to activate warning flasher lights. Door must remain in complete "locked" position while bus is in motion.

K. Four-way hazard lights may be used at bus turn arounds.

L. The bus shall not be started in motion until after pupils who have been discharged from the bus have reached a place of safety on their residence side of the road. (Sec. 4511.75(D) O.R.C.)

M. The driver shall use the established route and make stops as designated by the board of education or the administrator who is authorized to designate such stops.

N. The driver shall operate the bus on the approved time schedule and shall wait for pupils if running ahead of schedule.

O. School buses shall be brought to a stop before crossing railroad grade crossings and while so stopped, the driver shall listen through an open door or open window and look in both directions along the track. He shall not proceed until safe to do so.
The driver shall cross only in such gear of the vehicle that there will be no necessity for changing gears during the crossing. (Sec. 4511.63 O.R.C.)

P. The school bus driver shall require silence of all pupils at all railroad crossings. All school bus drivers shall obey all state and local traffic laws.
SPEED (Sec. 4511.21 O.R.C.)
No person shall operate a motor vehicle, trackless trolley, or streetcar in and upon the streets and highways at a speed greater or less than is reasonable or proper, having due regard to the traffic, surface, and width of the street or highway and any other conditions, and no person shall drive any motor vehicle, trackless trolley, or streetcar in and upon any street or highway at a greater speed than will permit him to bring it to a stop within the assured clear distance ahead.

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Introduction

The food service industry has undergone many changes and substantial expansion during the past two decades. These changes have created an unprecedented increase in the demand for well-trained personnel in food service. New production methods, improved refrigeration, pre-prepared frozen foods, mixes, and new types of equipment have caused the industry to look to the schools for trained workers.

In the past, outstanding chefs, cooks, and bakers, trained under the European apprenticeship system, were the main supply source. American hotel and restaurant operators experienced little difficulty in staffing their kitchens with distinguished food artists. Young Americans interested in becoming chefs could train under the tutelage of master craftsmen.

During the 1920's European-trained workers were beginning to be in short supply. Two distinct factors contributed to this shortage:

1. Immigration restrictions under the quota system limited the number of persons admitted to this country as potential citizens, and the aftereffects of World War I drastically curtailed the employment of many Europeans.
2. Hotel and restaurant operators, accustomed to obtaining qualified food preparation people from abroad, gave little thought to the need for programs to train American youths and adults for careers in the industry.

Neither food service operators nor educators gave much thought to the problem. Consequently, the importance of establishing training programs for food workers was neither fully recognized nor explored.

Generally, European-trained chefs believed that the apprenticeship system was the only way to prepare qualified cooks. Because this type of training for foods personnel was not popularly accepted in our country, apprenticeship programs in the food preparation field were not very successful and little was done to promote them.

An awareness on the part of hotel and restaurant operators of the growing shortage of European-trained chefs and cooks caused no little concern. Where were they to find the skilled food workers to meet their future needs?

A few farsighted leaders in the field advocated establishing organized vocational education programs in public schools. Outstanding proponents of this school of thought were Herman A. Breithaupt,[1] August Forester,[2] and Paul Muellet.[3] These leaders sought and gained the support of local school boards and were able to initiate food service training programs in public schools and post-high-school educational institutions.

As a result of the successful operation of these and similar programs, the food service industry began to realize that educational programs could produce the required skilled personnel. Consequently, public school systems were urged to develop and expand food service training.

The Council on Hotel, Restaurant and Institution Education—a membership organization composed of educators and industry representatives—and the Statler Foundation have actively supported and promoted the establishment of education for the food service industry. The National Restaurant Association and The American Hotel-Motel Association, working through their educational departments, have encouraged public school systems to establish food service training programs. Hotel and restaurant operators, as well as allied industry people, have done much to elevate the prestige or status of food service careers. Many hotel, restaurant, and allied firms have stimulated young people to seek careers in the food service industry by establishing scholarships.[4]

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[1] Herman A. Breithaupt established a foods training program at Chadsey High School in Detroit, Mich., in 1939.

[2] August Forester set up one of the first food programs at Washburne Trade School in Chicago, Ill.

[3] Paul Muellet organized a program at the Edison Technical School in Seattle, Wash.

[4] The Council on Hotel, Restaurant and Institution Education, Statler Hall, Ithaca, N.Y., publishes a bulletin listing available scholarships.

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The maximum speeds for school buses are:

1. 20 MPH in school zones (during restricted hours).
2. 25 MPH inside corporations, except on state routes, through highways outside business districts and alleys.
3. 35 MPH on state routes or on through highways within municipalities outside business districts.
4. 50 MPH on controlled-access highways and expressways within municipal corporations (day or night).
5. 55 MPH on freeways outside municipal corporations (day or night).
6. 15 MPH on alleys within municipal corporations.

Section 4511.22 O.R.C.

No person shall operate a vehicle, trackless trolley, or streetcar at such a slow speed as to impede or block the normal and reasonable movement of traffic, except when reduced speed is necessary for safe operation or to comply with law.

Q. A school bus shall not be refueled while the engine is running.

R. The driver shall not leave the bus until the brakes are set, the engine stopped and the ignition key is removed.

III. TRAFFIC REGULATION

A. No school bus shall be stopped, or shall be turned so as to proceed in the opposite direction, upon any curve or upon the approach to or near the crest of a grade, where such vehicle cannot be seen by the driver of any vehicle approaching from either direction within 500 feet. (Sec. 4511.37 O.R.C.)

B. The school bus driver shall permit other vehicles to pass when a line of traffic accumulates at the rear of the bus. (Sec. 4511.75(A) O.R.C.)

C. A school bus shall not be parked within the limits of the highway right-of-way. (Sec. 4511.66 O.R.C.)

IV. PUPIL BEHAVIOR

A. While riding on a school bus, reasonable conversation is permissible and may be regulated by the driver.

B. The driver shall be in charge of the bus at all times and shall be responsible for order. He should not exclude a pupil from the bus. The driver shall report the unmanageable pupil to the proper authority. Disorderly conduct shall be sufficient reason for refusing transportation service to any pupil.

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C. Whenever it becomes necessary to refuse a pupil transportation, the school authorities shall notify the parents of such refusal with a full explanation. Until such time as the school authorities have received assurance from the parents of future good conduct on the part of the pupil and the bus driver has been so advised, the driver shall not permit the pupil to board the bus.

V. SCHOOL BUS ACCIDENT REPORTING

The bus driver shall report any accident involving a school bus to the police agency within whose jurisdiction the accident has occurred and to the superintendent of schools.

The superintendent of the school district whose bus was involved in an accident shall report such accident on Department of Education Form T-10 within fifteen days from the time of the accident.

A copy of each report shall be retained in district file for a period of five years.

Definition of Motor Vehicle Accident

(a) Any incident or occurrence involving a school bus operated by or under contract to a school district which results in a fatality, an injury, or damage to any motor vehicle or property.

(b) Any action taken by a bus driver employed by a school district which contributes directly to any fatality, injury or damage to any motor vehicle or property.

VI. LOADING AND UNLOADING AT SCHOOL FACILITIES

A. When it is necessary to load or unload pupils off the school grounds, the bus shall be stopped and positioned so that pupils do not cross the road to get to or from the bus.

B. All warning flasher lights shall be turned off while loading and unloading at the school building in order that traffic may proceed without interference.

C. Bus drivers shall remain on the bus while pupils are loading and unloading.

D. Pupils waiting to board buses shall be supervised by school authorities.

VII. SCHOOL BUS STOPS

The board of education shall approve all bus stops. School bus stops shall be limited so far as possible. Pupils may be required to walk to a designated bus stop.

VIII. PUPIL LOAD

Pupils may be assigned seats. The number of pupil standees shall not exceed 10% of the number seated.

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IX. NON-ROUTINE USE OF SCHOOL BUSES

A. The regulations governing non-routine use of buses apply to vehicles owned and operated by boards of education or under contract to a board of education. The regulations pertain to summer use of buses as well as during the regular school year.

B. Trip Permit
City, exempted village and local superintendents shall issue a trip permit for each co-curricular use of a school bus. The permit shall provide the following information: (1) date of the trip; (2) destination of trip; (3) purpose of the trip; (4) name of the school district; (5) driver's name; (6) bus registration number; (7) total miles of trip; (8) superintendent's signature.

C. School buses may be used to transport pupils to and from any event that is a planned part of the classroom or the educational program. Expenses may be paid from the general fund.

D. School buses may be used to transport participating pupils to and from any co-curricular activity programs approved by the district boards of education. Pupil participants living on the most direct route to the activity from the school may be picked up and discharged as far as is practical. These expenses shall not be paid from the general fund.

E. Each event that requires the use of more than five school buses to transport participants to and from a co-curricular activity shall require a resolution by the district board of education.

F. School buses shall not be used for pleasure trips.

G. School buses shall not be used to transport spectators, either student or adult.

H. Adults may be transported to assist teacher on educational trips, if approved by the superintendent.

I. Students may not be transported to observe college or professional games - i.e., football team, band, etc.

J. Buses shall not be used for combination trips such as taking students to a museum in the morning and to view a football contest in the afternoon.

K. No pupil charge may be made for transporting pupils in any school bus to and from regular day classes and other co-curricular trips on school days. This applies equally to board-owned buses and privately owned buses operated under contract with a board of education.

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OHIO PUPIL TRANSPORTATION REGULATIONS

DEFINITIONS

Area Coordinator (Transportation)

A representative of the Ohio Department of Education who serves as liason in matters relating to pupil transportation and other services.

Civil Emergency

An unnatural condition resulting from an act of nature such as a flood or earthquake, from a catastrophe such as an explosion or fire or from a riot, etc., which threatens the safety of the general public.

Co-Curricular Activity

Any event or program approved by the board of education.

Four-Way Hazard Lights

Flashing signals used to warn other motorists of the presence of a vehicular traffic hazard requiring unusual care in approaching, overtaking or passing.

Non-Routine Use of School Buses

Every use of school buses other than the usual day to day transportation of pupils to and from school.

O.A.G.

Ohio Attorney General

O.D.E.

Ohio Department of Education

O.R.C.

Ohio Revised Code

Warning Flasher Lights

Alternately flashing signals used to inform other motorists of the school bus driver's intent to stop for the purpose of receiving or discharging school children.

Forms

T- 8 - School Bus Driver Physical Examination Report
T-10 - School Bus Accident Report
T-30 - Ohio Department of Education School Bus Inspection Form

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STATE LAWS PERTAINING TO PUPIL TRANSPORTATION

SEPARATE FACILITIES FOR MENTALLY RETARDED CHILDREN

3313.88

The board of education of any school district may establish separate schools or facilities for the instruction of mentally retarded children and may:

(A) Expend school funds in the establishment of such schools or facilities;

(B) Provide for the transportation of any such pupils to and from the schools or facilities established under this section;

(C) Contract with the child welfare board, the board of county commissioners, or any municipal corporation to provide training for mentally retarded children upon whatever terms the contracting parties agree upon for the division of the cost of maintaining and operating the schools or facilities for such pupils. (127 v H568. Effective 9-16-57.)

Board may contract for transportation of mentally retarded pupil to public school in another district, but not to private school.

TRANSPORTATION OF PUPILS; EXCESS COST FROM FEDERAL FUNDS

3327.01

In all city, exempted village, and local school districts where resident elementary school pupils live more than two miles from the school for which the state board of education prescribes minimum standards pursuant to division (D) of section 3301.07 of the Revised Code and to which they are assigned by the board of education of the district of residence or to and from the non-public school which they attend the board of education shall provide transportation for such pupils to and from such school except when, in the judgment of such board, confirmed by the state board of education, such transportation is unnecessary or unreasonable.

In all city, exempted village, and local school districts the board may provide transportation for resident high school pupils to and from the high school to which they are assigned by the board of education of the district of residence or to and from the non-public high school which they attend for which the state board of education prescribes minimum standards pursuant to division (D) of section 3301.07 of the Revised Code.

In determining the necessity for transportation, availability of facilities and distance to the school shall be considered.

A board of education shall not be required to transport elementary or high school pupils to and from a non-public school where such transportation would require more than thirty minutes of direct travel time as measured by school bus from the collection point as designated by the coordinator of school transportation, appointed under section 3327.011 of the Revised Code, for the attendance area of the district of residence.

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Where it is impractical to transport a pupil by school conveyance, a board of education may, in lieu of providing such transportation, pay a parent, guardian, or other person in charge of such child, an amount per pupil which shall in no event exceed the average transportation cost per pupil, such average cost to be based on the cost of transportation of children by all boards of education in this state during the next preceding year.

In all city, exempted village, and local school districts the board shall provide transportation for all children who are so crippled that they are unable to walk to and from the school for which the state board of education prescribes minimum standards pursuant to division (D) of section 3301.07 of the Revised Code and which they attend. In case of dispute whether the child is able to walk to and from the school, the health commissioner shall be the judge of such ability.

When transportation of pupils is provided the conveyance shall be run on a time schedule that shall be adopted and put in force by the board not later than ten days after the beginning of the school term.

A district receiving a payment pursuant to division (B) of section 3317.02 of the Revised Code is not eligible for reimbursement of transportation operating costs or eligible for school bus purchase subsidy payment pursuant to section 3317.06 of the Revised Code, except for transporting children who are crippled and for transporting pupils attending non-public schools.

The cost of any transportation service authorized by this section shall be paid first out of federal funds, if any, available for the purpose of pupil transportation, and secondly out of state appropriations, in accordance with regulations adopted by the state board of education.

No transportation of elementary or high school pupils shall be provided by any board of education to or from any school which in the selection of pupils, faculty members, or employees, practices discrimination against any person on the grounds of race, color, religion, or national origin. (132 v S 451. Effective 2-29-68. 132 v H 823, H1; 131 v S 365)

3327.011

Coordinators of school transportation shall be appointed according to provisions of section 3301.13 of the Revised Code to assure that each pupil, as provided in section 3327.01 of the Revised Code, is transported to and from the school which he attends in a safe, expedient, and economical manner using public school collection points, routes, and schedules.

In determining how best to provide such transportation, where persons or firms on or after April 1, 1965, were providing transportation to and from schools pursuant to contracts with persons or agencies responsible for the operation of such schools, a coordinator or the board of education responsible for transportation in accordance with section 3327.01 of the Revised Code shall give preference if economically feasible during the term of any such contract to the firm or person providing such transportation.

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The boards of education within the county or group of counties shall recommend to the coordinator of transportation routes, schedules, and utilization of transportation equipment. The coordinator, upon receipt of such recommendations, shall establish transportation routes, schedules, and utilization of transportation equipment, following such recommendations to whatever extent is feasible. The appeals from the determination of the coordinator shall be taken to the state board of education. (132 v H 455. Effective 12-11-67. 131 v S 365)

DESIGNATION OF DEPOTS

3327.03

The boards of education of city, exempted village, and local school districts may by resolution designate certain places as depots from which to gather children for transportation to school, when such districts provide transportation. The places designated as depots shall be provided with a shelter and be made comfortable during cold and stormy weather.

TRANSPORTATION OF NONRESIDENT PUPILS

3327.05

The board of education of any school district shall not provide transportation for any pupil who is a school resident of another school district unless the board of the district of the pupil's residence has given its written consent thereto. If the board of any school district files with the state board of education a written complaint that transportation for resident pupils is being provided by the board of another school district, contrary to this section, the state board of education shall make an investigation of such complaint. If the state board of education finds that transportation is being provided contrary to this section it may withdraw from state funds due the offending district any part of the amount that has been approved for transportation pursuant to section 3317.051 of the Revised Code. (126 v 288. Effective 10-1-56.)

SCHOOL BUSES AND DRIVERS

Purchase of School Buses; Terms; Bidding

3327.08

Boards of education of city school districts, exempted village school districts, local school districts, joint high school districts, and joint vocational schools may purchase on individual contract school buses and other equipment used in transporting children to and from school and to other functions as authorized by the boards of education, or the boards may, at their discretion, purchase such buses and equipment through whatever system of centralized purchasing is established by the state department of education for such purpose, provided that state subsidy payments shall be based on the amount of the lowest price avialable to the boards by either method of purchase. No such board of education

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shall be deprived of any form of state assistance in the purchase of said buses and equipment by reason of purchases of said buses and equipment on an individual contract. Boards of education, in the purchase of said buses and equipment on individual contract shall make such purchases on the following terms:

(A) Not less than one-fourth of the purchase price thereof shall be paid in cash.

(B) Not less than an additional one-fourth of the purchase price thereof shall be paid within one year from the date of purchase.

(C) Not less than an additional one-fourth of the purchase price thereof shall be paid within two years from the date of purchase.

(D) The remaining balance of the purchase price thereof shall be paid within three years from the date of purchase. Such boards may issue the notes of the school districts signed by the president and the clerk of the board, and specifying the terms of the purchase including deferred payments as provided in this section, which notes may bear interest at a rate not exceeding four per cent per annum. In the legislation under which such notes are authorized, the board shall make provision for levying and collecting annually by taxation amounts sufficient to pay the interest and the specified portion of the principal. Revenues derived from local taxes or otherwise, for the purpose of providing transportation of children or for defraying the current operating expenses of such district, may be applied to the payment of such interest and the retirement of such notes.

The purchase of school buses shall be made only after competitive bidding in accordance with divisions (A), (B), (C), (D), (E), (F), (H), and (I) of section 3313.46 of the Revised Code. Separate and independent bids shall be received with respect to the chassis and body type, and shall state that the buses, when assembled and prior to delivery, comply with the safety regulations of the department of education adopted by and with the advice and consent of the director of highway safety pursuant to section 4511.76 of the Revised Code and all other pertinent provisions of law. (131 v H 760. Effective 11-8-65.)

INSURANCE ON BUSES AND PUPILS

3327.09

The board of education of each school district may procure liability and property damage insurance covering each school bus or motor van and accident insurance covering all pupils transported under the authority of such board. This insurance shall be procured from a recognized insurance company authorized to do business of this character in the state, and such accident insurance shall provide compensation for injury or death to any pupil caused by any accident arising out of or in connection with the operation of such school bus, motor van, or other vehicle used in the transportation of school children, in such amounts and upon such terms as may be agreed upon by the board and the insurance

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company. The amount of liability insurance carried on account of any school bus or motor van shall not exceed five hundred thousand dollars. Such insurance coverage may be effected in one or more recognized insurance companies authorized to do business in this state. (130 v H 268. Effective 9-16-63.)

QUALIFICATION OF DRIVER

3327.10

(A) No person shall be employed as driver of a school bus or motor van, owned and operated by any school district or privately owned and operated under contract with any school district in this state, who has not received a certificate from the county board of education of the county in which he is to be employed, in case such person is employed by a school district under the supervision of the county board, or by the superintendent of schools, in case such person is employed by the board of a city or exempted village school district, certifying that such person is at least twenty-one years of age and is of good moral character and is qualified physically and otherwise for such position. The county board or the superintendent, as the case may be, shall provide for an annual physical examination that conforms with regulations adopted by the state board of education of each driver to ascertain his physical fitness for such employment. Any certificate may be revoked by the authority granting the same on proof that the holder has been guilty of improper conduct, failing to file all traffic convictions with the county board or the superintendent, or neglect of duty and the said driver's contract shall be thereby terminated and rendered void.

(B) No person shall be employed as driver of a school bus or motor van not subject to the regulations of the department of education pursuant to division (A) of this section who has not received a certificate from the school administrator or contractor certifying that such person is at least twenty-one years of age, is of good moral character, and is qualified physically and otherwise for such position. Each driver shall have an annual physical examination which conforms to the state highway patrol regulations, ascertaining his physical fitness for such employment. Any certificate may be revoked by the authority granting the same on proof that the holder has been guilty of improper conduct, failing to file all traffic convictions with the school administrator or contractor, or neglect of duty and such driver's contract shall be thereby terminated and rendered void.

(C) Any person who drives a school bus or motor van must give satisfactory and sufficient bond except a driver who is an employee of a school district and who drives a bus or motor van owned by the school district. (130 v H 161. Effective 10-14-63. 129 v 1003)

The Outlook for the Food Service Industry

Large increases in population, coupled with greater per capita income, have brought about an accelerated demand for persons in food service. At present the food service industry is ranked as the Nation's fourth largest.

Reports published by the United States Bureau of Census [5] indicate that there were approximately one-half million establishments serving food in 1963.[6] Commercial establishments accounted for more than 50 percent of the three million persons employed in the industry. Food sales by commercial establishments in 1963 totaled $18.5 billion, an increase of 20 percent over 1958. Population expansion, higher income levels, and increased leisure time have exerted pressure on the food service industry.

If the Nation's population continues to expand at the present rate, the food service industry will experience a similar growth rate. Industry expansion will stimulate the development of more efficient food preparation techniques. Improved equipment and techniques will simplify production processes and make possible greater productivity. As a consequence, the demand for well-trained food workers will continue to grow. One of the major sources of these workers will be graduates of commercial food service programs conducted by technical and vocational high schools and other post-high-school educational institutions.

Objectives of the Suggested Program

This manual is designed to assist the instructor in planning the course content for a quantity foods preparation training program; the broad objectives and specific goals of the program are identified as follows:

Broad Objectives

1. To determine the range of training required for personnel in food preparation.
2. To suggest the relative emphasis that should be placed on the various areas of instruction.
3. To encourage the development of occupational competency and high standards of workmanship.
4. To enhance the status and dignity of the food service industry.
5. To encourage the development of reliable workers and good citizens.
6. To foster students' understanding of the functions and functional relationships of jobs in the food service industry.

Specific Goals

1. To teach the fundamental skills associated with the preparation and service of food.
2. To teach the necessary related subject matter pertaining to food preparation.
3. To teach safe methods of work performance.
4. To teach the value of orderliness and preplanning.
5. To develop an appreciation of accuracy and the use of standards in production.
6. To develop through demonstration and practice an understanding of the use and care of equipment.
7. To develop an appreciation of sanitation and hygiene, as both personal and public trusts.

Suggested Program of Instruction

Successful training courses in quantity food preparation vary in content and method of operation. This outline has been prepared for use as a guide in developing a program of instruction in food service training. It does not limit or define in absolute terms what should or should not be included in developing a quantity food preparation program.

Educational and professional authorities generally agree that the minimum length of a basic course in quantity food preparation should be 2 years. A 3-year course, where circumstances permit, is preferable. The curriculum outline suggested in this manual may be adapted to a 2- or 3-year course as part of a high school program or a specialized trade program.

School authorities, responsible for starting a new or reorganizing an existing program of in-

[5] U.S. Bureau of Census, 1963 Census of Business.
[6] Hospitals, schools, colleges, and other public and private institutions where food is served are included in this estimate.

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MAINTENANCE OF SCHOOL BUS TURN-AROUND POINTS

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The board of education of a city, exempted village, or local school district may maintain school bus turn-around points. At the request of such a board, a municipal corporation may maintain turn-around points on municipal roads; the township trustees may maintain turn-around points on township roads; and the county commissioners may maintain turn-around points on county roads.

The municipal corporation, township trustees, or county commissioners may also, at the request of a board of education, maintain turn-around points located on private property after an investigation by such board of education has determined that such maintenance is necessary for the use of such private property as a turn-around point for school buses. Such board of education may provide the cost of the materials utilized for any such maintenance. (131 v H 782. Effective 11-5-65)

Section 4503.17

(A) No school bus as defined in division (E) of section 4511.01 of the Revised Code is required to pay the annual license tax provided for in section 4503.02 of the Revised Code or to apply for or display registration plates, provided: the school bus complies with the requirements of sections 4511.76 to 4511.77, inclusive, of the Revised Code.

(B) The owner of a school bus, other than a board of education, which is used as a school bus during the school year under a contract with a board of education may, upon proper application for registration and the payment of a license fee of twenty-five dollars, use such bus during summer vacation periods to transport children and their authorized supervisors to and from any camping function sponsored by a nonprofit tax-exempt, charitable, or philanthropic organization. The application for registration of such bus shall be accompanied by:

(1) An affidavit, prescribed by the registrar of motor vehicles and signed by the owner of such bus, stating that such bus is to be used exclusively, during the summer months, to transport school children to and from any school function or to transport children and their authorized supervisors to and from any camping function sponsored by a nonprofit, tax-exempt, charitable, or philanthropic organization,

(2) A certificate from the state highway patrol stating that such bus is safe for operation in accordance with such standards as are prescribed by the state highway patrol.

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TRAFFIC LAWS --OPERATION OF MOTOR VEHICLES

Section 4511.01

Definitions

(E) "School bus" means every bus designed for carrying more than nine passengers which is owned by a public, private, or governmental agency or institution of learning and operated for the transportation of children to or from a school session or a school function, or owned by a private person and operated for compensation for the transportation of children to or from a school session or a school function; provided "school bus" does not include a bus operated by a municipally owned transportation system, a mass transit company operating exclusively within the territorial limits of a municipal corporation, nor a common passenger carrier certified by the public utilities commission unless such bus is devoted exclusively to the transportation of children to and from a school session or a school function.

LOCAL TRAFFIC REGULATIONS

Section 4511.07

Sections 4511.01 to 4511.78, inclusive, 4511.99 and 4513.01 to 4513.37, inclusive, of the Revised Code do not prevent local authorities from carrying out the following activities with respect to streets and highways under their jurisdiction and within the reasonable exercise of the police power:

(J) Regulating traffic in reference to school buses.

No ordinance or regulation enacted under divisions (D), (E), (F), (G), (I), or (J) of this section shall be effective until signs giving notice of such local traffic regulations are posted upon or at the entrance to the highway or part thereof affected, as may be most appropriate.

VEHICLES REQUIRED TO STOP AT GRADE CROSSINGS

Section 4511.63

The operator of any motor vehicle or trackless trolley, carrying passengers, for hire or of any school bus, or of any vehicle carrying explosives or flammable liquids as a cargo, or such part of a cargo as to constitute a hazard, before crossing at grade any track of a railroad, shall stop such vehicle or trackless trolley, and while so stopped he shall listen through an open door or open window and look in both directions along the track for any approaching train, and for signals indicating the approach of a train, and shall proceed only upon exercising due care after stopping, looking and listening as required by this section and upon proceeding, the operator of any such vehicle shall cross only in such gear of the vehicle that there will be no necessity for changing gears while traversing such crossing and the operator shall not shift gears while crossing the tracks.

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This section does not apply at street railway grade crossings within a municipal corporation, or to abandoned tracks, spur tracks, side tracks, and industrial tracks when the public utilities commission has authorized and approved the crossing of such tracks without making the stop required by this section.

SCHOOL BUSES

Regulations Concerning School Buses

Section 4511.75

(A) The driver of a vehicle upon a highway outside the limits of a municipal corporation, upon meeting or overtaking from either direction any school bus which has stopped on the highway for the purpose of receiving or discharging any school child, shall stop the vehicle not less than ten feet from such school bus and shall not proceed until such school bus resumes motion, or until signaled by the driver to proceed.

(B) Where a highway has been divided into two roadways as set forth in section 4511.35 of the Revised Code a driver of a vehicle proceeding on one roadway of said highway need not stop when approaching a school bus which has stopped on the other roadway of said highway for the purpose of receiving or discharging any school child. The driver of any vehicle proceeding on the same roadway of said highway as the school bus shall comply with division (A) of this section.

(C) School buses operating on divided highways or on highways with four or more traffic lanes shall receive and discharge all school children on their residence side of the highway.

(D) No school bus driver shall start his bus until after any child who may have alighted therefrom has reached a place of safety on his residence side of the road.

REGULATIONS FOR OPERATION OF SCHOOL BUSES

Section 4511.76

(A) The department of education by and with the advice and consent of the director of highway safety shall adopt and enforce regulations relating to the construction, design, equipment, and operation of all school buses owned and operated by any school district or privately owned and operated under contract with any school district in this state. When such buses are privately owned and operated under contract with any school district in this state, these regulations shall, by reference, be made a part of any such contract with a school district. Every school district, its officers and employees, and every person employed under contract by a school district shall be subject to such regulations.

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Any officer or employee of any school district who violates any such regulation, or who fails to comply with regulations in any contract executed by him on behalf of a school district, is guilty of misconduct and subject to removal from office or employment. Any person operating a school bus under contract with a school district who fails to comply with any such regulation is guilty of a breach of contract, and such contract shall be canceled by the responsible officers of such school district.

No person shall operate such a school bus within this state in violation of the regulations of the department of education. No person, being the owner thereof or having the supervisory responsibility therefor, shall permit the operation of such a school bus within this state in violation of the regulations of the department of education.

(B) The department of highway safety shall adopt and enforce such regulations as relate to the safety of the construction, design, equipment, and operation of all school buses not subject to the regulations of the department of education pursuant to division (A) of this section. Such regulations shall be adopted pursuant to the provisions of Chapter 119. of the Revised Code.

No person shall operate such a school bus within this state in violation of the regulations of the department of highway safety. No person, being the owner thereof or having the supervisory responsibility therefor, shall permit the operation of such a school bus within this state in violation of the regulations of the department of highway safety.

(C) The department of highway safety shall adopt and enforce such regulations as relate to the issuance of a license under section 4511.763 of the Revised Code. Such regulations may relate to the moral character of the applicant; the condition of the equipment to be operated; the liability and property damage insurance carried by the applicant; the posting of satisfactory and sufficient bond; and such other rules and regulations as the director of highway safety shall deem reasonably necessary for the safety of the pupils to be transported.

SCHOOL BUS INSPECTION

Section 4511.761

The state highway patrol shall inspect every school bus to ascertain whether its construction, design, and equipment comply with the regulations adopted pursuant to section 4511.76 of the Revised Code and all other provisions of law.

The superintendent of the state highway patrol shall adopt a distinctive inspection decal not less than twelve inches in size, and bearing the date of the inspection, which shall be affixed to the outside surface of each side of each school bus which upon such inspection is found to comply with the regulations adopted pursuant to section 4511.76 of the Revised Code. The appearance of said decal shall be changed from year to year as to shape and color in order to provide easy visual inspection.

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No person shall operate, nor shall any person being the owner thereof or having supervisory responsibility therefor permit the operation of, a school bus within this state unless there is displayed thereon the decals issued by the state highway patrol bearing a date of inspection prior to the fifteenth day of October in the calendar year in which the decals were issued, except for a bus licensed by the department of highway safety pursuant to section 4511.763 of the Revised Code which shall display decals bearing a date of inspection between the sixteenth day of July and the first day of September of the calendar year in which the inspection was made, but if a bus is purchased after the first day of September, it shall display decals bearing a date of inspection later than the date the bus is purchased and prior to the date of its use for the transportation of pupils.

LICENSING

Section 4511.763

No person, partnership, association, or corporation shall engage in the transportation of pupils to or from school, for profit, or enter into a contract with a board of education of any school district, without being licensed by the department of highway safety.

REGISTRATION OF SCHOOL BUSES

Section 4511.764

The superintendent of the state highway patrol shall require school buses, as defined in division (E) of section 4511.01 of the Revised Code, to be registered, in the name of the owner, with the state highway patrol on forms and in accordance with regulations as the superintendent may adopt.

When the superintendent is satisfied that the registration has been completed, he shall assign an identifying number to each school bus registered in accordance with this section. The number so assigned shall be marked on the front and rear of the vehicle in black lettering not less than six inches in height and will remain undhanged as long as the ownership of that vehicle remains the same.

No person shall operate, nor shall any person, being the owner thereof or having supervisory responsibility therefor, permit the operation of a school bus within this state unless there is displayed thereon an identifying number in accordance with this section.

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Section 4513.17 (C and D)

Flashing lights are prohibited on motor vehicles, except as a means for indicating a right or a left turn, or in the presence of a vehicular traffic hazard requiring unusual care in approaching, or overtaking or passing. This prohibition does not apply to the use of a flashing, oscillating, or rotating amber light on emergency vehicles, *** road service vehicles servicing or towing a disabled vehicle, traffic line stripers, snow plows, rural mail delivery vehicles, state highway survey vehicles, funeral escort vehicles, and similar equipment operated by the department or local authorities, nor to vehicles or machinery permitted by section 4513.11 of the Revised Code to have a flashing red light.

Except a person operating a public safety vehicle, as defined in division (E) of section 4511.01 of the Revised Code, or a school bus, no person shall operate or move upon any public street or highway any vehicle or equipment which has a flashing red or a flashing combination red and white light, or any vehicle or equipment which has an oscillating or rotating red light or a combination red and white oscillating or rotating light. This section shall not prohibit the use of warning lights required by law or the simultaneous flashing of turn signals on disabled vehicles.

DISPLAY OF WARNING DEVICES ON DISABLED VEHICLES

Section 4513.28

(A) Whenever any motor truck, trackless trolly, bus, commercial tractor, trailer semi-trailer, or pole trailer is disabled upon the traveled portion of any highway or the shoulder thereof outside of any municipality, or upon any freeway, expressway, thruway, and connecting, entering or existing ramps within a municipality, at any time when lighted lamps are required on vehicles and trackless trolleys, the operator of such vehicle or trackless trolley shall display the following warning devices upon the highway during the time the vehicle or trackless trolley is so disabled on the highway except as provided in division (B) of this section:

(1) A lighted fusee shall be immediately placed on the roadway at the traffic side of such vehicle or trackless trolley, unless red electric lanterns or red reflectors are displayed.

(2) Within the burning period of the fusee and as promptly as possible, three lighted flares or pot torches, or three red feflectors or three red electric lanterns shall be placed on the roadway as follows:

(a) One at a distance of forty paces or approximately one hundred feet in advance of the vehicle;

(b) One at a distance of forty paces or approximately one hundred feet to the rear of the vehicle or trackless trolley except as provided in this section, each in the center of the lane of traffic occupied by the disabled vehicle or trackless trolley;

(c) One at the traffic side of the vehicle or trackless trolley.

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(B) Whenever any vehicle used in transporting flammable liquids in bulk, or in transporting compressed flammable gases, is disabled upon a highway at any time or place mentioned in division (A) of this section, the driver of such vehicle shall display upon the roadway the following warning devices:

(1) One red electric lantern or one red reflector shall be immediately placed on the roadway at the traffic side of the vehicle;

(2) Two other red electric lanterns or two other red reflectors shall be placed to the front and rear of the vehicle in the same manner prescribed for flares in division (A) of this section.

(C) When a vehicle of a type specified in division (B) of this section is disabled, the use of flares, fusees, or any signal produced by flames as warning signals is prohibited.

(D) Whenever any vehicle or trackless trolley of a type referred to in this section is disabled upon the traveled portion of a highway or the shoulder thereof, outside of any municipality, or upon any freeway, expressway, thruway and connecting, entering or exiting ramps within a municipality, at any time when the display of fusees, flares, red reflectors, or electric lanterns is not required, the operator of such vehicle or trackless trolley shall display two red flags upon the roadway in the lane of traffic occupied by the disabled vehicle or trackless trolley, one at a distance of forty paces or approximately one hundred feet in advance of the vehicle or trackless trolley, and one at a distance of forty paces or approximately one hundred feet to the rear of the vehicle or trackless trolley, except as provided in this section.

(E) The flares, fusees, lanterns, red reflectors and flags to be displayed as required in this section shall conform with the requirements of section 4513.27 of the Revised Code applicable thereto.

(F) In the event the vehicle or trackless trolley is disabled near a curve, crest of a hill, or other obstruction of view, the flare, flag, reflector, or, lantern in that direction shall be placed as to afford ample warning to other users of the highway, but in no case shall it be placed less than forty paces or approximately one hundred feet nor more than one hundred twenty paces or approximately three hundred feet from the disabled vehicle or trackless trolley. (130 H. 603)

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UNIT IV

DIGEST OF MOTOR VEHICLE TRAFFIC LAWS OF OHIO

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STATE OF OHIO
JAMES A. RHODES
Governor

DEPARTMENT OF HIGHWAY SAFETY
WARREN C. NELSON
Director

BUREAU OF MOTOR VEHICLES
FRED RICE, Registrar

STATE HIGHWAY PATROL
R. M. CHIARAMONTE, Supt.

Digest of MOTOR VEHICLE LAWS OF OHIO

(REVISED SEPTEMBER 1969)

IMPORTANT: Your driver's license expires on your birthday, in the year indicated on the license!

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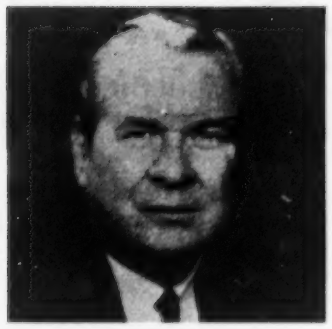

Dear Ohioan:

Good highways are necessary to transport Ohio-made products to the market to provide more and better jobs for Ohioans. Ohio is the transportation center of the nation. Our highways are the finest. As you drive on our fine highways you share with more than six million drivers the responsibility of being a safe and courteous driver.

By knowing and understanding the enclosed regulations and by being a cautious and careful driver you can help make Ohio highways the safest in the nation. Wear your safety belt at all times.

My very best wishes for a safe, accident-free driving record.

Sincerely,

James A. Rhodes

JAMES A. RHODES
Governor of Ohio

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struction, should ascertain the nature of the training course. They will want to consider the purpose of their particular course, the needs of the community, the available space and equipment, the type of students to be taught, and the time allotted to the program. Local planning should be in accord with State plans, developed by the State vocational education department, so that the program will be eligible to receive reimbursement from Federal vocational education funds.

Regardless of the type of program planned, it is essential that job functions and relationships be considered in each subject matter area. Students should be properly oriented so that they will understand the role each job plays as part of an organization.

The following subject-matter areas are included in this Curriculum Guide:

I. Basic Principles of Quantity Food Preparation.
II. Science Related to Food Preparation.
III. Mathematics Related to Food Preparation.
IV. English Related to Food Preparation.
V. Safety Instruction.

Presentation of Instructional Material

The subject-matter content outlined may be presented in several ways. Basic principles of food preparation can be taught according to:

1. Classification of foods, composition of foods, and/or the type of product.
2. Cooking procedure.
3. Production station or serving area.
4. Menu position.

It is imperative that instruction in preparing food in all categories be included regardless of which method is used. The main objective is to teach the basic steps of sound preparation methods rather than to familiarize the student with a large number of stations or jobs in the production area. It is more important for the student to understand fully the steps in broiling meats than to know the duties of the broiler cook. The latter specialization can be reserved for his internship in the food industry.

Outline of the Suggested Program of Instruction

The content suggested for each subject area has been classified into three phases of instruction and is outlined under the following columnar headings:

1. Essential learning (Skill and knowledge).
2. Scope of instruction (Suggested content).
3. Information (Technical and related).

Teaching materials (books, manuals, charts, films, and periodicals) are included in appendix A. Each item is numbered and the corresponding number is used to form the teaching materials list which follows each area of instruction.

This suggested outline neither limits the scope of instruction nor includes every possible unit which can be taught in quantity food preparation. The instructor will determine the specific topics and references which should be added in order to produce a complete, all-inclusive course of study in food service training.

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PRE-EXAMINATION

For the purpose of obtaining an Ohio Temporary Instruction Permit all persons are required to contact a driver license examination station and undergo a pre-examination. This examination consists of a vision test, a test of the applicant's knowledge of motor vehicle laws, and a sign test. Every applicant will be required to present evidence of correct date of birth either by a birth certificate or other legal documentary evidence. If under 18, applicant must first submit satisfactory evidence, by presentation of an official certificate, of having successfully completed a driver education course approved by the State Department of Education—or a driver training course approved by the Director of Highway Safety.

APPOINTMENTS FOR DRIVER EXAMINATIONS

All driver license examinations are conducted by the State Highway Patrol and consist of the following: (1) A test of your knowledge of the laws and rules for safe driving. (2) A test of your vision. (3) A test of your knowledge and understanding of road signs and traffic signals. (4) A test of your driving and parallel parking ability—and observance of regulating signals, signs and road markings.

Driver examinations are given by appointment only, in order to reduce the amount of time the prospective examinee must spend at the examining station. When an appointment to undergo a driver examination has been made, the prospective examinee must be punctual; and if it is found that due to unforeseen circumstances he is unable to appear at the appointed time, he shall notify the examination station or the Highway Patrol where the appointment was made. Please cancel appointments far enough in advance so that another examination time may be assigned.

A careful study of the following information will help you pass the examination and will improve your knowledge of the laws, road rules, signs and signals. No road examination will be permitted in an unsafe vehicle.

NOTE: Before and during the actual driving test follow the examiner's instructions. At no time will you be instructed to operate your motor vehicle in violation of any law or safe driving regulation.

EXEMPTIONS FROM EXAMINATIONS

TAXI CAB DRIVER who has a currently effective operator's license is exempt from a chauffeur's examination.

MILITARY OR NAVAL SERVICE PERSONNEL ON ACTIVE DUTY, and in possession of a driver's permit, when operating an official motor vehicle, in connection with such duty, is exempt from license requirements of this state. Also—when on furlough during period of active duty, and for 6 months after such duty—**provided** he had an active license prior to active duty.

Registrar may waive operator's or chauffeur's examination of any **honorably discharged military or naval personnel,** and without any mental or physical disability that would affect such driving—**providing** (a) he had an active license in this state at the time he commenced such service and (b) such application is made not more than 6 months following discharge.

MINIMUM AGE

The minimum age for a Temporary Permit or Operator License is 16 years. The application for a Temporary Permit or Operator's License of a person under 18 years of age must be signed by either parent, guardian or other person having custody—or when neither exists, by a responsible person who is at least 21 years of age.

Any negligence or willful or wanton misconduct of a minor under 18, when driving a motor vehicle upon a highway, shall be imputed to the person who has signed the application of such minor. Such person(s) shall be jointly and severally

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liable with such minor for any damages caused by such negligence or willful or wanton misconduct.

TEMPORARY INSTRUCTION PERMIT

An applicant must undergo and pass a pre-examination before he is permitted to obtain a temporary instruction permit. For details contact the nearest State Driver License Examining Station. Such temporary instruction permit, when granted and in the applicant's immediate possession entitles him to drive a motor vehicle upon any street or highway—and only when accompanied by a licensed operator or chauffeur, who is actually occupying a seat beside the driver. The permit is valid for a six-month period from date of issuance.

OUT-OF-STATE LICENSES

Any person having in his possession a valid out-of-state license recognized by the State of Ohio, is exempt from obtaining a Temporary Instruction Permit, but shall submit to the regular examination in obtaining an operator's or chauffeur's license in this state.

No person shall receive an operator's or chauffeur's license, or a motorcycle operator's endorsement of an operator's or chauffeur's license, unless and until he surrenders to the Registrar all valid licenses in his possession issued to him by another jurisdiction recognized by this state. All surrendered licenses shall be returned by the Registrar to the issuing authority, together with information that a license is now issued in this state. No person shall be permitted to have in his possession more than one valid license at any time. The Registrar may promulgate and enforce rules governing the use of such instruction permit.

PROBATIONARY LICENSE

A Probationary License shall be issued to persons between the ages of 16 and 21 years. The Registrar of Motor Vehicles shall revoke the Probationary License issued to any person—when such person (before reaching his 18th birthday) has been convicted, pleaded guilty, or adjudged in juvenile court, of having committed a total of three separate motor vehicle violations.

RESTRICTED LICENSE

The Registrar of Motor Vehicles—upon issuing an operator's or chauffeur's license, a motorcycle operator's endorsement, an operator's or chauffeur's license renewal, or the renewal of any other license issued under Chapter 4507. of the Revised Code—may, whenever good cause appears, impose restrictions suitable to the licensee's driving ability with respect to the type of or special mechanical control devices required on a motor vehicle, which the licensee may operate; or such other restrictions applicable to the licensee as the Registrar determines to be necessary.

Physical Disabilities

Persons who have physical disabilities; or those who must have attachments either to their person or on their motor vehicles—must have a Restricted Temporary Instruction Permit. Such permits are issued only after a pre-examination has been conducted, the disability determined, and attachments necessary for safe operation required. This may include persons who are of short stature and who need special equipment for driving.

CHAUFFEUR'S LICENSE

1. The Minimum age for a chauffeur's license is 18 years.
2. A chauffeur's license issued after an examination has been passed is valid for a period of three years from the last birthday, before such chauffeur license is issued.

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3. Chauffeur's licenses being renewed are valid for a period of three years from date of expiring chauffeur's license.
4. A 2-1/2" x 2-1/2" photograph is required. The picture must have been taken within thirty days of the time of the application for a chauffeur's license.
5. A valid operator's license may be converted to a chauffeur's license. The operator must take a complete driver examination including a special chauffeur's test.

MOTORCYCLES AND MOTORCYCLISTS

1. Motorcycle operators must have a special license. If the cyclist has no automobile driver's license, he must obtain a restricted motorcycle license costing $4.00 for four years. If he has an auto driver's license, his motorcycle permit may be added as an endorsement to it, also at a cost of $4.00 for four years.
2. The new law prohibits handlebars or grips more than 15 inches higher than the saddle; requires that both operators and passengers wear helmets and eye protectors approved by the director of highway safety; and demands that all motorcycles be equipped with rear-view mirrors and effective mufflers containing baffle plates.
3. Devices for producing excessive smoke or gas, and any equipment which permits oil or any other chemical to flow upon the exhaust pipe or muffler, are prohibited, as are muffler cutouts or by-passes which allow excessive noise.
4. Applicants for motorcycle operator licenses must give an actual demonstration of their ability to exercise ordinary and reasonable control in the operation of the cycle by driving it under the supervision of an examining officer. They must also pass tests on physical condition, understanding of traffic control devices, and knowledge of motor vehicle laws.
5. Motorcycles and bicycles are subject to the same rules and regulations as motor vehicles, in so far as practicable.
6. Every person riding a motorcycle or bicycle upon a roadway shall be governed by the same regulations—as if he were driving any vehicle. Every operator of a motor bike, motor scooter, motorcycle, or similar vehicle must be properly licensed under the Ohio Driver's License Law.
7. No motorcycle or bicycle shall be used to carry more persons at one time than the number for which it is designed and equipped.

YOUR LICENSE: A TRUST AND A FAITH

No person shall:

1. Display, or cause or permit to be displayed, or possess any operator's or chauffeur's license or temporary permit, knowing the same to be fictitious, or to have been canceled, revoked, suspended, or altered.
2. Lend to a person not entitled thereto, or knowlingly permit him to use any operator's or chauffeur's license or temporary permit, not issued to the person so displaying the same.
3. Display, or represent as one's own, any operator's or chauffeur's license or temporary permit, not issued to the person so displaying the same.
4. Fail to surrender to the Registrar of Motor Vehicles, upon his demand, any operator's or chauffeur's license or temporary permit, which has been suspended, canceled, or revoked.
5. Use a false or fictitious name, or give a false or fictitious address, in any application for an operator's or chauffeur's license or temporary permit.

It is unlawful to permit your car to be operated by:

1. A person who does not have a driver's license.
2. By the holder of a Temporary Instruction Permit when not accompanied by a licensed driver on the seat beside him.

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DRIVER LICENSE SUSPENSIONS

The trial judge of any court of record . . . . in addition to suspensions or revocations of licenses for periods of time not exceeding three years, and in addition to, or independent of, all other penalties provided by law or by ordinance . . . . shall impose a suspended jail sentence not to exceed six months, providing that imprisonment was not imposed for the offense for which the person was convicted.

No court shall suspend the first thirty days of suspension of license provided for under this section.

The violations for which a driver's license may be revoked or suspended are:

(A) Homicide by vehicle;

(B) Operating a motor vehicle while under the influence of intoxicating liquor or narcotic drug;

(C) Perjury or the making of a false affidavit, under Sections 4507.01 to 4507.39, inclusive, of the Revised Code, or any other law of this state, requiring the registration of motor vehicles, or regulating their operation on the highway.

(D) Any crime punishable as a felony under the motor vehicle laws of this state or any other felony in the commission of which a motor vehicle is used;

(E) Failing to stop and disclose identity at the scene of the accident when required by law to do so;

(F) Drag racing as defined in division (A) of Section 4511.25 of the Revised Code;

(G) Willfully eluding or fleeing a police officer.

Ohio's Point System Law

Within ten days after conviction or bond forfeiture of a person in a mayor's court or a court of record for any violation under the revised uniform traffic code, Section 4511.01 to 4511.78, inclusive, 4511.99 and 4513.01 to 4513.36, inclusive, or of any law or ordinance regulating the operation of vehicles, street cars, and trackless trolleys on highways, said court shall prepare and forward to the Bureau of Motor Vehicles abstracts of court records covering such conviction or bond forfeiture.

The Registrar, within ten days after receipt of such abstract, shall record the date of conviction or bond forfeiture and the number of points for each conviction or bond forfeiture based on the following formula:

(1) Violation of section 4507.38 or 4507.39 of the Revised Code or any ordinance prohibiting the operation of a motor vehicle while the operator's license is under suspension or revocation ..... **6 points**

(2) Violation of section 4549.04 of the Revised Code or any ordinance prohibiting the operation of a motor vehicle without consent of the owner .. **6 points**

(3) Homicide by vehicle ..... **6 points**

(4) Violation of section 4511.19 of the Revised Code or any ordinance prohibiting the operation of a motor vehicle while under the influence of alcohol or drugs ..... **6 points**

(5) Violation of section 4549.02 of the Revised Code or any ordinance requiring the driver of a vehicle to stop and disclose identity at the scene of an accident ..... **6 points**

(6) Violation of section 4511.02 of the Revised Code or any ordinance prohibiting the willful fleeing or eluding of a police officer ..... **6 points**

(6)

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(7) Any crime punishable as a felony under the motor vehicle laws of this state, or any other felony in the commission of which a motor vehicle was used ..... **6 points**

(8) Operating a motor vehicle in violation of a restriction imposed by the registrar ..... **2 points**

(9) Violation of section 4511.251 of the Revised Code or any ordinance prohibiting drag racing ..... **6 points**

(10) Violation of section 4511.20 of the Revised Code or any ordinance prohibiting the reckless operation of a motor vehicle ..... **4 points**

(11) Violation of any law or ordinance pertaining to speed ..... **2 points**

(12) All other moving violations pertaining to the operation of motor vehicles reported under this section except any violations under section 5577.01 to 5577.99, inclusive, of the Revised Code ..... **2 points**

Whenever the points charged against any person exceed five, the Registrar shall forward to such person a warning letter, listing the reported violations.

When any person has more than seven points charged against him, he shall be required to submit to a driver license examination or a physical examination, or both.

When the number of points against any person reaches 12 within a two-year period, the Registrar shall, advise the subject that his license will be suspended for a period of time, depending upon the number of prior suspensions under this statute—effective on the 20th day after the mailing of the suspension notice.

Exceptions:

Unless the licensee files a petition in the municipal court or county court—or in case the person is under the age of eighteen years, to the juvenile court—in the county where such person resides, agreeing to pay the costs of the proceedings and alleging that the licensee can show cause why his license should not be suspended. The court shall decide such issue as to whether the person is a habitual traffic law violator. **If the court finds from the evidence submitted that he is a habitual traffic law violator, then the court may:**

1. Uphold the suspension made by the Registrar.
2. Withhold the suspension, or a part thereof, and provide such conditions or probations as the court deems proper.

Any person whose license or permit or privilege to operate a motor vehicle has been suspended under this section, and who, during such suspension drives any motor vehicle, shall be fined not more than $500, or imprisoned not less than three days nor more than six months—**and no court shall suspend the first three days of any sentence provided under this section.**

SPEED RESTRICTIONS

Speed Limits

Automobiles may not be operated upon streets or highways at a speed either greater or less than is reasonable and proper, having due regard for the traffic, surface and width of the street or highway and of any other conditions then existing. **A driver must keep his vehicle under such control as to be able to bring it to a stop within the assured clear distance ahead.**

It shall be unlawful to drive at a speed exceeding:

(1) **15 miles per hour** in all alleys within a municipal corporation.

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(2) **20 miles per hour** when passing a school building or the grounds thereof during school recess and while children are going to or leaving school during the opening or closing hours. Also when appropriate signs giving notice of the existence of the school are erected—except, that on controlled-access highways and expressways, if the right-of-way line fence has been erected without pedestrian opening, the speed shall be governed by provision in paragraph (5) below. On freeways, if the right-of-way line fence has been erected without pedestrian opening, the speed shall be governed by provisions in paragraphs (8) and (9) below.

(3) **25 miles per hour** in all other portions of a municipal corporation, except on state routes, through highways outside business districts, and alleys.

(4) **35 miles per hour** on all state routes or through highways (which are not controlled-access highways) within municipal corporations outside business districts, except as provided in paragraphs (5) and (6) below.

(5) **50 miles per hour** on controlled-access highways and expressways within municipal corporations.

(6) **50 miles per hour** also on state routes within municipal corporations outside urban districts, unless a lower prima-facie speed is established.

(7) **60 miles per hour** during the daytime and **50 miles per hour during the nighttime** on highways outside of municipal corporations—**except** 50 miles per hour at all times . . . for operators of trucks and commercial tractors, which weigh in excess of 4000 pounds empty weight; also for school buses, street cars and trackless trolleys.

(8) **60 miles per hour at all times on freeways with paved shoulders inside municipal corporations**—**except** 50 miles per hour at all times for operators of trucks and commercial tractors weighing in excess of 4000 pounds empty weight, as well as school buses.

(9) **70 miles per hour at all times on freeways outside municipal corporations**—**except** 55 miles per hour for operators of trucks and commercial tractors weighing in excess of 4000 pounds, as well as school buses.

The State Director of Highways may set up or permit local authorities to set up speed zones of greater or lesser speed than these prima-facie speed limitations upon the basis of engineering and traffic investigations. Such studies must show that the prima-facie speed is greater or lesser than is reasonable or safe under the conditions found to exist at the locations to be designated as special speed zones. The greater or lesser speed, whichever is determined, shall be effective only when appropriate signs giving notice thereof are erected at these special speed zones.

Racing on Public Roads

No person shall participate in a drag race on a public road. A drag race is one which consists of operation of two or more vehicles from a point, side by side and at accelerating speeds in a competitive attempt to out-distance each other. Or the operation of one or more vehicles over a common selected course, from the same point to the same point, when timing is made of the participating vehicles involving competitive accelerations of speeds. Persons rendering assistance in any manner to such competitive use of vehicles shall be equally charged as the participants.

Speed Limits on Bridges

No person shall drive a motor vehicle over any bridge or other elevated structure, constituting a part of a highway, at a speed which is greater than the maximum speed that can be maintained with safety to such bridge or structure, when such structure is sign-posted.

Minimum Speed Limits

No person shall operate a vehicle at such a slow speed as to impede or block the normal and reasonable movement of traffic, except when reduced speed is necessary for safe operation or to comply with law.

Whenever the Director of Highways or local authorities determine, on the basis of an engineering and traffic investigation, that slow speeds on any part of a controlled-access highway consistently impede the normal and reasonable movement of traffic—the Director of Highways or such local authority may declare a minimum speed limit, below which no person shall operate a motor vehicle, except when necessary for safe operation or in compliance with law. (**No minimum speed limit established hereunder shall be less than 30 miles per hour**; nor effective until provisions relating to appropriate signs have been fulfilled and local authorities have obtained the approval of the Director of Highways.)

Speed Clocked By Radar—Arrest Without Warrant

A driver, who has been detected speeding by radar, or by any electrical timing device, **may be arrested until a warrant can be obtained** for such arrest. (Posted radar or other similar warning signs no longer required.)

SAFE DRIVING PRACTICES

When being overtaken and passed by another motor vehicle approaching from the rear you shall not increase your speed until completely passed by the overtaking vehicle.

When overtaking and passing another vehicle on a two lane highway, make certain of assured clear distance ahead, give audible signal to the vehicle to be overtaken, pass to left at safe distance, and be sure not to 'cut-in' too closely ahead of the overtaken vehicle.

The purpose of highways and streets being marked in lanes for traffic proceeding in the same direction is:

1. When the roadway is sufficiently wide to permit more than one line of traffic, lanes are marked to clearly divide the lines of traffic to more safely facilitate the flow. Slow traffic should travel in the extreme right lane.
2. To provide marked lanes for passing and other safety measures as required.

Whenever any roadway has been divided into three or more clearly-marked lanes, or wherever, within a municipal corporation traffic is lawfully moving in two or more substantially continuous lines in the same direction—a vehicle shall be driven, as nearly as practicable, entirely within a single lane or line of traffic—and shall not move therefrom until the driver has first made certain that such movement can be made with safety.

When entering a through highway you must yield the right-of-way to all vehicles on said through highway.

When making a left turn you must yield right-of-way to all vehicles approaching from the opposite direction.

When parked at a curb, the most important thing is to make certain the portion of the highway you are about to enter is free from oncoming traffic for a distance sufficient to allow you to safely enter that part of the roadway.

The meaning of the yellow line on the highway is: When the yellow line is in your lane do not pass. When there are double yellow lines, passing in either direction is prohibited.

ENTERING OR LEAVING A VEHICLE

Get into a vehicle from the curb side, when it is parked parallel at the curb of any street or highway, where there is even a small amount of traffic. Getting either into or out of a vehicle on the roadway side may cause sudden stops or collisions in the passing traffic.

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LIGHTS AND REQUIREMENTS

The minimum number of lights required on a motor vehicle operated at night are — Two head lights, one red tail light and white light so arranged as to illuminate the rear license plate.

1. The law requires you to dim your lights upon the approach of an oncoming vehicle.
2. Only one spot light is permitted on a vehicle and the beam must be directed to the right on the left side of the vehicle and not to exceed one hundred feet ahead.
3. Every vehicle must display headlights and tail light from one-half hour after sunset to one-half hour before sunrise, and at any other time when there is not sufficient natural light to render discernible persons, vehicles, and substantial objects on the highway.

When following a vehicle at night you should lower the beam of your light so as not to blind the driver ahead.

A driver's reaction to red flags, flares and fusees on a highway should be: Danger ahead — slow down and stop.

HIGH BEAM

TO BE USED IN OPEN COUNTRY EXCEPT WHEN APPROACHING ONCOMING CAR.

LOW BEAM

TO BE USED ON LIGHTED STREETS, WHEN FOLLOWING OTHER CAR, DRIVING IN FOG AND APPROACHING ONCOMING CAR.

PARALLEL PARKING TEST

This test is very important as it tests the applicant's judgment and ability to handle a motor vehicle. It is a known fact that a driver who can park will eliminate traffic congestion and accidents.

The following procedure should be used in parallel parking:

1. Stop even with and about a foot away from the car in front of the space where you are going to park.
2. Make sure that you will not interfere with oncoming traffic.
3. Turn steering wheel sharply right and back slowly towards the curb.
4. When your front wheels are opposite the rear bumper of the car ahead, quickly turn steering wheel to extreme left and back slowly to car behind.
5. Straighten out front wheels and pull into final parking position a few inches from curb allowing adequate clearance at both ends of car.
6. The test is presumed to be successfully completed when the driver has properly removed his car from within the parking zone.

20777

FIRST, and of greatest importance, remember that traffic may be approaching from the rear.

Step 1. Always look back and make sure that the road is clear, before even attempting to park.

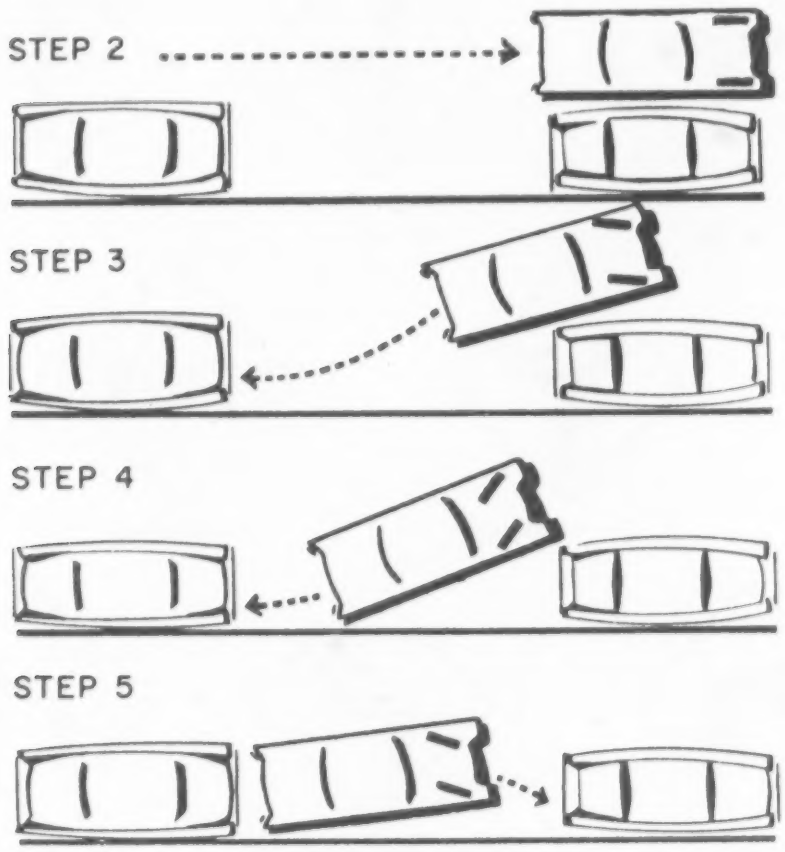

PARKING

It is illegal to park upon the paved or main traveled part of a highway outside of a business or residence district.

Six places where it is illegal to park a motor vehicle.

1. In front of a public or private driveway.
2. Within ten feet of a fire hydrant.
3. Within twenty feet of a cross-walk at any intersection.
4. Within thirty feet upon the approach to any stop sign.
5. Alongside any vehicle stopping or parked at the edge or curb of a street.
6. Within one foot of another parked vehicle.

The law requires a rear vision mirror. If operator is deaf, two rear vision mirrors are required—one inside and one outside.

20778

Heed Signs, Signals, and Pavement Markings .

TYPICAL WARNING SIGNS

Road ends – turn left or right

Road intersects from right

Crossroad

"Y" Intersection

School Zone

Sharp left turn

Sharp right turn, then sharp left turn

Sharp right turn

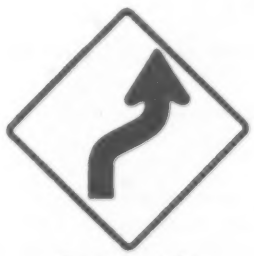

Curve right, then left

Curve left, then right

WARNING SIGNS – – FOLLOW INSTRUCTIONS

20779

Area I

BASIC PRINCIPLES OF FOOD PREPARATION

Area I is concerned with helping the student develop an appreciation and understanding of sound food preparation methods and skills. This entails a knowledge of the physical facilities within the food preparation area as well as the various methods of cooking food. An understanding of the characteristics that constitute quality in raw and finished foods is also involved.

Every effort should be made to help the student realize that patrons of hotels, restaurants, and other eating establishments, who will be consumers of his product, expect to receive full value for their expenditures. The student trainees, therefore, should recognize the factors involved in preparation and service, such as quality, appearance, and palatability, which determine the acceptability of food.

The instructor should use every means to help the student appreciate the importance of correct food preparation methods if the resultant product is to be satisfactory. The student must also appraise himself as a professional food worker. He must realize that work habits and standards of cleanliness have an important bearing on the quality of the food he prepares, on his performance as a food worker, and on his job success.

Area I is divided into 13 subdivisions, each devoted to a given phase of cookery or a related process. The 13 subdivisions are:

A. Care and Operation of Kitchen equipment.
B. Meat Cutting.
C. Meat and Poultry Cookery.
D. Fish and Shellfish Cookery.
E. Sauces and Gravies.
F. Ground and Variety Meat Cookery.
G. Egg and Breakfast Dishes.
H. Soups.
I. Vegetable Cookery.
J. Salads and Sandwiches.
K. Breads, Pastries, Cakes, and Cookies.
L. Desserts.
M. Appetizers, Canapés, and Hors d'Oeuvres.

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What To Do If A Tire Blows Out

A blow-out when traveling at a high rate of speed is dangerous, especially if the driver does not know what to do and becomes frightened. First of all, do not jam on the brakes and do not throw out the clutch. Keep your foot off the accelerator and let the vehicle coast against the engine to stop. When the blow-out is a rear tire, sudden application of the brakes will set up a "tail-sway" difficult to control and the vehicle is likely to turn over. Various types of safety tires may well be considered as important accessories.

When Wheels Run Off Pavement

If a vehicle's wheels run off the pavement onto the berm or soft shoulder, do not try to jerk the wheels immediately back onto the road. Stop accelerating without throwing out the clutch. Allow the engine to slow the vehicle so that it can be pulled safely back onto the pavement.

When Rounding a Curve

Never apply the brakes while you are rounding a curve but apply them before entering it. You may accelerate slightly on the way out of the curve—this extra power will offset the side-thrust of centrifugal force. It is not possible to apply brakes safely while in the process of rounding a curve.

No Coasting

Never coast down a grade in neutral gear. Shift into second gear when going down a steep hill. Coasting not only causes quicker wear-out of the brakes, but increases the possibility of an accident.

Funeral Procession

The following requirements are necessary for vehicles traveling in a funeral procession in order to be recognized and given right of way by other traffic: Each vehicle in a funeral procession must have its headlights lighted and display a purple and white pennant, so as to be visible from any direction.

The Blind Person As A Pedestrian

Watch out for persons carrying white canes or white canes with red tips. The blind are the only pedestrians authorized by law to carry white canes and the law further provides that the blind carrying such canes, as well as those led by guide dogs, are to be given the right-of-way by every driver.

Walking Along Roadway

Persons walking along or upon the highway where sidewalks are not provided must face approaching traffic.

ACCIDENTS

In case of accident on a public road or highway the law requires you as a driver to stop, give your name and address, the name and address of the owner and registration number of the motor vehicle, to the injured person or any person involved in the accident or to a police officer at the scene. You must also display your driver's license or furnish satisfactory proof that you are licensed.

In case of an accident with an unoccupied or unattended motor vehicle you shall securely attach the information required to be given in writing, to a conspicuous place in or on the unoccupied or unattended motor vehicle which was struck.

The operators of all motor vehicles, including non-residents, when they become involved in an accident, resulting in the death or injury to a person or property damage in excess of $100.00, must within 30 days after such accident, file a written

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EXPRESSWAY/FREEWAY DRIVING ILLUSTRATED

The Traffic Movement

(1) Pick your lane—and stay with it. Observe and obey signs.

(2) Faster travel means that you'll need more room between you and the car ahead in case of emergency. Follow no closer than one car length for every 10 miles of speed. Pass lawfully and safely.

(3) Stay within the posted speed limit, but be careful that you don't become a traffic hazard by driving too slowly.

(4) Watch for signs noting changes in speed limits. A "slow zone" signals a a danger area.

Fatigue

Be on your guard against highway monotony. Drive with the window open; shift your gaze; play the radio and engage in light conversation to keep alert. Stop periodically to stretch your legs and have a cup of coffee, milk or a cold "soft" drink.

How to Get Off An Expressway

(1) Watch for advance signs for your proper turn-off and move to the correct lane.

(2) Decrease your speed and signal your intention of turning.

(3) Drive slowly, or stop if necessary, before you enter traffic on the cross highway.

Skidding

Precautions taken against skidding are much simpler than steering out of one. However, when a vehicle does go into a skid, take your foot off the accelerator (never apply brakes) and turn the steering wheel in the direction of the skid.

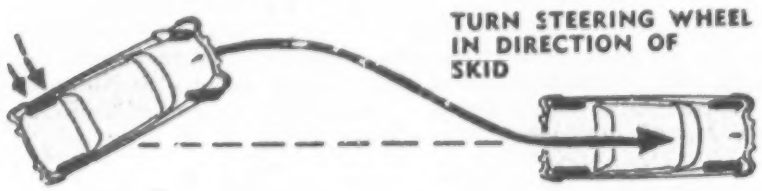

Weaving

Weaving in and out of traffic lanes is a dangerous habit practiced only by the exhibitionist, or the inexperienced or discourteous driver. It actually gains for the driver no more than a few seconds, and causes sudden stops, near sideswipes and irritation among other drivers. Stay in the proper traffic lane and overtake and pass other vehicles only when the roadway ahead is clear.

One-Arm Drivers

Proper control and handling of a vehicle is achieved only when both hands are on the steering wheel. The safety of all occupants of a car, should any road hazard or emergency appear, is very uncertain when the driver is steering with one arm only. It is said rather humorously, but it may well be a fact, that "One-arm drivers are usually headed for the church aisle; some walk down it, others will be carried."

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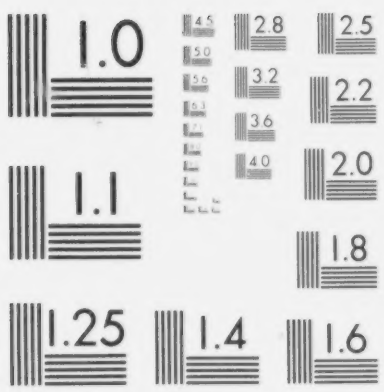

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

4. **Remember:**
   a. Shaded spots on the highway will retain frost and ice when the other portions of pavement are dry.
   b. Bridges will take on frost and retain ice when the rest of the road may be in a safe condition.
5. To prevent skidding when a sudden stop is necessary, apply the brakes lightly and intermittently. This "pumping of the brakes" will reduce momentum without losing traction and without locking the brakes.
6. To start a car on ice, release the clutch slowly, since the tires will have a better chance to grip if the wheels are turning slowly. Starting in second gear will also help.
7. When driving in a snow storm or fog, use the lower headlight beam. The high beam reflects the snow or fog, while the lower beam reduces the amount of reflection. Fog lights, incidentally, are a good investment.
8. Double the distance at which you normally follow behind another vehicle. This is necessary because of the increased distance needed to stop on slippery pavements.

Left of Center On Roadway With Obstruction

When obstruction exists, making it necessary to drive to left of center of highway, right-of-way shall be yielded to vehicles traveling in proper direction on unobstructed portion.

EXPRESSWAY/FREEWAY DRIVING

A new era of driving lies ahead. Superbly-engineered arteries, arrow-straight, like concrete ribbons, allow the traveler, weary from bucking bumper-to-bumper traffic on congested Main Street, to breeze with amazing time saving across the countryside. Expressway/freeway driving is different from the stop-start routine the motorist finds on the normal humdrum roadway. Expressways force the motorist to adjust to a higher speed of travel. Here are some pointers on expressway driving:

How to Get On An Expressway (See diagram)

(1) Slow down and look before turning into an expressway approach.

(2) If you make a mistake, you must proceed with traffic until you reach the next intersection. Leave the expressway and re-enter by the proper approach.

(3) Wait for a let-up in the traffic stream. Expressway drivers are traveling faster than ordinary city drivers.

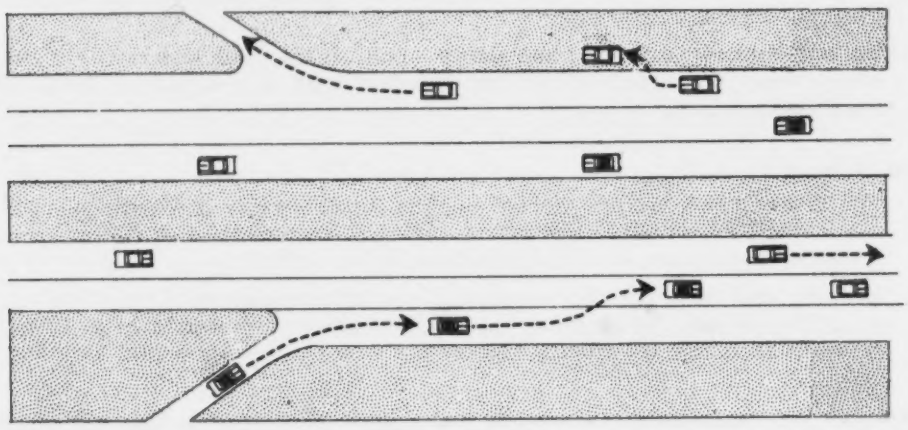

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Provides that a concentration of .15 per cent by weight of alcohol in a person's blood is presumptive evidence of such person's intoxication. Provides that a lesser concentration does not constitute such a presumption, but may be considered along with other evidence in determining the person's guilt or innocence.

- Requires that test results be made immediately available to the person or his attorney, if requested. Permits the person to choose another qualified person to administer tests in addition to those directed by a police officer. And provides that failure to obtain additional tests does not preclude the admission of evidence relating to the police department's test.

- Requires driver's licenses to be suspended for a minimum of 30 days for driving while intoxicated (also for traffic homicide by vehicle, perjury, false affidavits, all felonies relating to or involving motor vehicles, and also willfully fleeing a police officer). Also requires that persons convicted of driving while intoxicated receive the prescribed fine and jail sentence (of present law), in addition to the required driver's license suspension.

Special Note: The term "alcohol" has replaced "intoxicating liquor" in the Ohio Code provisions covering drunken driving (Sec. 4511.19). Also, it is now against the laws of the state for any person to consume any beer or intoxicating liquor in a motor vehicle.

SPECIAL DRIVING PROBLEMS

Night Driving

1. The most important precaution to observe for safe night driving is to drive at a cautious, reasonable speed, so as to be able to stop within the distance illuminated by your headlights, should any unexpected hazard appear out of the darkness.
2. Turn on driving lights immediately at sunset, or earlier if twilight visibility is poor.
3. Dim headlights for every approaching vehicle, and when closely following any vehicle. Use the upper beam only for driving in open country with a clear roadway ahead.
4. Watch for pedestrians who may take chances walking along roads or crossing streets because they do not realize that motorists just can't see them.
5. Keep windows clean. The haze and glare caused by lights shining on dirty glass reduce visibility at night.
6. Do not continue driving when sleepy—pull off the road and rest. Fatigue, which slows down perceptions and reaction time, is a significant factor in nighttime accidents.

Winter Driving

1. The first adjustment a driver must make to winter driving is to reduce speed. No matter what road or weather conditions are encountered, a slower speed is the first consideration for safe handling of any vehicle.
2. Be sure that your car is in excellent operating condition. Lights, brakes, windshield wipers, defroster fan, radiator and other parts should be in perfect order, particularly for winter. Use tire chains for severe snow and ice conditions.
3. Open the ventilator or a window just a little. This helps to keep the windshield clear of a fog and guards against possible carbon monoxide leakage.

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STOP STREETS AND AUTOMATIC SIGNALS

You must stop before entering or crossing a highway from a private road, driveway, alley or building.

You must yield the right of way to all traffic on said highway.

When you are confronted with a 'STOP' sign or when approaching a highway from an area requiring a stop at such highway—you must come to a full stop even though no traffic is approaching and must yield the right-of-way to all vehicles not obliged to stop.

Know and obey these traffic light signals, arrows:

1. **Green alone**—move through intersection.
2. **Yellow appearing with green**—all traffic stop, except that traffic that has entered the section.
3. **Red alone**—stop.
4. **Green arrow alone**—traffic may move in direction arrow indicates. If arrow indicates a turn, right-of-way must be yielded to pedestrians.
5. **Green arrow appearing with red**—through traffic is prohibited, turn in direction indicated with caution.
6. **Signs may indicate a right turn on red**—turn may be made with caution after stopping if sign so indicates.
7. **A flashing red traffic signal is the same as a stop sign.** You must come to a full stop and only enter the intersection by yielding the right-of-way to all vehicles not required to stop at the intersection.
8. **A flashing yellow traffic signal means caution.** You must slow down and proceed through the intersection with caution.

IMPLIED CONSENT
ALCOHOL CONCENTRATION IN INTOXICATION CASES
PENALTIES

Here are the important provisions:

- Permits such persons to refuse to take such tests, but requires the Registrar, in such cases, to revoke the person's license or driving privileges for 6 months.

- Establishes procedures for advising such persons of the consequences of refusal to take the test, for revoking the license, for hearing, for review, and for notifying the Registrar of other states of cases involving persons from such states.

- Provides that a person who is dead, unconscious, or otherwise incapable of refusing such a test, is deemed not to have withdrawn consent therefor. Also provides procedures for administering such tests to such persons.

- Requires the State Director of Health to determine and approve methods for chemically analyzing bodily substances, in order to determine blood alcohol content. Also authorizes him to determine necessary qualifications of persons to conduct such analyses. And requires him to issue revokable permits to such persons authorizing them to conduct tests. Limits withdrawals of blood for testing to registered nurses or physicians. Permits breath or urine samples to be taken by other persons.

- Authorizes courts to admit evidence on concentration of alcohol, if taken within two hours of violation.

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SCHOOL BUS

When meeting or overtaking from either direction, a school bus which has stopped for the purpose of discharging or receiving any school child, **you must stop your vehicle at least 10 feet from the school bus and not proceed until such school bus resumes motion, or until signalled by the driver to proceed.**

When traveling on any highway, which has been divided into two roadways by a physical barrier or clearly indicated dividing section—so constructed to impede vehicular traffic—it shall be necessary to stop, as indicated above, but only when traveling the same direction as the school bus.

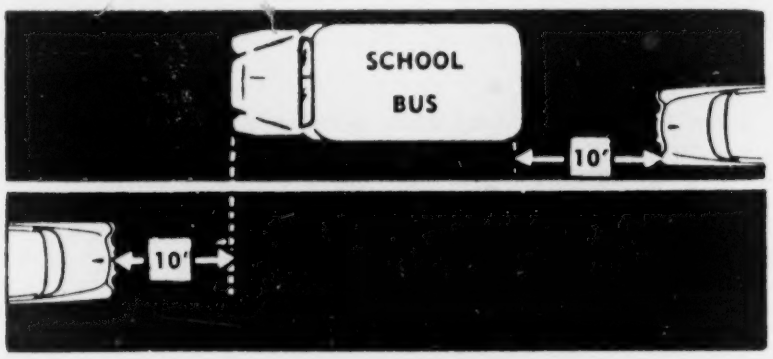

PUBLIC SAFETY AND EMERGENCY VEHICLES

On the approach of a public safety vehicle, responding to call, meaning ambulances, vehicles used by public law enforcement officers, and any vehicle used by fire departments—the driver of a motor vehicle is required to pull to the curb and remain stationary until the public safety vehicle has passed.

The driver of any vehicle other than an emergency or public safety vehicles on official business, shall not follow any emergency vehicle or public safety vehicle traveling in response to an alarm closer than 500 feet, or drive into or park such vehicle within the block where the fire apparatus has stopped in answer to a fire alarm, unless directed to do so by a police officer or a fireman.

No streetcar, trackless trolley or vehicle shall, without the consent of the fire department official in command, be driven over any unprotected hose of a fire department, when said hose is laid down on any street, private driveway or streetcar track to be used at any fire or alarm of fire.

Flashing lights are prohibited on motor vehicles, except as a means for indicating turns, or in the presence of a vehicular traffic hazard requiring unusual care in approaching, overtaking or passing. This prohibition does not apply to the use of flashing, oscillating or rotating amber lights on emergency vehicles, road service vehicles servicing or towing a disabled vehicle, traffic line stripers, snow plows, rural mail delivery vehicles, official survey vehicles and funeral escort vehicles.

Except a person operating public safety vehicles, school buses, or vehicles authorized to display slow moving vehicle emblems, no person shall operate or move upon any public street or highway any vehicle or equipment which has a flashing, oscillating, rotating red or combination red or white light.

SLOW MOVING VEHICLES

All farm machinery and other machinery which is designated for operation at a speed of 25 MPH or less shall be operated at a speed not exceeding 25 MPH, and shall display a triangular slow moving vehicle emblem (SMV). Use of the (SMV) emblem upon any other type vehicle is prohibited when such vehicle is operated at a speed of 26 MPH or more. Use of the emblem on stationary objects on the highway is also prohibited.

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When making right and left turns, make certain that your directional signals are operating effectively. If necessary, use hand signals as indicated. And don't forget to yield the right-of-way to traffic approaching from the opposite direction.

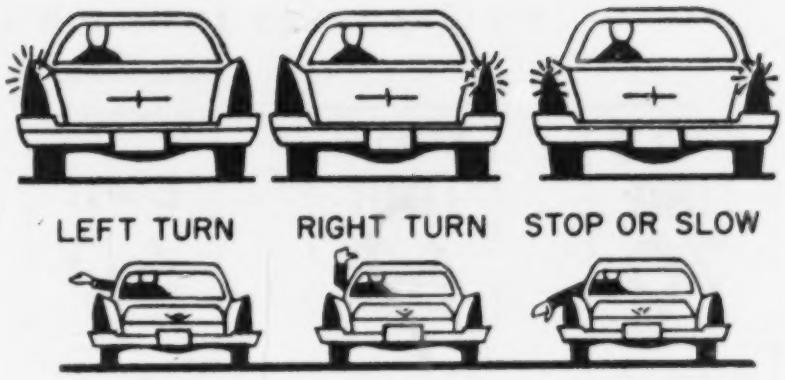

HAND SIGNALS

Give all signals well in advance. The following hand and arm signals control the operations of a motor vehicle.

1. Left turn—left hand and arm straight out.
2. Slowing or stopping—left hand and arm down.
3. Right turn—left hand and forearm straight up.

It is not necessary to use the hand signals if mechanical directional signals are used.

PROCEDURE FOR MAKING RIGHT & LEFT TURNS

The correct procedure in making:

1. Right turn—Give appropriate signal and stay as near to the right side of the road or curb as possible.
2. Left turn—Give appropriate signal and approach as near to the center line on your left side of the roadway as possible and leave the intersection to the right of the center of the roadway being entered.

The correct procedure for making a left turn from a roadway restricted to one-way traffic is—Give appropriate signal and approach the intersection in the extreme left hand lane entering as nearly as practicable into the left hand lane of the roadway being entered available for traffic in that direction.

RAILROAD CROSSINGS

It is unlawful to drive across a grade crossing:

1. When a crossing gate is lowered.
2. When an electrical or mechanical signal device or a human flagman gives warning of the immediate approach of a train.
3. Flashing yellow lights are sometimes used at railroad crossings, and drivers are urged to use extreme caution when observing these signals.

When a stop sign has been erected at a grade crossing all vehicles shall stop and not proceed until the driver has made certain that no train is approaching.

Note: Use caution though signals have stopped flashing—in the event another train may be approaching.

20786

. . and You Save Lives . . . Perhaps Your Own

TYPICAL SPEED ZONE SIGNS

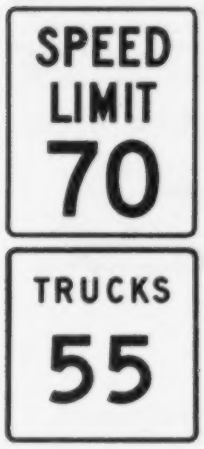

Freeway Speed Limit

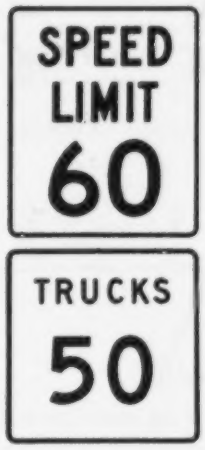

Daytime Speed Limit

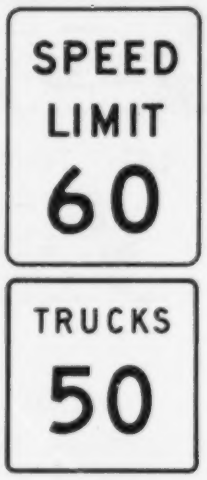

Nighttime Speed Limit

Posted Speed Limit

This means "STOP"

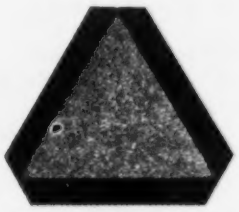

Slow Moving Vehicle

Other traffic has right of way

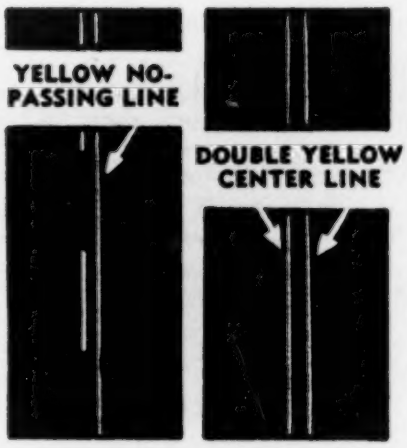

No Passing Zones

Railroad Warning Sign

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No vehicle shall be driven on the highway unless it is so constructed or loaded as to prevent any of its load from dropping, sifting, leaking or otherwise escaping.

Any commercial car, trailer, or semi-trailer, with a gross weight exceeding three tons, including load, must be equipped with suitable metal protectors or substantial flexible flaps on the rearmost wheels to prevent, as far as practicable, the throwing of dirt, water or other materials on the windshield of following vehicles.

The regulations governing towing connections for trailers are: When one vehicle is towing another the drawbar or other connection shall be of sufficient strength to pull all weight towed. In addition to such drawbar or other connections, each trailer or semi-trailer not connected to a commercial tractor by means of a fifth wheel shall be coupled with stay chains or cables to the vehicle drawing it. These chains or cables shall be of sufficient size and strength to prevent parting from the drawing vehicle should the drawbar or other connection break or become disengaged. Every trailer or semi-trailer shall be so coupled that the trailer will follow substantially in the path of the vehicle drawing it without whipping or swerving from side to side. When one vehicle is towing another and the connection consists only of a chain, rope or cable, a white flag or cloth not less than 12 inches square shall be displayed upon such connection.

Any vehicle transporting explosives upon a highway must be marked or placarded on each side and the rear with the word 'explosives' in letters not less than eight inches high, or there must be displayed on the rear of such vehicle, a red flag not less than 24 inches square marked with the word 'danger' in white letters six inches high.

Every such vehicle shall be equipped with not less than two fire extinguishers, filled and ready for immediate use and placed at convenient points on the vehicle.

You must obtain a permit from the Department of Highways if you wish to haul a load on the highway that is larger or heavier than the law allows:

INFORMATION ON LIMITATIONS ON MOTOR VEHICLE DIMENSIONS AND WEIGHTS

Width (except municipal bus or traction engine)	8'0"
Width of municipal bus	8'8"
Width of traction engine	11'0"
Height of all motor vehicles	13'6"
Length of single vehicle (except municipal bus)	40'0"
Length of passenger bus type	40'0"
Length of municipal bus	48'0"
Length of commercial-tractor & semi-trailer	55'0"
Length of any other combination	65'0"

Maximum weight (in pounds)

1. On one axle	19,000
2. Total on two successive axles spaced four feet or less, center to center	24,000
3. Total on two successive axles (tandem) spaced more than four feet apart and less than eight feet, center to center	32,000
4. Total on two successive axles spaced eight feet or more, center to center	38,000
5. Total weight of vehicle and load 38,000 pounds plus an additional 900 pounds for each foot of spacing between the front axle and the rearmost axle of the vehicle.	
6. Three axle group, no more than nine feet	48,000
7. Maximum gross load for any combination of vehicles	78,000
8. Maximum wheel load shall not exceed 650 pounds per inch width of tire.	

20788

A. Care and Operation of Kitchen Equipment

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to use, manipulate, and care for:	Purpose, operation, and use of:	Layout of kitchen equipment
Equipment	Dish machines	Cost:
Utensils	Glass machines	Initial
Tools	Electric mixers	Operating
	Silver washers	Good work habits:
	Food choppers	Safe
	Others	Productive
	Cleaning and care of all types of mechanical kitchen equipment:	Sanitation and cleaning methods:
	Ranges:	Steam cleaning
	Gas	Cleaning supplies
	Electric	
	Broilers	Safety and work precautions
	Steam tables	
	Steam jacket kettles and steamers	
	Refrigerators	
	Freezers	
	Manipulating all types of electrical equipment:	Safety and work precautions
	Peelers	
	Vegetable cutters	
	Buffalo choppers	
	Lighting of all gas-fired equipment:	Safety precautions
	Ranges	Thermometers
	Broilers	Thermostats
	Ovens:	Timers
	Roasting	Cost of operation
	Baking	
	Deep fat fryers	
	Starting of electric cooking equipment:	
	Ranges	
	Ovens:	
	Roasting	
	Baking	
	Microwave	
	Deep fat fryers	
	Infrared equipment	
	Operating steam cooking equipment:	Pressure gauge
	Live steam equipment:	
	Steam jacket kettles	
	Pressure steamers	
	Self-contained electric steam cooking equipment	Timers Pressure gauge Electric controls
	Cleaning and care of kitchen tools and other utensils	Storage

Suggested teaching materials: See items 19, 32, 50, 55, 58, 60, 61, 67, 85, 109 in appendix B.

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report with the Registrar of Motor Vehicles. Official forms may be obtained from any Government subdivision, Police Department, State Highway Patrol Post, or Deputy Registrar.

FINANCIAL RESPONSIBILITY

Insurance requirements: $12,500 for bodily injury or death of one person in any one accident; $25,000 for bodily injury or death of two or more persons in any one accident; from $7,500 for property damage, and the amount of $30,000 to be deposited with the state treasurer as evidence of financial responsibility.

TRUCK REGULATIONS

The law requires enough space between a truck or a vehicle drawing another vehicle to permit an overtaking vehicle to enter and occupy without danger.

The law requires that operators of motor vehicles carrying passengers for hire, or of any school bus or of any vehicle carrying explosives or inflammable liquids before driving across any railroad grade crossing to:

Stop and listen through an open door or window and look in both directions. He shall cross in such a gear that will not require changing and shall not shift gears while crossing the tracks.

The Director of Highway Safety has the authority to prescribe clearance markers, reflectors and stop lights on buses, trucks, and trailers not operating under the Public Utilities Commission of Ohio.

The law requires a light at night or a flag in the daytime on the load overhang on the rear of a vehicle when the load extends four feet or more beyond the bed of such vehicle.

The following safety equipment shall be carried in all trucks:

1. At least 3 flares, or 3 red reflectors, or 3 red electric lanterns.
2. At least 3 red burning fusees, unless red reflectors or red electric lanterns are carried.
3. At least 2 red cloth flags not less than 12" square with standards to support them.

You, as a truck driver, must take the following steps in case of a breakdown on the highway.

1. Place a lighted fusee or red reflector on the traffic side of the vehicle unless the red electric lanterns are used.
2. Promptly place three lighted flares or red reflectors or three red electric lanterns as follows:
   One at a distance of forty paces to 100 feet to front and one of equal distance to the rear and each in the center of that lane and one on the traffic side of the vehicle. Red Flares shall be used when lights are not required. One shall be placed forty paces or 100 feet to the front and one equal distance to the rear and both in the center of that traffic lane. If disabled, near a curve, crest of a hill or near an obstruction to view, the flags or flares shall be placed to give ample warning, but never less than forty paces or a hundred feet or over one hundred and twenty paces or three hundred feet from the vehicle.

When driving a motor vehicle and hand signals are not visible both to the front and rear, mechanical turn signals must be installed.

Mechanical turn signals must be installed on a vehicle when the distance from the center of the steering post to the left edge of the vehicle exceeds 24 inches and/or when the distance from the center of the steering post to the rear of the vehicle exceeds 14 feet.

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20789

UNIT V

BUS MAINTENANCE

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UNIT V

I. TOPIC

Bus Maintenance

II. ORIENTATION

Each bus, before it is put into operation for a day's work, must have an inspection by its driver. Such an inspection will help insure the safety of both the pupils and the driver. This practice will also decrease the maintenance costs of the pupil transportation program. The daily inspection should become a matter of routine and the few minutes invested may pay rich dividends in the saving of lives and property.

Regardless of the engineering skill or workmanship incorporated in a school bus, it cannot continue to deliver maximum safety, economy, and dependability unless it is properly maintained. Although the repair of school buses is wisely left to a skilled mechanic, the individual driver can do much to aid the mechanic in locating any trouble and often prolong the life of the vehicle by daily inspections.

Every driver should have a basic knowledge of the school bus systems in order for him to know generally how these will affect the bus's operation. There will be times when this knowledge will be useful to the driver in diagnosing trouble while he is on the route. Proper diagnosis of mechanical trouble will increase the efficiency and economy of the operation.

III. PRESENTATION OF MATERIAL

A. Use of Senses

1. Listening for trouble

   a. Sharp knock when picking up speed
   b. Light knock when engine is running at idle speed
   c. Dull regular knock
   d. Clicking or tapping noises
   e. Continuous or intermittent squeal or squeak
   f. Loud exhaust noise
   g. Engine backfiring, missing, popping, spitting, or overheating
   h. Steaming and hissing

Figure 7

20791

2. Feeling for trouble

   a. Excessive vibration

      (1) Engine compartment
      (2) Steering Wheel
      (3) Drive line

   b. Low speed or high speed shimmy
   c. Hard Steering and steering wander

3. Looking for trouble

   a. Sudden drop in oil pressure
   b. Low oil pressure
   c. No oil pressure

NOTE: If any of the above exist, the vehicle shall not be driven until corrected.

Figure 8

   d. Excessive oil consumption
   e. Smoke coming from under dash
   f. Smoke coming from under hood
   g. Scuffed tires or spotty wear

4. Smelling trouble

   a. Odor of gasoling
   b. Odor of burning rubber
   c. Odor of burning oil
   d. Odor of burning rags
   e. Exhaust fumes

5. Any other unusual conditions should be reported immediately to the proper authority.

Figure 9

B. Driver's Daily Maintenance and Inspection Responsibilities

1. Pre-starting inspection

   a. Take a good overall look at the bus

      (1) Oil, gasoline, or water leaks
      (2) Vandalism

20792

b. Open hood - Make sure that safety latch, rod, or hinge is in holding position.

Figure 10
Check Oil Before Starting Engine

(1) Check oil level.
(2) This is the most logical time, as all the oil has drained to the crank case and an accurate reading can be made.
(3) Keep oil above "add oil" line.
(4) Be certain the oil level is not overly full as this may indicate a foreign substance in the oil.

c. Remove the radiator cap and check liquid level. It should be above core level.
d. Check fan belt for proper tension, cracks, and frayed edges.

(1) Most fan belts will operate efficiently if not more than "½ give" is maintained.
(2) A run-down battery in most cases is traced to a loose fan belt and/or a driver's failure to observe his instrument panel occasionally.

e. Look over engine for any loose wires and any excess oil.
f. Close the hood.
g. Wipe windshield turn signals, and warning lights clean.

NOTE: Windshield must be clean before turning on wipers.

20793

h. Start the engine, using proper engine starting procedures (Unit 6, Section B). In allowing the engine to warm up, accelerator should be set for a fast idle. Do not race the engine, as stiff oil will not lubricate fast enough; this can cause bearing damage.

2. First outside-inside inspection

   a. Turn on left directional light, marker lights, and headlights. (high beam)
   b. Front inside of bus, check operating condition of dash-mounted turn indicator signal, high beam indicator, and instrument panel light.
   c. From outside of bus, check left directional signal, marker lights, and headlights. Check for intensity of light, condition of lens, and dark spots on sealed beam unit.

3. Second outside-inside inspection

   a. Turn on right directional lights, warning lights, headlights (low beam), and passenger compartment lights.
   b. From inside of bus, check operating conditions of switches and dash mounted indicators.
   c. From outside of bus, check right directional signal, flasher lights, tail lights, and headlights (low beam). Check for intensity of light, condition of lens, and dark spots on sealed beam units.
   d. Wipe tail lights, stop lights, and headlights clean.
   e. Tires - Check for inflation (use hammer or bar) and general condition.
   f. Wheel bolts - Check visually for tightness, and rust dust around edge of bolt or nut. This is a good indication of a loose wheel bolt.
   g. Emergency door - Check the opening and closing and see that the emergency buzzer is operating.
   h. Windows and mirrors - Check for cleanliness, cracks, or breaks. Good visibility should always be maintained by clean windows and mirrors.
   i. View underneath of bus

      (1) Oil or grease leaks
      (2) Exhaust system
      (3) Springs and hangers
      (4) Body clamps

   j. Body - Check general condition noting any scratches or dents as well as the legibility of bus markings. Many times these markings are coated with so much road dust that they cannot be read nor can it even be distinguished that the vehicle is a yellow school bus.

20794

4. Interior equipment inspection

a. Emergency equipment

(1) Held securely in place
(2) Contents of first aid kit
(3) Contents of fire extinguisher - Note the position of the pressure guage indicator. The needle should always be in full charge area.
(4) Flags, fuses, and reflectors
(5) Wrecking bar

b. Check the horn loudness and operating condition of horn button.
c. Windshield and wipers

(1) Cleanliness of windshield inside
(2) Condition of wiper blades and their operation
(3) Wiper motor and linkage operation

d. Dashboard gauges

(1) Check operating condition and visibility of all gauges.
(2) Attention should be given to these gauges for their proper function at all times when engine is in operation.

e. Check four-way warning hazard switch (when applicable).
f. Brakes - Check

(1) The holding power of the parking brake
(2) The holding power of the parking and/or emergency air brake (when applicable)
(3) For full pedal on foot brake and the position the pedal holds under continued pressure (hydro-vac or hydraulic systems)
(4) Air brakes - depress foot pedal and listen for air leaks.
(5) Brake lights working. This can be checked by having the rear of the bus near a building or by noting the movement of the ammeter hand.
(6) Brake operation before leaving parking lot.

g. Drain water from air storage tank daily

(1) Manual - Use the petcock on the wet-tank drain once daily, preferably at the end of the trip.
(2) Moisture ejectors will operate:
(a) Automatically
(b) Manually - With button on the dash

20795

(3) Local policy

h. Condition of seats and floor
i. Writing on seats and inner skin of body
j. Emergency door operation from inside and wipe rear warning lights
k. Clutch

(1) Chattering or grabbing clutch
(2) The amount of free pedal
(3) A clutch that does not release properly
(4) A slipping clutch

l. Check body instrument panel
m. Steering - When leaving the parking area, check for stiffness and free or loose movement.

5. Bus Cleanliness - Inside and outside

a. The bus must be swept daily. Students should be taught not to throw paper, etc. on the floor.
b. All windows and mirrors should be kept clean. Remember clean windows for clear visibility. In case of an accident, the driver can be cited for vision obstruction.
c. The outside of the bus should be washed as often as needed. Do not allow road dirt to accumulate. Very often just wiping with a dry cloth will remove road dirt if it is not allowed to harden.
d. Seat condition should be checked each time your bus is unloaded. By so doing, any damage can be pin-pointed more effectively.
e. A driver that maintains a clean bus inside and outside will have the respect of the students he transports and they will also take pride in helping to keep a clean bus.

Figure 11

20796

IV. SUMMARY

As one can see after reading the above material, the driver must be alert for malfunctions. Knowing certain noises, feeling certain vibrations, smelling certain odors, and noticing the proper function of all guages may save the driver from a bus breakdown or a serious accident. A school bus inspection is important to the safety of the children being transported by that bus. The inspection need not be made in the same manner as outlined, but a systematic method shall be used so that no part of the bus is missed. Without a safe operating bus and an alert driver, our children will be in danger.

20797

UNIT VI

DRIVING FUNDAMENTALS

80/81
20798

B. Meat Cutting

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to cut beef	General procedure	Grades and classification Inspection
	Various cuts found in carcass Identification of primal cuts	Size Shape Location Use
	Bone structure Processing hind quarter Processing fore quarter	Steps involved
	Cutting, boning, and trimming	Tools and equipment Safety and work precautions Sanitation Calculation of costs
How to cut veal	General procedure	Grades and classification Inspection
	Various cuts found in carcass	Size Shape Location Use
	Processing whole or side of veal Cutting, boning, and trimming	Steps involved Tools and equipment Safety and work precautions Sanitation Calculation of costs
How to cut pork	General procedure	Grades and classification Inspection
	Various cuts found in the carcass Identification of primal cuts	Size Shape Location Use
	Bone structure Processing of hog carcass Cutting, boning, and trimming	Steps involved Tools and equipment Safety and work precautions Sanitation Calculation of costs
How to cut lamb	General procedure	Grades and classification Inspection
	Various cuts found in carcass	Size Shape Location Use
	Processing of lamb carcass Cutting, boning, and trimming	Steps involved Tools and equipment Safety and work precautions Sanitation Calculation of costs

Suggested teaching materials: See items 19, 35, 39, 42, 63, 69, 82, 110 in appendix B.

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UNIT VI

I. TOPIC

Driving Fundamentals

II. ORIENTATION

School bus drivers have entrusted to them the lives and safety of a human cargo that cannot be measured in terms of dollars and cents. The purpose of this unit on Driving Fundamentals is to teach drivers the basic skills necessary for them to operate buses properly in transporting this valuable cargo safely and efficiently.

The individual driver must not only learn these basic driving skills, but the driver must practice each skill correctly in order to become proficient. Through practice, each correct basic procedure will become a habit to the driver and will contribute to the safe operation of the bus. Experienced drivers who have not had the benefit of organized instruction must be made aware of their faults, and each must make a concerted effort to correct any poor driving practices.

In past years, accidents involving Ohio school buses were caused by the school bus driver in over fifty per cent of the cases. This can be traced in a large part to driver preoccupation and the absence of organized instruction for the driver.

The instructions which follow have been developed to assist the driver in correctly performing the task of driving a school bus. Each section in this unit is based on sound driving practices and procedures. If properly learned and adhered to, these proceudres will result in improving the performance of the bus driver.

III. PRESENTATION

A. **Driver Position** - To be a good bus driver each driver must position himself for comfort, for good vision, and to be within reach of all driver compartment controls.

1. Adjust driver's seat.
2. Adjust seat belt if available.
3. Adjust all mirrors for most advantageous use.

    a. Inside mirror
    b. Outside mirrors should be adjusted so that the driver can see the rear wheel-wells and bumper.

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4. The driver should be acquainted with the entire instrument panel and know where each gauge, dial, and switch is located.

B. **Starting the Engine** - The procedure used in starting a bus engine must become a matter of routine. It must incorporate principles of safety and be performed in keeping with good engine preventive maintenance practices.

1. Set parking brake to keep bus from moving.
2. Depress clutch pedal to disengage engine from transmission.
3. Shift gear lever into neutral position to relieve added strain on starter.

   a. Permit additional gears to remain idle.
   b. Check position by moving lever from side to side.

4. Turn on ignition key to complete electric circuits.
5. Engage starter switch.

   a. With clutch depressed and gear in neutral
   b. Use hand choke if necessary and available. Over choking will cause carburetor flooding.
   c. Use foot accelerator sparingly. Pumping will cause carburetor flooding.
   d. Bus engines will vary widely in their carburetor sensitivity; therefore, do not hesitate to ask the supervisor or bus mechanic for special techniques in starting a particular bus.

6. After engine is running

   a. Release clutch pedal slowly without stalling engine.
   b. Allow transmission gears to start rotation.

7. Warm up engine at fast idle.

   a. Do not race the engine.
   b. Much engine wear comes in the first three minutes after starting.

C. **Shifting Gears** - Gear shifting is a phase of bus driving which requires skill and practice. The driver must learn the best range of speed in changing gears upward and downward. Shifting the gears must be accomplished without loss of road vision. Syncro-mesh transmissions have alleviated most of the gear clashing. Generally, buses are equipped with a four or five speed transmission.

1. Know the gear positions.

   a. Check chart on lever knob or on dash.
   b. Ask mechanic.

20800

2. Depress clutch pedal.
3. Shift gear lever into starting gear.

   a. For average terrain and load this should be second gear.
   b. Load and/or terrain may dictate the use of first gear.
   c. Never start out in a gear higher than second as this places undue load and wear on the engine and clutch.

4. Depress foot brake.
5. Release parking brake lever. If ratchet type, pull brake lever slightly back to release pressure.
6. Release clutch gradually to friction point and hold. At this point you will have the clutch just at the point of friction and the foot brake on and ready to release.
7. Depress accelerator. Hold point of clutch friction and slightly depress accelerator to increase the power to prevent stalling.

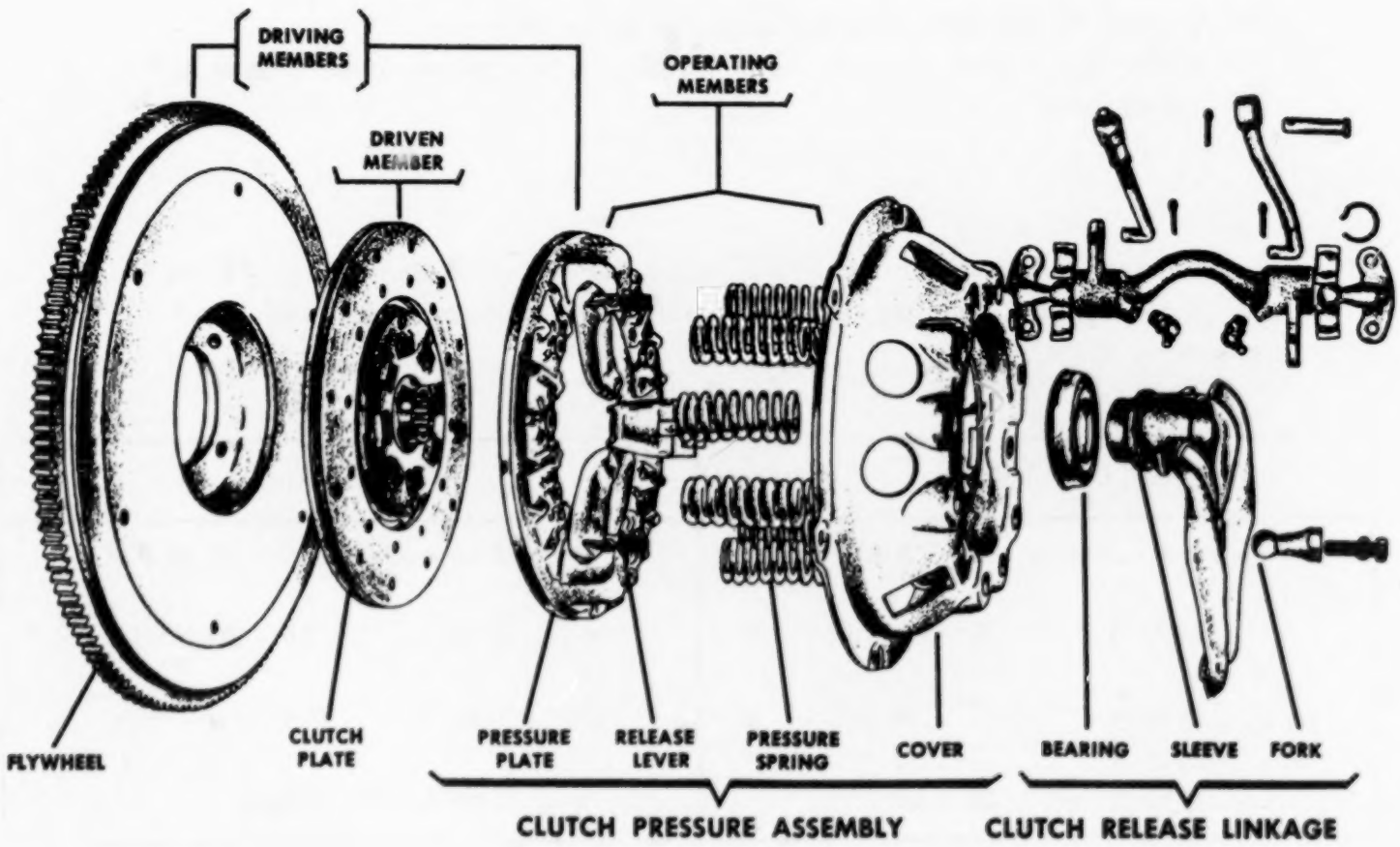

CLUTCH ELEMENTS

Figure 12

20801

8. Release Clutch.

   a. Slowly and gradually release the clutch to the remainder of pedal travel and at the same time slowly and gradually increase the acceleration.
   b. Remove foot from clutch pedal completely.
   c. Pick up engine speed before shifting to higher gear.

9. Shift to next higher gear.

   a. Depress clutch pedal and release accelerator.
   b. Shift to next higher gear.
   c. Release clutch smoothly but more quickly than in starting gear and depress accelerator smoothly and quickly.

      (1) To prevent loss of vehicle speed
      (2) Do not race the engine and slip the clutch.

   d. Remove foot from clutch pedal.
   e. Proceed in this gear until proper vehicle speed is reached for shifting to next gear.

10. Repeat #9 procedures until the bus is in cruising gear.
11. Never skip a gear in up or down shifting as this causes undue engine and clutch wear.

Approximate M.P.H. to be reached before upshifting or downshifting. M.P.H. may vary slightly depending on make of engine, transmission, gear ratio, and terrain.

Upshifting	Downshifting
From 1 to 2 Gear 1 - 5 M.P.H.	From 5 to 4 Gear 30 - 35 M.P.H.
2 to 3 " 5 - 12 "	4 to 3 " 25 - 30 "
3 to 4 " 12 - 20 "	3 to 2 " 5 - 10 "
4 to 5 " 25 - 30 "	2 to 1 " Stop "

Table 1

20802

12. Shift up or down as may be necessary to prevent engine lugging or excessive engine R.P.M.
13. In going down a hill, shift into the gear that would be used in going up the hill.

D. **Double Clutching** - Syncro-mesh transmissions have almost alleviated the need of double clutching. Shifting the gears on non syncro-mesh transmissions is done faster and smoother by double clutching. This process coordinates the engine speed and transmission speed for non-clashing of gears. Double clutching aligns the gears for easy up and down shifting. The gears should never be forced by improper timing of the shifting process. Reclutching and speeding up the engine will in most cases prevent excessive clashing. The engine should never be allowed to pull heavily going upgrade, on a turn, or on a curve. Neither should it be permitted to over-race downgrade.

1. Double clutching, up shifting

   a. Depress clutch pedal and release accelerator.
   b. Shift gear lever to neutral position.
   c. Release clutch pedal momentarily to engage clutch.
   d. Depress clutch pedal and shift to next higher gear.
   e. Release clutch and accelerate engine at the same time.

2. Double clutching, down shifting (See Table 1)

   a. Depress clutch pedal and release accelerator.
   b. Shift gear lever to neutral position.
   c. Release clutch pedal momentarily to engage clutch and accelerate engine to more than original speed.
   d. Depress clutch and shift to next lower gear.
   e. Release clutch pedal gradually and accelerate engine to match the speed of vehicle.

3. Related items of double clutching

   a. The double clutching procedure may be slow or fast depending upon the type of bus.
   b. Normally down shifting two gears is sufficient.
   c. Double clutching requires continuous practice.
   d. Syncro-mesh transmissions may be double clutched.

E. **Shifting Automatic Transmission** - Some buses are equipped with automatic transmissions and the driver should understand the operation of such transmissions.

1. Know the shift positions.
2. Depress foot brake.
3. Move selector lever into forward or driver position.

20803

4. Release parking brake.
5. Release foot brake and depress accelerator.
6. As speed of bus increases, the transmission will automatically shift to the next higher gear until reaching cruising gear.
7. Down shift for additional power.

   a. Depress accelerator to the floor firmly. This will cause transmission to down shift one gear.
   b. Move selector lever to next lower position.

F. **Steering and Turning** - The school bus driver, to be classified as an expert driver, must be able to assume the correct steering position and make all the turning maneuvers correctly and smoothly. He must learn the correct procedures necesary to prepare for the turn, make the turn, and re-enter the traffic pattern. The driver who is confronted with an unusual turn or turn-a-round shall do so with extreme caution. The raising of speed limits and the super highway system in Ohio, upon which the school buses may travel, has forced the driver to use added skills and judgment in making turns properly and safely.

1. Steering positions

   a. Grip the steering wheel with both hands.
   b. Left hand at approximately 10 o'clock position
   c. Right hand at approximately 2 o'clock position

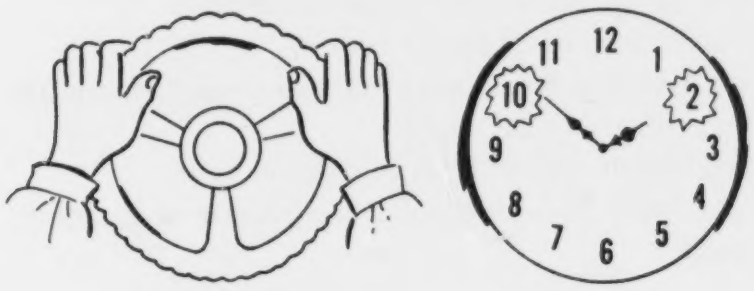

Figure 13

   d. Hands on outside of steering wheel and thumbs on top or outside of wheel

2. Focus eyes on road ahead.

   a. Eyes should be constantly on the move to obtain the "big picture".
   b. Ahead, left side, right side, rear view mirrors

20304

3. The push-pull steering method is recommended for school bus drivers. One hand pulls and the other hand pushes.
4. Hand over hand method may catch thumb in clothing, safety chain on the wrist watch, bracelets, etc., which are hazards to steering.

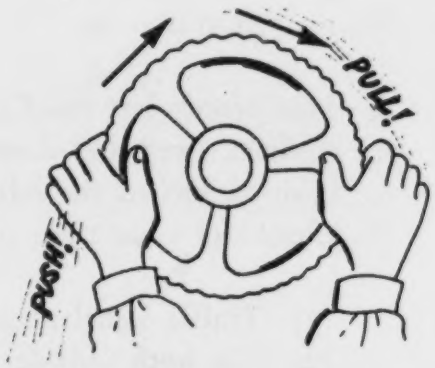

Figure 14

5. Preparing for turns

   a. Check traffic to the front and rear of the bus.
   b. Give proper signal to move vehicle into proper lane.

6. Making right turn

   a. Give proper right hand turn signal.
   b. Reduce speed and down shift to proper gear needed to execute turn.
   c. Position bus in right side of the lane.
   d. Check for clear right of way.

      (1) Traffic signals, signs pedestrians, or vehicles
      (2) Use both outside mirrors.

   e. Execute the turn.

      (1) Make turn smoothly without strain on the engine.
      (2) Never shift gears during a turn.
      (3) Check right mirror while executing turn.
      (4) Enter the right most lane available and check turn signal for cancellation.
      (5) Steer wheels back into position -- do not let steering wheel spin wheeks back into position.

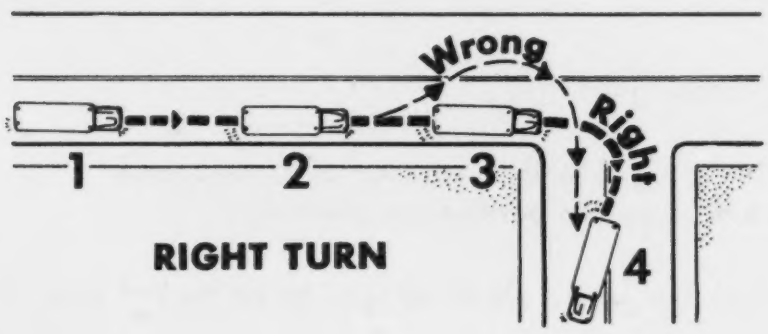

Figure 15

20805

7. Making left turn

   a. Give proper left hand turn signal.
   b. Reduce speed and down shift gear.
   c. Position bus to the left edge of the lane.
   d. Check for clear right of way.

      (1) Traffic signals, signs, pedestrians, or vehicles
      (2) Use both outside mirrors.
      (3) If necessary to stop, keep front wheels straight and brake pedal depressed.

         (a) Prevent drifting and activate stop lights.
         (b) This will prevent being shoved into line of approaching traffic if struck from the rear.

   e. Execute the turn.

      (1) Drive into the intersection, make turn smoothly, and without strain on the engine.
      (2) Check left mirror while executing turn.
      (3) Never shift gears in a turn.
      (4) Enter the highway in the left most lane available and check turn signal for cancellation.

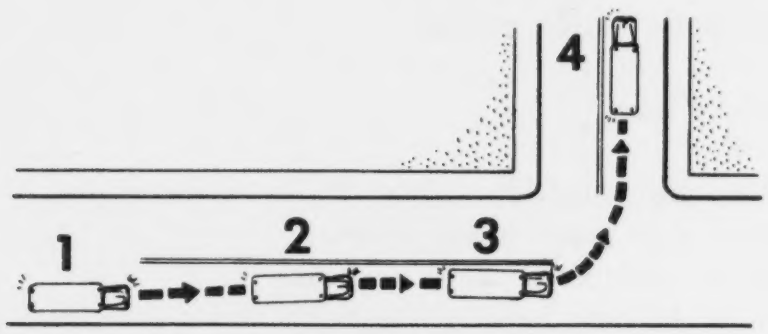

LEFT TURN

Figure 16

   f. After completing the left turn upon multiple lane highways, pick up speed and move into right hand lane as soon as possible.

8. Making a turn-a-round

   a. Give brake signal well in advance of turn-a-round.
   b. Stop bus in proper position on roadway.

      (1) One bus length ahead of road to be backed into

20806

(2) Check traffic front and rear.
(3) Visibility shall be 500 feet in either direction (ORC 4511.37).
(4) Have traffic move around bus if possible.
(5) Back into roadway or driveway using outside mirrors.
(6) Re-enter roadway.

(a) Check traffic.
(b) With caution

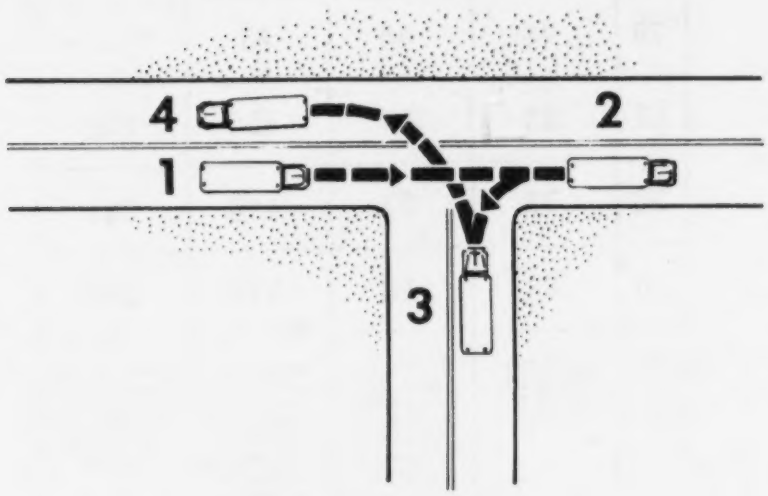

TURN AROUND

Figure 17

G. **Stoping and Parking Bus** - Stopping a school bus smoothly and within the limits of safety is another sign of an expert driver. A good driver has his vehicle under control at all times and knows that braking distances increase greatly as the speed and weight of the vehicle increases. With a reaction time of one second the driver must realize that at 20 m.p.h. the average stopping distance is 59 feet, and at 40 m.p.h. the stopping distance is 179 feet or approximately three times greater. The skillful driver also knows that by using correct stopping procedures the maintenance costs on the braking system will be less.

20807

Maximum Safe Stopping Distances for TRUCKS and BUSES In Accordance with ICC Regulations				
Speed Miles Per Hour	Feet Per Second	Vehicle Travels (One Second) Reaction Time	Braking Distance	Total Stopping Distance
20	29	29	30	59
30	44	44	67	111
40	59	59	120	179
50	73	73	188	261
60	88	88	270	358
Speed of vehicle.	No. of feet covered per second by vehicle.	Distance traveled in one second before brake can be applied after seeing danger (in feet).	Distance required to stop after brake is applied with good pavement and fair brakes (in feet).	Total feet covered after seeing danger (in feet). Reaction time plus stopping distance.

Table 2

1. Stopping when in a low gear or 10 m.p.h. and less

   a. Depress clutch pedal and release accelerator.
   b. Apply brakes gradually by increasing pressure.
   c. Reduce brake pressure slightly, but not completely just before coming to a stop to prevent jerking.
   d. Shift gear lever into neutral position.
   e. Release clutch and remove foot from pedal.

2. Stopping when in cruising gear

   a. Release accelerator and depress brake pedal.
   b. When proper m.p.h. is obtained for any gear, down shift to next lower gear. See Table 1.

      (1) Will reduce heat build-up
      (2) Reduce excessive brake wear

20808

C. Meat and Poultry Cookery

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
Roasting		
How to roast meats:	Explanation of roasting principle:	Characteristics of grades and cuts suitable for roasting
The understanding and application of recipes, formulas, and precedures	Beef	
	Pork	
	Veal	
	Lamb and mutton	
	Care and storage before roasting	
	Preparation:	Equipment:
	Fresh meats	Roast pans
	Frozen meats	Meat thermometers
		Oven thermometers
		Other equipment
	Procedure:	Shrinkage:
	Seasoning	Cause
	Roasting temperatures	Effect
	Time	Control
		Cost
	Testing for doneness	Methods of testing
		Methods of serving:
		Gravies
		Jellies
		Garnishes
	Carving	Carving:
		Tools
		Portions
	Care of meat:	Use of drippings, fat, and trimmings
	After roasting	
	During serving period	
	Storage	
		Calculation of costs
How to roast poultry:	Explanation of roasting principles:	Classification of poultry
The understanding and application of recipes, formulas, and procedures	Turkey	Effect of roasting
	Chicken	Nutritive value
	Capon	Characteristics of poultry suitable for roasting:
	Duck	Age
	Goose	Weight
	Preparation for roasting:	Equipment:
	Drawn (viscerated) poultry	Roast pans
	Undrawn (nonviscerated) poultry	Thermometers
	Frozen poultry	
	Procedure:	Shrinkage:
	Seasoning	Cause
	Basting	Effect
	Vegetable garnishes	Control
	Roasting temperatures	Cost
	Time	
	Carving	Carving:
		Tools
		Portion control
		Variation in roasting procedure for ducks and geese

2056

c. Down shifting can be very effective and smooth.

(1) 3rd gear for 5 speed transmission
(2) 2nd gear for 4 speed transmission

3. Parking the bus

a. Shift lever into low gear on level or upgrade.
b. Shift lever into reverse gear on down grade.
c. Turn wheels into curb.
d. Turn off ignition and remove ignition key.
e. Set parking brake (Parking brake may freeze in wet freezing weather.)

H. **Loading and Unloading** - The loading and unloading of pupils presents the driver with additional responsibilities and requires use of good judgment. The driver must learn the proper procedure for controlling traffic, for pupils crossing roadway, for pupils entering the bus, and for pupils seating themselves.

1. Loading

a. Check traffic - oncoming.
b. Check traffic - behind -- using mirrors.
c. Activate flasher lights approximately 300 feet before the stop.

(1) Warn traffic in front and to the rear of the bus in sufficient time.
(2) This will vary depending upon conditions.

d. Bring bus to stop using proper procedure (refer to Section G, Number 1 and 2).
e. Do not stop where visibility to front and rear is less than 500 feet.
f. Put gear shift lever into neutral.
g. Re-check traffic to front and rear of the bus and make certain traffic has come to a stop.
h. Open entrance door and signal pupils it is safe to cross in front of the bus.

(1) Pupils should be taught to cross at least 10 feet or 5 paces to the front of the bus.
(2) Instruct child to cross at distance where he can see the driver.
(3) Safety - cross mirrors are helpful.

i. Systematic loading can be very helpful.

(1) Various systems can be used.
(2) Pupil concentration must be considered.

20809

(3) Two pupils per seat starting from rear.
(4) Three pupils per seat starting from rear.
(5) Do not allow students to stand in step well or forward of the driver stantion.

j. Proceed when all students are seated.

(1) Shift into starting gear.
(2) Close the door.
(3) Check to see that all students are seated. Check traffic and move out slowly and smoothly.

2. Unloading

a. Follow the same procedure as outlined in loading under a., b., c., d., e., f., g., h.
b. Proceed when pupils are in complete safety on their residence side of road.

3. Unloading at school building

a. Stop bus using proper procedure.

(1) Place gear shift lever in low gear.
(2) Turn off ignition.
(3) Set parking brake.

b. Do not activate warning flasher lights.
c. Driver stand and face students.

(1) All students remain seated.
(2) Unload front seat entrance side first, then front seat driver side. Continue alternating to the rear of the bus.
(3) This unloading procedure promotes safety and efficiency.
(4) Develops good habits in case of emergency evacuation.

Figure 18

If In Full Control, Driver Need Not Deactivate Unit

20810

Shall Deactivate Unit Prior To Standing

Figure 19

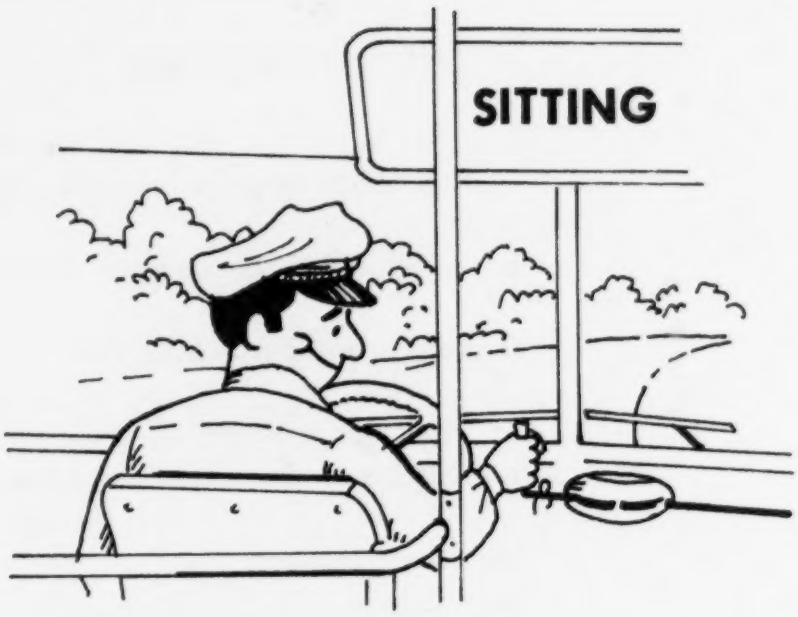

Shall Deactivate Unit Prior To Turning Sideways

Figure 20

I. **Railroad Crossing** - Through planned safety procedures for crossing railroad tracks, many accidents could be eliminated. Learn these procedures and practice them until they become automatic actions.

Crossing railroad tracks represents one of the greatest hazards insofar as mass casualities and fatalities are concerned. STOP, LOOK, and LISTEN. All school buses loaded or empty must stop for railroad crossings.

1. Prepare to stop.

   a. Request silence.

      (1) This is a must.
      (2) Turn heaters off if necessary to have more silence.

20811

b. Get "Big Picture", check traffic control devices.

2. STOP the bus.

   a. Follow stopping procedures.
   b. Stop in a position that gives a clear view of the tracks in both directions. The front bumper must be clear of the tracks.
   c. Shift into neutral.

3. LOOK and LISTEN.

   a. Open service door and driver's window.
   b. Look and listen through the open window and door.

4. If no indication of approaching train

   a. Shift into starting gear.

      (1) Must be a gear that will take bus across tracks without hesitation.
      (2) Shifting gears on tracks shall not be permitted.

   b. Look and listen a second time, close door, and proceed quickly and smoothly.

5. If there is an approaching train

   a. Hold bus position, may use the parking brake depending on waiting time.
   b. After train passes, follow items under Procedure 4.

6. Multitrack crossings

   a. Make sure no train is approaching on any of the tracks.
   b. After a train passes, wait until other tracks become visible before proceeding. A second train may be approaching from the opposite direction.
   c. Follow items under Procedure 4.

7. Railroad traffic control devices

   a. Flasher lights and bells

      (1) Warning of an approaching train
      (2) If train is stopped or signal is malfunctioning, a vehicle may proceed after driver insures a safe crossing can be made.

   b. Gates

      (1) All traffic must obey these devices.

20812

(2) Vehicles may proceed around the gates only at the direction of a peace officer or an authorized railroad representative.

c. Railroad crossing controlled by a flagman

(1) A school bus must make a safety stop.
(2) Follow directions of the flagman.

J. **Unusual Weather and Road Conditions** - A good driver will adjust his driving to all kinds of weather and road conditions to stay within the limits of safe driving. Bad weather may excuse a delay, but never an accident.

1. Conditions causing slippery roads

a. Rain
b. Freezing rain
c. Snow
d. Wet leaves
e. Spillage of oil, etc ., from trucks
f. Mud

2. Procedures for safe driving on slippery roads

a. Slow down.
b. Use brake fanning action. Sudden braking will cause skidding and loss of steering traction.
c. Allow more distance for driving action.
d. Allow more distance when signaling.

3. Conditions causing poor visibility

a. Rain
b. Snow
c. Clouds
d. Fog - Smoke
e. Inside bus fogging

4. Procedures for safe driving in poor visibility.

a. Slow down.
b. Use windshield wipers and defrosters.
c. Turn on marker lights and head lights.

NOTE: Driving with lighted parking lights is illegal.

d. Sound horn at intersections, curves, and other dangerous places.

20813

5. Road conditions caused by freezing, thawing, and rain

   a. Soft and spongy roads
   b. Chuck holes
   c. Broken road sections
   d. Humps

6. Procedures for safe driving on poor road conditions

   a. Slow down.
   b. Be alert for these conditions during the proper seasons.

7. Procedures when driving off roadway onto soft shoulder

   a. Slow down.

      (1) Brake gently.
      (2) Hold steering wheel firmly and steer along berm.

   b. Drive on shoulder.

      (1) Keep bus moving.
      (2) Look for place to pull onto the roadway.
      (3) Check traffic in front and rear.

   c. Turn onto roadway.

      (1) Hold steering wheel firmly.
      (2) As soon as front of bus is on roadway, return bus to normal position.
      (3) Do not allow bus to cross into next lane of the road.

8. Procedures for controlling skid

   a. Remain calm.
   b. Release accelerator.
   c. Do not put on the brakes.
   d. Turn front wheel in direction of the skid.

      (1) Make smooth turn and not too quickly.
      (2) Do not over steer.
      (3) This turn will bring front end of bus in line with rear end.

   e. Be ready to make the opposite turn as bus begins to re-align with the road.

      (1) This turn will need to be made more quickly.
      (2) Turn only enough to keep bus in line with the road.

20814

K. Types of Roads and Speed Limits

1. Interstate - bus speed limit 55 M.P.H.
2. State Highway and Turnpike - bus speed limit 50 M.P.H.
3. Entering and leaving freeway

   a. Use acceleration lane to pick up speed.
   b. Yield right of way to roadway traffic - stop only if necessary.
   c. Pick an opening in the traffic and move into the flow.
   d. To leave the roadway, activate turn signal and move from right lane into deceleration lane.
   e. Slow down for exit.
   f. Use proper turn signals.

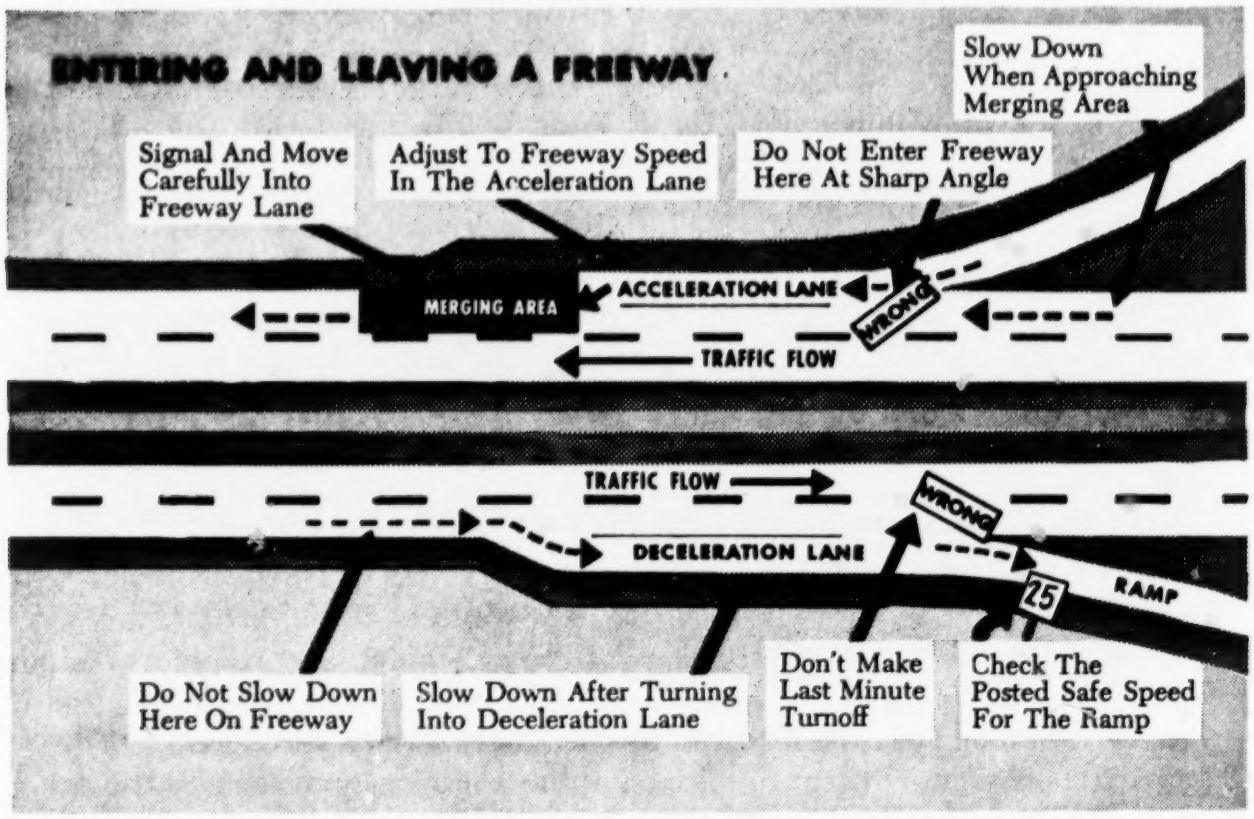

Diagram from Ontario (Canada) Department of Transport

Figure 21

4. Multilane and limited access highways - speed limit 50 M.P.H.

   a. These may or may not have short entrance and exit lanes.
   b. Entering traffic must yield the right of way.
   c. Exiting traffic must slow down for sharp turn off.

20315

5. Other state roads - bus speed 50 M.P.H.

   a. Seldom have entrance and exit lanes.
   b. Entering traffic must stop.

6. County and township roads - bus speed 50 M.P.H.

   a. The roads will run from good hard surfaced to dirt.
   b. Actual speed will be determined by the conditions of the road.

IV. SUMMARY

Before starting a bus, the driver should have complete vision all around him and be comfortably seated. The driver should be well skilled in the driving fundamentals of the bus before he attempts to drive it. It is his job to transport children and he should do his best to contribute to the safe operation of the bus.

Starting the bus, shifting gears, and double-clutching all require skill and practice. The driver should be able to do this efficiently as he watches the road ahead.

Steering and turning the bus are very important to the driver in his daily routine. He must be able to handle the bus properly whether on a deserted road or a road with heavy traffic. Stopping a bus smoothly and within the limits of safety is another sign of an expert driver. Parking procedures should be known well and practiced.

Loading and unloading presents the driver with additional responsibilities and requires the use of good judgment. He is responsible for the safety of the children on his bus and he must comply to the rules of loading and unloading a bus. He is to get the children <u>to</u> school and <u>from</u> school <u>safely.</u>

Bad weather presents the driver with some additional hazards. However, if the driver realizes the problems involved, he can take the necessary precautions to cope with these hazards.

Procedures before crossing a railroad crossing are extremely important. The driver should watch the railroad signals, open the door, look, and listen carefully up and down the tracks to see if a train is approaching. The parents, supervisors, and children of the community depend on the driver, so he must do his best to operate his bus skillfully and safely to maintain their faith in him.

20816

UNIT VII

I. TOPIC

Defensive Driving

II. ORIENTATION

Defensive driving may be defined as being able to drive in such a way as to avoid being involved in traffic accidents, regardless of another driver's actions, or the driving conditions. It is very important that the school bus driver should know, not only the purpose of defensive driving, what defensive driving is, and why defensive driving is needed, but the driver must master all of the driving skills in order to become a good defensive driver

III. PRESENTATION

A. **Purpose of Defensive Driving Is To Reduce Chances of Becoming Involved In An Accident**

B. **What Is Defensive Driving?**

134 143 144
1. Being careful not to commit driving errors
2. Making allowances for the lack of skill on the part of other drivers and self
3. Making allowances for hazardous weather conditions
4. Recognizing an accident producing situation far enough in advance to take preventive action
5. Yielding the right of way when necessary to prevent an accident

C. **Why Defensive Driving Is Needed**

1. To cope with the tremendous increase in the number of vehicles on the highway
2. To protect passengers, pedestrians, and self

D. **Defensive Driving Skills**

1. Major factors that should be known and practiced to keep from being involved in a motor vehicle accident.

   a. Observe and evaluate the big picture

      (1) Vehicles ahead
      (2) Vehicles behind

20818

C. Meat and Poultry Cookery—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
Roasting—Continued		
How to roast poultry—Continued	Testing for doneness	Methods of testing Methods of serving: Sauce Gravy Garnishes
	Stuffings and dressings: Types Variations in methods of preparation	
	Care of fowl: After roasting During serving period Storage	Related science Calculation of costs
Broiling		
How to broil different kinds of meat: The understanding and application of recipes, formulas, and procedures	Explanation of broiling principle	Purpose and effect of broiling: Beef Veal Lamb Pork
	Preparation: Fresh meat Frozen meat	Equipment Fuels used for broiling Manipulation of broiler
	Procedure: Seasoning Searing Temperature Broiling time: Fresh meat Frozen meat Thickness	Variations: Barbecuing
	Testing for doneness	Methods of testing Methods of serving: Sauces Gravies Butters Garnishes Calculation of costs
How to broil poultry: The understanding and application of recipes, formulas, and procedures	Preparation	Characteristics of poultry suitable for broiling: Weight Age Effect of broiling upon flesh of chicken Manipulation of broiler for proper heat
	Procedure: Seasoning Searing Basting Care while broiling Temperature Timing	
	Testing for doneness	Methods of testing Calculation of costs

2057

(3) Vehicles approaching from opposite direction
(4) Vehicles approaching from an angle
(5) Vehicle passing
(6) Vehicle being passed
(7) Pedestrians
(8) Adverse weather conditions

b. Actions of the other driver which can cause an accident

(1) Vehicle in front slowing down, stopping, or backing
(2) Vehicle behind following too closely
(3) Driver of vehicle approaching driving left of center, cutting across in front, or failing to dim headlights
(4) Vehicle approaching from an angle, pulling or backing across driver's path
(5) Vehicle that is passing, cutting back into the lane of traffic too quickly, or passing on the right
(6) Vehicle that is being passed racing into driver's path, or pulling from curb without looking

c. Defensive action that can be taken to keep from being involved in an accident.

(1) Maintain safe following distance.
(2) Watch for conditions ahead that would cause the driver in front of the bus to stop suddenly.
(3) When a car is following too closely behind

(a) Check mirrors frequently.
(b) Signal well in advance when slowing or stopping.
(c) Make slow gradual stops.
(d) Make authorized stops only.

(4) When a vehicle is approaching from an angle.

(a) Be prepared to stop at alleys, intersections, and driveways.
(b) Look in all directions before entering intersections.
(c) Double check at blind intersections.
(d) Move into intersection on green light after looking to right and left.

(5) When another vehicle is passing

(a) Slow down.
(b) Pull to the right.

(6) Maintain position in proper lane.

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(7) When passing another vehicle

(a) If the other vehicle attempts to race, slow down and let it proceed.
(b) Make audible signal before passing.
(c) Check position of other vehicle before passing.
(d) Maintain proper distance between school bus and parked vehicles. See Figure 22.

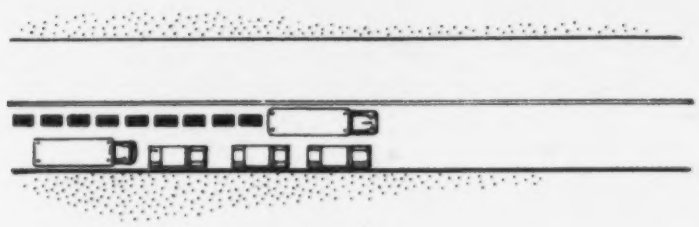

Figure 22

(e) Do not cut in too quickly after passing another vehicle.

2. Defensive driving is an art which does not permit preoccupation or inattention on the part of the driver.

IV. SUMMARY

Due to a tremendous increase in the number of vehicles and higher speeds, the potential for accidents is greatly increased. Proper application of defensive driving practices can substantially reduce the potential.

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UNIT VIII

SAFETY AND EMERGENCY PROCEDURES

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UNIT VIII

I. TOPIC

Safety And Emergency Procedures

II. ORIENTATION

The driver is responsible for the safety and well-being of the passengers in his bus as well as for the safe operation of his vehicle. He is in full charge of the bus at all times. His knowledge of proper emergency procedures, emergency evacuation procedures, and accident scene procedures is a must! These areas of responsibility deal directly with the safety and care for his passengers in the event of an accident, as well as other emergency situations which may arise.

The driver must know:

A. What to do

B. How to do

C. When to do

III. PRESENTATION

A. Know the Emergency Equipment on the Bus and How to Use It

1. Fusees — as warning devices

   a. Thirty-minute fusees encased in a metal container
   b. Located in driver's compartment
   c. Lighting of fusees

      (1) Grasp fusee in right hand.
      (2) Twist and lift off cap with left hand.
      (3) Strike fusee across cap.
      (4) Point ignited end away from body.

   d. Placement of warning devices (fusees)

      (1) One fusee is placed at the side of bus on roadway side – safe distance from bus and oncoming traffic.

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Figure 23

(2) Place second fusee approximately forty paces of one-hundred feet to rear of bus.

(a) Placement distance should be greater if bus is on a hill or curve.
(b) Not to exceed three-hundred feet

(3) Place third fusee forty paces or one-hundred feet to front of bus again using greater distances if conditions warrant.

2. Red flag and red reflectors as warning devices

a. Three red flags and three red reflectors are located in the driver's compartment.
b. The flags are for day time use.
c. The reflectors may be used both day and night.
d. Follow same directions for placement as was explained for fusees.

3. Use four way hazard flashers with good judgment.
4. Fire extinguisher

a. One two and one-half pound dry-chemical type fire extinguisher (or larger) is located in driver's compartment.
b. Operation of dry chemical fire extinguisher

(1) Remove extinguisher from mounting bracket.
(2) Hold extinguisher in vertical position.
(3) Release safety device.
(4) Squeeze handle to discharge chemicals.
(5) Direct chemical discharge at the base of the flame.

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c. A two and one-half pound extinguisher has approximately thirty seconds of use.
d. Recharge fire extinguisher after every use.

(1) Test
(2) Actual fire
(3) Gauge indicates red

5. Wrecking bar

a. Nearly all buses presently in use (since 1961) are equipped with a twenty-four inch wrecking bar (older buses may still carry a small axe.)
b. The wrecking bar is usually located close to the driver's compartment.

(1) Under front passenger seat
(2) On the firewall
(3) By driver's seat

c. Purpose of wrecking bar is to pry open doors, windows, etc., in the event of an accident where damage to vehicle prevents easy exit by normal means.

6. First aid kit

a. The first aid kit should be located in the driver's compartment, be dust-proof, well-labeled, and conform to federal standards. Standards require a 16 unit kit for buses carrying up to forty-two passengers and a 24 unit kit for larger buses.
b. For first aid, see Unit IX - First Aid.

7. Replace any item used from emergency equipment supplies as soon as possible.

B. Emergency Procedures for Mechanical Breakdowns

1. Move bus off roadway if possible to prevent accidents with other vehicles.
2. Turn off ignition switch and remove key.
3. Set the hand brake.
4. Use warning devices as explained in previous section "A" subheading 1., 2., 3.
5. Request assistance from passing motorist to notify school officials of bus location and possible difficulty.

a. Ask at least two different motorists to contact the school.
b. Provide them with proper phone number to call.

6. If no motorists are avialable, sent two reliable male students to nearby home, place of business, etc., to make telephone call to school officials.

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7. Keep pupils on the bus in most cases.

NOTE: Exception to above rule -- safety conditions may warrant removal because of possible fires, extremely dangerous section of highway, etc.

C. Accident Procedures

1. Turn off ignition switch, ground disconnect switch, and remove keys.
2. Set the hand brake.
3. Remain calm and reassure students.
4. Be alert for fire or the possibility of fire.

   a. Check for ruptured gas tank and fuel line; can be a potential furnace.
   b. Check for electrical fire.
   c. Look for smoke.
   d. Check for hot tires which may catch fire.

5. Use warning devices. See Section A., 1., 2., 3.
6. Check for injury of pupils.

   a. If pupils are injured, follow first aid procedures.
   b. See Unit IX.

7. Keep all pupils on bus.

NOTE: Exception -- conditions may warrant their removal such as: possibility of fire of if bus is situated in extremely dangerous section or roadway.

8. Account for all pupils.
9. Notify state highway patrol or other legal investigating officer.
10. Notify school administrators of the location of the bus and accident.
11. Protect the scene

    a. Protect the students and the bus from further accidents and injuries.
    b. Protect the scene from traffic and people so that evidence is not destroyed.
    c. Under normal circumstamces, the vehicles involved should not be moved until law officer advises the driver to do so.

12. Do not discuss the facts of the accident with other motorists; but give information only to investigating officer and school officials.

    a. Provide necessary information to the investigating officer.

       (1) List of students' names, ages, and addresses
       (2) Information about the school bus such as insurance, make, model number, owner, etc. (Carry emergency packet on the bus which

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includes bus information, emergency telephone numbers, ball point pen, pencil and tablet.)

b. While being investigated; be patient, evaluate questions, and give clear and concise answers.
c. Drivers in an accident are required to give their name, address, driver's license number, and vehicle information. Be ready to give this information to the other driver and also receive and write down the same information from the other driver involved.
d. If witnesses were present, get names, addresses, and license numbers.

13. Cooperate with school administration.

a. Continue the transportation of the students.

(1) By the present bus
(2) By spare bus
(3) By some other means

b. But not until authorized to do so

14. Prepare necessary written reports required by the school district and by law.

a. Accident report which must be forwarded by the driver to the Bureau of Motor Vehicles
b. Local school district reports

(1) Start as soon as possible to prepare accident reports.
(2) Make a record of necessary items at the scene of the accident.

D. **Emergency Evacuation of School Buses** -- In the interest of safety, all bus drivers should conduct an emergency evacuation drill through the front door when they unload at the schools at least once a month with each bus load of children.

1. Front door evacuation of school buses

a. The bus is stopped, parking brake set, and engine turned off.
b. The driver will stand, open the door, face the children, and get their attention.
c. The driver will give the command "Emergency drill, remain seated, front evacuation". If driver is incapacitated the bus helper will assume the responsibility.
d. Advise bus helper to guide passengers to assigned place of safety.
e. A second bus helper will stand outside of the bus by front door to count and assist passengers as they evacuate.
f. Any standees in the aisles then move out in good order, stay in a line, and follow bus helper to place of safety.

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g. Standing between the first occupied seats, the driver will then turn and face the front of the bus.

   (1) Starting with the right-hand seat, the driver taps the shoulder of the person nearest the aisle to indicate that those occupants shall move out.
   (2) The driver will hold his hand before the occupants of the left-hand seat in a restraining gesture.

h. When the pupils of the dismissed right-hand seat have moved forward far enough to clear the aisle, the driver dismisses the occupants of the left-hand seat.
i. The evacuation continues as described, right-hand and left-hand seats alternately, until the bus is empty.
j. When the last seat is empty, the driver walks to the front of the bus, checking to see that all are out.

   (1) This check must be made fron the extreme rear of the bus forward.
   (2) Be certain to check between and under seats.

k. As the driver leaves the bus, he removes the fire extinguisher, first aid kit, and can of fusees and takes them with him or assigns this duty to a reliable student.
l. The driver shall conduct a count of the pupils to assure that all are accounted for.

2. Rear emergency door evacuation – used when front door is <u>not</u> accessible.

   a. Appoint two responsible pupils on each load who are among the first to board the bus to sit by the rear door, one each side of the aisle.
   b. A third person may be appointed to lead the students to a place of safety designated by the driver, or of his choosing if none is designated by the driver.
   c. The appointee in the left-hand seat shall have two responsibilities:

      (1) To see that nobody touches the door latch
      (2) To open the door on command of the driver or, if the driver is unable to give such a command, to open it when he sees that a rear evacuation is necessary.

   d. The bus driver gives command "Emergency drill - remain seated - rear evacuation".
   e. Both helpers, the one who opened the door, and the other from the right-hand seat, then jump to the ground and aid the others in the evacuation, first emptying the aisle, then, beginning with the rear seats, alternating right and left until the bus is empty.

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f. The driver keeps the children under control, and makes sure that the bus is empty as he follows the last pupil out of the rear door, taking the fire extinguisher, first aid kit, and can of fusees with him.

g. The same instruction concerning the grouping of children and driver's responsibility as are given for a front door evacuation are effective for rear door evacuation.

E. Safety Awareness

1. Control children to prevent falls, fights, etc.
2. Control the physical aspects of the inside of the bus such as safe floor (no ice, banana peel, etc.) safe windows, etc.
3. Be prepared for icy weather with wiping rags, ice scraper, etc.
4. Have windshield wiper and defroster in working order. Use ventilation to reduce moisture inside.
5. Have lights, both inside and outside in working order.
6. Use braking light to indicate to those following the bus that the driver is preparing to stop or reduce speed.
7. Use flasher lights in such a manner that oncoming traffic will have ample time to stop.
8. The driver should use the seat belt at all times when operating the vehicle.

IV. SUMMARY

A. Accidents are going to happen.

B. Accidents do not always occur to the "other driver".

C. When accidents occur, it is too late to begin teaching emergency procedures.

D. Have a plan of action necessary for emergencies.

E. Instruct the pupils, through drills and talks, of their responsibilities and proper conduct for emergency situations.

F. The driver must not panic or show nervousness during an emergency situation.

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C. Meat and Poultry Cookery—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
Braising		
How to braise meat:	Explanation of braising principle	Cuts and grades of meat used for braising
The understanding and application of recipes, formulas, and procedures	Preparation:	Equipment
	Marinating	Purpose of:
	Larding	Marinating
		Larding
	Procedure:	
	Seasoning	Stocks
	Precooking or frying	Sauces or glaze
	Basting	
	Temperature	Importance of low temperature
	Timing	
	Finishing process	
	Testing for doneness	Methods of testing
	Care and storage	
		Calculation of costs
How to sauté (pan fry) meat and poultry:	Explanation of cooking principle	Cuts suitable for sautéing
The understanding and application of recipes, formulas, and procedures	Preparation	Selection of butter, vegetable shortening, lard, or oil
		Equipment and utensils
	Procedure:	
	Seasoning	
	Browning	
	Temperature	
	Timing:	
	Thickness	
	Finishing	Variations in finishing process in oven
	Preparation of sauce used with sautés	
	Testing for doneness	Methods of testing
		Methods of serving:
		Garnishes
		Sauces
		Gravies
	Care and storage	
		Calculation of costs
How to fry meat and poultry:	Explanation of the frying principle	Cuts and grades suitable for frying
The understanding and application of recipes, formulas, and procedures	Preparation:	Equipment
	Fresh meats and poultry	Fats used:
	Frozen meats and poultry	Amount
	Cured meats	Temperature
	Procedure:	
	Seasoning	
	Dredging	
	Temperature	
	Timing	
	Preparation of sauce or gravy	Variations in sauces and gravies
	Testing for doneness	Methods of testing
		Calculation of costs

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UNIT IX

FIRST AID

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UNIT IX

I. TOPIC

First Aid

II. ORIENTATION

The first objective of first aid is to save life. Therefore, it becomes necessary to know and understand the principles of first aid. First aid is the immediate and temporary care given to the victim of an accident or sudden illness until the services of a physician can be obtained.

First aid teaches more than how to apply a dressing or a splint. It teaches competence, which should be displayed by the person administering first aid to the injured. A victim will respond much more readily to treatment if he recognizes that a competent person is administering that treatment.

Common sense and a few simple rules are the keys to effective first aid. It is important to know what not to do, as well as to know what to do. In case of an emergency, making mistakes could be disastrous to the injured person.

First aid training is a necessity for everyone. It can be beneficial in the home and in the community, not only to give assistance in case of emergency, but to promote accident prevention and safety consciousness.

The so-called "Good Samaritan Law" is quoted from Ohio Revised Code, Section 2305.23, Liability for emergency care:

> "No person shall be liable in civil damages for administering emergency care or treatment at the scene of an emergency outside of a hospital, doctor's office, or other place having proper medical equipment, for acts performed at the scene of such emergency, unless such acts constitute willful or wanton misconduct.
>
> Nothing in this section applies to the administering of such care or treatment where the same is rendered for remuneration or with the expectation of remuneration. (130 v S14. Eff. 9-16-63.)"

III. PRESENTATION

A. **General Directions** - In case of a serious injury, the first concern of the person administering first aid is to save life. This may be accomplished by administering immediate and temporary care in the following manner.

1. Prevent heavy loss of blood.

   a. Heavy bleeding comes from severing one or more large blood vessels which can kill the victim in 3 to 5 minutes.

   b. Heavy bleeding may be controlled by using the following methods:

      (1) Place a pad, clean handkerchief, clean cloth, etc., over the wound and press firmly with the hand or both hands. If a pad or bandage isn't available, close the wound with the hand or fingers. See Figure 24.
      (2) Apply pressure directly over the wound.
      (3) Hold the pad firmly in place with a strong bandage, necktie, cloth strip, etc.
      (4) Raise the bleeding part higher than the rest of the body, unless bones are broken.
      (5) Keep the victim lying down.
      (6) Call a physician.

Figure 24

   c. Use of body pressure points to control severe bleeding.

      (1) Severe bleeding may be partially controlled by using the fingers or heel of the hand to press the supplying blood vessels against the underlying bone.
      (2) There are six points on each side of the body where pressure against the supplying vessel is of practical use. These Points are indicated by the black spots on the diagram. Pressure applied at any of these points will slow bleeding beyond this point. See Figure 25.

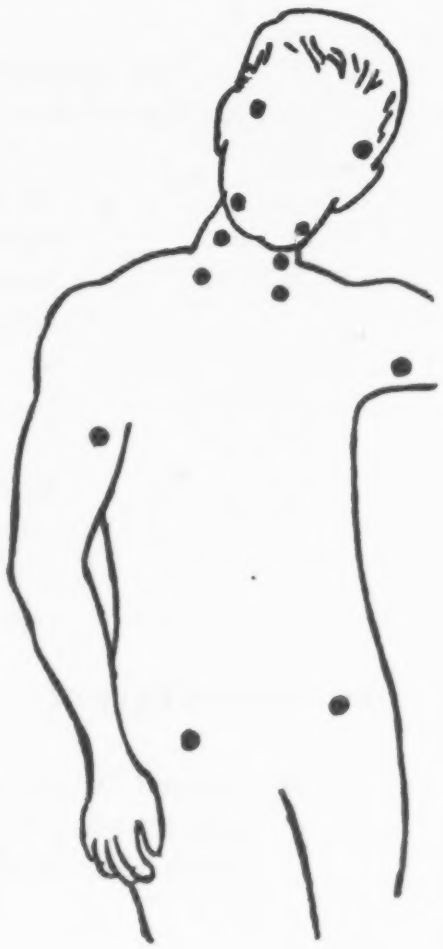

Figure 25

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d. A tourniquet should never be used to control bleeding, except for an amputated, mangled, or crushed arm or leg.

(1) To apply a tourniquet for an amputated arm or leg, use only a strong wide piece of material. Wrap tourniquet around the upper part of the limb, above the wound. Tie a half-knot; place a stick on the half-knot and tie a full knot above the stick; twist the stick just enough to stop the bleeding. See Figure 26.

(2) The time that a tourniquet is applied should be marked or written in a very prominent place, on or near the victim (write time on forehead).

Figure 26

2. Maintain Breathing - There is a need for artificial respiration when breathing movements stop, or lips, tongue, and fingernails become blue. No harm can result from the use of mouth to mouth respiration, and delay may cost a victim his life. There are a number of methods of artificial respiration used to induce breathing and they are administered in the following manner:

a. Mouth to mouth breathing is one of the newest and most effective methods of artificial respiration because of the direct force of air into the victim's lungs. It can be administered to a victim without the need for special equipment, and in almost any position or location. Rescuers can maintain mouth to mouth breathing for hours without fatigue. They can also see, feel, and hear the effect of each lung inflation as well as being able to control the amount, rate, and pressure of air being administered. The following procedure is used to administer mouth to mouth breathing:

(1) Place victim half-way between a face-up and a side position.
(2) Lift victim's neck with one hand and tilt his head back by holding the top of his head with your other hand.
(3) Pull the victim's chin up with the hand that was lifting the neck so that the tongue does not fall back to block the air passage. Clear air passage of foreign objects.
(4) Take a deep breath and place your mouth over the victim's nose or mouth, making a leak-proof seal. Close nose by pinching.

FOR CHILDREN, COVER MOUTH AND NOSE. See Figures 27, 28, and 29.

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Figure 27

Figure 28

Figure 29

(5) Blow your breath into the victim's mouth or nose until you see the chest rise. The air you blow into the victim's lungs has enough oxygen (3/4 of oxygen remains) to save his life.
(6) Remove your mouth and let the victim exhale while you take another breath.
(7) As soon as you hear the victim breathe out, replace your mouth over his mouth and repeat procedure.

REPEAT 15 TIMES PER MINUTE.

b. FOR CHILDREN: When possible, place your hand over the child's stomach. Use a moderate pressure to keep the stomach from becoming inflated. CAUTION: Very light pressure should be used when using mouth-to-mouth respiration on small children.

c. Manual Method of Artificial Respiration should be used if for any reason the mouth-to-mouth method cannot be used.

(1) Place victim in a face-up position.
(2) Place something under victim's shoulders to raise them and allow the head to drop backward.
(3) Kneel above victim's head, facing the victim.
(4) Grasp victim's arms at the wrists, crossing and pressing victim's wrists against the lower chest.
(5) Immediately pull upward, outward, and backward, as far as possible.

REPEAT 15 TIMES PER MINUTE.

(6) If a second rescuer is present, he should hold the victim's head, so that it tilts backward and the jaw juts forward.

Figure 30

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3. Recognizing and preventing shock -- Shock usually accompanies severe injury or emotional upset. It may also follow pain, disturbance of circulation from bleeding, stroke, heart attack, heat exhaustion, extensive burns, etc.

   a. A state of shock may be recognized by some of the following symptoms:

      (1) Cold and clammy skin
      (2) Pale face
      (3) Nausea or vomiting
      (4) Shallow breathing

   b. Life may be saved by prevention of shock.

      (1) Correct cause of shock, is possible.
      (2) Keep victim lying down.
      (3) Keep breathing airways open.
      (4) Elevate victim's legs if there are no broken bones.
      (5) Keep head lower than trunk of the body, if possible.
      (6) Keep victim warm if weather is cold or damp.
      (7) Give fluids (water, tea, coffee) if victim is conscious and can swallow (no alcoholic beverages).

B. In case of involvement in a serious accident, the first concern of the person administering first aid is to save life. After this phase is past, it then becomes necessary to attend to other injuries of persons involved. These injuries may be of a serious nature, but not likely to cause immediate death. It is, therefore, necessary to be able to recognize and administer first aid to the following:

   1. Recognizing and Treating Bone Injuries

      a. In case of injury to spine or neck:

         (1) Do not move victim or allow him to be moved until a proper stretcher is available.
         (2) A physician should be called immediately and should be present to supervise moving the victim, if possible.
         (3) Keep the victim warm and quiet.
         (4) Watch breathing and be prepared to start mouth to mouth breathing - but do not move the head.

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b. Fractures

(1) First aid to broken bones should do no more than prevent further injury. There are two types of fractures:

(a) Simple or Closed - The bone is broken but the skin has not been punctured.
(b) Compound or Open - The skin is broken as well as the bone.

(2) Do not move the injured person until the suspected fracture site has been splinted, unless the victim is in imminent danger.
(3) Place the limb in as natural a position as possible without causing discomfort to the victim.
(4) Apply splints. Splints must be long enough to extend well beyond the joints above and below the fracture. Any firm material can be used: board pole, metal rod, or even a thick folded newspaper.
(5) Use clothing or other soft material to pad splints to prevent skin injury. Fasten splints with bandage or cloth at a minimum of 3 sites:

(a) Below joint below break
(b) Above joint above break
(c) At level of break

(6) Broken bones in the hand or foot can be held steady with a pillow or blanket bound around it.

Simple or Closed Fracture

Compound or Open Fracture

Figure 31

2. Head Injuries

a. Consider anyone found unconscious to have a possible head injury, and take the following precautions:

(1) Call a physician immediately.
(2) Keep the victim lying down, preferably on his side so that the air passage will not become blocked and to allow for drainage of blood, vomitus or other fluids.
(3) Keep victim warm, if weather is cold or damp.

Figure 32

Figure 3

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(4) Control bleeding from a head wound by applying a pressure dressing. Caution should be used in regard to using pressure over a possible skull fracture.
(5) Do not move the head or any part of the body if there is bleeding from the nose, mouth, or ears.

b. Unconsciousness could be the result of a head injury, and should be treated as described before. The same precautionary measures should be used. Caution: Look for emergency medical identification around the victim's neck or wrist that could suggest the cause of unconsciousness, if physical signs aren't present.

3. Common Injuries or Illnesses that the School Bus Driver Might Encounter

a. Eye Injuries

(1) Any eye injury is serious, and the bus driver should never attempt to treat an injury of this nature.
(2) In case of eye injury, the eye should be covered with a sterile gauze pad and attended to by a doctor or nurse as quickly as possible. (If feasible, cover both eyes to prevent excessive eye movement.)

b. Vomiting

(1) Vomiting is very seldom preventable, but some relief could be given both before and after vomiting by exposing the person to fresh air.
(2) A partially filled bucket of sawdust or a commercial absorbent is highly recommended to the bus driver for such emergencies.

c. Mouth or face injuries

(1) Most minor internal mouth injuries are self-healing.
(2) An external cut on the mouth or other part of the face should be covered with a sterile gauze pad until the services of the school nurse or a physician can be obtained.

d. Fainting

(1) Fainting is caused by temporary loss of blood to the brain.
(2) Fainting can best be treated by getting the victim's head lower than the trunk of the body.
(3) If a student feels faint, it can best be prevented by having the student put the head between his knees.
(4) Use ammonia ampules to prevent fainting.
(5) Diabetic or epileptic attacks - See Unit X, Section F, Item 4.

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e. Falls inside and outside of the bus

(1) The driver should make a diligent search for injuries after a fall.
(2) If an injury has been sustained, the driver should render appropriate first aid treatment.

4. Moving the Injured

a. Do not move injured person before a physician or experienced ambulance crew arrives, unless there is real danger of his receiving further injury by being left at the accident site. If possible, control bleeding, maintain breathing, and splint all suspected fractures before moving. If it is necessary to move the victim, the following methods can be used:

(1) Pull the victim to safety either head first, if possible, or feet first, if necessary, as illustrated. See Figure 34. Victim should not be moved sideways. Be sure that the victim's head and back are protected.
(2) If the victim has to be lifted before a check for injuries can be made, every part of the body should be supported. The body should be kept in a straight line, and should not be bent. See Figure 35.

Figure 34

b. A great amount of care should be used when it becomes necessary to move an injured person, especially if the person is unconscious. There is grave danger of causing further injury to broken bones, aggravating or causing further internal injuries, and causing additional bleeding.

Figure 35

IV. SUMMARY

It is extremely important that the school bus driver should know and use the correct procedures in administering first aid to the injured if the necessity arises.

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The school bus driver should keep in mind that first aid procedures apply to immediate needs only, and that he should confine himself to perform only those immediate needs.

This unit is designed to teach the fundamentals of First Aid which deal with the immediate procedures to be used in case of accident. A complete course in First Aid is strongly recommended for every school bus driver.

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C. Meat and Poultry Cookery—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
Braising—Continued		
How to deep fat fry:	Preparation	Cuts of meat and poultry suitable for deep fat frying
The understanding and application of recipes, formulas, and procedures		Fats used:
		Temperature for frying
		Care and storage
		Breakdown or oxidation
		Equipment
	Procedure:	Precautions:
	Seasoning	Thermometers
	Dredging	Thermostats
	Coating	Safe cooking habits
	Temperature	
	Timing	
	Draining	
	Testing for doneness	Methods of testing
		Calculation of costs
How to simmer (boil) meats and poultry:	Explanation of the cooking principle	Cuts of meat and types of poultry suitable for simmering:
The understanding and application of recipes, formulas, and procedures		Age of animal
		Grades
		Variations in terminology:
		Parboiling
		Steaming
		Pressure cooking
		Blanching
		Stewing
		Poaching
	Preparation:	Equipment
	Fresh meats	
	Corned beef	
	Smoked meats	
	Procedure:	Use of resulting stock
	Seasoning	
	Care in cooking	
	Temperature	
	Timing	
	Testing for doneness	Methods of testing
	Carving	Variations in carving and serving
		Calculation of costs
How to cook stews:	Explanation of cooking principle	Selection of meats for stews
The understanding and application of recipes, formulas, and procedures	Preparation	Equipment
	Procedure:	Variations:
	Seasoning	Irish
	Care during cooking	Fricassees (curry, goulash)
	Temperatures	Brown stews—Ragout
	Timing	
	Finishing	Finishing process:
		Thickening agents
		Calculation of costs

Suggested teaching materials: See items 8, 15, 20, 29, 30, 31, 40, 42, 45, 51, 63, 65, 66, 81, 82, 93, 94, 99, 104 in appendix B.

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UNIT X

THE SPECIAL CHILD

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UNIT X

I. TOPIC

The Special Child

II. ORIENTATION

Figure 36

The education of handicapped children has been of great concern to educators for many years. The need to provide increased educational opportunities for these special children is being met through the creation of special schools, equipped with trained teaching personnel to accomplish this goal. Because these special schools must serve a larger attendance area than is normally served by a conventional school, transportation of handicapped children is of major importance.

The problems that arise in transportation of the special child are, in many ways, different and challenging. Each of these children presents different transportation problems. The blind, deaf mute, epileptic, slow learner, diabetic, hemophiliac, emotionally disturbed, and physically handicapped child, all possess different needs in the area of transportation.

This unit will discuss school board policies relevant to the transportation of the special child; proper orientation of parents, teachers, children, and school bus drivers concerning the responsibilities of each party; and some of the common handicaps with which the special child may be afflicted.

III. PRESENTATION

A. **Board Policies** - The school board should establish policies concerning local rules and regulations as to the transportation of special children. These policies should be in addition to the local rules and regulations normally covering the district's transportation program.

1. Thought must be given by the school board to the following factors:

   a. The best type of vehicle to be used to transport the special children.

      (1) Number of children to be transported
      (2) Types of handicaps

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b. Maximum size and weight of non-ambulatory children should be established to prevent injury to the child as well as to the driver or his assistant.

c. Proper methods and procedures for control of children.

(1) Establish guidelines for the driver and assistant.
(2) Seek professional advice in establishing said guidelines.
(3) Establish policy for the control of the special child.

d. Require orientation of parents of handicapped children.

(1) Transportation of the handicapped is the responsibility of the district school board.
(2) Parents have responsibilities for preparing their children to be transported each day.

e. Prepare two 3" x 5" cards for each special child.

(1) Cards to be kept:

(a) One card in school office
(b) One card on the school bus

(2) Card should contain necessary information regarding the child.
(3) The suggested information is covered in Section B, Item 6.
(4) Establish policies for transportation to the hospital or recognized medical center for the child who becomes ill while riding the bus.

f. Require drivers to successfully complete school bus drivers' training course.
g. A first aid course is recommended.
h. Establish drivers' assistants - whose main responsibilities would be:

(1) To load and unload children
(2) To maintain control of the children while on the bus.
(3) To look to the needs of each child while bus is in operation.
(4) To assist driver in times of need and for all emergency situations.

2. The board should direct its administrative officers to re-evaluate the programs periodically, and adjust the program as the needs dictate.

B. Parent Responsibilities

1. Know the bus schedule for pick-up and delivery of the child.
2. Have the child "ready" and on time to meet the bus.

a. Fed
b. Properly clothed

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c. Necessary supplies and materials to be carried in a pouch or packet
d. All bodily needs performed

3. Know where the child is to be picked up each morning.

   a. On the front porch, or
   b. Inside the house, or
   c. By the front walk

4. In case of inclement weather be certain sidewalks and porches have been cleaned of snow and ice.
5. In the event the child does not plan to attend school on a given day the parent should:

   a. Call school officials in advance, or
   b. Wave the bus on as it nears the house, or
   c. Put a note on the front door.

6. Parents, in cooperation with their doctor, should be responsible for preparing a 3" x 5" card containing:

   a. Student's name
   b. Address
   c. Home phone number and emergency phone number
   d. Nature of child's handicap
   e. Suggested steps to be taken by the driver or his assistant in the event of illness, or injury, while riding the bus.

7. Parents should be available at all times during the school day in the event that they are needed by the school officials.

C. **Teacher Responsibilities**

1. To see that the child is prepared both mentally and physically for the ride on the school bus.
2. Establish teacher-driver communication for the well-being of the child.

   a. Unusual situations may effect the behavior of the child.

      (1) Epileptic seizure or convulsion
      (2) Severe emotional experience

   b. Recommend procedures for beneficial assistance and/or control.
   c. Teacher should check with driver or assistant if any problems have occured.

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D. **Child Responsibilities** - The child must know and understand responsibilities, acceptable behavior, and conduct expected of him while riding on the bus to and from the school.

1. The nature and scope of these responsibilities must be determined by such factors as:

   a. Age
   b. Mental capabilities
   c. Nature of handicap

2. The driver should work with the transportation supervisor to seek advice from the school principal, teachers, or special counselor.

E. **Bus Driver and Assistant Responsibilities**

1. Driver and assistant should successfully complete first aid course.
2. Driver and assistant should become acquainted with the particular handicap and the emergency treatment of each child as stated on record card.
3. Driver and assistant should know the safest and most direct route to hospital or recognized medical center.
4. Driver should arrange seating of the children, if possible, to prevent emotional or physical disturbances.

   a. Two deaf mutes side by side may have a tendency to create a control problem.
   b. Some children, by the nature of their handicap, must require an entire seat to themselves.

F. **Various Types of Handicaps Suffered by the Special Child**

1. The blind

   a. May be totally blind
   b. May have only partial sight
   c. Must be guided and protected from objects that would injure them

2. The deaf and the deaf mute

   a. The deaf student may be totally deaf or partially deaf.
   b. The deaf mute is unable to speak or hear.

      (1) Usually relies on sign language and motions
      (2) Usually are taught to become lip readers in the special schools

         (a) Find out how the school wants you to communicate.
         (b) May want the child to lip read rather than use sign language or motion.

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c. The deaf mute may be an extremely active and energetic child.

(1) May be very intelligent as well as average or below average.
(2) Is inclined to be more mischievous and emotional.

(a) Special control methods must be used.
(b) Loud commands or stern voice mean nothing to them.

3. The physically handicapped (cerebral palsy, muscular distrophy, polio, etc.)

a. The ambulatory child

(1) Is able to walk. See Figure 37.
(2) May or may not wear braces.
(3) May need some assistance in being seated, and unlocking or adjusting braces.

(a) This is a good example of needed communication between teacher, driver, and assistant.
(b) Do all that is necessary to assure his comfort and safety.

Figure 37

b. The non-ambulatory child

(1) Must use a wheel chair and/or be carried. See Figure 38.
(2) Special seating apparatus may be necessary.
(3) Seat belts are a must for this child.
(4) Usually will need assistance with locking and unlocking braces.
(5) Maximum weight limitation should be established by board policy as child may have to be carried or lifted by the driver or his assistant.

Figure 38

4. The epileptic child

a. May appear normal in every respect.
b. Is subject to seizures or convulsive attacks usually with partial or total loss of consciousness.

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c. If seizure takes place on school bus

(1) Steer bus to side of roadway and stop vehicle.
(2) Know and follow directions on child's 3" x 5" card.
(3) Do not restrain the person during his convulsion, but protect him against injury.
(4) Push away near objects.
(5) Try to prevent the victim from biting his tongue by placing an appropriate object between his teeth on one side of the mouth.

(a) Pencil or pen
(b) Piece of wood or branch of tree
(c) Handkerchief
(d) When convulsion is over, loosen clothing about the neck and allow victim to lie flat with head turned to one side.
(e) Provide for undisturbed rest after regaining consciousness.

5. The hemophiliac - A child suffering from the disease of hemophilia (a bleeder).

a. Child is subject to hemorrhage (bleeding) from the slightest bump or bruise.
b. The bleeding may be external or internal.
c. Seek immediate medical help if in doubt concerning possible injury.

6. The emotionally disturbed and the slow learners

a. These children will vary greatly in abilities and response to directions.
b. Usually close supervision by the driver's assistant as to behavior and possible assistance is needed.
c. These children seek affection. The driver and assistant must be friendly and take an interest in each child.
d. Care must be exercised not to show favoritism.

G. Suggested Requirements for the Handicapped Vehicle

1. Maximum capacity should not be more than 28.
2. Seat belts are recommended fastened to the seat and buckled high around the waist of the child.
3. Handicapped vehicle should be identified better than normal school bus.
4. Two-way radios are recommended for the handicapped vehicles.
5. Extra heaters may be required because the handicapped chill easier.
6. Vehicles for the handicapped should have roof ventilators.
7. Rear door may need to be redesigned if used to load and unload children because of the size and type of seal used to prevent exhaust from seeping into the passenger compartment.
8. Tail pipe should be directed to the side in order to prevent exhaust entering the passenger compartment when the door is open.

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IV. SUMMARY

The transportation of the special child requires additional knowledge and responsibilities of the school bus driver. It is extremely important that the district school boards adopt policies relating to the transportation of these children. Such factors as:

Types of vehicles to be used
Special equipment needed
Number of children to be transported
Types of illness and handicaps involved

all play an important role in determining the policies and standards to be established. The parents, the school officials, and the school bus drivers and their assistants must have a closer working relationship than is normally required for the transportation of the well and healthy children.

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GLOSSARY

1. Accident - Unplanned occurrence that results in property damage or bodily injury.

2. Activate - Start into motion; to make active.

3. Ambulatory - Able to walk about and not bedridden.

4. Big Picture - The overall view of the traffic situation through the eyes of the driver.

5. Blind Intersection - Intersection of two roadways at which the driver approaching on one roadway cannot see the traffic approaching on the other roadway.

6. Blood Vessels - Tubes in which blood circulates. Veins, arteries, capillaries.

7. Braking Distance - The distance the bus travels from the time braking action is applied until the bus comes to a stop.

8. Center Line - The line down the center of the roadway.

9. Cerebral Palsy - A disability resulting from damage to the brain before or during birth manifested by muscular incoordination and speech defects.

10. City Ordinance - An authorative decree or direction set forth by a municipal government.

11. Control - Orderly or prescribed conduct or pattern of behavior; a rule or system of rules governing conduct. To impose order upon; punish; teach.

12. Convulsion - An abnormal violent and involuntary contraction or series of contractions of the muscles.

13. Cruising Gear - The highest speed gear of any one transmission.

14. Deactivate - To make inactive; to stop.

15. Diabetes - Any of various abnormal conditions characterized by the secretion and excretion of excessive amounts of urine.

16. Discipline - See No. 11 - CONTROL

17. Divided Highway - Multi-lane highway. The lanes that are open for traffic in one direction are separated from the lanes provided for traffic in the opposite direction by a median strip or a physical barrier.

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18. Downshift - Shift from a higher gear to a lower gear.

19. Epilepsy - A disorder of the central nervous system typically manifested by convulsive attacks.

20. Four-Way Hazard Flashers - Are activated by hazard switch. Activates all turn signals simultaneously to warn approaching traffic of road hazard.

21. Freeway - "A divided multi-lane highway for through traffic with all cross roads separated in grade and with full control of access."

22. Handicapped Vehicle - A special designed vehicle usually with larger doors, rear steps, seat belts, support rails, and extra padding to insure safety during the transportation of the handicapped child.

23. Hemophilia - Hereditary tendency to uncontrollable bleeding.

24. Highway - "The entire width between the boundary lines of every way open to the use of the public as a thoroughfare for purposes of vehicular travel."

25. Inspection Decal - An emblem issued by the Ohio State Highway Patrol to be displayed on each side of the bus. Issued by patrol after a safety inspection is made of the bus by the patrol and the bus meets the necessary standards.

26. M.P.H. - Miles Per Hour

27. Marker Lights (Clearance Lights) - The amber lights located on upper front corners of bus; red lights on upper rear corners.

28. May - to be able; optional.

29. Motor Vehicle - "Every vehicle propelled or drawn by power other than muscular power or power collected from overhead electric trolley wires, except road rollers, traction engines, power shovels, power cranes, and other equipment used in construction work and not designed for or employed in general highway transportation, hole-digging machinery, well-drilling machinery, ditch-digging machinery, farm machinery, threshing machinery, hay-baling machinery, and agricultural tractors and machinery used in the production of horticultural, floricultural, agricultural, and vegetable products."

30. Muscular Dystrophy - A hereditary disease characterized by progressing wasting of muscles.

31. Must - Mandatory; essential; shall.

32. O.R.C. - Ohio Revised Code

33. Polio - An acute infectious virus disease characterized by fever, motor paralysis, and atrophy of skeletal muscles.

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D. Fish and Shellfish Cookery

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to boil and steam: Fish Shellfish The understanding and application of recipes, formulas, and procedures	Preparation: Cleaning fish Preparing shellfish Filleting fish Steaking fish Procedure: Seasoning Temperature Timing	Equipment and utensils Kinds of fish and shellfish Variations in terminology: Cooking terms: Boiling Poaching Steaming Fish terms: Freshwater fish Saltwater fish Seafood Shellfish Methods of serving: Sauces Garnishes
	Testing for doneness	Methods of testing Calculation of costs
How to bake fish: The understanding and application of recipes, formulas, and procedures	Preparation Procedure: Seasoning Stuffing Temperature Timing Testing for doneness	Equipment and utensils Kinds of fish suitable for baking Variations in stuffings Methods of testing Methods of serving: Sauces Garnishes Calculation of cost
How to broil fish: The understanding and application of recipes, formulas, and procedures	Preparation: Small fish: Fresh and frozen Large fish: Fresh and frozen Procedure: Seasoning Temperature Timing	Kinds of fish suitable for broiling Equipment Manipulation of broiler for heat control Portion control: Thickness of slices Weight of fish
	Testing for doneness	Methods of testing Methods of serving Calculation of costs
How to sauté and pan fry fish: The understanding and application of recipes, formulas, and procedures	Preparation	Kinds of fish suitable Selection of fat Equipment

266-894 O-68—3

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34. Preventive Maintenance - Maintenance performed with the intent to reduce breakdowns.

35. Roadway - "That portion of a highway improved, designed, or ordinarily used for vehicular travel, except the berm or shoulder. If a highway includes two or more separate roadways, the term 'roadway' means any such roadway separately but not all roadways collectively."

36. R.P.M. - Revolution Per Minute of Engine.

37. Seizure - A sudden attack.

38. Shall - Mandatory; must.

39. Should - Urgent request.

40. State Law - A principle governing action or procedure imposed by the Ohio State General Assembly.

41. State Regulation - A principle governing action or procedure imposed by the State Board of Education.

42. Syncro-mesh Transmission - In a syncro-mesh transmission, there is a built-in unit that brings gears into position of alignment for easy shifting as soon as clutch pedal is depressed.

43. Traffic Control Device - "All signs, signals, markings, and devices placed or erected by authority of a public body or official having jurisdiction, for the purpose of regulating, warning, or guiding traffic, including signs denoting names of streets and highways."

44. Vehicle - "Every device in, upon, or by which any person or property may be transported or drawn upon a highway, except devices moved by power collected from overhead electric trolley wires, or used exclusively upon stationary rails or tracks, and except devices other than bicycles moved by human power."

45. Warning Lights (Flasher Lights) - Red lights alternately flashing; used for student pick-up and student discharge.

46. Will - A command; an order.

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THE FINAL REWARD

"You get here three minutes early!"

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295 OF 327

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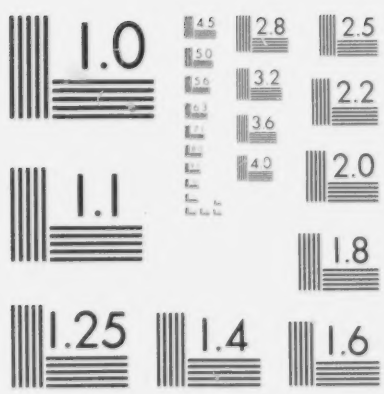

MICROCOPY RESOLUTION TEST CHART

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ABSTRACT - Ohio State staff prepared this manual to assist prospective school bus drivers in becoming familiar with the transportation laws and regulations, to acquaint them with the proper techniques of school bus driving, and to impress upon them the magnitude of their responsibilities. Five units included are: (1) The School Bus Driver, (2) Pupil Transportation Laws and Regulations in Ohio, (3) Digest of Motor Vehicle Laws in Ohio, (4) School Bus Orientation, and (5) Driving Fundamentals. Most sections in the units provide content, orientation material, presentation suggestions, and a summary. A limited number of illustrations are used throughout. A glossary and bibliography are included. (GEB)

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SCHOOL BUS DRIVER TRAINING

PRE-EMPLOYMENT MANUAL

OHIO TRADE AND
INDUSTRIAL EDUCATION SERVICE
Division of Vocational Education
State Department of Education
Columbus, Ohio

VT013278

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SCHOOL BUS DRIVER EDUCATION

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PREFACE

The purpose of this manual is: (1) to assist prospective school bus drivers in the State of Ohio to become familiar with the transportation laws enacted by the Ohio General Assembly and the transportation laws and regulations adopted by the State Board of Education, (2) to acquaint the drivers with the best known techniques of school bus driving and (3) to impress upon the drivers the magnitude of their responsibilities and the necessity to observe every safety precaution.

A combined effort by the personnel of the Transportation Section of the Division of School Finance and the Trade and Industrial Education Section of the Division of Vocational Education made the writing and publishing of this manual possible.

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D. Fish and Shellfish Cookery—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to sauté and pan fry fish—Con.	Procedure:	
	Seasoning	
	Dredging	
	Breading	
	Temperature	Temperature of fat
	Timing	
	Testing for doneness	Methods of testing
		Methods of serving:
		Sauces
		Garnishes
		Calculation of costs
How to deep fat fry fish:	Preparation	Selection of fat
The understanding and application of recipes, formulas, and procedures	Procedure:	Equipment
	Cutting	
	Breading	
	Seasoning	
	Temperature	
	Timing	
	Draining	
	Care in frying	Precautions:
		Thermometers
		Thermostats
	Testing for doneness	Methods of testing
		Methods of serving:
		Sauces
		Garnishes
How to cook seafoods:	General principles of seafood cookery	Variations in seafood
Clams		
Crabs		
Lobsters		
Oysters		
Shrimp		
The understanding and application of recipes, formulas, and procedures	Preparation:	Equipment
	Care and storage before cooking:	
	Fresh	
	Frozen	
	Procedure:	Preventing toughness
	Shelling	
	Seasoning	Variations in seafood dishes:
	Care during cooking	Newburg
		Stew
		Chowder
		Cocktail
		Casserole
	Testing for doneness	Methods of testing
		Methods of serving:
		Sauces
		Accompaniments
		Garnishes
	Care and storage after cooking	Calculation of costs

* Suggested teaching materials: See items 8, 15, 30, 31, 38, 51, 75, 76, 77, 78, 90 in Appendix B.

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UNIT I

THE SCHOOL BUS DRIVER

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UNIT I

I. TOPIC

The School Bus Driver

II. ORIENTATION

The school bus driver is the most important cog in the school transportation program. The drivers of school buses transporting boys and girls to and from school should know the qualifications and characteristics which are essential for them to fulfill their job safely and efficiently. This unit will deal with the necessary steps required to be certified as a school bus driver and driver qualifications and characteristics.

III. PRESENTATION

A. Certification Steps

1. Apply to school district for job application form and arrange for a personal interview.
2. Check school bus driver physical disqualification sheet.

Form 1

PHYSICIAN'S SCHOOL BUS DRIVER DISQUALIFICATION SHEET

Applicants shall be disqualified if:

(a) Applicant's heart and/or circulatory system are abnormal.

1) Diastolic Blood Pressure is less than 50 or more than 100
2) Coronary Insufficiency or evidence of coronary artery disease
3) History of Myocardial Infarction
4) History of Congestive Heart Failure
5) History of Cerebral Vascular Accident

(b) Applicant is taking medication to correct high blood pressure or drugs with sedative or other reactions which will impair physical or mental functions.

(c) Applicant has diabetes.

(d) Applicant's hearing must be a minimum of 10/15 by whispered voice. Hearing aid is permissible.

(e) Applicant's vision is less than 20/200 uncorrected in each eye.

(f) Applicant's vision is less than 20/30 corrected in each eye.

(g) Applicant cannot readily distinguish red, green, and yellow.

(h) Applicant's lateral peripheral field of vision is less than 70° in each eye.

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(i) Applicant does not have reasonable use of four extremities with thumb and at least two fingers on each hand. Applicant has artificial limb.

(j) Applicant has or has had a convulsive disorder.

(k) Applicant has speech defect which would make it impossible to give clear directions or commands.

(l) Applicant is known to have a mental disorder, drug addiction or alcoholism.

(m) Applicant shows evidence of active pulmonary tuberculosis, or other communicable diseases.

(n) Applicant has other defects which would affect his ability to drive a school bus.

3. Arrange for a tuberculin skin test or chest x-ray. (Performed within the past year)
4. Arrange for a physical examination. (Medical Examination Report Form for School Bus Drivers must be used.) See Form 2, Page 5.

   a. Obtain form from school district
   b. Payment for examination (Shall be paid by county, city or exempted village board)
   c. Designate examining physician(s) (Shall be designated by county, city, or exempted village board)
   d. Required each school year

5. Arrange with local State Highway Patrol Post Examining Station for written tests and driving examination. Secure a copy of the completed medical examination form from school district administrator and take to testing center.
6. Apply to county superintendent, city superintendent, or exempted village superintendent, whichever is applicable for the driver's certificate.

   a. Check local policy
   b. Required each school year

B. Physical Qualities

1. Vision

   a. Driver must have 20/30 vision or better in each eye - with or without glasses.

      (1) See clearly at 20 feet what the average person can see at 30 feet
      (2) Driver should have his vision checked by a qualified person each year.
      (3) A person shall not drive a school bus until visual defects are corrected.

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MEDICAL EXAMINATION REPORT FOR SCHOOL BUS DRIVERS & SUBSTITUTE SCHOOL BUS DRIVERS

THIS FORM TO BE COMPLETED BY THE EXAMINING PHYSICIAN AND RETURNED TO: _____
(City, County, or Exempted Village Superintendent)

DO NOT RETURN TO APPLICANT

_____ (Address) _____ (County)

APPLICANT'S NAME _____ ADDRESS _____

AGE _____ SEX _____ HEIGHT _____ WEIGHT _____

MEDICAL HISTORY

Do you have or have you had—

Diabetes	Yes ☐	No ☐	Vision problem	Yes ☐	No ☐
Tuberculosis	Yes ☐	No ☐	Hearing problem	Yes ☐	No ☐
Heart disease	Yes ☐	No ☐	Asthma	Yes ☐	No ☐
High blood pressure	Yes ☐	No ☐	Dizziness or fainting spells	Yes ☐	No ☐
Physical deformities	Yes ☐	No ☐	Back injury	Yes ☐	No ☐
Speech defect	Yes ☐	No ☐	Hernia	Yes ☐	No ☐
Head injury	Yes ☐	No ☐	Other chronic diseases or defects	Yes ☐	No ☐
Convulsions or epilepsy	Yes ☐	No ☐	Nervous disorders or mental illness	Yes ☐	No ☐
Alcoholism or drug addiction	Yes ☐	No ☐	Do you take any medication or drugs to correct blood pressure or of a sedative nature?	Yes ☐	No ☐
Syphilis	Yes ☐	No ☐			

Comments _____

The undersigned _____ hereby certifies the foregoing statements are true to the best of his knowledge and belief.

Signed _____
(Driver)

PHYSICAL EXAMINATION

NOTE TO SUPT. OF SCHOOLS: This report must be sent to: Ohio State Highway Patrol, 660 E. Main St., Columbus, Ohio — within 15 days following examination.

NOTE TO EXAMINING PHYSICIAN: Please check the Disqualification Sheet attached to this form before certifying driver.

(PLEASE DO NOT USE CHECK MARKS)

HEENT
Appearance _____ Blood pressure _____
Nose and throat _____
Eyes OD _____ OS _____ Snellen OD 20/_____ OS 20/_____ Corrected OD 20/_____ OS 20/_____
Peripheral Vision in Degrees OD _____ OS _____ Color Vision _____
Pupillary Reflex OD _____ OS _____ Muscle Balance OD _____ OS _____
Ears R _____ L _____ Hearing: Normal ☐ Abnormal ☐

LUNGS _____

HEART _____

ABDOMEN _____

GENITALIA (evidence of venereal disease) _____

HERNIA _____

EXTREMITIES _____

SPINE _____

NEUROLOGICAL Rhomberg _____ Deep tendon reflexes _____ Coordination _____

SKIN _____

CHEST X-RAY _____ Date of X-Ray or test _____
(A negative intra-dermal tuberculin test will be accepted in lieu of X-Ray; Tuberculin test or X-Ray must have been performed **within the past year**)

LABORATORY Urinalysis: Sugar _____ Albumin _____

COMMENT ON ABNORMAL FINDINGS _____

PHYSICIAN'S CERTIFICATE

I hereby certify that _____ has been examined by me in accordance with the medical examination report form above. The above named applicant is qualified ☐ disqualified ☐ to perform the duties of a school bus driver in accordance with the disqualification factors governing this examination.

Qualified only while wearing glasses ☐

Qualified only while wearing hearing aid ☐

Date _____

_____
(Licensed Physician's Signature)

_____
(Address)

Ohio Dept. of Education
Form T8 (Revised 1-20-69)

HIGHWAY PATROL COPY

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b. Peripheral vision or field vision

(1) The angle to the left and to the right that a person can see when looking straight ahead is known as field of vision.

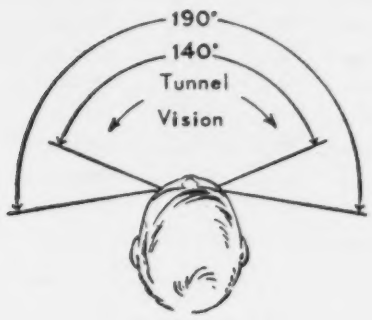

Figure 1

(2) The driver must have a field of vision of 140° or more.

c. Color blindness

(1) A driver must be able to distinguish colors in order to observe traffic lights, stop lights, warning signals.
(2) The colors used are red, green, amber, and yellow.

(a) Amber is used on traffic signals, directional signals, and vehicle clearance lights.
(b) Yellow is used for traffic control signs.

d. Depth perception

(1) The ability to judge the size, shape, distance, and rate of motion of an object is known as depth perception.
(2) Judgment of depth is required in important situations such as:

(a) Overtaking and passing another vehicle
(b) Turning in traffic
(c) Parking in limited spaces
(d) Judging relative sizes and distances of objects and spaces ahead

e. Night vision

(1) The effects of darkness and light glare on an individual's eyes determine the ability to drive safely at night.

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(2) Those qualities necessary for good night vision are:

(a) Dark adaptation - the ability of a person to see after his eyes have been subjected to darkness.

(b) Glare recovery - the ability of a person's eyes to re-adjust normally after passing glaring lights.

(c) Glare resistance - the measure of a driver's ability to see when facing the glare of lights from an approaching vehicle.

Figure 2

2. Hearing

a. A school bus driver's hearing must be a minimum of 10/15.

b. Good hearing enables him to hear warning bells, signals, mechanical trouble, and other sounds relating to traffic or safety in driving.

(1) Hearing a whispered voice 10 inches away which the average person can hear 15 inches away.

(2) Hearing aid is permissible.

3. The school bus driver should have sufficient strength to handle the bus confidently regardless of the driving situations.

4. Reaction time

a. The reaction time is the length of time it takes a driver to recognize a hazard, determine evasive action, and perform the necessary action.

(1) The driver's braking reaction time should not exceed one second.

(2) Quick reaction time may help to avoid a potential accident situation.

b. Other important reaction times

(1) Turning

(2) Acceleration

(3) Deceleration

C. Desired Mental and Emotional Qualities of a School Bus Driver

1. Positive attitude rather than negative

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2. Friendly personality
3. Emotional stability is a must

   a. Calmness under stress
   b. Even temperament

4. Alert and safety minded at all times
5. Patient and dependable
6. Honest and fair

D. Character Traits

1. Have good oral expression - free from derogatory remarks and abusive language.
2. The driver should help all children feel that they belong, are respected, and share in the rights and privileges as well as the responsibilities of the group. Children of all ages regardless of race, color, creed, or economic status need to feel socially acceptable.
3. Refrain from the use of tobacco while on duty.
4. Abstain from the use of any alcoholic beverage preceding and while driving a school bus.
5. Drivers should like and understand children.

E. Personal Hygiene

1. Cleanly shaven.
2. Maintain body cleanliness.
3. Clean and suitable wearing apparel for the occasion.

IMPROPER

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IMPROPER

PROPER

Figure 3

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IV. SUMMARY

School bus drivers must be alert to everything around them. Certainly their health must be given top priority, for without passing all the physical tests they cannot qualify as bus drivers.

Their personalities, character traits, and personal hygenic habits all lead to good mental health conditions which are necessary to handle a group of children, and face the public.

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UNIT II

PUPIL TRANSPORTATION LAWS AND REGULATIONS IN OHIO

10/11 20867

E. Sauces and Gravies

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare the basic sauces: The understanding and application of recipes, formulas, and procedures	Preparation: Methods	Use of sauces Variety sauces Equipment, utensils, tools
	Procedure: Seasoning Care during cooking Temperature Timing Care after cooking	Herbs and other seasonings Flavorings Color and thickening agents The roux: Color Gloss Variations for fish, meat, poultry, and vegetables
Cream sauce (Bechamel)	Preparation Procedure: Seasoning Care during cooking Temperature Care after cooking	Equipment, utensils, tools The roux: Texture Consistency Uses Sauces derived from cream sauce: Use
Fricassee sauce (Veloute)	Preparation and procedure: Seasoning Care in preparation Temperature Timing Care after preparation	How it varies from a true sauce Consistency, color, flavor, uses Sauces derived from fricassee base: Use
Tomato sauce	Preparation and procedure: Seasoning Care during cooking Care after cooking	The roux: Consistency Flavor Color Uses
Hollandaise sauce	Preparation and procedure: Seasoning Care during cooking Temperature Timing Care after cooking	General precautions: Temperature Equipment and utensils Uses and variations Prevention of curdling: Remedial measures
How to prepare gravy: The understanding and application of recipes, formulas, and procedures	Preparation and procedure	Distinction between gravy and the sauces
Natural gravy	Preparation and procedure: Seasoning	Color, flavor, consistency Utensils Uses
Thickened gravies (pan or brown gravy)	Preparation and procedure: Seasoning Thickening agents Care during cooking Care after cooking	Utensils Color, flavor, consistency Uses
Cream gravies (Country gravy)	Preparation and procedure: Seasoning Thickening agents Care during cooking Care after cooking	Utensils Color, flavor, consistency

Suggested teaching materials: See items 8, 10, 20, 30, 31, 108 in appendix B.

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PUPIL TRANSPORTATION LAWS AND REGULATIONS IN OHIO

Introduction

Pupil transportation in Ohio is governed by the Revised Code of Ohio, by Regulations adopted by the State Board of Education, and by policy adopted by school district boards of education.

A Board of Education is limited to powers expressly granted by statute and those necessary to carry into effect the powers expressly granted. Where discretionary powers are vested by statute in a Board of Education, such discretion is limited only by Judicial Review in case of fraud or abuse of discretion (1928 OAG 1714).

These Regulations have been adopted by the State Board of Education with the advice and consent of the Director of Highway Safety.

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UNIT II

SECTION ONE

I. TOPIC

Transportation Responsibilities of the State Agencies

II. STATE DEPARTMENT OF EDUCATION

A. Construction and Design of School Buses (Sec. 4511.76(A) O.R.C.)

The State Department of Education shall adopt and enforce standards of construction, design and equipment of all school buses owned and/or operated by public school districts or under contract with a public school district. (See Ohio School Bus Minimum Standards)

NOTE: All other buses are regulated by the Director of Highway Safety. (See Sec. 4511.76(B) O.R.C.)

B. Operating Regulations (Sec. 4511.76(A) O.R.C.)

The State Department of Education shall adopt and enforce regulations which govern pupil transportation administration and operation procedures.

NOTE: All other buses are regulated by the Director of Highway Safety. (See Sec. 4511.76(B) O.R.C.)

C. Fiscal Responsibilities (Sec. 3317.051 O.R.C.)

1. The State Board of Education shall determine by formula the total amount of money approved for each district in which the transportation meets the regulations prescribed by it to secure an efficient and economical program of pupil transportation. (Sec. 3327.012 O.R.C.)
2. The State Board of Education shall adopt a formula for assistance to eligible districts for the purchase of school buses. (Sec. 3317.07 O.R.C.)

D. Area Coordinator (Transportation)

1. The Area Coordinator (Transportation) has the following responsibilities:

   a. Designate collection points (Sec. 3327.01 O.R.C.)
   b. Establish routes, schedules, and utilization of equipment that has been recommended by each board of education to whatever extent is feasible. (Sec. 3327.011 O.R.C.)

III. COUNTY BOARD OF EDUCATION, CITY AND EXEMPTED VILLAGE SUPERINTENDENTS

A. The County Board or City or Exempted Village Superintendent shall provide annual physical examinations for school bus drivers. (Sec. 3327.10 O.R.C.)

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B. The County Board or City or Exempted Village Superintendent shall issue a drivers' certificate upon determining that each school bus driver and substitute driver has met the requirements as established by the Ohio Revised Code and these regulations. (See School Bus Driver)

C. The County Board of Education or City or Exempted Village Superintendent may revoke such certificate:

1. When the school bus driver fails to meet the requirements established by these regulations. (See School Bus Driver)
2. When a driver is found guilty of improper conduct or has failed to notify the authorities of all traffic violations and convictions; or has failed to comply with any laws of the State of Ohio, Regulations of the State Board of Education, or policies of the school district of employment.

D. The county, city or exempted village superintendent shall provide at least one (1) annual safety workshop for transportation personnel.

IV. LOCAL, CITY AND EXEMPTED VALLAGE SCHOOL BOARD RESPONSIBILITIES

A. District Boards of Education:

1. Are responsible for the operation of the school transportation program. The Board of Education may delegate the authority for direct control to the superintendent or other administrative employee.
2. Shall provide transportation for all pupils so crippled that they are unable to walk regardless of the distance to a school where the State Board of Education prescribes minimum standards. (Sec. 3327.01 O.R.C.)
3. Shall provide transportation for all resident elementary children who live more than two miles from the public school to which they are assigned or to the non-public school to which they attend. (Sec. 3327.01 O.R.C.)
4. Shall recommend to the Area Coordinator (Transportation) routes, schedules, and utilization of transportation equipment. (Sec. 3327.011 O.R.C.)
5. Shall adopt a time schedule and put in force no later than ten days after the beginning of the school term. (Sec. 3327.01 O.R.C.)

B. District Boards of Education may:

1. Provide transportation for high school pupils. (Sec. 3327.01 O.R.C.)
2. Provide transportation for any elementary or high school pupils residing any distance. (Sec. 3327.01 O.R.C.)
3. Pay a parent or guardian in lieu of transporting an eligible pupil when the board deems such transportation impractical. (Sec. 3327.01 O.R.C.)
4. Procure accident insurance on school buses. When carried by the Board, the amount of liability insurance shall not exceed five hundred thousand dollars. (Sec. 3327.09 O.R.C.)

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5. Designate depots to gather pupils for transportation purposes. If the board designates such a depot, they shall provide a shelter. (Sec. 3327.03 O.R.C.)
6. Maintain turn-around points. (Sec. 3327.12 O.R.C.)
7. Make cooperative agreements with recreation commissions for the use of school buses to transport students taking part in summer recreation programs. (OAG 67-081-1967)
8. Assess a fee, not to exceed the actual cost, for transportation to and from established educational exhibits and programs during summer months, Saturdays, and holidays.
9. Use buses for summer or auxiliary service programs for resident pupils sponsored by district boards of education.

NOTE: Transportation operational expense records must be maintained for sections 8 and 9 above. Such expenses are not reimbursable through state foundation monies.

10. Permit the use of school buses in the event of civil emergency.

C. **Boards of Education shall not:**

1. Transport pupils to or from any school which practices discrimination against any person on the grounds of race, color, religion, or national origin. (Sec. 3327.01 O.R.C.)
2. Pay a parent more than the state average cost per pupil for transporting pupils in the previous school year, when the board pays the parent or guardian in lieu of transporting a pupil eligible for such service. (Sec. 3327.01 O.R.C.)
3. Transport pupils residing within another district without that school district's written consent. (Sec. 3327.05 O.R.C.)
4. Transport pupils to a school which does not meet the minimum standards prescribed by the State Board pursuant to Division (D) of Section 3301.07 of the Revised Code. (Sec. 3321. O.R.C.)

D. **District Boards of Education Are Not Required to Provide Transportation For:**

1. Non-public pupils who attend a school which requires more than 30 minutes of direct travel time as measured by a school bus from the collection point to the pupil's school of attendance. (Sec. 3327.01 O.R.C.)
2. Pupils where it is impractical to provide such service with a school bus. (Sec. 3327.01 O.R.C.)
3. Pupils, when in the judgment of such board of education and confirmed by the State Board of Education, such transportation is unnecessary or unreasonable. In determining the necessity for transportation, availability of facilities and distance to school shall be considered. (Sec. 3327.01 O.R.C.)

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UNIT II

SECTION TWO

I. TOPIC

Transportation Personnel Responsibilities

II. THE TRANSPORTATION ADMINISTRATOR (SUPERINTENDENT OR SUPERVISOR)

A. A transportation administrator may be the superintendent, local superintendent, principal, transportation supervisor or any other person designated by the Board of Education to administer the transportation program. The Board of Education may delegate the administration, but not its legal responsibilities for, pupil transportation.

B. The transportation administrator shall provide safe school buses by:

1. Assuring that all school buses meet or exceed the "Ohio School Bus Minimum Standards" in effect at the time of purchase.
2. Providing a quality, continuing maintenance program.
3. Providing for the pre-inspection and completion of Form T-30 (O.D.E.) for all school buses before the annual Ohio State Highway Patrol inspection.
4. Assuring that all school buses are presented for inspection.
5. Providing for regular safety inspections and correcting immediately all deficiencies noted.

C. Is responsible for recommending to the Board of Education the names of qualified applicants for employment.

D. Shall see that all school bus drivers are instructed as to routes, time schedules, duties, laws, regulations, and school district policies related to pupil transportation.

E. Is responsible for seeing that all drivers meet the requirements of the laws of Ohio and Ohio Department of Education regulations before driving a bus with pupils on board. He shall make arrangements for the basic school bus driver's education program. (See School Bus Driver)

F. He shall maintain a school district map or route description system indicating all routes, pick-up points, names of students by bus by stop, the grade and school of attendance, and a route time schedule.

G. He shall administer the transportation policies and procedures relating to pupil behavior.

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H. He shall, in the case of city and exempted village school districts, provide for one (1) annual safety workshop for transportation personnel. Local school district transportation administrators shall require the transportation personnel to attend one (1) annual county sponsored safety workshop.

I. He shall be responsible for maintaining accurate records of:

1. Vehicle inventory
2. Daily miles traveled
3. Students transported
4. Annual operating costs by vehicles for the regularly scheduled trips.

J. He shall maintain accurate record of annual miles and costs for non-routine use of school buses.

K. He shall provide all information as required by the Ohio Department of Education.

III. THE SCHOOL BUS DRIVER

A. To be employed as a school bus driver the following requirements must be met:

1. Be at least 21 years of age.
2. Be of good moral character.
3. Be physically qualified as determined by an annual physical examination meeting the criteria established by Ohio Department of Education Form T-8.
4. Prior to testing by the Ohio State Highway Patrol, be trained in the operation of a school bus and have a knowledge of the Transportation Laws and Regulations.
5. Hold a current Ohio Chauffeur's License marked "School Bus Operator".
6. Hold a current bus driver's certificate issued by the County Board of Education or City or Exempted Village Superintendent.
7. Shall be required to satisfactorily complete the State Department of Education's Basic School Bus Driver Education Program within the first year of employment as a school bus driver.
8. Attend all safety workshops and meetings as required by district administration.

B. It is recommended that boards of education not employ any person as a school bus driver who has passed his 65th birthday.

C. No person shall be employed as a bus driver who is addicted to alcohol, narcotics or other drugs of a sedative nature.

D. The bus driver shall not use or permit the use of tobacco while pupils are on the bus.

E. The use of stimulants, sedatives or any other substance which will affect the bus driver's judgment and driving ability during his routes is prohibited.

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UNIT II

SECTION THREE

I. TOPIC

Operational Regulations

II. SCHOOL BUS OPERATIONS AND DRIVING PROCEDURE

A. The school bus driver shall make a daily inspection to determine if the bus is in safe operating condition.
The following items should be checked:

1. Air Brakes - (a) Drain water from air reservior tanks
   (b) Air pressure indicators
2. Brake Pedal - Travel on hydraulic brake systems
3. Steering
4. Tires and Wheel Lugs
5. Engine Oil Level - Must not be below "add" mark
6. Radiator Coolant Level
7. Emergency Equipment
8. Heaters and Defrosting Equipment (seasonal)
9. Lights
10. Instruments and Gauges
11. Horn
12. Windshield Wipers and Washers
13. Interior Cleanliness
14. Glass Areas - Clear vision to front, sides and rear.

B. All items checked and found deficient shall be reported to responsible authority. Mechanical defects shall be reported in writing.

C. In no event shall a bus be driven backward on school grounds while children are being loaded or unloaded.

D. When departing from the loading area, buses shall maintain a safe interval. No passing shall be permitted in the loading area.

E. Bus drivers shall maintain a distance of 300 feet behind any preceding moving vehicle while traveling on the highway at normal speed.

F. School buses operating on divided highways or highways with four or more traffic lanes shall receive and discharge all school children on their residence side of the highway. (Sec. 4511.75(C) O.R.C.)

G. Before receiving and discharging pupils on the highway, the bus shall be driven to the right side of the paved or traveled portion of the roadway and brought to a full stop.

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H. The bus driver shall be the only operator of the service entrance door. The door shall not be opened to load or unload pupils until traffic has cleared the the bus or come to a complete stop in all directions.

I. Warning flasher lights shall be used to prewarn other motorists of the intention of the bus to stop for the singular purpose of loading or unloading pupils. The lights shall remain in operation during the total time the bus remains stationary.
Warning flasher lights shall not be used:
(1) When stopped for railroad grade crossings.
(2) While stopped on traveled highway used for loading and unloading pupils at school locations.
(3) At turn arounds

J. Driver shall not use service door control to activate warning flasher lights. Door must remain in complete "locked" position while bus is in motion.

K. Four-way hazard lights may be used at bus turn arounds.

L. The bus shall not be started in motion until after pupils who have been discharged from the bus have reached a place of safety on their residence side of the road. (Sec. 4511.75(D) O.R.C.)

M. The driver shall use the established route and make stops as designated by the board of education or the administrator who is authorized to designate such stops.

N. The driver shall operate the bus on the approved time schedule and shall wait for pupils if running ahead of schedule.

O. School buses shall be brought to a stop before crossing railroad grade crossings and while so stopped, the driver shall listen through an open door or open window and look in both directions along the track. He shall not proceed until safe to do so.
The driver shall cross only in such gear of the vehicle that there will be no necessity for changing gears during the crossing. (Sec. 4511.63 O.R.C.)

P. The school bus driver shall require silence of all pupils at all railroad crossings. All school bus drivers shall obey all state and local traffic laws.
SPEED (Sec. 4511.21 O.R.C.)
No person shall operate a motor vehicle, trackless trolley, or streetcar in and upon the streets and highways at a speed greater or less than is reasonable or proper, having due regard to the traffic, surface, and width of the street or highway and any other conditions, and no person shall drive any motor vehicle, trackless trolley, or streetcar in and upon any street or highway at a greater speed than will permit him to bring it to a stop within the assured clear distance ahead.

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The maximum speeds for school buses are:

1. 20 MPH in school zones (during restricted hours).
2. 25 MPH inside corporations, except on state routes, through highways outside business districts and alleys.
3. 35 MPH on state routes or on through highways within municipalities outside business districts.
4. 50 MPH on controlled-access highways and expressways within municipal corporations (day or night).
5. 55 MPH on freeways outside municipal corporations (day or night).
6. 15 MPH on alleys within municipal corporations.

Section 4511.22 O.R.C.

No person shall operate a vehicle, trackless trolley, or streetcar at such a slow speed as to impede or block the normal and reasonable movement of traffic, except when reduced speed is necessary for safe operation or to comply with law.

Q. A school bus shall not be refueled while the engine is running.

R. The driver shall not leave the bus until the brakes are set, the engine stopped and the ignition key is removed.

III. TRAFFIC REGULATION

A. No school bus shall be stopped, or shall be turned so as to proceed in the opposite direction, upon any curve or upon the approach to or near the crest of a grade, where such vehicle cannot be seen by the driver of any vehicle approaching from either direction within 500 feet. (Sec. 4511.37 O.R.C.)

B. The school bus driver shall permit other vehicles to pass when a line of traffic accumulates at the rear of the bus. (Sec. 4511.75(A) O.R.C.)

C. A school bus shall not be parked within the limits of the highway right-of-way. (Sec. 4511.66 O.R.C.)

IV. PUPIL BEHAVIOR

A. While riding on a school bus, reasonable conversation is permissible and may be regulated by the driver.

B. The driver shall be in charge of the bus at all times and shall be responsible for order. He should not exclude a pupil from the bus. The driver shall report the unmanageable pupil to the proper authority. Disorderly conduct shall be sufficient reason for refusing transportation service to any pupil.

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C. Whenever it becomes necessary to refuse a pupil transportation, the school authorities shall notify the parents of such refusal with a full explanation. Until such time as the school authorities have received assurance from the parents of future good conduct on the part of the pupil and the bus driver has been so advised, the driver shall not permit the pupil to board the bus.

V. SCHOOL BUS ACCIDENT REPORTING

The bus driver shall report any accident involving a school bus to the police agency within whose jurisdiction the accident has occurred and to the superintendent of schools.

The superintendent of the school district whose bus was involved in an accident shall report such accident on Department of Education Form T-10 within fifteen days from the time of the accident.

A copy of each report shall be retained in district file for a period of five years.

Definition of Motor Vehicle Accident

(a) Any incident or occurrence involving a school bus operated by or under contract to a school district which results in a fatality, an injury, or damage to any motor vehicle or property.

(b) Any action taken by a bus driver employed by a school district which contributes directly to any fatality, injury or damage to any motor vehicle or property.

VI. LOADING AND UNLOADING AT SCHOOL FACILITIES

A. When it is necessary to load or unload pupils off the school grounds, the bus shall be stopped and positioned so that pupils do not cross the road to get to or from the bus.

B. All warning flasher lights shall be turned off while loading and unloading at the school building in order that traffic may proceed without interference.

C. Bus drivers shall remain on the bus while pupils are loading and unloading.

D. Pupils waiting to board buses shall be supervised by school authorities.

VII. SCHOOL BUS STOPS

The board of education shall approve all bus stops. School bus stops shall be limited so far as possible. Pupils may be required to walk to a designated bus stop.

VIII. PUPIL LOAD

Pupils may be assigned seats. The number of pupil standees shall not exceed 10% of the number seated.

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F. Ground and Variety Meat Cookery

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and relate ')
How to prepare ground and chopped 'meat dishes: The understanding and application of recipes, formulas, and procedures	Preparation of various types: Chopped meat: Raw Cooked Hashes	Economy factors: Use of leftovers Use of meat trimmings Storage and care Bacteriology and sanitation Equipment and tools
	Procedure: Seasoning Temperature Time	Sauces, gravies, stocks Methods of serving: Garnishes
How to prepare variety meats: The understanding and application of recipes, formulas, and procedures	Preparation of each kind of glandular or variety meat	Kinds: Liver Kidney Sweetbreads Tongue Brains Tripe Heart Care in storage Nutritive value, cost factor, acceptability, or regional preference Variety of uses
	Procedure: Seasoning Cooking process Temperature Time	

Suggested teaching materials: See items 8, 10, 20, 31 in appendix B.

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IX. NON-ROUTINE USE OF SCHOOL BUSES

A. The regulations governing non-routine use of buses apply to vehicles owned and operated by boards of education or under contract to a board of education. The regulations pertain to summer use of buses as well as during the regular school year.

B. Trip Permit
City, exempted village and local superintendents shall issue a trip permit for each co-curricular use of a school bus. The permit shall provide the following information: (1) date of trip; (2) destination of trip; (3) purpose of the trip; (4) name of the school district; (5) driver's name; (6) bus registration number; (7) total miles of trip; (8) superintendent's signature.

C. School buses may be used to transport pupils to and from any event that is a planned part of the classroom or the educational program. Expenses may be paid from the general fund.

D. School buses may be used to transport participating pupils to and from any co-curricular activity programs approved by the district boards of education. Pupil participants living on the most direct route to the activity from the school may be picked up and discharged as far as is practical. These expenses shall not be paid from the general fund.

E. Each event that requires the use of more than five school buses to transport participants to and from a co-curricular activity shall require a resolution by the district board of education.

F. School buses shall not be used for pleasure trips.

G. School buses shall not be used to transport spectators, either student or adult.

H. Adults may be transported to assist teacher on educational trips, if approved by the superintendent.

I. Students may not be transported to observe college or professional games - i.e., football team, band, etc.

J. Buses shall not be used for combination trips such as taking students to a museum in the morning and to view a football contest in the afternoon.

K. No pupil charge may be made for transporting pupils in any school bus to and from regular day classes and other co-curricular trips on school days. This applies equally to board-owned buses and privately owned buses operated under contract with a board of education.

20878

L. A fee not to exceed actual costs may be assessed for transportation to and from established educational exhibits and programs during summer months, Saturdays, and holidays.

M. Board-owned school buses may be used for trips outside the state, provided the entire round trip does not exceed one hundred twenty miles from the sending school. Contract buses are excluded from interstate trips under Interstate Commerce Commission. (Administrative Ruling No. 80, Sec. 203(b) 1 & 9)

N. School buses may be used by government agencies in Ohio for use during emergencies. (Example: National Guard Reserves transported to riot area.)

UNIT II

SECTION FOUR

I. GENERAL REGULATIONS

A. **Transportation of Special Equipment.** When it is necessary to transport special equipment, each passenger on the bus must be seated.

B. **Emergency Drills.** The transportation supervisor and/or the bus driver shall conduct a minimum of two rear door emergency evacuation drills on each school bus each year. Drills shall be conducted on the school grounds, or off the highway area. Responsible pupils should be assigned to open the emergency door and assist younger pupils from the bus.

C. **Forbidden Cargo.** While students are riding on the bus, animals, firearms, ammunition, explosives, or other dangerous materials or objects which may interfere with safe operation of the vehicle shall not be transported.

D. **Unauthorized Passengers.** No unauthorized passengers shall be transported on a school bus. (Example: Pre-school age children.)

20879

STATE LAWS PERTAINING TO PUPIL TRANSPORTATION

SEPARATE FACILITIES FOR MENTALLY RETARDED CHILDREN

3313.88

The board of education of any school district may establish separate schools or facilities for the instruction of mentally retarded children and may:

(A) Expend school funds in the establishment of such schools or facilities;

(B) Provide for the transportation of any such pupils to and from the schools or facilities established under this section;

(C) Contract with the child welfare board, the board of county commissioners, or any municipal corporation to provide training for mentally retarded children upon whatever terms the contracting parties agree upon for the division of the cost of maintaining and operating the schools or facilities for such pupils. (127 v H568. Effective 9-16-57.)

Board may contract for transportation of mentally retarded pupil to public school in another district, but not to private school.

TRANSPORTATION OF PUPILS; EXCESS COST FROM FEDERAL FUNDS

3327.01

In all city, exempted village, and local school districts where resident elementary school pupils live more than two miles from the school for which the state board of education prescribes minimum standards pursuant to division (D) of section 3301.07 of the Revised Code and to which they are assigned by the board of education of the district of residence or to and from the non-public school which they attend the board of education shall provide transportation for such pupils to and from such school except when, in the judgment of such board, confirmed by the state board of education, such transportation is unnecessary or unreasonable.

In all city, exempted village, and local school districts the board may provide transportation for resident high school pupils to and from the high school to which they are assigned by the board of education of the district of residence or to and from the non-public high school which they attend for which the state board of education prescribes minimum standards pursuant to division (D) of section 3301.07 of the Revised Code.

In determining the necessity for transportation, availability of facilities and distance to the school shall be considered.

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A board of education shall not be required to transport elementary or high school pupils to and from a non-public school where such transportation would require more than thirty minutes of direct travel time as measured by school bus from the collection point as designated by the coordinator of school transportation, appointed under section 3327.011 of the Revised Code, for the attendance area of the district of residence.

Where it is impractical to transport a pupil by school conveyance, a board of education may, in lieu of providing such transportation, pay a parent, guardian, or other person in charge of such child, an amount per pupil which shall in no event exceed the average transportation cost per pupil, such average cost to be based on the cost of transportation of children by all boards of education in this state during the next preceding year.

In all city, exempted village, and local school districts the board shall provide transportation for all children who are so crippled that they are unable to walk to and from the school for which the state board of education prescribes minimum standards pursuant to division (D) of section 3301.07 of the Revised Code and which they attend. In case of dispute whether the child is able to walk to and from the school, the health commissioner shall be the judge of such ability.

When transportation of pupils is provided the conveyance shall be run on a time schedule that shall be adopted and put in force by the board not later than ten days after the beginning of the school term.

A district receiving a payment pursuant to division (B) of section 3317.02 of the Revised Code is not eligible for reimbursement of transportation operating costs or eligible for school bus purchase subsidy payment pursuant to section 3317.06 of the Revised Code, except for transporting children who are crippled and for transporting pupils attending non-public schools.

The cost of any transportation service authorized by this section shall be paid first out of federal funds, if any, available for the purpose of pupil transportation, and secondly out of state appropriations, in accordance with regulations adopted by the state board of education.

No transportation of elementary or high school pupils shall be provided by any board of education to or from any school which in the selection of pupils, faculty members, or employees, practices discrimination against any person on the grounds of race, color, religion, or national origin. (132 v S 451. Effective 2-29-68. 132 v H 823, H1; 131 v S 365)

20382

3327.011

Coordinators of school transportation shall be appointed according to provisions of section 3301.13 of the Revised Code to assure that each pupil, as provided in section 3327.01 of the Revised Code, is transported to and from the school which he attends in a safe, expedient, and economical manner using public school collection points, routes, and schedules.

In determining how best to provide such transportation, where persons or firms on or after April 1, 1965, were providing transportation to and from schools pursuant to contracts with persons or agencies responsible for the operation of such schools, a coordinator or the board of education responsible for transportation in accordance with section 3327.01 of the Revised Code shall give preference if economically feasible during the term of any such contract to the firm or person providing such transportation. The boards of education within the county or group of counties shall recommend to the coordinator of transportation routes, schedules, and utilization of transportation equipment. The coordinator, upon receipt of such recommendations, shall establish transportation routes, schedules, and utilization of transportation equipment, following such recommendations to whatever extent is feasible. The appeals from the determination of the coordinator shall be taken to the state board of education. (132 v H 455. Effective 12-11-67 131 v S 365)

DESIGNATION OF DEPOTS

3327.03

The boards of education of city, exempted village, and local school districts may by resolution designate certain places as depots from which to gather children for transportation to school, when such districts provide transportation. The places designated as depots shall be provided with a shelter and be made comfortable during cold and stormy weather.

TRANSPORTATION OF NONRESIDENT PUPILS

3327.05

The board of education of any school district shall not provide transportation for any pupil who is a school resident of another school district unless the board of the district of the pupil's residence has given its written consent thereto. If the board of any school district files with the state board of education a written complaint that transportation for resident pupils is being provided by the board of another school district, contrary to this section, the state board of education shall make an investigation of such complaint. If the state board of education finds that transportation is being provided contrary to this section it may withdraw from state funds due the offending district any part of the amount that has been approved for transportation pursuant to section 3317.051 of the Revised Code. (126 v 288. Effective 10-1-56.)

20883

SCHOOL BUSES AND DRIVERS

Purchase of School Buses; Terms; Bidding

3327.08

Boards of education of city school districts, exempted village school districts, local school districts, joint high school districts, and joint vocational school may purchase on on individual contract school buses and other equipment used in transporting children to and from school and to other functions as authorized by the boards of education, or the boards may, at their discretion, purchase such buses and equipment through whatever system of centralized purchasing is established by the state department of education for such purpose, provided that state subsidy payments shall be based on the amount of the lowest price available to the boards by either method of purchase. No such board of education shall be deprived of any form of state assistance in the purchase of said buses and equipment by reason of purchases of said buses and equipment on an individual contract. Boards of education, in the purchase of said buses and equipment on individual contract shall make such purchases on the following terms:

(A) Not less than one-fourth of the purchase price thereof shall be paid in cash.

(B) Not less than an additional one-fourth of the purchase price thereof shall be paid within one year from the date of purchase.

(C) Not less than an additional one-fourth of the purchase price thereof shall be paid within two years from the date of purchase.

(D) The remaining balance of the purchase price thereof shall be paid within three years for the date of purchase. Such boards may issue the notes of the school districts signed by the president and the clerk of the board, and specifying the terms of the purchase including deferred payments as provided in this section, which notes may bear interest at a rate not exceeding four per cent per annum. In the legislation under which such notes are authorized, the board shall make provision for levying and collecting annually by taxation amounts sufficient to pay the interest and the specified portion of the principal. Revenues derived from local taxes or otherwise, for the purpose of providing transportation of children or for defraying the current operating expenses of such district, may be applied to the payment of such interest and the retirement of such notes.

The purchase of school buses shall be made only after competitive bidding in accordance with divisions (A), (B), (C), (D), (E), (F), (H), and (I) of section 3313.46 of the Revised Code. Separate and independent bids shall be received with respect to the chassis and body type, and shall state that the buses, when assembled and prior to delivery, comply with the safety regulations of the department of education adopted by and with the advice and consent of the director of highway safety pursuant to section 4511.76 of the Revised Code and all other pertinent provisions of law. (131 v H 760. Effective 11-8-65)

20384

INSURANCE ON BUSES AND PUPILS

3327.09

The board of education of each school district may procure liability and property damage insurance covering each school bus or motor van and accident insurance covering all pupils transported under the authority of such board. This insurance shall be procured from a recognized insurance company authorized to do business of this character in the state, and such accident insurance shall provide compensation for injury or death to any pupil caused by an accident arising out of or in connection with the operation of such school bus, motor van, or other vehicle used in the transportation of school children, in such amounts and upon such terms as may be agreed upon by the board and the insurance company. The amount of liability insurance carried on account of any school bus or motor van shall not exceed five hundred thousand dollars. Such insurance coverage may be effected in one or more recognized insurance companies authorized to do business in this state. (130 v H 268. Effective 9-16-63)

QUALIFICATION OF DRIVER

3327.10

(A) No person shall be employed as driver of a school bus or motor van, owned and operated by any school district or privately owned and operated under contract with any school district in this state, who has not received a certificate from the county board of education of the county in which he is to be employed, in case such person is employed by a school district under the supervision of the county board, or by the superintendent of schools, in case such person is employed by the board of a city or exempted village school district, certifying that such person is at least twenty-one years of age and is of good moral character and is qualified physically and otherwise for such position. The county board or the superintendent, as the case may be, shall provide for an annual physical examination that conforms with regulations adopted by the state board of education of each driver to ascertain his physical fitness for such employment. Any certificate may be revoked by the authority granting the same on proof that the holder has been guilty of improper conduct, failing to file all traffic convictions with the county board or the superintendent, or neglect of duty and the said driver's contract shall be thereby terminated and rendered void.

(B) No person shall be employed as driver of a school bus or motor van not subject to the regulations of the department of education pursuant to division (A) of this section who has not received a certificate from the school administrator or contractor certifying that such person is at least twenty-one years of age, is of good moral character, and is qualified physically and otherwise for such position. Each driver shall have an annual physical examination which conforms to the state highway patrol regulations, ascertaining his physical fitness for such employment. Any certificate may be revoked by the authority granting the same on proof that the holder has been guilty of improper conduct, failing to file all traffic convictions with the school administrator or contractor, or neglect of duty and such driver's contract shall be thereby terminated and rendered void.

20885

(C) Any person who drives a school bus or motor van must give satisfactory and sufficient bond except a driver who is an employee of a school district and who drives a bus or motor van owned by the school district. (130 v H 161. Effective 10-14-63. 129 v 1003)

MAINTENANCE OF SCHOOL BUS TURN-AROUND POINTS

3327.12

The board of education of a city, exempted village, or local school district may maintain school bus turn-around points. At the request of such a board, a municipal corporation may maintain turn-around points on municipal roads; the township trustees may maintain turn-around points on township roads; and the county commissioners may maintain turn-around points on county roads.

The municipal corporation, township trustees, or county commissioners may also, at the request of a board of education, maintain turn-around points located on private property after an investigation by such board of education has determined that such maintenance is necessary for the use of such private property as a turn-around point for school buses. Such board of education may provide the cost of the materials utilized for any such maintenance. (131 v H 782. Effective 11-5-65)

Section 4503.17

(A) No school bus as defined in division (E) of section 4511.01 of the Revised Code is required to pay the annual license tax provided for in section 4503.02 of the Revised Code or to apply for or display registration plates, provided: the school bus complies with the requirements of sections 4511.76 to 4511.77, inclusive, of the Revised Code.

(B) The owner of a school bus, other than a board of education, which is used as a school bus during the school year under a contract with a board of education may, upon proper application for registration and the payment of a license fee of twenty-five dollars, use such bus during summer vacation periods to transport children and their authorized supervisors to and from any camping function sponsored by a nonprofit tax-exempt, charitable, or philanthropic organization. The application for registration of such bus shall be accompanied by:

(1) An affidavit, prescribed by the registrar of motor vehicles and signed by the owner of such bus, stating that such bus is to be used exclusively, during the summer months, to transport school children to and from any school function or to transport children and their authorized supervisors to and from any camping function sponsored by a nonprofit, tax-exempt, charitable, or philanthropic organization;

(2) A certificate from the state highway patrol stating that such bus is safe for operation in accordance with such standards as are prescribed by the state highway patrol.

20886

TRAFFIC LAWS--OPERATION OF MOTOR VEHICLES

Section 4511.01

Definitions

(E) "School bus" means every bus designed for carrying more than nine passengers which is owned by a public, private, or governmental agency or institution of learning and operated for the transportation of children to or from a school session or a school function, or owned by a private person and operated for compensation for the transportation of children to or from a school session or a school function; provided "school bus" does not include a bus operated by a municipally owned transportation system, a mass transit company operating exclusively within the territorial limits of a municipal corporation, nor a common passenger carrier certified by the public utilities commission unless such bus is devoted exclusively to the transportation of children to and from a school session or a school function.

LOCAL TRAFFIC REGULATIONS

Section 4511.07

Sections 4511.01 to 4511.78, inclusive, 4511.99 and 4513.01 to 4513.37, inclusive, of the Revised Code do not prevent local authorities from carrying out the following activities with respect to streets and highways under their jurisdiction and within the reasonable exercise of the police power:

(J) Regulating traffic in reference to school buses.

No ordinance or regulation enacted under divisions (D), (E), (F), (G), (I), or (J) of this section shall be effective until signs giving notice of such local traffic regulations are posted upon or at the entrance to the highway or part thereof affected, as may be most appropriate.

VEHICLES REQUIRED TO STOP AT GRADE CROSSINGS

Section 4511.63

The operator of any motor vehicle or trackless trolley, carrying passengers, for hire or of any school bus, or of any vehicle carrying explosives or flammable liquids as a cargo, or such part of a cargo as to constitute a hazard, before crossing at grade any track of a railroad, shall stop such vehicle or trackless trolley, and while so stopped he shall listen through an open door or open window and look in both directions along the track for any approaching train, and for signals indicating the approach of a train, and shall proceed only upon exercising due care after stopping, looking and listening as required by this section and upon proceeding, the operator of any such vehicle shall cross only in such gear of the vehicle that there will be no necessity for changing gears while traversing such crossing and the operator shall not shift gears while crossing the tracks.

20887

G. Egg and Breakfast Dishes

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare eggs:	Preparation and procedure:	Selection and care of eggs
The understanding and application of recipes, formulas, and procedures	Seasoning	Techniques and methods of classifying and grading:
	Care while cooking	Inspection
	Temperature	Storage:
	Timing	Fresh eggs
		Dehydrated eggs
		Frozen eggs
		Methods or varieties:
		Boiled
		Fried
		Poached
		Scrambled
		Omelettes
		Shirred
		Utensils and tools
		Use in:
		Salads
		Garnishes
		Use in other foods:
		Fresh eggs
		Dehydrated eggs
		Frozen eggs
		Handling cooked eggs
		Methods of serving:
		Importance of prompt service
		Cost factors
How to prepare breakfast dishes:	Preparation and procedure	Prepared mixes
The understanding and application of recipes, formulas, and procedures		Types of flours
		Baking powders
Batters	Pancakes or griddle cakes	Varieties:
		Plain
		Fruited
		Buckwheat
	Waffles	Varieties:
		Plain
		Fruited
		Flavored
	Care during cooking:	Equipment, utensils, and tools
	Temperature	
	Time	Methods of serving
	Care after cooking	
		Cost factors
Toasts	Preparation and procedure:	Varieties:
	Seasoning	Cinnamon
	Flavoring	Melba
	Temperature	French
	Time	
		Selection of bread
		Equipment
		Methods of serving
	Storage and care of breads	
		Calculation of costs

2064

This section does not apply at street railway grade crossings within a municipal corporation, or to abandoned tracks, spur tracks, side tracks, and industrial tracks when the public utilities commission has authorized and approved the crossing of such tracks without making the stop required by this section.

SCHOOL BUSES

Regulations Concerning School Buses

Section 4511.75

(A) The driver of a vehicle upon a highway outside the limits of a municipal corporation, upon meeting or overtaking from either direction any school bus which has stopped on the highway for the purpose of receiving or discharging any school child, shall stop the vehicle not less than ten feet from such school bus and shall not proceed until such school bus resumes motion, or until signaled by the driver to proceed.

(B) Where a highway has been divided into two roadways as set forth in section 4511.35 of the Revised Code a driver of a vehicle proceeding on one roadway of said highway need not stop when approaching a school bus which has stopped on the other roadway of said highway for the purpose of receiving or discharging any school child. The driver of any vehicle proceeding on the same roadway of said highway as the school bus shall comply with division (A) of this section.

(C) School buses operating on divided highways or on highways with four or more traffic lanes shall receive and discharge all school children on their residence side of the highway.

(D) No school bus driver shall start his bus until after any child who may have alighted therefrom has reached a place of safety on his residence side of the road.

REGULATIONS FOR OPERATION OF SCHOOL BUSES

Section 4511.76

(A) The department of education by and with the advice and consent of the director of highway safety shall adopt and enforce regulations relating to the construction, design, equipment, and operation of all school buses owned and operated by any school district or privately owned and operated under contract with any school district in this state. When such buses are privately owned and operated under contract with any school district in this state, these regulations shall, by reference, be made a part of any such contract with a school district. Every school district, its officers and employees, and every person employed under contract by a school district shall be subject to such regulations.

20888

Any officer or employee of any school district who violates any such regulation, or who fails to comply with regulations in any contract executed by him on behalf of a school district, is guilty of misconduct and subject to removal from office or employment. Any person operating a school bus under contract with a school district who fails to comply with any such regulation is guilty of a breach of contract, and such contract shall be canceled by the responsible officers of such school district.

No person shall operate such a school bus within this state in violation of the regulations of the department of education. No person, being the owner thereof or having the supervisory responsibility therefor, shall permit the operation of such a school bus within this state in violation of the regulations of the department of education.

(B) The department of highway safety shall adopt and enforce such regulations as relate to the safety of the construction, design, equipment, and operation of all school buses not subject to the regulations of the department of education pursuant to division (A) of this section. Such regulations shall be adopted pursuant to the provisions of Chapter 119. of the Revised Code.

No person shall operate such a school bus within this state in violation of the regulations of the department of highway safety. No person, being the owner thereof or having the supervisory responsibility therefor, shall permit the operation of such a school bus within this state in violation of the regulations of the department of highway safety.

(C) The department of highway safety shall adopt and enforce such regulations as relate to the issuance of a license under section 4511.763 of the Revised Code. Such regulations may relate to the moral character of the applicant; the condition of the equipment to be operated; the liability and property damage insurance carried by the applicant; the posting of satisfactory and sufficient bond; and such other rules and regulations as the director of highway safety shall deem reasonably necessary for the safety of the pupils to be transported.

SCHOOL BUS INSPECTION

Section 4511.761

The state highway patrol shall inspect every school bus to ascertain whether its construction, design, and equipment comply with the regulations adopted pursuant to section 4511.76 of the Revised Code and all other provisions of law.

The superintendent of the state highway patrol shall adopt a distinctive inspection decal not less than twelve inches in size, and bearing the date of the inspection, which shall be affixed to the outside surface of each side of each school bus which upon such inspection is found to comply with the regulations adopted pursuant to section 4511.76 of the Revised Code. The appearance of said decal shall be changed from year to year as to shape and color in order to provide easy visual inspection.

20889

No person shall operate, nor shall any person being the owner thereof or having supervisory responsibility therefor permit the operation of, a school bus within this state unless there is displayed thereon the decals issued by the state highway patrol bearing a date of inspection prior to the fifteenth day of October in the calendar year in which the decals were issued, except for a bus licensed by the department of highway safety pursuant to section 4511.763 of the Revised Code which shall display decals bearing a date of inspection between the sixteenth day of July and the first day of September of the calendar year in which the inspection was made, but if a bus is purchased after the first day of September, it shall display decals bearing a date of inspection later than the date the bus is purchased and prior to the date of its use for the transportation of pupils.

LICENSING

Section 4511.763

No person, partnership, association, or corporation shall engage in the transportation of pupils to or from school, for profit, or enter into a contract with a board of education of any school district, without being licensed by the department of highway safety.

REGISTRATION OF SCHOOL BUSES

Section 4511.764

The superintendent of the state highway patrol shall require school buses, as defined in division (E) of section 4511.01 of the Revised Code, to be registered, in the name of the owner, with the state highway patrol on forms and in accordance with regulations as the superintendent may adopt.

When the superintendent is satisfied that the registration has been completed, he shall assign an identifying number to each school bus registered in accordance with this section. The number so assigned shall be marked on the front and rear of the vehicle in black lettering not less than six inches in height and will remain unchanged as long as the ownership of that vehicle remains the same.

No person shall operate, nor shall any person, being the owner thereof or having supervisory responsibility therefor, permit the operation of a school bus within this state unless there is displayed thereon an identifying number in accordance with this section.

20890

Section 4513.17 (C and D)

Flashing lights are prohibited on motor vehicles, except as a means for indicating a right or a left turn, or in the presence of a vehicular traffic hazard requiring unusual care in approaching, or overtaking or passing. This prohibition does not apply to the use of flashing, oscillating, or rotating amber light on emergency vehicles, *** road service vehicles servicing or towing a disabled vehicle, traffic line stripers, snow plows, rural mail delivery vehicles, state highway survey vehicles, funeral escort vehicles, and similar equipment operated by the department or local authorities, nor to vehicles or machinery permitted by section 4513.11 of the Revised Code to have a flashing red light.

Except a person operating a public safety vehicle, as defined in division (E) of section 4511.01 of the Revised Code, or a school bus, no person shall operate or move upon any public street or highway any vehicle or equipment which has a flashing red or a flashing combination red and white light, or any vehicle or equipment which has an oscillating or rotating red light or a combination red and white oscillating or rotating light. This section shall not prohibit the use of warning lights required by law or the simultaneous flashing of turn signals on disabled vehicles.

DISPLAY OF WARNING DEVICES ON DISABLED VEHICLES

Section 4513.28

(A) Whenever any motor truck, trackless trolley, bus, commercial tractor, trailer, semi-trailer, or pole trailer is disabled upon the traveled portion of any highway or the shoulder thereof outside of any municipality, or upon any freeway, expressway, thruway, and connecting, entering or existing ramps within a municipality, at any time when lighted lamps are required on vehicles and trackless trolleys, the operator of such vehicle or trackless trolley shall display the following warning devices upon the highway during the time the vehicle or trackless trolley is so disabled on the highway except as provided in division (B) of this section:

(1) A lighted fusee shall be immediately placed on the roadway at the traffic side of such vehicle or trackless trolley, unless red electric lanterns or red reflectors are displayed.

(2) Within the burning period of the fusee and as promptly as possible, three lighted flares or pot torches, or three red reflectors or three red electric lanterns shall be placed on the roadway as follows:

(a) One at a distance of forty paces or approximately one hundred feet in advance of the vehicle;
(b) One at a distance of forty paces or approximately one hundred feet to the rear of the vehicle or trackless trolley except as provided in this section, each in the center of the lane of traffic occupied by the disabled vehicle or trackless trolley;
(c) One at the traffic side of the vehicle or trackless trolley.

20891

(B) Whenever any vehicle used in transporting flammable liquids in bulk, or in transporting compressed flammable gases, is disabled upon a highway at any time or place mentioned in division (A) of this section, the driver of such vehicle shall display upon the roadway the following warning devices:

(1) One red electric lantern or one red reflector shall be immediately placed on the roadway at the traffic side of the vehicle;

(2) Two other red electric lanterns or two other red reflectors shall be placed to the front and rear of the vehicle in the same manner prescribed for flares in division (A) of this section.

(C) When a vehicle of a type specified in division (B) of this section is disabled, the use of flares, fusees, or any signal produced by flames as warning signals is prohibited.

(D) Whenever any vehicle or trackless trolley of a type referred to in this section is disabled upon the traveled portion of a highway or the shoulder thereof, outside of any municipality, or upon any freeway, expressway, thruway and connecting, entering or exiting ramps within a municipality, at any time when the display of fusees, flares, red reflectors, or electric lanterns is not required, the operator of such vehicle or trackless trolley shall display two red flags upon the roadway in the lane of traffic occupied by the disabled vehicle or trackless trolley, one at a distance of forty paces or approximately one hundred feet in advance of the vehicle or trackless trolley, and one at a distance of forty paces or approximately one hundred feet, to the rear of the vehicle or trackless trolley, except as provided in this section.

(E) The flares, fusees, lanterns, red reflectors, and flags to be displayed as required in this section shall conform with the requirements of section 4513.27 of the Revised Code applicable thereto.

(F) In the event the vehicle or trackless trolley is disabled near a curve, crest of a hill, or other obstruction of view, the flare, flag, reflector, or lantern in that direction shall be placed as to afford ample warning ot other users of the highway, but in no case shall it be placed less than forty paces or approximately one hundred feet nor more than one hundred twenty paces or approximately three hundred feet from the disabled vehicle or trackless trolley. (130 H. 603)

20892

UNIT III

DIGEST OF

MOTOR VEHICLE TRAFFIC LAWS

OF OHIO

38/39 20893

STATE OF OHIO
JAMES A. RHODES
Governor

DEPARTMENT OF HIGHWAY SAFETY
WARREN C. NELSON
Director

BUREAU OF MOTOR VEHICLES
FRED RICE, Registrar

STATE HIGHWAY PATROL
R. M. CHIARAMONTE, Supt.

Digest of MOTOR VEHICLE LAWS OF OHIO

(REVISED SEPTEMBER 1969)

IMPORTANT: Your driver's license expires on your birthday, in the year indicated on the license!

40/41 20394

Dear Ohioan:

Good highways are necessary to transport Ohio-made products to the market to provide more and better jobs for Ohioans. Ohio is the transportation center of the nation. Our highways are the finest. As you drive on our fine highways you share with more than six million drivers the responsibility of being a safe and courteous driver.

By knowing and understanding the enclosed regulations and by being a cautious and careful driver you can help make Ohio highways the safest in the nation. Wear your safety belt at all times.

My very best wishes for a safe, accident-free driving record.

Sincerely,

James A. Rhodes

JAMES A. RHODES
Governor of Ohio

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PRE-EXAMINATION

For the purpose of obtaining an Ohio Temporary Instruction Permit all persons are required to contact a driver license examination station and undergo a pre-examination. This examination consists of a vision test, a test of the applicant's knowledge of motor vehicle laws, and a sign test. Every applicant will be required to present evidence of correct date of birth either by a birth certificate or other legal documentary evidence. If under 18, applicant must first submit satisfactory evidence, by presentation of an official certificate, of having successfully completed a driver education course approved by the State Department of Education—or a driver training course approved by the Director of Highway Safety.

APPOINTMENTS FOR DRIVER EXAMINATIONS

All driver license examinations are conducted by the State Highway Patrol and consist of the following: (1) A test of your knowledge of the laws and rules for safe driving. (2) A test of your vision. (3) A test of your knowledge and understanding of road signs and traffic signals. (4) A test of your driving and parallel parking ability—and observance of regulating signals, signs and road markings.

Driver examinations are given by appointment only, in order to reduce the amount of time the prospective examinee must spend at the examining station. When an appointment to undergo a driver examination has been made, the prospective examinee must be punctual; and if it is found that due to unforeseen circumstances he is unable to appear at the appointed time, he shall notify the examination station or the Highway Patrol where the appointment was made. Please cancel appointments far enough in advance so that another examination time may be assigned.

A careful study of the following information will help you pass the examination and will improve your knowledge of the laws, road rules, signs and signals. No road examination will be permitted in an unsafe vehicle.

NOTE: Before and during the actual driving test follow the examiner's instructions. At no time will you be instructed to operate your motor vehicle in violation of any law or safe driving regulation.

EXEMPTIONS FROM EXAMINATIONS

TAXI CAB DRIVER who has a currently effective operator's license is exempt from a chauffeur's examination.

MILITARY OR NAVAL SERVICE PERSONNEL ON ACTIVE DUTY, and in possession of a driver's permit, when operating an official motor vehicle, in connection with such duty, is exempt from license requirements of this state. Also—when on furlough during period of active duty, and for 6 months after such duty—provided he had an active license prior to active duty.

Registrar may waive operator's or chauffeur's examination of any honorably discharged military or naval personnel, and without any mental or physical disability that would affect such driving—providing (a) he had an active license in this state at the time he commenced such service and (b) such application is made not more than 6 months following discharge.

MINIMUM AGE

The minimum age for a Temporary Permit or Operator License is 16 years. The application for a Temporary Permit or Operator's License of a person under 18 years of age must be signed by either parent, guardian or other person having custody—or when neither exists, by a responsible person who is at least 21 years of age.

Any negligence or willful or wanton misconduct of a minor under 18, when driving a motor vehicle upon a highway, shall be imputed to the person who has signed the application of such minor. Such person(s) shall be jointly and severally

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liable with such minor for any damages caused by such negligence or willful or wanton misconduct.

TEMPORARY INSTRUCTION PERMIT

An applicant must undergo and pass a pre-examination before he is permitted to obtain a temporary instruction permit. For details contact the nearest State Driver License Examining Station. Such temporary instruction permit, when granted and in the applicant's immediate possession entitles him to drive a motor vehicle upon any street or highway—and only when accompanied by a licensed operator or chauffeur, who is actually occupying a seat beside the driver. The permit is valid for a six-month period from date of issuance.

OUT-OF-STATE LICENSES

Any person having in his possession a valid out-of-state license recognized by the State of Ohio, is exempt from obtaining a Temporary Instruction Permit, but shall submit to the regular examination in obtaining an operator's or chauffeur's license in this state.

No person shall receive an operator's or chauffeur's license, or a motorcycle operator's endorsement of an operator's or chauffeur's license, unless and until he surrenders to the Registrar all valid licenses in his possession issued to him by another jurisdiction recognized by this state. All surrendered licenses shall be returned by the Registrar to the issuing authority, together with information that a license is now issued in this state. No person shall be permitted to have in his possession more than one valid license at any time. The Registrar may promulgate and enforce rules governing the use of such instruction permit.

PROBATIONARY LICENSE

A Probationary License shall be issued to persons between the ages of 16 and 21 years. The Registrar of Motor Vehicles shall revoke the Probationary License issued to any person—when such person (before reaching his 18th birthday) has been convicted, pleaded guilty, or adjudged in juvenile court, of having committed a total of three separate motor vehicle violations.

RESTRICTED LICENSE

The Registrar of Motor Vehicles—upon issuing an operator's or chauffeur's license, a motorcycle operator's endorsement, an operator's or chauffeur's license renewal, or the renewal of any other license issued under Chapter 4507. of the Revised Code—may, whenever good cause appears, impose restrictions suitable to the licensee's driving ability with respect to the type of or special mechanical control devices required on a motor vehicle, which the licensee may operate; or such other restrictions applicable to the licensee as the Registrar determines to be necessary.

Physical Disabilities

Persons who have physical disabilities; or those who must have attachments either to their person or on their motor vehicles—must have a Restricted Temporary Instruction Permit. Such permits are issued only after a pre-examination has been conducted, the disability determined, and attachments necessary for safe operation required. This may include persons who are of short stature and who need special equipment for driving.

CHAUFFEUR'S LICENSE

1. The Minimum age for a chauffeur's license is 18 years.
2. A chauffeur's license issued after an examination has been passed is valid for a period of three years from the last birthday, before such chauffeur license is issued.

20397

G. Egg and Breakfast Dishes—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare breakfast dishes—Con.		
Meat items (cured meat)	Preparation and procedure: Cooking temperature Time Draining	Varieties: Ham Sausage Bacon Equipment, utensils, tools Methods of serving Calculation of costs
Cooked cereals	General preparation and procedure: Seasoning Care while cooking Cooking temperature Time Care after cooking	Types of cereals: Cream of wheat Farina Oatmeal Variations Utensils Methods of serving Use of leftovers

Suggested teaching materials: See items 8, 10, 21, 30, 31, 48, 73, 104 in appendix B.

H. Soups

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare soup stock: The understanding and application of recipes, formulas, and procedures	Preparation: White stock Brown stock Procedure: Seasoning Care during cooking Temperature Time Care after cooking	Utensils Handling Holding Uses of stock
How to prepare the more popular soups: The understanding and application of recipes, formulas, and procedures	General preparation and procedure: Seasoning Temperature Time	Preparation of varieties: Gumbos Chowder Vegetable
Garnish soups	Care of finished product	Stock Storage Methods of serving Garnishes: Types When used

2065

3. Chauffeur's licenses being renewed are valid for a period of three years from date of expiring chauffeur's license.
4. A 2-1/2" x 2-1/2" photograph is required. The picture must have been taken within thirty days of the time of the application for a chauffeur's license.
5. A valid operator's license may be converted to a chauffeur's license. The operator must take a complete driver examination including a special chauffeur's test.

MOTORCYCLES AND MOTORCYCLISTS

1. Motorcycle operators must have a special license. If the cyclist has no automobile driver's license, he must obtain a restricted motorcycle license costing $4.00 for four years. If he has an auto driver's license, his motorcycle permit may be added as an endorsement to it, also at a cost of $4.00 for four years.
2. The new law prohibits handlebars or grips more than 15 inches higher than the saddle; requires that both operators and passengers wear helmets and eye protectors approved by the director of highway safety; and demands that all motorcycles be equipped with rear-view mirrors and effective mufflers containing baffle plates.
3. Devices for producing excessive smoke or gas, and any equipment which permits oil or any other chemical to flow upon the exhaust pipe or muffler, are prohibited, as are muffler cutouts or by-passes which allow excessive noise.
4. Applicants for motorcycle operator licenses must give an actual demonstration of their ability to exercise ordinary and reasonable control in the operation of the cycle by driving it under the supervision of an examining officer. They must also pass tests on physical condition, understanding of traffic control devices, and knowledge of motor vehicle laws.
5. Motorcycles and bicycles are subject to the same rules and regulations as motor vehicles, in so far as practicable.
6. Every person riding a motorcycle or bicycle upon a roadway shall be governed by the same regulations—as if he were driving any vehicle. Every operator of a motor bike, motor scooter, motorcycle, or similar vehicle must be properly licensed under the Ohio Driver's License Law.
7. No motorcycle or bicycle shall be used to carry more persons at one time than the number for which it is designed and equipped.

YOUR LICENSE: A TRUST AND A FAITH

No person shall:

1. Display, or cause or permit to be displayed, or possess any operator's or chauffeur's license or temporary permit, knowing the same to be fictitious, or to have been canceled, revoked, suspended, or altered.
2. Lend to a person not entitled thereto, or knowlingly permit him to use any operator's or chauffeur's license or temporary permit, not issued to the person so displaying the same.
3. Display, or represent as one's own, any operator's or chauffeur's license or temporary permit, not issued to the person so displaying the same.
4. Fail to surrender to the Registrar of Motor Vehicles, upon his demand, any operator's or chauffeur's license or temporary permit, which has been suspended, canceled, or revoked.
5. Use a false or fictitious name, or give a false or fictitious address, in any application for an operator's or chauffeur's license or temporary permit.

It is unlawful to permit your car to be operated by:

1. A person who does not have a driver's license.
2. By the holder of a Temporary Instruction Permit when not accompanied by a licensed driver on the seat beside him.

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DRIVER LICENSE SUSPENSIONS

The trial judge of any court of record . . . . in addition to suspensions or revocations of licenses for periods of time not exceeding three years, and in addition to, or independent of, all other penalties provided by law or by ordinance . . . . shall impose a suspended jail sentence not to exceed six months, providing that imprisonment was not imposed for the offense for which the person was convicted.

No court shall suspend the first thirty days of suspension of license provided for under this section.

The violations for which a driver's license may be revoked or suspended are:

(A) Homicide by vehicle;

(B) Operating a motor vehicle while under the influence of intoxicating liquor or narcotic drug;

(C) Perjury or the making of a false affidavit, under Sections 4507.01 to 4507.39, inclusive, of the Revised Code, or any other law of this state, requiring the registration of motor vehicles, or regulating their operation on the highway.

(D) Any crime punishable as a felony under the motor vehicle laws of this state or any other felony in the commission of which a motor vehicle is used;

(E) Failing to stop and disclose identity at the scene of the accident when required by law to do so;

(F) Drag racing as defined in division (A) of Section 4511.25 of the Revised Code;

(G) Willfully eluding or fleeing a police officer.

Ohio's Point System Law

Within ten days after conviction or bond forfeiture of a person in a mayor's court or a court of record for any violation under the revised uniform traffic code, Section 4511.01 to 4511.78, inclusive, 4511.99 and 4513.01 to 4513.36, inclusive, or of any law or ordinance regulating the operation of vehicles, street cars, and trackless trolleys on highways, said court shall prepare and forward to the Bureau of Motor Vehicles abstracts of court records covering such conviction or bond forfeiture.

The Registrar, within ten days after receipt of such abstract, shall record the date of conviction or bond forfeiture and the number of points for each conviction or bond forfeiture based on the following formula:

(1) Violation of section 4507.38 or 4507.39 of the Revised Code or any ordinance prohibiting the operation of a motor vehicle while the operator's license is under suspension or revocation ..... **6 points**

(2) Violation of section 4549.04 of the Revised Code or any ordinance prohibiting the operation of a motor vehicle without consent of the owner .. **6 points**

(3) Homicide by vehicle ..... **6 points**

(4) Violation of section 4511.19 of the Revised Code or any ordinance prohibiting the operation of a motor vehicle while under the influence of alcohol or drugs ..... **6 points**

(5) Violation of section 4549.02 of the Revised Code or any ordinance requiring the driver of a vehicle to stop and disclose identity at the scene of an accident ..... **6 points**

(6) Violation of section 4511.02 of the Revised Code or any ordinance prohibiting the willful fleeing or eluding of a police officer ..... **6 points**

(6)

20899

(7) Any crime punishable as a felony under the motor vehicle laws of this state, or any other felony in the commission of which a motor vehicle was used ..... 6 points

(8) Operating a motor vehicle in violation of a restriction imposed by the registrar ..... 2 points

(9) Violation of section 4511.251 of the Revised Code or any ordinance prohibiting drag racing ..... 6 points

(10) Violation of section 4511.20 of the Revised Code or any ordinance prohibiting the reckless operation of a motor vehicle ..... 4 points

(11) Violation of any law or ordinance pertaining to speed ..... 2 points

(12) All other moving violations pertaining to the operation of motor vehicles reported under this section except any violations under section 5577.01 to 5577.99, inclusive, of the Revised Code ..... 2 points

Whenever the points charged against any person exceed five, the Registrar shall forward to such person a warning letter, listing the reported violations.

When any person has more than seven points charged against him, he shall be required to submit to a driver license examination or a physical examination, or both.

When the number of points against any person reaches 12 within a two-year period, the Registrar shall, advise the subject that his license will be suspended for a period of time, depending upon the number of prior suspensions under this statute—effective on the 20th day after the mailing of the suspension notice.

Exceptions:

Unless the licensee files a petition in the municipal court or county court—or in case the person is under the age of eighteen years, to the juvenile court—in the county where such person resides, agreeing to pay the costs of the proceedings and alleging that the licensee can show cause why his license should not be suspended. The court shall decide such issue as to whether the person is a habitual traffic law violator. If the court finds from the evidence submitted that he is a habitual traffic law violator, then the court may:

1. Uphold the suspension made by the Registrar.
2. Withhold the suspension, or a part thereof, and provide such conditions or probations as the court deems proper.

Any person whose license or permit or privilege to operate a motor vehicle has been suspended under this section, and who, during such suspension drives any motor vehicle, shall be fined not more than $500, or imprisoned not less than three days nor more than six months—and no court shall suspend the first three days of any sentence provided under this section.

SPEED RESTRICTIONS

Speed Limits

Automobiles may not be operated upon streets or highways at a speed either greater or less than is reasonable and proper, having due regard for the traffic, surface and width of the street or highway and of any other conditions then existing. A driver must keep his vehicle under such control as to be able to bring it to a stop within the assured clear distance ahead.

It shall be unlawful to drive at a speed exceeding:

(1) 15 miles per hour in all alleys within a municipal corporation.

47 20900

(2) **20 miles per hour** when passing a school building or the grounds thereof during school recess and while children are going to or leaving school during the opening or closing hours. Also when appropriate signs giving notice of the existence of the school are erected—except, that on controlled-access highways and expressways, if the right-of-way line fence has been erected without pedestrian opening, the speed shall be governed by provision in paragraph (5) below. On freeways, if the right-of-way line fence has been erected without pedestrian opening, the speed shall be governed by provisions in paragraphs (8) and (9) below.

(3) **25 miles per hour** in all other portions of a municipal corporation, except on state routes, through highways outside business districts, and alleys.

(4) **35 miles per hour** on all state routes or through highways (which are not controlled-access highways) within municipal corporations outside business districts, except as provided in paragraphs (5) and (6) below.

(5) **50 miles per hour** on controlled-access highways and expressways within municipal corporations.

(6) **50 miles per hour** also on state routes within municipal corporations outside urban districts, unless a lower prima-facie speed is established.

(7) **60 miles per hour** during the daytime and **50 miles per hour during the nighttime** on highways outside of municipal corporations—**except** 50 miles per hour at all times . . . for operators of trucks and commercial tractors, which weigh in excess of 4000 pounds empty weight; also for school buses, street cars and trackless trolleys.

(8) **60 miles per hour at all times on freeways with paved shoulders inside municipal corporations**—**except** 50 miles per hour at all times for operators of trucks and commercial tractors weighing in excess of 4000 pounds empty weight, as well as school buses.

(9) **70 miles per hour at all times on freeways outside municipal corporations**—**except** 55 miles per hour for operators of trucks and commercial tractors weighing in excess of 4000 pounds, as well as school buses.

The State Director of Highways may set up or permit local authorities to set up speed zones of greater or lesser speed than these prima-facie speed limitations upon the basis of engineering and traffic investigations. Such studies must show that the prima-facie speed is greater or lesser than is reasonable or safe under the conditions found to exist at the locations to be designated as special speed zones. The greater or lesser speed, whichever is determined, shall be effective only when appropriate signs giving notice thereof are erected at these special speed zones.

Racing on Public Roads

No person shall participate in a drag race on a public road. A drag race is one which consists of operation of two or more vehicles from a point, side by side and at accelerating speeds in a competitive attempt to out-distance each other. Or the operation of one or more vehicles over a common selected course, from the same point to the same point, when timing is made of the participating vehicles involving competitive accelerations of speeds. Persons rendering assistance in any manner to such competitive use of vehicles shall be equally charged as the participants.

Speed Limits on Bridges

No person shall drive a motor vehicle over any bridge or other elevated structure, constituting a part of a highway, at a speed which is greater than the maximum speed that can be maintained with safety to such bridge or structure, when such structure is sign-posted.

Minimum Speed Limits

No person shall operate a vehicle at such a slow speed as to impede or block the normal and reasonable movement of traffic, except when reduced speed is necessary for safe operation or to comply with law.

Whenever the Director of Highways or local authorities determine, on the basis of an engineering and traffic investigation, that slow speeds on any part of a controlled-access highway consistently impede the normal and reasonable movement of traffic—the Director of Highways or such local authority may declare a minimum speed limit, below which no person shall operate a motor vehicle, except when necessary for safe operation or in compliance with law. (**No minimum speed limit established hereunder shall be less than 30 miles per hour**; nor effective until provisions relating to appropriate signs have been fulfilled and local authorities have obtained the approval of the Director of Highways.)

Speed Clocked By Radar—Arrest Without Warrant

A driver, who has been detected speeding by radar, or by any electrical timing device, may be arrested until a warrant can be obtained for such arrest. (Posted radar or other similar warning signs no longer required.)

SAFE DRIVING PRACTICES

When being overtaken and passed by another motor vehicle approaching from the rear you shall not increase your speed until completely passed by the overtaking vehicle.

When overtaking and passing another vehicle on a two lane highway, make certain of assured clear distance ahead, give audible signal to the vehicle to be overtaken, pass to left at safe distance, and be sure not to 'cut-in' too closely ahead of the overtaken vehicle.

The purpose of highways and streets being marked in lanes for traffic proceeding in the same direction is:

1. When the roadway is sufficiently wide to permit more than one line of traffic, lanes are marked to clearly divide the lines of traffic to more safely facilitate the flow. Slow traffic should travel in the extreme right lane.
2. To provide marked lanes for passing and other safety measures as required.

Whenever any roadway has been divided into three or more clearly-marked lanes, or wherever, within a municipal corporation traffic is lawfully moving in two or more substantially continuous lines in the same direction—a vehicle shall be driven, as nearly as practicable, entirely within a single lane or line of traffic—and shall not move therefrom until the driver has first made certain that such movement can be made with safety.

When entering a through highway you must yield the right-of-way to all vehicles on said through highway.

When making a left turn you must yield right-of-way to all vehicles approaching from the opposite direction.

When parked at a curb, the most important thing is to make certain the portion of the highway you are about to enter is free from oncoming traffic for a distance sufficient to allow you to safely enter that part of the roadway.

The meaning of the yellow line on the highway is: When the yellow line is in your lane do not pass. When there are double yellow lines, passing in either direction is prohibited.

ENTERING OR LEAVING A VEHICLE

Get into a vehicle from the curb side, when it is parked parallel at the curb of any street or highway, where there is even a small amount of traffic. Getting either into or out of a vehicle on the roadway side may cause sudden stops or collisions in the passing traffic.

20302

LIGHTS AND REQUIREMENTS

The minimum number of lights required on a motor vehicle operated at night are — Two head lights, one red tail light and white light so arranged as to illuminate the rear license plate.

1. The law requires you to dim your lights upon the approach of an oncoming vehicle.
2. Only one spot light is permitted on a vehicle and the beam must be directed to the right on the left side of the vehicle and not to exceed one hundred feet ahead.
3. Every vehicle must display headlights and tail light from one-half hour after sunset to one-half hour before sunrise, and at any other time when there is not sufficient natural light to render discernible persons, vehicles, and substantial objects on the highway.

When following a vehicle at night you should lower the beam of your light so as not to blind the driver ahead.

A driver's reaction to red flags, flares and fusees on a highway should be: Danger ahead — slow down and stop.

HIGH BEAM

TO BE USED IN OPEN COUNTRY EXCEPT WHEN APPROACHING ONCOMING CAR.

LOW BEAM

TO BE USED ON LIGHTED STREETS, WHEN FOLLOWING OTHER CAR, DRIVING IN FOG AND APPROACHING ONCOMING CAR.

PARALLEL PARKING TEST

This test is very important as it tests the applicant's judgment and ability to handle a motor vehicle. It is a known fact that a driver who can park will eliminate traffic congestion and accidents.

The following procedure should be used in parallel parking:

1. Stop even with and about a foot away from the car in front of the space where you are going to park.
2. Make sure that you will not interfere with oncoming traffic.
3. Turn steering wheel sharply right and back slowly towards the curb.
4. When your front wheels are opposite the rear bumper of the car ahead, quickly turn steering wheel to extreme left and back slowly to car behind.
5. Straighten out front wheels and pull into final parking position a few inches from curb allowing adequate clearance at both ends of car.
6. The test is presumed to be successfully completed when the driver has properly removed his car from within the parking zone.

20903

FIRST, and of greatest importance, remember that traffic may be approaching from the rear.

Step 1. Always look back and make sure that the road is clear, before even attempting to park.

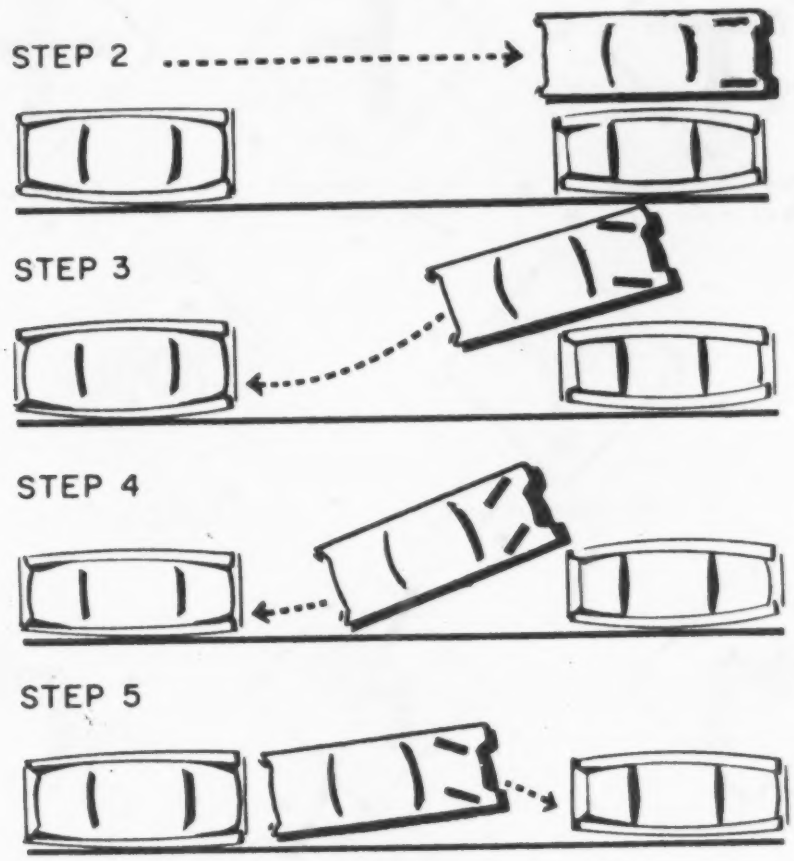

PARKING

It is illegal to park upon the paved or main traveled part of a highway outside of a business or residence district.

Six places where it is illegal to park a motor vehicle.

1. In front of a public or private driveway.
2. Within ten feet of a fire hydrant.
3. Within twenty feet of a cross-walk at any intersection.
4. Within thirty feet upon the approach to any stop sign.
5. Alongside any vehicle stopping or parked at the edge or curb of a street.
6. Within one foot of another parked vehicle.

The law requires a rear vision mirror. If operator is deaf, two rear vision mirrors are required—one inside and one outside.

20904

Heed Signs, Signals, and Pavement Markings .

TYPICAL WARNING SIGNS

Road ends—turn left or right

Road intersects from right

Crossroad

"Y" Intersection

School Zone

Sharp left turn

Sharp right turn, then sharp left turn

Sharp right turn

Curve right, then left

Curve left, then right

WARNING SIGNS—FOLLOW INSTRUCTIONS

20905

. . and You Save Lives . . . Perhaps Your Own

TYPICAL SPEED ZONE SIGNS

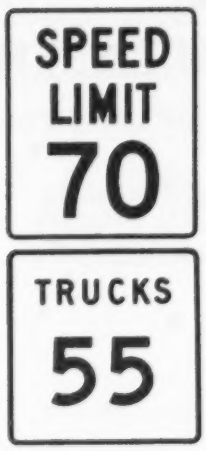

Freeway Speed Limit

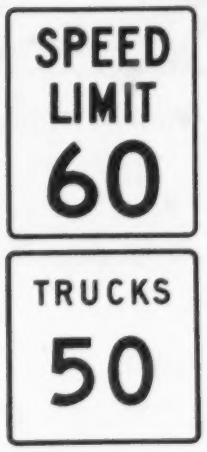

Daytime Speed Limit

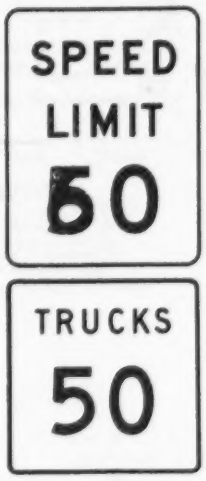

Nighttime Speed Limit

Posted Speed Limit

This means "STOP"

Slow Moving Vehicle

Other traffic has right of way

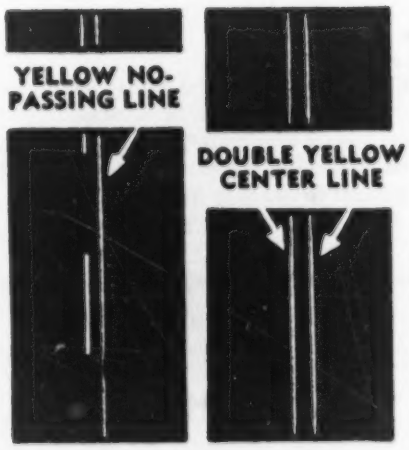

No Passing Zones

Railroad Warning Sign

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When making right and left turns, make certain that your directional signals are operating effectively. If necessary, use hand signals as indicated. And don't forget to yield the right-of-way to traffic approaching from the opposite direction.

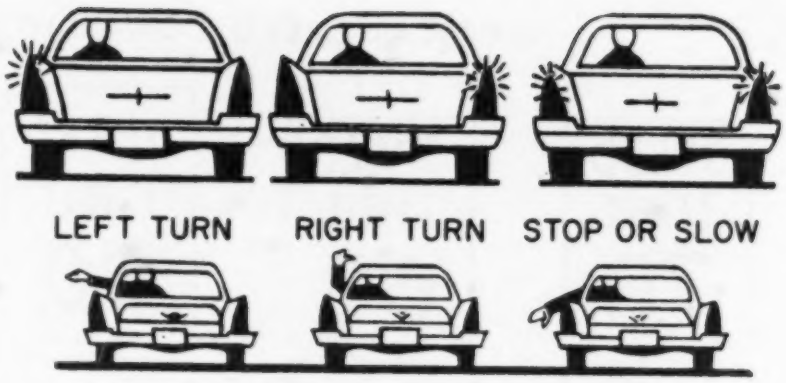

HAND SIGNALS

Give all signals well in advance. The following hand and arm signals control the operations of a motor vehicle.

1. Left turn — left hand and arm straight out.
2. Slowing or stopping — left hand and arm down.
3. Right turn — left hand and forearm straight up.

It is not necessary to use the hand signals if mechanical directional signals are used.

PROCEDURE FOR MAKING RIGHT & LEFT TURNS

The correct procedure in making:

1. Right turn — Give appropriate signal and stay as near to the right side of the road or curb as possible.
2. Left turn — Give appropriate signal and approach as near to the center line on your left side of the roadway as possible and leave the intersection to the right of the center of the roadway being entered.

The correct procedure for making a left turn from a roadway restricted to one-way traffic is — Give appropriate signal and approach the intersection in the extreme left hand lane entering as nearly as practicable into the left hand lane of the roadway being entered available for traffic in that direction.

RAILROAD CROSSINGS

It is unlawful to drive across a grade crossing:

1. When a crossing gate is lowered.
2. When an electrical or mechanical signal device or a human flagman gives warning of the immediate approach of a train.
3. Flashing yellow lights are sometimes used at railroad crossings, and drivers are urged to use extreme caution when observing these signals.

When a stop sign has been erected at a grade crossing all vehicles shall stop and not proceed until the driver has made certain that no train is approaching.

Note: Use caution though signals have stopped flashing — in the event another train may be approaching.

H. Soups—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare the more popular soups—Continued		
Purees (thick soups)	Preparation and procedure: Soaking Seasoning Care in cooking Temperature Time	Varieties: Green pea Yellow pea Lentil Kidney bean Equipment Stock Garnishes
	Care after cooking	Storage
Cream soups	Preparation and procedure: Seasoning Thickening agent Temperature Time	Varieties: Chicken Potato Corn Tomato Mushroom Utensils Variations in procedure Form of milk or cream used: Dry or dehydrated Canned Stock
	Care in cooking	Curdling: Cause Effect How to prevent Methods of serving
	Care after cooking	Storage

Suggested teaching materials: See items 8, 15, 20, 30, 108 in appendix B.

2066

SCHOOL BUS

When meeting or overtaking from either direction, a school bus which has stopped for the purpose of discharging or receiving any school child, you must stop your vehicle at least 10 feet from the school bus and not proceed until such school bus resumes motion, or until signalled by the driver to proceed.

When traveling on any highway, which has been divided into two roadways by a physical barrier or clearly indicated dividing section—so constructed to impede vehicular traffic—it shall be necessary to stop, as indicated above, but only when traveling the same direction as the school bus.

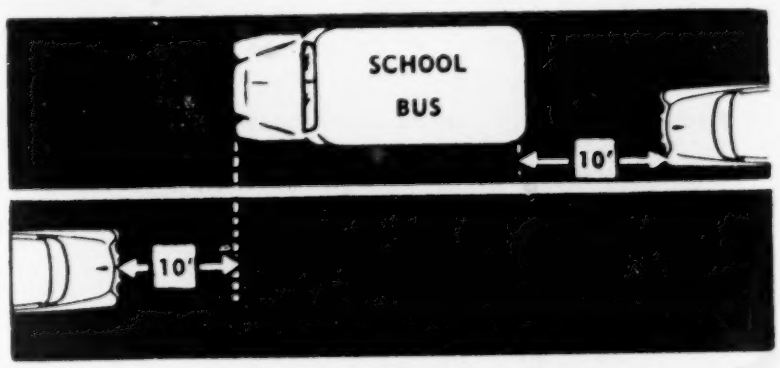

PUBLIC SAFETY AND EMERGENCY VEHICLES

On the approach of a public safety vehicle, responding to call, meaning ambulances, vehicles used by public law enforcement officers, and any vehicle used by fire departments—the driver of a motor vehicle is required to pull to the curb and remain stationary until the public safety vehicle has passed.

The driver of any vehicle other than an emergency or public safety vehicles on official business, shall not follow any emergency vehicle or public safety vehicle traveling in response to an alarm closer than 500 feet, or drive into or park such vehicle within the block where the fire apparatus has stopped in answer to a fire alarm, unless directed to do so by a police officer or a fireman.

No streetcar, trackless trolley or vehicle shall, without the consent of the fire department official in command, be driven over any unprotected hose of a fire department, when said hose is laid down on any street, private driveway or streetcar track to be used at any fire or alarm of fire.

Flashing lights are prohibited on motor vehicles, except as a means for indicating turns, or in the presence of a vehicular traffic hazard requiring unusual care in approaching, overtaking or passing. This prohibition does not apply to the use of flashing, oscillating or rotating amber lights on emergency vehicles, road service vehicles servicing or towing a disabled vehicle, traffic line stripers, snow plows, rural mail delivery vehicles, official survey vehicles and funeral escort vehicles.

Except a person operating public safety vehicles, school buses, or vehicles authorized to display slow moving vehicle emblems, no person shall operate or move upon any public street or highway any vehicle or equipment which has a flashing, oscillating, rotating red or combination red or white light.

SLOW MOVING VEHICLES

All farm machinery and other machinery which is designated for operation at a speed of 25 MPH or less shall be operated at a speed not exceeding 25 MPH, and shall display a triangular slow moving vehicle emblem (SMV). Use of the (SMV) emblem upon any other type vehicle is prohibited when such vehicle is operated at a speed of 26 MPH or more. Use of the emblem on stationary objects on the highway is also prohibited.

55 20908

STOP STREETS AND AUTOMATIC SIGNALS

You must stop before entering or crossing a highway from a private road, driveway, alley or building.

You must yield the right of way to all traffic on said highway.

When you are confronted with a 'STOP' sign or when approaching a highway from an area requiring a stop at such highway—you must come to a full stop even though no traffic is approaching and must yield the right-of-way to all vehicles not obliged to stop.

Know and obey these traffic light signals, arrows:

1. **Green alone**—move through intersection.
2. **Yellow appearing with green**—all traffic stop, except that traffic that has entered the section.
3. **Red alone**—stop.
4. **Green arrow alone**—traffic may move in direction arrow indicates. If arrow indicates a turn, right-of-way must be yielded to pedestrians.
5. **Green arrow appearing with red**—through traffic is prohibited, turn in direction indicated with caution.
6. **Signs may indicate a right turn on red**—turn may be made with caution after stopping if sign so indicates.
7. **A flashing red traffic signal is the same as a stop sign.** You must come to a full stop and only enter the intersection by yielding the right-of-way to all vehicles not required to stop at the intersection.
8. **A flashing yellow traffic signal means caution.** You must slow down and proceed through the intersection with caution.

IMPLIED CONSENT
ALCOHOL CONCENTRATION IN INTOXICATION CASES
PENALTIES

Here are the important provisions:

- Permits such persons to refuse to take such tests, but requires the Registrar, in such cases, to revoke the person's license or driving privileges for 6 months.

- Establishes procedures for advising such persons of the consequences of refusal to take the test, for revoking the license, for hearing, for review, and for notifying the Registrar of other states of cases involving persons from such states.

- Provides that a person who is dead, unconscious, or otherwise incapable of refusing such a test, is deemed not to have withdrawn consent therefor. Also provides procedures for administering such tests to such persons.

- Requires the State Director of Health to determine and approve methods for chemically analyzing bodily substances, in order to determine blood alcohol content. Also authorizes him to determine necessary qualifications of persons to conduct such analyses. And requires him to issue revokable permits to such persons authorizing them to conduct tests. Limits withdrawals of blood for testing to registered nurses or physicians. Permits breath or urine samples to be taken by other persons.

- Authorizes courts to admit evidence on concentration of alcohol, if taken within two hours of violation.

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Provides that a concentration of .15 per cent by weight of alcohol in a person's blood is presumptive evidence of such person's intoxication. Provides that a lesser concentration does not constitute such a presumption, but may be considered along with other evidence in determining the person's guilt or innocence.

- Requires that test results be made immediately available to the person or his attorney, if requested. Permits the person to choose another qualified person to administer tests in addition to those directed by a police officer. And provides that failure to obtain additional tests does not preclude the admission of evidence relating to the police department's test.

- Requires driver's licenses to be suspended for a minimum of 30 days for driving while intoxicated (also for traffic homicide by vehicle, perjury, false affidavits, all felonies relating to or involving motor vehicles, and also willfully fleeing a police officer). Also requires that persons convicted of driving while intoxicated receive the prescribed fine and jail sentence (of present law), in addition to the required driver's license suspension.

Special Note: The term "alcohol" has replaced "intoxicating liquor" in the Ohio Code provisions covering drunken driving (Sec. 4511.19). Also, it is now against the laws of the state for any person to consume any beer or intoxicating liquor in a motor vehicle.

SPECIAL DRIVING PROBLEMS

Night Driving

1. The most important precaution to observe for safe night driving is to drive at a cautious, reasonable speed, so as to be able to stop within the distance illuminated by your headlights, should any unexpected hazard appear out of the darkness.
2. Turn on driving lights immediately at sunset, or earlier if twilight visibility is poor.
3. Dim headlights for every approaching vehicle, and when closely following any vehicle. Use the upper beam only for driving in open country with a clear roadway ahead.
4. Watch for pedestrians who may take chances walking along roads or crossing streets because they do not realize that motorists just can't see them.
5. Keep windows clean. The haze and glare caused by lights shining on dirty glass reduce visibility at night.
6. Do not continue driving when sleepy—pull off the road and rest. Fatigue, which slows down perceptions and reaction time, is a significant factor in nighttime accidents.

Winter Driving

1. The first adjustment a driver must make to winter driving is to reduce speed. No matter what road or weather conditions are encountered, a slower speed is the first consideration for safe handling of any vehicle.
2. Be sure that your car is in excellent operating condition. Lights, brakes, windshield wipers, defroster fan, radiator and other parts should be in perfect order, particularly for winter. Use tire chains for severe snow and ice conditions.
3. Open the ventilator or a window just a little. This helps to keep the windshield clear of a fog and guards against possible carbon monoxide leakage.

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4. Remember:
   a. Shaded spots on the highway will retain frost and ice when the other portions of pavement are dry.
   b. Bridges will take on frost and retain ice when the rest of the road may be in a safe condition.
5. To prevent skidding when a sudden stop is necessary, apply the brakes lightly and intermittently. This "pumping of the brakes" will reduce momentum without losing traction and without locking the brakes.
6. To start a car on ice, release the clutch slowly, since the tires will have a better chance to grip if the wheels are turning slowly. Starting in second gear will also help.
7. When driving in a snow storm or fog, use the lower headlight beam. The high beam reflects the snow or fog, while the lower beam reduces the amount of reflection. Fog lights, incidentally, are a good investment.
8. Double the distance at which you normally follow behind another vehicle. This is necessary because of the increased distance needed to stop on slippery pavements.

Left of Center On Roadway With Obstruction

When obstruction exists, making it necessary to drive to left of center of highway, right-of-way shall be yielded to vehicles traveling in proper direction on unobstructed portion.

EXPRESSWAY/FREEWAY DRIVING

A new era of driving lies ahead. Superbly-engineered arteries, arrow-straight, like concrete ribbons, allow the traveler, weary from bucking bumper-to-bumper traffic on congested Main Street, to breeze with amazing time saving across the countryside. Expressway/freeway driving is different from the stop-start routine the motorist finds on the normal humdrum roadway. Expressways force the motorist to adjust to a higher speed of travel. Here are some pointers on expressway driving:

How to Get On An Expressway (See diagram)

(1) Slow down and look before turning into an expressway approach.

(2) If you make a mistake, you must proceed with traffic until you reach the next intersection. Leave the expressway and re-enter by the proper approach.

(3) Wait for a let-up in the traffic stream. Expressway drivers are traveling faster than ordinary city drivers.

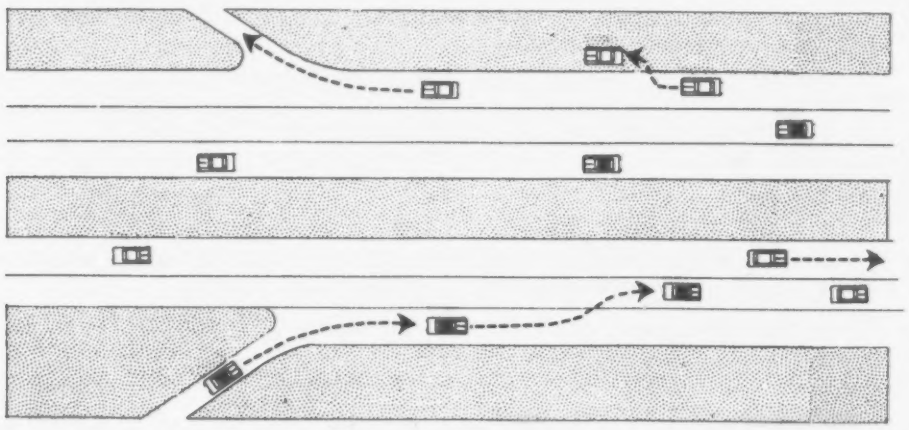

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EXPRESSWAY/FREEWAY DRIVING ILLUSTRATED

The Traffic Movement

(1) Pick your lane—and stay with it. Observe and obey signs.

(2) Faster travel means that you'll need more room between you and the car ahead in case of emergency. Follow no closer than one car length for every 10 miles of speed. Pass lawfully and safely.

(3) Stay within the posted speed limit, but be careful that you don't become a traffic hazard by driving too slowly.

(4) Watch for signs noting changes in speed limits. A "slow zone" signals a a danger area.

Fatigue

Be on your guard against highway monotony. Drive with the window open; shift your gaze; play the radio and engage in light conversation to keep alert. Stop periodically to stretch your legs and have a cup of coffee, milk or a cold "soft" drink.

How to Get Off An Expressway

(1) Watch for advance signs for your proper turn-off and move to the correct lane.

(2) Decrease your speed and signal your intention of turning.

(3) Drive slowly, or stop if necessary, before you enter traffic on the cross highway.

Skidding

Precautions taken against skidding are much simpler than steering out of one. However, when a vehicle does go into a skid, take your foot off the accelerator (never apply brakes) and turn the steering wheel in the direction of the skid.

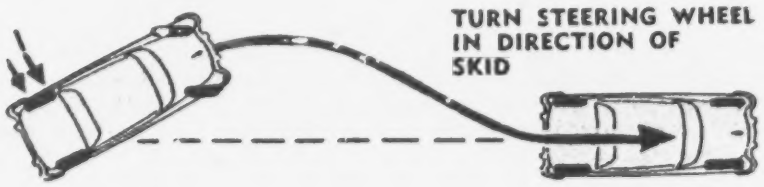

Weaving

Weaving in and out of traffic lanes is a dangerous habit practiced only by the exhibitionist, or the inexperienced or discourteous driver. It actually gains for the driver no more than a few seconds, and causes sudden stops, near sideswipes and irritation among other drivers. Stay in the proper traffic lane and overtake and pass other vehicles only when the roadway ahead is clear.

One-Arm Drivers

Proper control and handling of a vehicle is achieved only when both hands are on the steering wheel. The safety of all occupants of a car, should any road hazard or emergency appear, is very uncertain when the driver is steering with one arm only. It is said rather humorously, but it may well be a fact, that "One-arm drivers are usually headed for the church aisle; some walk down it, others will be carried."

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What To Do If A Tire Blows Out

A blow-out when traveling at a high rate of speed is dangerous, especially if the driver does not know what to do and becomes frightened. First of all, do not jam on the brakes and do not throw out the clutch. Keep your foot off the accelerator and let the vehicle coast against the engine to stop. When the blow-out is a rear tire, sudden application of the brakes will set up a "tail-sway" difficult to control and the vehicle is likely to turn over. Various types of safety tires may well be considered as important accessories.

When Wheels Run Off Pavement

If a vehicle's wheels run off the pavement onto the berm or soft shoulder, do not try to jerk the wheels immediately back onto the road. Stop accelerating without throwing out the clutch. Allow the engine to slow the vehicle so that it can be pulled safely back onto the pavement.

When Rounding a Curve

Never apply the brakes while you are rounding a curve but apply them before entering it. You may accelerate slightly on the way out of the curve—this extra power will offset the side-thrust of centrifugal force. It is not possible to apply brakes safely while in the process of rounding a curve.

No Coasting

Never coast down a grade in neutral gear. Shift into second gear when going down a steep hill. Coasting not only causes quicker wear-out of the brakes, but increases the possibility of an accident.

Funeral Procession

The following requirements are necessary for vehicles traveling in a funeral procession in order to be recognized and given right of way by other traffic: Each vehicle in a funeral procession must have its headlights lighted and display a purple and white pennant, so as to be visible from any direction.

The Blind Person As A Pedestrian

Watch out for persons carrying white canes or white canes with red tips. The blind are the only pedestrians authorized by law to carry white canes and the law further provides that the blind carrying such canes, as well as those led by guide dogs, are to be given the right-of-way by every driver.

Walking Along Roadway

Persons walking along or upon the highway where sidewalks are not provided must face approaching traffic.

ACCIDENTS

In case of accident on a public road or highway the law requires you as a driver to stop, give your name and address, the name and address of the owner and registration number of the motor vehicle, to the injured person or any person involved in the accident or to a police officer at the scene. You must also display your driver's license or furnish satisfactory proof that you are licensed.

In case of an accident with an unoccupied or unattended motor vehicle you shall securely attach the information required to be given in writing, to a conspicuous place in or on the unoccupied or unattended motor vehicle which was struck.

The operators of all motor vehicles, including non-residents, when they become involved in an accident, resulting in the death or injury to a person or property damage in excess of $100.00, must within 30 days after such accident, file a written

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report with the Registrar of Motor Vehicles. Official forms may be obtained from any Government subdivision, Police Department, State Highway Patrol Post, or Deputy Registrar.

FINANCIAL RESPONSIBILITY

Insurance requirements: $12,500 for bodily injury or death of one person in any one accident; $25,000 for bodily injury or death of two or more persons in any one accident; from $7,500 for property damage, and the amount of $30,000 to be deposited with the state treasurer as evidence of financial responsibility.

TRUCK REGULATIONS

The law requires enough space between a truck or a vehicle drawing another vehicle to permit an overtaking vehicle to enter and occupy without danger.

The law requires that operators of motor vehicles carrying passengers for hire, or of any school bus or of any vehicle carrying explosives or inflammable liquids before driving across any railroad grade crossing to:

Stop and listen through an open door or window and look in both directions. He shall cross in such a gear that will not require changing and shall not shift gears while crossing the tracks.

The Director of Highway Safety has the authority to prescribe clearance markers, reflectors and stop lights on buses, trucks, and trailers not operating under the Public Utilities Commission of Ohio.

The law requires a light at night or a flag in the daytime on the load overhang on the rear of a vehicle when the load extends four feet or more beyond the bed of such vehicle.

The following safety equipment shall be carried in all trucks:

1. At least 3 flares, or 3 red reflectors, or 3 red electric lanterns.
2. At least 3 red burning fusees, unless red reflectors or red electric lanterns are carried.
3. At least 2 red cloth flags not less than 12" square with standards to support them.

You, as a truck driver, must take the following steps in case of a breakdown on the highway.

1. Place a lighted fusee or red reflector on the traffic side of the vehicle unless the red electric lanterns are used.
2. Promptly place three lighted flares or red reflectors or three red electric lanterns as follows:
   One at a distance of forty paces to 100 feet to front and one of equal distance to the rear and each in the center of that lane and one on the traffic side of the vehicle. Red Flares shall be used when lights are not required. One shall be placed forty paces or 100 feet to the front and one equal distance to the rear and both in the center of that traffic lane. If disabled, near a curve, crest of a hill or near an obstruction to view, the flags or flares shall be placed to give ample warning, but never less than forty paces or a hundred feet or over one hundred and twenty paces or three hundred feet from the vehicle.

When driving a motor vehicle and hand signals are not visible both to the front and rear, mechanical turn signals must be installed.

Mechanical turn signals must be installed on a vehicle when the distance from the center of the steering post to the left edge of the vehicle exceeds 24 inches and/or when the distance from the center of the steering post to the rear of the vehicle exceeds 14 feet.

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No vehicle shall be driven on the highway unless it is so constructed or loaded as to prevent any of its load from dropping, sifting, leaking or otherwise escaping.

Any commercial car, trailer, or semi-trailer, with a gross weight exceeding three tons, including load, must be equipped with suitable metal protectors or substantial flexible flaps on the rearmost wheels to prevent, as far as practicable, the throwing of dirt, water or other materials on the windshield of following vehicles.

The regulations governing towing connections for trailers are: When one vehicle is towing another the drawbar or other connection shall be of sufficient strength to pull all weight towed. In addition to such drawbar or other connections, each trailer or semi-trailer not connected to a commercial tractor by means of a fifth wheel shall be coupled with stay chains or cables to the vehicle drawing it. These chains or cables shall be of sufficient size and strength to prevent parting from the drawing vehicle should the drawbar or other connection break or become disengaged. Every trailer or semi-trailer shall be so coupled that the trailer will follow substantially in the path of the vehicle drawing it without whipping or swerving from side to side. When one vehicle is towing another and the connection consists only of a chain, rope or cable, a white flag or cloth not less than 12 inches square shall be displayed upon such connection.

Any vehicle transporting explosives upon a highway must be marked or placarded on each side and the rear with the word 'explosives' in letters not less than eight inches high, or there must be displayed on the rear of such vehicle, a red flag not less than 24 inches square marked with the word 'danger' in white letters six inches high.

Every such vehicle shall be equipped with not less than two fire extinguishers, filled and ready for immediate use and placed at convenient points on the vehicle.

You must obtain a permit from the Department of Highways if you wish to haul a load on the highway that is larger or heavier than the law allows:

INFORMATION ON LIMITATIONS ON MOTOR VEHICLE DIMENSIONS AND WEIGHTS

Width (except municipal bus or traction engine)	8'0"
Width of municipal bus	8'8"
Width of traction engine	11'0"
Height of all motor vehicles	13'6"
Length of single vehicle (except municipal bus)	40'0"
Length of passenger bus type	40'0"
Length of municipal bus	48'0"
Length of commercial-tractor & semi-trailer	55'0"
Length of any other combination	65'0"

Maximum weight (in pounds)

1. On one axle	19,000
2. Total on two successive axles spaced four feet or less, center to center	24,000
3. Total on two successive axles (tandem) spaced more than four feet apart and less than eight feet, center to center	32,000
4. Total on two successive axles spaced eight feet or more, center to center	38,000
5. Total weight of vehicle and load 38,000 pounds plus an additional 900 pounds for each foot of spacing between the front axle and the rearmost axle of the vehicle.	
6. Three axle group, no more than nine feet	48,000
7. Maximum gross load for any combination of vehicles	78,000
8. Maximum wheel load shall not exceed 650 pounds per inch width of tire.	

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UNIT IV

SCHOOL BUS ORIENTATION

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UNIT IV

I. TOPIC

School Bus Orientation

II. ORIENTATION

The school bus driver shall be well acquainted with the bus which he is driving. This includes knowing the characteristics and purposes of the many parts that make up the school bus. Not so important is how the school bus is built, but how well the driver knows the bus and how he can use it properly, safely, and efficiently. This unit will orient the driver to the component parts of the school bus.

III. PRESENTATION

A. The Exterior of the Bus

1. Engine compartment

   a. Fan belt, radiator filler cap, crankcase filler cap, oil measuring stick, distributor, carburetor, generator or alternator, starter, steering gear, and power steering reservoir
   b. Know the location of each item.

2. Wiper blades and arms

   a. Steps and hand hold to reach wipers and windshield
   b. Constantly be aware of the condition of rubber on windshield wipers.
   c. Driver is cautioned not to move electric wiper arms by hand.

3. Warning lights, turn signals, headlights, marker lights, tail lights, and brake lights
4. Front and rear springs and shock absorbers

   a. Shock absorber permits smoother ride with light load.
   b. Condition of springs and shock absorbers should be checked regularly.

5. Transmission, drive line, rear axle, differential, and housing

   a. Each section of drive line is protected by metal guard.
   b. This prevents the drive line from going through the floor or dropping to the ground if broken.

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I. Vegetable Cookery

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to cook vegetables: The understanding and application of recipes, formulas, and procedures	Preparation: Proper handling and storage of vegetables before cooking	Nutritive value Effect of cooking Preservation of food value, color, flavor, and texture Temporary storage in cold water Equipment and utensils used in cleaning and preparing vegetables
	Procedure for cooking vegetables: Fresh Frozen Dehydrated Canned	Kinds: Leafy Stalk Flower Root Fruit Seed
	Cooking by different methods: Steaming Boiling Pressure cooking Sautéing Braising Frying	Principles involved in: Steaming Boiling Blanching Creaming Sautéing
	Seasoning Temperature Time	Variations
		Sauces used with vegetables
	Proper handling and storage of cooked vegetables	Related science
		Cost factors

Suggested teaching materials: See items 8, 15, 20, 95, 100, 102 in appendix B.

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6. Manifold, exhaust pipe, muffler, tail pipe, and hangers
7. Clamps which fasten the body to the chassis frame
8. Tires, rims, lug bolts, and nuts

    a. Recap tires are not permitted on the front wheels of bus.
    b. If used on the rear, it is recommended that a full recap is used.

9. Fuel tank

    a. Minimum capacity 30 gallons
    b. Watch for leaks.

10. Lettering - All black. The right and left side of any vehicle is determined by viewing the vehicle from the rear and the person facing in the same direction that the vehicle is headed.

    a. Name of school district on each side
    b. COUNTY (if local district) on each side
    c. BOARD OWNED - lower right front side
    d. Bus number on each side
    e. Capacity (CAP.) - each side
    f. SCHOOL BUS - 8" letters front and rear
    g. STOP - 10" letters rear
    h. STATE LAW - 5" letters rear
    i. EMERGENCY DOOR - 2" letters - No more than 3" from the top of the door

11. Mirrors - right and left side

    a. Two way adjustable
    b. Cross walk mirrors may be used.

12. Air pressure storage or vacuum storage

    a. Air tank drainage valve
    b. Types

        (1) Hand valve
        (2) Automatic moisture ejector valve

13. Amber and red reflectors

    a. Amber on each side front bottom
    b. Red on each side rear bottom

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B. The Interior of the Bus

1. Driver's seat

   a. Adjustment forward and backward
   b. Adjustment upward and downward
   c. Seat Belt

2. Chassis instrument panel

   a. Oil pressure gauge
   b. Ammeter gauge
   c. Speedometer and odometer gauge
   d. Water temperature gauge
   e. Fuel gauge
   f. Illuminated panel, high beam, and turn signal indicator
   g. Air pressure or vacuum gauge with either audible or warning signal

      (1) If warning signal is activated, stop immediately
      (2) Investigate the problem

   h. Light switch, high and low beam foot switch, choke, and throttle control
   i. Ignition switch

3. Body instrument panel

   a. Marker, dome, panel light switches
   b. Warning light master switch

      (1) Manual switch
      (2) Door switch

   c. All heater control switches
   d. Auxiliary fan switches
   e. Wiper motor switches

4. Steering wheel and column

   a. Turn signal switch

      (1) Self cancellation
      (2) Non-cancellation

   b. Horn button

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5. Parking brake location and type
6. Gear shift lever and chart of gear locations
7. Clutch, brake, and accelerator
8. Stanchion and grab rails
9. Emergency equipment

    a. Fusees (6 - 30 minute type, encased)
    b. Crowbar or ax
    c. First aid kit
    d. 12" red flags (3)
    e. Dry chemical fire extinguisher (with gauge, 2½ lb. minimum)
    f. 3 red reflectors (encased)

10. Sun visor
11. Interior mirror - adjustable
12. Entrance door and its operation
13. Floor and step well covering
14. Passenger seats

    a. Fiber glass
    b. Upholstered

        (1) Cushion fastening
        (2) Back fastening

15. Emergency door

    a. Operating instruction
    b. Buzzer warning when door is unlatched
    c. Lettering above door 2" high - not more than 3" from the top of the door

IV. SUMMARY

It is necessary for the driver to know the interior and exterior of the bus. He must be familiar with the driver's compartment so that his eyes can focus on the "big picture." Knowing the school bus helps to promote safe and efficient operation. The students deserve the best in transportation; therefore, the driver must be well orientated concerning his vehicle.

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UNIT V

DRIVING FUNDAMENTALS

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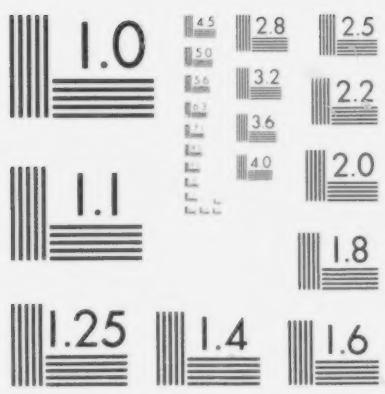

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNIT V

I. TOPIC

Driving Fundamentals

II. ORIENTATION

School bus drivers have entrusted to them the lives and safety of a human cargo that cannot be measured in terms of dollars and cents. The purpose of this unit on Driving Fundamentals is to teach drivers the basic skills necessary for them to operate buses properly in transporting this valuable cargo safely and efficiently.

The individual driver must not only learn these basic driving skills, but the driver must practice each skill correctly in order to become proficient. Through practice, each correct basic procedure will become a habit to the driver and will contribute to the safe operation of the bus. Experienced drivers who have not had the benefit of organized instruction must be made aware of their faults, and each must make a concerted effort to correct any poor driving practices.

In past years, accidents involving Ohio school buses were caused by the school bus driver in over fifty per cent of the cases. This can be traced in large part to driver preoccupation and the absence of organized insturction for the driver.

The instructions which follow have been developed to assist the driver in correctly performing the task of driving a school bus. Each section in this unit is based on sound driving practices and procedures. If properly learned and adhered to, these procedures will result in improving the performance of the bus driver.

III. PRESENTATION

A. **Driver Position** - To be a good bus driver each driver must position himself for comfort, for good vision, and to be within reach of all driver compartment controls.

1. Adjust driver's seat.
2. Adjust seat belt if available.
3. Adjust all mirrors for most advantageous use.

   a. Inside mirror
   b. Outside mirrors should be adjusted so that the driver can see the rear wheel-wells and bumper.

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4. The driver should be acquainted with the entire instrument panel and know where each gauge, dial, and switch is located.

B. **Starting the Engine** - The procedure used in starting a bus engine must become a matter of routine. It must incorporate principles of safety and be performed in keeping with good engine preventative maintenance practices.

1. Set parking brake to keep bus from moving.
2. Depress clutch pedal to disengage engine from transmission.
3. Shift gear lever into neutral position to relieve added strain on starter.

   a. Permit additional gears to remain idle.
   b. Check position by moving lever from side to side.

4. Turn on ignition key to complete electric circuits.
5. Engage starter switch.

   a. With clutch depressed and gear in neutral
   b. Use hand choke if necessary and available. Over choking will cause carburetor flooding.
   c. Use foot accelerator sparingly. Pumping will cause carburetor flooding.
   d. Bus engines will vary widely in their carburetor sensitivity; therefore, do not hesitate to ask the supervisor or bus mechanic for special techniques in starting a particular bus.

6. After engine is running

   a. Release clutch pedal slowly without stalling engine.
   b. Allow transmission gears to start rotation.

7. Warm up engine at fast idle.

   a. Do not race the engine.
   b. Much engine wear comes in the first three minutes after starting.

C. **Shifting Gears** - Gear shifting is a phase of bus driving which requires skill and practice. The driver must learn the best range of speed in changing gears upward and downward. Shifting the gears must be accomplished without loss of road vision. Syncro-mesh transmissions have alleviated most of the gear clashing. Generally, buses are equipped with a four or five speed transmission.

1. Know the gear positions.

   a. Check chart on lever knob or on dash.
   b. Ask mechanic.

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2. Depress clutch pedal
3. Shift gear lever into starting gear.

   a. For average terrain and load this should be second gear.
   b. Load and/or terrain may dictate the use of first gear.
   c. Never start out in a gear higher than second as this places undue load and wear on the engine and clutch.

4. Depress foot brake.
5. Release parking brake lever. If ratchet type, pull brake lever slightly back to release pressure.
6. Release clutch gradually to friction point and hold. At this point you will have the clutch just at the point of friction and the foot brake on and ready to release.
7. Depress accelerator. Hold point of clutch friction and slightly depress accelerator to increase the power to prevent stalling.

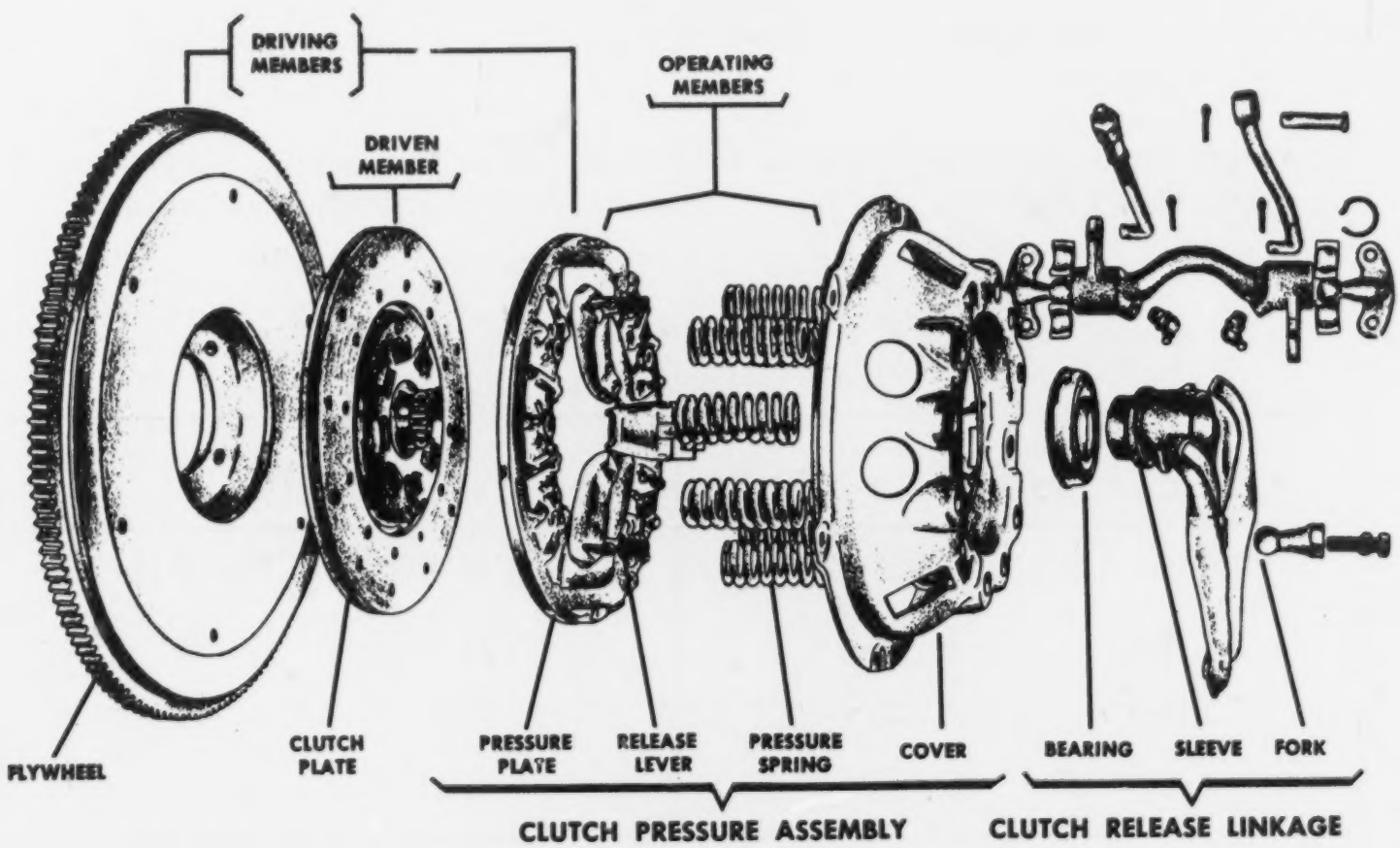

CLUTCH ELEMENTS

Figure 4

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8. Release clutch.

   a. Slowly and gradually release the clutch to the remainder of pedal travel and at the same time slowly and gradually increase the acceleration.
   b. Remove foot from clutch pedal completely.
   c. Pick up engine speed before shifting to higher gear.

9. Shift to next higher gear.

   a. Depress clutch pedal and release accelerator.
   b. Shift to next higher gear.
   c. Release clutch smoothly but more quickly than in starting gear and depress accelerator smoothly and quickly.

      (1) To prevent loss of vehicle speed
      (2) Do not race the engine and slip the clutch.

   d. Remove foot from clutch pedal.
   e. Proceed in this gear until proper vehicle speed is reached for shifting to next gear.

10. Repeat #9 procedures until the bus is in cruising gear.
11. Never skip a gear in up or down shifting as this causes undue engine and clutch wear.

Approximate M.P.H. to be reached before upshifting or downshifting. M.P.H. may vary slightly depending on make of engine, transmission, gear ratio, and terrain.

Upshifting		Downshifting	
From 1 to 2 Gear	1 - 5 M.P.H.	From 5 to 4 Gear	30 - 35 M.P.H.
2 to 3 "	5 - 12 "	4 to 3 "	25 - 30 "
3 to 4 "	12 - 20 "	3 to 2 "	5 - 10 "
4 to 5 "	25 - 30 "	2 to 1 "	Stop "

Table 1

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12. Shift up or down as may be necessary to prevent engine lugging or excessive engine R.P.M.
13. In going down a hill, shift into the gear that would be used in going up the hill.

D. **Double Clutching** - Syncro-mesh transmissions have almost alleviated the need of double clutching. Shifting the gears on non syncro-mesh transmissions is done faster and smoother by double clutching. This process coordinates the engine speed and transmission speed for non-clashing of gears. Double clutching aligns the gears for easy up and down shifting. The gears should never be forced by improper timing of the shifting process. Reclutching and speeding up the engine will in most cases prevent excessive clashing. The engine should never be allowed to pull heavily going upgrade, on a turn, or on a curve. Neither should it be permitted to over-race downgrade.

1. Double clutching, upshifting

   a. Depress clutch pedal and release accelerator.
   b. Shift gear lever to neutral position.
   c. Release clutch pedal momentarily to engage clutch.
   d. Depress clutch pedal and shift to next higher gear.
   e. Release clutch and accelerate engine at the same time.

2. Double clutching, down shifting (See Table 2)

   a. Depress clutch pedal and release accelerator.
   b. Shift gear lever to neutral position.
   c. Release clutch pedal momentarily to engage clutch and accelerate engine to more than original speed.
   d. Depress clutch and shift to next lower gear.
   e. Release clutch pedal gradually and accelerate engine to match the speed of vehicle.

3. Related items of double clutching

   a. The double clutching procedure may be slow or fast depending upon the type of bus.
   b. Normally down shifting two gears is sufficient.
   c. Double clutching requires continuous practice.
   d. Syncro-mesh transmissions may be double clutched.

E. **Shifting Automatic Transmission** - Some buses are equipped with automatic transmissions and the driver should understand the operation of such transmissions.

J. Salads and Sandwiches

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare salads: The understanding and application of recipes, formulas, and procedures	Preparation and procedure: Arrangement Care of salads during preparation Dressings Care of salads after preparation	Nutritive value of salads Types of salads involving use of: Cooked foods Raw foods Gelatin Care in washing and preparing salad greens and vegetables Organization of materials Storage of salad components: Fruits Vegetables Greens Types of dressings Methods of serving Cost factors
How to prepare cold sauces and salad dressings: The understanding and application of recipes, formulas, and procedures	Preparation and procedure: Sauce Seasonings Care during preparation	Variations Equipment Cause of curdling or breaking How to restore curdled mayonnaise
Mayonnaise	Care after preparation	Storage
French dressing	Preparation and procedure: Seasonings Care during preparation Care after preparation	Selection of oils Variety dressings Equipment Storage Cost factors
Cooked salad dressing	Preparation and procedure: Seasonings Care during preparation Care after preparation	Chemical principles involved Shortcomings of cooked dressings Equipment Dressings derived from cooked dressing Storage Cost factors
How to prepare sandwiches and sandwich fillings: The understanding and application of recipes, formulas, and procedures	Preparation of sandwiches: Open face Club Toasted Finger Rolled Hot Grilled Preparation of fillings: Seasoning Care in preparation Arrangement on plate Variety of cuts Care after preparation	Sanitation Handling precautions Variety breads Bread storage Equipment and tools: Type Care Safety precautions Kinds of fillings: Salads Spreads Sliced products Garnishes Storage of sandwiches Storage of sandwich fillings Cost factors

Suggested teaching materials: See items 4, 15, 20, 21, 56, 96, 106, 107 in appendix B.

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1. Know the shift positions.
2. Depress foot brake.
3. Move selector lever into forward or drive position.
4. Release parking brake.
5. Release foot brake and depress accelerator.
6. As speed of bus increases, the transmission will automatically shift to the next higher gear until reaching cruising gear.
7. Down shift for additional power.

   a. Depress accelerator to the floor firmly. This will cause transmission to down shift one gear.
   b. Move selector lever to next lower position.

F. **Steering and Turning** - The school bus driver, to be classified as an expert driver, must be able to assume the correct steering position and make all the turning maneuvers correctly and smoothly. He must learn the correct procedures necessary to prepare for the turn, make the turn, and re-enter the traffic pattern. The driver who is confronted with an unusual turn or turn-a-round shall do so with extreme caution. The raising of speed limits and the super highway system in Ohio, upon which the school buses may travel, has forced the driver to use added skills and judgment is making turns properly and safely.

1. Steering positions

   a. Grip the steering wheel with both hands.
   b. Left hand at approximately 10 o'clock position
   c. Right hand at approximately 2 o'clock position

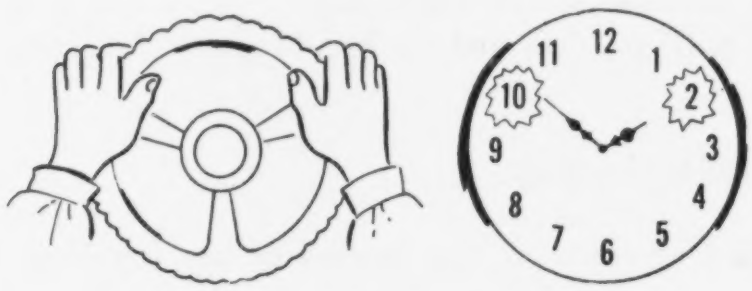

Figure 5

   d. Hands on outside of steering wheel and thembs on top or outside of wheel

2. Focus eyes on road ahead

   a. Eyes should be constantly on the move to obtain the "big picture."
   b. Ahead, left side, right side, rear view mirrors

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3. The push-pull steering method is recommended for school bus drivers. One hand pulls and the other hand pushes.
4. Hand over hand method may catch thumb in clothing, safety chain on the wrist watch, bracelets, etc., which are hazards to steering.
5. Preparing for turns

   a. Check traffic to the front and rear of the bus.
   b. Give proper signal to move vehicle into proper lane.

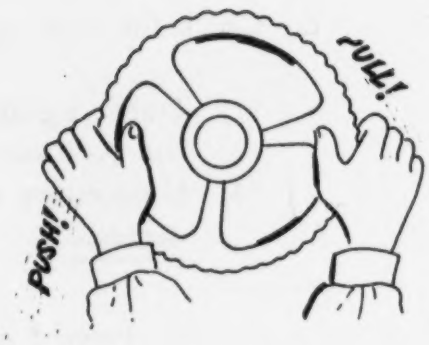

Figure 6

6. Making right turn

   a. Give proper right hand turn signal.
   b. Reduce speed and down shift to proper gear needed to execute turn.
   c. Position bus in right side of the lane.
   d. Check for clear right of way.

      (1) Traffic signals, signs, pedestrians, or vehicles
      (2) Use both outside mirrors.

   e. Execute the turn.

      (1) Make turn smoothly without strain on the engine.
      (2) Never shift gears during a turn.
      (3) Check right mirror while executing turn.
      (4) Enter the right most lane available and check turn signal for cancellation.
      (5) Steer wheels back into position -- do not let steering wheel spin wheels back into position

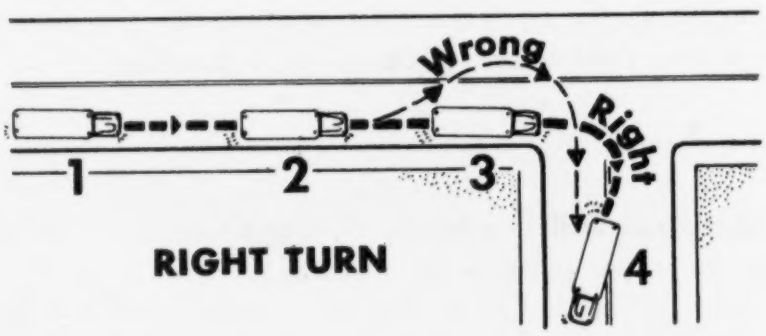

Figure 7

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7. Making left turn

   a. Give proper left hand turn signal.
   b. Reduce speed and down shift gear.
   c. Position bus to the left edge of the lane.
   d. Check for clear right of way.

      (1) Traffic signals, signs, pedestrians, or vehicles
      (2) Use both outside mirrors.
      (3) If necessary to stop, keep front wheels straight and brake pedal depressed.

         (a) Prevent drifting and activate stop lights.
         (b) This will prevent being shoved into line of approaching traffic if struck from the rear.

   e. Execute the turn.

      (1) Drive into the intersection, make turn smoothly, and without strain on the engine.
      (2) Check left mirror while executing turn.
      (3) Never shift gears in a turn.
      (4) Enter the highway in the left most lane available and check turn signal for cancellation.

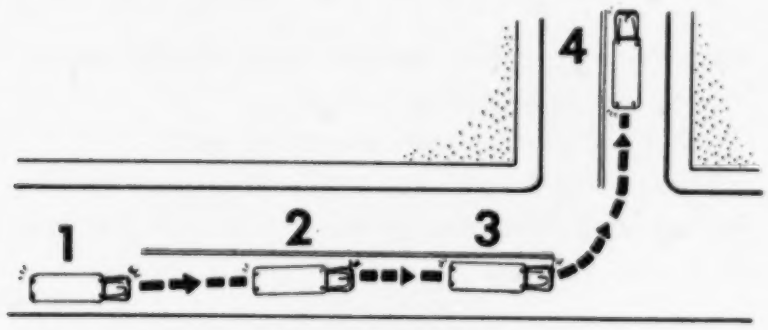

LEFT TURN
Figure 8

   f. After completing the left turn upon multiple lane highways, pick up speed and move into right hand lane as soon as possible.

8. Making a turn-a-round

   a. Give brake signal well in advance of turn-a-round.
   b. Stop bus in proper position on roadway.

      (1) One bus length ahead of road to be backed into
      (2) Check traffic front and rear.
      (3) Visibility shall be 500 feet in either direction (ORC 4511.37).

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(4) Have traffic move around bus if possible.
(5) Back into roadway or driveway using outside mirrors.
(6) Re-enter roadway.

(a) Check traffic.
(b) With caution

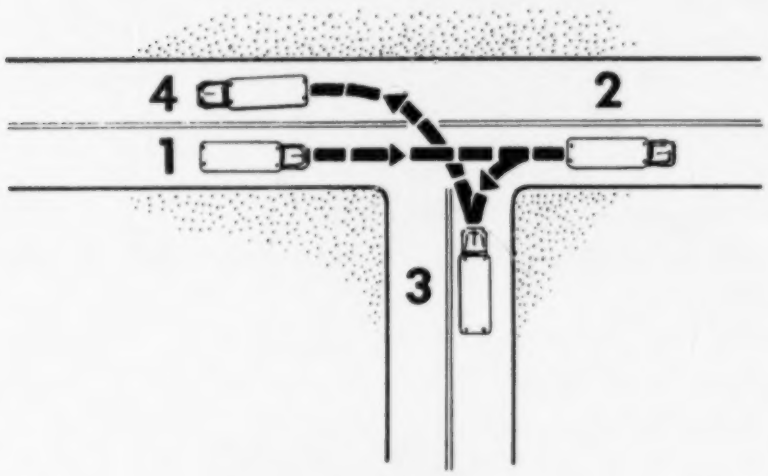

TURN AROUND
Figure 9

G. **Stopping and Parking Bus** - Stopping a school bus smoothly and within the limits of safety is another sign of an expert driver. A good driver has his vehicle under control at all times and knows that braking distances increase greatly as the speed and the weight of the vehicle increases. With a reaction time of one second the driver must realize that at 20 m.p.h. the average stopping distance is 59 feet, and at 40 m.p.h. the stopping distance is 179 feet or approximately three times greater. The skillful driver also knows that by using correct stopping procedures the maintenance costs on the braking system will be less.

Table 2

Maximum Safe Stopping Distances for TRUCKS and BUSES In Accordance with ICC Regulations

Speed Miles Per Hour	Feet Per Second	Vehicle Travels (One Second) Reaction Time	Braking Distance	Total Stopping Distance
20	29	29	30	59
30	44	44	67	111
40	59	59	120	179
50	73	73	188	261
60	88	88	270	358
Speed of vehicle.	No. of feet covered per second by vehicle.	Distance traveled in one second before brake can be applied after seeing danger (in feet).	Distance required to stop after brake is applied with good pavement and fair brakes (in feet).	Total feet covered after seeing danger (in feet). Reaction time plus stopping distance.

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1. Stopping when is a low gear or 10 m.p.h. and less

   a. Depress clutch pedal and release accelerator.
   b. Apply brakes gradually by increasing pressure.
   c. Reduce brake pressure slightly, but not completely just before coming to a stop to prevent jerking.
   d. Shift gear lever into neutral position.
   e. Release clutch and remove foot from pedal.

2. Stopping when in cruising gear

   a. Release accelerator and depress brake pedal.
   b. When proper m.p.h. is obtained for any gear, down shift to next lower gear. See Table 1.

      (1) Will reduce heat build-up
      (2) Reduce excessive brake wear

   c. Down shifting can be very effective and smooth.

      (1) 3rd gear for 5 speed transmission
      (2) 2nd gear for 4 speed transmission

3. Parking the bus

   a. Shift lever into low gear on level or upgrade.
   b. Shift lever into reverse gear on down grade.
   c. Turn wheels into curb.
   d. Turn off ignition and remove ignition key.
   e. Set parking brake (Parking brake may freeze in wet freezing weather).

H. **Loading and Unloading** - The loading and unloading of pupils presents the driver with additional responsibilities and requires use of good judgment. The driver must learn the proper procedure for controlling traffic, for pupils crossing roadway, for pupils entering the bus, and for pupils seating themselves.

1. Loading

   a. Check traffic - oncoming
   b. Check traffic - behind -- using mirrors.
   c. Activate flasher lights approximately 300 feet before the stop.

      (1) Warn traffic in front and to the rear of the bus in sufficient time.
      (2) This will vary depending upon conditions.

   d. Bring bus to stop using proper procedure (refer to Section G, Number 1 and 2).

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e. Do not stop where visibility to front and rear is less than 500 feet.
f. Put gear shift lever into neutral.
g. Re-check traffic to front and rear of the bus and make certain traffic has come to a stop.
h. Open entrance door and signal pupils it is safe to cross in front of the bus.

(1) Pupils should be taught to cross at least 10 feet or 5 paces to the front of the bus.
(2) Instruct child to cross at distance where he can see the driver.
(3) Safety - cross mirrors are helpful.

i. Systematic loading can be very helpful.

(1) Various systems can be used.
(2) Pupil concentration must be considered.
(3) Two pupils per seat starting from rear.
(4) Three pupils per seat starting from rear.
(5) Do not allow students to stand in step well or forward of the driver stantion.

j. Proceed when all students are seated.

(1) Shift into starting gear.
(2) Close the door.
(3) Check to see that all students are seated. Check traffic and move out slowly and smoothly.

2. Unloading

a. Follow the same procedure as outlined in loading under a., b., c., d., e., f., g., h.
b. Proceed when pupils are in complete safety on their residence side of road.

3. Unloading at school building

a. Stop bus using proper procedure.

(1) Place gear shift lever in low gear.
(2) Turn off ignition.
(3) Set parking brake.

b. Do not activate warning flasher lights.

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c. Driver stand and face students.

(1) All students remain seated.
(2) Unload front seat entrance side first then front seat driver side. Continue alternating to the rear of the bus.
(3) This unloading procedure promotes safety and efficiency.
(4) Develops good habits in case of emergency evacuation.

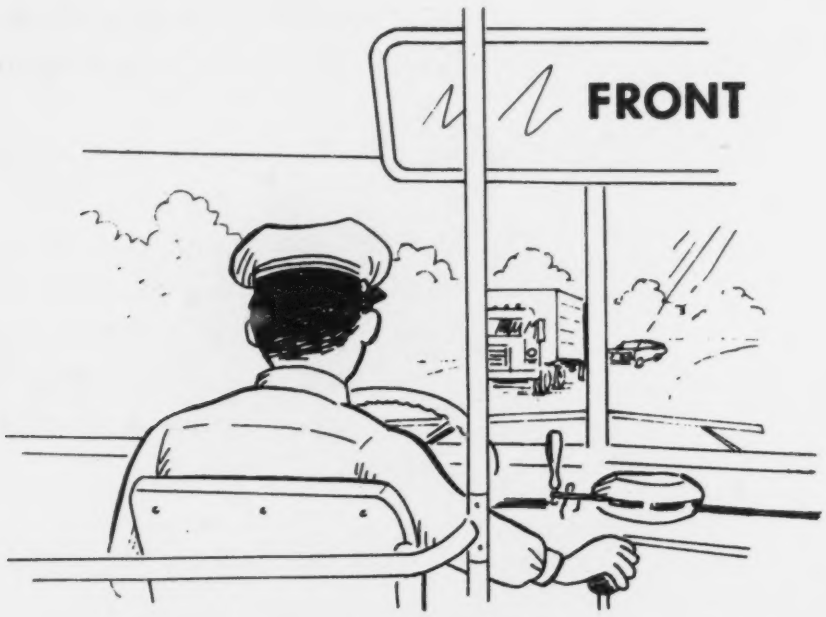

If In Full Control, Driver Need Not Deactivate Unit

Figure 10

Shall Deactivate Unit Prior To Turning Sideways

Figure 11

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Shall Deactivate Unit Prior To Standing

Figure 12

I. **Railroad Crossing** - Through planned safety procedures for crossing railroad tracks, many accidents could be eliminated. Learn these procedures and practice them until they become automatic actions.

Crossing railroad tracks represents one of the greatest hazards insofar as mass casualities and fatalities are concerned. STOP, LOOK, and LISTEN. All school buses loaded or empty must stop for railroad crossings.

1. Prepare to stop.

   a. Request silence.

      (1) This is a must.
      (2) Turn heaters off if necessary to have more silence.

   b. Get "Big Picture", check traffic control devices.

2. STOP the bus.

   a. Follow stopping procedures.
   b. Stop in a position that gives a clear view of the track in both directions. The front bumper must be clear of the tracks.
   c. Shift into neutral.

3. LOOK and LISTEN.

   a. Open service door and driver's window.
   b. Look and listen through the open window and door.

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4. If no indication of approaching train

   a. Shift into starting gear.

      (1) Must be a gear that will take bus across tracks without hesitation.
      (2) Shifting gears on tracks shall not be permitted.

   b. Look and listen a second time, close door, and proceed quickly and smoothly.

5. If there is an approaching train

   a. Hold bus position, may use the parking brake depending on waiting time.
   b. After train passes, follow items under Procedure 4.

6. Multitrack crossings

   a. Make sure no train is approaching on any of the tracks.
   b. After a train passes, wait until other tracks become visible before proceeding. A second train may be approaching from the opposite direction.
   c. Follow items under Procedure 4.

7. Railroad traffic control devices

   a. Flasher lights and bells

      (1) Warning of an approaching train
      (2) If train is stopped or signal is malfunctioning, a vehicle may proceed after driver insures a safe crossing can be made.

   b. Gates

      (1) All traffic must obey these devices.
      (2) Vehicles may proceed around the gates only at the direction of a peace officer or an authorized railroad representative.

   c. Railroad crossing controlled by a flagman

      (1) A school bus must make a safety stop.
      (2) Follow directions of the flagman.

J. **Unusual Weather and Road Conditions** - A good driver will adjust his driving to all kinds of weather and road conditions to stay within the limits of safe driving. Bad weather may excuse a delay, but never an accident.

   1. Conditions causing slippery roads

      a. Rain
      b. Freezing rain
      c. Snow
      d. Wet leaves
      e. Spillage of oil, etc., from trucks
      f. Mud

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2. Procedures for safe driving on slippery roads

   a. Slow down.
   b. Use brake fanning action. Sudden braking will cause skidding and loss of steering traction.
   c. Allow more distance for driving action
   d. Allow more distance when signaling.

3. Conditions causing poor visibility

   a. Rain
   b. Snow
   c. Clouds
   d. Fog - Smoke
   e. Inside bus fogging

4. Procedures for safe driving in poor visibility.

   a. Slow down.
   b. Use windshield wipers and defrosters.
   c. Turn on marker lights and head lights.

   NOTE: Driving with lighted parking lights is illegal.

   d. Sound horn at intersections, curves, and other dangerous places.

5. Road conditions caused by freezing, thawing, and rain

   a. Soft and spongy roads
   b. Chuck holes
   c. Broken road sections
   d. Humps

6. Procedures for safe driving on poor road conditions

   a. Slow down.
   b. Be alert for these conditions during the proper seasons.

7. Procedures when driving off roadway onto soft shoulder

   a. Slow down.

      (1) Brake gently.
      (2) Hold steering wheel firmly and steer along berm.

   b. Drive on shoulder.

      (1) Keep bus moving.
      (2) Look for place to pull onto the roadway.
      (3) Check traffic in front and rear.

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K. Breads, Pastries, Cakes, and Cookies

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to make doughs for bread, rolls, sweet doughs:	General procedure for making various kinds of dough:	Food values of breads
The understanding and application of recipes, formulas, and procedures	Baking powder	Weights and measures
	Yeast	Fermentation
		Yeast
		Care and operation of equipment
How to make bread and rolls	Preparation and procedure:	Types of bread
	Proofing	Types of rolls
	Shaping	Fuels:
	Temperature	Gas
	Time	Electricity
	Care after baking	Composition of flours
		Sanitary factors
		Sugars
		Related chemistry
		Glazes and crust
		Cost factors
How to make baking powder doughs (Quick or hot breads)	Preparation and procedure:	Types of baking powder
	Mixing	Related chemistry
	Handling	Equipment
	Baking temperature	Varieties:
	Baking time	Biscuits
	Care after baking	Muffins
		Corn bread
		Methods of serving
		Regional preferences
		Cost factors
How to prepare basic dessert doughs	Preparation and procedure:	Varieties of cake dough:
	Cakes	Plain
	Cookies	Sponge
	Pastries and tortes	Pound
	Pies	Types of shortening
	Doughnuts	Eggs:
	Cream puffs	Fresh, powdered, frozen
	Eclair shells	Milk:
	Flavorings	Fresh liquid, evaporated, powdered
	Care during preparation	
	Temperature	Equipment and tools
	Time	Storage
	Care after preparation	
	Fillings	Varieties and use
	Frostings	
	Icings	
	Decorations	
		Methods of serving
		Cost factors

Suggested teaching materials: See items 2, 17, 20, 30, 55, 91, 97, 98, 105 in appendix B.

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c. Turn onto roadway

(1) Hold steering wheel firmly.
(2) As soon as front of bus is on roadway, return bus to normal position.
(3) Do not allow bus to cross into next lane of the road.

8. Procedures for controlling skid

a. Remain calm.
b. Release accelerator.
c. Do not put on the brakes.
d. Turn front wheel in direction of the skid.

(1) Make smooth turn and not too quickly.
(2) Do not over steer.
(3) This turn will bring front end of bus in line with rear end.

e. Be ready to make the opposite turn as bus begins to re-align with the road.

(1) This turn will need to be made more quickly.
(2) Turn only enough to keep bus in line with the road.

K. **Types of Roads and Speed Limits**

1. Interstate - bus speed limit 55 M.P.H.
2. State Highway and Turnpike - bus speed limit 50 M.P.H.
3. Entering and leaving freeway

a. Use acceleration lane to pick up speed.
b. Yield right of way to roadway traffic - stop only if necessary.
c. Pick an opening in the traffic and move into the flow.
d. To leave the roadway, activate turn signal and move from right lane into deceleration lane.
e. Slow down for exit.
f. Use proper turn signals.

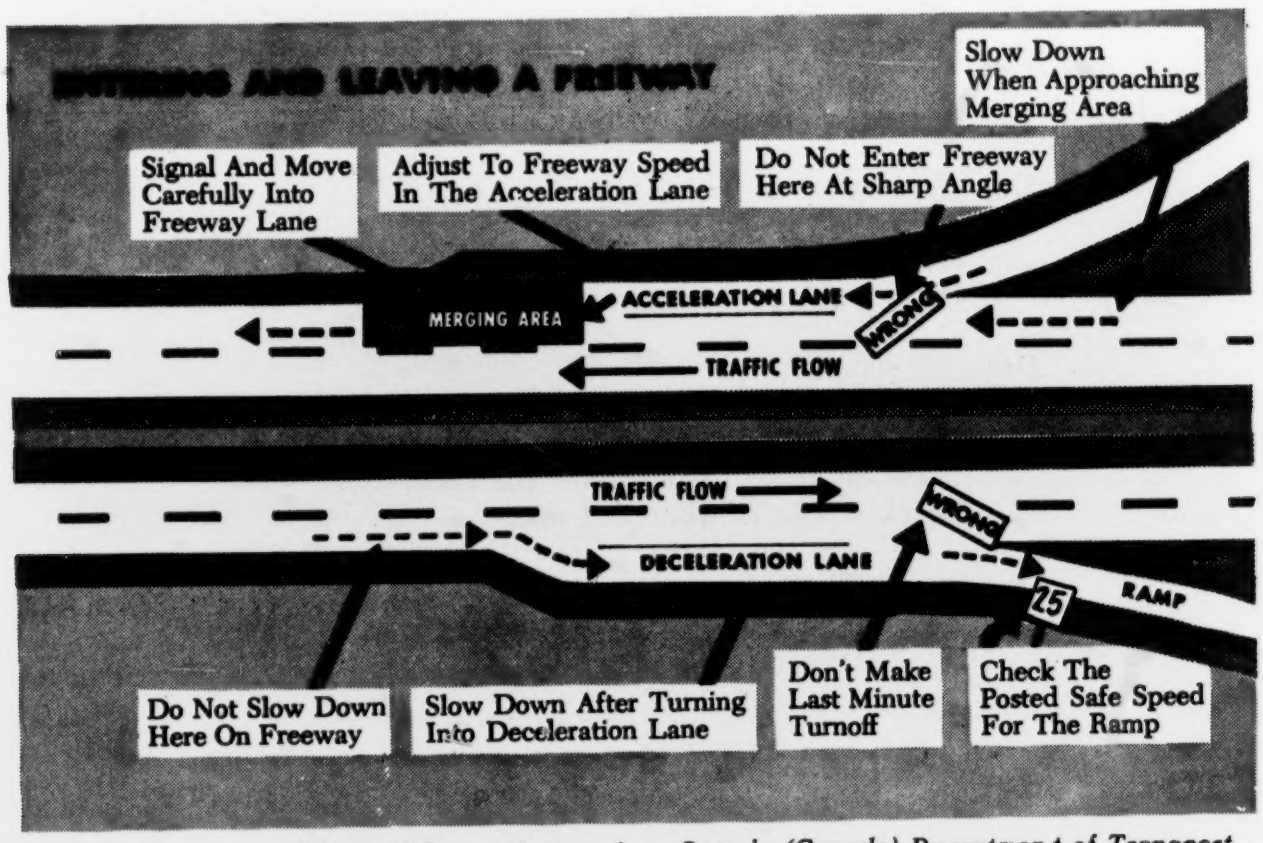

Figure 13 *Diagram from Ontario (Canada) Department of Transport*

4. Multilane and limited access highways - speed limit 50 M.P.H.

   a. These may or may not have short entrance and exit lanes
   b. Entering traffic must yield the right of way.
   c. Exiting traffic must slow down for sharp turn off.

5. Other state roads - bus speed 50 M.P.H.

   a. Seldom have entrance and exit lanes.
   b. Entering traffic must stop.

6. County and township roads - bus speed 50 M.P.H.

   a. The roads will run from good hard surfaced to dirt.
   b. Actual speed will be determined by the conditions of the road.

IV. SUMMARY

Before starting a bus, the driver should have complete vision all around him and be comfortably seated. The driver should be well skilled in the driving fundamentals of the bus before he attempts to drive it. It is his job to transport children and he should do his best to contribute to the safe operation of the bus.

Starting the bus, shifting gears, and double-clutching all require skill and practice. The driver should be able to do this efficiently as he watches the road ahead.

Steering and turning the bus are very important to the driver in his daily routine. He must be able to handle the bus properly whether on a deserted road or a road with heavy traffic. Stopping a bus smoothly and within the limits of safety is another sign of an expert driver. Parking procedures should be known well and practiced.

Loading and unloading presents the driver with additional responsibilities and requires the use of good judgment. He is responsible for the safety of the children on his bus and he must comply to the rules of loading and unloading a bus. He is to get the children <u>to</u> school and <u>from</u> school <u>safely.</u>

Bad weather presents the driver with some additional hazards. However, if the driver realizes the problems involved, he can take the necessary precautions to cope with these hazards.

Procedures before crossing a railroad crossing are extremely important. The driver should watch the railroad signals, open the door, look, and listen carefully up and down the tracks to see if a train is approaching. The parents, supervisors, and children of the community depend on the driver, so he must do his best to operate his bus skillfully and safely to maintain their faith in him.

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GLOSSARY

1. Accident - Unplanned occurence that results in property damage or bodily injury.

2. Activate - Start into motion; to make active.

3. Big Picture - The overall view of the traffic situation through the eyes of the driver.

4. Blind Intersection - Intersection of two roadways at which the driver approaching on one roadway cannot see the traffic approaching on the other roadway.

5. Braking Distance - The distance the bus travels from the time braking action is applied until the bus comes to a stop.

6. Center Line - The line down the center of the roadway.

7. City Ordinance - An authorative decree or direction set forth by a municipal government.

8. Cruising Gear - The highest speed gear of any one transmission.

9. Deactivate - To make inactive; to stop.

10. Divided Highway - Multi-lane highway. The lanes that are open for traffic in one direction are separated from the lanes provided for traffic in the opposite direction by a median strip or a physical barrier.

11. Downshift - Shift from a higher gear to a lower gear.

12. Fanning Action - A light pumping action that will not lock the wheels.

13. Freeway - "A divided multi-lane highway for through traffic with all cross roads separated in grade and with full control of access."

14. Highway- "The entire width between the boundary lines of every way open to the use of the public as a thoroughfare for purposes of vehicular travel."

15. Inspection Decal - An emblem issued by the Ohio State Highway Patrol to be displayed on each side of the bus. Issued by patrol after a safety inspection is made of the bus by the patrol and the bus meets the necessary standards.

16. M.P.H. - Miles Per Hour.

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17. May - To be able; optional.

18. Motor Vehicle - "Every vehicle propelled or drawn by power other than muscular power or power collected from overhead electric trolley wires, except road rollers, traction engines, power shovels, power cranes, and other equipment used in construction work and not designed for or employed in general highway transportation, hole-digging machinery, farm machinery, threshing machinery, hay-baling machinery, and agricultural tractors and machinery used in the production of horticultural, floricultural, agricultural, and vegetable products."

19. Must - Mandatory; essential; shall.

20. O.R.C. - Ohio Revised Code

21. Preventive Maintenance - Maintenance performed with the intent to reduce breakdowns.

22. Roadway - "That portion of a highway improved, designed, or ordinarily used for vehicular travel, except the berm or shoulder. If a highway includes two or more separate roadways the term "roadway" means any such roadway separately but not all roadways collectively."

23. R.P.M. - Revolution Per Minute of Engine.

24. Shall - Mandatory; must

25. Should - Urgent request

26. State Law - A principle governing action or procedure imposed by the Ohio State General Assembly.

27. State Regulation - A principle governing action or procedure imposed by the State Board of Education.

28. Syncro-mesh Transmission - In a syncro-mesh transmission there is a built-in unit that brings gears into position of alignment for easy shifting as soon as clutch pedal is depressed.

29. Traffic Control Device - "All signs, signals, markings, and devices placed or erected by authority of a public body or official having jurisdiction, for the purpose of regulating, warning, or guiding traffic, including signs denoting names of streets and highways."

30. Vehicle - "Every device in, upon, or by which any person or property may be transported or drawn upon a highway, except devices moved by power collected from overhead electric trolley wires, or used exclusively upon stationary rails or tracks, and except devices other than bicycles moved by human power."

31. Will - A command; an order.

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32. Warning Lights (Flasher Lights) - Red lights alternately flashing; used for student pick-up, student discharge, and at railroad crossing.

33. Marker Lights (Clearance Lights) - The amber lights located on upper front corners of bus; red lights on upper rear corners.

34. Four-Way Hazard Flashers - Are activated by hazard switch. Activates all turn signals simultaneously to warn approaching traffic of road hazard.

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THE FINAL REWARD

"You got here three minutes early!"

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Course of Study

CONSTRUCTION

SUPERVISION AND INSPECTION

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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STRUCTURAL SERIES № 1

CALIFORNIA STATE DEPARTMENT
OF EDUCATION,
Bureau of Industrial Education
Sacramento, 1966

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STRUCTURAL SERIES #1

This course of study was prepared by the Bureau of Industrial Education at the request of the industry, to meet the needs of persons engaged in the supervision and inspection of buildings under construction. Structural Series No. 1 covers one semester's work. This material was developed by the Education Advisory Committee of the California Council of Construction Inspectors Association. This publication is in draft form and will be refined by the Statewide Committee after it has been tested by various instructors.

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L. Desserts

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to make desserts:	Preparation and care of fruits used in desserts	Storage of fruit:
The understanding and application of recipes, formulas, and procedures		Fresh
		Dehydrated
		Frozen
Gelatin desserts	Preparation and procedure:	Equipment, utensils, tools
	Flavoring	Kinds:
	Temperature	Whipped
	Time	Molded
	Care during serving	Fruited
		Methods of serving
	Care after serving period	Storage
Puddings	Preparation and procedure:	Utensils and equipment
	Flavoring	
	Care while cooking	Varieties:
	Temperature	Cream puddings
	Time	Fruit puddings
		Custards
	Care after cooking	Storage:
		Related science
		Bacteriology
		Methods of serving
		Garnishes
Sauces for desserts	Preparation and procedure:	Preparation precautions
	Flavoring	Equipment
	Care in cooking	Cooked sauces:
	Temperature	Varieties
	Timing	Uncooked sauces:
		Varieties
	Testing for doneness	Methods of testing
		Methods of serving
		Storage of hard sauces

Suggested teaching materials: See items 14, 15, 20, 30 49, 55 in appendix B.

M. Appetizers, Canapés, and Hors d'Oeuvres

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare cocktails:	Preparation and care of materials	Equipment
The understanding and application of recipes, formulas, and procedures		Storage
		Refrigeration
		Cleaning
Fruit, fruit juice, and vegetable juice cocktails	Mixed fresh fruits	Glassware
	Mixed canned fruits	Silverware
	Fruit supremes	
	Melon supremes	
	Juice cocktails:	Garnishes
	Tomato	Seasoning
	Mixed vegetable juices	Chilling
	Sauerkraut juice	
	Mixed fruit juices	
	Berry juices	Varieties

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COURSE OUTLINE
CONSTRUCTION INSPECTION AND SUPERVISION

STRUCTURAL SERIES #1

UNIT I. CONSTRUCTION CONTRACT DOCUMENTS AND PLAN READING (Two three-hour sessions)

A. Objective

1. Objective of this unit is to review for the student the contract documents, their general organization, and to explain the role of the civil and structural plans and specifications as part of these contract documents. The inter-relationship between the architectural drawings and the engineering drawings will be discussed. Considerable emphasis will be placed on the detailed organization of the structural engineering drawings and the proper procedure to follow in getting information from the drawings.

B. Contract Documents

1. Bidding Documents
2. Agreement or Contract
3. Specifications
   a. General Conditions
   b. Special Conditions
   c. Detailed Specifications
4. Plans - Scope of Work Covered
   a. Architectural
   b. Civil
   c. Structural
   d. Mechanical
   e. Electrical
5. Role of Codes and Standards as Part of the Plans

C. General Organization of Trade Technical Specifications

1. Scope of Work
2. General Requirements
3. Materials
4. Workmanship

D. General Organization of Plans

1. Organization of Plans
   a. Order of Presentation
   b. Method of Cross Referencing
   c. Development of Views, Sections, and Details
   d. Use of General Notes, Symbols, and Typical Details
2. Architectural Drawings
   a. Drawing Index
   b. Site Plan
   c. Plans, Elevations, Sections, and Details
   d. Finish Schedules
   e. Door and Window Schedules

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3. Civil Engineering Drawings
   a. Topographic and Boundary Survey
   b. Grading Plan
   c. Site Work Plans
   d. Public Works Plans
   e. Coordination with Architectural and Engineering Plans
4. Structural Engineering Drawings
   a. Relationship with Architectural and Engineering Drawings
5. Mechanical Engineering Drawings
   a. Plumbing
   b. Heating and Ventilating
   c. Coordination with Architectural and Engineering Drawings
6. Electrical Engineering Drawings
   a. Line Diagrams
   b. Detailed Drawings
   c. Coordination with Architectural and Engineering Drawings

E. Detailed Organization of Structural Engineering Drawings (Suggested start of second session)

1. Foundation Plans
   a. Spread and Continuous Footings
   b. Pile and Caisson Foundations
2. Framing Plans
   a. Wood
   b. Steel
   c. Concrete
3. Framing Elevations
   a. Wood
   b. Steel
   c. Masonry and Concrete
4. Sections and Details
5. Typical Details and General Notes

F. Supplemental Drawings

1. Structural Shop Drawings
   a. Reinforcing Steel
   b. Structural Steel
   c. Precast Concrete
   d. Others
2. Architectural Shop Drawings
   a. Curtain Walls
   b. Doors and Windows
3. Equipment Drawings
4. As-Builts

INSTRUCTIONAL AIDS

Contract Documents

1. Samples of Standard Forms for General Conditions
2. Contracts, Specifications and Engineering Relations by Mead, Mead, and Ackerman; McGraw Hill Publishers, 1956.

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3. For studying plan organization, the preferred procedure will be to have a typical contract set of quarter size drawings for each pair of students.
4. Drawings may be available on 35 mm film for projection on the screen.

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UNIT II. SITE LAYOUT (One three-hour session)

A. Objective

1. Objective of this unit is to provide a cursory review of the site layout problem. This instruction shall include a brief description of surveying techniques and principles in preparation of the site and for operations during the construction period. Frequent reference to significant data as found on engineering plans is important to comply with the overall objectives of this unit.

B. Interpretation of Plan Requirements

1. Plot and Site Plans
   a. Property Lines and Dimensions
   b. Contours and Profiles
2. Existing Utilities
   a. To remain in place
   b. To be relocated or remodeled
   c. To be removed
   d. To be abandoned in place
3. Existing Structures and Improvements
   a. Removed
   b. Remodeled
4. Adjacent Structures and Improvements
5. Soil Representations
   a. Soil log and borings
      (1) Water Table
      (2) Stability
      (3) Classification
   b. Excavation and Grading
      (1) Erosion control
      (2) Stability of vertical and slope cut
      (3) Ground water control
6. Sequence of Operations

C. Principles of Surveying

1. Equipment and Tools
   a. Tape
   b. Level
   c. Transit
   d. Rod
   e. Special Equipment
2. General Principles
   a. Measurements
      (1) Linear
      (2) Angular
      (3) Leveling

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M. Appetizers, Canapès, and Hors d'Oeuvres—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
How to prepare cocktails—Continued		
Fish and seafood cocktails	Preparation and care of fish and seafood products used in cocktails	Storage Temperature
	Shrimp cocktail: Island shrimp Jumbo shrimp	Cooking Peeling Cooling Holding time Cost factors
		Preparation precautions Equipment Glass and silverware
Sauces for shrimp cocktails	Preparation and seasoning	
	Types of sauces: Hot (horseradish, pepper) Bland (mayonnaise base) Preparation process	Precautions in preparation Storage after preparation Ingredients
	Crab meat cocktails	Preparation precautions Equipment Glass and silverware
How to make canapés: The understanding and application of recipes, formulas, and procedures	Method of preparation: Treatment of toast or bread Other ingredients: Fish Caviar Seafood Shrimp Gooseliver Cheeses Meats	Precautions: Freshness Temperature Kinds of breads Toasting Use of aspic Method of service Garnishes Arrangement Utensils
How to make hors d'oeuvres: The understanding and application of recipes, formulas, and procedures	Kinds or varieties: Hot: Bacon-wrapped: Pre-cooking Final preparation Bouchees: Puff paste patties Fillings Others: Pastes Stuffed or filled	Varieties: Fish, meat, vegetable, seafood, chicken livers Baking Precautions in filling patties Method of preparing Holding after preparation Serving techniques

Suggested teaching materials: See items 20, 21, 34 in appendix B.

b. Control Points
   (1) Monuments
   (2) Stakes and Ties
   (3) Bench marks
   (4) Lot lines
c. Line and Grade
   (1) Stakes and Markers
   (2) Stationing
   (3) Center line
d. Field Notes
e. Grade Sheets

D. Site Conditions

1. Access to Site
2. Topography
3. Drainage Patterns
4. Temporary Construction Facilities
   a. Utilities
   b. Work Space
   c. Storage and Stockpiling
5. Public Convenience and Safety
   a. Detours
   b. Protective Works
      (1) Utilities
      (2) Adjacent structures and improvements
      (3) Fences

UNIT III. BASIC PRINCIPLES OF STRUCTURAL ENGINEERING AND MECHANICS OF MATERIALS

A. OBJECTIVE

In the coming meetings of this course, the basic requirements for good construction of foundations, concrete work, wood framing, steel framing and masonry work will be covered. These discussions will generally follow a basic pattern. The first item to consider will be the materials that go into each type of construction. They all have specified standards which they must meet. The second step will be to outline acceptable construction procedures for putting these materials together so that they can produce the quality of construction desired.

Now it is important that you understand why these material standards must be met and why the specified quality of construction must be achieved. For example, the specifications may call for all concrete in floor beams to have a twenty-eight day compressive strength of 4000 pounds per square inch and the drawings may show a particular beam to be such and such a size and to be reinforced with two number 8 steel bars conforming to ASTM Specification A432 in such and such location. If you have some understanding of how the designer intended this material to act in supporting its intended loading, it will emphasize the importance of getting the grades of material specified and of controlling the placing of this material so that the beam will have the load carrying capacity the design engineer intended.

In addition, all construction people are called on to do some of their own engineering in the course of putting a building together. When erecting the simplest shoring, temporary bracing or providing rigging for lifting, an understanding of how structural elements (beams, columns, tension ties, etc.) support loads will aid in making a safer and more economical construction system.

It is with this in mind that we present here some of the basic principles of structural engineering. It is not intended that the man doing the inspection will be called on to provide an engineering analysis of the structures he is watching go together. An understanding, however, of the engineering principles used to arrive at the details shown on the plans and to set forth the requirements in the specifications will be useful in interpreting these requirements and in following them out.

This discussion will cover the loads and forces which act on structures and how they are distributed to the various parts of the building such as beams, columns, and bracing elements.

B. LOADS ON STRUCTURES

In the planning of any new structure, be it a building, a bridge, or a dam, one of the primary objectives is that it remain standing during its expected service life.

Most building codes present this as a preamble. Section 102 of Title 21, the "Building Code" for public school buildings, requires that "Every building and all structural parts thereof shall be of sufficient strength to support the estimated or actual imposed loads, including lateral forces, without exceeding the allowable working unit stresses specified in these rules and regulations for the material, -----, or permissible combinations of materials of which said building and structural parts thereof are constructed;". Section 2302 of the Uniform Building Code states a similar requirement.

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The first consideration, then, for the structural analysis of a building is to determine what loads will act on it and secondly how these loads will be distributed to its various parts.

One job the structure must do is to support its own weight and the weight of all permanent stationary construction becoming part of the building. This type of loading is defined as "dead" load. Probably this term "dead" was felt to apply because these loads would remain more or less permanently in place on the structure as opposed to other types of forces on the structure which might not act continuously or which might vary in amount and direction.

The service loads, caused by various occupancies, are termed "live" loads and are intended to represent the weight of equipment and occupants on floors and possible snow or water on roofs.

Another very important class of loading is the "lateral" loading which includes earth pressure, wind and earthquake forces.

C. FORCES AND EQUILIBRIUM

Force is that which produces, or tends to produce motion. In buildings and other structures we are interested only in forces at rest or in equilibrium. Equilibrium is that condition in which forces acting upon a body balance one another.

The force by which all bodies are attracted to the center of the earth is the force of gravity. The magnitude of the force of gravity is the weight of the body.

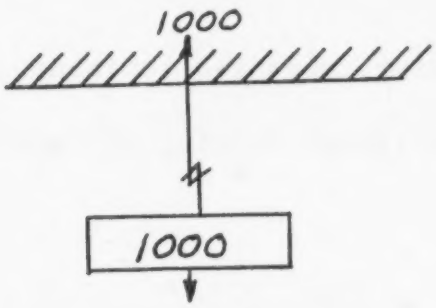

Fig. (1) The weight of the 1000# block is a force downward, and requires a 1000# upward force at the hook to be in equilibrium.

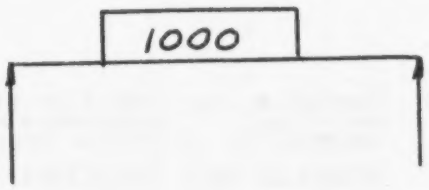

Fig. (2) The beam supporting the 1000# load is held in equilibrium by upward forces at the supports, called reactions. The sum of the two reactions upward must equal the downward force, namely 1000#.

D. STRESSES AND STRAINS

These two terms are often used erroneously and should be clarified. When a force acts on a body, resisting forces are set up in the fibers of the body. These resisting forces are called stresses, a stress being an internal resistance in a body to an external force.

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Total Stress on a section through a body is the total internal force on the section measured in pounds, tons, etc.

Unit Stress is the stress per unit area of the section, and is measured in pounds, per square inch (psi), tons per square foot, etc. Unit stress is usually the value referred to in engineering. Building Codes set up allowable unit stresses for all building materials, wood, steel, concrete, masonry, and foundation soils. The engineer must stay within these allowable stresses in designing members.

When a body is subjected to a force, there is a change in the size or shape of the body. These changes in dimensions are called deformation, or strain. They may be very small, but are always present, no matter how small the force.

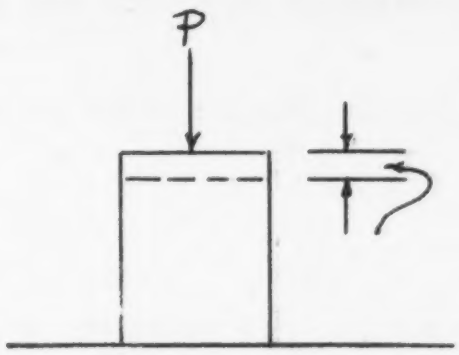

Strain or Deformation

Fig. (3) When a block is compressed under a force P, it shortens. The decrease in length is the strain, or deformation.

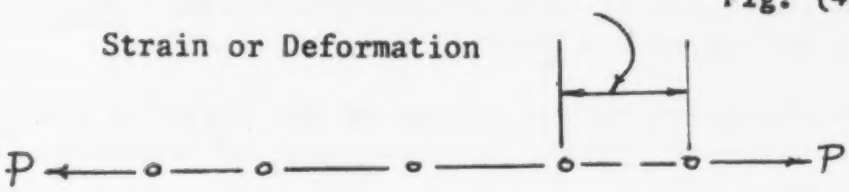

Strain

Fig. (4) When a rod is stretched, it lengthens. The increase in length is the strain.

Total Strain is the total elongation, or shortening, measured in inches, etc.

Unit Strain is the total strain divided by the original length, measured in inches per foot, centimeters.

Type of Stresses

There are three types of simple stresses, known as tension, compression and shear.

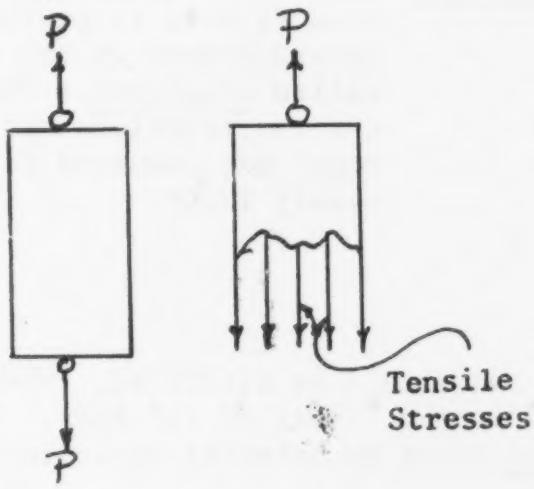

Fig. (5) Tension, or tensile stress is caused by a force tending to stretch and lengthen the member.

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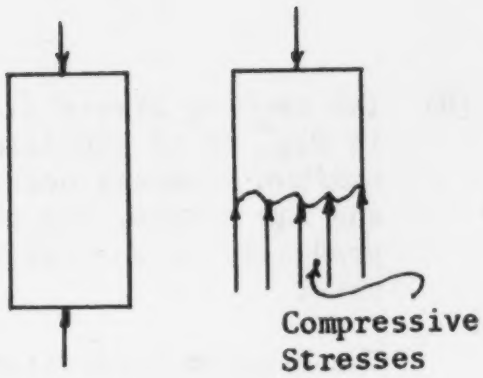

Fig. (6) Compression, or compressive stress is caused by a force which tends to shorten or push a piece together. A post carrying an axial load is in compression.

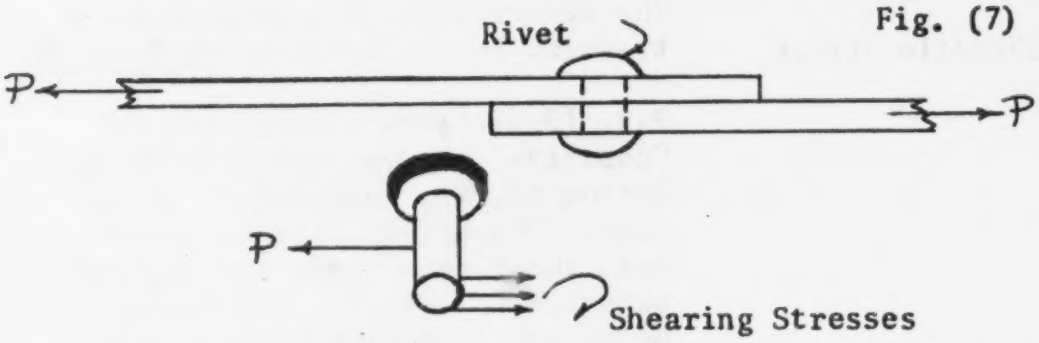

Fig. (7) Shear or shearing stress is caused by equal and opposite forces which tend to cause a sliding action of one part of the material past another.

The rivet is said to be in shear.

E. BENDING AND COMBINED STRESSES

So far we have talked about "direct" stresses, resulting from a pull or push along the axis of a member, or shearing stresses from a force at right angles to the axis. Many structural members have several types of stresses working at the same time.

A beam is a member that resists loads by bending. The stresses produced by the bending are called bending stresses or flexural stresses, but are actually partly compressive stress and partly tensile stress.

A simple beam with a load W is shown in Fig. (8). Before the load is applied the beam is straight, but deforms to the dotted position after loading. It can easily be seen that the bottom flange must stretch, and the top must compress. Evidently there is a point where the stress changes from compression to tension, and must therefore equal zero. This is called the neutral axis.

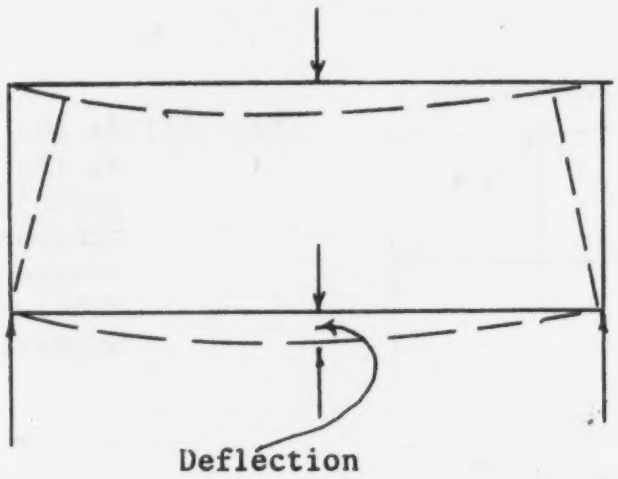

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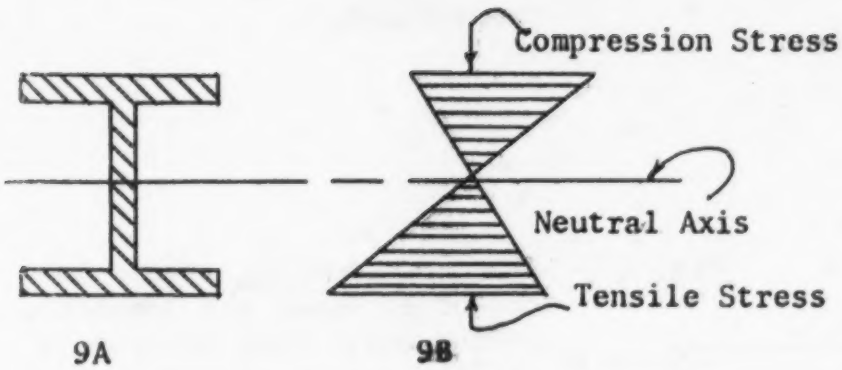

Fig. (9) The bending stress diagram shown in Fig. (9-a) indicates how the maximum stresses occur at the top and the bottom, and change gradually to zero at the neutral axis.

These maximum conditions are called extreme fiber stresses, and are the ones that are designed for by the engineer.

The deformation of a beam under a traverse force is called deflection.

Fig. (9-b) shows a condition of "positive" bending (tension on the bottom fibers, compression at the top). "Negative" bending occurs when the fibers above the neutral axis are in tension, and those below are in compression. (See "cantilever Beams" under BEAM TYPES, next section)

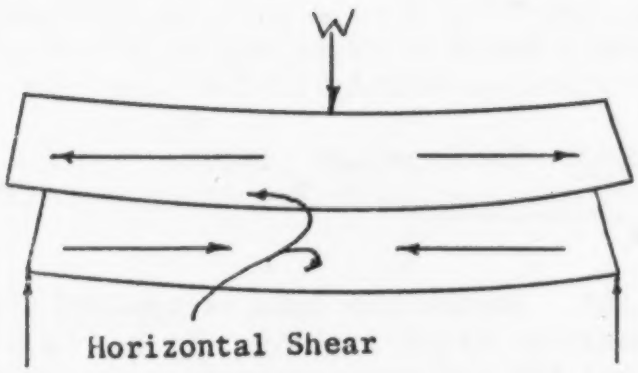

Fig. (10) In addition to bending stresses, the beam has shear stresses.

Vertical shear forces are the force W downward and the reactions upward. The tendency of the longitudinal fibers to slip past each other is called horizontal shear.

The chords of a bruss act similarly to the extreme fibers of a beam.

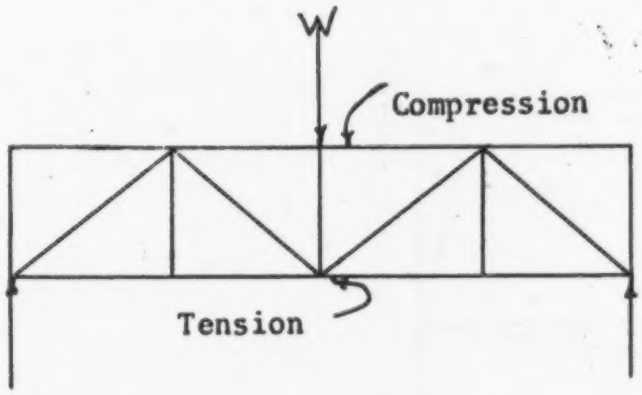

Fig. (11) As the truss deflects under load W, the top chord goes into compression, and the bottom into tension. This is true of all trusses, except those that are continuous over more than two supports.

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F. BEAM TYPES (Classified by kind of support)

1. Simple beam

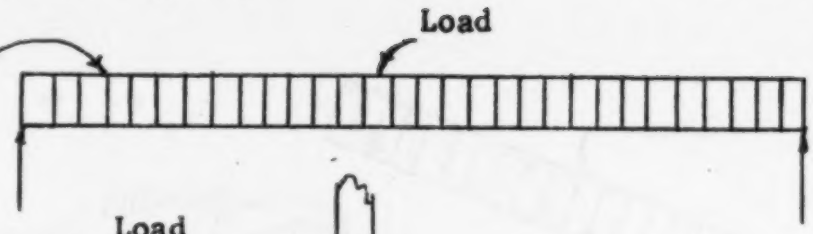

2. Cantilever

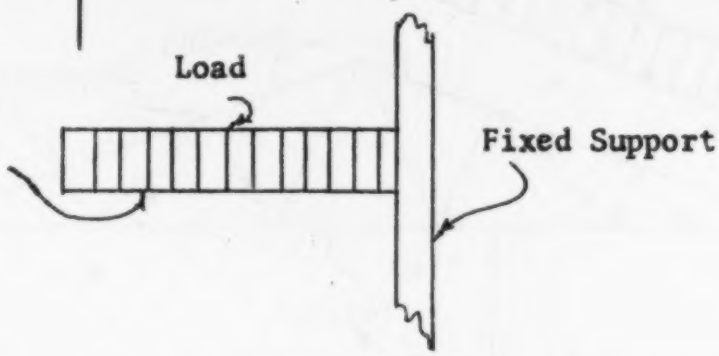

3. Beam overhanging on support

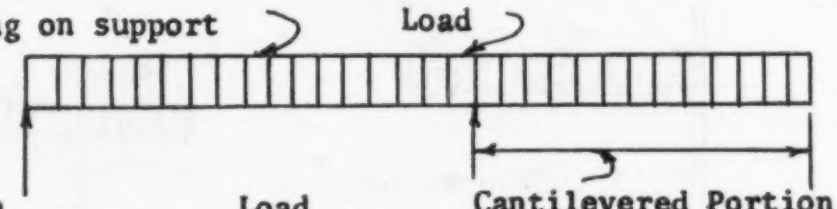

4. Continuous beam

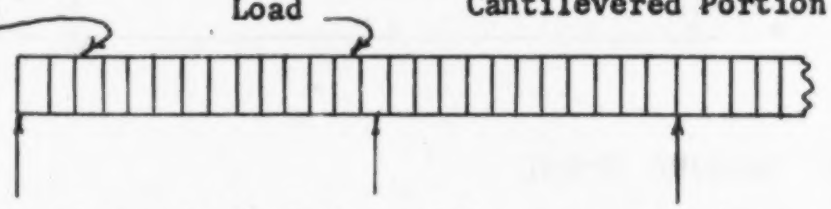

Beams do not have to be horizontal. A vertical window mullion acts as a beam to resist wind load. If the mullion helps support the roof, it also has compression. See Fig. (12).

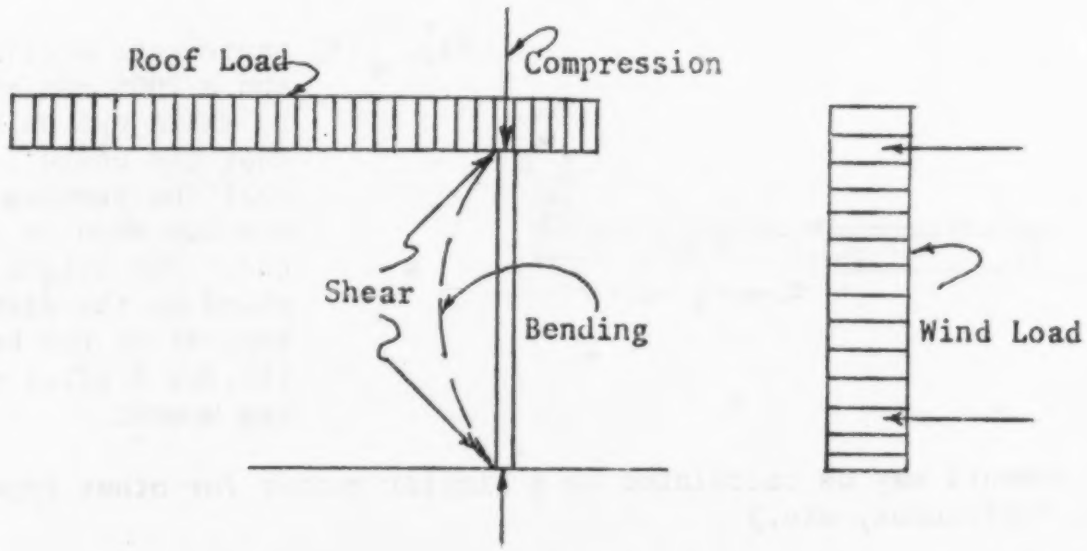

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Fig. (13) shows some obvious examples of different types of stress in a building.

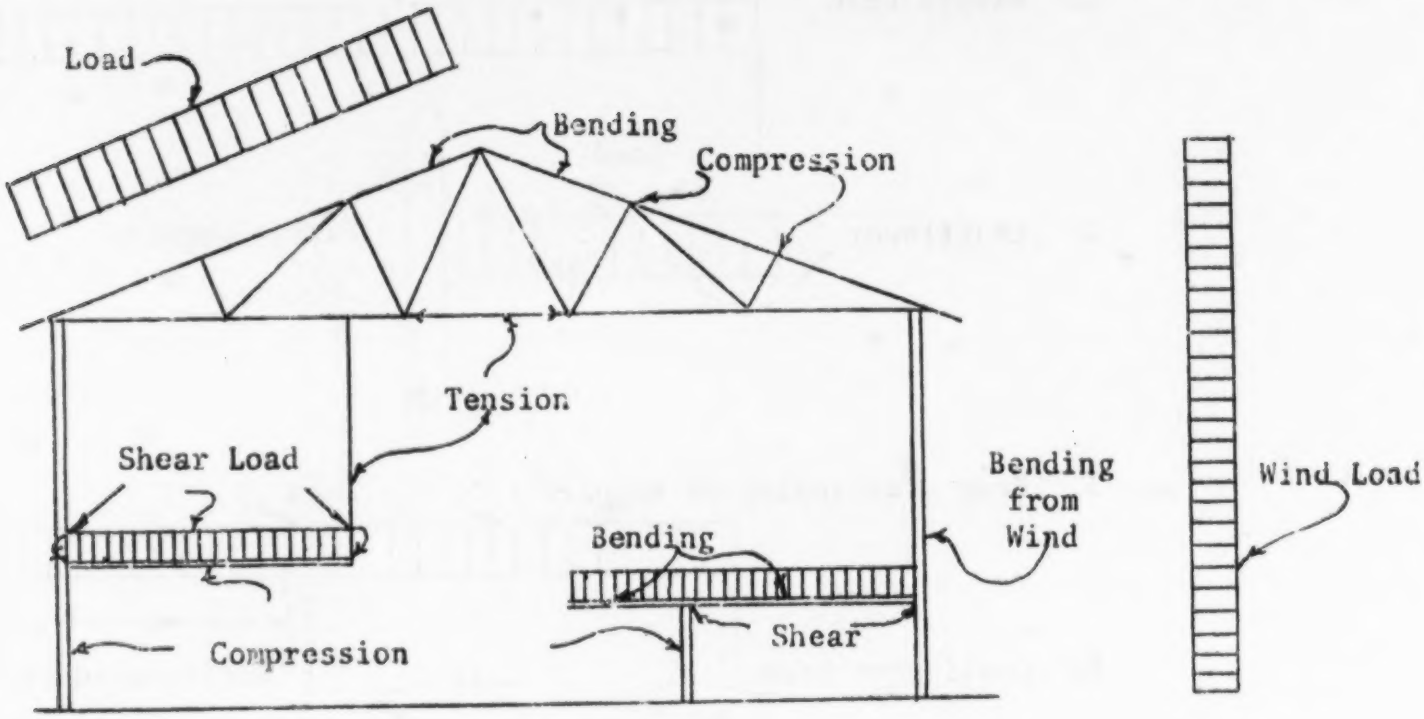

G. BENDING MOMENT

In the same way as we speak of the direct load in pounds or the unit stress in pounds per square inch, so we have the term bending moment to designate the measure of bending action. A moment is the tendency of a force to cause rotation about a given point or axis.

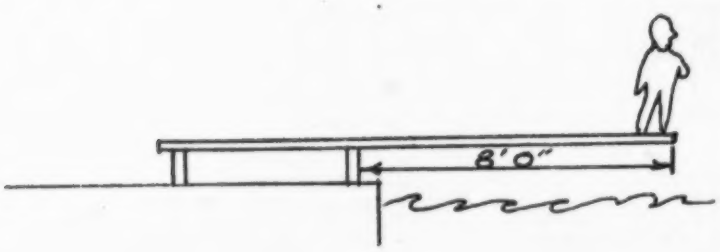

Fig. (14) represents a diving board 8' long, and a 200# man about to dive. As he walks out on the board we can see that the board is "bending", and that the bending increases to a maximum when he reaches the outer end. The weight of the man multiplied by the distance from the support is the bending moment. 200# (lb.) x 8 (ft.) = 1600 ft.-lb. bending moment.

Bending moments may be calculated in a similar manner for other types of beams (simple, continuous, etc.)

The bending moment is used to calculate the bending stresses in beams.

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H. MOMENT OF INERTIA AND SECTION MODULUS

These properties of a beam, along with the bending moment, are required before bending stresses can be obtained. The term "moment" in moment of inertia should not be confused with bending moment. The moment of inertia of a beam is complicated in its derivation, but depends only on the physical dimensions of the cross section of the beam. The larger and deeper the beam, the greater the moment of inertia, and the greater the resistance to bending moment. Section Modulus is the Moment of Inertia divided by the distance from the axis to the extreme fiber.

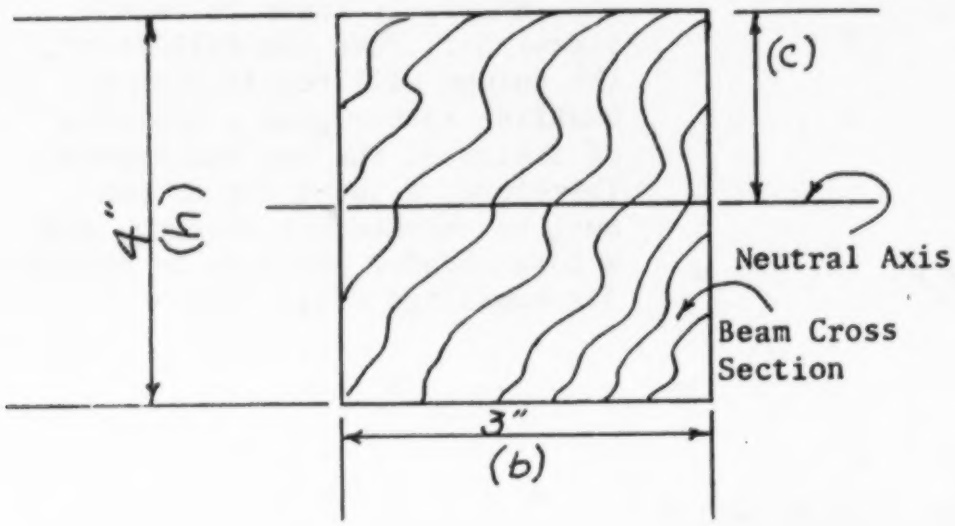

Fig. (15) The moment of inertia of any rectangular cross section is $\frac{bh^3}{12}$.

For this beam, moment of inertia $(I) = \frac{3x(4)^3}{12} = 16$ in.

Distance (c) from neutral axis to extreme fiber = 2 inches.

Therefore, Section Modulus (S.M.) $(S.M.) = \frac{16}{2} = 8$ in.

Beam bending stresses may be calculated by means of a formula involving bending moment and Moment of Inertia or Section Modulus.

$$\text{Bending stress} = \frac{\text{(Bending Moment)}}{\text{Moment of Inertia}} \times \text{extreme fiber distance c)} = \frac{Mc}{I}$$

$$\text{or Bending Stress} = \frac{\text{Bending Moment}}{\text{Section Modulus}} = \frac{M}{S.M.}$$

It can easily be seen that the larger the moment of inertia or section modulus, the smaller the bending stress. Deflection of a beam is likewise cut down as the moment of inertia increases.

I. BEARING AND COLUMN ACTION

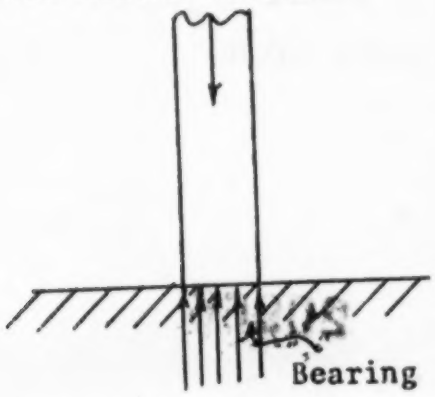

Fig. (16a) The column shown in Fig. (16a) is in compression, and exerts a a bearing force on the floor, which the floor in turn exerts upward on the end of the column. Allowable bearing stresses are given in Building Codes, and

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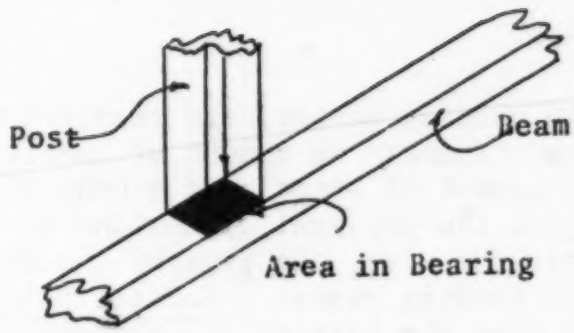

vary with different materials as do the other stresses. An excessive bearing stress tends to crush the fibers of the material in the immediate vicinity of the application of load. (Fig. 16b)

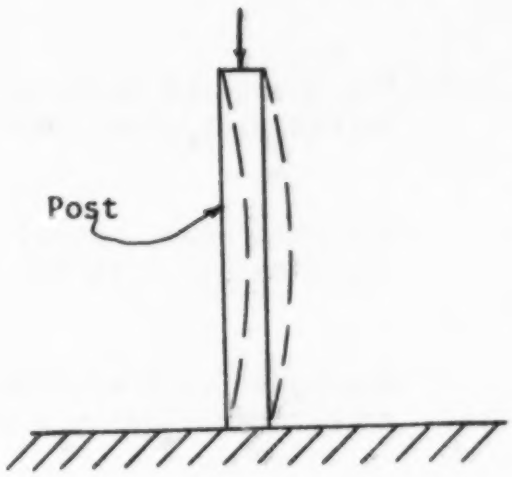

Fig. (17) However, as a column gets longer and longer, it tends to buckle sidewards. Then the failure of the column will result from a buckling rather than a crushing of fibers at the top and bottom. Therefore, a short fat column must be checked for bearing, and a long slender one must be checked for buckling. (Fig. 17)

J. YIELD POINT, ULTIMATE STRENGTH, SAFETY FACTOR

When a force is applied to a member it deforms, and when the force is removed, the member springs back to its original dimension, the same as a rubber band. The stresses are said to be within the elastic limit. If forces are increased until the member no longer springs back to its original dimensions, but stays permanently deformed, the stresses are said to have passed the yield point. If still further force is applied until the member is completely broken or collapsed, the ultimate strength has been exceeded.

Neither of these latter two conditions can be tolerated in structures, so all stresses must be in the elastic range. The Safety Factor of a member is the numerical ratio between the ultimate strength (or sometimes yield point) and the actual stress in the member. If a concrete member has an ultimate strength of 300 psi and is stressed to 1000 psi, the ultimate strength safety factor is $\frac{3000}{1000} = 3$.

If the yield point of a steel member is 33,000 psi, and the member is stressed to 20,000 psi, the yield point factor is $\frac{33,000}{20,000} = 1.65$. Thus Safety Factors may be referenced to either ultimate strength or to yield point.

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Area II

SCIENCE RELATED TO FOOD PREPARATION

Area II outlines the essential scientific knowledge applicable to food preparation. The student must have an understanding of the relationship between cooking as an art and the several sciences.

Food production people need a working knowledge of the chemical and physical changes that take place in the preparation and service of food. Hygiene and sanitation play an important role in the storage of food, the prevention of food poisoning, and the control of rodents and insect infestations. The instructor should teach students to realize that high standards of personal hygiene are essential in food service. The relationship between good personal health habits and food sanitation should be emphasized.

Area II contains three subdivisions:

A. Nutrition.

B. Food Chemistry.

C. Hygiene and Sanitation.

Related information important to an understanding of sound cooking procedures is presented for each subdivision.

A. Nutrition

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To know the basic principles of nutrition	Nutrition as a science	Soil conditions, climatic conditions, and preparation methods which influence food values
	Nutrition as related to food preparation and service	
	Function of food	Metabolism
	Importance of food and diet to health	
To know the value of nutrients	Carbohydrates:	
	Composition and sources	
	Classification	
	Effect of deficiency or excess	
	Effect of cooking	
	Digestibility	
	Fats:	
	Nature and composition	
	Sources	
	Digestibility	
	Effect of cooking	
	Proteins:	Quality proteins
	Composition	
	Sources	
	Function	
	Effects of deficiency	
	Effect of cooking on digestibility	
	Acceptability	
	Minerals:	
	Sources	
	Functions	
	Dietary requirements	
	Effect of shortage	
	Water:	
	A nutrient agent	
	Food sources	
	Body functions	

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SESSION 2

K. DEAD LOAD

The determination of dead loading for a member in a structure is relatively simple. It consists basically of finding the volume of material for each element of the structure and then multiplying this volume by the unit weight of the material. Take an isolated concrete beam for example. (Fig. 18)

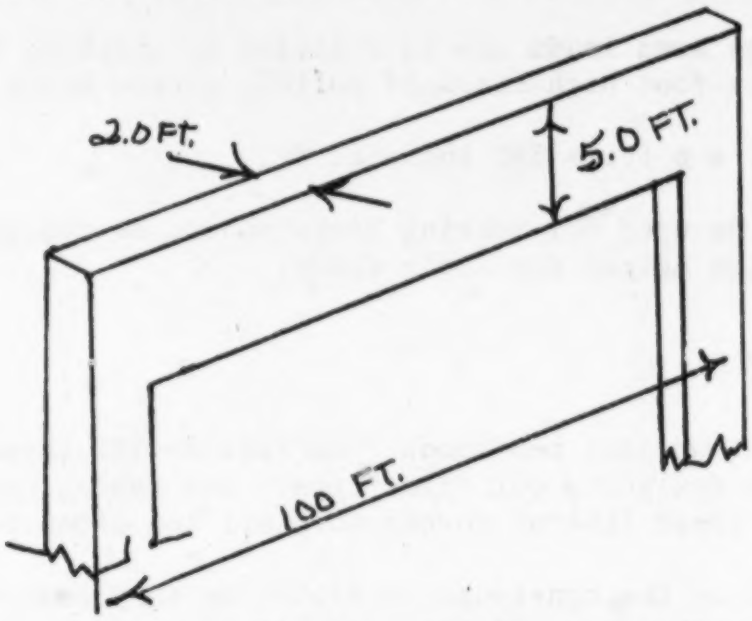

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This beam is seen to be 2.0 feet wide by 5.0 feet deep by 100 feet long. First we compute its volume per foot of length using cubic feet as a convenient unit of measurement.

Volume = 2.0 ft. x 5.0 ft. x 1.0 ft. = 10 cu. ft./$_{ft.}$

Next we determine the unit weight of material. We can find in various handbooks that heavy rock concrete weighs approximately 150 pounds per cubic foot of volume.

The dead load per linear foot of beam is then:

W = 150 lbs. / cu. ft. x 10 cu. ft./$_{ft.}$ = 1500 lbs./$_{ft.}$

L. LIVE LOAD

The live load or service load for floors and roofs would normally be taken from a building code which has compiled weights of probable concentrations of people and/or equipment per square foot of area for various uses and occupancies. The amount of this loading depends on the loaded area tributary to the member being analyzed. Some representative values taken from Title 21 are listed below:

Type of Loading	Pounds per square foot
Roof Loads	Snow load but not less than min. of 12-20
Classrooms	50

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Type of Loading (Contd.)	Pounds per square foot
Assembly Halls (level floor) . .	100
Storage Area	Actual loading but not less than 100

An example of storage area loads can be realized by checking the weight of stacked books. A six-foot high stack of solidly packed books weighs:

65 lbs./cu. ft. x 6 ft. = 390 lbs./sq. ft.

A mezzine, then, to be used for storing books should be designed for, say, 300 lbs. per sq. ft. which allows for aisle space.

M. LATERAL LOADS

The general statement we just mentioned from Section 102 emphasizes the inclusion of lateral forces in designing our structures. The reason for this emphasis is that the effects of these lateral forces have all too often been forgotten in the past.

It seems that people in the construction field, be they designers, contractors, or inspectors, have a pretty good understanding of the effect of gravity or "vertical force" loading. After years of experience they develop a "feel" for its action on structures and usually have a basic understanding of how a building should be put together to resist the action of these vertical forces.

Through all recorded history, however, we find that builders have had trouble with the action of lateral forces such as wind, earthquakes and water. Possibly this is because these particular forces of nature in their more violent forms occur infrequently and for short periods of time. As a result, it was difficult to study the ways in which the high winds, the hurricanes and our earthquakes acted to destroy buildings.

Today we can describe these forces in terms of "idealized" loadings and show how our buildings can be put together to resist them.

N. EARTHQUAKE LOADINGS

The action of earthquakes or oscillating ground motions on buildings can best be demonstrated by "idealizing" our typical building into a simple frame as shown in Fig. (19).

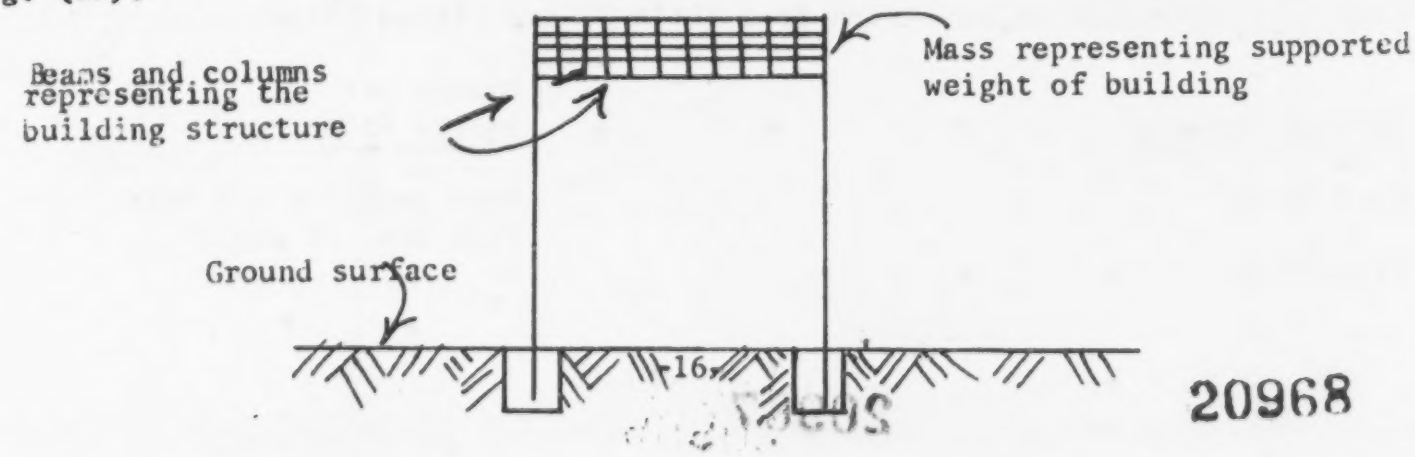

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By "idealizing" the action of the earthquake into a simple horizontal motion of the ground surface, its effect on our "building" can be studied. Consider first what happens when the ground moves slowly back and forth under the building. The mass supported on the columns moves with the ground. There is relatively little deflection or bending of these columns. The deflection that does occur can be shown as being equivalent to that of a small horizontal force applied to the mass (Fig. (20a). Now if the ground is moved rapidly, the mass lags behind and the deflection or bending of the columns is large. This action can be represented then by a larger force which, as shown in Fig. 20b, will be proportional to the deflection.

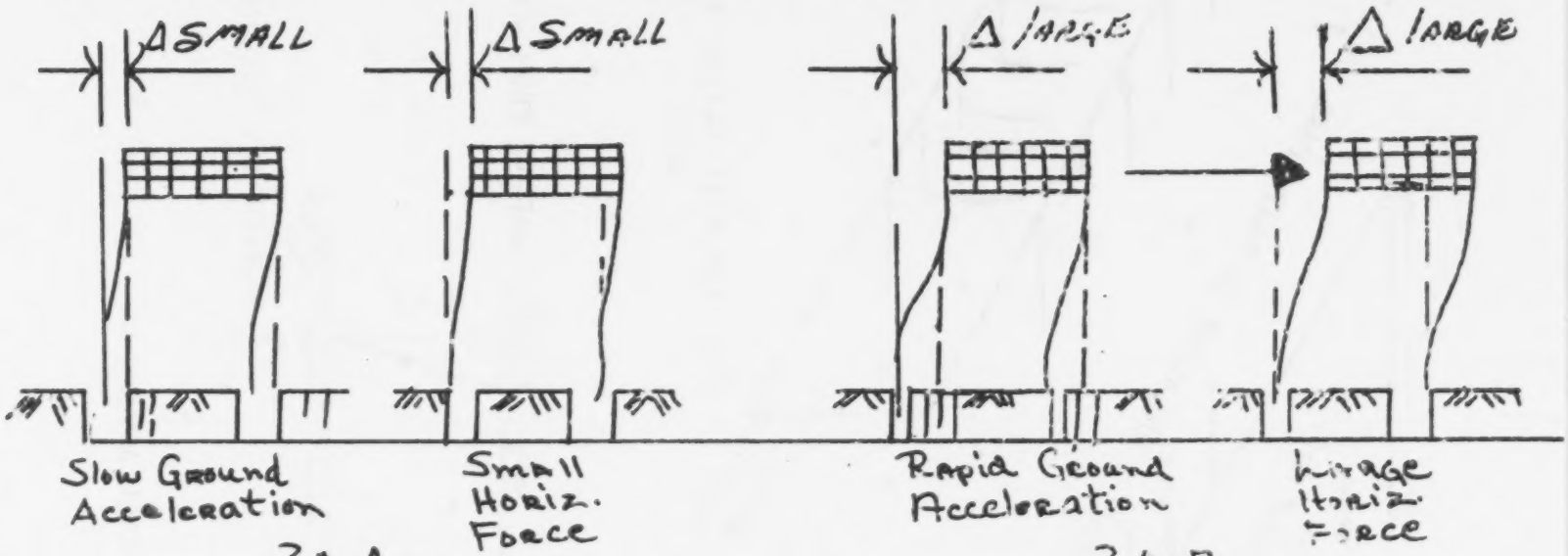

20 A

20 B

Thus by using the proper magnitude of horizontal force and applying it on our structures at points which will give equivalent deformations, we can represent our earthquakes by a system of static forces. A similar example of the type of forces involved is one we feel every day when we bring our car to a stop, especially if we are wearing a safety belt and stop suddenly.

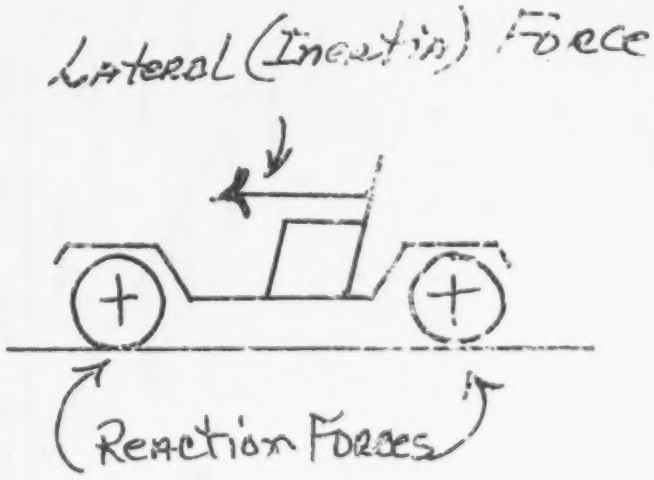

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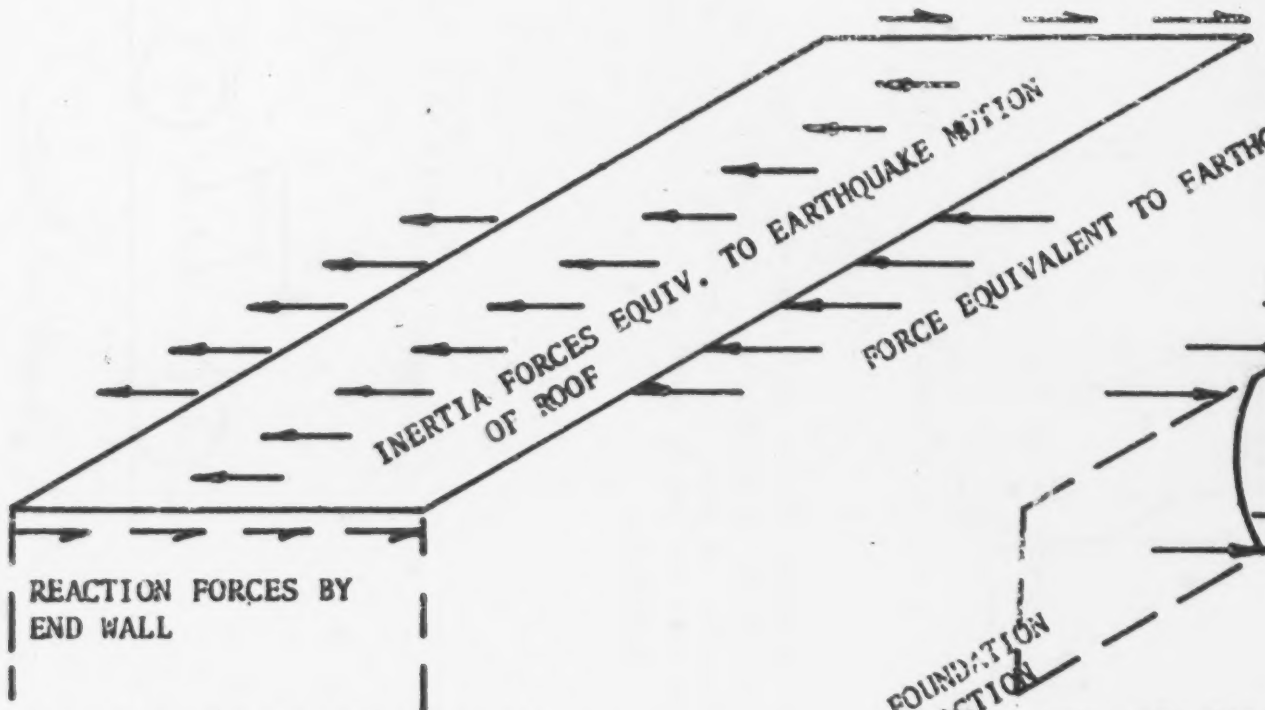

FIG. 23B - ROOF ACTION AS HORIZONTAL BEAM

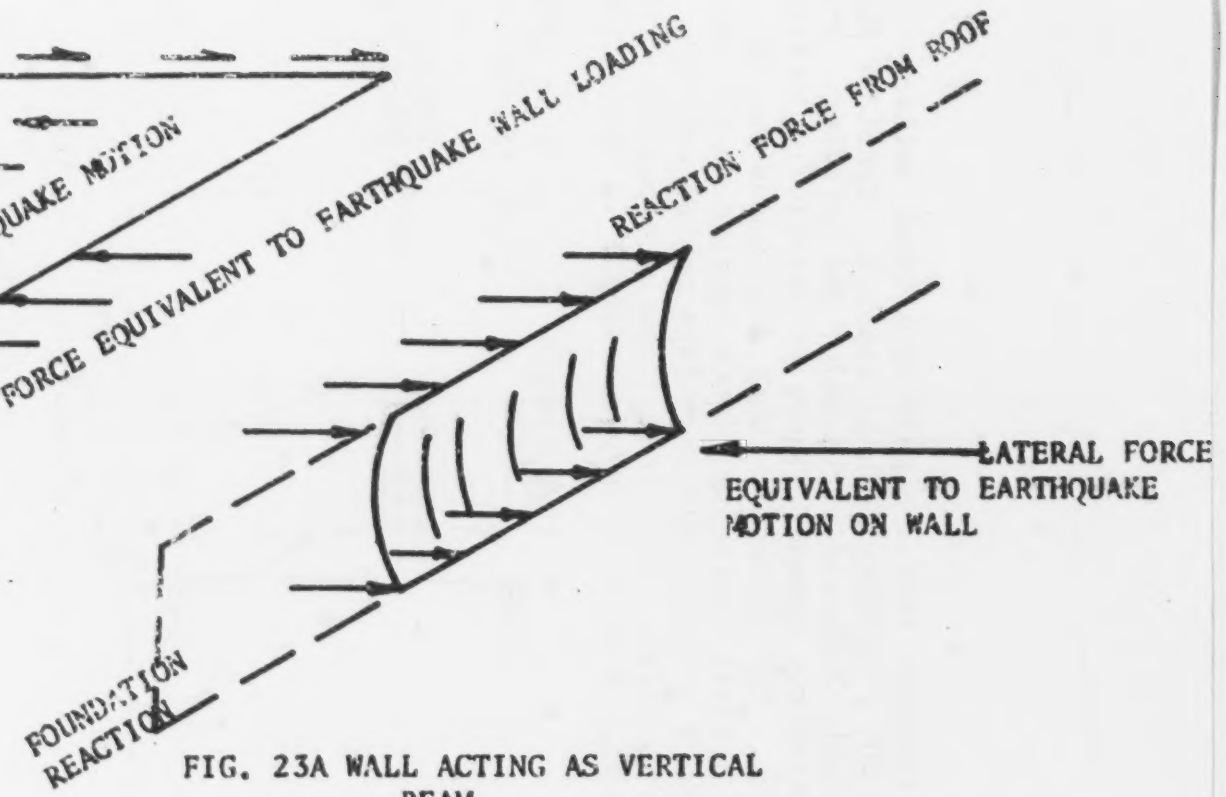

FIG. 23A WALL ACTING AS VERTICAL BEAM

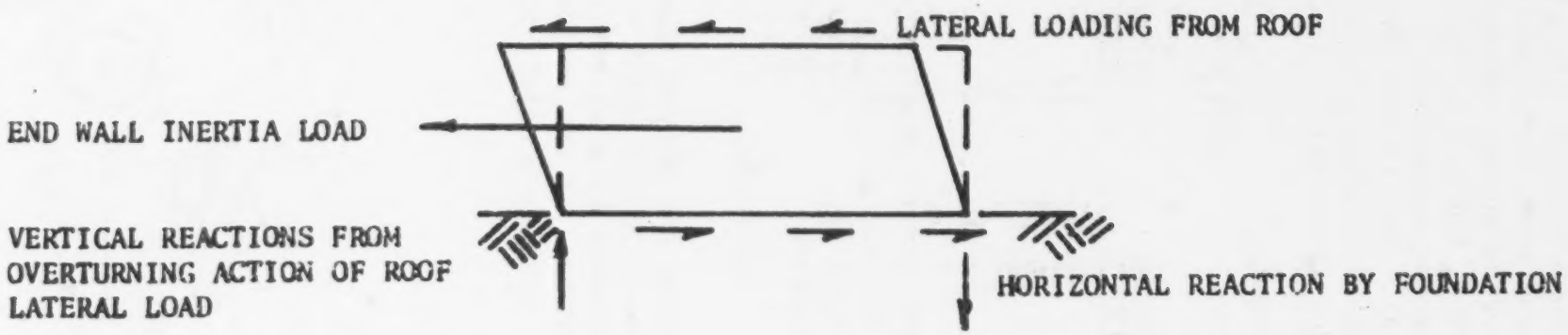

FIG. 23C - END WALL ACTING AS VERTICAL BRACE

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The force or load placed on the safety belt depends on two things, the rate at which the car was slowed down and the weight of the person held by the belt.

In designing buildings the size of horizontal force or load used is a function of the stiffness of the bracing system and weight of the supported structure. The method of arriving at these exact values are not necessary to understanding the underlying principles of "quake-resistant" construction although it is necessary, of course, for the designing engineer to determine their values within reasonable limits.

We can carry our study one step further by considering our idealized building in its three dimensions. While there are any number of framing systems with a wide variety of bracing methods to choose from, this analysis will be limited to the simple "box" type which is a very common type of building consisting of bearing walls and a flat roof.

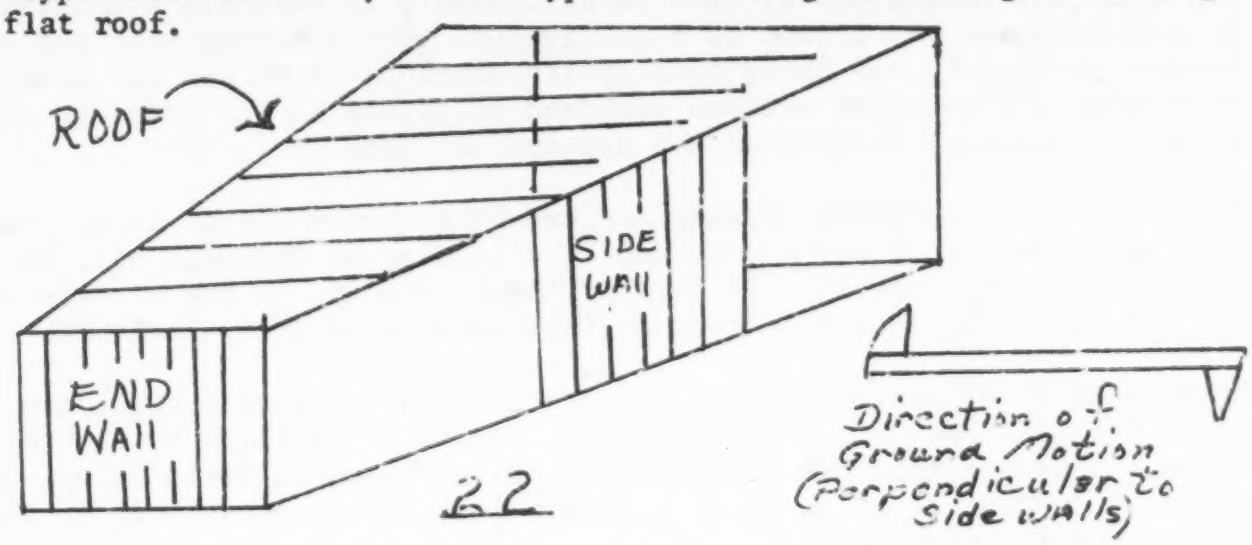

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The earthquake motion will be studied perpendicular to the side walls.

To start our analysis we apply a horizontal force to the side walls. This size of this force is determined by assuming the wall has "horizontal weight" and the amount of force generated by this horizontal weight is a fraction of the walls vertical weight. As shown in Fig.(23a), this equivalent horizontal force must be resisted by a reaction at the foundation and a reaction at the roof. If the wall is not held at the top by a roof or the connection to the foundation is not adequate, the wall may topple over.

Now we turn our attention to the roof framing. The reaction from the wall is equivalent to a horizontal force applied to the edges of the roof. In addition, the motion caused by the earthquake generates "horizontal weight" in the roof construction which we show as equivalent horizontal force. Two conditions must be satisfied if the building is to remain standing under the action of these forces. First, the roof construction must be capable of acting as a horizontal beam. This can be done by providing diagonal members to make a horizontal truss or by connecting together the sheathing material to make it work as a shear carrying diaphragm. Secondly support must be provided which can restrain the horizontal reactions. In the simple building example, this is done at the end walls. (Fig. 23c) These end walls must be designed to work as a vertical bracing system which cantilevers

up from its foundations. This bracing system may be in the form of diagonal braces or a shear carrying diaphragm commonly called a "shear wall."

The effectiveness of this system of framing depends on two items. One, the strength of the structural elements making up the bracing systems and, two, the strength of the connections between the various components. If either one of these two items is not properly taken care of in the building, there is the possibility of failure when an earthquake comes along. The old adage that "a chain is no stronger than its weakest link" certainly applies to this situation.

O. WIND LOADING

The effect of moving air or wind on a structure is actually a complex problem in aero-dynamics and a host of investigators have wrestled with the subject. Without going into the background of its development we can say that for most structures the reaction between wind and an object in its path can be simulated by an air pressure loading on the exposed surfaces.

Visualize a wall surface forming one end of a square tank. If we pressurize this tank up to 15 pounds per square foot the loading on the wall will be equivalent to the velocity pressure of a 75 mile per hour wind and is the minimum required loading for buildings (not more than 60 feet above ground) by Title 21.

On exposed framing and isolated structures such as towers, signs and floodlight poles the wind exerts a drag or friction force in addition to the velocity pressure force. This has been simulated for design purposes in Title 21 by increasing the pressure loading to 25 pounds per square foot on the gross area of the projected surface of the structure.

The development of framing systems in buildings to resist this wind pressure loading is similar to that discussed for earthquakes. Usually one or the other of the two types of lateral loadings will control and one design will be adequate for both sets of forces.

P. LOADS ON BUILDINGS

Live Load (Temporary loads, such as rain, snow, piles of building materials, etc.)

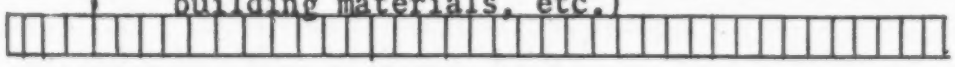

Dead Load (Actual weight of building materials)

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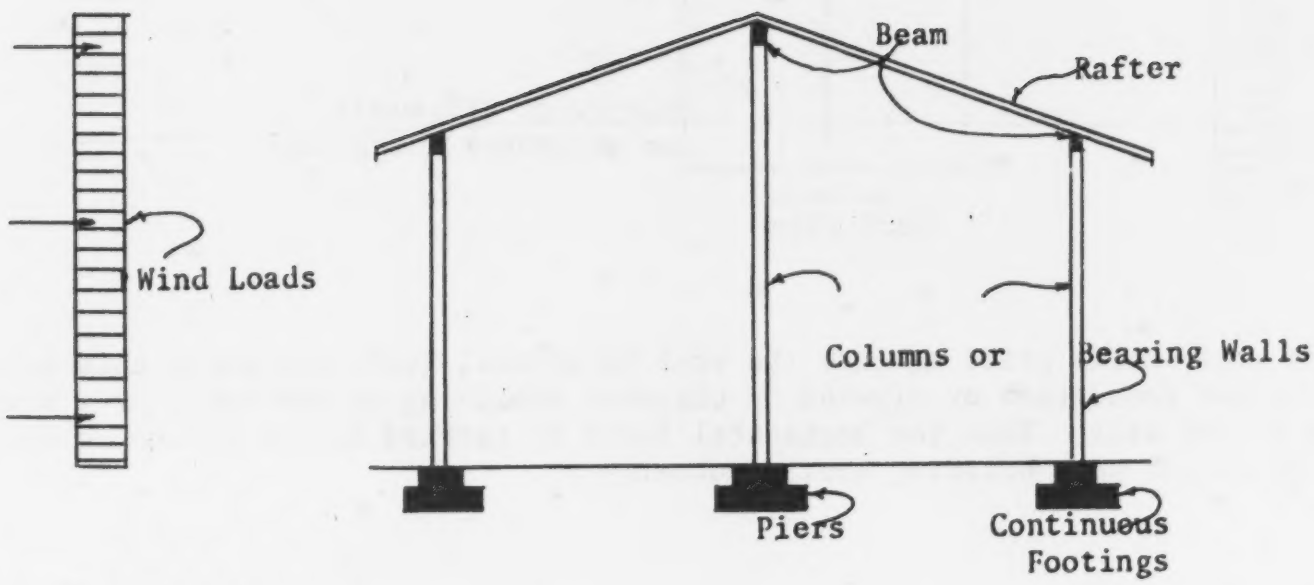

Vertical Loads

Vertical loads consist of Dead Loads and Live Loads, and are applied downward vertically. In the sketch, the rafters support the sheathing, roofing, insulation, ceiling, etc. Rafters rest on a longitudinal beam and outside bearing walls. The beam load is carried by columns which rest on pier footings, and the bearing wall rests on a continuous spread footing.

Wind Loads

Wind is applied horizontally against the vertical projection of the building. The wall is held against wind at the bottom by its fastening to the sill plate, and at the top by its fastening to the roof.

Fig. (25) The roof must carry the horizontal reaction due to 1/2A and the wind load B on the roof itself

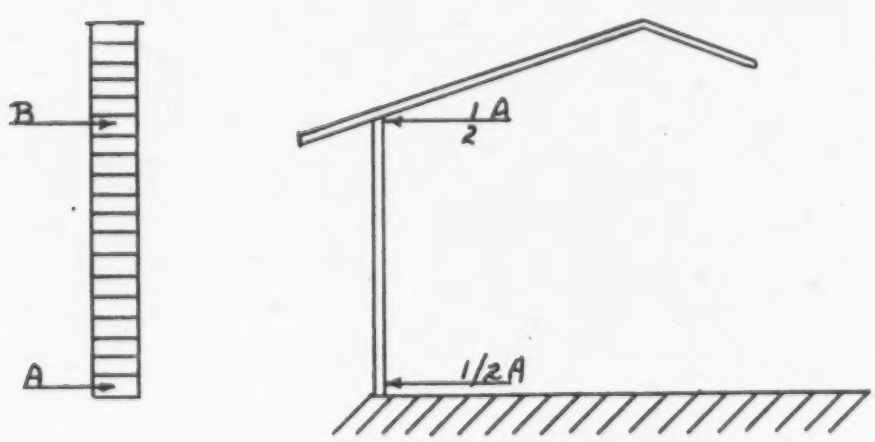

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Fig. (26) This load must be carried through the roof by a diaphragm or horizontal bracing system to the end walls, or other shear walls.

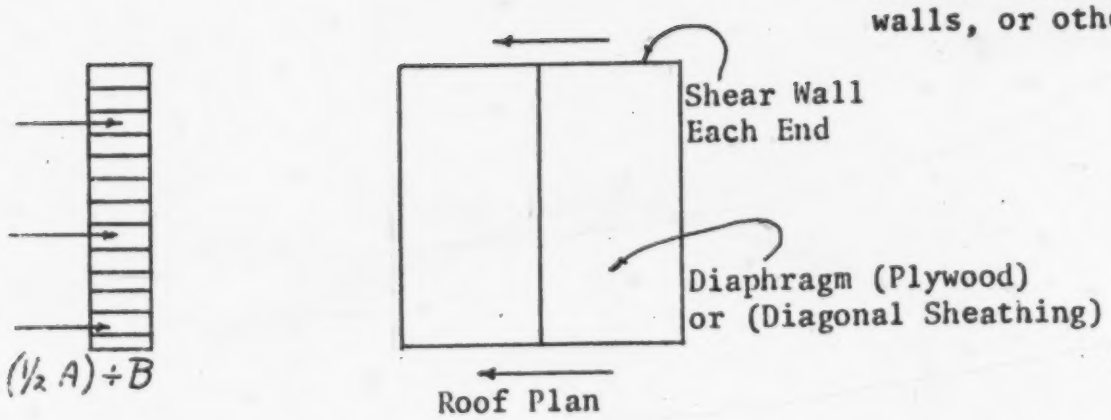

The end shear walls react against the roof horizontal load, and carry this horizontal force to the foundation by plywood or diagonal sheathing on the wall, or a bracing system in the wall. Thus the horizontal force is carried to the ground, where <u>all</u> types of forces on a building must eventually go.

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TERMS AND DEFINITIONS

Force: Force is that power which changes or tends to change the state of rest or motion of a body or causes a body to change its shape if held in place by other forces.

Work: Work is the product of force and distance or force acting through distance.

Stress: Stress is a distributed force. It is a measure of force per unit of area.

Fiber Stress: Fiber stress is the distributed force tending to compress, elongate or change the relative poisition of fibers.

Tension Stress: Tension stress is an internal stress induced by forces which tend to elongate the affected member.

Compression Stress: Compression stress is an internal stress induced by forces which tend to crush or shorten affected members.

Shear Stress: Shear stress is an internal stress induced when opposing forces tend to cause adjoining planes or surfaces of a member to slide, one on the other.

Allowable Unit Stress: Allowable unit stress, varicusly called safe working stress, working stress and allowable stress, represents the maximum stress which may be safely induced in a material.

Strength: In a broad sense the term "strength" embraces those properties of a material which enable it to resist imposed forces or loads.

Bending Strength: Bending strength is a measure of the load carrying capacity of a beam.

Bending Stress: Bending stress is a compound stress induced by loads which tend to cause the member to deflect, as a beam.

Stiffness: Stiffness is the property which enables a member acted upon by external forces to resist deformation.

Flexibility: Flexibility is the quality which renders a material capable of being appreciably bent without breaking.

Elasticity: Elasticity is the property which permits changing form with the application of force and immediate recovery upon release.

Plasticity: Plasticity is that property of material which permits it to develop a permanent set or change in dimensions whn an external force causing a change in length, shape, or volume is removed. Plasticity is the opposite of elasticity. Lead is a material having this property.

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Vector: Vector is an arrow used to indicate the amount and the direction of a force.

Equilibrium: Equilibrium is the state of balance of forces acting on or in a body resulting in a state of rest, the resultant force being equal, mathematically.

1000 lbs. + 1000 lbs. = 0

Strain: Strain is sometimes called "deformation". It is the change in the length of a body caused by internal stress induced by an external load.

Total Strain: Total strain is the sum of all the resulting strains in the body under strain.

Unit Strain: Unit strain is the intensity of the strain per unit of length of the piece.

Kip: Kip is a unit of force equal to 1000 lbs.

Bending Moment: Bending moment is the tendency of a force to cause rotation about a given point or axis (Force x Length = ft. lb.) bending moment.

Yield Point: Yield point is that point when a member subjected to forces no longer springs back to its original dimensions.

Ultimate Strength: Ultimate strength is the moment when further force is applied the member collapses. Failure by breaking indicates that the "ultimate strength" has been exceeded.

Live Load: Live loads are those loads imposed on a structure by rain, snow, workers, material, etc.

Dead Load: Dean load is the actual weight of the materials permanently attached to the building.

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A. Nutrition—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To know the value of nutrients—Con.	Vitamins: Composition Functions Food sources Effect of deficiency Effect of cooking Effect of freezing Loss of vitamins in cooking and preparation Prevention of loss	Enriched flours Enriched margarine Revitalized food Irradiated milk Demineralized foods Devitalized foods Vitamin fortifications
To understand the role of calories in the diet	Energy requirements of individuals: Physical activity Age Sex Body structure Weight and size	Formula for calculating caloric requirements Effect of: Cooking Storage Exposure
To know dietary balance and analysis	Importance of well-balanced food combinations Necessary nutrients Caloric content of foods Percentage retention after cooking	A daily food plan or foundation diet How dietary balance is accomplished Method of calculating required amount How to calculate Food habits Fads and fallacies
To understand digestion of food	Digestive system: Digestive juices Enzymes in digestive juices: Types and functions Absorption Digestion and health habits Proper eliminations	

Suggested teaching materials: See items 7, 11, 22, 24, 25, 33, 35, 47, 74, 79, 87, 101, 111, 113 in appendix B.

STOS

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UNIT IV - SOIL FUNDAMENTALS

Teaching Outline	Techniques, Aids Devices & References
A. Introduction to Principles & Terminology	
1. History of Soil Mechanics	See Appendix I - Soils
2. Definition of Soil by Engineers	MS-10, p.5
	PCA Soils Primer, p. 9
a. Any earthen material excluding solid rock	
b. It is composed of loosely bound mineral grains of various sizes and shapes, organic material, water and gases.	
3. Composition	
a. Solids, Water and Air	Diagram, p. 9 - Soils Manual - MS-10
b. Solids	
(1) Weight of the oven dried portion at 230°F.	
(2) Dry to constant weight	
(3) Temperature critical - do not break down water of crystallization	
c. Water	
(1) Internal in grains	
(2) Films around surface of grains	
(3) Voids between grains	
(4) Saturation	
(a) Displaces all air, leaving water and solids	
(b) Show by diagram	

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d. Air

(1) All soils contain some air

4. Size

a. Varies from boulders (12" dia +) to colloidal clays (1 micron or less)

b. Smallest particle size visible 0.074mm or 200 mesh

c. Divided in coarse grained soils (200 mesh +) and fine grained soils (200 mesh -)

5. Shape

BuRecl Earth Manual, p.4

a. Bulky grains (coarse grained)

(1) Rounded and subrounded; angular and subangular

b. Flaky grains (fine grained)

c. Elongated grains and fibers (fine grained and organic)

6. Source of Soils

a. Formed by decomposition of rock due to weathering into residual soils

b. Residual soils are transported by wind (aeolian), water (alluvial, marine, lacustrine) and ice (glacial till).

c. Sometimes reformed to sedimentary rocks by overburden pressures

7. Identification and Classification

a. Purpose

(1) Group soils with similar performance characteristics

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(2) Provides a reference standard (measuring tool) common denominator

b. Systems

(1) Five basic systems — PCA Soil Primer, p. 10

(2) We will study unified because most used by soils engineers — See Table VI-1, MS-10, and Chapter VI, MS-10

(a) Will be discussed later in more detail

c. Terms — For expansion see Glossaries in references

(1) Coarse grained soils

(a) Boulders (12" +)

(b) Cobbles (12" x 3")

(c) Gravel or crushed rock (3"x#4) (#4 is about 3/16")

(2) Sand

(a) Coarse #4 to #10, Concrete

(b) Median, #10 to #40, Plaster

(c) Fine, #40 to #200 Table salt and sugar

(3) Fines (Silts, Clays and Colloids, passing 200 mesh) like flour for baking

8. Properties

a. Internal Friction - is the resisting force in a soil mass due to particle roughness. In shear testing it is a constant quantity for a given normal force and the strength is usually expressed as the tangent of the angle of internal friction or the friction — Hough, p. 147; MS-10, p. 12

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angle. The friction angle remains essentially constant.

b. Cohesion - is the part of shear strength that is not due to friction. It is a variable quantity being 0 in clean sands and gravels (no fines) and increasing as silt and clay contents increase. For any given soil the cohesive force will vary with moisture content, rate and time of loading, confining pressures and other factors. The mutual attraction of the particles of a soil to each other in the presence of moisture.

Coulomb's Law

$s = c + p \tan \emptyset$

Hough p. 162

MS-10 p. 12

Use Fig. 6-17 Hough p. 163 to illustrate

c. Capillarity - is usually referred to as the rise in moisture in a fine grain soil above the level of free moisture or the water table. Inasmuch as capillaries (tubes) are small, capillary rise occurs in fine grain soils.

d. Elasticity, Plasticity, Compressability & Compaction -

(1) Elasticity is the ability of a soil to return to its original shape after being deformed by a load for a short period of time.

MS-10, p. 10

(2) Compressability in soils, refers to that part of volume change resulting from the expulsion of pore water. Consolidation is also used to describe this volume change. (Takes time to consolidate).

MS-10, p. 13

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(3) Compaction in soils, refers to that part of volume change resulting from the expulsion of air. (Can generally be accomplished in a short time period). — MS-10, p. 13

(4) Plasticity is the ability of a soil to be deformed rapidly without cracking or crumbling and maintain the deformed shape after the force causing deformation has been released. — MS-10, p. 11 — Examples: The PL Test w/crumbling thread

e. Permeability means the ease or difficulty with which water will flow through a soil. — MS-10, p. 11

9. Exploration and Sampling

a. Purpose - To determine subsurface soil conditions and secure samples to evaluate the engineering properties so that a satisfactory foundation can be designed. — Soils Man. Ch. III, Earth Man. Ch. II

b. Test Borings - Subsurface exploration is accomplished by the drilling of holes called "test borings." Test borings are usually carried to a depth of 1½ times the minimum width of the planned construction. At this depth the influence of the proposed construction would be negligible, unless latent soil conditions are encountered, as in the case found in tide land areas. Test borings in these locations are carried well into the firmer soils, regardless of depth.

c. Drilling Equipment — Earth Manual p. 139 - 147

(1) Post hole auger or Iwan

(2) Augers

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(3) Bucket

(4) Rotary Wash

(5) Others

d. <u>Sampling</u> - Samples are obtained from each soil strata encountered for observation and/or laboratory testing

(1) Disturbed

(2) Undisturbed

(3) Standard Penetration Test

(4) N Values

Earth Manual
p. 574 - 577

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UNIT IV - SOIL FUNDAMENTALS

B. Physical Analysis & Testing

1. Laboratory Classification Tests

a. Sieve

(1) Dry — MS-10 Appendix A, p. 189

(2) Wet — AASHO - T11

b. Atterberg Limits — Hough p. 43 - 47

(1) Liquid Limit — AASHO T89-60 (MS-10)

(a) Moisture contents above this limit make the soil behave as a liquid

(2) Plastic Limit — AASHO T90-56 (MS-10)

(a) Moisture contents between the LL & PL define the plastic range

(3) Shrinkage Limit — ASTM D427-61

(a) Moisture contents between the PL & SL define the semi-solid range — AASHO T92-60

(4) Plasticity Index — AASHO T91-54 (MS-10)

(a) LL - PL = PI

2. Field Classification Tests — MS-10, p. 73-76

a. Sand & Gravel - visual examination of sizes. Gravel sizes run from 3 inches to the No. 4 sieve (3/16 inch); coarse gravel 3 inches to 3/4 inch; fine gravel 3/4 inch to No. 4 sieve. Sand sizes run from #4 sieve to No. 200 sieve (the smallest size particle that can be seen by the unaided eye); coarse sand No. 4 to No. 10 sieve; — Earth Manual, p 15-17

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medium sand No. 10 to No. 40 sieve; and fine sand No. 40 to No. 200 sieve.

b. Silt & Clay - classified by physical behavior - clays having cohesion and silts acting granular. Over a large range of moisture contents, clays exhibit considerable cohesion and can be rolled into a thread of approximately 1/8 inch diameter. Silts, lacking in tensile strength, will break apart and feel gritty in the hand. On drying, clays will harden and have a high dry strength, while silts will tend to crumble under applied pressure when dry.

c. Organic Soils can be distinguished by the odor and/or presence of decayed vegetation, usually in fibrous form. Organic soils are usually dark in color - either brown, gray or black. The application of heat to these soils will bring out their odor stronger.

3. Hydraulic and Mechanical Property Tests

PCA Soil Primer
Chapter 3

Earth Manual p. 37-69

a. Moisture Density - The density of a soil is its weight in a unit volume and is usually expressed in pounds per cubic foot. The moisture content of a soil is the percentage of moisture by weight to the dry weight of soil.

b. Consolidation - This test determines the compressibility of the soil under given loads. Consolidation is the squeezing out of water from a soil mass by externally applied pressure. Generally, this is a slow process consuming

Example: A 1-inch-high soil specimen consolidated 1/10 of an inch under 2000 pounds per square foot loading.

much time. In simplicity, the test is run by applying an external load on a soil specimen of given height and the deflection recorded by means of gages.

A 10-ft.-thick strata of the soil under 2000# per sq. ft. would therefore settle 10% (1/10 of 1 inch = 10%) or 1 foot.

c. Shear - These tests determine the strength characteristics of soil (cohesion and/or angle of Internal Friction.

(1) Direct Shear - The test consists of forcing a portion on the soil to slide over itself under a pressure or surcharge. The soil to be tested is placed in a split mold, one end fixed, and the force necessary to move the other section of the mold recorded until failure occurs.

(2) Unconfined Compression - In this test a sample of soil is subjected to a vertical axial force until the specimen fails along a shear plane or by bulging. The shearing strength is assumed to be half of the compressive strength.

(3) Triaxial Shear - This test is similar to the unconfined test except that a constant laterial pressure is applied during the test.

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Several tests at different lateral pressures can be run to develop the cohesion and angle values.

d. Permeability - These tests determine the ability of soils to transport water. In the laboratory two basic permeability tests are used - the falling-head permeater or the constant-head permeater. The constant head permeameter, as the name implies, maintains a constant height of water above the sample and is used on the more permeable soils - sands and gravel. The falling-head permeameter is used on soils of low permeability - clays and silts - where a wide range of values can be obtained because of the different head heights.

e. Expansion Test - As the fine grain soils tend to change in volume with change in moisture content, expansion tests were developed, in order to evaluate the expansive characteristics. Generally, these tests are run on soil specimens in fixed diameter containers. The soil is subject to saturation and the change in height is recorded and converted to a percentage. Soil having a volume change of over 5% is generally avoided in earth work. It is not too uncommon for some clays to have up to a 40% volume change from an oven-dry to a saturated state.

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B. Food Chemistry

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To understand scientific principles involved in food preparation	Basic food chemistry Changes in food due to: Cooking Freezing Curing Dehydrating Composition of foods: Elements Compounds Identification of foods and detection of adulterants Food spoilage: Causes Prevention Chemistry involved Food preservation: Chemical and physical changes	Practical demonstrations: Pasteurization Homogenization Litmus test for acidity

Suggested teaching materials: See items 13, 24, 37, 44 in appendix B.

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3.

f. Tests for Pavement Subgrades

(1) California Bearing Ratio (CBR) — MS-10, Ch. VIII

(a) The load (psi) to force a piston into a soil to a certain depth, expressed as a percentage of the load (psi) to force the piston into a standard sample of crushed stone.

(b) Used with emperical curves to design asphalt pavements.

(c) Used as a quality index of a soil to be used in a pavement structure or pavement foundation (basement soil)

(2) Resistance Value (R-Value) — MS-10, Ch. X

(a) Type of Triaxial Shear Test — Test Method No. Calif. 301

(b) The ratio of a given applied unit compressive stress to the transmitted lateral pressure is used to determine an index (0 to 100) of the ability of the soil to resist deformation. This is called an R-Value. — Since this test is widely used in Calif., students may wish to visit one of the Highway Labs near the school.

(c) The R-value varies with moisture and density, therefore, the R-value must be determined at the expected field conditions to be of significance in a pavement design procedure.

(3) Plate Bearing (K-Value) — MS-10, Ch. IX

(a) Similar to a CBR using 12 to 30" plates in the field.

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(b) To be effective for design, the materials tested (subgrade) must be at the same density and moisture as they will be under the pavement.

(c) Can be used to evaluate the strength of an existing pavement.

(4) Other California Subgrade Tests

(a) Specific Gravity

(b) Moisture - Density

(c) Expansion Tests

Calif. Materials Manual - Part I 200 & 300 Series

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UNIT IV - SOIL FUNDAMENTALS

C. Principles of Soil Engineering

1. Basic Fundamentals

a. Air - Moisture - Solids

MS-10, p. 9
(Diagram & Formulas)
Hough, Chap. 2

b. Void Ratio $e = \frac{Vv}{Vs}$

MS-10

(1) Ratio of the volume of voids to the volume of solids

c. Water Content $w = \frac{W_w}{W_s} \times 100$

(1) Usually determined by oven drying at 110° C or 230° F

(2) Not too high temp. to affect the water of crystallization

d. Porosity $n = \frac{V_v}{V} \times 100$

Hough, p. 32-33

(1) Fine grained have high porosity values

(2) Channels are small or time is required to wet fine soils

2. Foundation Studies

Earth Manual
p. 212-213
Opt. Ref.
Foundation Engrng.
by Peck, Hanson &
Thornburg, Ch. 8,9 & 10

a. Foundations - There are many factors determining the type of foundation to be employed for a given structure. The nature of the structure, loads to be carried, subsurface conditions, and relative costs must be considered in the choice of a foundation. Foundations can be divided into two types - shallow (spread footings, rafts & mats) and deep (piles, piers & caissons). In choosing a foundation, all types should be

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considered. With the many factors involved, there are usually several acceptable solutions to each foundation problem. The final design is a balance of performance and cost.

b. Bearing Capacity - One condition the foundation must satisfy is bearing. From the shear test data obtained in the laboratory, the bearing capacity of the soil is computed. Roughly, the bearing capacity is 3 times the shearing strength. Other factors - size, type of footing, etc., will tend to increase this factor. In general, a factor of safety of 3 is used and in no case less than 2 in the final design.

Opt. Ref. Foundation Engrng. Ch. 13

c. Settlement - Another condition the foundation must satisfy is one of settlement. Generally, differential settlement within the structure is of more concern than a uniform settlement. While the whole structure could settle a few feet without damage, a differential settlement of 3/4 inch could crack the structure. The type of construction is considered in settlement studies. A concrete building is usually limited to a maximum differential settlement between adjacent columns of 3/4 inch, a steel structure, slightly more. Other factors involved are settlement time rates. On sand, as much as 75% of the settlement could occur upon application of load (during construction), while on some clays the settlement would not appreciably begin until after the structure is completed. Because of this, slightly more settlement is tolerable on sandy sites.

Earth Manual; p. 217-218

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3. Pavement Studies

a. Foundations

(1) Pavements are generally light structures with intermittant loads, therefore, except for heavy fill foundations and swampy areas, exploration is limited to 3 to 6' below finished grade.

(2) One purpose of the study, is to determine the quality of materials in cuts which are generally used in fills.

(3) Determine the strength of the materials directly under the structural section (basement soil or subgrade). In California we generally use the R-Value for highways or K-Value and CBR for airports.

(4) Sometimes the data are shown in a soil profile. Different soils are identified by a classification system, i.e., AASHO, FAA, Unified, etc.

Show soil profile

b. Structural Sections of Pavements

(1) The structural section is that portion above the prepared subgrade. Usually made of imported materials.

(2) Will be considering only light traffic pavements - heavy duty pavements are similar, however, have greater depth and more strict quality requirements.

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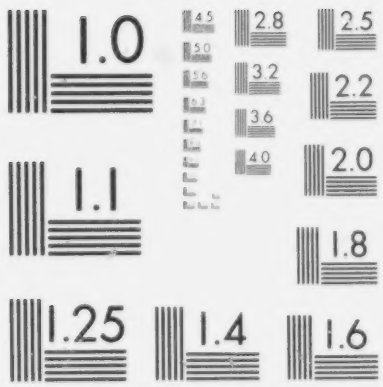

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(3) Will be covered in detail in Structural Series 2 for both flexible and rigid pavements.

4. Retaining Walls and Slopes

Opt. Ref. Foundation Engineering, Ch. 11

a. Design of retaining walls besides having to satisfy conditions of bearing in the foundation, also must resist lateral pressure. There are two extreme conditions of lateral pressure, that of active pressure and passive pressure. The active state occurs when all of the shearing strength of the soil is fully mobilized and the passive state occurs when the soil's strength is overcome in a backward direction. An at-rest condition falls between these two extremes and occurs on an unyielding wall when none of the soil's shearing strength is employed. Retaining walls are designed for conditions falling somewhere in between the two states, usually between the at-rest and active conditions. After the lateral pressures of the soil to be retained are known, an equivalent unit fluid pressure approximating the lateral pressure is employed in the design.

b. Backfills play an important part in the design of the retaining wall. Granular backfills are preferred as the active condition is more fully mobilized than with the fine grain soils. Clay

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will reach an active state; however, slow continued yielding will cause the clay to lose its mobilized shearing strength. This increases the pressure on the wall until, if not adequately designed, a failure of the walls occurs. A clay backfill should not be used on a wall designed for granular soils. Another important consideration is preventing hydrostatic pressure build-up. This is accomplished by providing backdrains and/or weep holes.

c. Constructed slopes are based on type of soil, climatic conditions, height of slope, and the seriousness of a possible failure. Permanent slopes are designed for a safety factor of usually 3 and not less than 2. In sandy soils this is a slope of about 1 vertical to 1½ horizontal or flatter. In clayey soils the safe slope is a function of the height. Temporary slopes are constructed steeper and preferably in the dry months. Surface protection is provided by planting, matting, etc. Analyses of slopes are made several ways. One common method is to assume a failure circle in the slope and compute the forces resisting sliding and the forces that tend to slide. The critical circle is the one where the forces resisting are a minimum and the forces

Earth Manual, p. 213-216

that tend to slide are at a maximum. The factor of safety is computed by dividing the forces resisting by the forces tending to slide.

5. Drainage Studies

a. Surface

(1) A building project will normally disturb the site thereby changing the surface drainage patterns which previously existed,

(a) Change grades

(b) Change materials which will change absorption of the surface and the speed of runoff of precipitation.

(2) The engineer must design a drainage system to prevent damage to both on site and off site facilities. The system may contain:

(a) Eave troughs

(b) Down spouts

(c) Catch basins

(d) Trenchs

(e) Underground storm drains

(3) Because the drainage facilities are designed as a system - no changes to grades, pipe sizes or tyes, etc. may be made without a possible unbalancing of the system. Proposed changes <u>must</u> be referred to the designer.

Note to Instructor:

(1) You may wish to explain briefly Q = CIA the rational method of estimating peak runoff. See "Water Supply Engineering" by Babbitt & Doland as one reference.

Students do not need to study the problem in detail.

(2) The Asphalt Institute has published a manual "Drainage of Asphalt Paving Structure" (MS-15), which is now available.

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b. Subsurface

(1) Subsurface moisture affects the strength of most foundation soils.

(2) Subsurface moisture which enters and exists from a site may be disturbed by the facilities being constructed. It is therefore necessary for the designer to prevent buildup of moisture under buildings or pavements. To accomplish this, he may design special facilities to handle underground water. These may take the form of cutoff trenches, filter drains, etc.

(3) Inasmuch as the designer's information of subsurface conditions may be limited to a few borings during a dry period, you may help him considerably by calling his attention to conditions exposed by excavations during construction. This may give him the opportunity to improve his underground drainage system. Particular attention to water seeps.

(4) We must keep in mind that the same things that apply to surface systems apply to subsurface systems. Careful attention to design details during construction will bear heavily on its successful operation.

Asphalt Handbook, Apr. 1965, pages 118 - 123 for pavements

Earth Manual, p. 294
74 a & b

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C. Hygiene and Sanitation

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To understand the importance of good personal hygiene	Basic principles of hygiene and their application to health	Diseases Parasitic infections Carriers Prevention of disease Characteristics of bacteria
	Bacteria: How bacteria may enter food Conditions needed for growth	
	Health habits: Rest Exercise Posture Recreation	
	Grooming: Hair care Teeth Skin Hands Feet Bathing Clothing	 Hair nets, caps Proper brushing habits Nails, nail polish Shoes, hose Uniforms
To know importance of sanitation	State and local sanitation laws	Laws relating to personal health
	Storing food: Raw Cooked	Types of refrigeration: Temperature Control
	Storing dry materials: Flour Meal Sugar	Bins, shelves, racks, containers
To know proper housekeeping procedures	Disposing of garbage and refuse material	Equipment
	Cleaning and care of all types of kitchen equipment	Detergents Sanitizing agents Purification agents
	Cleaning and maintenance of floors and work areas	
	Preventing rodents and insects	Insecticides Safety Other precautions
	Detecting presence of rodents and insects	
	Controlling rodents and insects	

Suggested teaching materials: See items 9, 18, 19, 25, 30, 50, 53, 59, 62, 72, 83, 88, 89, 92, 103 in appendix B.

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(a) Gradation of aggregates in filters and drains, pipe sizes, etc.

(b) No interruptions to system continuity by placing blocks in way.

6. Dams and Other Large Earthwork

Earth Manual, p. 229-234

Usually large earthworks are undertaken by governmental agencies. Many complex factors are involved and all must be considered in the development of large earthworks. The purpose of the development, as an earthfill dam, for example, must consider location, power development, irrigation and runoff distribution, flood control, wild life, and many other factors. Once the feasibility is established, a series of investigations are run until a site is selected. Following site selection, a more fully subsurface investigation is carried out and design of the structure is started. Usually several preliminary designs and cost estimates are made up from which a final design will be developed. In the case of earthfilled dams, the design must satisfy the following conditions: The foundation must be adequate to hold the embankment, relatively impervious, sloped sufficiently under all weather and reservoir conditions to prevent sliding, protected against wave action and erosion, and overturning. Riprap employed on the surface to prevent

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erosion from wave action must be protected from infiltration by the impervious core by designed "blankets" of selected material, sized between the two different materials. This is called a Zoned Embankment, and is the type generally used in earthfilled dam construction. Other large earthworks include canals, channel, bridges, tide-land filling, and piers and wharfs. Each has its own soil and water problems; however, are handled in a similar manner as discussed above.

7. Shoring and Underpinning

Opt. Ref.
Foundation Engineering. Ch. 12.

In the construction of subsurface structures, shoring is usually required during excavation and construction. Shoring consists of placing a temporary system of braces to retain the soil around the construction. The design of shoring is similar to that of retaining walls; however, the material employed is generally not of permanent nature; that is, subject to rot and/or rust. One generally accepted method is to install first, vertical soldier beams, and then horizontal lagging as the excavation progresses. In some instances, where the excavation is deep, struts placed against the beams are employed; or a newer method is that of tying the beam into the retained soil by means of a prestress anchor system called tie backs. Where an excavation is adjacent to an existing structure, it

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may be necessary to underpin the existing structure. The simplest method is to replace the existing foundation with a deeper one which then keeps the foundation pressure off the shoring. Underpinning is also employed in correcting inadequate foundations and often is expensive due to the working space restrictions.

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D. Use and Control of Soil Materials

1. Compaction

Hough - Chap. 14

Earth Manual
P. 192 - 211
P. 237 - 254

a. Purpose

(1) To densify the soil (reducing its volume) thereby increasing its strength by developing particle to particle contact.

(2) To decrease permeability

b. Principles and Methods

(1) Compaction is the volume change produced artificially by momentary load application such as rolling, tamping or vibration.

(2) Methods used are mechanical, vibration, jetting and other special methods.

c. Compaction Tests

(1) AASHO, ASTM and Calif.

(a) These are relative compaction test methods.

See Appendix A in A.I. Soils Manual for AASHO & ASTM and State of Calif. Materials Manual

(b) Compare in-place density with a laboratory density where the sample is compacted by a standard weight in a standard mold at optimum moisture content.

(c) Mold sizes and laboratory compaction efforts are different for the different methods

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(2) Others

(a) Proctor Needle is a penetrometer type of instrument. Measures the soils resistance to entry.

(b) Nuclear methods. Radioactive source is placed on or in the soil and the density is measured by special instruments. Specially trained technicians are required for this work.

d. Laboratory acceptance and control tests

(1) Acceptance tests will usually be gradation, plasticity, etc.

(2) Laboratory control tests as concerns compaction involve moisture-density relationships and determining a reference standard for field control tests.

(3) Sampling is most important. The material must be representative.

e. Field control tests

(1) Proctor Needle — Calibration ASTM D 1558-58T

(2) Sand-Volume. Carefully pour calibrated sand into a hole to determine the volume of the material removed. Part of the In-Place density test. — ASTM D 1556 - 58T

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(3) In-Place density. Comparison of the field density with lab density to determine relative compaction.

(4) Moisture content of soil

(5) Counting number of passes by rollers to see specifications are being met. (Many specs are written this way to eliminate necessity of expensive testing).

f. Compaction Equipment and Uses

(1) Sheepsfoot

(2) Vibratory Rollers and Tampers

(3) Grid Roller

(4) Pneumatic rollers

(5) Steel Wheel Rollers

(6) Construction Equipment

(a) Hauling trucks

(b) Graders

(c) Scrapers

(d) Tractors

(7) Hand operated

(a) Tampers - hand and pneumatic

(b) Vibratory compactors - Wacher, Barco, etc.

Hough - Chap. 14 has good discussion on each type, its advantages and the type soils where effective.

Instructor and students may obtain data from equipment dealers or manufacturers for each piece of equipment.

g. Compactive Effort

(1) Mechanical means consists of compressing the soil into a dense

Hough - Chap. 14

SOOLS 21001

state by applying weight. The end results depend on the size of lifts, moisture content, number of passes and weight of equipment.

(2) Jetting consists of forcing water thru the soil. This method can only be used on highly permeable material (clean sands and gravels) with a system to drain off the water. The water forces the grains to interlock better, thus reducing the voids.

(3) Special Methods include blasting with resulting shock waves, driving displacement piles, and a process of creating sand piles by jetting called Vibro flotation. The first two methods above are usually expensive.

2. Chemical Stabilization

PCA Soil-Cement Handbook

a. Principles and Methods - Chemical stabilization is used to improve certain properties and/or reduce undesirable ones. By adding a small quantity of chemical to a soil the bearing capacity can be increased, the expansion characteristics reduced, and/or frost heave prevented. The process involves adding the chemical and mixing it with the soil before compaction takes place.

Bros Handbook of In-Place Soil Stabilization

b. Cement added to soil increases the bearing capacity and reduces permeability. A soil-cement is a hardened material containing about 12% cement by weight. A cement modified soil is a material of less hardness employing about 4% cement by weight. This treatment is used where strength is not the required object, but some other characteristic of the soil requires changing.

c. Chemicals employed in chemical stabilization are lime to reduce expansion, salt or sodium chloride to prevent frost heave, or lime rock to increase strength. Also, many other chemicals are presently being tried.

3. Physical Stabilization

a. Asphalt Mixtures

(1) Asphalt coats each particle and provides cohesion. This prevents loss of density, therefore, loss of strength.

b. Crushing aggregates

(1) Crushing generally makes the surface texture rough, making it more difficult for one particle to slide past the other.

c. Aggregate blending

(1) Blends to improve gradation and improve stability are often made in road work. Gradation may be improved by blending to supply missing sizes and stability improved by providing rougher texture and more contact points within the compacted mass.

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E. Construction and Inspection of Earthwork

Earth Manual, P. 183, 184

1. Grading plans and specifications - The purpose or intent of grading plans and specifications is the development and completion of a final product which will meet the engineered requirements of the proposed construction. Plans can be divided into two categories - one specifying the engineering properties to be met, the other specifying the method and equipment to be used. In excavating, the intent is that an objectional material be removed and/or that a sufficient engineered fill can be developed and/or the new grades are lower. In the field it is important that this intent be met, even if the scope of the plans does not cover a given situation. This is done by change order to the plans. (A good base must be provided in order to compact the engineered fill properly.) In filling, a certain thickness of lift is usually specified in order that the required compaction can be met. The compaction test method must be specified along with what material may be used, including maximum rock size. Testing requirements and the method of correcting defective work should be included.

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Area III

MATHEMATICS RELATED TO FOOD PREPARATION

Area III has as its objective the development of the student's understanding of the mathematical background required to intelligently perform the varied tasks associated with food production and service. Instructors should help students develop an awareness of the importance of mathematics in the construction of formulas. The student should understand the necessity of accuracy in calculating ingredient amounts when reducing or increasing a formula.

The student should know that all controls—and formulas (recipes) are controls—depend on accuracy if they are to be effective. A knowledge of weights, measures, degrees of temperature, and percentages is essential. Purchasing requires a knowledge of arithmetic in order to calculate discounts for comparative purposes. Calculation of food costs, labor costs, and menu prices requires knowledge of addition, subtraction, multiplication, and division.

The outline gives the minimum essentials only; greater emphasis is not only desirable but recommended.

Essential Mathematics

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To master basic mathematical skills	Fundamental mathematical processes:	Weights and measures
	Addition	
	Subtraction	Use of scales
	Multiplication	
	Division	Use of oven and meat thermometers
	Fractions	
	Decimals	
	Percentages	Recipe calculation:
	Weights	Increasing
	Measures:	Decreasing
	Liquid	
	Dry	Steam and other pressure gauges
	Degrees	
To calculate costs	Calculation of raw food costs	Standard or accepted weights or measures of various servings
	Calculation of portion costs or cost per serving (Ready-to-serve cost)	Food Labor cost Overhead cost
To control kitchen costs	Maintenance of records necessary for adequate control cost within the kitchen	

Suggested teaching materials: See items 3, 28, 41, 52, 80 in appendix B.

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Existing grades, along with the planned new grades, should be clearly shown, including tolerances on finished grades.

2. General Grading and Filling

Earth Manual, P. 209 - 211

a. Excavating can be accomplished by many means, the method determined by the equipment available, type of material to be excavated, size of job, and access. Equipment includes loaders, rubber-tired or crawler type, shovels, drag lines, scrapper, and conveyors and hoppers. If the excavated material is to be employed in engineered fills, the area should first be cleared of surface vegetation and other deleterious materials. Also, the moisture content should be determined in order to bring the material to optimum for compaction. During the excavating work it is essential that a homogeneous consistency be maintained; that is, no rock or fines be allowed to occur. This is done by excavation from the bottom up (in the case of a bank) with each bucket load, rather than cutting down in horizontal layers. (Banks should be cut into on a slight angle rather than perpendicular to the face. This will yield larger loads and less wear on the

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passes required to meet the specifications should be determined with the equipment employed. This helps in establishing the criteria for the balance of the job. Prior to starting the fill, a firm base should be provided or provision be made to build up one. Fill cannot be compacted satisfactorily on a weak base. The equipment employed in the compaction work should be suited to the material. Many times two types of compaction equipment are employed and on occasion this will result in the equipment working against each other. An example would be where a flat-wheeled roller was used to compact the surface, followed by the sheepsfoot roller which tends to compact the lower lift. In this case all the sheepsfoot roller would be doing is destroying the crust left by the flat-wheeled roller. The fill should be placed on a level plane to receive uniform compaction and should be sloped slightly during the rainy season to help drainage.

3. Offshore Grading and Filling

a. Excavating under water usually is to remove poor soils or to increase the depth of water for ships. Excavating offshore areas takes

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on many forms, from channel clearing to dredging mud flats. The normal method for excavating under water is by dredging. Dredging can be done with a clam shell, dragline or dredge. A dredge works similarly to a vacuum cleaner. in that it sucks up the material and then carries it by pipes away from the areas. Another method of excavating mud is by displacement. A fill is placed concentrated on an area causing the mud to flow. This is called a mud wave.

In excavating near wharves or other structures not only must care be exercised against undermining but consideration must be given to existing wood piling. In many cases the wood is protected only to a nominal depth into the mud and a lowering of this mud would cause the piling to rot out of this point.

b. Filling in water presents many problems. Most materials cannot be compacted under water. Clays and silts become saturated and mushy, while the granular soils are less affected by the water. The standard method is either to dump rock, gravel or sand into the water or by pumping a sand slurry into the area to be filled. As discussed under

21009

Excavation it is sometimes possible to excavate a mud and fill concurrently by filling in a concentrated area and causing a mud wave. In this method, the fill is brought to grade at a point and worked outward over the planned area to be filled. However, in most cases a mud wave is to be avoided. This is accomplished by filling the site evenly, a lift at a time covering the entire area, and employing light equipment. Problems occurring in tideland filling is that of the existing ground, usually an old fill consisting of debris and garbage. Many tideland areas have long been used as dumps. This, coupled with the underlying mud, causes many settlement problems in reclaimed land. Fills adjacent to open waters also have to be protected from wave action. This is done by placing, what is called, riprap on the slope. Riprap runs from rocks weighing up to 20 tons down to 6 inches in diameter. These rocks tend to break up the force of the wave and prevent erosion. If the fill is fine grain, a filter blanket is provided between the fill and the riprap to prevent infiltration of the two materials. A filter material is a

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designed graded material with sizes between the two extreme sized materials.

4. Material Sampling

a. Material sampling in construction is a highly important item. Usually some 100 pounds of a proposed material, be it fill, rock or aggregate, is secured for approval. The problem is securing a sample that represents the material sampled and not an off-graded portion of it. In stockpiles the larger size will tend to collect along the outside bottom edge, the wind will blow the fines to the downward side. It can be seen that obtaining a sample at one point in the stockpile will not give a representative sample of same. In a bank the material at the crown will be slightly different than at the toe (soil usually is uniform horizontally for short distances). In securing a sample one must take portions of the material from as many points as practical, not only at the surface but in the material as well. Secure the most representative sample, that is, not what looks good or bad, but that which is a cross section of the material.

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If need be, take two or more samples if there is a large variance in the material. Mark on the container the source of the material, date of sampling, by whom, and intended use of the material. If the material is not going to the laboratory immediately, try to enclose a portion of the material in a waterproof container so that an in-place moisture content can be obtained.

5. Drainage - Surface and Subsurface — Earth Manual, P. 214-215

   a. Surface - to provide runoff — Opt. Ref. Foundation Engineering, P. 151-156

      (1) Sloping surface

      (2) Storm drains

      (3) Cut off drains

   b. Subsurface

      (1) Well points — Opt. Ref. Foundation Engineering, P. 190-199

      (2) Coffer dams

      (3) Sheet piling

6. Inspection Procedure and Techniques — Earth Manual, P. 181-192

   a. Importance of control

   b. Methods - visual and testing

   c. Material control — P. 237-254

   d. Reports

7. Installation of Underground Utilities

   a. Excavation - Size, material, and shoring — Earth Manual P. 320-322, P. 301-303

   b. Backfilling - material and compaction

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8. Special Materials

a. Filters - Selection and Placement

b. Others

Earth Manual
P. 322-325

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UNIT IV - SOIL FUNDAMENTALS

Teaching Outline	Techniques, Aids, Devices and References
F. Construction and Inspection of Earthwork (continued)	
1. Foundation Plans and Specifications	Earth Manual
a. Purpose. To provide a clear and precise plan of the foundation elements	P. 310-321
b. General - The plans should include footing size, elevation of bottom, unit loading, soil expected, reinforcement and other relative data.	
2. Installation of Structural Foundations	
a. Shallow	
(1) Machine excavation - Backhoes, trenching machines, Gradalls	
(2) Type of pours - neat or formed. Backfill required for formed pours.	
b. Deep	Opt. Ref. Foundation Engineering, Ch. 9 and 10
(1) Pile Driving - piles	
(2) Drilling - Belled caissons, piers	
c. Special	
d. Load Tests	
(1) Shallow footings	
(2) Piles	
3. Installation of Floor Slabs on Grade	
a. Subgrade preparation	
b. Moisture barriers - base work	
c. Waterproofing	

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4. Paving Plans and Specifications

a. Plans

(1) Plan view will generally show site with paved areas outlined, elevations and details of drainage installations, pavement cross sections, curb and gutter, etc. This is dimensional information.

(2) Small jobs (schools, etc.) will generally have one sheet for this.

(3) Highway plans will generally have several sheets of plans and profiles of the roadbed in addition to detail sheets.

Note to Instructor:

Obtain typical examples and make transparencies to project on screen to show the information.

b. Specifications

(1) Specifications outline the materials requirements.

(a) Quality of materials and types (grade of asphalts, etc.)

(b) Compaction requirements

(c) Equipment requirements

(d) Methods to be employed in construction.

(e) How quantities are measured for payment and how payment is to be made.

Note to Instructor:

Most paving in Calif. is done under Standard Specifications for the Div. of Highways. Obtainable from any Highway office. You can point out details from this publication.to the student, such as gradation of base courses, crushing requirements,etc.

There are 3 sessions on pavement in the next course (Structural Series #2) for more detail on placement, etc.

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Area IV

ENGLISH RELATED TO FOOD PREPARATION

Communication skills play an important role in food production and service. Area IV outlines the basic essentials of effective communication. Basic grammar should be stressed. It is essential that the student become familiar with the language of the trade. The instructor should acquaint the student with the meaning and correct use of cooking and menu terms, with the writing of menus, and with the sequence of items on menus.

The student who wishes to prepare for a career in the food industry must develop the ability to express himself adequately and correctly. Letters, orders, directives, and reports become very important as the food worker advances to positions of greater responsibility.

Basic Essentials of Effective Communication

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To know proper expression	Fundamental principles and rules of oral and written expression:	
	Letters	
	Reports	
	Instructions	
To know shop or trade vocabulary	Terminology for kitchen equipment such as:	Pronunciation, spelling, meaning
	Walk-ins	
	Trunnion kettles	
	Rotary ovens	
	Terminology used to describe utensils and tools	Pronunciation, spelling, meaning
	Terminology for cooking and baking operations:	Pronunciation, spelling, meaning
	Basting	
	Marinating	
	Blanching	
	Proofing	
	Terminology for stations or work operations	Pronunciation, spelling, meaning
To know how to plan menus	Basic factors to consider in menu planning:	
	Refrigeration	Left-overs
	Market	Availability of products
	Season or time of year	Foods that fit season or holiday
	Clientele	Age, income, sex, occupation
	Kitchen	Equipment, employee skills
	Time of day	Breakfast, lunch, dinner
	Appearance	Contrast, color, plate topography
	Dining area:	
	Tables	Top size
	Booths	Type of service
	Counter	Space

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(2) Specification requirements may be spelled out in the job specifications or included by reference to a Standard Specification, such as the Standard Specifications for the California Division of Highways. The current issue is dated July 1964.

5. Retaining Wall Construction
   a. Excavating - Precautions
   b. Backfilling - Materials, methods, Wall bracing and curing, drains
6. Inspection Procedure and Techniques
   a. Check - elevations, locations, soil conditions, reinforcement, disturbed bottoms, plumbness and caving in deep foundations, etc.
7. Safety
   a. Equipment working order, backup bells, traffic control
   b. Shoring
   c. Miscellaneous
8. General Codes and Specifications
   a. Uniform Building Code
   b. California Title 21
   c. California Standard Specifications (Div. of Highways)
   d. Local Building Codes

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APPENDIX - SOILS

General Information and History of Soil Mechanics

"Soil Mechanics" is a relatively recent term applied to the science of soil engineering which in itself is based on theories developed over many years. "Soil Mechanics" is defined as the application of known mechanics and hydraulics to engineering situations relating to soils.

Early studies of soil were persued in the 18th and 19th century by Coulomb and Rankine. They were recognized as the first to attempt to apply mathematical theory to soil reactions. The theories developed by these men are still forming the basis for modern methods of computing earth pressure.

Charles Augustin Coulomb (1736-1806) was a French military engineer prior to his retirement in 1789 because of poor health. In the period from 1789 until his death he devoted his efforts entirely to scientific research, a part of which was related to the mathematical solutions of soil failure. He was better known for his theories on friction, tension and electricity.

William John Rankine (1820-1872) was a Scottish civil engineer and physicist. He wrote many authorative papers on civil engineering and thermodynamics.

Scientific studies of soils have greatly increased in the last 40 years. An international conference on Soil Mechanics was held at Harvard University in 1936, which resulted in stimulating interest and may be considered as a landmark in present development. This conference was held again in 1948 and in 1953.

The very early studies related to cohesionless soils such as sand, in 1914 cohesion of soils was scientifically explored. In 1925 important studies were made in relation to the consolidation of soil.

Progress in soil studies were promoted to a great extent by the development of automobiles and airplanes, both of which, due to speed and loads, made existing methods of road building inadequate. The greatest period of advancement was during World War II when airfields were built in many parts of the world.

Early tests for measurement of shear in soil was developed originally about 1885. Many attempts have been made to develop reliable statistics for each type of soil. Most of these theories have been discarded for the standard laboratory tests and on the site tests presently used.

Dr. Karl Terzaghi wrote a publication entitled "Theoratical Soil Mechanics" in 1943. It has done much to consolidate known principles and create interest, which has resulted in many recent publications on the subject.

The texts used in this course have been developed quite recently and are usable working manuals of modern practice. If the student is desirous of expanding his knowledge in this area, he will find ample opportunity by studying the many publications available at our larger public and college libraries.

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BASIC SOIL DEFINITIONS

ADOBE
An alluvial playa clay, subject to large volume change with change in moisture content.

ALLUVIAL
Soil that has been deposited by the movement of water.

AZONIAL
Not restricted to any particular region; having no character or structural arrangement.

BARROW
To import soil from off-site for the purpose of forming elevations of structural soils.

BARROW PIT
The location from which imported soil is obtained.

BEAR
To support or hold up, passively or in passive form.

BINDER
Small particles in a soil (generally a minus No. 200 s.s. material) having the ability to hold together other and larger particles.

BLEND
To thoroughly fuse material of different gradation with each other.

BOULDER
Any rock, three inches or more in diameter, which has been moved from its original location or from its parent formation.

CAPILLARITY
The action by which a liquid rises in any direction above the horizontal plane of a supply of free water.

CLAY
A fine-grained earth, chiefly silica, but containing enough aluminum to make it plastic and cohesive.

COBBLES
Small boulders which have been worn smooth by the action of water and movement.

COEFFICIENT
A factor that contributes to produce a result.

COHESION
The mutual attraction of the particles of a soil to each other in the presence of moisture.

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COMPACT
To make more dense by compression; closely and firmly packed and fixed together. (Compactible soils do not rebound).

COMPRESS
To force or squeeze together; to make more compact by pressure. (Compressible soils can rebound).

COMPRESSIBILITY
A property of soil that causes it to rebound or to remain compressed after compaction.

DENSITY
The unit weight of a material to a given volumn.

DIATOMACEOUS
The siliceous remains or deposits of small marine live called diatoms.

DILATANCE
A characteristic of soil (silt) where surface moisture can be caused to recede by pressing the soil with the fingers.

ELASTICITY
The ability of a soil to rebound or retract after having been compressed or moved.

EXPANSIVE
To change volume with the change of moisture content.

FINES
The fine-grained particles in a soil mass. Usually designated as the percent of silt (M) and clay (C) in mass.

FLOURY
The fines whose structure is flat or flaky, rather than prismatic or granular.

FREE WATER
Water free to move downward by gravity, or disappear from evaporation.

FRIABLE
Easily crushed or crumbled into a powder.

GRADATION
The gradual change by steps or stages from one sieve size to another of the grain sizes of a soil.

GRANULAR
Soil whose molecules are prismatic, or grainy, or cubical in form.

GRAVEL
One of the four major divisions of soil, with an irregular surface, and sized between boulders and sand.

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GRAVITATIONAL

(Water) Water that is free to move downward and to drain from the soil by force of gravity.

HORIZON

Horizons are modified layers of soil, with particular characteristics, which form the profile of the earth.

IMPERVIOUS

Incapable of being penetrated by water.

IMPORT

To bring in from another site or location.

INTERNAL FRICTION

The resistance to the sliding of the particles of a soil by themselves within the mass.

INTRAZONAL

Soils with characteristics influenced by local factors, such as peat bogs, salt lakes, etc.

LIFT

To raise to a higher elevation by placing a quantity of soil upon the existing soil.

LINEAL CHANGE

An increase or decrease in one direction of the soil mass with the increase or decrease of the moisture content.

LIQUID LIMIT

The percentage of moisture content of the soil when it passes from a plastic to a liquid state.

LIQUID STATE

The percentage of moisture content of the soil when it passes from a plastic to a liquid state.

LIQUID STATE

When the moisture content is such that the soil flows easily and assumes the shape of its container.

LOAM

An even mixture of sand, silt and clay of different sizes.

LOESS

Wind born dust of variable composition found in dry continental areas.

MOISTURE

-The fluid (water) content suspended in the soil.

MOTHER

The origin or source of a soil; the "C" horizon of the earth's profile.

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NONPLASTIC
Silts and sands which contain no aluminum and cannot be rolled into 1/8th inch threads.

OPTIMUM
The best or most favorable degree or condition.

ORGANIC SOIL
Having to do with the fossils of organs, as: plant components, carbon compounds, etc.

PARENT MATERIAL
The mother material; the "C" horizon from which the "A" and "B" horizons are formed.

PEBBLES
Fragments of rocks, sized between boulders and sand (as gravel); worn smooth by water and motion.

PERMEABILITY
The property of a soil that allows it to transmit water.

PERVIOUS
Allowing passage through; same as permeable.

PLASTICITY
Material that, under certain conditions, can be influenced or molded into permanent shapes.

PROFILE (SOIL)
A vertical cross-section of the soil layers of the crust of the earth.

SAND
Loose, gritty particles of disintegrated rock.

SATURATION
Thoroughly soaked with moisture, completely wet.

SHEAR
The effect obtained when the external pressure upon a quantity of soil is greater than the internal resistance to that pressure.

SEPARATES
A name given to different sizes of soil and setting definite limits for the sizes of each.

SILT
A fine-grained, nonplastic earth, chiefly silica, but with little or no aluminum in the mass.

SOIL
The surface layer of the earth, composed of a disorganized mass of mineral particles, varying in shape, size and quantity.

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STRUCTURAL

The load-bearing value; the resistance to weight; the strength.

STRUCTURE

The shapes and sizes and quantities of the particles which make up the soil mass. The structure is indicative of the drainage characteristics of the soil.

SUBSOIL

The "B" horizon; usually structural soil.

SURFACE SOIL

The "A" horizon; usually organic in character, unstable, non-structural; the top-soil.

TEXTURE

The composition, or the amount of soil separates, in a soil mass. Greatly influences the feel of the soil in making field tests.

VOID-RATIO

The relation, prercentage-wise, between the volume of solid particles of a soil mass and the gaseous areas between the particles.

TEXT AND REFERENCES FOR UNIT IV - SOILS FUNDAMENTALS

1. Soils Manual (MS10)

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710

2. PCA Soil Primer

   Portland Cement Association
   San Francisco or Los Angeles District Offices

3. Earth Manual

   Bureau of Reclamation
   Order from: U. S. Printing Office
   Washington, D.C.

4. Asphalt Handbook

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710 (or nearest office)

5. Basic Soils Engineering

   Author - B. K. Hough
   The Ronald Press Co.
   New York, N.Y.

6. "Drainage of Asphalt Paving Structure" (MS-15)

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710

Note: Items 1, 2, and 3 above are recommended as textbooks to be obtained by each student.

The reference books (4, 5, and 6) should be available for use in the classroom.

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CONCRETE USES

Plain concrete is defined as concrete containing no reinforcement. In addition to plain concrete, there are other types used widely for construction. This unit will cover some of these uses.

REINFORCED CONCRETE

Reinforced concrete is concrete containing reinforcement to increase its tensile strength. It is designed on the assumption that the two materials (concrete and reinforcement) act together in resisting forces.

Reinforcement is the term used to describe the steel bars or welded wire fabric (wire mesh) placed in concrete to increase its tensile strength. Concrete is very strong in compression--that is, very strong for supporting loads that are placed directly upon it, but it sometimes requires steel reinforcement to help it resist stresses or forces that tend to bend or pull it apart.

PRESTRESSED CONCRETE

Prestressed concrete involves another concept. It, too, is generally applied to concrete members that are subjected to loads that cause bending, such as beams, girders, and slabs. The concrete is compressed by stretching steel wires through the member. In normal reinforced concrete, all tensile stresses are carried by reinforcing steel. In a prestressed member, the entire cross-section is effective in supporting loads.

Prestressed concrete has been used for highway and railroad bridges, industrial buildings, precast joists, pressure pipe, poles, piling, water tanks, roof systems, and many other purposes. The savings in materials made possible by prestressing is impressive. Up to 50 per cent of the concrete and 75 per cent of the steel used in a conventionally reinforced structure can be saved.

The prestressing force is applied by stretching the high-strength steel reinforcement. There are two general methods of doing this: pretensioning (before placing the concrete) and posttensioning (after the concrete has hardened).

In pretensioning, steel wire strand is stretched in the form prior to placing the concrete. Concrete is then cast and allowed to harden, after which the wires are released from the outside anchorage. As the wires contract, they transmit compressive stresses to the concrete by bond. Very-high-strength stranded-steel wires are used in pretensioning.

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In the posttensioning process, steel cables are located in ducts embedded in the concrete. The steel is stretched by hydraulic jacks after the concrete has hardened. The steel rods or cables are anchored to one end of the beam by mechanical means. Jacks are used to stretch the steel, which is then anchored at the other end by a mechanical anchor. Large-diameter rods or cables are used since the mechanical anchor holds the tension and it is not essential that the concrete be bonded to the steel.

PRECAST CONCRETE

Precast concrete has become popular because of the economy and quality control. When a large number of identical units are to be built, they may be precast on the job or at a specially equipped plant. By using assembly-line production methods, a considerable savings is realized, particularly in forming. Another advantage of precasting is that work can be done during slack periods and then stockpiled for later use. Components such as beams, girders, and columns are then available when needed.

Manufactured items such as concrete masonry, drain tile, concrete pipe, silo staves, and many other products are manufactured by large machines. These items are precast, of course, but are generally referred to as "concrete products." They are mass-produced.

LIGHTWEIGHT CONCRETE

Conventional concrete weighs on the average about 150 lb. per cubic foot. Lightweight concrete can be made either by using gas-generating chemicals or by the use of lightweight aggregates such as expanded shale, clay, and slag. Concretes containing aggregates such as perlite and vermiculite are very light in weight and are used primarily as an insulating material.

Lightweight concretes are sometimes classified according to the unit weight per cubic foot. These include:

1. Insulating lightweight concrete--unit weight of 20 to about 70 lb. per cubic foot and compressive strengths seldom exceeding 1,000 psi.

2. Structural lightweight concrete--unit weight up to 115 lb. per cubic foot and a 28-day compressive strength in excess of 2,000 psi.

3. Semi-lightweight concrete--unit weight of 115 to 130 lb. per cubic foot. Normal-weight sand is substituted as a partial or complete replacement for lightweight fine aggregate.

The first extensive use of lightweight concrete was for concrete block. Today, however, producers, contractors, and others are using lightweight concrete successfully for structural and insulation applications that include cast-in-place and precast walls, floors, roof sections, and for fireproofing.

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Basic Essentials of Effective Communication—Continued

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To know how to write menus	Basic principles of menu writing:	
	Menu terminology	Meaning, spelling, pronunciation
	Descriptive terms	French, German
	Format:	
	Print	
	Illustrations	Style, readability
	Clip-ons	Color, kind
		Size, shape
		General arrangement
	Pricing:	Necessary cost data
	Du jour	Raw food cost
	À la carte	Ready-to-cook cost
		Ready-to-serve cost
		Portion sizes

Suggested teaching materials: See items 9, 16, 23, 26, 27, 43, 46, 50, 68 in appendix B.

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The general principles of normal-weight concrete proportioning may be applied to lightweight-aggregate concretes. When the aggregates are highly absorptive, however, some modifications are needed.

The uniformity and quality of lightweight concrete are dependent largely on the uniformity of moisture content of the aggregate. If moisture varies in aggregates at the time of batching, slump, yield, and uniformity may be difficult to control. The moisture content of the aggregate should be known and aggregate batch weights should be adjusted to compensate for changes in absorbed water. If the final quantity of water added to the mix produces less than the required slump, additional water may be added to satisfy the slump requirements.

To control the uniformity of lightweight concrete, the cement content, slump, and volume of dry aggregates per cubic yard of concrete should be kept constant. Unit weight tests of fresh concrete should be made frequently.

THIN SHELLS

Thin shells of concrete were first used in Europe in the early 1920's. In recent years, thin shells have become very popular in the United States. As the term implies, concrete is placed in thin sections--some as thin as 2-1/2 in. In many cases, even this thin cross-section is more than is needed to meet strength requirements. However, rigid building codes prescribe a minimum of cover that usually makes 2-1/2 in. the thinnest allowable cross-section in the United States. In Mexico, shells of 5/8 in. have been built.

Fig. 1. Shell action.

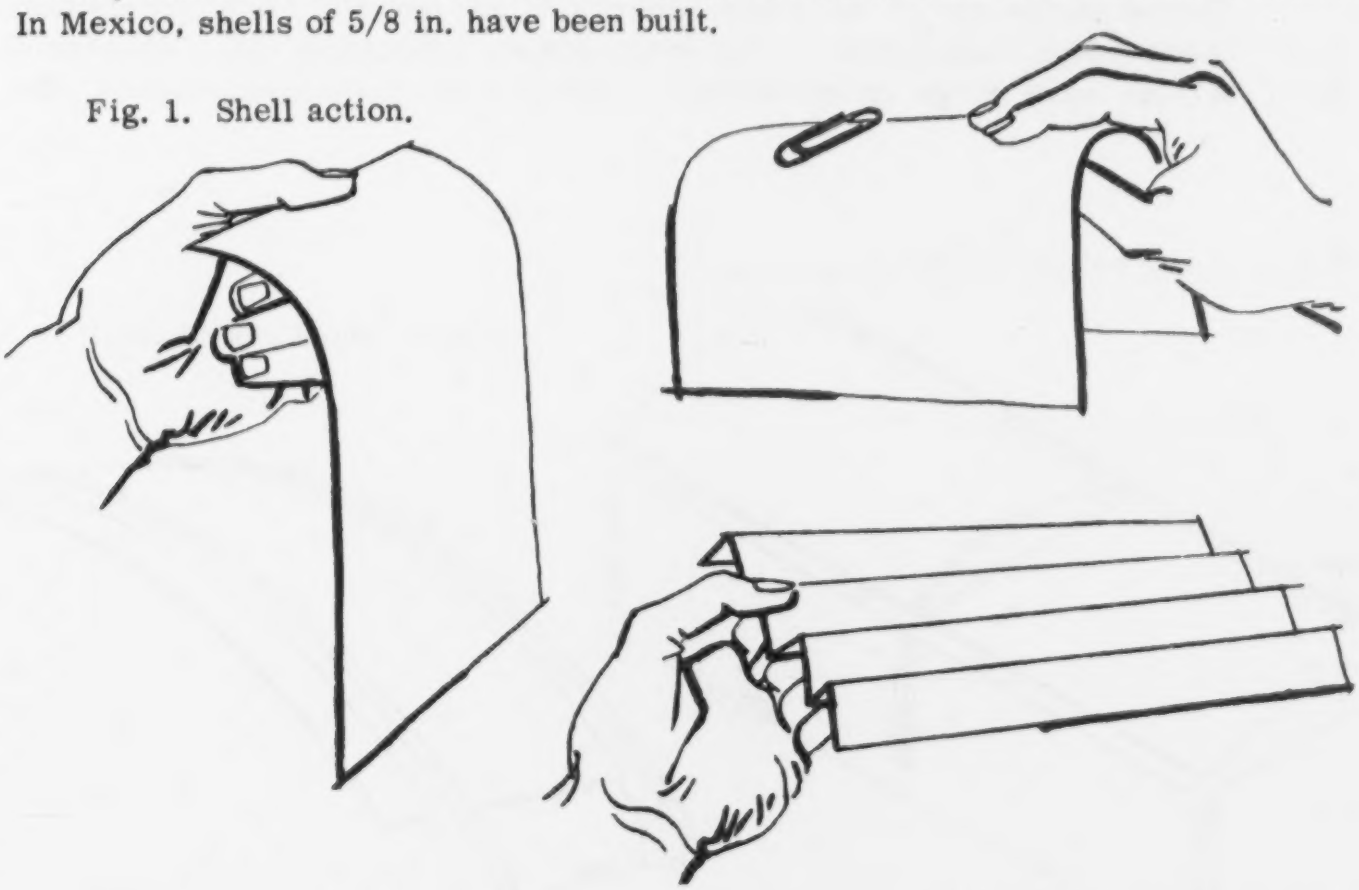

Shells derive their strength, and consequently part of their economy, from their shape. For example, hold a sheet of paper along one end and lift it

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from the table. It hangs limply from the points of support because it has practically no strength when cantilevered.

Roll the sheet into a semicircle and hold it along one edge. Now it will not only cantilever but will also support weights such as paper clips.

If we were to accordion-pleat our sheet of paper we would discover that its structural strength would be increased much in the same manner as when curved. The depth of the roof and the intersection of the folds explain the great spanning and load-carrying abilities of folded-plate shells.

The savings in materials for the roof, impressive though they are, are only one of the many economies in shell construction. Since considerable weight has been eliminated in the roof, the size of supporting columns and reinforcement can be reduced.

The economy of any shell roof is determined largely by the number of times that forms can be reused. Often forming costs can be reduced greatly by the use of mobile forms.

There are four commonly used types of shells--barrels, hyperbolic paraboloids, domes, and folded plates. Within each category there are many possible variations in shape.

Barrel shells are of two types--short and long barrels. Long barrels have short chord widths compared to the span between supporting ribs. Conversely, short barrels have large chord widths in proportion to the span between ribs.

Fig. 2. Long barrel shell.

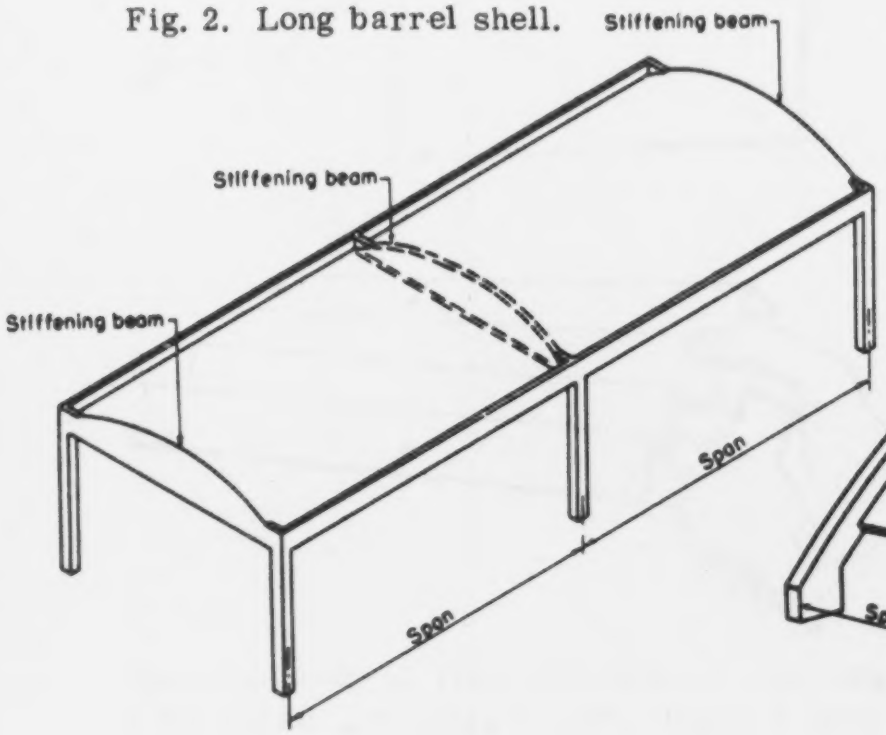

Fig. 3. Short barrel shell.

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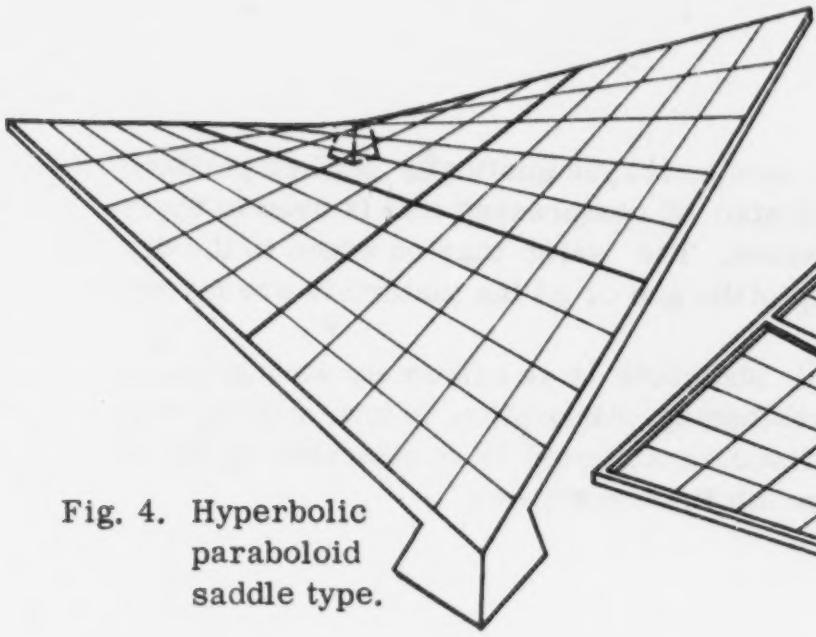

Fig. 4. Hyperbolic paraboloid saddle type.

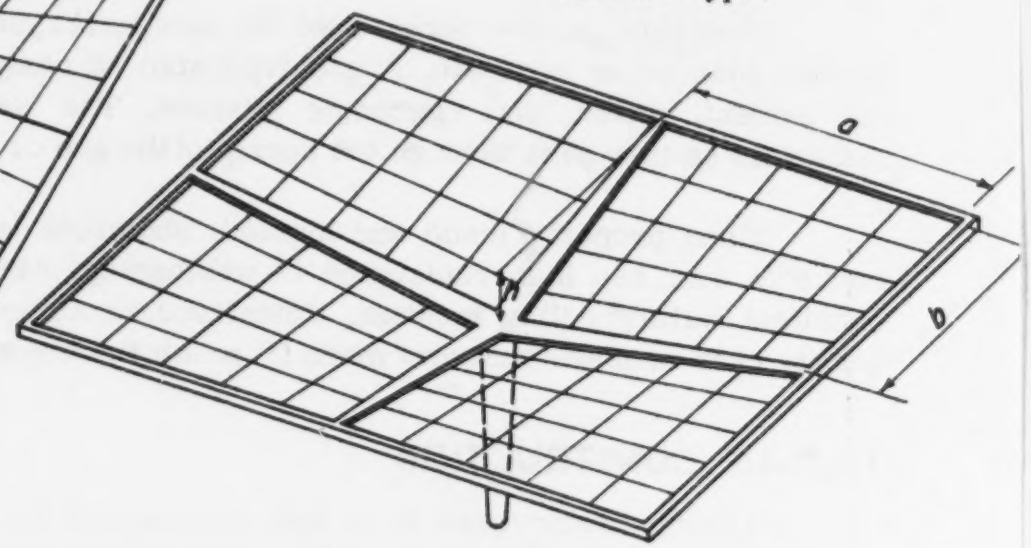

Fig. 5. Hyperbolic paraboloid umbrella type.

The hyperbolic paraboloid is a shape of double curvature; that is, its surface is curved on two planes. Double curvature imparts improved stiffness to hyperbolic paraboloid shells and increases their ability to span and carry unsymmetrical loads. Two commonly used variations of the hyperbolic paraboloid shell are the saddle and umbrella shapes. Despite its double curvature, this shape is composed entirely of straight lines. Therefore, it is possible to build forms with straight lumber.

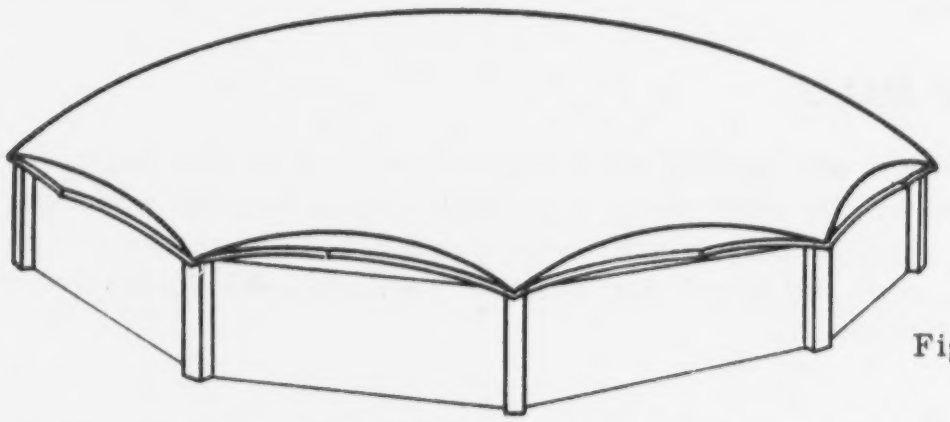

Fig. 6. Dome.

Dome shells are the aristocrats of roofs. (The dome is actually a portion of a sphere.) Their perfectly symmetrical shape and spacious, vaulted interiors are inspiring.

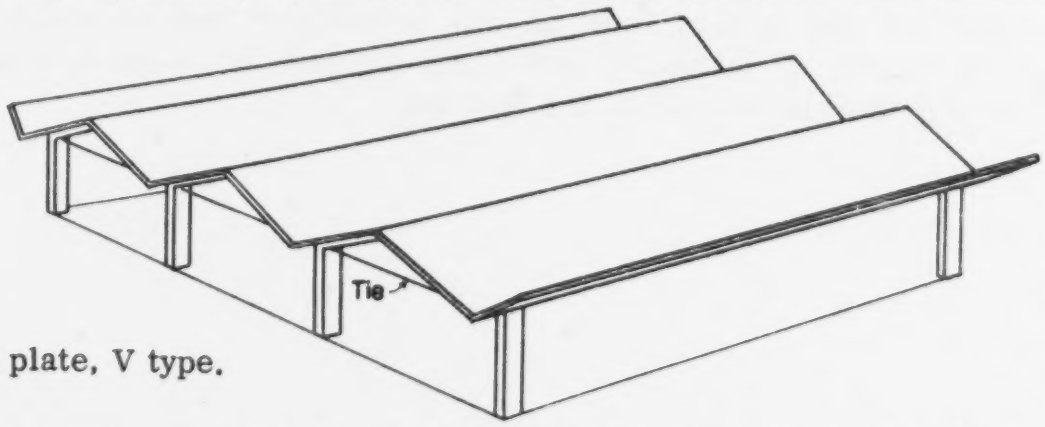

Fig. 7. Folded plate, V type.

There are three basic types of folded-plate shells--V-shaped, Z-shaped, and a modified W-shape. An example of the V-type is shown in Fig. 7.

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SHOTCRETE

Shotcrete is the term used to designate pneumatically applied portland cement plaster or concrete. A gun, operated by compressed air, is used to apply the cement, water, and aggregate mixture. The water may be added to the dry materials as they pass through the nozzle of the gun or as the materials are mixed.

When properly made and applied, shotcrete is an extremely strong, dense concrete and has high resistance to weathering. Absorption is low, making it an excellent waterproofing medium. Resistance to abrasion is comparable to that of quality cast-in-place concrete made from similar aggregates.

TILT-UP CONSTRUCTION

Tilt-up construction is a fast, economical way to build one-story buildings with concrete. The concrete walls of a tilt-up building are cast in sections or panels, flat on the floor or on a smooth bed of sand. After wall panels have been cured they are tilted to their vertical positions and fastened together to make a wall. Fastening of the wall panels into final position is accomplished by casting reinforced columns between them. These reinforced columns are cast on top of pier footings previously cast and extending into the ground, or on a continuous foundation. Reinforcing steel is continuous from the pier or foundation to the top of the column.

SANDWICH WALL

Sandwich wall panels are insulated concrete panels that are cast flat. They may be precast or site cast. A typical 6-in. wall panel would have a 1-1/2-in. section of expanded polystyrene between two 2-1/4-in. sections of concrete. Sandwich wall panels are lifted into vertical position and columns are cast much like tilt-up construction.

LIFT SLAB

Lift slab is a method of construction where the floor slabs of a building are cast on the ground, one on top of another. Then the slabs are jacked into place by means of hydraulic jacks and fastened to columns. Structures several stories high have been built by this method.

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TOOLS AND MATERIALS

Visual aid for demonstrating principle of prestressed concrete.
Samples of lightweight aggregates.
Samples of very lightweight aggregates.
Applicable films (see film list).

1. "Concrete's Finest Fifty Years" - 32 minutes

REFERENCE MATERIALS

Refer to the American Society for Testing and Materials, Designation ASTM C330, "Tentative Specifications for Lightweight Aggregates for Structural Concrete."
See Workability Is Easy, Information Sheet No. 1, Expanded Shale, Clay and Slate Institute.

TEST OR DISCUSSION POINTS

1. Define reinforced concrete.
2. What is reinforcement and how is it used?
3. What is the difference between reinforced concrete and prestressed concrete?
4. What are the two general methods used for prestressing?
5. What materials savings are possible with prestressing?
6. Why is precast concrete popular?
7. Regular concrete weighs approximately 150 lb. per cubic foot. What is the weight limit for lightweight concrete?
8. Name the three types of lightweight concrete.
9. What are thin shells?
10. Name the four common types of shells.
11. Describe tilt-up construction.

APPLICATION

Discuss concrete uses.
Plan a field trip to view local examples of special concrete uses.
Visit a concrete products plant.
Show film Tilt-up Construction on the Farm. (See film list; also note other applicable films that can be used.)

Concrete has several unusual characteristics that make it a versatile and widely used construction material. New developments backed by years of research have provided today's concrete user with a unique, attractive, and practical product. Architects, engineers, and builders have used concrete with imagination and skill to create exciting and distinctive structures.

Freshly mixed concrete is a combination of inert materials (aggregates) and a paste composed of portland cement and water. The aggregates generally used are sand and either gravel or crushed stone. These, obviously, have no cementing value of their own; their function in concrete is to serve as a filler. The paste changes from a semi-fluid substance into a solid binder as a result of chemical reactions between water and the various compounds in the cement. The final quality of the concrete depends upon the effectiveness of the hardened paste in binding the aggregate particles together and in filling the voids between them.

PROPERTIES DESIRED IN FRESH OR PLASTIC CONCRETE

Although freshly mixed concrete is plastic only temporarily, certain properties are desired at this stage because they affect the quality and cost of

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hardened concrete. These properties, discussed in detail later, are defined as follows:

1. The "wetness" or "dryness" of the mix is referred to as the consistency or slump.

2. All concrete should be mixed thoroughly until it is uniform in appearance, with all ingredients uniformly distributed.

3. Workability is the ease with which concrete is placed and consolidated.

PROPERTIES DESIRED IN HARDENED CONCRETE

The properties desired in hardened concrete are durability, strength, watertightness, and resistance to abrasion. All of these are influenced by the quality of the portland cement paste. The relation between the amount of water and cement used in the paste is known as the water-cement ratio. The quality of the paste is determined by the total amount of water mixed with the cement. The paste can be compared to a powdered wood glue: mixed to the right consistency it will glue; add too much water and it will be seriously weakened. This is why concrete is commonly proportioned according to the amount of water to be mixed with each bag of cement. The quality of the hardened paste is governed by the water-cement ratio and the extent to which the chemical reaction between the cement and water has progressed.

Concrete must be durable enough to withstand extreme exposure conditions and maintain long life with a minimum of upkeep. Concrete is used widely outdoors and is exposed to the destructive action of weathering. The prime essential of a durable concrete is watertightness. If water cannot penetrate the concrete to any appreciable extent, repeated freeze-thaw cycles will cause little or no deterioration of the concrete.

For concrete, the most destructive factor in weather is freezing and thawing of concrete while it is wet or moist. Destruction of the concrete may be caused by expansion of the paste, of some of the particles of the aggregate, or by a combination of both. The introduction of entrained air into the concrete can help prevent this destruction.

Concrete must be strong enough to carry the heavy loads placed on it. Strength in concrete usually refers to compressive strength. Strength often receives greater attention that either durability or watertightness. Yet strength is the quality most easily controlled during construction and is the one most easily checked by tests of samples taken on the job. Fortunately, the same precautions which increase the strength of concrete also improve its durability and watertightness to about the same degree. However, it is possible for concrete to be strong

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enough for its intended purpose and yet not be sufficiently durable and watertight for the conditions to which it is subjected.

If concrete is to be exposed to weather or other severe exposure conditions, it should be watertight. This requires a watertight paste. Tests show that a watertight paste depends on the water-cement ratio and the extent to which the concrete has been cured or kept moist prior to exposure.

For certain uses, concrete should be able to resist the abrasive action of wheeled vehicles, foot traffic, flowing water, etc. The same factors that increase durability, strength, and watertightness also increase the ability of concrete to resist abrasion or wear. When wear resistance is of primary importance, aggregate particles should be hard and tough. They should be as hard as the cementing paste.

THE PROPERTIES OF CONCRETE

Concrete hardens in the presence of water. Most materials deteriorate when they become wet, but concrete actually gains strength in the presence of water. This characteristic is of great importance in the construction of structures, especially foundations and footings in wet locations.

Since concrete is composed of mineral materials, it does not corrode or decay. It also resists vermin, termites, and rodents.

Freshly mixed concrete can be formed into practically any shape. Many materials can be molded only when heated and require elaborate casting facilities. Concrete, however, can be molded at normal temperatures, which gives it tremendous flexibility.

Concrete will withstand heat and fire because it is made of materials that will not burn. Portland cement is manufactured at temperatures from 2,600 to 3,000 deg. F. Aggregates are also incombustible. Thus, concrete has a high fire resistance which is desirable in any construction, especially in areas where fire protection is inadequate.

Concrete is widely available. Portland cement and aggregates are available in all parts of the country at reasonable prices.

VARIABLES THAT INFLUENCE CONCRETE QUALITY

All the desirable properties of hardened concrete are controlled by the amount of water in proportion to the amount of cement used in the mix. This relationship is known as the water-cement ratio and is expressed in terms of gallons of water per bag of cement.

There are several reasons for specifying grading limits and maximum

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aggregate size. The grading and maximum size of aggregates affect relative proportions, workability, economy, porosity, and shrinkage of concrete.

Variations in grading may seriously affect uniformity of concrete from one batch to another. Very fine sands are uneconomical and very coarse sands produce harsh, unworkable mixes. In general, aggregates that do not have a large deficiency or excess of any size produce the most satisfactory results.

The entrainment of air in concrete significantly improves the resistance of concrete to the adverse effects of freezing and thawing, as well as to the damaging effects of various de-icing chemicals. This improvement is particularly desirable in situations where the concrete will be saturated with water.

As water freezes it expands (up to 9 per cent), causing pressures that can rupture concrete and cause scaling. Air-entrained concrete has microscopic bubbles that provide reservoirs which relieve the pressure as excess water is forced into them, thus preventing damage to the concrete. The bubbles or air voids continue to serve their purpose during repeated cycles of freezing and thawing, improving resistance many times over that of concrete containing no entrained air.

Air entrainment has advantages in both plastic and hardened concrete:

1. Plastic Concrete

   a. Air entrainment lowers the water and sand requirement per cubic yard.
   b. Air-entrained concrete can be worked more easily.
   c. Air entrainment tends to reduce aggregate segregation and bleeding.
   d. Air-entrained concrete may be finished earlier than non-air-entrained concrete. Caution: Do not mistake the absence of bleeding water for the setting of concrete and attempt to finish it too soon.

2. Hardened Concrete

   a. Air entrainment greatly improves concrete's resistance to freeze-thaw action.
   b. Air entrainment is effective in preventing serious surface scaling caused by de-icing chemicals.
   c. Air-entrained concrete is more watertight than concrete with no entrained air.

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TEST OR DISCUSSION POINTS

1. What is concrete?
2. What are the "inert" materials?
3. What is the composition of the paste?
4. What properties are desired in fresh concrete?
5. Name four properties desired in hardened concrete.
6. Explain how the following variables influence the properties of concrete.
   a. Water-cement ratio
   b. Aggregate grading and maximum size
   c. Air entrainment

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Area V

SAFETY INSTRUCTION

Safety in the food industry cannot be overemphasized. It is essential that the instructor stress safety, not as a process but as part of a process. Safety is part of cooking; safety is part of care and maintenance; safety is part of any preparation process.

Safety instruction should be related to the various production and serving processes. The instructor should point out the hazards commonly associated with food production work and should stress common causes of accidents. The student should be made to understand that the right way is always the safe way.

The student must understand that the end purpose of safety instruction is to prevent accidents by eliminating causes of accidents. The instructor should emphasize the importance of first aid. A small scratch can become costly if proper first aid is not given immediately.

Materials from the National Safety Council, local health departments, American Red Cross, and Civil Defense Agency will be valuable in presenting this subject area.

Accident Prevention; First Aid

Essential learning (Skill and knowledge)	Scope of instruction (Suggested content)	Information (Technical and related)
To know the importance of safety rules	Basic principles of safety as related to all phases of food preparation	Orientation of new employees
Accident causes	Correct attitude towards accidents	
	Unsafe acts:	Proper supervision
	Failure to follow instructions	Job analysis
	Improper use of equipment	Proper use of tools and equipment
	Failure to control temper	
	Misconduct	Proper behavior
	Unsafe conditions:	Regular inspections
	Allowing floors to remain wet	Indentification of potential hazards
	Obstructed work aisles	Lighting
	Badly located equipment	Color markings for work areas
	Exposed hot pipes or electric wires	
Accident prevention	Methods of eliminating accident hazards	Posters
		Slides
	Personnel training:	Motion pictures
	Preinstruction	Demonstrations
	Instructions	
	Motivation	
	Discipline	
	Engineering revision:	
	Guards on slicing machines	
	Definite traffic lanes	
	Isolation of hazardous equipment	
First aid	First aid procedures:	Precautions in giving first aid
	Minor cuts	
	Bruises	
	Burns	
	Heat exhaustion and shock	What to do and what not to do
	Artificial respiration	
	Bleeding:	
	Arteries	
	Veins	

Suggested teaching materials: See items 1, 5, 6, 9, 50, 54, 84, 86, 112 in appendix B.

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CONCRETE INFORMATION
PORTLAND CEMENT ASSOCIATION
pca

NOTE: *Measurements are expressed in U.S. units. Water-cement ratio is expressed as U.S. gallons per 94-lb. bag of cement, followed by a weight ratio, pounds of water per pound of cement.*

Fundamental Facts About Concrete

CONCRETE CAN BE CONSIDERED to be made of two components, aggregates and paste. Aggregates are generally classified into two groups, fine and coarse. Fine aggregates consist of natural or manufactured sand with particle sizes smaller than about ¼ in.; coarse aggregates are those with particle sizes greater than about ¼ in. The paste is composed of cement, water, and sometimes entrained air.

Cement paste ordinarily constitutes 25 to 40 per cent of the total volume of concrete. As shown in Fig. 1, the absolute volume of cement is usually between 7 and 15 per cent (4 to 8 bags per cubic yard) and the water from 14 to 21 per cent (28 to 42 gal. per cubic yard). Air contents in air-entrained concrete range up to about 8 per cent of the volume of the concrete.

Since aggregate makes up about 60 to 80 per cent of the concrete, its selection is important. Aggregate should consist of particles having adequate strength and resistance to exposure conditions, and should not contain materials having injurious effects. A smooth gradation of particle sizes is desired for efficient use of the cement and water paste. In the following discussion, it is assumed that suitable aggregate is used.

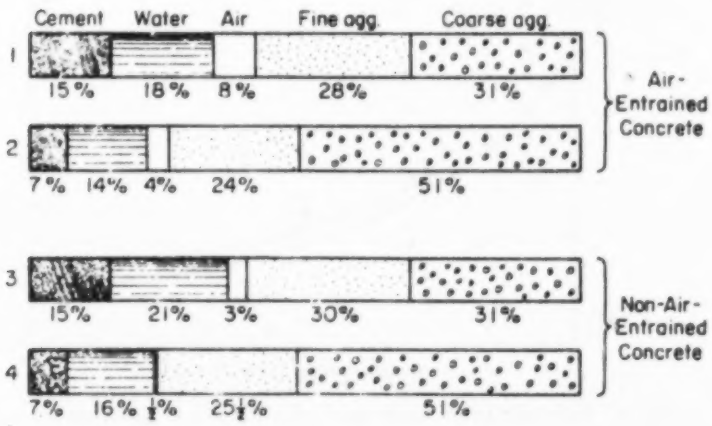

Fig. 1. Range in proportions of materials used in concrete. Bars 1 and 3 represent rich mixes with small aggregates. Bars 2 and 4 represent lean mixes with large aggregates.

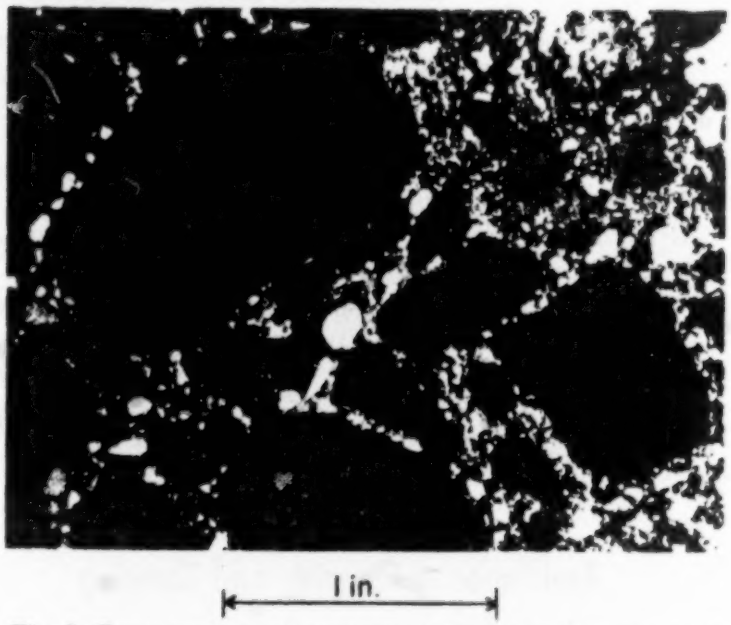

Fig. 2. Cross-section of concrete. Cement and water paste completely coats each aggregate particle and fills all of the space between particles.

In properly made concrete, each particle of aggregate is completely coated with paste. Also, all of the space between aggregate particles is completely filled with paste. This is illustrated in Fig. 2, which shows a section cut through hardened concrete. It can be shown that the quality of the concrete is greatly dependent upon the quality of the paste.

Quality of paste is dependent upon the ratio of water to cement used, and the extent of curing. The cementing properties of the paste are due to the chemical reactions between cement and water. These reactions, called hy-

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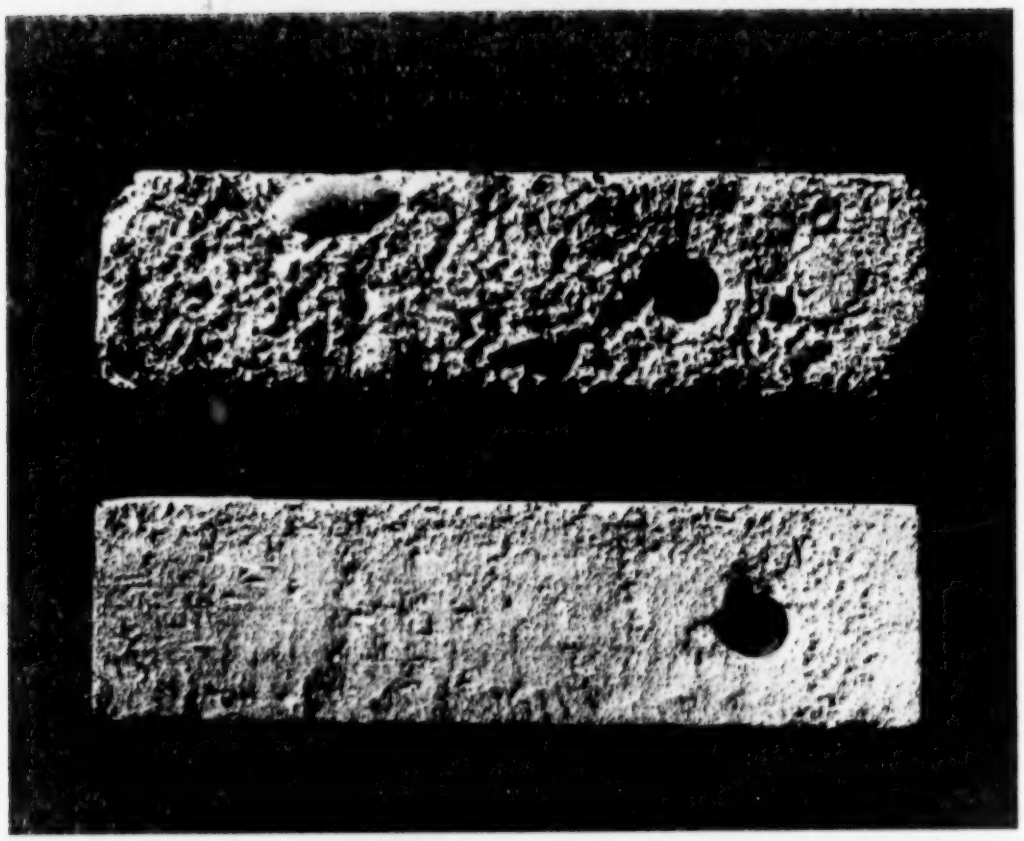

Fig. 3. The durability of concrete exposed to freezing and thawing is affected by the quality of the paste. Air-entrained concrete with a low water-cement ratio is highly resistant to repeated freeze-thaw cycles.

dration, require time and favorable conditions of temperature and moisture. They take place very rapidly at first and then more and more slowly for a long time under favorable conditions.

More water is used in mixing concrete than is required for complete hydration in order to make the concrete plastic and workable. However, as the paste is thinned with water, its quality is lowered; it has less strength and is less resistant to weather. For successful results, a proper proportion of water to cement is essential.

Resistance to Freezing and Thawing

Concrete is used in structures and pavements that are expected to have long life and low upkeep. One requirement of such concrete is high resistance to anticipated exposure conditions. The most destructive factor of weather is freezing and thawing while the concrete is wet or moist. Deterioration may be caused by expansion of the water in the paste, by expansion of some of the aggregate particles, or by a combination of both. Air entrainment improves resistance to this deterioration.

Destructive expansion of water in the paste during freezing is accommodated in air-entrained concrete. Air bubbles in the paste provide chambers in which the expansive force is relieved.

When freezing occurs in concrete exposed to wet conditions for a sufficiently long time to saturate some aggregate particles, destructive hydraulic pressures may be generated. Water displaced from these aggregate particles during the formation of ice is unable to escape fast enough through the surrounding paste to prevent such pressure.

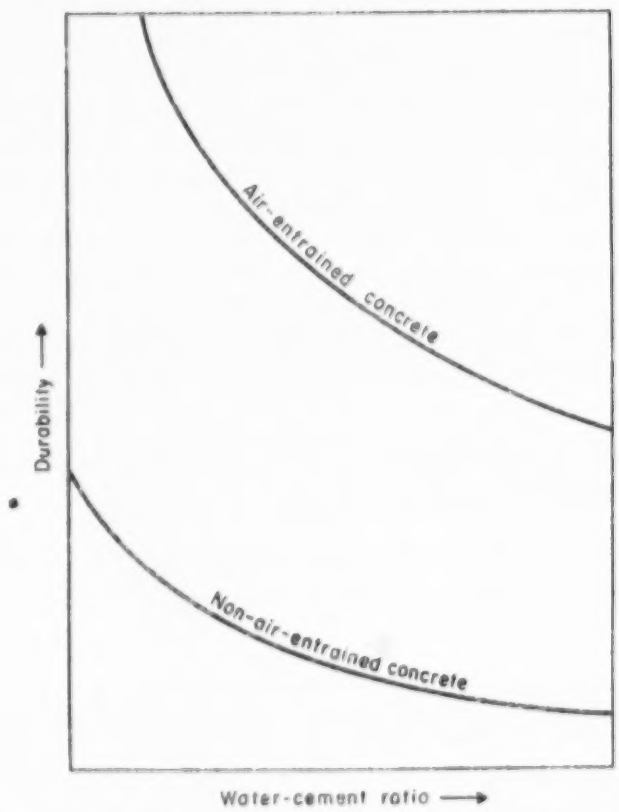

Fig. 4. Relationship between freeze-thaw resistance and water-cement ratio for air-entrained and non-air-entrained concretes. High resistance to freezing and thawing is associated with entrained air and low water-cement ratio.

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However, under nearly all exposure conditions, a paste of good quality, protected with entrained air, is able to prevent aggregate particles from becoming saturated. This enables air-entrained concrete to withstand freezing and thawing.

The mechanics of frost action in concrete is considerably more complicated than indicated by the above explanation. More comprehensive and accurate explanations of this subject are available.

Fig. 4 illustrates that within the range of water-cement ratios normally used, air-entrained concrete is much more resistant to freeze-thaw cycles than non-air-entrained concrete. Also, concrete with a low water-cement ratio is more durable than concrete with a high water-cement ratio. "Durability," as shown in Fig. 4, is a relative measure of the number of cycles of freezing and thawing required to produce a certain amount of deterioration in test specimens. Air-entrained concrete with a low water-cement ratio will withstand a great number of cycles of freezing and thawing without showing distress.

Watertight Concrete

Where concrete is exposed to weather or other severe exposure conditions, it is important that it be watertight. Such concrete requires a watertight paste. Tests show that watertightness of paste depends on the water-cement ratio and the extent to which the chemical reactions between the cement and water have progressed. Test results

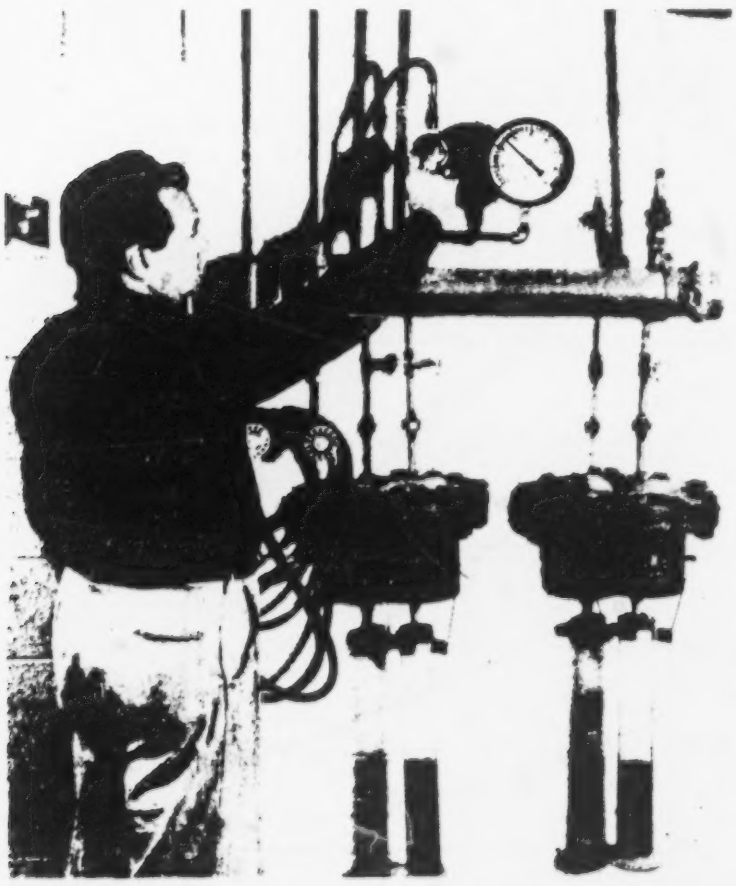

Fig. 5. Test apparatus for measuring watertightness of hardened concrete. Specimens are locked into the metal containers. Graduates below collect water that leaks through.

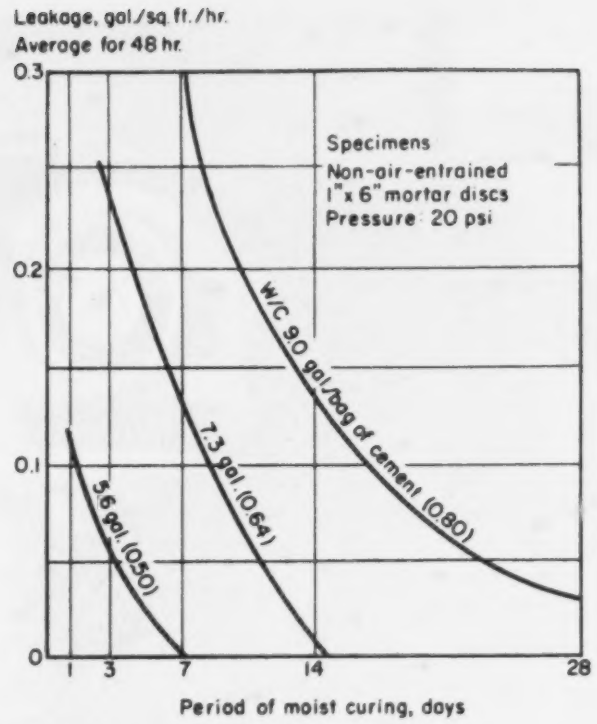

Fig. 6. Effect of water-cement ratio and curing on watertightness. Note that leakage is reduced as the water-cement ratio is decreased and the curing period increased.

obtained by subjecting non-air-entrained mortar discs to 20 psi water pressure are shown in Fig. 6.

In these tests, the mortar discs that were moist-cured for 7 days had no leakage when made with 5.6 gal. of water per bag of cement (0.50). Leakage was greater in mortars made with higher water-cement ratios. Also, for each water-cement ratio, the leakage became less as the length of curing period was increased. In the discs with 9 gal. per bag (0.80), the mortar still permitted leakage after being cured a month.

Air entrainment improves watertightness by increasing density through improved workability and reduced segregation and bleeding. Because the total water requirement of air-entrained concrete is less, the paste will have a lower water-cement ratio and will therefore be more watertight.

Watertight concrete must be free from cracks and honeycomb.

Strength of Concrete

The compressive strength of concrete is important in design of structures. In pavements and other slabs on ground, the flexural strength of the concrete is often used for design purposes. The principal factors affecting strength are the water-cement ratio and the extent to which hydration has progressed. Fig. 8 shows the compressive strengths for a range of water-cement ratios at different ages. Tests were made on 6-in.-diameter specimens that were 12 in. in height. Note that strengths increase as the water-cement ratios decrease, and that strengths increase with age. Flexural, tensile, and bond strengths are similarly influenced by water-cement ratio.

Fig. 8 also gives the typical age-strength relationships for air-entrained and non-air-entrained concretes. When

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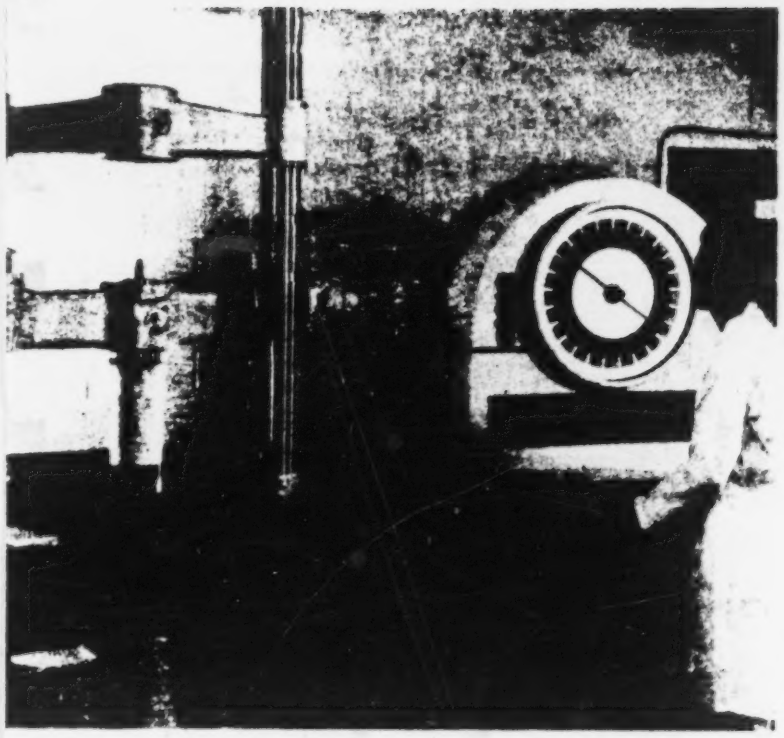

Fig. 7. Testing a 6x12-in. concrete cylinder in compression. The load on the test cylinder is registered on the scale.

more precise relationships are required, curves should be developed for the specific materials and cement contents that will be used. In general, greater strengths may be secured with lower water-cement ratios.

Air-entrained concrete requires less water for the same workability as non-air-entrained concrete. Hence, the water-cement ratio will be decreased when a given cement factor is maintained. Therefore, the lower water-cement ratio required for air-entrained concrete does not necessarily imply an increased cement factor.

Resistance to Abrasion

Concrete floors, pavements, and dam spillways are subjected to abrasion; hence resistance to abrasion or wear is important in these applications of concrete. Test results indicate that abrasion resistance is dependent principally upon the strength of the concrete. Strong concrete is more resistant to abrasion than weak concrete.

Fig. 10 shows results of abrasion tests on concretes of different compressive strengths. The tests were conducted by rolling steel balls under pressure over the surface of concrete specimens. Each specimen was subjected to the same number of revolutions. Since compressive strength is dependent upon water-cement ratio and curing, it is evident that a low water-cement ratio and adequate curing are necessary for abrasion resistance.

Moist Curing

The increase in strength with age continues as long as drying of the concrete is prevented. When the concrete

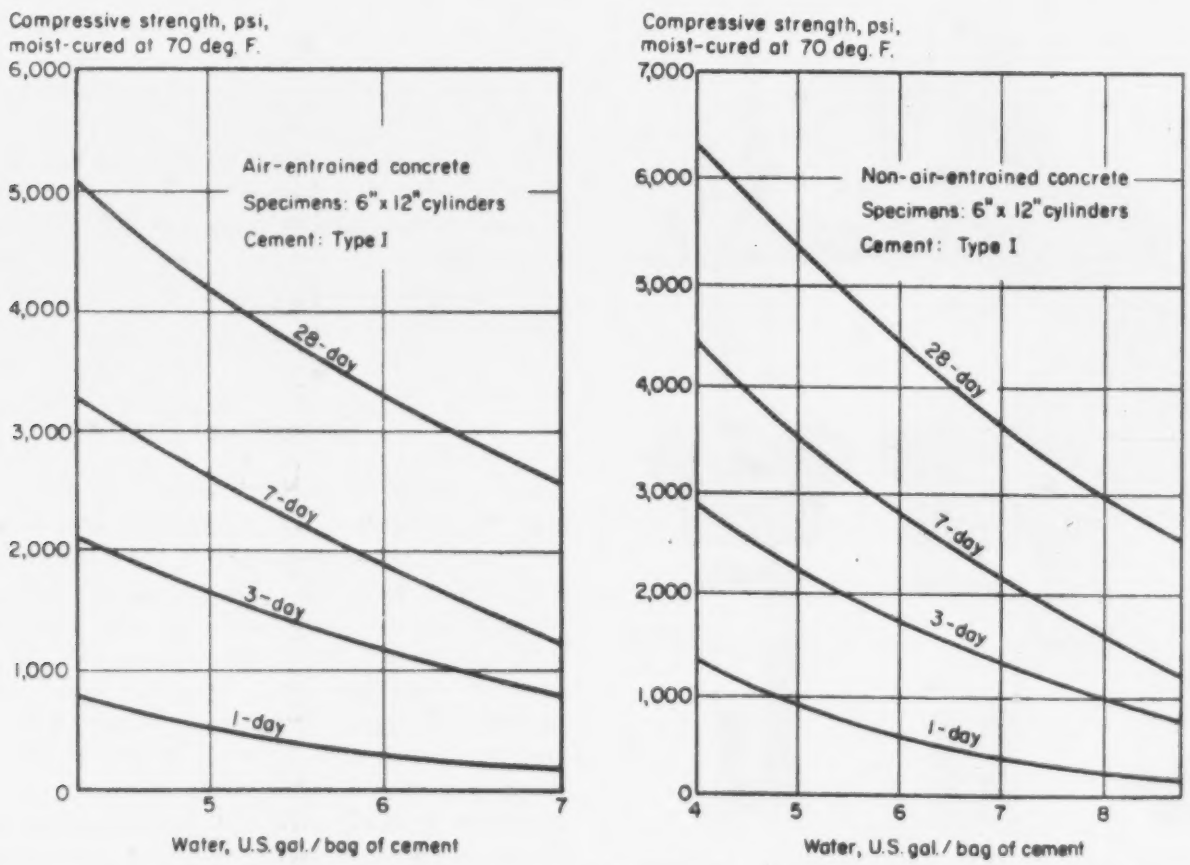

Fig. 8. Typical age-strength relationships based on compression tests of 6x12-in. cylinders (left, *for air-entrained concrete;* right, *for non-air-entrained concrete).*

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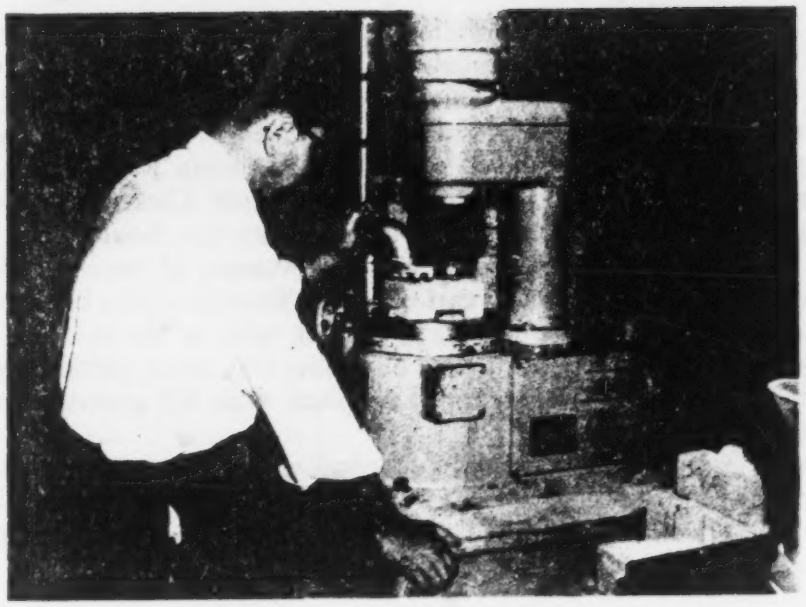

Fig. 9. Test apparatus for measuring abrasion resistance of concrete. Steel balls under pressure are rolled over the surface of the specimen.

is permitted to dry, the chemical reactions slow down or stop. It is, therefore, desirable to keep concrete continually moist as long as possible. This is illustrated in Fig. 11.

When moist curing is interrupted, the strength increases for a short period and stops. However, if moist curing is resumed, the strength will again increase. Although this can be done in a laboratory, it is difficult on most jobs to resaturate concrete. It is best to moist-cure the concrete continuously from the time it is placed until it has attained the desired quality.

The effects of concrete temperature during mixing and curing are discussed in *Hot-Weather Concreting** and *Cold-Weather Concreting.**

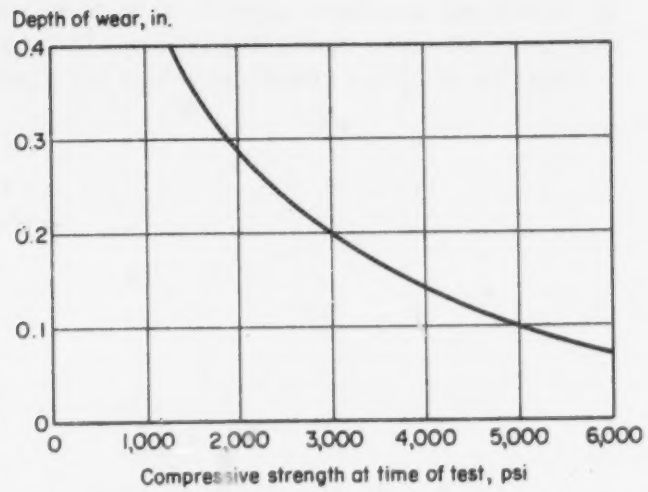

Fig. 10. Effect of compressive strength on the abrasion resistance to concrete. High-strength concrete is highly resistant to abrasion.

Volume Stability of Concrete

Hardened concrete undergoes small changes in volume due to changes in temperature and moisture content, and due to sustained stress. These volume changes may range from about 0.01 to 0.08 per cent in terms of length. Thermal volume changes are about the same as those for steel.

Concrete kept continually moist will remain almost constant in volume; actually a slight expansion may occur. When permitted to dry, concrete will shrink. The amount of shrinkage is dependent upon several factors, such as amounts of mixing water and aggregate used, properties of the aggregate, size of the specimen, relative humidity and temperature of the environment, and method of curing. Concrete subjected to stress will deform elastically. Sustained stress will result in a deformation called creep. The rate of creep deformation decreases with time.

The magnitude of volume changes and factors influencing them are discussed in *Volume Changes of Concrete.**

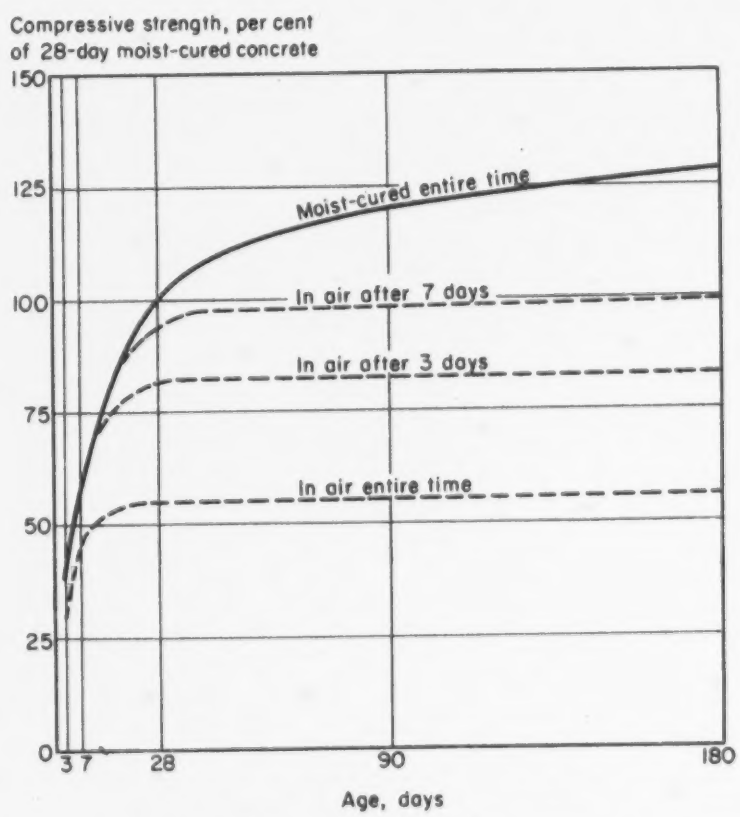

Fig. 11. Strength of concrete continues to increase as long as moisture is present for hydration of cement.

*Available free in the United States and Canada from the Portland Cement Association.

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Properties of Fresh Concrete

The foregoing discussion has dealt with properties of hardened concrete. Although freshly mixed concrete remains plastic only a short time, its properties are important, however, because they affect the quality and cost of hardened concrete.

With a given amount of water and cement paste, an increase in the amount of aggregate causes stiff mixes. Consequently, stiff mixes are more economical in use of materials. On the other hand, stiff mixes may require more labor in placing; the additional cost may offset savings in materials. In general, thin members and heavily reinforced members require more plastic mixtures than large members containing little reinforcement.

Concrete of *plastic* consistency does not crumble, but flows sluggishly without segregation. Mixtures of such consistency are suitable for most concrete work.

The ease or difficulty of placing and consolidating concrete is called workability. An experienced workman can readily judge when fresh concrete has adequate workability for use in a given situation. Concrete should be workable but should not segregate nor should it bleed excessively. Bleeding is the movement of water to the surface of freshly cast concrete. Since excessive bleeding may increase the water-cement ratio at the surface, a weak layer having poor durability may result, particularly if finishing operations take place while this excess water is present.

Generally the most economical mix is one that has the highest proportion of aggregate to cement and yet is workable at the water-cement ratio required for strength, durability, and other properties.

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SAMPLING AND TESTING PLASTIC CONCRETE

A complete discussion covering all methods for sampling and testing both plastic and hardened concrete would be too lengthy for inclusion in this unit. However, a general knowledge of sampling and testing plastic or fresh concrete will greatly benefit all concrete workers.

The need for standardization in testing led to the formation of the American Society for Testing and Materials (ASTM). All tests should be made in accordance with the standard methods of the ASTM.

SAMPLING FRESH CONCRETE

ASTM C172, "Standard Method of Sampling Fresh Concrete," covers the procedure for obtaining samples of fresh concrete from stationary and paving mixers, and from truck mixers, agitators, or dump trucks.

The sample must consist of not less than 1 cu.ft. when it is to be used for strength tests. Smaller samples may be permitted for routine air content and slump tests.

Sampling procedures shall include the use of every precaution that will assist in obtaining samples that will be representative of the true nature and condition of the concrete sampled, as follows:

(a) Stationary mixers, except paving mixers: Pass a receptacle through the discharge stream at about the middle of the batch.

(b) Paving mixers: After mixer has discharged onto subgrade, collect portions from at least five different points to be representative.

(c) Revolving drum truck mixers or agitators: Take three or more portions in regular increments throughout discharge of entire batch. Sampling is done by repeatedly passing a receptacle through the entire discharge stream or by diverting the stream completely so that it discharges into a container such as a wheelbarrow.

(d) Open-top truck mixers, agitators, dump trucks, or other types of open-top containers: Samples must be taken by whichever of the procedures described in Paragaphs (a), (b), or (c) is most applicable.

The sample must be transported to the place where test specimens are to be molded or where the test is to be made, and then remixed with a shovel the minimum amount to ensure uniformity. The sample must be protected from sun-

light and wind during the period between taking and using, which shall not exceed 15 minutes.

TESTS FOR CONSISTENCY

ASTM Designation C143, "Standard Method of Slump Test for Consistency of Portland Cement Concrete," is a test method covering the procedure for determining slump of concrete both in the laboratory and in the field.

The slump test may be used as a rough measure of the consistency of concrete--how wet or dry it is. This test is not to be considered as a measure of workability or proper water content, nor should it be used to compare mixes of entirely different proportions or containing different kinds of aggregates. Any change in slump on the job indicates changes have been made in grading or proportions of the aggregates or in the water content. The mix should be corrected immediately to get the proper consistency by adjusting amounts and proportion of sand and coarse aggregate. Care should be taken not to change the total amount of water specified for mixing with each bag of cement.

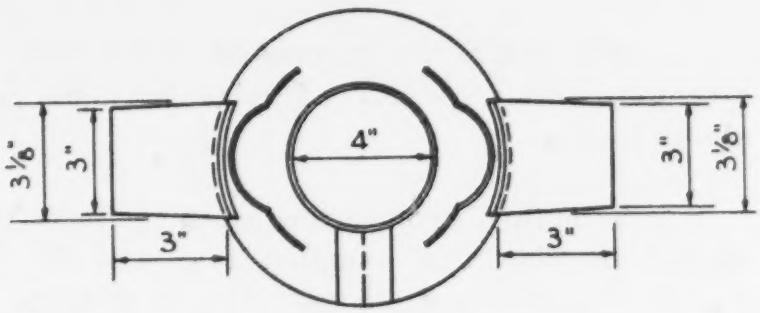

In making the slump test, the test specimen is made in a mold or "slump cone" of 16-gage galvanized metal in the form shown in Fig. 20. The diameter is 8 in. at the base and 4 in. at the top, and the height is 12 in. The base and top are open. The mold is provided with foot pieces and handles as shown.

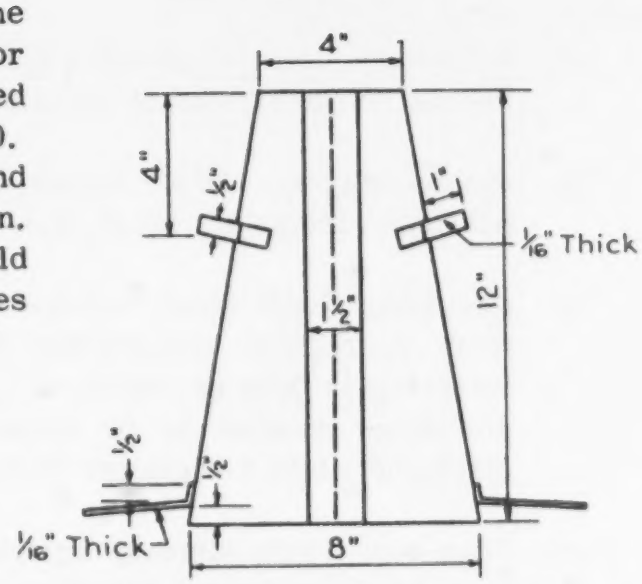

Fig. 20. Mold for slump test.

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The concrete sample for a slump test should be taken immediately prior to placing the concrete in the forms. The mold is dampened and placed on a flat surface such as a smooth plank or slab of concrete. The mold is filled with concrete to about one-third its volume. Then the concrete is rodded with 25 strokes of a 5/8 in. steel rod about 24 in. long, bullet pointed at the lower end (Fig. 21). The filling is completed in two more layers. Each layer is rodded 25 times and each rod stroke penetrates into the underlying layer. After the top layer has been rodded, it should be struck off by means of a screeding and rolling motion of the tamping rod. The mold is removed by gently raising it vertically immediately after being filled. The mold is then gently placed beside the concrete specimen and the slump is measured as shown in Fig. 22. For example, if the center of the top of the slumped pile of concrete is 5 in. below the top of the cone, the slump of the concrete is 5 in.

Fig. 21. The slump test shows consistency of concrete. Here, rodding concrete in cones ensures complete filling of the mold.

Fig. 22. Slump is measured from rod laid across the top of the slump cone. This amount of slump indicates a medium-wet concrete mixture.

BALL PENETRATION TEST

A convenient supplementary test for the consistency of concrete, but not a substitute for the slump test, is provided by ASTM Method C360, "Tentative Method of Test for Ball Penetration in Fresh Portland Cement Concrete." This test is sometimes referred to as the "Kelly Ball" test. It involves determining the depth to which a 6-in.-diameter metal hemisphere, weighted to 30 ± 0.1 lb., will sink into the fresh concrete. It has the advantage over the slump test of not involving the molding of a specimen and permitting the testing of concrete in a wheelbarrow or other container, or even in the forms. The test can be made quickly and thus provides a convenient means for the routine checking of consistency for control purposes. The results cannot be translated quantitatively into terms of slump and should not be used as a basis for acceptance or rejection of the concrete.

To avoid the effects of boundary conditions, the ball penetration test must be made on a reasonably large sample. The ASTM Method requires a depth of concrete of at least 8 in. and a minimum lateral dimension of about 18 in. Disturbance or vibration of the sample during test must be avoided and care must be taken that the weight is allowed to settle freely but without impact. The reported result should be an average of at least three readings.

UNIT WEIGHT TEST

The standard test for unit weight of fresh concrete (ASTM C138) is similar to that used for unit weight of aggregates (ASTM C29). The same measuring containers are used, except that for the test on concrete the 1/2-cu.ft. measure is used when the nominal maximum size of aggregate does not exceed 2 in., and the 1-cu.ft. measure when the maximum size of aggregate is greater than 2 in. The concrete is placed in three approximately equal layers. Each layer is rodded and the side of the measure is then tapped with the rod 10 to 15 times or until no large bubbles of air appear on the layer. The measure is struck off level full with a flat cover plate. Excess concrete is cleaned off and the net weight of the concrete is determined.

TESTING FOR AIR CONTENT

There are various methods for determining the air content of fresh concrete. Three methods have been standardized by the ASTM:

The Pressure Method (ASTM C231) is practical for field testing of all concretes except those made with highly porous and lightweight aggregates.

The Volumetric Method (ASTM C173) is practical for field testing of all concretes, but is particularly useful for concrete made with lightweight and porous aggregates.

The Gravimetric Method (ASTM C138) requires accurate knowledge of

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Appendix A

OCCUPATIONS IN THE FOOD SERVICE INDUSTRY

Instructors and student advisors should be familiar with the kinds of entry jobs available in the food service industry. The information included in this appendix covers a wide variety of jobs.[1] It should be equally valuable in counseling applicants for the training program and students already enrolled.

The job summary descriptions given in this appendix are not all-inclusive. They are not offered as complete job descriptions but as thumbnail descriptions of a few positions in the industry. It should be noted that job titles may vary from one food service establishment to another. It is not uncommon for one establishment to use the term dinner or first cook, while another restaurant will use the title of second cook for the same job.

In many hotels and restaurants two or more of the jobs listed or described may be combined; for example, the second cook may do all of the work normally assigned to the soup, sauce, roast, and broiler cooks. Job titles are used interchangeably in many instances. Regardless of terminology used, students and instructors should be familiar with the various occupational possibilities. (See *Occupational Outlook Handbook, 1966–67 edition,* U.S. Government Printing Office, Washington, D.C.)

In addition to knowing the types of jobs available, instructors and counselors should be familiar with laws and local regulations governing employment of minors and women. In areas requiring work permits for part-time student employment, it is essential that counselors and instructors know the procedure for acquiring them. Some sections of the Civil Rights Act of 1964 have a real bearing on the employment of women.[2] In some instances hours of employment for women are regulated by the State or local communities.

[1] See Teaching Materials Nos. 8 and 12.

[2] Public Law 352, 88th Congress, H.R. 7152, July 2, 1964.

The quantity food training program should prepare students for entry jobs in the food service industry. Training should be sufficiently thorough to enable graduates to advance, after a period of experience, to any or all positions described below. Jobs listed first are entry jobs; those with summary descriptions are jobs to which graduates may advance after varying periods of experience.

Kitchen helper	Storeroom clerk
Cook's helper	Receiving clerk
Salad preparer	Food checker
Pantry helper	Host or hostess
Dish machine operator	Counterman
Baker's helper	Cake decorator

Fry cook (short order cook, breakfast cook): Fries meats, fish, fowl, and vegetables; is responsible for making sandwiches and preparing wheat cakes and other breakfast dishes. He may assist the second cook. The term short order cook is used where the fry cook is responsible for cooked-to-order foods in counter-type operations.

Vegetable cook: Directs the preparation, cleaning, and cooking of vegetables. He is responsible to the chef. In many establishments the work done by the vegetable cook is combined with that of the second cook.

Roast cook: Roasts, bakes, and carves meats, fish, and fowl; may prepare gravies and stuffings. Work may be combined with that of the second cook or dinner cook.

Garde manger: Supervises the cold meat and sandwich department; makes salad dressings, cocktail sauces; makes seafood, fish, and shrimp salads and cocktails; makes and decorates canapés, hors d'oeuvers, and appetizers. The work of the garde manger is often done by pantry men or women. This position is usually found in very large establishments.

Meat cutter (butcher): Cuts, trims, and prepares meats for roasting, frying, broiling, and

specific gravities and absolute volumes of concrete ingredients. It is impractical as a field test method but can be used satisfactorily in the laboratory.

A field test for checking possible changes in air content or mix proportions is the unit weight test. The only equipment needed to perform this test is a sturdy container of known volume, preferably 1/4 or 1/2 cu.ft., and an accurate balance. Changes in air content generally result in changes in the unit weight of concrete from one batch to another.

One way to check the approximate air content of fresh concrete is with a pocket-size air indicator, shown in Fig. 23. The small container is filled with a representative sample of mortar from the fresh concrete. The tube is then filled with alcohol and, with the thumb over the open end, the tube is shaken to remove the air from the mortar. By using a calibration chart, the approximate air content is determined from the drop in the level of the alcohol. Since this test can be performed in only a few minutes, it is especially useful for estimating the air content of fresh concrete. However, it is not a substitute for the more accurate pressure and volumetric methods.

Fig. 23. Air indicator.

FOLLOW-UP TESTS

Follow-up tests to determine the effectiveness of the field control methods are made on many jobs. These tests are usually for compressive strength or flexural strength. The specimens should be made and cured in accordance with "Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field" (ASTM C31). For laboratory work, "Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory" (ASTM C192) may be used. The testing of the specimens should be done in accordance with "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders" (ASTM C39) and "Standard Method of Test for Flexural Strength of Concrete (Using Simple Beam and Third-Point Loading)" (ASTM C78).

At times it is desirable to make compressive or flexural strength tests of specimens taken from the hardened concrete. The work should be done as specified in "Standard Methods of Securing, Preparing and Testing Specimens from Hardened Concrete for Compressive and Flexural Strengths" (ASTM C42).

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STRENGTH TEST CYLINDERS (ASTM C31)

Test specimens are sampled from concrete being used in construction to determine if the concrete has the specified compressive strength. Field control specimens of various ages indicate the rate of strength gain and the effectiveness of job-site curing. Meticulous care must be exercised in the molding, protection, and curing of strength test cylinders.

In making the compressive strength field test, a sample of the concrete is taken at three or more regular intervals throughout the discharge of the entire batch. However, samples are not to be taken at the beginning or end of discharge. Before filling the molds, the individual portions of the sample should be remixed with a shovel to ensure uniformity. No water should be added. The batch of concrete thus sampled is noted as to its location in the work, the air temperature, and any unusual conditions.

The compressive test specimen is made in a watertight cylindrical mold. Standard cylindrical molds are 6 in. in diameter by 12 in. in length if the coarse aggregate does not exceed 2 in. in nominal size. The mold is filled in three equal layers. Each layer is rodded with 25 strokes of a 5/8 in. round steel rod about 24 in. long, with bullet-pointed tip. When rodding the second and third layers, the rod should penetrate through into the concrete layer underneath. Reinforcing rods or other tools should not be used as the tamping rod. After the top layer has been rodded, the surface of the concrete is struck off with a trowel and immediately covered with a glass or metal plate to prevent evaporation. The side of the mold should not be tapped or otherwise vibrated when it is being filled.

Molds should be placed on a rigid horizontal surface that will be free from vibration and other disturbances. During the first 24 hours, test specimens should not be moved. They should be stored under conditions that will prevent the loss of moisture and also maintain the temperature within a 60 to 80 deg. F. range. Send the cylinders to a laboratory as soon as possible for standard curing.

Standard procedures provide for curing the specimens either in the laboratory or in the field. Laboratory curing gives a more accurate indication of the potential quality of the concrete. Field-cured specimens may give a more accurate interpretation of the actual strength in the structure or slab, but they offer no explanation of whether any lack of strength is due to error in proportioning, poor materials, or unfavorable curing conditions. On some jobs both methods are used, especially when the weather is unfavorable to proper interpretation of the tests. The laboratory test result is the one that always prevails.

Concrete specimens at all ages should be protected from rough handling. In all cases, the specimens should be kept upright until they have hardened. If these precautions are disregarded, the concrete test specimens will indicate lower than normal strengths. Rough handling and lack of proper curing usually result in erratic and low-strength tests.

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At the laboratory, compression tests are made in accordance with ASTM Designation C39, "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders."

The specimen is placed in a testing machine where a load is applied and increased until the specimen fails. After this, the compressive strength of the specimen is calculated to the nearest 10 psi.

APPLICATION

Discuss slump test, consistency, and concrete test cylinders. Show mold and demonstrate proper procedures for slump test. Show mold for compressive test and discuss proper methods of obtaining specimens.

TEST OR DISCUSSION POINTS

1. What is the ASTM and why was it formed?
2. Explain why a slump test is used.
3. What would a change in slump indicate?
4. When should a concrete sample be taken for a slump test?
5. Explain the complete procedure for making a slump test.
6. After the cone is removed from a concrete specimen, how is the slump measured?
7. Of what value are compressive tests?
8. Explain the procedure for obtaining test cylinders.
9. How should preliminary storage and curing of compressive test specimens be handled?
10. What precautions should be observed when handling and shipping compressive test specimens?
11. Name some factors affecting air content in concrete.
12. Explain how you would make a simple field test for checking possible changes in air content of fresh concrete.

TOOLS AND MATERIALS

Slump cone, rod, and rule
Compressive test mold

REFERENCE MATERIALS

ASTM Designation C172, "Standard Method of Sampling Fresh Concrete."
ASTM Designation C143, "Standard Method of Slump Test for Consistency of Portland Cement Concrete."
ASTM Designation C31, "Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field."
ASTM Designation C39, "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders."
ASTM Designation C360, "Tentative Method of Test for Ball Penetration in Fresh Portland Cement Concrete."
ASTM Designation C231, "Standard Method of Test for Air Content of Freshly Mixed Concrete by Pressure Method."
ASTM Designation C173, "Standard Method of Test for Air Content of Freshly Mixed Concrete by Volumetric Method."
ASTM Designation C138, "Standard Method of Test for Air Content of Freshly Mixed Concrete by Gravimetric Method."

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PORTLAND CEMENT: HISTORY, MANUFACTURE, CHARACTERISTICS, AND TYPES

Portland cement, often called the "magic powder," is a finely ground material consisting primarily of compounds of lime, silica, alumina, and iron. When mixed with water, it forms a paste which hardens and binds the aggregates (sand, gravel, crushed rock, etc.) together to form a hard durable mass called concrete. Thus, cement is one ingredient of concrete.

SETTING AND HARDENING

When portland cement is mixed with water, a paste is formed which first sets--that is, becomes firm--and then hardens. The setting and hardening are due to a chemical reaction called hydration between the cement and water. This chemical reaction builds up a strong internal structure which makes concrete hard, strong, durable, and watertight. The set and subsequent hardening process are the same whether the cement is used alone or in combination with aggregates. If the concrete is kept moist, the reaction will continue for years and the concrete will become progressively stronger and more durable.

HISTORY OF CEMENTING MATERIALS

The history of cementing materials goes back to the time when ancient man first abandoned the cave and thought about building a home. His first problem was finding a material to chink the stones and to keep out the cold. The Assyrians and Babylonians used clay for this purpose. Then the Egyptians discovered lime and gypsum mortar which they used in their pyramids. The Greeks made further improvements, and finally the Romans perfected a cement that produced structures of remarkable durability. The Colosseum and the great system of aqueducts and other cement-bonded structures built by the Romans are in an excellent state of preservation today.

Despite the early use of these materials, little was known of their chemistry and no substantial advance was made in the manufacture of cementing materials from the time of the Romans until 1756. In that year, John Smeaton, who had been employed by the English government to build a lighthouse in the English Channel, discovered that a mixture of limestone and clay, when burned, would harden into a solid mass under water as well as in air. Smeaton's discovery led the way to rapid improvement of cement and masonry construction.

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In 1824, Joseph Aspdin took out a patent in England for the manufacture of an improved cement produced by heating a mixture of limestone and clay and crushing the resulting product to a fine powder. He called this powder "portland" cement, because it produced a yellowish-gray concrete which resembled stone quarried on the Isle of Portland, England. Aspdin is generally recognized as the father of the modern portland cement industry.

In 1872, the first cement plant was built in North America at Coplay, Pa., to give birth to the portland cement industry in North America.

RAW MATERIALS

Raw materials for cement may be divided into those supplying the lime component (calcareous), the silica component (siliceous), the alumina component (argillaceous), and the iron component (ferriferous). Portland cement consists of a combination of the following compounds:

1. Lime
2. Silica
3. Iron oxide
4. Alumina
5. Gypsum (added after burning)

Fig. 8. Raw materials for portland cement.

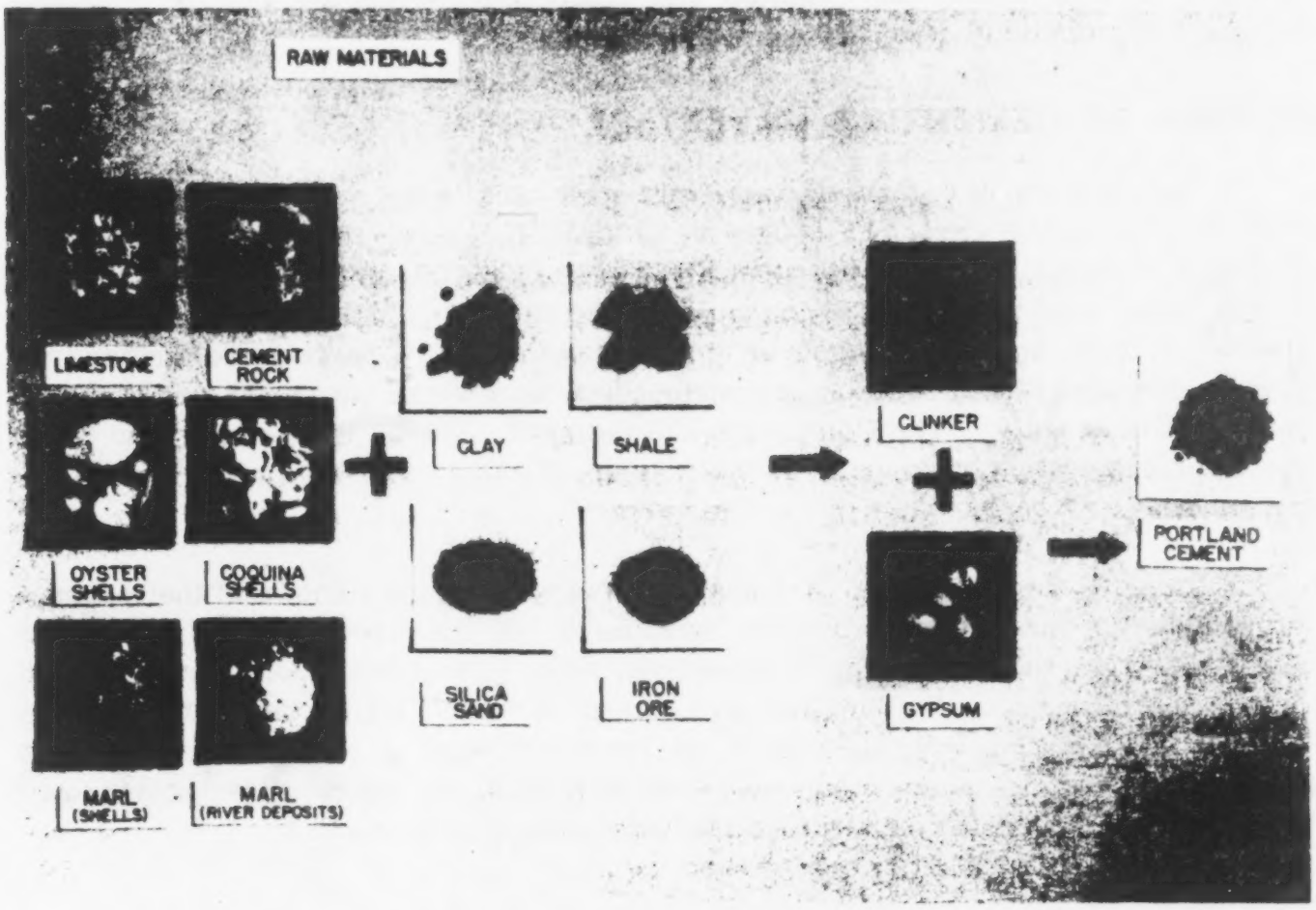

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The term "limestone" is used to include all carbonate rocks containing major quantities of calcium. Limestones are composed essentially of calcium carbonate, varying minor percentages of magnesium carbonate, and mechanically admixed impurities of clay and sand. Clay and sand are not objectionable impurities when the rock is used for the manufacture of portland cement.

Cement rock is a low-magnesium limestone containing clay.

Marls are earthy, friable accumulations of calcareous materials secreted by plants and animals in lakes and marshes. Over long periods of time the skeletal remains of plants mixed with shells of animals may form beds as much as 30 ft. thick, containing substantial tonnages of material suitable for cement manufacture.

Shell marls consist of mixtures of fossil shells, shell fragments, and varying amounts of clay and sand.

Oyster and clam shells of recent origin have been collected and burned for lime from Nova Scotia to Texas. Tonnage adequate for cement manufacture, however, is not known on the Atlantic coast of North America. In San Francisco Bay, shells occur in brackish water deposits as much as 30 ft. thick and are suitable for cement manufacture. Along the Gulf of Mexico, oyster shells are the principal source of lime for cement manufacturers.

Coquina shells, used in Florida, are excavated under water and cleaned completely or partially of their sand by washing.

Clay and shale must be added where alumina and silica are not present in the limestone in sufficient amounts.

MANUFACTURING PROCESS

Portland cement is manufactured from carefully selected materials and by closely controlled processes. The process starts by blending in proper proportions limestone, marl, or other calcareous materials with clay, shale, or blast-furnace slag. This mixture is heated in a rotary kiln to a temperature of approximately 2,600 to 3,000 deg. F., when it forms a clinker. The clinker is cooled and then pulverized. A small amount of gypsum is added to regulate the setting time. The pulverized product is finished portland cement. It is ground so fine that nearly all of it will pass through a 200-mesh sieve (40,000 openings to the square inch). The finished product is then stored in silos from which it is bagged or loaded for shipment.

PACKING AND STORAGE OF PORTLAND CEMENT

Much of the cement now being used is shipped in bulk by rail or truck to ready mixed concrete producers and block manufacturers, or direct to the construction site. It is quickly unloaded by automatic equipment into silos or hoppers

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for storage. Cement is also sold in paper bags. Each bag holds 1 cu.ft. of cement and weighs 94 lb. Cement is often measured in barrels equal to 4 bags or 376 lb. The weight of a bag of masonry cement (70 lb. average) is printed on the bag.

Portland cement will retain its cementing quality indefinitely if it does not come in contact with moisture. Thus, it should be stored in a location as dry and airtight as possible.

When bagged cement is in storage for long periods it sometimes acquires a "warehouse pack." This can usually be corrected by rolling the bag on the floor. When used it should be free flowing and free of lumps. If cement contains lumps that cannot be easily broken up, it is advisable not to use it.

CLASSIFICATION OR TYPES OF PORTLAND CEMENT

Portland cement is a type of cement, not a brand name. Each manufacturer of cement makes portland cement. Note that the words "portland cement" are not capitalized. All portland cements are hydraulic cements. This means they will set and harden under water. Portland cements are made to meet the American Society for Testing and Materials' standard specifications ASTM Designation:

C150 Portland Cement, Types I through V
C175 Air-Entraining Portland Cement
C205 Portland Blast-Furnace Slag Cement
C340 Portland-Pozzolan Cement

The first of these specifications, ASTM Designation C150, covers five types of portland cement:

Type I, normal portland cement, is a general-purpose cement suitable for all uses when the special properties of the other types are not required. It is used in pavement and sidewalk construction, reinforced concrete buildings and bridges, railway structures, tanks and reservoirs, culverts, water pipe, masonry units, and for all uses of cement or concrete not subject to sulfate attack from soil or water or where the heat generated by the hydration of the cement will not cause an objectionable rise in temperature.

Type II, modified portland cement, has a lower heat of hydration than Type I and generates heat at a slower rate. It also has improved resistance to sulfate attack. It may be used in structures of considerable size such as large piers, heavy abutments, and heavy retaining walls, to minimize temperature rise, especially when the concrete is placed in warm weather. In cold weather, when the heat generated is an advantage, Type I or III cement may be preferable. Type II cement is also intended for places where added precaution against moderate sulfate attack is important, as in drainage structures where sulfate concentrations in ground waters are higher than normal but are not unusually severe.

Type III, high-early-strength portland cement, is used when high strengths are desired at very early periods--from one to three days. It is used when it is desired to remove forms as soon as possible or to put the concrete into service quickly, or in cold weather construction to reduce the period of protection against low temperatures. It is also used when the high strengths desired at early periods can be secured more satisfactorily or more economically than by using richer mixes of Type I cement.

Type IV, low-heat portland cement, is a special cement for use where the amount and rate of heat generated must be kept to a minimum. The development of strength is also at a slower rate. It is intended for use in mass concrete such as large gravity dams where temperature rise resulting from the heat generated during hardening is a critical factor.

Type V, sulfate-resistant portland cement, is a special cement intended for use only in construction exposed to severe sulfate action, such as in some western states having soils or waters of high alkali content. It has a slower rate of strength gain than normal portland cement.

Air-entraining portland cements are covered by ASTM C175 and are designated as Types IA, IIA, and IIIA. These correspond to Types I, II, and III, respectively, in ASTM C150. In these cements, small quantities of air-entraining materials are incorporated by intergrinding them with the clinker during manufacture. These cements have been developed to produce concrete that will resist severe frost action as well as the effects of chemicals applied for snow and ice removal. Concrete made with these cements contains tiny, well-distributed, completely separated air bubbles. The bubbles are so minute that there are billions of them in a cubic foot of air-entrained concrete.

White portland cement is manufactured from raw materials that produce pure white color. It is used primarily for architectural purposes such as precast curtain wall and facing panels, terrazzo surfaces, stucco, cement paint, tile grout, and decorative concrete. Its use is recommended wherever white or colored concrete or mortar is desired. The only difference between white and gray cement is its color.

Portland blast-furnace slag cement (ASTM C205) includes two types of cement--Type IS, portland blast-furnace slag cement, and Type IS-A, air-entraining portland blast-furnace slag cement. In these cements, granulated blast-furnace slag of selected quality is interground with portland cement clinker. These cements can be used for the same type of concrete work as Type I or Type IA portland cement.

Portland-pozzolan cement (ASTM C340) also is available in two types--Type IP, portland-pozzolan cement, and Type IP-A, air-entraining portland-pozzolan cement. In these cements, pozzolan (such as volcanic ash or volcanic

rock) is blended with ground portland cement clinker. This cement is used largely for underwater structures such as bridge piers and dams.

Masonry cements conform to the requirements of ASTM C91. They are mixtures of portland cement, air-entraining additives, and supplemental materials selected for their ability to impart workability, plasticity, and water retention to masonry mortars. Because of manufacturing controls, the workability, strength, and color of masonry cements are maintained at a uniform level.

Special portland cements are special types of portland cement not covered by ASTM specifications.

Oil well cement is used for sealing oil wells. Generally, it must be slow-setting and resistant to high temperatures and pressures. The American Petroleum Institute Specification for Oil Well Cements (API Standard 10A) covers requirements for each of seven classes. Each class is applicable for use at a certain range of well depths. The petroleum industry also uses conventional types of portland cement together with suitable set-modifying admixtures.

Waterproofed portland cement is usually made by adding, during final grinding, a small amount of calcium, aluminum, or other stearate to portland cement clinker. It is available in either white or gray color.

Plastic cements are made by adding plasticizing agents up to 12 per cent by total volume to Type I or II cement during manufacturing. Plastic cements are commonly used for making mortar, plaster, and stucco.

AVAILABILITY OF CEMENTS

Some of the cements listed above may not be economically available in all sections of the country. Before specifying the type of portland cement, its availabity should be determined. For example, Type V cement is used mainly in western states and is seldom required in other areas.

Type I cement is generally carried in stock and is furnished if the type of cement is not specified. If a given type is not available, comparable results frequently may be obtained with one of the available types. For example, high-early-strength concrete can be made by using richer mixes (higher cement contents) of Type I portland cement. Also, the effects of heat of hydration may be minimized by using smaller lifts or artificial cooling.

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stewing. He is responsible to the chef. This job may be combined with that of chef or first cook.

Second cook (dinner cook): Prepares, cooks, and serves meats, vegetables, soups, sauces, and creamed dishes. He may operate the broiler and prepare special dishes.

First cook (working chef): Forecasts food consumption, plans menus, assists the cooks in preparing, cooking, and serving food. May take the place of the chef at times.

Pastry chef (baker): Bakes bread, rolls, muffins, and other hot breads; he may also be in charge of pastries and other dessert items. The term pastry chef is usually found in large establishments. The baker is his immediate assistant.

Chef: Plans meals; supervises and coordinates the work of all chefs, cooks, and other kitchen employees. The chef is responsible for the successful operation of the food production department. Since he is a manager, the term executive chef is often used.

It should be fully understood that the list above is not a complete one of all occupations in the food service industry. The descriptions are not intended to be complete. They merely indicate some of the responsibilities of key positions. It should also be noted that some establishments do not employ chefs. The food production manager, food production supervisor, and in some instances, the dietitian serve in much the same capacity as the chef.

For a complete listing of the many jobs in the food service industry refer to the *Occupational Outlook Handbook.*

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APPLICATION

Discuss portland cement, its history, manufacture, characteristics, and types.

Examine Type I and white portland cement samples.

Show film, From Mountains to Microns (see film list).

TEST OR DISCUSSION POINTS

1. What is the difference between "cement" and "concrete"?
2. Explain the difference between "concrete" and "mortar."
3. From what raw materials is portland cement made?
4. What is the volume of a bag of portland cement and how much does it weigh?
5. Explain how you would handle "warehouse pack."
6. Explain what is meant by hydration.
7. Is portland cement a brand or a type of cement?
8. What type of cement is most commonly used?
9. Are cements manufactured to meet particular specifications?
10. Which is correct terminology--a "cement sidewalk" or a "concrete sidewalk"?

TOOLS AND MATERIALS

Bag of Type I portland cement, sample of white portland cement

Film: From Mountains to Microns

Chart showing manufacture of portland cement

REFERENCE MATERIALS

Refer to Portland Cement Association publications:

1. Portland Cement Association--What It Is and What It Does, E102.
2. The Making of Portland Cement, E108.
3. Manufacture of Portland Cement Chart, E112 (9-1/2x11 folded).

MIXING WATER FOR CONCRETE

The principal purpose for using water with cement is to cause hydration of the cement. Additional water in excess of hydration requirements makes it possible to use more aggregates and thus produce a workable and economical mixture. Water ordinarily constitutes from 14 to 21 per cent (28 to 42 U.S. gal. per cubic yard) of the total volume of concrete.

As discussed later in this series, there is a definite relation between the amount of water used and the quality of the resulting concrete; too much water results in poor quality concrete. The amount of water must therefore be limited to produce concrete of the quality required for the job.

MIXING WATER FOR CONCRETE--HOW IMPURE CAN IT BE?

Almost any natural water that is drinkable and has no pronounced taste or odor is satisfactory as mixing water for making concrete. However, water suitable for making concrete may not necessarily be fit for drinking--even though many

Table 1. Typical Analyses of City Water Supplies
(parts per million)

Analysis No.	1	2	3	4	5
Silica (SiO_2)	2.4	12.0	10.0	9.4	22.0
Iron (Fe)	0.1	0.0	0.1	0.2	0.1
Calcium (Ca)	5.8	36.0	92.0	96.0	3.0
Magnesium (Mg)	1.4	8.1	34.0	27.0	2.4
Sodium (Na)	1.7	6.5	8.2	183.0	215.0
Potassium (K)	0.7	1.2	1.4	18.0	9.8
Bicarbonate (HCO_3)	14.0	119.0	339.0	334.0	549.0
Sulfate (SO_4)	9.7	22.0	84.0	121.0	11.0
Chloride (Cl)	2.0	13.0	9.6	280.0	22.0
Nitrate (NO_3)	0.5	0.1	13.0	0.2	0.5
Total dissolved solids	31.0	165.0	434.0	983.0	564.0

specifications for construction work state that water used should be fit to drink. Tests should be made to be sure that the setting time of the cement paste is not adversely affected by impurities in mixing water. Excessive impurities may affect

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not only setting time, concrete strength, and volume stability, but may cause efflorescence, surface discoloration, and corrosion of steel. When water of unknown performance (containing impurities that would cause possible adverse effects) is considered for use, particularly on larger concrete jobs, it is good practice to make a strength test in which known acceptable water is used for comparison. Both 7- and 28-day strengths of test cylinders should be equal to strengths of at least 90 per cent of companion specimens made with known acceptable water.

Five typical analyses of city water supplies are shown in Table 1. These waters approximate the composition of water supplies for about 45 per cent of the cities over 20,000 population in the United States. Water from any of these sources is suitable for making concrete. If a water is of unknown performance but is comparable in analysis to any of the waters in the table, it is probably satisfactory for use in concrete.

Water containing less than 2,000 ppm (parts per million) of dissolved solids can generally be used satisfactorily for making concrete. Although concentrations exceeding this amount are not always harmful, they affect certain cements adversely. Where possible, high concentrations should be avoided. Water departments usually will furnish an analysis of the local water.

HOW IMPURITIES AFFECT MIXING WATER

A summary of the effects of certain common impurities in mixing water on the quality of plain concrete follows:

Carbonates and bicarbonates of sodium and potassium have different effects on the setting time of different cements. Sodium carbonate may cause very rapid setting; bicarbonates may either accelerate or retard the set. In large concentrations, these salts can materially reduce concrete strength. When the sum of these dissolved salts exceeds 1,000 ppm (0.1 per cent). tests for setting time and 28-day strengths should be made.

A high dissolved-solids content of a natural water is usually due to a high content of sodium chloride or sodium sulfate. Both can be tolerated in rather large quantities. Concentrations of 20,000 ppm of sodium chloride are generally tolerable. Mixing waters containing 10,000 ppm of sodium sulfate have been used satisfactorily.

Carbonates of calcium and magnesium are not very soluble in water. As a result, they do not affect the strength of concrete. Bicarbonates of calcium and magnesium are present in some municipal waters. Concentrations up to 400 ppm of bicarbonate ion in these forms are not considered harmful.

Magnesium sulfate and magnesium chloride can be present in high concentrations without harmful effects on strength. Good strengths have been obtained with concentrations up to 40,000 ppm. Calcium chloride can be used in concrete (except concrete containing aluminum or prestressing strand) in quantities up to 2 per cent by weight of cement to accelerate both hardening and strength gain.

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Natural groundwaters seldom contain more than 20 to 30 ppm of iron. However, acid mine waters may carry rather large quantities of iron. Iron salts in concentrations up to 40,000 ppm do not usually affect mortar strengths adversely.

Salts of manganese, tin, zinc, copper, and lead in mixing water may cause a significant reduction in strength and cause large variations in setting time. Of these, salts of zinc, copper, and lead are the most active. Other salts that are especially active as retarders include sodium iodate, sodium phosphate, sodium arsenate, and sodium borate. All of these salts can greatly retard both set and strength development when present in concentrations of a few tenths per cent by weight of cement. Generally, concentrations of these salts up to 500 ppm can be tolerated in mixing water. Another salt that may be detrimental to concrete is sodium sulfide; even 100 ppm warrants testing.

Seawater, containing up to 35,000 ppm (3.5 per cent) of salt, is generally suitable as mixing water for non-reinforced concrete. Although concrete made with seawater may have higher early strength than normal concrete, strengths at later ages (after 28 days) may be lower. This strength reduction can be prevented by reducing the water-cement ratio. Quality concrete can be made with seawater if the mix is properly adjusted.

If suitable fresh water is not available, seawater may be used for making reinforced concrete. Its use may increase the risk of corrosion; however, this risk is reduced if the reinforcement has sufficient cover and if the concrete is water-tight and contains an adequate amount of entrained air. Reinforced concrete structures made with seawater and exposed to marine environment should have a water-cement ratio of less than 5 gal. per bag and the reinforcement cover should be at least 3 in.

Seawater should not be used for making prestressed concrete in which the prestressing steel is in contact with the concrete.

Sand and gravel removed from seawater are sometimes used for making concrete. The amount of sea salt on aggregate is usually not more than about 1 per cent of the weight of mixing water. Such aggregates used with drinkable water contribute less salt to the mix than seawater does.

Acceptance of acid mixing water should be based on the concentration (in parts per million) of acids in the water. Occasionally, acceptance is based on the pH, which is a measure of the hydrogen ion concentration. The pH of neutral water is 7.0; values below 7.0 indicate acidity and those above 7.0, alkalinity. The pH value is an intensity index and is not the best measure of potential acid or basic reaction.

Generally, mixing waters containing hydrochloric, sulfuric, and other common inorganic acids in concentrations as high as 10,000 ppm have no adverse effect on concrete strength. Acid waters with pH values less than 3.0 may create handling problems and should be avoided.

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Waters having sodium hydroxide concentrations of 0.5 per cent by weight of cement do not greatly affect the concrete strength provided quick set is not induced. Higher concentrations, however, may reduce the strength.

Potassium hydroxide in concentrations up to 1.2 per cent by weight of cement has little effect on the concrete strength developed by some cements, but the same concentration when used with other cements may substantially reduce the 28-day strength.

Most waters carrying industrial waste have less than 4,000 ppm of total solids. When such water is used as mixing water in concrete, the reduction in compressive strength is generally not greater than about 10 per cent. Waste waters from tanneries, paint factories, coke plants, chemical and galvanizing plants, etc., may contain harmful impurities. It is best to test any waste water that contains even a few hundred parts per million of unusual solids.

A typical sewage may contain about 400 ppm of organic matter. After the sewage is diluted in a good disposal system, the concentration is reduced to about 20 ppm or less. This amount is too low to have any significant effect on concrete strength.

Small amounts of sugar, as little as 0.03 to 0.15 per cent by weight of cement, usually retard the setting of cement. The upper limit of this range varies with different cements. The 7-day strength may be reduced while the 28-day strength may be improved. When the amount of sugar is increased to about 0.20 per cent by weight of cement, the set is usually accelerated. Sugar in quantities of 0.25 per cent or more by weight of cement may cause rapid setting and a substantial reduction in 28-day strength.

Less than 500 ppm of sugar in mix water has generally no adverse effect on the concrete strength, but if the concentration exceeds this amount, tests for setting time and concrete strength should be made.

About 2,000 ppm of suspended clay or fine rock particles may be tolerated in mixing water. Higher amounts may not affect strength but may influence other properties of some concrete mixtures. Muddy water should remain in settling basins before use to reduce the amount of silt and clay added to the mix.

Various kinds of oil are occasionally present in mixing water. Mineral (petroleum) oil, not mixed with animal or vegetable oils, probably has less effect on strength development than other oils. However, mineral oil in concentrations greater than 2 per cent by weight of cement may reduce the concrete strength by more than 20 per cent.

Algae present in mixing water may cause excessive reduction in strength either by combining with the cement to reduce bond or by causing a large amount of air to be entrained in the concrete. Algae may also be present on aggregates, in which case the bond between the aggregate and cement paste is reduced.

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APPLICATION

Discuss mixing water for concrete. Obtain or assign someone to obtain analysis of local water(s). This can be compared with analyses of city water supplies that are known to be satisfactory for use in concrete.

TEST OR DISCUSSION POINTS

1. What is the purpose of mixing water?
2. Why is more water used than necessary for its principal purpose?
3. What is a good rule for determining whether water is satisfactory as mixing water for making concrete?
4. If water of unknown performance is to be used for concrete, explain how to determine whether it will be acceptable.
5. What are some of the effects impurities in the miximg water may have on concrete?
6. Do you think seawater should be used in concrete?
7. After what process would sewage water be usable?
8. What effect would algae have if present in mixing water?

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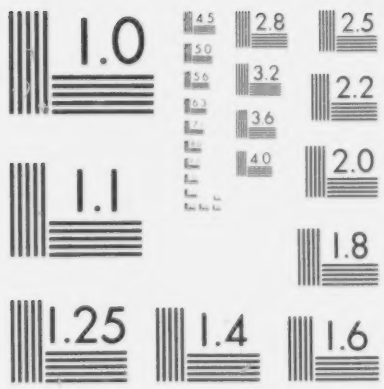

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AGGREGATES FOR CONCRETE

Sand, gravel, and crushed stone are the aggregates most commonly used in concrete to provide volume at low cost. Since aggregates make up about 60 to 80 per cent of the volume of concrete, they can be called a filler material.

The selection of aggregates is of particular importance in making concrete. Their characteristics greatly influence the properties, mix proportions, and economy. They should consist of particles having adequate strength and resistance to exposure conditions. They should not contain materials having harmful effects such as dirt, clay, coal, or organic matter. They should also be graded in size to secure the best economy from the paste. Aggregates are generally classified as fine and coarse.

CHARACTERISTICS OF AGGREGATES

Basically, good aggregates must have certain characteristics to give workable, strong, durable, and economical concrete. These characteristics include abrasion resistance, resistance to freezing and thawing, compressive strength, chemical stability, and good particle shape and surface texture.

Abrasion resistance of an aggregate is often used as a general index of aggregate quality. It is essential when the aggregate is used in concrete subject to abrasion, as in floors and pavements.

Resistance to freezing and thawing is important when aggregates are used in exposed concrete. The freeze-thaw resistance of an aggregate is related to its porosity, absorption, and pore structure. If an aggregate particle absorbs so much water that insufficient pore space is available to accommodate water expansion that occurs during freezing, it may be vulnerable to freezing.

Compressive strength of an aggregate is its resistance to compressive forces.

Chemical stability of an aggregate indicates that the aggregate will not react chemically with cement or be affected chemically by other external influences. In some areas, aggregates with certain chemical constituents react with alkalies in cement. This alkali-aggregate reaction may cause abnormal expansion and map-cracking of concrete.

Particle shape and surface texture of an aggregate influence the properties of fresh concrete more than they affect the properties of hardened concrete. Rough texture or flat and elongated particles require more cement paste to produce

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workable concrete than do rounded or cubical aggregates. However, crushed and uncrushed aggregates generally give essentially the same strength for the same cement content.

Coarse aggregate particles should be cubical in shape and free of excessive amounts of flat and elongated pieces. Long, slivery aggregate pieces should be avoided, or at least limited to 15 per cent by weight of the total aggregate. This requirement is equally important for fine aggregate, since sand made by crushing stone often consists of angular particles. When manufactured sand is used for fine aggregate in concrete, care should be taken to avoid materials having an abundance of thin, slivery particles, especially if the amount of water required to make a cubic yard of concrete is considerably greater than if well-graded particles were used.

GOOD AGGREGATES ESSENTIAL

Aggregates that are hard and durable are best suited for use in concrete. Aggregates that are soft and flaky and will wear away rapidly through exposure to weather generally are unsatisfactory. Weak, friable or laminated aggregate particles are undesirable. Shale, stones laminated with shale, and most cherts are to be avoided.

CLEAN AGGREGATES DESIRABLE

In addition to being hard and durable, the best aggregates are clean and free of fine dust, loam, silt, clay, or vegetable matter. These materials are objectionable because they prevent the cement paste from binding the aggregate particles, thereby reducing the strength of the concrete. Concrete made with dirty aggregates hardens slowly or may never harden enough to serve its intended use.

TESTING AGGREGATES FOR QUALITY

If it is necessary to use aggregates of unknown quality, they should be carefully examined and tested to make sure they are suitable for making concrete.

The silt test is used to detect the presence of extremely fine material. The colorimetric test is used to detect the presence of harmful amounts of vegetable matter.

In making the silt test, use an ordinary quart milk bottle or quart fruit jar (Fig. 9). Fill the container to a depth of 2 in. with a representative sample of dry sand to be tested. Add water until the bottle or jar is about three-fourths full. Shake vigorously for 1 minute. The last few shakes should be in a sidewise direction to level off the sand. Allow the jar to stand for an hour. During this time any silt present will be deposited in a layer above the sand. If the layer is more than 1/8 in. thick, the sand from which the sample is taken is not satisfactory for concrete work unless the excess silt is removed. This may be done by washing.

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Fig. 9 Silt test.

In making the colorimetric test, an ordinary 12-oz. prescription bottle, such as druggists or physicians use, is filled to the 4-1/2 oz. mark with a sample of the sand (Fig. 10). To this is added a 3 per cent solution of caustic soda which is made by dissolving 1 oz. of sodium hydroxide (household lye) in a quart of water, preferably distilled. The solution should be kept in a glass bottle tightly closed with a rubber stopper.

Handling sodium hydroxide with moist hands may result in serious burns. Do not spill the solution, as it is highly injurious to clothing, leather, and most other materials.

As soon as the solution of sodium hydroxide is added to the sand, shake the contents of the bottle thoroughly and then allow it to stand for 24 hours. The color of the liquid will indicate whether the sand contains vegetable matter. A colorless liquid indicates a clean sand free from vegetable matter. A straw-colored solution indicates some vegetable matter but not enough to be seriously objectionable. Darker colors mean that the sand contains injurious amounts and should not be used unless it is washed and tested again.

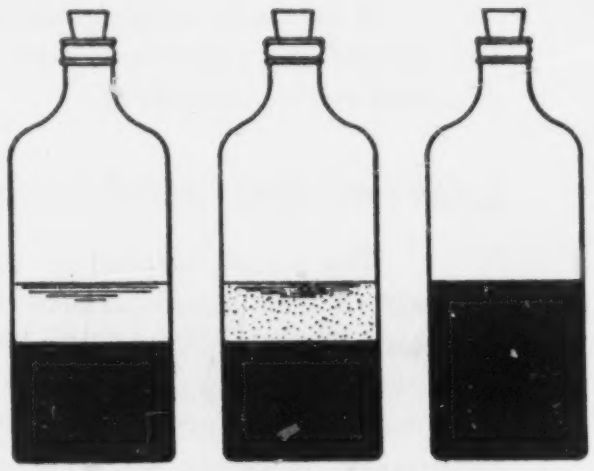

Fig. 10. Colorimetric test.

FINE AGGREGATES

Fine aggregates are particles 1/4 in. and less in size. Natural and manufactured sands are the most common. They have particles ranging from 1/4 in. down to some that will pass through a sieve having 100 openings to the inch.

COARSE AGGREGATES

Coarse aggregates are usually gravel or crushed stone. Sizes range from 1/4 in. up to the maximum size permissible for the job.

BANK-RUN AND COMMERCIALLY RECOMBINED AGGREGATES

Bank-run material is aggregate that is used as taken from the quarry or gravel pit. The natural mixture of fine and coarse aggregates as taken from a gravel bank or crusher usually does not make the most economical concrete unless it is first screened to separate the fine material from the coarse and then recom-

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Appendix B

TEACHING MATERIALS

Books and Manuals:

1. Ahern, Edwin F. *Safety Training Manual for Restaurants and Hotels.* New York: Ahrens Publishing Co., Inc., 1955. (116 West 14th St., Zip No. 10011)
2. Amendola, Joseph. *The Baker's Manual for Quantity Baking and Pastry Making.* New York: Ahrens Publishing Co., Inc., 1960. (116 West 14th St., Zip No. 10011)
3. American Home Economics Association. *Handbook of Food Preparation.* 5th revised ed. Washington, D.C.: American Home Economics Association, 1964. (1600 Twentieth St., NW., Zip No. 20009)
4. American Institute of Baking. *Modern Sandwich Methods.* Chicago: American Institute of Baking, Consumer Service Department, 1964. (400 East Ontario St., Zip No. 60611)
5. Belilios, Arthur David; Mulvany, Desmond K.; and Armstrong, Katharine F. *A Handbook of First Aid and Bandaging.* 5th ed. London: Bailliere, Tindall, and Cox, Ltd. Williams and Wilkins Co. (U.S. distributor), 1962. (428 East Preston St., Baltimore, Md., Zip No. 21202)
6. Blake, Roland Patton. *Industrial Safety.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963. (Zip No. 07632)
7. Bogert, Lotta Jean, *Nutrition and Physical Fitness.* 7th ed. Philadelphia: W. B. Saunders Co., 1960. (West Washington Square, Zip No. 19105)
8. Breithaupt, Herman A. *Commercial Cooking for Prospective Hotel and Restaurant Workers.* Detroit: Detroit Board of Education, Chadsey High School, Trade Division, 1963. (5525 Martin, Zip No. 48210)
9. Brodner, Joseph; Maschel, Harry C.; and Carlson, Howard N. *Profitable Food and Beverage Operation.* 4th revised ed. New York: Ahrens Publishing Co., Inc., 1962. (116 West 14th St., Zip No. 10011)
10. Caleva, Harry. *German Cook Book for Quantity Service.* New York: Ahrens Publishing Co., Inc., 1957. (116 West 14th St., Zip No. 10011)
11. Chaney, Margaret; and Ross, Margaret. *Nutrition.* 7th ed. Boston: Houghton-Mifflin Publishing Co., 1966. (2 Park Street, Zip No. 02107)
12. Club Managers Association of America. *Job Descriptions for Club Occupations.* Washington, D.C.: Club Managers Association of America, 1964. (1030 15th St., NW., Zip No. 20005)
13. Cox, Henry Edward; and Pearson, David. *The Chemical Analysis of Foods.* New York: Chemical Publishing Co., 1962. (221 Park Avenue South, Zip No. 10003)
14. Crane, Warren E. *Delectable Desserts.* New York: Ahrens Publishing Co., Inc., 1964. (116 West 14th St., Zip No. 10011)
15. Culinary Institute of America. *The Professional Chef.* Chicago: Institutions Magazine, 1962. (1801 Prairie Avenue, Zip No. 60616)
16. Dardarian, Leo. *Put Profit on the Menu.* New York: Ahrens Publishing Co., Inc., 1959. (116 West 14th St., Zip No. 10011)
17. D'Ermo, Dominique. *The Modern Pastry Chef's Guide to Professional Baking.* New York: Harper and Row, Publishers, Inc., 1962. (49 East 33d St., Zip No. 10016)
18. Ehlers, Victor Marcus; and Steel, Ernest W. *Municipal and Rural Sanitation.* 6th ed. New York: McGraw-Hill Book Co., Inc., 1965. (330 West 42nd St., Zip No. 10036)
19. Emery, W. H. *Manual of Catering.* London: Bailliere, Tindall, and Cox, Ltd. Williams and Wilkins Co. (U.S. distributor), 1961. (428 East Preston Street, Baltimore, Md., Zip No. 21202)
20. Escoffier, Auguste. *The Escoffier Cook Book.* New York: Crown Publishers, Inc., 1941. (419 Park Avenue South, Zip No. 10016)
21. Finance, Charles. *Buffet Catering.* New York: Ahrens Publishing Co., Inc., 1958. (116 West 14th St., Zip No. 10011)
22. Fleck, Henrietta; and Munves, Elizabeth. *Introduction to Nutrition.* New York: Macmillan Co., 1962. (60 Fifth Avenue, Zip No. 10011)
23. Fowler, Sina Faye; West, Bessie Brooks; and Shugart, Grace Severance. *Food for Fifty.* 4th ed. New York: John Wiley & Sons, Inc., 1961. (605 Third Avenue, Zip No. 10016)
24. Fox, Brian Anthony; and Cameron, Allan G. *A Chemical Approach to Food and Nutrition.* London: University of London Press, Ltd., Little Paul's House, 1961. (Warwick Square)
25. Harris, Robert Samuel; and von Loesecke, Harry W. *Nutritional Evaluation of Food Processing.* New York: John Wiley & Sons, Inc., 1960. (605 Third Avenue, Zip No. 10016)

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bined in the correct proportions. Most gravel banks contain too much sand in proportion to coarse material. More cement paste is required to produce concrete of a given quality when there is a high proportion of fine aggregate.

When using bank-run material, it is generally advisable to screen the material to separate it into fine and coarse aggregates. Some commercial firms also sell a mixed aggregate. Sand and gravel are separated and then recombined into the correct proportions for concrete.

Frequently, these aggregates are not clean enough for use until they are washed to remove silt, clay, or other materials detrimental to good concrete. Since clean aggregates are essential to quality concrete, washing is well worth the effort.

If concrete aggregates are sold by weight in your locality, you may assume, for estimating purposes, that a ton contains approximately 20 to 22 cu.ft. of sand, crushed stone, or gravel.

LIGHTWEIGHT AGGREGATES

The most commonly used aggregates, such as sand, gravel, crushed stone, and air-cooled blast-furnace slag, produce normal-weight concrete, i.e., concrete weighing from about 140 to 160 lb. per cubic foot. Expanded shale, clay, slate, and slag are used as aggregates to produce structural lightweight concretes having unit weights ranging from about 85 to 115 lb. per cubic foot. Other lightweight materials, such as cinders, pumice, scoria, perlite, vermiculite, and diatomite, are used to produce insulating concretes weighing about 20 to 70 lb. per cubic foot.

HEAVYWEIGHT AGGREGATES

Heavyweight materials, such as barytes, limonite, magnetite, ilmenite, iron, and steel particles, are used for producing heavyweight concrete.

GRADATION OF AGGREGATES

The photographs show how well-graded aggregates look before and after being separated into various sizes.

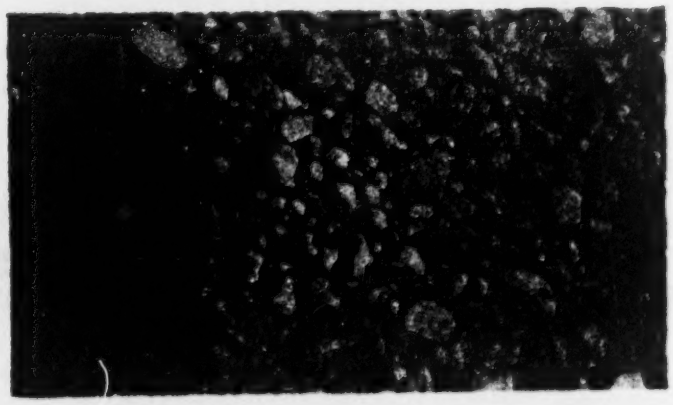

Fig. 11. This is how a well-graded coarse aggregate looks before being separated. Note how the smaller pieces fit among larger ones in the mixed aggregate.

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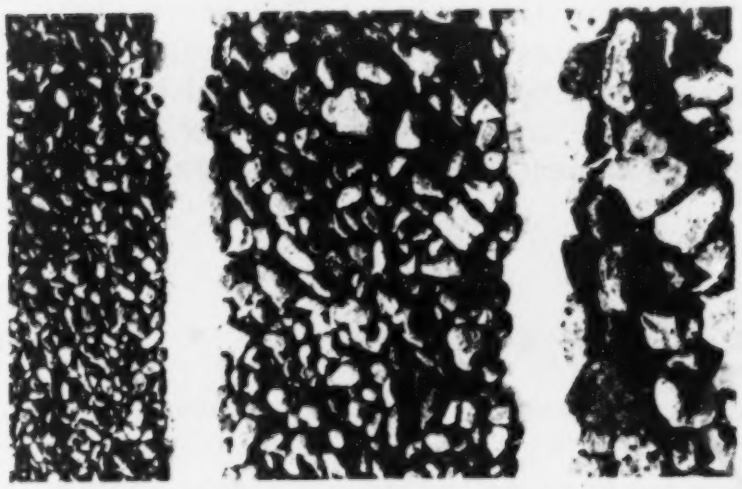

Fig. 12. This is how a well-graded coarse aggregate looks after being separated into three sizes. From left to right: 1/4 to 3/8 in., 3/8 to 3/4 in., 3/4 to 1-1/2 in.

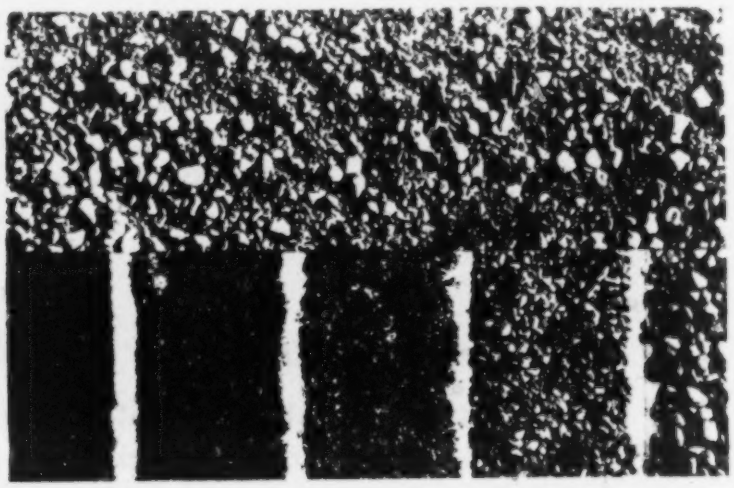

Fig. 13. Sample of well-graded sand before and after separation into various sizes. Particles vary from dust to those just passing the No. 4 sieve (approximately 1/4 in.).

In making good concrete, each particle of aggregate, regardless of size, must be completely surrounded by paste. It is important that fine and coarse aggregates be proportioned so that the finer particles will fill the spaces between the larger ones. This results in the most economical use of cement paste for filling the voids and binding together the aggregate particles.

To demonstrate this concept, a simple though crude method can be used. Obtain three transparent containers of equal capacity and place the same amount of water (representing a selected quality of cement paste) in each. Fill to approximately one-fourth capacity. Now add as much coarse aggregate to one container as the cement paste (water) will cover. Do the same with fine aggregate in the second container. To the last container add a combined or proper gradation of aggregates. Note that the same amount of cement paste (water) covers the

Fig. 14. Sample of sand which lacks particles larger than 1/16 in. (above). Sample separated (below) into four sizes. More cement is required when sand is fine. This is not a good concrete sand.

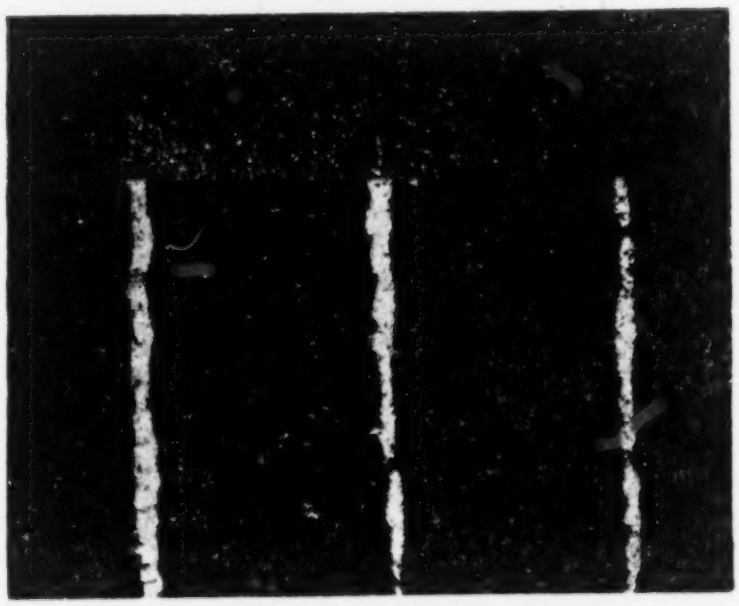

surface area of a greater volume of material in the last container. This shows that economy is obtained by proper gradation of aggregates. Also, it demonstrates that the cement paste requirement for concrete is proportional to the void content of the combined aggregates. It also shows that the amount of concrete (of a given quality) that can be obtained from a bag of cement depends on the filler material.

DETERMINING MAXIMUM SIZE OF COARSE AGGREGATE

As previously illustrated, the larger the coarse aggregate the less paste necessary. Hence, more concrete is obtained per bag of cement. This means that, generally, the most economical mix is obtained by using the largest coarse aggregate practical for the job. The maximum size generally depends on the size and shape of concrete members and the amount and distribution of reinforcing steel.

In general, the maximum size of aggregate should not exceed:

1. One-fifth the dimension of non-reinforced members,

2. Three-fourths the clear spacing between reinforcing bars or between reinforcing bars and forms, or

3. One-third the depth of non-reinforced slabs on grade.

The common maximum sizes are 3/8, 1/2, 3/4, 1, 1-1/2, and 2 in.

HANDLING AND STORING AGGREGATES

Aggregates should be handled and stored to prevent segregation of sizes and contamination with harmful materials. Stockpiles should be built up in layers of uniform thickness and not in cone-shaped piles, which result in segregation of sizes. Fine aggregates that are damp have less tendency to segregate than dry material. Material should be removed from stockpiles in approximately horizontal layers to minimize segregation.

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TERMINOLOGY

1. Aggregate - Term used in construction for crushed rock, gravel, sand or other materials used with cement, lime and asphalt to make concrete, plaster, etc.

2. Sand - The fine granular material (usually less than 1/4" in diameter) resulting from natural disintegration of rock, or the crushing of friable sandstone rocks.

3. Gravel - The coarse granular material, larger than sand, resulting from the natural erosion of rock.

4. Crushed Gravel - The product resulting from the artificial crushing of gravel with substantially all fragments having at least one face resulting from fracture.

5. Crushed Stone - The product resulting from the artificial crushing of rock, usually from a quarry, substantially all faces of which have resulted from the operation.

6. Crusher Run - The total unscreened product of a stone crusher.

7. Mesh - The number of openings per linear inch in a sieve.

8. Screen - In laboratory work, an apparatus in which the apertures are circular, for separating sizes of material.

9. Sieve - In laboratory work, an apparatus in which the aperatures are square, for separating sizes of material.

10. Grading Analysis - Made by separating a sample into sizes by the use of specified sieves and weighing the amount retained on each sieve. Results of this test are expressed most often as the percent passing each of the designated sieves. In the case of concrete aggregate, an empirical factor, finus modulus, is obtained by adding the total cumulative percentages of a sample of the aggregate retained on each of a specified series of sieves, and dividing the sum by 100.
The sieves are as used - No's. 100, 50, 30, 16, 8, 4, 3/8, 3/4, 1-1/2 and larger, increasing in the ratio of 2 to 1.

11. Saturated Surface Dry Aggregate - This is aggregate which has absorbed all the water it is capable of absorbing but has no free moisture on the surface.

12. Specific Gravity - In the case of concrete aggregate, is usually expressed as the ratio of the weight in air of a saturated surface dry sample to the weight of an equal volume of water.

13. Absorption - This is expressed in percent, and is found by dividing the difference between saturated surface dry weight and oven dry weight by the oven dry weight and multiplying by 100.

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14. Unit Weight - In the case of concrete, is the weight of a stated volume, usually 1 cubic foot, of fresh compacted concrete; in the case of aggregate, is the weight of a stated volume of loose dry or moist material, or the weight of compacted dry or moist material.

15. Mortar Making Properties of Sand - This is determined by making mortars using the sand under test and standard Ottowa sand, curing for 7 days, then testing for compressive strength. The strength of the sand under test is expressed as the ratio of the 7 day compressive strength of the tested sand to the 7 day strength of the standard sand.

16. Organic Impurities - In sand can be discovered by placing a sample of the sand in 3% solution of sodium hydroxide. If there are impurities in the sand, the solution will darken in color.

17. Silt and Clay - Is that material in a sand that will be lost by decantation. The amount of loss by decantation is equivalent to that which would pass a No. 270 sieve. In the case of USBR specifications, sediment is interpreted to mean the passing 200 mesh.

18. Sand Equivalent - This test is intended to serve as a rapid field test to show the relative proportion of detrimental fine dust or clay-like material in soils or fine aggregate.

19. Cleanness Value - This test is intended to serve as a rapid field test to show the relative proportion of detrimental fine dust or clay-like material in coarse aggregate.

20. Soundness of Aggregates - Is determined by alternate wetting with sodium sulfate (or magnesium sulfate) and drying in an oven with the aggregate under test. After 5 such cycles the sample is washed, dried and weighed. The sample before test is 100% retained on a stated sieve. The soundness is, by ASTM and USBR method, expressed as the loss in percent passing a stated sieve. Using the State of California method, the soundness is expressed as the loss in percent passing the next smaller than the stated sieve.

21. Tests for Abrasion - These are made in a machine known as the Los Angeles Rattler. A weighted sample is placed in the barrel of this machine and revolved a stated number of times, removed and sieved on a No. 12 sieve. The difference between the original weight and the final weight, expressed as a percentage of the original weight of the test sample is the Loss by Abrasion.

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APPLICATION

Lead discussion covering aggregates.
Show aggregate samples.
Show, explain, and demonstrate laboratory sieves.
Demonstrate silt test.
Demonstrate colorimetric test.

TEST OR DISCUSSION POINTS

1. Why are aggregates referred to as filler material?
2. What are the two classifications of aggregates?
3. What are some of the characteristics of a good aggregate?
4. What types of aggregates should be avoided?
5. What effect will dirty aggregates have on the strength of concrete?
6. How would you test sand for silt and organic matter?
7. What is a colorimetric test and how is it conducted?
8. Define "fine aggregates" and "coarse aggregates."
9. Why is bank-run gravel seldom suitable for concrete work?
10. How can bank-run gravel be made usable?
11. About how many cubic feet are in a ton of sand? Crushed stone? Gravel?
12. Why are lightweight aggregates used for certain jobs?
13. Why does the proportion of fine and coarse aggregates affect the concrete yield--the amount of concrete that can be obtained from a bag of cement and a fixed proportion of water?
14. Explain "void content" as it applies to concrete aggregates.
15. What factors determine the maximum size of aggregate that can be used?
16. How should aggregates be stockpiled on the job?

TOOLS AND MATERIALS

For silt test: quart milk bottle or quart fruit jar, dry sand, and water.
For colorimetric test: three 12-oz. prescription bottles, sodium hydroxide (household lye), water, rubber gloves, sand with no organic matter, sand with a small amount of organic matter, sand with a large amount of organic matter.
Aggregates: fine, coarse, bank-run and recombined, lightweight.
Set of laboratory sieves.

REFERENCE MATERIALS

ASTM Designation C33, "Standard Specifications for Concrete Aggregates."

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Fresh concrete containing entrained air is cohesive and looks and feels "fatty." The billions of disconnected air bubbles reduce segregation and bleeding (separation of the water from the paste) of freshly mixed concrete. This reduction in segregation and bleeding results in a more durable concrete. The air bubbles buoy up the aggregates and cement and thus reduce their rate of settlement toward the bottom of the placed concrete. Bleeding is retarded because water cannot readily pass through the minute bubbles. Air-entrained concrete can also be finished sooner than ordinary concrete. However, do not take the absence of bleeding water as an indication that the concrete is setting and attempt to finish too soon.

EFFECT OF ENTRAINED AIR ON PROPERTIES OF HARDENED CONCRETE

The resistance of concrete to freezing and thawing, as well as to various de-icing chemicals, is significantly improved by the use of entrained air. This improvement in freeze-thaw resistance is particularly desirable if the concrete is saturated with water. As water freezes, it expands (up to 9 percent), producing pressures that can rupture the concrete and cause scaling. Because the entrained air bubbles are round, they never completely fill with water. As water freezes, its expansion is relieved by the remaining air space in the bubble, thus preventing damage to the concrete. The bubbles or air voids continue to serve their purpose during repeated cycles of freezing and thawing. The resistance of air-entrained concrete to freeze-thaw action is improved several hundred per cent over concrete that contains no entrained air.

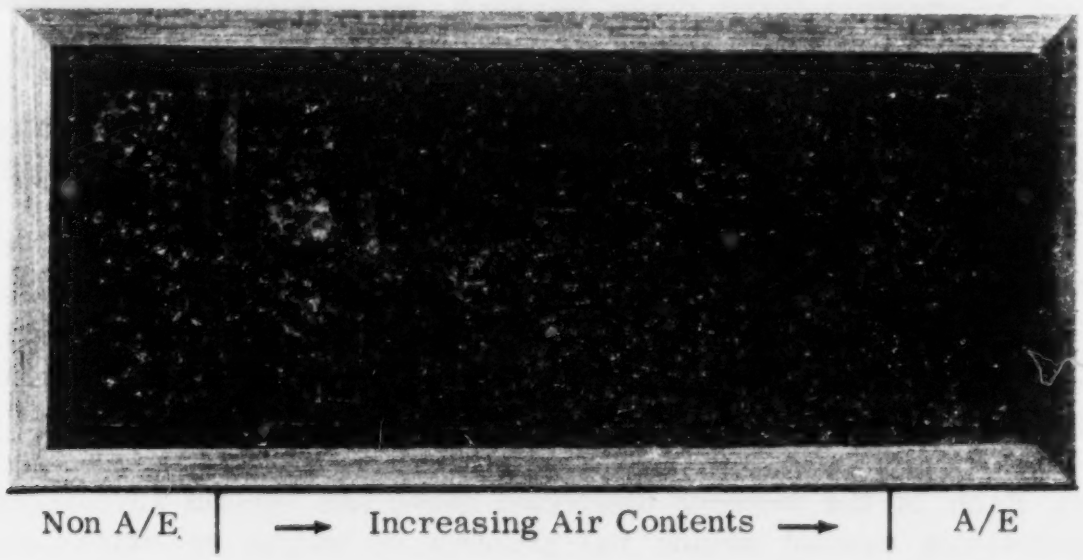

Fig. 16. Compare the results of freeze-thaw action on these test specimens containing varying amounts of air. Note the excellent resistance of the concrete containing adequate entrained air.

De-icing chemicals used for snow and ice removal can cause serious surface scaling. Entrained air prevents salt scaling and is recommended for all

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concretes that come in direct or indirect contact with de-icing chemicals. Indirect application of de-icers can be caused in various ways, such as by drippings from the underside of vehicles.

Concrete mixes that have been properly adjusted for the addition of air entrainment will have little if any loss of strength when compared to a similar non-air-entrained concrete. Adjustment of both water and sand contents is necessary to maintain the same strength. The water content for air-entrained concrete will be 3 to 5 gal. less per cubic yard than for non-air-entrained concrete having the same slump. The percentage of sand in air-entrained concrete can and should be reduced. A 3 to 6 per cent reduction of sand content is possible without any loss of workability. If no adjustment is made in the sand content, lower strengths result because of the increased yield.

Abrasion resistance of air-entrained concrete is about the same as that of non-air-entrained concrete of the same compressive strength. Compressive strength is one way to estimate abrasion resistance of concrete. Abrasion resistance usually increases as the compressive strength increases.

Watertightness of air-entrained concrete is superior to that of non-air-entrained concrete. For a given cement factor, air-entrained concretes generally have lower water-cement ratios and hence are more watertight. Air-entrained concrete should be used where watertightness is desired.

AIR-ENTRAINING MATERIALS

The entrainment of air in concrete can be accomplished by adding an air-entraining admixture at the mixer, by using an air-entraining cement, or by a combination of both methods.

Many cement manufacturers market portland cement containing air-entraining agents that are interground with the cement during manufacture. Such cements are identified on the bag.

Variations in air content can be expected with variations in aggregate type and size, proportions and gradation, mixing time, temperature, and slump. With air-entraining admixtures, the volume of entrained air can be adjusted more readily to meet job conditions by changing the amount of admixture.

Each of the methods described above has certain advantages. The use of air-entraining cement avoids the problem of adding an extra ingredient at the mixer. On jobs where careful control is not practical, air-entraining cements are especially useful since they eliminate the possibility of human or mechanical error when adding an admixture during batching. Regardless of which method is used, adequate control is required to ensure proper air content at all times.

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Recommended Amounts of Entrained Air

Per Cent Air	Maximum Size Aggregate
5 ± 1	1-1/2", 2", or 2-1/2"
6 ± 1	3/4" or 1"
7-1/2 ± 1	3/8" or 1/2"

Mixes should be designed to contain more air than desired when the concrete is placed. A good rule of thumb is to use 6 percent plus or minus 1 percent.

Aggregate type, gradation, size, and mix proportions affect the percentage of air required. There is little change in air content when the maximum size of aggregate is increased above 1-1/2 in. For aggregate sizes smaller than 1-1/2 in., the air content increases sharply as the aggregate size decreases.

FACTORS AFFECTING AIR CONTENT

In addition to aggregate gradation and mix proportions, there are other factors that affect the percentage of entrained air.

One factor is the fine aggregate content. Increasing the amount of fine aggregate results in a need for more entrained air.

Other factors are slump and vibration. Both slump and vibration affect the amount of air retained in the finished concrete. The desired air content can be maintained as long as the slump does not exceed 6 in. With further increases in slump, air content is lost rapidly.

The duration of vibration also affects air content. A normal amount of vibration does not materially affect the amount of entrained air. However, prolonged vibration of concrete should be avoided. For most concrete, the desired consolidation should be obtained with 5 to 15 seconds of vibration. If vibration is properly applied, little of the intentionally entrained air is lost.

A third factor is concrete temperature. Less air is entrained as the temperature of the concrete increases. The effect of temperature is especially important during hot-weather concreting when concrete may be quite warm. A decrease in air content can be offset, if necessary, by increasing the quantity of air-entraining admixture.

Mixing action also affects the amount of entrained air. This is especially important for ready mixed concrete. The amount of entrained air varies with the type and condition of the mixer, the amount of concrete being mixed, and the rate of mixing.

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MEASUREMENT OF AIR CONTENT

Tests for air content of fresh concrete should be made during construction for routine control purposes. Because of the effects of mixing and vibration, samples for air content should be taken preferably from concrete that has been placed and consolidated.

APPLICATION

Conduct discussion of air-entrained concrete.
Show sample of air-entraining admixture. Show bag of Type I-A cement.
Show slide 10 from Mr. Quality Concrete slide set.

TEST OR DISCUSSION POINTS

1. What is the principal reason for using intentionally entrained air in concrete?
2. Explain the effect of entrained air on the properties of fresh concrete.
3. How and why does air entrainment effect workability?
4. How does air entrainment affect the freeze-thaw resistance of concrete? How is this accomplished?
5. Under what conditions of climate would air-entrained concrete be especially desirable?
6. What are the two methods used to obtain air entrainment in concrete?
7. What is the rule of thumb for determining the percentage of air entrainment required in concrete?

TOOLS AND MATERIALS

Sample of air-entraining admixture
Bag of Type I-A cement
Mr. Quality Concrete slide set
Pocket-size air indicator

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ADMIXTURES FOR CONCRETE

Occasionally an admixture will be used in concrete. The inspector should determine the purpose of its use and familiarize himself with the characteristics of the particular admixture proposed and with expected results.

There are literally dozens of admixtures available, but most fall into one or more of the following categories:

1. Air-entraining admixtures.
2. Water-reducing admixtures
3. Retarding admixtures.
4. Accelerating admixtures.
5. Pozzolans.
6. Workability agents.
7. Miscellaneous, such as dampproofing and permeability-reducing agents, grouting agents, and gas-forming agents.

The most commonly used admixtures fall into the first four categories. Some admixtures perform dual functions. For example, air-entraining agents reduce water demand also for a given slump. Some water-reducers are also set-retarders.

In any structure where prestressed concrete is used, it is of the utmost importance that no admixture containing chlorides be permitted. Corrosion of prestressed steel can result from the use of even minor amounts of chloride. Chloride-containing admixtures should not be used in concrete in these structures even though it may not be in direct contact with the prestressed steel - it should be used, for instance, in slabs placed on prestressed girders.

Many specifications require admixtures to perform certain functions and limit their effect on certain concrete properties. The inspector should assure himself that the admixture being used is, in fact, the one specified, and also that it conforms to the specification requirements. Sometimes brand names are specified, sometimes tests are required either in the laboratory or in the field, and sometimes acceptance can be based on certification by the supplier or manufacturer.

Some combinations of admixtures are incompatible, that is, if added simultaneously to water, for example, will form a precipitate and neither may be very effective. When two or more admixtures are being used, the inspector should seek advice from a technical representative, or someone familiar with the products to determine if any special measures must be taken, or if one or the other products should be substituted by another.

Dosage is important for over-doses of many admixtures may have serious detrimental effects. The inspector should determine dosages recommended by the manufacturer, paying close attention to rates. Some are added on a "per sack of cement" basis; others might be added on a "per cubic yard of concrete" basis. Some admixtures increase the drying shrinkage of concrete, and if concrete shrinkage is a critical factor, it should be considered when the use of an admixture is being considered.

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Air-entraining Agents

Air-entraining agents, when used in proper amounts, increase the durability of all concrete. When it is used to produce frost resistant concrete, an adequate amount must be used, depending on the size of the coarse aggregate. Because air entrainment reduces compressive strength and much concrete is "bought" on a strength basis, there is a tendency to use as little air as possible. It is much better to put in sufficient air to provide needed frost protection and risk slightly lower strength than it is to reduce the air content to a point where adequate frost protection would not be achieved, merely to preserve strength. Air-entraining agents are usually in liquid form and should, as should water-reducers and set-retarders, beadded in liquid form to the stream of mixing water as it enters the mixer by means of a reliable injector. The specifications may describe the way admixtures are to be added to the concrete. Non-uniformity of results have often been traced to faulty methods of adding the admixture to the concrete.

The cost of additional portland cement to offset a minor strength loss because of the use of air-entrained concrete is normally an insignificant part of the total cost of a structure -- in the case of a typical highway bridge, for example, about 1/1000th of the total cost of the structure.

Air-entraining agents improve workability and finishability of concrete, reduce water content, reduce bleeding, and help prevent segregation. They are often used for these purposes in lesser amounts than are necessary for freeze-thaw protection. In any event, frequent checks on air content should be made on the fresh concrete for purposes of control. A pressure type meter can be used for ordinary aggregates, but a volumetric type is recommended when lightweight or porous aggregates are used. A low cost pocket air meter is available for making quick check tests, but should be used in conjunction with a meter requiring larger samples. If a mix has not been designed for entrained air, adjustments are usually made to maintain the yield and to avoid "sticky" mixes which are difficult to finish.

Water-Reducers and Set-Retarders

Many water-reducing agents also retard the setting of the concrete. Retardation up to four to six hours can be attained with normal dosages. While the set of the cement is retarded, there may be loss of slump with time just as if the retarder were not used. The amount of some admixtures needed to retard set for a specified period depends upon atmospheric conditions that prevail and the temperature of the concrete. Usually, the higher the air temperature and concrete temperature, the larger the dosage required for a given retardation. Some of these materials entrain five percent or more air. Adding a double dosage may double air content, resulting in substantial strength reductions and sticky concrete.

Some water-reducers do not retard the setting of the concrete, either by their basic nature or because some accelerating agent has been added to restore normal setting time. Some, depending on their chemistry, may substantially increase shrinkage.

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Some admixtures have been known to react differently with different cements. When any unusual or unexpected results occur, their use should be discontinued until the reason, or reasons for the unexpected results are determined. Pre-testing with job materials under job conditions of placement, temperature, etc., is recommended wherever practicable.

Set Accelerators

One of the most common set accelerators used in concrete is calcium chloride. Normally, the largest amount used is two pounds per sack of cement. It should be dissolved in water (adding the flakes or pellets to the water rather than adding the water to the calcium chloride) before adding to the concrete. Because of possible adverse effects, the decision to use calcium chloride should receive careful considerations.

Possible detrimental effects are:

1. Incompatible with certain other admixtures.
2. Contribute to corrosion problems, especially when aluminum and steel are imbedded in the same concrete.
3. May cause rapid stiffening of concrete which would be undesirable.
4. May reduce resistance of concrete to sulfate attack.
5. May increase expansion due to alkali-aggregate reaction.
6. May contribute to discoloration of slabs.

Often, high early strengths can be obtained without the use of calcium chloride, such as using extra cement, or Type III cement, or arranging to apply heat to the concrete (steam curing, for example). Since the decision to use calcium chloride may be made on short notice, the inspector should be familiar with the limitations and possible detrimental effects, and know beforehand what he should or could do in each case. In no case should it be used in prestressed concrete, whether the chloride-containing concrete will be in contact with the prestressing steel or not.

The accelerating agent in water-reducers may be calcium chloride and the proposed water-reducer should be examined for this if it is to be used with prestressed concrete.

Pozzolans

A material which is sometimes used as an admixture as well as for other purposes is called a pozzolan.

ASTM C219 defines a pozzolan as "a siliceous or siliceous and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties." A number of natural materials such as diatomaceous earth, opaline cherts and shales, tuffs and pumicites, and some artificial materials such as fly ash are used as pozzolans. Since the properties of pozzolans may vary widely, acceptance tests should be made before they are used. ASTM specifications and test methods for natural pozzolans (C402) and fly ash (C350 and C311) cover their use as admixtures in concrete.

Pozzolanic materials are sometimes used in concrete to help control internal temperatures. In massive structures such as dams, high temperatures can occur due to slow loss of heat generated during hydration. These temperatures can be minimized by using Type II, IV, V, IS or IP portland cement, lowering the temperature of the mixing water and aggregate, or using pozzolanic admixtures. Frequently, combinations of these three methods are used.

Some pozzolans are used as admixtures in order to reduce or eliminate potential expansion from alkali-reactive aggregates. Where reactive aggregates are to be used in concrete, for lack of non-reactive aggregates, a low-alkali cement or a proven pozzolan may be used to counteract expansion.

Fly ash is sometimes used as a pozzolanic admixture. It is a finely divided residue that results from the combustion of powdered coal. Generally it is not a uniform product and may contain varying amounts of carbon, silica, alkalies, sulfur and other components. Excessive amounts of some of these components may adversely affect the strength and durability of concrete.

Pozzolans vary considerably in their effect on concrete mixes. Before one is approved for use on a concrete job, it should be tested in combination with the cement and aggregates to ascertain its suitability with regard to water requirements, strength development, shrinkage, heat of hydration, durability, or other special properties.

Workability Agents

Fresh concrete is sometimes harsh due to certain aggregate characteristics such as particle shape and improper grading, or faulty mix proportions. Under these conditions, improved workability may be necessary, especially if the concrete requires a troweled finish. Improved workability is also important for concrete placed in heavily reinforced members, or placed by pumping or tremie methods. Frequently, increasing the cement content or the amount of fine aggregate will give the desired workability.

One of the best workability agents is an air-entraining admixture. Entrained air acts like a "lubricant" and is especially effective in improving the workability of lean, harsh mixtures.

Organic or finely divided materials are also sometimes used to improve the ease with which concrete can be placed and finished.

Some organic materials, when added to concrete of a given water content, will increase the slump. The composition of these compounds may be similar to that of water-reducing and retarding admixtures. These workability agents may also entrain air.

Finely divided materials are also used as admixtures to improve the workability of mixes deficient in material passing the No. 50 sieve. Some of these materials are relatively inert chemically while others are pozzolanic. When they are added to mixes that are not deficient in fines, additional water is generally required to maintain a given workability. This may reduce the strength, increase the drying shrinkage and adversely affect other properties of concrete. The use of pozzolans as cement replacements, however, can substantially reduce the early strength of concrete, especially during the first 28 days. Because of the slow pozzolanic action, prolonged continuous wet curing must be provided.

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Fly ash and natural pozzolans used as workability agents should conform to ASTM C350 or C402. These specifications warn that replacement of a portion of the portland cement by fly ash or a natural pozzolan may reduce the early strength of concrete and tend to reduce the amount of entrained air in concrete. Consequently, a greater amount of air-entraining admixture is generally required to obtain the recommended air content in concrete that contains fly ash or other pozzolans.

Other Types

Gas forming agents usually containing aluminum powder, are sometimes used to cause expansion of a plastic mortar or cement-water paste. Certain agents are known to react differently with different cements. Some field testing of the actual ingredients proposed for the work may be helpful in securing the desired results. Usually very small quantities are used so care must be taken to insure adequate dispersion in the mix. The aluminum reacts with the alkaline constituents in cement to form hydrogen gas bubbles. Some grouting admixtures contain other metals with chemicals to promote oxidation which causes an increase in the volume of the grout.

Admixtures known as permeability-reducing agents are usually either water-repellents or pozzolanic materials. They may reduce the permeability of concretes that have low cement contents and/or a deficiency of fines in the aggregate. However, their use in well-proportioned mixes may increase the mixing water required, resulting in increased rather than reduced permeability.

Dampproofing admixtures, usually water-repellent materials, are sometimes used to reduce the capillary flow of moisture through concrete that is in contact with water or damp earth. Many so-called dampproofers are not effective, especially when used in concretes that are in contact with water under pressure.

Inhibitors may be corrosion inhibitors or agents, such as pozzolans, which inhibit alkali-aggregate reaction. It is suggested that when agents of this nature are proposed, technical advice from someone who has knowledge of the products be consulted. This would apply to germicidal, fungicidal, and insecticidal agents as well.

Coloring agents are fairly commonly used in concrete. Some cause strength reduction and reduce the amount of air entrained if an air-entraining agent is also being employed. Usually, inorganic type pigments for coloring concrete are added in amounts of 2 to 10% of the weight of the cement; some much less. Often, when colored concrete is specified, a white cement is also specified to produce lighter colors. The specifications should be consulted and trial mixes are suggested whenever colored concrete is to be used.

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HOW TO ESTIMATE CONCRETE FOR A JOB

The unit of measure for concrete is the cubic yard, which contains 27 cu.ft. Ready mixed concrete is sold by the cubic yard. Concrete produced on the job is also figured by the cubic yard. To determine the amount of concrete needed, find the volume in cubic feet of the area to be concreted and divide this figure by 27. The following formula can be used to determine the amount of concrete needed for any square or rectangular area:

$$\text{Cubic yards of concrete} = \frac{\text{width in feet X length in feet X thickness in feet}}{27}$$

For example, a 4-in.- thick floor for a 30x60-ft. building would require:

$$\frac{30 \text{ X } 60 \text{ X } 1/3}{27} = 22.22 \text{ cu.yd. of concrete.}$$

The amount of concrete determined by the above formula does not allow for waste or slight variations in concrete thickness. An additional 5 to 10 per cent will be needed to cover waste and other unforeseen factors.

Note: The thickness dimension must be changed to feet or parts of a foot. The fractional part of a foot was used in the example. However, the decimal part may be used instead. Table 10 gives both the fractional and decimal parts of a foot for several common thickness dimensions.

Table 10. How to Change Thickness in Inches to Fractions and Decimal Parts of a Foot for Use in Calculating Quantities of Concrete

Inches	Fractional part of foot	Decimal part of foot
4	4/12 or 1/3	0.33
5	5/12	0.42
6	6/12 or 1/2	0.50
7	7/12	0.58
8	8/12 or 2/3	0.67
10	10/12 or 5/6	0.83
12	1	1.00

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MATERIALS REQUIRED FOR JOB BATCHING

When concrete is job batched, the quantities of materials (cement, fine and coarse aggregate) must be figured separately for each cubic yard of concrete needed. Table 11 shows the number of bags of portland cement, cubic feet of fine aggregate, and cubic feet of coarse aggregate required to produce 1 cu.yd. or 27 cu.ft. of mixed concrete for the different suggested trial mixes. The example shows how to compute amounts of materials needed.

Table 11. Materials Needed per Cubic Yard of Concrete Made with Separated Aggregates

Suggested mixtures for 1 bag trial batches*			Materials per cu.yd. of concrete				
Cement,	Aggregates		Cement,	Aggregates			
	Fine,	Coarse,		Fine		Coarse	
bags**	cu.ft.	cu.ft.	bags	cu.ft.	lb.	cu.ft.	lb.
With 3/4-in. maximum size aggregate							
1	2	2-1/4	7-3/4	17	1550	19.5	1950
With 1-in. maximum size aggregate							
1	2-1/4	3	6-1/4	15.5	1400	21	2100
With 1-1/2-in. maximum size aggregate (preferred mix)							
1	2-1/2	3-1/2	6	16.5	1500	23	2300
With 1-1/2-in. maximum size aggregate (alternate mix)							
1	3	4	5	16.5	1500	22	2200

*Mix proportions will vary slightly depending on gradation of aggregates. A 10 per cent allowance for normal wastage has been included in the above figures for fine and coarse aggregate.

**One bag of cement equals 1 cu.ft.

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Example: How much material will be required to place a 4-in.-thick concrete floor in a building 24 x 14 ft.?

Computation: First find the number of cubic feet of concrete required by multiplying length of floor times the width of floor times the thickness in ft. (4 in. = 1/3 foot).

$$24 \times 14 \times 1/3 = \frac{112 \text{ cu.ft.}}{27} = 4.15 \text{ cu. yd.}$$

Table 11 shows that to produce 1 cu.yd. of concrete (1:2-1/4:3 mix) requires 6-1/4 bags of portland cement, 15.5 cu.ft. of fine aggregate, and 21 cu.ft. of coarse aggregate. Therefore, 4.15 cu.yd. will require 4.15 times these amounts:

4.15 X 6-1/4 = 26 bags of cement

4.15 X 15.5 = 64-1/3 cu.ft. fine aggregate = 2-1/2 cu.yd.

4.15 X 21 = 87-1/4 cu.ft. coarse aggregate = 3-1/4 cu.yd.

CONCRETE ESTIMATING SHORT CUTS

Table 12. 1 Cu.Yd. of Concrete Will Place

Depth, in.	Sq.ft.	Depth, in.	Sq.ft.	Depth, in.	Sq.ft.
1	324	4-3/4	68	8-1/2	38
1-1/4	259	5	65	8-3/4	37
1-1/2	216	5-1/4	62	9	36
1-3/4	185	5-1/2	59	9-1/4	35
2	162	5-3/4	56	9-1/2	34
2-1/4	144	6	54	9-3/4	33
2-1/2	130	6-1/4	52	10	32.5
2-3/4	118	6-1/2	50	10-1/4	31.5
3	108	6-3/4	48	10-1/2	31
3-1/4	100	7	46	10-3/4	30
3-1/2	93	7-1/4	45	11	29.5
3-3/4	86	7-1/2	43	11-1/4	29
4	81	7-3/4	42	11-1/2	28
4-1/4	76	8	40	11-3/4	27.5
4-1/2	72	8-1/4	39	12	27

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trical Information Publications, Inc., annual publication. (2132 Fordem Avenue, Madison, Wis., Zip No. 53701)

59. Eshbach, Charles E. *Bacterial Food Poisoning.* Food Management Leaflet 1, Cooperative Extension Service, College of Agriculture, University of Massachusetts, 1962. (Amherst, Mass., Zip No. 01003)

60. General Motors. *A to Zero of Refrigeration.* Public Relations Staff, General Motors, 1964. (Detroit, Mich., Zip No. 48202)

61. *Institutions Magazine.* Monthly publication. (1801 Prairie Avenue, Chicago, Ill., Zip No. 60616)

62. Lukewski, Robert F.; Eshbach, Charles E.; and Wrisley, Albert L., Jr. *Using Storage in Food Service Establishments.* Food Management Program Leaflet 4, Cooperative Extension Service, College of Agriculture, University of Massachusetts, 1962. (Amherst, Mass., Zip No. 01003)

63. National Live Stock and Meat Board. *Meat Carving Made Easy.* National Live Stock and Meat Board, 1958. (36 South Wabash Avenue, Chicago, Ill., Zip No. 60603)

64. ———. *Ten Lessons on Meat for Use in Schools.* National Live Stock and Meat Board, 1964. (36 South Wabash Avenue, Chicago, Ill., Zip No. 60603)

65. National Turkey Federation. *Turkey Handbook.* National Turkey Federation, 1963. (P.O. Box 69, Mount Morris, Ill., Zip No. 61059)

66. Poultry and Egg National Board in cooperation with National Turkey Federation. *Let's Talk Turkey.* Poultry and Egg National Board, 1963. (8 South Michigan Avenue, Chicago, Ill., Zip No. 60603)

67. Schneider, Nicholas F.; and John, Edgar A. *Commercial Kitchen.* American Gas Association, 1962. (420 Lexington Avenue, New York City, N.Y. Zip No. 10017)

68. Swift and Co. *Menu Pricing for the Restaurant, Hotel and Institutional Trade.* Swift and Co., 1960. (115 West Jackson Boulevard, Chicago, Ill., Zip No. 60604)

69. ———. *Cuts of Meat—How You Can Identify Them.* Agricultural Research Bulletin No. 7, Swift and Co., Agricultural Research Department, 1963. (115 West Jackson Boulevard, Chicago, Ill., Zip No. 60604)

70. United States Government. *Food Purchasing Guide For Group Feeding.* Agriculture Handbook No. 284. Consumer and Food Economics Research Division, Agriculture Research Service, U.S. Department of Agriculture, U.S. Government Printing Office, 1965. (Washington, D.C., Zip No. 20402)

71. ———. *Food for Fitness . . . A Daily Food Guide.* USDA Leaflet 424. Consumer and Food Economics Research Division, Agriculture Research Service, U.S. Department of Agriculture, U.S. Government Printing Office, Rev. 1964. (Washington, D.C., Zip No. 20402)

72. ———. *Sanitary Food Service.* Public Health Service Publication No. 90, U.S. Government Printing Office, 1962. (Washington, D.C., Zip No. 20402)

73. ———. *Grading and Inspection of Eggs and Egg Products.* Agricultural Information Bulletin No. 159. Agricultural Marketing Service, U.S. Department of Agriculture, U.S. Government Printing Office, 1961. (Washington, D.C., Zip No. 20402)

74. ———. *Composition of Foods.* Handbook No. 8, Consumer and Food Research Division, Agriculture Research Service, U.S. Department of Agriculture, U.S. Government Printing Office, 1963. (Washington, D.C., Zip No. 20402)

75. ———. *Shrimp Tips.* Circular No. 41, Fish and Wildlife Service, U.S. Department of Interior, U.S. Government Printing Office, 1956. (Washington, D.C., Zip No. 20402)

76. ———. *Fish Cookery for 100.* Test Kitchen Series No. 1. Fish and Wildlife Service, U.S. Department of Interior, U.S. Government Printing Office, 1955. (Washington, D.C., Zip No. 20402)

77. ———. *How to Cook Ocean Perch.* Test Kitchen Series No. 6. Fish and Wildlife Service, U.S. Department of Interior, U.S. Government Printing Office. (Washington, D.C., Zip No. 20402)

78. ———. *How to Cook Crabs.* Test Kitchen Series No. 10. Fish and Wildlife Service, U.S. Department of Interior, U.S. Government Printing Office, 1957. (Washington, D.C., Zip No. 20402)

79. Wheat Flour Institute. *Eat to Live.* Wheat Flour Institute, 1961. (309 West Jackson Boulevard, Chicago, Ill., Zip No. 60606)

80. Wrisley, Albert L. Jr. *Using Storage Controls to Simplify Determination of Daily Food Costs.* Food Management Leaflet 5, Cooperative Extension Service, College of Agriculture, University of Massachusetts, 1962. (Amherst, Mass., Zip No. 01003)

Films and Filmstrips:

81. *The ABC's of Beef Cookery* (Armour and Co.). 16 mm, 14 minutes, color, sound. Modern Talking Picture Service, Inc. (1321 Main St., Kansas City, Mo., Zip No. 64105), or Association Films, Inc. (347 Madison Avenue, New York, N.Y., Zip No. 10017)

82. *Army Cook* (Series of six films). 16 mm, black and white, sound. 1. *Meat Cutting Tools and Equipment*—20 minutes. 2. *Cutting A Hindquarter of Beef*—14 minutes. 3. *Cutting a Forequarter of Beef*—14 minutes. 4. *Cutting Lamb*—14 minutes. 5. *Cutting Veal and Pork*—13 minutes. 6. *Cooking and Carving of Meat*—20 minutes. Government Film De-

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Table 13. Continuous Footing

Concrete footing size	Lin.ft. of footing		Factor*	
8 x 16-in.		X	3.5	=
10 x 20-in.		X	5.4	=
12 x 24-in.		X	7.7	=

*Includes adequate allowance for waste.

Total _____

Total divided by 100 = _____ cu.yd.

Example: An 8 x 16-in. footing for a 20 x 40-ft. building would require how many cubic yards of concrete?

Computation: 120 lin.ft. of footing multiplied by 3.5 (factor from table above) = 420 divided by 100 = 4.20. Use 4-1/4 cu.yd. concrete.

Table 14. Continuous Foundation

Foundation thickness, in.	Height, ft.		Length, ft.	Factor*	
6		X	X	2.0	=
8		X	X	2.6	=
10		X	X	3.2	=
12		X	X	3.8	=

*Includes adequate allowance for waste.

Total _____

Total divided by 100 = _____ cu.yd.

Example: An 8-in.-thick foundation 5 ft. high by 25 ft. long would require how much concrete?

Computation: 5 X 25 = 125
125 X 2.6 (8-in. thickness from table above)
= 325 divided by 100 = 3-1/4 cu.yd.

(or) $\frac{5 \times 25 \times 2.6}{100} = 3\text{-}1/4$ cu.yd.

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Table 15. Floor Slabs

Thickness of floor, in.	Area in sq.ft. length X width	Factor*	
4	X	1.3	=
5	X	1.6	=
6	X	2.0	=

*Includes adequate allowance for waste.

Total _____

Total divided by 100 = _____cu.yd.

Example: How much concrete is required for a 4-in.-thick slab 40 x 60 ft.?

Computation: 40 X 60 = 2,400 sq.ft. (area)
2,400 multiplied by 1.3 (factor from table above) = 3,120
3,120 divided by 100 = 31.2. Use 31-1/4 cu.yd.

USING A CONCRETE CALCULATOR

For quick calculations, small concrete calculators are often used. These small slide rules are not all accurately calibrated. At best, they can be only as accurate as the printing style and method used. However, they can be very useful for checking estimates and for quick estimating of small quantities of concrete.

APPLICATION

Discuss methods of estimating concrete for a job.
Reproduce, show, and discuss concrete estimating short-cut tables.
Demonstrate use of a concrete calculator.

TEST OR DISCUSSION POINTS

1. What is the unit of measure for estimating concrete requirements?
2. What is the formula for figuring concrete requirements?
3. Is the amount of concrete determined by the formula adequate for all jobs? Why?
4. For job batching, which materials need to be figured separately?
5. How many cubic yards of concrete would be required for the following?
   a. A grade beam 12 in. wide and 2 ft. deep for a 35x100-ft. building.
   b. A 6-in. floor slab for a 40x135-ft. building.
   c. A 4-in.-thick sidewall 3 ft. wide and 45 ft. long.
6. To the above solutions, what percentage should be added for waste and slight variations in thickness?
7. Can small concrete calculators be relied on for accurate estimates? Why?
8. Of what value are concrete calculators?

TOOLS AND MATERIALS

Reproduced tables for estimating concrete
Concrete calculator(s)

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TOOLS FOR PLACING AND FINISHING CONCRETE SLABS

It would take considerable time to discuss every tool that is now available for concrete work. Such a discussion is further complicated because new labor-saving tools are becoming available periodically. For these reasons, this information will deal only with those tools that are most commonly used for placing and finishing concrete.

STRAIGHTEDGE

A straightedge or strike-off rod (Fig. 36) is usually a specially prepared tool. It is the first finishing tool used after the concrete is placed and is used to strike off the concrete surface to proper grade.

A straightedge may be metal-clad or of lumber, as shown in Fig. 36, that has sufficient rigidity to perform the strike-off operation. The wood straightedge is generally made of 1-1/4-in. stock. In some sections of the country, workmen prefer to work with a shoe strip attached at the bottom (Fig. 37). A magnesium strike-off is usually 1 in. thick, 4-1/2 in. wide, and from 6 to 16 ft. in length.

Fig. 36. Straightedge or strikeoff rod.

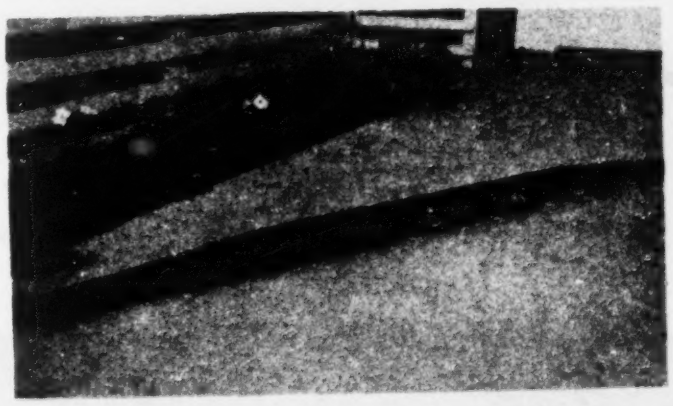

Fig. 37. Straightedge with shoe strip.

It is best to use a tool that has been specifically made for striking off the concrete instead of just a piece of lumber. However, a straight piece of 2x4 or 2x6 may be used.

The striking surface of a straightedge should always be straight and true. The straightedge should be longer than the widest distance between the screeds or edge forms. It is good practice to consider 12 ft. as the maximum span to strike off by hand. With greater spans there is a tendency for a sag or rollback to develop. When this occurs power equipment should be used or screeds should be placed closer together.

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Fig. 38. Hand tamper, commonly called a jitterbug.

HAND TAMPER

After the concrete has been struck off, hand tampers (Fig. 38) can be used to compact the concrete in flatwork construction into a dense mass.

One common form of hand tamper is better known in the trade as a "jitterbug." Its base is usually made of a metal grill 6-1/2 in. wide by 36 in. or 48 in. long. Tampers are used to force the large particles of coarse aggregate slightly below the surface to enable the concrete finisher to put the desired finish on the surface. This tool should be used only with concrete having a very low slump--about 1 in.-- and should be used to bring just enough mortar to the surface for proper finishing. The jitterbug or tamper should be used sparingly and in most cases is not recommended and not necessary. The user can proceed directly to darbying or bullfloating, the next step in quality finishing.

DARBY

A darby (Fig. 39) is a long, flat, rectangular piece of wood, aluminum, or magnesium from 3 to 4 in. wide with a handle on top. It is used to float the surface of the concrete slab immediately after it has been struck off to prepare it for the next step in finishing. This tool should be used to eliminate any high or low spots or ridges left by the straightedge. It should also sufficiently embed the coarse aggregate for subsequent floating and troweling.

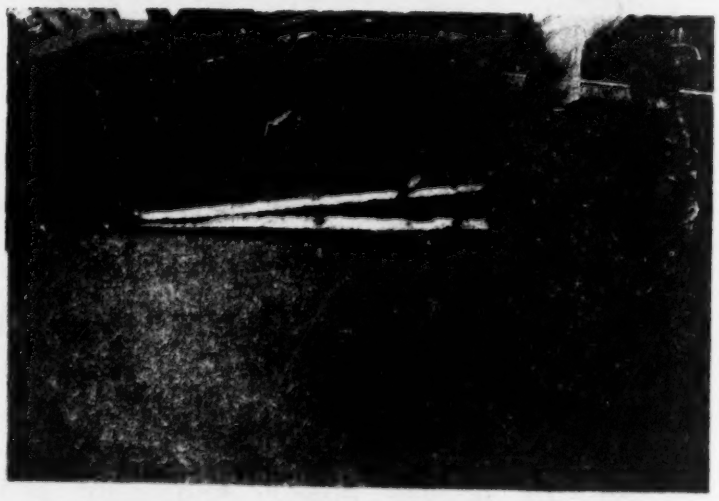

Fig. 39. Darby.

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BULL FLOAT

A bull float (Fig. 40) is a large flat, rectangular piece of wood, aluminum or magnesium, usually 8 in. wide and 42 to 60 in. long with a handle 4 to 16 ft. long. The function of the bull float is essentially the same as that of the darby, but it enables the concrete finisher to float a larger section of a wide slab. The bull float is more commonly used outdoors or where there is enough room to use the long handle.

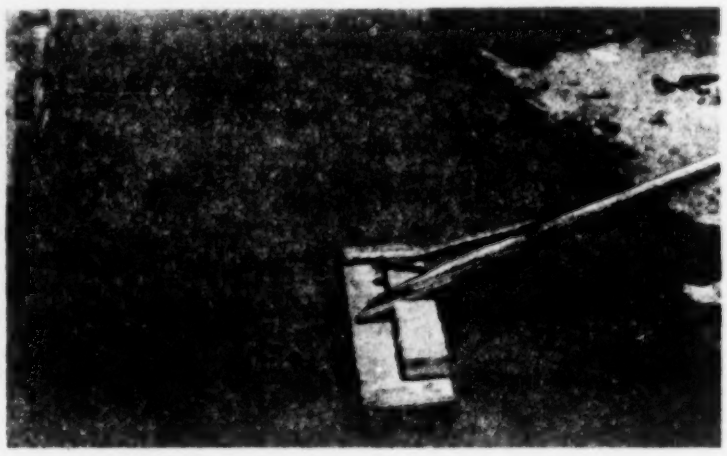

Fig. 40. Bull float.

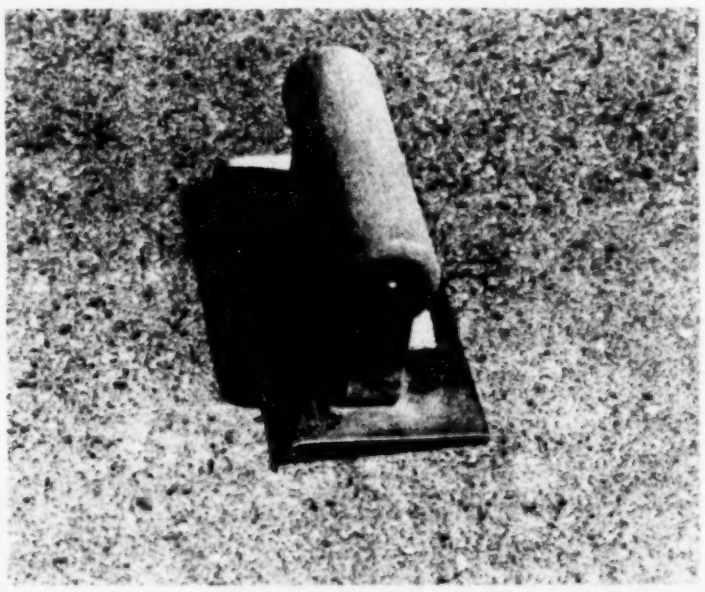

Fig. 41. Edger.

EDGER

Edgers (Fig. 41) come in many sizes; all are about 6 in. long and vary in width from 1-1/2 in. to 4 in. Lips range from 1/8 in. to 5/8 in., and radii from 1/8 in. to 1-1/2 in. The curved-end edger is one of the more popular types. Edgers are used to produce a radius at the edge of a slab. This improves the appearance and reduces the risk of damage to the edge.

JOINTER OR GROOVER

Jointers (Fig. 42), sometimes called groovers, are about 6 in. long and vary from 2 to 4-1/2 in. wide. They have shallow, medium, or deep bits (cutting edges) running from 3/16- to 1-in. in depth. The jointer is used to cut a joint partly through fresh concrete. It may be for appearance or can act as a control joint if cut 1/4 to 1/5 the depth of the slab. The control joints (sometimes also referred to as dummy or contraction joints) are used to predetermine the location of any possible cracks.

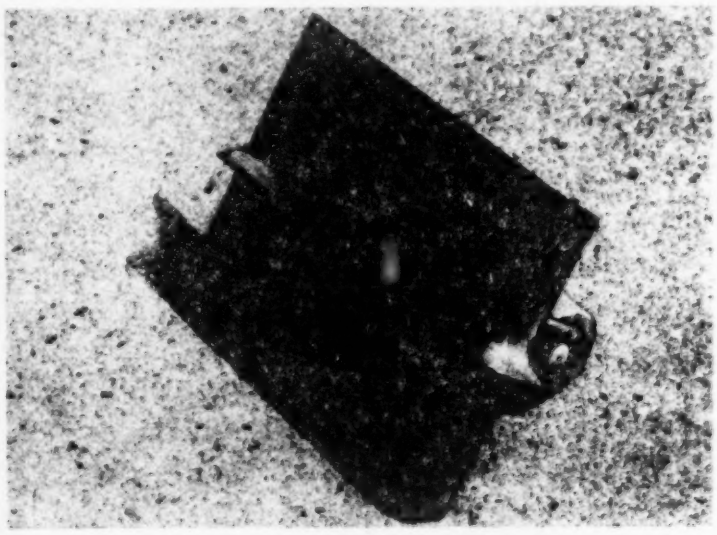

Fig. 42. Jointer or groover.

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Fig. 43. Power joint cutter.

POWER JOINT CUTTER

Another method of cutting joints in concrete slabs is with an electric or gasoline-driven saw (Fig. 43) fitted with a shatterproof abrasive or diamond blade. A power cutter produces a narrow joint that minimizes the possibilities of spalling at the joint due to traffic. The joint is generally cut in the concrete surface 4 to 12 hours after the concrete has hardened, or as soon as the concrete surface will not be damaged by the saw kerfs.

HAND AND POWER FLOATS

Hand floats are made of aluminum, magnesium, or wood. Aluminum or magnesium floats (Fig. 44) are usually made in two sizes, 12 or 16 in. long by 3-1/2 in. wide. Wood floats (Fig. 45) are 12, 15, or 18 in. long and 3-1/2 or 4-1/2 in. wide.

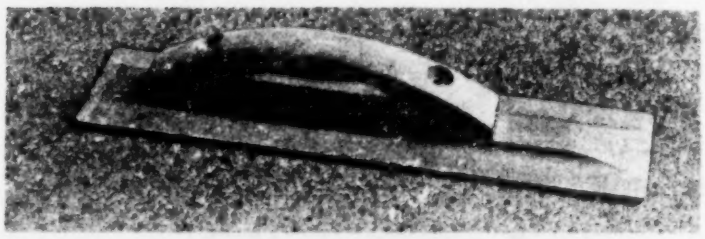

Fig. 44. Lightweight metal float.

The hand float is used to prepare the concrete surface for troweling. Hand floats are also used for floating the concrete around pipes and columns, against walls or other areas which power floats cannot reach.

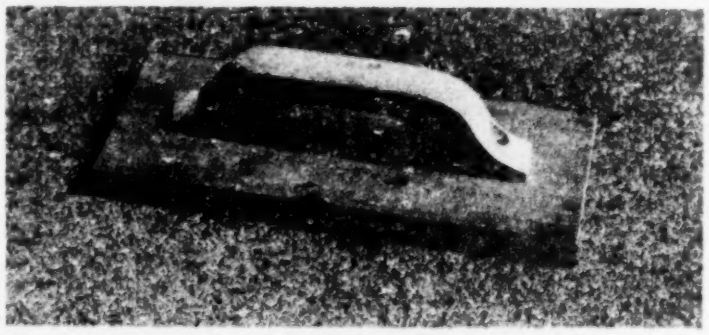

Fig. 45. Wood float.

After the concrete is stiff enough to support the weight of a man, a power float can be used to compact the concrete. These floating machines perform the same operations as hand floating but cover larger areas faster.

Power floats are driven by electric motors or gasoline engines. A power float with a rotating disk about 2 ft. in diameter (Fig. 46) is used only with no-slump concrete for

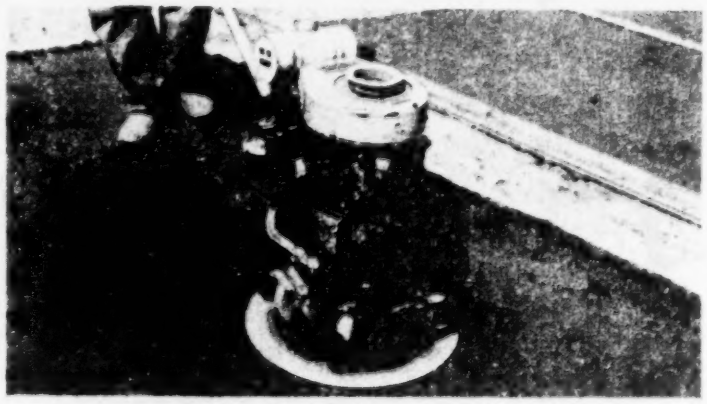

Fig. 46. Power float.

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heavy duty floor construction. For slab construction a power trowel (Fig. 48) with clip-on or shoe-type float blades is usually used.

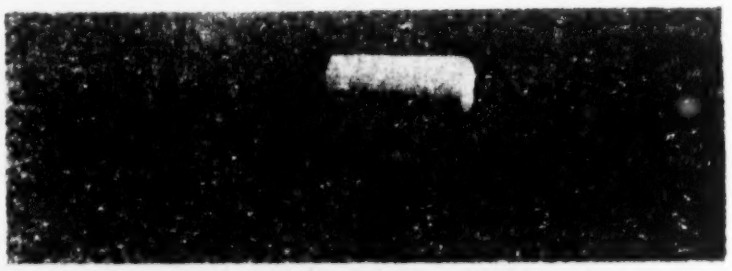

Fig. 47. Steel hand trowel.

HAND AND POWER TROWELS

The steel hand trowel comes in many different sizes ranging from 10 to 20 in. long and 3 to 4-3/4 in. wide (Fig. 47).

Each size trowel has its own use. For the first troweling of concrete flatwork, a wide trowel 16 to 20 in. long is generally used. For troweling the slab the last few times, most finishers prefer a "fanning" trowel 14 to 16 in. long and 3 to 4 in. wide.

A power trowel has three or four rotating steel trowel blades (Fig. 48). They are powered by electricity or by gasoline engine.

The purpose of steel troweling is to give the surface a dense, smooth finish.

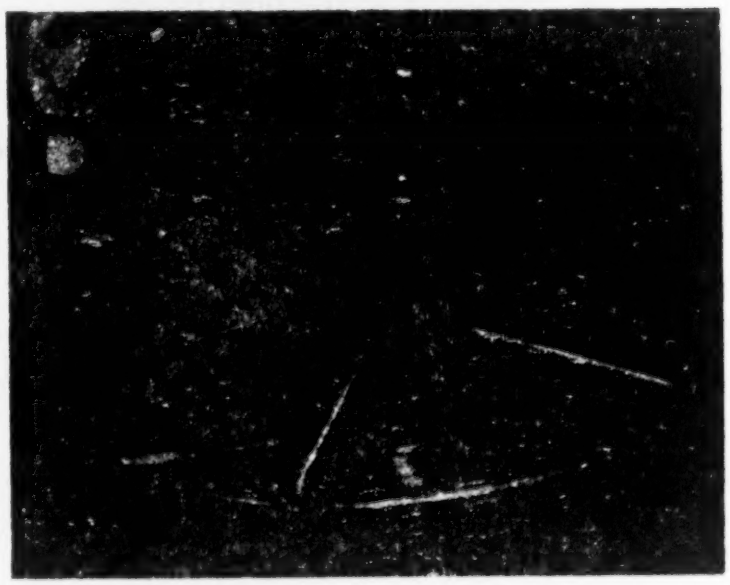

Fig. 48. Power trowel.

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APPLICATION

Discuss finishing tools used for flat work.

TEST OR DISCUSSION POINTS

1. Name some of the tools commonly used for finishing concrete.
2. Is it necessary that a straightedge be made of wood? Why?
3. When should a jitterbug be used?
4. When is a bull float used?
5. Why are jointers used?
6. At what time should a power cutter be used for cutting joints?
7. What are some of the materials used to make floats?
8. Explain the advantages of power floats or trowels.

TOOLS AND MATERIALS

Placing and finishing tools (If these are not available perhaps they can be borrowed from a contractor for classroom use.)

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SELECTION AND DESIGN OF CONCRETE MIXTURES

The design of concrete mixtures is the determination of the most economical and practical combination of concrete ingredients that is workable in its plastic state and that will develop the required qualities when hardened. Thus, a properly designed concrete mix achieves three objectives:

1. Required qualities of hardened concrete.
2. Workability of fresh concrete.
3. Economy.

If acceptable materials are used, the qualities of hardened concrete such as resistance to freezing and thawing, watertightness, wear resistance, and strength are dependent upon (1) water-cement ratio, (2) entrained air, and (3) curing.

When possible, the method and length of curing should be anticipated in order to select the proper water-cement ratio. The air content desired in the concrete is dependent upon the amount of mortar in the mix; the amount of mortar, in turn, is usually dependent upon the maximum size of coarse aggregate.

Workability of fresh concrete is the property that determines the amount of work required to fully consolidate the concrete. Although workability is difficult to measure, it can be readily judged by experienced technicians. Thus, the design of a concrete mix is an art as well as a science.

To achieve economy, the aim of concrete mix design should be to minimize the amount of cement required without sacrificing concrete quality. Since quality is primarily dependent upon water-cement ratio, the water requirement should be minimized to reduce the cement requirement. Steps to minimize water and cement requirements include use of (1) the stiffest practicable mixture, (2) the largest practicable size aggregate, and (3) the optimum ratio of fine to coarse aggregates. As will be shown later, the relative costs of fine and coarse aggregates should also be considered in determining the most economical mix proportions.

SELECTING MIX CHARACTERISTICS

Before a concrete mixture can be designed, certain criteria must be known. The size, shape, and required concrete strength of the structure and its exposure conditions must be ascertained. Since most of the desired properties of hardened concrete are dependent upon the quality of the cement paste, the first step in the design of a concrete mix is the selection of the appropriate water-cement ratio.

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partment, United World Films, Inc. (1445 Park Avenue, New York, N.Y., Zip No. 10029)

83. *The Clean Look* (Armour and Co.). 16 mm, 30 minutes, color, sound. Modern Talking Picture Service, Inc. (1321 Main St., Kansas City, Mo., Zip No. 64105), or Association Films, Inc. (347 Madison Avenue, New York, N.Y., Zip No. 10017)
84. *Cooking: Kitchen Safety* (Young America Classroom). 16 mm, 8 minutes, black and white, sound. Visual Instruction Service, Iowa State University. (Ames, Iowa, Zip No. 50012)
85. *Dishwashing Dividends.* 16 mm, 20 minutes, color, sound. Economics Laboratory, Inc. (Guardian Building, St. Paul, Minn., Zip No. 55101)
86. *Don't Be A Missing Link.* 35 mm, 50 frames, color, silent. National Restaurant Association. (1530 North Lake Shore Drive, Chicago, Ill., Zip No. 60610)
87. *Food for Fitness* (No. C–68). 35 mm, 24 frames, color, silent. Photo Lab, Inc. (3825 Georgia Avenue NW., Washington, D.C., Zip No. 20011)
88. *Food Preparation.* 16 mm, 13 minutes, color, sound. Government Films Department, United World Films, Inc. (1445 Park Avenue, New York, N.Y., Zip No. 10029)
89. *How Clean Is Clean?* 16 mm, 20 minutes, color, sound. National Sanitation Foundation, School of Public Health, University of Michigan. (Ann Arbor, Mich., Zip No. 48103), or American Gas Association. (420 Lexington Avenue, New York, N.Y., Zip No. 10017)
90. *How to Fillet Fish.* 16 mm, 11 minutes, black and white, sound. Fish and Wildlife Service, U.S. Department of Interior. (Washington, D.C., Zip No. 20240)
91. *Inside Story of Cake Baking.* 16 mm, 30 minutes, black and white, sound. American Society of Bakery Engineers, Department of Visual Education. (311 Second St., S.E., Minneapolis, Minn., Zip No. 55401)
92. *The Invaders.* 16 mm, 22 minutes, color, sound. The Diversey Corporation. (212 West Monroe St., Chicago, Ill., Zip No. 60606)
93. *Let's Talk Turkey.* 16 mm, 22 minutes, color, sound. Association Films, Inc. (347 Madison Avenue, New York, N.Y., Zip No. 10017), or Modern Talking Picture Service, Inc. (1321 Main St., Kansas City, Mo., Zip No. 64105)
94. *Make Mine Turkey.* 16 mm, 20 minutes, color, sound. National Turkey Federation. (P.O. Box 69, Mount Morris, Ill., Zip No. 61059)
95. *The Market Forge Steam-It.* 16 mm, 10 minutes, color, sound. Market Forge Co. (35 Garvey St., Everett, Mass., Zip No. 02149)
96. *Modern Sandwich Methods, Restaurant Version.* 35 mm, 22 minutes, color, sound or silent. American Institute of Baking. (400 East Ontario St., Chicago, Ill., Zip No. 60611)
97. *Ornamenting and Decorating Fancy Cakes.* 16 mm, 20 minutes, black and white and color, silent. American Society of Bakery Engineers, Department of Visual Education. (311 Second St., S.E., Minneapolis, Minn., Zip No. 55401)
98. *Pie, America's Favorite Dessert.* 16 mm, 24 minutes, color, sound. American Society of Bakery Engineers, Department of Visual Education. (311 Second St., S.E., Minneapolis, Minn., Zip No. 55401)
99. *The Pork We Eat.* 35 mm, 60 frames, color, sound or silent. American Meat Institute. (59 East Van Buren St., Chicago, Ill., Zip No. 60605)
100. *Pre-Preparation of Vegetables.* 16 mm, 13 minutes, color, sound. Film Librarian, Motion Picture Division, The Ohio State University. (113 Townshend Hall, 1885 Neil Avenue, Columbus, Ohio, Zip No. 43210)
101. *The Proof of the Pudding.* 16 mm, 10 minutes, color, sound. Association Films, Inc. (347 Madison Avenue, New York, N.Y., Zip No. 10017)
102. *Protect Frozen Foods From Temperature Damage* (No. C–70). 35 mm, 24 frames, color, silent. Photo Lab, Inc. (3825 Georgia Avenue NW., Washington, D.C., Zip No. 20011)
103. *A public Well Served.* 16 mm, 10 minutes, color, sound. Commercial Food Service Department, Farley Manning Associates, Inc. (342 Madison Avenue, New York, N.Y., Zip No. 10017)
104. *Quality Assurance for Quantity Buyers of Poultry and Eggs* (No. C–93). 35 mm, 40 frames, color, silent Photo Lab, Inc. (3825 Georgia Avenue NW., Washington, D.C., Zip No. 20011)
105. *Quick Breads* (in three parts). 35 mm, color, silent. Part 1: *Biscuit Method*—43 frames. Part 2: *Muffin Method*—39 frames. Part 3: *Variety Round-up*—48 frames. Wheat Flour Institute. (309 West Jackson Boulevard, Chicago, Ill., Zip No. 60606)
106. *Salad Preparation.* 16 mm, 14 minutes, color, sound. Department of Institution Management, Syracuse University. (Syracuse, N.Y., Zip No. 13210)
107. *Skills Count at the Sandwich Counter.* 16 mm, 10 minutes, color, sound, or 35 mm, 69 frames, color, silent. Wheat Flour Institute. (309 West Jackson Boulevard, Chicago, Ill., Zip No. 60606)
108. *Soups, Sauces, Entrees—The Modern Way.* 16 mm, 15 minutes, color, sound. Institutional Products Division, General Foods Corporation. (250 North St., White Plains, N.Y., Zip No. 10605)

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used for various exposure conditions. Note that the quantities shown are the maximum permissible water-cement ratios.

Under certain conditions, as indicated in Table 2, the water-cement ratio should be selected on a basis of concrete strength. In such cases, if at all possible, tests should be made with the job materials to determine the relationship between water-cement ratio and strength. If data for this relationship cannot be obtained because of time limitations, the water-cement ratio may be estimated from Fig. 17. A large majority of the results of strength tests made by many laboratories using a variety of materials falls within the band curves.

Table 2. Maximum Permissible Water-Cement Ratios (Gal. per Bag) for Different Types of Structures and Degrees of Exposure*

Type of structures	Exposure conditions**					
	Severe wide range in temperature, or frequent alterations of freezing and thawing (air-entrained concrete only)			Mild temperature rarely below freezing, or rainy, or arid		
	In air	At the water line or within the range of fluctuating water level or spray		In air	At the water line or within the range of fluctuating water level or spray	
		In fresh water	In sea water or in contact with sulfates †		In fresh water	In sea water or in contact with sulfates †
A. Thin sections such as reinforced piles and pipe	5.5	5.0	4.5	6	5.5	4.5
B. Thin sections such as railings, curbs, sills, ledges, ornamental or architectural concrete, and all sections with less than 1-in. concrete cover over reinforcement	5.5	–	–	6	5.5	–
C. Moderate sections, such as retaining walls, abutments, piers, girders, beams	6.0	5.5	5.0	††	6.0	5.0
D. Exterior portions of heavy (mass) sections	6.5	5.5	5.0	††	6.0	5.0
E. Concrete deposited by tremie under water	–	5.0	5.0	–	5.0	5.0
F. Concrete slabs laid on the ground	6.0	–	–	††	–	–
G. Concrete protected from the weather, interiors of buildings, concrete below ground	††	–	–	††	–	–
H. Concrete which will later be protected by enclosure or backfill but which may be exposed to freezing and thawing for several years before such protection is offered	6.0	–	–	††	–	–

Adapted from ACI Standard Recommended Practice for Selecting Proportions for Concrete (ACI 613-54).
***Air-entrained concrete should be used under all conditions involving severe exposure and may be used under mild exposure conditions to improve workability of the mixture.*
†Soil or ground water containing sulfate concentrations of more than 0.2 per cent. For moderate sulfate resistance, the tricalcium aluminate content of the cement should be limited to 8 per cent, and for high sulfate resistance to 5 per cent.
††Water-cement ratio should be selected on basis of strength and workability requirements, but should not exceed 9 gal. per bag.

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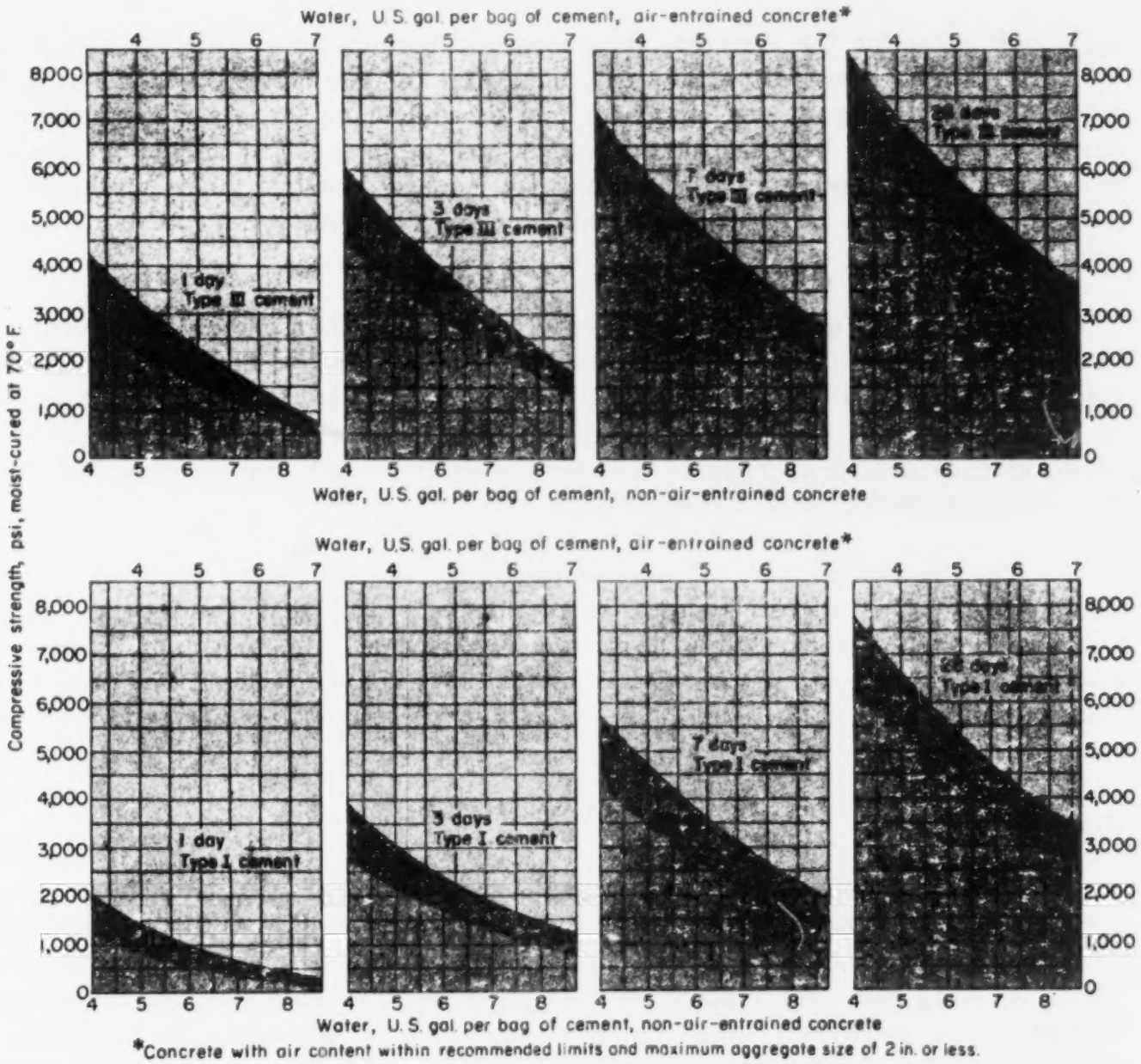

Fig. 17. Relationship between water-cement ratio and compressive strength for Types I and III portland cements at different ages. These relationships are approximate and should be used only as a guide in lieu of data on job materials.

If the design is based on flexural rather than compressive strength, tests should be made to determine the relationship between water-cement ratio and flexural strength. An approximate relationship between flexural and compressive strength is:

$$f'_c = \left(\frac{R}{K}\right)^2$$

in which f'_c = compressive strength in psi;
R = flexural strength (modulus of rupture) in psi; and
K = a constant, usually between 8 and 10.

If the exposure conditions and the strength must both be considered, the lower of the two indicated water-cement ratios should be used.

Maximum Aggregate Size

The maximum size of coarse aggregate that can be used depends on the

size and shape of the concrete members and the amount and distribution of reinforcing steel. Generally, the maximum size should not exceed one-fifth the minimum dimension of the member, nor three-fourths the clear space between reinforcing bars or between reinforcement and the forms. For unreinforced slabs on ground, the maximum size should not exceed one-third the slab thickness. Smaller sizes may be used when indicated by availability and considerations of economy.

The amount of mixing water required to produce a cubic yard of concrete of a given slump (a measure of fluidity) is dependent on the maximum size of aggregate--the smaller the maximum size of aggregate, the greater the amount of water required. It is therefore advisable to use the largest practicable maximum size of coarse aggregate. This minimizes the water requirement, and hence the cement content is kept to a minimum.

The maximum size of coarse aggregate that produces concrete of maximum strength for a given cement content depends upon aggregate source and the aggregate shape and grading. For many aggregates, this "optimum" maximum size is about 3/4 in. If strength is the primary consideration in the design of a concrete mix, use of the maximum size of aggregate that is optimum for strength is suggested.

Air Content

Entrained air should be used in all concrete exposed to freezing and thawing and may be used for mild exposure conditions to improve workability. The recommended total air contents for air-entrained concretes are shown in Table 3. Note that the amount of air required to provide adequate freeze-thaw resistance is dependent upon the maximum size of aggregate. Entrained air is contained in the mortar fraction of the concrete, and in properly designed mixes, the mortar content decreases as the maximum aggregate size increases.

Fig. 17 shows a lower compressive strength for similar water-cement ratios when air is entrained. Air-entrained concretes require less mixing water, however, to maintain equal slumps, as indicated in Table 3. When the cement content is maintained, the water-cement ratio is lowered. Hence, the strength of air-entrained concrete is generally only slightly less than that of non-air-entrained concrete.

Slump

The slump test is generally used as a measure of the fluidity of the concrete. It should not be used to compare mixes of wholly different proportions or mixes of different kinds or sizes of aggregates. Under conditions of uniform operation, changes in slump indicate changes in materials, mix proportions, or water content. To avoid mixes too stiff or too fluid, slumps within the limits given in Table 4 are suggested.

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Table 3. Approximate Mixing Water Requirements for Different Slumps and Maximum Sizes of Aggregates*

Slump, in.	Water, gal. per cu.yd. of concrete for indicated maximum sizes of aggregate**							
	3/8 in.	1/2 in.	3/4 in.	1 in.	1-1/2 in.	2 in.	3 in.	6 in.
Air-entrained concrete								
1 to 2	37	36	33	31	29	27	25	22
3 to 4	41	39	36	34	32	30	28	24
5 to 6	43	41	38	36	34	32	–	–
Recommended average total air content, per cent †	7.5	7.5	6	6	5	5	4	3
Non-air-entrained concrete								
1 to 2	42	40	37	36	33	31	29	25
3 to 4	46	44	41	39	36	34	32	28
5 to 6	49	46	43	41	38	36	–	–
Approximate amount of entrapped air in non-air-entrained concrete, per cent	3	2.5	2	1.5	1	0.5	0.3	0.2

**Adapted from ACI Standard Recommended Practice for Selecting Proportions for Concrete (ACI 613-54)*
***These quantities of mixing water are for use in computing cement factors for trial batches. They are maxima for reasonably well-shaped angular coarse aggregates graded within limits of accepted specifications.*
† Plus or minus 1 per cent.

TRIAL MIX METHOD

The most direct method for determining optimum mix proportions is through the use of trial mixes. Such mixes may be (1) relatively small batches made with laboratory precision or (2) job-size batches made during the course of normal concrete production. Use of a combination of both methods is often most satisfactory. In either method, the items listed previously (water-cement ratio, maximum size of aggregate, air content, and range of slump) must be selected first. By maintaining each of these items constant while varying the amounts of fine and coarse aggregates, a series of mixes is made. Proportions are computed for each mix and results are compared. Based on considerations of workability and economy, the mix proportions are selected.

Table 4. Typical Slump Ranges for Various Types of Construction

Types of construction	Slump, in.*	
	Maximum	Minimum
Reinforced foundation walls and footings	4	2
Unreinforced footings, caissons, and substructure walls	3	1
Reinforced slabs, beams, and walls	5	2
Building columns	5	3
Pavements	2	1
Sidewalks, driveways, and slabs on ground	4	2
Heavy mass construction	2	1

**When high-frequency vibrators are not used, the values may be increased by about 50 per cent, but in no case should the slump exceed 6 in.*

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TRIAL MIX DATA

STRUCTURE: _____ MAXIMUM SIZE AGGREGATE: _____

EXPOSURE CONDITION:
Severe or Moderate ____ Mild ____

In Air ____
In Fresh Water ____
In Sea Water ____

AIR CONTENT _____ % ± 1%

DESIRED SLUMP RANGE
Max. ___in. Min.___in.

STRENGTH REQUIREMENT ____ psi

TYPE OF STRUCTURE (A-H): _____

W/C FOR STRENGTH: ___to___gal. /bag

MAX. W/C FOR EXPOSURE: ___gal. /bag

USE W/C _____gal. /bag

DATA FOR TRIAL BATCH
(Saturated, surface-dry aggregates)

(1) Material	(2) Initial Wt. (lb.)	(3) Final Wt. (lb.)	(4) Wt. Used (lb.)	(5) Wt. for 1-bag Batch	(6) Wt. per cu. yd.	(7) REMARKS
Cement						Cement Factor = bag/cu. yd.
Water						gal. /cu. yd.
Fine Agg.						% of total aggregate
Coarse Agg.						
Air-Entraining Admixture						
		TOTAL(T)=				

Measured Slump: _____ in.

Air Content _____ %

Workability: _____

Wt. Container + concrete (lb.)	
Wt. Container (lb.)	
Wt. Concrete = A (lb.)	
Vol. Container = B (cu. ft.)	

Unit Wt. of concrete = $w = \frac{A}{B}$

$\frac{A}{B}$ = _____ = _____ lb. /cu. ft.

Yield = $\frac{T}{w}$ = _____ = _____ cu. ft. /bag

CALCULATIONS:

Column (4) = Column (2) minus Column (3)
Column (5) = Column (4) times (94 ÷ Wt. of Cement Used)

$$\text{Yield} = \frac{\text{Total Wt. of material for 1-bag batch (T)}}{\text{Unit wt. of concrete (w)}}$$

Cement factor = 27 ÷ yield
Column (6) = Column (5) times cement factor

$$\text{Gal./cu. yd.} = \frac{\text{(Cement factor) X (wt. of water for 1-bag batch)}}{\text{8.33 (lb. of water per gal.)}}$$

= (Cement factor) X (W/C)

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Laboratory Trial Mixes

EXAMPLE. To illustrate the procedure, assume that the mix proportions are to to be determined for the following:

Conditions. Concrete is required for a retaining wall that will be exposed to fresh water in a severe climate. A design compressive strength of 3,000 psi at 28 days is specified. Minimum thickness of the wall is 8 in., and 2 in. of concrete cover over the reinforcement is required.

Water-cement ratio. For these exposure conditions, line C of Table 2 indicates that air-entrained concrete with a maximum water-cement ratio of 5.5 gal. per bag should be used. Water-cement ratio required for strength from Fig. 17 should be between 5.8 and 6.8 gal. per bag (see dashed lines in graph for 28-day strength of Type I cement), assuming that the mix is designed for 3,450 psi (3,000 + 15 per cent*) to allow for job variations. These water-cement ratios are greater than that permitted for exposure conditions. Because of the exposure requirements, not more than 5.5 gal. per bag should be used, even though this water-cement ratio will produce strengths higher than needed for structural purposes.

Aggregate size. From the information given, the maximum size of aggregates should not exceed 1-1/2 in. Assume that satisfactory 1-1/2 in. maximum size aggregate is economically available and will be used. If this size were not available, the next smaller available size would be used.

Air content. Because of the severe exposure conditions, concrete should contain entrained air. From Table 3, the recommended air content for concrete with 1-1/2 in. aggregate is 5 per cent plus or minus 1 per cent.

To entrain air, either an air-entraining portland cement or an air-entraining admixture must be used. Unless an air-entraining cement is used, sufficient air-entraining admixture must be added to a portion of the mixing water to assure the desired air content. The amount recommended by the manufacturer will, in most cases, produce the desired air content.

Slump. A typical slump range for a reinforced foundation wall is 2 to 4 in., assuming that the concrete will be consolidated by vibration (Table 4).

All trial mix data are entered in the appropriate blanks on the trial mix data sheet, Fig. 18.

Representative samples of the aggregates, cement, water and air-entraining admixture must be used. To simplify calculations and to eliminate sources of error caused by variations in aggregate moisture content, the aggregates should be pre-wetted and allowed to dry to a saturated, surface-dry condition. They should then be placed in covered containers to keep them in this condition until use.

The size of the trial batch is dependent on the equipment available, and on the number and size of test specimens to be made. If the batches are to be mixed

**See ACI Standard Recommended Practice for Evaluation of Compression Test Results of Field Concrete (ACI 214-57).*

DATA AND CALCULATIONS FOR TRIAL BATCH
(Saturated, surface-dry aggregates)

BATCH SIZE: 1.0 ____ 0.5 ✓ 0.2 ____ 0.1 ____ bag

Note: Complete columns 1 thru 5, fill in items below, then complete columns 6 & 7

(1) Material	(2) Initial wt. (lb.)	(3) Final wt. (lb.)	(4) Wt. used (Col. 2 minus Col. 3)	(5) Wt. for 1-bag batch (Col. 4 ÷ by batch size)	(6) Wt./cu. yd. (Col. 5 X Cement Factor)	(7) Remarks
Cement	18.8	0	18.8	94	540	*Cement Factor 5.75 bag/cu. yd.
Water	9.2	0	9.2	46	264	**Water 31.6 gal./cu. yd.
Fine Agg.	66.2	30.2	36.0	180	1035	***Fine Aggregate 33.5 % of Total Aggregate
Coarse Agg.	89.8	18.4	71.4	357	2050	
A/E Admixture	0.30 oz.	TOTAL (T) = 677				

Measured Slump: 3 in. Measured Air Content: 5.4 per cent

Appearance: Sandy ____ Good ✓ Rocky ____

Workability: Good ✓ Fair ____ Poor ____

Wt. of Container + Concrete = 42.6 lb.

Wt. of Container = 6.6 lb.

Wt. of Concrete (A) = 36.0 lb.

Vol. of Container (B) = 0.25 cu. ft.

UNIT WT. OF CONCRETE (w) = $\frac{A}{B} = \frac{36.0}{0.25} = 144$ lb./cu. ft.

YIELD = $\frac{\text{Total Wt. of material for 1-bag batch}}{\text{Unit wt. of concrete}} = \frac{T}{w} = \frac{677}{144} = 4.70$ cu. ft./bag

*CEMENT FACTOR = $\frac{27 \text{ cu. ft.}}{\text{yield}} = \frac{27}{4.70} = 5.75$ bag/cu. yd.

**WATER, GAL./CU. YD. = $\frac{\text{Total wt. of water/cu. yd.}}{\text{lb. of water/gal.}} = \frac{264}{8.33} = 31.6$

or = cement factor X gal. water/bag (W/C) = 5.75x5.5=31.6

***Fine Aggregate % of Total Aggregates = $\frac{\text{Wt. of fine aggregate}}{\text{Total wt. of aggregates}} = \frac{1035}{3085} = 33.5$ %

Notes: 1 U.S. gal. water = 8.33 lb.
1 Imperial gal. water = 10 lb.
1 U.S. bag of cement = 94 lb.
1 Canadian bag of cement = 87-1/2 lb.

Fig. 18. Data sheet for laboratory trial mixes, page 2.

by hand and if no compression test specimens are required, a 0.1-bag batch may be adequate; however, larger batches will produce more accurate data. Machine mixing is recommended since it more nearly represents job conditions; it is mandatory if the concrete is to contain entrained air.

Batch weights. For convenience, a batch containing 0.2 bag of cement will be made. The quantity of mixing water required is therefore 0.2 × 5.5 gal. = 1.1 gal., or 9.2 lb. These quantities of cement and water are carefully weighed. Representative samples of fine and coarse aggregates in suitable containers are weighed. These weights are indicated as initial weights in column 2 of the data sheet (Fig. 18).

All of the measured quantities of cement, water, and air-entraining admixture are to be used. Fine and coarse aggregates are added to produce a workable concrete mixture having a slump adequate for placement in a retaining wall. An experienced technician can determine if the slump is adequate by noting

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if the ingredients tend to segregate; he can also observe if the concrete is workable. By adding fine and coarse aggregates in small increments, he controls the slump.

Excessive coarse aggregate will produce a harsh unworkable mix; excessive fine aggregate will result in an uneconomical mix with high water and cement requirements and greater potential volume changes. A rule of thumb is to use as much coarse aggregate as possible with sufficient fine aggregate to ensure adequate workability. Mechanical mixing, simulating the type to be used on the project, should be used to obtain the most reliable results.

Workability. When the slump of the concrete appears to be within the recommended range, tests for slump, air content, and unit weight are made. Results of these tests are noted on the data sheet as well as a description of the workability, which is noted as "Excellent" for the example. Weights of fine and coarse aggregates not used are recorded on the data sheet (Fig.18) in column 3, and the weights of materials used are noted in column 4 (column 2 minus column 3). Since the batch was based on a 0.2-bag mix, the quantities for a 1-bag mix are equal to the weights used multiplied by 5.

If the slump had been greater than that required, small quantities of fine or coarse aggregate (or both) would be added. Had the slump been less than required, water and cement, in the appropriate ratio, would be added to produce the desired slump. With the latter procedure, it would be important that the quantities be measured accurately and recorded on the data sheet.

Table 5. Example of Results of Laboratory Trial Mixes

Batch No.	Slump, in.	Air content, per cent	Unit wt., pcf	Cement factor, bags/ cu.yd.	Fine aggregate, per cent of total aggregate	Work-ability
1	3	5.4	144	5.75	33.5	Excellent
2	2¾	4.9	144	5.90	27.4	Harsh
3	2½	5.1	144	5.92	36.1	Excellent
4	3¼	4.7	145	5.75	30.5	Good

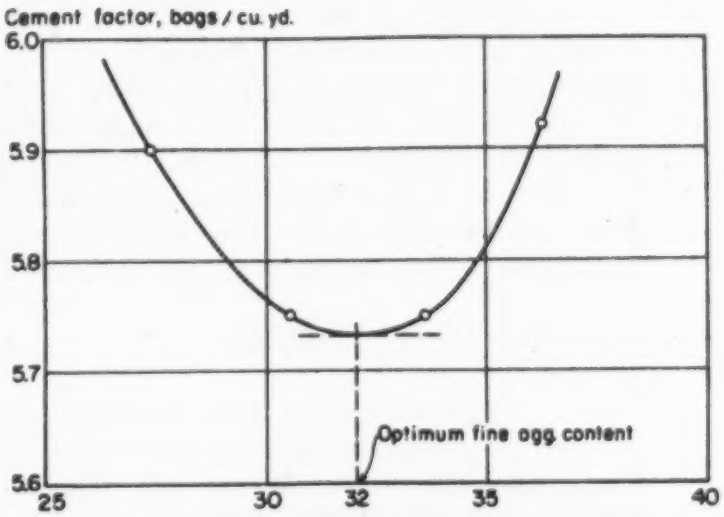

Fig. 19. Example of relationship between percentage of fine aggregate and cement content for a given water-cement ratio and slump.

Finding the yield and cement factor. The yield, as defined by the American Society for Testing and Materials, is the volume of concrete produced from a 1-bag mixture. It is equal to the weight of a 1-bag batch divided by the unit weight of the concrete. The number of bags of cement required per cubic yard of con-

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crete (cement factor) is computed by dividing 27 (cubic feet per cubic yard) by the yield in cubic feet. The percentage of fine aggregate of total aggregate is also calculated. In this trial batch the cement factor was 5.75 bags per cubic yard, the unit weight of the concrete was 144 pcf, and the fine aggregate made up 33.5 per cent of the total aggregate by weight.

To determine the most economical proportions, additional trial batches should be made varying the percentage of fine aggregate. In each batch the water-cement ratio, aggregate gradations, air content, and slump are maintained approximately the same. Results of four such trial batches are summarized in Table 5.

Quantities. For these mixes, the percentage of fine aggregate is plotted against the cement factor in Fig. 19. Note that for the combination of materials used, the minimum cement factor (5.74 bags per cubic yard) occurs at a fine aggregate content of about 32 percent of total aggregate. Since the water-cement ratio is 5.5 gal. per bag, and the unit weight of the concrete for an air content of 5 percent is about 144 pcf, the quantities of materials required per cubic yard can be computed:

Cement	5.74 bags	= 539 lb.
Water	5.74 × 5.5 × 8.33	= 262 lb.
Cement + water		= 801 lb.
Wt. concrete per cu.yd.	= 144 × 27	= 3,888 lb.
Wt. aggregates	= 3,888 − 801	= 3,087 lb.
Wt. fine aggregate	$= \frac{32}{100} \times 3{,}087$	= 990 lb.
Wt. coarse aggregate	= 3,087 − 990	= 2,097 lb.

Unless care is taken to control the slump and air content, and unless weights are accurately determined, it may be difficult to obtain data necessary to plot a curve such as Fig. 19. For well-graded, rounded aggregates the curve may be nearly flat. If there is a wide difference in the costs of fine and coarse aggregates, the optimum per cent of fine aggregate for economy may be different than that at which the minimum cement factor occurs. For example, if coarse aggregate costs more than fine aggregate, it may be more economical to use more fine aggregate, with an appropriate increase in cement content.

Job-Size Trial Batches

On most jobs, trial batches may be full size. These batches are often used in the foundations during the early phases of a construction project. The first trial may be selected on the basis of experience or from established relationships such as those given in Tables 6 and 7. These tables have been developed from experience and data from several sources. They indicate the amount of water required per cubic yard of concrete, cement content, and the porportion of fine aggregate required for good workability.

The quantities in Tables 6 and 7 are based on concrete having a slump of 3 to 4 in., with well-graded aggregates having a specific gravity of 2.65. The dry-rodded unit weight of the coarse aggregate was assumed to vary from 98 to 106 lb.

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per cubic foot for maximum sizes of 3/8 in. to 1-1/2 in., respectively. For other conditions it is necessary to recalculate the quantities in accordance with the footnotes. When making a trial batch, enough water should be added to produce the desired slump, whether this is more or less than the estimated amount. Slump, air content, and unit weight of the fresh concrete should then be measured.

EXAMPLE. To illustrate this method, assume that the mix proportions are to be determined for the following:

Conditions. A water-cement ratio of 6 gal. per bag, maximum aggregate size of 1 in., air content 6 ± 1 per cent, and a slump of 2 to 4 in. The fine aggregate has a fineness modulus of 2.85 and a moisture content of 4.3 per cent. The coarse aggregate has a moisture content of 1 per cent.

Weight. For these conditions, Table 6 shows the following quantities per cubic yard of concrete:

Cement	5.7 bags	=	536 lb.
Water	34 gal.	=	283 lb.
Fine aggregate		=	1,165 lb.
Coarse aggregate		=	1,835 lb.
	Total	=	3,819 lb.

The free moisture (above saturated, surface-dry) in the fine aggregate amounts to 4.3 per cent of 1,165 lb., or 50 lb.; the free moisture in the coarse aggregate is approximately 18 lb. The corrected weights per cubic yard of concrete are:

Cement (Type IA)	536 + 0	=	536 lb.
Water	283 - 50 - 18	=	215 lb.
Fine aggregate	1,165 + 50	=	1,215 lb.
Coarse aggregate	1,835 + 18	=	1,853 lb.
	Total	=	3,819 lb.

When these quantities of materials were mixed, the consistency was such that the slump was less than 1 in. Additional water (3 gal.) was added to bring the slump to 3 in. The air content was measured to be 5.3 per cent and the unit weight was measured to be 144 pcf. The workability of the mix was noted as good. The total amount of water used was 308 lb. (283 + 25), and total weight of concrete produced was 3,844 lb. (3,819 + 25).

Volume. Since the unit weight of the concrete was 144 pcf, the volume of concrete in this batch was 26.7 cu.ft. (3,844 lb. ÷ 144 pcf).

The principal reason for the discrepancy between actual and theoretical yield is that the specific gravity values of the aggregates were probably different from those assumed in Tables 6 and 7. Therefore these quantities must be adjusted to produce 27 cu.ft. of concrete and to maintain the water-cement ratio at 6 gal. per bag. Unless the corrections are very large, certain simplified assumptions can be made. These are that the unit weight of the concrete remains essentially constant and that the amount of water required (per cubic yard of concrete) remains constant.

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109. *The Winner.* 16 mm, 22 minutes, color, sound. The Cleveland Range Co. (3333 Lakeside Avenue, Cleveland, Ohio, Zip No. 44114)

Charts:

110. *Beef, Veal, Lamb, Mutton, and Pork Charts.* National Live Stock and Meat Board. (36 South Wabash Avenue, Chicago, Ill., Zip No. 60603)

111. *Nutrition Charts.* Agriculture Research Service, U.S. Department of Agriculture. (Washington, D.C., Zip No. 20250)

112. *Safety Posters.* National Safety Council. (425 North Michigan Avenue, Chicago, Ill., Zip No. 60611)

113. *Shield of Good Health* (essential 'four"). Wheat Flour Institute. (309 West Jackson Boulevard, Chicago, Ill., Zip No. 60606)

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Adjustment. The adjusted water requirement is thus:

$$\frac{27}{26.7} \times 308 = 312 \text{ lb.} = 37.4 \text{ gal.}$$

and the cement requirement is $\frac{37.4}{6} = 6.23$ bags or 586 lb.

The weight of materials per cubic yard of concrete must total 144 × 27 = 3,888 lb. The total weight of aggregates must therefore be

Table 6. Suggested Trial Mixes for Air-Entrained Concrete of Medium Consistency
(3 - to 4-in. slump)*

Water, gal. per bag of cement	Maximum size of aggregate, in.	Air content, per cent	Water, gal. per cu.yd. of concrete	Cement, bags per cu.yd. of concrete	With fine sand – fineness modulus = 2.50**			With coarse sand – fineness modulus = 2.90**		
					Fine aggregate, per cent of total aggregate	Fine aggregate, lb. per cu.yd. of concrete	Coarse aggregate, lb. per cu.yd. of concrete	Fine aggregate, per cent of total aggregate	Fine aggregate, lb. per cu.yd. of concrete	Coarse aggregate, lb. per cu.yd. of concrete
4.5	3/8	7.5	41	9.1	53	1320	1190	57	1430	1080
4.5	1/2	7.5	39	8.7	43	1120	1460	48	1230	1350
4.5	3/4	6	36	8.0	36	1010	1760	40	1120	1650
4.5	1	6	34	7.6	32	910	1940	36	1020	1820
4.5	1-1/2	5	32	7.1	28	820	2150	32	950	2030
5	3/8	7.5	41	8.2	54	1390	1190	58	1500	1080
5	1/2	7.5	39	7.8	45	1190	1460	49	1300	1350
5	3/4	6	36	7.2	38	1080	1760	42	1190	1650
5	1	6	34	6.8	33	970	1940	37	1090	1820
5	1-1/2	5	32	6.4	29	880	2150	33	1000	2030
5.5	3/8	7.5	41	7.5	55	1440	1190	59	1550	1080
5.5	1/2	7.5	39	7.1	46	1250	1460	50	1360	1350
5.5	3/4	6	36	6.6	39	1130	1760	43	1240	1650
5.5	1	6	34	6.2	34	1020	1940	38	1140	1820
5.5	1-1/2	5	32	5.8	30	930	2150	34	1050	2030
6	3/8	7.5	41	6.9	56	1490	1190	60	1600	1080
6	1/2	7.5	39	6.5	47	1300	1460	51	1410	1350
6	3/4	6	36	6.0	40	1170	1760	44	1280	1650
6	1	6	34	5.7	35	1060	1940	39	1180	1820
6	1-1/2	5	32	5.4	31	960	2150	35	1080	2030
6.5	3/8	7.5	41	6.3	56	1540	1190	60	1650	1080
6.5	1/2	7.5	39	6.0	48	1340	1460	52	1450	1350
6.5	3/4	6	36	5.6	41	1210	1760	44	1310	1650
6.5	1	6	34	5.3	36	1090	1940	40	1210	1820
6.5	1-1/2	5	32	5.0	32	990	2150	35	1110	2030
7	3/8	7.5	41	5.9	57	1570	1190	61	1680	1080
7	1/2	7.5	39	5.6	48	1370	1460	52	1480	1350
7	3/4	6	36	5.2	41	1240	1760	45	1350	1650
7	1	6	34	4.9	37	1120	1940	41	1240	1820
7	1-1/2	5	32	4.6	32	1020	2150	36	1140	2030
7.5	3/8	7.5	41	5.5	57	1600	1190	61	1710	1080
7.5	1/2	7.5	39	5.2	49	1400	1460	53	1510	1350
7.5	3/4	6	36	4.8	42	1270	1760	46	1380	1650
7.5	1	6	34	4.6	37	1150	1940	41	1260	1820
7.5	1-1/2	5	32	4.3	33	1050	2150	37	1170	2030
8	3/8	7.5	41	5.2	58	1620	1190	62	1740	1080
8	1/2	7.5	39	4.9	49	1420	1460	53	1530	1350
8	3/4	6	36	4.5	42	1280	1760	46	1400	1650
8	1	6	34	4.3	38	1170	1940	42	1290	1820
8	1-1/2	5	32	4.0	33	1070	2150	37	1190	2030

**Increase or decrease water per cubic yard by 3 per cent for each increase or decrease of 1 in. in slump. For manufactured fine aggregate, increase percentage of fine aggregate by 3 and water by 2 gal. per cubic yard of concrete. For less workable concrete, as in pavements, decrease percentage of fine aggregate by 3 and water by 1 gal. per cubic yard of concrete.*

***For definition of fineness modulus, see Aggregates for Concrete, available only in the United States and Canada on request from the Portland Cement Association.*

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3,888 - (312 + 586) = 2,990 lb. For this ratio of fine to coarse aggregates, saturated, surface-dry weights are thus 1,160 lb. and 1,830 lb., respectively.

To determine the optimum proportions for economy of materials, additional trial batches should be made varying the ratio of fine and coarse aggregates, as discussed under "Laboratory Trial Mixes."

Table 7. Suggested Trial Mixes for Non-Air-Entrained Concrete of Medium Consistency
(3 - to 4-in. slump)*

Water, gal. per bag of cement	Maximum size of aggregate, in.	Air content (entrapped air), per cent	Water, gal. per cu.yd. of concrete	Cement, bags per cu.yd. of concrete	With fine sand – fineness modulus = 2.50**			With coarse sand – fineness modulus = 2.90**		
					Fine aggregate, per cent of total aggregate	Fine aggregate, lb. per cu.yd. of concrete	Coarse aggregate, lb. per cu.yd. of concrete	Fine aggregate, per cent of total aggregate	Fine aggregate, lb. per cu.yd. of concrete	Coarse aggregate, lb. per cu.yd. of concrete
4.5	3/8	3	46	10.2	53	1320	1190	57	1430	1080
4.5	1/2	2.5	44	9.8	44	1150	1460	48	1260	1350
4.5	3/4	2	41	9.1	36	1000	1760	40	1110	1650
4.5	1	1.5	39	8.7	32	910	1940	36	1030	1820
4.5	1-1/2	1	36	8.0	28	830	2150	32	970	2030
5	3/8	3	46	9.2	54	1400	1190	58	1510	1080
5	1/2	2.5	44	8.8	46	1230	1460	50	1340	1350
5	3/4	2	41	8.2	38	1070	1760	42	1180	1650
5	1	1.5	39	7.8	34	990	1940	38	1100	1820
5	1-1/2	1	36	7.2	30	910	2150	34	1030	2030
5.5	3/8	3	46	8.4	55	1460	1190	59	1570	1080
5.5	1/2	2.5	44	8.0	47	1290	1460	51	1400	1350
5.5	3/4	2	41	7.5	39	1120	1760	43	1230	1650
5.5	1	1.5	39	7.1	35	1040	1940	39	1160	1820
5.5	1-1/2	1	36	6.6	31	960	2150	35	1080	2030
6	3/8	3	46	7.7	56	1520	1190	60	1630	1080
6	1/2	2.5	44	7.4	48	1340	1460	52	1450	1350
6	3/4	2	41	6.9	40	1170	1760	44	1280	1650
6	1	1.5	39	6.5	36	1090	1940	40	1210	1820
6	1-1/2	1	36	6.0	32	1000	2150	36	1120	2030
6.5	3/8	3	46	7.1	57	1550	1190	61	1660	1080
6.5	1/2	2.5	44	6.8	49	1380	1460	53	1500	1350
6.5	3/4	2	41	6.3	41	1220	1760	45	1330	1650
6.5	1	1.5	39	6.0	37	1130	1940	41	1250	1820
6.5	1-1/2	1	36	5.6	32	1030	2150	36	1160	2030
7	3/8	3	46	6.6	58	1610	1190	61	1720	1080
7	1/2	2.5	44	6.3	49	1430	1460	53	1540	1350
7	3/4	2	41	5.9	42	1250	1760	45	1360	1650
7	1	1.5	39	5.6	37	1160	1940	41	1280	1820
7	1-1/2	1	36	5.2	33	1060	2150	37	1190	2030
7.5	3/8	3	46	6.2	58	1640	1190	62	1750	1080
7.5	1/2	2.5	44	5.9	50	1460	1460	54	1570	1350
7.5	3/4	2	41	5.5	42	1280	1760	46	1390	1650
7.5	1	1.5	39	5.2	38	1190	1940	42	1310	1820
7.5	1-1/2	1	36	4.8	34	1100	2150	38	1220	2030
8	3/8	3	46	5.8	58	1670	1190	62	1780	1080
8	1/2	2.5	44	5.5	51	1490	1460	54	1600	1350
8	3/4	2	41	5.2	42	1300	1760	46	1410	1650
8	1	1.5	39	4.9	38	1210	1940	42	1330	1820
8	1-1/2	1	36	4.5	34	1120	2150	38	1240	2030

**Increase or decrease water per cubic yard by 3 per cent for each increase or decrease of 1 in. in slump. For manufactured fine aggregate, increase percentage of fine aggregate by 3 and water by 2 gal. per cubic yard of concrete. For less workable concrete, as in pavements, decrease percentage of fine aggregate by 3 and water by 1 gal. per cubic yard of concrete.*

***For definition of fineness modulus, see Aggregates for Concrete, available only in the United States and Canada on request from the Portland Cement Association.*

APPLICATION

Discuss the unit weight method of selection and design of a concrete mixture. (If equipment and materials are available, run through an actual mix design example.)
Show film, Principles of Quality Concrete (See film list)

TEST OR DISCUSSION POINTS

1. What is the design of a concrete mixture?
2. What are the three objectives of a properly designed concrete mixture?
3. Explain what "economy" refers to in mix design.
4. Name the three most direct trial mix methods for determining optimum mix proportions.
5. Explain what you feel would be the best size for a trial batch.
6. How can air be entrained in a trial batch?
7. Excessive coarse aggregate will produce what type of mix?
8. Excessive fine aggregate will produce what type of mix?
9. Explain two methods for selecting trial batches.
10. How would you determine optimum proportions for economy of materials?

TOOLS AND MATERIALS

Reproduce trial mix data sheet and tables from Related Information for this unit.

QUALITY READY MIXED CONCRETE

Most concrete used in construction is mixed and delivered to the job site. Exceptions involve massive structures on the one extreme--dams, for example, where it is economical to provide a concrete plant exclusively for the one job--and very small projects on the other extreme, where less than one full load of ready mixed concrete may be needed.

PRODUCTION OF READY MIXED CONCRETE

Using precision scales to weigh ingredients, ready mix plants batch portland cement with aggregates and water to achieve the desired concrete mixture.

The producer is responsible for selecting and proportioning the ingredients as specified by the purchaser and delivering the concrete in good condition. From the time of delivery, the quality of the hardened concrete depends entirely on the user, who assumes responsibility for placing, finishing, and curing. Obtaining concrete construction of high quality is a joint responsibility of the producer and user.

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Ready mixed concrete is manufactured for delivery to the job site in a plastic and unhardened state. Any of three types of mixing can be used:

1. Transit-mixed concrete is mixed completely in a truck mixer.

2. Central-mixed concrete is mixed completely in a stationary mixer and is delivered in a truck agitator, a truck mixer operating at agitating speed, or a special non-agitating truck.

3. Shrink-mixed concrete is mixed partially in a stationary mixer and the mixing is completed in a truck mixer.

The "Standard Specifications for Ready-Mixed Concrete" (ASTM C94) requires that mixers and agitators be operated within the limits and speed of rotation designated by the equipment manufacturer. Agitating speed is usually about 2 to 6 rpm, while mixing speed is generally about 8 to 12 rpm. Truck mixers consist essentially of a mixer with a separate water tank and water measuring device mounted on a chassis. Agitator trucks are similar but without provision for water.

ASTM C94 requires that when a truck mixer is used either for complete mixing or to complete the partial mixing, each batch of concrete should be mixed not less than 50 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer as mixing speed. Any additional mixing should be done at the speed designated by the manufacturer as agitation speed. The specifications also require that concrete be delivered and discharged within 1-1/2 hours or before the drum has revolved 300 times after introduction of the water to the cement and aggregates or the cement to the aggregates.

ADVANTAGES OF READY MIXED CONCRETE

A look at some of the practical benefits offered by ready mixed concrete will explain the phenomenal growth of this industry in recent years.

Today, the use of modern precision batching equipment in the ready mix industry assures purchasers of an accurately proportioned mix. Thorough mixing of each batch helps produce a concrete of uniform quality, durability, and high strength.

Use of ready mixed concrete helps create a more efficient operation at the job site. It eliminates time spent in estimating quantities of cement and aggregates to use and labor required to handle and mix materials. The problem of finding space at the job site for stocking aggregates and storing cement is eliminated. Excess materials aren't left to clean up after a job is completed. Specialized equipment and personnel for job-mixing, which may be used inefficiently because of fluctuating demand for concrete, are eliminated.

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Virtually any location is accessible to a ready mix truck. This mobility makes it possible to deliver concrete to a specific job site at the time required, ready for depositing in the forms. Construction crews don't have to lose time waiting to start or finish a job.

Efficient, large-volume production makes ready mixed concrete an economical material to use in modern construction. It is delivered in the exact quantity desired, eliminating waste and costly reordering. A mixer doesn't have to be rented, leased, or purchased for use on the job. There isn't any guesswork about the cost of the concrete either. Ready mix producers will quote the price of their product before making delivery.

SPECIFICATIONS FOR READY MIXED CONCRETE

Many engineers and architects now designate standard specifications for ready mixed concrete. Commonly used is the "Standard Specifications for Ready Mixed Concrete," (ASTM Designation C94). This is the standard of the American Society for Testing and Materials.

The specification covers the producer's responsibility for ready mixed concrete through delivery to the job site. Among the subjects covered are: basis of purchase, materials, quality of concrete, tolerances in slump, measuring materials, etc. However, they do not cover the placement, consolidation, curing, or protection of the concrete after delivery to the purchaser. These are the user's responsibilities.

In the absence of designated applicable general specifications, the purchaser must select one of two following alternative bases for specifying the quality of the concrete:

Alternate No. 1 is used when the purchaser assumes responsibility for the design of the concrete mixture. He must specify the following:

(1) Cement content in bags per cubic yard of concrete, or equivalent units.

(2) Designated size, or sizes, of coarse aggregate.

(3) Maximum allowable water content in gallons per bag of cement or equivalent units, including surface moisture, but excluding water of absorption, of the aggregates.

(4) Slump, or slumps, desired at the point of delivery.

(5) When air-entraining concrete is specified, the maximum and minimum limits for air content of samples taken from the transportation unit at the point of discharge.

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Alternate No. 2 is used when the purchaser requires the manufacturer to assume responsibility for the design of the concrete mixture. It is the same as alternate No. 1 with the exception of item (1) which reads: "Minimum allowable compressive strength as determined on samples taken from the transportation unit at the point of discharge. The basis shall be the compressive strength at 28 days. The purchaser shall specify the requirements for strength in terms of tests of standard specimens cured under standard laboratory conditions for moist curing."

After reading ASTM C94, one can understand why the purchaser designating this standard specification when ordering should receive a quality product.

REMIXING CONCRETE

The initial set of concrete does not ordinarily take place for 2 or 3 hours after the cement has been mixed with water. Fresh concrete that is left standing tends to dry out and stiffen somewhat before it begins to set. Such concrete may be used, if upon remixing it becomes sufficiently plastic that it can be completely compacted in the forms. Indiscriminate addition of water to make the mixture more workable should not be allowed since this lowers the quality just as would a larger amount of water in the original mixing. Under careful supervision, a small increment of water may be added to delayed batches provided that the maximum allowable water-cement ratio is not exceeded and provided that the concrete is remixed for at least half the minimum required mixing time.

PREPARING FOR READY MIX DELIVERY

Order ready mixed concrete well in advance for speedy and efficient service. Specify the hour when the concrete is needed. Doing this permits delivery schedules to be adapted to your work schedule. When you place an order, the ready mix producer will tell you approximately when your concrete will be delivered.

Plan placing operations far enough in advance of an order so that trucks can be scheduled to deliver concrete at the time it is needed. If the job is not ready for placing to begin when trucks arrive, excessive mixing and hydration may cause the concrete to become too stiff to place and finish.

Ready mixed concrete must be placed in the forms promptly--not more than about 1-1/2 hours after mixing. The time may be reduced during extremely hot weather. Have adequate facilities and labor available to handle the concrete when delivered.

Delays are costly in terms of lost time and quality. They may even result in the loss of the concrete. Expensive equipment may be tied up, affecting the cost per cubic yard. You may have to absorb this added expense.

Advance planning and preparation will save time and reduce confusion on the job. Here are some things you can do:

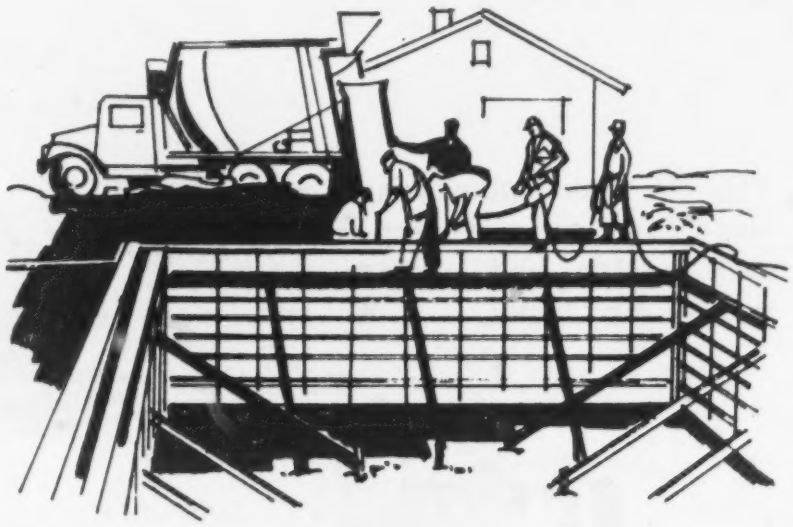

Fig. 24. Have forms well braced to keep them aligned while concrete is being placed. Oil forms so they can be removed easily.

Fig. 25. Have wheelbarrows handy to speed placing of concrete immediately upon delivery at the work site.

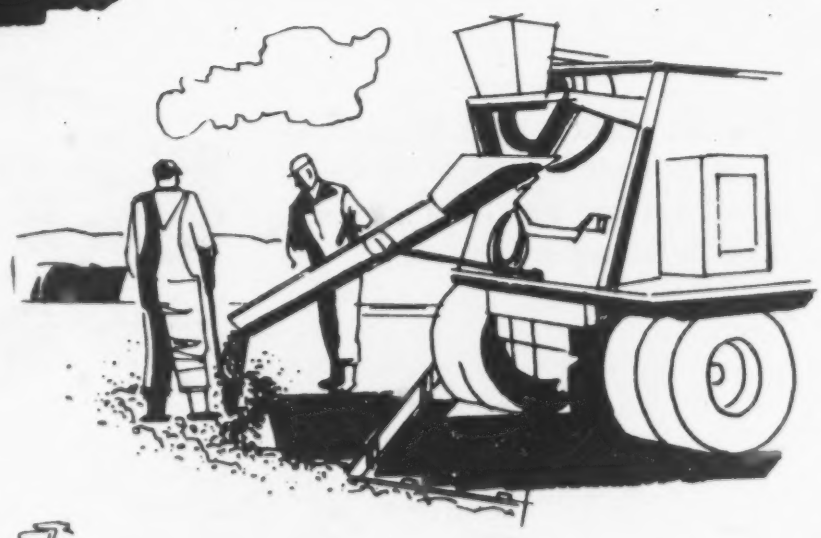

Fig. 26. Have subgrade dampened so the ground doesn't absorb water from the concrete, and level to ensure uniform concrete thickness.

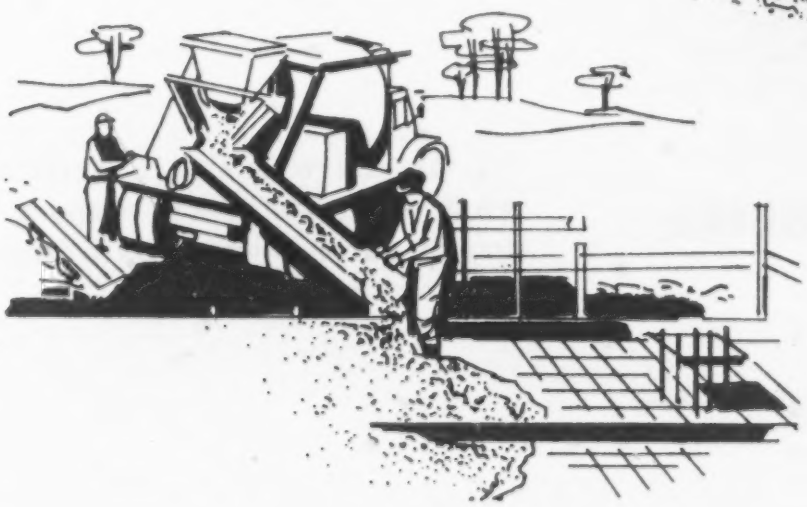

Fig. 27. Have strike-off boards ready and screeds in place to make sure that concrete will be finished to proper grade.

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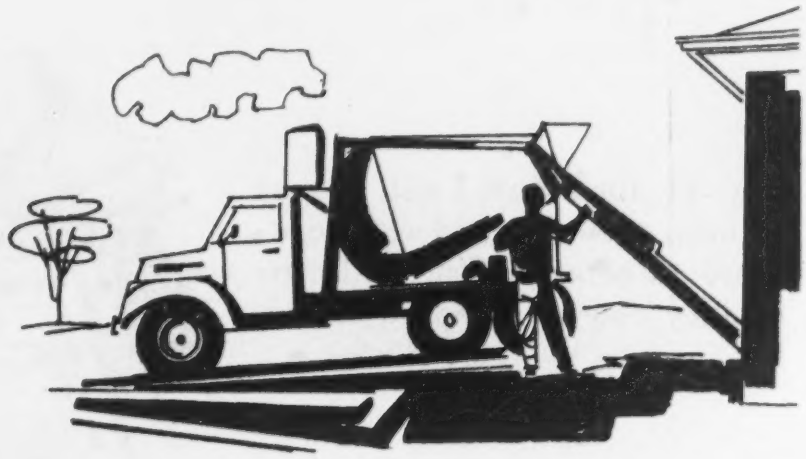

Fig. 28. Have planks and runways in place to protect existing construction and provide easy access for trucks.

Fig. 29. Have vibration equipment ready to ensure proper compaction and bond to reinforcement and to help eliminate air pockets.

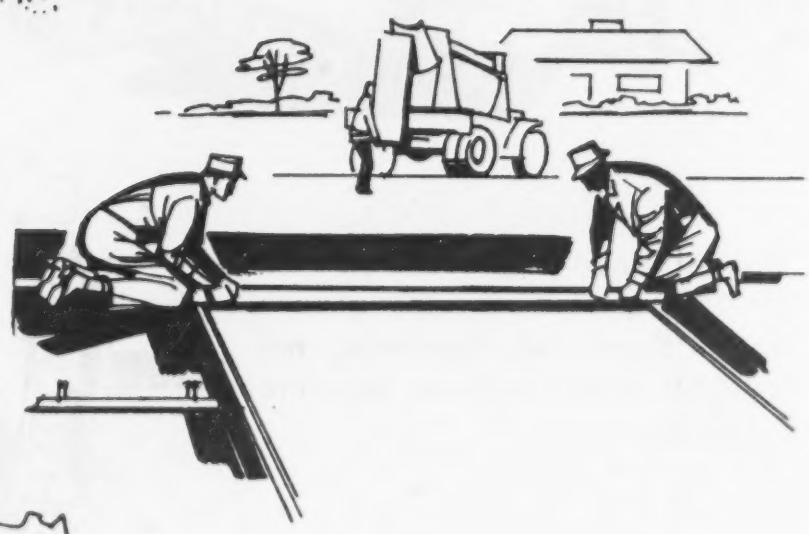

Fig. 30. Have straightedge ready to strike off concrete to the desired surface level before beginning finishing operations.

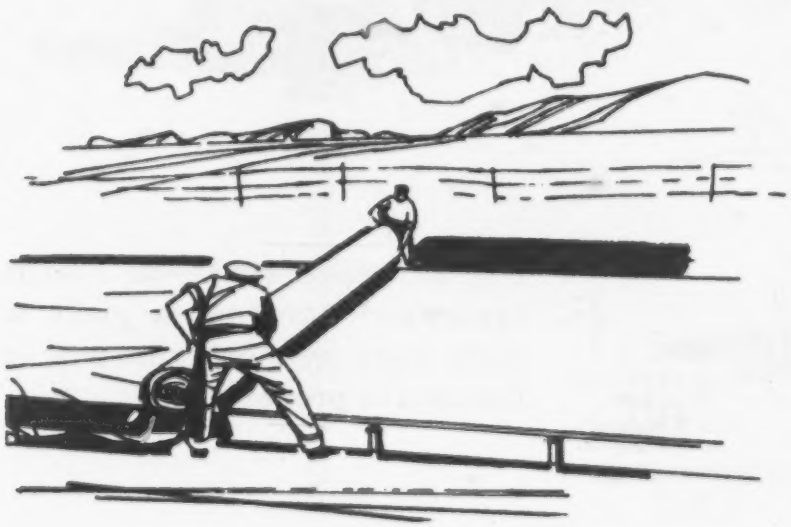

Fig. 31. Have curing materials ready to prevent rapid evaporation of surface water as a first step in proper curing.

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DANGERS OF ADDING WATER TO READY MIX

When the specified mix is ordered, the proper amount of water is determined at the plant and combined with the portland cement and aggregate. Addition of extra water to ready mixed concrete, which has been accurately designed for an individual job, will seriously affect the strength, durability, and watertightness of the finished concrete.

Many producers discourage the use of high slump concrete by requiring that requests for extra water at the job site be noted on the delivery ticket and signed by the user to acknowledge the addition of extra water. Drivers are usually trained not to add water indiscriminately at anyone's slightest wish. There is nothing wrong with delivering concrete to the job "on the dry side" and then adding water to bring the slump to the specified amount. When this procedure is used, an adequate amount of mixing must be performed to incorporate the added water into the mix.

Many fail to realize that too much water in a mix also results in additional man hours required for finishing. Finishers have to wait for the water to soak into the subgrade or evaporate. Stiff concrete usually is less expensive in terms of man hours required. The initial placing labor may be more than for a soupy mix, but the concrete can be finished sooner.

AVAILABILITY OF READY MIX

Ready mixed concrete is available for all types of construction. The mobility of mixer trucks makes most job sites easily accessible for the delivery of ready mixed concrete. After delivery, if quality concrete is combined with good workmanship, the completed job will give years of dependable service.

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Appendix C

SUPPLEMENTARY TEACHING MATERIALS

Diehl, Harold Sheeley, *Healthful Living*. McGraw-Hill Book Co., Inc. (330 West 42 St., New York, N.Y. 10036) 1964.

Hayes, Kirby M.; Eshbach, Charles E.; Sawyer, F. Miles; and Cournoyer, Norman G. *Frozen Foods in Food Service Establishments*. Food Management Leaflet 2, Cooperative Extension Service, College of Agriculture, University of Massachusetts (Amherst, Mass. 01003) 1962.

Lukowski, Robert F. *Receiving Food in Food Service Establishments*. Food Management Program Leaflet 3, Cooperative Extension Service, College of Agriculture, University of Massachusetts (Amherst, Mass. 01003)

National Restaurant Association. *Catalog of Books, Bulletins and Pamphlets*. National Restaurant Association (1530 North Lake Shore Drive, Chicago, Ill., 60610) 1965.

———— *Film Manual*. National Restaurant Association (1530 North Lake Shore Drive, Chicago, Ill. 60610) 1958.

———— *Quantity Food Production—Guidelines for Establishing Training Programs in Schools*. National Restaurant Association (1530 North Lake Shore Drive, Chicago, Ill. 60610)

Oklahoma State University and The University of Oklahoma. *Catalog of Educational Motion Pictures*. Oklahoma State University, Audio-Visual Center (Stillwater, Okla. 74075) or The University of Oklahoma, Audio-Visual Education (Norman, Okla. 73071) 1963–65 (published every three years).

Science Research Associates, Inc. *Career Pamphlets*. Science Research Associates, Inc. (259 East Erie St., Chicago, Ill. 60611)

Smith, Evelyn. *A Handbook on Quantity Food Management*. Burgess Publishing Co., 426 South Sixth St. (Minneapolis, Minn. 55415) 1955.

United States Government. *Filmstrip and Slide Series of the U.S. Department of Agriculture*. Agriculture Handbook No. 222. U.S. Government Printing Office (Washington, D.C. 20402) 1963.

Voegele, Marguerite, C.; and Wooley, Grace H. *Drink Dictionary*. Ahrens Publishing Co., Inc. (116 West 14 St., New York, N.Y. 10011) 1961.

————, and Wooley, Grace H. *Menu Dictionary. Multi-Lingual*. Ahrens Publishing Co., Inc. (116 West 14 St., New York, N.Y. 10011) 1960.

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APPLICATION

Discuss quality ready mixed concrete.
Arrange tour of local ready mix plant.
Show film, Quality Ready Mixed Concrete (see film list).

TEST OR DISCUSSION POINTS

1. Identify and explain the three methods by which ready mixed concrete is mixed and delivered.
2. What are the producer's responsibilities with regard to the five construction rules of quality concrete?
3. What are the three responsibilities of the purchaser or user?
4. Explain some of the advantages of using ready mixed concrete.
5. Explain why advance planning and preparation are worth while.
6. What advance plans should the user make?
7. Why is it never advisable to add water to ready mixed concrete at the job?
8. Will excess water affect finishing time? If so, how?
9. What can architects, engineers, and others use as a standard specification for ready mixed concrete?
10. Explain the five items that must be stated explicitly in a specification for ready mixed concrete.

TOOLS AND MATERIALS

Copy of "Standard Specifications for Ready Mixed Concrete" (ASTM Designation C94)
Film: Quality Ready Mixed Concrete

REFERENCE MATERIALS

ASTM Designation C94

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JOB MIXING CONCRETE

As discussed previously, the purchaser of concrete specifies the mix desired when ordering ready mixed concrete and is responsible for the concrete after it has been delivered to the job. However, in the case of job-mixed concrete, the user is responsible for selecting good ingredients and using the proper mix.

The selection of a proper mix is based on the kind of work or exposure condition the concrete will be subjected to.

The design of concrete mixtures is the determination of the most economical and practical combination of ingredients to make concrete workable in its plastic state and to make it develop required qualities when hardened. Commercial laboratories perform this service for many ready mix plants as well as for specific projects. However, for small concrete jobs this service is not always economical or practical, and someone must determine the mix on the job.

Quality concrete gives maximum service and satisfaction. It will result in installations that are durable, strong, and watertight. It is just as easy to make high-quality concrete that gives excellent service as to make poor quality concrete.

OBJECTIVES OF A CONCRETE MIX

A properly designed concrete mix achieves three objectives: (1) workability of fresh concrete, (2) required qualities of hardened concrete, and (3) economy.

Workability of fresh concrete is the property that determines the amount of effort required to consolidate and finish the concrete. Although workability is difficult to measure, it can be readily judged by experienced technicians. Thus, the design of a concrete mix is an art as well as a science.

Assuming that acceptable materials are used, the qualities of hardened concrete, such as resistance to freezing and thawing, watertightness, wear resistance, and strength, basically depend on the water-cement ratio.

To achieve economy, a concrete mix design should provide the maximum yield without sacrificing concrete quality. Since quality primarily depends on the water-cement ratio, the water requirement should be minimized to reduce the cement requirement. Steps to minimize water and cement requirements include use of (1) the stiffest practical mixture, (2) the largest size aggregate practical for the job, and (3) the optimum ratio of fine to coarse aggregate.

DETERMINING EXPOSURE CONDITIONS

The kind of work and exposure conditions that concrete will be subjected to

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should be known before a mixture is designed. Exposure conditions fall into three distinct classifications:

1. Mild exposure--conditions where concrete is not subjected to abrasion or severe weather (foundations and installations in mild climates where temperatures rarely fall below freezing).

2. Normal exposure--conditions where concrete is used for watertight structures and subjected to abrasion or weather (floors, sidewalks, paved barnyards, tilt-up wall panels, tanks).

3. Severe exposure--conditions where concrete is subjected to severe wear, weather, weak acids or alkali solutions (silos, mangers, floors in dairy plants).

WATER-CEMENT RATIOS FOR EXPOSURE CONDITIONS

When mixing concrete on the job, consider how the concrete will be used. A proper mix should be based on the kind of work or exposure conditions to which the concrete will be subjected. As previously discussed, desirable properties of quality concrete depend on the quality of the water-cement paste. To ensure quality concrete, the following desirable water-cement ratios have been established in terms of maximum water and minimum cement for the three exposure conditions:

FOR MILD EXPOSURES--7 gal. of water per bag of cement and 5 bags of cement per cubic yard of concrete.

Concrete not subject to abrasion or severe weather (foundations and installations in mild climates).

FOR NORMAL EXPOSURES--6 gal. of water per bag of cement and 6 bags of cement per cubic yard of concrete (air entrained).

Concrete for watertight structures and when subject to abrasion, weather (floors, sidewalks, paved barnyards, tilt-up wall panels, tanks).

FOR SEVERE EXPOSURES--5 gal. of water per bag of cement and 7 bags of cement per cubic yard of concrete (air entrained).

Concrete subjected to severe wear, weather, weak acids, or alkali solutions (silos, mangers, floors in dairy plants).

By using more or less aggregates (fine or coarse) the consistency of the mix can be varied. This helps make it more workable for a specific job.

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PROPER CONSISTENCY OF SLUMP

Under conditions of uniform operation, changes in slump indicate changes in materials, mix proportions, or water content. To avoid mixes that are too stiff or too fluid, slumps within the limits given in Table 8 are suggested. Concrete with a slump greater than 6 in. should not be used.

Table 8. Typical Slump Ranges For Various Types of Construction

Types of Construction	Slump, In.*	
	Maximum	Minimum
Reinforced foundation walls and footings	4	2
Unreinforced footings, caissons, and substructure walls	3	1
Reinforced slabs, beams, and walls	5	2
Building columns	5	3
Pavements	2	1
Sidewalks, driveways, and slabs on ground	4	2
Heavy mass construction	2	1

*When high-frequency vibrators are not used, the values may be increased by about 50 per cent, but in no case should the slump exceed 6 in.

WATER-CEMENT RATIO BASED ON REQUIRED COMPRESSIVE STRENGTH

Under certain conditions, the water-cement ratio should be selected on a basis of concrete strength. In such cases, if at all possible, tests should be made with the job materials to determine the relationship between water-cement ratio and strength. If data for this relationship cannot be obtained because of time limitations, the water-cement ratio may be estimated from Fig. 32. A large majority of the results of strength tests made by many laboratories using a variety of materials falls within the strength-band curves.

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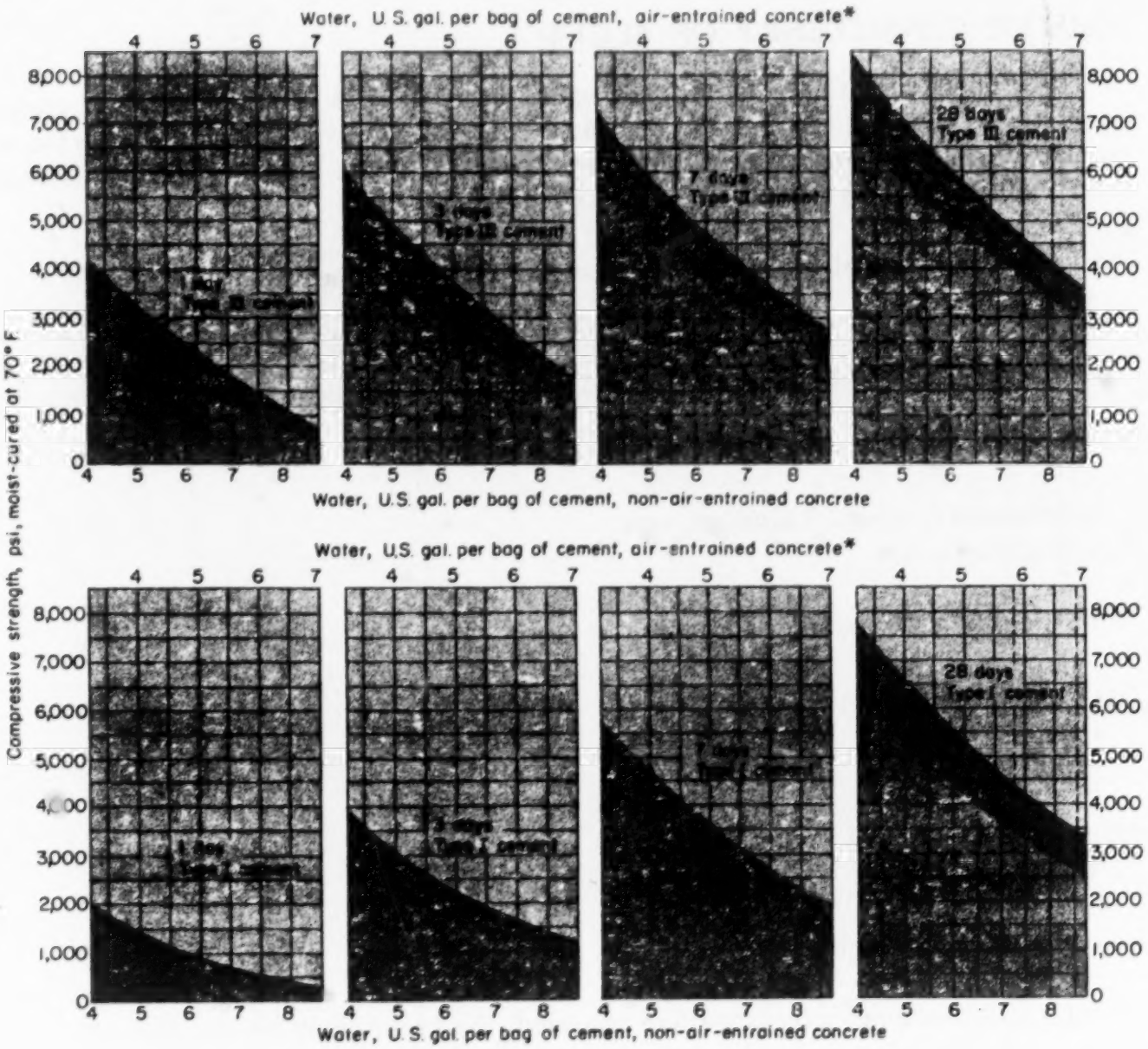

*Concrete with air content within recommended limits and maximum aggregate size of 2 in. or less.

Fig. 32. Relationship between water-cement ratio and compressive strength for Types I and III portland cements at different ages. These relationships are approximate and should be used only as a guide in lieu of data on job materials.

SELECTING GOOD INGREDIENTS

Concrete ingredients consist of aggregates, water, and portland cement, plus an air-entraining agent if required due to exposure conditions.

Aggregates (sand, gravel and crushed stone) are used in concrete to provide volume at low cost. Comprising 60 to 80 per cent of the volume of concrete, they can be called a filler material. Both fine and coarse aggregates must be clean,

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sound, and well graded. Consideration of aggregate size for the job is important. Generally, the most economical mix is obtained by using the largest-size aggregate that is practical for the specific job. Fine aggregate should have particles ranging in size from 1/4 in. down to particles that will pass through a sieve having 100 openings to the inch.

Mixing water for concrete should be clean and free of acids, alkalies, oils, sulfates, and other harmful materials. A good rule for all jobs is that the water used for concrete should be fit to drink, or tests should be made to determine its suitability.

Portland cement of the type best suited for the job should be selected. The cement should be free of hard lumps.

Air in the form of microscopic bubbles improves the durability of concrete. Air-entrained concrete should be used where the hardened concrete is exposed to alternate freezing and thawing or where de-icing chemicals are used. It is recommended for practically all outside concrete jobs. Because air-entrained concrete improves workability, it should also be considered for most indoor jobs. To entrain air, either an air-entraining portland cement or an air-entraining agent must be used. Unless an air-entraining cement is used, enough agent must be added to a portion of the mixing water to produce the desired air content. The amount recommended by the manufacturer will, in most cases, produce the desired air content.

ALLOWING FOR MOISTURE IN SAND

The proper water-cement ratio for the kind of work or exposure condition having been selected, the next step is to consider the effect of moisture in sand.

Knowing the gross amount of water is not quite enough. It is necessary to consider the amount of water carried by the fine aggregate. The amount carried by coarse aggregate is generally so small that it can be overlooked.

It is important to determine the net amount of water to use for sands of various degrees of wetness. Otherwise, this moisture is free to react with the cement and change the water-cement ratio. Hence, the sand must be tested for water content and an allowance made.

Dry sand is seldom available for concrete work. This is material which is as dry as it would be if it were spread out in a thin layer and dried in the sun or warm air.

Most sand used on the job contains a surprising amount of water. For small jobs it is possible to estimate the amount of water in the sand by squeezing it in the hand.

Damp sand feels slightly damp to the touch but leaves little moisture on

the hands. Damp sand usually contains about 1/4 gal. of water per cubic foot (about 2 per cent by weight).

Wet sand, which is the kind usually available, feels wet and leaves a little moisture on the hands after being handled. Wet sand contains approximately 1/2 gal. of water per cubic foot (about 4 per cent by weight).

Fig. 33. If sand falls apart it is damp. Fig. 34. If sand forms a ball it is wet.

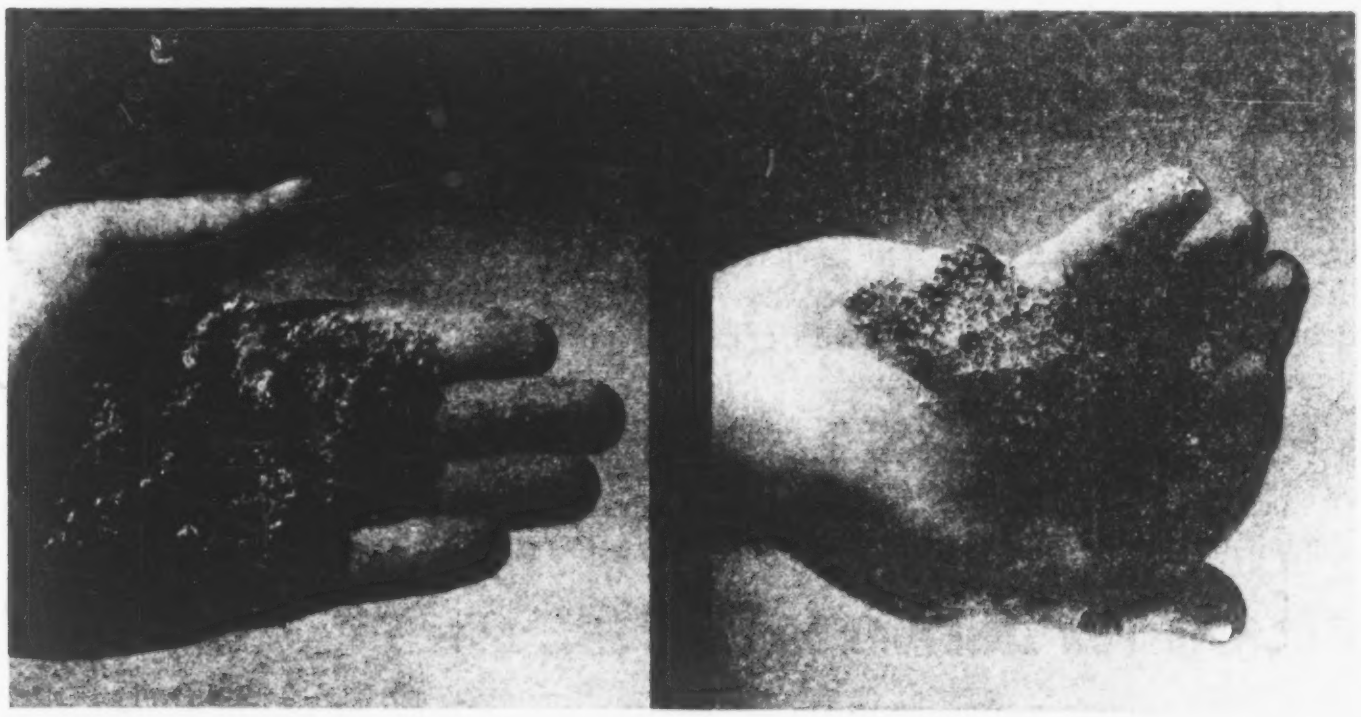

Very wet sand is dripping wet when delivered on the job and leaves more moisture on the hand than wet sand. Very wet sand carries about 3/4 gal. of water per cubic foot. When it contains large amounts of fine material, it may carry as much as 1-1/3 gal. per cubic foot (from 6 to 10 percent by weight).

Fig. 35. If sand sparkles and wets the hand it is very wet.

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PROPORTION THE MATERIALS

After the sand is classified as damp, wet, or very wet, the following table may be used to determine the trial proportions for any particular job:

Table 9. Trial Mix Proportions

	Gal. of water added to 1-bag batch if sand is:			Suggested mixture for 1-bag trial batches*		
	Damp	Wet Av. sand	Very Wet	Cement bags Cu.ft.	Aggregates Fine Cu.ft.	Aggregates Coarse Cu.ft.
FOR MILD EXPOSURE 7 gal. of water per bag of cement	For 1-1/2-in. max. size aggregate					
	6-1/4	5-1/2	4-3/4	1	3	4
FOR NORMAL EXPOSURE 6 gal. of water per bag of cement	For 1-in. max. size aggregate					
	5-1/2	5	4-1/4	1	2-1/4	3
FOR SEVERE EXPOSURE 5 gal. of water per bag of cement	For 1-in. max. size aggregate					
	4-1/2	4	3-1/2	1	2	2-1/4

* Mix proportions will vary slightly depending on gradation of aggregates.

USE MAXIMUM SIZE AGGREGATE PERMISSIBLE

As previously discussed, the larger the coarse aggregate the less paste will be necessary, hence the more concrete obtained per bag of cement used. This means that the most economical mix is generally obtained by using the largest coarse aggregate practical for the job.

The maximum size generally depends on the size and shape of concrete members and the amount and distribution of reinforcing steel. The maximum size of aggregate usually should not exceed:

1. One-fifth the dimension of non-reinforced member

2. Three-fourths the clear spacing between reinforcing bars or between reinforcing bars and forms, or

3. One-third the depth of non-reinforced slabs on grade.

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PREPARING TO MIX CONCRETE

Ways to save money or reduce labor on the job should not be overlooked.

The mixing site should be as close as practicable to the point where the concrete is to be placed. The size of the mixer depends upon the size and type of the job and the manpower available. Concrete for large flat jobs is easy to place and a large mixer will help speed up the job. The mixer should be checked for capacity, which is usually given on an attached plate.

The aggregates should be placed so that they are convenient to the mixer operators. The cement must be stored in a dry location. If it is stored outside, it should be raised above the earth and covered with a tarpaulin, polyethylene, or other suitable cover. Ample water and measuring containers should be available.

MEASURE ALL MATERIALS

All materials should be accurately measured. A pail marked on the inside at different heights to indicate quarts and gallons is handy for measuring water. On small jobs a pail may also be used for measuring cement, sand, and gravel. In mixing 1/2- or 1-bag batches, remember that a 94-lb. bag of cement contains exactly 1 cu. ft. loose volume. Aggregates are then conveniently measured in bottomless boxes made to hold exactly 1 cu. ft., 2 cu. ft., or other volumes desired.

MIXING THE CONCRETE

All concrete should be thoroughly mixed until it is uniform in appearance and all materials are uniformly distributed. This means that concrete should be mixed for at least 1 minute and preferably for 3 minutes after all materials have been placed in the mixer. There is little advantage in mixing for more than 3 minutes.

Under usual conditions, up to about 10 per cent of the mixing water should be placed in the drum before the dry materials are added. Water should then be added uniformly with the dry materials, leaving about 10 per cent to be added after all other materials are in the drum.

Accurate measurement of all materials, including water, is necessary to ensure production of uniform batches of quality concrete. Uniformity is assured by using accurate weighing or measuring equipment. Good judgment is necessary to secure concrete of proper consistency. Concrete in the mixer usually appears drier than it does after being placed.

Mixers used on the job vary in size from 1/2-cu. ft. to 2-bag mixers, or larger. Regardless of size, mixers should not be loaded above their rated capacity and they should be operated at approximately the speeds for which they are designed. If the blades of the mixer become worn or coated with hardened concrete,

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the mixing action will be less efficient. Badly worn blades should be replaced and hardened concrete should be removed before each run of concrete.

CLEANING EQUIPMENT

The mixer and other equipment or tools used in contact with concrete should be cleaned when necessary during use and thoroughly cleaned after use.

Mud and dirt on the frame and mixer can usually be hosed off. Periodically, it may be necessary to clean the cement film off the exterior. A weak vinegar solution (10 per cent acetic acid) is sometimes used for this purpose. Areas cleaned with acid solutions should be rewaxed.

Concrete build-up inside the drum must be prevented for top efficiency in mixing and discharging. The interior of the drum should be hosed thoroughly. However, residues of hardened cement and concrete may remain. Hard scraping or brushing may be necessary. One of the easiest ways to tear up a drum and blades is the continuous use of a heavy hammer to remove build-up. A much more satisfactory method for loosening stubborn material is to use a solution of 3 parts water to 1 part muriatic acid. Apply solution and allow about 30 minutes for penetration before using "elbow grease."

Commercially available releasing agents have proved satisfactory in reducing man-hours for cleaning mixers and concrete equipment and tools. Solvents are also available to protect implements from cement dust, concrete, and dirt adhesion.

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2088

APPLICATION

Discuss quality concrete made in small mixers.

Explain, show, and let students examine samples of dry, wet, and very wet sand.

Make a 1/10-bag mixture in mixing pan.

Show films: Concrete Example

TEST OR DISCUSSION POINTS

1. What is the objective of a properly designed concrete mixture?
2. Explain how the most economical mix can be obtained for a given exposure condition.
3. What are the proper mixes (water-cement ratios) for mild exposure? Normal exposure? Severe exposure?
4. Why is it necessary to consider the moisture content of the fine aggregate?
5. Explain how you determine if a sand is dry, damp, wet, or very wet.
6. How much moisture does wet sand contain?
7. Explain what "select good ingredients" means.
8. Why is it advisable to use the largest size aggregate practical for a job?
9. What should be considered when determining the mixing site?
10. Where should aggregates be located in relation to the mixer?
11. What effect has the quantity of mixing water on the quality of concrete?
12. What is the volume of 1 bag of cement?
13. Explain the procedure for loading a mixer.
14. Explain how a mixer should be cleaned after use.

TOOLS AND MATERIALS

Samples of dry, damp, wet, and very wet sand
Mr. Quality Concrete slide set
If available, small concrete mixer for cleaning demonstration
Samples of releasing agents
Films: Concrete Example

REFERENCE MATERIALS

Refer to an instruction manual for a mixer.

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PLACING CONCRETE

Preparation prior to concreting includes compaction, trimming, and moistening the subgrade, erecting the forms, and setting the reinforcing steel.

Time, transportation on the job, and methods of placing in forms are probably the most important phases of placing concrete.

TIME

Concrete must be delivered and discharged from a truck within 1-1/2 hours after water has been added to the mixture. In hot weather, or under conditions contributing to quick stiffening of the concrete, less than 1-1/2 hours should elapse. Usually it is good practice to place concrete in forms within 30 to 60 minutes after mixing. This means that the site must be ready and that ready mixed concrete trucks should not be kept waiting. If the truck is delayed, excessive mixing and hydration may cause the concrete to become stiff and difficult to place and finish. Also, the next delivery will be behind schedule.

TRANSPORTATION ON THE JOB

Methods used to move concrete from the mixer or truck to the forms will depend largely upon the job conditions. On small jobs, wheelbarrows are the usual means of transportation. However, concrete is handled and transported by many methods. These include the use of chutes, buggies operated over runways, buckets handled by cranes or cable ways, small rail cars, trucks, pumping through pipelines, and by forcing the concrete through hoses pneumatically.

Regardless of the kind of transportation used, care must be exercised to prevent segregation as the concrete is being moved. A rather stiff mix and smooth runways are usually required to prevent segregation. However, the method of handling and transporting concrete and the equipment used should not place a restriction on the consistency of the concrete. This should be governed by the placing conditions. If these permit the use of a stiff mix, the equipment should be selected and arranged to facilitate handling and transporting such a mix.

Plan the job so that the ready mix truck can get as near the job site as possible. This will save the time that would be needed to move concrete by hand methods. Remove debris and unnecessary equipment to give the truck more freedom of movement.

PLACING IN FORMS

Forms should be clean, tight, adequately braced, and constructed of materials that will impart the desired texture to the finished concrete. Sawdust, nails,

e. Avoiding reinforcement. Vibrator heads should not be held against reinforcement.

f. Caution necessary. Over-vibration or using the vibrator haphazardly can spread or tear apart forms.

APPLICATION

Discuss handling and placing concrete.
Show Slides No. 12, 13, 14, and 15 from Mr. Quality Concrete slide series.
Show film, How to Transport, Place, Finish, and Cure Quality Concrete (see film list).

TEST OR DISCUSSION POINTS

1. How much time is permitted between addition of water and concrete placement?
2. Describe some of the things that can happen when a ready mix truck is delayed from discharging a load of concrete.
3. Why should a ready mix truck get as close to a job as possible?
4. What methods are usually used to transport concrete at the job site?
5. What precautions should be observed?
6. Is it advisable to flow or drag concrete? Why?
7. Explain how to ensure consolidation of concrete after it has been placed in forms.
8. How can honeycombing and sand streaking be prevented?
9. How deep should the layers of concrete be when placed in forms?
10. When is it advisable to use drop chutes?
11. How long should concrete be vibrated to ensure consolidation?
12. What happens if the concrete is vibrated too long?

TOOLS AND MATERIALS

Mr. Quality Concrete slide set
Film: How to Transport, Place, Finish, and Cure Quality Concrete

REFERENCE MATERIALS

See Related Information for this unit.

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and other debris should be removed before concrete is placed. Wood forms should be moistened before concreting, otherwise they will absorb water from the concrete and swell. Forms should also be oiled or lacquered to facilitate form removal.

Reinforcing steel should be clean and free of loose rust or mill scale at the time concrete is placed. Any coatings of hardened mortar should be removed from the steel.

Concrete should be placed between the forms or screeds as near as practicable to its final position. To consolidate the concrete, it should be mechanically vibrated or spaded as it goes into the form, then thoroughly spaded next to the forms to eliminate voids or honeycombing at the sides. At inaccessible areas, the forms can be lightly tapped with a hammer to achieve the same results. This operation makes a dense concrete surface by forcing the coarse aggregate back from the form or face. The concrete should not be overworked while it is still plastic because too much water and fine material will be brought to the surface. This may later lead to scaling or dusting.

In slab construction, placing should be started around the perimeter at the far end of the work so that each batch will be dumped against previously placed concrete. The concrete should not be dumped in separate piles and the piles then leveled and worked together. Nor should the concrete be placed in large quantities (big piles) and allowed to run or to be worked over a long distance to its final position. Honeycombing and segregation may occur as the mortar tends to flow ahead of the coarser material. Water should be prevented from collecting at the ends and corners of forms and along form faces.

If concrete is placed in layers not more than 12 to 18 in. thick along a form, good uniformity will be obtained. Each layer should be thoroughly consolidated before the next is placed.

In some work, such as beneath openings in walls, it is necessary to move the concrete horizontally within forms. The horizontal distance should be minimized as much as practicable.

When concrete is placed in tall forms at a fairly rapid rate there is likely to be some bleeding of water to the top surface, especially with non-air-entrained concrete. Bleeding can be reduced by placing more slowly and by using concrete of a stiffer consistency. When practicable, the concrete should be placed to a level about a foot below the top in high walls; an hour or so should be allowed for settling. Concreting should be resumed before setting occurs to avoid formation of cold joints. It is good practice to overfill the form several inches and cut off the excess concrete after it has partly stiffened.

The old rule that "good concrete is placed, not poured" is still very true and should be kept continuously in mind. Also, concrete should be placed where

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needed; do not flow, push, or drag it into place. When using buggies, wheelbarrow, etc., dump into the face of previously placed concrete; don't dump away from it.

DO NOT ADD EXCESS WATER AT THE JOB SITE

Ready mixed concrete is usually delivered after it has been accurately designed for a specific job. Addition of water will seriously affect all of the desirable properties of the finished concrete such as durability, strength, and watertightness. Even so, occasionally you see jobs where excessive water is being added so that concrete can be flowed into forms without working it. This is a practice that should never be allowed. Don't expect to get good concrete into place without some work.

USING A DROP CHUTE

The use of a chute is recommended when fresh concrete must be dropped more than 3 or 4 ft. If concrete is allowed to strike one side of the form and bounce off, it will separate and cause stone pockets and sand streaking. Drop chutes are also sometimes used to prevent incrustation of dried mortar on reinforcement and forms. In thin sections, drop chutes of rubber or metal should be used. In narrow wall forms, the metal drop chutes are made rectangular to fit between reinforcing steel. Drop chutes are available in several lengths or in sections which can be hooked together so that the length can be adjusted as concreting progresses. Fig. 49 shows a drop chute with hopper.

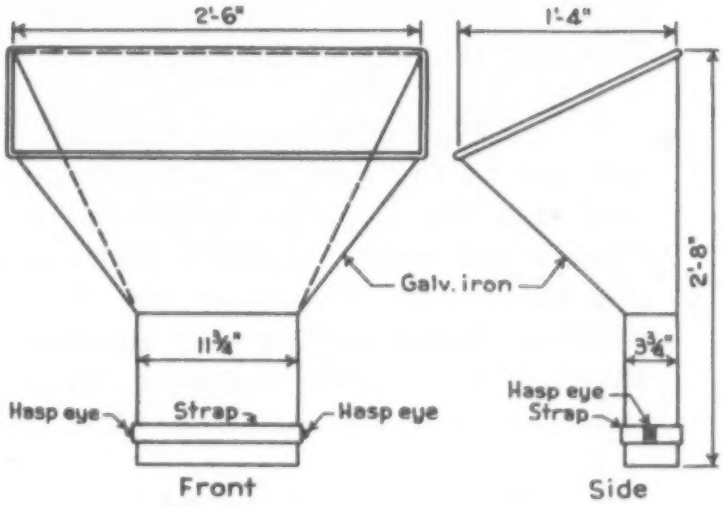

Fig. 49. A rectangular drop chute with hopper at top for placing concrete in narrow walls.

CONSOLIDATING CONCRETE IN FORMS

The most common methods for consolidating concrete in forms are by hand spading or vibration. Proper use of vibrators makes possible placement of stiff, harsh mixes that could not be placed and consolidated readily by hand. However, mixes that can be consolidated readily by hand should not be vibrated as they are likely to segregate under this action. In many cases, the slump can be less than one-half that required for hand placing and in most cases it can be reduced at least one-third.

VIBRATORS ARE A GREAT AID

Immersion-type vibrators, commonly referred to as spud vibrators, are excellent tools to consolidate fresh concrete in walls or other formed work. The spud vibrator is a metal tube-like device which vibrates at several thousand cycles per minute. It is usually powered by gasoline, air, or electricity. When inserted in the concrete for 5 to 15 seconds, the spud vibrator consolidates and improves the surface next to the forms.

Vibrators are excellent tools for placing dry mixes. However, handle vibrators carefully in wet mixes, or too much water and fine sand will be brought to the surface of the concrete. Systematic vibration will give concrete adequate consolidation, but never over-use them. Vibrators should not be used to move concrete horizontally since this practice results in segregation. Leaving a vibrator immersed in concrete after the paste accumulates over the head results in non-uniformity. The length of time that a vibrator should be left in the concrete is a function of the slump of the concrete; high slump requires little or no vibration. Vibrator heads should never be held against reinforcement. Over-vibrating, or using the vibrator haphazardly, can spread or tear apart forms.

Form vibrators may be attached to the exterior of forms. They are especially useful for consolidating concrete in thin-walled members and where metal forms are used.

APPLICATION

Discuss handling and placing concrete.
Show Slides No. 12, 13, 14, and 15 from Mr. Quality Concrete slide series.
Show film, How to Transport, Place, Finish, and Cure Quality Concrete (see film list).

TEST OR DISCUSSION POINTS

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11. How long should concrete be vibrated to ensure consolidation?
12. What happens if the concrete is vibrated too long?

TOOLS AND MATERIALS

Mr. Quality Concrete slide set
Film: How to Transport, Place, Finish, and Cure Quality Concrete

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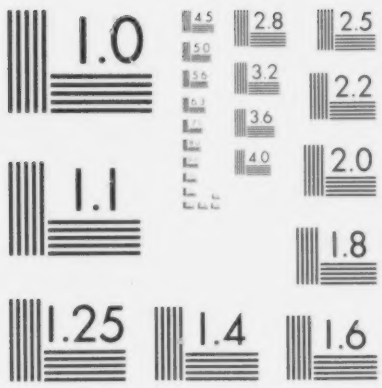

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FINISHING CONCRETE SLABS

Choice of concrete finish depends on the final use of the completed job and the effect desired. Various colors and textures, such as exposed aggregates, may be used. Some surfaces may require only striking off to proper contour and elevation, while in other cases a broom, float, or trowel finish may be specified. To finish concrete properly it is essential to know the specific operations required.

CONSOLIDATING

Consolidating concrete is necessary to give a uniform, plastic mass. It eliminates stone pockets and large air voids. Many methods are employed for consolidation. Probably the most common method is use of a strike-off board or straightedge.

Other tools for consolidating include tampers, rollers or roller screed, vibrating screed, and jitterbug or jitterbug crawler.

Tampers and jitterbugs should be used sparingly and only when consolidation cannot be accomplished readily by hand. Usually this would apply to concrete having a low slump; otherwise the concrete will tend to segregate.

STRIKING OFF

Striking off (sometimes called screeding) is a leveling operation that removes humps and hollows and gives a true, even concrete surface. Often consolidation and strike-off are combined into a single operation by the use of the strike-off rod or straightedge. This is usually a specially prepared tool, but in an emergency a 2x4 or 2x6 that is 1 to 2 ft. longer than the section being finished may be used. The surface is struck off or rodded by moving the straightedge back and forth with a sawlike motion across the top of the forms or screed and advancing forward a short distance with each movement. A small amount of concrete should always be kept ahead of the straightedge to fill in low spots and maintain a plane surface. Vibrator screeds, roller screeds, and mechanical screeds are also used for screeding or striking off.

Immediately after screeding, concrete should be darbied or bull-floated before any free water has bled to the surface. The bullfloat is very handy because it has a long handle and is easy to use on wide slabs.

Darbying and bullfloating eliminate the ridges and voids left by the strike-off operation. This also helps embed large aggregate beneath the surface and brings sufficient mortar to the surface in preparation for other finishing operations. Care must be taken during this operation to avoid overworking the surface.

Sometimes the concrete is left without further finishing, but for most jobs strike-off is followed by one or more of the following operations.

EDGING AND JOINTING

When all bleed water and water sheen have left the surface (the glossy appearance is gone) and the concrete has started to stiffen, it is time for the remaining finishing operations. All open edges should be rounded off with an edger to prevent spalling. The edger should be run back and forth until a finished edge is produced. The concrete finisher should make certain that all coarse aggregate particles are covered and that the edger does not leave too deep an impression in the top of the slab. Otherwise, the indentation may be difficult to remove with subsequent finishing operations. Initial edging should be done with a wide flange tool having a radius of 1/8 in. or less. Joints with greater radii are difficult to maintain.

The marks left by the edger and jointer should be removed by floating unless such marks are desired for decorative purposes, in which case the edger or jointer should be rerun after the floating operation. If necessary, tooled joints and edges should be rerun before and after troweling to maintain uniformity or to remove kinks.

Concrete expands and contracts slightly due to temperature differences. It may also shrink as it hardens. Control joints, often called dummy or contraction joints, are cut across each strip to control cracking. They do not extend completely through the slab but are cut to a depth of 1/4 to 1/5 of the slab thickness, thus making the slab weaker at this point. If the concrete cracks due to shrinkage or thermal contraction, the crack usually occurs at this intentionally weakened section.

Control joints should be cut soon after the concrete has been placed in order to work the larger pieces of coarse aggregate away from the joint. A simple way to cut this type of joint is to lay a board across the fresh concrete and cut the joint to the proper depth with a groover having a 3/4- or 1-in. bit. Sometimes a finisher will use a brick mason's trowel to cut the joint approximately 1/4 to 1/5 the slab depth. A groover is then used to finish the joint. Control joints are generally placed 10 to 15 ft. apart on floor slabs, driveways, and feeding floors. They are placed 4 to 5 ft. apart on sidewalks.

Since the development of special concrete saw blades, sawing contraction joints is becoming common. The proper time to saw joints is generally 4 to 12 hours after the concrete has been placed and finished. A sawed joint is clean and attractive and works well when cut to the proper depth. On larger jobs a special mobile concrete saw is used. On smaller jobs, such as sidewalks and driveways, a portable electric hand saw may be used. The operator must be careful to keep the saw blade straight so that it will not shatter.

21133

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Handbook and Study Guide for Aviation Mechanics I Inspection Authorization.

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DESCRIPTORS - *STUDY GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *AVIATION MECHANICS; *INSPECTION; *EQUIPMENT EVALUATION; ADULT VOCATIONAL EDUCATION

ABSTRACT - Prepared by the Flight Standards Service of the Federal Aviation Administration, this handbook and study guide is primarily for use by persons preparing for aircraft inspection authorization, including conducting annual and progressive inspections and approving major repairs of alterations of aircraft. Contents cover: (1) issuance, renewal, and change of operational base of inspection authorization, (2) suggestions for developing good owner/authorized inspector relations, and (3) basic functions of authorized inspectors. Publications and sample forms and figures are appended. The guide may also be useful to aircraft manufacturers and certified repair stations. (AW)

VT 011 872

floating is necessary after the concrete has partially hardened so that a desired permanent finish can be produced. It is used to produce gritty, non-slippery surfaces that wear well, are attractive, and provide good footing.

TROWELING

Where a smooth, dense surface is desired, floating is followed by steel troweling. This operation should be delayed as long as possible. Too long a delay, of course, will result in a surface that is too hard to finish with a trowel, but the tendency in most cases is to trowel the surface while the concrete is too soft and plastic. Excessive troweling at this stage may cause crazing and may result in a surface having less wear resistance.

Spreading dry cement on a wet surface to take up excess water is not a good practice. Such wet spots should be avoided insofar as possible by adjustments in the grading, mix proportions, and consistency. When wet spots do occur, finishing operations should be delayed until the water either disappears or is removed with a squeegee.

This first steel troweling should be sufficient to produce a smooth surface free of defects. Whether troweling is by power or hand, the trowel blade must be kept as flat against the surface as possible. If the trowel blade is tilted or pitched at too great an angle, an objectionable "chatter" or "washboard" surface will result. For first troweling a new trowel is not recommended. An older trowel that has been broken in can be worked quite flat without the edges digging into the concrete.

A second troweling is applied after the concrete has become hard enough that no mortar adheres to the edge of the trowel and a ringing sound is produced as the trowel passes over the surface. Additional trowelings may be desirable depending on the traffic and exposure conditions. During the final troweling, the trowel should be tilted slightly and heavy pressure should be exerted to compact the surface thoroughly. There should be a lapse of time between successive trowelings to permit concrete to increase its set.

Power troweling should be delayed until the concrete is firm. Power trowels are being widely used to finish concrete. Again, premature troweling must be avoided. The concrete should be hard enough to hold the power trowel.

PATTERNED AND TEXTURED FINISHES

A variety of patterns and textures can be used to produce decorative finishes for concrete slabs. Patterns are formed by using divider strips or by grooving the surface just before the concrete hardens.

An exposed-aggregate finish provides a rugged non-skid surface. Selected aggregates, usually of uniform size, 3/8 in. or larger, are evenly distributed on the

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surface immediately after the slab has been darbied. The aggregate particles are embedded in the concrete by lightly tapping them with a darby or a flat board. After the concrete hardens sufficiently to support a finisher on kneeboards, the surface should be hand-floated with a magnesium float or darby. The aggregate is then exposed by simultaneously brushing and flushing with water. On large jobs a reliable retarder may be sprayed or brushed on the surface, but on small jobs this may not be necessary. Timing is important, so test panels are usually made to determine the correct time for exposing the aggregate without dislodging the particles.

FINISHING AIR-ENTRAINED CONCRETE

Air entrainment gives concrete a somewhat altered consistency that requires a slight change in finishing operations from those used with non-air-entrained concrete.

Air-entrained concrete contains microscopic air bubbles that tend to hold in suspension all the materials in the concrete, including water. This type of concrete requires less mixing water than non-air-entrained concrete but still has good workability with the same slump. Since there is less water--and it is held in suspension--little or no bleeding occurs. With no bleeding, there is no waiting for the evaporation of free water from the surface before starting floating and troweling. This means that floating and troweling should usually be started sooner--before the surface becomes too dry or tacky. If floating is done by hand, the use of an aluminum or magnesium float is essential. A wood float drags and greatly increases the amount of work necessary to accomplish the same result. If floating is done by power, there is practically no difference between finishing procedures for air-entrained and non-air-entrained concrete, except that floating may be started sooner on the air-entrained concrete.

Practically all horizontal surface defects and failures are caused by finishing operations performed while bleed water or excessive surface moisture is present. Better results are generally accomplished, therefore, with air-entrained concrete.

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APPLICATION

Discuss the "why, when, and how" of finishing flat concrete work. Show slides 16, 17, 18, 19, 20, 36, and 37 from Mr. Quality Concrete slide set. Show film

How to Make Decorative Patio Floors for Outdoor Living (see film list).

TEST OR DISCUSSION POINTS

1. What is meant by finishing concrete?
2. Why is concrete consolidated? How is this done?
3. Explain why striking off is necessary. How is striking off performed?
4. Why should a small amount of concrete be kept ahead of the straightedge at all times?
5. What is the purpose of floating?
6. When is the right time to start floating?
7. What are the tools used for floating?
8. When should edging and jointing be performed?
9. What are two other names for control joints?
10. Why are control joints necessary?
11. What should be the spacing for control joints in slabs? Sidewalks?
12. How deep should control joints be cut?
13. If a saw is used, how soon should control joints be cut?
14. Explain the purpose of final finishing.
15. When should final finishing be started?
16. How can excessive surface water be removed from slabs?
17. What are some methods for obtaining a desired surface texture?
18. Why should a steel trowel be held as flat as possible for the first troweling?
19. Why is it best to use a broken-in trowel for first troweling?
20. Why is air-entrained concrete better?
21. Why is it necessary to use an aluminum or magnesium float on air-entrained concrete?
22. Why should metal tools be used only for low-slump concrete?

TOOLS AND MATERIALS

Mr. Quality Concrete slide set
Films:
How to Make Decorative Patio Floors for Outdoor Living

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CURING CONCRETE

Concrete hardens because of hydration, the chemical reaction between portland cement and water. Properties of concrete such as durability (resistance to freezing and thawing), strength, watertightness, wear resistance, and volume stability improve with age as long as temperatures are favorable and moisture is present to hydrate the cement.

Approximately three gallons of water are necessary to hydrate each bag of cement. Additional water is required, however, to make it possible to properly place the freshly mixed concrete. Excessive evaporation of water from newly placed concrete can cause the cement hydration process to stop at an early age. To prevent this loss of water, the concrete should be protected and curing started as early as possible. A rapid loss of water also causes concrete to shrink, thus creating tensile stresses at the drying surface. If these stresses develop before the concrete has attained adequate strength, plastic shrinkage cracks may result.

EFFECT OF CURING

All the desired properties of concrete are improved by proper curing. Soon after the concrete is placed, the increase in strength is very rapid (3 to 7 days). The strengthening then continues slowly for an indefinite period. Concrete which is moist cured for 7 days is about 50 per cent stronger than that which is exposed to dry air the entire period. If the concrete is kept damp for one month, the strength is about double that of concrete exposed only to dry air.

METHODS OF CURING

Concrete may be kept moist by a number of curing methods. They can be classified as (1) supplying additional moisture to concrete, and (2) preventing loss of moisture from concrete by sealing the surface. Following is a discussion of the methods used.

Water curing by flooding, ponding, or mist spraying, is widely used. It is the most effective of all known curing methods, in terms of preventing evaporation of mix water, but is not always practical because of job conditions. On flat surfaces such as pavements, sidewalks, and floors, the flooding or ponding method may be easily accomplished. A small dam of earth or other water-retaining material is placed around the perimeter of the surface and the enclosed area is kept flooded with water. Continuous sprinkling with water is also an excellent method of curing. If sprinkling is done at intervals, the concrete must not be allowed to dry between applications of water. A constant supply of water prevents the possibility of "crazing" or cracking caused by alternate wetting and drying.

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Water retaining methods involving use of coverings that are kept continuously wet such as sand, burlap, canvas, or straw. When concrete is cured by one of these methods, the entire concrete surface, including exposed edges or sides, must be covered--for example, the sides of pavements and sidewalks where the forms have been removed. Materials used for water retention must be kept damp constantly during the curing period. If drying is permitted, excessive moisture may be absorbed by the cover itself. In vertically formed concrete, a simple way to prevent the concrete from drying out is to leave the forms in place.

Mechanical barriers of waterproof paper or plastic film seal in the water and prevent evaporation. One important advantage of mechanical barriers is that periodic additions of water are not required. These materials should be applied as soon as the concrete has hardened sufficiently to prevent surface damage. The widest practicable width of material should be used. Edges of adjacent sheets should be overlapped several inches, then tightly sealed with sand, wood planks, pressure sensitive tape, mastic, or glue.

An added feature of mechanical barriers is that they provide some protection against damage from subsequent construction activity as well as protection from the sun.

In some cases, plastic films may cause discoloration of hardened concrete. This may be especially true when the concrete surface has been steel troweled to a hard finish. This is also true for exterior or exposed concrete. When discoloration is objectionable, some other curing method is advisable.

Chemical membranes can be sprayed on to cure concrete. Liquid membrane-forming curing compounds retard or prevent evaporation of moisture from concrete. They are effective curing materials when used correctly. The application should be made immediately after the concrete has been finished. If there is any delay, the concrete should be kept moist until the membrane is applied. Membrane curing compound should not be applied when there is free water on the surface, because the water will be absorbed by the concrete and the membrane broken. Nor should the compound be applied after the concrete has dried out since it will be absorbed into the surface of the concrete and a continuous membrane will not be formed. The correct time to apply the membrane is when the water sheen disappears from the surface of the finished concrete. Adequate and uniform coverage of curing compounds is essential. In most cases two applications are required. Chemical membranes are suitable not only for curing fresh concrete but also for further curing of concrete after removal of forms or after initial moist curing.

Curing compounds are of four general types: clear or translucent, white pigmented, light gray pigmented, and black. During hot, sunny days, white pigmented compounds are most effective since they reflect the sun's rays, thereby reducing the concrete temperature. Curing compounds can be used to prevent bond between hardened and fresh concrete. Consequently, they should not be used if bond is necessary. For example, a curing compound should not be applied to the base slab of a two-course floor since it may prevent the topping from bonding.

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Similarly, some curing compounds affect the adhesion of resilient flooring materials to concrete floors. Curing compound manufacturers should be consulted to determine if their product is in this category.

GENERAL CURING REQUIREMENTS

As a general rule, concrete should be cured for at least three days and preferably for a week after it is placed. The time depends on the concrete's temperature. When the temperature is 70 deg. F. or above, cure the concrete for at least 3 days. When the concrete temperature is 50 deg. F. or above, cure for at least 5 days.

The length of time that concrete should be protected against loss of moisture depends upon several factors--cement content, mix proportions, required strength, size and shape of the concrete mass, weather, and future exposure conditions. This period may be a month or longer for lean concrete mixtures used in massive structures such as dams, but it may be only a few days for richer mixes. Since all the desirable properties of concrete are improved by curing, the curing period should be as long as practicable in all cases.

Concrete should be protected so that moisture is not lost too rapidly during the early hardening period. Concrete should be kept at a temperature that is favorable for hydration. The most favorable temperature range for curing concrete is from 55 to 73 deg. F. At higher temperatures, hydration takes place more rapidly, but the concrete doesn't attain its full strength. Hydration proceeds at a slower rate when temperatures are below 70 deg. F. There is practically no chemical action between cement and water when the temperature is near freezing. At 33 deg. F. it takes more than three times as long to develop a given strength as it does at 70 deg. F. No gain whatever can be expected while concrete is frozen, but hydration will be resumed after it is thawed, provided suitable curing is applied. However, freezing within the first 24 hours is almost certain to result in permanent injury to the concrete.

A thought to keep in mind: The longer concrete is moist cured, the better its durabilility, strength, watertightness, wear resistance, and volume stability.

EPCTS

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APPLICATION

Discuss the "why, when, and how" of curing concrete.
Show slides 21, 22, 23, and 24 from Mr. Quality Concrete slide set.

TEST OR DISCUSSION POINTS

1. What causes concrete to harden?
2. Why does all concrete need to be cured?
3. About how many gallons of water are required to hydrate each bag of cement?
4. Why does concrete usually contain more water than necessary for hydration?
5. Concrete which has been moist cured for 7 days is about 50 per cent stronger than that which is kept in dry air the entire period.
6. If concrete is kept moist for 28 days, how would its strength compare with the strength of uncured concrete?
7. Explain some of the methods used for curing.
8. Can discoloration result from using mechanical barriers for curing?
9. Is discoloration always objectionable?
10. Are there situations where chemical membranes should not be used for curing? Why?
11. What is the general curing time requirement when the concrete is above 70 deg. F.?
12. What is the general curing time requirement when the concrete is above 50 deg. F.?
13. What is the most favorable temperature range for curing concrete?
14. What will happen if concrete freezes during the first 24 hours?

TOOLS AND MATERIALS

Mr. Quality Concrete slide set

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REINFORCEMENT FOR CONCRETE

Reinforcement is the term used to describe the steel bars or small or large welded wire fabric positioned in concrete to increase its tensile strength.

Concrete has great strength in compression--that is, it can support great loads that are placed directly upon it. However, steel bars or other metal reinforcement is required in some structures to increase the ability of concrete to resist stresses or forces that tend to bend or pull it apart. The compressive strength of concrete is about 10 times its tensile strength. See Fig. 51.

When reinforcement is used in concrete, the reinforcement acts to withstand tensile pull. Depending on how much reinforcement is used, the tensile strength can be made to equal or exceed the compressive strength. See comparison in Fig. 52.

Fig. 51. Comparison of the compression and tension properties of nonreinforced concrete.

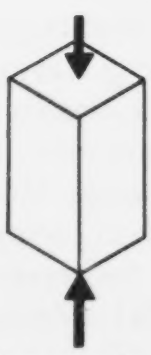

Thousands of pounds COMPRESSION

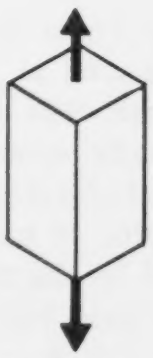

Hundreds of pounds TENSION

Fig. 52. Comparison of the compression and tension properties of concrete when reinforcing is used.

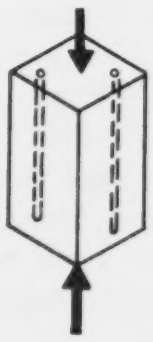

Thousands of pounds COMPRESSION

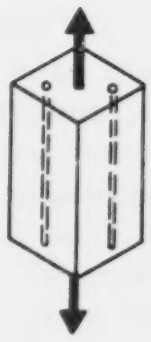

Thousands of pounds TENSION

KINDS OF REINFORCEMENT

Through the years, many materials have been tried as reinforcement in concrete. Today steel is universally accepted and used. One important advantage of steel is that it has nearly the same contraction and expansion characteristics, due to temperature changes, as concrete.

Reinforcing steel can be purchased in the form of reinforcing bars or as welded wire fabric. Bars may be either smooth or deformed. Smooth bars are

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usually of small diameter. Deformed bars have lug-like ridges that increase the bond between the concrete and steel. Bars come in standard sizes and are properly designated by number. The size of bar to use depends on the amount of tensile force the concrete will carry. Table 16 gives the standard bar sizes up to 1-in. diameter, the steel area that each provides, and the weight of 100 ft. of bar. Larger bars are also made for extremely heavy construction.

Table 16. Size, Area, and Weight of Reinforcing Bars

Bar number	Bar diameter, in.	Bar area, sq.in.	Approximate weight of 100 ft.
2	1/4	0.05	17
3	3/8	0.11	38
4	1/2	0.20	67
5	5/8	0.31	104
6	3/4	0.44	150
7	7/8	0.60	204
8	1	0.79	267

Bars are usually supplied by the mill in 60-ft. lengths. Local building materials suppliers ordinarily stock 20- or 40-ft. lengths.

Welded wire fabric is made in many types and sizes. The most common type used in light construction has wires spaced at 6-in. centers both ways; 6-, 8-, and 10-gage fabric is commonly available. The type of fabric is usually referred to as "6 x 6 - 10 - 10." This is usually spoken "six-six-ten-ten." This expression indicates that the fabric has longitudinal wires of No. 10 gage, spaced at 6-in. centers, and transverse wires of No. 10 gage, spaced at 6-in. centers. Table 17 shows the area of steel provided by the three sizes and the weight of 100 sq.ft. of the fabric. Welded wire fabric is used for jobs that require relatively light reinforcement.

Table 17. Steel Area and Weight of Three Sizes of Welded Wire Fabric

Fabric style	Longitudinal steel area, sq.in. per ft.	Transverse steel area, sq.in. per ft.	Weight, lb. per 100 sq.ft.
6x6 No. 6	0.058	0.058	42
6x6 No. 8	0.041	0.041	30
6x6 No. 10	0.029	0.029	21

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DATE: 4/15/69

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HOW REINFORCEMENT WORKS

Tensile forces are created in a structure in many ways. Concrete can be subjected to a straight tensile pull, to bending, or to temperature and moisture changes.

In many construction uses, concrete is subjected to a straight tensile pull. Round structures such as water tanks and farm silos are the most common examples. Pressures within the tank tend to push the two halves apart, as shown in Fig. 53. Reinforcing steel in the wall holds the tank halves together. Steel is needed around the entire tank wall since pressures act in all directions, not just in the directions shown in Fig. 53.

Fig. 53. Diagram illustrates the use of steel reinforcement to overcome the outward pressures within a round structure.

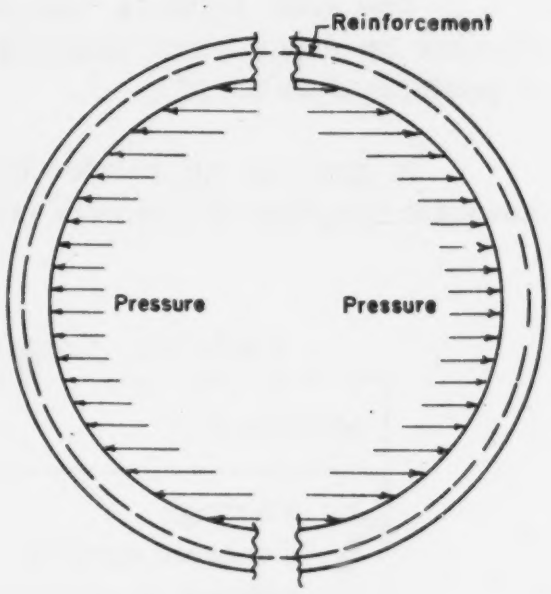

In round structures of this kind, the steel is usually placed near the center of the wall cross-section, preferably slightly outside the centerline.

In concrete beams, only part of the beam contains tensile forces. In this case, location of the reinforcement is just as critical as the amount used to resist bending loads. In concrete lintels across door or window openings or in a beam, for example, reinforcement is placed near the lower side, as that is the side which tends to pull apart when the beam is loaded.

The lintel must be able to carry the load of the wall, floor, or roof that rests on it. The dotted lines in Fig. 54 show a greatly exaggerated picture of the bending that occurs in the lintel. Note that the ends of the beam at the top surface have moved closer together. The ends at the bottom surface have moved apart. Thus, the concrete at the top of the lintel has been compressed; that at the bottom has been stretched. Since concrete cannot survive much stretching or tension, reinforcing steel must be placed near the bottom of the lintel.

Fig. 54. An illustration showing the location of the compressive and tensional forces in a simple beam.

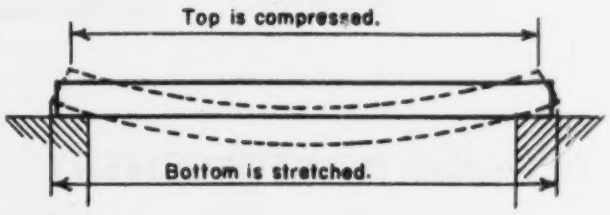

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TEMPERATURE AND MOISTURE CHANGES

Concrete, like other construction materials, expands and contracts with changes in temperature and moisture. Reinforcement is sometimes used to reduce cracking due to these changes. While welded wire fabric will not prevent formation of the cracks, it will distribute them and generally make them smaller. In some concrete work a system of jointing the slab into 10- to 15-ft. squares is usually more economical than using reinforcement if the sole purpose is to control temperature and shrinkage stresses.

PLACEMENT OF STEEL

The size, location, and spacing of reinforcement usually are determined in advance by experienced engineers. However, the important operation of placement is performed on the job.

In general, all reinforcement should be placed so that it is protected by an adequate coverage of concrete (see Table 18).

Table 18. Concrete Protection for Reinforcement*

Members	Minimum concrete protection
1. Footings	3 in.
2. Concrete surface exposed to weather	2 in. for bars larger than No. 5, 1-1/2 in. for No.5 bars and smaller
3. Slabs and walls	3/4 in.
4. Beams and girders	1-1/2 in.
5. Joists	3/4 in.
6. Columns	Not less than 1-1/2 in. or 1-1/2 times the maximum size aggregate
7. Corrosive atmospheres or severe exposures	Protection shall be suitably increased

*American Concrete Institute ACI 318, "Building Code Requirements for Reinforced Concrete."

SPLICING REINFORCEMENT

Because reinforcing steel carries tensile load in concrete, the steel must be lapped at a splice. The overlap distance for deformed bars should always be at least 24 bar diameters, with a minimum lap of 12 in. (see Fig. 55). Smooth bars must be lapped even greater distances.

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Welded wire fabric is spliced by lapping at least one full stay spacing plus 2 in. For a 6x6 fabric this would require at least an 8-in. lap.

Fig. 55. Bars must be overlapped to transfer tensile stress.

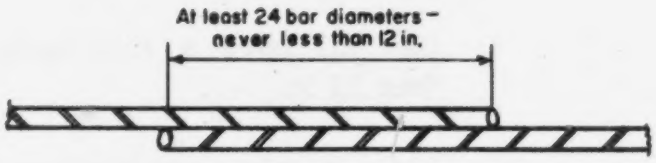

SLAB REINFORCEMENT

Reinforcement is often used in floor slabs for homes under the following conditions:

1. If load-bearing partitions are more than 4 ft. from the center axis of the slab.

2. If the slab is placed on fill more than 2 ft. deep, or if more than 10 per cent of the area within the foundation wall has been excavated and backfilled.

3. If heat ducts or pipes are embedded in the slab.

4. If unheated slabs are longer than 30 ft.

The use of reinforcement (bars or welded wire fabric) will not assure the prevention of cracks. However, it may reduce the size of the opening if a crack does occur. The reinforcing steel should be placed 1 in. from the top of the slab and held in this position. If welded wire fabric is used, it should not be placed on the subbase and pulled up with a rake or hook because it is virtually impossible to control its position by this method.

If the floor does not contain reinforcement but does have warm air ducts, the area over the ducts should be reinforced. Use a 6x6x10-gage fabric and extend it 18 in. past the point where the slab thickness returns to normal.

CONCRETING AROUND STEEL

Concrete should be placed around and under all reinforcement and embedded fixtures. Tapping the form with a rubber or wood mallet or any similar practical method may be used to make the concrete settle around and under reinforcement.

GENERAL RULES FOR STEEL REINFORCEMENT

The following represent general rules that should be followed:

1. Use only clean steel free from rust, paint, scale, etc.

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2. Place steel as recommended in Table 18, "Concrete Protection for Reinforcement."

3. Limit aggregate size used in concrete to 3/4 of the minimum spacing between reinforcing bars or between reinforcement and forms.

4. Lap all bars a minimum of 24 times their diameter and never less than 12 in.

5. Place reinforcement where concrete will be in tension.

REINFORCED CONCRETE ACCESSORIES

Contractors' supply houses and concrete accessory manufacturers stock a wide range of materials to help ease the job of steel placement. Bar chairs, form ties, bar spacers, slab bolsters, and many other devices are available. Fig. 56 shows some of the most common accessories.

Fig. 56. Three of the more common devices that are available for easing the job of steel placement.

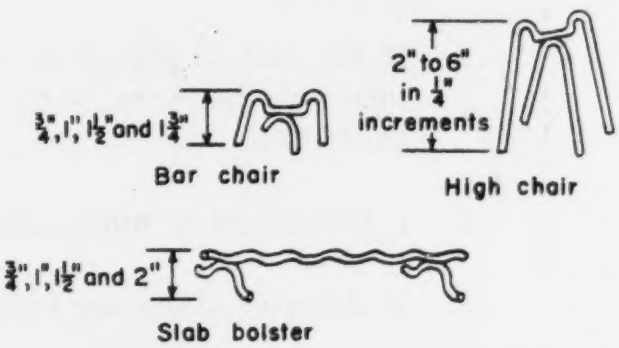

NEW DEVELOPMENT IN REINFORCEMENT

In the past few years, great strides have been made in reinforced concrete technology. Reinforcing bars are constantly being improved. The deformed bars used today bond to the concrete much more firmly than those used only a few years ago. This improvement was achieved by changing the shape of the deformity or lugs. One of the most recent developments is high-strength steel reinforcing bars. When high-strength steel is used, the amount of reinforcing steel can be reduced.

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APPLICATION

Discuss and illustrate by drawings on chalkboard the purposes of reinforcing concrete and methods for placing reinforcing bars and fabric.

TEST OR DISCUSSION POINTS

1. What is reinforcement?
2. What is the difference between tension and compression?
3. Is concrete considered to be strong in compression?
4. Bar diameters are designated by number. What is the number of a 1/2-in.-diameter bar?
5. What is the diameter of a No. 8 bar?
6. What are the three gages of fabrics commonly available?
7. When is welded wire fabric used?
8. Which side of a beam or lintel tends to pull apart when the concrete member is loaded--the top or the bottom?
9. Where should steel be placed to counteract the load applied to a beam or lintel?
10. Most construction materials expand and contract with changes in temperature and moisture. Is this true of concrete?
11. Explain the rule for lapping bars.
12. Explain the rule for lapping wire fabric.
13. Explain how concrete can be worked around and under all steel reinforcement.
14. What determines the minimum distance steel should be placed from an outside surface?
15. What is a bar chair?
16. What is a slab bolster?

TOOLS AND MATERIALS

Samples of steel bars and wire fabric

REFERENCE MATERIALS

American Concrete Institute (315-65) "Detailing Manual"

Refer to "Building Code Requirements for Reinforced Concrete," American Concrete Institute (ACI 318).

For more details on the use of reinforcing steel in slabs on ground, see Building Research Advisory Board Publication 1077, Design Criteria for Residential Slabs-on-Ground, Final Report.

Concrete Reinforcing Steel Institute "Recommended Practice for Placing Reinforcing Bars Including 1963 Supplement"

Field Engineering and Inspection of Forms for Concrete

1. Purpose of Forms

A. The primary purpose of the concrete form is to hold the plastic concrete in place during the setting period. Final appearance of the concrete structure is largely dependent upon the quality of the form work.

B. Forms also serve to prevent the loss of moisture from the concrete during the curing period. In cold weather forms provide some insulation to help retain the heat.

2. Form Building Material

A. Wood remains the major form building material because it is least expensive and it is easily worked.

(1) Dimension lumber is used to form structural members.

(2) Plywood sheathing is most commonly used as the face against which concrete is to be placed.

(3) There are features which limit the uses of wood. It is among the weaker of the form building materials -- it serves well where a form is used once and then dismantled and rebuilt, but it does not have sufficient strength to withstand repeated handling and reuse as a form unit.

A disadvantage of wood sheathing is that it can be easily scarred and gouged. There is danger of this both when handling the forms and during concrete placement. A type of blemish called vibrator burns, which results from hitting forms with the vibrator during concrete placement is particularly damaging.

(Drawings of typical wooden forms are included.)

B. Steel has a strength advantage over other form building materials, and in addition it does not swell nor warp in a wet environment. Its ability to withstand rehandling is its most important advantage.

(1) Steel is finding considerable use in forming structural members -- especially where long spans are required. It is also used in patented stringers and shoring.

(2) Steel faced forms are generally limited to specialty work where a formed detail is to be repeated many times, such as in a concrete railing.

Steel faced flat panels, for assembly into wall forms, and steel pans, for forming waffle or beam and girder floor systems, are other uses of this material.

(3) Steel, however, has some features which limits its use. This is especially true in form facing.

(a) Concrete will adhere to a steel surface unless it is treated or oiled.

(b) Thin sheets of steel, while high in resistance to failure, are weak in resistance to bending deflections. Steel plate thick enough to overcome this would be too heavy to handle economically. The difficulty is accentuated because concrete surfaces cast against steel plates have a glossy surface which reflects every wrinkle and dent.

(c) Plastic concrete will penetrate seemingly tight joints in steel forms and, by expanding, force the plates further apart with each form reuse. This can be prevented only by seal welding the joints or by opening and cleaning the joints periodically.

(d) Versatility in the reuse of steel forms is lost because new tie bolt holes are difficult to make and old holes are extremely difficult to patch satisfactorily.

(e) Installation of hardware, inserts, bolts, nailer strips, chamfer, joint material, etc., are very difficult to hold accurately in position in steel forms. Actually, the inability to fasten these odds and ends into the steel form is one of their major drawbacks and must be considered at an early planning stage.

C. Fiberglass and epoxy resin is being used in specialized forms. It has the advantage over steel plates or plywood sheets in that it can be molded to surfaces curved about two intersecting axes.

D. A heavy cardboard tube is often used for forming circular columns and concrete piles.

3. Planning

If the form work is at all complicated, there must be a planning stage. It is usually advantageous to make sketches or drawings of the form detail and to distribute these so that they can be checked by the engineering inspector, subcontractors, etc. Plans are also needed for ordering form building material and hardware for the carpenter shop or saw table foreman and, of course, for the final erection crew.

4. Strength

A. Forms must support the weight and withstand the fluid pressures of the enclosed concrete. Concrete weighs about 150 pounds per cubic foot. During placement by modern methods, where it is consolidated with high frequency vibrators, full fluid pressures will be developed and must be provided for. After concrete has taken its initial set, usually within one to one and one-half hours, additional fluid pressures are no longer transmitted through it.

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Forms should also be designed to withstand live loads that can be expected during concrete placement.

Horizontal forms must withstand the additional weight of the placing crew and equipment -- such as runways and buggies. Some form designers add one inch to the deck thickness when determining the weight to include the live load.

Wall forms should be capable of withstanding a horizontal wind load of at least 10 pounds per square foot.

Horizontal live loads on falsework are assumed at 3 to 5% of the supported weight.

B. If the final concrete surface will be exposed and visible to the eye, the deflection of the form and not its ultimate strength will be the major factor in the form design.

Concrete pressures always cause form deflections and the appearance requirement will determine what deflections can be tolerated in each case. It is common to limit this to about 1/300 -- this means that each element of the form cannot deflect more than 1/300th of its unsupported span.

As an example, tests have shown that when 5/8 inch plywood is laid across studs on 12 inch centers with the grain of the outer plywood layers normal to the studs, the plywood will deflect 1/300ths of the 12 inch span when under a load of 750 lbs. per square foot. In warm weather this pressure would be produced by placing concrete at a rate of five foot of depth increase per hour. The failure strength of the plywood would withstand several times this much pressure.

If the grain of the outer ply of the plywood were running in the other direction, that is, parallel to the studs, then the studs should be only 6 inches apart to meet the same deflection requirements.

Forms for thin walls and columns present the greatest problem from concrete fluid pressures, because with their small volumes, there is the greatest temptation to fill them rapidly.

C. Form Continuity is probably the most important factor in quality form building. It is necessary to maintain continuous rigidity throughout the form unit.

(1) Where good visual wall lines are to be maintained, it is necessary that stiff continuous members be incorporated in the forms near and parallel to the line locations. Stiff continuous top plates will give good top of concrete wall alignments. Along the top of sloping walls continuous plates or wales should be parallel to the sloping top of the wall.

(2) Continuity of some stiff members across plain surfaces is also necessary. This becomes increasingly important as the trend is toward small

form panels. Continuous studs, wales, and strong-backs or something equivalent must be incorporated into the form.

(3) In falsework, a system of continuous stiff mud-sills, cap-beams, and stringers can give a very effective mat action which will minimize the hazards of unequal settlement over poor foundation areas.

(4) It is good practice to stiffen column forms and girder soffit forms with continuous two-inch lumber.

5. Units of Construction

A. Concrete footings are seldom visible after a structure is completed. A high quality form in this case is not necessary. It is usual to permit considerable tolerance in dimensions and quite frequently forms are omitted entirely. Care is taken in making the excavation and concrete is placed directly against the earth walls.

The structural qualities of a footing, however, are important. The positioning of the reinforcing steel must be accurate, and it must be securely held in place. The template that holds the wall or column steel dowels must be firmly installed.

B. Most concrete structure walls are exposed to view and good quality form work is required -- some are important architectural elements and demand precision work.

(1) Contractors frequently use pre-built panel forms. Special attention must be paid to getting continuity between the units. Off-setting of the panels, when subjected to the concrete pressures, will cause surface blemishes which are nearly impossible to correct.

(2) Metal tie rods or bolts are used to resist pressure across the wall. There are many types of these on the market -- it is seldom wise to exceed the safe load recommended by their manufacturer. It is usually necessary that at least part of the rod be removed and the resulting hole in the concrete patched as a final operation. Occasionally, special water-proofing is also required.

Twisted wire should not be used as form ties except in very minor work. They cannot support even minor pressures without yielding, and removing the wire below the concrete surface damages the concrete.

(3) Steel straps, of the type used in packaging, are sometimes utilized in form construction where tension ties are required. They can be pulled tight and work well when used outside the form -- they can seldom be used through the concrete because of the difficulty of cutting the metal back from the concrete face.

Occasionally it is necessary to form only one side of a wall and to pour the opposite face against an existing earth or concrete surface. In these cases it is seldom possible to use ties through the wall and concrete

pressures must be held by placing struts against the form. This is a precarious arrangement and should be done with caution. If the struts are angled, they may have a strong tendency to lift the form when loaded. It is necessary to place the concrete in such walls slowly.

(4) A spreader of some type is necessary to hold the wall forms apart during the construction phase. Most manufactured wall ties perform this function too. Check to be sure their use will result in the full planned wall thickness. Occasionally, careless contractors use spreaders 1/4 inch short, assuming forms will spread during concrete placement.

Precast concrete spreaders are occasionally used and generally with excellent results. They are held in place by wiring to the reinforcing steel.

Temporary wood spreaders that must be removed during the concrete pour are a poor solution. Some are invariably overlooked during the pour and must later be chipped out of the finished concrete wall.

(5) It is good practice to place strong-backs at intervals along the wall forms. The forms will be aligned at these locations. They also afford a margin of safety needed when form ties are overloaded.

(6) Where one face of a wall is on a batter, the wall ties will not completely neutralize the fluid pressure forces. Additional tieing or bracing is required. For instance, a wall that is appreciably thicker at the bottom than at the top will tend to lift and must be tied down.

(7) Form corners must not only be constructed grout tight, but they must remain tight while under the concrete fluid pressure. If a joint should open, even a small amount, a ragged concrete corner will result. When corners are chamfered, this forming operation should be carefully done with precision milled material. If the corner angle is other than 90°, special chamfering material is necessary.

C. Columns require good quality form work, and corners particularly are critical. Columns are often poured rapidly. Unless care is taken, this can result in poor quality concrete work where it is least desirable.

In the design of column forms, the corners should interlock in such a way that each form acts as a spreader when tightening the ties across it. This permits the placement of active compressive stresses in the form units prior to placing the concrete and the possibility of form materials yielding under the fluid concrete pressures sufficiently to open corner joints is minimized. The ties must have wedge or thread action to provide this active encasing force.

Only where rough work can be tolerated should column corners be held by nailing only.

Circular columns are common -- Forms for these utilize ring tension to contain the pressures. Types of forms include:

(1) Single use cardboard tubes which are destroyed in the stripping process.

21153

AC NO: AC 65.95-2A

DATE: 4/15/69

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: HANDBOOK AND STUDY GUIDE FOR AVIATION MECHANICS INSPECTION AUTHORIZATION

1. PURPOSE. This handbook gives guidance to persons conducting annual and progressive inspections and approving major repairs or alterations of aircraft. It also stresses the important role they have in air safety. While the handbook is primarily intended for mechanics holding or preparing for an Inspection Authorization, it may be useful to aircraft manufacturers and certificated repair stations who have these privileges.

2. CANCELLATION. AC 65.95-2 dated May 3, 1967, is canceled.

3. REFERENCES. Part 65 of the Federal Aviation Regulations sets forth the privileges of mechanics holding an Inspection Authorization. Part 43 of the FARs sets forth maintenance rules and standards of performance.

4. HOW TO GET THIS HANDBOOK.

   a. Order from: Department of Transportation; Federal Aviation Administration; Distribution Unit, TAD-484.3; Washington, D.C. 20590

   b. Identify this publication in your order as: FAA AC No. 65.95-2A Handbook and Study Guide for Aviation Mechanics' Inspection Authorization dated 4/15/69.

   c. This publication will be furnished free of charge.

Director,
Flight Standards Service

2091

Initiated by: FS-340

(2) Multi-use steel plate forms -- these are split into half-cylindrical with bolted joints along each side of the column.

(3) Built up wooden forms are similar to the steel forms but use steel hoops as the pressure resisting element.

D. Horizontal forms used under concrete slabs and girder stems are called soffit forms. They must be designed to carry the full weight of the concrete. Alignment of lower concrete edges requires special attention. Keep the joints tight and provide stiff supporting form members under these locations.

Forms for horizontal spans are usually bowed upward. This is called cambering. Camber is necessary to compensate for the falsework deflection under the load of the concrete. Additional cambering is necessary through the length of the final concrete span to provide for the deflection of the concrete member when the forms and falsework are removed. Mid-span camber should be from 1/600ths to 1/1,000th of the span length.

E. The temporary posts and beams that support horizontal form and concrete loads are called falsework. Uneven settlement in this area can be very serious and complete falsework failure is catastrophic. Falsework plans must be checked for structural adequacy. Falsework is composed of the following units:

(1) Mud-sills or pads supporting falsework must be firmly bedded. If on soil, bed them in fine granular material and protect the soil from softening or scouring by water. Soil bearing pressures under mud-sills are generally limited to about one ton per square foot. Relatively uniform pressures should be developed under adjacent sills so that a final uniform falsework settlement will be obtained.

When adjacent shores rest upon supporting material of completely different yield characteristics, such as, where one shore rests upon a concrete footing and the adjacent shore is supported by a mud-sill on poorly consolidated fill, extreme measures are required to obtain uniform settlement under load. In this case the mud-sill should be extra stiff, it should pass across and be supported on the footing, and its bearing area on the fill should be increased.

(2) Posts, often called shoring, carry the column load in the falsework. They are most often critical in crushing strength where they bear on the sills and caps. The capacity of most falsework timber in cross-grain bearing is about 400 pounds per square inch.

Shoring should be braced with horizontal ribbons in both directions and as often in height as needed to prevent buckling. Diagonal bracing might also be provided in both directions to carry the horizontal or tipping forces.

(3) Cap-beams are important in heavy falsework construction -- they serve to stiffen the frame structure and to distribute uneven settlements and loads. They are sometimes omitted in light construction.

(4) A poor grade of timber should not be used in stringers or joints -- strength and stiffness are important here. On long falsework spans, camber strips are often necessary to compensate for the loaded timber deflection. Block bridging or bracing is required for lateral support of deep stringers.

(5) All falsework must have some means of making elevation adjustments. Wooden wedges are commonly used for this. They must be used in pairs in full bearing and must be firmly nailed in place after making the final adjustment or vibration will loosen them during concrete placement. They are often critical in cross-grain bearing capacity. One of their disadvantages is that they are difficult to back off when releasing the falsework.

Various types of steel screw jacks are coming into more general usage for falsework adjustment. They are very efficient. All of them, however, are somewhat unstable to horizontal forces and lateral bracing should be provided.

(6) Lateral bracing must be provided in falsework to resist horizontal forces. Insufficient lateral bracing is probably the major factor in most falsework failures. The diagonal bracing, mentioned earlier, serves this function. To be effective it must extend from the mud-sills to the deck forms.

(7) There are many patented falsework accessories on the market including variable length stringers and posts. Care must be exercised in their use. Most manufacturers test load samples of their product to failure. Safe working loads are generally assumed at half-failure loads. Untested products should only be used with extreme caution.

6. Form Surface Treatment and Reuse of Forms

Most forms are surface treated to assist in their removal and to preserve them for reuse. Only a form coating material manufactured for this purpose should be used. Care must be used when applying it. It must be kept off concrete construction joint surfaces and reinforcing steel.

The maximum reuse of forms represents a major factor in the economies of modern construction, and it should be encouraged by everyone involved in concrete forming operations.

7. Checking Out Forms

A checking out of the forms is done before concrete placement.

A. The position and alignment is checked from batterboards or construction stakes. Elevations are checked by measuring down from batterboard elevations and up from footings. Dimensions are checked against the contract plans. Imbedded bolts and hardware must be checked out. If these are extensive, a list should be prepared ahead of time.

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B. Check for cleanliness. There should be no sawdust nor trash in the forms, and concrete construction joints and reinforcing steel must be clean of oil and mud. Be sure all loose pieces of tie wire and nails are cleaned off the soffit form. If this metal is allowed to remain, it will cause brown rust stains on the exposed concrete surface. Nails temporarily used to support reinforcing steel along wall faces must also be removed.

C. Give special attention to expansion joint details. Be sure these joints are free to move.

8. Forms During Concrete Placement

A. The rate and sequence of concrete placement will be limited by the strength of the concrete forms. As mentioned previously, the pressures due to the fluid head of concrete will limit the depth increase that can be permitted. In well built forms, this is generally 4 to 6 feet per hour.

Horinzontal forms should be uniformly loaded during the placing operations.

Where concrete in a form unit is placed in two operations, such as, where a girder and a slab are poured on different dates, considerable care is required to prevent cracking of the concrete placed during the first pour when the forms deflect further during the loading of the second pour. To prevent this, the first placed concrete should be several days old before making the second pour. This will permit it to attain some strength. In addition, reinforcing steel must be provided where needed to resist tensile stresses set up by form deflection. In girder stems this often requires that special reinforcing steel be placed near the top of the stem pour to resist negative moments which will develop at falsework supports and columns.

B. It is general practice to assign someone to watch forms and falsework while taking the load during the pour. Many failures can be discovered early enough to prevent their becoming serious. Experience has shown that just because a type of form or falsework had been used several times before without problems is no guarantee that it will not fail this time.

To assist this operation, tattle-tale guages are used to check falsework settlement and plumbobs used to check lateral movement.

The form watcher should keep alert for the sounds of spilling concrete and splintering wood. He should watch for deflecting stringers, leaning joists, loosening of braces, and excessive settlement of supports.

9. Stripping and Falsework Release

The method by which forms will be removed should be considered during their construction. Forms in small enclosures particularly require that their method of removal be pre-planned. Sometimes forms in hollow concrete structural units are allowed to remain permanently in place.

If side forms are removed while the concrete is still low in strength, considerable care must be used to prevent damaging the concrete. In this case, too, curing of the concrete must be attended to.

Supporting forms must remain until the concrete has attained sufficient strength for the spans involved. Unusually large deflections can occur in concrete spans where the supporting forms are released too early.

10. Safety

There are inherent hazards during form construction and safety precautions are needed. The personal use of hard hats, stout clothing, and high friction shoe soles are among these.

Published construction safety regulations covering this type of work are available.

REFERENCE MATERIAL

Formwork for Concrete
American Concrete Institute

Recommended Practice for Concrete Formwork
American Concrete Institute 347-63

Forms for Architectural Concrete
Portland Cement Association

Construction Joints
Portland Cement Association AC19-3

Construction Safety Orders
California Division of Industrial Safety

Standard Wall Form

J. Neil Perry

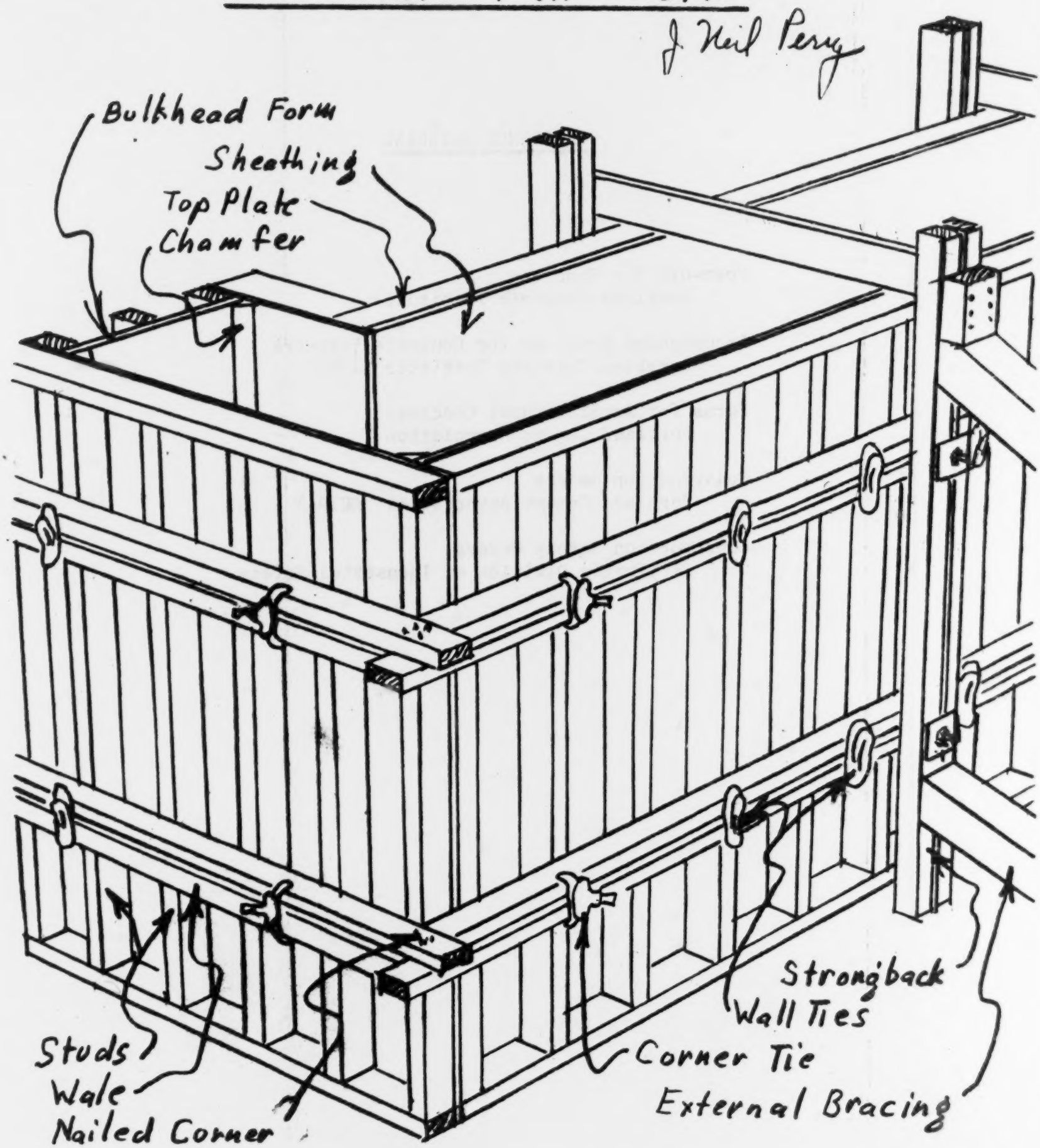

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Column Form

J. Neil Perry

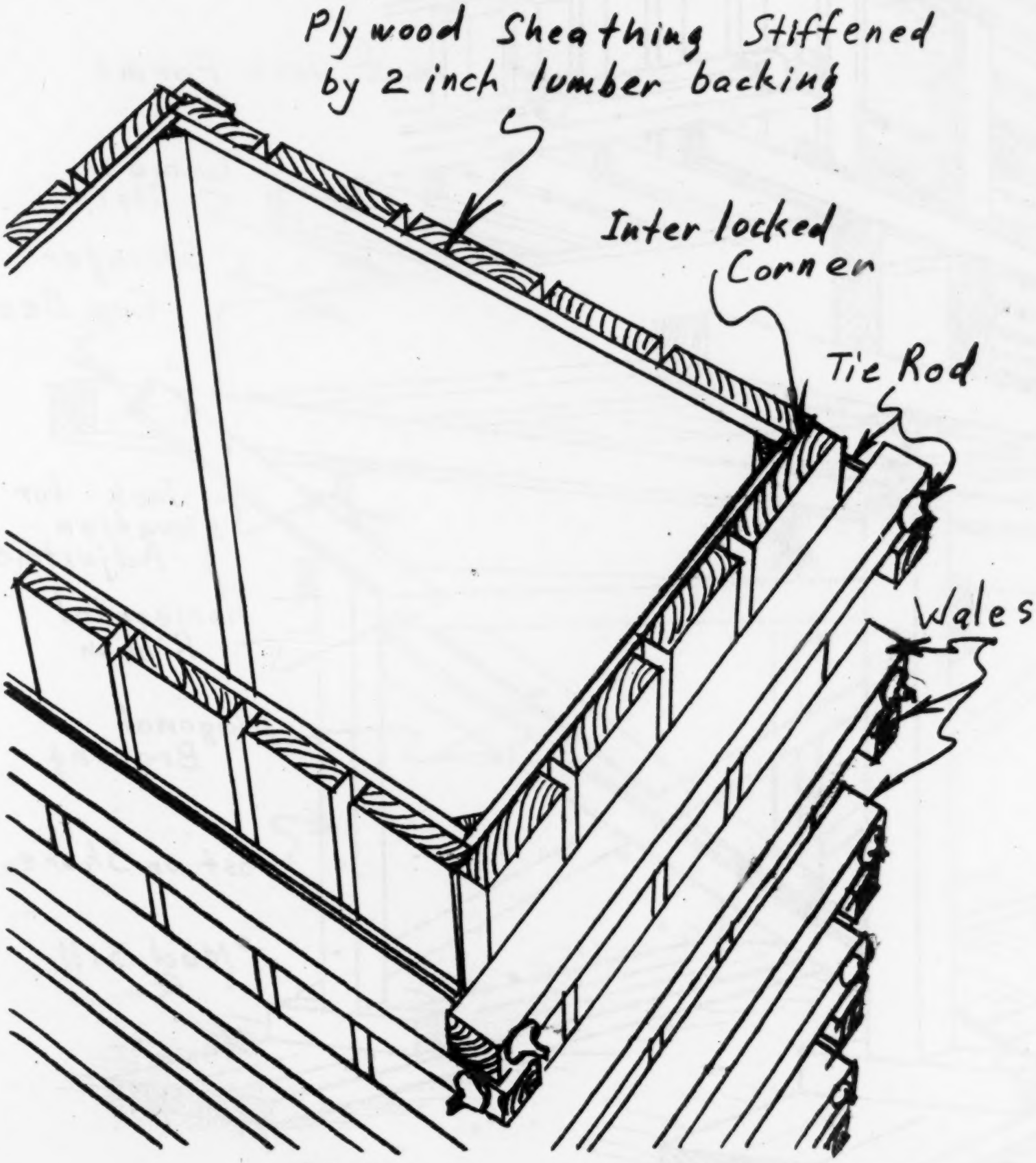

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False Work

J. Neil Perry

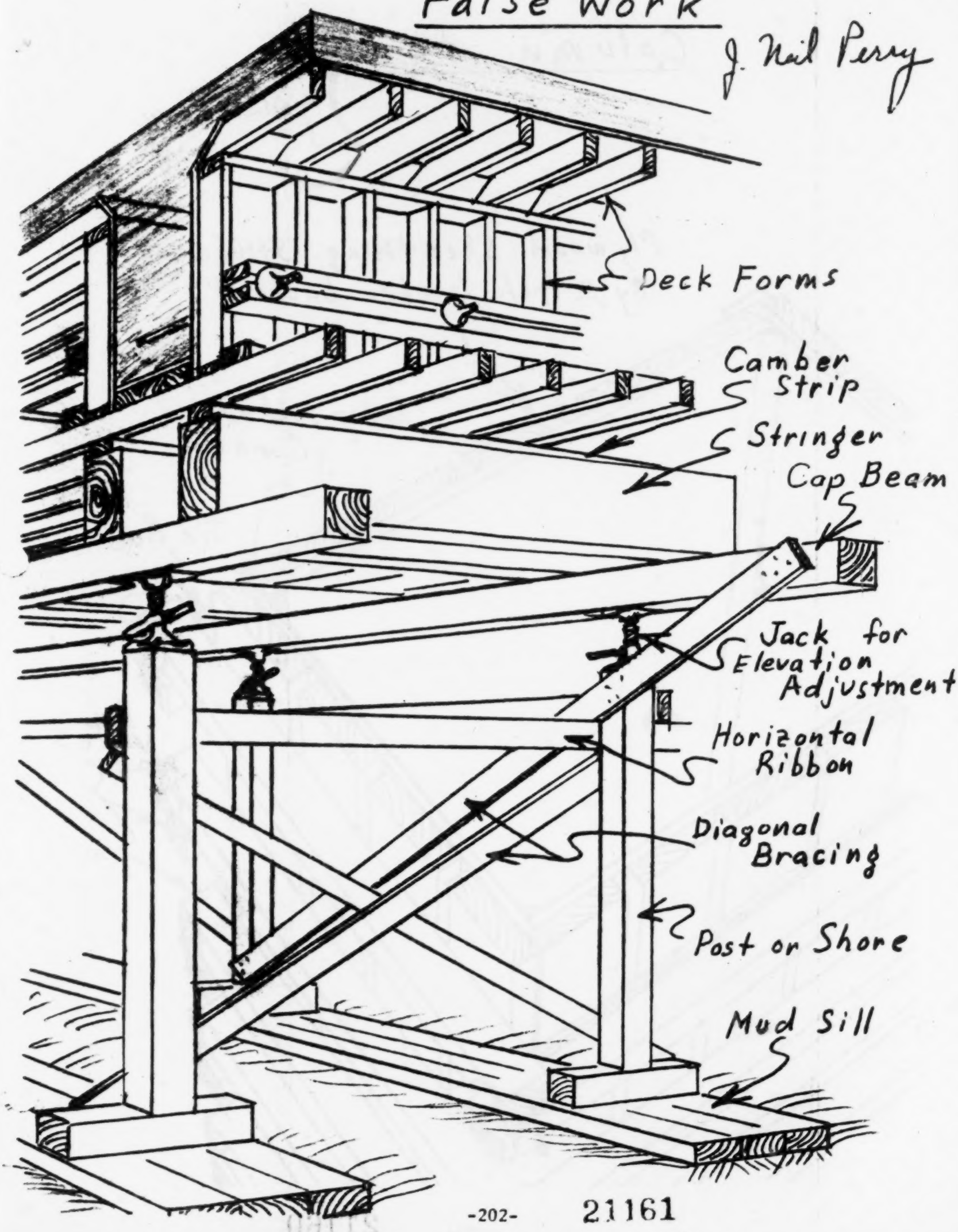

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CONCRETING DURING HOT WEATHER

Spring and fall usually are considered the ideal seasons for concreting. The temperature extremes that are prevalent in winter and summer are not usually encountered. However, construction proceeds all year. Therefore, concrete must be handled and placed during hot weather. Concreting in hot weather poses some special problems but certainly is practicable provided precautions are observed.

PREVENTING RAPID EVAPORATION

The main precaution during summer concreting is to prevent rapid evaporation of water from the concrete. Consequently, concrete should be protected during and after the placing and finishing operations so that the chemical reaction can proceed unrestricted. Obviously, if too much water evaporates the hydration will not be complete.

Rapid drying sometimes causes problems such as strength reduction and plastic shrinkage cracks. In extreme cases, a rapid loss of moisture from the concrete at the surface may cause cracks to form within the first day or so and often within the first few hours. Concrete may also stiffen before it can be consolidated because of rapid setting of the cement and excessive absorption or evaporation of mixing water. This leads to difficulty in finishing flat surfaces.

TEMPERATURE, RELATIVE HUMIDITY, AND WIND

Several factors affect the rate of evaporation of water from concrete. It is influenced by the concrete and air temperatures, relative humidity, and wind velocity. Even relatively small changes in these conditions may have a pronounced effect on the rate of evaporation, especially if they occur simultaneously.

For example, when the relative humidity changes from 90 to 50 per cent (see Table 19, Part 2), the rate of evaporation is increased five times; if the humidity is further reduced to 10 per cent, evaporation is increased nine times.

When both concrete and air temperatures increase from 50 to 70 deg. F. (Table 19, Part 3), evaporation is doubled; if further increased to 90 deg. F., evaporation is increased four times.

With an air temperature of 40 deg. F., the rate of evaporation is tripled when the concrete temperature is raised from 60 to 80 deg. F. (Table 19, Part 5).

Wind velocity is also important. The rate of evaporation is four times greater when the wind velocity increases from 0 to 10 mph (Table 19, Part 1), and is nine times greater when the wind velocity increases to 25 mph.

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It is apparent that the rate of evaporation is highest when the relative humidity is low, when concrete and air temperatures are high, when the concrete temperature is higher than the air temperature, and when the wind is blowing over the concrete surface. The combination of hot, dry weather and high winds often prevailing during summer months removes moisture from the surface faster than it can be replaced by normal bleeding.

CEMENT TEMPERATURE

Cement temperature has only a minor effect on the temperature of freshly mixed concrete. This is due to the low specific heat of cement and the relatively small amount of cement in the mix.

Since the cement loses heat slowly during storage, it may be warm when delivered. This heat is produced during grinding of the cement clinker in manufacture. Since the temperature of cement does affect the temperature of fresh concrete to some extent, some specifications place a limit on its temperature at time of use. However, test results indicate that it is desirable to specify a maximum temperature for freshly mixed concrete rather than place a limit on the temperature of the ingredients.

BEFORE PLACING AND FINISHING CONCRETE

A few simple precautions may save many dollars. These procedures will also give the concrete an earlier strength gain, greater durability, and will greatly reduce chances of surface defects. To assure a quality concrete job, at little or no additional cost, here's what you can do before and after placing and finishing concrete:

Plan ahead. Before beginning extensive concreting operations, check with the weather bureau to obtain latest forecasts for temperature, wind velocity, and relative humidity. (Each, or a combination, influences excessive evaporation of water from concrete. See Table 19.)

Be prepared with necessary equipment and material well in advance of hot weather.

Be sure of an ample water supply for sprinkling subgrades, wood forms, and aggregates, and for curing.

Have tarpaulins or polyethylene sheets and lumber ready for sunshades and windbreaks.

Schedule work so that concrete can be placed with the least delay. Jobs could be started late in the afternoon during extremely hot periods to take advantage of lower evening temperatures and winds.

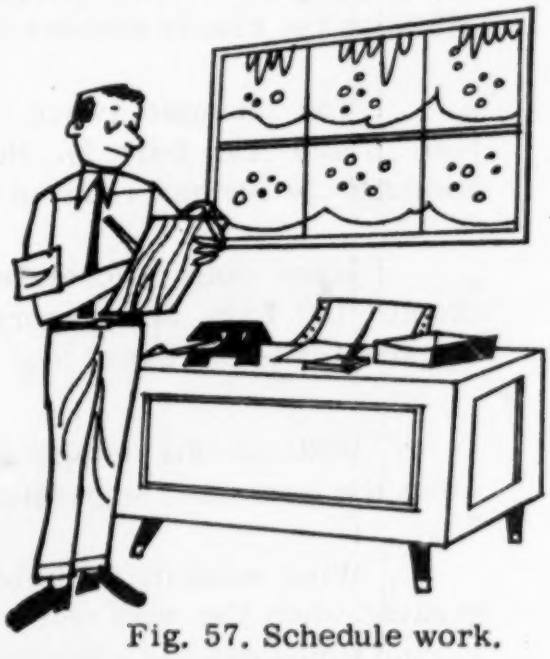

Fig. 57. Schedule work.

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Table 19. Effect of Variations in Concrete and Air Temperatures, Relative Humidity, and Wind Speed on Drying Tendency of Air at Job Site.

Case No.	Concrete Temp., °F.	Air Temp., °F.	Relative Humidity, %	Dew Point, °F.	Wind Speed	Drying Tendency lb./sq.ft./hr.
(1) Increase in Wind Speed						
1	70	70	70	59	0	.015
2	70	70	70	59	5	.038
3	70	70	70	59	10	.062
4	70	70	70	59	15	.085
5	70	70	70	59	20	.110
6	70	70	70	59	25	.135
(2) Decrease in Relative Humidity						
7	70	70	90	67	10	.020
8	70	70	70	59	10	.062
9	70	70	50	50	10	.100
10	70	70	30	37	10	.135
11	70	70	10	13	10	.175
(3) Increase in Concrete and Air Temperatures						
12	50	50	70	41	10	.026
13	60	60	70	50	10	.043
14	70	70	70	59	10	.062
15	80	80	70	70	10	.077
16	90	90	70	79	10	.110
17	100	100	70	88	10	.180
(4) Concrete at 70°F. Decrease in Air Temperature						
18	70	80	70	70	10	.000
19	70	70	70	59	10	.062
20	70	50	70	41	10	.125
21	70	30	70	21	10	.165
(5) Concrete at High Temp.; Air at 40°F. and 100% R. H.						
22	80	40	100	40	10	.205
23	70	40	100	40	10	.130
24	60	40	100	40	10	.075
(6) Concrete at High Temp.; Air at 40°F. Variable Wind						
25	70	40	50	23	0	.035
26	70	40	50	23	10	.162
27	70	40	50	23	25	.357
(7) Decrease in Concrete Temp.; Air at 70°F.						
28	80	70	50	50	10	.175
29	70	70	50	50	10	.100
30	60	70	50	50	10	.045
(8) Concrete and Air at High Temp.; 10% R. H.; Variable Wind						
31	90	90	10	26	0	.070
32	90	90	10	26	10	.336
33	90	90	10	26	25	.740

Use cool materials. If you job mix, keep all materials cool by storing aggregates in shade if possible, sprinkling coarse aggregate with water, and protecting water supply from direct sun rays. Mixing water may be chilled in very hot weather by refrigeration or by using ice as a part of the mixing water. The ice should be melted by the time the concrete leaves the mixer. Most ready mix producers follow these procedures to provide you with cool concrete.

Prevent absorption. Thoroughly moisten subgrade, reinforcing steel, and wood forms just before placing concrete so that they will not absorb water from the mix.

Sprinkling cools the surrounding air and increases its relative humidity. This not only reduces the temperature rise of the concrete but also minimizes evaporation of water during placing. For slabs on ground, it is a good practice to dampen the subgrade the evening before concreting. Prior to placing concrete, there should be no standing water or puddles on the subgrade.

Coarse aggregates should be sprinkled before they are added to the batch.

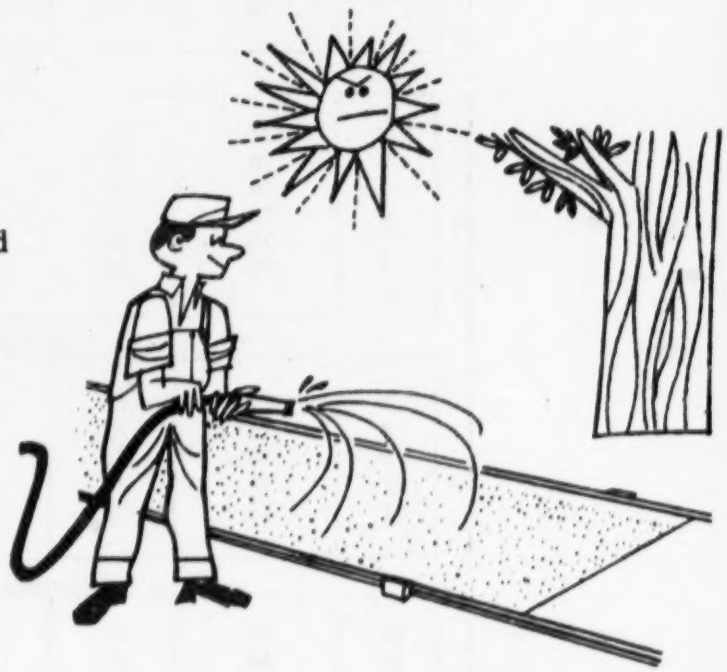

Fig. 58. Moisten subgrade.

DURING AND AFTER CONCRETE HAS BEEN PLACED

Don't delay placing concrete. Strike it off and darby or bullfloat it at once.

Place temporary covers, such as burlap kept continuously wet, over the fresh concrete immediately after striking and darbying.

When ready for floating and/or final finish, uncover only a small section immediately ahead of the finishers. Cover again at once after final finish and keep the cover wet.

Any delays in finishing air-entrained concrete in hot weather usually lead to the formation of a rubber-like surface which is difficult to finish without leaving ripples or ridges.

Protect against evaporation. When placing concrete under a hot sun and drying winds, make sure the elements do not ruin otherwise top-quality concrete. The problem under such conditions is to prevent rapid loss of water, which may cause plastic shrinkage cracks.

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Protect concrete by placing a windbreak on the windward side when high winds prevail. It may also be necessary to fog air over new concrete with a mist of water.

Protect from sunlight. Protect concrete from direct sunlight on hot days by erecting a sunshade or delaying placing operations until late in the day and by taking advantage of the shade from nearby buildings or trees.

Start curing as soon as surfaces are hard enough to resist marring. Cover the concrete with polyethylene film, waterproof paper, or waterholding materials such as straw or burlap, or by spraying on a curing compound. If curing compound is to be used, apply it immediately after final finishing. See that adequate and uniform coverage is obtained.

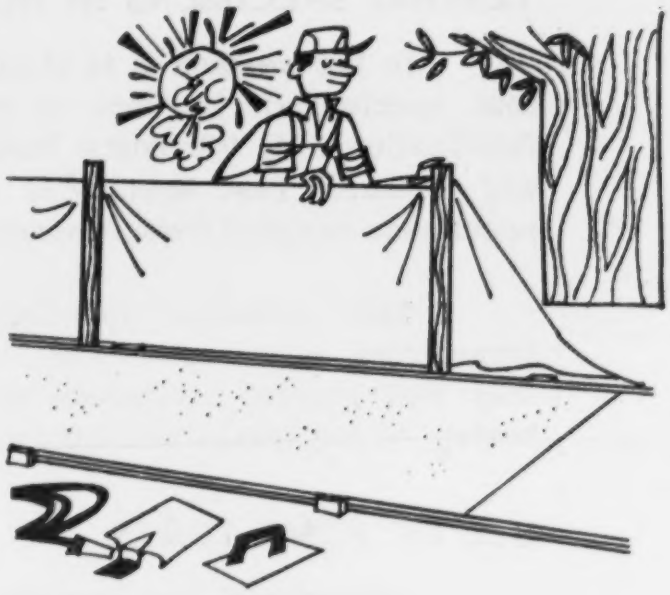

Fig. 59. Protect concrete.

Keep the concrete surface constantly wet to avoid alternate wetting and drying during the curing period.

Continue curing for at least 3 days and preferably for a week. Water not only acts as a curing agent but also cools the slab.

Fig. 60. Keep concrete surface wet.

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RECORDING WEATHER CONDITIONS

Weather conditions should be recorded and made a part of the permanent job record. Humidity, temperature, wind, and clouds should be noted.

TESTING SPECIMENS IN HOT WEATHER

In hot weather it is absolutely necessary that sampling (making and curing test specimens) be done in conformance with standard specifications. ASTM Designation C31, "Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field," governs the procedure to use for specimens sampled from concrete being used in construction.

Test cylinders definitely should be kept shaded and damp and must be transferred at the age of 1 day to the laboratory (or other suitable location) where they will receive continuous standard moist curing until tested. Damp sand, wet burlap, or fog sprays will ensure retention of water by the specimens.

USE OF ADMIXTURES

Admixtures are sometimes used during hot weather to delay the setting time of concrete and lessen the need for an increase in mixing water. Water-reducing agents may be beneficial provided they do not interfere with strength development and other properties of the concrete and provided their use is carefully controlled. They should be used only to supplement (not replace) other hot weather concreting procedures.

If admixtures are used, they should meet ASTM or federal specifications. They should also be tested with job-site materials under job conditions, including temperature, in advance of construction to determine their compatibility with the other materials and their ability under these conditions to produce the desired properties.

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APPLICATION

Lead discussion covering hot weather concreting.

TEST OR DISCUSSION POINTS

1. What seasons are usually considered to be ideal for concreting? Why?
2. What adverse effect does temperature, relative humidity, and wind have on concrete during hot weather?
3. What may happen to concrete in hot weather if precautions are not taken?
4. What planning is necessary before placing and finishing concrete in hot weather?
5. What is meant by "use cool materials"?
6. What can be done to prevent water being absorbed from the mix?
7. What job operations should be completed as soon as possible after concrete is in place?
8. What can be done to protect against evaporation?
9. Is curing necessary during hot weather? Why?
10. How long should concrete be cured during hot weather?
11. What procedures should be followed when securing test specimens during hot weather?

REFERENCE MATERIALS

Refer to ASTM Designation C31, "Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field."

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CONCRETING IN COLD WEATHER

Concrete can be placed throughout the winter months if certain precautions are taken. For successful winter work, adequate protection must be provided when temperatures of 40 deg. F. or lower occur during placing and during the early curing period.

To protect fresh concrete from freezing and maintain minimum permissible curing temperatures, plans should be made well in advance. Appropriate equipment should be at hand and ready to use for heating the concrete materials, for constructing enclosures, and for maintaining favorable temperatures after the concrete is placed. The cost of construction will be increased somewhat by these essential precautions and will vary with the amount of protection required.

EFFECT OF CONCRETE TEMPERATURES

Temperature has a considerable effect on the rate of hardening of concrete and it affects the rate at which hydration of cement occurs. Low temperatures retard concrete hardening and strength gain. Near the freezing point, the rate is very slow and at temperatures below freezing there is almost no increase in strength. At temperatures below 73 deg. F., strengths are lower at early ages but higher at later periods. Concrete made and cured at 55 deg. F. has relatively low strengths for the first few days, but after 28 days it has slightly higher strengths than concrete made and cured at 73 deg. F. Concrete made at 40 deg. F. and cured for 28 days at 25 deg. F. has very little strength at early ages. However, if favorable curing is then provided, this concrete develops strength comparable to that of concrete cured at 73 deg. F.

Strength gain practically stops when moisture required for curing is no longer available. Concrete placed at low temperatures (above freezing) may develop higher strengths than concrete placed at high temperatures. However, curing must continue for a longer period.

HOW TO GET HIGH-EARLY-STRENGTH CONCRETE

There are occasions when it is desirable to increase the setting rate and strength development of concrete. High strength at an early age is frequently desired during winter construction to reduce the length of time protection is required. High early strength may be obtained by using one or a combination of the following:

1. High-early-strength cement
2. Additional portland cement
3. Higher curing temperatures (e.g., steam curing).

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The value of using high-early-strength cement during cold weather is often realized through early re-use of forms, savings in the cost of additional heating and protection, and earlier use of the finished concrete.

USE OF CHEMICAL ACCELERATORS

Chemical admixtures known as accelerators are also sometimes used to shorten the setting time and increase early strength development of concrete mixes.

Calcium chloride is the most commonly used accelerating admixture. If used in concrete, it should be added in solution as part of the mixing water. However, the solution should not come into direct contact with the cement or a flash set may occur. If it is added to the mix in dry form, undissolved lumps may cause popouts or dark spots in hardened concrete. In the case of long hauls for ready mix, the addition of the calcium chloride solution is sometimes delayed until after the concrete has been mixed, shortly before discharge. Twenty revolutions of the drum will usually adequately incorporate the calcium chloride thoroughly in the mix.

The American Concrete Institute recommends use of 1 percent calcium chloride by weight of cement for cold weather concreting when mean temperatures are below 40 deg. F. Up to 2 percent by weight of cement is sometimes used. However, calcium chloride in amounts greater than 2 percent can cause problems. It may cause flash set, increase drying shrinkage, and corrode reinforcement. Addition of calcium chloride in recommended amounts has no significant corrosive effect on ordinary steel reinforcement provided the concrete is watertight.

Calcium chloride or admixtures containing soluble chlorides should never be used under the following conditions:

1. In concrete for prestressed concrete construction. Corrosion of the prestressing strands may result.

2. In concrete containing embedded aluminum, such as conduit. Serious corrosion may result, especially if the aluminum is in contact with embedded steel and the concrete is in a humid environment.

3. In lightweight insulating concrete placed over metal decks.

4. In concrete that will be in contact with soils or water containing sulfates.

DON'T DEPEND ON CHEMICALS TO PREVENT FREEZING

After concrete is in place it should be protected against freezing. However, so-called antifreeze compounds or other materials to lower the freezing point of concrete should not be used. The quantity of these materials needed to lower the

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freezing point of concrete appreciably is so great that strength and other properties are seriously affected. There is no such thing as an antifreeze for concrete, so don't depend on chemicals to prevent freezing.

Where several cycles of freezing and thawing occur at an early age, strength and other qualities of concrete are permanently affected. However, the strength of concrete that has been subjected to a light freezing at an early age may be restored to normal by resumption of favorable curing conditions. But such concrete will not have the resistance to weathering, nor will it be as watertight, as concrete that has not been frozen.

BEFORE PLACING AND FINISHING CONCRETE

Fig. 61. Plan in advance.

1. Plan in advance. Have equipment and materials ready before cold weather arrives. Provide heaters, insulating materials, and enclosures. Use high-early-strength concrete where job conditions make it desirable.

Fig. 62. Heat the materials.

2. Heat the materials. The temperature of the concrete as it is placed in the forms should be between 50 and 70 deg. F. for slabs. When air temperatures are between 30 and 40 deg. F., the mixing water should be heated. When air temperatures are below 30 deg. F., the mixing water and sand (and sometimes coarse aggregate) should be heated. No frozen aggregate lumps should be in concrete at the time it is placed.

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To prevent flash set, materials should not be overheated. Maximum allowable water temperature is about 140 deg. F.

Do not place concrete on frozen ground--unequal settling will occur when the ground thaws. This can cause cracking.

Fresh excavations should be covered with straw or other insulating material to prevent the ground from freezing until concrete can be placed.

Remove all ice and frost from forms and steel reinforcing.

3. Use accelerators carefully. Use about 1 lb. of calcium chloride per bag of cement to hasten hardening. Not more than 2 lb. should ever be used because of danger of flash set.

Don't use any admixtures to prevent concrete from freezing.

Don't use calcium chloride with other admixtures which accelerate hardening.

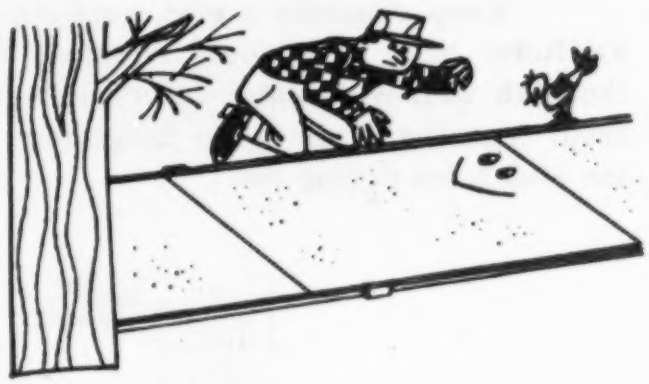

Fig. 63. Provide suitable curing temperatures.

AFTER CONCRETE HAS BEEN PLACED

1. Provide suitable curing temperatures. Maintain the temperature of the concrete, when using normal portland cement, at 70 deg. F. or above for 3 days, or 50 deg. F. or above for 5 days.

Maintain the temperature of high-early-strength concrete at 70 deg. F. or above for 2 days, or 50 deg. F. or above for 3 days.

Do not allow the concrete to freeze during next 4 days.

Cool the concrete gradually at a rate of 1 to 2 deg. per hour until it reaches the outside temperature.

2. Keep job condition records. Record date, hours, weather conditions, and temperature (both of air surrounding concrete and surface of concrete) at least twice daily.

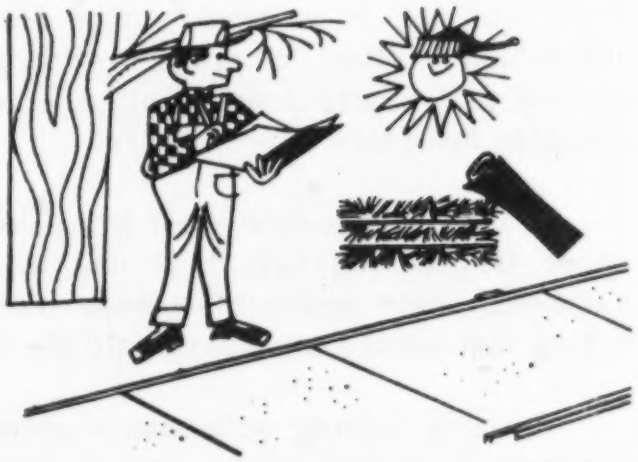

Fig. 64. Keep job condition records.

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3. Protect concrete. Insulation, such as a thick blanket of straw, without artificial heat, is often sufficient protection for slabs on ground. At lower temperatures, housing and artificial heat are necessary.

Housings can be made of wood, insulation board, waterproof paper, or tarpaulins over wood frames.

Circulate moist warm air between floor slabs and housing.

Avoid the risk of fire by placing coke or oil-fired heating units away from flammable material. Vent to outside.

Raise heating units above the floor to avoid rapid drying of concrete underneath.

Keep concrete moist, especially near heating units. In cold weather, when artificial heat is applied, moisture for curing is still very important. First wet the slab well with water and cover with waterproof paper. Then apply heat to keep from freezing. This water treatment, along with covering, prevents the surface of the slab from drying out.

Fig. 65. Protect concrete.

CURING METHODS

Concrete in forms or covered with insulation seldom loses enough moisture at 40 to 55 deg. F. to impair curing. However, moist curing is needed during winter concreting to offset the drying tendency when heated enclosures are used. It is important that concrete be supplied with enough moisture when warm air is used to maintain favorable temperatures.

Live steam exhausted in an enclosure is an excellent method of curing because it provides both heat and moisture. Steam is especially practical during extremely cold weather because moisture provided by steam offsets the rapid drying that occurs when very cold air is heated.

Early curing with liquid membrane-forming compounds may be used on concrete surfaces within heated enclosures. It is a better practice, however, to cure first with water or exhaust steam during the initial period of protection and then apply a curing compound after the protection is removed and the air temperature is above freezing.

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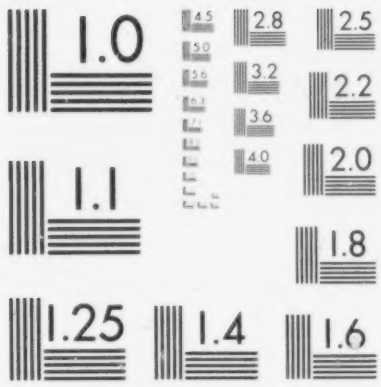

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Heat may be retained in the concrete by use of commercial insulating blankets or bat insulation. The effectiveness of insulation can be determined by placing a thermometer under the insulation in contact with the concrete. If the temperature falls below the minimum required, additional insulating material should be applied. Corners and edges of concrete are most vulnerable to freezing and should be checked to determine the effectiveness of the protection.

Recommendations on the amount of insulation necessary for protection of concrete at various temperatures may be obtained from the manufacturers of these materials or by referring to the American Concrete Institute's "Recommended Practice for Winter Concreting" (ACI 604).

Heated enclosures are commonly used for protecting concrete when air temperatures are near or below freezing. There are a number of suitable materials for making enclosures.

Enclosures may be heated by live steam, steam in pipes, oil-fired burners, salamanders, and other heaters of various types. Salamanders are easily handled and inexpensive to operate. They are convenient for small jobs but have several disadvantages. They produce a dry heat, so care must be taken to prevent drying of the concrete, especially near the heating element. When placed on floor slabs, they should be elevated and the concrete near them protected with damp sand.

Salamanders and other fuel-burning heaters also produce carbon dioxide, which combines with calcium hydroxide in fresh concrete to form a weak layer of calcium carbonate. When this occurs, the surface of a concrete floor will dust under traffic. For this reason, carbon dioxide-producing heaters should not be used while placing concrete and for the first 24 to 36 hours of the curing period unless they are properly vented.

REMOVE FORMS AT PROPER TIME

During cold weather, allow ample time for concrete to attain its required strength before removing forms. Removing forms too soon may cause the corners and edges to chip. Let forms remain in place until the concrete has attained sufficient strength to sustain its own weight in addition to any other load that may be placed upon it during construction.

APPLICATION

Discuss cold-weather concreting methods.
Show slide 11 from Mr. Quality Concrete slide set.

TEST OR DISCUSSION POINTS

1. Can cold weather concreting be accomplished without damaging the properties of concrete?
2. What is the effect of temperature on the rate of hardening?
3. At what temperature should provisions be made for adequate protection during cold weather concreting?
4. Explain three methods for obtaining high-early-strength concrete.
5. Why should one be careful when using chemical accelerators?
6. What is the maximum recommended amount of calcium chloride, by weight of cement, that should be used in concrete?
7. Under what conditions should calcium chloride or soluble chloride never be used?
8. Is there such a thing as an antifreeze for concrete? Why?
9. Name several things that should be done before placing and finishing concrete in cold weather.
10. Name several things to do after placing concrete in cold weather.
11. How long should the temperature of concrete be maintained at 70 deg. F.? At 50 deg. F.?
12. What cold weather curing methods are suitable for your area?
13. What precautions are necessary when using salamanders?
14. What may happen to concrete if forms are removed too early?
15. How long should forms remain in place?

TOOLS AND MATERIALS

Mr. Quality Concrete slide set

REFERENCE MATERIALS

See American Concrete Institute (ACI 604-56), "Recommended Practice for Winter Concreting."

JOINTS FOR FLAT CONCRETE WORK

Three basic types of joints are commonly used in slab-on-ground construction--isolation, control, and construction joints. They are easy to put in and should be used in flat work such as floors, slabs, and walks.

WHY JOINTS ARE NECESSARY

All plastic concrete contains more water than is needed for hydration of the cement. When this extra water starts to evaporate, drying-shrinkage of the slab begins creating tensile stresses in the concrete. These tensile stresses must be relieved by providing joints; otherwise unsightly cracks will develop.

Slabs of varying shapes and sizes expand and shrink by different amounts. The larger the slab, the greater will be the horizontal movement. Provision must be made for this differential movement to prevent unnecessary cracking.

Slabs may also have some vertical movement due to heaving or settling of the subgrade. The amount of movement may vary due to lack of uniform subgrade bearing pressures, unequal loading conditions, changes in moisture content of the soil, and freezing and thawing of the subgrade.

Slabs may also require joints that are not concerned with movement, but rather with ease of concrete placement. Many times this type is combined with another type of joint.

ISOLATION JOINTS FOR POINTS OF ABUTMENT

Isolation joints are used to separate slabs-on-ground from points of abutment such as walls, columns, and footings. By separating or isolating the slab, it is permitted to move without unsightly cracks developing.

To prevent bonding and provide a cushion, a continuous rigid asphalt-impregnated insulation strip, building paper, polyethylene, or similar material is placed upright between the edge of the slab and the immovable object. The joint material need not be more than 1/4 in. thick.

If watertight joints are desired, they can be formed with beveled wood siding or strips held from the wall by wedges. The wedges and strips can be easily removed after the concrete has hardened, and the space is partially filled with sand and other resilient material to provide a watertight joint.

CONTROL JOINTS TO PREDETERMINE CRACK LOCATIONS

Concrete has a tendency to contract or shrink in cooler temperatures or when it loses moisture. In large slabs of concrete this shrinkage, if uncontrolled,

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will cause random cracking at 15- to 25-ft. intervals, depending upon such factors as (1) total amount of water in the concrete mix; (2) temperature and humidity ranges experienced; and (3) subbase restraint. Therefore, it's best to predetermine the crack location. This is done by cutting into the slab to create a series of weakened planes. The weakened planes or joint spacing should be laid out so that slab panels are approximately square. Slabs that are not rectangular or square should have a control joint across the slab at the point of juncture of the offset. Control joints are generally placed 10 to 15 ft. apart on floor slabs, driveways, and livestock feeding floors. They are placed 4 to 5 ft. apart on sidewalks. Cracks will follow the grooves or joints and random cracking is prevented.

Control joints are cut to a depth of 1/4 to 1/5 the thickness of the slab. Depth is important. If the cut is too shallow, the crack forms elsewhere. If the cut is too deep or all the way through the slab, load transfer may not be obtained. This would result in a differential vertical movement. With properly cut joints, aggregate interlock prevents unequal settlement of the slabs. Cuts should be made as soon as possible after placement of the concrete in order to work larger pieces of aggregate away from the joint. A simple way to cut this type of joint is to use a groover or jointer with a bit 3/4 to 1 in. deep. Another method of providing a joint is to use a brick mason's trowel to cut the concrete. A groover is then used to finish the joint.

Another method of cutting joints is with an electric or gasoline-powered saw. The joint is usually cut in the concrete surface 4 to 12 hours after the concrete has hardened or as soon as the concrete surface will not be torn or damaged by the saw blade kerf.

CONSTRUCTION JOINTS FOR PLACING LARGE AREAS IN STAGES

A true construction joint should constitute neither a plane of weakness nor an interruption in the mass of concrete. Therefore, every effort must be made to ensure bonding of the newly placed concrete to that previously placed. To assure bond, the old concrete should be thoroughly cleaned and dampened before the new concrete is put in place. To avoid the possibility of breaking the bond after the pavement is in use, tiebars or keyways are frequently used to assist in vertical transfer across the joint. Tiebars have the added advantage of being able to resist shearing stresses caused by differential shrinkage of the "old" and "new" concrete.

COMBINATION CONTROL AND CONSTRUCTION JOINTS

A method is available for forming a control joint along with a "semi-construction" joint. Instead of creating a weakened plane, the joint is constructed completely through the slab. The resulting joint is a non-bonded and keyed control joint as shown in Fig. 50. Bond is broken between the new and previously placed slabs by spraying or painting with a curing compound, asphaltic emulsion, or form oil, which allows freedom of horizontal movement necessary for crack control. The key provides the same type of vertical load transfer achieved by the aggregate interlock in the cut joints and prevents unequal settlement of the slabs.

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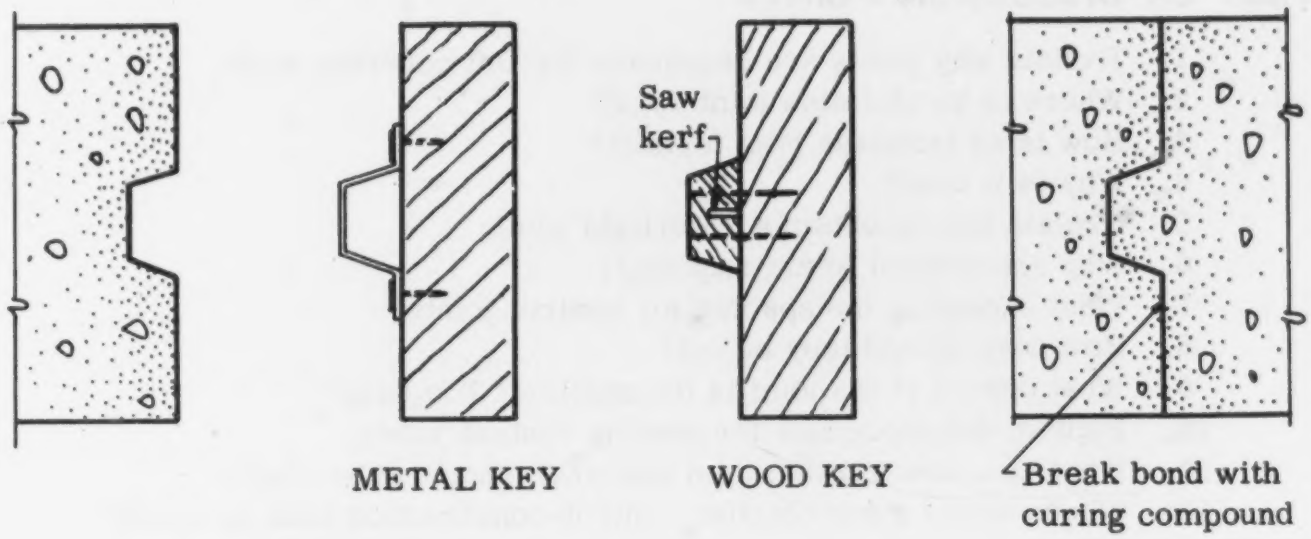

Notes: A beveled 1 x2'' strip is adequate for most slabs

Saw kerf prevents breaking up concrete edge when moisture expands 1 x2''

(Used when necessary to stop and join later)

Keys of galvanized metal may be used.

Fig. 50. Combination control and construction joints.

Keyways may be formed by a sheet metal form, premolded mastic 1/8 in. thick, composition hardboard, or 2-in. lumber with a metal strap or wood strip attached to form the groove. If wood strips are used to form the keyway, they may swell when absorbing moisture from the concrete and cause cracking of the concrete lip above the keyway. Therefore, they should be well oiled and grooved with a saw kerf to minimize swelling. A 1x2-in. keyway with beveled edges is sufficient for slabs of 5- to 8-in. thickness. Larger keyways, such as 2x2-in., should be avoided. If metal is used to form the keyway, it should be thick enough to withstand handling. One advantage of the metal keyway form is ease of cleaning for re-use.

APPLICATION

Discuss joints for flat concrete work.
Show Slides 34 through 39, Mr. Quality Concrete slide set.

TEST OR DISCUSSION POINTS

1. Explain why joints are necessary for flat concrete work.
2. Where is an isolation joint used?
3. How is an isolation joint formed?
4. Why is it used?
5. Explain how to obtain a watertight joint.
6. Why are control joints required?
7. What should be the spacing for control joints?
8. How deep should they be cut?
9. What occurs if the joint is too shallow? Too deep?
10. Explain the procedure for making control joints.
11. What is a construction joint and when should it be used?
12. Where would a combination control-construction joint be used?
13. When a wood strip is used to form the groove for a keyway, what precaution should be observed?
14. What size strip is adequate for 5- to 8-in. slabs?

TOOLS AND MATERIALS

Mr. Quality Concrete slide set

CONCRETE TROUBLESHOOTING

Concrete made with good materials, properly proportioned, thoroughly mixed, with optimum air entrainment, and, properly placed, finished and cured will be quality concrete. Concrete made in accordance with the principles outlined in this text will perform well.

However, since rules can be, and often are broken, difficulties do occur and remedies must be found.

To assist in determining the causes of, and correcting some of the more common problems that do occur, the following list of difficulties, their causes, and some of their preventive measures is presented.

Low Cylinder Strength

Cylinders are not meeting specified strengths. Section 504 of the 1963 ACI code requires the following:

1. For structures designed in accordance with Working Strength Design methods, the average of any five consecutive strength tests of the laboratory-cured specimens for each class of concrete shall be equal to or greater than the specified strength, and not more than 20 percent of the strength tests shall have values less than the specified strength.

2. For structures designed in accordance with Ultimate Strength Design methods, and for prestressed structures, the average of any three consecutive tests of the laboratory-cured specimens for each class of concrete shall be equal to or greater than the specified strength, and not more than 10 percent of the strength tests shall have values less than the specified strength.

Causes	Preventive Measures
1. Improper mix design	Increase cement content, decrease water/cement ratio, check aggregate grading and proportions.
2. Proper mix design, but inadequate cement content	Check scales, hoppers and chutes to assure cement is being supplied to the mixer as specified.
3. Proper mix design, adequate cement content, but excessive water added at batch plant or job site	This is the major universal cause of low strength concrete. Slump should be maintained within specified limits. If water needed, also add cement and mix thoroughly.
4. Proper mix design, but variations in consistency caused by: a. Poor control of water content b. Excessive variation of moisture in aggregate c. Non-uniform materials and grading d. Variations in proportions	Improve batching and testing procedures.

Low Cylinder Strength-Continued

Causes	Preventive Measures
5. Air-entrained concrete supplied when not specified	When air-entrained concrete is to be used, the mix must be redesigned to compensate, with some reduction in water and sand content, and perhaps some adjustment of cement content (depending on richness of mix).
6. Cylinders improperly made	Samples from which compression test specimens are to be made shall conform to "Method of Sampling Fresh Concrete"-- ASTM C 172. Specimens to check proportions, or as a basis for acceptance shall conform to "Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field" -- ASTM C 31. Strength tests shall be made in accordance with "Method of Test for Compressive Strength of Molded Concrete Cylinders" -- ASTM C 39.
7. Impurities in water and aggregates	Organic materials from swamp waters, sewage, sulfates, humus, as well as trucks which have carried sugar, fertilizers, stock feed, etc., will seriously reduce strength. Check water and aggregates for these impurities. ASTM C 40
8. Incompatible admixtures	Check compatibility of admixtures with the concrete ingredients and with other admixtures by mixing batches without the admixtures.
9. Excessive fines in the mix	Reduce sand content if oversanded. If aggregates are degrading from mixing too long, reduce mixing time. Wash dirty sands and coarse aggregates. Check abrasion resistance of aggregates by ASTM C 131.

Poor Finishability

Finishability can only be judged by the concrete finisher. Slump is not an indication of finishability, although some factors affecting slump also affect finishing characteristics.

Causes	Preventive Measures
1. Insufficient sand	Increase sand content, and/or, use air-entraining agent.
2. Poorly graded sand	Correct gradation. Add fines if needed, especially those sizes passing a #50 sieve.
3. Harsh aggregates	Increase sand content, insure proper grading. Use air-entraining agent.
4. Sliver-shaped aggregates	Screen, if possible. Seek other source of aggregates.
5. Insufficient cement	Increase cement content of mix. May greatly aid finishing.
6. Improper mix design	Check mix design.
7. Improper finishing sequence, tools and/or timing	Suggested finishing sequence: Sidewalks, Driveways, etc.:

Placing: Consolidation
Strike off
Darby or Bullfloat
(LAPSE OF TIME)
Edging
Jointing (Grooving)
Finishing: Floating*
Troweling**
(LAPSE OF TIME)
Texturing (Broom, Burlap)
Curing

* Non-air-entrained, wood float
Air-entrained, aluminum or magnesium float.
**Troweling may be omitted if float finish desired.

Floors, etc.:
Placing: Consolidation
Strike off
Darby or Bullfloat
(LAPSE OF TIME)

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Poor Finishability-Continued

Causes	Preventive Measures
	Edging Jointing (Grooving) Floating* Finishing: Troweling* (LAPSE OF TIME) Second Troweling* Final Troweling (Hand) Curing *Power or hand troweling LAPSE OF TIME in some cases may be several hours.
8. Lightweight aggregate of non-uniform moisture condition, or replacement of light weight fines with normal weight fines may produce finishing difficulties	Follow manufacturers' recommendations when using light weight aggregates.
9. High air contents in excess of recommended contents, especially in hot weather, cause a sticky surface	Use an air meter to control air content.

Poor Workability

The ease or difficulty of placing and consolidating concrete is called workability. Consistency is measured by means of a slump test, and is not necessarily a measure of workability.

Causes	Preventive Measures
1. Insufficient sand	Increase sand content, and/or, use air-entraining agent.
2. Poorly graded sand	Correct gradation. Add fines if necessary.
3. Insufficient cement	Increase cement content.
4. Improper mix design	Check mix design and correct.
5. Prolonged mixing, raises temperature, reduces slump, may increase fines with soft aggregates	Follow manufacturer's recommended mixing speeds. Do not exceed maximum mixing specifications. ASTM C 94, "Standard Specifications for Ready-Mixed Concrete" provides mixing information.

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CHAPTER 1. ISSUANCE, RENEWAL, AND CHANGE OF FIXED BASE

1. ISSUANCE. Section 65.91 of the FAR sets forth the issuance rules for an Inspection Authorization.

   a. Apply for the Inspection Authorization at the nearest FAA General Aviation District Office. Applicants outside the United States should apply to the International Field Office. Tests are given by appointment only and usually take a minimum of five hours.

   b. The applicant is required to provide all the reference material needed for the test. A list of the publications needed and where to obtain them is given in Appendix 1 of this handbook.

   c. Applicants who are employed full time in aviation maintenance under the Federal Aviation Regulations will be considered to have been actively engaged. Those working part time should be evaluated by the Inspector to whom they apply.

   d. An AI needs a fixed base where he can be contacted for FAA administrative purposes. A list of AIs and their locations is made available for people who might need an AI's services.

   e. The AI needs equipment, facilities, and data to help him do a good job. Our modern, complex aircraft require maintenance to be done "by the book" and the use of special tools or equipment to do the work accurately and efficiently.

   f. The written test is designed to test your ability to inspect an aircraft, and how to approve major repairs and alterations. You should know how to use reference indexes to be able to locate specific information quickly:

      (1) Part 1 of the test consists of 10 questions and has a time limit of 20 minutes. It is based on the issuance, privileges, and limitations of the Inspection Authorization. Use of reference material is not permitted during this part of the test.

      (2) Parts 2 and 3 consist of 20 questions each and have a time limit of two hours for each part. They cover situations you would likely encounter while doing annual and progressive inspections and approving major repairs and alterations. Some questions relate to a specific aircraft that is assigned by the test monitor. You will be expected to use or be familiar with the following:

         (a) FARs pertaining to maintenance and airworthiness certification.

         (b) Specifications: Aircraft, engine, and propeller.

         (c) Type certificate data sheets.

Retarded Set

Concrete does not harden or gain strength at a normal rate.

Causes	Preventive Measures
1. Organic impurities in concrete	Organic materials from swamp waters, sewage, sulfates, as well as trucks which have carried sugar, fertilizers, stock feed, etc., will seriously reduce strength and retard set.
2. Improper use of water-reducing and/or retarding admixtures	Use in accordance with manufacturers' recommendations.
3. Concrete too cold	In cold weather, heat concrete, protect concrete in place from cooling.

Rapid Stiffening

Concrete stiffens rapidly becoming difficult to finish.

Causes	Preventive Measures
1. Concrete too warm	Aggregate stockpiles should be kept wet to cool by evaporation. May be necessary to cool mixing water with ice.
2. Concrete mixed too long	Follow recommended mixing times. Counters on trucks.
3. Concrete in truck too long	Follow recommended time in transit, ASTM C 94. Time of charging mixer should be recorded.
4. Aggregates dry (Primarily in old stockpiles)	Aggregates should be kept damp in the stockpile, so that they will not absorb water from the mix.
5. Subgrade dry	The subgrade will draw moisture from the fresh concrete unless it has been previously dampened. On some highly absorptive subgrades, wetting may require a day in advance of placing concrete.

Scaling, D-Cracking

Scaling may be occurring when the surface of a hardened concrete slab tends to crumble and break away from the slab. D-Cracking is a form of distress in concrete surfaces characterized by the successive formation of a series of fine cracks at rather close intervals, often of random patterns, but in slabs paralleling the edges, joints and cracks and usually curving across slab corners. Both of the above may occur in areas subjected to frequent freezing and thawing.

Causes	Preventive Measures
1. Cycles of freezing and thawing when non air-entrained concrete was used.	Use adequate amount of cement and air-entrainment.
2. Early cycles of freezing and thawing of the surface of newly placed air-entrained concrete	The temperature of freshly placed concrete should be maintained above 50 degrees F. for at least five days when using normal portland cement, and 50 degrees F. for at least three days when using high early strength cement. Thirty days of drying should occur after curing is completed, prior to the application of ice control chemicals.
3. Faulty workmanship. Any one of the finishing operations -- screeding, darbying, floating or troweling -- performed while free water or bleed water is on the surface, will create a condition in the top surface layer conducive to scaling, even when the concrete is properly air-entrained.	No finishing operation should ever be performed while free water is present on the surface.

Frozen Concrete

Surface of concrete crumbles after exposure to below-freezing weather while still in the plastic state, or before adequate strength has been attained.

Causes	Preventive Measures
1. Concrete frozen while in the plastic or weak state, generally from the surface inward	In cold weather, heat concrete. Protect new concrete from freezing by use of insulation and heaters. Do not place concrete on frozen ground. See course unit on "Concreting in Cold Weather."

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Spalling

Spalling is the disruption of otherwise sound concrete by force, generally taking the form of chipping or shattering in the vicinity of joints or cracks, or over rusting reinforcement or expanding aggregate.

Causes	Preventive Measures
1. Severe loading, especially on an exposed corner	Do not overload concrete. Avoid point loadings.
2. Rusting reinforcing bar	Protect reinforcing with adequate cover of concrete over the bars.
3. Restraint which prevents normal movement of a slab or other concrete member. Movement would be caused by variations in temperature and moisture.	Arrange joints in such a manner that concrete members will not be restrained and can freely adjust themselves to size variations.
4. Foreign material in a joint	Keep joints clean.

Blister

Bubbles form in the surface of the plastic concrete during finishing operation.

Causes	Preventive Measures
1. Improper finishing tools and techniques	Use a wood float after strikeoff.
2. Excessive slump, especially in hot weather	Use concrete with slump less than four inches.
3. Extreme difference of temperature between concrete and surface on which concrete is being placed	Concrete temperature should be within 10 degrees of surface on which it is to be placed.
4. Poor gradation of sand	Check sand grading and correct.
5. Excessive air content	Check air content and correct.
6. Improper use of retarders	Follow manufacturers' directions.

Discoloration

Light and dark areas and markings on the surface of the concrete, particularly with troweled surfaces.

Causes	Preventive Measures
1. Sprinkling dry cement on the surface of the concrete during finishing. May also lead to scaling and alligator cracking	Dry cement should never be sprinkled on the surface of the concrete.
2. Use of a metal trowel for final troweling of a concrete surface which contains chlorides and which has not been cured	Cure concrete. Wet curing or covering recommended.
3. Mixes containing impurities	Be sure materials are clean.
4. Use of various tyeps of coverings for curing	Curing should be applied evenly. Blankets and membranes should be securely anchored in place.

Abrasion

Excessive wear of the concrete, exposing the aggregates.

Causes	Preventive Measures
1. Inadequate concrete strength	Increase cement content, decrease W/C ratio. Follow principles for making high strength concrete.
2. Lack of curing	Concrete must be cured under favorable conditions of temperature and moisture. There is no such thing as "dry curing". "Dry curing" is no curing.
3. Soft aggregates	Use abrasion-resistant aggregates. See ASTM C 131, "Abrasion of Coarse Aggregates by use of Los Angeles Machine."
4. Other	See "Dusting."

Popouts

Round conical pits 1/4" or deeper in the surface of outside concrete slabs, varying in size with the depth and size of the aggregate particle and the strength of the concrete surface.

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Causes	Preventive Measures
1. Certain types of aggregate particles, such as coal, clay, lignin, flint, glass, etc. Such aggregates swell in the presence of moisture and freezing, or by a chemical reaction between the alkalis in the cement and alkali-reactive aggregates. Sufficient pressure is often built up around the offending aggregate particle to force concrete to break away from it near the surface. This condition is aggravated by freezing and thawing.	Often, popouts are more objectionable from the standpoint of appearance than from danger to structural integrity. If popouts are objectionable, aggregates which have a history of producing popouts should be beneficiated or rejected. A tamper may be used to push aggregates down, provided it is not used to excess. Such aggregate should be pushed down about one inch from the surface. A two course slab with known satisfactory aggregate in the top course may also be employed.

Dusting

Dusting is the appearance of a powdery material at the surface of a hardened concrete slab.

Causes	Preventive Measures
1. An excess of clay or silt in the concrete	Use clean, well-graded coarse and fine aggregate.
2. Premature floating and troweling	Delay floating and troweling until all free water or excess moisture has disappeared and concrete has started its initial set. See proper finishing sequence.
3. Carbon dioxide from open salamanders or power buggy and mixer engines	Vent combustion fumes to the outside. Provide sufficient ventilation.
4. Condensation on the surface before floating and troweling operations have been completed	Provide adequate ventilation and air circulation in enclosed areas.
5. Concentration of dry heat from heaters on freshly placed concrete may inhibit proper hydration of cement	Water jackets may be needed on heaters to increase humidity. Location of heaters may be changed periodically.
6. No curing or inadequate curing	Proper curing for the specified length of time is essential. Concrete that is not cured will often be weak and the surface easily worn by foot traffic.
7. Excessive slump	Use recommended slump.

Volume Change Cracking

Like other construction materials, concrete expands and contracts under various conditions of moisture and temperature. When provision is not made for these volume changes, uncontrolled cracks will result. Generally these cracks do not materially reduce the structural capacity of the concrete, but they may be unsightly.

Causes	Preventive Measure
1. Lack of or inadequate control joints in slabs and walls	Follow recommended jointing procedures. Floors, mzximum joint spacing - 20 feet. Outside flatwork, maximum joint spacing - 15 feet. Walls, maximum joint spacing - not more than 25 feet. Local experience may dictate joint spacings different than the above, since joint spacing necessary to control cracking is related to water content and other characteristics of the concrete.

Structural Cracking

A crack through a slab on grade which has been properly jointed, generally across a corner or parallel to an edge.

Causes	Preventive Measures
1. Inadequate design thickness	Proper design
2. Too early loading	Assure adequate concrete strength before allowing the slab to be loaded.
3. Excessive loads, greater than design loads	Avoid overloads.
4. Poor support	Adequate and uniform compaction of foundation materials. Remove all vegetation, loose earth, mud and organic materials from the sub-grade. Remove all soggy or soft spots, replace with dry earth, cinders, slag or gravel, compacted. A well compacted foundation of 4" to 6" depth is recommended. Where an area is to be filled before concrete is placed, fill material should be placed in layers not exceeding 4 - 6" and each layer thoroughly compacted.

Construction Caused Cracks

Cracks caused by some difficulty occuring during construction.

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Causes	Preventive Measures
1. Construction loads in excess of design loads	Avoid overloading.
2. Settlement of shoring and forms	Assure adequate form support and bracing. See unit on forms.

Plastic Shrinkage Cracks

Plastic shrinkage cracks are random cracks that sometimes occur in the exposed surface of fresh concrete while the concrete is still plastic and before attaining significant strength. They are primarily unsightly, but do not impair the performance of a slab or structure.

Causes	Preventive Measures
1. Excessively rapid evaporation of water from the surface of the concrete	The early application of appropriate curing procedures is the most effective means for preventing plastic shrinkage cracks. Reduce the rate of evaporation by erection of windscreens and sunshades. Use a fog spray in the air over the concrete, but do not sprinkle the concrete. Dampen the subgrade and forms. Dampen the aggregates if they are dry and absorptive. Lower the temperature of the concrete in hot weather if necessary. Avoid overheating the concrete in cold weather. Reduce time between placing and finishing to a minimum. Apply curing as soon as possible after final finishing. Protect the concrete with temporary coverings.

Crazing

Crazing is the occurence of numerous fine hair cracks in the surface of a newly hardened slab due to surface shrinkage. These cracks form an overall pattern similar to a crushed eggshell.

Causes	Preventive Measures
1. Rapid surface drying usually caused by either high air temperatures, hot sun, or drying winds, or a combination of these	Apply fog spray or cover with burlap or canvas immediately after screeding and darbying. Keep covered until ready for floating and troweling. Cure as soon as possible without marring the surface. See Plastic Shrinkage Cracks.

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Causes	Preventive Measures
2. Premature floating and troweling	Do not start floating and troweling until excess moisture has evaporated from the surface.
3. Overuse of the jibberbug, vibrating screed, darby or bull float may contribute by working an excess of mortar to the surface	Use these tools properly.

Honeycomb

Open areas and holes in formed concrete.

Causes	Preventive Measures
1. Use of a harsh, dry mix not properly consolidated. This is sometimes due to excessive or prolonged mixing during hot weather often because of poor scheduling of trucks.	Redesign mix to provide better workability. Use proper consolidation methods. The entire layer or lift of concrete should be vibrated. Vibrators should be inserted rapidly and withdrawn slowly, just the reverse of what appears to be normal practice. Concrete along forms should be spaded, or puddled. Forms may be vibrated or tapped.
2. Loss of cement or mortar through cracks or knot holes in the forms, sometimes called rock pockets or gravel streaks.	The use of good quality, tightly built forms. See unit on Forms.

Sand Streaking

Sand streaking shows as areas of sand giving a non-uniform appearance to formed concrete.

Causes	Preventive Measures
1. Oversanded mix	Redesign mix.
2. Improper vibration	Vibrate properly. See unit on Placing Concrete.
3. Wet mix	Use stiffer mix. Air-entrainment will greatly reduce sand streaking.
4. Improper placement	Use a drop chute to avoid bouncing concrete against forms and rebars during placing. Lifts should not 18 to 24 inches when appearance important.

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Flow Lines

Concrete layers show in formed concrete.

Causes	Preventive Measures
1. Concrete placed in piles in forms instead of even layers	Concrete should be placed in even lifts generally not exceeding 18-24 inches throughout the forms to avoid layers of concrete flowing over other concrete.
2. Improper vibration	Vibrators should extend through the lift to the previously placed lift and withdrawn properly.

Application

Discuss the Causes and Preventive Measures of the common difficulties.

Test or Discussion Points

1. Explain the causes of and preventive measures for each of the 21 difficulties listed in the text.

2. Define quality concrete.

Tools and Materials

Photographs of difficulties, specimens, sample laboratory reports.

Reference Materials

1. Portland Cement Association, Finishing Concrete Surfaces -- Preventing Blemishes, CP83.

2. Permanente Cement Company, Concrete Surface Defects -- Causes, Prevention and Repair, Technical Service Dept. Bulletin No. 17.

3. American Concrete Institute, Concrete Primer

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REFERENCES

PORTLAND CEMENT ASSOCIATION

Single copies of the following Portland Cement Association publications are available free in the United States and Canada. Contact your nearest Portland Cement Association district office or write to the Portland Cement Association, 33 West Grand Ave., Chicago, Ill. 60610.

Portland Cement Association--What It Is and What It Does (E 102)
The Making of Portland Cement (E 108)
Chart: Manufacture of Portland Cement (E 112)
Cement and Concrete Reference Book (M 109)

AMERICAN SOCIETY FOR TESTING AND MATERIALS

The following publications are available at a nominal price from the American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa. The latest edition should always be used, as specifications are supplemented and revised periodically.

Designation C31, "Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field"

Designation C33, "Standards, Specifications for Concrete Aggregates"

Designation C39, "Standard Method of Test for Compressive Strength of Molded Concrete Cylinders"

Designation C94, "Standard Specifications for Ready Mixed Concrete"

Designation C143, "Standard Method of Slump Test for Consistency of Portland Cement"

Designation C172, "Standard Method of Sampling Fresh Concrete"

Designation C330, "Tentative Specifications for Lightweight Aggregates for Structural Concrete"

AMERICAN CONCRETE INSTITUTE

The following publications are available at a nominal price from the American Concrete Institute, P.O. Box 4754, Redford Station, Detroit, Mich. 48219.

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(d) Procedures for conducting annual and progressive inspections.

(e) Rules pertaining to the Inspection Authorization; issuance, privileges, and limitations.

(f) Airworthiness Directives.

2. RENEWAL. All Inspection Authorizations expire on March 31 of each year. For renewal you should be prepared to show that you have had the activity required in FAR 65.93.

a. Renewals usually are done in conjunction with a safety meeting designed to help the AI with his work. These usually include:

(1) Discussion of maintenance problems of a general nature.

(2) Discussion of recent regulation changes and how they affect the AI.

(3) When available, manufacturers of aviation products hold service clinics, etc., to acquaint an AI with current or new equipment and service problems.

b. If you are unable to attend these meeting or if none is held in your area you should arrange with your local FAA office for renewal during the month of March.

3. CHANGE OF FIXED BASE. Change of address of a fixed base of operations by an AI requires that the FAA be given written notice prior to exercising his privileges at the new address.

ACI 318, "Building Code Requirements for Reinforced Concrete"

ACI 347, "Recommended Practice for Concrete Formwork"

ACI 604, "Recommended Practice for Winter Concreting"

ACI 605, "Recommended Practice for Hot Weather Concreting"

ACI 613, "Recommended Practice for Selecting Proportions for Concrete"

ACI 614, "Recommended Practice for Measuring, Mixing, and Placing Concrete"

Special Publication SP-1, "Concrete Primer"

NATIONAL READY MIXED CONCRETE ASSOCIATION

900 Spring Street, Silver Spring, Md. 20910

Publication 44, Control of Quality of Ready Mixed Concrete, prepared by the Engineering Division. Fifth Edition, October 1962.

Publication 66, Sampling and Testing Ready Mixed Concrete, prepared by the Engineering Division, September 1960 (replaces Publications 29 and 47). Revised edition, March 1962.

Publication 100, (JRL No. 10), "Testing Uniformity of Large Batches of Concrete," by D. L. Bloem, R. D. Gaynor, and J. R. Wilson. Authorized reprint from ASTM Proceedings.

Publication 106, Cooling Ready Mixed Concrete, published by the Engineering Division, June 1962.

Publication 110, Control of Mixing Water in Ready Mixed Concrete, panel discussion presented at 1963 NRMCA Convention.

EXPANDED SHALE, CLAY AND SLATE INSTITUTE

The following publications are available at a nominal price from the Expanded Shale, Clay and Slate Institute, National Press Building, Washington 4, D.C.

Lightweight Concrete Information Sheet No. 1, Workability Is Easy.

Lightweight Concrete Information Sheet No. 3, Suggested Mix Design for Job Mixed Structural Concrete.

Lightweight Concrete Information Sheet No. 7, Floor Finishing.

NATIONAL ACADEMY OF SCIENCES--NATIONAL RESEARCH COUNCIL

2101 Constitution Ave., N. W., Washington 25, D.C.

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Building Research Advisory Board Publication 1077, Design Criteria for Residential Slabs-on-Ground, Final Report.

MANUFACTURERS OF SMALL CONCRETE MIXERS

Instruction manuals.

FILM LIST

Several 16 mm. sound-color motion pictures produced by the Portland Cement Association are available to you and your group on a free loan basis.

Instructional films are effective teaching aids. Good films enable an instructor to make a presentation that is understood more easily than written or spoken words.

Here is a list of films now available. Instructions on how to order appear at the end of the list.

Building a Highway (15-1/2 minutes). Use in Unit 3. This film shows the construction of a modern highway from the initial planning stages through the final ribbon-cutting ceremony. It explains in layman's language the complicated work of planning, designing, and engineering for today's heavy-traffic roads. Some unusual and colorful animation shows construction of the Appian Way in ancient Rome, development of other ancient roads, and the history of highways in the United States.

Building the Acacia Avenue Reservoir (14 minutes). Use in Unit 3. This is an on-the-job report of the construction of a 4-million-gallon buried reservoir constructed with ready mixed concrete and precast roof elements. The film explains the need for such reservoirs and points out interesting construction procedures. It was produced with the cooperation of the City of Fullerton, Calif.

Concrete Example (16 minutes). Use in Unit 11. Particularly recommended for agricultural students. This film shows how to obtain good concrete jobs with the materials and equipment available. It includes directions for selecting aggregates and for mixing, placing, finishing, and curing concrete. A recommended method of ordering and using ready mixed concrete is also covered.

Concrete in the Sixties (approx. 22-1/2 minutes). Use in Unit 1. An annual newsreel of outstanding and exciting concrete projects in North America. The film shows new applications of concrete in the United States and Canada.

Concrete-Lined Irrigation Canals Save Water (15 minutes). Use in Unit 21. This film dramatizes the importance of concrete canal linings in conserving irrigation water. In addition basic steps in the construction of lined canal systems are discussed and illustrated.

Construction of a Demonstration Section of Prestressed Concrete Pavement (10 minutes). Use in Unit 18. The film shows all steps in construction of a 1,500-ft. section of 9-in.-thick prestressed concrete taxiway at Biggs Air Force Base in Texas. Scenes include tearing up the old pavement, preparing subbase and subgrade, locating ducts for prestressing strands, and methods of stressing longitudinal and transverse strands. Produced in cooperation with the U.S. Air Force and the U.S. Army Corps of Engineers, the movie was filmed during conversion of Biggs AFB facilities for full jet operations.

From Mountains to Microns (24-1/2 minutes). Use in Unit 4. This film shows production of portland cement from raw materials to the finished product. It includes outstanding examples of concrete construction, the use of cement in making concrete, and a brief examination of the organization and work of the Portland Cement Association.

How to Make Decorative Patio Floors for Outdoor Living (19-1/2 minutes). Use in Unit 14. The film shows all the required steps in producing decorative patio slabs with exposed aggregate and colored finishes. Flagstone, incised geometric, and leaf patterns are illustrated.

How to Transport, Place, Finish, and Cure Quality Concrete (32 minutes). Use in Units 13, 14, or 15. It follows the steps involved in taking a proper concrete mix from the mixer by means of buggies, buckets, chutes, trucks and pipes to the point of placement. The film shows approved methods for placing concrete in horizontal and vertical forms, proper finishing techniques for slabs and for vertical walls, and a variety of curing methods with particular emphasis on winter protection.

New Shapes in Concrete (16-1/2 minutes). Use in Unit 3. This film provides an exciting look at the large number and variety of shell structures--domes, barrels, folded plates, and hyperbolic paraboloids--that have been erected all over America. A section of the film demonstrates the principles of shell construction and a portion is devoted to the brief but astounding history of shell design and construction in Europe and the Western Hemisphere.

Pageant of American Farms (16 minutes). Use in Unit 1. This film traces the history of agriculture from the days of the rugged, self-sufficient pioneer to modern push-button farming. It shows authentic old-time equipment and early farming methods contrasted with the latest innovations such as confinement feeding systems of livestock breeding and feeding. The film describes the basic changes that have taken place in farm buildings, including scenes of Frank Lloyd Wright's proposed "unified farm."

Principles of Quality Concrete (37 minutes). Use in Unit 11. This movie describes the essential steps in making quality concrete from the design of the mix to the time the concrete comes from the mixer.

Quality Ready Mixed Concrete (31-1/2 minutes). Use in Unit 10. The film shows

various plant operations involved in producing quality ready mixed concrete and the steps necessary on the part of the contractor and workmen to maintain its quality in the field to produce satisfactory jobs. Many large and small projects, both urban and rural, are shown.

The Road That Can't Rest (22 minutes). Use in Unit 21. This is the story of the network of roads that run through your area. How these expressways, freeways, parkways, or whatever you choose to call them, affect your life is told in this colorful and exciting film.

Tilt-Up Construction on the Farm (15-1/2 minutes). Use in Unit 3. This film is designed as a training aid to show step-by-step methods of tilt-up concrete construction--from excavation to roofing. It contains construction sequences and animation to dramatize building procedures. The film also illustrates the vast range of farm buildings well suited to tilt-up construction. Buildings from many geographic areas are shown in use to dramatize the versatility of tilt-up construction.

Concrete's Finest Fifty Years (32 minutes). The film dramatizes the spectacular role of concrete in the past half century; in structures, highways, farms, water facilities and homes.

HOW TO ORDER FILMS

Just write a postcard or letter to the Portland Cement Association district office serving your area (see list on next page). Specify the title of the film. Print your name and full mailing address. List the first and second choice of dates for your film showing. Please allow at least three weeks for booking. The film will be sent to you postpaid.

Films may be purchased for classroom use. Further information may be obtained from your Portland Cement Association district office.

PORTLAND CEMENT ASSOCIATION SLIDE SET

Mr. Quality Concrete. This set consists of 40 2x2-in. color slides. Some Portland Cement Association district offices have sets available on a loan basis. Sets may be purchased at a cost of 25 cents per slide from the General Office of the Association. Address:

Portland Cement Association, 33 West Grand Ave., Chicago, Ill. 60610

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680 Wilshire Place
Los Angeles, Calif. 90005

Northern California-Nevada
235 Montgomery St.
San Francisco, Calif. 94104

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721 Boston Bldg.
Denver, Colo. 80202

Florida
1612 East Colonial Drive
Orlando, Fla. 32803

Georgia-South Carolina
161 Peachtree St., 4th Floor
Atlanta, Ga. 30303

Illinois
111 West Washington St.
Chicago, Ill. 60602

Indiana
612 Merchants Bank Bldg.
Indianapolis, Ind. 46204

Iowa
408 Hubbell Bldg.
Des Moines, Iowa 50309

Kansas
618 Capitol Federal Bldg.
Topeka, Kan. 66603

Kentucky
1105 Commonwealth Bldg.
Louisville, Ky. 40202

Louisiana
611 Gravier St.
New Orleans, La. 70130

Maryland-Delaware
Jefferson Bldg.
Baltimore, Md. 21204

Michigan
900 Stoddard Bldg.
Lansing, Mich. 48933

Minnesota-Dakotas
1490 Northwestern Bank Bldg.
Minneapolis, Minn. 55402

Missouri
913 Syndicate Trust Bldg.
St. Louis, Mo. 63101

Montana
Mezzanine--Placer Hotel
Helena, Mont. 59601

Nebraska
720 City National Bank Bldg.
Omaha, Neb. 68102

New England
(Conn., Maine,
Mass., N. H., R. I., Vt.)
20 Providence St.
Boston, Mass. 02116

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VT 013 299
Construction--Supervision and Inspection,
Course of Study.

California State Dept. of Education,
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DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *SUPERVISION; *CONSTRUCTION PROGRAMS; *INSPECTION; VOCATIONAL EDUCATION; ROAD CONSTRUCTION; STRUCTURAL BUILDING SYSTEMS; UTILITIES; METALS; TEACHING GUIDES; STUDY GUIDES; BUILDING MATERIALS

ABSTRACT - This teaching guide, developed by the Bureau of Industrial Education in cooperation with the Education Advisory Cwmmittee of the California Council of Construction Inspectors Association, is intended for one semester's instruction of persons who will be engaged in the supervision and construction of buildings under construction. The material is divided

into seven units which include: (1) Duties of the Construction Inspector, (2) Structural Wood Materials, (3) Structural Metals, (4) Masonry, (5) Paving, (6) Utilities, and (7) Review and Examination. This document is illustrated with diagrams, graphs, charts, and pictures. A related document is available as VT 013 298 (also in this issue). (GEB)

VT 013 299

VT013299

Course of Study

CONSTRUCTION

SUPERVISION AND INSPECTION

STRUCTURAL SERIES № 2

CALIFORNIA STATE DEPARTMENT
OF EDUCATION
Bureau of Industrial Education
Sacramento, 1967

MAX RAFFERTY,
Superintendent of
Public Instruction

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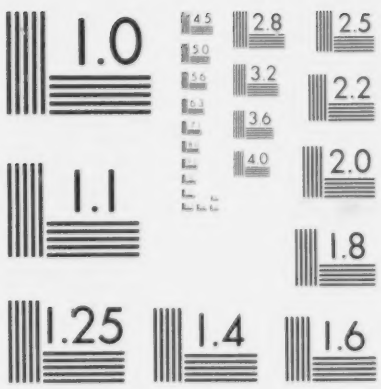

MICROCOPY RESOLUTION TEST CHART
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Course of Study

CONSTRUCTION

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STRUCTURAL SERIES № 2

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Sacramento, 1967

MAX RAFFERTY,
Superintendent of
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CHAPTER 2. SUGGESTIONS FOR DEVELOPING GOOD OWNER/AI RELATIONS

4. GET IT STRAIGHT. Misunderstandings usually result from a lack of clear communication. Be sure to come to a mutual agreement with an owner as to just what is to be done. Attention to the following details will usually avoid the ill-will a later disagreement may generate:

a. Itemize the work on a work order or in some manner that will provide a clear understanding of the work to be done.

b. Establish a firm understanding about the cost or range of cost anticipated for the job.

c. If an annual inspection is involved, point out that certain maintenance is required to perform the inspection, such as:

(1) Removal of cowling, inspection plates, fairing, upholstering, etc.

(2) Aircraft and engine to be cleaned.

(3) Disassembly of wheels and other components to determine their condition.

d. Advise the owner that an annual inspection involves determination of compliance with aircraft specifications and airworthiness directives.

e. Agree as to whether routine servicing is to be included as part of the inspection or is to be performed separately. Such servicing may not be a part of the inspection, but may be conveniently done while conducting the inspection. Such items might be:

(1) Cleaning spark plugs.

(2) Servicing landing gear oleos.

(3) Changing oil.

(4) Minor adjustments.

(5) Servicing the brakes.

(6) Dressing propeller blade nicks.

(7) Lubrication.

(8) Stop drilling small cracks and minor patching of cowling and baffles.

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STRUCTURAL SERIES #2

This course of study was prepared by the Bureau of Industrial Education at the request of the industry, to meet the needs of persons engaged in the supervision and inspection of buildings under construction. Structural Series No. 2 covers one semester's work. This material was developed by the Education Advisory Committee of the California Council of Construction Inspectors Association. This publication is in draft form and will be refined by the Statewide Committee after it has been tested by various instructors.

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STRUCTURAL SERIES #2

UNIT I - DUTIES OF THE CONSTRUCTION INSPECTOR

I-A - History of Inspection

Inspections, in some form or another and under a variety of nomenclatures, have been carried on through all ages of history, this being particularly true at various stages of extensive construction carried out by rulers throughout all civilized areas of the world, an example being an overseer for the various Pharaohs during their program of monumental construction, these particular inspectors, of course, being basically concerned with maintaining a force of slave labor.

From that time forward, the complexities of government, use of greater varieties of materials, and creation of guilds (ultimately unions) of various trades have steadily increased the need for intelligent and responsible inspection of all types of construction.

In the State of California, in the current century a massive earthquake occurred in 1933, as a consequence of which inspections became enacted into law relative to all public school construction.

Within the past few years, in this State, the Inspectors have created a statewide association aimed to extend their knowledge and abilities toward better inspection service.

I-B - Qualification

1. Experience:

The major qualification of a good Inspector is his years of experience in construction work of a type similar to that for which he is being assigned.

It is becoming more and more - on large projects - a practice to assign Inspectors on the basis of specialized knowledge, such as mechanical, electrical, concrete work, steel work, etc.; however, large portions of construction projects still require the services of an Inspector with a good general knowledge of all phases of construction.

Experience on that basis would indicate an Inspector drawn from the ranks of construction superintendents.

2. Education:

The need for inspection service is steadily increasing to such an extent that it is becoming more and more difficult to draw men of experience from the ranks of their previous occupations.

As a consequence, younger people, without a great amount of job experience, are becoming interested in this field of work.

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Also, it is increasingly evident that the qualifications of an Inspector definitely require the inclusion of a basic and current knowledge of building materials and construction procedure.

Hence, the current presentation of a course of study for construction supervision as presented by the California State Department of Education, Bureau of Industrial Education.

3. Personality:

The prime duty of a construction Inspector is to make sure that construction is performed in accordance with the drawings and specifications. An Inspector has no authority to deviate from the drawings and specifications; however, at the same time, an Inspector should avoid assuming an unreasonable attitude concerning his own interpretation when reasonable doubt exists as to intent, especially concerning minor details.

At all times, the Inspector should bear in mind that the principal objective is the successful completion of the intent of the contract documents. All directions by the Inspector should be based upon obtaining the best possible final result in accordance with the documents.

Accepted and proven construction practices in the use of common sense and good judgment should be the basis of the Inspector's attitude.

The above results can only be successfully obtained by the Inspector through a dignified, quiet, tactful, and firm attitude on his part.

I-C - Duties

Copies of such codes as Uniform Plumbing, Electrical and Safety Codes, Uniform Building Code, local ordinances, etc., must be maintained on the project at all times for the use of the Inspector, the Owner, and the Architect/Engineer.

The Inspector shall set up and maintain files, including a daily diary, Inspector's copies of correspondence, daily reports, the contract form, an approved set of plans, specifications, addenda, and change orders, approved shop drawings, approved samples, concrete placing records, welding records, pile driving records, water, gas, sewer tests, concrete tests, steel tests, progress reports, and other correspondence pertaining to the contract.

Contract documents usually call for (and if not the Inspector should require) a schedule of parts of the work showing the estimated starting and completion dates, all within limits of the time for completion of the contract. As the work progresses, he shall plot on this chart the weekly progress of the work.

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UNIT I - DUTIES OF THE CONSTRUCTION INSPECTOR

Whether called for or not by the contract documents, it is imperative for the good of the project that the Inspector keep a daily diary. The prime value of the diary is to cover current actions, attitudes, and conditions while the work is in progress.

It is potentially extremely valuable.

It may be used to advise supervisors of the progress of the work, of any difficulties being encountered, of any non-compliance with the drawings and specifications, and matters of similar nature. Being maintained on file, it will be of use in the event a Contractor requests an extension of time or an increase in contract price, and for audits of work progress.

It is therefore important that the diary be completely filled out in a legible manner and that all pertinent facts be stated percisely. Statements should be so worded that persons reading and evaluating the diary at some future date will be aware exactly what happened and what information the Inspector intended to convey.

The greatest value of this diary is its information over and above current weather conditions, amounts of material received, lists of material in use, or data on the contractor's labor force.

Items to incorporate in a diary:

a. Any oral statement or order given to Contractor's supervisory personnel on behalf of the Architect/Engineer concerning additional work or concerning a controversial item.

b. Warnings given to the Contractor's personnel concerning improper, inadequate, or unsafe methods which are likely to result in injury to personnel or in damage to the Owner.

c. Conditions encountered in excavation, such as change of material from that indicated on the plans, the presence of rock, boulders, or other hard material. The encountering of utility lines not shown on the drawings or, if shown, found in a different location.

d. Any claim the Contractor may make to the Inspector regarding interpretations of drawings and specifications with respect to the inclusion of work or material which he feels is not covered or required.

e. Any materials or equipment rejected because of non-compliance with the specifications. This should include any material or equipment that is found to be defective as a result of tests or analysis.

f. Delays caused by non-delivery of material, equipment breakdowns, weather conditions, insufficient supply of labor, etc. Remarks concerning general progress of the job.

g. Work accomplished by the Contractor, and its location.

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Any and all other reports required on the project can be lifted from this diary on the basis of weekly, semi-monthly, or monthly reports. For example, should the particular project be a public school, an additional report on a form provided by the Office of Architecture and Construction is required on a quarterly basis and at completion of a project. This State form is termed a "Verified Progress Report" and formerly was required to be notarized.

The Inspector shall notify the Contractor and Architect/Engineer of any deviation from the approved plans and specifications. Care shall be taken that the Inspector does not issue instructions to the Contractor which will result in a claim for extra compensation or extension of contract time. Such orders will be issued only as contract change orders from the Architect/Engineer's office after proper approvals have been obtained, and any changes in contract price or time have been determined.

The Inspector shall verify that shop drawings and samples of certain materials, and satisfactory reports of tests of certain materials, as required by the plans and specifications and in the instructions to the Contractor are submitted to the Architect/Engineer's office and approved before the materials are incorporated in the work.

The Inspector shall verify percentage of work completed as presented by the Contractor for payment on an approved percentage breakdown form before this information is forwarded to the Architect/Engineer. All items of percentage shall be consistent with work completed. Contract documents usually require that the bidder submit list of subcontractors. Any change in the listed subcontractors should be approved by the Owner and the Architect/Engineer. Work on the job by any subcontractor not listed in the contract documents or properly approved is a violation of the contract and the Architect/Engineer should be advised immediately.

The contract documents provide for monthly payments to be made under the contract on the basis of percentages of work completed, this usually on a form prepared by the Architect/Engineer or by the Contractor and approved by the Architect/Engineer. This monthly estimate and request for payment must be checked for percentage of work completed and approved by the Inspector before it is submitted to the Architect/Engineer's office for certification.

Changes in the plans and/or specifications are a possibility in any contract.

No deviations from the approved plans and specifications shall be permitted until the Inspector receives notification from the Architect/Engineer that the change meets with the approval of all parties concerned.

A formal change in plans and specifications and, if a change in price or time is involved, a change in contract - termed a Change Order - will be prepared and issued by the Architect/Engineer's office.

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Occasionally the Architect/Engineer may notify the Contractor to proceed with the change after necessary informal approvals have been obtained, pending approval of the formal Change Order. This information will also be given to the Inspector and will be the Inspector's authority to allow the Contractor to proceed with the change.

The Inspector has no authority to order change in plans, specifications or contract. The above-mentioned Change Orders, which stem from any condition necessitating a deviation from the requirements of the contract documents, must be registered as a Change Order.

The Owner is the only party legally authorized to approve any changes in the work under the contract. This means that no individual has the authority to order a change in the work prior to the approval of the Owner, and the Construction Inspector cannot authorize Change Orders.

Each Change Order, upon approval, becomes a complete supplemental contract document; therefore must be complete in every respect, including the following:

a. Reference as to the party requesting the change.

b. Reason for requesting the change.

c. A detailed description of the proposed change, listing the exact location and nature of the work, or a supplemental drawing attached and referred to on the face of the Change Order.

d. Change in contract amount, if any.

e. Change in contract time, if any.

As-built or record drawings need to be maintained by marking up a set of prints indicating items which may comply with the approved plans and specifications but are not located or indicated in detail, such as the depths of any footings carried below those shown on the drawings, the exact locations and depths of underground and underslab conduits and piping, the location of conduits embedded in concrete or otherwise inaccessible. These as-built or record prints shall be turned over to the Architect/Engineer upon completion of the project, or as requested.

If the project is not completed within the time prescribed in the contract, the Inspector shall make a complete report listing all missing items and work not completed, this to be forwarded to the Architect/Engineer. When the project is complete, the Inspector will review with the Architect/Engineer any and all guarantees, keying instructions, and completion of final punch list items, etc., that are called for in the contract documents. The Inspector must confirm that the above are received by the Owner before the Architect/Engineer can certify the completion of work.

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f. Make a written list of all discrepancies found on the aircraft indicating if and how corrected. The owner may want a copy of this list.

g. Discrepancies not corrected that result in the aircraft being reported as "unairworthy" must be listed in duplicate with the original going to the owner and the copy to FAA. The owner should understand that the aircraft is not eligible to be operated without a special authorization until the discrepancies are corrected.

h. Establish a reasonable time period to accomplish the inspection.

i. Request the owner to supply the complete aircraft records for review and entries. Point out that this is necessary to properly conduct an annual inspection.

j. Complete the inspection as soon as practicable. Often an aircraft will sit around the shops waiting for parts, etc., even though the inspection as such was actually finished. In these cases it is advisable to officially report the aircraft unairworthy. (Ref: FAR 43.11(a)(5).) When the parts arrive, the repairs can be completed and the aircraft returned to service in the usual manner. Very often this time lapse represents several weeks, or even months, during which many things can deteriorate on the aircraft. Also, there is always the chance that an AD involving some part of the aircraft may have been issued in the interim. In these cases, it might be unwise to complete the repairs originally intended and sign the aircraft off as "airworthy" without doing another complete inspection.

k. Complete the aircraft record entries as required by sections 43.9 and 43.11 of the FARs. Make adequate descriptions of repairs or alterations if accomplished along with your inspection. It is not necessary to record preventive maintenance; however, anything defined as a repair or alteration should be entered.

l. Record compliance with all Airworthiness Directives actually accomplished. Provide sufficient information so that the owner has that required of him by FAR 91.173(b)(2). A general statement such as "All ADs complied with" is NOT an adequate entry and should be avoided. Many owners keep a separate record of AD compliance in the back of the logbook or a specially provided section. This is a good place to identify those ADs of a recurring nature and when the next compliance is due. See Figures 1 & 2, for typical entries.

m. When approving repairs and alterations, if possible, be available as work progresses on major jobs. This way you can see affected areas and structures better than after completion of the entire job. In many cases the workmanship during the progress of the job can be improved much more easily than having to do it over later.

All questions, interpretations, suggestions and criticisms posed by the Contractor or Inspector shall be directed to the Architect/Engineer, or his field representative.

I-D - Criteria for Good Inspection

The Inspector must keep in mind that the Owner is the only party legally authorized to make any change in the work under the contract. The Architect/Engineer, as part of his service and duties under his contract with the Owner, is completely responsible for all phases of the work to and including the completion of the construction contract.

The Inspector, while an employee of the Owner, must constantly and consistently, to his best ability, keep the Architect/Engineer completely current with all phases of the progress of construction. He serves as the "eyes" for the Architect/Engineer to make sure that the design is carried out as contemplated. He must be alert not only in inspecting the structural phase of the job but must also give careful attention to all phases of the finished work with particular emphasis on mechanical and electrical systems.

The Inspector should not be satisfied with merely reporting mistakes that occur on the job after they are made. He should become so well acquainted with the plans and specifications and with all phases of the project that he can anticipate and prevent costly and time-consuming mistakes and foresee bottlenecks due to delayed delivery of material or improper scheduling of the work.

In this way the Inspector can perform a real service to the Owner, to the Architect/Engineer, and to the Contractor. He thus becomes an important member of the team that it takes to insure a smoothly running construction job, a safe and properly constructed building, delivered on schedule.

The Inspector should keep in mind that the attitude of the public toward the Owner and his building program is influenced by the manner in which he conducts himself. He must be just, fearless, impartial, unprejudiced and constructive. Finally, he should remember that there is a common rule of law that says "in every contract there exists an implied covenant of good faith and fair dealing."

I-E - Relationships

1. In General:

The position of Inspector involves responsibility that requires technique. The following rules should be observed governing personal conduct:

He should not talk about administrative problems connected with the project in public. Such discussion by the Inspector should only be held with appropriate personnel officially connected with the project. (Loose talk is poor relations for all concerned.)

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He should be swift and decisive in his actions against violence, negligence, or evidence of bad faith. He should be just as quick to recognize and commend good work.

He shall have no personal connection with and should not accept a loan, gift, nor gratuity either directly nor indirectly from any individual, contractor, subcontractor, group, company, corporation, nor public body that is in any way responsible for compliance with the terms and conditions of the contract.

He shall not use narcotics nor intoxicating liquors while on duty, nor appear on duty under their influence.

He shall not suggest nor recommend for employment any particular person or persons or subcontractor nor should he suggest nor recommend the purchase of any specific material nor product except insofar as the specifications may require.

He should not give orders nor instructions to the contractor nor any subcontractor involving any change in the work not covered by the contract, except upon instruction from the Architect/Engineer with approval of the Owner.

He shall not give orders and instructions to the Contractor nor any subcontractor that in any way involves responsibility for or gives cause for claim against the Owner. He shall not assume the duties of any superintendent nor foreman of the General Contractor nor any subcontractor.

2. Contractors:

An Inspector should understand that as a general rule he should not interfere with the Contractor's method of performing work. Such interference could, to some extent, release the Contractor from his responsibility under the contract for the results obtained.

An Inspector's action ordinarily is limited to the rejection or acceptance of various parts of the work as they are completed. If the Contractor's methods are obviously unsafe, inadequate, or do not comply with established construction practices, the Inspector could warn the Contractor against continuing such methods. Following such warning, if the Contractor continues to use such methods, the matter should be promptly brought to the attention of the Architect/Engineer or his designated representative for further action.

An Inspector should always do business with the responsible superintendent or foreman on the job, and should carefully avoid the issuance of any directions to the Contractor's workmen. At no time should an Inspector take any action which could be interpreted as supervision or direction of the Contractor's operations.

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An Inspector should be alert to cooperate with the Contractor in expediting progress of the work; to catch errors in questionable practices in time to avoid future rejection or slowdown of work or material; to observe the Contractor's equipment and operations from a safety standpoint, assisting him in correcting safety hazards. An Inspector's relationship with the Contractor should be cooperative and friendly at all times without compromising the Owner's objective of obtaining high quality construction in accordance with the drawings and specifications, and within the limits of allowable contract time.

An Inspector's actions should show neither favoritism toward, nor discrimination against, the Contractor.

3. Owners:

In almost every case the Inspector is directly an employee of the Owner and as such is fully responsible to the Owner.

By the same token, the Architect/Engineer, in his services to the Owner is completely responsible for the project from its inception to its completion, which puts the Inspector in a position of being responsible to the Architect/Engineer as well.

The Inspector should, as a consequence, at any time that he receives direct orders from the Owner in any phase of the work, such as reports, changes in work or material, etc., be very careful to contact the Architect/Engineer before proceeding with any such issued orders.

4. Architect/Engineer:

The Inspector shall work under the direction of the Architect/Engineer. In his review of plans and specifications, any inconsistencies or seeming errors must be reported promptly to the Architect/Engineer for interpretation and instructions. Should he feel that such interpretations and instructions are not in conformity with the approved plans and specifications, he shall request further clarification.

5. Field Representatives:

Certain Federal, State, Local, and Building Trade representatives periodically visit most projects. These people are in the nature of Inspectors for such organizations as Health, Education and Welfare, Department of Housing and Urban Development, Office of Architecture and Construction, Department of Local Assistance, Fire Marshal, Industrial Safety, County Health Department, Electrical and Plumbing Codes, Trade Unions, etc.

These people should contact the Inspector. If not, the Inspector should be alert to the visits, make himself known and record in

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general all conversations and specifically any indicated violation or recommendation of Code, or agency requirement indicated for prompt report to the Architect/Engineer.

I-F - Legal Obligations

Aside from the legal obligations imposed on the Inspector by the terms of the construction contract between the Owner and the Contractor, he has the following legal obligations:

1. To make truthful reports on the forms furnished.

2. To comply with the conditions imposed on his employment as an Inspector by local building departments and/or State agencies.

There is no State licensing law governing Inspectors at the Present time. Should such be enacted, the Inspector will have legal obligations as enumerated therein.

I-G - Tips to Inspectors

1. The Inspector shall carefully study and analyze the terms and conditions of the contract agreement, plans, specifications, and addenda, or interpretations, if any. All inconsistencies or seeming errors in the documents should be reported promptly to the Architect/Engineer for interpretation and instruction.

   The Inspector shall keep a file on the job of all approved plans, specifications, shop drawings, instructions, etc., and he shall immediately return to the Architect/Engineer any unapproved documents for proper action. He shall also keep copies of applicable codes on the job and he shall refer to them from time to time as necessary.

2. The Inspector shall give special attention to the terms and conditions of the specifications relative to the testing of materials. At the start of the project he should obtain the name of the testing laboratory which will conduct the testing of materials for the project. When materials are required to be tested, the laboratory reports showing them to be in accordance with the plans and specifications shall be in his hands before the materials are incorporated in the work except, of course, that concrete is tested as it is placed and reports are received when specified. If any tests do not meet the specification requirements, the Inspector shall notify the Architect/Engineer immediately and request instructions in writing.

3. The Inspector shall inspect all materials immediately upon their delivery to the job. Delivery shall be arranged for such a place and in such a manner so that he can inspect them and so that they will be protected from damage by the weather or other causes and so reject any material not acceptable under the terms of the contract, and notify the Architect/Engineer.

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4. The Inspector shall immediately notify the Architect/Engineer in the event he does not feel qualified in passing judgment on questionable material or workmanship. The Architect/Engineer will take the necessary action to provide additional information and/or inspection.

5. When any work is let on a unit cost or cost-plus basis, as provided for in some contracts or in some Change Orders, the Inspector shall keep a daily record in duplicate of all labor and material, including quantities used, and report this information to the Architect/Engineer.

6. The variety and complexity of materials and methods of work requiring inspection suggest that a check list of pertinent items for inspection be prepared for reference by the Inspector as the job progresses. The following is a recommended check list, comprising four basic items:

   I. Structural Work:

      a. The Inspector shall keep a special record of certain phases of the construction procedure, as follows:

         Concrete Placing Operations: The record shall show the time and date of placing of concrete, and the time and date of removal of forms in each portion of the structure. Verify material testing requirements of the A.C.I. Manual of Concrete Inspection, or other applicable codes, for cast in place, precast, prestressed and pneumatically placed concrete. Verify with Architect/Engineer location of cold, expansion, and tooled or weak joints.

         Welding Operations: The record prepared by a certified welding inspector shall include identification marks of welders, list of defective welds, manner of correction of defects, etc.

         Structural Steel: Verify material in accordance with applicable Codes, laboratory tests, erection specifications, field and shop painting, bolted and riveted connection, use of high tension bolts. Note: Use of drift pins, slotting of holes or cutting members to force sections in place is not permitted.

         Driven and Drilled Piling: Driven concrete piles shall be carefully recorded and the penetration under the last ten blows for each pile when piles are being driven. Drilling of concrete piles shall be verified for depth, belling, alignment, cleanness of shaft, and foundation soil material. Support of reinforcing, placing of concrete and cap elevations shall be checked.

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Structural Glued Laminated Lumber: All structural glued laminated lumber must be continuously inspected during fabrication by an approved inspector. Verify specified lumber grade marking, timber connections and approved types of glue and gluing methods.

b. Layout:

Check general instrument layout for accurate locations of property lines, building locations, easements, grades, floor lines, drainage, etc.

Verify utility service locations.

Check contiguous street, curb and sidewalk work.

Record completely field conditions of any existing work or landscaping on site to be maintained during building operations.

Verify soil and foundation conditions indicated on the drawings.

Verify excavations, specified undisturbed foundation areas, and over excavation.

Verify and record specified compaction of soils with soil laboratory.

II. Architectural Work:

a. Asphaltic Concrete:

Verify Drainage patterns indicated on drawings.

Verify specified base materials and surface treatment with poisons.

Verify compacted thickness, and compaction methods and equipment.

Verify temperature of hot aggregate.

Surface seals.

b. Fencing: Check installation and wire ties for alignment and safety (avoid sharp edges, finger catching shapes, etc.).

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c. Roofing:

Verify roof drainage.

Verify roof materials and weights

Make complete roof deck check inspection

Check temperature of roofing asphalt.

Check cleanup of asphalt drippings.

Check manufacturers' and roofers' warranties.

d. Plastering Work:

Check lathing attachment, grounds, metal trim mould, use of galvanized and high rib lath, metal stud anchorage, and any specified boxes, ducts, etc.

Check adequate protection at adjacent finish surfaces during plastering operations.

Verify plaster mixes, materials and thickness either hand or pneumatically placed.

Check control of curing with specified moisture spray.

Check drying of interior plastering work with adequate mechanical drying equipment, if required.

e. Mill Work:

Check for adequate care and protection of finish mill work delivered to site.

Verify secure anchorage of wall cabinets.

Check installation of finish hardware.

Verify delivery to Owner of specified key systems, identified.

f. Ceramic Tile Work:

Verify specified grades of material, shapes, colors and patterns.

Check sub-slab, wall backing, floor drains.

Check location and threshold materials.

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g. Terrazzo Work:

Check sub slab, wall backing, location of floor drains, and drainage, etc.

Check location of divider strips.

Check adequate protection of plumbing, fixture finishes contiguous to ground surfaces.

h. Metal Sash and Doors:

Verify specified bonderizing or other special finishes.

Check adequate and proper protection of sash delivered and installed on job.

Check alignment and proper operation of sash and doors.

Check seal-vents and caulking compounds.

Check weather tight sealing of exposed metal doors.

i. Sheet Metal:

Verify gauges and materials.

Check location of expansion joints.

Verify specified cleaning and priming.

j. Glass and Glazing:

Verify glass grade, thickness and pattern and caulking compounds.

Check installation of all glazing points, clip bars, beads and angles.

Check back putty, true clean installation of putty work, free of cracks, etc.

k. Acoustical Tile:

Verify pattern, finish and fire rating of specified material.

Check layout pattern of tile.

Check true surface and edge scribing (against diagonal or edge lighting).

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1. Resilient Floors:

Check filling and cleaning of sub floor surfaces and base backing.

Verify flooring materials.

Check floor patterns and alignment with Architect.

Check threshold materials and location.

Check final waxing and adequate protection of finished floor.

m. Painting Work:

Check and verify specified preparation of surfaces and materials:

Back priming;
Galvanized metal;
Waterproofing;
Iron and steel;
Masonry, concrete, stucco;
Interior plaster;
Pigmented and clear finishes.

Test for hot plaster, surfaces and moisture content of materials to be painted.

Check for adequate protection of adjacent finished surfaces.

Review complete color schedule with Architect.

Check specified professional sign painting.

III. Electrical Work

a. The Inspector shall notify the Architect and Electrical Engineer at the following principal stages of electrical installation or as required by specifications:

When Contractor commences to install large conduit in underground trenches.

Before any work is to be closed in.

When Contractor commences pulling high voltage cable and making splices.

When complex control wiring is begun.

When electrical work is completed and being tested.

b. The Inspector should watch the following for compliance with specifications:

Conduit:

Galvanized or sherardized. (Not black.) Check label on conduit.

Flexible conduit only where specified.

Rigid conduit where specified.

E.M.T. (thin-wall) conduit only where specified.

Fiber and transite conduit in trenches should be level, straight, supported by spacers and tied to prevent floating. Alignment should be maintained during pouring of concrete envelope.

No debris or rocks dumped in conduit trenches during backfilling

Check for contact of conduit with soil; see specifications for requirement of concrete envelope or wrapping, particularly at couplings and fittings.

No unnecessary bends in conduit; check against flattening bends.

Check required large radius bends for telephone and electric service.

Reaming and elimination of burrs from cut conduit.

Swabbing, cleaning and pulling of test mandrels through fiber, and other conduit.

Installation of pull wires in empty conduits.

Grounding of systems as specified.

Outlet Boxes:

Flush and plumb.

Excessive use of extension rings where tile or brick occurs is not acceptable.

Secure mounting.

Verify elevation and locations to clear cabinet work, splashes, base and other finishes. Verify all

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February 9, 1966. Total time 445 hours. Complied with AD 64-27-2 by installing new rubber float, and new bowl cover screws. Inspected solder on float valve bracket and found okay. Stamped -64 on nameplate.

George B. Jones

George B. Jones IA 272182

FIGURE 1.

Typical entry for compliance with an Airworthiness Directive with one-time compliance.

February 9, 1966. Total time 352 hours. Complied with AD 61-23-1 paragraphs a(1) and a(2) by tapping and magnifying glass. No cracks found. Void on top of blade #2, B2-248-53A, S/N 123, is 2" long and extends from 25" to 27" outboard of blade butt rib. Next inspection due at 377 hours.

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George B. Jones IA 272182

FIGURE 2.

Typical entry for compliance with an Airworthiness Directive with recurring inspection.

elevations and locations shown on drawings. Check location of conflict with other items.

Cast pull boxes for work exposed to the weather where specified.

Wire:

Compare type and size stamped on wire with specifications and plans.

Check use of temperature rated wire in high temperature locations requiring heat resistance insulation where specified.

Check use of higher temperature rated wire where branch circuits pass through thuroescent fixtures adjacent to ballasts. (Ballast heat will damage ordinary insulation.)

Do not allow high voltage cable to be bent sharper than specified minimum radius in pull boxes or during installation.

Do not allow wires with nicked or damaged insulation to be installed.

Lubricant for pulling heavy conductors must only be an approved cable lubricant.

All connections to be soldered except where connectors are specified.

All connections completely and neatly taped. Splices to be properly made and joints to be tight when splice connectors used, only approved type.

Required slack in conductors at all panels, equipment and pull boxes. (Required slack in underground pull boxes is one complete turn around the sides of the box.)

Placement of required pull wires.

Receptacles and Switches:

Check catalog numbers on packages with specifications.

Watch for special outlets for specific uses.

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Lamps and Fixtures:

Check color of fluorescent lamps with specifications.

Check security of all fixture mountings, also for swivels and sway adapters as specified.

Check fixtures for type, size, defects and required mounting heights.

Type of ballast must conform to specifications.

Underground Pull Boxes:

Check elevation and surface drainage before installation.

Check sealing of cover.

Panels:

Good practice requires main terminal connectors to be retightened 24 hours after original tightening.

Wire cables to be neatly arranged. Color coding as required.

Panel schedules to be neatly identified with circuit descriptions, with panel designation typed at top.

Doors or covers to fit tight and secure.

Grounding:

Check tightness of all ground connections.

Require all ground connections to be accessible.

All equipment to be securely grounded.

Bonding strips required for motor grounding where motor is connected with flexible conduit and voltage to ground is over 150 volts (this applies to 220-volt and 440-volt, 3-phase systems, but is not required on 208, 3-phase systems).

General:

Name plates on all equipment.

Delivery of proper operating instructions.

Check for proper working clearance in front of panels, switchboards, motor controls, etc.

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Coordinate underground piping and ductwork routing, elevations, slope and arrangements so as to accommodate other trades.

Inspecting underground piping and ductwork and requiring Contractor to correct or replace defective materials or workmanship.

c. Verify testing all systems as they are put into operation.

IV. Mechanical Work

a. The Inspector shall keep the Architect and Mechanical Engineer advised as to the status of the job by notifying him at the following principal stages of construction:

When Contractor commences underground work.

When Contractor begins installation of ductwork.

When plumbing, heating and ventilating is roughed-in and the buildings are ready for lath and plaster.

When Contractor commences to install finish plumbing and heating.

When plumbing, heating and ventilation or refrigeration work is completed and ready for testing.

b. The Inspector should watch for the following:

Pipe and Fittings:

Materials used are as specified.

Joints are made as specified.

Wrapping of joints and underground piping where specified.

Piping is supported as specified.

Water piping is isolated from hangers and supports as specified.

Piping is properly flashed.

Insulation is installed as specified.

Installations by other trades to avoid damage to piping, etc.

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Valves:

Installed where and as specified or approved.

Unions are installed where and as specified.

Make sure that all building shut-off valves are properly located and installed in access boxes and identified.

Plumbing (General):

Make sure contractor has roughed in all waste, water and gas lines for all fixtures and equipment and that all specified tests have been satisfactorily completed, before any lathing and plastering is done.

Make sure fixtures are supported as specified, with proper backing and supporting arms.

Have Contractor sterilize water supply system as soon as possible after plumbing fixtures and trim are set, where specified.

Check earth compacting around pipes for possible damage to lines and soundness of backfill.

Check danger of shear loads on C.I. piping.

Spacing of hangers (close to hub, etc.).

Wrapping of pipe and electrolysis considerations as specified.

Installation of insulation on chilled lines as specified.

Sound insulation of pipes.

Check access to cleanouts, valves, drainage of lines, vents, installation of equipment guards, etc.

Check specified identification of lines, valves, etc.

Secure required operating instructions, supplies, etc.

Heating (General):

Make sure piping is installed as specified.

Do not allow Contractor to change arrangement of equipment piping or valves from that shown on the drawings without first being approved by the Engineer.

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Check clearances of gas fired equipment and gas vents from combustible materials.

Name plates on all equipment.

Delivery of proper operating instructions.

Ventilation (General):

Check gauges of sheet metal being used.

Make sure installation of sheet metal work conforms with specifications.

Check for the installation of duct turns and air extractor before it is concealed or becomes inaccessible and check fire dampers in ductwork for installation and accessibility.

Check performance of Contractor air balance testing readings.

Name plates on all equipment.

Delivery of proper operating instructions.

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PHYSICAL PROPERTIES

WOOD STRUCTURE

Wood is an aggregate of cells, essentially cellulose in composition, which are cemented together by a substance called lignin. Although wood cells vary in shape and size according to their function, the greater portion are elongated and are positioned vertically in the standing tree. Known as fibers in hardwoods and tracheids in softwoods, wood cells vary from about 1/25 to 1/3-inch in length, and 1/100 of these dimensions, in width.

Hardwoods and softwoods have horizontally positioned bands of cells called rays. These are usually evident on quarter-sawed surfaces and are more conspicuous in some species than others. They provide a pleasing pattern where visible.

HARDWOODS AND SOFTWOODS

Native trees are divided into two classes - hardwoods which have broad leaves, and softwoods or conifers, which have scalelike or needlelike leaves. Hardwoods, except in the warmest regions, shed their leaves at the end of each growing season. Softwoods, except cypress and larch, are evergreen.

The terms "hardwood" and "softwood" do not necessarily apply to the hardness or softness of the wood. In fact, some species of hardwoods have softer wood than some of the species of softwoods while certain softwoods are as hard as the medium density hardwoods.

Principal commercial softwoods and hardwoods in the United States are listed in the table of weights, page 6

HEARTWOOD AND SAPWOOD

The end of a log shows three distinct zones, the bark, a light-colored zone just beneath it called the sapwood; and an inner zone, often darker in color, called heartwood. At the structural center of the heartwood is the pith or "heart center" as it is termed in the lumber trade. When the pith is enclosed in a piece of lumber it is called "boxed pith", when it is not, the piece is termed "side-cut".

A tree increases in diameter by forming new layers of cells at the outer surface of the sapwood. Here a thin band of tissue called the cambium lays down new bark cells toward the outside and new wood cells toward the inner or sapwood side.

The young tree is composed primarily of sapwood which functions in sap conduction and food storage. As the tree increases in diameter, inner sapwood cells cease their conductive function and form the inactive heartwood. Deposits in these inactive cells give the heartwood of many species a darker color than the sapwood.

As all heartwood was once sapwood, there is no consistent difference between heartwood and sapwood in weight when dry or in strength. Inclusions in the cells, however, make heartwood more durable when in contact with soil and under other conditions conducive to decay. Where wood is to be treated with preservative, however, deeper and more effective penetration can be attained in sapwood.

ANNUAL GROWTH RINGS

The activity of the cambium tissue in forming new wood is influenced in temperate zones by the growing season. Through winter months the tree is dormant. In the spring, however, the cambium begins to lay down thin walled cells with large cavities. Through the summer cell walls increase in thickness and cell cavities decrease in size until growth virtually ceases in the fall. Differences in cell wall thickness between those last formed in the fall and the thin walled new cells formed the following spring results in rings of annual growth which are apparent on cross sections of all native woods.

Annual rings vary in width according to growth conditions. Narrow rings are formed during short dry seasons and wider rings occur when growing conditions are more favorable.

Annual growth rings appear on the ends of "boxed pith" timbers as concentric circles around the pith or heart center. On side cut (pithless timbers) rings appear as arcs of circles whose centers would be located at the pith in the log from which timbers were obtained.

SPRINGWOOD AND SUMMERWOOD

In many woods two distinct areas are visible in each ring of annual growth: (a) an inner light colored portion, known as springwood; and (b) an outer darker portion, known as summerwood.

The springwood is composed of the large cavitied thin walled cells formed during the early part of each growing season. The thicker walled cells formed later in the year make up the summerwood portion. As the summerwood contains more solid wood substance than springwood, it usually appears darker in color. Springwood and summerwood bands are usually most noticeable in the dense softwood species.

In these species the proportion of springwood and summerwood present has an important effect upon strength properties and physical characteristics.

DENSITY AND RATE OF GROWTH

In the softwoods commonly used for structural purposes the rate at which trees grow; i.e., form new wood substance, has an important effect on their strength properties. An accurate measure of this is provided by the relative width and character of wood in each annual growth ring.

In such woods pieces having medium to narrow growth rings generally have higher strength properties than those having wide rings. In addition, pieces in which a considerable portion of each annual ring is made up of dense darker summerwood are recognized as having higher strength properties than pieces with a lower percentage of summerwood. Therefore, in grading structural material for use under known loads, the rate of growth (number of rings per inch) and the density (proportion of summerwood) are considered and made a part of the specification. Material having a specified minimum number of annual rings per inch is termed "close-grained" and that having, in addition, one-third or more summerwood is termed "dense".

GRAIN AND TEXTURE

The terms "grain" and "texture" are used in various ways to describe the characteristics of wood. Wood from slow growing trees in which annual growth rings are narrow is sometimes described as "close-grained"; that from rapidly growing trees with wide rings as "coarse-grained". This is another way of describing the number of rings per inch in strength grading.

Straight grained and cross grained describe wood in which the direction of the fibers (not annual rings) are parallel to, or at an angle with, the sides of the piece. Cross grain includes a spiral grain where fibers wind around the trunk of the tree. The expression "slope of grain" is employed in the grading of structural lumber to describe the extent of cross grain permitted as slope of grain has an important influence on strength.

PHYSICAL PROPERTIES

"Grain" and "texture" refer usually to appearance rather than strength. Fine grain is used to describe woods in which cells are small and thick walled making a compact wood with smooth surface. Coarse grain woods have cells which are large and open, producing a porous surface where pores are cut at an angle to their longitudinal axis.

Lumber sawed in such a manner that the annual rings when viewed from the end of the piece form an angle of 45° or more with the wide faces is described as edge-grain, vertical grain or rift-sawn in softwoods, and as quarter-sawn or comb-grained in hardwoods.

Edge grain softwoods and quarter-sawed in hardwoods

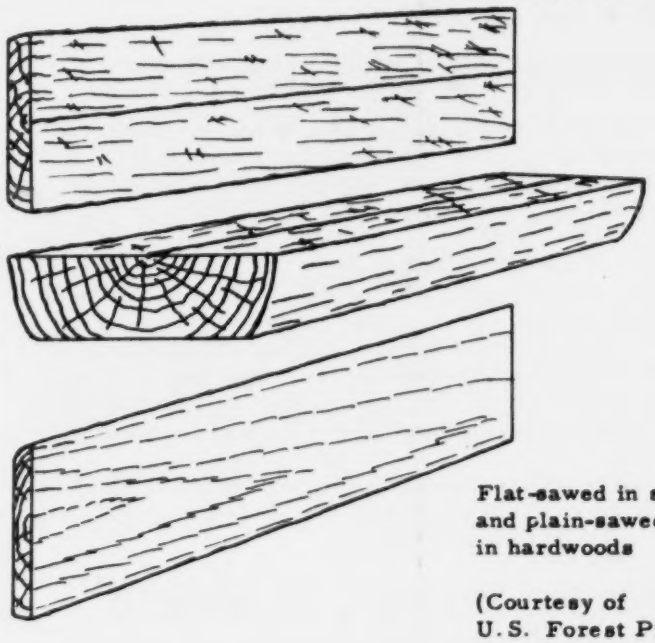

Flat-sawed in softwoods and plain-sawed in hardwoods

(Courtesy of U.S. Forest Products Laboratory)

The term "flat grain" or "plain-sawed" describes lumber in which the annual rings are at an angle of 45° or less with the wide faces of the piece. "Bastard-sawed" in hardwoods is lumber having both plain-sawed and quarter-sawed portions, thus falling midway between true quarter-sawed and true plain-sawed stock.

WEIGHT OF WOODS

Specific Gravity

Solid wood substance is heavier than water, its specific gravity being about 1.5 regardless of the species of wood. Despite this fact, dry wood of most species floats in water because a portion of its volume is occupied by air filled cell cavities.. Variation among species in the size of cells and in the thickness of cell walls affects the amount of solid wood substance present and hence, the specific gravity. Thus, specific gravity of wood is a measure of its solid wood substance and an index of its strength properties. Specific gravity values, however, may be somewhat affected by gums, resins, and extractives, which contribute little to strength. The relationship of specific gravity to wood strength is evident in the practice of assigning higher basic stress values to lumber designated as "dense".

Weights of Wood

Weights of sawed or round timbers are approximate because of moisture content, density and sapwood thickness variations within the piece. Average weights per cubic foot of various commercial woods, at 12 per cent moisture content, are given in the following table. Weight of individual pieces will vary from these averages and are also different at other moisture contents. Green weight represents the weight of wood in the standing tree.

Weight in Pounds of Commercially Important Woods Grown in the United States

Species	*Average weight per cubic foot based on weight and volume at a moisture content of 12 percent.
Alder	28.5
Ash, black	34.9
Ash, white	42.2
Aspen(1)	26.8
Basswood	25.8
Beech	43.8
Birch, sweet	46.7
Birch, yellow	43.0
Butternut	27.0
Cedar, Alaska	31.1
Cedar, Eastern red	32.9
Cedar, incense	24.9
Cedar, Port Orford	29.6
Cedar, Western red	22.9
Cedar, Northern white	21.4
Cherry	35.5
Chestnut	30.1
Cottonwood, black	24.2
Cottonwood, Eastern	28.6
Cypress, Southern	32.1
Douglas fir, Coast Region	33.8
Douglas fir, (Inland Region)	31.3
Douglas fir, Rocky Mountain Type	29.9
Elm, rock(2)	44.4
Elm, soft(3)	36.6
Fir, balsam	26.7
Fir, white(4)	27.3
Gum	36.0
Hackberry	36.9
Hemlock, Eastern	28.6
Hemlock, West Coast	29.2
Hickory(5)	51.6
Larch, Western	38.9
Locust, black	48.0
Magnolia, Southern	35.0
Maple, hard(6)	42.2
Maple, soft(7)	34.9
Oak, red(8)	43.5
Oak, white(9)	46.3
Pecan(10)	44.7
Pine, Eastern white	24.9
Pine, Idaho white	27.6
Pine, Lodgepole	28.8
Pine, Norway	31.0
Pine, Ponderosa	28.1
Pine, Southern longleaf	41.0
Pine, Southern shortleaf	35.2
Pine, Sugar	25.5
Poplar, yellow	29.8
Redwood	28.1
Spruce, Eastern(11)	28.5
Spruce, Engelmann	23.7
Spruce, Sitka	27.7
Sycamore	35.3
Tamarack	37.0
Tupelo(12)	35.3
Walnut, black	37.9

(1) Average of bigtooth and quaking aspen.
(2) Average of cedar and rock elm.
(3) Average of American and slippery elm.
(4) Average of California red fir, grand fir, Noble fir, Pacific silver fir and white fir.
(5) Average of mockernut, pignut, shagbark hickory.
(6) Average of black and sugar maple.
(7) Average of red and silver maple.
(8) Average of black oak, laurel oak, Northern red, Southern red, water and willow oak.
(9) Average of burr oak, post oak, swamp chestnut and white oak.
(10) Average of pecan and water hickory.
(11) Average of black spruce, red spruce, white spruce.
(12) Average of black and water tupelo.

*Values computed using data from Wood Handbook No. 72, Forest Products Laboratory, U.S. Dept. of Agriculture, 1955.

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PHYSICAL PROPERTIES

Specific gravity of commercially important species of wood based on oven dry weight and oven dry volume.

Species	Specific gravity
Alder, red	0.43
Ash, black	.53
Ash, Oregon	.58
Ash, white	.64
Aspen	.41
Basswood	.40
Beech	.67
Birch, paper	.60
Birch, sweet	.71
Birch, yellow	.66
Buckeye, yellow	.38
Butternut	.40
Cedar, Alaska	.46
Cedar, Eastern red	.49
Cedar, incense	.37
Cedar, Northern white	.32
Cedar, Port Orford	.44
Cedar, Southern white	.35
Cedar, Western red	.34
Cherry	.53
Chestnut	.45
Cottonwood, black	.37
Cottonwood, Eastern	.43
Cypress, Southern	.48
Douglas fir	.51
Douglas fir, dense	.54
Douglas fir, Rocky Mountain Type	.45
Elm, American	.55
Elm, rock	.66
Elm, slippery	.57
Fir, balsam	.41
Fir, white	.42
Gum, black	.55
Gum, red	.53
Hackberry	.56
Hemlock, Eastern	.43
Hemlock, West Coast	.44
Hickory	.80
Larch, Western	.59
Locust, black	.71
Locust, honey	.67
Madrone	.69
Magnolia, cucumber	.52
Magnolia, evergreen	.53
Maple, big leaf	.51
Maple, hard (black)	.62
Maple, hard (sugar)	.68
Maple, soft (red)	.55
Maple, soft (silver)	.51
Oak, red	.66
Oak, white	.71
Pecan	.69
Pine, Eastern white	.37
Pine, Idaho white	.42
Pine, Lodgepole	.43
Pine, Norway	.47
Pine, Ponderosa	.42
Pine, Southern	.59
Pine, Southern longleaf	.64
Pine, Sugar	.38
Poplar, yellow	.43
Redwood	.42
Spruce, Engelmann	.36
Spruce, red	.41
Spruce, Sitka	.42
Spruce, white	.45
Sugarberry	.54
Sycamore	.54
Tamarack	.56
Tupelo	.52
Walnut, black	.56
Willow, black	.42

MOISTURE IN WOOD

Wood may contain moisture in two forms: As "free water" in the cell cavities and as "absorbed water" in the capillaries of the cell walls.

When green wood begins to lose moisture, the cell walls remain saturated until the free water has been evaporated. The point at which evaporation of free water is complete and cell walls begin to lose their moisture is called the "fiber saturation point" (fsp). This point occurs between 25 and 30 percent moisture content for most species.

Moisture in wood is expressed as a percentage of the oven dry weight and is determined most accurately by weighing a representative sample, drying it at slightly over 212° until no further loss of weight takes place, reweighing, and then dividing the difference between the original and final weights by the final (oven dry) weight. Electric moisture meters offer a simpler though less exact method of determining moisture content.

With slight seasonal variations, wood in use over a period of time attains an equilibrium moisture content (emc) corresponding to the humidity of the surrounding atmosphere. When exposed to similar atmospheric conditions, different woods will have the same moisture content regardless of their density. The following chart shows the moisture content of wood when in equilibrium with various relative humidities at given temperatures.

Moisture content has an important effect upon susceptibility to decay. Most decay fungi require a moisture content above fiber saturation point to develop. In addition, a favorable temperature, an adequate supply of air, and a source of food, are essential. Wood that is continuously water-soaked (as when submerged) or continuously dry (with a moisture content of 20 per cent or less) will not decay.

Moisture content variations above the fiber saturation point have no effect upon the volume or strength of wood. As wood dries below fiber saturation point and begins to lose moisture from the cell walls, shrinkage begins and strength increases.

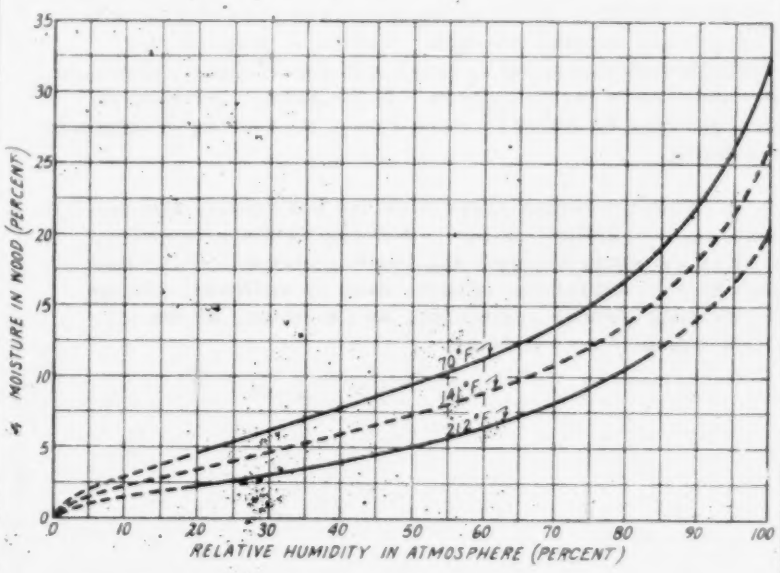

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PHYSICAL PROPERTIES

Shrinkage

Shrinkage of wood takes place between fiber saturation point and the oven dry condition. It is stated as a percentage of the original or green dimension. Where wood is installed at approximately the moisture content it will attain in service, only minor dimensional changes occur. These are caused by absorption or release of moisture due to atmospheric changes.

Wood shrinkage is greatest in the direction of the annual growth rings (tangentially), somewhat less across the rings (radially), and very little along the grain (longitudinally). Longitudinal shrinkage is usually a small fraction of 1 per cent and is too small to be of practical significance.

Shrinkage of commercial softwood boards across the grain averages about 1 per cent for each 4 per cent change in moisture content. Shrinkage of hardwoods is slightly greater.

Large structural members shrink proportionately less than smaller lumber because drying does not take place simultaneously in the inner and outer portions of such pieces. The inner portion which dries more slowly than the outer section prevents the wood near the surface from shrinking normally. Later, when drying of the interior occurs, outer layers which have become set in drying, prevent the inner portion from shrinking to the extent that it would normally.

In softwood structural lumber, 6" x 6" or larger in cross section, a shrinkage of approximately 1/64" per inch width of face may be expected in drying from green to average equilibrium moisture content in service.

Hardwood structural lumber may shrink slightly more than these amounts.

Effect on Strength

Increase in strength begins when the cell walls begin to lose moisture; that is, as the wood is dried below the fiber saturation point. From this point most strength properties increase rapidly as drying progresses.

Drying wood from green to 5 per cent moisture content often doubles and in some species triples end crushing strength and bending strength. However, increase in strength with seasoning is greater in small clear specimens of wood than in large timbers. In the latter, increase in strength may be offset to some extent if checking develops in seasoning.

Other strength properties are not equally affected by changes in moisture content. Although some properties, such as crushing strength and bending strength, increase greatly with seasoning, others, such as stiffness, change moderately. Shock resistance, an exception, shows only slight change as wood dries.

The following table presents the average variation in strength properties of wood for 1 per cent change in moisture content.

Average Increase (or Decrease) in Wood Strength Properties for a 1-percent Decrease (or Increase) in Moisture Content Below Fiber Saturation Point.*

Property	Change per 1-percent change in moisture content (percent)
	Percent
Static bending	
Fiber stress at proportional limit	5
Modulus of rupture, or cross-breaking strength	4
Modulus of elasticity or stiffness	2
Work to proportional limit	8
Work to maximum load or shock-resisting ability	1/2
Impact bending	
Fiber stress at proportional limit	3
Work to proportional limit	4
Height of drop of hammer causing complete failure	1/2
Compression parallel to grain	
Fiber stress at proportional limit	5
Maximum crushing strength	6
Compression perpendicular to grain	
Fiber stress at proportional limit	5-1/2
Hardness, end grain	4
Hardness, side grain	2-1/2
Shearing strength parallel to grain	3
Tension perpendicular to grain	1-1/2

*References: "Strength and Related Properties of Woods", Forest Products Laboratory, Forest Service, U.S. Dept. of Agriculture, Technical Bulletin No. 479.

"Wood Handbook", Forest Products Laboratory, Forest Service, Handbook No. 72, U.S. Dept. of Agriculture, 1955.

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PHYSICAL PROPERTIES

*HEAT TRANSMISSION THROUGH WOOD

The property of heat transmission through wood called thermal conductivity varies with density and moisture content and to an extent with wood structure. As with most materials thermal conductivity of wood increases with increased moisture content and with increased density.

At a moisture content of 12 per cent, thermal conductivity of commercial softwoods and hardwoods varies from 0.65 to 1.22 Btu per hour, per inch of thickness, per square foot, per degree F. temperature difference between opposite faces.

*SPECIFIC HEAT OF WOOD

The specific heat of wood is the ratio of the thermal capacity of wood substance to that of water at 60°F. The coefficient of thermal capacity of water at 60°F. is one British thermal unit (Btu) per pound per degree (Fahrenheit) change in temperature, i.e., the amount of heat required to raise the temperature of a pound of water one degree Fahrenheit is one Btu.

Specific heat of oven dry wood substance is substantially the same at any given temperature for all species of wood. In experiments on 20 species of wood, which included softwoods and hardwoods, average specific heat within the temperature range of 32° to 223°F. was found to be about 0.33, i.e., an average of 0.33 Btu was required to raise the temperature of a pound of dry wood one degree Fahrenheit.

The specific heat of wood increases in an approximately straight line relation with increase in temperature. Therefore, if a more accurate value for the specific heat of oven dry wood than the average value 0.33 is desired, it may be computed from the formula:

$c_t = 0.266 + 0.000644\,(t - 32)$, in which

c_t = the specific heat at a temperature of "t" degrees Fahrenheit

t = the temperature at which the specific heat is desired.

The quantity of heat "H" (Btu) required to raise the temperature of 10 pounds of dry wood substance from "t_1" degrees Fahrenheit to "t_2" degrees F. is equal to $10\,(t_2 - t_1)\,(c_t)$ Btu.

Average specific heat (c_t) of oven dry wood for any range of temperatures can be determined from the equation:

$$c_t = 0.266 + 0.000322\,(t_2 + t_1 - 64)$$

where t_1 and t_2 refer to initial and final Fahrenheit temperatures, respectively.

For wood containing moisture, thermal capacity may be obtained by determining the amount of heat required to produce a given change in temperature in a unit volume of wood on the basis of its oven dry weight and the amount of heat necessary to produce the same temperature change in the included water. This can be expressed mathematically as follows:

$H = m\,(t_2 - t_1)\,(c_1 + \frac{M}{100})$, in which

H = total heat requirement (Btu)

c = average specific heat for the temperature range $(t_2 - t_1)$

m = oven dry weight of wood (pounds)

M = weight of included water expressed as a percentage of the oven dry weight "m" of the wood

*ELECTRICAL PROPERTIES

Dry wood is an excellent insulator against transmission of direct electrical current and low frequency alternating current. Electrical resistance of wood, however, varies appreciably with wood moisture content. Variations in the distribution of a fixed amount of moisture in the area of measurement also have a considerable effect upon electrical resistance. Variations in species, specific gravity and amount of inorganic ash content have a much smaller effect upon electrical resistance.

Below fiber saturation point (24 to 31% moisture content) electrical resistance of wood increases very rapidly with decrease in moisture content, whereas above fiber saturation point electrical resistance changes much more slowly. Resistance is also affected by temperature, approximately doubling with each drop of 22-1/2°F.

Electrical resistivity (specific resistance) of a material is the electrical resistance in ohms between opposing faces of a cubic centimeter unit. Electrical resistivity of wood varies from 10^8 ohm-centimeters at 16% moisture content to 3×10^{18} at the oven dry condition.

Dielectric Constant. The ratio of the capacitance of a condenser having a wood dielectric to the capacitance of the same condenser with a vacuum dielectric is termed the dielectric constant for the wood used. Dielectric constant values differ along the grain from across the grain, being as much as 30 per cent greater in the parallel-to-grain direction.

Increases in wood density and in moisture content both result in appreciable increase in dielectric constant values. The capacitance type of moisture meter is based upon the variation of the dielectric value of wood with corresponding moisture content changes.

Resistivity of Wood at Radio Frequencies. Low frequency parallel resistivity of wood is much greater than corresponding resistivity at high (radio) frequencies. The resistivity (r) of wood is approximately inversely proportional to the frequency (f) as evident in the following equation where the power factor ($\cos \phi$) and the dielectric constant (ϵ) vary only slightly with frequency:

$$r = \frac{1.8 \times 10^{12}}{\epsilon f \cos \phi}$$

This reduction in resistivity with increase in current frequency is the principle upon which the curing of glue lines in wood by radio frequency heating is based.

Where wood is employed as a dielectric (as in high-frequency gluing) the power (P) dissipated in the wood as heat is proportional to the capacitance of the condenser (C), the power factor of the wood ($\cos \phi$), the voltage (E) and the frequency (f). This is indicated in the equation

$$P = 2\pi f E^2 C \cos \phi$$

As high voltage (E) in the foregoing equation is difficult to generate, presents insulating problems and tends to produce arcing, the power (P) necessary to produce heat is best increased by increasing the current frequency ($\cos \phi$). The heat thus generated affords a rapid means of polymerizing synthetic resin wood glues.

CHAPTER 3. BASIC FUNCTIONS OF THE AI

5. GENERAL. The basic functions of the AI are set forth in section 65.95 of the FAR. This section permits an AI to approve major repairs and major alterations, conduct annual inspections, and to perform or supervise progressive inspections in accordance with the standards and procedures set forth in FAR 43.

   a. The AI may not approve major repairs or major alterations on any aircraft maintained in accordance with a continuous airworthiness program under Part 121 or 127 of the FARs.

   b. The AI is permitted to perform one other function set forth in section 21.183(d) of FAR 21. This section permits AIs to perform an airworthiness inspection on single-engine airplanes, prior to issuance of an airworthiness certificate. The scope of the inspection is comparable to the 100-hour inspection.

6. APPROVING MAJOR REPAIRS AND ALTERATIONS. The AI's primary responsibility is to determine airworthiness by inspecting for compliance with pertinent Airworthiness Directives (ADs) and Aircraft Specifications or Data Sheets; that repairs or alterations conform to approved data, and the aircraft is in a condition for safe operation.

   a. The AI should conduct this inspection himself as the regulations do not provide for delegation of this responsibility.

   b. The approval should not be taken lightly as a paper signoff. It should consist of a detailed investigation to determine the material used, quality of workmanship, compliance with approved data, completeness, and possible effect on other structures or systems. The finished product should be at least equal to its original or properly altered condition.

   c. The approval of alterations by AIs is often a misunderstood term. The AI cannot approve the DATA for major alterations. He may, however, inspect to see that the alteration conforms to data PREVIOUSLY APPROVED BY THE ADMINISTRATOR. (FAR 65.95.) This means the AI must assure that data is available as a basis for approval. Preferably, this should be prior to beginning the repair or alteration. If data is not available, or you are not sure that the data you have is acceptable, discuss it with your local FAA inspector. The inspector may be able to:

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PHYSICAL PROPERTIES

*CHEMICAL COMPOSITION OF WOOD

Wood is a complex aggregate of compounds which may be segregated into two major groups, those which make up the cell structure and other substances known as extractives or infiltrated materials.

The cell wall components of wood consist of carbohydrates and a cementing substance known as lignin. The carbohydrates consist of cellulose and hemicelluloses, while the exact chemical composition of lignin is unknown. In addition to carbohydrates and lignin, cell wall composition also consists of a small amount of mineral matter which remains when wood is subjected to complete combustion. The principal minerals are calcium, potassium and magnesium and small amounts of sodium, manganese, iron and aluminum. The most abundant compound, however, is calcium oxide which comprises one-half to three-fourths of the total ash. The best known compound, however, is potassium carbonate or potash, which is of value as fertilizer and in the manufacture of soap.

The extraneous materials in wood are those which can be removed by neutral solvents such as water, alcohol, benzol, ether and chloroform. These include oils, acids and fats, tannins, dyestuffs starch and nitrogenous materials known as alkaloids. The natural durability of some woods is closely related to the toxicity of certain of these extractives.

*THERMAL EXPANSION OF WOOD

Seasoned wood like most other solid materials expands and contracts with changes in temperature. The coefficient of thermal expansion (increase in dimension per unit of measurement for a temperature rise of one degree Fahrenheit) differs in the three structural directions of wood. Longitudinally, the values are independent of the specific gravity and vary from about 1.7×10^{-6} to 2.5×10^{-6} per degree Fahrenheit for different species. Across the grain the values vary from 25×10^{-6} to 45×10^{-6} per degree Fahrenheit, varying directly with the specific gravity.

The coefficient of thermal expansion varies slightly with temperature but for all ordinary uses may be considered constant. In the longitudinal direction thermal expansion of wood is from 1/10 to 1/3 as great as the expansion of metals, concrete and glass for the same temperature change. Thermal expansion values for wood across the grain are generally greater than along the grain but usually less than values for other structural materials.

In most structural design the coefficient of thermal expansion of wood can be neglected. Thermal expansion is of importance only in the case of special structures that are kept dry and are subjected to considerable temperature change.

*References:

"Wood Technology, Vol. 2" by Brown, Panshin and Forsaith

"Wood Handbook", Forest Products Laboratory, Forest Service, Handbook No. 72, U.S. Department of Agriculture, 1955.

"The Electrical Resistance of Wood as a Measure of Its Moisture Content" - A. J. Stamm (U.S. Forest Products Laboratory Ind. Eng. Chem. 19:1021 (1927)

"The Fiber-saturation Point of Wood as Obtained from Electrical Conductivity Measurements" - by A. J. Stamm (U.S. Forest Products Laboratory) Ind. Eng. Chem., anal. ed. 1:94 (1929)

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MECHANICAL PROPERTIES*

MECHANICAL PROPERTIES

The mechanical or strength properties of wood are of importance in structural design. They are a measure of the ability of wood to resist externally applied forces which tend to alter its shape, size or result in any other deformation. Mechanical properties determine the applicability of wood in structural as well as many other uses where resistance to bending, compression, tension, shear and other effects of external forces is required.

The various mechanical properties are briefly described herein as general information, their quantitative values and determination usually being a matter of laboratory investigations and tests made in accordance with established procedure. Test results are interpreted in the data used as the basis for structural design or other service requirements. The allowable unit stresses recommended for the material investigated are examples of such interpretation.

Mechanical properties of wood considered in these data are:

Bending Strength under Static and Impact Loads

Tensile Strength Parallel and Perpendicular to Grain

Compressive or Crushing Strength Parallel and Perpendicular to Grain

Shear Strength

Stiffness

Hardness

Resistance to Cleavage

OTHER FACTORS

Position of Growth Rings

Timber from Live and from Dead Trees

Effect of Resin and Turpentining

Comparative Strength of Air-dried and Kiln-dried Wood

Effect of Preservative Treatment on Strength and Permanence

DEFINITIONS

Force

Force is that power which changes or tends to change the state of rest or motion of a body or causes a body to change its shape if held in place by other forces.

Work

Work is the product of force and distance, or force acting through distance.

Stress

Stress is a distributed force. It is a measure of force per unit area.

Fiber Stress

Fiber stress is the distributed force tending to compress, elongate or change the relative position of wood fibers.

Tension Stress

Tension stress is an internal stress induced by forces which tend to elongate the affected member.

Compression Stress

Compression stress is an internal stress induced by forces which tend to crush or shorten the affected member.

Shear Stress

Shear stress is an internal stress induced when opposing forces tend to cause adjoining planes or surfaces of a member to slide, one on the other.

Allowable Unit Stress

Allowable unit stress, variously called safe working stress, working stress and allowable stress, represents the maximum stress which may be safely induced in columns, beams and other structural parts. It is the stress per unit of section area used as the basis of design computations and is the proportional part of the ultimate stress which experience, investigation and tests have indicated as being safe to use.

Strength

In the broad sense, the term "strength" embraces those properties of wood which enable it to resist imposed forces or loads. In a more restrictive sense, strength applies to any one of the mechanical properties, i.e., strength in shear, strength in compression parallel to grain, strength in compression perpendicular to grain, strength in bending or hardness, etc.

Bending Strength

Bending strength is a measure of the load carrying capacity of a beam.

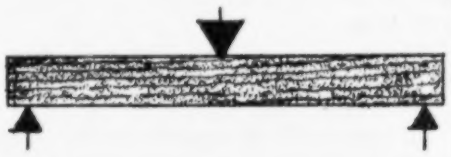

Bending Stress

Bending stress is a compound stress induced by loads acting perpendicular to the longitudinal axis of a member or other loads which tend to cause the member to deflect as a beam. It is a composite of the simple stresses, i.e., compressive, tensile and shear.

Fiber Stress in Bending

Fiber stress in bending is the computed stress in a wood member subjected to loads which cause deflection.

Stiffness

Stiffness is the property which enables a member acted upon by external forces to resist deformation.

*References: "Wood Handbook," Forest Products Laboratory, Forest Service, Handbook No. 72, U.S. Department of Agriculture, 1955.

"Mechanical Properties of Wood" by F.F. Wangaard

"Textbook of Wood Technology, Vol. II" by Brown, Panshin and Forsaith.

MECHANICAL PROPERTIES

Flexibility

Flexibility is the quality which renders a material capable of being appreciably bent without breaking. It is not the exact counterpart of stiffness, however, as toughness and pliability are also involved.

Elasticity

Elasticity is the property which permits changing form with the application of force and immediate recovery upon release. In any elastic material the deformation is proportional within limits to the force applied.

Proportional Limit

Proportional limit is the limit below which deformation is proportional to the applied load. Beyond the proportional limit value deformation increases by a greater percentage than the increase in load. Because a member stressed within the proportional limit recovers from its deformation upon removal of the load, the proportional limit is also known as the "elastic limit".

Bending loads or loads in compression parallel to grain which produce stresses in excess of the stress at proportional limit will ultimately cause failure if they continue to act on a wooden member.

STATIC BENDING

Resistance of a wood beam to slowly applied loads is measured in static bending tests.

Stress at Proportional Limit, Static Bending

The fiber stress at proportional limit in static bending is the computed stress in the wood member beyond which the induced strain is no longer proportional to the stress or applied load.

Modulus of Rupture, Static Bending

Modulus of rupture is the computed maximum fiber stress in the extreme upper and lower fibers of a beam at the maximum load. It is a measure of the ability of the beam to support a slowly applied load for a short time. Modulus of rupture is not a true stress since the formula by which it is computed is based on assumptions which are only valid within the proportional limit.

Since the modulus of rupture is based upon the maximum applied load, values can be determined more precisely than proportional limit values.

Modulus of rupture values for clear wood in conjunction with results of tests on larger members containing knots and other strength reducing characteristics are used in determining safe working stresses for structural timbers.

Modulus of Elasticity, Static Bending

Modulus of elasticity is a measure of the stiffness or rigidity of a material. It is the ratio of stress per unit area to corresponding strain per unit length within the proportional limit.

High modulus of elasticity indicates a stiff material. In beams, deflection under load varies inversely as the modulus of elasticity, that is, the higher the modulus, the smaller the deflection. Modulus of elasticity is used in computing deflection of beams, joists and stringers where imposed loads do not result in stress beyond the proportional limit. It is also used in computation of allowable loads for columns.

Work to Proportional Limit, Static Bending

Work to proportional limit in static bending is a measure of the energy absorbed by a beam when it is stressed to the proportional limit. Since work is the product of force times the distance moved, work to proportional limit involves both load and deflection at the proportional limit. It is a comparative property which indicates the ability of wood to absorb shock without permanent damage.

Work to Maximum Load, Static Bending

Work to maximum load in static bending represents the capacity of a member to absorb shocks which cause stress beyond the proportional limit and are of sufficient magnitude to cause permanent deformation. It is a measure of the combined strength and toughness of the material under bending stresses. Work to maximum load is closely related to height of drop of the test load in impact bending as a measure of toughness or shock resistance.

Work to maximum load, as well as work to proportional limit, cannot be used directly in design. Their usefulness is limited to comparisons.

Total Work, Static Bending

Total work in static bending is a measure of the toughness of wood when loaded to complete failure. Like work to maximum load, it is a measure of that quality involving shock resistance. It is also indicative of that quality measured by height of drop of the test load in impact bending.

IMPACT BENDING

Relative elastic behavior and other properties of wood beams when subject to shock are measured by impact bending tests.

Stress at Proportional Limit, Impact Bending

The stress at proportional limit in impact bending is the computed stress in a beam when impact loads reach the proportional limit. Such values average more than twice as great as similar values from static bending tests.

Work to Proportional Limit (Elastic Resilience), Impact Bending.

Work to proportional limit in impact bending is a measure of the energy a beam absorbs in being stressed to proportional limit by impact loads. It is used to compare the ability of a timber to absorb shock and recover promptly without injury, and applies only to conditions in which stress is applied and removed in a fraction of a second.

Height of Drop Hammer, Impact Bending

Height of drop hammer to cause complete failure in impact bending gives a comparative figure expressing the ability of wood to absorb shock which cause stress beyond the proportional limit.

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MECHANICAL PROPERTIES

COMPRESSION PARALLEL TO GRAIN

Compression parallel to grain is a measure of the capacity of a short column to withstand loads acting in a direction parallel to the long axis.

Stress at Proportional Limit, Compression Parallel to Grain

Stress at proportional limit is the greatest stress at which the compressive load remains proportional to the shortening of the specimen. It is the limiting stress in compression parallel to grain which should not be exceeded in determining safe loads. Stress at proportional limit in compression parallel to grain is taken into account in arriving at safe working stresses for columns and other compression members, and in determining design values for bolted and other joints.

Maximum Crushing Strength, Compression Parallel to Grain

Maximum crushing strength is the maximum ability of a short piece to sustain a slowly applied end load over a short period. This property is important in estimating endwise crushing strength of wood and in developing safe working stresses for structural timbers and design of joints.

COMPRESSION PERPENDICULAR TO GRAIN

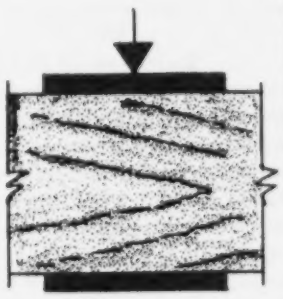

Compression perpendicular to grain is a measure of the bearing strength of wood across the grain.

Stress at Proportional Limit, Compression Perpendicular to Grain

Stress at proportional limit is the maximum across-the-grain stress of a few minutes duration which can be applied without injury to the piece through a metal plate covering but a portion of the timber surface. It is useful in deriving safe working stresses in compression perpendicular to grain, for computing the bearing area of beams, stringers, and joists, etc.

In deriving proportional limit stresses in compression perpendicular to grain, test load is applied on the radial surface of test specimens. Experience has shown that the supporting action of wood fibers in the unloaded area adjacent to the bearing plate results in an increase in stress over that which occurs if load is applied to the entire area of the specimen. The stress obtained in this standard test is about 50 per cent greater than that obtained in loading the entire area of the piece being tested. As the ratio of loaded to unloaded areas is decreased, further increase in proportional limit stress is obtained. This is evident in derivation of safe working stresses where higher stress values are permitted for bearing areas less than six inches in length.

SHEAR STRESS

Maximum Shearing Strength, Shear Parallel to Grain

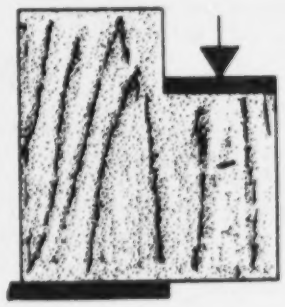

Shear strength parallel to the grain is a measure of the ability of wood to resist slipping of one part upon another along the grain. Derivation of this stress is accomplished by loading a 2" x 2" portion of a 2" square wood block 2-1/2" long on a 3/4" projection as indicated in the accompanying sketch.

Horizontal Shear

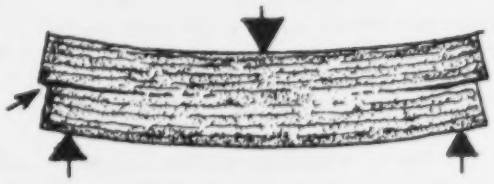

Horizontal shear stress is important in the design of beams, especially those of short span and deep section. It is the resistance to the tendency of the upper half of the beam to slide upon the lower half when the beam is loaded. In a beam of rectangular section the maximum tendency for horizontal shear occurs at the neutral axis of the section.

TENSION PARALLEL TO GRAIN

Available results of tension tests show that, generally, ultimate tensile strength values exceed values for modulus of rupture. Modulus of rupture values, however, are used as a conservative estimate of the ultimate tensile strength parallel to grain as it is difficult to devise attachments which permit tensile strength of the full cross-section of the wood member to be developed.

TENSION PERPENDICULAR TO GRAIN

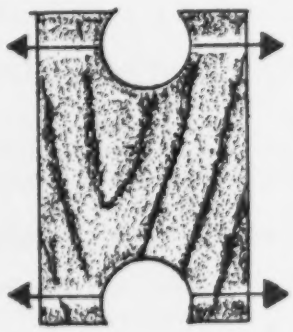

Tensile strength perpendicular to the grain is a measure of the resistance of wood to forces acting across the grain which tend to cause splits or cleavage. Strength of a specimen of wood in this respect is determined by measuring the force required to produce failure. Maximum load divided by the smallest area over which the load is distributed provides the tensile strength of the specimen. Strength values measured in this manner are of use in estimating the resistance of wood to the splitting action of bolts and other fastenings.

HARDNESS

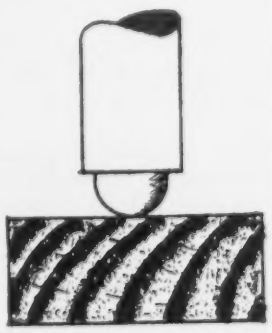

Hardness is a measure of the resistance of wood to indentation. The term is also used to indicate the ability of wood to withstand abrasion, and in this connection is related to toughness.

The measure of hardness is the load required to imbed a 0.44-inch hardened steel ball to one-half its diameter in the wood. It represents a property important in wood

MECHANICAL PROPERTIES

subjected to wear and marring, such as flooring, furniture, railroad ties, paving blocks, etc. There is no significant difference between radial and tangential hardness. End hardness, however, generally exceeds that obtained from tests on the sides of the specimen.

CLEAVAGE

Cleavage in wood is defined as the resistance offered to splitting. It is related to tension perpendicular to grain but differs in that the acting force is concentrated at the bottom of the cleft rather than being uniformly distributed over the surface of failure. The stress, obtained by dividing the force required to produce failure by the width of the split surface, is measured in pounds per inch of cleft surface. Resistance to cleavage is important where wood must hold nails or screws.

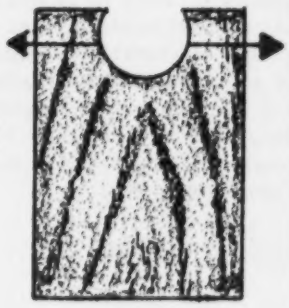

TORSION

The torsional strength of wood is little used in structural design. It is the internal moment of resistance which develops when a member is twisted by an external force tending to cause rotation about its longitudinal axis. Torsion plays a secondary role in the analyses of wood beams which show a tendency to buckle.

OTHER FACTORS

POSITION OF GROWTH RINGS

In sawing lumber and timber the position of growth rings may be made to assume different directions with respect to the surfaces of the piece.

Bending

Tests in bending indicate little difference in the strength properties of wood regardless of whether the rings as viewed on the end of a piece are vertical or horizontal.

Compression Parallel to Grain

Values from tests in compression parallel to grain have shown that wood members with growth rings in any position were practically equivalent in strength.

Compression Perpendicular to Grain

In compression perpendicular to grain the principal variation affected by the position of growth rings occurs in the modulus of elasticity. Indications are that differences in proportional limit and in maximum crushing strength perpendicular to the grain are considerably less than for modulus of elasticity.

TIMBER FROM LIVE AND FROM DEAD TREES

Sound wood from trees killed by insects, fungi, wind or fire, unless unduly checked, is as good for any structural purpose as that from trees which were alive when cut.

In considering the utility of timber from a dead tree it is helpful to remember that the heartwood of a living tree is essentially dead, and in the sapwood only a portion of the cells are functional. The important consideration is not whether the trees from which timber products are cut are alive or dead but whether the timber itself is free from decay or other defects that would render its wood unsuitable for use. This is determined by careful inspection.

EFFECT OF RESIN AND OF TURPENTINING

Resin is formed in some of the conifers and especially in the southern pines. Amounts up to 6 per cent of the dry weight of the wood are common and pieces with a resin content up to 50 per cent are sometimes found.

Tests at the Forest Products Laboratory indicate that resin will slightly increase some strength properties but that the effect is too small to be of any practical significance. An excessive amount of resin, however, is sometimes associated with an injury such as compression failure which may substantially reduce strength.

The results of a special investigation involving mechanical tests and physical and chemical analyses of the wood of turpentined and unturpentined trees from the same locality show that (1) turpentined timber is as strong as unturpentined timber of the same species for like densities; (2) the weight and shrinkage of the wood is not affected by turpentining; (3) except in parts adjacent to "faces" where there may be a concentration of resin, turpentined trees contain neither more nor less resin than unturpentined trees. As the exudation of resin occurs only from the sapwood, the resin content of the heartwood is not affected by the turpentining process.

COMPARATIVE STRENGTH OF AIR DRIED AND KILN DRIED WOOD

Comparative strength tests by the Forest Products Laboratory on kiln-dried and air-dried specimens show that good kiln-drying and good air-drying have the same beneficial effect on the strength of wood.

For certain uses it is possible to dry wood to a lower moisture content by kiln-drying than is practicable through air seasoning. Since most strength properties of wood increase with loss of moisture, higher strength values may thus be obtained from kiln-dried material than are possible from air-dried wood. This difference in strength, however, is not permanent when the wood is used for the same purpose, since, in use, wood will eventually reach the same moisture condition regardless of whether it is kiln-dried or air-dried.

EFFECT OF PRESERATIVE TREATMENT ON STRENGTH

Coal-tar creosote and the various creosote mixtures used as wood preservatives are practically inert with respect to wood substance and have no chemical influence upon it which affect its strength. Also, standard water-borne preservatives in the concentrations commonly used in preservative treatment have no important effect on the strength of wood. Care should be taken, however, that the severity and duration of the heating and pressure conditions to which wood is subjected in receiving treatment do not exceed those which are known to be satisfactory.

PERMANENCE

All structural materials are subject to attack by certain destructive agents. Most metals must be painted to resist corrosion. Wood, while being exceptionally resistant to corrosive action, can be made more resistant to attack by fungi, insects and marine borers by adequate preservative treatment when used where the hazard from these agencies is severe. Protection from attack by wood destroying agents may also be provided by proper methods of construction and by the selection and use of naturally resistant species.

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MECHANICAL PROPERTIES

Lignin, cellulose and other constituents of wood substance exhibit little or no change or loss with time when wood is adequately protected from the elements and other destructive agents. Color, however, may be slightly changed by long and continued exposure to air.

The effect of time on strength cannot be accurately appraised by tests of wood from old structures as the original strength of the material is generally unknown. Evidence from tests of sound aged wood as are on record indicate that no significant loss of strength has occurred.

A survey of wood bridges has shown that literally hundreds of these structures made entirely or partly of wood have served satisfactorily and with but little attention for long periods of time. Many bridges that are more than a century old are still in service. Others have been replaced while still in good condition because of the demands for greater width of roadway and higher load capacity than that for which they were constructed.

Association and others. The U. S. Forest Service and others maintain test plots to make compensative evaluations of various preservatives, treated and untreated wood. AWPA standards are based upon the long time record service life of different commodities in actual use which has been treated with the many preservatives.

Preservatives are grouped into three types, 1) Creosote and creosote solutions, 2) Oil-borne and 3) Water-borne.

The creosote type preservatives include straight creosote, creosote-petroleum solutions and creosote-coal tar solutions. This type is most commonly used to treat poles, piles, railroad ties, bridge and wharf timbers. Wood, pressure treated with creosote and creosote solutions was the first mainly used approved preservative. Some creosote marine piling in New York Harbor is still in use after 80 years. Creosote timber foundation piles are considered permanent.

The oil-borne types include, 1) Pentachlorophenol, 2) Copper Napthenate, and 3) Solubilized Copper-8-Quinalinolate. Pentachlorophenol is the most commonly used and is available from most commercial treating companies. The petroleum oils will vary from heavy fuel oil to mineral spirits, and most recently a new process has been developed using liquid petroleum gas as a carrier.

Pentachlorophenol in heavy oil is commonly used to treat utility poles. It is increasingly used for piles other than marine. Using either a light petroleum solvent or liquid petroleum gas as a carrier, producers have included additions to make it also water repellant. Copper-8-Quinalinolate is commonly used to treat lumber which may come in contact with produce or foods. Copper Napthenate is most commonly used for brush application.

Water-borne preservatives consist generally of inorganic chemicals which are carried into the wood via water solution. These preservatives are commonly used for treatment of lumber and plywood used in building construction. They have the advantage of no odor and can be painted when dried after treatment. Most commercial treating companies treat with one of these preservatives. Some are more resistant to leaching when in ground contact and offer a longer expectant service life. These latter preservatives are becoming more popular for treatment of poles for pole buildings.

The heartwood of some species of trees contain chemicals which impart some protection. The degree of protection will vary by the amount of toxic chemicals endowed by nature. Lumber cut from old-growth timber and selected from the butt area will usually contain the greater amount of chemicals. Heartwood

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cut from the following species are considered to be the most naturally resistants:

Bald Cypress	Chestnut
Cedars	Black Locust
Junipers	Mesquite
Redwood	Red Mulberry
Pacific Yew	Osage Orange
Catalpa	Black Walnut

The heartwood of the species listed below are usually classified as moderate in decay resistance and provide good service under milder conditions such as siding or similar above ground uses:

Douglas fir	Southern yellow pine
Eastern White Pine	Sweet gum
Honey locust	Western larch
Sassafras	White oak

The wood preserving industry was built on the idea of imparting longer life in all species as well as to sapwood and heartwood alike so that forests could be conserved and wood could be economically used in broader applications. Even though it is more difficult to treat heartwood than sapwood, most all commercially available species can be adequately treated by pressure process. Species having heartwood, which is most difficult to treat, are first incised so that the preservative may enter the closely spaced incisions. Thus, the preservative may be distributed to the required depth of penetration.

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UNIT II - STRUCTURAL WOOD MATERIALS

II-A - Wood Preservatives

3. Decay and Insect Attack

There are several preservatives which have been tested and approved for inclusion in nationally recognized standards. These preservatives must be placed deeply into the wood at a high concentration where they can offer adequate protection. The minimum recommended depth of penetration and retention will vary by use, species of wood, and preservative.

Standards such as the American Wood Preservers Association Manual of Recommended Practice have been in almost constant development since AWPA was organized in 1904. It reflects these years of experience and the results of tests conducted by the U. S. Forest Service, universities and others which are for the purpose of evaluating preservatives and results of treatment. These standards establish the minimum penetration, retention and the preservatives recommended for the various species intended for such uses as railroad ties, bridge timbers, marine and foundation piles, utility poles, posts, lumber and plywood used above and in the ground.

The permeability of wood will vary greatly by species and can vary along the surface of any single piece of wood. In addition, the heartwood is always more difficult to penetrate with a preservative than is the sapwood. In view of this, it is apparent that either the wood must be carefully selected so that this material can be uniformly and easily penetrated or these variables must be overcome by conditioning prior to treatment and/or by using the pressure process method of treatment. Pressure treatment eliminates erratic and shallow penetrations resulting in premature failures caused by checks or abrasion exposing the untreated wood.

There are over 300 commercial pressure treating plants located throughout the United States which are equipped to process wood in the form of poles, piles, sawn timber, plywood and glu-lam. This method of treatment also permits special conditioning treatments which prepare the wood to be more receptive to the actual preserving process. The wood is treated in metal cylinders usually 6 to 9 feet in diameter and up to 150 feet long. They are typically built to withstand working pressures of 250 to 300 pounds.

Nonpressure treating processes are not equivalent to pressure treating processes, but can be safely relied upon when used for millwork treated under the quality program of the National Woodwork Manufacturers Association.

Several preservatives are in common use. All AWPA approved preservatives have been subject to extensive test by the U. S. Forest Products Laboratory, Bell Laboratories, American Railroad

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UNIT II - STRUCTURAL WOOD MATERIALS

II-B - Manufacturing, grading, and handling of lumber (First Session - 2 to 3 hours)

1. Logging and mill practice
   (Film only - Such as "Forever Living Forests" - CRA)

2. Grading

   a. General Criteria

      (1) General information about lumber grading.

      (2) Lumber sizes, terminology and measurement

         Lumber size classes

            LWPS - pgs. 16-19
            WLTM - pg. 3
            ASTM D-245 - pg. 146, Par. 24(a)

         Lumber Use Classes

            LWPS - pgs. 16 & 17
            WLTM - pg. 3
            ASTM D-245 - Pg. 146 Par. 24(a), (b)

         Terminology

            WLTM - pg. 3
            WCLIB Rule #15 - pgs. 310-312, Par. 580

         Measurement

            WLTM - pg. 3

      (3) Basic Clearwood Stresses & Working Stresses

         ASTM D-245 - pgs. 161-170, Pars. 51-68
         DFUB - pgs. 6 & 7, to "Effect . . . Characteristics."
         WMID - Chapter 2
         WWPA GRB - pgs. 220-222, Par. 500i
         WCLIB Rule #15 - pgs. 279-282, Par. 500i

         Derivation of stress grades for structural lumber wood research lab, Purdue University. Mimeo F-50

         ASTM - D-2018
         ASTM - D-2555-66T

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(1) Establish an acceptable approval basis, or

(2) Approve the data himself, or

(3) Recommend application for a Supplemental Type Certificate (STC) as the circumstances warrant.

d. Quite often repairs are performed that are eventually covered by fabric, metal skin, or other structure. AIs should have all access needed to make a valid determination of compliance with the approved data. The commonly accepted practice for repairs that are to be covered allows the AI to inspect before the repair is obscured and to make an entry to this effect on the reverse of the FAA Form 337. An example of this appears as Figure 3. When the repair is completed, the final inspecting AI can determine that the inaccessible portions of the repair were done in accordance with FAA approved methods and have been properly inspected.

e. Minor deviation from approved data is permissible IF the change is one that could be approved as a minor alteration when considered by itself. Be sure to list the deviations when completing the aircraft records. When in doubt, contact the local FAA inspector. He may decide the change is not minor and would need specific approval or amendment of the original approval.

f. Approved data to be used as a basis for approval of repairs and alterations may be one or more of the following:

(1) FAA Publications. FARs, Aircraft Specifications, Type Certificate Data Sheets, Advisory Circulars, etc.

(2) Supplemental Type Certificates. A summary is available that lists those STCs which the holders have said will be made available to the public. See Appendix 1.

(3) Parts Manufacturing Approval. Identifies FAA-approved replacement parts.

(4) Technical Standard Orders. Conformity to TSOs indicates FAA approval of materials and appliances.

(5) Airworthiness Directives. FAA-approved data for mandatory action concerning deficiencies found in service.

(6) Manufacturer's Instructions, Kits, and Service Handbooks. Such instructions must bear indication of being FAA-approved when pertaining to major alterations.

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(4) Natural growth characteristics that affect strength and usability

WHB - pgs. 93-103; 137-141; 143-164
ASTM D-245 - pgs. 138-146, Pars. 5-22
DFUB - pgs. 7 & 8, (only fair)
LWPS - pgs. 19-21
WWPA GRB - pgs. 239-256, Pars. 600a - 642a.
WCLIB Rules #15 - pgs. 313-326, Paras. 600-644
Textbook of Wood Technology, Vol. I
pgs. 282-350, (advanced reference only)

b. (1) Visual Grading

LWPS - pgs. 19-21
ASTM D-245 - pgs. 137-161, Pars. 2-50
WHB - pgs. 142-158
WWPA GRB - pgs. 226-238, Paras. 501-504d
WCLIB Rules #15 - pgs. 284-296, Paras. 501-504d

(2) Machine Stress Rating

WWPA Supplement 1, Par. 500k
WCLIB Rules #15 - pgs. 297-299, Pars. 506a.b.
WLTM - pgs. 21-23
"They are not the Same" by T.K. May
Contact WWPA Portland Office for latest information

c. Softwood Lumber Grading Agencies and Grade Marks

WHB - pg. 111
WWPA GRB - pg. 5, Par. 1
WLTM - pg. 24
1964 UBC pg. 169 Sec. 2504 (c)

Latest ALSC ruling regarding quality control by agencies

3. Procurement, Handling and Site Storage - Lumber

a. Procurement and Handling practices

(1) General information

LWIS - pgs. 23-27 (?)
WLTM - pg. 2
WWPA Form A-27
WPA Research Note 6.711
WHB - pg. 130-131

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(2) Yard and Framing Lumber

Framing - Ordering practices, methods of distribution (whsl. dist. yard), sample specs.

Yard Lumber - Sample specs. for commons and finish items; protection at site

(3) Job Site Protection from Weather and Damage

Framing and Timbers

a. Unseasoned - protect lumber piles or units from contacting soil and keep them straight and even until use

b. Seasoned - protect lumber piles or units from contacting soil and store in protective covers provided by the manufacturer or cover with some type of water repellent tarp.

Finish items - store in area and/or manner to protect from weather or other elements. Allow flooring, paneling, interior trim, etc., to adjust to moisture conditions of room before installation from 1-2 weeks.

II-C - PLYWOOD

(Reprinted from "Plywood Properties, Designs and Construction" by Nelson S. Perkins, C.E., unless otherwise noted)

1. PHYSICAL AND MECHANICAL PROPERTIES

It should be emphasized that the data contained herein are applicable only to plywood complying fully with the appropriate U.S. Commercial Standards.

Durability. Exterior type plywood is as durable as the wood of which it is made. So far as is known, only strong alkalis or acids will break down an Exterior glue, in which cases the wood itself will usually be attacked.

Approved Interior type plywood is designed to withstand temporary exposures normally encountered during construction and, in certain construction grades, to have a reasonable resistance to mold and bacteria through the use of a toxic adhesive.

Both types of plywood must have adequate bond strength to resist expansion and shrinkage stresses due to climatic variations.

Bending Strength and Stiffness. The construction of a plywood panel by cross-laminating veneers and gluing them together capitalizes on the more desirable physical and mechanical properties of wood. The strength of wood along the grain is many times greater than that across the grain. The cross-laminated construction, by providing longitudinal grain both lengthwise and crosswise, also provides bending strength and stiffness in these directions.

The strength and stiffness lengthwise will be somewhat less than for solid wood, but crosswise strength and stiffness are significantly increased over solid wood, being about twice as great in 3-ply 3/8" panels and almost six times as great in 5-ply 3/4" panels.

21245

Racking Resistance. Plywood also functions effectively in its own plane as a structural bracing material. (See 4.b. for the structural diaphragm concept of this action.)

Racking resistance is another term for this bracing action on a wall, roof, or floor that is sheathed with plywood or other structural material.

Actually, although 5/16" is the minimum recommended, 1/4" plywood sheathing on a standard stud-framed wall provides twice the stiffness and twice the strength furnished by 1" diagonal boards, long recognized as adequate. This superior racking strength of plywood was demonstrated first some years ago in a series of tests* by the U.S. Forest Products Laboratory.

Shear Strength and Nail Bearing. Two properties stemming directly from its cross-banded construction are mainly responsible for this superiority of plywood as a structural bracing. First is its high shear strength in all directions perpendicular to panel faces, and second is plywood's relatively high nail bearing, even when nails are within 3/8", or even less of the panel edge.

Similarly, splitting is impossible lengthwise or crosswise, since no cleavage plane can exist.

Impact Resistance. Plywood functions well under impact or heavy concentrated loads, due to distribution of stress by the crossed veneers, over a wide area of the panels

*See "Guide to Improved Framed Walls for Houses" by Alan D. Freas, Senior Engineer, U.S. Forest Products Laboratory, reprinted from "Engineering News Record," Oct. 17, 1946. ----- B.M.S. No. 104, tests on lightweight prefabricated construction.

21246

This can be important in sheathing, sub-flooring, wall sheathing under shingles, and exterior siding directly over studs, as well as in wall paneling and various industrial uses.

Dimensional Stability. This is another benefit from plywood's cross-laminated construction.

Wood has virtually no expansion or contraction along the grain, even with large moisture content changes, whereas across the grain it has considerable. Accordingly, in plywood, any tendency for veneers to expand or contract crosswise is greatly minimized by one or more adjacent veneers running lengthwise.

Obviously, a thin veneer, in changing dimension crosswise, exerts less force than a thick one, and accordingly is more easily restrained by the veneers bonded to it at 90°. It follows that panels with a low percentage of veneers lengthwise (i.e., "parallel plies") will shrink or expand less across their width than panels with a high percentage of lengthwise veneers.

The expansion of a plywood panel consists of a uniform restrained swelling across the main part plus a less restrained swelling at the edges. As might be expected this edge-effect varies directly with the thickness of veneers having grain parallel with the edges. Regardless of panel construction or size, this edge-effect can be estimated at a maximum of 0.012" at each edge for thick (1/16") veneer, and at half (0.006") of this for 1/12" veneer.

The internal, uniform dimensional changes in a panel are approximately proportional to changes in moisture content within the ranges of 6% to 18%.

The total expansion both across the width and along the length of a 48" x 96" panel from 6% (a dry condition) to 18% moisture content may be expected to average between 0.05" and 0.09".

Under an extreme range of moisture conditions (seldom encountered), the dimensional change may be 50% greater. Under normal variations of from 8% to perhaps 14%, however, such changes should average between about 0.03" (1/32") and 0.05" (1/20").*

Concentrated Loading. Puncture tests reported by the American Plywood Association** in 1959, using a 1" loading disc, showed 3/8" panels, (long edges unsupported) over framing spaced 16" center to center, taking loads of 600 to 660 lbs., at edges, and 644 to 1010 lbs. midway between framing. Similarly 5/16" showed ultimate loads of 300 to 600 lbs. at edges and 400 to 550 lbs. at center of span.

Such loads are safely above those to be anticipated for normal plywood sheathing or siding use.

One-half inch subflooring in a series of tests took loads of 732 to 1268 lbs. at unsupported edges, and 600 to 1505 lbs. at center of span.

Thermal Changes. Plywood, like wood, is also subject to dimensional changes due to changing temperature.

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*Values from Product Research Laboratory, Services Div., American Plywood Assn.

**Laboratory Report No. 59--Concentrated Load Tests on Plywood Subfloors.

21248

Wood expands about ten times as much across the grain as it does parallel, where dimensional changes are quite small.

In plywood, consequently, thermal expansion along the face grain is somewhat greater than in wood, because of the influence of the crossbands. In a typical 96" long Douglas fir panel (5 equal plies), the expansion caused by a 120° F. rise in temperature should average approximately 0.021 inches. This is about 40% more than for plain Douglas fir wood, but still rather insignificant for most cases. On the other hand, across the grain, it is close to 0.029", which is only about 1/6 that for plain wood.

Acoustical. Plywood also rates reasonably well both in absorbing sound and in reducing sound transmission. Plywood 1/4" thick on each side of a 2" x 4" stud wall, has a sound transmission loss of 31.3 decibels*. The sound absorption of this wall varies from about .10 at high frequencies to .31 at low, which compare favorably with other common materials.

Warping and Bowing. Unequal absorption of moisture along panel edges, unequal exposure of opposite faces to moisture, or their unequal painting or coating, may all lead to arching or bowing of panels, as well as to twisting or warping. Unbalanced construction, such as use of different species or thicknesses and diagonal grain in crossbands and faces, may also be a contributing factor. As noted in the next section under "Checking," protection of panel from uneven moisture changes is one of the best preventives.

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*Tests at Riverbank Laboratories, Geneva, Illinois

21249

Checking. Checks may occur in any wood surface and may attain significant open width under adverse conditions. They may appear on a plywood surface in the form of hairline cracks or even slightly open splits. Under severe moist and dry conditions, such as on unpainted, unprotected panels exposed to the weather, checks may in time become open cracks penetrating virtually the full thickness of the face.

Causes. A certain potential checking occurs during manufacture in the unwinding and subsequent flattening out of the veneer.

Moisture changes, however, are the prime cause of objectionable checking. Under high humidities, the exposed veneer surface expands, while the under surface, glued to the crossband, is held relatively fixed. The expanding exposed fibers push against one another and acquire a "compression set." Then, as the fibers dry out and shrink, they pull away from each other, creating checks of different intensity. These can be more severe under rapid drying than under slow drying since wood is a somewhat plastic material.

Remedies. The remedy, and a most important one which should always be observed, is to avert exposure to extreme variations from the moisture content of the panel at time of manufacture, i.e., about 5 to 9% for hot-press Exterior or Interior, and about 13% for cold-press Interior.

Obviously, panels should be protected from dampness or moisture, either during transit or later storage.

Panels shipped to a job site require protection from elements. They should be protected from ground moisture as well. This will also prevent mold attack.

21250

In addition, certain treatments, such as conventional painting and water-repellent dips to be discussed later, will minimize moisture absorption and loss, and thus permit control of checking within acceptable limits.

Insulation. Plywood renders a wall airtight because of the sparsity of joints, and, by preventing air leaks and drafts, contributes to room comfort. It also has favorable thermal insulation properties, a resistance (1/k) of 1.28 generally being used. This is the temperature difference between the two surfaces of a material that will transmit one btu per squ. ft. per hr., per inch of thickness, through the material.

Since plywood is used generally in panel thicknesses of 1/4" and 3/8", exterior walls may require added insulation. This should be computed for the complete wall assembly since comparisons of separate materials may be quite misleading.

Workability. Plywood is easily worked, cut to various sizes and shapes, and may be bent to fairly sharp radii. It may be finished in a great variety of ways.

21251

2. MANUFACTURE

The softwood plywood industry, once confined to Western Washington and Oregon now utilizes Douglas fir, Southern pine and Western softwoods timbers from forests south to California and east to the Atlantic seaboard. The larger trees in these forests provide the "peeler" logs which, through a scientific manufacturing process, are transformed into plywood. About 195 mills are engaged in plywood production. Their aggregate annual production capacity exceeds sixteen billion square feet (3/8" rough basis).

The manufacture is accomplished by cutting selected logs into "blocks," usually about 8-1/2' long and from 16" to 50" or more in diameter. The blocks are placed in a giant lathe and rotated against a long knife which peels the wood in long, continuous veneer sheets, mostly 1/10" to 3/16" thick. The veneer is belt-conveyed to clippers, cut into desired widths, then run through long dryers which reduce the moisture content usually to 2% or 3% up to about 6%.

Next, after careful grading, the veneer goes to the glue spreaders where, after the cross-bands have been passed between two rotating cylinders with grooved rubber facings that spread glue evenly and in desired amounts on both sides of the veneer, it is laid crosswise into panels of balanced construction, i.e., symmetrical about the center as to thickness and generally as to species. These are inserted into a huge hydraulic press, where pressure of about 150 psi is applied. After removal from the press, panels are trimmed to exact size and, if to be of a sanded grade, are run through large drum sanders to emerge as finished plywood.

NOTICE

Weight and balance or operating limitation changes shall be entered in the appropriate aircraft record. An alteration must be compatible with all previous alterations to assure continued conformity with the applicable airworthiness requirements.

8. DESCRIPTION OF WORK ACCOMPLISHED *(If more space is required, attach additional sheets. Identify with aircraft nationality and registration mark and date work completed.)*

1. Removed right wing from aircraft and removed skin from outer 6 feet. Repaired buckled spar 49" from tip in accordance with Figure 8 in the manufacturer's structural repair handbook #18-1.

   DATE: January 5, 1966, inspected splice in item 1 and found it to be in accordance with data indicated. Splice is okay to cover.

   George B. Jones
   George B. Jones, IA 272182

2. Primed interior wing structure and replaced skin P/Ns 63-0085, 63-0086, 63-0087R with same material, 2024T3, .025" thick. Rivet size and spacing all the same as original and using procedures in Section 3 of AC 43.13-1, dated 1965.

3. Replaced stringers as required and installed 6 splices as per figure 10 in handbook #18-1.

4. Installed wing, rigged aileron, and operationally checked in accordance with maintenance manual.

5. No change in weight or balance.

END

☐ ADDITIONAL SHEETS ARE ATTACHED

FAA AC 65-60B1

FIGURE 3.

Reverse of FAA Form 337 showing typical entries. Note the specific references in identifying FAA approved or acceptable data. Also note the entry regarding inspection of the repair by an AI prior to the cover being applied.

3. ADHESIVES

Exterior Type Plywood. Exterior type plywood, comprising about one-third of production, is made only with a hot-pressed phenolic resin adhesive which becomes permanent and insoluble under practically any exposure condition, including boiling. It is designed for permanent exterior exposure.

Interior Type Plywood. Interior type plywood, comprising the other two-thirds of production, is made for the most part with protein glues having a soya bean-blood base. Most of this (about 45% of the total production) is now hot-pressed, while only about 12% to 14% is cold-pressed. Another 4% to 5% is hot-pressed with extended phenolic resin adhesives, while a small percentage is bonded with urea resins.

Interior plywood is designed both for withstanding temporary wetting during construction, as where used for sheathing and sub-flooring, and, of course, for permanent interior service, provided the wood is not exposed to continued dampness where the moisture content of wood or plywood might exceed 20%. For added protection agains mold, several Interior grades, i.e., C-D sheathing concrete form B-B (Plyform*), Underlayment and C-D Plugged are all manufactured with mold-resistant adhesives if conforming to the U.S. Commercial Standards

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*Trade name used by members of the American Plywood Association

21253

4. GRADES

Each type is manufactured in several appearance grades to fit a wide variety of uses. Designation of these grades is based primarily on the quality of the veneer used on the face and back.

All softwood or structural plywood conforming to the Commercial Standards is built-up of veneer from one or more of five classes of veneer, ranging from N (the highest) through A, B, C, and D (the lowest).

Most veneer may be repaired to raise its quality to a higher class. Repairs consist of various sizes and shapes--more often oval or circular--of patches, plugs, and long, narrow shims, nearly always of sould wood which fill voids in the veneer sheet or replace characteristics such as knots and pitch pockets.

Veneer Grades

"N"Grade - a somewhat specialized veneer used for natural finish; varies from clear veneer to sheets with only a few small well-matched repairs.

"A" Grade - a smooth "paint" grade permitting a number of neatly-made repairs, plugs, patches, etc., with certain restrictions.

"B" Grade - a "solid surface" veneer, except for specified minor characteristics;

Typical characteristics permitted in veneer.

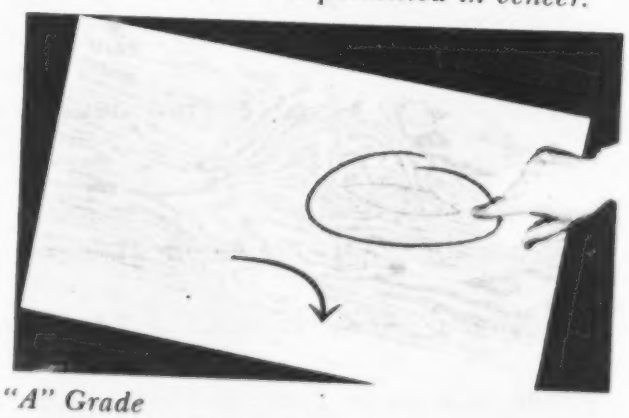

"A" Grade

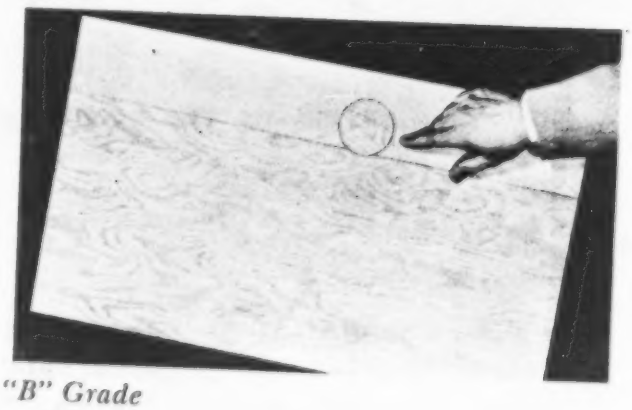

"B" Grade

21254

may have a considerable number of neatly-made repairs; may be generally described as suitable for concrete form work where a smooth surface is desired.

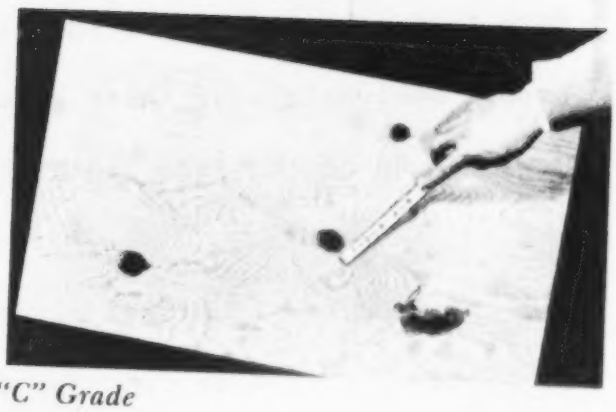

"C" Grade

"C" Grade - the lowest quality of veneer permitted in any Exterior type panel; commonly used also as face of sheathing grade panels. Permits 1" knotholes, tight knots up to 1-1/2", 3/16" splits tapering to a point, and other minor characteristics.

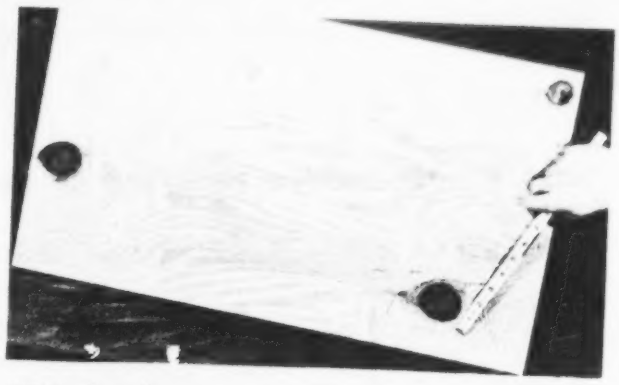

"D" Grade

"D" Grade - The lowest quality of veneer permitted in any Interior grade. Permits 2-1/2" knotholes, pitch pockets 2" x 4", tapering splits up to 1/2", and restricted white pocket of specified degree and extent.

Plywood Grades. Plywood grades* are indicated by two letters, such as "A-D", meaning a panel with an A face and a D back. The inner plies for any Interior grade are also D or better, and for an Exterior panel, "C" or better.

A guide for selecting the proper grades for various uses is shown in Table 1, p. 8.

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*See U.S. Commercial Standard CS45-60, Tables 1 and 2, for details of various grades of Douglas fir plywood, and CS122-60, Tables 1 and 2 for grades of Western softwood plywood; and CS 259-63, Tables 1 and 2 for grades of Southern Pine plywood.

21255

Panels in most grades are run through large drum sanders, where they are sanded smooth for appearance and on both sides, of course, for balance.

The sheathing grades, however, the most important construction items, are generally left unsanded for greater stiffness and strength as (see copy. There was no more.)

GRADE USE GUIDE TABLE

	GRADE	DESCRIPTION AND SUGGESTED USES	FACE	BACK	INNER PLIES
EXTERIOR TYPES	A-A	Use where the appearance of both sides is important. Fences, built-ins, signs, boats, cabinets, commercial refrigerators, shipping containers, tote boxes, and ducts.	A	A	C
	A-B	For uses similar to EXT-A-A panels, but where the appearance of one side is less important.	A	B	C
	A-C	Use where the appearance of only one side is important. Siding, soffits, fences, structural uses. Box car and truck lining and farm buildings.	A	C	C
	B-B PLYFORM®	Concrete form grade, with high re-use factor. Red painted edges, mill-oiled unless otherwise specified.	B	B	C
	B-C	An outdoor utility panel. For farm service and work buildings. Box car and truck linings, containers, and agricultural equipment.	B	C	C
	C-C PLUGGED	Use as a base for resilient flooring, mosaic tile, carpeting, where unusual moisture conditions exist, such as bathrooms, utility rooms, kitchens. Use for conventional or single layer subfloor-underlayment. Other uses include pallets, pallet bins, and farm service buildings.	C PLUGGED	C	C
	C-C	Unsanded grade with waterproof bond. Use for backing, rough construction, farm service buildings, crating, pallets, and pallet bins.	C	C	C
INTERIOR TYPES	A-A	For interior applications where both sides will be viewed. Built-ins, cabinets, furniture, and partitions.	A	A	D
	A-B	For uses similar to INT-A-A panels, but where the appearance of one side is less important and two smooth surfaces are necessary.	A	B	D
	A-D	Interior use where appearance of only one side is important. Paneling, built-ins, shelving, partitions, and flow racks.	A	D	D
	B-B PLYFORM®	Re-usable form plywood. Glue is moisture-resistant, not waterproof. Green painted edges, mill-oiled unless otherwise specified.	B	B	C
	B-B	Interior utility panel used where two smooth sides are required.	B	B	D
	B-D	Interior utility panel used where one smooth side is required. Good for backing, sides of built-ins. Industry: separator boards and bins.	B	D	D
	UNDER-LAYMENT	Base for resilient flooring and carpeting. A backing material where moisture is not a problem. Used for conventional or single layer subfloor-underlayment.	C PLUGGED	D	C OR D
	C-D	Unsanded structural grade panel for sheathing, subflooring, limited exposure crates, containers, pallets, and dunnage.	C	D	D
	EXTERIOR GLUE C-D	Same as C - D , but with waterproof glue. Not a substitute for Exterior-type plywood	C	D	D
	2-4-1®	Combination subfloor and underlayment. Base for resilient finish flooring, carpeting, and wood strip flooring. Available in square edges; or with tongue and grooved sides or sides and ends. Use 2-4-1 with Exterior Glue in baths, kitchens or utility areas where moisture may be a problem (or when construction delays are anticipated).			

21256

5. PLYWOOD SHEATHING-STORAGE*

Storage. At job site, stack plywood flat on a dry, level platform under shelter. PROVIDE FOR FREE AIR CIRCULATION. Tightly wrapped coverings prevent air circulation. When exposed to the sun this creates a virtual "steam chamber" which is a condition for mold fungi. Long-time storage should be indoors in flat stacks on dry, level platforms. One good means of storing plywood at the job site is shown at right.

Edge protection. Where any edge or surface of the plywood is to be permanently exposed to the weather, use only Exterior-type plywood.

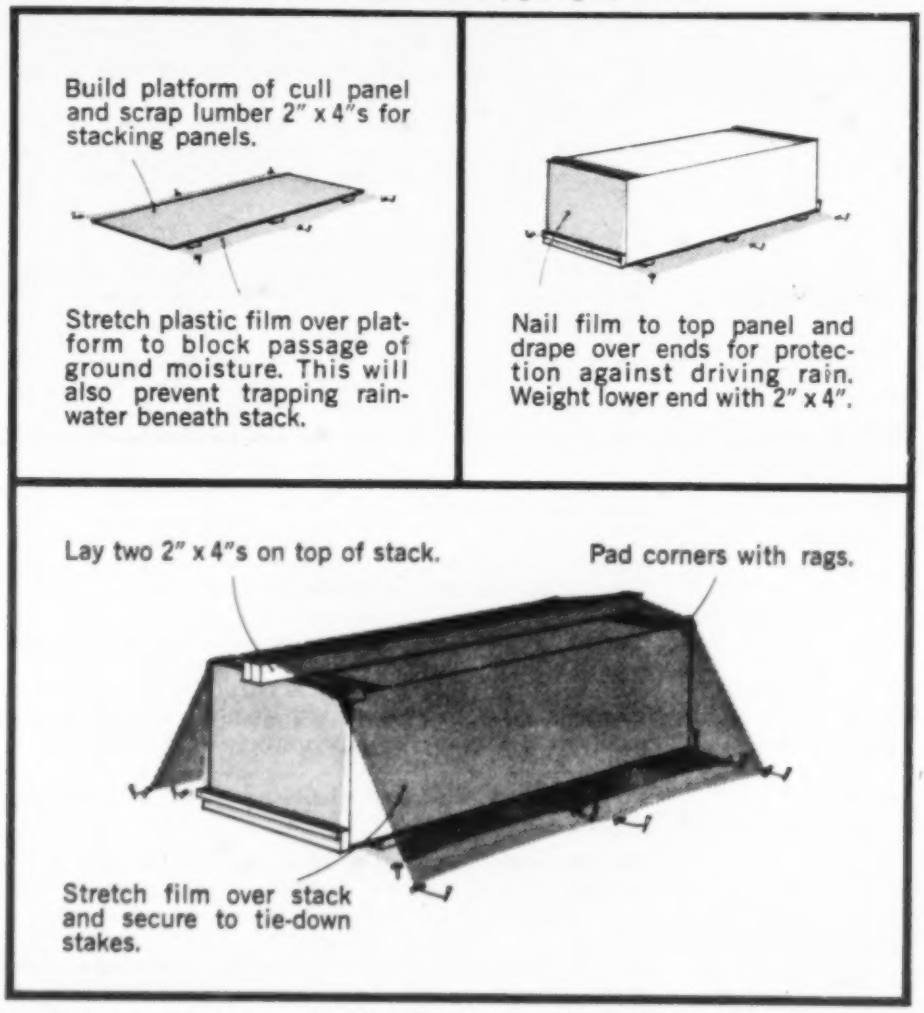

*from the American Plywood Association's Form No. 64-690.

21257

D.4. PLYWOOD (Reprinted from "Plywood Properties, Design and Construction" by Nelson S. Perkins, C.E. unless otherwise noted)

2. FASTENINGS

These include various devices, such as nails, staples, and glue, for attaching both plywood to framing, and other materials such as shingles to plywood. They also include plywood gussets for jointing co-planar truss or rigid frame members, and clips for aligning adjacent panels on roofs.

Most important of these several structural accessories are nails and glues.

NAILS

Nail-holding Strength. This is the capacity to resist withdrawal of nails that may be used to attach anything to plywood. This property is essential for any material serving as a base for shingles and must be adequate to hold nails firmly in place under maximum wind uplift or suction. In hurricane areas, this force may amount to as much as 25 psf and, in Southern Florida, has been estimated as high as 50 psf.

Since any type of shingle is applied with at least tow nails per sq. ft., the maximum withdrawal force in the worst storm should not exceed 25 lbs. per nail, and in most instances would be nearer 10 lbs. per nail.

Extensive testing by the U.S. Forest Products Laboratory and the American Plywood Association, as well as research at Purdue University and the Canadian Forest Products Laboratory, have served to establish plywood's nail-holding power at considerably above the maximum required in service.

21258

Annular-ring nails and screw-shank nails with a flat pitch, both types readily available, have a still higher resistance to withdrawal compared with smooth-shank nails. Such deformed nails should preferably be just long enough to have points protrude through plywood, although a minimum 1-1/8" length is needed for ease in handling; nails that are too long may cause a rasping action in plywood--thus reducing withdrawal resistance.

Tests on Sheathing and Roofing Nails. In 1952 and 1953, some 1800 nail tests were conducted by the American Plywood Association Research Laboratory to determine the best type of nail for attaching asbestos-cement shingles to 5/16" plywood sheathing. Various moisture cycles, varying from 6% to 24%, were used--thus reducing over-all average loads. Best results were obtained with a screw-shank nail, 12 gauge, 1-1/8" long, with average withdrawal load from 5/16" plywood of about 87 lbs. This nail is now recommended for use with plywood by a number of the leading asbestos-cement shingle manufacturers.

In a series of tests in 1958 at the U.S. Forest Products Laboratory*, about 700 nails were pulled from 3/8" plywood (3 plies of well randomized 1/8" D veneer) conditioned to a moisture content of approximately 12%. Withdrawal values per nail averaged about 100 lbs. with asphalt shingle nails (11 ga.), and somewhat more than 85 lbs. both with wood shingle nails (13 ga. 3d) and asbestos cement shingle nails (14 ga.) annular-ringed but 1.79" long, which is somewhat excessive for 3/8" plywood. Even when the nails were deliberately driven into knotholes in face plies, the values ranged from 37 lbs. to 98 lbs. and averaged about 58 lbs.

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*Mechanical properties of Douglas fir plywood of "D" Grade Veneer, etc. (Limited distribution).

21259

Asphalt shingles applied to 5/16" sheathing with standard 12 gauge galvanized shingle nails, in the American Plywood Association tests, always tore away without dislodging nails; the average withdrawal load was 43 lbs. per nail.

In further American Plywood Association nail tests in 1960 for built-up roofing over 3/8" plywood, average withdrawal loads, after three cycles of 17% to 9.7% moisture content, ranged from 95 to 114 lbs. in sixty tests of annular-ring nails, and from 67 to 90 lbs. in thirty tests of screw-shank nails.

When several Western softwood plywoods were tested, withdrawal loads from 3/8" plywood sheathing ranged from 69 to 98 lbs.

It will be noted that in all these tests the average nail-holding strength of 5/16" plywood proved several times greater (4 to 10 and more*) than that needed to resist even a severe hurricane, with still higher safety factors for 3/8" and greater thicknesses.

Experience records from a number of severe hurricanes have confirmed these laboratory results. In the 1954 hurricanes, Carol and Edna, which swept Newport, R.I., with winds of 90 m.p.h., a 200-house project with asphalt shingles over 3/8" plywood roof sheathing and asbestos cement shingles on 5/16" plywood wall sheathing, survived with the loss of only two shingles on the entire project, and both of these were torn from the roofing nails.

Since then, the nail-holding power of 5/16" and 3/8" plywood under asbestos, asphalt, and wood shingles has been demonstrated during a number of similar storms, as well as by scores of case histories of less severe exposure.

---

*In Southern Florida, these safety factors might be only 3 to 5.

21260

Wood Shingles on a Tight Deck. The old question of the durability of wood shingles over a "tight" roof deck, such as plywood or T & G boards, still arises occasionally.

This matter was thoroughly investigated some 30 years ago by the National Committee on Wood Utilization*, but no evidence against the tight deck was ever uncovered. Twenty-five years' experience with plywood roof sheathing has pretty well laid this ghost to rest.

The tightness of the deck is immaterial. FHA accepts such construction under its MPS, and so does every building code, so far as is known. Although "spaced" sheathing is permitted under wood shingles, a plywood deck is better construction.

Subflooring Nails. Nail-holding strength also comes into play in a much less critical manner with plywood subflooring in the conventional 1/2" and 5/8" thicknesses, where finished flooring is applied. No particular problem arises, however, except where nails are driven into green, unseasoned joists. In such cases, the joists dry out and shrink away from the nail-head since obviously the nail will not penetrate deeper because of this. This so-called "nail popping" may cause bumps or local raised areas in thin tile flooring, but may be minimized by setting nails slightly below surface and omitting any filling. This popping has no relation to nail-holding strength of plywood, but has often been confused with it.

Why Nails Pop

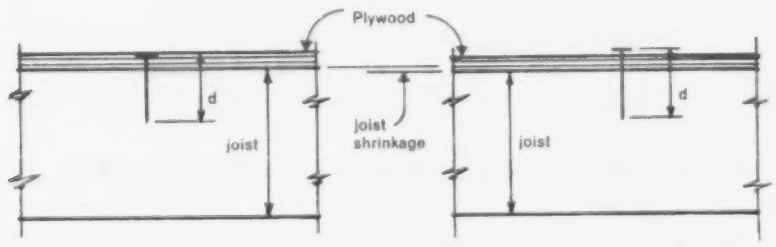

*U.S. Department of Commerce

21261

Nail-Bearing Strength. In plywood this is usually a measure of the lateral bearing load that can be transmitted from the panel to the shank of a nail driven into a wood framing member. The nails are in single shear.

Important applications occur in roof sheathing, which transmits horizontal stresses (wind, earthquake, etc.) to framing, and in plywood wall sheathing, which transmits such shear forces down to the bottom plate and into the foundations. Plywood gusset plates in roof trusses, diaphragms, and nailed box beams constitute other common uses.

The strength of the nail joint in actual practice is usually governed by the bearing value of the nail against wood studs, plates, or rafters, but could be limited by the plywood if the panel were too thin or the nailing unduly heavy. Obviously, proper balance of joint details is desirable for the most economical utilization of materials.

Tests have shown that 5/16" plywood is thick enough to develop approximately the full bearing strength of 6d common nails, 3/8" for 8d common, 1/2" for 10d common, and 5/8" for 16d common nails, all driven into wood members of similar density and of adequate thickness.

A 3/8" edge-clearance is desirable for nailing plywood, as nail-bearing strength decreases rapidly with lesser margins. A 3/8" edge distance is practical and is normal for panels that butt over a 2" framing member. Results of nail-bearing tests by the American Plywood Association, where plywood was nailed with a 3/8" edge-clearance to 2" x 4" studs, showed values below:

21262

ULTIMATE NAIL BEARING LOADS

3/8" EDGE CLEARANCE

PLYWOOD THICKNESS	"COMMON" NAIL SIZE			
	6d	8d	10d	16d
5/16	275	305		
3/8	275	340		
1/2		350	425	
5/8		350	425	445
3/4			410	445

Even with loads acting perpendicular to the edge of the panel (and framing member), maximum bearing values occurred with nails about 1/2" to 3/4" from the panel edge and 1" or so from the side of the stud, and ran as much as one-third higher than those in table above. The grain direction of the plywood had no influence on the ultimate loads.

It should be noted that, when plywood walls or roofs are subjected to shearing stresses, the principal forces act parallel with the edge, making the nail location much less critical than it might otherwise be.

Casing Nails. The bearing value of these, from limited American Plywood Association tests, averages about two-thirds that for common nails having the same "d" (penny) designation.

STAPLES

Rapid-acting stapling machines, some pneumatic, others mallet-driven, have brought patented staples into use both for attaching plywood to framing, and asphalt shingles to plywood.

21263

The Research Committee of the Uniform Building Code, for example, has approved* a 16 gauge staple with 1-1/8" legs and 1/2" width as an alternate for 6d common nails, for either 5/16" or 3/8" plywood diaphragms, but has limited its shear values to 7/16 of those in the Code for plywood applied with 6d common nails.

A heavier staple, 14 gauge with 1-1/4" legs, tested by the American Plywood Association, showed values equivalent to 6d common nails in both lateral bearing tests and in full-scale diaphragm tests. T-nails and other types of mechanically applied fasteners are also available. Information on further code approvals and acceptance by FHA may be obtained from the various fastener manufacturers.

Power-driven staples used to attach shingles to plywood sheathing, in general should be of following minimum dimensions:

Wood shingles: 16 ga.; 7/16" crown; length, sufficient to penetrate bottom surface of plywood; 2 to each shingle.

Asphalt shingles: 16 ga.; 3/4" crown; 3/4" length; 2 to each shingle, or 6 for 36" section of strip shingles.

Built-up Roofing: 16 ga.; 7/16" crown; 7/8" length, driven through tin caps on 12" centers.

BOLTS

These have only limited use in plywood construction. No accurate bearing values have been established, although the American Plywood Association had a series of

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* Research Committee Reports Nos. 1101.4 and 1101.5, 1960.

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tests conducted a number of years ago on 1/2" and 3/4" diameter bolts in plywood of 1/2", 5/8", and 3/4" thicknesses.

Attempts to rationalize bolt-bearing values by taking projected area of bolt against the several veneers and using allowable compression stresses for wood at applicable angle to the grain, lead to ultra-conservative results. Even if such theoretical values are doubled, factors of safety are still higher than those commonly associated with wood, i.e., 3.6 on ultimate and 1.6 on proportional limit. These presuppose adequate end-clearance of at least 3" for 1/2" bolts in 1/2" to 3/4" plywood, up to 6" for 3/4" bolts in 3/4" plywood. Edge distances should range from 1" to 3" depending on bolt size and plywood thickness.

GLUING

When glue is used to attach plywood to a wood framework, as in various structural components, cabinet work, and the like, the process is known as secondary gluing, to distinguish it from the primary gluing in manufacturing plywood itself.

Secondary gluing for structural assemblies may be of a water-resistant type or of a virtually waterproof type, depending on the anticipated exposure. In either case, the glue is designed to develop shearing stresses between the two surfaces being joined, and therefore should be stronger than the wood itself in this respect. Fortunately, excellent glues are available for such work, which includes box beams and other structural components.

Glue joints in direct tension perpendicular to the glued surfaces are comparatively weak, since at best they can be no stronger than wood in tension perpendicular to the grain.

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GUSSET PLATES

Plywood gusset plates constitute an effective and economical means of jointing co-planar truss members. These are also effective as bracing between columns or posts and bearing trusses or beams.

High panel shear and nail-bearing of the plywood are responsible for its success in all applications.

Gussets may be glued instead of nailed to truss members.

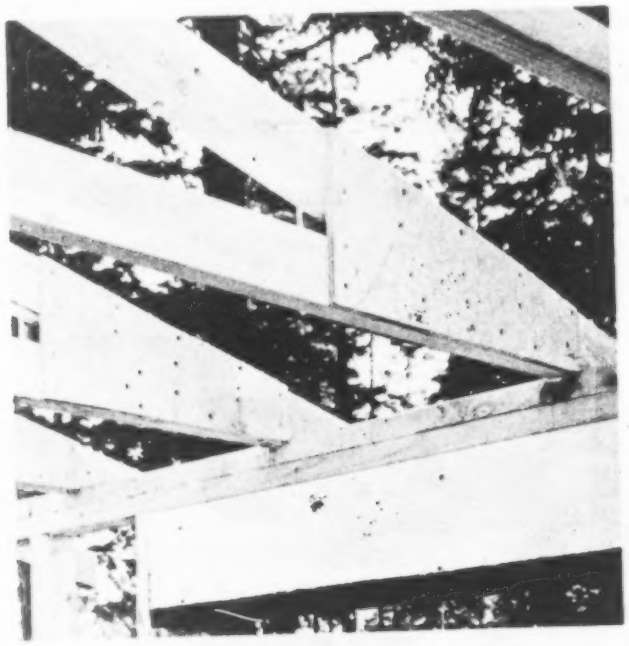

Gusset Plate At Heel Joint

PLYCLIPS*

These are patented H-shaped extruded structural aluminum-alloy clips 3/4" long and 1-3/16" wide. They were developed* as roof panel support in lieu of cut-in blocking, primarily for 3/4" plywood on 48" spans where two Plyclips per span are used.

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*By Plywood Research Foundation (An American Plywood Association subsidiary), Tacoma, Washington.

These permit significant labor savings over cutting and applying blocking.

They are available in sizes for 5/16", 3/8", 1/2", 5/8", 3/4", and 13/16" plywood panels. A single Plyclip at middle of allowable plywood span is adequate edge support, except for 3/4" and 13/16" panels on 48" spans, where two equally spaced clips are recommended.

In tests at the American Plywood Association's Applied Research Laboratory, Plyclips sustained average concentrated loads of 849 lbs. with a minimum of 558 lbs. and a maximum of 1309 lbs. Loads were applied 3" back from the Plyclips placed at center of span between two butting panels nailed conventionally to framing.

Edge deflections under 250 lb. loads were reduced about 40%; differential deflection between adjacent panels was less than 1/16".

Repetitive loads of 500 cycles @ 250 lbs. showed no deteriorating effect.

Plyclips At Joint Between 3/4" Roof Panels

Plyclips were approved by the Research Committee of ICBO* in 1958. Since then some 55 million have been used, mostly in plywood roof construction.

*International Conference of Building Officials

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RECOMMENDED MINIMUM NAILING SCHEDULE *

Minimum edge distance of $\frac{3}{8}''$ recommended.

ywood Use	Plywood Thickness (inches)	Nail Size	Nail Type	Nail Spacing on Supports (inches)		Special Requirements
				Panel Edges	Intermediate	
of Sheathing	5/16, 3/8, 1/2 5/8, 3/4	6d 8d	Common Common	6 6	12 12	
all Sheathing	5/16, 3/8, 1/2 5/8	6d 8d	Common Common	6 6	12 12	
Subflooring	1/2 5/8, 3/4 1" 1 1/8" (2.4.1)	6d 8d 8d (or 10d com.) 8d (or 10d com.)	Common Common Deformed Shank Deformed Shank	6 6 6 6	10 10 6 6	If resilient flooring is to be applied without underlayment, set nails 1/16" and use deformed shank nails. (6d for 1/2", 5/8", and 3/4" plywood).
Diaphragms	1/4 and thicker		Common	6	12	Nail size and spacing determined by shear requirements; do not exceed spacing shown.
nderlayment	1/4, 3/8, 1/2 5/8, 3/4	3d 4d	Ring Shank	6 6	8 each way 8 each way	Nails shall have 20 annular rings per inch of shank, to within 5/16" of head. Heads shall be flat counter-sunk. Length shall be sufficient to penetrate 3/4" at least into subfloor. For plywood 1/2" and less, shank diameter shall be at least 0.080" and head diameter 3/16". For plywood 5/8" and 3/4" thick, shank diameter shall be at least 0.098" and head diameter 1/4".
erior Paneling	1/4 3/8	4d 6d	Finish or Casing Finish or Casing	6 6	12 12	
terior Siding exture 1-11	5/8	8d	Galv. Casing	6	12	Nails on ship-lap edges 3/8 from exposed edge and slant driven towards it; do not set.
anel Siding	3/8, 1/2 5/8 and thicker	6d 8d	Non-Corrosive, Siding or Casing	6 6	12 12	Do not set.
Lap Siding	3/8 1/2 and thicker	6d 8d	Non-Corrosive, Siding or Casing	One nail per stud on bottom edge. Space not more than 4" at vertical joints. If siding is wider than 12", space nails on each intermediate stud not more than 8". Do not set.		

Reproduced from the American Plywood Association's "Construction Guide," Form No. 62-220

NAIL SIZE AND NUMBER PER POUND

Size	Length	COMMON		BOX	
		Gauge	No. per pound	Gauge	No. per pound
4d	1-1/2"	12-1/2	316	14	453
5d	1-3/4"	12-1/2	271	14	389
6d	2"	11-1/2	181	12-1/2	225
7d	2-1/4"	11-1/2	161	12-1/2	200
8d	2-1/2"	10-1/4	106	11-1/2	136
10d	3"	9	69	10-1/2	90
12d	3-1/4"	9	63		
16d	3-1/2"	8	49	10	69
20d	4"	6	31	9	50
30d	4-1/2"	5	24		
40d	5"	4	18		

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RECOMMENDED MINIMUM STAPLING SCHEDULE *

All values are for 16-gauge galvanized wire staples having a minimum crown width of $\frac{3}{8}''$.

Plywood Thickness	Staple Leg Length	Spacing Around Entire Perimeter of Sheet	Spacing at Intermediate Mem
A. PLYWOOD WALL SHEATHING* *(without diagonal bracing)*			
5/16"	1-1/4"	4"	8"
3/8"	1-3/8"	4"	8"
1/2"	1-1/2"	4"	8"
B. PLYWOOD ROOF SHEATHING			
5/16"	1-1/4"	4"	8"
3/8"	1-3/8"	4"	8"
1/2"	1-1/2"	4"	8"
C. PLYWOOD SUBFLOORS			
1/2"	1-5/8"	4"	7"
5/8"	1-5/8"	2-1/2"	4"
D. PLYWOOD UNDERLAYMENT			
1/4" **	7/8"	3"	6" each way
3/8"	1-1/8"	3"	6" each way
1/2"	1-5/8"	3"	6" each way
5/8"	1-5/8"	3"	6" each way
E. ASPHALT SHINGLES TO PLYWOOD *(staples to have crown width)*			
5/16" and thicker	3/4"	**According to shingle mfg.** but not less than 6 staples for 36" section, or 2 stap each individual shingle.	

**Wall sheathing with diagonal bracing requires staples only at studs.*
***18-gauge staples with 3/16" crown width may be used for ¼" Underlayment.*

*Reproduced from the American Plywood Association's "Construction Guide," Form No. 62-220

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UNIT II - STRUCTURAL WOOD MATERIALS

4. b. PLYWOOD DIAPHRAGMS

From the standpoint of racking resistance and bracing, the conventional applications of plywood for wall and roof sheathing, and to some extent also for subflooring, have been based on knowledge of its adequacy as developed originally in a series of tests by the U.S. Forest Products Laboratory.

In the modern plywood diaphragm, however, a rigorous engineering design has replaced older empirical methods.

Definition. A diaphragm has been defined as a thin, structural element, either flat or curved and usually rectangular, capable of resisting shear parallel to its edges.

More clearly, perhaps, the Semismology Committee of the Structural Engineers Association of California defines a diaphragm as "essentially a horizontal girder, composed of a web (such as a floor or roof slab) with adequate flanges, which distributes horizontal forces to the vertical resisting elements."

History. California has the distinction, born of necessity, of fathering earthquake design methods which other areas are wisely pursuing.

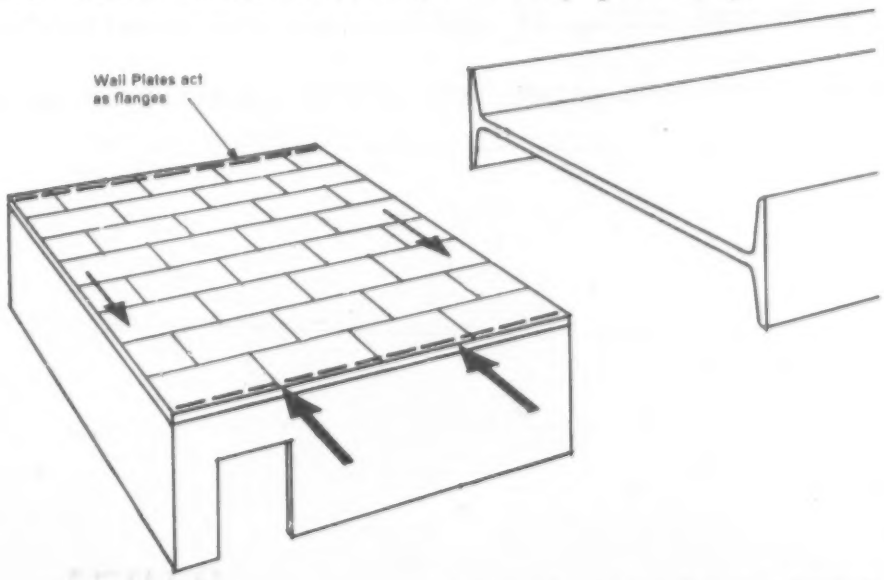

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Flat Girder Concept of Plywood Roof Sheathing

UNIT II - STRUCTURAL WOOD MATERIALS

The San Francisco earthquake in 1906 tragically demonstrated the need for designing buildings to resist seismic as well as wind stresses. The Santa Barbara quake in 1925 stimulated research, and the Long Beach quake of 1933, with its wide destruction of buildings, many of which were masonry-walled schools (fortunately not in session), prompted immediate legislative action by which the State Office of Architecture and Construction was made responsible for approval of plans and specifications, as well as supervision of construction for all public buildings. That State Office quickly adopted design rules which, among other requirements, established lateral design loads based on weight of the building and its live load. Since then, due to extensive research and field investigations of various quakes, many refinements have been developed by structural engineering societies and their members, and have been adopted in building codes.

Out of the many studies came the concept of floors and roofs acting as plate girders, and of vertical walls acting as shear walls.

Research by Industry. Much of the design data on plywood diaphragms stems from a comprehensive research program initiated in 1949 by the American Plywood Association.

This work was facilitated by suggestions from the California Structural Engineers Association, the State Office of Architecture and Construction, Professor A. L. Miller, University of Washington, and others experienced in seismic design.

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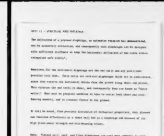

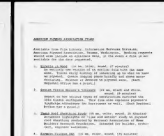

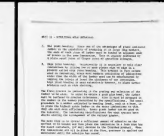

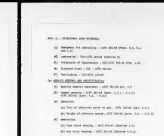

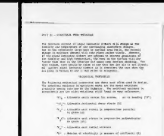

7. ANNUAL AND PROGRESSIVE INSPECTIONS. The procedures and scope of these inspections are set forth in Appendix D of Federal Aviation Regulation Part 43 and should be followed in detail. There are additional requirements listed in FAR 43.15. The regulations speak of 100-hour and annual inspections as being of identical scope; the only difference between the two is the persons authorized to perform them. Record entries you make are very important as they are the only evidence an aircraft owner has to show that he has complied with the inspection requirements of FAR 91.169 or 91.171. The following list should be helpful in reminding the AI of areas his responsibilities cover in determining that the aircraft complies with all airworthiness requirements (Ref: FAR 43.15(a.)

a. Configuration. The aircraft should conform to the aircraft specification or type certificate data sheet. When the aircraft does not conform, use the "unairworthy" procedures of FAR 43.11(a)(5).

(1) Alterations to the product may have changed some of the operating limitations.

(2) Unrecorded alterations or repairs may have been made. A remedial course of action may warrant the following:

(a) Contact owner for pertinent information.

(b) With owner's consent, wire FAA in Oklahoma for information.

(c) If approved data is available, conduct inspection and personally approve.

(d) Contact local FAA inspector for assistance.

(3) The aircraft specification or data sheet indicates when a flight manual is required. It also identifies limitations which must be displayed in the form of markings and placards.

(4) The type certificate data sheets on later models of aircraft do not contain the lists of equipment approved for a particular aircraft as did the older aircraft specifications. This list of required and optional manufacturer's approved equipment can now be found in the original equipment list furnished with the aircraft. Sometimes a later issue of the list is needed to cover recently approved items.

b. Condition. Using the checklist in FAR 43, Appendix D, the manufacturer's inspection sheets, or one of your own design, that includes the items listed in Appendix D, check the condition of the entire aircraft. This includes checks of the various systems as called for in FAR 43.15.

(1) Routine servicing is NOT a part of the annual inspection. The inspection itself is essentially a visual evaluation of the condition of the aircraft and its components and certain

After two years' exploratory tests of several variables in 1/4 scale models, a series of twenty full-scale diaphragms from 12' x 20' to 20' x 40' were tested.* These were supplemented by three tests** on 20' x 60' and 12' x 60' diaphragms at the Oregon Forest Products Research Center, Corvallis, Oregon, in cooperation with the American Plywood Association.

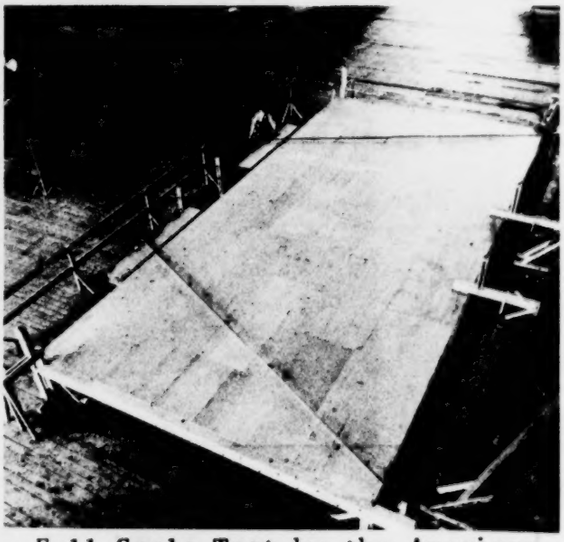

Full Scale Test by the American Plywood Association of Plywood Roof Diaphragm

Results. Diaphragms with blocking and nailing at all panel joints were found to be fully shear-resistant, with less deflection and greater strength than if unblocked.

Also, arrangement of panels as to staggering and continuous joints affected results. These features were all considered in the widely accepted table of shear loads approved in the Uniform Building Code. These values, however, are actually limited by the bearing value of nails in wood, and not by the recommended plywood shear stresses which are considerably higher. Note that, although blocked diaphragms may be calculated quite accurately for deflection, unblocked cannot. Nevertheless, in the tests mentioned above, both types had about the same deflection at their own design load.

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*Full report, the American Plywood Association Laboratory Report 63-A, "1954 Horizontal Plywood Diaphragm Report," by Countryman and Colbenson.

**Report T-5, October '53 by Stillinger and Countryman, and Report T-11, 1955, by J. W. Johnson.

Importance. Plywood diaphragms have proved to be a significant improvement over former construction systems. They are of great importance because they offer a simple, logical, and economical way to engineer precisely any structure sheathed with plywood to withstand lateral loads from cyclonic winds or earthquakes. Practically no area in the United States is immune to one menace or the other.

Diaphragm Action. Most diaphragms are either horizontal or vertical, although curved or gabled roofs may also be included. With ordinary good construction practice, plywood roofs, floors, and walls all will act as diaphragms while performing their other functions. A plywood sheathed exterior wall, for example, if properly anchored, will automatically act as a "shear wall" or cantilevered diaphragm, and thus usually counteract the weakening effect of large glass areas.

Plywood Decorative Panel As Shear Wall in Home With Large Glass Areas

The plywood diaphragm concept assumes that the lateral loads from wind and earthquake, which tend to deflect or push in the walls of a building are carried by the roof, functioning as a large, horizontal girder. Such a girder has for its web the fully shear-resistant plywood sheathing, and for its flanges, which carry the flexural stresses, the long wall plates to which the sheathing is attached.

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UNIT II - STRUCTURAL WOOD MATERIALS

II-C - WOOD, GLUED Laminated Timber, Plywood and other Products

GLUED LAMINATED TIMBER (NDS, WHB, TCS, Film Slides AITC, Laminating Standards WWPA, WCLIB, CRA)

INTRODUCTION

Glued laminated timber is defined in the Commercial Standard CS 253-63 as "An engineered, stress-rated product of a timber laminating plant, comprising assemblies of suitably selected and prepared wood laminations securely bonded together with adhesive. The grain of all laminations is approximately parallel longitudinally. The separate laminations shall not exceed 2" in net thickness. They may be comprised of pieces end-joined to form any length of piece placed or glued edge to edge to make wider ones of pieces bent to curved form during gluing." This differs from plywood in regard to the orientation of grain in each lamination. It is also larger in size than the smaller glued lumber products.

The use of glue to join pieces of lumber together is an ancient art. There are examples in the Egyptian tombs of wood bonded together by adhesives. However, glued laminated timber as we know it today was first used on a large scale in Europe around 1905. There is a continuing history of its use throughout Europe and in the United States to a limited extent in the years between World War I and World War II. In the years following World War II the use increased dramatically, due in part to a better understanding of its properties and use potential, followed by more economical means of production. Many of the references still in use were developed during the early days of the industry. As more was learned about making the product, some of the older concepts have given way to new ideas and techniques. For example, some of the references cited list only the plain scarf joint as a means of end jointing the individual pieces of lumber. The only criteria set forth was in the slope of the cut such as 1:10. As new techniques in maching were developed, the structural finger joint became a reality. Today most of the modern specifications equate the end joint to a performance test type criteria thus permitting the use of finger joints if the joint can qualify by physical testing.

Basically glued laminated lumber consists of two raw materials -- lumber and adhesives. The adhesive is used to bond the individual piece of lumber together in a process generally called laminating. Three distinct types of bonding operations may be performed during the laminating operation:

1. Face joint bonding: The faces of each lamination must be bonded to the faces of the adjacent laminations so that members of the desired depth can be obtained.

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2. End joint bonding: Since one of the advantages of glued laminated lumber is the capability of producing it in large long members, the ends of each piece of lumber must be bonded to adjacent ends of pieces in the same lamination. This is usually performed by a plain scarf joint of finger joint of specified strength.

3. Edge joint bonding: Occasionally it is necessary to make wider laminations by joining two or more pieces edge to edge in a process called edge joint bonding. This process is very seldom used in laminating, since most members consisting of laminations wider than the width of the lumber used can be manufactured by lapping the joints at least the thickness of the lamination. Edge joint bonding is used extensively however, in glued lumber products such as wide shelving.

The first process in laminating is the grading and selection of the lumber to be used. In order to obtain a good glue bond, the lumber must be surfaced to precise tolerances. Also it must be arranged in the member in the manner prescribed by the specifications. The usual procedure in a member subjected to bending loads, such as a beam, is to place the highest grade lumber in the outer laminations so that they can work more efficiently. Lower grade lumber can be used on the interior. The laminating specifications for each species have charts showing the arrangement of the various grades.

The next step is to spread a sufficient amount of adhesive on the surface to be bonded and then place the lamination in a form that has the exact curvature, (if any) desired in the finished product. When the laminations are all in place in the form, pressure is applied and maintained until the adhesive has cured.

The two types of adhesives used in laminating are dry-use adhesives and wet-use adhesives.

(a) Dry-use adhesive: A water resistant adhesive designed primarily for dry use conditions. These adhesives are of the casein type and although termed dry-use they have a fair degree of water resistance and can withstand the exposure normally experienced in erecting the timbers. They should not be used where the equilibrium moisture content of the wood exceeds 16%.

(b) Wet-use adhesive: These adhesives are designed to withstand any condition of use including dry-use and wet-use where the timbers are saturated. (See TCS AITC 103-65 Section 5)

A certain amount of heat is necessary to cure the adhesives. The caseins will cure at any temperature above freezing, but higher temperatures decrease the time for which the members must remain clamped under pressure in the forms. The wet-use adhesives will cure at temperatures ranging from 70% F

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The moisture content of glued laminated timbers will change as the humidity and temperature of the surrounding atmosphere changes. Due to the relatively large mass to surface area ratio, the overall change in moisture content will take place rather slowly. However, if the glued laminated timbers are subject to extreme conditions of low humidity and high temperature, the wood on the surface will dry faster than that in the interior and cause some surface checking. For this reason, care should be taken to see that hot dry air is not directed against glued laminated timbers as is sometimes the case when the building is heated to dry it out prior to occupancy.

MECHANICAL PROPERTIES

The following mechanical properties are those most often used in design. The notations enclosed in quotation marks are the newer notations gradually coming into use by the industry. The notations enclosed in parenthesis are the older notations still found in many references.

"F_b" - Allowable units stress for extreme fiber in bending ("f")

"F_v"- Allowable Horizontal shear stress (H)

"F_c" - Allowable unit stress in compressions parallel to grain (c)

"F_{c1}"- Allowable unit stress in compression perpendicular to grain (c1)

"F_r" - Allowable unit radial stresses

"E" - Modulus of elasticity (a measure of stiffness) (E)

The mechanical properties of glued laminated wood which are taken into account in design are essentially those which are used in solid sawn lumber. However, in bending of the laminations to produce a curved member, some account must be taken for the effect of bending. Also, in curved beams the effect of the radial stresses induced by bending or stensile stresses at right angles to the grain of the wood can affect the design.

Basically the allowable stresses for glued laminated timber are greater than for comparable grade of solid sawn lumber for the following reasons:

1. There is a natural dispersion of knots which tends to prevent the accumulation of strength reducing characteristics at a single cross section as can happen when a single knot occupies a large portion of the cross section of a solid sawn piece.

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The deflection of a plywood diaphragm, as extensive research has demonstrated, can be accurately calculated, and consequently such diaphragms can be designed with sufficient stiffness to keep the horizontal deflection of the walls within recognized safe limits*.

Reactions for the horizontal diaphragm are the end walls and any partitions parallel with them. These walls are vertical diaphragms which act as cantilevers, since they receive the horizontal forces from the girder along their top plates. This stresses the end walls in shear, and consequently they are known as "shear walls." They must be properly anchored at base to resist both shear and overturning moments, and to transmit forces to the ground.

It will be noted, from previous discussion of mechanical properties, that plywood can function effectively as a shear wall and as a diaphragm web because of its high panel-shear strength and nail-bearing values.

Uses. Plywood wall, roof, and floor diaphragms are used most commonly in wood frame buildings. Plywood roofs and floors as well as interior partitions are frequently used as diaphragms in masonry or concrete walled buildings. In earthquake areas such as California, plywood roof diaphragms in one-story industrial buildings and in schools have virtually displaced other materials. Plywood sheathing, although customarily used in combination with wood joists has also been employed successfully as horizontal diaphragms with steel joists.

Churches, auditoriums, warehouses, and commercial buildings, ranging in size up to at least 500,000 sq. ft., have utilized plywood diaphragms successfully.

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*See "Timber Design &Construction Handbook," page 246, F. W. Dodge Corporation.

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(3) Equipment for laminating - AITC 201-63 (Pars. 3.1, 3.2 and 3.3)

(4) Laminating - TCS-AITC 103-65 (Section 6)

(5) Tolerances of Manufacture - TCS-AITC 103-65 (Par. 3.6)

(6) Standard Sizes - TCS - AITC 113-65

(7) Fabrication - TCS-AITC 113-65

(c) QUALITY CONTROL AND IDENTIFICATION

(1) Quality control equipment - AITC 201-63 par. 3.4

(2) Lumber grading - AITC 201-63 (pars. 2.2.1 - 2.2.4)
AITC 103-65 (pars. 4.3. - 4.8.)

(3) Adhesives

(a) Test of adhesives prior to use. AITC 103-65 (par. 5.4.)

(b) Weight of adhesive spread. AITC 103-65 (pars. 5.6. - 5.6.2)

(4) Laminating

(a) Face Joint bonding - AITC 201-63 (Section 1.4)

(b) End Joint Bonding - AITC 201-63 (Section 4.4.2)

(c) Pressure AITC 201-63 (Section 4.4.4)

(d) Testing AITC 201-63 (Section 5)

(e) Visual Inspection - AITC 201-63 (Section 5.6)

(f) Appearance grades - TCS-AITC 110-65

(g) Identification - TCS-AITC 103-65 (Pars. 9.1, 9.2, 9.2.1, 9.2.2, 9.3, 9.3.1 and 9.3.2)

PHYSICAL PROPERTIES

The physical properties of glued laminated timber are essentially the same as the species used in manufacturing the timber. The adhesive has a relatively minor effect on the basic physical properties of the wood. The main difference between solid sawn timber and glued laminated timber is in the moisture content and shrinkage. Glued laminated timbers are manufactured with dry lumber, and the amount of shrinkage and checking due to change of moisture content is considerably less than solid sawn timbers.

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AMERICAN PLYWOOD ASSOCIATION FILMS

Available from Film Library, Information Services Division, American Plywood Association, Tacoma, Washington. Booking requests should also include an alternate date, in the event a film is not available for the date requested.

1. Miracle in Wood (16 mm, color, sound, 27 minutes)
   An entirely new version of an earlier film with the same name. Traces early history of veneering up to what we know as plywood. Covers logging phase briefly and shows manufacturing. Balance is devoted to plywood uses. (Each Regional Office has a print.)

2. Design Versus Nature's Violence (16 mm, black and white, sound, 18 minutes)
   Report on how various types of construction survived the 1964 Alaska earthquake. This film also explains plywood's diaphragm advantages for hurricanes as well. (Each Regional Office has a print.)

3. Tamap Roof Sheathing Study (16 mm, color, sound, 26 Minutes)
   Documents highlights of "time and motion" study on plywood roof sheathing conducted by National Association of Home Builders Research Foundation. Intended for builder, architect, engineer audiences.

4. Olympic Village USA (16 mm, color, sound, 14½ minutes)
   Film report on site preparations for the 1960 Winter Olympics... how Squaw Valley, California, was transformed from a peaceful meadow into an Olympic site in record time. Construction and planning of sport facilities and related structures illustrated. Unique construction methods and softwood plywood products combined to finish job on schedule.

AMERICAN PLYWOOD ASSOCIATION SPEAKERS

Speakers are available from the American Plywood Association. Arrangements should be made with either the Los Angeles Regional Office (9845 McNerney, South Gate, California) or the San Francisco Regional Office (3030 Bridgeway, Sausalito, California) at least two months prior to speaking engagement. Plywood Association speakers will make folders of appropriate literature available to class.

"PLYWOOD PROPERTIES, DESIGN AND CONSTRUCTION" by Nelson S. Perkins is available from the American Plywood Association at a cost of $2.00 per copy. Reduced rates are available to local book stores.

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to 300° F depending upon the type and brand of the adhesive. In all cases however, the curing temperature should be in accordance with the adhesive manufacturer's recommendations.

After the adhesive has set, the sides of the timbers are planed smooth and usually some additional fabrication such as triming, cutting of slopes etc., is performed as may be required by the plans.

Arches and other curved members are checked during the fabrication to make sure they comply with the plans and specifications. For this purpose the same template that was used to set the forms is used to cut the member to the correct shape supplemented by checks of key dimensions. Most beams are manufactured with a slight curvature called camber to offset the deflection or sag in the beam caused by the dead load of the building. This camber should be in accordance with the plans and specifications. (See reference TCS AITC 102 65 Par. 9.8 and appendix B.) In erection it is important that the beams are placed in an upright position and not turned over so that the "cambered" beam does not sag. End sealers and surface sealers are often specified since they offer a degree of protection to the member.

(a) DESCRIPTION AND EXAMPLES OF USE

(1) WHB - (pages 250-262)

(2) TCS - AITC 102-65 (paragraphs 9.1 and 9.8.1)

(3) AITC 103-65 (Paragraph 2.1.1)

(4) Examples of Use

(a) Film Slides "Modern Timber Construction" 30-35 mm film slides showing use of glued laminated Timbers available on loan from AITC 1700 K St., N.W. Washinton, D.C. 20006 (Sets may also be purchased for $10.00)

(b) Possibility of obtaining reprints or Brochures from AITC with pictures of use.

(b) MANUFACTURE

(1) Lumber for laminating - TCS-AITC 103-65 (Sec. 4)

(2) Adhesives

(a) TCS-AITC 103-65 (Sec. 5)

(b) AITC 103-65 Appendix A-Selection of Adhesives.)

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Horizontal plywood diaphragms are particularly suitable where appearance of the exposed smooth undersurface is important. Plywood in shear walls or partitions may serve as interior finish while also performing its diaphragm function. Diaphragms are frequently used also to carry gravity loads, as in the case of folded plate roof construction, discussed in the next chapter.

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operational checks. The manufacturer may recommend certain services to be performed at various operating intervals. These can often conveniently be done at this time, and in fact should be, but should not be considered as being the inspection itself.

(2) It is very important to be familiar with the service manuals, bulletins, letters, etc., for the product being inspected. It makes good sense to utilize the experience other people have had on similar products, so use these publications to avoid overlooking problem areas which might not otherwise come to your attention.

(3) The FAA General Aviation Inspection Aids are also a source of service experience available to you. These Aids are summaries of difficulties reported to FAA on FAA Form 1226, Malfunction or Defect Report.

(4) At the time he certifies the inspection for an aircraft as airworthy, the AI will be held responsible for condition of the aircraft AS OF THE TIME OF THAT CERTIFICATION.

c. Airworthiness Directives. The AI should make it a point to see whether all applicable airworthiness directives have actually been complied with on the aircraft, the powerplant, propeller, instruments, and appliances.

(1) If the maintenance records indicate compliance with an AD, the AI should make a reasonable attempt to verify this. He would not be expected to disassemble major components such as cylinders or crankcases, etc. The reason for this being that it is not uncommon for a component to have an AD complied with and properly recorded and then later be replaced by another on which the AD had not yet been accomplished.

(2) When the records do NOT contain indications of previous compliance, the AI should do whatever disassembly is necessary to verify the actual condition.

(3) Often an AD calls for an inspection at one time with a modification required at a later date. On these it is very important to identify the portion of the AD complied with and the exact method of compliance.

(4) Section 91.173(b)(2) of the FAR requires an owner to keep a chronological listing of compliance with service bulletins, and airworthiness directives, and the method of compliance. As a vital part of the services an AI performs, he can provide the information the owner is expected to keep.

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2. There is less chance for hidden imperfections to be present in glued laminated timber since the use of relatively thin pieces permits a visual inspection of most of the wood substance contained in the member.

3. Glued laminated timbers are required to be manufactured from dry lumber. Full advantage can be taken of the increase in strength for dryness. In bending, for instance, dry lumber is 25% stronger than green lumber. When glued laminated timbers are used in wet locations where the fibers become saturated, this increase in strength for dryness does not apply.

4. The adhesive used in laminated timbers is capable of bonding the wood together in side grain bond in a joint that is as strong if not stronger than the wood itself in the mechanical properties essential to developing the strength of the wood. Therefore, it is possible to consider glued laminated timbers as one solid mass of wood, the strength of which depends on the strength of the wood. The allowable stresses of glued laminated timbers as shown in the laminating specifications were determined by making an extensive study and analysis of each species used, which included the basic stress of the species, the effect of allowable knots permitted and the probability of dispersion of the knots through the member, the effect of slope of grain and the strength of the end joint that is needed. Such studies have been made on most of the important commercial species and laminating specifications for each have been prepared. The references at the end of this section contain the laminating specifications generally used in Commercial production.

When adhesives are used to join wood, end grain to end grain, the resulting joint is not as strong in tension as the wood. Therefore, either a plain scarf joint or a finger joint is used to increase the area of gluing. Such joints develop a large percentage of the strength of clear wood. The strength of the end joint is taken into account in setting the allowable stresses of combinations used in laminating. Many of the references cited include only the plain scarf joint of a specified slope such as 1:10 as the only criteria for end joints. The more modern specifications include a performance test (See TCS-AITC 103-65) which allows the use of finger joints as well as plain scarf joints.

The references included at the end of this section list the allowable stresses for the most important species used in laminating.

The allowable strength properties for each combination of each species are listed. Since most members used are flexual members, the allowable fiber stress in bending quite often controls. This stress varies as the grade of the lumber in the combination varies, also the allowable compression parallel to grain varies with the grade of the laminations, compression perpendicular to grain varies only as the density of the

wood varies, horizontal shear and modulus of elasticity vary very little with grade and are considered to be the same for all combinations of a given species. It is interesting to note that on long span beams (particularly those used on flat roofs), the deflection may control the design instead of bending strength. In which case a combination with a lower allowable fiber stress in bending may be specified. For instance, where deflection controls a combination with an allowable fiber stress in bending of 2400 or 2200 psi may be used rather than a 2600 "f" combination.

Glued laminated timbers are quite often relatively large and deep compared to solid sawn timbers. For this reason the effect of depth must be taken into account when determining the allowable fiber stress in bending used in design. (See appendix D NDS). This factor is taken into account in the design of glued laminated timbers and is usually of no concern as far as the erection and inspection is concerned. It is interesting to note however, that the allowable fiber stress in bending of a beam 32" deep is only 85% of that of a similar beam 12" deep.

References: NDS Table 20 page 51 part IX, page 49-50 Standard Specifications for Structured Glued laminated Douglas fir (Coast Region) Timbers.

WSDD (Page 33-34)

(f) <u>Handling, Delivery,Storage</u>

TCS - AITC 111-65

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UNIT II - STRUCTURAL WOOD MATERIALS

II-D - STRUCTURAL USE OF WOOD PRODUCTS

BASIC ENGINEERING AND CONSTRUCTION PRINCIPLES

(A) INTRODUCTION

This section is intended to cover the use of wood in Structures where the sizes, shapes, placement and fastenings of wood members have been determined on a rational basis by engineering design. It is beyond the scope and purpose of this section to include the design of structural wood members, however it is felt that the basic principles involved should be discussed in order to develop a better understanding of the reasons behind the design of the structure.

In small buildings such as residences etc., much of the design is done by the use of tabular information such as selection of the species and size of floor joists rafters, ceiling joists, studs nailing patterns, etc., from charts or tables. In many cases the nailing pattern is not specifically shown on plans and is left up to the carpenter to use standard nailing practices. However, in larger structures the loads and forces involved in design require that each part of the building be analyzed by engineering methods to determine the size of each member and the design of fastenings for the structural system. In which case the sizes, spacing and details of fastenings are included in the building plans.

Wood as a structural material is subject to the same laws of engineering and physics as other materials. The load carrying capacity of wood varies with species and grade. Allowable stresses have been devised for all important commercial species of wood so that the designer can proportion the material to carry the loads to which it may be subjected. Although the basic laws of physics apply to lumbers, it is unique in some of its strength properties and certain adjustments to the general rule are used in design.

For these reasons adjustments are made for duration of load, moisture content, and deflections.

Design information concerning these and other aspects of wood design and construction are contained in the following references.

(NDS, WSDD, DFUB, WHB, NSP, WCD series and TDCB)

(B) WOOD FRAME CONSTRUCTION
WCD series

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(C) TIMBER CONSTRUCTION

(1) TCS-AITC 102-65 Design of Heavy Timber framing

(2) TCS-AITC 103-65 Typical Construction details

(3) DFUB Page 61-74, 178-185

(4) WSDDD Tabular data

(5) TDCB Chapter 10, Chapter 4

(6) NDS Reference tables and specifications

(7) Timber Construction Manual TCM

(D) LATERAL FORCES AND DIAPHRAMS

(1) DFUB Page 261-265

(E) ERECTION ENGINEERING AND SAFETY

TCS-AITC 105-65 Erection of Structural timber framing

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UNIT II - STRUCTURAL WOOD MATERIALS

Course of Study for:

Construction Inspectors and Supervisors

by

California State Department of Education
Bureau of Industrial Education
in cooperation with
California Construction Inspectors Association

D-2. Fasteners and Connectors

Suggested Texts for Study

(a) TIMBER DESIGN AND CONSTRUCTION HANDBOOK by Timber Engineering Company. Available from McGraw Hill Publishers, Price is $15.

Specific References:

Beginning page 56 of Section 3.

3.27 - 3.30 Nails and Spikes

3.31 Framing Anchors

3.32 Wood Screws

3.33 Driftpins, Driftbolts, Lag Screws

3.34 Bolts

3.35 - 3.43 Timber Connectors (split rings, shear plates, spike grids, clamping plates, toothed rings)

3.44 - 3.50 Choice of fastening and method of fabrication

Section 5 (pages 112 - 180) Roof Trusses

Section 10 (pages 333 - 350) Fabrication, Assembly, Erection, and Maintenance

(b) TECO DESIGN MANUAL FOR TECO TIMBER CONNECTOR CONSTRUCTION by Timber Engineering Company

1. Complete design and loading information for timber connectors.

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(c) NATIONAL DESIGN SPECIFICATION FOR STRESS-GRADE LUMBER AND ITS FASTENINGS Available from National Forest Products Association

Specific References:

Part IV. 406 - Metal Plates

Part V. Timber Connector Joints

Part VI. Bolted Joints

Part VII. Lag-Screw Joints

Part VIII. Nail, Spike, Drift-Bolt, and Wood-Screw Joints

(d) TIMBER CONSTRUCTION MANUAL by American Institute of Timber Construction

Section 5 - Fastenings and Connections

(e) STRUCTURAL WOOD FASTENERS a Catalog of TECO Products

page 2 TECO Line-A-Joist Connectors

page 3 TECO-U-Grip Joist and Beam Hangers

page 4 TECO Trip-L-Grip Framing Anchors
TECO Fas-Lok Metal Bridging

page 5 TECO Truss Plates

page 6 TECO Du-Al-Clip Framing Anchors
TECO H-Clip Plywood Supports

page 7 TECO Wedge-Fit Split Rings
TECO Shear Plates

page 8 TECO Ty-Down Rafter Anchors
TECO Post Caps
TECO Angles

page 9 TECO Toothed Rings
TECO Spike Grids
TECO Clamping Plates

page 10 Tools for Installation of TECO Connectors

page 11 TECO All Purpose Framing Anchors
TECO Post Anchors (Bases)
TECO Post Caps (one piece)

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UNIT II - STRUCTURAL WOOD MATERIALS

Legend of Abbreviations Used Herein

APA - American Plywood Association
CRA - California Redwood Association
WWPA - Western Wood Products Association
NLMA - NFPA, formerly National Lumber Manufacturers Association
NFPA - National Forest Products Association
AITC - American Institute of Timber Construction

ALSC - American Lumber Standards Committee
TECO - Timber Engineering Company
NDS - "National Design Specification for Stress-Grade Lumber and Its Fastenings" - NLMA 1962
WCD - Appropriate issue of "Wood Construction Data" booklets - NLMA
LWPS - "Lumber and Wood Products School" booklet - NLMA 1961
WSDD - "Wood Structural Design Data" - Handbook NLMA 1962
DFUB - "Douglas Fir Use Book" - Handbook WWPA
WHB - "Wood Handbook No. 72" U. S. Department of Agriculture, Forest Products Laboratory, Madison, Wisconsin.
TDCB - "Timber Design and Construction Handbook" - F. W. Dodge Corp. N. Y. 1956
MTE - "Modern Timber Engineering" by Scofield and O'Brien - Southern Pine Association 1963
PwCS - "Plywood Construction Systems for Commercial and Industrial Buildings" APA - 1965
TCS - "Timber Construction Standards - AITC 100-65"
YSKL - "What you should Know about Lumber" NFPA booklet 1965
WLTM - "Western Lumber Technical Manual" - WWPA booklet 1965
SPR 16-53 - "American Lumber Standard for Softwood Lumber" U. S. Department of Commerce, 1953
VGRS - The various published grading rule booklets for softwood lumber.
NSP - Perkins' Book on Plywood.
AWPA - American Wood Preservers Association
AWPB - American Wood Preservers Bureau, Inc.
AWPI - American Wood Preservers Institute

UNIT II - STRUCTURAL WOOD MATERIALS

Reference Books

Douglas Fir Use Book	DFUB
Timber Construction Manual American Institute of Timber Construction John Wiley and Sons, Inc. New York, New York 1966	TCM
Timber Design and Construction Handbook	TDCB
Wood Handbook No. 72	WHB
"Wood Preservation" by Hunt & Garratt	WP
Wood Structural Design Data	WSDD
Grading Rules	
Standard Rules	WWPA
Standard Grading & Dressing Rules	WCLIB
Standard Specifications for grades of California Redwood lumber	CRA
National Design Specifications	NDS
National Standard for Wood Frame Construction	NSWFC
Plywood Construction Systems	PCS
Timber Construction Standards	TCS
Western Lumber Technical Manual	WLTM
Wood Preservation Treating Practices Federal Specification TT-W-571	WPTP
"How to Build Homes That Will Outlive the Mortgage"	AWPI
"Pressure Preserved Plywood"	APA
"Fire-Protect Wood for greater freedom of design"	AWPI
"How to Design Pole-type Buildings"	AWPI
"Pressure Treatment Best for Timber"	AWPI

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(5) The owner should also be informed if there are subsequent requirements of an AD or that some may require reinspection at certain operating intervals other than at annual inspections. Often these are at 100-hour intervals and will be due whether or not the aircraft is legally required to have 100-hour inspections.

(6) To assist an AI in keeping his reference material current, we recommend that he add the new ADs to the space provided in the index of the AD summary.

d. AIs are encouraged to report all malfunctions or defects that come to their attention. Report forms, FAA Form 1226, are available from all FAA district offices, are easy to fill out, and need no postage. See Figure 4. Prompt reporting will contribute much toward improving air safety by helping correct unsafe conditions.

e. Paperwork Review. The owner/operator is responsible for maintaining the equipment list, center of gravity, weight distribution, and loading schedules if necessary.

(1) The AI should determine that the placards and documents set forth in the aircraft specification or data sheet are available and current. The aircraft is not to be reported as "unairworthy" if these placards and documents are not available, but the owner/operator should be informed that under FAR 91.31 the aircraft should not be operated until they are available.

(2) The AI should refer to the registration and airworthiness certificates for the owner's name and address and for the aircraft make, model, registration, and serial numbers needed for reporting purposes. Be sure not to use the manufacturer's trade names as these do not always coincide with the actual model designation (Cessna Skyland is 182, Piper Comanche is PA-24-250, etc.). Here again, if these certificates are not available, the aircraft is not to be reported as unairworthy. The owner/operator should be informed that the documents must be in the aircraft with the airworthiness certificate displayed as required in FAR 91.27 WHEN THE AIRCRAFT IS OPERATED.

(3) Other documents often needed but not a part of the airworthiness requirements might be state registration, FCC radio station licenses, etc. The owner/operator is responsible for the proper display of these documents. However, the AI will be performing an appreciated service when he informs the operator of any deficiencies in the display and carriage of these documents.

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UNIT II - STRUCTURAL WOOD MATERIALS

Audio - Visual

Movie

Syracuse University film on wood "Forever Living Forests"	CRA
The Full Treatment	AWPI

Slides

Modern Timber Construction	AITC

Sources of Information

1.	American Institute of Timber Construction 1700 K Street, N.W., Washington, D.C. 20006	AITC
2.	American Lumber Standards Committee	ALSC
3.	American Plywood Association 1119 A Street, Tacoma, Washington 98401	APA
4.	American Society for Testing & Materials	ASTM
5.	American Wood Preservers Association 839 Seventeenth Street, N.W., Washington D.C.	AWPA
6.	American Wood Preservers Institute 1707 L Street, N.W., Suite 710, Washington D.C.	AWPI
7.	California Redwood Association 617 Montgomery Street, San Francisco, Calif.	CRA
8.	Hardwood Plywood Manufacturers Association P. O. Box 6246, Arlington, Virginia 22206	HPMA
9.	Maple Flooring Manufacturers Association 424 Washington Avenue, Oshkosh, Wisconsin 54901	MFMA
10.	National Forest Products Association 1619 Massachusetts Avenue, N.W., Washington, D.C.	NFPA
11.	National Oak Flooring Manufacturers Association 814 Sterick Building, Memphis, Tennessee 38103	NOFMA
12.	National Paint, Varnish & Lacquer Association 1500 Rhode Island Avenue, N.W., Washington, D.C.	NPULA
13.	National Woodworking Manufacturers Association 400 West Madison Street, Chicago, Illinois 60606	NWMA

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UNIT III - STRUCTURAL METALS

Objective

The objective of this unit is to familiarize the student with the physical properties of structural metals, the shapes available for building construction, identification of metals and shapes, and how metals are used in building construction. Most of the course time will be spent on interpretation of construction drawings, study of welded and bolted connections, and analysis of field problems.

First Session

A. Introduction (One Hour)

The introductory period is intended to broadly cover the entire field and the use of structural metals in building construction. This might be formally divided between aluminum and steel or treated by function within the building.

A group of slides depicting buildings during construction can be used to begin the period. A representative selection of slides featuring member types, connections, and overall building views often are available through the local AISC representative and can be supplemented with similar slides obtainable from the Aluminum Association. The industry representatives usually are willing to present the slides with appropriate comments.

Following the slides, a general outline of the content of the structural metals portion of the course should be presented. The outline should lightly touch upon those topics of importance to the inspector that will be covered in detail in subsequent sessions.

B. Material Properties (One Hour)

References:
a. Chapter 2 of Structural Steel Design - Ronald Press. * (C)
b. Pages 5 - 155, 156, 157 of the AISC Manual of Steel Construction (Sixth Edition). (C)
c. Pages 4 - 11, 124 - 125 of the Aluminum Association's Standards for Aluminum Mill Products (1966). (C)

1. Structural Steel Available

   a. Common structural steel (A-36)
   b. High strength steels
   c. ASTM standards
   d. Material selection

* (C) Classroom Notes

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e. Light gauge material

2. Properties of importance

a. Yield point
b. Ductility
c. Tensile strength
d. Modulus of elasticity
e. Weldability
f. Corrosion resistance

3. Factors Affecting Properties

a. Chemical composition and alloying elements
b. Hot rolling
c. Cold working
d. Heat treatment

4. Verification of Principle Mechanical and Chemical Properties

a. Mill tests
b. Laboratory tests
c. Material identification shop and field

5. Aluminum Alloys

a. Alloy numbers
b. Commonly used alloys
c. Properties as compared to steel
d. Cladding or Anodizing for corrosion protection

C. Structural Steel Shapes (45 Minutes)

References: a. AISC Manual of Steel Construction
b. AISI Light Gauge Cold Formed Design Manual
c. Decking Catalogs

1. Rolled Sections

2. Febricated Sections

3. Light Gauge Steel Decking and Cold Formed Shapes

4. Dimensional Tolerances for Rolled Sections, Fabricated Sections, and Cold Formed Sections

D. Common Aluminum Shapes (15 Minutes)

Reference: a. Standards for Aluminum Mill Products - Aluminum Association
b. Designing for Aluminum Extrusions - Kaiser Aluminum

1. Extruded Mullions and Similar Members

2. Roofing and Decking

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UNIT II - STRUCTURAL WOOD MATERIALS

14. Northern Hardwood & Pine Manufacturers Assn. NHPMA
Suite 207 Northern Building, Green Bay, Wisconsin

15. Ponderosa Pine Woodwork PPW
39 South LaSalle Street, Chicago, Illinois 60603

16. Red Cedar Shingle & Handsplit Shake Bureau RCSHSB
5510 White Building, Seattle, Washington 98101

17. Redwood Inspection Service RIS
617 Montogomery Street, San Francisco, Calif.

18. Southern Hardwood Lumber Manufacturers Assn. SHLMA
805 Sterick Building, Memphis, Tennessee 38103

19. Southern Pine Association SPA
P. O. Box 52468, New Orleans, Louisiana 17150

20. Southern Pine Inspection Bureau SPIB
P. O. Box 52468, New Orleans, Louisiana 17150

21. Timber Engineering Company TECO
1619 Massachusetts Avenue N.W., Washington, D.C.

22. West Coast Lumber Inspection Bureau WCLIB
1410 S.W. Morrison Street, Portland, Oregon 97205

23. Western Red Cedar Lumber Association WRCLA
Yeon Building, Portland, Oregon 97204

24. Western Wood Products Association WWPA
Yeon Building, 522 S.W. 5th Avenue
Portland, Oregon 97203

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STRUCTURAL STEEL INSPECTION

A. A. Anderson

INTRODUCTION

Any job with structural steel requires a steel inspector and he can be from a testing lab or hired directly by the owner from an approved list, or from the Department of Building and Safety. Where the steel is not to be stressed over a low percentage of its capability, some testing and inspection is usually waived. Structural steel is particularly important because of the high allowable stresses used by the Structural Engineer in his design where each member is required to carry this stress safely. The steel members, columns, beams, or tapered steel girders are the structural members upon which the rest of the building depends and it is not hard to understand why so much emphasis is placed upon proper design, fabrication, erection, and inspection. Connections from one member to another are the means whereby the strength of the steel is transmitted eventually to the foundation and the structure is no stronger than its connecting elements. Welding is being used more and more to make these connections and more and more emphasis is being placed on proper welding.

ELECTRODES

Title 21 of the State of California Administrative Code of Public Works sets up certain construction procedures and regulations that school districts must follow. Local, Federal, and other governmental agencies also have regulations that follow in most respects the American Institute of Steel Construction recommendations. Certain rigid qualifications must be adhered to in inspection and the inspector shall be trained and experienced in inspecting welds on work requiring unquestioned reliability. First, the basic steel used must meet A.S.T.M. specifications and be sampled, tested, and approved. The welders must have demonstrated their ability to produce sound welds. Also, the welding electrodes must meet qualification or specifications. Because the electrode is an important part in making the connection, I would like to discuss various aspects of electrodes and some newer electrodes that are becoming generally used. Technically an electrode is a filler metal in the form of a wire or rod which is used as a terminal in an electric current to produce an electric arc.

General Electrode Classifications. There are many types of electrodes and they may be classed in many respects, for instance, as to the kind of material, either metallic or carbon. Or as to the coating whether a real light or wash coating is used or a heavy coating or perhaps something in between. The metallic electrode may be mild steel, low alloy steel, manganese steel, or another alloy. Other classifications include these with respect to current, DC or AC, or respect to size or polarity. The usual el ctrodes range in size from 3/32 to 3/8 inch in diameter and are from 9 to 18 inches long. For our use, however, we are concerned primarily with the American Welding Society classification of heavy coated shielded arc electrodes.

is to use an old refrigerator with a light bulb left on continually for heat. On the job the welder must keep these rods dry. We require that they have a method of keeping the rods warm and that only a few rods be taken out of this hot-box at a time. Also the welding heat or amperage is higher for the low-hydrogen electrodes, so it is important that the welder demonstrate proficiency in its use. Used properly with the right heat, the weld is practically self-slaging. This is also a method of checking on the welder. If he is having difficulty in slaging,he is not welding properly with the low-hi rod. The advantages of the low-hi electrodes lie primarily in their ability to weld the difficult to weld steels such as higher carbon or high sulfer steels. It is proper to use low-hydrogen when the carbon content is unknown, such as in welding bolts or connections to existing structural elements. It is necessary to use them when welding reinforcing bars. Again the low-hydrogen electrode is the equivalent of E6010 in strength and is superior in welding higher carbon steels and leaves a much smoother shinier weld, and once the welder learns the knack of using it he usually prefers to use it. Indeed a great number of field welders carry only low-hydrogen rods because of their all purpose qualities.

Newer low-hydrogen electrodes, as well as others, have iron-powder as part of their coatings. This iron-powder melts with the coating in the arc and forms part of the weld, making a smoother and faster weld. Another new development is the classification of a single electrode in the E70 series as well as in the E60 series so that the same one is qualified for both 60,000 psi and 70,000 psi welds.

POWER REQUIREMENTS

The arc welding process requires a continuous supply of current sufficient in amount (amps) and of proper voltage to maintain the arc. The current may be either alternating or direct, but it must be provided through a source which can be controlled to meet the variables of arc welding. The voltage will range from 17 to 45 volts and the current will range between 10 to 500 amps. In automatic welding, the amperage can go as high as 1500. Alternating current is produced in special welding transformers designed so that they respond to the varying demands for current. Direct current is produced by either rectifier sets or motor driven generators. Combination welders producing both AC and DC are basically transformer-rectifier sets. A rectifier is a metal (selenium or silicon) which allows the current to pass through in only one direction thereby changing AC to DC. On the job site a gasoline motor driven generator mounted on a truck provides the DC used in the field welding. The utility lines are a cheaper power source therefore the shops use either electric motor driven generators or transformers. However, all welding machines must be able to vary the voltage and current to meet the constantly changing demands as the length of the arc changes or when starting the arc. They are provided, also, with suitable manual controls to regulate the speed and to adjust the operating amperage or heat. Most machines have controls for regulating the heat but because of the delicate mechanism required and the rough usage they get, the only sure indication of the proper heat is in the welding itself. The welder and the inspector can tell by the puddle and the weld whether the heat is right or not and also by the sound if the welding is being done properly in most cases.

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UNIT III - STRUCTURAL METALS

Second Session

Fabrication

E. Shop Practice (30 Minutes)

References: a. AISC Structural Steel Detailing Manual * (R)
b. Aluminum Construction Manual-Aluminum Association (R)

1. Drawings

   a. Design drawings
   b. Shop drawings

2. Fabrication Procedures

   a. Material control
   b. Layout and preparation
   c. Cutting and punching
   d. Sub-assembly
   e. Cleaning and painting

3. Tolerances

F. Welded Connections (One and One-Half Hours)

References: a. Structural Steel Inspection - A.A. Anderson** (C)
b. Welding Procedures at Kaiser Steel Fabricating Division (C)
c. Code for Welding in Building Construction - AWS (R)
d. Welders Training Manual - Kaiser Aluminum (R)

1. Welding Processes Used in Building Construction

2. Types of Connections

3. Weld Symbols

4. Electrodes and Wires and Rods

5. Welding Technique

6. Qualifications of Welders

7. Welding Inspection

   a. Visual
   b. X-ray
   c. Magnaflux
   d. Ultra-sonic
   e. Die penetrant test

* (R) Reference Books
** Pages 90 - 105 which follow

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8. Welding Defects

9. Light Gauge Steel

10. Structural Aluminum Welding

G. Bolted and Riveted Connections (One Hour)

Reference: a. High Strength Bolting - Bethlehem Steel (R)
b. Structural Handbook - Aluminum Company of America (R)

1. Types of Bolts and Rivets

2. Identification

3. Installation

4. Testing

Third Session

H. Workshop (Two Hours) (Pass out sufficient sets of shop drawings to be shared three students to a set)

1. Detailing Practices

2. How to Read Drawings

3. How to Check Anchor Bolts

4. How to Inspect Members

5. How to Check Erection

6. How to Inspect Connections

I. Field Problems (One Hour)

1. Introduction

2. Erection Tolerance

3. Misplaced Anchor Bolts

4. Misplaced Bolt Holes

5. Oversized Holes

6. Poor Alignment

7. Damaged Members

8. Protection of Finishes

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UNIT III - STRUCTURAL METALS

J. Coordination and Responsibility

1. Arch, Eng., and Code Agencies

2. Acceptance of Finished Product

Number Coding. The A.W.S. designation is a series of four or five digit numbers prefixed with the letter E (indicating electric welding or electrode). The two numerals following the letter E multiplied by 1000 predicts the minimum tensile strength of the deposited metal. The next digit indicates the best welding position of the rod and the last number covers other information, such as coating, polarity, or presence of iron-powder in the coating. For instance, take the E6012 red. We know by this number E6012 that the weld will develop 60,000 psi tensile strength. It can be used in all positions - flat, horizontal, or overhead, as indicated by the number one. If the number two had been the next to the last number such as E6024, we would know the rod is recommended only for horizontal or flat welding. Number three limits the rod to a flat position. These position numbers actually show the rate of solidification of the weld metal. The number one rod quickly solidifies or freezes as would be required for an overhead weld. Number three flows easily and is best suited for a flat weld where the sides of the groove help restrain the molton metal. The last number in the example E6012, the number 2 tells us that the electrode is preferably used with an AC machine, has a medium digging arc, and has from 0-10% iron-powder in the casting. These qualities are practically the same regardless of the manufacturer. The most important information is in the first three numbers, that the deposit metal will be in the right range and used properly.

Color Coding. There are many other properties of welding rods classified by A.W.S. Because most of our structural steel is low carbon steel having a tensile strength between 60,000 psi to 75,000 psi in the case of A7 steel and up to 80,000 psi for A36 steel the electrode must have the same properties as the base metal, so our principle concern is with the E60 and E70 series, heavy coated shielded arc electrodes. A color coding system for the purpose of readily identifying the electrode is furnished. The inspector should be familiar with this system. We are concerned primarily with the color on the bare end of the electrode that is attached to the holder and the spot color located on the uncoated section. Absence of a color on the end tells us the electrode is in the 60,000 tensile strength series. A blue or black end indicates an E70 electrode . Then the individual A.W.S. classification is defined by the color spot located on the bare, uncoated section. No colored spot means the electrode is 6010, a blue spot means 6011, a white spot means 6012, and so on. This system also allows manufacturers to stamp identification numbers on the rod coating. Now most manufacturers are doing this, stamping the A.W.S. number right on the coating of the larger rods thereby making it easier to identify for the inspector as well as the welder.

Electrode Coating. The quality of the weld metal is affected to a marked degree by the coating on the electrode. Before the advent of the coated electrode, a bare rod was used; but this left the molten weld unprotected from the surrounding air and did not concentrate or direct the electric arc, so it is really the development of the coating that has brought welding into prominence. This coating causes a more stable arc, smoother weld beads, and improves the quality of the weld by protecting the liquid metal from the gases in the air - oxygen,

FEDERAL AVIATION AGENCY	Budget Bureau No. 04-R003.	MALFUNCTION OR DEFECT REPORT			
1.	AIRCRAFT	ENGINE	PROPELLER	SPECIFIC PART WHICH CAUSED DIFFICULTY	
COMPLETE ALL ITEMS →	MAKE AND MODEL: Flimor 2B	0 & A 275	Skyflite 80x	NAME OF PART AND PART NO.: Elev. Pulley Guard 6-149	HRS. SINCE OVERHAUL: TOTAL TIME 462
	SERIAL NO.: 947	AS 3-15 19	9504 - 16		
	REGISTRATION NO. N- 0000P				

2. IDENTIFY THE MALFUNCTIONING OR DEFECTIVE PART. DESCRIBE THE MALFUNCTION OR DEFECT AND THE CIRCUMSTANCES UNDER WHICH IT OCCURRED. STATE PROBABLE CAUSE AND RECOMMENDATIONS TO PREVENT RECURRENCE.

DATE OF SUBMISSION: 11-29-65

Stiff elevator control noted on preflight inspection.

Found elevator pulley guard on right side of cabin floor at rear door bent against pulley preventing it from turning.

Probably caused by passengers stepping on pulley guard when entering and leaving cabin.

Recommend installation of a reinforced guard that will resist bending when stepped on.

FORM FAA-1226 (1-63) USE PREVIOUS EDITION (8330)

3. SKETCH OF MALFUNCTION OR DEFECT—OTHER COMMENTS

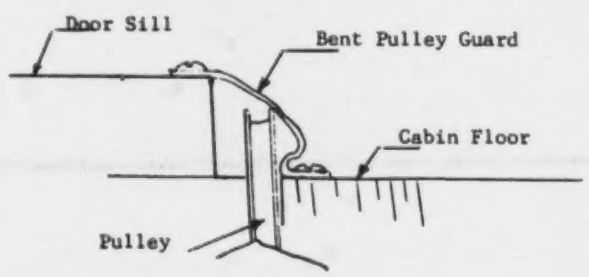

REPORT SUBMITTED BY (Name and address): S. A. Nell, 13 Main Street, Phoenix 2, Arizona

☐ REPAIR STATION ☒ OPERATOR ☐ MECHANIC ☐ FAA INSPECTOR ☐ CAB INVESTIGATOR

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FIGURE 4.

The above is a typical FAA Form 1226, Malfunction or Defect Report. AIs are urged to use this form for all malfunctions or defects that cannot be attributed to poor maintenance procedures. AIs are requested to be accurate in completing the blocks on the face of the form. It is not necessary to furnish models and serial numbers when they are not pertinent. Note that there is a recommendation as to how the defect can be corrected.

nitrogen, and hydrogen, which, if allowed to combine with the molten weld would reduce its tensile strength and ductility. This ductility is very important. It is that ability of the weld, as well as of steel itself, that allows the stress to be uniformly spread out over the entire section by the plastic giving or flow until all surfaces are bearing. Anyway, these harmful gases are prevented from reaching the weld until it has solidified by an inert gas envelope and the coat of slag both caused by the burning of the coating in the electric arc. The coating is usually organic or metallic depending upon what characteristics are desired in the arc. An organic coating such as cellulose usually cotton fibers provides a carbon monoxide gas which protects a deep digging penetrating arc while the metallic coatings induce a softer and less penetrating arc. The mineral types produce slag only while it takes the cellulose to form the gas shield. The residue from the burned coating forms the slag on the weld surface which also serves to protect the weld, as I have said.

Welding Technique. Basically, the lower the number of the electrode the more penetrating the arc and the faster the solidification. The E6010 electrode is an all position rod that produces excellent welds in mild steel. It is the primary field rod used because of these qualities and because it performs best on direct current such as a gasoline driven motor generator mounted on a truck would provide. The counterpart in the shop is E6011 having much the same characteristics but operating best on alternating current furnished by a transformer. Because the shop has the facilities, many different rods are used primarily because of economic reasons. If a weld can be positioned to a flat position, a larger electrode can be used and a more fluid type can be used thereby making it faster and easier to make the weld. There is very seldom an overhead weld in the shop, for example, as you would find on the job. These mud rods such as the E6024 make an acceptable weld in most cases but should be avoided on butt weld splices because they make a more brittle weld than the E6010 or E6012, and the butt weld must transmit these forces that require more ductility. The technique of welding with this rod is to drag it over the area with the coating just touching. This makes the weld relatively easy to make which is a great advantage. Also, it makes a very good appearance compared to the definite ripples made by the E6010. The drag technique makes holding a short stable arc much easier and holding the arc so that it penetrates or digs into the base metal is very important. The digging action of the arc is much more apparent in the E6010. Here the welder holds the molten puddle behind the short arc as it moves along being sure that the arc at all times is digging into the base metal and not wasting energy over the liquid metal itself. The maintaining of a uniform arc is also very important. To make a sound weld it is necessary that the metal deposited from the electrode fuse completely with the base metal. This can be done only when the base metal has been heated to a liquid condition and the electrode metal flowing into it is also liquid. The length of the arc determines how liquid these metals are. If the arc is too short, it causes the electrode to stick frequently and is hard to manipulate and also fails to create enough heat to form the crater of molten base metal. If the

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arc is too long, the metal drops off in large globules and the heat is not localized enough to form the molten puddle thus also producing poor fusion of the steel. The correct length of the arc is about equal to the diameter of the core wire of the electrode being used.

Current and Polarity. Some of these electrodes are best for direct current and some for alternating current. Some direct current electrodes are best for straight polarity and some are best for reverse polarity. In straight polarity the electrode is negative and the work is positive; in reversed polarity the electrode is positive and the work is negative. In other words, the condition of the electrode determines the polarity. The welding machine will either have a switch for polarity or the leads will have to be reversed to change the polarity. I try to remember it in this way, the symbol for negative is a straight line, therefore, if the electrode is negative when used, it is in straight polarity. And, if the electrode is positive or plus, it must be in reverse polarity.

Special Electrodes. An increasingly popular stick is the low-hydrogen electrode. This is an all purpose r d originally developed for welding higher strength, high carbon steels where the other types of electrodes produced underbead cracking. This cracking occurs in the base metal just under the fusion zone due to the hydrogen in the air entering into the weld. The name comes from the fact that their coating contains very little hydrogen forming chemicals. These electrodes are designed to operate with direct current, reverse polarity or alternating current with the exception of the E6015 which operates only on direct current, reverse polarity. The AC, DC, types E6016, E6018 have better usability characteristics and can be used on AC especially where magnetic arc blow is encountered. When using DC machines, a curious action of the arc sometimes occurs. This is called arc blow, indicated by a wild arc action and fingernailing of the electrode, that is, uneven burning of rod coating. Arc blow causes very poor welds in appearance and quality and is caused by the current returning to the welding machine taking an indirect course. Moving the grounding clamp will help and so, sometimes, will backstepping the weld. This is, of course, not encountered in AC due to the constantly reversing action of the current. The low-hydrogen types are generally accepted as being superior in weld metal quality when applied correctly, but the possibility of a welder making a poor application with improper techniques are greater than with the conventional types. The welding technique required by low-hydrogen electrodes is somewhat different because of the quick decomposition of the special coating forming the carbon dioxide gas. Since it takes only a fraction of a second for the electrode covering to reach the decomposition temperature when the arc is struck, a close arc must be held and a molten puddle established before proceeding with the weld. For this reason, the low-hydrogen rod is more prone to develop starting porosity or gas bubbles frozen in the weld itself, than the other types. Moisture in the coating of the low-hydrogen electrode is more harmful in its effect on the weld than in other electrodes. Although all electrodes must be kept dry to be used properly, it is more important to have a new unopened box of low-hydrogen electrodes when starting if there is any question as to whether they have been exposed to damp weather or left unprotected overnight. A good method of storing electrodes

MACHINE WELDING

Another of the changes coming about is the use of more and more semi-automatic and automatic welding because it reduces fabrication time, cuts costs, and improves weld quality. It involves the continuous wire process. Every day more and more welding is done by this method. Yet the stick or rod is used more than ever but the continuous welding is growing at a much faster rate. There are basically four processes: The submerged arc with granular flux, gas-shielded solid wire, gas-shielded flux-cored wire, and gasless flux-cored wire. All of them are either completely automatic or semi-automatic. In the welding of mild steel, either A7 or A36, the gas shielded solid wire process commonly known as CO_2 welding is used. This CO_2 process using a very small diameter wire is the only mechanized welding that can be used for out-of-position welding. The advantage here is, of course, the higher speed of welding and the increased heat or amps used makes complete penetration more positive, and since only about 60% to 70% of the stick electrode is actually deposited as weld metal whereas almost 100% of the wire becomes the actual weld, the savings in material is important. Continuous wire welding is about three times as fast. The mechanical operation makes it easier to obtain complete penetration with less skill required of the operator. The function of the semi-automatic welder is simply the automatic control of the wire electrode feed. When the operator strikes an arc, the wire starts to feed. In another semi-automatic process the welder holds a cone containing granular flux in his hand with a continuous wire electrode protruding from the pointed end of the gun. The bare wire is automatically fed by a motor on the spool at the rate of speed set by the welder. The specifications for this wire electrode are the same as for 6010 or 7010 without the coating and are as set forth in the A.I.S.C. manual. The flux pours out of the funnel on and over the weld continuously as the weld progresses. Actually continuous wire is now available in any classification found in the stick electrodes. The A.W.S. classifies, for example, a continuous wire equivalent of E7018 (a low-hydrogen rod) as E70S-J. The equivalent of E6024 is E60T-4. The S means the wire is solid while the T means tubular for the flux-cored wire. In the automatic welding process the work is usually positioned in a frame and the machine moves along the work when welding fillets on a tapered girder, for example, although sometimes the work does move through a stationary welding machine. This submerged arc welding with a bare metal electrode underneath a blanket of granular flux permits much higher speeds in welding because the arc and the molten metal are completely covered until the weld is cool. Much higher currents can be used. The arc itself is not visible being hidden beneath a heap of loose flux. The flux serves the same purpose as the coating on an electrode. The flux does not, however, form a gas but rather the flux adjacent to the arc melts, floats on the surface of the molten weld and then solidifies to form the slag. This slag is very easy to remove and in most cases it will crack off by itself as it cools, of course, some of these automatic processes using gas only leave no slag at all. The inspection required on automatic welding is to be sure that the plates are cut properly, cleaned and closely fitted before welding and also in the case of gas-shielded only that no breeze is blowing the gas shield away from the weld. The most common defect is porosity of the weld due to improper cleaning of the plates. More than a very few small pin holes on the surface of the weld is cause for rejection because many porous sections are probably hidden underneath.

example, the use of Nelson studs would be specified. The welding symbol is the language of the trade. So that everyone will know what kind of weld is required, a standard system is used. Basically, there are only four types of welds:

1. A bead weld or stringer bead
2. A fillet weld
3. A plug or slot weld
4. The butt weld or groove weld

In this last group we find the various ways of preparing the pieces to be joined depending on the thickness of the material and the weld is described or defined by this preparation:

a. The square butt weld is used only in a flat position and where the material is not over 5/16 inch thick. No beveling is done to either edge, but a gap between the pieces must be maintained.
b. The various methods of beveling the thicker peices to allow the weld to completely penetrate the joint describe the shaping to be done. Some of them are:

    1. single vee
    2. single bevel
    3. double vee
    4. double bevel
    5. single U or J
    6. double U or J
    7. flared vee
    8. flared bevel

All of these are described fully in the A.I.S.C. manual available at the Technical Book Store for $7.00. In inspecting these welds the preparation must be checked not only for shape but for the root opening called out in the welding symbol.

DUTIES OF WELDING INSPECTOR

The welding inspector must list all structural welders and can require them to make an identification mark on each of their welds. He must assure himself that all welds are sound. He may choose to test any weld by means of x-ray, magnetic flux, dye penetrant or any other method. Perhaps a cut through the weld will be sufficient to show penetration or porosity or slag. The inspector is required to inspect each weld layer, therefore, he must be present at multipass welding. Single pass welding can be inspected after welding if the fit-up and the welder have been checked out ahead of time. Any manual fillet welds over 1/4 inch shall be multiple pass welds. The inspector on school projects furnishes the architect, structural engineer and the Office of Architecture and Construction with a verified report that the welding and fabrication conform with the plans and specifications and that he has used all means necessary to determine this. The inspector should have in his possession:

1. A.I.S.C. Manual, The Sixth Edition Issued in 1963
2. A.W.S. Standard Code of Arc and Gas Welding

3. A.W.S. Standard Welding Symbols
4. A.W.S.-A.S.T.M. Specification for Electrodes
5. Title 21--This is the basic law on school construction. Article 8 of Title 21 concerns structural steel while Article 9 deals with Light Steel Construction.
6. Circular 6 from the State. This circular sets forth certain requirements for steel fabrication. The method of qualification of welders, for example, the requirements for submerged-arc welding and the welding of reinforcing bars.

His equipment includes:

1. Welders hood or hand viewer
2. Slag hammer
3. Welding gauges
4. Identification stamp

Before each welder begins, the inspector looks at each license, notes the type and position the welder is qualified for and the expiration date of the license, turns it over and checks the picture on the back. He also checks each welder's work making sure the approved electrode is used and the weld is proper.

The welder proceeds to weld using shop procedure unless otherwise directed. By this, I mean some shops prefer certain electrodes and differing procedures; but unless they affect the quality of the weld there is no reason to object. Most of the fabrication shops in our area have been licensed by the City of Los Angeles, Department of Building and Safety to be able to perform structural welding without constant inspection. The shop is always subject to periodic inspection by the Building and Safety Department at any time, however. The inspector's most important task is to inspect the welding. Most other items can be checked afterwards, but a multipass weld may be defective and only by inspection during welding can the inspector be sure that the weld is sound. The inspector watches the weld through his shield while the welder is welding. The arc must be digging into the base metal and not over the puddle. Each successive pass must be deslaged and brushed and examined for defects. As in the inspection during welding, certain signs will reveal considerable information after the welding is done. Items to consider include size and shape of the bead, appearance of the slag, undercut, overlap, location of craters (indicating where the welder started and stopped welding).

COMMON WELDING DEFECTS

Most common defects of welds are excessive concavity or convexity in fillet welds and these can be corrected by either adding more passes or grinding off the excess, undercut which is caused by too long an arc, incorrect electrode angle, excessive heat, or too rapid an arc motion, or insufficient size, either of which can be corrected with additional passes, overlap, a protrusion of weld metal over the base plate, a defect indicating poor penetration because of low heat or arc traveling too slowly.

UNIT III - STRUCTURAL METALS

QUALIFICATION OF WELDERS

The welder must be certified by some public authority as to having passed tests proving his ability to weld satisfactorily. Manual welding procedures and welder qualifications for structural steel, that is, (3/16 inch or over in thickness) are as prescribed in the "Standard Code for Arc and Gas Welding in Building Construction" of the American Welding Society. Incidentally, gas welding is not used for structural welding because of many reasons. Most important is its lower strength due to lower welding temperature and its relatively more difficult welding technique and consequent loss of reliability. The gas company, however, conducts classes in gas welding for its employees on their pipe lines and has found it satisfactory. In our work the welder, in order to be certified, must have passed rigid tests of his ability to perform the quality of welding required by the designed strength of materials. The welder must be qualified to perform the type of welding to be done. In the case of the automatic weld, the operator may be checked by testing some of his work using the same equipment that he will use for production. Welders shall be checked by the welding inspector, and those not doing satisfactory work can be removed and be required to pass the qualification tests again.

In this area certification by the Los Angeles Department of Building and Safety is accepted. The types of licenses issued are Structural Steel-Shop, Structural Steel-Shop and Field, Lightgage Steel-Shop and Field, and Aluminum Shop and Field. The applicant must first pass an oral examination on electrode identification, that is be able to identify the electrode number by the color code, know the approved welding position and polarity. He must be able to read welding symbols and answer questions on procedures and terminology. He must also be familiar with requirements of the building code and the standard code for arc and gas welding. After the oral examination, he must prove that he can weld in the various positions required. These sample welds are machined and tested for quality. For a Structural Steel-Shop license he must make approved welds in the horizontal and vertical positions as well as flat. The field license requires that he must weld overhead as well. A Lightgage welder must pass similar tests. His picture is attached to the license so there should be no doubt that the one using the license is the one that qualified. However, the mere possession of the license does not mean that every weld is satisfactory. The welding inspector must approve all welds and may require the welder to take new tests before doing structural welding. Here, let me say that a tack weld is not considered a weld unless it be at least one inch long and certification is not required for this welder. However, tack welds later incorporated into the work must pass the requirements. The inspector must be familiar with welding symbols in order to tell the type of weld the engineer is calling for. About 80% of all welds are fillet welds, 15% are butt welds, and only 5% are special type welds. I will not go into the subject of welding symbols in detail, however, I might say the symbol itself is not enough to describe a weld. The arrow must point to a corner or pieces to be welded and sometimes additional information is needed. Anything that is not clear should be brought to the engineer's attention for his clarification. The tail section of the welding symbol may be used to specify any unusual condition. Here, for

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UNIT III - STRUCTURAL METALS

REFERENCES

1. AISC Manual of Steel Construction - American Institute of Steel Construction, 101 Park Avenue, New York, New York 10017.

2. Light Gage Cold-Formed Steel Design Manual - American Iron and Steel Institute, 150 East Forth-Second Street, New York, New York 10017.

3. Decking Catalogues of Miscellaneous Manufacturers -

   Inland Steel Products Company
   2945 South Sunoc Drive
   Los Angeles, California 90023

   Granco Steel Products Company
   3600 Wilshire Boulevard
   Los Angeles, California 90005

   H. H. Robertson Company
   1015 Fremont
   South Pasadena, California 91107

   Fen Cal Inc.
   14911 East Don Julian Road
   City of Industry, California 91746

3A Standards for Aluminum Mill Products - The Aluminum Association, 420 Lexington Avenue, New York, New York 10017.

4. Designing for Aluminum Extrusions - Kaiser Aluminum & Chemical Sales, Inc., 200 Lakeside Drive, Oakland, California 94604.

5. AISC Structural Detailing Manual - American Institute of Steel Construction, 101 Park Avenue, New York, New York 10017.

6. Aluminum Construction Manual - The Aluminum Association, 420 Lexington Avenue, New York, New York 10017.

7. AWS Code for Welding in Building Construction - American Welding Society Inc., 345 East 47 Street, New York, New York 10017.

8. Welders Training Manual - Kaiser Aluminum & Chemical Sales, Inc., 200 Lakeside Drive, Oakland, California 94604.

9. High Strength Bolting - Bethlehem Steel Company, 100 California Street, San Francisco, California.

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Lack of fusion and cracks are cause to reject the weld and the welder. Any welds with these defects must be removed and rewelded. Poor fusion is caused by too low current setting, or improper technique or failure to properly prepare the joint or perhaps too large an electrode. There are different kinds of cracks in welds such as crater cracks, underbead cracks, and longitudinal cracks. The cause here is sometimes very difficult to determine. Perhaps the base metal is not weldable or the joints have not been properly prepared or wrong procedure or too rigid a joint will result in cracked welds.

A weld crater is a depression located at the end of each pass. Any arc welding process or procedure produces weld craters. The ability to fill this crater varies considerably with the welding current and weld size; but there is usually no problem if at the completion of a pass, the electrode travel is delayed sufficiently to fill the crater. All craters shall be filled to the full cross section of the weld. Draw the electrode away from the work slowly and on the next bead strike the arc a little ahead of the crater, hesitate momentarily, then move back over the crater and completely remelt and fill it. It is important to fill this crater because many cracks start in this relatively weak area. This is one reason that the length of a fillet weld, as called out on the drawings, is increased by twice the weld size to be sure that the sections where the welder started and stopped are not in the required length. Any questionable welds should be tested or rewelded.

To avoid some of these problems, the welding inspector should check out the procedure to be used, see that the polarity is correct and that the fit-up is tight. Also, if he can have the work positioned for flat welding it makes a great difference in appearance and quality.

A nondestructive method of testing requiring no electrical equipment involves the use of a dye penetrant. Imperfections such as cracks, laps, and porosity are indicated by lines, dots or blotches of a color easily detected visually. First the surface is cleaned. Then it is covered with a dye which is left on for five or six minutes. After removing with cleaner, a developer is applied. The color will remain in any crevices until it is drawn to the surface by the action of the developer. A colored line indicates a crack. A series of dots or blotches indicates a tight crack or unwelded area.

Other methods of nondestructive testing include magna flux, a method in which a piece of welded material is held in a magnetic field and the groupings and arrangement of iron filings indicate faults in the piece. This is an unwieldy process and is not used very much in larger welded pieces. The x-ray picture is another way to detect faults in welding. Here, the interpretation of the picture by experts takes time and is somewhat unwieldy. Ultrasonic sound waves and magnetic currents are others. However, because any of these methods may be called for by the inspector, the fabricator will usually decide to reweld the piece when requested by the inspector rather than argue the point.

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SHOP PROCEDURES

Now as to the shop procedure itself, when the order for steel is received by the fabricator, his first step is to prepare the detailed drawings. These are in two sections, the erection drawings which locate each piece and show its relation to the whole job, and the fabrication or shop drawings showing precisely how each piece is made. These drawings are sent to the structural engineer for his approval before any work is done. The erection drawings guide the field crew as to where each piece is located so that the actual erection can be done efficiently. Each piece of steel shown on the shop drawings is marked with an identifying letter and number to coincide with those on the erection drawings. Any changes in the fabrication must be approved and noted on these drawings. When the job is complete,the as-built drawings required will be corrected from these shop drawings and show what was actually done.

The shop drawings are the actual orders from the front office to the shop to make the beams, columns or girders, or whatever it may be. These drawings show precisely where each weld, hole, bolt or rivet is to be and what shape of steel member is to be used. Work lines are also shown on the shop drawings. These lines are the center lines of action of a member of a truss or other built-up section and must be correctly lined up to avoid eccentricity in the truss components. A list of the materials required is also on each drawing.

The inspector looks the drawings over for the engineer's approval which indicated the engineer has checked the drawings and found them in accord with the design drawings. The inspector has no authority to make a change. His responsibility is to secure compliance with the approved drawings and any change must be made by a change order. The shop drawings must have the approval of the engineer. However, the design drawings are still the contract drawings and any changes therefrom must be approved by the engineer and the Office of Architecture and Construction in the case of school work. Sometimes a minor clarification may be shown on the approved shop drawings without a change order. The inspector should compare the shop drawings with the design drawings and call the attention of the structural engineer to any changes even though they have been stamped approved unless the changes have been definitely marked as a change on the drawings.

Before use, the steel may be tested by a laboratory (if such tests are required) which issues a report stating the steel meets the specifications. The welding inspector looks for the laboratories' stamp and heat numbers to be sure the steel used is the same one tested. He also checks for the correct steel shape called for. In the shop a layout man assembles the required items, after any cutting or shearing; and if any multiple pieces are to be made, he makes a template out of stiff cardboard to show the outline and connections for a gusset plate, for example, in order to assure accuracy in every piece. He marks the location of any bolt holes.

The fitter tacks the assembled items together with a small weld, or bolts the parts together temporarily, and the item is then delivered to the welder. When the material is being laid out and fitted is the

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time for checking work lines, the relative location of members, built-in camber and location of holes and correct fit up for welding. Drilled holes are preferred to punched holes because the area around the punched hole is over stressed during the punching operation and therefore the immediate metal around the hole cannot be counted on to perform in the usual manner. However, punched holes are permitted if the metal being punched is not thicker than the diameter of the bolt plus 1/8 inch. Most fabricators now use a drill with a magnetic chuck to drill any required holes instead of the punch which is a relatively large fixed machine. Only on light material easily handled such as angles and small plates are punching machines still used. The magnetic chuck holds the drill in place and aligned straight on the work. As part of the check-up before welding, the inspector must see that the joint preparation is correct. The contact surfaces of all welded connections shall be free from any paint, oil or cutting slag and have straight edges. Clean surfaces and close fitting pieces eliminate many weld defects. The faying surfaces where the pieces connect for a fillet weld can have no more than 1/16 inch gap tolerance. The steel manual lists the details for welding structural connections. All butt welds must be full penetration welds. Butt welds with over 5/16 inch thick pieces must have at least one side beveled to allow room for the electrode to reach the root area. The details for various conditions depending on the thickness of the material are shown in the A.I.S.C. Manual and must be followed both as to gap required and beveling, back up strips and back gouging. It is necessary to have this bevel to allow not only the electrode to reach into the root area but to leave room for the protective gases to cover the weld as well. A new method of preparing groove welds is now in use in most shops. A carbon electrode with a thin copper coating is used together with a jet of compressed air. The electrode is used with an ordinary DC welding machine. The holder is so built that a jet of compressed air is directed at the arc so that the steel as it melts is blown away. The electrode can be used in any direction and the air jet is always aligned with the point of the arc regardless of position. Slag and molten steel are being constantly blown clear of the work leaving a clean surface. This system is much faster than grinding or chipping so that this new procedure is now used in making full penetration, 100% welds. The welder makes his pass on the reverse side merely holding a small gap between pieces to assure penetration. Then he changes his holder to one with the compressed air attachment and cuts through the joint from the front side until the root of the firts weld has been exposed and cleaned off. This removes all slag and opens the joint so that the filler passes can be easily done. This arcair torch makes a good tool for investigating suspected areas also. A cut can be made quickly in any weld and the interior of the weld can be visually inspected.

The effects of distortion must be considered when preparing to weld. Weld metal, in its molten state, is at its largest volume and when cooled it contracts across the weld, and if the connecting plates are not very firmly held in position, they will move in toward the weld as it cools. The amount of shrinkage depends upon metal type, thickness,

Operation Limitations Zeph-Air 63-1A N 40023

RPM	Do not exceed 2300
Oil temp	212° max.
Airspeed limits do not exceed:	
Level flight or climb	95 m.p.h.
Glide or dive	129 m.p.h.
Gross weight	1220 lbs.
Empty C.G.	14.4" aft of datum
Useful load	453 lbs.
Kinds of operation	VFR-Day

Maximum baggage: 40 lbs. solo front; 20 lbs. solo rear

FIGURE 5.

Sample operation limitations placard for a typical light aircraft certificated under Civil Air Regulations Part 4a.

joint type, weld position, electrode type and size and welding method. Using the least amount of heat consistent with weld quality will help prevent distortion. This distortion is of concern because it will throw welded members out of line or cause warping in connecting plates. Even if the distortion is not apparent, a built-in stress may cut down on the safety factor. If a connecting plate has welding on the reverse side and is to be used with high strength bolts in a friction joint, for example, the distortion here will prevent the surface to surface flat contact required.

It is important when welding to allow as much movement as possible so that built-in stresses and distortion are held to a minimum. Where a wide flange shape is used as a column and welded to a base plate, the web is welded first to the base plate and then the flanges are welded to allow as much movement as possible to ease the strain. Warping in some instances may be compensated for by positioning the weld to anticipate the distortion. A strong frame holding the parts in position may prevent distortion and in some cases the distortion may be removed by heating and slowly cooling the affected area.

Any shop bolting or Nelson stud welding is done next. Bolts should be checked for grip, that is, the unthreaded portion if a full grip is called for. This grip should be equal to the thickness of the parts being joined and a washer then is required to assure a tight connection with no threads in the hole. If a full grip is called for, the design stress may be increased about 50%. Holes must be free from burrs so that the connection will be made tight. Then the material is straightened if any of these operations have tended to deform it and send to the painter. Check the piece for camber (the deviation from a straight line in the vertical plans) and for sweep (the deviation from a straight line horizontally). Heating the member to straighten it is permitted because the heating and cooling, even if water is used to hasten the cooling, has only a minor affect on the steel. After thorough cleaning, wire brushing and perhaps sand blasting the primer is applied unless the steel is to be encased in concrete. The pieces are marked according to the shop drawings and sent to the job. The actual erection process starts before the shop fabrication is barely begun, however. Anchor bolts must be placed and the wise steel shop will wait and take field measurements for the beams or girders after concrete is poured before fabricating the items. The job inspector should have a set of shop drawings as well as the erection drawings on hand. He also should be sure that the fabrication has been inspected either by finding an inspection stamp on the delivered pieces or other means. The erection of the steel framework is usually done by the fabricator's own crew. Sometimes, however, a special crew is used. The inspector can help by seeing that coordination between general contractor and the steel fabricator is maintained to be sure that embedded items are ordered to be ready when needed, for example, and that measurements shown on the design drawings are adhered to and that changes affecting the steel are passed along to the fabricator quickly. With the erection drawings showing the location of each piece, he can check the steel work. Anchor bolts must be accurately placed. A template should be used in multiple cases. Base plates setting on those anchor bolts must be leveled,

preferably by means of leveling nuts under the base plate at each bolt. Separate leveling plates should not be used as a rule because of the difficulty in getting a good contact with the column base plate. There must be at least 1" room for drypack under the base plate. According to Title 21, any bolt holes must not be more than 1/16 of an inch greater in diameter than the bolt. Most engineers, however, will allow some extra room in the case of anchor bolts. The frame shall be carried up true and plumb and temporary bracing shall be used to take care of all loads that may be encountered including wind loads while under construction. Particular care shall be taken to brace any girders, trusses or beams before leaving any steel frame. No final bolting or welding is to be done until the frame is properly aligned. Bolted connections shall be aligned by use of temporary bolts until all lower connections affected are in alignment. Forcing by means of driving drift pins in the holes to enlarge the holes is not permitted. As the erection progresses the work shall be securely bolted up or welded to take care of all dead load, lateral forces and erection stresses.

FIELD INSPECTION

The steel inspection in the field is not necessarily continuous unless multiple pass welding is being done or during the installation of rivets or high strength bolts. The inspector should be present when the anchor bolts are set and when the structure is plumbed and braced before the permanent connections are made. The location of anchor bolts in concrete is very important and even if field measurements are taken many times, remedial action is needed when the members are to be erected. Because of the hole allowance from Title 21 of only 1/16 inch greater than the bolt, a field problem is often encountered. Shop practice allows a larger hole, 3/16 to 5/16 larger, for anchor bolts because of the difficulty in securing the bolts exactly in place while pouring and vibrating concrete. Wall bearing beams and ledger angles may also have slotted holes to allow for minor differences. However, unless your drawings show a slotted or larger bolt hole, check with your engineer first. The anchor bolts have no deformations such as are found on reinforcing bars and develop their strength through bond with concrete and their hooks. They must not be hit with a sledge hammer to bring them in line with the hole. This could break the bond with the concrete. This is one item that should be checked out on the issuing of the drawings and settled before the item is made by alerting the engineer to the problem. It is rather late to discover this condition where you can't get the girder in the concrete chase or the bolts don't fit and the truss is hanging in the air and the crew is waiting. Anchor bolts must be cleaned of all oil so that they will bond to the concrete. If the bolt is short by one to three threads, the nut can be welded on the inside to the bolt; but if the bolt is still too short, an extension might have to be welded on. Here is where low-hydrogen electrodes must be used because of the possibility of a higher carbon steel. All bends in the anchor bolts must be checked and for that matter any bent plate should be checked for the presence of fracturing. The steel must be examined when it is delivered to be sure it has not been damaged during transit and that the paint is in good condition. Check the work against the approved drawings to see that the arrangement, size and number of bolts is correct and that the size and length of each weld corresponds with that shown on the approved drawings. All bolt holes must be fair

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and drifting of holes to alignment is not permitted. The nuts should be tested for tightness and complete thread. When field welding is to be done, the welder must be certified for all position welding, have a welding machine capable of furnishing sufficient current and have the right electrode for the job. For field welding the electrode should never be larger than 3/16 and for corrective items or difficult positions 1/8 inch diameter. The welder must have a wire brush and slag hammer. He will probably carry a torch and oxygen and acetylene tanks on his truck. Another item not carried by the field welder, but at times quite essential, is a fire extinguisher. When welding close to wood or other combustible material, this must be watched. The welder can't see the fire through his hood and it may be well along before discovered. Also, heating any structural member, especially reinforcing bars to facilitate bending, is not allowed. Gas cutting on members not designed, therefore, is not permitted except with the approval of the engineer and then only if the member is not under stress. It is often found that reinforcing bars have to be welded. This may be either to a mild steel plate or welded together as a butt joint or a lap weld. The procedure for welding reinforcing bars is given in the State Circular #6. The amount of lap is called out for various size bars and the profile of weld is shown. These lap dimensions must be followed. Also the low-hydrogen electrode must be used. For structural grade bars the electrodes shall be E60 series low-hydrogen electrodes. For intermediate grade use E70 electrodes and for hard grade use E60 electrodes. The E60 will have no end color, the E70 has a blue color and the E80 is white. An orange color spot on the side indicates the low-hydrogen rod. Check the unopened box for the exact classification and see that the rods are kept dry. Preparation of the joining surfaces must be done to assure penetration. The difficult part in welding reinforcing bars is to use only as much heat as necessary to get penetration and avoid the build up of excessive heat or weld. Pre-heating of large bars will prevent a too rapid cooling effect on the weld. Excess heat will cause the bar immediately adjacent to the weld to be brittle and it will invariably snap off right next to the weld. If there are a number of welds to be made, one method is to weld them a pass at a time. While one pass is cooling on one joint, a pass is welded on the next one and time allowed for the heat of welding to dissipate. At any rate, undercut is very serious and so is any overwelding on reinforcing bars. When welding to a flat surface, the deformations of the re-bar should be ground off for a better connection.

Miscellaneous steel including railings, ornamental fences, tank supports, decking and other items not found in the structural section of the specs are important too. Not only do some of these have structural value, usually they must present a pleasing picture to the eye and a poor weld or poor erection can hurt an otherwise good job.

The steel deck is frequently used as a horizontal shear panel, and the welding and installation is structural. Perimeter welding must be done as detailed and the welds between individual pieces must be sound in order to carry the continuity of forces. The welder must have a

Lightgage Welding certificate and use either a low-hydrogen electrode or an E6013. Puddle or plug welds to the supporting members are usually called for and must penetrate into the sub member and be slightly convex. Sometimes welding washers are used when the decking is comparatively thin. The hole in the washer is filled with weld metal, thus assuring a good connection.

On decking as well as bleachers and light standards and pipe columns we find galvanized material. This is a coating of zinc and aluminum put on in a dipping process. The galvanizing should be done in the largest practical units after fabrication. The zinc bath is about 600 to 900 degrees, and this heat sometimes poses a problem in that it allows built-in stresses of the welding to be relieved. This is shown by buckling of plates or warping of stringers or other deformations. The only remedy for this is not to put into the piece the stresses that could cause this deforming. This is done by either making the individual pieces small enough so that large stresses are not there or by having the members strong enough to withstand the stresses. This is another case where too much weld is bad. Overwelding can be as troublesome as underwelding. The galvanizing must be free from icicles or barbs and cover each piece completely. In the case of bleachers where one style is to use flattened pipe at the bolted connection particular care must be taken to see that the galvanizing enters into the seals of the flattened end. Also it is important in preparing pieces for galvanizing, to have no enclosed portion so that the hot air can't escape. Holes must be drilled into each piece to allow the expanded gas to get out when it is dipped. Welding on galvanized pieces does not produce structural quality joints. The galvanizing should be melted off in important field connections before welding. When the galvanized area is welded, the protective coating is lost, and the use of a galvanizing stick is recommended. The weld and surrounding area is heated to about 600 degrees by the gas torch and the stick is rubbed on and the melted galvalloy is brushed on with a wire brush. Aluminum or galvanized spray is sometimes used but will not last as long. New paints are being developed that have zinc in suspension, such as Galvicon or Dry Galv. and can be used in the field. But galvanizing at best is not for looks but merely to protect the steel from rusting, which it does very well.

I have tried to present something about steel fabrication in this area. Of course there is much more to it than what I have said, but it is a very interesting field and I am sure that the more you know about it the more you appreciate it. There is always something new and different, faster and more efficient, challenging ideas and methods where progress is shown illustrating the ingenuity of modern design and materials with the safety built in by the engineer and guaranteed by the inspection.

UNIT III - STRUCTURAL METALS

SOURCES OF MATERIAL TO BE INCLUDED IN LECTURE NOTES

1. Chapter 2 of Structural Steel Design by Lynn S. Beedle & et al., The Ronald Press Company, New York, New York.
2. Pages, 155, 156, 157 of Section 5 of the AISC Manual of Steel Construction, American Institute of Steel Construction, 101 Park Avenue, New York, New York 10017.
3. Pages 4 to 11 & 125 - 125 of the Standards for Aluminum Mill Products, the Aluminum Association, 420 Lexington Avenue, New York, New York 10017.
4. Structural Steel Inspection by A. A. Anderson, Steel Inspector, Los Angeles Board of Education, 1425 South San Pedro, Los Angeles, California 90015.
5. Welding Procedures at Kaiser Steel Fabricating Division, C. A. Zwissler, Manager of Construction Marketing, Kaiser Steel Corporation, 200 Lakeside Drive, Oakland, California 94604.

UNIT IV - MASONRY

Course for Inspectors, Quality Control of Masonry

A. Introductory

References

1. Objective: The objective of this course is to provide an outline and subject material for the teaching of inspectors responsible for the quality control of masonry. It will provide an outline and will list some of the reference material that can be used to amplify and augment that outline, leaving it up to the individual instructor to provide the detail amplification of the material as best suits his skill and talent.

2. Function of the Inspector: The function of the inspector is to help bring into being the dream behind the creation of the plans for the project, to assure that the intent of the plan and specs is realized.

   "Reinforced Grouted & Brick Masonry Field Inspectors Handbook"

3. Codes: The inspection may be performed under various jurisdications, for example, Uniform Building Code of various year issues or Title 21 of the State Office of Architecture & Construction, or Los Angeles City or San Francisco, and, in addition, will have specific requirements from the design offices for some particular reason. The inspector should acquaint himself with these differences so that, for example, he does not enforce high quality school requirements upon lower quality warehouse construction, or does not permit warehouse construction in high quality school work. Each is suitable in its own place.

   "Reinforced Concrete Masonry Inspectors Manual"

B. Materials

1. Terminology:

   a. Become familiar with the correct connotation of the language or masonry "dialect."
   b. Check specifications to note use of unusual items.
   c. Glossaries.

   Journal of the Structural Division, ASCE, Reinforced Masonry Inspectors Manual; Reinforced Grouted Brick Masonry Field Inspectors Handbook

2. Specifications:

   a. General: Job specs versus reference specifications, care in use of reference specs. ASTM Standards
   b. Reference Specifications:

      C 150 - Cement
      C 5 - Quick Lime
      C 207 - Hydrated Lime
      C 144 - Mortar Aggregate
      C 404 - Grout Aggregate
      C 476 - Mortar & Grout for Reinforced Masonry
      C 216 - Facing Brick
      C 62 - Building Brick
      C 67 - Sampling and Testing Brick
      C 126 - Ceramic Glazed Structural Clay
      C 34 - Clay Load Bearing Tile
      C 55 - Concrete Brick
      C 90 - Load Bearing Concrete Block
      C 140 - Sampling, Testing of Concrete Masonry
      A 15 - Rebar
      A 82 - Wire

3. Sampling:

   a. General: The field inspector is frequently responsible for the sampling of materials which are to be tested by the laboratory and care must be exercised because improper sampling can result in test results indicating failures which causes considerable concern and lack of confidence in the job and needless upsetting of the proper conduct of the project.
   b. Sand: Representative sampling is difficult, due to flow segregation. What to do?
   c. Reinforcing: Generally checking of tags and mill reports.
   d. Aggregate.
   e. Block: One method is to follow the CMA Q Quality Control Program. Q-Block Program
   f. Brick: Representative samples should be taken - not all light or dark
   g. Mortar: by spreading on masonry.
   h. Grout: Cast in absorbative molds of the masonry being used on the job.
   i. Coring: Done by professional organizations. However, careful note should be made of the taking and handling, as well as determination of proper location.

UNIT III - STRUCTURAL METALS

SUPPLEMENTAL LIBRARY MATERIAL

1. The Procedure Handbook of Arc Welding Design and Practice
   (The Lincoln Electric Company)

2. Manual of Design for Arc Welded Steel Structures
   (Air Reduction Company)

3. The Welding of Concrete Reinforcing Bars
   (Bethlehem Steel Company)

4. Identification Markings for Fasteners
   (Industrial Fasteners Institute)

5. Engineering Essentials for Welders
   (American Institute of Steel Construction)

6. An Evaluation of Weld Quality as a Cost Factor
   (The Welding Journal)

7. Inspection Manual for Hot Dipped Galvanized Products
   (American Zinc Institute)

8. Why Do Welds Crack - How Can Weld Cracks be Prevented
   (Omer W. Blodgett, Design Consultant)

9. Effect of Operating Variables in Submerged Arc Welding
   (The Lincoln Electric Company)

10. Designers' Guide for Welded Construction
    (The Lincoln Electric Company)

11. Studies in Structural Arc Welding, The Question of Corrosion in Hollow Steel Sections (The Lincoln Electric Company)

12. Arc Welding Trends in Steel Structures
    (The Lincoln Electric Company)

13. Weldirectory of Manual Electrodes
    (The Lincoln Electric Company)

14. Master Chart of Electrode Data
    (The Lincoln Electric Company)

15. Stud Welding Quality Control
    (Nelson Stud Welding Division)

16. Stud Welded Fastening Systems for Construction
    (Nelson Stud Welding Division)

17. Ten Commandments of Quality Stud Welding
    (Nelson Stud Welding Division)

18. Products and Services
    (The Lincoln Electric Company)

19. Care, Cleaning and Maintainance of Architectural Aluminum.

UNIT IV - MASONRY

4. Testing:

   a. General: In general, there is not a great deal of testing to be done by the field inspector; however, he must check the specifications and determine what are the requirements in the specifications for testing and confirm or check to see that such testing has been done and that the materials are satisfactory and in compliance with the specifications for the project.
   b. Sample approvals.

5. Mortar:

   a. Specification Clarification - Proportion versus property — ASTM
   b. Proportioning and measuring
   c. Mixing. Discussion of various types, order of adding to mixer
   d. Admixes

6. Grout:

   a. ASTM Specification Discussion and discussion of grout for high lift grouting.
   b. Proportioning
   c. Mixing
   d. Admixes

7. Handling and Storage

8. Retempering

   a. Code requirement
   b. Variations from those limitations & basic physics

C. Construction

1. Hollow Concrete Block

   a. Site & preparation
   b. Cleaning
   c. Dowels
   d. Reinforcing
   e. Story poles
   f. Sample panels for quality of workmanship
   g. Bolts and details of connections
   h. Spreading mortar bed and adjoints
   i. Grouting, low lift method
   j. Grouting, high lift method
   k. Absorption
   l. Waterproofing
      (1) Waterproofing of block

V-A-3 Subgrade or Basement Soils

Subgrade or basement soils constitute the basic foundation of the pavement upon which the structural section will be placed. It must be brought to grade by cut and fill operations and must be compacted to the specified requirements to prevent future settlements which can be destructive to the pavement.

In the previous course, Structural Series #1, earthwork was covered to include cuts, fills and compaction. We recommend that this portion of SS #1 be reviewed, to include references at this time, for refreshment on the techniques in earthwork construction.

Inasmuch as drainage is such an important subject, we wish to emphasize again that wet spots, springs, etc., are likely to be discovered in construction and may require a change in the drainage plans. The engineer who prepared the plans should be consulted where discrepancies may exist and changes made before proceeding. It becomes expensive to correct drainage problems when they show up after the pavement has been placed.

V-A-4 Subbase Construction

Subbases, when used, are generally composed of granular materials. Specifications for these materials will contain a minimum strength requirement (R-Value or CBR), a gradation requirement with broad limits and a plasticity limit (sand equivalent or plasticity index). Subbase materials are of lower quality than bases and are used for economic reasons. They may be treated, however, seldom are treated in Western practice in flexible pavement construction. Rigid pavements on California highways are built over a cement-treated base on a granular subbase, however, a layer of imported material directly under the slab is most generally referred to as the subbase.

Prior to placing subbase material, the subgrade is to be properly compacted and brought to the grading plane (the top of the subgrade or basement soil elevation). Specifications will generally allow some tolerance in grade, such as that contained in the California Standard Specifications of $\pm$ 0.10'. The specifications also should contain a smoothness requirement such as $\pm$ 0.05' variation when tested with a 10' straightedge. The chances of building a smooth pavement over a rough subgrade are poor; therefore, working within the tolerances specified is required.

In placing the subbase, segregation must be avoided. Placement in windrows and spreading with a blade is generally the method used in highway construction. It can also be placed using spreader boxes which strike off the material at a certain depth. End dumping should be avoided if possible to prevent segregation. Thickness limits are generally specified for the layers to insure the lifts are capable of being properly compacted. Remember, again, that strength is governed by the degree of compaction.

Compaction of the subbase may be accomplished with pneumatic rollers, steel wheeled rollers, vibratory rollers and segmented steel wheeled rollers. To obtain maximum density, the subbase material should be kept at or near optimum moisture by adding water as necessary. The specification will spell out the density requirement or the rolling procedures to follow. Testing for density was covered in Structural Series No. 1, however, briefly it requires that the density of the field sample bear a certain relation to a specimen compacted by certain methods in the laboratory.

$$\text{Relative density (\%)} = \frac{\text{Field density (lbs/ft}^3)}{\text{Laboratory density (lbs/ft}^3)} \times 100$$

Test methods (AASHO) are shown in the Soils Manual (MS-10) and the Asphalt Paving Manual (MS-8) distributed by The Asphalt Institute and used as texts in these courses.

Specifications will generally contain a finished grade tolerance and a smoothness requirement similar to those for subgrade but with

less variation allowed. For instance, the California Division of Highways Standard Specifications state that the grade shall be within $\pm$ 0.08' of that set by the engineer. Smoothness requirements are set for Navy Airfields at 3/8" variation when tested with a 10' straightedge. Highway requirements are sometimes set greater than this amount because surface smoothness is not as critical because of slower speed traffic.

Aggregate subbase is generally paid for by the ton or cubic yard in highway and airfield work, however, in small jobs may be included in the square foot cost of the completed pavement.

The thickness of the subbase should be checked after compaction occasionally to see that you are in fact obtaining the thicknesses required by the plans. This may be accomplished when making the compaction test if the sand volume method is used.

(4) On aircraft for which there is no approved flight manual required, the operating limitations prescribed during original certification and as required by FAR 91.31 must be carried in the aircraft. Where appropriate, these can be range markings on the instruments. Another method may be in the form of typed data on cards similar to 3" x 5" file cards. For convenience these can be covered with clear plastic and mounted in a conspicuous place in the cabin or cockpit. See Figure 5.

f. Completion of the FAA Form 8320-3. Within 48 hours after completion of the annual inspection, the Aircraft Use and Inspection Report, FAA Form 8320-3, should be completed and mailed to the local General Aviation District Office. Advisory Circular 43.11-1B, Aircraft Use and Inspection Report, or subsequent revision, describes how to complete the form. See sample form in Figure 6. For use of the form on progressive inspections, see FAR 43, Appendix C. The forms may be mailed without folding unless the aircraft is reported as "unairworthy." In this case, the discrepancy list may be enclosed by folding and stapling the form.

g. Aircraft Markings. It is the owner/operator's responsibility to have the nationality and registration marks properly displayed on the aircraft. (FAR 91.31(c).) AIs can, and should, offer advisory service to owners and operators in regard to any deficiencies in marking; however, they are not cause to report an aircraft "unairworthy." FAR 45 sets forth the required identification markings of aircraft.

h. Inspection Reminder. Encourage owners to use the inspection reminder, FAA Form 8320-2. When you perform an annual inspection, complete the inspection due date and install the sticker in a conspicuous place in the cockpit or where it will be seen during a preflight inspection. (Inspection date September 15, 1966; due date September 30, 1967.) See the example in Figure 8.

i. Unairworthy Aircraft. If the aircraft is not approved for return to service, use the procedures specified in FAR 43.11(a)(5). This will permit an owner to assume responsibility for having the discrepancies corrected prior to operating the aircraft.

(1) The discrepancies can be cleared by an A&P mechanic unless they consist of major repairs or alterations. If preventive maintenance, they could be cleared by an owner or pilot.

(2) The owner may want the aircraft flown to another location to have repairs completed, in which case he should be advised that a special flight authorization (ferry permit) is necessary. Have him contact the FAA GADO for the authorization.

2. Solid Reinforced Brick Masonry

   a. Site & preparation
   b. Types of details
   c. Sample panels
   d. Absorption
      (1) ASTM requirements
      (2) The effect of these requirements
      (3) The control of these requirements
   e. Bed and head joints
      (1) Furrowing
      (2) Filling of head joints
      (3) Tapping of brick
      (4) Shoving of joints
      (5) Tooling of joints
   f. Grouting procedures for low lift
   g. Grouting procedures for high lift

3. Veneers

   General: There have been many arbitrary requirements in veneer and many different types of specifications and code limits on veneer. Therefore, it would be well for the inspector to check that the detail specified is completely specified and question items possibly not covered, such as unusual conditions. Although there are many arbitrary requirements in veneers, the new Uniform Code requirements classify two types of veneer, namely adhered veneer and anchored veneer, and provide the requirements necessary to design these items. These codes also permit the use of arbitrary methods which have proven satisfactory over the years, some of which may not be in compliance with those basic requirements. In the interest of clarification, these different types have been outlined.

4. Adhered Veneer

   a. Types, such as thin ceramic units, thin brick, special thin stone, etc. (Reference)
   b. Specification. The type that has proven satisfactory was first developed by and included in the Los Angeles City Code.
   c. The basic procedure for this is to dampen the two elements to be bonded, then brush them with neat cement slurry and apply mortar to each which is squeezed together, developing the bond.

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d. Weather: If the weather is unusual, e.g. unusually hot, the inspector should check with the engineer as to need for expansion joints. Also if the conduct of the work is such that the veneers will be applied on concrete surfaces still undergoing initial shrinkage, the inspector should check with the engineer for need of such joints. In hot weather inspector should be very careful to see that the backing and the veneer units are thoroughly damp at time of setting.

5. Anchored Veneer of Stone or Masonry Units

6. Anchored Veneer of Slab Type Units

   a. General
   b. Examples, such as marble, stone, travertine, precast concrete, ceramic veneer.
   c. Typical details and anchors.

7. Masonry Units and Stone Veneer on Paperback Mesh

   a. General: This is sometimes called an anchored veneer and sometimes an adhered veneer. It consists of laying up a wythe of masonry and then pouring grout behind to bond the masonry to the mesh attached to the supporting structure.
   b. Mortar might be used in some cases for adhering the veneer, but only if the veneer is shoved into the mortar; otherwise the mortar bond, from slushing, will not be adequate.
   c. Specifications require development of fifty pound per square inch shear on this type of unit, and if there are questionable areas, they should be checked and marked by cord ruling.

8. Specific Miscellaneous Types

   a. General: Many items are developed specifically by test and have specific approval.
   b. Bowers tie
   c. Paper backed mesh (above)
   d. Special anchors

UNIT IV - MASONRY

LIST OF REFERENCES

(1) "Reinforced Masonry Design and Practice" - A Journal of the Structural Division ASCE

(2) "Reinforced Grouted Brick Masonry Field Inspectors Handbook"

(3) "Reinforced Concrete Masonry Inspectors Manual"

(4) "Handbook on Reinforced Grouted Brick Masonry Construction" by Brick Institute of California

(5) "Concrete Masonry Design Manual" by Concrete Masonry Association of California

(6) "Specifications Recommended to Secure Dry Brick Walls"

(7) "Type of Workmanship Recommended for Concrete Block Walls"

(8) "Specifying Natural Stone Veneer"

(9) "Specifying Structural Glazed Tile"

(10) "Specifying Mortar and Grout"

(11) "High Lift Grouting Specifications"

(12) "Specifying Brick Masonry"

(13) "Specifying Concrete Block Masonry"

(14) "Uniform Building Code, 1964 Edition, Volume 1, Chapter 24."

(15) "Uniform Building Code, 1961 Edition, Volume 1, Chapter 24."

(16) Los Angeles City Building Code

(17) Title 21, Chapter _____

(18) "Reinforced Brick Masonry Lateral Force Design" by Plummer & Blume

(19) "Brick Manufacturers Specification (Southern California)"

(20) "Brick Manufacturers Specification (Northern California)"

UNIT V - PAVING

V-A-1 Introduction

This portion of the course consists of three sessions on paving, as follows:

V-A Earthwork, Subgrade Preparation, Aggregate Bases and Subbases

V-B Asphalt Paving

V-C Portland Cement Concrete Paving

Pavements are designed to carry loads like any other structure. Generally, the heavier the load the thicker the pavement must be to adequately carry the load without failure. As other materials vary in strength so do the materials used in pavements, however, pavements, that is, soil, rock, asphalt concrete or portland cement concrete, are fabricated in the field and the handling of these materials can affect the strength and durability of the final product.

The designer will specify the quality of the materials, how they are to be handled, the thicknesses of lifts, the degree of compaction required, as well as where to place them and at what grade. The inspector's job is to see that the design is built according to the plans and specifications.

The cross sectional sketches shown here serve to illustrate the various elements of the pavement. In addition, they show three common cross sections built to carry loads:

HEAVY DUTY ASPHALT PAVEMENT

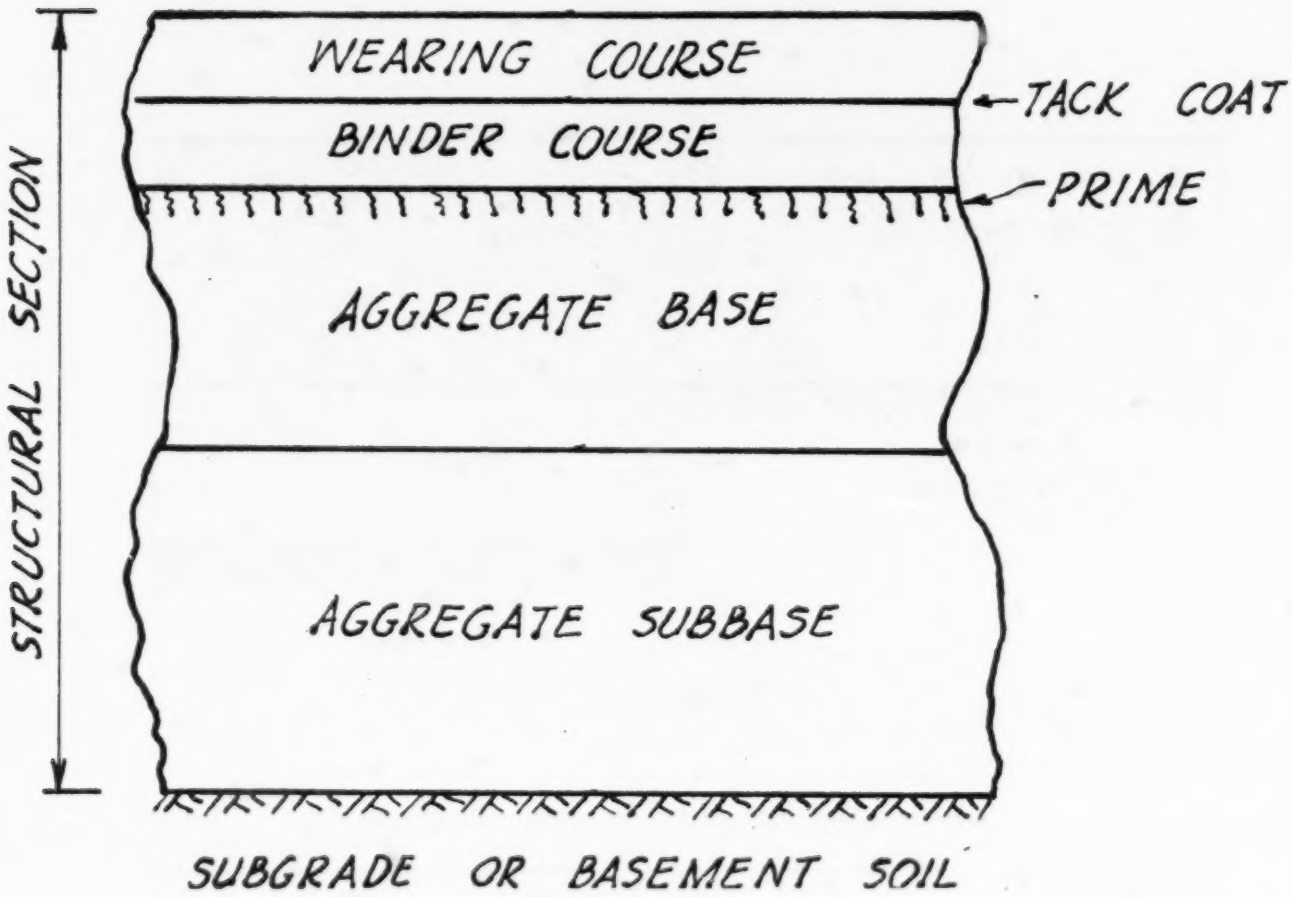

LIGHT DUTY ASPHALT PAVEMENT

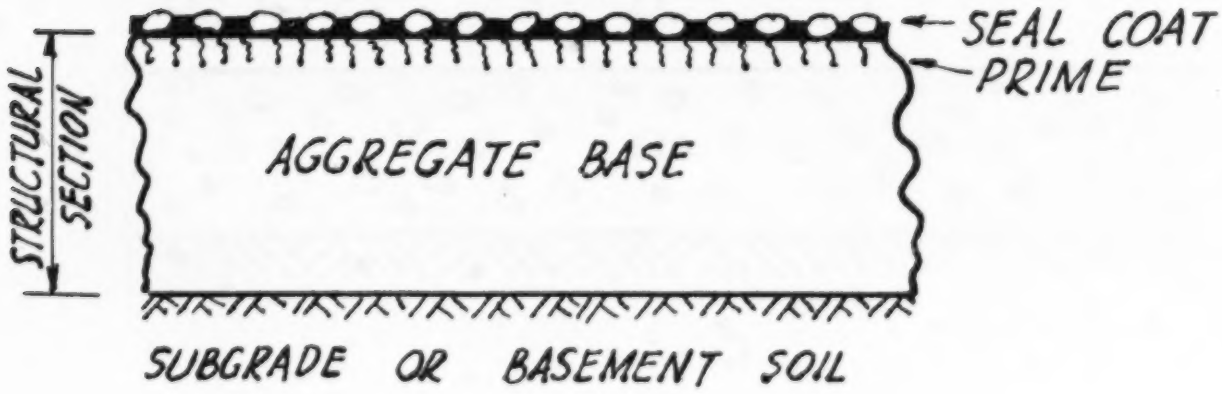

RIGID PAVEMENT

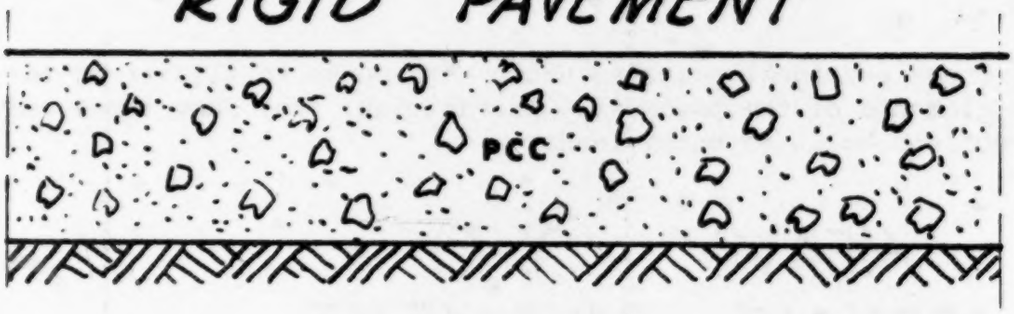

A (Light)

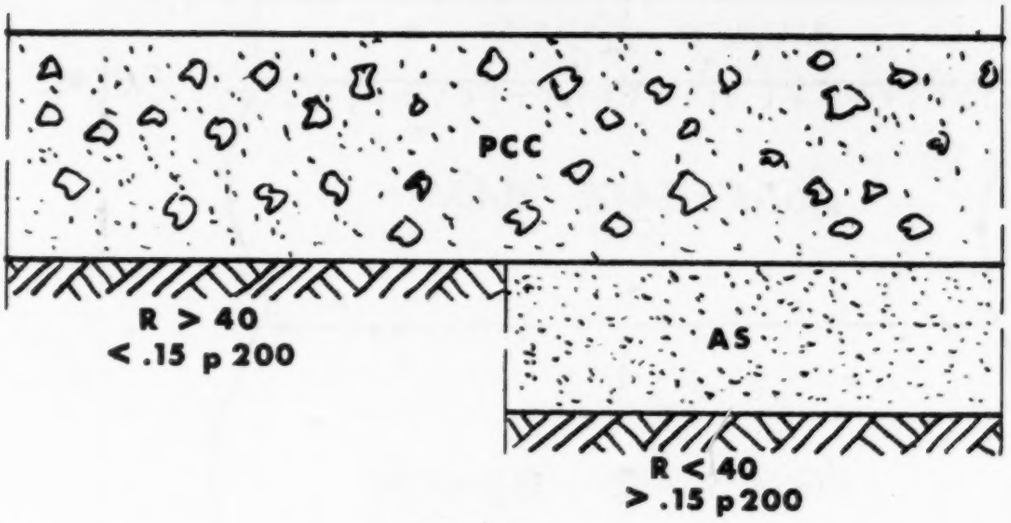

B (Medium)

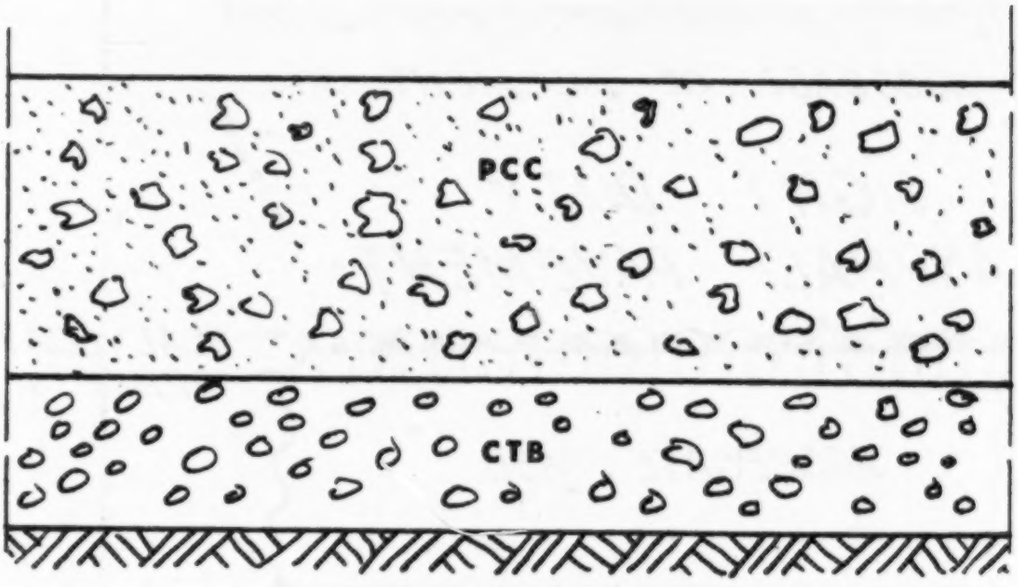

C (Heavy)

There are many other variations of the sections; the use of stronger materials, such as asphalt, cement or lime-treated aggregates or soils, will make the structural section thinner. The structural section composition will be governed by the section which costs the least to build.

UNIT V - PAVING

Asphalt Specifications

1. Asphalt Cements or Paving Grades

The Uniform Pacific Coast Specifications for paving asphalt, as shown in Table 1, were adopted by Pacific Coast user agencies in 1957. They are in general use on the Pacific Coast, although other specifications are occasionally used here by national specification writing agencies. Paving asphalt meeting Pacific Coast specifications will comply with Asphalt Institute and other national specifications.

TABLE I
UNIFORM PACIFIC COAST SPECIFICATIONS FOR PAVING ASPHALTS*

Specification Designation	AASHO Test Method	Grade				
		40-50	60-70	85-100	120-150	200-300
Flash Point-- P.M.C.T. °F., Min.	T73	460	450	440	425	400
Penetration of Original Sample at 77°F.	T49	40-50	60-70	85-100	120-150	200-300
Loss on Heating, 5 hr. at 325°F., % Max. (Calif. Test Method No. 337, Thin Film Procedure)	--	0.75	0.80	0.85	1.00	1.50
Pen. after loss at 325° F., % of Orig. Pen., Min.	T49	52	50	47	44	40
Ductility at 77°Fs, cm. after loss at 325° F. Min.	T51	50	50	75	75	75
Penetration Ratio $\frac{\text{Pen. 39.2°F.-200 gm.-1 Min.}}{\text{Pen. 77°F.-100 gm.-5 Secs.}} \times 100$	T49	25 Min.	25 Min.	25 Min.	25 Min.	25 Min.
Furol Viscosity at 275° F.	T72	120-430	100-325	85-260	70-210	50-150
Solubility in CCl_4, % Min.	T45	99	99	99	99	99
Heptane Xylene Equiv., % Max.	T102 (Modified as noted below**)	35	35	35	35	35

* These specifications were adopted by Pacific Coast user agencies in 1957 and are in general use on the Pacific Coast, although other specifications are occasionally used here by national specification writing agencies. Paving asphalt meeting Uniform Pacific Coast Specifications will comply with Asphalt Institute and other national specifications.

**Normal spot test and glass plate test repeated at end of 24-hour period will not be required.

2. Liquid Asphalt Specifications

The Specifications for Liquid Asphalts are given in Tables III, IV, and V. Table VI shows the alternate Viscosity Specifications in Saybolt Furol seconds. The viscosity specifications are illustrated graphically in Figure 2.

In these specifications, the nomenclature for type is based on the curing rate, i.e., RC (Rapid Curing), MC (Medium Curing), and SC (Slow Curing). The numerical designations within the types correspond to the minimum viscosity in centistokes at 140 degress F. For example, RC-70 is the most fluid

Rapid-Curing Liquid Asphalt and has a viscosity range at 140 degrees F. of 70 to 140 centistokes. RC-3000 is the most viscous Rapid-Curing Liquid Asphalt and has a viscosity range at 140 degrees F. of 3000 to 6000 centistokes. Thus, the designation number relates directly to the minimum viscosity for the grade. Note that the upper viscosity limit is twice that of the lower limit. The table of recommended uses of asphalts (Table No. II) includes liquid asphalts and their primary uses in construction.

TABLE III
ASPHALT INSTITUTE
SPECIFICATIONS FOR RAPID-CURING (RC) LIQUID ASPHALTS

Characteristics	AASHO Test Method	ASTM Test Method	GRADES			
			RC-70	RC-250	RC-800	RC-3000
Flash Point (Open Tag.), °F.	T 79	D 1310	.....	80 Min.	80 Min.	80 Min.
Kinematic Viscosity at 140°F., cs.[1]	.....	D 445	70-140	250-500	800-1600	3000-6000
Distillation—						
Distillate (per cent of total distillate to 680°F.):						
to 374°F.	T 78	D 402	10 Min.	.....	.....	.....
to 437°F.			50 Min.	35 Min.	15 Min.	.....
to 500°F.			70 Min.	60 Min.	45 Min.	25 Min.
to 600°F.			85 Min.	80 Min.	75 Min.	70 Min.
Residue from distillation to 680°F., volume per cent by difference			55 Min.	65 Min.	75 Min.	80 Min.
Tests on Residue from Distillation:						
Penetration, 77°F., 100 g., 5 sec.	T 49	D 5	80-120	80-120	80-120	80-120
Ductility, 77°F., cms.	T 51	D 113	100 Min.	100 Min.	100 Min.	100 Min.
Solubility in Carbon Tetrachloride, %	T 44[2]	D 4[2]	99.5 Min.	99.5 Min.	99.5 Min.	99.5 Min.
Water, %	T 55	D 95	0.2 Max.	0.2 Max.	0.2 Max.	0.2 Max.

Note: When the Heptane-Xylene Equivalent Test is specified by the consumer, a negative test with 35 per cent xylene after 1 hour will be required, AASHO Method T 102.

[1] As an alternate, Saybolt Furol Viscosities may be specified as shown in Table VI.

[2] Except that carbon tetrachloride or trichloroethylene is used instead of carbon disulphide as solvent, Method No. 1 in AASHO Method T 44 or Procedure No. 1 in ASTM Method D 4.

FIGURE 6.

Showing a typical FAA Form 8320-3 after completion of an Annual Inspection. Detailed instructions for the completion of this form appear in AC 43.11-1B. This form must be submitted within 48 hours after the completion of an Annual Inspection. See Figure 7, for sample discrepancy list when reporting an aircraft unairworthy. While the name of the inspection has been changed, you may continue to use forms with the name "periodic" inspection until directed otherwise.

FORM APPROVED
BUDGET BUR. NO. 04-R063

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AIRCRAFT USE AND INSPECTION REPORT

PRINT OR TYPE ALL ENTRIES EXCEPT SIGNATURES.
SHADED BOXES ARE FOR FAA USE

SECTION I—IDENTIFICATION

1. AIRCRAFT REGISTRATION MARK N– 40023	AIRCRAFT MFR. SERIAL NO. 63-11046
2. AIRCRAFT MAKE Zeph-Air	AIRCRAFT MODEL 63-1A

3. NAME OF OWNER *(As shown on Certificate of Registration)*
Robert D. Thomas

4. ADDRESS OF OWNER *(As shown on Certificate of Registration)*
NUMBER AND STREET: 606 Elm Street
CITY: Urbana STATE: Illinois ZIP CODE: 06114

5. AIRCRAFT IS BASED AT: COUNTY: Champaign
AIRPORT: Skyhome
CITY: Urbana STATE OF: Illinois

SECTION II—ACTIVITY DATA

6. DATE OF PREVIOUS ANNUAL INSPECTION 1/12/64	AIRCRAFT TIME IN SERVICE PREVIOUS 12 MONTHS 158 HRS.

7. PRIMARY USE OF AIRCRAFT *(Check one box only)*

1		EXECUTIVE TRANSPORTATION	6		AIR TAXI
2	X	BUSINESS TRANSPORTATION	7		INDUSTRIAL, SPECIAL
3		PERSONAL	8		OTHER *(Specify)*
4		AERIAL APPLICATION			
5		INSTRUCTION			

SECTION III—INSPECTION REPORT

8. NAME OF INSPECTING AGENCY
George B. Jones

9. TYPE INSPECTING AGENCY 3 ☒ INSPECTION AUTHORIZATION 5 ☐ MANUFACTURER 6 ☐ REPAIR STATION	CERTIFICATE NO. AND TYPE IA 272182

10. TYPE OF INSPECTION 1 ☒ ANNUAL 2 ☐ PROGRESSIVE	DATE OF INSPECTION 2/9/65	CONDITION OF AIRCRAFT 1 ☒ AIRWORTHY 2 ☐ UNAIRWORTHY

11. SIGNATURE OF CONDUCTOR OF THIS INSPECTION
George B Jones

EA	SW	CE	WE	AL	PC	SO	EU	FAA DIST. OFF NO.
1	2	3	4	5	6	7	9	

FAA Form 8320-3 (11-67) FORMERLY FAA FORM 2350 GPO : 1967 OF—283-055

TABLE IV
ASPHALT INSTITUTE
SPECIFICATIONS FOR MEDIUM-CURING (MC) LIQUID ASPHALTS

Characteristics	AASHO Test Method	ASTM Test Method	GRADES			
			MC-70	MC-250	MC-800	MC-3000
Flash Point (Open Tag.), °F.[1]	T 79	D 1310	100 Min.	150 Min.	150 Min.	150 Min.
Kinematic Viscosity at 140°F., cs.[2]	.....	D 445	70-140	250-500	800-1600	3000-6000
Distillation—						
Distillate (per cent of total distillate to 680°F.):						
To 437°F.			20 Max.	0-10	.....	.....
To 500°F.	T 78	D 402	20-60	15-55	35 Max.	15 Max.
To 600°F.			65-90	60-87	45-80	15-75
Residue from distillation to 680°F., volume per cent by difference			55 Min.	67 Min.	75 Min.	80 Min.
Tests on Residue from Distillation:						
Penetration, 77°F., 100 g., 5 sec.	T 49	D 5	120-250	120-250	120-250	120-250
Ductility, 77°F., cms.[3]	T 51	D 113	100 Min.	100 Min.	100 Min.	100 Min.
Solubility in Carbon Tetrachloride, %	T 44[4]	D 4[4]	99.5 Min.	99.5 Min.	99.5 Min.	99.5 Min.
Water, %	T 55	D 95	0.2 Max.	0.2 Max.	0.2 Max.	0.2 Max.

Note: When the Heptane-Xylene Equivalent Test is specified by the consumer, a negative test with 35 per cent xylene after 1 hour will be required, AASHO Method T 102.

[1] Flash Point by Cleveland Open Cup may be used for products having a flash point greater than 175°F.

[2] As an alternate, Saybolt Furol Viscosities may be specified as shown in Table VI.

[3] If penetration of residue is more than 200 and its ductility at 77°F. is less than 100, the material will be acceptable if its ductility at 60°F. is 100+.

[4] Except that carbon tetrachloride or trichloroethylene is used instead of carbon disulphide as solvent, Method No. 1 in AASHO Method T 44 or Procedure No. 1 in ASTM Method D 4.

TABLE V
ASPHALT INSTITUTE
SPECIFICATIONS FOR SLOW-CURING (SC) LIQUID ASPHALTS

Characteristics	AASHO Test Method	ASTM Test Method	GRADES			
			SC-70	SC-250	SC-800	SC-3000
Flash Point (Cleveland Open Cup), °F.	T 48	D 92	150 Min.	175 Min.	200 Min.	225 Min.
Kinematic Viscosity at 140°F., cs.[1]	.....	D 445	70-140	250-500	800-1600	3000-6000
Distillation:						
Total Distillate to 680°F., % by volume	T 78	D 402	10-30	4-20	2-12	5 Max.
Float Test on Distillation Residue at 122°F., sec.	T 50	D 139	20-100	25-110	50-140	75-200
Asphalt Residue of 100 Penetration, %	T 56	D 243	50 Min.	60 Min.	70 Min.	80 Min.
Ductility of 100 Penetration Asphalt Residue at 77°F., cms.	T 51	D 113	100 Min.	100 Min.	100 Min.	100 Min.
Solubility in Carbon Tetrachloride, %	T 44[2]	D 4[2]	99.5 Min.	99.5 Min.	99.5 Min.	99.5 Min.
Water, %	T 55	D 95	0.5 Max.	0.5 Max.	0.5 Max.	0.5 Max.

Note: When the Heptane-Xylene Equivalent Test is specified by the consumer, a negative test with 35 per cent xylene after 1 hour will be required, AASHO Method T 102.

[1] As an alternate, Saybolt Furol Viscosities may be specified as shown in Table VI.

[2] Except that carbon tetrachloride or trichloroethylene is used instead of carbon disulphide as solvent, Method No. 1 in AASHO Method T 44 or Procedure No. 1 in ASTM Method D 4.

TABLE VI
ASPHALT INSTITUTE
ALTERNATE VISCOSITY SPECIFATIONS FOR LIQUID ASPHALTS [1]

Characteristics	AASHO Test Method	ASTM Test Method	GRADES			
			RC-, MC- or SC-70	RC-, MC- or SC-250	RC-, MC- or SC-800	RC-, MC- or SC-3000
Furol Viscosity at 140°F., sec.	T 72	D 88	35-70	125-250	400-800	1500-3000
Or						
Furol Viscosity at 122°F., sec.			60-120	.....	.....	.....
Furol Viscosity at 140°F., sec.	T 72	D 88	.....	125-250	.....	.....
Furol Viscosity at 180°F., sec.			.....	.....	100-200	300-600

[1] As an alternate for kinematic viscosity limits included in specifications on Tables III, IV, & V, Furol Viscosity limits may be used. These Furol Viscosity limits may be specified, as shown above, either at a constant temperature (140°F.) or at three temperatures. This alternate is provided in recognition of the transition period required in changing from the Saybolt Furol test to the more fundamental kinematic viscosity test.

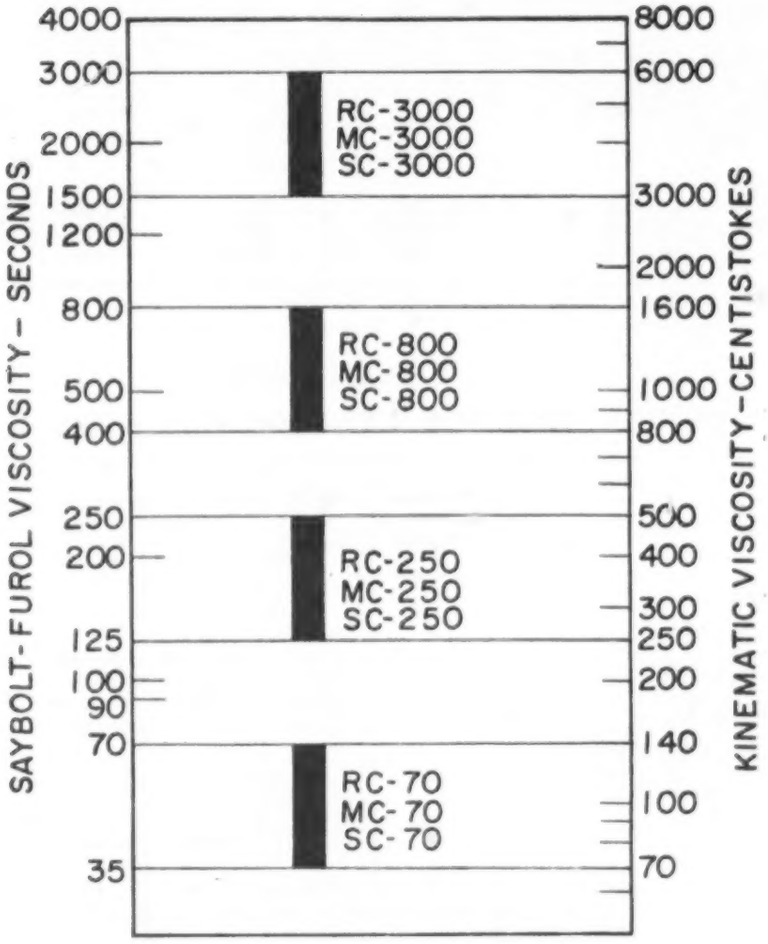

Fig.2-GRADES OF LIQUID ASPHALT, VISCOSITY AT 140° F

UNIT V - PAVING

V-A-5 Base Construction

Bases are considered by some to be the main load carrying portion in a flexible pavement. When we consider a simple pavement consisting of a surface treatment over an aggregate base on subgrade, the base must withstand the shearing forces of surface loads and reduce the loads transmitted to the subgrade to the point where the subgrade will not be overstressed and fail. In multi-layer pavements the same type of load distribution is carried out from layer to layer. The base then becomes one distributor in a series which alters the load to the point where the subgrade will not fail. The mechanism is more complicated than this, however, it serves to illustrate in general the function of the layers. The load ultimately is carried by the subgrade and the pavement is a distributing agent.

The base is a layer under the surface with a primary load distribution function. It is not as efficient in this function as the surface (which must also resist abrasion by traffic) but more efficient than the subbase. Therefore, we can expect the quality of the base material to lie somewhere between the high quality surfacing and a lower quality subbase. This in-between quality position is, in fact, where we find base material quality.

Aggregate bases require more stability, more careful gradation control and less plasticity in their specifications than do subbases. To illustrate, the requirements for Class 2 aggregate bases and subbases specifications are shown as defined in the California Division of Highways Standard Specifications dated July 1964:

Class 2 Aggregate Base -- Aggregate for Class 2 aggregate base shall be free from vegetable matter and other deleterious substances.

The coarse aggregate (material retained on the No. 4 sieve) shall consist of material of which at least 25 percent by weight shall be crushed particles as determined by Test Method No. Calif. 205.

The percentage composition by weight of aggregate base shall conform to one of the following gradings when determined by Test Method No. Calif. 202.

Sieve Sizes	Percentage Passing	
	1½" Maximum	¾" Maximum
2"	100	---
1½"	90-100	---
1"	---	100
¾"	50- 85	90-100
No. 4	25- 45	35- 55
No. 30	10- 25	10- 30
No. 200	2- 9	2- 9

The aggregate base shall also conform to the following quality requirements:

Tests	Test Method No. Calif.	Requirements
Resistance (R-Value)[1]	301	78 Min.
Sand Equivalent	217	30 Min.
Durability Index	229	35 Min.

[1]The R-Value requirement will be waived provided the aggregate base conforms to the specified grading and durability and has a sand equivalent value of 35 or more.

Aggregate Subbase -- Aggregate for Class 1, Class 2, and Class 3 aggregate subbases shall be clean and free from vegetable matter and other deleterious substances.

The percentage composition by weight of Class 1, Class 2, or Class 3 aggregate subbases shall conform to the grading shown in the following table for the class specified when determined by Test Method No. Calif. 202.

Sieve Sizes	Percentage Passing		
	Class 1	Class 2	Class 3
3"----------	100	100	100
2½"----------	90-100	90-100	90-100
No. 4----------	35- 70	40- 90	50-100
No. 200----------	0- 20	0- 25	0-30

Class 1, Class 2, and Class 3 aggregate subbases shall also conform to the quality requirements shown in the following table for the class specified.

Tests	Test Method No. Calif.	Requirements		
		Class 1	Class 2	Class 3
Sand Equivalent	217	20 Min.	20 Min.	20 Min.
Resistance (R-Value)[1]	301	60 Min.	50 Min.	40 Min.

[1]The R-Value requirement will be waived provided the aggregate subbase conforms to the specified grading and has a sand equivalent value of 25 or more.

You will note the base minimum stability is higher as well as the Sand Equivalent. The base also has more stringent gradation requirements, crushing requirements and a durability requirement.

The sand equivalent is a measure of the amount of deleterious fines in an aggregate mixture. The higher the sand equivalent, the better the quality of the material. (See Soils Manual, MS-10, p. 241, for test method. The quality it measures is similar to that measured

by the Plasticity Index.

Aggregate bases should be placed using equipment that will prevent segregation of the fine and coarse aggregates. Dampening of the aggregates also helps prevent segregation.

Maximum compacted lift thicknesses are generally considered to be 6 inches compacted depth. If the base thickness is greater than 6 inches, it should be placed in two or more lifts.

The balance of the base placement requirements are similar to those for subbases with the exception that the smoothness requirements and grade tolerances are generally more stringent than for subbases.

Treated bases are sometimes used for greater efficiency in distributing loads. They are thinner than equivalent strength aggregate bases. It is considered beyond the scope of this course to discuss in detail construction of these bases, however, you may obtain information concerning this type of work from the nearest offices of The Asphalt Institute for asphalt-treated bases or the Portland Cement Association for cement-treated bases.

UNIT V - PAVING

V-B-1 Asphalt Paved Surfaces

There are several types of asphalt surfaces commonly used. They vary from a light spray application of a low viscosity asphalt to a thick layer of high quality asphalt concrete used in heavy duty highway, airfield and industrial yard construction. As we have noted before, the type of surface will depend upon the use the pavement is expected to receive.

Four common surfaces are described:

1. Penetration treatment - A spray application of a low viscosity liquid asphalt on the surface of an aggregate base. The asphalt penetrates the top 3/4 to 1" binding the particles together to resist abrasion and prevent the entrance of excess water.

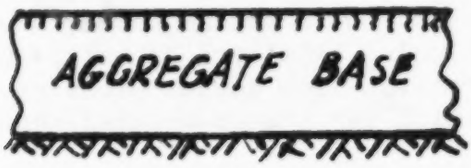

2. Seal Coats - A spray application of asphalt followed by a cover of one size aggregate over a penetration treatment or an old surface. The function of the asphalt is to seal against the entrance of moisture. The function of the aggregate is to carry the traffic. The aggregate may vary from a sand (sand seal) to a crushed aggregate chip (chip seal). These applications may consist of one application of asphalt and aggregate (single seal) to two or more applications of asphalt and aggregate (multiple seals).

3. Road Mix Asphalt Surfacing - This surface is built by either mixing the native material in place or an imported graded aggregate with an asphalt of low viscosity on the roadbed. The depth of the treated material is generally 2

to 4 inches. It provides a low cost surfacing that toughens with time as the asphalt cures.

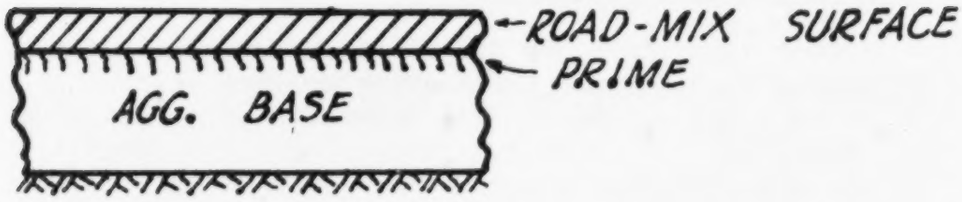

4. Asphalt Concrete Surfaces - This is a surface of the highest quality composed of well graded aggregate hot mixed with asphalt cement in an asphalt plant. It is generally placed with a paving machine and well compacted to provide a tough, smooth surface for traffic use. It can be placed over old pavements, aggregate bases, road mixed asphalt or cement treated bases or asphalt concrete bases.

UNIT V - PAVING

V-B-2 Asphalts Used in Paving, Specifications, Tables and Uses

Classification of Asphalts

Most asphalts today are obtained from the refining of selected petroleum crude oils. The heavier or more viscous portions of these crude oils are asphalts. The breakdown of such a crude is shown schematically in Figure 1. This is merely a schematic representation of the constituents of crude oil. The proportions will vary depending upon the particular crude.

There are three general types of asphalt used to construct and maintain pavements:

1. Paving Asphalts
2. Liquid Asphalts
3. Emulsified Asphalts

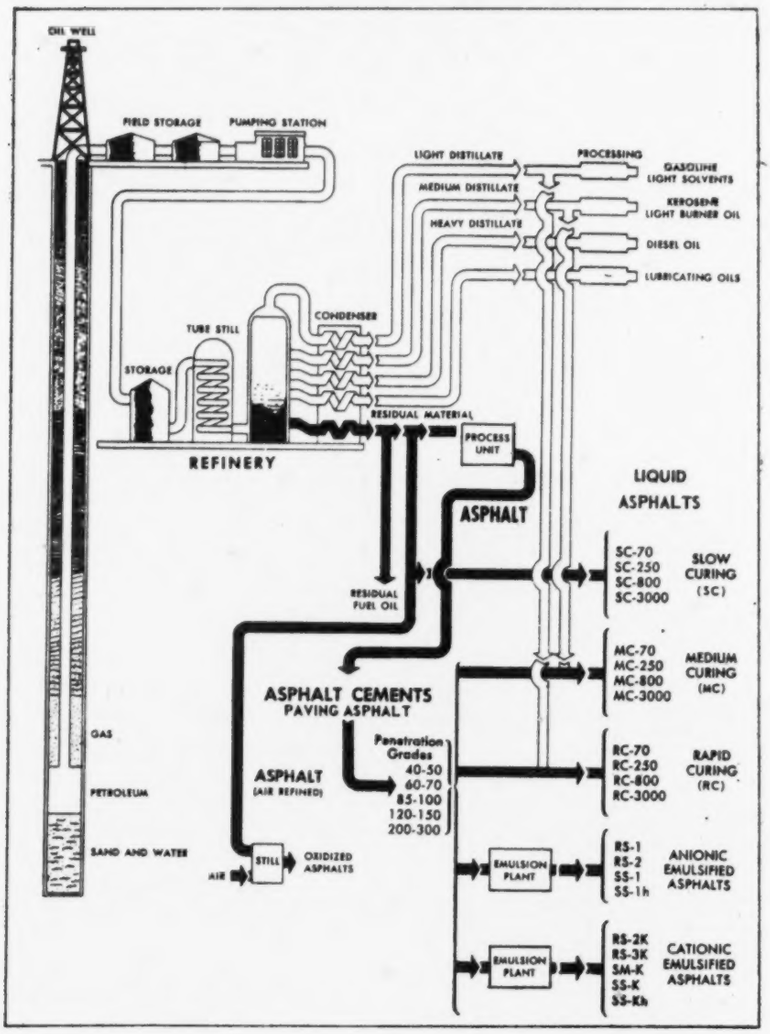

1-PETROLEUM ASPHALT FLOW CHART

UNIT V - PAVING

Grading of Asphalts

All asphalts are graded on the basis of consistency. The hardest paving asphalt (i.e. the most viscous) is the 40-50 penetration grade, and the softest (i.e. the least viscous) is the 200-300 penetration grade. The penetration test at 77°F. is used to determine these grades. Still softer asphalts are termed liquid asphalts (RC, MC, and SC). The kinematic viscosity test is used to grade these.

Liquid asphalts are graded by viscosity at 140 degress F. - RC-, MC-, and SC-3000 liquid asphalts have the highest viscosity, while RC-, MC-, and SC-70 have the lowest viscosity. Liquid asphalts are also graded by the type of solvent used to "thin" the paving asphalts, thereby enabling them to be handled at lower temperatures. Rapid curing (RC) liquid asphalts are produced by dissolving a paving asphalt in a naphtha-type solvent. Medium curing (MC) liquid asphalts are produced by dissolving paving asphalt in a kerosene-type solvent. Slow curing (SC) liquid asphalts are produced by either reducing the crude directly to grade by the distillation process, or by fluxing a paving asphalt with a light oil.

Emulsified asphalts are produced by dispersing paving asphalt into water by means of high-speed agitators and an emulsifying agent. There are two types of emulsified asphalts - cationic and anionic, depending on the type of emulsifying agent used in production of the product. These two types are further classified by the rate of setting of the emulsion; that is, the rate at which the dispersed asphalt particles will recombine and form a continuous film of asphalt cement.

There are four grades of rapid setting (RS) emulsified asphalts - RS-1, RS-2, RS-2K, and RS-3K. The K designation refers to the cationic type of emulsified asphalt.

The viscosity of the RS-1 and RS-2K are similar, as are the viscosities of RS-2 and RS-3K. The numerical designation indicates the minimum percent of asphalt as follows:

1 . . . . . 57%
2 . . . . . 60% or 62%
3 . . . . . 65%

The RS-1 and RS-2K have a low viscosity, while the RS-2 and RS-3K have a higher viscosity to reduce run off on grades and superelevations.

There are five grades of medium and slow setting (SM and SS) emulsified asphalts. These grades are used for mixing with aggregates or where dilution with water is desirable. The SS-1 and SS-1h are similar except that the base asphalt in SS-1h is harder than in SS-1. The cationic emulsified asphalts are designated SS-K, SS-Kh and SM-K.

3. Emulsified Asphalt Specifications

Specifications for the nine grades of emulsified asphalts in general use on the Pacific Coast are given in Tables VIIA and VIIB. Primary uses of these grades are also given in the table of recommended uses, Table II.

TABLE VII A

SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALTS

Characteristics	AASHO Test Method	ASTM Test Method	GRADES			
			Rapid Setting		Slow Setting	
			RS-1	RS-2	SS-1	SS-1h
TESTS ON EMULSION						
Furol Viscosity at 77°F., sec.			20-100	.....	20-100	20-100
Furol Viscosity at 122°F., sec.			.....	75-400	.....	.....
Residue from Distillation, % by weight			57+	62+	57+	57+
Settlement, 5 days, % difference	T59	D244	3—	3—	3—	3—
Demulsibility:						
35 ml. of 0.02 N $CaCl_2$, %			60+	50+	.....	.....
50 ml. of 0.10 N $CaCl_2$, %			.....	.....	.....	.....
Sieve Test (Retained on No. 20), %			0.10—	0.10—	0.10—	0.10—
Cement Mixing Test, %			.....	.....	2.0—	2.0—
TESTS ON RESIDUE						
Penetration, 77°F., 100g., 5 sec.	T49	D5	100-200	100-200	100-200	40-90
Solubility in Carbon Tetrachloride, %	T44[1]	D4[1]	97.5+	97.5+	97.5+	97.5+
Ductility, 77°F., cms.	T51	D113	40+	40+	40+	40+

[1] Except that carbon tetrachloride is used instead of carbon disulphide as solvent. Method No. 1 in AASHO Method T44 or Procedure No. 1 in ASTM Method D4.

TABLE VII B

SPECIFICATIONS FOR CATIONIC EMULSIFIED ASPHALTS

Characteristics	AASHO Test Method	ASTM Test Method	GRADES				
			Rapid Setting		Medium Setting	Slow Setting	
			RS-2K	RS-3K	SM-K	SS-K	SS-Kh
TESTS ON EMULSION							
Furol Viscosity at 77°F., sec.	T 59	D 244	.....	.....	.....	20—100	20—100
Furol Viscosity at 122°F., sec.	T 59	D 244	20—100	100—400	50—500	.....	.....
Residue from Distillation, % by weight	T 59	D 244	60+	65+	60+	57+	57+
Settlement, 7 days, % difference	T 59	D 244	3—	3—	3—	3—	3—
Sieve Test (Retained on No. 20), %	T 59[1]	D 244[1]	0.10—	0.10—	0.10—	0.10—	0.10—
Aggregate Coating-Water Resistance Test	.....	D 244					
Dry Aggregate (Job), % Coated			.....	.....	80+	.....	.....
Wet Aggregate (Job), % Coated			.....	.....	60+	.....	.....
Cement Mixing Test, %	T 59	D 244	.....	.....	.....	2—	2—
Particle Charge Test	.....	.....	Positive	Positive	Positive	.....	.....
pH	.....	E 70	.....	.....	.....	6.7—	6.7—
Oil Distillate, % by Volume	T 59	D 244	5—	5—	20—	.....	.....
TESTS ON RESIDUE							
Penetration, 77°F., 100 g., 5 sec.	T 49	D 5	100—250	100—250	100—250	100—200	40—90
Solubility in Carbon Tetrachloride, %	T 44[2]	D 4[2]	97.0+	97.0+	97.0+	97.0+	97.0+
Ductility, 77°F., cm.	T 51	D 113	40+	40+	40+	40+	40+

[1] Except that distilled water is used instead of sodium oleate solution.

[2] Except that carbon tetrachloride is used instead of carbon disulphide as solvent, Method No. 1 in AASHO Method T 44 or Procedure No. 1 in ASTM Method D 4.

Notes a) "K" in grade designations signifies cationic type

b) In Medium Setting Grade "SM" indicates sand mixing grade

Danville, Illinois
February 9, 1965

Mr. Robert D. Thomas
606 Elm Street
Urbana, Illinois

Dear Mr. Thomas:

This is to certify that on February 9, 1965, I completed an annual inspection on your aircraft Zeph-Air 63-1A, S/N 63-11046, N 40023, and found it to be in unairworthy condition for the following reasons:

1. Engine logbook entry indicates that the engine had been overhauled but had not been approved for return to service as required by section 43.5 of the Federal Aviation Regulations.

2. Fabric on both horizontal stabilizers tests below allowable minimum of 56 lbs.

3. Number three cylinder compression checks below manufacturer's recommendations.

Your aircraft will be considered to be in an airworthy condition when the above listed discrepancies have been corrected and approved for return to service by a person authorized in Part 43 of the FARs.

George B. Jones

George B. Jones
IA 272182

cc: FAA District Office

FIGURE 7

Sample discrepancy list to be provided an aircraft owner when reporting an aircraft "unairworthy" on FAA Form 8320-3.

302 OF 327
ED
056 238

Temperature-Volume Corrections for Asphalt

Asphalt changes in volume with change in temperature. Change in unit volume, per degree change in temperature, is termed "Coefficient of Expansion," a factor which varies with the specific gravity of the asphalt. A temperature of 60 degrees F. is customarily used as the standard basis for volume determinations of asphalt and other petroleum products. Therefore, if the volume is actually measured at any temperature other than 60 degrees F., a correction factor must be applied to convert the measured volume to volume at 60 degrees F.

The American Society for Testing and Materials prepared and published extensive tables on temperature-volume corrections of petroleum products. These tables appear in a book entitled "ASTM-IP Petroleum Measurement Tables," published in January 1953 (ASTM Designation D 1250). Temperature-Volume correction tables contained herein have been extracted from this ASTM publication.

Temperature-Volume correction factors are given in the following tabulations for asphalt having a specific gravity at 60 degrees F. above 0.966 (designated by ASTM as Group 1 materials), and for emulsified asphalts.

Liquid asphalts of grades RC, MC, and SC 250, 800, and 3000, and all paving asphalts fall into the Group 0 classification. Use Table X for volume corrections.

Liquid asphalts of Grades RC, MC, and SC 70 fall into Group 1. Use Table XI for volume correction.

Use Table XII for temperature-volume correction factors for emulsified asphalts.

EXAMPLE OF USE. Assume an MC 250 grade of liquid asphalt. Assume also that a volume of this material is measured to be 9,000 gallons at a temperature of 180 degrees F. Determine the volume of this material at the standard temperature of 60 degrees F.

METHOD. MC 250 grades are in Group 0. Opposite a temperature of 180 degrees F. in the tabulation for Group 0 materials, the correction factor is determined to be 0.9587. Multiply 0.9587 x 9000 gallons which gives a volume at 60 degrees F. of 8628 gallons.

TABLE X

TEMPERATURE—VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS

GROUP 0—SPECIFIC GRAVITY AT 60°F ABOVE 0.966

LEGEND: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M
0	1.0211	50	1.0035	100	0.9861	150	0.9689	200	0.9520										
1	1.0208	51	1.0031	101	0.9857	151	0.9686	201	0.9516										
2	1.0204	52	1.0028	102	0.9854	152	0.9682	202	0.9513										
3	1.0201	53	1.0024	103	0.9851	153	0.9679	203	0.9509										
4	1.0197	54	1.0021	104	0.9847	154	0.9675	204	0.9506										
5	1.0194	55	1.0017	105	0.9844	155	0.9672	205	0.9503										
6	1.0190	56	1.0014	106	0.9840	156	0.9669	206	0.9499										
7	1.0186	57	1.0010	107	0.9837	157	0.9665	207	0.9496										
8	1.0183	58	1.0007	108	0.9833	158	0.9662	208	0.9493										
9	1.0179	59	1.0003	109	0.9830	159	0.9658	209	0.9489										
10	1.0176	60	1.0000	110	0.9826	160	0.9655	210	0.9486										
11	1.0172	61	0.9997	111	0.9823	161	0.9652	211	0.9483										
12	1.0169	62	0.9993	112	0.9819	162	0.9648	212	0.9479										
13	1.0165	63	0.9990	113	0.9816	163	0.9645	213	0.9476										
14	1.0162	64	0.9986	114	0.9813	164	0.9641	214	0.9472										
15	1.0158	65	0.9983	115	0.9809	165	0.9638	215	0.9469										
16	1.0155	66	0.9979	116	0.9806	166	0.9635	216	0.9466										
17	1.0151	67	0.9976	117	0.9802	167	0.9631	217	0.9462										
18	1.0148	68	0.9972	118	0.9799	168	0.9628	218	0.9459										
19	1.0144	69	0.9969	119	0.9795	169	0.9624	219	0.9456										
20	1.0141	70	0.9965	120	0.9792	170	0.9621	220	0.9452										
21	1.0137	71	0.9962	121	0.9788	171	0.9618	221	0.9449										
22	1.0133	72	0.9958	122	0.9785	172	0.9614	222	0.9446										
23	1.0130	73	0.9955	123	0.9782	173	0.9611	223	0.9442										
24	1.0126	74	0.9951	124	0.9778	174	0.9607	224	0.9439										
25	1.0123	75	0.9948	125	0.9775	175	0.9604	225	0.9436										
26	1.0119	76	0.9944	126	0.9771	176	0.9601	226	0.9432										
27	1.0116	77	0.9941	127	0.9768	177	0.9597	227	0.9429										
28	1.0112	78	0.9937	128	0.9764	178	0.9594	228	0.9426										
29	1.0109	79	0.9934	129	0.9761	179	0.9590	229	0.9422										
30	1.0105	80	0.9930	130	0.9758	180	0.9587	230	0.9419										
31	1.0102	81	0.9927	131	0.9754	181	0.9584	231	0.9416										
32	1.0098	82	0.9923	132	0.9751	182	0.9580	232	0.9412										
33	1.0095	83	0.9920	133	0.9747	183	0.9577	233	0.9409										
34	1.0091	84	0.9916	134	0.9744	184	0.9574	234	0.9405										
35	1.0088	85	0.9913	135	0.9740	185	0.9570	235	0.9402										
36	1.0084	86	0.9909	136	0.9737	186	0.9567	236	0.9399										
37	1.0081	87	0.9906	137	0.9734	187	0.9563	237	0.9395										
38	1.0077	88	0.9902	138	0.9730	188	0.9560	238	0.9392										
39	1.0074	89	0.9899	139	0.9727	189	0.9557	239	0.9389										
40	1.0070	90	0.9896	140	0.9723	190	0.9553	240	0.9385										
41	1.0067	91	0.9892	141	0.9720	191	0.9550	241	0.9382										
42	1.0063	92	0.9889	142	0.9716	192	0.9547	242	0.9379										
43	1.0060	93	0.9885	143	0.9713	193	0.9543	243	0.9375										
44	1.0056	94	0.9882	144	0.9710	194	0.9540	244	0.9372										
45	1.0053	95	0.9878	145	0.9706	195	0.9536	245	0.9369										
46	1.0049	96	0.9875	146	0.9703	196	0.9533	246	0.9365										
47	1.0046	97	0.9871	147	0.9699	197	0.9530	247	0.9362										
48	1.0042	98	0.9868	148	0.9696	198	0.9526	248	0.9359										
49	1.0038	99	0.9864	149	0.9693	199	0.9523	249	0.9356										
										250	0.9352	300	0.9187	350	0.9024	400	0.8864	450	0.8705
										251	0.9349	301	0.9184	351	0.9021	401	0.8861	451	0.8702
										252	0.9346	302	0.9181	352	0.9018	402	0.8857	452	0.8699
										253	0.9342	303	0.9177	353	0.9015	403	0.8854	453	0.8696
										254	0.9339	304	0.9174	354	0.9011	404	0.8851	454	0.8693
										255	0.9336	305	0.9171	355	0.9008	405	0.8848	455	0.8690
										256	0.9332	306	0.9167	356	0.9005	406	0.8845	456	0.8687
										257	0.9329	307	0.9164	357	0.9002	407	0.8841	457	0.8683
										258	0.9326	308	0.9161	358	0.8998	408	0.8838	458	0.8680
										259	0.9322	309	0.9158	359	0.8995	409	0.8835	459	0.8677
										260	0.9319	310	0.9154	360	0.8992	410	0.8832	460	0.8674
										261	0.9316	311	0.9151	361	0.8989	411	0.8829	461	0.8671
										262	0.9312	312	0.9148	362	0.8986	412	0.8826	462	0.8668
										263	0.9309	313	0.9145	363	0.8982	413	0.8822	463	0.8665
										264	0.9306	314	0.9141	364	0.8979	414	0.8819	464	0.8661
										265	0.9302	315	0.9138	365	0.8976	415	0.8816	465	0.8658
										266	0.9299	316	0.9135	366	0.8973	416	0.8813	466	0.8655
										267	0.9296	317	0.9132	367	0.8969	417	0.8810	467	0.8652
										268	0.9293	318	0.9128	368	0.8966	418	0.8806	468	0.8649
										269	0.9289	319	0.9125	369	0.8963	419	0.8803	469	0.8646
										270	0.9286	320	0.9122	370	0.8960	420	0.8800	470	0.8643
										271	0.9283	321	0.9118	371	0.8957	421	0.8797	471	0.8640
										272	0.9279	322	0.9115	372	0.8953	422	0.8794	472	0.8636
										273	0.9276	323	0.9112	373	0.8950	423	0.8791	473	0.8633
										274	0.9273	324	0.9109	374	0.8947	424	0.8787	474	0.8630
										275	0.9269	325	0.9105	375	0.8944	425	0.8784	475	0.8627
										276	0.9266	326	0.9102	376	0.8941	426	0.8781	476	0.8624
										277	0.9263	327	0.9099	377	0.8937	427	0.8778	477	0.8621
										278	0.9259	328	0.9096	378	0.8934	428	0.8775	478	0.8618
										279	0.9256	329	0.9092	379	0.8931	429	0.8772	479	0.8615
										280	0.9253	330	0.9089	380	0.8928	430	0.8768	480	0.8611
										281	0.9250	331	0.9086	381	0.8924	431	0.8765	481	0.8608
										282	0.9246	332	0.9083	382	0.8921	432	0.8762	482	0.8605
										283	0.9243	333	0.9079	383	0.8918	433	0.8759	483	0.8602
										284	0.9240	334	0.9076	384	0.8915	434	0.8756	484	0.8599
										285	0.9236	335	0.9073	385	0.8912	435	0.8753	485	0.8596
										286	0.9233	336	0.9070	386	0.8908	436	0.8749	486	0.8593
										287	0.9230	337	0.9066	387	0.8905	437	0.8746	487	0.8590
										288	0.9227	338	0.9063	388	0.8902	438	0.8743	488	0.8587
										289	0.9223	339	0.9060	389	0.8899	439	0.8740	489	0.8583
										290	0.9220	340	0.9057	390	0.8896	440	0.8737	490	0.8580
										291	0.9217	341	0.9053	391	0.8892	441	0.8734	491	0.8577
										292	0.9213	342	0.9050	392	0.8889	442	0.8731	492	0.8574
										293	0.9210	343	0.9047	393	0.8886	443	0.8727	493	0.8571
										294	0.9207	344	0.9044	394	0.8883	444	0.8724	494	0.8568
										295	0.9204	345	0.9040	395	0.8880	445	0.8721	495	0.8565
										296	0.9200	346	0.9037	396	0.8876	446	0.8718	496	0.8562
										297	0.9197	347	0.9034	397	0.8873	447	0.8715	497	0.8559
										298	0.9194	348	0.9031	398	0.8870	448	0.8712	498	0.8556
										299	0.9190	349	0.9028	399	0.8867	449	0.8709	499	0.8552

TABLE XI

TEMPERATURE—VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS

GROUP 1—SPECIFIC GRAVITY AT 60°F OF 0.850 TO 0.966

LEGEND: t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60°F

t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M
0	1.0241	50	1.0040	100	0.9842	150	0.9647	200	0.9456										
1	1.0237	51	1.0036	101	0.9838	151	0.9643	201	0.9452										
2	1.0233	52	1.0032	102	0.9834	152	0.9639	202	0.9448										
3	1.0229	53	1.0028	103	0.9830	153	0.9635	203	0.9444										
4	1.0225	54	1.0024	104	0.9826	154	0.9632	204	0.9441										
5	1.0221	55	1.0020	105	0.9822	155	0.9628	205	0.9437										
6	1.0217	56	1.0016	106	0.9818	156	0.9624	206	0.9433										
7	1.0213	57	1.0012	107	0.9814	157	0.9620	207	0.9429										
8	1.0209	58	1.0008	108	0.9810	158	0.9616	208	0.9425										
9	1.0205	59	1.0004	109	0.9806	159	0.9612	209	0.9422										
10	1.0201	60	1.0000	110	0.9803	160	0.9609	210	0.9418										
11	1.0197	61	0.9996	111	0.9799	161	0.9605	211	0.9414										
12	1.0193	62	0.9992	112	0.9795	162	0.9601	212	0.9410										
13	1.0189	63	0.9988	113	0.9791	163	0.9597	213	0.9407										
14	1.0185	64	0.9984	114	0.9787	164	0.9593	214	0.9403										
15	1.0181	65	0.9980	115	0.9783	165	0.9589	215	0.9399										
16	1.0177	66	0.9976	116	0.9779	166	0.9585	216	0.9395										
17	1.0173	67	0.9972	117	0.9775	167	0.9582	217	0.9391										
18	1.0168	68	0.9968	118	0.9771	168	0.9578	218	0.9388										
19	1.0164	69	0.9964	119	0.9767	169	0.9574	219	0.9384										
20	1.0160	70	0.9960	120	0.9763	170	0.9570	220	0.9380										
21	1.0156	71	0.9956	121	0.9760	171	0.9566	221	0.9376										
22	1.0152	72	0.9952	122	0.9756	172	0.9562	222	0.9373										
23	1.0148	73	0.9948	123	0.9752	173	0.9559	223	0.9369										
24	1.0144	74	0.9944	124	0.9748	174	0.9555	224	0.9365										
25	1.0140	75	0.9940	125	0.9744	175	0.9551	225	0.9361										
26	1.0136	76	0.9936	126	0.9740	176	0.9547	226	0.9358										
27	1.0132	77	0.9932	127	0.9736	177	0.9543	227	0.9354										
28	1.0128	78	0.9929	128	0.9732	178	0.9539	228	0.9350										
29	1.0124	79	0.9925	129	0.9728	179	0.9536	229	0.9346										
30	1.0120	80	0.9921	130	0.9725	180	0.9532	230	0.9343										
31	1.0116	81	0.9917	131	0.9721	181	0.9528	231	0.9339										
32	1.0112	82	0.9913	132	0.9717	182	0.9524	232	0.9335										
33	1.0108	83	0.9909	133	0.9713	183	0.9520	233	0.9331										
34	1.0104	84	0.9905	134	0.9709	184	0.9517	234	0.9328										
35	1.0100	85	0.9901	135	0.9705	185	0.9513	235	0.9324										
36	1.0096	86	0.9897	136	0.9701	186	0.9509	236	0.9320										
37	1.0092	87	0.9893	137	0.9697	187	0.9505	237	0.9316										
38	1.0088	88	0.9889	138	0.9693	188	0.9501	238	0.9313										
39	1.0084	89	0.9885	139	0.9690	189	0.9498	239	0.9309										
40	1.0080	90	0.9881	140	0.9686	190	0.9494	240	0.9305										
41	1.0076	91	0.9877	141	0.9682	191	0.9490	241	0.9301										
42	1.0072	92	0.9873	142	0.9678	192	0.9486	242	0.9298										
43	1.0068	93	0.9869	143	0.9674	193	0.9482	243	0.9294										
44	1.0064	94	0.9865	144	0.9670	194	0.9478	244	0.9290										
45	1.0060	95	0.9861	145	0.9666	195	0.9475	245	0.9286										
46	1.0056	96	0.9857	146	0.9662	196	0.9471	246	0.9283										
47	1.0052	97	0.9854	147	0.9659	197	0.9467	247	0.9279										
48	1.0048	98	0.9850	148	0.9655	198	0.9463	248	0.9275										
49	1.0044	99	0.9846	149	0.9651	199	0.9460	249	0.9272										
										250	0.9268	300	0.9083	350	0.8902	400	0.8724	450	0.8550
										251	0.9264	301	0.9080	351	0.8899	401	0.8721	451	0.8547
										252	0.9260	302	0.9076	352	0.8895	402	0.8717	452	0.8543
										253	0.9257	303	0.9072	353	0.8891	403	0.8714	453	0.8540
										254	0.9253	304	0.9069	354	0.8888	404	0.8710	454	0.8536
										255	0.9249	305	0.9065	355	0.8884	405	0.8707	455	0.8533
										256	0.9245	306	0.9061	356	0.8881	406	0.8703	456	0.8529
										257	0.9242	307	0.9058	357	0.8877	407	0.8700	457	0.8526
										258	0.9238	308	0.9054	358	0.8873	408	0.8696	458	0.8522
										259	0.9234	309	0.9050	359	0.8870	409	0.8693	459	0.8519
										260	0.9231	310	0.9047	360	0.8866	410	0.8689	460	0.8516
										261	0.9227	311	0.9043	361	0.8863	411	0.8686	461	0.8512
										262	0.9223	312	0.9039	362	0.8859	412	0.8682	462	0.8509
										263	0.9219	313	0.9036	363	0.8856	413	0.8679	463	0.8505
										264	[illegible]	314	0.9032	364	0.8852	414	0.8675	464	0.8502
										265	[illegible]	315	0.9029	365	0.8848	415	0.8672	465	0.8498
										266	0.92[illegible]	316	0.9025	366	0.8845	416	0.8668	466	0.8495
										267	0.9205	317	0.9021	367	0.8841	417	0.8665	467	0.8492
										268	0.9201	318	0.9018	368	0.8838	418	0.8661	468	0.8488
										269	0.9197	319	0.9014	369	0.8834	419	0.8658	469	0.8485
										270	0.9194	320	0.9010	370	0.8831	420	0.8654	470	0.8481
										271	0.9190	321	0.9007	371	0.8827	421	0.8651	471	0.8478
										272	0.9186	322	0.9003	372	0.8823	422	0.8647	472	0.8474
										273	0.9182	323	0.9000	373	0.8820	423	0.8644	473	0.8471
										274	0.9179	324	0.8996	374	0.8816	424	0.8640	474	0.8468
										275	0.9175	325	0.8992	375	0.8813	425	0.8637	475	0.8464
										276	0.9171	326	0.8989	376	0.8809	426	0.8633	476	0.8461
										277	0.9168	327	0.8985	377	0.8806	427	0.8630	477	0.8457
										278	0.9164	328	0.8981	378	0.8802	428	0.8626	478	0.8454
										279	0.9160	329	0.8978	379	0.8799	429	0.8623	479	0.8451
										280	0.9157	330	0.8974	380	0.8795	430	0.8619	480	0.8447
										281	0.9153	331	0.8971	381	0.8792	431	0.8616	481	0.8444
										282	0.9149	332	0.8967	382	0.8788	432	0.8612	482	0.8440
										283	0.9146	333	0.8963	383	0.8785	433	0.8609	483	0.8437
										284	0.9142	334	0.8960	384	0.8781	434	0.8605	484	0.8433
										285	0.9138	335	0.8956	385	0.8777	435	0.8602	485	0.8430
										286	0.9135	336	0.8952	386	0.8774	436	0.8598	486	0.8427
										287	0.9131	337	0.8949	387	0.8770	437	0.8595	487	0.8423
										288	0.9127	338	0.8945	388	0.8767	438	0.8592	488	0.8420
										289	0.9124	339	0.8942	389	0.8763	439	0.8588	489	0.8416
										290	0.9120	340	0.8938	390	0.8760	440	0.8585	490	0.8413
										291	0.9116	341	0.8934	391	0.8756	441	0.8581	491	0.8410
										292	0.9113	342	0.8931	392	0.8753	442	0.8578	492	0.8406
										293	0.9109	343	0.8927	393	0.8749	443	0.8574	493	0.8403
										294	0.9105	344	0.8924	394	0.8746	444	0.8571	494	0.8399
										295	0.9102	345	0.8920	395	0.8742	445	0.8567	495	0.8396
										296	0.9098	346	0.8916	396	0.8738	446	0.8564	496	0.8393
										297	0.9094	347	0.8913	397	0.8735	447	0.8560	497	0.8389
										298	0.9091	348	0.8909	398	0.8731	448	0.8557	498	0.8386
										299	0.9087	349	0.8906	399	0.8728	449	0.8554	499	0.8383

Sampling of Asphalt

In order to properly test asphalt for compliance with specifications, it is necessary to take a representative sample. Samples taken in the field should be forwarded immediately to laboratory for testing.

Spraying and Mixing Temperatures

Table VIII provides a guide for use in determining application temperatures for asphalt.

The temperature of asphalt drops about 1 degree F. per hour in transit. (This varies with loading and atmospheric temperatures, and amount and type of insulation on the vehicle.)

Destination temperatures cannot be guaranteed.

Shipping of Asphalt

ADVANCE SCHEDULES. The shipping of asphalt is highly seasonal, and is sometimes accompanied by temporary shortages of transportation equipment. For this reason, service can be improved if the customer will furnish the supplier with a definite shipping schedule as far as possible in advance of the required date of shipments.

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TABLE VIII
SUGGESTED TEMPERATURES FOR USE OF ASPHALTS

Grade of Paving Asphalt	Distributor Spraying Temp., °F.		Pugmill Mixing Temperature of Aggregates, °F.	
	Min.	Max.	Min.	Max.
40 - 50 pen.	*	*	300	350
60 - 70 pen.	295	350	275	325
85 - 100 pen.	290	350	275	325
120 - 150 pen.	285	350	275	325
200 - 300 pen.	275	325	225	275

Grade of Liquid Asphalt	Distributor Spraying Temp., °F.		Pugmill Mixing Temperature of Aggregates for MC & SC Liquid Asphalts, °F.	
	Min.	Max.	Min.	Max.
RC, MC, SC Grade 70	120	180	95	140
RC, MC, SC Grade 250	165	220	135	175
RC, MC, SC Grade 800	200	255	165	205
RC, MC, SC Grade 3000	235	290	200	240

Grade of Asphalt Emulsions	Distributor Spraying Temp., °F		Pugmill Mixing Temperature of Aggregate, °F.	
	Min.	Max.	Min.	Max.
RS-1, RS-2K	75	130	(Not used	
RS-2, RS-3K	110	160	for mixing)	
SS-1, SS-K	75	130	50	130
SS-1h, SS-Kh	75	130	50	130
SM-K	100	160	60	140

* Seldom used for spraying

Stockpile mixes should be mixed at lower temperatures.

Pugmill mixing temperatures for open graded mixes should be between 225°F. and 250°F.

CAUTION: The purpose of the above table is to indicate temperature ranges necessary to provide proper asphalt viscosity for spraying and mixing applications for the grades of asphalts shown. It must be recognized, however, that temperature ranges indicated by this table generally are above the minimum flash point for the RC, MC and SC liquid asphaltic materials as specified by The Asphalt Institute and other agencies. In fact, some of these liquid asphalts will "flash" at temperatures below these indicated ranges. Accordingly, suitable safety precautions are mandatory at all times when handling these liquid asphalts. These safety precautions include, but are not limited to, the following:

(1) Do not permit open flames or sparks of any kind close to these materials except in heating kettles, mixers, distributors, or other equipment properly designed and approved for handling and applying them.

(2) Do not use an open flame to inspect or examine drums, tank cars, or other containers in which these materials have been stored.

(3) Properly vent and ground all vehicles transporting these materials.

(4) Permit only experienced personnel to supervise the handling of these materials.

(5) Comply with all applicable intra- and interstate commerce requirements.

TABLE IX
AVERAGE WEIGHTS AND VOLUMES OF ASPHALTS

Grade	Gallons per Ton @ 60° F.	Barrels per Ton @ 60° F.	Pounds per Gallon @ 60° F.	Pounds per Barrel @ 60° F
LIQUID ASPHALTS				
70	253	6.03	7.90	332
250	249	5.93	8.03	337
800	245	5.83	8.16	343
3000	241	5.74	8.30	349
PAVING ASPHALTS				
40 - 50 pen.	235	5.60	8.51	357
60 - 70 pen.	235	5.60	8.51	357
85 - 100 pen.	235	5.60	8.51	357
120 - 150 pen.	237	5.64	8.44	355
200 - 300 pen.	239	5.70	8.36	353
EMULSIFIED ASPHALTS				
All Grades	240	5.71	8.33	350

The average number of gallons per ton for the various types and grades of asphalt, as well as additional useful information, is shown in Table IX.

While actual weights may vary slightly, weights of asphalts used on the Pacific Coast may be considered uniform for all ordinary purposes.

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displacement by wind or traffic. SC-70, MC-70, or a diluted SS type is recommended.

2. Prime Coat - A spray application of a low viscosity asphalt on an untreated base preparatory to construction of the asphalt pavement or surfacing.

   For tightly bonded bases in hot climates, MC-70 or SC-70 is recommended. In cooler climates where curing may be slow, RC-70 is suggested.

   For open bases in hot climates, MC-250 is recommended. In cooler climates where curing may be slow, RC-250 is suggested.

3. Tack Coat - A very light spray application of asphalt on an existing paved surface to promote bond between this surface and the subsequent course. For this purpose, a diluted SS type is recommended. A light application of RC-70 or undiluted RS-1 or RS-2K will also serve satisfactorily as a tack coat.

4. Fog Seal - A very light spray application of emulsified asphalt, without cover aggregate, to an existing pavement as a seal to inhibit ravelling or enrich the surface. For this purpose, the SS types, diluted with water, are recommended.

5. Sand Seal - A spray application of asphalt on an existing surface, followed by a cover of sand to function as a seal coat.

   For hot climates, either MC-800, RC-800, RS-1 or RS-2K is recommended.

   For cool climates, RC-250 or MC-250 is recommended, although RS-1 or RS-2K will be satisfactory with adequate drying conditions.

6. Chip Seal - A spray application of asphalt on an existing surface, followed by a cover of rock chips or screenings to function as a seal coat.

   The asphalt used for chip seals must be fluid enough to wet and adhere to the chips and yet develop sufficient strength to retain the chips under fast traffic. RS-1, RS-2, or RS-3K are recommended for hot climates and good drying conditions. RC-3000, RS-2K, or RS-3K is recommended for cooler climates.

   If proper construction practice is followed, MC-3000 or paving asphalt 120/150 penetration grade may be successfully used in hot climates.

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11. Plant-Mixed Cold Laid - With well-graded aggregate having 4% to 10% passing the No. 200 sieve, SC-800 or MC-800 should be used in hot climates. In cool climates, MC-800 is recommended.

    This type of mix is normally prepared in a central mixing plant with the aggregate heated to some degree (see Table VIII) to produce a well-mixed product for use in light traffic areas.

    Central mixing plant base stabilization without heat can be done with SM-K or SS-Kh.

12. Patching Mix - Mixes prepared for maintenance patching, usually in a central plant, and occasionally by road-mixing methods.

    For mixes that are to be used immediately in hot climates, MC-800 or MC-250 is recommended. If immediate use is anticipated in cool climates, SC-800 or MC-250 is recommended.

    For mixes that are to be stockpiled before use, SC-250 or MC-250 is recommended. For patching mixes to be prepared by road-mixing methods or stockpiled for long periods before use, SC-250 is recommended.

13. Asphalt Concrete - This material is mixed in a central plant using heated aggregates of high quality and a paving grade asphalt. The mix is produced under close control and provides the highest type of asphalt pavement for any use.

    a. Industrial Floors - For this use, 40-50 penetration grade is recommended with a good quality aggregate having rough surface texture.

    b. Parking Areas - For parking lots and driveways in hot climates, 40-50 or 60-70 penetration grade is recommended. In cooler climates, 60-70 or 85-100 penetration grade should be used.

    c. Highways - Good Quality, Rough-Textured Aggregate. With good quality aggregates and in hot climates, 60-70 or 85-100 penetration grade is recommended. With the same type of aggregate in cool climates, 85-100 or 120-150 penetration grade should be used.

       With borderline quality aggregate, the use of 60-70 or 85-100 penetration grade is recommended.

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d. Airports - Good Quality, Rough-Textured Aggregate. In airport paving, 60-70 penetration grade is recommended in hot climates. In cool climates, 60-70 or 85-100 penetration grade should be used.

e. Curbs - For asphalt concrete to be used for curb construction, 40-50 or 60-70 penetration grade is recommended.

f. Open-Graded Surface Course - For open-graded mixes used as wearing courses, 60-70 or 85-100 penetration grade is recommended.

TABLE II
RECOMMENDED USES OF ASPHALT

TYPE	PAVING ASPHALTS					LIQUID ASPHALTS												EMULSIFIED ASPHALTS								
						RC				MC				SC				ANIONIC				CATIONIC				
GRADE	40-50	60-70	85-100	120-150	200-300	70	250	800	3000	70	250	800	3000	70	250	800	3000	RS-1	RS-2	SS-1	SS-1h	RS-2K	RS-3K	SM-K	SS-K	SS-Kh
Dust Palliative										x				x						x[1]					x[1]	
Tack Coat						x												x		x[1]	x[1]	x			x	x
PRIME COAT																										
Tightly Bonded Surface						x				x				x												
Open Surface							x				x															
SEAL COATS AND SURFACE TREATMENTS																										
Fog Seal - light application without cover																					x[1]					x[1]
Sand Seal - light application with sand cover							x	x			x	x						x				x				
Chip Seal				x					x				x					x	x			x	x			
Slurry Seal																					x					x
Penetration Treatment											x				x											
PENETRATION MACADAM			x	x					x									x				x				
MIXED-IN-PLACE																										
Open-graded aggregate - low on No. 8 & No. 200							x	x				x														
Clean sand - 100% ± pass No. 4, 0-10% pass 200							x				x										x			x		x
Graded aggregate - up to 15% pass 200											x	x				x					x			x		x
Sandy soil - to 20% pass No. 200											x				x					x				x		
PLANT MIX, COLD LAID																										
Graded aggregate - 4% to 10% pass No. 200												x				x								x		x
PATCHING MIX																										
Immediate use											x	x				x										
Stockpile											x				x											
ASPHALT CONCRETE																										
Industrial floors	x																									
Parking areas	x	x	x																							
Highways, good quality, rough-textured aggregate		x	x	x																						
Highways, borderline quality aggregate		x	x																							
Airports, good quality, rough-textured aggregate		x	x																							
Curbs	x	x																								
Open-graded surface course - 3/8" max., 0-2% No. 200		x	x																							

(1) Diluted with water.

In northern areas where rate of curing is slower, a shift from MC to RC or from SC to MC may be desirable.

For very warm climates, a shift to next heavier grade may be warranted.

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Recommended Uses of Asphalt

The selection of the type and grade of asphalt for a particular use is influenced by several considerations. Some of the major factors to be considered are:

1. Type of construction, ranging from a dust palliative to an asphalt concrete pavement.

2. Conditions of usage after construction (type of loading, i.e., rolling or static; magnitude of loading, i.e., maximum gross loads and maximum unit loads; climatic conditions in the area of usage, i.e., hot, cold, wet)

3. Aggregates with which the asphalt will be used (gradation, soundness, absorptiveness, surface texture)

4. Method of construction and equipment available (mixing, spraying, central plant, mix in place, machine or hand-placing)

5. Climatic conditions during construction (temperature, humidity, wind).

In general, for cooler climates the softer, more fluid paving asphalts or the liquid asphalts having the more volatile solvents may be favored because of construction considerations. The reverse will frequently be true in hotter climates.

The viscosity of the asphalt that will be desirable after construction will be influenced by the gradation or the amount of fine particles in the aggregates used. This factor will also be influenced by the magnitude and type of loads that will be imposed and the climatic conditions under which the finished surface will be used. For example, aggregates deficient in fine particle sizes will require more viscous asphalts. The more viscous asphalts will also be desirable under high unit loads and in hot climates. The viscosity of the asphalt that can be properly handled during construction, however, will be determined by the method of construction and the equipment available.

Because of these factors and considerations, it is not uncommon and, in fact, is quite proper to use different types and grades of asphalt in different areas for the same type of work and for the same conditions of usage after construction.

Following is a brief discussion of the various types of construction with asphalt and the types and grades of asphalt recommended for use. The discussions should be used in conjunction with Table II "Recommended Uses of Asphalt."

1. Dust Palliative - A light application of asphalt to knit fine surface particles together to minimize their

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7. Slurry Seal - A slurry mixture of SS type emulsified asphalt, sand, and water applied to an existing surface and squeegeed into place to serve as a seal coat. Only slow-setting emulsions should be used.

8. Penetration Treatment - A surface treatment consisting of a spray application of liquid asphalt applied to an untreated granular roadway to form a light duty wearing course by penetrating the roadway material.

   The type and grade of asphalt should be selected to fit the climatic conditions and the gradations of the material in the roadway. For most conditions, SC-250 or MC-250 is recommended.

9. Penetration Macadam - This type of construction consists of placing a uniform layer of coarse, crushed aggregate to a thickness slightly greater than the maximum size of aggregate used, followed by a heavy spray application of asphalt. A second layer of stone of smaller maximum size and another spray application of asphalt follows.

   For most conditions, 85-100 or 120-150 penetration paving asphalt is recommended. RC-3000, RS-1, or RS-2K may also be used.

10. Mixed-in-Place - Mixed-in-place or road-mix asphalt construction may be used for surface or base courses. It utilizes operations and equipment that allows the asphalt to be incorporated with the aggregate on the roadbed.

    With an open-graded aggregate that is low in amounts passing the No. 8 and No. 200 sieves, MC-800 is recommended in hot climates. With the same aggregate in cool climates, RC-800 or RC-250 is recommended.

    With clean sand passing a No. 4 sieve but with small amounts passing the No. 200 sieve, RC-250, MC-250, SS-1h, SM-K, or SSKh are recommended in hot climates. With the same aggregate in cool climates, RC-250 or SM-K is recommended.

    With well-graded aggregate containing up to 15% passing the No. 200 sieve, SC-800, MC-800, SS-1h, SS-Kh, or SM-K are recommended in hot climates. With the same aggregate in cool climates, MC-250 is recommended.

    For stabilizing sandy soils having up to 20% passing the No. 200 sieve, SC-250, MC-250, SS-1, or SM-K should be used in hot climates with good drying conditions. With the same sandy soil, SC-250, MC-250, or SM-K should be used in cool climates.

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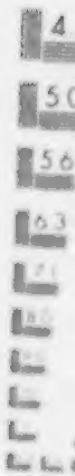

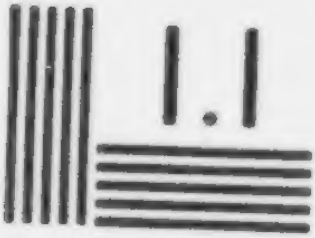

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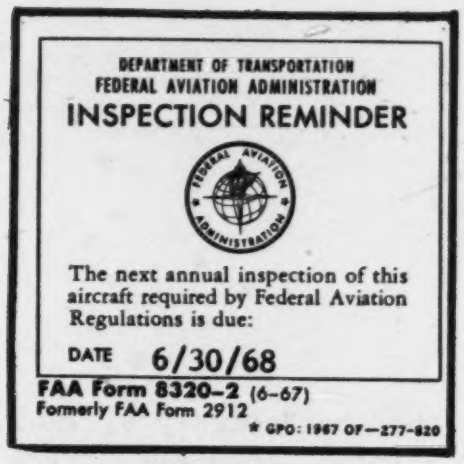
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
INSPECTION REMINDER

The next annual inspection of this aircraft required by Federal Aviation Regulations is due:

DATE 6/30/68

FAA Form 8320-2 (6-67)
Formerly FAA Form 2912
* GPO: 1967 OF—277-820

FIGURE 8.

AIs should issue FAA Form **8320-3 on completing annual** inspections. The form is issued regardless of airworthy or unairworthy findings. The date the next Annual Inspection is due will be the last day of the month, 12 months following the date of the inspection. AIs may receive a supply of these forms from the FAA field offices.

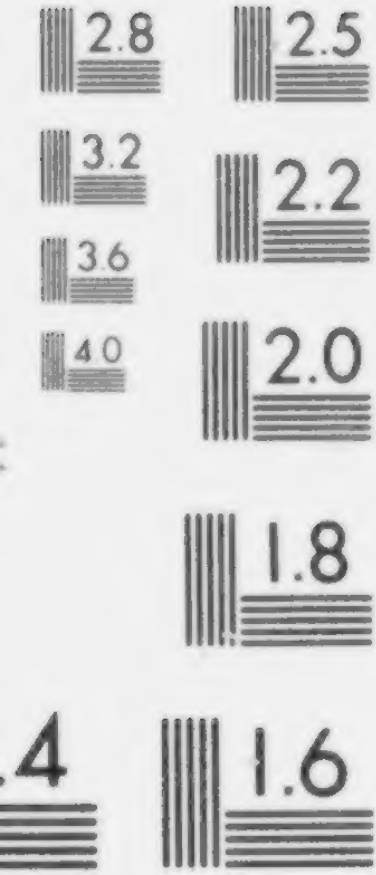

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V-B-3 Construction of Seal Coats

The surface upon which a seal coat is to be placed must be clean. This may be accomplished using paver brooms or other suitable equipment to remove dust and loose particles. If the seal coat is to be placed over a base it must first be primed, usually with RC or MC 70 and allowed to cure until all volatiles are evaporated. Wet spots (excess asphalt which has not penetrated) should be sanded to prevent pick up.

In any spray application of asphalt the temperature of the surface is critical. It is generally recommended that the surface temperature be above 80°F. to allow the asphalt to spread out and be fluid enough to wet the chips or penetrate the base in the case of a prime coat.

The asphalt used for seal coats must be capable of holding the chips in place after curing. There must also be enough to bury the chips to about 60% of their depth. The amount of asphalt to spray depends upon the gradation of the chips, the absorption of the surface on which the seal is to be placed and on the amount the chips may absorb.

Chips should be clean and slightly damp. They should be placed as soon as possible after the asphalt has been spread. The chips should be rolled with pneumatic or steel rollers, with pneumatic rollers being preferred. The rollers used for paving are generally suitable for rolling chips but should be unballasted; that is, heavy rollers are not necessary since the roller's function is to seal the chips in the asphalt.

For a more detailed discussion on surface treatments, the student is referred to the Asphalt Institute's Manual Series #13 "Asphalt Surface Treatments and Asphalt Penetration Macadam" available from any office of the Institute.

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UNIT V - PAVING

V-B-4 Road-Mix Surface Construction

Introduction

Mixed-in-place, or Road-mix, is an asphalt course produced by mixing aggregate and liquid asphalt at the roadsite by means of travel mixers, motor graders, or other road mixing equipment. The principal advantage of this type of construction is that it utilizes aggregate already on the site, or which is available from nearby sources. When using such materials, aggregate and asphalt can be mixed in place at low cost, with a minimum of equipment.

Road-mix may be used for surface, base, or subbase courses if the pavement structure is designed properly. As a surface course, it is suitable for medium and light traffic. For base or subbase, it is suitable for all types of traffic. It has special advantages for outlying areas; long stretches of farm, desert, or ranch roads; detours; and other locations where an economic problem exists in getting the necessary improved mileage. It is seldom used in urban and other heavy traffic areas.

Some significant factors in road-mix construction are:

1. Suitability for stage construction. By road-mix methods the pavement structure can (a) be designed and built to meet current traffic requirements, and (b) be increased to thicknesses dictated by subsequent traffic by the laying of additional courses.

2. Weather. To facilitate evaporation of moisture and volatiles from the mixture the weather should be hot and dry. Extra manipulation is required to remove volatiles in cool and humid conditions. Work should be suspended during wet weather.

3. Versatility. A number of types and grades of asphalt are available that will satisfy the varying requirements of different aggregate and weather conditions.

4. Economy. Road-mix is economical because of the high production rates possible with a comparatively low investment in equipment.

Consideration (4) applies especially to mixing with motor graders and rotary tine mixers. Travel mixers, other than the rotary tine type, fall in an intermediate category--both as to economics and quality or operation--between motor graders and central plant mixers.

Aggregate

A wide variety of aggregates and soil-aggregate combinations can be processed satisfactorily by mixed-in-place methods. Surface course

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3. The uniformity of the gradation of the material and volume of the windrow must be controlled.

4. The proper amount of asphalt must be determined and applied.

In performing this type of work, the mixing machine moves along the windrow adding asphalt as it goes. If the windrow is so large that all of the asphalt cannot be incorporated in one mixing pass, it should be split into two or more windrows and the asphalt added to each in one mixing pass. Further mixing of the windrowed material after the addition of the asphalt may be necessary. Unless the travel mixer can be used as a multiple pass mixer this additional mixing usually is done with a motor grader; this makes sure that all the windrowed material is incorporated into the mix, and it also aerates the mixture for the removal of moisture and volatiles. The number of passes with the motor grader required for this purpose varies with different job conditions. However, in general a minimum five or six passes are necessary. After the mixing and aeration procedure has been completed, the windrow should be moved to one side of the area to be surfaced in preparation for spreading.

A different type of travel plant operates by mixing asphalt and aggregate deposited directly into the plant's hopper by truck; it then spreads the mix in one pass. Except when using open graded mixtures, in this technique care must be taken to insure sufficient evaporation of moisture and volatiles from the spread mix prior to compaction.

The rotary type of travel plant combines the asphalt and aggregate under a hood by means of whirling tines or blades as the machine moves over the surface. Most of these machines are now equipped with a spray system which applies the asphalt while mixing. When using this rotary type of mixer the following steps are recommended:

1. Spread the aggregate to uniform grade and cross section with motor graders.

2. Thoroughly mix the aggregate by one or more passes of the mixer. When ready for the asphalt the moisture content of the aggregate should not exceed 3 per cent, unless laboratory tests indicate that a higher moixture content will not be harmful when the asphalt is added.

3. Add asphalt in increments of about 0.5 gallon per square yard until the total required amount of asphalt is applied and mixed-in. A total of 0.4 to 0.6 gallons per square yard per inch of compacted thickness of the course is usually necessary. If the mixer is not equipped with spray bars the asphalt may be applied with an asphalt distributor.

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4. Make one or more passes of the mixer between applications of asphalt, as necessary to thoroughly mix it in.

5. Maintain the surface true to grade and cross section by using a motor grader during the mixing operations.

6. Aerate the mixture by additional manipulation, if needed.

For blade mixing the material should be placed in the windrow either through a spreader box or by running through a windrow sizer prior to the addition of asphalt. The proper percentage of asphalt for the aggregate in the windrow must be determined, and the amount needed per lineal foot of windrow calculated. Non-uniformity of grading of the aggregate in the windrow will cause a fluctuation in the asphalt demand, and this should be avoided.

The asphalt is applied to the flattened windrow from a distributor truck. Best results are obtained by adding asphalt to aggregate in multiple applications and by folding the asphalt into the windrow immediately behind the distributor truck.

NOTE: Where a pavement surface is available it can be utilized as a mixing platform--the mix being windrowed on it and later moved to the place of use. This practice is most often followed in the preparation of maintenance mixtures.

As the mixing progresses close attention should be given to uniformity of the mix in the windrow--the mixing of the material in the windrow should continue until all aggregate particles are uniformly coated. During mixing, attention should be paid to the vertical and horizontal angles of the mold board of the grader; this board should be adjusted so that a complete rolling action of the material is obtained when the windrow is manipulated. Also, during mixing, care must be exercised in order that extra material is not taken from the mixing table and incorporated into the windrow. At the same time, none of the windrow should be lost over the edge of, or left on, the mixing table. After mixing and aeration are complete, the windrow should be moved to one side of the area to be surfaced in preparation for spreading.

NOTE: When skilled operators are not available, trouble is sometimes encountered in controlling the depth of mixing of a road mix made on the roadbed. An unskilled operator may pick up additional material and thus dilute the mix; or conversely, drop out some of the mix material and produce a layer which is too thin and over-asphalted.

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TABLE XII

TEMPERATURE—VOLUME CORRECTIONS FOR EMULSIFIED ASPHALTS

LEGEND: t = observed temperature in degrees Fahrenheit
m = multiplier for correcting volumes to the basis of 60°F

t	M	t	M	t	M
60	1.00000	90	.99250	121	.98475
61	.99975	91	.99225	122	.98450
62	.99950	92	.99200	123	.98425
63	.99925	93	.99175	124	.98400
64	.99900	94	.99150	125	.98375
65	.99875	95	.99125	126	.98350
66	.99850	96	.99100	127	.98325
67	.99825	97	.99075	128	.98300
68	.99800	98	.99050	129	.98275
69	.99775	99	.99025	130	.98250
70	.99750	100	.99000	131	.98225
71	.99725	101	.98975	132	.98200
72	.99700	102	.98950	133	.98175
73	.99675	103	.98925	134	.98150
74	.99650	104	.98900	135	.98125
75	.99625	105	.98875	136	.98100
76	.99600	106	.98850	137	.98075
77	.99575	107	.98825	138	.98050
78	.99550	108	.98800	139	.98025
79	.99525	109	.98775	140	.98000
80	.99500	110	.98750	141	.97975
81	.99475	111	.98725	142	.97950
82	.99450	112	.98700	143	.97925
83	.99425	113	.98675	144	.97900
84	.99400	114	.98650	145	.97875
85	.99375	115	.98625	146	.97850
86	.99350	116	.98600	147	.97825
87	.99325	117	.98575	148	.97800
88	.99300	118	.98550	149	.97775
89	.99275	119	.98525	150	.97750
		120	.98500		

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c. The travel plant mixer that takes the aggregate from windrows, mixes it with the asphalt and usually deposits the mixture in a windrow behind, ready for spreading and aerating by motor graders.

3. The water distributor that is used to dampen the aggregate.

4. The asphalt distributor that is used to apply the asphalt when the mixer is not equipped to do so.

5. Rollers, self-propelled steel-wheeled tandem and pneumatic-tired, used to compact mixes.

6. Asphalt tank trucks, dump trucks, power brooms, windrow sizers, and other auxiliary equipment.

Proportioning of Materials

The amount of asphalt for mixed-in-place can be determined by one of the following methods:

1. "Method of Testing Soil-Bituminous Mixtures," ASTM Designation D 915; "Methods of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus," ASTM Designation D 1560; "Method for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor," ASTM Designation D 1561; and the Centrifuge Kerosene Equivalent (CKE) Method.

2. Where the laboratory equipment required in the above methods is not available, one of the following formulas may be used:

FORMULA No. 1

Formula for Determination of Estimated Per Cent RC, MC, and SC Asphalt Requirement

$$p = 0.02a + 0.07b + 0.15c + 0.20d$$

Where p = Per cent* of asphalt material by weight of dry aggregate

a = Per cent* of mineral aggregate retained on No. 50 sieve

b = Per cent* of mineral aggregate passing No. 50 and retained on No. 100 sieve

c = Per cent* of mineral aggregate passing No. 100 and retained on No. 200 sieve

d = Per cent* of mineral aggregate passing the No. 200 sieve.

Absorptive aggregates--such as slag, limerock, vesicular lava and coral--will require additional asphalt.

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FORMULA No. 2

Formula for Determination of Estimated Per Cent Asphalt Emulsion Requirement

$$P = 0.05A + 0.1B + 0.5C$$

Where P = Per cent* by weight asphalt emulsion, based on weight of graded mineral aggregate

A = Per cent* of mineral aggregate retained on No. 8 sieve

B = Per cent* of mineral aggregate passing No. 8 sieve, retained on No. 200 sieve

C = Per cent* of mineral aggregate passing No. 200 sieve.

* Expressed as a whole number.

Construction

Prior to road-mixing operations, the roadbed on which the mixed material is to be placed must be shaped and compacted. A prime coat should be applied and allowed to cure. Where the prime coat does not penetrate, the excess asphalt should be blotted with sand.

A check should be made of all drainage facilities. Any that are not functioning properly should be corrected before road-mixing operations begin.

In several types of road-mix construction it is necessary to place the aggregate into windrows. Windrow sizers should be used to insure the placing of the correct volume for the desired depth of pavement.

Usually, loose material on the road surface is in too small quantity and is not uniform enough for worthwhile use in the road mix. In such a case it is more economical to blade the loose material on to the shoulders rather than perform the several operations necessary to blend it with the imported material.

However, if it is practical to use material from the road surface in the mixture, it should first be bladed into a windrow and measured. This material should then be made to conform to grading specifications by the addition of other aggregate, if necessary. Finally, imported material meeting the specifications should be added to the windrow to provide the required volume. If two or more materials are to be combined on the area to be surfaced, each should be placed in its own windrow. These windrows should then be mixed together thoroughly before the asphalt is added.

A method of determining the quantity of material in a windrow is illustrated in Figure 1.

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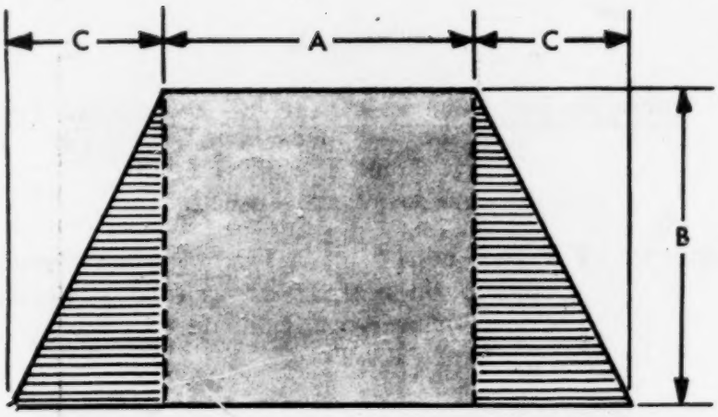

To calculate the quantity of aggregate in cubic feet per lineal foot of windrow:

Take measurements "A," "B," and "C."*

Then, ("A" × "B" × 1 ft.) + ("C" × "B" × 1 ft.) = cubic feet of windrowed aggregate per lineal foot.

* Note: If measurement "C" is not the same on both sides of windrow, use the average measurement.

Figure 1 - Volume of Windrows

Asphalt is added to the aggregate from an asphalt distributor or from a travel mixer. Whichever method is used, close control of the quantity and viscosity of asphalt applied is necessary to insure a proper mixture. Proper viscosity is essential, for the asphalt must be fluid enough to flow easily through the spray nozzles and to adequately coat the aggregate particles. Liquid asphalts, although already fluid, need some heating to bring them to the proper viscosity for spraying. But, unless mixing begins immediately after the asphalt is sprayed, the viscosity will quickly rise above that recommended for mixing. The volatiles in liquid asphalts keep them fluid long enough for completion of road mixing if it is done promptly. Mixing will take place at the temperature of the aggregate, but aggregate temperatures below 50° F. or above the temperature of the liquid asphalt should not be permitted. Figure 2 and Table 1 can be used to determine the range of temperatures for the proper spraying and mixing viscosities of liquid asphalts.

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TABLE 1

MIXING AND SPRAYING TEMPERATURES FOR VARIOUS GRADES OF ASPHALT EMULSIONS*

Type and Grade	Suggested Temperature	
	For Mixing**	For Spraying#
Anionic		
SS-1	75-130°F	75-130°F
SS-1h	75-130°F	75-130°F
Cationic		
SM-K	100-160°F	100-160°F
SS-K	75-130°F	75-130°F
SS-Kh	75-130°F	75-130°F

* Since the working temperature range for emulsions is comparatively low and is based only on that temperature necessary to provide a viscosity at which they can be dispersed through spray nozzles, the same temperature is specified for spraying and mixing. Mixing will take place at the temperature of the aggregate, but aggregate temperatures below 50°F. or above the temperature of the liquid asphalt should not be permitted.

** Temperatures based on 75-150 seconds Saybolt Furol viscosity.

Temperatures based on 25-100 seconds Saybolt Furol viscosity.

(3) There is no stigma attached to the aircraft because it was reported as "unairworthy." In effect, the report says the aircraft is airworthy with the exception of the items on the discrepancy list. When those listed items are corrected, the aircraft is eligible to be operated.

j. Incomplete Inspection. In the event the annual inspection is not entirely completed, the AI:

(1) Should indicate in the aircraft records any discrepancies he has found.

(2) Should NOT indicate that an annual inspection was conducted.

(3) Will not forward the inspection report FAA Form 8320-2.

8. MAINTENANCE RECORDS. The AI and other maintenance personnel or agencies are required to record maintenance, inspections, or alterations that they perform or approve in accordance with the requirements of FAR 43.9 and 43.11. FAR 91.173 requires the owner/operator to keep maintenance records and to present them each time an inspection, repair, or alteration is performed. He is also required to indicate the time in service when the work is done. See Figures 9 and 10 for typical entries used by AIs.

a. Significance of Maintenance Record Entries. Responsibility for maintenance performed rests with the person who enters his name on the appropriate maintenance records and/or forms. The responsibility for annual and progressive inspections and for approval and return to service of major repairs or alterations is assumed by the AI whose signature appears on the appropriate maintenance records.

b. Completion of FAA Form 337 by AIs. See Figure 11. The FAA Form 337 serves two purposes; one is to provide owners/operators with a record of major repairs and alterations indicating details and approval, and the other is to provide the FAA with a copy for the records. The FAA copy of FAA Form 337 is retained by the Agency's Data Services Division, AC-300, P.O. Box 25082, Oklahoma City, Oklahoma 73125. Copies of these forms may be obtained for established fees.

(1) The person who performed or supervised the repair or alteration prepares the original FAA Form 337 (two copies). The AI then further processes the forms when they are presented to him for approval.

(2) The official instructions for the completion of the form appear in AC 43.9-1B, or subsequent revisions.

c. Disposition of FAA Form 337.

(1) After the AI has found the alteration or repair to be in accordance with FAA-approved data, reviewed the FAA Form 337 for completeness, and completed item 7, he:

SITS 2111

construction normally requires higher quality aggregates than do base and subbase construction.

Commercially crushed stone, slag, and gravel are widely available for mixing-in-place. There are also many localities where it is economical to crush aggregate from road cuts, pits, or nearby quarry sites. Crusher run material with from 0 to 10 per cent passing a U. S. Standard No. 200 sieve, up to a maximum size of two inches, or two-thirds of the course thickness, whichever is smaller, usually proves excellent for mixed-in-place bases. Generally, the entire output of the crusher that is below the specified maximum size may be used in the asphalt pavement structure. This affords maximum economy.

Suitable local materials range all the way from granular soils with up to 25 per cent passing a No. 200 sieve, liquid limit up to 30 and P.I. up to 6, through the range of clean sands and gravels. Higher limits, proved by experience, can be used for some aggregates. With these finer gradations, however, mixing, aeration and compaction problems may be encountered. On many projects, by careful selection, suitable materials for road-mix courses may be obtained from excavation or borrow. On other sites, materials may be available within or adjacent to the right-of-way either as they are in the pits, by blending different strata or areas of the pits, or by blending with other materials at the pit or on the road. Well-graded aggregates are always desirable for any course of the asphalt pavement structure, but many poorly graded and gap-graded aggregates have proven adequate for base course road mixes when combined with the proper asphalt in accordance with good construction procedures.

The suitability of road-mix materials can be determined by the various tests now utilized by state highway departments and other road-building agencies.

Asphalt

The types and grades of asphalt for use in road-mix construction are determined by the characteristics of the aggregate, type of road mixing equipment to be used, and climatic conditions. Generally, types and grades of asphalt used are as follows:

1. Open-graded aggregate

   a. Rapid and medium curing liquid asphalts RC-250, RC-800 and MC-800.

2. Well-graded aggregate with little or no fine aggregate and material passing the 200 sieve

   a. Rapid and medium-curing liquid asphalts RC-250, RC-800, MC-250 and MC-800.

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b. Slow-curing liquid asphalt SC-800.

c. Slow-setting asphalt emulsions, SM-K, SS-1, SS-1h, SS-K and SS-Kh.

3. Aggregate containing a considerable percentage of fine aggregate and material passing the 200 sieve

a. Medium-curing liquid asphalt, MC-250.

b. Slow-curing liquid asphalts, SC-250 and SC-800.

c. Slow-setting asphalt emulsions, SS-1 and SS-K.

Asphalt emulsions are often used with damp aggregate. Very dry aggregate with considerable fines may require dampening with water before emulsions are applied.

Equipment for Mixed-in-Place Construction

Equipment for road-mix constructions falls into the following principal categories:

1. Motor graders.

2. Three types of travel mixers that employ rotary tines or blades: (a) the pulverizer type that mixes in place and (b) and (c) types that are intermediate between the pulverizer type and the stationary asphalt plant--see below for details. The latter two contain many of the parts found in the usual asphalt plant with the exception of dryer and screens.

a. The rotary pulverizer-type mixer with transverse shafts that mix the asphalt and aggregate with revolving tines under a hood. Most makes have only one rotor but some have up to four rotors, all under a long hood. Many are now equipped with a spray system which applies the asphalt, and water if needed, while mixing.

b. The travel plant mixer that receives the aggregate into a hopper from trucks, mixes it with asphalt, and spreads the mixture--all in one pass of the machine.

21356

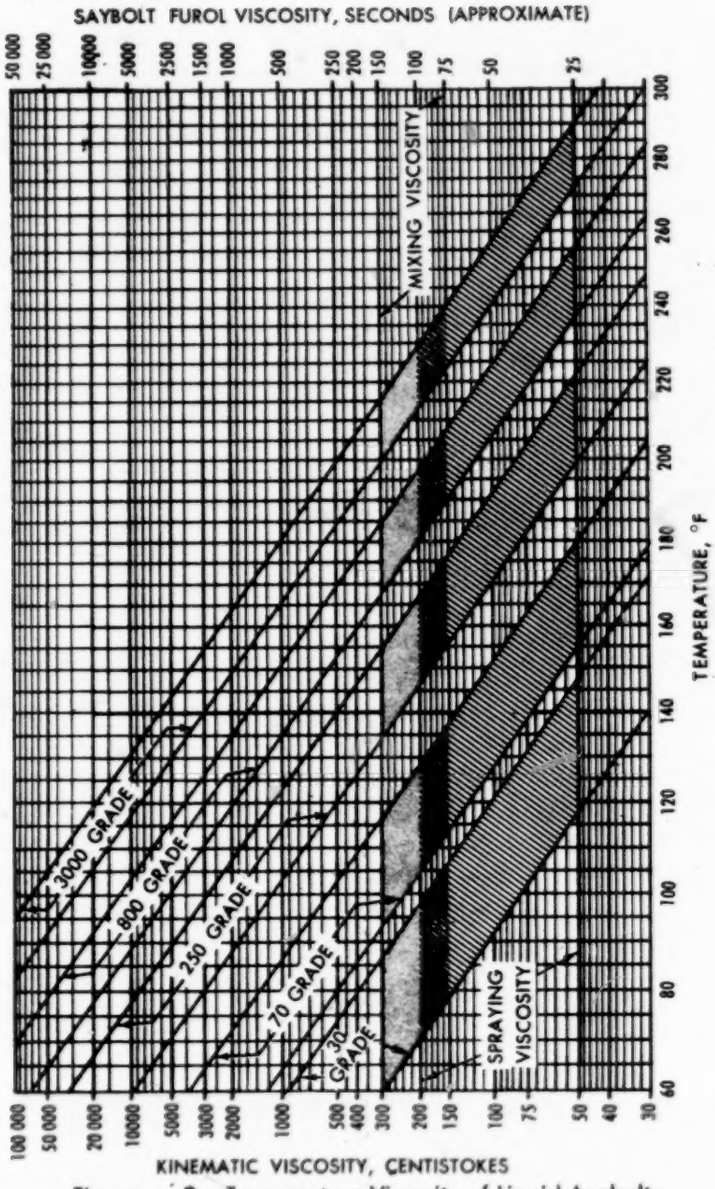

Figure -2—Temperature-Viscosity of Liquid Asphalts

Kinematic viscosity, centistokes = $\frac{\text{Absolute viscosity, centipoises}}{\text{density}}$

Saybolt Furol viscosity $\simeq$ 0.5 centistokes viscosity

An advantage of travel-plant mixing is that closer control of the mixing operations can be achieved. The proportioning of the asphalt with the material, as well as the uniformity with which the two can be incorporated, are of the greatest importance. However, in order to achieve a uniform product it is necessary that several precautions be taken:

1. The road-mixing machine must be in satisfactory operating condition.

2. A windrow of prepared material must be established.

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resistant and light-reflecting properties. If a burlap drag is used, it should be at least 3 ft. wide and long enough to cover the entire lane width. The burlap is pulled forward in such a manner that at least 1 ft. of the burlap is in contact with the pavement surface. If the burlap is kept wet and free from hardened mortar a sandpaper-like texture will result-an attractive texture that is highly skid-resistant. Either type of surface finish must be produced after the water sheen has disappeared from the surface and before the concrete has hardened too much to permit good finishing.

JOINTS

LONGITUDINAL JOINTS

Longitudinal construction joints of the tongue-and-groove type must be provided between construction lanes. The joints are formed in the slab edge by attaching to the side forms a metal or wooden keyway form of the desired shape and dimensions. If wooden keyway forms are used they must be maintained in good condition and well oiled before each use.

Generally, in order to control cracking, lane widths should not exceed 12 feet, and in thin slabs, 10 feet or less may be desireable.

CONTRACTION JOINTS

Transverse contraction joints in the slab will generally be spaced at relatively short intervals. Contraction joints may be one of three different types: sawed, formed dummy grooves or premolded strips. The depth of all joints regardless of type must be at least one-fourth of the slab thickness in order to properly control cracking.

Sawed joints are made by sawing a groove in the hardened concrete with a concrete saw after the concrete has gained sufficient strength to prevent ravelling of the joint during sawing. Sawing must be completed as soon as possible after paving, usually within the first 24 hours and often the same day the concrete is placed. If sawing is delayed too long, cracks may develop in the slab because of shrinkage of the concrete. If a diamond saw blade is used, it must be cooled with water to facilitate sawing. An abrasive blade

may be used wet or dry.

A contraction joint of the surface-groove type is formed in the plastic concrete by impressing a T-shaped bar into the surface, either by means of plow handles attached to each end of the bar or by a special joint-cutting machine that rides on the side forms. A metal or wooden templet of desired dimensions is then placed in the groove to prevent slumping of the concrete before some degree of stiffness is obtained. This templet must be removed from the joint before the concrete has completely hardened and the joint must be edged to remove sharp corners that might break off under traffic. The templet must be cleaned and oiled after each use to facilitate removal.

The third type of joint is a premolded bituminous strip embedded in the slab flush with the surface. The strip, which is inserted in a groove formed in the plastic concrete, must be vertical and continuous from slab edge to slab edge and through integral curbs. The joint must be edged in curb sections to prevent spalling of adjacent concrete. Care must be taken that the strips are not bent or tipped out of vertical by final surface finishing operations.

Contraction joints-sawed, surface groove, or premolded strips-are intended to reduce the slab cross-section at given points so that contraction stresses in the concrete will result in cracking at the joint instead of elsewhere in the slab. Joints must be formed with care or spalling will develop at these locations.

The contraction joint must be carried through adjacent curb sections. It should be sawed, formed and edged to match the joint in the pavement.

Transverse joints generally should not exceed 15 feet.

EXPANSION JOINTS

Expansion joints are sometimes provided at intersections and other special locations to reduce compressive stresses that may develop because of expansion of the concrete. Expansion joints usually consist of a filler of nonextruding bituminously treated fiber or a wooden board. Wooden boards must be free of knots. These fillers must be continuous from slab edge to slab edge and through curbs or curb and gutter sections, and they must be vertical through the full depth of concrete if they are to function properly as expansion joints. Any plug or sliver of concrete that extends over, under, through, around or between sections of the joint filler will cause spalling of the concrete. Usually fillers are held in place by stakes

in the sub-grade that are removed after the concrete is placed but before final finishing. The fillers are installed with the top about 3/4 in. to 1 in. below the surface and a groove is cut in the concrete immediately above the filer for sealing. It is of great importance that the groove is the same width as the filler and that no concrete overhangs the filler on either side.

CURBS AND
CURB AND GUTTER

The construction of curbs and of curb and gutter is covered in detail in the publication, Concrete Curbs and Gutters.* If integral curb is specified, the concrete for it should be left against a high outside form during screeding of the surface or brought from the mixer and deposited immediately after screeding so that bond to the slab will be ensured. If a rolled curb is called for, it can usually be built without any face form, the curb being shaped by use of a specially shaped mule or by the use of a straightedge and templets. If a straight-faced curb is specified, a special form will have to be attached to the outside form to permit construction. Curbs of this type require vibration in order to prevent honeycombing and ensure a dense curb face. Two-course construction should not be necessary to obtain good-looking concrete curbs if the concrete is vibrated or spaded in the curb forms. In integral curb pavement the transverse joints must extend entirely through the curb at the same location as the joints in the pavement. If a separate curb and gutter is used there should be joints in the curb and gutter opposite the joints in the slab, even though there may be intermediate joints in the curb and gutter.

The drainage of the gutter, whether integral curb or separate curb and gutter, should be checked while the concrete is still plastic by pouring water at the high point of the grade and observing its flow to the nearest catch basin. The concrete surface will not be damaged if the water is poured from a bucket onto a piece of burlap or curing paper. Such a check at this time will allow correction of any high or low spots detected by this test. This will eliminate "bird baths" or puddles in the gutter line of the pavement.

CURING

All concrete must be cured in order to ensure proper

* See Appendix A.

STRUCTURAL SERIES #2

CONCRETE PAVING

V-C-1 STREETS, PARKING AREAS, WALKS AND OTHER FLATWORK

The rules for obtaining and constructing quality concrete work outlined in Structural Series #1 also apply to paving work.

Probably the major distinguishing feature of paving as opposed to floors and similar types of flatwork is the method of finishing. Generally, paving serves to support people and vehicles out-of-doors. For good skid resistance in all types of weather, a rougher surface texture is required than for inside floors. Therefore, except for special conditions, steel-troweling is not required. The finishing process consists of striking off, floating at the proper time and texturing. These sequences can usually be accomplished in a shorter time than when troweling is necessary. For some special finishes, steel-troweling may be desired.

The following general description of construction procedures will apply to most outside flatwork.

SPECIFICATIONS

The materials and construction methods used must comply with all requirements of the specifications, and the pavement must be built according to the plans. Inspectors and contractors' representatives must be familiar with the plans and specifications. They must be alert and attentive throughout all construction operations to see that all pavement is built to meet the specification requirements in every detail.

SUBGRADE PREPARATION

The subgrade for concrete pavement should be uniformly compacted so that no soft spots are present. To obtain such results the subgrade soil should be compacted at or slightly above the optimum moisture content. In the absence of standard testing, a reasonable evaluation of moisture content may be made by squeezing a ball

of damp soil in the hand. If the ball is so dry that it crumbles easily, additional water should be added. If it is so wet that free water comes to the surface when kneaded, the subgrade should be permitted to dry before final rolling. If there is free water standing on the subgrade in puddles, the subgrade must be permitted to dry before placing concrete.

The subgrade can be compacted with a flat steel-wheel roller of adequate weight or with a rubber-tire wobbly-wheel roller. Special care must be taken in the compaction of backfill of sewers and around manholes and other permanent structures in the paved area. This can be done best by use of some type of vibratory compacter that is small enough to operate within the limited area.

If the plans call for a layer of granular subbase under the pavement, the material used should comply with specifications and should be uniformly spread and compacted to the specified thickness and density.

Both subgrade and subbase should be checked before paving to see that there are no puddles,soft spots or frozen soil. Any such areas should be corrected and, if necessary, the subgrade should be removed and replaced with suitable material before concrete is placed.

FORMS

Either wood or steel forms may be used. Forms that are bent, have battered top surfaces of defective fasterners, or are otherwise defective should be removed from the job and not be returned until careful inspection shows them to have been adequately repaired.

Forms should be carefully set to the required line and grade to ensure both a smooth-riding surface and proper drainage of surface water. They should be placed on firm, properly compacted subgrade, not on loose, unconsolidated material. All forms must be firmly staked to prevent movement during paving operations. This will require at least three form pins for each 10-ft. length of form. The distance between the side forms should be checked to see that the specified width of paving lane is provided. All forms should be oiled before placing concrete and cleaned after each use.

Forms must remain in place at least 12 hours after

the concrete has been placed. Great care should be exercised in removal of the forms to prevent damage to the concrete. Bars or heavy tools should not be used to pry against concrete during form removal.

FINE GRADING

After the forms have been set and staked, the subgrade between the forms should be graded with a suitable planer. This may be a motor patrol grader or a planer of some type that rides on the side forms. It should be set to cut the subgrade to the desired cross-section. After this final grading any loose material should be recompacted by rolling or tamping and the eveva-tion of the subgrade should be checked with a scratch templet. This is a series of spikes that projects down to the correct subgrade level from a bridge spanning the space between the forms. The templet should be checked often to avoid error from sagging and warping.

Just before paving, the subgrade should be uniformly dampened to prevent it from absorbing water from the concrete mix. On projects where concrete is placed from ready-mix trucks, sprinkling can be done with a hose from the water tank on the truck.

PAVING WITH QUALITY CONCRETE

PROPORTIONING AND TESTING

The concrete should be proportioned at a batch plant equipped with properly calibrated scales to ensure that all batches contain required cement content and specified weight of fine and coarse aggregate. Frequent checks should also be made of the water meter on the paver or ready-mix trucks to ensure that the water content does not exceed the amount specified. The concrete mix should be such that the slump as measured in a standard slump cone does not exceed 4 in. for hand-finishing methods or about 2 in. for machine-finished concrete. A Kelly ball may be used instead of a slump cone, in which case it should be correlated with the slump cone for any given concrete mix to ensure proper consistency.

On all projects where snow, ice and freezing temperatures will be encountered, it is essential to use air-entrained concrete

for maximum durability. It is frequently used in other areas of the country because of the improvement in workability. When air-entrained concrete is used occasional checks of the plastic concrete should be made to ensure that the required amount of air (3 to 7 per cent is usually specified, but special conditions may require a higher air content) is present in each batch. For field inspections the pocket air indicator provides an easy method of determining the approximate air content. If the air content is not within the specified range, corrections should be made in the mix design to obtain the right amount of air. Dispensers for air-entraining agents must be inspected frequently to make sure that they are functioning property and dispensing the agent in the right proportion.

TRANSPORTING AND MIXING

Ready-mix trucks should be inspected before use to be sure that mixing time and speed comply with specifications. All concrete mixers should be checked to see that blade wear is not excessive and that mixing is uniform from batch to batch.

The importance of maintaining uniform consistency of the concrete from batch to batch cannot be overemphasized. Without uniformity good pavement quality, drainage and riding qualities cannot be attained.

PLACING

The concrete should be spread on the sub-grade by the paver or from a ready-mix truck as uniformly as possible to minimize the amount of additional spreading necessary. When concrete is being discharged from a ready-mix truck, it is important to have the discharge gate from the mixer wide open to prevent scalping of the large aggregate. Concrete may be spread with a mechanical spreader, shovels or a strike-off screed that rides on the side forms.

The process of spreading must also be accompanied by consolidation. Good dense concrete cannot be obtained by simply striking off level with the forms. Consolidation during spreading will ensure watertightness, high strength and durability. Uniform consolidation will also improve riding qualities.

Some special compaction is necessary along the side forms to prevent honeycombing and ensure good construction joints. This may be accomplished by the use of a vibrator along the forms or by hand-tamping with a shovel or special puddling tool. Such special

consolidation is also necessary at expansion joints or construction headers. Overvibration is to be avoided, especially of concrete having the higher slumps permitted with hand finishing.

FINISHING

Where mechanical finishing is used it is usually done with a two-screed finishing machine and, on the larger projects, with a mechanical longitudinal float. Before paving is begun these machines must be adjusted and checked as outlined in the manufacturer's instructions to ensure satisfactory operation in the consolidation, finishing and floating of the concrete. If mechanical finishing machines are not used, the concrete is usually struck off with a wooden screed in a sawing movement across the forms or with a vibrating screed that is pulled forward to strike off and consolidate the concrete. A vibrating screed pulled over the surface by two men can produce the desired results. In any case, a roll or head of concrete should be maintained ahead of the screed to ensure consolidation.

Following the screeding operation, use of a longitudinal float is necessary to remove surface irregularities and work up an adequate amount of mortor for proper finishing. If a mechanical longitudinal float is not used a manually operated wooden "bull" float is satisfactory. It should be operated with a longitudinal sawing motion while it is moved transversely across the slab by two operators standing on bridges that span the pavement. It is moved forward one-half its length after each transverse crossing of the slab.

Behind the longitudinal float the surface is given a final floating, if necessary, with long-handled floats approximately 4 ft. long and 8 in. wide. Following this operation the surface should be checked with a long handled 10-ft. straightedge to ensure a smooth-riding surface. The straightedge may be used with a scraping motion to remove any bumps and excess mortar from the surface, or it may be used to check evenness of the surface by placing it on the concrete at about 2-ft. intervals across the lane width. It should be advanced 5 ft. or one-half the length of the straightedge for successive checks.

After the surface has been floated and checked with the straightedge the concrete should be edged along the form and a final surface texture applied with either a broom or a burlap drag. The broom is used in a transverse direction across the lane to form uniform transverse ridges that will produce a surface with good skid-

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In graded granular aggregate mixtures the moisture and volatile contents are usually not highly critical. However, for maximum compaction, fine grained aggregate mixtures should be aerated to the required moisture and volatile content. Proper aeration is reached when the volatile content is reduced to about 50 per cent of that contained in the original asphalt and the moisture content does not exceed two per cent by weight of the total mixture (two to five per cent for emulsified asphalt mixtures).

When fine-grained materials are used as a base course that will be surfaced within 30 days, the volatile content of the asphalt should be reduced by aeration to approximately one-third of the original amount.

These values should be determined in accordance with the "Standard Method for Determination of Moisture or Volatile Distillates in Bituminous Mixtures," AASHO Designation T 110. Experience with the particular mixture being used and trial rolling are of value in determining the proper moisture and volatile contents when test data are not available.

Open-graded mixtures may be spread to the required depth and compacted with steel-wheeled tandem rollers and pneumatic-tired rollers immediately after mixing. The voids in the compacted open-graded mixture will allow the volatiles to evaporate in a reasonable length of time.

Well-graded and fine-grained mixtures are usually aerated before spreading. They are then placed in one or more windrows at the sides of the area to be paved. Motor graders are used to move material from the windrows, which is then spread in layers not exceeding four inches in depth. Compaction is done with pneumatic-tired rollers.

After one course is thoroughly compacted and cured, other courses may be placed on it. This operation should be repeated as many times as necessary to bring the road to proper crown and grade. For a smooth riding surface the motor grader should be used to trim and level as the rollers complete compaction of the upper layer. Any loose material that will not compact should be wasted over the sides.

Good weather is important to the success of a road-mix job. Road mixing operations should be scheduled for a time of year when weather conditions are likely to be hot and dry during, and for some weeks after, the work.

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January 18, 1967. Total aircraft time 853.00 hours, Tach reading 420.80. Replaced right main wheel bearing, P/N 19844, upper bushing in R & L landing gear frames, both brake hoses, P/N 34052, and bled brakes. I certify that this aircraft has been inspected in accordance with an annual inspection and was determined to be in airworthy condition.

George B. Jones
George B. Jones IA 272182

FIGURE 9.

Sample logbook entry for a typical annual inspection when the aircraft is found to be "airworthy." Note that the date, aircraft total time, and Tach or recorder reading are included. The tach or recorder reading should not be confused with the total time and should only be shown IN ADDITION to the total time entry. The mechanic has indicated he holds an Inspection Authorization by prefixing his certificate number with the letters "IA."

January 18, 1967. Total time 853.00 hours, Tach reading 420.80. I certify that this aircraft has been inspected in accordance with an annual inspection and a list of discrepancies and unairworthy items dated (insert date) has been provided for the aircraft owner or lessee.

George B. Jones
George B. Jones IA 272182

FIGURE 10.

Required entry for Annual Inspection when aircraft is found to be "unairworthy." Note that the date, total time, and tach reading are included.

HELPFUL HINTS

1. **Do not buck nature—stop operations when working under adverse weather conditions.**
2. **Keep the mixture or aggregate in a well-peaked windrow for better water shedding and control.**
3. **Provide drainage cuts through the windrow during heavy rains.**
4. **When a motor grader comes to the end of a section with a full blade, lift it rapidly to avoid carrying materials into the next section.**
5. **The distributor spray must be cut sharply at sectional joints; carry-over to the next section will cause undesirable fat joints.**
6. **Plan the work to avoid inconvenience to traffic.**
7. **Apply the asphalt at the recommended spraying viscosity to insure uniform application.**
8. **A shoe on the outer end of the motor grader blade or mold board helps obtain a good edge during spreading operations.**
9. **Aggregate in shaded areas usually requires extra aeration.**

UNIT V - PAVING

V-B-5 Constructing Asphalt Concrete Surfaces

This portion of Unit V - Paving is presented by using a text for the complete subject. The text is The Asphalt Institute's Manual Series No. 8 (MS-8) "Asphalt Paving Manual" available at any Institute office. This manual has been prepared for use by construction inspectors and others involved in asphalt paving.

The following is an outline of the text with supplementary notes to aid the instructor and students. It is suggested that at least two hours of classroom time be devoted to it and more if time is available:

Chapter I - Introduction

Chapter II - The Engineer and the Contractor

This chapter deals with pre-job planning. It discusses administrative matters, operations, equipment, procedures and timing of certain operations.

Chapter III - Preparation of Foundation for Asphalt Pavements

This chapter covers detailed procedures for preparing the underlying foundation for a surface. It includes compaction of granular bases, priming, preparation of old pavements, both flexible and rigid, cleaning old surfaces, etc. Some of the material duplicates that presented earlier.

Chapter IV - Inspection and Adjustment of Equipment

This is a rather thorough discussion of asphalt distributors, motor graders, windrow sizers, paving machines, rollers, hauling equipment and incidental tools from the inspector's standpoint.

Chapter V - Spreading

This chapter deals with mix inspection, spreading with motor graders, placing leveling wedges, paver spreading, automatic screed controls, hand spreading, joints and checking of the daily spread.

Chapter VI - Compaction

Rollers and their operation, sequence of rollers, rolling joints and compacting areas inaccessible to a roller are discussed.

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UNIT V - PAVING

Chapter VII - Shoulders

This chapter contains a short discussion on techniques of shoulder work.

Chapter VIII - Supplemental Work

Dike, curb, gutter, ditch and slope paving techniques are presented.

Chapter IX - Other Duties of the Inspector

Record keeping and house cleaning is discussed in this chapter.

strength gain and durability of the concrete. Curing prevents rapid loss of water from the mix and thus permits full hydration of the cement. It also helps maintain a relatively uniform temperature in the slab, preventing excessive volume changes that can cause cracking of the slab at an early age before the concrete gains adequate strength. If a wet-curing method such as the use of burlap, cotton mats or straw is specified, the curing medium must be kept wet for the entire curing period to ensure proper curing. If water-proofed paper or plastic film is used, it must cover the entire surface and edges of the slab and be free from rips, tears or holes that would permit moisture loss. If water-proofed curing membranes are used, they must be applied at the rate specified to ensure adequate coverage and they must be applied to the entire surface and pavement edge if they are to perform their intended function. White-pigmented membranes are preferred to clear membranes because they minimize temperature changes in the concrete and reduce early cracking. They must be well agitated before use to prevent settlement and to ensure uniform distribution of the pigment over the entire surface.

Regardless of the method used, curing must be applied early enough to prevent excessive moisture loss which could result in development of plastic shrinkage cracks. Usually curing can be applied as soon as the water sheen has left the surface and the final surface texture obtained with a broom or burlap drag. The curing medium should be left in place and properly maintained for the entire period called for in the specifications.

During periods of cold weather, paving operations must include special provisions to prevent freezing of subgrade or concrete. If freezing temperatures are expected, curing methods must provide for necessary slab protection.

OPENING TO TRAFFIC

The entire pavement area should be closed to all traffic during the period called for in the specifications, usually until about seven days after placement of the concrete unless a high-early-strength concrete is used. This traffic restriction applies to the contractor's construction equipment and vehicles as well as general traffic. Early traffic before the slab has gained adequate strength to support the loads can cause cracking of the new slab. Concrete pavers should never be allowed to operate on a completed slab.

Early and thorough cleanup of the job is an important responsibility of the contractor. As soon as curing and sealing are completed the slab should be cleaned of all debris and construction equipment. This will remove an objectionable eyesore to adjacent property owners.

SUMMARY

Failure to carry out specifications and follow good construction practices will result in a pavement that is unattractive, rough riding and lacking in strength and durability, a pavement that will not give the state, city, or adjacent property owner the return for his money which he has a right to expect. If all the operations outlined in this booklet are property carried out the resulting pavement will be attractive, smooth riding and durable.

APPENDIX B provides information on recommended practices of the construction of walks, driveways, floors and steps. APPENDIX C describes several methods of achieving interesting surface finishes. APPENDIX D is a slide talk covering simple low-cost methods and equipment for use in concrete street paving.

UNIT V - PAVING

APPENDIX A

CONCRETE CURBS AND GUTTERS

CONCRETE has become the standard material for curbs and gutters. Concrete combines good appearance with ample strength and reasonable cost. It permits the use of combined curb and gutter sections as well as various shapes and sizes of gutters and separate or integral curbs.

There are many types of curb and gutter construction, but the ones usually designed and built may be grouped into five general classifications:

1. Integral curb
2. Combined curb and gutter
3. Separate curb
4. Separate gutter
5. Lip curb

Curb Design

Certain principles of curb design are independent of the type of curb used. The height of the curb above the pavement, or curb exposure, depends on the established grades and on the quantity of water to be carried in the gutter. Usually, curbs should not be lower than about 4 in. and should not be high enough to damage fenders and bodies of cars parking on the adjoining pavement. If a height greater than 8 in. is necessary, some form of step curb should be used.

As a safety measure, curb radii should be sufficient to permit cars to enter or leave the street when making a right turn without interfering with traffic in other lanes. A radius of approximately 20 ft. will accomplish this. Smaller radii may be necessary at alleys or private drives, but they should approach this limit.

A curb with a sloping face and a well-rounded top edge is unlikely to damage tires. It encourages drivers to park close to the curb, adding to the effective width of the street. Curbs with a face in the shape of a reverse curve extending from the back of the curb to the gutter are easily shaped during construction and are attractive in appearance. When they are moderate in height with a fairly flat face they require no opening for driveways. This design is suitable for integral curbs or for combined curbs and gutters.

When sidewalks are to be built next to the curb or when an existing concrete walk abuts the curb, an expansion joint is placed between the curb and the sidewalk.

Integral Curb

This type is built as an integral part of the concrete slab. Besides performing the usual functions of a curb, the integral curb adds strength to the edge of the pavement and avoids a longitudinal joint between curb and pavement.

It is built, frequently without the use of a face form, by installing a supplementary back form. Fresh concrete is deposited against this back form and the front face is shaped by means of a special template or "mule."

A height of 4 to 6 in. and a base thickness of 8 to 12 in. are commonly used.

The only joints required in integral curbs are continuations of the transverse joints in the pavement. Dividing the curb into 6- to 10-ft. blocks is neither necessary nor desirable.

Combined Curb and Gutter

Combined curb and gutter designs are used on concrete-paved streets and frequently on unpaved streets or streets with surfaces other than concrete. When built to an established line and grade, they permit improvement of abutting property to proceed without fear of future change in alignment or gradient of the street.

The width of the gutter apron may range from 6 in. to an 8- or 10-ft. slab to provide a parking area where other types of pavement would be damaged by oil drippings or standing wheels, but the usual widths of the apron range from 12 to 36 in. While the curb may be

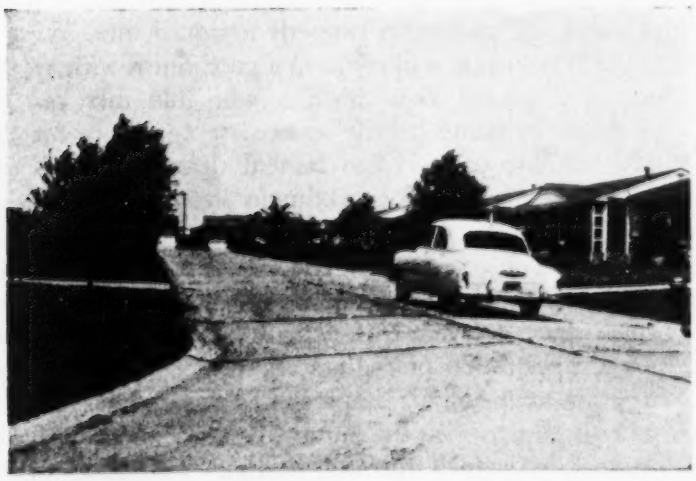

Integral curb may range from this flat rolling curb to one with an almost vertical face.

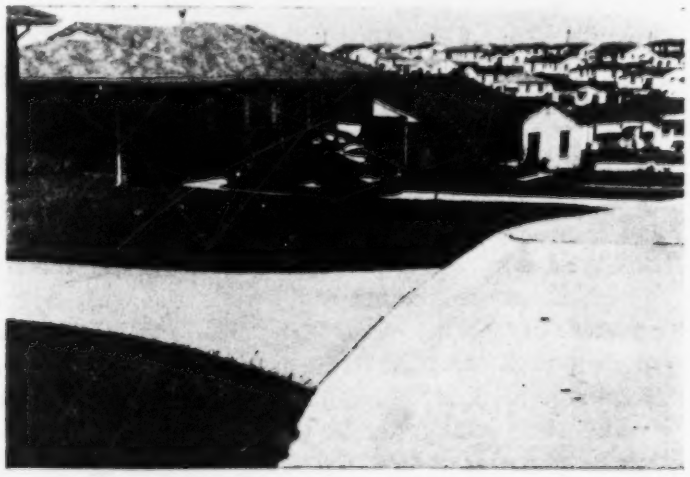

Drives built to meet top of sloping integral curb. It is not necessary to break out this type of curb when drives are built.

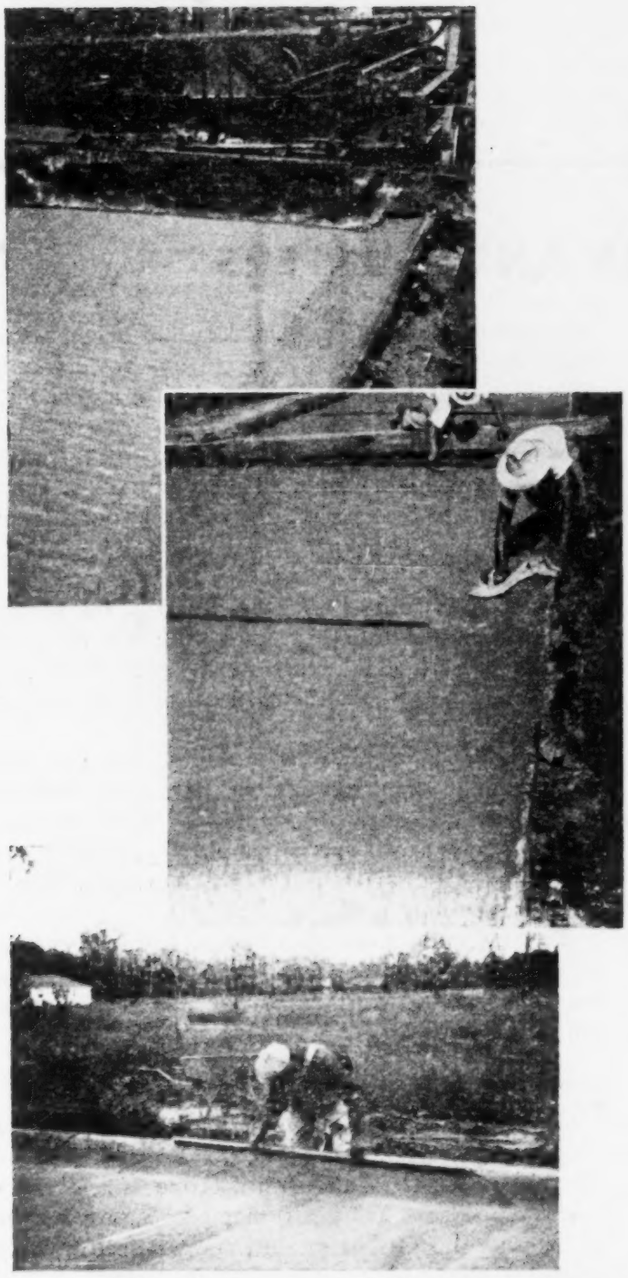

Top: Finishing machine rides on form for integral curb, and notched screed leaves proper amount of concrete to build curb.

Center: Shaping integral curb with a special tool called a "mule."

Bottom: Straightedging curb after shaping with a "mule."

of any height, 5 to 8 in. is the usual range. To encourage parking close to the curb, a sloping face and well-rounded edge are recommended. The slope of the apron should be a continuation of the regular street crown.

When built in conjunction with concrete pavement, expansion and contraction joints should be placed at the same locations as in the pavement slab. The curb and gutter should be tied to the pavement by ½-in. round deformed bars at about 3-ft. intervals. If no concrete pavement is being built at the time the curb is constructed, expansion joints should be placed at the ends of all returns and at intervals not to exceed 100 ft. Contraction joints should be installed at 15- to 20-ft. spacing.

The curb and gutter is often further divided into blocks by means of steel division plates used to maintain the correct relative positions of the front and back forms. The plates either fit into keys in wooden forms or are equipped with wings or lugs which fit into holes or slots in the top of either wooden or steel forms. They usually have two holes near their upper edge into which hooks may be inserted for withdrawing the plates as soon as the concrete is sufficiently hard.

Separate Curbs

Separate curbs are generally from 18 to 24 in. in overall height and 5 to 7 in. wide at the top, with the front face sloped to give a 6- to 10-in. width at the bottom. They should be jointed as described for combined curb and gutter. Separate curb is frequently built after the pavement is completed, which facilitates the construction of both the curb and the pavement.

Precast concrete curb is used to meet certain special job requirements or where it is convenient or desirable to cast it indoors during winter months. Dowels or tongue-and-groove joints are used to hold the separate blocks to line and grade.

Separate Gutters

Separate gutters are used to prevent erosion in shoulders or ditches. Concrete-paved gutters drain readily and therefore require a minimum of width and depth to handle a given volume of water. Many shapes are used, but the most common are those shaped like a V or the arc of a circle. When built adjoining the pavement, the side slopes and depth of a gutter and its outlets should be designed so as not to form a hazard to traffic in the adjacent lane.

Tiebars may be provided to hold gutter and pavement together, in which case joints in the pavement must be continuous across the gutter. Otherwise, they should be jointed as described for combined curb and gutter.

Lip Curb

Lip curb is really nothing but a very low, flat integral curb. Its use is confined to rural pavements in rolling country where its purpose is to prevent washing of channels in the shoulders. Lip curbs are constructed in a manner similar to that described for integral curbs. Usually from 2 to 4 in. high, they feather out in a width of 8 to 12 in.

No special joints are used, the transverse joints of the pavement being continued through the lip curbs.

Concrete for Curbs and Gutters

One-course construction is recommended for all types of curbs and gutters. A properly designed mix giving a workable concrete will result in a good finish without the use of a plaster coat. Such a workable mix can be produced by using a little less coarse aggregate for the same volume of sand and cement than is used in the pavement mixture. The maximum size of coarse aggregate should not exceed 1½ in.

The use of air-entrained concrete is recommended for the construction of concrete curbs and gutters in areas where there is severe frost action. It is needed where repeated application of sodium chloride, calcium chloride or granular materials impregnated with these salts is anticipated either on the gutters or on the adjacent pavements from which the salt solution will drain or be splashed onto the curbs and gutters.

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Combined curb and gutter is used on both paved and unpaved streets.

Curbs are sometimes built of white concrete since their high visibility gives them an important safety value. They are built like ordinary curbs except that white portland cement is used in place of normal portland cement. White aggregates are also used where available. Curbs of solid white concrete above the pavement grade have proved better than those with a facing of white mortar.

Condensed Specifications

Concrete shall consist of portland cement, fine and coarse aggregate and water. If air-entrained concrete is specified it shall contain 4 to 7 per cent air.*

Portland Cement and air-entraining agents shall comply with the requirements of the latest Standard Specifications of the American Society for Testing Materials.

Fine Aggregate shall be obtained from an approved source and shall consist of natural sand or an artificial sand having cubical particles produced from a durable coarse aggregate. It must be clean and well graded.

Coarse Aggregate may be gravel, crushed stone or air-cooled blast furnace slag. It must be clean, hard, durable, uncoated and free from deleterious material. It shall be well graded with no excess of any one size. All shall pass a 1½-in. sieve and not less than 95 per cent shall be retained on a ¼-in. screen.

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* Air-entrained concrete may be obtained by the use of air-entraining portland cement Type IA, Type IIA or Type IIIA or by the use of Type I, Type II or Type III portland cement plus an air-entraining admixture.

Water suitable for drinking shall be considered satisfactory. Other water may be used only after analysis has proved it free from harmful materials.

Joint Filler shall be nonextrusive premolded material cut to the shape of the cross-section of the curb or curb and gutter. It shall be at least ½ in. thick or of the same thickness as that in the pavement.

Forms shall be of wood or steel of sufficient strength to resist the pressure of wet concrete. If of wood, they shall be of 2-in. material. When forming returns or curved sections, flexible strips may be used. The forms shall be held with suitable clamps and stakes to prevent movement or bulging when the concrete is being placed.

Division Plates for separate curb or for combined curb and gutter shall be of steel. They shall be of the correct size and shape and shall not be bent or otherwise deformed.

Subgrade shall be well drained and compacted to a firm surface having a uniform bearing power. It shall be wet down so as to be moist immediately before the concrete is placed.

Proportions shall be the same as those specified for the pavement if a concrete pavement is being constructed at the same time. Otherwise, a mix of approximately 94:204:306 by weight (for aggregates having a specific gravity of 2.65) or 1:2:3 by volume of dry, loose aggregate shall be used. The mixing water shall not exceed 5½ gal. per sack of cement, including the free water contained in the aggregates.

Mixing and Placing. The concrete shall be thoroughly mixed in an approved batch mixer for at least one minute

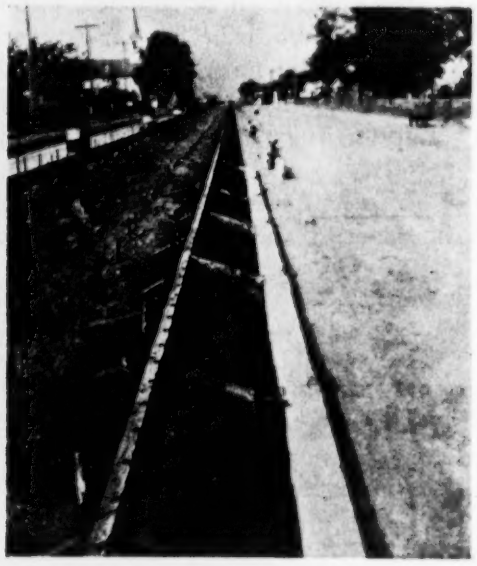

Left: Front form has been partly removed from separate curb to permit finishing.

Right: Spacer plates for sloping-face separate curb are held in place by notches in back form and plank along edge of pavement.

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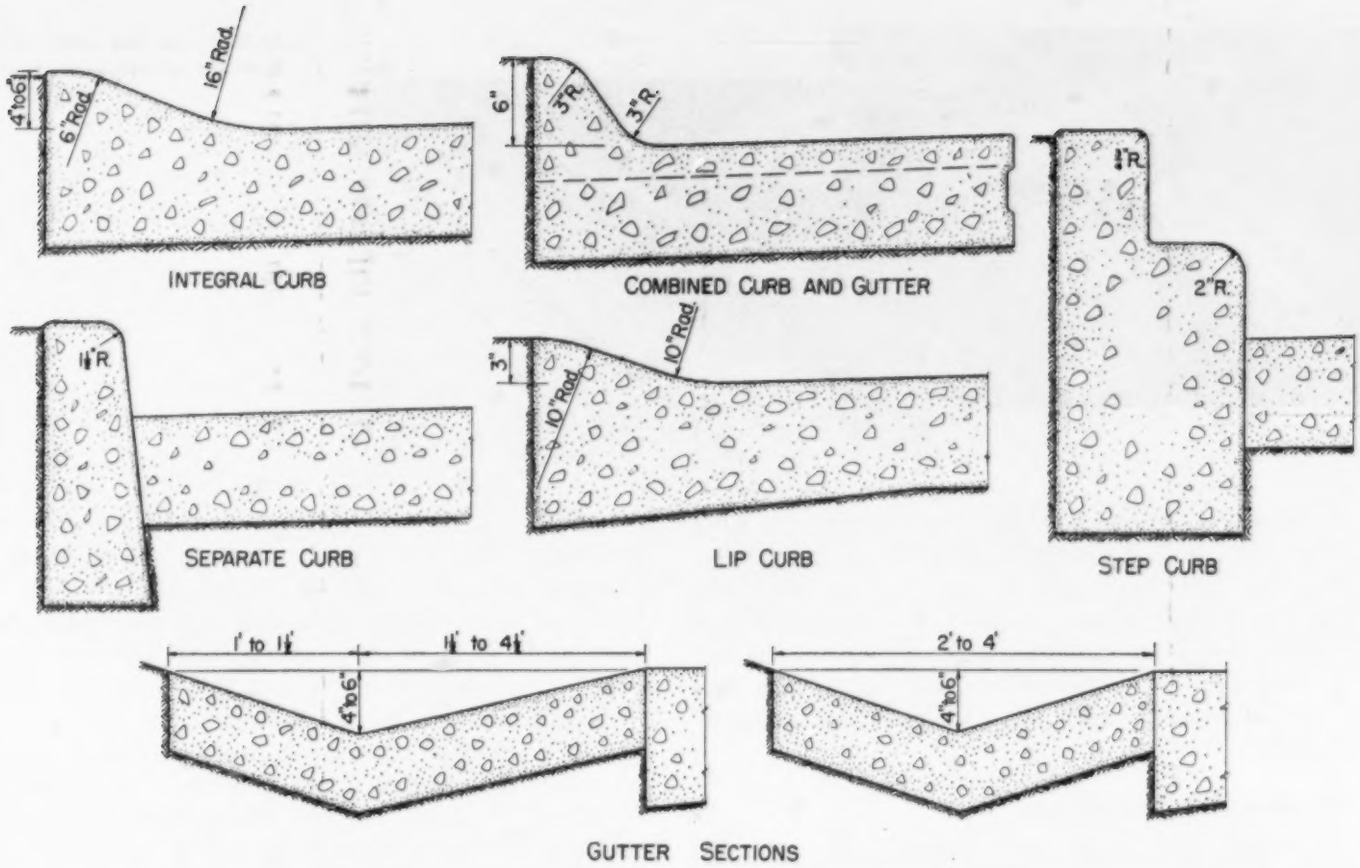

Curb and gutter cross-sections are subject to wide variation in shape and dimensions. A few typical ones are shown here.

and shall have a consistency which will permit it to be worked readily into the forms. Usually a slump of not less than 2 in. nor more than 3 in. will be satisfactory. The concrete shall be placed promptly after mixing and in a manner to prevent any segregation of the mix. It shall be tamped and spaded sufficiently to bring the mortar to the surface and so that no honeycomb will be found when the forms are removed.

Finishing. The concrete shall be struck off true to cross-section, after which it shall be finished smooth and even by means of a woodfloat. Face forms, if used, shall be left in place until the concrete has hardened sufficiently so that they can be removed without injury to the curb. The exposed surfaces shall then be finished smooth and even by means of a moist woodfloat or a moist-wet brick. The remaining forms shall not be removed for at least 24 hours after the concrete has been placed.

The edges shall be rounded with an edging tool. No tool marks are to be left on exposed edges.

Before final finishing, gutters shall be tested with a 10-ft. straightedge to see that the finished gradient is uniform. Any depressions which will not drain shall be corrected.

Curing. As soon as possible without marring, the finished curb and gutters shall be covered with wet burlap, cotton mats, straw or earth and kept moist for a period of three days, or longer if directed. As an alternate, where practical, clear or white-pigmented membrane seal coats may be used, if, at the end of three days, they retain within the concrete at least 85 per cent of the original mixing water. In cold weather curbs and gutters shall be protected from freezing during the curing period.

Inspection. A competent inspector shall be present at all times while concrete is being placed. He shall see that forms for curb or curb and gutter are in alignment and are securely staked before concrete is placed. He shall check the proportions of concrete and, when it is placed, shall see that the concrete has the specified slump and air content. This will avoid segregation and insure adequate durability. If the slump is too great, it will be difficult to keep the face forms aligned and they must be kept in place longer to prevent the curb from slumping down. If the slump is too little, honeycomb and finishing difficulties may result. The best consistency will be one with which the concrete can be placed with a minimum of manipulation and yet result in uniformly dense concrete without honeycomb. In no case shall plastering of curb and gutter faces be permitted.

The inspector shall see that the curing and protection of the concrete is started as soon as possible and continued the required length of time.

FEDERAL AVIATION AGENCY

MAJOR REPAIR AND ALTERATION
(Airframe, Powerplant, Propeller, or Appliance)

Form Approved Budget Bureau No. 04-R060.1
FOR FAA USE ONLY
OFFICE IDENTIFICATION

INSTRUCTIONS: Print or type all entries. See FAR 43.9, FAR 43 Appendix B, and AC 43.9-1 (or subsequent revision thereof) for instructions and disposition of this form.

1. AIRCRAFT	MAKE: ZEPH-AIR	MODEL: 63-1A
	SERIAL NO.: 63-11046	NATIONALITY AND REGISTRATION MARK: N 40023
2. OWNER	NAME (As shown on registration certificate): Robert D. Thomas	ADDRESS (As shown on registration certificate): 606 Elm Street, Urbana, Illinois

3. FOR FAA USE ONLY

4. UNIT IDENTIFICATION				5. TYPE	
UNIT	MAKE	MODEL	SERIAL NO.	REPAIR	ALTERATION
AIRFRAME	(As described in item 1 above)			X	
POWERPLANT					
PROPELLER					
APPLIANCE	TYPE / MANUFACTURER				

6. CONFORMITY STATEMENT

A. AGENCY'S NAME AND ADDRESS	B. KIND OF AGENCY	C. CERTIFICATE NO.
Lawrence M. Youngster 4702 Maple Street Danville, Illinois	X U.S. CERTIFICATED MECHANIC FOREIGN CERTIFICATED MECHANIC CERTIFICATED REPAIR STATION MANUFACTURER	AIRFRAME 52547-41

D. I certify that the repair and/or alteration made to the unit(s) identified in item 4 above and described on the reverse or attachments hereto have been made in accordance with the requirements of Part 43 of the U.S. Federal Aviation Regulations and that the information furnished herein is true and correct to the best of my knowledge.

DATE	SIGNATURE OF AUTHORIZED INDIVIDUAL
2/6/65	Lawrence M. Youngster Lawrence M. Youngster

7. APPROVAL FOR RETURN TO SERVICE

Pursuant to the authority given persons specified below, the unit identified in item 4 was inspected in the manner prescribed by the Administrator of the Federal Aviation Agency and is [X] APPROVED [ ] REJECTED

BY						OTHER (Specify)
	FAA FLT. STANDARDS INSPECTOR		MANUFACTURER	X	INSPECTION AUTHORIZATION	
	FAA DESIGNEE		REPAIR STATION		CANADIAN DEPARTMENT OF TRANSPORT INSPECTOR OF AIRCRAFT	

DATE OF APPROVAL OR REJECTION	CERTIFICATE OR DESIGNATION NO.	SIGNATURE OF AUTHORIZED INDIVIDUAL
2/9/65	272182	George B. Jones George B. Jones

FAA Form 337 (1-65) OBSOLETE PREVIOUS EDITION 0052-025-8000 (8320)

FIGURE 11.

Typical completion of the face of FAA Form 337. Detailed instructions for the use of this form are in FAR Part 43 and Advisory Circular 43.9-1B or subsequent revision.

UNIT V - PAVING

APPENDIX B

APPENDIX B

CONCRETE

SIDEWALKS DRIVEWAYS STEPS

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SIDEWALKS

Well-constructed concrete sidewalks, driveways and steps increase property value and improve the appearance of the home. Properly built, they are durable, easy to keep clean, and provide many years of safe, dependable cost-free service. As a guide to insure quality concrete construction, a few simple rules are set forth in this bulletin.

LOCATION AND WIDTH

Where considerable pedestrian traffic is expected, sidewalks should be at least wide enough to allow two people walking abreast to pass a third person without crowding. A minimum width of 5 ft. is advisable and 6 ft. is preferred, as this width provides for convenient passage of two couples. A greater width should be used near schools, churches and other locations where walks are used by a great number of people.

In some neighborhoods sidewalks are built immediately adjacent to the curb. This type of construction gives the property owner a larger lawn and provides proper footing for people alighting from autos at the curb. However, sidewalks at this location give pedestrians less protection from street traffic.

TYPE AND DESIGN

At one time, almost all sidewalks were constructed in two layers—a base course and a wearing surface. Usual practice now is to build walks, driveways and garage floors with one-course construction. The full thickness of the concrete is placed at one time, and the same mixture is used throughout. Such construction is stronger and easier to build.

One-course residential walks should be not less than 4 in. thick. In business districts or shipping areas where sidewalks are required to resist the weight and impact of boxes dropped from trucks and wheeled into stores, the thickness should be a minimum of 6 in.

A slope of $^1/_8$ in. to the foot is sufficient to take care of surface drainage. The direction of slope will depend on local conditions but in general should be toward the curb.

Sidewalk design is very closely linked with street pavement and curb design. By coordinating the three, a pleasing effect may be obtained which adds to the appearance of the neighborhood. For the convenience of pedestrians, approaches at street crossings may be planned to do away with the step from street to sidewalk or to provide a low step over which baby carriages can be taken easily.

PREPARING THE SUBGRADE

The first step in construction is to prepare the subgrade. All sod and vegetable matter should be removed and any soft or mucky places must be dug out and filled with granular material, thoroughly tamped. Exceptionally hard, compact spots must be loosened and tamped to provide the same bearing power as the remainder of the subgrade.

When additional fills are required under walks to bring them to the proper grade, they should also be of a granular material thoroughly compacted in 6-in. layers. It is best to extend the top of all fills at least 1 ft. beyond the edges of the walk, and to make the slope flat enough to prevent undercutting during rains.

A well-compacted, well-drained subgrade does not require a specially prepared subbase. Subgrades which are water soaked much of the time should be provided with a 6-in. subbase of sand, gravel, crushed stone or cinders. Subbases must be drained to prevent the collection of water.

FORMS

Sidewalk forms may be of wood or metal. They must be staked so that they are held firmly to line and grade. The upper edge of the forms should be level with the finished grade of the walk and the forms should be oiled before the concrete is placed.

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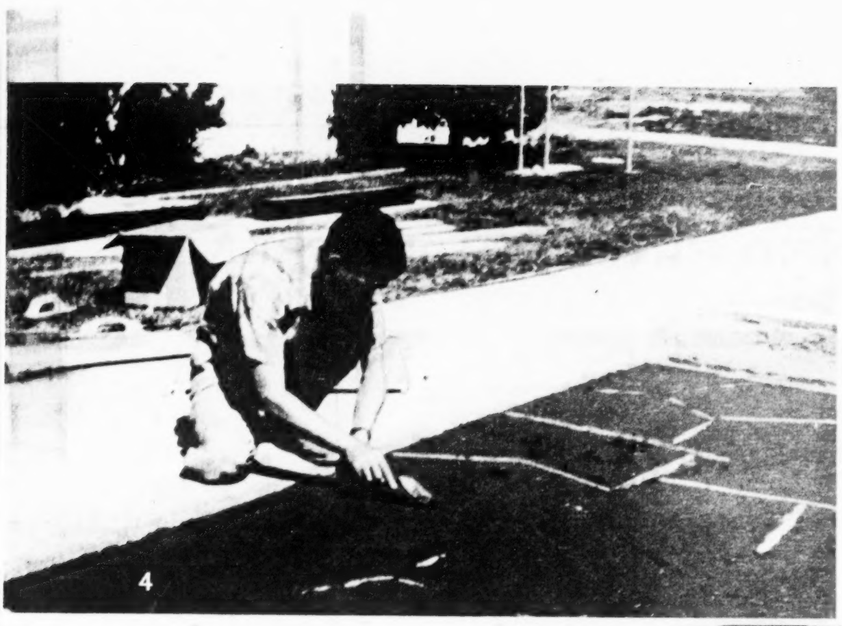

Fig. 4. Cleaning wooden strips.

Fig. 5. Removing joint forms.

Fig. 6. Filling joints with contrasting mortar.

The concrete may then be troweled for a normal gray color, or if desired, a different color can be added at this time.

To ensure uniformity of color, it is best to use a factory-prepared color topping. Color toppings consist of portland cement and fine aggregate in equal proportions, plus a pure mineral oxide pigment to produce the desired color. This pigment is an extremely fine powder and must be applied as a dry shake. Dry-shake color is thrown over the surface with a swinging arm motion. The powder is released between spread fingers; this breaks it up and produces a more uniform distribution. For best results, first spread out half the required amount, then float and trowel the surface before adding the second half.

After floating the second application, and before troweling, the top of the wood strips are cleaned of any paste that may have been carried over them. A patching trowel or putty knife can be used to scrape the wood clean (Fig. 4). A final steel-troweling will then bring the wood joints and concrete to a uniform surface, which can be left smooth or be lightly brushed.

The following day the curing cover can be taken off, and the wooden strips are removed by lifting with a patching trowel (Fig. 5). The slab may be left with depressed joints or with the joints filled in with a contrasting mortar. A natural gray slab with white mortar joints is very attractive; a colored slab looks good with natural gray joints.

Before filling the joints, the slab should be flooded with water to keep the slab cool and the joints damp. Immediately before troweling in the mortar, the

Fig. 7. Tooling joints in slab.

Fig. 8. Troweling after initial jointing.

Fig. 9. Touching up joints with soft brush.

joints should be brushed with a paste of portland cement and water, mixed to the consistency of heavy cream (Fig. 6). Care must be taken to prevent smearing mortar outside the joint area. A large coarse synthetic sponge and bucket of water will be useful in cleaning the joint edges. In this operation it is best for two finishers to work together, with one painting in the cement grout ahead of the mortar and cleaning up the joint edges, while the other concentrates on packing in the mortar firmly and neatly.

Alternate Method

An alternate method of producing the flagstone pattern involves tooling the joints into the surface. After the concrete has been screeded and darbied, and after excess moisture has left the surface, the slab is scored in a random flagstone design. This can be done with a jointer or groover; it is best, however, to use an 18-in.-long piece of ½- or ¾-in. copper pipe bent into a flat S-shape. This tooling must be done while the concrete is still very plastic, as coarse aggregate must be pushed aside by the tool and embedded into the slab (Fig. 7). The first jointing will leave burred edges. After the water sheen has disappeared, the entire area should be floated and the jointing tool run again to smooth the joints. A careful troweling follows (Fig. 8). The final operation is a light brushing of the troweled surface, along with a careful touching-up of the joints with a soft-bristle paint brush (Fig. 9).

Geometric Patterns

An attractive geometric pattern can be produced by marking circles or other designs on the slab after

MATERIALS

To insure quality concrete, the aggregate and water should be clean and mixed in proper proportions with portland cement. For sidewalks, driveways and garage floors, the recommended trial mix, when proportioned by volume, should be 1 part portland cement to 2¼ parts sand and 3 parts gravel or crushed stone. When proportioned by weight, the approximate amounts of fine and coarse aggregates recommended for one sack of cement are:

Pounds of Material

Portland cement	Sand	Coarse aggregate
94	215	295

(One sack of portland cement weighs 94 lbs.)

The gravel or crushed stone should be well graded in size between ¼ in. and 1 in. A mix proportioned by either of the above methods will usually produce 4½ cu.ft. of concrete for each bag of portland cement. Not more than 5 gal. of water per bag of cement should be used in mixing the concrete when the sand is in an average wet condition. Only enough water should be used to produce a concrete that works readily and does not segregate. Concrete with a slump of 3 in. or less, when tested with a standard slump cone, should be used and will permit proper placement.

If the recommended proportions do not make a smooth workable mix in the first trial batch, it may be necessary to vary the quantities of the sand and gravel or crushed stone slightly, but the amount of water should not be changed. The use of more mixing water than is recommended lessens the durability and reduces the strength of the concrete.

In northern climates where the concrete is subjected to freezing and thawing, air-entrained concrete is recommended. Air-entrained concrete can be made by using air-entraining portland cement or by adding an air-entraining agent at the mixer. The use of air-entraining cement is recommended for small jobs, or where adequate engineering supervision is not available to make determinations of the air content of the freshly mixed concrete.*

*On large jobs, where adequate engineering supervision is available, the method for obtaining air-entrained concrete should be that which best serves the users' interests.

SIDEWALKS

MIXING

Concrete made on the job should be mixed for a full minute after all the materials are in the drum. The drum should be completely emptied before receiving the materials for succeeding batches.

Ready-mixed concrete, used by many contractors, is generally available in most areas. When ordering ready-mixed concrete, it should be specified that aggregate used be not more than 1 in. in size with not less than 6 sacks of cement per cubic yard. The concrete should have a total water content of not more than 6 gal. per sack of cement and a slump of not more than 3 in.

Before the concrete is placed, the subgrade should be thoroughly dampened so that it is moist throughout, but without puddles of water. Concrete should be placed in the forms as near to its final position as practicable. Precaution should be taken not to overwork the concrete while it is still plastic because an excess of water and fine material will be brought to the surface, which may lead to scaling or dusting later on.

FINISHING

The concrete should be placed in the forms and tamped and spaded just enough to compact it firmly. Sidewalks should be finished with a slightly roughened surface to insure a safe foothold in wet weather. To obtain this, walks are finished with a wood float or are lightly broomed. After the concrete has been struck off, it is smoothed with a wood float or darby, leveling any raised spots and filling depressions. Side edges are then rounded with an edger to prevent chipping of the concrete. Where necessary, the marks left by the edges of the wood float may be removed by brushing with a calcimine brush dipped in water.

In some localities, the smooth finish obtained with a steel trowel is still preferred. When steel troweling is done it should be after all water sheen has disappeared and the concrete is so hard that no mortar accumulates on the trowel. This requires considerable effort on the part of the finisher to produce a satisfactory finish. Drawing the trowel over the surface of the concrete should produce a ringing sound. Excessive troweling is to be avoided as it tends to bring too much water and fine material to the top, forming a chalky surface.

Walks built on grades should have coarse surface texture, and steps should be built if the grade is steeper than 20 to 25 per cent.

SIDEWALKS

In sidewalk construction one form is set accurately to line and grade. Top edge of other form is determined with a level.

Forms in place for a 3-ft. wide sidewalk along curb. Driveway is already in place.

Strikeboard is used to level off concrete with a saw-like motion.

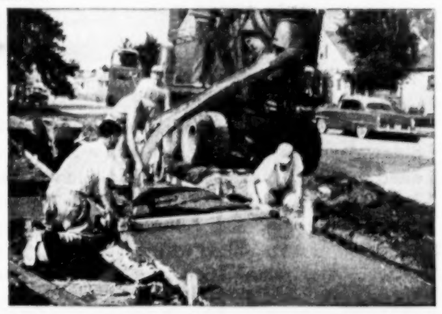

Long-handled wood floats or darbys are frequently used to smooth and level the concrete.

A small wood float produces an even, gritty, non-slip surface.

Outside edges of the walk are cut free f the side forms and expansion joints wit steel trowel.

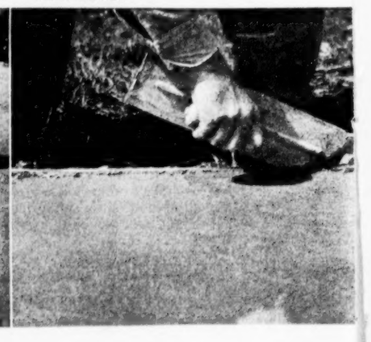

JOINTS

Joints are placed in concrete sidewalks to take care of expansion and contraction caused by changes in temperature. There are two kinds of joints—expansion and contraction.

Contraction joints are simply separation planes between slabs. When the concrete shrinks in cold weather, these joints open slightly, thus preventing irregular and unsightly cracks. They are generally spaced at 5- to 6-ft. intervals.

Contraction joints may be formed by cutting a slot in the slab about 1 in. deep. This forms a plane of weakness and when the slab contracts, it will crack at this joint. The slot is cut by a T-bar forced into the fresh concrete for a depth of 1 in. After the concrete has partly hardened, the bar is withdrawn and the joint edged with a double edger held against a straight edge to make a clean, straight joint.

Expansion joints consist of premolded material usually ½ in. thick and as wide as the depth of the walk. They should be placed wherever the walk meets another walk, driveway, building, curb, lighting standard, fireplug or other rigid object. They are placed on all four sides of the square formed by the intersection of two walks. When the sidewalk fills the space between the curb and a building or wall, an expansion joint should be placed between the sidewalk and the curb and between the sidewalk and the building or wall. Expansion joints are not required at regular intervals in the sidewalk.

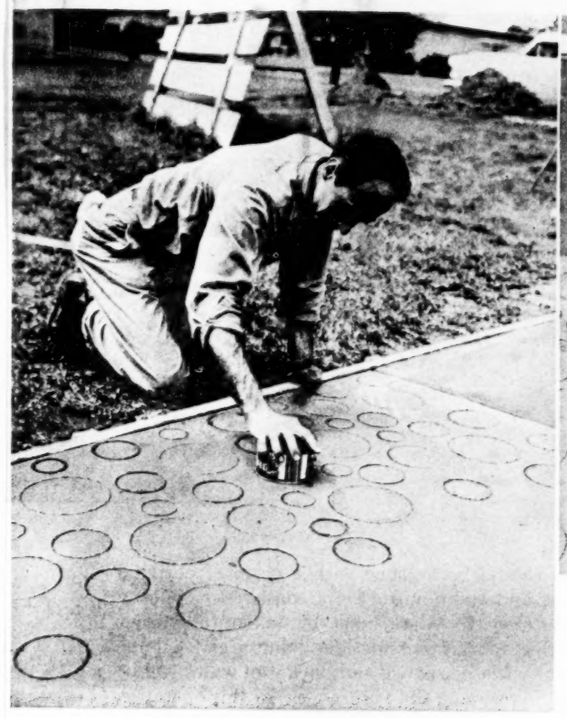

Fig. 11. Making leaf impressions.

Fig. 10. Making geometric patterns.

the final smooth finish has been completed. This can be done with a variety of sizes of tin cans in random pattern, or by one or more sizes in a definite regular pattern. Large metal cookie cutters of various shapes may also be used for this purpose.

Wherever a large area is to be finished in this fashion, several workmen will be required. Immediately after the final troweling, the surface will be quite hard but still easily marked (Fig. 10). However, as the slab continues to harden, it will become more and more difficult, and finally impossible, to make impressions to the same depth and appearance. In cases where more than one workman is involved, all must carefully coordinate their efforts so that the finished pattern will be uniform. A good method for determining the design to be followed is the production, on a nearby driveway or sidewalk, of a sample pattern. This is done by dipping the cans in powdered chalk and marking an area large enough to serve as a guide. The sample can easily be washed away later. If no slab is convenient, a large sheet of wallboard may be used.

Leaf Patterns

A pattern giving the effect of fossils can be produced by pressing leaves into the slab surface, either singly as a border, or in groups or sprays as a focus of interest. Fresh leaves are carefully pressed into the surface immediately after it has been floated and troweled (Fig. 11). The leaves should be so completely embedded that they may be troweled over without dislodging, but no mortar should be deposited over the leaves. After the concrete has set sufficiently, the leaves are removed.

Finishing Concrete Surfaces—

EXPOSED-AGGREGATE FINISHES FOR FLAT SLABS

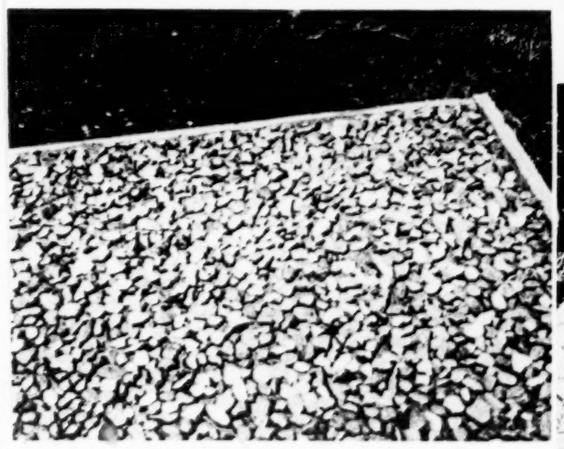

Fig. 1. Selected aggregate is spread on darbied surface.

Fig. 2. Pressing aggregate beneath concrete surface.

Exposed aggregate is one of the most popular decorative finishes for flat concrete slabs. It offers unlimited color selection and a wide range of texture variation. Properly prepared exposed-aggregate finishes have a rugged nonskid surface that is highly resistant to wear and weather.

Selection of Aggregate

Things to consider in selecting decorative aggregate include size and color—to produce the desired effect; and shape and hardness—to produce a good-looking, long-lasting finish.

Size of the aggregate can vary from pea gravel to fist-size rocks, depending on the texture desired; the smaller the size, the finer the texture. Color can be a single uniform color, a mixture, or a random selection of hues, shades, and tones. In any case, aggregate chosen should be hard and sound. Flat, sliver-shaped particles, or aggregate that is too smoothly polished or ball-shaped should be avoided; such aggregates may not bond properly, are easily dislodged during exposing operations, and may be loosened, once exposed, by freezing and thawing. Aggregate should be cleaned prior to use. Aggregate normally used in concrete is dull in color, offers little variation in texture, and seldom gives satisfactory results for exposed finishes. Whatever aggregate is selected, a test panel should be made using it before the job is started. This will ensure that the material chosen will produce the desired finish.

Preparation

A 5½- to 6-bag concrete mix with a maximum slump of 3 in. should be used. Aggregate to be exposed should be cleaned and wet thoroughly before use to prevent mixing water being drawn from the concrete. Wetting also serves to lubricate the entry of the aggregate into the surface of the slab. After wetting, however, the aggregate must be drained to prevent free water being carried into the concrete.

Placing and Embedding Aggregate

Immediately after the slab has been screeded and darbied, the selected aggregate should be scattered by hand—evenly distributed so that the entire surface is completely covered with a single layer. Special care should be taken in covering the edge to ensure a uniform appearance (Fig. 1).

The initial embedding of the aggregate is usually done by patting with the darby or the flat side of the strike-off rod (Fig. 2). After the aggregate is

CURING

Concrete should be protected so that moisture is not lost during the early stages of hardening. Newly placed concrete should not be permitted to dry out too fast and must be protected from the sun or drying winds. This may be accomplished with burlap or canvas coverings which are kept wet. As soon as the concrete has hardened enough so that the surface will not be marred, the burlap or canvas can be removed, and earth, sand, or straw, kept moist by occasional sprinkling for three days, can be substituted. Sometimes watertight paper is used for such coverings. Membrane curing compounds sprayed on the surface of the concrete are often used to prevent evaporation of the moisture from the freshly placed concrete. These compounds should be applied immediately after the concrete has been finished.

COLD WEATHER CONCRETING

In cold weather the mixing water should be heated so that the concrete is between 50 and 70 deg. F. when it is placed. At no time should it be over 70 deg. F. In general, when outdoor temperatures are near freezing, the concrete should be protected by coverings of heavy paper and then with hay or straw, 10 to 12 in. deep, for the first three days after placing. Materials containing frost or ice should never be used in making concrete, and the concrete should never be placed on a frozen subgrade. The use of high-early-strength portland cement, the addition of calcium chloride (not more than 2 lb. per sack of cement), or the use of richer mixes when using Type I portland cement, will accelerate the hardening of the concrete and thus minimize the time protection is required.

SIDEWALKS

Applying a fine spray of membrane curing compound. Wet burlap or canvas may also be used for curing the concrete.

Sidewalk adjacent to curb at street intersection, showing low curb.

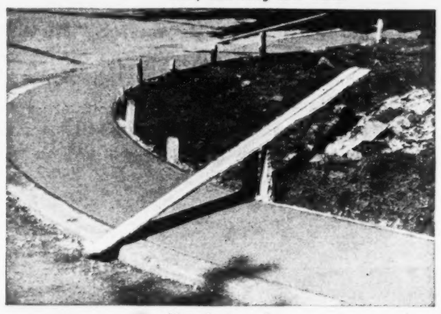

Hair broom drawn over concrete produces a slightly rough, gritty, non-skid surface.

lging tool is run along the edges of the walks d at expansion joints, rounding the edges prevent chipping.

Contraction joint grooves are sometimes cut with a steel trowel.

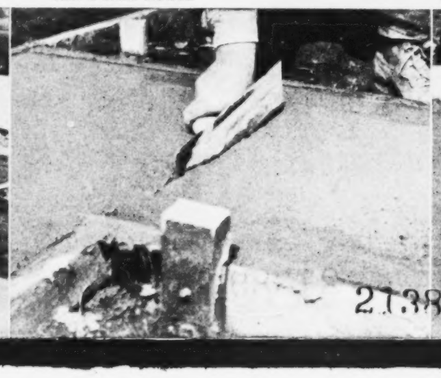

When edging contraction joints, a board is used as a guide to assure straight joints.

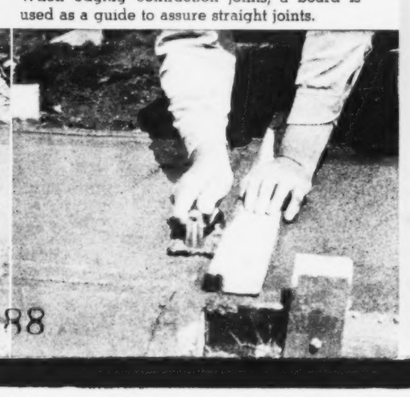

DRIVEWAYS AND GARAGE FLOORS

CONSTRUCTION

Concrete for driveways and garage floors is mixed, placed, finished and cured in the same manner as described for walks. If driveways are for residential use and subject to the occasional load of fuel or delivery trucks, they should have a minimum thickness of 4 in. Where they lead to stores or commercial buildings, the thickness should be at least 8 in. Garage floors should be at least 4 in. thick.

Driveways are usually constructed 8 to 10 ft. wide for single garages. When the approach to a two-car garage is short, the entire driveway is usually made double-width or about 16 ft. wide. On a long lot the driveway for a double garage may be widened near the garage so that cars can swing into either stall.

Some driveways are built with two strips for the car wheels. These strips are usually 24 in. wide and spaced about 5 ft. center to center.

If the sidewalks are constructed first, the driveway should be built with ½-in. premolded expansion joints placed on each side of the walk and where the driveway abuts the street pavement and garage. Frequently driveways are built before sidewalks. When this is done the driveway is placed directly from the street pavement to the garage with expansion joints at each end.

Contraction joints, similar to those described for sidewalks, should be placed in driveways at about 10-ft. intervals. Wide driveways for double garages should also have a center contraction joint to divide it into strips about 10 ft. wide.

The driveway, if built first, should meet the proposed sidewalk grade and rise gradually to the garage. From the sidewalk grade, the driveway should drop to meet the gutter grade where the curb is omitted, or to the top of any low-height curb.

Where the street is not paved it is advisable to end the driveway at the sidewalk. A temporary drive from the sidewalk to the street can be used until the street is paved. The driveway can be extended to the curb line at that time.

Concrete for driveways is struck off with a templet which shapes the surface with a crown or valley to insure proper drainage.

Edging contraction joints with double edger.

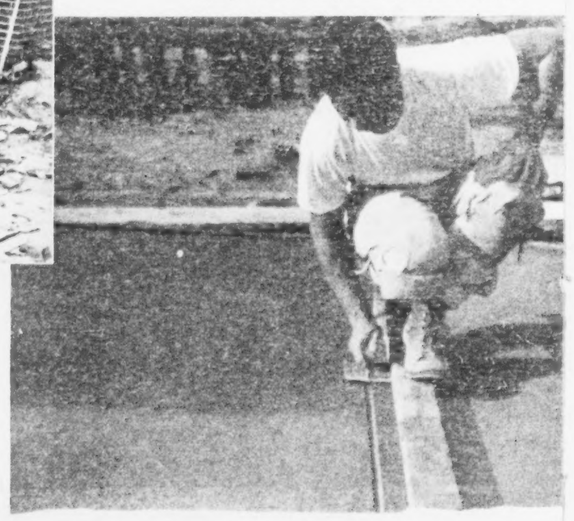

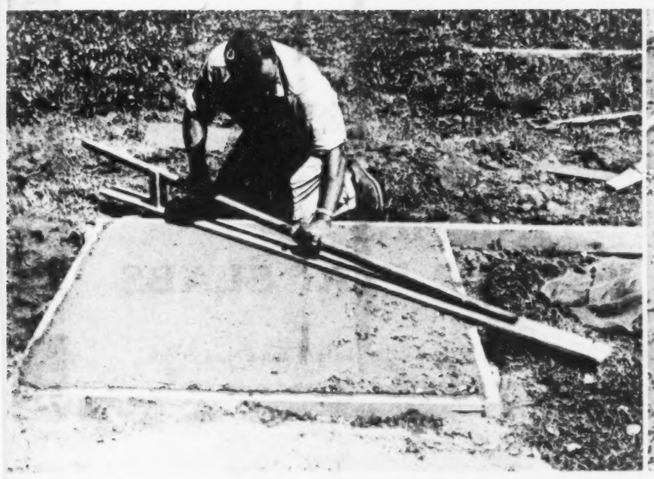

Fig. 3. Smoothing surface after aggregate is embedded.

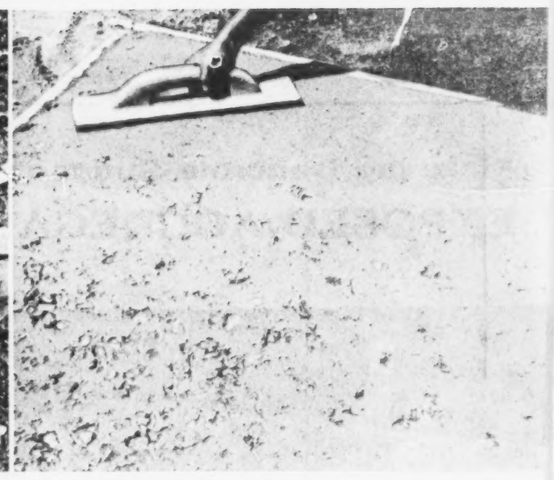

Fig. 4. Floating to seal surface.

embedded, and as soon as the concrete will support the weight of a mason on kneeboards, the surface should be hand-floated with a magnesium float or darby (Fig. 3). This operation should be performed thoroughly, so that all aggregate is completely embedded just beneath the surface. The grout should completely surround and slightly cover all aggregate, with no holes or openings left in the surface (Fig. 4).

Following this floating, a reliable retarder may be sprayed or brushed on the surface according to the manufacturer's recommendations. On small jobs a retarder will probably not be necessary; retarders are generally used on large jobs for better control of exposing conditions. When a retarder has been used, exposure of the aggregate can generally be delayed. When a retarder has not been used, the aggregate must be exposed sooner.

Fig. 7. Slab after aggregate is exposed.

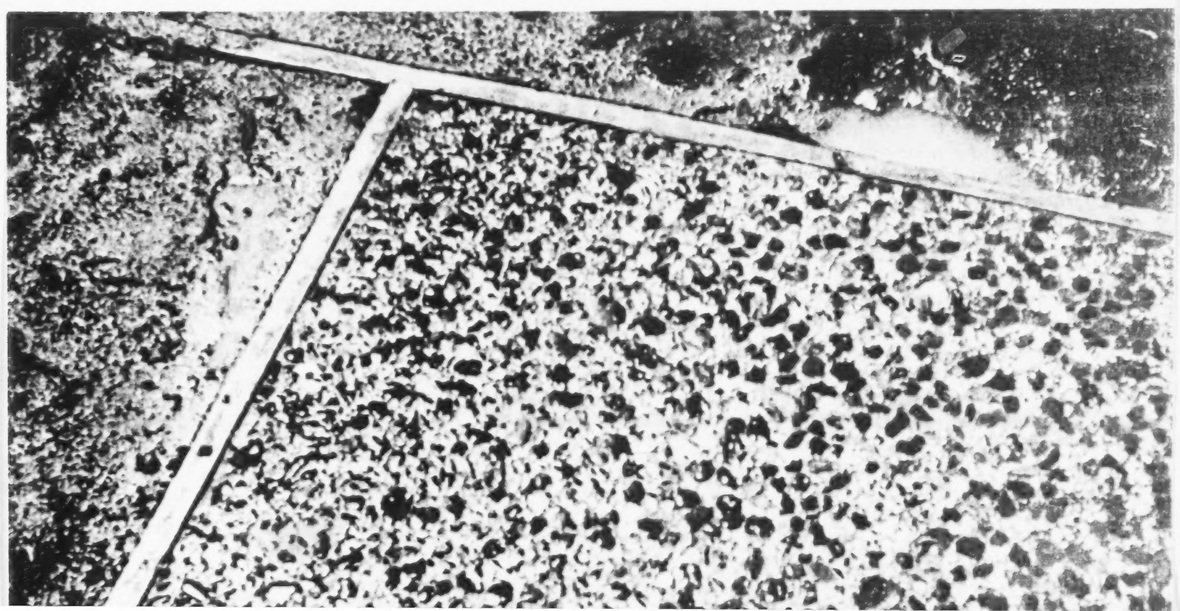

Fig. 5. Exposing aggregate by flushing and brushing.

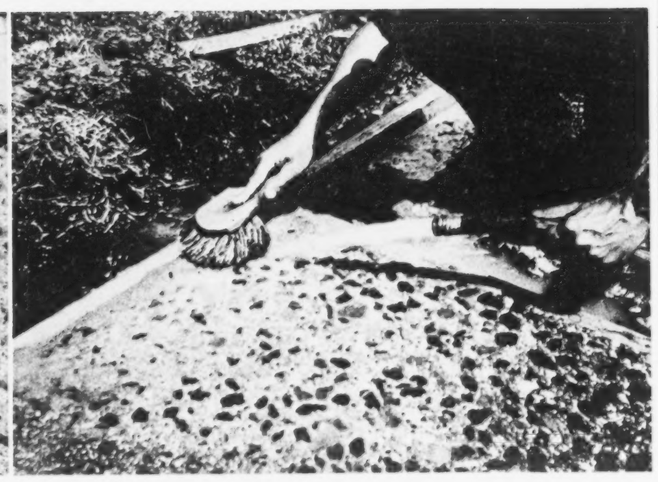

Fig. 6. Touching up with hand brush.

Exposing the Aggregate

Proper timing is quite critical in exposing aggregate; a test panel should be made and tested to determine the best time to begin. Exposing should be done as soon as the grout can be removed by simultaneous brushing and flushing with water (Fig. 5 and 6) without overexposing or dislodging the aggregate. If it is necessary for masons to move about on the surface during exposing operations, kneeboards must be used with special care. If possible, this should be avoided because of the risk of breaking aggregate bond.

Curing

Exposed-aggregate slabs should be cured thoroughly. Care must be taken that the method of curing does not stain the surface. Straw, earth, and some types of building paper may cause staining.

Fig. 8. Sample panels show various aggregates.

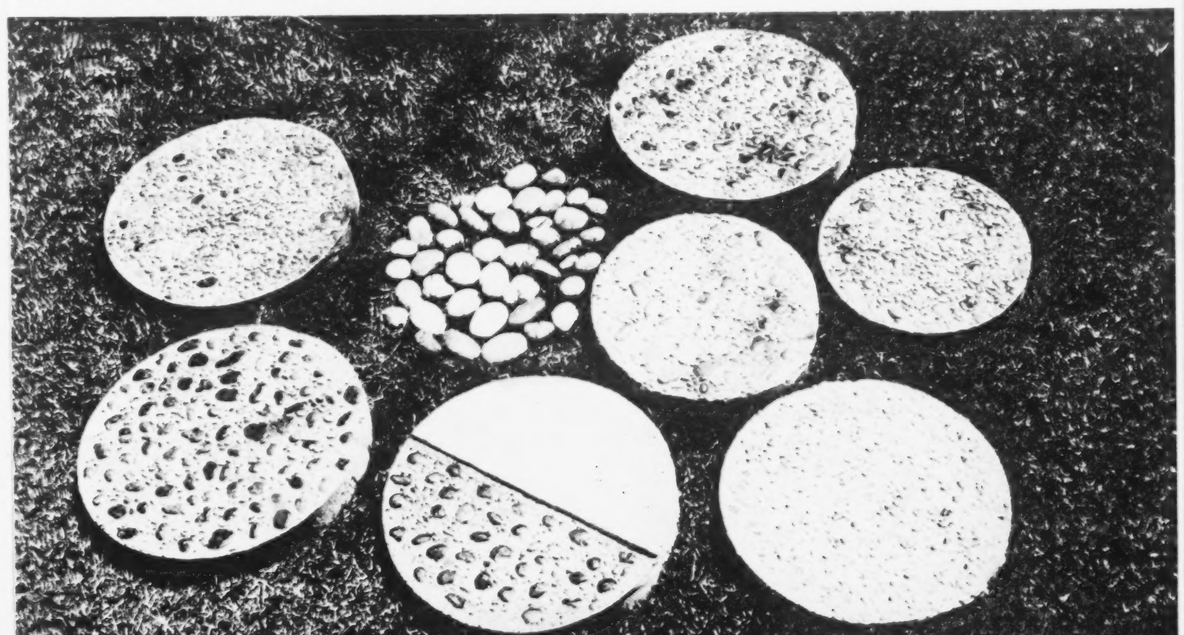

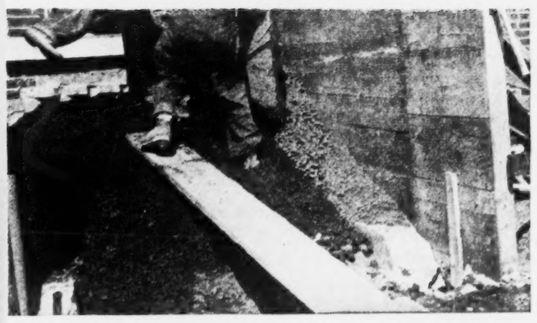

Concrete is placed between the side forms and the fill.

Riser forms are checked with a hand level.

STEPS

FOOTINGS

Footings for the sidewalls for the steps should be placed on firm soil and below the frost line. The side walls should be tied in with the foundation walls with anchor bolts or tie rods. Often these footings are cast integrally with the basement walls.

FILLING

After the forms for the side walls are in place, cinders, crushed stone or gravel is used to make a fill before the concrete is placed. The fill should be well compacted by tamping. The concrete for the side walls is placed between the fill and the side forms and it too should be well compacted by tamping.

Riser forms are well braced.

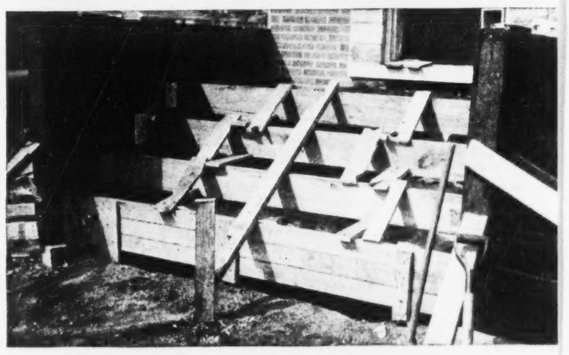

The base course is tamped.

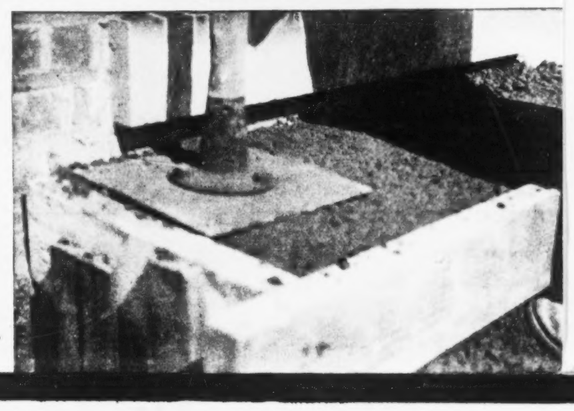

MEASURING MATERIALS

In building concrete steps, the concrete is usually placed in two layers—a base course and a wearing surface.

The base course should be composed of 1 part portland cement by volume to 2¼ parts sand and 3 parts gravel or crushed stone. Maximum size aggregate is limited to 1 in. Concrete should be mixed to a stiff, dry consistency, using only enough water to make it workable, and tamped into place. Concrete for the wearing surface, when proportioned by volume, should range from 1 part portland cement, 1½ parts sand and 1½ parts gravel or crushed stone to 1 part portland cement, 2 parts sand and 2 parts gravel or crushed stone. Maximum size of aggregate for the wearing surface should be ⅜ in. Not more than 4 gal. of water per sack of cement should be used in the mix for the wearing surface when the sand is in an average wet condition.

STEPS

FORMS

Forms for the risers should be carefully placed and checked with a hand level. The riser or step height should be about 7½ in., with treads either 9 or 10 in. in depth. For additional comfort in climbing, the face of the riser form can be tilted about 1 in., thereby increasing the width of the tread. The riser forms must be securely fastened to the side forms and well braced to prevent bending when the forms are filled with concrete.

PLACING

The dry-mixed concrete for the base course should be well tamped into place allowing a 1-in. space for the wearing surface. The wearing surface should be placed on all treads as soon as possible (within 45 minutes) to insure proper bond.

The riser forms can be removed one at a time, starting with the top riser, as the wearing surface is placed.

FINISHING

After the first riser form is removed, the face of the riser should be plastered, using the concrete wearing-surface mix. An outside edger is used to round the corner of the tread, and an inside edger is used to finish the corner at the bottom of the riser. A wood float should be used to provide a gritty, safe, non-skid surface on the treads.

Concrete steps should be cured in the same manner as walks are cured.

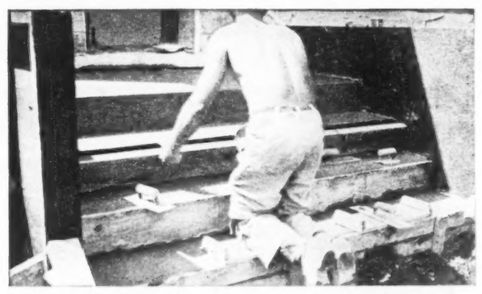

Riser forms are removed, starting with the top riser.

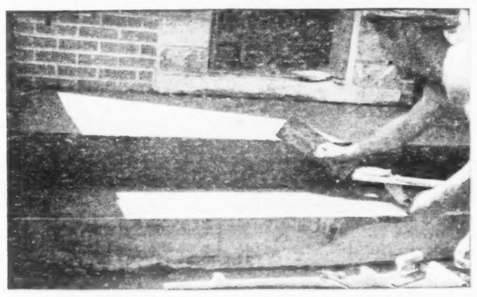

Face of the riser is plastered with concrete.

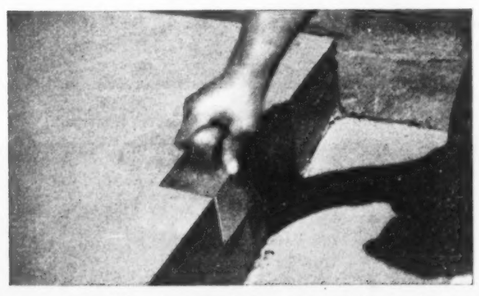

An outside edger rounds the corner of the tread.

Wood floating the treads assures a gritty, safe, non-skid surface.

Colored Finishes for Slabs

Many pleasing decorative effects can be achieved by the use of colored concrete in and around homes for patios, floors, stepping stones, walks, driveways, swimming pool decks, etc. There are four methods of producing colored concrete finishes: (1) the one-course method, (2) the two-course method, (3) the dry-shake method, and (4) stains, dyes, or paints. The first three methods give the most satisfactory results.

Dyes, stains, or paints are normally used only when it is necessary to color an existing slab. It is difficult to obtain a uniform color with dyes or stains; thus, the manufacturer's directions should be very closely followed. Paints, especially where subject to heavy traffic, wear away soon and must be continually renewed if a good appearance is to be maintained.

The one-course method consists of adding the appropriate amount of color pigment to the concrete in the mixer, producing a uniform color throughout the entire slab. The pigment must be a pure mineral oxide especially prepared for use in concrete. Both synthetic and natural pigments are satisfactory if they are insoluble in water, free from soluble salts and acids, fast to sunlight, fast to alkali and weak acids, have only limited amounts of calcium sulfate, and are ground fine enough so that 90 per cent passes a 325-mesh screen. The amount of pigment used should be the minimum amount necessary to produce the desired color, but never more than 10 per cent by weight of the cement. Full-strength pigments will normally produce a good color when 7 lb. are mixed with 1 bag of cement; 1½ lb. per bag normally produces a pleasing pastel color. White portland cement will produce cleaner, brighter colors and should be used in preference to normal grey portland cement, except for black or dark grey colors. To maintain a uniform color throughout the slab, proportioning of all materials in the mix must be carefully controlled by weight. Mixing time should be longer than normal to assure uniformity. To prevent streaking, the dry cement and color compound should be thoroughly blended before adding to the mix.

The two-course method consists of placing the base course in the usual manner, allowing it to stiffen and the surface water to disappear, and then placing the top ½ to 1 in. of colored concrete. This method is frequently used because of the economies offered. The savings in materials normally more than offset the slightly higher labor cost.

The dry-shake method consists of applying a dry color material that may be purchased from various manufacturers ready for use. Its basic ingredients are mineral oxide pigment, white portland cement, and specially graded silica sand or fine aggregate. Do not select, proportion, and mix a dry-shake material on the job.

After the concrete has been screeded and darbied, and free water and excess moisture have evaporated from the surface, the surface should be floated by either power or hand float. If by hand, a magnesium or aluminum float should be used. Preliminary floating should be done before the dry-shake material is applied—to bring up enough moisture for combining with the dry material. Floating also removes any ridges or depressions that might cause variations in color intensity. Immediately after the floating operation, the dry material is shaken evenly by hand over the surface. If too much color is applied in one spot, nonuniformity in color and possibly surface peeling will result.

The first application of the colored dry-shake material should use about two-thirds of the total amount needed (in pounds per square foot as specified). In a few minutes this dry material will absorb some moisture from the plastic concrete; it should then be thoroughly floated into the surface, preferably by a power float. Immediately, the balance of the dry-shake material should be distributed evenly over the surface. This should also be thoroughly floated and made part of the surface, taking care that a uniform color is obtained.

All tooled edges and joints should be "run" before and after the applications.

Shortly after the final floating operation, the surface should be power-troweled. If work is being done by hand, troweling should immediately follow the final floating. After the first troweling, whether by power or by hand, there should be a lapse of time—the length depending upon such factors as temperature, humidity, etc.—to allow the concrete to increase its set. Then the concrete may be troweled a second time to improve the texture and produce a denser, harder surface.

For exterior surfaces a second troweling is usually sufficient. Then a fine, soft-bristle push broom may be drawn over the surface to produce a roughened texture for better traction under foot. Smooth surfaces are slippery and hazardous when wet.

For interior surfaces a third hard troweling could be specified. This final troweling should be done by hand to eliminate any washboard or trowel marks. This final hand troweling produces a smooth, dense, hard-wearing surface.

Colored slabs, as with other types of freshly placed concrete, must be cured thoroughly.

After thorough curing and surface-drying, interior surfaces may be given at least two coats of special concrete floor wax containing the same mineral oxide pigment used in the dry-shake material. This wax is also available from various reliable manufacturers. Care should be taken to avoid any staining, such as by dirt or foot traffic, during the curing and drying period and before waxing.

UNIT V - PAVING

APPENDIX C

APPENDIX C

Finishing Concrete Surfaces–

TEXTURED FINISHES FOR SLABS

Fig. 1. Medium brush texture.

Fig. 2. Heavy wavy brush texture.

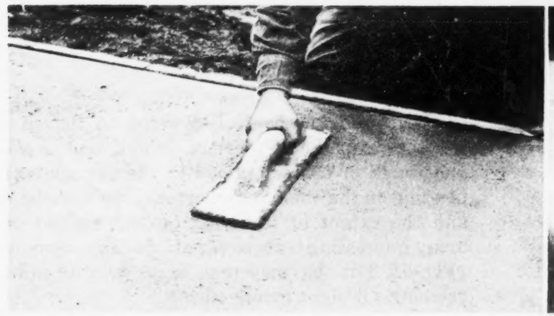

Fig. 3. Swirled float finish.

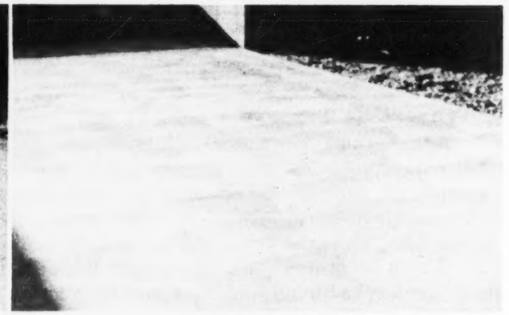

Fig. 4. Patterned float finish.

Variation in texture of concrete surfaces is limited only by the imagination of the designer and the skill of the craftsman. Many interesting and practical textured finishes can, in fact, be produced with less effort and expense than a smooth-troweled surface.

Finish texture can be varied as desired, from a smooth, slick, polished appearance to the roughness of a frozen gravel path. The smoothest finish is produced by a highly skilled workman and a steel trowel, with the final troweling taking place when the surface is very hard.

A light brushing with a soft hair brush will slightly reduce the gloss of such a finish.

Progressively heavier brushing of progressively softer concrete produces increasingly rougher finishes. Brushing newly floated concrete with a fiber broom produces a rugged surface for use where mud, moisture, or heavy traffic makes the added safety of a nonskid texture a necessity (Fig. 1).

Patterns of Texture

Patterns of texture lend visual interest as well as surer footing. Methods of obtaining such patterns include drawing a brush across the surface in wavy lines (Fig. 2), brushing in alternate directions, or combinations of these.

Other texture variations can be produced by floating the surface (Fig. 3). A smooth matte finish is attained by holding the steel trowel flat as a float and finishing with swirling motions. Medium textures are produced by aluminum or magnesium floats, and coarser textures by wood, cork, or carpet floats. Patterns are introduced by using the float in a series of uniform arcs or twists (Fig. 4).

Fig. 5. Travertine or keystone finish.

Fig. 6. Rock salt finish.

Travertine Texture

A travertine (or keystone) texture requires a more elaborate procedure. After the concrete slab has been struck off, darbied, and edged in the usual manner, the slab is broomed with a stiff-bristle broom to ensure bond when the finish (mortar coat) is applied.

The finish coat is made by mixing 1 bag of white portland cement and 2 cu.ft. of sand with about ¼ lb. of color pigment. Yellow is generally used to tint the mortar coat, but any mineral oxide color may be used. Care must be taken to keep the proportions exactly the same for all batches. Enough water should be added to make a soupy mixture having the consistency of thick paint.

This mortar is placed in pails and thrown vigorously on the slab with a dash brush to make an uneven surface with ridges and depressions. The ridges should be about ¼ to ½ in. high. The surface is allowed to harden enough to permit a cement mason on it with kneeboards.

The slab is then steel-troweled to flatten the ridges, leaving the slab surface smooth in some places and rough or coarse-grained in the low spots. Depending on the amount of mortar thrown on the slab and the extent of troweling on this mortar coat, many interesting texture variations can be produced (Fig. 5). The slab may then be scored into random geometric designs before curing.

A similar texture can be produced by scattering rock salt over the troweled surface and then pressing it into the concrete with a trowel. After the concrete has completely hardened, the salt is washed away by thorough flooding with water. The dissolved salt will leave pits or holes in the surface (Fig. 6).

Neither the keystone nor rock salt finishes should be used in an area subject to freezing weather. Water trapped in the recesses of these finishes tends, when frozen, to break up the surface.

Finishing Concrete Surfaces—

PATTERNED FINISHES FOR SLABS

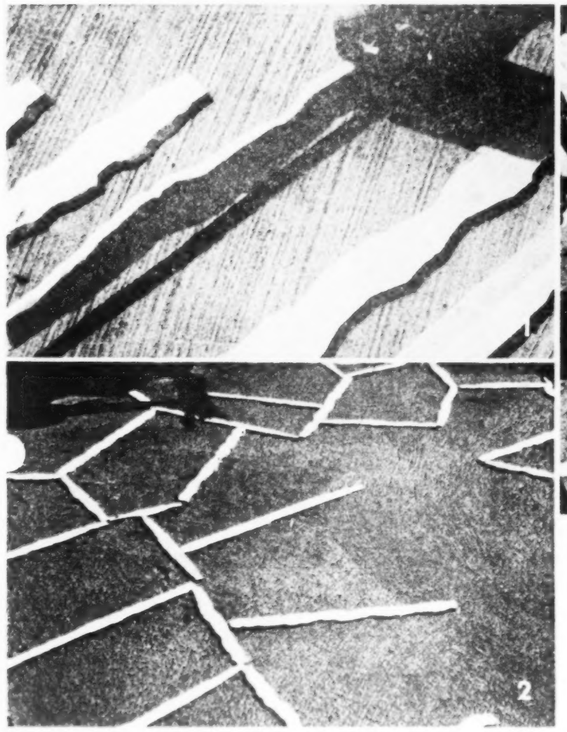

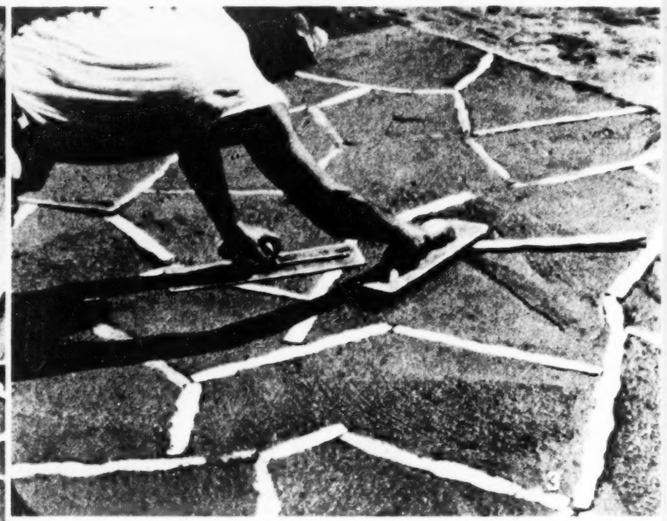

Fig. 1. Wood "joint" forms for flagstone finish.

Fig. 2. Laying out flagstone pattern with wooden strips.

Fig. 3. Floating in wooden strips.

A wide variety of finishes can be used to enhance the beauty of any concrete slab. One increasingly popular method of embellishing sidewalks, driveways, and patio slabs is the use of incised patterns, including carved flagstone, geometric, or inlaid leaf designs.

Carved Flagstone Patterns

Random flagstone patterns make an attractive finish for patio, sidewalk, or poolside slabs. Such patterns are easily made by embedding prepared wooden "joints," which are removed after the slab has hardened. Wood lattice stock (¼x1½-in.) is cut into varying lengths of from 4 to 32 in. Individual pieces are finished by carving the sides into irregular jagged shapes. Edges must be undercut to ease removal and prevent locking of the wood into the slab surface (Fig. 1). Curling of the wood strips may be prevented by thoroughly soaking them in water prior to use or by waterproofing with two complete coats of good varnish.

After the slab has been screeded and darbied, it is allowed to set until ready for finishing—in this case somewhat sooner than normal. The wooden joints are laid out on the slab in the desired pattern (Fig. 2). Very small or complex shapes should be avoided.

As soon as the pattern is laid out, the wooden strips are pressed into the concrete and the surface is floated. The top of the wood should be just flush with the surface of the concrete (Fig. 3).

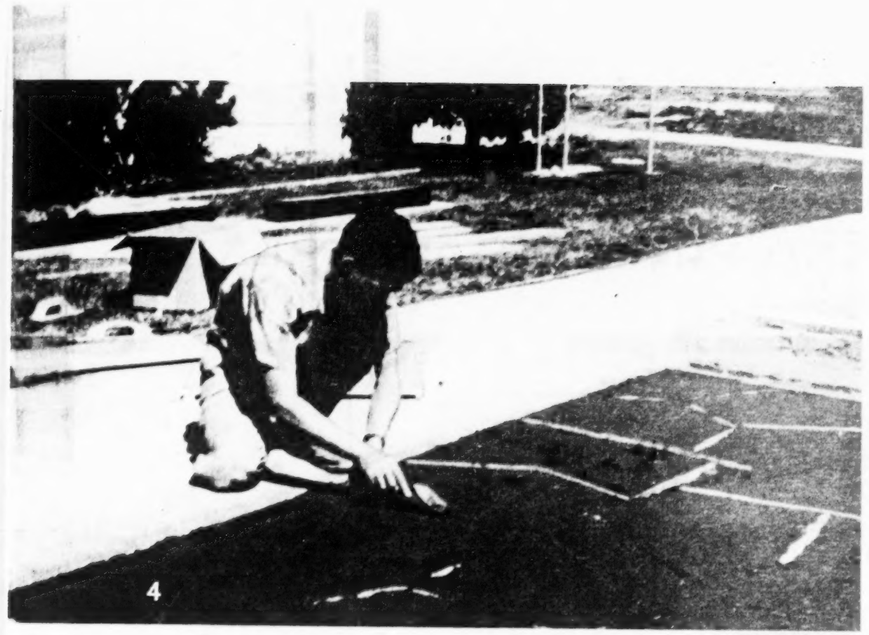

Fig. 4. Cleaning wooden strips.

Fig. 5. Removing joint forms.

Fig. 6. Filling joints with contrasting mortar.

The concrete may then be troweled for a normal gray color, or if desired, a different color can be added at this time.

To ensure uniformity of color, it is best to use a factory-prepared color topping. Color toppings consist of portland cement and fine aggregate in equal proportions, plus a pure mineral oxide pigment to produce the desired color. This pigment is an extremely fine powder and must be applied as a dry shake. Dry-shake color is thrown over the surface with a swinging arm motion. The powder is released between spread fingers; this breaks it up and produces a more uniform distribution. For best results, first spread out half the required amount, then float and trowel the surface before adding the second half.

After floating the second application, and before troweling, the top of the wood strips are cleaned of any paste that may have been carried over them. A patching trowel or putty knife can be used to scrape the wood clean (Fig. 4). A final steel-troweling will then bring the wood joints and concrete to a uniform surface, which can be left smooth or be lightly brushed.

The following day the curing cover can be taken off, and the wooden strips are removed by lifting with a patching trowel (Fig. 5). The slab may be left with depressed joints or with the joints filled in with a contrasting mortar. A natural gray slab with white mortar joints is very attractive; a colored slab looks good with natural gray joints.

Before filling the joints, the slab should be flooded with water to keep the slab cool and the joints damp. Immediately before troweling in the mortar, the

APPENDIX D

Note to Instructor:

Slides and original photos for the illustrations in APPENDIX D are available from the Portland Cement Association at either address:

680 Wilshire Place Los Angeles, Calif. 90005	or	235 Montgomery Street San Francisco, Calif. 94104

(a) Transmits the original FAA Form 337 to the owner/operator.

(b) Forwards the copy to the local FAA office within 48 hours.

(2) AIs should insure that the copy is an exact and legible reproduction of the original. The signatures should not be carbon copies but original signatures in ink.

(3) In the event the FAA Form 337 has been completed for spare parts or components, both copies of the form with the approval portion (item 7) completed should be attached to the part or component until it is installed on an aircraft.

(a) Those items identifying the component with a particular aircraft and the owner's name and address will be left blank on the form.

(b) The installing mechanic will complete both copies of the form by filling in the blank items and will sign for the installation in the aircraft records. He should make reference to the FAA Form 337 in his record entry.

(c) The original copy of the completed FAA Form 337 goes to the owner/operator of the aircraft upon which the component was installed.

(d) The duplicate copy is forwarded to the FAA office for the area where the installing mechanic is operating.

d. When FAA Form 337s are received the FAA office may review them for completeness and accuracy. In the event they find discrepancies, they will return the form to the approving AI and request that it be corrected. Since it usually entails considerable time and effort in locating the owner/operator's copy of the form to make corrections, the AI should review the form carefully at the time of approval. The most common causes for FAA return of the form are:

(1) Item 8 (reverse of the form) lacks sufficient information to adequately locate and describe the repair or alteration and the basis for approval. The information given in this block should be extremely specific in identifying the data that was utilized in making the repair or alteration. A general reference to FAR 43 or AC 43.13-1 for repairs is not sufficient. Identify specific drawings, sections in AC 43.13-1, or manufacturer's instructions. If an advisory circular is utilized, identify it by title, number, and issuance date.

CIIS 2114

high degree of smoothness as do high-speed highways, it is possible and desirable to use simple hand methods for finishing.

Another exception is coarse aggregate size. In general, the coarse aggregate should not be larger than ¼ the pavement thickness. In many cases 3/4-inch maximum size aggregate will be most economical and satisfactory.

SUBGRADE PREPARATION

The first step in the construction procedure is that of subgrade preparation. (Slide 2) One of the most important points to remember in relation to the subgrade is that of uniformity -- both uniformity in compaction and uniformity in moisture content. Uniform compaction will be obtained unless you have uniform moisture. Subgrades should be compacted at or slightly above optimum moisture contents.

For low traffic streets, no subbase is required, and the pavement will be constructed directly over the basement soil, referred to in this talk as "subgrade".

GRADING

(Slide 3) The first step in preparation of the subgrade begins with grading work. In established neighborhoods, this generally consists of removing old pavement and cutting to grade.

In new areas, grading is sometimes accomplished in two steps. (Slide 4) The first step is major grading to sidewalk elevation with pans and scrapers. (Slide 5) The second step is grading to just above the final subgrade elevation, with final grading deferred until after forms are set.

(Slide 6) Except in very hilly areas, most streets in residential areas will be built in cuts, primarily as a result of the need to drain adjacent properties. (Slide 7) Where fills are required, they should be constructed in accordance with recognized embankment practices.

If a subbase is to be used, it is constructed to grade prior to the setting of forms.

Colored Finishes for Slabs

Many pleasing decorative effects can be achieved by the use of colored concrete in and around homes for patios, floors, stepping stones, walks, driveways, swimming pool decks, etc. There are four methods of producing colored concrete finishes: (1) the one-course method, (2) the two-course method, (3) the dry-shake method, and (4) stains, dyes, or paints. The first three methods give the most satisfactory results.

Dyes, stains, or paints are normally used only when it is necessary to color an existing slab. It is difficult to obtain a uniform color with dyes or stains; thus, the manufacturer's directions should be very closely followed. Paints, especially where subject to heavy traffic, wear away soon and must be continually renewed if a good appearance is to be maintained.

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After the concrete has been screeded and darbied, and free water and excess moisture have evaporated from the surface, the surface should be floated by either power or hand float. If by hand, a magnesium or aluminum float should be used. Preliminary floating should be done before the dry-shake material is applied—to bring up enough moisture for combining with the dry material. Floating also removes any ridges or depressions that might cause variations in color intensity. Immediately after the floating operation, the dry material is shaken evenly by hand over the surface. If too much color is applied in one spot, nonuniformity in color and possibly surface peeling will result.

The first application of the colored dry-shake material should use about two-thirds of the total amount needed (in pounds per square foot as specified). In a few minutes this dry material will absorb some moisture from the plastic concrete; it should then be thoroughly floated into the surface, preferably by a power float. Immediately, the balance of the dry-shake material should be distributed evenly over the surface. This should also be thoroughly floated and made part of the surface, taking care that a uniform color is obtained.

All tooled edges and joints should be "run" before and after the applications.

Shortly after the final floating operation, the surface should be power-troweled. If work is being done

by hand, troweling should immediately follow the final floating. After the first troweling, whether by power or by hand, there should be a lapse of time—the length depending upon such factors as temperature, humidity, etc.—to allow the concrete to increase its set. Then the concrete may be troweled a second time to improve the texture and produce a denser, harder surface.

For exterior surfaces a second troweling is usually sufficient. Then a fine, soft-bristle push broom may be drawn over the surface to produce a roughened texture for better traction under foot. Smooth surfaces are slippery and hazardous when wet.

For interior surfaces a third hard troweling could be specified. This final troweling should be done by hand to eliminate any washboard or trowel marks. This final hand troweling produces a smooth, dense, hard-wearing surface.

Colored slabs, as with other types of freshly placed concrete, must be cured thoroughly.

After thorough curing and surface-drying, interior surfaces may be given at least two coats of special concrete floor wax containing the same mineral oxide pigment used in the dry-shake material. This wax is also available from various reliable manufacturers. Care should be taken to avoid any staining, such as by dirt or foot traffic, during the curing and drying period and before waxing.

FORMS

(Slide 8) At present, most street pavements are built with forms. The use of formless pavers for this purpose may not be too far in the future. One equipment manufacturer is right now working on a slipform machine to pave street, curbs and sidewalks in a single pass.

Forms are normally set following subgrade compaction. (Slide 9) They may be either of wood or steel construction. When the finishing work will be done with light equipment, wood forms are quite satisfactory.

(Slide 10) Forms should be carefully set to the required line and grade to ensure both a smooth riding surface and proper drainage of surface water. This slide shows how well wood forms can be set.

(Slide 11) Forms should be well anchored and supported so that they will not move under the pressure of concrete and finishing operations. This slide shows a Symons steel pin nailed with double-headed nails to a wood form.

(Slide 12) The usual procedure for setting forms involves setting blue tops for grade reference, followed by a string set to line and grade from the blue-tops. From this stringline, forms are set to grade. Grade stakes are normally set 1½ to 2 feet outside of the form line.

FINE GRADING

(Slide 13) The next operation following form setting is that of fine grading. This is accomplished by planing the subgrade, which has been intentionally left slightly on the high side so that the planer is always cutting -- not filling low spots.

(Slide 14) This may be done by the use of a motor patrol grader. (Slide 15) or it may be done with an inexpensive subgrade planer riding on the forms.

(Slide 16) Following planing, the subgrade needs to be recompacted. Here you see a tandem roller, commonly used for

this purpose.

(Slide 17) This is a simple wood scratch template which is pulled along the forms to check the final grade and to ensure correct pavement thickness. Pavement thickness is as important to the contractor as it is to the inspector.

PLACING

(Slide 18) The final grade check is followed by placing and finishing of the concrete. Since most of the concrete used in street work will be ready-mix, the following comments will be based on placement from ready-mix trucks.

(Slide 19) It may be desirable to operate the ready-mix trucks between the forms. However, if trucks cause rutting or displacement of the subgrade, it may be necessary to use lighter trucks, provide suitable runways, or deposit concrete from outside the forms. Just prior to placing concrete, it is usually necessary to dampen the subgrade to prevent absorption of mix water from the concrete. This can be easily accomplished using water from the tank on the truck mixer.

There are many techniques used for striking off, consolidating and finishing, all of which when used properly can produce an excellent pavement. (Slide 20) The first step is to place the concrete on the subgrade. It should be spread as uniformly as possible, USING THE CHUTE OF THE TRUCK AND NOT BRUTE STRENGTH AND SHOVELS.

(Slide 21) The use of a vibrator will prevent honeycomb along the forms and keyways.

After spreading, the concrete must be consolidated and struck off level with the forms. Any one of the following items of equipment may be used to accomplish this, varying from the more sophisticated down to the simplest:

1. Iowa Curbmaster. (Slide 22) This piece of equipment extrudes the desired shape of curb as it is driven electrically along the forms. (Slide 23) The curb form is set full height when this type of equipment is used.

(The following devices require the outside form to be set in two operations. The first form is set to pavement thickness, the following item of equipment used, and a second form is tacked on for subsequent construction of the curb)

2. Clary Roller. (Slide 24) This consists of three driven rollers, two which turn one direction, and the other counter-rotates.

3. Thor Vibrator. (Slide 25) This has a series of vibrating steel bands along the bottom.

4. Vibrating beam. (Slide 26) A very common device used for construction of floors.

5. Oscillating screed. (Slide 27) This motor-driven device "see-saws" two boards back and forth across the concrete.

6. Pipe roller. (Slide 28) Perhaps one of the simplest, but a very effective piece of equipment. It has been used to build very smooth slabs 36 feet wide and there is no reason other than weight why it cannot be used for slabs up to 50 feet wide.

There are many other devices, using various ways of doing the job, too numerous to mention here.

FINISHING

(Slide 29) After the concrete has been spread, struck off, and consolidated, it is floated, if necessary, to close any holes in the surface and to remove any marks left by the previous operations. The float should be at least 4 feet wide and should not be used in such a manner as to create bumps in the pavement. The improper use of this tool is one of the most frequent causes of rough pavement.

Following floating, the pavement is straight-edged with a 10-foot scraping straightedge to remove any irregularities in the surface. (Slide 30) This item of equipment, too often overlooked, can be the major factor in providing a good

riding pavement. Frequently, it may be used in place of the float shown in the previous slide, or in combination with it. After strike-off and consolidation, the least amount of hand-work that can be done in order to get a satisfactory surface is most desirable. Excessive working brings water and fines to the surface (very pronounced when air-entrained concrete is not used).

CURBS

(Slide 31) Next follows the construction of the integral curb. Integral curb construction is recommended for all pavements requiring curbs, for two obvious reasons. One reason is the economy realized in the construction operation. Integral curbs built with the pavement in a one-step operation provide savings not possible with separate curb and gutter construction. Further, the time saved is most significant, since the entire lane including curbs, base and surface is built in a single pass and can be opened to traffic in seven days. In addition, integral curbs substantially strengthen the pavement edges, thereby reducing stresses and deflections and increasing the structural capacity.

There are several methods of forming integral curbs and they may be formed to almost any desired cross-section.

Enough concrete to construct the curb may be left along the form line, or extruded as shown here with the Curb-master, (Slide 32) or, (Slide 33) Forms for the curb can be tacked on later and enough concrete deposited with which to construct the curb. (Slide 34) This must be done while the previously placed concrete is still plastic and as quickly as possible.

The curb is then shaped to the desired cross-section using templates similar to the one shown here. (Slide 35) Templates can be made to match any ordinary curb shape.

(Slide 36) These are inserted in the concrete left for construction of the curb, one end resting on the pavement and the other on the top of the curb form.

(Slide 37) Workmen shape the curb according to the template using a straightedge, as shown here.

Since curbs and gutters are a part of the drainage system, it is important that they will drain properly to the nearest water outlet. (Slide 38) Grade can be checked with a string line, as shown.

FINAL TEXTURING

(Slide 39) Finally, the pavement is edged and is ready for final texturing. Just after the water sheen leaves the surface is about the proper time for texturing. Texturing before or after this may result in less than the desired gritty surface. (Slide 40)

(Slide 41) For best skid resistance, the use of a burlap drag at the proper time is recommended. (Slide 42) This should include the curbs to provide a uniform appearance. (Slide 43) Some engineers prefer the appearance of a broomed finish.

CURING

(Slide 44) A most important, and frequently ignored, part of any concrete work is the need for proper curing. If the concrete surface is allowed to dry out after finishing without any effort made to retain mix water, crazing, plastic shrinkage cracks, and lack of strength may be the likely result. This applies to all concrete work.

The function of curing is to prevent rapid drying of the concrete during the hardening period. This can be accomplished in several ways: Through the use of wet burlap, (Slide 45) waterproof paper, (Slide 46) polyethylene, or by the use of liquid membrane-forming compounds. (Slide 47) This latter method is one of the best methods. It is probably the easiest and cheapest methods. White compounds are recommended for two reasons: One; the inspector and contractor can be sure of adequate coverage, and two; the white surface will reflect heat, reducing the internal heat of the concrete, and therefore,

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SLIDE 17

SLIDE 18

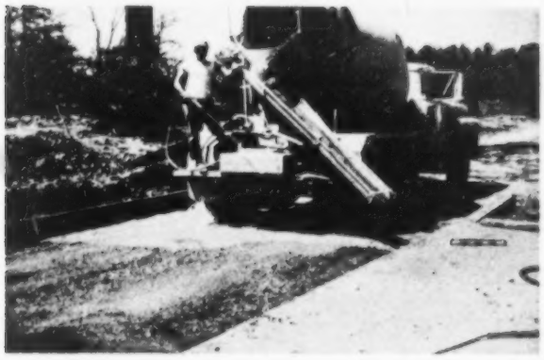

SLIDE 19

SLIDE 20

SLIDE 21

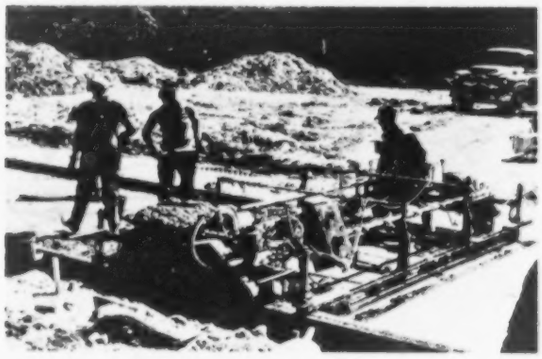

SLIDE 22

SLIDE 23

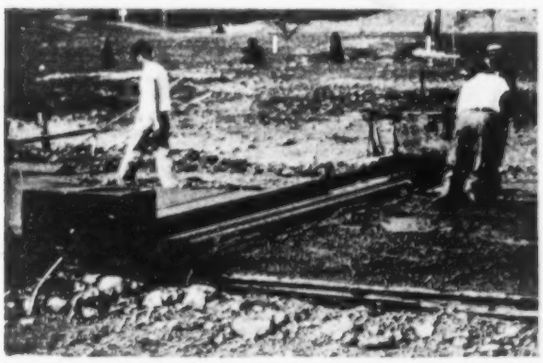

SLIDE 24

(2) Omission of, or incorrect reference to, model and serial number. Transfer this information directly from the nameplate or registration form of the aircraft concerned. Do not use manufacturers' trade names.

(3) Signatures missing, either mechanic or AI.

(4) The FAA Form 337 was completed for a minor repair or alteration or solely for a weight and balance report. Weight and balance reports, in most cases, are separate documents and usually incorporate lists and loading schedules.

e. Weight and Balance. Weight and balance entries are no longer required on the FAA Form 337. As this data is no longer reviewed by FAA inspectors, it is imperative that weight and balance checks and computations be made very carefully. Since practically every aircraft manufacturer uses a different method of weight and balance control, it would be impossible to provide a universally adaptable method. The examples provided in Figure 12, will be general in nature and can be modified or revised as needed to fit the aircraft involved. When revising weight and balance data, these general rules should be followed:

(1) The weight and balance data should be kept together in the aircraft records.

(2) When making revisions, use a permanent easily identified method, with full-size sheets of paper large enough to contain complete computations and to minimize the possibilities of their becoming detached or lost.

(3) The pages should be identified with the aircraft by make, model, serial number, and registration number.

(4) The pages should be signed and dated by the person making the revision.

(5) Describe nature of the weight change.

(6) The old weight and balance data should be marked superseded and dated.

(7) The new page should show the date of the old figures it supersedes.

(8) Appropriate fore and/or aft extreme loading conditions should be investigated and the computations shown.

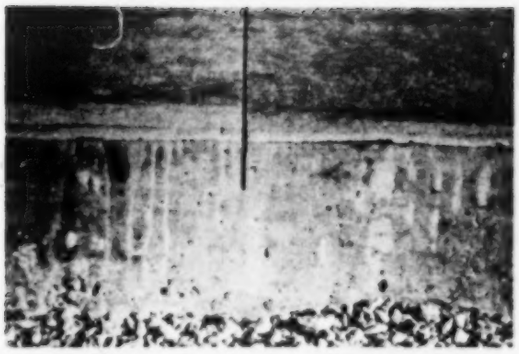

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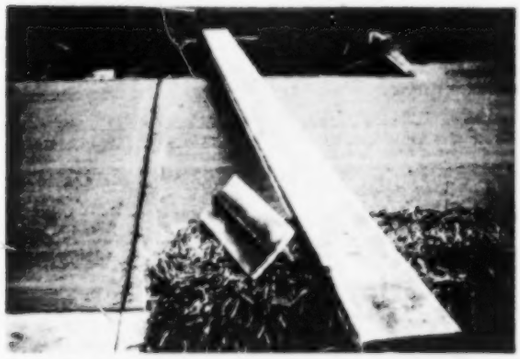

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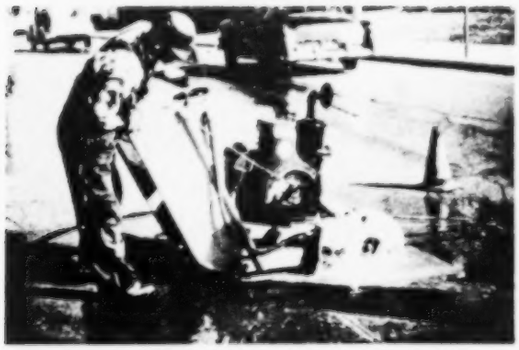

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SLIDE 53

SLIDE 54

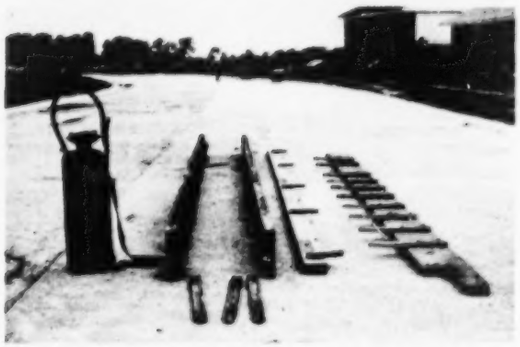

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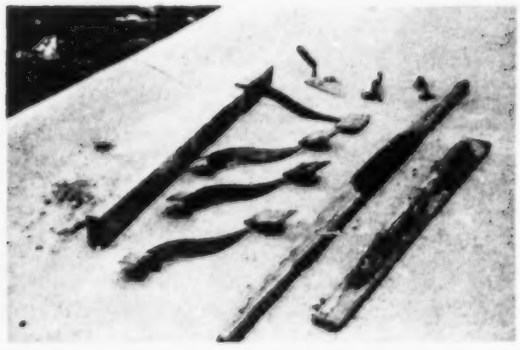

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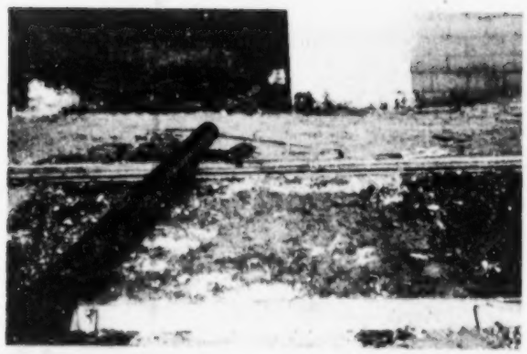

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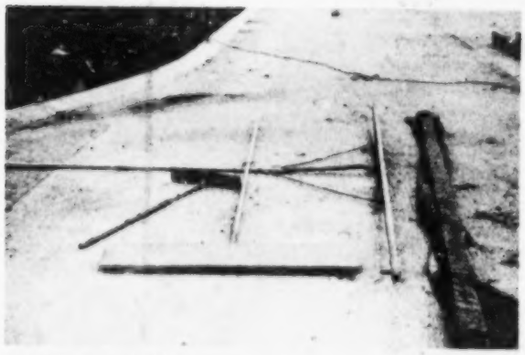

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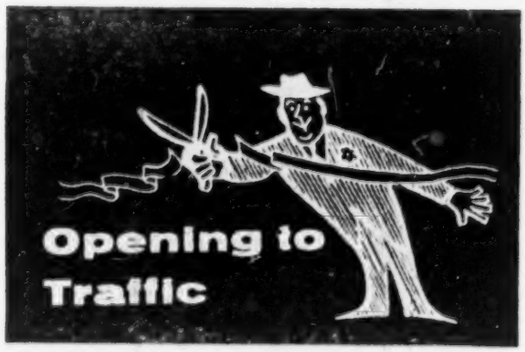

SLIDE 60

SLIDE 61

21421

1. (Slide 55) Forms. B
sprayer for form oili
type of sprayer can b

2. (Slide 56) Curb Tool
strikeoffs and floats

3. (Slide 59) A roller.

4. (Slide 58) Finishing
edge, burlap drag, ku

5. (Slide 59) A telepho

This assumes excavat
contractor.

Everything necessary
included in the foregoing basi
however, most contractors add

(Slide 60) Normally
be required before the new pav
When paving a half-width at a
may begin within two days, pro
or load the previously placed

(Slide 61) And this
attention to each step in the
in an attractive and serviceab

The end

ottom form, curb form, stakes,
ng, scratch template. The same
e used for curing compound.

s. Templates, curb form,
, trowels and edgers.

Tools. Float, scraping straight-
m-along.

ne to call the Ready-mix company.

ion will be done by a grading

to do a good job of paving was
c tools. To increase production,
more mechanized equipment.

, about seven days of curing will
ement can be opened to traffic.
time, paving of the second half
vided care is taken not to damage
concrete.

is the finished product. Proper
construction operation will result
le pavement.

.

its degree and speed of shrinkage, particularly important when joints are to be sawed.

JOINTS

(Slide 48) Joints seem to be somewhat of a mystery. They shouldn't be. Concrete, like any other rock-like material, adjusts itself to changes of temperature and moisture by cracking into small enough units as to limit stresses. This will normally result in slabs with dimensions of 15 to 20 feet out-of-doors. (Slide 49) Jointing does not eliminate cracking, rather it weakens the slab so as to force it to crack in a neat straight line rather than in an unsightly random pattern.

(Slide 50) Joints may be installed in plastic concrete by impressing as you see here. Much care and skill is needed to avoid creating a bump.

(Slide 51) Or, they may be sawed into the concrete shortly after it has gained some strength and hardness. Sawing eliminates the possibility of creating the bumps sometimes caused by hand-finishing methods. However, time of sawing is critical, and it must be done as soon as the concrete will accept the saw without excessive raveling of the joint. Any delay beyond this will see the formation of nature's "joints" occur before the man-made joints. After a crack has already occured, no further sawing should be done at that location. Transverse joints are normally spaced about 15 feet apart, and longitudinal joints about 12 feet. Reinforcement with mesh and dowels is not necessary.

(Slide 52) It is often desirable to box-out around manholes and catch-basins, returning at a later date to place concrete around the castings. (Slide 53) A good arrangement is to orient the box-out so that the corners coincide with both longitudinal and transverse joints.

CONCLUSION

(Slide 54) In answer to my question at the beginning as to how much equipment is needed to pave a concrete street, $500 will provide every basic item. This will include the following tools:

SLIDE 1

SLIDE 5

SLIDE 2

SLIDE 6

SLIDE 3

SLIDE 7

SLIDE 4

SLIDE 8

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SLIDE 9

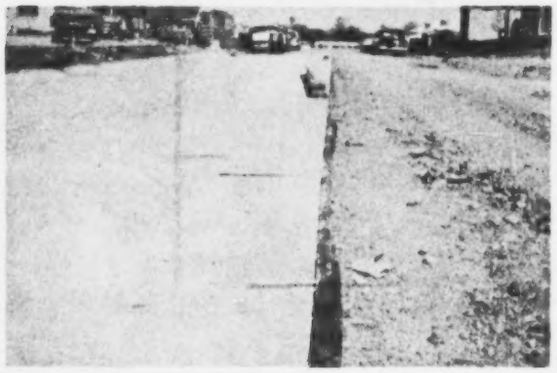

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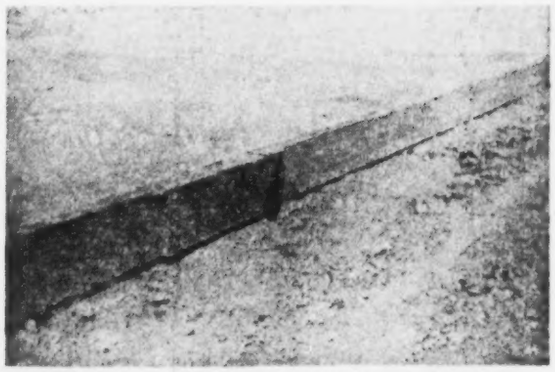

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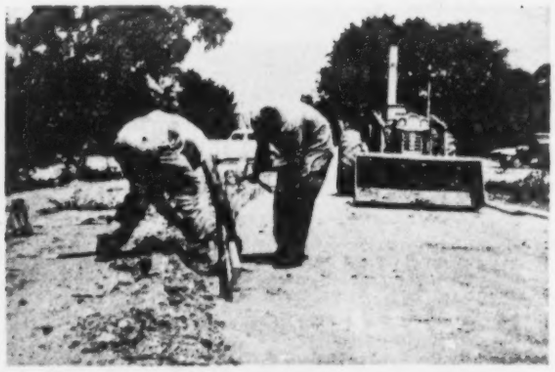

SLIDE 12

SLIDE 13

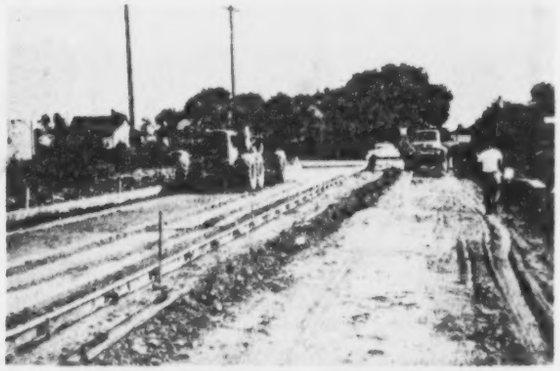

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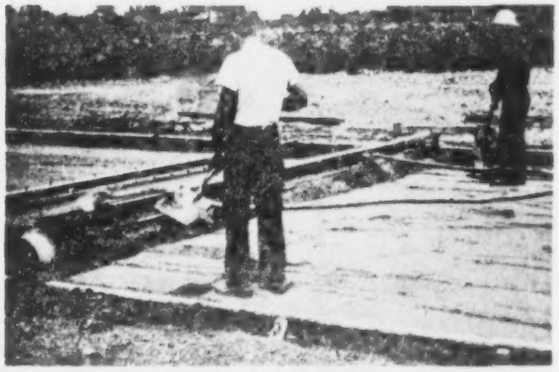

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SLIDE 16

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SLIDE 41

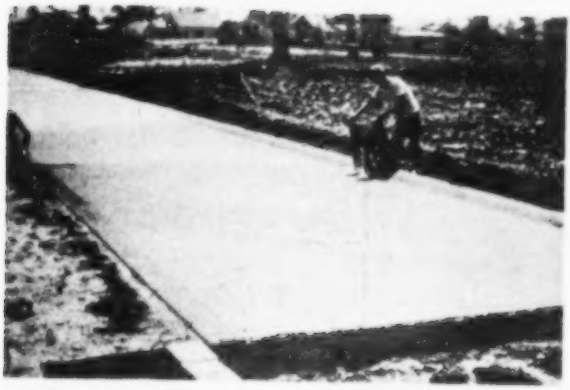

SLIDE 42

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LIDE 46

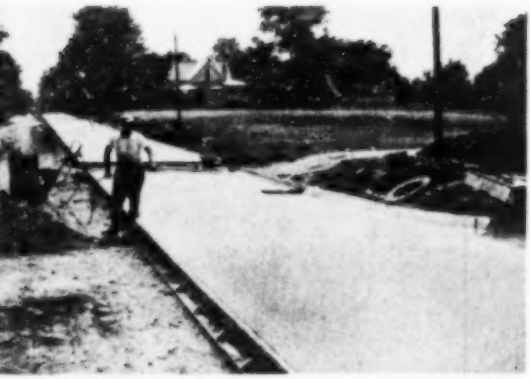

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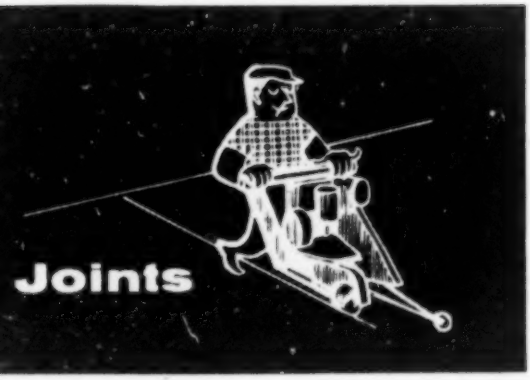

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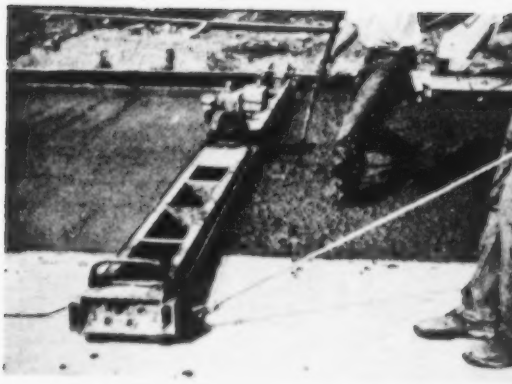

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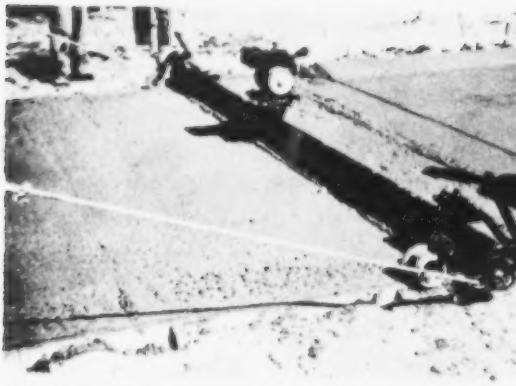

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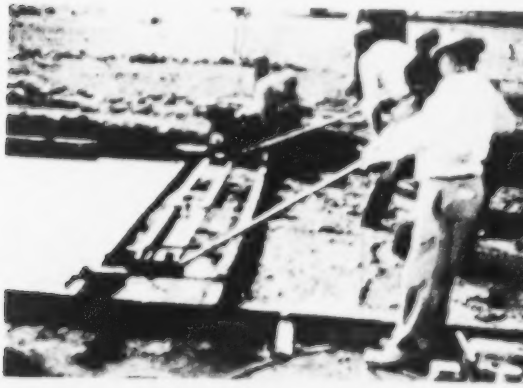

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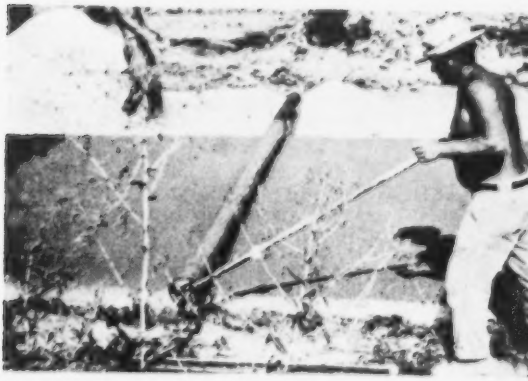

SLIDE 28

Weight & Balance
Zeph-Air 680
N 5436E
S/N 680 - 628-1

8/25/65
Supersedes computation on
FAA Form 337 of 7/30/64

Installed Item 412c, RCA AVQ-50 Weather Radar.

	Weight	Arm	Moment
Aircraft	3990 lbs.	174.6	696654.0
Radar	120 "	124.0	14880.0
	4110 "		711534.0

$$ECG = \frac{711534}{4110} = 173.1$$

Forward Loading Condition

	Weight	Arm	Moment
Aircraft	4110 lbs.	173.1	711441.0
2 pilots	340 "	94.0	31960.0
2 passengers	340 "	128.0	43520.0
8.5 gal. oil	64 "	191.0	12224.0
Min. fuel, 53.3 gal.	320 "	187.0	59840.0
	5174 "		858985.0

$$CG = \frac{858985}{5174} = 166.0'$$

Forward CG limit = 166.0'

Loading Subtotals

	Weight	Arm	Moment
Corrected Empty Weight	4110.0 lbs.	173.1	711
Usable oil 8.5 gal.	64.0 "	191.0	12
Pilot	170.0 "	94.0	16
	4344.0 "		739

(Use these subtotal figures when checking aircraft loading on loading chart

George B. Jones
George B. Jones
IA 272182

FIGURE 12.

Sample weight and balance revision for a typical light, twin aircraft. Note that computations are shown. Form is signed, dated, and identifies the computations or figures it supersedes.

SLIDE 29

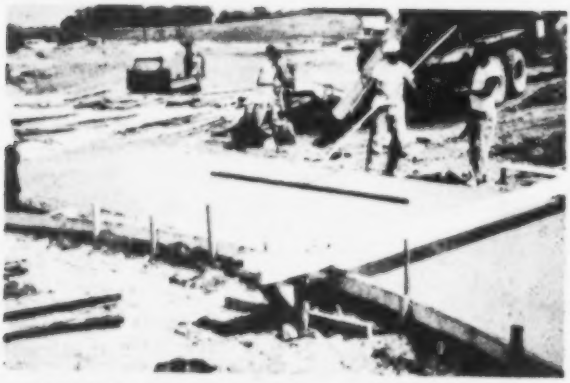

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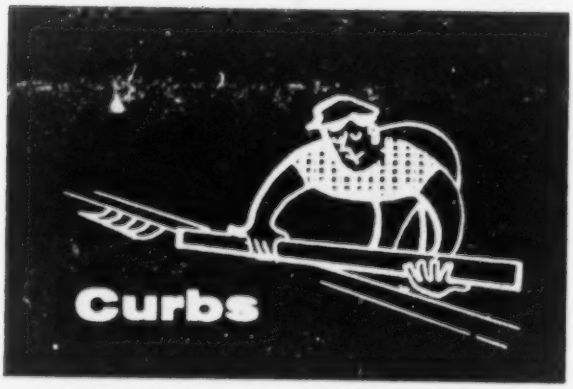

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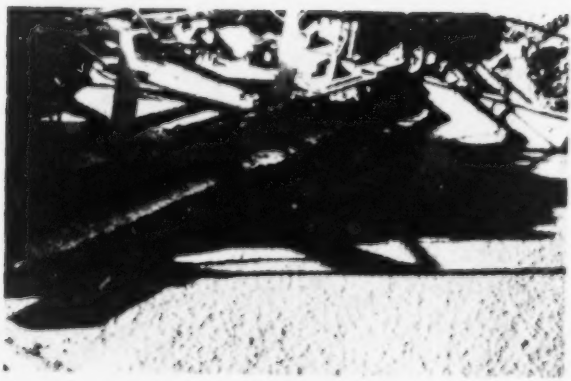

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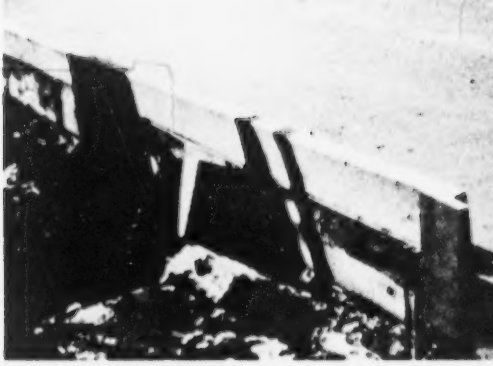

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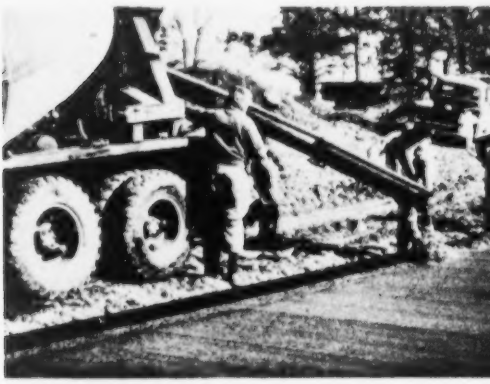

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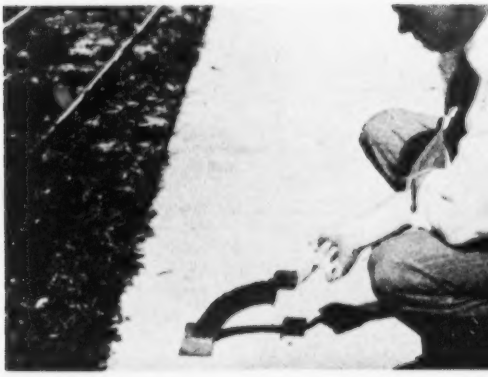

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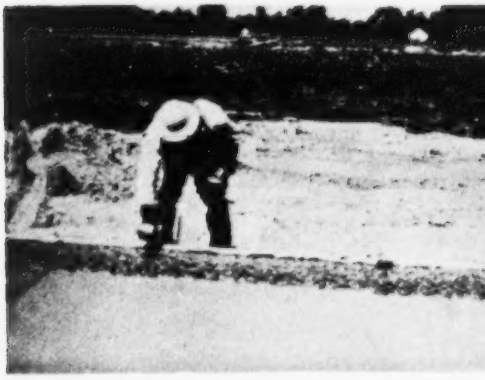

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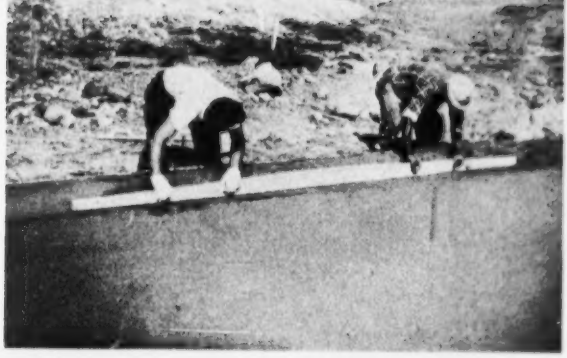

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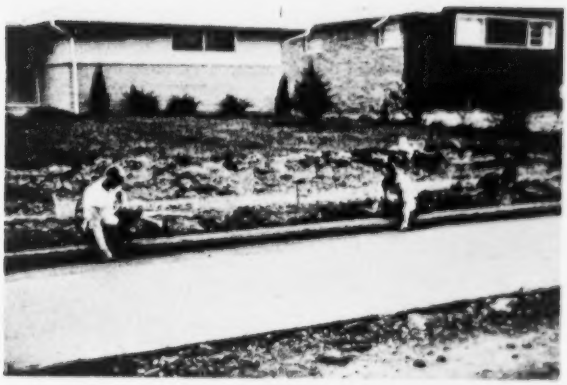

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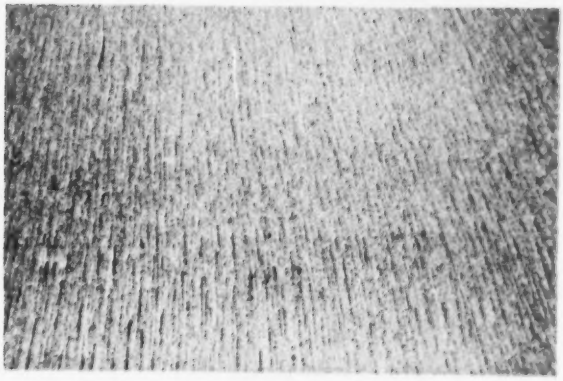

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21418

MICROCOPY RESOLUTIO
NATIONAL BUREAU OF ST

ON TEST CHART
TANDARDS-1963-A

TEXTS AND REFERENCES FOR UNIT V - PAVING

1. Asphalt Paving Manual (MS-8)

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710 (or nearest office)

2. Asphalt Surface Treatments and Asphalt Penetration Macadam (MS-13)

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710 (or nearest office)

3. Asphalt Mixed-in-Place (Road-Mix) Manual (MS-14)

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710 (or nearest office)

4. Specifications and Construction Methods for Asphalt Concrete (SS-1)

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710 (or nearest office)

5. The Asphalt Handbook (MS-4)

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710 (or nearest office)

6. Asphalts, Paving and Liquid

   The Asphalt Institute
   810 University Avenue
   Berkeley, California 94710 (or nearest office)

Note: Item 1 is required as a text by all students.

Items 2, 3, 4 and 5 should be available for use in the classroom.

Item 6 should be consulted for latest edition of asphalt specifications.

21422

UNIT VI - UTILITIES

A. General discussion of utilities in relation to total construction project

1. Reference to civil engineering drawings

   a. Site and site development plans

2. Verification of existence of utilities as indicated

   a. Locating on the building site

   b. Through local utility companies

   c. Checking easements

3. Installation of temporary facilities

   a. Electrical

   b. Water

   c. Sewage

4. Underground installation

   a. Coordination with site development

   b. Coordination with local utility companies

   c. Checking installations and verification of work by local authorities and utility companies

   d. Testing and inspection

5. Overhead installation

6. Back-filling of trenches

   a. Compaction requirements

   b. Types of back-fill allowed

21423

VT 013 307
Evans, Henry K., And Others
A Career in Traffic Engineering.

Institute of Traffic Engineers, Washington, D.C.
Automotive Safety Foundation, Washington, D.C.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 27p.

DESCRIPTORS - *VOCATIONAL EDUCATION; *CAREER OPPORTUNITIES; *INSTRUCTIONAL MATERIALS; *OCCUPATIONAL GUIDANCE; *CIVIL ENGINEERING; VEHICULAR TRAFFIC; OCCUPATIONAL INFORMATION; EDUCATIONAL OPPORTUNITIES; CAREERS; CAREER PLANNING

ABSTRACT - Intended primarily for persons interested in science and engineering, this booklet should be helpful for high school students making career choices related to traffic engineering. Highlights of job descriptions and educational opportunities are presented. (GB)

VT 013 307

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ED0 56238

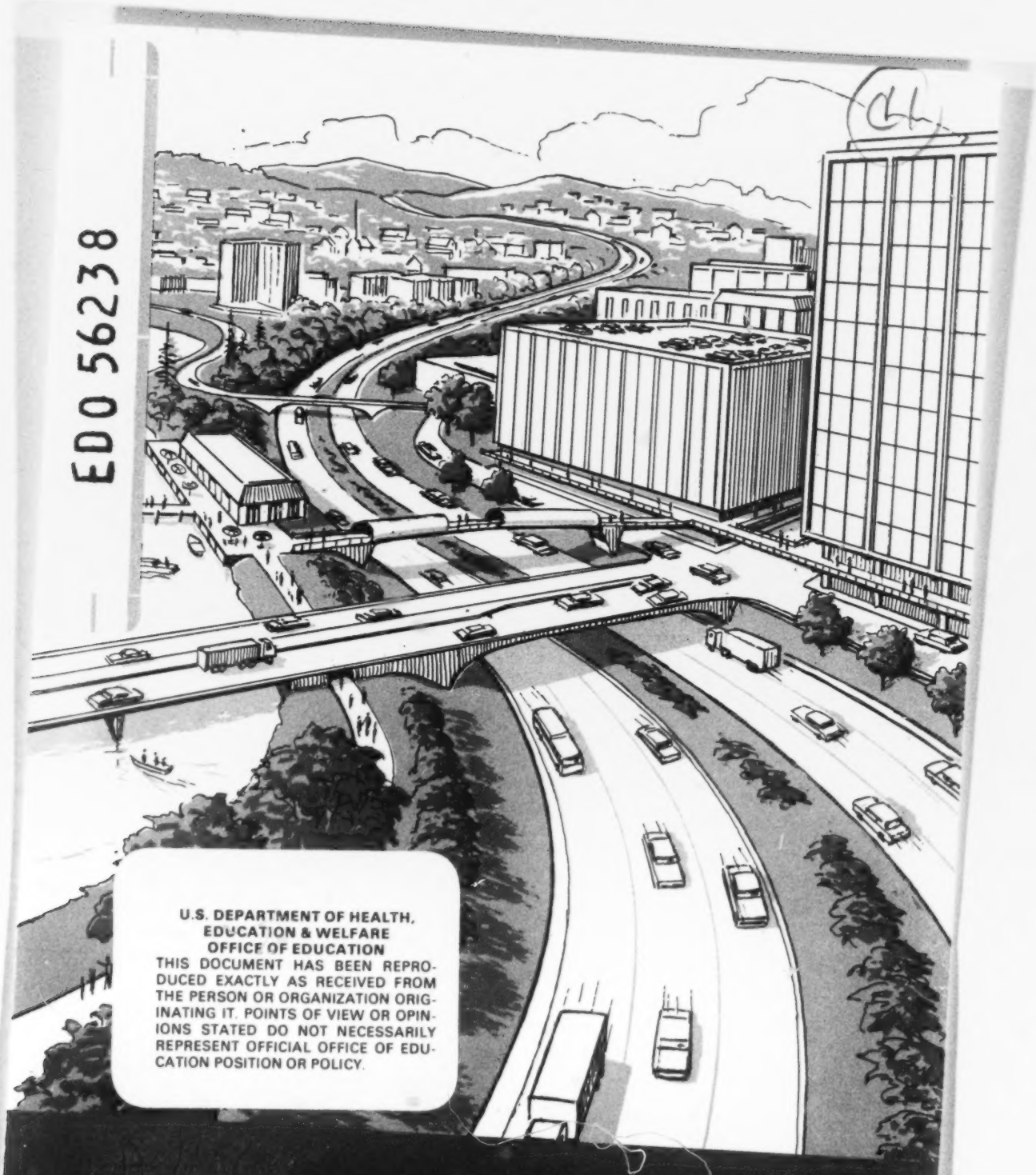

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
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A CAREER
in traffic engineering

21425

FOREWORD

This booklet is for young men and women in high school and for those entering college who are facing a key decision in life: choice of a career. It is intended primarily for persons interested in science and engineering, especially those who desire an understanding of traffic engineering and of the opportunities it offers as a profession.

The traffic engineer deals with the dynamics of the transportation system. His use of electronics, his concern with drivers and pedestrians, and the swiftly changing nature of his work all serve to make his a challenging and rewarding profession.

A 1963 survey found a shortage of over 1400 traffic engineers in the United States alone, additional to the 7000 then employed. The shortage is becoming greater. Increasing traffic problems here and in other countries make it abundantly evident that the need for traffic engineers will grow.

Traffic growth has long outpaced the building and widening of streets and highways. This situation seems likely to continue. Keeping ever-growing traffic moving with maximum safety and efficiency while helping to plan and bring into being needed highway improvements are the major tasks of traffic engineering.

The Institute of Traffic Engineers acknowledges with appreciation the assistance of the Automotive Safety Foundation in preparing both the earlier edition and this booklet. Financial support of publication by the Foundation and ITE Participating Organizations is also much appreciated.

The text of this edition was prepared primarily by an ITE Technical Council committee composed of Henry K. Evans (Chairman), Martin J. Bouman, George A. Hill and Adolph D. May, Jr.

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HISTORY 2
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DUTIES OF THE TRAFFIC ENGINEER 7
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FEDERAL LEGISLATION 15
REWARDS – PERSONAL & PROFESSIONAL 16
LEARNING TO BECOME A TRAFFIC ENGINEER 19
SOURCES OF INFORMATION 24

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(9) Sample loading computations may be helpful.

(10) On large aircraft, be careful to distinguish between empty weight and operating weights that may include items such as commissary supplies, spare parts, lavatory water, etc.

(11) On small aircraft it is often convenient to post a placard in the aircraft indicating the empty weight, useful load, and empty c.g. along with sample loadings or general instructions to cover the most likely used loading conditions. (Ref: FAR 91.31(b)(3).)

FIG. 1—Early road construction

FIG. 2—Lincoln Tunnel, New Jersey Toll Plaza

INTRODUCTION

At one time, there were only two kinds of professional engineers: *military engineers* who built and operated the buildings, structures and machines of the armed forces of those days; and *civil engineers* who applied their knowledge of materials, of laws of physics and energy, and of mathematics to all the other needs of civilization. This, in fact, is how the name "civil engineer" started.

As man learned more about the world around him and how to mold its resources to his needs, it became impossible for any one person to command all its accumulated knowledge. Specialized branches of engineering began to emerge. This process continues today and will tomorrow, as engineers proceed toward their goal of learning and applying knowledge to better our way of life.

Traffic engineering is one such specialized limb on the civil engineering branch of the tree of engineering. Its roots are in the common knowledge of mathematics and science. Its strength is in the trunk of engineering methods and discipline. Among the group of civil engineering limbs are traffic engineering, municipal engineering and highway engineering. The pages to follow will tell you more.

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HISTORY

Traffic engineering in a broad sense is the use of engineering principles and methods to help create or bring about safe, orderly and efficient highway transportation. It makes use of systems analysis and operations research. Although the profession is modern, it has precedents as old as vehicles on wheels. One-way streets, a familiar traffic engineering tool today, were used in ancient Rome. Five hundred years ago the Incas planned and built a "controlled access" highway in Peru which bypassed cities and villages. Traffic counts were made in London in the 1840's as an aid to street planning.

Modern traffic engineering, however, owes its impetus to the automobile, which brought great changes in our way of living. Many roads and streets which served the horse and wagon era well, proved unsuitable for large volumes of fast-moving motor vehicular traffic.

The rapid popularity of this new way of travel brought many things–not all of them good. The numbers of persons killed and injured in the use of the "horseless carriage" rose to alarming totals, and major urban streets often became jammed with vehicles.

FIG. 3–Traffic congestion in 1910. Dearborn & Randolph Streets, Chicago.

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In the early nineteen twenties, the first "traffic engineer" joined the highway engineer, planner and others seeking safe and efficient highway transportation. Planning, use-designing and managing safe, convenient trafficways for urban living offer a challenge to the best brain-power which traffic engineers can bring to this team.

Now the traffic engineer is a part of every state highway department in the United States and of most large city and metropolitan county governments. His job continues to grow in importance as highway transportation needs increase in magnitude and complexity. He has a part in planning, designing and operating the 41,000 mile National System of Interstate and Defense Highways–the biggest public works project ever undertaken. The traffic engineer, with traffic police, is responsible for the traffic management and operation of the system as more sections are opened for travel. He also participates in development of electronic equipment and other means to make freeway use safer and easier.

"Electronic drivers" may someday be as important on the highway as "automatic pilots" are in air transportation. When and if this comes about, the traffic engineer will have taken an active part in the development and will be the official in charge of operating such traffic guidance devices.

Every year the United States increases in population equal to another Chicago. Every year a million acres of "new city" are created. These people and this land must be served by streets and other travel facilities planned to provide the greatest transportation advantages while preserving the

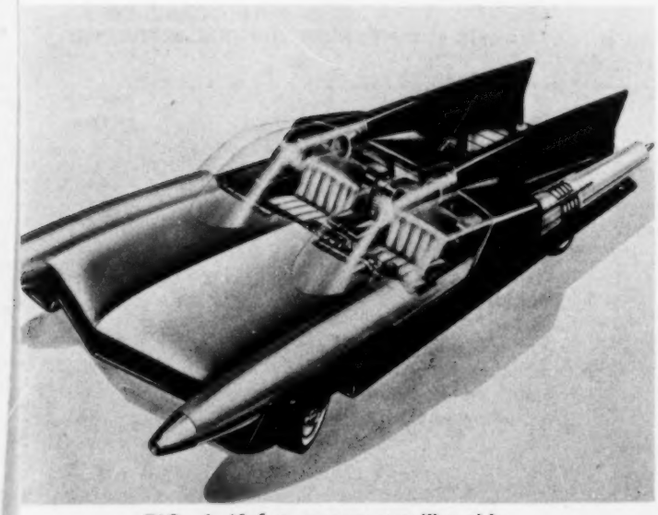

FIG. 4–If future cars are like this, how will traffic engineering be affected?

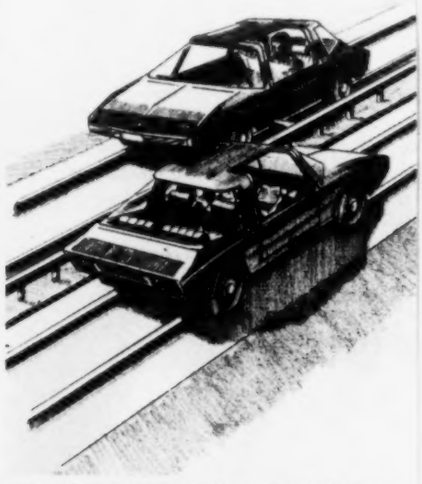

FIG. 5–Automatically guided "Urb-mobile", – a possible vehicle of the future.

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amenities of the city as a place to live and the efficiency of the city as a place to work. The traffic engineer is making important contributions in meeting this tremendous challenge: in analyzing the transportation values of alternative plans for major street systems, in establishing functional designs, and in supervising traffic operation over these systems when completed. Urban redevelopment, off-street parking, rapid transit systems, new shopping centers and airport expansions are creating additional demands for traffic engineers.

THE TRAFFIC ENGINEERING PROFESSION

The Institute of Traffic Engineers is the professional society of traffic engineers. Many also belong to the American Society of Civil Engineers, National Society of Professional Engineers, and other professional organizations. The statistics shown in Table I are from a survey of the United States membership of the Institute of Traffic Engineers. In August 1968, the Institute had over 3400 members.

The Institute of Traffic Engineers defines traffic engineering as "that phase of engineering which deals with the planning, geometric design and traffic operations of roads, streets and highways, their networks, terminals,

TABLE I

FIELD OF EMPLOYMENT OF ITE MEMBERS

Field of Employment		*Percent of Members**
All Governmental Employees		
State Highway Departments	24.0	
Cities over 250,000 population	14.8	
Cities, 100-250,000 population	4.9	
Cities under 100,000 population	5.1	
Governmental and Inter-governmental authorities	4.8	
Federal Agencies	4.6	
County Highway Departments	4.3	
Total -- All Governmental Employees	62.5	62.5
Engineering Consultants		20.4
Educational Institutions		6.8
Industrial Organizations		3.9
Other		3.6
Associations		2.8
		100.0

Source: ITE Analysis of Membership Records - 1967
*Includes all members except Students and Retired Members.

TABLE II

TIME SPENT BY THE AVERAGE MUNICIPAL, COUNTY, STATE, FEDERAL OR CONSULTING TRAFFIC ENGINEER ON VARIOUS ACTIVITIES

Activities	*Percent of Time*
Administration	40
Traffic Planning	17
Traffic Design	9
Signs & Markings	7
Traffic Signals	7
Research	6
Other	6
Other Highway Engineering	4
Sales and Purchasing	2
Teaching, Workshops and advanced studies	2
	100

Source: ITE Membership Survey - Revised 1967

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abutting lands and relationships with other modes of transportation for the achievement of safe, efficient and convenient movement of persons and goods." There are opportunities for many different applications of this field of knowledge as shown by Tables I and II.

EMPLOYMENT AND EDUCATION

Most traffic engineers are employed by government—city, state or federal—or by engineering consultants. Table 1 shows that Federal agencies employ modest numbers, but large cities and state highway departments employ about half of the practicing traffic engineers in the Institute. One of five Institute members is in consulting work and the use of such consultants is growing. Substantial numbers are engaged in teaching and research.

97% of all practicing traffic engineers have college degrees in engineering and a majority are registered Professional Engineers, proving their engineering knowledge by passing special examinations given by most states. Almost half of the practicing members of the Institute have taken university graduate training.

Qualified women hold responsible positions in varied activities of this profession.

ACTIVITIES

Table II presents another "average" picture of traffic engineering. It shows the relative time spent by the more advanced traffic engineers on specific activities. Those in charge of traffic engineering activities usually work in an organization with other people and often supervise the work of numerous other engineers and technicians. Report writing is an important ingredient of all activities shown in Table II. These aspects should be borne in mind in deciding what subjects to study in becoming a traffic engineer.

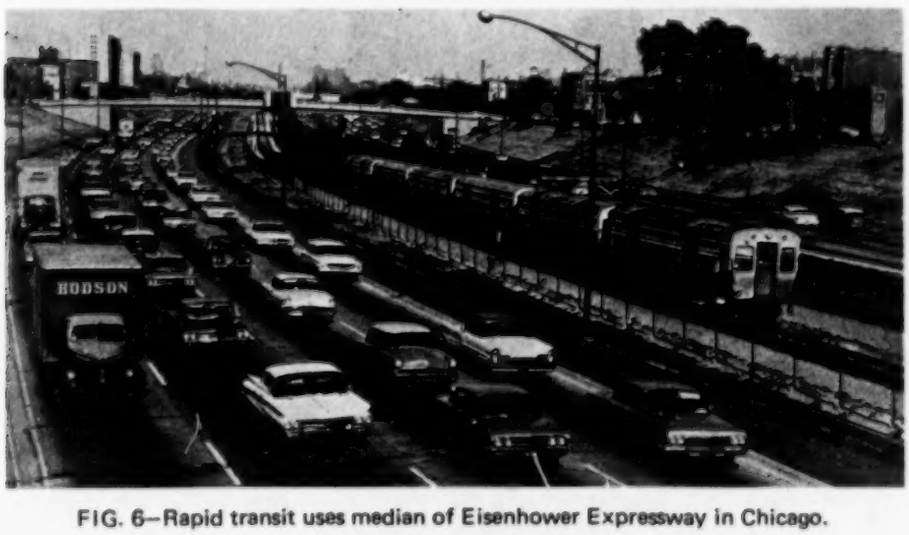

FIG. 6—Rapid transit uses median of Eisenhower Expressway in Chicago.

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FIG. 9

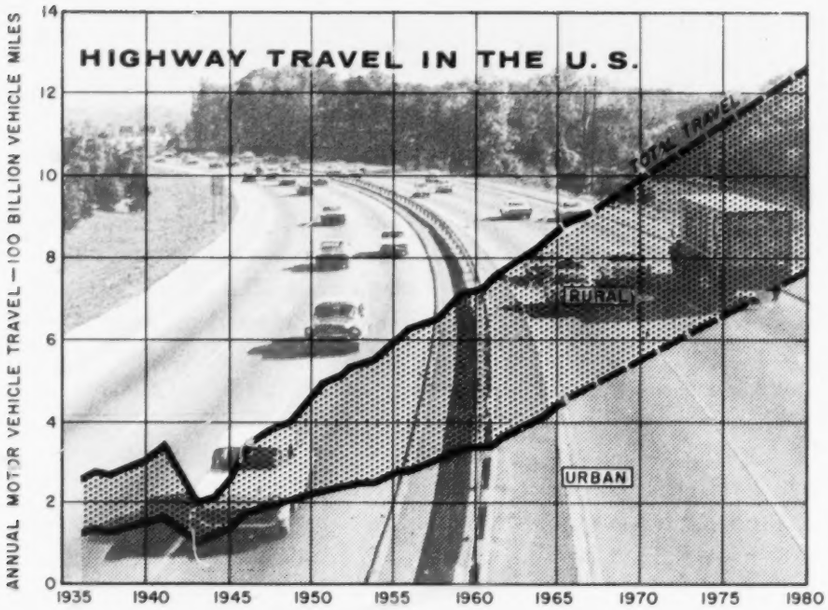

DUTIES OF THE TRAFFIC ENGINEER

The amazing growth of highway travel has created a great backlog of highway improvement needs. Thus, while the traffic engineer must constantly seek to improve efficiency of operations of today's over-crowded streets and highways, he is at the same time engaged in helping to engineer a tremendous program of new roads.

Some such activities require the use or study of: problem-solving techniques, higher mathematics, statistical methods, computer processing of data, human factors including capabilities and behavior of drivers and pedestrians, light, sound and physics; as well as design, economics and other subjects fundamental to highway engineering.

As the traffic engineer develops and gains experience, his authority and scope of work will usually increase. He may become the head of a major department as has happened in many governmental and private organizations. He will assume many administrative duties on such traffic-related matters as public transportation, parking, terminals, street construction and maintenance, and urban planning.

The traffic engineer's responsibilities and opportunities are many and varied. They cannot be completely described in a few words or a few pages. Nevertheless, the following pages will introduce four typical traffic engineers and will help you to understand kinds of work of traffic engineers.

Mr. A– City Traffic Engineer. He heads the Department of Traffic and Transportation in his city. On his desk in the morning is a report of a problem discovered the previous night in the traffic signal system

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LOCATION

Traffic engineers are at work in most large urban communities throughout the world. As people in less advanced parts of the world obtain and use motor vehicles more, the need for trained traffic engineers increases. For example, besides the federal and state governments and most cities of 50,000 to 100,000 population or more in the United States, official traffic engineering positions have been created by many cities, regions and nations in over 60 other countries.

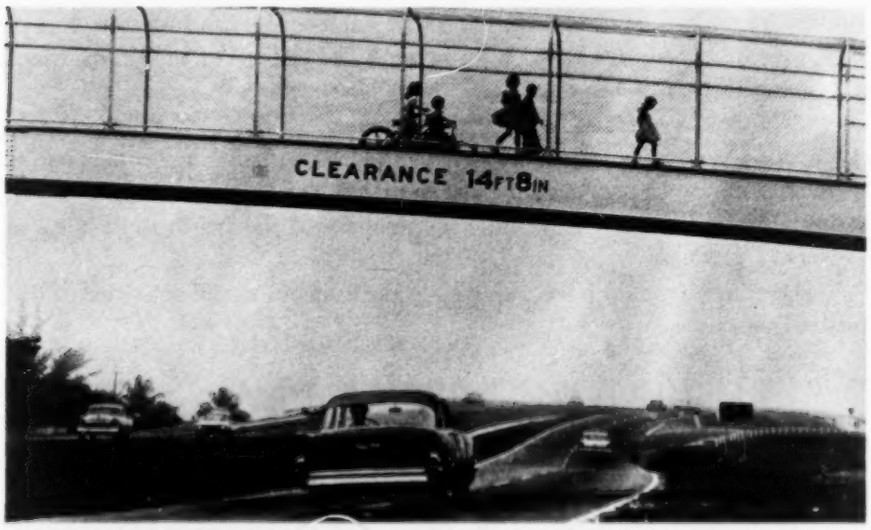

FIG. 7—Pedestrian overcrossings are one means of physically separating pedestrian and vehicular traffic, an increasingly necessary measure.

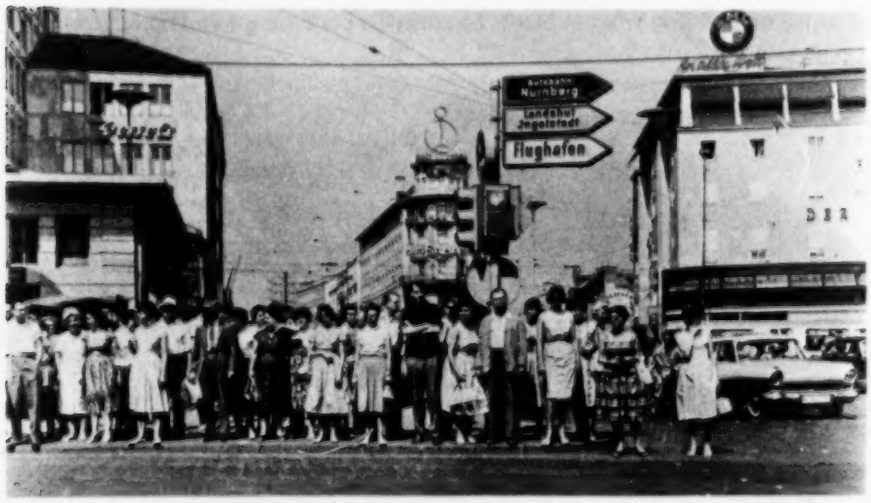

FIG. 8—If you select Traffic Engineering as a career, one of your responsibilities will be to assure that pedestrians reach their destinations safely and quickly, and to reduce conflicts between pedestrians and vehicles.

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Mr. C has responsibilities in highway planning, geometric design, construction and operations which affect the lives of all citizens of the state. He spent his morning with the highway design engineer going over the plans for a new highway. The designer is, to an extent, a traffic engineer too. The needs and abilities of the highway user are also in his mind. But he must consider all the physical parts of the highway as well to be sure that the road will be smooth, strong, easily maintained and a good investment of public funds. Therefore, he relies on State Traffic Engineer C to point out features which might confuse or endanger the driver; to advise him as to whether traffic signs can be effectively located if certain proposed road design features are used; and to tell him just where curbs and traffic islands should be placed at important intersections requiring channelization and traffic signals.

THE TRAFFIC ENGINEER PLAYS AN IMPORTANT PART IN STREET AND HIGHWAY TRANSPORTATION - FROM BEGINNING TO END BOTH IN RESEARCH AND APPLICATION

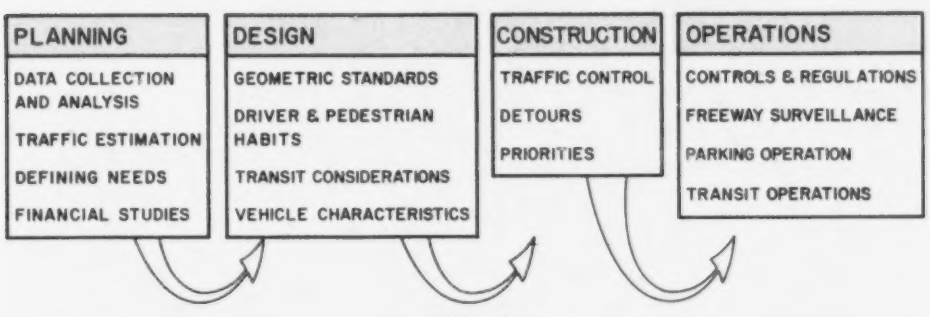

FIG. 16

Following this conference, Mr. C went with one of the assistant traffic engineers to inspect a rural cross road shown by accident records to be particularly dangerous. Traffic counts and studies plus the pattern of accidents had indicated that traffic control signals might have to be installed. The assistant engineer's detailed study, however, had brought to light other factors. Instead of signalization, which would require many cars to stop, he recommended widening the pavement for a few hundred feet and painting new lines so that left-turning cars could pull out of the lane of

FIG. 17
Accident investigation.

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SEEKING EMPLOYMENT

Opportunities in the traffic engineering profession are increasing rapidly. For years there have been more positions than qualified candidates to fill them. A shortage of 1400 highway transportation engineers was disclosed by an ITE survey in 1964. All indications – including expanding highway programs, population and travel growth, rapid development of urban areas – are that the deficiency of trained traffic engineers will grow for some years to come. Qualified job applicants are hence in the fortunate position that they can often select not only the type of employment but also the general location in which they wish to work.

Usually the young engineer enters the traffic engineering field through government employment although engineering consultants are offering increasing opportunities, some including experience in other countries. U.S. Civil Service Regional Offices and their local "boards" maintain a file of position offerings in their own and other locales. Notices in "Traffic Engineering" magazine and other engineering-oriented publications supply information on job opportunities. Also the Executive Director of the Institute of Traffic Engineers will be happy to recommend one or more names of practicing traffic engineers in your geographical area who may be willing to discuss traffic engineering and your interests and qualifications with you.

FIG. 36–Peak hour traffic at places having a large number of employees, often requires special study.

FIG. 37–If Shopping Center parking entrances and exits are designed properly, congestion on the access roads can be avoided.

fast through vehicles. This, plus the removal of some trees too close to the intersection (obstructing drivers' view) and an improvement in the illumination, was decided on as a far better solution. Later a recheck showed that the improvements did increase safety without sacrificing efficiency.

On the way home, Mr. C's thoughts turned to another problem --- the forthcoming hearings before the State Highway Commission on a proposed new freeway, which had excited much citizen interest, both pro and con. Mr. C would be called on to present the State's findings relative to improved traffic service for the State-supported route. He decided that as long as he was going to a college town for the hearings, he would arrange to confer with his friend, Professor D of State College.

FIG. 18—Controlled crash tests with anthropometric dummies, belted and unbelted, help greatly in guiding many decisions.

Professor D teaches Highway and Traffic Engineering at State College, and he is typical of many traffic engineers whose work is teaching and research. While most are on faculties of colleges and universities, some work for the federal government or national organizations; others work in industry, developing better traffic control and research methods and devices. In common with Professor D, they are all looking for answers to the many important problems yet unsolved in this field.

On the morning Mr. C's letter arrived concerning a conference, the professor was working with his advanced students on the safety values of belt restraining devices. Experimental vehicles equipped with carefully made anthropometric dummies in driver and passenger seats were being crashed against abutments and different types of guard rails to find out how best to protect the occupants from injury with seat belts of different designs and with variations in the interior design of the vehicle.

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FIG. 20—Testing of driver tension.

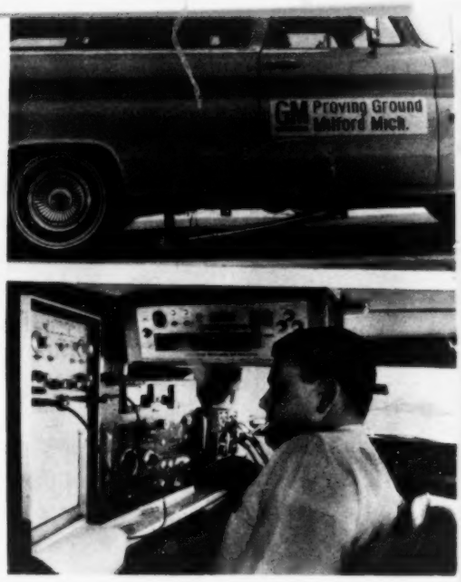

FIG. 21—Road surface smoothness testing.

More county governments are establishing traffic engineering agencies as the continuing trend toward concentration of people in metropolitan areas results in a "spilling out" beyond municipal boundaries and produces increasing traffic problems to such urbanizing areas on the fringes of cities. The day-to-day duties of the typical county traffic engineer have many elements in common with those of both the city and state traffic engineer. The county traffic engineer must also often diplomatically arrange for cooperation among municipalities within the county.

The federal government and other agencies are employing increasing numbers of traffic engineers in planning and research. Increasing federal programs of financial aid in highway development, traffic research and urban area planning have increased the need for federal leadership in techniques and standards.

FIG. 22—Motion pictures made of high congestion and accident locations are sometimes used to determine the type of improvement needed.

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APPENDIX 1. PUBLICATIONS

1. REGULATIONS.* The following list includes regulations the AI uses most frequently. Those marked with an asterisk should be available for reference when taking the test for Inspection Authorization.

PART NO.	FEDERAL AVIATION REGULATIONS (NEW) TITLE	PRICE
*65	CERTIFICATION: AIRMEN OTHER THAN FLIGHT CREWMEMBERS	.35
*43	MAINTENANCE, PREVENTIVE MAINTENANCE REBUILDING, AND ALTERATION	.55
* 1	DEFINITIONS AND ABBREVIATIONS	.45
*21	CERTIFICATION PROCEDURES FOR PRODUCTS AND PARTS	.60
*23	AIRWORTHINESS STANDARDS: NORMAL, UTILITY, AND ACROBATIC CATEGORY AIRPLANES	1.25
27	AIRWORTHINESS STANDARDS: NORMAL, CATEGORY ROTORCRAFT	.70
33	AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES	.40
35	AIRWORTHINESS STANDARDS: PROPELLERS	.30
37	TECHNICAL STANDARD ORDER AUTHORIZATIONS	1.00
*39	AIRWORTHINESS DIRECTIVES VOLUME 1, UNDER 12,500 LBS. VOLUME 2, OVER 12,500 LBS.	.20 5.25 6.00
45	IDENTIFICATION AND REGISTRATION MARKING	.20
47	AIRCRAFT REGISTRATION	.25
*91	GENERAL OPERATING AND FLIGHT RULES	1.25

* See Important Notice, Appendix 2, page 1.

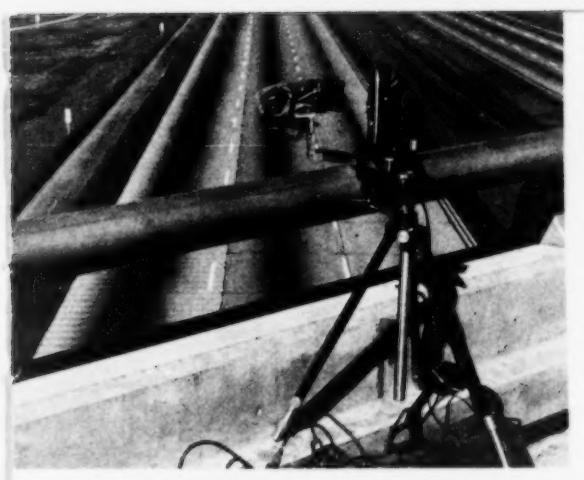

FIG. 23—Motion picture camera being used to study vehicle passing characteristics.

FIG. 24—Traffic and safety features of new road are checked during construction stage.

Many large metropolitan areas in the United States have established continuing transportation study agencies, employing traffic engineers and planners, in accordance with the Federal Highway Act of 1962 which requires such continuing study work.

FEDERAL LEGISLATION

The Highway Safety Act of 1966 and federal administrative provisions which call for considerable emphasis on traffic operational measures in urban areas, indicate increasing interest in the kinds of programs for which traffic engineers are responsible. These federal developments will greatly expand present traffic engineering programs, and will open doors to new applications for traffic engineering skills.

FIG. 25—Scale model shows how proposed highway improvements have been adapted to the community and to proposed developments

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TEACHING UNITS IN

Farm Machinery Safety

FOR

Vocational Agriculture Instruction

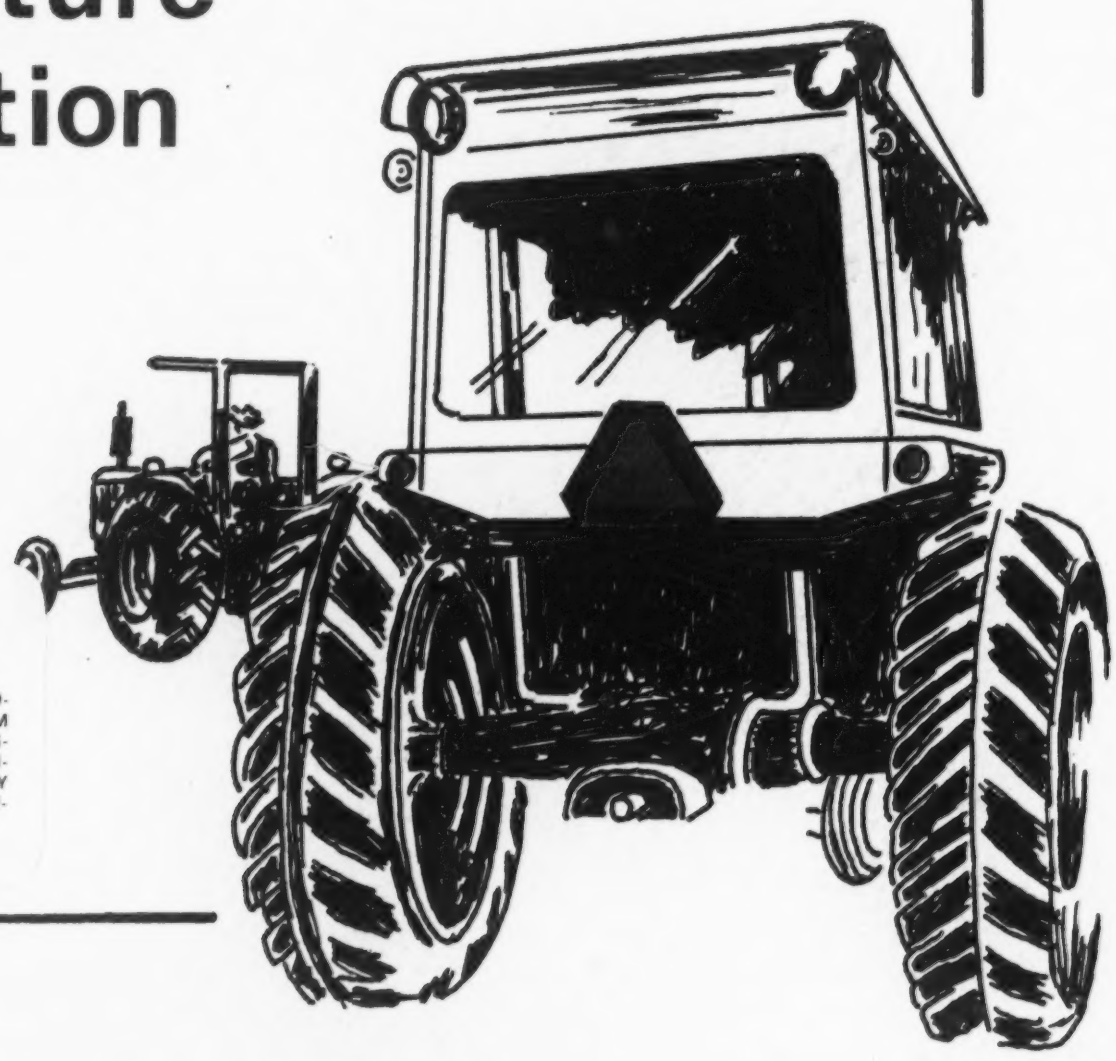

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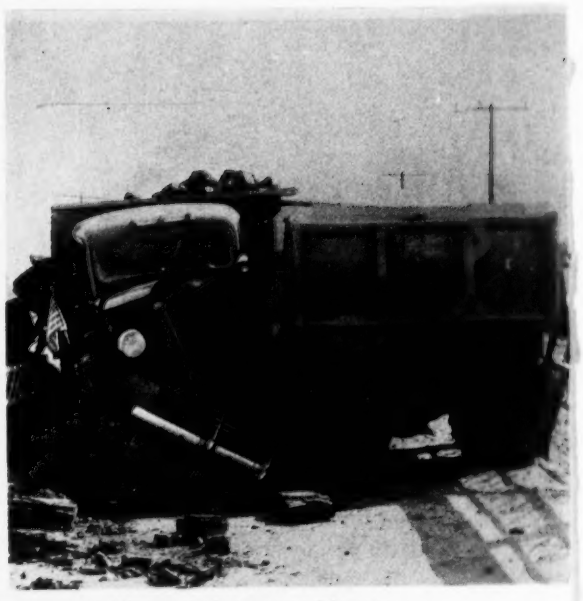

Snow emergencies and accidents can create traffic and detour problems.

FIG. 26 FIG. 27

REWARDS - PERSONAL AND PROFESSIONAL

The rewards for any work well done are measured in personal satisfaction and warranted recognition. One of the strong appeals of traffic engineering is knowledge of the many ways in which this work contributes to saving lives and reducing the human costs of traffic accidents. The traffic engineer also sees day-to-day evidence of results of his work in improved traffic flow and living conditions.

If you are one who wants to be "where the action is", consider who is responsible for making the instant decisions changing the flow of traffic when a snow storm makes some streets impassable, or when a major highway accident or other emergency requires traffic to be rerouted. When

FIG. 28—Many unusual traffic problems can arise to keep a traffic engineer busy.

Teaching Units

in

FARM MACHINERY SAFETY

for
Vocational Agriculture Instruction

Office of the State Superintendent of Public Instruction
Richard D. Wells

Division of Vocational Education
Don E. Pennington, Director

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March, 1970

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police, fire equipment and ambulances are necessary at a large conflagration, who directs them as to emergency routings, changes in traffic plans and operations? Usually the traffic engineer makes these decisions and takes these steps, or his advice to others results in these emergency actions.

Traffic engineering offers financial and other rewards in abundance. Almost immediately the young traffic engineer will find that he is given tasks which call for individual judgment, and which well done, provide a sense of accomplishment and service to his fellow men. At first, of course, he will have assistance and supervision by more experienced engineers. But, as he proves himself, he will be given more responsibility and later will supervise other engineers and technicians.

FIG. 29—Traffic engineers and other municipal officials discuss traffic problems of mutual interest at a regional workshop.

FIG. 30—Traffic engineers discuss needed traffic improvements.

He will be in contact frequently with traffic committees and boards as well as the public, and his recommendations and actions will be publicized often in newspapers and on radio and TV.

The U.S. Bureau of Public Roads and several state highway departments offer in-service training programs wherein the young engineer gains experience in a variety of jobs: design, construction, traffic studies, computer programming, material testing, etc. At the end of the training program, he selects the field of greatest interest to him. Cities and states often help their employees obtain graduate training in traffic engineering.

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controlling downtown traffic. The electronic computer which adjusts the signal timing to meet traffic changes did not perform well after the big show at the auditorium. Though the computer works fast and accurately, it cannot think for the engineer.

The auditorium situation was a special one requiring additional facts and study. Mr. A assigned the task of obtaining the needed data to his traffic survey engineer. He then left his office to attend a meeting of the City Planning Commission. An urban renewal project for the out-of-date wholesale district would require changes in the street pattern. His transportation planning staff had studied the kinds and numbers of vehicles these streets would be serving, and the traffic effects of proposed street pattern changes. One of his long-range studies, made 2 years before, had anticipated this very development.

At lunch, Engineer A was the speaker at a downtown businessmen's meeting. He told the group about current problems frequently referred to him involving requests for such things as changed curb parking regulations, more off-street parking and installation of traffic signals. Looking toward the future, he also told of plans underway aimed at establishing a freeway surveillance system to monitor traffic on the new city freeway, regulate its use and vary the speed limits in accordance with traffic and weather conditions. Mr. A described how the use of closed-circuit TV cameras for visual monitoring and vehicle detectors on the freeway operating in conjunction with an electronic computer, would greatly increase safety and facility of freeway operation.

During the afternoon, Mr. A studied and approved the report of his traffic operations engineer on an improved arrangement of signs and pavement markings to protect children at school crossings. Lieutenant Jones, head of the Traffic Division of the Police Department, had pointed out the need for these new standards from reports of his patrolmen.

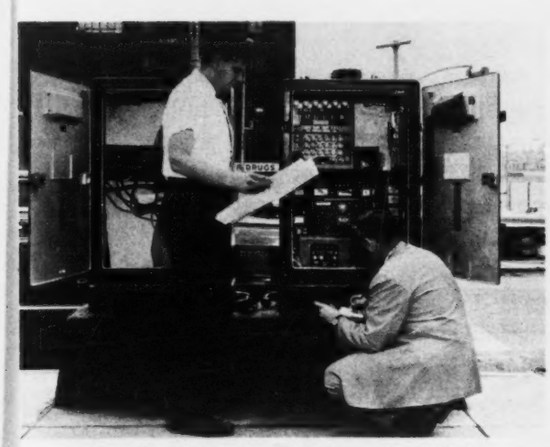

FIG. 10—Technician modifying signal timing.

FIG. 11—Sign messages need to be concise, yet easily understood.

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FIG. 12—Traffic surveillance control center, John C. Lodge Freeway, Detroit.

The last assignment that day was an appointment with Mr. B, Consulting Traffic Engineer. Mr. B's firm was hired to locate and provide functional design for a new freeway to be built in the city, mainly with state and federal funds. To assure that there would be enough lanes and ramps at the right places, he needed traffic counts and other data from Mr. A. These figures would be adjusted to account for growth and changes in traffic patterns which would take place in years to come.

This was one of several projects Mr. B was supervising. His firm provides expert traffic engineering service to cities, highway departments and private organizations in several states and occasionally to foreign countries. Mr. B naturally moves around quite a bit. On the previous day he had been in a nearby city advising a shopping center owner on how best to design for all the pedestrian, service, truck, and private car traffic his center would attract.

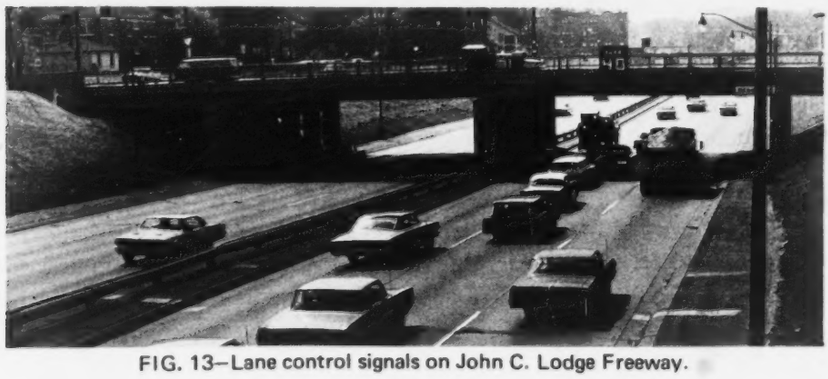

FIG. 13—Lane control signals on John C. Lodge Freeway.

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FIG. 14—Traffic survey to obtain information on drivers' origins and destinations.

FIG. 15—Motorist being interviewed in O.D. Study.

The next day at his office, Mr. B inspected the first results of a traffic origin-destination survey just completed. In this study, motorists on several roads were interviewed as to their trips: where they started, where they were going, and how often they travelled that route. The purpose of this study, which Engineer B had planned and supervised, was to find out whether a proposed toll bridge would carry enough traffic to be economically sound, and if so, which of several possible locations would be best.

Before he finishes this study, Mr. B, Traffic Consultant, will need a lot of help. Bridge engineers will study the locations he selects and make preliminary bridge design decisions to permit reasonably correct estimates of the costs of buying needed land at each location and of building the bridge. Assistance of planners and economists will be required in predicting future land use and economic development, as well as computer programmers and data analysts to aid in projecting and assigning future traffic. Mr. B will put all this information together in reaching his final recommendations.

Near the end of the day, Mr. B telephoned a professional friend, Mr. C, State Traffic Engineer. Mr. C is in charge of the Division of Traffic and Planning in the State Highway Department. Since this state is large, he has Traffic Engineers as assistants in different parts of the state to help supervise traffic operation on several thousand miles of state highways.

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After lunch, Professor D has time for his favorite project. He knows that water flows through a pipe according to definite laws of physics. An apple falls from a tree according to the law of gravity. In card games, predictions can be made by the statistical laws of chance. Professor D is trying to improve on the "modal splits" equation used to estimate how many people will utilize public transit vs. private autos in planned future metropolitan transportation systems. People make choices and act based on many factors and considerations. All of the values of statistics and higher mathematics available to Professor D including the University's giant electronic computer, have not produced a fully satisfactory mathematical model yet; but he is not discouraged. Already the things that he has learned in trying to develop a more perfect "law of traffic flow" have helped Messrs. A, B and C in their work as professional traffic engineers.

FIG. 19—Computerized traffic control system in San Jose, Cal.

RESEARCH

Research is an important part of the work of consultants and specialists in federal agencies as well as of many other traffic engineers who, in addition to their regular duties, search for new knowledge to do their jobs better.

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The young traffic engineer can be assured of adequate financial rewards similar to other engineering and professional positions and higher than most non-engineering pursuits. The increasing shortage of engineering personnel has caused a healthy rise in starting salaries so that most engineering college graduates are earning more than most of their contemporaries. The steady increase in the traffic engineer's earning ability as he gains experience (see graph below) will be very satisfying.

As in other professions, individual ability counts most and outstanding individuals find great opportunities in traffic engineering for increases in responsibility, service and income. The figures in the graph below may be useful for comparison purposes. However, they should be considered thoughtfully. For example, as engineering salaries are rising, the 1967 figures in this chart will soon be outdated. Moreover, no attempt has been made in this chart to evaluate "fringe" benefits such as retirement plans and other privileges, which are often substantial.

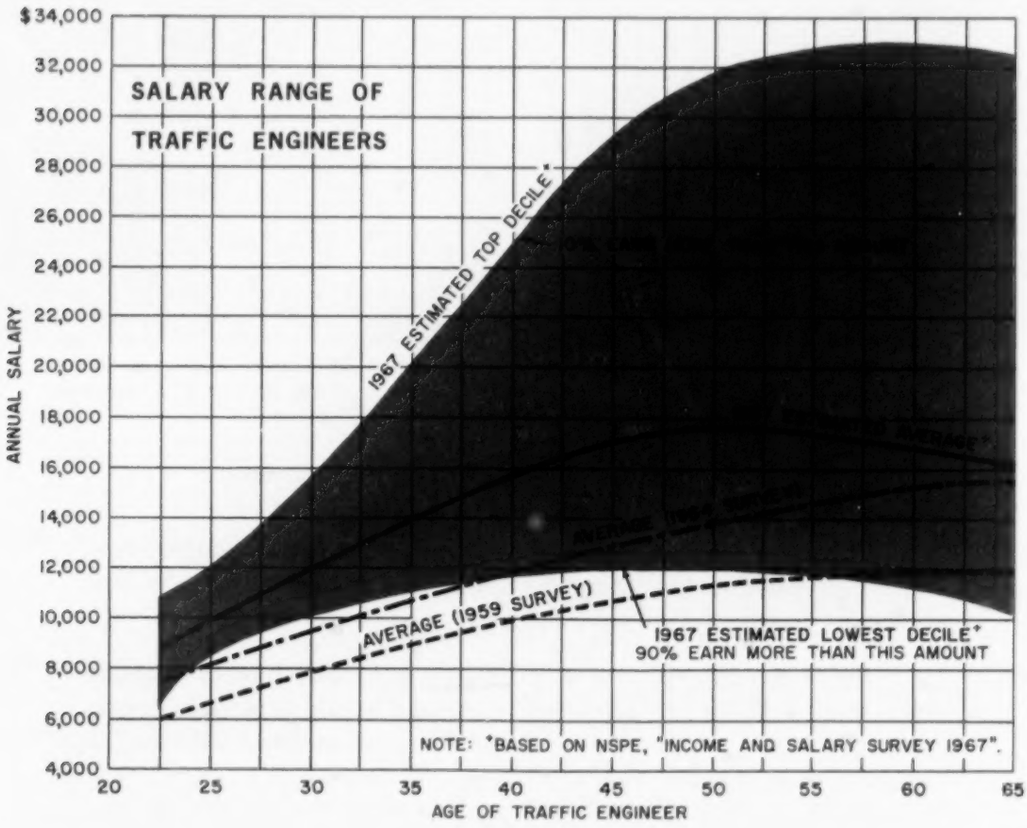

FIG. 31—Table of Salary Graphs

LEARNING TO BECOME A TRAFFIC ENGINEER

A person who has finished school without traffic engineering training can often "learn on the job" by obtaining employment where he will be assigned to work under a traffic engineer. Or if he has a college degree in engineering or science, he can seek admission to a graduate program in traffic engineering. In-service training courses, given for short periods by agencies such as the Institute of Traffic Engineers, employers and educational institutions, can be helpful and deserve consideration, especially if college level training cannot be obtained. However, the best preparation for becoming a traffic engineer is to obtain the proper education in high school and college.

HIGH SCHOOL The foundation for traffic engineering begins in high school. Almost all traffic engineers are college graduates and your high school advisor can tell you how a student must prepare in high school to meet the entrance requirements of engineering colleges. You can take further beneficial steps in preparing for traffic engineering by studying civics and government and by improving your ability to speak and write well. These skills are important, as well as skills in engineering and science.

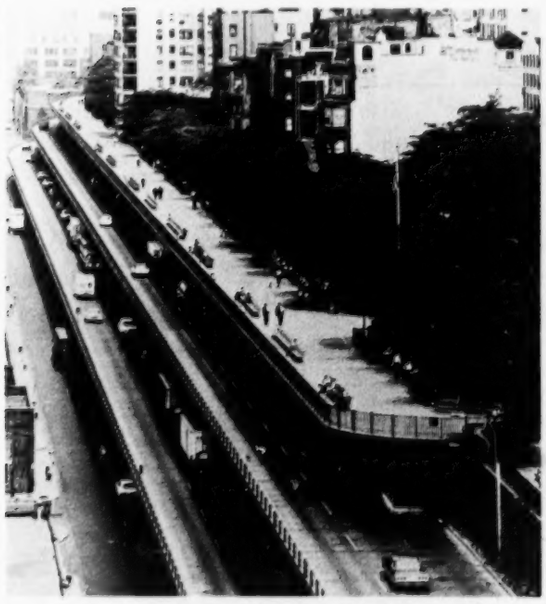

FIG. 32—Careful planning has provided an attractive promenade and play area while meeting vehicular traffic needs effectively.

FIG. 33—It might well become one of your jobs "Prospective Traffic Engineer", to plan the main stream routings for sports spectators.

21445

VT 013 309
Biery, Gordon
Farm Machinery Safety for Vocational Agriculture Instruction. (Teaching Units).

Indiana State Office of the State Superintendent of Public Instruction, Indianapolis.
MF AVAILABLE IN VT-ERIC SET.
Vocational Instructional Materials Laboratory, School of Technology, Indiana State University, Terre Haute, Indiana 47809.
PUB DATE - Mar70 98p.

DESCRIPTORS - *AGRICULTURAL EDUCATION; *VOCATIONAL AGRICULTURE; *AGRICULTURAL MACHINERY; *AGRICULTURAL SAFETY; *TEACHING GUIDES; AGRICULTURAL ENGINEERING; SAFETY EDUCATION; SECONDARY GRADES; BIBLIOGRAPHIC CITATIONS; FILMS

ABSTRACT - Intended for vocaticnal agriculture teachers in teaching farm machinery safety for secondary grades, this teaching unit was developed by the Indiana State Office of Public Instruction. The unit includes 21 lessons which should take from 25 to 35 hours for instruction. Each lesson includes teaching suggestions, objectives, motivation techniques, and questions for discussion and tests. References and film listings are appended. (GB)

VT 013 309

2. TECHNICAL DATA. The following should be available when taking the AI test:

a. Aircraft Type Certificate Data Sheets and Specifications. Basic subscription consists of specifications and type certification data sheets in all weight groups; monthly supplements for approximately one year; the Aircraft Listing; and Index. Prices: $20.00 domestic; $25.00 foreign. Order from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

b. Aircraft Engine and Propeller Type Certificate Data Sheets and Specifications. Basic subscription consists of engine and propeller specifications; monthly supplements for approximately one year; the Listings; and Indexes. Prices: $16.00 domestic; $20.00 foreign. Order from GPO.

c. The Airworthiness Directives are now summarized in two volumes, one covering small aircraft and the other large aircraft. Each volume may be purchased separately on subscription which consists of the basic volume plus annual supplements.

(1) Summary of Airworthiness Directives for Small Aircraft. Volume I, $5.25 domestic; $6.50 foreign. Order from GPO.

(2) Summary of Airworthiness Directives for Large Aircraft. Volume II, $6.00 domestic; $7.25 foreign. Order from GPO.

d. Acceptable Methods, Techniques, and Practices. These advisory circulars replace the policy material formerly contained in CAM 18. Order from GPO.

(1) AC 43.13-1, Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, $3.00 domestic; $4.00 foreign.

(2) AC 43.13-2, Acceptable Methods, Techniques, and Practices - Aircraft Alterations, $2.00 domestic; $2.50 foreign.

3. ORDERING FARs AND TECHNICAL DATA. Orders for the FARs and technical data should include remittance by check or money order made payable to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Except where otherwise designated, orders from foreign countries should include an additional amount of about one-fourth the purchase price to cover foreign postage. Remittance should be by International Money Order or by a draft on a U.S. bank.

21446

COLLEGE If your career goal is traffic engineering, your choice of college is important. First, you should select one with a strong engineering program and one which offers undergraduate courses in the highway and traffic field. Your high school advisor, the engineering faculty of many colleges and universities, and the Institute of Traffic Engineers can help you with this choice. There are many fine schools offering such instruction, including the following:

Notes: Letter g denotes graduate courses only. The list may be incomplete, particularly for schools outside the U.S. or schools with a recently added transportation curriculum. Almost all of the U.S. colleges and universities listed have a member of the Institute of Traffic Engineers on their faculty. For many colleges and universities outside the United States, the same is true and the number for which it is true is growing.

United States
Arizona State University
Arizona, University of
Arlington State College
Brooklyn, Polytechnic Institute of
California, University of (Berkeley)
Catholic University of America
Carnegie Institute of Technology
Cincinnati, University of
Clemson University
Colorado, University of
Connecticut, University of
Cornell University
Delaware, University of
Georgia Institute of Technology
Harvard University[g]
Idaho, University of
Illinois, University of
Iowa State University
Kansas State University
Kentucky, University of
Louisiana State University
Marquette University
Massachusetts Inst. of Technology
Massachusetts, University of
Michigan State University
Michigan Technological University
Michigan, University of
Minnesota, University of
Missouri, University of
New Mexico, University of
New Mexico State University
New York, State University of (Buffalo)
North Carolina State University
Northwestern University
Ohio State University

FIG. 34—Night photographs are sometimes used in traffic movement studies.

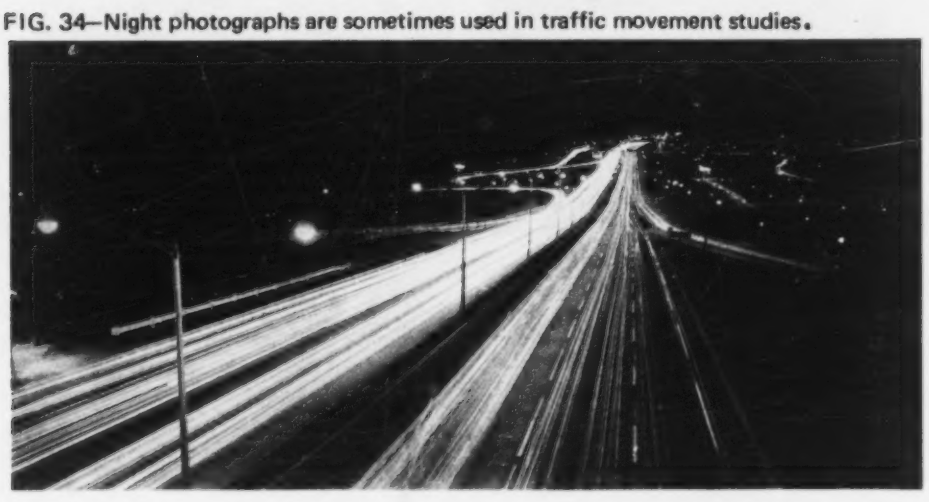

FARM MACHINERY SAFETY
...Tractor

(R)

I. Teaching Unit I . . . Importance of Tractor Safety

II. Suggestions for Teaching:

A. Show film, "Farm Tractor Safety - A Family Affair."

B. Have students make a local survey of tractor accidents in the past year.

C. Collect additional data on tractor accidents - local, state and national.

D. Save newspaper and magazine articles on tractor accidents.

E. Have reaction time demonstrations - See Farm Safety Memo S-49, Pg. 2.

III. Objective:

To develop the students' awareness of the importance of tractor safety.

IV. Motivation:

A. Show the film, "Farm Tractor Safety - A Family Affair."

B. Accidents kill more young people than all diseases.

C. Accidents never just happen, they are caused.

D. Do reaction time demonstration, see memo S-49.

E. According to the 1966 Indiana Farm Accident Report, from 1956 1964, 386 people were killed in accidents involving farm tractors. There were about 14,000 tractor accidents during this time in Indiana and over 33% of them involved persons under twenty years of age.

F. Discuss local data collected.

G. Here are some famous last words:

- It can't happen to me.

- I can get by this time.

- I've got a special way.

- I don't have time for safety.

21447

Oklahoma, University of
Oklahoma State University
Oregon State University
Pennsylvania State University–
Bureau of Highway Traffic
Purdue University
Rensselaer Polytechnic Institute
San Diego State College
San Jose State College
South Carolina, University of
Tennessee Technological University
Tennessee, University of
Texas, University of
Texas A&M University
Tulane University
Utah State University
Utah, University of
Villanova University
Virginia Military Institute
Virginia Polytechnic Institute
Washington, University of
Washington State University
Wayne State University
West Virginia Institute
West Virginia University
Wisconsin, University of
Wyoming, University of

Australia

New South Wales, University of [g]

Brazil

Instituto De Pesquisas Rodoviarias[g]

Canada

Alberta, University of
Carleton University
Manitoba, University of
McGill University
New Brunswick, University of
Queen's University
Saskatchewan, University of
Toronto, University of
Waterloo, University of
Western Ontario, University of

Germany

Lehrstuhl und Institut für
Verkehrswirtschaft, Hannover[g]
Technische Hochschule, Braunschweig
Technische Hochschule, Karlsruhe
Technische Universität, Berlin

Iran

Pachlavi University

Lebanon

American University of Beirut

Philippines

Philippines, University of

Sweden

Institute fur Orts-Regional and
Landesplanung, ETH
Royal Institute of Technology

Switzerland

Ecole Polytechnique do l'Universite
de Lausanne–EPUL

Thailand

SEATO Graduate School of Engineering
Bangkok[g]

Turkey

Ege Ozel Mimarlik ve Muhendislik
Yuksek Okulu-Buca-Izmir
Middle East Technical University,
Ankara
Technical University of Istanbul

United Kingdom

Birmingham, University of
Bradford, University of[g]
Glasgow, University of (Scotland)
Imperial College, University of
London[g]
Leeds, University of
Liverpool, University of
Manchester, University of
Newcastle Upon Tyne, University of
Nottingham, University of
Sheffield University
Strathclyde, University of (Scotland)

Venezuela

Universidad Central De Venezuela

Yugoslavia

University of Belgrade

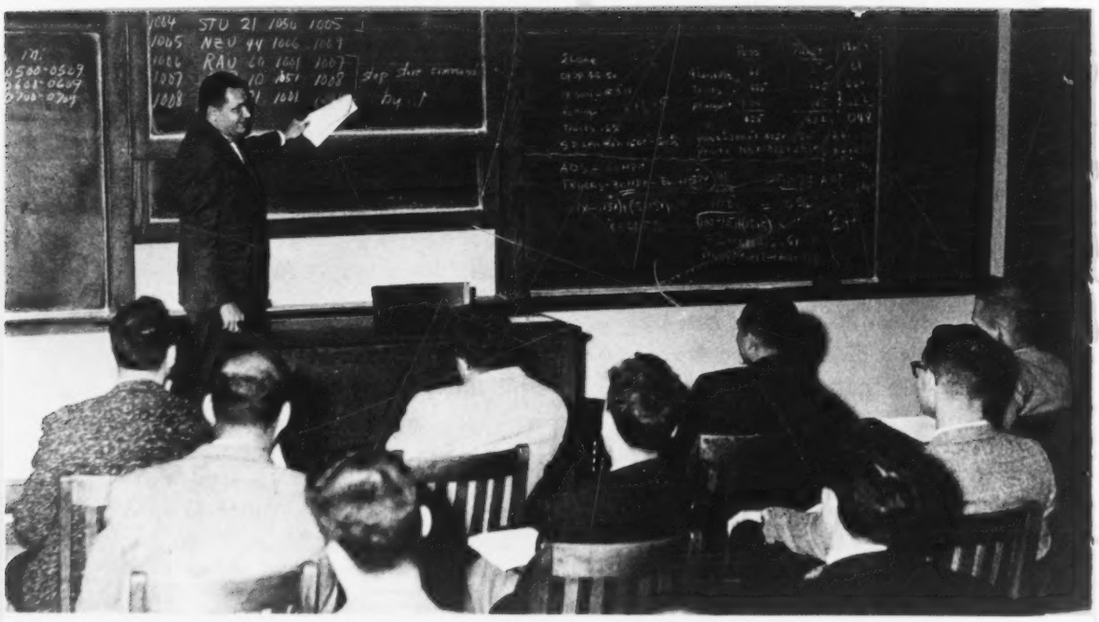

FIG. 35—Many Universities offer a curriculum in Traffic or Transportation Engineering.

Engineering curricula which offer elective courses in such subjects as transportation planning, geometric design and traffic characteristics will not leave much time for other elective subjects. However, courses in statistics, psychology, law, public administration, engineering report writing, public speaking and personnel management, will all be helpful in the practice of traffic engineering.

GRADUATE STUDY Many traffic engineers continue their formal education beyond college graduation. This is not necessarily done immediately upon graduation, as often a few years of practical experience make such graduate study more meaningful. Approximately 40 percent of traffic engineering graduate students have been supported with fellowships; an equal number have had other kinds of financial support such as teaching assistantships or employer support. The Institute of Traffic Engineers will gladly furnish you with information as to available fellowships.

The opportunity for graduate traffic engineering study is now available at a number of colleges or universities. Your own Alma Mater, your employer, or the Institute of Traffic Engineers can assist you in making your selection. Many of the schools previously listed offer graduate traffic engineering courses.

SOURCES OF INFORMATION

The Institute of Traffic Engineers is one of a number of organizations interested in the traffic engineering profession. The organizations and publications listed hereinafter can provide you with further information and answer your questions about the field.

HIGHWAY TRANSPORTATION RELATED ORGANIZATIONS

American Association of State Highway Officials
341 National Press Building, Washington, D.C. 20004

American Public Works Association
1313 East 60th Street, Chicago, Illinois 60637

American Road Builders' Association
525 School Street, S.W., Washington, D.C. 20024

American Transit Association
815 Connecticut Avenue, N.W., Washington, D.C. 20006

Automotive Safety Foundation
200 Ring Bldg., Washington, D.C. 20036

Bureau of Public Roads
Federal Highway Administration
U.S. Department of Transportation
Washington, D.C. 20591

Highway Research Board
2100 Pennsylvania Avenue, N.W., Washington, D.C. 20006

Insurance Institute for Highway Safety
Watergate Office Building, 2600 Virginia Avenue, Washington, D.C. 20037

International Association of Chiefs of Police, Inc.
1319 18th Street, N.W., Washington, D.C. 20036

International City Managers Association
1140 Connecticut Avenue, N.W., Washington, D.C. 20036

International Road Federation
1023 Washington Bldg., Washington, D.C. 20005

National Association of Counties
1001 Connecticut Avenue, N.W., Washington, D.C. 20036

National Highway Safety Bureau
Federal Highway Administration
U.S. Department of Transportation, Washington, D.C. 20591

National League of Cities
1612 K Street, N.W., Washington, D.C. 20006

PERIODICALS

American Highways (quarterly) – American Association of State Highway Officials, 341 National Press Building, Washington, D. C. 20004 – Single copy 50¢ – Subscription price $2.00 per year.

Traffic Engineering (monthly) – Institute of Traffic Engineers, 2029 K Street, N.W., Washington, D. C. 20006 – Single copy 75¢ – Subscription price $6.00 per year.

Traffic Engineering and Control (monthly) – Printerhall Limited – 34-40 Ludgate Hill, London, E.C.4, England – Subscription price – United States $7.00 per year.

Traffic Quarterly (quarterly) – Eno Foundation, Saugatuck, Connecticut 06880 (Contact library – selective free distribution)

REFERENCES

Manual of Traffic Engineering Studies – Published by the Institute of Traffic Engineers – $6.50 ($5.00 to ITE Members)

Traffic Engineering Handbook – Published by the Institute of Traffic Engineers – $10.00 ($8.00 to ITE Members)

Traffic Engineering – Matson, Smith and Hurd – Published by McGraw-Hill Book Company, Inc. – 330 West 42nd Street, New York, N.Y. 10036 – $12.50.

Opportunities in Traffic Engineering – Carlton C. Robinson – Published by Vocational Guidance Manuals – Universal Publishing & Distributing Corp., 800 Second Avenue, New York, N.Y. 10017 – $1.45.

An Introduction to Highway Transportation Engineering – Published by the Institute of Traffic Engineers in 1968 – $6.00.

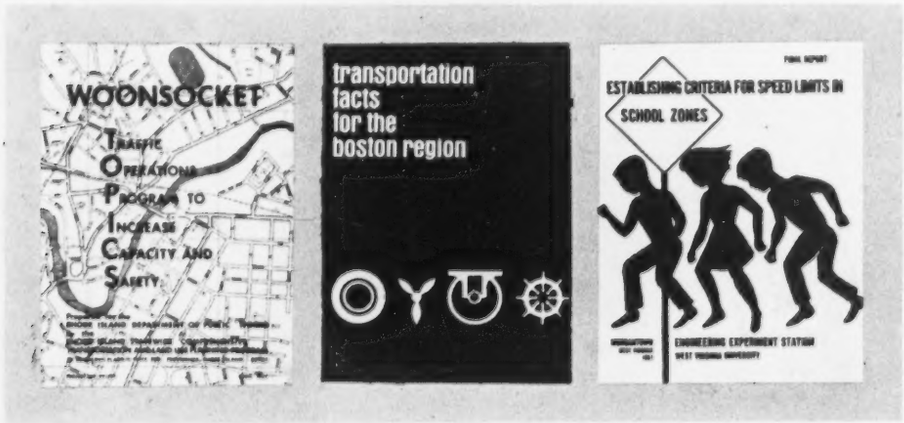

FIG. 38.– Typical Traffic Engineering Studies & Reports

FOREWORD

The Federal Literature uses the terms Farm Tractor Safety and Machinery Safety. These terms are also used most of the time in this publication. However, to simplify the title we have used the term FARM MACHINERY SAFETY to include both tractor and other machinery. FARM MACHINERY SAFETY is also used as the title for each unit with the word "Tractor" added when appropriate.

Reference is made to the publication "A Suggested Program Guide for Implementing the 1968 HAZARDOUS OCCUPATIONS ORDER in Agriculture." This was distributed to all Indiana teachers of Vocational Agriculture in 1968 and additional copies are available from the State office. The list of "16 hazardous areas of agricultural employment" on pages 1 and 2 were modified in 1969.

INTRODUCTION

The following is a brief summary of the Federal regulations concerning 14 and 15 year olds working in hazardous occupation areas. For details, see the latest edition of "A Suggested Program Guide for Implementing the Hazardous Occupation Order in Agriculture" or "Federal Register", Volume 34, Title 29 - Labor, Chapter XIII - Bureau of Labor Standards, Department of Labor, Part 1500, Sub-part E-1, for more detailed information.

For both the tractor (20 horsepower and over) and other farm machinery specified as hazardous, the employer shall instruct the 14 and 15 year olds on safe and proper operation of the specific equipment the student is to use. The student shall be closely supervised and his safety checked at least three times each day (midmorning, noon, and midafternoon). The student shall satisfy whichever of the following requirements are appropriate.

Vocational Agriculture Training Exemption

(1) Operating a TRACTOR over 20 horsepower

- (i) 14 years old and older
- (ii) child is familiar with normal working hazards in agriculture
- (iii) has completed at least 15 hours training program as specified by department of HEW
- (iv) has passed written and practical test
- (v) employer has a copy of certificate signed by parent and vo-ag instructor

(2) Reference to hazardous FARM MACHINERY as specified in the latest edition.

- (i) has completed the tractor program (1)
- (ii) has completed 10 hours of additional training on farm machinery safety
- (iii) has passed written and practical test on safe machinery operation
- (iv) employer has copy of certificate signed by parent and vo-ag instructor

Only when a student (14 and 15 years old) has completed the above requirements can he work for an employer in a hazardous occupation area. Even after completing the training program, he still CANNOT work in certain areas. (See "Hazardous Occupations Order" for detailed listings of these items). Be sure this reference is current because these work areas will be reclassified from time to time.

The vocational agriculture teacher and the parent both must sign the exemption certificate before the student is exempt from the hazardous occupations law. The teacher is not responsible in case of an accident. His signature certifies that the student has satisfactorily completed the safety training program set up by the Federal agencies.

COMMENTS ON TRACTOR SAFETY TEACHING UNITS

The tractor safety program must have a minimum of fifteen (15) hours of instruction. Twenty-five (25) hours are considered more desirable. The emphasis on the program is safety and quality of instruction.

Teaching units marked (R) are required. Other units are optional. The tractor units must be completed prior to the units on machinery.

The student must pass a written and practical test prior to receiving certification for tractor operation.

COMMENTS ON MACHINERY SAFETY TEACHING UNITS

The Machinery Safety Program must have a minimum of ten (10) hours of additional instruction. Units marked (R) are required. Depending upon the time lapse between the two major units (tractor and machinery), portions of the tractor units may have to be repeated to supplement or reinforce the machinery units.

The student must pass a written and practical test prior to receiving a machinery operation certificate.

COMMENTS

These teaching units are not intended to be complete. They should be supplemented with information that pertains to your area of the state. All equipment should be discussed in greater detail and safety precautions that pertain to a particular piece of machinery should be pointed out. These units are only a guide.

At the end of the tractor safety units and the machinery safety units, you will find sample questions. They are divided into groups that correspond with the teaching units. After teaching a major unit (tractor or machinery safety), a fifty (50) point written test must be given. If the student does not receive seventy percent (70%) or more, he cannot receive an exemption certificate. He is allowed to take only one retest in a given calendar year. In addition to the written test, the student must also take a practical test such as the one outlined at the end of each major unit. Use the attached score sheet to evaluate the student performance. Note all automatic disqualifications listed.

V. Central Problem:

Why is tractor safety important?

VI. Sub-Questions:

A. What is an accident?

1. The National Safety Council recommends that a reportable accident be defined as one that requires professional medical care or loss of one-half day or more of normal activity. (Such activities might include work, play, school, etc.)

B. What are the costs involved in an accident?

1. Damage to property.

2. Medical expense (Doctor's bill, hospital, medicine, undertaker?)

3. Time lost.

4. Increased insurance cost.

5. Hired labor to do your job.

6. Hidden costs.

a) Was the hay rained on?

b) Will the cows be milked properly?

c) Will the weeds over take your crops?

d) Will your injury slow you down in the future?

e) Will you have to sell the farm?

f) Will you ever be able to work again?

C. How many of you have been involved in a tractor accident or <u>near</u> accident?

D. What are some types of tractor accidents?

1. Tipping

a) Side

b) Back

2. Jack-knifing.

3. Automobile - tractor

5. PTO

6. Run over

7. Crushed between tractor and other object

E. What are some causes of accidents?

1. Failure to observe safety rules.

a) May not know the rules.

1) Haven't bothered to study the operator's manual.

2) Have never had safety instructions.

3) Have copied the wrong practices.

b) Fail to respect power and speed of moving machinery.

c) Tend to develop fearless attitude.

1) Haven't seen accidents happen.

d) See only the immediate problem.

1) You don't really gain if you have an accident while trying to get a little more work done.

2. Over 80% of all accidents are due to carelessness.

3. Being a safe operator is a matter of thinking about and avoiding hazardous situations.

4. It takes an accident 1/2 second to happen, a person with quick reactions might have a reaction time much slower, the operator may freeze or make the wrong move.

5. Daydreaming, thinking about Saturday night, etc.

VII. Evaluation:

A. Does the student understand the importance of tractor safety?

B. See Questions on Unit I (Tractor).

Due to the nature of the requirements regarding the testing of this unit, no sample questions will be given for each lesson. However, the questions referring to each lesson will be identified.

4. ADVISORY CIRCULARS. To receive advisory circulars, write to Department of Transportation, Federal Aviation Administration, Distribution Unit, TAD-484.3, Washington, D.C. 20590. You may ask to be put on the mailing list to receive those circulars that are free concerning subjects of interest to you such as:

AC 00 General
AC 10 Procedural
AC 20 Aircraft (Includes 30 and 40)
AC 60 Airmen
AC 70 Airspace
AC 90 General Operations
AC 120 Air Carrier and Commercial Operators

The basic number of an advisory circular is always the same as the FAR to which it is related. For instance, this handbook concerns FAR 65.95 and is so numbered.

a. General Aviation Inspection Aids. Advisory Circular 20-7 consists of a summary and 11 monthly supplements. Order from GPO: $2.00 domestic; $2.50 foreign for each subscription.

b. Summary of Supplemental Type Certificates. Advisory Circular 21-5 announces the availability of this summary. Order copies from the United States Government Printing Office and remit $9.00 (add $3.50 for foreign mailing) for each volume requested. Identify the publication as Summary of Supplemental Type Certificates, Advisory Circular, 21-5.

VIII. References:

A. "Hazardous Occupations in Agriculture for 4-H Members"

B. "The 1968 Hazardous Occupation Order in Agriculture"

C. "Indiana Farm Accident Report," 1964, Pg. 1-25

D. "Indiana Farm Accident Report," 1966, Pg. 1-7

E. "Rural Manpower Center," Special Paper Number 8

F. Purdue Memo S-49, Pg. 3

G. Purdue Memo S56, Pg. 1-8

H. Films:

1. "Farm Tractor Safety - A Family Affair," Purdue Audio-Visual Center, Room 65, Memorial Center, Purdue University, Lafayette, Indiana 47907.

2. Substitute films available at the same address are:

a) "Tractor Tragedies"

b) "Farm Tractor Safety"

FARM MACHINERY SAFETY
...Tractor

I. Teaching Unit II . . . Pre-operating Procedures

II. Suggestions for Teaching:

A. Show film strip, "Tractor Operation and Daily Care"

B. Obtain operator's manuals for different models and makes of tractors.

C. Obtain a set of 4-H Tractor Program Books.

D. Make a poster, transparency or hand-outs of pre-operating procedures for tractors.

E. Collect broken and worn tractor parts.

III. Objective:

To make the students aware of the values of pre-operating procedure.

IV. Motivation:

A. Explain the value of preventative maintenance. Repairs that result from the lack of preventative maintenance are much more costly in time and money.

B. Show film strip, "Tractor Operation and Daily Care."

V. Central Problem:

Why be concerned with pre-operating procedures?

VI. Sub-Problem:

A. Why check crankcase oil level?

1. The crankcase oil should be checked daily. It is checked by the aid of a dip-stick or a plug level check. See your operator's manual for the specific location of the oil checking devices on your tractor.

2. The crankcase oil lubricates, cleans, cushions, and cools the engine parts. The oil must be clean and found in adequate amounts to do its job properly. See your operator's manual for more information on lubricants for your tractor.

7. Keep all controls free of foreign materials. This will reduce accidental moves.

8. Think and practice safety at all times.

VII. Evaluation:

A. Does the student understand all the pre-operating procedures and know why they are important?

B. See questions for Unit II (Tractor).

VIII. References:

A. Operator Manuals

B. Hazardous Occupations in Agriculture for 4-H Members, Pg. 23-25

C. 4-H Tractor Program Book 1, Pg. 55-58

D. Film strip. "Tractor Operation and Daily Care" or "Tractor Maintenance."

E. Hazardous Occupations Order in Agriculture, Pg. 8

a) An engine low on oil will over-heat and wear excessively. Both cause delays, costly break-downs, and loss of power.

b) An engine with water in its oil can cause rusting and extensive wear to an engine.

c) An engine with fuel in its oil can cause damage similar to water in the oil. It also creates a fire hazard due to static electricity.

d) Anti-freeze in the crankcase oil can also cause serious damage to the engine. The heat of the engine will cause the anti-freeze to form deposits on the parts of the engine, these deposits will then burn leaving a harmful residue.

B. Why check the cooling system?

1. The cooling system controls the temperature of the engine.

a) A thermostat opens and allows more water to flow through the radiator when the engine is hot.

b) If the engine is cold, the thermostat closes thus decreasing the amount of water that flows through the radiator.

NOTE: If an engine operates too cold or too hot, it will consume more fuel and a power loss will be noticed.

2. Checking the cooling system:

a) Most modern tractors have a pressurized cooling system. It should be checked daily.

b) Never attempt to remove a radiator cap while the coolant is boiling or hot.

c) When removing the radiator cap to check the coolant level, observe the following rules:

1) Place a rag over the radiator cap. This prevents burning of hands on the hot metal.

2) Allow the pressure to escape by pressing a special button found on some caps or by loosening the cap part way. Be careful of steam burns.

3) After all the pressure has escaped, remove the cap slowly keeping your body away from the filler hole.

E. Why service the air cleaner?

1. Every gallon of fuel burned in an engine requires from 6,000 to 9,000 gallons of air. If the air is not cleaned the engine can be completely ruined in one day.

2. See your operator's manual for specific information on servicing your air cleaner.

3. Some general rules in servicing the air cleaner are:

   a) Never service the air cleaner while the engine is running. The engine will pull dirt into the cylinders while the cleaner is off.

   b) Service the air cleaner at least every 10 operating hours.

   c) Oil-bath air breathers must have clean oil every time they are serviced. Be sure to remove all dirt from the cup before adding new oil.

   d) The dry filter must be changed according to manufacturer's specifications. Compressed air can be used to remove excess surface dirt from the filter.

   e) The pre-cleaner collecting bowl should always be kept free of dirt.

   f) The pre-cleaner filter should be cleaned daily. It can be blown out with compressed air and some models can be cleaned out by washing them in a clean solvent. Never use gasoline.

F. What should one remember about clothing and miscellaneous items?

1. Clothing should not fit too loose nor too tight. It should be loose enough to allow freedom of movement but tight enough to prevent being caught in moving parts. Gloves, loose pant legs and loose sleeves are especially dangerous.

2. Keep mud, dirt, oil and tools off the mounting step. This will help to reduce falls.

3. Check the steering for excess play and loose bolts.

4. Do not jump from the tractor. Use hand hold and mounting steps.

5. Check the wiring and ignition systems for possible shorts or worn insulation.

6. Keep flame away from the battery. The battery gives off an explosive gas when it is being charged.

B. What are the principles and affects of rear wheel spacing?

1. The wider the rear wheels are spaced the more stable the tractor will be.

2. Be certain that the tractor is securely jacked when moving the rear wheels in or out. Only jack up one side of the tractor at a time. Never get under a tractor while it is jacked up. Rear wheels on some tractors can be moved in and out without jacking up the tractor.

C. What are the principles and affects of front wheel spacing?

1. In general it is probably a good practice to keep front wheel spacing wide. Don't let this give you too much confidence because wide front-ends are not rigid. The tractor can tilt many degrees before it touches the axle.

2. Be certain that the front of the tractor is jacked securely before adjusting the front wheels.

3. When operating a tricycle type tractor in mud or snow, the front wheels should be spaced as wide as possible by reversing the dish of the wheels. This prevents mud and snow from being packed around the wheels and bearings.

D. What are the principles and affects of adding weights?

1. There should always be a balance between the weight on the front and rear of the tractor. If a heavy rear mounted implement is placed on the tractor, weight should be added to the front, for counter balance. Likewise many front-end loader accidents could be eliminated by adding rear weights.

2. See your operator's manual for specific information about the addition of weights on your tractor. Only add weights when it is necessary.

3. If you add weights only to the rear you increase your chances of tipping backward.

4. Excessive weight on the front end may reduce rear wheel traction and result in side tipping.

E. What are the principles, placements and uses of controls?

1. The controls on your tractor make it possible for you to control the movements of the tractor. The safe operator will know the function and location of all controls of the tractor he is operating.

2. The starting control, on most late model tractors, is a key. This control completes a circuit between the starting motor and the battery. Some tractors have a safety device that requires the transmission to be in neutral before the starter will engage.

3. The tractor has at least one clutch, it controls the transmission. Some tractors have auxiliary clutches that control the PTO or other secondary power supplies. All clutches should be disengaged before starting or dismounting from the tractor. Consult your operator's manual for specifics concerning clutches on your tractors.

4. The throttle controls the engine speed of your tractor. It is actually a device that adjusts the spring pressure of the governor on a gas tractor. A diesel throttle simply controls the amount of fuel being injected into the cylinders.

5. The brakes should be adjusted evenly. The brakes have three primary functions: to assist in making sharp turns, to make stops, and to keep the tractor from rolling while traveling at high speeds the brakes should be locked together. This helps to prevent upsets due to unexpected turns.

6. The steering controls the turning movements of your tractor. It should be checked regularly to be certain it is safe and does not have excessive play.

7. The transmission is a device that transfers the engine power into a driving power. It has many speeds and the operator must be familiar with the locations of all possible selections. Some tractors have automatic transmissions.

8. There are other controls than will be covered in greater detail in later lessons. They are hydraulic controls, three-point hitches, etc.

VII. Evaluation:

A. Does the student know how to make proper adjustments to meet operational needs.

B. See questions on Unit III (Tractor).

VIII. References:

A. 4-H Tractor Program, Book 1, Unit 5, Pg. 37-38.

B. 4-H Tractor Program Leader's Manual and Demonstration Guide, Pg. 10.

C. Purdue Leaflet S-48, Pg. 1-2.

D. Hazardous Occupations in Agriculture for 4-H Members, Pg. 17-18, 36.

d) Never add hot water to a cold engine or cold water to a hot engine.

e) Keep the cooling system clean. Remove any foreign material from the radiator fins and flush the cooling system annually to prevent the accumulation of rust deposits.

C. Why check the lubricant level?

1. Lubrication is used to clean, cushion and cool moving parts, not only in the engine but also in the drive train and other power transfer points.

2. Your operator's manual will tell you the proper oil level and recommendations for servicing these lubrication points. The manual will also tell you the type and weight of oil to use.

3. When checking the lubricant levels be sure that no dirt falls into the libricant.

4. Be sure to clean all grease fittings before attempting to lubricate.

D. Why keep water and sediments from fuels?

1. A tractor will not run properly if it does not receive the proper amount and quality of fuel. Water or sediments will prevent the proper fuel from reaching the engine.

2. Fuel should be stored in a manner to prevent water or sediments from entering the tractor's fuel tank.

3. The sediment bowl and fuel filters are designed to prevent water and sediments from reaching the engine. These devices must be serviced regularly so that they will operate properly.

a) Be careful when changing or servicing the sediment bowl or fuel filter. If fuel is spilled on a hot engine a fire could result. Check for leaks, immediately after replacing any fuel line parts.

4. If sediment reaches the carburetor, it can cause permanent damage.

5. Foreign materials in the cylinder can also cause extensive damage.

FARM MACHINERY SAFETY
...Tractor

I. Teaching Unit IV . . . Starting and Stopping the Tractor Engine

NOTE: This is not meant to include movement of the tractor.

II. Suggestions for Teaching:

A. Have several different tractors and explain how to start and stop each one.

B. Have a student tell how to start and stop his tractor's engine. Then have some other student to try and start and stop another tractor following the directions of the first. Point out the differences.

III. Objective:

To teach the student how to properly start and stop different types of tractor engines.

IV. Motivation:

A. Have a student tell how to start and stop his tractor's engine. Then have some other student to try and start and stop another tractor following the directions of the first. Point out the differences.

B. Have some students start and stop tractor engines then point out errors.

V. Central Problem:

What is the correct procedure for starting and stopping a tractor engine?

VI. Sub-Problem:

A. Why should one never start a tractor engine inside a closed building?

1. A colorless, orderless gas, called carbon monoxide (CO), is given off by a tractor's engine. The gas can kill a person.

2. Sparks may come out of the exhaust system; creating a fire hazard.

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VII	121, 123, 127, 129.
VIII	133, 135, 137.
IX	61, 63, 65, 67, 141, 143, 147.
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B. What are the normal starting procedures?

1. Turn the fuel supply valve on. The fuel supply should always be shut off when the tractor is not in use. This practice will eliminate the possibility of explosion due to fuel vapors from a leaking fuel supply.

2. Be sure the seat is properly adjusted.

3. Be sure the transmission is in neutral or park and the brake is depressed. This will prevent the tractor from moving unexpectedly when it is started. Many modern tractors have safety features to prevent accidents of this kind.

4. Advance the throttle slightly.

5. Turn on the key and see that all gauges or indicator lights are working properly. Check your operator's manual for more detailed instructions.

6. Activate the starter and never crank the engine over 15 seconds at a time. If the engine does not start after 4 or 5 attempts try to find the trouble. Most operator's manuals have a trouble shooting section. Continuous cranking can deplete your battery and force fuel into the crankcase, creating a hazardous situation.

7. After starting allow the engine to warm up slowly before putting the engine under a heavy load.

C. How are the throttle and choke used?

1. The throttle is used to control the engine speed by regulating the spring tension of the governor.

2. The choke is used to enrich the fuel-air mixture when starting an engine by decreasing the air supply.

D. What is the proper way to crank or tow an engine to start it?

1. A hand crank is seldom found on the modern farm; however, when cranking an engine by hand, never put your thumb on one side of the crank and your fingers on the other. Keep your body out of the area where the crank rotates. If the engine were to backfire, the crank could break your thumb, your ribs, or an arm.

2. Before attempting to tow a tractor to start it, consult your operator's manual. Some tractors require special adjustments before towing.

3. If towing is attempted be sure that someone is on the tractor at all times and never tow at high rates of speed. Also, never tow for long periods or fuel will be forced into the crankcase. The person riding the towed tractor should be ready when the engine starts so that he will not ram the vehicle towing him.

4. A high percentage of backward tipping occurs while towing another vehicle. Be sure to hitch at or below the drawbar height and avoid having the rear wheels of the towing tractor lower than the front wheels.

5. Before starting to tow a tractor there should be some pre-arranged signals for stop and start.

E. What is the proper way to use the clutch and the brakes?

1. The clutch should always be engaged slowly, never pop the clutch. Keep all obstructions away from the clutch pedal and be certain that the clutch is fully engaged or fully disengaged. Never over-grease the throw-out bearing because it will allow grease to get on the clutch plate, causing it to slip.

2. Never ride the brakes. Apply them slowly. Keep the brakes evenly adjusted and lock them together when traveling at high speeds. Keep obstructions away from the brake pedals. If your tractor has power brakes, remember that it takes only a small amount of pressure to activate them.

F. How should one start a warm or cold engine?

1. Choking or use of starting fluid may be needed to start a cold engine. Starting fluid is extremely flamable so keep away from fire and sparks. Always allow the engine to warm up before operating.

2. A hot engine should never be choked. If the fuel mixture is too rich fuel may run out onto the hot engine causing a fire hazard or an engine backfire.

G. What are the shut-off procedures?

1. Disengage all clutches, reduce the engine speed and set the brakes before shutting off the engine. If the engine speed is not reduced the engine could backfire causing valves to warp or cause a fire. The transmission should be placed in park or in a low gear and the ignition key removed after the engine has been shut off.

VII. Evaluation:

A. Does the student know how to safely start and stop a tractor engine?

VIII. Peferences:

A. Your Tractor Operator's Manual.

B. Hazardous Occupation in Agriculture for 4-H Members, Pg. 29-30.

C. Hazardous Occupations Order in Agriculture, Pg. 9

FARM MACHINERY SAFETY
...Tractor

I. Teaching Unit V . . . Controlling Tractor Movement

II. Suggestions for Teaching:

A. Make up a situation with a tractor parked with many hazards around. Ask students to point them out.

B. Have one student move a tractor. Point out mistakes and overlooked hazards.

C. Duplicate the cartoon sheet found in the FFA tractor safety program kit and see how many hazards the students can find.

III. Objective:

To teach the student how to safely control the movements of a tractor.

IV. Motivation:

A. Refer to film showed in Lesson I and point out mistakes in controlling a tractor.

B. Have a student to move a tractor and point out mistakes he made or hazards he overlooked.

V. Central Problem:

What is the proper way to control the movements of a tractor?

VI. Sub-Problems:

A. How do tractor controls operate?

1. See your Operator's Manual.

2. Some controls are usually uniform.

a) Clutch

1) Left foot

2) Down - disengage

3) Up - engage

4) Hand clutches vary

b) Brakes

1) Brake nearest left wheel controls the left.

2) Brake nearest right wheel controls the right.

3) Brakes side by side and can be locked together.

4) Depress to apply brakes.

c) Steering

1) Get the feel of the steering wheel - power steering - turning radius.

2) Spinner knobs may catch on your clothing or hit wrist.

d) Others

1) See manual for location and directions for use.

B. Why keep area clear of obstructions?

1. You must be able to see; therefore, permit no riders or anything else that might obstruct your view.

C. What should one do before starting the move the tractor?

1. Double check all instrument readings.

2. Look around for possible hazards.

3. Place tractor in a low gear.

4. Release clutch slowly.

5. Increase throttle slowly.

6. Drive with special caution until you are completely familiar with the tractor and its surroundings.

D. Why reduce speed when approaching a turn?

1. When speed is doubled the possibility of an upset is four times as great.

2. Slow gradually for a turn, a slide or sudden stop may cause you to overturn.

3. Keep the center of gravity low to the ground to prevent tipping. For example, a raised loader creates a greater hazard than one lower to the ground.

4. All tractors should have a protective frame or crush-resistant cab and a seat belt to protect the operator in case of an upset.

5. Avoid sharp turns if possible, if not use extreme caution.

6. Jack-knifing is a serious problem while turning or stopping with a load behind a tractor.

E. What should one remember about using the clutch?

1. There are only two positions for a clutch, all the way in or all the way out.

   a) A partially engaged clutch will start slipping and will wear out quickly.

   b) When disengaging a clutch push it down quickly.

   c) When engaging a clutch, release it in a steady slow manner until it is fully released. Then keep your foot off it until you are ready to disengage it again.

2. Keep the clutch free of grease, mud and dirt so that your foot will not slip off.

3. Adjust the clutch at the first signs of slippage. Consult your manual for instructions.

4. If the clutch is difficult to reach, lengthen the pedal, if possible, or move the seat forward.

F. How should one shift gears?

1. The shifting of gears should be coordinated with the use of the clutch.

2. Never force the gear shift lever, you may damage the transmission.

3. Be sure the gears are engaged completely before releasing the clutch.

4. Be familiar with the shifting pattern.

5. Some tractors must be completely stopped before one can shift gears. On the other extreme some tractors have automatic transmissions.

G. What should one do before backing up?

1. Always look to see what is behind you before you start backing.

2. If you are backing a load that blocks part of your view, have someone to help guide you.

3. Always look back while backing, but remember the front of your tractor may hit something also.

4. Never back up at a fast rate of speed.

5. Be careful when turning while backing up because you might turn the steering wheel in the wrong direction or may turn to much.

6. Never back up any farther than absolutely necessary.

H. What is the proper way to stop?

1. Start preparing to stop far in advance and look for possible hazards.

2. Avoid sudden stops whenever possible.

   a) You can slide.

   b) The load may jack-knife.

   c) You may loose control and upset.

3. Reduce the throttle and apply both brakes easily. Do not take tractor out of gear until you have almost completely stopped.

4. After you have completely stopped -

   a) Set both brakes.

   b) Shut off tractor.

   c) Place transmission in low gear or park.

   d) If you are on a slope, block the wheels of the tractor and load.

5. If possible stop on level, solid ground.

6. Remove the ignition key to prevent an unauthorized person from moving the tractor.

VII. Evaluation:

A. Does the student
of a tractor?

B. See questions on

VIII. Reference:

As no one public
fore, no referen

understand how to safely control the movements

Unit V (Tractor).

ation discusses many of the above items; there-
ces are listed.

FARM MACHINERY SAFETY
...Tractor

I. Teaching Unit VI . . . Hitching to Tractor Operated Equipment

II. Suggestions for Teaching:

A. Refer to film in Lesson I

B. Use tractor training safety aid to demonstrate points (See Unit III).

C. Show film "Hitching and Belting Pointers."

D. Use examples of actual accidents in your community.

III. Objective:

To develop the ability to hitch the tractor to power driven equipment safely.

IV. Motivation:

A. Show "Hitching and Belting Pointers."

B. Ask students to tell about accidents or use examples you have collected.

C. Use model tractors and equipment to demonstrate.

V. Central Problem:

What is the proper method of hitching the tractor to tractor operated equipment?

VI. Sub-Questions:

A. What is the proper drawbar height?

1. When you hitch to a load, the load is trying to tip the tractor backward.

2. The higher the hitch, the greater the possibility of overturning the tractor.

3. Always keep the drawbar as low as possible, usually 13 to 17 inches above the ground.

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Gumaer, Harry T.; Wildman, George F.
Leadership in Curriculum Development; A Handbook for Teachers, School Administrators, and Consultants.

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DESCRIPTORS - *VOCATIONAL EDUCATION; *CURRICULUM GUIDES; *CURRICULUM DEVELOPMENT; *LEADERSHIP RESPONSIBILITY; *TEACHER ROLE; CURRICULUM PLANNING; ADMINISTRATOR ROLE; CONSULTANTS; CHECKLISTS

ABSTRACT - Prepared by the Curriculum Development Council (CDC), this handbook was designed as a curriculum guide for administrators, teachers, and consultants. To help develop curriculum at the local level, the handbook states general principles for curriculum development and outlines specific processes and roles involved in curriculum change. Chapters are (1) Curriculum Development, (2) What Kind of Leadership, (3) Getting Started, (4) Maintaining Momentum, (5) The Roles to be Played, (6) Finishing the Job, and (7) The CDC in Operation. Also included are a leadership inventory, an orientation checklist, a checklist for consultants, and sources of reference materials. (JS)

VT 011 898

4. Always hitch to the **drawbar**. Never the seat, axle, or any other point even though just a little above the drawbar.

5. Raising the hitch to increase traction is a dangerous practice.

6. Never have a free swinging drawbar unless you are doing field work at a very slow speed.

B. How should one position a tractor during the hitching process?

1. Align the center of the drawbar with the center of the equipment hitch.

2. Get the drawbar as close as possible to the equipment hitch.

3. When the tractor is positioned, lock both brakes.

C. How should one attach equipment to the drawbar?

1. Always use a safety pin to hitch equipment.

2. Never get between the tractor and equipment while the tractor is in motion. This may seem unnecessary to the person who has been lucky in the past, but it only takes one time to kill or seriously injure.

3. Never try to lift heavy equipment--use a jack.

4. Move the drawbar or tractor if hitch does not align.

5. After the equipment is hitched to the tractor with a safety pin, remove any blocks that might have been used to prevent equipment from rolling.

D. What should one remember about hitching rear mounted equipment?

1. Be careful not to place too heavy a load on the rear of your tractor.

2. The weight of the rear mounted equipment should be added to the front of the tractor.

3. Be sure hydraulic system is full of oil.

4. Reduce speed while equipment is lifted.

5. Always use recommended locking pins--do not make your own.

E. What should one know about PTO standards and usage?

1. There are two types of PTOs.

a) 540 rpm - 6 tooth spline - standard

b) 1000 rpm - 21 tooth spline - more power - auxiliary

c) Never use adaptors to change from one type to another unless the speed of the PTO is changed accordingly.

F. How should one connect equipment with the PTO shaft?

1. Check equipment to see if it requires 540 rpm or 1000 rpm's to operate properly.

2. After you have the right type of PTO, align the teeth on the equipment's PTO shaft with the teeth on the tractor's PTO. On some equipment a hole for a lock pin in the PTO must also be aligned.

3. Slide shaft forward slowly until shaft is in the proper position. Now lock the shaft into position by releasing a spring loaded pin or by inserting a pin through the shaft and PTO stub.

G. What should one remember about safety shields for PTO shafts?

1. Always keep all PTO shields in place. A person can be completely wrapped around an unshielded PTO shaft in about one-half second.

2. Whenever you dismount the tractor, shut off the PTO.

3. Never get near a moving PTO even if the shield is in place.

4. Keep PTO shields in good repair.

5. Keep stubshafts shielded.

6. There are two types of PTO shields, the permanent shield (non-removable) and the inverted U shield.

H. What should one remember about connecting hydraulic cylinder hoses?

1. Never try to connect or disconnect hydraulic hoses if there is pressure on the line.

2. Be sure that all connections are tight.

C. What should one remember about the use of right away privileges?

1. Regardless of the fact that you have the right to use the highway, you are in a vulnerable position. So, far as your own safety and the safety of other highway users, stay off the main traveled portion of the highway whenever possible.

D. What should one know about turning at road speeds?

1. Don't -- Don't ever attempt to turn a tractor while traveling at road speed.

2. In turns tractors are easier to upset than nearly any other type of vehicle.

3. Slow to nearly a stop before attempting to turn, especially if you are pulling a load.

4. Allow extra room for trailing equipment when turning near bridges, posts, trees, etc.

E. What should one remember about slowing and stopping from road speeds with and without trailing equipment?

1. Never attempt to make sudden stops while traveling at high rates of speed. Plan ahead and anticipate slowing or stopping.

2. Most equipment being towed does not have brakes; therefore, the equipment will jack-knife if a sudden stop is attempted.

3. When towing equipment it takes longer to stop so allow for this.

4. Signal when you are planning to stop.

5. Loose gravel can cause an accident when stopping or turning at high speeds.

F. What about towing a farm tractor?

1. Before towing a farm tractor read the operator's manual. Some tractors require special treatment if they are towed.

2. Never tow at a high rate of speed. The tractor may upset. Also towing at a high rate of speed can over-heat wheel bearings or severely damage the transmission.

3. Display all safety warning devices while towing a tractor on a public highway.

G. What should one remember when entering and leaving main roads?

1. Be sure there are no cars coming for a long distance. If the car is travleing 60 mph and you pull out on the highway when the car is 1/16 (33 feet) of a mile away, the driver of the car has less than 4 seconds to bring his car under control. It will take the car at least 200 feet to make a full stop; therefore, if the driver doesn't see you for one second and if his reactions are not quick, he will hit you from the rear.

2. Signal all turns while on or leaving the highway. Be sure your signal is visible.

3. If you cannot signal due to equipment you are pulling, have someone following you signal.

4. Eliminate the use of blind corners of any other highway entrance when it is difficult to see or to be seen.

H. What local laws apply to farm tractors?

1. Indiana requires the SMV emblem on all vehicles traveling under 25 mph.

2. For night travel, Indiana requires red or amber flashing light that is visible at least 500 feet to the rear.

3. Indiana requires that you pull off to the side of the road and allow cars to pass if you are obstructing traffic.

4. License plates are required on farm tractors if they are being used on public highways for any other use than moving equipment from farm to farm. The same is true for farm-trailers and wagons.

VII. Evaluation:

A. Does the student know how to operate the farm tractor safely on the highway?

B. See questions on Unit VIII (Tractor).

VIII. References:

A. Hazardous Occupations Work in Agriculture for 4-H, Pg. 43-45.

B. Purdue Leaflet S-56.

2. Indiana requires that any vehicle traveling under 25 mph on any public highway, at a time or under circumstances specified by law for the use of lighted lamps on vehicles, there shall be displayed on such vehicles, in addition to the Slow Moving Vehicle emblem, a red or amber flashing lamp be mounted at a height as low as practicable but no more than eight feet from the ground. The flashing light must be visible for a distance of not less than 500 feet to the rear. A double faced lamp may be used, displaying amber light to the front and red or amber to the rear. This light should be used at any time the tractor is on the highway but the law only requires it when visibility is poor.

3. You are also required to have two white lights on the front of the tractor and a red tail light on the rear, at times specified in Item 2 above. They must be visible for at least 500 feet.

4. Any other safety warning device used will be helpful. Other devices are reflective tape, reflectors, red flags or additional lights.

B. What is a suitable speed for a farm tractor?

1. Farm tractors were not designed for use on public highways.

2. As speed doubles your chances for upset are four times as great.

3. It is difficult for a tractor to stop quickly especially if it is pulling a load.

4. Tractors should not travel on public highways unless there is not another alternative.

5. Tractors travel too slow for safe automobile traffic. However, tractors can travel too fast for the safety of the tractor and its operator.

6. Many items should be considered when deciding your tractor speed. They are: the condition of the road, the tractor, the traffic and the weather, also the kind of a load being pulled.

7. A rear-view mirror is a valuable safety device due to the fact that loads often obstruct the view and it is difficult for a tractor operator to hear other traffic.

5. Be sure equipment is properly hitched. (Discussed in detail in Unit IV.)

6. Check the equipment for safety. (e.g. shielding, lubrication, etc.)

B. What should one check on the instrument panel?

1. The instrument panel is there for your convience, use it.

2. Be familiar with the location and meaning of the gauges, indicators, etc. on your tractor. Keep them working properly at all times.

3. Look at them frequently to see if all systems are operating properly.

C. What should one know about gear selection, engine speed and load?

1. The experienced tractor operator knows that for economy and safety one must find the proper combination, ground speed and engine speed for equipment to run at its option level. Check the equipment manual to find this information.

2. Be familiar with the gear selection pattern for your tractor.

3. Never operate at an unsafe speed. Doubling speed increases your chances of side tipping four times. Consider the effect of speed under various field and load conditions. Field examples: Heavily loaded wagon going down hill, difficult to stop, possibility of jack-knife, etc. Rough ground, sloping ground, narrow wheels, sharp turns, high center of gravity all contribute to side tipping and they are much more hazardous at high speeds than at low speeds.

D. Why is it dangerous to overload your tractor?

1. Never overload your tractor. This is a very dangerous practice.

2. The tractor can tip backward.

3. The tractor can overheat thus causing serious damage to the engine.

4. Overloading is very hard on tires, wheels, clutches, bearings, etc.

E. What should one remember while operating on slopes?

1. Never attempt pulling a heavy load up a steep slope.

2. Always keep your tractor in gear while going down a steep slope.

3. Excessive slippage can damage tires very quickly. If you have slippage, adjustments must be made to correct the situation.

4. Slippage wastes power and can cause the tractor to flip or spin if a slipping tire suddenly catches.

5. Slippage can be decreased by adding weights to the rear of the tractor or some tractors have advice that uses the hydraulic system to decrease slippage.

K. What about dismounting?

1. Never dismount from your tractor before it stops.

2. Before dismounting shut off the tractor, place it in a low gear and lock the brakes, or place all power (PTO and tires, etc.) in neutral, lock the brakes, then dismount.

VII. Evaluation:

A. Does the student know how to operate a tractor properly in field conditions?

B. See questions on Unit VII (Tractor).

VIII. References:

A. Purdue Memo S-56

B. Hazardous Occupations in Agriculture for 4-H Members, Pg. 37

FARM MACHINERY SAFETY
...Tractor

I. Teaching Unit VIII . . . Operating Under Highway Conditions

II. Suggestions for Teaching:

A. Make a collection of data on tractor highway accidents.

B. Have a SMV emblem, a flashing light and other safety warning equipment on hand.

C. Show pictures of tractor highway accidents - see the State Police for pictures.

III. Objective:

To teach the student how to safely operate a tractor under highway conditions.

IV. Motivation:

A. About 1/3 of all fatal Indiana tractor accidents happen on highways.

B. Tell about some highway accidents. Point out that the tractor operator has little chance of surviving a serious accident.

C. Display pictures of tractor highway accidents.

D. Discuss the courteous highway usage.

V. Central Problem:

What is the safest way to operate a farm tractor on the highway?

VI. Sub-Problems:

A. What safety warning devices should one use while operating a farm tractor on a public highway?

1. Indiana state law requires that any vehicle which ordinarily travels under 25 mph must display a SMV emblem while on a public highway. The emblem should be displayed 3 to 5 feet above the ground and the point should be up.

3. Be sure that the hose is in good condition.

4. Use only hoses recommended for hydraulic pressure.

5. Be sure coupler is securely locked into position before attempting to operate hydraulic system.

6. Never allow dirt to get into the hydraulic system.

7. Never allow hoses to drag the ground or rub against machinery parts.

8. Check the oil level of the hydraulic system before using.

9. Use only oil recommended for hydraulic systems.

I. What should one remember about belt driven equipment?

1. Always ground the tractor when using belt driven equipment.

   a) Place one end of a chain over the drawbar and allow the other end to touch the ground.

   b) Static electricity can give you a bad shock or a spark could start a fire if the tractor is not grounded.

2. Drive a pole into the ground in a position so that the belt cannot rub against the front tire.

3. Use a pulley that is as wide as the belt.

4. Never attempt to operate belt above rated speed.

5. Never get near a moving power belt.

   a) The belt speed is almost 40 mph and is nearly as dangerous as a PTO.

6. Align the tractor pulley and the equipment pulley so that the belt will not come off.

J. What about proper clothing?

1. Too loose.

2. Torn or raged.

3. See Unit II, Part F, for more detailed information.

CDC HANDBOOK

The Curriculum Development Council
for Southern New Jersey
Glassboro State College
Glassboro, New Jersey

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LEADERSHIP In Curriculum Development

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Harry T. Gumaer

George F. Wildman

VII. Evaluation:

A. Can the student hitch

B. See questions on Unit

VIII. References:

A. 4-H Tractor Program,
4-H Tractor Program,

B. Purdue Leaflet S-49,
Purdue Leaflet S-56,

C. Hazardous Occupations

to tractor-operated equipment safely?

VI (Tractor).

3rd year, Unit 6, Pg. 5,
3rd year, Unit 6, Pg. 1-4.

Pg. 4 (Shielding Demo 1 & 2).
Pg. 8.

in Agriculture for 4-H Members, Pg. 51-54, 36.

21483

3. Decrease your speed while operating on slopes. One small hole or rut can cause an upset on a slope.

4. The use of protective frame and seat belts will help protect the operator in case of an upset on a slope.

5. Keep your brakes in equal adjustment and avoid sudden movement on slopes.

6. If you must go up a steep slope, back up.

F. How should one attempt to get out of a mud hole or ditch?

1. Always back out of mud holes and ditches. Never attempt to pull out forward or your tractor may tip backwards.

2. If you cannot back out then get help, and have someone pull you out and be sure they hitch properly.

3. Never chain a post to the rear wheels to try to get out of the mud. The tractor will either tip back or the post may fly around and hit you.

G. What hazards do riders create?

1. An extra rider has an excellent chance of falling off the tractor. A warning to "hold tight" is practically useless.

2. Never allow anyone else to ride on the tractor unless there is a seat inside a protective frame and a seat belt is used.

3. An extra rider may block your vision and distract you from your work.

H. What should one remember about making short turns?

1. If you must make a short turn, decrease your speed and proceed with caution.

2. Use your wheel brake gradually; don't depress the brake quickly even at slow speeds.

I. Why should one make observations of tires and tire slippage?

1. Inspect your tires regularly. A blow-out can cause a serious accident.

2. To check for slippage, make a line on the tractor tire with a piece of chalk, mark a starting point and move the tractor forward so that the tires make ten revolutions without a load. Measure the distance the tractor traveled. Now go to the field, and mark off the same distance. With the equipment or load attached, have someone count the number of revolutions the tire makes in the distance you have marked off. If the number of revolutions is greater than ten you have some slippage.

21486

FA

(R)

I. Teaching Unit VII . . .

II. Suggestions for Teaching

A. Use the tractor trai
demonstrate misuse o

B. Collect data on trac

C. Collect pictures of
field conditions. (
misuse of weights, t

III. Objective:

To teach the student
field conditions.

IV. Motivation:

A. Explain how accident
properly.

B. Demonstrate how acci
aid/or model tractor

C. Show pictures you ha

V. Central Problem:

What are the proper
conditions?

VI. Sub-Questions:

A. What checks and adju
work?

1. See Lesson Numbe

2. Adjust seat so t
that there are n

3. Check for worn p
breakage.

4. For night work c
plow lights, ins
working and are

RM MACHINERY SAFETY
...Tractor

Operating Under Field Conditions

:

ning safety aid (or model tractors) to
f tractors in field conditions.

tor accidents under field conditions.

hazards that could cause accidents under
Rough ground, getting on and off equipment,
ractors on slopes, ditch banks, etc.)

how to safely operate a tractor under

s can happen if a tractor is not operated

dents occur with the tractor training safety
s.

ve taken of hazards.

methods for operating a tractor under field

stments should be made before beginning

r III.

hat all controls are easily reached and so
o visual obstructions.

arts and make repairs as needed to prevent

heck all lights, head lamps, warning lights,
trument panel lights, to see that they are
properly adjusted.

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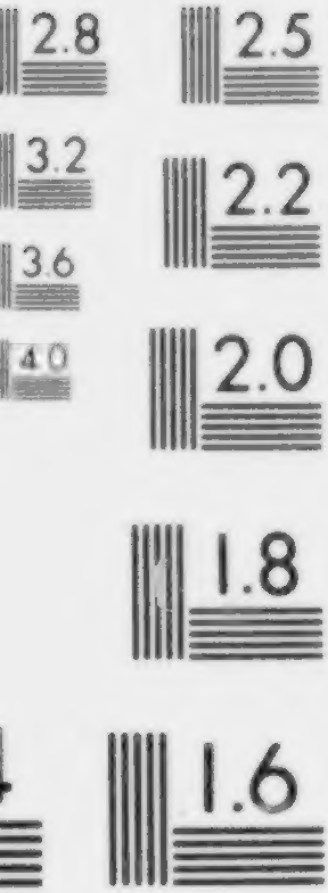

N TEST CHART

NDARDS-1963-A

5. It is important from a safety standpoint to have both brake pedals (A - adjusted for different pressures) (B - adjusted so pressure is applied evenly when the pedals are locked together). _____

6. The main pupose of brakes on a tractor is (A - to help make short turns in the field) (B - to make emergency stops) (C - parking the tractor) (D - all of the above). _____

UNIT VI

1. The proper horizontal distance between the end of the PTO shaft and the hitch point on the drawbar for operating the PTO at 1,000 RPM is (A - 14 inches) (B - 16 inches) (C - 10 inches) (D - 8 inches). _____

2. The ideal way to attach an implement is to have its center of pull fall (A - directly behind) (B - slightly to the right of) (C - slightly to the left of) (D - any of the above) the center of the tractor. _____

3. Raising the drawbar height (A - increases) (B - decreases) (C - has no effect on) the chance of a backward upset. _____

4. When getting ready to operate power-driven equipment, the first step is to (A - start it up and see if it is still runs) (B - be sure all of the shields and guards are in place) (C - check the speed of the PTO). _____

5. It's safe to hitch to your tractor (A - anywhere on the back end) (B - to the tractor hitch only). _____

6. Before hooking up implements to tractor it is advisable to (A - shut off tractor power) (B - leave tractor motor running). _____

7. It is (A - permitted) (B - not permitted) to operate a tractor in a closed building. _____

8. The spline for a 540 rpm PTO shaft (A - is) (B - is not) the same as the spline for a 1,000 rpm shaft. _____

9. Single-acting hydraulic cylinders (A - exert force in one direction only) (B - exert force in both directions). _____

10. Auxiliary power shafts all run at (A - 540 rmp) (B - 1,000 rpm) (C - no certain speed). _____

11. When an implement is operated with the PTO shaft in use, the drawbar should be in the (A - close) (B - extended) position. _____

12. Shortening the top link of a three-point hitch will make a plow run (A - deeper) (B - shallower). _____

13. It (A - is) (B - is not) always safe to use regular crankcase oil in the hydraulic system. _____

14. Some power line shielding is put on equipment only to meet legal requirements, but it is not really needed. T F

15. Hitching a machine to a tractor at a point lower than normal may turn the tractor over backwards on a steep slope. T F

UNIT VII

1. Tractor tire slippage can be reduced by: (A - increasing the air pressure) (B - increasing the engine speed) (C - adding weights to the rear wheels). _____

2. When going down hill tractor should be (A - placed in high gear) (B - placed in low gear) (C - neutral) (D - middle gear). _____

3. When working on slopes, near ditches or on rough, uneven ground the tractor should be operated (A - at the same speed as on level ground) (B - at faster speed than on level ground) (C - at slower speed than when working on level ground) (D - any of the above). _____

4. Extra riders are (A - always) (B - never) permitted on a tractor. _____

5. When driving a tractor downhill make certain the clutch is always (A - engaged) (B - disengaged). _____

6. When pulling a heavy load up a slope, keep the hitch (A - as low as possible) (B - as high as possible). _____

7. When climbing a very steep grade, tractor should be (A - driven as fast as possible) (B - backed up the grade). _____

8. When working hilly or rough ground, wheels on the tractor should be set (A - as wide as possible) (B - as narrow as possible). _____

9. When tractor is mired in muddy ground and you are unable to back out you should (A - chain blocks to drive wheels) (B - get someone to pull you out). _____

10. It is better to (A - back out) (B - drive out) of a ditch when the rear wheels start to spin. _____

11. Riders are not allowed on tractors but are alright on self-propelled machines such as combines. T F

UNIT VIII

1. When speed is doubled, the chance of an upset is (A - doubled) (B - three times as great) (C - four times as great) (D - the same). _____

2. If it is necessary to tow a tractor a short distance along the highway it should be towed at (A - a very slow speed) (B - ordinary tractor operating speed) (C - high speed in order to get it off the road as quickly as possible) (D - any of the above are satisfactory). _____

3. When operating a tractor on a highway, the tractor should be provided only with (A - lights and SMV emblem) (B - warning flags) (C - reflectors, lights, warning flags and SMV emblem) (D - equipment required by state law). _____

4. When operating a tractor on a highway, the tractor should be driven in (A - normal traffic lane) (B - road shoulder) (C - either of the above). _____

5. It is (A - more) (B - less) dangerous to move farm machinery on the highway than to use it on the farm. _____

6. The stopping distance for a car going 60 miles per hour, including reaction time and braking distance, is approximately (A - 100 feet) (B - 280 feet) (C - 366 feet) for a wet pavement. _____

7. It is safer to (A - pull halfway off the road) (B - get completely off the road) if someone tries to pass you on a two-lane highway. _____

8. In a collision between a tractor and a car the driver of the (A - car) (B - tractor) is more likely to become a fatality. _____

9. Safe operation of a tractor on a highway begins with (A - courtesy) (B - assuming that others will look out for your safety). _____

10. Speed is a major factor in tractor accidents. T F

UNIT IX

SAME AS UNIT VI.

e) Never get under a raised loader unless it is securely blocked or chained up.

f) Do not use a loader to lift a person or allow anyone to ride in it.

g) Position the loader so that it does not block your vision.

h) Weights should be added to the rear of a tractor before using a loader. Wheel weights give greater stability than one heavy weight added to the draw bar.

i) Become familiar with the controls and movements before attempting to use a loader or fork lift.

In summary keep wheels wide (front and rear), speed low, use extreme caution if necessary to operate on unlevel ground, keep sufficient weight on rear of the tractor.

The weight distribution problem is often overlooked; however, if the load on the front end takes most of the weight off the rear wheels, tractors tip sideways very easily.

VI. Evaluation:

Does the student know how to operate a loader or fork lift safely?

VII. Reference:

References are scattered and not very specific; therefore, they are not listed.

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FARM MACHINERY SAFETY
...Tractor

I. Teaching Unit X . . . Refueling

II. Teaching Suggestions:

A. Use demonstration #8, Pg. 31 (4-H Leaders Manual).

Place a partly full safety gas can half way between a slide projector and a viewing screen. Turn the projector on. Now open the lid on the gas can. You can see a shadow of the vapors flowing out and down.

B. Collect data on refueling accidents.

C. Obtain film, "Farm Petro Safety."

D. Place a small piece of cotton soaked with gasoline in a metal trough. Tilt the trough in a 45 degree angle. Put a lighted candle at the top end them put it at the bottom end. The cotton will catch fire while the candle is at the bottom.

III. Objective:

To teach the student how to refuel a farm tractor safely.

IV. Motivation:

A. Show film, "Farm Petroleum Safety."

B. Give Demonstration II A.

C. One gallon of gasoline has the explosive power of 87 pounds of dynamite.

D. Give demonstration II D.

V. Central Problem:

What is the proper procedure in refueling a farm tractor?

VI. Sub-Problem:

A. How should one refuel a gasoline tractor?

1. Never refuel around fire or sparks. One gallon of gasoline has the same explosive forces as 87 pounds of dynamite. However, gasoline will not burn in the liquid state. Gasoline will vaporize at -45°F. The gasoline state will explode quite readily. Gasoline vapors are heavier than air, therefore, these vapors will move down around the tractor engine and tend to stay near the ground for a period of time.

Preface

Tremendous innovations and revisions are taking place in American elementary and secondary education today. Whether these changes turn out to be minor or substantial, temporary or permanent, bad or good, depends most of all on the quality and nature of leadership at the local school level.

This Handbook, originally conceived as a set of guidelines for the use of member school districts of the Curriculum Development Council for Southern New Jersey, has been developed for a more universal use. It is a guide for administrators, teachers, and consultants engaged in curriculum development at the local level in any school system, particularly one which relies on some outside consultant help.

The Curriculum Development Council is a non-profit educational organization of public school districts associated with Glassboro State College for the purposes of study and action in selected curriculum areas, and for the exchange of ideas and experiences.

The Council's method of operation is to engage experienced consultants to work with local study committees on curriculum problems of local importance. Each committee makes plans for study and experimentation under the guidance of the consultant, conducts the experimentation, and is asked to submit an annual report on its work. The Council also conducts conferences and prepares publications for its members.

The Handbook is divided into three major sections. Chapters I and II state general principles and indicate supporting references. Chapters III through VI outline specific processes and develop the roles involved in curriculum change, as tested by members of the Curriculum Development Council in accord with the principles previously developed. Chapter VII shows how ideas about leadership and curriculum change have applied as the Council has worked with school systems.

In order that schools may get maximum use from this publication, the Curriculum Development Council authorizes administrators and teachers to use or reproduce ideas verbatim or adapt them as they see fit. However, no part of this Handbook may be reproduced for commercial purposes, nor may quotations be used that appear in this material but are credited to another source.

HARRY T. GUMAER
Series Editor

QUESTIONS FOR FARM SAFETY

UNIT I

1. It takes half a second for a tractor accident to happen. In any emergency it may take you (A - 1/10 second) (B - one second or more) (C - 1/2 second) (D - 3/4 second) to make the proper reaction to avoid the accident. _____

2. Being a safe operator is mostly a matter of (A - pure chance) (B - thinking ahead and avoiding accident situations) (C - skill and luck) (D - none of these). _____

3. It has been estimated that (A - 50) (B - 30) (C - over 80) (D - 10) percent of accidents are caused by operator error. _____

4. Safe operation of farm machinery is (A - impossible) (B - a matter of pure chance) (C - learning and practicing safe procedures at all times). _____

5. A modern tractor is about (A - 5) (B - 50) (C - 500)(D - 5,000) times more powerful than the average man. _____

6. Diseases kill (A - more) (B - fewer) farm children than accidents. _____

7. A good way to prevent a tractor accident is (A - take your chances) (B - make sure your tractor is safe at all times). _____

8. Records show that accidents are caused by (A - working when tired) (B - trying to hurry) (C - not using what you have learned about being a safe tractor operator) (D - all of the above). _____

9. Many accidents result from a momentary lack of attention. T F

10. It has been estimated that 10% of the accidents with farm machinery were unavoidable. T F

11. The simplest and easiest way to avoid accidents is to think about accident situations. T F

12. Your natural reaction in an accident situation is either to do nothing at all, or to make the wrong move. T F

UNIT II

1. The liquid in a battery is a solution of water and (A - hydrochloric acid) (B - sulfuric acid) (C - nitric acid) (D - acetic acid). _____

2. It is possible to ruin an engine in (A - one hour) (B - one day) (C - one week) (D - one month) by operating it with the air cleaner out of order. _____

1. Never refuel around fire or sparks. One gallon of gasoline has the same explosive force as 87 pounds of dynamite. However, gasoline will not burn in the liquid state. Gasoline will vaporize at -45°F. The gaseous state will explode quite readily. Gasoline vapors are heavier than air, therefore, these vapors will move down around the tractor engine and tend to stay near the ground for a period of time.
2. Never refuel a hot or a running engine.
3. If you spill gasoline on the tractor, allow the fuel to vaporize completely and blow away before you attempt to start the engine. Remember only one spark is required to create an explosion.
4. Keep the container or hose nozzle against the funnel or fuel tank to prevent static electricity from igniting the gasoline vapors.
5. Never over fill the fuel tank. While you are driving the fuel can splash out onto the hot engine. Also never operate a tractor without a nonsurge gasoline filler cap.
6. If you are refueling from portable gas cans, always use a funnel to prevent spilling and use only a safety gasoline can (one with a self closing cap.)
7. Never smoke around gasoline.

B. How should one refuel a diesel tractor?

1. Diesel fuel does not vaporize as quickly as gasoline but it is also dangerous to refuel around spark or fire.
2. Since diesel fuel does not vaporize quickly, if spilled it can cause a fall. It vaporizes at about 100°F.

3. Never refuel a hot or a running engine.

4. If you spill fuel on the tractor, allow the fuel to vaporize completely and blow away before you attempt to start the engine. Remember only one spark is required to create an explosion.

5. Keep the container or hose nozzle against the funnel or fuel tank to prevent static electricity from igniting the fuel vapors.

6. Never over fill the fuel tank. While you are driving the fuel can splash out onto the hot engine. Also never operate a tractor without a nonsurge gasoline filler cap.

7. If you are refueling from portable gas cans, always use a funnel to prevent spilling and use only a safety gasoline can (one with a self closing cap).

8. Never smoke around gasoline.

9. Diesel fuel does not vaporize as quickly as gasoline but it is also dangerous to refuel around spark or fire.

10. Since diesel fuel does not vaporize quickly, if spilled it can cause a fall. It vaporizes at about 100°F.

11. Keep diesel fuel clean because one small particle of dirt can clog an injector, thus causing a delay which can lead to an accident.

C. How should one refuel a LP Gas Tractor?

1. LP Gas (Liquefied Petroleum Gas) is a liquid under pressure, if the pressure is removed it becomes a gas. Be sure all connections are securely tightened to prevent leaks.

2. Sometimes frost will form during the refueling process, if this happens be careful that you do not freeze your hand.

3. Never fill the LP gas tank full. (Follow safety instructions for your equipment.) The pressure will increase when the sun shines on the tank thus increasing the internal pressure. This could rupture the tank or a fuel line.

4. In case of fire shut off the fuel supply and allow it to burn out. Spray water on storage tank to prevent an increase in pressure.

5. Do not smoke around LP gas.

3. The liquid in a battery (A - will) (B - will not) be dangerous if spilled accidentally. _____

4. Removing a radiator cap suddenly from a pressure cooling system (A - is) (B - is not) dangerous. _____

5. A loose or broken spark plug wire (A - can) (B - cannot) cause a fire. _____

6. Operating a tractor engine with a low radiator temperature will result in (A - more power) (B - less power) than when the temperature is normal. _____

7. The use of proper clothing is an important part of safe machinery operation. T F

UNIT III

1. Operation of a modern tractor requires use of (A - both hands and both feet) (B - both hands and the left foot) (C - both hands, both feet and your head) (D - either hand and both feet). _____

2. A tractor with a wide front end is (A - more) (B - less) (C - no difference) likely to tip than a tricycle type tractor. _____

3. For better pulling up grades, weights should be added to (A - front wheels) (B - the rear wheels). _____

4. The oil pressure guage (A - will) (B - will not) tell you when you need to add a quart of oil. _____

5. A tractor speed indicator tells you (A - the number of revolutions per minute the engine is turning) (B - the number of feet per second the tractor is traveling). _____

6. If you are plowing and the red light comes on, indicating low oil pressure you should (A - leave the tractor engine running and go for help) (B - increase the throttle setting to see if the light will go out) (C - shut the engine off at once). _____

7. The ammeter or charge indicator light will show a discharge of the battery if (A - the generator is not charging properly) (B - there is a broken spark plug wire). _____

UNIT IV

1. Exhaust gases are deadly poisonous because they contain (A - carbon monoxide) (B - carbon dioxide) (C - hydrogen sulfide) (D - argon). _____

2. When cranking tractor, crank (A - should be spun to insure quick starting) (B - limited to quarter turns of crank) (C - limited to half turns of the crank). _____

3. Sparks in exhaust gases (A - are) (B - are not) a fire hazard. _____

4. When starting a tractor it is safe procedure to determine that gears (A - are) (B - are not) in neutral position. _____

5. It is (A - permitted) (B - not permitted) to operate a tractor in a closed building. _____

6. If you apply only one brake while traveling at a high rate of speed you will probably (A - kill the engine) (B - upset the tractor). _____

7. When you push down on a foot-pedal clutch, the transmission is (A - engaged) (B - disengaged). _____

8. The throttle on a gasoline tractor is actually a (A - governor control) (B - control attached to the carburetor) (C - device for increasing the fuel as it mixes with air). _____

9. It is important from a safety standpoint to have both brake pedals (A - adjusted for different pressures) (B - adjusted so pressure is applied evenly when the pedals are locked together). _____

10. It is a good idea always to (A - leave the ignition key in the tractor) (B - remove and place the ignition key where it is not available to children too young to operate the tractor). _____

11. The first step in starting any tractor is (A - turn on the ignition) (B - check the gearshift lever) (C - make certain the area is clear of other people). _____

12. If a tractor fails to start immediately (A - give up and do something else) (B - see if you can locate the trouble) (C - keep trying, because all tractors start if you crank them long enough). _____

UNIT V

1. A brake on each wheel assists in turning. When making a short turn apply the brake: (A - suddenly) (B - lightly) (C - gradually after reducing speed) (D - hard after reducing). _____

2. If you apply only one brake while traveling at a high rate of speed with no load you will probably (A - kill the engine) (B - upset the tractor) (C - skid sideways). _____

3. (A - all) (B - some) tractors can be shifted from one gear to another without using the clutch. _____

4. (A - one) (B - both) of the brakes should be used to make an emergency stop. _____

FARM MACHINERY SAFETY
...Tractor

I. Teaching Unit IX . . . Fork Lift and Loader Operation

II. Suggestions for Teaching:

A. Obtain pictures of fork lifts and loaders used commonly on farms in your area.

B. A model tractor with a loader could be used to demonstrate hazardous errors.

III. Objective:

To teach the student how to safely operate a fork lift or any similar device.

Iv. Motivation:

A. Using pictures of loaders and fork lifts, point out errors the operator might be making.

B. Demonstrate hazardous situations with model tractor and loader.

V. Central Problem:

A. What are some safety practices to use while operating a fork lift?

1. The manure loader is a common piece of equipment found on many Indiana farms. In many respects it is quite similar to the fork lift as far as safety is concerned. Some general safety rules are:

a) Keep the loader low to the ground while you are traveling. Be prepared to quickly lower the loader to the ground in case the brakes fail on an incline.

b) Do not overload the loader. This often results in tipping.

c) Many loads may shift in a turn or on a slope; therefore, when practicable the load should be secured to prevent rolling or sliding.

d) Loads suspended from the loader by a chain tend to swing sideways and often cause a serious tipping problem.

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D. What are some general refueling practices?

1. Keep an approved fire extinguisher on tractor and near the fuel tanks.

2. The following types of fire extinguishers can be used on fuel fires:

   a) Dry-chemical extinguisher

   b) Foam extinguisher

   c) Carbon dioxide extinguisher

3. Never use water to extinguish a gasoline or diesel fuel fire. These fuels will float on top of water and the fire will spread.

4. Sand or dirt can be used to smother the fuel fire.

5. To prevent static electricity from igniting the fuel keep a continuous contact of the hose nozzle and the fuel tank.

NOTE: See Farmer's Bulletin No. 2156 in Safety Notebook.

VII. Evaluation:

A. Does the student know how to preform the refueling process safely?

B. See questions on Unit X (Tractor).

VIII. References:

A. Farmer's Bulletin No. 2156, Pg. 3, 4, 6, 7, 8, 9, 10, 11, 12

B. Hazardous Occupations in Agriculture for 4-H Members, Pg. 38

C. Purdue Leaflet, S-49, Pg. 3

D. Purdue Leaflet, S-58

UNIT X

1. When refueling a tractor it is permissible to (A - have the motor running) (B - shut off the motor first) (C - either of the above). _____

2. It (A - is) (B - is not) permissible to refuel a hot engine. _____

3. A fire extinguisher of the (A - carbon tetrachloride type) (B - dry chemical or carbon dioxide type) should be mounted on the tractor. _____

4. If a diesel engine runs out of fuel (A - the fuel system has to be vented) (B - the engine can be restarted immediately). _____

5. (A - LPG) (B - Diesel) (C - Gasoline) tractors use a pressurized fuel tank. _____

6. It is the vapor of fuels that burns. These vapors, being lighter than air, float off when filling a gas tank and are not dangerous. T F

TESTING PROCEDURES

I. Practical Test

The student must demonstrate his ability to hitch, tow, back and unhitch a two-wheeled farm implement. He must demonstrate proficiency and observance of safety procedures that indicate, in the opinion of the instructor, that he is qualified to use this type of tractor for simple tasks. The driving must include turning and driving around obstacles. Gates, old tires, or a lime marker can be used to lay out a course. A side delivery rake provides a good test of driving skill. A suggested driving course and score sheet may be found in Appendix A.

The emphasis is on safety. Therefore this is not a "timed" event. The student must be allowed time to demonstrate his operating ability. There are at least 20 safety items (Appendix B) on which the student is to be graded during the practical test. It is suggested that five points be deducted for each item missed. A passing score would be 70 percent.

(Appendix A) Directions for Tractor Operators Test

1. Students will operate the tractor in a safe manner and at safe speeds at all times. Unsafe operation, at the discretion of the instructor, will disqualify a student. Road gear will not be used in negotiating the two wheel course layout. The use of steering wheel spinners is not permitted.

2. The two wheeled implement to be used will be determined by the local teacher. A two wheel trailer with a pin type hitch for quick coupling is recommended. A wooden frame can be mounted on the trailer if necessary to make it wider than the widest tractor be used.

3. Markers may be constructed according to the plans attached. Used golf balls may be obtained inexpensively by buying "practice balls" from any golf driving range.

4. Since the emphasis is upon safe operation this event is not timed. However, past experience indicates most students should be able to complete the two wheel course in six to eight minutes.

5. The severity of the two wheel course layout may be tailored to fit the ability of the students by changing the spacing between the markers. A marker spacing of the trailer width and six inches is a very severe course. A layout of trailer width and twenty-four inches may be necessary for younger boys. Boundary limits may also be increased to reduce the severity of the course.

6. Judging and Scoring

Two score sheets are kept on each student. One will be for driving safety, an example of which is given in Appendix B. The student will be scored on this sheet at all times he is operating a tractor, including the two wheel course layout.

N. Insist upon a sturdy, comfortable seat that can be adjusted. You must be able to reach all controls with ease at all times.

O. Put all controls in neutral before turning on the ignition key.

P. Excessive speed is dangerous and is also hard on machinery.

Q. Use special caution and slow speed when making turns or abnormal maneuvers, especially on slopes, near ditches, gullies, rough ground or fences.

R. Keep proper fire extinguishers on hand and ready for use. Check them at regular intervals and be sure that all operators know how to use them properly.

S. Before stopping equipment, place all controls in neutral, set the brakes, shut off the engine, place transmission in low or park, lower all hydraulic systems and remove the key. Removing the key will prevent children or unauthorized persons from moving or operating the equipment.

T. Never attempt to use a machine for something it is not designed for.

U. Observe all warnings, cautions, and safety precautions posted on the equipment or found in the operator's manual.

V. If possible do not operate machinery under diverse conditions.

W. When transporting machinery on roads or highways, use all safety warning devices required by law. (SMV emblems, flashing lights, etc.)

X. Avoid using heavily traveled roads. If it is not possible drive in the ditch or pull off the side of the road to allow traffic to pass.

Y. Installing a rear-view mirror will permit the operator to see when traffic is approaching from the rear.

Z. Wear rather close-fitting clothing. Loose clothing is more apt to get caught in moving parts. Tight fitting clothing may limit movement.

AA. Try to keep body temperature comfortable. A person who is extremely hot or cold is more apt to have an accident.

BB. Know first aid practices and carry a first aid kit on farm equipment.

CC. Think and practice safety at all times.

DD. Use caution when turning. Be sure that
not catch the equipment and flip it ove
operator.

EE. Many people have tripped and fallen int
stay far enough away to prevent this ty

VI. Evaluation:

A. Does the student know all safety practi
machinery operation?

B. See questions on Unit II (Machinery).

VII. References:

A. 4-H Tractor Program, Book 4, Unit 1, Pg

B. Purdue Leaflet S-48.

LEADERSHIP In Curriculum Development

A Handbook for Teachers
School Administrators
and Consultants

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THE CURRICULUM DEVELOPMENT COUNCIL
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: the tractor tread does
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ces common to farm

. 1-2.

FARM MACHINERY SAFETY

I. Teaching Unit III . . . Safety in Tillage Operations

II. Suggestions for Teaching:

A. Collect data on accidents involving tillage equipment.

B. Either have pictures of or actual tillage equipment used in your area on hand.

C. Think through specific hazardous of various pieces of tillage equipment used in your area.

III. Objective:

To teach the student how to use tillage machinery safely.

IV. Motivation:

A. Point out the dangers involved in the use of tillage equipment common to your area.

B. Give data on accidents involving tillage operations.

V. Central Problem:

A. How can tillage operations be done safely?

1. Never attempt to misuse tillage equipment.

2. Tillage equipment has sharp points so be careful when working with the equipment.

3. Always stay in the operators seat. Rough ground, hitting a rock, or a sudden movement can throw you off the tractor.

4. Keep adjustment levers placed so that no one can fall on them or be tripped by them.

5. Never attempt to adjust, unplug, or unclog tillage equipment while in motion unless the adjustment can be easily made from the operator's seat.

6. Never operate two pieces of tillage equipment on the same land. For example, a trailing tractor may run into stalled equipment.

7. Watch for hidden hazards such as rocks, holes, etc.

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The other will be the score sheet for the two wheel layout given below. This sheet may be used in several ways. The teacher will decide how it best fits his local conditions. The number of times an error is made is recorded. It is suggested if two or more marks are made for items 1 or 2 or three or more against items 3, 4, or 5 additional instruction is needed by the student.

The teacher may desire to determine a disqualifying score in terms of penalty points as indicated. Students exceeding this score would be considered as failing the test.

Two-wheel Course Test

I. Procedure

Two persons will be needed for recording scores, measuring, and observing operation.

The student will start and warm up tractor at starting line. Student signals instructor that he is ready to begin - engine running, brake set, in neutral. Instructor will give signal to begin.

Drive tractor to implement, stop tractor, dismount, and attach implement to tractor drawbar. Student will drive through course layout as shown in the diagram, returning implement to its starting point. Implement is unhitched, tractor returned to starting line and shut off.

II. Rules

A. No assistance will be allowed in hitching or unhitching. Implement will be on the ground.

B. Whenever dismounting from the tractor, at least one brake must be set. For tractors with automatic transmission, the selector lever must be in the "Park" or "Lock" position.

C. The test begins when the student mounts the tractor to start it. Test ends when the student has dismounted after shutting of the tractor.

D. The instructor may at his discretion require the student to change the direction of travel of his equipment when the trailer hitch gets in a cramped position, or when striking a marker, to prevent damage to the trailer or marker.

E. Stakes will be considered "knocked out of line" (See Item B of score sheet) when the stake is leaning so far that the golf ball will not stay on top when replaced without first straightening the stake. When scoring a stake "knocked out of line," the student will also be assessed a penalty for "golf balls dislodged" (Item A on score sheet).

III. Scoring

		No. of Times		Penalty Points
A.	Golf balls disloged	_____	x 50	_____
B.	Stakes knocked out of line	_____	x 100	_____
C.	Tractor engine			
	1. Stalled	_____	x 10	_____
	2. Grated gears	_____	x 10	_____
D.	Travel direction reversed to clear marker or prevent fouling of equipment	_____	x 10	_____
E.	Measurement in shed (no fractions)			
	1. Inches off center at front	_____	x 10	_____
	2. Inches off center at rear	_____	x 10	_____
	3. Inches or fractions thereof greater than one inch from rear of shed. Within one inch is perfect. Fractions to be counted as whole inch.	_____	x 10	_____
		Total penalty points		_____

Appendix B

The following safety procedure items are to be observed during the practical tractor proficiency test:

Starting Safety

1. Failure to check neutral or "park" position.
2. Failure to disengage clutch while starting engine.
3. Failure to check PTO for disengagement.

Driving Safety

1. Failure to engage clutch gently
2. Failure to ride on seat or stand on plateform in a safe manner
3. Skidding or pinning of rear wheels
4. Turning too short and fouling implement
5. Operation of tractor at unsafe speed

6. Moving tractor with brakes set

7. Inadequate precautions with people or objects in the way

8. Driving in such a manner as to be hazardous to equipment or surroundings

9. Any turn which causes inside rear wheel to leave the ground - automatic failure of test

Mounting and Dismounting Safety

1. Failure to check neutral or "park" position of gearshift

2. Failure to set brake or transmission in park before dismounting

3. Jumping on or off tractor

4. Failure to bring tractor to complete stop before dismounting

Other Safety

1. Smoking

2. Extra rider

3. Loose-fitting clothing

4. Others (list and explain)

FARM MACHINERY SAFETY

(R)

I. Teaching Unit I . . . Importance of Farm Machinery Safety

II. Suggestions for Teaching:

A. Collect data on farm machinery accidents.

B. Show pictures of farm machinery accidents.

III. Objective:

To create an awareness of the importance of farm machinery safety.

IV. Motivation:

A. About one out of every seven fatal accidents on the farm involve machinery excluding tractors. This ratio is even higher when non-fatal accidents are concerned.

B. Have students tell about farm machinery accidents or near accidents and the teacher should reinforce all points of safety.

V. Central Problem:

How important is farm machinery safety?

VI. Sub-Problems:

A. Is agriculture a hazardous occupation area?

B. What is the role of machinery in accidents?

C. How does the complexity of machinery affect accidents?

1. Many machines used in factories are more dangerous than farm machinery. However, farm machinery is operated under many different conditions. Also, the farmer does not operate the same machinery every day; therefore, he does not establish a routine and must renew his familiarity frequently.

2. Farm machinery is constantly changing. A new machine is different than the old one. The controls may be moved. Any minor change in a machine requires the operator to change his behavioral pattern if he is going to be a safe operator.

3. Farm machinery operators do not receive safety supervision to the extent that it is common in most industrial situations.

D. Why don't people follow safe human practices?

1. Human errors are responsible for most accidents. From 86-88 percent of all accidents are due to carelessness. People get in a hurry or are not thinking about their work. Being a safe operator is a matter of thinking about and avoiding hazardous situations.

2. During peak labor periods the machinery operator is in a hurry. He attempts to operate his machine in diverse conditions such as rain, mud, poorly lighted areas, dusty places, etc.

3. Modern farm machinery has many moving parts. While the operator is working on one part another part may catch his clothing.

4. Some farmers never attempt to learn safety practices for pieces of machinery. Some machines appear to be so simple that the operator thinks that there is no danger. All machines are dangerous if they are not used properly.

5. Some people simply believe that they are too smart to get involved in an accident.

VII. Evaluation:

A. Does the student understand the importance of farm machinery safety?

B. See questions on Unit I (Machinery).

VIII. References:

A. Purdue Leaflet S-48

B. 4-H Tractor Program, Book 4, Unit 1, Pg. 1

C. Hazardous Occupations in Agriculture for 4-H Members, Pg. 59.

FARM MACHINERY SAFETY

(R)

I. Teaching Unit II . . . Safety Practices Common to All Farm Machinery Operation

II. Suggestions for Teaching:

A. Make a poster, transparancy, or hand-out on safety practices common to all farms.

B. The teacher should supplement all of the following units with special instruction on the adjustments, care and operation for any given piece of equipment used in his area.

C. Ask victims of farm machinery accidents to talk to the class.

III. Objective:

To be certain that the student is familiar with basic safety practices common to most farms in the area.

IV. Motivation:

A. Show pictures of farm machinery accidents.

B. Give data connected with farm machinery accidents.

C. Most farm machinery is used only a few days each year. This is hardly enough time to become an expert operator. Since this is true the operator has a greater chance of misusing the machine thereby causing more accidents.

V. Central Problem:

What safety practices are common to all farm machinery accidents?

NOTE: The degree to which the following practices are repeated will probably depend upon how recently they have been discussed. Therefore, in some cases the basic principles will only need to be briefly reviewed when discussing such units as tilliage, seeding, etc. Emphasis would then be placed upon hazards particular to the specific equipment.

A. Permit only the operator on equipment. Never allow extra riders unless the machine is designed for them; an example would be a mechanical tomato picker or people riding on a wagon behind a baler.

B. While machinery is in operation, keep everyone away, especially small children.

C. Be certain that operators of all machinery are qualified - mentally and physically.

   1. Recognize limitations due to physical size and strength.

   2. Be sure that all operators have been properly trained for the machine they are operating.

D. Keep alert and avoid fatigue by taking frequent breaks. Get off the machine, walk around and drink or eat something.

E. Keep all shields and guards in place and in good repair. Never remove a guard or shield while the machine is running.

F. Keep your machinery adjusted properly and in good repair. Service according to the manufacturer's instructions. Read the operator's manual thoroughly before attempting to operate the equipment.

G. Disengage the power before attempting to make repairs, adjustments, or unclog the machinery.

H. Never attempt to jack up the equipment without using a jack stand to support the equipment. The jack stand will give the equipment greater stability and will support the equipment if the jack fails. Have someone else around before you crawl under the equipment.

I. Do not allow grease, oil, dirt, or mud to accumulate anywhere on the machinery where you may have to climb while getting on or off or while servicing the machine.

J. Keep the fuel system in good repair and use metal sediment bowls to reduce fire hazards.

K. Keep the exhaust system in good repair to reduce fire hazards and the possibility of carbon monoxide poisoning.

L. Use extreme care when working around moving parts.

M. Use caution while operating machinery that becomes weighted on one side, for example a combine that has a full grain storage hopper on one side.

8. Aways keep your tillage equipment properly adjusted and in good repair.

9. Never attempt to pull a load that is too heavy. This can cause tipping and slippage. Excess slippage can also cause an upset.

   a) The addition of weights can decrease slippage. If you add weights remember to balance the weight, front and rear.

   b) Using dual drive wheels can also decrease slippage. If you use duals remember your tractor is wider, so working near a fence or going through gates can be hazardous.

VI. Evaluation:

Does the student know how to operate tillage equipment safely?

VII. References:

References are quite numerous, therefore they are not listed.

FARM MACHINERY SAFETY

I. Teaching Unit IV . . . Seeding Equipment

II. Suggestions for Teaching:

A. Collect data on seeding accidents.

B. Have pictures of or actual seeding equipment on hand.

C. Using seeding equipment common in your area show or demonstrate hazards and safety precautions.

III. Objective:

To teach the student how to safely operate seeding equipment.

IV. Motivation:

A. Using picture or actual equipment point out hazardous practices or areas.

B. Have students tell about accidents involving seeding equipment.

V. Central Problem:

A. What are the hazards in using seeding equipment?

1. Keep your hands, arms and clothing away from moving parts.

2. Observe safe lifting practices. (Don't lift too much, use legs - not back, etc.)

3. Do not travel at high rates of speed.

4. Be sure to wash your hands after handling treated seeds, fertilizer, or chemicals.

5. Protect your eyes, keep both fertilizer and seed out of your eyes.

6. Keep all shields in place.

VI. Evaluation:

Does the student know the hazards of using seeding equipment?

VII. References:

References are quite numerous; therefore they are not listed.

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Price: $1.50

2125

2126

2. There are two major types of sprayers and many variations of each type.

   a) Low pressure sprayer is used on most common farm crops.

   b) A high pressure sprayer is used on special crops such as tomatoes or fruit trees.

3. A chemical sprayer has five major parts:

   a) A pump to supply the pressure.

      1) Low pressure pumps are less expensive. They include gear pumps and nylon roller pumps.

      2) High pressure pumps work like a piston in an engine.

      3) Before storing your pump it should be flushed with water to remove all chemicals. Fill the pump with a light oil to prevent rusting and corrosion.

   b) The nozzle actually sprays the liquid onto the crop. There are many different types depending upon the pattern desired and the amount of chemicals to be sprayed.

      1) The most common nozzles work under low pressure (15 to 100 psi) and are located close to the crop. The three most common patterns are the hollow cone, the fan and the solid cone.

      2) High pressure nozzles usually spray a mist.

   c) The pressure regulator controls the spraying pressure. It is usually a screw device that simply restricts the amount of liquid being delivered to the spray nozzles. If a high spraying pressure is desired the line restriction is increased and if a low pressure is desired the opposite is true.

   d) The screens and filtering devices remove foreign material from the liquids. If the foreign materials reach the nozzles they can cause serious damage or malfunction. The pump can also be damaged.

      1) Never use dirty water to mix the chemicals. A rule of thumb is don't use water that is not clear enough to drink.

e) The supply tank holds the liquid mixture until it is needed.

1) Keep the tank clean.

2) Rinse thoroughly after use to remove the remaining chemicals.

3) Use special care when changing from one type of chemical to another. A reaction may take place thus neutralizing the new chemical or the residue from the new chemical may damage your crop.

4) A mixer or agitator should be in the supply tank to keep the chemical concentration equal in all parts of the tank.

B. What is a dry chemical applicator?

1. The most common dry chemical applicator looks very much like a fertilizer applicator.

a) Dry chemicals are usually either dust or granular.

b) Dry applicators are commonly found on corn planters. In most cases they apply the chemical in a band or row.

c) A gear meters out a given amount of chemical and it drops on the soil.

C. What should one remember when applying chemicals or using an applicator?

1. Never use a chemical before reading the label throughly. Follow all directions and observe all precautions and warnings.

2. Mix the chemical throughly and use only recommended amounts.

3. Calibrate your sprayer. Calibration depends on:

a) The ground speed of the applicator.

b) The area covered by each sprayer.

c) Rate of flow through each nozzle.

1) The rate of flow is dependent upon the spraying pressure and the size of hole in the nozzle.

2) The gallons per minute is equal to the application rate per acre, times the width in inches of the area sprayed per nozzle, times the ground speed divided by 5940.

NOTE TO TEACHER:

$$\text{gal per min} = \frac{\text{gal per A} \times \text{width of spray pattern} \times \text{mph}}{5940}$$

The figure 5940 provides a short cut because it takes into consideration several factors such as the number of square feet per acre, etc.

4. To change the application rate one can:

   a) Raise or lower the nozzle height

   b) Increase or decrease the spraying pressure

   c) Increase or decrease the number of nozzles

   d) Change the size of the nozzle

   e) Increase or decrease the ground speed

   f) Increase or decrease the chemical concentration

   g) Increase or decrease the pump speed

   NOTE: Carefully analyze the effects of these changes on the spray rate.

5. Never eat or smoke while using chemicals. This is an excellent method of consuming the chemical internally.

6. Always wash skin and clothing after handling chemicals. If any chemical is spilled on you, wash it off immediately. See the label to see if a further step should be taken, such as seeing a doctor.

7. Store chemicals in a safe place. Keep out of the reach of small children. Some chemicals should be kept in a locked metal cabinet.

8. Never mix chemicals near well or stream. A spill can cause contamination.

9. The original "Hazardous Occupations Order" for youth considered the certain chemicals a particular hazard and placed limitations on their use by persons under 16. The classification of chemicals may be changed from time to time; therefore, consult the current Hazardous Occupation Order for up-to-date information.

10. Never store chemicals in anything other than their original container. Bury or burn the container when it is empty.

VII. Evaluation:

Does the student know how to operate a chemical application properly and safely?

VIII. References:

A. 4-H Tractor Program, Book 4, Unit 4

B. See Purdue Leaflets, S-50, S-60, S-63, S-64

FARM MACHINERY SAFETY

I. Teaching Unit VI . . . Forage Equipment

II. Suggestions for Teaching:

A. Collect data on local forage equipment accidents.

B. Make a collection of pictures of forage equipment.

III. Objective:

To teach the student how to operate forage equipment safely.

IV. Motivation:

A. Do these statements sound familiar?

- 73 year old farmer killed when he fell in the path of a mower
- 37 year old falls into a silage chopper
- 24 year old killed when caught in a silage chopper
- 3 year old caught in silage chopper and killed
- silage chopper kills 42 year old farmer when his arm was caught in the conveyor

B. Using the pictures of forage equipment point out the dangerous areas of each machine.

V. Central Problem:

What is the safe way to use forage equipment?

VII. Sub-Problems:

A. Why is forage equipment dangerous?

1. Mowers, hay conditioners, choppers, balers, shredders and silo fillers are made to cut, crush or chop forage crops. Most forage equipment will do its job on anything that is run through it - including a person.

2. Some forage equipment such as choppers and silo fillers can easily pull you into their cutting parts. Use extreme caution when working with such equipment.

3. Cutting blades are sharp and must be kept sharp to insure proper cutting.

B. What precautions should one follow when using forage equipment?

1. Never walk in front of any forage equipment when it is running or being operated.

2. Keep all shields and guards in place.

3. When equipment is not in use keep all sharp points covered. Such as the front edge of a mower sickle.

4. Keep away from moving parts. Such as the conveyor on a silage blower or a baler intake.

5. Keep equipment in good repair and keep it adjusted properly. Consult your operator's manual for specifics.

6. It is a good practice to paint hazardous areas a contrasting bright color to warn people working around these areas.

7. Lawn mowers are also quite hazardous. Be careful of objects that might be thrown by the mower and keep feet and hands away from the cutting blades.

8. Never attempt to unclog any equipment while it is running. Shut it off and crank it by hand. Unclog the machine then engage the power.

VII. Evaluation:

A. Does the student know how to safely operate forage equipment?

B. See questions on Unit VI (Machinery).

VIII. References:

4-H Tractor Program, Book 4, Unit 5

2. Keep your equipment in good repair and keep it properly adjusted.

   a) Keep all clutches adjusted.

   b) Adjustments can save you money by harvesting more of your crop thus decreasing the field loss.

   c) Proper lubrication will decrease machinery wear.

3. If your havesting equipment becomes clogged, shut off all power. Attempt to unclog the machine by turning the power supply in a reverse direction with a wrench. Never attempt to unclog any machine while it is running.

4. Fire is a serious hazard during harvest time. If crops are dry, they will catch fire easily.

   a) Check the exhaust system and keep it in good repair.

   b) Do not refuel while engine is hot or running.

   c) Be careful not to over fill the tank or spill fuel.

   d) Do not start the engine immediately after refueling.

   e) Be sure matches, cigars, cigarettes and pipe ashes are cold before discarding them. If you smoke an ashtray would decrease the fire hazard.

   f) Carry a fire extinguisher on your harvesting equipment. Be sure it is in working order and know how to use it.

5. No rides should be allowed on machinery unless the machine is designed for riders.

VII. Evaluation:

A. Does the student know how to operate harvesting equipment used in his locality.

B. See questions on Unit VII (Machinery).

VIII. References:

A. FFA Safe Corn Harvesting Program Kit.

B. 4-H Tractor Program, Book 4, Unit 7.

For additional information on Harvesting Equipment see: Purdue Leaflets S-51, S-52, and S-53.

FARM MACHINERY SAFETY

I. Teaching Unit VIII . . . Wagons and Trailers

II. Suggestions for Teaching:

A. Collect pictures of wagons and trailers used in your area.

B. Collect data on any wagon or trailer accidents in your area.

III. Objective:

To teach the student how to operate wagons and trailers safely.

IV. Motivation:

A. A study conducted by Ohio State University showed that the number of accidents involving wagons was only second to tractor accidents.

B. Following are some examples of fatalities involving wagons:

17 year old - load shifted, wagon overturned crushing the victim

55 year old - fell off wagon when baler stopped and run over by loaded wagon

74 year old - run over by wagon while unhooking from corn picker.

12 year old - jumped off wagon and hit by passing auto

V. Central Problems:

A. What are the proper methods of operation or using wagons and trailers.

1. Keep your wagons and trailers in good repair:

a) Check the tires and be sure they are safe.

b) Be sure that the floor, sideboards and rack boards are in good repair:

1) Replace broken and weak boards.

FARM MACHINERY SAFETY

I. Teaching Unit VII . . . Harvesting Equipment

II. Suggestions for Teaching:

A. Obtain the film, "Hands Off." It can be obtained at Purdue University's A-V Center.

B. Collect data on local harvesting accidents.

C. Obtain pictures of harvesting equipment used in your area.

III. Objective:

To develop the ability to operate harvesting equipment safely.

IV. Motivation:

A. Showfilm, "Hands Off."

B. Post pictures of harvesting accidents.

C. Tell about local harvesting accidents and explain how they could have been avoided.

D. Point out hazardous areas of harvesting equipment.

V. Central Problem:

What is the proper way to operate harvesting equipment safely?

VI. Sub-Problem:

A. What are some types of harvesting equipment?

1. Combines, corn, vegetable and other specialized harvesters.

NOTE: All types of harvesting equipment used in your area should be covered in detail. Explain how it works and how it should be operated, include a safe means of unclogging.

B. What are some general safety precautions one should observe?

1. Keep all shields in good repair and in place. Shield as much of the equipment as possible without interfering with the harvesting process.

Foreword

This booklet, Leadership in Curriculum Development, is the child of experience. Like its predecessors, Reading in Grades 7-12 and Teaching Study Skills, it is the fruit of a relationship that has existed between Glassboro State College and the school districts which constitute the Curriculum Development Council for Southern New Jersey.

During the past three years the College and the member school districts have learned much about the excitement, the difficulties, the advances, and the problems which are involved in any sincere attempt to improve curricular programs. To that end, there is no royal road. There are not adequate directions for schools such as those in the Council, who want to join forces, consolidate resources, and pursue together the curricular values which can be achieved only when they are actively and consciously sought.

It has become increasingly apparent that the early stages are crucial in any curricular enterprise--when school or district needs are examined, when the study topic is selected, when leadership roles are determined, when faculty involvement is obtained, when board of education expectations are made realistic, when consultants are selected and oriented, and when a philosophy of curricular reconstruction is understood and accepted.

It is to guide districts, administrators, faculties, and consultants in the formative as well as the later stages of curricular projects that this Handbook was created. The ideas in it have obviously been distilled from the experiences of participants in the pioneering work which the Curriculum Development Council has conducted during the past several years of difficult but productive activity.

Council projects are built on the "do it ourselves" principle, undergirt by a conviction that only by participation, by agreement, and by experience, can schools and faculties change--and only as they change will the curriculum change.

It is believed that the materials in this Handbook, although designed for Curriculum Development Council members, will be equally pertinent and beneficial to any school district or group of districts actively attempting to improve curricula.

THOMAS E. ROBINSON
President
Glassboro State College

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FARM MACHINERY SAFETY

I. Teaching Unit X . . . Materials Handling Equipment

(This unit includes various types of conveyors, augers, distributors. etc.)

II. Suggestions for Teaching:

A. Collect pictures of materials handling equipment.

B. Collect data on materials handling equipment accidents for your area.

C. See Purdue Leaflet S-55 for a more complete list of materials handling equipment.

III. Objective:

To teach safe operation of augers, conveyors, portable elevators and related equipment.

IV. Motivation:

A. The following are some fatalities involving elevators, augers and conveyors:

- 44 year old pulled into silage feeder auger when loose clothing caught
- 12 year old - portable elevator fell on victim's head
- 14 year old - portable elevator fell on victim
- 66 year old - fell into elevator

B. Using pictures point out possible hazards of augers, conveyors, etc.

V. Central Problem:

A. What safety practices should one follow when using materials handling equipment?

1. Be sure that portable elevators are securly anchored to prevent them from falling.

2. When moving a portable elevator, lower it and move at a low rate of speed.

3. Be careful not to hit electrical power lines with the elevator. Numerous people have been electrocuted due to this careless act.

4. Keep all end shafts, belts, etc. shielded.

5. Never allow any one to ride up an elevator. Walking up one is also a dangerous practice.

6. All conveyors, augers, grinders, etc. should be shielded to the greatest extent practicable.

7. When working on conveyors, grinders, unloaders, augers, etc. that are controlled by automatic devices, be certain to shut off the device before starting to work on it. Use a fool-proof method to prevent another person from starting the device (use special locks, signs, etc.)

8. Be certain to dull sharp projections or place a shield on them to prevent someone from injuring themselves.

9. Place a flag, bright paint, etc. on equipment that is about head high, to prevent head injuries.

10. Place warning or caution signs around permanent equipment.

VI. Evaluation:

Does the student know how to operate materials handling equipment safely?

VII. References:

A. Purdue Leaflet S-55

B. Operator's Manuals for Specific Equipment.

14. When descending a sharp grade, equipment should be slowed by (a. braking) (b. keeping implement in gear). _____

15. The principal cause of accidents involving farm machinery is (a. faulty equipment) (b. operator error). _____

16. A long experienced farm machinery operator (a. does) (b. does not) have to be concerned about safety precautions. _____

17. When making turns near ditches, gullies or fences it is advisable to (a. speed up the machine to get away from the danger area as soon as possible) (b. slow down the machine to make the turn). _____

18. Before leaving the tractor seat for adjusting or repairing any equipment (a. shut off the tractor) (b. disengage the PTO) (c. shut off the tractor and disengage the PTO). _____

19. Adequate clothing (a. is) (b. is not) an important safety item for farm machinery operators. _____

20. In hot weather you should drink plenty of water and take extra salt (a. because you are thirsty) (b. to make up for perspiration losses). _____

21. (a. it is) (b. it is not) advisable to equip exhaust pipes from machinery engines with a non-spark screen to avoid fire. _____

22. Older machines that were manufactured without safety guards and shields (a. need them) (b. do not need them). _____

23. Power-take-offs are provided with shields to (a. protect them from dirt and dust) (b. protect the operator). _____

24. Small children (a. should) (b. should not) be permitted around farm machinery. _____

25. When performing the hitching operation you should (a. lift with your leg muscles) (b. lift with your back muscles). _____

26. When hand cranking farm equipment engines the crank should (a. be spun around to start the engine rapidly) (b. only be pulled up in quarter or half turns). _____

27. The crank handle should be held with fingers and thumb on (a. same side of crank handle) (b. thumb on opposite side of handle from fingers). _____

28. Engines should be cranked with the (a. equipment in gear) (b. equipment in neutral). _____

29. Keeping a machine in good condition and good adjustment makes it safer to operate. T F

30. Some machines may clean easier when operating. If this is known, it is all right to clean them without shutting off the power if you are careful. T F

31. One of the main reasons it is so easy to become entangled in a running machine when trying to clean it, is that you can't let go rapidly enough. T F

32. When stopping a machine at mealtime or at night, -it is not necessary to take the PTO out of gear as long as the clutch is disengaged when restarting. T F

UNIT III

UNIT IV

UNIT V

UNIT VI

1. When handling the cutter bar on farm machinery it is (a. permitted to leave tractor engine running) (b. necessary to shut off tractor motor). _____

2. When servicing or adjusting the hay baler it is (a. sufficient to disengage all power and shut off engine) (b. wait until baler flywheel has stopped rotating). _____

3. When working on the knives of a hay baler it is (a. permissible to move the flywheel) (b. not permissible to move the flywheel). _____

4. On forage harvesters it is (a. permitted) (b. not permitted) to open auger or cutterhead doors while cutterhead is operating. _____

5. A spring release is used on mowing machines to (a. allow cutter bar to swing back when striking an object) (b. allow mower to be thrown into gear without slipping) (c. brush trash off the cutter bar). _____

6. (a. it is advisable) (b. it is not advisable) to use a wood block to prevent the cutterhead of a forage harvester from turning when adjusting the knives. _____

7. Overloading a forage harvester will (a. get the job done faster) (b. cause the machine to clog). _____

8. After unclogging a hay baler, the operator should (a. stand close to the machinery to see that it will operate properly) (b. stand clear) (c. should be on the tractor seat) before putting it back in operation. _____

2) Drive or remove all protruding nails.

2. Use all safety warning devices while on public roads:

a) The state law requires you to properly display a SMV emblem while the wagon is on any public road.

b) Reflectors and tail lights help warn traffic approaching from the rear. You should have two tail lights or one light and two reflectors.

c) A red or amber flashing light should be displayed on the rear of your wagon or trailer if used at night.

d) Slow down and allow traffic to pass. Pull off the road if necessary.

d) If any of the safety warning devices required by law are not **fully visible on the tractor while pulling a** wagon or trailer they must be installed on the wagon. This includes the SMV emblem during the day or night, a flashing light at night, and tail lights.

3. Be sure your wagon or trailer is hitched properly:

a) Use safety pins.

b) Hitch only to the drawbar or recommended hitches, such as a hitch on the rear of a corn picker.

c) Self coupling hitches are available. These hitches prevent the hazard of a person between the wagon and tractor during the hitching process.

4. Use extreme care while pulling wagons and trailers:

a) Loaded wagons and trailers tend to push a tractor when you attempt to stop. Allow extra time to stop and stop gradually.

b) When pulling two or more wagons or trailers use extreme caution. The weight of the load is increased, this makes it more difficult to stop. A quick stop may cause the wagon to jack-knife or upset.

c) Decrease your speed. If a load shifts while traveling at high speeds an accident will occur.

d) If you are pulling an extremely heavy load you should have brakes on the wagon or trailer - especially at high speed.

e) Safety chains should be used as an extra precaution while pulling wagons or trailers on the highway.

5. Some wagons require special handling care:

a) Hoist wagon will very easily. Always unload both sides evenly to prevent an upset. Even when the hoist is lowered the wagon may not be as stable as a regular wagon.

1) Use break-away hydraulic couplers.

2) Never get under an elevated wagon bed.

b) Wagons that unload due to gravity upset easier because their center of gravity is elevated.

1) Never allow anyone in the wagon while it is unloading. There have been cases where persons have been trapped and suffociated in the grain.

c) Many self unloading wagons and trailers have conveyors or augers in them. These present special hazards.

1) Keep all moving parts shielded as much as possible.

2) The sides of the trailer or wagon slope. If a person slips, he may fall into the auger. Never get inside an auger wagon while it is unloading.

3) Manure spreaders have claimed many lives during the past decade. People fall into them and are killed by the rear unit.

4) Never attempt to unclog any self unloading device while it is running.

VI. Evaluation:

A. Does the student know how to operate a wagon or trailer safely?

B. See questions on Unit VIII (Machinery).

VII. Reference:

"How To Get Your Wagon Rolling Safely," 699.31-122, National Safety Council.

FARM MACHINERY SAFETY

I. Teaching Unit IX . . . Unhitching Equipment

II. Suggestions for Teaching:

A. Give examples of unhitching accidents.

B. Refer to film, "Hitching and Belting Pointers"

III. Objective:

To teach the safest methods for unhitching equipment.

IV. Motivation:

A. Give examples or tell how one could get hurt while unhitching.

B. Refer to Unit VI on Hitching.

V. Central Problem:

What is the proper procedure for unhitching equipment?

VI. Sub-Problem:

A. What are some precautions for unhitching?

1. Before unhitching equipment block the wheels so that the equipment cannot roll.

2. Securely support equipment that can fall easily.

3. Unhook all auxiliary equipment such as PTO shafts, hydraulic hoses, and controls that are attached to the tractor and equipment.

4. The last thing you do is the actual unhitching. Be sure the equipment will not drop, block the tongue to prevent this.

5. Pull the tractor away slowly making sure that the equipment is not still attached or rolling forward.

6. Be sure that you have placed the equipment so that it will not be a hazard to other vehicles, livestock or people.

7. Remember never attempt any portion of the unhitching procedure before the tractor has made a complete stop.

VII. Evaluation:

A. Does the student know how to unhitch equipment safely?

B. See auestions on Unit VI (Tractor).

VIII. References:

References are too scattered to mention.

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FARM MACHINERY SAFETY

(R)

I. Teaching Unit XI . . . Farm Equipment on Highways

II. Suggestions for Teaching:

A. Have on hand safety warning devices such as: SMV emblems, flashers, reflectors, flags, etc.

B. Have students tell of highway accidents involving slow-moving vehicles and analyze some of them.

C. Obtain a copy of Indiana's SMV emblem law from your local State Police Post or the Farm Safety Office, Agricultural Engineering Building, Purdue University.

III. Objective:

To teach the student how to operate farm equipment on the highway.

IV. Motivation:

A. When collisions involving farm equipment occur, the person on the farm equipment is the most likely to be killed or injured.

B. In Indiana about 300 reportable collisions occur each year between motor vehicles and slow-moving vehicles. The death rate is high in these accidents.

V. Central Problem:

What should one know about operating farm equipment on highways? See Unit VIII of Tractor Safety.

VI. Sub-Problems:

A. What safety warning devices should one use while operating farm equipment on highways?

1. SMV emblem - This emblem must be displayed any time a vehicle which ordinarly travels under 25 mph is on a public road or highway. This includes nearly all farm machinery. Many other states have similar laws.

a) The emblem must be fully visible from the rear; therefore, if you are pulling any equipment that blocks the view of the SMV emblem on the tractor, one must be displayed on the rear of the towed equipment.

2. A red or amber flashing light that is visible at least 500 feet to the rear must be displayed while any SMV is on a public highway or road at a time when visibility is poor, e.g. dark, fog, rain, etc. It should not be mounted over 8 feet high.

3. Other state regulations when visibility is poor include:

   a) Two white head ligts visible for a least 500 feet.

4. Other optional safety warning devices include:

   a) Red flags.

   b) Reflectors or reflecting tape to mark the outside edges of equipment.

   c) Clearance lights.

   d) An amber flashing light facing forward.

      NOTE: These safety warning devices are for your protection - use them.

5. Farm machinery may be moved on highways, they are exempt from size and weight restrictions if they do not damage the highway.

6. Any person driving farm machinery must have a driver's license unless he is traveling from field to field or farm to farm.

7. Any piece of farm machinery, including farm tractors, should have two red lights or one red light and two red reflectors visible 500 feet to the rear.

8. Any towed equipment should have a white or amber light on the equipment marking the farthest protection on the traffic side.

B. What rules of the road should an operator of farm equipment observe?

   1. Obey all laws pretaining to operating motor vehicles on public hgihways.

   2. Drive on the berm whenever possible.

   3. Yield to fast moving traffic.

   4. Allow traffic to pass you even if you must pull off the road and stop. (If three or more vehicles are following closely behind you are required by law to give them the right of way.)

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5. Signal all movements. If your load blocks your rear vision, have someone follow you in another vehicle and have them signal stops and turns.

6. Never allow riders.

C. What special preparation should precede traveling on highways?

1. Be sure your equipment is in good repair. Check the tires, hitch, brakes, etc.

2. Be sure the brakes are locked together and equally adjusted.

3. Traveling at a slow rate of speed will decrease the chance of an upset or loss of control.

4. It is much safer for any trailing equipment to have its own braking system. (Some foreigh countries now require this.)

VII. Evaluation:

A. Does the student know how to operate farm equipment safely on public highways?

B. See questions on Unit XI (Machinery).

VIII. References:

A. Indiana Farm Accident Report 1966, Pg. 9-11.

B. Purdue Leaflet S-48, Pg. 2.

C. Purdue Leaflet S-43.

QUESTIONS FOR SAFE MACHINERY OPERATION

UNIT I

1. More than one-third of the accidents among the farm population involved farm machinery. T F

UNIT II

1. Before hooking up farm implements to tractor it is advisable to (a. shut off tractor power) (b. leave tractor motor running.) _____

2. When starting self-propelled farm machinery it is safe procedure to determine that gears (a. are) (b. are not) in a neutral position. _____

3. Extra riders are (a. always) (b. never) permitted on farm machinery. _____

4. Exhaust gases are deadly poisonous because they contain (a. carbon monoxide) (b. carbon dioxide). _____

5. When refueling farm machinery it is permissible to (a. have motor running) (b. shut off motor first). _____

6. A fire extinguisher of the (a. carbon tetrachloride type) (b. dry chemical or carbon dioxide type) should be mounted on the equipment. _____

7. If equipment is not provided with shields and guards over power shafts and drive mechanisms it is (a. all right to operate the machine) (b. not all right to operate the machine). _____

8. Farm machinery provided with the proper guards and shields is (a. completely safe) (b. never completely safe). _____

9. When operating machinery on rough, uneven ground (a. maintain normal speed) (b. reduce speed). _____

10. Belts or chains (a. may) (b. may not) be put on or removed while the pulley or gear is in motion. _____

11. To reduce tipping hazards rear wheels on equipment should be (a. as close together as possible) (b. as wide apart as possible). _____

12. To reduce fire hazard on farm machinery (a. metal sediment bowls) (b. glass sediment bowls) should be used on the engines. _____

13. All controls should be (a. in neutral) (b. in gear) before turning on the ignition key. _____

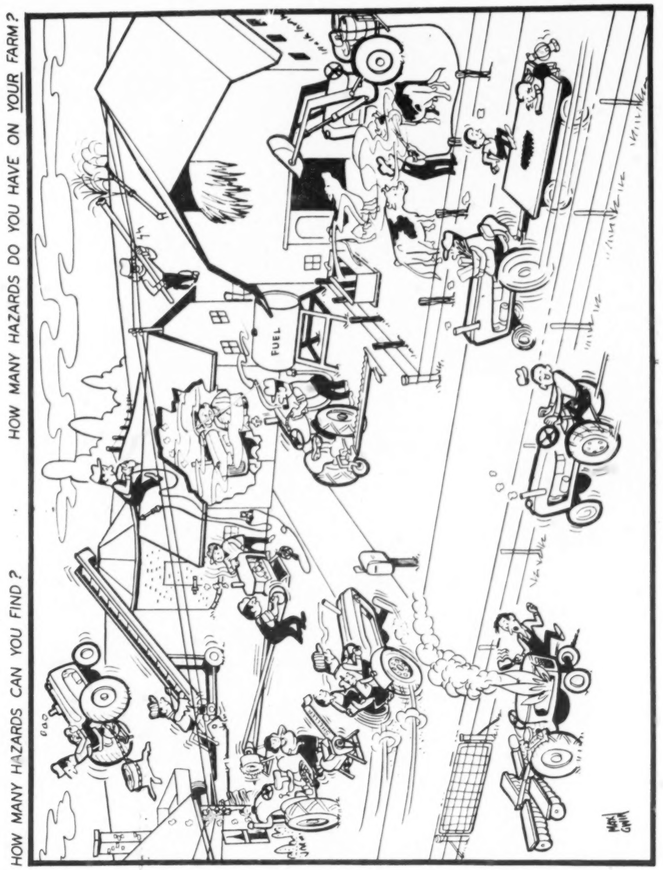

VT 013 310
Radar Speed Detection.

North Carolina State Board of Education, Raleigh.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 5p.

DESCRIPTORS - *COURSE CONTENT; *RADAR; *TRAFFIC SAFETY; *TRAFFIC CONTROL; VOCATIONAL EDUCATION; INSTRUCTIONAL MATERIALS; SAFETY EDUCATION; TRAFFIC REGULATIONS; COOPERATIVE EDUCATION; *TEACHING GUIDES

ABSTRACT - This course outline details the minimum orientation and training requirements necessary to equip an uninformed officer in the use of radar. In general this orientation is to be conducted in two parts, the classroom instruction in the morning and the on-the-job training in the afternoon. Topics covered in the outline include: (1) Description of Instruments, (2) Range Setting, (3) Interpreting Meter Readings, (4) Enforcement Activity Records, and (5) Meeting Court Requirements. Also included is a series of questions that a defense attorney may raise in regard to the condition of the radar and the manner of its use. (Author/JS)

VT 013 310

9. PTO-driven forage choppers or balers do not always stop immediately after you have disengaged the power shaft. T F

10. On a mower, if possible, all lubricating and adjusting should be done from behind the cutter bar. T F

UNIT VII

1. It is (a. permitted) (b. not permitted) to unclog a corn harvester with a wooden stick. _____

2. Young people have quick reactions. It is (a. safe) (b. not safe) for them to unclog a corn picker harvester while the power is on. _____

3. The danger spots in a corn harvester are: (a. snapping rolls) (b. stalk ejectors) (c. husking rolls and snapping rolls) (d. chains, and elevators) (e. all of these). _____

UNIT VIII

1. It is (a. permitted) (b. not permitted) to get in a forage box wagon while it is operating. _____

2. When hitching wagons to a tractor for road operation (a. use a safety hitch pin and a safety chain) (b. use a safety hitch pin only) (c. use a safety chain only). _____

3. When hitching implements or farm wagons to a tractor you should (a. straddle the pole) (b. stand to one side of the pole). _____

UNIT IX

UNIT X

UNIT XI

1. When operating farm machinery on highway, vehicle should be provided with (a. lights and SMV emblem) (b. warning flags) (c. reflectors, lights, warning flags, and SMV emblem) (d. devices required by state law). _____

2. When collisions involving farm equipment and other vehicles occur the person on the farm equipment (a. is) (b. is not) most likely to be killed or injured. _____

3. Rear view mirrors (a. are) (b. are not) recommended for farm equipment moving on the highway.

Key For Farm Safety Questions

Unit I

1. B
2. B
3. C
4. C
5. C
6. B
7. B
8. D
9. T
10. F
11. T
12. T

Unit II

1. B
2. B
3. A
4. A
5. A
6. B
7. T

Unit III

1. C
2. B
3. B
4. B
5. B
6. C
7. A

Unit IV

1. B
2. B
3. A
4. A
5. B
6. B
7. B
8. A
9. B
10. B
11. C

Unit V

1. C
2. B
3. B
4. B
5. B
6. D

Unit VI

1. B
2. A
3. A
4. B
5. B
6. A
7. B
8. B
9. A
10. B
11. A
12. A
13. B
14. F
15. T

Unit VII

1. C
2. B
3. C
4. B
5. A
6. A
7. B
8. A
9. B
10. A
11. F

Unit VIII

1. C
2. A
3. D
4. B
5. A
6. C
7. B
8. B
9. A
10. T

Unit X

1. B
2. B
3. B
4. A
5. A
6. F

Key For Machinery Questions

Unit I

1. T

Unit II

1. A
2. A
3. B
4. B
5. B
6. B
7. B
8. B
9. B
10. B
11. B
12. A
13. A
14. B
15. B
16. A
17. B
18. C
19. A
20. B
21. A
22. A
23. B
24. B
25. A
26. B
27. A
28. B
29. F
30. F
31. T
32. F

Unit VI

1. B
2. B
3. B
4. B
5. A
6. A
7. B
8. C
9. T
10. T

Unit VII

1. B
2. B
3. E

Unit VIII

1. B
2. A
3. B

Unit XI

1. D
2. A
3. A
4. B

TESTING PROCEDURES

I. Test of Operational Proficiency

The student must demonstrate his ability to safely operate those machines he expects to be using. This can be done on the home farm, land laboratory, school farm or other area satisfactory to the teacher and student. It can be done during the laboratory periods, field trips or supervised farm visits by the teacher. It must be demonstrated to the teacher and to his satisfaction. The student will pass the operational test given in Appendix A as a requirement to the successful completion of this program.

Vocational Agriculture Program in Safe Farm Machinery Operation

Farm Machinery Operation, Safety and Skill Test[1]

General Information

1. Successfully passing a FARM MACHINERY OPERATION, SAFETY, AND SKILL TEST is included as a part of the basic requirements for 14 and 15 year old youths to qualify for a Certificate of Exemption to the U.S. Department of Labor Orders Nos. 6, 7, 8, 9, and 10.

2. This test will involve three (3) separate phases or events:

   a. Starting with a tractor at a starting point, spot the tractor to a 3-point hitch implement, attach the implement to the tractor, move the tractor and implement approximately ten (10) feet, then detach the implement from the tractor, and return the tractor to the starting point.

   b. Starting with a tractor at a starting point, move the tractor to a self-unloading wagon, attach the wagon to the tractor drawbar, then properly connect the power-take-off shaft of the wagon to the tractor. Return to the tractor seat, engage the PTO and operate the unloading mechanism at low speed for approximately 30 seconds. Disengage the PTO, dismount and disconnect the PTO shaft from the tractor, return it to its proper transport position on the wagon, unhitch from the tractor drawbar, and move the tractor back to the starting point.

   c. Starting with a tractor at a starting point, spot the tractor to an implement equipped with a remote hydraulic cylinder, (with the implement in "transport" position). Connect the hydraulic hoses to the tractor, release the transport locking device (if present), operate the remote cylinder through one cycle, return the implement to transport position, engage the transport locking device, then disconnect hydraulic hoses, replace dust protective devices, and return the tractor to the starting point.

[1]Tests and score sheets developed by Robert G. White, Associate Professor of Agricultural Engineering, Michigan State University.

3. After the student has spotted the tractor to the implement, as outlined in Paragraph 2a, b, or c, and made the required connection between tractor and implement, he will then give the teacher the opportunity to check and approve the connection between tractor and implement before the implement is operated or moved in any way.

4. The student must work in a safe manner at all times. He must be on the tractor seat any time the tractor is in gear, any time the PTO drive is engaged, or any time the hydraulic controls are being operated.

5. Safe operating practices, including those set forth in the Safety Score Sheet, will be in effect at all times the student is actively involved in any of the phases of this test.

6. Certain unsafe acts, or failure to meet certain performance standards, will be considered as automatic failure to pass the test. They are:

   a. Putting the tractor in gear, engaging the clutch, engaging the PTO drive, or operating any of the hydraulic controls, without first being on the tractor seat.

   b. Fouling the tractor and any of the implements in any manner so as to damage the tractor or implements.

   c. Accumulating more than a total of one thousand (1,000) penalty points from the three events outlined above, including safety penalties.

   d. Any gross act of negligence or safety violation which, in the opinion of the teacher in charge, constitutes a major safety hazard to the student, teacher spectators, or equipment.

7. If a student fails to pass this test, but otherwise meets all the requirements for successfully completing this program, he may, at the discretion of the teacher in charge, be granted a second try. A second try, however, will be granted only after the student has had an opportunity for some additional study and coaching. Any student who fails this test for a second time, will not be given another opportunity during the current calendar year.

Scoring Procedures

1. Scoring will be done on a "points off" or "points penalty" basis, and will cover both safety and operational skills as outlined on the attached score sheets.

2. Teachers may, at their discretion, require an applicant to stop or change the direction of travel or change his procedural methods, if, in their opinion, damage may occur to equipment or injury occur to a person.

Farm Machinery Operation Safety Score Sheet

_____
Student's Name

Procedure:

Each student will be scored on safety any time he is concerned with tractor or machinery operation. This includes practice, as well as before, during and after the machinery tests. Safety officials will be on hand to record violations during these periods.

Scoring:

	No. of Times Found	Points Added
Starting Safety		
1. Failure to check neutral position	____ x 100	____
2. Failure to disengage clutch while starting engine	____ x 10	____
3. Failure to check disengaged position of PTO	____ x 50	____
Driving Safety		
1. Failure to engage clutch gently.	____ x 10	____
2. Failure to ride on seat or stand safely on platform.	____ x 100	____
3. Skidding or spinning wheels when starting	____ x 50	____
4. Turning too short and fouling implement.	____ x 20	____
5. Operation of tractor at unsafe speed.	____ x 100	____
6. Moving tractor with brake set.	____ x 10	____
7. Inadequate precautions when teachers, other students, or spectators, get in the way.	____ x 100	____
8. Any turn which causes inside rear wheel of tractor to leave ground.	Disqualifies Applicant	
Mounting and Dismounting Safety		
1. Failure to set brake before dismounting.	____ x 50	____
2. Failure to dismount to insert or remove drawbar pin.	____ x 20	____
3. Failure to bring tractor to complete stop before dismounting.	____ x 100	____
4. Failure to mount and dismount safely.	____ x 50	____
Other Safety		
1. Smoking	____ x 20	____
2. Extra riders	____ x 100	____
3. Loose fitting clothing	____ x 50	____
4. Failure to give teacher an opportunity to check the completeness of the connection between tractor and implement.	____ x 100	____
5. Failure to release and reset any transport locking device under Paragraph 2c.	____ x 100	____
6. Failure to operate equipment as called for in Paragraph 2a, b, and c of the instructions in a safe manner.	x 50	

Farm Machinery Operation Score Sheet

_____
Student's Name

Procedure:

Two officials will be available for timing, recording scores, and observing operation.

The student will start and warm up the tractor at a designated starting point. He will then move the tractor to the implement, perform the required operations, and then return the tractor to the starting point. Time will not be recorded, but officials may set an arbitrary time limit on an event if the applicant appears to be taking an unreasonably long time to finish the event.

Rules:

1. No assistance will be allowed in any of the hitching or connecting operations.*
2. Whenever dismounting from tractor, at least one brake must be set. For tractors with automatic transmissions, the selector lever must be in the "Park" or "Lock" positions.
3. Remember, officials must be given an opportunity to check the completeness and safeness of attaching the tractor to the implement as outlined in 2a, b, and c of the instructions prior to his activating, moving or operating the implement.

	No. of Times	Points Added
a. Three-Point Hitch		
1. Tractor engine stalled.	____ x 10	____
2. Gears grated.	____ x 10	____
3. Additional attempts at spotting tractor.	____ x 10	____
4. Failure to use crank on lift arm (if needed to equalize lift arms to implement).	____ x 50	____
5. Failure to lift implement from ground before moving it to new location	____ x 100	____
6. Failure to lower implement gently.	____ x 50	____
b. Power-Take-Off		
1. Tractor engine stalled.	____ x 10	____
2. Gears grated.	____ x 10	____
3. Additional attempts at spotting tractor.	____ x 10	____
4. Failure to first attach implement to tractor drawbar.	____ x 50	____
5. Failure to physically check to see that all shielding is properly attached, or that self-contained shield is free to rotate on PTO shaft.	____ x 100	____
6. Failure to gently engage PTO power to implement.	____ x 50	____

*Officials should be sure that PTO splines are clean and free of paint, 3-point hitch equipment is in good condition, and hydraulic hose break-away

c. Remote Hydraulic Cylinder

1.	Tractor engine stalled.	_____ x 10	_____
2.	Gears grated.	_____ x 10	_____
3.	Additional attempts at spotting tractor.	_____ x 10	_____
4.	Failure to place remote hydraulic control lever in neutral or non-pressure position before making or breaking connection.	_____ x 50	_____
5.	Failure to wipe couplings or coupling covers clean before putting them in place.	_____ x 100	_____
6.	Failure to cycle remote cylinder gently.	_____ x 50	_____

Total Machinery Points Penalty	_____
Total Safety Points Penalty	_____
TOTAL POINTS PENALTY	_____

REFERENCES FOR

TRACTOR AND FARM MACHINERY SAFETY UNITS

Note: All S____ Leaflets and Farm Accident Reports can be found in your Indiana Vocational Agriculture Safety Handbook

S-43 . . . With Slow Moving Vehicles
S-48 . . . With Farm Machinery (some basic rules)
S-49 . . . With Farm Machinery (demonstrations)
S-50 . . . In Crop Production
S-51 . . . In Corn Harvesting
S-52 . . . In Forage Harvesting
S-53 . . . In Harvesting Soybeans and Small Grains
S-55 . . . With Farmstead Equipment
S-56 . . . With Farm Tractors
S-60 . . . First Aid for Poisoning
S-63 . . . With Pesticides Around the Home
S-64 . . . With Pesticides on the Farm

Indiana Farm Accident Report - 1964
Indiana Farm Accident Report - 1965
Indiana Farm Accident Report - 1966

1. Farm Machinery Safety, Physical Welfare Effects of the Man-Machine Interaction on Farms, Queen's Printer, Ottawa, Ontario.

2. FFA Safe Corn Harvesting Program Kit. FIEI and National Safety Council.

3. 4-H Tractor Program Leader's Manual and Demonstration Guide.

4. 4-H Tractor Program Books, I, II, III, and IV.

5. Hazardous Occupations in Agriculture for 4-H members,
   Kansas State University,
   Manhattan, Kansas 66502

6. How to Get Your Wagon Rolling Safely, 699.31-122, National Safety Council,
   425 North Michigan Avenue,
   Chicago, Illinois 60611

7. Operating Farm Tractors and Machinery,
   Iowa State University
   Cooperative Extension Service
   Ames, Iowa 50010
   (Cost $1.00)

8. Rural Manpower Center - Special Paper No. 8,
   U. S. Office of Education,
   Michigan State University
   East Lansing, Michigan 48823

9. A Suggested Program Guide for Implementing the 1968 Hazardous Occupation Occupation Order in Agriculture
   Vocational Instructional Materials Laboratory,
   Indiana State University
   Terre Haute, Indiana 47809

Note: Reference #7 (Operating Farm Tractors and Machinery) has been compiled

FILMS ON TRACTOR AND FARM MACHINERY SAFETY

The following films can be borrowed from Purdue's Audio-Visual Center, Memorial Center, Purdue University, Lafayette, Indiana 47907. c/o Film Clerk

Title	Shelf No.
Care of a Tractor	666
Farm Petroleum Safety	1108, 1114, 1115, 1116, 1834
Farm Tractor Safety	945
Farm Tractor Safety - A Family Affair	2056
For Your Tractor's Sake	581
Hands Off (Corn Pickers)	1597
Health Hazards of Pesticides	817
Hitching and Belting Pointers	798
A Safe Shop	856
Safe Use of Pesticides	919
The Safest Township Anywhere	1947
Tractor Tragedies	1396

The following film strips may be purchased from the Vocation Instructional Materials Laboratory, Department of Vocational/Technical Education, Indiana State University, Terre Haute, Indiana 47809, for about 70% of actual cost.

Tractor Operation and Daily Care

Tractor Maintenance

Contents

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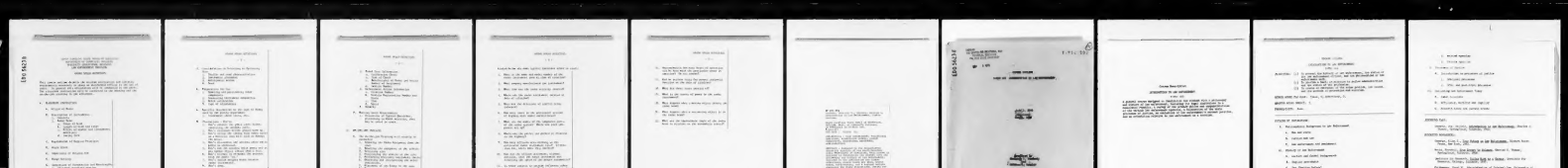

Course Description

INTRODUCTION TO LAW ENFORCEMENT

T-PSC 101

A general course designed to familiarize the student with a philosophy and history of law enforcement, including its legal limitations in a democratic republic, a survey of the primary duties and responsibilities of the various law enforcement agencies, a delineation of the basic processes of justice, an evaluation of law enforcement's current position, and an orientation relative to law enforcement as a vocation.

COURSE OUTLINE

INTRODUCTION TO LAW ENFORCEMENT

T-PSC 101

OBJECTIVES: (1) To present the history of law enforcement, the status of the law enforcement officer, and the philosophies of law enforcement work.
(2) To provide a basic orientation to police administration and the ethics of the profession.
(3) To create an awareness of the crime problem, its causes, and the methods of prevention and solution.

COURSE HOURS PER WEEK: Class, 5; Laboratory, 0.

QUARTER HOURS CREDIT: 5.

PREREQUISITE: None.

OUTLINE OF INSTRUCTION:

I. Philisophical Background to Law Enforcement

A. Man and state

B. Justice and law

C. Law enforcement and punishment

II. History of Law Enforcement

A. Ancient and feudal backgrounds

B. English precedents

C. The "Peelian Reform"

D. Development in the United States

III. Constitutional Limitations

A. Law enforcement and personal liberties

B. The Bill of Rights and major enforcement problems

C. Constitutional law enforcement

IV. Agencies of Law Enforcement

A. Local agencies

B. State agencies

C. Federal agencies

D. Related agencies

E. Private agencies

V. Processes of Justice

A. Introduction to processes of justice

1. Pre-trial processes

2. Trial and post-trial processes

VI. Evaluating Law Enforcement Today

A. Human relations

B. Efficiency, morality and legality

C. Research areas and current trends

SUGGESTED TEXT:

Germann, Day, Gallati, Introduction to Law Enforcement, Charles C. Thomas, Springfield, Illinois, 1962.

SUGGESTED REFERENCES:

Gammage, Allen Z., Your Future in Law Enforcement, Richard Rosen Press, New York, 1961.

Houts, Marshall, From Arrest to Release, Charles C. Thomas, Springfield, Illinois, 1958.

Institute for Research, Police Work as a Career, Institute for Research, Chicago, Illinois, 1957.

Puttkammer, Ernst W., Administration of Criminal Law, University of Chicago Press, Chicago, Illinois, 1953.

Rodzinowicz, Leon, History of English Criminal Law and Its Administration from 1750 (3 vol.), Stevens, London, England. Vol. I, 1948; Vol. II and III, 1957.

Smith, Bruce, Police Systems in the United States, Harper and Brothers, New York, 1960.

Tappon, Paul W., Crime, Justice, and Correction, McGraw-Hill Book Company, New York, 1960.

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NORTH CAROLINA STATE BOARD OF EDUCATION
DEPARTMENT OF COMMUNITY COLLEGES
SPECIALTY EDUCATIONAL DIVISION
LAW ENFORCEMENT TRAINING

RADAR SPEED DETECTION

This course outline details the minimum orientation and training requirements necessary to equip an uninformed officer in the use of radar. In general this orientation will be conducted in two parts. The classroom instruction will be conducted in the morning and the on-the-job training in the afternoon.

I. CLASSROOM INSTRUCTION

A. Origin of Radar

B. Description of Instruments
   1. Controls
   2. Radar Beam
      a. Shape of beam
      b. Length of beam and range
      c. Effect of opaque and transparent materials
      d. Tuning fork

C. Explanation of Doppler Principle

D. Angle Error

E. Importance of Antenna Aim

F. Range Setting

G. Comparison of Frequencies and Wavelengths
   1. Standard broadcast station
   2. Mobile transmitter
   3. Radar (10,525 MC)

H. Interpreting Meter Readings
   1. Vehicle size
   2. Distance of vehicle from the antenna
   3. Operating on two and four lane roads
   4. Types of interference

I. License Requirements
   1. Operator - station
   2. Six month instrument check
   3. FCC form 452-C

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305 VT013340

VT 013 316
Goodman, Sherrill T.; Spitler, William L.
Introduction to Law Enforcement. Course Outline.

North Carolina State Board of Education, Raleigh. Dept. of Community Colleges.
MF AVAILABLE IN VT-ERIC SET.
T-PSC-101
PUB DATE - 1Jul66 4p.

DESCRIPTORS - *LAW ENFORCEMENT; *VOCATIONAL EDUCATION; *CURRICULUM GUIDES; COURSE OBJECTIVES; EDUCATIONAL RESOURCES; BIBLIOGRAPHIES

ABSTRACT - Prepared by the Occupational Education Division of the North Carolina State Department of Education, this course is designed to familiarize the student with the philosophy and history of law inforcement. Included in the publication are course objectives, course hours per week, credit hours, bibliography, and a topical outline stressing the legal limitations, duties and responsibilities of law enforcement agencies, processes of justice, current position of law enforcement, and orientation to law enforcement as a career. (SB)

VT 013 316

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COURSE OUTLINE

T-PSC 101 INTRODUCTION TO LAW ENFORCEMENT.

July 1, 1966
Reprinted
March, 1969

Developed by
Sherrill T. Goodman
and
William L. Spitler

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EDUCATION & WELFARE
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DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

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16. Approximately how many hours of operation did he have with the particular radar in question? On all radars?

17. Did he perform tests for proper equipment function on the date of citation?

18. What did these tests consist of?

19. What is the source of power to the radar instrument?

20. What happens when a moving object enters the radar beam?

21. What happens when a non-moving object is in the radar beam?

22. What was the approximate angle of the radar beam in relation to the automobile travel?

2. Radar Test Information
   a. Calibration Check
   b. Time of Check
   c. Manufacturer of Radar and Serial Number of Instrument
   d. Vehicle Number
3. Enforcement Action Information
   a. Citation Number
   b. Vehicle Registration Number and State
   c. Time
   d. Speed
4. Remarks

P. Meeting Court Requirements
   1. Discussion of Typical Questions, pertaining to Radar activity, that may be asked in court.

II. ON-THE-JOB TRAINING

A. The On-the-job Training will usually be conducted
   1. Removing the Radar Equipment from the case
   2. Mounting the equipment on the vehicle
   3. Selecting site
   4. Positioning the vehicle at the site
   5. Performing necessary instrument checks
   6. Observing and interpreting the meter indication.
   7. Placement of the Radar in the case
   8. Repeating as often as necessary.

Instances will arise when an attorney representing a person cited for speed violation will question the condition of the radar and the manner of its use. It is wise, therefore, for an officer to take certain precautions for meeting these objections.

If the officer has properly prepared and adjusted the radar equipment, no difficulty should be encountered on the witness stand in meeting defense questions. In addition, the officer should keep an activities log and enter necessary information during his tour of duty, not at the end of the day.

Listed below are some typical questions asked in court:

1. What is the name and model number of the radar instrument used at time of citation?

2. What company manufactured the instrument?

3. What time was the radar activity started?

4. Where was the radar instrument located on date of citation?

5. What was the direction of traffic being surveyed?

6. How many lanes in the particular section of highway were under surveillance?

7. What are the names of the component parts of the radar system? Where was each component set up?

8. Where was the patrol car parked in relation to the highway?

9. How many officers were working at the particular radar instrument site? If more than one, where were they located?

10. How did the officer determine, without question, that the radar instrument was recording the speed of the proper automobile?

11. Is radar subject to outside influence other than moving automobiles? How do you detect the difference between a traveling auto and a false return?

12. Was the operator ever trained in the use of radar equipment?

13. What was the duration of the schooling and the number of hours per day spent in training?

14. Did the officer have "on-the-job" training in the use of radar?

15. Did the officer have a training certificate?

J. Consideration in Selecting an Operating Site
   1. Traffic and road characteristics
   2. Instrument placement
   3. Enforcement action
   4. Need

K. Preparation for Use
   1. Mounting and positioning radar components
   2. Connecting instrument components
   3. Meter calibration
   4. Type of adjustments

L. Specific instruction on the type of Radar used by the police department
   1. Instrument check lists, etc.

M. Precautions - Don'ts
   1. Don't connect the power cable before connecting the antenna cable.
   2. Don't calibrate before proper warm up.
   3. Don't strike the tuning fork (when used) on a material that will nick or damage the metal.
   4. Don't disconnect the antenna cable while power is connected.
   5. Don't aim the antenna (with power on) at any opaque object closer than 6 feet.
   6. Don't attempt to re-mount the antenna with the power "on."
   7. Don't switch antenna heads between radar instruments.
   8. Don't drop.

N. Anti-Radar Devices Used by Some Motorists.
   1. Radar detectors
   2. Jamming devices
   3. Other methods.

O. Enforcement Activity Records
   1. Site information
      a. Date
      b. Location of Site
      c. Direction of Vehicle Travel
      d. Type of Road - local, arterial, expressway
      e. Legal Speed Limit - Posted, Unposted.
      f. Type of Area - Residential, Commercial
      g. Weather Conditions

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CHAPTER I

Curriculum Development

In this changing world we must find ways of overcoming resistance to new things.

We begin with eight assumptions:

The curriculum is what the school sets out to teach.

Change is a major characteristic of the world today.

As the world changes, so must the curriculum of the schools.

Curriculum change is the responsibility of all the people.

Implementing curriculum change is primarily the teacher's task.

The focus of curriculum study is change in the classroom.

The process of curriculum change should reflect concern for the teacher's readiness.

Curriculum change is possible to some degree in all types of schools.

The general emphasis in this Handbook is upon change in the teaching-learning processes, centering upon the teacher. The intent is to suggest principles and procedures that create a good environment for change--change that comes about because teachers feel it is necessary and desirable, not simply expedient.

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VT 013 317
Farkas, A.G.
Construction Methods and Equipment. Course Outline.

North Carolina State Board of Education, Raleigh. Dept. of Community Colleges.
MF AVAILABLE IN VT-ERIC SET.
T-CIV-217
PUB DATE - Nov63 14p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *CURRICULUM GUIDES; POST SECONDARY EDUCATION; *CONSTRUCTION (PROCESS); *ROAD CONSTRUCTION; BUILDING MATERIALS; VOCATIONAL EDUCATION; *TRANSPORTATION; EQUIPMENT; MASONRY; STRUCTURAL BUILDING SYSTEMS

ABSTRACT - Developed by the Vocational-Technical Division of the North Carolina State Board of Education, this outline is for instructor use in planning a course on construction methods and equipment. Specific objectives are to: (1) study methods and equipment for various types of excavations, and for highways and pavement construction, (2) study types of piles, and techniques of steel erection, and (3) investigate residential building methods and details. The material is presented in outline form consisting of 17 major topics, and is recommended for use with the text by R.L. Peurifoy entitled "Construction Planning, Equipment, and Methods." A list of suggested references is included. A related document is available as VT 013 318, also in this issue. (GEB)

VT 013 317

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T-CIV 217

COURSE OUTLINE

T-CIV 217 CONSTRUCTION METHODS AND EQUIPMENT.

November, 1963

Reprinted
January, 1968

Developed by
A. G. Farkas, Consultant

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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RALEIGH, NORTH CAROLINA

VT013317

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5. Cast-in-place concrete piles

6. Steel piles

7. Composite piles

B. Resistance of piles to penetration

1. Skin friction

2. Bearing resistance

C. Uses of the different types of piles

D. Pile driving equipment

1. Types of leads

a. Fixed leads

b. Swinging leads

2. Types of pile hammers

a. Drop

b. Single-acting steam

c. Double-acting steam

d. Differential-acting steam

e. Diesel

E. Pile driving methods

1. Jetting piles

2. Determining choice of method and equipment

3. Determining location of piles

F. Proper inspection of piles

1. During actual driving operation

a. Proper method of handling piles and placing them into the leads

b. Method of determining correct pile penetration

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Course Description

T-CIV 217 CONSTRUCTION METHODS AND EQUIPMENT

Excavating methods and equipment used in building and highway construction; pile driving; construction techniques and equipment used in reinforced concrete buildings, bridges, lift-slabs, thin-shells and folded plates, erection methods and equipment for structural steel buildings and bridges, carpentry in house and heavy timber construction; construction safety. Field inspection trips.

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COURSE OUTLINE

T-CIV 217 CONSTRUCTION METHODS AND EQUIPMENT

OBJECTIVES: (1) To study methods and equipment for various types of excavations.
(2) To investigate equipment and methods used in highway and pavement construction.
(3) To study different types of piles, and the methods and equipment used in driving them.
(4) To study techniques, details, and equipment pertaining to steel erection, timber and concrete construction.
(5) Introduction to lift-slab, thin shell and folded plate construction techniques.
(6) To investigate residential building methods and details.

COURSE HOURS PER WEEK: Class, 3; Laboratory, 2.

QUARTER HOURS CREDIT: 4.

PREREQUISITES: T-DFT 102, T-CIV 102.

OUTLINE OF INSTRUCTION:

I. Classification of building construction according to:

A. Size of project

1. Small

2. Medium

3. Large

B. National Board of Fire Underwriters

1. Fireproof construction

2. Semifireproof construction

3. Heavy timber (mill building) construction

4. Ordinary construction

5. Frame construction

C. Usage

1. Public buildings

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2. Institutional buildings

3. Residence buildings

4. Business buildings

5. Storage buildings

II. Preparation of job site

A. Clearing and grubbing requirements

B. Equipment used for clearing and grubbing

1. Tractor and dozer

2. Root rakes

3. Winch and cable

4. Dragline

5. Chain saws

C. Stripping

1. Requirements

2. Methods

D. Grading

E. Drainage

III. Excavation

A. Methods of excavating

1. Open excavation with unsupported slopes

2. Sheeting and bracing for shallow excavations

3. Sheeting and bracing for deep excavations

a. Timber sheet piling

b. Steel sheet piling

c. H-piles and lagging

d. Single-wall cofferdams

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g. Scraping units

(1) Crawler-tractor-pulled scrapers

(2) Wheel-type tractor-pulled scrapers

h. Bulldozers

2. Factors affecting the selection of equipment to use

a. Available equipment on hand

b. Type of equipment that could do job most economically

D. Dredging and hydraulic excavation

IV. Drilling and blasting rock

A. Equipment used in drilling

B. Drilling methods

C. Blasting processes

V. Drainage and stabilization

A. Ditches and sumps

B. Pumps

C. Wellpoint systems

D. Miscellaneous methods

VI. Highways and pavements

A. Equipment and methods used in earthwork operations

1. Roadway and drainage excavation

2. Drainage structure excavation

3. Embankments

a. Special treatment of foundations

b. Transportation of materials

c. Compaction

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c. Method of checking piles for plumbness and damage

d. Checking adjacent piles for upheaval or damage

2. Piles in place

a. Determining cut-off of piles

b. Checking piles for damage

VIII. Methods of forming, placing reinforcing steel, and pouring concrete in substructures

A. Buildings

1. Footings

a. Single footings

b. Combined footings

c. Pile footings

2. Foundations

a. Soil bearing foundations

b. Pile foundations

3. Foundation walls

B. Bridges

IX. Methods of concrete superstructure construction

A. Types of forms and construction equipment for:

1. Columns

2. Wall construction

a. Poured in place

b. Tilt-up construction

c. Slip forms

3. Types of floor systems

a. Concrete beam and slab

b. Concrete flat-slab

c. Concrete slab on steel beam framing

d. Steel-joist-system

e. Metal-pan and concrete-joist construction

f. Cellular-steel floor system

g. Combined corrugated-steel forms and reinforcement for floor system

4. Concrete bridges

B. Methods of placing reinforcing steel for the above forms

C. Concrete operations for the above forms

1. Cleaning forms

2. Pouring concrete

3. Curing

4. Stripping forms

5. Finishing concrete

D. Lift-slab construction

E. Thin shell construction

F. Folded plate construction

X. Methods and equipment used in floor finishing

A. Concrete floor finishes

1. Monolithic topping

2. Separate concrete topping

B. Terrazzo floors

C. Asphalt tile

XI. Masonry construction

A. Brick masonry

1. Types of brick

a. Common brick

b. Face brick

c. Modular brick

2. Bonds for brick masonry

a. Common bond

b. English bond

c. Flemish bond

d. Basket pattern

e. Stretcher course

f. Soldier course

g. Header course

h. Rowlock course

3. Mortar joints for masonry

a. Flush cut

b. Struck

c. Weathered

d. Concave

e. Convex

f. Raked

4. Types of construction

a. Solid brick walls

b. Hollow brick walls

B. Concrete pavement construction methods and equipment

1. Preparations and preliminary finishing of the subgrade
2. Placing of forms
3. Final subgrade preparation
4. Installation of joints
5. Batching of aggregates and cement
6. Mixing and placing paving concrete
7. Finishing concrete pavements
   a. Hand finishing
   b. Machine finishing
      (1) Mechanical spreader
      (2) Transverse finishing machine
      (3) Longitudinal finisher
8. Curing

C. Asphalt pavement construction methods and equipment

1. Preparation of foundations for asphalt pavements
2. Hauling and spreading asphalt plant mixes
3. Compacting asphalt plant mixes
4. Asphalt mixed-in-place construction
5. Surface treatments and seal coats

VII. Piles

A. Types of piles

1. Wood-sheet piling
2. Steel-sheet piling
3. Timber piles
4. Precast concrete piles

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THE AIM OF THIS HANDBOOK

The specific aim of this Handbook is to help schools to make better use of co-operative study-action in improving the curriculum. Special emphasis is placed on the use of outside consultant services, particularly those from colleges and universities, in developing ideas and in putting them to work.

The writers assume that all suggested ways of curriculum improvement will be examined by the local leadership to determine the extent to which they apply to the local situation.

In developing this theme, the writers are conscious of some serious criticisms which will be made:

1. There is evidence that the colleges and universities and their associated study councils in most cases have had relatively little effect in changing elementary and secondary education.

2. There is a reasonable fear on the part of personnel of the elementary and secondary schools, and of state education departments, that colleges and universities will attempt to control the direction of public school curriculum or be unsympathetic to the aim of educating all children and youth.

Let us point out in reply that many study councils limit themselves to exhortation, inspiration, and advice on curriculum problems. The evidence on the few groups which personalize their services and adapt their advice to the local situation may be quite different.

As to the second point, this publication strongly recommends a partnership of colleges and public schools, not domination of one by the other. Each has much to offer to American children and youth.

WHO SHOULD READ IT?

If a school leader is in accord with the aim of this Handbook and its assumptions, he might wish the following groups of people to read it:

Those Who May Be Directly Involved in Curriculum Development

The administrator in charge
The curriculum committee chairman
Each committee member
The consultant

Those Who Must Provide Support for the Program

Building principals
Assistant superintendents
Supervisors
County school leaders
High school department chairmen
School board members
P. T. A. officers
All interested teachers

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B. Excavation classification

1. Machine excavation

2. Grading

a. Rough grading

b. Fine grading

3. Structural excavation

C. Excavating equipment

1. Basic parts and operation

a. Power shovels

(1) Crawler-mounted

(2) Wheel-mounted

(3) Truck-mounted

b. Draglines

(1) Crawler-mounted

(2) Wheel mounted

(3) Truck mounted

(4) Walking

c. Clamshells

d. Hoes

e. Trenching machines

(1) Wheel-type

(2) Ladder-type

(3) Vertical-boom type

f. Trucks

(1) Rear-dump trucks

(2) Bottom-dump wagons

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c. Face brick type construction

(1) Common brick backing

(2) Hollow tile backing

(3) Concrete block backing

d. Brick veneer

e. Reinforced brick masonry

B. Concrete blocks

C. Structural clay tile

1. Side-construction tile

2. End-construction tile

a. Load-bearing tile

b. Non-load-bearing tile

D. Stone masonry

XII. Carpentry

A. Methods and equipment used in rough carpentry house construction

1. Types of house framing

a. Braced framing

b. Balloon framing

c. Platform framing

2. Parts of house framing

a. Sills

b. Floor girders

c. Floor and ceiling joists

d. Studs

e. Rafters

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f. Subfloors

g. Roof decking

h. Wall sheathing

i. Wall siding

j. Window frames, door bucks, finished floors, etc.

B. Methods and equipment used for:

1. Interior finish

2. Millwork

3. Wallboard

C. Methods and equipment used in mill building (heavy timber) construction

1. Columns

2. Beams and girders

3. Floors

4. Roof trusses

XIII. Lathing and plastering

XIV. Roofing and flashing

XV. Steel construction

A. Structural shapes and their uses

B. Types of structural steel connections

C. Types of framing

D. Erecting structural steel for:

1. Buildings

a. Sequence of erection

b. Methods of erection

c. Equipment for erection

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2. Bridges

E. Roof trusses

1. Types of trusses

2. Methods used in erection

3. Equipment for erection

F. Plumbing and bracing steel skeletons

XVI. Painting and glazing

XVII. Construction safety

SUGGESTED TEXT:

Peurifoy, R. L. Construction Planning, Equipment and Methods; First Edition. New York: McGraw-Hill Book Company, Inc., 1956.

SUGGESTED REFERENCES:

Huntington, Whitney C. Building Construction; Second Edition. New York: John Wiley and Sons, 1962.

Peurifoy, R. L. Estimating Construction Costs; Second Edition. New York: McGraw-Hill Book Company, Inc., 1958.

Cooper, George H. Building Construction Estimating; Second Edition. New York: McGraw-Hill Book Company, Inc., 1959.

Steinberg, Joseph and Stempel, Martin. Practices and Methods of Construction; First Edition. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1957.

21576

VT 013 318
Farkas, A.G.
Construction of Roads and Pavements. Course Outline.

North Carolina State Board of Education, Raleigh. Dept. of Community Colleges.
MF AVAILABLE IN VT-ERIC SET.
T-CIV-227
PUB DATE - Nov63 7p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *CURRICULUM GUIDES; *CONSTRUCTION (PROCESS); *ROAD CONSTRUCTION; *TRANSPORTATION; POST SECONDARY EDUCATION; BUILDING MATERIALS; VOCATIONAL EDUCATION

ABSTRACT - Developed by the Vocational-Technical Division of the North Carolina State Board of Education, this outline is for instructor use in planning a course on construction of roads and pavements. Specific objectives are to: (1) analyze the effects of various types of loads on flexible and rigid pavements, (2) study subgrades, including types, properties, preparation, stabilization, and testing, (3) teach the design of bituminous surfaces and concrete pavements, and (4) study techniques and details pertaining to pavements. The material is designed in outline form with 13 major topics included, and is recommended for use with the text by Laurence Hewes and others entitled "Highway Engineering." Two other suggested references are listed. A related document is available as VT 013 317, also in this issue. (GEB)

VT 013 318

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T-CIV 227

COURSE OUTLINE

T-CIV 227 CONSTRUCTION OF ROADS AND PAVEMENTS.

November, 1963

Reprinted
January, 1968

Developed by
A. G. Farkas, Consultant

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
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VOCATIONAL-TECHNICAL DIVISION
DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

VT013318

Course Description

T-CIV 227 CONSTRUCTION OF ROADS AND PAVEMENTS

Construction practices for various types of road building, including soil properties, grading, subgrading, base courses, drainage, embankments, compaction, and formwork. Design, construction, and testing of rigid portland cement concrete and flexible bituminous pavements. Field inspection trips.

COURSE OUTLINE

T-CIV 227 CONSTRUCTION OF ROADS AND PAVEMENTS

OBJECTIVES: (1) To analyze the effects of various types of loads on flexible and rigid pavements.
(2) To study subgrades, including types, properties, preparation, stabilization, and testing.
(3) To teach the design of bituminous surfaces and concrete pavements.
(4) To study the techniques and details pertaining to the control, construction, and testing of both flexible and rigid pavements, and perform the necessary tests.

COURSE HOURS PER WEEK: Class, 3; Laboratory, 2.

QUARTER HOURS CREDIT: 4.

PREREQUISITES: T-CIV 217, T-CIV 218, T-CIV 202.

OUTLINE OF INSTRUCTION:

I. Pavement types and wheel loads

A. Definition of pavement types

B. Comparison of highway and airport pavements

C. Wheel loads

1. Effective contact areas

2. Distribution of wheel loads to subgrade

a. Elastic soil deformation

b. Consolidation soil deformation

c. Plastic soil deformation

II. Stresses in flexible pavements

III. Stresses in rigid pavements

IV. Pavement behavior under moving loads

V. Rigid-pavement pumping

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VI. Subgrades

A. Investigation

B. Classification of soils

1. American Association of State Highway Officials (AASHO) classification

2. Public roads administration classification

C. Important properties of soils in highway construction

1. Density

2. Supporting power

3. Permeability

4. Compressibility

5. Elasticity

6. Capillarity

D. Tests of subgrade soils

1. Direct measurement of supporting power

2. California bearing-ratio method (CBR)

3. Shrinkage

4. Density

a. Relation between moisture content and density

b. Optimum moisture content

E. Effect of subgrade movements on wearing surfaces

1. Elastic rebound after compression

2. Shrinkage and expansion

3. Frost heave

4. Slides in cuts and fills

5. Slips

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6. Settlement of fills

7. Lateral flow of soft subsoil

8. Erosion by surface water

F. Preparation and stabilization of subgrades

1. Drainage

a. Side ditches

b. Pipe drains

c. Underdrainage

(1) Blind drains

(2) Tile drains

d. Culverts

2. Removal and replacement of defective soils

3. Mechanical manipulation

4. Use of blanket courses

5. Use of foundation courses

6. Surface treatment

7. Subsurface waterproofing

8. Use of admixtures

9. Consolidation

10. Measures for the prevention and correction of slides and slips

11. Control of erosion

G. Stability of fills and slopes

H. Problems of construction

VII. Granular bases and subbases

A. Typical grading requirements

WHY CURRICULUM DEVELOPMENT?

Why is it important that educators constantly work on the improvement of curriculum? We suggest these reasons:

1. To keep up with our constantly changing world, communities, and schools. Affecting us are the population explosion, urbanization, changing neighborhoods, inter-group problems, and changes in values. There are evident today new technologies, new forms of energy, and the rise of new nations and ideologies.

2. To keep up with the extension of knowledge. We have much more content from which to select, many new and valuable tools of learning to use. To discard those aspects of traditional pedagogy which have become ineffective should be a first order of business. The time lag between the invention of more effective practices and their general usage may be greater in education than in any other profession.

3. To evaluate carefully the many pressures for change. Proposals for revision are being initiated not only from within the profession, but by representatives of academic disciplines, by large foundations, and by proponents of new technologies. Via mass media, pressures for some of these proposals reach our school boards. We must not become merely faddists or opportunists in education.

A Great Task for School People

The task for teachers and administrators is not necessarily to invent new practices and discover new knowledge. Scientists, inventors, psychologists, professors of education, historians, sociologists, and scholars in a host of other fields are doing this. Our main task is to apply these new skills and knowledges to our local situations.

The problem, then, is how to help teachers and administrators become aware of cultural change and new knowledge, recognize their roles in modifying the curriculum, and set up programs of school improvement appropriate to the students they teach.

How do we proceed to work on the problem? The writers believe that the essential labor must be performed at the local level. Only when a school staff becomes personally involved in innovation, experimentation, and research are lasting changes likely to be implemented in the classroom.

On the following page are presented several alternative approaches for working on the local scene. In the chapters which follow, the writers develop suggestions for local leadership in curriculum improvement, with particular reference to the function of the outside consultant.

Factors Which Block or Support Change

Whatever the approach, a realistic assessment of blocking and supporting factors must be made. Then a setting must be created in which teachers can best work with intellectual freedom and responsibility.

This must not be a setting in which the participants are indifferent, confused, or battling, but where they know what they are doing and work together to achieve common goals.

Some References

Background references for this chapter include AASA-ASCD (1), Alexander (2), Brickell (10), Clark (14), Fleming (18), Passow (24), and Trump (31).

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B. Macadam base courses

C. Bases for rigid pavements

D. Bases and subbases for flexible pavements

E. Construction

VIII. Bituminous surfaces

A. Function of the surface

B. Types of bituminous materials

C. Surface treatments

D. Road mixes

E. Penetration macadam

F. Asphalt concrete

G. Thickness requirements

IX. Flexible airport pavements

X. Design of flexible highway pavements using "North Carolina Bearing Method"

XI. Design of rigid pavement (Portland cement concrete pavement)

XII. Construction of flexible and rigid pavements

A. Construction techniques and details

B. Handling traffic during construction

C. Safety

D. Supervision of construction

E. Control of materials of construction

a. Soil tests

b. Aggregate tests (including Los Angeles Abrasion Test)

c. Concrete cylinder tests

d. Core tests

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e. Hubbard field test

f. Marshall test

2. Control of pavement construction

XIII. Field inspection trips

SUGGESTED TEXT:

Hewes, Laurence I. and Oglesby, Clarkson H. Highway Engineering; First Edition. New York: John Wiley and Sons, Inc., 1960.

SUGGESTED REFERENCES:

Ritter, Leo J. and Paquette, Radnor J. Highway Engineering; Second Edition. New York: The Ronald Press Company, 1960.

Bruce, Arthur G. and Clarkson, John. Highway Design and Construction; Third Edition. Scranton, Pennsylvania: International Textbook Company, 1960.

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VT 013 319
Driver and Traffic Safety Education Guide.

New York State Univ., Oswego.
New York State Education Dept., Albany.
Bureau of Secondary Curriculum Development.
MF AVAILABLE IN VT-ERIC SET.
The Publications Distribution Unit, State Education Department, Albany, New York 12224 (single copies available).
PUB DATE - ND 44p.

DESCRIPTORS - *VOCATIONAL EDUCATION; *DRIVER EDUCATION; *TRAFFIC SAFETY; *TEACHING GUIDES; *SAFETY EDUCATION; MOTOR VEHICLES; TRAFFIC REGULATIONS; INSTRUCTIONAL MATERIALS; SKILL DEVELOPMENT; SKILLS

ABSTRACT - This manual represents a modern approach to the teaching of driver and traffic safety education and is designed to encourage the teacher to place emphasis on development of positive student attitudes toward driving. Topics are: (1) Introduction to Driver and Safety Education, (2) Orientation to the Automobile, (3) Operational Skills, (4) The Driver as a Mechanism, (5) Laws, Regulations, Ordinances, and Their Environment, (6) Physical Factors that Control Driving, (7) Perceptual Skills and Traffic Strategy in the Country, (8) Perceptual Skills and Traffic Strategy in the City, (9) Perceptual Skills and Traffic Strategy on Limited-Access Highways, (10) Social Problems and Driving, (11) Consumer Education, (12) Engineering, (13) Laboratory Instruction, and (14) Emergency Driving Procedures. Each unit is divided into an overview of the topic, unit problem, expected outcomes, content, teaching suggestions, and pupil activities. Two optional sections are appended. (GB)

VT 013 319

INSTRUCTIONS TO PROGRAM PLANNERS

This manual represents a modern approach to the teaching of driver and tra
Guide is intended to do more than facilitate the teaching of manipulative skil
More important, it is designed to encourage the teacher to place emphasis on d
attitudes toward driving. The urgent need for a change in the frame of mind o
vehicle requires flexibility and understanding on the part of the driver educa
this manuscript presents concepts and suggestions for development of material,
accumulation of facts.

The Guide is made up of 14 major units and 2 appendices. As you turn to
unit is presented on facing pages.

It would be well for the program planner to note that each unit is divide
Unit Problem, Expected Outcomes, Content, Teaching Suggestions, Pupil Activiti

- Overview of the Topic contains a brief explanation of the topic.
- Unit Problem presents the central concern of the unit, usually in
  a goal.
- Expected Outcomes state objectives in terms of understandings, aw
  skills.
- Content outlines suggestions of learnings that should form a nuc
  and course. These are in no way absolute and may be weighed as
  individual instructor. In addition, local needs frequently dict

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INSTRUCTIONS TO PROGRAM PLANNERS

ts a modern approach to the teaching of driver and traffic safety education. The
ore than facilitate the teaching of manipulative skills in operating an automobile.
igned to encourage the teacher to place emphasis on development of positive student
The urgent need for a change in the frame of mind of today's youth toward the motor
ity and understanding on the part of the driver education teacher. For that reason,
concepts and suggestions for development of material, rather than a lock-step, rigid

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ines suggestions of learnings that should form a nucleus of the unit
These are in no way absolute and may be weighed as to value by the
nstructor. In addition, local needs frequently dictate emphasis in certain areas.

- Teaching Suggestions are a supplement to the teacher's method of i section contains recommendations on those activities, instructiona procedures that might assist the instructor in providing a more me
- Pupil Activities are not a part of every unit. They are suggested where a vital activity is concerned, an evaluation called for, or experience involved.

Except for Units 1 and 2, which should be taught at the beginning of the cour need not be presented in any particular sequence. Teacher preference, availabilit convenience in scheduling, or a number of other reasons can justify varying the or

re a supplement to the teacher's method of instruction. This
nendations on those activities, instructional aids, and
assist the instructor in providing a more meaningful program.
ot a part of every unit. They are suggested in those instances
is concerned, an evaluation called for, or an enriching

hould be taught at the beginning of the course and in that order, the units
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of other reasons can justify varying the order of teaching respective units.

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EDUCATION & WELFARE
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The University of the State of New York THE S
Bureau of Secondary Curriculum Deve

RIVER & TRAFFIC SAFETY... EDUCATION

A GUIDE

University of the State of New York THE STATE EDUCATION DEPARTMENT
Bureau of Secondary Curriculum Development Albany, New York 12224

4.D

DRIVER AND TRAFFIC SAFETY EDUCATION GUIDE

THE UNIVERSITY OF THE STATE OF NEW YORK/ THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT/ALBANY/1969

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SOME WAYS OF CURRICULUM DEVELOPMENT

Here are five ways of going about the improvement of curriculum and instruction at the local level. Beside each we present some major pros and cons.

THE WAY	THE BEST THAT CAN BE SAID ABOUT IT	THE WORST THAT CAN BE SAID ABOUT IT
1. REWRITE COURSE OUTLINES	This can be helpful for those who do the rewriting and for new teachers.	The outlines often get lost, are ignored, or serve as excuses to avoid trying new things.
2. FIND BETTER TEXTBOOKS AND DEVICES	There are many excellent new texts, varied teaching materials, and helpful devices and machines on the market to supplement any program or course.	Texts and devices do not necessarily motivate people to learn. Also, great reliance on texts or commercially developed programs means that the curriculum is being determined by the financial interest of the publisher, who may turn out to be an inhibitor of change.
3. SEEK FUNDS FROM VARIOUS SOURCES	A great amount of money is available from federal, state, and private foundation sources for varied jobs which need doing.	These agencies can exert a subtle and indirect but real control over the direction of education by choosing where to place or not place their money, and by diverting local matching funds from other worthwhile areas.
4. REORGANIZE FOR BETTER INSTRUCTION	The process of searching for new organization and scheduling forms can help clarify our total needs and goals. It will appeal to the business and lay public for its efficiency.	Reorganization does not necessarily change people. It is possible to reorganize a whole school system without affecting the quality of teaching in a single classroom.
5. ENLIST THE HELP OF COLLEGES	The work of college or university consultants in an active partnership with public school personnel may be a most helpful experience to both. Other proposals on this page may be utilized in this joint effort.	Some colleges and universities may merely wish to publish more research, exhort the public schools to raise their standards, or determine the public school curriculum without examining the total problem.

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Chief, Bureau of Secondary Curriculum Development
Gordon E. Van Hooft

Supervisor, Safety Education Unit
Louis Frani

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FOREWORD

As the motor vehicle looms larger each year as a pivotal forc
driver no longer can be sent forth with just the simple mechanics
that each American youth develop an understanding of both driver a
responsibilities from legal and social viewpoints.

With the realization that education has a prime role in reach
Curriculum Development produced a prototype driver education guide
and John Ryan of Guilderland Central School assembled these materi

After a limited field test by selected schools, the material
outline was developed by an ad hoc committee composed of Louis Fra
Supervisor, Safety Education, this Department; Gene MacDowell, Ins
Rome; and Lloyd Wolfe, Instructor, Syracuse.

Mr. Frani, Mr. MacDowell, and Mr. Wolfe met again in January
is a broad, behavioral approach to driver and traffic safety educa
toward driver citizenship.

The development process was coordinated by John W. Surra, Ass
ment, who also prepared the manuscript for publication.

Gordo
Chief
Curri

William E. Young
Director, Curriculum
Development Center

supplement to the teacher's method of instruction. This
tions on those activities, instructional aids, and
t the instructor in providing a more meaningful program.
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APPENDIX II - THE SIMULATOR METHOD OF TEACHING DRIVER EDUCATION (Optional). 35

UNIT TOPIC III - OPERATIONAL SKILLS

OVERVIEW OF THE TOPIC

At this point students must become aware of the fundamental skills such as turning corners, backing, turning around, positioning of car, signaling, speed control, stopping position, lane change, and parking the vehicle.

These operational skills are not necessarily taught at one time but are covered as the students progress (i.e., parallel parking may be taught after student becomes proficient in backing).

The fundamentals of traffic foresight should be developed from the beginning, and the procedure necessary for "reading traffic" should constantly be emphasized so that the student can anticipate traffic hazard potentials.

AL SKILLS

UNIT PROBLEM

To develop b
driving experience

To develop t

To acquire t
safe, efficient op

s must become aware of the
turning corners, backing,
g of car, signaling, speed
, lane change, and parking

lls are not necessarily
covered as the students
arking may be taught after
in backing).

traffic foresight should be
ng, and the procedure
affic" should constantly be
dent can anticipate traffic

UNIT PROBLEM

To develop basic operational skills during first driving experiences

To develop the ability to anticipate hazards

To acquire the advanced skills necessary for the safe, efficient operation of the motor vehicle

UNIT TOPIC III - OPERATIONAL SKILLS

EXPECTED OUTCOMES	CONTENT
The student becomes aware of:	Simple tracking and turning paths
Traffic situations and patterns	Changing gears
Back-in-turn with no following traffic	Braking, backing, turning, and back tracking
Pull-in-turn with no approaching traffic	Stopping procedure for intersection control
Traffic problems involved in these maneuvers	. Stop line . Cross walk . Point of conflict
Problems of controlling the car in close maneuvering	Backing in street or driveway on right and pulling in on left
Problems of coordination and perception in controlling the car	Parking procedures
	Identification of problems and hazards of each
	Orientation to on-street parking an reduced-risk traffic situations (li to moderate traffic in residential areas)
	Scanning for the identification of problems and intersection procedures

UNIT TOPIC I - INTRODUCTION TO DRIVER AND SAFETY EDUCATION

UNIT TOPIC II - ORIENTATION TO THE AUTOMOBILE

OVERVIEW OF THE TOPIC

The safe, efficient operation of a motor vehicle requires that each new driver understand the function of the various instruments, controls, and safety features within his reach; be familiar with the positions of all instruments and controls; be able to interpret them with only a swift glance; and manipulate them without taking his eyes off the road.

UNIT PROBLEM

To learn to use a
various gauges, indica
safety devices before

To operate the co
while keeping his atte

To develop the co
tion of the control de

21603

TATION TO THE AUTOMOBILE

ent operation of a motor vehicle
w driver understand the function
ments, controls, and safety
each; be familiar with the
ruments and controls; be able
h only a swift glance; and
ut taking his eyes off the road.

UNIT PROBLEM

To learn to use and interpret the meaning of the various gauges, indicators, lights, controls, and safety devices before operating the vehicle

To operate the control devices and safety aids while keeping his attention on the driving path

To develop the correct habits necessary for operation of the control devices

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UNIT TOPIC II - ORIENTATION TO THE AUTOMOBILE

EXPECTED OUTCOMES	CONTENT
The student becomes aware of:	The procedure for:
The use of gauges, indicator lights, controls, and the techniques he will use in his first driving experience	. Preparation for driving . Starting the engine . Starting the car . Stopping the car . Leaving the car
Maintaining controlled attention on his driving while manipulating the controls	Steering technique
	Use of accelerator
	Use of brake
	Use of clutch
	Use of mirrors
	Use of eyes
	Hand and turn signals
	Changing drivers in traffic

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N TO THE AUTOMOBILE

	CONTENT	TEACHING SUGGESTIONS
of:	The procedure for:	Mock-up of steering wheel, accelerator, clutch, and brake pedal is desirable.
dicator the e in erience	. Preparation for driving . Starting the engine . Starting the car . Stopping the car . Leaving the car	Visual aids for clutch and brake system.
d ing while rols		Transparencies of gauges and dials.
	Steering technique	Discuss hand-over-hand steering vs. "walking the wheel."
	Use of accelerator	
	Use of brake	Discuss left- vs. right-foot braking.
	Use of clutch	Discuss car ventilation.
	Use of mirrors	Discuss blind spots.
	Use of eyes	PUPIL ACTIVITIES
	Hand and turn signals	Compare school car with family car.
	Changing drivers in traffic	Discuss warning lights vs. gauges.

UNIT TOPIC I - INTRODUCTION TO DRIVER AND SAFETY EDUCATION

OVERVIEW OF THE TOPIC

Each high school driver and traffic safety education pupil should become familiar with the fundamental objectives of the course. The insurance premium savings and full licensing privileges at age 17 are of minor importance compared to the long-range objectives of the program. However, a discussion by the teacher of these immediate pupil objectives may develop a more receptive attitude on the part of the entire class toward the program's long-range goals.

UNIT PROBLEM

To develop kn
are requisite to t
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CHAPTER II

What Kind of Leadership

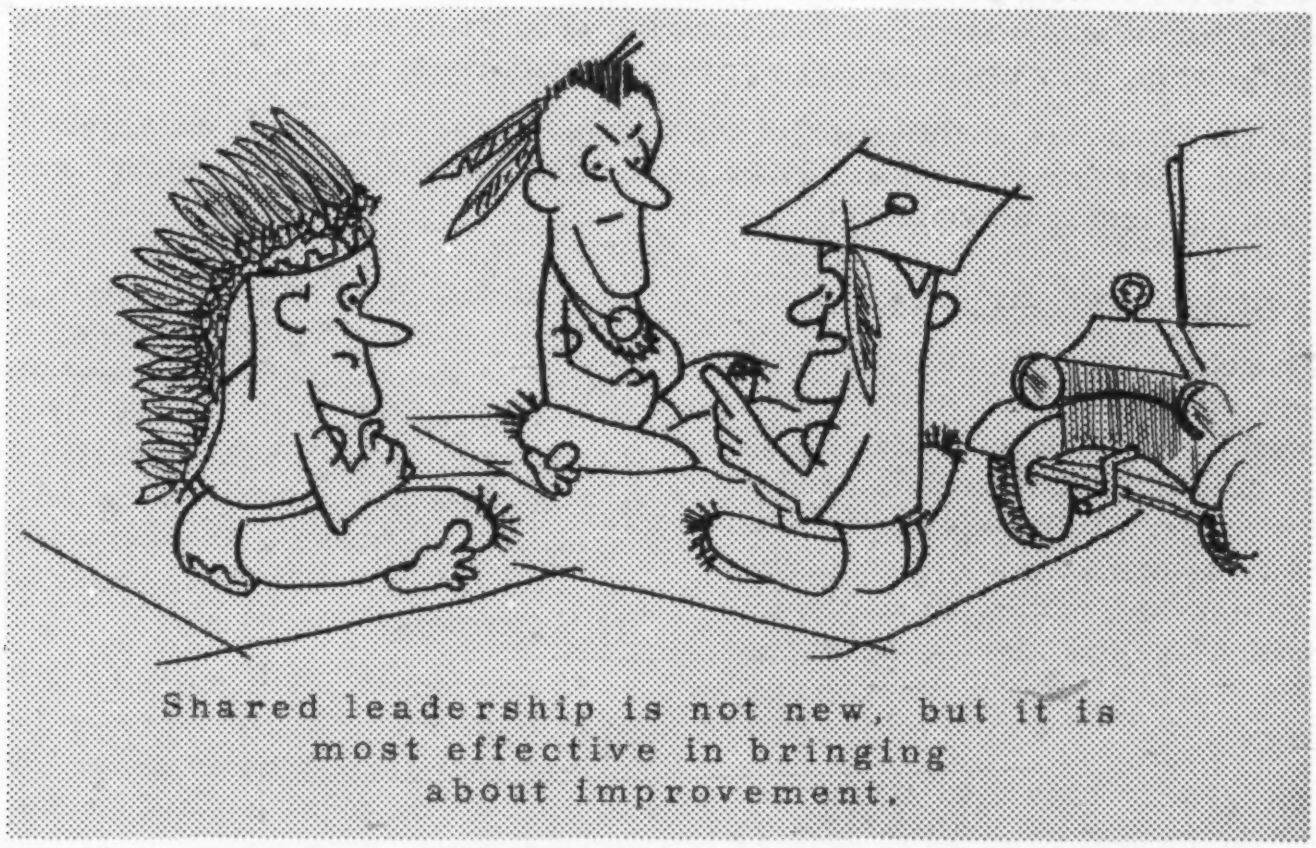

Many a school administrator has said: "I know we need curriculum revision. But I don't have the time to do it. And how do I get teachers interested?"

Many a teacher has said: "I know we need curriculum changes. But if I have to sit through one more meeting where a committee just talks and talks--I'd rather go home and peel the potatoes."

What kind of leadership will surmount these common obstacles to change? We believe it is shared leadership, where the official leader takes into account the ideas of the group. Shared leadership takes many forms and is at least as old as this ancient poem from the Chinese:

A leader is best
When people barely know that he exists,
Not so good when people obey and acclaim him,
Worst when they despise him.
"Fail to honor people
They fail to honor you";
But of a good leader, who talks little,
When his work is done, his aim fulfilled,
They will all say, "We did this ourselves."

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and traffic safety edu-
miliar with the funda-
se. The insurance
nsing privileges at age
mpared to the long-range
owever, a discussion by
e pupil objectives may
tude on the part of the
am's long-range goals.

UNIT PROBLEM

To develop knowledges, attitudes, and skills which are requisite to the life and health of the pupil and to the people of the community

UNIT TOPIC I - INTRODUCTION TO DRIVER AND SAFETY EDUCATION

EXPECTED OUTCOMES	CONTENT	TEA
The student becomes aware of:	The purposes of the program:	The schoo screen st defects o instructo or, in do student t the motor
Course requirements	Insurance requirements and licensing privileges	Have stud quirement
Advantages of completing course	Accident statistics	Arrange f send home
History of driver and traffic safety education	Conduct in the classroom and in the vehicle	Distribut
Potential benefits of driver and traffic safety education	The values of driver and traffic safety education	Have stud supplemen
The student is able to:	How to interpret statistics, charts	
Properly use and care for equipment	Criteria for evaluation of students (student's progress chart)	

DRIVER AND SAFETY EDUCATION

CONTENT	TEACHING SUGGESTIONS
The purposes of the program:	The school medical department should screen students for any physical defects or impairments. Thus, an instructor can suggest compensations or, in doubtful cases, require a student to procure a clearance from the motor vehicle department.
Insurance requirements and licensing privileges	Have students read mimeographed requirements for course completion.
Accident statistics	Arrange for a meeting with parents or send home a letter to parents.
Conduct in the classroom and in the vehicle	Distribute texts.
The values of driver and traffic safety education	Have students keep a notebook of supplementary materials.
How to interpret statistics, charts	
Criteria for evaluation of students (student's progress chart)	

UNIT TOPIC III - OPERATIONAL SKILLS

EXPECTED OUTCOMES	CONTENT
The student becomes aware of:	Simple tracking and turning paths
Traffic situations and patterns	Changing gears
Back-in-turn with no following traffic	Braking, backing, turning, and back tracking
Pull-in-turn with no approaching traffic	Stopping procedure for intersection control
Traffic problems involved in these maneuvers	. Stop line . Cross walk . Point of conflict
Problems of controlling the car in close maneuvering	Backing in street or driveway on right and pulling in on left
Problems of coordination and perception in controlling the car	Parking procedures
	Identification of problems and hazards of each
	Orientation to on-street parking and reduced-risk traffic situations (ligh to moderate traffic in residential areas)
	Scanning for the identification of problems and intersection procedures

TIONAL SKILLS

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CONTENT

Simple tracking and turning paths

Changing gears

Braking, backing, turning, and back tracking

Stopping procedure for intersection control

- Stop line
- Cross walk
- Point of conflict

Backing in street or driveway on right and pulling in on left

Parking procedures

Identification of problems and hazards of each

Orientation to on-street parking and reduced-risk traffic situations (light to moderate traffic in residential areas)

Scanning for the identification of problems and intersection procedures

TEACHING SUGGESTIONS

Off-street use of stanchions and cones

- Develop off-street drills

Stress proper body and hand positions.

Encourage proper use of rearview mirror.

Develop on-street routes that facilitate practice.

Begin use of anecdotal records.

PUPIL ACTIVITIES

Study material in N.Y.S. Driver Manual.

Students should diagram and explain the identification of the problems encountered and maneuvers necessary to accomplishing tasks.

UNIT IV - THE DRIVER AS A MECHANISM

OVERVIEW OF THE TOPIC

The driver is the most important single element in traffic safety. It is generally believed that people drive as they live and, therefore, it is important for all drivers to evaluate their total personalities and realize the potential effect of this on their driving. The driver who is able to adjust in a positive way to the many stresses and tensions of living can become a safe and responsible driver.

Many possible distracting factors may affect the driving of youngsters such as socioeconomic background, intelligence, personality, motivation, and age. These factors must be recognized and understood if we are to influence a behavior pattern in the young driver.

Insights and meaningful experiences must be provided so that students may understand behavior and human error as they relate to traffic accidents.

The fact that several states have enacted legislation requiring thorough physical examinations for all drivers over age 65 indicates the importance of the physical condition of the driver in relation to the safe operation of a motor vehicle. If each driver knows and understands his own physical limitations, and learns to compensate for them, his driving can be made safe and enjoyable.

UNIT PROBLEM

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UNIT PROBLEM

The relationship between the human characteristics of drivers and the motor vehicle accident problem

Attitude and behavior as significant factors in traffic safety

Attitudes relating perceptions to performance

Self-preservation as an instinct

Attitudes being subject to change as the acquisition of knowledge and maturity increases

The relationship between good physical condition and driver performance

The adjustment of driving patterns to physical limitations

UNIT V - LAWS, REGULATIONS, ORDINANCES, AND THEIR ENVIRONMENT

OVERVIEW OF THE TOPIC

Many of our existing traffic regulations have been derived from custom, but the Vehicle and Traffic Law was developed to control the increased volume of vehicles.

Voluntary compliance with traffic ordinances will reduce the need for additional enforcement and legislation.

Drivers' licenses are granted by the State Department of Motor Vehicles, and all persons applying for the driving privilege must pass preliminary tests administered by that department.

A student desiring to take a road test before completing a State-approved driver education course must complete a special course of classroom instruction prescribed by the Motor Vehicle Department.

Driver and traffic safety education pupils must understand that they may retain the privilege of driving only so long as they maintain satisfactory driving records. Violations become a permanent part of their records.

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UNIT PROBLEM I

To teach the beginning driver the following about vehicle and traffic laws:

Vehicle traffic laws reflect the history of transportation.

There are federal, State, and local laws and regulations for drivers and vehicles.

UNIT PROBLEM II

That the driver understand the following about police traffic supervision:

Enforcement of vehicle and traffic laws is one of the responsibilities of the police.

Police effort and driver cooperation help provide safe and efficient highway transportation.

The value of enforcement is highly dependent upon the proper disposition of charges by the courts.

Selective enforcement should be directed toward the alleviation of violations known to be accident causative.

Traffic law enforcement reflects "community climate."

UNIT IV - THE DRIVER AS A MECHANISM

EXPECTED OUTCOMES	CONTENT
To develop understandings and awareness in beginning drivers of the following:	Mental perspective. . Responsible maturity . Irresponsible immaturity . Environmental influence and behavior
Physical disabilities which affect driving.	
The effect of emotions on safe driving.	Relationship of age to driving patterns.
The behavioral patterns that produce bad risks as drivers.	Effect of physical fitness on body endurance, test performance, and driving ability.
The student is able to:	Disabilities. . Permanent - visual, auditory, muscular . Temporary - fatigue, carbon monoxide, medications and drugs, alcohol, and other depressants.
Drive when physically fit.	
Drive with controlled emotions.	
Compensate for temporary disabilities, i.e., fatigue.	
Evaluate vehicle and environmental limitations.	

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CONTENT

Mental perspective.

- Responsible maturity
- Irresponsible immaturity
- Environmental influence and behavior

Relationship of age to driving patterns.

Effect of physical fitness on body endurance, test performance, and driving ability.

Disabilities.

- Permanent - visual, auditory, muscular
- Temporary - fatigue, carbon monoxide, medications and drugs, alcohol, and other depressants.

TEACHING SUGGESTIONS

Administer and interpret a psychological test such as Mann's Personal Attitude Survey.

Administer and interpret psychophysical test: reaction time, night vision, depth perception, visual acuity, peripheral vision.

Discuss accident statistics of older drivers and handicapped drivers compared to drivers under 25. Emphasize why the young driver's record is so bad.

Arrange for the school psychologist to talk to the class about the psychological manifestations of good and poor drivers.

Discuss the difference between an accident and a crash.

Show and discuss the film: "Anatomy of an Accident."

PUPIL ACTIVITIES

List medicines found at home that produce drowsiness and discuss their implications.

Identify conflicts leading to tension.

Discuss ways of resolving conflicts.

UNIT V - LAWS, REGULATIONS, ORDINANCES, AND THEIR ENVIRONMENT

EXPECTED OUTCOMES

The student becomes aware and develops an understanding of:

Traffic laws as the responsibility of the State and local municipality

Special conditions for Federal Government intervention (National Highway Safety Bureau)

What constitutes the uniform traffic code

The necessity of laws for regulating traffic

The process involved in making and enforcing laws

The part enforcement plays in reducing accidents

The responsibility and privilege of having a driver's license

How to obtain and keep a license

The function and problems of the Department of Motor Vehicles

CONTENTS

Vehicle and traffic law as o lined in the drivers manual:

- Uniform vehicle code
- State & local ordina
- Interstate travel
- Interstate compacts

The law and its enforcement:

- The role of federal, and local agencies
- Enforcement, selecti nonselective barrier proper enforcement
- Effects of verdicts

The licensing privilege:

- Test requirements
- Permit and license
- Issuance, renewal
- Suspension, revocati and cancelation

DEVELOPING SHARED LEADERSHIP

A leader is someone who causes others to get something done. The leader who tries to involve others in determining what should be done and how to do it--the leader who tries to help each person involved to make such judgments with the greatest concern for others--is called democratic. The preference here is for this democratic leadership, with its tendency to develop leadership in others.

For the purposes of this booklet the terms shared, evolving, emergent, and democratic leadership will generally be used interchangeably, even though each word has its own particular connotation.

Add a Dash of Reality

Every school system has those who have been given official responsibility for the children, staff, curriculum, resources, buildings and grounds, and so on. Such responsibilities require thousands of decisions, big and small. Time and circumstances often affect the extent to which an official--or status leader, as we shall call him--can consult with others.

Status leaders may find it easy to make decisions that have little impact on human behavior. But when people must change, others in the schools may be far more able to promote the change.

The need for change must be felt by teachers. Status leaders should learn how to encourage this without chicanery, cajoling, or other questionable techniques. Attention to the theory of evolving or emergent leadership may help.

Leadership Evolves

This theory says that leadership is a product of the situation, the group, and the person. There cannot be a leader without a group, nor an effective group without a leader. The leader is the one who is most sensitive to the needs of the group and helps to establish its goals and carry them out.

Leadership, therefore, is any contribution which helps the group define and attain its purposes.

Although it is helpful to the leader to possess certain desirable traits--intelligence, the ability to express himself, self-confidence, and others--it should be remembered that these traits are not the special gift or property of any individual. We all possess them in varying degrees, and can make our contributions to leadership accordingly.

According to this theory everyone may be a leader at one time or another. There will usually be an official or status leader in a purposeful group, but this is not incompatible with the idea that the real leader at a given moment may be someone else. This evolving, emergent, or shared leadership is variable and may rotate as the situation changes.

The idea of shared leadership is not new--it has been the basis of ancient republics and modern democracies. It has existed in primitive civilizations. Today it has support from historians, psychologists, and sociologists.

The writers accept the theory that leadership evolves, and have based the remaining chapters of this Handbook on its inherent assumptions.

Some References

The implications of shared leadership are discussed at length by Miel (20). Excellent treatments may also be found in Burnham (13), Douglass (17), Shane (27), Wiles (33), and ASCD 1960 (7).

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LATIONS, ORDINANCES, AND THEIR ENVIRONMENT

OMES	CONTENTS	TEACHING SUGGESTIONS
aware and develops f:	Vehicle and traffic law as outlined in the drivers manual: . Uniform vehicle code . State & local ordinances . Interstate travel . Interstate compacts	Distribute a mimeographed summary of rules of the road. Discuss the implications of federal control. Discuss similarity of traffic rules in the interstate system.
as the responsi- State and local tions for Federal tervention way Safety Bureau) es the uniform of laws for affic nvolved in making laws rcement plays in dents lity and privilege river's license and keep a license and problems of the Motor Vehicles	The law and its enforcement: . The role of federal, State, and local agencies . Enforcement, selective and nonselective barriers to proper enforcement . Effects of verdicts The licensing privilege: . Test requirements . Permit and license . Issuance, renewal . Suspension, revocation, and cancelation	Request a speaker from the local governing body or State legislature for an assembly program. Invite a local magistrate or police officer to be a speaker. Visit a traffic court in session. Have police demonstrate equipment used in enforcement. Distribute pamphlets on the "point system," and inspection law. Discuss "driver improvement clinic." Discuss "what to do in case of an accident."

PUPIL ACTIVITIES

Debate inspection law.

Fill out forms and insurance report.

Clip accident reports from newspapers.

UNIT VI - PHYSICAL FACTORS THAT CONTROL DRIVING

EXPECTED OUTCOMES	CONTENT
The student becomes aware and has understanding of:	Emphasize the pre-crash, cra post-crash phases as outline National Highway Safety Act.
The crash as a traffic safety problem	
The adverse conditions leading to a crash	Laws of motion-centrifugal f and inertia. . Kinetic energy . Gravity . Tires and frictio
The physical laws contributing to a crash	. Brakes and fricti . Effects of road s and friction
Conditions that affect a driver's reaction time	. Road characterist banked, crown, fl
Value of restraining devices	. Weather conditio . Force of impact . Reduction of spe - before enterin - approaching cr - under adverse - in doubtful si as children pl animals, or ab pedestrians . Stopping distance - seeing and per recognition - decision makin - reaction dista - braking distan . Passenger restrai

UNIT TOPIC VI - PHYSICAL FACTORS THAT CONTROL DRIVIN

OVERVIEW OF THE TOPIC

Man has been ingenious in using nature's laws propel himself and his car. These same natural for can injure or destroy him if he fails to consider them in his driving. If he allows a difficult situ tion to go beyond a certain point, the laws of phys take over and the result is out of his hands.

Adverse conditions such as darkness, slippery pavement, fog, sleet, and snow make observance of these natural laws of prime importance.

The automobile industry is attempting to desig the vehicle with built-in safety devices and equipment to compensate for driver indifference to or ignorance of physical laws.

L FACTORS THAT CONTROL DRIVING

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UNIT PROBLEM

To teach the beginning driver about forces and natural laws that influence driving

To assist him in learning to cope with these factors

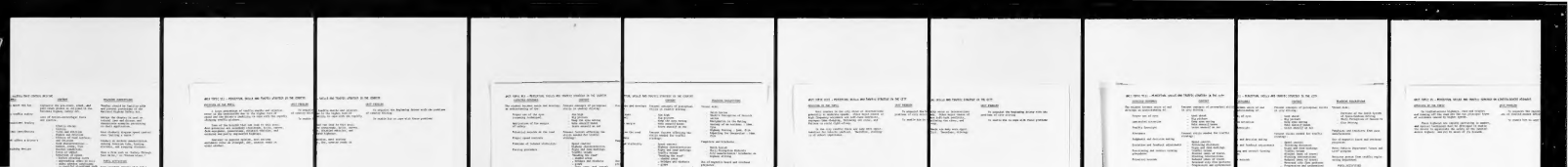

UNIT TOPIC VIII - PERCEPTUAL SKILLS AND TRAFFIC STRATEGY IN THE CITY

EXPECTED OUTCOMES

The student becomes aware of and develops an understanding of:

Proper use of eyes

Controlled attention

Traffic foresight

Alertness

Judgments and decision making

Evalution and feedback adjustments

Positioning and correct turning procedures

Potential hazards

CONTENT

Present concepts of perceptual skills in city driving:

- Look ahead
- Big picture
- Keep eyes moving
- Make oneself known
- Leave oneself an out

Present skills needed for traffic strategy:

- Speed control
- Following distances
- Signs and road markings
- Traffic volume
- Blocked lanes of travel
- Blocking intersections
- Reduced lanes of travel
- Reversed city flow patterns
- Progressive and sychronized lights
- Multiple intersection control
- Irregular intersections
- Lane changing
- One-way street
- Turning procedure
- Car doors opening into traffi
- Absent-minded pedestrians

II - PERCEPTUAL SKILLS AND TRAFFIC STRATEGY IN THE CITY

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CONTENT

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- Look ahead
- Big picture
- Keep eyes moving
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- Blocked lanes of travel
- Blocking intersections
- Reduced lanes of travel
- Reversed city flow patterns
- Progressive and sychronized lights
- Multiple intersection controls
- Irregular intersections
- Lane changing
- One-way street
- Turning procedure
- Car doors opening into traffic
- Absent-minded pedestrians

TEACHING SUGGESTIONS

Visual Aids:

- Portions of the Smith System of Space-Cushion Driving
- Shell Perception of Hazard #1
- City Driving

Pamphlets and brochures from auto manufacturers

Use of magnetic board and overhead projector

Motor Vehicle Department "Learn and Live" program

Resource person from traffic engineering department

PUPIL ACTIVITIES

News clippings, charts, and posters

Essays and letters to editor for community action

Accident spot maps

Discussion of hazardous intersections

Visit to traffic court

UNIT TOPIC IX - PERCEPTUAL SKILLS AND TRAFFIC STRATEGY ON LIMITED-ACCESS HIGHWAYS

OVERVIEW OF THE TOPIC

On limited-access highways, rear-end crashes and running off the road are the two principal types of accidents caused by higher speeds.

These highways are rapidly increasing in number, and special techniques must be developed to enable the driver to appreciate the safety of the limited-access highway and yet be aware of its hazards.

UNIT PROBLEM

To acquaint the beg
ems of limited-access dr

To enable him to co

UNIT TOPIC VIII - PERCEPTUAL SKILLS AND TRAFFIC STRATEGY IN THE CITY

OVERVIEW OF THE TOPIC

Most crashes in the city occur at intersections generally at moderate speeds. Other major causes of high frequency accidents are left-turn conflicts, improper lane changing, following too close, and failure to yield right-of-way.

In the city traffic there are many more opportunities for vehicle conflict. Therefore, strategy is of utmost importance.

UNIT PROBLEM

To acquaint the be
problems of city drivi

To enable him to

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UAL SKILLS AND TRAFFIC STRATEGY IN THE CITY

city occur at intersections
eds. Other major causes of
are left-turn conflicts,
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UNIT PROBLEM

To acquaint the beginning driver with the problems of city driving

To enable him to cope with these problems

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SKILLS AND TRAFFIC STRATEGY IN THE COUNTRY

UNIT PROBLEM

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CAN SHARED LEADERSHIP WORK?

It would be surprising if most school staffs were ready for the application of the concept of evolving leadership. Most faculty members have had little experience with this.

Many teachers have heard the democratic theory proclaimed, only to find that the proposal was a gesture, a mere verbalism. They will tend to be especially suspicious the next time they hear the idea mentioned.

What other resistances may be expected when an administrator tries to share his leadership? What could be done about them? The chart below suggests some ways.

Charting a Strategy for Changing Attitudes Toward Democratic Leadership

Staff Perceptions of Attempts at Democracy	What the Leader May Do To Modify the Perceptions
Some teachers will doubt the leader's sincerity--will be afraid of being hoodwinked.	Don't go overboard to prove it. Take time. Carefully delegate responsibility and back up staff decisions even though there may be some doubtful ones. Be sure the scope of authority delegated is clear at the start.
Some simply won't want the responsibility.	Start with those who do. Most teachers want responsibility on some problem. Be sure that the range of problems on which teachers are consulted is wide enough to attract most of them.
Some will see their vested interests jeopardized by open examination.	Try to start with problems that do not seriously divide the staff and badly threaten the balance of power.
Some will be afraid of the new learnings involved in democratic operations.	In the orientation and planning with groups be sure to account for participation roles that involve some very simple, as well as complex abilities.
Some will question whether this kind of decision-making is part of their job.	Be careful to involve staff in problems that are clearly connected with instructional policy and procedure.

FACTORS THAT CONTROL DRIVING

ES	CONTENT	TEACHING SUGGESTIONS
aware and has	Emphasize the pre-crash, crash, and post-crash phases as outlined in the National Highway Safety Act.	Teacher should be familiar with and present provisions of the National Highway Safety Act.
traffic safety	Laws of motion-centrifugal force and inertia.	Assign the chapter in test on natural laws and discuss and demonstrate examples pertaining to their application.
ditions leading	. Kinetic energy . Gravity	
ws contributing	. Tires and friction . Brakes and friction	Have students diagram speed control when "pulling a curve."
affect a driver's	. Effects of road surfaces and friction . Road characteristics - banked, crown, flat	Conduct an outdoor demonstration showing reaction time, braking distance, and stopping distance.
ining devices	. Weather conditions . Force of impact . Reduction of speed: - before entering curve - approaching crest of hill - under adverse conditions - in doubtful situations such as children playing, animals, or absent-minded pedestrians . Stopping distance factors: - seeing and perceptual recognition - decision making - reaction distance factors - braking distance factors . Passenger restraining devices	Show a film such as "Safety Through Seat Belts," or "Broken Glass." PUPIL ACTIVITIES Clip accident reports that illustrate the results of ignoring natural laws. Discuss the value of seat belts.

UNIT TOPIC VII - PERCEPTUAL SKILLS AND TRAFFIC STRATEGY IN THE COUNTRY

OVERVIEW OF THE TOPIC

A large percentage of traffic deaths and injuries occur in the countryside due to the higher rate of speed and the driver's inability to cope with the rapidly changing traffic picture.

Some of the hazards that can lead to this accident potential are secondary crossroads, hills, curves, farm equipment, pedestrians, disabled vehicles, and outdated and poorly engineered highways.

Contrary to popular opinion, most serious accidents occur on straight, dry, country roads in clear weather.

UNIT PROBLEM

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UNIT TOPIC VII - PERCEPTUAL SKILLS AND TRAFFIC STRATEGY IN THE COUNTRY

EXPECTED OUTCOMES	CONTENT
The student becomes aware and develops an understanding of the:	Present concepts of perceptual skills in country driving:
Proper use of the eyes (scanning technique)	. Aim high . Big picture . Keep the eyes moving
Application of the margin of safety	. Make oneself known . Leave oneself an out
Potential hazards on the road	Present factors affecting the skills needed for traffic strategy:
Proper speed controls	
Problems of reduced visibility	. Speed control . Highway characteristics
Passing procedure	. Signs and road markings . Traffic volume . "Reading the road" - shaded areas - bridges and viaducts - glare - rain, snow, mud, gravel, wet leaves
	Present defensive driving techniques to avoid collisions under the following conditions:
	. Intersections . Merging roads . Car approaching . Car following . Passing . Traffic circles . Hills and curves . Emergency vehicles . Trucks and buses . Populated areas

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S	CONTENT	TEACHING SUGGESTIONS
are and develops e:	Present concepts of perceptual skills in country driving:	Visual Aids:
eyes ue)	. Aim high . Big picture . Keep the eyes moving	. Smith System . Shell's Perception of Hazards series . Emergencies in the Making
e margin	. Make oneself known . Leave oneself an out	. Anatomy of an Accident - 16mm. film . Highway Driving - 16mm. film . Expecting the Unexpected - 16mm. film
on the road rols	Present factors affecting the skills needed for traffic strategy:	Pamphlets and brochures:
ed visibility	. Speed control . Highway characteristics . Signs and road markings . Traffic volume . "Reading the road" - shaded areas - bridges and viaducts - glare - rain, snow, mud, gravel, wet leaves	. Smith System . Shell Perception Booklets . Auto manufacturers' brochures on highway driving Use of magnetic board and overhead projector Motor Vehicle Department "Learn and Live" program Resource person from enforcement agency
	Present defensive driving techniques to avoid collisions under the following conditions:	PUPIL ACTIVITIES
	. Intersections . Merging roads . Car approaching . Car following . Passing . Traffic circles . Hills and curves . Emergency vehicles . Trucks and buses . Populated areas	News clippings for charts and posters Discussion of student experiences in highway driving Trip planning, map reading, and car preparation

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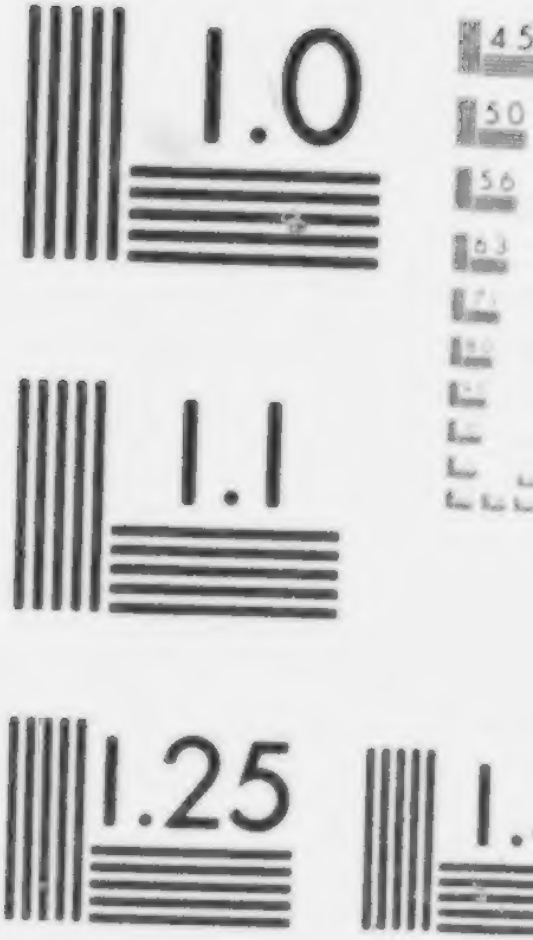

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UNIT TOPIC X - SOCIAL PROBLEMS AND DRIVING

OVERVIEW OF THE TOPIC

Motor vehicles have given the American people a great freedom, but this freedom is being abused. The traffic toll for a holiday weekend is often described as "a national disaster." But even this fails to arouse people to demand a solution.

Many Americans will either ignore or reject research statistics about the relationship of alcohol and traffic accidents.

National Safety Council figures, based on accident reports, indicate that nearly one out of every two fatal motor vehicle accidents involved a drinking driver, and that one out of every four adult pedestrians killed in motor vehicle accidents had been drinking. Drivers who had been imbibing caused over half of the Christmas-New Year's fatal accidents.

It is interesting to note that none of the studies indicated "drunken driving." The term "had been drinking" characterizes the driver who staggers to his car and then weaves recklessly in and out of traffic. But as dangerous as this individual is in traffic, it is the so-called "social drinker," the person who believes that one or two drinks do not affect his behavior, who is the real problem. Scientists who study the nervous system have found that the first few drinks often have a very serious effect on behavior.

The driver education teacher's role includes teaching pupils how important this problem is to our society.

UNIT PROBLEM

The beginning driver unders
about the effects of alcohol an
driving:

That use of alcohol and drugs d
driving efficiency

That alcohol may act as a depre
as a stimulant

That use of alcohol and drugs m
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UNIT PROBLEM

The beginning driver understanding the following about the effects of alcohol and drugs upon safe driving:

That use of alcohol and drugs definitely decreases driving efficiency

That alcohol may act as a depressant rather than as a stimulant

That use of alcohol and drugs may be manifestations of existing emotional maladjustments

That custom and lack of understanding by the public sometimes encourage social drinking before driving

That alcohol may not outwardly affect the skills of the driver, but it makes the driver unfit to drive

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UNIT TOPIC IX - PERCEPTUAL SKILLS AND TRAFFIC STRATEGY ON LIMITED-ACCESS HIGHWAYS

EXPECTED OUTCOMES	CONTENT	TEA
The student becomes aware and develops an understanding of: The importance of preparing the car and driver for travel Entering, traveling on, and leaving limited-access highway Traveling to the next exit if one overshoots the exit desired The importance of a good space cushion	Present concepts of perceptual skills of limited-access highways: . Aim high . Get big picture . Keep one's eyes moving . Make oneself known . Leave oneself an out Present skills for traffic strategy: . Types of interchanges . Trip planning and knowing the exit . Use of rumble strip . Purpose of center mall . Proper use of acceleration lanes . Lanes of travel . Passing maneuvers . Speed control with traffic flow . Avoid bunching . Emergency procedures . Highway hypnosis . Use of deceleration lanes . Problem of being velocitized	Visual Ai . Por Spa . Per on Pamphlets manufactu Use of ma projector Motor Veh Live" pro Explain l access hi Resource PUP News clip Trip plan Have stu breakdown Have stu distance Have stu periodic

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TUAL SKILLS AND TRAFFIC STRATEGY ON LIMITED-ACCESS HIGHWAYS

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CONTENT

Present concepts of perceptual skills of limited-access highways:

- Aim high
- Get big picture
- Keep one's eyes moving
- Make oneself known
- Leave oneself an out

Present skills for traffic strategy:

- Types of interchanges
- Trip planning and knowing the exit
- Use of rumble strip
- Purpose of center mall
- Proper use of acceleration lanes
- Lanes of travel
- Passing maneuvers
- Speed control with traffic flow
- Avoid bunching
- Emergency procedures
- Highway hypnosis
- Use of deceleration lanes
- Problem of being velocitized

TEACHING SUGGESTIONS

Visual Aids

- Portions of the Smith System of Space-Cushion Driving
- Perception of Hazards #2 film on limited-access driving

Pamphlets and brochures from auto manufacturers.

Use of magnetic board and overhead projector.

Motor Vehilce Department "Learn and Live" program.

Explain local variations on limited-access highways.

Resource person in traffic safety.

PUPIL ACTIVITIES

News clipping, charts, and posters.

Trip planning.

Have students identify some common breakdown problems.

Have students discuss why following distance is so important.

Have students discuss the value of periodic rest.

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SAFEGUARDS FOR THE LEADER

If a status leader starts out to develop and share leadership, he is bound to be tested. Teachers who do not understand the many pressures on administrators will hope for too much. The doubters and skeptics will have to be shown.

The point is that the leader must not promise more than he can deliver. And knowing what one can deliver takes honest self-study. Here are some questions to help the leader check himself before he embarks on a democratic venture with his faculty.

A Leader's Checklist for Self-Evaluation

The leader should attempt to analyze himself with questions such as these:

In what situations am I likely to be most anxious or fearful?

What things tend to annoy or anger me most?

How badly do I need the center stage in school affairs?

How do I take criticism and in what areas can I take it most and least?

In what affairs must I have the veto power?

How interested am I in helping the staff to take responsibility--or is this simply a gimmick to let people think they have authority?

What proportion of my leadership time is usually devoted to each of the following: (a) telling the group what to do, (b) promoting my ideas or manipulating the group, (c) listening to the group's ideas, (d) joining the group as a member in arriving at a common decision?

Such questions, answered as honestly as we know how, may tend to limit the scope of initial ventures in sharing leadership. But better to start modestly and succeed than to over-commit and fail.

Questions on Delegating Responsibility

Fuzzy delegation of responsibility accounts for many disappointments and conflicts in efforts to share leadership. Here are some guidelines:

Be sure that other status leaders understand what is being delegated, especially if it might interfere with their authority as they see it.

In describing what is being delegated, give specific illustrations of what is and is not within the scope of authority of the person to whom it is delegated.

Develop standards or criteria for group recommendations. These should be based upon:

Examination of all the facts available locally

Expert opinion

Research

Be sure that delegating responsibility does not merely mean "passing the buck."

Setting Personal Standards

Buffeted as the leader is likely to be, it might help him to use a leadership inventory of some kind. The checklist that follows might serve this purpose.

UNIT TOPIC XI - CONSUMER EDUCATION

OVERVIEW OF THE TOPIC

Purchasing, insuring, and maintaining automobiles will be a major financial decision to be faced by most of the class members.

The students should consider these factors when purchasing a car: amount of money available, uses for the car, whether the car is new or used, the past history of the particular car, economy of operation, future trade-in value, insurance, and operating costs.

Special emphasis should be given to methods of financing the purchase and proper insurance coverage.

UNIT PROBLEM

That drivers and vehi
following about automotive
available to them;

The percentage of an indiv
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Selecting new and used vel
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operating condition

Purchasing insurance

Follow manufacturer's rec
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Exploring various availab
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Reading contract carefully
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UNIT PROBLEM

That drivers and vehicle owners understand the following about automotive products and services available to them;

The percentage of an individual's income that is allocated to the purchase and maintenance of a motor vehicle

Selecting new and used vehicles that are safe and efficient to operate and maintaining them in good operating condition

Purchasing insurance

Follow manufacturer's recommendations for preventive maintenance

Exploring various available sources of financing before signing an installment loan agreement

Reading contract carefully and making sure all blank spaces are filled in before signing

Lowest purchase price or cheapest maintenance may not always be the best value

UNIT TOPIC X - SOCIAL PROBLEMS AND DRIVING

EXPECTED OUTCOMES	CONTENT
The student becomes aware of: The effect alcohol has on an individual The laws relating to drinking and driving The detrimental effect of alcohol consumption upon safe driving	Alcohol consumption is a major cause of automobile accidents and fatalities. . Removes sound judgments . Removes inhibitions . Slows reaction time . Affects muscular coordination . Blurs vision Effects of barbiturates Effects of "pep pills" Effects of narcotics

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OCIAL PROBLEMS AND DRIVING

UTCOMES	CONTENT	TEACHING SUGGESTIONS
es aware of: alcohol has on al lating to drinking ntal effect of alcohol upon safe driving	Alcohol consumption is a major cause of automobile accidents and fatalities. . Removes sound judgments . Removes inhibitions . Slows reaction time . Affects muscular coordination . Blurs vision Effects of barbiturates Effects of "pep pills" Effects of narcotics	Discuss statistics from The National Safety Council. Collect local accident statistics. Utilize a local doctor or school nurse as a consultant. Assign the New York State Motor Vehicle Law (Driver's Manual). Invite a resource person to discuss with class the impact upon our society of the misuse of intoxicants. Have demonstration by proper authorities of various breath tests for alcohol content in the body.

21638

SKILLS AND TRAFFIC STRATEGY ON LIMITED-ACCESS HIGHWAYS

ways, rear-end crashes
e the two principal types
er speeds.

idly increasing in number,
be developed to enable
e safety of the limited-
aware of its hazards.

UNIT PROBLEM

To acquaint the beginning driver with the problems of limited-access driving

To enable him to cope with these problems

UNIT TOPIC XI - CONSUMER EDUCATION

EXPECTED OUTCOMES

The student becomes aware of:

The danger of making financial commitments which he cannot possibly meet

The reduction in operating costs attributable to proper maintenance and safe, skillful driving

The advantages of comparison shopping

The benefits of paying cash

Variance in credit costs

The relationship between safe driving and reduced insurance premiums

The student is able to:

Select a car to fit his needs and pocketbook

CONTENT

Transportation costs

- Purchasing a vehicle
  - credit
  - interest charges
- Preventive maintenance costs
- Operating costs
  - tires
  - gasoline
  - oil
  - antifreeze
  - repairs

Insurance policy coverages (Legal Minimum Coverages and Low Cost of Expanded Limits).

- General liability
  - personal injury and property damage
- Medical payments
- Collision
  - deductible clause
- Comprehensive coverage
- Tow and labor
- Uninsured motorist clause

SUMER EDUCATION

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CONTENT

Transportation costs

- Purchasing a vehicle
  - credit
  - interest charges
- Preventive maintenance costs
- Operating costs
  - tires
  - gasoline
  - oil
  - antifreeze
  - repairs

Insurance policy coverages (Legal Minimum Coverages and Low Cost of Expanded Limits).

- General liability
  - personal injury and property damage
- Medical payments
- Collision
  - deductible clause
- Comprehensive coverage
- Tow and labor
- Uninsured motorist clause

TEACHING SUGGESTIONS

Compare the advertised price with dealer's "Blue Book."

Assign readings from text and Driver's Manual.

Invite an insurance representative and/or auto mechanic to talk to the class.

Discuss Vehicle and Traffic Law, Sections 250 and 345 - Insurance.

Exhibit and discuss sample insurance policies.

PUPIL ACTIVITIES

Develop a checklist to help determine the type of car students need and can afford

Role playing - dealer and buyer

Evaluate a typical guarantee

Discuss magazines such as Consumer Reports

UNIT TOPIC XII - ENGINEERING

OVERVIEW OF THE TOPIC

Entire cities are being built or redesigned to accommodate to the anticipated increase in numbers of automobiles. Engineers no longer are concerned with simply providing new homes, stores, or office buildings. New highways and parking facilities must be built to accommodate the motoring public. Cars and highways of the future must be safe and efficient. By 1975 anticipated vehicle registration will surpass 111 million.

Automobile manufacturers are directing their engineers to produce safer cars. Safety is becoming a major selling point.

It has been predicted that highway and traffic engineering will prevent highway collisions in the future. Anticipated speeds in excess of 100 miles per hour on the highways of tomorrow are expected to be safer than 40 miles per hour on today's roads.

Many states and localities have not as yet accepted the *Manual on Uniform Traffic Control Devices*.

The Federal Government's interest in automobile safety will cause safer cars to be manufactured and will improve the State traffic safety program.

The engineering approach is a three-phase program essential to any long-range traffic safety plan.

UNIT PROBLEM

To understand the
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interest in automobile
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c safety program.

is a three-phase pro-
nge traffic safety plan.

UNIT PROBLEM

To understand the role of the auto, highway, and traffic engineer in the traffic accident problem

21644

UNIT TOPIC XIII - LABORATORY INSTRUCTION

EXPECTED OUTCOMES	CONTENT
The students become aware of:	Understanding lanes of traffic on two-lane, four-lane streets, one-way streets, and access lanes for turning
Legal driving procedures	Moving the vehicle from one position or lane to another with minimum risk
Proper positioning of car to identify intent	Understanding problems of left turns on multilane streets
Communication with other drivers to show intent and to understand their intent	Developing driving procedures for yielding to traffic conflicts
Scanning and assessing traffic situations	Developing defensive-driving techniques
Selecting reduced-risk alternatives in event of traffic conflicts caused by road design	
Accurate car guidance on the selected path	

21649

LABORATORY INSTRUCTION

COMES	CONTENT	TEACHING SUGGESTIONS
e aware of: procedures oning of car ntent with other ow intent and their intent assessing traffic uced-risk alter- ent of traffic sed by road guidance on the n	Understanding lanes of traffic on two-lane, four-lane streets, one-way streets, and access lanes for turning Moving the vehicle from one position or lane to another with minimum risk Understanding problems of left turns on multilane streets Developing driving procedures for yielding to traffic conflicts Developing defensive-driving techniques	Illustrations of the various techniques identified: . Slides . Film strip . Magnetic board . Charts Assign students supplementary information to reinforce textbook materials. Teacher demonstration of desired maneuvers in the vehicle followed by student participation and evaluation. Each lesson should be introduced with specific driving objectives. Instructor demonstrations should portray examples of expected student performance. Laboratory instruction should be an integral part of classroom instruction to reinforce student learning experiences. PUPIL ACTIVITIES Encourage home practice to reinforce teacher-demonstrated procedures.

21650

UNIT TOPIC XIV - EMERGENCY DRIVING PROCEDURES

OVERVIEW OF THE TOPIC

After a student has mastered basic driving techniques and procedures, he should be exposed to the common emergency driving techniques he may encounter. The teaching at this point should be directed toward a familiarization of potential emergencies and their possible solutions. At no time should the teacher expose students to a situation unless they are in complete control. The safety of the student means more than the completion of the problem.

UNIT PROBLEM

To acquaint the beg
emergencies and prepare
sions to prevent potenti

21651

A LEADERSHIP INVENTORY

This is a self-evaluation checklist for the leader. He should give himself a rating ranging from 0 (low) to 5 (high) on the extent to which each item is true.

Recognizing Limitations and Capabilities

_____He realizes the limits of his own authority and responsibility.

_____He understands the real power structure in his school system.

_____He recognizes his personal limitations. He realizes that he doesn't know everything.

_____He is willing to acknowledge when he has been mistaken or when he has had a change of viewpoint.

_____He knows what his strengths are. He sees new vistas and doesn't lose sight of them, even if the going gets difficult.

Knowing the Group

_____He helps his group to know one another better.

_____He acquaints himself with the strengths and weaknesses of the individuals in the group, and is sensitive to their needs.

Functioning as a Member of the Group

_____He helps the group see the overall picture of what might be done.

_____He informs the group of the limits of his own and the group's authority.

_____He helps create a feeling of need to do the job, whether he or the others previously saw the need or not. He helps the group determine that the job is possible.

_____He helps the group set reasonable, definite and solvable goals.

_____He involves the group in work assignments based on each individual's needs, drives and abilities.

_____He does not rely on exhorting, but works along with the group and sets a good example.

_____He gives the group praise, recognition, and high acceptance.

Securing Results

_____He gets something done without doing it all himself.

_____He tests his results by looking at how the people of his group are affected, and whether he has developed leadership within the group.

_____He achieves reasonable goals. He accepts gradual achievement when he can see that a more rapid pace would not bring lasting results.

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PROCEDURES

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UNIT PROBLEM

To acquaint the beginning driver with possible emergencies and prepare him to make the correct decisions to prevent potentially dangerous situations.

21652

UNIT TOPIC XII - ENGINEERING

EXPECTED OUTCOMES	CONTENT
The student becomes aware of:	Traffic surveys, i.e., origin and destination, speed, and vehicle count
The possibility of designing highways and streets for safer and more efficient transportation	Federal impact: . Baldwin Amendment . Interstate highway systems . Types of construction and surfaces
Improved vehicle design to minimize the effect of the "second collision" experienced by the occupants	Implementation of seat belts, laminated glass, safety locks
Many vehicle safety features that may have been added as a result of pressures for State and federal legislation	Research in highway construction
Proper uses of safety equipment	Definition of engineering
Good and poor traffic engineering	Role of the State Traffic Commission
	Reading and interpreting road maps
	Figuring the percentage of tax dollars apportioned to highways
	Differences between planned and unplanned cities

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CONTENT

Traffic surveys, i.e., origin and destination, speed, and vehicle count

Federal impact:

- Baldwin Amendment
- Interstate highway systems
- Types of construction and surfaces

Implementation of seat belts, laminated glass, safety locks

Research in highway construction

Definition of engineering

Role of the State Traffic Commission

Reading and interpreting road maps

Figuring the percentage of tax dollars apportioned to highways

Differences between planned and unplanned cities

TEACHING SUGGESTIONS

Show and discuss films: "Survival Car I and II".

Discuss specifications for Federal vehicles.

Invite a local traffic engineer to talk to the class.

Display cross sections of different types of roads (concrete - blacktop).

PUPIL ACTIVITIES

Discuss and utilize a spot map.

Observe local traffic flow for good and poor examples of highway engineering.

Analyze causes of traffic delays and have various groups offer suggestions for eliminating these delays.

Have a discussion on suggestions for future improvements in automobile safety design and equipment.

Study local traffic regulations and determine their causes and effectiveness.

Plan a trip across the country using the Interstate Highway System.

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UNIT TOPIC XIII - LABORATORY INSTRUCTION

OVERVIEW OF THE TOPIC

It is imperative that before the student performs a maneuver he is able to identify the elements of safe-driving performances which are most crucial to the safe completion of that driving maneuver.

The classroom should be utilized to identify and emphasize driving procedures and techniques that eliminate conflicts with moving traffic.

Loss of valuable laboratory-in-car-instruction time would be avoided if the student knows the maneuver he is to perform and the hazards he is likely to encounter.

UNIT PROBLEM

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UNIT PROBLEM

To enable the teacher to best utilize laboratory instructional time

To develop in the student necessary competencies for safe driving

To assure valid student driving experiences that are both appropriate and fitted to student competencies

21648

UNIT TOPIC XIV - EMERGENCY DRIVING PROCEDURES

EXPECTED OUTCOMES	CONTENT
The student becomes aware of: The potentially hazardous situations that may arise Proper responses to enable him to avoid accidents	Following are some of the potentially dangerous emergencies that a driver might encounter: . Mechanical failures - brakes - steering - generator - lights . Front or rear blowouts . Skidding . Running off the pavement . Gas pedal sticking . Hood flying up . Blinded by lights of oncoming vehicle . Stalling on railroad tracks . Horn stuck . Changing tires on road . Frozen fuel line . Overheating engine . Flooded engine . Stuck in mud or snow . Driving through water . Bee in vehicle . Animals on road . Submerged vehicle . What to do in case an accident is imminent - driver - right front passenger - rear passengers . Accident procedure

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NCY DRIVING PROCEDURES

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CONTENT

Following are some of the potentially dangerous emergencies that a driver might encounter:

- Mechanical failures
  - brakes
  - steering
  - generator
  - lights
- Front or rear blowouts
- Skidding
- Running off the pavement
- Gas pedal sticking
- Hood flying up
- Blinded by lights of oncoming vehicle
- Stalling on railroad tracks
- Horn stuck
- Changing tires on road
- Frozen fuel line
- Overheating engine
- Flooded engine
- Stuck in mud or snow
- Driving through water
- Bee in vehicle
- Animals on road
- Submerged vehicle
- What to do in case an accident is imminent
  - driver
  - right front passenger
  - rear passengers
- Accident procedure

TEACHING SUGGESTIONS

Discussion relative to emergency procedures

Films and other visual aids diagraming skid recovery, driving off pavement, crossing parallel tracks, driving in ruts, and other abnormal situations

Laboratory instruction under controlled conditions demonstrating skid recovery, running off pavement, and other abnormal situations

Changing of tires, use of jumper cables, vehicle check for exhaust gas leaks, faulty fan belts, and proper maintenance procedures

PUPIL ACTIVITIES

Panel presentations by students

Notebook; charts; newsclippings diagraming and recording driving emergencies and accidents

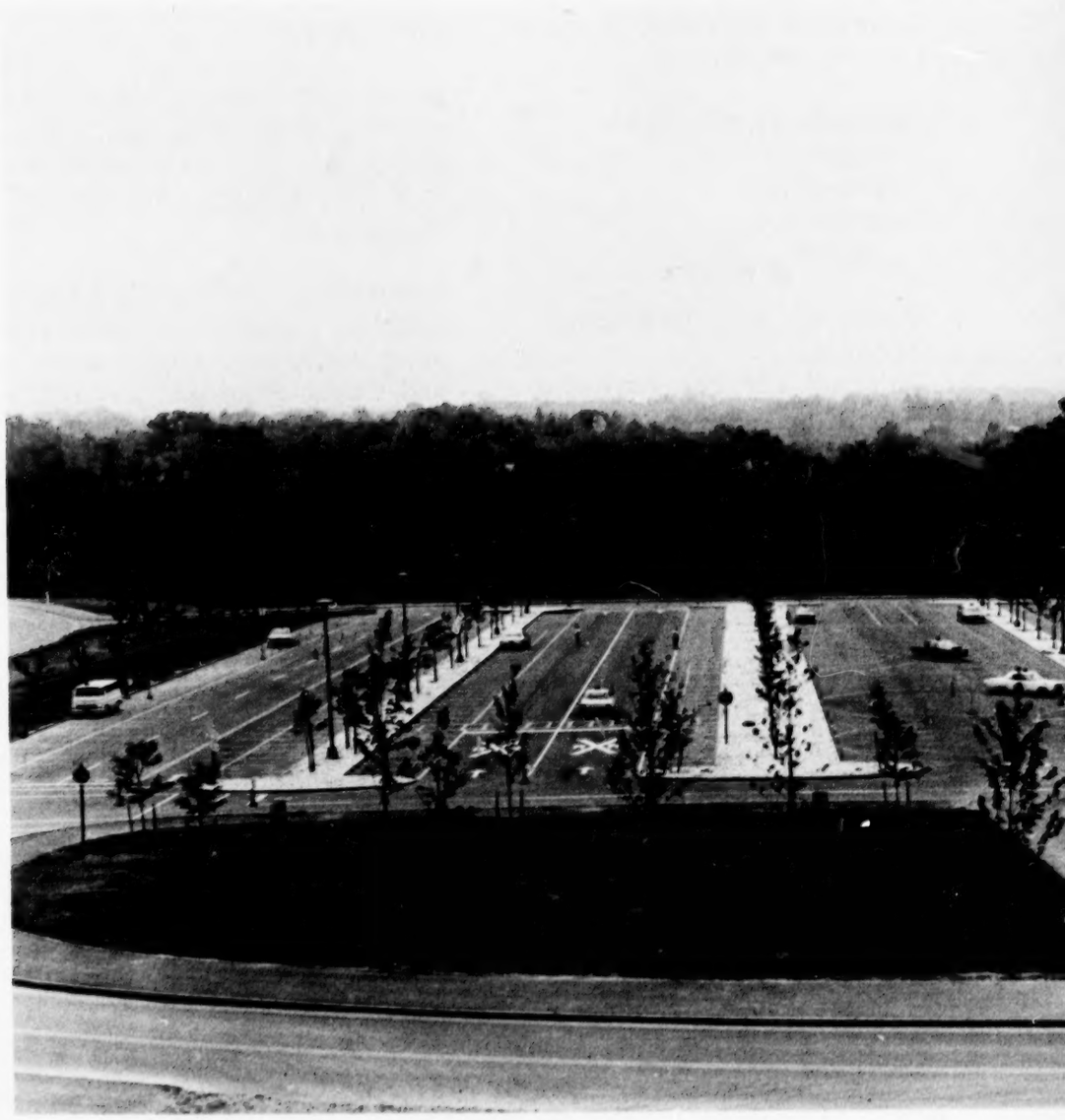

Utilization of a school parking lot as a multiple car range makes

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a school parking lot as a multiple car range makes for both convenience and safety.

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VT 013 320
Accident Investigation.

California Highway Patrol Academy.
MF AVAILABLE IN VT-ERIC SET.
HPG 70.17
California Highway Patrol, P.O. Box 898, Sacramento, California 95804 ($1.00, plus California state sales tax).
PUB DATE - Apr70 52p.Revision.

DESCRIPTORS - *VOCATIONAL EDUCATION; *STUDY GUIDES; *ACCIDENTS; *MOTOR VEHICLES; MANUALS; SAFETY; ACCIDENT PREVENTION; INSTRUCTIONAL MATERIALS; INVESTIGATIONS

ABSTRACT - Intended to supplement classroom instruction rather than serve as a complete text, this publication has been prepared as a basic training manual in the field of accident investigation for cadets at the California Highway Patrol Academy. Topics are (1) Vehicle Crashes--The Problem: The Solution, (2) Accident Investigation--A Professional Challenge, (3) Accident Investigation Procedure, and (4) Determination of Speed from Skidmarks. The document is also designed to serve as a ready reference for investigators in the field. (GB)

VT 013 320

APPENDIX I - THE MULTIPLE CAR METHOD OF TEACHING DRIVER EDUCATION (OPTIONAL)*

OVERVIEW OF THE TOPIC

The goal of driver educators is to reach all students eligible for instruction in the secondary school. School administrators are constantly concerned with per-pupil cost and frequently give this reason for not expanding the program during the regular school day.

Some solution of this problem may be realized by using the Multiple Car Method** or "Range Program" as it is commonly called. Experience has shown that the quality of the program remains high, more students are taught, and per-pupil cost drastically reduced.

Essentially the Multiple Car Method involves teaching by utilizing an off-street area on which a number of vehicles are used simultaneously to provide laboratory instruction under the supervision of one or more teachers.

A school employing two teachers and needing a third teacher would be well advised to investigate the advantages offered by the Multiple Car Method in teaching driver education.

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*In all instances, when planning and/or organizing an optional driver education method, reference should be made to State Education Department Policies.

**Section V, paragraph 5.1, Multiple Car Facility states, "Special approval from the State Education Department is required by schools for multiple car driving range programs before such instruction can be given. All enrolled pupils must receive a minimum of 18 periods (1 per week) of range instruction, two pupils per vehicle; and a minimum of 18 periods (1 per week) of actual practice on public streets and highways, using four pupils per vehicle."

UNIT PROBLEM

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FINDING AND DEVELOPING NEW LEADERS

The obligation of leaders to generate more leadership is brought out by Miel (20). Here are some brief suggestions for developing new leaders. For an extended treatment see ASCD 1960 (7).

On-the-job experience. In every school and within every committee, there are temporary or sub-leadership jobs to be done. Use these opportunities to try out and train potential leaders. Coach these people and be generous with praise when the job is done well.

Local leadership meetings. Call leaders, sub-leaders, and potential leaders of a particular curricular project together for planning. Use part of the time for informal, friendly evaluations of the type of leadership being offered.

Laboratory sessions. A number of universities conduct extended laboratory or workshop sessions where leaders and potential leaders live and work together, often for two-week periods during the summer. Emphasis may be placed on self-involvement, role-playing, interaction analysis, group dynamics or other aspects of leadership.

RECOMMENDED FOR PURCHASE

This list might form a priority for purchase for a school's professional library on leadership in curriculum development. The complete bibliographical listing is found in the list of reference sources in the back of this booklet.

ASCD 1960 Yearbook. Leadership in Improving Instruction.

ASCD 1960 Yearbook. Role of Supervisor and Curriculum Director in a Climate of Change.

Douglass, Harl R. et al. Democratic Supervision in Secondary Schools.

Miel, Alice. Changing the Curriculum.

National Education Association. Schools for the Sixties.

Schmidt, W. H. (ed.) Looking into Leadership. (Series.)

Shane, H. G. and W. A. Yaugh. Creative School Administration.

Wiles, Kimball. Supervision for Better Schools.

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UNIT PROBLEM

To assist the beginning driver in developing his operational skills

To increase teacher-pupil ratio from 1:4 to 1:12 or more

To increase pupil "behind the wheel" time by 50 to 100 percent

To provide a safe, off-street area where the student may efficiently practice all operational skills with special concentration on his weaknesses

APPENDIX 2 - THE SIMULATOR METHOD OF TEACHING DRIVER EDUCATION (Optional)

APPENDIX I - THE MULTIPLE CAR METHOD OF TEACHING DRIVER EDUCATION (Optional

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APPENDIX I - THE MULTIPLE CAR METHOD OF TEACHING DRIVER EDUCATION (OPTIONAL)*

EXPECTED OUTCOMES	CONTENT
The student becomes aware of and has an understanding of:	Orientation to car
Basic operational skills	Steering in straight line
Communicating with other drivers	Smooth acceleration and braking
Scanning and assessing traffic situations	Pulling into curb and stopping
Selecting reduced-risk alternatives	Leaving the curb
Lanes of traffic and their use on one-way and two-way streets	Hand-over-hand steering (figure 8)
Traffic signs and signals	Left and right turns at intersections
Right-of-way and other rules of the road	Lane changing
	Turning onto and off one-way streets
	Backing in a straight line ("T" exercise)
	Backing left or right into street ("X" exercise)
	Turning the car around
	Parking; angle, parallel (right), parallel (left)
	Stopping and starting on a hill
	Advanced backing
	Snow-day activities

LE CAR METHOD OF TEACHING DRIVER EDUCATION (OPTIONAL)*

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CONTENT

Orientation to car

Steering in straight line

Smooth acceleration and braking

Pulling into curb and stopping

Leaving the curb

Hand-over-hand steering (figure 8)

Left and right turns at intersections

Lane changing

Turning onto and off one-way streets

Backing in a straight line ("T" exercise)

Backing left or right into street ("X" exercise)

Turning the car around

Parking; angle, parallel (right), parallel (left)

Stopping and starting on a hill

Advanced backing

Snow-day activities

TEACHING SUGGESTIONS

Teacher must have additional college course or suitable inservice training.

During first few lessons, emphasis is on group instruction. In later lessons this will change to a combination of group and individual instruction.

After the first lesson, introduce at least one new maneuver each period.

Use simple, direct commands.

Avoid double meaning terminology.

Preface commands with "all cars" or car number.

Limit directions to essentials.

Know and watch the trouble spots.

Alert students to potential dangers.

Develop a sound emergency plan to use if need arises.

PUPIL ACTIVITIES

An alert, advanced pupil may be assigned to a car with a slow learner to act as a teacher's assistant, giving individual instruction to the slower pupil. This plan has merit.

APPENDIX 2 - THE SIMULATOR METHOD OF TEACHING DRIVER EDUCATION (OPTIONAL)

OVERVIEW OF THE TOPIC

The use of simulation to supplement the laboratory phase of Driver and Traffic Safety Education was adapted from the process of training airplane pilots on the Link Trainer during World War II.

Driving simulators use electro-mechanical devices designed to represent the driver's compartment in an automobile. The student operates the unit just as he would a real vehicle on the highway. His reactions to driving conditions, which are projected on a wide screen in full-color motion pictures, are monitored and evaluated by a recording device.

The simulator provides numerous opportunities for varied driving experiences which the student might never encounter in the dual-control program. Control of traffic conditions, through the use of film, simplifies learning experiences by allowing the student to focus his attention on the development of fundamental skills without distraction.

Simulation does have some limitations such as the lack of movement, the restricted field of vision on the screen, the false security of not being in "live" traffic, and the difference in the feel of the operating devices.

Nevertheless, simulators are helping to meet the quality-quantity-cost challenge facing driver education and should be investigated closely by schools with sufficient enrollment.

UNIT PROBLEM

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METHOD OF TEACHING DRIVER EDUCATION (OPTIONAL)

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UNIT PROBLEM

To develop in the beginning driver necessary operational skills by simulation

To increase the teacher-pupil ratio 1:4 to 1:12 or more

To increase pupil "behind-the-wheel" time by 50 to 100 percent thereby reducing program cost

R METHOD OF TEACHING DRIVER EDUCATION (OPTIONAL)

	CONTENT	TEACHING SUGGESTIONS
of	Orientation to simulators	Use a simulator as a supplemental tool to achieve course objectives.
lls	Steering skills	Devise a system for handling ignition keys.
	A drive in the automatic transmission vehicle	Prepare students for the film and interject relevant comments during the film showing.
ing	Shifting skills	Follow film with discussion of key situations.
nses	A drive in the manual shift vehicle	Use instructional aids such as traffic board blackboard, film strips, and slides to accomplish objectives
ocedures	Highway driving	Use the simulators in manual and automatic. This allows the teacher to move about, when they are on automatic, to aid students.
ving	Traffic driving	Teacher should use:
	Defensive driving	. Light pointer to key situations . Blindfold techniques for checking procedures such as starting vehicle and locating controls . Projector on silent position to give students a realistic situation
	Special driving techniques	
	Expressway driving	
	Angle parking and turning maneuvers	
	Parallel parking	
	Adverse weather driving	
	Driving emergencies	
	Test films	

PUPIL ACTIVITIES

Implement silent film with narration

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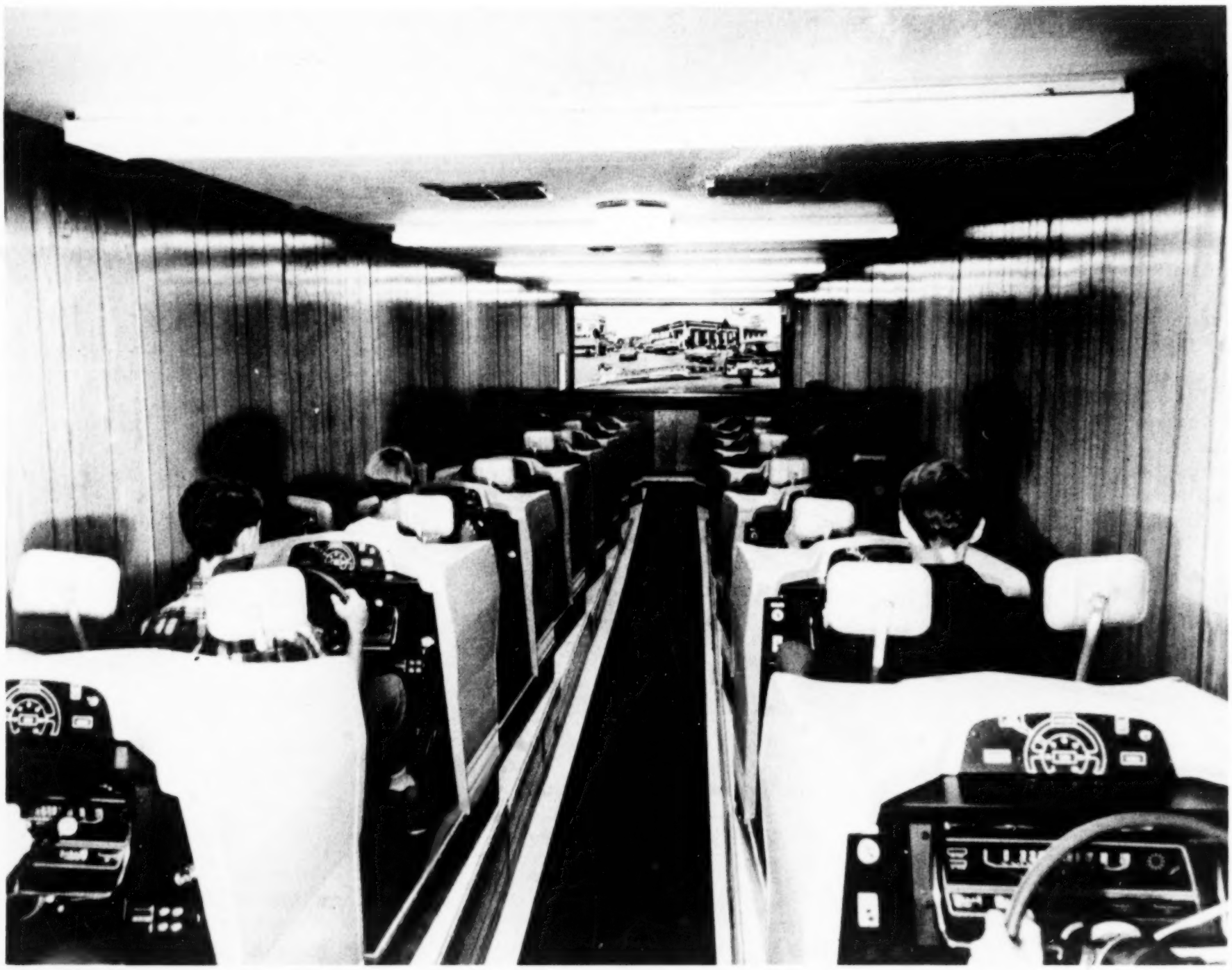

Students in simulators react to real situations projected on a wide screen.

CHAPTER III

Getting Started

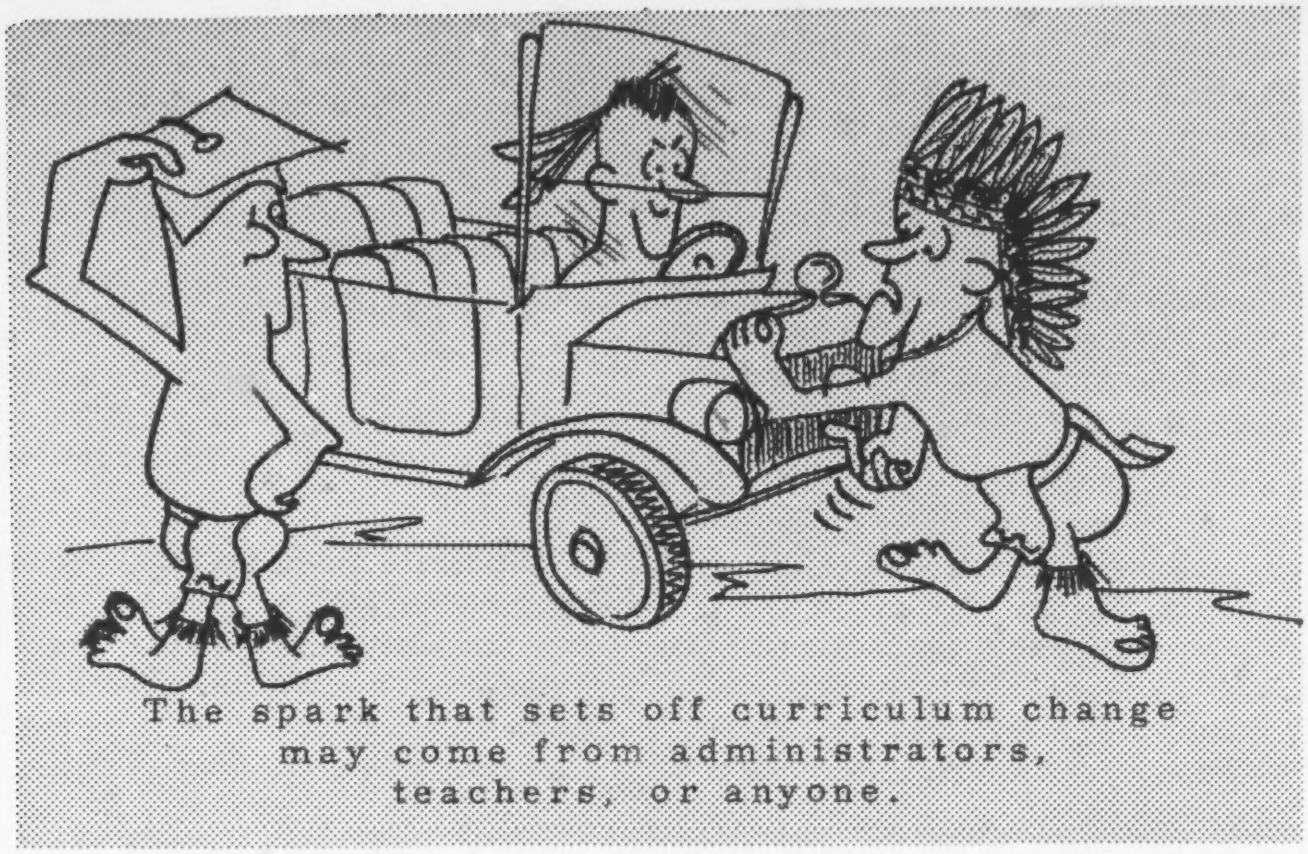

The spark that sets off curriculum change may come from administrators, teachers, or anyone.

Who decides to do something about curriculum development? The question is not whether curricular decisions must be made, but rather who should make them and how. The decision may result directly from administrative leadership or from questions raised by classroom teachers who face the task of finding the best and most effective ways of working with students. This daily challenge gives rise to many questions that can only be resolved by curriculum study.

It is recognized that there is no one way of creating concern for the curriculum. Much is dependent upon the philosophy of a particular school, the relationships which exist between the administration and staff, and the nature of the community and its demands. However, without the impetus of inspired administrative leadership little will take place in curriculum development.

Recognizing, therefore, the key role of the administrator, let us examine the process by which a program of curricular study might be effectively undertaken with the full support of the administration.

Important references for this chapter are Douglass (17), Pratt (25), and Shane (27).

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CHAPTER 1

VEHICLE CRASHES - THE PROBLEM; THE SOLUTIONS

In our modern industrial society motor vehicles are an economic necessity. Without them our economy would collapse because neither people nor materials would be capable of movement sufficient to sustain it.

When there is movement of physical objects there is conflict between them. The degree of conflict depends upon the space available for movement and the number and size of the objects in motion. While chemists can effect compounds of materials which combine without occupying additional space, drivers of motor vehicles cannot so blend their conveyances without causing damage, injury, or death. Efforts to enlarge the space available to motor vehicle traffic continue as streets are widened and more freeways are constructed. Yet, every citizen knows that the number and size of motor vehicles increase apace. Thus, conflict is inevitable. Traffic crashes continue to cause damage and injury so extensive that all citizens are affected either directly or indirectly.

Traffic collisions cannot be eliminated, but they can be reduced to an acceptable minimum. The problem is attacked by utilizing the techniques of EDUCATION, ENGINEERING, and ENFORCEMENT. Through education public interest is stimulated in order that all persons not only understand the extent of the problem, but they also become aware of the skills and attitudes necessary to reduce collisions. Properly engineered highways and vehicles reduce both the causes and effects of traffic crashes. The enforcement of governmental regulations, aimed toward the reduction of traffic conflict, accidents, and their resulting damage and injury, both guide and direct highway users in order to solve our society's problem. Forceful implementation of each tine of the three-pronged attack against the traffic problem of our society is essential in every community of our country.

Information essential for effective planning of the "Three E's" is obtained mainly through accident investigation. Reports of accident investigations provide one of the few sources of unbiased information available. These investigation reports perform a great public service. Accident investigation is the cornerstone of the foundation of any program of traffic supervision. Without accurate information upon which to base plans, this function cannot be progressive or accurate.

If planning to prevent accidents is to be valid and productive, it must be based upon consideration of accident causes. To achieve this there must be careful investigation, together with complete and accurate reporting, to determine cause.

The question then arises, which accidents should be investigated and reported? Fatal accidents alone, fatal and injury only, or to develop the complete picture should all collisions be investigated?

The number of damage or injury accidents which occur for each fatality is unknown. Their incidence in cities, with slower speeds, is greater in proportion to fatal accidents than in rural areas where higher speeds are attained. In California during a sample year, accidents were reported in the ratio of 1 fatal to 28.6 injury to 42.0 damage accidents. This was a statewide total based upon 3,041 fatal collisions. All crashes were not reflected because many damage and some injury accidents were not investigated or reported.

If planning were based on fatal accidents alone, only 3,041 of the total 218,255 accidents would be considered. This is but a small percentage of the total. If planning is expanded to include injury accidents, the base is expanded to 90,306 collisions. However, 127,949 (59%) of known crashes would still not be considered; thus, planning would still be based on only 41% of the total.

The investigation and reporting of all known accidents is suggested for two reasons--adequate planning and good public relations. No matter how minor an accident may appear to one not directly affected, it is an important matter to those people actually involved. They look to the police for help. Although police are primarily concerned with the criminal aspects of the investigation, parties concerned expect (and are entitled to) an impartial evaluation of the circumstances in order that the rights of all may be protected. The investigator should not attempt to establish civil liability or fix the blame, but he should impartially record the facts so that in any future civil action an unbiased, intelligent, and complete factual record will be available.

However, the time necessarily consumed by investigation of all accidents known to a department may not be available. There is validity in the argument that prosecution of the violator who has caused an accident is too late. It is proper to consider that the officer's presence on visible patrol, which deters other potential accident causing violators, is time better spent than in the investigation

of minor property damage collisions--especially those in which no violation is immediately discernible. Today, many of the larger departments find it necessary to curtail their investigations of such minor accidents because their available manpower is insufficient.

Instead of basing investigations upon the severity of accidents the professional approach would appear to be consideration of the incidents in terms of possible violations--an enforcement viewpoint. Thus, a one-car fatality in which the victim was alone in his car might take a minimum of investigation (in spite of its grave consequences), as contrasted to a property damage accident involving violations by both drivers. As an enforcement officer, the investigator must not lose sight of his objective. Obviously, the same amount of time cannot be devoted to all minor accidents because there are too many of them. Evaluation of the occurrence in terms of possible violation appears to be a firm basis to use as a guide to investigative effort.

Prosecution after accident is the most equitable type of enforcement. Much time is spent in apprehending and citing drivers whose violations might cause an accident. If these drivers are prosecuted, it follows that in all fairness prosecution should be instituted against those whose violations have caused accidents. By pointing out the relationship between collisions and violations, the public may be brought to realize the need for strict enforcement of all traffic laws as a preventive measure. The entire enforcement program will be bolstered by public support as the realization grows that if traffic violations were not combatted by enforcement, a terrific increase in highway casualties would surely result. The philosphy of "haven't they suffered enough already?" is no valid reason for failing to prosecute. The fleeing felon who is seriously wounded during an escape attempt undoubtedly suffers from his wound. Society, however, spares no effort to keep him alive in order that he may stand trial for his offense. Why should personal suffering, no matter how great, limit prosecution of the traffic violator?

This type of prosecution is readily understood by the general public. People who witness, or are involved in an accident where there is a violation, expect the police to do something about it. They are perplexed if nothing is done. Prosecution of violators is an objective lesson to the general public, acts as a strong deterrent, and lessens opportunities for further deaths, injuries, and economic losses. It presents the officer to the public as someone who is doing something tangible for them. It engenders a feeling of protection which, in turn, creates a desirable

relationship. To the violator it points out that all traffic laws must be obeyed.

In contrast to the crime rates, which steadily increase, the accident rate not only can be but has been lowered. In the face of increased travel, California's mileage death rate (deaths per 100 million miles traveled) has dropped. In 1949 the rate was 7.7, in 1959 was 5.3, and in 1969 was down to 4.5. The population death rate (deaths per 100,000 population) has also been reduced. In 1949 it was 29.1, but by 1968 it had been lowered to 24.5. While it is true that the number of fatalities attributed to motor vehicle collisions has risen, it can be seen that the attack against the problem has been successful. The statistics prove that the chance of a California citizen being killed in an accident has been significantly reduced.

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CHAPTER 2

ACCIDENT INVESTIGATION - A PROFESSIONAL CHALLENGE

Accident investigation is not only important, it is interesting. The investigator deals with human problems, frailties, and suffering. In turn, he renders a service to humanity. His immediate action may directly save one life and indirectly many lives. Each investigation presents a new challenge, calling for the utmost in skill, knowledge, and ability.

Because of lack of motive, accident investigation is different from other types of police investigations. If the occurrence were planned, it would no longer be an accident. Accidents happen unexpectedly, without design, or by chance. The element of surprise is a part of any traffic accident.

During recent years, scientists have turned to the word "crash" in preference to the term "accident" in reference to traffic collisions. Their belief is that traffic collisions are CAUSED OCCURRENCES rather than incidents involving chance alone. In almost every traffic crash there has been human failure--someone has made a mistake by neglecting to obey the dictates of either traffic laws or defensive driving. For police investigative purposes, however, both terms may be used interchangeably since the officer's objective is to determine collision cause. Accident investigation offers a challenge to the investigator and gives him an unlimited opportunity to use his initiative, skill, and experience to uncover the factors which caused the crash.

Accident investigators are given the opportunity to perform a public service. Not only are the results of investigations utilized in research, but officers render immediate assistance to those involved in the collision. They become the protectors of the suffering. The public views with favor actions to expedite traffic and assist victims of accidents. Such positive actions are necessary in order to elicit public support of enforcement organizations.

Many major arrests will follow accident investigation. These include arrests for misdemeanor and felony drunk driving, manslaughter, hit and run, reckless driving, auto theft, and other crimes. Obviously, a great amount of care must be used in case preparation. Essential evidence must be recognized, identified, and properly preserved. The investigator must be careful to make a thorough

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investigation, prepare his case meticulously, and present his case well in court. The officer whose work is inadequate will fall short of accomplishing his duty to the people whose rights he is sworn to defend, protect, and uphold.

In civil cases, too, courts have come to rely upon the investigating officer for unbiased and informed testimony. The California Highway Patrol has acquired an enviable reputation in this connection, and judges and attorneys have come to give great weight to the officers' testimony. The investigator should always be conscious of this, and he must realize that a poor investigation or presentation of evidence will destroy that which has taken years to build.

In view of the importance of accident investigation, it becomes apparent that the successful accident investigator must possess certain qualities and abilities. This will assure that the task is accomplished satisfactorily from the standpoint of the individual, the public, and the department which the investigator represents.

The first of these is ENTHUSIASM. The individual must be interested in his work, zealous, and anxious to do the best possible job. Each new investigation must be accepted as a challenge. Lacking enthusiasm, the operation becomes routine, something to be accomplished with a minimum of time and effort. The completed investigation will fall short of the quality which is necessary. It will be a recording, not an investigation.

DETERMINATION is another essential for the successful investigator. He must possess tenacity of purpose to do a competent job, get the job done and done well, or the investigation will lack that completeness which marks the good report.

The investigator must possess SINCERITY. He must truly believe in his work and its importance as a public service. His feelings must direct his actions toward a definite goal. Believing fully that what he is doing is worth doing well, he will be content with nothing less than sincere effort to achieve the best in each investigation.

A sense of RESPONSIBILITY is important--a desire to be an asset to the organization he represents. He must recognize the need to make a thorough investigation, do a proper job of enforcement, write a complete and concise report, and represent the department well at the accident scene. He should realize that investigation goes far beyond mere

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recording of readily available information on an official form.

The ABILITY TO COMMUNICATE is essential. As an investigator, he will be expected to know more about the accident than a layman. This information must be so written that any reader will have as much knowledge of the circumstances as the investigator. The investigator's report must contain all his knowledge of the incident. IF, AFTER READING THE REPORT, THE READER CAN ASK A RELEVENT QUESTION REGARDING THE ACCIDENT, THE INVESTIGATOR HAS IN SOME MEASURE FAILED. Either the investigation or the report has been in some way inadequate.

Proper representation of the department at the scene entails the ability to REPRESENT AUTHORITY without a display of excessive command. The officer need not remind people who he is--they recognize him the moment they see his uniform. The investigator is being observed all the time. Some welcome him, some believe in him, but others would like to criticize him. The actions of the officer reflect not only upon himself, but upon his department and the whole police profession.

The investigator must possess INVESTIGATIVE ABILITY. He must be able to interview, observe efficiently and completely, reach sound conclusions, and make his investigation meaningful and valuable. Some fatal accident investigations may be very difficult, as in those cases without survivors. With no witnesses, the accident must be reconstructed from physical evidence alone. There have been attempts to make it appear that victims of murder met death as the result of a traffic crash. Casual examination of the scene would have led to a false conclusion, allowing the perpetrator to escape. In many cases, however, proper application of investigative techniques have uncovered evidence that the incidents were not what they appeared to be, and the responsible parties have been brought to justice. The ability to analyze situations--measure statements against physical evidence and probability--in order that his opinions will approach reality is essential for the investigator.

Dealing as he does with people who are not in a normal situation, the investigator must possess the qualities of LEADERSHIP. It is necessary that he quickly bring order to the chaos existing at accident scenes. He must have the ability to control emotionally and physically upset people. He must use skill and tact in answering or asking questions. An attitude of disinterest or levity is out of place at the scene of any accident. No matter how commonplace or routine the particular incident may appear to the

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ACCIDENT INVESTIGATION

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ACCIDENT INVESTIGATION

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SELECTING A PROBLEM FOR STUDY

While the administrator is vital in the decision to do curriculum improvement work, he must look to the staff for ideas, reactions and proposals. Unless the final choice of the study topic is based upon the real and felt needs of the classroom teacher, there will not be much self-motivation on the part of the participating teachers. If it is accepted that meaningful curriculum change must include change in teacher behavior, there should be a sincere desire on the part of teachers involved to want to change their methods and habits for the better.

But will teachers feel the need to change? Will such feelings throw too much emphasis on some areas of the curriculum to the neglect of others? The answers seem to be that teachers do feel many needs to change, but the administrator must make sure that gradually their sensitivity to balance in the curriculum is broadened.

Several methods may be used to select a problem. The final choice should hold the interest and support of both administration and staff. Here are some possible approaches:

Build or expand upon an existing program.

Develop a local problem which has been partially defined. Everyday complaints of teachers and parents (e.g., "Why can't they read this material?") might become the basis of a thorough study.

Hold a brain-storming session with the entire faculty or a group of representative members. Compile the ideas and recommendations, and study the most common problems.

Defining and Limiting Tasks

After potential problem areas are explored, the group should settle down to specify the problems on which it will concentrate. Probably there should be two concerns at this time:

What common goals will we have as a group?

What individual or sub-group goals will be set?

This process of goal-setting should not be hurried. Nothing could be more important.

Set goals in behavioral terms, as much as possible. That is, try to indicate how differently things would be done if the goals were being achieved. This helps all concerned really to understand what they are beginning to agree upon.

Reasonable Expectations

Unrealistic goals or expectations, on the part of either administrators or teachers, result in disillusionment.

Administrators, at times, attempt to revise the entire curricula from K-12 or even K-8 as a single year's project when even small divisions of such a continuum represent more than one year's study.

The classroom teacher who has already completed a full day's teaching load cannot be expected to contribute on a daily basis to a curricular study committee's work. But a teacher may rightfully be expected to devote a reasonable amount of time to the never-ending task of curriculum development.

FOREWORD

This publication has been prepared as a basic training manual in the field of accident investigation for cadets at the California Highway Patrol Academy. It is intended to supplement classroom instruction rather than serve as a complete text in itself. In addition, it is designed to serve as a ready reference for investigators in the field.

Success in the field of accident investigation requires continued study and research to keep abreast of new techniques and to refresh the memory of the investigator. It is hoped that use of this publication will awaken the desire for further study.

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investigator, he must always bear in mind that to the participants there is nothing routine about it. To them it is an unusual, frightening, and sorrowful experience. The investigator must approach his task with empathy. As a further instance of leadership, the investigator must be able to recognize how much authority he can delegate to volunteers, as well as properly evaluate their actions to determine if they will actually assist, rather than hinder him in his investigation.

INITIATIVE is essential. Many times he will not have a supervisor to direct him, so he must be able to work on his own. He must be able to think logically and clearly under conditions of duress and pressure. He must persevere in his endeavor to conduct a thorough and complete investigation with a minimum of guidance and direction.

A basic knowledge of PHOTOGRAPHY will be of value. The investigator must plan his picture for its evidential rather than its news value. He should know where a photograph will help in his investigation and where one will not.

A SENSE OF DUTY to protect the rights of the participants is essential to the investigator. He must strive to get the facts. He must realize the need for conducting an impartial investigation without preconceived opinions to color or slant his investigation to either side. It will help if he considers participants as things, materials, and formulas, rather than people. He should approach the investigation in terms of what each vehicle did in relation to other physical conditions. With this viewpoint, he is less apt to be swayed by prejudices as to age, sex, race, color, occupation, or personality. Any of these may subconsciously affect the unbiased consideration of all the elements which he must collect and evaluate. His report of the investigation must reflect the true accident picture.

Knowledge of these, as well as other police techniques and qualities will help. The successful investigator will always be alert for new knowledge, ideas, and techniques. When he uncovers a new way of doing things, he will pass the information on. Progress in any field is a group effort, built upon the contributions of many individuals. The accident investigator today profits from the experience of past investigators, and he in turn can contribute by making available to others the results of his experience and knowledge.

truck ten feet above the highway has a far different field of view than the driver of a low-slung sports car. Skid marks, gouge marks, tire marks and vehicle position should all be checked and the information recorded in notes at the scene, for both the accident report and possible use when testifying.

In addition to notes, the investigator should make a sketch to aid investigation and preserve information. This sketch should be drawn with north at the top and all wording oriented to this direction. The scale should be large enough to make it clear, yet small enough to show the whole area. Everything that might have a bearing on the accident should be included: length and position of skids; distance traveled after collision; width of streets, shoulder and roadways; distance and height of view obstructions; location of traffic control devices; distance from the pavement to any fixed object which was struck; victims or parts of vehicles; and debris. Distances should be measured, rather than estimated or stepped off.

The investigator should not neglect to locate and record the evidence that may be hidden beneath the vehicles. When making the sketch, vehicles should be treated as transparent, viewed from the top, and evidence should be recorded in its proper location.

Necessary photographs should be taken. They may be a great aid to the prosecution as they present physical circumstances of a case in a manner that is easily understood. Most people are visual minded. A photograph of large or perishable evidence is accepted in place of the original. Include such items as skid marks, footprints, or a body to show the location and type of injury. But before the shutter is snapped, the investigator should ask himself, "What will this tend to prove?" If the answer is "nothing", the photo should not be taken.

The photographer must be qualified. He must know what he is doing and why, for the more important the picture the stronger will be the attempt to discredit or disprove it. A commercial photographer is usually not satisfactory for several reasons. In addition to being expensive, he may not know what is required; he is often reluctant to appear in court; and he may not keep proper data to insure that the photograph will be admitted as evidence. If a commercial photographer is used, the officer should direct the photographer to take the type of picture the officer needs and record exposure and other related data. It should be remembered that these photographs are not for publicity but are evidence, as is the sketch of the scene. Valuable as

they may be, the investigator should not depend on photographs only. They may be an important part of the case, but photographs alone do not constitute a complete investigation.

Pictures of many of the following subjects are often needed as evidence or to complete the records of a case: general scene from driver's viewpoint; point of impact; traffic control devices; skid marks showing length and direction; nature of roadway at location, showing defects; position of cars, victims, and parts of vehicles after impact, showing distances from point of collision; view obstructions or the lack of them; blood, flesh, hair, fabrics, scrape marks, etc., frequently useful in hit and run cases; tire prints; footprints; defects in vehicles involved, such as missing headlight, stickers obscuring driver's vision, trucks lacking turn indicators, etc.; the roadside, to show kind of district; sagging springs of overloaded vehicle; license number of vehicle for identification.

The investigator should also make a sketch. Photographs do not show measurements or dimensions. The photo may be incorrectly exposed, blurred, or otherwise worthless. The accident sketch is the record of the investigator's intricate, personal examination of the scene.

With the information gathered, the investigator should now determine the cause or causes of the accident. He should be very careful in this, as it is one of the most important parts of the investigation. It should be approached in terms of the violation and facts should be gathered to prove the essential elements of the action. It is quite possible that there may be one or more violations on the part of each driver.

What the investigator faces upon his arrival at the scene is the result of a combination of circumstances. He must start from this result and work backwards as his investigation progresses, until at its conclusion he knows the cause or causes of the accident.

CAUSES - RESULTS

Broadly speaking, accidents may be classified as either one of two types, collision or non-collision. The collision may be with another vehicle, train, bicycle, fixed object, pedestrian, street car, animal drawn vehicle, animal, or other type of object. Non-collision may be running off the roadway, overturning in the roadway, or other non-collision, such as fire, falling from a vehicle, or injury

their undirected efforts may hamper rather than help the investigation. Attempts should be made to keep onlookers in a safe location. This at times poses an extremely difficult problem to the investigator.

Where gasoline or oil is spilled on the highway, it may be necessary to request fire equipment to wash it from the pavement, or highway crews may be needed to sand the area to eliminate the hazard. Where fire hazard exists, as from gasoline, liquid petroleum gas, or similar fluids, care should be used in placing flares, onlookers should be warned of the danger of smoking, and if necessary the crowd should be cleared from the area.

Where there is injury, first aid will be necessary. In certain instances this may be the most important thing for the moment and should be given without delay. Where injury is minor, protection of the scene may warrant top priority. Placing flares and directing traffic while a person bleeds to death would undoubtedly be the wrong order of operations, as would bandaging slight injuries before protecting the scene when a high speed road was blocked in an area of low visibility. The investigator must consider each situation on its own merits. First things should come first, regardless of their position on his check list of procedures. An ambulance should be ordered, if required. This is one of the first considerations when there is serious injury. Where there is absolutely a fatality, the coroner must be notified. Any question of doubt as to whether the victim is dead or alive should be resolved in his favor. He should be treated as alive unless, by the very nature of his injuries, there can be no doubt that he is dead.

The investigator must care for the property of those injured. A tow car may be needed, and it should be ordered as soon as it can be conveniently done. If possible, the driver's preference as to towing service should be ascertained, and the tow car of his choice ordered. When the driver is unable to care for his own vehicle, and the investigator orders it stored for safe keeping, a report of stored vehicle must be filled out, and the contents of the car listed and inventoried, securing the signature of the tow truck driver on the inventory form as a receipt for the vehicle and its contents.

GATHERING EVIDENCE - DETERMINATION OF CAUSE

The remaining steps of the investigation come under the headings of gathering evidence for prosecution and determining the cause of the accident. These two objectives are

common to accident investigations and cannot be separated. They go hand in hand. Evidence as to the cause will lead to the violation involved; evidence of the violation will lead to the cause. From evidence and statements of witnesses and participants the investigator must determine the cause of the accident. He must bear in mind that there probably will be more than one cause in any but the most simple type of accident; and where more than one vehicle is involved, there may be one or more violations on the part of each driver.

There are three factors in any accident - the HIGHWAY, the VEHICLE or vehicles, and the PEOPLE involved. All three should be checked for evidence. Whereas it is impossible to get all the facts about everything, the investigator should strive to get all the pertinent facts. If a violation is indicated, an effort should be made to secure sufficient evidence to prove the elements of that violation.

Usually the officer will begin to form an opinion of what happened early in the investigation and will look for evidence to confirm it. At this point care must be taken not to overlook evidence which does not agree with the investigator's theory. Evidence which tends to disprove his first impression may be very important. Things are not always what they seem. The officer must never attempt to distort facts to fit his theory; the opinion must be adjusted to fit the facts. He must never be reluctant to accept negative or conflicting evidence, no matter how convinced he is that the accident happened in a different way. That would be like saying, "Don't confuse me with the facts; my mind is made up."

Every fact, each statement, and every shred of evidence must be analyzed and evaluated in order to get a true picture of what happened. To start with, the investigator is faced with a result. Step by step he must work backwards from that result to find the causes. He must proceed from the "what" of a situation in order to determine, insofar as possible, the "how" and the "why".

A logical first step is to locate and question the drivers and witnesses. This is done by making a quick preliminary check to see that all drivers are present, then attempting to locate witnesses. The investigator should get the operator's license of each driver, determine which vehicle each was driving, then look for persons who might have seen the accident. Many persons may remain at the accident scene until the police arrive then leave before the officer has had an opportunity to question them. An early search for these people may provide the investigator with information which he would not otherwise obtain.

Early in the investigation, it should be determined if it is a hit and run, for the procedures in this type of investigation are different from normal accident investigation. Time is of the essence, and the sooner the hit and run procedures can be put into effect the more likely will be the chance of apprehension.

The second factor to be considered is the vehicle. Much evidence may be developed by thoroughly examining and testing the vehicles involved. It should be determined if all the visible damage was the result of the current accident. The exact location and extent of damage should be noted. Evidence of crumpled fenders and broken glass which does not tie in may be the result of a previous incident. Fresh damage, not connected, may lead to solution of an earlier hit and run. Perhaps the driver's statement is not correct, and damage which it does not explain may lead to the true account of the accident. A check of the mechanical devices, brakes, lights, windshield wipers, turn indicators and mirrors should be made to see if they are adequate. In some cases, operator's licenses are restricted to the operation of vehicles equipped with certain safety devices. The officer should check to determine if safety devices are employed if required. The condition of each tire on the vehicle should be noted and a check made of the front end, providing the damage is not such as to make the test impossible. The driver's statement may give the investigator a clue as to what to look for. Brakes may fail or be faulty or inadequate. Loss of control may suggest a worn steering assembly. A fresh break in the steering mechanism will probably be a result of the accident rather than a cause. Other points to check are lack of safety devices on commercial vehicles, inadequate lighting equipment, defective windshield and vision obscurements. Tire failure is often claimed as the cause of an accident, but many times it is a result rather than the cause. The investigator should know whether or not vehicle failure contributed. In the event of prosecution, the driver may claim vehicle failure as a defense. If the investigator has not checked he will be unable to refute this type of argument. However, if he has made a thorough check, he will have the answers to any possible questions which may arise.

The third factor is the surrounding physical conditions. Any which might have contributed to the accident should be carefully observed by the officer: holes in the roadway surface; loose material on the pavement; the weather; visibility from the driver's path of view, including obstructions to vision such as hedges, trees, poles, signboards; traffic control devices; and warning signs. All observations should be made from the driver's line of sight. The operator of a

Like any other endeavor, accident investigation has its pitfalls:

1. Do not discuss the accident with anyone outside of the department or outside the line of duty.

2. Do not take sides. The investigator is an impartial fact finder.

3. Do not tell any participant he is either blameless or at fault. These are matters for an adversary proceeding.

4. Do not tell anyone you will be a witness for or against him. You will be a witness for no individual. Testimony must be honest and impartial.

5. Do not mention garage charges, repair bills, or civil liability, as these are not part of the investigation.

6. Do not enter into any discussion of a probable or possible fine. This is a court function.

7. Do not be hasty in making decisions as to cause. Consider every possible cause, gather all the evidence, then analyze to exclude factors not involved.

CHAPTER 3

ACCIDENT INVESTIGATION PROCEDURE

Of direct concern to the officer are three equally important reasons for accident investigation. First is the basic police function of PROTECTION OF LIFE AND PROPERTY. This includes the civil aspects of accident investigation. A second reason is to DETERMINE THE CAUSE OF THE ACCIDENT. This is necessary to gather the information required for the department to perform the mandatory functions set forth in the Vehicle Code. The third reason is to GATHER EVIDENCE FOR the PROSECUTION of persons guilty of any violation of the law contributing to the accident. This power is given by Vehicle Code Statute concerning fatal and personal injury accidents, and is extended to property damage accidents (Attorney General's Opinion No. 45-337).

Since the success of any accident prevention program hinges on thorough investigation and complete reporting, it becomes necessary to distinguish between ATTENDING an accident and INVESTIGATING one. It is a comparatively simple matter to go to an accident scene and determine where and when it happened, what happened, who was involved, and record this information on a printed form. This, however, is not accident investigation. It more closely approaches newspaper reporting. The investigator must have this information, but the critical part of his task is to determine HOW and WHY the accident happened. It is in these two areas that the success or failure of the investigator will appear.

Every action of the investigator, from the original accident call to the completion of the report, falls within one of the three reasons for investigating accidents. Steps in normal accident investigation will be grouped under these three broad headings in the order in which they most logically fall.

In order to assure uniformity of understanding, it becomes necessary that certain terms must be narrowly defined. The following basic definitions are in common use in the accident investigation field. These are the meanings used throughout this discussion.

1. ACCIDENT: An undesirable or unfortunate happening; casualty; mishap; anything that happens unexpectedly without design, or by chance.

2. MOTOR VEHICLE ACCIDENT: Any accident involving a motor vehicle in motion that results in death, injury, or property damage.

3. MOTOR VEHICLE TRAFFIC ACCIDENT: Any motor vehicle accident occurring on a highway.

4. POLICE TRAFFIC ACCIDENT INVESTIGATION: Determining what happened, and who and what was involved in a motor vehicle traffic accident, usually at the scene.

5. MOTOR VEHICLE: Any mechanically or electrically powered device (except one moved by human power), not operated on rails, upon which or by which any person or property may be transported or drawn upon a land highway. The load on a motor vehicle is considered a part of the vehicle.

6. STREET OR HIGHWAY: A way or place, of whatever nature, publicly maintained and open to the use of the public for purposes of vehicular travel.

7. TRAFFIC: The term "traffic" shall include pedestrians, ridden animals, vehicles, street cars, and other conveyances, either singly or together, while using any highway for purposes of travel.

There are three types of accident investigations:

1. NORMAL accident investigation will include investigation of those accidents where the principals are present, vehicles approximately as they came to rest, physical evidence unaltered, and with witnesses possibly present.

2. LATE REPORTED, or late investigated, accidents are those in which knowledge of the accident is gained, and investigation, if any, is made after some lapse of time.

3. HIT AND RUN accidents are those in which the operator knowingly causes damage or injury and leaves the scene without identifying himself.

VALUE OF A FIXED PROCEDURE

Some type of fixed procedure is extremely valuable in accident investigation. It is not intended that this should serve as a limitation of the investigator's actions. It should be flexible. Steps should be taken as conditions warrant, rather than by rote. By realizing the need for a fixed procedure, the investigator will use it as a sort of

INVOLVING THE FACULTY

As many of the staff as possible should be involved in curriculum development. The degree of involvement will, of course, change with the readiness, interest, and prior commitments of the staff members.

Committee work is but one way of changing the curriculum. Sometimes change comes faster through work with individual department chairmen, teachers, or intermediate supervisors. These approaches may complement each other.

When a study will affect all of the staff they should be informed and consulted, even if their involvement level remains low. Honest consultation sets the stage for better acceptance of findings or recommendations later.

At what point should the total faculty be involved in a program? The answer is--from the beginning. They must know what is going on. A plan for orientation is suggested in the next chapter.

One caution! Don't let faculty seriously engaged in other studies feel that they are being neglected in favor of the latest fad. This is one of the most common mistakes in introducing new ventures.

WHO ELSE MAY BE INVOLVED?

Many schools will wish to move carefully in the involvement of non-staff members in curriculum building. Such participation, however, holds much promise for the reasons indicated below:

Students

They are the recipients; their needs, as they see them, are important starting points.

Most teachers really care about students; often teachers are more ready to listen to student suggestions than to those of other teachers.

Students tend to say things that the power structure of the school prevents teachers from saying.

Board Members

They are the people who can give strong support to a good curriculum.

They need to know what is going on so they can interpret it to the taxpayers.

They are policy-makers and have a right to know how the policies for which they are legally responsible are being executed.

Parents

Their cooperation and understanding are vital in the long run.

They can help interpret to other parents.

They can reflect needs from a very different slant.

They can help support released time for curriculum study.

Other Citizens

They often become the best resource people the school could get.

They can raise questions that "gentlemen's agreements" among faculty would otherwise block.

They can help to secure resources that might not be available otherwise.

Their understanding is essential to taxpayer support of revisions and new programs.

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mental check list. It will make the task easier for the officer, assist in determining the cause and gathering data, tend to make sure that nothing is overlooked in the investigation, give a definite starting point, and help to prevent duplication of effort. A planned procedure impresses the public with the efficiency of the investigator's department and builds favorable public opinion. Officers will find that accident investigation will consume a great part of their time. The better they know the correct procedure, the more reliable their reports will be, and the more pleasant their job will be. When one is familiar with a task it is easier to perform.

PROTECTION OF LIFE AND PROPERTY

In a normal accident investigation there are various steps which may be conveniently grouped under the broad heading of protection of life and property. Not all of these steps will be required in all accident investigations, nor will they always be done in any particular order. The important thing for the investigator to remember is that each investigation should be evaluated in the light of each of these steps, assigning top priority to that which in each instance is most important. The best procedure is a planned procedure which can be adapted to each event.

Before any investigation can commence, the investigator must be at the scene. Therefore, his safe arrival is essential. There are many reasons why the investigation should be made as soon as possible after the occurrence of the accident. It follows, then, that prompt arrival at the scene is also important. The first thing the investigator has to do is get to the scene safely, yet quickly.

Since the accident has already occurred, the investigator can do nothing to prevent it; he should take this fact into consideration and protect his life and others' by driving at a safe speed. Taking unnecessary chances may lead to the investigator being involved in an accident himself. This not only slows down the investigation of the accident he was assigned to cover, but also provides an additional accident which must be investigated. Bad public relations can be caused by the officer becoming involved in an accident while enroute to the original accident scene.

The arrival of the investigator is necessary to protect the scene and other traffic, preserve evidence which might be lost, and in some cases to save life by applying first aid. Another accident may occur because the highway is obstructed. Traffic congestion is usually present, and the investigator must attempt to restore normal vehicular movements. By

prompt arrival he will prevent driver irritation and poor public relations. To those involved in an accident time is fleeting. Each minute they wait seems much longer than it really is. They wonder, and sometimes audibly express their thoughts as to what is keeping the officer. Also important is the fact that witnesses, who might be of great value, often become impatient and leave the scene once their curiosity is satisfied, and the investigator will not derive the benefit of information which he might otherwise receive.

A safe but quick arrival is a challenge to the investigator. One way is to plan the approach over the quickest route (not necessarily the shortest). The investigator must know his area - the short cuts, detours, construction zones and areas of congestion. A few seconds spent thinking out the best route may save minutes of hazardous high speed driving. The officer should start at once upon receipt of the call. A short delay in getting started will have to be made up on the road, and a long delay means that time is lost which can never be regained.

Upon arrival at the scene, the investigator should park safely and conveniently. Consideration should be given to the safety of the officer, the patrol car, and other traffic. Rather than park opposite the accident, where the traffic stream will have to be crossed each time it becomes necessary to return to the patrol vehicle, parking on the same side of the highway will be safer and more convenient. By proper parking, the warning lights on the patrol car may be used to help protect the scene. Safety and availability of the equipment in the vehicle should be considered, as use will be made of the radio, flares, first aid equipment, and the like. Also, unguarded equipment may offer an incentive to potential looters. By safe parking the investigator will help to establish a safe parking and passing pattern, and his task will be much easier if he has the various items he needs close at hand and where they can be kept under observation.

It will be necessary to protect the accident scene to prevent the occurrence of further accidents and to preserve the evidence which the investigator will need. This may require placing flares at night or under conditions of poor visibility. Thought should be given to the proper location of flares to give approaching drivers a chance to slow down before running into the obstruction and to channel traffic into a safe path around the accident. It may be necessary to direct traffic around the scene. In many cases bystanders will volunteer to assist. If their aid is enlisted they should be told what to do; otherwise,

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The person who begins his search with a query, "Were there any witnesses to this accident?" will probably not be very successful in finding any. The word "witness" has an unpleasant connotation in the minds of many people. They have been conditioned by motion pictures and other types of entertainment to visualize a witness in court being badgered by the opposing attorneys to the point of acute discomfort, and they want no part of it. The indirect approach is inherently much more productive. The officer should find out from the drivers, if possible, who was the first one they saw or talked to after the accident, then approach these persons and ask them what they saw. They might say that the accident had already happened when they stopped, but they may be able to furnish information as to who was there when they arrived. Thus, by indirection, a witness may be discovered. Many times, while giving first aid or performing some of the other duties incidental to the investigation, the officer may overhear someone telling how the accident occurred. This person may or may not be a witness. He may have talked to someone who did see it, and in this way, too, a witness may be located. A check and recording of the license numbers of the vehicles parked closest to the scene may be valuable. Drivers of these vehicles are most apt to be the first arrivals. Even if witnesses cannot be found at the scene, contacting these drivers at a later date may develop the fact that one or more of them may have witnessed the accident. However, witnesses should be located as soon as possible. Not only are they prone to leave when the excitement is over, but their statements may be valuable in offering leads to develop during the actual interrogation of the drivers. They may also suggest what physical evidence the investigator should look for.

In all contacts with witnesses or potential witnesses, the investigator must act with tact, diplomacy and understanding. It must be remembered that he is asking for something, and that these people have no obligation to tell him anything. Their assistance may be very valuable, if freely given, but if coerced or bulldozed into making a statement, their feeling of resentment toward the interrogator will probably destroy the value of any statement he may extract.

Drivers must be thoroughly checked as to their physical condition. Intoxication is a state which often changes rapidly. Tests for intoxication should be conducted without unnecessary delay. The condition of the driver at the time of the accident is important, not the condition an hour or two after the accident occurred.

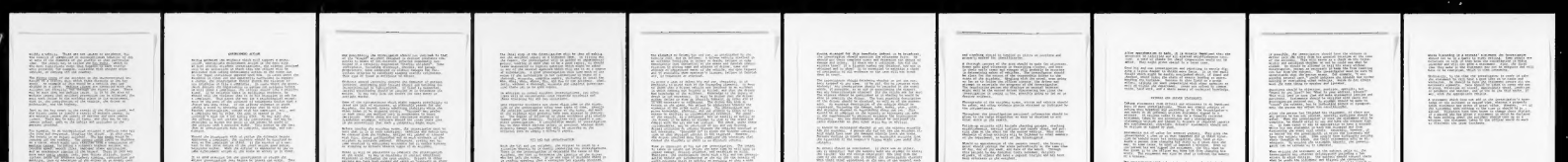

within a vehicle. These are not causes of accidents, but the results of unexpected or unconventional behavior of one or more of the elements of the traffic at that particular time. The result may be called the key event, which is the most significant event that happens to each traffic unit involved; for example, collision with another motor vehicle, or running off the roadway.

The direct cause of the accident is the unconventional behavior of a traffic unit which leads directly to the key event. An example of this would be a vehicle that had skidded on a curve. Mediate causes are connected with the accident not directly, but through the direct cause. There may be more than one mediate cause. It is in the area of mediate causes that accident prevention can be effected; the part each factor in the accident plays in its occurrence, that is, the contribution of the vehicle, the driver or pedestrian, and the highway.

Just as the key event is the result of the direct cause, and the direct cause is itself a result of mediate causes, so are mediate causes the result of earlier and more remote causes. There may be many of these, and they may be very remote indeed, such as the habits and attitudes of the persons involved.

For example, in an uncomplicated accident a vehicle runs off the road and overturns, injuring the driver. In this case, the result is an injury accident. The key event would be running off the roadway. The direct cause could be skidding on a curve, which might have resulted from a combination of mediate causes, including a slippery highway surface, excessive speed, smooth tires, improper brake application, and an inadequate signing of the hazard. These in turn may have many early causes; rain, poor driver attitude, insufficient funds for adequate highway signing, construction and policing, lack of education of the driver as to proper care of equipment, and many more acts, neglects or conditions which lead up to mediate causes. The area of improvement in all three phases of traffic supervision fall within the area of mediate causes.

Many of the early causes also offer a field where improvement may be effected, but others are so remote as to be of little immediate concern to the investigator, although they may play a part in the total picture of traffic supervision.

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After apprehension is made, it is vitally important that the broadcast be cancelled and all alerted establishments notified. A word of thanks for their cooperation would not be amiss. They might prove useful in a later case.

Good hit and run investigation and reporting is merely digging a little deeper to obtain more facts. It is the small detail which might be easily overlooked which, if found and checked, would start the chain of events leading to apprehending the violator. Success in this field is a group effort, calling for much cooperation with other agencies as well as within the department. Cases are solved by common sense, hard work, and a small amount of technical knowledge.

WITNESS AND DRIVER STATEMENTS

Taking statements from drivers and witnesses is an important part of many investigations. These may simply consist of asking what happened and recording it in the investigator's own words or an informal written statement signed by a witness. In serious cases it may be a formally recorded statement taken by the prosecutor and a stenographer. Statements written and signed by drivers in required reports are confidential; therefore, drivers' statements should not be written or signed by them.

Statements are of value for several reasons. They give the investigator a clue as to what happened and in which direction he should start his investigation; they tend to dissuade a person from changing his story at a later date and may, in some cases, be used to impeach a witness. Even if the person has not signed the statement, the fact that he has given it to the officer may keep him from changing his story. The statement may also be used to refresh the memory of a witness.

The investigator will take statements to assist him in determining facts. By statements, he may place the driver behind the wheel, determine probable point of impact if there were no skid marks, or tie skid marks to a particular vehicle, and establish other circumstances of the accident.

One of the first considerations in taking statements is to talk to the person in private. Many people are reluctant to talk if others are listening. They may be afraid of what the driver or his friends might do if the statement is unfavorable. Spectators may interrupt by interjecting their own ideas, and arguments may start as the result of disagreements between participants.

If possible, the investigator should have the witness or driver tell the story from his general location at the time of the accident. This will serve as a check on his reliability and establish whether or not he could see what he claims. He should be allowed to tell his story without interruption, except as necessary to keep him from rambling too far from the subject. The investigator must be sure he understands what the person means. For example, "I was passing several cars," could indicate the speaker was either meeting or overtaking other vehicles. Words do not always mean the same thing to speaker and listener.

Questions should be objective, positive, specific; not "Where do you live?" but "What is your address, please?" This will tend to save time and make statements concise and pertinent. Statements should be verified with facts and discrepancies pointed out. No attempt should be made to "coach" the witness, but by indicating points of disagreement the person may adjust his recollections.

After the person has finished his statement, if there are any points he has not covered, specific questions should be asked. When the investigator is sure the statement will be complete, he should write it out and have the witness sign it. In some cases it may be appropriate to have a witness write his own statement to keep him occupied and from discussing the event with others. Generally, however, it is better for the investigator to write the statement and have the subject sign. Some people have difficulty putting their thoughts on paper, and their statements will be inadequate. By writing the statement himself, the investigator can be certain it is complete.

When writing the statement as the subject tells it, the investigator may consider deliberately including a few errors in minor details. The subject should correct these when he reads the statement and initial the correction. If he fails to notice the errors, they should be called to his attention. He should then correct and initial them. This precludes the chance of the subject saying he did not read the statement, and by having the pencil in his hand and becoming used to it he is conditioned toward signing the statement when requested.

If the witness refuses to sign, the officer must not insist upon a signature. He should use the positive approach in attempting to get the signature, and if this fails drop the matter. The signature in itself is not essential. Having given the statement to an officer, the subject will be less likely to change his story if he knows it has been recorded.

While listening to a witness' statement the investigator should not be in a hurry to start writing. Some people are reluctant to talk if they know the conversation is being recorded and will not give a statement. Also, the first time they make it the statement may not be adequate and will have to be rewritten, which is time-consuming.

Ordinarily, by the time the investigator is ready to take the statement he will have a good idea as to cause and violation. He should be sure the statement covers all the necessary elements. Care should be taken to cover who was driving, direction of travel, approximate speed, condition of pavement and weather, and to tie in the skid marks, if any, with the appropriate vehicle.

A statement which does not add to the investigator's knowledge of the accident is wasted time, whereas a properly taken statement may prove of great value. However, even if the statement adds nothing to the case it should be preserved. Witnesses have been known to change their stories. If a person who has given a statement in which he declares he knew nothing about the accident should turn up as a witness, the statement taken by the officer would do much to discredit the later testimony.

ENFORCEMENT ACTION

Having gathered the evidence which will support a prosecution, appropriate enforcement action is the next step. In most traffic accident investigations, the offense involved will be an infraction in which case the officer will be precluded from taking enforcement action at the scene due to the legal restraints imposed upon him. In cases where the evidence is clear cut and apparently sufficient to support a charge, the investigator should inform the violator of his intention to file a complaint. In cases where the prosecutor desires the opportunity to review the evidence before he will issue a complaint, the officer should take a positive stand. If he believes there is sufficient evidence, he should tell the violator that it is his intention to ask for a complaint. This paves the way for a psychological acceptance on the part of the violator of subsequent notice that a charge has been filed. If the officer attempts to evade taking a stand by advising the driver that he will make further investigation, confer with his superiors, etc., and a complaint may be filed, the door is opened in the violator's mind for a not guilty plea. He may feel that the officer is not certain in his conclusions, and may be reluctant to accept his guilt to the extent he would if the officer took a positive stand. This points up the fact that an investigation must be complete, thorough, and conclusive.

Should the prosecutor wish to review the evidence before approving a complaint, the violator should be notified as soon as the complaint is filed. If the service of a warrant is his first notice of the court action good public relations suffer. When the officer is empowered by law to take enforcement action at the scene an arrest is in order.

It is good practice for the investigator to review the entire investigation just before he leaves the scene. This serves two purposes. It gives him a double check to assure that all points have been covered and that he has gathered all of the necessary information. A physical recheck may disclose a piece of overlooked evidence, and property of the participants may be found which might otherwise be lost. If two officers are conducting the investigation, they should compare notes to be sure that each has all the necessary information. It takes little time but may be very productive in terms of results obtained.

In some instances, when an investigation is made by one officer alone, it may be advisable to solicit the opinions of other investigators in order to bring the investigation to a well-balanced conclusion.

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One possibility the investigator should not overlook is that of the "staged" accident designed to defraud insurance companies by means of non-existent injuries supposedly sustained in a carefully engineered "traffic accident". Some individuals, including attorneys, doctors, and garage proprietors, have conspired to collect damages for fictitious injuries by carefully staging traffic collisions. This type of fraud is difficult to detect.

Officers should carefully observe the demeanor of persons involved, developing good factual detail and watching for inconsistencies or fabrications. If fraud is suspected, careful questioning should be carried on to determine its motive. It may vary from the desire for easy money to outright murder.

Some of the circumstances which might suggest possibility of fraud are lack of witnesses, no plausible reason for the accident, one person freely admitting liability while the other seems to be feigning injury. "Victims" may prefer to seek their own medical care in preference to usual facilities. While these are not conclusive evidence of fraudulent attempts, officers should not close their eyes to the possibility that such a conspiracy might exist.

Before leaving the accident scene, the investigator must be sure that it is in safe condition: vehicles and debris must be cleared from the highway, spilled oil sanded or covered with dirt, flares extinguished and as much evidence of the accident as possible removed. Otherwise, traffic may become involved in additional accidents due to sudden slowing or stopping as drivers observe signs of an accident.

Often it will be impossible to complete the investigation at the scene. It may be necessary to contact additional witnesses to determine the true causes. Drivers or other persons may have been injured and taken to hospitals or their homes after treatment. Sometimes the officer will do this himself, and in other cases this further investigation will be done by officers assigned to accident follow-up. Should it become necessary to interview injured persons, the officer should check with the doctor in attendance before attempting to talk to these people. In some cases their condition will be such that it will not be advisable to interview them. In other cases, they may have been given sedatives or other treatment so that their statements will not be reliable. Each instance will have to be treated on its merits by the investigator. Just as no two accidents will be alike, so no two investigations will be alike. The planned procedure must be flexible, and steps taken in the order called for by each set of circumstances encountered.

The final step of the investigation will be that of making out the accident report on a standard form. In filling out the report, the investigator will be guided by departmental policy, bearing in mind that to be a good report, it should leave unanswered no logical question which might be asked by any of the several agencies which will use it as a source of information. A good investigation will lose much of its value if the information is not transmitted by means of a thorough, accurate, complete report, including in total the Who, What, When, Where, Why, and How of the accident. Similarly, without a thorough, accurate and complete investigation there can be no good report.

In addition to normal accident investigations, two other types will be encountered--late reported accidents and those involving hit and run violations.

Late reported accidents are those which come to the attention of the investigator after some lapse of time. Usually the vehicles involved are no longer at the scene, and much of the evidence will probably have been altered or destroyed. The degree of follow-up of these accidents will usually depend upon the severity. Fatalitites will require a complete investigation. A considerable amount of investigation may be done where serious injury is involved, whereas minor property damage accidents may only be recorded on the official form as simply a driver's report.

HIT AND RUN INVESTIGATION

With the hit and run accident, the officer is faced by a situation wherein he is really conducting two investigations. There is the investigation to determine the cause of the accident, and that to determine the identity of the driver who has left the scene. It is one type of accident where it is readily apparent that a violation has already occurred, that of evasion of responsibility. The officer, however, must not lose sight of the fact that leaving the scene is not a cause of the accident. The investigation, insofar as determining cause, must be complete, thorough and in addition to locating the missing driver.

Hit and run may be a felony, as in cases resulting in injury or death, or may be a misdemeanor, wherein only property damage is involved. In either case, the accident should be investigated just as any other accident, except that the hit and run procedure should be followed.

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The elements of felony hit and run, as established by the Vehicle Code, are as follows: A driven vehicle involved in an accident resulting in injury or death; failure to stop immediately (not instantly) at the scene and furnish identification by giving name and address of driver, name and address of registered owner of the vehicle, and upon request and if available show operator's license; failure to furnish aid, if requested or required.

To prove a case of felony hit and run, therefore, it is necessary to prove each of the foregoing elements. It must be shown that a driven vehicle was involved in an accident in which someone was injured or killed, and that the driver had knowledge of the accident. Knowledge of the injury or death is not necessary. It must be proved that the driver either failed to stop or identify himself, or offer aid if it was necessary or requested. The driver may stop or return to the scene, but unless he identifies himself the elements of the crime still exist. The investigator may prove knowledge, identity, and the offense by means of witnesses or entirely by circumstantial evidence. The owner of the vehicle, as a passenger, may be equally as guilty as the driver if he makes no attempt to stop at the scene and comply with the hit and run statute. The owner, under these circumstances, may be convicted of hit and run driving. Actual collision or contact between the vehicles involved is not necessary. "Involved in" is given the broader construction so that physical contact is not required. However, the driver involved must have committed the violation that caused the accident if there is no physical contact.

Time is important in hit and run investigation. The longer it takes to locate the driver the more time he will have to repair damage, destroy evidence, and establish an alibi. Therefore, the investigator faced with a hit and run investigation should get information on the air for the benefit of radio-equipped units as quickly as possible so that a wide search for the violator may be instituted at once.

Procedure at the scene of a hit and run investigation should be keyed to this need. A check should be made, first for injuries, then to be sure that the drivers of all vehicles involved are present. As soon as it is determined it is a hit and run, a description of the responsible vehicle, the driver and occupants, direction of travel, area of possible damage, and probable paint transfers should be obtained. The names of witnesses should be secured and the preliminary information broadcast as soon as possible in order that a minimum amount of time is lost in launching the search.

SELECTING A CHAIRMAN

If a committee is to be the vehicle for curriculum study, one of the most important factors to consider is the choice of a chairman.

The Administrator as Chairman

Sometimes a school administrator or supervisor--e.g., the assistant superintendent, a principal, curriculum coordinator, elementary supervisor, department chairman, or vice-principal--is asked to serve as chairman of the curriculum study committee.

Such an appointment is usually based upon the premise that curriculum work needs the immediate attention and direction of the administrator, who feels his responsibility for the program and wants his staff to know that he has a sincere concern for the curriculum.

The plan has some possible disadvantages. Sometimes, where the administrator acts as the chairman, the committee attempts to learn what the administrator wants the findings to be, and works in that direction regardless of their own personal feelings. Service on the committee may become more a matter of duty than real interest on the part of the teacher. Or, the administrator, burdened by many other responsibilities, neglects the work of the committee, fails to call meetings, and in the end stymies real progress or interest.

The Classroom Teacher as Chairman

Sometimes a classroom teacher acts as chairman. The administrator may hope through this plan to deliberately give teachers freedom in this area. He may wish to develop leadership among teachers and encourage teachers to assume greater responsibility for the direction of curriculum.

When the administrator, however, clings too closely to a "hands-off" policy, teachers often feel uncertain, especially if the administrator does not attend meetings. Members may not be sure that their recommendations will be supported, or that they are definitely working within overall school philosophy and program.

The Co-Chairmanship

Another possible plan is the co-chairmanship--with a classroom teacher and an administrator sharing the status leadership.

Once the committee is organized, and the administrative phases arranged, the administrator can step into the background, permitting the teacher to work closely with fellow teachers, while having the continuing interest and support of the administrator as a fellow committee member. Even when it is necessary for the administrator to give his attention to other matters, the committee can operate effectively.

A potential disadvantage of this plan is that the two leaders may fail to plan together, and the committee thus may have two heads leading in different directions.

In Any Case

Chairman or co-chairman, as the case may be, the role calls for one who can relate warmly and effectively with the committee. He must know the strengths of each committee member and be able to guide the application of these talents wisely.

His is the delicate task of balancing freedom and respect for the individual with responsibility for group progress--the challenge of helping each committee member to take increasing responsibility for his own development and that of the group.

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Having arranged for this immediate lookout to be broadcast, the investigator should question the witnesses fully. He should get their complete story and determine the amount of damage and injury. If there was a collision, how did the witness know? If a license number was obtained, how was it obtained and by whom? It is essential to maintain a chain of continuity of all evidence so the case will not break down in court.

The investigator should determine whether or not the suspect stopped at any time. If he did, did he converse with anybody? Any conversation should be recorded in the exact words, if possible, as an aid in questioning the suspect. Was any identification offered? Did the victim ask for any? The witness should be questioned as to whether he would be able to identify the driver. The best possible description of the driver should be obtained, as well as of the passengers. An accurate description of the vehicle should be requested, including the damage, make, model, year, color, and anything unusual or outstanding about the car. This should be as complete as the witness or witnesses can make it and supplemented by physical evidence the investigator discovers. Any new developments should be furnished the radio dispatcher so that other units may be advised.

It should be determined whether or not the witness actually saw the accident. A person who did not see the accident itself might have seen the damaged vehicle leave the scene. Persons working in nearby areas, or motorists arriving from the direction of the suspect's flight might come under this category.

No detail should be overlooked. If there was an injury, was it apparent? Did the suspect make any attempt to assist the victim? Was the victim conscious? How long from the time of the accident was it before the investigator arrived? Were there other violations on the part of the suspect such as excessive speed or driving while intoxicated? This is a two-fold investigation, and no particle of evidence should be overlooked.

The scene should be literally combed for physical evidence. Extremely small parts broken from the suspect's car may be matched with the vehicle to make a positive identification. Paint transfers or chips may be discovered. Clothing should be preserved to be analyzed, using great care not to handle clothing unnecessarily or roughly as paint is invisible to the naked eye in many cases and might be lost. The clothing of persons killed should be obtained from the coroner. In auto-pedestrian cases clothing should be analyzed whenever possible. Chain of possession should be maintained,

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and clothing should be handled as little as possible and properly marked for identification.

A thorough canvass of the area should be made for witnesses. Women make good witnesses in describing clothes, and boys in their early teens and younger will probably be accurate in determining makes of vehicles. The investigator should be alert for the return of the responsible driver to the scene of the accident. Mingling with the crowd, even going so far as to follow the officer closely, the driver may attempt to ascertain the progress of the investigation. The inquisitive person who displays an unusual interest might well be the wanted driver discovering how close the investigation is coming to him, possibly going so far as to destroy evidence.

Photographs of the accident scene, victim and vehicle should be taken, and other evidence photos obtained as indicated by the circumstances.

Throughout the investigation pertinent information should be given to the radio dispatcher as soon as obtained to aid other units in the search.

Follow-up activity will include checking garages, wrecking establishments, service stations and repair shops, and putting them on the alert for the wanted vehicle. Many other channels of group activity will be followed by other members of the department, as well as the investigator.

Should no apprehension of the suspect result, the investigator should revisit the scene periodically at the same time of day, day of the week, and date of the month. Through this pattern he may discover route salesmen, delivery drivers, or others who have a regular routine and may have been witnesses to the accident.

Once the vehicle is located and identification established, the driver will have to be found and connected to the crime.

When located, the approach should be positive. The suspect may spontaneously make a statement which will identify him as the driver involved. However, officers must remember to properly admonish the suspect.

Hit and run investigation and apprehension is one of the most difficult and interesting jobs of the investigator. There is no apparent motive. The driver may have acted spontaneously through fear or nervousness to avoid apprehension because of being intoxicated, unlicensed, with "the other woman", uninsured, or wanted for another crime.

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CHAPTER 4

DETERMINATION OF SPEED FROM SKIDMARKS

In many investigations knowing the initial speed of the accident vehicle is of great value to the investigator. Drivers may not admit accurate speeds. Often the speed estimate of witnesses will be unreliable or disbelieved due to their unfamiliarity with speed and its results. A scientific method which eliminates much of the guesswork is that of computing minimum initial speeds from the measured length of skidmarks.

Excessive speed is a common accident cause. When faced with an emergency a driver will usually apply the brakes with maximum force or swerve the vehicle sharply. The resultant skidmarks provide evidence which serves as a basis for computing the minimum initial speed of the vehicle with reasonable accuracy.

Not only will this evidence be of assistance in prosecuting violators, but it may also serve to exonerate drivers who might otherwise be charged. A skid of 20 feet from 20 miles per hour does not mean that a skid of 100 feet, or five time times as long, indicates five times as much speed. The actual speed in this case would be only about 45 miles per hour.

This type of evidence is particularly valuable in auto-pedestrian cases where little damage is done to the vehicle. Where extensive damage results, all that can be measured is the amount of speed the vehicle lost in sliding. Energy absorbed in the collision is above and beyond that figure.

With emergency stopping, rotation of the wheels ceases almost instantly and wheels are said to be "locked." Locking the wheels will not stop the vehicle at once. Instead, the tires will slide upon the surface until all the kinetic energy of the vehicle has been transformed into heat energy, represented by the sliding of the tires. Since, by the law of conservation of energy, energy cannot be created or destroyed, the energy of motion must be equal to the energy of stopping.

While this energy transformation is taking place, a heavy deposit of rubber will be left on the pavement. This can be readily identified, and the length of the skidmark left by each wheel can be measured.

Coefficient of friction is defined as the ratio of force required to slide an object over a surface to the force (usually the weight) pressing the object against the surface.

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The force created by locking the wheels of a moving vehicle is the same as that necessary to drag the vehicle were its wheels locked. The coefficient of friction (also called the drag factor) formula is $f = \frac{F}{W}$ For example, if a force of 3,000 pounds were necessary to move a 4,000 pound vehicle with locked wheels, the coefficient of friction would be 75%.

$$f = \frac{F}{W} = \frac{3,000}{4,000} = 75\%$$

If the same vehicle were moving and the wheels were locked, a 3,000 pound force would "pull" on the vehicle until it stopped.

On dry, hard road surfaces braking forces which can be developed are fairly uniform. The coefficient of friction will vary slightly with changes in speed. In contrast, on wet surfaces, due to the lubricating effect of the water and other factors, the coefficient of friction will vary with different initial speeds. Therefore, use of the formulas for computing speed from skidmarks should generally be confined to dry pavements.

Even with a freely rolling wheel minute particles of rubber are being deposited on the surface of the pavement. However, these deposits are so small that no clearly defined markings are visible. With a heavy brake application it is often difficult to detect any markings on the pavement if the wheels continue to rotate. Under emergency conditions, however, maximum braking force generally causes the wheels of the vehicle to lock. On dry pavement the locked wheels will leave a heavy deposit of rubber which can be accurately assessed as to length, location, direction, and number of wheels affected.

When a heavy braking force is exerted the retarding force is greatest just before the wheels are locked. This type of tire marking is termed "impending". The wheels are just about to cease rotating, and usually the tire marks are less visible than those made by locked wheels. In some instances it is possible to see the design of the tire tread in the impending markings. Usually this type of mark leads directly to the locked wheel markings.

A general characteristic of the locked wheel type of markings is that the path of the vehicle is straight. This is true because it is impossible to change direction by steering once the wheels are locked.

21702

In many collisions there may be a sudden and violent change of direction due to impact with another vehicle or object. This change is usually visible, but many times results in a confusion of tire markings which are difficult to describe accurately.

In some instances, an abrupt change of direction is effected by the operator attempting to turn the vehicle from its path. It is possible when this occurs that clearly defined tire markings will be visible and that braking may or may not be in effect. In this case, a new force has been added to the vehicle which is described as "centrifugal force". This new force resists the change of direction which the operator is attempting to impart by turning the wheels.

Investigators should be aware that it is possible to leave tire markings on the pavement which closely resemble "locked wheel" or "impending" marks without any brake application. Such markings are many times identified by a variety of terms which are confusing. These types of descriptions do not lend themselves to intelligent interpretations or evaluations in reconstructing the facts of the collision.

In order to rectify this situation, a uniform terminology must be developed and used. To arrive at a conclusion as to speed based upon the evidence left on the roadway, it is necessary that all deceleration factors be considered. The primary deceleration factor is the braking mechanism. Secondary factors are the surface upon which the vehicle is traveling, its grade percentage, and its condition.

First among the uniform definition of skid mark terminology is that of a tire skid mark, defined as a mark left by a tire due to the sliding of the tire over a surface. Visible tire skid marks are made in three ways: EXTREME DECELERATION, EXTREME CHANGE OF DIRECTION, and EXTREME ACCELERATION.

Extreme deceleration: When the braking system is sufficient to cause the wheels to cease rotating they will lock and skid marks will be left on the surface. Even when the wheels are still turning, but are about to cease rotating, skid marks will be visible.

Extreme change of direction: This action may result from effort on the part of the operator or an impact. The resulting skid marks are usually visible to the investigator.

Extreme acceleration: This condition occurs when a propelling force exceeding the pavement efficiency is generated. If the driving force applied to the rear wheels is such that it will cause the wheels to "spin," skid marks will result.

The following basic terms have been adopted and will be used throughout this discussion as defining the various types of tire skid marks:

1. IMPENDING skid mark: left by a braked wheel rotating slower than the forward motion of the vehicle in a straight or curved line.

2. LOCKED WHEEL skid mark: left by a non-rotating wheel of a vehicle moving in a straight or curved line in the original direction of motion.

3. SIDE SKID mark: left by a locked, braked, or rotating wheel of a vehicle sliding in other than a forward direction, except when caused by centrifugal force.

4. CENTRIFUGAL skid mark: left by a rotating wheel of a vehicle rounding a curve or turning at such a speed that centrifugal force entirely or partially overcomes the frictional resistance between roadway and tire.

There are descriptive terms which can be used to describe skid marks after the basic term has been used. These may be "intermittent" to describe markings which are not continuous; " dual wheel," "single vehicle," etc., to indicate the number of wheels affected and the type of equipment; "curving," "straight line," etc., to describe direction and type. Any term which further describes the skid marks after the basic terminology has been used, and which can be employed to clarify the facts of the collision, is acceptable.

Only when the basic terminlogy is used by all investigators will it be possible to reach a common understanding. Thus, definite conclusions may be determined concerning speed, direction of travel, and point of impact from the skid marks at the accident scene.

In order that such evidence may prove of value in determining minimum initial speeds and to assure its acceptance by the courts, it is imperative that it be properly obtained and recorded. The investigator is concerned with how far the vehicle skidded. Therefore, it is necessary to measure the mark left by each tire of the vehicle. In some cases this is fairly easy to do; in other instances it is almost impossible when the marks of front and rear wheels are superimposed. In the latter case, the investigator must measure the total length of the skid mark and deduct the wheel base of the vehicle. In any event, he must establish that the marks were left by a certain vehicle. This is usually accomplished by an admission from the driver, the testimony of a witness, or the wheels of the vehicle being atop each skid mark when at rest.

In measuring curved skids (other than centrifugal skids) the tape should follow the curvature of the skid mark, as the distance the wheels were in contact with the road surface is needed to calculate for speed. The investigator must see both ends of the tape in order that his testimony will be admissible.

Sometimes a locked wheel will bounce and leave a "skip skid" - a series of locked wheel skid marks with short spaces between them where the wheel was in the air. In these cases the distances during which the wheel was not in contact with the road surface should be included in the skid measurement. Although none of the speed is being dissipated while the wheel is in the air, the greater energy dissipated before the wheel leaves the road compensates for this. The skips will be only a few feet long.

In some instances a person will apply brakes when faced with an apparent danger, leaving skid marks, release them as the situation changes, then apply them again - or the driver may "pump" the brakes. The skid marks will have a gap between them, but the gap will generally be more than ten feet in length. Each set of marks should be measured, added, and their total used for speed computation (the gaps are not included as is the case with skip skids).

Having measured the skid marks, the measurements must be properly recorded to be useful. For each wheel the length of the impending and locked wheel skids should be separately listed. It is also necessary to record the weather, the condition and the type of pavement, and the percentage of grade (noting whether it is up or down).

When this information is secured and preserved it is simple to calculate the minimum initial speed of the vehicle. This can be done in several ways. What the investigator must remember is that skid marks do not show all of the speed. Neither the energy used in braking before the wheels began to leave visible marks nor the energy left in the vehicle at the time of the collision will appear. What can be determined is the amount of speed lost in the distance the vehicle slid. The calculation will show less speed than the actual speed of the vehicle. Any deviation from the actual speed will, therefore, be in favor of the driver.

The simplest way to estimate the minimum initial speed of a vehicle traveling on a dry, level, hard surfaced pavement is to arbitrarily assign a coefficient of friction of 60%. This is a safe minimum. The percentage of grade is added to this figure if uphill or subtracted if downhill. Skids (impending plus locked wheel) from all skidding wheels should be averaged and the result used to calculate the vehicle's speed.

The formula used in calculating speed from skid marks is:

$$S = \frac{V^2}{30f}$$

"S" represents the skid distance in feet, "V" the speed in miles per hour, and "f" the coefficient of friction. This formula may be transposed to read $V^2=30Sf$ or $V = \sqrt{30Sf}$, which are easier to use. What the investigator is concerned with is the speed. He simply substitutes known factors in the righthand side of the equation, performs the multiplications, extracts the square root, and he has the minimum speed. This can be easily done in a matter of a few seconds at the accident scene and gives him a result close enough to guide his investigation. It is a quick method of determining whether there was sufficient speed involved to warrant running test skids or further analysis.

If there is indication of excessive speed, particularly in a serious accident, test skids should be made to assure that the evidence will be as good as possible in the event of prosecution. Although it is true that the weight of the vehicle involved, the condition of tires, or the condition of brakes (provided they are sufficient to lock the wheels) are not significant, the task of convincing a jury is much simpler if test skids are made by the same vehicle which was involved in the accident. In some cases damage may prevent its use; however, if possible the vehicle involved should be used. The tests should be made at the same location and in the same direction the accident vehicle was traveling. A minimum of three test skids from the same speed should be made and the longest skid mark used. Great care should be used in running test skids due to the danger involved. For all practical purposes, 30 miles per hour should be fast enough.

To compute speed from skidmarks it is necessary to know how to extract square roots. To find the square root of a number:

Step 1. Begin at the decimal and group digits to the left and right in pairs. The first "group" will be a single digit if the number has an odd count of digits; the first group will be a pair of digits if the number has an even digit count.

Odd digit number --12345.00

Grouped in pairs - 1 23 45. 00

Even digit number - 1234.00

Grouped in pairs - 12 34. 00

CHOOSING AND ORIENTING A COMMITTEE

Who should serve on the curriculum development committee? Although there is no universal answer to this question, it seems certain that the size of the committee should depend upon the coordinating time available, the nature of the problem, and the number of schools involved.

Surely an important factor will be provision for a wide variety of skills and abilities, a combination of experienced and inexperienced teachers, and a number of teachers who are held in high esteem by the faculty in general.

A large committee may be more representative of the total faculty, but the advantage of a smaller committee which can work more efficiently should be kept in mind. If true group consensus is to be sought through face-to-face discussion, the committee should be no larger than from twelve to fifteen.

Should teachers be chosen from one building, or from all buildings in a district? This depends in part upon those whom the problem will affect. Commonly esprit de corps is high and communication and transportation problems are minimized when the committee comes from one building. But district morale and articulation may be better served by an inter-building committee.

Should the committee be chosen on a voluntary basis or by formal appointment? The answer may well be a little of each. An all-volunteer committee is excellent if it has the balance of competence that is needed. If not, the administrator should be ready to ask others to contribute.

Is a standing or temporary committee better? This again depends on the problem or problems facing the committee.

How important is the committee members' orientation? However the committee is formed, there are two things its members must come to believe: (1) that what they are doing is meaningful and worthwhile, and (2) that the results will have an excellent chance for incorporation into school practice.

To make sure that these beliefs will foster real commitment to the work of the committee, the appointing authority must pay great attention to the orientation of the committee.

A painstaking preparation for the initial orientation of participants in curriculum study cannot be overstressed. The status leader responsible for getting the committee underway has very definite questions that he should be prepared to answer. Many such questions involve careful clearance with the rest of the administration and the board.

The checklist that is provided on the following page may guide the local leadership in planning for committee orientation.

What preparation is needed for the first committee meeting with the consultant? The administration has the responsibility for setting the scene for such a meeting. The committee should be aware of the forthcoming visit of the consultant so that he may be properly welcomed at the time of the meeting.

The reasons for inviting a consultant into the school should be clear to staff members. The consultant's background and special talents and experiences should be outlined when the introduction of the consultant is made to staff. Such information will tend to build respect and rapport in the eyes of those with whom the consultant is to work.

2144

Step 2. Find the largest digit which, when squared, will be equal to or less than the first group.

Odd digit number--

```
     1
  ┌──────────
  │1 23 45. 00
  │1
  │─
```

Even digit number--

```
     3
  ┌──────────
  │12 34. 00
  │ 9
  │──
```

Step 3. Subtract the square from the first group and bring down the next group.

Odd digit number--

```
     1
  ┌──────────
  │1 23 45. 00
  │1
  │─
  │0 23
```

Even digit number--

```
     3
  ┌──────────
  │12 34. 00
  │ 9
  │──
  │ 3 34
```

Step 4. Double the digit above the horizontal line, then place the product on line with and to the left of the difference determined in Step 2.

Odd digit number--

```
     1
  ┌──────────
  │1 23 45. 00
  │1
2 │─
  │0 23
```

Even digit number--

```
     3
  ┌──────────
  │12 34. 00
  │ 9
6 │──
  │ 3 34
```


21707

Step 5. Find the digit which, when placed to the right of the doubled figure and multiplied by the digit discovered, gives a product not in excess of the difference with its new group. Multiply, place the product below the difference, and subtract.

Odd digit number--

```
        1  1
      ------------
      | 1 23 45. 00
      | 1
   21 | 0 23
      |   21
      |    2
```

Even digit number--

```
        3  5
      ------------
      | 12 34. 00
      |  9
   65 |  3 34
      |  3 25
      |     9
```

Step 6. Repeat Step 5 (doubling figure above horizontal line, etc.) until desired decimal accuracy is achieved.

Odd digit number--

```
                1  1  1.  1  0  8
              ----------------------
              | 1 23 45. 00 00 00
              | 1
        21    | 0 23
              |   21
       221    |    2 45
              |    2 21
      2221    |      24 00
              |      22 21
    (22220)   |       1 79 00 00
    222208    |       1 77 76 64
              |           1 23 36
```


21708

Even digit number--

```
                 3  5.  1  2  8
              ┌──────────────────
              │ 12 34. 00 00 00
              │ 9
              │ 3 34
   65         │ 3 25
              │    9  00
  701         │    7  01
              │    1  99 00
 7022         │    1  40 44
              │       58 56 00
70248         │       56 19 84
              │        2 36 16
```

Step 7. Round off the result and check by squaring.

Odd digit number--

```
      111.11
      111.11
      111 11
     1111 1
    11111
   11111
  11111
  12345.43 21
```

Even digit number--

```
      35.13
      35.13
      10539
      3513
    17565
   10539
   1234.1169
```

As an example of the use of skid marks in determining initial speeds, the following will illustrate several principles: The investigator has measured 50 feet of accident skid marks, locked wheel plus impending, on a dry, level asphaltic concrete pavement. The driver involved states he was going 20 to 25 miles per hour. The quick method of estimating initial minimum speed is $V^2 = 30 \times 50 \times .60$, or 900. The square root of 900 is 30. Therefore, the minimum speed is 30 miles per hour. This can be done simply and without a test skid by arbitrarily assigning a 60 per cent coefficient of friction.

21709

Desiring to arrive at a true coefficient of friction, the investigator will run three test skids from the admitted speed of 25 miles per hour. These tests give skid distances of 28, 29, and 30 feet respectively. The longest skid from the claimed speed is 20 feet shorter than the accident skid. This should be quite convincing to the driver that he was traveling faster than he admits, particularly if the investigator points out the discrepancy in the skidding distance.

Results of the test skids may be used in three different ways. One of these is by means of a skid-speed chart, CHP Form 185, as illustrated.

21710

The investigator notes the necessary information, records his test skids, and arrives directly at the minimum speed of the accident vehicle by the following method:

Step 1

On the "Skid Distance in Feet" axis he plots the longest test skid, in the above instance 30 feet.

Step 2

On the "Speed in M.P.H." axis of the chart he runs a line up at 25 miles per hour, which was the test speed.

Step 3

These lines intersect at the broken line indicating 70 per cent coefficient of friction.

Step 4

The investigator then, using the same steps as indicated above, plots the 50 feet of accident skid on the "Skid Distance in Feet" axis. From the point where this line intersects the 70% "Coefficient of Friction" line, he draws a line to the "Speed in M.P.H." axis and read a minimum speed of 32 miles per hour.

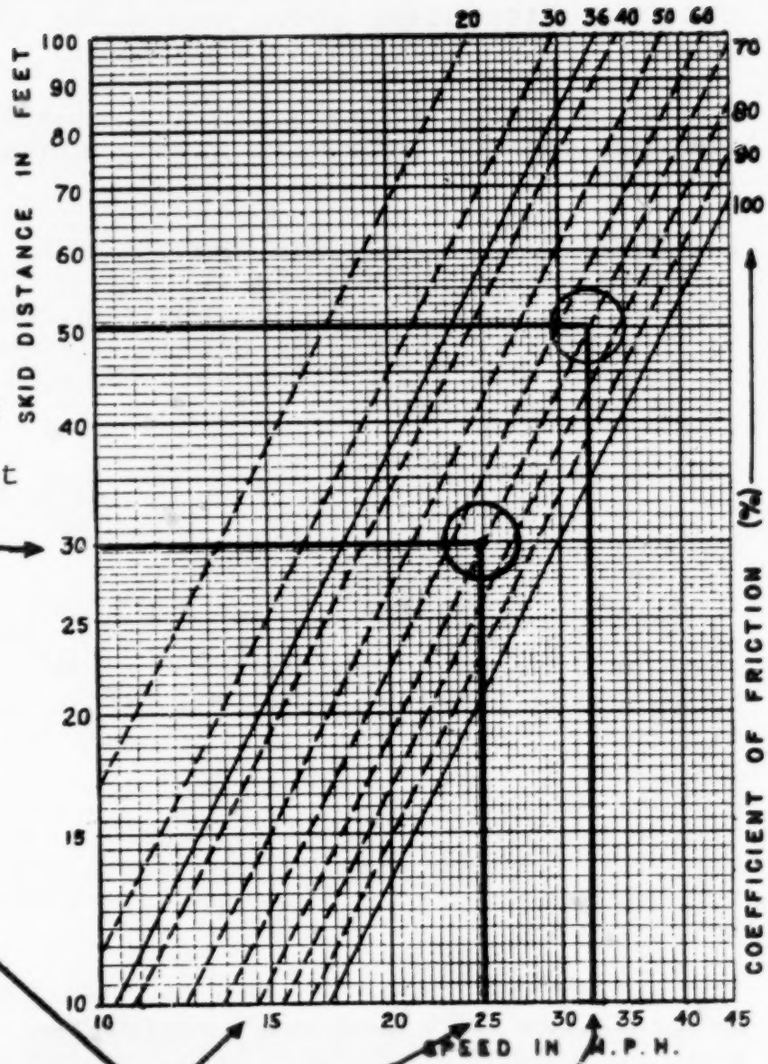

21711

In the absence of a skid chart, the problem could be worked out by substituting known values in the equation for determining the coefficient of friction, $f = \frac{V^2}{30S}$, then substituting this in the $V^2 = 30 \times S \times f$ equation and solving for the unknown speed. This will give a minimum speed of 32 miles per hour.

A method which saves one operation is by direct substitution in the formula $V_a = V_t \frac{S_a}{S_t}$, where V_a equals accident speed, V_t equals test speed, S_a equals accident skid distance, and S_t equals test skid distance. This, too, gives a result of 32 miles per hour.

It can be seen by the above that the quick approximation with the assumed coefficient of friction of 60 per cent gives a result close enough for practical use.

In using a test skid, it is important that every effort be made to get all the impending skid; otherwise the value of the coefficient of friction obtained will be too high. It is necessary that the speedometer be accurate so that the evidence obtained will be reliable for presentation in court.

While the investigator will be able to calculate initial speeds closely by these methods, presentation in court will probably require expert testimony, including explanation of the various physical laws and mathematical formulas involved.

The expert will rely on the information given him by the investigator to reach his conclusion. This information must be accurate, understandable, and complete, for without this information skid mark evidence will be of little value. With the proper measuring and recording of skid mark evidence accurate minimum initial speeds may be computed.

In complicated cases where not all the wheels slide, or where the skid marks are on different types of surfaces, it will probably be up to the expert to determine if any use can be made of the skid mark evidence. However, it is important to record the evidence so that the expert may decide to what extent it is usable.

When a vehicle is rounding a curve there are two opposed forces acting upon it. Centrifugal force acts to keep the vehicle moving in a straight line, while centripetal force is being applied to turn the vehicle. If the centrifugal force is greater than the frictional resistance between the tires and the pavement, the vehicle will skid. Skid marks left by a vehicle sliding on a curve can be used to tell

something about how fast a vehicle was going, for centrifugal force is directly proportional to the weight of a body and the square of the velocity and is inversely proportional to the radius of the curvature of its path. The speed at which a curve can be rounded without skidding is known as the CRITICAL SPEED. When a vehicle skids on a curve without brake application it is because the critical speed was exceeded. By calculating the critical speed of a curve the investigator will know the minimum speed at which the vehicle must have been traveling in order to slide.

To calculate the critical speed for a curve, the investigator must know the RADIUS of the curve, the bank or SUPER-ELEVATION, and the COEFFICIENT OF FRICTION.

The radius of a curve is determined as follows:

1. Mark two points on the curve using the center line or outside edge. The points used can be where the curve straightens or two points 100 feet or less apart near the accident.

2. Measure the distance between these marks. The distance measured is called the chord. It is "C" in the formula below.

3. Divide the length of the chord by two, and without moving the tape find the middle of the chord.

4. Measure the shortest distance from the middle of the chord to the curve. Use a pocket tape if available. Measure to the nearest half inch. This distance is called the middle ordinate. It is "M" in the formula below.

   Example: Measure straight across part of a circular curve with a chord of 50 feet, "C." The distance from the middle of the chord (at 25 feet), to the curve is one foot. This is the middle ordinate, "M." Using these figures in either of the two formulas for determining radius:

   $$\text{Radius} = \frac{C^2}{8M} + \frac{M}{2}$$ (in this formula the middle ordinate is in feet)

   $$\text{Radius} = \frac{50 \times 50}{8 \times 1} + \frac{1}{2} = \frac{2500}{8} + \frac{1}{2} = 312.5 + 0.5 = 313 \text{ feet}$$

OR

$$\text{Radius} = \frac{3C^2}{2M} + \frac{M}{24}$$ (in this formula the middle ordinate is in inches)

$$\text{Radius} = \frac{3 \times 2500}{2 \times 12} + \frac{12}{24}$$

$$= 7500 + \frac{1}{2}$$

$$= 312.5 + 0.5 = 313 \text{ feet}$$

It is easier to use a calculator which works the formula. The radius of the circle (of which the measured curve is a part) is determined by drawing a straight line across the chart through the two known points - length of chord and middle ordinate. The radius is read at the point at which the line crosses the radius scale.

On the following page use the same measurements as in the previous example; chord 50 feet and middle ordinate 1 foot. Find the chord, 50, on the left scale, C. Find the middle ordinate, one foot, on the middle scale, M. Draw a straight line from the 50 on scale C through 1 on scale h to scale R. Read the radius on scale R at this point. It is 313 feet.

This same formula and calculator can also be used to find the radius of a small circle by using inches instead of feet for measurements. This might help find the size of a round headlight lens from a piece of glass found at the scene of an accident.

21714

Coefficient of friction may be determined as previously described. Superelevation is added or subtracted just as grade percentage is in other skid mark problems. (If test skids are made, the superelevation or grade is already included in the resultant coefficient of friction.)

Superelevation or grade percentage means the steepness of the road banking or a hill. They are both measured by the number of feet the road rises for each foot of level distance along or across the road. The resulting number is less than 1.00, and except on steep hills or banks, is less than 0.10.

When drawing a diagram of an accident scene, always draw an arrow pointing uphill after the grade number. Also, since uphill is plus grade, put the plus sign (+) in front of the number.

If the slope is uphill, it is a positive grade, and a plus sign (+) is written in front of the number. Downhill or negative grades are written with a minus sign (-) in front of the number. Whether a grade is positive or negative depends upon the direction of travel.

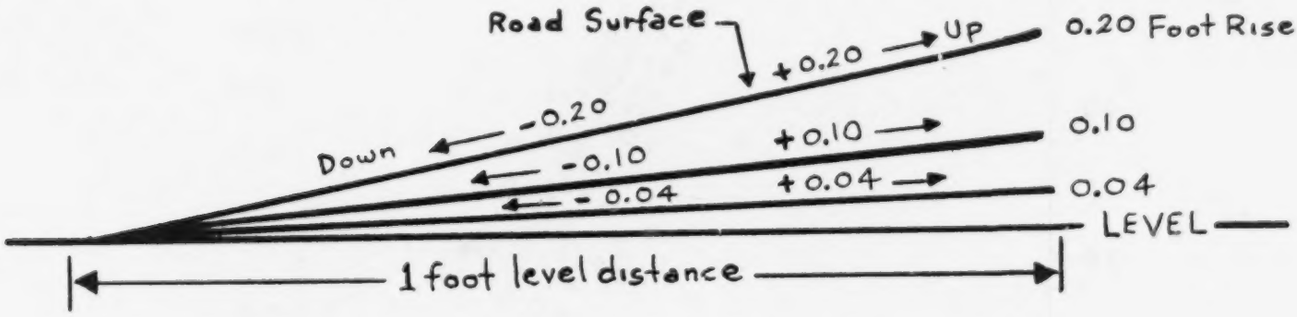

The grade or slope of a road is the rise divided by the level distance. The bank or superelevation is the same thing across the road.

The number representing grade is often mentioned in terms of feet of rise or fall per hundred feet of horizontal distance. It then becomes feet per hundred of grade, or per cent grade.

Example: A road rises two feet in a level distance of 50 feet. Divide 2 by 50. The result is 0.04. (This is 4 feet per hundred, or a 4% grade.) This information would be indicated on a diagram by an arrow pointing uphill and

21716

writing + 0.04 grade. This percentage of grade would be added to the coefficient of friction when computing speed from skid marks.

The formula to calculate critical speed is $V^2 = 15 \times R \times f$, or $V = \sqrt{15Rf}$, where V equals speed, R equals radius, and f is the coefficient of friction.

> Example: Calculate critical speed where the chord measures 50' the middle ordinate is 11", the coefficient of friction is 68%, and the superelevation is 2%.
>
> $R = \frac{3 \times 2500}{22} + \frac{11}{24} = 341$ feet.
>
> $f = .68 + .02 = .70$
>
> $V^2 = 15 \times 341 \times .70$
>
> $V = \sqrt{3580.50}$
>
> F = 59.8 mph (See illustrated page 2 of speed-skid chart.)

Where brakes are applied during a centrifugal skid the formula will not hold true, however, as brake application will cause skidding at lower speeds than if brakes were not applied.

The same formula used to calculate the critical speed of a curve is used to compute minimum initial speed from centrifugal skid marks. The centrifugal skid mark is the curve on which the chord and middle ordinate are measured. The radius of the curve of the centrifugal skid is entered into the formula and the initial speed calculated.

AN ORIENTATION CHECKLIST

This is a school administrator's checklist for providing orientation for teachers who will be participating in a curriculum improvement project. It might be used as a discussion guide at an early meeting of a committee.

Do all who are involved understand the following with relation to the proposed project?

_____1. Long range goals? What are the possibilities for the years ahead?

_____2. Short range goals? What are some reasonable expectations for this semester or year?

_____3. Approach? Is the focus of change on the improvement of classroom instruction?

_____4. Functions? What is the exact nature of the committee's job? What is the committee's authority? What is its relation to other committees or to school leaders?

_____5. Blocking possibilities? Who or what may possibly block or impede the committee's work?

_____6. Supporting efforts? What support is being developed for the committee--among school authorities, the public, other staff members, or elsewhere?

_____7. Communication lines? To whom does the committee report? Who else should be informed of committee progress?

_____8. Freedoms? With whom may the committee consult? Whom may the committee involve in its work?

_____9. Responsibilities? What deadlines must the committee meet? What obligations does it have?

_____10. Resources available? What may the committee expect in the way of secretarial, consultant, or other professional help? What materials for study, or instructional materials for experimentation? How much released time for committee work, visits, and conferences?

CRITERIA USED IN CHART DERIVATION

LAY OUT A 50 FT. CORD WITH A TIGHTLY DRAWN TAPE-MEASURE ACROSS THE ARC OF THE CENTRIFUGAL SKID MARK, THE DISTANCE FROM THE MIDDLE OF THE CORD, MEASURED ON A PERPENDICULAR TO THE TAPE AT 25 FT. TO THE OUTSIDE OF THE ARC, IS THE MIDDLE ORDINATE AND IS READ IN INCHES AND CONVERTED TO FEET.

TO FIND THE SPEED OF THE VEHICLE WHICH LEFT THE CENTRIFUGAL SKID MARKS, FIND FIGURE, ON THE CHART BELOW, CORRESPONDING TO THE MEASUREMENT OF THE MIDDLE ORDINATE; PROJECT A LINE HORIZONTALLY UNTIL IT INTERSECTS WITH THE DIAGONAL LINE FOR THE COEFFICIENT OF FRICTION FOR THE ROAD SURFACE; THEN PROJECT A LINE DOWN TO THE SCALE AT THE BOTTOM OF THE FORM AND READ THE SPEED IN MILES PER HOUR.

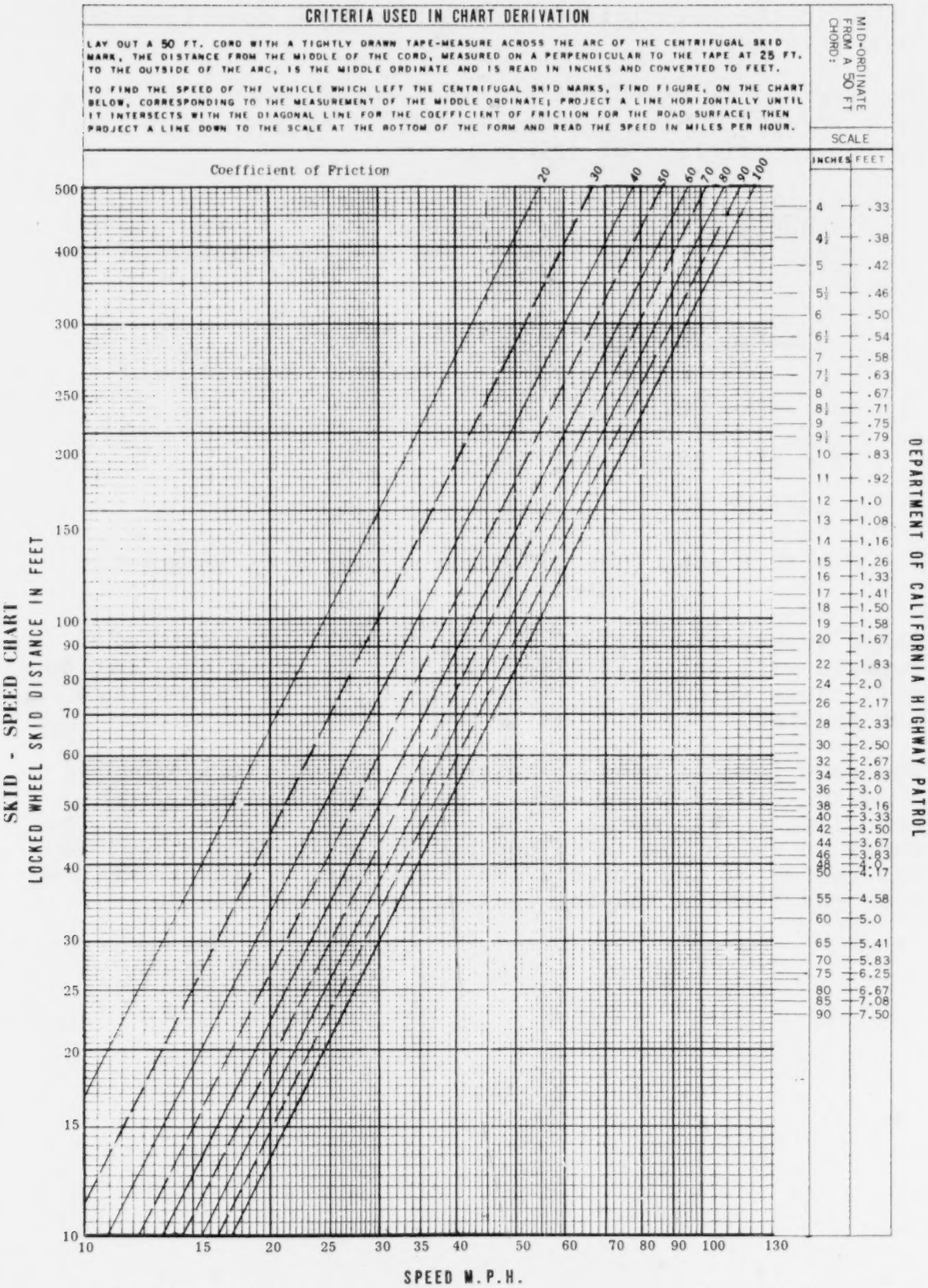

CHP FORM 185(REV.1-70)

PAGE 2 OF 2 PAGES

DEPARTMENT OF CALIFORNIA HIGHWAY PATROL

SKID - SPEED INFORMATION

ACCIDENT NO	ACCIDENT LOC.	ACCIDENT DATE	TEST SKID DATE

ROAD CONDITIONS

TYPE OF ROAD

CONDITION

GRADE

ACCIDENT SKID DATA

	IMPENDING	LOCKED WHEEL	TOTAL
L.F.			
R.F.			
L.R.			
R.R.			
TOTAL			
AVERAGE			

ACCIDENT VEHICLE *(year, make, model)*

CENTRIFUGAL SKID

LENGTH FT.

CHORD FT.

MID-ORDINATE

TEST SKID INFORMATION

NO.	MPH	L.F.	R.F.	L.R.	R.R.	TOTAL	AVERAGE
1.							
2.							
3.							

OTHER DATA

DRIVER		T.D.NO.
VEH LIC OR EQUIP NO	MAKE	YEAR/MODEL
SPEEDOMETER READING	ACTUAL SPEED	DATE CALIBRATED

METHOD SKIDMARKS MEASURED

ACCIDENT ☐ TAPE ☐ OTHER ☐ PACED

TEST ☐ TAPE ☐ OTHER ☐ PACED

WEATHER *(temp.)*		TIME	
ACCIDENT	TEST	ACCIDENT	TEST

MINIMUM SPEED FROM CHART *(over)* MPH

INVESTIGATING OFFICER - ACCIDENT

I.D.NO.

COEF. OF FRICTION _____ %

BASED ON TEST SKID NO. _____

CALCULATIONS/DIAGRAM

SYMBOLS		FORMULAS		EXAMPLE: CENTRIFUGAL SKIDMARK
f - COEFFICENT OF FRICTION	C - CHORD (FT)	$F = \frac{V^2}{30S}$	$R = \frac{C^2}{8M} + \frac{M}{2}$	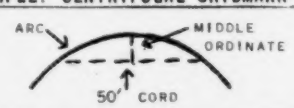
V - SPEED (MPH)	M - MID-ORDINATE	$V = \sqrt{30FS}$	$V = \sqrt{15RF}$	
S - SKID LENGTH (FT)	R - RADIUS (FT)			

CHP FORM 185(REV.1-70)

PAGE 1 OF 2 PAGES

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Handbook for School Bus Drivers, A Suggested Outline.

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ABSTRACT - School bus drivers must be familiar with school district rules and procedures relating to bus routes, maintenance, personnel policy, time schedules, and transportation policy. This can be achieved through a pamphlet given to each driver for ready reference. Developed by the New York State Department of Education, this outline is intended to assist school administrators in the development of such a pamphlet. The outline points up the important areas of information which should be available to the school bus driver. (GB)

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HANDBOOK FOR SCHOOL BUS DRIVERS

A SUGGESTED OUTLINE

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THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
DIVISION OF EDUCATIONAL MANAGEMENT SERVICES
ALBANY, NEW YORK 12224

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Handbook For School Bus Drivers

A Suggested Outline

It is important that all school bus drivers be familiar with school district rules and procedures relating to bus routes, maintenance, personnel policy, time schedules, and transportation policy. This can best be achieved through a pamphlet given to each driver for ready reference.

The following outline, compiled by the Division of Educational Management Services of the State Education Department, is intended to assist school administrators in the development of such a pamphlet. The outline points up the important areas of information which should be available to the school bus driver. Undoubtedly, each district will find that other important local information must be added.

The Division of Educational Management Services is ready to assist any school district that would like additional information and assistance.

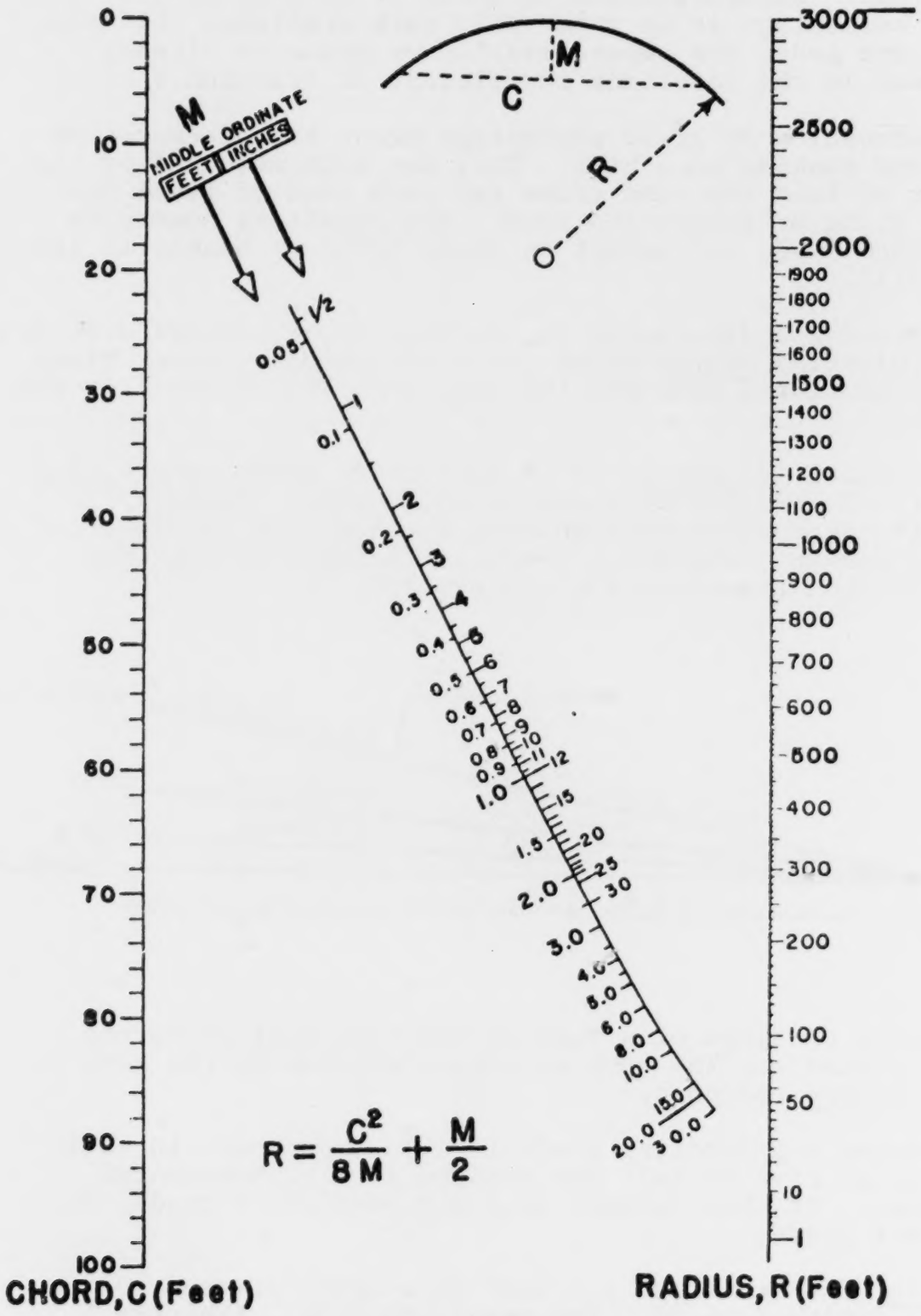

RADIUS CALCULATOR

is especially important. During the fall and late spring, when the days are warm, the children often lower the bus windows. When a bus with lowered windows drives past brush, twigs on the brush slap along the side of the bus much as a stick will rattle down a picket fence. As the twigs rattle they vibrate faster and faster until parts of the limbs actually break off. These parts have been known to fly into the bus and injure students. Be especially cautious when operating a bus under these conditions.

(20) In parking the bus at the end of each run, be certain that it is positioned well off the roadway where it cannot become a hazard to other motorists. Don't expect them to know that the bus is not in use.

(21) Do not allow the bus to stand beside the road while you take a "coffee break." Better yet, take the break after you have stored the bus for the day.

c. Local Driving Rules

Because of the differences in the transportation patterns of various school districts, local driving regulations are often necessary. This portion of the handbook can describe any existing local driving rules.

OUTLINE - SCHOOL BUS DRIVERS' MANUAL

Part I - General Information

1. Directory of School Principals, Central Office Personnel, and Telephone Numbers

   a. This section should be placed at the front of the manual, with instructions as to conditions under which each listed person should be contacted. This will provide the driver with a ready reference for use in emergency.

2. School Transportation Philosophy and Policy

   a. A statement of the objectives of the transportation system will help familiarize the driver with the thinking of the administration and board of education regarding transportation philosophy.

   b. A clear statement of policy will help the driver understand the necessity for establishing distances from the school as a criterion for eligibility for transportation.

Part II -The School Bus Driver and His Daily Responsibilities

1. Specific Duties

   a. This section should include the daily work of the driver, presented in such a manner that there can be no doubt as to the routine duties he is to perform, and the times the work is to be performed.

2. Responsibility to the Board of Education

This section is reserved for a statement of general responsibilities the board may impose upon the driver as a condition of employment. Included are the following items:

a. To understand and honor the conditions of his employment

b. To take maximum precautions for the safety of the pupils placed in his care

c. To take good care of the equipment entrusted to him

d. To understand and support school policy

e. To assist in the establishment of desirable attributes in pupils

f. To heed all regulations relating to routing, schedules, loading, and unloading

g. To observe faithfully school requirements relating to transportation reports

h. To practice every practical economy so that maximum service may result

3. Responsibility to the (District) Superintendent

This section explains the powers and duties of the (district) superintendent of schools, and outlines the responsibilities of the driver to him. These responsibilities include:

a. To maintain desirable personal habits and moral standards

b. To recognize and respect the superintendent's authority

4. Responsibility to the Supervising Principal

Here may be enumerated the various responsibilities the driver owes to the supervising principal as executive officer of the board

of education. Among the responsibilities are:

a. To comply with the principal's requests

b. To recognize that all school employees are under the principal's supervision

c. To cooperate with the bus safety program

d. To report all matters of discipline, and to cooperate in the correction of them

e. To observe all regulations relating to routing and schedules as laid down by the principal

f. To conduct himself in a prudent manner

5. Responsibility to the Transportation Supervisor

Since the bus driver's closest relationship with the school administration is usually through the transportation supervisor, the driver must be fully aware of his responsibility to the supervisor. Some of the responsibilities are:

a. To recognize the authority of the transportation supervisor as the driver's immediate superior

b. To make all necessary reports in accordance with the supervisor's directions

c. To be available for work at the specified times

6. Emergency Procedures

a. Breakdown procedures

This portion of the manual would spell out specific action to be taken in the event of a breakdown of a vehicle on the road. Special weather and road conditions should be taken into account in preparing material to be presented here.

b. Accident Procedures

Each year a number of accidents involving school buses occur in this State. The driver should be aware of his responsibility and the exact procedure to be followed if he is involved in a traffic mishap. In this regard, there are certain basic rules which should be followed by the driver who is involved in an accident

(1) Stop immediately, quickly survey passengers

(2) Protect the scene; use flares, flags, etc.

(3) Render assistance to the injured. Send, don't go, for help

(4) Call police, local school authorities, if necessary

(5) Get names and addresses of witnesses and/or passengers

(6) Supply name, address, operator's license number and vehicle registration to proper authority

(7) Get similar information from other driver. Also, the name of his insurance carrier

(8) Get names and addresses of occupants of other vehicles

(9) Determine extent of injuries

(10) Make notes of damages to vehicles or property

(11) Refrain from trying to argue, place blame, make settlements

(12) Do not sign statements

CHOOSING A CONSULTANT

The choice of a consultant to work with a school on a curriculum problem can be very important to the success of the project. How should such an individual be selected to assure the proper person for the job?

Often a consultant is chosen on the basis of past reputation and experience in other situations. Usually such a background is quite helpful and accurate in predicting success. However, wherever possible the consultant and the school should hold a preliminary meeting to explore the problem that has to be studied. This meeting can be accomplished with no commitment on the part of either side. Such a meeting permits everyone to become acquainted and to establish an early rapport, or allows opportunity for both sides to withdraw, if expectations are not satisfied. Experience has shown that it is better to have such discoveries at the start, rather than at a later time when the situation becomes much more involved.

What should be recognized in this process is that success in one situation does not necessarily guarantee success in a similar one. Much of the success of the consultant in helping a school is dependent directly upon the rapport and faith he establishes over a period of time with the school personnel involved.

Some Cautions

It is the responsibility of the consultant to bring to the school the kinds of experience and training that are needed for the tasks to be accomplished. If this cannot be done, then the consultant should not accept the assignment. But there is another responsibility--this one on the part of the school. Quite often the success of the consultancy will depend upon how the school uses or misuses the consultant.

Some schools have made the mistake of expecting the consultant to act as the local committee chairman, or to play the same role as a staff member. But the consultant cannot act for the local chairman simply because it may be necessary for the chairman to continue to function with his committee in the interim periods between meetings with the consultant.

Even were it possible, it would certainly be unwise for the chairman to abdicate his leadership role in the curriculum process to an "outsider." For the consultant to take on the same role as a staff committee member would mean involvement in considerable minutiae resulting in waste of valuable consultancy time.

Other examples of the improper usage of a consultant by schools could be presented. The school that expects the consultant to have all the answers is surely in for disillusionment. The staff that looks to the consultant merely to confirm its already pre-conceived beliefs will no doubt be disappointed at the first honest disagreement of opinions. In short, a school needs to learn how to use the services of the consultant effectively, as much as the consultant needs to develop his skill.

Whether the school district is ready to work with a rather flexible, permissive type of consultant, or whether it needs a more aggressive or directive person, should be carefully considered in the selection process.

Possible Assistance

Helpful in the selection of a consultant may be membership in an area study council or curriculum association whose leaders are prepared to locate and nominate potential consultants with special skills.

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c. Accident Reporting

The reporting of accidents or mishaps in writing cannot be emphasized too strongly. In any given case, it may be necessary to report to one or more of the following agencies:

(1) Local authorities and school administration

(2) Commissioner of Motor Vehicles

(3) Public Service Commission

(4) State Education Department

When the accident involves personal injury, the driver should fill out MV-104 Forms, or some facsimile, for any injury to any passenger, no matter how trivial he may feel it is. (This could be such things as bumped knees, cut lips, or injury caused by falling on the stepwell of the bus).

In any case where the driver is unaware of such accidents, but has them brought to his attention by the school administration or parent, he should fill out the appropriate form, making a statement to the effect that he "was not aware of anything out of the ordinary happening" on the school bus that day. The driver has the obligation to tell the truth and not to report on what students think they saw.

The driver should immediately report all personal injuries to authorized personnel employed by the district.

A summary file of accident data should be kept by the transportation supervisor. This file will supply immediate

(1) Drivers shall be familiar with the Vehicle and Traffic Law, Regulations of the Commissioner of Motor Vehicles, and Regulations of the Commissioner of Education pertaining to pupil transportation.

(2) Drivers shall make a full stop at all railroad crossings and at State highways before crossing.

(3) Drivers shall give warning before making a left-hand or right-hand turn.

(4) Drivers shall not leave the school bus when children are inside except in case of emergency, and in such case before leaving the bus, the driver shall stop the motor, remove the ignition key, set the auxiliary brake, and leave the transmission in gear.

b. Defensive Driving

In addition to the Commissioner's Regulations, there are certain defensive driving practices which should be observed by all school bus drivers. These include the following:

(1) Safety is first, schedules are secondary. Safe driving takes precedence over all other considerations.

(2) Definition of a safe-defensive driver is one who is careful not to commit driving errors himself, who makes allowances for lack of skill or lack of proper attitudes on the part of other drivers, allows for weather and road conditions or the actions of pedestrians and other drivers to involve him in an accident. He keeps continually on the alert,

control to stop if necessary. Professional school bus drivers often come to complete stops at all rural road intersections. Before making a turn, make sure that no vehicle is approaching from the rear and that the turn can be made without interference with oncoming traffic or pedestrians. Use turn signals. Get into the proper lane for a turn.

(7) Be sure of clearance before attempting to pass, sound horn if needed, and check for clearance before returning to your proper lane. Use mirrors and turn signals when changing lanes.

(8) When following traffic, maintain a safe braking distance between your bus and the vehicle ahead for full assurance that you can stop, should the vehicle ahead make a sudden stop. There is no excuse for colliding with the vehicle ahead.

(9) When approaching a stop to pick up children, give a right turn signal when you are certain the move to the right can be done safely. Then turn to the right and establish your position in the correct stopping lane. Be sure to neutralize the right turn signal at this point. Pull to a stop, allowing plenty of room for unexpected actions of the children. There will never be any excuse for running over a child who is unexpectedly pushed in front of a school bus by others around him, or who suddenly makes

a move placing him in such danger. Allow every student to be seated before starting.

(10) When pulling onto the highway, check to make sure that the move can be done with safety. Give a left turn signal, then move out into traffic, neutralizing the left turn signal when you have established your position in the right hand lane of traffic.

(11) When stopping, aim high in traffic, check the passengers, and the traffic following in the rear view mirrors, before making a smooth stop. Make the stop in a manner so as not to endanger passengers or place the bus in danger of being struck in the rear by another vehicle.

(12) Be certain that all backing movements can be done with absolute safety. Be certain that there is no child behind the bus. Be certain there are no vehicles behind your bus in a place where you could back into them. Get a guide whenever possible. Eliminate backing on the school grounds.

(13) No bus shall be driven at a speed greater than is reasonable and prudent, having due regard for weather, traffic, and road conditions. A maximum route speed of 35 miles an hour is recommended. At a maximum speed of 35 miles an hour you will be able to complete your route in a reasonable time.

(14) Whenever passengers must stand while the bus is in operation, make certain that they move to the rear, and that none is standing ahead of the stanchion bars and the floor marking.

(15) All lights on a school bus must be in operating condition. Burned out or defective lights must be repaired before operating the school bus under conditions where these lights must be in operation.

(16) No passenger is to be permitted to board or alight while the bus is in motion. Doors must be kept closed while the bus is in motion.

(17) School bus operators should give pedestrains the right of way at all times.

(18) Make an effort to get a disabled bus out of the roadway and into a safe place where it is protected from further damage. It is recommended that emergency equipment, such as flares and flags, be displayed.

(19) When you have knowledge of road hazards, such as ruts, or holes in the roadway, dangerous bus stops, projecting objects such as tree limbs or leaning poles, make a report to your supervisor for investigation and correction. State road commissions, generally speaking, are responsible for clearing brush from roadways so that buses can operate without damage to the vehicle or injury to the passengers within the vehicle. With school buses this

recognizes an accident-producing situation far enough in advance to apply the necessary preventive action and concedes the right of way when necessary to prevent an accident.

(3) Brakes must be tested before operating the school bus. The bus must be operated within its mechanical limitations. If the brakes are inadequate for safe operation, park the bus off the road if possible, and immediately call the transportation supervisor. Better yet, don't start on a trip when the condition of the brakes is questionable.

(4) Windshields and mirrors are to be kept clean for clear visibility. Open the side window for proper ventilation if necessary, and report any defective defroster. Check heater hoses and hose clamps for leaks. Mirrors are to be properly adjusted. Report for repair any cracked or defective mirror. A hand cloth should be in every operator's kit.

(5) Smooth starts and smooth stops will prevent personal injuries and preserve equipment. Reduce speed over rough roads. Gears are to be meshed without clashing. The bus is to be held by the foot brake on any grade, and not by power.

(6) Avoiding collisions at intersections is the bus operator's responsibility. Approach at a prudent rate of speed, observe to right and left, and have bus under

d. Seasonal Driving Conditions

Some geographic locations and climatic conditions will require that drivers be provided with information regarding emergency procedures, such as controlling the vehicle in a skid. This section might be used for this purpose.

8. Maintenance and Sanitation

This section may spell out the specific responsibilities of the driver in inspection and maintenance of the buses. Also detailed here would be the specific duties of the driver in maintaining his bus in a clean and orderly condition.

Part III - The School Bus Driver - His Qualifications and Relationships

A. Driver Qualifications

1. Legal Requirements

Section 163 of the Regulations of the Commissioner of Education provides for certain minimum physical, license, age, and character requirements for school bus drivers.

a. Approval for employment of school bus drivers. Approval for employment of a school bus driver shall be in writing on a form prescribed by the Commissioner of Education.

b. Age. All drivers of school transportation conveyances shall be at least 21 years of age, but not in excess of 70 years of age.

c. Physical fitness

(1) Each driver of a school transportation conveyance shall meet the following basic minimum physical requirements:

(a) Minimum vision (with or without glasses) shall be 20/40 in each eye

(b) Shall have all limbs, hands and feet. In the case of fingers there shall be at least two fingers and the thumb on one hand and four fingers and the thumb on the other hand

(3) Personal Qualifications

Beyond the legal requirements and the regulations of the local school district, every school bus driver is expected to possess certain personal attributes which enable him to adequately perform his duties. Among these are:

(a) Reliability

(b) Ability to get along with others

(c) Freedom from undersirable language

(d) Sufficient initiative to handle unforeseen situations

(e) Moral conduct above reproach

(f) Ability to work within an organization

Other characteristics may be added as the board of education desires.

B. School Bus Driver Training

If some form of driver training is required as a prerequisite to employment or as a requirement for continuing employment, the driver should be made aware of this fact in this portion of the manual.

An explanation of the course content and the school bus driver training certificate might also be discussed.

CHECKLIST FOR CONSULTANTS

The following checklist is intended as a general guide for consultants for the preparation and conduct of initial meetings with school districts. All items do not apply in all situations.

Preparation Prior to Meetings

_____Read available materials on the proposed study topic.

_____Find out all you can about the district and its problems.

_____Accept the idea of beginning where the school district is.

_____Have a 20-minute speech ready in case it is requested.

_____Select, if possible, a book, a bibliography, or some material on the study topic to take to the local committee.

Preliminary Visit with Administrator and Local Chairman

_____Encourage them to state their goals and expectations.

_____Suggest goals or procedures as appropriate.

_____Find out how much leeway the curriculum development committee will have in operation.

_____If committee has not yet been chosen, discuss membership, expectations, and method of choosing committee.

_____Discuss role of the total faculty in the project.

_____Differentiate roles of local study chairman and consultant.

_____Discuss the best times for meetings and the possibilities of released time for teachers.

First Visit with Committee

_____Let the local study chairman preside.

_____Explore definition of the proposed study topic and sub-topics.

_____Elicit problems, as they see them, from all committee members.

_____Offer suggestions on experimentation or studies, either individual or group, for the committee.

_____Offer to help the committee locate important data which may be needed.

_____Discuss time arrangements for this work.

_____Discuss need for faculty involvement in the project.

_____Set time for the next meeting.

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Weaver, Jack K.
Nature and Scope of the Highway
Transportation System.

Highway Users Federation for Safety and
Mobility, Washington, D.C.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 56p.

DESCRIPTORS - *VOCATIONAL EDUCATION;
*INSTRUCTIONAL MATERIALS; *TRAFFIC CONTROL;
*TRANSPORTATION; *CURRICULUM GUIDES;
COMMUNITY COLLEGES; RESOURCE MATERIALS;
TRAFFIC REGULATIONS; TRAFFIC SAFETY;
BIBLIOGRAPHIES; MOTOR VEHICLES

ABSTRACT - Developed by the Highway Users
Federation for Safety and Mobility, this
course syllabus will be useful in introducing
students to the broad spectrum of highway
transportation. Such a survey course is
intended for the community college level and
treats such topics as: (1) Police Traffic
Supervision, (2) Motor Vehicle Administration
and Traffic Accident Records Systems, (3)
Traffic Engineering, (4) Education and Public
Information, (5) Traffic Legislation and
Judicature, and (6) Health, Medical Care, and
Transportation of the Injured. Included in
the outline is an introductory synopsis,
educational objectives, and a rather
comprehensive list of references. (JS)

VT 013 333

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C1

NATURE AND SCOPE OF THE HIGHWAY TRANSPORTATION SYSTEM

A syllabus of a survey course designed to introduce the student to the broad spectrum of highway transportation.

by

Jack K. Weaver, Ph.D.

Highway Users Federation
For
Safety and Mobility

Washington, D. C.

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NATURE AND SCOPE OF THE HIGHWAY TRANSPORTATION SYSTEM

I

COURSE PURPOSE

Intended for the community college student who will come from (1) government, business, and industrial groups engaged in some phase of traffic management, (2) students enrolled in some other fields, (3) students matriculating in college, but not yet decided on a specific career.

This course is designed to (1) improve the student's knowledge and understanding of the highway transportation system, (2) provide the student with a broad conceptual base as preparation for advanced and more specific learning.

Prerequisite: None

Catalog Description:

Nature and scope of the Highway Transportation System; a survey of the major functional areas and their inter-relationship.

(c) There shall be a good utilization of both arms and legs

(d) Hearing in each ear shall be adequate (without hearing aid)

(e) Shall not have any other physical or mental condition which might impede the ability to operate a bus safely

(2) Each regular and substitute school bus driver shall be examined by a physician prior to beginning service. Medical examination shall be reported by the physician on forms prescribed by the Commissioner of Education. Such physical examinations shall be conducted within two weeks prior to the beginning of service in each school year and shall be immediately reported to the superintendent of schools or district superintendent of schools. The physical examination shall include, as a minimum, those requirements specified on the prescribed Medical Examination Report. The report of the physician, in writing, shall be considered by the superintendent or district superintendent in determining the fitness of the driver to operate or continue to operate any transportation facilities used by pupils.

d. Required licenses. Each driver of a motor vehicle conveying school children shall have the appropriate operator's or chauffeur's license to operate such motor vehicle.

e. Character requirement. The driver of a vehicle for the transportation of school children shall be of good moral character and thoroughly reliable. At the time of initial application and at such other times as the superintendent of schools or district superintendent of schools may determine, each applicant for approval for employment as a school bus driver shall furnish to the superintendent at least three statements from three different persons who are not related, either by blood or marriage to the applicant, pertaining to the moral character and to the reliability of the applicant.

(2) Local Requirements

The requirements set forth by the Commissioner's Regulations constitute only minimum standards. A school district may establish more rigorous requirements if the board of education so desires. If such regulations exist, they should be detailed in this section of the handbook.

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C. Relationship to Parents and the Driving Public

The school bus driver is, in a sense, an important public relations agent for the school. His relationships with parents, pupils, and the public can influence sentiment toward the school for good or ill. Listed below are some examples of the kinds of material to include in this section.

1. Relationship to Parents

Parent cooperation is necessary in maintaining acceptable standards of education and discipline in the schools. The school bus driver can favorably impress parents by:

a. Adhering strictly to the time schedule

b. Observing strictly all traffic rules

c. Demonstrating a firm but friendly attitude toward pupil passengers. Other items may be added at the discretion of the individual school district

2. Relationship to the Driving Public

The motoring public is influenced in its attitude toward the school by the actions of the school bus driver. In order that these drivers be favorably impressed, the school bus driver should observe the following rules:

a. Obey all traffic signs, rules, and regulations

b. Use flashing red signal lamps only when receiving or discharging passengers

c. Be considerate

d. Don't lose your temper

Other items may be added at the discretion of the individual school district.

D. Relationship to Pupils

1. Driver Attitude

The attitude of the driver should be consistent with the three F's (firm, friendly, and fair). The good school bus driver is able to control the pupils without alienating them.

2. Characteristics of a Well-Disciplined Bus

a. The bus is clean and well kept

b. The pupils practice a proper amount of self restraint for their developmental stage

c. The bus driver adheres strictly to the schedule

d. The pupils themselves frown upon "horseplay"

e. The pupils enter and leave the bus in an orderly fashion

f. The pupils remain seated after entering and before leaving the bus

g. A friendly, but not intimate, feeling exists between the driver and the pupils, especially at the secondary level

h. Pupils refrain from thrusting their arms out of the windows and keep their legs out of the center aisle

i. The pupils hold conversations in a normal tone of voice so that driver distraction is kept to a minimum

j. The authority of the driver is accepted by the pupils

k. The rules of conduct are well established and there is a high degree of compliance on the part of the pupils

3. Rules to be Observed by Pupil Passengers

Section 163 of the Commissioner's Regulations prescribes certain basic rules for pupils riding buses. In addition to these, each school district will undoubtedly have certain regulations governing pupil conduct on buses. These rules should be listed here.

4. Acceptable Forms of Disciplinary Action

Although each school district will have its own procedures for handling cases of discipline, there are certain methods of correction which are forbidden to school bus drivers. These, as well as the acceptable disciplinary procedures, should be clearly spelled out in this section.

Part IV. Standard Forms and Their Use

A. This section explains forms which all bus drivers may be required to use. For example, a copy of the standard medical blank could be included, together with a statement that an annual physical examination is required within two weeks of the time that the driver begins service. Other forms to include are:

1. Accident reports
2. Daily reports
3. Application and renewal blanks
4. Other local reports required of drivers

II

COURSE OBJECTIVES

Activities during the course should be directed toward aiding the student to:

1. Acquire a knowledge of the manpower requirements of the system that will enable one to identify broad-field occupational opportunities.

2. Develop a recognition level of the functional areas in the system, and a concept of their interrelationship.

3. Realize the importance of having well qualified personnel in the system.

4. Become aware of the highway transportation system's contributions to society.

5. Distinguish the role of the (1) driver, (2) pedestrian, (3) vehicle, (4) and environment, in the system.

6. Become better informed as to the magnitude of the traffic problem, and the consequences of its continued growth.

7. Stimulate interest in professional literature related to highway transportation.

8. Recognize the contribution of modern technology to the highway transportation system.

9. Appreciate the value of a continuing education program for those persons working within the system or in a related enterprise.

10. Develop a concept of the highway transportation system as an essential element in the total transportation system.

CHAPTER IV

Maintaining Momentum

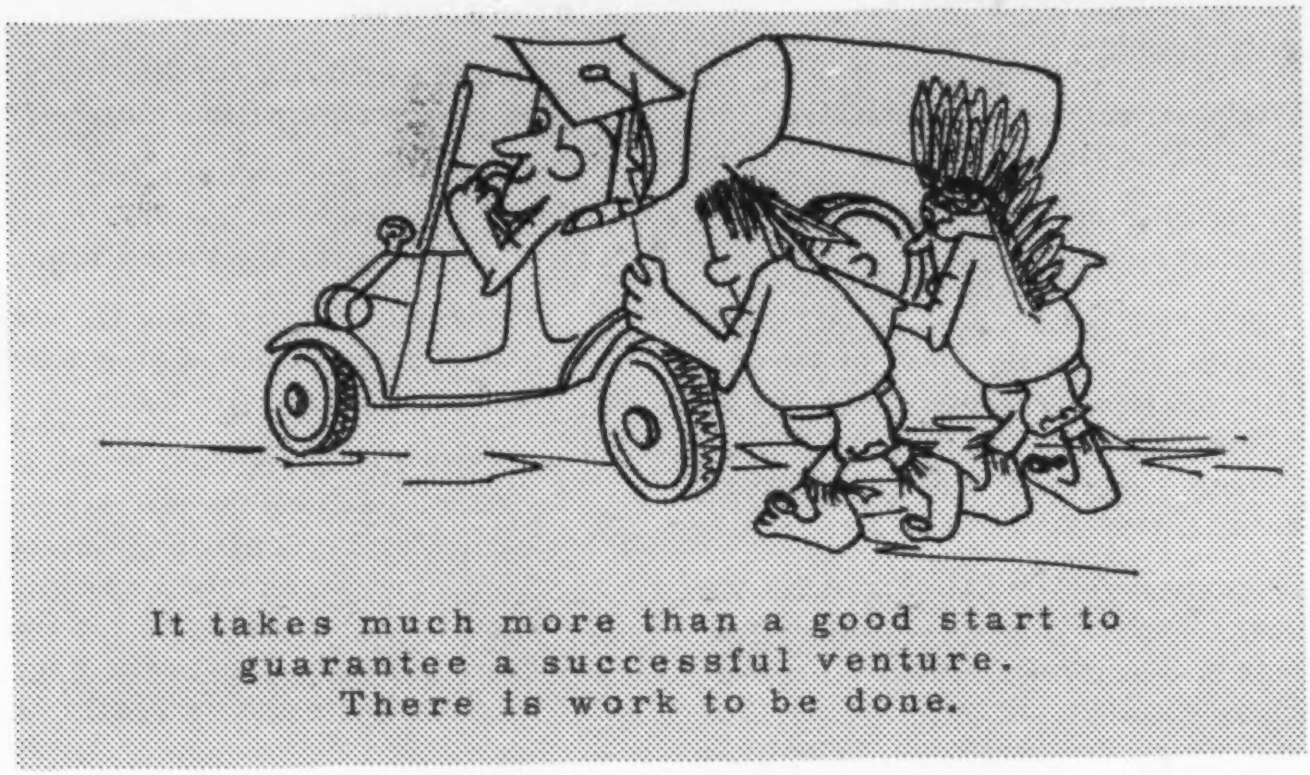

It takes much more than a good start to guarantee a successful venture. There is work to be done.

When a curriculum revision program is off the ground, the matters of management, continued careful planning, and communication become crucial.

Once the glamour of novelty wears thin, curriculum ventures become a real test of insight, human relations, and dedication. A responsible plan for curriculum improvement provides for the conservation of human resources.

This chapter is especially concerned with conditions under which human potential keeps growing. The big goal, of course, is morale. Morale grows when people grow. Morale is not complacency or even contentment; it demands a continuing challenge that teachers feel they have a reasonable chance to meet.

We emphasize the techniques of working with groups. Important references for further study on group process in curriculum development include Amidon (3), ASCD 1948 (5), Douglass (17), Fleming (18), Prestwood (26), Shane (27), and Thelen (30).

"Better not to preach the crusade than to neglect the crusaders."

4. Research can assist in the identification of conditions which tend to be associated with highway problems.

5. A characteristic of research is that answers to questions generally lead to new questions.

6. Disseminating research findings.

G. The universal utility of computerized data processing in the highway transportation system.

Listed below are just a few of the tasks performed by computers. The teacher may wish to equate these tasks and/or others with specific functions within the highway transportation system to illustrate the variety of application.

1. Information storage.

2. Performing calculations.

3. Communications

4. Programmed instructions.

5. Accounting

6. Mechanical analysis.

H. Highway transportation as an element of the total transportation system.

1. Operational relationship with air, rail, and water transportation.

2. The inter-dependent nature of the elements of the system.

I. The role of commercial highway transportation within the system.*

1. Contribution to the system.

2. Reliance upon the system.

3. Manpower requirements.

*The teacher may enhance (I) if the commercial manpower requirements of a particular community warrants. Additional development of this section

may be accomplished by relating each
ional areas listed under (J), with t
of the commercial highway transporta

J. Functional areas* of the highway tra
system and their inter-relationship.

1. Police traffic supervision.

2. Motor vehicle administration.

3. Traffic engineering.

4. Public education and information

5. Traffic legislation and judicatu

6. Health, medical care and transpo
the injured.

*These areas represent the major cla
be dealt with in this course. Ther
presentation at this time should be
identifying these areas as represent
which will follow, and; (2) establis
a concept of their inter-relationshi

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UNIT TWO

Police Traffic Supervision

A. Traffic direction and control.

1. Vital part of traffic policing.

2. The role in which the police make the most direct contact with the most people.

3. The increasing problem of keeping traffic moving efficiently and safely.

4. The changing character of the job. (Resulting from increased traffic volume and the complexities of street traffic movement.)

B. Traffic accident reporting and investigating.

1. Protection of life and property.

2. Observing and recording data that might be useful in determining how and why the accident happened.

3. The distinction between accident reporting and accident investigation.

4. Accident investigation data may be utilized by the courts, engineers, educators, and motor vehicle administrators in the administration of their responsibilities.

5. The utility of a coordinated accident record system. (Inter-departmental, inter-city, inter-county, inter-state.)

C. The role of enforcement.

1. The philosophy of traffic law enforcement.

2. Supervision of motor vehicle traffic is a major activity of all American police departments.

3. Effectiveness of enforcement is affected by; (1) legislation, (2) education, (3) highway and traffic engineering, (4) driver licensing, and (5) vehicle inspection.

4. The impact of enfo

5. The value of citiz enforcement.

6. Research needed to behavior and the e ment activity has

7. Certain quanititie necessary to produ pliance. (Princip

8. The development an improved enforceme

9. Evaluating and enf of the most import for traffic law en Arrest Rate, (2) H Enforcement Index,

10. The pedestrian rep problem in enforce

11. Obstacles to effec

12. The police-court r

13. The most important supervision progra of all traffic per of appropriate sta intelligence, judg and character.

14. Traffic policing h which demand speci skills and abiliti

a. An understandi of the traffic

b. Realization of proper attitud traffic superv

c. Knowledge and

15. Resources for pre- ing of enforcement

rcement on driver behavior.

en support to traffic law

learn more about driver
ffects that police enforce-
on this behavior.

s of enforcement activity are
ce desired levels of com-
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d implementation of new and
nt tactics.

orcement program. (Four
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forcement are; (1) Accident
it-and Run Arrest Rate, (3)
(4) Traffic Conviction Rate.)

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sonnel must be on the basis
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problem.

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skill to perform traffic duties.

service and in-service train-
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III

COURSE TOPICS

Unit One	Introductory Synopsis
Unit Two	Police Traffic Supervision
Unit Three	Motor Vehicle Administration and Traffic Accident Records Systems.
Unit Four	Traffic Engineering
Unit Five.	Education and Public Information
Unit Six	Traffic Legislation and Judicature
Unit Seven	Health, Medical Care and Transportation of the Injured.

UNIT ONE

Introductory Synopsis

A. Historical perspective of the highway transportation system. (Include a brief review of the National Highway Safety Act of 1966.)

B. The function of the highway transportation system in contemporary society.

C. Manpower requirements of the system.

   1. Professionals

   2. Semi-professional technicians.

   3. Highly skilled technicians.

   4. Craftsmen and skilled tradesmen.

   5. Semi-skilled workers and operatives.

   6. Unskilled workers.

D. The need for increasing the competencies of personnel working in the highway transportation system.

E. Basic components of the system and the consequence of their inter-action.

   1. The driver.

   2. The vehicle.

   3. The environment.

F. Research: A vital element in each of the functional areas of the highway transportation system.

   1. Research is an orderly way of seeking answers to questions.

   2. Research is stated in terms of probability rather than certainty.

   3. The objective nature of research.

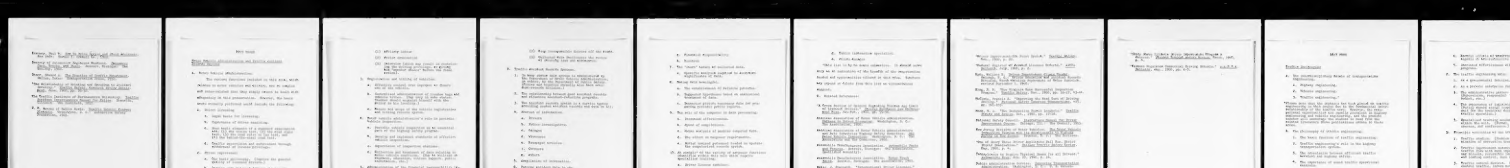

Bibliography

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Bibliography

g. Public information specialist.

h. Office manager

*This list is by no means exhaustive. It should serve only as an indication of the breadth of the competencies needed and opportunities offered in this area. Teachers may expand or delete from this list as circumstances suggest.

C. Related References:

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PROBLEMS OF COMMITTEES

Finding Time to Meet

Where do we get the time to do this extra work? This question will be in many teachers' minds. The answer is usually one of the following:

After school

Partly on school time, partly after school hours

On regular school time in the regular school day

As superintendents come to see curriculum work as a basic part of teaching and not as an extra, they often try to give the last answer, tending to accept the old adage: "No souls are saved after four o'clock."

But because released time means the possibility of added expense, and often a problem in obtaining suitable substitutes, the administrator may not be free to do what he would like to do. The problem of building community support for the idea of released time is one on which faculty committees can help by direct involvement of parents and citizens, especially those who exercise unusual influence in the community.

How Often To Meet?

The frequency of meetings should depend on the job to be done and the urgency of its completion. For committees meeting with a consultant, perhaps a two to three week interval is about right. Sub-committees might meet in between.

A good committee chairman does not try to complete everything in a bi-weekly or tri-weekly meeting, however. He plans for interim conferences with subcommittee chairmen, makes sure that reports are ready in advance, and tries to iron out personal problems before the meeting--problems that otherwise would derail the committee.

Careful Structuring

Most good meetings don't happen. They are very carefully structured.

What does this mean? It means that the chairman:

Plans carefully for the involvement of every committee member.

Builds in procedures for helping the members to identify more strongly with the committee.

Encourages very specific short-range targets for each member and sub-committee for the next meeting.

Briefs the consultant or other resource persons on the nature of the contribution desired of them. Prepares an advance agenda allotting tentative times for each item depending upon the degree to which discussion is really necessary.

The Chairman's Dilemma

In structuring a meeting the chairman faces the problem of whether his hand shall be too light or too heavy. If he plans the meeting too casually, hoping for a maximum of freedom of discussion, he may end up with a rambling, wandering meeting which has accomplished nothing. If he structures it too much, hoping for maximum efficiency in use of time, he may find he has railroaded through a program which has not been thoroughly considered by all.

The middle way is to prepare an agenda, but always consider it tentative. Abide by its time schedules unless the committee by deliberate action decides otherwise. As the agenda samples on the next pages illustrate, much can take place in a meeting, but rarely without the most intensive pre-planning.

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UNIT FOUR

Traffic Engineering

A. The interdisciplinary nature of transportation engineering.

1. Highway engineering.

2. Vehicle engineering.

3. Traffic engineering.*

*Please note that the emphasis has been placed on traffic engineering in this course due to the fundamental interrelationship of the traffic core. However, the occupational opportunities are equally prevalent in highway engineering and vehicle engineering, and the prudent teacher will encourage the student to read from the related literature those publications common to these areas.

B. The philosophy of traffic engineering.

1. The basic function of traffic engineering.

2. Traffic engineering's role in the highway transportation system.

3. The correlation between efficient traffic movement and highway safety.

4. The importance of sound traffic operational controls.

C. Improved operations through traffic engineering.

1. Traffic engineering investigation of vehicle-flow.

2. Coordinated signal systems for continuous traffic flow.

3. Curb parking control.

4. The through-street plan.

5. One-way operations.

6. Harmful effects of unwarranted traffic signals or too-restrictive speed regulation.

7. Increased effectiveness with broad-scale programs.

D. The traffic engineering unit.

1. As a governmental function.

2. As a private enterprise function.

3. The administrative pattern of the unit. (Supervision, responsibility, authority, budget, etc.)

4. The importance of legislative authority. (Policy should assign responsibility to the unit for the technical decisions concerning traffic operation.)

5. Specialized training needed for individuals within the unit. (Formal, inservice, short courses, and conferences.)

E. Principle activities of the traffic engineering unit.

1. Traffic studies. (Problem analysis and determination of corrective treatment.)

2. Traffic improvement measures. (Facilitating traffic flow with such improvements as one-way streets, reversible lanes, curb parking and loading control, turn restrictions, etc.)

3. Traffic control devices. (Guide, warn, and control traffic, inform motorists and pedestrians of specific traffic regulations.)

4. Selective physical improvements. (The use of physical aids and controls, including channelization and refuge islands, crosswalk markings, traffic signals, and pedestrian barriers to alleviate causes of traffic accidents and congestion through highway construction.)

5. Official cooperation with the over-all transportation efforts of a community.

6. Research. (a) Provides a better understanding of traffic operations. (b) Offer evidence to suggest the application of more effective engineering techniques.

UNIT SIX

Traffic Legislation and Judicature

A. Traffic Laws and Ordinances.

1. Their importance in the growing highway traffic problem.

2. A key role in establishing standards of motorist and pedestrian conduct.

3. Based upon sound, realistic principles.

B. Administration, enforcement, and interpretations of traffic laws and ordinances.

C. Uniform vehicle code and model traffic ordinance.

1. Need for uniformity.

2. Desired effect of uniformity.

a. Enable motorists and pedestrians to know and obey rules wherever they go.

b. Make for a more orderly and efficient flow of traffic.

c. Reduce the danger of accidents.

d. Improve the standards for driving licensing.

3. The concept of uniform laws.

a. Acceptable variances.

b. Flexibility

c. Proper balance of uniformity and variance.

4. The effective use of uniformity.

a. Operator and chauffeur license laws.

b. Registration and certificates-of-title laws.

c. Financial responsibility laws.

D. The role of the traffic court in the highway transportation system.

1. Accident prevention.

a. Inculcate voluntary observance of traffic laws.

b. Application of corrective measures to individual offenders.

c. Exercise proper deterrents on violators.

2. Adjudicate cases arising under traffic laws and ordinances.

a. Sound administration of justice.

b. Judicial rights of the defendant.

3. Penalization designed to correct the behavior of the violator.

a. Not intended as a source of revenue.

b. Instrumental in correction through education.

c. A reciprocal relationship with driver improvement schools.

E. The future of the specialist in traffic legislation and judicature.

(It is suggested that the teacher evaluate the interest of the class before proceeding into this topic. Should it become apparent that an interest does exist, a brief survey of the present manpower deployment, and a review of the statistical trend should provide adequate evidence of the future potential. Students may wish to explore beyond this level through resource reading.)

F. Related References:

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(1) Advisory letter

(2) Review examination

(3) Interview (which may result in restricting the driving privilege, or giving him "another chance" before the final action).

3. Registration and titling of vehicles.

a. Effective control over improper or unsafe use of the vehicle.

b. Centralized administration of license tags and vehicle titles. (May vary in some states. Teacher should acquaint himself with the policy in his locality.)

c. Nature and scope of the vehicle registration and titling records system.

4. Motor vehicle administration's role in periodic vehicle inspection.

a. Periodic vehicle inspection as an essential part of the highway safety program.

b. Develop and implement standards of effective vehicle inspection.

c. Supervision of inspection stations.

d. Collection and treatment of data relating to motor vehicle condition. (May be utilized in research, education, citizen support, public information, etc.)

5. Administration of the financial responsibility law.

a. Fundamental purpose of the law. (Drivers show proof of financial responsibility in cases of involvement in motor vehicle accident, or conviction of a major traffic offense.)

b. The law serves many secondary purposes.

(1) Required reports provide valuable information for; driver-licensing activities; enforcement; engineering; education; and other accident prevention measures.

(2) Keep irresponsible drivers off the roads.

(3) Collected data facilitates the review of existing laws and ordinances.

B. Traffic Accident Records Systems.

1. In many states this system is administered by the Department of Motor Vehicle Administration, in others, by the Department of Public Safety. (Cities and counties normally also have accident-records division.)

2. The relationship between good accident records and effective accident-reduction programs.

3. The accident records system is a service agency providing needed accident records and data to all.

4. Sources of information.

a. Drivers

b. Police-investigators.

c. Garages

d. Witnesses

e. Newspaper articles

f. Coroners

g. others

5. Compilation of information.

6. Putting accident data to use.

a. Law enforcement

b. Education

c. Public support and public information.

d. Legislation

e. Driver licensing

f. Traffic engineering

g. Financial responsibility

h. Research

7. The "inert" nature of collected data.

a. Specific analysis required to determine significance of data.

8. Making data meaningful.

a. The establishment of definite patterns.

b. Suggested hypotheses based on statistical treatment of data.

c. Summaries provide necessary data for preparing periodic public reports.

9. The role of the computer in data processing.

a. Increased effectiveness.

b. Speed of compilations.

c. Human analysis of machine computed data.

d. The effect on manpower requirements.

e. Better trained personnel needed to operate the computerized records system.

10. An example* of the variety of manpower functions identified within this unit which require specialized training.

a. Driver license examiner.

b. Driver improvement analyst.

c. Traffic accident records analyst.

d. Data processing and computer specialist.

e. Investigator's (license investigation, financial responsibility investigation, title investigation, etc.)

f. Supervision in the motor vehicle inspection program.

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1957.

Traffic Control Roadway
C.: Automotive Safety

Motor Vehicle Administration
Records Systems

A. Motor Vehicle Administrat

The various functions
relates to motor vehicles
and inter-related that th
adequately in this present
tasks normally performed

1. Driver licensing

a. Legal basis for li

b. Importance of driv

c. Four basic element
are; (1) the visi
test, (3) the roa
(4) the behind-th

d. Traffic supervisi
withdrawal of lic

2. Driver improvement

a. The basic philoso
quality of licens

b. Dealing with lice
do not know how t
laws enacted for
or revocation.)

c. Certain serious o
revocation of the

d. Individual diagno
precedes restrict

e. Types of action w
without taking aw

tion.

s included in this area, which
and drivers, are so complex
ey simply cannot be dealt with
tation. However, the basic
would include the following:

icensing.

ver examining.

ts of a standard examination
on test, (2) the road signs
d rules or law test, and
e-wheel road test.

on and enforcement through
ense privilege.

phy. (Improve the general
ed drivers.)

nsed drivers who cannot,
o, or simply will not obey
public safety. (Suspension

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Bulletin, Aug., 1960,

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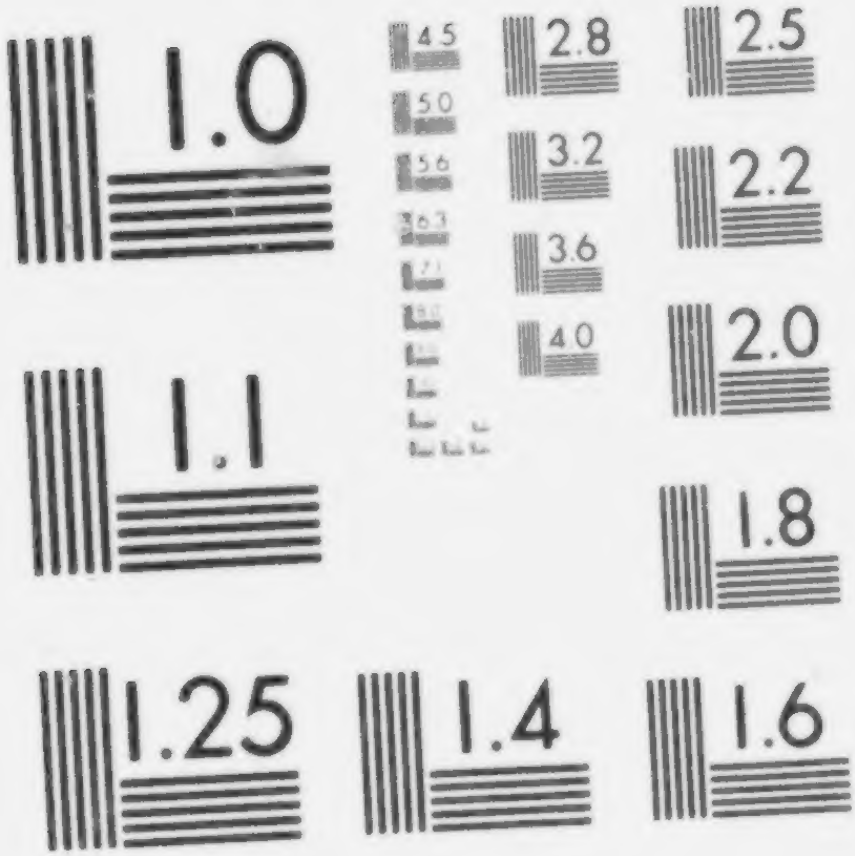

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PLAN FOR A FACULTY ORIENTATION MEETING

The agenda on this page was planned by a junior high school principal, in cooperation with his curriculum study committee chairman, to introduce a curriculum development project in reading to the entire faculty. The newly formed Reading Improvement Committee had met for the first time the week before. This agenda was distributed to the faculty two days prior to October 14. The hand-written notes at the right are those on the principal's own copy.

AGENDA FOR OCTOBER 14
FACULTY MEETING
Western Junior High School
Cafeteria, 3:00 P.M.

Remind secretary to have coffee and cookies!

Purposes:

To inform faculty of Reading Improvement Committee's tentative plans.
To introduce new reading consultant to the faculty.
To acquaint study committee with specific reading problems facing teachers of subject areas.

Staff needs to know the consultant's special capabilities.

3:00 Introduction by principal of new consultant and reading committee chairman

Give chairman credit for willingness to do a difficult job.

3:10 Report by committee chairman
How the committee sees the problem
Possible ways to proceed with the study
The need to obtain faculty thinking

3:20 Commentary by consultant on problem
General observations
Other schools' experiences with problem

Emphasize need for involvement of all. Everyone in our school has mentioned "the reading problem" at the lunch table!

3:30 Departmental group meetings
Discussions of reading problems faced by teachers
Compilation of written lists of problems in reading for specific areas

3:45 Oral reports to faculty by department chairmen
Highlights of departmental group meetings
Brief comment by consultant

Remind committee secretary to take notes.

4:00 Questions or comments from the floor

4:10 Meeting summary by principal
Clarification of recommendations made in this meeting
Explanation of reading committee's next steps
Set time for committee to report back to faculty

Promise to support committee.

End on time!

4:15 Adjournment

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UNIT FIVE

Education and Public Information

A. Education

1. The goals of traffic safety education.

   a. Building responsible traffic citizens.

   b. Conservation of human life.

2. A comprehensive traffic safety education program.

   a. Elementary education's role in the comprehensive program.

      (1) Responsibility for practical traffic safety instructions.

      (2) Assist the child in developing a working knowledge of the rules of the road. (He must relate to the traffic situation as a pedestrian, bicycle rider, and vehicle passenger.)

      (3) Provide instruction which will help the child identify and understand the basic traffic signs, signals and marking.

      (4) Identify physical and mental deficiencies which may underlie behavior leading to accidents. (Faulty hearing, limited vision, emotional s'ress, etc.)

   b. The role of secondary education in the program.

      (1) Driver and traffic safety education.*

         (a) Need for: (Reinforce with current statistical data relating to youthful drivers.)

         (b) Motorcycle safety program.

         (c) Pedestrain safety.

(d) School bus safety.

(e) Purpose of: (1) Promotion of the safe, efficient, and rewarding use of the motor vehicle. (2) Develop high standards of performance and conduct. (3) Foster a sense of responsibility. (4) Nuture patterns of cooperation.

*Driver and traffic safety education constitutes a major function of the secondary safety program. The design of this course limits the dissemination of information relating to this topic; therefore, it has been superficially treated in this outline. The instructor may expand this topic if time permits, or suggest related reading for those students expressing increased interest.

(2) Traffic safety in other basic courses.

(a) Social studies. (Need for improving traffic conditions, analysis of traffic problems, etc.)

(b) Science. (Effects of gravity, friction, and inertia on moving vehicles.)

(c) Health and physical education. (Establish relationship between driving and general health, fatigue, coordination, effects of alcohol and drugs.)

(d) Shop. (Study of automobile design and mechanics.)

c. Adult traffic safety education programs.

(1) Driver education provided by commercial driving schools.

(2) Driver education provided by public school systems.

(3) Driver improvement programs.

(4) Driver training for the career oriented driver. (Commercial vehicle drivers: Truck, bus, etc.)

(5) Driver rehabilitation programs. (Court directed, and for those recovering from physical or mental illness.)

(6) In-service driver education programs for employees of agencies, governmental units and others. (Example: Traffic safety clinics conducted by businesses utilizing a considerable number of motor vehicles and drivers.)

d. Manpower requirements of the comprehensive traffic education program.

(1) Immediate need.

(2) Anticipated need.

(3) Levels of employment opportunities.

(4) Training required.

B. Public Information

1. Public information as a function in the highway transportation system.

a. The public information programs as a useful tool in the general education of the public.

(1) The success of all highway transportation programs rely largely upon public support.

(2) The relationship between public support and public understanding.

(3) The basic functions of the public information programs.

(a) Tell the public the facts about traffic accidents.

(b) Provide individual drivers and pedestrians with the information they need to protect themselves and others against accidents.

(c) Introduce to the public the various services offered by divisions of the highway transportation systems.

(d) Presenting special-emphasis programs when circumstances call for accenting specific problems.

b. Responsibility for the public information service in highway transportation.

(1) Public officials with responsibilities in the field of highway transportation.

(2) Public information media: (Newspapers; magazines; radio and television stations; motion pictures; outdoor advertising; etc.)

(3) Organizations and agencies enrolled in the cause of safety.

c. The role of the specialist in the public information program.

(1) The tasks of the specialist include:

(a) Assembling, tabulating or analyzing information.

(b) Providing facilities to expediate the flow of information to the proper media.

(c) Making information available to media reporters.

(d) Creation and distribution of printed materials.

(e) Preparation of speeches.

2. Education and public information as a prerequisite to organized citizen support of the highway traffic safety program.

a. Public awareness and public action.

b. Citizen traffic safety organizations.

(1) Rural organizations. (To reach the farm population.)

(2) Women's and parent's organizations.

(3) Employers.

(4) Labor unions.

(5) Motor clubs.

(6) Churches.

(7) Social, fraternal, and service clubs.

(8) Civic associations.

c. Functions of the citizen traffic safety organizations.

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PLAN FOR A STUDY COMMITTEE MEETING

The agenda on this page was planned by the chairman of the reading improvement committee for a session one week after the meeting outlined on the previous page. It was distributed to the committee two days before October 21. The handwritten notes at right are on the chairman's own copy.

AGENDA FOR OCTOBER 21
READING IMPROVEMENT
COMMITTEE MEETING
Western Junior High School
Lounge, 2:00 P. M.

Double check on the arrangements for released time for teachers to attend meeting!

Purposes:

To review and study lists of reading problems submitted by staff in subject areas
To explore other evidences of reading problems; e.g., reading test scores
To discuss references investigated by consultant

Emphasize importance of follow-through after once involving the faculty.

2:00 Faculty recommendations (Committee secretary)
Distribution of duplicated copies of faculty recommendations of October 14; time to read them
Discussion of report by committee
Tentative conclusions drawn

Remind committee on need to be tentative until all facts are in.

2:20 "Reading Test Scores" (Guidance director)
Explanation of school's testing program
Comparison of test findings with general staff recommendations

Every committee member - and the consultant - must understand the testing program and findings.

2:55 Announcement of conference (Chairman)
Reading instruction program at College in November

Emphasize our solid administrative support - we can call pick representatives.

3:00 Coffee break

3:10 "Pertinent Reading References" (Consultant)
Distribution of written bibliography of applicable materials for committee's study
Discussion of areas of interest for follow-up study by individuals; assignment of materials

3:40 Wrap-up (Chairman)
Summary of day's accomplishments
Review of individual committee responsibilities for next meeting
Consultant to contact a school familiar to him having a similar problem, and bring to next meeting a report of that school's findings
Time of next meeting

Be sure to ask for comments from the floor.

Remind them the next meeting will be after school - can't get enough substitutes.

4:00 Adjournment

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UNIT SEVEN

Health, Medical Care and Transportation of the Injured.

A. Health aspects of driver licensing.

1. Physiological conditions which may result in loss of ability to control a vehicle safely.

2. Procedures controlling the denial or revocation of a driving license based on pathological reasons.

3. Special requirements of fitness for commercial vehicle drivers.

B. The nature, magnitude, and contribution of ALCOHOL to the highway accident problem.

1. The effect of blood alcohol concentration on driver behavior.

2. Contribution to highway accidents.

3. Enforcement of the drinking-driver laws.

4. The role of the medical examiner in accident investigation and reporting.

5. The importance of the public understanding the problem.

6. The function of psychiatrically oriented medical clinic in enforcement and judicial processing of the drinking driver.

7. Employment of community resources in the control of the drinking driver and drinking pedestrian.

8. Utilization of citizen support groups.

C. The relationship of DRUGS to highway safety.

1. Beneficial and harmful effects.

a. Many pharmaceutical drugs contribute substantially to highway safety by maintaining the health of their users.

b. The effects of some physician prescribed drugs can decrease the ability of the driver or pedestrian to negotiate safely.

c. The psycho-physiological effects of drugs include modification of judgement, vision, alertness and neuromuscular control.

2. The need for research to elucidate the relationship between drugs and highway safety.

3. The uniform vehicle code states that license to drive shall not be issued to any person who is a habitual user of narcotic drugs.

4. Need for public information and education relative to the problem.

D. Emergency care and transportation of the injured.

1. Magnitude of the problem. (Approximately 46 million persons are injured each year.)

2. Two major classes of emergencies.

a. Conditions which require immediate medical attention.

b. Conditions in which care may be delayed.

3. Emergency care of the patient.

a. First aid at the scene of the accident.

b. Level of care administered the patient at the scene of the accident.

4. Transporting the patient in comfort and safety.

a. Competencies desired of ambulance personnel.

(1) Training in emergency medical technique.

(2) Ability to use ambulance equipment properly.

(3) Experience in determining the relative severity of the patient's condition.

(4) Skill in handling and transporting the patient to the hospital in such a manner as not to aggravate his condition.

(5) Training in the proper way to remove persons from wrecked vehicles.

b. Emergency vehicles should be manned by adequately trained and appropriately licensed driver and an adequately trained attendent.

c. The problem of the "speeding ambulance".

d. Ambulance design. (Emphasize that the vehicle must be equiped with facilities for the handling and care of the patient at the scene and in transit.)

e. Communications: A vital segment in the care and transportation of the injured. (Dispatching - inroute communications - on-the-scene communications - coordinating activities-summoning additional aid - correlating arrival time at hospital.)

5. Increased scope and effectiveness of emergency care and transportation requires:

a. A vigorous program of careful selection and training ambulance drivers and attendants.

b. Provision for continuing refresher training in new techniques, equipment, and procedures.

c. High standards of competency in operating an emergency vehicle.

d. Fully equiped ambulances, designed to provide facilities for maximum care of the injured or ill.

e. Periodic inspection of the vehicle to assure mechanical reliability and dependable emergency equipment.

f. Improved coordination and communication among groups providing emergency care.

g. Adequate recognition and compensation of manpower.

E. Related References:

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IV

APPRAISING ACHIEVEMENT AND GRADING

An evaluation of the student in a course of this nature would vary with the grading policies of a particular institution, and the student achievement desired by the teacher. However, the author suggests the behavioral modification of the student be measured at the awareness level. This would be in keeping with the generalized course objectives listed under II of this syllabus.

V

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DEVELOPING AND SUSTAINING INTEREST

How does the leader prevent the first fires of enthusiasm from dying out? Some of the principles and practices sketched below should serve. Notice that much attention must be paid to psychological needs such as respect, variety, recognition, and security; these are just as important as professional materials or services.

Show awareness and appreciation of the effort each person makes.

Mention instances casually at meetings. Send members occasional clippings related to their work. Send thank-you notes for jobs well done. Mention a member's contribution to his friends; it gets back.

Help each member to feel a stronger identification with the group.

Promote joint visits to other schools and to conferences. Encourage taping, logs, pictures, and other dramatic testimonials to the group's progress. Be sure each member gets a chance to contribute to the group's work.

Help the group to feel that they are growing in responsibility.

Encourage their participation in interpretation to the superintendent and school board. Urge them to write-up their activities for publication in local papers or educational journals. Enlist them in orienting other teachers to the committee's work.

THE GOOD GROUP MEMBER

Thus far we have emphasized to the leader: "Accept the group. Involve the group. Trust the group."

But it works two ways. Each member of the group has a responsibility, too, if the group process is to work. The group must deserve to be trusted. Here are some important points for each group member to think about:

Do your own thinking.

You don't have to agree with the status leader's proposals. Neither do you have to go along with the proposal most popular with the group. Don't be silent out of courtesy to the person who has persuasively presented his pet idea. Submit neither to leader tyranny nor group tyranny.

Learn to listen to others.

Train yourself to talk less and listen more. Don't just wait impatiently for your turn to talk. A committee is not a debating society--it is a place to get work done, to arrive at consensus on issues.

Maintain a tolerant attitude.

Learn to live with the idea of change. Be willing to accept responsibility. Accept the notion that there are probably more than two sides to every question, and many ways of accomplishing a desired goal.

Trust the leader.

Try to understand and identify with the goals of the group. Recognize the group leader's faults, but give him credit for his good points.

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APPENDEX I

The Teacher:

Selection of a competent person to teach a highway transportation survey course may present a problem to many colleges. A suggested approach to this problem is offered below:

The most competent and experienced teacher available would be employed to; (1) present unit one, "Introductory Synopsis," (2) coordinate the entire course of instruction; (3) summarize the course content and evaluate the students. Unit two through seven would be taught by selected resource persons possessing extensive knowledge and a working concept of a specific functional area within the highway transportation system. (For example: Unit four, "Traffic Engineering" may best be taught by an experienced traffic engineer that has demonstrated ability to present information to an assemblage, and conduct meaningful group discussions.)

This course was designed to permit each unit to be taught by an individual resource person. However, an instructor fully competent in more than one of the functional areas of highway transportation, may be effectively utilized in as many units as considered feasible.

APPENDEX II

Course Time Distribution

Suggested time allotment* for each of the seven units of this outline.

Unit	Title	Estimated Time Required
Unit One:	Introductory Synopsis	12 hours
Unit Two:	Police Traffic Supervision.	6 hours
Unit Three:	Motor Vehicle Administration and Traffic Records Systems . . .	6 hours
Unit Four:	Traffic Engineering	6 hours
Unit Five:	Education and Public Information	6 hours
Unit Six:	Traffic Legislation and Judicature	3 hours
Unit Seven:	Health, Medical Care and Transportation of the Injured . .	6 hours
Summary and Evaluation		3 hours
	Total	48 hours

*It should be noted the above time allotment represents only the thinking of this author, and it is not expected to be the most desirabe in all cases. Realistically, the time distribution may best be determined by an advisory committee, after reviewing pertinent data provided by a community survey. (Caution: Care should be taken, when time allotment changes are made, not to unbalance the course content to a degree which would render it ineffective as a survey presentation.)

Roadside Assistance Service

Prepared by
Traffic Department
NATIONAL SAFETY COUNCIL

U.S. DEPARTMEN
EDUCATION &
OFFICE OF ED
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Periodicals and Reports

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GROWING THROUGH ACTION RESEARCH

What is action research? It's not much more than the old problem-solving method in fancier clothes. Essentially it says to the teacher, "Look, most research is done in a situation that doesn't resemble yours. What you want is to solve your own problems as skillfully and independently as you can. Action research is one method which can apply to the individual classroom."

These Are The Steps

The procedures for action research are simply these:

Suggest a hypothetical solution--an educated guess at a relationship that may or may not exist if you study the problem carefully.

Plan to test your hypothesis--a procedure that needn't involve complex statistics;this isn't a graduate thesis.

Try out your plan and evaluate it.

Conclude what your data indicate.

Apply what you have learned.

Now do you have world-shaking findings? Of course not. But you have sharpened your method of inquiry so that you are more sure of what will work for you, with your students, under the conditions of the study.

How Does Action Research Apply Here?

Either a committee can follow an action research approach in some of its work, or it can help other teachers to use it.

If it is true that morale grows as people grow, there is little that could help more than the feeling that teachers are gaining in ability to tackle their own problems. What's more, teachers who are doing modest research tend to be most interested in that of others.

A typical action research study is one of immediate, local concern to the teacher. Its results can be put into effect immediately.

Special Help Needed

Action research devours time. But it is better to take time to find out what the problem really is than to move rapidly on a vague problem and end up with nothing.

A good consultant can be of much help in bringing the problem into focus. Not that he is so much smarter. Probably he is not. But he should have training in research procedure. He may also bring a perspective that those who are too close to the situation may not have.

Another special problem is resources. In action research the emphasis is upon change in teaching-learning. To know about change we have to develop evaluation tools, and we may need special materials. Study committees urging an action research approach should insure that reasonable requests for resources can be met.

An Emphasis on Commitment

A perennial committee bugaboo is talk. And talk cannot be clearly focused and diminished until the problem is clear and the directions for action become discernible. That's where the action research stress on problem-definition comes in.

A second problem is getting real personal involvement. It is an old committee tradition to avoid personal exposure to change by immersing ourselves in developing recommendations for change in others. Action research doesn't let us pass the buck.

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INTRODUCTION

A MODEL ORDINANCE OR STATUTE REGULATING AMBULANCE SERVICE

Development of this model ordinance or statute began in 1956 when representatives of the medical profession concluded that the medical profession had taken too little interest in preventing trauma, while those responsible for traffic safety were too little concerned with the human salvage operations of the doctors. This resulted in a Joint Action Program sponsored by three organizations, the American College of Surgeons, the American Association for the Surgery of Trauma, and the National Safety Council.

Late in 1959 the policy committee of this group asked the Traffic Conference to develop a model ordinance or statute relating to the transportation of the injured. A special Conference committee was activated representing the several interests involved, including a legal consultant to undertake the task.

The attached is a copy of the ordinance or statute developed after a number of meetings of the committee, and extensive correspondence with many interested groups. Numerous city ordinances and the National Institute of Municipal Law Officers' model were used as a guide. At the October 28, 1962, meeting of the special committee of the Conference, representatives of ambulance associations throughout the country in attendance offered several excellent suggestions which were incorporated. The model was approved by the Traffic Conference on October 27, 1963. Section 8(a) and 10(b)(iv) were amended February 1970, to require ambulance equipment for handling several kinds of emergencies, other than dressing wounds and hemorrhages and additional training for ambulance attendants.

At this meeting it was concluded that such a regulation would be more effective if it became a state law. Therefore, the draft is designed so that with appropriate changes, it may be used also as a Model Statute. Where feasible, it was concluded, a state statute is preferable to a local ordinance.

On page 2, Section 2 Licensing Requirements, it is presumed that where the model is used as an ordinance the city or county has legal authority under state law to adopt special license requirements for ambulances. The legal assumption, which should be verified in each case, is that the city or county has authority under its police power to prescribe regulations necessary to supplement state laws where the public safety and welfare so require. Therefore, it should be expressly understood that, in any state, the model, when adopted as an ordinance, must be modified to eliminate any conflict with existing state laws.

The intent of the model is to serve as a guide to improve a necessary public service and provide uniformity throughout the United States.

A MODEL ORDINANCE* REGULATING AMBULANCE SERVICE

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*This model is designed so that, with appropriate changes, it may be used also as a Model Statute. Where feasible, a State statute is preferable to a local ordinance. It has been adapted as a Model State Statute by the Council of State Governments.

A MODEL ORDINANCE REGULATING AMBULANCE SERVICE

An Ordinance to Regulate the Licensing, Inspection and Operation of Ambulances, to Provide Standards for the Licensing of Ambulances and of Ambulance Drivers, Attendants, and Attendant-Drivers, to Provide for Renewal and Revocation of Licenses, to Require Written Reports, to Provide for Traffic Regulations of Ambulances, and to Establish Penalties for Violation of its Provisions.

The (_____) of (_____)
enacting body city or county

ordains as follows:

SECTION I Definitions. Unless otherwise specified, the term "Ambulance" means

(a) any privately- or publicly-owned motor vehicle that is specially designed or constructed, and equipped, and is intended to be used for and is maintained or operated for the transportation of patients, including dual purpose police patrol cars and funeral coaches or hearses which otherwise comply with the provisions of this Ordinance, except any such motor vehicle owned by, or operated under the direct control of, the United States.

(b) "Attendant" means a trained and/or qualified individual responsible for the operation of an ambulance and the care of the patients whether or not the attendant also serves as driver.

(c) "Attendant-Driver" means a person who is qualified as an attendant and a driver.

(d) "Driver" means an individual who drives an ambulance.

(e) "Dual purpose police patrol car" means a vehicle, operated by a police department, which is equipped as an ambulance, even though it is also used for patrol or other police purposes.

SECTION 6 Duties of License Officer

(a) The License Officer shall, within _____ days after receipt of an application for an ambulance license as provided for herein, cause such investigation as he deems necessary to be made of the applicant and of his proposed operations.

(b) The License Officer shall issue a license hereunder for a specified ambulance, to be valid for a period of _____ years unless earlier suspended, revoked or terminated, when he finds:

(i) That the public convenience and necessity require the proposed ambulance service.

(ii) That each such ambulance, its required equipment and the premises designated in the application, have been certified by the Health Officer as provided for herein.

(iii) That the applicant is a responsible and proper person to conduct or work in the proposed business.

(iv) That only duly licensed drivers, attendants and attendant-drivers are employed in such capacities.

(v) That all the requirements of this Ordinance and all other applicable laws and ordinances have been met.

SECTION 7 Duties of Health Officer

(a) Prior to the issuance of any ambulance license hereunder, the Health Officer shall cause to be inspected the vehicles, equipment and premises designated in each application hereunder, and shall certify his approval in a written report to the License Officer when he finds compliance with the standards prescribed in Section 4(a) and in Section 8 of this Ordinance, and with the regulations promulgated under such sections;

(ii) is able to speak, read and write the English language;

(iii) has been found by a duly licensed physician, upon examination attested to on a form provided by the Health Officer, to be of sound physique, possessing eyesight in both eyes and corrected to at least 20/40 in the better eye, and free of physical defects or diseases which might impair the ability to drive or attend an ambulance; and

(iv) for each applicant for attendant or attendant-drivers license, that such applicant has a currently valid certificate evidencing successful completion of a course of training equivalent to the advanced course in first aid given by the American Red Cross or the United States Bureau of Mines and, in addition, has completed successfully a course of training developed by the Department of Transportation or the Department of Health, Education and Welfare, or their appropriate constituent units.

PROVIDED HOWEVER, that no one shall be licensed as a driver or attendant-driver unless he holds a currently valid chauffeur's permit from the State of (_____).

(c) A license as driver, attendant or attendant-driver issued hereunder shall not be assignable or transferable.

(d) No official entry made upon a license may be defaced, removed, or obliterated.

SECTION 11 Renewal of License

Renewal of any license hereunder, upon expiry for any reason or after revocation, shall require conformance with all the requirements of this Ordinance as upon original licensing.

SECTION 12 Revocation of License

(a) The License Officer may, and is hereby authorized to, suspend or revoke a license issued hereunder for failure of a licensee to comply and to maintain compliance with, or for his violation of, any applicable provisions, standards or requirements of this Ordinance, or of regulations promulgated hereunder, or of any other applicable laws or ordinances or regulations promulgated thereunder, but only after warning and such reasonable time for compliance as may be set by the License Officer. Within _____ days after a suspension, the licensee shall be afforded a hearing, after reasonable notice. The Licence Officer shall, within _____ days after conclusion of such hearing, issue a written decision (which shall include written findings) as to the suspension of said license. Such written decision shall be promptly transmitted to the licensee to whom it refers.

(b) The initial, semi-annual or other ambulance, equipment and premise inspection reports of the Health Officer herein provided for shall be prima facie evidence of compliance or non-compliance with, or violation of, the provisions, standards and requirements provided herein, and of the regulations promulgated hereunder, for the licensing of ambulances.

(c) Upon suspension, revocation or termination of an ambulance license hereunder, such ambulance shall cease operations as such and no person shall permit such ambulance to continue operations as such. Upon

(f) "Health Officer" means the (_____) Health Officer
city or county
or other designated official.

(g) "License Officer"* means the (_____)
city or county
(_____).
designated officer

(h) "Patient" means an individual who is sick, injured, wounded, or otherwise incapacitated or helpless.

(i) "Person" means any individual, firm, partnership, association, corporation, company, group of individuals acting together for a common purpose or organization of any kind, including any governmental agency other than the United States.

SECTION 2 License Required*

(a) No person, either as owner, agent or otherwise, shall furnish, operate, conduct, maintain, advertise, or otherwise be engaged in or profess to be engaged in the business or service of the transportation of patients upon the streets, alleys, or any public way or place of (_____) unless he holds a currently
city or county
valid license for an ambulance, issued pursuant to this Ordinance. An ambulance operated by an agency of the United States shall not be required to be licensed hereunder.

(b) No ambulance shall be operated for ambulance purposes, and no individual shall drive, attend or permit it to be operated for such purposes on the streets, alleys, or any public way or place of (_____) unless it shall be under the immediate
city or county
supervision and direction of a person who is holding a currently valid license as an attendant-driver or attendant.

*Where there is a Health Officer, he should be designated as the License Officer.

(c) Provided however, that no such licenses shall be required for an ambulance or for the driver, attendant or attendant-driver of an ambulance,

(i) which is rendering assistance to licensed ambulances in the case of a major catastrophe or emergency with which the licensed ambulances of (_____) are insufficient or unable to cope; or is
city or county

(ii) operated from a location or headquarters outside of (_____) in order to transport patients who are picked up beyond the limits of
city or county

(_____) to locations within (_____),
city or county city or county

but no such outside ambulance shall be used to pick up patients within (_____) for transportation to locations within
city or county

(_____) unless the driver, attendant and attendant-driver and the person subject to the provisions of Section 2(a) of this Ordinance in respect of such ambulance, hold currently valid licenses issued pursuant to this Ordinance.
city or county

SECTION 3 Application for Ambulance License. Applications for ambulance licenses hereunder shall be made upon such forms as may be prepared or prescribed by the License Officer and shall contain:

(a) The name and address of the applicant and of the owner of the ambulance.

(b) The trade or other fictitious name, if any, under which the applicant does business and proposes to do business.

(c) The training and experience of the applicant in the transportation and care of patients.

(d) A description of each ambulance, including the make, model, year of manufacture, motor and chasis number; current state license number; the length of time the ambulance has been in use; and the color scheme, insignia, name, monogram or other distinguishing characteristics to be used to designate applicant's ambulance.

USING RESOURCES WISELY

Human Resources

While instructional aids are important in creating motivation, of even greater importance is the utilization of human resources. These resources should include people from outside, as well as within the school system. The committee might call on guest speakers, state department personnel, county helping teachers, local citizens, parents, college experts, and many others.

However, it should be clearly understood that these people can but supplement, advise, and encourage the staff in their work. There is no denying that the final outcome in the curriculum development process must be the result of local staff efforts in order to be long-lasting. As has been so aptly expressed, "You can't buy an in-service program. A school staff must do it themselves."

Locating Materials

Most study projects require various kinds of research materials and supplementary literature. Location of such materials can be time-consuming and demanding. As in most studies, the committee will wish to search the related field before beginning any action program.

There are several ways that this task can be accomplished in reasonable time:

Certain committee members can be assigned the task of checking the local library for related materials.

The consultant may be able to supply background materials from his own past experiences.

Other committee members may accept the responsibility of writing to certain publishers or sources for appropriate books, pamphlets, or similar materials.

If the project involves the examination of textbooks, these too can be obtained by contacting and inviting in representatives of various companies.

If it is possible to anticipate needs for materials in advance of the establishment of the project, the administration might assign the collection of materials to certain staff members such as the school librarian, curriculum coordinator, or a department chairman. Such preliminary materials could furnish a basis for the formation of bibliographies which can be expanded as the study proceeds.

Reading and Using Materials

It is one thing to gather a vast collection of reading matter on a topic. It is quite a different task to have such material read, analyzed, and culled for that which is applicable to the study being considered. Here the work can be divided up and shared among the committee members. Faculty members not serving on the committee might also be asked to do some reading in relation to this phase of the study.

Brief reports of the highlights of such reading might be submitted to one person on the committee for final compilation and reporting to the committee as a whole. The committee can then evaluate them in terms of their meaning to the study project. A further application of this process would be to distribute summaries to the entire staff. This could be done through a mimeographed flyer, a curriculum bulletin, or directly in a general faculty meeting.

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(e) The location and description of the place or places from which it it intended to operate.

(f) Such other information as the License Officer shall deem reasonably necessary to a fair determination of compliance with this Ordinance.

(g) An accompanying license fee of $_____.

SECTION 4 Standards for Ambulance License

(a) Each ambulance shall, at all times when in use as such,

(i) be suitable for the transportation of patients from the standpoint of health, sanitation and safety, and be maintained in suitable premises;

(ii) contain equipment conforming with the standards, requirements and regulations provided for herein, which equipment shall be in proper and good condition for such use;

(iii) currently comply with all applicable laws and local ordinances relating to health, sanitation and safety;

(iv) be equipped with such lights, sirens and special markings to designate it as an ambulance as may be prescribed in reasonable regulations promulgated by the License Officer; and

(v) be equipped with approved safety belts for the driver, and for a passenger in the front seat if such seat is provided.

(b) Any change of ownership of a licensed ambulance shall terminate the license and shall require a new application and a new license and conformance with all the requirements of this Ordinance as upon original licensing.

(c) Application for transfer of any ambulance license to another or substitute vehicle shall require conformance with all the requirements of this Ordinance

as upon original licensing. No ambulance license may be sold, assigned, mortgaged or otherwise transferred without the approval of the License Officer and a finding of conformance with all the requirements of this Ordinance as upon original licensing.

(d) Each licensed ambulance, its equipment and the premises designated in the application and all records relating to its maintenance and operation as such, shall be open to inspection by the Health Officer or his designated representatives during usual hours of operation.

(e) No official entry made upon a license may be defaced, removed or obliterated.

SECTION 5 Standards for Ambulance License -- Liability Insurance

(a) No ambulance license shall be issued under this Ordinance, nor shall such license be valid after issuance, nor shall any ambulance be operated in (_____) unless there is at all times in force and
city or county
effect insurance coverage, issued by an insurance company licensed to do business in the State of (_____), for each and every ambulance owned and/or operated by or for the applicant or licensee, providing for the payment of damages;

(i) for injury to or death of individuals in accidents resulting from any cause for which the owner of said vehicle would be liable on account of liability imposed on him by law, regardless of whether the ambulance was being driven by the owner or his agent, and

(ii) for the loss of or damage to the property of another, including personal property, under like circumstances,

in such sums and under such terms as may be required in regulations promulgated by the License Officer.

(b) Said insurance policies shall be submitted to the License Officer for approval prior to the issuance of each ambulance license. Satisfactory evidence that such insurance is at all times in force and effect shall be furnished to the License Officer, in such form as he may specify, by all licensees required to provide such insurance under the provisions of this Ordinance.

(c) Every insurance policy required hereunder shall contain a provision for a continuing liability thereunder to the full amount thereof, notwithstanding any recovery thereon, that the liability of the insurer shall not be affected by the insolvency or the bankruptcy of the assured, and that until the policy is revoked the insurance company will not be relieved from liability on account of non-payment of premium, failure to renew license at the end of the year, or any act or omission of the named assured. Such policy of insurance shall be further conditioned for the payment of any judgments up to the limits of said policy, recovered against any person other than the owner, his agent or employee, who may operate the same with the consent or acquiescence of the owner.

(d) Every insurance policy required hereunder shall extend for the period to be covered by the license applied for and the insurer shall be obliged to give not less than _____ days written notice to the License Officer and to the assured before any cancellation or termination thereof earlier than its expiration date and the cancellation or other termination of any such policy shall automatically revoke and terminate the licenses issued for the ambulances covered by such policy, unless another insurance policy complying with the provisions of this section shall be provided and be in effect at the time of such cancellation or termination.

Provided, however, that under the terms of this Ordinance the Health Officer shall have no responsibility, and shall exercise no authority, in connection with laws and ordinances of general applicability which deal with motor vehicle inspection.

(b) Subsequent to issuance of an ambulance license hereunder, the Health Officer shall cause to be inspected each such licensed vehicle, and its equipment and premises, whenever he deems such inspection to be necessary but in any event no less frequently than twice each year, and shall promptly report his findings in a written report to the License Officer. The periodic inspection required hereunder shall be in addition to any other safety or motor vehicle inspection required to be made for ambulances or other motor vehicles, or other inspections required to be made, under general law or ordinances, and shall not excuse compliance with any requirement of law or ordinance to display any official certificate of motor vehicle inspection and approval nor excuse compliance with the requirements of any other applicable general law or ordinance.

(c) A copy of each initial, semi-annual or other ambulance, equipment and premises inspection report submitted by the Health Officer to the License Officer under the provisions of this section shall be promptly transmitted to the applicant or licensee to whom it refers.

SECTION 8 Standards for Ambulance Equipment

(a) Required equipment in each ambulance shall include, at all times when the ambulance is in use as such, equipment adequate in the judgment of the Health Officer for light rescue, protected extrication, dressing wounds,

splinting fractures, controlling hemorrhage, providing oxygen, assisting respiration, monitoring blood pressure, pulse and respiration rates, assisting in emergency childbirth and management of mentally deranged.

(b) The Health Officer is authorized and directed to promulgate regulations, after public notice and opportunity for public hearing, to implement the standards provided herein as to required equipment in ambulances. In determining the adequacy of equipment, the Health Officer shall take into consideration the current list of essential equipment for ambulances, adopted by the American College of Surgeons or its duly authorized Committee on Trauma. Each licensee of an ambulance shall comply with such reasonable regulations hereunder as may be promulgated by the Health Officer and shall maintain in each such ambulance, at all times when it is in use as such, all such equipment as may be prescribed by the Health Officer hereunder.

SECTION 9 Applications for Drivers, Attendants and Attendant-Drivers License

Applications for drivers, attendants and attendant-drivers licenses hereunder shall be made upon such forms as may be prepared or prescribed by the License Officer and shall contain:

(a) The applicant's full name, current residence, places of residence for _____ years previous to moving to his present address, and length of time he has resided in (_____).
city or county

(b) The applicant's age, marital status, height, color of eyes and hair.

(c) Whether he has ever been convicted of a felony or misdemeanor, and if so, when and where and for what cause.

(d) The applicant's training and experience in the transportation and care of patients, and whether he has previously been licensed as a driver, chauffeur, attendant or attendant-driver, and if so, when and where, and whether his license has ever been revoked or suspended in any jurisdiction and for what cause.

(e) Affidavits of good character from two reputable citizens of the United States and residents of (_____) who have
city or county
personally known such applicant and observed his conduct during _____ years next preceding the date of his application.

(f) Two recent photographs of the applicant, of a size designated by the License Officer, one of which shall be attached by the License Officer to the license.

(g) Such other information as the License Officer shall deem reasonably necessary to a fair determination of compliance with this Ordinance.

(h) An accompanying license fee of $_____.

SECTION 10 Standards for Drivers, Attendants and Attendant-Drivers License

(a) The License Officer shall, within a reasonable time after receipt of an application as provided for herein, cause such investigation as he deems necessary to be made of the applicant for a drivers, attendants or attendant-drivers license.

(b) The License Officer shall issue a license to a driver, attendant or attendant-driver hereunder, valid for a period of _____ years, unless earlier suspended, revoked or terminated, when he finds that the applicant

(i) is not addicted to the use of intoxicating liquors or narcotics, and is morally fit for the position;

ACKNOWLEDGMENTS

The Automotive Safety Foundation and the Highway Users Federation for Safety and Mobility was fortunate to have DR. JAMES E. CARNAHAN of Michigan State University serve as the principal investigator and writer for the highway safety program managment syllabus. During the project work, Dr. Carnahan gave freely of his personal time while continuing to carry out his duties as Coordinator of Research and Development at the Highway Traffic Safety Center, Michigan State University.

Dr. Carnahan brought to this work a valuable technical competence and a talent for deliberate investigation. We are indebted to him for his productive organizational ability and overall contributions to the project.

In addition to Dr. Carnahan, the contributions of many people have made this syllabus possible. The Automotive Safety Foundation and the Highway Users Federation wish to express their appreciation to the following persons who actively participated in the syllabus development and review.

suspension, revocation or termination of a drivers, attendants or attendant-drivers license hereunder, such driver, attendant or attendant-driver shall cease to drive or attend an ambulance and no person shall employ or permit such individual to drive or attend an ambulance.

SECTION 13 Reports

(a) Within _____ hours after transporting any patient within (_____ city or county), or from one place within (_____ city or county) to another place within or beyond its limits, the licensee of an ambulance hereunder shall file a written report with such (_____ designated official) of (_____ city or county) upon such form as they may provide or prescribe, giving all information therein required and any other relevant information which such (_____ designated official) may require.

(b) The provisions of subsection (a) of this section shall apply with equal force in case such patient shall die before being so transported in such ambulance or dies while being transported therein or at any time prior to the acceptance of the patient into the responsibility of the hospital or medical or other authority if the patient is still under the care or responsibility of the ambulance.

SECTION 14 Obedience to Traffic Laws, Ordinances and Regulations

(a) The driver of an ambulance, when responding to an emergency call or while transporting a patient, may exercise the privileges set forth in this section, but subject to the conditions herein stated, and only when such driver has reasonable grounds to believe that an emergency in fact exists requiring the exercise of such privileges.

(b) Subject to the provisions of subsection (a) hereof, the driver of an ambulance may

(i) Park or stand,
provisions of

(ii) Proceed past a
after slowing

(iii) Exceed the max
or regulation
erty; and

(iv) Disregard laws
or movement or

(c) The exemptions herein gr
making use of audible ar
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(d) The foregoing provisions
from the duty to drive w
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SECTION 15 Penalties

(a) Any person violating, or
Section 2(a) of this Or
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misdemeanor and upon co
exceeding $_____ or i
or be both so fined and

(b) Any person violating, o
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irrespective of the otherwise applicable
law, ordinance or regulation;
red or stop signal or stop sign, but only
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so long as he does not endanger life or prop-

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shall not relieve the driver of an ambulance
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for the safety of others.

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viction thereof shall be fined an amount not
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imprisoned, for each offense.
failing to comply with, any other provision of
deemed guilty of a misdemeanor and upon conviction

thereof shall be fined an amount not exceeding $_____ or be imprisoned for a period not exceeding _____ days, or be both so fined and imprisoned, for each offense.

(c) Each day that any violation of, or failure to comply with, this Ordinance is committed or permitted to continue shall constitute a separate and distinct offense under this section and shall be punishable as such hereunder; provided, however, that the Court may, in appropriate cases, stay the cumulation of penalties.

SECTION 16 Separability

If any section, subsection, sentence, clause, phrase or portion of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate, distinct and independent provision and such holding shall not affect the validity of the remaining portions hereof.

SECTION 17 Effective Date. This Ordinance shall become effective on

(_____)
date

SECTION 18 Ordinances Repealed. All ordinances and parts of ordinances in conflict with the provisions of this Ordinance are hereby repealed as follows:

_____

_____

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_____

Adopted this _____ day of _____, 19____.

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Highway Users Federation
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*TRANSPORTATION; MANAGEME
APPROACH; MANAGEMENT

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Program, (4) Highway Traf
Management, and (5) Progr
Arranged in outline forma
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THE IMPORTANCE OF COMMUNICATIONS

All phases of school life involve a great need for good communication. In the curriculum development process, the need is very specific. At all levels, there must be a clear understanding of purposes and procedures at all times. The only way to achieve such an objective is to assure an active program of information for everyone concerned.

There are many techniques by which good communication can be fostered.

Staff Meetings

As progress is begun and continued in a curriculum development project, information can be made available to the entire staff through many types of meetings:

General faculty meetings
Committee meetings
Small faculty group meetings, such as departments
Grade level meetings
In-service workshops or conferences
Informal discussions
Panel discussions

Written Materials

Many types of written communication are available to a committee to explain its work:

Regular issues of curriculum bulletins
Mimeographed releases by chairman or administration
Duplication of minutes of meetings
Formulation of staff handbooks
Personal notes and letters by the chairman to committee members and consultants
Newspaper publicity releases which will be read by faculty, students and parents

Personal Involvement

Let us face the fact that some people daydream in meetings and seldom read written bulletins. Here are some ways to personally involve other staff members, which committee members may wish to try:

Invite a panel of observers, some whose position is positive, some negative, to attend a committee presentation and react to it.

Talk over a particular suggestion for curriculum improvement with one other faculty member for his reaction.

If you are trying out a piece of action research, invite a faculty member not on the committee to help you with it.

Communication with Outsiders

If the school is working with an outside curriculum organization, college, or consultant, then it is very important that a close contact be established and maintained among the people involved. It is not uncommon for misunderstandings to arise as the result of misinterpretation or lack of information. If this is not given careful attention, ill will and loss of rapport can easily be the result.

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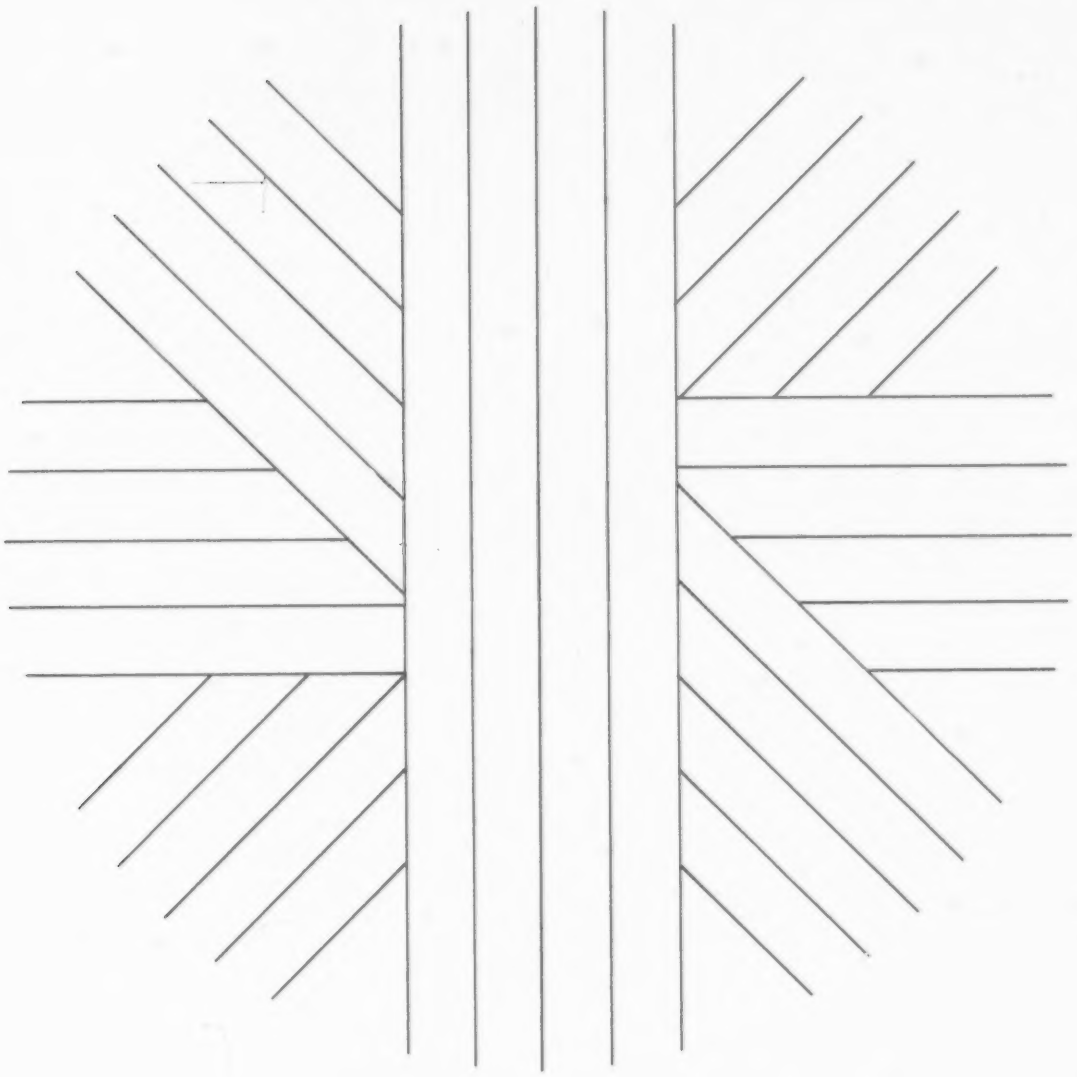

HIGHWAY SAFETY PROGRAM MANAGEMENT SYLLABUS

Published by the Highway Users Federation for Safety and Mobility

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HIGHWAY SAFETY PROGRAM MANAGEMENT

A SYLLABUS

Manuscript Prepared by

James E. Carnahan, Ph. D.

For the Advisory Committee for Development of a Syllabus
on Highway Safety Program Management

This Project was Funded by the Automotive Safety Foundation
and Administered by the
Highway Users Federation for Safety and Mobility

PREFACE

With the enactment of the Highway Safety Act of 1966, many highway administration functions became elements of a cohesive highway safety program management system. Many federal, state and local highway programs were restructured to take advantage of strengths inherent to a systemized methodology. With the implementation of the system's approach, certain manpower training and retraining problems became apparent. Skilled and knowledgable highway safety program management personnel were needed immediately, and the colleges and universities were called upon to provide the necessary educational programs. As in the past, the colleges and universities answered the quest, and provided programs of instruction designed to accomplish the identified objectives.

However, the educational institutions were faced with a critical shortage of highway safety program management resource materials. In an effort to provide the best possible program, each institution developed courses of instruction utilizing the highway safety resources accessible to them in their area. This effort generally resulted in a wide variance in course content between the schools. Recognizing this instructional inconsistency, highway safety and college administrators explored the related disciplines and concluded that there was a common core of knowledge essential to highway safety program management, but it was not clearly defined.

For many months the Automotive Safety Foundation, functioning through the staff of the Highway Users Federation for Safety and Mobility, explored the possible role it may play in assisting the highway safety and college administrators in dealing with this manpower training problem. In 1969 it adopted a two-part plan of action. The first part of the plan called for the development of a highway safety program management information base in syllabus form. The syllabus would identify a core of knowledge that would be compatible to the system approach of highway safety program management and be applicable to most state and local highway safety program offices. The second part of the plan called for the printing and distribution of the completed highway safety program management syllabus.

With the printing and distribution of this syllabus, the plan conceived in 1969 has been carried out. However, it should be noted that the Foundation does not consider this resource manuscript to be the solution to the training problem, but rather the beginning of an extensive highway safety management manpower preparation effort. Much remains to be done before a wide-spread, comprehensive highway safety management personnel training program can be effected. Training funds must be identified, curriculums designed and approved, additional resources (e.g., textbooks, films, video tapes, case study manuals) developed, credit and non-credit courses structured, in-service training programs established, etc.

The tasks yet to be done are formidable indeed. But through the combined and coordinated efforts of the state, local and federal governments, colleges and universities, and the private sector, fully effective highway safety manpower training programs are becoming a reality.

Jack K. Weaver, Ph.D.
Education & Training Specialist
Highway Users Federation
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A special acknowledgment is given to the late J. AL HEAD for his role in the planning and implementation of the project. In the relatively short time Al Head served as co-director of the project, he made many contributions which significantly benefited the final form of this vital manpower publication.

D. Grant Mickle
President
Highway Users Federation
for Safety and Mobility

AUTHOR'S FOREWORD

Australian Road Models of the Highway Design Formulation for Rural and Semi-Urban Roads are developed considering an average condition on earth, 1963, for overall with the development of a highway design management Guideline. The Rural Condition Analysis was held in St. Louis, Kansas, September 11-12, 1963. The process was focused by Mr. Jack Hosey with the involvement of the Core in Detail.

The road network was developed on the 1st. Core Analysis with the various Committee members in attendance (Accordingly Core Analysis Group). In. Jack Hosey Committee of the Highway Traffic Safety Center of Highway Research Program was chosen as Core Leader to develop an outline for the Highway Design as Core Coordinator. Then employed Discipline Leaders who prepared Overall Design Guidelines. The Core Leader prepared a Highway Design Management Guideline and presented it to the Highway Design Committee in December, 1963.

The Core Leader Committee developed a Guideline from the overall Analysis Committee and Design of the Highway Design Management Guideline. The Core Leader Committee developed the Guideline for Rural Roads and Semi-Urban Roads. The Core Leader Committee developed the Guideline for Rural Roads and Semi-Urban Roads. The Core Leader Committee developed the Guideline for Rural Roads and Semi-Urban Roads.

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c. Inadequate reporting and records

d. Fragmented responsibilities

2. Reducing the consequences of collisions

a. Highway design

b. Vehicle design

3. Multi-faceted nature of highway safety management

a. Numerous agencies involved

b. Various participants make public policy decisions

4. Insufficient manpower development

a. Need for informed, interested and competent leaders

b. Need for many types of traffic safety workers

c. Need for research into education and training programs

5. Insufficient public support

a. Apathy of the public

b. Lack of organized support of official programs by the public sector at local, state and national level

c. Poor relations between citizen support organizations and government officials with traffic safety responsibilities

6. Insufficient attention from public officials

a. Apathy of public officials

b. Insufficient preparation and training of government officials having traffic safety responsibilities--local, state, and federal level.

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c. Lack of coordinated effort between government agencies, each having a different responsibility in the total highway traffic safety effort

D. Reducing the incidence of traffic crashes

1. Accident losses can be reduced

a. Value judgment regarding public desires

(1) Some risks will be taken

(2) Public not willing to have extreme controls

(3) Development of the public "will" or desire for safety

b. Trade-off syndrome

(1) Paradox of mobility vs. safety

(2) Conflict between individual and system objectives

c. Finding the acceptable balance

(1) Establishing acceptable controls

(2) Applying enforcement tolerance

(3) Maintaining public acceptance

(4) Encouraging individual conformity

2. Factors utilized in reducing accidents

a. Primary factors

(1) Highway engineering programs

(a) Primitive systems

(b) Right of private access

(c) Primary and secondary roads

AUTHOR'S FOREWORD

President Grant Mickle of the Highway Users Federation for Safety and Mobility established an Advisory Committee in July, 1969, to assist with the development of a Highway Safety Management Syllabus. The first Committee meeting was held in St. Louis, Missouri, September 11-12, 1969. The project was managed by Dr. Jack Weaver with the assistance of the late Al Head.

The over all plan was developed at the St. Louis meeting with the various Committee members in attendance contributing their initial inputs. Dr. James Carnahan of the Highway Traffic Safety Center of Michigan State University was asked at this time to draft a skeleton outline for the Syllabus based on Committee deliberations. When completed (October 1969) the project manager caused the outline to be printed and distributed to the Committee membership.

The Committee member responses to the outline were routed to Carnahan who incorporated the ideas and recommendations of the members into the Syllabus format and then proceeded to research pertinent content areas so as to prepare the total document. The first draft of the complete Syllabus was submitted in July 1970.

A Review Committee was then selected by the Highway Users Federation to critique and react to the Syllabus.

CHAPTER V

The Roles to be Played

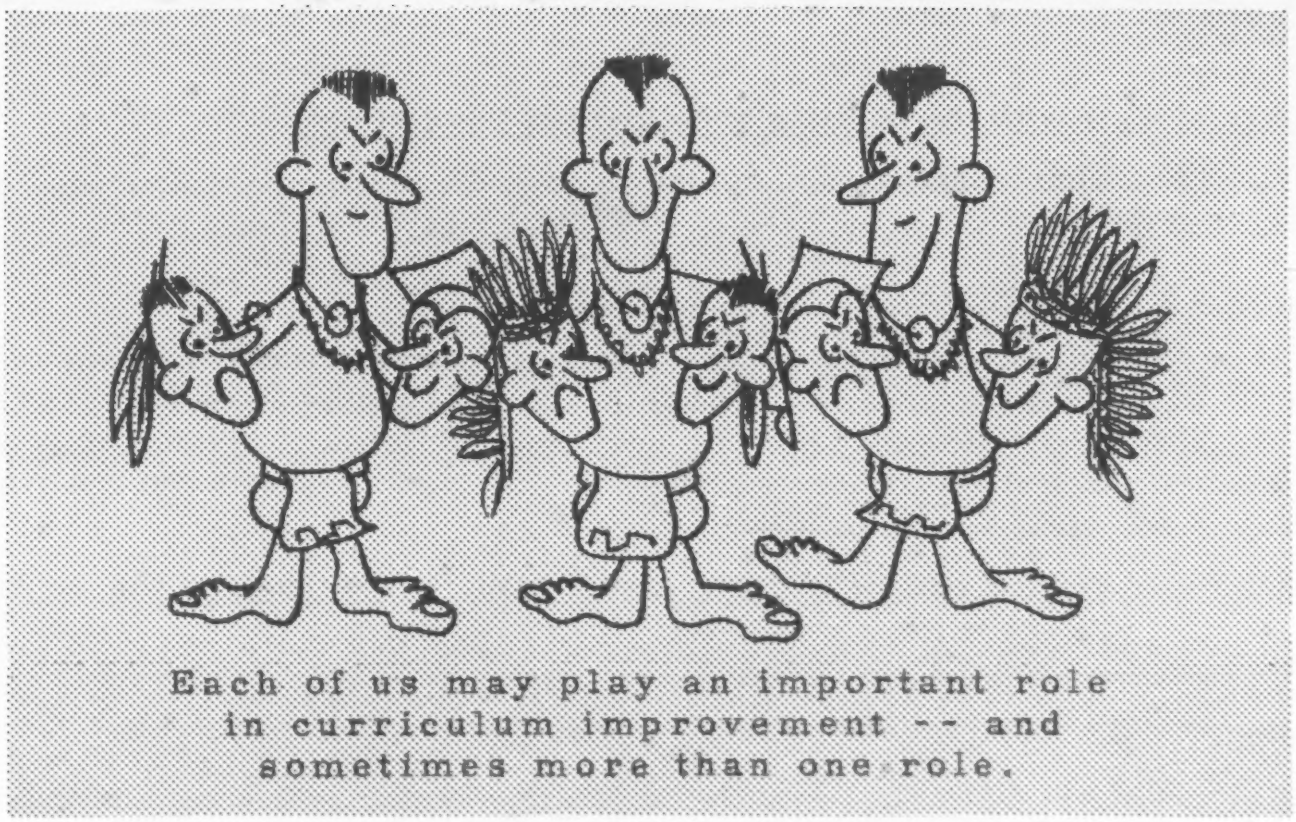

What roles are necessary in evolving curriculum revision through local efforts in cooperation with an outside consultant and an area study council? You will note on the following pages that some common threads run through the various statements about the roles.

These threads include:

An assumption of competence in one's chosen position, discipline, or subject field.

The belief that each person has an important contribution to the success of the project.

A need for adequate communication among all members of the team.

A need for mutual support among all those concerned with a project.

The idea that good human relationships are essential to this work.

Important references for this chapter include AASA-ASCD (1), ASCD 1961 (4), ASCD 1964 (6), ASCD 1965 (9), Buell (12), Burnham (13), Douglass (17), Miel (20), Prestwood (26), and Wiles (33).

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This Review Committee consisted of members from the parent Advisory Committee and Users of the document from both state and local levels of government. This group met in Memphis, Tennessee in August, 1970, to discuss and finalize revisions they had made on the Syllabus. The changes were incorporated into the document and a revised draft was completed in September 1970.

The Revised Draft (Second Draft) of the Syllabus was then routed to specific readers for review and editorial comment. Recommendations and suggestions from the editorial reviewers were incorporated into the document. The author then prepared a final Syllabus Manuscript and submitted it to the Highway Users Federation in December 1970.

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PART I

Overview

THE HIGHWAY TRANSPORTATION SYSTEM

I. General Description of the Highway Transportation System

A. Definition of transportation systems

1. Definition of any system

"An orderly arrangement of components and sub-systems that serve to perform some task in a given environment." (#35, p. 19)

2. Definition of highway transportation system

"A sub-system of transportation system composed of many man-machine-environment combinations interacting in a loosely coordinated fashion." (#35, p. 19)

B. Sub-systems of transportation system

1. Water

2. Rail

3. Air

4. Highways

5. Pipeline

6. Military

C. Relationships of components in transportation system.

1. System components

a. Man

b. Machine

c. Environment

3. More travel per capita

4. More travel per vehicle

5. More vehicles

E. Driver education

1. Effective program mandatory to handle problem cited in C-4 above.

2. Changing costs.

III. The Highway Accident Problem

A. Description of problem

1. Accidents are a system failure -- not simply a component failure

2. An accident is an occurrence in a sequence of events which usually results in death, injury or property damage.

3. Multiple-Cause theory.

B. Nature and scope of the problem

1. Increase in number of vehicles led to increase in potential conflicts

2. Traffic conflict characteristics

3. Theories related to accident causation

4. Factors that contribute to accidents

C. Obstacles to reducing accidents

1. Insufficient data base.

a. Poorly trained investigators

b. Insufficent research

2. Components inter-relate

3. Tasks are performed by both man and machine

D. Nature and purpose of highway transportation system

1. Purpose of system

a. To move people and goods

b. In a safe, rapid and efficent manner

2. Components of system

a. Roadways

Millions of miles of roadway varying in design, construction, and condition.

b. Vehicles

Millions of vehicles of various styles, ages, and conditions.

c. Users (operators)

Millions of operators of varying ages, skill, knowledge, and temperment.

3. Role of institutions in the system

a. Government

b. Business

c. Industry

d. Social

e. Educational

4. Criteria for measuring system effectiveness

a. Safety

b. Volume

c. Speed

d. Convenience

e. Cost

f. Environmental control

II. Trends and Development in the Highway Transportation System

A. Roadway system

1. Interstate urban

2. Interstate rural

3. Other urban

4. Other rural

5. Spot improvements

B. Traffic characteristics

1. Relative traffic densities

2. Traffic patterns

3. Traffic volume

C. Driver population

1. Increase in population -- gravitation towards large population centers

2. Increase in number of drivers

3. Increase in vehicle ownership

4. Change in age structure of drivers

D. Travel Mileage

1. Increased vehicle mileage

2. Shift from rural to urban driving

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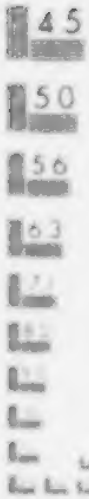

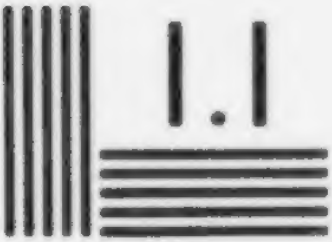

MICROCOPY RESOLUTIO
NATIONAL BUREAU OF ST

THE SUPERINTENDENT'S ROLE

He makes the decision to do something about curriculum development.

He solicits the advice of his staff, but the recommendation to the school board to use an outside consultant or to join a regional study council is his considered responsibility.

He works closely with the building principals of the district.

In relation to a curriculum study, he draws upon the principals' knowledge of staff abilities and needs.

He chooses a local study chairman and supports him.

If the chairman is not now in the school district's power structure, either officially or unofficially, the superintendent gives him special support and advice. He lets the chairman know what is expected of him and what the limits of his authority are. He is sympathetic with the chairman's problems. He works out with the chairman the best way of selecting the committee.

He helps the chairman and study committee members see the need for the project.

He explores with them not merely the district's need, but their own need for the proposed study. He explains the need for outside help, and the reasons he has recommended a consultant and/or regional study council membership.

He gets to know the regional study council representative and the consultants.

He is involved in the final selection of the consultant, and takes time to acquaint the consultant with the district and its problems and expectations.

He involves the total faculty.

This does not mean that every faculty member must be on a committee. It does mean that provision is made, with the help of the consultant, for making the faculty aware of what is going on and inviting cooperation.

He provides continued support for the project.

He provides materials, books, and secretarial help requested by the committee. He provides funds for substitutes so that committee members may have some released time for local meetings, preparation of reports, attendance at conferences, and visitation days to other school systems. He supports the committee against outside pressure groups seeking to dictate to it. He explains the committee's project to the staff, parents and school board. He shows enthusiasm and interest for the committee's work, and gives encouragement and recognition. He follows through.

He understands that real curriculum change is a slow process.

He is trying to change human behavior. He realizes that this does not change because of a speech in a faculty meeting or the publication of a new outline, but that it changes only with commitment, involvement, action, and time. The superintendent is satisfied with reasonable progress each year, and does not expect the millenium.

ON TEST CHART

TANDARDS-1963-A

(d) Limited access approach

- Expressway
- Freeway
- Parkway

(e) Functional classification of highway system for planning, design, and operation of facilities

- Land service vs. traffic services

(f) Reducing severity of crash

- Breakaway signs
- Improved median barriers
- Paved shoulders
- Object free right of ways
- Elimination of curves
- Multi-lanes and auxiliary lanes
- Spot improvements

(2) Traffic engineering

(a) Control of traffic

- Signs, signals, markings
- Traffic surveillance
- Correcting high accident locations

(b) Uniform traffic control devices

(c) Accident analyses

(d) Vehicle storage

(e) Coordination with other modes of transportation

(3) Automotive engineering

(a) Evolution of vehicle safety

(b) Crash-injury research

(c) Vehicle safety standards

(d) Current vehicle design

(4) Motor Vehicle administration

(a) Driver licensing and driver improvement

(b) Registration and titling

(c) Motor vehicle inspection

(d) Financial responsibility

(e) Reciprocity

(5) Enforcement programs

(a) Policing the highways

- Various law enforcement systems

  . State
  . Regional
  . County
  . City

- Control of interstate system

(b) Adjudicating traffic matters

- Civil action

- Criminal action

- Quasi-criminal action

(6) Education programs

(a) Traffic and safety education

- Elementary schools
- Middle schools
- High school driver education
- Adult driver and safety education

(b) Violators schools

(c) Commercial driving schools

(d) Driver improvement schools

(e) Higher education programs

b. Other factors utilized in reducing accidents

(1) Governmental services

(a) Programming to meet standards and reduce crashes

(b) Legislative action at all governmental levels

(c) Executive action at all governmental levels

(2) Post crash services

(a) Emergency medical care

(b) Transportation of injured

(c) Debris clean up and removal

(3) Fleet safety supervision

(a) Commercial fleets

(b) Private fleets

(c) Public fleets

PART II

NATURE AND CHARACTERISTICS OF MANAGEMENT SYSTEM

(Simply The State of The Art of systems without endorsement necessarily of any system)

I. Fundamental Management Goals

A. To manage means to manage with a purpose

B. First step toward enhancing highway safety management thus must be the quest for a common purpose

1. Discover what is socially desirable

2. Do not yield to only that which is technically feasible

3. Implementation of this step raises question about adequacy of our present methods for assessing public philosophy and opinions

C. Advanced analysis requirements

1. Management now has unprecedented means to illiminate possible unwanted consequences

2. Advance analysis capabilities now permit use to improve our technique before applying them

a. Minimizes need for subsequent costly or politically difficult correction measures

3. Depend on new form of planning capability

a. Purpose to examine long term consequences of management activities

b. Concern for quality of the environment

(1) Quality involves achievement of harmony among potentially conflicting uses

B. New approach

1. In order to attain benefits from highway safety technology we need fresh approach flowing from

   a. Concepts of use

   b. Relationships among institutions involved

   c. Legal principles

   d. Ideology

2. To aid this analysis a new model will be needed

   a. Model as used here is rhetorical device referring to the analytical tools necessary for dealing with highway safety management

   b. Over come barrier of compliance with minimal requirements of national standards

   c. Model would follow principles applicable to catholocity of highway safety system

   d. Questions that arise:

      (1) What intelligence should be portrayed in the model?

      (2) What is its ultimate purpose?

   e. Proposed rationale for model and enhancing management of highway safety technology

      (1) Technology is properly thought of as concerned with the means

      (2) Management of technology involves notion of ends as well as means

      (3) Concept of managing technology is a relatively new abstraction

         (a) Has taken hold due to technology being ineffectively managed by human institutions

(4) Control center for accident data

(a) Coordination of various agencies concerned

(b) Information storage and retrieval

II. Management of Highway Safety Technology

A. Historical approach

1. Society has increasingly failed to manage technology successfully

   a. Many problems of today are second or third order consequences of a technology adopted for a particular goal

   b. Although goal may have been met, its accomplishment has resulted in serious and unwanted effects that now require emergency correction

   c. More deliberate and accurate assessment of technological side effects could have headed off some of the costs we now face

2. Management of highway safety technology has been directed toward facilitating safe and speedy transit

   a. Design characteristics

   b. Traffic flow patterns

   c. Volume and speed

3. Did not sufficiently convey issues of

   a. Legal subdivisions

   b. Cultural aspects

   c. Economic development

   d. Wastemanagement (pollution)

   e. International character

      (1) National defense

      (2) International signing

      (3) Reciprocity

(b) Has inflicted damage on our environment

(c) Application of concept is tentative and untried

(4) Definition

(a) "Technology" is the complex process by which a technique is successfully applied to achieve a selected purpose

(b) In contemporary terms, techniques are based more on engineering research than on empirical experience or craftmanship

(5) To translate specialized knowledge into effective accomplishment, techniques must be afforded appropriate institutional vehicle

(a) Must have capacity for decision-making

(b) Must incorporate regard for risk

(c) Must provide means for raising capital

(d) Must mobilize specialized manpower

(e) Must articulate with both the public and other surrounding enterprises that affect it

(f) Must provide platform for leadership

(6) Institution must have capacity to cope with change and to innovate

(a) Ability to collect and analyze information

(b) Undertake "pre-crisis" as well as "post-crisis" studies

(c) Generate new knowledge

- perform necessary research to extend and refine techniques on which organ was initially founded

- may spawn subsidary programs with goals to extend knowledge

(7) Development of harmonous relationship among institutional components drawn from several familiar groupings

(a) National government

(b) State governments

(c) Local governments

(d) Public and private organizations

(e) Academic institutions

(8) Management of all components of highway safety technology

(a) Involves

- stimulation

- control

- administration

- coordination

- regulation

(b) Optimized so that the aggregate activity may best serve a particular purpose

THE IMPORTANCE OF THE SUPERINTENDENT

The entire educational program depends upon the leadership and support provided by the superintendent. It is recognized, therefore, that any curriculum study is but a part of a large picture. In this very fact there exists an obstacle to success.

Because the superintendent does have a great responsibility and must concern himself with a multitude of details, there is danger that he lose sight of the problems that teachers face in working with curriculum projects.

Follow-Through

Sometimes superintendents are instrumental in beginning programs for curriculum improvement, only to seem to lose interest after the project gets underway. Some superintendents see their role as prime movers, and forget there is a need for a follow-through.

If a superintendent wants worthwhile results from a study, he must be willing to offer his continuing support at all stages of the project. Such support may take the form of interpreting the proposed program to the Board of Education in order to obtain financial backing. It may mean helping to establish and clarify objectives or goals, occasionally meeting with the working committee to keep posted on developments, or simply writing a note of thanks to some staff member for a job well done.

Financial Support

Any program of curriculum development worthy of its name will undoubtedly entail additional expense to a school district. Even if the staff were to restrict its work to within the school with no outside help of any kind, there would still be added expense, probably in the form of needed materials or books. But, where a school system desires more than a minimal attempt at curriculum improvement, the administration must make plans long before the actual work gets underway.

Budget Items

A superintendent faced with the task of formulating his annual budget should give consideration to the following items, when planning a curricular improvement program in his school:

Funds for research or working materials based on an estimate of need for the study group and faculty. Examples: books, pamphlets, film rentals, tapes, and subscriptions.

Fees for membership in curriculum associations or councils.

Consultant fees.

Funds for any special equipment involved in anticipated experimentation. This might include, for example, standardized tests, special toys for kindergarten, specific kinds of maps.

Expenses for substitutes so that there may be a released-time policy for meetings and conference attendance.

Expenses for trips and conferences to be attended by the working committee. These would include travel, registration, and luncheon fees.

Cost of in-service institute days.

(c) Requires

- "early warning system" and corresponding discipline if newly generated technology is not to induce undesired side effects inadvertently, through narrow application

- Urgent to recognize this management precept

  . in present era of transition from time when man utilized technology to protect himself from environment

  . to one in which technology is needed to protect the environment from man and his technology

(9) Technology mangement goes beyond resource management

(a) In its concern

- for technique and tools

- for development of new materials

- with conservation of environment

(b) Concept requires systems approach

- takes into account interactions that occur in management process

- activity of various institutional groups involved in technological development

- all potential uses of system must be considered rather than only movement of people and goods

- motor vehicle "crash loss" factor
- waste disposal
- time loss factor
- space allocation factor

- harmony among uses is object of planning
  - sees that no single-purpose use unwittingly pre-empts options for future

II. Structure for Implementation (theory behind NHSB - as author sees it)

A. Steering mechanism with independent analytical facilities to aid in national decision-making

B. Analyses should be based upon, but not dependent upon, facts developed by federation of states and local governments

C. Minimize violence to present structure, limiting it to those changes necessary to achieve stated purpose

D. Thus, some national authority required to help in management of highway safety technology

1. Authority should function as planning and coordinating body

2. Develop cooperative effort from a wide variety of public and private enterprises to meets its objectives

3. Would have option of taking initiative to meet nationally agreed upon goals if randomonly initiated by users leave critical gaps

4. Authority is equipped to collect and disseminate information about highway traffic envirnoment

5. Should undertake long range studies of resource potential

6. Should make management analysis to predict consequences of projected uses

7. Would assess unmet needs and opportunities that cross jurisdictional lines of interstate organizations

8. Would recommend priorities for programs

9. Advocate development of new techniques necessary for optional use of highway transportation system

III. Types of Management Systems and/or Techniques (#13)

A. PERT -- Program Evaluation and Review Technique

1. Developed for nonstandard situations (not good as model)

2. Objectives of PERT cost

a. Aid development of realistic project estimate

b. Compare estimated and actual cost

c. Determine best allocation of resources to project activities

d. Forecast total project cost

3. Use of cost estimate

a. Start when work structure is formulated

b. Base upon program elements and work units

c. May be computed for individual activities

4. Application of cost estimate

a. Basic

b. Resource allocation

c. Time cost

5. Implementing PERT technique

a. Point of implementation

(1) Proposal development

(2) Program planning

b. Network processing

(1) Manual

(2) EDP - Electronic Data Processing

c. Reports

(1) Project outlook report

(2) Milestone report

(3) Analysis report

d. Project updating

(1) Normal interval updating

(2) Unique updating at intervals

e. Providing management support

(1) Published policy

(2) Personnel training

6. Operational considerations

a. Contractor requirements

b. Internal management requirements

c. Project nature

d. Project duration

e. Project complexity

B. PPBS -- Planning-Programming-Budget System (#47)

1. Philosophical base of structure is formed by single concept dealing with accountability

2. Eight mainstructure members

   a. Objectives

   b. Programs

   c. Program alternatives

   d. Outputs

   e. Progress measurements

   f. Inputs

   g. Alternative ways to do a given job

   h. Systems analysis

3. Basic concept: Accountability

   a. PPBS is multi-purpose system

   b. When implemented properly has a variety of uses

   c. Concept is that each agency is accountable to chief executive

      (1) Focuses attention of each agency on question of what is our role

      (2) Provides a basis for particularizing answers to the questions:

         (a) Accountable for what product?

         (b) Delivered to whom?

d. Explicit business of each agency is to satisfy the public's actual and potential market demands for the agency's particular product/service lines

e. Accountability discharge becomes subject to evaluation in terms of each agency's success in:

(1) gauging the nature and proportions of market demands

(2) fulfilling these demands

4. Apex-term of PPBS structure is "objectives"

a. Each agency is supposed to generate explicit market objectives

(1) To make possible an agency wide understanding

(2) To permit a common agency approach toward their achievement

b. Customer-oriented market objectives are destined to become key standards for agency self-appraisal and accountability

5. Idea of the term "program"

a. A package which encompasses each and every one of the agency's efforts to achieve a particular objective or set of allied objectives

b. Individual activities, functions, and professional disciplines are the antithesis of programs in PPBS sense

c. Idea is to facilitate:

(1) The drawing together

(2) The summation of all agency efforts to meet particular objectives

(3) So as to validate each program and assess in terms of:

(a) overall approach

(b) dimension

(c) costs

(4) Compare with other programs

d. There is strong conceptual relationship between objectives and program

(1) In PPBS language there are no objectives recognized except those which suggest a program designed specifically to fulfill them

(2) There can be no recognized program unless it is designed to accomplish explicit objectives

6. Program alternatives

a. Other possible programs besides those already decided upon

b. Suggests a comparison of two or more possible program approaches

7. Output

a. Idea is inseparably linked to idea of objectives and programs

b. Service produced must satisfy

(1) An explicit market objective

(2) Must be an indicator of program results

8. Progress measurement

a. Program fulfillment must imply that two conditions have occurred

(1) The output which has been planned has materialized

(2) The output distribution which had been intended has been completed

b. Progress then must imply one of two questions:

(1) Either, how closely does the production progress match planned progress?

(2) Or, how well is the output distribution proceeding as compared with the distribution plan?

9. Input

a. PPBS definition close to the traditional use of term

b. The total quantity of manpower, facilities, equipment, and materials applied to program, expressed in either units or dollars, is the program input

10. Alternative ways to do a given job

a. Input related concept

b. The "given job" notion means output has already been decided upon

c. Question is can we alter production and by doing so improve either:

(1) The timing of the production, or

(2) The quantity or quality of the item, or

(3) The unit or total cost of the production

11. Systems analysis

a. Is not the same as PPBS

(1) PPBS consists of premises, concepts and relationships

(2) System analysis consists of techniques attached to a way of approaching problems

b. It is application of benefit-cost analytical techniques to several areas of PPBS anatomy

C. PMMS -- Peat, Marwick, Mitchel Structure for Management and Reporting System (#24)

1. The highway safety program structure

a. Structure development

(1) Physical components classification

(2) Program phases classification

(3) Program elements

(4) Program sub-elements

(5) Program tasks

THE BUILDING PRINCIPAL'S ROLE

He realizes his own importance and his limitations.

He is aware that except for the classroom teacher no one has more direct influence upon curriculum improvement than the principal. Usually what he encourages takes place, what he neglects does not. Teachers cannot perform in the face of administrative indifference. At the same time, the principal knows he is not an expert in everything, and welcomes outside help in working with his staff.

He sets the tone concerning change.

He can accept innovation. He is not a "Don't rock the boat" man. He tries to see, moreover, that all those concerned with change are consulted about it. He helps the staff see the need for change, and to change. He contributes new ideas.

He supports the study committee.

Whether he is a member of the committee or not, he keeps informed on its progress. He helps interpret the committee's work to the faculty. He cooperates in attempting to provide materials, secretarial help, and released time for the committee. He recognizes and commends good work. He follows through.

He cooperates with other administrative and supervisory personnel.

He accepts other status staff members, whether from the superintendent's office, the county office or his own office, as partners in the program. He interprets his school and faculty to the other status personnel.

THE INTERMEDIATE ADMINISTRATOR

(The intermediate administrator is the title we have given to assistant superintendents, curriculum coordinators, county helping teachers, school vice-principals, supervisors, subject-matter specialists, department heads, or those of other titles who have status in between an institution head and the classroom teacher.)

He recognizes that his role may be misunderstood.

Some may not understand his job, or be in accord with his appointment to it. Some may resent him because his job represents authority;others because it may represent change which is threatening to them.

He asks the superintendent for a clarification of his role.

He wants to know what his job is, and what is expected to happen.

He recognizes his own importance and limitations.

He knows he has strengths which the committee may call for--in human relations, curriculum planning, administration, or in a particular subject area, as the case may be. He also knows his limitations, that he can't dictate particular policies to the committee, and that "keeping the peace" with other status personnel may prove difficult.

(c) Preparing objectives statement

(d) Identifying measurement parameters

- volume measures
- coverage measures
- effectiveness measures

(e) Selection of tasks and milestones

- types and sequence of tasks
- milestones
- schedule considerations
- task interrelationships

(f) Scheduling tasks and projecting measures

(g) Estimating and distributing costs

(h) Completing sub-element plan

e. Submission of annual work plan

(1) Reconciling SEP to total funding limitation

(2) Other forms to be submitted

(a) Program standards summary

(b) Objectives and priorities narrative

(c) Program-to-date-narrative

(d) Grant agreement

(3) Summary of AWP preparation process

D. CESEC -- Cost/Effectiveness System for Evaluation Counter Measures, by Operations Research Corp. (#19)

1. Need for cost/effectiveness evaluation

   a. Which corrective activities are most effective?

   b. At what level should each activity, ranked by importance, be undertaken?

   c. To resolve these issues, decision-makers must be able to formulate and evaluate alternative counter measure programs

2. The CESEC is a quantitative evaluation total and will improve the management of the entire safety program by:

   a. The existance of a formulized system will ensure that the developing state systems of analysis are properly directed and are compatable with the NHSB system

   b. The results of quantitative evaluation will be available at a level of detail most useful to the decision-makers.

   c. The flexibility of the system provides an extensive range of explorable "trade-offs."

3. Preferred program structure

   a. Synthesis of other alternative structures

   b. The major program categories recommended

      (1) Crash prevention

      (2) Damage amerlioration

(3) System restoration

(4) General support

(5) Research and development

E. ASF -- Highway Safety Program Management, 1968 (#16)

1. Use of Ideal Model to portray quality organization and management of highway safety programs

2. The "East Dakota" model

a. Organization of model program

b. Structure of model program

c. Manager outlines his duties

d. Sets forth role of committees in highway safety

(1) Proper use of committees

(2) When not to use committees

(3) Rules for overcoming disadvantages of committees

e. Operational procedures

(1) Secure statement of program's policy boundaries

(2) Gather facts

(3) Develop project proposals

(4) Assemble total program and establish priorities

(5) Implement program

(6) Report results

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(7) Start again with step one

f. Measurement

(1) Application of measuring instruments

(2) Measurement requirements

(a) Indepth factual data on all elements

(b) "Yardsticks" for evaluating this data

(3) Several ways to implement measurement process:

(a) Working cooperatively with agencies

(b) Coordinating efforts through other agencies

(c) Form staff of specialists to carry out necessary duties

(d) Use of outside consultants to evaluate performance

g. Priority programming

(1) Determine total dollars available

(2) State-local division of funds

(3) Allocation between functions

(4) Select projects

(5) Test program against objectives

(6) Develop implementation schedule

F. HTSC -- Highway Traffic Safety Center, MSU, Model

1. Various systems have been developed by both public and private sector in an attempt to improve management of highway safety programs. This encompasses both organizational, administrative, and operational considerations.

2. The focus has in fact been on subsystems; thus, resulting in suboptimization entrapment and seriously limiting proper focus on the larger system, i.e., Highway Traffic Safety. The emphasis on the development of a "crash system" has resulted in a subsystem being given the treatment of a total system. Attempts are made to crowd all information and analyses from the total highway traffic system into the one subsystem or "crash involvement." The ultimate users of the system (Governor's representatives, etc.) then become frustrated when trying to implement noncompatable items, activities, or relationships.

3. There is a need, therefore, to design and develop other subsystems and build them into a comprehensive highway traffic safety system. The concepts on this system are:

   a. Collision control system

   b. Congestion control system

   c. Public services system

   d. Management system

4. This would supply information on needs and resources, provide techniques for predicting consequences of alternative programs, and provide control of the operational status of selected programs.

IV. Program Dimensions

A. Time

Time dimension consists basically of those aspects of a project relating to the time that each work element is expected to consume plus the total time for finalization of the project.

B. Cost

The cost dimension involves allocation of resources

C. Performance

The performance dimension refers essentially to levels of quality stated as end objective specifications.

V. Concepts of Program Structures

A. Display of major program and activity alternatives among which the department can choose to achieve its objectives.

B. Plays crucial role in identification, development, analysis, and choice of viable alternatives for pursuing objectives.

C. Because program structure provides the focus for analysis and decisions regarding alternative courses of action, it can significantly influence the evolution of a systematic plan to achieve departmental objectives.

D. Since effective management systems are evolutionary rather than a revolutionary process, there is no simple "correct" program structure for the government or a department.

E. Thus, a number of possible program structures exist at any point in time which change both in substance and appropriateness over time as the issues of concern to departmental managers change.

VI. Guidelines for Developing a Program Structure

A. Objectives orientation

D. Usefulness for management and control

1. If program structure is to serve as a management and control device, it must be capable of performing following functions:

   a. Facilitate current activity allocation

   b. Promote activity management

   c. Inter-relate the program and the accounting structure

2. Meaningful program structures will almost never correspond to organizational structures

VII. Project Management

A. Classic principles of organization

1. Nature of principles

   a. Unity of command

   b. Span of control

   c. Hierarchy

2. Validity as criteria for organizational design

   a. Method is obsolete

   b. Regidities encumber modern organization

      (1) Need to be adaptive

      (2) Need capacity for rapid response to rapidly changing environments, problems, and objectives

      (3) Capacity is optimized by organization

(2) Manager participates in and is responsible for development and operation of project through

(a) Planning

(b) Organizing

(c) Directing

(d) Controlling

c. Team is made up of people taken from several departments in the organization

(1) Members look to their parent departments for their continuing organizational identifications

(2) Results in many conflicts of interest

3. Problems associated with work-team forms of organization

a. Employees who want their work laid out for them precisely and who feel insecure without established procedures may find the work situation intolerable.

b. Shifting people from project to project may disrupt the training of new employees and impede the growth and maturation of specialists.

c. In the event of disagreement with department heads over the use of employees, the project manager must go to their common supervisor.

d. The project manager must act as a buffer between the frequent conflicting needs of his specialists and top management, without having the stabilized base of operation of the department heads.

e. The work-team approach is ineffective when the task at hand requires the coordinated efforts of numerous organizational elements and the coordinated efforts of numerous people.

4. Work-team approach to project management is not a panacea

a. Most effective when:

(1) Organization is large with diversified service

(2) Numbers of individual skill categories to produce a given service is large

(3) Large number of professionals are expected to exercise considerable discretion

b. A major disadvantage relates to effect of team approach on the informal organization

(1) Transitory status of members mitigates against development of enduring interpersonal relationships

(2) Can be counteracted by dedication to challenge of new assignment

THE LOCAL CHAIRMAN'S ROLE

He understands his task as committee leader.

He finds out from his superintendent or principal what is expected of him. He has a talk with the consultant to help clarify roles. He realizes he has a real responsibility to get something done. He analyzes his own strengths and limitations, including his own place in the school's power structure. He recognizes the importance of the involvement of teachers in planning.

He helps the committee to grow.

With the help of the consultant he gets his committee to identify the school district's own problems. With the help of the consultant he involves the teachers in a definite project. He gets to know the committee members and helps each to take on an appropriate portion of the total task. He leads them to discover their own needs, and their own talents. He makes suggestions, and welcomes ideas from others.

He does a communications job.

He maintains continual liaison among superintendent, principal, intermediate administrator, consultant, committee, and faculty. He arranges for consultant to have a chance to talk and work with committee members individually. He sends out notices of meetings and distributes materials ahead of time. He asks the committee to study and review its own procedures, and read materials on group process such as this Handbook.

He briefs administrators on committee progress.

He develops close understanding with the superintendent, who must fully grasp the committee's goals and progress in order to support the committee. He keeps in close touch with the building principal and intermediate administrator, who directly affect the conditions under which the committee works, as well as the prospects for real application of committee recommendations.

He does his homework.

He prepares an agenda for each committee meeting, even though he will not adhere to it rigidly. He keeps a file of everything pertinent to the committee. He sees that summaries are made of every meeting, duplicated, and distributed to all concerned. He expects his committee members to do their homework.

He understands the nature of change.

He personally feels comfortable with change and innovation. He is prepared, however, for some resistance to his committee's work. He knows that desirable and lasting change often comes slowly.

He follows through.

He does his best to see that agreed-upon tasks are completed on time. He reminds the superintendent or principal of previous commitments such as released time for his committee members.

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PART III

ELEMENTS OF HIGHWAY SAFETY PROGRAM

I. Key Events in the development of Highway Safety Prior to 1966

   A. First National Conference on Highway Safety (1924)

   B. Activity during the 1930's: the three E's

   C. White House Conference on Highway Safety (1946). Action program adopted

   D. Robert's Committee Held extensive hearings between 1958 & 1962.

   E. Ribicoff hearings of 1965

II. Federal Legislation of 1966

   A. Created a Department of Transportation which includes a National Highway Safety Bureau

   B. Passed a Motor Vehicle Safety Act

   C. Passed a Highway Safety Act

III. Standards as a prerequisite for control

   A. Primary factor for efficient control is accurate and up-to-date standards.

   B. Proper standards give management a workable yard-stick by which adverse variances may be detected.

   C. Origin of Standards

      1. Stems from managerial function of planning

      2. Goals are set and limitations or restrictions are identified.

      3. Standards then established in relation to these factors

D. Two basic but different catagories of standards

1. Independent standards

a. Not affected by variables

b. Value of standard is constant. Not affected by fluctuations in level of activity

2. Dependent standards

a. Affected by change

b. Have a positive or negative correlation to change in activity level

E. Standards enable management to:

1. Measure and evaluate the progress at periodic levels of activity.

2. Determine if the factor in question is above or below normal for a given level of activity.

F. In establishing standards following factors are considered:

1. Determination of what is the normal usage of x resources per given level of activity

2. What variables affect the standard as the level of activity fluctuates.

IV. Elements of the Highway Safety Program as Structured by the NHSB: History, Assumptions, Current Practices, Review of Effectiveness

A. Functional Elements

1. Periodic motor vehicle inspection

2. Motor vehicle registration and titling

3. Driver and Safety Education

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1. Program category designations should focus attention on activity objectives, rather than organizational position or resource composition.

2. Research activities are designated a separate program category because outputs do not lend themselves to quantification.

3. Same principle set forth above (2) applies to a general support category which involves joint-product, joint-cost items that cannot be assigned to other categories.

B. Trade-off orientation

1. Substitution

When two activities are directed to the same end, they are substitutes for one another, although the means,method or form by which they achieve that purpose differ.

2. Complementary

Activities grouped for analytical purposes because their close positive interdependencies mean that a change in the output of one will lead to a predictable change in the output of the other.

C. Unambiguous quantification of benefits and costs

1. First attribute that characterizes progress categories is that the benefit and costs associated with each category should be measureable in units that correspond to the arguments of the objectives.

2. Second attribute is that the program categories must be sufficiently distinct that benefits and costs generated by subordinate activities can be uniquely assigned.

(a) On a fluid work-team basis

(b) With project oriented teams:

- formed
- changed
- disbanded
- formed anew as work requires

B. Nature of work-team concept

1. Work-team design has existed in some form for some time

a. Project management

b. Product management

c. Program management

d. Task forces

e. Matrix management

2. Experience with work-team organization

a. Forerunners of the project manager

(1) Project expeditor: -- staff position concerned primarily with maintaining work schedules and removing work barriers

(2) Project coordinator: -- more formal role in organization, concerned with synchronization of activities directed toward specific objectives

b. Evolvement of project manager

(1) Due to work projects obtaining greater autonomy

4. Driver Licensing and Driver Improvement

5. Traffic codes and laws

6. Traffic courts (prosecution, adjudication, penalization)

7. Identification and surveillance of accident locations

8. Traffic records

9. Emergency medical services

10. Highway design, construction, and maintenance

11. Traffic control devices

12. Police traffic services

13. Accident cleanup

14. Accident investigation

B. Special Highway Safety Problems

1. Motorcycle safety

2. Pedestrian safety

3. Alcohol and Highway Safety

C. Services that support above elements

1. Public information and support

2. Highway safety research

3. Manpower development and training

V. Conceptualization of Highway Safety Programs

A. Highway Safety Program Areas

1. Education

2. Enforcement

3. Engineering

4. Legal

5. Service

6. Administration

B. Suggested Highway Safety Program Sub-Elements

1. General Traffic Safety Education

2. High School Student Driver Education

3. Adult Driver Education

4. Driver Improvement Education

5. Higher Education

6. Commercial Vehicle Operators Training

7. Trade School Driver Training (Commercial Vehicle)

8. Private School Driver Training

9. Traffic Law Enforcement

10. Alcohol and Drug Enforcement

11. Accident reporting and investigation

12. Traffic regulation and control

13. Motor vehicle inspection

14. Motor vehicle registration

15. Driver licensing

16. Conducting engineering surveys

17. Engineering design
18. Highway Construction
19. Highway Maintenance
20. Inspection of highways
21. Traffic law adjudication
22. Local codes and ordinances
23. State legislation
24. Accident Service
25. Aid to motorists
26. Public information
27. Non-governmental support
28. Bus transportation and safety
29. Research and Development

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PART IV

HIGHWAY TRAFFIC SAFETY MANAGEMENT

I. Nature and Purpose of Management

A. Definition of management

1. Desmond L. Cook (#13)

a. The art and science of planning, organizing, motivating and controlling human and material resources and their interaction in order to attain a predetermined objective.

b. According to Cook, management is broader than administration.

(1) Management focuses on process of decision making which is considered to be one of tasks of management.

(2) Administration focuses on implementation of policy and provision of administrative support to research programs.

c. Under this concept managers have line responsibilities while administrators have staff responsibilities.

2. Peter F. Drucker (#2)

a. Management is the specific organ of the business enterprise.

b. Management has partial rather than comprehensive social responsibility, hence partial rather than comprehensive social authority.

c. Management is a multi-purpose organ that manages workers and work.

d. Management is a rational activity.

(1) Means that organization must set objectives that express what is desirable of attainment.

(2) Rather than aim at accomodation of the possible.

3. Glenn Bassett (# 41)

a. Management involves at its core the ability to allocate resources of variable scarcity/ abundance in satisfying to the full needs of the organization, its clientele, its employees, and society as a whole.

4. Center for Safety Education, N. Y. Univ.

a. Traffic safety management is the application of sound management principles and practices to unified official programming for improved traffic movement and safety at national, state, and metropolitan levels. . . means of achieving the maximum results from coordinated planning and programming.

B. Purpose of management

1. To identify alternative forms of actions for making and implementing decisions in highway safety management.

II. Components of Highway Safety Management

A. General component groupings

1. POSDCORB (Acronym developed by Fayol)

a. Traditional grouping

b. Acronym coined in 1930 by Henry Fayol in his INDUSTRIAL AND GENERAL ADMINISTRATION.

c. Grouping consists of:

(1) Planning -- working out in broad outline the things that need to be done and the methods for doing them in order to accomplish the purpose set for the enterprise.

(2) Organizing -- establishment of the formal structure of authority through which work subdivisions are arranged, defined and coordinated.

(3) Staffing -- includes the whole personnel function of recruiting and training staff, and studying and improving working conditions.

(4) Directing -- consists of the continuous task of making decisions, embodying them in specific and general orders and instructions, and serving as the leader of the enterprise.

(5) Coordinating -- the all important duty of interrelating the various parts of the work.

(6) Reporting -- involves keeping those to whom the executive is responsible informed as to what is happening. This includes keeping himself and his subordinates informed through records, research, and inspection.

(7) Budgeting -- includes formulating the budget and performing fiscal planning, accounting and control.

2. POMC (Acronym developed by Department of Defense)

a. Component grouping currently recommended by federal government.

b. Grouping consists of:

(1) Planning

(2) Organizing

(3) Motivating

(4) Control

THE COMMITTEE MEMBER'S ROLE

He sees the need for curriculum improvement.

He knows that curriculum must change as society's needs change. He considers new ideas as challenges. He does not look upon suggestions for change as a reflection on his past performance.

He attempts to work as a group member.

He tries to understand the committee's purposes, and works to develop a "we" spirit among the group. He thinks before he speaks, and tries to put himself in the other fellow's shoes. He believes that the wisdom of the group is likely to be greater than that of any one of its members, but he is not afraid to make suggestions.

He tries to think impersonally and not defensively.

When he proposes an idea, he explains it but is not defensive about it. He is not hurt if the idea is torn apart or dropped; he treats his own ideas as he would anyone else's. He can accept advice from others, and invites the consultant to visit his classroom to observe experimentation.

He does his homework.

He realizes committee work should be divided up, and does his share. He gives of his own time, and expects the administrator also to allow him some time for committee business.

He acts as a missionary.

Without overdoing it, he interprets the committee's work to others among the faculty.

THE ROLE OF THE FACULTY MEMBER NOT ON A COMMITTEE

He can accept change.

He sees the need for the school to do something about curriculum revision. He does not consider change as a personal threat.

He recognizes individual differences.

He sees individual differences not only among students, but among teachers and administrators. He accepts himself, his fellow teachers, and his administrators as individuals who will each react to curriculum change in his own way.

He supports the efforts of a study committee.

He becomes acquainted with the needs of the total school system, not merely of his own level or department. He will listen to a study committee's report, make constructive suggestions, and be willing to put into effect adopted changes.

c. A management model utilizing this grouping is set forth in Figures 1 & 2.

B. Primary components of highway safety management

1. Planning
2. Organizing
3. Motivating
4. Coordinating
5. Funding
6. Evaluation

C. Other components in highway safety management

1. Budgeting
2. Cooperation
3. Staffing
4. Communication
5. Reporting
6. Policy formulation
7. Fact finding
8. Records
9. Training
10. Procedures development
11. Procurement of facilities and supplies
12. Research and development
13. Office administration

Figure 1

MODEL OF MANAGEMENT* PRACTICE

Plan

1. Forecast
2. Establish conditions and assumptions.
3. Establish objectives.
4. Anticipate possible future problems.
5. Establish policies.
6. Establish a program of accomplishment.
7. Plan standards and methods of measuring accomplishment.
8. Revise and adjust the plan in light of control results and changing conditions.
9. Coordinate ≠ throughout the planning process.

Organize

1. Identify and define work to be performed.
2. Break work down into operative duties.
3. Establish an ideal organizational concept.
4. Group operative duties into operative positions.
5. Group operative positions into manageable and properly related units.
6. Define position requirements.
7. Provide personnel facilities and other resources.
8. Revise and adjust the organization in light of control results.
9. Coordinate ≠ throughout the organizing process.

Motivate

1. Communicate and explain objectives and goals to subordinates.
2. Assign work to be performed, accountability, and extent of authority.
3. Assign performance standards.
4. Coach and guide subordinates to meet performance standards.
5. Train and develop subordinates to realize full potential.
6. Provide a motivating environment by communicating the changing situation and its requirements.
7. Praise and censure fairly.
8. Reward subordinates based on performance.
9. Revise and adjust the work of motivation in light of control results.
10. Coordinate ≠ throughout the motivating process.

Control

1. Review operations.
2. Compare results against goals (sub-objectives).
3. Appraise results against performance standards and policies.
4. Determine reasons for exceptions.
5. Record.
6. Revise and adjust control methods in light of control results.
7. Coordinate ≠ throughout the control process.

* Management is the vocation of achieving desired results through other people.

≠ Coordination is the consideration of relationships and/or utilization of activities outside a chain of command.

Source: R. J. House and J. M. McIntyre, "Management Theory in Practice," Advanced Management, October, 1961, (reprint, 8 pages).

III. Processes of Highway Safety Management

A. Decision-making

1. Definition

Decision-making is the process by which individuals and/or groups of individuals attempt to adjust their ideas and actions to outside factors which are believed likely to have influence on them. It may involve a personal action or an organizational one. It may be important or relatively consequential.

2. Complexity of the multitude of factors and forces operating in formation and implementation of decisions

3. Factors affecting decision-making

4. Analysis of the Process

a. Rather than looking to given standards of value and behavior, the new executive will be forced to rely on his self-created norms and interests in coping with change.

b. Action

(1) That aspect of decision making which a manager can most readily grasp

(2) Men of action have long been our acknowledged leaders

(3) Freedom is the indispensable condition to action

c. Choice

(1) All leaders know the anguish of choice

(2) The nature of choice

(a) Optimism -- Even in times of uncertainty, our choices are the best that seem possible. When goals beckon clearly, a person is most enterprising and resourceful.

(b) Open mindedness -- A manager must be prepared to alter his choices as he receives fresh information

(c) Empathy -- On the basis of subjective feelings of making choices, we also impute choices of others

(d) Alters personality of chooser

(e) Choices must be made among different ways to deal with limitations or barriers

(3) Awareness of freedom of choice

(a) Managers would engage in more creative acts if they were more aware of their elemental intent

(b) Laziness and pasivity cause a person to submerge freedom to choose in the unconscious

(c) This leads to a person becoming too secure, bored, and losing a sense of action

(d) This develops a habit of limited perception

(4) Code compliance

(a) Most pronounced in hierarchial organization where code seems to require different behavior for

(b) Manifested in a tenacious attachment to the system

(c) Concepts of cooperation and feasibility are invoked repeatedly to stifle deviant action

d. Objectivity

(1) Choice imposes on its practitioners a sense of objectivity

(a) An exact appreciation of where-I-am-now and how-I-am-to-get-there

(b) This requires a certain discipline in viewing one's impulses

(2) For the individual, objectivity means an understanding of the consequences of one's behavior

(3) For the organization, objectivity means a critical examination of the values and processes which have been created and maintained in its environment

(4) The enemy to true reality is ultrapracticality

(a) Managerial class has long given its homage to pragmatism

- method of prior formulation

- recurrent testing

- optimal decision making

(b) Such scientism is inevitably impersonal because models formulated for testing cannot encompass the complexities of people problems

(c) Hence, organizations tend to lose their rapport with people, i.e., their objectivity

(d) Thus, decision making is delegated to experts who frequently make the wrong choices

- expert's refuge and security is in rationalism

- when threatened by chaotic situation, he defines his terms, states his assumptions, applies his rigorous logic, and sticks by his conclusions by aloof superiority and catastrophic failure

(5) Following established rules may result in bizarre irrationalities because it suppresses recognition of nonroutine problems

(a) It is irrational to believe that administrators can conduct their affairs in same manner as scientists conduct research

(b) Because of its multidimensionality, there are few managers capable of considering the relationship and rationality of an organization's entire purpose pattern

(c) No matter what elements they may be concerned with, most managers develop a personal style of comparative weighting among desirability, feasibility, and consistancy

(6) Choice requires the manager to take risks which is endowed by a sense of commitment

e. Authenticity

(1) Primary quality of choice

(2) Involves behaving the way you are, instead of posing in a role

(3) Involves getting rid of irrelevant emotional garbage which is usually associated with the past

(4) It means honesty with one's self and directness with others

(5) It means telling it like it is

(6) An organization, like an individual is authentic to the extent that:

(a) Through its leadership it accepts its finitude, uncertainty, and contingency

(b) It realizes its capacity for responsibility and choice

(c) It acknowledges guilt and errors

(d) It fulfills its creative managerial potential for flexible formulation

(e) It responsibly participates in wider community

5. Developing your personal decision-making process

a. Organizational objectives

b. Organizations dynamics

c. Role of the individual

d. Problem areas

e. Improving human relations skills

f. Improving relationships

g. Relating decision-making to action

h. Defining organization's communications

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6. How decisions are influenced

   a. Typical patterns

   b. Various forces

7. Processes for insuring correct decisions

   a. Planning

   b. Review

   c. Research

B. How to improve desision-making process

1. Understand objectives

2. Know what is going on

3. Understand role of individual

4. Identify problem areas

5. Improve problem solving skills

6. Strengthen communications

7. Clarify relationship between decision and action

8. Improve operational relationships.

C. Planning Process

1. Definition of terms.

   a. A plan is:

      (1) a method or scheme of action

      (2) a decision made in advance of what is to be done

Figure 2

CLASSICAL MANAGEMENT THEORY IN PRACTICE*

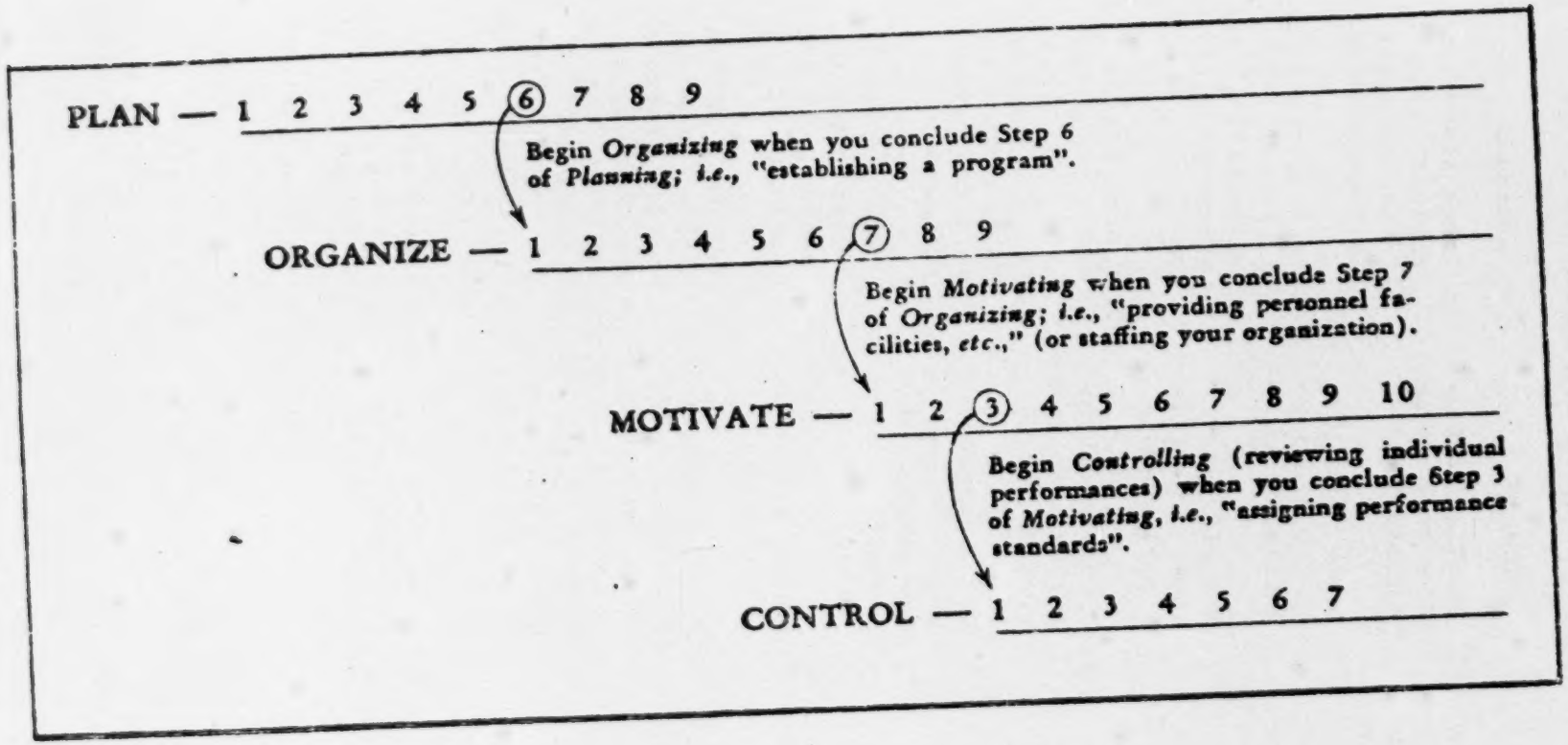

*Source: R. J. House and J. M. McIntyre, "Management Theory in Practice," Advanced Management, October, 1961, (reprint, 8 pages).

b. Planning

(1) is the working out in broad outline of the things that need to be done and the method for doing them in order to accomplish the purpose set for the enterprise.

(2) involves a forecasting of the future problem and a scheme for meeting it.

(3) involves intellectual processes -- thinking before acting, and acting in light of the facts in an orderly way.

(4) involves the critical and exhaustive investigation or experimentation aimed at revising accepted conclusions in the light of newly discovered facts.

(5) involves a research attitude which requires that every statement, every principle, every pronouncement by oneself or by another be examined from two points of view.

2. General principles

a. Effective performance necessitates planning

b. Must organize to collect needed information to permit realistic planning and effective implementation

c. Create mechanism to collect and evaluate traffic safety related information

d. Conduct programs based on specific action plans

e. Locals should be involved in planning process of specific plans

THE CONSULTANT'S ROLE

He sets a tone.

He helps everyone clarify roles and uncover objectives. To do this, he must know his field, and know how changes take place in people.

He develops skill in listening.

He encourages group members to talk and react, and listens to each carefully. He is thus better able to discern problems and attitudes, and to be able to put himself in the other fellow's place.

He is a resource person.

He gives counsel to the local study committee. He helps them identify problems. He is not expected to know all the answers, but can advise and suggest alternate approaches. He locates reference materials for the group. He calls attention to new ideas. He talks to the faculty at the request of the local chairman. He visits classrooms to observe experimentation when this is helpful. He brings to the committee special knowledge and understanding. He acts as a sounding board for the ideas of others. He is willing to demonstrate procedures he advocates.

He works closely with the local chairman and other leaders.

He remembers that the whole thing is a team approach. He is particularly careful to become well acquainted with the superintendent, principal, and any intermediate administrators. He and they must clearly understand his role as consultant.

He does his homework.

Early in the process he learns a great deal about the district and its problems. If the committee needs certain information or background material, he finds it without delay. He anticipates the committee's needs whenever possible, and has information ready. He keeps in touch regularly with the area study council office.

He helps with evaluation and pushes for conclusions.

He acts as a sounding board for ideas. He helps the group to grow, and then to see how much they have grown. He helps the local group decide on recommendations and conclusions from its study and experimentation. He helps to draw the project to a close in reasonable time.

He adapts his role to the situation.

If things are not going well, or if a project seems to be floundering, he does something about it. For a time, he may have to take a more forceful role in direct leadership. While avoiding authoritarianism, he knows that sometimes he must become directive.

He has a professional dedication to his job as consultant.

He feels a responsibility to do the job well. He is willing to do more than his share of work to see the completion of the task at hand. He is concerned with upholding his own reputation and that of his college and/or council.

f. Professionals formulate plans but selected officials are responsible for implementation.

g. Plans should be in conformance with those of the adjacent jurisdictions to the greatest extent possible.

h. Areawide planning is more comprehensive and thus more efficient than fragmented planning.

3. Extent of planning

a. Trend appears to formalize planning with a special unit as size of operation increases.

b. This function is specialized when it exceeds the capacity of any single manager.

4. Importance of planning

a. Primary requisite to managerial functions of organizing, staffing, directing, and controlling.

b. Planning is unique in that it establishes the objectives necessary for group effort.

c. Primary function which manager must do before he can intelligently perform any of other managerial functions.

d. Plans provide basis for economical operation.

e. Good planning results in sounder decision-making at all levels.

f. Plans supply and emphasize the factor of adjustment among multiple interests, programs, ideas, specialties and pressures.

g. Plans give meaning and direction to action.

h. More efficient and more effective programs can only be developed as highway safety managers develop means of identifying and measuring underlying causes of highway traffic problems and then discover or create appropriate techniques to reduce these problems.

5. General Nature of Planning Process

a. Developing projects for getting things done.

b. Formulation and implementation of proposals based on facts.

c. Assists managers in discharging their responsibilities.

d. Charting of a predetermined course of action

e. Implies a wide consensus of opinion

(1) Steps to be taken

(2) Awareness of common problems

(3) Awareness of overall objectives

f. Perception of what exists today

(1) Available community resources

(2) Appraisal of needs and deficiences

(a) Financial

(b) Physical

(c) Manpower

g. Projection of long term trends in community development

(1) Rate of urbanization

(2) Public transportation facilities

(3) Population growth

(4) Highway construction

(5) Car sales

h. Serves four basic functions

(1) Identifies highway safety problems

(2) Provides factual information needed for administrative program

(3) Provides technical and financial information needed to implement highway safety resources

(4) Serves to stimulate further change

6. Process of Highway Safety Planning

a. Formulating objectives

(1) NHSB performance standards offer set of minimum guidelines

(2) Must have sound policy for

(a) Decision making

(b) Resource allocation

(c) Policy development

(3) Correlate program goals and resources available to accomplishment of objectives

b. Data collection

(1) Conduct detailed inventory

(a) Necessary to discover and eliminate deficiencies

(b) Needed to establish program priorities

(c) Needed to project cost estimates

(2) Functional inventory useful technique

(a) Focuses on safety activity

(b) Once facts are accumulated it facilitates evaluation

(3) Search of law and legal authority

(a) Laws creating and regulating agency

(b) Laws affecting behavior

(c) Collate traffic law with UVC

(d) Compare state's model ordinances and local code

(4) Develop fact gathering guide

(5) Conduct surveys

(6) Sources of information

(a) Accident records and reports

- Key to information system
- Basic tool for management
- Core of planning activity
- Must be based on facts

(b) Community disaster plans

- Contingency plans
  - . Based on local features of environment
  - . Geared to probable danger areas
  - . Take into account factors of:
    - Traffic volume patterns

- Location of hospitals
- Other emergency installations

c. Identification of problems and needs

(1) In light of local condition

(2) In terms of current technology

(3) In terms of the national standards

(4) In terms of available resources

(5) Identification techniques

(a) Formulation of accident review committee

(b) Other methods

d. Developing plan

(1) Should provide complete strategy to be followed in reaching objectives

(a) Citing specific responsibilities of each component of organizations staff

(b) Describe functions of specific anchillary groups and private organizations concerned

(c) Set forth time schedule of priorities

(2) Spirit of cooperation is essential to process

(3) Priority consideration a basic factor in plan development

e. Plan implementation

(1) Plans are implemented when they become

(a) Official policy

- Adopted by local legislatures and executes those various kinds of legal procedures

  . Administrative rulings

  . Policy statement

  . Legislative enactments

  . Ordinances

(b) Operational

- Elected officials responsible for putting plans into action

f. Plan evaluation

(1) Competent evaluation will facilitate plan modification

(2) Evaluation procedures should determine

(a) How far has plan progressed towards stated objectives, within time frame given

(b) What improvements are needed to make plan more effective

(c) What program needs can be anticipated during next evaluation period

(3) Adoption of conceptual yardstick or standard

(a) Equate performance to cost

(b) Calculate and compare various returns on investment

- Outline various program objectives that can be acheived by:

  . Alternate means

  . For the same cost

g. Updating plan to improve its effectiveness

7. Anatomy of planning

a. Activities of planning

(1) Forecasting

(2) Establishing objectives

(3) Programming

(4) Scheduling

(5) Budgeting

(6) Establishing procedures

(7) Developing policies

b. Characteristics of plans

(1) Good plan is based on clearly defined dimensions and objectives.

(2) It is as clear and simple as subject matter will permit.

(3) It has stability while providing for flexibility.

(4) It outlines standards of operation and clearly provides for them.

(5) It is economical in terms of resources needed for its implementation.

(6) It meets a real need and anticipates the future.

(7) Plans should be made in terms of total situation.

(8) Plans should provide for continuous review and evaluation.

c. Types of administrative plans

(1) Figure 3 depicts types of plans

(2) Figure 4 sets forth key questions to guide the extent of planning.

d. The planning process: - Suggested steps or units as a comprehensive guide.

(1) Need determination

(2) Objective

(3) Preparing proposal

(4) Obtaining approval proposal

(5) Organizing for planning

(6) Determining specific outline of plan

(7) Establishing contact with cooperating groups

(8) Obtaining necessary data

(9) Evaluating the data

(10) Formulating tentative conclusions and preparing tentative plans

(11) Testing components of tentative plans and making adjustments

(12) Preparing the final plan

(13) Testing plan

(14) Obtaining approval of plan

Figure 3

TYPES OF ADMINISTRATIVE PLANS*

Scope	Goals	COURSES OF ACTION	
		Single-Use Plans	Standing Plans
Broad Plans	Objectives (Missions)	General Programs	Policies
	Budget and Deadlines	Projects	Organization Structure
	Performance Standards for Expense, Quality, Quantity, etc.	Personnel Assignments	Standard Procedures
Detailed Plans		Detailed Schedules, Specifications, Methods, etc.	Standard Methods

*Source: W. H. Newman, Administrative Action (second edition; New York: Prentice-Hall, 1963), p. 53.

Figure 4

QUESTIONS AN EXECUTIVE SHOULD ASK HIMSELF ABOUT PLANNING*

Key Questions Guiding the Extent of Planning

Single-Use Plans (Programs, projects, detailed specifications, schedules, and the like)

1. Will the plan help to get the right man at the right place at the right time, adequately supplied with instructions, materials, and equipment; instead of "too little, too late"?

2. Will the plan improve coordination of several activities?

3. Will planning lower costs or increase effectiveness of the activity, through
   a. anticipating trouble, and
   b. developing more efficient methods?

4. Will planning ease the load on hard-worked executives by
   a. permitting more decentralization of authority to act, and
   b. providing guides for use in control?

5. To what extent is detailed planning warranted by the reliability of forecasts of operating conditions?

6. Will planning in advance lead to unwise commitments?

7. Will executives continue to be alert to new conditions and quick to adapt their actions to them?

8. Is the activity important enough to warrant formal planning? Will the improvement in results be worth more than the added expense involved in additional planning?

9. Is there time for detailed planning, or is prompt action more important?

10. Will the planning capitalise on the abilities and ideas of individuals throughout the enterprise and build morale?

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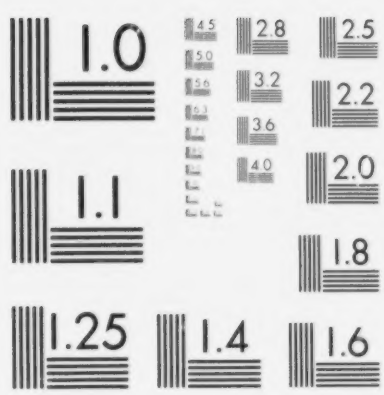

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Standing Plans (Policies, standard methods, standard procedures, and the like)

1. Can administrative work be simplified by adoption of plans that will be used over and over again?

2. Will efficiency be improved by intensive study to discover the "one best way", and by insistence on the use of such standard methods and procedures?

3. Is uniformity of action important, and will standing plans help to achieve it?

4. Will standing plans ease the load on hard-worked executives by
   a. permitting more decentralization of authority to act, and
   b. providing an established behavior pattern to use in appraising action of subordinates?

5. Will use of standard methods simplify training and permit use of less experienced workers?

6. Is the repetition in operations significant enough to justify the effort involved in making standing plans?

7. Can operating conditions be controlled closely enough to make detailed standard methods feasible?

8. Will the expense of preparing the plans and enforcing them more than offset the benefits?

9. How serious is the inflexibility that will arise? Can provision be made for prompt modifications and exceptions when they are needed?

10. Will insistence on standing plans have a bad effect on individual initiative?

Goals (Objectives, missions, deadlines, performance standards, and the like)

1. Are the efforts of executives ineffective due to lack of clearcut objectives?

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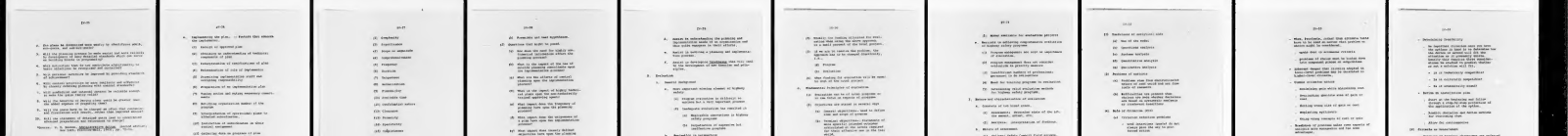

D-55

4. Are plans be prepared here mainly by identifying which, problems, and questions?

5. Will the planning process be made easier and more realistic if the planning commission and the city council meet jointly to develop goals to recommend?

6. Will valuable time be saved (problems identified) by preparing a list of problems and questions?

7. Will problem statements be improved by providing standards for measuring them?

8. Will current resources be more realistic and efficient if the planning commission meets jointly with the city council?

9. Will the planning commission process be valuable enough to justify the additional effort?

10. Will the process of identifying goals be greater than the process of identifying problems?

11. Will the goals have to be changed as time goes because of changes in the community? Will the process be valuable enough to justify the effort?

12. Will the problems or goals need just to be reviewed or revised periodically and continued or dropped?

Source: "A Guide to Comprehensive Municipal Planning", Illinois Institute for Environmental Quality, Chicago, Illinois, 1972, pp. 55-56.

D-56

6. Implementing the plan. -- Factors that enhance the implementation:

(1) Issues in approved plan

(2) Strategies to implementation of feasibility; Implementation strategies

(3) Institutionalization of identification of plan

(4) Determination of role of implementation

(5) Prioritize implementation steps and relationships

(6) Adaptation of the implementation plan

(7) Taking action and making necessary commitments

(8) Establishing implementation schedule of the program

(9) Determination of operational plans to implement the program

(10) Initiation of undertakings in order (actual) documents

(11) Ordering data on progress in plan

D-57

(1) Complexity

(2) Significance

(3) Scope of expenditure

(4) Commitment

(5) Responsibility

(6) Authority

(7) Incentives

(8) Motivation

(9) Flexibility

(10) Available time

(11) Intelligent action

(12) Coordination

(13) Resources

(14) Capacity

(15) Adjustment

D-58

(2) Potentially just have significance.

(3) Questions that might be posed:

(a) What are the goals for public sector financial investment efforts over the next decade?

(b) What is the impact of the use of private planning consultants upon the implementation process?

(c) What are the effects of capital financing upon the implementation process?

(d) What are the impacts of federal financial aids upon the implementation process?

(e) Are the goals of the planning process have been the planning process have been the planning process?

(f) What impact does the implementation process have upon the planning process?

D-59

2. Assess in understanding the problems and opportunities of the community and how plans relate to meet future:

Analyzed in terms of planning and implementation.

Analyzed in development functions (see text) by the development of new functions and priorities.

B. Evaluation

1. Search background:

a. Most important criteria element of highway analysis

b. Program evaluations be difficult to measure but a most important process

(1) Inadequate evaluation has resulted in:

(a) Negative consequences of program

(b) Inadequacies of expensive but ineffective programs

D-60

(2) Models: (see Dunham, Alexander Pas text) Models of evaluation of a well planned or poorly planned program.

(3) Are you in the business of identifying (or evaluating) the relevant (identifying) [illegible]

(a) Problem

(b) Objectives

(c) Data (evaluation) will be used to use of the data process

c. Expenditure Indicators of evaluation

(1) Evaluation can be of long programs or short programs (see Alexander Pas text)

(2) Evaluation is an attempt to measure:

(a) Impact objectives: need to define the impact objectives

(b) Process objectives: Statement of the process of the program (specific activities) (specific data) (data) (data) (

- Thus, Proximate, rather than ultimate tests have to be used no matter what problem or choice might be considered.
  - opens door to erroneous criteria
  - problems of choice must be broken down into component pieces or subproblems
- Inherent danger that criteria adopted in lower-level problems may be unrelated to higher-level criteria.
- Common criterion errors
  - Maximizing gain while minimizing cost
  - Overlooking absolute size of gain or cost
  - Setting wrong size of gain or cost
  - Neglecting spillovers
  - Using wrong concepts of cost or gain
- Breakdown of problems makes some aspects of analysis more manageable and has some advantages.
  - Suitable criterion forms
    - Maximum gains minus costs
    - Either gains or costs fixed

(b) Working definition of criterion

- test of preferredness

(c) Stages of applying criteria

- Determining options

- Determining feasibility
  - An important criterion once you have the options in hand is to determine how the device or method will fit the situation as it presently exists. Usually this requires three considerations be studied to predict whether or not a solution will fit.
    - Is it technically compatible?
    - Is it culturally compatible?
    - Is it economically sound?
- Devise an installation plan
  - Start at the beginning and follow through a step-by-step projection of the application of the option.
  - Predict obstacles and devise methods for overcoming them
  - Allow for contingencies

(d) Criteria as Measurement

- Measures of terminal objectives are referred to as "ultimate criteria."
- Measures of enabling objectives are termed "intermediate criteria."
- Both may vary in terms of their reliability and validity.
- Most prevalent practice has been to measure levels of accomplishment either on intermediate or ultimate criteria, and then, ex post facto, attempt to determine if these levels of accomplishment can be accounted for in terms of past program experience. This practice has yielded, at best, equivocal results.

- Means of supervision and control over matters that require services to public by assuring that all departmental resources and information is focused on each case.
- Focal point of analysis of all reports that are submitted in departmental operations.
- Report review is function of supervision
  - Quality of system is primarily dependant upon supervisor's review of reports.
  - Report review is vital aspect of management.

3. Practice Session for Students to Develop Evaluation Tool

   a. Distribute and explain bedsheet model.

      (1) Objective

      (2) Measure of effectiveness

      (3) Criteria

      (4) Tasks and Milestones

   b. Divide students into working groups.

      (1) Distribute worksheets

      (2) Assist students with the development of an evaluation plan of their own choosing.

IV. Nature of Management Objectives

A. Enables us to do five things.

1. To organize and explain the whole range of phenomena in a small number of general statements.

2. To test these statements in actual experience.

3. To predict behavior.

4. To appraise the soundness of decisions when they are still being made.

5. To enable practioners to analyze their own experience and as a result improve performance.

B. Areas of performance objectives

1. State of the art

2. Innovation

3. Productivity

4. Physical and financial resources

5. Profitability

6. Manager performance and development

7. Worker performance and attitude

8. Public responsibility

C. Determining objectives for:

1. Manager performance and development

   a. Direction of manager and self control

   b. Setting up of jobs

   c. Spirit of management

   d. Structure of management

   e. Development of new managers

2. Public responsibility

   a. Set according to social and political conditions

   b. Set by beliefs of each manager

2. Can plans be dovetailed more easily by identifying goals, sub-goals, and sub-sub-goals?

3. Will the planning process be made easier and more reliable by development of many detailed standards which can serve as building blocks in programming?

4. Will activities that do not contribute significantly to basic objectives be recognized and curtailed?

5. Will personal incentive be improved by providing standards of achievement?

6. Will control activities be more realistic and effective by closely relating planning with control standards?

7. Will prediction and internal control be reliable enough to make the goals really valid?

8. Will the benefits of having clear goals be greater than the added expense of preparing them?

9. Will the goals have to be changed so often that confusion and frustration will result, rather than improved morale?

10. Will the statement of detailed goals lead to unwarranted advanced preparation and reluctance to change?

*Source: W. H. Newman, Administrative Action (second edition; New York: Prentice-Hall, 1963), pp. 72-73.

(1) Complexity

(2) Significance

(3) Scope or magnitude

(4) Comprehensiveness

(5) Frequency

(6) Duration

(7) Uniqueness

(8) Authorization

(9) Flexibility

(10) Available time

(11) Confidential nature

(12) Clearness

(13) Formality

(14) Specificity

(15) Completeness

(16) Accuracy

(17) Stability

c. Manner in which a given function is planned and then put into operation may be influenced by the intensity with which dimensions occur.

d. Impact of dimensions.

(1) Important to know relationships between dimensions and the processes.

(a) Observe a variety of plans differing in the intensity with which dimensions occur and record the variations.

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(b) Formulate and test hypotheses.

(2) Questions that might be posed.

(a) How does the need for highly confidential information affect the planning process?

(b) What is the impact of the use of outside planning consultants upon the implementation process?

(c) What are the effects of central planning upon the implementation process?

(d) What is the impact of highly technical plans upon the non-technically trained approving agent?

(e) What impact does the frequency of planning have upon the planning process?

(f) What impact does the uniqueness of a plan have upon the implementation process?

(g) What impact does loosely defined objectives have upon the planning and implementation processes?

9. Planning-Implementation model can serve at least six purposes.

a. Assist in understanding <u>how</u> the management process is carried out in all kinds of organizations.

b. Assist in understanding <u>why</u> the process is carried out in a certain manner.

c. Assist in determining the <u>results</u> that are likely to be achieved from following a given process.

(2) Usually the funding allocated for evaluation when using the above approach is a small percent of the total project.

(3) If we are to resolve the problem, the approach has to be changed drastically, i.e.,

(a) Program

(b) Evaluation

(4) Thus funding for evaluation will be equal to that of the total project

c. Fundamental Principles of evaluation

(1) Evaluation can be of total programs or it can focus on aspects of programs

(2) Objectives are stated in several ways

(a) General objectives:- used to define aims and scope of program

(b) Terminal objectives:- Statements of more specific intended outcomes articulated at the levels required for their effective use in the real world.

(c) Enabling objectives:- Statements of intended outcomes which are:

- either meaningful components of the outcomes specified under terminal objectives,

- or outcomes which are believed to be essential background inputs for the terminal objectives.

d. Forces supporting comprehensive evaulation

(1) Requirements of federal standards

d. Assist in understanding the planning and implementation needs of an organization and thus guide managers in their efforts.

e. Assist in auditing a planning and implementation process.

f. Assist in developing hypotheses that will lead to the development of new theories and principles.

D. Evaluation

1. General Background

a. Most important missing element of highway safety

(1) Program evaluation is difficult to achieve but a very important process

(2) Inadequate evaluation has resulted in

(a) Negligible innovations in highway safety programs

(b) Perpetuation of expensive but ineffective programs

b. Evaluation in perspective

(1) We have continuously tried to make evaluation a small subpart (component) of operations. This is why it has not been mastered, i.e.,

(a) Plan

(b) Assess

(c) Control

(d) Evaluate

e. Implementing the plan: -- Factors that concern the implementor.

(1) Receipt of approved plan

(2) Obtaining an understanding of technical components of plan

(3) Interpretation of ramifications of plan

(4) Determination of role of implementor

(5) Organizing implementation staff and assigning responsibility

(6) Preparation of an implementation plan

(7) Taking action and making necessary commitments

(8) Notifying organization member of the program

(9) Interpretation of operational plans to affected subordinates.

(10) Instruction of subordinates in their control assignment

(11) Gathering data on progress of plan

(12) Review and evaluation of plan

(13) Taking corrective action when necessary

(14) Reporting progress to authorized personnel

8. The dimension concept.

a. Helps planner understand the nature of the variations occuring in the planning and implementation process as different activities are considered.

b. Seventeen dimensions characterize either the planning process or the implementation process.

(2) Money available for evaluation projects

e. Barriers to achieving comprehensive evaluation of highway safety programs

(1) Program management not sold on importance of evaluation.

(2) Program management does not consider evaluation as priority measure

(3) Insufficient numbers of professional personnel to do evaluations

(4) Need for training programs in evaluation

(5) Determining valid evaluation methods for highway safety programs.

2. Nature and characteristics of evaluation

a. Consists of two broad areas.

(1) Assessment: determine state of the art; the amount, extent, etc.

(2) Analysis: interpretation of findings.

b. Nature of assessment

(1) National Safety Council field surveys.

(2) Highway Traffic Center, M.S.U., Questionnaire Method Testing study as example of self assessment and attempt to validate same.

(3) Univ. of Michigan, Highway Safety Research Institute, Study to develop methodology for program evaluation.

c. Nature and Use of Analysis in Evaluation of highway safety

(1) Role of analysis in economizing

(a) Careful analysis in many instances leads to increased output or a larger pay off.

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CHAPTER VI

Finishing the Job

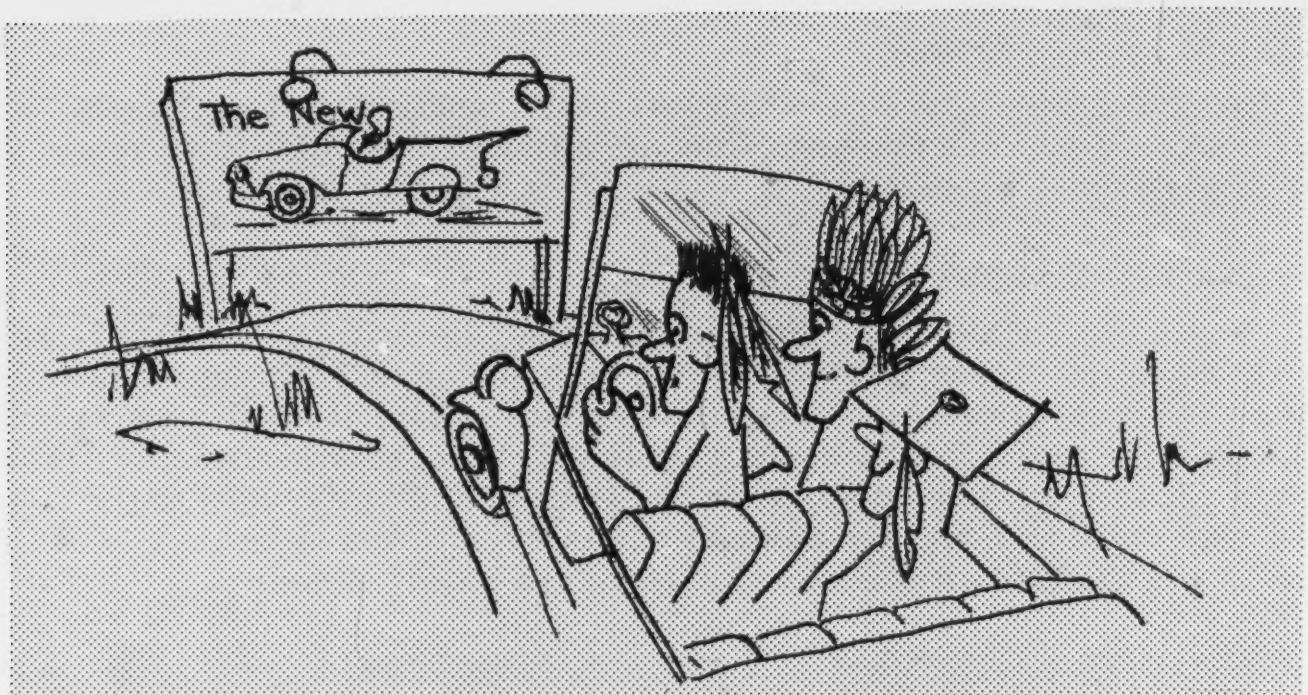

Implementing change is essential,
but the process of changing
is really never finished.

"Whatever happened to that report?"...."Didn't we have a committee that worked on that a couple of years ago?"...."Whatever happened to Committee X? We never heard any more about it."..."I'm not getting on another committee. I put all that time into the last one and nothing was done about our recommendations."

Do these sentences sound familiar? Unfortunately, many teachers have heard or said them. They reflect a tendency in some school systems to fail to set reasonable target dates or deadlines for action.

This chapter is intended to help those who are involved in curriculum study to make the kind of evaluation and reports that tend to get attention and action. As just implied, action generates more action. Inaction breeds disillusionment and discontent. What is done as a result of one curriculum study affects not only that study, but the curriculum development hopes of a school for the future.

Mere action, of course, is not enough. Only carefully prepared, responsible recommendations are likely to be considered by an administration or Board of Education.

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(2) Usefulness of analytical aids

(a) Use of the model

(b) Operations analysis

(c) Systems analysis

(d) Quantitative analysis

(e) Qualitative analysis

(3) Problems of analysis

(a) Problems stem from obstructionist nature of real world and not from tools of research

(b) Difficulties are present when choices are made whether decisions are based on systematic analysis or irrelevant assertions

(4) Role of Criterion (#37)

(a) Criterion selection problems

- Good intentions (goals) do not always pave the way to preferred action

- In choosing alternatives we also adopt criteria or tests of preferredness

- Criterion problem could swallow up all aspects of the comparison of alternative courses of action

- Problem of deciding what consequences decision-maker should know about

- In practical problem solving we have to look at some "Proximate" criteria which serve to reflect what is happening to product

MICROCOPY RESOLUTION
NATIONAL BUREAU OF STAND

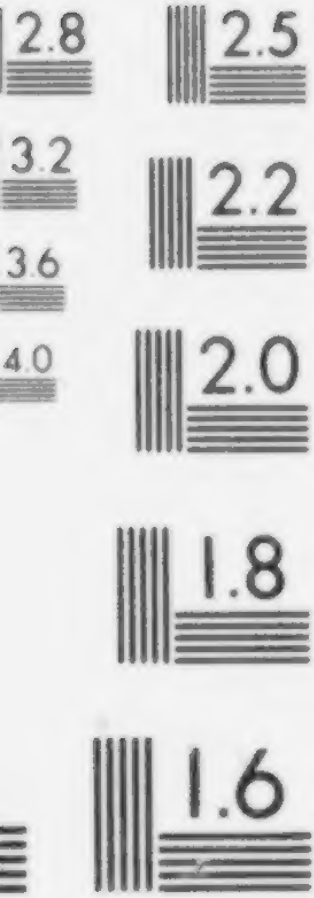

TEST CHART
NDARDS-1963-A

(5) Measuring costs and benefits

(a) Cost-benefit analysis functions as a tool to assist management in its attempt to optimize use of available funds.

(b) Potential benefits of project can be predicted and evaluated.

- Because of a reasonable degree of certainty as to its extent and impact

- Because of relative short time span between performance of research on project and implementation of results

- Improvements in working conditions create benefits by increasing quality of work environment

(c) Types of project costs and benefits

- Direct benefits and costs

  . Increases in production of goods and services

  . Marginal benefits must equal or exceed marginal costs.

  . Direct benefits are net benefits of the incremental output associated with a specific alternative, not the net difference in benefits between the superior and the next best alternative.

- External or "spillover" effects

  . Pecuniary spillovers

  . Technological spillovers

- Secondary benefits and costs

  . Expansionary effects of project's direct benefits

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- . Differ from external benefits and cost in that they are compensated shifts in economic resources

- Intangible benefits and costs

  - . Those project effects which are unmeasureable in any objective and generally accepted terms

  - . Actually, number of completely intangible effects may be very limited.

  - . Avoid tendency to overload this category.

- Incommensurable effects

  - . Cannot be neatly categorized

  - . Are intangibles that can be quantified by "at least" method and submitted in section along with other qualitative aspects.

- Prescribed benefits

  - . When made explicit project goals, they must be quantified to degree practicable.

(d) Relationship of standards to cost-benefit

- Standards serve to internalize previously external costs.

- Such costs are quantified and become subject to profit and loss calculations.

- Therefore, when standards exist, the entailed costs necessary for compliance are available.

- As standards are revised, they may change previously computed benefits and costs.

(6) Other measurement and evaluation concepts

(a) Cost-effectiveness system for evaluation of accident countermeasures (#19)

- Individual components

  . Effectiveness model

    Estimates the anticipated reduction in mortality, morbidity, and property damage owing to the implementation of a new standard, or a change in the level or implementation of an existing standard.

  . Cost Analysis Model

    Estimates the total system costs generated by implementing a new standard or changing level of implementation of an existing standard.

  . Allocation Model

    Determines on a cost-effectiveness basis the best mix of the standards being considered (by NHSB) and the expenditure level for each standard to achieve a maximum reduction in mortality, morbidity, and property damage subject to specified resource constraints.

- Provides insights into "trade-off" questions.

  . Given a budget to be allocated among alternative standards, what is the greatest reduction in deaths, injuries, property damage, or some combination thereof, that can be achieved?

  . Given a desired reduction in deaths, injuries, property damage, or some combination thereof, what is the smallest budget that can be allocated among alternative standards to achieve such a reduction?

(b) Program evaluation and review technique

- PERT/COST System
- Resource allocation
- Time cost
- Implementing PERT
  - . At time of proposal (planning)

(7) Administrative review

(a) Personnel review

- Evaluation of performance
  - . Quantification of qualitative criteria
    - <u>Nature of quantification</u>
      - . Roger Bacon said that knowledge wasn't scientific until it used numbers.
      - . Sir Francis Galton, who launched the modern theory of statistics, suggested, "Whenever you can, count."
      - . For managers, numbers are an important tool for thinking and problem solving. Problems that seem vague and unmanageable come into sharper focus when you can count and compare.
    - <u>Measuring the Unmeasureable</u> (#7)
      - . (See Figure 5)
        - When quantification is not built in.
          - . Assignment of values

Figure 5

MEASURING THE UNMEASURABLE

1. It is often necessary to devise measurements of present levels in order to be able to estimate or calculate change from this level.

2. The most reliable measures are the real time or raw data in which the physical objects involved comprise the measures to be used (dollars of sales, tons of output, number of home runs hit).

3. When raw data can't be used, an index or ratio is the next most accurate measure. This is a batting average, a per cent, a fraction or a ratio.

4. If neither of the above two can be used, a scale may be constructed. Such scales may be "rate from one to ten," a nominal rating against a checklist of adjectives such as "excellent, fair, poor," or one which described "better than" or"worse than" some arbitrary scale. (These are useful but are far less precise than the above.)

5. Verbal scales are the least precise but can be extremely useful in identifying present levels and noting real change. Verbs such as "directs," "checks" and "reports" are indicative of actions to be taken.

6. General descriptions are the least useful, but still have value in establishing benchmarks for change. "A clear, cloudless fall day" is obviously not the same as a "cloudy, foggy, misty day" and the two descriptions could be used to state conditions as they exist and conditions as they should be.

7. The statements of measurement should be directed more toward results than toward activity. (Much activity may prove impossible to state in specific terms, whereas results of that activity can be stated.)

8. In stating results sought or in defining present levels, effort should be made to find indicative, tangible scales, ratios or raw measures where possible.

9. If you can't count it, measure it, or describe it, you probably don't know what you want and often can forget it as a goal.

(b) Management review (#9)

- Assess your job for changes in responsibility and activity

  . Be practical. Look at longer-range perspective. You will win a few and lose a few.

  . If dissatisfied, tackle problem of self-scheduling from scratch.

- Reconsider important problems from time to time.

- Periodical review of progress in order to make sure original objectives will be achieved.

- The Managerial Grid approach to management review. (Dr. R. Blake & J Mouton, U. of Texas)

  . Managerial Grid approach has two basic premises:

    - A manager can be measured according to two variables:

      . concern for people

      . concern for production

    - The best management is team management

  . Nature of the Managerial Grid

    - "Concern for people" is measured vertically on line divided into nine sections.

    - "Concern for production" is measured horizontally on line similarly divided.

Figure 6

MANAGERIAL GRID

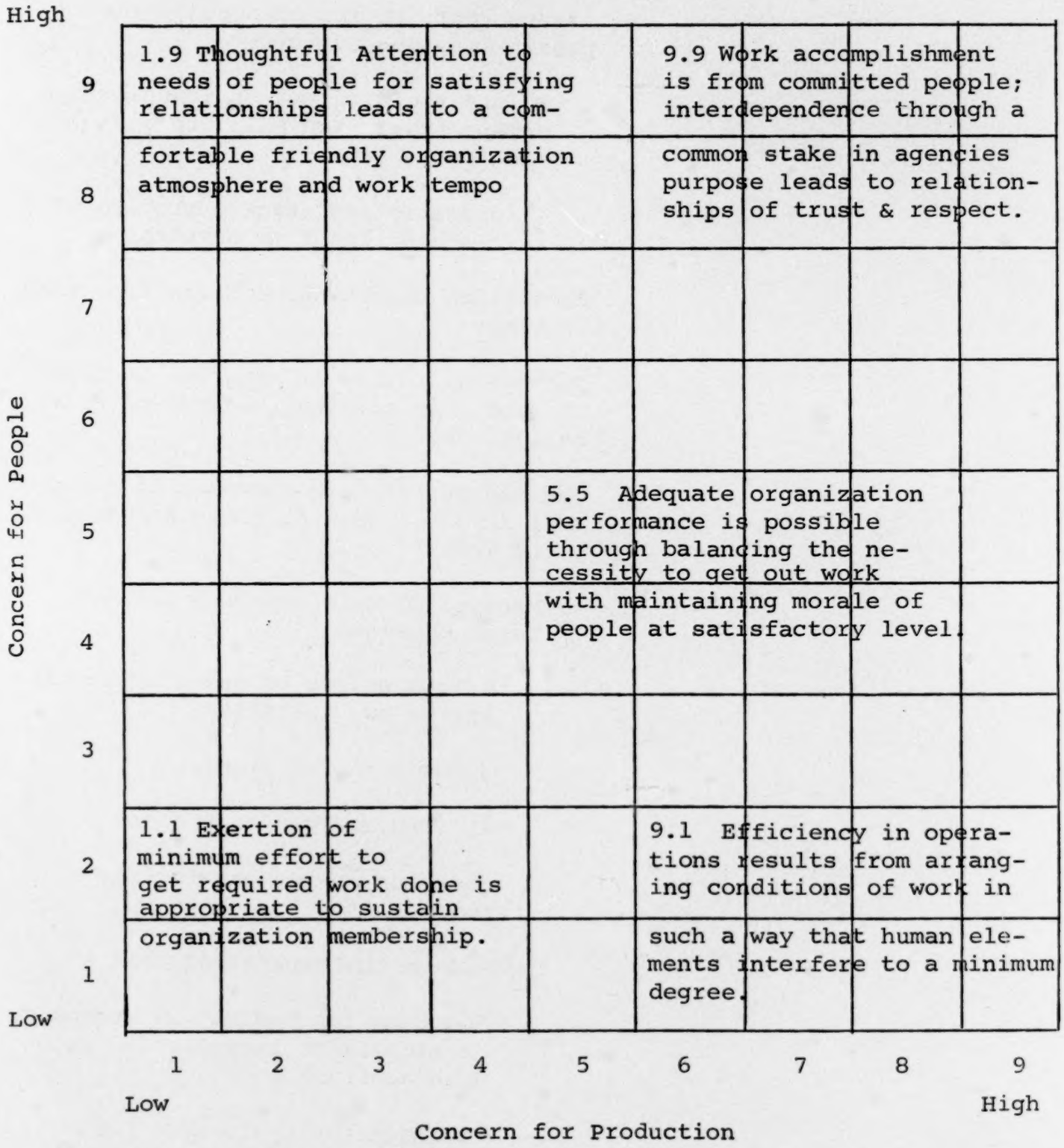

EVALUATING THE COMMITTEE'S WORK

Real evaluation of a committee's efforts and findings often fails to take place. We never really know if the work was worthwhile. How do we find out? We must examine our efforts as we go along, and again after the job is completed.

Sitting in Judgment

A regular part of every meeting of a curriculum committee should be used for a quick checkup. How are we doing? How do we know?

This means we ask ourselves:

What did we set out to do?

What sub-goals did we set?

What have we accomplished?

Where are our strengths?

Where are our limitations?

What should we continue?

What should we do differently?

This needn't be as time-consuming as it appears. The focus can be on short-range goals that were set up as targets for each meeting.

Getting the Habit

The habit of evaluating is a vital habit. Why? Because it:

Provides sureness of focus on the real problem.

Stresses the accountability of the committee.

Provides "feedback" of ideas to correct errors.

Promotes more effective long-range evaluation.

This practical experience of making judgments within the committee--and learning to take criticisms from others in good grace--will make members more sensitive to criteria for reporting the final evaluation.

Tangible Evidence

Any committee should try to set some goal, however small, that lends itself to tangible evidence of achievement. Committee members and others can scoff at testimonials and feelings about success, but they cannot laugh off hard evidence.

What, specifically, could be used as tangible evidence? Here are some examples:

Test scores that show progress in skills or subject-matter beyond that normally expected.

Statistics that show increases in whatever behaviors the committee set out to increase.

Pictures--before and after--when they are relevant to the studies undertaken and when they are honest comparisons.

A study committee should think about the evidence that would reflect achievement of committee goals when it starts work. It may be too late to collect comparative data later.

Don't Stop

Evaluation should not cease with the "final recommendations" of the committee. It should continue for at least a year in order to see if changes really take place. Perhaps the same committee, already familiar with the problem, should continue in existence. The task of curriculum building is never really finished.

References

Amidon (3) and ASCD 1948 (5) provide ideas on evaluation.

- Resulting Grid has 81 positions which can be used to delineate various styles of leadership.

. Management styles depicted on Grid

- Task management: Lower right hand corner of grid portrays this style, i.e., 9.1 management. It is characterized by strong emphasis on task to be performed. People are of little consequence. Strict authoritarian type of leadership. Results in subordinates losing initiative; creative approach to problems; increased skill remains untapped. Consequence is gradual shift of managerial persons in direction of 1.1, accomodation.

- Country-Club management: Located at 1.9 in upper left-hand corner of grid. Opposite of task management. Emphasis all on people. Production suffers at the expense of harmonious relations. When called upon to increase efficiency frequently unable to respond. Tends to succomb to competitive pressures.

- Impoverished Management: Located at 1.1 in lower left corner of grid. Couples low concern for people with low concern for production. Just enough to get by. Leads to deep frustration and discouragement. Situation of a failure.

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- Represent a difference in elements by weighting.
    - Element A=50%
    - Element B=25%
    - Element C=25%

- Rating Scale
    - Instead of numbers make comparisons by use of graded scale e.g.,
        - Excellent
        - Good
        - Fair
        - Poor
        - Unsatisfactory
    - Objective is to make your thinking more specific. By avoiding vagueness you sharpen the facts and make possible comparisons that are helpful for evaluation.

- Check on progress
    - If task is not simple and clearcut, it may be desirable to keep in touch with developments.

- Evaluate achievement
    - reward achievement
    - review aspects of job
    - progress review is a running evaluation of plan. Much to gain in a retrospective view.

- Dampened pendulum management: Located at 5.5 in the center of the grid Manager aware of conflict between people and production and tries to effect a compromise, Real problems are apt to be muted and climate is frequently paternalistic. Has limitations; provides a poor base for promoting innovation, creativity, discovery, and novelty. These sacrificed by adherence to tradition and "majority" standards of conduct. Results in status quo, a gradual slipping behind.

- Team management: Upper right hand corner 9.9 sets forth obvious goal of good management. High concern for both people and production. In short, "the needs of individuals to be engaged in meaningful interdependent effort mesh with the organization requirements for excellent performance."

. Management Grid is a tool to help analyze one's managerial style, the styles of other managers, or the total management of a company. Its a way of structuring one's thinking about styles of management, and as such, both an analytical and constructive tool.

(c) Program or Project review

- Report review

. Obtain progress reports for information and control purposes.

C. Span of control vs. span of managerial responsibility

1. Latter is wider than former.

2. Latter reduces temptation to supervise, that is take over the job.

D. Authority and responsibility

1. Authority should be task oriented

2. Setting limitations on authority

a. All authority not expressly reserved for higher management is granted to lower management.

VI. Management Responsibilities of Government Official

A. Highway Safety Act of 1966

1. Public Law 89-564

2. Administered by NHSB of DOT

3. Purpose

a. Provide assistance to state and local gov'ts. for improvement and expansion of highway safety programs in accordance with standards issued by Secretary of Transportation.

b. Act specifies requirements relating to program administration, program areas to be implemented and formulation procedures of performance standards.

4. Funding -- grants and aids

a. Section 402: grants-in-aid

b. Section 403: research and development funds

5. Act provides mechanisms for coordinating highway traffic safety programs.

a. Throughout the nation

b. Created state programs directed by governors' representatives

c. Logically should be applied at local level in form of individuals or committees

B. Primary responsibility for highway safety programs is invested in governor's office.

1. Each state enacted specific provision conforming to federal requirement.

2. Some states created an office of state highway safety coordinator within the governor's office.

3. Some states have created an official state body to assist the governor's representative in developing priorities and promoting a statewide program based on local needs.

a. Official traffic safety commission

b. Highway safety study committees

c. Highway safety advisory committees

4. Function of state safety commission, advisory committee and coordinator

a. Organize, plan and conduct a statewide highway safety program

b. Coordinate and supervise activities and programs of the several agencies engaged in promoting highway safety

c. Provide highway safety information and publicity to all appropriate media and develop other means of public information

d. Cooperate fully with all national, local and public and private agencies and organizations interested in promoting highway safety

e. Serve as clearinghouse for all highway safety materials and information

f. Cooperate in promoting research, studies, and analyses of problems concerning highway safety

g. Make studies and recommendations to legislature concerning safety regulations and law

h. Prepare and submit annual report to governor re activities of Commission

i. Basic responsibilities of coordinator

(1) Define objectives

(2) Coordinate and balance resources

(3) Provide leadership and liaison between local-state departments of government and independent agencies

(4) Assist local programs to conform with state and national standards

(5) Monitor program development

VII. Management at Local Level (#28, 29, 32, 33)

A. Primarily a local responsibility

1. Statistical data on crashes

a. Deaths and injuries

b. Costs

2. Analysis of problem

a. Responsibility for local traffic program difficult to identify

b. Almost impossible to hold anyone accountable for results at local level

c. Many agencies at local level duplicate efforts of others, thus overlapping functions and costs.

d. Non-government organizations also are involved in projects.

e. Need for program coordination at local level.

3. Responsibilities related to program standards

a. Must deal with each functional standard

b. Will vary from standard to standard

c. Must develop management approaches for the improvement of highway traffic safety

(1) By effective administration of standards

(2) By coordination of various standards

4. Responsibilities in relation to administrative areas

a. Coordination of local activities

(1) Highway safety program is system made up of various sub-systems which include all the activities carried out by local agencies and organizations directly or indirectly involved in traffic safety related organizations within the community.

(2) Local government lacks administrative framework for highway safety programs.

(3) Local government lacks management tools to provide multi-functional coordination of traffic safety activities.

(a) Need to implement safety management coordination techniques

- Establish local highway safety coordinator

- Adoption of inter-agency agreements

(4) Coordination at local level

(a) Basic responsibilities of local coordinator

- Ensure that local programs conform to state and national standards

b. Organizing and administering local activities (#29)

(1) Organize subsystems into a structured framework

(a) Purpose of organization is to provide ordered structure for decision making.

(b) Human resources must be directed in unified effort toward a common goal.

(c) Productiveness will depend on character, motivation, knowledge and skill of each participant.

(d) Results will also depend on system within which individuals must work.

(e) Design of organization can inhibit or increase efficiency or effectiveness of those who operate it.

(f) Structure must permit:

- Smooth flow of ideas
- Creation of sound policy
- Efficient operation of inter-related projects

(2) Organizational problems

(a) Cohesive organizational entities at local level with responsibility for highway safety activities are virtually non-existent.

(b) Responsibility is fragmented between numerous functional agencies.

- Results in needless duplication
- Inefficient use of funds
- Gaps in highway safety services

(c) Most pressing problem in highway safety programs is lack of organization capable of effectively coordinating highway safety activities at local level.

c. Staffing local activities (#33)

(1) Highway safety activities should be administered and operated by professionals.

(2) Determine staff functions necessary to develop personnel systems tailored to special demands of each standard area.

(3) Determine manpower needs

(4) Establish recruitment procedures

(5) Provide necessary training

(6) Manpower problems

(a) Personnel policies should encompass sound staffing principles.

- A position classification plan
- An equitable payment plan
- A merit system for recruitment
- Recruit and in-service training program
- Promotion program based on merit
- A fair system of job evaluation
- A scheduled system for vacations and sick days
- An effective grievance procedure
- An effective system for maintaining discipline
- A retirement system which allows for economic security in old age

3. Worker performance and attitude

a. Union relations

b. Employee relations index

D. Measuring performance

1. Cannot measure quantitatively

2. Need qualitative standards

3. Judgment rather than data

4. Appraisal rather than measurements

V. Management Techniques

A. Management by objectives and self-control

1. It is the only management principle that

a. Establishes team work

b. Gives full reign to individual strength and responsibility

c. Gives common direction of vision and effort

d. Harmonizes goals of individuals and common weal.

2. It substitutes for control from outside the more exacting control from inside.

3. It is a philosophy of management.

a. It rests on a concept of the job of management.

b. It rests on an analysis of the specific needs of the management group and the obstacles it faces.

c. It rests on a concept of human action, human behavior and human motivation.

d. It applies to every manager, whatever his level or function and to any enterprise whether large or small.

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B. Proper use of reports and procedures

1. Reports and procedures can be easily misused.

   a. The belief that procedures are instruments of morality

      (1) Procedures never decide what is to be done only how it is to be done.

      (2) Right conduct cannot be established by procedure.

   b. Considering procedures substitutes for judgement.

      (1) Procedures only work where judgement no longer required.

   c. Used as instrument of control from above.

2. Reports and procedures should be kept to a minimum.

   a. Used only when save time and labor

   b. Simple as possible

3. Periodical review and evaluation of every report form

   a. Should focus only on needed performance

   b. To control everything is to control nothing

   c. To attempt to control the irrelevant misdirects

4. Reports and procedures should be the tool of the man who fills them out.

   a. Should not be used as measure of his performance

   b. Should not be judged by quality of forms

REPORTING THE COMMITTEE'S PROGRESS

Those concerned with a curriculum study look forward to reporting the findings. All of the work of the committee completed in the earlier stages must be drawn together, synthesized, and made available in a usable format.

The steps listed below suggest one pattern that might be followed in this final phase of the program:

1. Oral reporting to the committee as a whole. Individual members present their findings. These are then discussed by the whole committee, placed into their proper perspective in relation to the overall project, and summarized for the final committee report.

2. Preparation of the committee's written report. The heart of this report may be a synthesis or compilation of the individual committee findings. This part of the task will be simplified, if the study chairman has insisted on maintaining minutes of all meetings, and has required intermittent or periodic individual written progress reports to be made to him as the study or experimentation has proceeded.

One final word should be said about written reports. Be simple and be brief. Insist that written reports follow the simplest and shortest plan that serves their purpose.

3. Oral reports to total faculty by the committee. This is vital to communication. But, more important, it is necessary if the project is to conclude in a way that results in implementation of the conclusions and recommendations.

4. Oral reports to the Board of Education and to the public. There is much value in having the study committee present its work orally to the Board of Education. Such a report will inform the Board members of the outcomes and meanings of the study for the district. They can then interpret more completely to the public the significance of the project.

If desired, the committee might make its report on the occasion of a public meeting in order to gain general support for the implementation of recommendations.

Wider Distribution

Much good work is accomplished by curriculum study committees in schools. Although such work may have wide significance beyond the local school district, it fails to serve others because of a lack of distribution. Of course, school districts are not in the publishing business, but there are ways in which wider distribution can be reasonably accomplished.

For example, if a school is working with other schools on a curriculum improvement program as part of a curriculum association or council, a sharing of final written reports will prove to be a very valuable experience. New ideas are gained in the interchange; but more important is the fact that other schools may have already completed work that is being planned by a particular school. By studying such reports, they may save much time and duplication of effort.

Some schools which have special projects of great value have seen fit to reproduce and bind the work in an attractive handbook or guide and to make it available to other districts at cost. Quite often these publications can be of help to another district in its efforts.

Other examples could be given, but the important point is that curriculum findings can only receive the serious attention of others if made available for their use.

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- Monitor program development

(b) Suggested role of local highway safety coordinator

- Serving as an inter-agency liaison
- Liaison between commission and member governments
- Carrying decisions reached by commission
- Coordinating planning
- Plan local programs
- Develop priorities for programs
- Initiate traffic safety programs and concepts
- Directing programs
- Assist local governments in preparing applications for federal assistance
- Provide advice on request to local governments and groups
- Periodically evaluate progress of programs
- Provide staff assistance to commission
  - . Gathers and interprets data
  - . Carry out commission recommendations
  - . Needs all available information
  - . Needs time to relate federal and state program to local needs

(b) Field has acute manpower shortages.

- Need for immediate manpower expansion
- Insufficient time to mobilize resources
- Need compounded by existing short supply of qualified personnel and lack of educational opportunities.

(c) Need for increased training and education

- Lack of organized instruction
- No types of programs at state level for many types of highway safety personnel
- At local level instruction is almost non-existent.
- Instruction especially lacking at administrative and supervisory levels
- Little attention given to providing advanced education and training throughout person's career
- Existing programs are specialized within program areas.
  - . Students fail to acquire understanding of total traffic safety program.
  - . Limits on the job performance
  - . Limits lateral job entry
- Need to develop highway safety generalists

(d) Need for sufficient numbers of faculty

- Few programs to educate instructors
- Lack of standardized courses and curricula

- Scarcity of training materials and teaching aids
- Little instruction program evaluation

d. Legal authority to conduct highway safety activities (#28)

(1) Local governments derive their powers from state constitutions and state laws.

(2) Home rule charters permit more flexibility in municipal law-making.

(3) Need enabling legislation to conduct activities in some standard areas.

(4) Laws should rest on three principles

(a) Certainty -- clearness and precision

(b) Reasonableness -- relating reasonably to preservation of health and safety, moral and general welfare or public peace

(c) Uniformity -- equal protection

(5) Legal questions for local officials

(a) What state laws will affect program?

(b) What ordinances will be needed to implement program?

(c) Does local government have sufficient authority to adopt ordinances?

(d) Does local law meet test of certainty reasonableness and uniformity?

e. Financing local activities (#27)

(1) Local officials have responsibility to develop and secure financial resources needed for programs.

(8) Enact legislation requiring the recording of all blood alcohol levels of drivers, regardless of sentencing measures taken after conviction. Also refer to DMV for evaluation, any driver found to have a drinking problem.

(9) Modify court system so as to handle cases in fewer courts

(10) Establish experimental programs with probated and indeterminate sentences to deal with drinking drivers

(11) Establish uniformly among all states the .10% BAL as a standard

(12) Make provision for centralized control of chemical test methods and certification of qualified persons to conduct tests

(13) Allow for chemical testing for alcohol prior to arrest

(14) Insurance penalties

(15) Revocation of registration of vehicle

(16) Confiscation (impounding) of vehicle

(17) Medical and psychological examination as to extent of alcoholism

(18) Issuance of special license plates to identify problem drinking driver

(19) Mandatory reporting of chronic alcoholics by physicians, hospitals, etc.

(20) Mandatory BAL sampling on all hospitalized persons as a result of a traffic crash.

2. Staffing for alcohol and highway safety

a. Personnel trained in operation of intoxication measuring devices

b. Personnel trained to supervise and/or inspect devices

c. Lab technicians and/or analysts

d. Rehabilitation personnel

(1) Psychiatric social workers

(2) Psychologists

(3) Social psychologists

(4) Administrators of rehabilitation programs

(5) Nurses

(6) Medical doctors

(7) Group therapists

(8) Social workers

(9) Counselors

F. Pedestrian Safety

1. Legal implications

a. Standard provides for

(1) Inventory of pedestrian-vehicle accidents

(2) Improved protection of pedestrians

(3) Improved education programs to acquaint drivers with pedestrian problems

(4) Improved education programs of traffic rules for pedestrians

b. Nature of pedestrian regulation

(1) Insure efficient and safe movement of people

(2) Relate to two essential problems

(2) Can add safety function to other federal and state aid support programs

(3) Local officials should be aware of sources of financial assistance available from federal, state and private sector. (See source document of NACO, Vol. IX of their series.)

f. Public support for local activities (#31)

(1) Safety activities must have public support and involvement to be effective.

(2) Local officials should develop public information programs directed to increase public concern and response.

(3) Local officials should create methods to increase public awareness of highway safety activities and use all sources to solicit support.

VIII. Legal Implications and Staffing Considerations for Management of Selected Standard Areas (#33)

A. Codes and laws

1. Legal implications

a. Standard requires each state to have plan to achieve uniform rules of the road.

b. Local governments should adopt model ordinance.

c. Tools for planning in legal area

(1) UVC (Uniform Vehicle Code)

(2) MTO (Model Traffic Ordinance)

2. Staffing for codes and laws

a. Need program specialist at state level

(1) Undertake continuous review of state and local laws, statutes and ordinances

(2) Ensure conformance of above with national standards

b. Local official should be designated to establish liaison with state program specialist.

B. Traffic courts

1. Legal implications

a. Theoretically every person charged with moving violation should go to court.

b. Courts do not have adequate judicial, administrative, and clerical personnel.

c. Those committing non-hazardous violations are permitted to admit guilt and pay fine without going to court.

d. Standard attempts to encourage uniform procedure in handling cases that go to court.

e. Local traffic courts must have jurisdiction

f. Functional aspects of traffic court standards

(1) Hearing of cases

(a) Jurisdiction to hear traffic cases exists in all states.

(2) Reporting convictions

(a) Courts required by law to report convictions of motor vehicle violations to state licensing agency.

- Records essential for administration of driver license programs.

- Provide bases for courts to analyze own performance

(5) Should have qualities of character that demonstrate broad personal excellence

(6) Appointment of judge should be free from community pressures.

(7) Judge should ensure that traffic court program becomes integral coordinated part of total community highway safety program.

(8) Judge should establish liaison with other pertinent agencies.

b. Other traffic court staffing roles

(1) Court administrator

(2) Clerk of the court

(3) Court officer

(4) Court liaison officer

(5) Court recorder

(6) Prosecutor

(7) Defense counsel (public defender)

(8) Traffic referees

(9) Juvenile referees

(10) Probation officer

C. Emergency medical services

1. Legal implications

a. Many people die each year due to inadequate care

(1) At scene

(2) Enroute to hospital

(3) Emergency reception room at hospital

b. Ambulance attendents lack sufficient training

c. Inadequate legislation to assure level of competency to be consistent with responsibilities of ambulance attendent

d. Inadequate equipment

e. Laws regulating ambulance service are vague and inadequate.

f. Reasons for ambivalence and the ambiguity of EMS law

(1) Morticians provide over 50% of service

(2) State legislators reluctant to pass stringent standards which might effect marginal operations.

(3) Local officials and legislators are unwilling to exceed state requirements. They have no legal frame of reference based on local experience.

(4) Systems with financial capability to exceed state standards are under no legal obligation to do so. Thus, regulation is conditioned by lowest levels of performance, rather than serving as a model of excellence.

g. Most existing ambulance statutes and ordinances are fragmented.

(1) Authority is delegated to several agencies with no clear indication of responsibility of each.

(2) Model legislation needed to correct these inadequacies.

h. Need for legal flexibility to allow an attendant with sufficient training to perform basic life-saving procedures now permitted only nurses or physicians

i. EMS standard requires for each state in cooperation with its political subdivisions:

(1) Training, licensing, and related requirements for ambulance and rescue vehicle operators

(2) Requirements for types and number or emergency vehicles including supplies and equipment to be carried

(3) Requirements for operation and coordination of ambulances and other emergency care systems

2. Staffing for emergency medical service

a. Ambulance service personnel

(1) Administrative supervisor

(2) Training supervisor

(3) Operation supervisor

(4) Shift supervisor

(5) Attendant

(6) Driver

(7) Communications technician

(8) Dispatcher

(9) Mechanic

b. Para-medic personnel

D. Driver education

1. Legal implications

a. Legal authority to conduct driver education in schools has long been established.

b. Legislative support provided for driver education in several ways.

(1) Special instruction permits for students of approved courses

(2) Many states require applicants under 18 years of age to have completed driver education. Also in the Uniform Vehicle Code.

c. States regulate control of high school driver education as well as preparation of teachers.

(1) Teachers must possess a valid operator's license.

(2) Teachers must have a driving record free from repeated accident and violations.

(3) Teachers are required to have a given educational level, varies among states.

d. Driver education legislation is concerned with

(1) Age limits of driver applicants for driver education course

(2) Establishing medical advisory boards for driver licensing

(3) Funding of driver education programs

(4) Provision of driver education in the schools

(5) Regulation of driver education schools and/or instructors

2. Staffing driver education programs

a. Driver education teachers

(1) Need for increase in number of teachers in commercial and secondary schools

(2) Need for additional instructors for behind-the-wheel phase of driver instruction

(3) Need to initiate development of effective recruitment program

(4) Success of educational programs depends on quality leadership provided by colleges and universities.

(a) Setting of high entrance requirements

(b) Raise quality of instruction

(c) Expand range of course offerings

b. Driver education supervisors for school systems

(1) Manage staff of driver education teachers

(2) Insure that students receive uniform comprehensive instruction

(3) Performs coordination service

(4) Background should reflect substantial course work in driver and traffic safety education.

(5) Should have teaching experience

c. Area-wide driver education center coordinators

(1) Should have experience in supervising or coordinating driver education programs

(2) Should have specialized and general knowledge in field

(3) Should hold advanced degree in safety education, educational administration, or supervision

E. Alcohol and highway safety

1. Legal implications

a. Most states have laws prohibiting a person from operating a vehicle after he has consumed alcohol to such an extent that his driving ability has been impaired.

(1) Some have not included "physical control" aspect.

(2) Many have combined references to drugs with those relating to alcohol.

b. Conviction for DUIL or DWI is usually followed by some action against defendant's license.

(1) Some states' license action is permissive

(2) Others require mandatory revocation or suspension

c. Catagories of laws under which alcohol highway safety programs are enforced

(1) Impaired driving laws

(a) Prima facie evidence of .15% or more of alcohol by weight

(b) Prima facie evidence of .10% or more of alcohol

(c) Prima facie evidence of .05% BA level for anyone under 21 years of age

(2) Implied consent laws

(a) Exist in most states

(b) Differ among the states

(3) Laws involving chemical tests

(a) Tests are used to determine percent by weight of alcohol in an individual

FORMAT FOR PROGRESS REPORT

The outline on this page is intended to serve as a guide for the preparation of a curriculum study committee's annual or periodic progress report. The basic report, including the ideas listed in Parts I through IV below, might run from two to ten mimeographed pages. The appendix might be as long or longer.

Sufficient copies of the report should be run off for the superintendent's office, board of education, all administrators and faculty members, the curriculum council or association to which the school district may belong--plus a supply for new teachers the following year. The responsibility for the preparation of this report should be that of the committee chairman--with the help of the consultant.

The Cover Page

This should be an attractively-spaced page perhaps in color, including the following information:

Name and address of school district
Title of project
Name of superintendent
Names of committee members and chairman
Name of consultant
Mention of affiliation with area study council
Date (month and year)

The Basic Report

Part I Brief description of the overall project, including its purpose, its scope, its goals.

Part II Descriptions, perhaps of one paragraph each, of sub-projects or individual studies or experiments, including purpose, results to date, subject or grade level, teacher's name.

Part III General conclusions on the part of the committee, even if only tentative.

Part IV Specific recommendations to the superintendent of schools including (1) curriculum proposals, policy revisions, or purchases of equipment, supplies, or materials for the following year, and (2) proposals for continuation, completion, or implementation of the committee's study.

Appendix

The appendix to the report might include some of the best examples of work produced by the committee, such as:

Informal tests, exercises, or outlines developed by teachers
A full page description of the most significant experiment tried
Annotated bibliographies of materials on a specific topic
Reviews of important teaching materials which have been tried
Lists of Do's and Don'ts for teachers
Recommended outlines of concepts to be taught at various levels of schooling
Outline or handbook developed by the committee

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(3) Education

(a) Courts have role in re-education of drivers

(b) Authority to sentence drivers to driver improvement school

(4) Presentence investigations to probation

2. Staffing traffic court programs

a. Traffic court judge

(1) Respect for court depends upon presiding judge.

(2) Judge should wear judicial robe.

(3) Judge should have knowledge of:

(a) Traffic laws

(b) Traffic engineering and policing

(c) Traffic problem and its relationship to his work

(4) Should have a legal background

(a) Familiar with trial procedure

(b) Familiar with presentation of evidence

(c) Knows constitutional law

(d) Knows statutory law and regulations

(e) Knows essentials of court administration

(f) Must establish administrative policy

(g) Has responsibility for overall supervision of court

(b) Evidence obtained is admissible in court of law.

(c) Evidence is rebuttable.

(d) Nature of tests:

- Blood
- Saliva
- Urine
- Breath
- Tissue

d. Proposed changes for dealing with problem

(1) Regulate post-mortum investigations

(2) Mandatory revocation of operator's license upon conviction of DUIL

(3) Authorize discretionary administrative action in suspending operator's license when evidence that driver has committed an offense serious enough for revocation upon conviction.

(4) Establish immunity from lawsuits for physicians and others who draw blood specimens.

(5) Require that analysis of alcohol specimens be conducted by procedure which is considered specific for ethyl alcohol.

(6) Make jail or treatment mandatory for those found guilty of DUIL.

(7) Require all convictions of DUIL to be recorded, regardless of sentence.

(a) Time

(b) Space

(3) Protect pedestrian's rights

(a) Control unreasonable usurpation or extension of these rights

(b) Jaywalkers are seldom prosecuted.

(4) Model traffic ordinance regulations

(a) Crossing only at right angles

(b) Prohibiting crossing in business district outside of crosswalks

2. Staffing for pedestrian safety

a. Police safety officer

b. Adult school crossing guard supervisor

c. School crossing guard

d. School route map analyst

e. Public relations personnel

f. Others who contribute

(1) Traffic engineer

(2) Accident records analyst

(3) Driver education instructor

(4) School officials

G. Highway design, construction and maintenance

1. Legal implications

a. Purpose of standard is to assure streets and highways are:

(1) Maintained in safe condition

(2) That new improvements meet standards.

(3) That approprite precautions are taken to protect motorists and highway workers at construction sites.

b. Main issue of function of maintenance and construction is who has authority to do the work

(1) All roadways should be under control of some jurisdiction.

(a) State legislation usually has made broad classification of road systems.

- State highways
- County roads
- City streets

(b) Problem with this classification

- Lesser jurisdictions are included in larger ones which often result in overlap.
- Roads cross jurisdictional boundaries.
- Certain road systems need individualized legislative action.

2. Staffing for highway design, construction and maintenance programs

a. Staff requirements for this standard range from professional engineers to road maintenance crews.

b. Position classifications

(24) Maintenance craftsman

(25) Mechanical maintenance foreman

(26) Mechanic

(27) Mechanical serviceman

(28) Administrative assistant

(29) Programmer

(30) EDP Operator

(31) Clerical positions

H. Traffic control devices

1. Legal implications

a. Traffic control devices include signs, signals, markings, and lines placed to regulate, warn, and guide traffic.

b. Uniformity of devices necessary.

c. Clarity is very important. Driver must know at a glance what a device means.

d. Purpose of standard

(1) Assure that devices conform to specifications of Federal Highway Administration.

(2) Promote use and application of efficient traffic engineering practices

(3) Promote installation of uniform devices

(4) Calls for identification of deficiencies of existing devices

(5) Calls for preventive maintenance and efficient repair practices

e. Most states authorize local communities to place and maintain traffic control devices.

(3) Police Traffic Services Deputy Administrator of Field Operations

(4) Director of Police Traffic Training

(5) Director of Communications

(6) Director of Research and Development

(7) Police Traffic Services Supervisor

(8) Accident Investigation Supervisor

(9) Vehicle Inspection Supervisor

(10) Breath Examiner Specialist Supervisor

(11) Supervisor of Training

(12) Public Information Officer

(13) Supervisor of Fleet Management

(14) Communications Engineer

(15) Police Traffic Services Patrolman

(16) Traffic Accident Investigation Specialist

(17) Police Traffic Control Specialist

(18) Motor Vehicle Inspection Specialist

(19) School Bus Inspection Specialist

(20) Policewoman (metermaid)

(21) Police Traffic Services Training Instructor

(22) School Resource Officer

(23) Communications Officer

(24) Dispatcher

K. Traffic records and identification and surveillance of accident locations

1. Legal implications

a. Traffic records standard calls for coordinated

(1) Collection of data

(2) Storage of data

(3) Retrieval of information

b. Types of information are:

(1) Information on drivers, including licensing violations and financial responsibility

(2) Information on vehicles, including make, model, and seriel number

(3) Information on highways, i.e. structures, traffic control devices, curves, intersections

(4) Information on accidents, such as drivers involved, vehicles, locations and road conditions

c. Barriers to record system

(1) Non-uniform accident reporting

(2) Inadequate reports submitted to state

(3) Data is frequently never analyzed and used to update programs.

(4) Limited public cooperation in accident reporting

d. Most local governments have established some form of identification and surveillance systems.

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e. Needed legislation in traffic records and identification and surveillance standard areas

(1) Require all police to submit written reports on every motor vehicle accident investigated to Department of Motor Vehicles on form provided by DMV.

(2) Prescribe that minimum information on accident report form should enable:

(a) Measurement of magnitude of accident problem

(b) Definition of major traffic problem areas

(c) Selection of modes of prevention action

(d) Measurement of countermeasure effectiveness

(e) Judgment if additional research is needed for effective programs

(3) Require gathering of information about high accident locations so as to develop improvement programs

f. Legislation should require

(1) Uniform, complete, and accurate accident reports

(2) Stored in one center in every state

(3) Subject to rapid retrieval and analysis

(4) Compatible with national record system

(1) Chief engineer

(2) Deputy engineer

(3) Special project engineer

(4) Traffic engineer

(5) Engineering aid

(6) Design supervisor

(7) Design engineer

(8) Surveyor

(9) Instrument man

(10) Survey helper

(11) Right of way supervisor

(12) Right of way agent

(13) Construction supervisor

(14) Construction inspector

(15) Construction engineer

(16) Construction foreman

(17) Construction craftsman

(18) Heavy equipment operator

(19) Light equipment operator

(20) Bridge operator

(21) Maintenance supervisor

(22) Materials inspector

(23) Maintenance foreman

(1) Care must be taken to make sure this is done only on roads within local jurisdiction

(2) Devices must conform to state standards.

(3) Ordinances must be reasonable

f. Most states have either adopted manual of uniform traffic control devices or have state laws conforming to the provisions of the manual.

g. Traffic control devices should conform to requirements.

(1) Any device should be capable of fulfilling desired need.

(2) Any device should command attention.

(3) Any device should convey clear simple meaning.

(4) Any device should command respect of road users.

(5) Any device should be located to give adequate time for response.

h. Elements to assure fulfillment of above requirements

(1) Design

(2) Placement

(3) Operation

(4) Maintenance and uniformity

2. Staffing for traffic control devices

a. Traffic engineer

(1) Major functions

(a) Planning

PUTTING IDEAS INTO ACTION

The results of a study will be meaningful only if they have a real effect on the existing curriculum. The only way to assure that this occurs is to follow-up the study with action on the recommendations.

The file cabinets and desk drawers across the country are full of curriculum studies that have been made. In each case recommendations have usually been made to the authorities. But, too often, the studies end at that point because of a lack of follow-through.

This may occur (1) because the committee is dissolved by the administration as having completed its work, (2) because committee members are weary after their long labors, (3) because the administration having the responsibility for following up the study neglects to do so as the result of new and different pressures, or (4) because the implementation of the recommendations was not clearly understood in advance.

Whatever the reason, the result may be the same--the failure to culminate the study with meaningful and immediate action. Nothing can be more disastrous to the morale of those involved. The damage to the long-range prospects of future curriculum study efforts is devastating.

Necessary action should be taken, therefore, as soon as possible on the recommendations, to take advantage of the interest of the staff while it is at a peak.

HAVE WE DONE WHAT WE COULD?

Here are two checklists for putting committee proposals into action:

What the Committee Asks Itself

_____Have our recommendations been clear and specific?

_____Have we suggested a step-by-step implementation?

_____Have we suggested probable costs for each recommendation?

_____Can our recommendations be supported by our evaluations?

_____Are recommendations that require additional costs timed to the development of the school budget?

What the School Superintendent Asks Himself

_____Have I read the recommendations carefully?

_____Have I discussed them with the Committee or its chairman?

_____Have I discussed the recommendations with the board?

_____Have I carefully reviewed the board's reactions with the chairman?

_____Have I explained to the staff the plans for action on recommendations?

_____Have I incorporated the approved plans in the budget requests?

_____Have I discussed the recommendations with other official leaders?

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(b) Design

(c) Construction

(d) Operations

b. Assistant to traffic engineer

(1) Often is engineer from another speciality

(2) Technicians

(3) Student help

c. Position classifications

(1) Field investigator technician

(2) Traffic records analyst

(3) Traffic engineer

(4) Traffic engineer specialist

(5) Traffic control device technician

(6) Traffic control device craftsman

(7) Traffic control device laborer

(8) Clerical positions

I. Debris hazard control and clean-up

1. Legal implications

a. Effective implementation of standard requires close coordination and cooperation of number of functional departments of local government.

(1) Ambulance companies

(2) Tow truck operators

(3) Local and state police

(4) Health departments

(5) Other

b. Must plan for a variety of contingencies and establish policies and procedures which outline legal responsibilities of local departments.

c. Standard requires that drivers be warned of hazards and rerouted if possible.

(1) Use of traffic control devices

(2) Use of police to detour motorists

d. Transportation of hazard materials is controlled by state legislation.

(1) Requires local enforcement

(2) Should cover various aspects

(a) Hazardous cargo identification

(b) Special handling precautions

(c) Emergency procedures

(d) Transportation of hazardous materials regulated by DOT

(1) Developed on a case by case basis

(2) Consists of a collection of miscellaneous rules and procedures

2. Staffing for debris hazard control and clean-up

a. Activity involves several functional departments as well as resources from private sector.

b. Central manager of accident clean-up

c. Emergency patrol driver

d. Dispatcher

J. Police traffic services

1. Legal implications

a. Enforcement agencies from all governmental jurisdictions (state, county, city) possess a wide range of functions and authority including:

(1) Accident prevention

(2) Enforcement of rules

(3) Accident investigation

(4) Emergency medical aid

(5) Others

b. Much overlap in jurisdictions

c. Nature of state police agencies

(1) Sixteen states have state police forces.

(2) Nine states have highway patrols.

(3) Nine states have DPS which functions as state police.

(4) Seven states have DPS which functions as highway patrol.

(5) Eight states which have a highway patrol that is part of another governmental unit.

(6) Hawaii has no state police agency

d. Nature of traffic enforcement in local police agencies

(1) Sheriff's traditional responsibility as chief law enforcement officer of county

(2) Delegation of sheriff's traffic enforcement responsibility to highway patrol and municipal departments

(3) Contract or agreement by sheriff to provide traffic law enforcement for small communities

(4) Cooperative efforts between various agencies

e. Police agencies in all the states leave traffic services on city streets to city police department.

2. Staffing for police traffic services

a. Police are principle sources for

(1) Control

(2) Inspection

(3) Investigation

(4) Reporting of community condition

b. Recruitment

(1) Attracting competent manpower requires desirable jobs.

(2) Quality working conditions stimulates high morale and performance.

(3) Salaries should not depend on fines or court penalty assessments.

c. Police traffic service positions

(1) Police Traffic Services Administrator

(2) Police Traffic Services Deputy Administrator of Administrative Services

2. Staffing for traffic records and the identification and surveillance of accident location programs

   a. Accident investigator and aids

      (1) Has burden of establishing high quality accident data

      (2) Requires high level of training

   b. Highway and traffic engineering personnel

      (1) Must be familiar with high accident locations

         (a) Conduct continual surveillance

         (b) Specify what conditions should be

      (2) Must recognize conditions that contributes to accident

      (3) Must repair hazardous condition

   c. Traffic records analyst

      (1) Essential to determine causes and corrective measures

      (2) Will need support personnel

         (a) Programmers

         (b) Computer operators

         (c) Records clerk

         (d) Office machine operator

PART V

PROGRAM IMPROVEMENT

I. Methods and Principles of Program Improvement

A. Nature of Research and Development

1. Categorization of Activities

a. Broad ambiguous division of research

(1) Basic

(2) Applied

b. Traditional taxonomy for research

(1) Historical research

(2) Experimental research

(3) Surveys and studies

(4) Ex post facto (cause/effect) studies

c. New paradigms of research and development (little or no previously established procedure)

(1) Developmental projects

(2) Theory development projects

(3) Projects integrating knowledge

(4) Services projects

(5) Research integration studies

(6) Performance prediction studies

B. Conducting Task Analysis

1. Methods of conducting task analyses and job

descriptions for organizational positions

2. Quantitative Perspectives for selecting Managers

   a. Must have history of striving for personal betterment and a high level of energy/drive/motivation for application to the problems he faces.

   b. Must have a rich fund of experience. Must have seen life and business from a variety of perspectives.

3. Analysis of task of Highway Safety Management

   a. Understands the traffic problem

   b. Understands administrative function

   c. Knows organizational structure

   d. Understands function and use of records

   e. Knows purpose and function of data processing

   f. Identifies and analyzes needs

   g. Collects data for decision-making

   h. Compares alternatives

   i. Develops policies and directives

   j. Plans and directs program execution

   k. Checks performance against established standards

   l. Evaluates performance

   m. Directs planning and research

   n. Maintains control as management function

   o. Manages personnel

p. Manages business affairs

q. Prepares budget

r. Cooperates with other agencies

s. Participates in community affairs

t. Obtains public support

u. Directs preparation of materials

4. Tasks in Local Highway Safety Management

a. Role of Local Highway Safety Coordinator

(1) Should be a generalist in the field

(2) Should understand full significance of highway safety program standards

(3) Should possess capability to implement standards

(a) able to achieve coordination of services provided by local, regional, state, and federal government agencies as well as private interests concerned with highway safety activities

(b) important point of contact between community and government representatives

(4) Should acquire thorough knowledge of traffic problems in community

(5) Should understand the relationship of these problems in the administrative function of traffic related agencies

b. Suggested duties of local coordinator

(1) Maintain liaison with government representatives through monthly meetings and written communication

(2) Keep records of projects and grant applications

(3) Insure that project directors are keeping records

(4) Determine local funding capability

(5) Establish a local highway safety advisory committee

(6) Take an active interest in:

(a) traffic engineering improvements

(b) public school safety education programs

(c) public support through stimulation of business and industry

C. Use of Case Study Method to Develop Understanding and Insight into Management Problems

1. Development of Case Study

a. Definition

b. Scope of a Case Report

c. Organization of a Case Report

(1) Problem

(2) Relevant facts

(3) Alternative decisions

(4) Making the decision

(5) Decision implementation

(6) Evaluation

2. Case of the 2:00-4:00 a.m. Parking Control Directive (See Appendix for complete case)

a. Sets Forth Poor Policy Development and Improper Implementation

b. Portrays Several Generalizations regarding Principles of Management

(1) Initiation of any administrative policy decision will result in similar resistance to change and create like problems in the initial stages of development

(2) The administrator making most of the decisions stymies initiative and instills distrust in subordinates

(3) For an administrator to give an adequate amount of thought-time to long range problems, he must delegate many decisions

(4) Internal acceptance of policy making decisions is necessary before external application can successfully take place

(5) Malum prohibition laws require public support before appreciable enforcement can take place

(6) Better decisions occur when they are made with the aid of a staff or persons concerned with the issues

(7) The administrator must consider departmental policy, and the law and its precedence, special interest

CHAPTER VII

The CDC in Operation

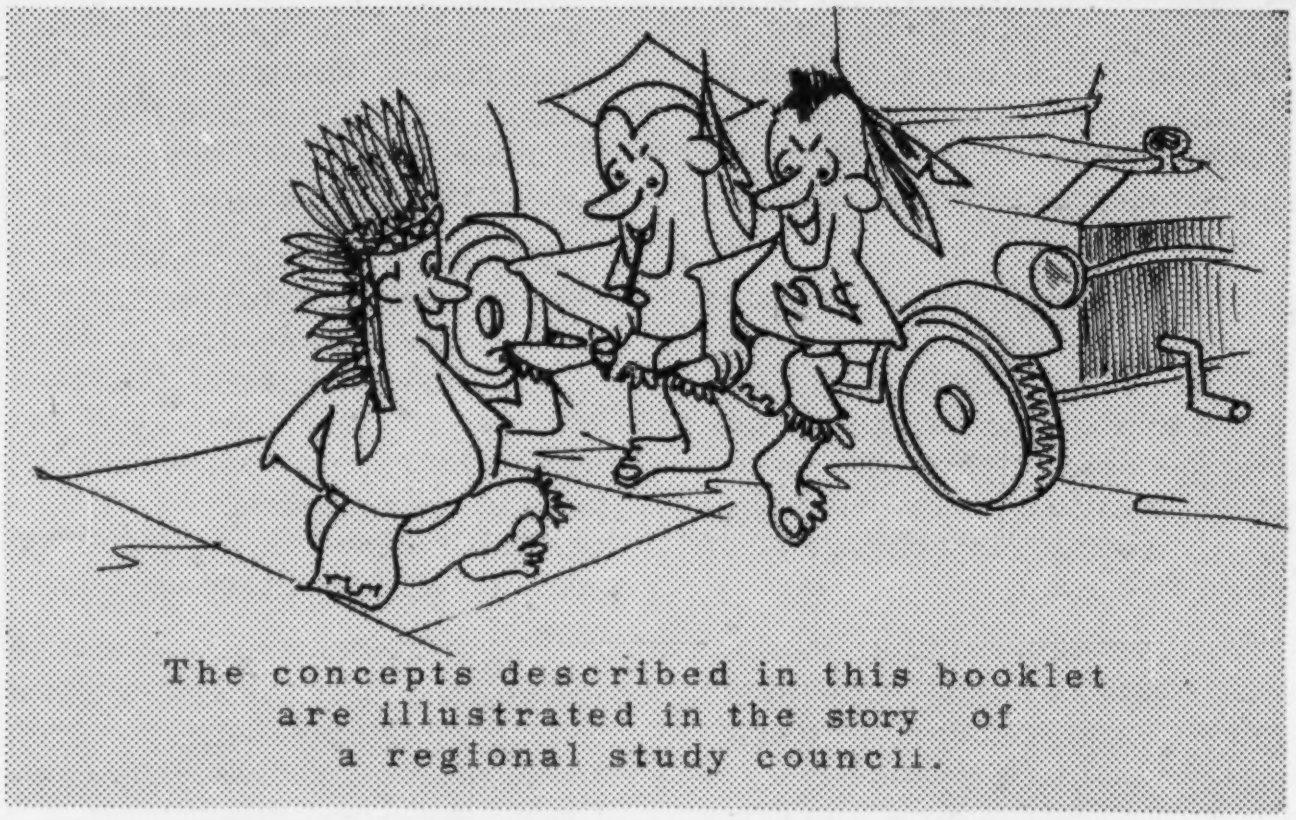

The dream came out of a conference of public school administrators and professors of education at Glassboro State College, a teacher preparation institution. The idea was to establish a regional study council which, through in-service work with teachers, would substantially affect curriculum and instruction in the public schools.

The first step was taken by the college. A preparatory committee of interested professors, headed by a former public school administrator who was to serve as executive secretary of the new organization, began to formulate ground rules. A sample of public school superintendents, principals, and curriculum supervisors was polled on their views and hopes.

The committee drew up a prospectus which proposed three major functions for the organization, to be known as the Curriculum Development Council for Southern New Jersey:

> To develop, coordinate, and publish selected curriculum studies in which member schools participate, and from which they can profit educationally.
>
> To share ideas through Council meetings and workshops, a regular newsletter, and at least two published study reports per year.
>
> To effect close, systematic communication and working relationships between the college and member schools.

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groups and factors affecting internal and external support in creating decisions

(8) Information concerning the "pulse of the community" is most difficult to obtain, therefore the administrator must have experience in predicting the reaction of the community to a given type of decision

(9) Any administrative decision that requires departure from established behavior must be programmed into acceptance by those affected

(10) Unless adequate explanation appears, operation policy decisions can be enforced and interpreted in as many ways as there are persons responsible for its implementation

D. Role of Colleges and Universities (#21)

1. Education institutions have not established instruction programs for highway safety personnel other than for driver education teachers and traffic engineers

2. University traffic safety centers can perform several functions to assist in augmenting the force of highway safety manpower

a. Education and training of a wide variety of highway safety personnel including researchers, administrators and supervisors, professional specialists and technical personnel, instructors, directors and coordinators of educational programs

b. Research and development activity that ranges from basic research to simple surveys, including applied research, experimentation and developmental projects. Incorporating research findings into ongoing activity of various agencies.

c. Service activity which encompasses a wide range of types of assistance to agencies responsible for implementation of the standards. These services could be:

(1) Implementing research into action

(2) Providing technical information

(3) Evaluating program performance

(4) Analyzing problems and programs

(5) Assessing improvement needed

(6) Program and project planning

(7) Developing manuals and procedural guides

(8) Surveying particular activities

(9) Planning and execution of experiments

(10) Assisting legislative committees

(11) Stimulating professional activity

(12) Provide consultation

(13) Provide expert opinion on issues and needs.

3. Educational institutions should provide degree programs as well as non-degree programs.

E. Role of local government agencies

1. Should structure training and education programs to meet local needs.

2. Operational staffs should be instructed in interrelationships of the standard areas.

3. Cooperative programs should be developed with universities and centers.

a. Pool resources into management institutes

b. Could provide entry education to various public service careers

c. Could provide in-service training for middle management and supervisory positions

F. Areawide management approaches (#26)

1. Definition and principles of areawide request

a. Defined as either a formal or informal agreement or cooperative arrangement between or among two or more local jurisdictions for purpose of achieving mutually agreed upon goals.

b. Activities should be coordinated in accordance with geographic areas large enough to accomplish effectiveness and economy.

c. Some standard areas are best operated by one government.

d. Some standard areas lend themselves to multi-jurisdictional management.

2. Problem of fragmented jurisdictional management

a. Preponderence of local government units independently arranging traffic safety programs.

(1) overlap geographically, functionally, and representationally.

(2) 81,000 independent units.

(a) 3,000 counties

(b) 35,000 cities and villages

(c) 22,000 school districts

(d) 21,000 special districts

b. Preponderence of social mobility

c. Disparity and lack of uniformity in programs. services and laws between jurisdictions.

(1) creates sharp inequities in service

(2) creates confusion

(3) creates non-compliance and general disrespect for the law

d. Need system to promote concept of highway safety as a comprehensive effort designed to reduce accidents

(1) need mechanism of coordination

(2) need mechanism of cooperation

(3) need management approaches which prevent

(a) fragmented nature of existing activities

(b) duplication of effort

(c) wasted resources

3. Rational for area wide approach for problem solving.

a. Recognizes the fact that some problems cannot be solved by single local government entity acting alone.

b. Problems affecting local governments do not respect political or administrative boundaries.

c. Local governments are challenged to provide new services that traditionally have been beyond this responsibility.

(b) Operationally this involves

- collecting basic data from area as a unit.

- synthesizing these data to portray jurisdictional interrelationships.

c. Advantages of areawide approach

(1) Elimination of duplicated effort

(2) Uniform procedures and programs

(3) Greater flexibility in program administration

(4) Economics of scale

(5) More effective method of obtaining federal and state financial and technical assistance

5. Criteria for areawide organization

a. Conditions which necessitate areawide coordination.

(1) Nature of person currently responsible for a particular activity

(2) Nature of jurisdiction currently doing work (large enough, too large)

(3) Nature of jurisdictions resources to do work effectively and efficiently

b. Criteria to be considered.

(1) Prerequisite is state enabling legislation

(2) Need for adequate funding

(3) Function to be administered must be

e. Necessary to develop effective management and coordination procedures to conduct multi-jurisdictional activities.

f. Proper professional management may not be cost/effective for small local communities.

4. Concepts involved in an Areawide Approach

a. Historical development

(1) Federal role

(2) Action at state level

b. Functions of areawide organizations

(1) Agreements and contracts are the usual mechanisms to create areawide organizations.

(a) Usually exist as advisory bodies

(b) No authority to implement plans

(c) Authority for implementation reserved within decision-making power of individual member jurisdiction.

(2) Primary function to coordinate activities and programs between jurisdictions.

(a) coordination responsibility takes form of planning how function of several jurisdictions might be discharged.

(b) contributes to economical and efficient delivery of services.

(3) Major function is to develop and demonstrate practicalities of centralized management.

(a) Purpose is to promote conditions

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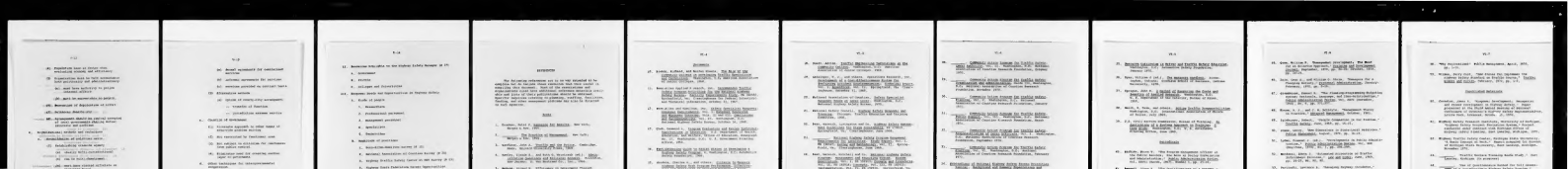

(d) Functions based on fixed rate, variable rate, and efficiency.

(e) Alternative ways to take advantage of economies of scale.

(f) Ways to make equitable to private vendors efficient

(g) Ways to encourage in public.

(h) Encouraging of Expansion of other

(i) Reference Materials.

(j) Alternative ways to provide equitable and economically feasible School Services and facilities

3. Supplementary services and facilities

a. Consolidation of individual units.

(a) Establishing regional administrative units

(b) Establish multi-functional units

(c) Use of Intermediate units

(d) Ways to make regional activities or programs.

(e) Model methods of contracting services

(f) Alternative methods for contracting services provided on contract basis

(g) Alternative methods

(h) Issues of county-city management

(i) Transfer of function

(j) Jurisdiction extreme service

b. Charter of Governance

(1) Alternative approach to other forms of governance and control

(a) Non-existent or functional case

(b) Not subject to principles for contracting services

(c) Alternative ways for creating centers of Governance

c. Alternatives for intergovernmental cooperation.

(d) Model methods for contracting services

(e) Alternative methods for contracting services provided on contract basis

(f) Alternative methods

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to the average citizen who is not concerned about thefts or noise, unless it directly affects him. Captain Bright did not consider the full legal aspects of such a law; departmental policy toward the enforcement; ethical questions; special interest groups; political factors; internal station morale; and external or public relations considerations before the decision was made. It was evident that he considered these factors only after someone of higher authority or a special interest group complained about a problem created by enforcing or not enforcing the ordinance. In other words, the Captain did not establish valid criteria in which to judge community complaints.

Many police decisions affect the public and should be widely announced and clearly explained prior to enforcement. Captain Bright should have developed some universal method of announcing and explaining the necessity for enforcing the 2:00 am to 4:00 am parking law.

Once enforcement took place, complaints for such enforcement flooded the station. Here again, a law enforcement officer must enforce statutory laws, especially when a formal complaint is made. The Captain did what was legally required, however, personnel enforced the ordinance without using discretion. Whether it was in retaliation to unfavorable personnel policies initiated by the Captain or a method to

embarrass him is for the reader to decide. The men apparently realized the Captain had created a paradox. They could enforce any law in the legal manner as they desired. Their strict enforcement of the parking law resulted in the Department reassigning the Captain to a position where his decisions could not directly affect the community.

Generalization

Many of the generalizations contained in this case study have been listed in the evaluation of the case. To ensure that the learning process of the case study is complete, those generalizations and others that apply to the study are enumerated.

1. Initiation of any administrative policy decision will result in similar resistance to change and create like problems in the initial stages of development.
2. The administrator making most of the decisions stymies initiative and instills distrust in subordinates.
3. For an administrator to be able to give an adequate amount of thought-time to long range problems, he must delegate many decisions.

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SOME EARLY DECISIONS

A decision was made to form a non-profit educational corporation with annual dues, ranging from $300 to $800 depending upon pupil enrollment, for each member public school district. The college agreed to underwrite meeting space, secretarial service, and salary for the executive secretary.

Control of the Council would be vested in a Board of Trustees to include three superintendents of member school districts elected by their peers; three staff members of the college appointed by the president; and one county superintendent of schools chosen by his colleagues in southern New Jersey.

The Council would be similar to other school study councils in that it would offer its members publications on educational research and experimentation, and its members would share ideas and promote curriculum development at a reduced cost.

The new organization would differ from most Councils, however, by limiting its research to curriculum matters of interest to schools in the local geographical area, and by involving consultants for its scheduled studies to work directly with staff members in the member schools.

It was decided to proceed with the plan if a minimum of 20 school districts joined--enough to make the organization financially feasible. After an informative campaign through mailings, talks at county-wide educational roundtables, publicity at the state education association convention, and personal contacts, 42 districts signed up in the spring of 1963 for the following school year. The unanticipated number indicated a fine degree of interest in the plan, but was later to prove something of a strain on the resources of the new organization.

THE FIRST YEAR OF OPERATION

For the school year 1963-64, the planning group limited Council activities to two major study areas. Fourteen districts chose "Reading in the Secondary School" as their year's project, while 28 other districts chose "Study Skills and Critical Thinking."

Ten consultants, members of the college staff, chosen for their technical competence and ability to work with public schools, visited the districts an average of eight times each during the school year, met with local committees, and aided in planning or revising programs designed to meet the needs of each particular school system.

The Board of Trustees met regularly to establish policies and precedents for the fledgling organization. A College Resource Board, including representatives from every department at the college, served the Council in an advisory capacity.

During the year the new Council conducted several conferences:

An all-day conference for orientation of all local committee members in October.

Meeting of consultants with leaders from the state department of education on policy coordination in December.

Leadership conference for all local study chairmen in January.

An exchange-of-ideas conference for all local committees in February.

The annual meeting and superintendents' evaluation forum in April.

A leadership conference for the following year's chairmen in May.

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(4) Population base is factor when evaluating economy and efficiency

(5) Organization must be held accountable both politically and administratively

(a) must have authority to police internal affairs

(b) must be accountable to people

(6) Prevention of duplication of effort

(7) Political feasibility

(8) Arrangement should be logical grouping of local governments sharing mutual interests and problems

6. Organizational methods and techniques

a. Consolidation of political units.

(1) Establishing areawide agency

(a) usually multi-jurisdictional

(b) can be multi-functional

(c) must have elected officials on governing board

b. Coordination of similar activities and consolidation of functions.

(1) More acceptable than consolidation of political units

(a) preserves integrity of units

(2) Most frequently used methods are various types of intergovernmental agreements or contracts

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(a) formal agreements for centralized services

(b) informal agreements for services

(c) services provided on contract basis

(3) Alternative methods

(a) Option of county-city arrangement

-- transfer of function

-- jurisdiction assumes service

c. Councils of Government

(1) Alternate approach to other means of area-wide problem solving

(2) Not restricted by functional area

(3) Not subject to criticism for remoteness from public control

(4) Eliminates need for creating another layer of government

d. Other techniques for intergovernmental cooperation

(1) Concept of joint power organization

(a) County Highway Safety Organization initiated by Supervisors Association of California

(b) Becomes a legal governmental unit

- can use in-kind matching funds

- use of collective personnel

- becomes eligible as an applicant agency

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II. Resources Available to the Highway Safety Manager (# 27)

A. Government

B. Private

C. Colleges and Universities

III. Manpower Needs and Opportunities in Highway Safety

A. Kinds of people

1. Researchers

2. Professional personnel

3. Management personnel

4. Specialists

5. Technicians

B. Magnitude of positions

1. Booz-Allen-Hamilton Survey (# 12)

2. National Association of Counties Survey (# 20)

3. Highway Traffic Safety Center at MSU Survey (# 63)

4. Highway Users Federation Career Opportunities Booklet (#17)

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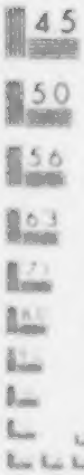

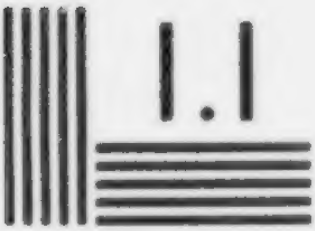

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one, including his fellow officers. He never married, lived alone and enjoyed good food and fiction novels.

Grandview Patrol Station is one of ten stations located within the city that provides services for over 1 million people. It covers 40 square miles and has a mixture of single and multiple dwellings with business establishments located on the main streets.

Captain William Long commanded the station for 4 years prior to Captain Bright's assignment. Morale was good, the men were able to pick their work shifts according to seniority. The crime rate was the fourth highest in the city for all major offenses. In general, the patrolmen considered Captain Long as a good able administrator, easy to get along with and democratic in his dealings with the men.

New Policies

During the first two months under Captain Bright's administration, the station and its policies remained the same. In March, 1967, the first new administrative decision appeared on the bulletin board announcing that all patrolmen of Grandview Station would conform to department rules and regulations by not accepting free meals. Up to this time it had been the practice by patrolmen to accept free meals. Effective one week later, a station order was posted

to notify members of the patrol force that beginning April 1, 1967, all patrol and traffic officers would be assigned to different cars on rotating shifts. The immediate reaction to these new orders was resentment toward the new Captain. Many veteran officers, who had been assigned to the station for years had outside or extra jobs and planned their shifts to meet the extra employment. Twenty-two men requested a transfer to other patrol stations in the city that still ran their duty assignments according to seniority. Morale began to deteriorate.

In early April, 1967, Mr. Sirmans, representing home owners in a mixed neighborhood of apartments and single residences wrote a letter to the Captain complaining about the streets being cluttered with cars, some considered junkers, numerous thefts in the area and people sitting in cars during the early morning hours making loud noise.

The Captain conferred with his Lieutenants and Sergeants about the complaint and advised them a directive would be submitted regarding enforcement of certain laws to handle the situation. Sergeant Smith asked Captain Bright what law did he have in mind? The Captain stated he was thinking of enforcing the no parking ordinance between 2:00 am to 4:00 am daily. No other opinions or questions were asked by the staff or other information offered by the Captain.

THE LEADERSHIP CONFERENCE

Perhaps the most significant meeting of the year was the first Leadership Conference, attended by local district committee chairmen and conducted by college staff members.

In this all-day session real problems of the local chairmen were taken up. These, of course, could have been predicted from a reading of the literature referred to in Chapter II of this Handbook, but had not been seriously examined up to this point.

The minutes of the meeting were published as a mimeographed document called "What Kind of Leadership?" which was the predecessor of this Handbook.

District committees developed an annual report, mimeographed for distribution to all member districts as well as for home consumption. Reports contained conclusions and recommendations directed specifically at the local district administration.

From these reports and from a wealth of personal experience, the consultants wrote two Handbooks which were published for member districts and general public sale: Reading in Grades 7-12 and Teaching Study Skills.

At the end of the first year, 31 districts renewed their contracts with the Council, and five new districts joined. Districts which dropped out of the Council did so for a wide range of reasons: lack of finances due to budgetary problems, school staff and consultant not knowing how to function effectively together, choice of a study topic which the staff felt was not important, a feeling that the district could now continue its curriculum work without the aid of the Council.

THE SECOND YEAR

For the second year several changes were made in the operation of the Council. The Trustees enlarged the choice of study areas for member districts to include any project in curriculum for which the Council could find adequate consultant service.

A number of systems continued their initial studies. Other choices included:

- Reading at the elementary level
- A program for the culturally different
- Classroom dynamics
- The reluctant learner
- English K-12
- Social Studies K-6
- Modern mathematics K-8
- Block-of-time programs 7-8
- Social studies K-8
- Foreign language 7-9

Another change was the allocation of CDC budget funds for conferences on topics other than those already under study by districts. As a result new or experimental ideas could be investigated without a district having to commit itself to a year's study.

Notable during the second year were two conferences with nationally-known speakers, an improvement in the quality and substance of some of the annual reports, and the promotion of an NDEA summer workshop for teachers of disadvantaged children.

By the end of the year, the Council was apparently in the process of stabilizing membership. The college indicated its confidence in the organization through increased financial assistance in the form of professional and secretarial salaries.

Encouraging reports from many member districts indicated satisfaction with the growth which had taken place in staff members during the two-year period.

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Two days later a directive was posted on the bulletin board and each Sergeant read it to personnel at roll call briefing. The order stated, "All patrol units from this date forward will enforce 2:00 am to 4:00 am parking in the residential area surrounded on the East and West by K Street and Indiana Street and on the North and South by 1st Street and Pierce Boulevard." The streets contained no posted warning signs to the effect that it was illegal to park cars in residential areas between 2:00 am to 4:00 am. Most of the citizens were unaware that such a law existed. The ordinance had been in effect for thirty years, but because of the work load and shortage of personnel and type of law, no attempt had been made to enforce it.

On the early morning shift thirteen patrol cars were used to handle the crime problem in Grandview. The whole Department deployed units according to the area need and amount of criminal activity. During the first week that the directive was in effect, a total of nine citations were issued. The Captain reissued his order with the qualification that orders would be complied with. The following week three citations were issued for 2:00 am to 4:00 am parking.

At the end of the secondweek the Captain called in all supervising personnel for a staff meeting. The discussion focused on non-compliance of orders by patrolmen. He cited

the 2:00 am to 4:00 am parking orders and demanded that each supervisor see to it that the men enforce his orders. Lieutenant Brown, a veteran of Grandview Station for 9 years, brought up the fact that the thirteen cars were too busy between 2:00 am and 4:00 am each morning to enforce the directives. Other administrators agreed. The Captain stated he anticipated this sort of argument and personally checked the activities sheet of each officer and found ample time to write parking citations. The other supervisors inspected the log sheets and agreed with the Captain.

That evening the briefing Sergeants made it clear to the patrolmen that the Captain wanted his orders followed. Several officers commented about the order and its affect on good police work and emergency situations. That morning the area cars were busy handling large gatherings of juveniles and numerous calls resulting in no citations being issued. Similar situations and required services occurred on Saturday and Sunday.

On Monday morning, Captain Bright was checking the weekend activities through the weekly summary form. He noticed that no citations were issued since his staff meeting Thursday. He immediately called the staff into emergency conference and demanded to know why his orders were not followed. Each supervisor presented the activity sheet of

of the patrol cars that indicated excessive amounts of criminal activity during the weekend. The officers patrol time in each case was well accounted for and there was never an indication on a log sheet that time was available to enforce 2:00 am to 4:00 am parking. Captain Bright made the statement that officers were padding the logs and the supervisors were supporting them in an effort to purposely defy him. The meeting was ended with no further comment on the situation.

Enforcing the Order

That afternoon an order was issued stating noncompliance with all directives would result in disciplinary action. Morale was at an all time low for the station. Officers complied at once by issuing 39 citations during the early morning hours for 2:00 am to 4:00 am parking. That number of citations continued for two weeks resulting in an increase in resisting arrest, interfering, insolence and insulting behavior. The burglary rate increased in the business area, especially between 1:00 am and 6:00 am causing the local businessmen to complain to the Captain for more police protection. Phone calls to the station increased by citizens wanting to know why their vehicle was cited for parking in front of their homes. Desk personnel were kept busy answering irate citizen complaints which frequently tied up the lines for emergency calls.

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Community Pressure Groups

Shift Lieutenants and Sergeants made inspections of residential parking affacted by the station order. It was evident that the officers were enforcing the law. The streets were almost vacant during the early morning hours while car thefts decreased to the lowest level in 5 years.

The local newspaper carried articles both pro and con on enforcing 2:00 am to 4:00 am parking. As a result, several citizen committees were formed to present their feeling about the situations. Mr. Sirmans and his group met with Captain Bright and expressed their approval of the enforcement action. He presented a letter to the station that stated the home owners in the area appreciated the streets being cleared of junkers and people sitting in cars during the early morning hours drinking and making noise. The letter was noted by Captain and posted on the Bulletin board.

Officers continued to enforce the ordinance. Apartment owners formed an association to protest the law because of the many renters who owned more than one car and had to park the extra vehicle on the streets. Their protests were heard at City Hall and by the Chief of Police. As a result, Inspector Fred Jones visited Captain Bright to discuss the situation. He presented the apartment owners complaint protesting enforcement of the parking ordinance and suggested to Captain Bright that it was his duty to enforce the law and displayed citizen

complaints requesting its enforcement The Inspector appreciated the situation, but indicated that discretion in enforcement is part of the administrative job. The meeting concluded with the Captain agreeing to re-evaluate the directive.

The following day Captain Bright posted a new parking directive, to the effect that strict enforcement was not necessary and citations should be issued as needed. No further explanation was offered or indicated by the Captain or his administrators.

During the last part of May and the first week in June, 1967, the patrol force cited every car that violated 2:00 am to 4:00 am parking. Pressure from groups within the community continued to mount. Several citizens had been cited five or six times for parking in front of their apartments. When they appeared before the judges in the local judicial district, many of the citations were dismissed. Court officers were swamped with the increase in citations that filled the Court Calendar and delayed many trials. Finally the District Attorney and presiding judge conferred with Captain Bright to clarify the issue. The Court indicated that because of many major civil and criminal matters and the cost and time it took the judges to dispose of the controversial parking cituation, most were being dismissed by the judges in the interest of justice. The Captain presented citizen complaints

APPENDIX

CASE OF THE 2:00 - 4:00 AM PARKING
CONTROL DIRECTIVE

Introduction

This case describes the affects of a policy imposed by a new administrator on an organization.* Some of his decisions are studied, the reasons for each decision, the forces that prompted the decision, and the problems generated by it. The case centers around a decision to enforce a malum prohibition law that had not been enforced until the administrator received a citizen's complaint.

Background

Captain Thomas A. Bright was transferred to Grandview Patrol Station in January, 1967. Prior to this assignment, he spent 4 years commanding the Central Jail; 3 years at the same facility as a Lieutenant; 3 years as a Traffic Sergeant; and 6 years working as a Patrolman. He received a baccalaureate degree from the state university in 1947 with a major in the social sciences.

Fellow officers regarded him as a competent man, somewhat quiet and reserved, able to think for himself, professional in his work but peculiar because he appeared to trust no

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*The names of persons and jurisdictions used in this case study are entirely fictitious. The facts have been taken from an actual situation.

to justify enforcement action, but agreed that if most of the citations were being dismissed, he would direct officers to discontinue issuing citations.

Two weeks later Captain Bright was transferred to the Central Jail. He was replaced by Captain Jim Berg who eliminated rotating shifts and 2:00 am to 4:00 am parking directives. Morale increased and most transfer requests to other patrol stations were withdrawn.

Evaluation and Comments

The Captain's first administrative actions can be considered professionally justified, however, initiation of any administrative policy decision will result in similar resistance to change and create like problems in the initial stages of development. In turn, this case points out that any change in normally accepted practices requires internal cooperation prior to external cooperation and enforcement. Captain Bright failed to realize or appreciate the natural tendency to resist change.

A pressure group requested enforcement of an unpopular law. Captain Bright could have handled the complaint differently by considering the following alternatives: (1) avoid enforcing the 2:00 am to 4:00 am parking regulation; (2) provide conspicious patrol in the area of concern to discourage thefts and noise; (3) enforce the law; (4) enforce

the law, but issue warnings; and (5) enforce the law, but first condition the public and officers to the need for such enforcement. He chose the least acceptable alternative in making his decision. Any of the others would have resulted in less resistance.

When Captain Bright issued his orders, he did not properly prepare for the decisions. A staff meeting was called on several occasions to discuss the problem, but he failed to delegate the matter, thereby mistrusting others with responsibility to handle the complaint. He failed to realize that the best decisions are made by a staff group who affect the operational, policy making functions of the station.

Each directive or station order issued was written and posted for all to read. Resistance to change would have been minimized if some explaination or reason would have accompanied the order. Lines of communications must be open and policies of the department clear to those responsible for it. Policy in this matter was not clear.

The 2:00 am to 4:00 am parking law is another factor that played an important role. Numerous case studies indicate that malum prohibition law requires public support before enforcement can take place. The 2:00 am to 4:00 am parking law is definitely a malum prohibition law, quite unpopular

4. Internal acceptance of policy making decisions is necessary before external application can successfully take place.
5. Malum prohibition laws require public support before appreciable enforcement can take place.
6. Better decisions occur when they are made with the aid of a staff or persons concerned with the issues.
7. The administrator must consider departmental policy, the law and its precedence, special interest groups and factors affecting internal and external support in creating decisions.
8. Information concerning the "pulse of the community" is most difficult to obtain, therefore the administrator must have experience in predicting the reaction of the community to a given type of decision.
9. Any administrative decision that requires departure from established behavior must be programmed into acceptance by those affected.
10. Unless adequate explanation appears, operation policy decisions can be enforced and interpreted in as many ways as there are persons responsible for its implementation.

STATE OF OHIO
DEPARTMENT OF HIGHWAY SAFETY
Ohio State Highway Patrol Bureau of Motor Vehicles
240 PARSONS AVENUE
COLUMBUS, OHIO 43205

JAMES A. RHODES
GOVERNOR

WARREN C. NELSON
DIRECTOR

May 5, 19-Safety-9

TO: ALL STATE AND LOCAL W R A P COMMISSION AND COMMITTEE CHAIRMEN, MEMBERS - OHIO FEDERATION OF BUSINESS AND PROFESSIONAL WOMEN'S CLUBS

Dr. Ruth Morris, Chairman
W R A P Commission
1948 Cass Road
Toledo, Ohio 43614

Dear Dr. Morris:

This letter of gratitude, written to you, but directed to all "who may be concerned" - will also serve as a Foreword to our publication of the Patrol Defensive Driving Manual. As your group and associates meet at the annual convention of the Ohio Federation of Business and Professional Women's Clubs, we want all of you to know how grateful we are for your services toward our department's objectives. And we do hope for your continuing services in these efforts.

Although this Manual will be used by many groups, in addition to your Ohio Federation and W R A P Commission, we are happy to dedicate it to you and all of your associates, both on the state and local club levels. Of course, apart from this dedication, we have already made token expressions of our sentiments in the form of special certificates.

As you know, we have processed for you the Guidelines you prepared for sponsoring and administering Defensive Driving Courses. Previously we supplied you with samples of kits of materials available to leaders and to participants.

This Defensive Driving Course Manual, as you know was originally developed by a task group headed by Lt. Joseph A. Wolfe,*formerly with the State Highway Patrol, and now executive of the Safety Council of Columbus Area Chamber of Commerce. With his counsel we have prepared this latest edition. We are therefore grateful to him and his associates and to the Federation of Ohio Safety Organizations for their commendable services. As you know, suggestions are offered here for sponsoring both a four-hour and a three-hour course.

Also, as a complementary part of this Manual, we have had produced professionally the Chart (somewhat revised) used in the course. This too has been reviewed with Mr. Wolfe.

Our Research and Services staff planned and coordinated the production of all of these materials; and also did all of the necessary editing. A copy of the Course Manual and a Flip Chart will be sent to and earmarked for each Patrol Post - and to members of your Commission. A limited number will also be held by our department for other uses.

We wish all of you well!

Sincerely,

WARREN C. NELSON, DIRECTOR
Ohio Department of Highway Safety

"Make Safety Your Driving Ambition" *"Speeding is a Habit — Brake it"* *"Make Safety a Family Affair"*

* Member, American Society of Safety Engineers

21997

STATE OF OHIO
JAMES A. RHODES
GOVERNOR

STATE HIGHWAY PATROL

ROBERT M. CHIARAMONTE, SUPERINTENDENT

DEPT. OF HIGHWAY SAFETY
WARREN C. NELSON
DIRECTOR

Columbus, Ohio 43205

FILE NO. 00-2-220

TO: Ohio Federation of Business and Professional Women's Clubs

SUBJECT: Driver Improvement Program

The Ohio Federation of Business and Professional Women's Clubs is to be commended for the presentation of this driver improvement program.

We are convinced that your efforts have contributed immeasurably toward the prevention of traffic accidents. We are also certain that your program will be effective in the future as a result of your dedication to furthering the cause for safety.

This constructive, educational traffic safety activity is an excellent example of accomplishment through determination of purpose and dedication of efforts that contribute to the safety of many people.

Very truly yours,

Robert M. Chiaramonte

Robert M. Chiaramonte
Superintendent

STATE OF OHIO
BUREAU OF MOTOR VEHICLES
P.O. BOX 1199-DEPARTMENT ___
275 S. 4TH ST., COLUMBUS, OHIO 43216

JAMES A. RHODES
GOVERNOR

FRED RICE
REGISTRAR

Dear Friends:

Because we have a mutual interest, that of traffic safety, it is a special pleasure to extend congratulations on your fiftieth year celebration.

The W R A P Commission and your Club W R A P Committees have put forth valuable services in behalf of traffic safety. These services are especially appreciated at the Bureau of Motor Vehicles since one of our duties is to collect the revenue for driver education through the issuance of driver licenses.

At anytime that we can be of service in any way, please feel free to call on us.

Sincerely yours,

FRED RICE
REGISTRAR

FR:mng

THE
OHIO
FEDERATION
OF
BUSINESS AND PROFESSIONAL WOMEN'S CLUBS

AFFILIATED WITH THE NATIONAL FEDERATION OF BUSINESS AND PROFESSIONAL WOMEN'S CLUBS, INC.

TO: Business and Professional Women of the Ohio Federation

SUBJECT: Women Responsible for Accident Prevention

The Ohio Federation of Business and Professional Women's Clubs is dedicated to citizen support through its program of civic participation. Our organization is honored to have such a responsible cooperative role presenting this Patrol Defensive Driving course to communities throughout Ohio.

In the presentation of this manual, we wish to extend our sincere gratitude for support to our Governor, the Honorable James A. Rhodes - to Mr. Warren C. Nelson, Director of the State Department of Highway Safety - to Colonel Robert M. Chiaramonte, Superintendent of the State Highway Patrol, whose service has been immeasurable - to Joseph A. Wolfe who as a State Highway Patrolman prepared and compiled the original version of this manual...and which is still basically similar in this edition to the original version - to Professor William E. Stuckey of the Cooperative Extension Service at the Ohio State University, for the outstanding service he gave us in helping to administer the original course - and finally to the Federation of Ohio Safety Organizations and its State Defensive Driving Coordinator, Mr. Harry R. Werner, Jr., Manager of the Toledo-Lucas County Safety Council for the tremendous help and continuing guidance he and his organization have given us. We thank the Federation of Ohio Safety Organizations for underwriting the cost of production of course instruction manuals for clubs these past two years.

Citizen education for accident prevention is the sole objective of WRAP as part of the total effort to reduce traffic accidents on our streets and highways. We appreciate the great need for responsible citizens to support existing enforcement and safety education measures. We intend to continue to so address ourselves to this objective.

Sincerely,

Ruth P. Morris

Ruth P. Morris, O.D.
Chairman, WRAP Commission

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Mrs. Hazel T. Zwayer

22000

COURSE OUTLINE
DRIVER IMPROVEMENT PROGRAM
(County or Local Training)

LESSON	SUBJECT	TIME ALLOWED
Lesson One	Course Introduction - Orientation and Traffic Safety Problems.	20 Minutes
Lesson Two	Defensive Driving Defined	20 Minutes
Lesson Three	Safety Equipment - Mechanical Condition of Vehicle	30 Minutes
Lesson Four.	Laws of Nature	30 Minutes
Lesson Five	Defensive Driving Principles.	60 Minutes
Lesson Six	Freeway Driving	20 Minutes
Lesson Seven	Rules of the Road	50 Minutes
Lesson Eight	Summary	10 Minutes

ADDENDUM

(1) The OFFICIAL OHIO DRIVERS MANUAL used in the course, as well as other materials are obtainable from the Ohio Department of Highway Safety.

(2) This department also has available films that may be used to enhance the value of the course.

(3) At the completion of the course certificates of satisfactory fulfillment may be given - and these too are obtainable from the same source.

(4) The time sequences indicated here are adjusted to a total course span of four hours. However, depending on the needs of the particular group and the judgment of the instructor, the course may be broadened or diminished, but within reason.

(5) Generally speaking increase or reduction may be made in the discussion that follows the instruction presentation. See individual chapter notes for time reduction for three-hour course.

Traffic Accident Problem - Today and in the Future

The latest available statistics should be used. National and state figures may be supplemented with local figures to add interest and personal involvement.

The following data are shown in general approximations as of this writing. Steady increases in all areas are being experienced, however these basic figures should provide assistance to you in building interest in the course.

NATIONAL

Registered Vehicles	99,958,000
Licensed Drivers	105,700,000
Motor Vehicle Mileage	One Trillion plus
Accidents (1967)	13,700,000
Deaths	55,200
Injuries (1)	2,000,000
Economic Costs	$10,700,000,000
Death Rate (2)	5.5
Drivers Involved in Accidents (1967)	24,300,000

(1) Injuries causing disability beyond the day of accident. Less serious injuries: Another 2,000,000.

(2) Per 100 million motor vehicle miles traveled

VT 013 337
Defensive Driving Course. Instructors Manual.

Ohio State Dept. of Highway Safety, Columbus.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - May69 40p. 1969 Revision

DESCRIPTORS - *TEACHING GUIDES; *DRIVER EDUCATION; *TRAFFIC SAFETY; COURSE OBJECTIVES; LEARNING ACTIVITIES

ABSTRACT - Prepared by the Ohio State Department of Highway Safety, this guide is for teaching a driver improvement course. Lessons are: (1) Introduction, (2) Defensive Driving Defined, (3) Safety Equipment: Mechanical Condition of Vehicle, (4) Laws of Nature, (5) Defensive Driving Principles, (6) Freeway Driving, (7) Rules of the Road, and (8) Summary. Each lesson contains time allotment, objectives, materials and equipment, and content and methods suggestions. The official Ohio Drivers Manual which is used in this course, and films and other materials are available from the Ohio Department of Highway Safety. (SB)

VT 013 337

21994

STATE OF OHIO
DEPARTMENT OF HIGHWAY SAFETY
Ohio State Highway Patrol Bureau of Motor Vehicles
240 PARSONS AVENUE
COLUMBUS, OHIO 43205

JAMES A. RHODES
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DIRECTOR

ED0 56238

INSTRUCTORS MANUAL

STATE HIGHWAY PATROL OHIO

COL. ROBERT M. CHIARAMONTE, Superintendent

DEFENSIVE DRIVING COURSE.

(Revised May 1969)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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VT013337

Programed in cooperation with FEDERATION OF OHIO SAFETY ORGANIZATIONS F.O.S.O. to further traffic safety education

21995

4.K

Published by Ohio Department of Highway Safety

JAMES A. RHODES
GOVERNOR

STATE OF OHIO
OFFICE OF THE GOVERNOR
COLUMBUS 43215

May 5, 1969

TO: ALL MEMBERS ..... OHIO FEDERATION OF BUSINESS AND PROFESSIONAL WOMEN'S CLUBS

Dear Friends:

Fifty years of devoted effort on the part of an organization dedicated to the advancement of business and professional stature of its membership on the one hand - and active civic participation in the life of communities throughout our state ..... these are remarkable principles by which a group or individual can perpetuate worth to fellowmen.

Yet, these constitute what we might call the personal code of the Ohio Federation of Business and Professional Women's Clubs and its total individual membership. To use a hackneyed expression, not many can make this claim.

As the Governor of our great state, I am happy to congratulate all of you at this beginning of your second fifty years of service. Particularly here I take note of your services in behalf of life-saving measures in traffic safety.

Sincerely,

James A. Rhodes

JAMES A. RHODES,
Governor

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON ONE:

Course Introduction - Orientation and Traffic Safety Problems.

Time:

Twenty (20) Minutes. (Reduce discussion time by 10 minutes for three-hour course.)

Objective:

To have students understand course content and importance of traffic safety knowledge.

Materials and Equipment:

Blackboard, chalk and eraser
"Ohio Accident Facts"

CONTENT AND METHODS

Notes

(This introductory lesson will be the only one in the entire course where class discussion potential is limited. In all other lessons it is highly recommended that instructor involve the students in discussion.)

Introduction

-- Instructor introduce himself and other participants or is introduced by representatives of sponsoring agency.

-- Have students introduce themselves giving names, city, county, organization and years of driving experience.

-- If time permits and class is small, list years of student driving experience on blackboard and total. Point out that their total experience and knowledge will be helpful in contributing to success of course.

Course Orientation

-- Review subjects to be discussed and time schedule for days activity.

-- Advise class that reference material will be passed out and explain procedure. (In most instances this material should be passed out after the lesson is completed.)

Appeal for Participation

-- Explain to class that lessons designed for student participation - show importance of:

- Participation in discussion.

- Asking questions.

- Future study and involvement.

Course Benefits to Students (These may vary with type of class)

-- Traffic toll serious national problem and inexcuseable.

-- Waste of most precious resources - lives and health of Americans.

-- Nine out of ten motor vehicle fatalities caused by driver or pedestrian error.

-- Learning arts and sciences of driving can prevent accident.

-- Information obtained from course will assist leaders -

- Basic qualifications of leader is ability to communicate.

The general committee throughout the year studied various reading programs and related topics. These included the Initial Teaching Alphabet, the Joplin plan, the linguistics approach, and others. The Osbornville plan, a locally developed modified Joplin plan arrangement, named after the school in which it originated, was evaluated by the committee.

A Glassboro State College faculty member worked as the CDC consultant with the district throughout its study. In the course of the year, committee members attended workshops and conferences sponsored by the CDC. Resource people were also called upon including Dr. Nila Banton Smith, Distinguished Service Professor in Reading.

Conclusions

By the end of the year, the committee reached a number of conclusions including the following:

Teacher enthusiasm appears to be an important ingredient in instructional success.

Interaction among teachers at committee meetings is an important method for educational sharing.

There does not appear to be a genuine difference between the vocabulary and comprenension skills of our fourth through eighth grade students.

Based upon results of the Gates Reading Survey, our students generally tend to conform to normal expectations while the lowest quarter contains fewer pupils than expected.

All teachers have some responsibility for the improvement of their students' reading.

Recommendations

These conclusions led the committee to make several recommendations to the local administration:

Preventive and remedial action, to be emphasized at grade levels three and four, should be considered as one approach to aiding readers with potential learning problems.

Remedial and developmental reading experiences should continue to be expanded, particularly at the secondary level.

Subject-matter teachers can do much to insure progress by students in their particular field, if they will teach effective use of the textbook and have a supply of supplementary materials readily available.

Results of the Gates Reading Survey should be made available to all instructional leaders in the district.

The reading improvement study, in affiliation with the Curriculum Development Council, should be continued for another year.

The Process

The pattern of group process seemed almost classic as the committee met during the year. The chairman understood principles of group dynamics, felt he had a strong committee, and did not hurry things. When some classroom teachers complained of "too much brass" attending committee meetings, he took care of the matter. Although chairman and consultant both doubted the workability of the sub-committee plan proposed after considerable discussion by the committee, they accepted it. Having "tested" its leadership's sincerity, the committee settled down to hard work, found its direction, and moved.

2172

STATE

Registered Vehicles	6,050,000
Licensed Drivers	7,000,000
Motor Vehicle Mileage	52,800,000,000
Accidents (1)	220,000
Deaths	2,555
Injuries	110,000
Economic Cost	$510,000,000
Death Rate (2)	4.8
Drivers Involved (3)	390,000

(1. Reported Accidents only)
(2. Per 100 million motor vehicle miles traveled)
(3. Excludes drivers of legally parked vehicles)

Based on prior experience, it has been predicted that by 1975 there will be approximately 125 million licensed drivers in the United States; registered vehicles, 117 million, and vehicle miles of travel, 1.24 trillion.

Current mileage death rate trends indicate at least 54,000 traffic deaths can be expected in the U.S. by 1975, unless there is a substantial increase in accident prevention efforts.

22005

Review Qualities of an Expert Driver (See Chart #3)

Notes

Expert driver . . . . knows:

-- What to look for.

-- How to insure seeing it.

-- How to comprehend its significance.

-- How to be in a position that will give him time for safe action.

(Chart #3 available for visual summary.)

Five Seeing Steps (See Chart #4)

Since "seeing" is important to defensive and expert driving review the following five steps and supplement remarks by drawing appropriate sketch on blackboard.

-- Aim high in steering.

-- Get the BIG picture.

-- Keep your eyes moving.

-- Leave yourself an out.

-- Make sure they see you.

(Chart #4 available for visual summary.)

Summary of a Defensive Driver . . . He is a: (See Chart #5)

-- Traffic hazard detective.

-- An analyst and evaluator.

-- Good communicator.

-- Good samaritan
in other words he is a:

-- Nib nose.

-- Cynic.

-- Gossip.

(Chart #5 available for visual summary.)

Suggest ending session on humorous note by showing Chart #6.

Shows that more people are getting loaded than box cars.

22008

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON THREE:

Safety equipment and mechanical condition of vehicle.

Time:

Thirty (30) Minutes. (Reduce discussion time by 10 minutes for three-hour course.)

Objective:

Acquaint students with importance of proper safety equipment and good mechanical condition of vehicle.

Materials: (See Charts #7 and #8)

Grab box of safety equipment.
Equipment for demonstrating seat belt effectiveness.
Diagram of vehicle inspection points.
Charts 7 and 8 (baseball catchers)
Blackboard, chalk, eraser
SMV Emblem Brochure.

CONTENT AND METHODS

Notes

Safety Equipment

Have a box containing the safety equipment that should be carried in the car. After appropriate remarks regarding importance of such equipment, remove the equipment from the box, a piece at a time, and discuss:
(Introduce with Charts 7 and 8 -- needed for protective equipment)

-- Flare

- A 15 to 20 minute red flare to be used when car is disabled at night. In addition to slowing traffic, the flare will provide light for changing tire.

-- Flashlight

- When trouble occurs, can be used for seeing about the car or for flagging traffic.

-- First Aid Kit

- Someone should be trained to give proper first aid.

-- Litter Bag

- There's a law against littering. Then, too, it's safer to put litter in a bag than it is to turn down window to throw it out.

-- Window Scraper

- Many accidents occur because vision is obstructed.

-- Sideview Mirror

- This, in addition to a glare-proof rearview mirror; but remember we still have a blind spot.

-- Sand

- A small box to give traction in case of ice may keep us going safely.

-- Slow-Moving Vehicle Emblem (SMV)

- For vehicles which normally travel 25 miles per hour or less.

Notes

-- Seat Belts

- Demonstrate principle of seat belts -- that is -- objects on the inside of car will continue to travel at same speed of car, if car stops, unless fastened down.

-- Others

- Fire extinguisher.
- Bumper strips.
- Tire chains.
- Tire changing tools.
- ? ? ?

Mechanical Condition of Vehicle:

Now discuss importance of good mechanical condition of vehicle. Volunteer checks and State Patrol Inspections indicate about 20 percent of vehciles on our highways have one or more defects.

Ask student to list points to inspect and discuss the "why" of each point.

-- Points to Consider

- Brakes - Two checks should be made. First, with car standing still, apply full pressure on the foot brake pedal. There should be at least one inch between the pedal and floor board when brakes are fully applied. Second, set hand brake and put car in gear and attempt to move forward. Hand brake should hold against engine pull.

- Lights - This check should include headlights, parking lights, turn signals, tail lights, stop lights and back-up lights.

- Steering - Excessive play in the steering wheel makes steering difficult. Turn wheel back and forth to determine play. Check tie-rod couplings. Excessive toe-in or toe-out and broken springs should be noted.

- Tires - Smooth rubber, cracks, and cuts, fabrics showing through, and presence of nails in tires should be eliminated.

Notes

- Exhaust - Muffler and tail pipe should be free of cracks and leaks. Loose or broken couplings should be corrected.

- Glass - All glass should be free of cracks and discoloration. Windshield should be free of stickers.

- Windshield Wiper - Turn on windshield wiper to make sure it operates. Check blades for deterioration.

- Rear View Mirror - Should be in place and free from excessive vibration.

- Horn - Sound horn.

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON FOUR:

Laws of Nature

Time:

Thirty (30) Minutes. (Reduce discussion time by 10 minutes for three-hour course.)

Objective:

To inform students regarding the relationship of laws of nature to safe driving.

Materials: (See Chart #9)

Blackboard, chalk and eraser.
Small object attached to rubber band to demonstrate centrifugal force.
Chart #9 listing chances of being killed in collision.
Stopping distance charts.

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON TWO:

Defensive Driving Defined.

Time:

Twenty (20) Minutes.

Objectives:

Have student understand the meaning and importance of Defensive Driving and its relationship to accidents.

Materials:

Charts 1, 2, 3, 4, 5 and 6.
Blackboard, chalk and eraser.

CONTENT AND METHODS

Notes

(Involve the students in the discussions whenever possible. Remember its easier for you to tell them the answer but more interesting and acceptable if they participate in solving the problems.)

Is it Possible to Operate a Vehicle Safely in Today's Traffic?

Yes - Professionals (truck drivers, bus drivers, etc.) with some rare exceptions, have reduced their accident rate per 100 million motor vehicle miles from 36 to 12.

Discuss Preventability of Accidents - (Get Views of Class.)

-- Are all accidents preventable - by whom?

-- Have class define preventable accident.

- If there is anything either driver could reasonably do to prevent it, no matter what conditions exist, it can be classified as preventable.

-- Review conditions (if time permits). (Road, weather, attitudes, physical and mental fitness.)

How Can Accidents be Avoided? (See Chart #1)

By drivers becoming skilled drivers.

-- Knowing HOW to handle a car. (Physical Skills)

-- WHAT to do.)
-- WHEN to do it.) Laws of man and laws of nature.

Drive Defensively.

(Summarize by showing Chart #1 which contains above listed information.)

Define and Explore Qualities of Defensive Driver. (See Chart #2)

One who expects the unexpected - recognizes driving hazards and adjusts to them.

-- Observes all laws (nature and man made) and road ethics.

-- Allows for lack of skills and knowledge on part of other driver.

-- Makes concessions to avoid collisions (concedes right-of-way.)

-- Recognizes common hazards.

-- Not caught at last minute making futile attempts to avoid accident.

-- Defensively alert to avoid accident traps.

Notes

Centrifugal Force

All moving objects have a tendency to travel in a straight line. When this tendency impels an object from a center of rotation it is called centrifugal force. By application of a stronger counter force this tendency can be controlled.

Demonstrate centrifugal force - attach small object to rubber band and whirl. Note how object tends to pull away. As the speed of the whirling motion increases the pull on rubber band increases. The pull is centrifugal force. The rubber band acts as a counter force and is called centripetal force.

Use blackboard to explain how centrifugal force, friction and speed affect a vehicle rounding curve.

Inertia

Tendency of object at rest to remain at rest and an object in motion to continue moving in a straight line.

Use seat belt principle as example.

Energy

-- Ability to do work.

- Potential energy.
- Kinetic energy.

-- Potential Energy:

- Stored energy - gas in tank is stored energy when ignited by spark it becomes kinetic.

-- Kinetic Energy:

- Energy of motion - greater the speed of object, the greater its kinetic energy and momentum.
- It's a measure of how long a motion of an object persists.

  (Example - distance car moves after accelerator pressure released.)

- Varies as the square of the speed - if you double speed of car (30 mph to 60 mph) you quadruple the amount of kinetic energy (takes four times as far to stop.)

Gravity

-- Downward pull. Natural force that causes objects to be pulled toward center of earth.

-- The amount of pull is called weight.

AN OVERALL EVALUATION

This interim overall evaluation of the work of the Curriculum Development Council program, 1963-65, is based on annual district reports, evaluations conducted at the various conferences, and the direct observations of the executive secretaries.

Some Council Successes

1. Fine support of the idea from college staff members and school district leaders in the experimental period.*
2. Enthusiastic attitudes toward curriculum change among classroom teachers in many Council schools.
3. Maturity of thinking on the part of many school superintendents in recognizing realistic goals in curriculum development.
4. Leadership improvement sessions which served to inspire local Council chairmen and clarify their roles.
5. The fine work of many consultants of high caliber and dedication.
6. Growth in the ability of schools to use consultant service profitably, accompanied by growth in the ability of consultants to apply their skills.
7. The publication of handbooks, bulletins, and annual reports.
8. Continued development of an excellent working relationship between the college and the public schools.
9. Improvement effected in schools as a result of the Council operation.

Some Unsolved Problems

1. The need for more careful selection of study topics limited to tangible goals appropriate to the local school situation.
2. The need for public school staffs to realize that curriculum revision is an on-going, continuous effort, not concluded at the end of a study.
3. The need to produce meaningful results in order to convince local school boards of the importance of adequate finances for action research.
4. The need for a continuing leadership program for local chairmen and consultants.
5. The need for better communication between local study committees and the total school staff.
6. The need to find better ways for Council districts to share their curriculum improvements with others.
7. The need for increased Council staff to insure more comprehensive service and help to member districts.
8. The need to draw further on the abilities of the College Resource Board.

*The writers wish to pay tribute to the preparatory committee members from the Glassboro State College staff, whose help was so valuable in the formation and achievements of the Council: Dr. Lawson J. Brown, Dr. Horace T. Keller, Dr. Stanton B. Langworthy, Dr. Lawrence E. Smith, and Dr. V. Eugene Vivian; and to the presidents of the Council, Superintendents Paul Jones of Cherry Hill Public School District, Lawrence R. Winchell, Jr., of Margate City Public Schools, and Herbert Gansz of Deptford Township Public Schools.

2173

Notes

- Pull of gravity is stronger when driving down hill than on level. This will increase kinetic energy (motion) and increase stopping distance.

Center of Gravity

-- In auto there is a point on which the whole weight is centered - a point at which distribution of weight will evenly balance off pull of gravity.

- The higher this center the more likely the car is to tip.

- Automotive engineers have lowered this center.

- Adding weight (luggage, etc.) on top raises this center.

Force of Impact

-- Amount of force with which two or more objects are brought together.

-- Measured by pounds - determined by speed of object and resistance moving object encounters.

- Driver can control speed but not weight. (fixed factor)

- Resistance varies with "give" of object. (stone wall vs bushes)

- When you double speed the force of impact increases about nine times.

-- Chart #9 shows chances of being killed at various speeds.

MPH	ODDS
21 - 30	1 out of 317
31 - 40	1 " " 98
41 - 50	1 " " 89
51 - 60	1 " " 32
61 - 70	1 " " 8
over 70	1 " " 3

Review Stopping Distance. (Pass out stopping distance charts.)

Speed - feet traveled per second - reaction time - braking distance - total stopping distance.
(Use dollar bill to demonstrate reaction time.)

22016

CONTENT AND METHODS

Notes

The material covered in this session is important to driving but can be very technical. Instructor should make every attempt to simplify this material. Use of blackboard and illustrations to explain important points is recommended.

Friction

A. If you push or slide one object over another you feel a force which opposes your attempt. This resistance to motion of one object pressing or sliding against or over another is called friction.

-- If you rub dry hands together there is more resistance than if hands were wet or soapy.

-- If pressure is applied to hands there is more resistance than if palms held together loosely.

(Ask students to experiment by rubbing hands together.)

B. Friction is neither good or bad - depends on how used.

-- Without friction we could not control car - need it to start, speed up, slow down, turn, stop.

-- If this force used improperly it can cause skid.

C. Coefficiency of Friction

-- Is a measure of frictional force available for controlling the vehicle.

-- Two types - sliding and rolling.

- Some sliding friction has less coefficiency than rolling.

- Stopping distance longer when skidding.

- Generally coefficiency greater if car slowed to a stop.

- The higher your coefficiency of friction the greater is control over the car.

-- Factors affecting coefficiency:

- Speed - lowers friction. At high speeds coefficiency may be only half of that at normal speed.

- Tires - smooth thread reduces friction.

- Road Surface - texture of road, wet pavement, snow and ice affect the coefficiency of friction.

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON FIVE:

Defensive Driving Principles.

Time:

Sixty (60) Minutes. (Reduce discussion time by 10 minutes for three-hour course.)

Objective:

Develop among the students an appreciation and understanding of the principles and techniques of defensive driving.

Materials: (See Chart #10)

Blackboard, chalk, eraser.
Chart number ten (10). How to avoid being hit from the rear.

CONTENT AND METHODS

Notes

Review Defensive Driving Principles

-- Trust no one - expect the unexpected.

-- Look for traffic hazards.

-- Communicate with others.

Test Knowledge of Class on Most Prevelant Types of Accidents

Before class begins, list the underscored words on blackboard and have class guess which type account for the most and least number of fatalities - then insert correct figures as follows:

Collision with non-motor vehicle (train, bike, animal, fixed object, etc.)	12.9%
Collision with pedestrian	17.2%
Non-collision - ran off road, etc.	28.2%
Collision with another motor vehicle	44.7%
Total	100 %

Review Six Positions Another Vehicle Can Take in Relation To Your Car Prior to Crash. (List on blackboard as discussed.)

I. Car in front of you
2. Car following you
3. Car approaching you from opposite direction
4. Car approaching you from angle
5. Car passing you
6. Car you are passing

Review Defensive Driving Procedures Used to Avoid Collision With: (Use of blackboard diagrams strongly recommended for rest of lesson.)

CAR IN FRONT OF YOU

-- Review safe following distance rule. (One car length for every 10 mph.)

- Review reaction distance - braking distance - stopping distance.

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON SIX:

Freeway Driving.

Time:

Twenty (20) Minutes. (Reduce discussion time by 5 minutes for three-hour course.)

Objective:

To have students develop an understanding of proper freeway driving techniques.

Materials:

Blackboard, chalk, eraser.

-- Causes of this type of accident.

- Inattention.
- Excessive Speed.
- Following too closely.
- Poor maintenance. (brakes, etc.)

-- Clues to look for:

- Brake lights or signals.

- Traffic congestion ahead.

- Tavern or motel ahead.

- Police officer ahead.

- Pretty girl walking down street.

- Ball rolling onto street or dog running across street.

- Children playing on walks.

- Pedestrian preparing to cross street.

CAR FOLLOWING YOU

-- What usually happens in this type of accident? (Suggest use of blackboard to depict accident.)

- Driver number one noting slow moving vehicle (farm tractor ahead) - applied brakes suddenly.

- Driver number two did not see slow moving vehicle failed to stop and crashed into vehicle number one and farm tractor.

- Was rear driver at fault? Possibly.

- Could it have been averted? Whose responsibility?

-- Re-enact accident on blackboard.

- Review stopping distance. (50 mph at 3/4 second reaction time = 55 feet during reaction period - 138 feet during braking period.)

- Diagram showing how lack of communication by number one caused driver number two to react 3/4 second and 55 feet later causing accident.

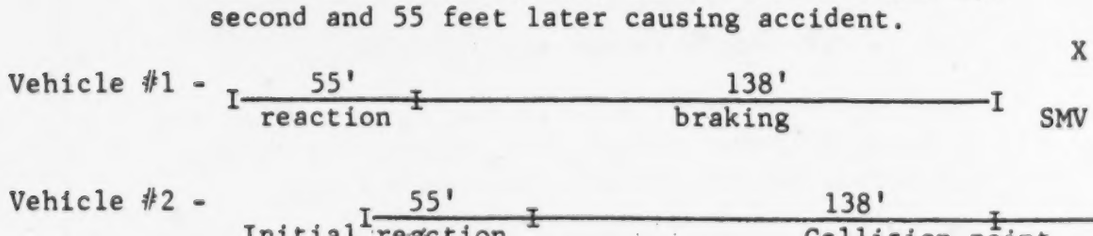

Notes

-- How to avoid being hit from rear?
(Summarize on Chart #10.)

- Signal well in advance of stops, turns, or lane changes.

- Stop gradually over a long distance, giving following cars more time to react.

- Flash brake lights when standing or moving slowly to warn high-speed vehicles coming from the rear.

- Keep pace with traffic within limitations of conditions and speed limits.

- Adjust inside and outside mirrors to give best possible view of the rear.

- Keep a check of vehicles in the rear.

- Avoid cruising in the blind spot of car just ahead in adjacent lane.

- Get rid of tailgaters by arranging for them to pass when it is safe.

- Raise hood if car is stalled and can't be moved out of a traffic lane. Turn on signal lights as an additional warning, especially if both right and left can be set to flash together. If not, some authorities think it is better just to use tail and dome lights.

- Never change your mind suddenly.

VEHICLE APPROACHING POSITION

-- Head-on collisions are extremely serious. Two cars approach each other at a speed equal to the sum of their speeds - if they collide, the impact is terrific.

- Only thin paint line separates the two. At times both drivers are inches from eternity.

- Keep away from centerline - plenty room on right.

- If other driver crowds or crosses line - give ground don't die fighting for your right-of-way.

-- Round Curves Expertly

- Stay in own lane - on own side of road.

- Decrease speed prior to entering curve - negotiate curve under power to overcome centrifugal force. (re-emphasize centrifugal force vs friction.)

-- Left Turns

- Signal intentions ahead of time - not after stopped.

- Position vehicle near center of road.

- If stopped, keep wheels straight ahead.

- Yield to approaching traffic.

-- Clues Review (Look for clues - don't trust anyone.)

- String of cars coming towards you - all out to get you. Where will you go.

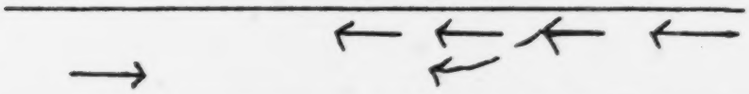

- Large truck coming towards you - cars behind truck. One may be following too close and veer into your lane to see.

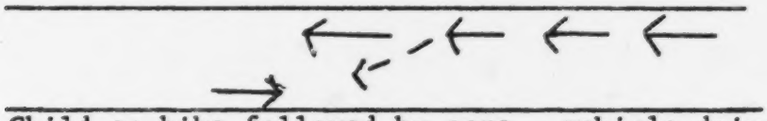

- Child on bike followed by cars - vehicle driver may pass bicycle and come into your lane.

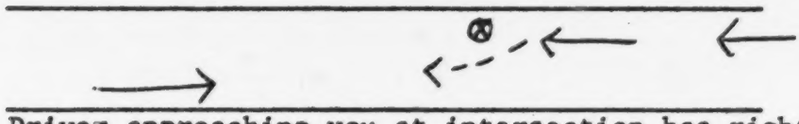

- Driver approaching you at intersection has right turn signal on. What if he turns left? Are you prepared?

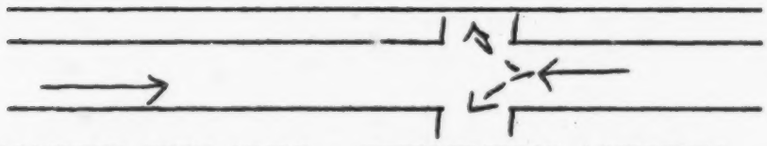

VEHICLE APPROACHING FROM ANGLE - INTERSECTION ACCIDENTS

-- Review dangers of intersection travel.

- Area of greatest traffic conflict. One-fourth of all traffic accidents occur at intersections and one-half the urban traffic deaths occur there.

- Indecision of drivers.

-- Four Point Plan for Intersection Safety - Know - Slow - Show - Go (Copy on blackboard)

KNOW

-- Drivers do unexpected things at intersections. They --

- Turn abruptly - often from wrong lane.

- Signal improperly - or not at all.

Note

- Stop suddenly - without warning.

-- Know in advance where you want to turn or what you want to do at intersections.

- Watch for map landmarks.

- Next exit signs.

- House numbers.

- Sudden last minute swerves cause pile-ups.

-- Know that traffic signs and signals only regulate traffic - they don't guarantee right-of-way.

- Obey them but be prepared to yield.

- Be cautious of traffic control devices that permit you to make your own decisions. (Yield, right-of-way signs, caution signals.)

- Be sure your decision is a safe one.

-- Know rules of right-of-way but don't die fighting for them.

-- Know your stopping distance - a critical matter at intersections - be prepared to stop.

- Know your reaction - braking and stopping distance formula.

- Remember on wet pavement it takes longer to stop.

- On ice, it takes up to ten times further to stop.

SLOW

-- Slow down for intersections - no place to speed-- your seeing distance is as important as your stopping distance.

- Slow down gradually.

- Never speed up to beat a light - may have to stop suddenly.

-- Have your foot off accelerator and over brake pedal - give yourself that extra split second reaction time.

-- Look to the left first, then right. Traffic from left is closest to you, crosses your path first - take second look.

SHOW

-- Show others what you intend to do - where you intend to go. Show by getting into proper lane.

-- Use turn signals at least a half block away.

-- To turn right get close to curb - watch for bicycles and pedestrians.

-- Don't try to beat oncoming traffic - pedestrians.

-- Keep wheels straight while waiting to make turn.

-- Check mirrors to see if others aware of your intentions.

GO

-- Go when sure. Get through intersection without hesitation. Over caution confuses others.

-- Go easy when light changes. Somebody may try to beat the signal.

-- Don't tailgate another car - something you can't see may make him hit brakes.

VEHICLE PASSING YOU

-- How Do You Feel When Vehicle Passes You? (Discuss)

- Emotional reaction - resentment?

- Reflection on your driving ability and capabilities of your car?

- Passing is a normal driving experience - no need to react emotionally.

-- What is Wrong When Too Many Vehicles Pass You? (Discuss)

- Speed too slow for traffic.

- Dangers of traffic stacking up behind us - impatient drivers - risky passes.

- Pull off road to allow traffic to go by.

- Discuss dangers of waving traffic on.

-- Dangers Involved in Vehicle Passing You (Discuss)

- Sideswipe - cut in - run off road.

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Notes

-- Traffic Situations Which Involve Being Passed (Discuss)

- Normal straight away driving.
- We may attempt to change lanes when another vehicle is overtaking on the right or left.
- We may be attempting to make a right turn.
- We may be pulling from a parked position.

-- Defensive Driving Rules to Remember When Being Passed (Discuss)

- Don't race - slow down and make it easy for other fellow.
- As soon as you realize you are being passed, check oncoming traffic - then slow down and give the passing car room to get back in line in front of you.
- Check the rear before changing lanes. Check mirrors and look back at the blind spot. Use turn signals then move over when lane is clear.
- When turning right - get into proper lane early - stay close to right hand curb to block right hand passes - use signals early.
- When coming out of parking space - don't nose out to look for oncoming traffic - take a good look before you move - wait for break in traffic - then pull out promptly.

VEHICLE YOU ARE PASSING

-- Discuss Reasons for Passing

- Other vehicle too slow.
- Emotional reaction - hate to follow other vehicle.

-- Is There Anything Wrong With Passing? (Discuss)

- Should be done with consideration and courtesy.
- Can cause sideswipes, head-on collisions, or run-off-road accidents.
- Nothing wrong if legal and done carefully.

-- What Do We Gain By Passing? (Discuss)

- Best to get into stream of traffic and stay there.
- Always ask yourself "Is this pass necessary?"
- It is legal - it is optional - sometimes desirable and necessary.

-- Places You Don't Pass (Discuss)

- Curves, hills, Railroad Crossings, Intersections, etc.

-- Four Conditions to Consider Before Passing (Discuss)

- Speed of your vehicle.
- Speed of vehicle being passed.
- Speed of oncoming vehicle.
- Distance of oncoming vehicle.

-- Things You Should Do To Insure Safe Pass (Discuss)

- Check rear view mirror - and blind spot
- Sound horn.
- Pass as quickly as possible.
- Pull back when you have sufficient clearance.

-- Good Passing Rule to Remember -

"When in Doubt, Don't"

CONTENT AND METHODS

Take a few minutes to discuss the changes taking place in our highway system. Point out that many of the defensive driving principles are the same on freeways as on ordinary highways. However, there is a major difference -- high speed. These straight, ribbon-like, concrete freeways save time and expense. Experience proves there are fewer accidents on these roads, but the accidents which do occur are big ones, usually involving three or more cars.

Not

Entering the Freeway

Purpose of acceleration lane:

-- Allow blending in with normal flow of traffic.

-- Stops are dangerous and cause rear-end collisions on acceleration lane and the freeway proper.

-- Freeway driver also has obligation -- he should cooperate by --

- Slowing down to create gap for entering vehicle.

- If traffic permits, he should move into left lane.

Driving on Freeway

-- Pick lane and stay with it.

-- Move with traffic, show speed can result in rear-end collision.

-- Follow at safe distance, remember your speed is greater, requiring longer stopping distance.

-- When passing, look before you start your movement and communicate your intentions.

-- Avoid monotony --

- Turn on radio.

- Vary speed as traffic permits.

- Open window for fresh air.

- Change sitting position.

- At night change light intensity on instrument panel.

- Stop every 75 - 100 miles for gasoline or refreshments.

- If all this fails, stop and sleep. Fatigue can result in disa

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Notes

-- Slippery spots at overpasses and bridges.

-- Disabled car?

- Pull off on shoulder.
- Raise hood.
- Tie handkerchief on aerial or door handle and wait for assistance.
- Don't walk or hitchhike.
- At night put on dome and flasher lights.

Getting Off Freeway

-- Plan your trip. Know the name and appropriate location of your desired exit.

-- Get into proper lane early.

-- Signal intent to leave as soon as you slow down.

-- Adjust your speed to normal highway speed and conditions.

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program for
highway
technicians

teacher's guide

Unit II
Highway Drawing

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of Continuing Education

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON SEVEN:

Rules of the Road.

Time:

Fifty (50) Minutes. (Reduce discussion time by 15 minutes for three-hour course.)

Objective:

Have students more completely understand the rules of the road.

Materials:

Blackboard, chalk and eraser.
Driver's Manual.
Who's Right - Who's Wrong cases.

DRIVER IMPROVEMENT PROGRAM
Leader's Guide

LESSON EIGHT:

Summary.

Time:

Ten (10) Minutes.

Objective:

Summarize Course - issue challenge.

Materials:

None.

CONTENTS AND METHODS

Use your own judgment on how your particular course should be summarized.

One approach could be to have students feed back to you one important item they got out of the course.

Summary should include a recap and challenge.

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Drawing. Teacher's Guide

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*ENGINEERING DRAWING; *D
CURRICULUM GUIDES; POST

HIGHWAY ENGINEERING AIDE
DRAFTING; PLANNING; TEST
TECHNICAL EDUCATION

ABSTRACT - Developed by
Department of Education
Department of Transporta
guide is for instructor
highway drawing as part
relieve the shortage of
The program is intended
additional technicians a
upgrading people employe
technical jobs. The main
document consists of 14
1) Drawing equipment an
Topography, (3) Drawing
(4) Highway plans. Each
references, objectives,
assignment, and some hav
Each lesson is designed
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TEACHER'S GUIDE

UNIT II

HIGHWAY DRAWING

HIGHWAY TECHNICIANS PROGRAM

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    - The Leader Looks at Self-Development
    - The Leader Looks at the Process of Change
    - The Leader Looks at Decision-Making
    - The Leader Looks at Communication
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FOREWORD

This Teacher's Guide, *Highway Drawing*, is one of a series in the Highway Technicians Program. This program was initiated by the New York State Department of Transportation (formerly the Department of Public Works) to help relieve the shortage of highway technicians. As a result of their initiative the first editions of Units I through V were published, starting in 1961.

John L. DeLee, now Principal Civil Engineer in the Bureau of Highway Planning of the Department of Transportation, planned the original series of nine units with the help of other personnel from the district offices. Edward Umiker, now Associate Civil Engineer in the Buffalo District Office of the Department of Transportation, and Ralph Fimmano, Senior Civil Engineer in the Utica District Office, collaborated in developing the topical outlines for the nine units.

Early in 1967 Philip E. Hagerty, Assistant Administrative Deputy of the Department of Transportation, called for a renewed effort to complete all the units planned in the program and to update as needed those already published. As a result, several Department engineers were made available as consultants to the New York State Education Department to do the writing needed in completing and updating the whole series.

The first edition of the present Guide (published in 1961) was written by Ralph Fimmano, under the guidance of Berton P. Plummer, Associate in the Bureau of Occupational Extension and Industrial Services of the Education Department. Frank E. Howard, former Associate in the Bureau of Vocational Curriculum Development and Industrial Teacher Training, also cooperated in the production of the 1961 edition. As part of the renewed effort to complete the program, Mr. Fimmano made the present revision. Nelson S. Maurer, Associate in the Bureau of Continuing Education Curriculum Development, supervised the revision and preparation of the final manuscript for publication.

To all the agencies and individuals mentioned above, this Bureau makes grateful acknowledgment for the responsibilities which they so faithfully fulfilled.

HERBERT BOTHAMLEY, *Chief*
Bureau of Continuing Education Curriculum Development

WILLIAM E. YOUNG, *Director*
Curriculum Development Center

INTRODUCTION

The rapid expansion in the building of state and Federal highways has caused a serious shortage of qualified technicians and engineers for planning, supervising, constructing, and maintaining highways. The New York State Department of Transportation and the State Education Department have collaborated in planning the Highway Technicians Program to overcome this shortage.

This program is expected to help provide the additional technicians and engineers by upgrading people employed in the lower-level technical jobs. This Teacher's Guide, *Highway Drawing*, and the others in the program are intended primarily to improve the skills and technical knowledge of those technicians.

Local boards of education and other sponsors of adult education programs are being encouraged to offer the courses in this program as part of occupational education. Besides attracting students from the Department of Transportation in the job categories mentioned above, students will also be drawn from the public works departments of counties, cities, and towns; in addition technicians, estimators, and junior engineers employed by construction contractors will be found in these classes.

The units of the Highway Technicians Program have been planned to be taught in numerical sequence. Enough subject matter has been included in each lesson for about 2½ hours of classroom instruction. The total length of the course, however, may be adjusted to fit in with the prior experience and education of enrollees.

The units in the Highway Technicians Program are:

Unit I. Basic Mathematics Review
Unit II. Highway Drawing
Unit III. Highway Surveying
Unit IV. Preliminary Highway Planning
Unit V. Soils and Drainage
Unit VI. Highway Design and Estimating
Unit VII. Highway Construction and Inspection
Unit VIII. Highway Structures
Unit IX. Highway Maintenance

EDWARD L. BOOTH, *Chief*
Bureau of Occupational Extension and Industrial Services

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Division of Industrial Education

CONTENT AND METHODS

Notes

In Lesson Four we discussed the laws of nature and their effect on safety. Let us now consider the laws of man.

Point out these laws are made for our protection.

It behooves all of us to know and abide by these laws.

Use the cases in the Who's Right - Who's Wrong mimeograph to stimulate discussion.

Introduce the Who's Right - Who's Wrong discussion by relating the three kinds of drivers responsible for our accidents:

1) Those who can't - physical limitations.

2) Those who won't - attitudes.

3) Those who don't know - Do you know the rules of the road? Use cases to find out.

WHO'S RIGHT - WHO'S WRONG?

Accident cases, with answers as interpreted from The Ohio Motor Vehicle Code.

CASE I: Car A is driving 40 miles per hour on the inside lane of a four lane roadway with marked lanes. You approach from rear to pass.

After following Car A for some time, you see that the driver is not going to give way to the right, so you start passing on the right.

Car A then proceeds to give way to right, colliding with your car.

Who is right - who is wrong?

ANSWER: Driver of Car A is wrong. The law provides that when outside a municipality, you may pass to right or left providing lanes are clearly marked and this move can be made with safety. However, if lanes are not marked, you shall pass on left only. Inside a municipality, you may pass on either side if traffic is moving in two continuous lines in the same direction and this move can be made with safety. Whenever changing lanes, a driver must ascertain that such movement can be made safely.

CASE II: You are going west on Route 40, west of Columbus, (on a four lane divided highway) at a rate of 45 mph. A school bus going east stops to unload children. As soon as you see the flasher lights on the bus, you apply your brakes and come to a sudden stop without giving arm signal.

Notes

Car B, following, cannot stop and collides with your car.

Who is right - Who is wrong?

ANSWER: In this case there are three phases of traffic law, stopping for school bus, signaling intention to stop, and stopping in assured clear distance ahead.

When a school bus stops on highway outside a municipality for the purpose of loading or unloading, drivers of all vehicles must stop at least 10 feet away from front or rear of bus, unless the highway has been divided in two roadways, separated by a physical barrier. Then, only the driver operating on the same roadway must stop. In this case, you did not have to stop, but it was legal to stop providing you gave the proper signal.

The driver of Car B was negligent inasmuch as he failed to stop within the assured clear distance ahead.

CASE III: Car A suddenly slows down to turn to the right without giving a signal. Car B, following, cannot stop, so he swerves into left lane to avoid Car A.

Car B collides head on with Car C, coming in opposite direction at a speed of 68 mph.

Who is right - Who is wrong?

ANSWER: In this case, driver of Car A did not give proper signal. Driver of Car B failed to stop within the assured clear distance ahead and drove into left lane of traffic when that lane was occupied. Driver of Car C, according to your statement, was driving 68 mph, thus exceeding the speed limit. Therefore, all three drivers were wrong.

CASE IV: You approach a through highway and stop in obedience to a stop sign. You see Car B coming, but he is way down the road, so you proceed. Car B collides with you and the investigation of the accident shows Car B to be travelling at a speed of 75 mph.

Who is right - Who is wrong?

ANSWER: The law states that when intending to enter a through highway, the driver shall stop, in obedience to a stop sign, and shall yield right-of-way to all other vehicles who are not obliged to stop. You were wrong because you did not comply. Driver B was exceeding the speed limit. So both drivers were wrong.

CASE V: You approach from the rear a car travelling at 20 mph. You try to pass several times but cannot.

Notes

So, you take a chance and try to pass, but you collide with a car going in the opposite direction.

Who is right - Who is wrong?

ANSWER: You attempted to pass when the left lane was occupied; thus, you are in violation. Driver of the car going 20 mph on a highway with heavy traffic was wrong. He was obstructing the natural flow of traffic.

CASE VI: It is 11 o'clock at night and raining hard. A truck without a tail light is driving ahead of you but you don't know it. You are driving at 45 mph on a road with a speed of 50 mph. You are blinded by the lights of an approaching car which did not dim and you collide with the truck.

Who is right - Who is wrong?

ANSWER: First of all, just because you were driving 45 mph on a road marked "50 mph", does not mean that you were not driving too fast. You should always adjust your speed to conditions. The driver of the truck did not have a tail light. The law requires that any vehicle using the highways at night must have a light on the rear, that can be seen 500 feet. Driver of the approaching car did not dim, thus he was in violation. You must dim your light when meeting oncoming vehicles. So, all were wrong.

CASE VII: You are involved in an accident which resulted in more than $100 property damage. You call the state patrol and they investigate and make their full report. Two months pass and you receive notice that your driver's license has been suspended for failure to report the accident.

Who is right - Who is wrong?

ANSWER: Even though an accident is investigated by an enforcement official, it still does not relieve the driver of the responsibility of reporting this accident to the Ohio Department of Highway Safety. The Financial Responsibility Law states that if there is personal injury or property damage in excess of $100 to either car, the accident must be reported within five days, on a form provided. In this case, the driver apparently assumed the report made out by the State Patrolman was sufficient. This is not true. The report form and information can be secured from any enforcement official.

SUMMARY

In all these cases the question is asked: "Who's Right and Who's Wrong?"

It doesn't really matter who is right and who is wrong if you're dead, right or wrong! So we must all remember not to be completely satisfied and at ease because we ourselves are obeying all traffic rules and regulations, but we must train ourselves to always be alert, drive defensively, and in this manner compensate for the other driver's lack of knowledge or so-called mistakes, if we hope to survive on our highways, Right or Wrong.

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_____. Standard symbols and abbreviations. Albany. 1965. (Referred to in this unit by symbol "E")

Sloane, R. C. & Montz, J. M. Elements of topographical drawing; 2nd ed. McGraw-Hill. 1943. (Referred to in this unit by symbol "C")

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Lesson 1 - Introduction to the Course

OBJECTIVES

1. To become acquainted with members of the class
2. To provide a description of the course
3. To point out the value of this unit in the training of a technician

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	* Print the name of the course and your name on the chalkboard, and give a brief description of your experience.
II. Purpose of Course	* Explain that the course is being given primarily for the upgrading of

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Department of Transportation technicians in the design office and in the field including: 1. Engineer technician 2. Surveyor's assistant 3. Inspector on construction 4. Design tracers
III. Introduction of Class Members	* Have each student introduce himself to the class, volunteering such information as his occupation and where employed.
IV. Required Student Equipment	
A. Textbook	* Write on the chalkboard the name of the basic textbook for the course, Ref. A. * Point out the advisability of owning a text. * Ask the students to sign a sheet for a group order.
B. Looseleaf notebook	* Suggest the advantages of keeping a looseleaf notebook for the recording of class notes and important job information.
C. Engineer's scale	* Stress the importance of owning an engineer's scale.
D. Instruments and equipment	* List on the chalkboard the equipment needed for this course: 1. Drawing pencils, 4H, 2H, and B 2. Penholder 3. Crow quill penholder 4. Crow quill penpoint 5. Tank penpoint (B-6) 6. Hunt penpoints, Nos. 22, 30, and 38 7. Drawing set 8. Drawing board and T-square 9. Drawing paper 10. Black india ink 11. Erasing shield and ruby eraser 12. Sharpening stone

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
E. Maps	* Order rural and urban 7½ min. U.S.G.S. maps of your area. Each student should buy both maps.
V. Course Prerequisites	* State that the students must have some knowledge of algebra and geometry, which is given in Unit I of the Highway Series.
VI. Course Description	* Indicate that this course covers many facets of drawing that are only indirectly related to highway work.
A. Title and brief resume of each lesson	* Explain briefly the subject material that is covered in each of the 14 lessons of this unit.
1. Introduction to the course	* Indicate that Lesson 1 gives a brief outline of the material covered in the course.
2. Drawing equipment	* Mention that Lesson 2 covers all the necessary equipment used in ordinary engineering drawing.
3. Use of drawing equipment	* State that Lessons 3 and 4 describe the proper nomenclature, manipulation, and adjustment of drawing equipment.
4. Topographic maps	* Emphasize that Lesson 5 presents a specialized type of drawing that records to scale the topographic features of a portion of the earth's surface.
5. Topographic symbols	* Indicate that Lesson 6 covers the conventional symbols used on topographic maps to convey a variety of information.
6. Abbreviations, lettering, and inking	* Explain that Lesson 7 presents the techniques that will make a topographic map more meaningful.
7. Techniques of reproducing drawings	* Point out that Lesson 8 presents the fundamentals required to produce an ink tracing. Explain that many copies of a drawing may be required and that the student should be familiar with the different methods of duplicating drawings.

Lesson 2 - Drawing Equipment

OBJECTIVES

1. To introduce the language of drawing
2. To provide the basic information on the drawing equipment necesary for engineering drawing

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Engineering Drawing	* State that engineering drawing is a graphic language used by engineers to describe the shape, size, condition, and detail of structures, mechanisms, and land surfaces. (Ref. A, pp. 1-2; Ref. B, pp. 1-2)†
A. Purpose	* Explain that drawing is a method an engineer uses to record and convey his instructions to others.
B. Importance to the technician	* Note that engineering drawing affords an insight into the engineer's method of attacking engineering problems. (Ref. B, p. 3)
II. Drawing Equipment	* Explain the necessity of all technicians and students of engineering drawing owning at least a minimum amount of equipment.
A. Drawing instrument set	* Mention that there are many expensive and elaborate sets available, but only certain basic tools are required. (Ref. B, pp. 27-29)
1. Compass	* Show examples of the three main designs of the compass. (Ref. A, pp. 23-25)
a. Construction	* Explain that the joints of the compass are pivoted to maintain a constant, regulated pressure on the points.

†Reference citations are shown on page 1.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
b. Combination	* Illustrate the double use of the compass which allows insertion of either the pen leg or an extension leg.
c. Adjustments	* Show how a compass may be tested for alinement by checking the point of the needle against the closed nibs. (Ref. A, p. 36)
2. Dividers	* Explain the difference between the compass and the dividers.
	* Illustrate how the dividers are used to separate a line into equal parts.
a. Construction	* Exhibit the difference between the plain divider and the hairspring divider. (Ref. A, p. 22)
3. Bow instruments	* Describe and exhibit the bow divider, bow pencil, and bow pen. (Ref. A, p. 23)
a. Construction	* Illustrate a bow compass of the continuous type and one of the loop-spring type, with either a side or center adjusting screw. (Ref. B, p. 29)
b. Preference	* Point out that the loop-spring type is stronger and provides more uniform pressure.
c. Adjustments	* Explain that the side adjusting screw can be turned by holding the legs together, which takes the pressure off the nut and minimizes the wear on the thread, but the center screw provides a faster adjustment because of its double action.
4. Ruling pen	* Exhibit the common ruling pen available. (Ref. A, p. 26)
a. Construction	* Show that the steel blades are formed from one solid piece of high-grade steel.

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Lesson 3 - Use of Drawing Equipment . . .

Lesson 4 - Use of Drawing Equipment . . .

Lesson 5 - Topographic Maps . . . . . .

Lesson 6 - Topographic Symbols. . . . . .

Lesson 7 - Abbreviations, Lettering, and

Lesson 8 - Techniques of Reproducing Draw

Lesson 9 - Map Projections. . . . . .

Lesson 10 - U.S. Geological Survey Maps. .

Lesson 11 - Plotting Field Notes (Transit)

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Lesson 13 - The Highway Plan . . . . . .

Lesson 14 - Aerial Photography and the Dig

Glossary of Abbreviations. . . . . .

Final Examination. . . . . .

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CONTENT OUTLINE

8. Map projections

9. U.S. Geological Survey maps

10. Plotting field notes (transit)

11. Plotting field notes (cross-secti

12. The highway plan

13. Aerial photography the digital comput

* Note that Lesson 9 discusses the problem of distortion that results when a portion of the earth's surface is projected onto a flat surface. The lesson also covers the various projections that have been developed to secure as accurate a map as possible by reducing distortion to a minimum.

* Indicate that Lesson 10 explains in detail the information found on U.S. Geological Survey Maps. The lesson also includes instruction on reading and interpreting of these maps.

* Mention that Lesson 11 gives the rules used to secure and plot information obtained in the field.

* Explain that the lesson also includes the opportunity to plot topography from a highway survey.

ons) * State that Lesson 12 discusses the methods of securing a true picture of a land area by placing differences in elevation on a map.

* Add that the lesson also includes the plotting and studying of profiles and cross-sections.

* Emphasize that Lesson 13 covers the method used by the design staff to indicate to the contractor the way the highway is to be built.

* Note also that the lesson includes highway plan composition and interpretation.

and er * Point out that Lesson 14 covers the recent advances made in the field of aerial photography with respect to highway design.

* Mention that the lesson also includes the rudiments of photogrammetrics and its relationship to the digital computer.

TO THE INSTRUCTOR

Highway Drawing is the second in a series of nine courses which provide fundamental information to prepare your students for advanced work in highway planning, design, construction, and maintenance. Follow the content as closely as possible. Keep in mind that topics other than those in this unit are covered in other units of the Highway Technician Program. The units are planned to be given in numerical order as adult (or continuing) education courses.

In general, lessons in each of the units are planned for a session of 2 hours and 40 minutes. You may adjust this period to fit the class level, time schedule, and classroom situation. This course contains 14 lessons.

Plan each lesson before you present it to your class. You will need to plan classwork, discussion, and review. The left-hand column of each lesson contains suggested topics to be covered. The right-hand column gives accepted techniques, methods, and tips, as well as related information which should help you achieve effective teaching. Also this column shows page references for selected books for which the complete citations and symbols are given on page 1. Specific assignments are given at the end of each lesson. You should preview each lesson and arrange for needed visual aids and reference material in advance of the class.

Use the chalkboard, overhead projector, charts, diagrams, and other visual aids to clarify the material being presented. Duplicate for student use any important reference material. Give typical job situations as illustrations whenever possible.

Give a summary of key points at the end of each lesson. Also refer to past and future lessons and remind the students of needed references and other materials for the next lesson. Emphasize to the students that answers to the questions for each lesson provide a good summary of the important points.

A final examination is provided at the end of this Guide. The questions are derived from the basic material given in the lessons and the difficulty of each type is in proportion to the importance placed on any particular phase. The questions are in the form of multiple choice, true-false, completion, and matching and must be completed in 1 hour. The correct answers given in each case are for the instructor only, and the spaces are to be left blank in presenting the questions to the students.

As an instructor uses this course guide, he may have ideas for improving its content. Any suggestions he wishes to make should be addressed to the New York State Education Department, Bureau of Continuing Education Curriculum Development, Albany, New York 12224.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
14. Final examination	* Note that the final examination is an objective type test.

ASSIGNMENT

1. Read pages 1-9 in Ref. A.

2. Study pages 17-28 in Ref. A.

INSTRUCTOR'S NOTES

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1 Suggested Line Widths - Plan . .

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3 Trees and Brush. . . . . .

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Point out that a thumbscrew is used to regulate the distance between the nibs.
b. Maintenance	* Note the different types of devices used to open the blades for cleaning.
5. Drawing board	* Exhibit the type of drawing board in common use.
a. Construction	* Explain that a drawing board is made of soft textured, straight-grained, thoroughly seasoned wood. It is from 3/4 to 1 in. thick, with the end pieces tongue and grooved to the main section. (Ref. A, p. 18)
	* Mention that the top surface of the drawing board must be smooth and true and that both working edges must be perfectly straight.
b. Sizes	* Point out that drawing boards are available from 12 x 17 in. to 60 x 120 in.
	* State that the size of board selected depends on the type of work that will be done.
6. T-square	* Exhibit a T-square and explain its construction. (Ref. A, p. 30)
a. Construction	* Explain that a T-square usually consists of a head of ebonized hardwood and a maple blade lined with transparent plastic so that the lines may be seen through the edge.
b. Types	* State that some heads are double and adjustable but that the working edges are the upper edge of the blade and the inside edge of the head.
	* Compare the T-square with the parallel rule attachment, mentioning the advantage of the permanent alinement of the latter.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
7. Triangles	* Exhibit a 45° and a 30°-60° triangle. Also show the class an adjustable triangle. (Ref. A, p. 20; Ref. B, p. 37)
a. Construction	* Mention that triangles may be made of various materials but that transparent, hard plastic is preferred. * State that the edges of the triangle must be perfectly straight and the angles true.
b. Sizes	* Point out that triangles are made in many sizes ranging from 2 to 36 in. and they should be a minimum of .060 in. thick.
8. Scales	* Display the four types of scales and explain the differences in graduations of the mechanical engineer's scale, the civil engineer's scale, the architect's scale, and the metric scale. (Ref. A, pp. 21-22; Ref. B, pp. 40-45) * Demonstrate the shapes of scales that are available and explain that thoroughly seasoned boxwood is used for their construction.
9. Curves	* Exhibit a variety of irregular or noncircular curves, which are commonly called french curves, and state that their edges are composed of combinations of different mathematical curves. (Ref. A, p. 22) * Point out that the best curve is made from a transparent plastic so that the work underneath is visible. * Mention that there are many designs and shapes on the market but that only a few curves are required to adequately cover most situations. * Show the class a series of circular curves which are definitely portions of circles.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
10. Pencils	* Note that a high-quality pencil has uniform lead and straight-grained wood. (Ref. A, p. 19; Ref. B, pp. 33-34) * Explain the system used by manufacturers to grade pencils according to their degree of hardness: 1. Design and layout work—9H, 8H, 7H, and 6H (very hard) 2. Centerlines, dimension lines—5H and 4H (medium hard) 3. Ordinary detail and line work—3H and 2H (medium) 4. Lettering—H and F (medium soft) 5. Sketching—HB, B, 2B, 3B, 4B, 5B, and 6B (soft) * Point out that the hardness of the paper must be considered when selecting the proper grade of pencil. * Display the automatic pencil which utilizes any one of the 17 hardnesses of lead.
11. Pencil pointers	* Show the sandpaper pad and the flat file and how they are used to sharpen a pencil or lead. * Display also an automatic pencil or lead pointer. (Ref. A, p. 20)
12. Erasers	* Exhibit the ruby pencil eraser and explain that only this should be used to erase both pencil and ink lines from paper or cloth, since it does not break into the fibers of the material. (Ref. A, p. 20) * Explain that the artgum or soft-rubber eraser is used to clean off smears, smudges, and fingermarks from the paper. * Exhibit an electric erasing machine and show the different types of erasers used with it.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
13. Erasing shield	* Display the different erasing shields available. * Explain that they are made from a very thin sheet of highly tempered spring steel and contain many odd-sized openings. (Ref. A, p. 20)
14. Drawing ink	* Point out that drawing ink (india ink) should be waterproof, free-flowing, and quick-drying. (Ref. A, p. 20) * Mention that it must not contain any chemicals which will corrode instruments, nor any ingredients which will separate out of solution.
15. Penpoints	* Show several types of penpoints and mention that individual experience is the best guide in the selection of a penpoint. * Explain that a good penpoint is one that has enough resistance to normal pressure to permit the drawing of curved and straight strokes of uniform width. (Ref. A, p. 93; Ref. B, pp. 7-8) * Mention that several penpoints are tank pens which are graded from a thin line to a wide line. * Explain that the Rapidograph type of pen is an india ink fountain pen and emphasize the necessity of keeping it thoroughly clean.
16. Protractor	* Display a semicircular or circular protractor and show how it is used to measure an angle. (Ref. B, p. 30)
17. Drawing paper	* Exhibit the most common type of drawing paper (buff-colored manila paper) and show how the slightly grained surface readily takes pencil work and repeated erasures. (Ref. A, p. 18)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Placement	* Indicate that the right-handed draftsman places the triangle on the right of the line being drawn. A left-handed draftsman places the triangle on the left of the line being drawn.
2. Control	* Mention that the T-square blade is held with the palm and thumb of the left hand while the triangle is held and adjusted by the fingers of the left hand.
3. Accuracy	* Explain that a line should never be drawn to the extreme corner of the triangle.
4. Vertical lines	* Indicate that vertical lines are drawn upward along the vertical leg of the triangle. The horizontal leg is supported and guided by the T-square blade. * Ask the students to draw lines perpendicular to the horizontal lines already drawn on their sheet.
5. Inclined lines	* Mention that inclined lines of certain definite angles may be drawn by using the 30°-60° and the 45° triangles. (Ref. B, pp. 37-41)
a. To horizontal lines	* Demonstrate how a line that makes a 15° angle or any multiple of 15° with the horizontal line may be drawn. (Ref. A, p. 17) * Have the students draw lines at angles of 15° with a basic horizontal line.
b. To oblique lines	* Show how a line may be drawn at a 15° multiple with any oblique line. * Have the students draw lines at angles of 15°, 30°, 45°, 60°, and 75° with any random oblique line.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
6. Parallel lines	* Mention that two triangles in combination will enable one to draw a line parallel to a given line. (Ref. A, p. 32) * Ask the class to draw a straight line at random and then to draw lines parallel to it.
7. Perpendicular lines	* Show how a line may be drawn perpendicular to another by either of two methods: 1. Sliding triangle 2. Revolving triangle. (Ref. A, p. 32) * Ask the class to draw a line perpendicular to some of the lines on their paper but not to include the horizontal lines.
E. Scales	* Explain that in any drawing or layout the relative position of a line must be found by scaling. (Ref. A, pp. 32-35)
1. Purpose	* State that not all objects can be drawn full size because of space limitations. (Ref. B, p. 42) * Mention that while some objects may be drawn larger than actual size, most objects must be reduced. * Explain that the first reduction would be half-size or 1/2 in. on paper = 1 in. of object and that 1/4 size is 1/4 in. on paper = 1 in. of object. (Ref. A, p. 33) * Note that when working with a given scale, the work must be thought of and spoken of in its full-scale dimensions and not in its reduced size.
2. Architect's scale	* Emphasize that architects use the quarter scale (not the quarter size), which is 1/4 in. = 1 ft.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Engineer's scale	* Stress that in highway work the engineer's scale is used. (Ref. A, p. 33)
a. Divisions	* Explain that each inch is divided into 10, 20, 30, 40, 50, and 60 parts or divisions. * State that in drawing a plan on a 50-ft. scale, 1 in. on paper is equal to 50 ft. on the ground.
4. Mechanics of scaling	* Show how the scale is alined and how points are marked off. * Emphasize the importance of placing eyes directly over the scale. (Ref. A, p. 33; Ref. B, p. 45) * Direct the students to mark off lines using the different scales.

QUESTIONS FOR REVIEW

1. Why should a pencil be rotated when drawing a line?
2. Is it possible to draw a line inclined at 15° from the horizontal blade of a T-square if only a 30°-60° triangle is used with a 45° triangle?
3. When using a triangle on a T-square, in which direction is a vertical line drawn?
4. What is the major difference between the engineer's scale and the architect's scale?

ASSIGNMENT

1. Study pages 35-44 in Ref. A.
2. Ask the class to draw five circles on a sheet of drawing paper and, using the T-square and triangles, divide each circle into 4, 6, 8, 12, and 24 parts.

QUESTIONS FOR REVIEW

1. Describe briefly what is meant by engineering drawing.

2. What type of bow instrument construction provides the more uniform pressure?

3. What would be the most important requirement of the wood used to make an engineer's scale?

4. When would you use a 2B pencil? A 5H pencil?

5. What is the most important attribute of india ink?

6. How does water affect tracing cloth?

7. Is a pair of proportionate dividers fixed for one given scale?

ASSIGNMENT

1. Study pages 28-35 in Ref. A.

INSTRUCTOR'S NOTES

22056

Lesson 3 - Use of Drawing Equipment

OBJECTIVE

To demonstrate the proper techniques of handling drawing equipment

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Technique Requirements for Drawing	* Explain that a good drawing technique is essential and this is a matter of habit. (Ref. A, p. 28)†
A. Accuracy and speed	* Mention that the goal of the technician is to draw rapidly and accurately. A poor drawing takes as much time to do as a good one.
II. Preparation for Drawing	
A. Light and table	* Point out that the light should come from the left when working on a drawing and that the table should be slightly inclined at about 1 to 8 slope. (Ref. A, p. 28)
B. Neatness	* Mention that the table, board, and equipment should be wiped off with a cloth before starting to work.
III. Basic Equipment and Procedures for Drawing	
A. T-square	* State that the T-square is used for drawing horizontal lines and for guiding triangles. (Ref. A, p. 30; Ref. B, p. 37)
1. Placement	* Show that the T-square is used with the head held firmly against the left edge of the board.
2. Control	* Ask the students to slide the T-square with their left hand until they have full control.

†Reference citations are shown on page 1.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Explain that for a closer positioning the thumb can be placed on the top of the head, while the fingers of the same hand press against the bottom of the board. Or the fingers can remain on top of the head with the thumb on the board. Indicate that the latter method is preferred.
3. Left-handed students	* Indicate that all operations are reversed when the draftsman is left-handed.
	* Point out that the T-square is used on the right edge of the board and that horizontal lines are drawn from right to left.
	* Emphasize that the light should come from the right in the case of a left-handed person. (Ref. A, p. 32)
B. Drawing paper	* Exhibit the heavy buff-colored manila drawing paper used in class.
1. Position on board	* State that the paper is placed on the board close to the working edge and several inches from the bottom of the drawing board. (Ref. A, p. 29; Ref. B, p. 36)
	* Ask each student to place a sheet of paper on his board, squaring the top of the paper with the T-square.
2. Holding on board	* Explain that either tape or tacks can be used to hold the paper on the board but that tacks are obstacles. Point out that tape becomes sticky in hot weather.
C. Pencil	* Point out that the first work in drawing consists of simple pencil lines.
1. Selection	* Indicate that the pencil selected should neither smudge nor cut grooves in the paper.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* State that the surface of the paper being used and the quality of line desired also influence the selection of a pencil. (Ref. A, pp. 28-29)
	* Note that a 5H or 6H pencil is used for layout work and construction lines and a 2H, 3H, or 4H pencil is used for a finished drawing. (Ref. B, pp. 32-34)
2. Sharpening	* Demonstrate how to cut away the wood from the unlettered end of a pencil with a penknife, making a long conical point.
	* Show how to point a pencil with the sandpaper file.
3. Control	* Explain that the pencil is held firmly but not tightly and, while applying a constant pressure, is rotated as a line is drawn.
	* Indicate that the pencil is inclined slightly in the direction the line is being drawn, and slightly away from the body so that the point is close to the blade of the T-square. (Ref. A, p. 30; Ref. B, pp. 35-36)
	* Explain that the pencil hand glides along the blade of the T-square on the little finger.
	* Ask the students to place pencil points on the paper and then to draw horizontal lines through these points, using the T-square.
	* Indicate that lines are drawn from left to right.
D. Triangles	* Emphasize that there are certain procedures to follow when using triangles. (Ref. A, pp. 30-33)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Nib sharpening	* Illustrate how pen nibs are sharpened on a hard Arkansas knife piece. (Ref. A, p. 38; Ref. B, pp. 52-53) * Show how burrs are removed by opening the blades completely and rubbing the inside surface of each blade flat on the stone. * Explain that a hairline can be drawn easily when a ruling pen is properly sharpened.
C. Control	* Indicate that the pen is held by the fingertips with thumb and second finger on the nibs and the handle resting on the forefinger. The tips of the third and fourth fingers rest on and glide along the straightedge. (Ref. A, pp. 39-40; Ref. B, pp. 49-50) * Note that the pen is held against the straightedge with the blades parallel to it. The screw is always facing the outside. * Mention that the handle of the pen is inclined to the right and always in a plane passing through the line and perpendicular to the paper. * Point out that the pen is guided by the upper edge of the straightedge. * Explain that a line is drawn with an even arm movement. (Ref. B, pp. 49-50) * Mention that as the end of a line is approached, the guiding fingers are stopped and without interrupting the motion of the pen the line is abruptly finished with a finger movement. * Note that the pen pressure is light, in general, but it does vary with the type of paper and the sharpness of the pen.

VT 011 919
Suggested Curriculum in Office Occupations.

Gila River Career Center, Ariz.
Central Arizona Coll.
Arizona State Dept. of Vocational Education, Phoenix.
Four Corners Regional Commission, Ariz.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 64p.

DESCRIPTORS - *CURRICULUM GUIDES; *OFFICE OCCUPATIONS EDUCATION; *FILE CLERKS; *STENOGRAPHERS; *TYPISTS; OFFICE OCCUPATIONS; VOCATIONAL EDUCATION

ABSTRACT - Intended to aid in preparing students for entry and advancement in office occupations, this program provides detailed outlines for the four major office occupations of receptionist, file clerk, clerk-typist, and stenographer. Contents give general information on the program, including a flow chart of student progression through all phases of the program, followed by the course outlines, which are broken down into separate instructional units giving course description, course objectives, suggested hours, and teaching aids and suggestions. The course is designed to provide terminal points within the total program in order to provide students with some saleable skills regardless of whether or not the entire program is completed. (AW)

VT 011 919

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* State that when ink will not flow in the pen the problem can sometimes be corrected by touching or pinching the blades.
	* Suggest that dried ink should be wiped away and a fresh supply added.
D. Inking rules	* Note that ink lines must be centered over pencil lines.
	* Tell the students that when they are inking circles, arcs, and straight lines that touch they should ink the circles and arcs first and keep the points of contact equal to the width of one line. (Ref. A, p. 40)
V. French Curve	* Describe how the french curve is used as a template for non-circular curves. (Ref. A, pp. 42-43; Ref. B, p. 48)
	* Show that a french curve is applied so that at least three points are on the edge of the curve.
	* Mention that to avoid cusps or humps, each line drawn should start and stop short of the first and last points being fitted.
A. Practice	* Have the class place a series of points and use the french curve to connect them, first in pencil, and then in ink.
	* Note that ink work with the french curve is the best practice available.
VI. Protractor	* Indicate that a protractor is divided into degrees and parts of a degree. (Ref. A, p. 646)
	* Show how a protractor is used to measure and to lay out an angle.
A. Practice	* Have the class draw specific angles with a protractor.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
VII. Erasers	* Explain that a ruby eraser removes pencil lines satisfactorily and removes ink lines effectively without damaging the paper. (Ref. A, p. 20) * Mention that an erasing shield helps to obtain clean erasures. * Note that when a line has made a groove in the paper the spot should be rubbed with a burnisher or the back of the thumbnail. * Explain that a gum eraser is used to remove soft pencil lines and smudges. * Advise the class not to use an ink eraser since too much of the fiber of the paper is removed. * Caution the students not to use a knife or razor blade for the removal of ink lines. * Point out that proper erasing procedure must be learned. (Ref. A, pp. 20, 43-44; Ref. B, p. 48)
VIII. Standard Line Symbols	* Explain that symbolic lines of different widths are used to make technical drawings. All the lines needed may properly be called an "alphabet of lines." (Ref. A, pp. 41-42) * Draw on the chalkboard the symbols for the following: 1. Visible outline 2. Hidden outline 3. Centerline 4. Dimension line 5. Extension line 6. Repeat line 7. Short break 8. Long break

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Line widths	* Inform the class that there are three widths of lines: 1. Thick—used for visible outline, cutting plane, and short break lines 2. Medium—used for hidden outline 3. Thin—used for centerline, dimension, extension, repeat, long break, and section lines (Ref. A, p. 42; Ref. B, pp. 54-55) * Emphasize that each line size should be readily distinguishable. * Explain that construction lines are drawn very fine so as to be unnoticeable on the completed drawing.
B. Line width recommended by Department	* State that architecture and engineering have their own method of line identity. * Distribute to each student a print of "Standard Symbols and Abbreviations." (Ref. E) * Point out that the line widths suggested by the State Department of Transportation for use on highway design plans are listed on the Standard Symbols Sheet. This information is shown in Tables 1 and 2 on page 27.
C. Practice	* Request the class to practice the drawing of pencil lines, checking particularly the width of lines, texture, and uniformity. * Ask the class to ink the pencil lines and then to analyze their errors or problems. (Ref. A, p. 42)

TABLE 1 SUGGESTED LINE WIDTHS PLAN	
Feature	**Symbol**
EXISTING TOPO. (PRINTING)	NO. 00 NO. 0
NEW CONST. (PRINTING)	NO. 3 NO. 1
LIMITS OF CONST.	NO. 1
NEW R.O.W.	NO. 2
℄ OF IMPROVEMENT	NO. 3

Table 2 SUGGESTED LINE WIDTHS PROFILE	
Feature	**Symbol**
DATUM LINE	NO. 2
VERT. LINES ℄	NO. 00
EXIST. GRADE LINE	NO. 0
NEW GRADE LINE	NO. 3
FLAGS (PRINTING) NEW EXISTING	 NO. 1 NO. 0

Note: All line thicknesses refer to those made by Koh-I-Noor Rapidograph pen. Adjust ruling pens to comparable widths. The size of symbol varies according to the scale of the drawing.

QUESTIONS FOR REVIEW

1. How much of the compass lead should be sharpened and beveled?

2. What is the largest circle which can be drawn with a compass without utilizing the lengthening bar?

3. Explain how the compass is adjusted to fit a radius mark.

4. When is the bow compass used?

5. Describe the problems encountered when the blades of a ruling pen are either too pointed or too rounded.

6. Explain the position of the fingers on the ruling pen when drawing a straight line.

7. What is the alphabet of lines?

8. Is it possible to erase india ink from tracing cloth by using only a ruby eraser?

ASSIGNMENT

1. Study pages 597-605 in Ref. A.

2. Study the "Page of Cautions" listed on page 44 of Ref. A.

3. Pencil and ink the designs in Problems 2.1.3, 2.1.7, 2.2.4, 2.2.5, and 2.3.3 on pages 45-46 in Ref. A.

INSTRUCTOR'S NOTES

22071

Lesson 5 - Topographic Maps

OBJECTIVE

To provide the basic information about recording to scale the topographic features found on a given portion of the earth's surface

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Purpose	* State that the purpose of a topographic map is to convey quickly to the trained person a mass of information. Conventional symbols, authorized abbreviations, lettering, and distinctive colors are used to achieve this result. (Ref. C, p. 1)†
	* Point out that a topographic map is a combination of both freehand and mechanical draftsmanship.
II. Type	* Note that a topographic map corresponds to a plan view in mechanical drawing.
III. Classes of Topographic Maps	* State that in general all topographic maps fall into four classes, grouped according to use (Ref. A, pp. 597-598; Ref. C, pp. 2-4): 1. Geographic maps 2. Cadastral or city maps 3. General topographic maps 4. Engineering or working maps
A. Geographic maps	* Define the geographic map as one which covers a large area and shows only the most prominent relief, culture, and hydrographic features.

†Reference citations shown on page 1.

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Lesson 4 - Use of Drawing Equipment

OBJECTIVE

To demonstrate the proper techniques of handling drawing equipment

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Dividers	* State that the dividers are used for transferring measurements and for dividing lines into any number of equal parts. (Ref. A, pp. 35-36; Ref. B, p. 46)†
A. Control	* Show how the dividers are held in one hand.
B. Trial method of line division	* Explain how a line may be divided into equal parts by estimation and retrial. (Ref. A, p. 36)
C. Practice	* Ask the class to divide a straight line into certain divisions.
	* Have the student divide the circumference of a circle into a certain number of divisions.
II. Compass	* Point out that the compass is used primarily for drawing circles and arcs. (Ref. A, pp. 36-38)
A. Compass lead	* Mention that the type of work determines the type of compass lead to use but in general a hard lead gives satisfactory results.
	* Explain that the compass lead must be sharpened to a flat bevel about 1/2 in. long. (Ref. B, pp. 45-46)

†Reference citations are shown on page 1.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Needle adjustment	* Show that the needle should extend 3/8 in. beyond its sleeve and that it should be just slightly longer than the compass lead.
C. Use	* Emphasize that in drawing a circle two intersecting lines at right angles must be drawn and a radius marked off. * Show how the pivot point is guided accurately into position at the center, adjusting the pencil point to the radius mark. * Indicate that the handle is rotated between thumb and finger, as the circle is drawn in a clockwise direction. * Note that the compass is inclined slightly in the direction of the line. (Ref. A, p. 37) * State that for circles over 2 in. in radius the pivet legs have to be bent so that both nibs of the pen will touch the paper at the same time. * Explain that the lengthening bar is used for circles over 5 in. in radius. * Note that when concentric circles are drawn the smallest one is made first as the center hole becomes worn with use. (Ref. A, p. 38)
D. Practice	* Ask the students to draw different sized circles, following all of the above instructions.
E. Pen leg	* Show how the pencil leg is replaced with the pen leg. * Demonstrate how the pen is filled with ink. * Caution the class not to use more than 1/2 in. of ink in the pen. (Ref. A. p. 39)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Remind the students that the needle should extend slightly beyond the pen.
F. Practice	* Ask the students to fill their compass pens and ink the pencil circles already drawn.
III. Bow Instruments	* State that the bow pen and the bow pencil are used to draw small circles having a radius of 1 in. or less. (Ref. B, p. 47)
	* Explain that bow instruments are used like the larger type dividers. Note that it is possible to obtain greater accuracy with the locked-in bow dividers.
A. Adjustments	* Demonstrate how small changes are made with the fingers that hold the instrument.
	* Mention that large changes for the side screw type are made only after the pressure is taken off the threads by closing the legs with the left hand.
B. Practice	* Instruct the class to draw a series of small circles with both the pencil and pen bow instruments.
IV. Ruling Pen	* Point out that the ruling pen is used to draw straight lines and flat curves. (Ref. A, pp. 38-39)
A. Nib shape	* Sketch on the chalkboard the proper shape of the ruling pen nibs and show how they become pointed and rounded by use.
	* Emphasize that pointed nibs will not allow the ink to flow freely and rounded nibs will cause the ink to flow too freely.
	* Explain how to use the reflection method to check for dullness of the nibs.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Explain that the scales for geographic maps usually vary from 1:1,000,000 to 1:62,500. This is equal to 1 in. = 15 mi. to 1 in. = 1 mi. The numerator, usually 1, represents map distance and the denominator, a large number, represents the actual distance with both being expressed in the same unit.
B. Cadastral maps	* Mention that cadastral maps are made as a control in the development and growth of a large city or a suburban district.
	* Indicate that the scale for cadastral maps usually varies from 1 in. = 1,000 ft. to 1 in. = 200 ft.
C. General topographic maps	* Point out that general topographic maps are especially made for a given project such as a very large industrial expansion, a hydroelectric project, drainage development, or flood control.
	* Indicate that the scale for general topographic maps usually varies from 1:62,500 to 1:6,000 or 1 in. = 1 mi. to 1 in. = 500 ft.
	* Note that these maps are not as accurate as the cadastral maps.
D. Engineering maps	* Explain that engineering maps are the ones we are most concerned with as they cover the preliminary planning and construction plans for any engineering project.
	* Point out that the scale of engineering maps usually varies from 1:2,400 to 1:240 or 1 in. = 200 ft. to 1 in. = 20 ft.
	* Note that the amount and nature of the information shown varies according to the final purpose and use of these maps.

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S-508

SUGGESTED CURRICULUM

III

OFFICE OCCUPATIONS

adapted from
previously developed
material by

Gila River Career Center in cooperation
with Central Arizona College, the Arizona
State Department of Vocational Education,
and the Four Corners Regional Commission

VT011919

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
IV. Scale	* Define the scale of a map as the constant ratio of dimensions of objects and distances on the map to the corresponding actual dimensions and distances on the ground. (Ref. C, pp. 18-20)
	* Explain that the scale will apply only to horizontal distances since everything on a topographic map is shown in a plan view.
	* Note that vertical distances are shown to scale by means of the contour interval.
A. Scale control	* Point out that only controlling distances and the most important objects are shown to scale. General background details, consisting of symbols for forests, trees, meadows, etc., are not shown to an exact scale.
B. Scale choice	* Explain that the choice of scale depends on the purpose for which the map is to be used. In general a 50-ft. scale is used on the rural highway and a 20-ft. scale for city arterial work.
	* Indicate that the equation for a scale is $1/F = S/L$. (Ref. C, pp. 20-23; Ref. D, p. 639)
V. Content	* State that the information shown on a topographic map is divided into four major classifications (Ref. A, p. 606; Ref. C, pp. 1-2): 1. Culture or manmade works 2. Relief or contours indicating differences in elevation 3. Hydrographic or water features 4. Vegetation
A. Culture	* Explain that culture embraces all the features built or constructed by man with the exception of canals and artificial cuts and fills, which fall into either hydrographic or relief

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	features. Included in this classification are highways, railroads, towns, houses, fences, and property lines.
B. Relief	* Indicate that relief is shown by certain conventional symbols or by a combination of symbols and lettering. * Note that valleys, hills, plains, plateaus, and mountains are included in this classification. * Explain that variations in elevation of the earth's surface are indicated by contour lines.
C. Hydrography	* Define hydrographic features as those showing all information pertaining to water. They include oceans, seas, lakes, ponds, rivers, and creeks.
D. Vegetation	* Point out that vegetation includes all natural features such as forests, orchards, crops, and meadows.
VI. Contour	* Define a contour as a theoretical line of constant elevation on the ground. (Ref. D, pp. 631-633) * Explain the following points about contours: 1. Points of equal elevation are joined by a contour line. 2. Contours on the ground are represented by contours on the map. 3. The horizontal distance between contour lines is inversely proportional to the angle of the slope. 4. On uniform slopes the contour lines are spaced uniformly. 5. On plane surfaces the contour lines are straight and parallel to one another.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	6. Contour lines are perpendicular to lines of steepest slope. 7. All contour lines must close upon themselves either within or without the borders of the map. 8. The smallest closed contour line on a map indicates either a summit or a depression. 9. Contour lines cannot cross one another except in the case of a vertical cliff. 10. Contour lines bend toward the upgrade when crossing a stream or valley and toward the downgrade when crossing a ridge. (Ref. C, pp. 143-144)
A. Contour interval	* Define the contour interval as the vertical distance between contours. * State that the choice of interval depends on the horizontal scale and on the purpose of the map. * Indicate that the usual contour interval for ordinary work is 20 ft. and the 1-ft., 2-ft., and 5-ft. intervals are used on large scale maps.
VII. Construction	* Explain that topographic maps are constructed in three operations: 1. Plotting horizontal control 2. Plotting details including locations of known ground elevations 3. Drawing contour lines at a given interval (Ref. D, p. 633)
A. Plotting horizontal control	* Mention that a horizontal control provides the skeleton of the drawing. * Note that the protractor and tangent offset are two methods commonly used to plot horizontal control.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Describe briefly the procedure of establishing a reference line or base line on the ground, using a transit and tape (portion of the survey course).
	* Explain that this base line is then oriented from the north in some manner.
	* Indicate that this base line is positioned on the paper exactly as it exists on the ground and is then drawn to scale.
1. Protractor method	* Explain that in the protractor method the position on the paper of the first line is determined by estimation only and that its actual length is laid off by measurement. (Ref. C, pp. 91-93; Ref. D, pp. 446-447)
	* Mention that in a survey the second line is referenced off the first line (portion of survey course).
	* Show that the protractor is oriented at the forward point of the first line. The deflection angle of the next line is marked off and a line of indefinite length is drawn.
	* Explain that the actual distance is measured off on this line, which determines the point for the next step.
	* State that every line is lettered or stationed at each extremity.
	* Emphasize the need for accuracy to avoid errors which will affect the correctness of the entire project.
2. Tangent offset method	* Explain that the tangent offset method is similar to but more precise than the protractor method. (Ref. C, pp. 93-96; Ref. D, pp. 447-450)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that the position on the paper of the first line represents a plotted position and is drawn longer than required. The actual length is marked off and lettered.
	* Mention that this line is extended 10 in. and at the end a perpendicular is erected in the direction of the next part of the base line.
	* Explain that along this perpendicular is measured off a distance equal to 10 in. times the natural tangent of the deflection angle.
	* Show how a line is drawn from the end of the plotted line to the measured distance on the perpendicular line. Then the actual length is measured off and lettered. This becomes the starting point for the next step.
B. Plotting details	* Point out that plotting details is less refined than plotting horizontal control. (Ref. C, p. 103; Ref. D, pp. 466-468)
	* Emphasize the importance of plotting objects of definite size and shape with enough precision so that dimensions may be scaled off.
C. Constructing contour lines	
1. Ground point	* Explain that a point may be located by a right angle offset from a certain point or station on the base line or by an angular reading together with a distance from a base line.
	* Describe briefly that the methods used to find elevations in the field are: 1. Section method 2. Checkerboard method 3. Random spot method (Ref. D, pp. 634-638)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* State that a point of known elevation is called a ground point.
	* Point out that a ground point on a contour is called a contour point.
	* State that a map has vertical dimension when ground points have been obtained and plotted.
2. Contour interval	* Explain how to select a suitable contour interval.
3. Locating contour lines	* Describe the method of interpolation by which contour lines are drawn for a given set of elevations.
	* Show how to use the checkerboard system of available elevations for locating contours and sketch on the chalkboard a block of several squares with an elevation at every intersection. (Ref. D, p. 635)
a. By estimation	* Note that when a desired contour falls between two given elevations, its position is estimated by eye. (Ref. D, p. 635)
b. By computation	* State that when a desired contour falls between two given elevations, its position is determined mathematically. (Ref. D, pp. 635-636)
	* Indicate that two intersections of the checkerboard have elevations of 857.9 ft. and 862.8 ft. Note that there is a differential of 4.9 ft. between them.
	* Show how the 858, 860, and 862-ft. contours are placed by the following methods:
	1. Point out that the 858-ft. contour is .1 ft. above the known elevation of 857.9 ft. The 858-ft. contour is placed .1 of 4.9 (total difference in elevation) of the map distance between the two known elevations.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2. Point out that the 860-ft. contour is 2.1 ft. above the known elevation of 857.9 ft. The 860-ft. contour is placed 2.1 of 4.9 (total difference in elevation) of the map distance between the two known elevations.
	3. Point out that the 862-ft. contour is 4.1 ft. above the known elevation of 857.9 ft. The 862-ft. contour is placed 4.1 of 4.9 (total difference in elevation) of the map distance between the two known elevations.
c. By graphics	* Demonstrate the method of graphic interpolation, using a piece of coordinate paper. (Ref. D, p. 636)
	* Mention that a rubberband graduated at equal intervals, similar to the coordinate paper, can also be stretched between two points to furnish an interpolation.
4. Drawing contour lines	* Explain that when drawing contour lines the procedures below should be followed:
	1. Use skill and judgment when placing contour lines so they may best represent the actual configuration of the ground.
	2. Draw contours as lines that are smooth and of uniform width.
	3. Draw every fourth or fifth contour as a heavier line. (Ref. C, p. 108; Ref. D, p. 634)

QUESTIONS FOR REVIEW

1. Name the four general classifications of information found on the ordinary topographic map.

2. What is a contour line?

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3. Describe the scale of a geographic map.
4. What is the scale ordinarily used for a cadastral map?
5. What is meant by the map scale?
6. Explain the equation of a scale.
7. Why must all contour lines eventually close upon themselves?
8. When do contour lines cross themselves?
9. What three operations are necessary to draw a topographic map?
10. Describe a contour point.
11. Name three methods of interpolating elevations.

ASSIGNMENT

1. Study pages 602-605 in Ref. A.
2. Distribute prints of a grid sheet consisting of 100 squares at a 20-ft. scale with elevations at each intersection. Restrict the elevations from 50 ft. to 70 ft. and ask the class to draw a contour map using a 1-ft. interval.

INSTRUCTOR'S NOTES

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Lesson 6 - Topographic Symbols

OBJECTIVE

To provide the information necessary to represent features on a topographic map by means of symbols

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Use of Symbols	* Indicate that the symbols used are standard and of a size that blends with the drawing. (Ref. A, pp. 606-610; Ref. C, p. 25)†
	* State that the symbols taught first are those used throughout the world.
	* Note that the Department of Transportation's Standard Symbol Sheet (distributed in Lesson 4) differs slightly in nomenclature, classification, and composition from other standard symbols. Department personnel are to use only the recommended symbols.
A. Legibility	* Point out that all the symbols are designed to be rapidly made, readily understood, and pleasing in appearance.
B. Plan view	* State that since the topographic map is a plan view, the symbol should resemble the plan view of the object it represents. Exceptions include telephone poles and crops. They are drawn in elevation for appearance and clarity.
C. Shading	* Explain that shading produces relief in a symbol. (Ref. C, p. 25)

†Reference citations are shown on page 1.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Mention that the source of light is assumed to be coming from above and to the left of the object at an angle of 45°.

* Note that the use of shading increases as the size of the map or the size of the scale increases.

D. Composition

* Indicate that the purpose of the map determines which symbols are emphasized. (Ref. C, p. 26)

E. Selection of pen

* State that the most successful work is done with a crow-quill pen or a reasonable facsimile. A limber, larger pen may be used when the draftsman has had some experience. (Ref. C, p. 26)

F. Construction rules

* Emphasize that the following rules should be observed when drawing symbols (Ref. C, p. 27):

1. Do not carry an excessive amount of ink in the pen.
2. Do not let the pen dry before refilling.
3. Use different pens for different colors.
4. Throw away any penpoint with a sprung nib.
5. Keep paper clean and avoid erasures.
6. Work in a relaxed position.

II. Classification of Symbols

* Indicate that commonly used symbols are classified under one of the following headings (Ref. C, p. 25)

1. Vegetation
2. Hydrography
3. Ground surface and character of soils
4. Subdivisions and surveying data
5. Works and structures
6. Railroads
7. Utilities
8. Standard cross-sections

CONTENT OUTLINE

III. Construction of Symbols

A. Vegetation

TEACHING POINTS AND TECHNIQUES

* Mention that some symbols are created by mechanical drafting while others are drawn freehand.

* Draw on the chalkboard the following symbols and have the class practice drawing them (Ref. C, pp. 29-35, 89):

1. Grass or cleared land
2. Corn
3. Deciduous trees
4. Oak trees
5. Orchard
6. Evergreens
7. Woods
8. Vineyard
9. Tobacco
10. Cultivated land
11. Wheat
12. Oats
13. Willows

* Analyze the symbols listed under No. 15 Trees and Brush on the Standard Symbols Sheet. This information is shown in Table 3 below.

* Explain that the amount of descriptive detail used on certain maps may not be required on highway plans.

Table 3 TREES AND BRUSH

Feature	Symbol	Remarks
WOODED AREA	W	IDENTIFY
BRUSH	B	IDENTIFY
TREE, SINGLE (DECIDUOUS)		IDENTIFY AS TO TYPE
TREE, SINGLE (CONIFEROUS)		IDENTIFY AS TO TYPE
ROW OF TREES		IDENTIFY
HEDGE ROW		
STUMP		IDENTIFY

Table 18 DAMS AND DIKES

Feature	Symbol	Remarks
DAM		
SPILLWAY		
DIKE	DIKE	USED WHEN CONTOURS ARE SHOWN
DIKE	DIKE	USED WHEN CONTOURS ARE NOT SHOWN
JETTY	JETTY	
PIER	PIER	

CONTENT OUTLINE

F. Railroads

TEACHING POINTS AND TECHNIQUES

* Indicate that modern clearance problems and grade elimination techniques require differentiation among the types of railroads.

* Draw on the chalkboard the following symbols and have the class identify as many as possible by analysis (Ref. C, pp. 54, 61):

1. Railroad
2. Electric railroad
3. Railroad in street
4. Railroad grade crossing
5. Grade crossing (railroad overhead)
6. Grade crossing (railroad under)
7. Railroad tunnel
8. Railroad bridge
9. Narrow gauge railroad
10. Trestle
11. Turntable
12. Signal tower
13. Railroad station

* Compare the above symbols with those listed under Number 11 Railroads on the Standard Symbols Sheet. This information is shown in Table 19 on page 53.

Table 19 RAILROADS

Feature	Symbol	Remarks
SINGLE TRACK		
MULTIPLE MAIN LINE TRACK		NUMBER OF TRACKS LABELED IF OVER TWO
ABANDONED TRACK		IDENTIFY
JUXTAPOSITION		
YARD OR SIDING		
TURN TABLE		
NARROW GAUGE SINGLE TRACK		
NARROW GAUGE MULTIPLE TRACK		NUMBER OF TRACKS LABELED IF OVER TWO
ABANDONED TRACK NARROW GAUGE		
HIGHWAY-RAILROAD CROSSING SIGN		
HIGHWAY-RAILROAD CROSSING GATE		
BRIDGE WARNING TELLTALE		
MILE POST		SHOW NUMBER

CONTENT OUTLINE

G. Utilities

TEACHING POINTS AND TECHNIQUES

* State that utilities can occupy the right-of-way of any highway, so they will appear on most maps concerning highway work.

* Draw on the chalkboard the following symbols (Ref. C, pp. 59, 61, 77):

1. Telephone or telegraph line
2. Electric power transmission line
3. Power distribution line

TABLE OF CONTENTS

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Unit V, Financial Activities	20
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CONTENT OUTLINE

B. Hydrography

TEACHING POINTS AND TECHNIQUES

* Point out that only a few hydrographic symbols are used on highway plans. But stress that these symbols may be found on maps used to develop highway plans.

* Draw on the chalkboard the following hydrographic symbols and have the class practice drawing them (Ref. C, pp. 36-37, 46):

1. Pond
2. Small lake
3. Marsh or swamp
4. Brook
5. Small stream
6. River
7. Shore line
8. Current direction
9. Canal and lock

* Review the hydrographic symbols listed under No. 8 Water Locations on the Standard Symbols Sheet of the New York State Department of Transportation. This information is shown in table 4 on page 43.

* Review the hydrographic symbols used on U.S.G.S. topographic maps. (Ref. F, pp. 16-17)

C. Surface ground forms and character of soils

* Explain the two methods used to represent hills, mountains, and surface undulations. (Ref. C, p. 39)

1. By contours (preferred)
2. By some form of hill shading (not commonly used)

* Draw on the chalkboard the following symbols and have the class practice drawing them (Ref. C, pp. 35-36, 44):

1. Sand
2. Gravel
3. Mud
4. Rock

Table 4 WATER LOCATIONS

Feature	Symbol	Remarks
STREAM		
LAKE OR POND	W.E. 121.1	
DRY POND OR DRY STREAM	X117.2	
RAPIDS		
FALLS		
BRAIDED STREAM		
SAND AND MUD BANKS	MUD	
CANAL (WITH LOCK)	E-7	LETTER INDICATES CANAL SECTION AND NUMBER INDICATES LOCK NUMBER
SHIP OR BARGE LINE ON A CANAL		
SHIP OR BARGE LINE ON A STREAM		
SWIMMING POOL	POOL	
SPRING		
MARSH, FRESH	F	
MARSH, SALT	S	
FORD	FORD	
GRAVEL AND ROCKS		
RIPRAP		

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

4. Water main
5. Catch basin and manhole
6. Gas pipe
7. Hydrant
8. Gas valve and meter
9. Shaft
10. Gas well

* Explain that the Standard Symbols Sheet divides all utilities into above ground, Number 17, and below ground, Number 18. This information is shown in Tables 20 and 21 on pages 54-55.

Table 20 UTILITIES - ABOVE GROUND

Feature	Symbol	Remarks
HIGH TENSION TRANS. TOWERS		
ELECTRIC POWER TRANS. LINE	E	IDENTIFY
TELEPHONE OR TELEGRAPH LINE	T	IDENTIFY
TRAFFIC LIGHT		
FIRE HYDRANT		TICKS POINTING TOWARDS THE ROAD
PULL BOX (STREET LIGHTS)	L	
PULL BOX (SIGNAL)	S	
STREET LIGHT	STA. 5+00 400W - 15'	STA. OF LIGHT POLE WATTAGE - BRACKET L.
FLUORESCENT LUMINAIRE		UNDER DECK

Table 21 UTILITIES - BELOW GROUND

Feature	Symbol	Remarks
ELECTRIC	— — E — —	IDENTIFY
GAS	— — G — —	INDICATE DIAMETER
TELEPHONE	— — T — —	IDENTIFY
WATER MAIN	— — W — —	INDICATE DIAMETER
WATER MAIN CONNECTIONS	VALVE	
SEWER, SANITARY	— — Sa — —	INDICATE DIAMETER
SEWER, STORM	— — St — —	INDICATE DIAMETER
MANHOLE	T	LETTER INDICATES TYPE

CONTENT OUTLINE

H. Standard cross-sections

TEACHING POINTS AND TECHNIQUES

* Explain that there is sometimes a need to describe the character of the material used in the symbol on a plan.

* Draw on the chalkboard the following symbols (Ref. C, p. 68):

1. Cinders
2. Crushed rock
3. Solid rock
4. Earth
5. Wood
6. Brick
7. Plain concrete
8. Reinforced concrete
9. Rubble
10. Concrete reinforced with mesh

* Mention that the Standard Symbols Sheet Number 3 Cross-Sections indicates some mixtures of commonly used materials. This information is shown in Table 22 on page 56.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Compare the above symbols with those listed under Numbers 9 Topography and 14 Cut and Fill Limits on the Standard Symbols Sheet. This information is shown in Tables 5 and 6 below.

Table 5 TOPOGRAPHY

Feature	Symbol	Remarks
CONTOURS		
DEPRESSION		
SAND DUNES		
MINE OR GRAVEL BANK		
BOULDERS	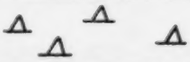	IDENTIFY
ROCK OUTCROP	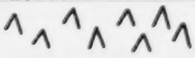	IDENTIFY

Table 6 CUT AND FILL LIMITS

Feature	Symbol	Remarks
TOP OF CUT	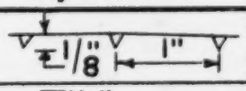	IDENTIFY AT BOTH ENDS OF THE SHEET
BOTTOM OF FILL	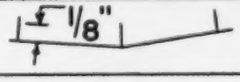	IDENTIFY AT BOTH ENDS OF THE SHEET

D. Subdivisions and surveying data

* Emphasize that this classification embraces political and private subdivisions.

* Point out that much surveying data or field information must be symbolized on a set of plans.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Draw on the chalkboard the following symbols and have the class practice drawing them (Ref. C, p. 52):

1. National border
2. State line
3. County line
4. Town line
5. Village line
6. Reservation line
7. District line
8. City line
9. Cemetery line
10. Park line
11. Property line
12. Barbed wire fence
13. Smooth wire fence
14. Hedge fence
15. Rail fence
16. Snow fence
17. Worm fence
18. Stone fence
19. Stone monument
20. Iron monument
21. Iron pipe
22. Tree line

* Point out that the Department Standard Symbols Sheet Numbers 10 Surveying Data, 13 Boundaries, 19 Subsurface Explorations, and 20 Miscellaneous cover this category. This information is shown in Tables 7-10 on pages 45-47.

* Review the comparable symbols used on the U.S.G.S. maps. (Ref. F, pp. 16-17)

Table 7	MISCELLANEOUS	
Feature	**Remarks**	**Symbol**
SYMBOL FOR NEW R.O.W. PARCELS	M23 P128 FEE (P.E, TE)	3/4" DIAMETER CIRCLE LEROY LETTERS

Table 10 SURVEYING DATA		
Feature	**Symbol**	**Remarks**
SPOT ELEVATION	X 103.2	
WATER ELEVATION	WE 102.5	IDENTIFY
BENCH MARK	BM 131 USGS EL. 241.31	IDENTIFY
TRIANGULATION STATION	N938,122.10 E590,619.60 N.Y.S.	IDENTIFY
NORTH ARROW (TRUE)	TRUE	
NORTH ARROW (MAGNETIC)	MAG. 1957	

CONTENT OUTLINE

E. Works and structures

TEACHING POINTS AND TECHNIQUES

* Mention that only the most common symbols in this classification will be covered in this lesson.

* Draw on the chalkboard the following symbols and have the class practice drawing them (Ref. C, pp. 53, 54, 57, 77, 80):

1. Foundation
2. Mine and quarry
3. Tank
4. Cemetery
5. School
6. Church
7. Hospital
8. Highway
9. Trail
10. Dam
11. Ditch
12. Abandoned canal
13. Aqueduct
14. Poor highway
15. Private road
16. Highway tunnel
17. Buildings in general
18. Highway bridge
19. Footbridge

Table 12	BRIDGES	
Feature	**Symbol**	**Remarks**
SINGLE SPAN BRIDGE		
MULTIPLE SPAN BRIDGE		IDENTIFY: LIFT, CONTIN. DECK SPAN, ETC.
HIGHWAY UNDERPASS		
HIGHWAY OVERPASS		
PEDESTRIAN UNDERPASS		
RAILROAD TUNNEL		
CATTLEPASS		

Table 13	ROADS	
Feature	**Symbol**	**Remarks**
PAVED		
UNIMPROVED (DIRT)		
ROAD UNDER CONSTRUCTION		
TRAIL		
ABANDONED	ABANDONED ROAD	IF NO LONGER PUBLIC R.O.W.
DRIVEWAY		
SIDEWALK	S. W.	
CURB	CURB	

Table 14 ROUTE MARKERS		
Feature	**Symbol**	**Remarks**
INTERSTATE	90	
U. S.	20	
STATE	152	
COUNTY	5	
TOWN	4	

Table 15 DRAINAGE FACILITIES		
Feature	**Symbol**	**Remarks**
CULVERT	EXIST. PROP.	SHOW DIRECTION ARROW OR INVERT ELEVATIONS
CATCH BASIN, ETC.	C.B.	IDENTIFY: CATCH BASIN, DROP INLET, ETC.
NATURAL DRAIN		
DITCH		
GUTTER	ASPHALT	IDENTIFY: ASPHALT, CONCRETE, ETC.

Table 16 SIGNS AND BILLBOARDS		
Feature	**Symbol**	**Remarks**
SIGN, GROUND MOUNTED		CIRCLES INDICATE NO. & LOCATION OF POSTS
OVERHEAD SIGN		
NEW SIGN		SIGN CONTRACTS, ETC.
NEW SIGN LOCATION AND TEXT	1 / 2	LOCATION TEXT

Table 18 DAMS AND DIKES		
Feature	**Symbol**	**Remarks**
DAM	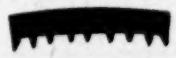	
SPILLWAY		
DIKE		USED WHEN CONTOURS ARE SHOWN
DIKE		USED WHEN CONTOURS ARE NOT SHOWN
JETTY	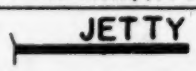	
PIER	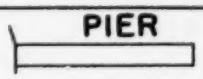	

CONTENT OUTLINE

F. Railroads

TEACHING POINTS AND TECHNIQUES

* Indicate that modern clearance problems and grade elimination techniques require differentiation among the types of railroads.

* Draw on the chalkboard the following symbols and have the class identify as many as possible by analysis (Ref. C, pp. 54, 61):

1. Railroad
2. Electric railroad
3. Railroad in street
4. Railroad grade crossing
5. Grade crossing (railroad overhead)
6. Grade crossing (railroad under)
7. Railroad tunnel
8. Railroad bridge
9. Narrow gauge railroad
10. Trestle
11. Turntable
12. Signal tower
13. Railroad station

* Compare the above symbols with those listed under Number 11 Railroads on the Standard Symbols Sheet. This information is shown in Table 19 on page 53.

Table 19	RAILROADS	
Feature	**Symbol**	**Remarks**
SINGLE TRACK	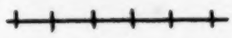	
MULTIPLE MAIN LINE TRACK	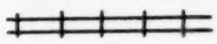	NUMBER OF TRACKS LABELED IF OVER TWO
ABANDONED TRACK	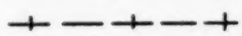	IDENTIFY
JUXTAPOSITION	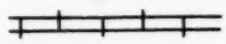	
YARD OR SIDING	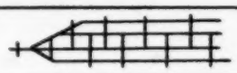	
TURN TABLE	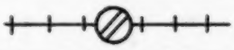	
NARROW GAUGE SINGLE TRACK	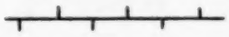	
NARROW GAUGE MULTIPLE TRACK	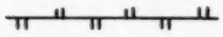	NUMBER OF TRACKS LABELED IF OVER TWO
ABANDONED TRACK NARROW GAUGE	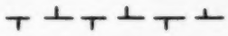	
HIGHWAY-RAILROAD CROSSING SIGN		
HIGHWAY-RAILROAD CROSSING GATE		
BRIDGE WARNING TELLTALE	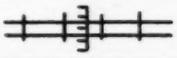	
MILE POST		SHOW NUMBER

CONTENT OUTLINE

G. Utilities

TEACHING POINTS AND TECHNIQUES

* State that utilities can occupy the right-of-way of any highway, so they will appear on most maps concerning highway work.

* Draw on the chalkboard the following symbols (Ref. C, pp. 59, 61, 77):

1. Telephone or telegraph line
2. Electric power transmission line
3. Power distribution line

Table 8 SUBSURFACE EXPLORATIONS		
Feature	**Symbol**	**Remarks**
DRILL HOLE	⦿	IDENTIFY BY NUMBER
AUGER HOLE	◎	IDENTIFY BY NUMBER
PROBE HOLE	●	IDENTIFY BY NUMBER
UNDISTURBED SAMPLE D.H.	◐	IDENTIFY BY NUMBER
TEST PIT	■	IDENTIFY BY NUMBER
POWER AUGER HOLE	⊙	IDENTIFY BY NUMBER
SEISMIC POINT	◒	IDENTIFY BY NUMBER
RETRACTABLE PLUG SAMPLE HOLE	○	IDENTIFY BY NUMBER

Table 9 BOUNDARIES		
Feature	**Symbol**	**Remarks**
NATIONAL	CANADA / U. S.	IDENTIFY
STATE	NEW YORK / PA.	IDENTIFY
COUNTY	NIAGARA / ERIE	IDENTIFY
TOWN	BETHLEHEM / COEYMANS	IDENTIFY
CITY OR INCORPORATED VILLAGE		IDENTIFY
PROPERTY LINE	PL	IDENTIFY
FIELD LINE		
RIGHT OF WAY LINE		IDENTIFY
CONTROLLED ACCESS LINE	WO/A (W/A)	WO/A=WITHOUT ACCESS W/A= WITH ACCESS

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

20. Suspension bridge
21. Truss bridge with girders
22. Arch bridge
23. Ferry
24. Radio tower
25. Radio beacon
26. Salt well
27. Bench mark

* Mention that the Standard Symbols Sheet covers this category with Number 1 Roads, Number 2 Route Markers, Number 4 Barriers, Number 5 Bridges, Number 6 Dams and Dikes, Number 7 Drainage Facilities, Number 9 Topography, Number 12 Buildings and Special Sites, and Number 16 Signs and Billboards. This information is shown in Tables 5, 11-18 on pages 44, 48-52.

Table 11 BARRIERS

Feature	Symbol	Remarks
BARRICADE		
BOX BEAM OR BEAM GUIDE RAILING		
BOX BEAM OR BEAM MALL BARRIER		
CABLE GUIDE RAILING		
RETAINING WALL		IDENTIFY: CONCRETE, STONE, ETC.
FENCE	5' 5'	IDENTIFY: TYPE FENCE, NO. INDICATES HEIGHT
STONE FENCE		
STREET BARRICADE BAYS		

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Table 17 BUILDINGS AND SPECIAL SITES		
Feature	**Symbol**	**Remarks**
BUILDINGS IN GENERAL		IDENTIFY: TYPE, USE AND STORIES
BUILDINGS TO BE DEMOLISHED		
CHURCH		IDENTIFY
SCHOOL		IDENTIFY
CEMETERIES	CEM.	IDENTIFY
ATHLETIC FIELD		IDENTIFY
REST AREA OR PARKING LOT		IDENTIFY
FOUNDATION	FOUND	IDENTIFY
UNDER CONSTRUCTION	U/C	
RUINS	RUINS	IDENTIFY
WATER TOWER	WATER TOWER	
TANK	TANK	IDENTIFY
SILO	SILO	IDENTIFY
POWER PLANT		
TRANSFORMER STATION	TRANS. STA.	
LIGHT HOUSE		
HELIPORT	H	
RADIO TOWERS	WGY	

Table 22 CROSS - SECTIONS		
Feature	**Symbol**	**Remarks**
CEMENT CONCRETE		
ASPHALT CONCRETE		
PENETRATION TREATMENT		
TRUING & LEVELING COURSE		
ORIGINAL GROUND		
ROCK		

QUESTIONS FOR REVIEW

1. In shading a symbol, from what direction is the light assumed to be coming?

2. What type of pen is most successfully used in the drawing of symbols?

3. What are the different classifications of symbols in common use?

4. Why are symbols used on a topographic map?

ASSIGNMENT

1. Study pages 83-93 and 606-610 in Ref. A.

2. Complete problem 4.1.8 on page 94 in Ref. A.

3. Ask the students to ink, on one sheet of drawing paper, any 50 symbols of the standard sheet. Emphasize that the name of each feature is not to be placed on the drawing. Point out that these drawings will be exchanged with another student for feature identification.

Lesson 7 - Abbreviations, Lettering, and Inking

OBJECTIVE

To provide the techniques that will make a topographic map more meaningful

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Abbreviations	* State that abbreviations are used in order to conserve space and to expedite the drawing of a topographic map.
A. Standards	* Emphasize that all of the abbreviations used are authorized and can be recognized easily.
B. Experience	* Mention that after gaining experience, some draftsmen wrongly invent their own abbreviations. Their symbols may mean little to the reader of the map and could even cause confusion.
C. General abbreviations	* Inform the class that certain abbreviations are used in highway work. Many of these will not be covered here since they pertain to the more technical data which will be encountered in later courses.
	* State that some of the abbreviations covered at this time will be found on the U.S. Geological Survey maps and on many highway plans.
	* Have the students study the Table of Abbreviations on the Standard Symbols and Abbreviation Sheet.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

1. Alinement

* Discuss each symbol under alinement and emphasize that each one is designed for easy recognition and interpretation.

Ah.	= Ahead
Beg.	= Begin
Bk.	= Back
B_L	= Base line
C_L	= Centerline
Cor.	= Center correction of V.C.
C.S.	= Point of curve to spiral
Dc	= Degree of curve
Def.	= Deflection
e	= Maximum superelevation
Eq.	= Equality
Ext.	= External
H.S.D.	= Headlight sight distance
L	= Length
P.C.	= Point of curve
P.I.	= Point of intersection
P.O.L.	= Point on line
P.O.T.	= Point on tangent
P.S.D.	= Passing sight distance
P.T.	= Point of tangent
P.V.I.	= Point of vertical intersection
R	= Radius

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

S.C.	= Point of spiral to curve
S.S.D.	= Stopping sight distance
S.T.	= Point of spiral to tangent
T	= Tangent (Ts = spiral; Tc = compound)
T.Pt.	= Tie point
T.S.	= Point of tangent to spiral
V.C.	= Vertical curve
° ' "	= Degrees, minutes and seconds (such as 6°26'33")

2. Section notes

* Explain briefly the meaning of cross-sections, noting that this subject will be covered in the surveying unit.

B.C.	= Bottom of curb
B.M.	= Bench mark
B.O.	= Bottom of opening
Elev. or El.	= Elevation
H.I.	= Height of instrument
O.S.	= Original surface
P.M.	= Procedure manual
S.S.C.	= Same slope continues
T.C.	= Top of curb
T.H.W.	= Top of headwall
T.O.	= Top of opening
T.P.	= Turning point

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

3. Topography (Pavement)

* Indicate that these items are probably the most widely used since they cover visible features.

A.C. = Asphalt concrete

Bit.Mac. = Bituminous macadam

Brk. = Brick

Conc. = Concrete

E.P. = Edge of pavement

Pav't = Pavement

Rd. = Road

S.S. = Shoulder stabilization

4. Topography (Drainage)

* Point out the importance of abbreviations in an area where a concentration of drainage facilities is found.

B.B. = Bottom of bank (stream)

C.B. = Catch basin

C.I. = Curb inlet

C.I.P. = Cast iron pipe

C_L Strm. = Centerline of stream

C.M.P. = Corrugated metal pipe

C.P. = Concrete pipe

C.R. = Curb receiver

Culv. = Culvert

D.I = Drop inlet

D'Xing = Ditch crossing

E.H.W. = Extreme high water

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

E.S. = End section

H.W. = Headwall

Inv. = Invert

M.H. = Manhole

M.H.W. = Mean high water

O.C.M.P. = Oblate corrugated metal pipe

O.H.W. = Ordinary high water

R.C.P. = Reinforced concrete pipe

T.B. = Top of bank (stream)

T.G. = Top of grate

V.C.P. = Vitrified clay pipe

V.T.P. = Vitrified tile pipe

5. Topography (Utilities)

* Explain that these abbreviations assist the designer to locate utilities within a minimum of space.

G. = Gas

G.P. = Guy pole

G.S.B. = Gas service box (house line)

G.V. = Gas valve (main line)

H.P.G. = High pressure gas

Hyd. = Hydrant

L.P. = Light pole

L.P.G. = Low pressure gas

P.P. = Power pole

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Tel.P. = Telephone or telegraph pole
	W. = Water
	W.S.B. = Water service box (house line)
	W.V. = Water valve (main line)
6. Topography (Miscellaneous)	* Write each abbreviation on the chalkboard and explain its meaning.
	Abut. = Abutment
	Bldg. = Building
	Br. = Bridge
	Brk.Ho. = Brick house
	C.B.Ho. = Concrete block house
	C-C = Center to center
	CR = County road
	C.R.W. = Concrete retaining wall
	D = Deed distance
	DM = Direct measurement
	Drwy. = Driveway
	Fd. = Foundation
	Fr.Ho. = Frame house
	Ho. = House
	I.P. = Iron pin or iron pipe
	M = Measured distance
	Mon. = Monument
	N & R = Nail and red

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	N & W = Nail and washer
	P_L = Property line
	Por. = Porch
	RR = Railroad
	R.O.W. = Right-of-way line
	SH = State highway
	Spk. = Spike
	St. = Street
	Stk. = Stake
	Sto.Ho. = Stone house
	Sty. = Story
	SW. = Sidewalk
	T.L. = Tree line
	W.W. = Wingwall
II. Lettering	* Mention that the lettering on the topographic map is simple and dignified and is used mainly to convey information. (Ref. C, p. 93)†
A. Style	* State that in most highway work the style of lettering is either upright or inclined commercial gothic or upright or inclined modern roman. Show examples of each on the chalkboard.
	* Mention that gothic is referred to as single-stroke lettering, which means the width of the straight and curved lines of the letter are the same width as the stroke of the pen or pencil.

†Reference citations are shown on page 1.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that the modern roman type requires more time and recently it has been reserved only for titles or for some predominate feature of a map.
	* Recall that inclined letters are at an angle of about 70° with the horizontal.
B. General proportions	* State that the height of letters on a topographic map should be proportionate to the size of the drawing.
	* Indicate that a certain amount of flexibility is used when compressing or extending lines of letters.
C. Technique	* Show the correct way to hold a pencil for both the vertical strokes and for horizontal strokes. (Ref. A, pp. 85-86)
1. Lettering pens	* Point out that the choice of a penpoint depends on the draftsman, the paper used, and the size of lettering required. In general, a Henry tank pen, Gillott's points, Hunt's points, or any of the Speedball series is used.
	* Stress that a good penpoint has enough resistance to normal pressure to permit the drawing of curved and stem strokes of uniform width. A flexible penpoint is unsatisfactory for lettering. (Ref. A, p. 93)
2. Proportion	* Show how every letter has a definite relationship of width to height.
	* Mention that each letter is envisioned on a background block consisting of 36 little squares (6 vertical and 6 horizontal). The proportion of each part of a letter should be learned visually. (Ref. A, p. 86)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Order of strokes	* Demonstrate the entire alphabet by family groups, showing the order of strokes in the construction of each letter or number.
a. I, H, T group	* Explain that the I is the foundation stroke. The H is a square—5 small squares by 5 small squares. The top of the T is 6 small squares across. (Ref. A, p. 86)
b. L, E, F group	* Show that the L is made in two strokes. A third stroke places the top of the E, and a fourth stroke is 2/3 as long as the top and base. The F has the same proportions as the E. (Ref. A, p. 86)
c. N, Z, X, Y group	* Stress that the parallel sides of the N are made first. The Z and X are both started inside the background block at the top and go all the way out at the bottom. This places the crossing of the X above center. Note that the junction of the Y is at the center. (Ref. A, p. 86)
d. V, A, K group	* Show that the V and A are both one background square wide. The A bridge is 1/3 up from the bottom. The second stroke of the K strikes the stem 1/3 up from the bottom. The third stroke of the K is aimed from the top of the stem. (Ref. A, pp. 86-87)
e. M, W group	* Point out that the M is made in 6½ small squares and add that the W is made in 8 small squares. (Ref. A, p. 87)
f. O, Q, C, G group	* Mention that the O, Q, C, and G are letters of the O family and are made as full circles. (Ref. A, p. 87)
g. D, U, J group	* State that a common problem with the D is the failure to draw the stem horizontally. The J is a portion of the U. (Ref. A, p. 87)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
h. P, R, B group	* Point out that the middle lines of the P, R, and B are in the center of the stem. (Ref. A, p. 87)
i. S, 8, 3 group	* Emphasize that the S, 8, and 3 are all formed in the same way.
	* Note that a perfect 3 can be finished into an 8 and caution that a flat top should never be used on the 3. (Ref. A, p. 87)
j. 0, 6, 9 group	* Show that the cipher is 5/6 as wide as the O. The 6 and the 9 have the same curve as the cipher, with the lobes at 2/3 of the height. (Ref. A, p. 87)
k. 2, 5, 7, & group	* Demonstrate the problem of having the reverse curve of the 2 crossing exactly at the center of the block. The bottom of the 2 and the top of the 5 and 7 are horizontal straight lines. The stem of the 7 ends directly below the middle of the top. The ampersand requires practice to make it carefully balanced. (Ref. A, p. 87)
4. Fractions	* Explain that fractions are always made with the horizontal bar. The total height of the fraction is twice as high as one number. The numerator and the denominator are made 3/4 as high as one number. (Ref. A, p. 88)
5. Lowercase letters	* Mention that lowercase letters are used extensively on topographic maps. (Ref. A, pp. 88-89)
	* Emphasize that the basic form of the lowercase letters is a combination of a circle and a straight line.
	* Demonstrate the construction of the lowercase letters in a comparable fashion as with the capitals.

FOREWORD

The Office Occupations Program as it is designed at the Gila River Career Center, has as its salient objective the preparation of students to get and hold jobs in office occupations. These jobs, listed in graduated order of training time required, are receptionist, file clerk, clerk-typist, and stenographer.

While achieving this objective the program has taken into consideration certain factors that are inherent to all training programs as well as those inherent to the Gila River Center in particular. These factors have dictated that the program design meet the following needs: (1) student termination at any time during the training cycle, (2) student transfer to different job classifications, (3) student transfer to Central Arizona College, (4) rapid feedback on each student's progress through the total program to the student, instructor, and counselor (5) maximum of individualized instruction, (6) administrative control.

Students, particularly adult students, often choose to terminate their training before completion of a total program. In order to allow for this possibility, the program is designed to provide terminal points within the total program. This allows the student to terminate his training with some saleable skill acquired. For example, a student wishes to train as a clerk-typist (see "Student Flow Chart" page vi), but after only 150 hours of training he decides to quit. The counselor needs only to convince him to continue for (32) more hours of occupational training and he can quit with the skills required of a receptionist.

The design allows for the same situation in reverse. Suppose a student acquires the necessary skills required of a receptionist and wishes to continue. He simply goes back into the process taking the first unit required for file clerks.

The desire of students to transfer to a college curriculum at Central Arizona College is provided for through the basic education block. This block offers the student individual aid in communications, reading and math geared to passing the G.E.D. test.

Emphasis on individualized instruction necessitates the need for the fourth factor, i.e., the need for rapid feedback. With students following different paths and progressing at different speeds, counselors and instructors must have instant information on student progress if they are to tailor instruction to meet individual needs. This factor has been designed through use of computerized instructional management. The system, called Individual Program Control (IPC), provides the student, the counselor, and the instructor with up to the minute information on student progress in the total program.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
6. Left-handed person	* Advise the class that the left-handed person can reverse certain strokes but that he should exercise caution in inclined lettering. (Ref. A, pp. 90-91)
7. Composition	* Point out that composition is the selecting, arranging, and spacing of appropriate styles and proper sizes of letters. (Ref. A, pp. 91-92)
	* Note that each letter is spaced according to its shape and the shape of the letter preceding it.
8. Guidelines	* Demonstrate the use of the lettering triangle or the Ames Lettering Instrument. (Ref. A, p. 84)
	* Explain how the holes are used to provide guidelines for any size of lettering.
	* Show how the slant height is set on the guidelines.
D. Types of lettering	* Indicate that different types of lettering are used for the various elements of the topographic map.
1. Subdivisions	* Note that the names of states, counties, and townships are shown in upright capital letters.
	* State that the most important subdivision on the map is noted by the largest letters and that the size of the letters depends on their location on the map.
	* Note that the names of small towns and villages are lettered in upright lowercase letters. (Ref. C, p. 115)
2. Hydrography	* Point out that the names of hydrographic features are lettered in inclined capitals. The importance of the feature determines the size of the letters used.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Stress that water will ruin a tracing, so precautions must be taken for sweating hands and arms during hot weather.
b. Cleaning	* Note that only a volatile liquid such as benzene or carbon tetrachloride will clean tracing cloth. These agents remove all pencil marks, dirt, and smudges but they give off poisonous fumes so care must be taken in using them. (Ref. A, p. 398)
c. Erasing	* Explain that erasures are more easily made on the smooth side, but the dull side is tougher and will withstand more erasing. If an eraser other than the ruby is used, the fibers of the cloth will be broken. * Demonstrate erasing with different types of erasers on both the smooth side and on the dull side of the cloth. When the fibers are broken, rub the spot with talc and cover with collodion to prevent the cloth from spreading any ink. * Indicate that soapstone will also place a slick, smooth finish on damaged areas.
d. Inking	* Note that all pens are filled by means of a quill or dropper and are never dipped. Caution the class to keep the ink bottle off the board and to the right and tell them to be sure to cap the bottle when it is not in use. * Stress the importance of inking exactly over the pencil lines. * Indicate that the order of inking on a tracing is as follows (Ref. A, p. 398; Ref. B, p. 52): 1. Full line circles and arcs 2. Dotted circles and arcs

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	3. Irregular, curved lines 4. Straight lines; first horizontal (top to bottom), then vertical lines (left to right), and last inclined lines, the uppermost first. 5. Dotted lines in the same order as above 6. Centerlines 7. Crosshatching 8. Pencil guidelines for lettering 9. Lettering 10. Border 11. Check the tracing for any errors and/or omissions.
e. Practice	* Distribute a small piece of tracing cloth to each member. Have them place it over a map or drawing and ask them to trace with ink a portion of the material underneath.
C. Pencil transfer	* Discuss the pencil transfer method of copying a drawing. (Ref. A, p. 643; Ref. C, p. 179)
D. Glass top drawing board	* Describe the glass top drawing board fitted with lights and explain how it is used for copying a drawing. (Ref. C, pp. 179-180)
E. Pantograph	* Exhibit a pantograph and explain how it is used to make duplicate, enlarged, or reduced copies of a drawing. (Ref. C, pp. 180-181)
III. Duplicating Drawings	* Point out that the simplest method of duplicating a drawing is a direct print from the original tracing by means of a processed paper.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Blueprinting	* Explain the blueprinting process. (Ref. A, p. 404; Ref. B, p. 652; Ref. C, pp. 185-186)
1. Advantages	* Note that economy of equipment and operation makes blueprinting a good method of duplicating drawings. It was once the most widely used process.
2. Disadvantages	* Point out that the blueprint process is time consuming. The process involves the use of chemicals in solution. So the resulting print is wet and must be dried before using.
B. Van Dyke process	* Explain that the Van Dyke process involves the printing of a negative first. (Ref. A, p. 404; Ref. B, pp. 653-654; Ref. C, pp. 186-187)
1. Advantages	* Note that the negative may be used on Van Dyke paper or on ordinary blueprint paper. * Explain that the negative may be used many times without harming the original drawing. * Indicate that erasures may be made on the negative without changing the original.
2. Disadvantages	* Point out that the Van Dyke method is a wet, chemical process and is time consuming.
C. Ozalid process	* Describe the ozalid process and indicate that it is an excellent method for reproducing drawings. (Ref. A, p. 405; Ref. B, p. 654)
1. Advantages	* Indicate that the process uses a dry ammonia vapor, so it is not messy. * State that a print is made in a matter of seconds and is an exact copy of the original with no distortion.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that the operator needs little training. * Mention that the process will print milars or paper transparencies, which in turn can be used as originals. * State that wide and long originals can be printed.
2. Disadvantages	* Mention that the ozalid printing machine has a high initial cost. * Explain that an exhaust system must be provided to blow out the ammonia fumes.
D. Photocopying	* Describe the photocopying process. * Indicate that this process can be used to enlarge or to reduce the scale of the original. (Ref. A, p. 405; Ref. B, p. 657; Ref. C, p. 187)
E. Other process	* Explain the lithoprinting, line etching, typographic etching, and photolithographic processes but point out that they are unsuitable for highway plans. (Ref. B, pp. 652-658) * Indicate that these processes are suitable for some elements of industrial practice. * State that the U.S. Geological Survey (U.S.G.S.) maps are made by a photolithographic process.
F. Samples	* Distribute samples of the various duplicating processes and explain each with information about printing time, cost, and value. * Ask the class to make their own analysis of the material and elicit comments.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* State that blue india ink is used on hydrographic features, red opaque paint for all new work, and black for all existing features.
V. Meridian	* Note that any map, regardless of size or shape, must have some orientation from the north.
	* Indicate that magnetic north is shown by a half arrow and true north is shown by a full arrow.
	* Caution the class not to make the north point too ornamental or heavy. It should be simple and proportionate to the size of the drawing. (Ref. C, p. 120)

QUESTIONS FOR REVIEW

1. Explain the meaning of the following abbreviations:

(a) R	(b) RR	(c) CR	(d) N & R
(e) R.O.W.	(f) R.C.P.	(g) Rd.	(h) C.R.W.

2. Would the O.S. necessarily be disturbed if a C.M.P. with an E.S. were to replace an R.C.P. with a low Inv.?

3. Why is it not feasible to use ornamental lettering on topographic maps?

4. Where is the modern roman type of lettering used?

5. Which letter occupies the largest space?

6. Identify the difference between the letter O and the cipher 0.

7. List three important factors to follow when drawing fractions.

8. At what angle to the horizontal is an inclined letter?

9. What is the order of inking on a topographic map?

10. Describe a true north arrow.

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Lesson 8 - Techniques of Reproducing Drawings

OBJECTIVE

To understand the techniques of reproducing drawings

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. The Original Drawing	* Note the amount of time and work required to produce a topographic drawing. * Point out that it may be necessary to have a number of identical drawings for a given phase of work.
II. Copying Drawings	
A. Pricking	* Explain that if only one more copy is required, the second drawing could be expedited by pricking points with a fine pointed instrument through the original map into the new copy.
B. Tracing	* Point out that the most common method of copying drawings is by tracing the lines of the original (pen or pencil) in india ink onto tracing paper or cloth. (Ref. C, pp. 181-182)†
1. Tracing cloth	* Mention that tracing paper lacks strength and stability. So tracing cloth should be used for any permanent work. (Ref. A, pp. 395-398) * Explain that tracing cloth has one dull side and one smooth side, but it is possible to order cloth which is dull on both sides.

†Reference citations are shown on page 1.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Indicate that the smooth side is the working side. Most draftsmen use the dull side because it takes ink and pencil lines more readily, erases more easily, and produces less glare.
	* State that when ink is used on the smooth side, any pencil shading must be placed on the back, or dull side, of the sheet.
	* Distribute samples of different types of tracing cloth and tracing vellum and tell the class to make both pen and pencil marks on the different samples.
2. Procedure	* Caution the class to be certain that the tracing cloth is stretched smoothly and evenly over the pencil drawing. (Ref. C, pp. 183-184)
	* Explain that the working side of the cloth may be dusted with chalk dust, talcum powder, or prepared pumice. This is then rubbed off, which removes the waxy film and permits an easy flow of ink.
	* Add that when the finished tracing is used for reproduction, all inking should be a little heavier than if it were for a single product.
	* Mention that pencil guidelines made with a soft lead prevent an even flow of ink on the paper.
a. Problems	* Note that tracing cloth is very sensitive to changes in humidity and temperature. When the entire map or plan cannot be finished in one day, work should be segregated to a selected area. Otherwise the next day the tracing would have to be reoriented on the original map.

22116

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Mention that for lettering winding creeks the name follows only general curves. (Ref. C, p. 116)
3. Natural land features	* Explain that the names of prominent, natural land features are shown in upright capitals but smaller than those used for political subdivisions.
	* Note that the names of small valleys, peaks, and islands use lowercase upright letters. (Ref. C, pp. 116-117)
4. Public works	* Stress that the names of railroads, highways, tunnels, bridges, and ferries are lettered in inclined capitals. (Ref. C, p. 117)
5. Map titles	* Note that only upright roman is used for map titles.
	* Demonstrate the method of locating the title box on a map.
	* Describe the information required in the title box on a map. (Ref. C, pp. 117-120)
E. Rules	* Point out the rules and procedures to follow when lettering topographic maps (Ref. C, pp. 111-113): 1. Place names carefully so that the topographical symbols are not covered or crowded. 2. Place names to the right or left of the object. 3. In general, make names parallel to the lower border. 4. Letter railroads, highways, and utility lines parallel and close to their boundaries. The letters are placed with ordinary spacing, but the words themselves should be separated by a space equal to the length of the longest word in the title.

22111

ASSIGNMENT

1. Study pages 394-399 and pages 404-405 in Ref. A.

2. Ask the students to prepare a penciled topographic map of any design on drawing paper. Stipulate that the scale should be 1 in. = 50 ft. and that the following features should be shown:

   (a) Highway
   (b) River
   (c) Island
   (d) Railroad
   (e) Bridge
   (f) Town line
   (g) Bench mark
   (h) High tension lines
   (i) Magnetic north

   Add that proper lettering is to be used in designating the various features of the map, including the title and scale and that the map will be checked at the next class.

INSTRUCTOR'S NOTES

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	5. Letter utility lines and streams to read from the bottom of the map.
	6. Extend the names of elongated forests, swamps, and bodies of water in the direction of the long dimension and have the lettering extend almost its entire length.
	7. If a name does not fit because of the small scale being used, place it in the legend of the map.
	8. Study the relative importance of all the names before beginning to letter.
III. Order of Inking	* Mention that all topographic draftsmen do not follow the same pattern in inking maps. The following fundamental principles, however, must be used (Ref. C, pp. 109-111):
	1. Certain classes of symbols having no option of location—towns, houses, railroads, highways, and property lines—are inked first.
	2. All names are lettered next because they have precedence over the information which follows.
	3. Contours are inked next. They are drawn through houses and highways except on large scale maps.
	4. Contour elevations, all water features, and vegetation symbols are then inked.
IV. Color Inking	* Explain that while the topographic map is made up in several colors to denote different features, the highway map is less demanding.

22112

Administrative control is provided for through a subsystem within IPC. This subsystem utilizes the method of cost effectiveness analysis to insure that the total program as well as the office occupations program is meeting its stated objectives.

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MICROCOPY RESOLUTI
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ON TEST CHART

TANDARDS-1963-A

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* State that the geographical center of the United States including Alaska and Hawaii is in Butte County, South Dakota, 14 mi. east of the junction of the borders of South Dakota, Montana, and Wyoming at latitude 44°58' N. and longitude 103°46' W.
	* Point out that the geographical center of the 48 states is near Lebanon, in Smith County, Kansas at the intersection of latitude 39°50' N. and longitude 98°35' W.
	* Mention that the geographical center of New York State is in Madison, southwest of Utica.
II. U.S. Geological Survey (U.S.G.S.)	* State that the U.S. Geological Survey, commonly called U.S.G.S., is a bureau of the U.S. Department of the Interior, established by Congress in 1879. (Ref. F, p. 3)
	* Point out that this bureau has the following four divisions: 1. Topographic 2. Geologic 3. Conservation 4. Water Resources
A. Topographic division	* Stress that the mission of the topographic division is to collect, publish, and distribute data concerning the physical features of the United States.
1. National Topographic Map Series	* State that the topographic division is responsible for the delineation of the physical features of the United States as quadrangles of the National Topographic Map Series.
	* Emphasize that these multi-purpose three-dimensional maps provide basic information for engineering projects, mineral and water resource studies, national defense, and industrial and community planning. (Ref. F, pp. 6-8)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Revisions	* Note that when maps require revision, the area is surveyed again and remapped at a larger scale.
III. U.S.G.S. Map	
A. Projection	* Remind the class that these topographic maps are a polyconic projection and the greatest accuracy is found close to the center meridian. The information is located in the lower margin of the map.
B. Mapping	* State that much of the work in mapping is done by aerial photography and that contours are placed on the map by stereoscopic plotting. (Ref. F, pp. 10-11)
C. Plan of development	* Explain that the country is divided into quadrangles bounded by parallels of latitude and meridians of longitude. These quadrangles are mapped in different scales, depending on the use to be made in developing that particular area.
D. Scale	* Recall the definition of scale or the representative fraction as the fixed ratio between linear measurements on the map and corresponding distances on the ground. (Ref. F, pp. 4-6)
	* Point out that the graphic scales are printed in the center of the lower margin of each sheet. The scale shows distances in feet, kilometers, and miles.
E. Coverage	* Explain that many of the older U.S.G.S. quadrangles covered 15' longitude and 15' latitude. Today quadrangles of this size, based on recent data and drawn by photogrammetric methods, are generally used for sections of sparce population like the Adirondack Mountain area in northeastern New York State.
	* Indicate that the scale of this map is 1:62,500 or 1 in. = 1 mi.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that the common contour interval is 20 ft.
	* Emphasize that to provide greater accuracy many of the 15' quadrangles now have been divided into quarters that cover 0°7'30" of longitude and 0°7'30" latitude. Generally this size map is replacing the 15' quadrangle.
	* Indicate that the scale of the map is 1:24,000 or 1 in. = 2000 ft.
	* State that the common contour interval is 20 ft.
	* Remind the class that in this latitude (New York State) 1 degree of latitude is much longer in miles than 1 degree of longitude.
F. Grids	* Explain that the map is divided and marked into a grid system at specific minutes of latitude and longitude depending on the scale.
	* State that the longitude lines or vertical grid lines are true north lines and the parallels of latitude are true east and west lines.
	* Describe the difference between true north and magnetic north. Point out that a complete study of these will be made in the unit on surveying.
	* Note the true north and magnetic north symbols in the lower margin and explain the principle of declination. Point out that this topic will be covered in detail in the unit on surveying.
G. Coordinate system	* Explain the New York State coordinate system and show how it is used and marked on the map.
	* Add that the 1,000-meter Universal Transverse Mercator gridticks are shown in blue on all four edges of the map.

QUESTIONS FOR REVIEW

1. What is the value of the pantograph for ordinary map work?

2. When should soapstone be used on tracing cloth?

3. What is the order of inking a tracing?

4. Why is it incorrect to dip a pen into india ink?

5. What is the best process of duplicating drawings available to the highway draftsman?

ASSIGNMENT

1. Study pages 97-103 in Ref. A.

2. Tell the students to ink on tracing cloth the corrected topographic map of the preceding lesson. Add that these will be printed by the ozalid process.

INSTRUCTOR'S NOTES

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Lesson 9 - Map Projections

OBJECTIVES

1. To introduce the concept of projecting a sphere onto a flat surface
2. To acquaint the student with the different methods of map projection

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Location Factors	* State that some type of a geographical grid is necessary to locate specific points on the surface of the earth.
A. Coordinate system	* Sketch on the chalkboard a simple x-y axes and explain a basic coordinate system. * Show how a point may be located or referenced from another point by the use of a coordinate system.
B. Latitude	* Explain that parallels of latitude are imaginary horizontal lines running parallel to the Equator and extending to the poles. * Demonstrate on a globe how these parallels become smaller as they approach the poles. * Describe how these lines are numbered in degrees from 0 at the Equator to 90 at the poles.
C. Longitude	* Explain that the meridians of longitude are imaginary vertical lines running north and south around the earth.

22122

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Physical facts	* Emphasize that the following facts must be considered before mapmaking is attempted: 1. The earth is considered a sphere. 2. All meridians are of equal length and meet at the poles. 3. All parallels are complete circles which decrease in length as they approach the poles. 4. The distance between all parallels is the same along all meridians. 5. The distance between all meridians is the same along a given parallel. 6. Each meridian crosses the Equator and all parallels at right angles. * Suggest that no projection of the earth on a flat surface could follow all of these requirements. So to achieve one purpose something else must be given up.
B. Problems	* Explain that it is impossible to show any portion of the earth's surface on a flat map because of the sphericity of the earth. This may be compared to the flattening of a piece of orange peel or flattening a half of a rubber ball. * Mention that a flat map of the earth cannot be drawn without some kind of squeezing, stretching, or tearing. * State that regardless of size every map has some type of distortion. This is ignored in a survey of a small piece of property.

22124

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Emphasize that methods have been developed to depict a portion of the earth's surface on a flat map.
C. Projections	* State that a projection is the representation of an object on a flat surface.
	* Point out that any map of a portion of the earth's surface is a projection. (Ref. D, p. 937)†
	* Explain that each type of projection satisfies a certain set of conditions.
1. Gnomonic	* Describe the gnomonic projection as a geometric projection to a plane tangent to the earth's surface at any point with lines radiating out from the center of the earth and intersecting the tangent plane. (Ref. D, p. 938)
	* Note that this projection shows the great circles (meridians) as straight lines, which makes this very useful in navigation.
	* Indicate that this projection is true only in the area that is close to the point of tangency. Everything else is distorted.
2. Stereographic	* Show how the stereographic projection is a geometric projection to a plane tangent to the earth's surface at any point with lines radiating from a point on the earth's surface opposite the point of tangency. (Ref. D, p. 939)
	* State that this projection is excellent for showing a picture of a hemisphere but the areas are not true.
3. Mercator	* Explain that the mercator projection is a cylindrical projection made by projecting all points from

†Reference citations are shown on page 1.

22125

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	the earth to a cylinder which then is unrolled. This shows all parallels and meridians as straight lines and at right angles to each other which is perfectly true only at the Equator. (Ref. D, p. 942)
	* Explain that Greenland, which is about 1/8 the size of South America, appears larger than South America on this type of map.
4. Conic	* Point out that the conic projection places the earth in a cone and that projections are made from the earth to the cone. In this projection all the parallels are shown as curved lines.
	* State that this projection has its greatest accuracy at the line of contact. (Ref. D, p. 939)
5. Polyconic	* Explain that the polyconic projection consists of placing the earth in a series of cones, which then are unrolled and fitted together.
	* Point out that this projection is sufficiently accurate for maps of large areas. Also it has been adopted by the U.S. Geological Survey for the making of topographic maps. (Ref. D, pp. 940-942)
	* State that a vertical straight line marks a central meridian. This meridian is divided accurately so that the parallels are spaced correctly. Each parallel is divided truly and curved lines are drawn through these points to form meridians.
	* Indicate that the distortion is very small near the central meridian, which makes it excellent for small areas.

22126

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
6. Other projections	* Emphasize that there are other types of projections, each achieving a specific purpose. Most of these are called Conformal Projections.
	* Note as an example the Lambert Conformal Conic Projection, a simple conic projection except that the cone cuts the surface of the earth along two parallels of latitude called Standard Parallels. A map of the United States in this projection has an error of less than 2% at any point. (Ref. D, p. 942)
III. Highway Maps	* Indicate that the financial capability of contractors restricts new highway projects to relatively short distances. Thus the problem of error, due to projection, that occurs within the length of the project can be disregarded.
	* Note that it is important to coordinate the highway line when a long stretch of highway is built, like the New York State Thruway.
A. Convergency of meridians	* Explain that in survey work the convergency of meridians will be computed for a line run at a certain latitude. If this were not done, it would be impossible to coordinate any two projects.
B. Highway planning	* State that the most pertinent information for the location of a new highway will come from a U.S.G.S. map. Thus the system of projection and orientation is readily available.

QUESTIONS FOR REVIEW

1. Explain in terms of latitude and longitude why no projection of the earth on a flat surface can be precise.

2. Why did the U.S. Geological Survey select the polyconic projection for their use?

22127

UNIT CODE NUMBERS AND SUGGESTED
TIME ALLOCATIONS FOR ALL JOB
CLASSIFICATIONS

The following table shows individual unit titles, their respective code numbers, and suggested time allocations for each of the job classifications to which they relate.

		JOB CLASSIFICATIONS			
UNIT CODE #	TITLE	Stenographer	Clerk-Typist	File Clerk	Receptionist
-01	Occupational Orientation	5- 7 Hrs	5- 7 Hrs	5- 7 Hrs	5- 7 Hrs
-02	Fundamentals of Typing	70-85 Hrs	70-85 Hrs	70-85 Hrs	70-85 Hrs
-03	Office Equipment	20-30 Hrs	20-30 Hrs	10-15 Hrs	10-15 Hrs
-04	Communications	15-20 Hrs	15-20 Hrs	15-20 Hrs	35-45 Hrs
-05	Sources of Information	3- 5 Hrs	3- 5 Hrs	3- 5 Hrs	3- 5 Hrs
-06	Reception and Telephone				15-25 Hrs
-07	Production Typing	60-80 Hrs	60-80 Hrs		
-08	Financial Activities	8-10 Hrs	8-10 Hrs	8-10 Hrs	
-09	Record Management	15-20 Hrs	15-20 Hrs	30-40 Hrs	
-10	Transportation	2- 4 Hrs			
-11	Shorthand Principles	90-100 Hrs			
-12	Machine Transcription	15-20 Hrs			

Lesson 10 - U.S. Geological Survey Maps

OBJECTIVE

To provide information necessary to interpret the U.S. Geological Survey maps

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. U.S. Coast and Geodetic Survey	* Explain that the U.S. Coast and Geodetic Survey is a bureau of the Department of Commerce. The bureau's geodetic branch is involved with the precise measurement of the size, shape, and curvature of the earth. The U.S. Coast and Geodetic Survey is often confused with the U.S. Geological Survey.
	* Explain that the U.S.C.G.S. surveys establish exact positions and altitudes of rivers, mountains, cities, and other natural or cultural features. This information is supplied to engineers, surveyors, and to the U.S.G.S. for use in mapping, establishing boundaries, and planning highways and railroads.
	* Note that the geodetic center of North America is at the Meade's Ranch Triangulation Station in Osborne County Kansas, 12 mi. north of Lucas, Kansas. This point (lat. 39°12'26.686" N. and long. 98°32'30.506" W.) is the point of origin for all governmental mapping in the United States, Canada, and Mexico. (Ref. D, p. 381)†
	* Point out that the geographical center of North America is in Pierce County, North Dakota, at latitude 48°10' N, and longitude 100°10' W.

†Reference citations are shown on page 1.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Point out that the meridian of longitude passing through the Royal Observatory at Greenwich, England is called the zero meridian or Prime Meridian.
	* Mention that the other meridians are numbered from this zero point to 180° E. and 180° W.
	* Show the position of certain meridians on the globe.
D. Use of parallels and meridians	* Illustrate how any point on the surface of the earth can be located by its latitude and longitude.
1. Distance versus degrees	* Show that one degree of latitude is equal to 69.4 mi. This is determined by dividing the earth's circumference at the Equator, about 25,000 mi., by 360°.
	* Explain that 1 degree of longitude is not the same at different latitudes. Note the equivalencies below for 1 degree of longitude at various latitudes: 1. Equator - 69.17 mi. 2. 30° - 59.96 mi. 3. 60° - 34.67 mi. 4. 80° - 12.05 mi. 5. 90° - 0.0 mi.
	* Note that this presents problems in highway orientation. These problems will be brought out in the unit on surveying.
II. Mapmaking	* Relate that for centuries man has tried to make a flat map that is accurate.
	* Explain that a flat map cannot be made correct in all respects, because of the curvature of the earth.

22123

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
H. Features of maps	* Stress that the features shown on the U.S.G.S. maps may be divided into three groups: 1. Hydrographic 2. Relief 3. Culture * State that certain features, like vegetation, cannot fit on the maps because of the scale used.
1. Symbols	* Review the symbols that are used on U.S.G.S. maps. (Ref. F, pp. 16-17)
2. Colors	* Point out that U.S.G.S. maps use: 1. Black for culture 2. Brown for relief 3. Blue for hydrography 4. Red for highway type differentiation. * State that small streams or small canals are shown by a single blue line and larger streams by a double blue line. Large bodies of water are actually colored blue. Intermittent streams (whose beds are dry for a large part of the year) are shown by lines of blue dots and dashes. (Ref. F, pp. 14-15)
3. Datum	* Explain that the datum used for contours on U.S.G.S. maps is zero altitude or mean sea level. * Discuss how the contours indicate the shapes of slopes, hills, mountains, and valleys. Point out the location of the summit or valley elevation. * Indicate that the contour interval is located in the lower margin of the map. * Add that the bench marks are noted to the nearest foot. Explain that they are listed in a governmental publication by level runs in exact figures to three places.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note the triangulation points on the map and explain how and why they were so placed. * Point out that the intersections of highways are marked with the elevation of the ground at that point to the nearest foot. * Note that the elevation of the surface of a lake is shown at ordinary high water level. (Ref. F, pp. 12-13)
4. Highways	* Explain that the color code and size of line indicates the type of highway. This legend appears in the lower margin of the map. * Point out that as a highway reaches the border of the map, an arrow indicates its direction and distance to a terminal point. * Mention that the names of highways and roads are the local names attached to such roads. The numbers of the roads are designated by either the town, county, state, or the U.S. classification system.
5. Political subdivisions	* Indicate that the names of counties, cities, and towns usually are identified by large letters that stretch across the entire political subdivision. The limits of these areas are shown by marked boundaries.
I. Quadrangle information	* Point out that the name of the quadrangle, the name of the state, and the size of the series appear in the upper margin of the map. The quadrangle is named when the map is a quarter subdivision. (Ref. F, p. 18)
1. Area name	* Note that the area name and the coverage by the latitude and longitude in degrees are located in the lower margin of the map.
2. Location sketch	* Point out the small sketch of the State with the rough location of the

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	quadrangle that appears in the lower margin of the map.
3. Dates	* Indicate that the date of the map, the date the aerials were taken, and the date of revision appear in the lower margin of the map.
4. Adjacent quadrangles	* Point out that the names of the adjacent quadrangles are shown in the margins of the map. The diagonal name in the corner identifies the quadrangle next to the one that is directly above the quadrangle being read.

QUESTIONS FOR REVIEW

1. Why is the U.S.G.S. topographic map called three dimensional?
2. What is meant by the representative fraction of a U.S.G.S. map?
3. What is the latitude and longitude covered in a U.S.G.S. map with a scale of 1:24,000?
4. What do the blue gridticks signify on the quarter section of a U.S.G.S. map?
5. What type of projection is used for a U.S.G.S. map?
6. How can the type of highway be determined from a U.S.G.S. map?
7. Explain what is meant by the datum of a U.S.G.S. map.
8. What is a triangulation point as used on a U.S.G.S. map?

ASSIGNMENT

1. Ask the students to list the vegetation, works of man, and utilities that appear on their copy of the U.S.G.S. map.
2. Have the students locate the lowest and the highest marked elevation and the lowest and highest contour on the quadrangle.
3. Ask the students to list all political subdivisions on the map.
4. Have the students locate two prominent spots on the map by latitude and longitude.

Lesson 11 - Plotting Field Notes (Transit)

OBJECTIVES

1. To emphasize the importance of interpreting correctly every detail of the field notes
2. To provide the necessary information to plot field notes

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Field Notes	* Emphasize that field notes are the most important single element in the entire operation of surveying. (Ref. D, p. 43)†
A. Permanent record	* Stress the fact that the field notes are the permanent record of a survey. A field record reinforced by memory is worthless. * Add that notes of apparent insignificance may someday be very valuable for design, construction, or a court case. * State that sometimes a survey is rerun and the value of the original notes will depend on their clearness and completeness.
B. Content	* Explain that field notes consist of numerical data, explanatory notes, sketches, dates, weather conditions, names and duties of the chief of party and his assistants, and the title and purpose of the survey. (Ref. D, p. 44) * Emphasize that field notes are entered as the work is being done. There can be no erasing. A single fine line is drawn through any mistake and the correction made, initialed, and dated.

†Reference citations are shown on page 1.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Indicate that this plotting will be checked by another person, using a different method, before it is inked.
2. Map details	* Suggest that the topographic details for the first two courses be plotted before the base line is completed.
	* Circulate about the class, explaining and correcting the methods and procedures of plotting map details.
3. Procedures	* Emphasize that the points indicated below should be followed when plotting: 1. Use a 2H pencil. 2. Use triangles for right angle offsets. 3. Place the symbol for a tree location at the point closest to the base line. 4. Account for each point plotted with either a symbol or letter. 5. Use triangles to square-in houses or buildings. 6. Be careful not to erase the wrong item. 7. Do not write on the field notes. 8. Place the date and the name of the plotter and checker on the sheet.

QUESTIONS FOR REVIEW

1. What information is placed in a field notebook just before the survey is begun?

2. Why do survey notes begin at the bottom of a page and progress to the top?

3. Why is the tangent offset method of plotting more accurate than the protractor method?

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4. Explain the function of a base line.

5. How should an error in a field notebook be corrected?

ASSIGNMENT

1. Instruct the students to finish plotting the base line and to plot the remaining topographic details as found in the survey notes.

2. Remind the students that this work is to be done in pencil and after the work has been carefully checked the pencil work will be inked.

INSTRUCTOR'S NOTES

22140

Lesson 12 - Plotting Field Notes (Cross-Sections)

OBJECTIVES

1. To understand the fundamentals of cross-sectioning and profiling
2. To provide the techniques for the plotting of a cross-section and a profile of a survey

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Profile Leveling	* Describe profile leveling as the process of determining the elevations of points at measured intervals along a fixed line. (Ref. A, pp. 611-612)†
	* Explain the use of the level for determining elevations and mention that leveling is covered in the unit on surveying.
A. Profile from centerline	* Sketch on the chalkboard a line A-B consisting of 10 full stations with an elevation at each station.
	* Draw a datum line and plot the elevations above to show the profile of the line A-B. (Ref. D, pp. 213-214)
B. Profile from plan	* Explain that it is often necessary to construct a profile from a plan. (Ref. C, p. 137; Ref. D, p. 643)
	* Give each student the locations of two points on their copy of a 7½-min. topographic map. Have them mark these points and connect them with a straight line, A-B.
	* Indicate that the procedure to follow when making a profile is:
	1. Place the topographic map firmly on the board.

†Reference citations are shown on page 1.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

2. Draw horizontal lines on a sheet of paper spaced in the vertical scale desired and number from the lowest to the highest contour line crossed by the line A-B.

3. Orient the horizontal lines until they are parallel to the line A-B.

4. Project all intersections of the line A-B with the contour lines crossed to the appropriate horizontal line on the paper.

5. Connect the series of points to complete the profile of the line A-B. (Ref. C, p. 156).

* Note that the horizontal scale is the same as that of the contour map.

II. Route Cross-Sections

* Explain by means of a base line how sections are run in the field.

* Point out that the mechanics of leveling will be covered in the unit on surveying.

* Explain that this method of taking sections is merely the construction of cross-profiles. (Ref. D, pp. 215-217, 638, 672)

* State that these cross-sections are required to furnish data for location studies and for estimating the quantities of earthwork involved.

A. Pattern

* Mention that these crosslines intersect the base line either at 50-ft. points or at even stations or at both these points.

* Point out that if these crosslines are short they are run out by eye perpendicular to the base line. But if they are long (100 ft. or more) they are set by the use of an instrument,

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

preferably a right-angle mirror. (Ref. D, p. 218)

B. Elevations

* Emphasize that the level is used to find the elevations of all points. (Ref. D, p. 218)

* Describe and illustrate the method of ascertaining the elevation of the height of instrument and the procedure of rod reading.

C. Notes

* Display some typical sheets of cross-section notes and explain the procedure of entry and control.

1. Reduction

* Emphasize that the rod readings are simply numbers and are of no consequence unless they are subtracted from the height of instrument. This subtraction gives the elevation of the point.

* Distribute to each student a sheet of cross-section notes and indicate that these notes are to be reduced to rod readings.

D. Plotting

* Demonstrate the plotting of a cross-section on the chalkboard and explain the following:

1. Selection of the size of paper or the scale of the cross-section

2. The direction of the plotting

3. The selection of a datum

4. The marking of the base line

5. The circling of the plotted points

6. The process of checking the points

7. Signing name and date

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Furnish each student with a sheet of cross-section paper and a sheet of level notes. Ask the students to plot one cross-section, beginning at the bottom of the sheet and then to exchange sheets so that points can be checked.

* Point out that after checking, the points are connected with lines in black ink. Indicate that the black ink line is known as the O.S. or the original surface.

III. Use

* Explain that the design engineer uses this procedure to plot the cross-section of the new highway. Add that this work is done in pencil.

* Show the importance of the cross-section in furnishing an excellent picture of the ground at each section.

* Elaborate on the sequence by which information is placed on those sheets throughout a project.

QUESTIONS FOR REVIEW

1. What is a profile?

2. Explain how to construct a profile from a plan when elevations are given.

3. Describe the process of obtaining a profile between any two points from an ordinary U.S.G.S. map.

4. What is the difference between a profile and a cross-section?

5. What is meant by note reduction?

ASSIGNMENT

Instruct the class to finish the reduction of the level notes which were used in this lesson. Add that these notes are to be plotted at a horizontal and vertical scale of 1 in. = 5 ft. and 1 in. = 10 ft. so that an evaluation may be made of the results. Remind the students that inking should not be done until the points have been checked.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Mention that notekeeping will be discussed in the unit on surveying, but emphasize here that the notebook should contain all the necessary information recorded in a form that will give only one interpretation—the correct one.
C. Examples	* Show the standard, coordinated looseleaf notebook used by the New York State Department of Transportation for many years.
	* Exhibit the new type notebook designed for use with the electronic computing machines.
	* Explain briefly how these notebooks are organized.
	* Point out the index marking on the outside of the book and on every page in the book (permanent record code).
	* Explain that the sheets on the left are used for base-line information while the sheets on the right are used for topographic information and sketches.
	* Mention that all information moves along the stationing from the bottom of the book to the top.
II. Mapping	* Note that the process of mapping is the precise plotting of horizontal control and the plotting, by less precise methods, of features called map details.
	* Point out that the process of mapping is in a way the reverse of the process of surveying. Data collected in the field is used to make a graphic representation of an area by showing features in the same relative location that they occupied on the ground, but to scale. (Ref. D, p. 445)

22137

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Horizontal control	* Review briefly the general idea of the base line and how it is used as the basis of the survey.
	* Recall briefly the methods used in plotting horizontal control. (Ref. D, pp. 446-450)
B. Details	* Emphasize that it is important to plot details within the proper limits of error. (Ref. D, pp. 466-468)
	* Mention that the accuracy of details affects the value of a set of plans.
1. Linear plotter	* Exhibit a plotter made of plastic and demonstrate how it is used to facilitate the locating of points at right angles to the base line.
	* Explain that the location of a detail is usually measured to the nearest foot. So a plotter that is accurate to the nearest foot will give satisfactory results.
	* Point out that when placed on the required station, this plotter can be set for any right angle offset, right or left of the base line.
	* Note that these plotters are usually homemade.
C. Practice	* Distribute individual sets of prints of the notes for a base-line survey. The base line should be at least 1,500 ft. long and consist of at least five transit points.
1. Base line	* Have each student estimate (or by drawing a small sketch) where to place the first course on their paper.
	* Direct the class to plot and draw the first and second course. This may be done by either the protractor or the tangent method at a scale of 50 ft. per in.

OFFICE OCCUPATIONS
STUDENT FLOW

Students preparing for one of the four job categories within the office occupations program would follow one of the paths illustrated below. The program is so structured as to allow students a choice, upon completion of specified performance objectives, of terminating or continuing into another job category path. Individual units are not necessarily presented in the sequence shown. A beginning student should, however, start with the Orientation Unit and progress from there.

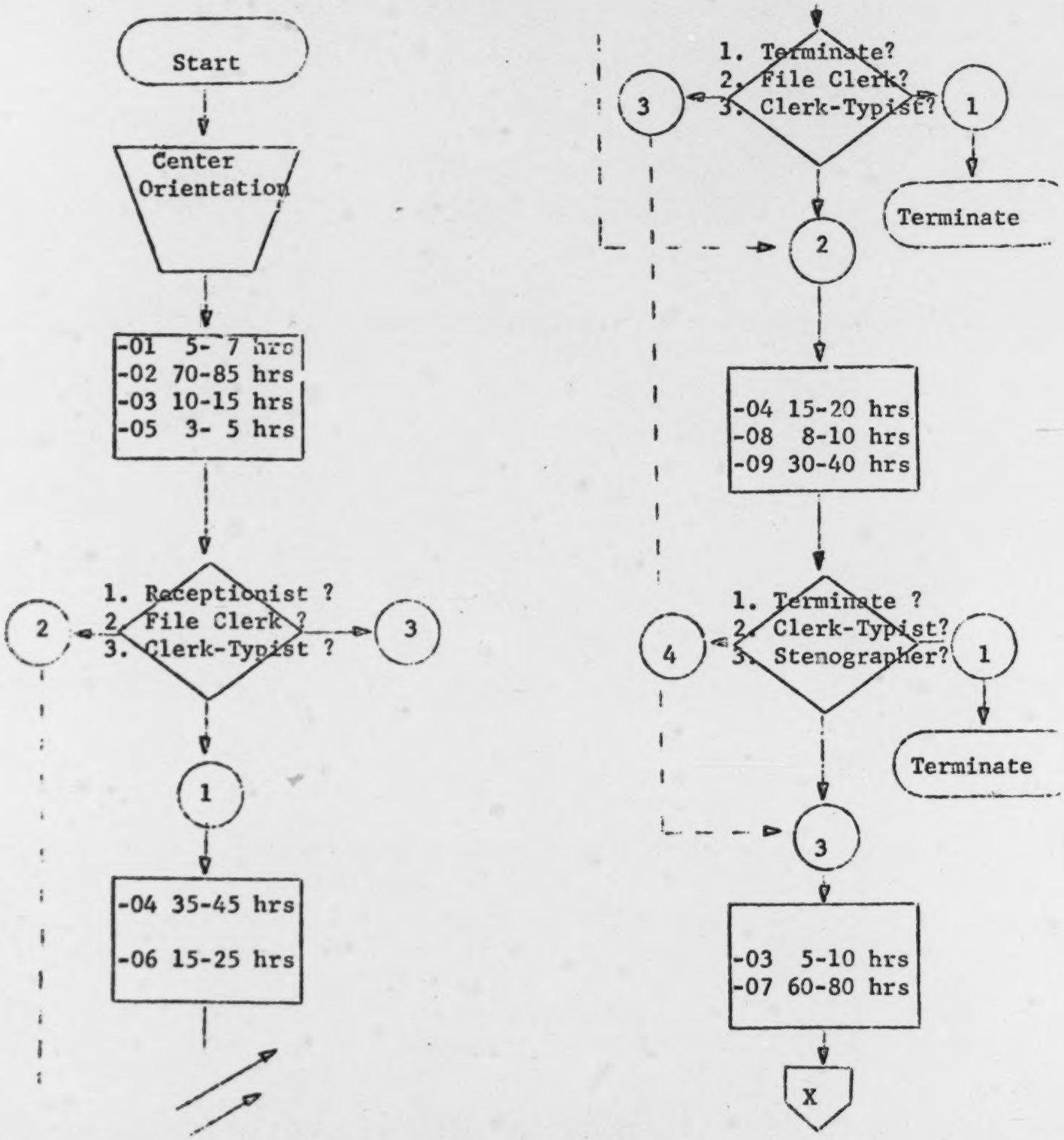

Lesson 14 - Aerial Photography and the Digital Computer

OBJECTIVE

1. To discuss the rudiments of aerial photography
2. To understand the application of aerial photography to highway design and its use with the digital computer

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Aerial Surveying	* Explain that aerial surveying provides valuable information about the terrain and assists the highway engineer in analyzing proposed route locations and in designing new highways. (Ref. D, pp. 838-844)†
A. Concept	* State that the aerial survey records on film a segment of the earth's surface.
	* Indicate that aerial photographs consist of individual views in perspective that ordinarily use a 9 in. by 9 in. negative format. Along the line of survey, the individual views overlap each other by 60 percent, which affords two different views of anything on the ground.
	* Explain that a viewer is able to study these overlapping prints with stereoscopic instruments and distinguish the three dimensions of length, width, and height. The stereoscopic instrument used may be either a lens or mirror stereoscope.
	* State that the stereoscope is a mechanical device used to facilitate seeing in three dimensions. An observer can view two aerial photographs of the same object with his two eyes

†Reference citations are shown on page 1.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	in such a manner as to cause the photographs to fuse into a single, spatial model of the original object.
	* Demonstrate the simple stereoscope.
B. Photoreading	* Explain that photoreading is the process of recognizing certain features in the photograph either by eye or by instrument.
C. Photointerpretation	* Mention that photointerpretation is broader in scope than photoreading since it includes photoreading and is supplemented by the measurements from photogrammetry.
	* State that photointerpretating is a specialized art requiring knowledge of geology, climatology, hydrology, biology, and sociology.
	* Indicate that photoreading and photointerpretation are inference techniques and are qualitative.
D. Photogrammetry	* Define photogrammetry as the quantitative science of making vertical and horizontal measurements from aerial photographs.
	* Point out that these measurements are compiled into a topographic map directly or prepared for a digital computer.
II. Techniques of Photoreading and Photointerpretation	* Mention that cultural features are easily recognized on aerial photographs.
	* Show the class aerial photographs of the local area and have them locate features that are well known to them.
A. Buildings	* State that buildings are readily recognized by straight lines, sharp angular corners, and geometric roof patterns.
	* Explain that the type of building or functional use can often be inferred by its shape or position.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that commerical buildings are larger than residential buildings. High cost residential areas contain large lots, irregular shaped roof patterns, and landscaped drives and boundaries. Low cost residential areas are in clusters of small lots with very regular and repetitive roof patterns.
	* Emphasize that everyday observations assist in the recognition of buildings.
B. Highways	* Indicate that a low cost gravel road is identified on an aerial photograph by sharp turns, light gray tone, and very irregular edges. In front of farmhouses, a dark gray tone may occur where oil has been applied to keep down the dust.
	* Explain that bituminous roads have an intermediate gray tone. High quality bituminous roads may be distinguished from low quality roads by differences in width, edges, shoulders, and drainage. Low quality roads have irregular edges, almost no shoulders, and poor drainage ditches overgrown with brush.
	* State that concrete roads will be very light gray to almost white in tone, have sharp edges, and contain transverse lines of dark gray or black tone that indicate various joints in the pavement. On an old, well used concrete road, longitudinal oil smears will be visible on large-scale photographs.
C. Railroads	* Exhibit an aerial photograph showing a railroad.
	* Mention that the railroad is in direct contrast with the highway in alignment and in width. Point out the following about railroads:

Lesson 13 - The Highway Plan

OBJECTIVES

1. To introduce the component parts of the highway plan as designed in the New York State Department of Transportation
2. To understand the role of drawing in the finished plan

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. The Highway Plan	* Define the highway plan as a book of plans prepared by a design team to inform the contractor about how to build the highway.
A. Purpose	* Mention that every detail necessary to the construction of a highway is described in this set of plans, either by drawings or by notes.
B. Standards	* Explain that certain aspects of a highway design are standard and that this information is furnished on standard sheets. * Point out that since every highway varies in terrain, soil conditions, drainage, and right-of-way, standards for a complete design are impossible.
C. Divisions	* Emphasize that there are 16 divisions in a modern highway plan. In small projects or in special contracts some of the categories are unused or combined with another division.
II. Divisions of Plans	* Display the various divisions of the plan, using a large-scale set mounted on a frame. * Furnish the class with as many copies of the plan as possible and have the students form small groups around them.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Cover sheet	* Note that the cover sheet will vary with the project and the design engineer. In general, the following information will be on the cover sheet and on the next sheet or two.
1. Title of project	* Explain that the title of the highway is shown as either a construction or a reconstruction project and the following information always appears on the cover sheet: 1. Contract limits 2. Length of work in stations and in miles 3. Name of city, town, or county 4. Total number of sheets 5. Sheet number (1 on the cover sheet) 6. Contract number
2. Corner insert	* Mention that every sheet has a box insert in the upper right-hand corner with pertinent information concerning Federal aid numbers, sheet number, and the total number of sheets in the complete plan. * Note that the title is repeated in this box insert. * State that for the cover sheet only a note appears just below the box which indicates the type of construction and its length. Another note, just below the last one, indicates the listing of the standard sheets necessary for the contract. * Indicate that the date of the specifications used is also included.
3. Approval and recommendation	* Differentiate between the signature of the district engineer, who recommends the project for construction by his signature, and the approval by the chief engineer of the Department of Transportation.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Index sheet	* Explain that the index sheet is necessary when involved with a large set of plans.
C. Table of maintenance	* Describe the table of maintenance as a list of the portions of the contract showing the political entity that will maintain each section after the completion and acceptance of the contract.
D. Small-scale key map	* Point out the key map (scale usually 1 in. equals 200 ft.) and indicate that the following elements are shown by this map: 1. North arrow and scale 2. New centerline with stations 3. Base line with transit points and stations 4. Beginnings and endings of curves with stations 5. Equalities in horizontal alinement 6. Contract limits 7. A certain amount of existing topography 8. Property lines and property owners 9. Profile on a vertical scale of 1 in. = 20 ft. and on a horizontal scale of 1 in. = 200 ft.
E. Typical sections and general notes	* State that the typical sections and general notes describe completely each part of the new highway as it will be built. * Discuss the scales used in these sections. * Show how the typical section is defined between certain stations. * Explain how the typical section describes the items to be used in the construction.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	concrete boxes, arches, or large corrugated metal pipes are shown on the drainage structures sheet. * State that any special design involving manholes, catchbasins, and covers is also detailed here.
I. Miscellaneous details	* Mention that fencing, curbing, sidewalks, or retaining walls are shown under miscellaneous details. * Indicate that anything that is on the standard sheets will not be detailed again.
J. Roadside development	* Note that roadside development indicates the schedules for planting trees and bushes, seeding, clearing and grubbing and includes the following: 1. Location of plantings 2. Types of bushes and trees 3. Preparation by the landscape architect 4. Table of tree removals
K. Parking areas	* State that the design of the parking area sites with required quantities is shown and includes the following: 1. Drives 2. Guide railings 3. Seeding schedules
L. General large-scale plan	* Note that the large-scale plan (50 ft. for rural highways and 20 ft. for urban highways) is the nucleus of the highway design. * Mention that on large contracts two sheets are often used to cover the same area, one for drainage and one for layout. * Point out that the following important elements are shown on most combination layout and drainage sheets:

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

1. Base-line alinement with transit points and ties, with stationing and azimuths
2. New centerline alinement (marked as centerline of improvement), with stations and bearings or azimuths
3. Horizontal curves, complete with design data
4. Topography in its entirety
5. The new right-of-way line
6. Demolition items
7. North arrow and scale
8. Bench-mark location and elevation
9. Appropriation map numbers, together with the type of acquisition such as a temporary easement, permanent easement, fee taking with or without the right of access
10. Limit of grading
11. Limits of work at the beginning and at the end and also on the sidelines
12. Drainage notes
13. Invert elevations at all drainage structures
14. Culvert pipe flow
15. Stream relocations
16. Special ditch sections
17. Equalities
18. Fencing

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

19. Utility relocations

20. Temporary work

M. Profiles

* Note that on most contracts the profile is placed in the lower portion of the design plan. With arterial work the tendency is to place the profile in a special section.

* Point out that there is much design information on the profile sheets and includes the following:

1. Datum
2. Scales
3. Stationing
4. Vertical curvature and data
5. Percentage of grade in new line
6. Drainage structures in elevation view
7. Passing sight distance and safe stopping distance
8. Equalities

* State that the cross-section sheets used to design the project are not part of the contract.

N. Lighting and traffic control signals

* Emphasize that lighting and traffic control information is listed only when required for a given project. This occurs mostly on arterial highways.

* Note that a special set of large-scale plans are drawn for lighting, but the alinement is shown only with pavement edges, cross streets, and centerlines.

* Discuss the symbols used on the lighting sheets.

* Explain the lighting detail sheet and show how the conduit and pull boxes are indicated.

* State that any design for traffic signals is described on its own sheet.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

O. Bridges

* Show plans which include a bridge and state that the order of sheets is:

1. Plan views and elevations
2. Rounded and neat quantities
3. Approach sections
4. Footings, abutments, and piers
5. Superstructure
6. Bar lists of reinforcing steel
7. General notes

P. Standard sheets

* Discuss some of the more common standard sheets used in highway design and explain how the draftsman often has to make certain changes in a standard sheet. Show how the sheets are filed in a standard sheet book, one for roadway and one for bridges.

QUESTIONS FOR REVIEW

1. Why is it difficult to standardize any more of the highway plan than is done now?
2. List five items that appear on the cover of highway plans.
3. What is the table of maintenance?
4. Describe the key map as used on highway plans.
5. Are the typical sections of a highway plan scaled drawings?
6. Why is a retaining wall drawn in detail while a drop inlet is not?
7. What can be done to ease the concentration of details on a contract plan sheet of a very complex urban design?
8. Why are the dimensions on the bridge plans in feet and inches?

ASSIGNMENT

Furnish students with a contract plan (200-ft. scale plan and profile) and have them draw on a 50-ft. scale a 15-station portion of the plan. Note that the work is to be done in pencil on vellum so it can be checked as an overlay on the original 50-ft. contract plan.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
4. Design staff	* Point out the signatures of the engineers who worked on the individual sheets. Each sheet will have at least three signatures in the bottom left-hand corner.
5. Location maps	* Indicate that the map of the State of New York on the cover sheet is divided into the 10 geographical districts. In the district involved there is a circle denoting the rough location of the contract. * Call attention to the larger scale map (usually a tracing of an U.S.G.S. topographic map of the area) with the new highway shown as a very heavy line. This map also shows the contract limits of the project.
6. Design data	* Explain the meaning of the following information found in the design data box: 1. The design classification of the highway 2. The projected traffic count (20 years usually) showing the design hour traffic count and the annual average daily traffic count
7. Project numbers	* Indicate that the project number appears outside of the border in four places on the first sheet, and outside of the border in the upper right-hand corner on subsequent sheets. * State that the first number is the year the contract was let. * Explain the following: 1. F.A.R.C. 2. F.G.R.C. 3. R.C. 4. F.A.C. 5. F.A.S.H. 6. F.A.L.D. 7. F.A.S.S.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Explain that specialized conditions are shown and include the following typical sections: 1. Ditch 2. Special ditch 3. Interceptor ditch 4. Gutter 5. Rock 6. Bank 7. Classification of embankment in a fill
F. Miscellaneous tables	* Mention that miscellaneous tables furnish locations and quantities. * Exhibit the various tables used in the different contracts. * Explain that there is no precise pattern as to the order of listings or distribution of tables but might include any of the following: 1. Lengths 2. Drainage structures 3. Bench marks 4. Driveways 5. Guide railings 6. Trench, culvert and bridge excavation summary 7. Unclassified excavation 8. Earthwork summary 9. Items 10. Curve data 11. Old pavement removals 12. Guide posts 13. Fencing 14. Paved shoulders 15. Right-of-way markers 16. Curbs 17. Signs 18. Concrete or asphalt concrete gutters
G. Delineator details	* Note that a small-scale plan of the entire contract is shown with the necessary information as to type and location of the delineators used.
H. Drainage structures	* Emphasize that the detail and quantities of large culvert structures consisting of multiplate arches,

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HIGHWAY DRAWING

Glossary of Abbreviations

Elev. or El.	= Elevation
E.P.	= Edge of pavement
Eq.	= Equality
E.S.	= End section
Ext.	= External
Fd.	= Foundation
Fr.Ho.	= Frame house
G.	= Gas
G.P.	= Guy pole
G.S.B.	= Gas service box (house line)
G.V.	= Gas valve (main line)
H.I.	= Height of instrument
Ho.	= House
H.P.G.	= High pressure gas
H.S.D.	= Headlight sight distance
H.W.	= Headwall
Hyd.	= Hydrant
Inv.	= Invert
I.P.	= Iron pin or iron pipe
L	= Length
L.P.	= Light pole
L.P.G.	= Low pressure gas
M	= Measured distance
M.H.	= Manhole
M.H.W.	= Mean high water
Mon.	= Monument
N & R	= Nail and red
N & W	= Nail and washer
O.C.M.P.	= Oblate corrugated metal pipe
O.H.W.	= Ordinary high water
O.S.	= Original surface
Pav't	= Pavement
P.C.	= Point of curve
P.I.	Point of intersection
P_L	Property line
P.M.	Procedure manual
P.O.L.	Point on line
Por.	Porch
P.O.T.	Point on tangent
P.P.	Power pole
P.S.D.	Passing sight distance
P.T.	Point of tangent
P.V.I.	Point of vertical intersection
R	Radius
R.C.P.	Reinforced concrete pipe
Rd.	Road
R.O.W.	Right of way line
RR	Railroad
S.C.	Point of spiral to curve
SH	State highway

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HIGHWAY DRAWING

Spk.	= Spike
S.S.	= Shoulder stabilization
S.S.C.	= Same slope continues
S.S.D.	= Stopping sight distance
S.T.	= Point of spiral to tange
St.	= Street
Stk.	= Stake
Sto.Ho.	= Stone house
Sty.	= Story
SW.	= Sidewalk
T	= Tangent (ts = spiral; Tc = compound)
T.B.	= Top of bank (stream)
T.C.	= Top of curb
Tel.P.	= Telephone or telegraph pole

Glossary of Abbreviations

T.G. = Top of grate

T.H.W. = Top of headwall

T.L. = Tree line

T.O. = Top of opening

ent T.P. = Turning point

T.Pt. = Tie point

T.S. = Point of tangent to spiral

V.C. = Vertical curve

V.C.P. = Vitrified clay pipe

W = Water

W.S.B. = Water service box (house line)

W.V. = Water valve (main line)

W.W. = Wingwall

° ' " = Degrees, minutes, & seconds such as 6°26'33"

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FINAL EXAMINATION

Final Examination Part I — True or False Statements

INSTRUCTIONS: In the space provided, write the letter T if a statement is true and F if the statement is false.

F 1. The loop spring type of bow instrument is popular because it is easier to hold in one hand.

T 2. When drawing plans for a highway project, the architect's scale is used on many aspects of bridge design.

T 3. A pencil soft enough not to smudge and hard enough not to cut grooves in the paper is used in higheway drawing.

F 4. If the blades of a ruling pen are pointed, the ink will tend to flow too freely.

T 5. A map scale of 1:62,500 is actually 1 in. = 1 mi.

F 6. A closed contour line on a map indicates a summit.

T 7. The horizontal distance between contour lines is inversely proportional to the slope.

F 8. In lettering, the letters N, Z, V, and Y belong to the same group.

T 9. Soapstone is used to place a slick, smooth finish on damaged areas of tracing cloth.

T 10. In linear miles 1 degree of latitude is approximately equal to 1 degree of longitude at the Equator only.

F 11. On a U.S.G.S. map a number placed at a highway intersection is an index number for location.

F 12. If one has an excellent memory, he may enter field information in the notebook at a later time and perhaps at a more convenient place.

T 13. A cross-section is a profile made on a line at right angles to a base line.

F 14. The cover sheet of a set of highway plans consists only of administrative information and the title of the project.

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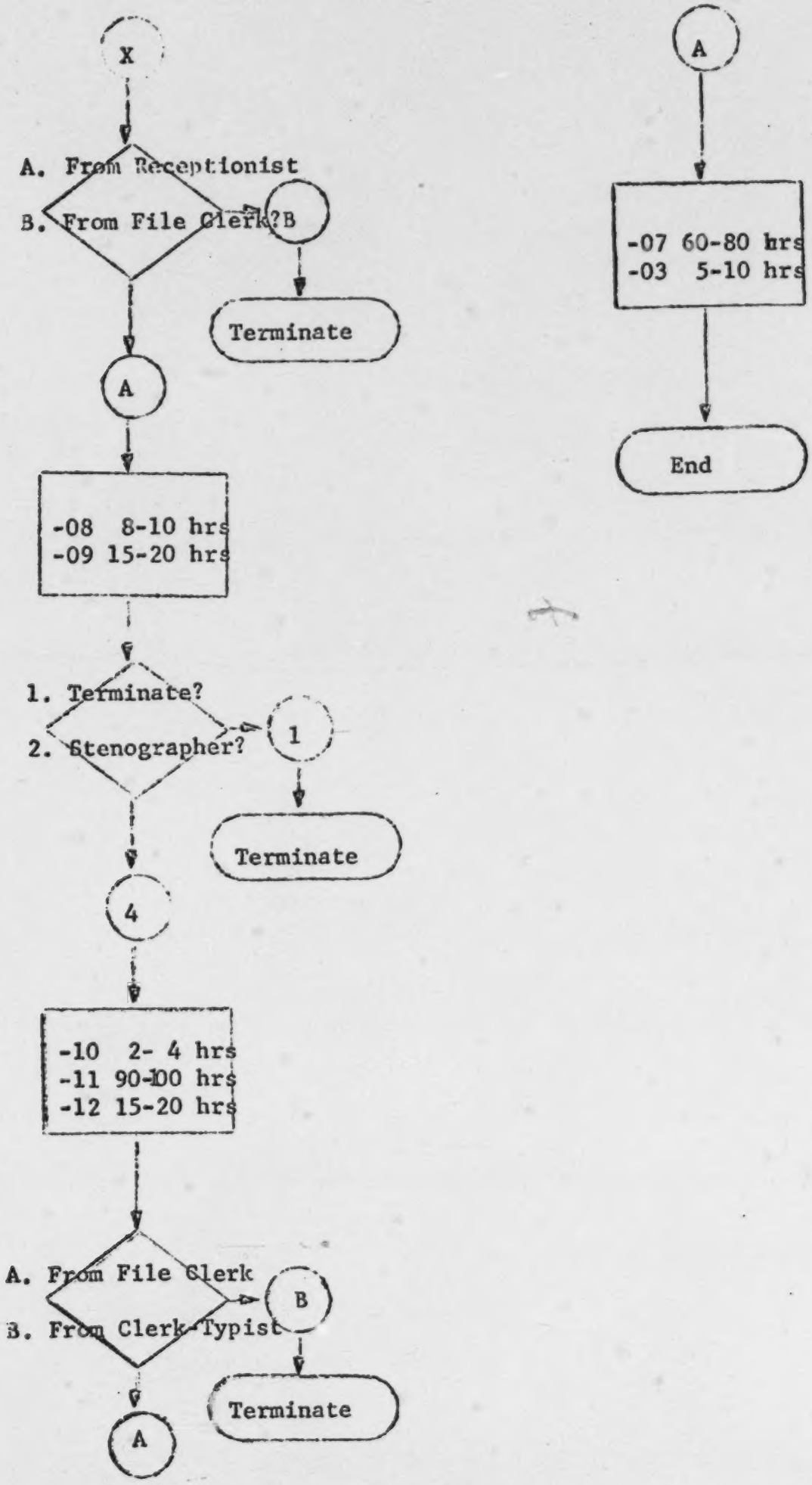
X
A. From Receptionist
B. From File Clerk?B
Terminate
A
-08 8-10 hrs
-09 15-20 hrs
1. Terminate?
2. Stenographer?
1
Terminate
4
-10 2- 4 hrs
-11 90-100 hrs
-12 15-20 hrs
A. From File Clerk
B. From Clerk-Typist
B
Terminate
A
A
-07 60-80 hrs
-03 5-10 hrs
End

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Very long radius horizontal curves 2. Follow the natural topography more than highways 3. Seldom show a connection to a building cluster 4. Cuts and fills more frequent and larger than highways
D. Fields	* Mention that individual fields are easily recognized on aerial photographs and that it is possible to identify general types of crops by the gray tone, height, and texture conditions as follows: 1. Green crops photograph dark gray to almost black. 2. Stubble fields will be light gray in tone. 3. Pasture land is irregular in tone, somewhat splotchy, and contains trails.
E. Natural features	* Point out that rivers, streams, creeks, and gullies are readily visible with the major streams showing a very definite shape and a gray tone. * Indicate that lakes, ponds, swamps, and marshes are recognized by shape, gray tone, and texture. Bodies of water are very smooth in appearance while swamps show irregular texture of brush. * Mention that general topographic shapes and surface configurations may be easily recognized. Basins, plains, hills, valleys, ridges, and mountains are spotted by shape and position with respect to the surroundings. * Stress that natural material types are recognized by studying the geology of the area and using comparable geologic maps. * Explain that trees and woods are easily identifiable and point out that

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	often the shadows assist in the recognition of tree types.
	* State that much drainage information is found on aerial photographs as well as the characteristics of watersheds.
	* Note that erosion characteristics may help to identify soil types.
	* Point out that a light gray tone in the aerial photograph indicates coarse textured, well-drained soils while a medium gray tone indicates heavy textured clays and silty clays. Organic soils photograph dark gray and muck soils show almost black.
F. Controls	* Establish that there are certain features which could control a highway alinement—airports, factory buildings, and educational institutions—that can be detected if a similar situation or shape has been recognized before.
	* Point out a cemetery on an aerial photograph (an important highway control) and indicate that it may be identified by landscaping features, winding or closely spaced road systems, and the white dots that represent the gravemarkers.
III. Photogrammetry	* Indicate that photogrammetry is the science of obtaining reliable measurements by means of aerial photographs.
	* Mention that the science of photogrammetry combined with techniques of electronic surveying makes it possible to establish the position and elevation of any point on the earth's surface and to compile accurate topographic maps without actually setting foot on the ground.
A. Characteristics	* Explain that the aerial photograph is a perspective projection, somewhat like the ordinary photograph, but that

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	a photogrammetric model is made by taking the same picture from a camera in two different positions. (Ref. D, pp. 847-849)
	* Compare this operation with that of the human eye and describe the duplication of natural binocular vision as stereovision.
	* Explain that the three-dimensional impression constructed by the mind is a spatial model. (Ref. D, p. 843)
B. Scales	* State that the scale of an aerial photograph is expressed either as a representative fraction or as a ratio between 1 in. on the photograph and a specific distance on the ground. (Ref. D, pp. 874-876)
	* Indicate that topographic maps are made to any scale desired.
	* Show some aerial photographs using the common scales of 1 in. equals 440 ft., 1 in. equals 660 ft., or 1 in. equals 1,320 ft. If possible, use aerial photographs of the same area.
	* Demonstrate the computation of a scale by using a sketch with similar triangles. (Ref. D, p. 874)
	* Determine the flight altitude necessary to obtain a photograph at the desired scale. (Ref. D, pp. 877-878)
	* Ascertain the coverage of aerial photographs by computing the net area covered by a single photograph. Use a 60-percent overlap in the line of flight and a 30 to 50-percent overlap between the lines of flight in the computations. (Ref. D, pp. 878-879)
C. Accuracy	* Indicate that horizontal accuracy is established at 1 percent for all

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Indicate that since the stereoplotter is able to perform the above operations in one continuous process, the instrument is the basis of most topographic maps made from aerial photographs. (Ref. D, pp. 911-912)
E. Use of map data	* Explain that the construction of profile and cross-sectional data is easily done from a contour map.
	* Note that improved models of digital computers can be connected to the stereoplotter and all the information derived from the aerial photograph can be computed and filed electronically.
IV. The Digital Computer	* Describe the digital computer as one of the most important tools of the modern highway engineer.
	* Explain that the engineer performs calculations on the computer for the basic purpose of making decisions and communicating information to others.
	* Note that the engineer often has routine problems that can be performed by a computer. This relieves him of a time-consuming job essentially mechanical in nature. But the engineer still remains fully responsible for contributing the necessary knowledge of engineering and mathematics, experience, and judgment required to solve the problems at hand.
A. The digital computer as a hypothetical mechanical man	* Compare the digital computer to the hypothetical mechanical man in that the abilities of the mechanical man would be limited to reading simple instructions and data, making very limited decisions based on simple rules, and writing down answers.
	* Indicate that since the mechanical man lacks knowledge in engineering and mathematics, that since he cannot exercise judgment or express emotion,

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	he stands ready to do only what the engineer instructs him to do.
B. Operation	* Point out that the greatest problem is that of efficient communication between the engineer and the mechanical man. * State that the digital computer is a machine which can perform calculations, make simple decisions at high speed, and memorize a list of detailed instructions. * Describe the IBM 1620 computer, which is used by the Department of Transportation in New York State. * Exhibit photographs of the different units of the computer and explain briefly the function of each individual machine. * Explain that the steps in machine computation are: 1. Problem formulation 2. Problem statement 3. Input and output 4. Ranges and precision 5. Programing or flow charting 6. Error checks 7. Summary
C. Capabilities	* List and describe the basic capacity of the digital computer as being able to: 1. Follow automatically a set of stored instructions expressed in its own language 2. Make simple logical decisions and automatically alter a sequence of operations 3. Perform simple arithmetic operations such as adding, subtracting, multiplying and dividing at high speed

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
D. Automatic plotters	* Describe the following types of plotters used with the digital computers: 1. On-line plotter 2. Off-line plotter 3. Point plotter 4. Line plotter 5. Cathode ray tube plotter
E. Highway engineering applications	* State that due to the cost of programing, the computer is used to its best advantage on problems which occur repetitively. * List the following as the geometric calculations which are handled with great efficiency on the digital computer: 1. Survey calculations 2. Horizontal alinements 3. Vertical profiles 4. Sight distances 5. Right-of-way takings 6. Curves and spirals 7. Superelevations 8. Interchange geometrics 9. Bridge geometrics * Establish that the machine cannot design in the sense of furnishing the concept for a solution of the problem. It cannot use judgment or experience. * Stress that the computer can evaluate hundreds of correct solutions for a given problem, thus affording an economic optimization of location and design solutions. * Point out that in the design units of this course, more information will be given on the use of the computer for actual design work.

QUESTIONS FOR REVIEW

1. What is photogrammetry?
2. Explain the use of the stereoscope.
3. Describe how various types of highways are identified on an aerial photograph.
4. How can a body of water be differentiated from a swamp?
5. How is the representative fraction of an aerial photograph noted?
6. Explain the circumstances under which the digital computer works to the best advantage of a design office.

ASSIGNMENT

Announce that the final examination will be given at the next class.

INSTRUCTOR'S NOTES

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GLOSSARY OF ABBREVIATIONS

Abut.	= Abutment	C_L	= Centerline
A.C.	= Asphalt concrete	C_LStrm.	= Centerline of stream
Ah.	= Ahead	C.M.P.	= Corrugated metal pipe
B.B.	= Bottom of bank (stream)	Conc.	= Concrete
B.C.	= Bottom of curb	Cor.	= Center correction of V.C.
Beg.	= Begin	C.P.	= Concrete pipe
Bit.Mac.	= Bituminous macadam	CR	= County road
Bk.	= Back	C.R.	= Curb receiver
B_L	= Base line	C.R.W.	= Concrete retaining wall
Bldg.	= Building	C.S.	= Point of curve to spiral
B.M.	= Bench mark	Culv.	= Culvert
B.O.	= Bottom of opening	D	= Deed distance
Br.	= Bridge	Dc	= Degree of curve
Brk.	= Brick	Def.	= Deflection
Brk.Ho.	= Brick house	D.I.	= Drop inlet
C.B.	= Catch basin	DM	= Direct measurement
C.B.Ho.	= Concrete block house	Drwy.	= Driveway
C-C	= Center to center	D'Xing	= Ditch crossing
C.I.	= Curb inlet	e	= Maximum superelevation
C.I.P.	= Cast iron pipe	E.H.W.	= Extreme high water

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	grid lines and control points and 2 1/2 percent for all planimetric features.
	* State that vertical accuracy is established so that 90 percent of the map has an error no greater than one-half of the contour interval. The remaining 10 percent of the map will have an error no greater than the contour interval.
D. Procedures	* Stress that the aerial photographs are used in various ways to produce different information for the engineer.
1. Analytical	* Explain how the stereocomparator is used for measuring linear distances on the aerial photograph. (Ref. D, pp. 911-926)
	* Note that this is also called the "digital approach", since the measured distances can be fed into a digital computer and stored for use in making a map.
2. Graphical	* State that by using the stereoplotter the figures from the aerial photographs can be stored in lines or shapes (cross-sections or contour). This is also called the analog approach.
	* Describe the stereoplotter and discuss the following: 1. The projection system 2. The viewing system 3. The measuring system 4. The plotting system
	* Point out that in compiling a topographic map from stereoscopic photographs the stereoplotter: 1. Compensates for tilt in the photograph 2. Measures elevation and delineates contour 3. Plots the compiled information onto the map manuscript

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THE UNIVERSITY OF THE STATE OF NEW YORK

Regents of the University (with years when terms expire)

1984 Joseph W. McGovern, A.B., LL.B., L.H.D., LL.D., D.C.L., Chancellor- New York
1970 Everett J. Penny, B.C.S., D.C.S., Vice Chancellor - - - - White Plains
1978 Alexander J. Allan, Jr., LL.D., Litt.D. - - - - - - - - - - Troy
1973 Charles W. Millard, Jr., A.B., LL.D., L.H.D.- - - - - - - - Buffalo
1972 Carl H. Pforzheimer, Jr., A.B., M.B.A., D.C.S.- - - - - - Purchase
1975 Edward M. M. Warburg, B.S., L.H.D.- - - - - - - - - - - - - New York
1977 Joseph T. King, LL.B. - - - - - - - - - - - - - - - - - - - Queens
1974 Joseph C. Indelicato, M.D.- - - - - - - - - - - - - - - - - Brooklyn
1976 Mrs. Helen B. Power, A.B., Litt.D., L.H.D.- - - - - - - - - Rochester
1979 Francis W. McGinley, B.S., LL.B.- - - - - - - - - - - - - - Glens Falls
1980 Max J. Rubin, LL.B., L.H.D. - - - - - - - - - - - - - - - - New York
1971 Kenneth B. Clark, A.B., M.S., Ph.D., Litt.D.- - - - - - - - Hastings on Hudson
1982 Stephen K. Bailey, A.B., B.A., M.A., Ph.D., LL.D. - - - - Syracuse
1983 Harold W. Newcomb, B.A. - - - - - - - - - - - - - - - - - - Owego
1981 Theodore M. Black, A.B. - - - - - - - - - - - - - - - - - - Sands Point

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Berton P. Plummer

VEO # 14.0406
DOT # 237.368

TRAINING COURSE FOR

RECEPTIONISTS

The material in this guide is presented in the form of suggestions. Every student participating in this program will be different in regard to education, experience, and ability. The instructor must, therefore, adjust and adapt the suggestions in this guide to the needs of individual students.

The first step in insuring this adjustment is to secure as much information as possible about each new student. This can be accomplished through study of the pre-enrollment information gathered by the Center counselors. The second step is to keep up to date on the progress of each student through the regular use of the information prepared by Individual Program Control (IPC). With this information on hand the instructor can effectively adapt specific objectives, teaching methods, and time alloted to each aspect of the training, directly to the student's needs.

This guide will aid the instructor in accomplishing part of his job. It will provide performance objectives, suggest time allotments, unit outlines, and supplemental teaching aids. Only the instructor, however, can combine these factors with a knowledge of each individual student.

Course Objectives:

The receptionist program at Gila River Career Center is designed to:

1. develop in the student an awareness of the importance of office work and of the career opportunities which it offers.

2. develop in the student an understanding of the place and purpose of the office in general, and the receptionist in particular, in the typical business organization.

3. develop a job-centered approach to development of business-like work habits and attitudes and effective human relations.

4. prepare the student to perform the fundamental tasks commonly required of all beginning office workers.

5. prepare the student to perform the technical tasks commonly expected of the receptionist.

__T__ 15. Along the line of survey, aerial photographs overlap each other by 60 percent.

__T__ 16. Cross-sections for a preliminary survey are plotted in pencil and then inked.

__F__ 17. A true north and magnetic north symbol must have a date on the arrow.

__T__ 18. When drawing concentric circles, the smallest one is drawn first.

__T__ 19. An Arkansas knife piece is used to sharpen a ruling pen.

__F__ 20. The protractor is divided into degrees, minutes, and seconds.

Final Examination Part II — Fill-In Statements

INSTRUCTIONS: Complete the following statements.

1. When shading a symbol, the source of light is assumed to be coming from above and to the LEFT of the object at an angle of 45°.

2. If an observer wishes to view aerial photographs in three dimensions, he should use a STEREOSCOPE.

3. The process of determining the elevations of points at measured intervals along a fixed line is called PROFILE leveling.

4. The method of locating a certain point on the earth may be done by using the COORDINATE system.

5. The U.S.G.S. generally uses the POLYCONIC projection for making their topographic maps.

6. The ozalid process of duplicating requires AMMONIA vapor in the presence of light.

7. Prominent natural land features are lettered in UPRIGHT capitals.

8. When filling a ruling pen, never place more than ½-in. of ink in the pen.

9. The engineer's triangular scale has THREE calibrated edges.

10. The engineer's triangular scale has SIX available scales.

11. The first step in making a topographic map is the plotting of HORIZONTAL control.

12. The contour interval is the VERTICAL distance between contours.

13. On a topographic map the FIFTH contour is always drawn heavier.

14. Various types of projections used to achieve one certain purpose are called a (an) CONFORMAL.

15. The scale of a 7½-minute U.S.G.S. map is 1:24,000.

Final Examination Part III — Matching

INSTRUCTIONS: Write in the space provided the number of the expression in Column B which is best suited to the expression in Column A.

	Column A	Column B
4	Ruling Pen	1. Ebonized hardwood
8	Economic operation	2. Finished drawing
11	Arterial highway plan	3. Quarter scale
18	Copying device	4. Reflection method
3	Architect's scale	5. French curve
13	Ampersand	6. 1/F = S/L
20	Freehand lines	7. 1:62,500
12	W	8. Blueprinting process
5	Non circular	9. H.I.
1	T-square	10. Subdivision names
16	Tangent offset method	11. 20-ft. scale
10	Upright capital letters	12. Water
2	2H pencil	13. &
9	Height of instrument	14. Hydrographic names
6	Equation of scale	15. Wind
		16. Horizontal control
		17. Bench mark
		18. Pantograph
		19. Ozalid process
		20. Contour lines

Final Examination Part IV — Multiple Choice

INSTRUCTIONS: Place an X in the space next to the choice which most accurately completes the statement. Read all possible answers.

1. The revolving triangle method of drawing lines enables one to draw:

   _____ (a) A line parallel to another line

   _____ (b) A line at an angle with another line

   _____ (c) A line bisecting another line

   __X__ (d) A line perpendicular to another line

2. Using a T-square and a 45° and a 30°-60° triangle, a student may draw lines at any angle which is a multiple of:

   _____ (a) 5°

   _____ (b) 10°

   __X__ (c) 15°

   _____ (d) 20°

3. The heaviest lines in any drawing are:

   _____ (a) Construction lines

   _____ (b) Dimension lines

   __X__ (c) Object lines

   _____ (d) Hidden lines

4. A drawing pen is checked for dullness by:

   _____ (a) Using a micrometer

   __X__ (b) The reflection method

   _____ (c) Cutting paper with one blade

   _____ (d) Running blade across fingertips

5. On a topographic map a canal would be classified as:

_____ (a) Culture

__X__ (b) Hydrography

_____ (c) Relief

_____ (d) Vegetation

6. When the scale of a topographic map is 1 in. equals 2000 ft. the representative fraction is:

_____ (a) 1:62,500

__X__ (b) 1:24,000

_____ (c) 1:2,400

_____ (d) 1:31,680

7. The most likely contour interval on a large-scale topographic map of flat country would be:

__X__ (a) 2 ft.

_____ (b) 10 ft.

_____ (c) 20 ft.

_____ (d) 100 ft.

8. The type of lettering most often used in highway drawing is:

_____ (a) Modern roman

__X__ (b) Commercial gothic

_____ (c) Old English

_____ (d) Old roman

9. The first item inked on a tracing is:

_____ (a) Straight horizontal lines

__X__ (b) Circles

_____ (c) Cross-hatching

_____ (d) Lettering

10. The projection used for a U.S.G.S. topographic map is:

_____ (a) Mercator

__X__ (b) Polyconic

_____ (c) Gnomonic

_____ (d) Stereographic

11. The shape of a U.S.G.S. topographic map with a scale of 1:24,000, covering an area of 0°7'30" of latitude and of longitude, is:

_____ (a) Square

__X__ (b) Rectangular

_____ (c) Parallelogram

_____ (d) Rhombic

12. The planimetric map shows only:

_____ (a) Drainage

_____ (b) Culture

__X__ (c) Drainage and culture

_____ (d) Drainage, culture, and relief

13. The topography, referenced by a field surveyed base line, is plotted by using:

_____ (a) A protractor

__X__ (b) A linear plotter

_____ (c) Tangent offsets

_____ (d) Perpendicular lines to the base line

14. The rodreadings of the level survey are plotted on the cross-sections after the height of instrument has been:

_____ (a) Added

__X__ (b) Subtracted

_____ (c) Divided

_____ (d) Multiplied

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15. The scale for the general highway plan for a rural highway is usually made at:

_____ (a) 1 in. = 10 ft.

_____ (b) 1 in. = 20 ft.

__X__ (c) 1 in. = 50 ft.

_____ (d) 1 in. = 100 ft.

16. The size ratio of the capital "W" to the capital "M" is:

_____ (a) 8 to 7

_____ (b) 8 to 6

__X__ (c) 8 to 6-1/2

_____ (d) 8 to 5-1/2

17. An item not classified as special equipment is a:

_____ (a) Beam compass

_____ (b) Contour pen

_____ (c) Railroad pen

__X__ (d) Erasing shield

18. When the ink refuses to flow from a ruling pen:

__X__ (a) Pinch the blades

_____ (b) Shake the pen

_____ (c) Tap the pen

_____ (d) Place more ink in the pen

19. In the alphabet of lines, the finest line is a:

__X__ (a) Construction line

_____ (b) Object line

_____ (c) Dimension line

_____ (d) Hidden line

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20. The most exacting item in drawing is:

_____ (a) Detail

__X__ (b) Horizontal control

_____ (c) Contour

_____ (d) Symbols

This booklet is published primarily for use in the schools of New York State, and free copies are available to New York State school personnel when ordered through a school administrator from the Publications Distribution Unit, State Education Building, Albany, New York 12224.

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Highway Technici
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The main content
divided into 15
Fundamentals of
study, analysis,
safety, law, and
transportation p
objectives, a co

Course Outline:

The following table provides a listing of course units along with time estimates for each unit. Both sequence and estimates can be varied to meet student needs. Units should be presented concurrently as students meet objectives that prepare them to move ahead.

Course Unit	Title	Hours	Code
Unit I	Occupational Orientation	5- 7	-01
Unit II	Fundamentals of Typing	70-85	-02
Unit III	Office Equipment	10-15	-03
Unit IV	Communications	35-45	-04
Unit V	Reception and Telephone	15-25	-06
Unit VI	Sources of Information	3- 5	-05
	Total	138-182	

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tribution Unit, New York
of Education, Education
, New York 12224.
69 117p.

EACHING GUIDES; *VOCATIONAL
NEERING TECHNICIANS; *ROAD
LANNING; CURRICULUM GUIDES;
DUCATION; TRANSPORTATION;
TRAFFIC PATTERNS; STATE
CAL EDUCATION

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employed in technician jobs.
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lessons including: (1)
highway planning, (2) Traffic
and forecasting, (3) Highway
finance, and (4) Urban
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ELEMENTS O

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UNIT IV

F HIGHWAY PLANNING

ECHNICIANS PROGRAM

U.S. DEPARTMENT OF HEALTH,
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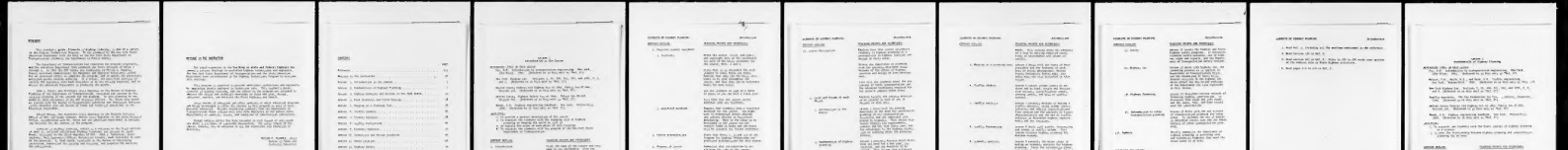

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
II. Course Description	Explain that this course introduces students to highway planning as a prerequisite to highway location and design in rural areas. Stress the importance of planning even for sparsely developed areas because of the effect of highway location and design on area development. Also tell the students about the new concept of total transportation and the advanced techniques required for the State's complex urban areas.
A. Title and resume of each lesson	Explain briefly the subject material to be covered in each of the 15 lessons of this unit.
1. Introduction to the course	Lesson 1 deals with the growing awareness of the need for coordinated planning of all transportation facilities and the important role played by highways. This lesson also covers Federal aid requirements, Federal and New York State laws, and the advantages to the highway technician of learning about the planning process.
2. Fundamentals of highway planning	Lesson 2 presents factors which determine the need for a new road, its location, and the benefits to be gained. This lesson also discusses the relationship of highway planning to other types of planning by many different organizations.
3. Highway agencies and systems in New York State	Lesson 3 describes the highway agencies of the State, and of the county, town, city, and other subdivisions. The systems of highways in the State are also described, as well as the relationships among all types of highways and the sources of finances for them.
4. Road inventory and field scoring	Lesson 4 covers taking inventory of existing roads, including complete descriptions, and the field scoring of

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	roads. This scoring shows the adequacy of a road in meeting required conditions of maintenance and volume of traffic.
5. Mapping as a planning tool	Lesson 5 deals with the types of maps available and the features of each. Uses of aerial photographs, United States Geological Survey maps, and other maps are also described in this lesson.
6. Traffic studies	Lesson 6 covers volume counts by machine and by hand, origin and destination surveys, classification counts, turning counts, and uses of traffic surveys.
7. Traffic analysis	Lesson 7 presents methods of making a traffic analysis, using volume characteristics and vehicle classifications. Also covered are the analysis of travel characteristics and the use of traffic analysis to determine highway improvements and new locations.
8. Traffic forecasting	Lesson 8 deals with traffic forecasting and trends in traffic volume. This lesson stresses highway planning for maximum economy.
9. Economic analysis	Lesson 9 presents the major steps in making an economic analysis for highway planning. Costs for alternative plans, and costs due to social and other factors are also analyzed.
10. Geometrics and highway standards	Lesson 10 is concerned with design standards and how these standards vary with traffic volume, terrain features, and type of area. This lesson also describes New York State geometric standards and their applicability to different types of highways.
11. Route location	Lesson 11 deals with the planning of highway routes and corridors. It also explains the basic differences between planning and preliminary engineering.

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FOREWORD

This teacher's guide, *Elements of Highway Planning*, is one of a series in the Highway Technicians Program. It was produced by the New York State Education Department with the help of the New York State Department of Transportation (formerly the Department of Public Works).

The Department of Transportation had requested the program originally, and the Education Department then produced the first editions of Units I through V. In 1967 the DOT (under the leadership of Philip E. Hagerty, Deputy Assistant Commissioner for Manpower and Employee Relations) called for an increased effort to complete the program, and to update any previously published guides needing updating. As a result, the part-time services of several DOT engineers were made available to do the writing required, and to assist the Education Department in producing the guides.

John L. DeLee, now Principal Civil Engineer in the Bureau of Highway Planning of the Department of Transportation, initiated and carried on the original planning of the content for the program. In this planning he was aided by other personnel of the DOT district offices. Mr. DeLee also acted as liaison with the Bureau of Occupational Extension and Industrial Services (later absorbed into the Bureau of Trade and Technical Education) in the Education Department.

Edward Umiker, now Associate Civil Engineer in the Buffalo District Office of DOT, and Ralph Fimmano, Senior Civil Engineer in the Utica District Office, collaborated with Mr. DeLee and the Education Department in developing outlines for the courses in the program.

Elements of Highway Planning, (which is a revision of the first edition of Unit IV, entitled *Preliminary Highway Planning*) was written by Jacob Mende, Assistant to the Chief Engineer of DOT. John C. Kacharian, Chief Engineer, Post Engineer's Office, Watervliet Arsenal, made revisions in some of the material. E. Noah Gould, Associate in the Bureau of Continuing Curriculum, supervised the writing and revising, and prepared the material for publication.

The Bureau of Continuing Curriculum Development gratefully acknowledges the parts played by each of the individuals and organizations mentioned above in producing this guide.

HERBERT BOTHAMLEY, *Chief*
Bureau of Continuing Education
Curriculum Development

WILLIAM E. YOUNG, *Director*
Curriculum Development Center

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CONTENT OUTLINE

C. Required student equipment

1. Textbooks

2. Looseleaf notebook

D. Course prerequisites

E. Purpose of course

TEACHING POINTS AND TECHNIQUES

Write the author, title, publisher, and copyright date on the chalkboard for each of the basic textbooks for the course, Refs. A and F.

State that it is advisable for each student to order these two books. Mention that they are the basic textbooks to be used throughout the course, and that they can be reference books for many years.

Ask the students to sign on a sheet of paper so you can have a class list.

Tell them that the course varies somewhat from the textbooks.

Suggest that students keep a looseleaf notebook for the course. You might want to mimeograph sheets showing the content outline to facilitate notetaking. Many of the ideas to be developed in the course are not readily found in books and the notes will be valuable for future reference.

State that Units I, II, and III of the Program for Highway Technicians are preferred prerequisites for this course.

Summarize this introduction by explaining the aims of the course:

1. To upgrade the highway technician who works on survey, design, construction, maintenance, traffic, or some other phase of highway work

2. To show the relationships among the technician's job, the elements of highway planning, and the science of transportation planning

3. To convey to the highway technician useful factual data and a broad perspective on highways as a development force

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
12. Safety	Lesson 12 covers the Federal and State highway safety programs. It discusses standard safety measures, use of highway signs and signals, and the Department of Transportation Safety Crusade.
13. Highway law	Lesson 13 deals with highway law, the lawmaking process as it applies to Department of Transportation bills, and the channeling of local bills. Several articles in the highway law which affect the day-to-day workings of the Department are also explained in this lesson.
14. Highway financing	Lesson 14 describes various methods of financing highway construction. It discusses free roads and toll roads, and the taxes, fees, and bond issues used for construction.
15. Introduction to urban transportation planning	Lesson 15 deals with the new science of transportation planning for urban areas. It includes the use of models to determine travel flow and the fundamentals of urban transportation planning.
III. Summary	Briefly summarize the importance of highway planning in providing safe and economical highways that meet the broad needs of an area.

QUESTIONS FOR REVIEW

1. What benefit will a highway technician receive from a knowledge of highway planning?

2. What is the difference between highway planning and transportation planning?

3. Why is a different study technique required for planning a highway for a large urban area as compared to a small rural area?

4. In highway planning what factors should be considered besides location and type of highway?

ASSIGNMENT

1. Read page 411 in Ref. A.

UNIT I (14.0406-01)

OCCUPATIONAL ORIENTATION

Performance Objectives:

Upon completion of this unit the student will be able to describe orally the general purpose and organization of business. She will be able, as determined by instructor observation, to demonstrate good interpersonal relations with other class members and good organization of a work station.

The student will be able to demonstrate in a role playing, or other simulated situation, the proper dress and grooming for an office worker and correct techniques and good manners. She will be able to score 80% on an objective test covering the responsibilities of a receptionist.

Unit Outline:

A. Review of Modern Business Enterprise

   1. Methods of organization

   2. Purposes of business

B. Types of Offices and Opportunities for Office Workers

C. What Business Expects of Office Workers

   1. General expectations

   2. Appropriate attire

   3. Posture and figure control

   4. Complection and health

   5. Personal hygiene

D. Office Techniques of Etiquette

   1. Basic good manners

   2. Application of social graces to office situations

   3. Some special problems that occur

E. Interpersonal Relations

   1. Role of motive and emotion

   2. The office worker's role in business-human relations activities

2. Read Ref. C, including all the sections mentioned in the reference.

3. Read Section 134 in Ref. D.

4. Read section 402 in Ref. E. Write in 100 to 200 words your opinion of the Federal role in State highway activities.

5. Read pages 2-3 to 2-6 in Ref. F.

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Lesson 2
Fundamentals of Highway Planning

REFERENCES CITED IN THIS LESSON

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

Matson, T.M., Smith, W.S., and Hurd, F.W. Traffic engineering. New York. McGraw-Hill. 1955. (Referred to in this unit as "Ref. I")

New York Highway Law. Sections 3, 10, 340, 341, 343, and 349C, D, E, and F. (Referred to in this unit as "Ref. C")

Traffic Quarterly. The Eno Foundation for Traffic Control, Saugatuck, Conn. (Referred to in this unit as "Ref. N")

United States Federal Aid Highway Act of 1962, Public law 87-866. Section 134. (Referred to in this unit as "Ref. D")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint the students with the basic concept of highway planning as a science
2. To show the relationship between highway planning and comprehensive planning for an area

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Fundamentals	Explain that the science of highway planning can be divided into two parts, regardless of whether it is applied to a small area or a much bigger metropolitan area.
A. Is a new road necessary?	State that we cannot answer this question in only one way, even for a simple project like a village bypass. Many studies are needed, regardless of the size of the project.
1. Inventory of roads	Tell the students that in good highway planning we must take stock of existing roads, whether we are dealing with a

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MESSAGE TO THE INSTRUCTOR

The rapid expansion in the building of state and Federal highways has caused a serious shortage of qualified highway technicians and engineers. The New York State Department of Transportation and the State Education Department have collaborated in the Highway Technicians Program to overcome this shortage.

This program is expected to provide additional technicians and engineers by upgrading people employed in technician jobs. This teacher's guide, *Elements of Highway Planning*, and the others in the program are intended to improve the skills and technical knowledge of those who plan, design, construct, operate, and maintain the State highways and canals.

Local boards of education and other sponsors of adult education programs are being encouraged to offer the courses in this program as part of occupational education. Besides attracting students from the Department of Transportation these classes will also draw employees of the public works departments of counties, cities, and towns, and of construction contractors.

Enough subject matter has been included in each lesson of this guide for about 2-1/2 hours of classroom instruction. The total length of the course, however, may be adjusted to fit the experience and education of enrollees.

BERTON P. PLUMMER, *Chief*
Bureau of Trade and
Technical Education

JOHN E. WHITCRAFT, *Director*
Division of Occupational Education

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Lesson 1
Introduction to the Course

REFERENCES CITED IN THIS LESSON

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

New York Highway Law. Sections 3, 10, 340, 341, 343, and 349C, D, E, and F. (Referred to in this unit as "Ref. C")

United States Federal Aid Highway Act of 1962, Public law 87-866. Section 134. (Referred to in this unit as "Ref. D")

United States Highway Safety Act of 1966. Public law 89-564. Section 402. (Referred to in this unit as "Ref. E")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To provide a general description of the course
2. To acquaint the students with the changing role of highway planning in shaping the world we live in
3. To explain the value of each phase of this training
4. To acquaint the students with the program of the New York State Department of Transportation

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	Print the name of the course and your name on the chalkboard. Give the students a brief description of your background.
A. Purpose of course	Explain that the course is given to improve the knowledge of technicians in highway planning and to help them advance in their jobs in highway design, construction, and maintenance.
B. Introduction of class members	Have each student introduce himself to the class, volunteering information about himself, such as name, occupation, and where employed.

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CONTENTS

Foreword . . . . . .

Message to the Instructor. . . . . .

Lesson 1. Introduction to the Course.

Lesson 2. Fundamentals of Highway Plan

Lesson 3. Highway Agencies and Systems

Lesson 4. Road Inventory and Field Sco

Lesson 5. Mapping as a Planning Tool.

Lesson 6. Traffic Studies . . . . . .

Lesson 7. Traffic Analysis. . . . . .

Lesson 8. Traffic Forecasting . . . .

Lesson 9. Economic Analysis . . . . .

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Lesson 11. Route Location. . . . . .

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	small two-lane approach or a complex network of highways. The capital investment in existing roads is too high to make changes without very good reason.
2. Studies of traffic volume and classification of roads	Explain that highways are built to move people and goods. We must know the quantities moved and the physical condition of the roads before we can decide what improvements are needed.
3. Traffic analysis	State that raw data alone, (from the traffic studies) do not give us the answers we need. We must convert traffic counts to *average annual daily traffic (AADT)* and *design-hour (DH)* figures.
4. Traffic forecasting	Tell the students that in forecasting we must look 20 years ahead. We must do this to protect the public investment and to assure that a new road will meet future needs.
5. Geometrics	Show that determining the need for a new road is an orderly procedure. Determining this need will not only resolve the question of how many lanes are needed for 20 years ahead, but will also show that only a certain number of lanes are available on the existing location.
	Explain that control of access doubles or more than doubles the capacity of a highway. We must not leave out control of access without a very good reason.
B. Where should a new road be located?	State that before we decide we need a new road, we must first study the possibility of improving the existing road.
	Tell the students that except near very small cities and villages, most of the traffic in a given area has destinations in and around big population centers. Therefore, a bypass around a big popu-

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	lation center may not give the needed service.
1. Mapping	State that maps are another form of facilities inventory and we need them to show the geographical relationships of the roads and other facilities in an area we are studying.
2. Origin and destination (O&D) studies	Explain that figures for volume of traffic can show only overloads, but an O&D study can show whether traffic can be diverted from overloaded facilities.
3. Economic analysis	Inform the students that for good highway planning we must consider all feasible alternates and compare their costs and benefits. The consideration of benefits must include non-economic benefits, which cannot be measured in dollars.
	Point out that in an economic analysis we first determine from the O&D data whether or not a completely new facility is justified. If it is justified,we continue the economic analysis and evaluate alternate new facilities.
	Tell the students this procedure is similar to the concept of highway design in which two or more lines are compared for costs.
4. Route location	State that in the highway planning study we have now established the most desirable *corridor* from a cost and community service point of view. The design process now takes over to determine the best location for the highway within the selected corridor.
	Explain that the traffic and economic studies will establish the best *locations* and *types* of interchanges needed for the traffic conditions forecast. But specifying the location and type of an interchange does not constitute a design.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
II. The Relation of Highway Planning to Other Types of Planning	Explain that *planning* is such a general term, and there are so many kinds of planning that the meaning of *highway planning* tends to be vague.
A. Community planning	Tell the students that almost every city, town, village, and county has a planning organization or is forming one.
1. Planning board	State that a planning board is usually either an executive or an advisory group. Ordinarily none of its members are professional planners.
2. Planning staff	Show by an organization chart that a planning staff is usually no more than a staff arm to a planning board, or to a local government official.
a. Duties	Explain that the job of a planning staff is to prepare plans for its community. Also explain that local planning staffs are a valuable source of information about cities, villages, etc.
b. Coordination	Tell the students that it is to the advantage of the Department of Transportation to coordinate State plans with local plans for highway improvements. Show how knowledge about local plans will help the DOT in planning and development.
	Remind the students that highway planning is only one part of comprehensive planning, and that local planners are also concerned about schools, parks, public utilities, and other elements of community development.
B. Regional planning	Mention that sometimes it is in the public interest to make *one* plan for a broad geographical area, which might include several cities, villages, towns, and counties. The agency which plans for such a broad area is either public or quasi-public. The DOT will find that sometimes its plans for a highway must be modified to fit in with a regional plan.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. By a public agency	Explain to the students that a public agency like the Nassau-Suffolk Regional Planning Board might achieve greater public benefit by planning for a larger area than the DOT is planning for. For example, the Planning Board might bring a badly needed park to an area, where the DOT was planning only a by-pass.
2. By a quasi-public agency	Point out that a quasi-public agency like the Port of New York Authority has direct influence over large areas of the State and over areas which go beyond State boundaries. It is extremely important to coordinate State highway plans with Authority plans.
III. Summary	Briefly summarize the fundamentals of highway planning. Point out that two basic questions are posed: (1) Is a new road necessary? (2) Where should it be located? Emphasize how vital it is to coordinate State planning with the planning of other governmental agencies and groups. Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. What two questions should be answered by a highway planning study?

2. What are the principal elements of the first question which should be answered by the study?

3. What are the principal elements of the second question which should be answered by the study?

4. A plan for a new highway should cover transportation needs for some time into the future. How far into the future?

5. Who should fix the exact location of a new route?

6. In addition to the DOT what other agencies do highway planning?

7. Besides highway planning, what other types of planning are these other agencies involved in?

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F. Personal Attributes

1. Punctuality

2. Physical health

3. Integrity

4. Leadership

5. Attitudes

G. Personal Efficiency in Identifying Responsibility, Planning and Organizing Work and Work Stations.

Supplemental Teaching Aids:

Excellent resource people for this unit are working secretaries, State Department of Public Instruction personnel, beauty school operators or department store buyers, and nurses.

The best general resource book is the Arizona State Department of Vocational Education's Suggested Curriculum Guide in Vocational Office Procedures. A good resource for role playing is Case Problems: for Vocational Office Block Project. This is available from the Department of Vocational Education also. Other useful resource books are: You as a Secretary, Royal Typewriter Company. How to be a Super Secretary, Remington Rand, and Sheaffer's Handbook for Secretaries, W. A. Sheaffer Pen Co., Fort Madison, Iowa ($1).

Some very good films are applicable to this unit. For example; "Office Etiquette" (15 min.), Britannica Press, Chicago, Ill., "Office Teamwork" (12 min.), Britannica Press, and "Off to a Beautiful Start", Scott Paper Co., Philadelphia, Pa.

Training Time 5-7 hours

8. Why should the DOT coordinate its highway planning with other planning groups?

ASSIGNMENT

1. Read pages 377-379 and 420-430 in Ref. A. Write 100-200 words explaining the difference between highway planning and preliminary engineering.

2. Review Chapter 717 in Ref. C.

3. Review Section 134 in Ref. D.

4. Read pages 2-6 to 2-19 in Ref. F.

5. Read Chapter 1 in Ref. I.

6. In Ref. N read: "Integrated planning," October 1960 issue; "Highway planning in a small community," April 1965 issue; and "A scenic approach to roadbuilding," October 1965 issue.

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Lesson 3
Highway Agencies and Systems in New York State

REFERENCES CITED IN THIS LESSON

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

National Highway Users' Conference. Federal aid for highways; revised edition. The Conference, Washington, D.C. 1959. Includes a supplement dated 1961. (Referred to in this unit as "Ref. B")

New York State Department of Public Works. 1966 annual report. The Department, Albany, New York. (Referred to in this unit as "Ref. H")

New York State Department of State. 1966-1967 Legislative manual. The Department, Albany, New York. (Referred to in this unit as "Ref. G")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint the students with the various highway agencies and systems in New York State
2. To show why planning for State highways should be coordinated with planning for other highway systems

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Highway Agencies in New York State	Explain why it is important to know about agencies other than the Department of Transportation which also have responsibilities for highways.
A. Public agencies	Point out to the students that public agencies are established by law and are nonprofit organizations.
1. New York State Department of Transportation	State that this new agency has taken over the responsibilities for highways previously held by the former Department of Public Works. The DOT is also responsible for aviation, public transportation, and traffic regulation.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. United States Government Department of Transportation	Explain that the U.S. Bureau of Public Roads, formerly in the Department of Commerce, is now a unit of the Federal Highway Agency in the new U.S. Department of Transportation. The functions of the Bureau of Public Roads (BPR) are unchanged.
3. County	Point out to the students that each county has a road system, and usually has an organization responsible for the system. Display a map of a county road network.
4. Town	Describe a typical town road system and point out its routes on a map. Mention a typical organization responsible for town roads.
5. City, village, and other subdivisions	Show the students maps of city and village streets, and mention the kind of organizations that are responsible for them.
B. Quasi-public agencies	State that quasi-public agencies are established by law in the public interest. A good example of one which controls construction, maintenance, and operation of highways is the New York State Thruway Authority. This agency and other quasi-public agencies have characteristics of both a public agency and a private business.
II. Highway Systems in New York State	Inform the students that all highway systems change from time to time to meet current or anticipated needs for service.
A. Highways receiving Federal aid	Explain that New York State, like other states, relies heavily on financial aid from the U.S. Government. For Federal aid purposes, highway systems are classified as primary and secondary. A primary system of highways connects urban centers and has a high traffic count; a secondary system connects smaller, non-urban areas, and carries less traffic. The Government financing for primary highway systems differs

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
d. Parkways	Explain that some parkways are expressways as far as traffic service is concerned, but do not permit commercial traffic. Mention that some parkways are also in the Federal Aid Primary (FAP) highway system.
B. Highways not receiving Federal aid	Remind the students that the Federal Government does not participate in financing and planning *all* roads in a state.
1. State system	Point out to the students that there are many miles of State highway not on either the FAP or the FAS system. These are special purpose roads such as access roads to State parks, stub connections, and alternates to FAP and FAS roads.
2. County system	Explain that not all county roads are part of the FAS system. For some the county bears full financial responsibility.
3. Town roads	On a map with town roads show that these are only minor feeders to the county or State systems and do not qualify for Federal aid.
4. City and village streets	Explain that the many thousand miles of city and village streets do not usually qualify as either trunk routes, collectors, or feeders. Those in cities that do qualify are usually arterials; those in villages are usually State highways.
C. Quasi-public highways	Remind the students that quasi-public agencies have characteristics of both a public agency and a private business. Explain that Federal law and policy do not permit Federal participation in construction, operation, or maintenance of a toll highway. State that parts of highway projects under a quasi-public agency may be Federally-aided upon meeting the con-

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	dition that the public can use the highway without paying toll. Example: The Cross-Bronx Expressway, where westbound traffic is not required to use the George Washington Bridge but can exit to free roads.
III. Coordination Among Highway Agencies	Explain that all highway systems together make up an integrated transportation network for vehicles. Point out that no highway agency can plan without knowledge of the plans of other agencies because practically all highways in the State are very much interrelated. Impress on the students that all funds for highways are public money, including funds of quasi-public agencies. Coordinated planning can save the public many dollars.
IV. Summary	Present a summary covering the highway agencies in New York State. Do the same for the highway systems in the State. Sum up the importance of coordinated planning by all highway agencies. Remind the students that it is very easy to look at a small part of one highway and forget the big interrelated system of which it is a part.

QUESTIONS FOR REVIEW

1. What new concept is being implemented by the creation of new Federal and State highway agencies?

2. What other agencies in New York State besides the Department of Transportation are responsible for highways?

3. Are all these other highway agencies classified as *public* agencies?

4. Are all State highways part of the Federal aid system?

5. Are any city streets part of the Federal aid system?

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Lesson 4
Road Inventory and Field Scoring

REFERENCES CITED IN THIS LESSON

Highway Research Board. Highway capacity manual. The Board, Washington, D. C. 1965. (Referred to in this unit as "Ref. U")

New York State Department of Public Works, Bureau of Programming. Highway condition survey manual. The Department, Albany, New York. 1966. TM 20-266-01. (Referred to in this unit as "Ref. K")

New York State Department of Public Works, Bureau of Programming. Manual for the inventory to update city and village street data. The Department, Albany, New York. 1967. (Referred to in this unit as "Ref. L")

New York State Department of Public Works, Bureau of Programming. Rating physical sufficiency of New York State highways. The Department, Albany, New York. 1961. (Referred to in this unit as "Ref. J")

New York State Department of Public Works, Bureau of Programming. Town and county road inventory. The Department, Albany, New York. 1962. (Referred to in this unit as "Ref. M")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint the students with the elements of road inventory and field scoring
2. To fit the inventory and scoring into the highway planning process

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Inventory of Roads	Explain that highway planning starts with a knowledge of what roads are on hand. Also explain that the Department of Transportation has developed changes in the type and amount of detail required for the inventory. Inform the students that Ref. K is the manual used for road surveys. Ref. J has been superseded but is useful for background information.

6. What is the functional difference between a Federal Aid Primary road and a Federal Aid Secondary?

7. Does the Federal Government contribute towards the cost of roads built by an agency like the East Hudson Parkway Authority?

ASSIGNMENT

1. Read pages 85-90 in Ref. A.

2. Read pages 5-8 in Ref. B.

3. Read pages 2-6 to 2-8 in Ref. F. Write 100 to 200 words on setting up a system of expressways which would receive Federal aid.

4. Read the sections about highway agencies in Ref. G.

5. Read Ref. H.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	centages listed above to give a maximum total of 100% for top conditions. A lesser score is given when each element is less than ideal.
C. Relation of volume to capacity	Tell the students that whenever a traffic jam occurs on a road the cause is insufficient capacity, not poor structural condition. Point out that a road may be in good condition structurally and be well maintained, but its width may be inadequate for the traffic volume it carries. As a part of field scoring we use an additional rating factor to reflect the volume-to-capacity relationship.
1. Ref. U, good source	Tell the students that many types of studies have been used to measure the capacity of roads and streets. Show Ref. U and state that this is a national reference book and is an important tool for the DOT.
2. Meaning of volume-to-capacity scores	Explain that for the volume-to-capacity ratio, a score of 118 or less indicates a satisfactory condition. A higher score denotes an unsatisfactory condition.
III. Sufficiency Ratings	State that field scores are useful only if they are translated into meaningful numbers. The rating for structural and maintenance conditions combined with the score for volume-to-capacity gives a *sufficiency rating*, which is an overall rating for the road.
A. Averaging field scores	Explain that the above scores are averaged to obtain a sufficiency rating. For example, suppose a road has a structural score of 40 and a volume-to-capacity score of 100. The sufficiency rating of this road is 70. A road with scores of 100 and 40 (rather than 40 and 100) also has a sufficiency score of 70. However the first road is deficient structurally, while the second

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	road is new and has low traffic volume.
	Explain that averaging is useful to compare general road conditions throughout a county, a district, or the State from one year to another. However, no specific improvement programs are developed from averages.
B. Index number	Tell the students that the DOT uses a system of machine methods which takes into account the individual scores and determines the nature of the improvement needed, by index number.
C. Engineering judgment	State that not all engineering decisions can be based solely on the answers from a computer.
	Point out to the students that the field scoring team makes a recommendation for road improvement, based on judgment, from the observed factors. Conclusions reached by judgment are checked against the machine computation for consistency.
IV. Summary	Remind the students that a road inventory is merely a collection of facts used to arrive at an evaluation. Changes are then recommended on the basis of the evaluation.
	Summarize the steps required for a road inventory and the field scoring elements involved.
	State that a complex planning study requires a very detailed inventory. A study for a small region, however, usually requires only a minor amount of detail.
	Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. Why is a road inventory necessary?

UNIT II (14.0406-02)

FUNDAMENTALS OF TYPING

Performance Objectives:

Upon completion of this unit the student will be able to type at a rate of 30 wpm/ecol.

Unit Outline:

A. Machine Fundamentals

1. Parts

2. Maintenance procedures

3. Manual and electric typewriters

4. Operation

B. Quality and Performance Standards

1. Speed and accuracy

2. Neatness

3. Language arts

C. Skill Development

1. Keyboard mastery

2. Manipulation of machine parts

3. Speed, accuracy and erasing

D. Typing Applications

Supplemental Teaching Aids:

No suggestions will be made for this unit since free or inexpensive resources are not applicable

Training Time 70-85 hours

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Elements of the inventory	Tell the students that there are many elements that make up a road inventory. A few are discussed in this lesson to illustrate principles only.
1. Length of roads	State that it is not necessary to send a transit party out to measure the mileages of State highways. Mileages can be measured accurately enough for highway planning by using special automobile odometers which read to hundredths of a mile. The automobile tire pressure must be checked daily and adjusted, if necessary, to maintain accuracy of readings. Point out that a fifth wheel geared to a measuring device may be attached to a car bumper and used as an alternate method for mileage measurements.
2. Width of roads	Remind the students that a planning survey inventory does not require great precision. Pavement and shoulder widths measured to the nearest foot give enough accuracy for this survey.
3. Type of paving	Mention that the type of pavement is an important element of the inventory. This information is used to determine the nature and cost of improvement, if the existing road is to be kept and developed.
4. Development of surrounding areas	Tell the students that the nature and extent of development of the area adjacent to each road is important. This information is used when alternate corridors on new locations are evaluated. Also the area development pattern must be known to estimate the cost of the right-of-way.
B. Uses of inventory data	Emphasize that the DOT requires varying degrees of precision in road inventories, determined by the purpose served by each.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. For highway planning	Inform the students that the basic data for planning studies are available from the periodic road inventories that are conducted. Point out that a planner for State highway systems cannot be fully effective without a thorough knowledge of other road systems. For example, he needs data on local road and street widths and mileages, for vehicle-mile forecasts or *needs* studies.
2. As basis for allocating aid to towns and counties	Explain that the State gives financial aid to local governments based on mileages of existing roads. These mileages are determined from the inventories.
II. Field Scoring	Tell the students that field scoring is a way of evaluating the condition of a road and its adequacy for the volume of traffic it carries. Considerable judgment and experience are required to make this evaluation. State that there are several factors in the field scoring system. The Resident Engineer for the area is part of the scoring team that rates a road.
A. Surface and structural condition	Tell the students that the surface condition of a road is given a maximum score of 30% and the degree of rupture is given a maximum of 40%. Explain that inspection of surface condition and extent of rupture by an experienced scorer can reveal the underlying problems of sub-base, drainage, and other valuable engineering information. We can then use this data in various phases of highway development.
B. Maintenance condition	State that the condition of the road based on degree of maintenance is given a weight of 30%. This element of the score is used with the per-

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2. What are the principal elements in an inventory?

3. Why isn't a topography survey included in the inventory?

4. Why is a specialist required to conduct field scoring?

5. What improvement should be recommended if:

   a. A road is deficient structurally?

   b. A road is deficient in volume-to-capacity ratio?

   c. A road is deficient in both a and b?

6. How would an inventory be made for highway planning in a large urban area?

ASSIGNMENT

1. Read pages 2-9 in Ref. F.

2. Read Ref. J and Ref. K. Write in 100 to 200 words your ideas on the need for updating a road inventory every year.

3. Read Ref. L.

4. Read Ref. M.

Lesson 5
Mapping As A Planning Tool

REFERENCES CITED IN THIS LESSON

New York State Department of Public Works, Bureau of Programming. Prospectus for a highway-planning mapping program. The Department, Albany, New York. 1965. (Referred to in this unit as "Ref. O")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill Book Company. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint the students with the kinds of maps in common use for highway planning
2. To show the students the uses of different kinds of maps in highway planning, highway engineering, and related fields

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Kinds of Maps	Explain that there are a great many kinds of maps, including those for special purposes. This lesson will discuss only the few types concerned with highway planning. Point out that maps are used in a great many activities, ranging from navigation to census taking. Mention that maps are important tools for planning. Those used in planning are custom-made for each need.
A. *Planimetric* maps	Tell the students that *planimetric* or *flat* maps are adequate for many purposes. Cite several uses for this type of map. Show a preliminary plan drawn to a scale of 1" = 200' and describe its use without revealing the scale. Ask the students to try to determine the scale by guesswork.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Highway planning series (HPS) county maps	Mention that in 1940 the Department of Public Works prepared a series of highway planning maps using several scales: 1" = 1 mile, 2" = 1 mile, and 1" = 2000'. County maps are part of this series. Point out that this variety of scales was based on available sources for the map features and on the intensity of development in the areas mapped. Inform the students that years of experience have shown that the most useful map scale for general highway planning is 1" = 1 mile.
2. HPS city maps	Explain that the city map series has been tailored to fit standard-size map sheets. Therefore, not all maps in the series use the same scale. Mention that city maps are made with many different scales and with varying detail to suit a particular purpose. Illustrate with assessment maps, plot plans, sewer and water maps, and maps of other utilities.
3. Travel guides and atlases	Remind the students that maps are tools. Briefly discuss the tourist guide series and the atlases prepared for the major oil companies by General Drafting Company, Hagstrom, Baker, etc.
4. *Sanborn* maps	Show a typical *Sanborn* map sheet and briefly explain the details included on it. Remind the students that a given type of map can be used for many purposes. Ask the class to cite a few uses of Sanborn maps.
5. Photomaps	Explain that mapping is a science, and that research is constantly being conducted to produce better maps.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Inform the students that the Department of Transportation made an exhaustive study on the possibility of using aerial photos as base maps, with all important features labeled.
	Mention that after several years of testing, the idea was dropped because of unsatisfactory results.
B. *Photogrammetric* maps	Tell the students that for certain purposes it is important to have the third dimension added to a flat map.
	Mention that the science of aerial photography has developed to such a high degree that three-dimensional maps can be produced quickly and cheaply.
	State that photogrammetric methods have produced much contour information. This cuts out the need for a ground survey of every inch of an area.
1. Ground controls needed	Explain that some ground survey work is necessary to provide base elevations and to check the accuracy of the contours.
2. Map scales used	Mention that the most convenient scale for preliminary engineering is 1" = 200'; for detail design 1" = 50'. Maps for complex designs such as interchanges are usually at 1" = 20'.
C. United States Geological Survey (USGS) maps	
1. Functions of USGS	Describe briefly the role of the USGS, explaining the functions of its triangulation stations and other control stations.
	State that the USGS is also eliminating much of the old-time theodolite and plane table methods in favor of the newer aerial photography techniques.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Updating of maps	Explain the new program of updating USGS sheets at a scale of 1" = 2000' for 7½-minute quadrangles. Point out that ground controls are especially important for USGS maps because of the large area they cover. Ask students if they know what scale the USGS formerly used for most of its mapping. The correct answer is 1:62,500.
D. Aerial photographs	Inform the students that aerial photos are not maps in the strictest sense, but are enlargements of vertical photos of surface areas.
1. The usual scale	Tell the students that the usual scale for a route study is 1" = 400'. Show an aerial photo and draw a line on it with a grease pencil to illustrate that it can be made into a route study map.
2. Another scale used	Indicate that where right-of-way is the critical factor, the 1" = 50' scale is used for a quick office study of alternate routes. Mention that the photos with a 50' scale are often used to lay out ROW maps.
II. Uses of maps	Remind the class that maps are tools and each type serves a specific purpose.
A. Planimetric maps	Explain that planimetric or flat maps fill many needs. Point out that time and money will be wasted if contours are obtained when not needed.
1. HPS county maps	Show a section of an HPS county map with several colored lines drawn on it as route relocation alternates. Mention that a map of this kind is not used for design but for evaluating general location factors.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. HPS city maps	Repeat the procedure with an HPS city map, showing several alternates. Point out that planning for a complex area requires advanced techniques and many detailed maps.
3. Travel guides and atlases	Tell the students that for a broad look at a regional corridor study, an oil company map would be sufficient. Ask them to explain why this type of map is sufficient.
4. Sanborn maps	Explain that a Sanborn map gives the accurate detail needed in cities for insurance rating, assessment, zoning, building codes, etc.
5. Photomaps	Point out that the photomap is better than other planimetric maps. If a good reproducible photomap could be made inexpensively, it would be used more than other planimetric maps.
B. Photogrammetric maps	
1. Main uses	State that a photogrammetric map is used primarily for locating and designing roads. Because its cost is very high, this map is not used for highway planning. Show a highway location on a map drawn to a scale of 1" = 200'. Explain that adding contours to the map permits the plotting of lines to show feasible construction.
2. Other uses	Tell the students that this kind of map is quite satisfactory for comparing alternate lines, establishing grades, etc. Mention that they can also be used for review by the main office of the DOT, the Bureau of Public Roads, and for a public hearing.
C. USGS maps	Explain that the scale of the USGS maps makes them less useful than photogrammetric maps for *small* areas. For regional studies or for long route sections,

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	however, their 1" = 2000' scale, their contours, and other topography details make them more useful.
D. Aerial photos	Inform the students that aerial photos are not only used for general review but also for plotting lines and other features. Therefore, these photos must be taken vertically, not obliquely. Indicate that 1" = 400' is usually a good scale for route studies, but a 1" = 50' scale is more useful for design, especially in ROW work. Remind the students that interpretation of aerial photos is a very complex technique, used for geological, agricultural, and other work. And point out that the class is considering only one or two uses of aerial photos.
III. Summary	Begin summarizing by stating that maps are highly specialized tools and that the discussion has been limited to only a few of the many types. Summarize the pertinent information about the various types of maps. Explain that highway planning involves the location of corridors and not the preliminary design of a highway.

QUESTIONS FOR REVIEW

1. What is another name for a *flat* map?
2. What is the best scale for a map?
3. Should all maps be prepared to the same scale to avoid confusion in measuring?
4. Would an oil company map be of any use in a highway planning study?
5. What is the difference between a *planimetric* map and a *photogrammetric* map?
6. What are the differences among a photomap, photogrammetric map, and an aerial photo?

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7. What is the main use for a photogrammetric map?

8. What is the main use for a Sanborn map?

9. What is the objection, if any, to using oblique aerial photos for highway planning?

10. What is the current, updated scale for USGS maps?

ASSIGNMENT

1. Read pages 2-11 and 2-12 in Ref. F.

2. Read Ref. G. Write 100-200 words comparing a mapping program prepared by a commercial map company to a program prepared by DOT staff.

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UNIT III (14.0406-03)

OFFICE EQUIPMENT

Performance Objectives:

Upon completion of this unit the student will be able to score 90% or above on an instructor established scale that considers both accuracy and time, in operation of adding machines and calculators.

Unit Outline:

A. Ten-key Adding Machines and Printing Calculators

1. Adding by touch

2. Subtraction

3. Multiplication

4. Decimals and factions, conversions

5. Division on printing calculators

Supplementary Teaching Aids:

No resource book suggestions are provided due to the nature of this unit. As a general overview of business machines the following film might be considered; "Modern Business Machines", Teaching Aids Exchange, 307 South B Street, San Mateo, Calif. 94401.

Training Time 10-15 hours

Lesson 6
Traffic Studies

REFERENCES CITED IN THIS LESSON

American Association of State Highway Officials. A policy on geometric design of rural highways. The Association, Washington, D.C. 1966. (Referred to in this unit as "Ref. P")

Matson, T.M., Smith, W.S., & Hurd, F.W. Traffic engineering. New York. McGraw-Hill. 1955. (Referred to in this unit as "Ref. I")

New York State Department of Public Works, Bureau of Highway Planning. External survey manual. The Bureau, Albany, New York. 1966. TM 00-112-01R1. (Referred to in this unit as "Ref. R")

New York State Department of Public Works, Bureau of Highway Planning. Urban area reports. The Bureau, Albany, New York. (These consist of 60 reports, each on a separate urban area, published between 1946 and 1956.) (Referred to in this unit as "Ref. Q")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint the students with the various types of traffic surveys and studies forming the basis for highway design
2. To show how each serves a specific purpose in highway planning for smaller areas
3. To introduce the students to the more detailed types of traffic studies required for complex areas

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Volume Counts of Traffic	Explain that counts of traffic volume are records of the passage of vehicles across a given point in a given time.
A. Machine method	Tell the students that previously counting was accomplished by manual means. Modern traffic volume requires use of machines to count vehicles. State that traffic counters have been improved to a very high degree of reliability.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Indicate that there are several types of *detectors* and that constant research is being conducted to develop new and improved types.
1. Fixed detectors	Inform the students that the principal types of detectors are: a. treadles which count axles b. radar and ultrasonic devices which emit beams that reflect from vehicles c. infrared and electric eye detectors that have beams which are interrupted by vehicles d. electromagnetic and loop detectors placed under the pavement. This type emits electric fields which are interrupted by vehicles
2. Portable detectors	Explain that for short counts it does not pay to install a fixed detector, and a portable one is used. For this purpose we use rubber tubes laid across the road, connected to the recorder.
3. Printed-tape recorders	State that in a printed-tape recorder the impulses from the detector actuate a mechanism which counts traffic and prints the count on a tape. Recorders can be battery operated or be connected to regular electric-line current.
4. Punched-tape recorders	Explain that punched-tape recorders print out vehicle volume data on a tape. This information is later translated to IBM cards.
5. Computer control	Mention that it is possible to have traffic counters connected to a *computer center* where the data can be automatically processed. This type of installation is very expensive and is used only for special applications.
B. Manual method	Point out that for turning counts at intersections, or other short term needs, use of machines is not practical. Purposes such as these can be satisfied by taking counts manually.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Inform the students that there is no benefit in getting more information than we need for the study purpose. For example, data for an intersection design may be adequately obtained by a manual count of 8 to 12 hours.
II. Origin and Destination (O & D) Surveys	Remind the students that the class is considering highway planning for a small area and is not concerned with an urban transportation study.
A. Roadside interview	
1. *Spot survey*	Point out that a one-station survey *(spot survey)* is the simplest type for data collecting.
2. *Screen line*	State that *screen lines* consisting of stations for taking data may be thrown across any series of routes. This type of survey is necessary for comparing *alternate* corridors.
	Show a map with two alternate parallel corridors and a screen line cutting across the corridors. Explain that at least two stations should be operated as part of the screen line.
3. *Cordon* around an area	Mention that for study of a village bypass it would be necessary to encircle the area with a *cordon* of interviewers and checkers to get a comprehensive O & D pattern.
	Tell the students that complex areas require more sophisticated studies, both for O & D surveys and for traffic counts.
B. Other O & D surveys	Name a few other types of O & D surveys. These include: home interview, destination interview, questionnaire postal card, license plate survey, telephone interview, and headlight survey.
III. Classification Counts	Tell the students that it is important to know the composition of traffic. This information, which is obtained by

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	a *classification count*, is used for various aspects of highway planning.
	Point out, for example, that heavily traveled truck routes require heavier pavement, bigger ramp radii, etc.
A. Comprehensive data collection	Explain that important routes under study require classification counts all year (on a 24-hour basis) to obtain daily and seasonal composition patterns.
	Inform the students that the classification system for vehicles is quite detailed. For example, trucks can be classified into 15 or more groups.
B. Short-term count	State that a short-term classification count is often sufficient for planning purposes. Point out, for instance, that if a count is needed for a day's traffic peak, a count from 4-5 P.M. at the Holland Tunnel would probably give it.
IV. *Turning-Count*	Show a sketch of an intersection and ask the students which legs should be counted for a *turning-count*. The proper answer is that all four legs must be counted, including the legs for through traffic, and those for left and right turns.
	Mention to the students that a turning-count is a good example of a manual count. Explain that turning-count information is used to design left and right turning lanes.
V. Uses of Traffic Surveys	Review the previous parts of the lesson covering traffic counts, O & D surveys, classification counts, and turning-counts.
	Ask the students if they can give one major use for each of these types of traffic study. Acceptable answers are:

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	a. Traffic count--the data from a count is translated to AADT and DH. b. O & D survey--survey information is used to determine bypassable traffic areas. c. Classification count--the resulting information is used in designing the geometrics of a road. d. Turning-count--the information is used in designing intersections.
VI. Summary	Point out that the general purpose of traffic studies is to give the highway planner the data he needs to make intelligent recommendations to the designer. State that the decision whether to build a new highway or to improve an existing one must be based on sound analytical data. The high cost of highways does not allow any guesswork in decision-making. Tell the students that wide reading is required to promote their understanding of highway planning and highway engineering. Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. What are the principal elements of a traffic study for highway planning?

2. What is the basic difference between a treadle detector and a tube detector? Between a treadle detector and a loop detector?

3. Where would you use computer control for traffic count-information?

4. Why are O & D surveys made?

5. When would a home-interview survey be used? A screen-line survey? A spot O & D survey?

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6. Of what value is a classification count in a village bypass study in dairy country?

7. What kind of traffic study should be made for intersection design?

ASSIGNMENT

1. Read pages 2-13 to 2-18 in Ref. F.

2. Read Chapters 5 and 6 in Ref. I.

3. Read pages 53-58 in Ref. P.

4. Read any one of the reports in Ref. Q.

5. Read Ref. R. Write 100 to 200 words on what you would do to solve the problems of a congested state highway in a village where diagonal parking is permitted in front of stores.

Lesson 7
Traffic Analysis

REFERENCES CITED IN THIS LESSON

Matson, T.M., Smith, W.S., & Hurd, F.W. Traffic engineering. New York. McGraw-Hill. 1955. (Referred to in this unit as "Ref. I")

New York State, Department of Public Works, Bureau of Highway Planning. Urban area report. The Bureau, Albany, New York. (Referred to in this unit as "Ref. Q")

Traffic Quarterly. The Eno Foundation for Traffic Control, Saugatuck, Conn. (Referred to in this unit as "Ref. N")

Winch, D.M. Economics of highway planning. Toronto, Canada. University of Toronto Press. 1963. (Referred to in this unit as "Ref. T")

OBJECTIVES

1. To show the major steps in making a simple traffic analysis for a small-area study
2. To show how an analysis is used in highway planning for such an area

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Analysis of Traffic Volume	Explain that raw data on traffic volume are most useful when translated into two standard measures: average annual daily traffic (AADT) and design hour (DH).
A. Average annual daily traffic (AADT)	Mention that traffic volume varies with the hour of day and the season of the year. State that the most useful indicator of traffic load on a highway is the AADT, which is the average traffic volume for each day of the year.
1. Continuous count	Display a graph which shows traffic volume by hour of the day and another which shows volume by day of the year.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Explain that records from a continuous counter provide counts 24 hours a day and cover all of the 8760 hours of the year. Dividing the year's total by 365 gives the AADT.
2. Short count	Tell the students that portable counters are used for a short count. They are shifted from place to place in accordance with a schedule, or to meet a specific need. Ask the students for their ideas of the definition of a short count. State that many studies have been made on the desirable length of a short count. Explain that some are taken for only 24 hours, but others are taken for 7 days to get the week-end traffic volume. Point out that short counts must be translated to AADT by using conversion factors. Show an annual curve with the AADT line through May and October. State that from continuous counts, factors are derived to convert short counts into annual data.
B. Design hour (DH)	Tell the students that a design hour is the volume of traffic per hour for which the highway is designed.
1. With a continuous count	Explain that where continuous records of traffic are available, the 8760 hours of the year are arrayed in decending order of traffic volume. The 30th highest hour in this array is most commonly used for design. Ask the students to explain why. Inform the class that it would be uneconomical to design roadways for the small percent of the total year's traffic above the 30th highest hour.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Point out that in designing special roads, such as those with highly seasonal traffic, the DH may be other than the 30th hour. For such roads it might be desirable to use the 50th or the 80th hour.
	State that the choice of the DH is based on economics plus engineering judgment.
2. With a short count	Mention that for short counts a complete array of the hours of the year cannot be made. In such cases a computation is made to determine the DH.
	Explain that the Albany office of the New York State DOT has traffic data covering many years and has made many studies to derive conversion factors. The AADT and the DH are computed in Albany from short count data furnished by the districts. The computed figures are then given to the districts as required.
C. Composition of traffic	State that it is important to know the composition of traffic.
1. Equivalent traffic count	Show on the chalkboard that 100 vehicles consisting of 5 trucks and 95 passenger cars is equivalent to 105 passenger cars. (This assumes an average truck factor of 2.)
	Also show that 100 vehicles consisting of 5 tractor-trailers and 95 passenger cars is equivalent to 115 passenger cars. (This assumes a tractor-trailer factor of 4.)
2. Effect on road design	Ask the students to enumerate road features that could be affected by a large volume of heavy trucks. These include lane width; pavement thickness; subbase type and thickness; shoulder type, width, and thickness; grades, including climbing lane, ramp widths, and radii.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
II. Analysis of Travel Characteristics	Mention that up to this point the lesson is concerned only with actual traffic on existing roads. Point out that volume studies do not help to determine whether traffic can be bypassed.
A. Origin and destination (O & D) surveys	Tell the students that O & D spot, screen line, and cordon surveys were designed to determine what traffic can be bypassed.
1. Through traffic	Explain that through-traffic can be classified into two types: *long-distance* and *area*. Discuss with the students the difference between *area* through-traffic and *long-distance* through-traffic. Explain that traffic in a business district which originates within a certain number of miles from the center point of the district is *area* through-traffic. Traffic originating further away than that is *long-distance* through-traffic. Ask the students what that number of miles is. (The correct answer is 25 miles.) State that for some studies the difference between the two types of through-traffic is significant, and for other studies it is not. To find out if any students have a grasp of regional planning, ask the class why this situation might exist.
2. Local traffic	Remind the students that this course is concerned with elements of highway planning. Mention that the principal traffic problem in villages and small cities is the main street congestion caused by shoppers, etc. Explain that the percentage of total traffic in large cities which can be bypassed varies with population. In villages and small cities a significant percentage can always be bypassed.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Note that it is pointless to split a small area into many O & D survey zones when you want to decide only whether to bypass or not to bypass the area.
B. Assignment of traffic to a bypass	State that once the O & D survey data are analyzed, it is easy to assign traffic either to an existing route or to a proposed bypass. This assignment will be based on the origin and destination of travelers, and on the time-distance ratio as shown in a diversion curve.
1. Diversion curve	Tell the class that most people will drive their cars on a long, round-about route to avoid the congested traffic on a shorter route. Show a *diversion curve* and point out the breakeven point.
2. Variations from the curve	Impress on the students that some people have personal preferences and habits that do not follow a scientific curve. Therefore, it is unwise to base the assigning of traffic completely on the curve. Some allowance should be made for these preferences and habits. Point out that 20 to 25% of divertable traffic will not divert. Therefore, no bypass should be justified by a curve only.
III. Applications of Traffic Analysis	Remind the students that for all engineering work the objective should be clearly stated. Mention that all the analyses above are aimed at helping to arrive at a high-way-planning decision.
A. Improving existing routes	Sketch a village grid system on the chalkboard and show Main Street with volume notations of 800 DH and 8,000 AADT. Explain that these volumes impose too heavy a traffic load for a two-lane highway.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	State that an O & D analysis showed that only 25% of the traffic was bypassable and 75% would theoretically stay on Main Street. Remind the students that some of the 25% will also choose not to use the bypass.
	Conclude for the students that this analysis calls for improving the existing route. Ask for suggestions on ways to make improvements.
1. Ways of improving	Show that there are many possibilities for improving the road, such as: widening toward one side, widening toward both sides, establishing one-way couples, and widening a parallel street and rerouting through-traffic.
B. Planning a bypass	Reverse the figures of the example and tell the students that 75% of the traffic is bypassable. Caution the class again about using the full percentage in planning diversion of traffic.
	Sketch a bypass around the village following the general direction of the desire lines from the O & D survey.
	Point out that at this point in the planning the problem enters the engineering stage.
	Draw the conclusion for the class that Main Street won't need widening when 50 to 60% of the traffic uses a bypass.
IV. Summary	Explain that this lesson has considered only existing traffic and that forecasting will be studied later.
	Point out that forecasts of traffic volume are normally used in highway planning studies and, perhaps, should have been presented in this course before now. Instead, traffic forecasting is the next lesson. This order is followed to maintain continuity of travel characteristics.

Lesson 9
Economic Analysis

REFERENCES CITED IN THIS LESSON

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

New York State Executive Department, Office for Regional Development. Change, challenge, response. The Office, Albany, New York. 1964. (Referred to in this unit as "Ref. X")

Winch, D.M. Economics of highway planning. Toronto, Canada. University of Toronto Press. 1963. (Referred to in this unit as "Ref. T")

Woods, K.B. Highway engineering. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To show the major steps in making an economic analysis for a highway planning study of a small rural area
2. To show how an economic analysis helps the highway planner in decision-making

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Economic Analysis in Highway Planning	Point out that each phase of highway planning has a specific purpose. Economic analysis is also a phase of highway planning, and an important one.
A. Decision-making	Emphasize that professionals do not use guesswork in economic analysis but base their decisions on all facts available. They use judgment, which is the application of professional experience to a specific set of facts. Explain that the highway planner must prove the value of his recommendations to many individuals and many agencies.
B. Presentation	Tell the students that a planning study must be thorough and of high quality. It must be written so its value will be evident to people unfamiliar with highway planning.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

Tell the students that highway planning is invaluable, even for areas with very simple traffic problems.

QUESTIONS FOR REVIEW

1. If traffic studies are carefully made, can they be used by the highway planner as raw data?

2. What are the standard traffic measures? (Suggested answer: AADT and DH.)

3. Is there any objection to taking all short counts in either May or October? If so, what is it? (Suggested answer: Too much equipment is required.)

4. What is the objection, if any, to using the 30th hour as the DH on a road leading to a racetrack?

5. Why is a factor as big as 4 applied to tractor-trailers in a traffic count, when converting to equivalent passenger vehicles? (Suggested answer: A tractor trailer interferes with the sight-distance of vehicles behind it; it takes up a considerable length of roadway; it is difficult to pass; it climbs hills slowly; and it requires a large side-clearance.)

6. What is the basis for assigning traffic to either an existing road or to a proposed bypass?

7. Will a bypass hurt village business? If so, how?

8. Suppose an O & D survey of Main Street indicates a 50% theoretical diversion to a bypass. What improvement should be made if Main Street is 30 feet wide? 40 feet wide? 50 feet wide?

   Suggested answer: For 30 to 40% diversion, a bypass would be practical for the 30- or 40-foot street. Approximately one-third relief would be obtained. Although small, this improvement could allow the street to operate efficiently. For a 50-foot street it is possible to operate 4 lanes, with one side lane for parking. But this would probably leave the village dissatisfied. Therefore, a bypass would be recommended for all cases, if present volumes are critical.)

ASSIGNMENT

1. Read Chapter 37-4 in Ref. I. Write 100-200 words giving arguments you would present in explaining the need for a bypass to a Chamber of Commerce.

UNIT IV (14.0406-04)

COMMUNICATIONS

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate to the satisfaction of the instructor a level of coherence and clarity in oral communications that is adequate for the business office. In an objective test the student will be able to score at least 80% on items covering mail handling and telegraph techniques and procedures.

Unit Outline:

A. Elements of Good Speech

1. Voice control

2. Vocabulary, pronunciation

3. Grammar and writing

B. Speech Problems

1. Individual analysis

2. Corrective program

C. Business Office Uses of Telegrams

1. Comparison with other uses and forms of communications

D. Methods of Sending Messages and Various Systems

E. Types of Services and Rates

F. Processing Activities

1. Incoming

2. Outgoing

G. Importance of Mail

H. Procedures for Handling Mail

I. Classification of Mail and Rates

J. Postage Equipment and Supplies

1. Postage meters and scales

2. Automatic addressing systems

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2. Read "An approach to O & D data analysis" in the April 1955 issue of Ref. N.

3. Read Ref. Q.

4. Read pages 30-34 and 93-95 in Ref. T.

Lesson 8
Traffic Forecasting

REFERENCES CITED IN THIS LESSON

Automobile Manufacturer's Association. Highways for the future. The Association, Detroit, Michigan. 1961. (Referred to in this unit as "Ref. S")

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

New York State Department of Public Works, Bureau of Highway Planning. Urban area reports. The Bureau, Albany, New York. (These consist of 60 reports, each on a separate urban area, published between 1946 and 1956.) (Referred to in this unit as "Ref. Q")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill, 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint students with the procedures for making traffic forecasts for road networks in small areas
2. To show how traffic forecasts, as developed through this course, are used in highway planning

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Principles of Traffic Forecasting	Tell the students that *traffic forecasting* requires engineering judgment applied to certain basic principles, which have evolved over the years from nationwide research. Forecast data is used in almost all phases of highway planning and engineering.
A. Selection of forecast period	Point out that each forecast is designed to meet a specific road need; it covers specified conditions for a specified period of time.
1. 10-year forecast	Cite as an example the use of field scoring and traffic studies which showed that a certain road needed only resurfacing. This resurfacing is estimated as having a 10-year life. Therefore, we limit our forecast to a 10-year period.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Explain to the class that in highway planning it is best to plan for a specified time period. Explain that all work must have a specific objective and our objective should be to meet the traffic needs of a given period in the future.
2. 20-year forecast	Point out that inventory and traffic studies could, in certain cases, indicate the need for either a new highway location or a major reconstruction of an existing road. State that in such cases it would be uneconomical to plan for only 10 years of traffic growth because the economic life of new pavement is estimated to be 20 years.
3. 30-year forecast	Tell the students that *structures* which form part of a highway system are designed for a 30-year life. Therefore we use a 30-year forecast for these structures.
4. Forecast for a longer period	Mention that a forecast for more than 30 years may appear to be unfeasible. But sometimes an estimate must be made for 40 or 50 years. Ask the class why forecasts for such a long period may be necessary. After discussion explain that they may be required for toll-road revenue studies.
B. Obtaining traffic figures for the base year	Explain that traffic counts are not made every year and often there will be no current count available when a forecast is being made. Point out that lack of a count is not serious because we base a traffic forecast only on estimates, using the best known techniques. When traffic information for the current year is not available, we derive it from earlier figures.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Declining trend	Show on the chalkboard the following three traffic-count figures for the years indicated:
	1957: $\frac{484}{5250} = \frac{\text{Design hour}}{\text{Avg. annual daily traffic}}$
	1959: $\frac{312}{4925}$
	1961: $\frac{115}{1911}$
a. Estimating the traffic	Ask students which figures they would use in projecting the future status of the road. Have them explain any choice they give.
	Conduct a discussion and then give the conclusion to the students that a decision could not be made solely on the basis of these three figures. Although the figures indicate a declining trend, these figures alone are not sufficient to arrive at a conclusion.
b. Analyzing the decline	Point out that the downward trend could be the result of traffic diverting temporarily because of construction or because a new road has been opened. Suppose we assume that a new road had opened in 1959. Traffic might still be using it for trips by an indirect route in 1961, simply because many people like to ride on a new road even if the trip is longer.
c. Overall study needed	State that the only sure way that we can determine whether there was a declining trend is to examine the road network of the whole area. Based on an overall study of all factors, we can arrive at a conclusion for the traffic trend.
	Emphasize that highway planners must be sure that their base year figures are accurate before proceeding with further planning.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Ask the students why accuracy at this point is important, to see if the class realizes that the forecast is projected from the base. This point must be well emphasized.
2. Static trend	Tell the students that extra care must be used in the analysis, if traffic seems to have stabilized on the road under study.
a. Analyzing the trend	Assume a prediction has been made that traffic on a certain road will not change for 20 years. Such a prediction is very unlikely to be correct because traffic rarely remains the same for any length of time. It must be analyzed periodically because unforeseeable conditions may arise. Explain that planning and design will be based on traffic forecasts and that we must use extreme care in selecting the base year.
3. Upward trend	Reverse the figures shown for the road with the declining trend. Ask the students whether they are satisfied that the figures truly show an upward trend.
a. Analyzing the trend	Explain that we must also use care in analyzing upward trends and arriving at conclusions, because factors not evident could be responsible for changes. Ask the class for possible conditions that may be causing the upward movement of traffic. One likely cause is that construction on other roads in the area is diverting traffic to the road being studied.
C. Expansion factors influencing forecasts	State that in making a traffic forecast all known factors that could influence the traffic must be considered. In this process we must apply the best engineering judgment to the latest and best traffic information.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Normal traffic	Point out that the economy is growing: there are more people, more and better highways, more automobiles, and incomes are going up. And there is more automobile use.
a. Auto registration going up	Draw a population growth curve and a vehicle registration curve on the chalkboard. Show that automobile registration is growing faster than the population.
2. *Generated traffic*	State that *generated traffic* results from unpredictable things such as curiosity and desire for movement, which motivate people to travel by car. There is no scientific basis for estimating this type of traffic.
a. Different from normal	Point out that generated traffic does not grow like normal traffic. Draw a normal growth curve and superimpose a *generation curve*, using an average 25% increase over 3 years. Show that the generation curve levels off after 3 years.
3. *Development traffic*	*Development traffic* is the increase in traffic on a new highway resulting from economic development along the highway. The economic development takes place in the *general traffic corridor*, an area on each side of the highway which follows it along its length or part of its length.
a. Economic development	This economic development includes the building of houses and the growth of business and industry. The houses are built to supply the normal growth of population. They are built in the general traffic corridor because of the travel convenience. The population growth in the corridor also stimulates the business growth to serve this population. The labor supply in the traffic corridor encourages the growth of industry.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Inform the class that this rapid development is not a flash boom but is an acceleration of the normal growth in the area.
	Draw a 30-year graph of development traffic. Show on it 20% growth in the first 10 years, 50% in the second 10 years, and 30% growth in the third 10-year period. These are, of course, only figures assumed for illustration, and can vary greatly from one place to another and from one time to another.
D. Computation for forecasting	Tell the students that once the three basic expansion elements have been determined we can reduce the rest of traffic forecasting to simple mathematics.
	Show a typical problem on the chalkboard using the three factors, and work out a 30-year traffic forecast in 10-year periods.
II. Uses of Traffic Forecasts	Remind the students that the objective of forecasting is to answer the questions, "How much traffic will there be, and when will it occur?"
	Point out that each area has its own characteristics and rate of growth. Therefore a traffic forecast should be tailored to suit the area. The highway planner should not use averages if specific information is available.
A. To determine the geometrics of roads	Tell the students that the designer uses the forecast figures to determine the geometrics of a road. Inaccuracies at this point could result in waste of millions of dollars.
III. Summary	Repeat that there is no magic in highway planning--only engineering judgment based on facts.
	Remind the students that the procedures taught in this lesson represent the application of scientific principles

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

to factual data collected and analyzed for a specific purpose--the forecast.

State that traffic forecasting has three main elements: the forecast period, traffic figures for the base year, and expansion factors.

Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. What are the elements of a traffic forecast?
2. What are the usual periods covered by forecasts?
3. What type of improvement is usually associated with each type of forecast period?
4. What is the best base year to use for a forecast?
5. What precautions should be taken when selecting a base year from a series of counts compiled over a period of time?
6. What are the principal elements in the growth of traffic?

ASSIGNMENT

1. Read page 424 and pages 426-428 in Ref. A.
2. Read pages 2-33 and 2-34 in Ref. F. Write 100 to 200 words on using a 30-year statewide forecast as the basis for planning a gasoline tax increase next year.
3. Read any one of the reports in Ref. Q.
4. Read pages 4-5 in Ref. S.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Point out that every planning study should result in a report. Economic analysis will be an important part of that report.
	Draw two alternate route lines on the chalkboard between points A and B, and tell the students Line 1 costs 1 million dollars to build and Line 2 costs 2 million.
	Ask the class if this brief comparison of costs is an economic analysis, to see if the students have grasped the idea of coordinated, comprehensive planning.
	After discussing, point out that cost is only part of an economic analysis.
II. Elements of Economic Analysis	Explain that economic analysis is a planning tool and must be tailored to each need. An economic study, like a traffic study, should contain only enough details to accomplish its objectives.
A. Unfeasible route	Sketch on the board three or four alternate route lines, with one through a cemetery and obviously not worth considering.
	Point out that it is a waste of time and money to study an obviously unfeasible route.
B. Economic impact	Emphasize to the students that they are not economists. Therefore, they should rely on the experts for information on the economic impact of a highway plan on an area.
	Ask the students for their ideas on the economic impact a highway might have. (This discussion should bring out the way a new highway location could affect land values, industrial location, new shopping centers, residential development, existing gas stations, motels, etc.)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Point out that economic impact is only one of the factors considered in comparing alternate routes. But it is one of the most important factors.
C. Construction cost	Explain that public money is scarce and that the highway planner must be concerned about costs.
1. Limited accuracy sufficient	Mention that the cost estimates prepared at this point in the planning do not require great accuracy. Determine whether the students know the reasons for this limited accuracy. Tell them that, first, they are only comparing alternates with the same yardstick. Second, they have no basis for accuracy--they do not have enough information.
2. Designer's costs accurate	Inform the students that the designer will arrive at actual costs by use of plans, specifications, and estimates. Remind them that they are not designing a highway but only comparing alternate routes.
3. Information needed now	For a satisfactory economic analysis, cost information is needed about the road itself and about any structures involved in it. For the road itself, the cost per mile is needed for level terrain, rolling terrain, and mountainous terrain. The cost of structures should be in dollars per square foot; the number of square feet can be based on dimensions of streams and roads scaled from drawings. Explain that the tendency in planning studies is to estimate too low. When retaining walls and ramps are part of the highway, the structure costs should be increased by about 25%.
D. Right-of-way (ROW) costs	Show the class a photogrammetric map with two or three alternate route lines. Have one of the lines pass through developed land and the others through open land.

22238

Supplemental Teaching Aids:

Many good resource books applicable to this unit are available, particularly in the field of special education. Others are the following: Communicating Facts and Ideas in Business, Leland Brown, Prentice-Hall, Englewood Cliffs, N. J., 1961, Business English in Communications, Himstreet, Porter and Maxwell, Prentice-Hall, Englewood Cliffs, N. J. 1964.

A series of three programmed texts by Joseph C. Blementhal are available from Harcourt, Brace, and World. A great deal of free material is available from Western Union including the film "Telegram for America". Pitney-Bowes, Inc. distributes two publications on mailing machines entitled How to Increase the Prestige of Your Mail and 29 Timely Mailing Tips.

Training Time 35-45 hours

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Remind the students that for highway planning, cost figures for acquiring property in the right-of-way need not be exact.
	Ask for suggestions on costing. Point out that an average cost for a gas station or residence is satisfactory.
	Ask the students how they would arrive at these costs. Their answers will show whether they know how their DOT District Offices are organized. The discussion should bring out the fact that the ROW Unit in the District Office has information for making quick property estimates.
E. Benefit to the road user	Write on the chalkboard a user-benefit formula. Explain that the cost of travel time is obtained by averaging a number of estimates.
	Ask the students how much an hour of saving in travel time is worth. Elicit discussion from the class on the reasoning behind the students' thoughts on the value of travel time saved.
1. Example	Work out a typical user-benefit problem on the board.
2. Differences in alternate routes	Tell the class that the user-benefit method takes into account the difference in length of alternate routes. Explain further that all of the alternate routes involve costs of: construction, ROW, maintenance, and travel time.
	Point out that the shortest route does not always have the shortest travel time. Show the diversion curve.
III. Use of Economic Analysis in Highway Planning	
A. New location of road	Display the photogrammetric map with the alternate routes.

CONTENT OUTLINE

1. Steps leading to new location

2. Data from previous ies

3. All factors to be c sidered

TEACHING POINTS AND TECHNIQUES

Review the steps in highway planning discussed previously:

1. Inventory and field scoring
2. Mapping
3. Traffic study
4. Traffic analysis
5. Traffic forecasting

w Point out that an orderly process of highway planning led to the alternate routes on the photogrammetric map.

Assume that in a particular planning study the traffic volume shows a need for improvement of the present road, but the O & D survey shows enough bypassable traffic to warrant a new route.

Also state that the cost of improving on the existing road is excessive.

Remind the students that the full diversion indicated by the curve was not used in assigning traffic to a bypass because not all people follow the theoretical curve.

stud- Point out that the figures which formed the basis for the decision came from the series of studies explained earlier in the course.

Tell the students that the user-benefit method does not always make a clear-cut case for one route over another. Sometimes there is little to choose from between alternates.

Mention that user-benefit is only one more factor to be considered along with the other factors discussed in earlier lessons.

on- A highway planning decision must be based on all pertinent factors, not just one or two.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	State that there is no such thing as only one solution to a problem. Explain that often the traffic study makes only a weak case for a bypass as compared to an existing road location.
a. Political and sociological factors	Tell the students that political or sociological considerations may outweigh economic considerations, as in cases involving relocation of an ethnic group.
	Remind the students that highways cannot be planned with a limited knowledge: all aspects must be evaluated.
IV. Summary	State that this course covers only the elements of planning, but the students can get a broader grasp of transportation planning by reading beyond the required text.
	Mention that this lesson covered only briefly the highlights of economic analysis. It did not consider the social values of accident reduction.

QUESTIONS FOR REVIEW

1. Is the primary purpose for making an economic analysis to help the planner with his work or to convince others of the value of highway development? (Suggested answer: These two purposes are equally important.)

2. What are the principal elements of a simple economic analysis for highway planning?

3. Who should make an economic impact study? How detailed should it be?

4. How do you determine the cost for a rock excavation as compared to an all-earth excavation?

5. Will high ROW costs make an alternate route unfeasible? (Suggested answer: All factors must be considered--not just one.)

6. What circumstances would show that user-benefit calculations to justify the location of an alternate route are not worthwhile? (Suggested answer: Where location is dictated by such things as the

need to preserve scenic or historic areas, or unique agricultural land.)

ASSIGNMENT

1. Read pages 382-392 in Ref. A.
2. Read pages 3-2 and 3-18 in Ref. F. Write 100-200 words giving your views on the State's responsibility to anyone put out of business by a village bypass.
3. Read pages 35-60, 71-82, and 88-92 in Ref. T.
4. Read pages 88-147 in Ref X.

22242

Lesson 10
Geometrics and Design Standards

REFERENCES CITED IN THIS LESSON

American Association of State Highway Officials. A policy on geometric design of rural highways. The Association, Washington, D.C. 1966. (Referred to in this unit as "Ref. P")

Highway Research Board. Highway capacity manual. The Board, Washington, D.C. 1965. (Referred to in this unit as "Ref. U")

Matson, T.M., Smith, W.S., & Hurd, F.W. Traffic engineering. New York. McGraw-Hill. 1955. (Referred to in this unit as "Ref. I")

National Highway Users' Conference. Federal aid for highways; revised edition. The Conference, Washington, D.C. 1959. Includes a supplement dated 1961. (Referred to in this unit as "Ref. B")

New York State Department of Public Works, Bureau of Highway Planning. Geometric standards for urban, primary, and secondary highways. The Bureau, Albany, New York. 1959. (Referred to in this unit as "Ref. V")

Winch, D.M. Economics of highway planning. Toronto, Canada. University of Toronto Press. 1963. (Referred to in this unit as "Ref. T")

OBJECTIVES

1. To show the students how design standards vary with traffic volume, type of terrain, and type of area development
2. To acquaint the students with the basic standards used for design of New York State highways
3. To show how geometrics are selected by the highway planner

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Factors Affecting Design Standards	Tell the students that geometric design standards have evolved after years of study and analysis of traffic flow, highway capacities, and highway use. Point out that normal progress requires that we revise standards from time to time to keep abreast of changes. Ask the students to cite a few changes in automobiles in recent years that have influenced geometric standards.

CONTENT OUTLINE

A. Traffic volume

1. Determines design stan

2. Varies with length of designed for

B. Terrain characteristics

TEACHING POINTS AND TECHNIQUES

Examples of such changes are: wider trucks, higher operating speeds, lower cars, increasing marginal friction compelling more access control, etc.

Mention that the highway planner is concerned with providing an adequate facility which will last for the designated length of time. With this aim in mind the planner must also assure that public money is used efficiently to prevent overbuilding or underbuilding.

dard Explain that a road planned for a 20-year forecast of 200 cars a day should obviously be of a lower design standard than a 20,000-vehicle road.

Tell the students that geometric features of a road are designed to suit the forecast traffic. These features include pavement and shoulder widths, curvature, and steepness of grades.

Ask the class why all geometric features are related to traffic volume. The students' answers will show whether they associate traffic volume with operating speed, sight distance, etc.

time Remind the class that the traffic forecast could be for 10, 20, or 30 years, and the requirements could vary substantially for the same road.

Use a hypothetical design-hour and show that designing for a 10-year forecast might require only an R-6 design-class highway. But a design for 20 years might call for an R-5 highway. ("Reference V" explains the various classes of highways.)

Discuss terrain features and their effect on design standards with the class.

After the discussion, remind the students that it is uneconomical to spend

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

a great deal of money on high standards for roads that will have little traffic.

1. Affect design standards

State that even for high traffic volume some concession must be made to the high cost of flattening curves and grades in mountainous terrain.

Explain that motorists expect operating speeds to be lower in mountainous areas. Also, grades for interstate highways are a maximum in these areas.

Point out that steep grades and sharp curves are incorporated in roads throughout the country in mountainous terrain. This applies to New York State also.

C. Developed areas

Tell the class that reduced speed is required in developed areas. Ask the students to give examples of conditions requiring reduced speeds in developed areas. (Examples are: driveways, pedestrians, bicycles, delivery trucks, and other vehicles stopping or standing.)

Explain that the same high design standards are not required for a 40-mph road as for a 60. This is an example of economizing by applying sound planning principles.

State that for developed areas, the slower speeds will not require the long sight distances that high-speed roads require.

Ask the class to cite some effects of sight distances on design. (The answer should bring in: shorter vertical curves, sharper horizontal curves, and steeper grades for crest curves.)

II. New York State Geometric Standards

Inform the students that all states are members of the American Association of State Highway Officials (AASHO) and all

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

help formulate design standards. New York State geometric standards conform to the guidelines of the AASHO. Refer the class to "Reference V."

A. Standards for expressways

Point out that an expressway has approximately twice as much capacity as an ordinary highway. Features such as controlled access, separation of traffic, and elimination of grade intersections give extra capacity.

Write on the chalkboard the capacities of a controlled and an uncontrolled highway of the same width. From these examples illustrate the increase in capacity for roads in U-3, U-4, U-5, R-2, and R-4 design classes.

Explain to the students that in New York State the term *expressway* is used, while in other states *freeway* is used.

Tell the students that the *interstate system* is a system of expressways financed from special funds. Highways in this system are built to a uniform national standard.

Inform the students that the standards already discussed in this lesson do not include *interstate* highway standards. Standards for such highways are described in a different publication of the DOT.

1. Rural expressways

Give each student a copy of Ref. V, the Department's 1959 standards. Review the standards sheet with the class and ask the students to point out which roads have a 70-mph design speed. (The answer: R-1 and R-2.)

Ask why U-1, U-2, and U-3 roads have only a 60-mph speed, to find out if the students realize that these are urban highways, which require lower operating speeds.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Point out that *operating* speeds are usually 10 mph less than *design* speeds.
	Ask the students to compare the capacities of a U-1 road and an R-1 road. Then ask them to give opinions on the difference. After discussion explain that the higher the speed, the greater the required safety; therefore, the lower is the capacity on the high-speed expressways.
2. Urban expressways	Tell the students that urban expressways often create Chinese walls in cities. This type of road cannot accept road crossings approximately every mile as rural expressways commonly do.
	Point out that in cities it is often necessary to maintain local traffic service along with express service. To achieve this we provide service roads (or *frontage roads*) where needed.
	State that traffic generators in cities are usually more closely spaced than in rural areas. Because of this, interchanges must be closer together.
	Remind the students that urban expressways usually have lower design speeds than rural expressways. There are two basic reasons for this: (1) higher ROW costs will not permit the same design standards to be used, and (2) interchanges are closer together, requiring lower speed.
	Ask the class to explain why interchange spacing affects design speed. Their answers will show whether they understand acceleration and deceleration lanes, and weaving and merging traffic.
B. Standards for rural highways	Mention that standards for rural roads merit some attention. Tell the students that the limits on class time

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	prevent the study of the details of each type of highway. Study of the standards sheet, however, will provide some valuable detail.
	Explain that we have two basic reasons for using several types of design. One is to achieve economy; the other is to provide proper service to the highway user. Standards must economically meet forecast traffic.
C. Standards for urban arterials	State that design of urban arterial highways warrants close study because of ROW cost and the special need to provide for parking.
	Ask the students what type of parking they would recommend in place of parking lanes. Discuss *off-street parking* as the solution to the problem of providing adequate parking for an urban arterial highway.
	Explain that urban roads, like rural roads, are designed to meet forecast traffic data.
III. Selection of Geometrics	State that it is the duty of the highway planner--not the highway designer--to select the geometrics.
A. The highway planner selects	Ask the class for the reason that the planner selects the geometrics. The students should know that the designer depends on the traffic forecast of the planner. Retrace the steps leading to the traffic forecast to reaffirm their knowledge as to how the forecast figure was derived.
1. Practice in selecting	Write a few typical DH figures on the chalkboard and ask the students to select a geometric class. (Do not give the type of terrain or the kind of development until a student asks for this information.)
	If students do not ask for additional information, point out that the given

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	information is insufficient. Planners cannot make assumptions but must have factual data for proper selection.
IV. Introduction to Advanced Design Standards	Remind the class that this course is limited to the elements of highway planning. Explain, however, that someday the students may be involved in planning or designing highways for a metropolitan area. Point out that new and progressive thinking must be used on the problems of a large city. Explain that ROW costs are extremely high for urban freeways. With such high costs urban highways may be designed as depressed roads, with air rights reserved for construction of apartment houses or other commercial construction. Inform the class that even the high cost of a tunnel might be justified where property costs and dislocation problems prevent standard treatment. Tell the students that multiple-tiered, elevated highways are a possibility; roof-top roads might also be considered. Mention that the considerations which govern corridor location, route location, and design apply to small rural areas as well as to the large complex metropolitan areas. But the techniques for each area must be tailored to the problem.
V. Summary	Tell the class that there is a great deal of literature on geometric standards and that they should study as much of this material as possible. Explain why DOT personnel, no matter what their present assignment, should have a good knowledge of highway design standards and practice.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. What is the basis for the Department's geometric design standards?
2. What are the most important factors affecting design standards?
3. What features distinguish an expressway from any other highway?
4. What features distinguish a *rural* expressway from an *urban* expressway?
5. When are *frontage roads* required?
6. How does a designer decide on the class of highway to build?
7. What determines the spacing of interchanges in the city and in the country?

ASSIGNMENT

1. Read page 15 in Ref. B.
2. Read pages 3-6 in Chapter 23, and Chapters 25, 26, 27, 28, in Ref. I.
3. Read Chapter 1 in Ref. P.
4. Read pages 65-70 in Ref. T.
5. Read Chapters 4 and 5 in Ref. U. Write 100 to 200 words giving your views on separate geometric standards for warm climates and cold climates.
6. Study Ref. V.

7. What elements should be included in a route-location report?

8. How long should an effective route-study report be?

ASSIGNMENT

1. Read pages 432-437 and 443-452 in Ref. A.

2. Read pages 5-6 to 5-62 in Ref. F. Write 100-200 words explaining what you would do as a location engineer if a recommended westerly bypass went through a swamp, and the second choice, an easterly bypass, went through a housing development.

Lesson 12
Highway Safety

REFERENCES CITED IN THIS LESSON

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

Matson, T.M., Smith, W.S., & Hurd, F.W. Traffic engineering. New York. McGraw-Hill. 1955. (Referred to in this unit as "Ref. I")

New York Highway Law. Sections 3, 10, 340, 341, 343, and 349C, D, E, and F. (Referred to in this unit as "Ref. C")

New York State Department of Transportation. Deputy Chief Engineer General Letter 67-35, dated May 3, 1967. The Department, Albany, New York. (Ref. AA)

New York State Department of Transportation. Deputy Chief Engineer General Letter 67-43, dated May 15, 1967. The Department, Albany, New York. (Ref. BB)

New York State Department of Transportation. Deputy Chief Engineer General Letter 67-55, dated June 8, 1967. The Department, Albany, New York. (Ref. CC)

New York State Traffic Control Commission. Manual of uniform traffic control devices. The Commission, Albany, New York. 1967. (Ref. W)

Traffic Quarterly. The Eno Foundation for Traffic Control, Saugatuck, Conn. (Referred to in this unit as "Ref. N")

United States Government, Bureau of Public Roads. Bureau of Public Roads Policy and Procedure Memorandum 21-16, Transmittal 44, dated August 30, 1965. The Bureau, Washington, D.C. (Referred to in this unit as "Ref. DD")

United States Highway Safety Act of 1966, Public Law 89-564. Section 402. (Referred to in this unit as "Ref. E")

Winch, D.M. Economics of Highway Planning. Toronto, Canada. University of Toronto Press. 1963. (Referred to in this unit as "Ref. T")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint the students with Federal and State programs for highway safety
2. To acquaint the class with the Department of Transportation procedures for implementing the State safety program
3. To inform the students of safety measures such as pavement striping, signing, signals and others

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Accent on Safety	Explain that this lesson is primarily concerned with highway safety. Tell the students that the annual *death toll* on the nation's highways is approaching the 60,000 mark. Many agencies are concerned and alarmed at the high loss of life. As highway planners we must design our highways to be as *safe* as possible.
A. The Federal safety program	Explain that a Federal safety program existed but was given added impetus by President Johnson. Legislation relating to highway safety was strengthened and Congress enacted additional laws. Read to the class excerpts from Section 402 of Ref. E. Point out to students that Section 402 relates only to the driver and the road, not the vehicle. Safety standards for cars are covered under separate Federal legislation.
B. The New York State program for highway safety	Tell the class that the State legislature became increasingly concerned with the rising State death tolls. In consonance with Federal legislation, a *State Highway Safety Program* was approved. State that the concern for highway safety is so universal that it is not necessary to mandate local safety programs. As a minimum service, State agencies provide guidance and coordination to local agencies to promote safety.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Tell the students that the present highway law is being recodified. The changes will make the law more useful to the DOT in its operations.
B. Law often confusing: 1. A route description	Show the class how confusing the present law is by reading a route description from Section 340 of Ref. C. Ask the students if they can find the described routes on a map. Trace one of these routes on an oil company map. We can readily see that route numbers in Section 340 have no relation to the route numbers we see posted on highways. Discuss Articles XII-A and XII-B. These sections show how a facility such as an expressway gets it start in the legislature.
C. Many changes made in law 1. Route changes	Point out that every time a route location is changed a new law must be passed. The change in the law revises the legal description of the route.
2. Location changes	Read excerpts to the class from Section 30, paragraph 1, of Ref. C. This section establishes procedures for making these changes. Special enabling legislation is usually required for new highway locations and reconstruction projects. In some cases, however, approval by the county board of supervisors is enough.
3. Abandonment of a highway	Discuss abandonment of highway facilities. This type of action also requires legislation when tied into new highway locations. Official abandonment orders of the DOT and of a county or town are based on authority granted by the State highway laws. Explain that the DOT, like any other public agency, cannot spend money without legal authority.
IV. Other Laws Related to Highways	Tell the class that the legislature passes many laws. Some of these affect the DOT but are not highway laws.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. State laws	Read excerpts to the class from Chapter 620 of Ref. C. This chapter shows that the *Executive Law* was revised to institute a highway safety program. Ask for opinions as to why the highway law itself was not amended to include the safety program. The students should realize that it was necessary to broaden the Governor's powers before the safety program could be started. Read excerpts aloud from Chapter 687 of Ref. C. This chapter shows that it was necessary to pass a *special law* to control junkyards and automobile graveyards. This is another example of the need for new legal authority for work not covered by other legislation.
B. Federal laws 1. To provide safety	Point out that *Federal safety legislation* also places a requirement on each state. The Federal Act, (Section 402 of Ref. E) requires the Governor of each state to carry out the provisions of the law.
2. To require planning	Discuss Section 134 of Ref. D. This section shows how the Federal requirement for comprehensive planning affects the State highway program. Section 134 applies to urban areas having more than 50,000 population. These areas cannot receive Federal funds until the provisions of this section are met. Ask the class at what stage of design they would try to meet the requirements of Section 134. The students' replies should cover a range from the earliest design stage up to contract plans. Write the range of answers on the chalkboard. Point out that Section 134 requires submission of a planning report to the *urban area planning group*. We must often obtain approval from this plan-

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	ning body before Federal consideration is given. Any design effort on our part before approval by the Government would be premature and wasteful.
V. Value of the Law to DOT	Ask for opinions as to specific authority granted by the laws which aids the DOT in planning and design of highways.
A. Authority granted to DOT	Write acceptable answers on the chalkboard. Add the following as necessary to complete the list:
1. To survey	1. The right given the DOT to make surveys, borings, and soil tests on private property
2. To remove encroachments	2. The right to remove encroachments from the ROW, such as trees and billboards
3. To provide access	3. The right to provide access to a public highway for a parcel of land which has none
4. To remove abandoned cars	4. The right to remove abandoned or disabled vehicles from the ROW if they are a hazard to the traveling public
5. To limit access	5. The right to limit access from a driveway to a State highway and to specify the detailed design of the access; the right to curb the road for drainage; and the right to limit access to such areas as shopping centers, gas stations, and other businesses
VI. Summary A. Importance of Highway law	Point out that the DOT receives many benefits from the highway laws. This lesson covers only a few; there are many others. Explain to the students that later in their careers they will find knowledge of the laws of tremendous value.
1. Many legal actions needed	State that higher level DOT personnel are involved in other legal actions.

UNIT V (14.0406-05)

RECEPTION AND TELEPHONE

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate to the satisfaction of the instructor her mastery of the following: various types of telephone equipment for conference, sequence, toll call, etc., office forms associated with telephone usage, effective telephone techniques, handling of office callers and appointment records.

Unit Outline:

A. Basic Telephone Information

1. Types of telephone calls
2. Effect of time zones
3. Types of equipment
4. Directories
5. Special telephone services

B. Development of an Attractive Telephone Voice

1. Element of speech
2. Attitudes

C. Handling Calls

1. Incoming calls
2. Outgoing calls

D. Telephone Records

1. Itemized accounting of toll calls and charges
2. Recording conversations
3. Frequently called numbers

E. Receiving Office Visitors

1. Appointments
2. Unexpected callers

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Use of photogrammetric maps	Tell the class that once a corridor has been selected it is possible to obtain photogrammetric maps covering the proposed route. Ask the class whether these maps should be prepared for the planning study. The answers you receive will tell you whether the class remembers that the details of contours and a 200' scale are needless refinements for a planning study.
C. Use of reconnaissance	State that there is no substitute for a field reconnaissance, whether it is made on foot, by car, or from the air. Point out that after trial lines have been plotted on a photogrammetric map, the next step is to make a field inspection. Explain that the alternates now being considered are *not* the alternates considered in the planning study. The present ones are alternate routes within the same corridor. A route location will be chosen from them on the basis of engineering factors--not social impact or other factors. Ask the students what they would look for on a field inspection. (Suggested answer: Soils, drainage, structures, excavation, and other design features.)
1. Construction problems	Mention that valuable effort and money can be saved on a location study by avoiding a route which is clearly unfeasible because of such conditions as swamp, deep muck, or rock. Point out that only one location may be feasible in a corridor, simply because of construction problems. Or there may be several feasible locations.
2. ROW costs	State that some locations may be quickly dropped as unfeasible because of excessive ROW costs.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Mention that the planning study does not consider more than general costs. The preliminary engineering study, however, must make an exact determination of costs.
D. User-benefit analysis	Ask the students if a user-benefit analysis is necessary in a route location study.
	After their comments, point out that such an analysis is definitely useful in route location. This analysis is a straightforward comparison of user costs without the intangibles of impact, development, social, and community values.
	Explain that intangible elements were considered in selecting the *corridor*. The only remaining problem is to define the best and cheapest route that will give the traffic service needed, as shown by the planning study.
E. Revision of economic analysis	Tell the students that in some cases it may be necessary to retrace the planning study to make a revision in the corridor.
	Ask the class when a revision may be necessary. The students should recognize that one answer to the question is the following: The situation where the selected corridor is unfeasible because of construction or ROW costs.
	Point out that the location engineer should consult the highway planner in such a case, and not arbitrarily change to another corridor, himself.
F. Route-location report	Repeat that the preliminary engineering study usually fixes the final line and grades.
	Mention that the preliminary plan is the one presented at public hearings in which the selected location must be justified to the public.

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CONTENT OUTLINE

IV. Summary

QUESTIONS FOR REVIEW

1. What is the fundamental
   preliminary engineering
2. How wide is a corridor
3. What type of map is best
   the best scale to use?
4. What is the basis for se
   route costs?
5. How large an area should
   location study?
6. Should a field inspectio
   are started?

TEACHING POINTS AND TECHNIQUES

Explain that it is not enough to work out two or more alternates and just select one as the best. Point out that the alternate lines, grades, costs, and other elements should be included in a route-study report, similar to the planning study.

Remind the students there is no substitute for a thorough, factual engineering presentation.

State that first the DOT must be satisfied it is getting the best report, and second, the public must be satisfied. Point out that a report has no set length.

Briefly highlight the difference between highway planning and highway engineering.

Explain that a planning comparison of alternate routes really is a comparison of alternate corridors represented b single routes.

Point out that comparison of two routes (which provide approximately equal traffic service in a single corridor) is done in the engineering phase.

difference between highway planning and
?

and what defines its limits?

t suited for a route-location study? What is

electing the cross section used to determine

l be covered by photogrammetry for a route-

on be made before or after the contract plans

22257

7. What elements should be included in a route-location report?

8. How long should an effective route-study report be?

ASSIGNMENT

1. Read pages 432-437 and 443-452 in Ref. A.

2. Read pages 5-6 to 5-62 in Ref. F. Write 100-200 words explaining what you would do as a location engineer if a recommended westerly bypass went through a swamp, and the second choice, an easterly bypass, went through a housing development.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Preliminary engineering, can also be financed partly from Federal funds (but only from regular highway funds). At the option of the state, however, it can be financed completely from state funds.
	NOTE: The highway planning research funds consist of $1\frac{1}{2}\%$ of the total of Federal highway funds.
A. Determining the corridor	Explain that there is no definite width to a corridor. Mount a USGS sheet on the chalkboard and draw a line along a valley to illustrate one type of corridor.
	Mount another USGS sheet on the board showing a city, and draw a line down a street to show another type of corridor.
	Ask the students for their ideas on the criteria which determine a corridor.
	Conduct a discussion and then explain that the highway planner considers *traffic service* as the key element in defining a corridor.
	Point out that one corridor could provide vastly different traffic service from an adjacent corridor. Explain that one corridor might carry bypassable traffic around a village; another corridor might bypass the village and also serve a second community.
	Mention that the highway planner compares alternate corridors using all the factors taught in the course.
	Remind the class that the costs used in the study are limited to estimates per mile. The planner is not concerned with the cost of individual design features, except in a general way.
	Use the USGS map on which you previously drew a valley corridor and draw a second

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	line next to the first one. Explain that the alternate line is really an alternate corridor.
	Ask for comments on the second line to see if the class understands that a planner would not need to consider alternate routes in the same corridor. Planning alternate routes is part of preliminary engineering, the next phase of work after highway planning.
B. Determining the route	Tell the class that a route is mainly the line a road will follow.
	Point out that preliminary engineering does not require the same detail as *final design*. Usually route location is accurate and only minor adjustments are made when the contract plans are drawn, in the final design phase.
	Refer to the two alternate lines in the valley, (drawn on the previous map) and ask the class which one they would select.
	The discussion should bring the answer that no decision can be reached from merely looking at a map with a scale of 1" = 1 mile. Point out, also, that a USGS sheet is *not* the right tool for preliminary engineering.
	Remind the students that different types and phases of planning require different methods and procedures.
	Ask what would be the proper type of map for a *route location* study. (Answer: Photogrammetric at 1" = 200'.)
II. How to Select the Corridor	Briefly review the steps which lead to the selection of a traffic corridor. (The steps are: road inventory, traffic study, traffic analysis, traffic forecasting, and economic analysis.)
	Remind the students that a highway planning study is the basis for ex-

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	penditures and must be based on facts.
	Tell the class that a planning-study report should include all information needed to back up the choice of a particular corridor. This report is the end-product of the planning study.
III. How to Determine the Route Location	Point out that the preliminary engineering phase follows the highway planning phase.
	State that the route-location study is part of the preliminary engineering phase. In this study, the route is determined within the traffic corridor defined by the highway planning study.
	Mention that the geometrics of the route are fixed by the traffic forecast.
A. Review of the route-study	Ask the students why the location engineer should review the route-study report.
	Indicate that it is always helpful to know the background of the problem. Mention in particular that a knowledge of the traffic, the economics, and the land-use could help the designer when he has two apparently equal routes to choose between.
	Remind the class that the designer should not be required to repeat any of the highway planner's work. Unless the report is well prepared, however, there will be much needless investigation of such factors as location and traffic for proposed interchanges.
	Emphasize that a route-location study is basically a straightforward problem in engineering design. Point out, however, that this is true only if the designer can limit his study to the selected corridor, and also has all the necessary data.

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Lesson 11
Route Location

REFERENCES CITED IN THIS LESSON

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To explain the basic differences between highway planning and preliminary engineering, as they affect route location
2. To review the principal elements of route location in small cities, as for a village bypass

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Differences Between Highway Planning and *Preliminary Engineering*	State that it is important to know the difference between highway planning and *preliminary engineering*, especially for route location. Ask the students to explain the difference to determine if they understand the principle of lowest level of required effort. If proper answers are not given, explain that the highway planner will not be concerned with line, grade, drainage, and other design details. He is concerned only with determining a *corridor* or general route location. Point out that another difference between highway planning and preliminary engineering is in the method of financing. Highway planning studies are financed partly from Federal Highway Planning Research (HPR) funds and partly from state funds. (The amounts from each are in the ratio of about 2 to 1.)

MICROCOPY RESOLUTION
NATIONAL BUREAU OF STAN

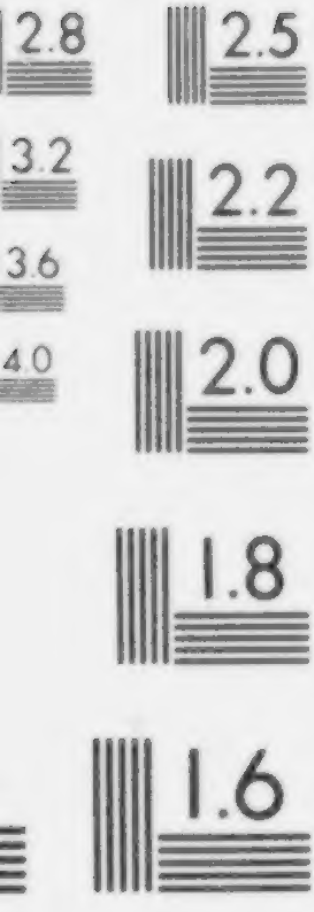

TEST CHART
NDARDS-1963-A

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
II. The DOT Safety Crusade	Relate to the students that the DOT is conducting a *safety crusade*. The object of this campaign is to reduce highway accidents and deaths. On the chalkboard write three headings: Driver, Vehicle, Road. Ask each student in turn to write weights for each, reflecting safety importance, and adding up to 100 percent. Conduct a class discussion on the safety poll. Ask for suggestions on how to achieve safety improvements on the state highway system. Write suggestions on the chalkboard for reference during this lesson.
A. Updating safety standards	Read excerpts from Refs. AA, BB, and CC. These documents will acquaint the students with the nature of the *safety standards* revisions. Point out that the intent of the revised standards is to permit *safe recovery* when a vehicle is out of control. State that there are numerous causes of vehicle accidents. Two causes are driver error and machine failure. Considering only these factors we must make highways as safe as possible. Explain that safety considerations take precedence over the concept of beautification. For example, trees are potential hazards. Highway beauty can be attained but plantings must be at safe clearances. Tell the class that 3114 persons were killed on highways in New York State in 1968 and 355,799 were injured. These drastic figures emphasize that highway engineers have an obligation to the public. We must provide the driver every possible highway safety feature. In highway planning nothing has a higher priority than the safety program.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Review the students' suggestions for safety improvements previously written on the chalkboard. Compare the suggestions with the points contained in Ref. CC. Ask for additional items to add to standards revision.
B. Spot improvements of unsafe conditions	State that the safety improvements mentioned above are limited to some of the problem areas on the State highway system. Point out that there are many dangerous conditions which can be corrected with minor effort. This type of effort falls into the category of *spot improvement*. Safety improvements under this category can be accomplished without resorting to extensive programs. Write on the chalkboard the 14 types of improvements listed in Ref. DD. Ask each student to comment on the relative hazard priority of each improvement. Compare comments to determine the extent of agreement on highway hazards. Explain that priorities have not been established for the 14 types of improvements. Sufficient data is not available to correlate Federal and State highway system deficiencies.
III. Standard Safety Measures	Inform the students that experience has brought establishment of a set of standard safety measures. For example the DOT *pavement markings* and other driver aids are parts of the standard measures.
A. Road markings	Striping and other road markings are simple and effective means for safety control. Ask for comments on the use of *yellow striping* to designate "no passing." Point out that the traditional double lines, broken lines, and combination of broken and solid lines are still

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	standard. Explain further that the yellow line, used to denote a barrier to passing, alerts a driver immediately to a dangerous passing situation. Ask for comments on the practice in some states of also posting "No Passing" signs at the beginning of each restricted section. Poll the students to determine whether the class would recommend that this practice be followed by the DOT. Point out that *edge striping* is just as important as centerline or lane striping. This practice helps drivers at night, and during rain or fog. Ask the students what they consider to be a safe sight distance for passing. Inform the students that a distance of 1500 feet is desirable without striping, and 600-800 feet is acceptable with a striped road. Tell the class that pavement markings are detailed in Ref. W. This Manual is based on national standards, developed through agreement among all the states. Inform the students that two important fields in highway planning are *traffic* and *safety*. Ref. W is an invaluable aid for students interested in these fields as careers.
B. Signs for safety	State that the proper selection and installation of signs is a recognized safety measure. Ask the class if they know the types of signs by function. They are: a. Regulatory--used to control speed for stops and traffic movement b. Warning--for approaching curves, intersections, and impending hazards c. Information--used to designate

F. The Receptionist Area

1. Order and attractiveness
2. Reading materials
3. Cleaning services

G. Managing Appointments and Appointment Record-Keeping

1. Maintaining desk calendars
2. Caller's register
3. Updating card file of visitors
4. Planning meetings and appointments
5. Easing employer's burden

Supplemental Teaching Aids:

The telephone company will often provide resource people as well as free materials for this unit.

Two very good resource books are Clerical Office Practice by Agnew and Meehan, South-Western, 1961 and General Office Practice by Archer, Brecker and Frakes, McGraw-Hill, New York, 1963.

The telephone company utilizes teletrainer equipment which is accompanied by scripts which are quite useful.

Training Time 15-25 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	route numbers, identify towns, and provide other data
	Explain that sign standards for size, shape, color, reflection, etc., are the result of years of development. These features, which are nationally standardized, assist the highway user as he travels throughout the country.
	State that drivers must be alerted at decision points on highways. These points are at intersections, interchanges and other critical points. We must alert drivers to such factors as speed changes, lane changes, and other maneuvers. Every indecision on the part of a driver could cause an accident.
	Ask the students for their views on color coding in complex signing areas. An example of such an area includes intersections of 5 or 6 numbered routes within a short distance.
	Draw on the chalkboard a typical complex of intersections and numbered routes. Illustrate how color coding could help a driver trace a specific route through a maze of route numbers and turns.
	Tell the students that this concept is similar to the trail blazer idea leading to the toll roads such as the Thruway. Color coding may be a standard practice in the future.
C. Traffic signals and devices	Explain that pavement markings and signs are only part of the program for highway safety. *Signals* represent an equally important element for safe traffic control.
	Ask each student to list the different types of signals on a sheet of paper. Write answers on the chalkboard. Fill in any missing types so that the full family of devices will be listed on the board. These are:

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	a. Fixed-time (preset time) b. Semi-actuated c. Fully actuated d. Progressive
	Point out that there are many devices for detecting traffic, such as radar, ultrasonic, loops, infrared, electric eye, treadles, etc. These devices send impulses to controllers which regulate traffic safety.
	State that *controllers* can be operated by radio, electronically from a computer, by programming a master controller, or by other means.
	Explain that signal installations have become very sophisticated to keep up with increasing traffic demands. Each student can strengthen his technical knowledge by studying various books on traffic signals and devices.
IV. Summary	Repeat the 1968 accident statistics for New York State--3114 killed, 355,799 injured.
	Repeat that safety is the concern of every branch of the DOT and of each student.
	State that the DOT can do nothing about improving the driver or the vehicle. But every effort can be made to provide safer highways.
	Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. What critical condition has stimulated the intensive campaign for highway safety?

2. What is being done about safety on the national level? On the State level?

3. What changes in standards is the DOT making to provide safer highways?

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4. What is the most desirable type of spot improvement to make from the viewpoint of accident reduction?

5. What are the principal traffic control devices?

6. What is color coding?

7. What are the principal types of traffic signals, by function?

8. What determines which type of signal should be used for a specific situation?

ASSIGNMENT

1. Read pages 248, 281, and 282 in Ref. A.

2. Read Chapter 620 in Ref. C.

3. Read section 402 in Ref. E.

4. Read pages 22-5, 22-41, and 22-42 in Ref. F. Write 100 to 200 words stating what a highway designer can do to provide safer highways.

5. Read Chapter 1, Introduction, and Chapters 2, 3, 4, 10, and 20 in Ref. I.

6. Read the article "Monitoring Traffic Speed and Volume," in Ref. N.

7. Read pages 82-88 in Ref. T.

Lesson 13
Highway Law

REFERENCES CITED IN THIS LESSON

New York Highway Law. Sections 3, 10, 30, 340, 341, 343 and 349C, D, E, and F. (Referred to in this unit as "Ref. C")

United States Federal Aid Highway Act of 1962, Public law 87-866. Section 134. (Referred to in this unit as "Ref. D")

United States Highway Safety Act of 1966, Public law 89-564. Section 402. (Referred to in this unit as "Ref. E")

OBJECTIVES

1. To acquaint the students with the New York State laws and with other State and Federal laws about highways
2. To show how a knowledge of these laws will help employees carry out the functions of the Department of Transportation

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. The New York State Highway Law	Tell the class that many of the laws passed each year by the legislature apply to the State highways.
A. DOT created by law	Explain that the *Department of Transportation* was created by an act of the legislature and operates under authority granted by law. Remind the class that the functions of the former Department of Public Works have been transferred to the new Department of Transportation. All laws previously relating to the DPW now apply to the DOT.
B. Knowledge of law needed by DOT employees	Explain that the Department of Transportation has a *legal staff* to handle all matters pertaining to the law. A brief introduction to highway laws and the lawmaking process will be beneficial to the student.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Reviewed by department	Tell the class that all local bills are referred to the appropriate State department for review. Explain that the Governor usually relies on the advice of his cabinet members when acting on approved bills.
2. Steps in review	Write on the chalkboard the steps taken by the Department of Transportation in reviewing a local bill. These are: 1. The DOT receives the bill from the Governor's Counsel. 2. DOT staff elements review the bill. This usually includes the following elements: a. Chief engineer b. Deputy chiefs c. Operation and Maintenance unit d. ROW Unit e. Planning and Programming group f. Other elements 3. The DOT Counsel together with the rest of the DOT staff makes one set of recommendations. 4. The DOT sends the recommendations to the Governor's Counsel.
III. Details of the Highway Law	Write on the chalkboard the title of the articles (I thru XII-B) in the highway law which affect the day-to-day workings of the DOT. Briefly explain each, to show the class how the Department gets its authority to design, construct, and maintain highways and bridges.
A. Court interpretations sometimes needed	Point out that most laws are written in general language. Interpretations by the courts are sometimes necessary to clarify particular questions. Explain that the intent of the laws is not a matter for engineers to decide. This is done by the DOT Counsel.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
II. The Lawmaking Process	Inform the class that there is a formal procedure for changing the laws of the State. Point out that sometimes the legislative process is slow and combersome. Laws are not passed in haste because the *health, safety, and welfare* of the public are at stake.
A. Department of Transportation bills	Explain that the basic highway law of New York has been comulatively enacted over many years. This process started when New York State first recognized the need for special highway laws. As progress in transportation is made and problems arise, we must also adjust the laws.
1. Reasons for changes in laws	Ask the students if they can state the legal reasons for changes in the laws. The class should understand that new locations, arterial route revisions, and many other changes require *special legislation*.
2. Early steps for Department bill	Inform the students that all State department heads are members of the Governor's cabinet. Therefore, any department bill is a *Governor's bill*. The early steps for getting a bill passed are: a. Drafting of a bill by the DOT b. Submitting of bill to Governor's office for review and approval by Budget Bureau and Governor's Counsel c. Introduction of bill in legislature as a Governor's bill
B. Local bills	Point out that many senators and assemblymen introduce bills relating to State highways. These are often introduced on behalf of some local group with a special interest.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Some of these are: property taking, quit-claiming, replacement in kind, system mileage, legal limitations, archeological and historical salvage, flight-path clearance, air and water pollution, and air rights.
2. Knowledge of law needed by students, too	Remind the class that they are not lawyers and need not try to do the work of lawyers. But a good knowledge of highway law will promote better public relations and help protect both State and private property.
	Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. What is a Department bill and how is it introduced in the legislature?
2. Who reviews a local bill?
3. What is the basic difference between Sections 340 and 341 of the Highway Law?
4. If a reconstruction contract includes 2.0 miles of new location broken into three pieces of different lengths, what procedures are required to authorize it?
5. By what authority does the DOT take property for road construction?
6. Who is responsible for the State highway safety program?
7. Who must approve the design of an arterial highway in Yonkers? In Buffalo? In Glens Falls?
8. Of what use is knowledge of the highway law to a senior engineering technician in the Soils Lab?

ASSIGNMENT

1. Read Articles I-IV in Ref. C. Write 100 to 200 words expressing your opinion of how the Highway Law should be recodified to simply it.

Lesson 14
Highway Finance

REFERENCES CITED IN THIS LESSON

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

National Highway Users' Conference. Federal aid for highways; revised edition. The Conference, Washington, D.C. 1959. Includes a supplement dated 1961. (Referred to in this unit as "Ref. B")

Traffic Quarterly. The Eno Foundation for Traffic Control, Saugatuck, Conn. (Referred to in this unit as "Ref. N")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To acquaint the class with various methods of financing highway construction
2. To review current highway financing practices in New York State
3. To show how a knowledge of financing will help the students in their jobs as planners or engineers

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Philosophy of Highway Financing	Remind the students that the State of New York has an extensive highway program estimated to cost many millions of dollars. Tell the students that there are several schools of thought about the proper way to finance highway construction. Basically, there are two concepts that predominate in financing.
A. Pay as you go	Ask the class for opinions on the concept of building highways that can be paid for from current revenues. Point out that this method would relieve the State of long-term debt but would result in fewer miles of highways being built annually. We must realize that ready cash is available only in limited amounts.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Emphasize that in making financing decisions, as in engineering decisions, it is necessary to have all the facts before forming judgments.
II. Methods of Financing New York State Highways	Repeat that there are many methods of raising money to construct highways and that there is no one method which is superior to others. Remind the students that finance problems are like design problems and the solutions must be tailor-made to fit the needs of the particular government agency involved.
A. Financing for free (non-toll) roads	Ask the students if they know whether all roads in New York State are *free roads* and list on the chalkboard the roads that the students say are not free. Assuming that the only toll road cited is the Thruway, ask for comments on the various toll bridges, tunnels and highways such as the Southern State Parkway and Whiteface Mountain Road. Determine from the comments if the class considers these roads as toll roads, when the only access to a portion is through a toll facility. Point out that a road is considered a free road up to the point of the last free access. Explain that there are numerous sources of finance for free roads.
1. Gas tax revenue	Elicit from the class the amount of gas tax charged by New York State and by the Federal government. Tell the students that some states earmark gas tax revenues for highways only, but in New York State the money goes to the general fund. Mention that in New York State the

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UNIT VI (14.0406-06)

SOURCES OF INFORMATION

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate her knowledge of information sources by compiling a list of information to meet specifications designated by the instructor.

Unit Outlines:

A. Reference Books as a Tool of the Office Worker

1. Importance of accurate business information
2. Kinds of information needed
3. Necessity of obtaining information quickly
4. Necessity for initiative in finding information

B. Reference Books of the Office Worker

1. Dictionaries
2. Reference manual for stenographers and typists
3. English grammar and style books
4. Directories
5. Thesaurus

C. Other Sources of Factual Information

Supplemental Teaching Aids:

The most obvious resource person is of course the librarian. Also available is the Gregg Secretarial Record #6, Set #2 Finding Needed Information. The film "Look It Up-Dictionary Habits" (11 min.) is available from Cornet Instructional Films.

Training Time 3-5 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	general fund provides for highways *and* other needs.
2. Motor vehicle fees	Point out that vehicle registration fees and operator license fees yield additional revenue which goes to the general fund. Some states also earmark these funds only for highways.
3. Bond issues	Refer to the earlier discussion of the philosophy of financing and tell the class that New York State has had numerous bond issues for highway financing. Mention that highway bond money can be spent on highways only. Ask for comments on the difference between crediting the general fund with user taxes and diverting special purpose funds which cannot be used for general purposes. Explain that a bond issue for any special purpose is like a trust fund and cannot be diverted.
4. Sales tax and income tax	Tell the students that the State sales tax and income tax also go to the general fund. Therefore, in one sense these taxes are another method of financing highway construction.
B. Financing for toll roads	Ask the class why toll roads are necessary and what are the alternatives to charging tolls on roads. Point out that in principle there should be no toll roads, but in practice we have the choice between charging tolls or having no road at all for many years. Remind the students that motorists who pay tolls have made a decision that their time plus the lower exposure to accidents are worth the toll they pay.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Interstate roads	Ask the class if any toll roads can be on the Interstate System. Mount a highway condition map on the chalkboard and trace Interstate 87 to show how part is free and part is toll. Repeat for Interstate 90 in the Albany area, to show that part of the Berkshire Thruway is on the Interstate System and part is not. Explain that the Federal government is inconsistent in its toll road policy because there is not enough money in the highway trust fund to buy up the toll bonds and make these sections free. In New York State alone it would take a billion dollars to pay for the Thruway. Ask the students for comments on what should be done about the toll parts of the Interstate System. Tell the class that when its toll bonds have been retired, any toll road can become free. State that the legislation which created the toll authority usually spelled out what would happen to the toll status after the bonds were paid off.
2. Other types of roads	Mention again that all toll roads are not on the Interstate System. Refer to the earlier part of the lesson and remind the students that there are other toll facilities in New York State in addition to the Thruway. Refer to the condition map again and review the portions of the Thruway that are not classified as being in the Interstate System. Ask the class to discuss Federal-aid financing of interstate roads. Trace the free parts of the Interstate 87 and Interstate 90 on the map and mention

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	that the State received Federal financing for these portions.
	Explain that the Federal government would not approve the Southern Tier Expressway as an interstate highway because it was planned as a parallel route to the Thruway. The 90-percent Federal support money can be spent on only one of two parallel roads.
	Remind the class that no support money was provided for the Thruway, either. New York State has been trying for years to recover the money spent on this road from the Federal government.
III. Refunds and Assistance	Ask the students if all the gas tax and other user funds go to the general fund or if any is diverted.
	Explain that in New York State there is an extensive program of state aid for highways. Cities, counties, and towns receive financial assistance to help pay for the cost of local highway programs.
	Point out that the arterial program is basically a local financial aid program. ROW costs are paid in full by the State; construction costs are provided in equal amounts by State and Federal governments.
IV. DOT 1968 Program	Ask the class to estimate how much the Department spent in 1968 on highways and write the estimates on the chalkboard.
	Tell the class that the 1968 Annual Report shows $450 million for construction and $64 million for maintenance
	Point out that the construction work included both new highways and reconstruction. The funds came from three sources: 1. Bond issue money, balance from earlier years

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

Briefly mention the scope of the next lesson.

QUESTIONS FOR REVIEW

1. What are the usual methods of financing governmental spending?
2. What is meant by diversion?
3. What determines the limits of a toll road?
4. What highway user taxes are levied in New York State?
5. If a highway bond issue is passed by the Legislature and approved at a referendum, what percentage of the money can be used for highway maintenance?
6. What percentage of an interstate highway system is allowed to be toll road?
7. New York City has a city tax on gasoline. How do other cities and counties obtain money for highways?
8. Of what value is a knowledge of highway financing to a designer?

ASSIGNMENT

1. Read pages 393-403 in Reference A.
2. Read pages 9-14 in Reference B.
3. Read pages 1-5 thru 1-56 in Reference F. Write 100 to 200 words giving your views on allocating road user funds such as gas tax.
4. Read the article "Financing Highways Now and in the Future," in the October 1956 issue of Reference N.
5. Read the article "Financing a Highway Program," in the October 1959 issue of Reference N.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2. General funds appropriations 3. Federal aid Emphasize that decisions on methods of financing are fiscal problems, not engineering problems.
V. Uses of Financing Knowledge	Explain that both planners and designers should know the financial resources of the State. Ask the class why a knowledge of financing is important. Determine if the students grasp the principle of not producing elaborate plans or designs which cannot be implemented because of funding limits. Tell the class that *stage construction* is an answer to financial limitations, and provision for future highway lanes in the median is an application. Another answer to financial limitations would be to plan a new route 100 miles in length, but to provide for building it in five sections. All of the sections would be beneficial for several years and ultimately would be connected to provide a whole new route. Tell the class that it is not good practice to plan or design against a limit of dollars, but *knowing* the limit results in *more realistic* planning and designing.
VI. Summary	A broad knowledge of highways will help the highway engineer do a better job. Highways are financed from various sources, and maximum return must be obtained for the dollar. Financial planning by Federal and State governments covers the same type of problems that an individual encounters.

Lesson 15
Introduction to Urban Transportation Planning

REFERENCES CITED IN THIS LESSON

Automobile Manufacturer's Association. Highways for the future. The Association, Detroit, Mich. 1961. (Referred to in this unit as "Ref. S")

Automobile Manufacturer's Association. Urban transportation issues and trends. The Association, Detroit, Mich. 1961. (Referred to in this unit as "Ref. Y")

Hay, W.W. Introduction to transportation engineering. New York. John Wiley. 1961. (Referred to in this unit as "Ref. A")

New York State Department of Public Works. Niagara frontier transportation study; Volumes 1 and 2. The Department, Albany, N.Y. 1964 and 1966. (Referred to in this unit as "Ref. Z")

Traffic Quarterly. The Eno Foundation for Traffic Control, Saugatuck, Conn. (Referred to in this unit as "Ref. N")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill. 1960. (Referred to in this unit as "Ref. F")

OBJECTIVES

1. To introduce the students to transportation planning for urban areas
2. To review the previous 14 lessons and offer the students a program for continuing study at home

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Evolution of Urban Transportation Planning	Tell the class that urban transportation planning developed out of the need to analyze and design the complex highways of today and tomorrow.
A. Finding minimum traveltime	Mount a city map on the chalkboard and point out that large cities have hundreds of miles of streets. On the map pick any street intersection and call it Point A. Then locate another point 4 blocks east and 4 blocks south of A; call it Point B.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Show that there are about 40 possible routes for going from Point A to Point B. Ask the students how they would select the route of minimum traveltime from these 40 choices.
B. Method of finding it 1. Manual methods not feasible	Point out that there may be literally thousands of alternate paths for travel across an entire city and it would be impossible to select minimum paths by manual means. Explain that the sheer bulk of data to be analyzed forced the development of special tools to do the job.
2. Mathematical methods developed	Tell the class that procedures have been developed for finding paths of minimum traveltime by mathematical techniques. Each subsequent transportation study improved and refined the process as better and faster computers become available.
a. Computer used	State that a typical problem might be to determine the minimum path from a point to approximately 3,000 other points. Solving problems of this kind is not feasible without a computer.
II. Mathematical Models	Tell the class that there are a number of theories about the best way to make traffic assignments in complex urban areas.
A. Terminology	Explain that no one theory has been proven superior, but it will be helpful to briefly discuss the principal techniques and to learn some of the terminology. The terms used include the following: 1. Node--a point designating a highway intersection or zone centroid 2. Link--a portion of a highway connecting two nodes 3. Route--a group of connected links;

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	the shortest route in time is the minimum time path. 4.Tree--all the minimum time paths from one node to all other nodes.
B. Gravity model	Point out that as far back as the 1920's, it was reasoned that a model from Newton's law of gravity could be used for determining intercity travel flows. Explain that research and study is still continuing to improve the accuracy of the gravity model. The original Newton formula has been modified to account for the purpose of each trip and other factors which influence travel patterns.
C. Intervening opportunities model	Tell the students that the *intervening opportunities model* is based on the principle that people tend to travel minimum time paths. This mathematical model states: the probability of a trip originating in one zone finding a destination in another zone is proportional to the possible trip destinations in the other zone. Further, the proportion takes into account the number of trip origins which have not found a closer destination. Point out that this model is different from the gravity model because it is based on distribution of trips made to near or far destinations of similar characteristics, regardless of the size of the zones (mass). The gravity model, however, is not based on attraction of masses proportional to size and distance.
D. Competing opportunities model	Explain that the *competing opportunities model* is not based on either the relative mass or relative distance of traffic zones, but on relative traveltime.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Tell the class that this model states: the probability of a trip that originates in one zone, finding a destination in another zone is the ratio of the trip destinations in the other zone to the total trip destinations between the zone of origin and the same time band which contains the zone of destination.
E. Special purpose models	State that some studies go into greater depth because of special considerations such as mass transit. Mention that models have been developed to estimate what percentage of trips will use private transportation and what percentage will use public transit. Inform the group that models have also been constructed to allocate trips solely by *land use* (allocation of trip ends). Summarize by pointing out that all the models already developed and to be developed are special tools to quickly process huge quantities of data.
III. Fundamentals of Urban Transportation Planning	Mention that the basic principles of urban transportation planning were learned earlier in this unit. Point out that the two basic principles for small rural areas also apply to urban transportation planning: 1. Is a new road necessary 2. Where should a new road be located? Point out that road requirements for cities are very complicated and, therefore, an urban planning study requires more special tools.
A. Approaches	Ask the class to comment on two different schemes for a large city traffic study: a *cordon* system and a *screen-line* system.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. *Cordon* system	Sketch a grid system of streets on the chalkboard. Show outer and inner *cordons* of O & D stations, one around the city limits and the other around the downtown area.
2. *Screen-line* system	Now sketch a number of *screen-lines* through the city. State that an analysis would be almost impossible for either system. Explain that even by ignoring the complete tie-up of traffic that would result from either the downtown cordon or the downtown screen-lines, the O & D patterns are too complicated to analyze. Show by a few desire lines the "spider web" that would result from the many criss-crossing traffic movements in a city.
3. *Land use*	Tell the class that the basic principle in urban transportation planning is to relate travel to *land use*. To obtain discussion on this concept, ask the class why this relationship is used. Explain that with large concentrations of people and large traffic generators (such as factories, office buildings, and shopping centers) it has been found that travel can be related mathematically to land use. This relationship holds because unusual individual trips tend to average out when large amounts of traffic are involved.
B. Techniques in the land-use system	Tell the students that trips are related to land-use by measuring the types of trips and the types of land-use and then correlating them. For example, trips are made for work, school, shopping, and social-recreational uses. Land use in a business district is categorized as retail

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	service, office, wholesale, etc.
1. Trip generation	Explain that internal urban trips are determined from home-interview surveys or similar surveys. These give the pattern of travel by time of day, purpose of trip, income group, and other characteristics. Further explain that an external cordon is usually established to get the external traffic into or through a city. Point out that this lesson is a *brief* introduction only and much has been omitted, such as truck-taxi surveys, and bus routes.
2. Trip distribution	Tell the class that the first step in analysis is to find the number of trips per unit of land for each type of land use. The next step is to distribute the trips among the zones which make up the area. Remind the class that what they previously learned of the different mathematical models is used in the distributing of trips among zones.
3. Traffic assignment	Explain that the trips are assigned by computer to the existing street network. Any new facilities needed to relieve congestion are then determined. Point out that this procedure makes allowance for future trips (based on prediction of future land use). Also adjustments are made for trip generation factors. These adjustments are made to account for increased car usage, income group, etc.
C. The plan	Mention that the complex urban planning differs in several respects from the simpler rural planning. Explain the need to consider other modes of travel and alternative land uses.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	Tell the class that several dozen plans may be considered in an urban study. Each of these plans is compared by computer to each of the other plans in the traffic assignment program. This is done to get the most satisfactory total transportation plan for all modes of travel.
	Explain to the students that the selection of new routes in urban planning is more subjective than in rural planning. It is more strongly influenced by considerations of socio-economic values, boundaries of school and voting districts, and other elements.
	State that computers are used to analyze and process mountains of data but that professional judgment is still required, as in any other engineering work.
IV. Brief Course Review	Remind the class that the 15 lessons in this course have given them only the beginning of a knowledge of the DOT processes.
	Tell the students that in all their future work they must remember that the mission of the Department is to provide transportation facilities that will give the best and safest service for the least cost.
	Read the titles of Lessons 2-15, and give a brief description of each: 2. Need for a new road and the best location 3. Highway systems and responsible agencies 4. Road inventory and field scoring 5. The correct mapping tool for the job 6. Traffic volumes and destinations 7. Analysis and movement of traffic 8. Predicting future traffic 9. The cheaper and better route

VEO #14.0302
DOT #206.388

TRAINING COURSE FOR

FILE CLERKS

The material in this guide is presented in the form of suggestions. Every student participating in this program will be different in regard to education, experience, and ability. The instructor must, therefore, adjust and adapt the suggestions in this guide to the needs of individual students.

The first step in insuring this adjustment is to secure as much information as possible about each new student. This can be accomplished through study of the pre-enrollment information gathered by the Center counselors. The second step is to keep up to date on the progress of each student through the regular use of the information prepared by Individual Program Control (IPC). With this information on hand the instructor can effectively adapt specific objectives, teaching methods, and time alloted to each aspect of the training, directly to the student's needs.

This guide will aid the instructor in accomplishing part of his job. It will provide performance objectives, suggest time allotments, unit outlines, and supplemental teaching aids. Only the instructor, however, can combine these factors with a knowledge of each individual student.

Course Objectives:

The file clerk program at Gila River Career Center is designed to:

1. develop in the student an awareness of the importance of office work and of the career opportunities which it offers.

2. develop an understanding of the place and purpose of the office in general and the file clerk in particular in the typical business organization.

3. develop a job-centered approach to businesslike work habits and attitudes and effective human relations.

4. prepare the student to perform the fundamental tasks commonly required of all beginning office workers.

5. prepare the student to perform the technical tasks commonly expected of the file clerk.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	10. Designing the features for service 11. Establishing the line and grade for service and economy 12. Safety for lives and property 13. Laws and authority to permit highway development 14. Sources of funding and funding problems 15. Complex highways require special tools
V. Summary	Tell the students that if they are especially interested in any topic in the course they will profit from reading more than the assigned references. Offer the students the full reading list and encourage them to develop the habit of reading more fully in technical highway literature. Point out that modern society demands that professional people be articulate in speech and fluent in writing. Remind the class that in professional work they must be able to prove to others that they have sound professional judgment. The principles learned in this course are applicable to many situations. Ask for comments on the scope and content of the course.

QUESTIONS FOR REVIEW

1. Why is it necessary to use computers for transportation planning studies in urban areas?

2. What general mathematical models are most commonly used in these studies?

3. What is the basic principle underlying today's urban transportation planning?

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Ref. REFERENCES FOR UNIT IV (Continued)

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CC New York State Department of Transportation. Deputy Chief Engineer General Letter 67-55, dated June 8, 1967. The Department, Albany, New York.

DD United States Government, Bureau of Public Roads. Bureau of Public Roads Policy and Procedure Memorandum 21-16, Transmittal 44, dated August 30, 1965. The Bureau, Washington, D.C.

TEACHING HINTS FOR THE INSTRUCTOR

Elements of Highway Planning is one of a series of units (or courses) which provide fundamental information to prepare your students for advanced work. Follow the content as closely as possible. Keep in mind that topics other than those in this unit are covered in other units of the Highway Technicians Program. The units are planned to be given in numerical order.

Plan each lesson before you present it to your class. You will need to plan classwork, discussion, and review. The left-hand column of each lesson contains suggested topics to be covered. The right-hand column gives accepted techniques, methods, and tips, as well as related information which should help you achieve effective teaching. You should review each lesson before class and arrange for needed visual aids and reference material.

Use the chalkboard, overhead projector, charts, diagrams, and other visual aids to clarify the material being presented. Duplicate for student use any important reference material. Give typical job situations as illustrations whenever possible.

Give a summary of key points at the end of each lesson. Also refer to past and future lessons and remind the students of needed references and other materials for the next lesson. Emphasize to the students that answers to the questions for each lesson provide a good summary of the important points.

As you use this course guide, you may have ideas for improving its content. Address any suggestions you wish to make to the New York State Education Department, Bureau of Continuing Education Curriculum Development, Albany, New York 12224.

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Highway Technicians Program. Unit V, Soils and Drainage. Teacher's Guide.

New York State Education Dept., Albany. Bureau of Continuing Education Curriculum Services.
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ABSTRACT - Developed by the New York Department of Education and the State Department of Public Works, this teacher's guide is for instructor use in teaching soils and drainage information to help relieve the shortage of highway technicians. The highway technician program is intended to help provide additional technicians and engineers by training personnel employed in lower-level technician jobs. The contents of this document, illustrated with line drawings, include 11 lessons, among which are: (1) soil and rock deposits in New York State, (2) soil description, classification, explorations, and water, (3) engineering properties of soils, and (4) highway drainage. Each lesson, designed for 2 hours and 40 minutes, contains cited references, objectives, a content outline, an assignment, and some contain questions for review. A glossary of symbols, a three part final examination, and a bibliography are included. Related documents are available as VT 013 359, VT 013 360, and VT 013 062 (all in this issue). (GEB)

VT 013 361

ED0 56238

program for
highway
technicians

teacher's guide

Unit V
Soils and Drainage

THE UNIVERSITY OF THE STATE OF NEW YORK
The State Education Department
Bureau of Continuing Education
Curriculum Development
Albany, New York 12224, 1967

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TEACHER'S GUIDE

UNIT V

SOILS AND DRAINAGE

HIGHWAY TECHNICIANS PROGRAM

1967

THE UNIVERSITY OF THE STATE OF NEW YORK
The State Education Department
Bureau of Continuing Education Curriculum Development
Albany, New York 12224

22296

4. How is trip generation determined?

5. How is trip distribution performed?

6. How is traffic assigned?

7. How many alternative plans are commonly evaluated in an urban study?

ASSIGNMENT

1. Read pages 3-15, 407-430, and 471-484 in Ref. A.

2. Read Chapter 4 in Ref. F.

3. Read the following articles in Ref. N: "Land Use and Transportation," April 1965; "Composite Networks--A New Planning and Testing Tool," January 1966; "Planning Transportation Facilities To Guide Urban Development," April 1966.

4. Read Ref. S.

5. Read Ref. Y.

6. Read Ref. Z. Write 100-200 words giving your opinion of the model concept versus the old-fashioned *judgment concept* for developing an urban transportation plan.

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FOREWORD

This Teacher's Guide, Soils and Drainage, is intended to be used primarily to improve the skills and technical knowledge of certain members of the team which plans, constructs, and maintains highways.

The New York State Department of Public Works, recognizing the shortage of highway technicians, called upon the State Education Department for assistance in developing inservice training to overcome the shortage.

John L. DeLee, who is now Principal Civil Engineer in the Bureau of Highway Planning of the Department of Public Works, initiated and carried on the planning of the curriculum, aided by other personnel from the District Offices of that Department. Mr. DeLee also acted as liaison with the Bureau of Occupational Extension and Industrial Services of the State Education Department. Edward Umiker, Associate Civil Engineer in the Buffalo District Office, and Ralph Fimmano, Senior Civil Engineer in the Utica District Office, collaborated in developing topical outlines for the nine Units (or courses) in the Highway Technicians Program--five of which are now published, four yet to come.

This Guide, Unit V, was written by Lyndon H. Moore, Associate Soils Engineer in the Bureau of Soil Mechanics of the DPW, under the guidance of Berton P. Plummer, Associate in the Bureau of Occupational Extension and Industrial Services. E. Noah Gould, Associate in the Bureau of Continuing Education Curriculum Development, supervised the review and final preparation of the manuscript for publication.

To all the agencies and individuals mentioned above, this Bureau makes grateful acknowledgment for the responsibilities they so faithfully fulfilled. For permission to reproduce illustrations, thanks are also due to the New York State College of Agriculture at Cornell University for Figures 2-1 and 2-2; the National Research Council for Figures 8-7 and 8-8; and Armco Steel Corporation for Figures 7-7, 11-1(a), 11-1(b), 11-1(c), and 11-1(d).

Vivienne Anderson
Chief
Bureau of Continuing
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William E. Young
Director
Curriculum Development Center

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PREFACE

The rapid expansion of the state and federal highway building program has caused a serious shortage of qualified technicians and engineers for planning, supervision of construction, and maintenance of highways. The New York State Department of Public Works, recognizing this shortage, called upon the State Education Department to assist in planning an educational program to overcome this shortage.

These two departments together planned to develop the additional technicians and engineers by training personnel employed in the lower-level technician jobs. This Teacher's Guide and the others in the Highway Technicians Program are a product of that planning. They are published as aids to the teachers of the upgrading classes.

Local boards of education and other sponsors of adult education programs are being encouraged to offer Soils and Drainage and the other courses in this Program as part of vocational-industrial education. Besides drawing students from the Department of Public Works in the job categories mentioned above, students will also be drawn from the public works departments of counties, cities, and towns; in addition, technicians, estimators, and junior engineers employed by construction contractors will be found in these classes.

The units of the Highway Technicians Program--this being Unit V, and the latest published--have been planned for sequential offering. Sufficient subject matter has been suggested in each lesson for about 2 hours and 40 minutes of classroom instruction. The total length of the course may be adjusted to fit in with the prior experience and education of enrollees.

Units so far published in the program are:

Unit I.	Basic Mathematics Review	1961
Unit II.	Highway Drawing	1961
Unit III.	Highway Surveying	1962
Unit IV.	Preliminary Highway Planning	1962
Unit V.	Soils and Drainage	1967

Units contemplated for future publication are:

Unit VI. Highway Design and Estimating
Unit VII. Highway Construction and Inspection
Unit VIII. Highway Structures
Unit IX. Highway Maintenance

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General Occupational Education II

Robert S. Seckendorf
Assistant Commissioner for
Occupational Education

Course Outline:

The following table provides a listing of course units along with time estimates for each unit. Both sequence and estimates can be varied to meet student needs. Units are presented concurently as students achieve objectives that prepare them to move ahead.

Course Unit	Title	Hours	Code
Unit I	Occupational Orientation	5- 7	-01
Unit II	Fundamentals of Typing	70- 85	-02
Unit III	Office Equipment	10- 15	-03
Unit IV	Communications	15- 20	-04
Unit V	Financial Activities	8- 10	-08
Unit VI	Record Management	30- 40	-09
Unit VII	Sources of Information	3- 5	-05
	Total	141-182	

TO THE INSTRUCTOR

Soils and Drainage is the fifth in a series of nine courses which provide fundamental information to prepare your students for advanced work in highway planning, design, construction, and maintenance. Follow the content as closely as possible. Keep in mind that topics other than those in this unit are covered in other units of the Highway Technician Program. The units are planned to be given in numerical order as adult (or continuing) education courses.

In general, lessons in each of the units are to be given in a session of two hours and 40 minutes. You may adjust this period to fit the class level, time schedule, and classroom situation.

Lesson Format

Plan each lesson before you present it to your class. You will need to plan classwork, discussion, and review. The lefthand column of each lesson contains suggested topics to be covered. The righthand column gives accepted techniques, methods, and tips, as well as related information which should help you achieve effective teaching. Specific pages for assignments are given in each lesson. You should preview each lesson and arrange for needed visual aids and reference material.

Give a summary of key points at the end of each lesson. Also refer to past and future lessons, and remind the students of needed references and other materials.

Many of the illustrations in the text can be reproduced and distributed to the class to aid in teaching and for the future reference of the students. You can get a set of master copies for duplicating by writing to:

Director, Bureau of Soil Mechanics
New York State Department of Public Works
1220 Washington Avenue
Albany, New York 12226
Attention: Training Coordinator

The Soils Engineer in each of the State's DPW District Offices can supply you with copies of forms for gradation tests, compaction tests, drill logs, and any other reference data published by the Bureau of Soil Mechanics. You can also get soil samples for the lesson on visual identification and sieves for the lesson on soil classification from the District Soils Engineer. If he cannot supply you with any of the materials mentioned, contact the Director of the Bureau of Soil Mechanics.

A set of about 40 slides (35 mm.) has been prepared, showing many actual examples of the soils problems discussed in the course. You can get these slides on loan from the Director of the Bureau of Soil Mechanics. It is suggested that you show them after the students have covered Lesson 10.

This course contains 11 lessons. For some of the lessons you may need more than the standard session of two hours and 40 minutes. The presentation of the whole course may require up to 15 sessions. Lessons 6 and 8 are particularly long and may require two sessions each.

Selected References

A list of 13 references is given in the bibliography. The references used in each lesson are also shown on the first page of the lesson. The basic text for the course is Ref. A, B. K. Hough, Basic Soils Engineering, and you should encourage the students to buy their own copies. The book may be obtained from a book store or from

The Ronald Press Company
15 East 26th Street
New York, New York 10010.

The price of this book is $9.50 as of March 1966. A discount of 20 percent is allowed on orders of 25 or more copies. Also, the instructor may be able to obtain a free desk copy on request.

The Highway Research Board publications should be available in the library of all DPW District offices. Free copies of the drainage handbooks (Refs. L and M) may be obtained for the class by sending a request to Armco and Bethlehem Steel companies.

Examination

A final examination is provided at the end of this Guide. The questions are in the form of multiple choice, true-false, and matching questions. The correct answers given in each case, needless to say, are for the instructor only, and the spaces are to be left blank in presenting the questions to the students.

Comments Solicited

As an instructor uses this course guide, he may have ideas for improving its content. Any suggestions he wishes to make should be addressed to The New York State Education Department, Bureau of Continuing Education Curriculum Development, Albany, New York 12224.

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Lesson 1 - Introduction to the Course

REFERENCE CITED IN THIS LESSON

Hough, B. K. Basic soils engineering. New York. The Ronald Press Co. 1957. (Referred to in this unit by symbol "A")

OBJECTIVES

1. To get acquainted with class members
2. To provide a general description of the course
3. To explain the value of each phase in the training of a technician
4. To describe the basic types of soil materials and bedrock

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	* Print the name of the course and your name on the chalkboard. Give the students a brief description of your experience.
II. Purpose of Course	* Explain that the course is given to improve the knowledge of technicians in soils and drainage and to help them advance in their jobs in highway design, construction, and maintenance. * Add that material in this course will be valuable for future Department of Public Works examinations for the engineering titles.
III. Introduction of Class Members	* Have each student introduce himself to the class, volunteering information about himself, such as name, occupation, and where employed.
IV. Required Student Equipment	
A. Textbook	* Write the name of the basic textbook for the course, Ref. A., on the chalkboard. * State that it would be advisable for each student to have his own textbook since it can be used as a reference book for many years.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	soils engineer, but to give him the basic soils knowledge he will need in his future engineering career.
VII. Course Description	* Explain that 90 percent of the course will be concerned with soils, the remainder with drainage.
A. Title and brief resume of each lesson	* Explain briefly the subject material which will be covered in each of the 11 lessons of this Unit.
1. Introduction to the course	* Lesson 1 will be concerned with the study of the importance of soils engineering in highway construction and design.
2. Rock and soil deposits of New York State	* Lesson 2 will deal with the history of the deposition and formation of the rock and soils of New York State. Recognition of various types of soil deposits from land forms will be covered. This study will help to show how the soils and rock can vary on a typical highway project.
3. Index properties of soils	* In Lesson 3 the basic tests for measuring the index properties of soils will be presented. These tests are used in highway engineering to compare various soils and to predict their behavior as construction materials.
4. Soil description and classification	* In Lesson 4 the basic method used by New York State Department of Public Works for visual identification of soils will be presented, using soil samples. Some of the soils classification systems used outside of New York State will also be discussed.
5. Soil explorations	* Lesson 5 will be concerned with the methods of conducting a soil survey for a highway project. Indirect exploration methods involving geologic reports, pedology (agricultural soil maps), airphoto interpretation, and seismic investigations will be explained. Direct exploration methods, which involve making a hole in the ground by

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	various techniques, will be covered in detail. Drilling equipment should be available for class inspection and instruction.
6. Engineering properties of soils: consolidation and strength	* Lesson 6 will be primarily concerned with the engineering properties of soils. When soil is used as an embankment or as a structure foundation, it must have enough strength to support the load. Also, the amount of consolidation or settlement of the foundation soil should not adversely affect the riding qualities of the pavement. Laboratory tests and methods for analyzing settlement will be discussed. Design solutions commonly used for highway stability and settlement problems will be reviewed.
7. Soil water	* Lesson 7 will deal with the types and behavior of soil water and the influence of each type on the design, construction, and performance of highways.
8. Compaction of embankment soils	* Lesson 8 will deal with earthwork inspection as performed in the field. Discussion of the mechanics of compaction, the standard compaction test, and field inspection will be included.
9. Compaction control test, granular subbase courses, and stabilized soils	* Lesson 9 will cover a detailed description of the field compaction control test as conducted by earthwork inspectors. The purpose, use, and requirements of granular subbase courses under pavements, and the types of stabilized soils used for highway shoulders will also be discussed.
10. Influence of soil conditions in construction and design problems	* Lesson 10 will involve an analysis of earthwork design and construction problems. The soils knowledge gained in the previous sessions should help the student understand the problems and solutions.
11. Highway drainage	* Lesson 11 will cover the types of highway drainage problems. It will

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Ask students to sign a sheet of paper so that a group order may be made.
	* State that the course varies somewhat from the textbook. In the course, the soils theory is presented as concisely as possible, and emphasis is placed on demonstration of soil principles by examples of soil behavior in highway construction.
B. Looseleaf notebook	* Suggest that students keep a looseleaf notebook for course notes. The instructor may consider mimeographing sheets listing the content outline to facilitate note-taking. The course notes will be valuable for future reference.
V. Course Prerequisites	* State that the students must have some knowledge of basic mathematics, since no time will be spent in reviewing the subject. The mathematics needed includes: 1. Basic trigonometry and geometry 2. The content of Basic Mathematics, Unit I of this series
VI. Purpose of Course	* Summarize this introduction by explaining the aims of the course: 1. To develop an appreciation of the different types of soil deposits 2. To become acquainted with the details of testing necessary for construction supervision 3. To understand some of the principles that determine soil behavior 4. To develop an ability to recognize, understand, and solve the soil problems that are commonly encountered in highway design and construction * Mention that the intent of this course is not to make the student a

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	include application of the principles of hydrology to predict the frequency and intensity of runoff, and the principles of hydraulics to design drainage facilities.
12. Final examination	* At the end of the Unit is a final exam, with questions on problems a highway technician will encounter.
VIII. Importance of Soils in Highway Construction	
A. Economics	* The basic assignment of a highway engineer is to construct an adequate highway system by the most economical methods. Thus, the importance of the following:
1. Cheapest construction material	* For highway construction soil is the most common and cheapest building material available. Ninety percent of the volume of materials in a highway is earth.
2. Importance of knowledge of soils	* Explain that an understanding of the engineering properties of soils is essential for the most economic use of soils in design and construction.
3. Earthwork share of total highway costs	* State that earthwork accounts for 31 percent of all the money spent on highway construction. Large economic savings can be realized by the efficient use of soils in highway design and construction. Distribute copies of Figure 1-1 and discuss it.
B. Basic uses of soils	* Mention that in highway construction soils are used for the following purposes (Fig. 1-2): 1. In its original position, as a foundation to support embankments and structures, and to provide cut slopes 2. As a material for embankment construction 3. As a support for pavements in cuts and fills

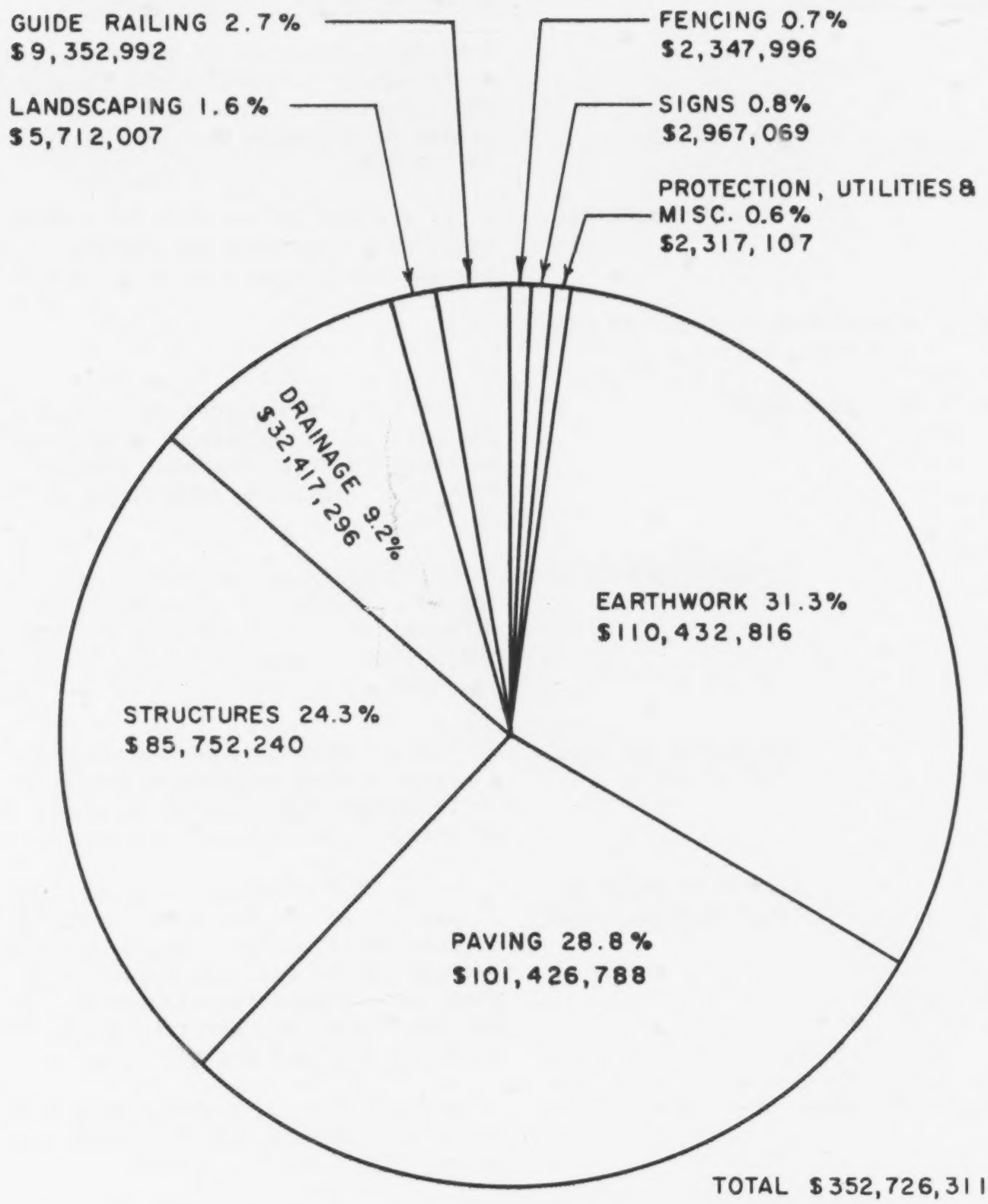

FIGURE 1-1
DISTRIBUTION OF HIGHWAY CONSTRUCTION COSTS
1965

UNIT I (14.0302-01)

OCCUPATIONAL ORIENTATION

Performance Objectives:

Upon completion of this unit the student will be able to describe orally the general purpose and organization of business. She will be able, as determined by instructor observation, to demonstrate good interpersonal relations with other class members and good organization of a work station.

The student will be able to demonstrate in a role playing, or other simulated situation, the proper dress and grooming for an office worker and correct techniques and good manners. She will be able to score 80% on an objective test covering the responsibilities of a receptionist.

Unit Outline:

A. Review of Modern Business Enterprise

1. Methods of organization
2. Purposes of business

B. Types of Offices and Opportunities for Office Workers

C. What Business Expects of Office Workers

1. General expectations
2. Appropriate attire
3. Posture and figure control
4. Complection and health
5. Personal hygiene

D. Office Techniques of Etiquette

1. Basic good manners
2. Application of social graces to office situations
3. Some special problems that occur

E. Interpersonal Relations

1. Role of motive and emotion
2. The office worker's role in business-human relations activities

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CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

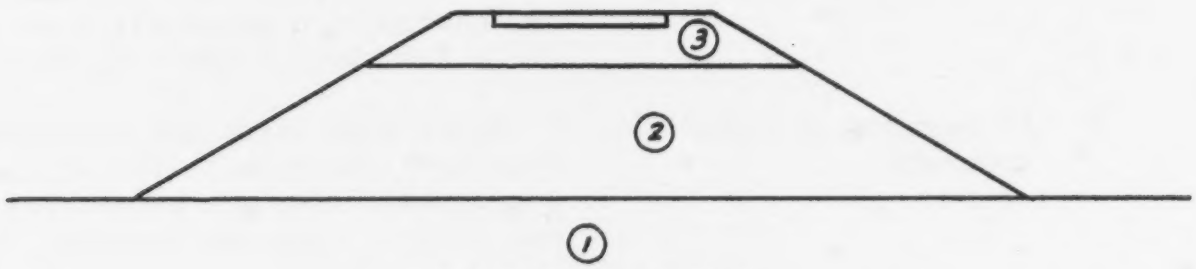

Embankment Section

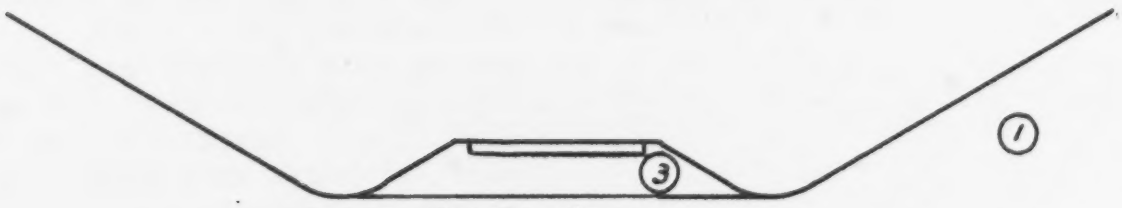

Cut Section

① Foundation to support embankments, cut slopes and structures
② Embankment material
③ Support for pavements

FIGURE 1-2
USES OF SOILS IN HIGHWAY ENGINEERING

C. Basic requirements of soils as construction material

* Explain that to be used in these ways soil must meet the following requirements:

1. It must have enough strength to support the applied loads of embankments, structures, and traffic under all climatic conditions without shear failure.
2. It must be able to support the above loads without undergoing objectionable deformation or settlement.

D. Treatment of soils

* Mention that the soils may need treatment during construction to improve their strength and settlement properties for satisfactory performance as foundation and embankment material. Knowledge of this treatment is important in highway engineering.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
IX. Comparison of Soils to Other Construction Materials	* Explain that analysis of soil is even more complex than the analysis of construction materials like concrete and steel. (Ref. A, Chap. 1)
A. Properties of steel and concrete	* State that steel and concrete are relatively uniform solids which have predictable strength properties within the elastic range of loading.
1. Control of strength	* The strength may be "ordered" in the manufacture of steel and in the making of a concrete mix. This strength will be constant under all climatic conditions. Structures can then be built of these materials with confidence in their strength.
B. Properties of soils	* Explain that soils are composed of a mixture of three dissimilar materials: soil, water, and air. The properties will be influenced by the action of each of these materials in the soil mass.
1. Factors influencing strength	* Some of the factors influencing the strength of soil are: 1. Size, shape, and distribution of soil particles 2. Degree of packing of soil particles 3. Amount of water in soil 4. Climatic variations
C. Understanding the properties of soils	* Emphasize that it is important to understand the fundamental properties of soils to use them as construction material. The fundamentals are not the same as for steel and concrete.
X. The Growth of Soils Engineering	* Soils engineering is a phase or subdivision of structural engineering. It deals with soils as foundation materials upon which structures rest and with soils as structural materials. * From information previously covered some of the important differences between conventional structural engineering

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	and soils engineering are apparent.
A. History	* Man's earliest attempts at construction probably involved soil. As civilization developed through many centuries, man learned by trial and error about soil as foundation material.
1. Recent and current	* Since World War I much greater understanding of the behavior of soil has been achieved by applying the principles of physics, mechanics, hydraulics, strength of materials, and structural engineering. This approach to analyzing soils problems is called "soil mechanics."
B. Limitations of theoretical approach	* Because soil is very complex an entirely theoretical solution of most soil problems is not practical.
C. Practical approach to soils problems	* The most practical solution to soil problems can be reached by a combination of the following sources of information:
1. Experience	* Experience was obtained by trial and error in the past; this developed into the empirical or "rule of thumb" procedures of today. The weakness of this type of experience is that it does not recognize differences in the engineering properties of soils. What works well at one location may not succeed with the type of soil at another location.
2. Laboratory testing	* Information on the properties of soils can be obtained by field explorations and laboratory tests.
3. Scientific principles	* Scientific principles from various fields of engineering and science are used to explain or predict the behavior of soils under various conditions.
XI. Basic Types of Soil Material	
A. Definition of soil	* Define soil as sediment and unconsolidated mineral material which have

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

been produced by physical disintegration and chemical decomposition of rocks. It includes the total amounts of air, water, organic material, and other substances that may be mixed with the mineral material.

B. Classification of particle size

* Point out that the most useful method of classifying soils is by particle size. Natural soil deposits usually contain mixtures of these materials. Soils may be classified as follows:

SOIL	UPPER SIZE LIMIT	LOWER SIZE LIMIT
Boulders	None	12 inches
Cobbles	12 inches	4 inches
Gravel	4 inches	1/10 inch
Sand	1/10 inch	3/1000 inch
Silt	3/1000 inch	1/12,000 inch
Clay	1/12,000 inch	None

1. Class demonstration

* Show the class samples of various soil sizes so they can retain mental pictures of them. Mention that soils are measured by the smallest dimension. Natural soils are usually mixtures of two or more soil sizes.

2. Identification of silt and clay

* Indicate that particles from boulder size to sand can be identified by eye. Silt and clay particles, however, are too small to be distinguished by eye.

* Silt and clay can be identified by their behavior under various conditions.

a. Silt

* Silt may be considered finely ground-up particles with about the same grain size as powdered sugar. It is non-plastic; water will appear on the surface of a moist silt sample when shaken in the hand.

b. Clay

* Clay consists of extremely fine, plate-like particles which cannot be seen under an ordinary microscope. Each particle has an electric charge

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	which attracts a film of water to its surface. This condition gives clay putty-like properties and makes it plastic. Plasticity is the main difference between silt and clay.
XII. Basic Types of Rock	* Explain that an understanding of the basic types of bedrock is important since rock cuts are often involved in highways. Also, all of the soils are derived from bedrock.
A. Igneous rock	* State that igneous rock is formed by molten masses of rock pushed up from deep below the surface of the earth and hardened by cooling.
1. Types	* Variations in type of igneous rock result from their mineral content and rate of cooling. The best known igneous rocks are granites, gabbro (traprock), and volcanic lava. The igneous rock found in New York State is usually very hard.
B. Sedimentary rock	* Emphasize that sedimentary rock is the most common type. It is found over three-quarters of the earth's surface. It is formed from gravel, sand, silt, and clay particles deposited in layers at the bottom of former lakes, seas, and rivers. Some types of sedimentary rock contain organic remains of marine life and chemical precipitates formed in water.
1. Types	* The principal types of sedimentary rock are as follows:
a. Sandstone	* Sandstone consists of grains of sand cemented together. It was formed as beach and delta deposits and often shows ripple marks. Sandstone may be very hard.
b. Shale	* Shale was formed from clay hardened by pressure into rock. It was usually formed in the deep, quiet water of ancient lakes or seas. Shale is often

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	thin-bedded or layered and breaks up into thin slabs. It is used in the manufacture of brick and cement.
c. Limestone	* Limestone was formed from deposits of the remains of sea life (such as coral, worms, algae, and shells) and from precipitation of calcium carbonate. Limestone varies in color and appearance. It is used in the manufacture of cement and as a principal source of coarse aggregate in New York State.
d. Conglomerate	* Conglomerate is composed of rounded pebbles cemented into a mixture of finer material. It was formed by beach action and by action at the mouths of swift rivers.
e. Mixtures	* Sedimentary rocks often appear as mixtures, such as a sandy shale or a shaley limestone. Shaley limestone is an important source of cement.
f. Layers	* In New York State sedimentary rock often consists of layers ranging in thickness from several inches to several feet. These deposits may consist of various combinations of shale, limestone, and sandstone.
C. Metamorphic rock	* State that metamorphic rock is formed from sedimentary or igneous rock that has undergone tremendous pressure or heat or both. The result is a change in the structure of the rock. "Metamorphic" is a combination of the Latin words for change and form.
1. Types	* The principal types of metamorphic rock are as follows:
a. Slate	* Slate is formed from shale. It is harder than shale and often shiny in appearance.
b. Marble	* Marble is recrystallized limestone. It is often tinted with varied colors.

CONTENT OUTLINE	TEACHING POINTS AND TECNHIQUES
c. Quartzite	* Quartzite is altered sandstone. It is usually extremely hard and difficult to drill.
d. Schist	* Schist is highly changed rock with crystals oriented in wavy parallel planes. Mica is often found in this rock.
e. Gneiss (pronounced "nice")	* Gneiss is highly changed rock with crystals appearing in thin bands.
XIII. Fossils	* Touch on the subject of fossils by stating that they are the remains, prints, or other indications of former plant or animal life found buried in rock. Studies indicate that the older the rocks the simpler the types of plant and animal fossils found in them. The fossils have been used to establish the age of the rock which encloses them.

QUESTIONS FOR REVIEW

1. Review the high points of the lesson.
2. Remind the students to bring notebooks for use at next session.
3. Emphasize the need for regular attendance and punctuality.

ASSIGNMENT

1. Read Chapter I of Ref. A.

Lesson 2 - Soil and Rock Deposits of New York State

REFERENCES CITED IN THIS LESSON

Cline, M.C. Soils and soil association of New York. Ithaca, N. Y. Cornell University. 1952. Cornell Extension Bulletin No. 930. (Referred to in this unit by symbol "D")

United States Government, National Research Council, Highway Research Board. Washington, D. C. Appraisal of terrain conditions for highway engineering purposes. The Council. 1948. Highway Research Board Bulletin No. 13. (Referred to in this unit by symbol "C")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill Book Co. 1960. (Referred to in this unit by symbol "B")

OBJECTIVE

To describe the history, characteristics, and surface land-form appearance of the major rock and soil deposits in New York State and their significance in highway engineering

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Physiographic Regions of New York State	* Define physiography as the description and classification of land forms. The major physiographic regions of the State are shown in Figure 2-1. Distribute Figure 2-1 to class. (Ref. C, pp. 56-59)
A. Engineering significance of physiographic regions	* Mention that major changes in topography define the boundaries of these regions. * State that each region has individual features for land relief, type and structure of bedrock, and type and characteristics of soils. * The engineering problems involved with highway design and construction will vary from one region to another.

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

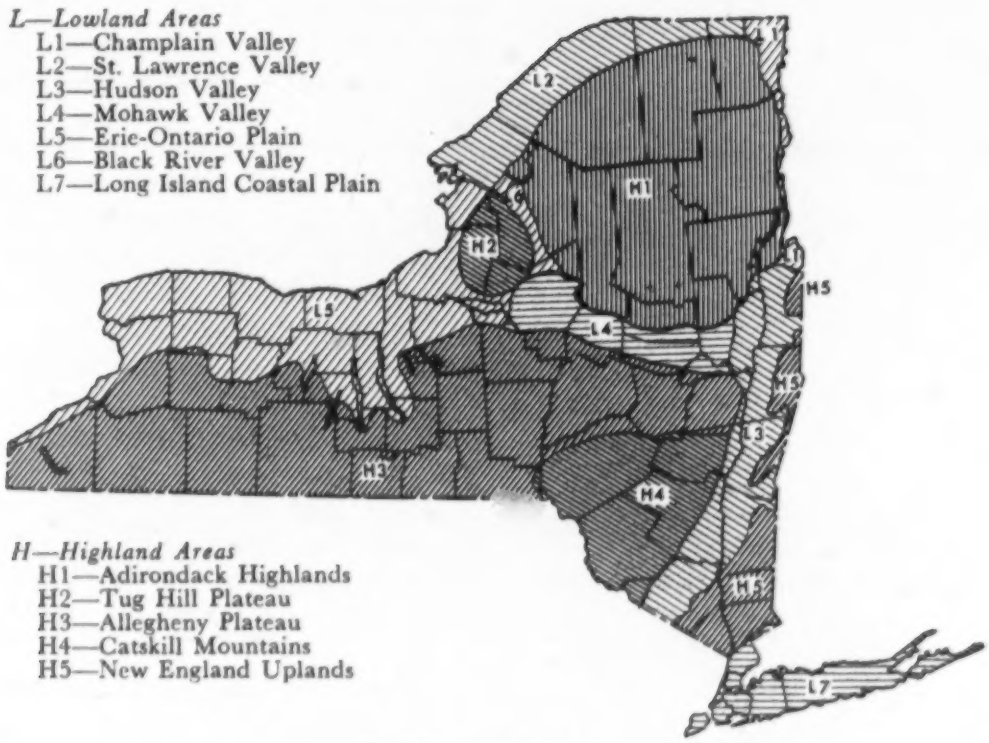

FIGURE 2-1
PHYSIOGRAPHIC AREAS OF NEW YORK STATE
(Source: Ref. D, p. 6)

B. Description of regions

* Mention that there are seven lowland and five highland regions in the State. The lowland areas occupy about one-third of the total area and contain the majority of the population and major transportation systems.

* The rock and soil characteristics will be developed in further detail in the following sections.

II. Rock Geology of New York State

* Mention that this section on the early geologic history of the State is presented for general background. It is not necessary for the student to remember the sequence of events in detail.

A. Introduction

* For hundreds of millions of years every square inch of the earth's surface has been subjected to tremendous opposing forces of construction and destruction.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Uplift forces	* The forces of uplift, originating deep in the interior of the planet, periodically force the crust of the earth to buckle and bend upward, creating mountain ranges and plateaus.
2. Destructive forces	* In opposition, the forces of the atmosphere in the form of water, wind, and glaciers constantly strive to erase the earth's high places and transport their materials to the valleys and the sea.
3. Time element	* During the span of a lifetime the progress of these forces is barely perceptible.
B. History of the rock deposits of New York State	* Mention that the age of the world is estimated to be between two and five billion years. * Pass out the bedrock map of New York (Fig. 2-2) to be used with the following section.
1. Adirondack Mountains 500,000,000 years ago	* Point out that the oldest rock in New York is in the Adirondack Mountains, where a huge shield of molten igneous rock was pushed up about 500,000,000 years ago. * This igneous rock, which is mostly granite, was pushed through an even older deposit of sedimentary rock that was changed by heat and pressure into marble, quartzite, and gneiss. Patches of these metamorphic rocks are found throughout the Adirondacks. * The original mountains were much higher and have been cut down by erosion.
2. Age of shallow seas 500,000,000 to 200,000,000 years ago	* For 300,000,000 years most of New York was covered by a vast, shallow sea, which extended over much of the North American Continent. * A land mass existed in the Atlantic Ocean with its western boundary near the present New England Coast.

F. Personal Attributes

1. Punctuality

2. Physical health

3. Integrity

4. Leadership

5. Attitudes

G. Personal Efficiency in Identifying Responsibility, Planning and Organizing Work and Work Stations.

Supplemental Teaching Aids:

Excellent resource people for this unit are working secretaries, State Department of Public Instruction personnel, beauty school operators or department store buyers and nurses.

The best general resource book is the Arizona State Department of Vocational Education's Suggested Curriculum Guide in Vocational Office Procedures. A good resource for role playing is Case Problems: for Vocational Office Block Project. This is available from the Department of Vocational Education also. Other useful resource books are: You as a Secretary, Royal Typewriter Company. How to be a Super Secretary, Remington Rand, and Sheaffer's Handbook for Secretaries, W. A. Sheaffer Pen Co., Fort Madison, Iowa ($1).

Some very good films are applicable to this unit. For example: "Office Etiquette" (15 min.), Britannica Press, Chicago, Ill., "Office Teamwork" (12 min.), Britannica Press, and "Off to a Beautiful Start", Scott Paper Co., Philadelphia, Pa.

Training Time 5-7 hours

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	the rate of ice melting, and the ice front remained stationary. The plastic flow of the bottom ice continued in these periods. The lower ice carried large amounts of debris which was piled up at the foot of the glacier.
1. Moraine	* Moraine is the term used for the ridges of soil built up around the glacier at a temporary stopping point. The surface of the moraine is usually irregular with depressions and hummocky hills. The material consists of unconsolidated till. (Distribute Figures 2-3 and 2-4 to the class.)

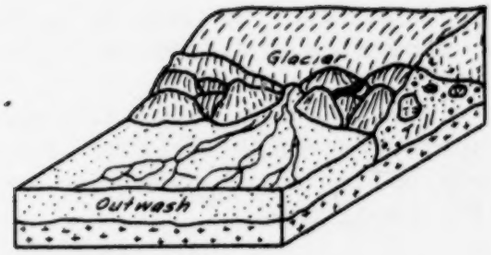

Formation of Terminal Moraine

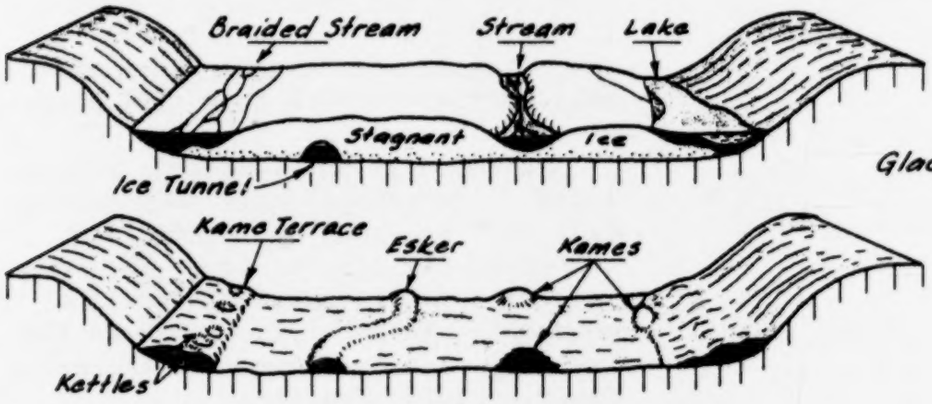

Glacial Stream Deposits

FIGURE 2-3
FEATURES OF GLACIATION

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Relation of till to bedrock	* Have the class refer to the bedrock map of New York (Fig. 2-2). Mention that the composition of the till is determined by the type of bedrock immediately to the north of the deposit. The stones are usually, but not always, angular and sharp-edged. (Ref. D, pp. 10-11)
a. Limestone and shale areas	* In limestone and shale areas the till is predominantly clay and silt.
b. Sandstone areas	* In sandstone areas the till is sandy.
c. Granite rock areas	* In the areas of the Adirondacks and Westchester County, where granite bedrock exists, the till consists of boulders, gravel, sand, and silt.
3. Condition of till	* Till is usually very compact, but the surface five feet may be loose from weathering and frost action.
4. Thick till	* State that thick till has a wavy and hummocky ground surface. Bedrock is deep and does not influence the surface topography.
5. Thin till	* In areas of thin till, such as on hillsides, the topography is influenced by the underlying bedrock. It is important to classify till in two categories as highway cuts often encounter bedrock in thin-till areas.
6. Drumlin	* A drumlin is an elongated, streamlined, cigar-shaped hill composed of till that has been overridden and shaped by the glacial ice. The long axis of the hill parallels the ice movement. These hills are 50 to 150 feet high and are common in the Erie-Ontario Plains Province.
B. Ice contact deposits	* Explain that after many years the climate warmed up and the glacier began to recede to the north. During this recession there were periods when the rate of ice advance was equaled by

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* In the quiet waters of the glacial lakes the finer-sized silt and clay particles were deposited.
1. Bottom sediments	* State that bottom sediments containing clay have limited strength and present foundation problems for constructing embankments.
a. Varves	* A combination of a silt layer and a clay layer is called a varve. Usually glacial lake sediment was laid down in consecutive layers of light-colored silt and darker-colored clay. Each layer may be 1/32- to 1/2-inch thick. The clay layers were laid down in winter when little sediment was carried into the lake, and the silt layers were laid down in the summer when there was more turbulence and more sediment entering the lake.
b. Surface features	* The topography is level to hummocky with gully development by present-day streams.
2. Delta deposits	* Explain that where the glacial streams entered lakes the velocity of the water decreased suddenly. The coarser materials were dropped from suspension and deposited in a fan-shaped formation at the mouth of the stream.
a. Surface features	* Deltas have smooth tops and steep sides around their borders. They may consist of layered silt, sand, and gravel. The coarser materials are usually on top, and the size of particles decreases with depth.
b. Beaches and bars	* At the boundaries of the glacial lakes, beaches and sand bars were formed. They consist of assorted sand and gravel with a predominance of sand. These deposits are common in the Erie-Ontario Plains Province as the Great Lakes were at a higher elevation than today.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* The bars, the elongated ridgelike land forms, and the beaches appear as smooth, slightly sloping areas. They offer sources of granular material for highway construction in areas where other sources of gravel are scarce.
E. Marine bottom sediments	* Mention that the crust of the earth was elastically depressed by the tremendous weight of ice. When the ice sheet receded to Canada an arm of the Atlantic Ocean extended into the St. Lawrence and Champlain Valleys. These areas were covered with marine, or salt-water, silt and clay. The crust of the earth rebounded slowly, and the sea water receded over thousands of years.
1. Clay properties	* Clay deposited in salt water is brittle in structure and sometimes offers more serious embankment foundation problems than fresh-water clay.
V. Postglacial Deposits	* Define postglacial deposits as soils that have been formed or laid down since the time of glaciation.
A. Alluvial	* State that materials deposited by modern streams are termed alluvial. These materials are usually in a loose condition. The type of material deposited depends on the velocity of the stream. Alluvial deposits usually consist of silt and sand, but may include gravel and cobbles.
1. Surface appearance	* Alluvial soils represent smooth, flat areas adjacent to present-day streams. In broad valleys they may be thought of as flood-plain deposits. When a stream meanders across a valley, attention should be given to old stream channels, filled with organic soil, which may present foundation problems. These channels may be covered up with later flood-plain deposits.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Mountain building in New England 350,000,000 years ago	* About 350,000,000 years ago there was a tremendous mountain range pushed up along the Atlantic Coast.
	* The mountains of New England and the Highlands-of-the-Hudson in southern New York are remnants of this mountain range.
a. Rock in the Hudson Valley	* The pressures of upheaval changed the sedimentary rocks along the eastern New York State border to slates and schists.
	* The upheaval folded the sedimentary rocks in the Hudson Valley.
b. Rock in the Catskill Mountains and Southwestern Plateau	* The exposed, nearly horizontal layers of sandstone and shale in the Catskill Mountains and the Southwestern Plateau were formed from sediment eroded from this new land mass.
4. Formation of the Appalachian Mountains 170,000,000 years ago	* About 170,000,000 years ago the Appalachian Mountains were formed to the south of New York State.
a. End of seas in New York State	* At that time the whole area of New York State was raised never to be covered by a sea again.
b. Formation of Palisades	* A later period of volcanic activity produced the basalt sheet that forms the Palisades along the lower part of the Hudson River.
c. Subsequent erosion	* For millions of years up to the time of glaciation, starting a million years ago, erosion took place over New York State, and the major stream valleys existing today were formed.
5. Rock deposits in local areas	* Discuss the characteristics of the rock deposits in the local area of the class, and relate these to the geologic sequence described above.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
III. Glacial History of New York State	* Mention that it is important to understand the effect of glaciation on the landscape of New York State, as most of the present-day soil deposits resulted from an ice sheet covering the State. This section on glacial history is intended as background information in preparation for the topic of glacial deposits.
A. Formation of a glacier	* Explain that glaciers form when snow accumulates faster than it melts off, over a long period of time.
	* As the accumulating snow thickens it changes to ice. When the ice becomes 100 to 200 feet thick the bottom layers become plastic from the pressure of the overlying ice.
	* The plastic bottom ice moves toward the edges of the glacier, causing the whole mass to move.
B. Continental glaciers	* In the past climatic conditions have been favorable for formation of continental glaciers that covered large areas of North America, Europe, and Asia.
	* These glaciers were similar in appearance to those in Greenland and the Antarctic today.
1. Volume of former glaciers	* Present-day glaciers cover about 10 percent of the surface area of the world. During the last period of glaciation ice covered about 30 percent of the surface area of the world. It is estimated that the volume of frozen water in the glaciers at that time was enough to lower the water level in all the seas and oceans by 300 feet.
2. Thickness of ice	* The ice was thousands of feet thick. The maximum measured thickness of the existing Greenland glacier is 10,000 feet near the center.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
C. Glacial period in New York State	* Explain that, at a time estimated to be a million years ago, there was a change in climate causing the formation of huge glaciers or ice sheets in Labrador and the Hudson Bay region of Canada. The glaciers advanced and receded across the northern United States several times during this glacial period.
1. Thickness	* The last ice sheet expanded southward covering all of New York State, except a very small area in Cattaraugus County, with several thousand feet of ice. The ice covered the highest peaks of the Adirondack Mountains.
2. Southern boundary	* The southern boundary of this ice mass extended from Cape Cod on the east, across Long Island, through Pennsylvania, along the Ohio River, and through Illinois, Iowa, and Minnesota to Canada.
3. Ice retreat	* The ice disappeared from New York State about 10,000 years ago.
IV. Glacial Deposits of New York State	* Mention that the combination of the tremendous weight of ice and the fluid-plastic movement of the lower ice planed down the mountains and widened and deepened the existing valleys. (Ref. C, pp. 59-61)
A. Glacial till	* State that tremendous amounts of rock and soil were ground up, mixed together, carried short distances to the south with the ice movement, and then laid down in a very compact condition under the ice. These deposits are called glacial till and consist of variable mixtures of stones, gravel, silt, and clay. In extreme cases till may be 99 percent clay or 99 percent stones.
1. Occurrence and surface appearance	* Glacial till is the most common soil deposit found in New York State and covers three-fourths of its land area.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Terminal moraine	* Terminal moraine refers to the moraine formed at the end of the glacial advance. The northern half of Long Island is a terminal moraine. Here the hummocky moraine hills are several hundred feet high.
C. Glacial stream deposits	* Indicate that, as the climate warmed, the stagnant ice melted rapidly. Water from melting ice flowed off the top and through ice tunnels or canyons. The water flowed southward into the valleys, depositing large amounts of soil.
1. Kames	* Water flowing down through holes in the ice left conical hills of roughly sorted sand, gravel, and silt, called kames. Water flowing in the notch between the ice and the valley walls left series of irregular kames, sometimes called kame terraces, on the edge of the valleys. (Fig. 2-4)

GEOLOGIC AGE	GEOLOGIC ORIGIN	DEPOSITIONAL UNIT
GLACIAL	ICE DEPOSIT	Thick Till
		Thin Till
		Drumlin
		Major Moraine
	STREAM DEPOSIT	Outwash
		Kame Field
		Esker
	LAKE DEPOSIT	Bottom Sediments
		Delta
		Bars & Beaches
	MARINE DEPOSIT	Marine Bot. Sed.
POST GLACIAL	STREAM DEPOSIT	Alluvial
	ORGANIC DEPOSIT	Muck & Peat
		Meadow
		Muck Over Marl
	WEATHERED BEDROCK	Residual

FIGURE 2-4
ENGINEERING GROUPING OF NEW YORK STATE SOILS

22327

CONTENT OUTLINE

2. Eskers

3. Outwash

a. Surface featur

b. Kettle holes

D. Glacial lake deposits

UNIT II (14.0302-02)

FUNDAMENTALS OF TYPING

Performance Objectives:

Upon completion of this unit the student will be able to type at a rate of 30 wpm/ecol.

Unit Outline:

A. Machine Fundamentals

1. Parts

2. Maintenance procedures

3. Manual and electric typewriters

4. Operation

B. Quality and Performance Standards

1. Speed and accuracy

2. Neatness

3. Language arts

C. Skill Development

1. Keyboard mastery

2. Manipulation of machine parts

3. Speed, accuracy and erasing

D. Typing Applications

Supplemental Teaching Aids:

No suggestions will be made for this unit since free or inexpensive resources are not applicable.

Training Time 70-85 hours

TEACHING POINTS AND TECHNIQUES

* Eskers were formed by material deposited in streams flowing through or under the ice. They are long, winding, narrow, steep-sided ridges and are almost triangular in cross-section. They consist of sand, silt, gravel, and cobbles,and sometimes provide a source of granular construction materials. (Fig. 2-4)

* The rivers flowing from the melting glacier carried all sizes of soil particles. The larger cobbles, gravel, and sand sizes were dropped from suspension in order of size as the stream velocity decreased. Outwash deposits consist of stratified rounded cobbles, gravel, and sand. Outwash is the best source of gravel for highway construction.

es * The identifying land form is a smooth and pitted plain that gradually slopes down valley. Frequently outwash deposits occur as terraces above the present valley bottom. (Fig. 2-4)

* Occasionally, deep, steep-sided depressions are found in an outwash plain. These depressions were formed when blocks of ice were detached from the receding glacier. The ice was covered with sand and gravel, and, when it melted, a depression was formed. These depressions are often filled with organic deposits and present foundation problems for highway embankments. Other kettle holes appear as lakes.

* Throughout the State many temporary lakes were formed in the valleys. In south-flowing valleys temporary dams were formed by moraine deposits or blocks of ice. In north-flowing valleys the dams were formed by the ice sheet. Tremendous quantities of water from melting ice supplied these lakes.

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CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

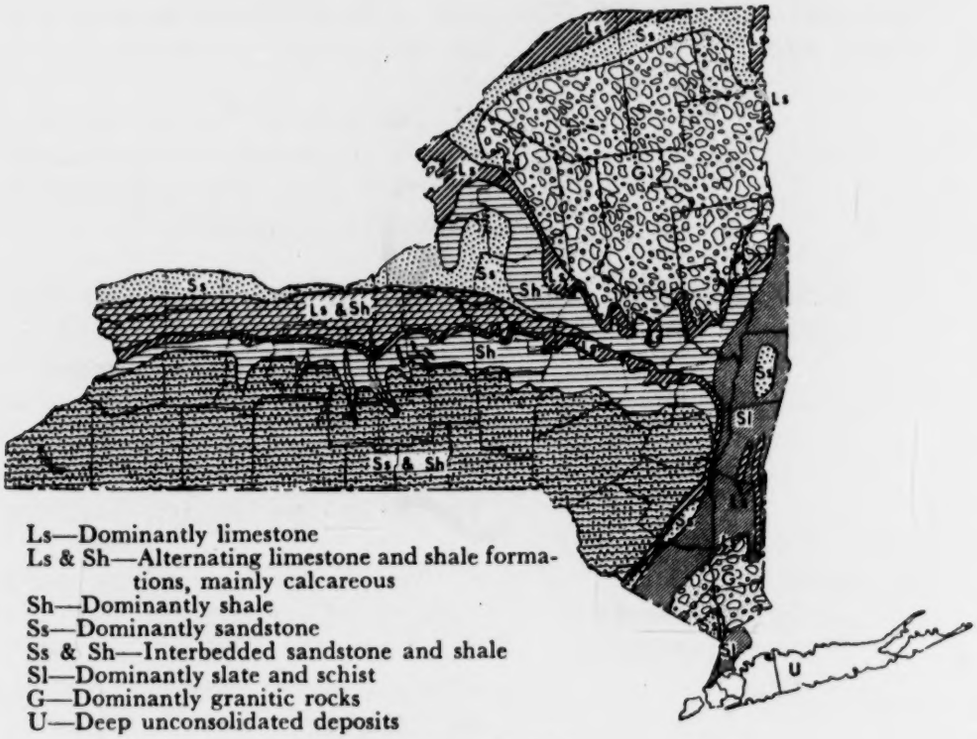

FIGURE 2-2
IMPORTANT BEDROCK AREAS OF NEW YORK
(Source: Ref. D, p. 10)

a. Deposition of sediments	* Sediment washed in from this land mass formed deposits of sedimentary rock thousands of feet thick across most of New York. The continent was depressed slowly under the weight of the accumulating material, enabling a great thickness of sediment to be deposited in shallow water.
b. Variations in sedimentary rock	* The variations in strata of shale, limestone, and sandstone we find today resulted from changes in climate, water depth, and the type of material deposited during this great period of time. The sediment was consolidated into rock under the influence of pressure and time. * The deep salt deposits of western New York were formed from evaporation of salt water in very shallow seas over long periods of time.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
5. Mixtures	* All of the organic deposits described above may occur as mixtures of different soils, or mixtures with various amounts of sand, silt, and clay.
6. Meadow	* Meadow is a poorly drained area which may contain organic deposits. Investigation is required.
C. Manmade fill	* State that in urban areas manmade fill of assorted materials may be found. This type of fill should be examined thoroughly since it is usually placed over the most undesirable land and often covers organic deposits.
D. Residual soil	* "Residual" describes soil developed from weathering of the bedrock in place. In parts of the world that were not glaciated, much of the soil was formed in this manner, but in New York State there is very little residual soil.
VI. Summary of Soil Deposits	* Summarize previous sections on soil deposits by discussing Figure 2-4.
A. Area concept of soils	* State that all soil deposits can be classified into these groupings. All the soil in a given deposit should have the same engineering properties since it consists of material deposited by the same geologic process. The boundaries of a deposit may be determined by the characteristic land form.
B. Application of the area concept to a highway project	* On a highway project the land forms in an area can be determined by field reconnaissance and by studying air photos, agricultural soil maps, and exploration data.
1. Use of exploration data	* The information obtained from exploration may be used to estimate the engineering properties of the entire deposit. This reduces the number of explorations required.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Highway design	* Knowledge of the land forms and of the engineering properties of the soils will enable the designer to determine the most economical location for alignment and grade, to evaluate design problems for each type of soil deposit, and to determine sources of granular borrow.
3. Highway construction	* The type and extent of soils to be encountered during construction may be predetermined, and construction problems may be anticipated before they occur.
C. Usefulness of the area concept	* The usefulness of the area concept cannot be fully appreciated in this early part of the course. It will be demonstrated in the following lessons.
VII. Description of Local Area	* Discuss the major soil deposits in the local area where the class is being held. (Ref. D, Soil Map)

ASSIGNMENT

1. Review notes and become familiar with definitions presented in this lesson.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Class problems	* Work out several problems in class, starting with simple problems involving one relationship. More complicated problems involving several relationships may be attempted after the class is familiar with the basic definitions.
Problem 1	* The weight of a container of moist soil is 152 grams. After drying in an oven, the dry soil and container weigh 131 grams. The container weighs 45 grams. What is the moisture content of the soil? Answer: 36 percent
Problem 2	a. A sample of soil weighs 106 pounds and its volume is 0.86 cubic feet. What is the wet density of the sample? Answer: 123.5 pounds per cu. ft. b. If the moisture content is 22 percent, what is the dry unit weight? Answer: 101.0 pounds per cu. ft.
Problem 3	a. A 40-pound sample of dry sand just fills a container of 1/3 cubic foot volume. If the specific gravity is 2.70, what is the void ratio? Solution: $G = \frac{\gamma_s}{\gamma_w} = \frac{W_s}{V_s \gamma_w}$ $V_s = \frac{W_s}{G\gamma_w} = \frac{40}{(2.70)(62.4)} = .235$ cu. ft. $V_v = V - V_s = .330 - .235 = .095$ cu. ft. $e = \frac{V_v}{V_s} = \frac{.095}{.235} = .405$ Answer: e = 0.41

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	b. If the above sample were saturated with water, what would be the moisture content? Solution: $W_w = V_v \gamma_w = (.095)\ (62.4) = 5.93$ $w = \frac{5.93}{40} = .15$ Answer: w = 15 percent
Problem 4	* The moisture content of a sample is 20 percent. The void ratio is 0.7 and the specific gravity is 2.70. What is the degree of saturation? Answer: S = 77 percent
Problem 5	* A large stone, whose volume was computed to be 1 cubic foot, weighed 165 pounds. What is the specific gravity of the stone? $G = \frac{\gamma_s}{\gamma_w} = \frac{\frac{W_s}{V_s}}{\gamma_w} = \frac{\frac{165}{1}}{62.4} = 2.65$ Answer: G = 2.65
IV. Soil Consistency	* The physical properties of clay soils differ greatly at different moisture contents. A clay sample may vary from a liquid condition, to a plastic condition, to a bricklike condition, depending on the moisture content. The term used to describe the condition of a clay soil is "consistency," expressed in such terms as soft, firm, or hard. (Ref. A, p. 43)
A. Mechanics of consistency	* The state in which a clay soil exists depends on the amount of water in the soil.
1. Liquid state	* In the liquid state the clay has an excess of water between soil particles. As the water content is reduced, the clay particles come closer together, and the sample becomes plastic.

22342

Lesson 3 - Index Properties of Soils

REFERENCES CITED IN THIS LESSON

Hough, B. K. Basic soils engineering. New York. The Ronald Press Co. 1957. (Referred to in this unit by symbol "A")

Lambe, T. W. Soil testing for engineers. New York. John Wiley and Sons, Inc. 1951. (Referred to in this unit by symbol "F")

New York State, Department of Public Works, Bureau of Soil Mechanics. Albany, New York. Visual identification of soils. The Bureau. Undated. (Referred to in this unit by symbol "E")

OBJECTIVES

1. To define and explain the significance of soil index properties
2. To describe the tests for determining soil index properties
3. To explain the use of these index properties in construction and design

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	* State that the basic problem in building a highway is determining how the various soils will behave as foundation and embankment material. Certain simple tests will indicate the index properties and the suitability of a soil for a given use. Many of these tests are conducted in the field as part of construction control.
II. Soil Gradation by Particle Size	* Explain that the size of soil particles and the distribution of sizes throughout a soil mass are important factors which influence soil properties and performance. (Ref. A, Chap. 2)
A. Method of testing	* The size and distribution of soil particles are determined by a sieve analysis.
1. Demonstration	* Use a nest of sieves for demonstration.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Explain the numbering system of sieves: e.g. "No. 40 sieve" indicates 40 openings per inch.
	* A sieve full of dry soil is shaken thoroughly. The soil then remaining on the sieve is weighed.
	* Work out a simple problem, listing in tabular form on the chalkboard for each sieve size: the weight retained, the percentage retained, and the percentage of total sample passed.
	* Explain the importance of washing the sample through the No. 200 sieve.
	* Silt and clay particles will bind together or adhere to fine sand, and this gives erroneous results for the percentage retained on No. 200 sieve if the sample is not washed through. This is very important in field tests as the No. 200 sieve is the critical grain size for some specifications.
B. Grain size distribution	* There are several systems for classifying soil according to grain size. We will use the system adopted for use in New York State. (Ref. E)
	* Explain that, for convenience, sieve sizes are used as soil size limits.
C. Method of presentation	* The standard procedure for presenting gradation analysis is to plot percent finer by weight versus grain size. It is suggested that form SM37A1, which is available from the Bureau of Soil Mechanics, be passed out to the class and a typical problem be worked through from a set of sieve results. (Visual aid: Show soil sample being sieved.)
1. Typical test presentation	* Indicate: 1. How to determine the percent finer from weight retained on a sieve

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UNIT III (14.0302-03)

OFFICE EQUIPMENT

Performance Objectives:

Upon completion of this unit the student will be able to score 90% or above on an instructor established scale that considers both accuracy and time, in operation of adding machines and calculators.

Unit Outline:

A. Ten-key Adding Machines and Printing Calculators

1. Adding by touch
2. Subtraction
3. Multiplication
4. Decimals and fractions, conversions
5. Division on printing calculators

Supplementary Teaching Aids:

No resource book suggestions are provided due to the nature of this unit. As a general overview of business machines the following film might be considered; "Modern Business Machines", Teaching Aids Exchange, 307 South B Street, San Mateo, Calif. 94401.

Training Time 10-15 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2. How to determine the percentages of gravel, sand, and silt from the graph at bottom of test form 3. Grain size, plotted on a logarithmic scale because of the large range in particle sizes (Largest particle is a million times the smallest.)
D. Significance of curves	* The shape of a gradation curve is an important indicator of the engineering properties of a soil. 1. Show on the chalkboard Figure 2-5 from page 18 of Ref. A. 2. Discuss well-graded, skip-graded, and uniform soils, and how engineering properties vary. (Ref. A, p. 19) 3. The gradation test is conducted as a control on gravel items used for highway construction. This test is made in the field project soil laboratories.
E. Hydrometer test	* The No. 200 sieve is the smallest practical size for sieve analysis. For determining the grade of a finer particle size, the hydrometer test is used. The features of the test are as follows: 1. The soil is dispersed in water in a glass cylinder about 18 inches high. 2. The velocity at which the particles fall out of suspension is measured. (The largest particles drop fastest.) 3. A hydrometer similar in shape to those used for testing automobile batteries is placed in the solution. The specific gravity of the solution, which decreases as the soil settles out of solution, registers on the hydrometer.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

headings: term, symbol, definition, and units as shown in the handout sheet labeled Figure 3-1.

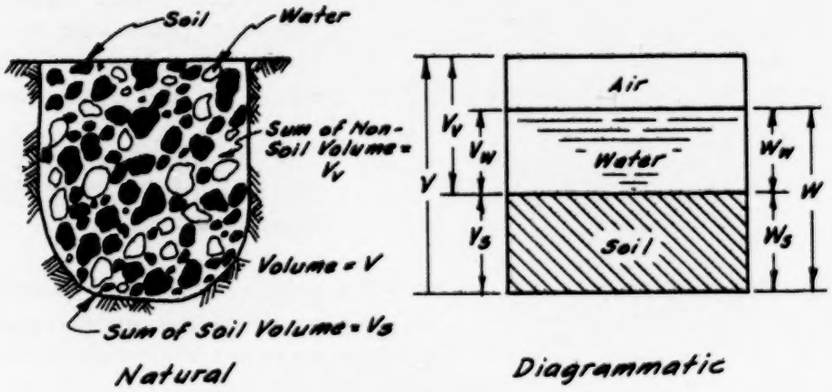

FIGURE 3-1
SOIL WEIGHT AND VOLUME RELATIONS

C. Unit weight or density (γ)

* Explain that unit weight or density is an important indication of the effects of compaction of soil. (Ref. A, p. 27)

1. Wet unit weight (γ_t)

W = total weight of sample

V = total volume of sample

* Wet unit weight is defined as weight of soil and water per unit volume, and is measured in pounds per cubic foot. In symbolic terms:

$$\gamma_t = \frac{W}{V}$$

2. Dry unit weight (γ_d)

W_s = weight of soil

* Dry unit weight is defined as weight of soil per unit volume, and is also measured in pounds per cubic foot.

$$\gamma_d = \frac{W_s}{V}$$

3. Typical values for wet unit weight

* The wet unit weight of natural soils in place varies widely. (Ref. A, pp. 30-31)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	4. By use of conversion charts, the amount and size of soil solids remaining in suspension can be determined from the readings. Repeated readings at established time intervals make it possible to determine the proportion of each grain size in the soil sample.
	5. The hydrometer test is not conducted in field project laboratories.
III. Physical Measurements	* The physical measurements of the weight and volume properties provide simple tests to estimate the strength and compressibility properties of a soil sample. These measurements can also be used to determine the similarity of various soil samples. It is important to understand these tests, as some of them are used in the field for embankment compaction control, which will be studied in a later lesson.
A. Basic parts of a soil sample	* Every soil sample consists of three parts (Fig. 3-1): 1. Soil particles 2. Soil water in the void spaces between soil particles 3. Air in the void spaces between soil particles
B. Weight and volume nomenclature and relationships	* To simplify the mental picture of the volumes and weights of the component parts of a soil sample, assume that in a cylinder the solids, water, and air can be separated and shown diagrammatically. (Fig. 3-1)
V = total volume of soil mass V_V = volume of voids (nonsoils) V_S = volume of soil solids	1. Explain letters and subscript labels. 2. Use Figure 3-1 to explain the definitions that follow under content outline, C through G. 3. As terms are defined, list them in a table with the following

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
F. Void ratio (e)	* The void ratio is defined as the ratio between the volume of voids and the volume of solids. $e = \frac{V_v}{V_s}$ (no units) 1. For sands the void ratio varies between 0.40 for a dense sand and 1.0 for a loose sand. 2. For clays the void ratio varies between 0.50 and 2.0. 3. The void ratio is an indication of the strength and compressibility of a soil.
G. Degree of saturation (S)	* The degree of saturation is defined as the ratio of the volume of water to the volume of voids in a soil sample. $S = \frac{V_w}{V_v}$ expressed as a percent S = 100 percent for a saturated sample * S is used as decimal when working weight-volume problems.
H. Relationship of definitions	* Refer the student to Figure 3-1 and a chart of definitions which will be made available to him, for working out sample problems. (Handout Fig. 3-1)
1. Useful relations	* From the basic definitions, it is possible to work out the following relation: $Gw = Se$ * This is too involved to work out in class. Present this, without deriving it, as a useful equation to solve problems. * Another useful relation is as follows: $\gamma_d = \frac{\gamma_w}{1 + w}$

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Organic deposits	* Organic deposits were formed when the remains of organic plant life were deposited under water. The lack of oxygen in the water nearly stopped the decomposition process. This has permitted deposits to build up to depths of more than 50 feet in the thousands of years since the glacier receded. Organic deposits present critical foundation problems for embankments because of their high compressibility and low strength.
1. Peat	* Peat contains partially decomposed but still recognizable plant fibers. Its fibrous structure contains over 90 percent water by volume. The color ranges from brown to black.
2. Muck	* Muck is organic material more completely decomposed than peat; plant fibers are no longer visible in it. Its color is black.
3. Organic silt and organic clay	* Organic silt and organic clay are swamp deposits which contain the remains of microscopic organisms.. The organic material, which cannot ordinarily be seen by the naked eye, gives the soil a fluffy structure. Occasionally shells and organic fibers can be seen in it. These soils have the appearance of soft silt or clay, dark gray in color, and are weak and compressible. They are commonly found in western Long Island and the tidewater areas of the lower Hudson River.
4. Marl	* Marl is a calcium deposit which is soft and has the color and consistency of toothpaste. It is formed by precipitation in water from the remains of animal and plant life containing calcium carbonate. It is found in limestone bedrock areas where the ground water contains calcium carbonate, and usually underlies muck.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Plastic state	* Plasticity is defined as the ability of a soil to undergo deformation without rupture. It may be thought of as "putty-like" property.
3. Semisolid state	* Further drying causes the continuous water films to break, and air enters the voids. This is the semisolid state. Because the clay particles are extremely small (submicroscopic in size), the water molecules next to the clay particles are held by a strong molecular attraction.
4. Shrinkage forces	* These layers of water exert increasing shrinkage forces on the sample, hold the dry soil tightly together, and give it a bricklike consistency. Tensile forces of a large magnitude are created at the boundaries between the water and air, pulling the soil together. This is called capillarity, and will be discussed later.
5. Solid state	* When a clay soil reaches its minimum volume after shrinkage, it passes into a solid state. (Fig. 3-2)
B. Importance of consistency	* The strength of a clay soil will vary greatly with the amount of water in the sample. Seasonal variations in moisture become important in clay soil.
C. Atterberg limits and indices	* About 50 years ago, an agricultural scientist named Atterberg devised a series of tests to determine the moisture content at which a clay sample passes from one state to another. * Refer to Figure 3-2, and define the Atterberg classification system. Show samples of clay in liquid, plastic, and semisolid states.
1. Liquid limit (LL)	* The liquid limit (LL) is the moisture content at which a remolded clay soil starts to exhibit shear strength.
a. Test procedure	* Describe the mechanics of the test. (Ref. F, p. 24) Demonstrate equipment, if available.

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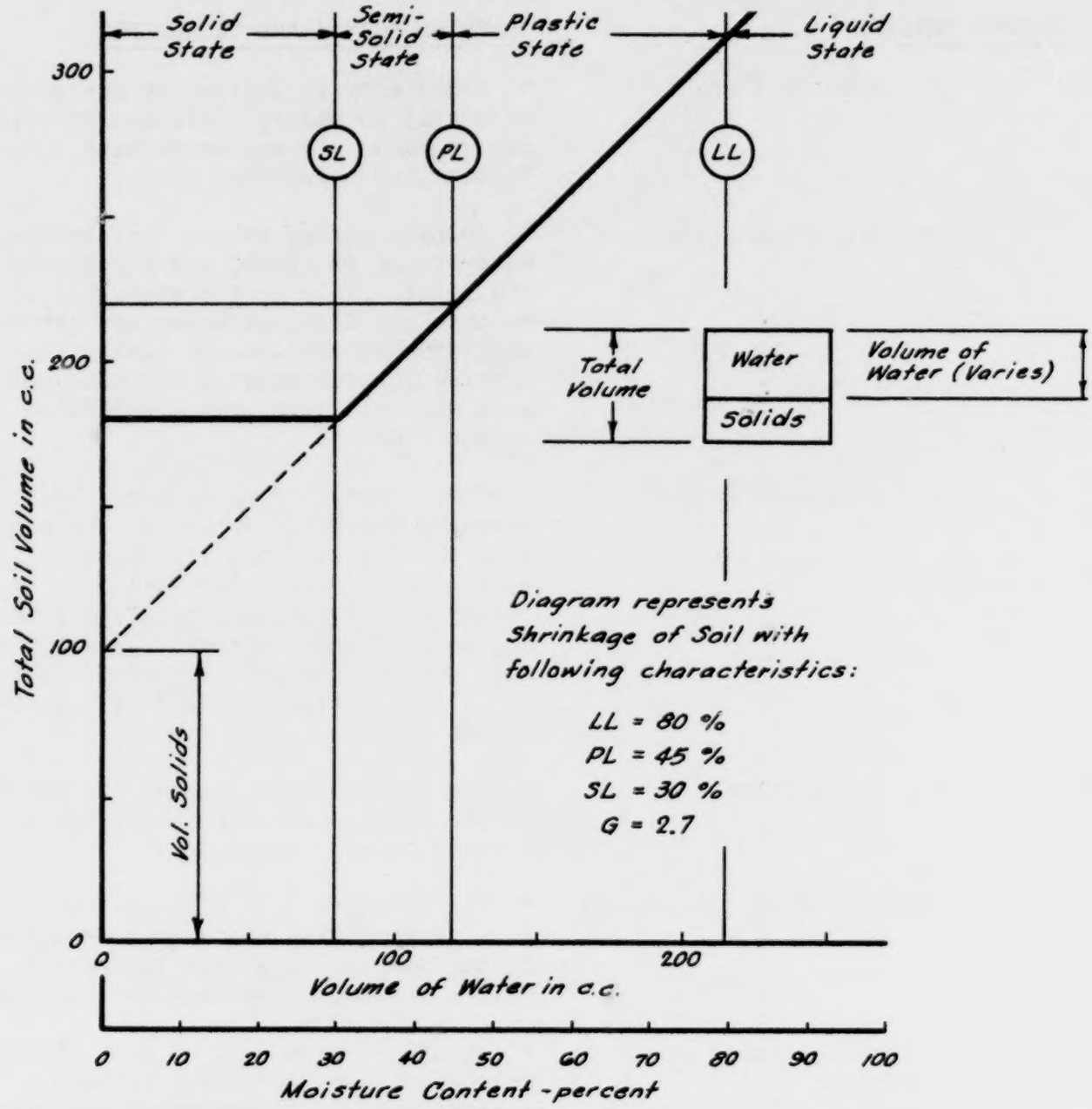

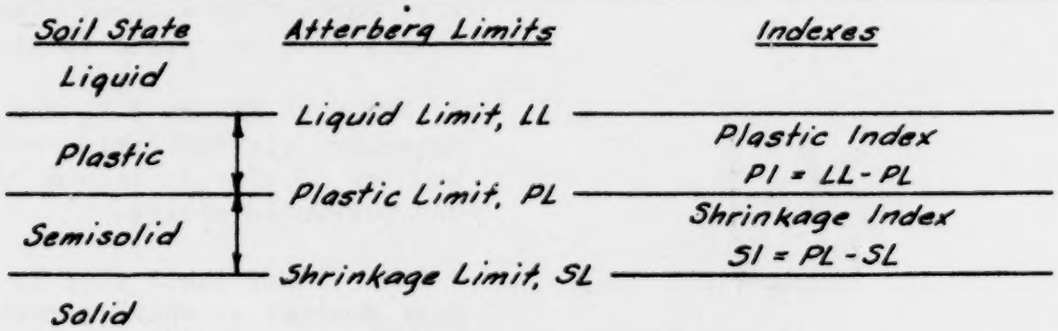

FIGURE 3-2
SHRINKAGE OF CLAY SOIL
WITH DECREASE IN MOISTURE CONTENT

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Plastic limit (PL)	* The plastic limit (PL) is the lowest moisture content at which the soil can be rolled into a thread 1/8 inch in diameter without breaking.
a. Test procedure	* Describe the mechanics of the test. (Ref. F, p. 25) Demonstrate the test.
b. Plastic limit and compaction	* Clay may be best compacted when the moisture content is at or slightly below the plastic limit. Farmers find clay soil most tillable at the plastic limit.
c. Color change	* The color of the clay becomes lighter at the plastic limit since air begins to enter the voids.
3. Shrinkage limit (SL)	* The shrinkage limit (SL) is defined as the moisture content required to fill the voids when the sample reaches its minimum volume. This limit is not widely used, and only a definition is required.
4. Plasticity index (PI)	* The plasticity index (PI) is the numerical difference between the liquid and plastic limits. 1. Present a numerical example. 2. The plastic index indicates the spread of moisture content over which the soil will exhibit plasticity.
5. Shrinkage index	* Define the shrinkage index as the numerical difference between the plastic limit and shrinkage limit. * There is little engineering significance to the shrinkage index.
6. Atterberg limits applied to New York State soils	* Remember that Atterberg limits are moisture contents representing consistency boundaries for remolded soils.
a. Average limits for New York State	* Plastic clay: LL = 40 percent PL = 20 percent PI = 20 percent

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Silt with a trace of clay: LL = 25 percent PL = 15 percent
	* Slightly plastic: PI = 10 percent
	* Silt, sand, and gravel with small amount of clay: LL = 20 percent PL = 15 percent PI = 5 percent
	* Neither silt, sand, nor gravel without clay is plastic.
b. Trend of limits	* As the proportion of either silt, sand, or gravel (or any mixture of them) increases, the LL and the PI decrease. The PL decreases more slowly.
7. Use of Atterberg limits	* Atterberg limits are used: 1. To compare plasticity characteristics of different soils 2. To estimate the suitability of soil for embankment construction 3. To estimate the suitability of granular soils containing small amounts of clay for uses such as subbase course gravel 4. To estimate compressibility and strength of foundation soils

ASSIGNMENT

1. Study index properties in Chapter 2 of Ref. A.

22346

UNIT IV (14.0302-04)

COMMUNICATIONS

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate to the satisfaction of the instructor, a level of coherence and clarity in oral communications that is adequate for the business office. The student will be able to prepare and write a mailable letter or brief report, from facts provided by the instructor. In a role playing, or other simulated situation, the student will be able to demonstrate correct telephone technique, procedure, and usage. The student will be able to score at least 80% on an objective test covering mail handling and telegraph procedures and use.

Unit Outline:

A. Oral and Written Communications

1. Importance of oral and written communications

2. Importance of good listening

B. Elements of Good Speech

1. Voice control

2. Vocabulary and pronunciation

3. Grammar

C. Speech and Writing Problems

1. Individual analysis

2. Corrective activities

D. Review of Rules for Punctuation, Capitalization, etc.

E. Importance of the Voice in Telephone Usage

1. Control

2. Enunciation

3. Resonance

4. Tone

5. Distance between lip and mouthpiece

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Lesson 4 - Soil Description and Classification

REFERENCES CITED IN THIS LESSON

Hough, B.K. Basic soils engineering. New York. The Ronald Press Co. 1957. (Referred to in this unit by symbol "A")

New York State, Department of Public Works, Bureau of Soil Mechanics. Albany, New York. Visual identification of soils. The Bureau. Undated. (Referred to in this unit by symbol "E")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill Book Co. 1960. (Referred to in this unit by symbol "B")

OBJECTIVES

1. To learn the technique of describing soil by a visual inspection of the material

2. To become acquainted with the soil classification systems in general use

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	
A. Soil description	* Soil description is necessary for predicting the engineering properties and behavior of a soil.
1. Purpose	* Explain that soil description conveys a definite meaning to people who have not had the benefit of examining the soils at firsthand and who desire to estimate the engineering properties of the soil.
2. Simplicity	* Soil description must be simple, as it is often made in the field without the aid of any special equipment.
3. Use	* State that soil description of exploration samples makes it possible to determine depth and boundaries of various types of soil deposits.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
4. Need for practice	* Point out that it is not always easy to prepare a good soil description because of the variable character of the material. Practice is required.
B. Soil classification	* State that soil classification consists of conducting one or more index property tests on a sample to place a soil in a certain class.
1. Purpose	* The purpose is to estimate the engineering behavior of the soil according to its class and to compare one soil with another.
2. Index properties	* Explain that the index property tests used, which were studied in the previous lesson, are: moisture content, gradation, Atterberg limits, density, and specific gravity.
II. Soil Description	* Soil description consists of systematic observation and tabulation of the following items (A through E under Content Outline):
A. Description of grain sizes	* State that this involves the determination of the proportion of each component of the soil by grain size.
1. System used by NYSDPW	* For consistency, one system of description should be used in an organization. The New York State Department of Public Works uses the system described on page 1 of Ref. E.
2. Grain size limits	* Review grain size table; suggest converting millimeter scale to inches.
3. Proportions	* Show how proportions are described by adjective system.
B. Grain size	
1. Description of coarse-grain soils	* State that coarse-grain particles of soil are those that can be seen by eye. They are all sizes coarser than the No. 200 sieve opening.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
a. Estimating proportion	* Spread out sample and estimate proportion of total sample by weight of cobbles, gravel, and sand. Since specific gravity values of all samples are about the same, the proportional volume of each material is the same as its proportion by weight. Drying the sample will help separate the particles in it.
2. Description of fine-grain soils	* State that particles of fine-grain soil cannot be seen by eye. These are silt and clay sizes smaller than No. 200 sieve opening.
a. Difficulty of grain size estimate	* It is obvious that a visual description of grain size is impractical when the grains cannot be seen.
b. Description by behavior	* Fine-grain soils must be described by their behavior. The main difference between a clay and a silt is plasticity. The .002 mm. boundary between silt and clay is not considered practical. Eliminate it from the chart on page 1 of Ref. E.
c. Silt and clay identification	* Field observations to identify silt and clay are listed on page 3 of Ref. E, and in Section 8, pages 32-33 of Ref. B. Discuss and demonstrate before the class. * A practical method of distinguishing between silt and clay is to cut a moist sample with a knife or wire. If the surface of the cut is shiny, clay predominates; if the surface is dull, silt predominates.
d. Dry soils	* Some fine-grain soils will be hard and dry in nature and will have to be moistened to make the preceding field observations.
3. Description of mixtures	* Mention that mixtures of the two major soil groups, i.e. granular and fine-grain soils, are more difficult to describe.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Drying the sample may simplify separating silt.
	* Estimate plasticity of fines.
	* Samples with more than 60 percent granular material will feel like granular material when rolled in a ball between the hands.
	* Samples with more than 40 percent fine-grain soil will feel like fine-grain soil when rolled between hands.
	* Most glacial till soils are mixtures of coarse- and fine-grain soils.
C. Class participation	* Emphasize the importance of grain-size description and the need for practice by the class to become proficient. Designers and field men should become familiar with the description system by identifying samples. This will enable them to have a mental picture of soil described on exploration logs in future projects.
	* Samples of soils in each grain-size class should be examined, by eye and hand, by each individual.
	* Samples of typical soils found in the general geographical area of the class should be available. Class members should prepare a visual grain-size description of each sample. Set up a columnar form on the chalkboard to be filled in. Allow enough space to put in additional description to be discussed in the next section.
	* Discuss the characteristics of samples as related to geological deposit and land form as presented in Lesson 2.
D. Other important characteristics for soil description	* Explain that grain-size description is not sufficient to fully describe a soil. Other items are very important, (Ref. E, p. 2; Ref. B, Section 8, p. 34), such as:

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Color	1. Color
2. Moisture	2. Moisture condition (by adjective description) a. Soils from below the water table are always wet.
3. Shape of particles	3. Shape of coarse-grain soil particles a. Angular--sharp edges; usually found in glacial till b. Rounded--caused by transportation in water; found in water-laid deposits, sometimes in till c. Flat--usually shale
4. Consistency	4. Consistency a. Coarse-grain soils--loose or compact b. Fine-grain soils--plastic or nonplastic; soft, medium firm, hard, or stiff
5. Gradation	5. Overall gradation a. Well-graded b. Skip-graded c. Uniform--soil particles are all the same size
6. Other features	6. Other features of the sample--varves, fissures, shells, fibers, etc.
E. Organic soils	* Show the organic soil samples to the class and mention that pure organic soils are not difficult to describe. When organic soils are mixed with mineral soils the description becomes more difficult. The colors are dark, and the soil usually has an organic odor. * The kinds of organic soils are:

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Peat--fibrous, black to brown
	2. Muck--no structure or fibers, black
	3. Organic silt--dark gray with occasional shells or organic specks; feels light and fluffy
	4. Marl--consistency of toothpaste, white to gray, often mixed with mineral soils and shells
III. Soil Classification	* Explain that a soil classification system consists of a systematic arrangement of classes of soils based upon the relationships among their physical properties.
	* Coarse-grain soils are classified by grain-size distribution.
	* Fine-grain soils are classified by plasticity (Atterberg Limits).
	* The class of a soil may be estimated by a visual description and can be checked by laboratory tests.
A. Classification systems	* Indicate that there are two well-known classification systems in use today. It is not necessary for the students to know the details of each system but only the general arrangement.
1. Unified system	* Mention that the unified system is used by the U. S. Army Corps of Engineers and the U. S. Bureau of Reclamation. (Ref. B, Section 8, pp. 28-29; or Ref. A, p. 482)
	* Describe the letter abbreviations and the 15 soil groups.
2. AASHO system	* State that this system was introduced by the U. S. Bureau of Public Roads to classify soils by their performance as subgrade soils under pavements. (Ref. B, Section 8, p. 24)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Now describe the eight major soil groups.
	* Mention that classification is based on a series of charts using various relations from the results of grain-size gradation and plasticity tests combined.
3. Use in NYSDPW	* Explain that the requirements for gravel items used in construction by the State Department of Public Works are based on classification tests.
	* For example, granular subbase material must meet gradation and plasticity test standards as stated in specifications.
	* State that a classification system is not used for routine soil descriptions.
	* Classification tests are used in problems involving analyses for embankment stability, cut stability, and structure foundations.

ASSIGNMENT

1. Review Ref. E.

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Lesson 5 - Soil Explorations

REFERENCES CITED IN THIS LESSON

Hough, B.K. Basic soils engineering. New York. The Ronald Press Co. 1957. (Referred to in this unit by symbol "A")

Woods, K.B. Highway engineering handbook. New York. McGraw-Hill Book Co. 1960. (Referred to in this unit by symbol "B")

OBJECTIVE

To explain the methods for obtaining the information about rock and soil that may influence the design, construction, and performance of a highway system.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Types of Exploration	* Mention that there are two general types of exploration available.
A. Indirect methods	* Enumerate the indirect methods employed in obtaining information: from the fields of geology, pedology (study of soils for agricultural purposes), airphoto interpretation, and geophysics (seismic investigations).
B. Direct methods	* State that direct methods involve putting a hole in the ground by the use of drill rigs, power and hand augers, probe rods, and test pits.
II. Engineering Problems	* Explain that the purpose of an exploration is to provide information to solve the engineering problems concerned with design and construction.
III. Progression of a Soil Survey	* Point out that soil explorations should progress during all the design stages of a highway project.
A. Reconnaissance survey	* Mention that at the start of a highway project a general appraisal should be made of the typical soils that will be encountered. The concept

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	of geological deposits and land forms discussed in Lesson 2 is applied. 1. The indirect methods of exploration should be used. 2. If some areas appear to be critical, field explorations are used. 3. Line changes may be made at this stage to avoid areas of critical soils that will be expensive to stabilize in order to support embankments and/or structures.
B. Preliminary survey	* Explain that preliminary survey is made during development of preliminary plans: 1. Borings are made at structure locations. 2. Foundations for high embankments are investigated. 3. Cut locations are explored to determine type of material. 4. Survey is made for availability of construction materials.
C. Detailed survey	* Set forth that in many areas preliminary explorations are sufficient to solve engineering problems or to indicate there are no problems. In areas of critical problems, such as swamp crossings, detailed explorations will be required.
IV. Exploration Tools--Indirect Methods	* Explain that the importance of each tool varies with the type of problem. Often several tools are used to obtain the answers.
A. Geology	* State that geology is defined as the study of the composition and arrangement of rocks and soils.
1. Published geologic reports	* Mention that there are geologic reports published by the State Museum which give detailed geology of most areas of New York State.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Pedology	* Define pedology as the study of surface soils (upper 3 feet) for agricultural purposes.
1. Principles of pedology	* Explain that when like soils are subject to identical conditions of climate, topography, and time, they will develop identical soil profiles.
2. Soil profile	* State that in pedology the soil profile used extends down to the parent soil, which is unaltered by weathering. It is usually at a depth of 2 to 3 feet, but may be 6 feet.
a. A horizon	* Explain that the surface layer, usually 12 inches thick, is the zone of topsoil and leaching. Percolating water and chemical action have removed finer material from this layer.
b. B horizon	* Explain that the zone of deposition is at an average depth of 1 to 2 feet. The finer material from above is deposited in this layer. In some areas of New York State, this layer is cemented and very impervious.
c. C horizon	* Explain that this layer consists of the unaltered parent soil.
3. Soil series	* State that the most important class of identification is the soil series. This series classifies soils derived from the same parent material and having similar characteristics
a. Nomenclature	* Soil series are given names taken from the place names near the spot where they were first defined, such as Chenango, Lordstown, Ontario, and Farmington.
4. Agricultural soil maps	* Inform the class that the United States Department of Agriculture has published agricultural soil maps for most of New York State.

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F. The Telephone Directory

1. Alphabetical directory

2. Classified directory

3. Out-of-town directory

G. Types of Telephone Services

H. Handling Calls

1. Incoming calls

2. Outgoing calls

I. Types of Telegraph Services

J. Preparation of Messages

1. Choice of class of service

2. Use of special words and code

3. Cost of transmission

4. Time differences (zones)

K. Importance of Mail

L. Procedures of Handling Mail

M. Classification of Mail and Rates

N. Postage Equipment and Supplies

1. Postage meters and scales

2. Automatic addressing systems

Supplemental Teaching Aids:

Many good resource books applicable to this unit are available, particularly in the field of special education. Others are the following: Communicating Facts and Ideas in Business, Leland Brown, Prentice-Hall, Englewood Cliffs, N.J., 1961, Business English in Communications, Himstreet, Porter and Maxwell, Prentice-Hall, Englewood Cliffs, N.J., 1964.

A series of three programmed texts by Joseph C. Blumenthal are available from Harcourt, Brace, and World. A great deal of free material is available from Western Union including the film "Telegram for America". Pitney-Bowes, Inc. distributes two publications on mailing machines entitled How to Increase the Prestige of Your Mail and 29 Timely Mailing Tips.

Training Time 15-20 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
a. Map information	* These maps indicate boundaries of various soil series, descriptions of parent material, and the type of deposit: glacial till, outwash, lake-laid clay, etc.
5. Use of agricultural soil maps	* Mention that these maps are valuable in a preliminary reconnaissance to determine the location, boundaries, and types of soil deposits that will be encountered.
a. Discussion of soil map for local areas	* Show the class a soil map of a local area and discuss features and principal soil series shown. Relate this with glacial deposits discussed in Lesson 2. Maps can be borrowed from District Soils Engineer.
(1) Limitation	* Remind the class that the principal limitation of a soil map is that it does not give sufficient information about the soil to the depth encountered in highway work.
b. Airphoto interpretation	* Explain that stereoscopic examination of aerial photos is sometimes used to determine the types and limits of soil deposits.
(1) Factors in identification	* For additional details on factors, see Section 10, page 38, of Ref. B. 1. Land forms 2. Drainage and erosion 3. Soil tones 4. Vegetation 5. Land use
c. Engineering soil maps - New York State Department of Public Works	* State that for major highway projects on new locations, engineering soil maps are prepared by the New York State Department of Public Works.
(1) Information	* The soil map shows the boundaries of each soil type. The soils are grouped into 16 depositional groups based on the type of glacial or post-glacial deposit. (Fig. 5-1)

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CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

GEOLOGIC AGE	GEOLOGIC ORIGIN	DEPOSITIONAL UNIT
GLACIAL	ICE DEPOSIT	Thick Till
		Thin Till
		Drumlin
		Major Moraine
	STREAM DEPOSIT	Outwash
		Kame Field
		Esker
	LAKE DEPOSIT	Bottom Sediments
		Delta
		Bars & Beaches
	MARINE DEPOSIT	Marine Bot. Sed.
POST GLACIAL	STREAM DEPOSIT	Alluvial
	ORGANIC DEPOSIT	Muck & Peat
		Meadow
		Muck Over Marl
	WEATHERED BEDROCK	Residual

FIGURE 5-1
ENGINEERING GROUPING OF NEW YORK STATE SOILS
(For convenience, this chart is repeated from Lesson 2)

(2) Tabular summary

* A tabular summary is included with the map indicating all of the engineering considerations for design and construction problems in each soil deposit.

d. Seismic investigations for highway cuts

* State that the seismic method of subsurface exploration consists of creating sound or vibration waves within the earth by exploding small charges of dynamite 3 or 4 feet beneath the surface. The time of travel of these waves is then measured from their point of origin to each of several detectors, placed at known distances from the source. These sensitive detectors record the amplitude of vibrations and the time it takes for the vibrations to reach the detector.

(1) Wavefront advance

* Explain that the velocity of wavefront advance is a function of the density of the material.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Velocity of sound waves in rock is two to four times the velocity in soil.
	* The wave will travel down through the soil and then along the surface of rock and generate return waves going up to ground level.
(2) Data recording	* Each detector makes a photographic record of the time it takes for the first wave to arrive.
(3) Determination of rock depth	* Explain that the results of the photographic record are analyzed, and the following information is determined mathematically: 1. The velocity of waves through the overburden, which is a rough indication of the density and type of overburden 2. The velocity of waves through the rock, which indicates the approximate type of rock 3. The depth of rock below the blast location within 5 percent accuracy
(4) Engineering application	* State that seismic explorations are used to determine the depth of the rock and that this information is used for preparation of cross-sections.
(a) Usefulness to designer and contractor	* Point out the uses of seismic explorations: * A steeper cut slope can be used in rock than in earth. Combined slopes are plotted on cross-sections and the right-of-way limits determined. * The rock slopes vary from one-vertical-on-one-horizontal for a very soft rock, to vertical for a sound rock. This information is provided for the designer by geologists.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* A contractor can estimate more accurately the volume of rock excavation, which results in more realistic bid prices at savings to the State.
(5) Seismic explorations by the NYSDPW	* Relate that the New York State Department of Public Works has two or three seismic crews in the field. The average cost of this work is one-fifth the cost of getting the same information with borings.
V. Exploration Tools--Direct Methods	* The type of exploration used depends on the design information desired. The limitations of the various methods should be recognized, as misleading information is worse than none at all.
A. Soundings or probings	* Define sounding or probing as forcing a rod in the ground and recording the penetration resistance.
1. Methods	* Discuss methods of progressing sounding.
a. Sledge hammer	* The simplest arrangement is to drive a 1-inch diameter, pointed steel rod into the ground with a sledge hammer. Additional 3- to 4-foot sections of rod may be coupled onto the point section.
b. Power-driven hammers	* More elaborate methods use a gasoline or air hammer, or a 25- to 50-pound weight mounted on a small tripod.
2. Limitations	* Explain the limitations of information from sounding.
a. No soil samples	* No samples of the soil penetrated can be obtained. The soil profile is unknown.
b. Cause of refusal indefinite	* Refusal of the tool to penetrate may indicate a boulder, very compact soil, or ledge rock. It is important, in design, to know what caused refusal.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Useful application	* Explain useful applications of probing. It should be used only by people who know the limitations of the method.
a. Areas of known soil profile	* State that probing is done in areas where borings have determined the soil profile and it is known that soft or loose boulder-free materials are underlaid by compact material.
B. Auger borings	* Define auger borings as explorations progressed by means of rotating a spiral-shaped bit into the ground.
1. Procedure	* State that the auger is advanced a distance equal to its length. The bit is withdrawn, the soil removed, and the procedure repeated.
2. Limitations	* Explain that soil and water conditions determine the major limitations.
a. Water table	* Mention that an auger hole will cave in when the sample is noncohesive sand and gravel below the water table.
b. Soil types	* Point out that augers will not penetrate soil containing cobbles and boulders.
c. Sampling	* Explain that the structure of auger samples is much disturbed. Care is needed to avoid knocking soil from the sides of a hole when inserting the auger.
3. Advantages	* Explain that this is a very economical method of exploration, since it uses light equipment.
a. Water table	* Indicate that relatively shallow water tables can be determined accurately.
4. Hand-auger borings	* Mention that there are two types of hand-augers:

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
a. Post-hole or Iwan digger	* Post-hole or Iwan digger, consisting of a spiral-shaped bucket available in diameters from 3 to 8 inches.
b. Helical auger	* Helical-shaped bit, similar to a carpenter's ship auger, ranging in diameter from 1 to 1-1/2 inches
5. Power auger	* Explain that augers can be rotated, fed, and withdrawn by motor power.
a. Equipment details	* State that power augers are mounted on heavy-duty trucks or crawler tractors. 1. Auger is fastened to a square- or hexagonal-shaft "Kelly bar" which can be rotated and lowered or raised. 2. These units are also used by utility companies for setting poles.
b. Limitations	* State that principal limitations are: 1. Access to site 2. Difficulty in penetrating soil containing boulders
C. Tube sample borings	* Mention that the most common method of exploration utilizes drill holes and tube samples of the soil.
1. Progression of drill hole	* Explain that advancing a drill hole consists of repeating three basic operations:
a. Driving casing	* Driving a length of pipe or casing into the ground by means of a falling weight
b. Cleaning soil out of casing	* Cleaning the soil out of the casing by breaking the soil up with a chopping tool on the end of a hollow drill rod. The soil is washed out of the casing with water under pressure forced out of the end of the chopping tool.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
c. Sampling soil	* Sampling the soil immediately below the bottom of the cleaned casing by forcing downward one of the various types of tube samplers connected to the bottom of a drill rod
2. Drill rig	* Describe the basic parts of the type of drill rig required for soil exploration.
a. Power source	* A gasoline or diesel motor is used as a source of power.
b. Hoisting unit	* Power is transmitted to a cathead hoist through a transmission and clutch assembly.
c. Tripod or derrick	* The tripod or derrick unit has a sheave or pulley on top.
d. Water pump	* The water pump may be driven by the drill-rig power unit or a separate power source.
3. Core drill rig	* Describe the equipment in addition to soil drilling rigs needed to drill rock. For rock drilling, it is necessary to rotate the rock core sampler attached to the drill.
a. Spindle	* The drill rod is attached to a spindle.
b. Power transmission to spindle	* Power for rotation is transmitted to the spindle through the drill head.
c. Vertical movement of spindle	* Explain that a means of raising or lowering the spindle is provided to force the rock core sampler into rock. Three types of units are: 1. A lever arrangement, called a hand feed rig 2. A hydraulic device, called a hydraulic feed rig 3. A mechanical device, called a screw feed rig

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
4. Drive hammers	* State that the falling weight used to drive the sampler is called a drive hammer.
a. Weight	* The two commonest weights are 140 pounds and 300 pounds.
b. Operation	* Explain that the operator lifts the weight by means of a rope running from the drive hammer over the sheave at the top of the tripod and wrapped around the cathead hoist. When the free end of rope is pulled, the friction of the rope on the rotating cathead lifts the drive hammer.
c. Driving energy	* The operator hoists a 140-pound weight 30 inches, or a 300-pound weight 18 inches, and allows the weight to drop on the drill pipe or sampler-spoon drill rod.
d. Recording hammer blows	* The number of hammer blows to drive the casing each foot is recorded. The blows required to drive the sampler every 6 inches are recorded.
5. Soil samplers	* Explain that numerous types of soil and rock samplers are available for various soil conditions.
a. Split-tube drive sampler	* Mention that the split-tube drive sampler is the most widely used and includes a hardened cutting shoe, an 18-inch-long split tube to retain the sample, and a connection for the drill rod. The connection includes a ball check valve that prevents water from draining out of the hollow drill rod and washing out the sample. The structure of samples obtained is disturbed but they are useful for soil description and classification tests.
b. Pressed samplers	* State that these samplers are thin-walled and are intended to be pressed into fine-grain soils to obtain undisturbed soil samples for laboratory testing. The Shelby tube sampler is the most common type.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
c. Core samplers	* Inform the class that core samplers are used to sample boulders and bedrock. The sampler consists of a cutting bit, a tube to hold the sample, and a connection to the drill rod. Water is circulated to reduce friction. Two types of cutting bits are the tungsten carbide bit and the diamond bit faced with industrial diamonds.
d. Retractable plug sampler	* Explain that a retractable plug sampler is a light portable unit consisting of a tube 1 inch in diameter, with pipe extensions that can be driven into the ground. 1. The lower end has a retractable point which keeps the soil from entering the pipe until sampling depth is reached. 2. The point is retracted inside the tube and a series of 6-inch brass tubes above the open end are filled with soil by driving the sampler. 3. The equipment is useful for sampling soft soils in areas difficult to move a drill rig to.
e. Test pits	* Mention that test pits are holes, pits, or shafts large enough to be accessible to a man, excavated for the purposes of engineering exploration.
VI. Recording Exploration Information	* State the importance of accurately recording all of the information obtained for use in design and construction.
A. Review of drill-hole log form	* Pass out to the class a typical drilling log. Prints of logs may be obtained from the Bureau of Soil Mechanics, NYSDPW.
1. Information required	* Review the list of minimum information for drill log, shown in Section 10, page 63, of Ref. B.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Use of information	* Indicate that analysis of the drill-hole log can supply considerable information to a highway designer.
1. Blows on drive pipe or casing	* State that the number of blows on the drive pipe is a very approximate indication of the driving resistance encountered by a pile.
2. Blows on drive sampler	* Mention that blows on drive sampler are an indication of the relative density of coarse-grain soils and an indication of the strength and consistency of fine-grain soils.
3. Field identification or description	* State that field description determines the types of soil and depths of various layers. Soil profiles may be developed from this information.
4. Ground water	* Relate that ground-water elevation is often an important consideration in design.
VII. NYSDPW Subsurface Exploration Organization	* Mention that the State Department of Public Works maintains about 35 drilling crews who do exploration work for highways and State buildings. * It is suggested that the instructor arrange to let the class examine a drill rig and other drilling equipment in conjunction with the portion of this lesson describing drill rigs. Arrangements may be made with the soils engineer in the local district office.

ASSIGNMENT

1. Study pages 418-453 of Ref. A.

Lesson 6 - Engineering Properties of Soils - Consolidation and Strength

REFERENCES CITED IN THIS LESSON

Hough, B. K. Basic soils engineering. New York. The Ronald Press Co. 1957. (Referred to in this unit by symbol "A")

Lambe, T. W. Soil testing for engineers. New York. John Wiley and Sons. 1951. (Referred to in this unit by symbol "F")

OBJECTIVES

1. To explain the consolidation characteristics of various types of soils under vibrational and static loading, and to review laboratory test procedures and methods of analyzing settlement problems

2. To explain the strength characteristics of various types of soils, including laboratory testing and analysis of stability problems

3. To discuss practical solutions used to solve consolidation and stability problems in highway design and construction

4. To review the methods used for determining the pressure distribution of applied loads on soils and the horizontal earth pressures on retaining walls

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	* Remind the class that in highway construction earth is used for the following purposes: 1. As a foundation to support embankments and structures 2. As an embankment construction material 3. To form cut slopes * Consolidation problems are involved with purposes 1 and 2. * Stability problems are involved with purposes 1, 2, and 3.
II. Consolidation of Soils	* Define consolidation as a decrease in the volume of a soil due to static

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	weight of soil, shown as P_0 in Figure 6-3. 2. The additional load due to the applied fill is added to P_0 and shown as P_F in Figure 6-3. 3. The change in void ratio due to the added load (e_o - e_f) is determined from the laboratory test. 4. The total settlement in the field may be determined by using the following formula: $\text{Settlement} = \frac{H(e_o - e_f)}{1 + e_o}$ where H is the thickness of the compressible layer in the field.
5. Time for settlement	* Mention that the time for settlement in the field is a function of permeability and compressibility of the soil.
a. Analysis of test results	* State that time-consolidation relationships are indicated on a plot of compression vs. logarithm of time. * From the geometry of this plot, a constant called the coefficient of consolidation is determined. This is related to permeability. (Fig. 6-4)

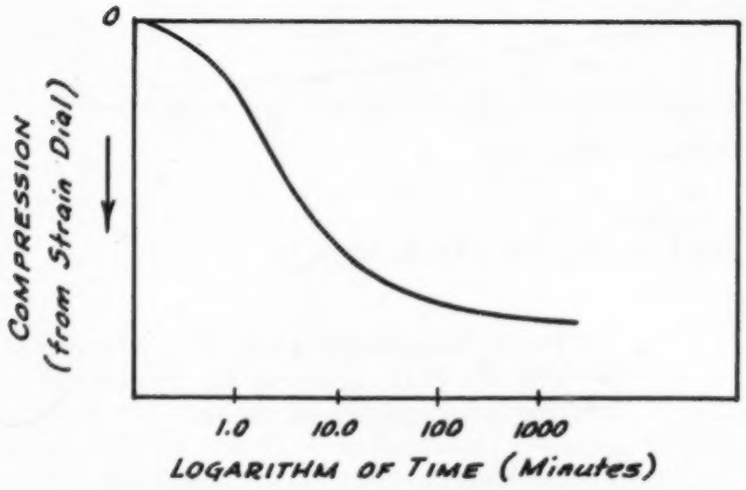

Permeability constant for rate of consolidation derived from geometry characteristics of curve.

Constant is called Coefficient of Consolidation.

FIGURE 6-4
SOIL CONSOLIDATION CHARACTERISTICS:
COMPRESSION vs. LOGARITHMIC TIME PLOT FOR ONE LOADED INCREMENT
(Consolidation Test Data Obtained In Laboratory)

UNIT V (14.0302-07)

FINANCIAL ACTIVITIES

Performance Objectives:

Upon completion of this unit the student will be able to score at least 80% on an instructor developed objective test covering the handling and verifying of forms involved in ordering, receiving, selling, and general financial records. Also covered in this test should be common reports required by governmental agencies.

Unit Outline:

A. Importance of the Need of Financial Records

B. Types of Records

1. Personnel
2. Payroll
3. Sales and purchases
4. Inventory
5. Taxes
6. Financial Statements
7. Petty cash
8. Budgets
9. Credit applications

Supplemental Teaching Aids:

An excellent resource person for this unit is a staff member from the college business office. Free or inexpensive information is available from the Massachusetts Bankers Association, 125 High St., Boston, 12110. Of some value is the comic book-The Story of Checks, available from the Federal Reserve Bank of New York.

Training Time 8-10 hours

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

b. Computing time-settlement

* The details of computing time-settlement curves will not be covered in this course. The important factors to remember are:

1. Time required varies, since it is proportional to the square of the longest distance required for water to drain from the deposit. This distance is the thickness of the layer if all water drains vertically to the surface.

2. Time required for consolidation varies inversely as the coefficient of consolidation.

3. Rate of settlement decreases as time increases. Figure 6-5 shows a typical time-settlement curve for a clay deposit under embankment loading.

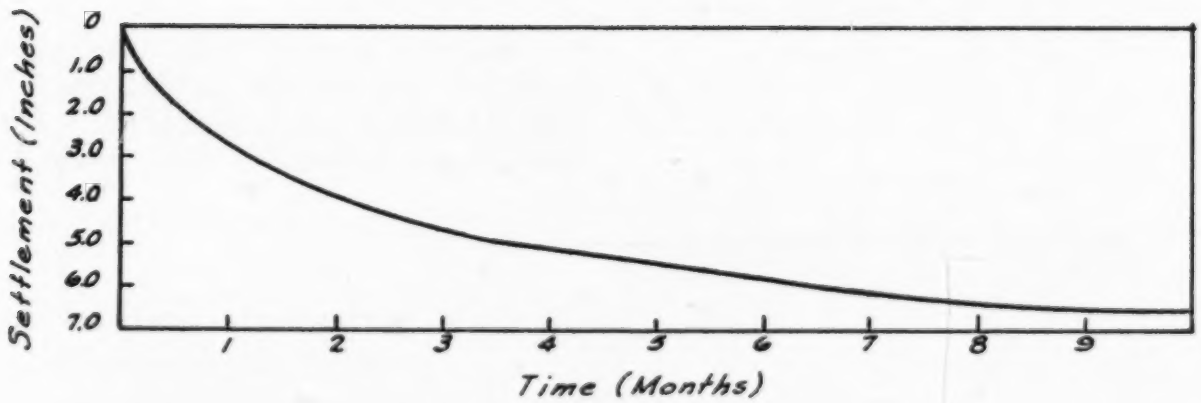

FIGURE 6-5
TIME-SETTLEMENT CURVE FOR FIELD PROBLEM

6. Summary

* It is suggested that the principal points of this section be reviewed before proceeding further.

* Emphasize that silt and clay soils will compress under loading. There is a time delay, while water flows from the voids, before settlement goes to completion.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
III. Strength of Soils	* State that the most important property of soils is strength. Slopes of all kinds, including hills, river banks, and man-made cuts and fills, stay in place only because of the strength of the material of which they are composed. * Note: A knowledge of soil strength is important for the design of structure foundations, embankments, retaining walls, pavements, and cuts.
A. Basic concepts	* Explain that a soil can derive its strength from two sources--friction between particles, and cohesion between particles. 1. Cohesionless soils, such as gravel, sand, and silt, derive their strength from friction between particles. 2. Cohesive soils, composed mainly of clay, derive their strength from the attraction, or bond, between particles. 3. Mixtures of cohesionless and cohesive soils derive strength from both friction between particles and cohesion.
1. Frictional strength	* Perform a simple demonstration of the idea of frictional strength by placing a block on a tabletop. Demonstrate and illustrate on the chalkboard.
a. Friction P_S = horizontal force P_F = frictional resistance	* Point out that a horizontal force is required to move the block and overcome frictional resistance. The frictional resistance is a function of the roughness between the two surfaces.
b. Normal force (P_N)	* State and demonstrate that an increase in the normal force P_N also increases P_F.

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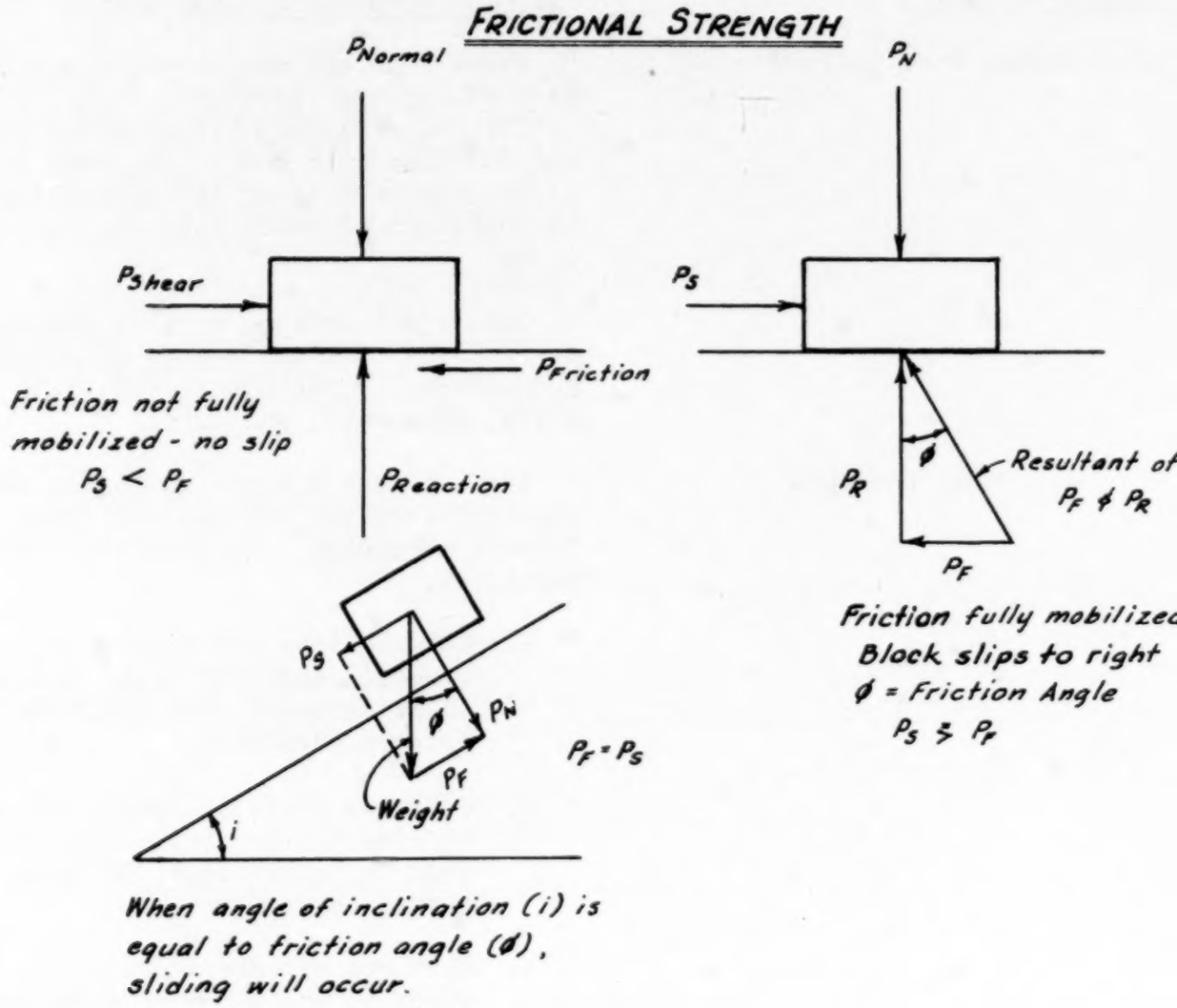

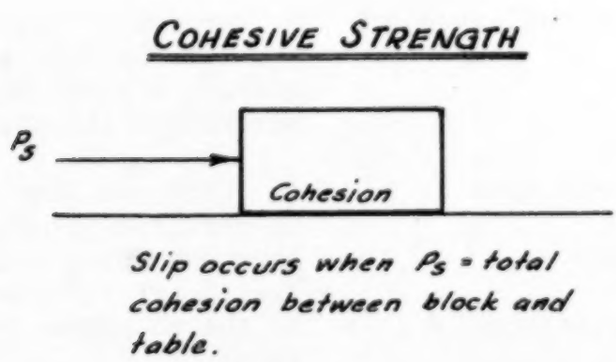

FIGURE 6-6
BLOCK-ON-TABLE DEMONSTRATION: FRICTIONAL AND COHESIVE STRENGTH

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
c. Friction angle Φ	* When movement occurs, the angle from the vertical formed by the resultant of the normal-force reaction component and the frictional resistance component is called Φ, or the friction angle.
d. Frictional resistance	* The total available frictional resistance is equal to the normal force times the tangent of Φ. $P_F = P_N \tan \Phi$
e. Sloping surface	* Mention that if the table is tipped, the block will slide when the table is inclined at an angle to the horizontal equal to Φ.
	* State that a pile of dry sand will have an angle of repose of 30°. This is equal to the friction angle between soil particles (30°).
2. Cohesive strength demonstration	* Use the same block-on-table demonstration. This time there is an adhesive corresponding to cohesion in the soil, between the block and the table. If the horizontal force (P_S) is increased, the block will move suddenly when the cohesion is overcome. This indicates the strength of a clay is constant and results from the bond between particles. (Fig. 6-6)
a. Practical aspects	* The demonstrations show that the shear strength of granular soils increases as the load increases to a maximum amount determined by N tan Φ. The strength of a clay is constant and does not increase under a load. Therefore, clays are the more critical of the two soils for stability.
	* State that for practical purposes all clay deposits have some silt or sand mixed with them. Hence, under increased normal load there will be a slight increase in strength as the granular particles come in contact with each other when the soil consolidates.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Remind the class that the previous section on consolidation indicated there is a timelag for consolidation of clays which would also influence the rate of strength increase.
B. Strength testing	* Relate that the majority of strength tests are conducted on cohesive soils. Samples for testing are obtained from Shelby tube samples. It is very difficult to obtain undisturbed samples of noncohesive soils.
1. Unconfined compression test	* State that the unconfined compression test is the simplest and quickest laboratory method used to measure the shear strength of a cohesive soil.
a. Test procedure	1. A cylindrical specimen is placed on the testing machine and the load applied until the sample fails. 2. The unconfined compressive strength is one-half the applied load at failure, divided by the cross-section area of the sample. 3. Shear strength of soil is expressed in pounds per square foot (p.s.f.). 4. The test is conducted in the same manner as a compression test on a concrete cylinder.
2. Triaxial compression test	* Explain that the triaxial compression test is a strength test where the sample is subjected to confining pressures similar to those which existed in the ground before sampling. (See Fig. 6-7.)
a. Test procedure	1. The sample is trimmed to a cylinder 4 inches high and 1-1/2 inches in diameter. 2. The sample is covered with a thin rubber membrane and placed on a pedestal with a porous base for drainage.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	loading or vibrational forces applied to the soil mass.
A. From vibrational forces	* State that only loose, nonplastic, granular soils will consolidate from vibratory forces.
1. Structure of loose granular soils	* Indicate with sketch the structure of sand soil in loose condition and the same soil after consolidation. (Fig. 6-1)

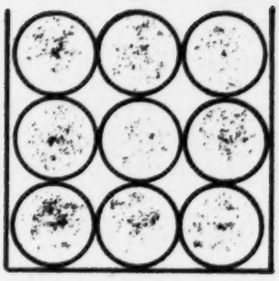

Uniform Spheres Loose

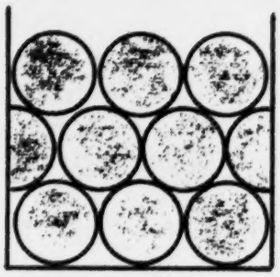

Uniform Spheres Dense

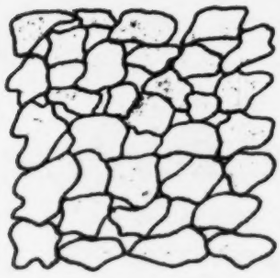

Uniform Gradation

Well-graded Soil

FIGURE 6-1
STRUCTURE OF SOIL

2. Vibratory action	* State that vibration forces will cause soil grains to readjust into a more compact arrangement.
	* Mention that there is a type of compaction equipment operating on the vibration principle, which will be discussed in a later lesson.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Vibratory consolidation as a problem	* State that consolidation of soils from vibratory forces, such as heavy truck traffic, is not a problem so long as good construction practices are used to compact the soils under the pavement. * The magnitude of vibrational forces from traffic diminishes rapidly with depth below the pavement.
B. From static loading	* Define static loading as the permanent loads placed on the soil by embankments and structures.
1. Mechanics of consolidation	* Introduce by reviewing the basic concept of soil as consisting of soil solids, water, and air. (Fig. 6-1) * Most compressible foundation soils, being below the water table, have all the voids filled with water.
a. Load application	* State that load applied will cause soil grains to readjust to a more compact position in order to carry the load.
b. Escape of water	* Explain that this readjustment cannot take place until the water, which is incompressible, escapes from the voids.
c. Time delay	* In impervious soils, water will travel very slowly, and it may take years for the water to drain away from the loaded soil area so the settlement can go to completion.
2. Consolidation characteristics	* State that it is necessary to know what types of soils will be critical for consolidation for highway design.
a. Gravels, sand, and nonplastic silt	1. Gravels, sands, and nonplastic silts are relatively incompressible and will consolidate immediately when fill is placed. These soils do not present settlement problems.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
b. Plastic silts and clays	2. Plastic silts and clays are compressible. Soft silts and clays are more compressible than stiff silts and clays. Settlement may continue long after construction.
c. Organic soils	3. Organic soils are very compressible, and settlement of large magnitude will continue for years.
3. Consolidation test	* State that, in order to predict the amount of foundation soil consolidation under an embankment, it is necessary to determine the consolidation properties of the soils. * An undisturbed sample is obtained in the field with a Shelby tube sampler and brought to the laboratory for testing.
a. Consolidometer	* Explain and sketch the details of the consolidometer apparatus. (Ref. A, p. 101)(Fig. 6-2)
b. Test procedures	* Explain the test procedures as follows: 1. A soil sample is trimmed from the Shelby tube sample. Its dimensions are: diameter, 2-1/2 inches; height, 3/4 inch. 2. Loads are applied in increments at 24-hour intervals to cover the range of load intensity expected in the field. Loads are measured in pounds per square foot (p.s.f.). 3. The amount and rate of deflection are measured. 4. Complete drainage occurs in less than 24 hours, because of the short drainage distance the water travels to the porous plates.

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CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

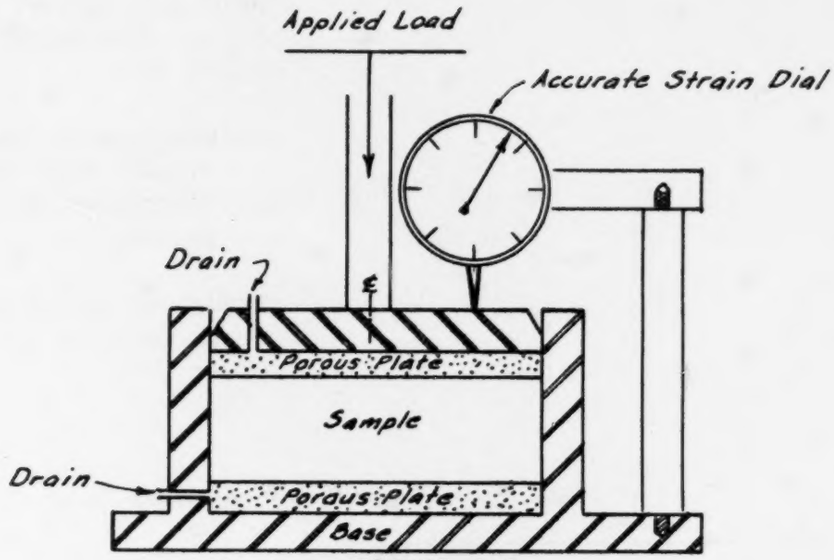

FIGURE 6-2
CONSOLIDOMETER

c. Analysis of test results

* State that the compression characteristics are indicated on a plot of void ratio versus logarithm of pressure. (Fig. 6-3)

1. The curve indicates that there is very little change in void ratio or consolidation under loads up to the point of maximum past compression. This load is determined by the history of the forces acting on the clay in the past.

2. Above the point of maximum past compression, the clay is more compressible.

3. Clays having a point of maximum past compression equal to the existing overburden load are defined as normally loaded clays.

4. Some clays have been precompressed to loads above the

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

present overburden pressure. These are called preconsolidated clays. Preconsolidation may be caused by:

a. Overburden that has been eroded away in the past
b. Shrinkage forces due to drying

(Refer to shrinkage of clay in the discussion on plasticity, Lesson 3.)

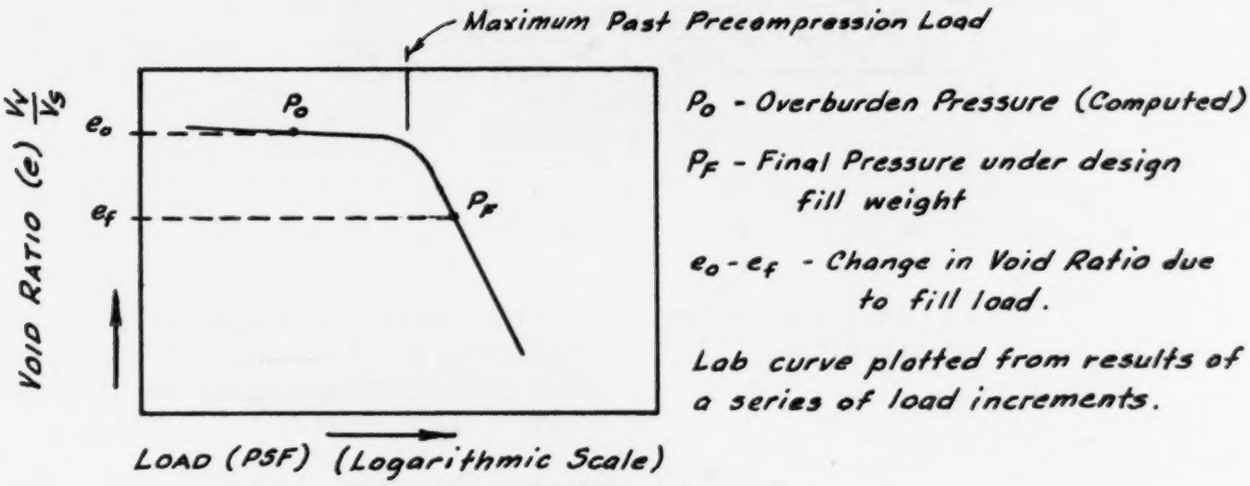

FIGURE 6-3
SOIL CONSOLIDATION CHARACTERISTICS:
VOID RATIO vs. LOGARITHM OF LOAD (p.s.f.)
(Consolidation Test Data Obtained In Laboratory)

4. Application of results

* State that a series of consolidation tests is conducted for the total depth of a soil deposit to determine the average consolidation characteristics.

a. Amount of settlement

* Explain that the void ratio vs. logarithm of pressure curve is used to predict field settlements.

1. The existing pressure in the ground due to soil overburden may be determined from the unit

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UNIT VI (14.0302-08)

RECORD MANAGEMENT

Performance Objectives:

Upon completion of this unit the student will be able to score at least 90% of an objective test dealing with the techniques and mechanics of indexing and filing basic to records handling.

The student will be able to type names and code numbers on fifty cards and file the cards accurately in 40 minutes. She will be able to file accurately 60 to 90 pieces of correspondence in twenty minutes. She will be able to index a variety of documents having names, geographical locations, or numbers. For all of the preceding the student will be able to demonstrate quick and accurate retrieval methods.

Unit Outline:

A. Need for Filing

1. Information retrieval
2. Safe keeping
3. Storage

B. Types of Business Papers and Records Commonly Filed

1. Office
2. School
3. Home
4. Financial department files
5. Miscellaneous files

C. Filing Equipment Supplies

D. Nature of Business Records

1. Correspondence files
2. Personnel files
3. Inventory
4. Financial department files
5. Miscellaneous files

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

3. A pressure-tight lucite chamber and metal top fit around the sample.

4. An air pressure is applied in the chamber and the sample consolidates to its original void ratio.

5. The failure load is applied through a piston in the top cover.

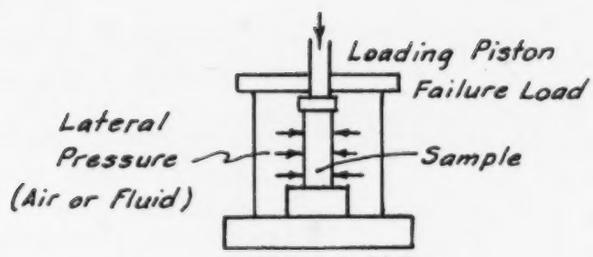

FIGURE 6-7
TRIAXIAL TEST

b. Comments on test

* Explain that the triaxial compression test duplicates as accurately as possible the pressure conditions in the ground and gives an accurate indication of shear strength.

* State that the test is longer and more expensive than the unconfined compression test.

* Explain that a series of tests may be run under various confining pressures in order to determine the amount of strength increase with consolidation under embankment loads.

3. Vane shear test

* Explain that the vane shear test is a field test made in conjunction with drill-hole explorations in soft clays.

a. Equipment

* The vane consists of four fins spaced at 90°. The vane is 4 inches high and 2 inches in diameter. The apparatus is attached to the drill rods and pressed carefully into the

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	clay at the bottom of the drill hole. At the ground surface a lever arm applies torque and a force gauge measures the torque.
b. Operations	* The vane is rotated slowly until a cylinder of soil is sheared. The force gauge measures the torque, which can be converted into shear strength of the soil.
c. Comments	* This is a test for determining shear strength rapidly without laboratory testing. The results are accurate in soft silts and clays.
C. Presentation of strength results	* The strength results of the triaxial compression test are plotted on a Mohr's circle of stresses. This is used in determining strength of materials.
1. Mohr circle plot	* List the main points of a Mohr circle plot. (Fig. 6-8)
a. Shear stress (S)	* Mohr's circle is made on a plot of shear stress (in p.s.f.) vs. principal stress (in p.s.f.). * The principal stresses in a test are the confining pressure and failure pressure. They are plotted and used as a diameter for the Mohr circle. * A line drawn tangent to a series of Mohr circles is called the Mohr envelope and represents the maximum shear strength. The point of tangency of the envelope to any circle represents the shear strength for the combination of vertical and lateral pressures represented by that circle.
b. Friction angle ϕ	* The slope of the envelope line is equal to the friction angle ϕ.
c. Cohesion (C)	* The intercept of the Mohr envelope with the shear-stress axis is the cohesion. This is strength with no confining pressure; such is obtained from the unconfined compression test.

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

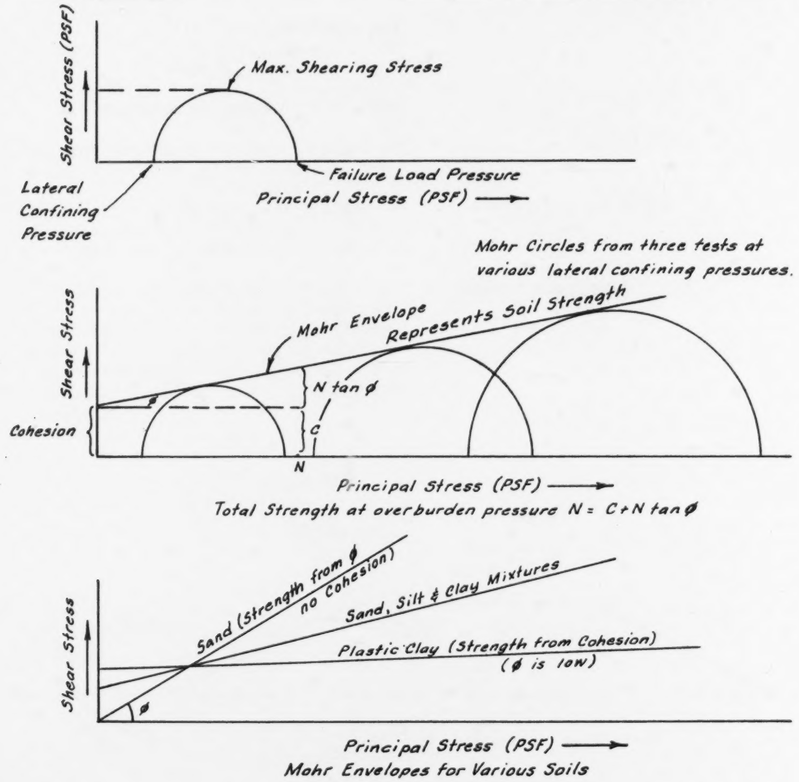

FIGURE 6-8
MOHR CIRCLE PLOT OF SHEAR STRENGTH

* The Mohr circle plot is useful in determining the strength of a soil for any pressure condition.

* The total shear strength at any overburden pressure is defined by

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

the equation:

$$S = C + N \tan\phi$$

where N is overburden pressure.

* Indicate typical envelopes for various soils. (Fig. 6-8)

D. Stability analysis

* Mention that the shear strengths obtained are used to perform stability analysis of embankments and structures.

1. Embankment stability analysis

* State that observations of many embankment failures involving the underlying foundation soils indicate that the failure surface is a circular arc. The embankment sinks down and the adjacent ground rises. (Fig. 6-9)

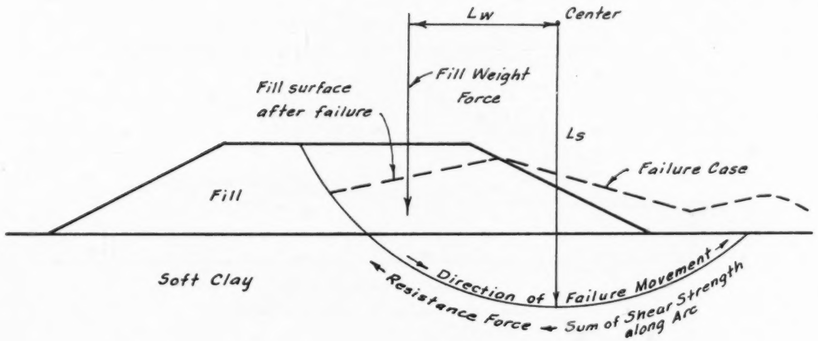

$$\text{Factor of Safety} = \frac{\text{(Resisting Moment)}\ \text{Total Shear Strength} \times L_s}{\text{Weight Force} \times L_w\ \text{(Overturning Moment)}}$$

FIGURE 6-9
EMBANKMENT STABILITY ANALYSES

CONTENT OUTLINE

a. Failure force

b. Resisting for

c. Mechanics of analysis

d. Factor of safe

IV. Design Solutions

A. Embankment stability problems

TEACHING POINTS AND TECHNIQUES

* Explain that the failure force consists of the weight of the embankment. The overturning moment is the product of the weight of the embankment (acting through its center of gravity) times the lever arm distance to the center of rotation (L_W).

ce * The resisting force against movement is the sum of all the soil shear strength acting along the failure arc. The resisting moment is the product of the shear strengths times the radius of the circle (L_S).

* For convenience, the width of the slice measured along the centerline is 1 foot. This simplifies computing total weight and total shear strength.

ety * The factor of safety against overturning is equal to the ratio of resisting moment to overturning moment.

$$\frac{\text{total shear strength} \times L_S}{\text{weight force} \times L_W}$$

* When the factor of safety is less than 1, failure will take place. The usual range of factors of safety used in design is 1.25 to 1.50.

* State that there are usually several solutions to a stability or settlement problem. The one chosen should be the most economical considering the following factors:

1. Available materials
2. Quantity and cost of materials
3. Construction time schedules
4. Line and grade requirements
5. Right-of-way

* Mention that the soil profile and soil properties have to be determined by explorations and testing in order to complete this final part of the analysis.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Relocate highway alignment	* State that a line shift of the highway to a better soils area may be the most economical solution.
2. Reduce grade line	* Explain that a reduction in grade line will decrease the weight of the embankment and may provide stability.

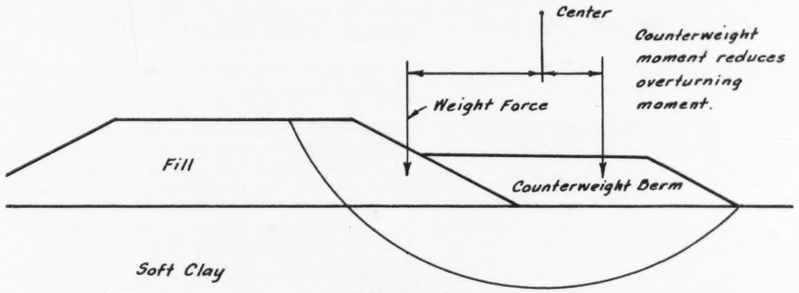

FIGURE 6-10
COUNTERWEIGHT BERMS

3. Counterweight berms	* Explain by using Figure 6-10 that the weight of the terraces, or berms, being on the outside of the center of rotation, provides an increased moment which resists failure. This increases the factor of safety.
4. Excavation of soft soil	* Mention that the strength of swamp soil is often insufficient to support embankments, and that in such cases soft soils are excavated and replaced with granular material.
5. Displacement of soft soil	* Indicate that for deep swamp deposits excavation is difficult and the swamp soil is displaced by continuous shear failures along the advancing fill front until the embankment is on firm bottom. The mudwave forced up in front of the fill is excavated to insure continuous displacement.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
6. Slow rate construction	* Mention that as a soil consolidates there is an accompanying increase in shear strength. For soils that consolidate relatively fast, such as some marls and silt-clays, this method is practical.
7. Lightweight embankment	* Point out that in some areas of New York State, for instance Buffalo, lightweight slag is available. This material weighs about 80 pounds per cubic foot. The overturning force is decreased by the lighter embankment weight.
8. Vertical sand drains	* Explain that vertical sand drains are usually the most expensive treatment and are not often used.

1. A sand drain is installed by driving a 12- to 18-inch diameter, closed-end casing to the bottom of the soft soil.
2. Clean, permeable sand is placed in the casing through a hopper with a pressure-tight gate.
3. When the mandrel is withdrawn, the bottom opens as a flap gate and the sand is forced out of the bottom of the casing by air pressure, leaving a column of sand in the ground.
4. Drains are installed at 8- to 12-foot centers, and a 2- to 3-foot layer of sand is placed for the full width of the embankment to permit drainage.
5. When the embankment is placed, the soil will consolidate if the water can drain from the voids. The soil water is initially under a pressure equal to the embankment weight pressure. This pressure forces the water laterally to the drains and upward through the permeable sand to the blanket.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	6. Sand drains diminish the time-lag for consolidation by reducing the drainage distance through the slow-draining soil.
	7. Sand drains accelerate settlement while increasing shear strength.
	8. Mention that a common point of confusion about sand drains is that the word "drain" usually implies downward drainage by gravity. In sand drains, the drainage is upward due to pressures in the soil water.
B. Embankment settlement problems	* Note that several of the methods for solving embankment stability problems also eliminate settlement.
	* State that embankments and pavements may undergo considerable foundation settlement as long as the settlement is uniform.
	* Objectionable differential settlements occur next to pile-supported structures.
1. Surcharge treatment	* State that the most common method is the surcharge treatment. The embankment is built up 1 to 10 feet above final grade elevation and allowed to remain for a determined waiting period. When the settlement with surcharge equals the estimated settlement without surcharge, the surcharge may be removed. (Fig. 6-11)
C. Stability and settlement problems for structure footings	* State that structure footings are designed with an allowable bearing capacity expressed in tons per square foot of footing. The allowable bearing capacity determines the size of footing for a design structure load.

CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

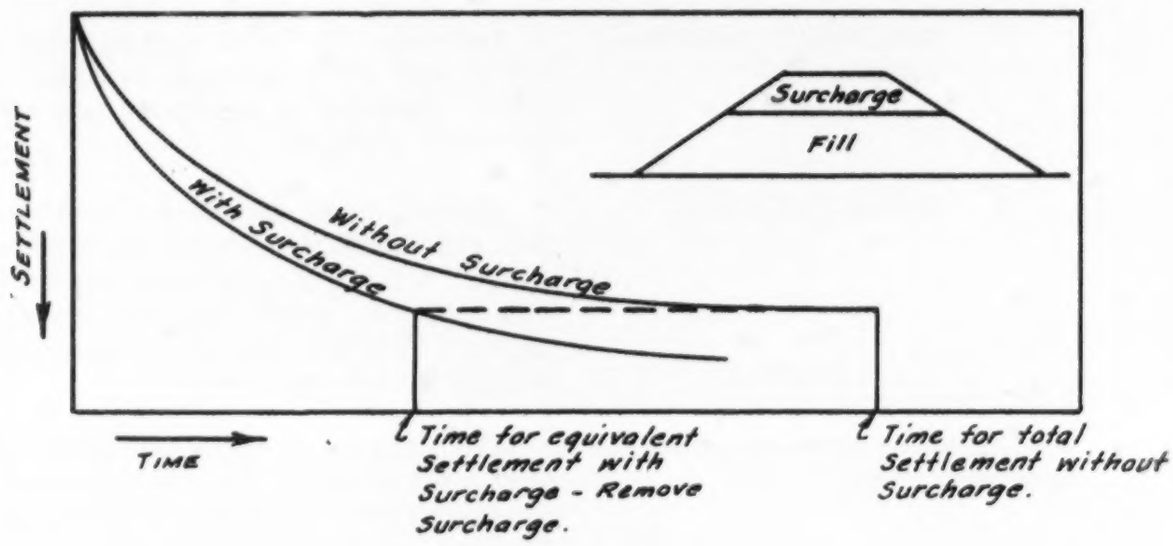

FIGURE 6-11
SURCHARGE TREATMENT

1. Stability requirements

* Explain that footings will fail with a circular-arc shear failure in the same manner as an embankment. Footings are designed with a factor of safety of three against shear failure. (Fig. 6-12)

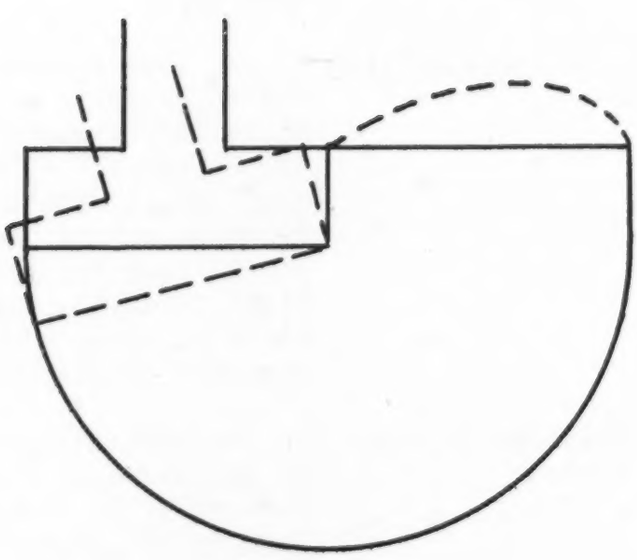

FIGURE 6-12
FOOTING FAILURE

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Settlement requirements	* Indicate that the maximum allowable settlement of a footing is usually 1 inch. Settlement analysis may be made for each problem.
3. Design handbooks	* Explain that the above settlement and stability requirements have been worked into design tables using the blows on the drive sampler, with soil identification, for an estimate of strength and settlement.
V. Distribution of Pressure from Applied Loads	* The practical application of pressure distribution is used in analysis of embankment foundation settlement, footing pressures, and wheel loads.
A. Fundamentals	* Explain that the fundamental principle to remember is that the stresses from a surface loading spread out with depth. Picture a continuous footing on the ground surface with a unit load of 2 tons per square foot (t.s.f.). If the footing is 5 feet wide, the total load will be 10 tons. (Fig. 6-13) * Note that total load is the same at all depths. The <u>pressure</u> decreases with depth.
1. Pressure decrease with depth	* The load spreads out with depth. The approximate boundary of pressure distribution may be determined by a trapezoid with sides extending down at a 60° angle with the horizontal. This is often called the two-on-one method since, from the geometry of a 30°-60° right triangle, the line may be determined by going down two units and out one unit of measurement.
a. Pressure determination	* The vertical pressure on any horizontal plane at a given depth can be determined by dividing the total footing load by the area of the plane at the desired depth. For long footings, the length may be made 1 foot to simplify computations.

CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

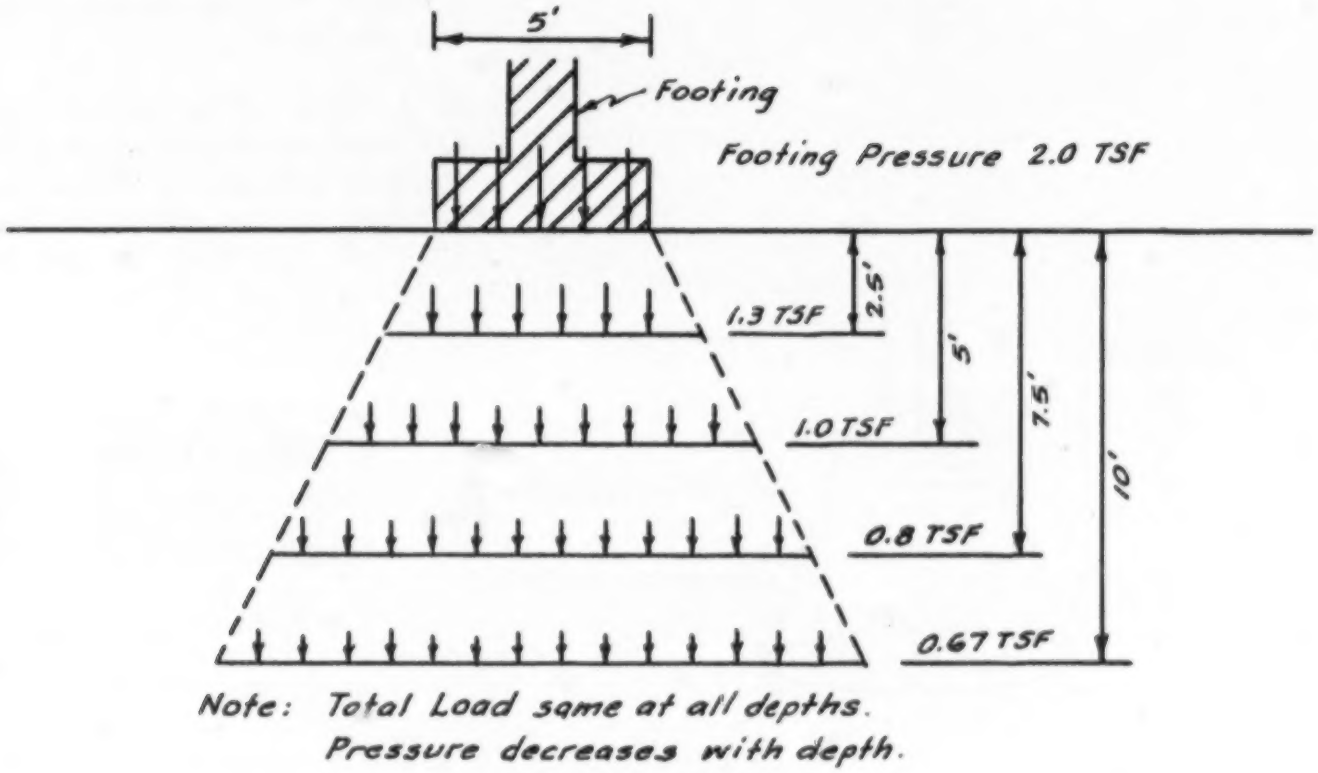

FIGURE 6-13
PRESSURE DISTRIBUTION UNDER FOOTING

* Note that the total load on any plane is equal to the surface load, but the pressure intensity decreases with depth.

* The pressure intensity is the factor that influences settlement and shear failures.

B. Distribution under wheel loads

* Explain that wheel loads applied at the ground or pavement surface create a moving applied load which is roughly circular in shape. The load is distributed in circles of diameters that increase with depth.

* Discuss Figure 6-14 showing wheel-load pressure distribution.

1. The tire pressure of 100 pounds per square inch (p.s.i.) is comparable to the heavier construction equipment.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

2. At a depth of 12 inches, the pressure is one-fourth that at the surface.

3. At a depth of 36 inches the pressure is 6 percent of the surface pressure. This is comparable to the pressure exerted by a man standing on one foot.

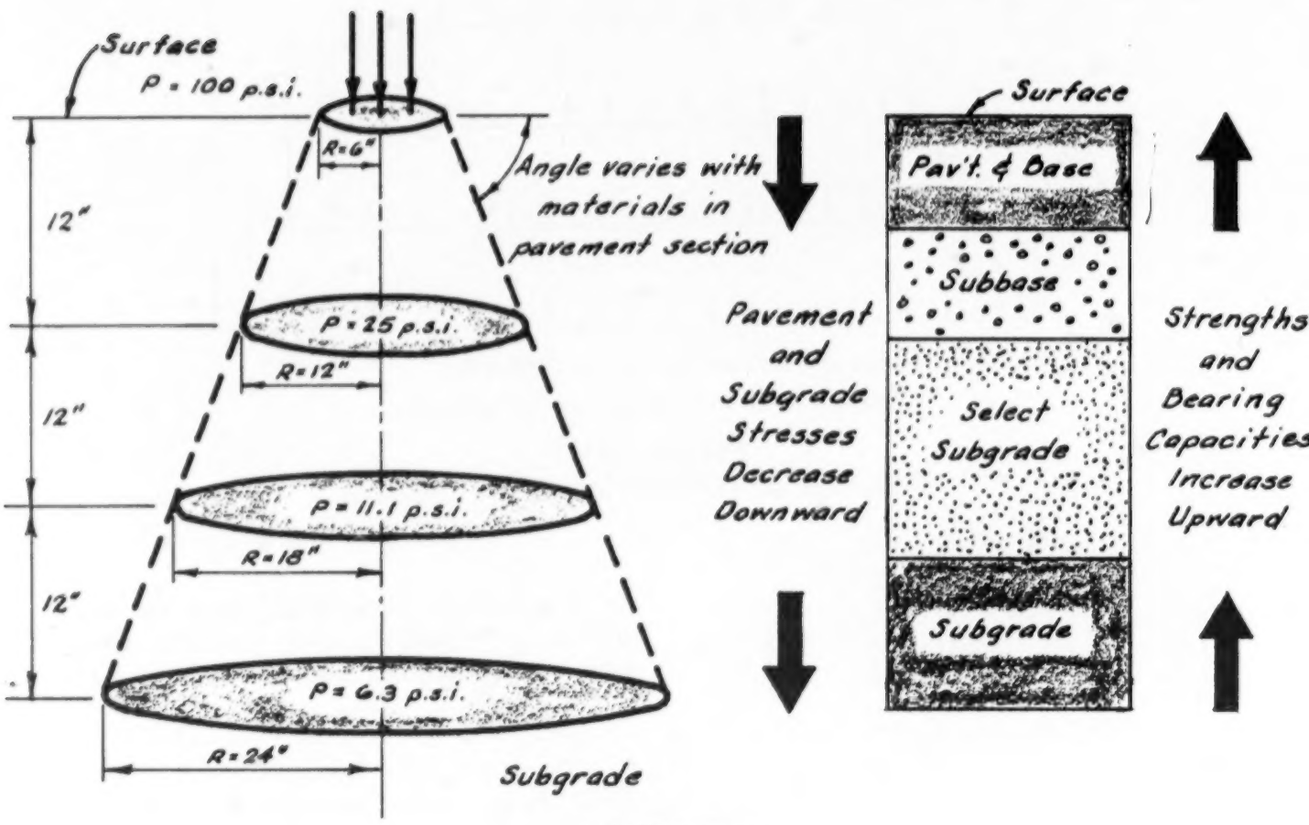

FIGURE 6-14
STRESS DISTRIBUTION UNDER WHEEL LOAD

C. Significance of pressure distribution

* Mention that the rapid decrease in loading pressures with depth is an important reason why embankment layers should be placed in 8-inch lifts in order to obtain uniform compaction.

* The design of pavement foundations should have the materials with the highest strength immediately below the pavement. (Fig. 6-14)

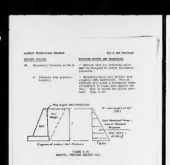

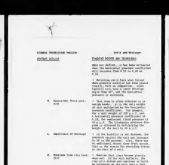

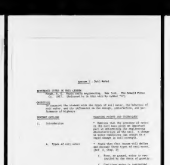

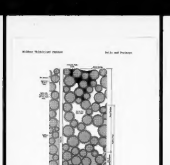

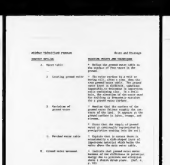

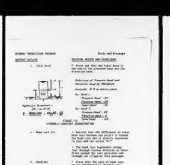

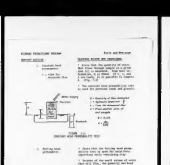

E. Basic Rules for Alphabetic Filing

1. Terminology
2. Rules for indexing
3. Variations in names and applicable rules
4. Variations in company names and applicable rules
5. Special consideration-deviations from basic rules
6. Geographic location filing
7. Subject files
8. Cross-referencing

F. Basic Rules for Numeric Filing

1. Use of numeric files
2. Cross reference to alphabetic order
3. Chronological files

G. Correspondence Files

1. Notations for signaling materials ready for filing
2. Procedures for preparing materials for filing

H. Special Files

1. Central files
2. Micro files
3. Computer tab files
4. Punched card

I. Information Retrieval

1. Identifying nature of information or document to be retrieved
2. Knowing the filing system
3. Computer or microfilm use

2208

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Constant head permeameter t = time for measured flow	* State that the quantity of water that flows through sample in a given time (t) is measured. From this information, Q is found. If i, t, and A are known, it is possible to compute k. (Fig. 7-3) * The constant head permeability test is used for pervious sands and gravels.

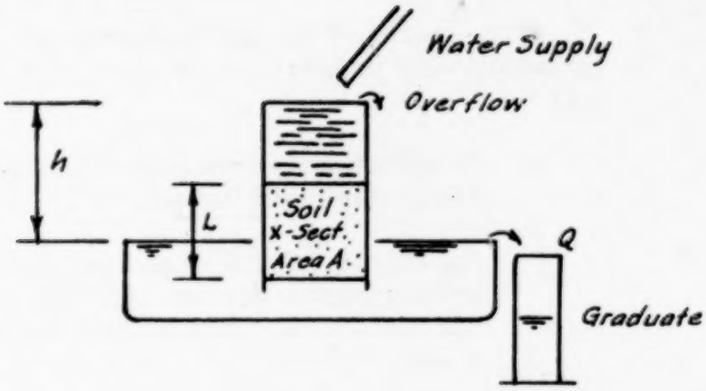

Q = Quantity of flow measured
i = Hydraulic Gradient - $\frac{h}{L}$
t = Time for measured flow
A = Cross-section area of soil sample

$$Q = kiAt$$

$$k = \frac{QL}{hAt}$$

FIGURE 7-3
CONSTANT HEAD PERMEABILITY TEST

2. Falling head permeameter	* State that the falling head permeability test is used for relatively impervious soils containing clay. * Because of the small volume of water that will flow, the quantity and head measurements are taken from a standpipe reservoir of small diameter.
3. Field tests	* State that the method of computing the permeability of the soil around a drill hole or well is to lower the water surface and measure the time required for the water surface to return to its original elevation.
4. Typical permeability values	* List values of the coefficient of of permeability for typical soils. The velocity of flow will be equal to the permeability when the hydraulic gradient is 1. Typical values:

22399

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Clean gravel--10,000 feet per day 2. Clean sands, clean sand and gravel--100 feet per day 3. Fine sand--1 foot per day 4. Silt--0.01 foot per day 5. Silt and clay--0.0001 foot per day
E. Uses of permeability characteristics	* Cite engineering applications of permeability properties of soil, to wit: 1. Computation of seepage through earth dams and levees 2. Estimates of pumping capacity requirements for unwatering cofferdams or excavations below a water table 3. Spacing and depth of underdrains for lowering the water table under a roadway in order to improve subgrade stability
F. Effect of ground water seepage on soil stability	* Observe that we often see flowing water moving solid material, such as sand and pebbles, along the bottom of a stream. * Ground water flow has the same effect on a soil when there is sufficient force.
1. Quicksand experiment	* Perform, or illustrate on the chalkboard, the quicksand experiment. (Fig. 7-4) * Describe the mechanics of the experiment.
a. Seepage force	* State that when the seepage force caused by the head of water on the bottom of the sample equals the weight of the sample, a "quick" or "boiling" condition develops.

22400

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Water table	* Define the ground water table as the surface of free water in the ground.
1. Locating ground water	* The water surface in a well or boring will, after a time, show the true ground water table. The ground water level is difficult, sometimes impossible, to determine in impervious soils containing clay. In a drill hole, the elevation of the water used for drilling is frequently mistaken for a ground water surface.
2. Variation of ground water	* Mention that the surface of the ground water follows roughly the contours of the land. It appears at the ground surface in lakes, swamps, and streams. * State that the supply of ground water is continually replenished by precipitation soaking into the soil.
3. Perched water table	* Explain that in nature there is occasionally a dish-shaped layer of impervious material which holds the water above the main water table.
B. Ground water movement	* Indicate that ground water moves because of the difference in potential energy due to pressure and elevation above a chosen datum plane. (Ref. A, p. 65)
1. Pressure head	* Explain that if a standpipe is placed at a point in the soil the water will rise in the pipe above the point, if the water is under pressure. The height of rise is the pressure head, and it is usually measured in feet. Discuss Figure 7-2.
2. Elevation head	* Explain that the height of the point above a datum plane is called the elevation head and is also expressed in feet.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

3. Total head

* Point out that the total head is the sum of the pressure head and the elevation head.

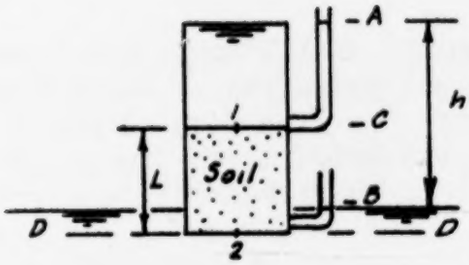

Hydraulic Gradient =
(Pt. 1 to Pt. 2)

$$\frac{h}{L} = \frac{\text{Head Loss}}{\text{Distance}} = \frac{AD - BD}{DC} = \frac{AB}{DC}$$

Definition of Pressure Head and Elevation Head by Standpipe

Consider D-D as datum plane.

For Point 1

Pressure Head	- AC
Elevation Head	- CD
Total Head	- AD

For Point 2

Pressure Head	- BD
Elevation Head	- 0
Total Head	- BD

FIGURE 7-2
HYDRAULIC GRADIENT DEMONSTRATION

4. Head loss (h)

* Mention that the difference in total head loss between two points is termed the head loss and is usually expressed in feet and the letter "h."

* The head loss represents energy lost through viscous friction as water flows around the soil particles and through the irregular void passages.

5. Gradient

i = hydraulic gradient
L = distance flow

* State that the rate of head loss may be determined by dividing the head loss by the distance between the two points. This is called the gradient, and it has no dimensions. It is expressed as the letter "i."

$$i = \frac{h}{L}$$

6. Aquifers and artesian flow

* Define an aquifer as a soil layer in which flow of water is occurring. It usually consists of a pervious layer overlaid by a less pervious layer.

* Define artesian flow as the condition in which the static water pressure raises the water level in wells

22397

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	does not deflect, it has been estimated that the horizontal pressure coefficient will increase from 0.33 to 0.40 or 0.45.
	* Retaining walls have also failed when granular backfill has been placed loosely, with no compaction. Loose backfill will have a lower friction angle than 30°, and the horizontal pressure is increased.
B. Equivalent fluid pressure	* This term is often referred to in design books. It is the unit weight of soil multiplied by the horizontal pressure coefficient. For example, for a unit weight of 120 p.c.f. and a horizontal pressure coefficient of 0.33, the equivalent fluid pressure is 40 p.c.f. The triangular pressure diagram is obtained by multiplying the height of the wall by 40 p.c.f.
C. Importance of drainage	* If the backfill is not drained, the pressure against the wall may increase by 50 to 200 percent. Also, there may be additional thrust from frost action. This is the reason for providing drains at the back of a wall.
D. Pressure from clay backfill	* Mention that clays become plastic when wet. If the wall deflects, the clay will deform and continue to build up pressures on the wall over a long period of time.
	* The pressures on a wall from a wet, plastic clay backfill can be as much as nine times greater than the pressures from an adequately drained granular backfill.
	* Clays cannot be drained.
E. Wall failure	* Many retaining walls have failed because they were designed for granular backfill and clay was used in the field.

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ASSIGNMENT

1. Read Chapter 5 of Ref. A, on compressibility and consolidation, with special attention to sections 1, 2, 3, 6, and 14-18.

2. Read Chapter 6 of Ref. A, on shearing strength, with special attention to sections 1-3, 6, 10-12, and 19-21.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
VI. Horizontal Pressure on Walls	* Mention that all retaining walls must be designed to resist horizontal pressures.
A. Pressure from granular backfill	* Retaining walls will deflect very slightly when backfilled. This deflection will allow a triangular wedge of backfill to slide down against the wall. This is called the active pressure. (Fig. 6-15)

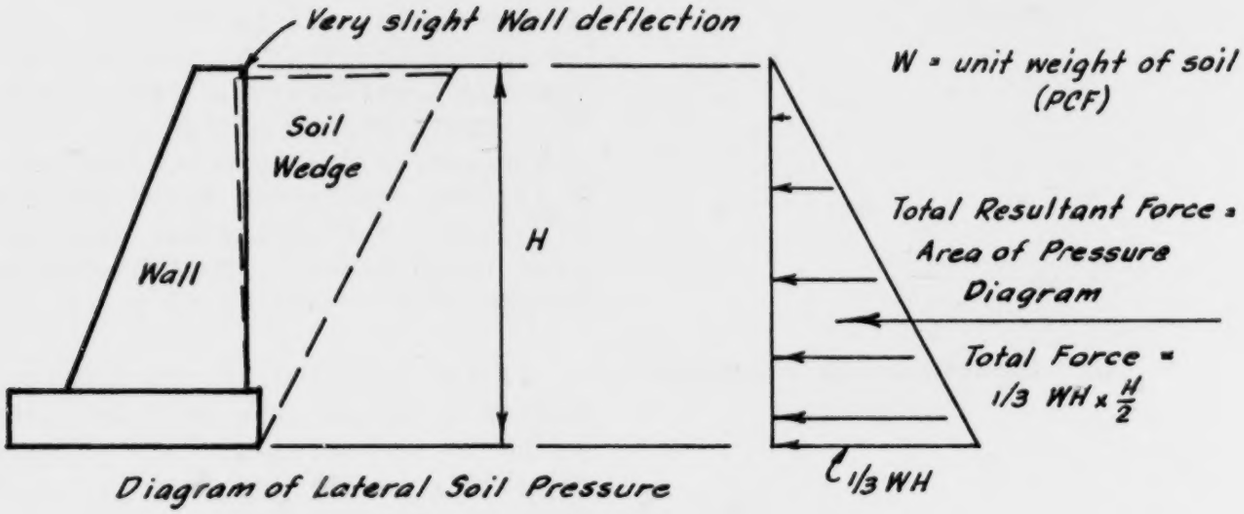

FIGURE 6-15
BACKFILL PRESSURE AGAINST WALL

1. Active pressure (1/3 WH)	* The active pressure which acts against the wall is one-third the unit weight of soil (W) times the height of soil (H). One-third represents the horizontal pressure coefficient for a soil friction angle of 30°. This coefficient is different for soils other than granular backfill. Since walls are backfilled with granular material, a friction angle of 30°, which gives a lateral pressure coefficient of one-third, is reasonable. This applies only if the ground surface is horizontal and if there is no surcharge loading behind the wall. If the wall

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HIGHWAY TECHNICIANS PROGRAM

CONTENT OUTLINE

C. Darcy's Law

v = velocity

1. Coefficient of permeability (k)

2. Quantity of flow

Q = quantity in cubi feet of flow, measured per day minute, or secon

A = cross-section area of flow analyzed

D. Measuring permeability

TEACHING POINTS AND TECHNIQUES

or drill holes above the ground water table. The popular definition for artesian flow is a condition in which the water level rises above the ground surface.

* Explain that Darcy's Law is an important principle in hydraulics, stating that for flow of water through soil the velocity or flow is proportional to the gradient: (Ref. A, p. 66)

$$v \text{ is proportional to } i$$

* State that the constant of proportionality is expressed as "k" and is called the coefficient of permeability. It is used thus:

$$v = ki$$

* State that the coefficient of permeability can be expressed in feet per day, feet per minute, or feet per second.

* State that the range of k varies with the type and density of soil. The coefficient of permeability for a clean gravel is over one million times the value for a clay. The large range in k explains the variable time units used.

* State that quantity flow may be determined from the formula:

$$Q = Av = kiA$$

* Mention that both laboratory and field procedures are used to measure permeability characteristics.

22398

Lesson 7 - Soil Water

REFERENCE CITED IN THIS LESSON

Hough, B. K. Basic soils engineering. New York. The Ronald Press Co. 1957. (Referred to in this unit by symbol "A")

OBJECTIVE

To acquaint the student with the types of soil water, the behavior of soil water, and its influences on the design, construction, and performance of highways

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	* Mention that the presence of water in the soil mass plays an important part in determining the engineering characteristics of the soil. A change in water conditions can result in a rapid change in soil strength.
A. Types of soil water	* State that this lesson will define and discuss three types of soil water. (Ref. A, Chap. 3) 1. Free, or ground, water is controlled by the force of gravity. 2. Capillary water is controlled by the forces of capillarity. 3. Absorbed water consists of very thin layers of water attached by molecular attraction to the soil surface. This is also called hygroscopic water. * Discuss Figure 7-1, showing the types of soil water.
II. Ground Water	* Define ground water as that water in the soil that is completely free to move through or drain from the soil under the influence of gravity. (Ref. A, p. 62)

22394

J. Retention and Purging of Files

1. Permanent record identification

2. Length of retention

3. Active and inactive files

4. Transfer and storage

Supplemental Teaching Aids:

Good resource people for this unit are school librarians or bank employees. A visit to a local library to observe its filing system is useful also.

The following are good resource books for the unit; Business Filing and Records Control, 3rd ed., Ernest D. Bassett, South-Western, Cincinnati, 1963, Records Management, Mary C. Griffin, Allyn and Bacon, Boston, 1964, and Gregg Quick Filing Practice, McGraw-Hill, New York, 1965.

A useful programmed instruction book is Basic Rules of Alphabetic Filing, by Fahrner and Gibbs, South-Western, Cincinnati, 1965. Free or inexpensive pamphlets are available from Smead Manufacturing Co., Hastings, Minnesota (Do's & Dont's of Filing and Science of Filing), and from the Oxford Filing Supply Company, Inc., Garden City, N. Y. 11533 (33 Common Filing Questions). Remington Rand, Systems Division has the film "It Must be Somewhere", while Cornet Films has "Filing Procedures in Business".

Training Time 30-40 hours

2209

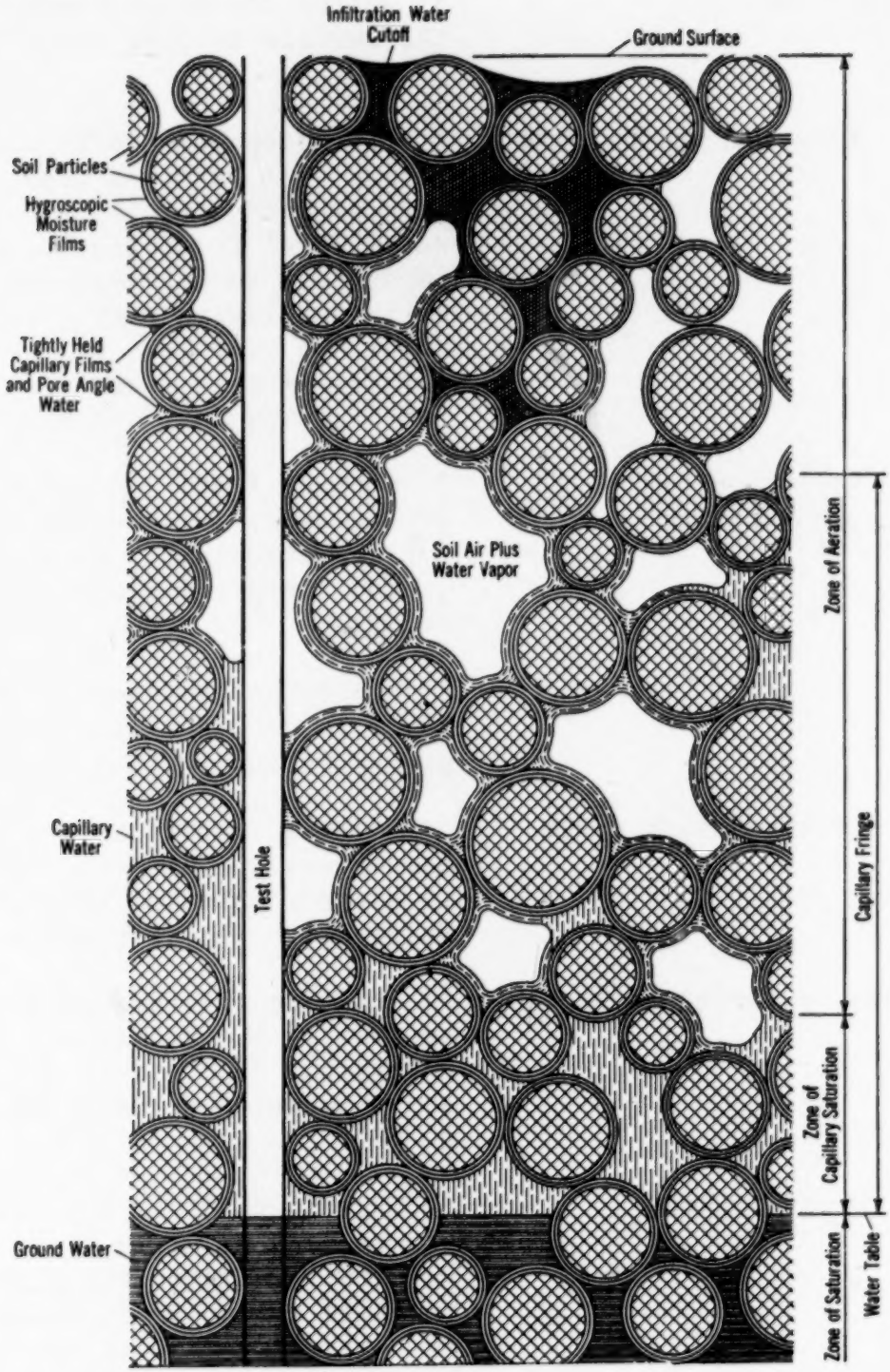

FIGURE 7-1
SOIL-WATER DISTRIBUTION

22395

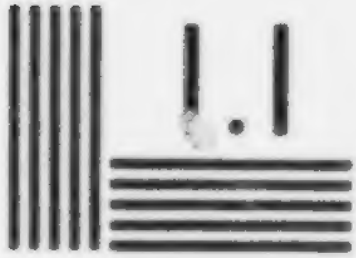

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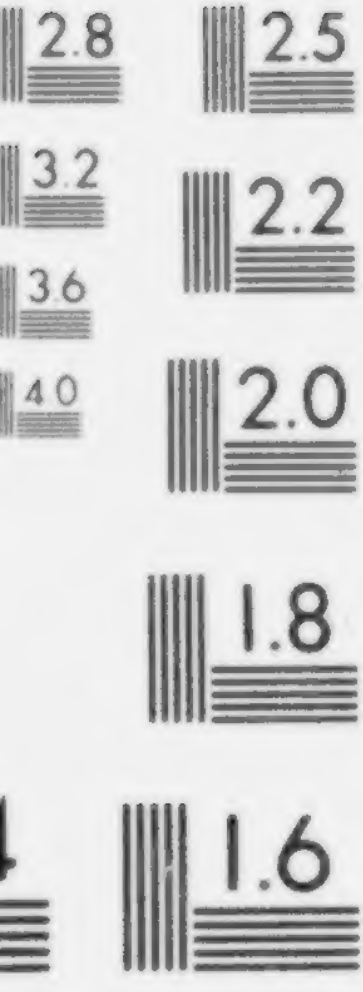

N TEST CHART

ANDARDS-1963-A

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

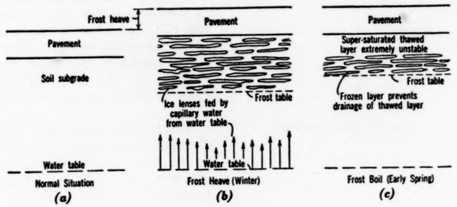

FIGURE 7-7
FROST HEAVE AND FROST BOIL IN SOIL
(Source: Ref. L, p. 309)

a. Frost boils

* Frost boils are the areas where pavements break up due to loss of subgrade support. Frost boils may last as long as several weeks until the soil thaws completely and the excess water can drain. Extensive frost boil conditions can develop in one day after a period of thawing weather.

B. Cause of frost heave

* Assert that the early belief was that frost heaving was caused by the expansion of water in freezing. Since freezing causes only a 9 percent volume increase, it did not explain frost heaves two feet high.

1. Growth of ice layers

* Ice layers grow in the following sequence (Fig. 7-7):

1. Pore water is frozen directly under the pavement.
2. The freezing causes a pressure decrease in the capillary forces of soil water. This decrease in pressure attracts capillary water from below, which forms additional ice crystals. The lenses will continue to build up as long as:

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

a. Freezing conditions continue
b. There is a water table to supply water
c. The water can be carried by capillary forces to the ice lenses

C. Control of frost heaving

* State that frost heaving can be controlled by removing the factors that cause it and determining the potential areas of frost heave during design.

1. Coarse-grain subbase

* Explain that heaving can be eliminated if a layer of clean sand and gravel is placed to a depth greater than the maximum depth of frost penetration. Tests indicate that the material must not have more than 3 percent of content finer than 0.02 mm., which is a very clean gravel. This treatment is quite expensive.

2. Lowering water table

* Ditches may be used to lower the water table and increase the vertical distance necessary for capillary rise between the water table and the pavement.

D. Critical soils for frost heaving

* Mention that most frost heaves occur in cuts.

* The most critical soils in frost heave are silt deposits that overlie water-bearing sands or gravels.

1. Moraine deposits

* Remind the class that moraine deposits are irregular mounds of debris left at the edge of the receding ice sheet. They often contain pockets of silt adjacent to coarser water-bearing soils. Kames are in the same category.

* A survey in Michigan indicated that about two-thirds of the detrimental frost heaves occurred in moraine deposits.

2. Other deposits

* Frost heaves do not occur in clay deposits, since the capillary flow of water in these is extremely slow.

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

* Frost heaves do not occur in clean, coarse sands and gravels, where the capillary rise is low.

* Frost heaves can occur in soils where the capillary properties are strong enough to carry the water from the water table to the zone of freezing.

* In the Adirondack Mountains, frost heaves are common at the transition into rock cuts. Ground water flowing off the surface of the rock creates the necessary conditions for heaving.

E. Frost heaving phenomena

1. Shallow culverts

* Culverts are raised by the movement of freezing soil adjacent to the pipes. The depth of frost penetration adjacent to a culvert increases as cold air circulates through the culvert. As the pipe heaves, a void forms under the bottom. When the soil thaws, material fills the void so that the culvert cannot subside with the surrounding soil. The result is an objectionable bump in the road.

2. Boulders

* Farmers have found that new boulders appear in their fields each year. These are brought to the surface by the same action described for culverts. Boulders are also pushed through pavements, forming bumps. Boulder undercutting is used on new construction in northern New York State.

3. Structures

* Foundations for major structures are placed below frost depth to avoid heaving.

ASSIGNMENT

1. Read all of Chapter 3, Ref. A.

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

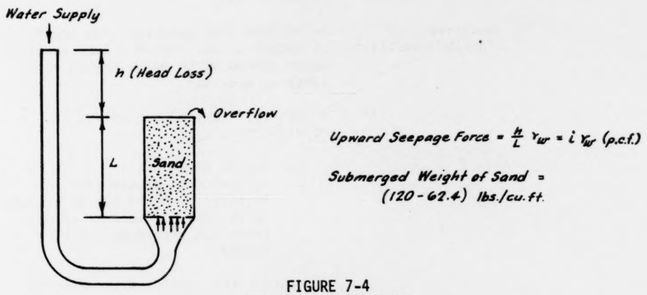

FIGURE 7-4
QUICKSAND EXPERIMENT

b. Submerged weight of sand

* The seepage force is the force imparted to the soil by the flow of water. As the void size and particle size decrease, there will be more frictional resistance to the flow which acts as a force on the soil mass. The direction of the seepage force is always in the direction of flow. The magnitude of the force is $i\gamma_w$. This is the force acting on each cubic foot of soil. In the quicksand experiment, the submerged weight of sand is about 60 pounds per cubic foot. The upward seepage force is 62.4 pounds per cubic foot when i = 1. The critical hydraulic gradient of 1 will cause a "quick" condition in a fine sand.

2. Quicksand conditions

* Mention that quicksand conditions are most likely to occur in fine sands and nonplastic silts. They very seldom occur in coarse sands or gravels.

a. Critical soils

* Explain, from the basic relation v = ki. The coarser granular soils have coefficients of permeability 100

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

times, or more, that of the finer sand and silt soils.

b. Occurrence of "quick" conditions

* Mention that quicksand can occur in nature in the bed of a lake or river where ground water flows upward under artesian pressure.

* Describe "quick" conditions in construction, viz:

1. In cut excavations
2. In unwatered excavations for footings of buildings or bridges
3. On the downstream side of dams after the reservoir has been filled

* Mention the popular misconception of quicksand as a type of soil deposit. Actually it is a temporary instability of a soil caused by water conditions.

* People caught in quicksand will not sink if they remain still.

c. Prevention of sand boils

* State that the usual method to stabilize a "quick" area is to cover it with a blanket of gravel which will add weight to the soil. Since the permeability of the gravel is many times that of the sand, the hydraulic gradient in the gravel will be reduced below the critical value of 1. Explain from the equation v = ki.

* Another method is to build a ring of sand bags around the area, allow the water to pond, and make a back pressure which reduces the hydraulic gradient and quiets the soil. Barrels have been used to control small boils.

3. Compaction by puddling

* Mention that an old method of compacting excavation backfills was puddling. As the excavation was backfilled the trench was flooded with water. The downward seepage force of the water supposedly compacted the backfill.

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

a. Conditions needed for compaction

* Explain that in order for any compaction to take place the following conditions must be present:

1. The backfill has to be permeable enough to allow reasonably rapid drainage.
2. The surrounding soil has to have a permeability equal to or greater than the backfill.

b. Puddling not recommended

* Point out that puddling is not recommended for compacting excavation backfill, because the relative permeabilities of the backfill and surrounding soil are difficult to estimate. Success depends on the right combination of permeabilities, which does not always exist.

4. Ground water seepage on cut slopes

* Explain that where concentrated zones of ground water seepage emerge on a cut slope seepage forces may cause the soil to become "quick" and flow down the slope.

a. Typical critical soil conditions

* Inform the class that this condition often exists where a fine sand or silt overlies an impervious soil, such as clay.

* Concentrated horizontal ground water flow along the top of the impervious layer emerges on the cut slope at a velocity great enough to make the fine sand or silt "quick." The condition of instability works back from the cut surface and undermines the slope above.

b. Gravel slope protection blanket

* Indicate that the treatment for this problem is to place a 2- or 3-foot gravel blanket from the zone of seepage to the bottom of the slope. Often the lower slope will erode from the concentrated flow on its surface. The requirements of this gravel blanket are:

1. A permeability great enough to reduce the hydraulic gradient

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	causing instability (v = ki relations)
	2. Sufficient fine material to make voids in the gravel blanket small enough to prevent fine sand and silt from washing in and clogging the voids
c. NYSDPW use of granular blanket	* The New York State Department of Public Works uses a granular slope-protection blanket item with a gradation that satisfies the above two requirements.
III. Capillary Water	* Explain that above the water table is a zone where the soil voids are filled with capillary water. In contrast to the ground water, which is controlled by the forces of gravity, capillary water is controlled by the forces of capillarity. (Fig. 7-1) (Ref. A, p. 56)
A. Capillarity demonstration	* Illustrate or demonstrate a small-bore tube inserted in water. The water rises a distance inside the tube. Experiments with tubes of various sizes show that the capillary rise increases as the diameter decreases. (Fig. 7-5)
B. Explanation of capillarity	

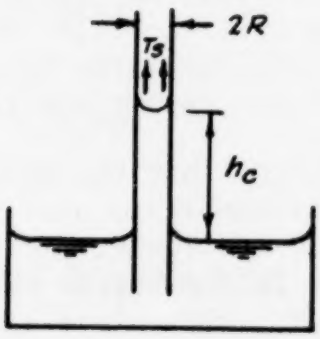

$$\text{Capillary Force} = \frac{2T_s}{R}$$

$$\text{Wt. Water in Column} = h_c \gamma_w$$

$$h_c = \frac{2T_s}{\gamma_w R}$$

FIGURE 7-5
CAPILLARY RISE

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Surface tension	* Explain that the force holding up the column of water is surface tension. It is a property of liquids that the molecules at the surface are in tension and appear to act like a stretched membrane.
2. Wetting property of water	* Explain that water tends to wet surfaces with which it comes in contact, resulting in a curvature of the water surface.
3. Capillary rise H_c = height of capillary rise T_s = surface tension R = radius of tube	* Show that surface tension force, acting along a radius of curvature results in a vertical component of force. This force is equal to and supports the weight of the column of water in the capillary rise. From this relation it can be determined that: $H_c = \frac{2T_s}{\gamma_w R}$ * The most important thing to remember is that the height of capillary rise varies inversely as the radius of the tube or soil void.
C. Practical aspects	* Capillary rise and the forces of surface tension influence greatly the properties of soils. * Consider the voids in a soil sample to be similar in shape to a series of small, winding, irregular capillary tubes. * Plants and trees lift water from their roots to the leaves in small capillary tubes.
1. Greatest rise in fine-grain soils	* It has been demonstrated that the height of capillary rise varies inversely to the radius of the soil pores. The fine-grain soils have the smallest pores and therefore the greatest capillary rise.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	becomes free water, the pile of sand will diminish in volume. Bulking may increase the volume of sand by as much as 25 percent.
3. Effect on beach sands	* Describe the behavior of sand beaches, which can support heavy traffic when damp but will rut badly when dry. 1. When soil is dry, concentrated wheel loads will exceed the shearing strength of the granular material, and failure of the soil, or rutting, will occur. 2. After high tide recedes, the sand will drain. Tightly held capillary films develop at the contact points between particles, drawing the soil together and resulting in high shear strength. As the particle sizes decrease, the void diameters decrease and the capillary strength increases.
IV. Construction Drainage	* Mention that an understanding of the behavior of soil water movement is important when excavating cuts and making excavations for structure foundations.
A. Ground water control	* Repeat that ground water is controlled by gravity.
1. Ditches and dumping	* Drainage can be accomplished with ditches in cuts and pumping in excavations.
2. Well points	* Mention that well points are used where there are large quantities of water to remove or where excavating conditions are difficult in wet soils. Well points are pipes with perforated and screened end sections driven or jetted to an elevation below the bottom of proposed excavation. The pipes are connected to a pumping system and the

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

water surface is lowered by pumping. Well points are not effective in silt soils or clay soils due to the low permeability of the material. (Fig. 7-6)

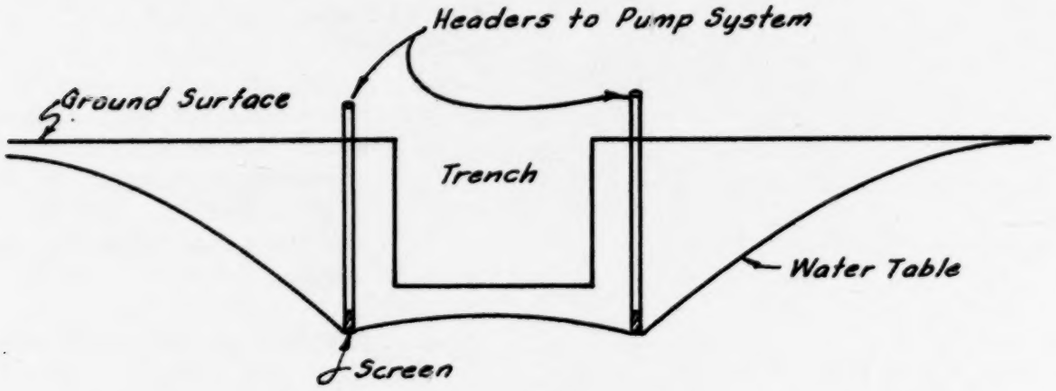

FIGURE 7-6
WELL POINTS

3. Cuts in water-bearing soils

* State that cuts should be made on an upward grade to allow drainage. Cuts made on a downgrade will collect water at the excavation face.

B. Surface water control

* Mention that ditching and drainage grading should be maintained in all cuts to provide drainage for surface runoff. Ponding of water and saturation of soils make all soils except highly pervious materials difficult to handle during construction. Surface water may be controlled by gravity drainage.

C. Problem soils for drainage

* Explain that the effectiveness of drainage varies with the properties of the soils encountered.

1. Silts

* State that silts may be difficult to drain by ditches when the capillary rise above the water table is greater than the practical depth of a ditch.

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UNIT VII (14.0302-06)

SOURCES OF INFORMATION

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate her knowledge of information sources by compiling a list of information to meet specifications designated by the instructor.

Unit Outline:

A. The Reference Book as a Tool of the Office Worker

1. Importance of accurate business information
2. Kinds of information needed
3. Necessity of obtaining information quickly
4. Necessity for initiative in finding information

B. Reference Books of the Office Worker

1. Dictionaries
2. Reference manual for stenographers and typists
3. English grammar and style books
4. Directories
5. Thesaurus

C. Other Sources of Factual Information

Supplemental Teaching Aids:

The most obvious resource person is of course the librarian. Also available is the Gregg Secretarial Record #6, Set #2 "Finding Needed Information". The film "Look It Up-Dictionary Habits" (11 min.) is available from Cornet Instructional Films.

Training Time 3-5 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Clays	* Assert that ground water control is not a problem with clays because the soil is impervious and there is little ground water. The big problem is to provide drainage for surface runoff, as the soil will lose strength from soaking in ponded water.
3. Sands and gravel	* Point out that sand and gravel deposits may have water-bearing layers, or lenses, that provide water in large quantities. Special drainage may be required for these areas.
4. Soil mixtures	* Explain that the majority of soils contain mixtures of the above soils in various proportions. It will take observation and judgment to determine whether the properties of silt, clay, or granular materials are influencing the behavior of soil water in excavations.
V. Frost Action in Soil	* State that damage to pavements by frost action is one of the most difficult soil problems to solve. Such damage may be serious and expensive to repair. (Ref. A, p. 77)
A. Phases of frost damage	* Mention that frost damage to pavements occurs in two distinct phases.
1. Pavement heave	* State that, as the frost line penetrates the soil beneath a pavement, ice may form in areas where soil and water conditions are favorable to their growth. The depth of frost penetration in New York State varies from 1 foot on Long Island to 4 to 6 feet in the upstate. (Fig. 7-7)
a. Differential heaving	* Uniform heaving is not objectionable. When soil conditions are not uniform, differential heaves of several inches to 2 feet can occur.
2. Thaw period	* State that thawing works from the surface down. Soil becomes supersaturated because it cannot drain, and loses all strength.

22409

Lesson 8 - Compaction of Embankment Soils

REFERENCES CITED IN THIS LESSON

Hough, B.K. Basic soils engineering. New York. The Ronald Press Co. 1957. (Referred to in this unit by symbol "A")

Lambe, T.W. Soil testing for engineers. New York. John Wiley and Sons. 1951. (Referred to in this unit by symbol "F")

New York, Department of Public Works, Division of Construction. Public works specifications of January 2, 1962. Albany, New York. The Division. 1962. (Referred to in this unit by symbol "H")

New York State, Department of Public Works, Bureau of Soil Mechanics. Guide to the proper construction of highway embankments. The Bureau. 1958. Engineering Research Series No. TM 58-2. (Referred to in this unit by symbol "I")

United States Government, National Research Council, Highway Research Board. Washington, D.C. Factors that influence field compaction of soils. The Council. 1960. Highway Research Board Bulletin No. 272. (Referred to in this unit by symbol "G")

OBJECTIVE

To explain the principles of soil compaction and the field procedures and equipment used to obtain proper soil compaction

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	* State that compaction is one of the most important lessons in this course, as most technicians will perform or supervise earthwork inspection at some time in their careers.
A. Proper compaction for pavements	* Proper compaction of embankments and backfills is an essential factor contributing to a smooth-riding pavement.
B. Need for knowledge of compaction principles	* Knowledge of the principles of compaction and the behavior of types of soils under varying field conditions

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	is necessary to an understanding of the problems a field inspector will encounter.
II. Fundamentals of Soil Compaction	* Define compaction as the process of artificially densifying a soil by pressing the soil particles together so that air and water are expelled from the soil mass.
A. Method of densification	* State that densification is achieved by applying moving loads to the soil mass.
	* Explain that the dynamic compaction of moving loads is different from the compaction of foundation soils by static loading (embankment loads), discussed in Lesson 6.
B. Advantages gained from compaction	* Mention that the advantages gained from compaction have made it a standard procedure in the construction of highways, earth dams, and airports.
1. Minimizing settlement	* State that densification by compaction will prevent later consolidation of the embankment soil from static and moving traffic loads and from the weight of the overlying embankment material. (Fig. 8-1)

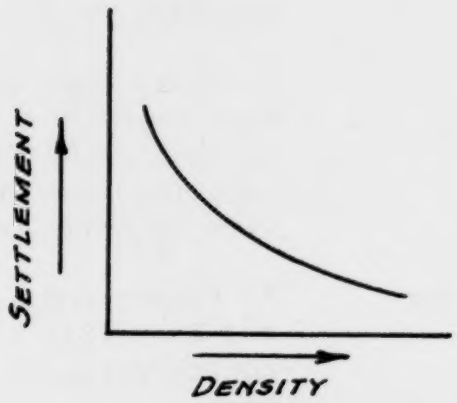

FIGURE 8-1
EMBANKMENT SETTLEMENT vs. DENSITY

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Point out that embankment compaction will not eliminate the settlement caused by consolidation of deep underlying compressible soil layers which form the foundation for the embankment (discussed in Lesson 6).
2. Increased shearing resistance	* Explain that increasing density by compaction will increase the shearing strength of a soil. (Fig. 8-2) Pavement failures can occur if the supporting soil has insufficient strength.

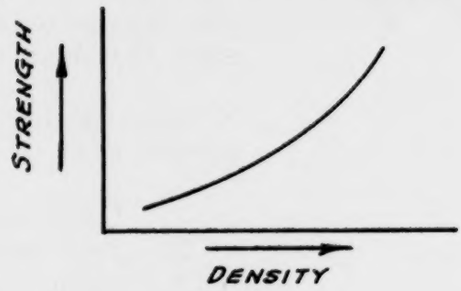

FIGURE 8-2
EMBANKMENT STRENGTH vs. DENSITY

3. Effects on water movement	* State that the densification of a soil will lessen the water movement by reducing the number of void spaces and the sizes of voids.
a. Reduction in permeability	* Inform the class that reduction in permeability will decrease the water movement or seepage in the soil mass. This minimizes the tendency for the soil to take up water and suffer later reductions in strength.
b. Reduction in air space	* Remind the class of the principle of capillary flow and the need for air in voids to develop capillary movement of water. A reduction of air in the soil diminishes the possibility of water increase by capillary flow.
c. Importance	* Emphasize that decreasing the tendency for water movement in the zone of the embankment immediately below

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	the pavement is very important. The surface portion of the embankment is subject to infiltration from precipitation and the effects of freezing and thawing, all of which tend to increase the moisture and decrease the shear strength.
C. Factors influencing density	* Mention that there are three fundamental factors that influence the density of a compacted soil.
1. Compactive effort	* State that compactive effort is the energy used per unit volume of soil for densification. * Factors influencing the compactive effort are: 1. Layer thickness 2. Type and weight of equipment 3. Number of passes of equipment * Mention that these factors will be discussed in detail in a later section.
2. Type of soil	* List the various soil properties affecting compaction: 1. Size of soil particles 2. Gradation of soil particles 3. Shape of soil particles 4. Plasticity of fine-grained particles 5. Specific gravity
3. Moisture content	* State that the moisture content of soil at compaction is one of the most important factors influencing the soil density.
D. Moisture-density relation	* Show, using Figure 8-3, that for each soil a maximum dry density is developed at an optimum moisture content for the compactive effort used.
1. Optimum moisture content	* Define optimum moisture content as the moisture content at which a soil has a maximum dry density for the compactive effort used.

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CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

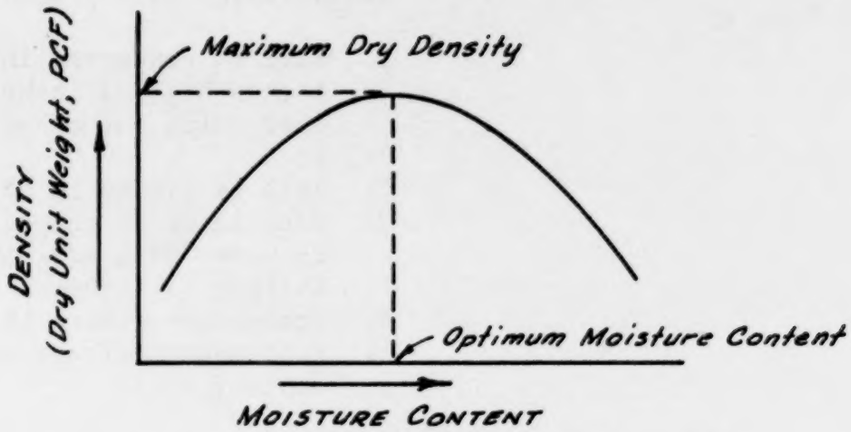

FIGURE 8-3
BASIC COMPACTION CURVE

2. Mechanics of moisture-density relation

* Explain the mechanics of the compaction as follows:

1. When soil is dry, soil grains pressed together will rebound.
2. When soil is very wet, the water in the voids interferes with the packing of particles. The particles will slide over one another instead of packing.
3. When a soil is at the optimum moisture content, there is sufficient water to lubricate the particles. They will slide over one another and hold in place in the closest-packed arrangement for the given compactive effort.

3. Laboratory compaction tests

* Indicate that two standardized compaction test procedures are used in the United States.

a. Standard AASHO

* State that the standard AASHO (American Association of State Highway Officials) compaction procedure is used by most state highway departments. (Ref. F, Chap. 5)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Describe the test procedures: 1. Soil is compacted in mold 4.6 inches high, 4 inches in diameter, with volume of 1/30 cu. ft. 2. Soil is placed in three layers. 3. Each layer is compacted with 25 blows of 5 1/2-pound hammer falling 12 inches. 4. Compactive effort is 12,400 foot-pounds of energy per cubic foot of soil.
b. Modified AASHO	* State that the modified AASHO compaction procedure is used by the U.S. Corps of Engineers and several state highway departments. * Describe the test procedure: 1. Soil is compacted in same mold as used for standard AASHO test. 2. Soil is placed in five layers. 3. Each layer is compacted with 25 blows of a 10-pound hammer falling 18 inches. 4. Compactive effort is 56,200 foot-pounds of energy per cubic foot of soil.
c. Test procedure	* Indicate that to develop the moisture-density relationship several samples of the soil at various moisture contents are compacted. The wet unit weights and moisture contents are determined and the dry unit weight corresponding to each moisture content is calculated. The points are plotted on a moisture-dry density curve. (Fig. 8-3)
4. Zero-air-voids ratio curve	* State that the zero-air-voids ratio curve represents the theoretical dry density of the sample if all the air is expelled from the voids. This curve may also be called the 100 percent saturation curve. (Remind the class that the saturation is $\frac{V_w}{V_v}$ expressed as a percent.)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
a. Significance of curve	* Explain a sketch, showing lines of 80 and 90 percent saturation. (Fig. 8-4) * At moisture contents above the optimum moisture content the moisture-density curve is parallel to a percent-saturation line. * The positions of the curves indicate that as water is added beyond the optimum moisture content, a certain volume of air is entrapped in the voids that no amount of compaction or addition of water will remove.
b. Use of curve	* State that the zero-air-voids ratio curve serves two practical purposes: 1. If any values of the dry density curve are plotted to the right of the zero-air-voids curve, there must be an error. The error may be in the test measurement, the calculation, or the specific gravity. 2. The zero-air-voids ratio curve serves as an aid to drawing the moisture density curve, since they are parallel.
E. Variables affecting moisture-density curve	
1. Variation of compactive effort	* Explain that, for all soils, in field or laboratory compaction, an increase in compactive effort will increase the maximum dry unit weight and decrease the optimum moisture content. (Fig. 8-5)
2. Compaction characteristics	* State that the moisture-density curves for each type of soil will vary in shape and location on the graph. * These variations are influenced by grain size, gradation, particle shape, plasticity, and specific gravity.

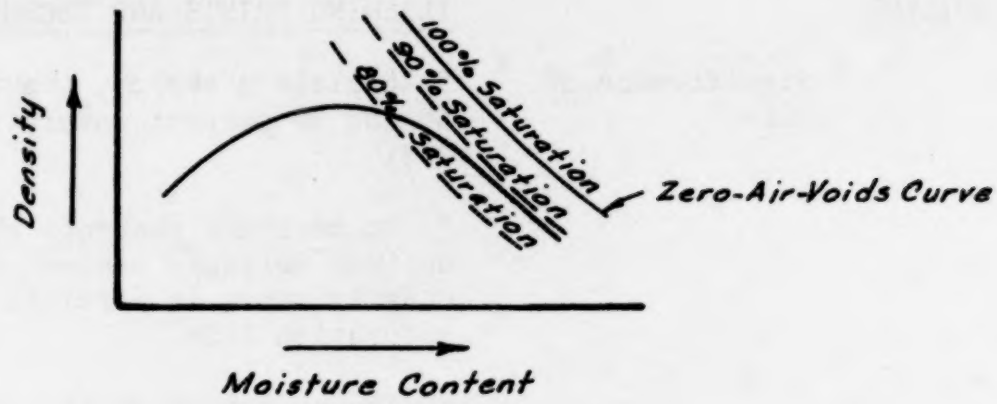

FIGURE 8-4
BASIC COMPACTION CURVE AND PERCENTAGE OF SATURATION

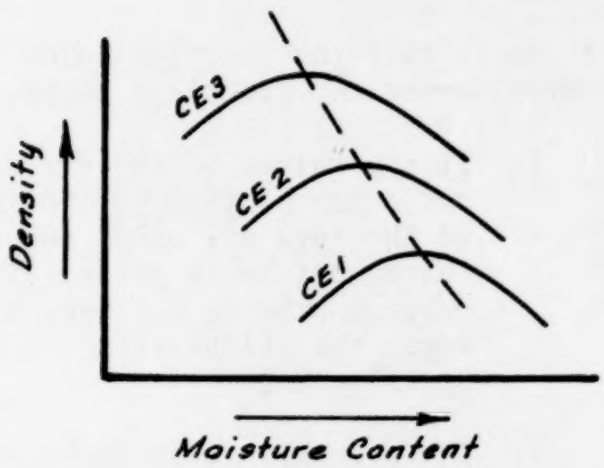

Compactive Effort increases from CE 1 to CE3.

With increase in Compactive Effort, maximum density increases and optimum moisture content decreases.

Soil Type is same for all tests.

FIGURE 8-5
EFFECT OF COMPACTIVE EFFORT ON MOISTURE-DENSITY CURVE

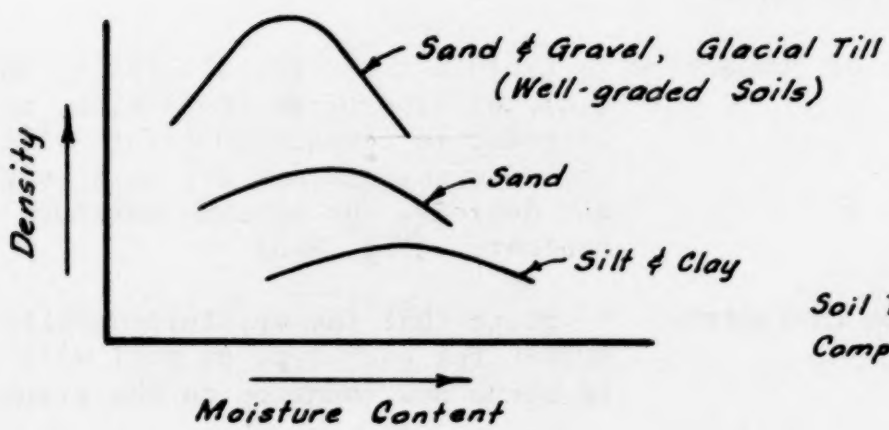

Soil Type varies.
Compactive Effort constant.

FIGURE 8-6
EFFECT OF SOIL TYPE ON MOISTURE-DENSITY CURVE

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Illustrate, using Figure 8-6, the position and shape of typical curves.
a. Effect of gradation	* Explain that a well-graded soil whose grain sizes vary from coarse to fine gives the highest density.
	* The smaller particles fill the voids between larger particles.
	* Well-graded materials are sensitive to changes in moisture when compacted, and their curves have sharp peaks.
	* Uniform soils, whose particles are all the same size, are slightly sensitive to change in moisture content, and their moisture-density curves have only slight curvatures.
b. Effect of particle size	* Explain that, in general, the coarse-grain soils will have higher densities than the fine-grain soils.
	* Sometimes the factor of gradation may mask this trend.
3. Effect of temperature	* Point out that it is very difficult to compact soil when the temperature is below 32° F., because there is no water to lubricate particles and allow the mass to densify.
III. Compaction Requirements for Embankments	* Mention that the compaction requirements to be discussed are those specified by the New York State Department of Public Works in its construction specifications. All agencies have compaction specifications, most of which contain all or some of the New York requirements.
A. Layer construction	* Mention that soil should be placed in layers no more than 8 inches in thickness before compaction.
1. Purpose	* Layer construction is intended to insure that the soil is uniformly compacted with depth.

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VEO #14.0901

DOT #209.388

TRAINING COURSE FOR

CLERK-TYPISTS

The material in this guide is presented in the form of suggestions. Every student participating in this program will be different in regard to education, experience, and ability. The instructor must, therefore, adjust and adapt the suggestions in this guide to the needs of individual students.

The first step in insuring this adjustment is to secure as much information as possible about each new student. This can be accomplished through study of the pre-enrollment information gathered by the Center counselors. The second step is to keep up to date on the progress of each student through the regular use of the information prepared by Individual Program Control (IPC). With this information on hand the instructor can effectively adapt specific objectives, teaching methods, and time alloted to each aspect of the training, directly to the student't needs.

This guide will aid the instructor in accomplishing part of his job. It will provide performance objectives, suggest time allotments, unit outlines, and supplemental teaching aids. Only the instructor, however, can combine these factors with a knowledge of each individual student.

Course Objectives:

The Clerk-Typist program at Gila River Career Center is designed to:

1. develop in the student an awareness of the importance of office work and of the career opportunities which it offers.

2. develop an understanding of the place and purpose of the office in general, and the clerk-typist in particular, in the typical business organization.

3. develop a job-centered approach to businesslike work habits and attitudes and effective human relations.

4. prepare the student to perform the fundamental tasks commonly required of all beginning office workers.

5. prepare the student to perform the technical tasks commonly expected of the clerk-typist.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Field tests	* Mention that field tests have been conducted to determine the effectiveness of compaction with depth. Pneumatic-tired rollers were used. The unit pressure decreased rapidly with depth. At a depth of 12 inches the roller pressure on the soil was about 50 percent of the surface loading intensity. (Ref. G, p. 68) (Fig. 8-7) Even the heaviest compaction equipment will not give uniform compaction with depth.

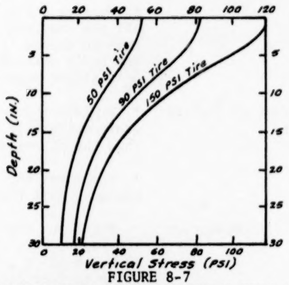

FIGURE 8-7
PRESSURE DISTRIBUTION BELOW PNEUMATIC-TIRE ROLLER WHEEL
(Source: Ref. G, p. 68)

B. Number of roller passes	* Indicate that a minimum number of six passes is required for full coverage of each embankment layer.
1. Field tests	* Assert that field tests indicate that the density increases rapidly with the first few passes. There is practically no increase in density after about 10 passes. (Ref. G, p.54) (Fig. 8-8)
	* Explain that six passes give the density required for sufficient compaction.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES

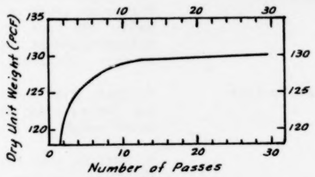

FIGURE 8-8
EFFECT OF NUMBER OF ROLLER PASSES ON COMPACTION
(Source: Ref. G, p. 69)

C. Embankment density	* Embankment density is expressed as a percent of the maximum density set by the AASHO test.
1. Requirements	* A minimum embankment density of 90 percent of maximum is required.
	* For sand, or a sand and gravel mix, with less than 20 percent fines (material passing No. 200 sieve), a minimum embankment density of 95 percent of the maximum density is required.
D. Moisture content control	* Fill material must have a moisture content not less than 3 percent drier than the optimum set by the AASHO density test. Water can be added to soil and mixed by blading or harrowing. (Ref. H, p. 200)
	* State that wet soils which cannot be properly compacted may be dried by aeration or by the addition of dry material. Aeration is hastened by discing, harrowing, or blading.
	* Drying is most effective when the maximum surface area of the soil is exposed to the air.
E. Type of compaction equipment	* State that the type of compaction equipment for various types of soil is specified, including minimum unit contact pressures.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
IV. Compaction Equipment	* Explain that there are several different types of compaction equipment. The type of soil to be compacted determines what type of equipment will be most efficient. (Ref. A, p. 396)
A. Smooth-wheel roller	* State that the smooth-wheel roller was the earliest type developed. Its usual weight is 10 tons.
1. Uses	* Mention that New York State specifications require that the smooth-wheel roller be used to compact rock, coarse gravel, soil and rock, and slag.
	* Add that the roller is used to compact base courses and to seal the fill surface to expedite runoff of rain.
B. Sheepsfoot roller	
1. Origin	* Describe the features of the sheepsfoot roller and explain that its design was based on the observation that sheep or cattle paths become very compact from the passage of many hooves.
2. Use	* Explain that sheepsfoot rollers are used to compact fine-grain soils composed of silt, or of silt and clay.
3. Effectiveness	* Discuss the advantages of high unit pressures of 100 to 250 pounds per square inch developed by the tamping feet. Mention the following points:
a. Kneading action	1. Compaction is obtained from the pressures on the tamping feet and the kneading action of the tamping feet.
b. Walking out	2. The soil is compacted from the bottom of the layer upward. After each pass, the feet should ride higher on the soil. This effect is called walking out.
c. Clay	3. The roller is effective in breaking up chunks of clay.
d. Granular soil	4. Warn that in granular soil the tamping feet tend to tear and displace the soil instead of giving compaction.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
e. Stony fill	5. In stony soils the tamping feet will not penetrate.
C. Grid roller	* Explain that the grid roller is a recently developed type of roller made in grid sections, formed by 1-1/2-inch round bars with 3-1/2-inch spaces between them. * The action of the roller is similar to that of the sheepsfoot roller, as the total weight is applied at contact points under high unit pressure.
D. Rubber-tired or pneumatic-tired rollers	* Describe the features of the rubber-tired roller. * Mention that the size of these rollers has increased in the last 20 years. Thirty- and 50-ton rollers are common. Tire pressures are about 80 pounds per square inch.
1. Use	* Point out that the pneumatic-tired roller is used to compact granular soils, such as sands and gravels. Granular soils compact best when they are confined under a larger load area and compressed.
2. Versatility	* State that this is the most versatile roller, since the action of the tires combines kneading and rolling properties.
E. Vibratory rollers	* Mention that rollers are manufactured using vibratory equipment to increase the effectiveness of compaction.
1. Effect of vibration on compaction	* State that the particles in a soil mass will vibrate when subjected to a vibratory force of a certain frequency (cycles per second).
a. Natural frequency	* Each soil mass has a natural frequency at which the soil particles will vibrate. The natural frequency depends on the properties of the soil.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
b. Frequency range	* The range of natural frequencies for soils varies from 18 to 30 cycles per second.
c. Compaction	* The combination of a static load with vibrations at the natural frequency of the soil will allow the soil grains to readjust and densify to a smaller volume.
2. Use	* State that vibratory compaction is most effective in granular, non-plastic soils.
3. Types of equipment	* Describe the types of equipment. (Ref. A, p. 400)
4. Comparison to bulldozers	* Mention the frequent argument that bulldozers compact soils by vibration. The unit load under the tracks is low and it is doubtful that the vibrations have an effect on the soil which will result in satisfactory compaction for highway embankments.
F. Small compaction units	* Explain that for compacting backfill in close quarters around structures small portable compaction units are used.
1. Tampers	* Tampers are powered by gasoline motors or by compressed air. Describe them.
	* The minimum compaction energy per blow is stated on page 201 of Ref. A.
V. Inspection Control of Embankment Construction	* Emphasize that to properly inspect and control embankment construction it is necessary to read and understand the specifications pertaining to earthwork. (Ref. I)
A. Intelligent inspection	* State that intelligent inspection depends upon a knowledge of the specifications, an understanding of the behavior of various types of soils, the ability to observe, and commonsense.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Uniformity of results	* The goal of embankment construction is to provide a smooth-riding foundation for many miles. This can be achieved only by providing a stable and uniform embankment. One of the best ways to achieve a uniform embankment is for the contractor to develop an efficient operational procedure, and to see that it is adhered to by continual checking. Visual observation by the inspector can determine whether the routine is producing the required results at all times.
C. Importance of testing	* Field density tests reveal whether the compaction requirements are being obtained. The tests can be run on only a small proportion of the materials used, and thus serve as a guide. For the major portion of the operations, good inspection is the key to achieving a good embankment.
D. Preparation of embankment foundation	* Indicate that all unsuitable material should be removed from the embankment foundation area.
1. Compaction	* The ground surface should be rolled to provide a firm surface for compacting the first layer of fill.
2. Leaving topsoil in place	* Mention that the 1962 specifications of New York State allow leaving topsoil in place under embankments more than 6 feet high. The topsoil layer will consolidate rapidly under the embankment loads, and will have sufficient strength.
E. Dumping and spreading	* State that the soil must be spread in 8-inch lifts before compaction.
1. Scraper units	* Scraper units can adjust dumping to spread the soil out.
2. Trucks	* Mention that dumping should be planned so that bulldozers and scrapers can spread the material with a minimum of effort.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. End dumping	* No embankment may be placed in its final position by end dumping, except underwater fill.
F. Compaction	* State that the essential control of compaction equipment stated in the specifications should be enforced.
1. Uniformity of compaction	* Explain that the intent of the compaction procedures is to obtain adequate and uniform compaction throughout the embankment. There is an age-old argument that construction equipment working on the embankment will provide compaction. The truth is they do not provide uniform compaction. Equipment operators inevitably will follow the tracks of preceding equipment.
2. Equipment and procedures	1. Equipment must be appropriate for type of soil. 2. There must be sufficient load or ballast for compaction. 3. A minimum of six passes should be made over the entire surface of lift. 4. The minimum number of passes must be determined after appropriate field tests to evaluate the effectiveness of the rolling equipment. 5. The rate of fill placement should not exceed the capacity of the compaction equipment.
3. Behavior of soil under construction equipment	* State that this discussion will explain the observed behavior of soils under moving loads from compaction and hauling equipment. * Illustrate with the picture of a soil mass consisting of soil particles and voids filled with water and air. Refer to Figure 7-1 in Lesson 7.
a. Mechanics of soil action under wheel load	1. When a sand and gravel soil is under a wheel load, the soil tends to compress into a smaller volume. The soil is permeable

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

enough so that the water and air flow out of the voids under the wheel load to areas of lower water pressure.

2. When wheel loads are applied to soils containing silt and clay, the water and air cannot escape because of the low permeability. The soil cannot densify until water and air are expelled. Therefore, part of the wheel load is carried by air and water, resulting in a pore pressure. This pore pressure travels in all directions away from the wheel. (Fig. 8-9)

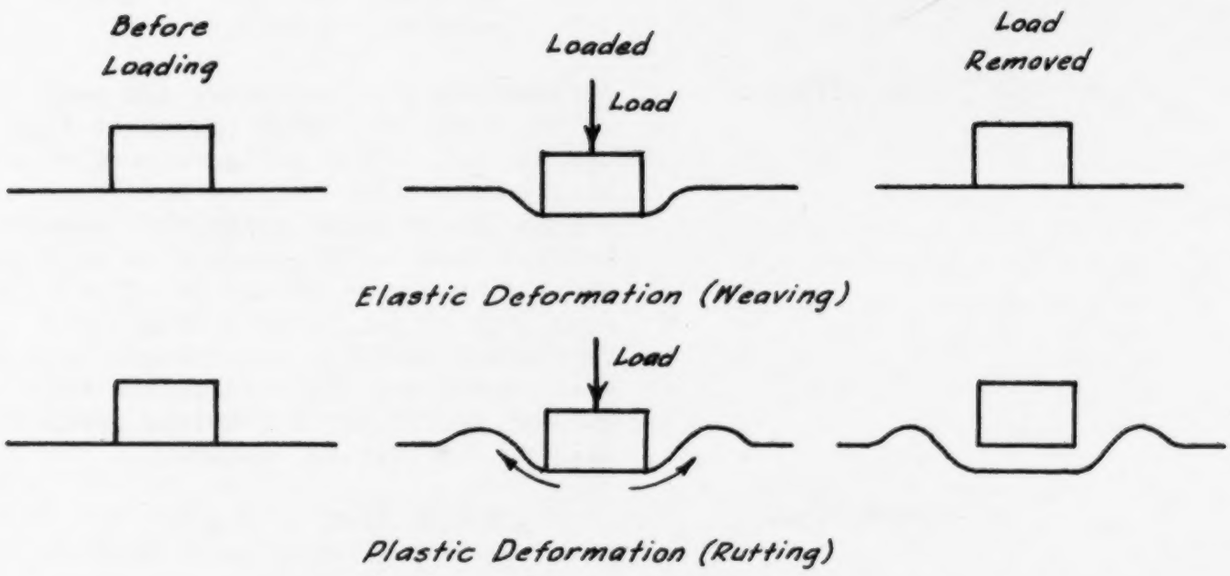

FIGURE 8-9
SOIL DEFORMATION UNDER WHEEL LOADS

b. Spongy or weaving fills

1. The pore pressures adjacent to the wheel are great enough to force the soil up in a traveling wave. As the wheel passes on, the soil springs back into place.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	This condition is called a weaving, or spongy, fill.
	2. If this weaving occurs during rolling, lighter rolling equipment should be used.
	3. Usually weaving occurs under hauling equipment where the wheel loads may be heavier than the compaction equipment loads.
	4. Depressions in the full surface should be graded and compacted to a smooth surface before placing the next layer of embankment, in order to obtain uniform compaction.
c. Time effects	* Residual pore pressures are left in the soil mass after the wheel load has passed. These pressures will dissipate with time, and the soil will regain its original strength. Repeated traffic loads will continue to increase the residual pore pressures after each load application, with a resultant continuous decrease in strength between soil particles. This increases the weaving action until complete shear failure, or rutting, occurs.
d. Conclusions	1. A fill that is spongy, or weaving, under heavy hauling equipment loads is not unsuitable, providing required densities have been obtained. In the upper portion of the fill, within 4 feet of final grade, other considerations apply, and these will be discussed in a later section
	2. Tracking, or repeated traffic loads, should be avoided, as weaving will become worse.
	3. The fill will regain its original strength with time.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	4. Rutting indicates a shear failure of the fill, and it should be graded and recompacted. Rutting also ruins surface drainage and makes it impossible to place lifts in uniform layers. The 1962 specifications of New York State require the contractor to repair and recompact embankments damaged by hauling equipment.
4. Compaction equipment loads	* Mention that it is possible to have compaction equipment loads which are too great to properly compact the soil.
a. Pneumatic-tired compactors	* When loaded too heavily, the rubber-tired compactor will shear and rut the soil under the wheels. Ballast load should be decreased.
b. Sheepsfoot roller	* When loaded too heavily, the sheepsfoot roller weight will ride on the drum instead of the feet. Ballast should be decreased until the tamping feet will "walk out" of the soil after successive passes.
G. Drainage	* Mention that if water is allowed to stand on the fill surface seepage into the fill will soften and decrease the strength of the compacted material.
1. Fill surface	* The fill surface during and after construction should be crowned and rolled to insure satisfactory drainage at all times.
2. Ditches	* Sufficient ditches are required for drainage.
H. Estimating optimum moisture content	* State that an experienced inspector can estimate if a soil is near the optimum moisture content from its appearance.
1. Nonplastic soils	* State that for sands, gravels, and nonplastic silts, the soil will be near the optimum moisture content when it can be compressed into a firm cast by hand.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Plastic soils	* For plastic soils containing clay, the optimum moisture content (OMC) is near the plastic limit. If the soil is rolled into a thread, it should begin to crack and fall apart when the thread is 1/8 inch in diameter.
I. Drying wet soils	* State that frequently in cut excavations, soils will be encountered with natural moisture contents above the optimum. * These soils will require drying before compaction, and may be dried in the cut or on the fill.
1. Drying in cut	* Explain that drying is accomplished by exposing the soil to aeration and sunlight.
a. Manipulation	* Drying can be hastened by manipulating the soil with cultivators, disc harrows, or rotary speed mixers used with the hoods raised. The key is to expose the maximum surface area of soil to air and sun.
b. Exposure of large cut areas	* The contractor should plan operations so as to open up large areas of the wet cuts and gain the maximum advantage from drying.
c. Information from borings	* The moisture conditions and type of soil in a cut can be estimated from the project explorations. In clay cuts, moisture content profiles are often prepared from the drill hole samples.
2. Drying on fill	* Fill material may be spread on the embankment and dried prior to compaction. * Changes in weather may hold up all filling operations as fill becomes wetter. * Drainage of the fill surface to protect lower layers from wetting by rain is difficult.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Types of problem soils	* Soils containing large amounts of silt or clay are usually the wetter soils. * Clay soils are the most difficult to dry. * Brown, weathered clay soils from above the water table are easier to dry than gray clays from below the water table. It is difficult to compact some clays at moisture contents higher than optimum because of the low strength characteristics of these soils.
J. Compaction of subgrade foundation	* Define subgrade foundation as an area with a top width equal to the width of pavement plus 1 foot on each side, the sides sloping down and out at a 45° angle, and with the bottom 4 feet below the top outer edge of the pavement. (Ref. H, p. 198)
1. Traffic loads	* This zone of the embankment will support the traffic wheel loads. Review Figure 6-13.
2. Climatic effects	* This zone of the embankment will also be affected by freezing and thawing. Plate bearing tests indicate that in the spring immediately after thawing, the subgrade soil may have only 20 percent of the strength present in the fall. The strength returns slowly over the summer months. (Fig. 8-10)
3. Compaction requirements	* Mention that it is important for this portion of the embankment to be compacted as well as possible. Specifications require a minimum dry density of 95 percent of the maximum density and, for granular soils (less than 20 percent passing No. 200 sieve) a minimum dry density of 100 percent of the maximum density. These requirements are higher than for the lower embankment.

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Course Outline:

The following table provides a listing of course units along with time estimates for each unit. Both sequence and estimates can be varied to meet student needs. Units are presented concurrently as students achieve objectives that prepare them to move ahead.

Course Unit		Title	Hours	Code
Unit	I	Occupational Orientation	5- 7	-01
Unit	II	Fundamentals of Typing	70- 85	-02
Unit	III	Production Typing	60- 80	-07
Unit	IV	Office Equipment	20- 30	-03
Unit	V	Communications	15- 20	-04
Unit	VI	Financial Activities	8- 10	-08
Unit	VII	Record Management	15- 20	-09
Unit	VIII	Sources of Information	3- 5	-05
		Total	196-257	

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CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

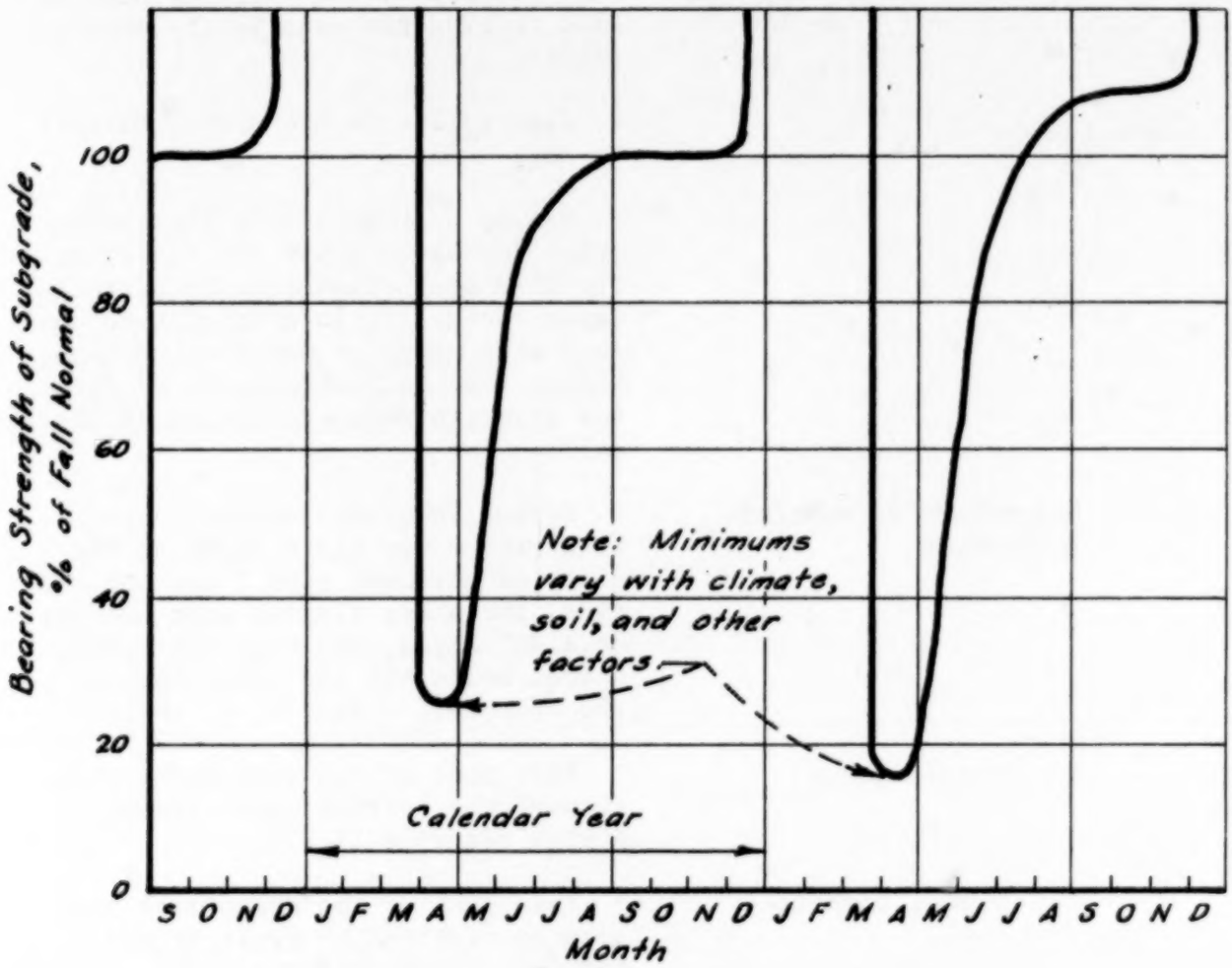

FIGURE 8-10
SEASONAL VARIATION IN BEARING STRENGTH OF SUBGRADE

4. Proof rolling

* Proof rolling is performed on the top of the subgrade, which is the embankment or cut surface immediately below the lower granular subbase layer.

a. Procedure

* The entire subgrade surface is rolled with a 30- to 50-ton pneumatic-tired roller, in three or four passes.

* In areas where weaving or rutting occurs, the soft material is replaced with suitable granular material and recompacted.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* In areas where compression occurs, additional suitable material is added and compacted to bring the surface of the subgrade to proper elevation.
b. Purpose	* The purpose of proof rolling is to provide a uniform support for the granular subbase and pavement.
	* Weaving and rutting materials are removed because they tend to mix with and contaminate the gravel in the granular subbase layer when critical climatic conditions are combined with repeated traffic loads.

ASSIGNMENT

1. Read Chapter 14 of Ref. A: "Soil Compaction and Stabilization."

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Lesson 9 - Compaction Control Test - Subbase Courses - Stabilized Soils

REFERENCES CITED IN THIS LESSON

New York State, Department of Public Works, Bureau of Soil Mechanics. Albany, New York. Instructions for the field compaction control density test. The Bureau. 1958. Engineering Research Series No. TM 58-1. (Referred to in this unit by symbol "J")

New York State, Department of Public Works, Bureau of Soil Mechanics. Albany, New York. Construction of foundation courses for concrete pavement. The Bureau. 1958. Engineering Research Series No. TM 58-3. (Referred to in this unit by symbol "K")

United States Government, National Research Council, Highway Research Board. Washington, D. C. Factors that influence field compaction of soils. The Council. 1960. Highway Research Board Bulletin No. 272. (Referred to in this unit by symbol "G")

OBJECTIVE

To explain the details and use of the compaction control test and the function of subbase course of granular materials and stabilized soils in highway construction

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Compaction Control Test	* State that field density tests are made to determine the degree of compaction obtained to insure conformance with the specifications.
	* Note: The following section is an outline of the compaction control test. Further details may be found in Ref. J.
A. Field density test	* The location of the field density test should be carefully chosen to:
	1. Represent the average soil type and average compaction effort for a lift of embankment
	2. Check specific areas where compaction is doubtful or where

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	a change in fill material has taken place 3. Check areas where previous values of density have been low and conditions have been improved by additional rolling or other means
1. Test procedure	* Note that the steps of tests are outlined. It is suggested that the class be shown the density test equipment. If the class has not conducted this test in the field, the instructor may desire to use the detailed procedures in Ref. J. 1. A hole is dug in the fill 6 inches in diameter and 6 inches deep. 2. The volume of the hole is determined by the sand cone apparatus. 3. The material taken from the hole is weighed and then dried to determine the moisture content. 4. From the volume, wet weight, and dry weight values, it is possible to compute the wet density, dry density, and moisture content.
B. Dry density from standard compaction test	* Explain that the standard compaction test is conducted in the field laboratory. 1. A portion of the wet sample is compacted in layers in a standard compaction mold as described under laboratory compaction tests in the prior lesson. 2. The moisture content and dry density are determined.
C. Compaction control curves	* Mention that compaction control curves are prepared for each project. A set of curves is made for each type of soil that will be encountered on the project.

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CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

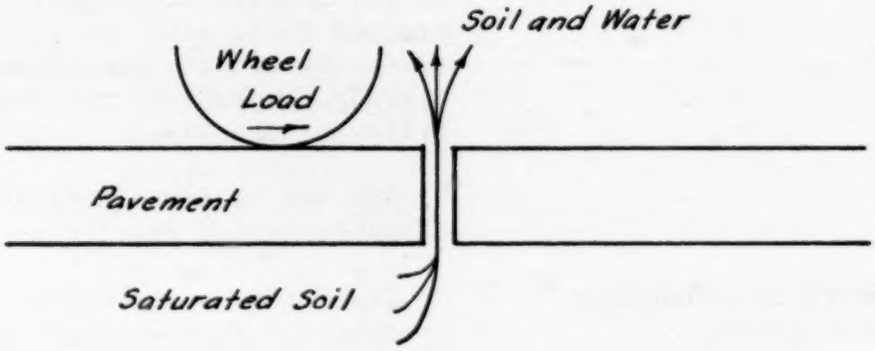

FIGURE 9-2
PUMPING OF PAVEMENT JOINTS

* Continued pumping action results in a void under the pavement, and a failure of the concrete slab occurs adjacent to the joint.

2. Critical soils

* Critical soils for pumping are gravels that contain large amounts of fine-grain soil. Shale-type gravels fall into this category after the gravel fragments break down to silt and clay sizes.

III. Stabilized Soils

* Stabilization of soils consists of adding a chemical to the soil to make the effect of mechanical stabilization more lasting.

* State that adequately compacted soils are capable of carrying the heaviest traffic loads.

* Without additional treatment, soils will abrade rapidly under traffic; and they will soften as a result of wetting, drying, freezing, and thawing. (Ref A, p. 412)

A. Use

* State that stabilization methods are used for the following purposes:

1. Low-cost road surfaces
2. Roadway shoulders
3. Subgrades and base courses
4. Parking areas

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Soil cement	* State that cement may be mixed with a soil to form a low-strength concrete. * Cement will not mix readily with soils containing clay and will not set up properly with soils containing organic materials.
1. Procedure	* Describe steps of the treatment: (Ref. H, Item 59Y, p. 428) 1. Preparation of soil grading and shaping 2. Distribution (The amount of cement is about 5 to 16 percent by weight of the soil. The exact amount will vary with the type of soil. The fine-grain soils will require the most cement.) 3. Mixing, to be done when soil is dry to a depth of 6 to 8 inches (Special equipment is manufactured for this work.) 4. Addition of water 5. Compaction, which may be done with sheepsfoot, pneumatic-tired, or smooth-wheel roller 6. Curing period, a maximum of five days 7. Seal coat and wear coat (stone chips) to provide protection against wearing by traffic
C. Bituminous stabilization	* State that the strength of soils can be increased by coating each particle with bitumen. Usually a graded gravel is used for the soil.
1. Procedure	* Describe steps of the treatment: (Ref. H, Item 59W, p. 424) 1. Placement of the gravel layer 2. Applying bitumen (A medium-curing cutback asphalt or emulsified asphalt is used. Application is with a pressure spray bar, followed by a power-driven rotary-type mixing machine. Several passes may be required.)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	3. Curing (A period of seven days is required before rolling.) 4. Compaction (Done with a pneumatic-tired roller. The final rolling is done with a smooth-wheel roller.) 5. Seal coat and wear coat (Stone chips are applied.)
2. Plant mix	* The gravel may also be mixed with the bitumen in a plant before placing.
D. Calcium chloride stabilization	* State that calcium chloride stabilization is based on the deliquescent hygroscopic properties of the chemical. Deliquescence is the ability to absorb moisture from the air and to change vapor moisture to liquid. The hygroscopic property is the ability to absorb and retain moisture without necessarily becoming liquid. The two properties keep the soil moist during the dry seasons and prevent loss of shear strength from drying. This process also eliminates dust. * The stabilization effects are questionable during wet seasons when the soil loses strength because of too much water. * Seepage will dissolve calcium chloride and remove it from the soil. *(Ref. H, Item 59C, p. 421)*
E. Sodium chloride stabilization	* Sodium chloride achieves about the same results as calcium chloride through electrolytic and crystalline properties, which retain water in the soil mass.
F. Lime stabilization	* Lime is used to stabilize plastic clay soils principally in the subgrade. Lime reduces the plasticity of some clays. An increase in shear strength results.

ASSIGNMENT

1. Study Refs. G, J, and K, if they are available for class distribution.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Explain that the principle of a compaction control curve is based on the following facts:
1. Variation in soil properties	* State that the moisture-density characteristics of a soil will vary mostly with gradation, shape of particle, and plasticity. In a soil deposit, all of these properties vary in some degree.
2. Effect on moisture-density curves	* If moisture-density curves are prepared for many samples from a soil deposit that appears uniform, the curves will not plot in the same area on the graph.
3. Properties	* Illustrate with sketch the family of curves and their identical properties. (Fig. 9-1) 1. The shape of the curves will be nearly identical. 2. The position of the curves will be offset to the left, as the optimum moisture content decreases.
4. Plotting standard compaction point	* Mention that the moisture-density point from the laboratory test should fall anywhere in the family of curves.
5. Optimum moisture content of laboratory sample	* Explain and illustrate that a theoretical moisture-density curve may be drawn through the point following the general curvature and parallel to the straight portions of the adjacent control curves. (Fig. 9-1) * Show how the optimum moisture content and maximum dry density for the laboratory sample are determined.
D. Determination of percent of maximum density	* Explain that the dry density of a field sample, divided by maximum dry density from the compaction control test, times 100, gives the percent of compaction.

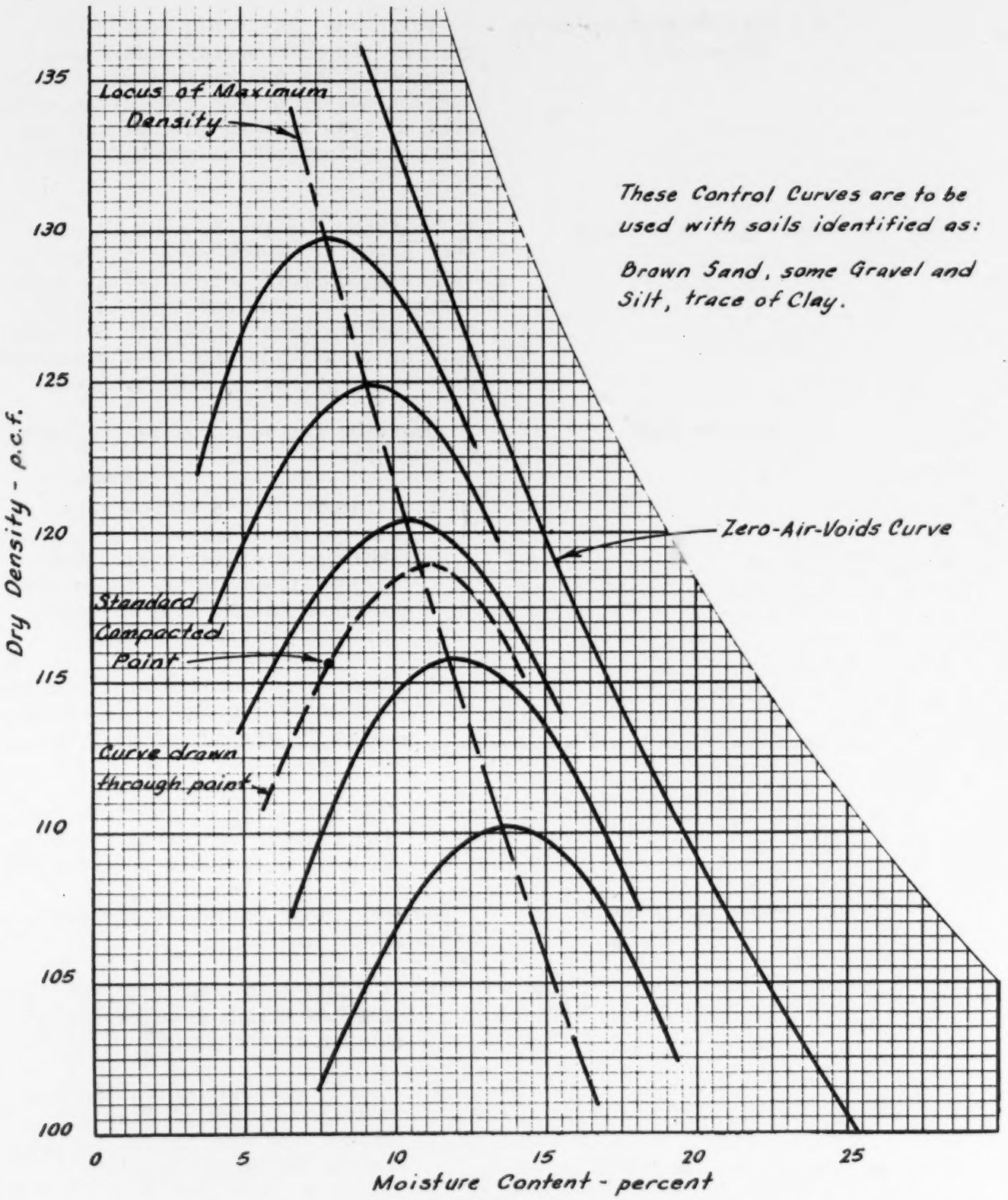

FIGURE 9-1
TYPICAL COMPACTION CONTROL CURVE

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Field densities above 100 percent	* Point out that field densities greater than 100 percent often are obtained. The reason is that the compaction energy of the compaction equipment is greater than that of the compaction effort of the standard density test.
E. Nuclear test methods	* Mention that in the past 10 years some agencies have adopted nuclear test methods for conducting the field density test. Nuclear tests can be performed in about one-fifth the time for the regular density test described previously. (See Ref. G, p. 124.)
1. Density test	* Describe the features of the test for density: 1. A probe with a radioactive source is inserted in the ground through a driven tube. Some types are placed on the ground surface and testing is done without driving a tube. 2. Gamma neutrons are sent out into the soil from the radioactive source. (Radium, cobalt 60, or cesium 137) 3. The intensity of neutrons bouncing back is measured. Density of soil is related to intensity.
2. Moisture content	* Mention these points in the test for moisture content: 1. A probe with a radioactive source of radium-beryllium is placed in the ground. 2. "Fast" neutrons colliding with hydrogen atoms in water are slowed down and return to the source as "slow" neutrons. 3. The intensity of "slow" neutrons determines the moisture content.

UNIT I (14.0901-01)

OCCUPATIONAL ORIENTATION

Performance Objectives:

Upon completion of this unit the student will be able to describe orally the general purpose and organization of business. She will be able, as determined by instructor observations, to demonstrate good interpersonal relations with other class members and good organization of a work station.

The student will be able to demonstrate in a role playing, or other simulated situation, the proper dress and grooming for an office worker and correct techniques and good manners. She will be able to score 80% on an objective test covering the responsibilities of a clerk-typist.

Unit Outline:

A. Review of Modern Business Enterprise

1. Methods of organization
2. Purposes of business

B. Types of Offices and Opportunities for Office Workers

C. What Business Expects of Office Workers

1. General expectations
2. Appropriate attire
3. Posture and figure control
4. Complection and health
5. Personal hygiene

D. Office Techniques of Etiquette

1. Basic good manners
2. Application of social graces to office situations
3. Some special problems that occur

E. Interpersonal Relations

1. Role of motive and emotion
2. The office worker's role in business-human relations activities

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Advantages	* Mention these advantages of nuclear testing: 1. Speed of operation 2. No disturbances of soil structure
4. Disadvantages	* Mention these disadvantages of nuclear tests: 1. High initial cost 2. Uncertain accuracy 3. Difficulty of choosing the correct compaction control curve (In the previous section it was shown that there is an individual compaction curve for each sample, and that for any soil deposit there is a family of curves. Without knowing the compaction curve for the sample tested in the field, it is difficult to choose the correct maximum density as determined by the standard compaction test.)
5. Use in New York State	* State that nuclear units have been used in the New York State Department of Public Works on an experimental and research basis.
II. Subbase Courses	* Define the subbase course as a layer of selected granular soil supporting the pavement.
A. Functions of subbase course	* Describe the purposes of the subbase course layer: 1. To provide uniform support to the pavement 2. To distribute the pavement and traffic loads to the underlying subgrade soil 3. To decrease frost heaving under the pavement 4. To provide drainage for water infiltrating through the pavement or from below. The effectiveness of the drainage will vary with the gradation of the

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	gravel. Most subbase gravels are quite impervious when compacted.
B. Requirements for soil properties	* Mention that, for the performance of the above functions, the following soil properties are required:
1. Strength	* Explain that soil must have internal strength to support the superimposed loads.
a. Particle sizes	* Strength is obtained by using a material composed mostly of gravel and sand-sized particles.
b. Gradation	* A well-graded sand and gravel will develop high densities and high interlock strength.
c. Limitation of fines	* Strength must be permanent and not subject to change due to variations in water conditions. This is assured by limiting the amount of silt and clay-sized particles in the material.
2. Frost heaving	* State that the subbase course is in the zone of frost penetration. A subbase material susceptible to frost heaving and subsequent loss of strength on thawing would result in pavement failures.
a. Limitation on amount of fines	* Frost heaving may be controlled by limiting the amount of silt and clay-sized particles in the material. Tests and experience indicate that in a well-graded sand and gravel subbase course, frost heaving is eliminated when not more than 10 percent of the sample passes the No. 200 sieve and the plasticity index test of the finer soils is not greater than 3.
b. Density	* The material should be dense in order to reduce the tendency for water migration with subsequent softening and loss of strength.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Drainage	* Explain that drainage is desirable to remove water leaking through the pavement or rising from subgrade. If the subgrade is impervious, this drainage will be lateral. * For well-graded sands and gravels the rate of drainage may be relatively slow due to the high density of the soil.
4. Soundness of gravel	* State that the gravel-sized material must be sound stone that will not break down into smaller particles under the effects of freezing and thawing. 1. Such breaking down results in reduction of strength. 2. Gravel derived from shale rock may behave in this manner.
C. Subbase course requirements in NYSDPW	* State that the subbase course material may be gravel, slag, or broken stone, provided it meets the specifications. (Ref. K) The term "base course" is used for crushed-stone bases for flexible pavements.
1. Subbase course materials	* State that there are two types of subbase course materials.
a. Select granular material	* Describe the test requirements for select materials. (Ref. H, p. 275) 1. Gradation 2. Plasticity 3. Soundness or quality
b. Granular material	* Describe the test requirements for granular material. 1. Gradation 2. Plasticity 3. Soundness
2. Magnesium sulphate soundness test	* Explain that the soundness test is a duplication of the effects of freezing and thawing on gravels.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. The sample is sieved before testing. 2. The sample is run through four cycles of soaking and drying in a magnesium sulphate solution. 3. Upon drying, the salt crystallizes and expands. 4. If there are cracks in the stone, the pressure of crystallization breaks the stone apart at the cracks. This is similar to freezing action. 5. The sample is sieved after the test. 6. The decrease in weight retained on all the sieves indicates the amount of particle breakdown that has occurred. 7. If the total sieve weight loss is greater than 20 percent, the gravel is unsuitable for select granular material. If the sieve loss is greater than 30 percent, then the material is unsuitable for granular material.
D. Subbase course design	* Mention that the usual thickness of the subbase course is 12 inches. Thicknesses up to 36 inches are used occasionally where the subgrade soil in cuts has extremely low strength.
1. Subbase course--select granular material	* State that the higher-quality gravel is used next to the pavement in all designs.
2. Subbase course--granular material	* In some shale areas, local deposits of sound gravel are difficult to find and expensive. * A two-course subbase course is used with 6 inches of select granular material on top, over 6 inches of granular.
E. Construction of subbase course	* Explain that the subbase course should be properly compacted to attain adequate strength.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Mention that construction traffic on the subbase course will mix fine-grained soils with the gravel. This adversely affects the strength, frost-heaving properties, and drainage properties of the layer.
	* See Ref. K for a detailed discussion of construction practice.
F. Sources of foundation course gravel	* State that most subbase course gravel is obtained from sand and gravel outwash deposits in the vicinity of the project.
1. Gravel pits	* Emphasize the importance of the following: 1. Not mixing unsuitable overburden material with subbase course gravel 2. Conducting excavation operations so as to thoroughly mix sand layers and gravel layers, since select granular material requires stockpiling and sampling
2. Processed subbase course material	* State that in some parts of New York State natural gravel deposits are becoming depleted.
a. Crushing	* Some contractors have crushed and processed rock excavation or oversized gravel. Emphasis of construction control is placed on mixing and stockpiling in order to reduce segregation.
G. Pumping	* Define pumping as a condition that develops at the joints of concrete pavements. (Fig. 9-2)
1. Mechanics	* When water collects below the pavement, heavy wheel loads will cause the water to be ejected with force at the joints.
	* Fine-grain soils in the subbase will be carried out with the water.

Lesson 10 - Influence of Soil Conditions on Highway Design and Construction

REFERENCES CITED IN THIS LESSON

New York State, Department of Public Works, Division of Construction. Public works specifications of January 2, 1962. Albany, New York. The Division. 1962. (Referred to in this unit by symbol "H")

OBJECTIVES

1. To describe soil problems that are often encountered in design and construction
2. To describe the soil behavior in these problems and to discuss possible solutions

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Embankment Foundation Problems	* State that embankment foundation problems involve the support of the embankment by the natural soil. Refer to the discussion of stability and consolidation properties of soils and design solutions in Lesson 6.
A. Foundation stability and settlement	* Mention that field investigations are made under the supervision of the district soils engineer. Testing and design analyses are conducted by the Bureau of Soil Mechanics. Close coordination is required between the designer and the other units, in order to determine the most economical solution. Berms are often required to provide stability for a high embankment on soft silt or clay.
1. Berm design	* State that a design report including typical sections is submitted to the District from the Bureau of Soil Mechanics.
2. Berm construction	* Mention that berms should be made concurrently with embankment.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* The embankment should never be completed prior to berm construction, since the critical time for shear failures is at the end of embankment work.
a. Inspection	* Recommend that fill construction be watched in critical stability areas for any long cracks or subsidence that may develop on the embankment surface, or upheaval of the ground surface outside the toe of the slope. Observations of this type should be reported immediately to the district soils engineer.
3. Surcharge construction	* Remind the class that surcharges are used to decrease post-construction foundation settlements. Surcharges and waiting periods are often used in the vicinity of bridge abutments to eliminate the need for pile foundations.
a. Inspection	* State that all surcharge material should be properly compacted and the final surface rolled and sealed for drainage.
	* Failure to follow the above procedures may result in a very wet subgrade when the surcharge is removed.
4. Construction control devices	* Construction control devices are included in the design to determine the safe rate of fill replacement and the rate of foundation consolidation for major stability treatment problems.
a. Consolidation and strength relations	* Remind the class how, in Lesson 6, the study of soil consolidation indicated that embankment load was carried first by the pore water in the soil, and then transferred to the soil particles as consolidation progressed. Soil strength also increased with consolidation.
b. Pore pressure	* In slow-draining soils, a portion of the embankment load is carried by pore water and is called the pore pressure. Pore pressure decreases with consolidation.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
c. Piezometer	* Define a piezometer (pronounced pee-zom-eter) as a device for measuring the pore pressures in soil masses. (Fig. 10-1)

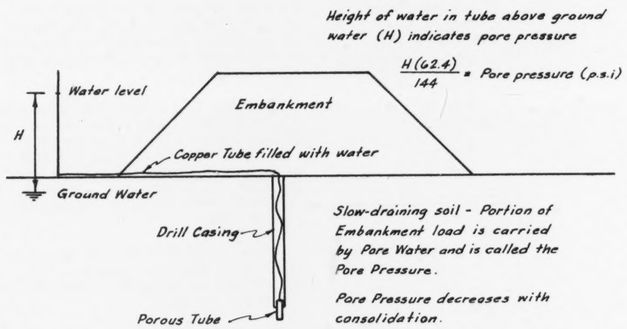

FIGURE 10-1
PIEZOMETER INSTALLATION

(1) Description	* Describe a piezometer as a porous carborundum tube placed in the ground by means of a drill hole and connected by air-tight tubing to a standpipe extending above the ground surface.
(2) Principle	* The height of water (H) in the standpipe above the ground water table indicates the pressure of the pore water in the ground at the porous tip, in pounds per square inch. Standpipes are not practical on most highway projects, and Bourdon pressure gauges are used instead. $\frac{H(62.4)}{144}$ = pore pressure (in p.s.i.)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* It is possible to determine from the pore pressure reading the percentage of consolidation of the foundation soil for a given fill height.
(3) Use of piezometer data	* By correlation with laboratory test data, it is possible to predict the available shear strength, the amount of settlement remaining, and the rate of settlement at any time during fill construction.
d. Settlement platforms	* Describe a settlement platform as a base 3 feet square placed on the ground surface with a pipe extension that is carried up through the fill. By taking elevations on the top of the pipe, it is possible to plot a time-settlement curve of the original ground surface.
(1) Use of data	* Correlation of settlement records with laboratory consolidation test data allows predictions of future time-settlement rates.
(2) Construction of platforms	* Mention that the standpipe must not be disturbed by construction operations. A white barrel is often placed over the pipe.
B. Excavation of unsuitable material	* State that peats and mucks usually consist of 90 percent water by volume and 10 percent organic material.
1. Strength and settlement characteristics	* Explain that these soils have low shear strength and are removed from the area of future embankments.
a. Shear strength properties	* Mention that an embankment 5 or 10 feet high may be constructed on a deep peat deposit, and sink out of sight overnight because of shear failure.
b. Consolidation properties	* Embankments may be built less than 5 feet high, but will settle 3 to 4 feet in a few years due to consolidation of the peat.
2. Appearance of swamp deposit	* Mention that the surface aspects of swamp deposits may vary in these ways:

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Open water 2. High water table with swamp grasses and sedges on surface 3. Full-grown forest, usually with high water table 4. Normal ground surface with no indication of underlying organic deposit (This condition usually occurs on flood plains where silts and sands may have been deposited over swamp. Buried organic deposits are often discovered by "springy" action of the ground under construction equipment. It should be brought to the attention of a soils engineer.)
3. Excavation procedures	* State that excavation is usually done by dragline, sometimes by clamshell.
a. Depth of excavation	* Mention that the depth of excavation should be determined by field explorations before construction. Additional explorations or probes may be required during construction if depths vary from cross-sections.
b. Over-excavation	* Observe that it is possible to excavate too much of the unsuitable material. 1. Organic soils are often underlain by loose silts or fine sands. 2. These materials appear unsuitable when excavated through water. 3. These loose, temporarily unstable materials left in place will consolidate and stabilize rapidly under the backfill, and will make an adequate embankment foundation. 4. Large-quantity overruns in excavation and backfill can occur because of unnecessary removal of loose silts and sands. In

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	a large swamp these overruns can cost several hundred thousand dollars.
c. Controlling depth of excavation	* The dragline operator is the key man on any muck excavation project. Mention these methods of controlling depth of digging: 1. Excavating to firm bottom, which is practical when organic soil is underlain by firm or compact soil 2. Excavating to a soil change or color change (Usually organic soils are dark and underlying soils are lighter.) 3. Excavating to a design elevation (This is practical when borings show a uniform deposit and the first two methods cannot be used.) Note: Be careful of changing surface-water levels during excavation.
d. Excavation side slopes	* State that as long as organic material is underwater vertical-cut slopes may be used. Although the soil has low strength, stability also depends on weight of soils. Organic soils weigh 65 to 70 pounds per cubic foot above water level, and 5 to 8 pounds per cubic foot underwater (due to the buoyancy effect). If the water level is lowered in the excavation, instability of slopes may be expected, owing to the increased weight of the soil.
e. Measuring excavation quantities	* Mention that cross-sectioning, using a probe rod to determine bottom, can be used. Aluminum rowboats are included in specifications for large projects.
4. Disposal of unsuitable material	* Emphasize that unsuitable material should not be side-cast next to an open

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	excavation, since its weight will cause shear failures and unstable excavation slopes. * In using organic material to flatten slopes, remember that organic material will shrink to a volume of two-thirds or even half the original volume, upon drying.
5. Underwater backfill	* State that granular material or rock is used for underwater backfill, and is usually placed by end dumping. * Remark that granular material will settle out fast underwater, will consolidate rapidly, and will have adequate shear strength. * Assert that materials containing considerable amounts of silt and clay will settle out very slowly, will consolidate slowly, and if placed in large chunks will soften and weaken over a period of time. * A minimum 2-foot lift above the water surface is usually required to support construction equipment.
C. Displacement of unsuitable material	* State that for organic deposits greater than 30 feet in depth the displacement method is often used, since it is difficult to excavate deep organic soil deposits. Displacement involves removal of the mudwave that has been pushed up in front of the fill. * The key to a successful displacement job is to keep the rate at which the mudwave is removed the same as the rate at which the fill is placed. This insures complete displacement of the organic material and allows the fill to sink to firm bottom.
II. Soils Problems in Cuts	* State that the two principal problems in cuts are stability of slopes and stability of subgrade.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Cut slope stability	* Observe that two types of slope failure occur: deep-seated and shallow-surface.
1. Deep-seated failure	* Mention that deep-seated failure usually occurs in a clay soil. The underlying clay has insufficient shearing strength to support the slope, and a circular-arc shear failure occurs. (Fig. 10-2) If the clay has water-bearing silt layers, the seepage forces will also contribute to instability.

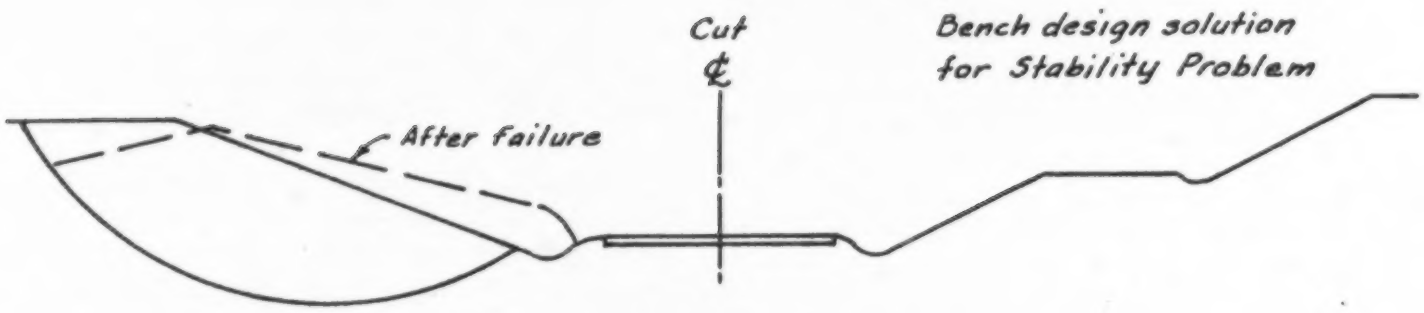

FIGURE 10-2
CIRCULAR ARC SLOPE FAILURE IN CUT

a. Solution	* A critical failure condition can be solved by flattening the slope to reduce the overturning moment. * In very critical cases, a bench may be placed in the slope.
b. Design	* Designs of this type are usually based on strength-testing of undisturbed Shelby tube samples and stability analysis.
2. Surface failures	* Explain that shallow-surface failure is the most common type, and may involve either an entire slope or local areas in the slope.
a. Failures caused by seepage	* State that the prime cause of slope failures is water seepage. This reduces the shear strength of the surface soils, causing them to slide or flow.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
b. Solution	* State that instability of slopes due to ground water seepage may be remedied by placing a 2-foot gravel blanket over the critical area. This blanket reduces the seepage forces, drains the water, and acts as a weight on the unstable soil.
c. Slope protection blanket	* The gravel blanket must have special gradation in order to: 1. Be permeable enough to carry the water and reduce the seepage force 2. Have sufficient fines to prevent underlying soil from washing in and clogging voids * A special item "Granular Fill, Slope Protection " is included in the New York State Department of Public Works specifications.
d. Field correction	* State that in some cases the critical seepage zone may be determined from explorations, and the slope protection blanket may be included in the design. * Assert that for most cases critical seepage areas cannot be determined by exploration, and such areas will have to be treated as they appear during excavation and construction. * State that soils most likely to be unstable are water-bearing silts and layered clays. These occur in delta deposits and silt-and-clay bottom sediments. Silts may also occur as pockets in till deposits.
e. Failures due to thawing of frozen soil	* Often after construction sheet failures occur as frozen soils thaw on the upper and lower surfaces of the soil mass. Layers of supersaturated soils exist at the surface of the frozen material, and large sheets of surface soil and grass may slide

F. Personal Attributes

1. Punctuality

2. Physical health

3. Integrity

4. Leadership

5. Attitudes

G. Personal Efficiency in Identifying Responsibility, Planning and Organizing Work and Work Station.

Supplemental Teaching Aids:

Excellent resource people for this unit are working secretaries, State Department of Vocational Education personnel, beauty school operators or department store buyers.

The best general resource book is the Arizona State Department of Vocational Education's Suggested Curriculum Guide in Vocational Office Procedures. A good resource for role playing is Case Problems: for Vocational Office Block Project. This is available from the Department of Vocational Education also. Other useful resource books are: You as a Secretary, Royal Typewriter Company. How to be a Super Secretary, Remington Rand, and Sheaffer's Handbook for Secretaries, W. A. Sheaffer Pen Co., Fort Madison, Iowa ($1).

Some very good films are applicable to this unit. For example: "Office Etiquette" (15 min.), Britannica Press, Chicago, Ill., "Office Teamwork" (12 min.), Britannica Press, and "Off to a Beautiful Start", Scott Paper Co., Philadelphia, Pa.

Training Time 5-7 hours

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	down the slope. Areas where sheet failures may occur are practically impossible to anticipate in design or construction.
B. Stability of cut subgrades	* State that the problem soils in cut subgrades are soft plastic clays and nonplastic silts.
	* Mixtures of sand, gravel, silt, and clay glacial till having more than 40 percent silt or clay will also be problem soils, but to a lesser degree.
	* The trouble starts when construction traffic travels on the subgrade and gets bogged down in the soils. The worst problem is the difficulty of building a stable subbase course layer on top of the soft soil.
1. Clay soils	* Mention that in clay soils the wheel loads cause failure by rutting. Further wheel loads continue to remold the soil and decrease the shear strength.
a. Solution: undercutting Note: Items 3 and 2EC are described in the New York State Public Works Specifications.	* The problem may be solved by undercutting the subgrade and placing a layer of sand and gravel (Item 3 or 2EC) over the clay. For most clay conditions, a layer 1 foot thick will be sufficient. For extremely soft clay, a 2-foot layer is required. This layer is sometimes called a working platform.
b. Mechanics of the working platform	* State that the working platform serves to distribute the wheel loads and reduce the shearing stresses in the clay.
2. Silt soils	* State that in silt soils wheel loads applied suddenly are carried by the pore water. The water pressures in the voids force the soil particles apart, leaving little or no strength in the silt. A weaving condition soon progresses to rutting.

CONTENT OUTLINE

a. Solution: undercutting

b. Pumping

c. Working platf material

3. General comments

III. Earthwork Factors

TEACHING POINTS AND TECHNIQUES

* The problem may be solved in the same manner used for the clay soils. For silt soils a heavier working platform, usually 2 to 3 feet thick, is required.

* State that the mechanics of failure of the silt soil can place the pore water under considerable pressure. The water carries silt upward into the overlying gravel layer. This action is called pumping, and in extreme cases the silt will work through the gravel, forming silt cones like miniature volcanoes. The pumping action is the reason heavier working platforms are used on silts than on clays.

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* Mention that the working platform material should be well graded with small void spaces to prevent silt from pumping. A two-layer system with sand on the bottom and gravel on top is also practical.

* Explain that construction engineers often try to use broken rock as a working platform. After several wheel load applications, the silt pumps up around the pieces of rock, and the working platform disappears under the silt. In some cases a well-broken-up shale in fine pieces has provided an adequate working platform on silt.

* Mention that a working platform of granular material should be extended to intersect the slope of the ditch in order that it will drain properly during and after construction.

* State that an important calculation in the design of a highway project is to determine the volume of excavation and the volume of embankment. The answers determine whether the project will require borrow, be a balance job, or require wasting. This is important for preparation of the contract estimate.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Definition of factor	* The earthwork factor is a number used to modify the cut volume in order to determine the embankment volume that will be obtained. For example:
1. Example	* Assume that the natural dry density in a cut is 110 (pounds per cubic foot). Assume that the compacted dry density in the embankment is 125 p.c.f. Then 1 cubic yard of cut will yield 110/125 cubic yards of embankment. The factor may be expressed in two ways: 1. Cut volume X $\frac{110}{125}$ (or .88) = embankment volume 2. Cut volume ÷ $\frac{125}{110}$ (or 1.07) = embankment volume * The second of the above methods, dividing the cut volume by a factor, is the general practice and will be used in the following discussion.
B. Effect of soil type on earthwork factor	* State that the density of the natural soil will have a large influence on the earthwork factor.
1. Water-laid soils	* Water-laid and wind-deposited soils are relatively loose and should be expected to have a smaller volume when compacted. (Earthwork factor greater than 1.0)
2. Glacial tills	* Glacial tills were compacted under several thousand feet of ice; compaction equipment cannot improve on the work of nature to much extent. Shrinkage will be little if any.
C. Effect of rock on earthwork factor	* State that rock in nature is in its most compact position and, when blasted and broken into small pieces, may never be compacted to its original volume again.
1. Swell factor	* Rock excavation will make a larger volume in the embankment. This is called the swell factor.

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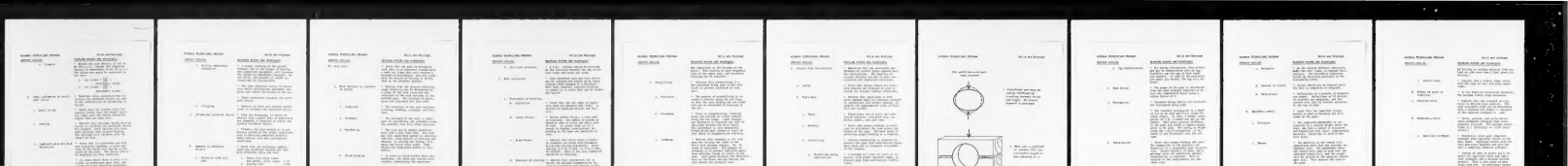

AUDIO VISUALIZATION PROGRAM
(AVPROG) (AVPLAY)

Aims and Purposes

TEACHING PROGRAMS AND DEVELOPMENTS

1. Concept

a. Audio Lab (Program in audio) (Program in audio and video) (Program in adaptation of AV TV to a classroom setting)

b. Use of Audio Lab

c. Use of Audio Lab (Program in audio and video)

2. Audio laboratory in audio and video

3. Audio of use

4. Coaching

5. Audio-visual and a division of audio-visual

a. Teaching (Teaching audio-visual) (Teaching audio-visual)

b. Teaching (Teaching audio-visual) (Teaching audio-visual)

c. Support of audio-visual

d. Education (AVE) (AV) (AV) (AV

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
c. Mechanics	* As the culvert deflects vertically under the fill loads, it expands horizontally. The horizontal expansion builds up resisting pressures in the surrounding earth.
d. Removal of struts	* Struts should not be removed until the fill is completed to subgrade.
e. Deflections	* Deflections of 5 percent of diameter are normal. Deflections of 20 percent of diameter are dangerous, and the culvert will fail by reverse curvature at the top of pipe.
D. Imperfect trench	* State that the imperfect trench method is used to decrease the fill loads on the pipe.
1. Procedure	* The compacted embankment is constructed to a certain height above the pipe, and then a trench is excavated and backfilled with loose, compressible material. Baled hay is used in New York State.
2. Theory	* The material in the trench will consolidate more than the adjacent embankment soil. The embankment above the trench will tend to arch over the subsided trench fill, and the weight will be carried by the adjacent embankment soil. This reduces the load on the pipe.
3. Practice	* If the top of an imperfect trench is too close to the pavement elevation, settlements will show up in the pavement.
VI. Structure Excavations	* State that the stability of temporary excavations for structure foundations or pipes is important, since failures may involve loss of life.
A. Labor code	* Mention that the State Industrial Code requires sheeting and bracing for all excavations "where any employee in an excavation is exposed to the hazard

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	of falling or sliding material from any bank or side more than 5 feet above his footing."
1. Stable slope	* Explain that a stable slope varies with the type of soil and water conditions.
B. Effect of depth on stability	* As the depth of excavation increases, the maximum stable slope decreases.
C. Cohesive soils	* Explain that the strength of clay soils is derived from cohesion. The safe allowable slope may be determined from a circular arc stability analysis if the cohesive strength is known.
D. Nonplastic soils	* Sands, gravels, and silts derive their permanent strength from intergranular friction. The maximum stable slope is 1 (vertical) to 1-1/2 (horizontal.)
1. Capillary strength	* Nonplastic soils gain temporary strength from capillary forces in the pore water. Capillary forces hold the soil particles together and give the soil a temporary cohesive strength. * Drying of sand or gravel soils removes the capillary water and capillary strength, and a delayed failure results. This is the cause of many fatal cave-ins. An additional hazard once the soil has dried out is that sudden saturation by rain will reduce the capillary strength and increase the weight of the soil. Such drying can occur in one hour or take many days.
E. Surcharge loading	* Piling excavated material alongside the top of a trench will make the excavation stability more critical.
VII. Earthwork Computations	* State that in design it is necessary to determine the volume of excavation and volume of fill to prepare cost estimates for a project.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
a. Example	* Assume the rock density in cut to be 150 p.c.f. Assume the compacted density in embankment to be 115 p.c.f. The factor may again be expressed in two ways: 1. Cut volume X $\frac{115}{150}$ = embankment volume 2. Cut volume ÷ $\frac{150}{115}$ = embankment volume
D. Other influences on earthwork factor	* Numerous other considerations influence the earthwork factor and add to the difficulties of estimating in design.
1. Depth of cut	* State that the surface soils are usually looser than the deeper soils. For light cuts the factor should be higher than for deep cuts.
2. Hauling	* Mention that spillage during hauling serves to increase the earthwork factor. For example, truck hauling will have more spillage than scraper hauling. The spillage will increase with the length of haul.
3. Combined soils and rock excavation	* State that if overburden and rock are excavated together, a large portion of the earth will end up in the voids of the rock. The factor should be modified for this condition. * In cases where there is only 2 to 4 feet of overburden upon rock, the volume of earth should be neglected in the quantities, as it is almost certain to disappear in the voids of the rock fill. This increases the earthwork factor.
4. Waste	* Some soil excavation may be wasted because it is too wet to be properly compacted. * Some rock excavation may be wasted because of oversize. * Waste increases earthwork factor.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	the explosives in the bottoms of the holes. This results in poor fragmentation of the upper rock, and secondary blasting may be required.
3. Presplitting	* Indicate that presplitting is a new procedure being used in New York State to prevent overbreak on rock cuts.
a. Principle	* The purpose of presplitting is to create a barrier along the cut face, so that the rock forming the cut slope will not be disturbed by blasting in the cut.
b. Procedure	* Prior to fragmentation, blasting holes are drilled on 3-foot centers along the cut slope. Light charges are detonated to fracture the rock in the plane between the drill holes. This procedure is very successful. Presplitting must extend at least 20 feet ahead of fragmentation blasting.
c. Stemming	* Mention that stemming is the term used for filling the voids in the drill hole between charges. No. 1A stone is specified. The purpose of stemming is to prevent explosive gases from entering cracks or joints in the rock. Such gases decrease the effectiveness of the blast and may shatter the rock behind the presplit line.
d. Other methods	* State that there are other methods of slope drilling but that they are more expensive than the method described.
(1) Line drilling	* Drill holes are made on 6-inch centers along the excavation line, prior to the fragmentation blast. These holes are not loaded. As a general rule, the spacing is twice the diameter of the drill holes.
(2) Slash blasting	* The center of the cut is blasted and excavated. The sides are then drilled and blasted with light loads to trim to shape.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
V. Culvert Pipe Construction	* Emphasize that the successful performance of culvert pipes depends upon the installation. The majority of culvert failures are due to poor construction and inspection practices.
A. Design	* State that design sheets are available, showing the strength of pipe required for various loading conditions.
B. Rigid pipe	* Mention that rigid pipe is that which depends upon its inherent strength in conjunction with proper bedding, to support the superimposed loads of backfill and traffic.
1. Types	* Rigid pipes are of plain and reinforced concrete, vitrified clay, asbestos cement, and cast iron.
2. Bedding	* State that proper bedding is necessary to distribute the load across the bottom of the pipe. The best means of achieving proper bedding is a template.
3. Backfilling	* Careful backfilling is required to protect the pipe from construction equipment loads and to eliminate settlement of the roadway.
a. Protection during construction	* A minimum of 2 feet of cover is required, with proper approach ramps, to protect pipe from construction traffic loads.
b. Material	* Gravel backfill is needed since it is the easiest material to compact to the required densities.
C. Flexible pipes	* State that flexible pipes are those which deflect within tolerable limits under load, and in so doing mobilize resisting pressures from the surrounding soil to support the imposed loads.
1. Theory of flexible pipes	* Explain that the strength of a flexible pipe is derived from ring compression. That is, compressive stresses must be equal all around if the pipe is to be stable. (Fig. 10-3)

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HIGHWAY TECHNICIANS PROGRAM

CONTENT OUTLINE

3. Soil-rock interface

C. Rock excavation

1. Principles of blast

a. Explosives

b. Powder factor

c. Blast holes

d. Sequence of bla

e. Nonuniform load

TEACHING POINTS AND TECHNIQUES

* A 5-fo setback should be provided at the interface between the top of the rock slope and earth cut slope.

* Some weathered rock and soft shales may be loosened and broken up by heavy ripping teeth dragged by a bulldozer. Most rock, however, requires blasting to reduce it to sizes that can be loaded and hauled.

ting

* State that the two types of explosive used are dynamite and "anfo" (a mixture of ammonium nitrate and fuel oil).

* Define powder factor, a term used in blasting: the number of pounds of dynamite used to blast one cubic yard of rock. It varies from 1/2 to 2 pounds in highway construction, depending on the type and condition of rock.

* Explain that drill holes 3 inches in diameter are bored with pneumatic drills,for placing explosives. Usual spacing is 6 by 8 feet, or 8 by 8 feet, on centers. This is the most expensive operation in blasting.

asting * Explain that contractors try to obtain the maximum fragmentation for ease in excavation and placing in fill. The maximum size of rocks allowed in fill is 2 feet. The usual blasting round extends no more than 50 feet from the face of cut. The rounds are detonated with millisecond-delay caps, so that the blast proceeds back from the face of the cut. This allows more effective fragmentation and throws the rock outward into the cut where it can be more efficiently excavated. It is much more economical to heave rock in a horizontal direction than upward.

ding * In areas where fly rock is a problem, the contractor will often put most of

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UNIT II (14.0901-02)

FUNDAMENTALS OF TYPING

Performance Objectives:

Upon completion of this unit the student will be able to type at a rate of 30 wpm/ecol.

Unit Outline:

A. Machine Fundamentals

1. Parts

2. Maintenance procedures

3. Manual and electric typewriters

4. Operation

B. Quality and Performance Standards

1. Speed and accuracy

2. Neatness

3. Language arts

C. Skill Development

1. Keyboard mastery

2. Manipulation of machine parts

3. Speed, accuracy, and erasing

D. Typing Applications

Supplemental Teaching Aids:

No suggestions will be made for this unit since free or inexpensive resources are not applicable.

Training Time 70-85 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
5. Rolling embankment foundation	* A slight lowering of the ground surface, due to the weight of hauling and compaction equipment, will increase the volume of embankment required. On low fills, the percent of volume increase may be considerable. * The same condition exists in borrow pits where construction equipment compacts and lowers the bottom of the pit. * These conditions increase the earthwork factor.
6. Stripping	* Removal of trees and surface growth tends to increase the earthwork factor.
E. Estimating earthwork factor	* From the foregoing, it should be obvious that a great deal of experience and judgment is required to choose the correct earthwork factor. * Probably the best method is to use factors guided by the actual quantities used in previous, completed projects under similar soil and construction conditions.
F. Summary of earthwork factors	* State that the following summary shows how earthwork factors may vary with different soils and rock.
1. Variation with soil type	1. Water-laid soils (sand and gravel, silt, clay) 1.15 2. Glacial till 1.05 3. Soft shale 0.85 4. Sandstone and limestone 0.75 5. Igneous rock 0.70
2. Variation with cut depth	* The next summary shows how factors may vary with depth of cut for water-laid soils. 1. Shallow cuts (less than 6 feet): 1.35 to 1.15, depending on vegetation 2. Moderate cuts (6 to 25 feet): 1.15 3. Deep cuts (more than 25 feet): 1.10

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
IV. Rock Cuts	* State that the goal in designing rock cuts is to construct economically a safe cut slope that will require a minimum of maintenance and will eliminate the hazard of falling or fallen rock on the pavement surface.
A. Rock features to consider in design	* Mention that the factors affecting slope stability may be determined by a study of the rock cores and the structure of the rock outcrops in the problem area. The services of geologists are available for this work.
1. Structure	* The structure of the rock involves jointing, bedding, cleavage, and fracture.
2. Strength	* The strength of the rock is important in considering the allowable slope. The soundest rock will stand vertical.
3. Weathering	* The rock may be deeply weathered, more like a soil than rock. The rock may look sound when opened in construction but, from effects of freezing and thawing or wetting and drying, will spall and build talus slope. Some shales and sandstones behave in this manner.
4. Stratification	* In areas of thick-bedded shale and sandstone, the shale may weather more rapidly, undermining the sandstone.
B. Rock cut design	* State that adequate explorations are required to determine surface of rock and type of rock.
1. Design slope of rock	* Design slope may vary from vertical to 1-on-1, depending on rock features discussed above.
2. Setback to toe of rock slope	* The setback distance is to provide storage space for rock falls, and to keep falling rock from rolling onto the pavement. A 25-foot setback from pavement edge is considered the minimum distance if rock falls are expected to be a problem.

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Use coffee can with both ends removed

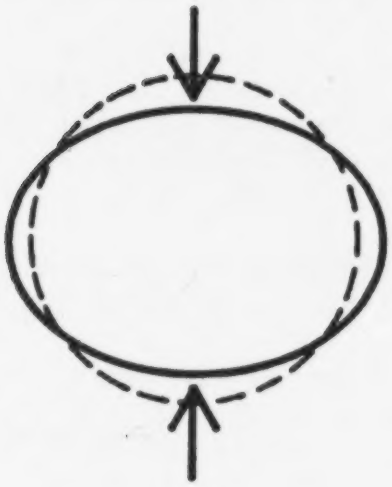

1. Unconfined can may be easily flattened by crushing between thumb and finger. No lateral support is available.

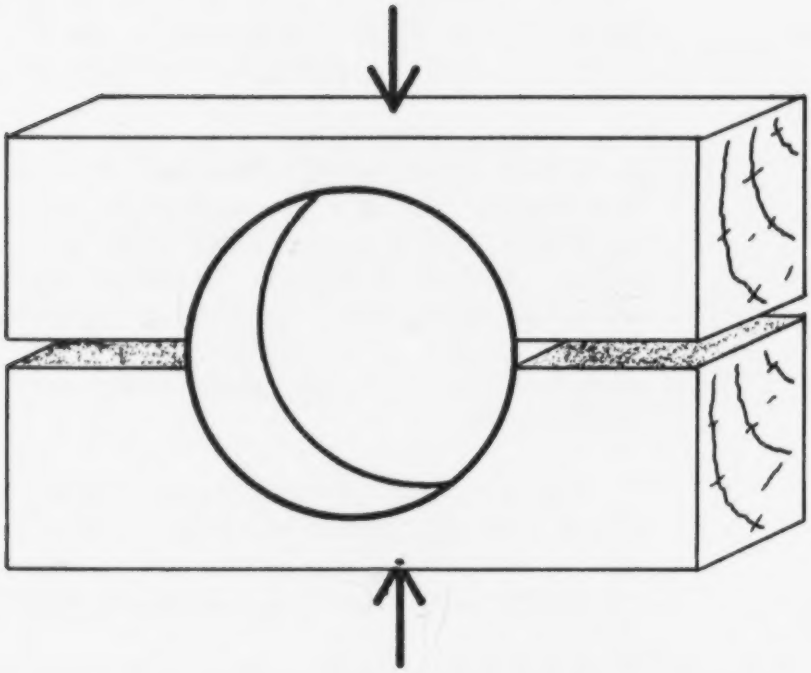

2. When can is confined in wooden "fill", can will sustain weight of man standing on it.

FIGURE 10-3
DEMONSTRATION OF FLEXIBLE PIPE BEHAVIOR

CONTENT OUTLINE

a. Egg demonst

2. Pipe design

3. Corrugation

4. Installation

5. Elongation

a. Strutting

b. Purpose

TEACHING POINTS AND TECHNIQUES

ration

* For daring instructors, this principle may be demonstrated with an egg. Carefully cup the egg in both hands and squeeze. As long as the pressures are equal all around, the egg will not break.

* The gauge of the pipe is determined from the seam strength required to resist the compressive force using a safety factor of 4.

* Standard design sheets are available for corrugated metal pipe.

* The standard corrugation is a depth of 2/3 of an inch and 2-1/2 inches between ridges. In 1965, a deeper corrugation of 1 by 3 inches was put on the market. This gives greater stiffness to the pipe and allows a lighter-gauge metal to be used. The saving in weight using the 1-by-3 corrugation is between 25 and 40 percent over the old type.

* State that proper bedding and careful compaction of the backfill are essential to a successful pipe installation. Gravel backfill is used, and a minimum cover for protection against construction is required. This is similar to the requirements for concrete pipe.

* Mention that some corrugated metal pipes are delivered with horizontal wire ties to hold a vertical elongation of about 5 percent of the pipe diameter.

* Structural plate pipes are made with timber strutting to elongate them by 5 percent.

* Vertical elongation is a type of pre-stressing that allows lighter-gauge metals to be used and/or greater heights of fill to be placed than with round pipe.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Volumes from cross-sections	* The usual method of volume computation is from cross-sections prepared at 50-foot intervals and where major surface irregularities occur.
1. Average end area method	* Mention that the volume of cut or fill is obtained by computing the areas with a planimeter for each section. The volume of earthwork is determined by averaging the areas of two sections and multiplying by the distance between cross-sections. The volume of cut or fill is expressed in cubic yards.
2. Computer programs	* Quantities may also be determined by computers. Computers can be used, too, for plotting cross-sections. Input requires ground surface data, grade line, and typical section.
B. Earthwork factor	* Explain that the earthwork factor must be applied to the cut volume to estimate the embankment volume that may be obtained from the excavation.
1. Earth and rock excavation	* Indicate that quantities of earth and rock excavation must be computed separately since the earthwork factor will be different. Review previous discussion in this lesson on factors.
C. Determination of total earthwork volume	* First, determine the volume of embankment fill that can be built with excavation after earthwork factors are applied. Second, compare the quantity of available fill to the total fill volume to ascertain if additional borrow is required or if there will be excess material from cuts. (This is called waste excavation.)
D. Balance of cut and fill	* Explain that, in the past, designers tried to balance cut and fill for most economical design. With present-day design standards this becomes more difficult.
1. Economics	* Relate that a designer should use judgment in design to reduce the total

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	volume of earthwork for economic reasons. This will require study and adjustments of profile alignment and cross-sections, keeping the design standards in mind.
E. Earthwork factors influencing grade lines	* In preparing a highway design, the following factors should be considered. They may not be as important, however, as other design considerations, and adjustments may not always be possible.
1. Rock excavation	1. Explain that rock excavation is two or three times more costly than earth excavation. One should reduce rock excavation as much as possible.
2. Cuts in clay	2. If the clay is too wet to be used in embankments, reduce cuts in this material as much as possible, since excavation will have to be wasted.
3. Grade line in flood plain or swamp	3. Keep the grade line at least 4 feet above the high-water level for good performance of pavement.
4. Shallow cuts in wet silt or clay	4. Undercutting will be required for a working platform during construction. It may be more economical to raise the grade to provide 3- or 4-foot fill without undercutting.
F. Final earthwork summary	* Explain that all earthwork quantities are summarized for estimate purposes. These include unclassified excavation (earth, rock, and borrow), selected granular borrow, underdrain filter, subbase courses, and trench, culvert, and bridge excavation.

ASSIGNMENT

1. Study the class notes.

Lesson 11 - Highway Drainage

REFERENCES CITED IN THIS LESSON

Armco Drainage and Metal Products, Inc. Handbook of drainage and construction products. Middletown, Ohio. Armco Drainage and Metal Products, Inc. 1958. (Referred to in this unit by symbol "L")

Woods, K. B. Highway engineering handbook. New York. McGraw-Hill Book Co. 1960. (Referred to in this unit by symbol "B")

OBJECTIVES

1. To discuss the types of highway drainage problems
2. To study the principles of hydrology concerned with the frequency and intensity of runoff to be handled
3. To become acquainted with the procedures used in the hydraulic design of drainage facilities

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Introduction	* State that this lesson concerns methods of collecting, transporting, and disposing of surface water originating on or near the highway right-of-way, or flowing in streams crossing or bordering the right-of-way. It also covers control of subsurface drainage.
A. Economics	* Indicate that, on the average, 10 to 15 cents from each highway construction dollar is spent for culverts, bridges, and other drainage structures.
B. Legal responsibility for drainage	* Inform the class that highway agencies have legal responsibility for damage to private property resulting from changes they make in natural drainage patterns.
II. Types of Drainage Problems	* Mention that this section will summarize the different types of drainage problems and will discuss in detail those problems involved with soil properties.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Bridge waterway openings	* State that in most cases the height and length of a bridge depend on the amount of clear waterway opening required to accommodate the flood waters of the stream.
1. Design flood stage	* The structure is usually designed for a predicted maximum flood. * For example, a bridge may be designed for a 50-year flood interval. This would allow for a flood which can be expected, by the laws of probability, to occur on the average of once in 50 years.
2. Flood data	* Mention that the U. S. Geological Survey publishes flood data for many streams based on information obtained from stream gauging stations.
B. Highway culverts	* Define a culvert as any closed conduit used to conduct water under a roadway. * All conduits greater than 20 feet in total span are treated as bridges.
C. Municipal storm drainage	* Indicate that in urban areas runoff waters are carried through a system of storm sewers. * Drainage problems are increased by: 1. Impervious surfaces which create very high runoff 2. Too few natural water courses to handle the runoff
D. Roadway surface drainage	* Point out that roadways are built with crown or cross slopes, which provide lateral or oblique drainage flow to the sides of the pavement. The transverse slope is 1/4 inch per foot.
1. Disposal of drainage	* Usually the water flows across the road shoulder and down the slope to a natural drainage area, or to side ditches.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Erosion problems on fill slopes	* Mention that on embankments made of fine sand and silt roadway runoff will cause erosion gullies that work back under the shoulder. * Curbs may be placed at the edges of paved shoulders to control water. Inlets with ditches or pipes may be used to conduct water down the embankment side slope.
E. Ditches	* Point out that a highway cross-section normally includes ditches on each side of the roadway parallel to the centerline.
1. Purpose	* Ditches serve four purposes: 1. They intercept surface drainage from cut slopes and conduct water away from highway section. 2. They intercept subsurface drainage and conduct water away from highway. 3. They lower the water table below pavement, thus reducing the possibility of frost heaving. 4. They improve subsurface drainage of water that infiltrates pavement and shoulders.
2. Design	* Mention that ditches should be designed to accommodate the maximal flow of water. Sufficient waterway should be provided to prevent erosion of the roadway shoulder and undercutting the toe of the slope.
a. Dimensions	* The standard ditch section is 4 feet deep and 3 feet 8 inches wide, with a radial bottom.
3. Blasted rock trench	* Mention that blasted rock trenches are used in rock cuts where ground water is flowing through the joints or bedding planes of the rock. * The rock is blasted, creating a trench 3 feet deep and a minimum of 2 feet wide. The rock fragments are

UNIT III (14.0901-07)

PRODUCTION TYPING

Performance Objectives:

Upon completion of this unit the student will be able to type at a rate of 55 wpm/eco2.

Unit Outline:

A. Skill Refinement and Development

1. Keyboard

2. Proofreading

3. Specific areas of improvement

B. Improvement of Production Typing Skills

1. Desk, chair, typewriter adjustments

2. Choice of appropriate materials and tools for specific tasks

3. Erasing

4. Materials

Supplemental Teaching Aids:

No suggestions will be made for this unit since supplemental resources are not applicable.

Training Time 60-80 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	left in the trench. Care should be taken to have continuous blasting in order not to leave a dam of unbroken rock.
F. Cut slope drainage	* Proper control of drainage on a cut slope is difficult due to the high velocity of flow. This is a source of many maintenance problems.
1. Top-of-slope ditch	* State that the top-of-the-slope ditch is used for the erosion protection of cut slopes against runoff from the slopes above the cut. * Care should be taken in design to prevent erosion and subsequent spilling of water in concentrated quantity on the cut slopes. Paved gutters may be required for prevention of erosion on long, steep slopes.
a. Design	* Standard design for the top-of-a-slope ditch is a minimum 5-foot set-back from top of the slope, with existing vegetation remaining between the ditch and the top of slope. The minimum depth is 2 feet, and the width varies.
2. Slope benches with gutters	* State that slope benches are sometimes used to intercept water part way down the slope and to carry runoff along the bench to the end of cut, or to slope gutters or drain pipes at intervals.
a. Failure of slope benches	* Slope benches are unnecessary as drainage features, and usually perform unsatisfactorily for the following reasons: 1. The slope runoff resulting from precipitation on a slope will not cause erosion if the slope is covered with a growth of grass. Sufficient fertilizer, mulching, and proper choice of grass seed produce adequate grass cover on most cut slopes.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2 or 3 feet per second. Good sod will erode when the velocity exceeds 4 to 6 feet per second.
b. Erosion	* Once the water overflows the gutter, it erodes the soil from under the gutter.
c. Damage	* The end result from loss of support and subsequent frost action is a gutter broken and twisted into many pieces.
d. Design	* Consideration should be given to designing a gutter with hydraulic properties adequate to carry the water, and with bedding adequate to resist frost heaving and cracking. The most difficult part of the design usually is channeling the water around the 90° turn from top-of-the-slope ditch down the slope gutter.
	* Corrugated metal pipe buried in the slope is one method of conducting water down the slope and avoiding erosion problems.
G. Subsurface drainage: underdrains	* State that subsurface drainage is an important factor in preserving a roadway surface.
1. Effects of water on subgrade	* Tests have indicated that during the spring thaw the bearing capacity of the roadway subgrade is suddenly reduced to about 25 percent of its autumnal strength; it slowly builds up again over a period of several months as the soil drains. (Refer to Figure 8-10 in Lesson 8.)
2. Importance of drainage	* The strength loss in the subgrade may be reduced if good drainage prevents water from accumulating in the subgrade.
	* The majority of pavement failures are caused by too much water and not enough drainage.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Purpose	* State that underdrains are pipe drains usually placed outside the pavement sections to accomplish one or more of the following results: 1. To drain the subbase course gravel 2. To drain the subgrade soil under the roadway 3. To intercept ground water coming from outside the roadway section
4. Mechanics	* Mention that damage to the pavement is due to loss of subsoil strength by the effects of water and frost. * Lowering the water table reduces the moisture in the soil and also lessens the tendency for water to accumulate by capillary rise. * Drains also help remove the water that infiltrates through the pavement and shoulder areas.
5. Type of underdrain	* State that the principal types of underdrain used are perforated corrugated metal, porous concrete, vitrified clay, asbestos cement, and bituminous fiber. * State the features of each as described in New York State Specifications. (Ref. H)
6. Design of underdrains	* The location of the underdrain depends on what type of drainage it is intended to accomplish. (Fig. 11-1)
a. Size	* For normal subdrainage 500 feet of 6-inch pipe may be used as an interceptor before any increase in diameter is needed.
b. Slope	* A minimum slope of 0.15 foot per 100 feet should be used.
c. Pipe outlets	* Free outlets are important. Many underdrains do not work because of plugged or damaged outlets.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Build outlets high enough so that they will not become plugged with silt or snow.
d. Depth of underdrain	* The bottom of a subdrain pipe should be deep enough in an impervious material to effect complete removal of the water. (Fig. 11-1a) In a pervious soil the water table is lowered to the bottom row of perforations. Space in the bottom of the pipe between the rows of perforations is sufficient to carry normal flow. (Fig. 11-1b)
7. Backfill material	* Mention that silting and plugging up is one of the main causes of failure in underdrains.
a. Requirements	* The underdrain filter material should be coarse enough to allow the water to drain into the openings of the underdrain (3/8- to 1/2-inch perforations or joint openings) without washing the fines out of the filter.
	* The material needs a gradation that will prevent the fine-grain material of the surrounding soil from washing into the filter and clogging the voids.
b. Materials used	* Up until 1962 a run-of-bank gravel was used. This material was so variable in gradation that it did not always meet the above requirements.
	* The 1962 Specifications (Item 2UF) require a better graded material which, if made of processed substance, will contain 50 percent concrete sand, 25 percent No. 1 stone, and 25 percent No. 2 stone. This higher-grade material will insure a satisfactory performance of the underdrain for a longer period of time.
	* Crushed stone is used by some agencies as a filter material. Tests indicate that this may clog up with fines from the surrounding soil over a period of time, with a serious loss in permeability.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

8. Installation

* Mention that underdrains may be placed in a trench or in a V-shaped excavation below the subbase gravel. This type of excavation may be made with a grader blade. (Fig. 11-2)

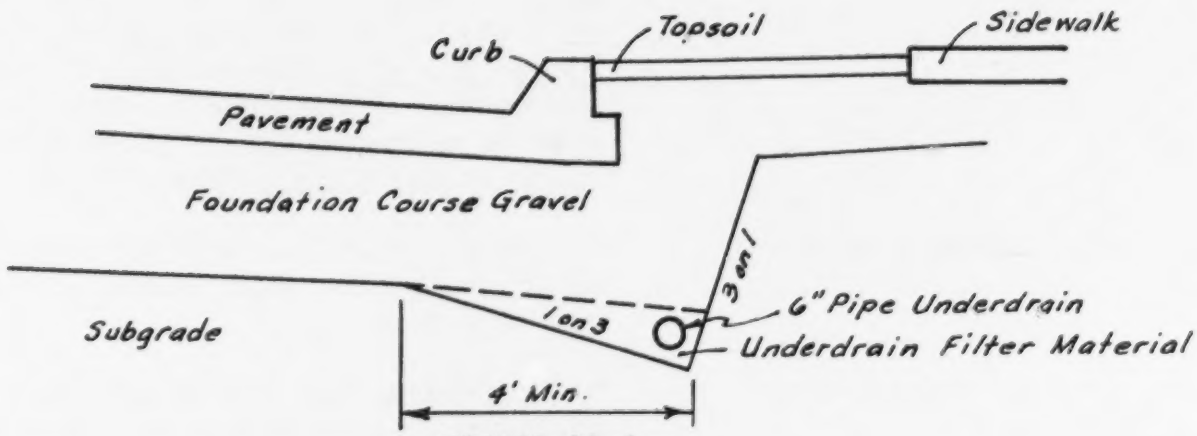

FIGURE 11-2
V-NOTCH UNDERDRAIN TRENCH
(Source: New York State Department of Public Works Standard Sheets)

a. Care

* Care should be taken to securely connect pipe joints. At least 4 inches of underdrain filter material should be placed below and around the sides of pipe.

b. Sealing surface

* Mention that underdrains below ditches should have a layer of impervious material above the filter material to prevent surface water from running in and silting up the granular backfill.

9. Construction considerations

* Explain that at the time underdrains are installed the soil may be dry and the underdrains may appear to be a waste of money. In the spring, however, when the soils are wet and the strength of soil is at a minimum, the drainage provided by the underdrain may save the pavement.

a. Transverse drainage

* Occasionally the grade line in a cut may intercept a water-bearing layer of soil. It is usually impossible to determine these areas from explorations.

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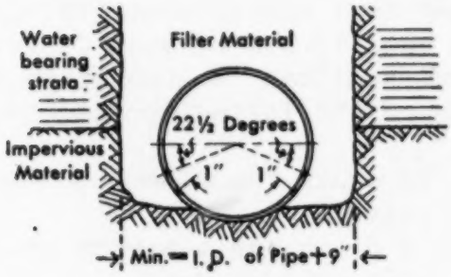

FIGURE 11-1 (a)
IMPERVIOUS TRENCH BOTTOM
(Source: Ref. L, p. 309)

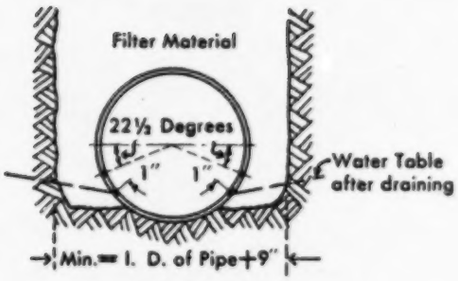

FIGURE 11-1 (b)
PERVIOUS TRENCH BOTTOM
(Source: Ref. L, p. 309)

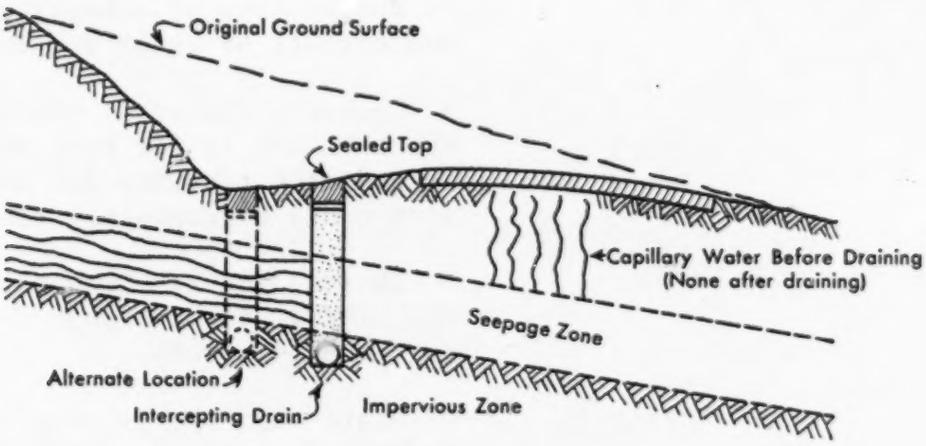

FIGURE 11-1 (c)
INTERCEPTING DRAIN TO CUT OFF CAPILLARY WATER
AND FREE WATER
(Source: Ref. L, p. 319)

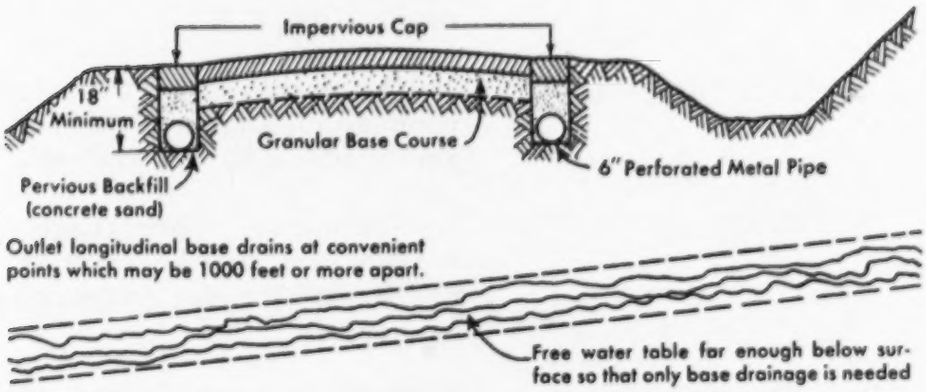

FIGURE 11-1 (d)
BASE DRAINAGE TO REMOVE SURFACE WATER
TRAPPED BETWEEN PERVIOUS BASE AND IMPERVIOUS SUBGRADE
(Source: Ref. L, p. 319)

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

The construction engineer should provide transverse underdrains in such areas. If the area is extensive, undercutting and backfilling with coarse granular material may be done across the seepage zone, and one or more transverse underdrains may be provided. Without treatment, this is a likely location for frost heaving and pavement failures. (Fig. 11-3)

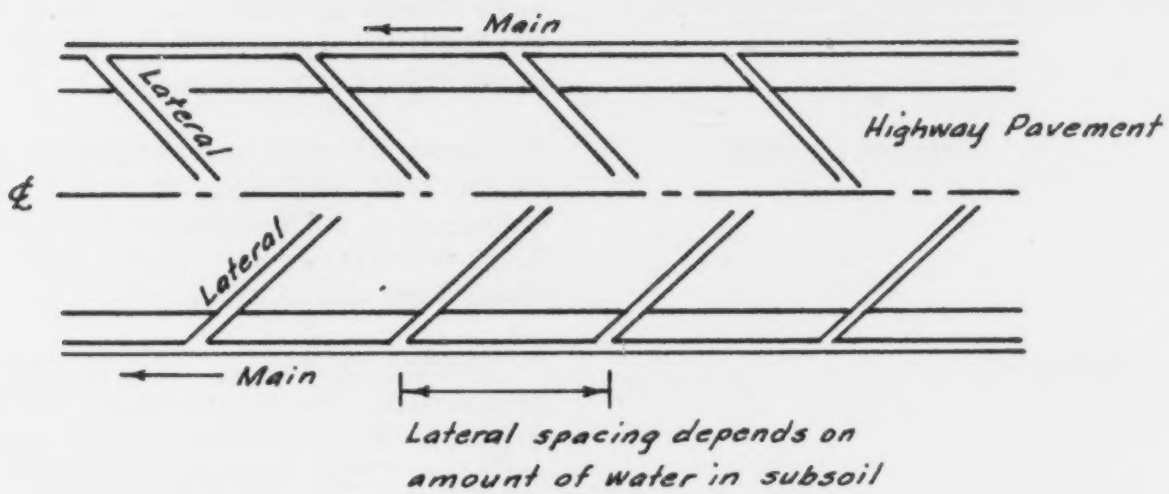

FIGURE 11-3
HERRINGBONE SUBDRAINAGE LAYOUT
USED IN CUTS INTERSECTING WATERBEARING ZONES OF SOIL

H. Channel relocations

* State that relocation of natural water courses to keep them on one side of the roadway is often done to eliminate drainage structures.

1. Analysis

* A thorough analysis should be made of the hydraulic properties of the stream to determine the effect of relocation on stream flow and scour.

* Channel relocation should have the same type of hydraulic analysis as that given culverts and bridges.

2. Scour

* Mention that existing streams have stabilized in their channels over many years. Changing the channel may start

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	unexpected erosion, scour, and undercutting of embankments and cut slopes.
a. Critical soils	* The most critical soils for scour and erosion are those made up predominantly of fine-grain silts and clays. Channel protection may be required, such as stone rip-rap.
I. Erosion protection	* Mention that the hydraulic design should be such as to prevent scour velocities if possible. When this is impractical, protection should be provided against scour.
1. Critical areas	* Scour or erosion should be prevented at culvert outlets; in all ditches, especially down-slope ditches where flow velocities are high; and on shoulders and slopes.
III. Hydrology	* Define hydrology as the science that deals with the occurrence and movement of water on and beneath the earth's surface. The application of hydrology to drainage design is in the estimating of the volume of water to be carried in the waterway or through a pipe.
A. Rainfall	* State that the application of hydrology important to drainage structures is the relation between rainfall and ultimate surface runoff.
	* The following three rainfall factors for design must be determined:
1. Intensity	1. The rate at which rain falls for a given period, usually expressed as inches per hour
2. Duration	2. The time during which rainfall prevails at that rate, usually expressed as minutes or hours
3. Frequency	3. The probable period of time within which combinations of intensity and duration repeat themselves, usually expressed in years

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
b. Flow area (A)	* "A" is the channel flow area at high water.
c. Hydraulic radius (R)	* The hydraulic radius is defined as the area of flow divided by the wetted perimeter.
d. Wetted perimeter	* The wetted perimeter is the length of the boundary of the cross-section which is in contact with water. This is a definition from hydraulics.
e. Slope of channel (S)	* The slope of the channel is the drop in water surface per unit distance. This was determined from the high water marks. Units are feet per foot.
3. Sample problem	* Work out the sample problem on page 38 of Ref. M.
V. Culvert Design	
A. Design for fill loads	* Mention that after the required pipe size is determined the strength of pipe to carry the embankment loads should be determined.
1. Design charts	* Design sheets have been developed by the State Department of Public Works to show the required pipe to support various embankment heights.
a. Corrugated metal pipe	* The gauge thickness of metal required in corrugated pipe varies with the full height.
b. Reinforced concrete pipe	* Two types of concrete pipe are available: reinforced concrete and extra-strength reinforced concrete.
B. Culvert location and length	* Proper location of the culvert is important to provide adequate control of stream flow.
1. Alignment	* The stream should have a direct entrance and a direct exit. If a direct entrance or exit does not exist, it may be provided by:

UNIT IV (14.0901-03)

OFFICE EQUIPMENT

Performance Objectives:

Upon completion of this unit the student will be able to score at least 90% on an instructor established scale that considers both accuracy and time, in operation of adding machines and calculators. She will be able to demonstrate correct procedure and technique in operation of reproducing machines. The student will be able to tabulate 50 handwritten checks in one minute or less with no errors.

Unit Outline:

A. Machines

1. Ten-key Adding Machine
2. Full-key adding machine
3. Printing calculator
4. Rotary calculator
5. Bookkeeping machine

B. Reproducing Machines

1. Spirit
2. Mimeograph-mimeoscope
3. Copy machines
4. Other reproducing machines
5. Analysis of reproduction requirements and selection of method

C. Other Office Equipment

1. Paper cutter
2. Stapler
3. Collator
4. Lablemaker
5. Punching and binding
6. Tape recorder

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. A channel change 2. A skewed alignment 3. A combination of 1 and 2
2. Prevention of stream changes	* Precautions should be taken to prevent the stream from changing its course near the ends of the culvert. Excessive ponding or washout of the roadway may result.
a. Protective steps	* Rip-rap, sod, paving, concrete headwalls, or metal end sections will help solve the above problem.
C. Culvert grade	* Explain that the ideal grade line produces neither silting nor excessive velocities and scour; it also provides the shortest length. (See Table of Scour Velocities, Ref. L, p. 210)
1. Minimum slope	* A minimum slope of 0.5 foot per 100 feet is needed to avoid sedimentation and erosion.
2. Average slope	* A slope of 1 to 2 percent is usually adequate.
3. Stream-bed grade	* Where possible, make the culvert grade coincide with the stream-bed grade.

ASSIGNMENT

1. Review the lesson lecture notes.

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5. In the laboratory, various amounts of clays are added to a sample of silt and sand. As the proportion of clay increases, which of the following best describes the behavior of the Atterberg Limits?

_____ a. The liquid limit increases, the plastic limit decreases, and the plasticity index decreases.
__X__ b. The liquid limit, plastic limit, and plasticity index all increase.
_____ c. The liquid limit, plastic limit, and plasticity index all decrease.
_____ d. The liquid limit, plastic limit, and plasticity index remain constant.

6. The No. 200 sieve is important in soil classification for which of the following reasons?

_____ a. All material retained on the sieve is classified as gravel.
_____ b. All material passing the No. 200 sieve is sand and silt.
__X__ c. The No. 200 sieve separates the coarse-grain sand and gravel from the fine-grain silt and clay.
_____ d. The No. 200 sieve separates the silt-size particles from the clay-size particles.

7. A proposed highway is to traverse an area that is hilly and wooded. The designer needs to know the depth of rock in cuts for preparing the cross-sections. Which of the following exploration methods would be the most practical to provide the design information?

_____ a. Drill holes with split-spoon drive samples
_____ b. Drill holes with core samples
_____ c. Auger holes
__X__ d. Seismic investigations
_____ e. A geologic survey mapping all rock outcrops

8. The results of the laboratory consolidation test are usually applied to which of the following design problems?

_____ a. Consolidation of embankment soils
_____ b. Settlement of soils due to vibration of traffic loads
_____ c. Determining earthwork shrinkage factors
__X__ d. Determining settlement of foundation soils caused by embankment loads
_____ e. Determining embankment stability

9. Granular foundation soils usually have sufficient strength to support all heights of embankments. The main reason for this is that:

_____ a. Granular soils build up extra capillary strength when loaded.
__X__ b. The granular soils consolidate rapidly as the fill is placed, with a corresponding increase in frictional shear strength in proportion to the load applied.

(continued)

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_____ c. Granular soils have a large shear strength, even before the load is applied, which is sufficient to support any load.

_____ d. The granular soils have unlimited shear strength, provided the side slope of fill makes an angle with the horizontal which is less than the friction angle (30°) of the granular soil.

10. Capillary forces play an important role in the strength of soils. Which of the following statements about capillarity is not true?

_____ a. The height of capillary rise in soils increases as the grain size decreases.

_____ b. Granular soils that develop capillary forces have greater strength than the same soil in a dry condition.

_____ c. Development of capillary forces in soils requires a partially saturated condition where the soil voids contain both air and water.

__X__ d. When a trench excavation is made in granular soils containing small amounts of fine-grained material, the capillary forces in the soil can provide sufficient shear strength to keep the sides of the trench permanently stable.

11. It is important to know the effect of compaction effort on the compaction characteristics of a soil. An increase in compactive effort on a given soil will do which of the following?

__X__ a. Decrease optimum moisture content and increase maximum density

_____ b. Increase optimum moisture content and increase maximum density

_____ c. Decrease optimum moisture content and decrease maximum density

_____ d. Increase optimum moisture content and decrease maximum density

_____ e. Have no effect on optimum moisture content or on maximum density

12. You are an engineer in charge of a project. A deep deposit of wet silt is encountered at subgrade elevation in a cut. It is impossible to get construction equipment through the cut. Which of the following solutions would you recommend for stabilizing the subgrade?

_____ a. Place a herringbone pattern of underdrains and put on subbase course gravel

_____ b. Increase depth of ditches

_____ c. Undercut until stable material is reached and backfill with gravel

_____ d. Undercut about 3 feet and backfill with large rock excavation if available

__X__ e. Undercut about 3 feet and backfill with well-graded gravel

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Emphasize that frequency is based on the mathematical law of probability. For example, a 50-year rainfall intensity may occur twice in 1 year or once in 100 years. Analysis of past records, however, indicates it will occur, on the average, once every 50 years.
B. Runoff	* Mention that a portion of the precipitation is returned to the atmosphere by evaporation and transpiration through plant growth. Some water soaks into the ground, becoming ground water.
1. Surface runoff	* The remainder flows over the surface to small tributaries and major streams. This portion is called surface runoff.
2. Effect of ground cover	* The runoff varies with the ground cover. Runoff is much greater in an urban area, where there are many roofs and pavements, than in a forested area or dense grass.
C. Use of stream flow records	* Explain that the major streams in New York have continuous records of runoff, accumulated over many years. These streams are gauged by the U. S. Geological Survey and other agencies, and the records are published.
1. Lack of records for small streams	* Stream flow records for smaller streams, with less than 10 square miles of drainage area, are few. Other methods must be used to estimate design flow.
IV. Determining Flow for Culvert Design	* The major problems of stream-flow analysis are for culvert designs.
A. Definition of culvert	* Culverts are defined as structures with a span of 20 feet or less between abutments. This category includes all kinds of pipes as well.
B. Determining culvert size by inspection	* State that a practical method of deciding culvert size is to inspect an existing structure at the site. Observe the following steps:

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Channel condition	* Note the size, shape, and condition of the channel upstream and downstream.
2. Length of service	* Investigate the length of service of an existing culvert from records. Is the time of service long enough for 20- to 50-year runoff?
3. High water marks	* Maintenance personnel or local residents may have recollection of high water marks.
4. New culvert	* Estimate the adequacy of the existing culvert and base the size of new culvert on that estimate.
C. Determining culvert size by empirical formulas	* Empirical formulas have been used for many years to design culverts. They are "rule of thumb" procedures, and are gradually being replaced by more accurate and scientific methods.
1. Talbot Formula	* The area of the waterway may be determined directly from the formula: $a = C^4\sqrt{A^3}$
a. Required waterway opening (a)	* In the Talbot Formula, "a" is based on a flow of 10 feet per second.
b. Runoff coefficient (C): ratio of runoff to rainfall	* "C" varies from 1 to 1/5 according to the steepness of the land (Ref. L, p. 226) and the type of ground surface (Ref. B, 12-17K)
c. Drainage area (A)	* The drainage area, in acres, may be determined from USGS maps or air photos.
2. Rational method	* The system applied to watersheds of less than 1,000 acres is called the rational method: $Q = CiA$
a. Runoff (Q)	* Runoff is measured in cubic feet per second for total drainage.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
b. Intensity of rainfall (i)	* Intensity is measured in inches per hour. Charts have been prepared showing intensity versus duration. These are available in drainage manuals and from the U. S. Weather Bureau. Sketch the sample chart from Section 12, page 11, of Ref. B.
c. Time of concentration	* The intensity chosen for design should be equal to the time of concentration in minutes for water from the most remote corner of the watershed to reach the drain. Peak design flow cannot occur until this condition is satisfied. For watersheds of 1,000 acres, this time is 5 to 10 minutes, depending on the gradient and vegetation.
D. Analysis of the natural channel	* State that the volume of flow may be determined from an analysis of the natural channel approaching the culvert.
1. Field procedure	* The following information is obtained in the field: 1. A typical cross-section of the channel is determined. 2. The high water marks are determined to find the gradient of water surface at flood stage. A minimum channel length of 200 feet is required. 3. The material on channel sides and the bottom roughness are noted.
2. Manning Formula	* The Manning Formula for channel flow is used. This is based on hydraulics. $Q = \frac{1.486}{n} AR^{\frac{2}{3}} S^{\frac{1}{2}}$
a. Roughness factor (n)	* This factor depends on the roughness and type of sides and bottom. It varies from .125 for rough channel surfaces to .015 for smooth pipe surfaces. Tables are in hydraulic handbooks.

GLOSSARY OF SYMBOLS

a = area of waterway opening

A = area

C = cohesion (in Lesson 6)
runoff coefficient (in Lesson 11)

e = void ratio

G = specific gravity

h = head loss

H_c = capillary rise

H = thickness, height

i = hydraulic gradient (in Lesson 7)
rainfall intensity (in Lesson 11)

k = coefficent of permeability

L = length

LL = liquid limit

n = roughness factor

P = pressure

PI = plasticity index

PL = plastic limit

Q = quantity

R = radius (in general)
hydraulic radius (in Lesson 11)

S = degree of saturation (in Lesson 3)
shearing strength (in Lesson 6)
slope of channel (in Lesson 11)

(continued)

GLOSSARY OF SYMBOLS (continued)

SL = shrinkage limit

t = time

T_s = surface tension

v = velocity

V = volume

V_s = volume of soil

V_v = volume of voids

V_w = volume of water

w = moisture content

W = weight

W_s = weight of soil

W_w = weight of water

γ_d = dry unit weight

γ_s = weight of soil solids per unit volume

γ_t = total unit weight

γ_w = weight of water per unit volume

Φ = friction angle

Final Examination Part I -- Multiple Choice Questions

INSTRUCTIONS: Read all the following statements carefully, then place a checkmark in the space before the choice you consider to be the correct one.

1. The most common type of rock found in New York State is:

   X a. Sedimentary
   _____ b. Igneous
   _____ c. Metamorphic
   _____ d. Conglomerate

2. A location study is being made for a highway alignment in the southwestern plateau region of New York State. The line is in a broad valley which, in one area, is filled with irregular, hummocky hills for the entire width of the valley. Which of the following is the soil deposit most likely to be?

   _____ a. Outwash
   X b. Moraine
   _____ c. Delta
   _____ d. Eskers
   _____ e. Drumlins

3. The gradation of particle sizes has an important influence on the density of a soil mass. Which of the following types of gradation will usually give the greatest soil density in nature?

   X a. Well graded, including all grain sizes from coarse to fine
   _____ b. Soil containing round particles all of the same size
   _____ c. Soil containing flat particles all of the same size
   _____ d. Skip-graded soils containing large and small particles but no intermediate sizes

4. Which of the following is the correct definition of liquid limit?

   _____ a. The moisture content at which a clay soil starts to crumble when rolled into a thread 1/8 inch in diameter
   _____ b. The moisture content at which no additional water can be added to the soil
   X c. The moisture content at which a clay soil starts to exhibit shear strength
   _____ d. The moisture content required to fill the voids when the sample reaches its minimum volume

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Unit VI
Highway Design and Estimating

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Albany, New York-12

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Supplemental Teaching Aids:

The following are good resource books for this unit: Machine Office Practice, Peter L. Agnew, South-western, Cincinnati, 1965, General Office Practice, Archer, Brecker, and Frakes, McGraw-Hill, New York, 1963.

"Modern Business Machines" (20 min.), Teaching Aids Exchange, 307 South B. Street, San Mateo, California 94401 and "Maintenance of Office Machines" (36 min.) Norwood Films are applicable to this unit.

Training Time 20-30 hours

program for
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teacher's guide

Unit VI
Highway Design and Estimating

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of Continuing Education
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Albany, New York-12224, 1968

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FOREWORD

This Teacher's Guide, *Highway Design and Estimating*, is one of a series in the Highway Technicians Program. This program was initiated by the New York State Department of Transportation (formerly the Department of Public Works) to help relieve the shortage of highway technicians. As a result of their initiative, the first editions of Units I through V were published, starting in 1961.

John L. DeLee, now Principal Civil Engineer in the Bureau of Highway Planning of the Department of Transportation (with the help of other personnel from the district offices of the Department), carried on the planning for the original series of nine units (or courses) in the Highway Technicians Program. Edward Umiker, now Associate Civil Engineer in the Buffalo District Office of the Department of Transportation, and Ralph Fimmano, Senior Civil Engineer in the Utica District Office, collaborated in developing the topical outlines for the nine units.

Early in 1967 Philip E. Hagerty, Assistant Administrative Deputy of the Department of Transportation, called for a renewed effort to complete all the units planned in the program and to update, as needed, those already published. As a result, several Department engineers were made available as consultants to the New York State Education Department to do the writing needed in completing and updating the whole series.

This Guide, *Highway Design and Estimating*, was written by Ralph Fimmano under the guidance of Berton P. Plummer, Associate in the Bureau of Occupational Extension and Industrial Services. Nelson S. Maurer, Associate in the Bureau of Continuing Education Curriculum Development, supervised the review and final preparation of the manuscript for publication.

To all the agencies and individuals mentioned above, this Bureau makes grateful acknowledgment for the responsibilities which they so faithfully fulfilled.

HERBERT BOTHAMLEY, *Chief*
Bureau of Continuing Education
Curriculum Development

WILLIAM E. YOUNG, *Director*
Curriculum Development Center

13. You are in charge of a highway design project on which there are high embankments to be built with fine sand and silt soils. You are concerned with erosion of the embankment slopes. Which of the following is the most practical method of preventing slope erosion from roadway runoff in order to reduce maintenance costs?

_____ a. Use topsoil, fertilizer, and grass seed on slopes
_____ b. Use sod strips on slopes
_____ c. Use asphalt curbs at edge of shoulder to confine water, and seeded gutters to carry water down the slope, at specified intervals
__X__ d. Use asphalt curbs at edge of shoulder to confine water, and corrugated metal pipe at specified intervals buried in the side slopes, to carry off water

14. The earthwork factor is the factor divided into the cut volume to determine the embankment volume. In which one of the following cases will the earthwork factor be less than 1?

_____ a. Glacial till cut
_____ b. Sand and gravel cut
_____ c. Clay cut
__X__ d. Sandstone and shale cut
_____ e. Borrow pit excavation

15. Which of the following soil deposits is the greatest cause of frost heaving in highway cuts?

_____ a. Water-laid silts and clays
_____ b. Water-laid sands
_____ c. Outwash gravels
__X__ d. Moraine deposits
_____ e. Drumlin deposits

16. The principal information gained from the seismic test is:

_____ a. Blasting properties of rock
_____ b. Type of soil
_____ c. Depth to groundwater
__X__ d. Depth to rock
_____ e. Strength of rock

17. A Shelby tube is used for which one of the following operations?

_____ a. Measuring embankment density
_____ b. Consolidation testing
_____ c. Atterberg Limit test
_____ d. Coring rock samples
__X__ e. Obtaining undisturbed soil samples

18. Frost heaves occur when there is a combination of freezing temperatures, groundwater, and frost-susceptible soils. Which of the following soils is most likely to have frost heaves?

    _____ a. Gravel
    _____ b. Organic deposits
    __X__ c. Silty soils
    _____ d. Sand and gravel
    _____ e. Clay soils

19. All footings for structures should be placed at least four feet below final ground surface for which one of the following reasons?

    _____ a. To eliminate settlement
    __X__ b. To eliminate frost heaving
    _____ c. To attain sufficient bearing capacity
    _____ d. To prevent tipping
    _____ e. To reduce settlement

20. Which of the following statements pertaining to the subbase course is <u>not</u> true?

    __X__ a. It provides uniform support for embankment
    _____ b. It distributes pavement and traffic loads to the underlying subgrade soil
    _____ c. It reduces frost heaving
    _____ d. It provides uniform surface for paving
    _____ e. It provides adequate strength to support wheel loads transmitted through pavement

Final Examination Part II -- True or False Statements

INSTRUCTIONS: Write in the space provided the letter T for True or F for False for each of the following statements.

T 1. The principal difference between the behavior of silt and clay is plasticity.

F 2. Plastic soils are easily consolidated by vibrational forces.

T 3. Organic soils left under embankments may cause large settlements in the pavement.

F 4. The hydrometer test is used to determine the amount of gravel in a soil sample.

T 5. The moisture content is defined as the weight of water divided by the weight of soil, times 100.

F 6. The void ratio is defined as the volume of voids divided by the volume of sample.

T 7. The core sampler is used to sample bedrock.

T 8. A permeameter measures the quantity of water flowing through a soil sample in a given time.

F 9. Quicksand is a type of soil deposit.

T 10. The optimum moisture content is the moisture condition in a soil that provides the maximum density with a standard compactive effort.

T 11. Frozen soils cannot be properly compacted.

F 12. Soils may be placed in four-foot layers and be adequately compacted with heavy compaction equipment.

F 13. The magnesium sulfate soundness test is used on all soils placed in embankments.

T 14. The most critical soil deposit to cause erosion problems in highway drainage is silt.

T 15. Structural failures of corrugated metal pipe culverts are often caused by lack of compaction in the backfill.

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Final Examination Part III -- Matching Questions (A)

INSTRUCTIONS: Write in the space provided the number of the expression in Column B which is best suited to the expression in Column A.

	Column A		Column B
8	Varves	1.	Measure strength of soil in drill hole
12	Plasticity tests	2.	Measure compression of clay soils
4	A horizon	3.	Measure vibrational settlement
2	Consolidation test	4.	Surface layer of soil
15	Drumlin	5.	Swamp deposit
7	Till	6.	Narrow, winding, steepsided ridge
9	Triaxial compression test	7.	Material deposited by glacier
10	Outwash deposit	8.	Alternate silt and clay layers
1	Vane shear test	9.	Strength of clay soils
11	Gradation curve	10.	Likely source of sand and gravel
13	Berms	11.	Distribution of soil sizes in sample
6	Esker	12.	Atterberg Limits
		13.	Provide embankment stability
		14.	Field measurement of compaction
		15.	Long, streamlined hill

Final Examination Part III -- Matching Questions (B)

INSTRUCTIONS: Write in the space provided the number of the expression in Column B which is best suited to the expression in Column A.

	Column A		Column B
4	Surcharge	1.	Quantity of groundwater flow
6	Equivalent fluid pressure	2.	Portion of highway embankment
1	Q = KiA	3.	Method of measuring settlement
10	Capillarity	4.	Elimination of settlement by overloading
7	Vibratory roller	5.	Rate of water movement
8	Optimum moisture content	6.	Soil pressure on retaining walls
2	Subgrade foundation	7.	Compaction of granular soils
11	Piezometer	8.	Moisture-density relation
9	Wet silt deposits	9.	Construction problems in cuts
15	Earthwork factor	10.	Rise of water above the water table
12	Substitute for dynamite	11.	Measures water pressures in soil
14	Imperfect trench	12.	Ammonium nitrate and fuel oil
		13.	Construction of stabilized shoulders
		14.	Method of pipe installation
		15.	Used in cut and fill quantity computations

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This booklet is published primarily for use in the schools of New York State, and free copies are available to New York State school personnel when ordered through a school administrator from the Publications Distribution Unit, State Education Building, Albany, New York 12224.

UNIT V (14.0901-04)

COMMUNICATIONS

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate to the satisfaction of the instructor, a level of coherence and clarity in oral communications that is adequate for the business office. The student will be able to prepare and write a mailable letter or brief report, from facts provided by the instructor. In a role playing, or other simulated situation, the student will be able to demonstrate correct telephone technique, procedure, and usage. The student will be able to score at least 80% on an objective test covering mail handling and telegraph procedures and use.

Unit Outline:

A. Oral and Written Communications

1. Importance of oral and written communications

2. Importance of good listening

B. Elements of Good Speech

1. Voice control

2. Vocabulary and pronunciation

3. Grammar

C. Speech and Writing Problems

1. Individual analysis

2. Corrective activities

D. Review of Rules for Punctuation, Capitalization, etc.

E. Importance of the Voice in Telephone Usage

1. Control

2. Enunciation

3. Resonance

4. Tone

5. Distance between lip and mouthpiece

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ABSTRACT - Developed by the New York State Department of Education and the State Department of Transportation, this teacher's guide is for instructor use in teaching highway design and estimating. The highway technician program, for which this document is intended, is to help relieve the shortage of technicians and engineers by upgrading people employed in lower-level technician programs. The contents of this document, illustrated with line drawings, include 14 lessons, among which are: (1) Highway Classification, (2) Features of Design, (3) Horizontal Alignment, (4) Engineer's Estimate, and (5) Report on Design and Estimate. Each lesson contains objectives, a content outline, questions for review, and an assignment, and each is planned for 2 hours and 40 minutes. A 3-part final examination, a bibliography, and a reference key symbol list are included. Related documents are available as VT 013 359, VT 013 360, and VT 013 061 (all in this issue). (GEB)

Lesson 2 - Sequence of Design (Phase 1)

OBJECTIVES

- To explain the relationship of this unit to previous units in the highway program
- To explain the procedures which lead to the sequential steps necessary to prepare the first phase of preliminary design

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Background	
A. Previous courses	* Point out that the units on basic mathematics, highway drawing, highway surveying, highway planning, and soils and drainage provide a sequence leading to the course in design.
	* Emphasize that this background information will be coordinated with the information contained in this unit on highway design and estimating.
B. Concept of design	* Review briefly (from Unit IV, Preliminary Highway Planning) the reasons which mandate a given design project.
1. Traffic growth	* Point out the tremendous increase in motor vehicles during the past 20 years and briefly recount the three expansion factors of growth. 1. Normal traffic growth 2. Generated traffic 3. Development traffic
2. Highway sufficiency	* Recall the method of road scoring and indicate the important role this plays in deciding whether a highway will be reconstructed.
C. Initiation of design	* Emphasize that as soon as a given project is placed on a design program, the preparation and submission of the program project data (P.P.D.) is the first step taken by the designers.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Context of program project data	* Discuss the submission of program project data, noting that it is a description and a justification of what is proposed. * Distribute prints of the program project data for a project under construction and mention that a rough cost estimate is included in this submission. (Ref. G, p. 3)†
2. Approval of program project data	* Signify that the approval of the program project data by the New York State Department of Transportation's chief engineer and deputy chief engineers (and the Bureau of Public Roads if Federal aid is requested) lays down the ground rules for the design of the highway.
D. Location plan	* Proceed from the approval of the program project data to the actual start of the preliminary design—the location plan.
1. Ordinary reconstruction	* Explain that if the project is merely a widening or a reconstruction along an existing highway with no major relocation contemplated, the route location plan and survey will usually consist of a field inspection, a visual soils investigation, and a review of geodetic maps and record plans of the existing facility.
2. Relocation	* State that if a major reconstruction or new location is contemplated, five steps are taken. (Ref. G, p. 4) 1. A 200-ft. scale topographic map for the general corridor area is required and is obtained either by photogrammetrics or conventional survey.

†Reference citations are shown on page 220.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2. Traffic information about all critical locations is necessary to implement the counts given on the program project data. 3. A preliminary soils investigation is required. 4. Any unusual condition such as stream channels and railroads must be investigated. 5. A location plan must be prepared in both the vertical and horizontal alinement.
3. Approval of the location plan	* Point out that the location plan is submitted to the deputy chief engineer of highways for review. * Add that a new route location should provide maximum service to the traveling public at minimum construction and maintenance cost and the least disruption cost to property. (Ref. G, p. 4)
E. Public hearing	* Explain that if a plan is approved and the project involves Federal participation, a public hearing is scheduled and advertised. * Show the importance of a public hearing by stating that suggestions given or questions raised may warrant review of the alinement.
F. Survey	* State that after the public hearing is held, a survey is begun either by conventional methods or by photogrammetrics. (Ref. A, pp. 312-318; Ref. G, p. 5)
II. Design Assignment	* Point out that the survey information now enables a squad of engineers and technicians to prepare a preliminary plan.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
E. Passing sight distance	* Note that passing sight distance (P.S.D.) will be covered in a later lesson. * Mention that a rural design class 5 highway permits only 20 percent of the highway to have less than 1500 ft. of passing sight distance.
F. Design speed	* Indicate that design speed is a basic principle of highway planning and that it is a function of traffic capacity. * Note that the rural design class 5 has a design speed of 60 m.p.h. with a running speed at peak hours of 45 m.p.h.
G. Traffic composition	* State that trucks usually make up between zero and 20 percent of the traffic. * Point out that a rural design class 5 highway should be adequate to accommodate a maximum truck traffic of 10 percent.
H. Clearance lanes	* Explain that clearance lane criteria for structures are indicated under bridge notes. * Note that here also criteria are being significantly affected by safety considerations.
1. Safety walks	* Point out that contrary to bridge-note 1 safety walks are not recommended for any structure. (Ref. L, p. 39)
2. Lane width	* Emphasize that all bridges will carry the full roadway section across the structure which will consist of the pavement widths plus the full shoulder width (the shoulder width must be a minimum of 6 ft.). * Note that a brush curb encroaches 6 in. on the clearance.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. General notes	* Comment on the general notes listed on the classification chart.
1. Minimum width	* Note that the travel width of pavement is never under 20 ft. although class 9 and 9M call for 18 ft. by traffic criteria but they are considered special cases.
2. Design elements	* State that the other general notes will be covered in the functional design criteria later in this unit.
J. Nonstandard classifications	* Emphasize that although standards are the key to design, sometimes exceptional conditions make it necessary to deviate from the recommended criteria. * Point out that if a different design from the one called for in the chart is used, permission must be obtained from the deputy chief engineer of highways. * Mention that the next lesson will provide ample opportunity for discussion on the evasion of criteria.
III. Traffic Composition	* State that the physical characteristics of vehicles and the number of each kind using the highways are positive controls in geometric design. (Ref. A, pp. 123; Ref. B, pp. 69-86)
A. Vehicle classification	* Note that all vehicles have been classified into two categories, (passenger cars and trucks), and that a design vehicle for each type has been selected by the AASHO.
B. Design vehicle	* Define a design vehicle as one whose weight, dimensions, and operating characteristics are used to establish highway design controls. * Add that for the purpose of geometric design, the design vehicle should be one with larger dimensions

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	and a smaller minimum turning radius than almost all vehicles in its class.
1. Passenger car	* Identify the passenger car classification with the symbol P and mention that all information is based on the 1962 production year.
a. Length	* Note that the length of the design passenger car is 19 ft. overall on an 11-ft. wheelbase with a rear overhang of 5 ft. and a front overhang of 3 ft.
b. Minimum turning radius	* State that the minimum turning radius is the radius of the turning path of the outside front wheel. This radius for the design passenger car is 24 ft. * Explain how the amount of overhang of a vehicle is related to its minimum turning radius.
c. Width and height of vehicle	* Point out that the overall width is 7 ft., the out-to-out width between tires is 6 ft. and the height is 4 to $5\frac{1}{2}$ ft.
2. Single unit trucks and buses	* Identify single unit trucks and busses with the symbol SU and note that all information is based on a survey of state loadometer stations in 1959.
a. Length	* State that the SU design vehicle is 30 ft. long overall on a 20-ft. wheelbase with overhangs of 4 ft. in front and 6 ft. in the rear.
b. Width and height	* Mention that the width of the SU design vehicle is $8\frac{1}{2}$ ft. No designation is used for height as most states limit vehicle height to $13\frac{1}{2}$ ft.
c. Minimum turning radius	* Indicate that the minimum turning radius of the SU design vehicle is 42 ft.

INTRODUCTION

The rapid expansion in the building of state and Federal highways has caused a serious shortage of qualified technicians and engineers for planning, supervising, constructing, and maintaining highways. The New York State Department of Transportation and the State Education Department have collaborated in planning the Highway Technicians Program to overcome this shortage.

This program is expected to help provide the additional technicians and engineers by upgrading people employed in the lower-level technician jobs. This Teacher's Guide, *Highway Design and Estimating*, and the others in the program are intended primarily to improve the skills and technical knowledge of those technicians.

Local boards of education and other sponsors of adult education programs are being encouraged to offer the courses in this program as part of occupational education. Besides attracting students from the Department of Transportation in the job categories mentioned above, students will also be drawn from the public works departments of counties, cities, and towns; in addition, technicians, estimators, and junior engineers employed by construction contractors will be found in these classes.

The units of the Highway Technicians Program have been planned to be taught in numerical sequence. Enough subject matter has been included in each lesson for about 2-1/2 hours of classroom instruction. The total length of the course, however, may be adjusted to fit in with the prior experience and education of enrollees.

The units in the Highway Technicians Program are:

Unit I.	Basic Mathematics Review
Unit II.	Highway Drawing
Unit III.	Highway Surveying
Unit IV.	Preliminary Highway Planning
Unit V.	Soils and Drainage
Unit VI.	Highway Design and Estimating
Unit VII.	Highway Construction and Inspection
Unit VIII.	Highway Structures
Unit IX.	Highway Maintenance

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EXHIBIT B

HIGHWAY DESIGN AND ESTIMATING

Lesson 1 - Introduction

OBJECTIVES

- To become acquainted with class members
- To provide a general description of the course

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Orientation	
A. Teacher introduction	* Print the name of the course and your name on the chalkboard and give a brief description of your activities and experience.
B. Purpose of course	* Explain that the course is being given primarily to increase the knowledge of technicians in the design office and in the field so that they may upgrade themselves.
C. Group evaluation	* Have each student introduce himself and volunteer such information as name, occupation, and where employed. * Distribute cards with spaces for name, address, phone number, occupation, place of employment, previous schooling, and units in this program already taken.
D. Course prerequisites	* State that the students must know geometry and trigonometry and should have completed the five preceding units because this unit utilizes all the information covered previously: 1. Basic Mathematics Review 2. Highway Drawing 3. Highway Surveying 4. Preliminary Highway Planning 5. Soils and Drainage

Lesson 2 - Sequence of Design (Phase 1)

OBJECTIVES

- To explain the relationship of this unit to previous units in the highway program
- To explain the procedures which lead to the sequential steps necessary to prepare the first phase of preliminary design

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Background	
A. Previous courses	* Point out that the units on basic mathematics, highway drawing, highway surveying, highway planning, and soils and drainage provide a sequence leading to the course in design. * Emphasize that this background information will be coordinated with the information contained in this unit on highway design and estimating.
B. Concept of design	* Review briefly (from Unit IV, Preliminary Highway Planning) the reasons which mandate a given design project.
1. Traffic growth	* Point out the tremendous increase in motor vehicles during the past 20 years and briefly recount the three expansion factors of growth. 1. Normal traffic growth 2. Generated traffic 3. Development traffic
2. Highway sufficiency	* Recall the method of road scoring and indicate the important role this plays in deciding whether a highway will be reconstructed.
C. Initiation of design	* Emphasize that as soon as a given project is placed on a design program, the preparation and submission of the program project data (P.P.D.) is the first step taken by the designers.

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TO THE INSTRUCTOR

Highway Design and Estimating is the sixth in a series of nine courses which provide fundamental information to prepare your students for advanced work in highway planning, design, construction, and maintenance. Follow the content as closely as possible. Keep in mind that topics other than those in this unit are covered in other units of the Highway Technician Program. The units are planned to be given in numerical order as adult or continuing education courses.

In general, lessons in each of the units are planned for a session of 2 hours and 40 minutes. You may adjust this period to fit the class level, time schedule, and classroom situation. This course contains 14 lessons.

Plan each lesson before you present it to your class. You will need to plan classwork, discussion, and review. The left-hand column of each lesson contains suggested topics to be covered. The right-hand column gives accepted techniques, methods, and tips, as well as related information which should help you achieve effective teaching. Also this column shows page references for selected books for which the complete citations and symbols are given on page 220. Specific assignments are given at the end of each lesson. You should preview each lesson and arrange for needed visual aids and reference material in advance of the class.

Use the chalkboard, overhead projector, charts, diagrams, and other visual aids to clarify the material being presented. Duplicate for student use any important reference material. Give typical job situations as illustrations whenever possible.

Give a summary of key points at the end of each lesson. Also refer to past and future lessons and remind the students of needed references and other materials for the next lesson. Emphasize to the students that answers to the questions for each lesson provide a good summary of the important points.

A final examination is provided at the end of this Guide. The questions are derived from the basic material given in the lessons and the difficulty of each type is in proportion to the importance placed on any particular phase. The questions are in the form of matching, completion, and multiple choice and should be completed in about 1 hour. The correct answers given in each case are for the instructor only, and the spaces are to be left blank in presenting the questions to the students.

As you use this course guide, you may have ideas for improving its content. Any suggestions you wish to make should be addressed to the New York State Education Department, Bureau of Continuing Education Curriculum Development, Albany, New York 12224.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Previous experience	* Indicate, however, that experience comparable to the coverage in the first five units is satisfactory.
II. Required Student Equipment	* Point out that this unit will require very little equipment but that two textbooks will be used.
A. Textbooks	* Write on the chalkboard the name, author, publisher, and copyright date of both texts.
1. *Highway Engineering*	* Show a copy of the 3rd edition of *Highway Engineering* by L. J. Ritter and R. J. Paquette, published by the Ronald Press Company in 1967. * State that this is a college textbook used to teach the fundamentals of highway engineering.
2. *A Policy on Geometric Design of Rural Highways*	* Exhibit a copy of *A Policy on Geometric Design of Rural Highways*, published in Washington, D.C. by the American Association of State Highway Officials in 1966. Emphasize that a designer should never be without a copy of this book. * Point out that the content of this book is limited to the geometric features of highway design as distinguished from structural design. * Ask the students to sign a sheet for the textbooks so that a group order may be made.
B. Looseleaf notebook	* Suggest that the students use a looseleaf notebook for notes, problems, and for printed matter distributed occasionally.
C. Engineer's scale and small triangles	* Indicate that two small triangles and an engineering scale with 10, 20, 40, and 50-ft. scales are necessary equipment.
III. Highway Design	* State that this course covers functional design.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Course description	* Explain briefly the subject matter covered in each lesson of this unit.
1. Introduction to the course	* State that the first lesson briefly outlines the content of the course.
2. Sequence of design (first phase)	* Point out that certain rudiments of design have already been discussed in previous units and that these basic ideas will combine with new concepts in Lesson 2 to form a sequential pattern.
3. Classification of highways	* Explain that Lesson 3 covers the important link between highway planning and highway design: the classification of a given highway. * Mention that the chart entitled *Geometric Highway Standards for Urban, Primary, and Secondary Highways* is used to establish design criteria and will be analyzed in this lesson.
4. Features of design	* State that Lesson 4 introduces the concept of functional design and covers subjects such as stopping sight distance, passing sight distance, lateral sight distance, and lane width. * Note that Lesson 5 continues instruction about design features and covers curbs, medians, pavement surfaces, crowns, and shoulders.
5. Horizontal alinement	
a. Control of curvature	* Point out that Lesson 6 is a study of the relationship between speed and curvature. The forces at work in circular motion will be used to control the curvature of highways.
b. Superelevation runoff	* Add that Lesson 7 is an additional refinement of horizontal alinement in which the basic mechanics of motion are applied in a practical sense. The methods of achieving full bank are discussed with the emphasis on the use of superelevation.

F. The Telephone Directory

1. Alphabetical directory

2. Classified directory

3. Out-of-town directory

G. Types of telephone services

H. Handling Calls

1. Incoming calls

2. Outgoing calls

I. Types of Telegraph Services

J. Preparation of Messages

1. Choice of class of service

2. Use of special words and code

3. Cost of transmission

4. Time differences (zones)

K. Importance of Mail

L. Procedures for Handling Mail

M. Classification of Mail and Rates

N. Postage Equipment and Supplies

1. Postage meters and scales

2. Automatic addressing systems

Supplemental Teaching Aids:

Many good resource books applicable to this unit are available, particularly in the field of special education. Others are the following: Communicating Facts and Ideas in Business, Leland Brown, Prentice-Hall, Englewood Cliffs, N.J., 1961, Business English in Communications, Himstreet, Porter and Maxwell, Prentice-Hall, Englewood Cliffs, N.J., 1964.

A series of three programmed texts by Joseph C. Blumenthal are available from Harcourt, Brace, and World. A great deal of free material is available from Western Union including the film "Telegram for America". Pitney-Bowes, Inc. distributes two publications on mailing machines entitled How to Increase the Prestige of Your Mail and 29 Timely Mailing Tips.

Training Time 35-45 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
6. Elements of horizontal alinement	* Explain that Lesson 8 is a summary guide for general horizontal controls together with the elements of widening, horizontal sight distance, intersections, grade separations, and speed-change lanes.
7. Vertical alinement (criteria and controls)	* State that in Lesson 9 a brief review of vertical curvature will be given with special emphasis on design criteria. Add that general controls for vertical alinement design will be studies together with combinations of horizontal and vertical controls.
8. Typical sections and standard structure sheets	* Note that in Lesson 10 the typical section (a quick analysis of the cross section of a highway) will be investigated and studied. * Add that the use of the standard structure sheets will also be discussed.
9. Geometric auxiliaries	* Point out that in Lesson 11 the geometric auxiliaries of a design will be studied with respect to the trend in lighting, signing, marking, landscaping, and delineation.
10. Sequence of design (second, third, and fourth phases)	* Correlate Lesson 12 with Lesson 2, noting that in phase 2 the centerline is controlled by mathematics, the cross section work is completed, and the layout design is prepared. * Mention that phase 3 is the preparation of the contract plans and that phase 4 is the preparation of the report on design and estimate.
11. Engineer's estimate	* Explain that in Lesson 13 the engineer's estimate will be examined with special emphasis given to the measurement and payment of contract items in accordance with Department of Transportation specifications.
12. Report on design and estimate	* Summarize the Report on Design and Estimate as being a consolidation of

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	all the pertinent data which make up a design project.
13. Final examination	* State that an examination will be given at the end of this unit to point out any weak areas. * Indicate that a seminar will follow the examination for the purpose of correcting papers and for open discussion of the more important areas in the unit. * Remind the students to bring their notebooks to the next class and emphasize the need for punctuality and regular attendance.

ASSIGNMENT

Read pages 3-32 and 52-69 in Ref. A.

INSTRUCTOR'S NOTES

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Preliminary plans	* State that preliminary plans at appropriate scales are prepared and include the following: 1. Typical sections 2. General drainage 3. Geometry of interchanges and ramps 4. Bridges (information submitted to the deputy chief engineer of bridges)
B. File information	* Note that the engineer who is called on to design the project may be unfamiliar with the preliminary steps so he should study the project files.
1. Correspondence	* Indicate that all letters which relate to the conception of the project must be read.
2. Program project data	* Recommend that all the pertinent information concerning design guides in the program project data be studied.
3. Route studies	* Explain the need for studying the history of the road including sufficiency reports, previous work done on the road, and the extent of right-of-way purchases. * Mention that it is helpful to search the records for the dedicated width of the right-of-way and note that in many design offices a complete investigation has been made to determine the dedicated widths of all highways in the district. * Emphasize the importance of actually walking the approved route.
4. Survey notes	* Have students check survey data books for proper indexing so that they may be drawn from and returned to the file room without confusion.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
III. Preliminary Line and Grade	* Advise that every project begins with a preliminary line and grade, the foundation of a design. (Ref. A, pp. 318-320)
A. Cross sections	* Point out the process used to draw cross sections from the base-line level notes.
1. Plotting	* Note that these sections are plotted on coordinate paper to a horizontal scale of 1 in. equals 5 ft. and to a vertical scale of 1 in. equals 5 ft.
2. Coverage	* Insist that this coverage should show tree lines, buildings, barns, drives, intersecting roads, curbs, centerlines, foundations, manholes, culverts, sewers, and wells.
3. Checkpoint	* State that all cross sections are checked, inked, marked with the base-line station, and verified for the signatures of the plotter and checker.
B. Base-line topography	* Clarify the process of plotting, checking, and inking the base line with its angular and distance control, together with all the topography shown in the transit notes.
	* Specify that this is done for the 1 in. equals 200-ft. scale plan and also for the 1 in. equals 50-ft. scale plan.
C. Base-line profiles	* Designate the next step as plotting, checking, and inking the base-line profile at 1 in. equal to 200 ft. horizontally and 1 in. equal to 20 ft. vertically for use with the 200-ft. scale plan.
	* Note that the 200-ft. scale plan is used for tentative line and grade but that the 50-ft. scale plan (for rural areas) and the 20-ft. scale plan (for urban areas or for densely populated rural areas) is used for the actual design.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Mention that when the 20-ft. scale plan is used, the corresponding profile scale is 1 in. equals 20 ft. horizontally and 1 in. equals 5 ft. vertically.
1. Form	* State that this work is done completely on reproducible material and that the profiles are on a continuous roll of coordinate paper.
2. Controls	* Review the importance of indicating control points with elevation and description.
D. Tentative centerline	* Note the need of studying the 200-ft. scale plan and profile and of actually walking the new route before drawing the tentative centerline and gradeline.
1. Soils report	* Explain that a soils report is obtained by furnishing a print of the tentative line and grade to the soils engineer.
2. Line shift	* Mention that the tentative line is shifted in accordance with soils reports, profile controls, and the right-of-way considerations.
E. Design centerline	* Stipulate that the centerline is designed on the 50-ft. scale plan and profile, while the templates of the typical section are fitted on the cross sections for the best location both vertically and horizontally. * Indicate that all control points are acknowledged in this operation. * Note that this step and the following steps involve design factors covered later in this unit.
1. Controls	* State that obstacles such as cattle passes, swamps, peat bogs, rock ledges, driveways, service roads, utilities, and special right-of-way restrictions located in the path of the centerline are noted on the 50-ft. scale plan.

Lesson 3 - Highway Classification

OBJECTIVES

- To show how the elements of highway planning apply to functional design
- To become familiar with the system of classifying highways

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Functional Design	* Mention that functional design is used to make the highway as nearly perfect as possible for both the vehicle and the driver.
A. Definition	* State that functional design applies to the motion and operating characteristics of vehicles and to the ability and psychological behavior of the operator.
B. Objective	* Indicate that functional design aims at providing greater traffic capacity and efficiency while maintaining safety. (Ref. C, section 22, p. 6)†
C. Elements	* Note that the functional design of a highway involves the design of only the visible features which will be covered in later lessons, namely: • Vehicle speed • Human reaction time • Space and time • Dynamics • Centrifugal and centripetal forces • Vehicle characteristics • Human behavior and psychology • Alinement • Grades • Right-of-way • Curvature • Superelevation • Channelization • Pavement friction

† Reference citations are shown on page 220.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Adjustments	* Point out that sight distances are checked and that line and grade are adjusted to obtain the proper percentage of passing sight distance as required by the classification chart.
F. Bridges	* Note that the district bridge section gives bridge and culvert topography, level notes, and approximate location of any structures.
G. Field inspections	* State that all necessary field inspections for line and grade are made and that special drainage problems, buildings built after the survey, and sites for cattle passes and utility relocations are investigated.
1. Alterations	* Add that both line and grade are shifted in accordance with this information.
H. Conference	* Note that a conference is then scheduled with representatives of the various departments involved for a final decision.
1. Approval by deputy chief engineer	* Indicate that prints of the tentative centerline on the 200-ft. scale plan and profile and typical sections that are to be used are prepared for final approval by the deputy chief engineer.
2. Approval by Bureau of Public Roads	* Note that these plans will be examined by the Bureau of Public Roads who will be represented at the conference if Federal aid is involved.
3. Plans for Right-of-Way Department	* State that a 200-ft. scale plan is submitted to the District Right-of-Way Department for investigation of land deeds and title searches.
IV. End of First Phase	* Emphasize that submission of the 200-ft. scale plan and profile to the deputy chief engineer for approval marks the end of the first phase of design.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Mention that despite its small scale the plan and profile submitted should be as accurate as possible.
A. Checklist	* Point out that the small-scale plan and profile are checked for the following items: 1. Scaling 2. Original ground elevations 3. Equalities 4. Property lines and corners 5. Maximum grades and curves 6. Town, county, city, or village lines 7. Road names and numbers 8. North arrow 9. Limits of the contract * Exhibit and discuss a 200-ft. scale plan and profile which has been prepared for submission.
B. Contract plans	* State that the actual design of the project begins at this point. It is here that the myriad of details are worked out. (Ref. G, p. 6)

QUESTIONS FOR REVIEW

1. How does road scoring assist in the determination of priority for construction of a highway?

2. Name six items which are classified on the program project data sheets.

3. What is the extent of a route location survey?

4. Explain why a public hearing is held.

5. How does the engineer prepare himself when placed in charge of the design of a project?

6. Discuss the importance of cross sections for a given base line.

7. Why is a 200-ft. scale plan and profile necessary for a design when it is a known fact that the plan and profile must be made on a 50-ft. scale plan?

8. Name three major reasons why a centerline would be shifted either vertically or horizontally, or both.

9. List six factors which should be checked on the small-scale plan.

10. What factors would necessitate field inspections for a design alinement?

ASSIGNMENT

Read pages 121-132 in Ref. A, and pages 69-133 in Ref. B.

INSTRUCTOR'S NOTES

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	• Pavement width • Shoulders • Pavement cross section • Guide railing • Roadside landscaping • Lighting • Reflectorization • Signs • Stopping sight distance • Passing sight distance • Marking • Signalization • Utilities • Delineators • Rest areas • Sidewalks
II. Highway Classification	* Discuss briefly the design hour volume (DHV) and indicate that a highway is classified according to this count.
A. Design class	* Explain the analysis of design classes. (Ref. D) 1. Urban design class 1 to 7 (level or rolling) for a DHV of 4400 to 550 or less 2. Rural design class 1 to 9 (level or rolling) for a DHV of 3000 to 20 3. Mountainous design class 5M to 9M (hilly or mountainous) for a DHV of 350 to 20 * Point out that the design class confines the project to specific standards or limits.
III. Design Standards	* Distribute a copy of Ref. D. to each student. Explain that the chart is the key to the design of a modern highway.
A. Width	* Note that in the columns under width data in Ref. D, standards for five items are shown.

UNIT VI (14.0901-07)

FINANCIAL ACTIVITIES

Performance Objectives:

Upon completion of this unit the student will be able to score at least 80% on an instructor developed objective test covering the handling and verifying of forms involved in ordering, receiving, selling, and general financial records. Also covered in this test should be common reports required by governmental agencies.

Unit Outline:

A. Importance of the Need of Financial Records

B. Types of Records

1. Personnel

2. Payroll

3. Sales and purchases

4. Inventory

5. Taxes

6. Financial statements

7. Petty cash

8. Budgets

9. Credit applications

Supplemental Teaching Aids:

An excellent resource person for this unit is a staff member from the college business office. Free or inexpensive information is available from the Massachusetts Bankers Association, [illegible] High St., Boston, 02110. Of some value is the comic book- The Story of Checks, available from the Federal Reserve Bank of New York.

Training Time 8-10 hours

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Pavement width or travel way 2. Travel lane 3. Parking lanes in addition to the travel lanes 4. Shoulder or clearance lanes 5. Width of right-of-way
	* Explain that a rural design class 5 highway is an example of an average highway. Since this design is classified as 500-vehicles per hour one way, it requires a 24-ft. travel pavement width consisting of two lanes at 12 ft. each, no parking lanes, 10-ft. shoulders and a minimum right-of-way of 120 ft.
	* State that at the present time it is recommended that a 12-ft. shoulder and a 12-ft. pavement be used for any highway with a DHV of 100. This may become part of the standards in the near future.
B. Gradient	* Point out that in the column of maximum grades (shown in percent) the grades increase as the traffic count decreases.
	* Observe that a rural design class 5 highway limits the maximum grade at 5 percent which is also the maximum value for urban classes 4, 5, 6, and 7 and rural classes 3 and 4.
C. Horizontal curvature	* State that in the column of maximum curve (shown in degrees) the allowed curvature increases as traffic decreases.
	* Note that a rural design class 5 highway is limited to a 5°-curve as are rural classes 3 and 4.
D. Stopping sight distance	* Explain briefly the meaning of stopping sight distance (S.S.D.) and mention that this will be taught and computed in a later lesson.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
4. Application	* Find the stopping distance on a wet pavement when the design speed is 60 m.p.h. (actual speed 52 m.p.h.). * Recall that the perception time and brake reaction time is assumed to be a total of $2\frac{1}{2}$ seconds. 60 m.p.h. = 88 ft./sec. $\frac{52}{60}$ x 88 ft./sec. = 76 ft./sec. 76 ft./sec. x 2.5 sec. = 191 ft. $d = \frac{V^2}{30f}$ $= \frac{52 \times 52}{30 \times 0.30}$ = 300 ft. * State that the stopping distance of the vehicle is 191 ft. plus 300 ft. for a total of 491 ft. This is rounded off to 475 ft. for design purposes.
5. Design Criteria	* Indicate that the safe stopping sight distances, rounded for design, are as follows: 1. 200 ft. at 30 m.p.h. 2. 275 ft. at 40 m.p.h. 3. 350 ft. at 50 m.p.h. 4. 475 ft. at 60 m.p.h. 5. 550 ft. at 65 m.p.h. 6. 600 ft. at 70 m.p.h. 7. 675 ft. at 75 m.p.h. 8. 750 ft. at 80 m.p.h.
B. Minimum stopping sight distance on grades	* Explain the effect of a grade on the stopping ability of a vehicle. * Note that the percent of grade divided by 100 (g) is added on a plus grade (and subtracted on a minus grade) to f in the denominator of the formula for braking distance.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	$d = \frac{V^2}{30(f \pm g)}$
1. Application	* Find the stopping distance on a 6-percent upgrade using the same basic information given in the preceding problem. * Note that the distance traveled during the perception time and brake reaction time remains at 191 ft. $d = \frac{52 \times 52}{30(0.30 + 0.06)}$ $= \frac{2704}{10.8}$ = 250 ft. * State that the stopping distance of the vehicle is 191 ft. plus 250 ft. for a total of 441 ft. * Find the stopping distance on a 6-percent downgrade using the same basic information given in the preceding problem. * Point out that the distance traveled during the perception time and brake reaction time remains at 191 ft. $d = \frac{52 \times 52}{30(0.30 - 0.06)}$ $= \frac{2704}{7.2}$ = 376 ft. * Indicate that the stopping distance of the vehicle is 191 ft. plus 376 ft. for a total of 567 ft.
C. Minimum passing sight distance (two-lane highway)	* Define the minimum passing sight distance as the distance required for a vehicle to safely pass another vehicle moving in the same traffic lane. (Ref. A, pp. 157-161; Ref. B, p. 140)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	that essentially the railing is used to guide a vehicle away from a hazard and to guard it from disaster.
A. Objective	* Mention that guide railing is used to reduce the hazard to traffic, not to protect any part of the highway. (Ref. L, p. 29) * Point out that guide railing is used only where the result of striking an object or leaving the highway would be more severe than the consequences of striking the guide railing.
B. Research	* Indicate the amount of research that has been conducted to develop a proper type of rail for a given condition. * State that up to the present time different types of railing have been used successfully, but now problems are being encountered with the transition from one type to another.
C. Uses	* Explain that guide railing is used at points of potential hazard such as: 1. Fixed objects close to the pavement 2. Fills on steep grades 3. Long through fills 4. Fills on sharp curvature 5. Along water courses 6. Escarpments 7. Deep ditches in cuts 8. Ledge rock in cuts
1. Protection on fills	* Mention that the following criteria indicate that guide railing should be used when fill height exceeds: 1. 10 ft. for a 1 on 2 slope 2. 20 ft. for a 1 on 3 slope 3. 40 ft. for a 1 on 4 slope 4. 50 ft. for a 1 on 5 slope 5. 60 ft. for a 1 on 6 slope

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Explain that the height of fill is measured vertically at the point 30 ft. out from the edge of pavement to a point on the original ground.
D. Edge distance	* Indicate that the edge distance from the pavement to the guide railing is a 30-ft. clear distance for a 1 on 6 slope plus 2 ft. 3 in. * Note that the explanation of the clear distance will be discussed in a later lesson. * Mention that these are guides and that they must not be confused with hazard areas.
E. Design	* State that guide railing is designed to deflect a vehicle so that it continues to move at reduced velocity along the rail. (Ref. B, p. 243) * Discuss the various types of guide railing as shown on the large scale prints of standard structure sheets. (Ref. H)
1. Cable guide railing	* Explain that cable guide railing is $\frac{3}{4}$-in. round cables connected to wood or steel posts. The cable ends must be securely anchored. (Ref. H, 64-2R1, 66-14A-R1 and 66-14B-R1) * Point out that posts are spaced 16 ft. on curves less than 4° and 12 ft. on curves between 4° and 6° and 8 ft. on curves between 6° and 8°.
2. Box beam guide railing	* Add that a box beam guide railing is a continuous hollow structural steel tube, 6 in. square. * Mention that this tube is mounted on 3-in. I-beam steel sections at 6-ft. intervals. (Ref. H, 66-15)
3. Box beam median barrier	* Note that the box beam median barrier is a 6 in. by 8 in. tube. (Ref. H, 65-16R2)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that the minimum passing sight distance is determined for a single vehicle passing a single vehicle.
1. Assumptions	* Point out the assumptions that must be made before any computations are attempted. (Ref. B, p. 141) 1. The overtaken vehicle travels at a uniform speed. 2. The passing vehicle has reduced speed and trails the overtaken vehicle as it enters a passing section. 3. When at the passing section, the driver needs time to perceive the clear passing section and to react before he begins his maneuver. 4. Passing is accomplished under a delayed start and a hurried return. The passing vehicle accelerates during the maneuver and its average speed during the occupancy of the left lane is 10 m.p.h. higher than that of the overtaken vehicle. 5. When the passing vehicle returns to its lane, there is a suitable length between it and an oncoming vehicle in the other lane.
2. Component parts	* Note that the minimum passing sight distance is actually the sum of four distances. Sketch on the chalkboard the position of the four distances. (Ref. B, p. 143) 1. Distance traversed during the preliminary delay period - d_1 2. Distance traversed while the passing vehicle occupies the left lane - d_2

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	3. Distance between the passing vehicle and the opposing vehicle at the end of the maneuver - d_3 4. Distance traversed by an opposing vehicle for two-thirds the time the passing vehicle occupies the left lane - d_4
3. Design criteria	* Indicate that the minimum passing sight distances used are as follows (Ref. B, p. 145): 1. 1100 ft. at 30 m.p.h. 2. 1500 ft. at 40 m.p.h. 3. 1800 ft. at 50 m.p.h. 4. 2100 ft. at 60 m.p.h. 5. 2300 ft. at 65 m.p.h. 6. 2500 ft. at 70 m.p.h. 7. 2600 ft. at 75 m.p.h. 8. 2700 ft. at 80 m.p.h.
D. Minimum passing sight distance (three-lane highway)	* State that the minimum passing sight distance for a three-lane highway is shorter than that required for a two-lane highway and is equal to d_1 plus d_2 plus d_3. * Point out that the three-lane highway is now being marked and signed as a two-lane road. * Refer to the standards chart and explain that only a percentage of the required minimum passing sight distance is necessary for a particular design. (Ref. D)
E. Minimum sight distance at intersections	* Mention that the minimum sight distance at an intersection should give an approaching driver an unobstructed view of the entire intersection and a portion of the intersecting highway sufficient to permit the safe operation of the vehicle. (Ref. B, pp. 392-401)
1. Minimum sight triangle	* Explain the minimum sight triangle by drawing a simple sketch on the

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
4. Beam type guide railing	* Indicate that the beam type guide railing is a section of 12-gage steel, 14 in. wide, that is curved and mounted on railroad rails, wood, or concrete posts spaced 12 ft. 6 in. apart. (Ref. H, 63-17) * State that when the beam type railing is used as a median barrier the posts are spaced 6 ft. 3 in. apart. (Ref. H, 66-17A)
F. Deflections	* Point out that a guide railing is selected because of its deflection capabilities. * Mention that the best type of guide railing is one where the posts give under impact but the railing holds the vehicle. * Point out that usage is based primarily on the amount of space available for deflection. * Suggest that tests indicate that at 60 m.p.h. with a 25° angle of impact, the following deflections take place: 1. A box beam on a 6 in. by 8 in. post deflects 2 ft. 2. A box beam on a 6 in. by 6 in. post deflects 4 ft. 3. A W section on a 3-in. I-beam post deflects 6 ft. 4. A cable railing deflects 8 ft.
G. Approach end	* Emphasize that the approach end of any guide rail is the most formidable roadside obstacle confronting traffic. * Recommend that the approach end be flared away from the pavement and turned down into the ground.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
H. Bridge approaches	* Mention that bridge approaches must be protected with box beam railing connected in line with the bridge railing. * Point out that bridge pylons are removed from existing bridges and not built on new bridges so that the flow line of the guide railing can be continuous.
IV. Pavement Surface	* Indicate that all highway pavement surfaces are grouped into three general types. (Ref. B, p. 222)
A. High type	* Add that the high type surface is built for a large volume of traffic and should have smooth riding qualities and good nonskid properties in all weather. * State that a smooth surface offers little frictional resistance to the flow of water. * Explain that the surface should retain its shape with a minimum of maintenance. The retention of shape guarantees the pavement without concern for raveled edges. * Note that the high type surface is usually a concrete pavement and often referred to as a rigid type of pavement. * Mention that the strength and stability of this type of pavement has a psychological effect on driver behavior.
B. Intermediate type	* Indicate that the intermediate type surface is usually bituminous and that it can vary from an excellent road structure to a mere surface treatment. It is often described as a flexible type of pavement.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Semitrailer combinations	* Note that because of the variances in wheelbases, semitrailer combinations are separated into two wheelbase groups.
a. WB-40	* Mention that the WB-40 design vehicle is 50 ft. long on a 40-ft. wheelbase with a semitrailer wheelbase of 13 ft. and an overall width of $8\frac{1}{2}$ ft. * Indicate that the minimum turning radius is 40 ft.
b. WB-50	* Add that the WB-50 design vehicle is 55 ft. long on a 50-ft. wheelbase with a semitrailer wheelbase of 20 ft. and an overall width of $8\frac{1}{2}$ ft. * Note that the minimum turning radius is 45 ft.
IV. Design Speed	* Define design speed as the speed determined after taking design and physical features of a highway into account. (Ref. B, pp. 87-98) * State that design speed is the maximum safe speed that can be maintained over a specified section of highway under conditions so favorable that the design features of the highway influence vehicle operation. * Indicate that the choice of a design speed is influenced by the character of the terrain, the extent of manmade features, and economic considerations.
A. Relationship to geometrics	* Note that as high a design speed as possible should be used in order to insure mobility and efficiency with a high degree of safety. * State that once design speed is selected, the complete geometrical design must be directly related to it.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Point out that features like curvature, superelevation, and sight distances directly affect design speed while lane and shoulder widths and clearance affect speed.
B. Design speeds used	* State that from this point on all references to design speed shall be made in accordance with the following speeds in miles per hour: 30, 40, 50, 60, 65, 70, 75, and 80.

QUESTIONS FOR REVIEW

1. Describe what is meant by the geometrics of a highway.
2. Name 25 elements of geometrical design.
3. Why are highway designs divided into different categories?
4. What is the maximum grade allowed on a rural design class 5 highway?
5. What is the maximum horizontal curvature allowed on a rural design class 5 highway?
6. What is the maximum truck traffic expected on a rural design class 5 highway?
7. How can a particular design deviate from the standards of the classification chart?
8. What is the concept on which functional design is based?
9. What are the listed design speeds used in the United States?
10. How is design speed directly related to horizontal curvature?
11. What is meant by design speed and how is it selected?
12. Why is it important to know the amount of overhang in a vehicle?
13. Describe how the minimum turning radius is measured.

ASSIGNMENT

1. Learn the classification criteria for the rural design class 5 highway.
2. Read pages 154-163 in Ref. A, and pages 134-151, 225-227, and 392-401 in Ref. B.

Lesson 4 - Features of Design

OBJECTIVES

- To provide a description of functional design with respect to various geometric features
- To set the basis for design criteria

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Sight Distance	* Indicate that a highway must provide sufficient clear vision so that a driver can avoid hitting unexpected obstacles and pass slower vehicles without danger. This length of highway visible to the driver is called sight distance. (Ref. A, p. 154 -155; Ref. C, section 22, p. 8)†
A. Minimum stopping sight distance	* State that the minimum stopping sight distance should be long enough to enable a vehicle at or near the design speed to stop before reaching an object in its path. This is often called the nonpassing sight distance. * Point out that this distance is a minimum and that a greater length is desirable. * Indicate that the minimum stopping sight distance is the sum of the distances traveled by a vehicle during: 1. Perception time 2. Brake reaction time 3. Braking
1. Perception time	* State that the time lapse from the instant a driver sights an object to the instant he decides to stop is called perception time. (Ref. B, pp 134 - 135). * Note that perception time is assumed to be $1\frac{1}{2}$ seconds.

†Reference citations are shown on page 220.

CONTENT OUTLINE

b. Coefficient of friction (f)

TEACHING POINTS AND TECHNIQUES

* Explain that f varies with speed and is influenced by;

1. Type of tire
2. Air pressure
3. Amount of tire tread
4. Type and condition of pavement
5. Presence of mud, snow, water, or ice on the pavement
6. Temperature
7. Vehicle load and weight
8. Brake fade

* Point out that the coefficient of friction for wet pavements is used for design criteria, noting that only 80 to 93 percent of the design speed is used. (Ref. B, pp. 136 - 138)

Design Speed	Actual Speed	f
30	28	0.36
40	36	0.33
50	44	0.31
60	52	0.30
65	55	0.30
70	58	0.29
75	61	0.28
80	64	0.27

* Indicate that most classification charts do not list the 65, 75, and 80-m.p.h. speed increments.

* Point out that the design speeds of 75 and 80 m.p.h. are applicable only to highways with full control of access. (Ref. B, p. 136)

* State that the coefficients of friction for a dry pavement are about twice those for a wet pavement.

* Note also that trucks require a longer stopping distance but this is offset because of better driver visibility and slower traveling speeds.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
4. Application	* Find the stopping distance on a wet pavement when the design speed is 60 m.p.h. (actual speed 52 m.p.h.). * Recall that the perception time and brake reaction time is assumed to be a total of $2\frac{1}{2}$ seconds. 60 m.p.h. = 88 ft./sec. $\frac{52}{60}$ x 88 ft./sec. = 76 ft./sec. 76 ft./sec. x 2.5 sec. = 191 ft. $d = \frac{V^2}{30f}$ $= \frac{52 \times 52}{30 \times 0.30}$ = 300 ft. * State that the stopping distance of the vehicle is 191 ft. plus 300 ft. for a total of 491 ft. This is rounded off to 475 ft. for design purposes.
5. Design Criteria	* Indicate that the safe stopping sight distances, rounded for design, are as follows: 1. 200 ft. at 30 m.p.h. 2. 275 ft. at 40 m.p.h. 3. 350 ft. at 50 m.p.h. 4. 475 ft. at 60 m.p.h. 5. 550 ft. at 65 m.p.h. 6. 600 ft. at 70 m.p.h. 7. 675 ft. at 75 m.p.h. 8. 750 ft. at 80 m.p.h.
B. Minimum stopping sight distance on grades	* Explain the effect of a grade on the stopping ability of a vehicle. * Note that the percent of grade divided by 100 (g) is added on a plus grade (and subtracted on a minus grade) to f in the denominator of the formula for braking distance.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Point out that factors which affect this time include: 1. Distance to the object 2. Driver alertness 3. Optical ability of the driver 4. Visibility 5. Type and condition of pavement 6. Color of object 7. Speed (people are usually more alert at high speeds)
2. Brake reaction time	* Mention that the time lapse from the instant a driver realizes he must stop to the instant the brakes are applied is called brake reaction time. * State that the average brake reaction time is about $\frac{1}{2}$ second and to provide a factor of safety another $\frac{1}{2}$ second is added. Thus the brake reaction time is assumed to be 1 second.
3. Braking distance	* Indicate that the distance required to stop a vehicle after the brakes are applied is called braking distance * Note that braking distance depends directly on tires, brakes, roadway, grade, and speed. (Ref. B, pp. 136-138)
a. Formula	* State that the braking distance is determined by a formula utilizing the coefficient of friction between the tires and the roadway (Ref. A, pp. 155-157; Ref. B, p. 136): $$d = \frac{V^2}{30f}$$ where d = braking distance in feet V = speed in miles per hour f = coefficient of friction between tires and roadway

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

(1) Derivation of factor

* Explain how the factor 30 is determined.

* Recall that force times distance equals change in kinetic energy.

$$Wfd = \frac{Mv^2}{2} = \left(\frac{1}{2}\right)\left(\frac{W}{g}\right)v^2 = \frac{Mv^2}{2}$$

where W = weight in pounds
f = coefficient of friction (no units)
d = distance in feet
M = mass in foot-pounds/second /second or $\frac{W}{g}$
v = velocity in feet/second
g = acceleration due to gravity or 32.2 feet/second/second

* Divide both sides of the equation by W and f:

$$d = \frac{v^2}{2gf}$$

* Indicate that it is desirable to eliminate g (a constant) and to use V in terms of miles per hour instead of feet per second. This is done as follows:

$$V \text{ (miles per hour)} \times \frac{5280 \text{ feet/mile}}{3600 \text{ seconds/hour}}$$

* Note that v is squared in the formula, and since the acceleration due to gravity remains quite constant at 32.2 feet/second/second, the mathematical manipulation may be simplified by incorporating these facts as follows:

$$\frac{V^2 \times \frac{(5280)^2}{(3600)^2}}{32.2 \text{ ft./sec./sec.}}$$

Simplified the above expression becomes:

$$\frac{V^2}{15}$$

Substituting this factor into the formula $d = \frac{v^2}{2gf}$ it now becomes:

$$d = \frac{V^2}{30f}$$

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MICROCOPY RESOLUTIO
NATIONAL BUREAU OF STA

UNIT VII (14.0901-08)

RECORD MANAGEMENT

Performance Objectives:

Upon completion of this unit the student will be able, in a simulated situation, to demonstrate her knowledge of filing procedures by organizing material for a filing system. She will be able to score at least 80% on an instructor made test dealing with rules and routines for filing.

Unit Outline:

A. Need for Filing

1. Information retrieval

2. Safe keeping

3. Storage

B. Types of Business Papers and Records Commonly Filed

1. Office

2. School

3. Home

C. Filing Equipment and Supplies

D. Alphabetic Filing

1. Advantages and disadvantages

2. Rules for indexing and filing

E. Filing Procedures

1. Checking for release mark

2. Reading to determine content

3. Indexing

4. Coding

5. Cross-referencing

6. Sorting

N TEST CHART
ANDARDS-1963-A

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Discuss the relation of design speed to sight distances required for stopped vehicles at intersections along a major highway. (Ref. B, p. 398)
	* Note that the minimum sight distance at a controlled intersection is greater than the product of the design speed of the major highway and the time necessary for the stopped vehicle to start and cross the road.
	* Explain the variables influencing perception time and the acceleration of the vehicle.
3. Effect of skew	* Sketch two highways intersecting at less than a right angle and show how this alters the line of vision.
	* Add that the actual line of sight is relatively unimportant as long as the sight triangle is free of obstructions.
	* Mention that this is true because the driver in the obtuse angle quadrant can see the full sight triangle with no effort since the angle between the sight line and any other vehicle is small. But the driver in the acute angle quadrant must struggle to see the full sight triangle area.
F. Effect of grade	* State that all discussions about minimum sight distance at intersections are based on level highways.
	* Indicate that grades up to 3 percent do not materially affect stopping sight distances but it is better to limit the grade of the intersecting leg to 3 percent
II. Lane Width	* Mention that all designations of lane width are based on safety. Note that lane width is directly related to the average annual daily traffic (A.A.D.T.) and to the design hour volume (DHV) of traffic. (Ref. A, pp. 132-135; B, pp. 225-227; Ref. C, section 22, p. 24)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Effects	* Discuss the bad psychological effect on the driver when there is little or no lateral clearance from an obstruction, or when passing vehicles have little allotted space in which to maneuver. * Point out that at the present time the maximum allowable width of vehicles is $8\frac{1}{2}$ ft. in most states and that this width is used for design purposes.
B. Clearances	* Mention that a vehicle should have a minimum of $1\frac{1}{2}$-ft. clearance to the centerline and a 1-ft. edge clearance whenever shoulders are used. Whenever curbs are used this edge clearance is increased to 3 ft.
C. Vehicle size	* State that a maximum sized vehicle requires a lane 11 ft. wide or when curbs are used a lane 13 ft. wide.
D. Cost	* Note that the extra cost of wider lanes is offset to a great extent by the reduction in cost of surface maintenance due to reduced wheel concentrations at the edges of the pavement slab. (Ref. B, p. 225)
E. Safety	* Indicate that in the interest of safety, efficiency, and ease of operation lane widths of 11 to 13 ft. are desirable on any highway. * Compare the lane widths with respect to traffic counts as shown on the geometric standards sheet. (Ref. D)

QUESTIONS FOR REVIEW

1. Explain sight distance as used in highway design.
2. What increments of time are involved in the computation of minimum stopping sight distances?
3. Name five factors which can drastically affect the perception time of an individual driver.

4. List eight conditions which will influence the braking distance of a vehicle.

5. What component distances are actually involved in the computation of the minimum passing sight distance?

6. What is the minimum passing sight distance for a design speed of 60 m.p.h.?

7. Explain the minimum sight triangle.

8. How does the skew angle affect sight distance at an intersection?

ASSIGNMENT

1. Read pages 135-143 in Ref. A, and pages 222-240 in Ref. B.

2. Compute the minimum stopping sight distance for design speeds of 30, 40, 50, 70 and 80 m.p.h.

INSTRUCTOR'S NOTES

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Lesson 5 - Features of Design

OBJECTIVES

- To provide a description of functional design with respect to various geometric features
- To set the basis for design criteria

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Curbs	* Describe the curb as a geometric feature that affects the safety and utility of a highway. (Ref. A, p. 138; Ref. B, pp. 227-234, 256)†
A. Uses	* Discuss the following uses of curbs: 1. Controls drainage 2. Confines vehicles in a designated path 3. Delineates the pavement or median edge 4. Assists in the development of the roadside
B. Types	* Draw sketches on the chalkboard comparable to those in Ref. B, pages 228 and 232, and describe curbs as either barrier type or mountable type. (Ref. C, section 22, pp. 20-22)
1. Barrier type	* Point out that the barrier type is used to prevent vehicles from leaving the pavement and that a 6-in. vertical faced curb is considered to be a barrier or nonmountable type. * Note that the barrier type has disadvantages since it prevents police cars, ambulances, and tow trucks from crossing over to an opposite lane.
2. Mountable	* Mention that the mountable barrier allows vehicles to cross over and, technically, only delineates the pavement edge.

†Reference citations are shown on page 220.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
II. Medians	* Define the median as a dividing strip separating opposing traffic on a highway. (Ref. B, pp. 251-256; Ref. L, pp. 36-38)
A. Uses	* List the uses of the median (Ref. A, p. 134; Ref. C, section 22, pp. 19-22): 1. Separates opposing traffic 2. Minimizes headlight glare 3. Provides waiting space for crossing or turning vehicles at grade intersections 4. Provides a storage area in case of emergency 5. Affords an opportunity to design line and grade to fit the topography
B. General features	* Indicate that the median must be highly visible during the day and night. * Mention that medians are built from 4 to 80 ft. wide and note that: 1. A median less than 4 ft. wide is defined as a separator. 2. A median less than 8 ft. wide is usually paved. 3. A high barrier median requires added edge clearance. * State that a driver feels better psychologically when the median is at least 40 ft. wide. A median is sometimes called a mall when over 40 ft. wide. * Point out that a highway looks attractive when the median is over 60 ft. wide.
C. Cross section	* Note that when a median is wide enough to be turfed, it is depressed to help drainage. This is especially true in heavy snow areas.

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CONTENT OUTLINE

D. Widths

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	chalkboard, showing an intersection utilizing a major and a minor road.
	* Discuss the space-time-velocity relationship between two vehicles entering the intersection.
2. Types of intersections	* Note that ordinary intersections are classified into three types.
a. Not controlled and vehicle speed altered	* Describe the first type of intersection as one not controlled by signs or signals and where the operator approaching the intersection must see a hazard early enough to alter the speed of his vehicle to avoid collision.
	* Show that in this case the minimum sight distance is the hypotenuse of the sight triangle when each leg of the triangle represents the distance traveled in 3 seconds by two vehicles entering the intersection. Emphasize that this sight distance is a minimum and not a desirable one.
b. Not controlled and vehicle stopped	* Describe the second type of intersection as one not controlled by signs or signals and where the operator of either vehicle approaching the intersection must be able to see both the intersection and the intersecting highway early enough to stop his vehicle if necessary.
	* Compute the minimum sight triangle, utilizing the safe stopping sight distances of the two vehicles entering an intersection of a major highway with a design speed of 60 m.p.h. and a minor road with a design speed of 50 m.p.h.
c. Controlled	* Describe the third type of intersection as one controlled by stop signs on the minor road and where a driver of the stopped vehicle should see enough of the major highway to be able to cross it before an approaching vehicle reaches the intersection.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

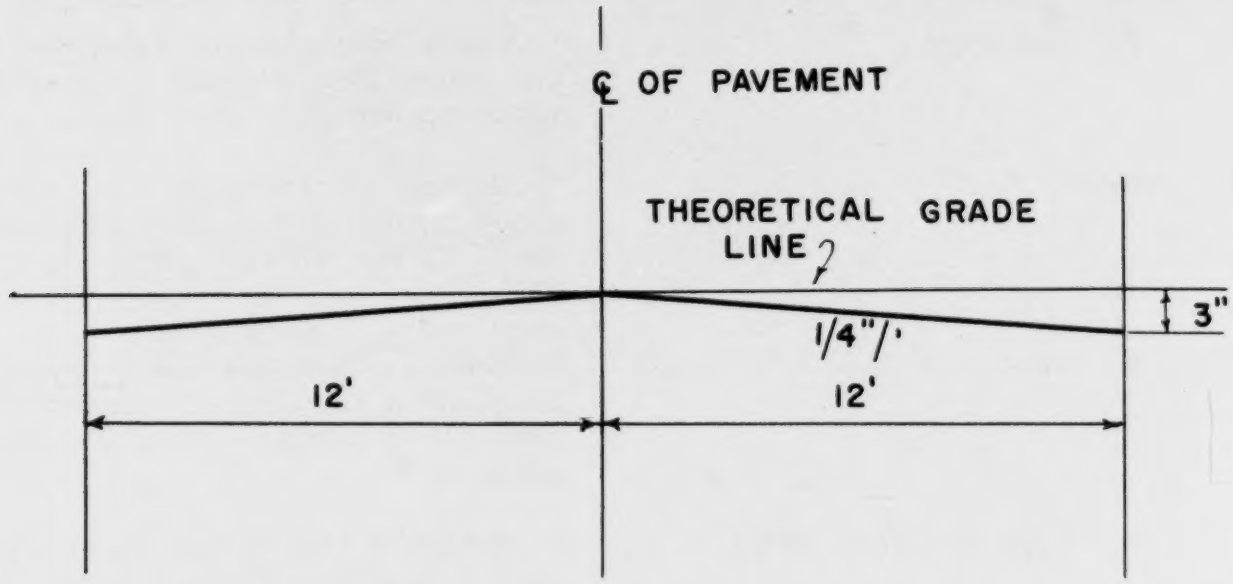

NORMAL CROSS-SECTION

FIGURE I

* Add that low surface types are built less accurately and with coarser top materials which tend to retard the flow of water.

2. Parabolic crown

* Describe the parabolic crown as having a slightly rounded surface at the center and an increasing cross slope toward the pavement edge.

* State that the points used to plot the curvature of this crown are determined by the following equation:

$$x = \frac{4cy^2}{w^2}$$

where x = vertical distance in inches from theoretical gradeline to any point on parabola

c = total crown in inches

y = horizontal distance in feet of any point on parabola from centerline

w = width of cross section in feet

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Sketch figure 2 on the chalkboard and point out the elements of a parabolic crown.

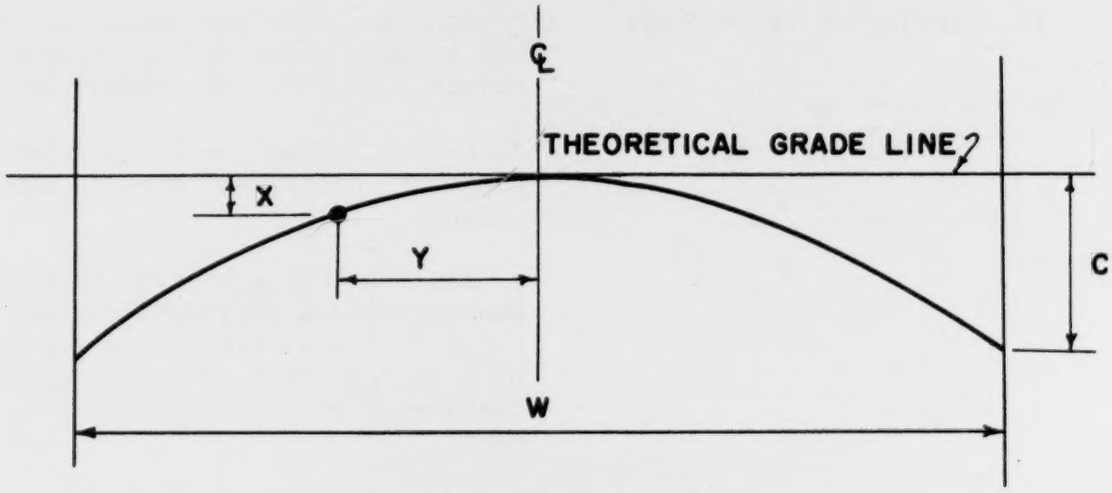

PARABOLIC CROWN
FIGURE 2

a. Application

* Find the difference in elevation between the theoretical gradeline and points 5 ft. apart on a 40-ft. cross section which is to be crowned 5 in.

* Use the equation to show that the difference in elevation 5 ft. from the center is $\frac{5}{16}$ in.

$$x = \frac{4cy^2}{w^2}$$

$$x = \frac{4 \cdot 5 \cdot 25}{1600}$$

$$x = \frac{500}{1600}$$

$$x = \frac{5}{16} \text{ in.}$$

* Solve for the remaining points and indicate that they are:

$1\frac{1}{4}$ in. at 10 ft.

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7. Filing

8. Out-slip

9. Follow-up

F. Other Filing Systems

Supplemental Teaching Aids:

Good resource people for this unit are school librarians or bank employees. A visit to a local library to observe its filing system is useful also.

The following are good resource books for the unit; Business Filing and Records Control, 3rd ed., Ernest D. Bassett, South-Western, Cincinnati, 1963, Records Management, Mary C. Griffin, Allyn and Bacon, Boston, 1964, and Gregg Quick Filing Practice, McGraw-Hill, New York, 1965.

A useful programmed instruction book is Basic Rules of Alphabetic Filing, by Fahrner and Gibbs, South-Western, Cincinnati, 1965. Free or inexpensive pamphlets are available from Smead Manufacturing Co., Hastings, Minnesota (Do's & Dont's of Filing and Science of Filing) and from the Oxford Filing Supply Company, Inc., Garden City, N. Y. 11533 (33 Common Filing Questions). Remington Rand, Systems Division has the film "It Must be Somewhere", while Cornet Films has "Filing Procedures in Business".

Training Time 15-20 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	$2\frac{13}{16}$ in. at 15 ft.
	5 in. at 20 ft.
D. Control of cross slope	* Indicate that the amount of crowning is controlled by the rollover effect, climate, and vehicle design.
1. Rollover effect	* Define rollover effect as the algebraic difference between cross slopes.
	* Explain that a vehicle in passing maneuvers must cross and recross the crown line and negotiate a rollover of $\frac{1}{2}$ in. per foot or 4 percent when the normal crown section is $\frac{1}{4}$ in. per foot.
	* Note that this is dangerous on a high speed road and that heavy trucks will sway from side to side, making steering difficult.
2. Climate	* Point out that a lesser slope is used in northern areas where snow and ice conditions are prevalent.
3. Vehicle design	* State that vehicles are built with a symmetrical caster-camber arrangement for level pavements and there is no difficulty in steering until the cross slope exceeds $\frac{1}{4}$ in. per foot.
VI. Shoulders	* Define the shoulder as a contiguous portion of the roadway built for stopped vehicles, emergency use, and lateral support of the pavement. (Ref. B, pp. 234-241)
A. Width of shoulder	* Add that the shoulder width varies from zero to 12 ft.
	* Mention that the width of the shoulder is directly related to: 1. Type of highway 2. Traffic volume 3. Traffic speed

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	4. Traffic composition 5. Type of terrain
	* Review the shoulder criteria as listed in the classification chart. (Ref. D)
B. Advantages	* Discuss the following advantages of a shoulder: 1. Provides space for emergency stops 2. Provides space for rest stops, map reading, etc. 3. Provides space for escape from a potential accident 4. Provides a psychological sense of freedom 5. Assists sight distance in cut sections 6. Provides aesthetic improvement 7. Increases traffic capacity 8. Encourages uniform speed 9. Provides space for maintenance and snow removal 10. Provides lateral clearance for signs, guide rails, delineators, etc. 11. Allows storm water to be drained farther away from the pavement minimizing edge seepage 12. Affords structural support to the pavement
C. Cross section	* Sketch on the chalkboard the cross section of the shoulder with the standard slope of 1 in. per foot, down and away, from the edge of pavement.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Note that as a vehicle speeds around a curve, it has tremendous centrifugal force and the vehicle remains on a level road only by an equal centripetal force. This centripetal force can come only from the force of friction between the tires and the weight of the vehicle.

* Sketch on the chalkboard the forces acting on and caused by the vehicle shown in figure 3.

* State that W is the pull of gravity and P is the upward push on the vehicle by the pavement.

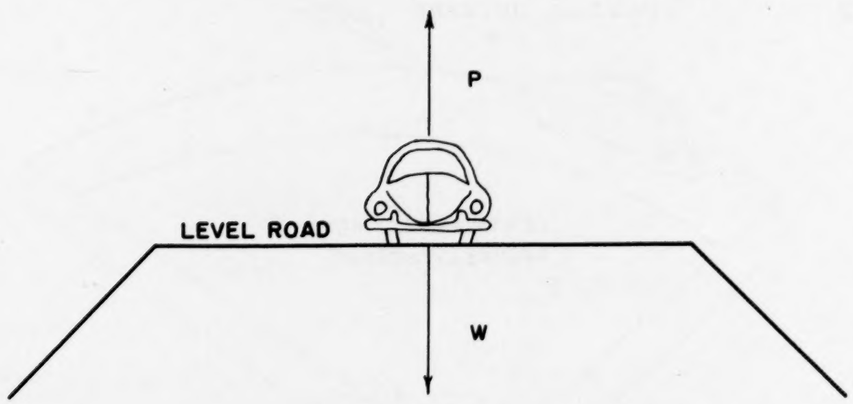

VEHICLE AND PAVEMENT FORCES

FIGURE 3

CONTENT OUTLINE

4. Unequal forces

TEACHING POINTS AND TECHNIQUES

* Indicate that when the centrifugal and centripetal forces are not equal, circular motion does not exist.

* Sketch figure 4 on the chalkboard and explain that when the centripetal force is insufficient to hold the vehicle on the road, centrifugal force causes the vehicle to move on a tangent to the curve as it attempts to follow a straight line.

* Elicit other examples of these forces and call attention to the fact that centripetal force holds us on earth.

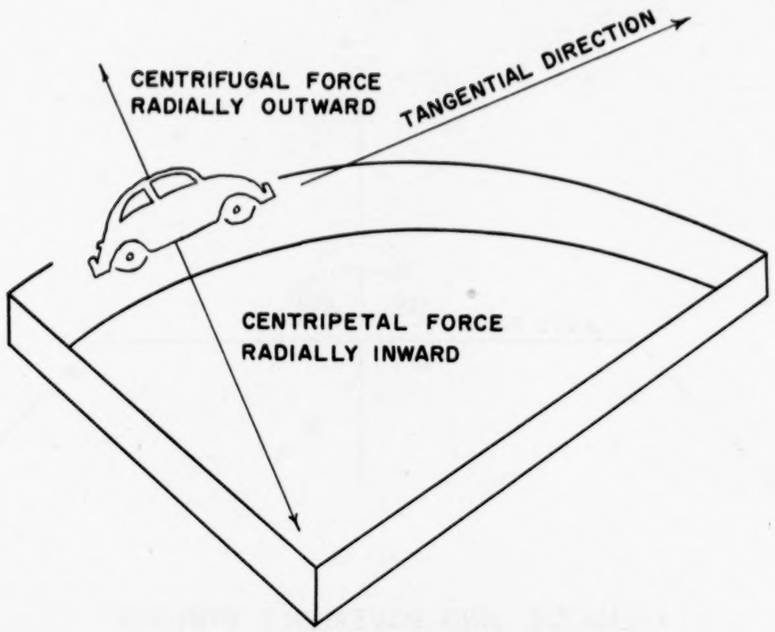

PATH OF VEHICLE WHEN CENTRIPETAL FORCE IS LESS THAN CENTRIFUGAL FORCE

FIGURE 4

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

5. The equation of force

* Point out that Newton's second law can be equated as force equals mass times acceleration.

$$F = Ma$$

* Note that mass is equal to the weight divided by the force of gravity.

$$M = \frac{W}{g}$$

* Indicate that acceleration in circular motion is equal to the velocity squared, divided by the radius.

$$F = Ma = \frac{(W)(V^2)}{(g)(r)}$$

a. Application

* Find the centrifugal force acting on a 4000-lb. vehicle traveling at 60 m.p.h. (88 ft. per second) traveling around a curve of a 1000-ft. radius.

$$F = Ma$$

$$= \frac{(W)(V^2)}{(g)(r)}$$

$$= \frac{4000 \text{ lbs.}}{32 \text{ ft./sec./sec.}} \times \frac{(88 \text{ ft./sec.})^2}{1000 \text{ ft.}}$$

$$= 968 \text{ lbs.}$$

* State that 968 lbs. of centrifugal force are acting outwardly against the forces of friction and gravity of the vehicle and that 968 lbs. of centripetal force are acting inwardly on the vehicle, attempting to accelerate it into the center of curvature.

C. Banking of curves

* Add that when a vehicle rounds a curve at constant speed, it is accelerating toward the center of the curve.

* Point out that on a highway that is level transversely, the only force holding a car on the pavement is the small and uncertain force of friction. The pavement is, therefore, banked or

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

tilted to assist the vehicle to remain in curvilinear motion.

* Sketch on the chalkboard figure 5. Explain the pull of gravity (W) and the push (P) exerted by the road and normal to it that act on a vehicle rounding a curve, banked at an angle theta.

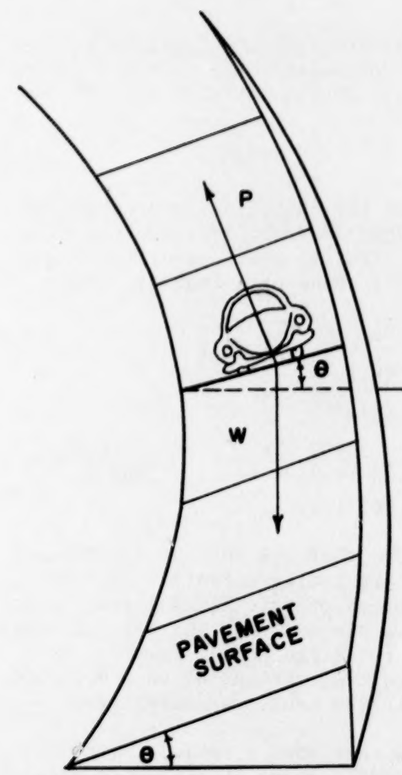

VEHICLE ON A BANKED CURVE

FIGURE 5

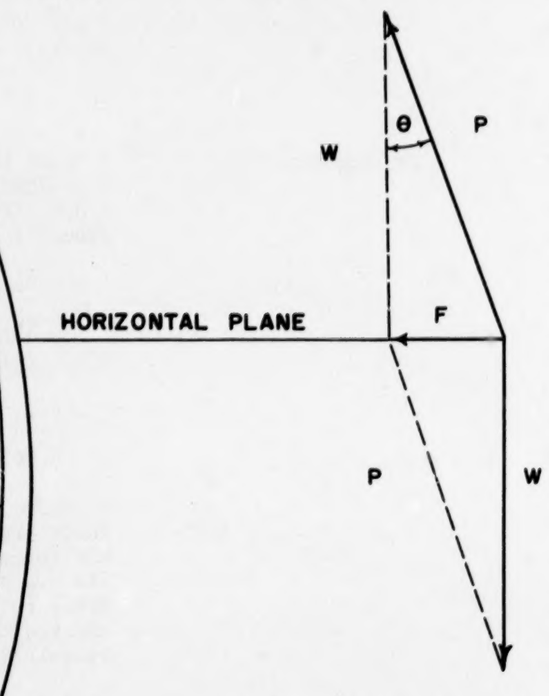

PARALLELOGRAM OF FORCES

FIGURE 6

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
C. Low type	* State that the low type surface can range from surface treated earth roads to ordinary dirt roads.
V. Crowns	* Define the crown as the transverse slope (cross slope) of a pavement. (Ref. A, pp. 135-137; Ref. B, pp. 223-225)
A. Need	* Mention that the chief reason for crowning a pavement is to provide for removal of surface water as quickly as possible.
B. Type of cross slope	* Describe the normal cross slope (N.C.S.) as two plane surfaces meeting at the crown or high point. * Draw a simple sketch on the chalkboard of a typical cross section. * Indicate that most city streets are usually crowned parabolically.
C. Amount of cross slope	* Point out that a slope of $\frac{3}{16}$ in. per foot was previously used for crowning a concrete pavement and $\frac{1}{4}$ in. per foot for a bituminous pavement, but a recent change calls for a $\frac{1}{4}$ in. per foot cross slope for all pavements regardless of the surface.
1. Plane crown	* Indicate that with a plane crown there is a uniform slope on each side extending from the center to the edge of the pavement. * Note the difference in elevation between the crown and the edges of the pavement on the 24-ft. cross section shown in figure 1 on page 44. * Emphasize that in general the lower the surface type, the greater the cross slope since lower type roads are designed for lower speed and fewer trucks.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
D. Stability	* Note that the shoulder must support vehicle loads in all types of weather. In the case of ordinary shoulders, the material should be granular, treated, and compacted. (Ref. C, Section 22, p. 39) * Describe the bituminous stabilized shoulders now being used. Add that too good a shoulder invites usage as another driving lane unless it is color contrasted or jiggled-barred.

QUESTIONS FOR REVIEW

1. Why are all curbs not constructed as a barrier type?
2. What is the value of a 14-ft. median on a city arterial?
3. Name three types of pavement surfaces.
4. Why is a graveled road cross sloped at $\frac{1}{2}$ in. per foot?
5. What is the normal cross slope of a bituminous surfaced highway?
6. Why would a parabolic crown be troublesome on a wide pavement?
7. Is there a connection between a low automobile and rollover effect?
8. Name five factors which control the width of a shoulder.
9. List 10 uses of the shoulder.
10. What is the usual cross slope of a standard shoulder?
11. How does climate affect the amount of cross slope used on a pavement?
12. What is the purpose of guide railing?
13. List five factors which would mandate the use of guide railing.
14. Describe three types of guide railing.

ASSIGNMENT

1. Solve problems 5-1 through 5-4 on page 187 in Ref. A.
2. Read pages 144-146 in Ref. A and pages 153-157 in Ref. B.

Lesson 6 - Horizontal Alinement (Control of Curvature)

OBJECTIVES

- To provide a background of pertinent information relating to the control of horizontal curvature
- To introduce superelevation as a limiting control of curvature

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Balanced Design	* State that an essential requirement in highway design is the balance of all geometric elements. This provides safe operation at the speed allowed by the general condition of the highway. (Ref. B, p. 152)†
A. Design speed	* Note that design speed is used as the overall control in achieving this balance of geometric elements.
B. Highway curves	* Point out that in the design of highway curves it is necessary to establish the proper relationship between design speed and curvature and their joint relationship with superelevation.
II. Mechanics of Curvature	* State that the relationship between speed and curvature is a matter of mechanics which explain the forces acting on a body in motion.
A. Newton's first law of motion	* Explain Newton's first law of motion—that a body at constant speed will move in a straight line until a force is applied to it. * Use as an example a baseball thrown in the air.
B. Newton's second law of motion	* Explain Newton's second law of motion—that a force acting on a body will accelerate that body in the direction of the force.

†Reference citations are shown on page 220.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Centrifugal force	* Point out that whenever a body is traveling around a circular curve at constant speed, the moving body acts on its restraining agent with a constant force directed radially outward from the center. * Use as an example a stone on a string (the restraining agent) whirled in a circle, or a bucket of water swinging rapidly in a circle over one's head.
2. Centripetal force	* State that centripetal force is that force which acts on the moving body by the restraining agent. * Note that the centripetal force acting on a body moving in a circular path varies directly as the square of the speed and inversely as the radius of the circle. Thus if the speed of a vehicle on a curved surface is doubled, four times as much centripetal force is brought into play.
3. Equal forces (equilibrium)	* Indicate that a body is in equilibrium when the forces acting upon it are so arranged that the body does not accelerate or decelerate. * Add that for uniform circular motion centrifugal and centripetal forces are always equal in magnitude and opposite in direction but they cannot balance each other since they are not acting upon the same object. * Repeat the example of the stone and string. The string pulls the stone, causing it to follow a definite path (a circle) so that centripetal force accelerates the stone toward the center of the circle. * Explain that a vehicle traveling on a curved surface acts the same as any body in motion on a circular path.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	3. Type of area (urban or rural)
	4. Frequency of slow moving traffic (uncertain operation
B. Minimum safe radius	* State that the maximum degree of curvature or the minimum radius is a limiting value for a given design speed and it is determined only when the maximum superelevation rate and the safe side friction factor have been established. (Ref. A, p. 146; Ref. E, pp. 5-6)
1. Application	* Utilize the information provided in the problem, found on page 53, and find the minimum safe radius using 0.08 ft./ft. as the maximum superelevation rate and a design speed of 60 m.p.h.

* Use the empirical equation:

$$e + f = \frac{V^2}{15r}$$

and solve for r:

$$r = \frac{V^2}{15(e + f)}$$

$$= \frac{(60)(60)}{15(0.08 + 0.13)}$$

$$= \frac{3600}{3.15}$$

$$= 1143 \text{ ft.}$$

* Note that the problem used a 1000-ft. radius which actually is too sharp. The maximum degree of curvature which can be used under the conditions of the problem is 5°.

* Find the minimum safe radius for an arterial highway with a superelevation rate of 0.06 ft./ft. and a design speed of 40 m.p.h.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

$$r = \frac{V^2}{15(e + f)}$$

$$= \frac{(40)(40)}{15(0.06 + 0.15)}$$

$$= \frac{1600}{3.15}$$

$$= 508 \text{ ft.}$$

* Find the minimum safe radius for a rural highway with a superelevation rate of 0.08 ft./ft. and a design speed of 80 m.p.h.

$$r = \frac{V^2}{15(e + f)}$$

$$= \frac{(80)(80)}{15(0.08 + 0.11)}$$

$$= \frac{6400}{2.85}$$

$$= 2246 \text{ ft.}$$

QUESTIONS FOR REVIEW

1. What is the relationship between Newton's laws of motion and curvilinear design?

2. What is centrifugal force?

3. What is centripetal force?

4. If a centrifugal force is in equilibrum with a centripetal force, why do they not balance each other?

5. In banking what is the relationship between "e" and the tangent of the banking angle?

6. How does side friction enable a vehicle to travel at a slower or faster rate than the design speed on a banked curve?

7. What is the side friction factor for a design speed of 50 m.p.h?

8. Why does New York State limit the maximum superelevation to 0.08 ft. per foot.

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9. Describe the control afforded by the minimum safe radius.

10. How does a motorcycle ride in a horizontal position on a race track?

ASSIGNMENT

1. Study pages 146-151 in Ref. A, and pages 157-181 in Ref. B.

2. Find the amount of centrifugal force that is exerted by a 30-ton semi-trailer traveling at 70 m.p.h. around a 3°-curve on a rural highway?

3. Find the amount of banking necessary to furnish enough centripetal force to hold the truck on a 12-ft. pavement without the force of friction.

4. Find the banking necessary when the force of friction is used.

5. What should the minimum safe radius be for this situation?

INSTRUCTOR'S NOTES

Lesson 7 - Horizontal Alinement (Superelevation Runoff)

OBJECTIVES

- To furnish a practical application of the mechanics of superelevation
- To discuss the methods used in achieving full bank

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Superelevation Standards	* Point out that in establishing standards of superelevation, the minimum curvature should vary with the range of speeds.
A. Flat curve	* Mention that the pavement of a flat curve requires no banking or superelevating. (Ref. B, p. 162)†
	* Note that a vehicle entering a curve to the right has some superelevation because of the normal cross slope. Traffic entering a curve to the left has an adverse or negative superelevation because of the normal cross slope.
	* State that the resultant friction required to counteract both centrifugal force and negative superelevation is small.
B. Limit of friction factor	* Indicate that as the curve becomes sharper the friction factor is not sufficient to hold the vehicle on the highway and superelevation is required.
	* Add that the minimum curvature for which superelevation is required or the maximum curvature for which a crowned pavement cross section is appropriate is part of any standard for superelevation.
C. Superelevation rates	* Explain that in highway curve design it is necessary to determine superele-

†Reference citations are shown on page 220.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	vation rates for the range of curvature used for each design speed. (Ref. B, p. 157)
1. Extremes of superelevation	* Point out that the extremes of superelevation range from zero on a tangent highway to a maximum, established by practical considerations like ice and snow. This maximum superelevation is used to determine the maximum curvature for each speed.
2. Area between extremes	* Emphasize that for radii of curves falling between zero and maximum curvature for a given design speed, the superelevation should be distributed so there is a logical relationship between the side friction factor and the superelevation rate.
	* State that there is a curvilinear relationship between the degree of curve and the varying superelevation rate.
	* Note that this curve is parabolic.
3. Graphs	* Discuss the graphs on pages 163-166 of Ref. B, which show a superelevation rate relationship between each design speed and the degree of curvature.
	* Mention that the four graphs are based on the maximum superelevation rates (established by practical considerations) of 0.06, 0.08, 0.10 and 0.12.
II. Superelevation Runoff	* Describe superelevation runoff as a general term denoting the length of highway needed to accomplish the change in cross slope of the pavement from a normal crown section to a fully superelevated section or vice versa. (Ref. B, p. 174; Ref. E, pp. 6-7)
	* Note that this transition is one of the most important features in highway design. It must be accomplished with no appreciable loss in speed and with the safety and comfort of the occupants of the vehicle assured.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* State that the forces P and W must be so proportioned that their resultant F is horizontal, since this is the centripetal force (the force of friction between tires and pavement) required to achieve circular motion around a horizontal curve. (Ref. E, p. 4)

* Draw figure 6 (found on page 54) on the chalkboard and note that the angle theta (Θ) in figure 5 is equal to angle theta in figure 6. Explain in the parallelogram of forces the following:

$$\tan \Theta = \frac{F}{W}$$

since $F = Ma$

$$\tan \Theta = \frac{Ma}{W}$$

since $M = \frac{W}{g}$

$$\tan \Theta = \frac{(W)(a)}{(g)(W)}$$

but $a = \frac{v^2}{r}$

$$\tan \Theta = \frac{(W)(v^2)}{(g)(W)(r)}$$

$$= \frac{v^2}{(g)(r)}$$

where v = speed of vehicle in feet per second

g = acceleration due to gravity of 32 ft. per sec. per sec.

r = radius of curve in feet

* Describe the banking angle as that angle whose tangent is equal to v squared, divided by g times r.

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VIII (14.0901-06)

SOURCES OF INFORMATION

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate her knowledge of information sources by compiling a list of information to meet specifications designated by the instructor.

Unit Outline:

A. Reference Books as a Tool of the Office Worker

1. Importance of accurate business information
2. Kinds of information needed
3. Necessity of obtaining information quickly
4. Necessity for initiative in finding information

B. Reference Books of the Office Worker

1. Dictionaries
2. Reference manual for stenographers and typists
3. English grammar and style books
4. Directories
5. Thesaurus

C. Other Sources of Factual Information

Supplemental Teaching Aids:

The most obvious resource person is of course the librarian. Also available is the Gregg Secretarial Record #6, Set #2 Finding Needed Information. The film "Look It Up-Dictionary Habits" (11 min.) is available from Cornet Instructional Films.

Training Time 3-5 hours

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

$$\Theta = \tan^{-1} \frac{v^2}{(g)(r)}$$

* Mention that the expression banking is usually termed superelevating.

1. Application

* Use the facts that are given for the problem found on page 53, and compute the banking required so that the developed centripetal force will hold the vehicle in its circular path without depending on friction.

* Reiterate that the

$$\tan \Theta = \frac{v^2}{(g)(r)}$$

$$= \frac{(88 \text{ ft./sec.})(88 \text{ ft./sec.})}{(32 \text{ ft./sec./sec.})(1000 \text{ ft.})}$$

$$= 0.242$$

* Note that all units cancel out, leaving a unitless answer which is the slope of the hypotenuse in the triangle where the tangent of Θ is equal to the side opposite over the side adjacent.

* Explain that this means that the vehicle in the problem requires a cross slope of 0.242 ft. per foot to achieve this particular circular motion without resorting to the force of friction between the tires and the pavement.

* State that the 0.242 ft. per foot or 0.242 in. per inch or 0.242 yd. per yard is equal to about 3 in. per foot or in a 12-ft. lane about 3 ft. of bank.

* Sketch figure 7 on the chalkboard and review the mechanics of the problem. (Found on page 57)

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CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

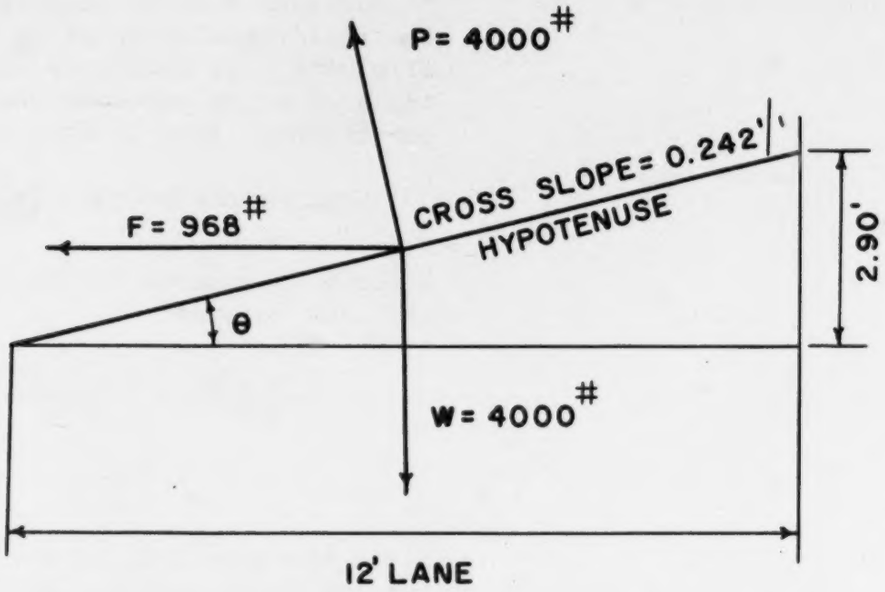

AMOUNT OF BANKING REQUIRED

FIGURE 7

a. Empirical formula

* Indicate that the required banking can also be determined by using the following empirical formula:

$$e = \frac{V^2}{15r}$$

where V is measured in miles per hour
r is measured in feet

(1) Derivation of factor

* Show the derivation of the factor 15.

* Recall the formula for determining the required banking as:

$$\tan \Theta = \frac{v^2}{(g)(r)}$$

where v is measured in feet per second
g is measured in feet per second per second
r is measured in feet

* Point out that tan Θ equals e.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Indicate that to simplify the mathematical calculation it is desirable to eliminate g (a constant) and use v in terms of miles per hour instead of feet per second. This is done as follows:

$$V(\text{miles per hour}) \times \frac{5{,}200 \text{ ft./mi.}}{3600 \text{ sec./hr.}}$$

Since v is squared in the formula the relation becomes:

$$\frac{V \times 5280}{3600} \times \frac{V \times 5280}{3600} \quad \text{or}$$

$$V^2 \times \frac{5280^2}{3600^2}$$

Since the acceleration due to gravity remains quite constant at 32.2 ft. per second per second the calculation may be simplified by incorporating this fact in the above transformation as follows:

$$\frac{V^2 \times \frac{5280^2}{3600^2}}{32.2}$$

Simplified the above expression becomes:

$$\frac{V^2}{15}$$

Substitute this expression into the original formula:

$$\tan \Theta = e = \frac{V^2}{15}$$

where V is measured in miles per hour
r is measured in feet

* Recompute the problem using the empirical formula:

$$e = \frac{(60)(60)}{(15)(1000)}$$

$$= 0.24$$

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Compare this amount of banking to a racetrack and state that in this case friction does no work.
	* Indicate that the vehicle will follow its circular path only when it is traveling at a constant speed which in this case is precisely 60 m.p.h.
2. Flaws in banking	* Caution that severe banking will force a slow driver to steer up the cross slope, or against the direction of the curve.
	* Add that if a car is traveling faster than the design speed, only tire friction will prevent the vehicle from sliding to the outside.
	* Conclude that highway banking must therefore depend on the force of friction.
III. The Force of Friction	* Establish that the force of friction is always present during unideal conditions (most of the time). (Ref. B, pp. 152-153)
A. Coefficient of friction	* Call this force the side friction factor. It manifests itself as a coefficient of friction.
	* Elaborate on the different terms assigned to side friction, such as "lateral ratio," "cornering ratio," "friction factor," "unbalanced centrifugal ratio, "and "unbalanced side friction." (Ref. B, p. 153)
	* Recall that the coefficient of friction is equal to the force of friction divided by the vehicle weight component perpendicular to the pavement (a unitless number).
	* Emphasize that the coefficient of friction is completely independent of the contact area involved.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Add that since the coefficient of friction diminishes the amount of banking, the formula now reads: $e + f = \frac{V^2}{15r}$
B. Side friction factors	* List the commonly used coefficients or side friction factors for the eight design speeds used at present. (Ref. B, p. 158) 1. 30 m.p.h. at 0.16 2. 40 m.p.h. at 0.15 3. 50 m.p.h. at 0.14 4. 60 m.p.h. at 0.13 5. 65 m.p.h. at 0.13 6. 70 m.p.h. at 0.12 7. 75 m.p.h. at 0.11 8. 80 m.p.h. at 0.11 * Emphasize that these factors are not the maximum values and a safety factor has to be considered.
C. Application	
1. Without friction	* Recompute the problem empirically without using the coefficient of friction. $e = \frac{V^2}{15r}$ $= \frac{(60)(60)}{(15)(1000)}$ $= 0.24$ ft./ft.
2. With friction	* Recompute the problem empirically using the coefficient of friction. $e + f = \frac{V^2}{15r}$ $= 0.24$ ft./ft. $e = 0.24$ ft./ft. $- f$ $= 0.24 - 0.13$ $= 0.11$ ft./ft.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Indicate that friction reduces the banking required for a 12-ft. pavement from 2.88 ft. to 1.32 ft.
IV. Superelevation	* Describe superelevation as an expression for banking and list the commonly used maximum rates as 0.06 ft./ft., 0.08 ft./ft., 0.10 ft./ft., and 0.12 ft./ft. (Ref. A, pp. 146-151; Ref. B, pp. 155-156)
	* Emphasize that using too high a maximum rate for superelevation creates a hazard in any area having ice and snow conditions.
	* Indicate that in New York State the allowable maximum rate of superelevation is 0.08 ft./ft. for rural highways, 0.06 ft./ft. for urban highways and 0.063 ft./ft. for structures.
	* Point out that consideration of superelevation has been a weak point in highway design but now considerable emphasis is being placed on this element.
V. Control of Curvature	* Caution that the maximum curvature for a given design speed is determined by the combination of the maximum rate of superelevation and the factor for safe side friction. (Ref. B, pp. 155-157)
	* Note that the limitations of the maximum superelevation rate and the safe side friction factor are technically the most important control in the design of curvature.
A. Control of rates	* Explain that the maximum superelevation rates are controlled by: 1. Climatic conditions (frequency of snow and ice) 2. Terrain conditions (flat or mountainous)

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Explain the three ways of attaining superelevation. (Ref. A, pp. 146-151; Ref. B, pp. 178-181)

1. Revolving the pavement about the centerline profile

2. Revolving the pavement about the inside edge profile

3. Revolving the pavement about the outside edge profile

* State that for simplicity the curve in all problems and sketches will always be to the right.

A. Revolving pavement about centerline profile

* Draw figure 8 on the chalkboard which shows the first method. Use colored chalk for each position of the pavement and exaggerate the vehicle scale.

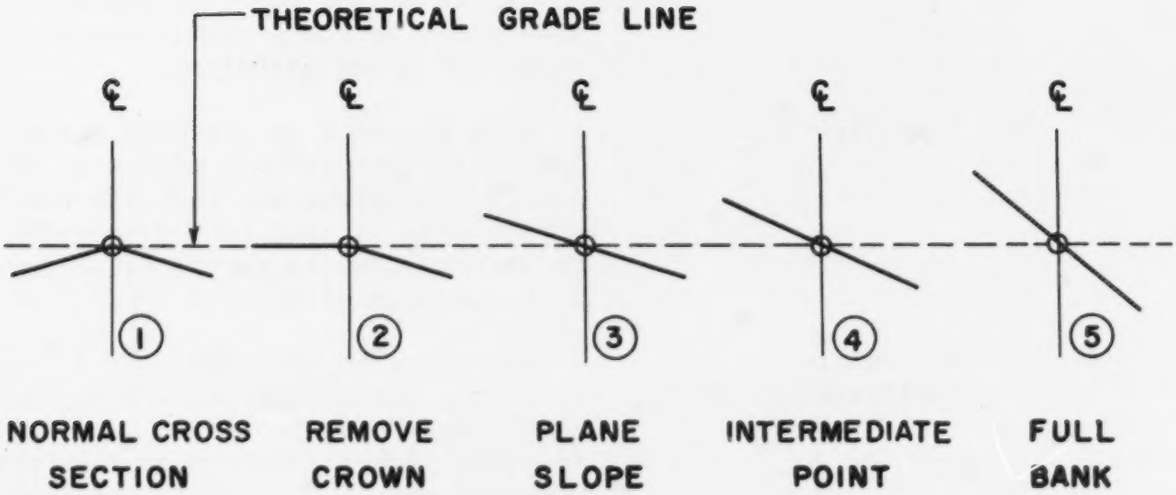

ATTAINMENT OF SUPERELEVATION BY REVOLVING ABOUT CENTERLINE

SEPARATE VIEWS

FIGURE 8

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

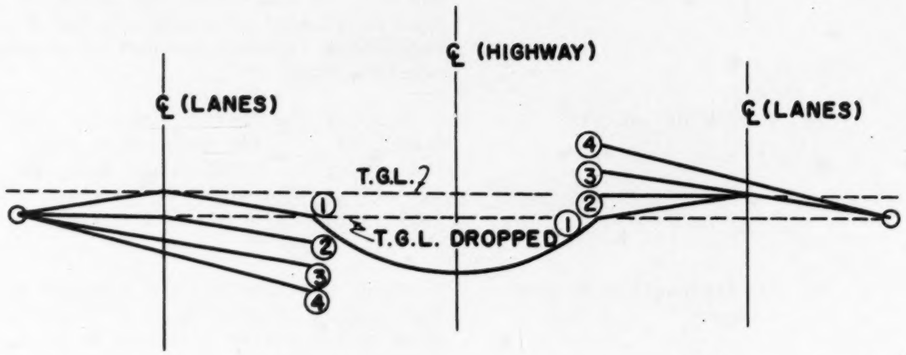

ATTAINMENT OF SUPERELEVATION BY REVOLVING ABOUT OUTSIDE EDGES

FIGURE 14

* Caution that to use this pivot on a four-lane divided highway the median must be at least 30 ft. wide to handle the difference in elevation between the median edges.

* State that if the median is over 40 ft. wide, the roadways may be treated as separate highways.

III. Placement of Superelevation

* Review briefly the geometry of the simple curve. Note that when a vehicle traveling on a tangent, reaches the point of curvature (P.C.) of a curve, the natural tendency for it to continue straight on must be overcome.

* Explain that superelevation runoff helps the vehicle move from a tangent direction to a curvilinear direction.

CONTENT OUTLINE | TEACHING POINTS AND TECHNIQUES

Schemetically, this takes place at the P.C. of the curve, but actually this point must be drawn out for a reasonable distance because of physical requirements.

A. Action of vehicle

* Display the sketches showing the method of pivoting a pavement about the centerline profile and describe the action when vehicles approach the curve, drive the curve, and leave the curve.

B. Superelevation on the tangent

* Point out that while a vehicle on the tangent is driving in a slightly unnatural position it would be in an exceedingly unnatural position if the pavement revolved from positions 1 through 4 completely on the tangent. Here full bank would be coincident with the P.C. in order to satisfy the laws of mechanics.

C. Superelevation on the curve

* Add that if the vehicle reaches the P.C. on a normal cross slope and is then gradually superelevated on the curve, it will be in opposition to the mechanics of curvilinear motion.

D. Compromise between tangent and curve

* Emphasize that some compromise must be made so that the transition satisfies the mechanics of curvature.

* Explain that the first alternative is to attain a certain portion of the superelevation runoff on the tangent and the remaining portion on the curve.

* State that a proportion has been devised which places 80 percent of the superelevation runoff on the tangent and 20 percent on the curve. Indicate that some design offices use a 70-30 percent proportion.

* Point out that the second alternative is the use of the spiral curve because it provides a natural distance for superelevation runoff.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

E. Length of superelevation runoff

* Emphasize that the length of superelevation is controlled by the difference between the longitudinal slope of the outside edge and the longitudinal slope of the centerline profile.

* Draw figure 15 on the chalkboard and explain the difference in longitudinal slope between edge and centerline profiles.

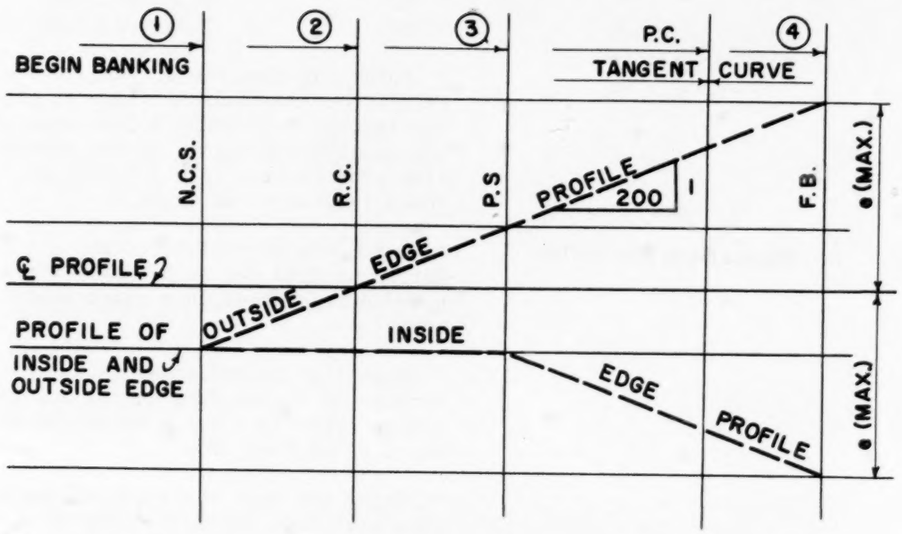

LONGITUDINAL VIEW OF CENTERLINE AND EDGES OF PAVEMENT

FIGURE 15

* Discuss the allowable differences in longitudinal slopes and emphasize that the design speed is the controlling factor.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

Design Speed in m.p.h.	Maximum relative slope between profiles of edge of two-lane pavement and centerline
30	0.66% or 1/150
40	0.58% or 1/175
50	0.50% or 1/200
60	0.45% or 1/225
65	0.41% or 1/245
70	0.40% or 1/250
75	0.38% or 1/265
80	0.36% or 1/280

* Point out that the criteria above brings the longitudinal slope of the outside edge to within 0.5 percent of the longitudinal slope of the centerline profile if a 50-m.p.h. design speed is used as an example.

F. Superelevation tables

* Use the charts on pages 168-171 of Ref. B to find the proper rate for a given design speed on a given design curve.

* Note that normal crown (N.C.) indicates no change from normal and that remove crown (R.C.) indicates the removal of adverse crown.

* Point out that the required superelevation rate for a 4°-curve at a 50-m.p.h. design speed is 0.063 ft. per foot when e max. is 0.08. (Ref. B, p. 169)

G. Application

* Find the required superelevation rate and the placement of the runoff for a rural, two-lane highway with 10-ft. pavements designed at 50 m.p.h. on a 4°-curve with normal crown section (N.C.S.) of $\frac{1}{6}$ in. per foot (0.021 ft. per foot).

* Sketch figure 16 (on the following page) on the chalkboard and explain how full bank is achieved.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Positions of pavement	* Describe figure 8 as a series of views depicting the cross section of a two-lane pavement as it changes positions from a normal crown section to full bank. * Indicate that the first position is a normal crown section which is assumed to be a $\frac{1}{4}$ in. per foot slope. * Note that in the next position the crown of the right lane remains unchanged while the left lane becomes level. * Emphasize that the next obvious change occurs in the plane slope where the entire pavement (both lanes) is on the original $\frac{1}{4}$ in. per foot slope. * State that the next position is an intermediate view of the pavement between a plane slope and full bank. * Indicate that the last position is the full bank for a particular design speed and given curvature.
2. Composite view	* Draw figure 9 on the chalkboard and state that it is a composite of all the positions and that the numbers at the edge of each lane denote the positions shown in figure 8. (Fig. 9 shown on page 69.)
3. Reasons for centerline pivot	* Explain that the method of pivoting about the centerline profile is the most widely used in design because the required change in the elevation of the pavement edge is made with the least distortion and it is more easily built. * Point out that since the centerline profile remains unchanged, any change in pavement cross slope is divided equally between the two edges when entering full bank. * Mention that when the centerline pivot is used on a four-lane divided

VEO #14.0703
DOT #202.388

TRAINING COURSE FOR

STENOGRAPHERS

The material in this guide is presented in the form of suggestions. Every student participating in this program will be different in regard to education, experience, and ability. The instructor must, therefore, adjust and adapt the suggestions in this guide to the needs of individual students.

The first step in insuring this adjustment is to secure as much information as possible about each new student. This can be accomplished through study of the pre-enrollment information gathered by the Center counselors. The second step is to keep up to date on the progress of each student through the regular use of the information prepared by Individual Program Control (IPC). With this information on hand the instructor can effectively adapt specific objectives, teaching methods, and time alloted to each aspect of the training, directly to the student's needs.

This guide will aid the instructor in accomplishing part of his job. It will provide performance objectives, suggest time allotments, unit outlines, and supplemental teaching aids. Only the instructor, however, can combine these factors with a knowledge of each individual student.

Course Objectives:

The stenographer program at Gila River Career Center is designed to:

1. develop in the student an awareness of the importance of office work and of the career opportunities which it offers.

2. develop an understanding of the place and purpose of the office in general, and the stenographer in particular, in the typical business organization.

3. develop a job-centered approach to businesslike work habits and attitudes and effective human relations.

4. develop an awareness of the need for continuous concentration on the fundamental skills--grammar, spelling, punctuation, vocabulary building, pronunciation, handwriting, and arithmetic.

5. prepare the student to perform the technical tasks commonly expected of the stenographer.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

highway the entire highway (four lanes) is superelevated as a single section as it rotates about the centerline of the median.

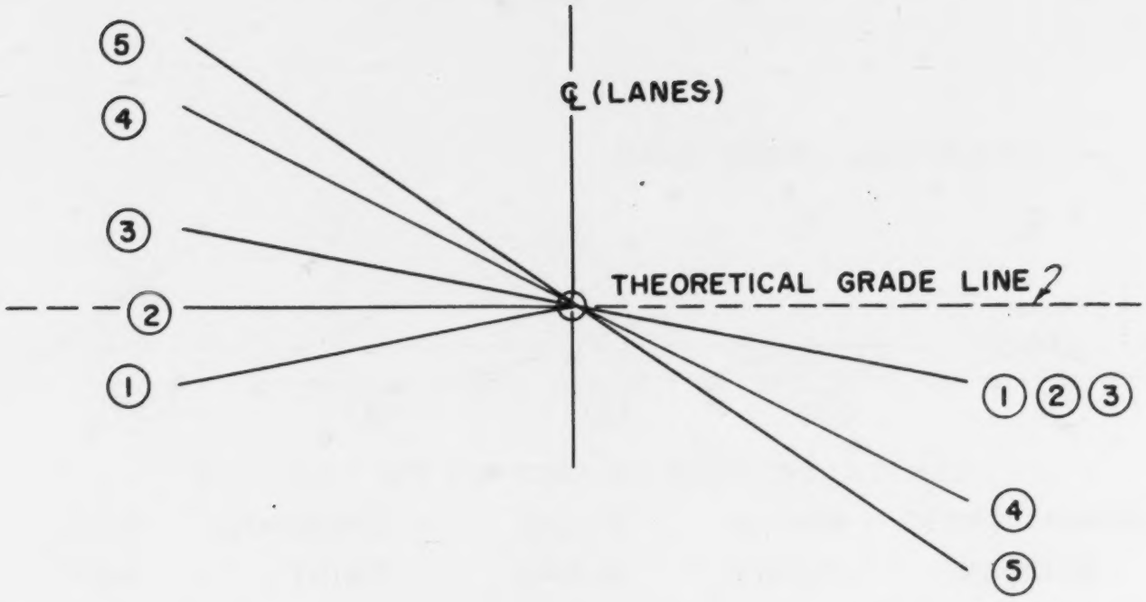

ATTAINMENT OF SUPERELEVATION BY REVOLVING ABOUT CENTERLINE

COMPOSITE VIEW

FIGURE 9

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Revolving pavement about inside edge	* Draw figure 10 on the chalkboard and explain how the pavement is revolved about the inside edge. * Note that in the four-lane divided highway the median is held on a horizontal plane while the two pavements are rotated about the inside or median edge.

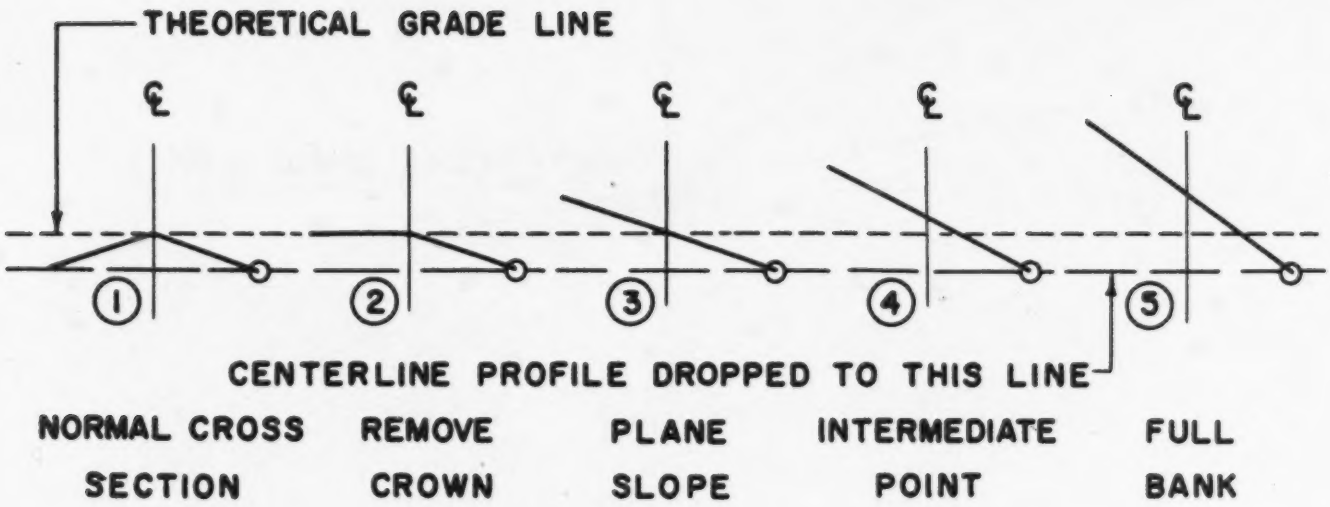

ATTAINMENT OF SUPERELEVATION BY REVOLVING ABOUT INSIDE EDGE
SEPARATE VIEWS
FIGURE 10

CONTENT OUTLINE

1. Transposition of theoretical grade-line

TEACHING POINTS AND TECHNIQUES

* Draw figure 11 on the chalkboard and indicate that it is a series of views depicting the cross section of a four-lane pavement as it changes from a normal cross section to full bank.

* Emphasize that the most important element in this type of revolution is the exchange of the theoretical grade-line from the normal position to a plane through the inside edge of the pavement.

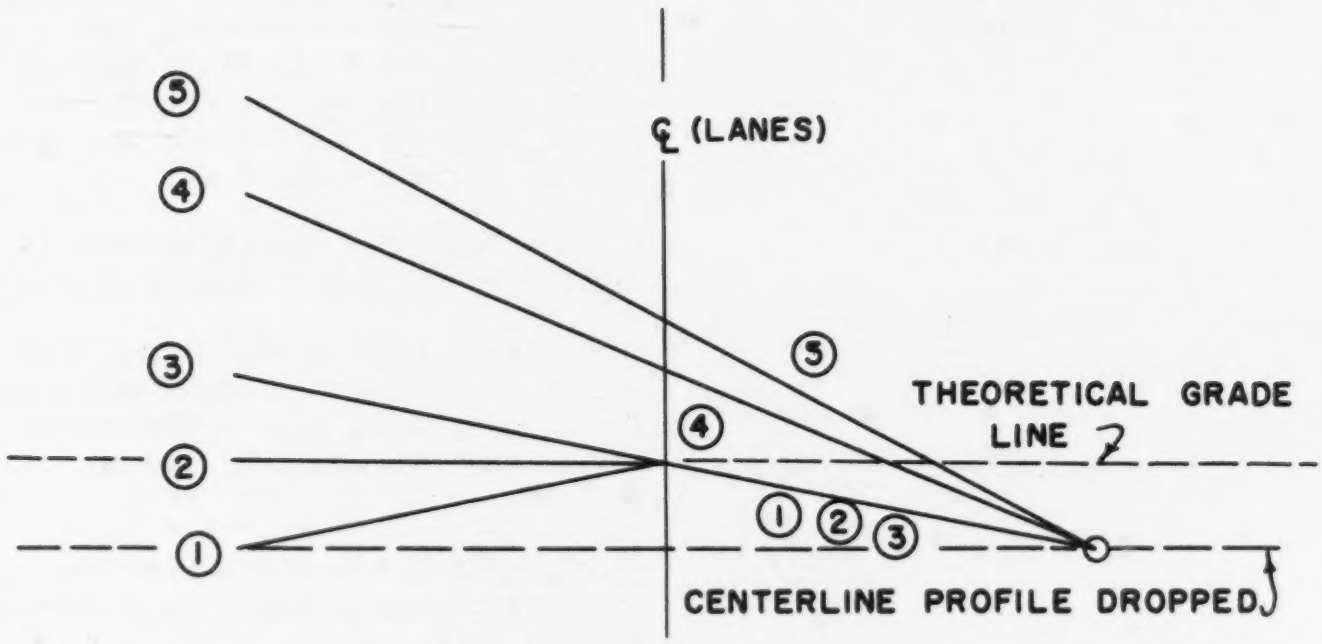

ATTAINMENT OF SUPERELEVATION BY REVOLVING ABOUT INSIDE EDGE
COMPOSITE VIEW
FIGURE 11

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Draw figure 13 on the chalkboard and note how an inside edge pivot remedies the problem in figure 12.

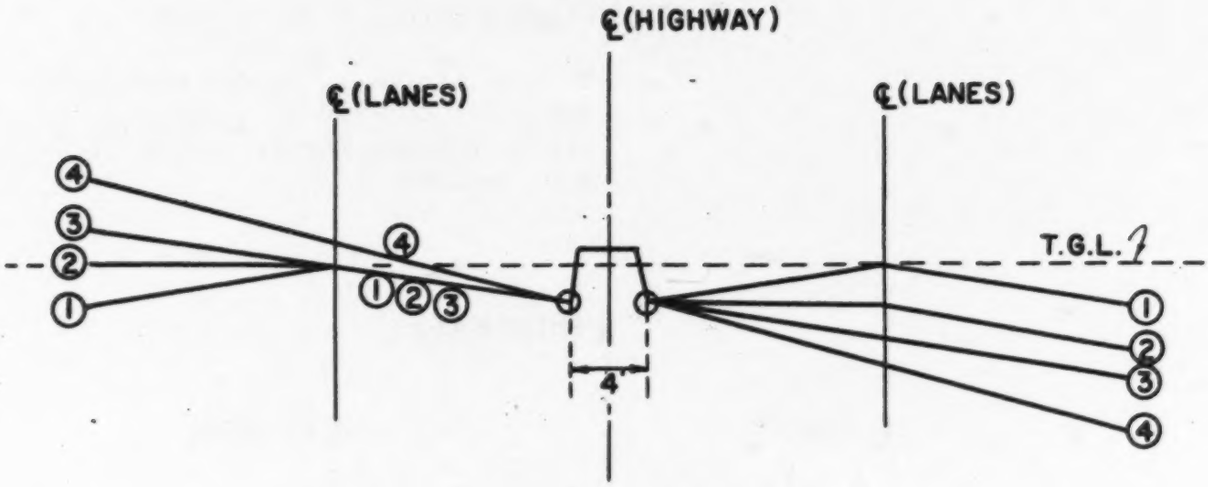

4 LANE DIVIDED HIGHWAY
PIVOT AT INSIDE EDGES
FIGURE 13

C. Revolving pavement about outside edge

* Draw on the chalkboard figure 14, found on page 75, and explain how the pavement is revolved about the outside edge.

1. Positions of pavement

* Note that the various positions of the pavement are opposite from the inside edge pivot.

2. Advantages

* Mention that pivoting about the outside edge is the best way aesthetically to superelevate a highway. Also this method keeps at a constant elevation the pavement edge (outside) most noticable to the driver which gives him a feeling of security.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* State that this type of revolution does not affect any part of the design or construction. As a highway is superelevated about the inside pavement edge the elevation of the new gradeline drops below the normal theoretical gradeline (lane width of 12 ft. times ¼ in. per foot = 3 in.).
	* Note that this new gradeline proceeds parallel to the normal theoretical gradeline and as soon as the banking operation is complete, the theoretical gradeline again assumes its normal position.
2. Positions of pavement	* Mention that since the inside edge of the pavement is anchored, the second view shows the right lane in normal position while the left lane is now level and similar to the second view in figures 8 and 9.
	* Point out that the third view is similar to the third view of figure 8.
	* Indicate that in the fourth view the entire plane slope revolves about the inside edge which places the center point above the original theoretical gradeline.
	* Add that in the fifth view the entire two-lane pavement is pivoted to full bank.
3. Reasons for pivoting about inside edge	* Repeat that in this method the inside edge profile is a line parallel to the calculated centerline profile.
	* Show that one-half of the required change in cross slope is made by raising the centerline profile with respect to the inside pavement edge and the other half is accomplished by raising the outside pavement edge an equal amount with respect to the centerline profile.
	* Emphasize that rotating about the inside edge creates better drainage

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

conditions and that this method must be used in the design of a four-lane divided highway when the median is narrow.

* Explain the results when a center pivot is used on a four-lane divided highway with a 4-ft. median.

* Draw figure 12 on the chalkboard and point out the difference in elevation between the two edges of the 4-ft. median.

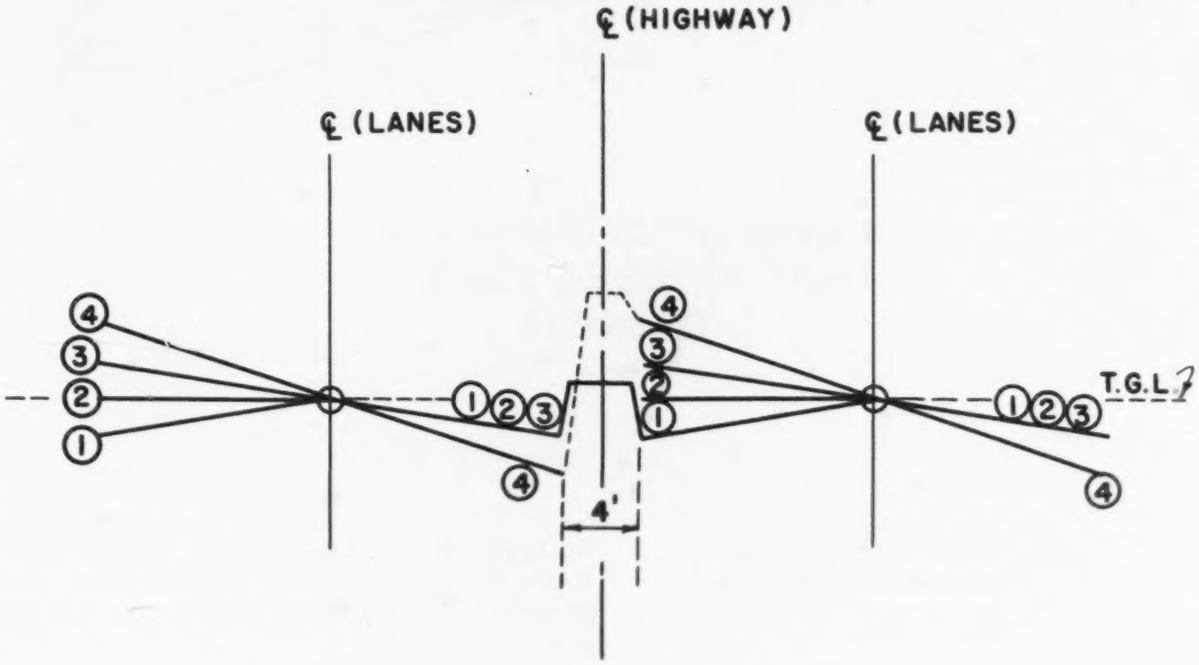

4 LANE DIVIDED HIGHWAY
PIVOT AT EACH ℄ PROFILE
FIGURE 12

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Indicate that the dimensions for the SU design vehicle (single unit truck with a 20-ft. wheelbase) is always used as representative of all design vehicles.
C. Design values	* State that the cost of widening curves far exceeds the gains accomplished but it is important to do on narrow pavements with sharp curves.
1. Minimum standards	* Explain that the additional width on curves should be in multiples of 6 in. starting with a 2-ft. minimum.
2. Widening chart	* Mention that table III-12 on page 186 of Ref. B indicates the required widening for 24, 22, and 20-ft. pavements at curvatures ranging from 1° to 26.5°.
	* Point out that all values under 2 ft. are to be disregarded and that all values for a four-lane or divided highway should be doubled.
3. Application	* Find the amount of widening required for an undivided four-lane pavement (11-ft. lanes) at a design speed of 50 m.p.h. on a 4°-curve.
	* Note that the chart calls for 1.5 ft. of widening for two lanes which means that it should be doubled to 3 ft. for a four-lane undivided highway.
D. Attainment of widening	* Describe a widening as a gradual change beginning on the approaches of a curve, proceeding through the curve, and ending on the tangent after the curve. (Ref. B, p. 187)
	* State that widening should be done only on the inside edge of simple curves but in the case of the spiral curve, a choice may be made between widening on the inside or dividing the widening on the inside and the outside of the curve.

CONTENT OUTLINE

III. Horizontal Sight Distan

TEACHING POINTS AND TECHNIQUES

* Caution that the change from a normal width to the widened section should occur within 100 to 200 ft. since a long transition results in narrow slivers which are difficult to construct.

* Emphasize that the edge of the widening should be a smooth, graceful curve, not a tangent or a series of tangents.

* Point out that one-half to two-thirds of the transition is placed on the tangent and the remainder on the curve but on spiral curves the transition should occur on the spiral.

* State that widening instructions should be placed on the plans for construction.

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* Define the horizontal sight distance as the clear line of sight across the inside of a curve. (Ref. A, pp. 161-163; Ref. B, pp. 188-189; Ref. C, section 22, p. 14)

* Mention the objects which will obstruct visibility.

1. Walls
2. Cut slopes
3. Wooded areas, trees
4. Signs
5. Buildings
6. Hedgerows
7. Farm crops
8. Utility poles

* Explain that the middle ordinate is the distance m from the centerline of the inside lane to any obstruction on the line of sight. (Ref. A, p. 166; Ref. B, p. 188)

* Add that this is not the middle ordinate distance of the design curve.

CONTENT OUTLINE

A. Equations

TEACHING POINTS AND TECHNIQUES

* Note that since only the factors of curvature and sight distance are involved, the equation for m (middle ordinate) is relatively simple.

* Indicate that the formula used by the AASHO to find the middle ordinate is:

$$m = \frac{5730}{D} \text{ vers } \frac{SD}{200}$$

where 5730 is the radius in feet of a 1°-curve

D is the degree of curvature

S is the stopping sight distance along the centerline of the inside lane

vers $\frac{SD}{200}$ equals 1 - cosine $\frac{SD}{200}$

1. Derivation of factor

* Explain how the factor 200 is determined.

* State that the geometry of a simple curve (from surveying) indicates that m (middle ordinate distance measured on a radial line from the curve to the long chord) is found as follows:

$$\cos \frac{\Delta}{2} = \frac{R - m}{R}$$

where Δ is the deflection angle between the tangents

R is the radius of the curve in feet or $\frac{5730}{D}$

m is the middle ordinate distance.

Therefore $m = R\left(1 - \cos \frac{\Delta}{2}\right)$ or

$= R \text{ vers } \frac{\Delta}{2}$

* Note that the geometry of the simple curve also indicates that the length of curve (L) is equal to $\frac{100\Delta}{D}$ and since L is approximately the line of sight distance then:

$$S = 100 \frac{\Delta}{D} \quad \text{or}$$

CONTENT OUTLINE TEACHING POINTS AND TECHNIQUES

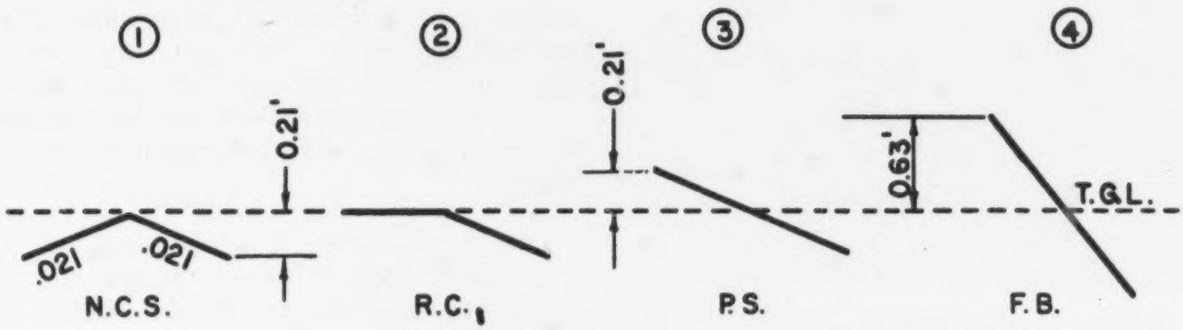

ACHIEVEMENT OF FULL BANK

FIGURE 16

* Note that the superelevation rate in this problem is 0.063 ft. per foot. This means that in full bank the outside edge will be 0.063 ft. per foot times the pavement width of 10 ft. or 0.63 ft. above the centerline profile or 0.084 ft. above the outside edge of the normal crown section (0.63 ft. plus 0.21 ft.).

* Draw figure 17 on the chalkboard and explain the change in elevations of the pavement edges.

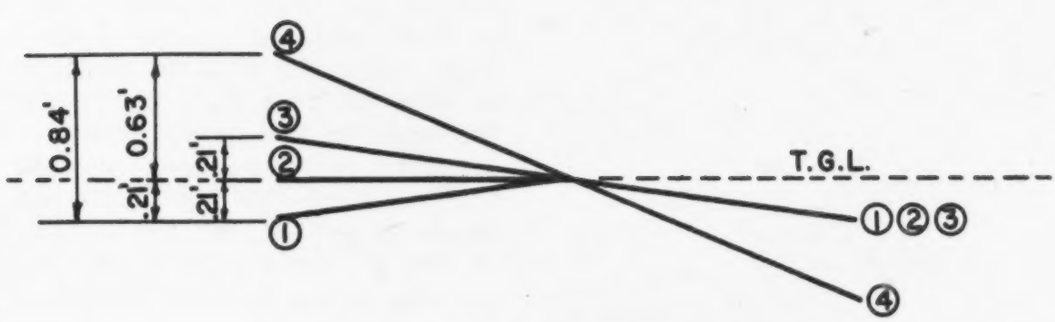

ELEVATION CHANGES IN PAVEMENT EDGES

FIGURE 17

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Criteria	* Indicate that the longitudinal slope of the outside edge cannot exceed the longitudinal slope of the centerline profile by more than 1/200, or 0.5 percent. This affects the distance that the outside edge can rise from its position in the normal crown slope to its position in full bank. * Note that this rise amounts to 0.84 ft. Show that 0.84 ft. times 200 is equal to 168 ft. and that 168 ft. is the distance in which this transition or superelevation runoff will occur.
2. Apportionment	* Recall the designation of 80 percent on the tangent and 20 percent on the curve and that 80 percent of 168 ft. is 134 ft., which automatically places the beginning of runoff at a point 134 ft. before the P.C. * Add that this also places 34 ft. of the runoff on the curve.
3. Deviation	* Point out that the transition from normal crown section to full bank is on a straight line deviation so that any position may be calculated by direct proportion.
4. Computation of position	* Refer to figure 17 and state that position #2 (remove crown) or #3 (plane slope) is located by a direct proportion with the elevation change in that position. Thus position #2 (left lane) is a level surface with an edge that is 0.21 ft. higher than its edge in the normal cross slope position. The pavement would, therefore, achieve this position at a distance of $\frac{0.21}{0.84}$ times the total distance of 168 ft. or 42 ft. from the point of the beginning of superelevation.
5. Rollover effect	* Describe the rollover effect and explain how the cross section of the

Course Outline:

The following table provides a listing of course units along with time estimates for each unit. Both sequence and estimates can be varied to meet student needs. Units are presented concurrently as students achieve objectives that prepare them to move ahead.

Course Unit	Title	Hours	Code
Unit I	Occupational Orientation	5- 7	-01
Unit II	Fundamentals of Typing	70- 85	-02
Unit III	Production Typing	60- 80	-07
Unit IV	Shorthand Principles	90-100	-11
Unit V	Machine Transcription	15- 20	-12
Unit VI	Office Equipment	20- 30	-03
Unit VII	Communications	15- 20	-04
Unit VIII	Transportation	2- 4	-10
Unit IX	Financial Activities	8- 10	-08
Unit X	Record Management	15- 20	-09
Unit XI	Sources of Information	3- 5	-05

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	shoulders is altered on both the low and high side of a banked section. (Ref. B, p. 251)
IV. Use of Superelevation Runoff	* Summarize this transition of superelevation on a simple curve and emphasize that there can be many solutions to the problem. (Ref. E, p. 11) * Add that many design offices use different apportionments of the runoff to fit certain field conditions but that in general most designs restrict 65 percent to 85 percent of the superelevation runoff to the tangent.
A. Spiral curve	* Draw figure 18 on the chalkboard and review the rudiments of a spiral curve. Note that the principal advantage of a spiral curve is that it provides a natural path for the vehicle. (Ref. B, pp. 172-174; Ref. C, section 22, pp. 13-14; Ref. E, pp. 12-14)

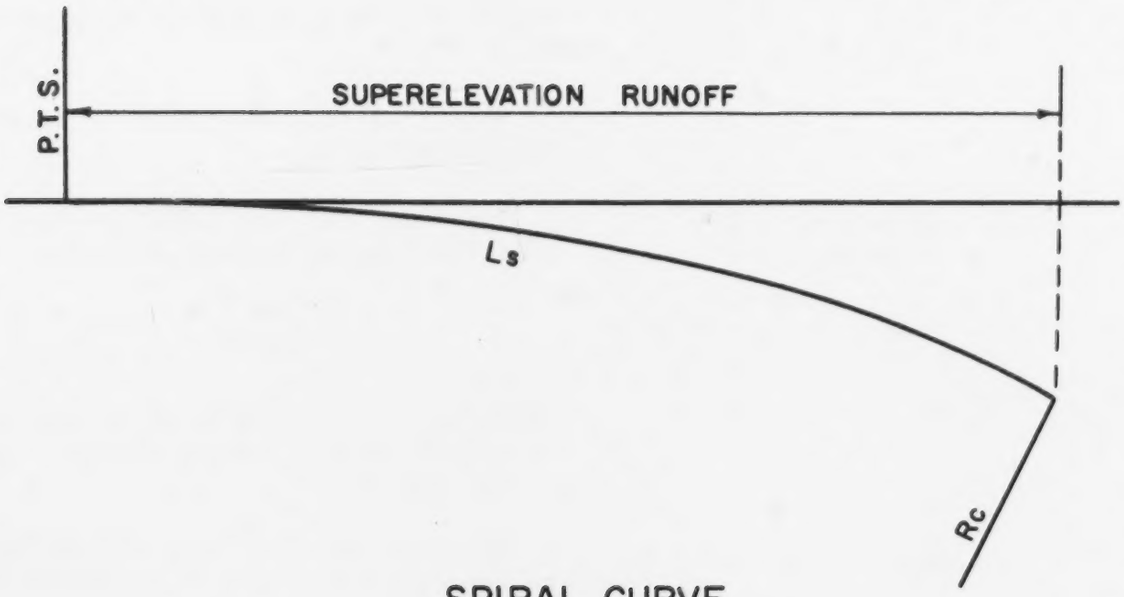

SPIRAL CURVE

FIGURE 18

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Length of spiral	* Explain that in any spiral curve, the length of spiral, which is the curvilinear transition between the tangent and the circular curve, is that distance dedicated to the superelevation runoff. * Emphasize that at the beginning of a spiral curve, a normal cross section (position #1) would rotate to position #2 (removal of crown) but point out that this would leave the left half of the pavement in a negative banked position while on the spiral. * Mention that this unorthodox position forces the driver to steer into the centerline in order to control his vehicle.
2. Tangent runout	* State that to rectify this condition, a tangent runout distance is utilized. This is a distance on the tangent directly before the point of tangency (P.T.) in which the pavement revolves from position #1 to position #2. * Note that this distance is always designated as X.
3. Equation of the tangent	* Indicate that the equation to compute the tangent runout distance X is: $X = \frac{L_s(N.C.S.)}{e}$ where L_s is the length of spiral as indicated on the e max. charts. (Ref. B, pp. 168-171) * Use the chart on page 169 of Ref. B to determine the length of spiral necessary for a given design speed at a given curvature using 0.08 as a maximum. * Add that these charts recommend the use of spiral curves only for cases below the heavy line.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
a. Application	* Find the necessary superelevation, where it begins and where it achieves full bank, for a rural, two-lane highway with 12-ft. lanes, for a 60-m.p.h. design speed on a 3°-curve. * Find the same information when a 180-ft. spiral curve is used.
1. e max.	* Point out that the maximum e for this problem is 0.067 in accordance with the 0.08 e max. chart and note that the longitudinal slope control at 60 m.p.h. is 1/225 or 0.45 percent.
2. Maximum change in elevation	* Indicate that the maximum change in cross slope is 0.021 ft. per foot plus 0.067 ft. per foot or 0.088 ft. per foot. * Add that this maximum change can be computed in actual difference of elevation: 0.021(12) + 0.067(12) = 1.056 ft. * Note that this change in elevation of 1.056 must occur in 238 ft. (1.056 ft. x 225). * Use 80 percent of this transitory distance on the tangent (238 x 0.8 = 190 ft.) and 20 percent on the curve (238 x 0.2 = 48 ft.).
3. Removal of adverse crown	* Indicate that the removal of the adverse crown occurs at a point measured by a direct proportion: $R.C. = \frac{0.021}{0.088} \times 238$ ft. = 57 ft. from the beginning of superelevation * State that the removal of the adverse crown occurs at a point 133 ft. (190-57 = 133) before the P.C.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
4. Pavement in plane slope	* State that the point where the entire pavement is a plane slope is: $\frac{0.042}{0.088} \times 237 = 114$ ft. * Point out that the plane slope position of the full pavement occurs 76 ft. before the P.C. (190 - 114 = 76)
5. Use of the spiral curve	* Compute the tangent runout X when a 180-ft. spiral curve is used. * Explain that there is now 180 ft. of spiral curve to handle the superelevation runoff. $X = \frac{L_s(N.C.S.)}{e}$ $= \frac{180(0.021)}{0.067}$ = 56 ft. * Indicate that the normal cross slope begins to change 56 ft. before the point of tangent to spiral (P.T.S.) and is completely removed at the P.T.S. * Note that the change from the removal of adverse crown to a full bank position will occur in the length of spiral or in 180 ft. * Emphasize that the full bank position occurs at that point where the spiral ends and the circular curve begins (the P.S.C.).

QUESTIONS FOR REVIEW

1. What is the e max. for a rural highway in New York State?
2. What is superelevation runoff?
3. Name three methods of attaining superelevation.
4. List the four steps in which a pavement reaches a superelevated position.

5. What is the superelevation of the right-hand lane on a tangent section of a two-lane highway?

6. What is the most widely used method of rotating a pavement for superelevation?

7. How does the transposition of the theoretical gradeline to an inside edge of pavement affect the profile of a highway?

8. Explain the problems which may result if a four-lane divided highway with a 20-ft. median were pivoted about the centerline of each pavement section.

9. Why would a four-lane divided highway be pivoted about the outside edges?

10. Describe the solution to the problem of superelevation in the vicinity of a tangent approaching a curve.

11. What is the maximum deviation between the longitudinal slope of the centerline profile and the pavement edge profile of a highway designed for 50 m.p.h.?

12. What is the relationship between a spiral curve and its tangent which makes it compatible for superelevation runoff?

13. Why is a tangent runout necessary on a spiral curve?

14. What is e for a 6°-curve at 70 m.p.h. when e max. is 0.08?

15. What is the e max. for an arterial highway in New York State?

ASSIGNMENTS

1. Study pages 151, 161-182 in Ref. A, and pages 183-192; 310-323; 332-358; 366-377 and 387-391 in Ref. B.

2. Find the placement of superelevation runoff with respect to the P.C. for a 5°-curve on a rural, two-lane highway with 10-ft. lanes and a design speed of 60 m.p.h.

3. Find the tangent runout if a spiral curve is used in #2.

Lesson 8 - Elem

OBJECTIVES

- To provide some of the
- To develop an understan horizontal alinement

CONTENT OUTLINE

I. General Horizontal Contr

†Reference citations are shown

ents of Horizontal Alinement

fundamental elements of horizontal alinement
ding of some of the general controls used in

TEACHING POINTS AND TECHNIQUES

ols * Indicate that a number of general horizontal controls are used to insure a safe, smooth flowing highway. (Ref. B, pp. 190-192)†

1. Make alinement as directional as possible but consistent with topography.

2. Avoid use of the maximum allowable curvature.

3. Hold alinement consistent and avoid any sudden changes.

4. Avoid short curves for small deflection angles. Use a minimum of 500 ft. (length of curve) for a central angle of 5°-curve with the minimum length increasing 100 ft. for each 1° decrease in central angle.

5. Avoid sharp curvature on high, long fills.

6. Avoid compound curves, but whenever one must be used, the radius of the flatter curve (R_L) should be no more than 50 percent greater than the radius of the sharper curve (R_S).

7. Avoid reverse curves and note that a reversal in alinement

on page 220.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

makes it difficult for a driver to remain in his own lane since proper superelevation is impossible.

8. Avoid broken-back curves by using a long, simple curve or by compounding the curvature.

9. Balance all horizontal alinement with vertical design.

II. Pavement Widening

* State that operating conditions on curves should be comparable to those on tangents. (Ref. A, p. 151; Ref. B, p. 183)

* Point out that on certain highways this is accomplished by widening the pavement on the curves so there is no difficulty in steering.

* Note that widening was the accepted practice when most pavements were narrow but with the advent of the 12-ft. lane, the need for widening has been restricted to the narrow highway of low classification.

A. Reasons for widening

* Emphasize that when a vehicle traverses a curve without superelevation, the rear axle is radial and the rear wheels track inside the front wheels.

* Point out that a vehicle traveling at excessive speed on a superelevated curve may also have the rear wheels outside the front wheels. This situation also creates a problem in steering if the pavement is too narrow.

* Note that this additional width of occupied pavement can be computed by geometry but when the pavement is superelevated it becomes difficult to determine the amount of this off-tracking.

B. Derivation of required widening

* Explain the equation used for the widening of pavements on curves. (Ref. B, p. 184)

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

Design Speed	Maximum Curvature
30 m.p.h.	21°
40 m.p.h.	14°
50 m.p.h.	10°
60 m.p.h.	6°
70 m.p.h.	3°

IV. Intersections

* Define an intersection as the area where two or more highways join or cross. (Ref. A, pp. 166-168; Ref. B, p. 308, pp. 387-391; Ref. C, section 22, p. 27)

* State that there are three types of intersections.

1. Intersections at grade
2. Grade separations without ramps
3. Interchanges

A. Design factors

* Mention that there are many possible designs for intersections and interchanges, all with advantages and limitations.

* Add that the coordination of traffic in certain topographical conditions poses a difficult problem for the designer.

* Emphasize that the primary factors in the choice of an intersection design are:

1. Volume of traffic
2. Composition of traffic
3. Highway design speed
4. Service to traffic
5. Physical condition of the area
6. Cost of right-of-way.

B. Intersections at grade

* Indicate that the geometric forms used for intersections include (Ref. A, p. 168; Ref. B, p. 388):

1. three-leg (T or Y)
2. four-leg
3. multileg
4. rotary

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Style of intersection	* Point out that any of these forms can be flared or channelized, or both.
a. Flared intersection	* Define a flared intersection as one where additional traffic lanes have been added.
	* State that the elimination of parking in the intersection area serves the same purpose as flaring.
b. Channelized intersection	* Show the difference between a channelized intersection and a flared intersection by noting the various channelizing devices used such as lane markings, separators, medians, and islands.
2. Forms of intersection	* Note that there can be an infinite number of intersection shapes and patterns but only the simple forms will be discussed.
a. Three-leg intersection	* Mention that the junction of three highways is called a branch, T, or Y intersection. (Ref. B, pp. 438-460)
(1) Branch	* Indicate that the branch is an offshoot of a major highway, usually at a small deflection angle.
(2) T	* Explain that the T is an intersection of two highways with one at, or nearly at, a right angle to the other.
(3) Y	* State that the Y intersection is one in which three highways meet at nearly equal angles.
b. Four-leg intersection	* Add that the four-leg intersection is the most common and consists of two highways crossing either at right angles or at some angle with each other. (Ref. B, pp. 461-475)
c. Multileg intersection	* Emphasize that the addition of another highway to the normal four-leg intersection creates a multileg intersection which presents many problems of traffic control. (Ref. B, pp. 476-477)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
d. Rotary intersection	* Point out the rotary intersection, or traffic circle is one in which all the traffic flows one way around a central island. (Ref. A, p. 171; Ref. B, pp. 478-491) * Mention that rotary intersections are often used to replace existing multileg intersections.
(1) Advantages	* State the advantages of the rotary intersection. 1. Traffic proceeds in an orderly manner with little delay. 2. Direct confrontation of traffic is eliminated. 3. Turning is easy. 4. The rotary is well suited for intersections with five or more legs. 5. The cost of construction is low compared with an interchange.
(2) Disadvantages	* Point out the disadvantages of the rotary. 1. Congestion begins on the rotary when two or more approach highways reach capacity at the same time. 2. A large amount of right-of-way is required. 3. The surrounding topography must be reasonably flat. 4. The rotary is not suitable for pedestrian movement. 5. Rotaries for high speed highways need to be large and this means extra driving for most vehicles.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	6. Many signs and ample lighting are required.
e. Traffic islands	* Define a traffic island as a triangular or elongated area between traffic lanes. (Ref. A, pp. 168-171; Ref. B, pp. 368-377)
(1) Purposes	* List the following purposes of the traffic island in intersection design: 1. Separation of conflicting traffic 2. Control of angle of conflict 3. Reduction in excessive pavement areas 4. Regulation of traffic 5. Channelization of certain movements 6. Protection for pedestrians 7. Protection and storage for crossing and turning vehicles 8. Location for traffic control devices 9. Area for loading and unloading public transit riders
(2) Types	* Indicate that all traffic islands are divided into three functional groups.
(a) Directional	* State that the directional island is designed to control and direct traffic movement in such a way that crossing streams of traffic cross at right angles and merging streams of traffic converge at flat angles.
(b) Divisional	* Explain that the divisional island divides opposing or same direction streams of traffic. It is useful in the control of turning traffic at skewed intersections.
(c) Refuge	* Describe the refuge island as a safety zone for pedestrians. A high barrier curb is considered essential for this type of island.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
d. T or trumpet interchange	* State that the trumpet interchange is known as a three-leg interchange and is especially adaptable to T intersections. * Compare this interchange with the others and note that it is directional since all turns are made in the direction of destination.
e. Y interchange	* Note that the Y interchange is comparable to the T and that it is also directional.
f. Directional interchange	* Indicate that the directional interchange has ramps for one or more left turning movements on directional alinement. * State that this interchange requires more than one bridge or one bridge with more than two levels.
g. Rotary interchange	* Point out that the rotary interchange is comparable to the rotary intersection at grade except that the major highway is separated from all other roadways. * Mention that other approach highways and diamond-patterned ramps are connected by the rotary. * Add that this interchange is excellent for a multileg intersection.
h. Advantages of the interchange	* Indicate the advantages of the interchange. 1. Traffic capacity is about the same within the interchange as it is outside the interchange. 2. There is an increase in safety for through traffic and left-turning traffic. 3. It is flexible in design and may be adapted to any topographical condition.

22609

UNIT I (14.0703-01)

OCCUPATIONAL ORIENTATION

Performance Objectives:

Upon completion of this unit the student will be able to describe orally the general purpose and organization of business. She will be able, as determined by instructor observation, to demonstrate good interpersonal relations with other class members and good organization of a work station.

The student will be able to demonstrate in a role playing, or other simulated situation, the proper dress and grooming for an office worker and correct techniques and good manners. She will be able to score 80% on an objective test covering the responsibilities of a stenographer.

Unit Outline:

A. Review of Modern Business Enterprise

1. Methods of organization

2. Purposes of business

B. Types of Offices and Opportunities for Office Workers

C. What Business Expects of Office Workers

1. General expectations

2. Appropriate attire

3. Posture and figure control

4. Complection and health

5. Personal hygiene

D. Office Techniques of Etiquette

1. Basic good manners

2. Application of social graces to office situations

3. Some special problems that occur

E. Interpersonal Relations

1. Role of motive and emotion

2. The office worker's role in business-human relations activities

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	4. It may be easily adapted to stage construction.
i. Disadvantages of the interchange	* Give the disadvantages of the interchange.
	1. Engineering, right-of-way, construction, and maintenance are costly.
	2. The unconditioned driver can become confused.
	3. Long approaches necessary in flat country are costly and reduce sight distance.
	4. The ordinary interchange cannot handle a multilege intersection.
V. Turns	* Point out that the principal control for the design of turning roadways is the alinement of the inner edge of pavement and the width of the roadway channel. (Ref. B, pp. 319-323)
	* Mention that this is necessary to provide accommodation for the design vehicle at low speed.
A. Design of turns	* Discuss minimum design for turns at an intersection. Explain plotting the paths of a design vehicle on each turn and fitting curves or combinations of curves to the paths of the inner rear wheels of the design vehicle.
	* Refer to table VII-1 in Ref. B, page 318, which is used in the design of any angled intersection and for all design vehicles.
1. Selection of vehicle design	* Indicate that after studying all the traffic information the choice of a design vehicle for criteria in designing an intersection is simply one of judgment.
	* Point out that it would be foolish to select a WB-50 as the design vehicle

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

$$\Delta = \frac{SD}{100}$$

* Multiply both terms by $\frac{1}{2}$ to get the deflection angle in terms of $\frac{\Delta}{2}$ and the expression becomes:

$$\frac{\Delta}{2} = \frac{SD}{200} \quad \text{also}$$

$$m = R \text{ vers } \frac{\Delta}{2}$$

Substituting $\frac{SD}{200}$ for $\frac{\Delta}{2}$ then

$$m = R \text{ vers } \frac{SD}{200} \quad \text{and}$$

$$R = \frac{5730}{D} \quad \text{then}$$

$$m = \frac{5730}{D} \quad \text{vers} \quad \frac{SD}{200}$$

* Emphasize that this formula does not apply when the length of the circular curve is less than the sight distance or when the radius of the curve is not constant.

* Add that since it is difficult to separate S from the equation (and often S may be desired when m is known) the following equation is used:

$$S = \frac{200}{D} \cos^{-1}\left(\frac{R - m}{R}\right)$$

B. Application

* Mention that in most instances a rough horizontal sight distance can be determined graphically from the plans but that if an accurate m distance is required, the equation must be used. (Ref. B, p. 150, figure III-3)

* Point out that the m distance may be measured graphically and the available stopping sight distance computed.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Emphasize that the stopping sight distance is directly related to the design speed.

* Find the distance from the centerline of the inside lane to an obstruction on a 5°-curve with a design speed of 60 m.p.h.

* Relate that a 5°-curve has a radius of 1146 ft. and that a design speed of 60 m.p.h. requires a stopping sight distance of 475 ft.

* Use the following equation:

$$m = R\left(1 - \cos \frac{SD}{200}\right)$$

$$= 1146\left(1 - \cos \frac{475(5)}{200}\right)$$

$$= 1146\ (1 - \cos 11.875°)$$

$$= 1146\ (1 - \cos 11° 53')$$

$$= 1146\ (1 - 0.97857)$$

$$= 1146\ (0.02143)$$

$$= 24.6 \text{ ft.}$$

* State that m of 24.6 ft., measured on a radial line, is the allowable distance from the centerline of the inside lane to any obstruction in order to preserve the sight distance of 475 ft.

* Mention that the radius of 1146 ft. is measured along the centerline of the highway but note that if it were decreased by the half-lane distance, the difference in m would be negligible.

* Determine if an m distance of 100 ft. is satisfactory for a 3°-curve with a design speed of 70 m.p.h.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

$$S = \frac{200}{D} \cos^{-1}\left(\frac{R-m}{R}\right)$$

$$= \frac{200}{3} \cos^{-1}\left(\frac{1910 - 100}{1910}\right)$$

$$= 66.7 \cos^{-1} (0.94764)$$

$$= 66.7 (18.6)$$

$$= 1240 \text{ ft.}$$

* Indicate that the stopping sight distance for a 70 m.p.h.-design speed is 600 ft.

* Solve the preceding problem when the m distance is 23 ft.

$$S = \frac{200}{3} \cos^{-1}\left(\frac{1910 - 23}{1910}\right)$$

$$= 66.7 \cos^{-1} (0.98796)$$

$$= 66.7 (8.9)$$

$$= 593 \text{ ft.}$$

* State that the 593 ft. of sight distance is not sufficient for a 70-m.p.h. design speed.

* Describe a situation with a cut slope on the inside of a curve and discuss with the class the computation of a minimum m distance which varies with the back slopes. (Ref. B, p. 189)

* Mention that one of the worst driving conditions occurs at night because the limited lateral spread of a headlight beam keeps the inside edge of the pavement from being visible for the required stopping sight distance. (Ref. B, section 22, p. 15)

* List the maximum curvatures for each design speed when using this criteria, noting that this is a 1960 specification.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
C. Grade separations	* State that a grade separation at an intersection of two highways permits the crossflow of traffic to proceed at different levels without interruption. (Ref. A, pp. 172-178; Ref. B, pp. 492-500)
1. Reasons for use	* Point out that the grade separation is used to facilitate the rapid movement of vehicles on high density traffic highways. Also that certain topographical features may demand this treatment.
2. Without ramps	* Mention that grade separation without ramps is used when a major highway crosses another major highway, a minor highway, or a railroad.
3. With ramps - interchanges	* State that there are seven types of interchanges. (Ref. A, p. 174; Ref. B, p. 494)
a. Cloverleaf	* Note that the cloverleaf has a full complement of ramps with a separate one-way ramp for each turning movement. (Ref. A, Fig. 5-26, p. 176) * Indicate that it is not possible to make a left-hand turn. Note that a driver who wants to turn left must pass road intersection and turn right for 270°
b. Partial cloverleaf	* Explain that the partial cloverleaf is a two-quadrant interchange without a full complement of ramps and where all movements are provided for but does allow left turns into the minor road.
c. Diamond interchange	* Mention that the diamond interchange is excellent for a limited right-of-way but does permit left or right turns into the minor highway. * Add that this is usually the least costly of all interchanges. It is also flexible since it can serve higher densities of traffic by merely increasing the number of lanes on the ramps and on the major highway.

22608

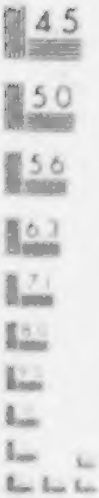

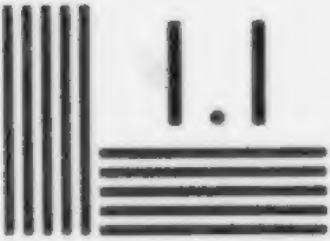

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Critical length of grade	* Emphasize that maximum grade in itself is not a complete design control since the length of grade can often slow up truck traffic enough to critically affect highway capacity. (Ref. B, pp. 195-203)
	* State that critical length of grade is the maximum length of an upgrade a loaded truck can operate on without an unreasonable reduction in speed.
	* Indicate that charts can be made which designate the critical length of grade for any condition of grade, approach grade , and speed.
	* Note that the general design guide has been established at a 15 m.p.h. reduction in speed for a grade.
a. Graph for design	* Explain how to use the graph, Critical Lengths of Grade for Design, in Ref. B, figure III-17, page 200.
	* Show that the critical length of grade is 1100 ft. for a 4-percent grade with a level approach at a design speed of 60 m.p.h.
	* Add that if the design speed is 40 m.p.h., the initial and minimum tolerable speeds on the grade are different, but for the same permissible speed reduction, the critical length of grade is still 1100 ft.
b. Vertical rise criteria	* Indicate that another design guide for the critical length of grade is the amount of vertical rise resulting from the 15 m.p.h. reduction in speed.
	* State that this total rise is 35 ft. for an 8-percent grade, 44 ft. for a 4-percent grade, and 55 ft. for a 2.5-percent grade.
c. Excess of critical grade	* Point out that when the critical length of grade is exceeded, an added uphill lane for slow moving vehicles must be considered.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
III. Vertical Curves	* Review the elements of the vertical curve as outlined in the unit on surveying.
A. Types	* Refer to the sketches in figure III-18 in Ref. B, page 202 and show that all vertical curves are divided into four types.
	* Note that type I covers the crest vertical curve which consists of an ascending grade followed by a descending grade.
	* Explain that type II is also a crest vertical curve but it can be an ascending grade followed by a flatter ascending grade or a descending grade followed by a sharper descending grade.
	* Mention that type III is a sag vertical curve consisting of a descending grade followed by an ascending curve and the opposite of type I.
	* Indicate that type IV is a sag vertical curve and is either a descending grade followed by a flatter descending grade or an ascending grade followed by a sharper ascending grade and the opposite of type II.
B. Design control	* State that considerations in the design of vertical curves are safety, comfort, appearance, simplicity in application, and adequacy of drainage. (Ref. A, pp. 152-153; Ref. B, pp. 203-209)
1. Safety	* Emphasize that the safety design factor on crest vertical curves is the minimum stopping sight distance.
2. Comfort	* Point out that comfort is important, especially in the sag vertical curve where gravitational and vertical centrifugal forces act in the same direction.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Appearance	* Note that appearance is important for psychological reasons.
	* State that long curves give a pleasing appearance but short curves give the profile a broken look.
4. Simplicity	* Reiterate that the vertical curve can be circular, parabolic, or cubic parabolic but that for ease in computing, designing, and constructing, the parabolic curve is used.
5. Drainage	* Mention that the drainage of curbed pavements on sag vertical curves is a difficult problem.
	* Add that the pavement cross slope can be increased and a drop inlet placed at the low point.
	* Indicate that three drop inlets should be placed in the gutter line, one at the low point and one on each side of this point but 0.2 ft. higher.
IV. Properties of the Vertical Curve	* Point out that highway length measurements are made on the horizontal plane rather than on the profile slope.
	* Note that since most highway grades are relatively flat, there is no practical error in using the parabola for a vertical curve.
A. Calculations	* State that the vertical offsets from the tangent vary with the square of the horizontal distance from the curve end (point of tangency).
	* Add that elevations along the curve are calculated simply as proportions of the vertical offset at the point of vertical intersection (P.V.I.).
B. Rate of change	* Describe the rate of change of grade to successive points on the curve as a constant amount for equal increments of horizontal distance.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	width for the three cases and also utilizes four types of design vehicles: P, SU, WB-40, and WB-50.
3. Pavement width by composition of traffic	* Add that table VII-7 in Ref. B, page 338 furnishes more detailed information about pavement widths for each of the three cases. Also it alters the pavement width in recognition of the composition of traffic.
	* Explain that three conditions of traffic are described (A, B, and C) and that although the predominant vehicle is the control, some consideration is given to other traffic.
a. Traffic condition A	* State that traffic condition A is predominantly P vehicles with some SU vehicles and this forces an increase in the minimum width given in table VII-6 in Ref. B, page 337.
b. Traffic condition B	* Note that in traffic condition B the SU vehicles govern the design but that also some consideration is given to semi-trailers.
c. Traffic condition C	* Point out that in traffic condition C semi-trailers (WB-40 and WB-50) govern the design.
4. Modifications due to pavement edge	* Emphasize the importance of the type of pavement edge and show with table VII-7 in Ref. B, page 338 that a barrier curb will require more width than a mountable curb.
VI. Speed-Change Lanes	* Indicate that a speed-change lane is an auxiliary lane, including tapered areas, primarily for the acceleration or deceleration of vehicles entering or leaving through traffic lanes. (Ref. B, pp. 341-358)
A. Purpose	* State that the primary purpose of the speed-change lane is to provide a physical assistance to the driver so that he can maneuver his vehicle into the necessary change between the speed of the highway and the speed of the ramp.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Uses	* Discuss the advantages and uses of speed-change lanes.
	* Mention the problems which occur on highways without extra lanes at intersections or at ramps.
C. Deceleration lanes	* Discuss the sketches shown in figure VII-13 in Ref. B, page 343 and note that there are three basic types of deceleration lanes.
1. Full lane width	* State that the full width deceleration lane gives the approaching driver a target so that he knows he may maneuver and decelerate on the full lane ahead.
	* Note that some pavement may be saved by beginning with a 6-ft. lane.
2. Tapered lane	* Point out that the tapered lane consists of an outside edge which angles from 4° to 5° with the inside edge.
	* Add that it becomes full width in approximately 140 ft. and show how this saves pavement.
	* Explain that contrasting pavements should be used to make tapering effective.
3. Direct path	* Indicate that the direct path method of designing a deceleration lane is preferred for major turning movements since the deceleration lane may be extended beyond the approach nose.
	* Note that the approach nose is that point where the added lane leaves the traveled way.
	* Mention that this design takes more space but that the distance from the approach nose may be proportioned to the speed differential between the highway and the ramp.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
D. Acceleration lanes	* Refer to the sketch in figure VII-13, Ref. B, page 343 and point out that there are two types of acceleration lanes.
1. Direct path	* State that the direct path acceleration lane is used for low volume highways. * Explain that the direct path acceleration lane consists of a full lane and a taper but note that most drivers never use much of the full lane.
2. Long taper	* Indicate that the long taper acceleration lane is preferred since as much of the speed-change lane as possible should be adjacent to the traveled way. * Mention that there should be no barrier at the far end of this taper.
E. Dimensions	* Emphasize that the dimensions of speed-change lanes are all based on design values and that the length, width, and taper are all computed.
1. Length (deceleration lane)	* Note that the length of the deceleration lane is based on three factors in combination. 1. The speed at which drivers maneuver into the auxiliary lane 2. The speed at which drivers turn after traversing the deceleration lane 3. The manner of decelerating
2. Length (acceleration lane)	* Add that the length of the acceleration lane is also based on three factors in combination. 1. The speed at which drivers merge with through traffic

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2. The speed at which drivers enter the acceleration lane 3. The manner of accelerating * State that table VII-10 in Ref. B, page 351 furnishes all the required information for the length of all speed-change lanes.
3. Width	* Mention that the width of a speed-change lane may be 11 or 12 ft. but 12 ft. is preferred. * Emphasize that although a full shoulder is not necessary on any speed-change lane, it is still advisable to use a partial shoulder with some stabilization.
4. Taper	* Point out that the length and shape of the taper should encourage drivers to use it. * State that table VII-9 in Ref. B, page 347 shows a listing of tapers used only in conjunction with designed full width speed-change lanes.

QUESTIONS FOR REVIEW

1. What is the minimum length of a horizontal curve when the central angle is 4°?
2. Is it possible to compound a 1°-curve with a 5°-curve and still remain within the bounds of good design?
3. What is the relationship between the rear and front wheels of a vehicle when the vehicle is rounding a curve?
4. When would it be advisable to widen a 24-ft. pavement?
5. How much of the widening transition should be on the tangent?
6. Why is the formula for the m factor in horizontal sight distance determined from the inside lane centerline?
7. Discuss the problem of nighttime sight distance when driving on a curve.

F. Personal Attributes

1. Punctuality

2. Physical health

3. Integrity

4. Leadership

5. Attitudes

G. Personal Efficiency in Identifying Responsibility, Planning and Organizing Work and Work Stations.

Supplemental Teaching Aids:

Excellent resource people for this unit are working secretaries, State Department of Vocational Education personnel, beauty school operators or department store buyers.

The best general resource book is the Arizona State Department of Vocational Education's Suggested Curriculum Guide in Vocational Office Procedures. A good resource for role playing is Case Problems: for Vocational Office Block Project. This is available from the Department of Vocational Education also. Other useful resource books are: You as a Secretary, Royal Typewriter Company. How to be a Super Secretary, Remington Rand, and Sheaffer's Handbook for Secretaries, W. A. Sheaffer Pen Co., Fort Madison, Iowa ($1).

Some very good films are applicable to this unit. For example; "Office Etiquette (15 min.), Britannica Press, Chicago, Ill., "Office Teamwork" (12 min.), Britannica Press, and "Off to a Beautiful Start", Scott Paper Co., Philadelphia, Pa.

Training Time 5-7 hours

8. Define an intersection and name three types of intersections.

9. What is a flared intersection?

10. Describe the three-leg intersection.

11. What are the advantages of a rotary intersection?

12. What are the disadvantages of a rotary intersection?

13. Give five uses of the traffic island.

14. Differentiate between the directional and divisional island.

15. Name seven types of interchanges.

16. Describe the traffic movements in a diamond interchange.

17. What is the greatest advantage of any interchange?

18. How is the width of a turning roadway classified?

19. Discuss how all types of vehicles are able to turn at an intersection designed for automobiles.

20. What is a speed-change lane?

ASSIGNMENT

1. Ask the students to make a simple sketch of three interchanges complete with traffic arrows.

2. Study pages 152-154 in Ref. A; pages 192-214, 438-460, and 476-499 in Ref. B.

INSTRUCTOR'S NOTES

22616

Lesson 9 - Vertical Alinement (Criteria and Controls)

OBJECTIVES

- To present the criteria used to select vertical alinement
- To provide a code for combining controls of horizontal and vertical alinement

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Criteria for Sight Distance	* Indicate that in Lesson 4 the mechanics of sight distance was discussed and point out that in this lesson sight distance as a control of vertical curvature will be analyzed.
A. Measurement of sight distance	* Note that sight distance along a highway is measured from the driver's eyes to an object when it first comes into view on the traveled way. (Ref. B, pp. 147-151)†
1. Height of eyes	* State that in 1965 the AASHO established 45 in. as the height of the driver's eyes above the road surface.
2. Height of object	* Mention that for the minimum stopping sight distance, the AASHO set 6 in. as the height of an object; for passing sight distance, the height was 54 in.
3. Department's criteria	* Add that the State Department of Transportation uses 44 in. as the height of the driver's eyes and 4 in. as the height of an object for the minimum stopping sight of distance.
B. Determination of sight distance	* Ask the students to study the profile of a highway section as shown in Ref. B, figure III-3, page 150. * Point out the stations, the centerline grade, the vertical curve, and the sight distance record below the profile.

†Reference citations are shown on page 220.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Plastic strip	* Exhibit a transparent plastic strip used to check sight distances graphically.
	* Describe the strip as being 4.5 ft. wide, with scratched lines 4 in. and 44 in. from the upper edge based on a vertical scale of 1 in. = 10 ft.
a. Use	* Place the 44-in. line on the station from which the sight distance is desired and pivot the strip about this point until the upper edge is tangent to the profile.
b. Measurement of stopping sight distance	* Note that the distance between the initial station and the station on the profile intersected by the 4-in. line is the stopping sight distance.
c. Measurement of passing sight distance	* Explain that the distance between the initial station and the station on the profile intersected by the lower edge of the strip is the passing sight distance.
2. Sight distance record	* Correlate the sight distances shown below the profile with the measurements made by the plastic strip.
3. Application	* Demonstrate the actual checking of a profile by using a sheet from a current contract plan.
	* Have each student check the sight distances from different stations and caution that the sight distances should be measured from both directions.
II. Grades	* Emphasize that highway design should give special consideration to proper grades and sight distances.
A. Effect of grades	* Mention that grades affect trucks more than passenger cars.
	* Note that trucks average about 6 m.p.h. less than cars and that truck speeds generally follow an erratic pattern. (Ref. B, pp. 192-194)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Upgrades	* State that studies indicate, for example, a truck entering a 6-percent grade at 47 m.p.h. will only be going 25 m.p.h. after a 1000 ft.
a. Weight-power ratio	* Point out that the weight-power ratio is 400 pounds per horsepower. * Explain that a ratio must be established so that a designer will recognize a critical grade.
2. Downgrades	* Mention the reason that trucks gain speed on downgrades of 5 percent or less but that they lose speed on downgrades of 7 percent or more.
B. Minimum grades	* Explain that a flat and level grade on uncurbed pavements is no problem if the pavement is adequately crowned. * Emphasize that the curbed pavement should not have less than a 0.5-percent grade except in such cases as a high type concrete pavement on excellent subgrade where 0.35 percent may be used.
C. Maximum grades	* State that the maximum grades now used have been determined by a number of studies made over the years. * Note that at the maximum design speed a 3-percent grade is considered maximum while at the minimum design speed, a 6-percent grade is maximum.
1. Warrant for grade increase	* Show that these maximums may be raised in accordance with general topographical conditions. (Ref. B, table III-13, p. 195) * Add that the maximum grades for the intermediate design speeds are fitted between these extremes. * Mention that for secondary roads or low volume rural roads the maximum grade may be increased by 2 percent. Grades under 500 ft. long or one-way downgrades may be 1 percent steeper.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	when such a tractor and trailer unit seldom uses the intersection.
2. Selection of turn	* Note that table VII-1 provides the minimum designs for a simple curve and also offers comparable results with a symmetrical and an asymmetrical three-centered compound curve. * Emphasize that much pavement can be saved by using the proper curve. * Discuss the sketches of curves shown in figure VII-1 to VII-4 in Ref. B, pages 310-314.
3. Increase in size of intersection	* State that to prevent the size of the intersection from becoming excessively large, it is wise to provide a corner island or some type of channelization. * Indicate that figure VII-6 in Ref. B, page 321 and table VII-2 in Ref. B, page 322 illustrate the use of a corner island.
B. Widths of turning roadways	* Explain that the widths of turning roadways are classified for three types of operation. (Ref. B, pp. 332-340) 1. One lane - one-way operation and no provision for passing 2. One lane - one-way operation with provision for passing a stalled vehicle 3. Two lane - either one-way or two-way operation
1. Derivation of pavement widths	* Note that figure VII-11 in Ref. B, page 333 illustrates the fundamental differences for the three cases by using a theoretical vehicle.
2. Pavement width for each design vehicle	* Emphasize that table VII-6 in Ref. B, page 337 shows the derived pavement

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Measurement of rate of change	* Mention that this rate of change is measured as the algebraic difference between intersecting tangent grades divided by the length of curve in feet or A/L in percent per foot.
2. Reciprocal of rate of change	* Indicate that the reciprocal, L/A, is the horizontal distance in feet which is necessary to effect a 1-percent change in gradient.
3. Measurement of curvature	* Point out that L/A is a measure of curvature termed K. * State that most tables use the factor K in assessing a given vertical curve.
V. Design Criteria	* Emphasize that when the minimum length of a crest vertical curve satisfies the minimum stopping sight distance requirements, it usually fits all other requirements.
A. Basic equations	* Write the two basic equations on the chalkboard and explain that both equations are solved, but only the appropriate one is used. (Ref. B, p. 204) 1. When S > L, $L = 2S - \frac{1398}{A}$ 2. When S < L, $L = \frac{A\,S^2}{1398}$ where L = length of the vertical curve in feet S = minimum stopping sight distance in feet A = algebraic difference in grade in percent
B. Application	* Find the stopping sight distance provided by a 500-ft. crest vertical curve when A is 5 percent. * Note that since L is known, solve for S. 1. First try S > L assuming that S is greater than L.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	$L = 2S - \frac{1398}{A}$ $2S = \frac{1398}{A} + L$ $= \frac{1398}{5} + 500$ $= 280 + 500$ $= 780$ ft. $S = 390$ ft. * Check the assumption of S > L or 390 > 500, which is not true, so this formula is null and void. 2. Now try S < L $L = \frac{AS^2}{1398}$ $S^2 = \frac{1398\ L}{A}$ $= \frac{1398\ (500)}{5}$ $= \sqrt{139{,}800}$ $= 374$ ft. * Check the assumption of S < L or 374 < 500, which is true, so the actual stopping sight distance for this design is 374 ft. * Find the length of a crest vertical curve when A is 5 percent with a 60-m.p.h. design speed. * Note that the minimum stopping sight distance for a 60-m.p.h. design speed is 475 ft. 1. First try S > L, where L is known and S is unknown.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

$$L = 2S - \frac{1398}{A}$$

$$= 2(475) - \frac{1398}{5}$$

$$= 950 - 280$$

$$= 670 \text{ ft.}$$

* Check the assumption of S > L or 475 > 670, which is not true, so this formula is void.

2. Now try S < L

$$L = \frac{AS^2}{1398}$$

$$= \frac{5(475)^2}{1398}$$

$$= \frac{5(225,625)}{1398}$$

$$= 807 \text{ ft.}$$

* Check the assumption of S < L or 475 < 807, which is true, so the actual design length of curve is 807 ft. (rounded off to 800 ft.)

1. Graphs

* Refer to figure III-19 on page 205 in Ref. B and check the problem just computed.

2. Use of K factor

* Note that table III-14 on page 206 in Ref. B computes the same problem by utilizing a rounded K factor.

* Point out that for a 60-m.p.h. design speed with a stopping sight distance of 475 ft. the K value is 160.

* Note that

$$K = \frac{L}{A}$$

or

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

$$L = (A)\ (K)$$

$$= (5)\ (160)$$

$$= 800 \text{ ft.}$$

C. Passing sight distance criteria

* State that it is impractical to use the passing sight distance criteria for the minimum length of curve since in this case the length of curve becomes too long.

* Discuss the information shown on page 207 in Ref. B which requires a 6700-ft. length of curve for the problem just completed. This table shows a K value of 1340.

$$L = (A)\ (K)$$

$$= (5)\ (1340)$$

$$= 6700 \text{ ft.}$$

VI. Design Criteria for the Sag Vertical Curve

* Indicate that at the present time there is no simple, widely used design criteria for computing lengths of sag vertical curves. (Ref. B, p. 208)

* Mention that at least four different criteria are recognized.

1. Headlight sight distance
2. Rider comfort
3. Drainage control
4. Rule of thumb for general appearance

A. Headlight sight distance criteria

* Emphasize that headlight sight distance is the control now being used in New York State.

* Explain that since the amount of highway lighted is directly dependent upon the position of the headlight (2.0 ft. above the ground) and upon the angle of divergence (1° upward), the following equations show the relationship of stopping sight distance, the length of curve, and the algebraic difference in grades.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

1. When S > L

$$L = 2S - \frac{400 + 3.5S}{A}$$

2. When S < L

$$L = \frac{AS^2}{400 + 3.5S}$$

* Note that for overall safety on highways, a sag vertical curve should be long enough so that the light beam distance is the same as the minimum stopping sight distance.

1. Application

* Find the length of curve for a sag vertical curve when A is 6 percent and the design speed is 60 m.p.h.

* Indicate that the minimum stopping sight distance for 60 m.p.h. is 475 ft.

1. First try S > L

$$L = 2A - \frac{400 + 3.5S}{A}$$

$$= (2)\ (475) - \frac{400 + 3.5(475)}{6}$$

$$= 950 - \frac{400 + 166.25}{6}$$

$$= 950 - 344$$

$$= 606 \text{ ft.}$$

* Check the assumption that S > L or 475 > 606, which is not true, so this formula is void.

2. Now try S < L

$$L = \frac{AS^2}{400 + 3.5S}$$

$$= \frac{(6)\ (475)^2}{2062.5}$$

$$= \frac{1,353,750}{2062.5}$$

$$= 656 \text{ ft.}$$

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Check the assumption that S < L or 475 < 656, which is true, so the design length of the sag vertical curve is 656 ft.
B. Comfort effect criteria	* Emphasize that on a sag vertical curve the comfort effect of change in a vertical direction is greater than on a crest vertical curve because gravitational and centrifugal forces are combining instead of opposing each other. * Mention that riding is comfortable on a sag vertical curve when the centripetal acceleration does not exceed 1 ft. per second per second.
1. Equation	* State that the following empirical equation is used to rate a sag vertical curve for comfort: $L = \frac{AV^2}{46.5}$ where L is the length of curve A is the algebraic difference in grades V is the design speed in m.p.h.
2. Derivation of factor	* Explain how the factor 46.5 is determined. * Mention that centripetal acceleration is equal to: $\frac{v^2}{R}$ where v is measured in feet per second R is measured in feet * Note that since the control is 1 foot per second per second then: $\frac{v^2}{R} = 1$ * State that the conversion of v (feet per second) to V (miles per hour) may be done by using a factor consist-

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

ing of the square of feet per second divided by the square of miles per hour. For example, using 44 ft. per sec., which equals 30 m.p.h., the formula becomes:

$$\frac{v^2}{R} = \frac{44^2V^2}{30^2R} = \frac{2.151V^2}{R}$$

* Add that since the control is 1 then:

$$1 = \frac{2.151V^2}{R} \quad \text{or}$$

$$R = 2.151V^2$$

* Indicate that since the parabola of the vertical curve practically coincides with the radius (R) of the circle then:

$$L = R\Delta = 2.151V^2\Delta$$

where Δ is the central angle in radians.

* Point out that $\Delta = \frac{A}{100}$

where A is the algebraic difference in grades of the sag vertical. Substitute $\frac{A}{100}$ for Δ in the equation $L = 2.151V^2\Delta$. A new expression for L is thus found:

$$L = \frac{2.151V^2A}{100}$$

$$= \frac{AV^2}{46.5}$$

3. Application

* Compute the length of a sag vertical curve for the same problem in which the headlight criteria was used.

$$L = \frac{AV^2}{46.5}$$

$$= \frac{(6)\ (60)^2}{46.5}$$

$$= 463 \text{ ft.}$$

* Note that this is almost as critical as is the headlight distance as far as length is concerned, but in

UNIT II (14.0703-02)

FUNDAMENTALS OF TYPING

Performance Objectives:

Upon completion of this unit the student will be able to type at a rate of 30 wpm/ecol.

Unit Outline:

A. Machine Fundamentals

1. Parts

2. Maintenance procedures

3. Manual and electric typewriters

4. Operation

B. Quality and Performance Standards

1. Speed and accuracy

2. Neatness

3. Language arts

C. Skill Development

1. Keyboard mastery

2. Manipulation of machine parts

3. Speed, accuracy and erasing

D. Typing Applications

Supplemental Teaching Aids:

No suggestions will be made for this unit since free or inexpensive resources are not applicable.

Training Time 70-85 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
VII. General Controls for Vertical Alinement	* Explain that certain general controls must be observed in the design of a gradeline. (Ref. B, pp. 209-211) 1. Use a smooth gradeline with gradual changes always consistent with the classification of the highway and with the character of the terrain. 2. Avoid the roller coaster or hidden dip type of profile. 3. The undulating gradeline involving substantial lengths of momentum grades should be carefully analyzed for their effect on traffic, and if possible avoided entirely. 4. Avoid the broken-back gradeline (two vertical curves in the same direction separated by a short section of tangent grade). 5. On long grades place the steepest grades at the bottom and lighten the grades near the top. An alternative would be to break the sustained grade with short sections of a lighter grade. 6. Reduce grade at the bottom of hills where an intersection occurs. 7. Use a high profile to simplify drainage.
VIII. Combination Horizontal and Vertical Controls	* Emphasize that horizontal and vertical alinements should not be designed independently since the two alinements complement each other. Poorly designed combinations can ruin the good points and aggravate the bad points of each. * Note that horizontal alinement and profile (line and grade) are the most

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

important elements of design. A good balance in their combination increases utility and safety, encourages uniform speed, and improves appearance, almost always without additional cost.

A. General design controls

* Point out that in general design it is usually assumed that the location of a highway is fixed. The only problem remaining is the specific design and harmonizing of the horizontal and vertical alinements. (Ref. B, pp. 212-214)

* State that physical controls acting alone or in combination, determine the type of alinement and include the following:

1. Character of highway justified by amount of traffic
2. Topography
3. Subsurface conditions
4. Existing highway and cultural development
5. Future developments
6. Location of highway terminals
7. Design speed as a check to hold all elements of design in balance

B. Combination controls

* Indicate that horizontal curvature and grades must be balanced and urge that tangent alinement should not be achieved at the expense of steep grades or excessive curves with flat grades.

* State that vertical curvature superimposed upon horizontal curvature gives results that are pleasing to the eye.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

* Mention that sharp horizontal curves should not be introduced at or near the top of a pronounced crest vertical curve since this can create a hazard at night. If this must be done, the horizontal curve should lead the vertical curve and the design should be above the minimum standards.

* Note that a sharp horizontal curve should not be introduced at the bottom of a sag vertical curve.

* Point out the importance of satisfying the passing sight distance requirements on a two-lane highway before attempting a combination of alinements.

* State that both vertical and horizontal alinements should be flattened at all intersections.

* Encourage the design of separate alinements on divided highways whenever possible.

QUESTIONS FOR REVIEW

1. What is the accepted height of eye and height of object when determining stopping sight distance?
2. What is the height of object when determining the passing sight distance?
3. Explain the procedure for checking sight distance graphically.
4. What is the minimum grade which can be tolerated on any pavement?
5. Define critical length of grade.
6. Name and describe four types of vertical curves.
7. What are the necessary controls for the design of a vertical curve?
8. How does a sag vertical curve affect the comfort of a driver?
9. What does A/L signify?

10. Explain what is meant by a measurement of curvature.
11. Explain the theory for the computation of the length of vertical curve with respect to the stopping sight distance.
12. Why is the minimum passing sight distance criteria never used in designating the length of a vertical curve?
13. List four criteria used for the design of a sag vertical curve.
14. Explain why the headlight sight distance criteria is the control used by most states in the design of a sag vertical curve.
15. What is the background for the comfort effect equation?
16. Describe four general controls for vertical curvature.
17. Name seven physical controls which determine the alinement of a proposed highway.
18. Why should a sag vertical curve be as long as the minimum stopping sight distance?

ASSIGNMENT

1. Study pages 244-254 and 259-298 in Ref. B.
2. Find the minimum stopping sight distance on a 1500-ft. crest vertical curve designed for 70 m.p.h. when A is 4 percent.
3. Find the length of crest vertical curve for a 50-m.p.h. design speed when A is 6 percent.
4. Find the length of sag vertical curve designed for 70 m.p.h. when A is equal to 5 percent. Use the headlight sight distance and comfort effect criteria.

INSTRUCTOR'S NOTES

Lesson 10 - Typical Sections and Standard Structure Sheets

OBJECTIVES

- To present the design work necessary to develop typical sections for a project
- To become acquainted with the numerous standard structure sheets used in modern highway design

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Typical Sections	* Define the typical section as a precise schematic diagram of a highway cross section at a particular point or between two particular points.
	* Mention that one typical section might suffice for an entire project but that as many as 40 have been required on a complex arterial highway to avoid the clutter of lines, notes, and figures.
	* Indicate that every possible condition should be shown so that the contractor will be able to construct exactly what was designed in its proper location but avoid using too many typical sections.
A. Variables	* Point out that in showing a cross section variable dimensions may be used to handle more than one situation.
	* Note that alternate factors which may sometimes occur over a given length of highway may also be shown. This is done to avoid making a typical section for every slight change because of topography.
B. Constants	* Emphasize that many items such as pavement and cross slope will remain constant for most of the project.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
C. Types of typical sections	* State that the typical sections which are shown in the plans will generally consist of five types. 1. Ordinary typical section for the normal portion of the highway 2. Ordinary typical section because of a designed change in the highway 3. Typical section in a rock cut 4. Typical section for intersections 5. Typical sections showing special items such as ditches, pipe underdrains, curbs, and/or gutters, widening sections, and superelevated treatments
D. Pavement changes	* Note that a change in pavement type always requires a different typical section.
II. Typical Highway Cross Section Sheets	* Show a copy of design data sheet 62-5 which consists of 41 sheets of typical highway cross sections approved by the New York State Department of Transportation. (Ref. J)†
A. Purpose	* Emphasize that the purpose of these data sheets is to standardize the use of typical highway cross sections.
B. Nomenclature	* Explain that AASHO structural definitions and terminology are used on typical sections for standardization.
C. Safety program	* Indicate that there have been many changes made for reasons of safety in the cross sections of designs in order to give a wide recovery area for a vehicle forced to leave the pavement.

†Reference citations are shown on page 220.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Add that this safety program has nullified most of sheet 2 and all of sheets 3-41.
	* Point out that in this lesson sheets 1 and 2 will be used together with sheets 3A and 9A, the latter two being revisions of sheets 3 and 9.
III. Structural Design Terms	* Distribute to each student a print of sheet 1 of D.D.S. 62-5, *Structural Design Terms and Legend.*
	* Note that this first sheet is a key to the other sheets in this series and that the code numbers on the sheet apply to every sheet in the series.
A. Categories of information	* State that the elements of a typical section are divided into two categories: those showing a mathematical relationship or dimension and those indicating the specific item of construction.
1. Dimensional elements (Group 1)	* Indicate that group 1 covers the dimensional elements.
a. Fill slope (No. 1)	* Point out that the legend indicates No. 1 as the fill slope.
	* Note that the slope is a 1 on 2 or a 1 on 4 but emphasize that in May 1967, a change was made which mandates at least a 1 on 5 (preferably a 1 on 6) slope from shoulder to ditch.
b. Original or existing ground (No. 2)	* Trace No. 2 which shows the original or existing ground, commonly called the O.S. (original surface).
	* Compare No. 2 on the left side (fill section) with No. 2 on the right side (cut section).
c. Ditch slope (No. 9)	* Note that this slope is shown as a 1 on 4 from shoulder to ditch but this also has been recently changed to a 1 on 5 (preferably a 1 on 6).

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
d. Cut slope (No. 10)	* Distinguish the cut slope from the ditch slope. Explain that this is the back slope and shown as a 1 on 2 slope.
e. Normal crown slope (No. 12)	* Recall that the normal crown slope is always measured in inches per foot.
f. Design thickness of pavement (No. 15)	* Emphasize that the design thickness is the total dimension for the pavement, whether it is all concrete, part concrete and part bituminous, or separate bituminous courses.
g. Shoulder slope (No. 16)	* Indicate the beginning and the ending of the shoulder slope and point out that the cross slope is now 1 in. per foot.
h. Travel lane (No. 17)	* State that the travel lane is always in the position shown so that a quick inspection will indicate the lane width immediately.
i. Shoulder width (No. 18)	* Note that the dimension line used for the lane width is extended to denote the width of shoulder.
j. Roadway (No. 19)	* Mention that the roadway is the distance covered by the shoulders and pavement.
k. Roadbed (No. 20)	* Point out that the roadbed is the distance between the intersection of the foundation course with the fill slope and/or the ditch slope.
l. Road section (No. 21)	* Define the road section as the portion of a highway included between the top of slope (in cut) and the bottom of the slope (in fill).
m. Theoretical grade line (No. 22)	* Emphasize the importance of the theoretical gradeline since it is the actual finished elevation of the pavement.
	* Demonstrate the simple computations for the elevation differences of all

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	structural end points from the theoretical gradeline and show how these are placed on the typical section.
2. Constructional elements (Group 2)	* Indicate that group 2 covers the constructional elements.
a. Embankment (No. 4)	* Note that the embankment is the roadbed material which fills the space necessary to carry the highway.
b. Shoulder surfacing (No. 5)	* Explain that No. 5 describes the thickness (4 in.) and type of material (bituminous mulch, soil cement color contrasted, or stabilized shoulder) of the shoulder surface.
c. Pavement subbase (No. 6)	* Point out that the pavement subbase indicates the thickness and the type of granular material to be used in the subbase.
d. Pavement base course or courses (No. 7)	* Note that the No. 7 shows a dual composition of pavement base courses.
	* Mention that the base for a bituminous pavement could be made with two base courses and for a bituminous surfaced concrete based pavement the concrete would be the base.
e. Pavement surface (No. 8)	* State that a bituminous pavement surface could consist of one layer but normally a binder course and a top course are used.
f. Shoulder base (No. 11)	* Indicate that the shoulder base is the same material used in the upper layer of the subbase under the pavement.
IV. Pavement Edge Treatment	* Distribute to each student a print of D.D.S 62-5 sheet 2 with details A, B, C, G and H marked superseded.
	* Explain that the treatment of pavement edges is relatively stable, as shown in the details on sheet 2.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Edge with shoulders	* Discuss the treatment given to a pavement edge with shoulders as shown in detail F.
	* State that some of the key numbers are familiar since they were discussed on sheet 1. Point out that three alternatives are shown. 1. Bituminous surface on a concrete base 2. Bituminous pavement 3. Concrete pavement
B. Asphalt concrete curb	* Explain that detail D shows an asphalt concrete curb (barrier type) with all the dimensions necessary for construction.
C. Cement concrete gutter	* Emphasize that detail E (cement concrete gutter) is an excellent example of dimensioning for a typical section.
	* Note that this detail also includes an underdrain which is shown in detail I.
V. Typical Cross Sections	* Add that the typical cross section has been severly altered because of the flattening of the slopes.
A. Dangerous fixed objects	* Mention that the dangerous fixed object (D.F.O.) program is responsible for this major change.
1. Objective of program	* State that the objective of this program is the complete elimination of any object (signs, poles, trees, guide rails) within 30 ft. of the pavement edge.
2. Research data	* Point out that research data indicates that a 30-ft. clear distance from the pavement edge provides a vehicle with an 85 to 90 percent chance for recovery if the slope is flattened to a 1 on 6.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
B. Two-lane highway	* Distribute to each student a copy of D.D.S. 62-5 3A (dated May 5, 1967). * Emphasize that this is the last official word in designing a typical section.
1. Legend	* State that the numbers used on this sheet are consistent with those described on sheet 1 (nomenclature sheet).
2. Dimensions	* Point out that the dimensions are lettered and listed in table A-1-2-3 under the different classifications of highways. * Use a class 5 (rural) for an example in explaining the values of each dimension.
a. Pavement width	* Explain that the pavement width is designated by the letter A and according to the chart is 12 ft. * Note that every highway now requires a 12-ft. pavement.
b. Shoulder width	* Show that the shoulder width is denoted by the letter B and is 12 ft.
c. Clear distance	* Indicate that the clear distance of 30 ft. begins at the pavement edge and ends at the back of the ditch. * Mention that the typical section on Sheet 3A shows the right side as a half section in earth cut or fill while the left side is a half section in rock.
d. Guide railing	* Show that guide railing is used if the section is in fill and if the slope changes from the flat 1 on 6 to a 1 on 2. * Recall that 2 ft. 3 in. is added to the 30-ft. clear distance whenever guide railing is used.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
e. Pavement cross slope	* Show that the pavement cross slope is marked H and is $\frac{1}{4}$ in. per foot for all classes.
f. Shoulder slope	* Point out that the shoulder slope marked by H (prime) is now 1 in. per foot for all classes.
g. Elevation drop from theoretical grade line	* State that No. 22 is the theoretical gradeline. Demonstrate that the drop in elevation from the gradeline to the outside edge of the shoulder is 12 ft. times $\frac{1}{4}$ in. per foot plus 12 ft. times 1 in. per foot or 15 in. which is indicated by the letter F in the cross section and in the table.
h. Depth of ditch	* Indicate that the depth of ditch is marked by G and that this is measured from the theoretical gradeline.
i. Slope distance	* Note that the slope distance is marked by C and is 14 ft. for class 5-R. This is measured from the outside edge of shoulder to the beginning of the ditch section. * Add that the difference in elevation between these two points is 4 ft. minus 1.25 ft. or 2.75 ft. and since C is 14 ft., the slope of C is approximately 1 on 6. * Show that for Class 7-R the shoulder is 10 ft. and the C distance is 16 ft. This results in a difference of 2.67 ft. between the ditch elevation and the outside edge of shoulder and is approximately a 1 on 6 slope. The typical section calls this a variable slope since the elevation of various points will change due to any superelevated sections.
j. Slope distance in earth fill	* State that the slope from the outside edge of shoulder to the ditch is a positive 1 on 6.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that at the 30-ft. clear distance, the slope may continue on a 1 on 6 or break into a 1 on 4, a 1 on 3, or a 1 on 2 depending on the topography.
k. Slope distance in earth cut	* Mention that again the slope is marked variable since the ditch section, which is begun 4 ft. before the end of the 30 ft. clear distance, alters the slope distance.
	* Emphasize that in an earth cut the back slope leaves the ditch section at a 1 on 4 slope for 10 ft. and then changes to a 1 on 2 slope to original ground.
3. Roundings	* Contrast the new method of rounding by using a vertical curve with the old method of using a horizontal curve.
a. Shoulders	* Point out that an 8-ft. vertical curve is used to round the breaking point of the outside edge of shoulder with the slope.
b. Ditches	* Show that ditches are rounded by using 4-ft. vertical curve.
c. Cut slopes	* Trace the change in cut slopes where a transition is made at the bottom of the ditch to a 1 on 4 slope (4-ft. vertical curve) and from a 1 on 4 slope to a 1 on 2 slope (8-ft. vertical curve).
	* Note that the top of a cut slope is rounded into the original ground with an 8-ft. vertical curve.
d. Slopes on fill	* Indicate that all toes of slopes in fill sections are rounded into the original ground with a 6-ft. vertical curve.
C. Four or six-lane divided highway	* Distribute to each student a copy of design data sheet 9A (dated May 5, 1967).

UNIT III (14.0703-07)

PRODUCTION TYPING

Performance Objectives:

Upon completion of this unit the student will be able to type straight copy at a rate of 40 wpm/ecol in five minutes. She will be able to produce double-spaced report copy of approximately 300 words, with no footnotes, from corrected draft and from hand written copy within 13 minutes. She will be able to produce a mailable business letter of approximately 150 words from corrected draft and from hand written copy within 11 minutes.

Unit Outline:

A. Skill Refinement and Development

1. Keyboard
2. Proofreading
3. Specific areas of improvement

B. Improvement of Production Typing Skills

1. Organization of secretarial work stations
2. Proofreading
3. Corrections
4. The most common typing jobs

C. Applied Production Practice

1. Correspondence
2. Simple statements
3. Tables (boxed and unboxed)
4. Telegrams
5. Cards and labels in quantity
6. Statistical materials
7. Programs, outlines, and similar business papers
8. Envelopes and circulars in quantity

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Compare this typical cross section with the two-lane section just covered.
1. Median under 36 ft. wide	* State that for a median less than 36 ft. wide, that 4-ft. shoulders are used with the cross slope extending at 1 in. per foot for two more feet before changing to a 1 on 6 slope.
	* Point out that important elements in this median are guide railing and a pipe underdrain in the center of the median.
2. Median over 36 ft. wide	* Mention that a median over 36 ft. wide requires no guide railing but it must have pipe under drains for each pavement edge.
D. Superelevated sections	* State that superelevated sections are shown in many different situations on the discarded design data sheets, but until new design data sheets are printed, each design office will have to design each particular section.
1. Shoulder cross slope	* Point out that for a superelevated section the shoulder is continued for 2 ft. on the same plane as the pavement on the high side before cross sloping with the shoulder.
	* Note that the shoulder cross slope begins immediately on the low side.
VI. Standard Structure Sheets	* Explain that the standard structure sheets have been developed by the New York State Department of Transportation in order to standardize certain features of design. (Ref. H)
A. Standardization	* Emphasize that standardization saves time and work whenever a particular item can be used on construction regardless of area, topography, or design class.
B. Method of updating	* Indicate that the standard sheets are a product of the research laboratory

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	of the State Department of Transportation and that the year of each updating is noted before the number of the sheet.
	* Give as an example sheet 67-1, *Cattle Pass, Guide Posts, R.O.W. Markers, Survey Marker.* Point out that this sheet was last revised in 1967.
	* Mention that the second number always remains the same unless another sheet is added.
	* Give as an example sheet 64-45, which was approved in 1964 as *Reticuline Type Grates and Frames.* Note that in 1964 sheet 64-45A was added and sheet 64-45 was retained. Add that in 1964 and 1965 sheets 45B and 45C were added so that at the present time there are four sheets on grates and frames.
C. Content of standard structure sheets	* State that the content of the standard structure sheets covers a wide range and that at present 106 sheets are available.
	* Give a sampling of the available material.
	1. Guide railing 2. Reinforcing for concrete pavement 3. Tools for concrete pavement construction 4. Reinforced concrete pipe 5. Longitudinal and transverse joint supports 6. Concrete cribbing and metal bin type walls 7. Pipe underdrain 8. Culvert backfill 9. Tree planting and guying 10. Sod gutter and strips 11. Railing

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	12. Fencing 13. Delineators 14. Standard closed box culverts 15. Standard bridge details 16. Signs, barricades and barriers

QUESTIONS FOR REVIEW

1. What is a typical section?
2. How is the typical section used in design?
3. How is the typical section used in construction?
4. Name four types of commonly used typical sections.
5. What is the purpose of the design data sheets?
6. Distinguish the ditch slope and the cut slope.
7. What two categories of information make up the typical section?
8. What is the major element of the dangerous fixed object program?
9. What is the usual depth of ditch on a rural highway?
10. Why was the shoulder cross slope changed from $\frac{3}{4}$ in. per foot to 1 in. per foot?
11. Under the newly established criteria when should guide railing be used in the median?
12. How do the standard structure sheets fit in with a design of a highway?
13. Name 10 items detailed on standard sheets.
14. How much distance is added to the 30-ft. clear distance whenever guide railing is used?
15. What is the shoulder treatment for a superelevated section?

ASSIGNMENT

1. Study pages 216-221 and 299-307 in Ref. B.

Lesson 11 - Geometric Auxiliaries

OBJECTIVES

- To understand the importance of geometric auxiliaries in highway design
- To furnish guides and policies relative to the geometric auxiliaries
- To introduce CO GO-90 as a problem-oriented computer language for solving problems on a digital computer

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Geometric Auxiliaries	* Explain that geometric auxiliaries are as important to highway design as the features already discussed. * Note that the previously covered design standards were based on mathematics where as geometric auxiliaries are based on experience. * State that the use of these additional features are usually prescribed by guides or policies furnished by the Department or by the AASHO.
II. Signing	* Emphasize that signing and marking are directly related to traffic volume, highway type, and the frequency of use by visiting drivers. (Ref. B, p. 220)† * Indicate that trunk highways are usually heavily traveled high type roads which have many signs to aid the visiting driver. * Mention that land service highways are lightly traveled low type roads with few signs because many of the drivers are repeat users.

†Reference citations are shown on page 220.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. Effective signing	* Point out that the physical layout of a highway must be supplemented by effective signing as a means of informing, warning, and controlling drivers. * State that the most important factor for aiding drivers is standardization.
1. Requirements	* Note that any traffic control device must meet the following five requirements (Ref. M, pp. 2-3): 1. Serve a specific need 2. Be easily seen 3. Convey information clearly and simply 4. Command respect of drivers 5. Located to give enough time for response
2. Basic considerations	* Outline the four considerations used to insure that the above requirements are met. 1. Design - size, construction, color, shape, composition, lighting, reflectorization 2. Placement - within the cone of vision of the driver before the situation it controls 3. Maintenance - retention of legibility, soundness of structure 4. Uniformity - aids constant recognition (the same interpretation everywhere), economy in manufacture, installation, and maintenance
B. Classification of signs	* Explain that there are three classifications of signs. (Ref. M, p. 10)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Regulatory signs - notice of traffic laws or regulations
	2. Warning signs - conditions in or adjacent to a highway
	3. Guide signs - route designations, destinations, directions, distances, points of interest
C. Design	* Emphasize that all shapes and colors are standard with only minor changes allowed in the layout of the legend. (Ref. M, pp. 11-12)
1. Shapes	* Point out that the sign shapes are universal in meaning.
	1. Octagon - stop sign
	2. Equilateral triangle (point down) - yield sign
	3. Round - railroad, civil defense evacuation route, state route, or Thruway trail blazer sign
	4. Diamond - hazard sign
	5. Rectangular (long dimension vertical) - regulating sign
	6. Rectangular (long dimension horizontal) - guide sign
	7. Shield - interstate or U.S. highway route sign
	8. Crossbuck - railroad crossing
2. Colors	* Outline the system of colors used in signs. (Ref. M, pp. 12-13)
	1. Regulatory signs, except the red stop sign and the yellow yield sign, are a black legend on a white background. If the sign is larger than 30 by 36 in., it may be black with a white background or vice versa.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

2. Warning signs have a black legend on a yellow background.

3. Guide signs may use white or black for the legend with white, black or green background.

D. Placement

* State that the lateral clearance of a sign is a minimum of 2 ft. from the face of the barrier curb to the near edge of the sign and 14 ft. from the edge of pavement to the near edge of the sign on shouldered highways if the sign posts are made of breakable material.

1. Longitudinal placement

* Note that the longitudinal placement varies with the average approach speeds as follows:

Average Approach Speeds	Advance Posting
Less than 25 m.p.h.	250 ft.
25 m.p.h. to 35 m.p.h.	300 ft.
35 m.p.h. to 45 m.p.h.	400 ft.
over 45 m.p.h.	500-750 ft.

2. Height

* Observe that signs in urban areas must be at least 7 ft. from the crown elevation to the bottom of the sign. In rural areas, they are at least 5 ft. from the crown elevation to the bottom of the sign.

* Emphasize that signs are mounted at right angles to traffic and face the traffic they serve.

III. Markings

* Explain that markings, like signs, control traffic. (Ref. B, p. 221)

* Point out that markings either supplement traffic signs or serve independently to indicate certain regulations or hazardous conditions.

A. Types

* Describe the two types of markings:

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Pavement markings - centerline stripes, lane lines, appropriate striping of no passing lanes on two and three-lane highways, and edge striping
	2. Object markings - painting of piers, abutments, poles, sign posts, guide rails, and curbs
1. Broken line	* Describe the broken line (4 to 6 in. wide) as consisting of 15-ft. line segments separated by 25-ft. gaps and that passing is permitted.
2. Solid line	* Note that the solid line is a warning that traffic should remain in its lane. It is not regulatory and cannot prohibit passing.
3. Barrier lines	* Describe the partial barrier line as consisting of parallel lines, one solid and one broken (for the passing of vehicles from the broken line side) and the full barrier type as consisting of two parallel solid lines which prohibit passing from either direction. * Point out that barrier lines are regulatory.
4. Edge marking	* Note that edge marking is being done on most heavy traffic volume highways.
B. Delineators	* Describe the delineator as a guide marker which is visible in all types of weather. It is composed of a reflector unit, or units, on a steel support which is visible under normal atmospheric conditions from a distance of 1000 ft. when illuminated by the upper beam of standard automobile headlights. (Ref. M, pp. 151-154)
1. Location	* State that these delineators are mounted on the right side of the highway and on the outside of curves. On all curves to the right they are mounted on both sides of the highway.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Types	* State that the one-unit white delineator is used along the right side or on both sides of the highway. The two-unit yellow, or amber, is used along interchange ramp connections, adjacent to acceleration and deceleration lanes and at small openings on divided highways. The three-unit yellow, or amber, is used at special hazard locations.
3. Height	* Mention that the mounting height is a minimum of 4 ft. above the pavement at a point 2 ft. from the edge of the shoulder or at a point 2 to 5 ft. from the face of the curb.
4. Spacing	* Indicate that the normal spacing on a tangent alinement is 200 ft. and on a curved section enough space to allow five delineators to be visible from the right lane. Tables are available for the placement of delineators on curves.
IV. Utilities	* Explain that in New York State private and public utilities are allowed to operate in the legal right-of-way of any State highway under the provisions of the Transportation Law which classifies utilities as common carriers. * Add that the location within this legal right-of-way is prescribed by the Department in a manner which best protects the design, construction, and maintenance interests of the highway.
A. Design	* Point out that the design process mandates relocating all utilities so that consideration may be given to their existing and ultimate location.
B. Municipal utilities	* Note that all municipal utilities are relocated by the State at no cost to the political entity. All private utilities are reimbursed for any relocations only when the utilities are

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	located on property to be appropriated. All other relocations are made at the owner's expense since the occupation of the right-of-way is by sufferance only.
C. Locations	* Emphasize that all pole lines and crossing poles or structures must be behind the ditch line, off the slopes, and as close to the right-of-way line as feasible but under no condition closer that 30 ft. from the pavement edge.
1. Subterranean	* State that waterlines, gas pipelines, or underground telephone conduits cannot be placed under the pavement or under the shoulders except crossings (at right angles to the pavement). If the crossing cannot be placed at right angles, it must be placed as close to a right angle as possible. * Mention that in cities or villages each case will have to be determined on its merits. In general, waterlines, sewers, telephone conduits, and gas pipelines should be placed behind the curb. Sidewalk areas are particularly well adapted for the use of underground facilities.
a. Sleeves	* Point out that a sleeve should be used for any underground conduit crossing under a pavement. This sleeve should extend beyond the out-to-out limits of shoulders but that in a controlled access highway, the sleeve must extend from right-of-way line to right-of-way line since no utilities are allowed on a controlled access highway.
2. Aerial	* State that the clearance from aerial powerlines (because of the summer sag) is usually no problem since the Public Service Commission regulations for the utility companies are much more severe than the Department's.

CONTENT OUTLINE	TEACHING POINTS AND SUGGESTIONS
a. Clearances	* Note that at the present time the Department requires a minimum of 18 ft. of clearance for voltages under 7500 and a minimum of 30 ft. of clearance for voltages over 7500. * Emphasize that all aerial crossings must be at right angles, or as close to right angles as possible. * Indicate that all poles must be a minimum of 30 ft. from the edge of pavement in rural areas and a minimum of 4 ft. from the face of a barrier curb in urban areas.
b. Median use	* Add that a median cannot be used for any utilities.
V. Lighting	* State that highway lighting is a relatively new field. It is used primarily on arterial highways and on rural highways in densely populated areas. Lighting is also used at interchange zones and at channelization areas of rural highways. (Ref. B, pp. 218-219)
A. Type	* Mention that color corrected mercury vapor lamps are generally used for traveled main lines and incandescent lamps may be used on ramps for the contrast effect. * Point out that the mercury vapor lamp, usually at 20,000 lumens, gives out a light made up of greens and blues so red is added (usually neon) to produce a natural effect and is called color corrected. * Indicate that the incandescent lamp, usually at 10,000 lumens, gives out a yellowish white light like the ordinary house-type lamp.
B. Definitions	* State that certain definitions are used in highway illumination work so

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	that design criteria can be established. (Ref. F, p. 2)
1. Luminaire	* Describe the luminaire as a device which directs, controls, and modifies the light source.
2. Candlepower	* Define candlepower as the amount of light that will illuminate a surface 1 ft. distant from the light source to an intensity of 1 ft.-candle.
3. Lumen	* Explain that the lumen is the amount of light which falls on 1-sq. ft. where every point is 1 ft. distant from a source of one candlepower. * Note that a 1 candlepower source of light emits 12.57 lumens.
4. Foot-candle	* Point out that the foot-candle is equal to a luminous intensity of one lumen per square foot. * Mention that all lighting design criteria is based on the average number of foot-candles required on the highway.
5. Uniformity of illumination	* Describe uniformity of illumination as a ratio of average illumination to minimum illumination at any point on the highway. This ratio should not exceed 3 to 1, for major highways and 6 to 1 for residential streets.
6. Lighting standard	* Explain that the lighting standard or pole is a support for the bracket arm and luminaire,and is equipped with the necessary internal attachment for wiring. * Note that the bracket arms are designed in 2, 4, 6, 8, 10, 12, 15 and 20-ft. lengths but caution that the 20-ft. arm must be doubly reinforced because the length tends to set it in motion.

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Supplemental Teaching Aids:

No suggestions are made for this unit since supplemental resources are not applicable.

Training Time 60-80 hours

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* State that all lighting standards are designed for a 150 m.p.h. wind
	* Indicate that the new types of lighting standards are constructed with a breakable base for safety and that any object within 30 ft. of the pavement edge must now have a breakable base.
	* Point out that a breakable structure is designed to yield when struck by a vehicle without inflicting serious injury upon the occupants.
	* Mention that only one type of light standard can be used on a project but consideration is given to the local utility company's preference since they will maintain the light standards for the community.
7. Mounting height	* State that the mounting height is the vertical distance between a roadway surface and the center of the luminaire.
	* Add that, at the present time, the mounting height is 30 ft. but it is believed that this height will be increased because a higher luminaire creates less glare and affords a better uniformity ratio.
8. Spacing	* Define spacing as the distance in feet between successive light standards and it is considered to be one-sided or staggered.
	* Mention that if opposite spacing is used, twice as much illumination is available.
9. Overhang	* Describe the overhang as the distance from the light standard to the pavement edge.
10. Coefficient of utilization	* Note that the coefficient of utilization is the ratio between the

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CONTENT OUTLINE

C. Spacing of luminaires

1. Equation for spacing

TEACHING POINTS AND TECHNIQUES

total light generated within the luminaire and the amount of light which actually falls on the area to be lighted.

* Emphasize that the spacing of luminaires is usually the required information for any design.

* Write the equation for spacing of luminaires on the chalkboard and explain the factors involved.

$$S = \frac{(MLL)(U)(LMF)}{(Avg.\ F)(W)}$$

where S = longitudinal spacing of luminaires

MLL = mean lamp lumens of the luminaire which is less than the rated value and is found on the manufacturer's rating sheet.

U = coefficient of utilization which must be secured from a graph for the particular type of luminaire being used. The graph uses the ratio of the effective width of pavement over the mounting height for the abscissa and the coefficient of utilization as the ordinate. (Ref. F, p. 11, figure 9)

LMF = luminaire maintenance factor is a manufacturer's figure (usually about 90 percent).

Avg. F = average foot-candles is the design criteria information specified by the design office.

W = width of roadway

CONTENT OUTLINE

2. Application

TEACHING POINTS AND TECHNIQUES

* Find the spacing required between luminaires in order to maintain an average illumination level of 1.5 foot-candles where the road width from curb to curb is 50 ft., mounting height is 30 ft., and the overhang is 4 ft. The luminaire is 400 watts, 24,000 initial lumens (20,200 mean lumens)—a type III distribution with a maintenance factor of 90 percent. (Ref. F, pp. 10-11)

* Point out that the coefficient of utilization must be found first for the area to be lighted from both the street side and from the house side.

$$\text{Ratio (street side)} = \frac{50 - 4}{30} = \frac{46}{30} = 1.53$$

$$\text{Ratio (house side)} = \frac{4}{30} = 0.13$$

* Distribute charts of the utilization curve for Illuminating Engineering Society (I.E.S.) type III distribution luminaires which are supplied by the major lamp manufacturers.

* Use the chart in figure 9, (Ref. F, p. 11) and show that 1.53 is located on the abscissa, that a vertical line intersects the street side curve, and that a horizontal line intersects the ordinate at 0.39.

* Duplicate this maneuver for 0.13 on the abscissa and find 0.04 on the ordinate.

* Indicate that the coefficients 0.39 and 0.04 become the total coefficient of utilization or 0.043.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Substitute in the equation: $S = \frac{(MLL)(U)(LMF)}{(Avg.\ F)(W)}$ $= \frac{(20,200)(0.43)(0.90)}{(1.5)(50)}$ = 104 ft. staggered spacing or 52 ft. opposite spacing
D. Design criteria	* Mention that in New York State our standards allow 1 foot-candle of light intensity on the main traveled lanes, which is increased by 15 percent when the surface is covered with bituminous material, and increased another 30 percent in an interchange area.
	* Explain that ramps require 0.8 foot-candles on concrete, increased by 15 percent for a bituminous surface.
1. Location	* Note that the locations of light standards are based first on safety (offset from the pavement edge) and second on light intensity.
a. Ramps	* Emphasize that for ramps on tangent alinement or on 1500-ft. radius curves luminaires may be placed on either side. If the curve is sharper than 1500 ft. and the lighting is placed on the outside of the curve, then the spacing must be 0.7 of the spacing required on the tangent. If the lighting is placed on the inside of the curve, the spacing must be 0.55 of the spacing required on the tangent.
	* State that when the luminaires are placed on the right side of the ramp in the direction of travel (with no curbs or with mountable curbs) there will be a 10-ft. minimum clear distance between the pavement edge and the face of the light standard base. If the luminaires are placed on the left side of the ramp (in the direction of travel), there will be

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	an 8-ft. minimum clear distance from the edge of the pavement and the face of the light standard base.
2. Traveled lanes	* Indicate that the minimum clear distance between the curb face and the face of the light standard base must be 4 ft. but that 6 ft. is more desirable. On pavement without curbs a 12-ft. minimum clear distance is required.
VI. Landscaping	* Emphasize that landscaping makes the highway look good and prevents erosion. (Ref. B, p. 216)
A. Erosion control	* Note that erosion is controlled to a considerable degree by the cross-section design, proper drainage, and appropriate landscaping. * Mention that erosion and maintenance are minimized largely by the use of: 1. Flat side slopes, rounded and blended with the terrain 2. Ditches and channels designed with due regard to width, depth, slopes, alinement, protective treatment and type of runoff 3. Interceptors located and spaced with erosion control in mind 4. Proper facilities for ground water interception 5. Dikes, berms, and other protective devices 6. Protective ground cover and plantings and light asphalt spraying to hold straw cover together while the grass is growing
B. Landscaping control	* State that in landscape design the following should be considered:

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	1. Removal of trees, the protection of trees left in the clearing, and grubbing procedure 2. Tree care, such as pruning, painting of tree wounds, tree feeding, and spraying 3. Selective thinning for highway construction through wooded areas 4. Use of herbicides 5. Seeding, sprigging, sodding of grass, and jute mesh 6. Fertilizing and mulching 7. Planting of suitable and pleasing trees and shrubs for erosion control, beauty, traffic guidance, and screening * Point out that screening assists in reducing headlight glare and sounds and also prevents snow drifting on highways.
C. Roadside parking areas and scenic overlooks	* Indicate that there is a trend of establishing roadside parking areas to let drivers rest and also scenic overlooks designed to beautify the area or to provide the opportunity to enjoy a view. * Note that areas are placed at intervals of 25 to 30 miles and are always accessible from the right-hand traffic lane. * Add that an island should separate the through traffic from the parking pavement and that acceleration and deceleration lanes should lead traffic in and out of the parking area.
1. Types	* Mention that two types of areas are used:

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. A safety turnout with trash cans and shade trees	
2. A more elaborate development with drinking water, fireplaces, toilet facilities, and telephones	
2. Size	* State that each area, regardless of type, should be about 800 ft. long and 100 to 400 ft. deep, exclusive of the approaching lanes.
VII. Right-of-Way	* Emphasize that the designation of an appropriate right-of-way for a given project is a design function.
	* Note that the standards chart specifies the amount of right-of-way necessary for each class of highway.
	* Point out that careful consideration is given to the acquisition of the right-of-way in an urban area.
A. Determination of taking lines	* Mention that the determination of the taking line begins with the placement of the toes and tops of slopes on the plan.
	* State that this information is taken from the cross-section sheets.
1. Grading line	* Designate that the line connecting the toes (circles for symbols) or tops (triangles for symbols) is the grading line and that at least 15 ft. more of right-of-way should be appropriated.
2. Exceptions	* Indicate that exceptions must be made when a property line is 10 ft. or 20 ft. away from the grading line.
B. Types of appropriation	* Relate that property on existing highways is appropriated either in fee (with or without the right of access), as a permanent easement, or as a temporary easement.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. Fee with the right of access	* Point out that a fee title with the right of access can be appropriated anywhere but positively must be used on an existing highway.
	* Note that this property now becomes lands of the State.
2. Fee without the right of access	* State that a fee title without right of access is usually taken when the highway is on a new location.
	* Emphasize that this is a condition where the right of abutting owners to access in connection with a highway is fully controlled by the State.
	* Describe a controlled access highway as one which may be fenced.
3. Permanent easement	* Indicate that the permanent easement is a perpetual privilege to the State while the original owner still possesses title.
	* Point out that these easements are used when work such as drainage, maintenance of slopes, grading, and maintenance of bridges is necessary.
4. Temporary easement	* Explain that a temporary easement is a short term loan of a piece of property (usually a period of time during construction) so that a certain type of work may be carried out. This easement is relinquished after the contract is executed.
VIII. CO GO	* Describe CO GO as a problem-oriented computer language and programing system for solving geometric problems in civil engineering on a digital computer. (Ref. N)
	* Emphasize that this program has become the most useful engineering data processing tool available in our department to date.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

1. Use for the *Start* command *Sample COGO Problem.*

2. Clear positions 1 to 999 of the X and Y coordinate tables.

3. Store the coordinates (Y = 5000, X = 2000) of point 51.

4. From point 51 locate point 22 at a distance of 2236.07 ft. and an azimuth of 116°34'00". Output and store the coordinates of point 22.

5. From point 22 locate point 14 at a distance of 2828.67 ft. and a bearing N 45°15'39" (NE = quadrant 1). Output and store the coordinates of point 14.

6. Include *Comment Point 14 on Main Street* in the output.

7. Backsight on point 22, turn an angle at point 51 to locate point 97 at a distance of 3605.09 ft. and an angle 82°27'00" (counterclockwise). Output and store the coordinates of point 97.

8. Inverse between points 97 and 14 and output the distance and bearing of the line between the points. Store the bearing in position 97 of the table of bearings.

9. Compute and output the clockwise angle at point 97 from point 14 to point 51 and store in position 97 of the table of angles.

10. Store the coordinates (Y = 8000, X = 6000) of point 6.

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

11. Locate point 42 by intersecting the line between points 51 and 6 with the line between points 14 and 97. Output and store the coordinates of point 42.

12. From point 51 in the direction of point 42 locate point 35 at a distance of 1156.21 ft. Output and store the coordinates of point 35.

13. Calculate and output the distance between points 51 and 42 and store this in position 20 of the table of saved distances.

14. Calculate, output, and store as point 342 in the coordinate table the intersection of the arc whose center is point 51 and whose radius is stored in position 20 of the table of saved distances with the line defined by points 14 and 22. Of the two possible answers (a line intersects a circle twice except at the point of tangency) the point to be used is the one closest to point 14.

15. Compute the area enclosed by the straight line sides formed by points 35, 42, 342, 22, and 35 and store in position 15 in the table of saved areas. Output the area in square feet and acres, and also output the distances, azimuths, and bearings for each side of the enclosed area.

16. Include *Comment Land Parcel Owned by J. Smith* in the output.

17. Calculate and output the area formed by the chord between points 42, 342, and the ard getween the same 2 points. The radius of the

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

arc is stored in position 20 of the table of save distances. Also calculate and output the chord length and arc length. Then add the calculated area to the area previously computed by the *Area* command and output the cumulative area with the segment included and store in position 16 of the table of saved areas.

6. Output

* Distribute prints of the output or answer to the sample problem (figure 21). (Ref. N, p. 13)

* Explain that with the output each input command is also reproduced.

* Note that the time of processing the problem and the cost is given at the bottom of the output sheet.

* Point out that the in-out time for this problem was 5.1 seconds and the cost was 15 cents.

7. Future use

* Indicate that at the present time 85 percent of the mathematical work in the design office is being done by computer.

* Emphasize that any use can be made of this program. An individual's ability and resourcefulness are the only limiting factors.

* Characterize the CO GO-90 as a device used to ease the communication barrier between the highway engineer and the computer.

QUESTIONS FOR REVIEW

1. What is the aim of signing?

2. Name four requirements of a traffic control device.

3. Describe a regulatory sign.

4. What does a solid yellow line on the centerline of a highway signify?

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
A. CO GO-90	* Explain the CO GO-90 as a language system by which an engineer, without programing experience, can translate a problem into the language of the IBM 1650 or the Burroughs B5500 digital computers.
B. Operation	* Point out that the digital computer can solve any problem which can be conceived and programed but that some difficulty is sometimes encountered in the mechanics of programing. * Note that the common, lengthy, error-prone type of problem can now be tramsmitted by telephonics directly to the computer center.
1. Typical problems	* Give examples of typical problems which can be solved: 1. Control, land, and right-of-way surveys 2. Highway and interchange design 3. Construction layout 4. Bridge geometry
2. Time element	* Mention that a program for a given problem can be written in minutes and the problem can be of any length since it is not limited by the size of the computer memory.
3. Cost	* State that the cost is relatively small because of the speed of the computer.
4. Programs	* Indicate that a new program is written for every problem and then discarded when the problem is solved. * Point out that the programs are written by using a series of commands which describe basic civil engineering operations such as alinement used to calculate the horizontal alinement of a curve.

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CONTENT OUTLINE

C. Sample problem

1. Sketch

TEACHING POINTS AND TECHNIQUES

* Use a sample problem to illustrate the structure of CO GO-90 commands. (Ref. N, pp. 6-14)

* Draw figure 19 on the chalkboard.

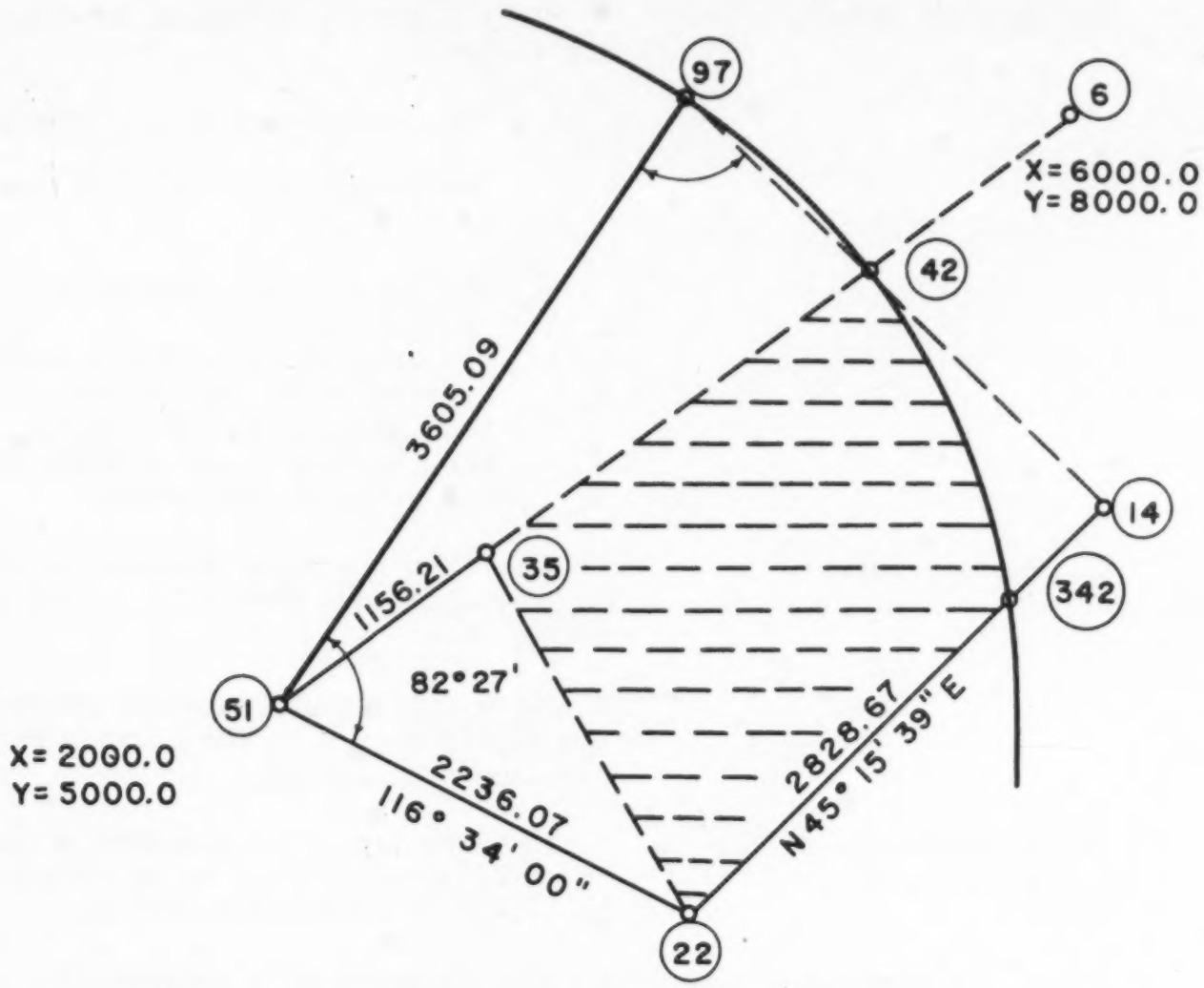

DIAGRAM OF SAMPLE COGO-90 PROBLEM

FIGURE 19

* Note that the known quantities are:

1. The coordinates of point 51 and 6
2. The length and azimuth of the line 51-22
3. The length and bearing of the line 22-14

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	4. The length of line 51-97 and the counterclockwise angle at 51 from 22 to 97
	5. The length of the line 51-35
2. Desired results	* State that the following results are desired:
	1. The coordinates of all points
	2. The length and bearing of the line 14-97
	3. The angle at 97 from 14-51
	4. The area of the parcel bounded by side 35-42, arc 42-342, side 342-22, and side 22-35 and the length and azimuth of the sides of the parcel
3. Input program	* Note that the input program is placed on a special form (EDP 98), called a coding form.
	* Distribute to each student prints of the coding form with the above problem programed (figure 20). Ref. N, p. 9)
4. Transmission of the programing	* Indicate that the transmission of the programing is done by an operator on a teletypewriter transmitter.
a. Transmission tape	* Show examples of a transmission tape which is punched out, checked, and transmitted.
b. Transmitter	* Exhibit pictures of the transmitter and point out its complexities but reiterate that it merely transmits the problems to the computer in Albany.
5. Instructions to the computer	* State that each line of the input is a command for the computer.
	* Have the students follow the commands for the sample problem on their copies of figure 20 which is found on the following page.

UNIT IV (14.0703-11)

SHORTHAND PRINCIPLES

Performance Objectives:

Upon completion of this unit the student will be able to: (1) transcribe, with at least 95% accuracy, familiar material dictated at 60 to 80 wpm for 3 minutes or at 50 to 70 wpm for 5 minutes. (2) transcribe with at least 95% accuracy, unfamiliar material dictated at a median rate of 60 wpm for 3 minutes.

Unit Outline:

A. Introduction to Shorthand

1. Abilities needed for development of shorthand skill.

2. The nature of shorthand

B. Reading and Construction of Shorthand Words and Abbreviations

1. Symbolic systems

2. Abbreviated alphabetic systems

C. Dictation

1. Familiar material practiced and previewed

2. Familiar material previewed

3. Unfamiliar material previewed

D. Spelling

E. Vocabulary

F. Punctuation

G. Pre-transcription Training

1. Oral transcription

2. Handwritten transcription

3. Typewritten transcription

Project Name:	Engineer:	Date	Page of
Route No:			IDENTIFICATION District No: EDP File No:

USAGE INSTRUCTIONS: Command Names Must Be Spelled Precisely As Given In the Manual. If the Command Name Is Left Blank, The Previous Command Is Used. Under No Circumstances Should Data Start Before C.C.21. The Remaining Space On The Line, After All The Data For The Particular Command Is Entered, Is Available For Comments. To Clarify Information Entered On The Form, Use Standards Shown Below.

STANDARD CHARACTERS O = ZERO Ø, Ō = ALPHA O 1 = ONE I = ALPHA I 2 = TWO Z = ALPHA Z

REMARKS or COMMENT MAY BE ENTERED STARTING IN COL. 11. COL. 1 MUST HAVE * OR COMMAND "COMMENT"

COGO COMMAND NAME (1–20)	DATA (AT LEAST ONE BLANK FOR SEPARATION BETWEEN EACH ENTRY. ZEROS MUST BE ENTERED) (21–70)	
START	SAMPLE COGO PROBLEM	
CLEAR	1 999	
STORE	51 5000.0 2000	
LOCATE/AZIMUTH	51 22 2236.07 116 34 00	
LOCATE/BEARING	22 14 2828.67 1 45 15 39	LOCATE PT 14
COMMENT	POINT 14 ON MAIN STREET	
LOCATE/ANGLE	22 51 97 3605.09 -82 27 0	
INVERSE/BEARING	97 14 97	
ANGLE	14 97 51 97	
STORE	6 8000 6000	
POINTS/INTERSECT	42 51 6 14 97	
LOCATE/LINE	51 42 35 1156.21	
DISTANCE	51 42 20	
ARC/LINE/POINTS	342 51 D20 14 22 14	
AREA/AZIMUTHS	35 42 342 22 35 15	
COMMENT	LAND PARCEL OWNED BY J. SMITH	
SEGMENT/PLUS	42 342 D20 16	
FINISH		

COGO - 90 CODING FORM

FIGURE 20

```
     SAMPLE COGO PROBLEM
12:26 PM   26 JAN 1967              PAGE   1

CLEAR                  1 999

STORE                  51 5000.0 2000

LOCATE/AZIMUTH         51 22 2236.07 116 34 00
POINT NUMBER   22      YCOORD =     3999.943    XCOORD =     3999.974

LOCATE/BEARING         22 14 2828.67 1 45 15 39        LOCATE PT 14
POINT NUMBER   14      YCOORD =     5990.988    XCOORD =     6009.230

COMMENT   POINT 14 ON MAIN STREET

LOCATE/ANGLE           22 51 97 3605.09 -82 27 0
POINT NUMBER   97      YCOORD =     7984.644    XCOORD =     4022.022

INVERSE/BEARING        97 14 97
FROM     97 TO     14 D.=  2814.899 AZ. =  135   5  34.1  BR.S  44  54  25.9  E
BEARING IS SAVED BEARING NUMBER   97

ANGLE                  14 97 51 97
ANG FORMED BY PTS      14 =   97 =   51 =    79   1  25.9SAVE ANG NO.   97

STORE                  6 8000 6000

POINTS/INTERSECT       42 51 6 14 97
POINT NUMBER   42      YCOORD =     7144.550    XCOORD =     4859.400
FROM     51 TO     42 D.=  3574.249 AZ. =   53   7  48.4  BR.N  53   7  48.4  E
FROM     14 TO     42 D.=  1628.746 AZ. =  315   5  34.1  BR.N  44  54  25.9  W
FROM      6 TO     42 D.=  1425.751 AZ. =  233   7  48.4  BR.S  53   7  48.4  W
FROM     97 TO     42 D.=  1186.153 AZ. =  135   5  34.1  BR.S  44  54  25.9  E

LOCATE/LINE            51 42 35 1156.21
POINT NUMBER   35      YCOORD =     5693.726    XCOORD =     2924.968
FROM     42 TO     35 D.=  2418.039 AZ. =  233   7  48.4  BR.S  53   7  48.4  W

DISTANCE               51 42 20
FROM     51 TO     42 D.=  3574.249 AZ. =   53   7  48.4  BR.N  53   7  48.4  E
LATITUDE =  2144.550   DEPARTURE =  2859.400
DISTANCE IS SAVED DISTANCE NUMBER 20

ARC/LINE/POINTS        342 51 D20 14 22 14
POINT NUMBER  342      YCOORD =     5521.977    XCOORD =     5535.930
FROM     14 TO    342 D.=   666.322 AZ. =  225  15  39.0  BR.S  45  15  39.0  W
FROM     51 TO    342 D.=  3574.249 AZ. =   81  36   9.3  BR.N  81  36   9.3  E
FROM     14 TO    342 D.=   666.322 AZ. =  225  15  39.0  BR.S  45  15  39.0  W
FROM     22 TO    342 D.=  2162.348 AZ. =   45  15  39.0  BR.N  45  15  39.0  E

AREA/AZIMUTHS          35 42 342 22 35 15
FROM     35 TO     42 D.=  2418.039 AZ. =   53   7  48.4  BR.N  53   7  48.4  E
FROM     42 TO    342 D.=  1757.963 AZ. =  157  21  58.8  BR.S  22  38   1.2  E
FROM    342 TO     22 D.=  2162.348 AZ. =  225  15  39.0  BR.S  45  15  39.0  W
FROM     22 TO     35 D.=  2006.125 AZ. =  327  35  51.5  BR.N  32  24   8.5  W
SAVED AREA NUMBER 15 IS   4179026.703 SQ. FT.   AND    95.9373 ACRES

COMMENT   LAND PARCEL OWNED BY J. SMITH

     SAMPLE COGO PROBLEM
12:26 PM   26 JAN 1967              PAGE   2

SEGMENT/PLUS           42 342 D20 16
CHORD =  1757.963 ARC LENGTH =  1776.183 SEGMENT AREA =  129042.494 SQ. FT.
CUMULATIVE AREA =   4308069.197 SQ. FT.   AND    98.8997 ACRES
SAVED AREA NUMBER 16

FINISH
PROCESS TIME =       2.2 SECS IN/OUT TIME =       5.1 SECS COST =  $   0.15
```

FIGURE 21

5. To what extent are utilities included in a highway design?

6. Where is the best location for subterranean utilities in an urban highway design?

7. What is the minimum edge distance from the pavement edge to the nearest utility structure?

8. What is a foot-candle?

9. Why can an aluminum light standard be tolerated with an edge distance of 12 ft.?

10. What is the coefficient of utilization?

11. How does proper landscaping prevent erosion?

12. Name five functions of landscaping control.

13. What single item basically controls the taking line of property for a new highway?

14. Differentiate between the four common types of property appropriations.

15. What is the function of the CO GO-90?

ASSIGNMENT

Study pages 312-331 in Ref. A.

INSTRUCTOR'S NOTES

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
F. End of second phase	* State that the work up to this point completes the second phase of design. * Add that the contract tracings are now begun.
V. Contract Sheets	* Note that the third phase begins with the completion of all the design data on the contract sheets. * Exhibit several contract sheets and explain that they contain all the design information necessary for construction of a given project. Use plans of a current design.
A. Orientation section	* Indicate that the orientation section contains data which identifies and locates the project.
1. Title sheet	* Point out the location map, which is a small scale map showing the geographic site of the work area. * Explain the use of the identification and signature blocks on the title sheet.
a. Official designation	* State that ample space must be furnished for the project title, names and numbers of the highways involved, a copy of the State map, and a list of the required standard sheets. * Add that these are placed on the title sheet by the main office along with the required signatures.
b. Traffic data	* Point out the block which indicates the projected traffic counts with a notation for the design hourly volume (DHV) and the average annual daily traffic (AADT) and the year into which it has been projected.
2. Index sheet	* Observe that a contract of any size should have an index sheet to simplify locating any particular sheet or detail.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
3. Table of maintenance and jurisdiction	* Explain the procedures for assigning jurisdiction of maintenance for certain portions of the highway such as abandoned sections, city portions, town portions, and highways on new alinement. * Emphasize that since this is a legal record, stationing should be very carefully computed and checked.
4. Item summary	* Mention that on any project it is advisable to have an item summary sheet, which shows each item with the actual or neat quantity and the proposed quantity in tabular form.
5. Scale plan and profile	* Indicate that the 200-ft. scale plan and profile is the next category of information in the contract plan and mention that this is used strictly as an aid for orientation.
B. Data section	* Advise the class that the data section contains the research background of the contract.
1. Typical sections	* Show that each typical section is placed in the contract plans in the order in which it is used. * Add that any general notes are also placed on the typical section sheets.
2. Tables and charts	* Describe briefly the system used in formulating the following listings: 1. Earthwork summary sheet 2. Unclassified excavation 3. Trench, culvert, and bridge excavation 4. Table of lengths 5. Bench marks 6. Guide railing 7. Pipe underdrain 8. Curbs 9. Drainage structures 10. Gutters 11. Grouted riprap 12. Driveways 13. Stone channel protection

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	14. Drop inlet and manhole locations 15. Intersections 16. Right-of-way monuments 17. Chain link fencing 18. Sign text data 19. Barricades 20. Design curve data with P.I. locations 21. Sidewalks 22. Utilities (waterlines, hydrants, water valves, valve boxes, etc.) 23. Superelevation chart or table * Distribute prints containing some of the listed items. These may come from different jobs and need not all be similar.
3. Special details	* Exhibit the sheets which cover detailed drawings of specials like drop inlets, manholes, ditching, berms, gutters, curbs, steps, medians, and soils apparatus
4. Special culverts	* Mention that the design of special culverts is shown on separate sheets which also includes the items and quantities to be used. * Note that the culverts are identified by a number, a centerline stationing, skew, type, and size. Channel inprovement profiles and details such as strutting of metal pipes are also included.
a. Concrete cribbing and bin-type retaining walls	* Indicate that a complete detailing of concrete cribbing and retaining walls is required for the foundation plans, elevations, and side views, and also a list of materials to be used.
5. Roadside development	* Point out the sheets which cover landscaping and developing of slopes, malls, parking areas, and islands with respect to applying topsoil, mulching, seeding, planting trees, and controlling erosion.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	to the base line for field use. The points of curvature (P.C.) and the points of tangency (P.T.) should also be tied in, at least for design records.
C. Equalities	* Note that the centerline is also properly equalized whenever it drifts far from the base line or whenever an existing stationing is to be continued.
	* Describe the operation of equalizing to the base line and mention that this procedure should be repeated only a limited number of times.
D. Records	* Mention that all centerline computations and checksheets are recorded and filed.
E. Profiles	* State that any hold controls such as railroad intersections, bridges, other highways, rock conditions, and potential drainage problems are marked for further investigation.
	* Point out that the grade line is now computed for verticle curvature. Also any equalities in elevation must be accounted for.
F. Contour maps	* Indicate that a large scale (usually 1 in. = 20 ft.) contour map is prepared for any area of a bridge site.
	* Note that all centerline information is shown on this topographic map and that it is given to the bridge section in the design office.
III. Cross-Section Design	* Review the process of plotting the survey level notes on cross-section paper and describe the method used in placing a template of the typical section on the cross-section sheet. (Ref. A, pp. 331-336)
	* Use a cross-section sheet with at least three stations.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Demonstrate how the template is placed on the cross-section sheet.
A. Ditches	* Point out that all ditches are shown on the cross sections.
B. Slopes	* Demonstrate how the toes and tops of slopes are located on the cross section and show how the information is plotted on the plan.
	* Designate the plotting of these points as the plotting of the grading line.
C. Drainage	* Note that the drainage is designed next and the drainage sheets drawn up.
	* Indicate that drainage design comprises culverts, lateral runoff pipes, underdrains, storm sewers, drop inlets, catch basins, manholes, headwalls, and endwalls.
D. Earthwork quantities	* Emphasize the importance of measuring the quantity of earthwork between stations and briefly describe the process.
IV. Layout Design	* Point out that at this stage the layout work of design begins with the location of the new right-of-way line.
A. Mapping of property	* Mention that the mapping and computing of the required appropriations of property is the next step.
B. Intersections	* Note that all intersections are designed individually with a workup detail sheet for each one.
C. Field inspections	* Emphasize that before more design work can be placed on paper, additional field inspections must be made to verify and supplement the original survey notes so that the design of drainage facilities, driveways, sidewalks, cattle passes, and utilities can be simplified.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
1. New information	* Indicate that any new information should be immediately fitted to the line and grade and to the templates of the typical sections. * State that most changes made at this time are usually minor.
D. Lateral cooperation	* Add that lateral cooperation with the other sections of the Department is most important at this stage. * Emphasize that prints of the alinement, complete with tops and toes of slopes, are furnished to the landscape architect, utility engineer, soils engineer, and to the resident maintenance engineer for study.
E. Details	* Explain that the work of detailing begins after the layout is completed but indicate that the following list of items is always a part of any design: 1. Items of construction 2. Earthwork details 3. Special drawings 4. Bench marks 5. Buildings 6. Table of lengths 7. Sight distance graphs 8. Superelevation tables 9. Item details * Many other items will be mentioned when the contract plans are discussed.
1. Items of construction	* Note that a list of all the items necessary for construction is now prepared with special attention given to nonstandard items.
2. Earthwork details	* Discuss the computation and compilation of the earthwork quantities and show that these figures will make up an earthwork summary sheet.
3. Special drawings	* Emphasize that special drawings must be made for any item which cannot be

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	found on the standard sheets such as curbs, sidewalks, gutters, manholes, drop inlets, or any appurtance which is considered to be a special item.
	* Add that when these special items can be altered to conform to the standard sheets, no detailing is necessary and the standard sheet is quoted by number.
4. Bench marks	* Indicate that a complete list of bench marks, in order of stationing, is prepared.
	* State that the contractor should be notified about any U.S.G.S. bench marks in the area.
5. Buildings	* Bring out the fact that a list of all the buildings to be demolished must be prepared for insertion in the plans and for use by the Lands and Claims Section of the Right-of-Way Department.
	* Point out that the buildings must be numbered and located by station offset.
6. Table of lengths	* Emphasize that every foot of new pavement must be accounted for in a Table of Lengths which is in tabular form and in geographical order.
7. Sight distance graphs	* Explain the necessity for checking the minimum passing sight distance and the minimum stopping sight distance so that the profile can be adjusted accordingly.
	* State that the graph information is now placed on the profile.
8. Superelevation tables	* Indicate that any superelevation tables necessary for construction should be made for inclusion in the plans.
9. Item details	* Note that all items are analyzed for quantity and this quantity, with the method of computation, is placed on the detail sheets.

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Lesson 12 - Sequence of Design (Second, Third, and Fourth Phases)

OBJECTIVES

- To introduce sequential steps necessary to prepare the second, third, and fourth phases of the design procedure
- To become acquainted with the procedures and methods of consolidating data.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Design Work	* Explain that the second phase begins with the actual design work which covers all of the operations and information required by the contract sheets.
A. Adjustments	* Note that any adjustments which may have been recommended are now incorporated in the design.
B. Working plans	* State that several prints are made of the 50-ft. (or 20-ft.) scale plan for use in the different design operations.
C. Typical section	* Mention that a detailed sketch of each typical section to be used in the project is drawn and the items to be used in construction are arrowed to the proper position.
II. Centerline Control	* Emphasize that the next step in the design is involved with the mathematical control of the centerline. (Ref. A, pp. 318 - 331)†
A. Orientation	* Add that the centerline is now mathematically tied both in direction and in length.
B. Ties	* Point out that all of the points of intersection (P.I.) are positively tied

†Reference citations are shown on page 220.

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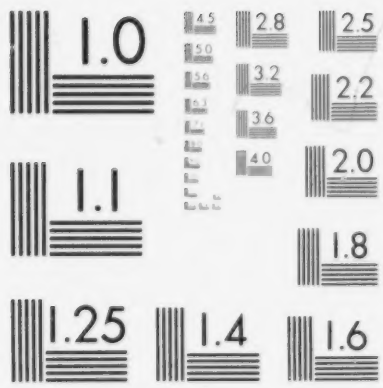

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

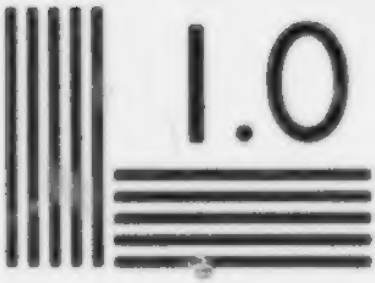

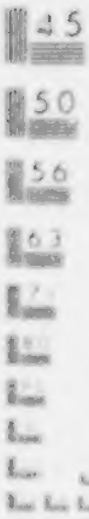

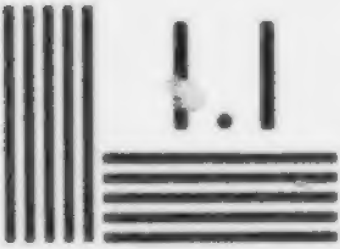

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
6. Delineators	* Note that the number and type of delineators required are identified by code on a line type diagram. * State that a layout plan in a schematic form is generally made using the 200-ft. scale.
7. Location plan for signs	* Display a location plan for signs and explain that the code is shown in the table of sign text data.
8. Traffic signalization	* Mention that the traffic signalization sheets consist of layout plans of intersections which show the locations, phase controls, pad locations, and design details of the traffic control equipment.
9. Lighting	* Explain that a set of layout design plan sheets are used for lighting plans. These sheets are merely skeletal drawings showing only the more important features such as lanes, sidewalks, curbs, intersections, centerline, base line, and a few identifying or orientating objects. * Note that a detailed sheet showing the design and specifications of light standards, pull boxes, conduit, and foundations precedes the layout sheets.
C. Design section	* Indicate that the next group of sheets contain the layout design of the new highway.
1. Plan	* Mention that the highway design is shown on either a 50-ft. or a 20-ft. scale plan together with its appropriately scaled profile. * Point out that the layout of the new design indicates all of the existing topography and all of the new elements to be constructed.
2. Drainage sheets	* State that if the layout is complex or crowded, it may be expedient to

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	follow each layout sheet with a sheet indicating drainage details only. * Add that the drainage sheet shows the drainage notes and diagrammatic legends. Point out the confusion which could occur if the drainage data and diagrams were superimposed on the design layout sheet.
3. Bridge design	* Note that any bridge to be constructed is a self-contained unit of separate sheets. This group of sheets is attached to the design plan for the highway (preferably at the end). * Point out that the bridge plans are tied in to the highway plans by centerline stationing and a skew angle.
4. Standard sheets	* Indicate that any standard work included in the contract is done according to its particular standard sheet. * Review that all the standard sheets used are listed on the title sheet and are automatically a part of the contract plans.
5. Large scale plans	* Emphasize that the large scale plans should be checked for the following information (Ref. G, pp. 11-1 to 11-5): 1. Scaling of stationing 2. Tie points, centerline distances, azimuths, and north points 3. Existing highway boundaries 4. Name and direction of creeks or rivers 5. Property lines, fences, corners, and monuments 6. Base line transit points and ties 7. Trees, buildings, sidewalks, driveways, utilities, culverts, and political subdivisions. 8. Names of property owners 9. Limits of work 10. Curve data and P.C. and P.T. locations

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	11. Equalities 12. Bench marks
6. Typical sections	* State that the typical sections should be checked for the following information: 1. Dimensions 2. Theoretical gradeline 3. Limits of use by stations 4. Variables with station control 5. Item titles and numbers 6. Cross slopes of the pavement, shoulders, and slopes
7. Profile	* Note that the 50-ft. (or 20-ft.) profile should be checked for the following information: 1. Scaling 2. Datum 3. Control points 4. Gradients 5. Vertical curve data 6. Invert and ditch end elevations 7. Gutter and ditch grades 8. Creek profiles 9. Profiles of intersecting highways
VI. Report on Design and Estimate	* Explain that the fourth and last phase of design is the report which is a collection of all the pertinent information relating to the design. This report will be examined in a later lesson.
A. Special notes and specifications	* Emphasize that all special notes and special specifications are written in a report-like description. Be careful of contradictions, ambiguities, and impossibilities.
B. Estimate	* Indicate that the next step is the preparation of the estimate with prices based on actual or neat quantity values.
1. Cost analysis	* State that a cost analysis is made of those items which are secured locally.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
C. Final check	* Note that in the final check, all tracings are oriented in the proper order and checked for other sheet references and match-line references on other sheets.

QUESTIONS FOR REVIEW

1. What is the first operation after line and grade have been approved?
2. Why is a template placed on every cross section?
3. Why is it necessary to make a field inspection before too much design work is completed?
4. Name four departments that require prints of the alinement of a new design as soon as the grading lines are established.
5. Why does the bridge section require a large scale contour map of a potential bridge site?
6. What is the table of maintenance and jurisdiction?
7. What is the purpose of a 200-ft. scale plan and profile?
8. Describe a roadside development sheet.
9. List 10 items which should be checked on the large scale contract plans.
10. What is the report on design and estimate?

ASSIGNMENT

Study pages 342-347 and pages 349-361 in Ref. A.

INSTRUCTOR'S NOTES

Lesson 13 - The Engineer's Estimate

OBJECTIVES

- To become acquainted with the procedures necessary to obtain data for an estimate
- To provide the nomenclature and mode of measurement for the typical items which appear in a design

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Preliminary Estimate	* State that the preliminary estimate is made to determine the approximate cost of a particular design of a proposed project.
A. Basis	* Note that since this estimate is based on incomplete information and on inconclusive evidence, the cost of each item should be amply assessed. (Ref. A, pp. 342-347)†
B. Source of information	* Add that all the available information is usually derived from a reconnaissance survey.
II. The Engineer's Estimate	* Define the engineer's estimate as an analysis of the estimated quantities of work which is used as a basis for financing the improvement and for comparison with the contractors bids.
A. Unit price contract	* Emphasize that the estimate is geared to a unit price contract and that the contractor is paid according to the unit price.
	* Observe that no matter how precisely the project is designed, there always

†Reference citations are shown on page 220.

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

1. Item 1 - clearing and grubbing (Ref. K, pp. 293-295)

2. Item 1W - furnishing water equipment (Ref. K, p. 296)

3. Item 6E - engineer's office (Type A, B, or C) (Ref. K, pp. 313-316)

4. Item 76 - maintenance and protection of traffic (Ref. K, pp. 482-489)

5. Item 77 - temporary structure and approaches (Ref. K, pp. 489-490)

6. Item 81 - dismantling and storing existing superstructures (Ref. K, p. 496)

7. Item 81A - removing existing superstructures (Ref. K, p. 497)

8. Item 81B - dismantling and removing existing superstructures (Ref. K, p. 497)

9. Item 87 - furnishing equipment for driving piles (Ref. K, pp. 521-522)

10. Item 88 - load tests for soils (Ref. K, p. 522)

11. Item 88P - load tests for piles (Ref. K, p. 522)

12. Item 114 - railroad protection (Ref. K, p. 561)

13. Item 116 - stakeout survey (usually at about 1 percent of the estimate) (Ref. K, pp. 563-565)

14. Item 120 - disposal of buildings (Ref. K, p. 567)

15. Item 120R - relocating buildings (Ref. K, pp. 569-571)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	are variables which the bidding does not reflect.
B. Detail sheets	* Distribute prints of a completed detail sheet and explain that this is a quantitative summation of each item in the contract and that this information is placed on the estimate sheet.
1. Order	* Note that each item to be used is listed in numerical order. If certain items are lettered, such as 14A, 14B, then the items are placed alphabetically within the number group.
2. Units	* Emphasize that each unit is measured in a certain manner and that payment for an item is based on this method of measurement.
3. Reference	* Indicate that each item is referenced by stations, by reference to another item, and by reference to a sheet of tables. Use the following examples: 1. Item 11-24, 200 ft. of round corrugated metal pipe, 24 in. diameter, 12 gage from station 10 + 62 to station 12 + 82 2. Item 13-20, cast iron pipe, 20-in. diameter, 72 ft. (Note 17U from table of Utilities) 3. Item 46, concrete foundation for pavement, 1000 square yards of pavement taken from the computation of Item 8, preparing fine grade. The amount of concrete required is 1000 square yards times 8 in. (thick) divided by 36 in. (sq. yds. to cu. yds.) or 222.2 cu. yds. but say 225 C.Y.
4. Rounding	* Emphasize that rounding of amounts for estimating is no longer used in the New York State Department of Transportation but that some other

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	departments and private consulting engineers still use rounding.
	* Explain that the actual or neat quantity which is required by the design is noted and then this neat figure is rounded in accordance with the amount of probable change which could occur in the item.
	* Mention that items which tend to be uncertain (such as earthwork) were often rounded from 15 to 25 percent. Positive items were rounded only from 2 to 5 percent.
a. Present method	* Point out that at the present time a neat quantity is computed and the figure is rounded to the next highest figure in order to simplify the mathematics in determining the cost.
	* State that almost all quantities (with exception of large single items like signs and light standards) have figures which end in 5 or zero.
(1) Advantages	* Indicate that the present method of handling quantities has been adopted for financial reasons.
	* Emphasize that as soon as a contract is let for bidding, the amount of the bid is set aside by the State Comptroller to pay the contractor when construction is finished.
	* Show that if an estimate were rounded excessively, the bid would be larger than necessary since it would involve money for quantities not really required, and despite the fact that the total sum is not used, it cannot be used elsewhere.
(2) Examples	* Note that if structural steel were computed to be 5,444,173 lbs. (neat), it would be listed in the plans as 5,445,000 lbs. (proposed).

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CONTENT OUTLINE	TEACHING ~~POINTS~~ AND TECHNIQUES
	* Add that if 1591 cu. yd. of concrete were computed, it would be shown as 1591 C.Y. (neat) and 1595 C.Y. (proposed).
III. Measurement of Items	* Explain that a definite measurement must be assigned to every standard item quoted in the specifications book and to any special item required for a particular function.
	* Emphasize that types of measurements are rigidly adhered to so that a comparative picture between two projects may be made regardless of the elapsed time between them.
	* Mention that a consistent pattern of measurements is helpful to the designer, the estimator, and the contractor.
	* State that since the cost of living rises approximately 5½ percent per year, it is of little value to distribute lists of past bid prices.
	* Point out, however, that whenever a certain item is discussed, its average price of the year before will be stated.
	* Note that this will make the item estimate more realistic and assure a better perspective of the design picture.
A. Items accounted for by a lump sum	* Define a lump sum item as one which includes the cost of furnishing all materials and/or labor and/or equipment necessary to complete the work.
	* Indicate that only one price is used, which is the estimated cost for the total execution of the item.
	* List and discuss the following standard items which are accounted for by a lump sum:

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

the maximum payment lines as shown on the plans. (Ref. K, p. 300)

7. Item 2UF - underdrain filter: paid for by the number of cubic yards measured in place between the maximum payment lines as shown on the plans. (Ref. K, pp. 300-301)

8. Item 3 - subbase course, granular material: paid for by the number of cubic yards of compacted material between the payment lines as shown on the plans (Ref. K, pp. 301-303)

9. Item 4 - subbase course, select granular material: paid for by the number of cubic yards of compacted material between the payment lines as shown on the plans (Ref. K, pp. 303-306)

10. Item 5 - trench, culvert, and bridge excavation: paid for by the number of cubic yards (measured in its original position) actually excavated from within the payment lines as indicated on the plans or called for by the specifications. If not detailed on the plans, the payments limits will be considered as:

    (a) The bottom width of the trench shall be in accordance with the details shown on the appropriate standard structure sheet.

    (b) The side surfaces of the trench; these surfaces shall have an inclination of 3 vertical to 1 horizontal.

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Supplemental Teaching Aids:

The following are useful in providing individual help for students: Complete Secretary's Handbook 2nd ed., Doris and Miller, Parker Publishing Co., West Nyack, N.Y., 1960. Timed Writings for Typing and Transcribing, Humphrey, Lambert, and Newhouse, McGraw-Hill, New York, 1966, Word Division Manual, J. E. Silverthorn, South-Western, Cincinnati, 1958.

How To Spell It is available free from Remington Rand Corp.

Training Time 90-100 hours

CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

(c) The subgrade of the roadway when under a cut section, otherwise the original surface at the site prior to the beginning of work. (Ref. K, pp. 306-307)

11. Item 18 - class 1 concrete for structures: paid for by the number of cubic yards, in the design volume, ignoring the volume occupied by the joint material, embedded metal reinforcement, structural shapes, tops of piles, or pipe with an end area of less than 1 sq. ft. (Ref. K. p. 343)

12. Item 20 - class B concrete for structures: paid for by the number of cubic yards in the design volume, ignoring the volume occupied by the joint material, embedded metal reinforcement, structural shapes, tops of piles, or pipe with an end area of less than 1 sq. ft. (Ref. K. p. 343)

13. Item 24A - bagged screened aggregate: paid for by the number of cubic yards measured in its final position within the payment lines as shown on the plans (Ref. K, pp. 353-354)

14. Item 45S - base course, bituminous macadam penetration method asphalt: paid for by the number of cubic yards of compacted material, measured in place, making no deduction for catchbasins and manholes (Ref. K, pp. 413-414)

* Note that in item 45S the bituminous material is always paid for under its respective item.

15. Item 46 - concrete foundation for pavement: paid for by the

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CONTENT OUTLINE

B. Items measured in cubic yards

TEACHING POINTS AND TECHNIQUES

* Emphasize that many items are measured in cubic yards, either in place or by the design volume.

* List and discuss the following as the items most commonly measured in cubic yards:

1. Item 2 - unclassified excavation

2. Item 2B - embankment in place: paid for by the number of cubic yards of material measured in its final compacted position placed within the payment limits as shown on the plans (Ref. K, p. 297)

* Note that in Item 2B the quantity of excavation is the number of cubic yards measured in its original position, excavated, and disposed of as required by the plans and specifications. (Ref. K, p. 297)

3. Item 2EC - selected borrow: paid for by the number of cubic yards measured in its original position, placed, and disposed of within the payment limits as shown on the plans (Ref. K, p. 298)

4. Item 2EC-B - selected fill: paid for by the number of cubic yards measured in place between the maximum payment lines as shown on the plans (Ref. K, p. 299)

5. Item 2EF-B - selected granular fill: paid for by the number of cubic yards measured in place between the maximum payment lines as shown on the plans (Ref. K, p. 299)

6. Item 2SP - granular fill, slope protection: paid for by the number of cubic yards measured in its final position between

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	number of cubic yards by design, making no deductions for catch-basins and manholes (Ref. K, p. 418)
	16. Item 47 - cement concrete pavement: paid for by the number of cubic yards by design, making no deductions for catchbasins and manholes (Ref. K, pp. 418-419)
	17. Item 78A - stone filling: paid for by the number of cubic yards measured in its final position (Ref. K, p. 490)
	18. Item 80 - dry riprap: paid for by the number of cubic yards measured in its final position (Ref. K, p. 495)
	19. Item 80A - grouted riprap: paid for by the number of cubic yards measured in its final position (Ref. K, pp. 495-496)
	20. Item 102 - catchbasins, field inlets, manholes, and drop inlets: paid for by the number of cubic yards used or if called for in the plans by linear foot of height (Ref. K, pp. 536-538)
	21. Item 121 - topsoil placed from stockpiles: paid for by the number of cubic yards of topsoil measured in place (Ref. K, pp. 577-578)
C. Items measured in linear feet	* State that all pipes (vitrified, concrete, reinforced concrete, metal, cast iron, porous concrete, wrought iron, corrugated metal, and perforated) used for sanitary sewers, storm sewers, underdrain, water conduits, cattle passes, and culverts are always measured in the actual linear feet of the laying length installed on the project.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* List the following as items measured in linear feet: 1. Item 7 - trimming road section: measured in linear feet of road (Ref. K, pp. 316-317) 2. Item 27 - transverse joint supports: measured in linear feet of joint used (Ref. K, pp. 335-356) 3. Item 37 - metal railing: measured in linear feet horizontally between the extreme outer limits of railing furnished and placed in accordance with the plans (Ref. K, p. 403) 4. Item 94 - stone curb: measured in linear feet according to the plans (Ref. K, pp. 525-528) 5. Item 95 - stone curb granite: measured in linear feet according to the plans (Ref. K, p. 528) 6. Item 97 - concrete curb: measured in linear feet according to the plans (Ref. K, pp. 529-530) 7. Item 106A - aluminum chain link fencing: measured in linear feet according to the plans (Ref. K, pp. 542-544) 8. Item 109 - relaying pipe: measured in linear feet of laying length (Ref. K, pp. 553-554) 9. Item 113 - highway-railroad barricade: measured in linear feet, completed in place, plus an allowance of 4 linear ft. for each terminal section (Ref. K, pp. 559-560)
D. Items accounted for by units	* Point out that many items are either complete units or are applied to a

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

series of small projects and are best paid for by a stated amount.

* List and briefly describe the following as items accounted for by units:

1. Item 6 - laboratory building (Ref. K, pp. 311-312)
2. Item 6B - concrete cylinder curing box (Ref. K, Addenda)
3. Item 11ES - galvanized metal end section (Ref. K, p. 329)
4. Item 11HW - galvanized metal headwall (Ref. K, p. 331)
5. Item 14ES - reinforced concrete pipe end section (Ref. K, p. 340)
6. Item 27L - longitudinal joint ties (Ref. K, p. 357)
7. Item 28B - stud shear connectors (Ref. K, p. 363)
8. Item 31 - pile shoes (Ref. K, p. 392)
9. Item 34 - guideposts (Ref. K, pp. 399-400)
10. Item 34R - resetting guideposts (Ref. K, p. 400)
11. Item 34S - removing and storing guideposts (Ref. K, p. 401)
12. Item 60D - drilling subsealing holes (Ref. K, p. 472)
13. Item 85A - splices for steel bearing piles (Ref. K, p. 512)
14. Item 88 - load tests for soils (Ref. K, p. 522)
15. Item 100 - leaching basins (Ref. K, p. 536)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	16. Item 104 - right-of-way markers (Ref. K, p. 539)
	17. Item 104X - permanent survey markers (Ref. K, p. 541)
	18. Item 106G - fence gates (Ref. K, pp. 544-545)
	19. Item 120 - reflectorized highway-railroad crossing signs (Ref. K, p. 567)
	20. Item 127 - planting (Ref. K, pp. 590-596)
	21. Item 128 - transplanting (Ref. K, p. 596)
	22. Item 129 - care of trees (Ref. K, pp. 597-598)
	23. Item 132 - tree removal (Ref. K, pp. 600-602)
	24. Items 251, 252, 253, 254 - road delineators (all types)(Ref. K, Addenda)
E. Items measured in square units	* Emphasize that the square yard, square foot, and acre are commonly used as units of measurement.
1. Square yards	* List the following as items measured in square yards and describe briefly any pertinent facts concerning them:
	1. Item 8 - preparing fine grade (Ref. K, pp. 317-318)
	2. Item 25 - metal reinforcement for concrete pavement (Ref. K, p. 354)
	3. Item 55B - surface course broken stone (Ref. K, pp. 436-437)
	4. Item 60C - color contrast for pavement (Ref. K, pp. 471-472)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	5. Item 62 - membrane waterproofing (Ref. K, pp. 474-476)
	6. Item 63 - protection course for membrane waterproofing (Ref. K, pp. 476-478)
	7. Item 79 - dry stone paving (Ref. K, p. 492)
	8. Item 79A - grouted stone paving (Ref. K, p. 493)
	9. Item 79B - dry concrete block paving (Ref. K, pp. 493-494)
	10. Item 89 - removing old bituminous carpet (Ref. K, p. 523)
	11. Item 90Y - cleaning existing pavement (Ref. K., pp. 523-524)
	12. Item 98 - concrete gutters (in square yards of exposed surface) (Ref. K, p. 534)
	13. Item 117 - surface dusting with fine aggregate (Ref. K, p. 565)
	14. Item 118 - concrete riprap in bags (Ref. K, pp. 565-566)
	15. Item 124 - sodding (Ref. K, pp. 583-586)
2. Square feet	* Describe the following as some items which are measured in square feet:
	1. Item 30B - open steel floor (Ref. K, p. 390)
	2. Item 30C - frames and grates: castings (Ref. K, pp. 390-391)
	3. Item 30F - frames and grates; fabricated (Ref. K, pp. 391-392)
	4. Item 83C - corrugated metal piling (Ref. K, pp. 499-500)

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	5. Item 83S - steel sheet piling (Ref. K, pp. 499-500)
	6. Item 83T - timber sheet piling (Ref. K, pp. 499-500)
	7. Item 110 - concrete cribbing (Ref. K, p. 554)
	8. Item 110M - metal bin type retaining wall (Ref. K, pp. 555-563)
	9. Item 111 - pneumatically projected concrete (Ref. K, pp 557-559)
	10. Item 115 - bridge bearing pads (Ref. K, pp. 562-563)
3. Acres	* Give the following as examples of items which are measured in acres:
	1. Item 123 - seeding (Ref. K, pp. 579-582)
	2. Item 126 - mulching (Ref. K, pp. 589-590)
	3. Item 131 - selective thinning (Ref. K, pp. 599-600)
F. Items measured by weight	* Indicate that many measurements are made by either pounds, tons, or barrels. Mention that whenever a unit is used in the estimate, it is always used in the singular.
1. Pounds	* List the following as items which are measured in the pound unit:
	1. Item 28 - bar reinforcement for structures (Ref. K, pp. 359-361)
	2. Item 28A - spiral bar shear connectors (Ref. K, p. 362)
	3. Item 29 - structural steel (Ref. K, pp. 364-388)
	4. Item 30 - miscellaneous metals (Ref. K, p. 388)

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
2. Tons	* Mention those items which are measured in the ton unit. 1. Item 16 - furnishing and applying calcium chloride (Ref. K, p. 343) 2. Item 42 - base course: granular material (Ref. K, pp. 408-409) 3. Item 43 - base course: screened gravel (Ref. K, pp. 410-413) 4. Item 44 - base course: broken slag (Ref. K, pp. 410-413) 5. Item 45 - base course: broken stone (Ref. K, pp. 410-413) 6. Item 45SX - base course: asphalt concrete, type 1A (Ref. K, p. 415) 7. Item 51 - asphalt concrete (all types) (Ref. K, p. 421) 8. Item 122 - applying soil conditioners (Ref. K, p. 578)
3. Barrels	* Point out that cement items are always measured in barrels. A barrel of portland cement contains 376 lbs. (Ref. K, p. 342) 1. Item 15-1 - portland cement, type 1 Item 15-1A - portland cement, type 1A Item 15-2 - portland cement, type 2 Item 15-2A - portland cement, type 2A Item 15-6 - portland cement, type 6 Item 15-6A - portland cement, type 6A

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2. Item 15N - natural cement, type N (Ref. K, p. 342)
	* Emphasize that natural cement is also measured by the barrel which contains only 320 lbs.
G. Items measured in gallons	* State that oils and liquid items are measured in gallons.
	1. Item 1WA - applying water: measured in M. gal. or thousand gallon units (Ref. K, p. 296)
	2. Item 1WP - watering plants: measured in M. gal. or thousand gallon units (Ref. K, p. 296)
	3. Item 60 - treatment with bituminous material (Ref. K, p. 469)
	4. Item 61 - bituminous material (Ref. K, p. 473)
	5. Item 351 - joint sealing compound (Ref. K, Addenda)
	6. Item 352 - rubber joint material (Ref. K, Addenda)
	7. Item 361 - protective coating for concrete (Ref. K, Addenda)
	8. Item 363 - epoxy protective coating for concrete (Ref. K, Addenda)
H. Items accounted for by specific units	* Describe the following as items which are measured in specific units or in accordance with changeable field conditions.
	1. Item 82 - cofferdams: quantity is the number of square feet, found by multiplying the distance from the elevation of the base of the permanent structure to an elevation 2 ft. higher than the highest water elevation

22700

UNIT V (14.0703-12)

MACHINE TRANSCRIPTION

Performance Objectives:

Upon completion of this unit the student will be able to produce mailable copy with the second draft. She will be able to demonstrate, to the instructor's satisfaction, her planning for and preparation of a variety of materials such as manuscripts, articles, business forms, and long letters.

Unit Outline:

A. Kinds of Machines

1. Belt

2. Disc

3. Tape

B. Concepts of Effective Use of Machines

1. Corrections and special instructions

2. Use of indication slip

3. Understanding the meaning of dictation

4. Development of a pattern

5. Errors in syllabication

6. Proofreading

C. Operation

Supplemental Teaching Aids:

All of the general reference books listed for the preceding units contain material pertaining to this unit. The only book that might be added specifically for this unit is Words 5th ed., by Crank, Crank, and Connelly, McGraw-Hill, New York, 1962.

Training Time 15-20

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CONTENT OUTLINE

TEACHING POINTS AND TECHNIQUES

recorded at the site (while the cofferdam is being used) by the measured length of the cofferdam. (Ref. K, pp. 498-499)

2. Item 84TC - creosoted timber piles (Ref. K, pp. 503-504)

   Item 84CP - precast concrete test piles (Ref. K, pp. 504-505)

   Item 84SB - steel bearing test piles (Ref. K, pp. 504-505)

   Item 84T - untreated timber piles (Ref. K, pp. 505-510)

   Item 84TU - untreated timber test piles (Ref. K, pp. 504-515)

   Item 85C - cast-in-place concrete piles (Ref. K, pp. 512-516)

   Item 85T - tubular cast-in-place concrete piles (Ref. K, pp. 516-518)

* Note that all the items in "2" are measured by the number of linear feet of pile remaining in the finished structure.

3. Item 86C - precast concrete piles: measured by the number of linear feet of pile placed in the leads in accordance with the ordered length (Ref. K, pp. 518-521)

4. Item 107 - timber and lumber

   Item 107S - stress graded timber and lumber

   Item 108 - treated timber and lumber

* State that all the items in "4" are measured by the number of thousand

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	feet (board measure) placed in the completed work. (Ref. K, pp. 550-553) 5. Item 132 - tree removal: all trees shall be measured before being cut and a unit price set for each (Ref. K, pp. 600-602) * Point out that all trees are measured 4½ ft. above the ground and referred to as diameter breast high or D.B.H.
IV. Special Items	* Explain that there are many items created for a particular situation. These items must be described and are incorporated in the Report on Design and Estimate covered in the next lesson.
A. Units of measurement	* Note that most of the special items (any arbitrary number may be assigned) are each or linear foot measurements. * Describe the following as some of the perennial items which have specific units: 1. Stone channel protection in cubic yards 2. Temporary lighting by lump sum 3. Uniformed watchman service by man days
B. Fixed lump sum items	* Describe a fixed lump sum item as a special item which is given an exact cost in the estimate and is sometimes known as a nonprofit item. * Emphasize that this item must be bid exactly as it is given in the estimate. * Explain that if a utility company desires a gas pipe on a proposed bridge, the company furnishes the pipe, sleeve, paint, and welding rod but they

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	pay for the cost of the extra steel and concrete added to support the gas pipe.
	* Note that in this small split, the cost of labor is added plus 10 percent of the total for engineering. This total figure becomes a fixed lump sum or nonprofit item.
V. The Estimate Form	* Distribute prints of a completed estimate form used on a current project.
	* Demonstrate the method of entering the necessary information on the form.
A. Prices	* Point out that prices used in any estimate reflect the prices adopted from the list published annually by the Department.
	* Explain that the prices listed are bid prices from the contracts of the year before. The cost of each item is shown for all 10 districts and then an average is taken of all the prices for that item.
	* Distribute copies of the weighted average bid prices and note that special items are not listed.
	* Mention that whenever a small quantity of any item is used, the price tends to increase.

QUESTIONS FOR REVIEW

1. Differentiate between the preliminary estimate and the engineer's estimate.
2. What is a detail sheet?
3. How does rounding the quantities in an estimate affect the general programing of highway construction?
4. Define a lump sum item.
5. Name five lump sum items.

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6. How does unclassified excavation differ from trench, culvert, and bridge excavation?

7. Why is concrete paid for by the amount of cubic yardage as computed by the design?

8. How is the payment computed for the installment of 300 four-foot sections of 24-in. reinforced concrete culvert pipe?

9. What is a laboratory building?

10. How is a cofferdam measured for payment?

ASSIGNMENT

1. Distribute prints of a workup detail sheet together with blank estimate forms and ask the students to complete an estimate for the project.

INSTRUCTOR'S NOTES

22704

Lesson 14 - Report on Design and Estimate

OBJECTIVES

- To complete the design of a project by consolidating the pertinent data into a final report
- To enable the student to understand the relationship of each element of design to the total project

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
I. Description	* Describe the Report on Design and Estimate as a detailed story of the complete design of a project.
	* Mention that this report is typed on 8½ by 11 in. paper, prepared for reproduction and forwarded to the Main Office for processing.
A. Purpose	* Explain that an engineer without any previous knowledge of the project may read this report and be oriented about the history and procedures of the design and all the intricacies dealing with soils, materials, other agencies, political entities, and property owners.
	* Emphasize that the report is also a control on the construction of the project since it mandates procedure, purpose, and results and is essentially the proposal for the contract. (Ref. A, p. 331)†
	* Describe the proposal as a book of instructions, procedures, and regulations for the contractor together with agreements between the contractor and the State.
B. Size	* Point out that a report can consist of a dozen pages (for a small project) but that it can become large for a major construction project.

†Reference citations shown on page 220.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Note that in this phase of the contract it is very likely that a city may request a betterment to be built under the contract which is paid for by the city. This will require a separate estimate breakdown.
	* Describe a betterment as any work done over and above a replacement of whatever existed prior to construction, e.g., furnishing and installing a 16-in. waterline where an 8-in. waterline existed.
E. Separation between construction and reconstruction	* State that a division is made between construction and reconstruction. Any of the foregoing breakdowns of estimates that apply are made for each division.
F. Federal aid contracts	* Indicate that estimates are broken down for each Federal aid project segment and for its source of funds.
	* Add that "source of funds" divides an urban section from a non-urban section and explain that an urban area is a designated area around a city and not necessarily bounded by a city line.
G. Nonparticipating shares	* Explain that some items are not paid for by the Federal Government even in a Federal aid project, e.g., resurfacing of a highway which is to be turned over to a county, town, or city.
	* State that this nonparticipating item must be in its own estimate.
H. Change in type of pavement	* Point out that a change in the type of pavement (on mainline only) requires a breakdown in the estimates.
III. Cost Analysis	* Note that next a cost analysis is made of those items which either are not listed in the published weighted average bid prices or are of such localized character that a few miles of hauling charges can drastically alter the price.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Mention that the usual items analyzed are unclassified excavation, selected granular fill, subbase course of granular material, and maintenance and protection of traffic.
A. Unclassified excavation	* Place an example of this item on the chalkboard and explain each step.

Borrow = 41% at $0.85 per C.Y.	=	$0.35 per C.Y.
Excavation = 44% at $1.00 per C.Y.	=	0.44 per C.Y.
Unsuitable material = 15% at $1.00 per C.Y.	=	0.15 per C.Y.
		$0.94 per C.Y.
Profit (20 percent)		0.19 per C.Y.
		$1.13 per C.Y.
	Say	$1.15 per C.Y.

B. Foundation course

* Add an example of Item 3R - subbase course, granular material (vibratory compaction).

Royalty	=	$0.15 per C.Y.
Loading	=	0.15 per C.Y.
Manipulation	=	0.40 per C.Y.
Haul 6 miles x 1.3 ton/C.Y. x $0.10	=	0.78 per C.Y.
		$1.48 per C.Y.
Compaction (25 percent)		0.37 per C.Y.
		$1.85 per C.Y.
Profit (20 percent)		0.37 per C.Y.
		$2.22 per C.Y.
	Say	$2.25 per C.Y.

* Indicate that many atypical highway items must be analyzed for a reasonable price. In the case of certain water pipes, the best source of information for an analysis is the local water district or companies which either furnish pipe or install pipe for the water districts.

* Note that catalogs and judgment are used as guides when determining a fair price.

IV. Field Inspections and Designers

* State that the names of all the engineers who participated in the design of the project and those who made field inspections are listed on the report.

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CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
V. Table of Lengths	* Point out that the table of lengths must account for every foot of the new highway, whether it consists of permanent or temporary pavement. * Mention that if the project contains splits, the table of lengths is split accordingly, with a length summation for each segment.
VI. History	* State that the history of the highway is recited in the report.
A. Reconstruction project	* Note that if this is a reconstruction project, the description would cover a brief history of any previous construction.
B. Construction project	* Explain that a construction project on a new location would have no history but the justification for the project should be mentioned. * Indicate that traffic projection data is included here with estimates of generated traffic and development traffic.
VII. Type of Construction	* Stress that this portion of the report concisely explains the type of construction used for the project.
A. General description	* Discuss the descriptive matter which furnishes a brief and concise account of the overall design. 1. Pavement lanes 2. Intersections 3. Curbing 4. Ramps 5. Traffic movements 6. Railings 7. Storage lanes 8. Speed change lanes 9. Pavement types 10. Foundation courses 11. Interchanges 12. Channelizations 13. Lighting 14. Signalization

22709

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	15. Utilities 16. Landscaping
B. Grades	* Mention that the maximum and minimum grades used in the design are listed.
C. Horizontal alinement	* Note that the horizontal alinement for the entire project is briefly described. Also the maximum degrees of curvature and the types of curvature are given.
D. Foundation soils and earthwork	* Emphasize that this portion of the report gives the geological background of the area and includes: 1. Results of soil surveys 2. Description of junkyards, debris, topsoil, ballast, old building foundations, old roadbeds 3. Recommendations for handling dumping grounds 4. Locations of rock
E. Drainage	* Stress that the overall drainage system is described with emphasis on the pavement collection system, any large drainage structures, types of ditches, the use of natural waterways, and any unusual drainage situations.
F. Right-of-way	* Point out that the actual number of maps and parcels to be appropriated are divided into a rural portion and an urban portion (if necessary). * Show that all maps are grouped as to fee maps (with or without the right of access), permanent easements, temporary easements, transfers of jurisdiction, and concurrent use and jurisdiction.

UNIT VI (14.0703-03)

OFFICE EQUIPMENT

Performance Objective:

Upon completion of this unit the student will be able to score at least 90% on an instructor established scale that considers both accuracy and time in operation of adding machines and calculators. She will be able to demonstrate correct procedure and technique in operation of reproducing machines. The student will be able to tabulate 50 handwritten checks in one minute or less with no errors.

Unit Outline:

A. Machines

1. Ten-key adding machine
2. Full-key adding machine
3. Printing calculator
4. Rotary Calculator
5. Bookkeeping machine

B. Reproducing Machines

1. Spirit
2. Mimeograph-mimeoscope
3. Copy machines
4. Other reproducing machines
5. Analysis of Reproduction Requirements and Selection of Method

C. Other Office Equipment

1. Paper cutter
2. Stapler
3. Collator
4. Lablemaker
5. Punching and binding
6. Tape recorder

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
G. Bridges	* Indicate that there is a report on the bridges in the project which explains the design criteria used for loading. There is also a physical description of each bridge and the following items are covered: 1. Stationing 2. Skew 3. Use 4. Number of spans 5. Type of construction * State that a list is made of any work which must be done where the new highway passes under an existing bridge.
H. Railroads	* Explain that all at-grade crossings, spurs, relocations, and directional changes of any railroad line are described and located.
VIII. Materials and Activities	* Mention that the next portion of the report covers the procedures used during construction such as time sequences, work under certain weather conditions, and general notes concerning detours.
A. Materials	* Indicate that all materials required on the project are listed with the nearest possible sources and include: 1. Names of the sources with the haul distance to the center of the project 2. Nearest point of railroad delivery
B. Standard sheets	* Emphasize that all the standard sheets to be used on the project are listed in numerical order.
C. Maintenance and protection of traffic	* Note that in this section additional controls may be added to the basic Item 76, maintenance and protection of traffic and includes: 1. Opening to traffic certain portions of the highway before the work is accepted

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	2. Rigid control on detours and for one way traffic during construction
	3. Repair of pavement breakdowns during construction
D. Participation	* Add that the source of funds is mentioned under the remark on participation.
	* Point out that on a Federal aid project the Federal share is 50 percent and the State's share is 50 percent, while on an interstate highway, the Federal share is 90 percent.
	* Note that some contracts are paid for completely by the State.
E. General remarks	* Mention that in this portion many facts may be inserted, e.g., completion date, use of transit mix, the specifications, protection of utilities, restrictions on blasting, schedule of operations, etc.
F. Disposal of buildings	* Explain that each building is listed (if the project is split, the lists must be split) with the following information: 1. Item 120D number 2. Station 3. Offset 4. Description 5. Reputed owner
G. Special notes	* Indicate that any special notes concerning driveways, sequence of operations for utilities or for the contractor, completion time of contract, or any other extraordinary situation are inserted in simple and direct language.
H. Special bridge notes	* State that information about records and samples of subsurface explorations for bridgework are given.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	* Advise that the type of footings, abutments, and piers to be used on each bridge structure are noted.
	* Explain that the justification for bridge-foundation piles and their locations are also mentioned here.
	* Add that an explanation of how the piles will be driven is listed as well as the information of what will constitute required resistance.
	* Note that any ground water in the bridge area is located.
IX. Construction Elements	* Mention that even though the general pattern of two jobs may be similar, the two reports probably would not closely resemble each other.
A. Estimated equipment	* Indicate that a list of estimated equipment is noted and includes the absolute minimum which must be used on the project.
	* Discuss the number and types of the various pieces of construction equipment ordinarily used.
	* Read a list from a report of a current contract.
B. Encroachments	* Point out that a definite disposition of encroachments is desirable in order to avoid entanglements with the contractor at a later date.
C. Railroad cooperation	* Emphasize that if a railroad is involved, a great deal of confusion may be avoided if the relationship between the contractor and the railroad is spelled out.
	* Add that clauses involving clearances, fouling distances, scheduling, inspection of railroad work, protection of crossings, and insurance should be incorporated here.

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
D. Blasting	* State that all the rules and regulations about blasting rock are listed.
E. Cesspools and septic tanks	* Emphasize that the contractor is required to pump, treat with chlorate of lime, demolish, and backfill any existing cesspools or septic tanks within the limits of the contract. * Note that there is no direct payment for this work.
F. Stream conservation	* Indicate that stream conservation is designed to protect fish life in any stream within the contract.
X. Conclusion	* Point out that the conclusion can be the largest part of the report.
A. Special specifications	* Mention that the special specifications are actually an addenda to the specification book. Any particular effect desired may be incorporated into the ordinary item, with a complete and rational description, and the item changed in number to become a special. * Discuss the example of bar reinforcement for structures, Item 28. If more stringent regulations are to be stipulated regarding rust or if the steel must be of a superior quality from that used in Item 28, then these facts, together with specifications, are incorporated in the item and the item is changed to 28R or 28X. * Describe other special items which will be used in the contract. * Explain that there may be special items currently used but not yet listed in the book of specifications and that there may be items peculiar to the contract which may never be needed again. * Add that all items not listed in the specification book, such as water pipes for cities and villages or lighting standards of a particular type are

CONTENT OUTLINE	TEACHING POINTS AND TECHNIQUES
	listed, described, and specified in detail in this section.
B. Signalization	* Point out that on urban projects where signalization is used to a great extent, all the specifications concerning the component parts of the signal system are recorded here. * Note that this covers items such as traffic signal heads, controls, housings, deflectors, lamps, reflectors, mountings, weights, and detectors.
XI. Report Procedure	* Emphasize that despite the similarity of material, no two reports are written alike. * Mention that elaboration and order of contents is strictly an interpretation of the design engineer.

QUESTIONS FOR REVIEW

1. What is the Report on Design and Estimate?
2. Explain how a roadway cost estimate can have as many as eight splits.
3. What is meant by a "city share?"
4. Describe a table of lengths.
5. Name 10 factors of design described in the type of construction section of the report.
6. What kind of information is stated under foundation soils and earthwork?
7. What are the various types of appropriations listed separately?
8. What information is disclosed by the report on bridges?
9. What is a special specification?
10. Why is a cost analysis necessary for certain items?

ASSIGNMENT

Indicate that the first part of the next class will consist of an examination and the remaining time will be used for correcting papers.

FINAL EXAMINATION

Final Examination Part I — Matching

Instructions: Write in the space provided the number of the expression in Column B which is best suited to the expression in Column A.

	Column A	Column B
9	Critical length of grade	1. Design class 5 (rural)
17	N.C.S.	2. Safe stopping sight distance of 475 ft.
12	Estimates	3. Provides space for storage lane
19	Sign post	4. Tangent runout
6	Multileg	5. Maximum degree of curvature
10	A/L	6. Rotary intersection
14	Side friction factor	7. Refuge islands
1	Maximum grade of 5 percent	8. Diamond interchange
16	Cross-slope criteria	9. Weight-power ratio
2	60 m.p.h. design speed	10. Measurement of rate of change
13	Light intensity	11. Clearing and grubbing
11	Lump sum item	12. Splits
8	Limited R.O.W.	13. Lumen
5	Minimum safe radius	14. 0.13 at 60 m.p.h.
3	14-ft. median	15. e max.
		16. Rollover effect
		17. One-quarter inch per foot
		18. Centrifugal force
		19. Frangible base
		20. Full cloverleaf interchange

41. In the mathematical control of the centerline, the best point to equalize it to the base line would be at:

____ (a) Point of curvature

____ (b) Point on a curve

__X__ (c) Point of tangency

____ (d) Transit point

42. When lighting is designed for a ramp curve sharper than a 1500-ft. radius, the placement of luminaires on either the inside, or outside of the curve becomes a matter of judgment. If the standards were placed on the inside of the curve, the lateral spacing:

__X__ (a) Should be decreased from the tangent requirement

____ (b) Should be decreased only if the inside of the curve is on the right of the direction of travel

____ (c) Is completely independent of curvature

____ (d) Should be increased from the tangent requirement

43. The objective of the dangerous fixed object (D.F.O.) program initiated in 1967 is:

____ (a) The complete elimination of any fixed object within 30 ft. of the edge of pavement

____ (b) A positive 1 on 6 slope from the edge of shoulder to the toe or top of slope

__X__ (c) The installation of only frangible base fixed objects within 30 ft. of the edge of pavement

____ (d) The installation of a 12-ft. stabilized shoulder on a 1 on 12 slope

44. In the Report of Design and Estimate, the following item that does not require a cost analysis is:

____ (a) Selected granular fill

____ (b) Maintenance and protection of traffic

____ (c) Unclassified excavation

__X__ (d) Granite curb

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45. The sequence of design is done in a very definite order and consists of the following phases:

    1) Profiles

    2) Layout design

    3) Cross-section design

    4) Typical sections

    5) Centerline control

    The correct sequence of the above phases for the maximum efficiency in design is:

    ____ (a) 5, 2, 1, 4, 3

    __X__ (b) 4, 5, 1, 3, 2

    ____ (c) 5, 1, 4, 3, 2

    ____ (d) 2, 1, 3, 5, 4

46. On a high-volume highway, the effectiveness of an acceleration lane is most dependent on:

    ___ (a) The elimination of a barrier curb on the taper end of the merging lane

    __X__ (b) The available accerleration length plus the available merging length

    ___ (c) Adequate signing well in advance of the accerleration lane and on the merging lane

    ___ (d) The grade differential between the acceleration land and the through traffic lane

47. In developing a proper width for a turning roadway, the design element that would be of the least consequence is:

    ___ (a) Curvature of the highway

    __X__ (b) Superelevation of the pavement

    ___ (d) Design speed of the highway

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Final Examination Part II — Fill-In Statements

Instructions: Complete the following statements.

1. The principal use of the median is to prevent MEDIAL interference.

2. A bituminous pavement is referred to as a FLEXIBLE pavement.

3. The principal control for e max. is the CLIMATE.

4. In pivoting about the inside edge of a 24-ft., two-lane pavement, the theoretical gradeline is lowered __3__ in.

5. The length of the superelevation runoff is controlled by the difference between the longitudinal slope of the outside edge and the longitudinal slope of the CENTERLINE profile.

6. The tangent runout is a function of the length of spiral, the normal crown slope, and __e__.

7. In computing horizontal sight distance, the stopping sight distance is measured along the CENTERLINE of the inside lane.

8. An intersection which has more traffic lanes than the intersecting highways is defined as a FLARED intersection.

9. The trumpet interchange is known as a THREE-leg interchange.

10. The term "K" is a measure of CURVATURE.

Final Examination Part III — Multiple Choice

Instructions: Place an X in the space next to the choice which most accurately completes the statement. Read all possible answers.

1. When a 200-ft. plan and profile is furnished to all of the departments concerned, the report that would least affect the shifting or changing of the alinement is:

   ____ (a) Soils

   ____ (b) Bridge

   ____ (c) Right-of-way

   __X__ (d) Landscaping

22717

2. The time interval used in design for the total reaction time is:

____ (a) $\frac{1}{2}$ second

__X__ (b) $2\frac{1}{2}$ seconds

____ (c) 1 second

____ (d) 3 seconds

3. To fully achieve its purpose, a traffic island should have:

____ (a) Grass

____ (b) Railing

__X__ (c) Elevation above the pavement

____ (d) Lighting

4. The vertical scale used for a profile of the 50-ft. scale plan is:

____ (a) 1 in. = 5 ft.

__X__ (b) 1 in. = 10 ft.

____ (c) 1 in. = 20 ft.

____ (d) 1 in. = 50 ft.

5. The element that is not part of the geometric features of a highway is:

____ (a) Guide railing

____ (b) Signs

____ (c) Lighting

__X__ (d) Subbase

6. The selection of a design speed for a given project is based on:

____ (a) Politics

____ (b) Other highways in the area

__X__ (c) Character of the terrain

____ (d) Motor vehicle laws

22718

7. The factor which would least affect the perception time of a driver is:

____ (a) Atmospheric visibility

____ (b) Color of object

____ (c) Speed

__X__ (d) Type of vehicle

8. The coefficient of friction between the pavement and the tires of a vehicle is least affected by the:

____ (a) Pavement

____ (b) Quality of tire

__X__ (c) Contact area

____ (d) Weight of vehicle

9. The safe stopping sight distance for a 50-m.p.h. design speed is:

____ (a) 250 ft.

__X__ (b) 350 ft.

____ (c) 450 ft.

____ (d) 550 ft.

10. The lane width of a highway is directly related to the:

____ (a) Maximum curvature

__X__ (b) DHV

____ (c) Proportion of trucks

____ (d) Climate

11. The median which separates the frontage road from the main highway is known as:

____ (a) A swale median

__X__ (b) An outer separator

____ (c) An island median

____ (d) A channelized median

12. The factor that does not affect the width of a shoulder is:

____ (a) Traffic volume

____ (b) Traffic speed

____ (c) Type of terrain

__X__ (d) Type of pavement surface

13. In a typical section of a 12-ft. pavement, 12-ft. shoulder, and an 18-ft. slope at 1 on 6, the theoretical gradeline is above the top of slope:

____ (a) 48 in.

__X__ (b) 51 in.

____ (c) 54 in.

____ (d) 57 in.

14. The rate of change of grade (A/L) is most useful when determining the:

__X__ (a) Length of a truck climbing lane on a crest vertical curve

____ (b) Length of a crest vertical curve

____ (c) Drainage design of a crest vertical curve

____ (d) Sight distance on a crest vertical curve

15. The comfort effect of change in a vertical direction is greater on sag vertical curves than on crest vertical curves because:

____ (a) Vehicle impact is greater on sag vertical curves

____ (b) Vehicle impact is less on sag vertical curves

__X__ (c) Gravitational and centrifugal forces are combined

____ (d) Gravitational and centrifugal forces are opposed

16. The situation of a sharp horizontal curve at the top of a pronounced crest vertical curve can best be alleviated by:

____ (a) Leading horizontal curve with vertical curve

__X__ (b) Leading vertical curve with horizontal curve

____ (c) Starting vertical curve and horizontal curve at same point

____ (d) Compounding horizontal curve

Supplemental Teaching Aids:

The following are good resource books for this unit; Machine Office Practice, Peter L. Agnew, South-western, Cincinnati, 1965, General Office Practice, Archer, Brecker, and Frakes. McGraw-Hill, New York, 1963.

"Modern Business Machines" (20 min.), Teaching Aids Exchange, 307 South B. Street, San Mateo, California 94401 and "Maintenance of Office Machines" (36 min.) Norwood Films are applicable to this unit.

Training Time 20-30 hours

17. The use of a compound curve is justified to:

____ (a) Correct an error made in the design of the original curve

____ (b) Shorten the length of curve for economic reasons

____ (c) Eliminate a horizontal broken-back curve situation

_X_ (d) Fit the alinement to the existing terrain and topography

18. For a new highway location, drainage is most likely to be a complicated problem:

_X_ (a) Under a railroad

____ (b) On a side hill

____ (c) Over another highway

____ (d) Parallel to a river

19. To provide adequate drainage in the design of a new highway, the greatest consideration should be given to the:

____ (a) Initial cost of providing satisfactory drainage facilities

____ (b) Cost of maintaining satisfactory drainage facilities

____ (c) Distance that the collected water must be carried

_X_ (d) Satisfactory removal of precipitation from the highway

20. The following five steps are taken when planning the location of a highway:

1) Preliminary location survey

2) Traffic survey

3) Reconnaissance survey

4) Geometric design

5) Final location survey

The correct sequence of the above steps is:

_X_ (a) 3, 1, 5, 2, 4

____ (b) 2, 4, 3, 1, 5

____ (c) 2, 1, 3, 4, 5

____ (d) 1, 5, 2, 3, 4

21. An important similarity between rural highway and urban arterial highway design is the:

____ (a) Control of access is required to the same extent in both types

____ (b) Alteration and replacement of utilities is an expensive and far reaching program in both types

____ (c) Design of drainage facilities requires the same type of analysis in both types

__X__ (d) Required quality of a particular pavement surface is the same in both types

22. An analytical comparison between the new method of rounding breaking points of slopes and ditches (using a vertical curve) and the old method (using a horizontal curve) would indicate that:

____ (a) There is very little difference in the result

____ (b) The old method was more complex but gave more accurate results

__X__ (c) The new method gives more consistent results

____ (d) The new method provides for more economical maintenance

23. Since the purpose of installing guide rails is to lessen the hazard to traffic and not to protect any part of the highway structure, guide rails would most likely be used:

__X__ (a) By fixed objects close to the pavement

____ (b) On fills on steep grades

____ (c) On fills on sharp curvature

____ (d) In cuts on steep grades

24. The ratio of the centrifugal force developed when a 4000-pound vehicle rounds a 1000-ft. radius curve at 60 m.p.h. to the centrifugal force developed by the same vehicle when it rounds the same curve at 30 m.p.h. is:

____ (a) 2:1

__X__ (b) 4:1

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____ (c) 6:1

____ (d) 8:1

25. The classification chart recommendation that 12-ft. pavement lanes be used whenever the traffic count surpasses a design hourly volume of 70 is least concerned with the premise that:

__X__ (a) The extra cost of wider lanes is offset by the reduction in cost of maintenance due to lessened wheel concentrations at the slab edges

____ (b) The maximum allowable width of vehicles requires sufficient clearance on either side as a necessary precaution for safety

____ (c) There is an involvement with psychological factors when there is little or no lateral clearance from an obstruction adjacent to the traveled lane

____ (d) The width of any lane is a function of the traffic volume which is expected to use the highway

26. The minimun passing sight distance for a two-lane highway is determined by the sum of four distances, the longest of which is the distance:

____ (a) Traversed during perception and reaction time and during initial acceleration to point of encroachment on the left lane

__X__ (b) Traveled while the passing vehicle occupies the left lane

____ (c) Between the passing vehicle at the end of its maneuver and the opposing vehicle

____ (d) Traversed by an opposing vehicle for two-thirds of the time the passing vehicle occupies the left lane

27. The best reason for the criteria mandating a height of an object to be 4 in. for measuring stopping sight distance on crest profiles is:

__X__ (a) A lower height would drastically raise the cost of construction

____ (b) A lower height would be impractical because of the possible lack of objects lower than 4 in.

____ (c) A higher height would not substantially change the length of curve

____ (d) A higher height would exaggerate the difficulty of the night time operation

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28. The choice of design speed is influenced principally by the;

____ (a) Character of the terrain

____ (b) Extent of manmade features

____ (c) Economic considerations

__X__ (d) Large volume of traffic

29. The current trend of the average spot speed (the arithmetic mean of the speeds of all traffic at a specified point) is best described by:

__X__ (a) Low design speed curves yield an average spot speed close to the design speed

____ (b) High design speed curves yield an average spot speed close to the design speed

____ (c) The differential between average spot speed and design speed is independent of the alinement

____ (d) Average spot speeds have been increasing rapidly over the past 15 years

30. The criteria for establishing the length of sag vertical curve is most critical when based on:

__X__ (a) Headlight sight distance

____ (b) Rider comfort

____ (c) Drainage control

____ (d) General appearance

31. The design of a 5°-curve (R = 1146 feet) at a design speed of 60 m.p.h. indicates that the horizontal sight distance is not sufficient for the required safe stopping sight distance because the piers of a bridge obstruct the line of sight. This condition can best be corrected by:

____ (a) Moving the bridge piers farther away from the pavement

____ (b) Using a radius of 955 ft. (D = 6°)

__X__ (c) Using a radius of 1433 ft. (D = 4°)

____ (d) Lowering the sight distance requirement

22724

32. The best reason for having a controlled access highway is that:

____ (a) Animals and pedestrians are prohibited from using or crossing it

__X__ (b) Accident fatalities are reduced to one-third of those on an access highway

____ (c) The extra cost of right-of-way is not extremely expensive

____ (d) The practical capacity of the highway is guaranteed

33. The most practical approach to the selection of the proper length of spiral curve for transition between a tangent and a simple curve is based on the:

____ (a) Rate of increase of centripetal acceleration

____ (b) Gradual increase and decrease of centrifugal force

____ (c) Aesthetic effects gained by the elimination of edge profile distortion

__X__ (d) Distance needed for superelevation runoff

34. The greatest asset of a 36-ft. median cross section is that it:

____ (a) Provides a refuge for vehicles in an emergency

____ (b) Reduces the intensity of headlight glare

____ (c) Provides a storage area for plowed snow

__X__ (d) Provides freedom from medial interference

35. The most undesirable alinement condition for safety, comfort, and ease of operation would:

__X__ (a) Consist of sharp curves at the ends of very long tangents

____ (b) Consist of very long and very large radius curves

____ (c) Consist of reversals in curvature at the ends of 1500-ft. tangents

____ (d) Consist of curves at the ends of the 1500-ft. tangents

36. The most important element of a typical section is the:

____ (a) Design thickness of pavement

____ (b) Cross slope of pavement

_X_ (c) Theoretical gradeline

____ (d) Pavement surface materials

37. The determination of the right-of-way lines for a highway to be built on new location is controlled by:

____ (a) Classification chart

_X_ (b) Toes and tops of slopes

____ (c) Economics

____ (d) Design storm

38. The primary use of the curb is to:

____ (a) Control surface drainage

_X_ (b) Confine vehicles in a designated path

____ (c) Delineate the edge of pavement or median

____ (d) Assist in the development of the roadside area

39. The item not found on the standard structure sheets is:

____ (a) Delineators

____ (b) Tree planting

____ (c) Metal bin type retaining walls

_X_ (d) Concrete mixes

40. The most important factor in obtaining driver obedience of signs and traffic control devices is:

____ (a) Simplicity in design

_X_ (b) Standardization

____ (c) Police enforcement

____ (d) Strategic placement

strong, desire or attitude can be seen to have an influence on our perception.

Attitudes and adjustment determine our perception in the driving situation. Our attitudes are our personal beliefs, our way of thinking, our feelings, and our emotional reaction. Therefore, our feelings and emotions influence one's capacity for accurate and objective perception.

Anything that causes a driver to be any less efficient in the driving task, is something that should be a concern to all of us. The results of drinking and driving -- impairment of ability and traffic accidents -- are well documented.

WHAT TO DO!

There is no one answer, solution, control or countermeasure to deal with the problem of alcohol and traffic accidents. Many methods have been developed and implemented in the past decades as well as in the present. Some measures have been purely punitive in character while others have stressed the preventive aspects. However, regardless of whether they are punitive or preventive, the measures must complement each other to achieve any degree of success.

TESTING THE DRINKING DRIVER

The drinking driver is one of the major factors in the nation's traffic accident picture, and enforcement of statutory prohibitions against driving under the influence of intoxicating liquor has become a major tool in the trafficc accident enforcement program.

48. The treatment that should not be incorporated in the construction of shoulders for an urban heavy volume facility would be:

____ (a) To have jiggle bars laid transversely across the shoulder

____ (b) To use a seal coating with colored chips for contrast

__X__ (c) To use the same materials as the pavement

____ (d) To have a coarse appearance and poor riding quality

49. In the comparison between two design projects, which are similar in classification, terrain features, and right-of-way, the large difference in the cost of the projects would be reconciled because:

____ (a) The drainage work in one could be more complex than in the other

__X__ (b) One alinement could be designed on a higher gradeline than the other

____ (c) One project could have more extras than the other such as stabilized shoulders, curbs, or acceleration lanes

____ (d) One project could have larger quantities of high-cost type items than the other

50. At a public hearing for a proposed project, severe criticism of the alinement should be handled by:

____ (a) Repeating the reasons for the alinement in a very positive and authoritative manner

____ (b) Acknowledging that perhaps the alinement could have been altered but it is too late to change it

____ (c) Explaining the procedures which led to the decision of the alinement in a kind and gentle manner

__X__ (d) Informing the group that all criticisms would be recorded for further study of the alinement

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This booklet is published primarily for use in the schools of New York State, and free copies are available to New York State school personnel when ordered through a school administrator from the Publications Distribution Unit, State Education Building, Albany, New York 12224.

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UNIT VII (14.0703-04)

COMMUNICATIONS

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate to the satisfaction of the instructor, a level of coherence and clarity in oral communications that is adequate for the business office. The student will be able to prepare and write a mailable letter or brief report, from facts provided by the instructor. In a role playing, or other simulated situation, the student will be able to demonstrate correct telephone technique, procedure, and usage. The student will be able to score at least 80% on an objective test covering mail handling and telegraph procedures and use.

Unit Outline:

A. Oral and Written Communications

1. Importance of oral and written communications

2. Importance of good listening

B. Elements of Good Speech

1. Voice control

2. Vocabulary and pronunciation

3. Grammar

C. Speech and Writing Problems

1. Individual analysis

2. Corrective activities

D. Review of Rules for Punctuation, Capitalization, etc.

E. Importance of the Voice in Telephone Usage

1. Control

2. Enunciation

3. Resonance

4. Tone

5. Distance between lip and mouthpiece

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IDENTIFIERS - *DRINKING DRIVERS

ABSTRACT - According to special studies, drinking of alcoholic beverages is believed to be a factor in at least half the fatal motor vehicle accidents. To explore the methods of controlling the driver who abuses alcohol and the components essential for setting up a control program, this publication was prepared by the National Safety Council. Topics are: (1) The Driving Task, (2) What to Do, (3) Testing the Drinking Driver, (4) Recognition, (5) Testing Methods, (6) Blood Alcohol Standards, (7) Testing Procedure, (8) Setting Up Chemical Tests for Alcohol Influence, (9) The Essential Elements, and (10) Test Method. References, various laws and forms, and supplemental information are appended. (GR)

VT 013 444

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testing the drinking driver

TRAFFIC SAFETY MONOGRAPH NO. 2

NATIONAL SAFETY COUNCIL

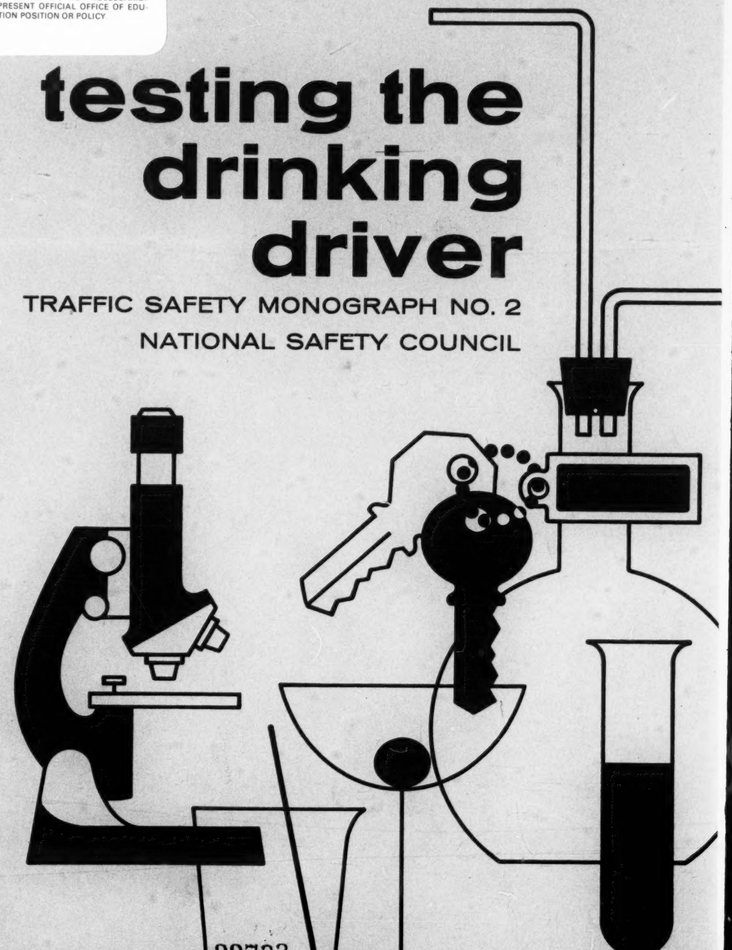

VT013444

TRAFFIC SAFETY MONOGRAPH

No. 2

"TESTING THE DRINKING DRIVER"

PREPARED BY: Michael T. Impellizzeri
Traffic Department
National Safety Council

This monograph is devoted to the methods by which drivers who abuse the use of alcoholic beverages can be controlled. Further information may be obtained from the sources and references listed in the appendices.

National Safety Council
425 North Michigan Avenue
Chicago, Illinois 60611

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"TESTING THE DRINKING DRIVER"

FOREWORD

Drinking of alcohol beverages is believed to be a factor in at least half of the fatal motor-vehicle accidents, according to special studies. Routine accident reports do not show the same frequency of drinking, but there are reasons to believe such reports understate the frequency, since the necessary arrangements and equipment have not been available for alcohol tests on all of the persons involved in accidents.

The purpose of this publication is to explore the methods of controlling the driver who abuses alcohol and the components essential for setting up a control program.

INTRODUCTION

Talk about the drinking-driver problem and the methods to control it are concerned with alcohol abuse rather than its use. But to be realistic, one must know as much about its use in order to develop and evaluate programs about its abuse.

Drinking is a commonplace activity. Just as the legal, psychological, physiological, ethnic and cultural factors must be considered when analyzing the use of alcohol, these factors must be borne in mind when considering the legal, educational, rehabilitation, driving licensing, and other preventive and punitive features of a balanced program dealing with the abuse of alcohol as related to the driving task.

THE DRIVING TASK

Driving an automobile involves a series of judgment situations. The driver reacts to a stimulus in the traffic stream as he would react to a stimulus in everyday life. Therefore, the key or link between the driving situation and the ultimate driving behavior is perception. Attitudes and adjustments are factors of our perception.

Perception represents our apprehension of a present situation in terms of our past experiences. What we perceive in the traffic stream or in everyday life is dependent upon: (1) the nature of the actual stimulus; (2) the setting in which it exists; (3) our previous sensory experiences; (4) our feelings at the moment; (5) our general prejudices; (6) our desires or ambitions; (7) and out attitudes and our goals in life. Thus, any mental factor, emotional state, physical impairment,

RECOGNITION

Recognition of the drinking driver is difficult. When an officer contacts a driver he suspects of being under the influence, he must assure himself that the suspect is actually under the influence to a degree that makes him a hazard on the highway. If the officer is so assured, he must obtain evidence to be presented in court which will convince the judge and jury, as the officer himself was convinced, that the driver was in fact under the influence of intoxicating liquor.

A number of factors make this recognition difficult. First, the appearance and actions of the suspect must be different from those of a normal, sober person. When appearance and actions are clearly abnormal, it must be ascertained that alcohol is the cause. There are over 60 clinically recognized disabilities having symptons the same or similar to those of alcoholic intoxication. The officer must have reason to believe that the suspect's condition may be due to alcohol and not due to an illness, injury, or medication (drugs).

An officer or doctor, can not look at a suspect and be certain in every case that the person is or is not under the influence of alcohol. This is the reason why chemical tests to determine alcoholic influence are so important. The tests determine the presence of alcohol and make it the most probable cause of impairment of a driver. The tests also determine the concentration of alcohol in the blood and thus give an idea of the degree of impairment.

TESTING METHODS

The methods for testing the drinking driver can be classified into two general groups: observational tests and chemical tests. The first group consists of the coordination tests given drinking drivers by most police departments throughout the country. This group also includes other methods of testing for alcoholic influence, such as, movies, voice recordings, etc.

The principle of an observational test is to determine any deviation from presumed normal behavior while a person is performing a particular task. Of course, it is further necessary to determine that alcohol is the cause of any such deviation. However, the observational tests will show the state of the suspected drinking driver immediately after apprehension and are necessary to show that the person's actions indicated impairment of normal abilities.

Chemical testing is the second method used to identify the drinking driver. There are many different methods that can be used to identify alcohol in the human body. However, not all are considered adaptable for use in determining the presence and amount in drinking drivers. Chemical tests can be divided into two categories: those requiring a subsequent laboratory analysis and those permitting an immediate analysis, as in tests of exhaled breath. Laboratory analysis usually is concerned with specimens of blood and urine, although it can also include saliva.

Breath testing devices are available in two sorts, the first is for preliminary screening and the second for quantitative analysis.

The more the public is sold before the program is started, the less opposition the department will have to face later. After the program has been instituted, the selling job must still continue. This can best be done by keeping the public informed of the progress and accomplishments of the chemical test program.

REFERENCES

American Medical Association, Alcohol and the Impaired Driver, A Manual on the Medicolegal Aspects of Chemical Tests for Intoxication, Chicago, 1968.

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U. S. Department of Transportation, Highway Safety Program Manual, Vol. 8 Alcohol in Relation to Highway Safety, NHSB, Jan., 1969.

U. S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY SAFETY BUREAU

Highway Safety Program Standard 8
(Issued June 27, 1967)

ALCOHOL IN RELATION TO HIGHWAY SAFETY

Introduction

The driver who drinks is one of the major problems affecting highway safety. Yet, while most States have some laws relating to control of drivers who drive while under the influence of intoxicating liquor, most of the States need: (1) to strengthen their "drunk driving" statutes, (2) to supplement these with "implied consent" authority, and (3) to establish an expanded information collection program on the extent to which alcohol is present among drivers and adult pedestrians involved in fatal accidents.

Background

Every witness who testified before the committee expressed deep and growing concern regarding the incidence of impairment by alcohol in relation to highway accidents. Though it is, on the basis of present information, impossible to state how many accidents were in fact, or even in part, the result, of the driver's or the pedestrian's consumption of alcohol, the statistics do indicate clearly that alcohol is a factor present to some degree in about 50 percent of all accidents. This is a serious problem, and a perplexing one. Its alleviation and control will be extremely difficult, but its magnitude precludes its evasion...

Report No. 1700, House of Representatives 89th Congress, 2d Session, July 15, 1966, p. 26.

Purpose

To broaden the scope and number of activities directed toward reducing traffic accident loss experience arising in whole or part from persons driving under the influence of alcohol.

Standard

Each State, in cooperation with its political subdivisions, shall develop and implement a program to achieve a reduction in those traffic accidents arising in whole or in part from persons driving under the influence of alcohol. The program shall provide at least that:

1. There is a specification by the State of the following with respect to alcohol related offenses:

   A. Chemical test procedures for determining blood-alcohol concentrations.

of alcohol analyses with certification of individuals meeting the performance requirements established.

5. Prepare for the development of adequate means for testing for drugs other than alcohol in specimens of body materials from subject suspected of being impaired by such drugs or by other exogenous chemical agents.

Blood

The methods of analysis must meet the reliability criteria including those of accuracy, precision, and specificity acceptable to the National Highway Safety Bureau. Blood concentrations giving rise to presumptions regarding alcoholic influence shall be those obtained by analysis of specimens taken as quickly as feasible after the time of the suspected offense. When a speculative retrograde extrapolation of a blood alcohol concentration to any prior time is made, this is to be in response to a carefully designed hypothetical question, or is to be accompanied by an explanation of the presumptions necessary in making the extrapolation. It is urged that blood analyses be limited to specimens of capillary blood, that is, blood approximating arterial composition, in respect to alcohol, as soon as the requisite procedural capabilities have been attained. As blood plasma or serum are the preferred blood components for analysis, they should be designated as the preferred fluids to be analyzed in any subsequent revisions of chemical test legislation.

Breath

Breath alcohol analyses shall be performed only with apparatus, equipment, and by techniques meeting the reliability criteria including those of accuracy, precision, and specificity acceptable to the National Highway Safety Bureau. The breath methods employed in obtaining evidence for use in court shall be those utilizing breath specimens which were substantially in equilibrium with respect to alcohol with pulmonary arterial blood plasma.

The limitations in extrapolation of derived blood alcohol concentrations giving rise to presumptions regarding alcoholic influence shall be those obtaining for the direct analysis of blood. (See preceding section on blood)

Qualifications of personnel involved in the various aspects of chemical testing shall be at least those acceptable to the National Highway Safety Bureau.

Screening, or on-the-spot tests for the approximate alcohol content of breath specimens for field use by law enforcement agencies for certain limited purposes (e.g., spot checks for the purpose of detecting the incidence of impaired drivers) should employ measured specimens of breath substantially alveolar with respect to alcohol.

The results of such screening or on-the-spot tests shall not be used in any subsequent prosecution for driving or being in actual physical control of a motor vehicle while under the influence of intoxicating liquor.

Specifications and Discussion

Blood and breath are preferred over a single random urine specimen for analysis for alcohol because ordinarily it is not possible to properly conclude that the concentration of alcohol in the water of the blood at the time delivery of the urine specimen closely approaches that found in the urine itself.

Upon completion of absorption and distribution, the blood alcohol concentration decreases with time consequent to various elimination processes (oxidation, urine formulation, pulmonary vaporization, etc.) by a rate which averages about 0.018% W/V per hour, but this may vary from person to person by at least ± 50% of this figure. Blood alcohol concentration may increase with time during absorption of alcohol from the gastro-intestinal canal. In any given case the relevant information is rarely available which permits the presumption that the blood alcohol had declined with the passage of time from the arrest to the taking of the specimen. Therefore, an unbiased estimate of blood alcohol concentration at a prior time can only be made by presuming certain "facts." This should always be made clear to law enforcement officers, judges, and juries. It follows that the shorter the interval between the time of arrest and specimen collection the better. It is believed this interval need not exceed one hour in the case of most arrests. To define statutorily the offense as that of having a blood alcohol concentration in excess of a given figure at the time of taking of the specimen appears to be the preferred means of eliminating this vexing aspect of chemical testing.

The use of capillary blood for alcohol analysis is preferred because this blood has a composition approaching that of arterial blood in respect to alcohol and if the plasma or serum of such blood is analyzed, the result obtained is directly comparable to the result obtained by calculation from a simultaneous breath analysis.

In the analysis of blood specimens at least duplicate determinations should be performed on each specimen. If the results agree within ± 10% of the mean, the mean should be reported as the result. If the agreement is not within these limits, each result obtained should be reported. Blood alcohol results should be expressed in terms of %W/V, i.e., grams of

The preliminary screening devices are portable items for testing breath and maybe used to confirm a police officer's suspicion that alcohol may be present. The officer is then able to subject the suspect to further testing in order to determine the precise amount of alcohol present, whether by laboratory analysis or with another breath device giving quantitative results.

It is an accepted fact that the amount of alcohol in the breath is a reliable index of the concentration of alcohol in the blood, which in turn is an accurate index of the amount of alcohol reaching the brain and affecting the judgment and abilities of the individual. Established methods of determining breath alcohol, when properly conducted, provide reliable and accurate information regarding the presence and concentration of alcohol in the blood.

An enforcement agency's choice of which test method to employ will be dictated by what facilities are available in its area. If the police department has a good laboratory, it may easily conduct blood or urine tests itself. If competent personnel are available, a breath testing program may be used. If hospital, clinic, or health department laboratories can assist, the agency may make use of these facilities to help gather the information necessary for adequate prosecution of drinking drivers.

A chemical test by itself is usually not sufficient to bring about conviction of persons charged with driving while under the influence. Evidence needs to be presented that the suspect's physical abilities

were impaired, in addition to the fact that the reason for impairment was the presence of alcohol in the blood. For this reason, both observational tests and chemical tests are essential for a good enforcement program dealing with drinking drivers.

BLOOD ALCOHOL STANDARDS

The National Highway Safety Bureau's Highway Safety Program Standard 4.4.8 Alcohol in Relation to Highway Safety (Appendix A) specifies that each state in cooperation with its political subdivisions, shall have a program at least that:

> "I. There is specification by the State of the following with respect to alcohol related offenses:
>
> A. Chemical test procedures for determining blood alcohol concentrations.
>
> B. (1) The blood alcohol concentrations, not higher than 0.10 per cent by weight, which define the terms "intoxicated" or under the influence; and
>
> (2) A provision making either unlawful, or presumptive evidence of illegality, if the blood-alcohol concentration of a driver equals or exceeds the limit so established."

Article 11-902.1 of the Uniform Vehicle Code contains the presumptions defining under the influence of intoxicating liquor:

> "I. If there was at that time 0.05 percent or less by weight of alcohol in the person's blood, it shall be presumed that the person was not under the influence of intoxicating liquor.
>
> 2. If there was at that time in excess of 0.05 percent but less than 0.10 percent by weight of alcohol in the person's blood, such fact shall not give rise to any presumption that the person was or was not under the influence of in-

F. The Telephone Directory

1. Alphabetical directory

2. Classified directory

3. Out-of-town directory

G. Types of Telephone Services

H. Handling Calls

1. Incoming calls

2. Outgoing calls

I. Types of Telegraph Services

J. Preparation of Messages

1. Choice of class of service

2. Use of special words and code

3. Cost of transmission

4. Time differences (zones)

K. Importance of Mail

L. Procedures for Handling Mail

M. Classification of Mail and Rates

N. Postage Equipment and Supplies

1. Postage meters and scales

2. Automatic addressing systems

Supplemental Teaching Aids:

Many good resource books applicable to this unit are available, particularly in the field of special education. Others are the following: Communicating Facts and Ideas in Business, Leland Brown, Prentice-Hall, Englewood Cliffs, N.J., 1961, Business English in Communications, Himstreet, Porter and Maxwell, Prentice-Hall, Englewood Cliffs, N.J., 1964.

A series of three programmed texts by Joseph C. Blumenthal are available from Harcourt, Brace, and World. A great deal of free material is available from Western Union including the film "Telegram for America". Pitney-Bowes, Inc. distributes two publications on mailing machines entitled How to Increase the Prestige of Your Mail and 29 Timely Mailing Tips.

Training Time 15-20 hours

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toxicating liquor, but such fact may be considered with other competent evidence in determining whether the person was under the influence of intoxicating liquor.

3. If there was at that time 0.10 percent or more by weight of alcohol in the person's blood, it shall be presumed that the person was under the influence of intoxicating liquor.

4. Percent by weight of alcohol in the blood shall be based upon grams of alcohol per 100 cubic centimeters of blood. (REVISED, 1968.)"

Many states have enacted legislation that contain the above standards on alcoholic influence. (Apendix B)

TESTING PROCEDURE

Many police agencies have regulations for handling of the drinking driver. The following paragraphs are intended to explain what elements are necessary to carry out a successful program and aid in the prosecution of drivers found under the influence.

For a driver to be charged with driving while under the influence of alcohol, it must be established that he was, in fact, driving a vehicle or in physical control of it at the time he was apprehended. To complete the charge, it must be ascertained that the suspect was under the influence of alcohol to such a degree that his driving abilities were impaired. All deviations from normal driving behavior (including extreme caution) and all violations should be noted.

If an arresting officer suspects a person of being under the influence, he should take the suspect to the police station or jail for a more complete examination, where other witnesses are present and

there are better facilities available for observation and the performance of a chemical test.

Satisfactory examination of a suspect is made easier through the use of the Alcoholic Influence Report Form. (Appendix C) The form is designed to give an officer a uniform guide in observing, testing, and interviewing a suspect. It is intended to record impairment in coordination and judgment, and to assist an officer to arrive at a conclusion that the individual is normal or his driving abilities are impaired.

SETTING UP CHEMICAL TESTS FOR ALCOHOLIC INFLUENCE

A program of chemical testing for alcoholic influence can be most helpful in dealing with the problem of the drinking driver. The program must, however, be properly planned and carried out if it is to be effective. Chemical tests are not a cure-all for the problem of the drinking driver, but they are an example of the application of scientific methodology police work aimed at in providing the court with positive, reliable evidence with which to judge the violator and in obtaining information regarding the relationship of alcoholic impairment to traffic accidents.

The police are the most intimately concerned with the program. They in general and the top command in particular, must be well aware of the benefits and pitfalls of such a program. While chemical tests definitely identify alcohol in the system of the suspect, the individual police officer is not relieved of the other necessary work in connection with a driving while under the influence (DWI) case. On the

contrary, additional effort by the officer is necessary and care must be taken in observing and recording the suspect's outward systems of alcohol influence.

Chemical tests of body fluids and breath determine the presence and concentration of alcohol in the blood of persons who have been drinking alcoholic beverages. Tests of blood, breath or urine are being used by over 1,000 communities in prosecuting persons charged with driving while under the influence.

The various established methods of analysis are scientifically sound and, when properly conducted, provide accurate information. There is adequate legal precedent to allow the introduction of this evidence. A number of states have laws which not only provide for the admissibility of the scientific findings, but also establish presumptions that give concentrations of blood alcohol are evidence of alcohol influence or sobriety, insofar as the operation of a motor vehicle is concerned. In addition, as of March 1, 1970, 46 states have implied consent laws whereby any person placed under arrest for operating a motor vehicle while intoxicated or under the influence of alcohol is deemed to have given his consent to a chemical test for the purpose of determining alcoholic content. If the person does not live up to this implied agreement he forfeits the privilege to use the highways in that state. See Appendix B for the list of States with various drinking-driver legislative provisions.

THE ESSENTIAL ELEMENTS

The initiation of a program of chemical testing for alcoholic in-

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fluence is a task to approach with much caution. Many factors must be considered to assure the success of the program. A community does not just start doing it; comprehensive plans must be made:

1. Official approval must be obtained
2. Facilities provided
3. Materials purchased
4. Training must be completed
5. Public acceptance and approval must be developed

As stated earlier, a good program of chemical testing is an indication of conscientious and progressive police work, and it requires a determined effort on the part of all concerned to be effective.

The various phases that must be considered for an effective program are outlined in Appendix D and Appendix E.

Appendix D is "A Model Program For The Control Of Alcohol For Traffic Safety" developed by the National Safety Council's Committee on Alcohol and Drugs for the National Highway Safety Bureau of the United States Department of Transportation. It deals with all program considerations, including chemical tests, putting each phase into proper perspective.

The "RECOMMENDATIONS OF THE AD HOC COMMITTEE ON TESTING AND TRAINING" of the Committee on Alcohol and Drugs, National Safety Council, are contained in Appendix E. Here the minimum standards of training for interpretation, scientific direction, technical supervision, sample analysis and remote sampling are specified.

TEST METHOD

One of the major factors to consider in setting up a program of chemical tests for alcoholic influence is the selection of the method to be employed. The reliability of the several methods of determining the presence and concentration of alcohol in specimens of body origin are well established.

Each community must evaluate its capacities and needs to determine which test method will be best suited for use. Listed below are some of the major factors to consider in choosing a test method.

Cost -- A breath test method involves an immediate cost of the apparatus to be used, while other methods make use of the existing facilities of hospitals, health departments, and private clinics. If the work involved in any method is done with a police department as part of the regular duties, the cost per test will be quite low. If these services are performed by outside personnel, the cost is increased.

Facilities -- The availability of a police laboratory or that of a hospital, clinic, or health department will determine the choice of a blood test method. If none of these facilities are available especially during the hours of darkness, a community would probably be inclined to choose a breath method.

Time -- Another factor to be considered is the time element, that is, the time required for each test. Blood tests usually take longer than breath tests. Time is also a factor in regard to how close the test facility is located. If too far away, the portability of a breath test device may be a determining factor.

Number of Tests -- Small municipalities might have a small number of tests to run each year which would not justify a

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large outlay of capital for equipment and training. In some areas a cooperative arrangement is made whereby different police agencies make use of the same facilities.

Personnel -- The availability of qualified personnel is perhaps the most important of the factors. Within this factor also lies the training of all personnel from police officer to prosecutor and scientific expert, all of whom will be concerned with chemical tests. The success of the program will depend upon the competence and abilities of the personnel involved -- chemists must be exact in their analyses; police officers thorough in their reporting; technicians well-practiced with breath devices; medical experts qualified by experience; and prosecutors attentive to each detail of the case. With personnel of this sort and a receptive court, the program can be successful.

Statutory Provisions -- The statutory provisions of the state must be reviewed to see what is and is not provided, to include authority, limitations, choices afforded subjects, immunity, etc.

As can be seen from the foregoing paragraphs, many factors are involved in the determination of the method to be used. These factors will vary in importance dependent upon local circumstance. Regardless of what type test method is finally decided upon, due consideration must be given each and every one of the factors mentioned so that unforeseen obstacles will not arise later.

When a decision has been reached on the procedure to be used, be it blood or breath, or a combination of methods, then the job of selling the program must be accomplished before it is actually put into operation.

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B. (1) The blood-alcohol concentrations, not higher than .10 percent by weight, which define the terms "intoxicated" or "under the influence of alcohol," and

(2) A provision making it either unlawful, or presumptive evidence of illegality, if the blood-alcohol concentration of a driver equals or exceeds the limit so established.

II. Any person placed under arrest for operating a motor vehicle while intoxicated or under the influence of alcohol is deemed to have given his consent to a chemical test of his blood, breath, or urine for the purpose of determining the alcohol content of his blood.

III. To the extent practicable, there are quantitative tests for alcohol:

A. On the bodies of all drivers and adult pedestrians who die within four hours of a traffic accident.

B. On all surviving drivers in accidents fatal to others.

IV. There are appropriate procedures established by the State for specifying:

A. The qualifications of personnel who administer chemical tests used to determine blood, breath, and other body alcohol concentrations.

B. The methods and related details of specimen selection, collection, handling, and analysis.

C. The reporting and tabulation of the results.

V. The program shall be periodically evaluated by the State, and the National Highway Safety Bureau shall be provided with an evaluation summary.

APPENDIX B

Drinking and Driving Laws

April, 1970

State	Year "Chemical Test" Law Enacted	Presumptive Level	Year "Implied Consent" Law Enacted
Alabama	1969	0.10%	1969
Alaska	1969	0.10%	1969
Arizona	1947	0.15%	1969
Arkansas	1957	0.10%	1969
California	1969	0.10%	1966
Colorado	1957	0.10% *(ID)*	1967
Connecticut	1964	0.15%	1964
Delaware	1954	0.10%	1969
Florida	1967	0.10% *(*)*	1967
Georgia	1968	0.10%	1968
Hawaii	1961	0.15%	1967
Idaho	1952	0.15%	1955
Illinois	1957	0.10%	
Indiana	1939	0.15%	1969
Iowa	1963	0.10% *(*)*	1964
Kansas	1954	0.15%	1955
Kentucky	1968	0.10%	1968
Louisiana	1968	0.10%	1968
Maine	1947	0.15% *(ID)*	1969
Maryland	1959	0.15% *(ID)*	1969
Massachusetts	1960	0.15%	1967
Michigan	1960	0.15% *(ID)*	1967
Minnesota	1967	0.10%	1961
Mississippi	*No Law*		
Missouri	1964	0.15%	1965
Montana	1957	0.15%	
Nebraska	1949	0.10%	1959

UNIT VIII (14.0703-10)

TRANSPORTATION

Performance Objectives:

Upon completion of this unit the student will be able to score at least 80% on an instructor made objective test dealing with types of transportation available and services of travel agencies.

Unit Outline:

A. Types of Service

1. Identification of methods of travel

2. Variations in uses, costs and processes

B. Sources of Travel Assistance

1. Agencies

2. Air line ticket offices

C. Hotel and Motel Reservations

D. Duties During Employer's Absence

Supplemental Teaching Aids:

A possible source of resource people or material is the local Hotel/Motel Managers Association. Periodicals applicable to this unit are the following: Hotel Red Book, American Hotel Directory Association, New York, Official Airline Guide, American Aviation Publications, Washington, D. C., TDIC (Transportation Displays, Inc.,) 70 East 45th St., New York.

Training Time 2-4 hours

State	Year "Chemical Test" Law Enacted	Presumptive Level	Year "Implied Consent" Law Enacted
Nevada	1958	0.15%	1969
New Hampshire	1949	0.15%	1965
New Jersey	1950	0.15% *(ID)*	1966
New Mexico	1969		1969
New York	1941	0.15% *(ID)*	1953
North Carolina	1962	0.10%	1966
North Dakota	1960	0.10%	1959
Ohio	1967	0.15%	1967
Oklahoma	1967	0.15%	1967
Oregon	1949	0.15%	1965
Pennsylvania	1968	0.10%	1968
Rhode Island	1966	0.10%	1966
South Carolina	1949	0.10%	1969
South Dakota	1959	0.15%	1959
Tennessee	1953	0.15%	1969
Texas			1969
Utah	1967	0.08%	1957
Vermont	1964	0.10%	1959
Virginia	1956	0.15% *(ID)*	1962
Washington	1968	0.10%	1968 *(**)*
West Virginia	1968	0.10%	1968
Wisconsin	1947	0.15%	1970
Wyoming	1955	0.15%	
District of Columbia		0.15%	

(*) Provides that the presumption arises when the blood-alcohol concentration is more than the specified percentage.

(**) Adopted by voter referendum.

(ID) State also has a lesser offense of "driving while impaired" with lower presumptive levels and separate penalties.

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APPENDIX C

(Check)	(Check)
☐ Driver	☐ Accident
☐ Pedestrian	☐ Violation
☐ Passenger	☐ Other

Date and time of Accident or Violation _____ am pm

ALCOHOLIC INFLUENCE REPORT FORM

Police Dept. _____
Arrest No. _____
Accident No. _____
Arresting Officer _____
Date and time in custody _____ am pm

Name _____ Address _____

Age _____ Sex _____ Race _____ Approx. Wt. _____ Operator Lic. No. _____ State _____

OBSERVATIONS:

CLOTHES	**Describe: (Type & Color)**	Hat or Cap _____ Jacket or Coat _____ Shirt or Dress _____ Pants or Skirt _____
	Condition:	☐ Disorderly ☐ Disarranged ☐ Soiled ☐ Mussed ☐ Orderly (Describe) _____
BREATH	**Odor of Alcoholic Beverage:**	☐ strong ☐ moderate ☐ faint ☐ none
ATTITUDE		☐ Excited ☐ Hilarious ☐ Talkative ☐ Carefree ☐ Sleepy ☐ Profanity ☐ Combative ☐ Indifferent ☐ Insulting ☐ Cocky ☐ Cooperative ☐ Polite
UNUSUAL ACTIONS		☐ Hiccoughing ☐ Belching ☐ Vomiting ☐ Fighting ☐ Crying ☐ Laughing
SPEECH		☐ Not Understandable ☐ Mumbled ☐ Slurred ☐ Mush Mouthed ☐ Confused ☐ Thick Tongued ☐ Stuttered ☐ Accent ☐ Fair ☐ Good

Indicate other unusual actions or statements, including when first observed: _____

Signs or complaint of illness or injury:

PERFORMANCE TESTS:

(Note—See departmental instructions for conducting these tests)

Check Squares If Not Made		Check appropriate square before word describing condition observed
☐	**BALANCE**	☐ Falling ☐ Needed Support ☐ Wobbling ☐ Swaying ☐ Unsure ☐ Sure
☐	**WALKING**	☐ Falling ☐ Staggering ☐ Stumbling ☐ Swaying ☐ Unsure ☐ Sure
☐	**TURNING**	☐ Falling ☐ Staggering ☐ Hesitant ☐ Swaying ☐ Unsure ☐ Sure
☐	**FINGER-TO-NOSE**	**Right:** ☐ Completely Missed ☐ Hesitant ☐ Sure
		Left: ☐ Completely Missed ☐ Hesitant ☐ Sure
☐	**COINS**	☐ Unable ☐ Fumbling ☐ Slow ☐ Sure ☐ (Other) _____
		(Balance during coin test) _____

Ability to understand instructions: ☐ Poor ☐ Fair ☐ Good **Tests performed:** Date _____ Time _____ am pm

OBSERVER'S OPINION:

Effects of alcohol: ☐ extreme ☐ obvious ☐ slight ☐ none **Ability to drive:** ☐ unfit ☐ fit

Indicate briefly what first led you to suspect alcoholic influence: _____

Observed by: _____ **Assignment:** _____

Witnessed by: _____ Date _____ Time _____ am pm

CHEMICAL TEST DATA:

Specimen: ☐ Blood ☐ Breath ☐ Saliva ☐ Urine ☐ None ☐ Refused ☐ Unable

Analysis result:

If Breath, what instrument?

If refused, why? _____

INTERVIEW:

Were you operating a vehicle?_____ Where were you going?_____

What street or highway were you on?_____ Direction of travel?_____

Where did you start from?_____ What time did you start?_____

What time is it now?_____ What city (county) are you in now?_____

What is the date?_____ What day of the week is it?_____

INTERVIEWER TO FILL IN ACTUAL: _____ am/pm _____ _____ _____

Time | Day | Date | Interviewer's Name

When did you last eat?_____ What did you eat?_____

What were you doing during the last three hours?_____

Have you been drinking?_____ What?_____ How much?_____

Where?_____ Started?_____ am/pm Stopped?_____ am/pm

Are you under the influence of an alcoholic beverage now?_____

What is your occupation?_____ When did you last work?_____

Do you have any physical defects?_____ If so, what?_____

Are you ill?_____ If so, what's wrong?_____

Do you limp?_____ Have you been injured lately?_____ If so, what's wrong?_____

Did you get a bump on the head?_____ Were you involved in an accident today?_____

Have you had any alcoholic beverage since the accident?_____ If so, what?_____

Where?_____ How much?_____ When?_____

Have you seen a doctor or dentist lately?_____ If so, who?_____ When?_____

What for?_____ Are you taking tranquilizers, pills or medicines of any kind?_____

If so, what kind? (Get sample)_____ Last dose?_____ am/pm Do you have epilepsy?_____

Diabetes?_____ Do you take insulin?_____ If so, last dose?_____ am/pm

Have you had any injections of any other drugs recently?_____ If so, what for?_____

What kind of drug?_____ Last dose?_____ am/pm When did you last sleep?_____

How much sleep did you have?_____ Are you wearing false teeth?_____ Do you have a glass eye?_____

HANDWRITING SPECIMEN Signature and/or anything he chooses.	

REMARKS:

_____

SUPPLEMENTARY DATA:

(Note—Get witnesses, including officers who observed, to prove driving)

WITNESSES			Was Suspect Driving or Operating	What Was His Condition	Where Observed
Name	Address	Tel. No.			

Passengers in Suspect's Vehicle	Name	Address	Condition

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APPENDIX D

A MODEL PROGRAM FOR THE CONTROL OF ALCOHOL FOR TRAFFIC SAFETY

developed by the
National Safety Council
Committee on Alcohol and Drugs
for the
National Highway Safety Bureau
United States Department of Transportation

July, 1967

A MODEL PROGRAM FOR THE

CONTROL OF ALCOHOL FOR TRAFFIC SAFETY

Each state must have a program designed to minimize the contribution of alcohol as a causative factor in traffic accidents. The program shall include educational and legal elements and a means for continued program evaluation. It shall be a balanced program emphasizing both preventive and punitive features of control of alcohol for traffic safety. All elements of the program shall maintain effective liaison in respect to their activities and policies.

I. PUBLIC INFORMATION AND EDUCATION

A. Public Information

Each state shall develop and activate a plan for effective communication with relevant segments of the public in respect to:

1. The nature and extent of alcohol involvement in traffic accidents.

2. Means to prevent and to control this involvement.

Pertinent information shall be directed towards selected target groups in addition to the public at large. These include the categories of users of alcohol, abstainers, the medical and legal professions, law enforcement agencies, various driver organizations, and educational institutions. The goal of this activity will be the accomplishment of an attitude-change toward drinking and driving.

B. Education

Each state shall provide, through its system of education, teaching materials relevant to alcohol and traffic safety to educational institutions, especially secondary schools. It will also conduct through appropriate educational channels training conferences for vocational and professional groups with direct program responsibility such as driver training instructors, and the police, prosecutors, and judges. Educational programs in the attack upon traffic-alcohol death and injury should be developed with liaison and in cooperation with groups in national, state and local government, and also with any other groups which are responsible for and experienced and concerned with (a) education, (b) other alcohol problems, and (c) other traffic problems.

II. LEGAL

A. Legislative

Each state should enact legislation which includes the following items:

1. That it is an offense to drive or operate or to be in actual physical control of any vehicle while under the influence of alcohol.

2. A chemical test law establishing admissibility of chemical test evidence in criminal and civil cases and establishing presumptive levels in respect to alcohol influence.

3. An implied consent law by which a driver on the highway is deemed to have given his consent to a chemical test, or alternatively, legislation making chemical tests compulsory for persons involved in accidents while driving or operating a vehicle. (See section on Law Enforcement)

4. Provisions for central state control of chemical test methods and certification of qualified persons to conduct chemical tests.

5. Authorization of law enforcement officers to apprehend drivers under the influence of alcohol without warrant in the same manner as in felony cases--upon probable cause.

6. Regulation of post mortem investigation with at least the following features:

   (a) Compulsory requirement for coroners and medical examiners to perform post mortem investigations of all vehicular-related deaths occurring within six hours as a result of accident or other happening.

   (b) That no person (funeral director, embalmer, etc.) having custody of the body of such a deceased person shall perform any internal embalming procedure until authorized to do so by the physician who has performed or shall perform the post mortem examination.

7. Mandatory revocation of the operator's license upon conviction for driving while under the influence of alcohol.

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8. Authorization of discretionary administrative action in suspending the operator's license when there is sufficient evidence that the licensee has committed an offense for which mandatory revocation of license is required upon conviction.

9. Establishment of immunity from lawsuits for physicians and other qualified persons withdrawing blood specimens from arrested motorists at the request of law enforcement officers.

10. The requirement that analysis for alcohol of the specimens obtained in such deaths shall be conducted by a procedure which is considered specific for ethyl alcohol and which will therefore distinguish among ethyl alcohol, isopropyl alcohol, methyl alcohol, formaldehyde, and acetone.

Specifications and Discussion

The Uniform Vehicle Code (Revised--1962) should be used as a guide in formulating legislation in respect to most of the various items: Item 1, Section 11-902 (a); Item 2, Section 11-902 (b); Item 3, Sections 1-155, 6-205.1, 6-208, 6-211, 11-902; Item 4, Section 11-902 (c); Item 5, Section 16-105 (a); Item 7, 6-205; Item 8, 6-206.

A procedure specific for alcohol should be used in death investigations for the sake of specificity itself, and to avoid measuring the varying and possibly quite large quantities of nonalcohol volatile reducing substances in specimens exhibiting putrefaction. In addition, an appropriate procedure shall be one which detects the components of embalming fluids when present.

B. Law Enforcement

All police agencies must adopt and maintain programs for prevention, detection, apprehension, and the processing of motor vehicles offenses by those persons whose driving ability is impaired by alcohol as defined by existing statute. Preventive procedures shall include cooperation and participation in educational matters (see section on Public Information), and careful administrative assignment and allocation of manpower for deterent purposes, including surveillance of drivers whose licenses have been suspended. In addition spot check tests, or tests with blockades should be encouraged as deterrents. Continued efforts to strengthen the relationship between police agencies, prosecutors, courts and the public are to be encouraged.

Measures for detection, apprehension, and processing of suspects shall include an appropriate amount of instruction of officers regarding:

1. The various manifestations of alcohol impairment, especially in connection with motor vehicle operation.

2. Proper acquisition and recording of the information requested in the Standard Accident Report Form.

3. Employment of chemical test devices.

4. The proper execution of the Alcoholic Influence Report Form including the performance and evaluation of appropriate behavioral tests.

5. The possible recognition and procedures for investigation of individuals under the influence of drugs other than alcohol, and referral to appropriate agencies of individuals with natural illness and injuries.

C. Chemical Tests

In each state an appropriate designated agency shall:

1. Promulgate regulations concerning the collection, preservation, and storage of blood, breath, and other body substances and for analysis of these for alcohol content. Analyses shall be performed only on specimens of blood, breath, or urine in the case of living subjects. Blood and breath are to be preferred. Choice of specimens from subjects of autopsies is at the discretion of the physician. Specimens of blood from sites not likely to be affected by admixture or diffusion of alcohol from the gastrointestinal tract contents are to be preferred.

2. Develop a suitable program for periodic monitoring of performance ("quality control") of laboratories performing blood or urine alcohol analyses and agencies or laboratories involved in the use of breath alcohol devices.

3. Provide information and advice relevant to chemical testing to law enforcement agencies and other interested parties.

4. Provide for appropriate training in the performance

alcohol per 100 milliliters of blood to the second decimal place. The test result reported in the case of breath analysis should be the mean of the results of the analysis of at least two separately collected breath specimens providing the results agree within ± 10% of the mean value. If the results do not agree within these limits, all results obtained should be reported. Breath alcohol analyses should be expressed in terms of the corresponding blood alcohol concentrations as directed in the case of direct analysis of the blood. As revisions in chemical test legislation are enacted it is recommended that the alcohol concentration in liquid specimens be expressed as mgs of alcohol per 100 ml of fluid with the third figure being zero in each case (e.g., 166 mgs per 100 ml found would be reported as 160 mgs per 100 ml of, etc.).

It is hoped that in the future breath quantities of alcohol may be defined in terms of milligrams of alcohol per unit volume of breath which is substantially alveolar in composition with respect to alcohol, thus avoiding the necessity of making any indirect calculation to a presumed blood alcohol concentration equivalent.

One or more laboratories in each state should prepare for the development of means for testing for drugs other than alcohol in subjects suspected of being impaired by the affects of such drugs or other exogenous chemical agents. It is recommended that the National Highway Safety Bureau accumulate information on such matters as (1) the effects of individual drug substances on human performance relevant to driving, and (2) choice and quantities of specimens for individual drug determinations, individual procedures for such determinations, and screening procedures for drug substances, especially the narcotic analgesics, sedatives, antihistamines, tranquilizers, psychodelics, other psychopharmacologic agents, and other central nervous system affectants which might be encountered in drivers. It is urged that the National Highway Safety Bureau arrange for the communication of the information (or listings of its sources) to an appropriate state official who in turn should transmit this to the various individual laboratories for immediate implementation to the degree each state deems fit. It is also recommended that existing information on the incidence and significance of drugs other than alcohol in drivers be accumulated and that further investigation of the incidence and significance to be encouraged. When and if, in the view of the National Highway Safety Bureau, sufficient justifying information has been accumulated, the Bureau should establish minimum criteria for testing for such drugs analogous to criteria for testing for alcohol.

Personnel qualifications for the education, training and experience of all individuals concerned with the technical aspects of chemical testing shall be at least those acceptable to the National Highway Safety Bureau. The details of individual program supervision by the state agency ought at least to meet the minimum requirements of the National Highway Safety Bureau.

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D. Behavioral Tests

Behavioral tests and observation for possible impairment should be made on every driver involved in accidents investigated by the police, and on every driver who is arrested on suspicion of driving while under the influence of alcohol. The Alcoholic Influence Report Form developed by the National Safety Council Committee on Alcohol and Drugs should be the minimum guide used in examining, interpreting, and recording the results of such tests and the form should be expanded to contain instructions to better standardize its use. The use of photographs, motion pictures, video tapes, and sound recordings to document behavior should be encouraged.

E. Prosecution

Each state shall conduct regular periodic court conferences within the state, making it mandatory for all judges and prosecutors in those courts having jurisdiction of offenses involving driving while under the influence of alcohol to attend. In such conferences all problems concerning prosecution and rehabilitation of the drinking driver and their solutions may be considered. These conferences should be integrated, when feasible, with the other elements of the educational program. To eliminate the unwarranted reduction of charges against motorists arrested for driving or being in actual physical control of a vehicle while under the influence of alcohol the administrative suspension of the operator's license described in legislative section (see above) is recommended.

III. PROGRAM EVALUATION

Each state shall devise a system of periodic program evaluation adequate to determine the effectiveness of each element of the program. Such a system must include arrangements for external as well as internal inspection; for example by the National Highway Safety Bureau. Results of the program evaluation are to be made available to the governor of the state and the National Highway Safety Bureau at one-year intervals. This report may be made a part of a more comprehensive report dealing with other aspects of the total Highway Safety Program.

UNIT IX (14.0703-08)

FINANCIAL ACTIVITIES

Performance Objectives:

Upon completion of this unit the student will be able to score at least 80% on an instructor developed objective test covering the handling and verifying of forms involved in ordering, receiving, selling, and general financial records. Also covered in this test should be common reports required by governmental agencies.

Unit Outline:

A. Importance of the Need of Financial Records

B. Types of Records

1. Personnel
2. Payroll
3. Sales and purchases
4. Inventory
5. Taxes
6. Financial statements
7. Petty cash
8. Budgets
9. Credit applications

Supplemental Teaching Aids:

An excellent resource person for this unit is a staff member from the college business office. Free or inexpensive information is available from the Massachusetts Bankers Association, 125 High St., Boston, 12110. Of some value is the comic book- The Story of Checks, available from the Federal Reserve Bank of New York.

Training Time 8-10 hours

APPENDIX E

E-1

RECOMMENDATIONS OF THE AD HOC COMMITTEE ON TESTING AND TRAINING OF THE COMMITTEE ON ALCOHOL AND DRUGS NATIONAL SAFETY COUNCIL

April 29 and 30

1968

Florissant, Colorado

PREAMBLE

For the purposes of traffic law enforcement and in connection with programs for the control of alcohol in respect to traffic safety, this Ad Hoc Committee concurs unanimously in making the following recommendations in the light of currently available information.

I. SPECIMENS

A. The biological specimens of choice for the determination of ethyl alcohol are those of blood or breath.

B. Suitable breath specimens are those in which the ethyl alcohol was substantially in equilibrium with the alcohol of the pulmonary arterial blood plasma.* "Deep lung air" (alveolar air) is such a specimen.

C. Urine. Because of various problems in the interpretation of the results of analyses of urine specimens for alcohol which cannot readily be overcome in law enforcement practice, analysis of urine for the purpose of determining blood alcohol concentration is to be discouraged except under the strictly controlled conditions employed in determining renal solute clearances.**

II. PROCEDURES FOR ANALYSIS

A. Procedural controls

1. Analytical procedures for breath alcohol analysis should include the following controls in conjunction with the testing of each subject:

a) Continuous observation of the subject for at least fifteen (15) minutes prior to collection of the breath specimen, during which period the subject must not have ingested alcoholic beverages or other fluids, regurgitated, vomited, eaten or smoked.

b) A blank analysis.

c) Analysis of a suitable reference or control sample, such as air equilibrated with a reference solution of known alcohol content at a known temperature, the result of which analysis must agree with the reference sample value within the limits of $\pm$ 0.01% W/V. This analysis shall immediately precede or immediately follow the analysis of the breath of the subject.

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* See E-7 to E-11 for pertinent references

RECOMMENDATIONS OF THE AD HOC COMMITTEE

2. Analytical procedures for blood alcohol analysis should include the following controls in conjunction with any sample or series of samples analyzed sequentially or simultaneously:

   a) A blank analysis where appropriate.

   b) Analysis of a suitable reference or control blood sample of known alcohol content within the range of 0.10 to 0.30% W/V, the result of which analysis must agree with the reference sample value within the limits of ± 0.01% W/V.

B. Reporting of Results

1. Results of alcohol determinations expressed as blood alcohol concentrations be reported to the second decimal place if expressed in terms of W/V or W/W, or to the same degree of precision if reported in other units of concentration such as milligrams per 100 milliliters.

C. Quantification of Breath Specimens

1. The quantity of breath analyzed for its alcohol content shall be established only by direct volumetric measurement, or by collection and analysis of a fixed breath volume.

III. STANDARDS OF TRAINING

In order to implement and monitor the application of the above and other applicable standards, the Ad Hoc Committee unanimously recommends the following minimum standards of training. For the purposes of the section, the activities of a program of chemical testing for alcohol will be classified as follows:

Interpretation
Scientific Direction
Technical Supervision
Sample Analysis
Remote Sampling

Although the titles assigned to the individuals associated with these several activities may vary in different jurisdictions, their functions generally will be expected to remain the same.

These recommendations are intended to describe the minimum training and educational requirements deemed necessary to ensure

efficient and dependable administration of a program of chemical testing for alcohol. They are not intended to provide guidelines for all aspects of a chemical test program.

A. Interpretation

In any chemical testing program there should be readily available professional personnel to provide expert testimony and to interpret the pharmacological and physiological significances of the analytical results.

No specific training recommendations are made at this level of professional competence in the light of the adequacy of the basis academic and professional education of such individuals.

B. Scientific Direction

A program of chemical testing for alcohol must be under the supervision of a scientific director. The director should have at least a baccalaureate degree in one of the natural sciencies or other appropriate field, and, in addition, specialized knowledge may be obtained through attendance at a course of instruction specifically designed for this purpose, or by nine months residency training in a recognized laboratory carrying out such functions.

If the program includes the direction of a laboratory that carries out direct analyses of blood samples for alcohol, the Director and the analysts under his supervision should possess at least the educational and experience qualifications set forth for these personnel categories in Title 20, Code of Federal Regulations, Chapter III, Part 405, Paragraphs 405.1312, 405.1313, 405.1315*, or equivalent educational and experience qualifications in other appropriate disciplines such as chemistry, criminalistics, or toxicology or combination thereof.

C. Technical Supervision

Technical supervision of chemical tests for alcohol must be exercised continually. The responsibilities of the technical supervisor include field inspection, maintenance and calibration of breath testing equipment, and training and re-evaluation of the breath test technicians under his jurisdiction. Further, he is responsible for periodic re-examination of the operators under his jurisdiction to ensure technical knowledge and competence.

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* Federal Health Insurance for the Aged ("Medicare") Regulations: Conditions for Coverage of Services of Independent Laboratories, February, 1968. See extracts from these regulations in E-15 to E-24.

For individuals exercising the preceding functions, the minimum qualifications are:

1. High school graduation or its equivalent.

2. Accreditation as an operator of the chemical test method he is to supervise, or possession of equivalent knowledge to qualify him as such.

3. Satisfactory completion of a technical supervisors' course, the content of which should include:

   a) Advanced survey of current information on the physiology and pharmacology of alcohol.

   b) Operational principles and theories applicable to the program.

   c) Instrument maintenance and calibration.

   d) Legal aspects of alcohol and traffic.

   e) Public relations aspects of alcohol and traffic.

   f) Principles of instruction.

D. Breath Testing Technicians

In lieu of formal educational requirements, a pre-course screening test may be used to determine the technical aptitude of prospective technicians. The recommended course of instruction includes the following subject matter: (The term "hour" as used in these recommendations refers to a 60-minute period of instructional time).

1. A minimum of three (3) hours of instruction on alcohol and the human body.

2. A minimum of three (3) hours of instruction on the operational principles of the selected testing method which is to include:

   a) A functional description of the testing method.

   b) A detailed operational description of the method with demonstrations.

3. A minimum of five (5) hours of instruction on the legal aspects of chemical tests generally and of the particular method to be employed.

4. A minimum of three (3) hours of instruction on supplemental information which is to include nomenclature appropriate to the field of chemical tests for alcohol.

5. A minimum of ten (10) hours of laboratory participation using appropriate equipment. Laboratory practice will include the use of reference alcohol samples, as well as the testing of actual drinking subjects.

6. A minimum of one hour of formal examination for purposes of determining the competency and qualifications of the technician or trainee.

E. Remote Collection of Specimens

This instruction should be provided within the context of local law enforcement training in the subject area of traffic law enforcement procedures. Additional instruction should be given where applicable in the remote collection of blood or breath specimens for subsequent analysis.

1. Blood Collection - In lieu of extensive training in this specific area, a standard collection kit should be utilized. It should include detailed instructions for the medical personnel responsible for the withdrawal of the blood specimen and emphasize pitfalls to be avoided. Law enforcement officers are laso to be acquainted with the proper employment of this kit in the collection and submission of the blood specimens for subsequent analysis.

2. Breath Collection - Law enforcement officers who are to collect breath specimens should be acquainted with those technical and environmental factors that might affect the validity of the subsequent analysis. They should receive instruction in the principles and use of any collecting device employed sufficient to become proficient in its use; should be acquainted with the scientific significance of the test to be conducted and should be acquainted with the proper techniques for the submission of collected specimens for analyses.

This Ad Hoc Committee estimates training for this activity will require a minimum of three (3) hours of instruction.

Continued training should be provided to communicate new developments apropos of the selected testing method and other aspects of chemical testing for alcohol.

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E-15

EXTRACTS FROM

CONDITIONS
FOR COVERAGE OF SERVICES OF
INDEPENDENT LABORATORIES

FEDERAL

HEALTH INSURANCE

FOR THE AGED

(CODE OF FEDERAL REGULATIONS,
TITLE 20, CHAPTER III, PART 405)

REGULATIONS

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
SOCIAL SECURITY ADMINISTRATION

405.1312 Condition - Clinical Laboratory; Laboratory Director. - The clinical laboratory is under the direction of a qualified person.

(b) **Standard Laboratory director - qualification.** The laboratory director meets the requirements of subparagraphs (1), (2), (3), or (4), and (5) of this paragraph:

(1) He is a physician certified in anatomical and/or clinical pathology by the American Road of Pathology or the American Osteopathic Board of Pathology or possesses qualifications which are equivalent to those required for such certification (board eligible).

(2) He is a physician who (i) is certified by the American Board of Pathology or the American Osteopathic Board of Pathology in at least one of the laboratory specialties, or (ii) is certified by the American Board of Microbiology, the American Board of Clinical Chemistry, or other national accrediting board acceptable to the Secretary in one of the laboratory specialties, or (iii) subsequent to graduation has had 4 or more years of general laboratory training and experience of which at least two were spent acquiring proficiency in one of the laboratory specialties in a clinical laboratory - with a director at the doctoral level - of a hospital, a health department, university, or medical research institution, or in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State.

(3) He holds an earned doctoral degree from an accredited institution with a chemical, physical, or biological science as his major subject ("accredited," as used herein, refers to accreditation by a nationally recognized accrediting agency or association, as determined by the U.S. Commissioner of Education) and (i) is certified by the American Board of Microbiology, the American Board of Clinical Chemistry, or other national accrediting board acceptable to the Secretary in one of the laboratory specialties, or (ii) subsequent to graduation, has had 4 or more years of general clinical laboratory training and experience, of which at least 2 years were spent acquiring proficiency in one of the laboratory specialties in a clinical laboratory - with a director at the doctoral level - of a hospital, a health department, university, or medical research institution, or in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State.

(4) For a period ending June 30, 1971, an exception to the requirements in subparagraph (1), (2), or (3) of this paragraph may be made if the conditions described in (i) and (ii) below are met:

(i) the director was responsible for the direction of a clinical laboratory for 12 months within the 5 years preceding July 1, 1966, and, in addition, meets one of the following requirements:

(a) The director holds a master's degree from an accredited institution with a chemical, physical, or biological science as his major subject and subsequent to graduation has had at least 4 years of pertinent clinical laboratory experience.

(b) The director holds a bachelor's degree from an accredited institution with a chemical, physical, or biological science as his major subject and subsequent to graduation has had at least 6 years of pertinent clinical laboratory experience.

(c) The director has achieved a satisfactory grade through an examination conducted by or under the sponsorship of the U.S. Public Health Service. Such examination shall be offered annually or more often if in the Secretary's opinion the need arises, except that such examination shall no longer be conducted subsequent to July 1, 1970 (see Sec. 405. 1314 (b)). For a period ending July 31, 1967, the State agency will give interim certification of compliance with respect to a clinical laboratory if such laboratory otherwise meets the requirements and if the director has indicated his intention, in writing, to take the examination. All such interim certifications and the determinations based on them shall terminate no later than July 31, 1967; and

(ii) the State agency has evidence of successful participation of the laboratory which he directs in State-operated or State-approved proficiency testing programs meeting standards prescribed by all Secretary and covering all the specialties or subspecialties in which the laboratory performs tests for individuals enrolled under the supplementary medical insurance plan (see Subpart B of this Part 405): except that for a period ending July 31, 1968, in a State where proficiency testing programs covering some or all specialties are not yet available, the State agency will give interim certification of compliance with respect to a clinical laboratory which otherwise meets the requirements, if the laboratory successfully participates in the proficiency testing programs (if any) which the State has in operation or has approved in specialties (including the subspecially of serology) in which the laboratory performs tests, all such interim certifications terminating no later than July 31, 1968. With respect to any period after July 31, 1968, where the Secretary determines that a State does not have, or that it appears that a State will not have, acceptable proficiency testing program or programs for purposes of this paragraph, and the laboratory in such State successfully participates in the proficiency testing program(s) approved by the Secretary in specialties (including the subspecialty of serology) in which the laboratory performs tests.

(5) The director who qualified under subparagraph (4) of this paragraph may continue to qualify under the program after June 30, 1971, if: (i) The laboratory which he directs is otherwise qualified; (ii) the laboratory which he directs successfully participates in a performance evaluation program conducted by the State, meeting standards prescribed by the Secretary; and (iii) as part of the participation in the performance evaluation program, the laboratory which he directs successfully participates for at least 2 consecutive years in the 3-year period between July 1, 1968, and July 1, 1971, and annually thereafter, in a State-operated or State-approved proficiency testing program meeting standards prescribed by the Secretary, or a program approved by the Secretary as prescribed in subparagraph (4) of this paragraph in all the specialties or subspecialties in which the laboratory performs tests for individuals enrolled under the supplementary medical insurance plan (see Subpart B of this Part 405), except that if the director first qualifies under subparagraph (4) of this paragraph after July 1, 1968, but before July 1, 1971, the 3-year period for purpose of this subparagraph (5) shall begin on the date he first qualified and, if otherwise acceptable, the laboratory he directs shall be deemed qualified subject to satisfactory participation in the performance evaluation program in subdivision (ii) and this subdivision (iii) of this subparagraph within the 3-year period beginning with the date the director so qualified.

405.1313 Condition - Clinical Laboratory; Supervision. - The clinical laboratory is supervised by qualified personnel.

(a) **Standard. Supervision.** The laboratory has one or more supervisors who, under the general direction of the laboratory director, supervise technical personnel and reporting of findings, perform tests requiring special scientific skills, and, in the absence of the director, are held responsible for the proper performance of all laboratory procedures. A laboratory director is considered to be qualified as a general supervisor; therefore, depending upon the size and functions of the laboratory, the laboratory director may also serve as the laboratory supervisor. The factors explaining the standard are as follows:

(1) There are two categories of required supervisors. A general supervisor - one who meets the requirements of paragraph (b) of this section - is on the laboratory premises during all hours in which tests are being performed. A technical supervisor - one who meets the pertinent requirements of Sec. 405.1314(b) - spends an adequate amount of time in the laboratory to supervise the technical performance of the staff in his specialty and is readily available for personal or telephone consultation.

(2) A general supervisor may also be a technical supervisor.

(b) **Standard. Supervisor - qualification.** The laboratory supervisor meets the requirements of subparagraphs (1), (2), (3), (4), or (5), or (5) and (6) of this paragraph:

(1) He (i) is a physician or has earned a doctoral degree from an accredited institution with a chemical, physical, or biological science as his major subject, and (ii) subsequent to graduation has had at least 2 years' experience in one of the laboratory specialties in a clinical laboratory - with a director at the doctoral level - of a hospital, a health department, university, or medical research institution, or in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State.

(2) He holds a degree of master of arts or master of science from an accredited institution with a major in one of the chemical, physical, or biological sciences and subsequent to graduation, has had at least 4 years of pertinent laboratory experience of which not less than 2 years has been spent working in the designated laboratory specialty in a clinical laboratory - with a director at the doctoral level - of a hospital, a health department, university, or medical research institution, or in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State.

(3) He holds a degree of bachelor of arts or bachelor of science from an accredited institution with a major in one of the chemical, physical, or biological sciences, and, subsequent to graduation (i) has had at least 6 years of pertinent laboratory experience of which not less than 2 years has been spent working in the designated laboratory speciality in a clinical laboratory - with a director at the doctoral level - of a hospital, a health department, university, or medical research institution, or in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State; and (ii) has successfully completed pertinent courses which, when combined with the foregoing experience, will provide technical and professional knowledge comparable to that of subparagraph (2) of this paragraph.

(4) He is qualified as a clinical laboratory technologist pursuant to the provisions of Sec. 405.1315 (b), (1), (2), (3), or (4), and (i) has had at least 6 years of pertinent laboratory experience of which not less than 2 years has been spent working in the designated laboratory specialty in a clinical laboratory - with a director at the doctoral level - of a hospital, university, health department, or medical research institution, or in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State; and (ii) has successfully completed pertinent courses which when combined with the foregoing experience, will provide a technical and professional knowledge comparable to that of subparagraph (2) of this paragraph.

(5) For a period ending June 30, 1971, an exception to the requirements in subparagraph (1), (2), (3), or (4) of this paragraph may be made if (i) the supervisor was performing the duties of a clinical laboratory supervisor on, or within the 5 years preceding July 1, 1966, and (ii) the supervisor has had at least 15 years of pertinent clinical laboratory experience prior to July 1, 1966: Provided, That a minimum of 30 semester hours of credit toward a bachelor's degree with a chemical, physical, or a biological science as his major subject or 30 semester hours in an approved school of medical technology shall reduce the required years of experience by 2 years, with any additional hours further reducing the required years of experience at the rate of 15 hours for 1 year.

(6) The supervisor who meets the requirements under subparagraph (5) of this paragraph may continue to qualify under the program after June 30, 1971, if he has performed the duties of a supervisor for at least 2 years between July 1, 1966, and July 1, 1971, or during the 15-year qualifying period in subparagraph (5) of this paragraph: (i) In a clinical laboratory - with a director at the doctoral level - of a hospital, university, health department, or medical research institution; or (ii) in a State which regulates clinical laboratory personnel in a clinical laboratory acceptable to that State; or (iii) in a laboratory approved under the supplementary medical insurance program, Provided also, That where qualifying years in a laboratory described in (i) or (ii) of this paragraph are obtained after June 30, 1966, the laboratory meets applicable conditions under the health insurance program.

405.1315 Condition - Clinical Laboratory; Technical Personnel. - The clinical laboratory has a sufficient number of properly qualified technical personnel for the volume and diversity of tests performed.

(a) Standard; Technologist - Duties. - The laboratory employs a sufficient number of clinical laboratory technologists to proficiently perform under general supervision the clinical laboratory tests which require the exercise of independent judgment. The factors explaining the standard are as follows:

(1) The clinical laboratory technologists perform tests which require the exercise of independent judgment and responsibility, with minimal supervision by the director or supervisors, in only those specialties in which they are qualified by education, training, and experience.

(2) With respect to specialties in which the clinical laboratory technologist is not qualified by education, training, or experience, he functions only under direct supervision and performs only tests which require limited technical skill and responsibility.

(3) Clinical laboratory technologists are in sufficient number to adequately supervise the work of technicians and trainees.

(b) Standard. Technologists - qualifications. Each clinical laboratory technologist possesses a current license as a clinical laboratory technologist issued by the State, if such licensing exists, and meets the requirements of subparagraphs (1), (2), (3), (4), or (5), or (5) and (6) of this paragraph:

(1) Successful completion of a full course of study which meets all academic requirements for a bachelor's degree in medical technology from an accredited college or university.

(2) Successful completion of 3 academic years of study (a minimum of 90 semester hours or equivalent) in an accredited college or university which met the specific requirements for entrance into, and the successful completion of a course of training of at least 12 months in, a school of medical technology approved by the Council on Medical Education and Hospitals of the American Medical Association.

(3) Successful completion in an accredited college or university of a course of study which meets all academic requirements for a bachelor's degree in one of the chemical, physical, or biological sciences, and, in addition, at least 1 year of pertinent laboratory experience and/or training covering the specialty (ies) or subspecialty (ies) in which he performs tests, provided the combination has given the individual the equivalent in such specialty (ies) or subspecialty (ies) of the education and training described in subparagraph (1) or (2) of this paragraph.

(4) Successful completion of 3 years (90 semester hours or equivalent) in an accredited college or university with a distribution of courses as shown below, and, in addition successful experience and/or training covering several fields of medical laboratory work of such length (not less than 1 year), and of such quality that this experience or training, when combined with the education, will have provided the individual with education and training in medical technology equivalent to that described in subparagraph (1) or (2) of this paragraph. Distribution of course work: (Where semester hours are stated, it is understood that the equivalent in quarter hours is equally acceptable. The courses must have included lecture and laboratory work. Survey courses are not acceptable.)

(i) For those whose training was completed prior to September 15, 1963: At least 24 semester hours in chemistry and biology courses of which not less than 9 semester hours must have been in chemistry and must have included at least 6 semester hours in inorganic chemistry, and not less than 12 semester hours must have been in biology courses pertinent to the medical sciences.

(ii) For those whose training was completed after September 15, 1963: 16 semester hours in chemistry courses which included at least 6 semester hours in inorganic chemistry and

are acceptable toward a major in chemistry; 16 semester hours in biology courses which are pertinent to the medical sciences and are acceptable toward a major in the biological sciences; and 3 semester hours of mathematics.

(5) For a period ending June 30, 1971, an exception to the requirements in subparagraph (1), (2), (3), or (4) of this paragraph may be made if (i) the technologist was performing the duties of a clinical laboratory technologist on, or within the 5 years preceding, July 1, 1966, and (ii) the technologist has had at least 10 years of pertinent clinical laboratory experience prior to July 1, 1966: Provided, That a minimum of 30 semester hours of credit toward a bachelor's degree from an accredited institution with a chemical, physical or a biological science as his major subject or 30 semester hours in an approved school of medical technology shall reduce the required years of experience by 2 years, with any additional hours further reducing the required years of experience at the rate of 15 hours for 1 year.

(6) The technologist who meets the requirements under subparagraph (5) of this paragraph may continue to qualify under the program after June 30, 1971, if he has performed the duties of a clinical laboratory technologist for at least 2 years between July 1, 1966, and July , 1971, or during the 10-year qualifying period in subparagraph (5): (i) In a clinical laboratory - with a director at the doctoral level - of a hospital, university, health department, or medical research institution; or (ii) in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State; or (iii) in a laboratory approved under the supplementary medical insurance program: Provided also, That where qualifying years in a laboratory described in (i) or (ii) of this paragraph are obtained after June 30, 1966, the laboratory meets applicable conditions under the health insurance program.

(c) Standard; Technician - Duties. - Clinical laboratory technicians are employed in sufficient number to meet the workload demands of the laboratory and they function only under direct supervision of a clinical laboratory technologist. The factors explaining the standard are as follows:

(1) Each clinical laboratory technician performs only those laboratory procedures which require limited technical skill and responsibility and a minimal exercise of independent judgment.

(2) No one with lesser qualifications than a clinical laboratory technician performs laboratory procedures, although manual and clerical supplemental services may be rendered by others.

(3) No clinical laboratory technician performs tests in the absence of a clinical laboratory technologist.

A Guide for Operating Ambulance Fleets

OBJECTIVE

The objective of this guide is to suggest minimum standards that the ambulance fleet operator can use as guidelines to help:

1. Prevent accidents involving his drivers.
2. Establish sound operating policies for his fleet.

PURPOSE

The purpose of this guide is to provide a tool that can be used to increase the safety and efficiency of ambulance fleet drivers and vehicles.

INTRODUCTION

The ambulance fleet operator has but one service to provide: the transportation of people. It is vitally important that this is done safely and efficiently. Safety and efficiency cannot be separated in any business. Among other things, accidents mean loss of revenue, and avoiding such loss is one of the chief functions of management.

Therefore, efficient management prevents accidents. If a job is to be done efficiently, it must be done safely.

What is included in this loss of revenue due to accidents? Let's take a quick look. Accidents occurring in ambulance fleets can be costly in terms of higher insurance premiums, profit loss due to lawsuits, permanent or temporary loss of experienced employees, the cost of management's time investigating and straightening out the accident, vehicle repair or replacement, and also in terms of poor public relations.

Sound operating policies, good driver selection and training programs, and adequate maintenance programs can help reduce accident experience

and costs. These, in turn, can increase the gross revenue of the ambulance fleet operator.

The ambulance driver must be a top professional because of the nature of his job: *he must do more than the average driver to avoid accidents.* He must be able to anticipate hazardous movements by other motorists and drive defensively in order to avoid collisions even though it is the other driver's error. In addition, he must be able to drive in a way that will not add discomfort, illness, or injury to his passengers.

It is very important, therefore, that the ambulance fleet operator use the latest techniques to select and train drivers.

Also, his vehicles must be in top mechanical condition so they operate properly at all times and can be relied upon when emergency calls are received. It is important that a regularly scheduled preventive maintenance program be established to insure peak vehicle performance.

Ambulance fleet operators should establish operating policies and put them in writing. In addition to the general operating procedures, these policies should spell out:

1. The minimum selection requirements for qualifying drivers.
2. The amount and type of training drivers should receive before they are permitted to drive an ambulance.
3. A schedule of substitute drivers in the event regularly authorized drivers are absent.

ESTABLISHING AMBULANCE FLEET OPERATING POLICY

The nature of ambulance service and the special provisions of motor vehicle regulations pertaining to it involves a responsibility for operational procedure more demanding than that of other fleet operations.

First, how is an *emergency* defined that would affect an ambulance fleet operator and second, what is an *authorized emergency vehicle?*

Definitions

1. *Emergency*—An unexpected occurrence resulting in an immediate need of attention to preserve life or lives, and/or to relieve undue suffering.

   (Of course, in this definition, good judgment is needed to determine the immediacy of the need for attention.)
2. *Authorized Emergency Vehicle*—Vehicles of the fire department (fire patrol), police vehicles and such ambulances and emergency vehicles of municipal departments or public service corporations as are designated or authorized by the commissioner or the chief of police of an

incorporated city. (Uniform Vehicle Code—Section 1-103, 1962 edition)

Receiving Information and Initial Identification of an Emergency

People become excited when confronted with unexpected illness or injury and usually don't think as clearly as they would under normal conditions.

Sketchy information given by the person calling for ambulance service can result in failure to get all the facts needed to handle the call quickly and properly. It is especially important that the person receiving the call get complete information so he can determine any unusual conditions needing special attention. However, if the call is from a physician, it should be his decision whether the case requires special attention.

To accurately identify an emergency, the ambulance fleet operator should train employees to properly handle the incoming calls and dispatch service needed. An emergency information checklist and dispatch form should be used to record information about each call. This will ensure getting all the facts, the exact location and the nature of the emergency so that the dispatcher and driver can properly evaluate the operational procedure. (See Figure 1 for a sample emergency information checklist and dispatch form.)

Dispatching Procedure

Generally, a person calling for ambulance service wants it right away, even if the nature of the illness or injury may not warrant speed.

The following is an example of effective dispatching procedure:

1. Dispatcher receives call for an ambulance.
2. Records time call was received.
3. Records information on dispatch form.
4. If an ambulance is not available for immediate dispatch when the call comes in, and the situation calls for immediate action, the dispatcher should accept the call and notify an alternate company to handle the call. Alternate ambulance facilities should be known and their telephone numbers kept on hand.
5. Dispatcher gives caller an estimated time that the ambulance will arrive.
6. Gives information on the type of emergency and location to the driver (this information should be recorded on the dispatch form).
7. Informs driver if emergency traffic regulations should be observed

2. Side streets and rural highway intersections
3. Approaching a traffic signal which is against the ambulance
4. Proper following distance
5. Passing techniques
6. Curves, hills and hidden dangers
7. Braking and acceleration

Local and state police departments may be able to provide the ambulance fleet operator with instruction in the most important aspects of each of the above subject areas. Basic data on emergency driving is provided in the North Carolina Highway Patrol's book "Police Pursuit Driving" and the U. S. Treasury Department's booklet "Pursuit Driving." (See References 14 and 23.)

VEHICLE AND EQUIPMENT MAINTENANCE

Both the ambulance and its equipment must be ready at the point of dispatch. A well-defined maintenance policy will ensure that the vehicle is in top mechanical condition at all times.

Routine preventive maintenance checks of the vehicles including brakes, steering, exhaust, emergency lights, and audible warning devices, etc., should be made each day.

Tires should also be checked carefully on a regularly scheduled program. Tire maintenance should include the following:

1. Proper inflation every time the vehicle is serviced for gas. Variation of air pressure can indicate hidden defects.
2. Careful checks for wear, cracks and scuffs at least once every 500 to 1,000 miles.
3. Rotation of the tires every 1,000 miles for maximum tire life.
4. Careful check of tire for possible replacement every 8,000 to 15,000 miles. Tire replacement should be made when the tread depth is worn to $\frac{3}{32}$'s of an inch.

During winter months, where weather conditions warrant, special duty tires, snow tires, or reinforced tire chains should be used for maximum safety. Snow tires should receive the same maintenance as regular tires. Tire chains should be checked daily when in use.

Windows must always be clean and free from all obstructions. Vehicle lights must also be kept clean and properly adjusted. Periodic

VEHICLE AND EQUIPMENT CHECKLIST

VEHICLE	OK	Needs Adjusting		OK	Needs Adjusting
1. Gas	☐	☐	9. Turn signals	☐	☐
2. Oil	☐	☐	10. Emergency lights	☐	☐
3. Water	☐	☐	11. Wipers	☐	☐
4. Battery	☐	☐	12. Horn	☐	☐
5. Brakes	☐	☐	13. Siren	☐	☐
6. Tires	☐	☐	14. Windows	☐	☐
7. Head lights	☐	☐	15. 2-Way radio	☐	☐
8. Stop lights	☐	☐	16. Heaters	☐	☐

Remarks: _____

EQUIPMENT	OK	Short	Replaced		OK	Short	Replaced
1. Pillows	☐	☐	☐	9. Mouth-to-mouth Airways	☐	☐	☐
2. Blankets and Sheets	☐	☐	☐	10. Tongue Depressors	☐	☐	☐
3. Oxygen	☐	☐	☐	11. Tourniquets	☐	☐	☐
4. Mask	☐	☐	☐	12. Other first-aid equipment	☐	☐	☐
5. Splints	☐	☐	☐	13. Fire-extinguishing equipment	☐	☐	☐
6. Bandages and Shears	☐	☐	☐	14. Warning devices	☐	☐	☐
7. Dressings	☐	☐	☐				
8. Adhesive Tape	☐	☐	☐				

Remarks: _____

should be installed properly and visually checked periodically for signs of wear or weakness.

The emergency equipment should be checked periodically to see that it is in working order. This includes the normal first-aid emergency equipment as well as any other emergency equipment: flags, flares, fusees, other warning devices, fire extinguishing equipment.

Driver's Inspection of the Vehicle and Equipment

As each driver's shift begins, his first duty should be to inspect his vehicle and equipment to make sure they are in top operating order.

A daily vehicle and equipment inspection should include checking the tires, brakes, windows, lights, windshield wipers, gas, oil, water, heaters, battery, horn, warning devices, and 2-way radios. Any deficiencies in the vehicle, or equipment should be immediately reported to the dispatcher. (See Figure 3.)

Next, he should adjust the movable parts in the driving compartment to suit his stature. The seat should be adjusted for correct body posture, comfort, and maximum efficiency in handling the driving controls. Rear-view mirrors inside and outside must be adjusted to allow maximum sight to the rear and sides of the vehicle. Finally, the safety belt should be adjusted to fit the driver.

Preferably vehicle inspection should be completed, and the adjustments made, when the driver reports for duty and prior to his response to calls.

QUICK REMINDERS FOR POSTING AND REPETITION

Seven rules of thumb recommended in the Pennsylvania Department of Health's "Ambulance Attendant Training Pilot Project Report" (See Reference 2) can serve as reminders to ambulance drivers and might be used for posting and repeated emphasis. Basically, they are:

1. Use warning lights and siren *only* on bona fide emergency trips. They should not be used on practice runs or other non-essential trips.
2. When warning lights and siren are in use, don't assume other motorists and pedestrians will give you the right-of-way. As you drive, check other traffic to make sure other drivers are responding

(d) **Standard. Technician - qualifications.** Each clinical laboratory technician possesses a current license as a clinical laboratory technician issued by the State, if such licensing exists, and meets the requirements of subparagraphs (1), (2), (3), or (4), or (4) and (5) of this paragraph:

(1) He is a high school graduate and subsequent to graduation has completed at least 1 year in a technician training program approved by the Council on Medical Education and Hospitals of the American Medical Association or approved by the Secretary.

(2) He is a high school graduate and subsequent to graduation has served 2 years as a technician trainee in a clinical laboratory with a director at the doctoral level, or in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State.

(3) He is a high school graduate and subsequent to graduation has successfully completed an official military medical laboratory procedures course of at least 50 weeks' duration, and has held, at the journeyman's level, the military enlisted occupational specialty of Medical Laboratory Specialist (Laboratory Technician).

(4) For a period ending June 30, 1971, an exception to the requirements in subparagraph (1), (2), or (3) of this paragraph may be made if (i) the technician was performing the duties of a clinical laboratory technician on, or within the 5 years preceding, July 1, 1966, and (ii) the technician has had at least 5 years of pertinent clinical laboratory experience prior to July 1, 1966: Provided, That a minimum of 30 semester hours of credit toward a bachelor's degree from an accredited institution with a chemical, physical, or a biological science as his major subject or 30 semester hours in an approved school of medical technology shall reduce the required years of experience by 2 years, with any additional hours further reducing the required years of experience at the rate of 15 hours for 1 year: And provided also, That the required 5 years of experience shall not be so reduced by more than 4 years.

(5) The technician who meets the requirements under subparagraph (4) of this paragraph may continue to qualify under the program after June 30, 1971, if he has performed the duties of a clinical laboratory technician for at least 2 years between July 1, 1966, and July 1, 1971, or during the 5-year qualifying periods in subparagraph (4): (i) In a clinical laboratory - with a director at the doctoral level - of a hospital, university, health department, or medical research institution; or (ii) in a State which regulates clinical laboratory personnel, in a clinical laboratory acceptable to that State; or (iii) in a laboratory approved under

the supplementary medical insurance program: Provided also, that where qualifying years in a laboratory described in (i) or (ii) of this paragraph are obtained after June 30, 1966, the laboratory meets applicable conditions under the health insurance program.

National Safety Council
425 North Michigan
Chicago, Illinois
60611

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7. Filing

8. Out-slip

9. Follow-up

F. Other Filing Systems

Supplemental Teaching Aids:

Good resource people for this unit are school librarians or bank employees. A visit to a local library to observe its filing system is useful also.

The following are good resource books for the unit; Business Filing and Records Control, 3rd ed., Ernest D. Brasett, South-Western, Cincinnati, 1963, Records Management, Mary C. Griffin, Allyn and Bacon, Boston, 1964, and Gregg Quick Filing Practice, McGraw-Hill, New York, 1965.

A useful programmed instruction book is Basic Rules of Alphabetic Filing, by Fahrner and Gibbs, South-Western, Cincinnati, 1965. Free or inexpensive pamphlets are available from Smead Manufacturing Co., Hastings, Minnesota (Do's & Dont's of Filing and Science of Filing), and from the Oxford Filing Supply Company, Inc., Garden City, N. Y. 11533(33 Common Filing Questions.) Remington Rand, Systems Division has the film "It must be somewhere", while Cornet Films has "Filing Procedures in Business".

Training Time 15-20 hours

2242

STANDARD REPORT OF ALCOHOL INVOLVEMENT IN FATAL MOTOR VEHICLE TRAFFIC ACCIDENTS

This form is intended to record the extent of alcohol involvement in FATAL Motor Vehicle Accidents. It is restricted to drivers and pedestrians, 15 years or older, who die within 4 hours of an accident. This includes ALL reported traffic fatalities, not only those tested for alcohol. Thus, it is to include results of post-mortem examinations and the results of ante-mortem studies in hospitals and clinics. However, no case in which post-accident survival was 4 hours or more is to be included. This form should not be completed on the basis of the final legal disposition of the cases, but, rather, on the basis of the considered judgment of the person completing it.

OFFICE OF RECORD _____ STATE _____
(Coroner, Health Dept., etc.)

REPORT PREPARED BY _____ DATE _____

REPORT COVERS CASES DATING FROM _____ TO _____

TYPE OF FATALITY			TOTAL DEATHS WITHIN 4 HOURS	NUMBER TESTED FOR ALCOHOL	NO. OF CASES IN EACH RANGE OF ALCOHOL CONCENTRATION					
					NEGA-TIVE	0.01 - 0.04%	0.05 - 0.09%	0.10 - 0.14%	0.15 - 0.24%	OVER 0.25%
PEDESTRIANS	AGED	15-64								
		65 --								
		TOTAL								
DRIVERS	CATEGORIES (*)	A								
		B								
		C								
		D								
		E								
		F								
		G								
		TOTAL								

(*) A. Only one vehicle involved – its driver fatally injured.
B. More than one vehicle involved, but only one in motion – its driver fatally injured.
C. More than one vehicle involved, but only one in motion – driver of nonmoving vehicle fatally injured.
D. More than one vehicle involved and in motion – driver in responsible vehicle fatally injured.
E. More than one vehicle involved and in motion – driver in nonresponsible vehicle fatally injured.
F. More than one vehicle involved and in motion – responsibility of fatally injured driver unknown or not clear.
G. More than one vehicle involved and in motion – two or more drivers fatally injured.

With respect to Categories D,E,F, and G above, the following explanations are offered:

- D should be chosen where there would be no reasonable doubt as to which driver or vehicle was responsible for an accident due to the dynamics of the crashes involved. An example might be a driver who crosses a median strip and hits an innocent driver, killing himself.
- E should be chosen if, in the example given above, the innocent driver is killed rather than the crossing driver.
- F should be chosen where there is no clear evidence which driver was at fault.
- Each driver killed in the G Category should be listed in the appropriate column of the form.

CONTROL OF THE DRINKING DRIVER

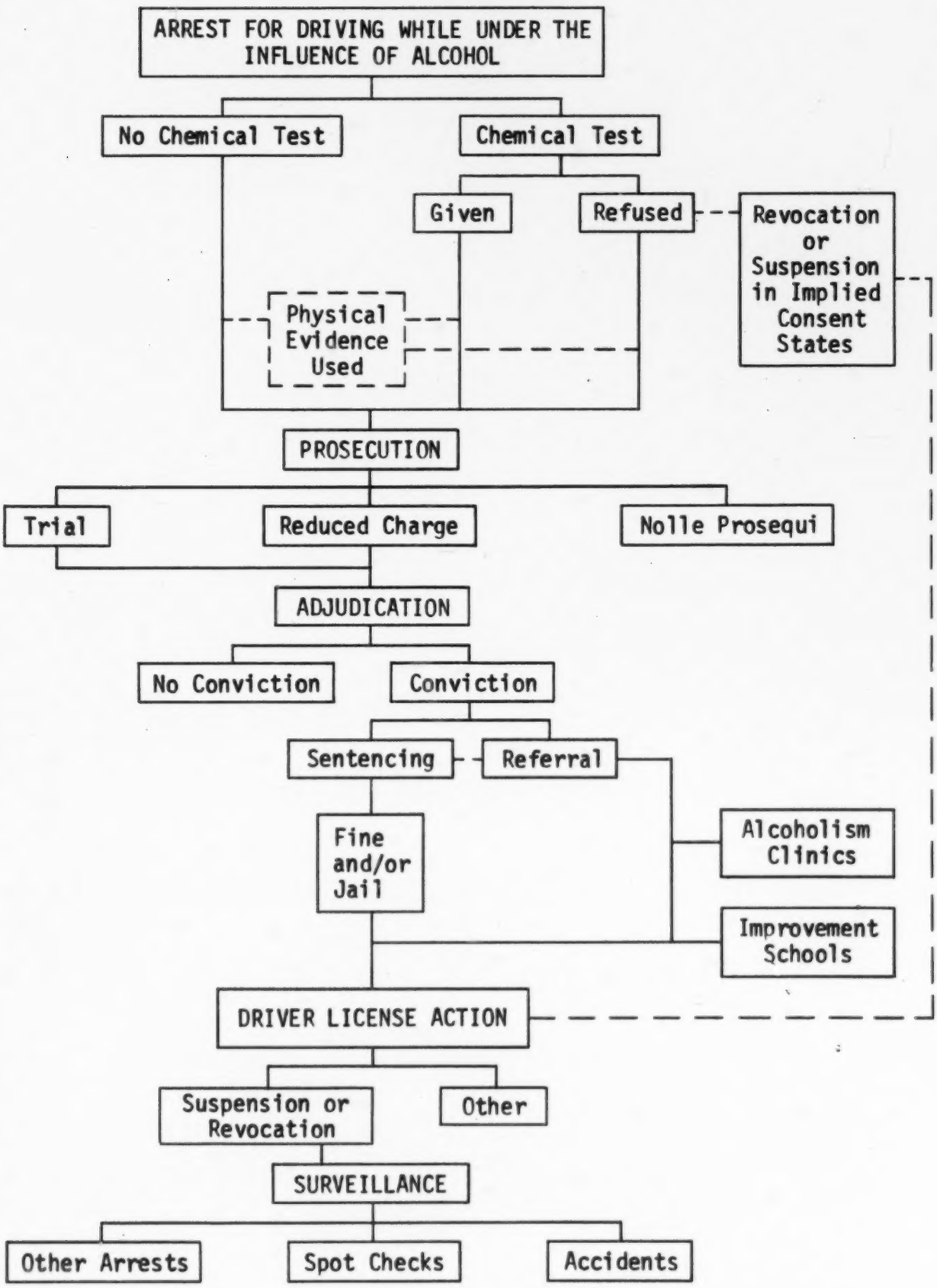

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National Safety Council, Chicago, Ill. Dept. of Motor Transportation.
MF AVAILABLE IN VT-ERIC SET.
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ABSTRACT - To provide a tool that can be used to increase the safety and efficiency of ambulance fleet drivers and vehicles, this guide was developed by the National Safety Council. The objective is to suggest minimum standards that the ambulance fleet operator can use as guidelines to help in preventing accidents involving his drivers and in establishing sound operating policies for his fleet. Topics are: (1) Establishing Operating Policy, (2) Selection of Drivers, (3) Driver Instruction, (4) Special Requirements of Ambulance Driving, (5) Emergency Vehicle Driving, (6) Vehicle and Equipment Maintenance, and (7) Quick Reminders for Posting and Repetition. References, a model ordinance, and a uniform vehicle code are appended. (GB)

A GUIDE FOR

OPERATING AMBULANCE FLEETS

ED0 56238

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VT013445

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Virginia State Police

A GUIDE FOR

OPERATING AMBULANCE FLEETS

NATIONAL SAFETY COUNCIL
Motor Transportation Department

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A Guide for Operating Ambulance Fleets

OBJECTIVE

The objective of this guide is to suggest minimum standards that the ambulance fleet operator can use as guidelines to help:

1. Prevent accidents involving his drivers.
2. Establish sound operating policies for his fleet.

PURPOSE

The purpose of this guide is to provide a tool that can be used to increase the safety and efficiency of ambulance fleet drivers and vehicles.

INTRODUCTION

The ambulance fleet operator has but one service to provide: the transportation of people. It is vitally important that this is done safely and efficiently. Safety and efficiency cannot be separated in any business. Among other things, accidents mean loss of revenue, and avoiding such loss is one of the chief functions of management.

Therefore, efficient management prevents accidents. If a job is to be done efficiently, it must be done safely.

What is included in this loss of revenue due to accidents? Let's take a quick look. Accidents occurring in ambulance fleets can be costly in terms of higher insurance premiums, profit loss due to lawsuits, permanent or temporary loss of experienced employees, the cost of management's time investigating and straightening out the accident, vehicle repair or replacement, and also in terms of poor public relations.

Sound operating policies, good driver selection and training programs, and adequate maintenance programs can help reduce accident experience

22796

Local and state police departments may be able to provide the ambulance fleet operator with instruction in the most important aspects of each of the above subject areas. Basic data on emergency driving is provided in the North Carolina Highway Patrol's book "Police Pursuit Driving" and the U. S. Treasury Department's booklet "Pursuit Driving." (See References 14 and 23.)

VEHICLE AND EQUIPMENT MAINTENANCE

Both the ambulance and its equipment must be ready at the point of dispatch. A well-defined maintenance policy will ensure that the vehicle is in top mechanical condition at all times.

Routine preventive maintenance checks of the vehicles including brakes, steering, exhaust, emergency lights, and audible warning devices, etc., should be made each day.

Tires should also be checked carefully on a regularly scheduled program. Tire maintenance should include the following:

1. Proper inflation every time the vehicle is serviced for gas. Variation of air pressure can indicate hidden defects.
2. Careful checks for wear, cracks and scuffs at least once every 500 to 1,000 miles.
3. Rotation of the tires every 1,000 miles for maximum tire life.
4. Careful check of tire for possible replacement every 8,000 to 15,000 miles. Tire replacement should be made when the tread depth is worn to $\frac{3}{32}$'s of an inch.

During winter months, where weather conditions warrant, special duty tires, snow tires, or reinforced tire chains should be used for maximum safety. Snow tires should receive the same maintenance as regular tires. Tire chains should be checked daily when in use.

Windows must always be clean and free from all obstructions. Vehicle lights must also be kept clean and properly adjusted. Periodic checks of the headlights for proper adjustment can easily be incorporated into the scheduled preventive maintenance checks.

Safety belts for the driver and attendant as well as patient cinches

2. Side streets and rural highway intersections
3. Approaching a traffic signal which is against the ambulance
4. Proper following distance
5. Passing techniques
6. Curves, hills and hidden dangers
7. Braking and acceleration

incorporated city. (Uniform Vehicle Code—Section 1-103, 1962 edition)

Receiving Information and Initial Identification of an Emergency

People become excited when confronted with unexpected illness or injury and usually don't think as clearly as they would under normal conditions.

Sketchy information given by the person calling for ambulance service can result in failure to get all the facts needed to handle the call quickly and properly. It is especially important that the person receiving the call get complete information so he can determine any unusual conditions needing special attention. However, if the call is from a physician, it should be his decision whether the case requires special attention.

To accurately identify an emergency, the ambulance fleet operator should train employees to properly handle the incoming calls and dispatch service needed. An emergency information checklist and dispatch form should be used to record information about each call. This will ensure getting all the facts, the exact location and the nature of the emergency so that the dispatcher and driver can properly evaluate the operational procedure. (See Figure 1 for a sample emergency information checklist and dispatch form.)

Dispatching Procedure

Generally, a person calling for ambulance service wants it right away, even if the nature of the illness or injury may not warrant speed.

The following is an example of effective dispatching procedure:

1. Dispatcher receives call for an ambulance.
2. Records time call was received.
3. Records information on dispatch form.
4. If an ambulance is not available for immediate dispatch when the call comes in, and the situation calls for immediate action, the dispatcher should accept the call and notify an alternate company to handle the call. Alternate ambulance facilities should be known and their telephone numbers kept on hand.
5. Dispatcher gives caller an estimated time that the ambulance will arrive.
6. Gives information on the type of emergency and location to the driver (this information should be recorded on the dispatch form).
7. Informs driver if emergency traffic regulations should be observed

INFORMATION AND DISPATCH FORM

1. Date _____ Time _____ a.m. p.m.

2. Name _____ (of person calling)

   Telephone No. _____

3. From _____ (address where patient is)

   _____

   _____

   To _____ (destination of patient)

   _____

   _____

4. Type of Emergency
   - ☐ Vehicle Collision
   - ☐ Illness
   - ☐ Other _____

5. Description of Emergency
   - ☐ Bodily Injury
   - ☐ Heart Attack
   - ☐ Drowning
   - ☐ Poisoning
   - ☐ Bleeding
   - ☐ Stroke
   - ☐ Convulsion
   - ☐ Heat Stroke
   - ☐ Other: _____

6. Type of Driving
   - ☐ Routine call—Observe all traffic regulations
   - ☐ Unusual call—Avoid unnecessary delays but waive traffic regulations *only* when necessary and then only with great caution

7. Driver: _____

   Attendant: _____

8 Remarks: _____

9. Dispatcher: _____ Dispatch Time: _____ a.m. p.m.

UNIT XI (14.0703-05)

SOURCES OF INFORMATION

Performance Objectives:

Upon completion of this unit the student will be able to demonstrate her knowledge of information sources by compiling a list of information to meet specifications designated by the instructor.

Unit Outline:

A. Reference Books as a Tool of the Office Worker

1. Importance of accurate business information

2. Kinds of information needed

3. Necessity of obtaining information quickly

4. Necessity for initiative in finding information

B. Reference Books of the Office Worker

1. Dictionaries

2. Reference manual for stenographers and typists

3. English grammar and style books

4. Directories

5. Thesaurus

C. Other Sources of Factual Information

Supplemental Teaching Aids:

The most obvious resource pereon is of course the librarian. Also available is the Gregg Secretarial Record #6, and Set #2 Finding Needed Information. The film "Look It Up-Dictionary Habits" (11 min.) is available from Cornet Instructional Films.

Training Time 3-5 hours

(for details: "En Route to and From Scene of Emergency" and "Appendix C").

8. Records time ambulance was dispatched.
9. Makes sure that medical care is available to patient upon arrival at the hospital, or other destination.
10. Notifies police agencies concerned of an emergency run that occurs in their respective territories. (Many times police agencies become involved in emergency calls, especially in cases of automobile accidents. If the ambulance dispatcher notifies the police, and vice versa, each will know if the other is en route to the emergency scene. Where both are using sirens, this procedure may help prevent collisions between the police vehicle and the ambulance. Hopefully, neither driver will depend on his siren to guarantee his right-of-way and will observe traffic regulations.)

Dispatcher Control Over Drivers and Vehicles

It is very important that the dispatcher knows where his drivers and units are at all times and what they are doing so that he knows exactly what units are available or likely to be on standby. This information will also make it easier for the dispatcher to schedule routine assignments such as moving a patient from his home to a hospital or from one hospital to another.

Dispatchers should be able to tell accurately if the driver waived or observed traffic regulations according to instructions. This is based on time it takes to arrive at the location compared with the time he was dispatched.

The following procedure will give the dispatcher control over drivers and vehicles:

1. The driver radios or calls when he arrives at the destination to pick up a patient.
2. Unusual delays or circumstances should be reported at time of arrival at pickup location.
3. Driver radios or calls both when he arrives at and clears the final destination for possible in-service rescheduling.

The time of each call should be recorded on the master dispatch form.

Complete control of the driver and the driving situation by some ambulance agencies is obtained by requiring that drivers radio to get permission to use the siren, to exceed speed limits, or to waive certain operating precautions. If an ambulance crew arrives at the scene of an emergency and finds conditions worse than first thought to be, the driver radios this information to the dispatcher. The dispatcher then decides

AMBULANCE SIREN REPORT

ORDERED BY_____

REASON FOR USE_____

* * * *

IF USED FROM SCENE, WHY?_____

_____

DISPATCHER_____ DRIVER_____ ATTN._____

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Figure 2—Sample ambulance siren report.

whether or not the siren should be used and any other precautionary measures should be taken. This can be documented by using an ambulance siren report. (See Figure 2.)

Another control device used by some ambulance operators is the Tachograph: a mechanical device that records vehicle speeds and non-moving intervals in relation to the time of day. The dispatcher can check the speed recorded on the Tachograph with the route through which the driver traveled. If unnecessary speeds are identified, the driver should be cautioned against abusive use of emergency running time and the dangers involved should be impressed upon him.

En Route to and From Scene of Emergency

Through the years, high speed and chance-taking have been associated with ambulance service. Flashing emergency lights and sirens to warn motorists lead to a false sense of security. Often when other drivers fail to heed such devices and fail to follow the regulations, serious accidents have resulted. It is not the purpose of emergency equipment, flashing lights and sirens, to aid the driver in exceeding speed limits, but to keep the ambulance moving at a safe and constant speed.

In recent years the need for speed, the emergency right-of-way, and use of sirens and flashing lights has been seriously challenged by physicians and ambulance fleet operators.

A one-year study conducted in New York City showed that accidents were reduced by one-third when ambulance drivers obeyed traffic regulations and did not use sirens. This reduction occurred even though more than twice as many calls were answered during that year than in previous years. Another part of this study revealed that one of the major causes of ambulance accidents was the reliance that drivers placed on a siren to give them the right-of-way. (See References 11 and 16.)

A study of ambulance accident cases conducted by the National Safety Council in 1961 supported the New York City findings regarding accident causes and the unsatisfactory reliance placed on the siren and flashing emergency lights by ambulance drivers to clear a path for them. (See Reference 7.)

The use of speed in answering emergency calls was questioned by physicians Curry and Lyttle, Flint, Mich., in their study of 2,500 Flint city ambulance runs. Their findings showed that *haste in transporting the injured was unnecessary in 98.2 per cent of the cases.* In the other cases, expeditious handling was considered necessary, but a speeding ambulance could have *increased* the severity of the injuries.

From their study they concluded that, *except in rare cases,* speed is not necessary and that traffic regulations and control devices should be followed when going to and from an emergency scene. (See References 3 and 12.)

Prompt responses to a call and prompt first-aid treatment at the scene usually eliminates the need for excessive speed.

At the Emergency Scene

When the driver arrives at the emergency scene he should park the ambulance close enough to facilitate handling the patient and to minimize interference with traffic.

Standard Emergency Equipment

Each ambulance should carry adequate equipment, as recommended by the Committee on Trauma of the American College of Surgeons, for dressing wounds, splinting fractures, controlling hemorrhage, and resuscitation. (See Reference 18.)

Other Useful Equipment

Rescue equipment that has been helpful, in addition to medical aid, are the tools needed to gain entry into a smashed vehicle. These include pry bars, tow cable (about 50 feet long), a dry chemical, multi-purpose

fire extinguisher, and other devices. When this equipment is carried, it should be stored in a place where it will not come in contact with sterile equipment in the ambulance.

Routing

Planned routing, because it establishes the best and most direct routes to various sectors of an area, will save time when going to the scene of an emergency. It will also reduce the possibility of a driver's being delayed by slow moving traffic or routes normally congested during certain periods of the day.

A plan for routing should include:

1. Dividing the area into sections.
2. Test runs conducted over the selected routes during peak traffic hours of the day and night to determine alternate routes available.
3. Test runs (not in ambulance vehicles, necessarily, and *never* with emergency lights or siren on) should be made at regular intervals. This will determine possible new routes, community construction that may cause heavier traffic, congestion or reduced speed areas of operation.
4. Maintaining an up-to-date area map.
5. A trip report following each service call that reveals new information to keep the route map up to date.

If a community ambulance fleet is of a size that warrants assigning each driver to a particular area of the city, each driver should be trained to be familiar with the streets and traffic patterns in his area. In smaller cities, drivers should be well acquainted with the entire street system. Whether the city served is large or small, alternate routes should be planned in case regular routes are blocked.

SELECTION OF DRIVERS OR ATTENDANT DRIVERS

Personal supervision of an ambulance driver is usually impossible once he is dispatched. Control of a driver, however, begins with his selection. Since ambulance driving is specialized, it is very important that the fleet employ only the very best of drivers.

Qualities of a prospective driver that can be checked and will help predict whether or not he will be a good driver include:

1. Ability in the driving task. Can the applicant operate a motor vehicle efficiently?
2. Are his physical qualifications acceptable?

3. Does he have a proper driving attitude?
4. Does he have the ability to recognize and anticipate possible accident-producing situations?
5. Is he emotionally stable, and does he have good character traits?

Four elements of the selection screening are related directly to driving. A thorough check of these conditions is the first step in selecting a good driver.

1. Driving Experience
   a. Type of vehicle—What type of vehicle has the applicant driven? For how long?
   b. What type of operator's license does he have?
   c. Type of driving job—What type of driving did the applicant previously perform?
2. Past Driving Record
   a. Violations—What is the applicant's history of traffic violations in both his personal and professional driving?
   b. Accidents—Has the applicant been involved in any? How many and what was the nature and cause of each? Were these preventable or not?
3. Previous Driver Instruction
   a. Classroom—Did the applicant receive formal classroom driving instruction? How much? Professional driver training? Did previous employer conduct training? Did the applicant receive high-school driver education training?
   b. Behind-the-wheel—Has the applicant had any behind-the-wheel driver training? What types of vehicles? How much? Did previous employer conduct driver training?
4. Physical Fitness
   a. Physical examination—Is a physical examination made before the applicant is hired? Is a periodic physical exam required thereafter?
   b. Minimum standards prescribed by the American Medical Association—Does the applicant meet minimum standards? (See Reference 17.) If not, are there any corrective measures that can be taken to bring him up to the standards? Are corrective glasses, medication, or treatments indicated?

Important sources of information which should be thoroughly checked to determine the applicant's emotional stability and character are his past employment record, his credit references, and personal references.

There are three types of tests that help to determine the applicant's

attitude behind the wheel and his ability to recognize and anticipate possible accident-producing situations. These tests are:

1. Traffic and driving knowledge tests. (For example, see Reference 21.)
2. Driving skill tests. (For example, see Reference 27.)
3. Attitude tests. (For example, see Reference 25.)

(NOTE: Attitude tests are still questioned as to their reliability and validity in predicting individual performance.)

Tests such as these can be very helpful in the driver selection process if they are used along with the steps previously discussed.

DRIVER INSTRUCTION

Once the applicant has been screened fully and employed, the next step is indoctrination. Ambulance driving is a specialized skill requiring special driving instruction.

Driver instruction consists of two parts: classroom instruction and behind-the-wheel training. The following outline lists suggests minimum instruction for trainees.

1. Classroom instruction
   a. Orientation
      (1) General description of the driver-training program and its content.
      (2) The traffic problem and its relation to accidents. (See Reference 13.)
      (3) The nature of the job and the problems connected with ambulance driving.
      (4) Description of the fleet safety program.
      (5) Discussion of the areas serviced by the fleet with attention to routes and hazards that might be encountered along these routes.
      (6) Instructions on the use and filling out of necessary forms and records.
   b. Physical laws and their effect on driving. (See Reference 13.)
      (1) Centrifugal force
      (2) Gravity
      (3) Kinetics
      (4) Friction
   c. Safe driving rules and regulations. (See References 13, 22 and 27.)

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(1) How the law provides special conditions.

(2) What is expected of the ambulance driver because of special conditions.

d. Laws and ordinances

(1) General—Local and state traffic regulations.

(2) Specific—Laws and ordinances for emergency vehicles. (See References 20 and 28.)

e. First-aid training. (See References 2, 8, 9 and 10.) Both drivers and attendants should be able to render first aid equivalent to the advanced American Red Cross course or the advanced United States Bureau of Mines first-aid qualifications. (The Committee on Trauma of the American College of Surgeons also recommends that annual first-aid refresher courses be given.)

2. Behind-the-wheel training

a. Basic driving skills. (See Reference 13.)

b. Emergency driving skills. (See "Emergency Vehicle Driving" Section of the Guide.)

SPECIAL REQUIREMENTS OF AMBULANCE DRIVING

It is very important that each new trainee be taught the special requirements of driving an ambulance and that he receives specific training in driving an ambulance.

As an introduction, the trainee might ride as a third man on an ambulance for a number of runs to observe how the general public reacts to sirens, red flashing lights, and the ambulance in general. In addition, the trainee might be placed on the emergency stretcher or cot in the ambulance while a skilled driver proceeds over a designated course so potential driver can feel the affects of riding in an ambulance. NOTE: This should *not* be done with siren or warning lights on. All traffic regulations should be observed.

The physical laws that affect an ambulance braking system and stopping distance must be related to the care and treatment of patients. Kinetic energy of a moving vehicle in relation to friction and gravity all come into play when bringing a vehicle to a stop. Friction and gravity tend to hold the vehicle to a given course. They can be overcome by the speed of the vehicle and its course. Abrupt changes tend to take control from the driver and involve uncomfortable conditions for the patient. (See Reference 13.)

Initial and repeated instruction is needed concerning physical changes

which are created by bad weather and slippery road conditions. The trainee must be thoroughly familiar with the effects of slippery road surfaces on stopping distances and other maneuvers of his vehicle. The relationship of visibility to operating speeds is also important to emphasize in training.

Roadside environment (such as buildings, and commercial and recreational areas) and conflicting traffic movement on the streets, plus the condition of the road (curves, chuck holes, and hills) can all contribute to the problems of ambulance driving. Driving should be adjusted accordingly.

Problems of driving an ambulance can also be affected by such conditions as the driver's health and emotional condition, which can change from day to day. Both driver and his supervisor must be taught to recognize these changes and to make necessary adjustments.

An angry or upset driver, or a physically unfit driver does not have his normal ability for quick decisions or react normally to situations that may require responses necessary under stress conditions. Unusual displays of anger or nervousness on the part of a driver should be considered clues to emotional stress. In such instances, it might be well to remove him from the driving roster because he might possibly be involved in an accident. This can inconvenience the ambulance fleet at the time, but it could save expense and trouble in the long run.

EMERGENCY VEHICLE DRIVING

Although it should be avoided as much as possible, when it is necessary to operate the ambulance at speeds over the posted limit, the ambulance driver should receive thorough specialized training. Emergency operation demands a high degree of skill, knowledge of the physical laws governing motor vehicle operation, rules of the road, eyesight, knowledge of the streets where the driving will be done, judgment, and experience. It should never be expected of the novice.

Previous driving experience must be considered in assigning "emergency" runs to new drivers. It takes much training to be prepared to make the important decisions required in ambulance driving. (See Reference 14.)

Specialized Instruction in Emergency Vehicle Driving

Specialized Instruction in the proper techniques of emergency driving should be given in at least the following:

1. Right-of-way (which is never guaranteed)

should be installed properly and visually checked periodically for signs of wear or weakness.

The emergency equipment should be checked periodically to see that it is in working order. This includes the normal first-aid emergency equipment as well as any other emergency equipment: flags, flares, fusees, other warning devices, fire extinguishing equipment.

Driver's Inspection of the Vehicle and Equipment

As each driver's shift begins, his first duty should be to inspect his vehicle and equipment to make sure they are in top operating order.

A daily vehicle and equipment inspection should include checking the tires, brakes, windows, lights, windshield wipers, gas, oil, water, heaters, battery, horn, warning devices, and 2-way radios. Any deficiencies in the vehicle, or equipment should be immediately reported to the dispatcher. (See Figure 3.)

Next, he should adjust the movable parts in the driving compartment to suit his stature. The seat should be adjusted for correct body posture, comfort, and maximum efficiency in handling the driving controls. Rear-view mirrors inside and outside must be adjusted to allow maximum sight to the rear and sides of the vehicle. Finally, the safety belt should be adjusted to fit the driver.

Preferably vehicle inspection should be completed, and the adjustments made, when the driver reports for duty and prior to his response to calls.

QUICK REMINDERS FOR POSTING AND REPETITION

Seven rules of thumb recommended in the Pennsylvania Department of Health's "Ambulance Attendant Training Pilot Project Report" (See Reference 2) can serve as reminders to ambulance drivers and might be used for posting and repeated emphasis. Basically, they are:

1. Use warning lights and siren *only* on bona fide emergency trips. They should not be used on practice runs or other non-essential trips.

2. When warning lights and siren are in use, don't assume other motorists and pedestrians will give you the right-of-way. As you drive, check other traffic to make sure other drivers are responding to your signals correctly.

3. If it is necessary to go through a red light, approach the corner cautiously and slowly. The siren and light must be functioning

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APPENDIX A

Urban Adult Con Surface Sensing to Emergency Patients

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APPENDIX B

A Social Evidence or Tribals Regarding Ambulance Service

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Draft of A Bill to Regulate Ambulance Service

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BILLS OF CONGRESS

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VT 011 920
Auto Damage Correction Occupations; A Suggested Outline of Service and Levels for the Automotive Industries Occupations. Special Field Test Edition.

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ABSTRACT - This curriculum guide is intended to assist instructors in identifying and organizing the course content necessary to prepare trainees for entry employment in the field of auto damage correction services. Based on services to be performed, content is divided into the major areas of General Services, Paint, Body, and Frame, with the instructional material for each area presented in outline form for basic, intermediate, and advanced levels. Outlines include: (1) level, (2) topics to be covered, (3) concepts to be developed, (4) teaching suggestions, and (5) applications. A bibliography and a listing of occupations ranging from entry to technical level within the field of auto damage correction are provided. (AW)

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well in advance of the crossing. Do not proceed through until you are sure all other traffic is stopped.

4. The use of siren and warning light should be used with discrimination.

5. Do not exceed the speed limits posted or dictated by weather and traffic conditions except under extreme conditions.

6. In unfavorable weather conditions such as ice, snow, or rain, always reduce speeds. Use snow tires or reinforced tire chains when necessary.

7. Don't endanger your own life and the lives of your patients. Many instances of D.O.A. have been caused by *poor* ambulance service and unnecessary chance-taking.

SUMMARY

Much has been learned about accident prevention in motor vehicle fleets which has resulted in the improvement of fleet operations and a savings of lives and dollars.

Standards of performance, established by the National Safety Council, when conscientiously applied, have proven extremely effective in reducing accidents. These standards provide a measure of driving performance that should be the goal of every successful fleet operation. These standards also provide a means of continuous in-service training in the techniques of defensive driving.

The four elements of a minimum fleet safety program include:

1. Set Standards—show drivers what is expected of them.
2. Show Them How—demonstrate how to meet the standards.
3. Keep Score—through complete accident records to determine whether drivers are meeting these standards.
4. Motivate—to show appreciation to drivers for doing a good job when they have met the standards.

The recommendations in this guide will help the ambulance fleet operator carry out the elements of a basic fleet safety program and will aid him in providing safe and efficient ambulance service. Other elements standard to all commercial driving have as much application to the ambulance fleet as to any other well-managed fleet operation.

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Uniform Vehicle Code Sections Pertaining to Emergency Vehicles

Sec. 1-103—Authorized emergency vehicle—Vehicles of the fire department (fire patrol), police vehicles and such ambulances and emergency vehicles of municipal departments or public service corporations as are designated or authorized by the commissioner (or the chief of police of an incorporated city).

Sec. 11-106—Authorized emergency vehicles

(a) The driver of an authorized emergency vehicle, when responding to an emergency call or when in the pursuit of an actual or suspected violator of the law or when responding to (but not upon returning from) a fire alarm, may exercise the privileges set forth in this section, but subject to the conditions herein stated.

(b) The driver of an authorized emergency vehicle may:

1. Park or stand, irrespective of the provisions of this chapter;
2. Proceed past a red or stop signal or stop sign, but only after slowing down as may be necessary for safe operation;
3. Exceed maximum speed limits so long as he does not endanger life or property; (Revised, 1956)
4. Disregard regulations governing direction of movement or turning in specified directions.

(c) The exemptions herein granted to an authorized emergency vehicle shall apply only when such vehicle is making use of audible and visual signals meeting the requirements of Sec. 12-218 of this act, except that an authorized emergency vehicle operated as a police vehicle need not be equipped with or display a red light visible from in front of the vehicle. (Revised, 1954)

(d) The foregoing provisions shall not relieve the driver of an authorized emergency vehicle from the duty to drive with due regard for the safety of all persons, nor shall such provisions protect the driver from the consequences of his reckless disregard for the safety of others.

Sec. 11-405—Operation of vehicles and streetcars on approach of authorized emergency vehicles

(a) Upon the immediate approach of an authorized emergency vehicle making use of audible and visual signals meeting the requirements of Section 12-218 of this act, or of a police vehicle properly and lawfully making use of an audible signal only: (Revised, 1954)

1. The driver of every other vehicle shall yield the right-of-way and shall immediately drive to a position parallel to, and as close as possible to the right-hand edge or curb of the roadway clear of any intersection and

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shall stop and remain in such position until the authorized emergency vehicle has passed, except when otherwise directed by a police officer.

2. Upon the approach of an authorized emergency vehicle, as above stated, the motorman of every streetcar shall immediately stop such car clear of any intersection and keep it in such position until the authorized emergency vehicle has passed, except when otherwise directed by a police officer.

(b) This section shall not operate to relieve the driver of an authorized emergency vehicle from the duty to drive with due regard for the safety of all persons using the highway.

Sec. 11-504—Drivers to exercise due care—Notwithstanding the foregoing provisions of this chapter every driver of a vehicle shall exercise due care to avoid colliding with any pedestrian upon any roadway and shall give warning by sounding the horn when necessary and shall exercise proper precaution upon observing any child or any obviously confused or incapacitated person upon a roadway. (Revised, 1962)

Sec. 12-218—Audible and visual signals on vehicles

(a) Every authorized emergency vehicle shall, in addition to any other equipment and distinctive markings required by this act, be equipped with a siren, exhaust whistle, or bell capable of giving an audible signal.

(b) Every school bus and every authorized emergency vehicle shall, in addition to any other equipment and distinctive markings required by this act, be equipped with signal lamps mounted as high and as widely spaced laterally as practicable, which shall be capable of displaying to the front two alternately flashing red lights located at the same level, and these lights shall have sufficient intensity to be visible at 500 feet in normal sunlight. (Revised, 1962)

(c) A police vehicle when used as an authorized emergency vehicle may, but need not, be equipped with alternately flashing red lights specified herein.

(d) The alternately flashing lighting described in subsections (b) and (c) of this section shall not be used on any vehicle other than a school bus or an authorized emergency vehicle. (New, 1962)

(e) The use of the signal equipment described herein shall impose upon drivers of other vehicles the obligation to yield the right-of-way and stop as prescribed in Sections 11-405 and 11-707 of this act. (New, 1954)

Sec. 12-401—Horns and warning devices

Paragraph (d)—Any authorized emergency vehicle may be equipped with a siren, whistle or bell, capable of emitting sound audible under normal conditions from a distance of not less than 500 feet and of a type approved by the department, but such siren shall not be used except when such vehicle is operated in response to an emergency call or in the immediate pursuit of an actual or suspected violator of the law, in which said latter events the driver of such vehicle shall sound said siren when reasonably necessary to warn pedestrians and other drivers of the approach thereof.

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APPENDIX "B"

A Model Ordinance or Statute Regulating Ambulance Service

INTRODUCTION

Development of this model ordinance or statute began in 1956 when representatives of the medical profession concluded that the medical profession had taken too little interest in preventing trauma, while those responsible for traffic safety were too little concerned with the human salvage operations of the doctors. This resulted in a Joint Action Program sponsored by: American College of Surgeons, American Association for the Surgery of Trauma, and National Safety Council.

Late in 1959 the policy committee of this group asked the Traffic Conference to develop a model ordinance or statute relating to the transportation of the injured. A special Conference Committee, representing the interests involved and including a legal consultant, was activated.

The ordinance or statute published here was developed after a number of meetings of the committee, and extensive correspondence with many interested groups. Numerous city ordinances and the National Institute of Municipal Law Officers' model were used as a guide. At the October 28, 1962, meeting of the special Conference Committee, representatives of many ambulance associations throughout the country offered several excellent suggestions which were incorporated. The model was approved, although not unanimously, by the Traffic Conference Executive Committee on April 3, 1963.

It was concluded at this meeting that such a regulation would be more effective if it became a state law. Therefore, the draft is designed so that, with appropriate changes, it may be used also as a Model Statute. Where feasible, a state statute is preferable to a local ordinance.

In Section 2, "Licensing Requirements," it is presumed that where the model is used as an ordinance, the city or county has legal authority under state law to adopt special license requirements for ambulances. The legal assumption, which should be verified in each case, is that the city or county has authority under its police power to prescribe regulations necessary to supplement state laws where the public safety and welfare so require. Therefore, it should be expressly understood that, in any state, the model, when adopted as an ordinance, must be modified to eliminate any conflict with existing state laws.

The intent of the model is to serve as a guide to improve a necessary public service and provide uniformity throughout the United States.

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Draft of
A Model Ordinance*
Regulating Ambulance Service

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*This draft is designed so that, with appropriate changes, it may be used also as a Model Statute. Where feasible, a State statute is preferable to a local ordinance.

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DRAFT OF ORDINANCE

An Ordinance to Regulate the Licensing, Inspection, and Operation of Ambulances, to Provide Standards for the Licensing of Ambulances and of Ambulance Drivers, Attendants, and Attendant-Drivers, to Provide for Renewal and Revocation of Licenses, to Require Written Records and Reports, to Provide for Traffic Regulation of Ambulances, and to Establish Penalties for Violation of its Provisions.

The (_____) of (_____)
enacting body — city or county

ordains as follows:

SECTION 1 **Definitions.**

(a) Unless otherwise specified, the term "Ambulance" means any privately- or publicly-owned motor vehicle that is specially designed or constructed, and equipped, and is intended to be used for, and is maintained or operated for the transportation of patients, including dual-purpose police patrol cars and funeral coaches or hearses which otherwise comply with the provisions of this Ordinance.

(b) "Attendant" means a trained and/or qualified individual responsible for the operation of an ambulance and the care of the patients whether or not the attendant also serves as driver.

(c) "Attendant-Driver" means an individual who is qualified as an attendant and a driver.

(d) "Driver" means an individual who drives an ambulance.

(e) "Dual-purpose police patrol car" means a vehicle, operated by a police department, that is equipped as an ambulance, even though it is also used for patrol or other police purposes.

(f) "Health Officer" means the (_____city or county_____) Health Officer or other designated official.

(g) "License Officer" means the (_____city or county_____) (_____designated officer_____).

(h) "Patient" means an individual who is stick, injured, wounded, or otherwise incapacitated or helpless.

(i) "Person" means any individual, firm, partnership, association, corporation, company, group of individuals acting together for a common purpose or organization of any kind, including any governmental agency other than the United States.

SECTION 2 **License Required***

(a) No person, either as owner, agent, or otherwise, shall furnish, operate, conduct, maintain, advertise, or otherwise be engaged in or profess to be engaged in the

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*These licensing requirements are based on the presumption that the city or county has legal authority under State law to adopt such special license requirements for ambulances. The legal assumption, which should be verified in each cases, is that the city or county has authority under its police power to prescribe regulations necessary to supplement State laws where the public safety and welfare so require.

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business or service of the transportation of patients upon the streets, alleys, or any public way or place of (_____city or county_____) unless he holds a currently valid license for an ambulance, issued pursuant to this Ordinance. An ambulance operated by an agency of the United States shall not be required to be licensed hereunder.

(b) No ambulance shall be operated, and no individual shall drive, attend or permit it to be operated on the streets, alleys, or any public way or place of (_____city or county_____) unless it shall be under the immediate supervision and direction of a person who is holding a currently valid license as an attendant-driver or attendant.

(c) *Provided however,* that no such licenses shall be required for an ambulance, or for the driver or attendant-driver of an

(i) ambulance, which is rendering assistance to licensed ambulances in the case of a major catastrophe or emergency with which the licensed ambulances of (_____city or county_____) are insufficient or unable to cope; or

(ii) is operated from a location or headquarters outside of (_____city or county_____) in order to transport patients who are picked up beyond the limits of (_____city or county_____) to locations within (_____city or county_____), or to transport patients who are picked up within (_____city or county_____) to locations beyond the limits of (_____city or county_____) but no such outside ambulance shall be used to pick up patients within (_____city or county_____) for transportation to locations within (_____city or county_____) unless the driver, attendant and attendant-driver and the person subject to the provisions of Section 2(a) of this Ordinance in respect of such ambulance, hold currently valid licenses issued pursuant to this Ordinance.

SECTION 3 **Application for Ambulance License.** Applications for ambulance licenses hereunder shall be made upon such forms as may be prepared or prescribed by the License Officer and shall contain:

(a) The name and address of the applicant and the owner of the ambulance.

(b) The trade or other fictitious name, if any, under which the applicant does business or proposes to do business.

(c) The training and experience of the applicant in the transportation and care of patients.

(d) A description of each ambulance, including the make, model, year of manufacture, motor and chassis number; current state license number; the length of time the ambulance has been in use; and the color scheme, insignia, name, monogram or other distinguishing characteristics to be used to designate applicant's ambulance.

(e) The location and descriptions of the place or places from which it is intended to operate.

(f) Such other information as the License Officer shall deem reasonably necessary to a fair determination of compliance with this Ordinance.

(g) An accompanying license fee of $_____.

SECTION 4 **Standards for Ambulance License**

(a) Each ambulance shall, at all times when in use as such,

(i) conform with the standards, requirements and regulations provided for in this ordinance for the transportation of patients, from the standpoint of health, sanitation, and safety, and the nature of the premises in which it is maintained;

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(ii) contain equipment conforming with the standards, requirements and regulations provided for herein, which equipment shall be in proper and good condition for such use;

(iii) comply with all currently applicable laws and local ordinances relating to health, sanitation and safety; and

(iv) be equipped with such lights, sirens, and special markings to designate it as an ambulance as may be prescribed in reasonable regulations promulgated by the License Officer; and

(b) Any change of ownership of a licensed ambulance shall terminate the license and shall require a new application and a new license and conformance with all the requirements of this Ordinance as upon original licensing.

(c) Application for transfer of any ambulance license to another or substitute vehicle shall require conformance with all the requirements of this Ordinance as upon original licensing. No ambulance license may be sold, assigned, mortgaged, or otherwise transferred without the approval of the License Officer and a finding of conformance with all the requirements of this Ordinance as upon original licensing.

(d) Each licensed ambulance, its equipment and the premises designated in the application and all records relating to its maintenance and operation as such, shall be open to inspection by the License Officer or his designated representatives during usual hours of operation.

(e) No official entry made upon a license may be defaced, removed, or obliterated.

SECTION 5 **Standards for Ambulance License—Liability Insurance**

(a) No ambulance license shall be issued under this Ordinance, nor shall such license be valid after issuance, nor shall any ambulance be operated in (_____ _____city or county_____), unless there is at all times in force and effect insurance coverage, issued by an insurance company licensed to do business in the State of (_____), for each and every ambulance owned and/or operated by or for the applicant or licensee, providing

(i) for injury to or death of individuals in accidents resulting from any cause for which the owner of said ambulance would be liable on account of liability imposed on him by law, regardless of whether the ambulance was being driven by the owner or his agent, and

(ii) against damage to the property of another, including personal property, under like circumstances, in such sums and under such terms as may be required in regulations promulgated by the License Officer.

(b) Said insurance policies shall be submitted to the License Officer for approval prior to the issuance of each ambulance license. Satisfactory evidence that such insurance is at all times in force shall be furnished to the License Officer, in such form as he may specify, by all licensees required to provide such insurance under the provisions of this Ordinance.

(c) Every insurance policy required hereunder shall contain a provision for a continuing liability thereunder to the full amount thereof, notwithstanding any recovery thereon, that the liability of the insurer shall not be affected by the insolvency or the bankruptcy of the assured, and that until the policy is revoked the insurance company will not be relieved from liability on account of non-payment of premium, failure to renew license at the end of the year, or any act or omission of the named assured.

(d) Every insurance policy required hereunder shall extend for the period to be covered by the license applied for and the insurer shall be obliged to give net less than _____ days written notice to the License Officer and to the assured before any cancellation or termination of the policy earlier than its expiration date and the cancellation or other termination of any such

policy shall automatically revoke and terminate the licenses issued for the ambulances covered by such policy, unless another insurance policy complying with the provisions of this section shall be provided and be in effect at the time of such cancellation or termination.

SECTION 6 **Duties of License Officer**

(a) The License Officer shall, within _____ days after receipt of an application for an ambulance license as provided for herein, cause such investigation as he deems necessary to be made of the applicant and of his proposed operations.

(b) The License Officer shall issue a license hereunder for a specified ambulance, to be valid for a period of _____ years unless earlier suspended, revoked or terminated, when he finds that:

(i) the public convenience and necessity require the proposed ambulance service;

(ii) each such ambulance, its required equipment, and the premises designated in the application comply with the standards prescribed in Section 4(a) and in Sections 7 and 8 of this Ordinance and with the regulations promulgated under such sections;

(iii) the applicant is a responsible and proper person to conduct or work in the proposed business;

(iv) only duly licensed drivers, attendants, and attendant-drivers are employed in such capacities; and

(v) all the requirements of this Ordinance and all other applicable laws and ordinances have been met.

(c) Prior to the issuance of any ambulance license hereunder, the License Officer shall cause to be inspected the vehicles, equipment, and premises designated in each application hereunder, to determine compliance with the standards prescribed in Section 4(a) and in Sections 7 and 8 of this Ordinance and with the regulations promulgated under such sections.

(d) Subsequent to issuance of any ambulance license hereunder, the License Officer shall cause to be inspected each such licensed vehicle, and its equipment and premises, whenever he deems such inspection to be necessary but in any event no less frequently than twice each year. The periodic inspection required hereunder shall be in addition to any other safety or motor vehicle inspection required to be made for ambulances or other motor vehicles, or other inspections required to be made, under general law or ordinances, and shall not excuse compliance with any requirement of law or ordinance to display any official certificate of motor vehicle inspection and approval nor excuse compliance with the requirements of any other applicable general law or ordinance.

(e) A copy of each initial, semi-annual, or other ambulance, equipment, and premises inspection report by the License Officer under the provisions of this section shall be promptly transmitted to the applicant or licensee to whom it refers.

SECTION 7 **Standards for Ambulance Equipment—Duties of License Officer and Licensees**

(a) The License Officer shall promulgate standards for ambulance equipment under this Ordinance, and shall apply the standards certified by the Health Officer pursuant to the provisions of Section 8 of this Ordinance.

(b) Each licensee of an ambulance shall comply with such regulations as may be promulgated by the License Officer under the provisions of Section 7(a) and shall maintain in each such ambulance, at all times when it is in use as such, all such equipment as may be prescribed by the License Officer hereunder.

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SECTION 8 **Standards for Ambulance Equipment—Duties of Health Officer**

(a) Required equipment in each ambulance shall include, at all times when the ambulance is in use as such, equipment adequate in the judgment of the Health Officer for dressing wounds, splinting fractures, controlling hemorrhage, and providing oxygen.

(b) The Health Officer is authorized and directed, after public notice and opportunity for public hearing, to certify to the License Officer standards for ambulance equipment to implement the standards provided herein as to required equipment in ambulances. In determining the adequacy of equipment, the Health Officer shall take into consideration the current list of minimal equipment for ambulances, adopted by the American College of Surgeons or its duly authorized Committee on Trauma.

SECTION 9 **Applications for Drivers, Attendants and Attendant-Drivers License.**

Applications for drivers, attendants, and attendant-drivers licenses hereunder shall be made upon such forms as may be prepared or purchased by the License Officer and shall contain:

(a) The applicant's full name, current residence, places of residence for _____ years previous to moving to his present address, and length of time he has resided in (_____city or county_____).

(b) The applicant's age, marital status, height, and color of eyes and hair.

(c) Whether he has ever been convicted of a felony or misdemeanor, and if so, when and where and for what cause.

(d) The applicant's training and experience in the transportation and care of patients, and whether he has previously been licensed as a driver, chauffeur, attendant, or attendant-driver, and if so, when and where, and whether his license has ever been revoked or suspended in any jurisdiction and for what cause.

(e) Affidavits of good character from two reputable citizens of the United States and residents of (_____city or county_____) who have personally known such applicant and observed his conduct during _____ years next preceding the date of his application.

(f) Two recent photographs of the applicant, of a size designated by the License Officer, one of which shall be attached by the License Officer to the license.

(g) Such other information as the License Officer shall deem reasonably necessary to a fair determination of compliance with this Ordinance.

(h) An accompanying license fee or $_____.

SECTION 10 **Standards for Drivers, Attendants and Attendant-Drivers License**

(a) The License Officer shall, within a reasonable time after receipt of an application as provided for herein, cause such investigation as he deems necessary to be made of the applicant for a drivers, attendants, or attendant-drivers license.

(b) The License Officer shall issue a license to a driver, attendant or attendant-driver hereunder, valid for a period of _____ years, unless earlier suspended, revoked, or terminated, when he finds that:

(i) the applicant is not addicted to the use of intoxicating liquors or narcotics, and is morally fit for the position;

(ii) the applicant is able to speak, read and write the English language;

(iii) the applicant has been found by a duly licensed physician, upon examination attested to on a form provided by the Health Officer, to be of sound physique, possessing eyesight corrected to at least 20/40 in the better eye, and free of physical defects or diseases that might impair the ability to drive or attend an ambulance; and

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5. Tact and Patience - The investigator must obtain the bulk of his information from persons who are generally under no compelling obligation to give it to him and who have a reluctance to get involved. Witnesses may be difficult to locate and when found may be unable to give information without careful questioning.

6. The Ability to Employ Logic - The investigator must be able to gather his facts and assemble them in a logical manner to determine what happened and to arrive at the accident cause. He must be aware that, in some cases, a definite cause cannot be determined and he must then be able to determine possible or probable causes.

7. Stamina - Because of the necessity of beginning each accident investigation promptly and tracking down clues and examining evidence before they become stale or are destroyed, the accident investigator must be able to stay on the job for protracted periods.

Because of the size and nature of a fleet operation, it may be necessary, to send a terminal manager, dispatcher or other company employee to the scene of an accident pending the arrival of the safety man. Such employees should have the necessary knowledge to protect the company's interests by notifying the insurance carrier (if this has not already been done), by protecting the cargo or making arrangements for such protection, by helping the driver to gather the necessary information for his accident report and by listing witnesses and gathering such additional factual information as they can for necessary follow-up by the safety man.

It is possible that other company employees may encounter company equipment involved in accidents. If such employees are not authorized to carry on any investigative activity, they should confine themselves to notifying the nearest terminal of the accident, to carrying out such instructions as they may be given, and to helping the company driver at the accident scene, or by taking charge until the arrival of company personnel assigned the task.

HOW THE INVESTIGATION STARTS

In most cases the investigation of an accident begins after the accident is reported by the driver involved. This fact highlights the necessity of training drivers in proper conduct at the scene of an accident, and in accurately recording the basic information for accident reports required by company policy and the law.

In training drivers on their conduct at the scene of an accident, first consideration must be given to instruction on protecting the scene through the use of the appropriate emergency warning devices. Drivers must be trained in the importance of extreme courtesy in dealing with others involved in the accident, with bystanders, and with the owners of other property involved. Above all, drivers must be instructed not to give out more information than required: a) the name and address of the company; b) their own name and address; c) show their chauffeur's license on request. In no case, should the company driver, in any way, admit responsibility for the accident regardless of the circumstances.

Information to be recorded by the driver includes:

a) Date, time and place.
b) Road surface and condition, weather and light conditions.
c) Names and addresses of owners and drivers of other vehicles or property involved, and names and addresses of passengers or others involved, whether or not injured, and if injured, where taken.
d) Names and addresses of witnesses, and license numbers of first vehicles on the scene after the accident.
e) Company driver's statement of what happened and similar statement by other driver if obtainable.
f) Description of damage to all vehicles, cargo and other property and estimate of amount of damage.
g) Name, badge and organization of investigating police officers.

Additional information on the driver's conduct at the scene of an accident is contained in "Minimum Standards for Selection and Training of Personnel," "Truck Drivers Handbook," and "Truck Driver Training," publications of the Department of Safety, American Trucking Associations, Inc.

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In most cases, drivers report being in accidents by telephone to the nearest company terminal. To facilitate receiving such reports from drivers and to insure that accurate basic information about the accident is obtained, many companies use a special form, such as that shown in the Appendix, to record drivers' telephoned reports of accidents. This form, or a copy, can then be turned over to the accident investigator. A form of this type leaves nothing to chance, as it can be used by the person receiving the phone call to remind the driver of the steps he should take at the scene to get all the necessary information.

Occasionally, a safety representative may come upon the accident scene in which one of his company's vehicles is involved. In this case, necessary information can be secured and the investigation initiated without delay.

WHEN TO DO IT

The investigation of an accident should commence as promptly as possible after the occurrence to permit the gathering of pertinent facts before the details become obscured and to permit the examination of physical evidence before it is altered or destroyed.

INVESTIGATION CONFIDENTIAL

The investigation must be conducted to elicit the greatest amount of information which will be useful in the fleet's accident prevention activities without revealing to others information which could prove prejudicial to the fleet's interests in subsequent legal action. In particular, the fleet safety man should avoid discussing the results of an investigation with anyone other than officials of his own company or representatives of the fleet's insurance carrier. He should always keep in mind the likelihood that others whose interests may be contrary to those of the fleet, will be investigating the same accident.

Inquiries from the press must, therefore, be handled carefully. A definite policy on this matter should be worked out by fleet management and its insurance carrier. In any event, the investigator should obtain authority from the fleet management before making public statements concerning accidents under investigation.

The fleet investigator must be prepared to deal with newspaper reporters seeking information about an accident and/or the results of the investigation. In general terms, such inquiries from the press represent legitimate public concern in an accident of public consequence. Such inquiries should be handled forthrightly. However, it should be kept in mind that statements made to the press can be misconstrued. It is important that the fleet's side of the story be told, where possible, to avoid the condemnation which often results from news stories written by persons who do not have all the facts or a full understanding of them.

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(iv) for each applicant for attendant or attendant-drivers license, that such applicant has a currently valid certificate evidencing successful completion of a course of training equivalent to the advanced course in first aid given by the American Red Cross or the United States Bureau of Mines.

PROVIDED HOWEVER, that no one shall be licensed as a driver or attendant-driver unless he holds a currently valid permit from the State of (_____ _____) to drive an ambulance.

(c) A license as driver, attendant or attendant-driver issued hereunder shall not be assignable or transferable.

(d) No official entry made upon a license may be defaced, removed, or obliterated.

SECTION 11 **Renewal of License.** Removal of any license hereunder, upon expiration for any reason or after revocation, shall require conformance with all the requirements of this Ordinance as upon original licensing.

SECTION 12 **Revocation of License**

(a) The License Officer may, and is hereby authorized to, suspend or revoke a license issued hereunder for failure of a licensee to comply and to maintain compliance with, or for his violation of, any applicable provisions, standards or requirements of this Ordinance, or of regulations promulgated hereunder; or of any other applicable laws or ordinances or regulations promulgated thereunder, but only after warning and such reasonable time for compliance as may be set by the License Officer. Within _____ days after a suspension, the licensee shall be afforded a hearing, after reasonable notice. The License Officer shall, within _____ days after conclusion of such hearing, issue a written decision (which shall include written findings) as to the suspension of said license. Such written decision shall be promptly transmitted to the licensee to whom it refers.

(b) The initial, semi-annual, or other ambulance, equipment, and premise inspection reports of the License Officer herein provided for shall be *prima facie* evidence of compliance or non-compliance with, or violation of, the provisions, standards and requirements provided herein, and of the regulations promulgated hereunder, for the licensing of ambulances.

(c) Upon suspension, revocation or termination of an ambulance license hereunder, operations as such shall cease with such ambulance and no person shall permit continued operation with such ambulance as such. Upon suspension, revocation or termination of a drivers, attendants or attendant-drivers license hereunder, such driver, attendant or attendant-driver shall cease to drive or attend an ambulance and no person shall employ or permit such individual to drive or attend an ambulance.

SECTION 13 **Reports**

(a) Each licensee of an ambulance hereunder shall maintain accurate records, upon such forms as may be provided or prescribed by, and containing such information as may be required by, the (_____designated official _____) of (_____city or county_____), concerning the transportation of each patient within (_____city or county _____), or from one place herein to another place within or beyond its limits. Such records shall be available for inspection by the (_____ designated official_____) at any reasonable time and copies thereof shall be filed by the licensee within _____ hours upon request of the (_____designated official_____).

(b) The provisions of subsection (a) of this section shall apply with equal force in case the patient shall die before being so transported in such ambulance or dies while being transported therein or at any time prior to the acceptance

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of the patient into the responsibility of the hospital or medical or other authority if the patient is still under the care or responsibility of the ambulance licensee.

SECTION 14 **Obedience to Traffic Laws, Ordinances and Regulations**

(a) The driver of an ambulance, when responding to an emergency call or while transporting a patient, may exercise the privileges set forth in this section, but subject to the conditions herein stated, and only when such driver has reasonable grounds to believe that an emergency in fact exists that requires the exercise of such privileges.

(b) Subject to the provisions of subsection (a) hereof, the driver or an ambulance may:

(i) park or stand, irrespective of the otherwise applicable provisions of law, ordinance, or regulation;

(ii) proceed past a red or stop signal or stop sign, but only after slowing down as may be necessary for safe operation;

(iii) exceed the maximum speed limits permitted by laws, ordinances, or regulation so long as he does not endanger life or property; and

(iv) disregard laws, ordinances, or regulations governing direction or movement or turning in specified directions.

(c) The exemptions herein granted shall apply only when such ambulance is making use of audible and visual signals meeting the requirements of law, ordinance, or regulation.

(d) The foregoing provisions shall not relieve the driver of an ambulance from the duty to drive with due regard for the safety of all persons, nor shall such provisions protect the driver from the consequences of his reckless disregard for the safety of others.

SECTION 15 **Penalties**

(a) Any person violating, or failing to comply with, the provisions of Section 2 (a) of this Ordinance and the applicable provisions hereof relating to the licensing of ambulances, shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined an amount not exceeding $_____ or imprisoned for a period not exceeding _____ days, or be both so fined and imprisoned, for each offense.

(b) Any person violating, or failing to comply with, any other provision of this Ordinance shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined an amount not exceeding $_____ or be imprisoned for a period not exceeding _____ days, or be both so fined and imprisoned, for each offense.

(c) Each day that any violation of, or failure to comply with, this Ordinance is committed or permitted to continue shall constitute a separate and distinct offense under this section and shall be punishable as such hereunder; *provided, however,* that the Court may, in appropriate cases, stay the cumulation of penalties.

SECTION 16 **Separability.** If any section, subsection, sentence, clause, phrase or portion of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate, distinct, and independent provision and such holding shall not affect the validity of the remaining portions hereof.

SECTION 17 **Effective Date.** This Ordinance shall become effective on (_____ _____date_____).

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SECTION 18 **Ordinances Repealed.** All ordinances and parts of ordinances in conflict with the provisions of this Ordinance are hereby repealed as follows:

_____

_____

_____

_____

Adopted this _____ day of _____, 19____.

_____

APPENDIX "C"

Specific Types of Emergencies

For a number of specific types of emergencies requiring immediate care by the ambulance attendant before moving the patient, the Pennsylvania Department of Health's publication, "Ambulance Attendant Training Pilot Project Report" (see Reference 2), cites three basic rules and labels them *important*. These are:

1. Don't panic
2. Reassure patient with a confident manner
3. *No siren or fast ride* in most all cases

The specific types of trauma to which these rules refer are as follows:

1. Uncontrolled hemorrhage
2. Respiratory failure or blockage (in which resuscitation is not totally effective)
3. Petroleum-base poisonings
4. Cardiac failure due to fibrillation (in which closed-chest heart compression is used en route but cannot stop the fibrillation)
5. Acute burns (2nd and 3rd degree over large part of body)
6. Full-term maternity cases involving complications of normal delivery

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APPENDIX "D"

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Darmstadter, Neill, Ed.
Truck Fleet Accident Investigation. A Manual for Investigation of Accidents Involving Motor Vehicles of Truck Fleets.

American Trucking Association, Inc., Washington, D.C. Dept. of Safety.
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ABSTRACT - This manual is designed for the guidance of truck fleet safety personnel and other fleet employees who may be given responsibility for investigating accidents involving vehicles operated by the company. Major emphasis is on accident prevention through accident investigation. To this end the manual is designed to enable motor career management and fleet safety personnel to collect and analyze information about each accident so that corrective measures may be taken for more effective training of drivers, revision of operating policies and procedures, correction of deficiencies in the maintenance program, disciplinary action, and cooperation with appropriate authorities to eliminate or reduce hazards at accident sites. Accident report forms, a speed nomography, and a drag factor table are appended. (Author/GB)

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TRUCK FLEET ACCIDENT INVESTIGATION

A Manual for Investigation of Accidents Involving Motor Vehicles of Truck Fleets.

AMERICAN TRUCKING ASSOCIATIONS, INC.
DEPARTMENT OF SAFETY

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TRUCK FLEET ACCIDENT INVESTIGATION

Developed under direction of
The Committee on Driver Training and Supervision
ATA Council of Safety Supervisors
for the guidance of those charged with the responsibility for the investigation of accidents involving vehicles of the truck fleet.

John W. Jacobson, Chairman

Edited by
Neill Darmstadter
Safety Engineer

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INTRODUCTION

An accident investigation is a search for facts. It must not only determine what happened in each accident, but it must go deeper to find out why it happened. The facts must then be studied to determine what can be done about it. It means more than just collecting the bare essentials of information needed to fill out required accident reports. It demands inquiry into many areas of human behavior, vehicle design and characteristics, and the environment of the accident. It requires a skillful and persistent investigator who will get all the facts without prejudgement and without attempting to support preconceived notions.

This manual is designed for the guidance of truck fleet safety personnel and other fleet employees who may be given responsibility for investigating accidents involving vehicles operated by the company. Major emphasis is on accident prevention through accident investigation, and to this end the manual is designed to enable motor carrier management and fleet safety personnel to collect and analyze information about each accident so that corrective measures may be taken for more effective training of drivers; revision of operating policies and procedures; correction of deficiencies in the maintenance program; disciplinary action; cooperation with appropriate authorities to eliminate or reduce existing hazards at accident sites, and the elimination of other hazardous conditions which may be uncovered.

The results of investigations can be checked against the fleet's overall accident experience to determine accident prevention needs and to give effective direction to its safety efforts.

The accurate determination of accident liability is vitally important to management because of its effect on accident costs. Investigation to make such a determination requires special training and skills. In addition to the type of fact-finding outlined in this manual, liability investigation requires legal knowledge which can be applied to the facts uncovered. It also entails investigation into the activities of third parties to determine possible contributory negligence.

In fleets having some form of self-insurance, it is a common practice for safety representatives to investigate accidents for the dual purposes of finding the cause and determining the company's liability in each instance. For fleets having the more conventional forms of insurance coverage, it is the practice for the liability investigation to be made by the insurance carrier or an independent adjuster. In any event, it is essential that all available facts of every accident be uncovered and made a matter of record for the information of fleet management and for the guidance of the fleet safety director.

To avoid the possibility of jeopardizing the fleets' position in legal action arising out of involvement in an accident, there must be full understanding and the closest cooperation between fleet management, the safety director and the fleet's insurance carrier, and between the safety and insurance departments within the fleet.

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DAMAGE CORRECTION OCCUPATIONS

A Suggested Outline of Services and Levels

for the

Automotive Industries Occupations

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THE INVESTIGATION

WHAT TO INVESTIGATE

Ideally, all accidents involving vehicles operated by the motor carrier should be investigated to determine their basic causes. In practice, limitations of time and manpower, the scope of the company's operations, or other factors, may preclude complete investigation of every accident. An investigation should be made of every accident sufficiently serious to require a report to the Department of Transportation and/or state regulatory authorities.

The following list is presented as a further guide to the type of accident that should be investigated to determine causation:

a) Accidents involving fatalities and/or personal injuries.
b) Accidents involving large property damage.
c) Accidents involving the transportation of explosives and other dangerous articles, particularly where the nature of the cargo contributed to the seriousness of the accident.
d) Accidents involving vehicles or loads of abnormal dimensions and/or weight.
e) Accidents involving unusual circumstances.

A series of accidents involving common factors or circumstances which would indicate a pattern should also signal the need for investigation. Such an accident pattern would include, but not be limited to:

a) Involvement of a single driver in several accidents, particularly when such accidents occur in a relatively short period of time or involve recurrent similar circumstances.
b) Accidents occurring in a particular locality.
c) Accidents involving particular types of cargo.
d) Accidents involving certain types or makes of vehicles or combinations.
e) Accidents having other factors in common: e.g. a particular type of accident.

WHO INVESTIGATES

Fleet management should designate personnel authorized to investigate accidents and arrange for necessary training along the lines set forth in this manual. All fleet safety representatives should be qualified in accident investigation and their services should be used for this purpose whenever possible because their specialized knowledge of all aspects of safety tends to insure a more careful, accurate and fruitful investigation.

In determining who shall investigate accidents, consideration must be given to the essential qualifications of a good investigator including such attributes as:

1. Initiative - The good investigator knows that he cannot do his job from behind a desk, and that he cannot work in a preconcieved conclusion. He must go to the accident scene and start from there.

2. Imagination - He must be able to visualize what is needed in making his investigation and he must be able to set up the lines of initial inquiry.

3. Inquisitiveness - The good investigator recognizes that his job is basically a search. He must be constantly on the lookout for clues and more clues which he must follow until each one is proven worthless or fruitfull

4. Attention to Detail - The smallest detail may point to the cause of an accident, and if overlooked, may prevent the investigator from finding the cause, or lead him to a false conclusion.

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BASIC INFORMATION

Basic information must be secured and recorded on each accident. Much of this information is identical to the items of information necessary to complete required accident reports for the motor carrier's records, for the insurance company, state and federal regulatory agencies, and motor vehicle and police departments. In the course of a full-fledged accident investigation, the basic information should be checked and rechecked for completeness and for such additional information as may be uncovered and for sources of helpful background information which can be used in determining underlying causes of the accident.

Basic information must cover:

I Time and location

a. Date and time of occurrence

b. The precise location of the accident described in such a manner as to permit a complete stranger to the area to find the scene without undue difficulty. Information on the location should include:

State and county of occurrence and city, town or community, if applicable.

Route or street.

Street address in built-up areas.

Street intersection or route junction.

Distance and direction from nearest community or junction of routes as shown on ordinary road maps. Also, distance and direction from numbered highway, bridge, utility pole or the like.

Distance and direction from other landmarks such as a farm, park, roadside business establishment in conjunction with distance and direction from nearest community or junction of routes.

II Parties Involved

a. Names and addresses of:

The owners, drivers and occupants of all vehicles involved. Other persons involved and whether or not they were injured. Owners of other property involved.

III Witnesses and Police Officers

a. Names and addresses of witnesses or first arrivals at the scene.

b. License numbers of the first vehicles arriving at the scene.

c. Name, badge and organization of investigating police officers or other officials.

IV Vehicles Involved

a. For the motor carrier's vehicle show: make, model, year of manufacture, serial number, company identification, current state license number, body type, type of cargo, and gross weight. (Separate identification should be made of each vehicle in a combination unit)

b. The information in (a), above, should be recorded for other involved vehicles operated by other motor carriers.

c. For each vehicle or combination operated by a motor carrier, the appropriate certificate or permit number issued by a federal or state regulatory agency should be shown.

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d. With respect to leased vehicles operated by motor carriers, the name and address of both lessor and lessee of each such vehicle should be recorded.

e. If a bus was involved, the information outlined in the foregoing sub-paragraphs should be recorded together with the number of passengers on board, a list of the passengers, and a diagram showing where each passenger was sitting or standing.

f. For passenger cars and other small vehicles; record make, year of manufacture, body type and current state license number.

V Fatalities, Injuries and Property Damage

a. Persons injured or killed

Name, address, sex and age of each person (approximate age if exact age not available).

Nature and extent of injuries, whether serious or minor.

Nature of treatment required - hospitalization, treated at hospital and released, given first aid at scene, treatment declined or victim said he would see own doctor.

Status of each person injured as of the date of the investigation report - i.e. discharged from hospital, still in hospital, under out-patient care, etc.

Clinical cause of death for each person killed, as well as the events in the accident which are established as a cause of death.

Date and place of death of each person killed.

Much of the foregoing information must be obtained from outside sources. Diplomacy must be exercised in contacting officials who are not necessarily obliged to give the information.

b. Property Damage

Description of damage sustained by each vehicle involved.

Description of damage to cargo.

Description of damage to other property.

Estimate of dollar value of damage to each vehicle, cargo and item of other property and total damage estimate.

Determination of causes of damage.

VI The Accident and The Accident Scene

a. The Accident

Chronological description of accident sequence of events including direction of travel of each vehicle to point of impact and from point of impact to final resting place.

Established, estimated or reported speed of vehicles involved.

Statements of the company's driver, drivers of other vehicles involved, other persons involved and witnesses.

b. The Accident Scene

One of the vital functions of the accident investigator is to visit the scene of the accident as soon as possible to determine the role played by physical features and traffic conditions in the cause of the accident. If at all possible, he should be accompanied to the scene by the company driver who was involved. This practice serves two purposes in the course of the investigation. It enables the investigator to question the driver about salient points of the accident on the spot and it may also serve to refresh the driver's memory of the events leading up to the accident, or about its occurrence, so that he may be able to furnish the investigator with additional information.

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The initial check at the scene must include the measurements of the following:

Width of traffic lanes.

Width of the highway, including separately the right of way, travelled part of highway, shoulders and clearance between parked vehicles, buildings, safety islands or other obstructions.

Length, width and depth of ditches adjacent to accident.

Length of straightaway or curve.

Point of impact with respect to center line or curb line or edge of pavement.

Skid marks.

Distance and direction vehicles travelled after impact.

Distances from point of accident to warning signs or traffic control devices, including height of such signs or warning devices above pavement, and their condition and location as to visibility.

Location of sight obstructions and height of such obstructions above pavement.

Distances at which drivers of vehicles may have had sight of each other approaching scene of accident, especially in intersection accidents.

Distance from pavement to fixed object struck.

Distance from point of collision to detached parts of damaged vehicles.

Photographs showing the overall accident scene, position of vehicles, skid marks, debris, damage to vehicles or other property, pertinent features of the surroundings and any other photographs which "tell a story" about the accident should be taken. Each photograph must be identified as to date and time, distance from object, position of camera and direction of view, the object photographed and the signature and address of the photographer.

Information on the Accident Scene must include:

Road and traffic conditions.

Light conditions including the presence or absence of artificial highway lighting.

c. Reading The Signs at the Scene

While it is important that the investigator visit the accident scene promptly before physical evidence is destroyed, it is also important that he know what types of evidence to look for and how to interpret what he finds:

1. Debris

Debris is useful in establishing the exact location of the impact. In conjunction with observation of the final resting place of the vehicle(s) involved, it may help to establish their relative speeds. For example, if two vehicles of the same size collide head-on at equal speeds, they will tend to rebound an approximately equal distance from the point of impact. If two vehicles collide head-on and one is larger, or was travelling faster than the other, the larger, and/or faster vehicle will tend to push the other backward from the point of impact.

In some cases, debris will tend to follow the paths of the vehicles after impact.

Mud and dirt knocked loose from the colliding vehicle affords the best indication of the point of impact.

Vehicle parts, or portions of the cargo are less useful because of their tendency to scatter.

Spilled liquids from the cargo; water, oil, grease, or battery acid; and blood

may also help to establish location of impact. Liquids characteristically leave a stream or trail of drops from the point of impact to final resting place where they form a puddle.

2. Pavement Marks

Skid marks are the most common and useful pavement marks to be observed and studied in accident investigation. Skid marks are essentially tire smears resulting from friction between the braked wheels and the pavement which is great enough to actually scrape rubber off the tires.

Skid marks indicate: (1) the direction of movement of the vehicles involved before and after impact; (2) the approximate speed of the vehicles through measurement of length of the marks; (3) whether or not the drivers involved applied their brakes.

Skid marks generally indicate that the driver has lost steering control due to the locked wheels which have no steering power. However, if a combination unit is involved, tractor drive wheels and trailer wheels may lock up and leave skid marks while the front wheels do not, thus leaving the driver able to steer to some degree.

Scratch marks may be made by stones or metal imbedded in tires. Gouge marks, which are generally heavier than scratch marks, may be made by parts of the vehicle.

Scuff marks made by the outside edges of the tires as the vehicle reached the limit of adhesion rounding a curve may be found. With a knowledge of the vehicle, the sharpness of the curve, the length of the scuff marks and the condition and type of pavement, an estimate of speed may be made.

On hot blacktop surfaces, skidding wheels may leave characteristic smears.

On a wet pavement, a skidding wheel leaves a squeegee mark from the wiping and drying action. This type of mark is apt to be quickly obliterated by traffic or continued precipitation and is of limited usefulness in investigation.

On a hard surface covered with dust or loose material, the sliding wheel displaces the loose material to leave erasure marks.

On loose snow or on other soft surfaces, ruts or furrows may be found. A furrow is a ploughed depression made by a sliding tire while a rut is made by a rolling tire.

3. Using Skidmarks to Estimate Speed

Charts for use in estimating speed from skid marks are available and such a chart developed by The Traffic Institute of Northwestern University is reproduced in the Appendix through the courtesy of the Institute. This chart shows the relationship between the length of the skidmark, the speed, and the drag factor of the surface on which the vehicle was operating.

This relationship can also be computed, by use of the formulas shown on the nomograph. In these formulas:

s = speed in miles per hour
d = slide-to-stop distance in feet
F = drag factor
f = grade

In using the nomograph, the drag factor must be determined so that it and the length of the skid marks will be known factors for use in estimating the speed. For maximum accuracy, drag factor should be determined by making a test skid with the vehicle(s) (or the same type of vehicle(s)) involved in the accident on the surface on which the accident occurred. It is seldom practicable for the fleet investigator to do this. He should obtain the drag factor from the table reproduced in the Appendix

through the courtesy of The Traffic Institute. In practice, it may be desirable for the investigator to estimate a range of speeds using the maximum and minimum drag factors for the type of road surface involved. It should be noted that two groups of drag factors are shown in the table for "Under 30 m.p.h." and "Over 30 m.p.h." The investigator should select the proper group depending on posted speed limits or known prevailing speeds at the scene of the accident. Any grade at the scene must also be taken into account. This is done by determining the slope as a decimal. For an upgrade, the slope is added to the drag factor and for a downgrade, it is subtracted.

To make a speed estimate with the nomograph, a straight line is drawn from the figure indicating the length of the skid-marks, to the figure indicating the drag factor. The estimated speed is the point at which this line crosses the speed column.

The following points must be kept in mind in attempting to estimate speed from skid-marks:

a) The actual speed of the vehicle is invariably higher than the speed estimated from its skid-marks because some deceleration takes place before skid-marks are made. The actual speed may be much higher. Skid-marks may end abruptly at the point of impact. The speed estimated from their length may be very low while the extent of damage clearly indicates a higher speed.

b) The estimate will be accurate only if all wheels lock up and leave skid-marks. Because of size, weight, brake adjustment, the number of wheels, and similar factors, it is rare for all wheels of a large truck or a combination to lock-up and leave skid-marks. Therefore it is extremely difficult to obtain an accurate speed estimate. Any estimates of speed made from skid-marks should be checked against other types of speed estimates. However, it may prove valuable for the fleet investigator to measure skid-marks and estimate speeds for other vehicles involved.

c) Skid-marks must be identified with the vehicles involved in the accident. This can be a problem for the fleet investigator who may arrive at the scene some time after the accident and after the vehicles have been removed. He will need the assistance of the company driver who was involved or the help of someone else who can identify the skid-marks made by each vehicle. At some locations, identification of skid-marks made in a particular accident may be further complicated by the presence of skid-marks from prior or subsequent accidents or sudden stops.

d) It is essential to make separate measurements of the skid-marks left by each wheel and to record them, not only as to length, but also as to their position with respect to the edge or center-line of the roadway. Skid-marks made by duals are considered in the same manner as marks made by single-tire wheels.

e) It is necessary to identify the marks made by each wheel. On passenger cars, the marks made by the front wheels show on the pavement as twin streaks made predominantly by the outside edges of the front tires. This type of mark results from overloading of the front tires due to weight transfer resulting from the severe brake application. Rear tire marks of a passenger car are heavy ones made by the center of the tires which are underloaded due to the weight transfer caused by severe braking. Because of longer wheelbase and higher tire pressure, these phenomena do not occur with trucks and front and rear skid-marks are most easily identified by whether they show single-tire or dual-tire marks.

f) Be sure to measure the entire length of each skid-mark. Skid-marks are generally preceded by "shadow" or erasure marks made as the wheel begins to slide. However, these preliminary marks may be obliterated by the time the fleet investigator reaches the scene. If skid-marks of front and rear wheels overlap, it is necessary to subtract the wheelbase of the vehicle to determine the distance through which the vehicle slid.

g) It is essential to distinguish between skid-marks and tire prints. Tire prints are created by a rolling tire and show a complete tread

patterns. They show the path of a vehicle and are of no value in estimating speed. Tire prints at the scene of an accident are frequently made by passing vehicles which are not involved in the accident.

b) Gaps in skid-marks may or may not be included in measuring the length of the marks to estimate speed. Gap-skids indicating release of the brakes may be present and the length of the gaps must be deducted from the overall length of the skid-marks before attempting to estimate speed. On the other hand, the bouncing of braked wheels, such as the wheel-hop of a tandem axle assembly, will leave skip-skids at short intervals. Skip-skids must be included in measuring the overall length of the skid-marks to estimate speed.

DEVELOPING BACKGROUND INFORMATION

The collection of basic information about an accident in sufficient detail to permit the preparation of required accident reports may also permit an analysis of the accident which will reveal the cause and indicate necessary corrective measures. In many cases, however, it will be necessary for the fleet investigator to probe more deeply in order to uncover the basic causes. Such additional investigation may be made in one or more of four general areas: the driver; the trip; the vehicle; the environment. In making such further investigations, the fleet safety man must remember that he has direct authority and access to records and information only within his own company. Other information can generally be obtained only with the cooperation of other persons or agencies.

Whenever any given line of inquiry is found to reveal no significant information relative to the cause of an accident, it should be discontinued. At the same time, the investigator must be aware that the causes of accidents are not apparent; a lines of investigation will have to be followed in arriving at the causes of some accidents. In some cases, it will be necessary to analyze a great many contributing factors to determine both the immediate and underlying causes of a particular accident. Every conceivable line of investigation is pertinent to every accident, none should be disregarded until proven irrelevant.

During the investigation, the fleet safety man must work closely with the representatives of the insurance carrier, or, in the case of a self-insured fleet, with the company's claims representative. This cooperation must exist to avoid the possibility of jeopardizing the company's position in subsequent legal action, and also, to enable the safety man to receive information which he might not otherwise get. Reciprocally, the safety man should transmit the results of his investigation to the insurance carrier or the company's claims representatives for their use.

THE DRIVERS INVOLVED

Because the vast majority of accidents arise out of the improper actions of one or more drivers, it is desirable to gather as much information as possible about each driver involved in the accident under investigation. Information about the company's driver should be readily available from the fleet's personnel records. Comparable information about other drivers or about pedestrians or passengers in other vehicles is likely to be more difficult to secure. In some cases, depending upon state laws, information about accident and arrest records of other drivers may be obtained from the police or the state motor vehicle agency.

The following list of items to be investigated is specifically applicable to the company's driver, and should be readily obtainable from the fleet's personnel records.

a) Length of employment
b) Previous employment
c) Information from personal references
d) Training
e) Overall driving experience and experience driving type of vehicle involved in accident.
f) Attitude toward job
g) Record of physical examinations
h) Accident record
i) Record of complaints, especially those dealing with safety of operations, and record of warnings and convictions for traffic violations.
j) Commendations
k) Disciplinary actions
l) Illness and personal problems
m) General reputation

n) Physical and mental condition at time of accident.

Factors applicable to other drivers involved such as driving experience, accident and arrest record, physical and mental condition, and general reputation may shed light on the cause of an accident. They should be investigated as thoroughly as possible where they appear to be of significance.

THE TRIP

a) Show the origin, destination and related distances of the trip on which the accident occurred. If the total trip extends over more than one day, the point at which driving began on the day of the accident should be shown, as well as the origin and destination of the entire trip.
b) Show distance covered from point of origin to accident scene.
c) List stops enroute, time spent at each and reconstruction of the driver's activities at each stop.
d) Reconstruct driver's activities for at least 24 hours prior to the accident showing time spent on and off-duty and endeavor to find how driver spent his off-duty time. Investigate driver's activities over a longer period of time preceding the accident double-checked where it appears desirable. A copy of the driver's log record for the same period should be made a part of the company's accident file and record. If the vehicle was equipped with an opertiosu recorder, the chart should be reexamined with special attention to speed and stops enroute, and its correlation with the drivers log. This chart, or a facsimile, should be a permanent part of the accident file.

Insofar as possible, the activities of other drivers, or other persons involved, should be reconstructed in the effort to determine the extent to which their actions or their physical and mental condition may have contributed to the accident. Such investigation should also cover a period of at least 24 hours prior to the accident and a longer period, if such appears fruitful. Information relative to the activities of other persons will generally have to be developed through direct inquiry.

THE ENVIRONMENT

In addition to the check made at the accident scene to determine the role played by physical features and traffic conditions in the cause of the accident, inquiry should be made of the State Police, Motor Vehicle Department or Highway Department, or the appropriate municipal agency to ascertain the number, kind and frequency of accidents which have occurred at, or in the immediate vicinity of the accident scene. If the necessary records can be obtained or reviewed, an analysis should be made to determine the character of previous accidents with respect to the consequences (fatalities, injuries, property damage), the apparent cause (e.g. speed, inadequate sight distance, improper access from the property frontage) and the nature of the accidents, (collision, ran off road, etc.).

The fleet safety representative should also make a check of traffic conditions at the site. To be of maximum value, such checks should be on a day when traffic conditions are comparable and at the time at which the accident occurred plus an hour before and after. If possible, official traffic counts for the area should be obtained and studied.

The effects of existing traffic controls, adherence to speed limits, operating habits of passengers, pedestrians and other pertinent circumstances should be noted by observation.

Any pattern of accidents or hazardous conditions revealed by such a study of the scene may serve as the basis of discussion with the appropriate authorities leading to the correction of the hazards noted. Such analysis may also enable the development of information to be given drivers concerning accident hazards in the area.

THE VEHICLES

Investigation should be made to determine the extent to which the mechanical condition of each vehicle involved may have been a causative factor in the accident. The most comprehensive investigation of this nature can be developed

with respect to the fleet's own equipment involved. However, the condition of other vehicles involved should be checked as thoroughly as possible.

If it is found necessary or desirable to make tests to determine the extent to which mechanical defects may have been a factor in an accident, the tests should be conducted in private.

If defective parts are found or suspected to be a contributing factor to the accident, laboratory analysis of the vehicle have occurred at, or in the immediate vicinity of the accident scene. If the necessary records can be obtained or reviewed, an analysis should be made to determine the character of previous accidents with respect to the consequences (fatalities, injuries, property damage), the apparent cause (e.g. speed, inadequate sight distance, improper access from the property frontage) and the nature of the accidents, (collision, ran off road, etc.).

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THE VEHICLES

Investigation should be made to determine the extent to which the mechanical condition of each vehicle involved may have been a causative factor in the accident. The most comprehensive investigation of this nature can be developed

D. Exhaust Leakage

(1) Check exhaust system for evidence of leakage if possible.
(2) If leakage is suspected determine effects on drivers, passengers, or others from clinical records. Blood samples taken from survivors soon after exposure will indicate extent of carbon monoxide absorption. Post mortem blood samples for the same purpose may be taken from those killed.
(3) Assistance in making tests for carbon monoxide in vehicles may sometimes be obtained from public health officials. Such assistance may also be secured from the insurance companies or independent testing agencies. In making tests, care must be taken to safe-guard test personnel. Vehicles should not be operated except when tests are in progress. If test vehicles must be operated under their own power, adequate ventilation must be assured.

E. Stopped Vehicles

(1) Determine why the vehicle was stopped where the accident occurred.
(2) If driver was making a traffic stop, find out if the stop was made in a proper manner and if stoplights were functioning.
(3) Ascertain how long vehicle was stopped prior to accident.
(4) Did driver stop in the safest practicable location? If vehicle was stopped for a protracted period, determine whether or not emergency warning devices were properly used, or if their use was desirable, even though not required by law.
(5) If vehicle was stopped because of mechanical defect, find out exact nature of defect and determine whether or not it contributed directly to the accident.
(6) If vehicle was disabled, find out what action driver took about reporting delay, attempting to make repair, or obtaining other assistance.

F. Other Mechanical Defects

(1) Examine vehicles involved in accidents to determine all other processing conditions which may have contributed to the cause of the accident such as: inoperative lights; defective coupling devices; structural weakness; overloading; defects in engine and drive line; defective tires; and any others.
(2) Use care in distinguishing between parts damaged in the accident and those which are found to have been defective before the accident. A "fatigued" part can generally be reported by the fact that only a part of the break in it shows as new.

DEALING WITH WITNESSES

The greatest volume of information about an accident traditionally comes from witnesses and their statements can be of extreme importance, both in an investigation to determine the cause of the accident and in legal action arising out of the accident. Because witnesses are human and subject to human fallibilities and foibles, great care must be encorcized in all dealings with them. It is in this area of accident investigation, perhaps more than in any other, that the closest cooperation must exist between the truck fleet and its insurance carrier. First of all, there must be basic agreement as to whether or not safety representatives of the fleet should contact witnesses or the extent to which such contacts can be properly made. Then, some carrier management should solicit the cooperation of its insurance carrier in giving the necessary instruction to the fleet safety representatives in dealing with witnesses.

In seeking out and interviewing witnesses, the fleet safety representative should use the following points for guidance:

(a) Sources of Witnesses

(1) The driver's report of the accident.
(2) Newspaper accounts of the accident.
(3) Canvassing of buildings, stores or shops near the accident scene.
(4) Operators and employees of garages, service stations, etc.
(5) Other insurance companies (insurance company, etc.)
(6) Police reports.
(7) Other witnesses.

(b) Dealing With Witnesses

(1) Show courtesy and consideration whether the witness is friendly or hostile.
(2) Initially allow witness to tell his own story in his own way without interruption of details later.
(3) No attempt should be made at coercion.
(4) Interview each witness separately.
(5) Never reveal the name or testimony of one witness to another. Stories of witnesses may be compared and checked for discrepancies but extreme care must be used in checking out discrepancies.
(6) Discount hearsay. Information recounting what has been told to witness by others is principally useful for locating other witnesses and may be of use in cross-checking information.
(7) Endeavor to get a signed statement from each witness.

(c) Evaluating the Witness and His Testimony.

The credibility of each witness has a major influence on the value of his testimony to the investigation. The following factors are listed to help the fleet investigator more accurately assess the credibility of witnesses.

(1) Intelligence - ability to observe and remember.
(2) Training - whether or not previous experience specially qualifies witness.
(3) Temperament - calm or excitable - logical or disjointed, etc.
(4) Physical characteristics - eyesight, hearing, perceptional keenness.
(5) Reputation - for truth and sobriety - status in society.
(6) Demeanor - Straightforward or evasive.
(7) Bias
(i) Money interest in outcome.
(ii) Malice against one or another of interested parties.
(iii) Marital or blood relation to one or another.
(iv) Fear of incrimination
(8) Admissions against interest - more credible than others.
(9) Fairness - apparent desire to be frank and open.
(10) Vantage point - position with relation to accident and distance therefrom.

PREPARING THE INVESTIGATION REPORT

Accident Reporting

Each motor carrier will have to determine how many copies of the accident report are necessary and what disposition will be made of them.

Organization of Report

(a) Cover page
(b) Summary
(c) Brief introduction
(d) Description of division or terminal area
(e) Location and description of roadway or other place of occurrence of accident
(f) Diagram preferably at least roughly to scale
(g) Narrative description of accident
(h) Complete identification and description of vehicles involved
(i) General condition of vehicles and conditions related to accident
(j) Discussion of driver or drivers
(k) Summary of evidence
(l) Discussion
(m) Conclusions
(n) Violations involved - of Motor Carrier Safety Regulations, Revised, or state law or regulations; of company rules; of good sense and sound judgment.
(o) Recommendations
(p) Signature and title of investigator
(q) Exhibits - Matters of the type which are brought to the knowledge of management but are not considered to be a part of the report or permanent file, such as, except insofar as management decrees.

Following, is an elaboration of some of the items above listed.

Item (b), Summary, should include:

(1) Name, address, and docket number of other motor carriers involved, if any were involved (if a leased operation, like information concerning the lessor)
(2) Motor carrier's driver - name, address, and age
(3) Other participants - names and addresses
(4) Date and time of occurrence of accident
(5) Weather and road conditions (verify with Weather Bureau)
(6) Location of accident - city, state, highway number of nearest city
(7) Other motor carrier's vehicle-type, Interstate Commerce Commission identification and State license plate numbers.
(8) Types of other vehicles involved
(9) Speeds of vehicles involved.
(10) Result of accident, including number of persons killed, number injured, and the total amount of property damage.

Item (f) Diagram

Preliminary sketch should be made at the scene of the accident which should include all dimensions necessary to the reproduction of the sketch to scale. Trace path of vehicle, show point of collision, distance traveled after impact took place, warning signs and whether or not of reflector type. Show lanes, adjacent shoulders, buildings, walls, shrubbery, trees, signboards, embankments, ditches, and guard rails. Indicate length and percent of grades and direction thereof, and length of curves and degree of curvature, and amount of super-elevation, if any. A

completed diagram, reasonably to scale, should accompany the report. Locate on the diagram the approximate position of all eyewitnesses to the accident who were outside the vehicle.

Item (1) Conclusions

Support all conclusions by concrete reference to evidence, stating names of witnesses, designating records, or other evidence relied upon. Refer to the exhibit numbers in which the supporting matter may be found.

Deductions from evidence are necessary in certain cases and, in some instances, speculation, or reconstruction along the most plausible lines of reasoning, must be relied upon when sufficient evidence is not available for the establishment of definite conclusions. When unavoidable, these must suffice. However, it should be made plain that such is the case, and such deductions, speculations, or reconstructions must be so identified.

Item (0) Recommendations

Because the prevention of future accidents is a primary objective of accident investigation by the motor carrier, recommendations, based on the conclusions reached in the investigation, are a vital part of the report. While the widest latitude should be allowed in the making of recommendations, they are restricted, for practical purposes, to matters which are adequately supported by the facts uncovered in the investigation and to those changes which are feasible in the light of existing conditions. General areas in which recommendations may be made, include:

(1) Disciplinary action - complete review
(2) Training or re-training of drivers
(3) Revision of personnel policies affecting selection, training and supervision
(4) Revisions of maintenance practices and maintenance schedules
(5) Revisions of operating practices and rules.
(6) Cooperation with appropriate state and local authorities working toward the correction or alleviation of physical hazards at accident scenes.
(7) Cooperation with equipment manufacturers to correct inherent hazards found to exist in vehicles.

Item (p) Exhibits

The exhibits should be separate from the main body of the text of the report and should have cover page listing and identification of the exhibits either by letter or number, as convenient.

Completeness and Clarity

Except as it may become necessary to interweave the various component parts of the report under the captions, "Conclusions," Recommendations" or "Discussion," the subject matter under the various other captions should be amply set forth under each caption and then dropped, so that the report will not be rambling and discursive. Additional captions or subcaptions may be supplied as desired.

The completed report should be critically examined to assure that there is completeness of coverage and clarity of expression and that all statements are substantiated to as great an extent as the available facts warrant. Before final completion of the report, it should be read to reassure the investigator that all questions as to the "who, how, what, why, when, and where" involved are fully and completely answered.

Where information is complete concerning a given accident except for one or two items, it is suggested that the report be submitted with appropriate notation to the effect that a supplementary report will be rendered, giving the approximate date at which such report may be expected. Any such item or items should not be such as would effect the principal conclusions or recommendations contained in the report even though additional recommendations may be warranted thereby.

AFTER THE INVESTIGATION

Accident investigation is not an end in itself. It is the objective of this manual to provide guidance for fleet safety men in the better investigation of accidents so that their causes can be determined and effective steps can be taken toward the prevention of future accidents. If this objective is to be attained in any degree, it is essential that necessary follow-up measures be taken based on the results of the investigation.

If recommendations are made as the result of an accident investigation, it is the responsibility of the fleet safety department to present them to management. The adequacy of the investigation is likely to have an important influence on the kind of case which can be presented to support any needed changes in operating practices in the fleet. Once approval for changes has been secured, it becomes management's job to see that they are carried out through education and enforcement.

When vehicle condition or design is a factor, the safety department should work with the fleet's own maintenance department, or with vehicle manufacturers to correct basic problems. In other cases, the safety man must work with the fleet's customers to seek correction of problems which require shipper and receiver cooperation for soltuion.

Where a solution appears to lie in the fields of highway or traffic engineering, the safety man is the logical liaison with the proper governmental agencies.

Constructive accident investigation must always work toward the avoidance of future accidents.

REFERENCES FOR THE TRUCK FLEET ACCIDENT INVESTIGATOR

"Traffic Accident Investigator's Manual for Police", The Traffic Institute, Northwestern University, Evanston, Ill.

"Charts and Tables for Stopping Distances of Motor Vehicles", The Traffic Institute, Northwestern University, Evanston, Ill.

"The American Standard Method of Recording and Measuring Motor Vehicle Fleet Accident Experience, D-15.1", American Standards Association, New York, N. Y.

"Manual on Classification of Motor Vehicle Traffic Accidents", National Safety Council, Chicago, Ill.

APPENDIX

Form AR-103

PRELIMINARY REPORT OF ACCIDENT OR LOSS

Exact Date Of Accident _____ Time _____ ☐ A.M. ☐ P.M. Day of Week _____

HOW MANY VEHICLES WERE INVOLVED IN ACCIDENT? _____

Company Employee _____ Tractor No. _____ Trailer No. _____

Can you be reached by phone, if necessary to call back? _____ Phone No. _____ City _____

Accident Within City or Village Limits — Accident Occurred In _____ (City or Village) _____ (County) On _____ (Street) At or Near _____ (Cross Street) _____

Accident Outside City Or Village Limits — Accident Occurred On _____ (Route Number and road name) Near _____ (Town) In _____ (County) At _____ (Name intersection or state distance and direction from nearest community, highway junction, crossroad, railroad crossing or bridge) Width of Road _____ (2-3-4 or more lanes) Were Lanes Marked? Yes ☐ No ☐

Were Opposing Lanes Separated by a Curb or Mall? _____ Yes ☐ No ☐

TYPE OF TRAFFIC CONTROL AT PLACE OF ACCIDENT

1 Police Officer ☐ 2 Signal Light ☐ 3 Stop Sign ☐ 4 Caution Sign ☐ 5 Other Control ☐ 6 No Control ☐

Cause of Accident or Loss — Weather _____ Condition of Road _____ Description of accident: _____

Driver of Other Vehicle — Name _____ Make of Car _____ Address _____ (Street or R. D.) Model _____ (City & State) Operator's License No. _____ No. State Registration _____ No. State

	Yes	No
Was Anyone Injured?		
Company Employee	☐	☐
Occupants other vehicles	☐	☐
Pedestrians	☐	☐
Have you called Police?	☐	☐
Have you secured witnesses--names & addresses?	☐	☐
Have you called doctor and/or ambulance?	☐	☐
Where have injured persons been taken?		
Hospital		
City		
Can your unit proceed safely under own power?	☐	☐
Do you need mechanic or wrecker or another unit?	☐	☐
Have you properly set flags and/or flares?	☐	☐

Notes on instructions to Company Employees: (Use other side of this form for additional information)

Person Notified _____ Time _____ A.M. P.M.

Date _____ Signature _____

SKIDMARK - SPEED NOMOGRAPH

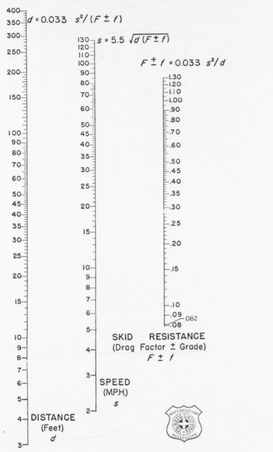

Courtesy, The Traffic Institute
Northwestern University

POSSIBLE RANGES OF PAVEMENT DRAG FACTORS FOR RUBBER TIRES

DESCRIPTION OF ROAD SURFACE	DRY				WET			
	Less Than 30 m.p.h.		More Than 30 m.p.h.		Less Than 30 m.p.h.		More Than 30 m.p.h.	
	From	To	From	To	From	To	From	To
Cement								
New, Sharp	.80	1.00	.70	.85	.50	.80	.40	.75
Travelled	.60	.80	.50	.75	.45	.70	.45	.65
Traffic Polished	.55	.75	.50	.65	.45	.65	.45	.60
Asphalt								
New, Sharp	.80	1.00	.65	.70	.50	.80	.45	.75
Travelled	.60	.80	.55	.70	.45	.70	.40	.65
Traffic Polished	.55	.75	.45	.65	.45	.65	.40	.60
Excess Tar	.50	.60	.35	.60	.30	.60	.25	.55
Brick								
New, Sharp	.75	.95	.60	.85	.50	.75	.45	.70
Traffic Polished	.60	.80	.55	.75	.40	.70	.40	.60
Stone Block								
New, Sharp	.75	1.00	.70	.90	.65	.90	.60	.85
Traffic Polished	.50	.70	.45	.65	.30	.50	.25	.50
Gravel								
Packed, Oiled	.55	.85	.50	.80	.40	.80	.40	.60
Loose	.40	.70	.40	.70	.45	.75	.45	.75
Cinders								
Packed	.50	.70	.50	.70	.65	.75	.65	.75
Rock								
Crushed	.55	.75	.55	.75	.55	.75	.55	.75
Ice								
Smooth	.10	.25	.07	.20	.05	.10	.05	.10
Snow								
Packed	.30	.55	.35	.55	.30	.60	.30	.60
Loose	.10	.25	.10	.20	.30	.60	.30	.60
Metal Grid								
Open	.70	.90	.55	.75	.25	.45	.20	.35

The drag factor or coefficient of friction of a pavement of a given *description* may vary considerably because quite a variety of road surfaces may be described in the same way and because of some variations due to weight of vehicle, air pressure in tire, tread design, air temperature, speed and some other factors.

These figures represent experiments made by many different people in all parts of the U.S. They are for straight skids on clean surfaces. Speeds referred to are at the beginning of the skid. This table is reproduced from the Accident Investigator's Manual for Police published by the Traffic Institute.

Courtesy, The Traffic Institute
Northwestern University

TRUCK FLEET

ACCIDENT INVESTIGATION

American Trucking Associations, Inc.
Department of Safety
1616 P Street, N. W.
Washington 6, D. C.

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FOREWORD

Auto Damage Correction deals with a phase of the broad curriculum field of Au
The outline was developed to assist instructors in identifying and organizing cont
pare individuals to enter the auto damage correction field. Since the course requ
of trade skills, it is recommended that qualified teachers with appropriate trade
employed as instructors.

The total concept for the project was initiated by C. Thomas Olivo, former Di
Industrial Education, State Education Department. During the summer of 1968, Aldo
County BOCES, West Nyack; John Gooding, Automotive High School, Brooklyn; Robert L
Occupational Center, Rochester; and Robert Smith, Monroe County BOCES # 1, Fairpor
course outline for Auto Damage Correction Occupations. Assistance relating to con
Edward A. Shattuck, Associate in Industrial Education.

This project is a joint effort of the Bureau of Secondary Curriculum Developm
of Continuing Education Curriculum Development. Earl Hay, Supervisor of Vocationa
of Secondary Curriculum, acted as general coordinator for the project. Nelson S.
Bureau of Continuing Education Curriculum Development, supervised the preparation
for publication.

This material is being distributed to all schools in New York State offering
program in the field of Automotive Industries with the hope that personnel involve
review the material, evaluate it, and submit suggestions for its improvement to th
consideration before final adoption.

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WILLIAM E. YOUNG, *Director*
Curriculum Development Center

FOREWORD

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GORDON E. VAN HOOFT, *Chief*
Bureau of Secondary
Curriculum Development

HERBERT BOTHAMLEY, *Chief*
Bureau of Continuing Education
Curriculum Development

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MESSAGE TO THE INSTRUC

Automotive Industries Occupations include those clusters of occupations repair of all types of automotive vehicles. Employment possibilities exist to those requiring a high degree of technical skill and knowledge.

Automotive Industries Occupations are classified into Automotive Servic motive Service deals with the general maintenance and repair of the systems automobile. Auto Damage Correction deals with the appearance of the vehicle glass, fabric, and finish. Automotive industries also require support occup business, sales, stock management, and other related areas.

This publication deals with Auto Damage Correction Occupations and foll steps necessary to enter the industry. It is designed to help instructors c body of knowledge and experiences that lead to the development of salable sk levels of complexity. It does not suggest a course of study, but rather an suggestions for use in developing a vocational program to prepare youths and suggest breadth of coverage of all fields, followed by depth of specializati

The instructional materials are divided into Topics, Concepts, Teaching reflect the services to be performed at each level. Concepts refer to the theory which relate to the services. Teaching Suggestions provide methods tions show the salable skills that should be mastered by the student. The of general safety have been left to the discretion of the instructor.

The content is based on the services to be performed and is divided in Body, and Frame. These services are presented on three levels: Basic, Int ment is intended to assist the instructor in selecting content with the app level is in the area of General Services and then into the area of Paint or after the student has had instruction in and developed skills related to Bo

A group may be given the basic material in Paint and Body and then be further work in Paint and the other additional work in Body. The two group the prescribed training. The two groups could be combined again for Frame last section and is contingent upon the completion of the other areas.

JOHN E. WHITCRAFT, *Director*
Division of Occupational Education

MESSAGE TO THE INSTRUCTOR

es Occupations include those clusters of occupations concerned with the maintenance and utomotive vehicles. Employment possibilities exist at all levels ranging from entry jobs h degree of technical skill and knowledge.

es Occupations are classified into Automotive Service and Auto Damage Correction. Auto- h the general maintenance and repair of the systems or groups of component parts in an Correction deals with the appearance of the vehicle and the repair of damaged metal, h. Automotive industries also require support occupations in the related fields of anagement, and other related areas.

als with Auto Damage Correction Occupations and follows, as closely as possible, the actual the industry. It is designed to help instructors of auto damage correction select the periences that lead to the development of salable skills required for entry at various t does not suggest a course of study, but rather an alinement of content and teaching eveloping a vocational program to prepare youths and adults for employment. It does age of all fields, followed by depth of specialization in any one area.

aterials are divided into Topics, Concepts, Teaching Suggestions, and Applications. Topics be performed at each level. Concepts refer to the principles, fundamentals, and trade he services. Teaching Suggestions provide methods of presenting the material and Applica- kills that should be mastered by the student. The use of basic hand tools and the teaching een left to the discretion of the instructor.

d on the services to be performed and is divided into the areas of General Services, Paint, services are presented on three levels: Basic, Intermediate, and Advanced. This arrange- st the instructor in selecting content with the appropriate depth or emphasis. The entry General Services and then into the area of Paint or Body. Frame should be undertaken only d instruction in and developed skills related to Body work.

n the basic material in Paint and Body and then be divided into two sections with one taking d the other additional work in Body. The two groups could be interchanged at the end of The two groups could be combined again for Frame work. Customizing is suggested as the ingent upon the completion of the other areas.

BERTON PLUMMER, *Chief*
Bureau of Trade and Technical Education

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UTO DAMAGE CORRECTION OCCUPATIONS

elow represent jobs ranging from the entry level through to the technical
cending order, starting at the bottom of the list with entry jobs which require
list so that jobs which require the greatest skills and knowledge are at or
nder the SERVICE OCCUPATIONS represent the normal progression within the
titles listed under RELATED OCCUPATIONS identify jobs in which persons with
might find employment. In certain jobs additional experience and training

itles, Vol. I and II, 3rd edition, was used as a reference in compiling this
can be secured from this reference. This is not intended as an exhaustive
rs identify a variety of possible points of entry into the auto damage

Shop

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irman
at, and Top

Leak Man
n

and Reconditioner

es Installer

le-Top Installer
er

d Polisher

RELATED OCCUPATIONS

Garage Foreman
Automobile Service Manager
Vocational Teacher
Claims Adjuster
Automobile Insurance Underwriter
Automobile Mechanic
Heavy Equipment Serviceman
Truck Body Builder
Sheet Metal Worker
Aircraft Sheet Metal Mechanic
Automobile Electrician
Hydraulics Repairman
Model Maker
Furniture Finisher
Appliance Refinisher
Radiator Repairman
Automobile Radio Repairman
Automobile Inspector
Automobile Parts Clerk
Automobile Salesman
Heavy Equipment Operator
Brake Drum Lathe Operator
Car Rental Clerk
Plating Processor
Commercial Equipment Painter
Automobile Production Worker
Automobile Service Station Attendant

Auto Damage Correction Services

LEVEL	GENERAL SERVICES	PAINT					
	Maintenance and Cleanup Services	Refinishing Services	Stencil and Decal Services	Customizing and Estimating Services	Sheet Metal and Welding Services	Electrical Services	Hardware
BASIC	Introduction to services Maintaining upholstery and carpets Preserving finishes Cleaning bodies and frames Painting (brush applications)	Introduction to services Preparing surfaces for refinishing	Introduction to services Applying stencils	Introduction to services Inspecting finishes Improving finishes	Introduction to services Craning and towing vehicles Applying undercoat Replacing sheet-metal panels	Introduction to services Replacing: headlights bulbs fuses circuit breakers wires mercury switches radio antennas horns electric clocks rear-body lights	Introduction services Replacing: rearview m hubcaps an covers fuel-tank striker pl hood sprin locking de reveal mol sill plate coat hooks sun visors
INTERMEDIATE	General service procedures to be drawn from the basic level of paint, body, and frame	Refinishing spots and panels	Applying decals	Custom refinishing of panels	Repairing sheet-metal panels Applying body filler Welding and brazing sheet metal Repairing bumpers Repairing trim	Replacing: starters generators dimmer switches marker lights courtesy lights electric locks	Replacing: trunk and trunk tors locks door handl window reg window sto
ADVANCED	Servicing used automobiles Managing and supervising auto service shops	Refinishing entire vehicles	Applying and preserving imitation wood-grained decals	Estimating jobs Custom refinishing entire vehicles	Arc and spot welding sheet metal Repairing major body damage	Replacing: power units ignition switches safety signals wiper motors instrument lights automobile radios	Replacing: glass-run channel re division b wiper arm eliminatin and ratt
TECHNICAL							

PAINT		BODY			
Stencil and ecal Services	Customizing and Estimating Services	Sheet Metal and Welding Services	Electrical Services	Hardware Services	Upholstery Services
troduction o services plying stencils	Introduction to services Inspecting finishes Improving finishes	Introduction to services Craning and towing vehicles Applying undercoat Replacing sheet-metal panels	Introduction to services Replacing: headlights bulbs fuses circuit breakers wires mercury switches radio antennas horns electric clocks rear-body lights	Introduction to services Replacing: rearview mirrors hubcaps and wheel covers fuel-tank doors striker plates hood springs and hinges locking devices reveal moldings sill plates coat hooks sun visors	Introduction to services Replacing: scuff pads floor mats trim arm rests sound deadeners safety belts
plying ecals	Custom re-finishing of panels	Repairing sheet-metal panels Applying body filler Welding and brazing sheet metal Repairing bumpers Repairing trim	Replacing: starters generators dimmer switches marker lights courtesy lights electric locks	Replacing: trunk and door hinges trunk torsion rods locks door handles window regulators window stops	Replacing: seat and back rests seat covers trim insulating materials
plying and reserving mitation ood-grain-d decals	Estimating jobs Custom re-finishing entire vehicles	Arc and spot welding sheet metal Repairing major body damage	Replacing: power units ignition switches safety signals wiper motors instrument lights automobile radios	Replacing: glass-run channels channel retainers division bars wiper arm assemblies eliminating squeaks and rattles	Replacing: headliners console units convertible tops

Glass Services	Remote Controls, Radiator, and Climate Control Services	Customizing and Estimating Services	Sectioning Services	Straightening Services
Introduction to services Replacing: vent assemblies door glass	Introduction to services Replacing: ventilating units concealed head-lights	Introduction to services Making minor design changes: dechroming vehicles adding scoops altering grilles	Introduction to services Replacing: front framehorns outer-frame cross-rails	Introduction to services Making minor repai to frames: Welding cracks Straightening fr Rebuilding brack
Replacing: quarter-panel glass tailgate glass	Replacing: thermostats radiators and hoses heater units water pumps	Making major design changes: recessing head-lights and tail-lights altering wheel openings	Replacing: rear-frame kickups frame siderails frame crossmembers	Making repairs to frames: spring sockets outer-frame cros members rear-frame kickups
Replacing: rear-window glass windshields	Replacing: air conditioning units	Making body dimen-sional changes Repairing fiberglass parts Estimating costs of repair work	Replacing: front-frame sections rear-frame sections	Making major repai to frames: Alining frames

		FRAME				
rols, and trol	Customizing and Estimating Services	Sectioning Services	Straightening Services	Unit Body: Extensive Damage and Alinement Services	Customizing Services	LEVEL
to units ead-	Introduction to services Making minor design changes: dechroming vehicles adding scoops altering grilles	Introduction to services Replacing: front framehorns outer-frame cross-rails	Introduction to services Making minor repairs to frames: Welding cracks Straightening frames Rebuilding brackets	Introduction to services	Introduction to services Altering frame designs	BASIC
nd s	Making major design changes: recessing head-lights and tail-lights altering wheel openings	Replacing: rear-frame kickups frame siderails frame crossmembers	Making repairs to frames: spring sockets outer-frame cross-members rear-frame kickups	Repairing unit bodies	Constructing tubular front suspensions	INTERMEDIATE
oning	Making body dimen-sional changes Repairing fiberglass parts Estimating costs of repair work	Replacing: front-frame sections rear-frame sections	Making major repairs to frames: Alining frames	Alining front ends	Constructing tubular frames	ADVANCED
						TECHNICAL

GENERAL SERVICES

Maintenance and Cleanup Services

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GENERAL SERVICES

aintenance and Cleanup Services

GENERAL SERVICES - *Maintenance and Cleanup Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Introduction to services	Job opportunities in maintenance and clean-up services	Discuss methods of securing a job.
		Importance of human relations	Discuss methods of developing good human relations on the job
			Demonstrate basic tools and equipment related to maintenance and cleanup services.
	Maintaining upholstery and carpets	Types of vacuum cleaning units	Demonstrate various types of vacuum cleaning units for automobiles.
		Types of upholstery and carpet cleaners	Discuss selection of upholstery and carpet cleaners for specific work and material.
Basic		Types of stains and methods of removal	Discuss stains and methods of removal from upholstery and carpets.
		Composition of dyes	Explain importance of following manufacturers' directions for dyeing upholstery and carpets.
	Preserving finishes	Types of detergents for washing automobiles	Discuss types of detergents used for washing an automobile.
		Types of solvents	Discuss function of solvents.
		Composition of compounding materials	Explain use of compounding materials.

leanup Services

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
ortunities in ance and clean- ices	Discuss methods of securing a job.	Role play situations involving job interviews
nce of human ns	Discuss methods of developing good human relations on the job.	Role play situations involving typical person-to-person problems
	Demonstrate basic tools and equipment related to maintenance and cleanup services.	Perform basic maintenance and cleanup operations
f vacuum cleants	Demonstrate various types of vacuum cleaning units for automobiles.	Vacuum upholstery and carpets
f upholstery and cleaners	Discuss selection of upholstery and carpet cleaners for specific work and material.	Clean upholstery and carpets with detergents
f stains and of removal	Discuss stains and methods of removal from upholstery and carpets.	Remove stains from upholstery and carpets
tion of dyes	Explain importance of following manufacturers' directions for dyeing upholstery and carpets.	Dye upholstery and carpets
f detergents hing automobiles	Discuss types of detergents used for washing an automobile.	Wash automobiles
f solvents	Discuss function of solvents.	Remove tar and grease from automobiles
tion of compound- erials	Explain use of compounding materials.	Compound finishes

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTION
		Types of chrome cleaners	Discuss use of chrome cl
Basic	Cleaning bodies and frames	Types of steam and chemical cleaning equipment used in the automotive industry	Demonstrate steam and ch cleaning equipment.
	Painting (brush applications)	Types and purposes of finishing materials	Discuss types and uses o ous paint materials.
			Demonstrate painting a m a tire.
			Demonstrate painting an compartment.
			Demonstrate painting an carriage.
Intermediate	General service procedures to be drawn from the basic levels of paint, body, and frame		Discuss, demonstrate, or any required service tha listed under paint, body frame.

GENERAL SERVICES - *Maintenance and Cleanup Services*

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
pes of chrome eaners	Discuss use of chrome cleaners.	Polish chrome parts of automobiles
pes of steam and emical cleaning uipment used in the tomotive industry	Demonstrate steam and chemical cleaning equipment.	Clean component parts with steam and chemicals
pes and purposes of nishing materials	Discuss types and uses of various paint materials.	
	Demonstrate painting a mat and a tire.	Paint mats and tires
	Demonstrate painting an engine compartment.	Paint engine compartments
	Demonstrate painting an undercarriage.	Paint undercarriages
	Discuss, demonstrate, or explain any required service that is listed under paint, body, or frame.	

GENERAL SERVICES - *Maintenance and Cleanup Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTION
	Servicing used automobiles	Types and functions of servicing units	Describe function of var types of servicing units
			Demonstrate methods of: Checking fluid levels Charging a battery Replacing a wiper blad Repairing a tire
Advanced	Managing and supervising auto service shops	Personnel management and training	Discuss techniques of su vising workers.
			Explain importance of gi clear, concise direction
		Types of required forms and records	Discuss use of such reco sales, purchases, invent and tax.
		Types of financial responsibilities	Discuss and show samples purchasing and billing procedures and credit references.
			Discuss payroll requirem
			Explain various governme regulations affecting a business.
			Discuss advantages and d advantages of affiliati local collection agencie

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and Cleanup Services

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
ypes and functions of ervicing units	Describe function of various types of servicing units.	Use servicing units to check component parts
	Demonstrate methods of: Checking fluid levels Charging a battery Replacing a wiper blade Repairing a tire	Prepare automobiles for delivery by: Checking all fluid levels Charging batteries Replacing wiper blades Repairing tires Cleaning inside Washing and polishing
ersonnel management nd training	Discuss techniques of supervising workers.	Supervise personnel
	Explain importance of giving clear, concise directions.	Train personnel
ypes of required forms nd records	Discuss use of such records as sales, purchases, inventory, and tax.	Keep such records as sales, purchases, inventory, and tax
ypes of financial esponsibilities	Discuss and show samples of purchasing and billing procedures and credit references.	
	Discuss payroll requirements.	
	Explain various government regulations affecting a business.	
	Discuss advantages and disadvantages of affiliating with local collection agencies.	

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PAINT

Refinishing Services

Stencil and Decal Services

Customizing and Estimating Services

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PAINT

Refinishing Services

Stencil and Decal Services

Customizing and Estimating Services

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PAINT - *Refinishing Services*

LEVEL	TOPICS	CONCEPTS	TEACHING
Basic	Introduction to services	Types and purposes of refinishing materials	Explain types refinishing m Discuss tools materials, an refinishing.
		Purpose of color codes	Discuss color manufacturers Show location identificati
	Preparing surfaces for refinishing	Methods of preparing surfaces for refinishing	Demonstrate surface for
Intermediate	Refinishing spots and panels	Methods of duplicating original finishes	Demonstrate spot (touchu Demonstrate methods of m color lighte Demonstrate Demonstrate panel.
		Methods of applying compounds and polishing finishes	Demonstrate and polishin

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
es and purposes of inishing materials	Explain types and purposes of refinishing materials.	
	Discuss tools, equipment, materials, and procedures for refinishing.	Use basic refinishing tools, equipment, and materials
pose of color codes	Discuss color codes used by manufacturers.	Select correct colors according to codes
	Show location of a paint identification plate on vehicle.	Select correct colors for specific vehicles
hods of preparing faces for refinish-	Demonstrate preparation of a surface for refinishing.	Remove old paint and clean areas to be refinished
		Mask off areas
		Apply primer
hods of duplicating ginal finishes	Demonstrate how to refinish a spot (touchup).	Refinish spots (touchup)
	Demonstrate gun techniques and methods of making a metallic color lighter or darker.	Match metallic colors
	Demonstrate blending techniques.	
	Demonstrate refinishing a full panel.	Refinish full panels
hods of applying pounds and polishing nishes	Demonstrate applying a compound and polishing a finish.	Apply compounds and polish finishes

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTION
Intermediate		Methods of computing time and materials for refinishing panels	Show method of computing and materials for a spec job.
	Refinishing entire vehicles	Composition of refinishing materials	Discuss composition of r ing materials.
		Procedures for refinishing entire vehicles	Demonstrate procedures f refinishing an entire ve
		Match colors using formulas	Demonstrate use of formu equipment for matching c
Advanced			Demonstrate matching a s color.
		Use of stripe as a decoration	Discuss various types of striping materials.
			Demonstrate procedure fo striping a vehicle.
		Methods of computing time and materials for complete refinish jobs	Discuss materials requir a complete refinish job.
			Explain how preparation affect time required for different jobs.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
thods of computing e and materials for finishing panels	Show method of computing time and materials for a specific job.	Figure cost of time and material for specific jobs
position of refinish- materials	Discuss composition of refinishing materials.	
cedures for refinish- entire vehicles	Demonstrate procedures for refinishing an entire vehicle.	Refinish entire vehicles
ch colors using mulas	Demonstrate use of formulas and equipment for matching colors.	
	Demonstrate matching a specific color.	Match colors to order
of stripe as a oration	Discuss various types of striping materials.	
	Demonstrate procedure for striping a vehicle.	Stripe lines on vehicles
hods of computing e and materials for plete refinish jobs	Discuss materials required for a complete refinish job.	Compute time and materials for complete refinish jobs
	Explain how preparation needs affect time required for different jobs.	

PAINT - *Stencil and Decal Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGEST
Basic	Introduction to services	Use of stencils and decals for identification	Discuss use of stenci decals for identifica
		Composition of stencils and decals	Explain manufacture o and decals.
		Surface preparation for application of stencils and decals	Demonstrate surface p for application of a and a decal.
		Types of protective materials for stencils and decals	Discuss composition a protective materials stencils and decals.
			Demonstrate applicati coating materials.
	Applying stencils	Methods of applying stencils	Demonstrate applicati simple stencil.
			Show application of
Intermediate	Applying decals	Design factors affecting decal location	Discuss location of based on principles
		Nature of monograms and decals	Review manufacturer' cations of monograms
			Show application of monograms, and tape

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Use of stencils and decals for identification	Discuss use of stencils and decals for identification.	
Composition of stencils and decals	Explain manufacture of stencils and decals.	
Surface preparation for application of stencils and decals	Demonstrate surface preparation for application of a stencil and a decal.	Prepare surfaces for application of stencils and decals
Types of protective materials for stencils and decals	Discuss composition and use of protective materials for stencils and decals.	Apply sealers for stencils and decals
	Demonstrate application of coating materials.	Clean and protect existing letters
Methods of applying stencils	Demonstrate application of a simple stencil.	Apply simple stencils
	Show application of letters.	Apply letters
Design factors affecting decal location	Discuss location of decal based on principles of design.	Lay out and position decals
Nature of monograms and decals	Review manufacturer's specifications of monograms and decals.	
	Show application of letters, monograms, and tape stripes.	Apply letters, monograms, and tape stripes

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTI
Advanced	Applying and preserving imitation wood-grained decals	Use of decals to create an effect	Discuss types and uses decals.
			Demonstrate applicatio a wet-type decal.
			Demonstrate alinement
			Demonstrate applicatio a dry-type decal.
			Demonstrate use of a h to soften decal during cation.

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Use of decals to create an effect	Discuss types and uses of decals.	
	Demonstrate application of a wet-type decal.	Apply wood-grained (wet-type) design to panels
		Apply approved sealer
	Demonstrate alinement of a decal.	
	Demonstrate application of a dry-type decal.	Apply wood-grained (dry-type) design to panels
	Demonstrate use of a heat lamp to soften decal during application.	
		Apply approved sealer

PAINT - *Customizing and Estimating Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Basic	Introduction to services	Importance of custom work	Discuss the extent of cust work.
			Discuss special materials for custom work.
	Inspecting finishes	Recognitation of defects in finishes	Explain common defects in commercial finish.
	Improving finishes	Development of quality finishes	Demonstrate methods of obt ing a mirror-like finish.
Intermediate	Custom refinishing of panels	Function of special spray equipment	Demonstrate use of specia tools and spray equipment.
			Review manufacturer's dire tions accompanying each p
Advanced	Estimating jobs	Methods of computing estimates for complete custom jobs	Discuss method of making accurate cost analysis.
			Explain that customizing be a cost-plus figure.
	Custom refinishing entire vehicles	Types and use of custom materials for special effects	Demonstrate methods of mi and applying special fini materials.
			Discuss extent of guarant

ONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
ce of custom	Discuss the extent of custom work.	
	Discuss special materials used for custom work.	
ation of in finishes	Explain common defects in a commercial finish.	Determine extent of irregularities in finishes
ent of quality	Demonstrate methods of obtaining a mirror-like finish.	Improve finishes with use of compounds and abrasives
of special uipment	Demonstrate use of special tools and spray equipment.	Refinish areas designated by customers
	Review manufacturer's directions accompanying each product.	
of computing s for complete obs	Discuss method of making an accurate cost analysis.	Itemize cost of parts, materials, and labor to determine total estimate for jobs
	Explain that customizing may be a cost-plus figure.	
d use of custom s for special	Demonstrate methods of mixing and applying special finishing materials.	Refinish entire vehicles as designated by customers
	Discuss extent of guarantee.	

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BODY

Sheet Metal and Welding Services

Electrical Services

Hardware Services

Upholstery Services

Glass Services

Remote Controls, Radiator, and Climate Control Services

Customizing and Estimating Services

BODY - *Sheet Metal and Welding Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Introduction to services	Composition of metals used in the automotive industry	Discuss fabrication of stee its use in the automotive i try.
		Methods of fabricating metal to increase its strength	Explain methods of forming to increase its strength.
			Demonstrate basic sheet-me tools.
Basic	Craning and towing vehicles	Design and construction of craning and towing equipment	Demonstrate procedures for craning and towing a vehic
		Principles of mechanical advantage	Discuss mechanical advanta an aid in doing work.
	Applying undercoat	Purpose of undercoating vehicles	Distinguish between underc and body-deadening materia
			Demonstrate undercoating a vehicle.
	Replacing sheet-metal panels	Design and construction of sheet-metal panels	Demonstrate removal and re ment of a sheet-metal pane
			Demonstrate safe removal a replacement of a fuel tank

Services

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
mposition of metals ed in the automotive dustry	Discuss fabrication of steel and its use in the automotive industry.	
thods of fabricating tal to increase its rength	Explain methods of forming metal to increase its strength.	
	Demonstrate basic sheet-metal tools.	Fabricate simple shapes from sheet metal
sign and construction craning and towing uipment	Demonstrate procedures for craning and towing a vehicle.	Crane and tow vehicles
inciples of mechanical vantage	Discuss mechanical advantage as an aid in doing work.	
rpose of undercoating hicles	Distinguish between undercoating and body-deadening materials.	
	Demonstrate undercoating a vehicle.	Undercoat vehicles
esign and construction f sheet-metal panels	Demonstrate removal and replacement of a sheet-metal panel.	Remove and replace sheet-metal panels
	Demonstrate safe removal and replacement of a fuel tank.	Remove and replace fuel tanks

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Repairing sheet-metal panels	Physical structure and shearing properties of sheet metal	Demonstrate sheet-metal re procedures.
	Applying body filler	Types and properties of body-filler materials	Discuss composition of bod filler materials.
			Demonstrate use of plastic filler and body solder.
Intermediate	Welding and brazing sheet metal	Effects of heat on metal	Demonstrate operation and of an oxyacetylene torch.
		Methods of controlling temperature of metal	Demonstrate brazing.
			Demonstrate use of an asbe heat dam.
			Discuss where and why weld permits are required.
	Repairing bumpers	Process of plating metal	Explain process of plating
		Importance of making accurate measurements when doing repair work	Demonstrate methods of str ening a bumper.
	Repairing trim	Types and purpose of fastening devices and molding clips	Demonstrate various types fastening devices and mold clips.
		Use of templates	Demonstrate making a templ

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
ysical structure and earing properties of eet metal	Demonstrate sheet-metal repair procedures.	Straighten, cut, and fit sheet metal
pes and properties of dy-filler materials	Discuss composition of body-filler materials.	
	Demonstrate use of plastic filler and body solder.	Fill damaged areas with plastic filler and body solder
fects of heat on metal	Demonstrate operation and use of an oxyacetylene torch.	Fuse metal parts using an oxyacetylene torch
thods of controlling perature of metal	Demonstrate brazing.	Braze panels
	Demonstrate use of an asbestos heat dam.	
	Discuss where and why welding permits are required.	
cess of plating al	Explain process of plating metal.	
ortance of making urate measurements n doing repair work	Demonstrate methods of straightening a bumper.	Straighten and repair bumpers
es and purpose of tening devices and ding clips	Demonstrate various types of fastening devices and molding clips.	
of templates	Demonstrate making a template.	Make and use templates

BODY - *Sheet Metal and Welding Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Intermediate			Demonstrate removal and placement of exterior an rior trim.
		Types of rivets and sheet metal screws	Demonstrate fastening w rivets and sheet metal s
			Show methods of locatin
	Arc-and spot-welding sheet metal	Methods of arc and spot-welding sheet metal	Explain function of ele
			Explain selection of am for different situation
Advanced			Describe types and use welding clamps.
			Demonstrate arc welding sheet metal.
			Demonstrate spot-weldin sheet metal.
	Repairing major body damage	Types of body construction	Explain unit body and c tional body constructio
		Principles of hydraulics	Demonstrate use of spec body equipment.
			Demonstrate repair of a

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate removal and replacement of exterior and interior trim.	Remove and replace exterior and interior trim using various types of fastening devices and special tools
Types of rivets and sheet metal screws	Demonstrate fastening with rivets and sheet metal screws.	Fasten metal using rivets and sheet metal screws
	Show methods of locating holes.	Remove and replace grilles
Methods of arc and spot-welding sheet metal	Explain function of electrodes.	
	Explain selection of amperage for different situations.	
	Describe types and use of welding clamps.	
	Demonstrate arc welding of sheet metal.	Arc-weld sheet metal sections
	Demonstrate spot-welding of sheet metal.	Spotweld sheet metal sections
Types of body construction	Explain unit body and conventional body construction.	Repair front fender and hood damage
Principles of hydraulics	Demonstrate use of special body equipment.	Repair side body damage
	Demonstrate repair of a pillar.	Repair pillars
		Repair rear body damage

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Advanced		Design and construction of roof sections	Demonstrate repair of a roof section. Demonstrate removal and replacement of component parts a roof.
		Design and construction of floor sections	Demonstrate repair of a floor section.
		Design and construction of cowl sections	Describe methods of reinforci a cowl section. Demonstrate repair of a cowl section.
		Principles of body alinement	Discuss body alinement procedures. Demonstrate alinement of component body parts.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
n and construc- of roof sections	Demonstrate repair of a roof section.	
	Demonstrate removal and replacement of component parts in a roof.	Repair roof damage by removing and replacing component parts
n and construc- of floor sections	Demonstrate repair of a floor section.	Repair floor sections
n and construc- of cowl sections	Describe methods of reinforcing a cowl section.	
	Demonstrate repair of a cowl section.	Repair cowl sections
iples of body ment	Discuss body alinement procedures.	
	Demonstrate alinement of component body parts.	Aline body with component parts

BODY - *Electrical Services*

LEVEL	TOPICS	CONCEPTS	TEACHING
	Introduction to services	Basic automotive electrical circuits	Discuss diffe circuits of a
	Note: These services are to be performed on specific body repair jobs		
	Replacing: Headlights	Importance of properly aimed headlights	Explain type lights.
			Demonstrate tion, and ad lights.
Basic	Bulbs	Types and sizes of bulbs	Explain use and sizes of
			Demonstrate ment of vari of bulbs.
	Fuses	Function, types, and sizes of fuses	Explain func sizes of fus
			Point out lo block.
			Demonstrate ment of a fu
	Circuit breakers	Function of circuit breakers	Discuss fun breaker.
			Demonstrate ment of a ci

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Basic automotive electrical circuits	Discuss different electrical circuits of an automobile.	
Importance of properly aimed headlights	Explain types and sizes of headlights.	
	Demonstrate removal, installation, and adjustment of headlights.	Remove, install, and aline headlights
Types and sizes of bulbs	Explain use for different types and sizes of bulbs.	
	Demonstrate removal and replacement of various types and sizes of bulbs.	Remove and replace bulbs in component units
Function, types, and sizes of fuses	Explain function, types, and sizes of fuses.	
	Point out location of a fuse block.	
	Demonstrate removal and replacement of a fuse.	Remove and replace fuses
Function of circuit breakers	Discuss function of a circuit breaker.	
	Demonstrate removal and replacement of a circuit breaker.	Remove and replace circuit breakers

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Wires	Principles of a single wire system	Discuss methods of groundin different types of devices.
		Types of wire splices and connectors	Discuss types of wire splic and connectors.
			Demonstrate methods of repa ing electrical wire.
	Mercury switches	Function of mercury switches	Explain operation of a merc switch.
			Demonstrate removal and ins lation of a trunk-light swi
B a s i c	Radio antennas	Purpose of radio antennas	Explain principle of a radi antenna and reasons for usi a shielded lead-in wire.
			Demonstrate removal and ins lation of a radio antenna.
	Horns	Types of horns and horn relays	Demonstrate removal, insta tion, and adjustment of a and a horn relay.
	Electric clocks	Types of electric clocks	Demonstrate removal and ins lation of an electric cloc
	Rear-body lights	Types of rear-body lights	Demonstrate removal and re ment of a taillight, a bac light, and a license-plate light.

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NCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
s of a single em	Discuss methods of grounding different types of devices.	
wire splices ctors	Discuss types of wire splices and connectors.	
	Demonstrate methods of repairing electrical wire.	Repair electrical wires
of mercury	Explain operation of a mercury switch.	
	Demonstrate removal and installation of a trunk-light switch.	Remove and install trunk-light switch
f radio	Explain principle of a radio antenna and reasons for using a shielded lead-in wire.	
	Demonstrate removal and installation of a radio antenna.	Remove and install radio antennas
horns and horn	Demonstrate removal, installation, and adjustment of a horn and a horn relay.	Remove, install, and adjust horns and horn relays
electric clocks	Demonstrate removal and installation of an electric clock.	Remove and install electric clocks
rear-body	Demonstrate removal and replacement of a taillight, a backup light, and a license-plate light.	Remove and replace taillights, backup, and license-plate lights

BODY - *Electrical Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIO
Intermediate	Replacing: Starting units	Types of drive belts	Demonstrate removal, i lation, and adjustment belts.
		Types of starting units	Demonstrate operation, installation, and adju a starting unit.
	Generating units	Types of generating units	Demonstrate operation, and installation of a or an alternator.
	Dimmer switches	Types of dimmer switches	Demonstrate operation, and installation of a switch.
	Marker lights	Types of marker lights	Demonstrate removal a lation of a marker lig
	Courtesy lights	Types of courtesy lights	Demonstrate removal a lation of a courtesy
	Electric locks	Types of electric locks	Discuss types of elec ing devices.
			Demonstrate operation and installation of a lock.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Types of drive belts	Demonstrate removal, installation, and adjustment of drive belts.	Remove, install, and adjust drive belts
Types of starting units	Demonstrate operation, removal, installation, and adjustment of a starting unit.	Remove and install starting units
Types of generating units	Demonstrate operation, removal and installation of a generator or an alternator.	Remove and install generators or alternators
Types of dimmer switches	Demonstrate operation, removal, and installation of a dimmer switch.	Remove and install dimmer switches
Types of marker lights	Demonstrate removal and installation of a marker light.	Remove and install marker lights
Types of courtesy lights	Demonstrate removal and installation of a courtesy light.	Remove and install courtesy lights
Types of electric locks	Discuss types of electric locking devices.	
	Demonstrate operation, removal, and installation of an electric lock.	Remove and install electric locks

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Replacing:	Types of electrical test equipment	Demonstrate use of electr test equipment.
	Power units	Types of power seat units	Demonstrate operation, re installation, and adjustm a power seat unit.
		Types of power window units	Demonstrate operation, re installation, and adjustm a power window unit.
		Types of power top units	Demonstrate operation, re installation, and adjustm a power top unit.
Advanced	Ignition switches	Types of ignition switches	Demonstrate removal and i lation of an ignition swi
	Safety signals	Types of safety signals	Demonstrate removal and i lation of a safety signal switch.
	Wiper motors	Types of wiper motors	Demonstrate operation, re and installation of a wip motor.
	Instrument lights	Types of instrument lights	Discuss types of bulbs an circuits used for instrum
			Demonstrate removal and i lation of an instrument l
	Automobile radios	Basic shapes and designs of automobile radios and speakers	Explain relationship of s of a radio and component to their location.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
ypes of electrical est equipment	Demonstrate use of electrical test equipment.	Use test equipment to check circuits and units
ypes of power seat nits	Demonstrate operation, removal, installation, and adjustment of a power seat unit.	Remove, install, and adjust power seat units
ypes of power window nits	Demonstrate operation, removal, installation, and adjustment of a power window unit.	Remove, install, and adjust power window units
ypes of power top nits	Demonstrate operation, removal, installation, and adjustment of a power top unit.	Remove, install, and adjust power top units
ypes of ignition witches	Demonstrate removal and installation of an ignition switch.	Remove and install ignition switches
ypes of safety signals	Demonstrate removal and installation of a safety signal and switch.	Remove and install safety signals and switches
ypes of wiper motors	Demonstrate operation, removal, and installation of a wiper motor.	Remove and install wiper motors
ypes of instrument ights	Discuss types of bulbs and circuits used for instruments.	
	Demonstrate removal and installation of an instrument light.	Remove and install instrument lights
asic shapes and designs f automobile radios and peakers	Explain relationship of shape of a radio and component parts to their location.	Remove and install automobile radios and component parts

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BODY - *Hardware Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Introduction to services	Types of automotive hardware	Discuss different types hardware used on a vehic
	Replacing: Rearview mirrors	Types of rearview mirrors	Demonstrate attaching a view mirror to a vehicle
	Hubcaps and wheel covers	Operation of gripping devices of hubcaps	Explain purpose of hubca
			Demonstrate replacement hubcap.
	Fuel-tank doors	Principles of inset design	Demonstrate removal and lation or adjustment of tank door.
Basic	Striker plates	Types and designs of striker plates	Discuss function of str plates.
			Demonstrate removal and lation or adjustment of striker plate.
		Types and design of insulators and spacers	Explain use of insulato spacers.
			Demonstrate removal and lation of a bumper stop
	Hood springs and hinges	Principles of leverage	Review principles of me advantage.
			Demonstrate removal, in tion, and adjustment of spring and hinge.

NCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
automotive	Discuss different types of hardware used on a vehicle.	
rearview	Demonstrate attaching a rear-view mirror to a vehicle.	Attach and adjust rearview mirrors to vehicles
of gripping f hubcaps	Explain purpose of hubcaps.	
	Demonstrate replacement of a hubcap.	Remove and replace hubcaps
s of inset	Demonstrate removal and installation or adjustment of a fuel-tank door.	Remove and install or adjust fuel-tank doors
designs of lates	Discuss function of striker plates.	
	Demonstrate removal and installation or adjustment of a striker plate.	Remove and install or adjust striker plates
design of s and spacers	Explain use of insulators and spacers.	
	Demonstrate removal and installation of a bumper stop.	Remove and install bumper stops
s of leverage	Review principles of mechanical advantage.	
	Demonstrate removal, installation, and adjustment of a hood spring and hinge.	Remove, install, and adjust hood springs and hinges

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Locking devices - spring type	Types and design of spring-locking devices	Discuss types and design of spring-locking devices. Demonstrate removal, installation, and adjustment of a hood-latch assembly.
Basic	Reveal moldings	Types and design of reveal moldings	Discuss types and design of reveal moldings. Demonstrate removal and installation of a reveal molding.
	Sill plates	Types and design of protective hardware	Discuss types and design of protective hardware. Demonstrate removal and installation of a sill plate.
	Coat hooks	Types and design of convenience hardware	Demonstrate removal and installation of convenience hardware.
	Sun visors	Importance of controlling sun glare	Demonstrate removal and installation of a sun visor.
Intermediate	Replacing:		
	Trunk and door hinges	Types and design of trunk and door hinges	Demonstrate removal and installation of trunk and door hinges
	Trunk torsion rods	Operation of trunk torsion rods	Demonstrate operation, removal, installation, and adjustment of trunk torsion rods.
	Locks	Types and operation of locks	Explain types and operation of locks.

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
and design of g-locking devices	Discuss types and design of spring-locking devices.	
	Demonstrate removal, installation, and adjustment of a hood-latch assembly.	Remove, install, and adjust hood-latch assemblies
and design of l moldings	Discuss types and design of reveal moldings.	
	Demonstrate removal and installation of a reveal molding.	Remove and install reveal moldings
and design of ctive hardware	Discuss types and design of protective hardware.	
	Demonstrate removal and installation of a sill plate.	Remove and install sill plates
and design of ience hardware	Demonstrate removal and installation of convenience hardware.	Remove and install coat hooks
tance of control- un glare	Demonstrate removal and installation of a sun visor.	Remove and install sun visors
and design of and door hinges	Demonstrate removal and installation of trunk and door hinges.	Remove, install, and adjust trunk and door hinges
ion of trunk n rods	Demonstrate operation, removal, installation, and adjustment of trunk torsion rods.	Remove, install, and adjust trunk torsion rods
and operation of	Explain types and operation of locks.	

BODY - *Hardware Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGEST
Intermediate		Methods of coding lock cylinders and keys	Discuss methods of c cylinders and keys.
			Demonstrate removal lation of a lock ass
	Door handles	Types of outside door handles	Demonstrate removal lation of an outside
		Types of inside door handles	Demonstrate removal lation of an inside
	Window regulators	Types of window regulators	Demonstrate removal, tion, and adjustment regulator.
	Window stops	Types of window stops	Demonstrate removal, tion, and adjustment dow stop.
Advanced	Replacing: Glass-run channels	Types of glass-run channels	Demonstrate operatio and installation of channel.
			Demonstrate techniqu lubricating a glass-
	Channel retainers	Types of channel retainers	Demonstrate removal, tion, and adjustment channel retainer.
	Division bars	Purpose of division bars	Demonstrate removal lation of a division

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
thods of coding lock linders and keys	Discuss methods of coding lock cylinders and keys.	
	Demonstrate removal and installation of a lock assembly.	Remove and install lock assemblies
pes of outside door ndles	Demonstrate removal and installation of an outside door handle.	Remove and install outside door handles
pes of inside door ndles	Demonstrate removal and installation of an inside door handle.	Remove and install inside door handles
pes of window regulars	Demonstrate removal, installation, and adjustment of a window regulator.	Remove, install, and adjust window regulators
pes of window stops	Demonstrate removal, installation, and adjustment of a window stop.	Remove, install, and adjust window stops
pes of glass-run annels	Demonstrate operation, removal, and installation of a glass-run channel.	Remove and install glass-run channels
	Demonstrate techniques for lubricating a glass-run channel.	Lubricate glass-run channels
pes of channel retains	Demonstrate removal, installation, and adjustment of a channel retainer.	Remove, install, and adjust channel retainers
rpose of division bars	Demonstrate removal and installation of a division bar.	Remove and install division bars

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Advanced	Wiper-arm assemblies	Types of wiper-arm assemblies	Demonstrate operation, removal, and installation of a wiper-arm assembly.
	Eliminating squeaks and rattles		Demonstrate locating and eliminating squeaks and rattles.

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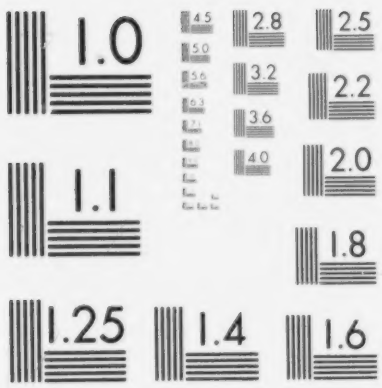

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
of wiper-arm lies	Demonstrate operation, removal, and installation of a wiper-arm assembly.	Remove and install wiper-arm assemblies
	Demonstrate locating and eliminating squeaks and rattles.	Locate and eliminate squeaks and rattles

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BODY - *Upholstery Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Introduction to services	Composition of upholstery materials used in automotive industry	Discuss compostion of upho stery materials used in au tive industry.
	Replacing: Scuff pads		Demonstrate removal and in lation of a scuff pad.
	Floormats		Demonstrate removal and in lation of a floormat and
B a s i c	Trim	Design and function of trim	Discuss design, function, nomenclature of trim.
			Demonstrate removal and in lation of trim items.
	Armrests	Importance of comfort while driving	Demonstrate removal and in lation of an armrest.
	Sound deadners	Methods of reducing noise	Discuss types and uses of reducing materials.
			Demonstrate installation o body deadeners.
	Safety belts	Types of safety belts	Discuss federal regulation manufacturers' specificati relative to safety belts.
			Demonstrate installation o safety belt.

NCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
on of uphol- erials used in e industry	Discuss compostion of upholstery materials used in automotive industry.	
	Demonstrate removal and installation of a scuff pad.	Remove and install scuff pads
	Demonstrate removal and installation of a floormat and lining.	Remove and install floormats and linings
d function of	Discuss design, function, and nomenclature of trim.	
	Demonstrate removal and installation of trim items.	Remove and install side trim and windlace
e of comfort ving	Demonstrate removal and installation of an armrest.	Remove and install armrests
f reducing	Discuss types and uses of noise reducing materials.	
	Demonstrate installation of body deadeners.	Install body deadeners
safety belts	Discuss federal regulations and manufacturers' specifications relative to safety belts.	
	Demonstrate installation of a safety belt.	Install safety belts

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS	
	Replacing: Seats and backrests	Design and construction of seats and backrests	Discuss design and construction of seats and backrests.	
			Demonstrate methods of repairing a seat and a backrest.	Re
			Demonstrate removal and installation of a seat and a backrest.	Re an
	Seat covers	Types of protective coverings for seats	Discuss types of protective coverings for seats.	
Intermediate			Demonstrate installation of a seat cover.	In
	Trim	Trim fastening devices	Discuss fastening devices for trim.	
			Demonstrate removal and installation of door trim.	Re
			Demonstrate removal and installation of quarter-panel trim.	Re pa
		Types of sealers	Discuss sealing materials.	
			Explain moisture barrier inserts.	
			Demonstrate procedures of locating and correcting water and dust leaks.	L d
	Insulating materials	Types of insulating materials	Discuss types of insulating materials.	

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COES 2308

EPTS	TEACHING SUGGESTIONS	APPLICATIONS
construction d backrests	Discuss design and construction of seats and backrests.	
	Demonstrate methods of repairing a seat and a backrest.	Repair seats and backrests
	Demonstrate removal and installation of a seat and a backrest.	Remove and install seats and backrests
otective or seats	Discuss types of protective coverings for seats.	
	Demonstrate installation of a seat cover.	Install seat covers
ing devices	Discuss fastening devices for trim.	
	Demonstrate removal and installation of door trim.	Remove and install door trim
	Demonstrate removal and installation of quarter-panel trim.	Remove and install quarter-panel trim
alers	Discuss sealing materials.	
	Explain moisture barrier inserts.	
	Demonstrate procedures of locating and correcting water and dust leaks.	Locate and correct water and dust leaks
nsulating	Discuss types of insulating materials.	

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BODY - *Upholstery Services*

LEVEL	TOPICS	CONCEPTS	TEACHING
Intermediate			Demonstrate insulating m
	Replacing: Headliners		Demonstrate lation of a
	Console units		Demonstrate lation of a
Advanced	Convertible tops	Principle of retracting vehicle top units	Discuss ope top retract
			Demonstrate ment of a v unit.
			Discuss mat convertible
			Demonstrate ment of co curtains.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate installation of insulating material.	Install insulating material
	Demonstrate removal and installation of a headliner.	Remove and install headliners
	Demonstrate removal and installation of a console unit.	Remove and install console units
Principle of retracting vehicle top units	Discuss operation of a vehicle top retracting unit.	
	Demonstrate service and adjustment of a vehicle top retracting unit.	Service faulty vehicle top retracting units
	Discuss materials used for convertible hard and soft tops.	
	Demonstrate removal and replacement of convertible top and curtains.	Remove and install convertible tops and curtains

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTI
Advanced			Demonstrate repair of tible top fabric. Demonstrate use of con top fabric adhesive.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate repair of convertible top fabric.	Repair convertible top fabrics
	Demonstrate use of convertible top fabric adhesive.	

BODY - *Glass Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIO
	Introduction to services	Types and composition of automotive glass	Discuss types and comp of automotive glass. Discuss storage of gla
	Replacing: Vent assemblies	Principles of automobile ventilation	Discuss automobile ven
Basic		Types and functions of vent assemblies	Demonstrate operation, and installation of a assembly.
	Door glass	Operation of door-glass raising mechanism	Explain operation of a glass raising mechanis Demonstrate removal, i tion, and adjustment o glass.
Intermediate	Replacing: Quarter-panel glass		Demonstrate removal, i tion, and adjustment o quarter-panel glass.
	Tailgate glass		Discuss type of glass tailgate window on a s wagon. Demonstrate removal, i tion, and adjustment o gate glass on a static

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NCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
composition of e glass	Discuss types and composition of automotive glass.	
	Discuss storage of glass.	
s of automo- ilation	Discuss automobile ventilation.	
functions of mblies	Demonstrate operation, removal, and installation of a vent assembly.	Remove and install vent assemblies
of door-glass echanism	Explain operation of a door-glass raising mechanism.	
	Demonstrate removal, installation, and adjustment of a door glass.	Remove, install, and adjust door glass
	Demonstrate removal, installation, and adjustment of a quarter-panel glass.	Remove, install, and adjust quarter-panel glass
	Discuss type of glass used in a tailgate window on a station wagon.	
	Demonstrate removal, installation, and adjustment of a tailgate glass on a station wagon.	Remove, install, and adjust tailgate glass on station wagon

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS	
	Replacing: Rear-window glass		Demonstrate removal and installation of a rear-window glass.	R w
Advanced			Demonstrate procedure for locating and correcting a leak around a rear window.	L a
	Windshields	Design of windshields	Discuss design of windshields.	
			Demonstrate removal and installation of a windshield.	R w
			Demonstrate procedure for locating and correcting a leak around a windshield.	L a

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate removal and installation of a rear-window glass.	Remove and install rear-window glass
	Demonstrate procedure for locating and correcting a leak around a rear window.	Locate and correct leaks around rear windows
n of windshields	Discuss design of windshields.	
	Demonstrate removal and installation of a windshield.	Remove and install windshields
	Demonstrate procedure for locating and correcting a leak around a windshield.	Locate and correct leaks around windshields

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BODY - *Remote Controls, Radiator, and Climate Control Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Basic	Introduction to services	Types of semiautomatic and manual controls	Discuss mechanical units ope ted by the driver.
	Replacing: Ventilating units	Types of ventilating units	Demonstrate removal and inst lation of an air duct and co trol.
			Demonstrate removal and inst lation of a defroster unit a ducts.
	Concealed headlights	Design of concealed headlights	Demonstrate operation, remov installation, and adjustment of a concealed headlight.
Intermediate	Replacing: Thermostats	Methods of controlling heat in an automobile	Discuss function of a thermo
			Demonstrate replacement and installation of a thermostat
	Radiator hoses		Discuss types and sizes of radiator hoses.
			Demonstrate replacement and installation of a radiator
	Radiators		Discuss function of a radiator cap.
			Demonstrate removal and ins lation of a radiator.
	Heater units		Demonstrate removal and ins lation of a heater unit.

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mate Control Services

CEPTS	TEACHING SUGGESTIONS	APPLICATIONS
emiautomatic controls	Discuss mechanical units operated by the driver.	
entilating	Demonstrate removal and installation of an air duct and control.	Remove and install air ducts and controls
	Demonstrate removal and installation of a defroster unit and ducts.	Remove and install defroster units and ducts
concealed	Demonstrate operation, removal, installation, and adjustment of a concealed headlight.	Remove, install, and adjust concealed headlights
controlling automobile	Discuss function of a thermostat.	
	Demonstrate replacement and installation of a thermostat.	Remove and install thermostats
	Discuss types and sizes of radiator hoses.	
	Demonstrate replacement and installation of a radiator hose.	Remove and install radiator hoses
	Discuss function of a radiator cap.	
	Demonstrate removal and installation of a radiator.	Remove and install radiators
	Demonstrate removal and installation of a heater unit.	Remove and install heater units

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Intermediate			Demonstrate locating and correcting a leak in heater system.
	Water pumps		Demonstrate removal and installation of a fan and water pump.
			Demonstrate locating and correcting a leak in a cooling system.
	Replacing: Air conditioning units	Principle of changing a gas into a liquid by using pressure	Discuss use of pressure to change a gas into a liquid.
			Explain function of a condensor.
Advanced			Demonstrate removal and installation of a condensor unit.
			Demonstrate procedures for evacuating an air conditioning system.
		Types of filters	Explain function of a receiver drier.
			Demonstrate removal and installation of a receiver drier.
		Types of temperature controlling devices	Explain operation of a magnetic clutch to control compressor operation.

BODY - *Remote Controls, Radiator, and Climate Control Services*

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate locating and correcting a leak in heater system.	Locate and correct leaks in heater systems
	Demonstrate removal and installation of a fan and water pump.	Remove and install fans and water pumps
	Demonstrate locating and correcting a leak in a cooling system.	Locate and correct leaks in cooling systems
le of changing a o a liquid by ressure	Discuss use of pressure to change a gas into a liquid.	
	Explain function of a condensor.	
	Demonstrate removal and installation of a condensor unit.	Remove and install condensor units
	Demonstrate procedures for evacuating an air conditioning system.	Evacuate air conditioning systems
filters	Explain function of a receiver drier.	
	Demonstrate removal and installation of a receiver drier.	Remove and install receiver driers
temperature ing devices	Explain operation of a magnetic clutch to control compressor operation.	

BODY - *Remote Controls, Radiator, and Climate Control Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGES
			Demonstrate removal lation of a clutch a pressor unit.
		Methods of regulating flow of refrigerant	Explain operation of sion valve.
			Demonstrate removal lation of an expansi
Advanced		Principle of changing a liquid into a gas by reducing pressure	Discuss use of reduc pressure to change a into a gas.
			Explain function of evaporator.
			Demonstrate removal lation of an evapora
		Types of refrigerants	Discuss types of ref
			Demonstrate rechargi conditioning system.
			Demonstrate locating recting a leak in an ditioning system.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate removal and installation of a clutch and a compressor unit.	Remove and install clutches and compressor units
ds of regulating of refrigerant	Explain operation of an expansion valve.	
	Demonstrate removal and installation of an expansion valve.	Remove and install expansion valves
iple of changing uid into a gas by ing pressure	Discuss use of reduced pressure to change a liquid into a gas.	
	Explain function of an evaporator.	
	Demonstrate removal and installation of an evaporator.	Remove and install evaporators
s of refrigerants	Discuss types of refrigerants.	
	Demonstrate recharging an air conditioning system.	Recharge air conditioning systems
	Demonstrate locating and correcting a leak in an air conditioning system.	Locate and correct leaks in air conditioning systems

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Basic	Introduction to services	Types of special services available	Discuss scope of customizing occupations.
	Making minor design changes:	Methods of making minor design changes	Discuss methods of making minor design changes.
	Dechroming vehicles		Demonstrate dechroming a vehicl and filling holes.
			Explain methods of sheet metal layout.
			Review methods of fabrication appropriate for changing a vehicle design.
			Review fastening devices.
	Adding scoops and louvers		Discuss types and functions of scoops and louvers.
			Demonstrate installation of a scoop and a louver.
	Altering grilles		Demonstrate methods of altering a grille design.
Intermediate	Making major design alterations:	Methods of making major design changes	Discuss methods and limitations of making major design changes.
			Demonstrate layout and construction of a template.
	Recessing headlights and taillights		Demonstrate methods of recessin a headlight and a taillight.

BODY - *Customizing and Estimating Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGES
Intermediate			Demonstrate alining justing recessed hea
			Demonstrate methods stituting and reloca ware.
	Altering wheel openings	Methods of reinforcing areas	Review wheel and tir
			Demonstrate altering opening.
	Making body dimensional changes	Principles of vehicle body design and construction	Explain necessity o taining vehicle bal
			Point out use of dr when making body ch
Advanced			Discuss importance ing a vehicle level
			Emphasize importanc accurate measuremen
			Demonstrate methods cuts and joints in
			Demonstrate methods ing a body.
			Demonstrate methods a body.

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NCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate alining and adjusting recessed headlights.	Aline and adjust recessed headlights
	Demonstrate methods of substituting and relocating hardware.	Substitute and relocate hardware
of reinforcing	Review wheel and tire sizes.	
	Demonstrate altering a wheel opening.	Alter wheel openings
es of vehicle ign and con- n	Explain necessity of maintaining vehicle balance.	
	Point out use of drawings when making body changes.	
	Discuss importance of keeping a vehicle level.	
	Emphasize importance of making accurate measurements.	
	Demonstrate methods of making cuts and joints in metal.	
	Demonstrate methods of shortening a body.	Shorten body designs
	Demonstrate methods of lowering a body.	Lower body designs

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
			Demonstrate methods of raising a body.
			Demonstrate methods of extending a body.
	Repairing fiberglass parts	Use of synthetic materials	Discuss composition of fiberglass.
			Demonstrate grinding down to raw fiberglass.
Advanced			Demonstrate cutting a mat to size.
			Demonstrate applying resin mixture to a mat.
			Demonstrate grinding and filling a patched area.
			Demonstrate smoothing a patched area.
		Methods of rebuilding areas	Demonstrate matching, gluing, and clamping a broken piece.
			Demonstrate reinforcing a back of a panel.
			Demonstrate applying a wet mat and use of a roller.
			Demonstrate final shaping, filling, and sanding of a damaged area.

NCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate methods of raising a body.	Raise body designs
	Demonstrate methods of extending a body.	Extend body designs
ynthetic s	Discuss composition of fiberglass.	
	Demonstrate grinding down to raw fiberglass.	Grind down to raw fiberglass
	Demonstrate cutting a mat to size.	Cut mats to size
	Demonstrate applying resin mixture to a mat.	Apply resin mixture to mats
	Demonstrate grinding and filling a patched area.	Grind and fill patched areas
	Demonstrate smoothing a patched area.	Smooth patched areas
of rebuilding	Demonstrate matching, gluing, and clamping a broken piece.	Match, glue, and clamp broken pieces
	Demonstrate reinforcing a back of a panel.	Reinforce backs of panels
	Demonstrate applying a wet mat and use of a roller.	Apply and roll wet mats
	Demonstrate final shaping, filling, and sanding of a damaged area.	Shape final form, fill, and sand damaged areas

BODY - *Customizing and Estimating Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTI
		Methods of joining fiberglass sections	Discuss bonding adhesi fiberglass.
			Demonstrate cleaning a face to be matched.
			Demonstrate applying a
			Review filling and smo a patched area.
		Methods of reinforcing fiberglass panels	Explain necessity of c connection with fiberg
A d v a n c e d			Demonstrate tieing int strut or a mounting br
			Demonstrate applying mat under a split area
		Methods of fabricating parts	Demonstrate use of an section as a core.
			Demonstrate masking o protecting an area to cated.
			Demonstrate placing ve al over a form.
			Demonstrate applying
			Discuss adequate curi and removal of a core
			Demonstrate positioni cementing of a core u damaged area.

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
thods of joining berglass sections	Discuss bonding adhesives for fiberglass.	
	Demonstrate cleaning a surface to be matched.	Clean surfaces to be matched
	Demonstrate applying an adhesive.	Apply adhesives
	Review filling and smoothing a patched area.	
thods of reinforcing berglass panels	Explain necessity of covering connection with fiberglass.	
	Demonstrate tieing into a wood strut or a mounting bracket.	Tie into wood struts or mounting brackets
	Demonstrate applying layers of mat under a split area.	Apply layers of mat under split areas
thods of fabricating rts	Demonstrate use of an undamaged section as a core.	
	Demonstrate masking off and protecting an area to be duplicated.	Mask off and protect areas to be duplicated
	Demonstrate placing veil material over a form.	Place veil material over forms
	Demonstrate applying a resin.	Apply resins
	Discuss adequate curing time and removal of a core.	Cure and remove cores
	Demonstrate positioning and cementing of a core under a damaged area.	Position and cement cores under damaged areas

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
			Demonstrate constructing a part by overlapping strips of mat and applying resin.
	Estimating costs of repair work	Analyze extent of damage	Discuss methods of determining direction of impact and possible damage to related parts.
		Methods of determining costs	Discuss estimating the cost of labor. Discuss estimating the cost of replacement parts. Discuss other costs such as: Fire and liability insurance Workmen's compensation Unemployment Insurance Payroll Rent Charge for tools and equipment Utilities Office equipment and supplies Taxes Maintenance and repair Advertising Discuss other items such as: Building and fire codes Customer relations Demonstrate methods of writing a job estimate.
Advanced			

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate constructing a part by overlapping strips of mat and applying resin.	Construct parts using cores
ze extent of e	Discuss methods of determining direction of impact and possible damage to related parts.	
ds of determining	Discuss estimating the cost of labor.	Estimate labor costs for repair jobs
	Discuss estimating the cost of replacement parts.	Estimate cost of replacement parts
	Discuss other costs such as: Fire and liability insurance Workmen's compensation Unemployment Insurance Payroll Rent Charge for tools and equipment Utilities Office equipment and supplies Taxes Maintenance and repair Advertising	Determine "overhead" charges
	Discuss other items such as: Building and fire codes Customer relations	
	Demonstrate methods of writing a job estimate.	Estimate total costs of repair jobs

FRAME

Sectioning Services

Straightening Services

Unit Body: Extensive Damage and Alinement Services

Customizing Services

LEVEL	TOPICS	CONCEPTS	TEACHING SU
	Introduction to services	Types, design, and construction of frames	Discuss fundamen shapes and sect
	Replacing: Front framehorns	Methods of sectioning damaged frames	Review manufactu tions for frame
			Demonstrate the Planning a jo Using special Measuring and Using heat to Fitting and a Welding
B a s i c			Demonstrate rem ment of a front
	Outer-frame cross-rails	Types of structural design	Explain purpose
			Point out reinf frame construct
			Demonstrate rem obstructing pa
			Demonstrate rem ment of an oute rail.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Types, design, and construction of frames	Discuss fundamentals of basic shapes and sectioning of a frame.	
Methods of sectioning damaged frames	Review manufacturers' specifications for frames.	
	Demonstrate the following: Planning a job Using special tools Measuring and cutting Using heat to repair damage Fitting and alining parts Welding	Perform basic operations
	Demonstrate removal and replacement of a front framehorn.	Remove and replace front framehorns
Types of structural design	Explain purpose of crossrails.	
	Point out reinforced areas in frame construction.	
	Demonstrate removal of an obstructing part.	Remove obstructing parts
	Demonstrate removal and replacement of an outer-frame crossrail.	Remove and replace outer-frame crossrails

FRAME - *Sectioning Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
	Replacing: Rear-frame kick-ups	Methods of replacing rear-frame kickups	Explain function of rear-fra kickups.
			Demonstrate measuring and ma ing off an area to be remove
			Demonstrate removal, replace ment, and alinement of a rea frame kickup.
Intermediate	Frame siderails	Methods of replacing frame siderails	Identify welded areas.
			Demonstrate removal of an attached part.
			Demonstrate removal, alineme and replacement of a frame rail.
	Frame crossmembers	Design and construction of frame crossmembers	Explain design and purpose frame crossmember.
			Demonstrate removal of an attached part.
			Demonstrate opening a seam, moving a rivet, and breakin weld.
			Demonstrate removal, replac ment, and alinement of a fr crossmember.

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
ods of replacing frame kickups	Explain function of rear-frame kickups.	
	Demonstrate measuring and marking off an area to be removed.	Measure and mark off areas to be removed
	Demonstrate removal, replacement, and alinement of a rear-frame kickup.	Remove, replace, and aline rear-frame kickups
ods of replacing siderails	Identify welded areas.	
	Demonstrate removal of an attached part.	Remove attached parts
	Demonstrate removal, alinement, and replacement of a frame siderail.	Remove, replace, and aline frame siderails
gn and construction rame crossmembers	Explain design and purpose of frame crossmember.	
	Demonstrate removal of an attached part.	Remove attached parts
	Demonstrate opening a seam, removing a rivet, and breaking a weld.	
	Demonstrate removal, replacement, and alinement of a frame crossmember.	Remove, replace, and aline frame crossmembers

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS	
	Replacing: Front-frame sections	Installation of pre-fabricated parts	Discuss advantages of replacing large sections of a frame.	
			Point out on charts areas to be removed.	
Advanced			Demonstrate fishplating a joined area.	Build
			Demonstrate removal, replacement, and alinement of a front-frame section.	Remove front-
	Rear-frame sections	Methods of replacing rear-frame sections	Discuss advantages and disadvantages of using used parts.	
			Demonstate positioning of jack stands for frame support.	
			Demonstrate removal, replacement, and alinement of a rear-frame section.	Remove rear-

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Installation of pre-fabricated parts	Discuss advantages of replacing large sections of a frame.	
	Point out on charts areas to be removed.	
	Demonstrate fishplating a joined area.	Build up areas to be fastened
	Demonstrate removal, replacement, and alinement of a front-frame section.	Remove, replace, and aline front-frame sections
Methods of replacing rear-frame sections	Discuss advantages and disadvantages of using used parts.	
	Demonstate positioning of jack stands for frame support.	
	Demonstrate removal, replacement, and alinement of a rear-frame section.	Remove, replace, and aline rear-frame sections

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FRAME - *Straightening Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SU
	Introduction to services	Techniques of correcting frame damage	Discuss special tions for frame
	Making minor repairs to frames:		
	Welding cracks	Methods of welding cracked frames	Demonstrate ele welding.
			Demonstrate rei cracked frame.
			Demonstrate fir repaired area.
B a s i c	Straightening frames	Methods of restoring frames to original shape	Discuss methods ing a frame in place.
			Demonstrate use reach an inacce
			Demonstrate rep and finishing c
	Rebuilding brackets	Methods of rebuilding brackets	Demonstrate met ening and posit
		Importance of alining frames with component parts	Demonstrate rep bolt hole.

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Techniques of correcting frame damage	Discuss special job qualifications for frame work.	
Methods of welding cracked frames	Demonstrate electric and gas welding.	
	Demonstrate reinforcing a cracked frame.	Weld cracked frames
	Demonstrate finishing off a repaired area.	Finish off repaired areas
Methods of restoring frames to original shape	Discuss methods of straightening a frame in a hard-to-get place.	
	Demonstrate use of a "door" to reach an inaccessible place.	
	Demonstrate repairing a "door" and finishing off an area.	Straighten frames or remove dents in hard-to-get places and finish off areas
Methods of rebuilding brackets	Demonstrate methods of straightening and positioning a bracket.	Repair damaged bracket mounts
Importance of alining frames with component parts	Demonstrate repair of a torn bolt hole.	Repair torn bolt holes

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS	
	Making repairs to frames:	Methods of straightening structural frame members	Emphasize importance of strong welds for structural frame members.	
Intermediate	Spring sockets	Importance of maintaining original clearances	Explain function of spring and necessity for proper clearances.	
			Discuss relationship of spring socket to suspension.	
			Demonstrate repair of a spring socket.	Repai
			Review manufacturers' specifications for structural frame members.	
			Explain limits of structural changes.	
	Outer-frame cross-members		Demonstrate use of heat to straighten a frame.	Repai memb
	Rear-frame kickups		Demonstrate repair of a rear-frame kickup.	Repai
Advanced	Making major repairs to frames:	Principles of frame design	Explain design of frame joints.	
			Point out necessity of accurate measurements to maintain original dimensions.	
			Demonstrate use of a frame gauge.	Use

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
s of straighten- ructural frame s	Emphasize importance of strong welds for structural frame members.	
ance of maintain- iginal clearances	Explain function of spring and necessity for proper clearances.	
	Discuss relationship of spring socket to suspension.	
	Demonstrate repair of a spring socket.	Repair spring sockets
	Review manufacturers' specifications for structural frame members.	
	Explain limits of structural changes.	
	Demonstrate use of heat to straighten a frame.	Repair outer-frame cross-members
	Demonstrate repair of a rear-frame kickup.	Repair rear-frame kickups
ples of frame	Explain design of frame joints.	
	Point out necessity of accurate measurements to maintain original dimensions.	
	Demonstrate use of a frame gauge.	Use frame gauges

FRAME - *Straightening Services*

LEVEL	TOPICS	CONCEPTS	TEACHING SUG
Advanced	Alining frames		Demonstrate alin Discuss effects frame on body a

TEACHING SUGGESTIONS	APPLICATIONS
Demonstrate alining a frame.	Aline frames
Discuss effects of a misalined frame on body and drive train.	Eliminate sidesway, buckle, sag, twist, and diamond

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LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS
Basic	Introduction to services	Methods of repairing unit body frames	Discuss techniques of repairing extensive damage and alining a unit body frame.
	Note: This service deals with extensive damage of inner structure of a unit body and does not consider finishing of sheet metal parts.		
	Ability in this section depends on previously developed skills in the Body area.		
Intermediate	Repairing unit bodies	Use of force and leverage to correct damage	Determine extent of damage.
			Review manufacutrers' specifications.
			Review stress and strain and transfer of force.
			Demonstrate use of anchors and clamps.
			Demonstrate use of wooden blocks to distribute force over a large area.

FRAME - *Unit Body: Extensive Damage and Alinement Services*

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
thods of repairing it body frames	Discuss techniques of repairing extensive damage and alining a unit body frame.	Perform basic operations
e of force and lev-age to correct damage	Determine extent of damage.	
	Review manufacutrers' specifications.	
	Review stress and strain and transfer of force.	
	Demonstrate use of anchors and clamps.	
	Demonstrate use of wooden blocks to distribute force over a large area.	

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FRAME - *Unit Body: Extensive Damage and Alinement*

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGEST
Intermediate			Discuss force limit attachments.
			Demonstrate positio jacks.
			Demonstrate cutting repair inner constr age.
			Demonstrate use of correct damage.
			Demonstrate squarin compartment opening
			Discuss methods of hidden buckle.
Advanced	Alining front ends	Principles of front-end geometry	Explain types of fr sion.
			Demonstrate front-e tion.
			Discuss caster and demonstrate adjustm
		Methods of eliminating hard steering, wander, and weave	Discuss directional returnability, redu tire scrub, and har
			Demonstrate toe-in adjustments.
			Explain why wheels to the side of leas

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Discuss force limits for various attachments.	
	Demonstrate positioning of body jacks.	Position jacks prior to starting repair work
	Demonstrate cutting a body to repair inner construction damage.	
	Demonstrate use of heat to correct damage.	
	Demonstrate squaring off a compartment opening.	Repair damage to unit bodies
	Discuss methods of locating a hidden buckle.	
inciples of front-end ometry	Explain types of front suspension.	
	Demonstrate front-end inspection.	Inspect for front-end wear
	Discuss caster and camber and demonstrate adjustments.	Adjust caster and camber
thods of eliminating rd steering, wander, d weave	Discuss directional stability, returnability, reduction of tire scrub, and hard turning.	
	Demonstrate toe-in and toe-out adjustments.	Adjust toe-in and toe-out
	Explain why wheels tend to pull to the side of least [illegible]ation.	

LEVEL	TOPICS	CONCEPTS	TEACHING SUGGESTIONS	
	Introduction to services	Types of specialized construction	Explain opportunities in automobile customizing.	
Basic	Altering frame designs	Purpose of changes in design	Discuss design changes with plans.	
			Demonstrate raising, lowering, shortening, and extending a frame.	Alter const
			Discuss determination of cost of altering a frame design.	
Intermediate	Constructing tubular front suspensions	Advantages of tubular construction	Demonstrate cutting, fitting, and welding tubular steel.	Const front
			Discuss importance of reinforcing parts.	
Advanced	Constructing tubular frames	Types, sizes, and strength of tubular materials	Discuss advantages of tubular construction.	
			Discuss making of plans for tubular construction.	
			Demonstrate shaping and attaching of tubular parts.	

CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
Types of specialized construction	Explain opportunities in automobile customizing.	
Purpose of changes in design	Discuss design changes with plans.	
	Demonstrate raising, lowering, shortening, and extending a frame.	Alter frame design and construction
	Discuss determination of cost of altering a frame design.	
Advantages of tubular construction	Demonstrate cutting, fitting, and welding tubular steel.	Construct and install tubular front suspensions
	Discuss importance of reinforcing parts.	
Types, sizes, and strength of tubular materials	Discuss advantages of tubular construction.	
	Discuss making of plans for tubular construction.	
	Demonstrate shaping and attaching of tubular parts.	

FRAME - *Customizing Services*

LEVEL	TOPICS	CONCEPTS	TEACHING S
A d v a n c e d			Demonstrate c a tubular fra Demonstrate a tubular frame Discuss facto such as numbe the pulls req

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CONCEPTS	TEACHING SUGGESTIONS	APPLICATIONS
	Demonstrate construction of a tubular frame.	Construct tubular frames
	Demonstrate alinement of a tubular frame.	Aline tubular frames
	Discuss factors affecting cost such as number of setups for the pulls required.	Figure costs of jobs

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ABSTRACT - Prepared by experienced supervisors in the area of shorthand instruction, this guide is designed to aid shorthand teachers at all experience levels in planning and conducting high school shorthand programs. The guide is organized in major sections for First Year, Second Year, Third Year, and Special Classes with the first three sections including objectives, classroom activities, instructional techniques, and evaluation, and the specialized course covering: (1) rapid advancement, (2) modified classes, (3) accelerated stenography, (4) Spanish stenography, (5) legal and medical stenography, (6) Gregg shorthand, (7) machine shorthand, (8) speedwriting, and (9) work experience. A section on cocurricular and extracurricular activities and an appendix providing a bibliography, teaching aids and resources, list of commonly misspelled words, various sample schedules and forms for use in electronic laboratories or classrooms, and speed dictation charts are also included. (AW)

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SHORTHAND

FOR HIGH SCHOOLS

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SHORTHAND
FOR HIGH SCHOOLS

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Foreword

This curriculum bulletin, *Shorthand for High Schools,* is designed to provide materials for teachers and pupils in the secondary schools. Included are practices and procedures representing current teaching methodology and contemporary business practices. Specific applications and general principles serve as a guide for the beginning teacher as well as the more experienced instructor. Recommendations are provided to meet the needs of students of differing ability levels and aspirations.

Modern offices function most efficiently with the aid of competent secretaries who serve as major assistants to the busy executive. Commerce and industry flourish through correspondence. Many of the new devices used for transcription and communication depend upon the ability of the trained stenographer.

Shorthand continues to be an important subject in the high school program and is a major interest of many young people preparing for careers in business and industry.

SEELIG LESTER
Deputy Superintendent of Schools

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Acknowledgments

This curriculum bulletin, *Shorthand for High Schools,* was developed cooperatively by the Bureau of Curriculum Development, David A. Abramson, Acting Director, and the Bureau of Business and Distributive Education, Norman W. Elliott, Acting Director. Harry E. Wolfson, Assistant Superintendent, cooperated in the preparation of these materials, and Seelig Lester, Deputy Superintendent of Schools for Instructional Services, provided overall direction for the curriculum development program.

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Daniel A. Salmon, Acting Assistant Director, Bureau of Curriculum Development, served as coordinator of this project. Edythe Kahn, Editor, supervised the printing production. Eleanor Shea edited the manuscript. Ruth Eriksen was responsible for page design and cover.

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Introduction

This guide has been prepared by experienced supervisors in the area of shorthand instruction for the purpose of assisting teachers at all experience levels. It seeks to contribute to the resolution of instructional problems of the type most frequently encountered. Essentially, this is a compendium of objectives, teaching aids, devices, techniques, materials, methods, and activities. It will provide the beginning teacher with suggestions for establishing a set of instructional priorities and for planning the daily lesson; and it will serve the experienced teacher as a reference source for acquiring additional approaches that may contribute to motivational impact and to instructional effectiveness.

This guide is organized in major sections for First Year, Second Year, Third Year, and Special Classes. However, a detailed Table of Contents for easy reference will enable the teacher to review a topic as it applies to every level of the course of study.

AIMS

The shorthand program has the following goals:

- To develop a degree of occupational competency which will enable the student to obtain gainful initial employment and a basis for progressive advancement.
- To develop students' ability to take dictated correspondence and to transcribe it in acceptable form.
- To build a broad understanding of modern business procedures and terminology.
- To strengthen the students' language arts skills.
- To acquaint students with the career opportunities available in the business world.
- To develop in the students desirable work habits, attitudes, and ideals essential to the successful performance of the duties of a stenographer and of the broader occupational role.

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Since fundamental English skills are essential for successful progress, it is recommended that where there is inadequacy in these skills, the basic two-year course be extended to provide for additional, correlated language arts learning activity. This extension may be in the form of double periods of shorthand in the first or second year of the subject, or in both; or it may extend the basic two-year course to two-and-one-half or three years.

CONTENT

The content of shorthand instruction is based on the principles embodied in the Gregg and Pitman stenography systems, both of which are taught in the New York City high schools. Instruction in machine shorthand and alphabetic shorthand systems is offered in some high schools.

DEVELOPING DESIRABLE ATTITUDES AND TRAITS

The development of desirable attitudes, ideals, and traits of character is a vital part of education. It must be recognized that these personal qualities cannot be taught as directly or measured as readily as technical skills. Nevertheless, this phase of the students' training must not be neglected.

The problem of how to develop these desirable attitudes, ideals, and traits of character can best be handled when there is an awareness and understanding on the part of the teacher of the background and upbringing of his students. In a large city such as New York, the school population is highly heterogeneous in family training and in socio-economic background. Since children bring to school many of their problems and difficulties, the teacher must be alert to accept the students as they are and to work with them to achieve more wholesome and desirable qualities. If the development of proper attitudes, ideals, and traits is to be successful, provision for the development of those qualities must be made in the classroom.

Special mention should be made of the problems of students who have initial difficulties in adjusting to the stenographic course. To avoid discouraging shorthand students during the first term or year of work, it must be remembered that the problems of home and environment are especially important in determining the level of success during this time.

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While it is the function of the teacher to help the students develop desirable traits, it is, by the same token, necessary for the teacher to know what qualities he himself should possess to bring about a better adjustment to the initial stages of shorthand learning. Teachers of beginning shorthand students should possess the following attributes:

INTEREST AND UNDERSTANDING

One of the best ways to obtain rapport with the student who is making a poor initial adjustment is to show a genuine interest in his problems, both in and out of school. The child who has been brought up in a home where punishment for any slight wrongdoing is the order of procedure will be reluctant to try something new. This may sometimes explain poor achievement.

ENCOURAGING ATTITUDES

The student with good potential who does poorly in school is in need of constant stimulation. Encouragement begins with faith in the child and a desire to help during the difficult periods of adjustment. Frequent reference to others who have surmounted similar difficulties, both celebrities and peers, is a helpful device. Also helpful is a cheerful attitude on the part of the teacher. Children "catch" enthusiasm and cheerfulness. The teacher who regards his lessons as drudgery will find that he cannot hide this attitude from his students and that they soon begin to assume the same attitude. Together with encouragement in the everyday work of the class should go the development of aspirations for future success. The teacher should constantly relate successful work of the day to successful work on a job.

The occupations of stenographer and secretary should be considered as objectives that can contribute significantly to the upward mobility and raised aspirations of inner-city youth. Therefore full recognition should be accorded to the desirability of encouraging students who have interest and potential that can be developed, to participate in this program. The special needs of these students can be met, by implementing the recommendations contained in this guide as they relate to curriculum practices found on p. 87 and p. 88 and instructional approaches found in the sections on Essentials of Instruction.

PERSONALITY TRAITS

In order to achieve maximum effectiveness in the training of students for stenographic jobs in the business world, the teacher should make it

a practice to include training and experience in the following traits as part of the regular routine of teaching.

Responsibility. The stenographer should carry out to a proper conclusion any job that he assumes. Students must be trained to complete assignments of work on days when they are absent and to accept responsibility for tasks or jobs of a daily, recurring nature.

Initiative. Initiative involves finding ways to handle a problem as well as assuming problems and responsibilities beyond the normal course of activity.

Punctuality. There is a close correlation between the record for punctuality in school and on the job. The teacher should insist that students get to class on time, that they begin work promptly, and that all work be submitted when due.

Courtesy. Many opportunities occur for training in courteous behavior, such as listening quietly while the teacher or another student is talking, not calling out answers, using the words "please" and "thank you" wherever appropriate, etc. Perhaps the best way of instilling courtesy lies in the example set by the teacher.

Getting Along with Others. Implicit in respect for others is the recognition and acceptance of individual differences. The teacher should guide the process so that individual students are not permitted to impose their own likes and dislikes on the rest of the class. He should also be alert to encourage understanding and acceptance of the weaknesses and strengths of individual students or groups of students. The teacher should not permit members of the class to exaggerate or publicize the faults or weaknesses of others in the group. Discussions should be held, when appropriate, on certain undesirable office practices such as gossiping, making derogatory remarks, acting to the detriment of others, and being unwilling to cooperate with others in carrying out a job. The value of a cheerful attitude, enthusiasm, and evenness of disposition should be emphasized in daily classroom routine.

Honesty. We may also interpret honesty as an open-minded acceptance of ourselves. This involves admitting faults and facing situations squarely. Such obvious situations as taking tests are splendid opportunities for building traits of honesty. Other opportunities will arise in connection with discussions of such undesirable practices as writing in textbooks, unauthorized use of longhand keys, and use of longhand in shorthand notes (when specifically prohibited), etc.

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Loyalty. The businessman expects his employees to maintain a high degree of loyalty to the firm. Making disparaging remarks about the employer or the firm, revealing company secrets, or spreading gossip about others in the firm are all practices that must be avoided. The discussion of these practices will serve to stress the need for loyalty.

Adaptability. The teacher must make students aware of the need for flexibility in their attitudes by emphasizing the process of continuous change in the business world and developing the willingness to adjust to change.

Personal Appearance and Voice. The first and sometimes decisive impression an employer receives of a prospective employee is his personal appearance and voice qualities. Special attention should be paid to cleanliness of person and of clothing, neatness of hair and the use of subdued makeup. The teacher should at all times be a model in these respects, and should utilize display materials showing correct business attire. The teacher should be on the alert to encourage a well-modulated speaking voice, good posture, and pride in personal appearance.

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First-Year Shorthand

SPECIFIC OBJECTIVES

To enable the students to learn the theory of the shorthand system

To enable the students to apply the principles of the system:

- To construct shorthand outlines in conformity with the system of shorthand taught
- To write shorthand fluently and correctly in form, direction, slant, and proportion
- To write short/brief forms, phrases, and basic vocabulary automatically
- To take from timed dictation simple business material, both familiar and unfamiliar, and to read and transcribe it accurately
- To read fluently from shorthand plates and notes.

To develop correct habits of studying shorthand

To develop correct and efficient work habits in using the notebook, in handling materials and in organizing work systematically

To train students to evaluate their performance, to analyze their own work for specific weaknesses, and to apply remedial measures

To build a basic skill in handling the conventions of written English: spelling, punctuation, and meaning of common business terms.

To develop in pupils desirable work habits, attitudes, and ideals essential to the performance of the duties of the stenographer and of the broader occupational role.

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CLASSROOM ACTIVITIES

The important elements of good teaching include the proper allocation and the optimum use of time; a simple, clear, step-by-step presentation; sufficient repetition to insure automatization; and an application phase for the new vocabulary.

To maintain and heighten interest the teacher should be familiar with and use a variety of approaches for the various parts of the lesson. The activities listed below are suggested and recommended procedures, by no means all-inclusive, by which a teacher may attain such variety. It would be advisable for the beginning teacher to use these as a checklist to insure that he does vary his procedures. More detailed information relating to these subheadings will be found in the pages that follow.

In addition, the teacher should remember that to stimulate effort the lesson must be paced suitably, and that to challenge attention much of the material reviewed and applied should be timed.

STARTING EACH LESSON PROMPTLY

The teacher must have prepared some form of set classroom activity, known to the students, for the start of each lesson. A student monitor may be assigned to start the activity even before the bell rings. By the time the bell has rung each pupil can therefore be at work. In addition, monitors preassigned should have cleaned, ruled (if desired), and dated the boards.

USING THE HOMEWORK ASSIGNMENT

Reading plate material

Stressing fluency, accuracy, and rapidity of reading
Questioning theory, spelling, and content
Having the class trace during the reading

Reading words or connected material from student's homework notes

Stressing fluency, accuracy, and rapidity of reading

Questioning theory, spelling, and content
Having the class trace or rewrite during the reading on lines or columns provided on the homework paper

Dictating homework material

Previewing difficult outlines and then dictating
Dictating material first and then postviewing troublesome outlines
Dictating at increasing rates of speed
Having students trace over their notes or rewrite during the reading back by other students

Using special stenographic workbooks in which the shorthand outlines are printed and blank lines are provided below the plates

Using records and tapes

READING SHORTHAND PLATES

Reading plate notes from previous lesson
Reading plates of new lesson

DAILY TEST (Optional — Short)

Word Test — limited in length

Based on homework assignment
Based on review of short/brief forms and phrases
Based on specific class needs

These tests should be checked immediately and followed by remedial practice; no more than three minutes need be allowed for the entire procedure.

Dictation Test

Based on homework assignment
Based on material previously covered
Based on new material but including familiar vocabulary

Spelling Test

Taken from homework
Taken from words commonly misspelled on previous tests
Taken from spelling list
Taken from students' lists of personal spelling difficulties

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Transcription Test

Based on textbook
Based on homework
Based on open-book dictation and transcribed from the student's own notes

BRIEF FORM, SHORT FORM, AND PHRASE DRILLS

Isolated brief forms, short forms, and phrases

Placing on the board for rapid reading both consecutively and at random
Timing of the reading
Competing of rows and individuals for rapid-reading speeds
Dictating at increasing rates of speed
Dictating of forms without preview, followed by correction and remedial practice
Checking up on how many times a given form may be written in five seconds (or any given unit of time)

Sentences or paragraphs of brief/short forms and phrases

Previewing difficult brief/short forms and phrases, followed by dictation of the material

Dictating brief/short forms and phrase sentences, followed by practice on difficult outlines

Individual practice based on individual difficulties
Class practice on difficult outlines as determined by teacher

Successive dictations at progressively higher speeds
Using brief/short form records and tapes

PRESENTING A NEW PRINCIPLE

Traditional Method
Language Arts Method
Eclectic Method
This presentation phase is an extremely important part of the lesson. See pages 15-16 for a detailed description.

REPETITIVE PRACTICE (Drill)

Spelling phonetically and reading outlines from the board in concert, then individually in consecutive order and at random

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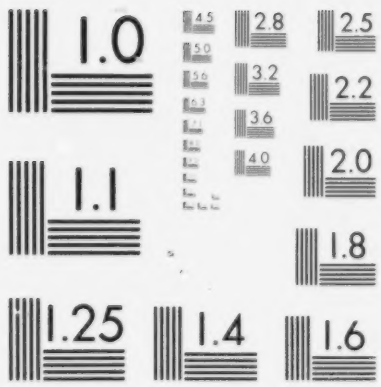

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Dictating outlines

Spelling first and then saying word repetitively to set the pace of writing

Consecutively and then at random

Redictating at a faster pace

Oral reading of final dictation

Practicing new outlines, their derivatives *(serve, serves, served),* and word families *(reserve, deserve, observe)*

Practicing with textbook open

Apply material under Dictating Outlines

APPLYING NEW MATERIAL

Using shorthand plates

Reading connected matter

Dictating such material with books open

Oral transcription

Tracing or rewriting during the oral transcription

Redictating with books closed and having students check their work after the dictation

Dictating original material containing words previously practiced in sentences or short letter form

Previewing difficult outlines before dictation

Dictating first then postviewing difficult outlines

Placing material on board as pupils read back for correction and remedial practice

Redictating at higher rate of speed

Redictating at a lower rate for shorthand penmanship control

Initiating new outlines based on principles learned (limited)

CORRELATED LEARNINGS

Spelling, vocabulary, punctuation, content meaning

Preplanned questions asked at suitable times during period

Questions arising from the context interspersed throughout lesson

SUMMARY

Elicit the principle learned with an example given.

Outline the new principles clearly and concisely on board.

Reread new outlines and/or connected material from board.

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ESSENTIALS OF INSTRUCTION

CLASSROOM ORGANIZATION

In order to use every minute of the period profitably, as well as to provide a businesslike atmosphere, it is imperative that the teacher establish classroom routines. Some recommended procedures are:

- Appointing monitors to erase and prepare blackboards for the work of the period
- Organizing activities to get students seated and to work immediately

  Practicing review short/brief forms, phrases, or outlines
  Transcribing to longhand from shorthand written at home
  Taking dictation of homework letters from the pupil leader
  Reading by pupils of letters practiced for homework
  Taking dictation from tape or record player

- Setting up definite routines for checking attendance, collecting homework, distributing papers, etc.

CORRECT WRITING AND WORK HABITS

The development of the correct writing of shorthand and of proper work habits is essential and should be stressed from the very beginning. Reminders to the class must be made daily. The teacher must be alert to check for lapses and to require conformance.

Good posture and correct position of hand and arm are important. The students should sit squarely in front of the desk with feet flat on the floor, body bent forward slightly at the hips, back straight, and both forearms on the desk.

Attention must be given to:

Organization of desks — only needed materials to be on pupils' desks

Use of correct tools — correctly lined and ruled notebooks with paper of good quality and well-sharpened pencils or smooth-writing pens

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Proper use of tools — lightly held, forward moving pen (with top removed) or pencil — no gripping or extra pressure, no drawing of outlines, no patching or retracing of poorly written outlines, no unnecessary lifting of pen or pencil, no erasing.

Good penmanship — correct proportion, slope, and direction checked by teacher through daily observation and inspection of homework and test papers

Proper use of notebook

- Daily dating of notebook at the beginning of the day's work and at the bottom of the page
- Writing in columns a quarter or a half of the width of the page, on one side only, to the bottom and to the end of the book before reversing
- Gradually moving paper or introducing thumb or finger under the left edge to turn it quickly with free hand
- Indicating end of letter dictated by leaving space or using a significant mark
- Making corrections in shorthand notes by circling errors and rewriting each incorrect or poorly written outline after comparison with the chalkboard or textbook models; no erasing permitted
- Marking notes to show completion of transcription of letter by line drawn through notes
- Indicating place to begin notetaking by rubber band around used pages

Using any pauses to read and edit notes by inserting punctuation, indicating paragraphs, improving outlines, etc.

LESSON PLANNING

A lesson plan is important because it

- Insures the best use of every minute of the class period
- Gives the teacher security and the class confidence
- Enables the teacher to analyze good teaching methods and procedures
- Serves as a basis for evaluation of the lesson and its improvement.

A lesson plan is a flexible guide because it

- Contains all of the essential elements of the lesson
- Includes more material than can be covered in one period
- May be varied as the need arises

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May be used as a follow-up for future lessons with proper notations made thereon by the teacher (Notations in the teacher's personal textbook will also prove helpful.)

PARTS OF A LESSON

While the parts of the lesson will vary to conform to the method used by the teacher, each lesson should make some provision for the following:

Aim

This should be:

Specific in terms of the material to be covered
Understood by students
Within the reach of the students
Directed toward the overall objectives of the course
Stated in terms of students' point of view rather than teacher's

Apperceptive base: This should supply the known material from which the new concept can be developed, through one of these procedures:

Contextual material written on the board in shorthand with the key words leading to the new lesson circled, written in colored chalk, and/or isolated

Contextual material stated orally and the key words isolated and written on the board in longhand and/or shorthand

Illustrative words from which the new principle is to be derived, stated orally, and/or written on the board in longhand and/or in shorthand

Motivation

Characteristics

Directly linked to the new lesson
Supplied by pupils when possible
Understood by pupils
Interesting and/or challenging
As short and simple as possible
Varied

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Variations in Approaches

Varied approaches capitalize on the motivational elements inherent in a particular method of presentation (see Presentation). The approaches make these methods more effective and interesting because they evoke attention and require active student participation. Their appeal to the imagination and their stimulation of the thinking process help to make the learning process more enjoyable. Once the students' curiosity is satisfied, some of the enthusiasm generated by the approach carries over into the drill period and contributes to automatization of outlines and successful learning.

THE SOUND APPROACH. In this approach the teacher recites three or more words, slightly exaggerating the new sound common to all of them. The students are asked to identify the new sound and to offer additional illustrations.

THE SENTENCE APPROACH may take several different forms. (a) An entire sentence may be written on the board in shorthand, all the outlines being familiar except the one introducing the new device. This outline should preferably come at the end of the sentence, and the context of the sentence should be such as to suggest clearly the new word to be read. (b) The sentence may be written in longhand on the board, with the new outline alone presented in shorthand. (c) Several sentences are recited by the teacher, and only the new outline in each sentence is written on the board.

THE SPELLING APPROACH. In this approach, students are asked to write in their notebooks the longhand spelling of a series of words. The teacher elicits the words and writes them in longhand in a column on the board. The students are asked to identify the common elements in the words. These elements are underscored by the teacher, who then demonstrates how the new words are written.

CONTRAST AND/OR ANALOGY. Students are asked to deduce a new principle from a familiar one, by recognizing similarities which may be based on a partial resemblance; or parallel columns of words written in longhand and in shorthand may be used to facilitate recognition.

THE DIRECT APPROACH is used for teaching brief/short forms and difficult theory concepts, or to save time when there are a

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number of new sub-principles to be presented in a particular lesson. This approach is most effective with the language arts method. The teacher writes the first word on the board and reads it; the students may read it aloud three times as the teacher points to it. The teacher now writes the next outline on the board and reads or elicits the word; and the students read it aloud three times as the teacher points to the outline. The teacher then points to the previous outline which is read once by the class. This procedure is repeated until all the important words have been developed. Then concert reading, rapid and random, is followed by individual readings. The success of this method depends on the speed and the intensity of response and the enthusiasm generated.

No approach is limited to a specific principle of theory, although one method may be more successful than another or more desirable in a particular instance. Several different approaches and even methods should be introduced to vary the presentations from day to day.

Presentation

Traditional Method

INDUCTIVE — the new generalization or principle will be elicited from the pupils through:

Sentences containing the new words written on the board in shorthand and read by students through the use of common sense and English and shorthand background

New words are sounded by the teacher, and the class given additional examples

New words are written on the board in longhand and the common sound elicited; examples: *nation, fashion, occasion, extension.* (Differences in longhand spelling should be established.)

DEDUCTIVE — the new generalization or principle is stated by the teacher and illustrated by:

A series of words supplied by teacher and/or pupils and written on board in shorthand

The textbook vocabulary read by the class

Language Arts Method. The teacher does not verbalize rules, but writes, spells, and identifies the new outlines and then has the pupils spell and

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read them. With minor variations, the method may be termed the direct method or the functional method. The general characteristics of this method include:

No verbalizing of rules

Spelling and reading of the first new outline by the teacher, followed by spelling and reading of additional examples by students

Developing skill in shorthand reading before writing is begun

Achieving automatization through reading and copying of shorthand plates

Evaluating pupil accomplishment through tests on transcripts (not on isolated outlines)

Providing a longhand key for the pupils

Emphasizing skill-building dictation containing familiar matter until theory is completed

Eclectic Method

The teacher selects from both preceding methods the procedures by which he can best achieve the final goal.

Repetitive Practice

These are activities used in connection with isolated outlines illustrating a principle, a word family, short/brief forms, or phrases. See page 41 for detailed suggestions. Some general procedures are:

Teacher points consecutively, then at random, to outlines on the board, as students spell and say them in concert, then individually

Teacher dictates these outlines

Teacher dictates the outlines followed by including each word in the simplest possible sentence. Example: *"Easy, easy, easy. This is easy."*

Class reads and possibly practices outlines from the textbook

Application

Can the student read and write in context what he has learned up to this point in this lesson? Reading plate notes involving illustra-

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tions of the new principle is an effective form of application. Dictating a short letter or sentences using words involving the new principle and previously drilled repetitively (see repetitive practice) is another method of shorthand application. These sentences are read back and placed on the board by the teacher so that the students can then check their work and engage in remedial practice. In first-year shorthand, material given for dictation should generally be checked with the blackboard or textbook.

Repetitive practice (drill) and application are the major activities of every lesson. In planning lessons at least two-thirds of the time should be allocated for these activities.

Brief Short Forms and Phrases

These should be presented directly and

- Drilled rapidly through reading from board and writing in notebook
- Applied in suitable phrases whenever possible
- Practiced with derivatives
- Applied in contextual material

Spelling, Vocabulary, Punctuation, Content Meaning

This correlated phase of learning may be obtained through

- Preplanned practice on spelling words, vocabulary, etc. at specific times during the lesson
- Incidental emphasis as the occasion arises during the lesson

Summaries

Medial and final summaries of the new principles should be

- Given by students at suitable intervals during the lesson
- Kept simple and understandable — example: What new sound have we learned? How is it represented?
- Written on the board
- Elicited after the practice or drill phase

Homework

See details under Homework, pages 49-51.

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GUIDES TO LESSON PLANNING

These guides are not intended to represent model or ideal lesson plans. They contain the elements that experienced teachers have found significant in planning a lesson. Each teacher must modify or adapt plans to adjust to his personal strengths and weaknesses and to meet the needs of his students.

SUGGESTED PRESENTATION LESSON

Opening Routines

Reserve a specific section on the chalkboard for your name, the class designation, date, homework, etc.

"Let's clear our desks of everything except our sten notebooks and our closed textbooks. Sit up straight, with feet flat on the floor, right elbow on the desk, left hand at the top fold of the notebook. Relax your grip on the pencil. Date your notebook. Let's see how well we can write these very easy sentences."

Speak slowly and pleasantly. Look directly at the whole class and invite cooperation. Avoid repetition of directions.

Warm-up

Dictate three short, easy sentences, slowly and distinctly. Weight the sentences with outlines which will serve as an apperceptive base. (For this illustration, Lesson 14, Pitman, is used. The apperceptive base uses words with the I diphthong.)

Walk up the aisle between Rows 1 and 2. On the redictation, walk between Rows 5 and 6. Look at students' notebooks; correct individual errors without sacrificing the pacing and timing of the dictation. Note common errors.

"Look at your notes for a second. Raise your hand if you would like to read back."

After the first sentence, call on students at random (not necessarily on volunteers) to transcribe orally one sentence at a time. Record on the board in shorthand as students read. Then say: "Correct

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your errors." Offer encouraging comments after each transcription:

"Good." "Do you agree with that?" "Who would like to help her?"

"How many of us had the sentences all right?" "Good. Let's practice a few of these outlines."

Isolate difficult outlines and provide repetitive practice. Select outlines that illustrate "old" learnings basic to the new lesson, such as "I" words, short forms, phrases.

"Now let's see if we can write these sentences faster and more accurately."

One student may read back all sentences, to save time, or a sampled rereading may be used. "How many did better this time?" "Good."

Apperceptive Base

"Let's look at these sentences again" (pointing to "I" outlines, underscoring or isolating them).

Have the identified outlines read by individual students or by the class.

"What did we use to represent the I sound (or, in other cases, to help us write faster)?" Elicit briefly: diphthong "I," description, position, place, etc.

Motivation

"Today we are going to learn something very similar, which will also help us to write more words (or to write faster). Let's see if you can figure out what it is."

Use one of varied possible approaches: longhand words on board, oral or written mystery sentence, sound, spelling, analogy.

(Sound approach) "Listen to these words: *toy, joy, voice.* "

"What sound is common to all of these words?" "What sound are we going to learn to read and write today?"

Presentation

"I am going to write the outlines for these words on the board. Raise your hand when you can read them." (TOY JOY VOICE)

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"Would another girl like to try?" Invite others individually, and then ask the class to read in unison.

"What is the new sound? How do we represent this new sound?"

Elicit entire concept briefly: sound, position, place. Do not hesitate to tell the correct designation if it is not easily elicited.

Spell the outlines in shorthand.

Have the class reread the outlines on the board.

"Raise your hand when you can read these words." (Write outlines.)

ENJOY TOIL NOISE EMPLOY

Have words read by two individuals; then by class.

"Raise your hand when you can read these words."

EMPLOYS EMPLOYED ENJOYS VOICING OIL

Elicit the difference in the formation of the outline OIL.

Drill

"Let's spell and read these words" (pointing to all words on the board). Repeat the exercise several times. "Now let's read these words without spelling." Elicit several individual readings at random.

"Let's see how well and quickly we can write these outlines in our notebooks." Provide for intensive written drill, with occasional reminders about posture and penmanship. Repeat each word three times to pace the writing. Supervise student practice by circulating through different aisles. Offer individual assistance where required.

"Let's skip a line and write these words once more for reading back." (Dictate the words in random order.)

Call on students at random to read back two or three words each. Strive to distribute the recitations so that each student will participate at least once during the course of a period. Offer encouraging comments.

"Let's read again from the chalkboard." Comment on good reading.

Application

"Let's see how well we can write some of these words in sentences."

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Dictate three sentences. Have sentences orally transcribed. Record them on the board in shorthand for comparison and correction. Redictate the sentences. Call on students to spell difficult words in longhand. Have correct spellings placed on board and practiced in student notebooks.

Reading the words in the textbook context and words illustrating the new principle are effective Application techniques.

Medial Summary

"What is the new sound we have learned to use today?" "How is it written?"

Elicit the sound, place, position, and other characteristics. Record the identification in symbolic form on a board section reserved for the summary.

Second Presentation and Drill (direct approach)

"Let's look at these sentences again" (referring to Warm-up sentences).

Call on students to read short forms and phrases in sentences.

"What do we call these outlines?" "Why do we use short forms and phrases?"

"Because they help us write faster, we are going to learn a few more simple important short forms today."

Provide a direct, oral presentation in the first set of three outlines. Have class read without spelling. Present the next set of three outlines; drill these and preceding outlines in random order. On completion of presentation and accompanying oral drill, proceed to written drill. Include derivatives and simple phrases.

Redictate short forms in random order for an oral transcription.

Second Application

Dictate application sentences; provide for correction and redictation.

Final Summary

"Would you like to tell us what we have learned to use today?" Elicit the entire concept for diphthongs: sound, position, place, examples. Have another student restate the summary.

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Review the new short forms by individual and group reading from chalkboard.

If time permits, have students read from the textbook, air tracing over outlines.

Homework

Direct attention to the new homework assignment. Identify difficulties that may be encountered. Provide for a rapid oral transcription, if desired.

Conclusion

"You were a wonderful class today. I am sure you will appreciate the improved skill your homework will give you."

PLAN FOR GREGG LESSON — LANGUAGE ARTS METHOD

(Lesson 15, Gregg Diamond Jubilee)

Aim

To learn to read and write in contextual matter

A group of new brief forms
Words ending in the syllable *ble*
Words beginning with the prefix *re*

Time Schedule (min.)	*Presentation*	
8	Spell and read the following brief forms and derivatives as they are listed on the board (in shorthand):	Instruct students to read loud and fast as each outline is written. First read the entire group in unison, then in random order, then individually to check mastery.

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VALUE ABOUT THING
THINK THINKING BUSINESS BUSINESSES BUSINESSMAN THAN WHY
ONE ONCE WHAT GREAT
GREATER

Add the derivatives indicated.

Dictate for written practice; then have students read from notes.

4 Have letters 116 and 117 of homework orally transcribed.

Distribute reading among individuals as widely as possible, but select students at random.

Practice concert reading of brief forms in this lesson.

½ Record the following outlines on the board (in shorthand), spelling *(p — a — bul)* and reading the first outline listed:

PAYABLE SENSIBLE
TABLES VALUABLE
RELIABLE POSSIBLE
AVAILABLE TERRIBLE
TROUBLE-ED CABLE-D

Ask: "What is the common ending? How do we represent it?"

5 Practice concert spelling and reading of presented outlines. Dictate for written practice. Have individual students read from notes.

5 Dictate letter 116:
1 minute at 40 wam
1 " at 50 wam
½ " at 60 wam
2 " at 30 wam

Have students write with textbook open.

List and practice outlines as requested.

¼ Practice concert reading of brief forms in this lesson.

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5 Spell *(re — s — e — v)* and read the first outline of the following listed on the board:	Practice concert spelling and reading.
RECEIVE-D REVISE RECEIPT-ED REFER-RING RESERVE REAPPEAR REPAIR-ED RESIST-ED	Dictate for written practice.
REOPEN REASON REASONABLE	Practice individual reading from notes.
3 Dictate letter 117	
1 minute at 40 wam 1 " at 60 wam 1 " at 50 wam	Have students write with open textbooks.
1¼ *Summary*	Practice concert reading of all outlines presented.
2 *English Pointers*	Have students write longhand in notebooks as word is dictated.
Spelling:	
referring receive *receipt* (meaning?) *asset severely reasonable*	Then list words in longhand on reserved section of board for comparison and correction.
Application	
3 Oral transcription of letters 125 and 126	Provide time for individual reading by students, followed by concert reading a second time if possible.
1 Rereading of theory outlines presented	
1 Rereading of brief forms	
1 Concert reading of all brief forms from chart in Appendix	

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PLAN FOR A PITMAN LESSON

(Lesson 11, New Basic Course)

Aims

Specific: To teach the vowels *A* and *AH*
To establish the concepts of first and second place and position

General: To automatize frequently recurring illustrative words and phrases
To develop skill in writing these words and phrases in context
To inculcate proper shorthand work habits
To improve spelling and word comprehension

Preparation

Dictate, transcribe orally, provide for correction from shorthand written on board, the following sentences:

THE BOAT WAS LEFT IN THE LAKE ON MONDAY.

JOE THINKS WE SHOULD CHANGE ITS NAME.

WE SHALL PUT IT TO A VOTE ON SUNDAY.

Provide for drill on the sentences, then redictate and have sentences reread from notes.

Apperceptive Base

Elicit: What four vowels have we learned to use so far?
Tell us which words illustrate the vowel sounds?
Where is the up or down stroke written in these words?
Where are the vowels written?
Where are the outlines written when there is no up or down stroke?
Where are these short forms and phrases written? (Record on board in shorthand and point to them.)

IN-THE A

Teach Directly:

State simply: "We refer to vowels written in the middle of the stroke as being in second place and outlines written on the line as being in second position."

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Ask several students to restate the rule, with examples.
State directly: Outlines and phrases written above the line are in first position (point to short forms and phrases).

Ask several students to restate the new rule, with examples.

First Motivation:

"Today we are going to learn a device which will help us write more important words. See if you can tell us what that device is. Listen to these words."

First Presentation

Enunciate the following words slowly and clearly, emphasizing the vowel sound:

at add pass pad lad am catch

"What sound do all these words have in common?"

"What sound do you suppose we are going to learn to write today?"

"Let us repeat the vowel sound together. Again. Now I'll call on you individually to repeat the new vowel sound."

"Watch me as I write the new words in shorthand." (Record the words in parallel columns of longhand and shorthand.)

Elicit the characteristics of the new vowel, using these questions:

How do I indicate the *A* sound?

Where is the light dot written?

In what place is a vowel written at the beginning of the stroke?

Where is the first down-stroke written in these words? Example?

Where is the first up-stroke written? Example?

Where is the outline written when there is no up- or down-stroke? Example?

In what position are all of these words written?

What determines whether a word is written in first or in second position?

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First Drill and Additional Vocabulary

"Raise your hand when you can read these words." (Place one group at a time on the board, in shorthand).

BLACK BAD GLAD CASH SAMPLE ATTACH
PACKAGE AWAY ACT ACTING ACTED
AWAIT AWAITING AWAITED AMONG AGO
BACK BACKING BACKED TAX (emphasize $x = ks$)
FACT (clarify *kt*)
BLANK (clarify *ing* + *k*) BLANKING BLANKED BANK BANKING BANKED

Give oral and written drill (with posture reminders).

Dictate once for an oral transcription.

Elicit the following spellings: *among ago await awaited.*

Medial Summary

Elicit: What is the new sound we have learned today?
How is it written?
Which stroke determines the position of the word?
Examples?

Write in the Summary Board section:

A = light dot, first place = AT LAD CASH AM (in shorthand)

First Application

Dictate the following sentences; elicit oral transcription; record on board in shorthand; provide for corrective procedures; drill; redictate:

WE SHALL PAY THIS TAX AT THE BANK.
JOE IS GLAD TO HAVE THE PACKAGE BACK.
GIVE THE SAMPLE AWAY.

Correlation

Elicit spellings: *package, sample, tax, tacks.*

Second Motivation, Presentation, Drill Application

Record the following sentences on the board in shorthand and instruct class to raise hands when they can read them:

I WILL GET A CAR ON MAY 18.
JOE LOVES HIS MA AND PA.
I CAN GO FAR IN THE CAR.

Elicit the new vowel sound.

Have the class repeat the new vowel sound in unison and individually.

Ask: "How do we write the new *AH* vowel sound?"

Provide for oral and written drill on the new words.

ma pa far car

Dictate the sentences, providing for correction and redictation.

Medial Summary

Elicit the characteristics of the new vowel and add to the Summary section.

AH = heavy dot, first place = MA PA FAR CAR (in shorthand)

Third Motivation, Presentation, Drill, and Application:

Instruct class to raise hands when they can read the following phrases recorded on the board in shorthand:

I-AM AT-THE CATCH-THE WE-BELIEVE TO-TAKE TWO-MONTHS IN-SUCH WITH-SUCH

Provide oral and written drill.

Final Application

Dictate the following letter, providing for oral transcription, remedial activity, drill, and redictation:

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Joe: I am glad that you can get a car when you are 18. You will be able to go far away. Has your pa given you the cash for it? Do you have to pay him back? Yours

Final Summary

Ask the following questions to elicit summary statements.

What are the sounds we have learned to write today?

How do we indicate the sound of *A*? Of *AH*?

In what position do we write the outlines for words which have the first vowel sound of *A*? Of *AH*?

How is the first-position word written?

What must be above the line in a first-position word?

Where are second-place vowels written?

How is a second-position word written?

What determines whether an outline is written in first or second position?

Write this mastery challenge word, but think before you write it. (Dictate the word *example*.)

(Correct, clarify, and practice the outline.)

Homework Preview

Students read outlines assigned from text, with longhand covered, then uncovered.

Students read selected sentences assigned from text, first silently, then orally (individually).

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INTERPRET-ED INTERVIEW-ED
INTERNATIONAL INTERFERED-D

Write the following outlines below the column headings:

INTR

INTRODUCE-S-TION
INTRICATE

ENTER

ENTER-ED-PRISE
ENTERTAIN-ED

ENTR

ENTRANCE-S

"What differences do you notice in the beginnings of the words *introduce, intricate, enterprise, enter, entrance?*"

(Enunciate slowly and clearly to stress differences.)

Spell and read as in preceding drills. Dictate for written practice. Spell and read entire group of words, in unison and individually.

First Application

Dictate:

What is the rate of interest at your bank?

Have pupils read from notes.

He entered the room but did not interrupt the meeting.

Place on board in shorthand for correction and remedial practice.

We shall not introduce an intricate proceeding.

Among other things I am interested in these two enterprises.

Redictate and have several or all sentences reread.

Check spelling of *proceeding, enterprise, interrupt, intricate* (meaning).

Medial Summary

"What is the new word-beginning?"

"How was it represented?"

Second Preparation

"What is the ending in the words *meeting, proceeding?*"

Write the outlines in a vertical column and read the words

HOLDING, EVENING, FEELING, THING, OPENING

Second Motivation

"How would you write the plural of these listed words?" (Invite suggestions from pupils.)

Second Presentation

Record the plural of each outline in parallel columns, as indicated:

MEETING	MEETINGS
PROCEEDING	PROCEEDINGS
HOLDING	HOLDINGS
EVENING	EVENINGS
FEELING	FEELINGS
THING	THINGS
OPENING	OPENINGS

"How was the plural written in each case?"

Spell and read, in unison and individually.

Dictate for written practice. Read from notes and from board.

Second Application

Dictate:

Do you want to hold our meetings on Tuesday evenings?

Several openings are reported in these clippings.

In the interview, he mentioned his feelings about these things.

Proceed as in the previous application.

Have all outlines on board read.

"What device have we learned to use in these words?"

Medial Summary

Third Motivation

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Write in longhand on the board:

Please send one them today.

"Can you supply the missing word in the sentence?"
"So you see, it is possible to read phrases that omit unimportant words."
"Why would we want to omit words?"

Third Presentation

List and read (pupil or teacher) the following, in shorthand:

ONE-OF-THEM IN-THE-WORLD
MEN-AND-WOMEN MANY-OF-
THE TWO-OR-THREE DURING-
THE-PAST WILL-YOU-PLEASE
GLAD-TO-SAY IN-A-FEW-DAYS

"What have we done in these outlines?"

Spell and read. Dictate for written practice.

Third Application

Dictate:

Will you please send one of them today?

Proceed as with previous applications.

Many of the books are up-to-date.

Spelling: *up-to-date*

Medial Summary

"What have we learned to do in these phrases?"

Final Summary

"What are the ways we have learned to write more quickly in today's lesson?"

Final Application

Have the board outlines read.

Orally transcribe letter 313 from the textbook.

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QUESTIONING

While a skill subject generally excludes much discussion and verbalization, good questioning stimulates thinking, involves pupil participation, and creates interest. It is therefore an essential part of good teaching. Key questions should be a part of the lesson plan. Questions should:

Generally start with *how, why, where,* or *what*
Be carefully planned, especially if they are pivotal in nature
Be simple, single, and pertinent
Be thought-provoking and factual
Be answered in complete sentences if they are thought-provoking; in one or two words, if factual

Be stated first, then answered by the student called upon
Be distributed throughout the class
Not be repeated by the teacher
Allow for individual differences among students
Involve nearly every member of the class, with volunteers being called on judiciously

Be answered in concert only on the rare occasions when a drilled response is acceptable

TEACHER ACTIVITY

In a typical developmental lesson the following activities are desirable:

- During the presentation the teacher at the board and in front of the room

  Makes eye contact with every member of the class
  Speaks audibly to the students in the last seats
  Writes so that pupils may observe the writing construction

- During the drill the teacher circulates about the room and

  Observes the writing of students
  Makes corrections in notebooks as needed
  Observes common errors requiring immediate reteaching
  Determines if the pacing of the drill is proper for the class
  Determines if sufficient drill is being given

  Makes suggestions to individual students regarding posture, penmanship, etc.

- During the dictation the teacher stands in a place visible and audible to all but not too close to anyone. This place should be changed from time to time.

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- During the reading back of homework the teacher

  Circulates about the room observing the quality of the homework

  Lists on the blackboard outlines on which errors have been made, for subsequent remedial work

  Uses the blackboard for spelling of English words, transcription items, etc.

USE OF THE CHALKBOARD

The chalkboard is the most effective visual aid available to the teacher. Use it:

To maintain student interest
To provide a model for student imitation
To enable students to see *how* outlines are written
To demonstrate the fluency with which outlines should be written
To show the logical development of the lesson

To supplement the material in the textbook by listing word families and derivatives, comparing outlines easily confused, and arranging the material in different combinations.

The chalkboard may be used to demonstrate correct penmanship by:

Enlarging difficult outlines
Illustrating contrast in sizes of strokes

It provides a place for:

Aim of the lesson
Transcription items — spelling, word meanings, capitalization, etc.
Summaries
Homework
Directions to students

It provides a means for oral review.

It demonstrates to pupils how to make corrections.

In using the chalkboard, consideration should be given to:

- Maximum visibility

  Assign seats according to height but make allowance for poor eyesight.

  Write high enough on the board to enable students in the rear to see easily.

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CHALKBOARD ILLUSTRATION OF THE DEVELOP
(with teaching suggestions)

Summary	Warm-Up	Apperceptive Base	First Presentation	First Drill
Class/Teacher/Date Medial Summary 1 Medial Summary 2	Dictate 3 to 5 short sentences or a letter. (Sentences should contain words to be used to relate "old" learnings to "new" learnings. Read back. Write on board for comparison. Correct and practice outlines. Drill selected outlines. Redictate. Reread (optional). **Note:** Where there is no "old" learning, review short forms.	Correlate with preceding column. Motivation	Select the most suitable method: Analogy (word method) Sentence method Sound method Direct method Elicit concept.	Write and identify outlines in families. Write and let students identify. Spell outlines phonetically and identify. Write and let students spell phonetically and identify. Pace by dictating each word repetitively. Dictate each word individually. Students read back from notebook and/or from board. Complete coverage. Elicit medial summary and place on first board.

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MENT OF A LESSON IN STENOGRAPHY 1-2

Second and Third Presentations and Drill	Application	Short Forms and Phrases	English	Miscellaneous
Similar organization to first Presentation and Drill, but vary approaches Elicit medial summary and place on first board.	Sentences or letter (see Warm-up). Final summary (elicited but not necessarily recorded)	Write outlines on board rapidly and read them. Apply in phrases at once. Drill rapidly. Apply in sentence or short letter form. Summarize by reading rapidly from board and then rewrite on Summary board.	Spelling Hyphenation Apostrophes Definitions Business terms	Homework Test announcement (in advance)

CHALKBOARD ILLUSTRATION OF THE DEVELOP

(with teaching suggestions and shorthand)

Lesson 8, New Basic Course

Summary	Warm-Up	Apperceptive Base	First Presentation	First Drill
Class/Teacher/Date Strokes in one syllable words are halved Light T (outlines **late, plate)** Dark D (outlines **bed, dead)**	Dictate sentences below. Read back. Write on board. Pupils correct and practice outlines. Drill selected outlines. Redictate. (In shorthand) **We can deliver the play clothes.** **The manufacturer believes that $14 is way below the fair sum.** **We think that the railroad ought to make all deliveries with no delay.** **Put his name on the envelope and lay it in the safe.**	Correlate with preceding column by dictating the following outlines and writing on the board: (In longhand and shorthand) *play* **play** *may* **may** *way/ weigh* **way** *no/know* **no** *lay* **lay** Elicit: One syllable words Light strokes Motivate by announcing: We are going to learn a shortcut to increase speed.	Use analogy. Write the longhand of the words below next to the related word of preceding column. Elicit the addition of "T". Then, write the shorthand outlines. (In longhand and shorthand) *plate* **plate** *mate* **mate** *wait/ weight* **wait** *note* **note** *late* **late** Elicit concept. Confirm: One syllable words Light stroke Followed by T	"Write, spell, and tell" outlines and families. Or, write, and let students "spell and tell." Spell outlines phonetically once or twice during drill. Emphasize proporations. (In shorthand) **play-plate may-mate way-wait know-note plate-plates wait-waits waiting wet met net note-notes late-let-lets coat-coats cut-cuts** EMPHASIZE: **kept left** Pace drill by repeating word and increasing speed. Complete coverage. Redictate. Read back from notes. Read from board. Elicit medial summary and place on first board.

MENT OF A LESSON IN STENOGRAPHY 1-2

Second and Third Presentations and Drill	Application	Short Forms and Phrases	English	Miscellaneous
Motivation: Can you read these mystery sentences? *I paid several dollars for the bed.* *I saved to pay this debt.* *bed* **bed** *saved* **saved** Elicit concept Drill: *bed beds saved dead* Emphasize: *loved* Elicit summary and place on first board Third Presentation Direct Method: Read these words: *paid played weighed laid led date debt* Elicit reason for non-halving. Drill all board outlines.	Dictate sentence observing procedure in Warm-up: *The manufacturers can deliver the beds and the plates in May.* *The sale of the goods may be kept for several days.* *We are waiting for the note that you left.* *They paid the debt in 30 days net.* *Can you wait on me and have this weighed?* Provide posture and penmanship reminders at the beginning and middle of the period and when needed.	Write outlines on board rapidly and read them. Apply outlines in phrases at once. Drill, pacing rapidly. Apply in sentence form. (See Warm-up.) **able-to you-will-be able-to to-be-able-to we-are-able-to called could could-be could-have-the cold gold told owe too-late to-let two-hours you-will-note-that met-the let-us to-deliver-the** *You will note that the manufacturers delivered the beds and the plates too late.* *You will be able to sell the goods that you kept in two hours.* *I paid the debt that I owe in gold.* *Your people told me that you had called them.* Final summary	English and spelling: *weight/wait* *equaled* *oh/owe* *too (late)* *two (hours)* *net = full amount/* *30 days net*	Homework

Keep boards clean — wash daily; clean erasers daily; erase properly.
Rule lines to simulate a shorthand notebook, Pitman or Gregg (permanent scratch lines are desirable).

Write shorthand standing sidewards; switch from one side to the other; avoid turning back to the class.

Use pointer and stand away from the board when outlines are read back.
Test visibility by sitting in the last seat.

- Teacher demonstration of a high degree of writing skill, indicated by

  Accuracy of outlines
  Perfection of size, shape, shading, and proportion
  Fluency of execution

  Writing an enlarged outline in slow motion, followed by normal writing of the outline

- Proper arrangement

  Logical, sequential order of material presented going from left to right
  Separate board sections reserved for homework, spelling, summaries, transcription items

  Colored chalk to highlight important outlines

As a general rule, students should not write shorthand on the board. However, the teacher may:

Assign a student to place homework on board in longhand.
Assign a student to write spelling words in longhand.
Assign a student to write longhand of test words when reviewing a test.
For variety (rare instances), send a good student to board for self-test.
As a treat on days of low attendance, send all students to board.

Air writing may be used by the teacher and students for difficult outlines either before or after outlines have been written on board.

The foregoing examples indicate what a chalkboard might look like as the lesson is developed. Teaching suggestions are included with the chalkboard material.

PRACTICE FOR DRILL AND APPLICATION

The word *drill* has come to mean repetition without variation. To escape this connotation, the word *practice* seems preferable. As used here, it means purposeful, varied and motivated repetition. This kind of practice generates active, attentive interest and insures learning.

Since the development of stenographic skill requires constant repetitive practice, it is important that this be done properly. Various suggestions are offered to make such drill effective. The teacher must be on the alert to sense which types of practice best suit her class and be ready to vary the practice when she recognizes any decrease of attention or interest. Several *different types* of practice should be included in each lesson.

Short/Brief Forms and Phrases

Motivate the learning. Demonstrate how much time is saved by short-cutting. Indicate that short forms constitute the major portion of the vocabulary of the average business letter.

Dictate short forms repetitively and briskly several times each when first presented.

Have students read from the board in sequence and at random.

Present the short forms with their phrases wherever possible.

Present the derivatives of the short forms.

Compare them with similar, known forms and practice together.

Time the dictation of the short forms; then increase their speed.

Apply them in short sentences or a short letter.

Dictate them in short sentences or in a short letter at higher rates of speed.

New Vocabulary

Motivate the practice for fluency or penmanship or speed.

Be specific about the goal of the practice.

Have students spell phonetically and read the outlines on the board, set a speed goal.

Have students read outlines from the board at random; set successively higher speed goals.

Have individual students or rows compete for speed in reading and spelling.

Dictate and spell outlines as pupils write in notebooks.

Dictate each outline several times to set the pace.

Dictate the outlines consecutively and then at random.

Redictate the outlines at a faster pace.

Have students read back the outlines practiced.

Have the class trace or rewrite outlines during the reading back.

Practice word families; e.g., *serve, reserve, deserve,* etc.

Apply words practiced in short sentences or in a letter.

Have students spell and read outlines from text on a timed basis.

Intersperse dictation of outlines with phrases or short sentences that include the outline.

Connected Matter Using Shorthand Plates

Read material from text; set a speed goal.

Have individual students or rows of students compete for highest speed.

Have students trace over shorthand plate during reading, with eraser end of pencil or back of pen; or write over transparent paper placed on page.

Dictate the material at announced rate of speed with textbook open.

Have students read back from notes, tracing with pen or pencil or eraser end

Redictate with textbook open increasing speed and having students trace outlines

When reading homework notes in class, have students trace over notes or have them leave blank lines under each line of homework notes to fill in during the reading back.

Allow a few seconds for silent reading of advanced sentence before calling on a student to read.

New Connected Matter

Preview difficult outlines before dictating or dictate material first; then postview difficult outlines.

PH2405

Have material read back as students trace over the notes or rewrite. Drill outlines on board and redictate at higher speed.

Some of the speed-building techniques listed on pages 70-72 may be used on occasion. However, for practice at this level the teacher should use shorter speed spurts, words of high frequency, copious previews, and very short letters.

It is neither necessary nor desirable to have all the dictated material read back. The teacher should select judiciously the parts to be read back.

The teacher's attitude and manner during repetitive practice is very important. Enthusiasm, cheerfulness, and encouragement are contagious. Pupils should leave the classroom with a feeling of achievement and accomplishment.

REVIEW

Review differs from repetitive practice in that it attempts to *combine* previous learnings in a different manner and to develop a more extensive automatized shorthand vocabulary. It is, in addition, a *re-view*, a different look, at what has been taught. Consequently, it should offer:

An approach different from that used during the original presentation and practice

A more inclusive vocabulary highlighting the relationships of principles and applications previously studied

A greater variety of the different drill techniques listed above

A greater opportunity for all students in the class to contribute to the lesson

An opportunity to provide a cumulative or spiral approach

At suitable intervals, written work to test the students' understanding of the principles learned and their application

Where no unusual difficulty is identified, the paramount goal of a review day may be the development of skill in reading connected matter and taking and transcribing dictated contextual material.

The lesson should move quickly from one phase to another.

Theory should be reviewed quickly, in the manner of a medial summary.

Activities during a review lesson might include the following:

- Dictation of a homework letter
- Reading back and remedial practice

TM2406

- Redictation 10 words faster
- Review of short/brief forms of the lesson by reading rapidly from the blackboard as the teacher points to the outlines in random order and by calling on individuals occasionally
- Reading a letter from the homework assignment
- Rapid review of the brief/short forms on the board
- Review of one section of the theory through dictation of outlines (The outlines are then placed on the board and the rules reviewed.)

Timed dictation of a letter previously dictated, with the textbook open:

Dictation at 40 wam for one minute

Reading by students from notes

Remedial work: comparison of student outlines with those in the textbook

Redictation of material at 50 wam

Remedial work: comparison of student outlines with those in the textbook and practice of any that caused difficulty

Redictation at 60 wam

Remedial work: as before

Dictation at 50 wam with books closed

Reading back from notes

Spelling and transcription elements selected for review

Rapid review of the theory and brief/short forms which are on the blackboard

Review of the remainder of the theory involved in the lesson

Additional dictation from the same letter, observing the same procedure until the students can take sustained dictation for 2 minutes, and then for 3 minutes

EARLY DICTATION, READING, AND TRANSCRIPTION

In Stenography 1, connected matter should be dictated almost at the start. The major advantages of using connected matter rather than isolated words are that previous learnings are reinforced thereby automatizing a larger vocabulary, and that the study of shorthand is placed in a

realistic setting. Dictation practice should include dictation with the book open first and then closed, of previously drilled shorthand plate material. This same familiar vocabulary may then be dictated in slightly different contexts. Short sentences may be used to review known principles and to introduce new ones. Application of new and old learnings may be made through the use of short sentences and simple letters.

Some of the elements to consider in the early stages of dictation and transcription are:

Teacher's Role

Voice: clear, low-pitched, well-modulated and audible

Inflection: indicative to some extent of the placement of commas and periods

Dictation: smooth and not affected by speed markings; avoiding metronomic dictation

Phrasing: following the thought sequence primarily but with attention to shorthand phrasing wherever possible

Position: standing in clear view of the entire class and away from any pupil

Rate of Dictation

Untimed at the beginning but rapid enough to establish a pattern of fluent writing (In the language arts method, a minimum dictation rate may be set.)

Governed by the level of students' skill but measured and increased gradually during the term

Adapted to the difficulty of the dictated matter, the length of the "take," the context, and whether new or review

Based on the number of syllables a minute. Material is to be marked off in appropriate intervals

Announced to the students as a motivational stimulus

Accuracy of Notes

Stressed from the beginning to enable students to transcribe easily and accurately (traditional method)

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Developed through extensive, repetitive, fluent practice on shorthand plates (language arts method)

Compared with those in the textbook or on the blackboard

Previewing Material

Develops fluency by eliminating mental and emotional blocks

Limited on occasion in order to encourage initiation of outlines

Governed by the purpose of the dictation; e.g., speed development, application, testing, etc.

Written Transcription

Affords an opportunity for pre-transcription training and remedial work in spelling, sentence structure, letter forms, punctuation, meaning of business terms, etc.

May include:

- Practice in class and at home from shorthand plates and later from students' notes
- Correction of such transcripts in class orally or from the blackboard

Must be emphasized from the beginning and properly weighted in the testing program

Reading Shorthand Plates

Reading shorthand plates serves several important purposes. Some of these are:

Developing the facility to read shorthand rapidly and fluently

Building the students' shorthand and longhand vocabulary

Enabling students to write shorthand through visual familiarity

Helping students to develop a superior shorthand penmanship

Aiding students to understand the thought content easily

Providing practice in correct speech habits and extending the students' speaking vocabulary

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Various techniques may be used in reading shorthand plates

- Reading of shorthand plates in class (silently or orally):
  - Reading to be rapid and timed for effective motivation
  - Immediate assistance to be offered to faltering pupils
  - Difficult outlines to be previewed
  - Procedure for deciphering difficult outlines to be taught
  - Questions as to thought content and English usage to be postponed to the end of sentence or paragraph
- Shorthand plates assigned for homework
  - Reading to be an integral part of the daily homework assignment
  - Material to be within students' understanding
  - Material to have been previously prepared or previewed in class
  - Printed transcripts to be made available for weak students
  - Completeness of preparation to be checked in class the following day
- Outside reading of shorthand books and magazines; e.g., *Junior Secretary, Pitman Journal, Today's Secretary*

Since shorthand is phonetic writing, it is ideally suited to motivate and to supplement the reading improvement program in the city schools. The "dictionary habit" for pronunciation, definition, and spelling can be initiated and habituated. The teacher's reading should, of course, be a model for students to imitate. Students should be trained to read audibly with correct pronunciation. Students with poor speech patterns should be corrected tactfully. Students with foreign accents should be encouraged to listen critically to the teacher and to other pupils for correct pronunciation and enunciation.

ENGLISH AND THOUGHT CONTENT (Correlation)

The use of correct English is essential for an accurate transcription of the material dictated. The teacher must strive to develop proficiency in written English through the following procedures:

- Widening the students' general English vocabulary and specialized business vocabulary by encouraging

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Reading good books and newspapers

Listening to worthwhile radio and television programs

Keeping a spelling and vocabulary notebook of individual difficulties

Assigning practice on lists of commonly misspelled words (See pp. 108-109 for sample lists.)

Teaching students the correct use of all parts of the dictionary and requiring them to consult the dictionary to determine spelling, pronunciation, syllabication and meaning of words

Requiring students to indicate punctuation, capitalization, and paragraphing when reading notes back

Dictating in such a manner that to some extent the commas and periods will be obvious

Training students to insert punctuation and paragraphing during silent reading and to check the spelling of unfamiliar words with the dictionary

Emphasizing correct spelling, hyphenation, pronunciation, capitalization, and paragraphing

Discussing daily at least one rule of the mechanics of written English and including numerous illustrations within the students' range of experience

Checking the students' understanding of the content of the material dictated

Calling students' attention to various business situations and business procedures as they occur in the correspondence, and to a particularly well-structured and well-composed letter

Note: However desirable these learnings are, judgment must be exercised about the amount of time to be allocated to these activities so that students will not sacrifice skill-development practice.

In order to communicate effectively with superiors, co-workers, and callers at the office, employees must also be able to speak English correctly and to enunciate clearly. The teacher's English should be cultured and his speech clearly and correctly enunciated. The students should at all times be encouraged to speak clearly and audibly, to pronounce and enunciate words correctly, and to speak intelligibly and without awkward pauses.

HOMEWORK

The importance of homework practice in a skill subject should be made abundantly clear to the class at the very beginning of the term. Analogies to known skills, such as piano playing and swimming, will help clarify this concept.

The following suggestions will prove helpful:

Supervise the first homework assignment. A step-by-step procedure under teacher supervision will make it clear how homework is to be prepared. Detailed instructions on the homework sheets (if these are used) will aid pupils to remember.

Motivate the assignment by devoting ample preview time to it, by permitting students to begin the assignment in class, and by holding the class responsible for:

- Reading plate material assigned
  Stress fluency and rapidity of reading.
  Ask questions on spelling, punctuation, word meanings.
  Time the reading to encourage rapidity.
  Have the class trace during the reading-back phase.
- Reading words, sentences, or letters copied in shorthand
  Follow instructions under the previous topic.
  Use blank lines or columns so that the class can write during reading
- Taking the material from dictation
  With or without preview of difficult words
  At increasing rates of speed
- Reading back material dictated above. The pupil should be trained to trace or rewrite during this activity.
- Identifying homework material used as the apperceptive base for new lesson
- Applying the homework as a test or self-test on either the vocabulary or contextual material

Give the assignment in writing at a predetermined time.

Beginning of period
End of period
Logical moment during period

Check the homework for completeness and correctness.

- Collect daily and record.
- Require absentee homework to be made up upon return.
- Return incomplete homework immediately to be completed.
- Spot-check regularly for proper preparation.
- Speak to delinquent homework-doers promptly.
- Inspect all papers on a regular schedule and return with appropriate comments.
- To simplify checking:

  Give each assignment a consecutive number.

  Assign each student a number according to some predetermined plan.

- To simplify returning. Have each student use assigned number, such as "42" to designate 4th row, 2nd seat.

Display well-prepared homework, and offer suitable class and individual commendations.

Simplify the homework.

Preview connected material.

Read shorthand plates in class before assigning them.

Teach and drill the new vocabulary thoroughly.

Provide for individual differences.

Give an average assignment of 40 minutes.

For more successful students provide something challenging—additional letters, word initiations, shorthand records based on homework.

For less successful students provide review material, short/brief forms and vocabulary, and shorthand records based on homework.

Provide variety of content in the assignment.

Introduce new and review vocabulary.

Present connected matter, both new and for review.

Present short/brief forms and phrases, both new and for review.

Provide for reading of shorthand material.

Provide for transcribing shorthand plates into longhand.

Provide for transcribing longhand into shorthand.

Provide practice of spelling words, comma rules, cities, states, and business terms.

Afford practice from dictation records or tapes.

STUDY GUIDE FOR STUDENTS

Set the stage for effective home study.

Time: Set aside an adequate amount of time. Draw up a schedule and adhere to it.

Place: Set aside a regular area or room free from distractions (TV, radio noise, interruptions, family conversation, and intrusions, etc.) Clear desk, table, and wall of those objects which might divert your attention.

Tools: Have essential tools (pen and/or pencil, notebook, rulers, dictionary, books, etc.) readily available.

Furniture: Provide comfort but not too much comfort as to induce drowsiness or inattentiveness.

Effort: Devote yourself wholeheartedly to the task at hand. The desire to learn and intensive, concentrated work are the keys to effective learning.

Develop the proper set of attitudes.

Aim to obtain as much benefit as possible from your study session.

Determination is important for effective, permanent learning from study.

MEASURING PROGRESS

TESTING PROGRAMS

The value of a shorthand test may be determined by the extent to which it motivates study, measures progress, reveals weaknesses for remedial teaching, provides specific evidence of achievement, and indicates that the class is ready for further learning. In addition, uniform tests establish standards for marking and provide a means of coordinating the work of one grade with that of the next.

It is essential, therefore, that in constructing a good measuring instrument the two basic factors of validity and reliability be considered. The validity of a test is the extent to which the test measures what it is supposed to measure. Does the test cover all the items, or is the sampling distributed so that the important material is covered? The reliability of a test is measured by the consistency with which it achieves approximately the same results each time it is used. Tests may include:

Short Daily Tests

Stimulate pupils to study
Check effectiveness of home study
Measure grasp of new learning

Specific Purpose Tests

Brief/short forms and phrases, with a high degree of mastery required

Word recognition in timed transcription of isolated outlines from the text, chalkboard, or homework

Transcription and reading of connected matter; first, from assigned, thoroughly drilled plates; later, from familiar material, such as homework, etc.

Dictation and transcription of

- Definitely assigned material (with textbooks open or closed)

- Selections from an assigned larger unit (with textbooks open or closed)
- New-matter dictation using familiar vocabulary

Spelling

Comprehensive Tests

Shorthand vocabulary, measuring the power to retain material taught over a period of time and covering a number of units of work

Dictation and transcription, measuring the power to write and transcribe material taken for a *maximum* of three minutes of uninterrupted dictation or two, two-minute "takes"

Departmental Uniform Tests

Provide uniform standards of evaluation for every class in the grade

Given at the end of a unit of work, at the midterm and/or at the end of the term

Tests for Awards

Measure knowledge of theory and/or dictation and transcription skill

Motivate pupils to greater effort in order to qualify for pins or certificates.

Sponsored by publishers of shorthand systems

SUGGESTIONS FOR CONSTRUCTING AND ADMINISTERING TESTS

Theory

Select common, useful, high-frequency words, all of which have been thoroughly drilled in class and practiced for homework.

Select words illustrating normal principles of outline construction covered within the unit.

Start with a few of the easier outlines to instill confidence.

Interpose relatively easy words with more difficult words.

Dictate the words at a prescribed rate.

Avoid repetition of words in the theory and in other parts of a longer test.

Test mastery of theory only after an opportunity for automatization has been provided.

Maintain a suitable proportion between the number of theory words and the number of brief/short forms and phrases and establish an appropriate relative value for each group.

Dictation and Transcription

Weigh this phase of the testing program more heavily as the year progresses.

Make provision for increasing the rate of dictation, the rate of transcription, and the length of the "take" during the course of the year. (See Suggested Goals for Tests, pp. 59-60.)

Encourage the use of a dictionary.

Mark major errors in accordance with the Regents schedule.

General

Maintain a proper balance between the time allocated to teaching and to testing.

Construct tests so that they are easy to administer and to correct.

Assign values to the various phases of the testing program in relation to their importance in the skill-building program.

At the beginning of the term, prepare tests simple enough to encourage and motivate students.

Establish definite routines for the heading and arrangement of test papers, and for their distribution and collection.

Make a careful diagnosis of individual and class errors while marking papers, and plan proper remedial work.

Return test papers as quickly as possible, and engage in remedial work while the content of the test is fresh and interest is high.

Establish a routine for reviewing papers that will save time and yet provide effective remedial practice.

Recognize outstanding test papers, especially those showing great improvement, by calling them to the attention of the class and posting them on the bulletin board.

Avoid penalties so severe as to discourage the class.

Penalize more heavily on short/brief forms, phrases, and spelling words than on theory words.

Penalize errors on theory tests covering a limited vocabulary proportionately higher than those on tests covering an extensive vocabulary.

Keep the mailability standard before students at all times, stressing the need of working towards 100% accuracy as the business standard.

SUGGESTED END-TERM GOALS

These tests are designed for a 40-minute period. They may be expanded in those schools where more than this time is allowed for testing.

FORM I
(For classes taught by the Traditional Method)

	FIRST TERM		SECOND TERM	
	Words a Minute	Number of Words	Words a Minute	Number of Words
PART A Dictation and transcription of a list of short/brief forms, phrases, and words illustrating principles	6 - 8	35 - 50	8 - 10	35 - 50
PART B Dictation and transcription of connected matter, using familiar vocabulary of 1.3 to 1.4 syllabic intensity	25 - 30	75 - 90	45 - 50	135 - 150 (Two Letters)
	VALUE AND DEDUCTIONS			
1. Value of Part A a. Deductions per word to be equated according to the number of words dictated b. Shorthand and longhand to receive 1/2 value each	50%		1. Value of Part A 35% (Same as a and b, First Term)	
2. Value of Part B a. Major error (as defined in the Regents marking schedule) — 2% b. Minor error (as defined in the Regents marking schedule) — 1/2%	50%		2. Value of Part B 65% (Same as a and b, First Term)	

FORM II
(For classes taught by the Language Arts Method)

	FIRST TERM		SECOND TERM	
	Words a Minute	Number of Words	Words a Minute	Number of Words
PART A				
Dictation and transcription of short forms, brief forms, and phrases	10	35 - 50		
PART B				
Transcription from shorthand plates		60 - 100		
PART C				
Transcription from open or closed book dictation of familiar connected matter, 1.3-1.4 syllabic intensity	40 - 60	80 - 120		
Dictation and transcription of connected matter, using familiar vocabulary of 1.3-1.4 syllabic intensity			45 - 50	(Three letters) 180 - 225

First Term

1. Value of Part A — 40%
   a. Deductions per word to be equated according to the number of words dictated
   b. Shorthand longhand to receive 1/2 value each
2. Value of Part B — 20%
   a. Major error (as defined in the Regents marking schedule), 2%
   b. Minor error (as defined in the Regents marking schedule), 1/2%
   c. Transcription to be timed at the rate of 20 w/m
   d. Incomplete transcripts to receive partial credit
3. Value of Part C — 40%
   (Deductions for major and minor errors same as in Part B)

Second Term

Value — 100%
a. Major error (as defined in the Regents marking schedule), 3%
b. Minor error (as defined in the Regents marking schedule), 1/2%

Second-Year Shorthand and Transcription

OBJECTIVES

Fundamentally, the second year focuses on the production of mailable transcripts. Specifically, these goals are established:

To improve shorthand skills through:

- Systematic review of shorthand theory
- Application of shorthand theory to an extended vocabulary
- Taking dictation at increasingly higher rates of speed for sustained periods of time
- Practice leading to greater fluency in reading shorthand notes.

To develop the ability to take easily and to transcribe accurately letter material dictated at 80 wam.

To develop transcription skills through:

- Emphasis on greater speed in typewriting and a higher degree of accuracy
- Stress on the use of the dictionary and manuals for identifying the elements of correct written English: spelling, word usage, punctuation, paragraphing, syllabication, business vocabulary
- Correct use of the shorthand notebook and writing tools
- Good shorthand penmanship and techniques in reading notes written under pressure
- Preparation of carbon copies and envelopes
- Techniques for making careful corrections including erasing, crowding, and spreading
- Proper use and care of equipment

To train students to evaluate their performance, to analyze their own work for specific weaknesses, and to apply remedial measures

To give students an understanding of business procedures and practices through analysis of the contents of letters

To develop the students' ability to arrange and type tabulations consistent with the standards of the New York State Regents Examination

To develop the ability to prepare neat, attractive, and correctly styled transcripts

To develop in the students desirable work habits, attitudes, ideals, and appreciations essential to the successful performance of the duties as a stenographer and of the broader occupational role

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CLASSROOM ACTIVITIES

Effective teaching in the second year of shorthand depends upon the appropriate allocation of time to the different elements of the lesson as well as upon a variety of approaches to maintain the interest and enthusiasm of the pupils. A vigorous tempo will stimulate greater effort on the part of the students toward established goals. A realization of success as revealed by frequent formal and self tests will develop the confidence necessary for continued drive toward accuracy and endurance in reading and writing shorthand.

The activities listed below are suggested procedures and are intended to serve as aids in preparing the daily lesson. Methods for carrying out these suggestions are treated in greater detail in the following pages. In the dictation class the major portion of time should be devoted to skill-building dictation.

STARTING EACH LESSON PROMPTLY

Establishing a definite activity to start students working as soon as they enter the room

Organizing materials and taking care of clerical duties so that the work of the period can begin when the bell rings

READING SHORTHAND PLATES

Reading familiar material for fluency, accuracy, and rapidity

Reading scattered selections throughout text to develop skill in deciphering unfamiliar outlines

Having the class trace during the reading

Timing the reading

REVIEWING HOMEWORK

Reading assigned plate material in preparation for writing while class traces

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Reading students' notes while class traces or writes

Dictating homework letters

As application of theory words reviewed

As means of building skill according to some definite plan

DAILY TEST (Optional - Short)

Word test

Spelling test

Dictation and/or transcription test

Homework letters

Previously practiced material

New material with familiar vocabulary

New material requiring the initiation of outlines

BRIEF/SHORT FORM AND PHRASE DRILLS

Isolated brief/short forms, and phrases

(See Shorthand Theory, p. 41.)

Brief/short form sentences, paragraphs and letters

Previewing brief/short forms before dictation

Dictating connected material followed by postview and practice on brief/short forms and redictation at increased rate of speed

THEORY WORDS

Previewing and practicing an expanded vocabulary of shorthand outlines, their derivatives and families in preparation for assigned homework

Previewing and practicing an expanded vocabulary of shorthand outlines, their derivatives and families before dictation of connected matter containing them

REVIEW LETTERS

Dictation of one or several letters according to some specific plan for building speed

Redictation of practiced letters at slower speed for control

Redictation of practiced letters with slight revisions to maintain students' attention

NEW LETTERS

Dictation of new letters with familiar vocabulary for speed building

Dictation of new letters with new vocabulary

Dictation for three to five minutes at slower speeds to build sustained writing power

Dictation at uneven rates of speed to develop memory (starting fast and slowing up)

Dictation in spurts to overcome speed plateaus

SPELLING, VOCABULARY, PUNCTUATION

Preplanned questions asked at suitable times during period

Questions interspersed throughout lesson arising from the context

Systematic presentation of punctuation rules followed by application in letters dictated

Developing a vocabulary common to a particular business

Use of dictionary and stenographers' reference manual

ESSENTIALS OF INSTRUCTION

CLASSROOM ORGANIZATION

In order to use every minute of the period profitably as well as to provide a businesslike atmosphere, it is imperative that the teacher establish efficient classroom routines. Some recommended procedures are:

Appointing monitors to prepare chalk boards for the work of the period and to erase them at the end

Organizing activities to get students seated and to work immediately:

- Practicing short/brief forms or outlines to be reviewed
- Transcribing in longhand from shorthand written at home
- Having a student leader dictate homework letters
- Having a student read the letters transcribed the previous day for individual checking
- Taking dictation from tape or record player

Setting up definite routines for checking attendance, collecting homework, distributing papers, and housekeeping activities

CORRECT WRITING AND WORK HABITS

Continued training of students in correct writing and work habits is essential. This should include:

Organization of desks, i.e., only needed materials to be on pupils' desks

Use of correct tools, such as correctly lined and ruled notebooks with paper of good quality and well-sharpened pencils or smooth-writing pens

Proper use of tools, for instance, lightly held forward moving pen (with top removed) or pencils; no gripping or extra pressure, no drawing of outlines, no patching or retracing of poorly written outlines, no unnecessary lifting of pen or pencil

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Good penmanship, including correct proportion, slope, and direction checked by teacher from daily observation and inspection of homework and test papers

Good posture, indicated by keeping feet flat on the floor, both elbows on the desk, head up, body bent forward slightly with one hand holding the notebook flat on the desk

Proper use of the notebook

Daily dating of notebook at bottom of page and at the beginning of the day's work

Writing in columns a quarter or a half the width of the page on one side only to the bottom and to the end of the book before reversing

Gradually moving page up or in introducing thumb or finger under the left edge in order to turn it quickly with the free hand

Indicating end of letter dictated by leaving space or using significant mark

Making corrections in shorthand notes by circling errors and rewriting each incorrect or poorly written outline after comparison with the chalkboard or textbook models.

Showing completion of transcription of letter by line drawn through notes

Indicating place to begin notetaking by rubber band around used pages

Using any pauses to read and edit notes, inserting punctuation, indicating paragraphs, and improving outlines.

LESSON PLANNING

At all times the teacher must be aware of the general and specific objectives in advanced shorthand classes. To achieve these goals, carefully planned instruction and remedial work are essential. The teacher's daily lesson plan and suggested time allotments should provide for:

1. Material designed to build shorthand vocabulary or theory (3 min.)

   Short/brief forms and common phrases to be automatized

   Outlines chosen to review shorthand theory systematically and sequentially

2. Outlines to be previewed from the material to be dictated for speed building

   Practice on these outlines follows the accepted procedures for developing skill: reading of the outlines from the chalkboard by individuals or the class before written practice of the outlines, derivatives, and word families

3. Letters for skill building

   These are the letters which have been previewed. Provision should be made for applying these letters in a variety of speed-building plans. (Items 2, 3, and 4: 24 minutes)

4. Correlation with elements of spelling, vocabulary and meaning of content matter, applied to the skill-building letters

5. Outlines to be previewed from materials planned for transcription letters

6. Letters dictated for transcription

   These letters should increase students' vocabulary, develop language sense, enlarge business or cultural background, and inculcate desirable attitudes or traits of character. The letters should be carefully chosen to introduce matter of this kind sequentially. (Items 5 and 6: 9 min)

The homework should be:

Checked for thoroughness of preparation by short, spot reading in class (3 min).

Checked for completeness by inspection of collected homework

Assigned by number preferably by means of a duplicated chart covering a period of a month or term

Properly labeled and identified by pupils

Prepared according to explicit instructions given and carried out under the teacher's direction on the day of the first assignment

Planned to take 45 minutes a day and to cover approximately four sides of shorthand paper

Comprehensive to review theory, to develop skill in reading and in copying fluently, to improve spelling and written English; i.e., punctuation, paragraphing, and to increase knowledge of the business world through an understanding of the context of the letters

Completed under good study conditions at home (See p. 51.)

Varied to take care of individual differences; e.g., remedial work for weak students, extra credit or bonus letters for the bright

Prepared in a notebook reserved for this purpose only

The use of records or tapes for additional practice at home or in a place set aside for this purpose in school is recommended. This is especially valuable as a means of maintaining and building skill during holiday periods.

PLANNING LESSONS FOR SECOND YEAR STENOGRAPHY

Two guides for lesson planning follow. These guides are not designed to represent model or ideal lesson plans, but rather to serve as a frame of reference for considering the elements that experienced teachers have found significant in planning the lessons for a week and planning the lesson for a day. Each teacher should prepare a plan to meet the needs of his students.

Lesson Plan for Stenography 3

Dictation text: Transcription Dictation
Student's text: Gregg Transcription Simplified

Aim

To develop ability to take dictation at 60 wam for transcription

To extend shorthand reading and writing vocabulary

To review brief forms and derivatives

To strengthen correlated English skills, such as spelling, punctuation, word meaning

To broaden the perceptions of business procedures

Preparation

Homework review of letters 221, 222, and 223; oral transcription by sampling of homework notes. Individual students may be called in random order to read a sentence while the rest of the class traces over outlines.

Dictate selected spelling words which students write in longhand in notebook. The words are then recorded on the board by a student, and the class compares and corrects spellings:

thoroughly depreciation (meaning) few days' time customary considerably normally description

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A WEEK'S ORGANIZATION PLAN FOR STENOGRAPHY 3, 4

Homework (4 minutes)	Theory Review (4 minutes)	Speed Building (19 minutes)	Transcription Letters (13 minutes)
Monday: Spot check	Brief forms and/or theory words for homework	Test letters from previous week; provide remedial practices, redictation at higher rate	Introduction of topic week; suggested vocabulary; preview and dictation of three letters; silent reading in preparation for typed transcription
Tuesday: Spot check (Assembly Day)	Brief forms and/or theory words for homework	Five-minute take with final rate 10 wam above transcription rate on topic of week, if possible; Pyramid Plan; oral transcription of entire take.	
Wednesday: Spot check	Brief forms and/or theory words for homework	Three letters of approximately 100 words each, from dictation test, on topic of week; Step-Stair Plan	Preview and dictation of four letters on topic of week; silent reading in preparation for transcription
Thursday: Spot check	Brief forms and/or theory words for homework	Three homework letters in three one-minute spurts beginning ten wam above rate for transcription letter.	Preview and dictation of four letters on topic of week; silent reading in preparation for transcription
Friday: Letters read completely, with oral punctuation and paragraphing	Brief forms and/or theory words for homework	Three letters on topic of week at four wam higher than transcription letters. Oral transcription.	Weekly test

The sequence of activities should vary each day.
Specific letters may be assigned to each row for transcription.
Transcripts are corrected in last five minutes of transcription period. Some papers are collected and corrected daily.

Theory Review

List on the board in shorthand the following brief forms and derivatives, which the students read in unison and individually. The outlines are then dictated for written practice:

COMPANY ACCOMPANY ACCOMPANIES ACCOMPANIED
ACCOMPANIMENT
KEEPER KEPT BOOKKEEPER HOUSEKEEPER
GENERAL GENERALLY GENERALIZE
PART PARTED IMPART DEPART PARTNERSHIP

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Speed Building

Implement the Step-Stair Plan on letters 65, 67, and 77. Place the following preview outlines on the board:

APPROACHES COVER COUNTY TO-MAKE BUSIER
ONE-OF-THE-MOST PROFITABLE HISTORY EQUIP IMPROVE
SINCERE PLEASANT PLEASURE CASHIER HONOR EXHIBIT TO-ME
LONG-TIME-AGO UNDERTAKING CONGRATULATED FORWARD
REPORT HELPFUL WITHOUT WISE BUYER FUEL LOWEST
THEY-WANT WEARY FINANCIAL

Read the preview outlines and dictate for practice. Dictate letter 65 at 70 wam. Give additional outlines and dictate letter 65 at 80 wam. Dictate letter 67 at 70 wam. Read the preview again. Dictate letter 65 at 90 wam, letter 67 at 80 wam, and letter 77 at 70 wam. Read preview again. Dictate all three letters at 70 wam. Provide for sampled oral transcription.

Review spellings of
questionnaire congratulate sincere convenient financial

Dictation for Transcription

Preview letters 75, 76, 79, and 83. Provide for concert reading of preview outlines before the written practice. Identify spelling difficulties.

Dictate the letters at 60 wam.

Provide for silent reading; in preparation for the transcription.

Record the following words and phrases presenting transcription difficulties on the board:

safe-deposit box	*small-town*	*anxious*
reasonably	*advice*	*definitely*
federal	*planning*	*responsible*

Review the letters briefly for elements of comprehension, with the following questions.

What is the bank trying to sell in letter 75? How much do they charge? Find the commas in letter 76. Read the sentence which is a polite request. Read the last word in each sentence in letter 79. How many commas did you insert in letter 83?

2430 ICAS

Motivation

While shorthand is largely a self-motivating subject, student interest and attention can be maintained by

Students' awareness of immediate and long-range goals to be achieved

Students' ability to measure progress through achievement on tests (See p. 52.)

Students' training to do remedial work necessary to improve achievement

Teacher's recognition of students' progress through display of good work, by posting records of improvement on individual or class charts, and through oral or written commendations for good performance, effort, and improvement.

Students' appreciation of the social and economic importance of the skill to be attained by a knowledge of job standards, Civil Service requirements, etc.

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TECHNIQUES OF INSTRUCTION

The transcription of shorthand outlines into a meaningful, mailable letter attractively arranged and carefully edited is a complex process involving many skills. The techniques for developing these skills are treated below.

ABILITY TO TAKE DICTATION

This is fundamental to all other skills. Unless the student "gets" the material dictated, the other skills are useless. To develop this ability the teacher must plan a comprehensive, sequential varied program. This should include:

Penmanship, Posture

Constant stress on penmanship, posture, and correct use of writing tools and notebooks.

Tracing

Training students to rewrite, trace, or shadow-write whenever shorthand is being read either from homework or from dictated matter.

Vocabulary Development

Continued emphasis on the development of a functioning shorthand vocabulary through automatization of short/brief forms and common phrases, review of shorthand theory, preview of outlines in material dictated, postview of difficult outlines in unpreviewed material which has provided the students with opportunities for outline initiation.

Word-Retention Capacity

Development of word-carrying capacity by suggested techniques, such as

Dictating a sentence while the students listen, permitting them to write only when the sentence has been completely dictated. The teacher must, of course, choose sentences of suitable length.

2432 ESAS

Dictating in "spurts" and then pausing until the students catch up.

Dictating to keep the material consistently several words ahead of the students taking dictation. At first dictator should no be more than two or three words in advance of the students; later he may be several phrases or an entire clause ahead of the students. Of course, this approach must be modified to meet the needs of a class of students having different levels of ability.

Speed-Building Plans

Using a variety of speed-building procedures to stimulate and achieve speed, accuracy, and endurance. (Dictation for typed transcription should generally be at least 10 wam lower than initial speed-building levels.) Some recommended plans for the speed-building phase, are:

Grubb's Stair-Step Plan (Time required is 20 minutes for four letters.)

Choose letters of 80 to 100 words in length. If class is writing at 60 wam proceed as follows:

1. Preview first letter; dictate at 70; give additional outlines if necessary.
2. Preview letter two; dictate letter one at 80 and letter two at 70. Reread previewed outlines and give any others requested by students.
3. Preview letter three; dictate letter one at 90, letter two at 80 and letter three at 70. Reread preview and give additional outlines.
4. Preview letter four; dictate letter one at 100, letter two at 90, letter three at 80 and letter four at 70. Reread all of preview; repeat dictation if necessary.
5. Dictate all letters with 15 second pause between each at 80 wam.

Step-Stair Plan

Choose letters as in previous section; preview in the same manner, but start dictation of the first letter at the highest speed and move downward.

One-minute Speed Builder

Choose three letters (for illustrative purposes) at 90 words each and proceed as follows:

2433

Preview first letter; dictate at 60. Preview and dictate one minute at 70. Reread preview and dictate one minute at 80. Dictate letter at 90 and repeat if necessary.

Follow the same steps for letters two and three.

Read all previews: dictate all three letters at 70 words a minute. The letters should be read by pupils individually or in concert.

Give spurt-dictation and planned uneven dictation to break skill plateaus. If pupils are writing at 60 words a minute, dictate at 80 words for half minute; then at 120 for a quarter minute.

Progressive Dictation

This is dictation at uniformly accelerated speeds to enable students to progress from one skill plateau to the next. For example, dictate at 80 wam for 20 seconds; 100 for the next 20; 120 for the following 20; and 140 for the last interval.

Leslie-Zoubek's Speed Forcing Plan (Time required is one period.)

Select a letter or several letters with a total of 400 words and follow this plan:

Preview the first 100 words and read.

Dictate one minute at 60; redictate at 80 wam; reread preview.

Dictate one minute at 75 wam and have pupils read.

Reread preview and redictate for one minute at 90 wam.

Reread preview and dictate at 100 wam.

Repeat steps one through five for the next 100 words; dictate the entire 200 words at 100 wam and have half of the letter read back.

Repeat the preceding steps for the next 200 words.

Dictate the entire 400 words at 80 wam.

A suggested variation of the plan retains the same number of words in the dictation but changes the time in each dictation span.

Preview as in the preceding section in every instance.

Dictate the first 90 words at 60 wam for 90 seconds.

Dictate the same material in 75 seconds and then in 60 seconds.

Repeat steps 1, 2, and 3 for each group of 90 words in the selection until all material is covered.

Dictate the entire selection at 80 wam.

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Blanchard's Pyramid Plan (Time required is 30 minutes.)

Select new matter of 400 words in length. The night before assign preview outlines for homework.

Dictate 300 words of the selection at 60 wam; first half is read back.

Dictate for four half-minutes at 100 wam, stopping for a few seconds after each half-minute; last two half-minutes are read back.

Redictate the above material at 90 wam without pause; i.e., two minutes at 90; half of take is read back.

Repeat step two for the second half of the material, i.e., four half-minutes at 100 wam; second half of material is read back.

Redictate these four half-minutes at 90 wam without pause; first half is read back.

Give students an opportunity to rest before redictating the entire 400 words at 80 wam; last 200 words of take are read back.

Grubb's 3 x 4 Plan

Assume that the class can now comfortably write at 70 wam, and your next goal is 80 wam. Thoroughly preview all outlines before beginning, and repeat the preview for each step of the take.

Select new matter of 240-word length.

Dictate for one-half minute at 120 wam.

Dictate the next group for one half-minute at 120 wam.

Combine both half-minutes (one minute) at 100 wam.

Next, dictate the third half-minute at 120 wam.

Dictate the fourth half-minute at 120 wam.

Combine the third and fourth half-minutes (one minute) at 100 wam.

Now combine all the material dictated to this point, for three minutes at 80 wam.

This plan should be reserved for development levels of 60 wam and above.

Dictation for Transcription

Dictation of letters for transcription in the following progressive approach from the beginning of the term:

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Material assigned and written for homework

New material with previews. At least ten percent of new material should be selected for preview at the beginning of the third term and the amount gradually decreased as the term progresses.

New material without previews. (Postviews of outlines with which students have experienced difficulty should be given quickly, willingly, and without comment) This material should be:

Graded in difficulty from simple familiar vocabulary to more complex vocabulary

Increased in speed from 50 wam at the beginning of the third term to 90 wam at the end of the fourth term

Varied in length from a minute or a minute and a half to five minutes

Increased in syllabic intensity from 1.3 to 1.4, with occasional extension to higher intensity

These letters should cover as wide a range of business activities as possible in order to acquaint students with the vocabularies of various businesses and activities. A logical sequence for the increase of speed and difficulty should be adopted.

ABILITY TO READ NOTES FLUENTLY

The transformation of the shorthand outlines in a letter into a meaningful, sensible message should be the students' prime consideration in reading shorthand notes. To build this skill there should be

Continued emphasis on fluent reading of plate notes at increased rates.

The homework assignment should require that reading of plate notes precede the copying of this material.

Oral transcription should be at a rate fluent enough so that the meaning of the sentence is not impaired. Prompting by the teacher where pupil hesitation indicates difficulty in recognizing an outline helps to achieve reading with meaning.

Continued stress on the writing of well-proportioned, legible outlines in correct form and style. Occasional dictation at a rate well within the students' ability will clearly demonstrate the ease with which legibly written outlines can be read. Care must be exercised, however, to preclude the pattern of blocking for the purpose of outline perfection.

Increasing students' vocabulary by:

Holding them responsible for the meaning of words which occur in the homework assignment

Defining words in letters to be dictated to facilitate understanding of the context

Selecting dictation material covering a wide range of business situations and a variety of businesses.

Encouraging student application of language sense in reading poorly executed outlines or in supplying omitted words or phrases. Students should be reminded of the benefits to be derived from an extensive reading of books, magazines, and periodicals.

Developing techniques to assist students to read material written under pressure. Students may be instructed:

1. To follow the reading of dictated material with pen or pencil in hand, prepared to insert missing words or improve poorly executed outlines

2. To read letters silently before oral or written transcription

3. To supply the meaning of badly written outlines through a systematic approach:
   - Skip the word presenting difficulty, and read the sentence to get the complete thought.
   - Substitute synonyms for missing word until one corresponding to the outline is found.
   - Write the words before and after the outline in longhand on a separate piece of paper.
   - Write in longhand the identifiable strokes of the outline.
   - Insert the word which completes the thought.

4. To develop a logical plan for interpreting outlines:

   Pitman and Gregg

   Analyze the symbols actually written in the outline.

   Make allowance for variation in size, slant, slope, proportion and position, resulting from haste.

   Select the word which fits into the context of the sentence.

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Pitman Only

Check all possible vowel sounds.

Try the outline in other positions.

Try hooks and circles on the other side of the stroke.

Adjust the shading of strokes.

5. To supply only one word for any blank left in notes, discouraging indiscriminate additions.

6. To avoid changing original notes, which may make it difficult to later read the outline correctly.

Typewriting Skill and Ability to Arrange Material Attractively

The pupil should bring to the transcription class a basic typewriting skill. A systematic program to maintain and develop this skill and to build transcription facility should be planned. This may be accomplished through:

A routine for daily warm-up at the beginning of the transcription period to include the Expert's Rhythm Drill, an alphabetic sentence, a facility drill, a sentence, etc.

Daily practice on a list of spelling words compiled from errors made on tests or prepared for daily homework

Repetitive transcription of brief forms or common phrases listed in shorthand on the board or in the textbook

Review of letter set-up

Weekly skill-building drives culminating in a timed writing

Frequent review of numbers and special characters

Review of tabulation and practice in arranging tables of varied and increasing difficulty to prepare pupils for this part of the Regents Examination in Combination Shorthand, Typewriting, and Transcription. Care must be exercised to avoid undue emphasis on this element at the sacrifice of shorthand and transcription skills. Some teachers prefer to delay this aspect until a few months prior to the Regents examination. Other teachers prescribe the planning of the tabulation problem for homework.

Preparing carbon copies and envelopes

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Training in making needed corrections include:

Erasing neatly and correctly moving the carriage away from the key basket; rolling the cylinder up to a convenient point; using short, light, circular strokes of the eraser to remove the error; placing a shield over the carbon paper; realigning paper and retyping with light strokes; keeping both eraser and fingers clean to avoid smudges on the paper

Spreading and crowding

Reinserting and realigning paper

Using erasable bond paper and correction coating devices

Developing in students an awareness of costliness of excessive erasures in time and production

Care of the typewriter to keep it in good working order

Replacing ribbons

Training in systematic organization of desks, notebooks, paper, and supplies

ABILITY TO TRANSCRIBE NOTES ON THE TYPEWRITER

The production of the mailable letter involves and depends upon all the component skills and knowledges developed. The successful development of the mailable transcript is a gradual process and may be achieved through these procedures:

1. Transcription of letters written in shorthand is presented in progressive steps:

   Shorthand plates of simple material, read by the class and by individual students are analyzed for punctuation and spelling difficulties, then typed sentence by sentence by the class. The material may be set up in either manuscript or letter form. This phase should not ordinarily extend beyond the first week or two of the third term.

   Letters are copied from shorthand plates for homework and prepared for transcription as suggested above. This phase may continue for the next week or two.

   Shorthand notes of familiar matter are taken from dictation and carefully prepared for transcription.

   Shorthand notes are taken from dictation of unfamiliar material liberally previewed at the beginning and prepared for the first few weeks by oral transcription, later by silent reading by the students to obtain an understanding of the context, to interpret outlines and

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to insert paragraphing and punctuation. The major allocation of time during the second year will be devoted to this phase.

Shorthand notes of unfamiliar matter, without preview, are taken from dictation. This, of course, is the ultimate objective of our skill development.

"Cold notes" of letters dictated the preceding day are transcribed. This is an occasional approach designed to introduce variety and higher levels of activity.

2. Training in correct techniques includes keeping eyes on notes and maintaining a smooth, uninterrupted movement of the typewriter.
3. Establish the habit of looking up the spelling of words before transcription to eliminate hesitation and to increase speed of transcription.
4. Require students to correct recognized errors immediately
5. Encourage students to ask for help so that the teacher may analyze their difficulties and make appropriate suggestions.
6. Training in careful proofreading by checking the transcript line by line against the shorthand notes while the letter is still in the typewriter. Encourage students to adopt a critical attitude of looking for unrecognized errors.
7. During the early stages, the practice of placing a check against each shorthand note may be used to insure the transcription of every outline. Some teachers prefer to have students apply this technique to examinations only, fearing that inordinate investment of time will interfere with production skills. Additional proofreading practice may be obtained from the correction of mimeographed material containing errors frequently overlooked or `of printed exercises which have been prepared by some business firms for this purpose.
8. Stress an accurate verbatim transcript and simultaneously provide for the development of intelligent substitution skills. Many teachers defer substitution practice to the period immediately preceding the Regents examination.
9. Provide a program of remedial work for each individual based on daily observation and record of achievement of regularly scheduled tests.
10. Provide students with a knowledge of the results of achievement as soon as possible. This may be accomplished by:

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Checking papers of some pupils at their desks at once.

Collecting papers from part of the class according to some prearranged plan which should make provision for the checking of the papers of every student during the course of a week.

Pupil checking of transcripts five minutes before the end of the period from the teacher's reading, which should elicit or stress elements of obvious difficulty, such as spelling, meaning, punctuation, typing style, proof-reading, and shorthand.

Having the students exchange papers and checking from the reading by the teacher

Using the overhead projector to display the transcript

Displaying perfect transcripts and recording the results on a chart is an effective motivating device. Requiring a minimum number of mailable letters per week sets a definite goal for achievement and stimulates students to higher levels of attainment.

ENGLISH AND THOUGHT CONTENT IN TRANSCRIPTION

The pupils' understanding of the thought content of the dictated material and their facility in using the conventions of written English must be developed concurrently with the abilities previously discussed. Attention should therefore be given to the following procedures:

1. Planning a systematic program

   To improve spelling through daily practice on words commonly misspelled (see Appendix) or remedial work on words misspelled on tests. Students should keep an individual list of errors. This technique must be reinforced by a regularly scheduled testing program.

   To build vocabulary by distinguishing between homonyms and other words frequently confused: e.g., affect, effect; advice, advise; and by defining words occurring in homework or dictated letters.

   To apply the rules of punctuation, syllabication, capitalization, hyphenation, and paragraphing. The basic rules for the use of the comma should be stressed.

   Parenthetical words, phrases, and clauses are generally set off by commas.

   Words, phrases, and clauses used in a series are separated by commas.

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Introductory words, phrases, and clauses ("if" clause, "when" clause, etc.) are set off by commas.

Words, phrases, and clauses in apposition are set off by commas.

Non-restrictive phrases and clauses are set off by commas.

To develop a knowledge of the preferred style for the expression of numbers and symbols. A department or published style manual is helpful in keeping instruction uniform.

To use the dictionary efficiently.

2. Dictating in a natural way with proper emphasis so that students' attention is focused on the thoughts conveyed, rather than on the individual words.

3. Training students to listen for the teacher's pauses and inflections during dictation. This will facilitate the placement of commas and require students to insert end-of-sentence punctuation.

4. Allowing a period of silent reading during which students insert punctuation, indicate paragraphing, look up spelling, and ask questions concerning the conventions of written English.

5. Acquainting students with common business expressions and activities by explaining or summarizing the contents of a letter, by developing concepts of business procedures, and by amplifying vocabulary meanings.

6. Encouraging students to expand their cultural and business background by wider general reading.

TEACHER ACTIVITY DURING TRANSCRIPTION PERIOD

The transcription period is a teaching period and the alert, interested teacher will use this time to give necessary class instruction but especially to discover the difficulties of individual students and to give immediate remedial work. During this period, the teacher should:

Observe, encourage, and help individual students. For specifically identified weaknesses, provide remedial exercises. These weaknesses may include inability to distinguish between present and past tenses, between plural and singular forms, and failure to recognize agreement of subject and verb.

For the individual student, identify errors of technique as they occur and provide remedial practice. For the group, defer class

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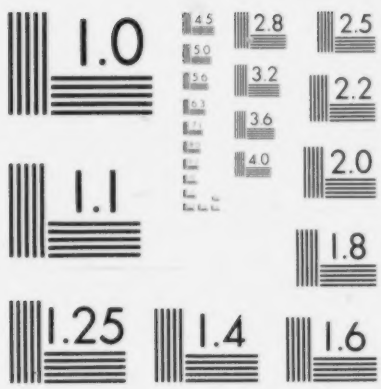

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

remedial activity until the end of the period to avoid interruption of the transcription process.

Illustrate common difficulties at the chalkboard so that the class can overcome them.

Be alert to correct poor typewriting and transcription techniques.

Watch erasing to see that carriage is moved to extreme right or left, avoiding clogging the key basket with eraser dust.

Help students overcome any difficulty in using the dictionary and reference manuals.

Observe proofreading technique, and insist that proofreading be done according to instructions.

Time transcription production and motivate to higher goals.

Correct transcripts according to plans suggested. (See p. 91.)

Use the last few minutes of the period to summarize or review problems.

TIMING THE DICTATION

While there is a body of evidence to indicate that syllabic intensity is not the most significant measure of difficulty, the standard word of 1.4 syllables continues to serve as a base in most textbooks.

There are two general approaches to timing the dictation to conform to accepted usage of the standard word count. The teacher may modify the number of seconds required to read the 20-standard-word group, or the teacher may notate the materials to indicate the ¼-minute word count.

Tables for identifying either approach are included in Appendix T.

There are stop watches available which simplify the timing procedure by dispensing with calculations.

For the preparation of original test materials where a specific dictation rate is prescribed, it is generally preferable to mark off the material in ¼-minute intervals. This method is suggested.

Procedure	*Illustration*
a. Determine the rate of dictation desired.	90 wam
b. Multiply the rate by 1.4 to find the syllabic total.	126

12443 SDS

c. Divide by 4 to find the ¼-minute syllabic content.	31½
d. Mark off groups at the syllabic unit determined in *c*.	32, 63, 95, 126
e. Indicate notation at nearest whole word.	
f. Where a fraction is calculated, compensate at alternate groups, as illustrated in *d*.	
g. Amounts, dates, addresses, time are syllabicated as though written in words.	$150 = 7 syllables

MULTICHANNEL ELECTRONIC DICTATION LABORATORY

The multichannel dictation laboratory is an efficient instructional approach that contributes to the effectiveness of shorthand instruction. In our classrooms the equipment consists of a taped input that is transmitted over an antenna loop encircling the room and a receiving instrument at the desk of each student.

The taped input may assume several forms, though the increasing practice in New York City is to use the *cassette* form which is in a large measure standardized and permits the purchase of dictation material or software from many sources. The use of an antenna loop obviates the hazard of trailing wires in the room. The receiving instrument generally provides options for selection of taped materials from three or four different programs of instruction. A headset similar to the type used on transcription machines is the listening device for individualized use; it is connected to the receiving instrument. In some systems, two headsets may be attached to one receiver. The multichannel description identifies the capability of the system to provide simultaneous programs.

All equipment used in the New York City schools offers additional facilities for teacher monitoring of students; selection, microphone, and loudspeaker rendition of any desired program for unison class activity; and input facilities for other sources that may be available, such as one-quarter inch tapes and records. Provision is made for the preparation of original taped materials to meet special needs.

Equipment may be moved from room to room, and thereby flexibility of use is provided; but a room must have a prewired antenna loop. The system is self-contained in a console that is portable and stores individual listening stations or receivers distributed to students' desks.

The effectiveness of the system is dependent upon the availability of appropriate materials and the extent to which teachers have been trained to use the equipment so that they can use it with assurance. It is desirable to utilize identical dictation material on each of the available channels so that appropriate learning experiences may be estab-

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lished. An increasing number of publishers are producing dictation materials that are correlated with their textbooks and are thereby providing options for adequate preparation and corrective processes. Materials are available for theory stages, for intermediate and advanced dictation stages, and for specialized areas such as medical and legal training.

ADVANTAGES

The advantages of this type of approach are:

Because of the novelty and variety of offerings, the system provides inherent motivation.

The teacher is able to monitor the selected program at the receiver of the student and note the strengths and weaknesses evidenced by the student as he takes the dictation.

The teacher may circulate through the room during the "take" and observe common and individual weaknesses in shorthand technique.

The use of multiple concurrent channels permits each student to select (or the teacher to prescribe) the rate of speed most appropriate to his skill-building process; in effect the teacher is providing instruction at varied levels of student ability.

The student learns to take dictation from a variety of voices and speech patterns, thereby contributing to the functional effectiveness of the learning process.

The problem of gearing the dictation rate to the medial ability of the class is in a large measure resolved, since several levels of ability may be accommodated concurrently.

Opportunities are increased for providing special tutoring either after school hours or in a supplementary class.

Provision is made for each teacher to prepare original materials that will best meet special needs of the class or recognized instructional weaknesses.

The facilities can be adapted to meet individualized instructional programs in other areas of business education: machine operation, transcribing machine training, key punch operation. These programs can be so organized that different instructional programs are implemented concurrently.

RECOMMENDATIONS

The following suggestions for effective utilization of a multichannel system are the product of the experiences of several years of classroom application.

Specific operational instructions should be available in mimeographed form. An illustrative Instruction Sheet is contained on page 111 and is designed to serve as a format rather than to constitute specific instructions.

The teacher should practice assembling the equipment until he feels comfortable with its use and has eliminated apprehension. In this connection, it is most important that the teacher delay any evaluation of the effectiveness of the system until he has used it for at least several weeks.

Mimeographed materials should be available, identifying and describing the materials contained on tape units. An illustration of this type of information is included on page 110.

One or two students in each class should be trained to distribute and collect receiving sets, and to organize and reassemble the console. However, the teacher must always retain his status as supervisor and expert.

A schedule for five-day (weekly) utilization of the system should be organized on a period basis, with room or class designations indicated. While it is desirable to adhere to such schedules, a degree of flexibility must be provided to meet emergencies. An illustration of such a schedule appears on p. 113.

The input devices and the transmission units should be permanently wired to avoid time-consuming and disconcerting setting-up procedures.

Security precautions must be applied to preclude theft. The input and transmission units may be permanently anchored to the top of the cabinet, or an additional protective covering with locking devices may be affixed.

If scheduling practices permit, it would be preferable to identify a specific room as the shorthand dictation laboratory, to install permanently all units including the receiving sets, and to assign shorthand classes exclusively to this room.

Students may be sensitive to the sharing of ear pieces. This problem may be resolved either by providing a bottle of rubbing alcohol

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available for cleansing use, or by providing each student with a personal earpiece cushion.

While the primary impact of this system is on the post-theory phases of shorthand instruction, carefully planned applications may be made in the theory stages.

The dictation laboratory should be used at planned intervals that contribute to the objectives of the suggestions included under Recommendations; but the significant emphasis must rest upon direct teacher-applied dictation and transcription patterns.

The dictation materials must be carefully previewed and selected to conform to the specific levels of pupil ability and the subject matter contained.

It is important to recognize that taped dictation programs are designed to be supplementary teaching devices which enable the teacher to engage in additional corrective activity.

During the automatic dictation interval, the teacher should circulate through the room consistently, observing the techniques of the students and identifying their common and individual weaknesses. Some experienced teachers leave a memorandum on the student's desk, with corrective suggestions.

As in all aspects of the teaching-learning process, it is advisable to introduce both the length and complexity of materials on a progressive basis. The first day the system is introduced to students, a one- or two-minute take is adequate; as the term advances, the duration of automatic dictation activity may be increased, but rarely should it exceed 15 minutes of uninterrupted application.

MEASURING PROGRESS

CONSTRUCTING AND ADMINISTERING TESTS

The building of skill in transcription depends not only on effective organization of the work and skillful techniques of teaching but also on a specific periodic testing program. Tests should be:

Scheduled regularly, approximately once a week.

Measurements of what has been taught; e.g., specific rules of punctuation, English and shorthand vocabulary. Many textbooks are organized on the basis of specific business topics. Administering tests using terms common to the field would be appropriate at the end of the unit.

Graded in difficulty from week to week. The length of the letters, their syllabic intensity, and the speed of dictation are factors which must be considered.

Corrected and returned promptly.

Followed by individual and class remedial work based on the errors occurring in the test.

Administered and rated according to the rules for rating transcripts on the Combination Shorthand, Typewriting, and Transcription Regents Examination. The New York State Education Department booklet, *Guide for Administering and Rating Regents Examinations in Business Subjects,* is available for this purpose.

SUGGESTED TEST GOALS

The schedules opposite illustrate planned weekly goals:

Where uniform midterm examinations are given, tests may consist of the transcription of three letters out of four. This may be equated to 100 per cent; or a timed-writing, spelling, and/or vocabulary test may be used for 25 per cent; or the Regents scale may be applied for an included tabulation problem.

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Letter length at *a* is 90 to 100 words; at *b*, 100 to 110 words; at *c*, 120 words.

A bonus of five per cent may be given for completion of a third mailable letter at any stage of development.

	Third Term Speed				Fourth Term Speed		
		Week	*Plan A*	*Plan B*		*Week*	*Plan A*	*Plan B*
Dictation and transcription of three letters; students to transcribe any two. Syllabic intensity 1.4	(a)	3	46	50	(c)	1	66	70
		4	48	50		2	66	70
		5	50	50		3	68	70
		6	52	55		4	70	75
		7	54	55		5	72	75
		8	56	55		6	74	75
		9	58	60		7	76	75
	(b)	10	60	60		8	78	80
		11	62	60		9	80	80
		12	64	65		10	82	80
		13	66	65		11	84	80
		14	68	65		12	86	85
		15	70	70		13	88	85
		16	72	70		14	90	85
						15	92	90
						16	94	90

Some teachers, in the second half of the year, prefer to dictate four letters and to require students to transcribe three, with a bonus for a mailable fourth. The marking scale may be modified to accommodate this approach.

MARKING SCHEDULES

Stenography 3: Value of each letter is 50%.
Major errors (as defined in the Regents marking schedule) equal a 3% or 4% penalty.
Minor errors equal a 1% penalty.

Stenography 4: Value of each letter is 50%.
Major errors (as defined in the Regents marking schedule) equal a 4% penalty.
Minor errors equal a 2% penalty.

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Third-Year Shorthand (Advanced)

OBJECTIVES

The third year is devoted to the development of the competent secretarial worker who is able to use stenographic skills at a higher level in more diversified applications. Specifically the following goals are established:

- To extend the level of skill in both stenography and typewriting
- To develop the ability to take comfortably and to transcribe letter material dictated at 120 words a minute
- To review and expand transcription techniques to include common written communication forms such as memoranda, reports, articles, multiple copies, in varied formats
- To edit transcripts
- To take and transcribe office-style dictation
- To reconstruct letters from notations given by the dictator
- To increase stenographic production of mailable letters in quantity, at transcription rates consistent with business standards
- To take sustained uninterrupted dictation for periods of from three to five minutes for transcription purposes
- To use reference books and office manuals effectively
- To prepare for employment tests and Civil Service examinations

CLASSROOM ACTIVITIES

Instruction in third-year shorthand will involve all the elements of second-year shorthand. There should be a more extensive coverage of activities requiring secretarial skills. The teacher must be aware of the wide range of student ability at this level and be alert to constantly changing office procedures and equipment.

The dictation patterns of the second year should be complemented by the following devices:

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Using articles and editorials
- Stressing ability to initiate new outlines
- Stressing the meaning of material dictated

Using Civil Service material
- Stressing the ability to follow directions
- Stressing the accuracy of the transcript
- Stressing the ability to take dictation from unfamiliar voices
- Stressing the ability to take dictation under tension

Providing office-style dictation
- With corrections, additions, and deletions made during dictation
- With reading back interspersed during the dictation of the letter
- Taken under especially difficult situations; e.g., voice deliberately muffled, speech unclear, etc.
- Started while class is engaged in another activity
- Dictating information to be included in a letter which students compose

Using records or tapes

Using multi-channel equipment at varying speeds

Inviting visitors to dictate

Using cold notes
- Reading of letters dictated on previous days
- Finding and reading specific portions of letters dictated on previous days

Reading and transcribing notes of another student

Positions of writing
- Taking dictation while standing
- Taking dictation with book in lap

TECHNIQUES

The techniques of skill development follow the same pattern as those for second-year shorthand. (See p. 81.) The material selected for transcription should include the following:

- Form letters
- Letters with inserts

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Letters with postscripts
Letters of more than one page
Interoffice correspondence
Postal cards
Telegrams, cablegrams, and radiograms
Letters of application
Civil Service material

Typewriting activities in connection with production should include:

Typing corrected copy
Typing handwritten copy
Using envelopes of various sizes
Typing letters or forms to be placed in window envelopes
Preparing invoices and statements
Typing on lined paper
Preparing multiple carbons

The use of multi-channel equipment is especially desirable in this grade to develop students' skills in accord with their individual levels of ability.

MEASURING PROGRESS

Suggested Goals for Final Tests

These tests require a thirty-minute transcription period with dictation and silent reading time provided within the preceding 10 minutes.

	Fifth Term		Sixth Term	
	Words a Minute	Number of *Words* Each Letter	*Words* a Minute	Number of *Words* Each Letter
Dictation and transcription of three letters of different lengths, students to transcribe any two, one with carbon and envelope, approximately 1.4 syllabic intensity	90 - 105	100 - 175	105 - 120	110 - 180

Since the abilities of students at this level are likely to cover a wide range, it is desirable to design tests to be dictated at different rates to provide for individual differences.

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Marking Schedule

Stenography 5 and 6: Value of letter equated with the length or speed; e.g., the shortest letter, 40%; medium, 45%; longest, 50%
Carbon and envelope, 5%
Major errors (as defined in the Regents marking schedule), 4%
Minor errors, 2% for each error.

Specialized Classes

In schools where the organization permits some or all of the following programs may be set up to serve the special needs of students:

RAPID ADVANCEMENT CLASSES: These classes are formed to

Permit the completion, by business or academic students, of two years of stenography and the taking of the Regents examination in a year and a half, with the other half-year available for a double period of Secretarial Practice.

Permit students to be selected from the normal classes at the end of the first year of stenography on the basis of teacher recommendation or qualifying marks in stenography, typewriting, and English.

Complete a year of transcription in one term.

Constitute "honor" classes if there is a sufficient number of students for a class; otherwise, students may be assigned directly to a Regents class instead of to Stenography 3. Under the latter conditions, students usually do very well after a preliminary period of adjustment.

MODIFIED CLASSES: These classes are formed to

Provide either an additional term or year of instruction, or double periods in the first and sometimes the second year, for the completion of the normal two-year course of study.

Furnish an opportunity for a successful experience in vocational training for selected students with certain types of problems (learning, language, emotional, etc.). The extra time is needed to afford opportunities for individualized remedial activity to prevent failure, to help build a good self-image, to strengthen identification with desirable social and economic goals, and concomitantly, to increase interest in school, to prepare for a marginal stenographic

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position, and to provide a basis for additional training after graduation.

Use all, or the greater part, of the three terms for theory when the additional term is scheduled. Where double-period classes are scheduled, the same rate of coverage is expected as that for normal classes.

De-emphasize verbalization and abstractions in the presentation of theory and concentrate on the automatization of a basic vocabulary through extensive and intensive drill, and devote more time to compensating for language weaknesses.

ACCELERATED STENOGRAPHY: Generally this is a one-year course offered to academic students in their junior or senior year.

In addition to the aims of the regular stenography course, these classes are designed to:

1. Meet certain additional needs, such as:
   - To assist students to take lecture notes
   - To prepare students for summer and/or part-time positions
   - To equip students for initial employment in their chosen fields after college training
   - To make students aware of career opportunities where shorthand is essential; e.g., shorthand teaching, court reporting, bi-lingual secretarial work, etc.
2. Present the basic theory of Pitman or Gregg in one term.
3. Provide for transcription in the second term, where separate periods of stenography and typewriting are offered. This gives students the opportunity to take the Regents examination after one year of instruction. Where there are no separate periods for shorthand and typewriting, enrolled students must either demonstrate a reasonable competency in typewriting skill or be required to take a separate period of typewriting.
4. Emphasize the following elements:
   - Carefully planned lessons presented at a brisk tempo
   - De-emphasis on theory
   - Stress on reading and writing connected matter
   - Open-book dictation in each lesson from the beginning, starting at a rate of 40 wam

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Dictation of new matter toward the end of the first term

Skill building activities that will enable pupils to write at 50 wam on familiar matter for two minutes, toward the end of the first term

Many experienced teachers use this plan and time schedule for a developmental lesson:

Review of previous day's learnings through oral or (occasional) written transcription of homework	4 minutes
Dictation of connected matter from the open textbook	5 "
Reading of material dictated by spot check	2 "
Apperceptive base for new lesson	1 "
Motivation	1 "
Presentation of and drill on new theory learnings	10 "
Application of new skills and knowledges in short sentences, in plate reading and in open-book dictation	15 "
Summary	1 "
Preview of new assignment	1 "

In the second term, the practice is to follow the procedures of a normal transcription class with dictation beginning at 50 wam and increasing five wam every two weeks until 80 wam is attained.

SPANISH STENOGRAPHY

Makes it possible for students who are fluent in oral and written Spanish but who experience difficulty with English, to acquire a marketable skill which will prepare them to serve the business needs of our large Spanish-speaking community and of our export-import trade with Latin America

Provides an opportunity for the kind of learning experiences that instill a feeling of accomplishment, foster interest in learning, and strengthen the desire to stay in school until graduation

May be offered in conjunction with typewriting instruction from a Spanish textbook

May serve as a tool for motivating the improvement of English, especially if additional instruction in English shorthand is offered to these students

2457

Should be offered only in schools with large registrations of Spanish-speaking students. A competent teacher, highly qualified in both Spanish and in stenography, must be available to conduct the classes

LEGAL AND MEDICAL STENOGRAPHY PROGRAMS

May be offered instead of, or in addition to, Secretarial Practice, to students in the senior year who have passed the Regents examination and who have indicated an interest in qualifying for beginning positions in these fields

Should seek to acquaint students with the basic terminology of the field; develop familiarity with the various forms and records in common use; attempt to develop the stenographic, transcription, and typewriting skills required to apply these learnings in realistic situations with a degree of efficiency

May be given for one or two terms and are usually concluded with a culminating project that permits the students to follow a case through in sequence

GREGG NOTEHAND

Is offered in some schools to academic seniors who are college bound, to facilitate note-taking in college

Provides a general education, personal-use tool

Develops an approach for taking lecture notes which emphasizes selectivity in abstracting important ideas

Uses shorthand symbols together with alphabetic symbols

MACHINE SHORTHAND — (TOUCH SHORTHAND)

Is particularly desirable for those students who have a good academic background, who possess better than average ability in written English, and who are interested in careers requiring high speed; e.g., court reporting, recording conferences

Has been found helpful for the student who has experienced difficulty with a symbol system of shorthand but has a successful, scholastic record

Is presently offered to seniors both as a one-year course on a double-period basis, or as a two-year course on a single-period basis

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Strives for a speed goal of 80-100 wam with a typewriting goal of 40-50 wam.

Should be subject to the following conditions:

Availability of a machine for students' home practice, for maintaining skill level after graduation, and for employment testing

Assurances of jobs for graduates of the course.

SPEEDWRITING

Is an alphabetic system of shorthand taught in several city schools.

Is offered on a single-period basis for one term or one year to seniors with good scholastic records in all subjects in the academic program.

Generally covers the twenty-five theory lessons in twelve weeks; then devotes three weeks to speed development and three weeks to transcription skill building.

May qualify selected students to pass the Regents examination.

May serve a vocational goal if student reaches competency of 80 wam.

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WORK EXPERIENCE PROGRAMS

The alternate week supervised cooperative work experience program should be available to students who need, want, or can profit from the experience. This program assumes that the shorthand student is assigned to a position which contributes to the educational objectives of the shorthand training program. Students who participate in the program must:

> Have reached that point in their training where their shorthand skill is usable
>
> Be placed in a station where the skill will be developed further by functional training

If the preceding conditions are not met, then learning difficulties resulting from the reduction of shorthand instruction will interfere with the development of a marketable skill. The possibility of failure may encourage students to drop the subject.

The half-day work experience program may be offered to seniors. This program mitigates many of the disadvantages of the alternate-week program for stenography students because the students

> Have usually completed their skill training or are in the final stages of it and are ready, or almost ready, for the kind of work they expect to do after graduation
>
> Have the maturity and motivation to appreciate the importance of orientation to the world of work and to benefit from such orientation

Here, too, the precautions of relating the job to the student's level of training must be observed. On-the-job experience must complement the school program and enhance the value of the schooling; the in-school program must be correlated with job experiences and contribute to the educational value of the work station.

Cocurricular and Extracurricular Activities

A course of study in stenography can be enriched by introducing many activities which will motivate students to work to the best of their ability, help them enjoy the time and effort they invest in learning, increase their understanding of the business world, and give them an opportunity to practice some of their skills in a realistic setting.

CLUBS

The effectiveness of a club program is determined by the interests and needs of the students in a particular school situation and the availability of an enthusiastic, imaginative teacher-sponsor.

Some of the more representative clubs currently being conducted in our city schools are listed below.

Stenography Club:

- Offers assistance to weak students in need of coaching
- Provides high speed dictation and transcription practice for better students
- Is specialized in function to provide experiences in medical and legal stenography, court-reporting, etc.

Stenography Honor Society, which is organized for outstanding business students who meet scholarship, personality, and school service requirements

Future Secretaries of America which:

- Acquaints outstanding students with the Certified Professional Secretary program
- Provides experiences which will help its members to establish the basis for future certification

Future Teachers Club, which may be oriented to have a specific appeal for academic students who are encouraged to become stenography teachers

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CLUB ACTIVITIES

Enrichment

Participation in audio-visual programs in the secretarial field with ensuing opportunities for information forums, panel discussions, etc.

Field trips to career conferences, to various types of business establishments, to institutions of higher learning in the business field, to Junior AMS meetings, etc.

Specific Purpose

Coaching for examinations: Regents, Civil Service, job proficiency, interviews, etc.

Preparation of department or school newspapers or magazines

Preparation for contests

Service

Maintaining attractive and current department and classroom bulletin boards

Acting as clerical assistants in department offices for a wide variety of tasks

Providing secretarial help, such as the taking of minutes, for designated school activities

Serving as a visual-aids squad for the department

Tutoring fellow students

INCENTIVES AND AWARDS

Devices and techniques which arouse interest and serve as incentives to stimulate student enthusiasm are essential:

- To provide tangible goals toward which students can work
- To encourage greater effort and additional practice
- To inspire students to achieve to capacity in an effort to win recognition and approval from teachers and classmates in the form of certificates and awards
- To permit students to compare their achievement with that of others in the class, giving them a realistic appreciation of the level at which they can fill positions in the business world
- To teach the importance of winning and losing graciously

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Spelling Program: Students are given a master list of frequently misspelled words compiled by the Society. Certificates are awarded to those who achieve 100% accuracy on teacher-conducted 100-word test constructed by the Society.

2. Business Education Association of Metropolitan New York. Award programs sponsored by this organization are conducted by the Bureau of Business and Distributive Education.

   Certificates of Merit: End-of-year certificates are available for the student obtaining the highest class mark in each grade of Stenography.

   Kroll Memorial Award: A certificate to students receiving 100% on the Regents Examination.

   Altholz Award: A medal awarded to the outstanding graduate of the Secretarial Studies Department.

3. Dictation Disc Company, 240 Madison Avenue, New York, N.Y. 10016

   DDC Shorthand Improvement Award: Information relating to contests is provided in the regularly published DDC Record. A pin is given to the student in each shorthand class who in the teacher's judgment has made the greatest improvement during the school year.

4. Gregg Awards Program, Gregg Awards Department, 330 West 42 Street, New York, N.Y. 10036. Detailed information relating to many awards is available in the "Gregg Tests and Awards Brochure."

   Certificates and pins are available for a small fee.

   Honor Roll charts

   OGA Shorthand Penmanship Tests. Copy contained in *Today's Secretary*.

   Shorthand Dictation Speed Tests. Sustained dictation at speeds of 60, 80, 100, 120, and 140 wam for 3 to 5 minutes' duration. Copy in *Gregg Tests and Awards Book,* published annually.

   Shorthand Complete Theory Awards: 100 word tests. Copy in *Gregg Tests and Awards Book.*

   Transcription Tests. Timed transcript of dictation at 60, 80, 100, and 120 wam. Copy in *Gregg Tests and Awards Book.*

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5. Pitman Publishing Corporation, Awards Department, 20 East 46 Street, New York, N.Y. 10017. Information relating to contests and awards may be obtained from the publisher or in its publication, *The Pitmanite*.

   Honor Roll charts

   Shorthand Theory Awards: Intermediate and comprehensive levels. Copy in *The Pitmanite*. Certificates and pins available.

   Shorthand Speed Awards: Dictation at 80, 100, and 120 wam. Copy in *The Pitmanite*. Certificates and pins available.

   Transcription Awards: Plate material available in the *Pitman Journal*. Miscellaneous awards and Honor Transcript Certificates.

   National and International Shorthand Contests. Conducted annually. Copy provided directly by publisher. Medals, plaques, pins are available in different categories.

6. Individual School awards programs. Schools may establish certificates and medals patterned on the procedures presented in the preceding sections. The programs may be individually oriented or group oriented.

When possible, school-wide publicity should be accorded to all award winners. Their names and achievements should be posted on hall bulletin boards and listed in the school newspaper. The presentation of outstanding awards at a school assembly increases the effectiveness of this type of motivation.

ASSEMBLY PROGRAMS

In addition to their enrichment possibilities and the opportunities they provide for an expression of the interests of business students, assembly programs can be used to convey to all students the impact of New York City as the office center of the world and the values of the skill training offered to equip students for service in many fields.

Individually adapted variations of the following programs have been used successfully in many schools:

1. Plays and original skits, especially those that dramatize and make more meaningful specific areas of training, such as correct typewriting technique, applying for a position, office behavior, etc. These

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productions may require a great deal of rehearsal time unless the scripts are planned to achieve effectiveness through a reading approach.

2. Outside speakers. The program may be based on presentations by successful graduates, by officers of the personnel or management offices of large companies, by representatives from civil service, institutions of higher learning, professional organizations (AMS, OEA, The National Secretaries Association, Business Advisory Commission, Commerce and Industry Association) to discuss careers, job requirements, educational opportunities, promotional areas, etc. Unless speakers are known to be unusually effective, a significant contribution to the presentation will result if a student panel is used to ask prepared questions of interest to students.

3. Demonstrations at the typewriter or at the chalkboard for stenography, by typewriting or shorthand champions, by court reporters, or by the students themselves either individually or in teams.

4. Occasionally, outstanding films are available from such sources as equipment companies and cultural, professional, public, or governmental organizations with messages of social or economic significance to the field of business. These films should be selected by the teacher on the basis of student appeal and educational value.

DEPARTMENT PUBLICATIONS

A department newspaper or magazine can be used effectively to create interest in the skill training opportunities offered by the secretarial studies department, to provide worthwhile experiences in the language arts so essential to transcription skill, and to reveal areas for placement.

To extend its appeal to all the students in a school, these publications may include features, such as:

Reports on current happenings in the school: outstanding assembly programs, trips to business offices, visits of guest speakers, descriptions of newly acquired equipment, etc.

Requirements for awards, graduation, and admission to institutions of higher learning in the business field

Job opportunities and requirements

Honor roll placement and award winners in a wide variety of categories

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Special features, cartoons with shorthand captions, puzzles in shorthand, etc.

Interviews with or reports on successful graduates

TRIPS TO BUSINESS OFFICES

Trips to business, professional, and government offices provide a background for much that is presented in the classroom and acquaint students with some of the actualities of the business scene. For maximum effectiveness, the project must provide for a preliminary visit to the office by the teacher, a briefing with students about proper behavior, and elements of interest, planning for transportation and lunch, a follow-up discussion of significant elements or a written committee report on items of importance and the preparation of letters of thanks.

TRAINING FOR JOB PLACEMENT

To meet the many testing experiences of a successful business career, students should be given training in taking employment and other civil service tests, in filling out application forms, and in conducting themselves properly at interviews. They should be encouraged to take civil service examinations and the New York State Employment Service Proficiency Test as part of a planned program of job placement.

SCHOOL-WORK EXPERIENCE

In many schools students serve in the administrative offices on a volunteer basis. If stenography or a high degree of skill in typewriting is required, the assignments should be coordinated by the department chairman in order to make available to outstanding students these valuable training and experiential opportunities. The job requirements should be reviewed periodically to make sure the assignments continue to be related to the desired objectives and contribute to skill development.

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Appendix

BIBLIOGRAPHY

TEXTBOOKS

For a list of textbooks used in shorthand classes, see *Textbook List For Use By High Schools,* current edition, published by the Board of Education, City of New York, 110 Livingston St., Brooklyn, N.Y. 11201.

PERIODICALS, YEARBOOKS, OTHER PUBLICATIONS

Periodicals

Balance Sheet, South-Western Publishing Co., 5101 Madison Rd., Cincinnati, Ohio 45227; free.

Business Education Forum, National Business Education Association, 1201 16 St. NW, Washington, D.C. 20036.

Eastern Business Teachers Association Journal, issued twice a year, Box 962, Newark, N.J. 07101.

Gregg Magazines, Gregg Division, McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036:

Today's Secretary
Business Education World (free)

Journal of Business Education, Trethaway Publishing Co., Inc., 512 Brooks Building, Wilkes-Barre, Pa.

National Business Education Quarterly, National Business Education Association, 1201 16 St. NW, Washington, D.C. 20036.

Pitman Journal, Pitman Publishing Corp., 6 E. 43 St., New York, N.Y. 10036; (free)

Typewriting News, South-Western Publishing Co., 5101 Madison Rd., Cincinnati, Ohio 45227; free.

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Yearbooks

Business Education Association of Metropolitan New York Yearbook, New York University Bookstore, 239 Greene St., New York, N.Y. 10003; issued biennially.

Eastern Business Teachers Association Yearbook, Box 962, Newark, N.J. 07101.

National Business Education Association Yearbook, NEA Centre, 1201 16 St. NW, Washington, D.C. 20036.

Other Publications

Bulletins from Bureau of Business and Distributive Education, The State Education Department, Albany, N.Y.; issued periodically to chairmen.

Bulletins of the Foundation for Business Education, Inc., 405 Park Ave., New York, N.Y. 10022; issued periodically, free.

Monographs of the Pitman Publishing Corp., 6 E. 43 St., New York, N.Y. 10036; issued periodically, free.

Monographs of the South-Western Publishing Co., 5101 Madison Rd., Cincinnati, Ohio 45227; issued periodically, free.

Syllabus in Business Subjects, The University of the State of New York, Albany, N.Y.; free.

Secretarial Practice for High Schools, Board of Education of the City of New York, 110 Livingston St., Brooklyn, N.Y. 11201.

Typewriting for Secondary Schools, Board of Education of the City of New York, 110 Livingston St., Brooklyn, N.Y. 11201.

TEACHING AIDS AND RESOURCES

The forthcoming curriculum guide, *Secretarial Practice for High Schools,* 1969-70 Series, provides a list of the following resources that may be related to the subject matter of the shorthand course of study:

16 mm sound films with brief descriptions of the content and the commercial or institutional distributor (including the Board of Education)

Kinescopes available at the Bureau of Audio-Visual Education

Addresses of publishers and suppliers

Selected list of common terms in data processing

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Additional Resources

Publications of the New York City Board of Education

Instructional Films and Tapes (Bavi Loan Collection)
Channel 25, WNYE TV Manual
WNYE FM Radio Manual

Film Library Catalogue, State of New York, Department of Commerce, 28 Howard St., Albany, N.Y. Free loan service.

Shorthand Dictation Tapes and Records

Allied Records, Allied Publishers, Inc., 1659 Morgan Bldg., Portland, Oreg. Records available for theory and speed building in speeds ranging from 60 to 120 wam.

Chesterfield Music Shops, Inc., 12 Warren St., New York, N.Y. 10007. Records for Pitman theory and selected business letters.

Children's Music Center, Inc., 5373 West Pico Blvd., Los Angeles, Calif. EMC Office Style Dictation. Set of five tapes.

Dictation Disc Records and Tapes and Laboratories Catalog. Dictation Disc Co., 240 Madison Ave., New York, N.Y. 10016. Sets for Gregg and Pitman Theory, for short-brief forms, for phrase drills, for speed development on business letters, for office style dictation, for legal dictation and for medical dictation; 32 tapes at 50 to 140 wam and 24 sets of records from 40 to 160 wam.

Educational Record Sales, 157 Chambers St., New York, N.Y. 10007. Steno-Disc and Steno-Speed records of brief forms, phrases, and business letters, 40 to 120 wam. Legal and Congressional matter at 130 to 240 wam.

Gregg Instructional Aids Catalog and Guide. Gregg Instructional Aids Department, McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036. Extensive listing of records and tapes at 40 to 170 wam, graded by terms. Tapes for electronic dictation laboratories. Suggestions for teaching and for handling equipment. Detailed descriptions and references to articles in professional literature.

Pitman Dictation Tapes. Pitman Publishing Corporation, 6 E. 43 St., New York, N.Y. 10017.

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500 MOST COMMONLY MISSPELLED WORDS IN TRANSCRIPTION

Through the courtesy of the Dictation Disc Company, we are providing this list of the 500 words most frequently misspelled in transcription. The lists are organized in groups of 100 each, with the first group the most commonly misspelled words, the second group the next most common, and so on. Printed copies and dictation records of these words are available from the Dictation Disc Company.

First Hundred Most Commonly Misspelled Words

absence	appearance	decision	judgment	procedure
accept	appointment	definite	loose	proceed
acceptance	arrangement	description	lose	receipt
accidentally	assistance	develop	maintenance	receive
accommodate	attendance	difference	necessary	recommend
accordance	beginning	disappoint	noticeable	reference
accuracy	believe	effect	occasion	remittance
achievement	benefited	embarrass	occurred	representative
acknowledgment	business	equipment	occurrence	separate
across	calendar	equipped	omission	shipment
affect	cancellation	exceed	omitted	shipping
agreeable	cannot	excellent	opportunity	similar
almost	coming	except	personal	strictly
already	committee	existence	personnel	surprise
altogether	confident	extension	planning	their
among	convenience	familiarize	possession	there
analysis	convenient	fourth	practical	too
analyze	criticism	grateful	precede	undoubtedly
apologize	criticize	immediately	preferred	unnecessary
apparent	customer	incidentally	privilege	whether

Second Hundred Most Commonly Misspelled Words

accessible	applicant	defense	formerly	pleasant
accompanying	appreciable	deferred	forward	practically
acquaintance	approximate	delegate	government	practice
adapt	argument	desirable	governor	preference
adequate	article	development	guarantee	previous
adjustment	ascertain	eagerly	inconvenience	principal
admirable	attorneys	economical	knowledge	principle
advantageous	available	edition	laboratory	probably
advertising	budget	efficient	legitimate	purchase
advice	businessman	eligible	license	really
advisable	busy	eliminate	management	recognize
advise	campaign	endeavor	manufacturer	referred
usually	capital	envelope	merchandise	referring
advisory	collateral	especially	miscellaneous	repetition
aggravate	commission	exercise	oblige	respectfully
allowance	conference	experience	organize	schedule
annoyance	congratulate	explanation	original	secretary
annual	controversy	February	paid	seized
anxious	courteous	finally	partial	submitted
allowable	courtesy	foreign	permitted	succeed

Third Hundred Most Commonly Misspelled Words

accessory	correspondence	hardware	overdue	significant
allotment	correspondents	height	pamphlet	someone

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anticipate	dissatisfied	indebtedness	particularly	specialize
bankruptcy	emphasis	independent	permanent	stationary
bargain	emphasize	indispensable	preliminary	stationery
basis	essential	individual	price list	substantial
bookkeeper	exaggerate	installment	quantity	successful
brilliant	excellence	inventory	questionnaire	sufficient
brochure	excessive	it's, its	quiet	superintendent
bulletin	expenditure	legible	quite	thorough
bureau	extraordinary	length	recently	throughout
career	extremely	maximum	recognized	typing
catalog	facilities	menus	renewal	until
choice	financial	minimum	requirement	valuable
choose	usable	mortgage	respectively	various
circumstances	forty	negotiate	response	vicinity
column	fulfillment	occupant	responsible	warehouse
concern	gauge	occurring	route	wholesale
conscientious	genuine	ordinary	salary	withhold
consignment	handled	organization	satisfactorily	worthwhile

Fourth Hundred Most Commonly Misspelled Words

accrued	concede	hazardous	magazine	professor
affidavit	consequence	hesitant	manuscript	psychology
appliance	continuous	identical	medical	reasonable
appraisal	controlling	illegible	modernize	recipe
architect	cordially	imperative	negligible	reimburse
assessment	council	impossible	neighborhood	restaurant
assignment	counsel	inasmuch as	nevertheless	securities
authorize	coverage	inducement	offense	simultaneous
beneficial	deductible	influential	offering	somewhat
beneficiary	deficit	initial	parallel	subscriber
capitol	depositors	inquiry	participant	supersede
casualty	director	intelligence	patronage	tariff
client	emergency	interfere	permissible	temporary
comparable	employee	interrupted	persuade	urgent
comparison	endorsement	investor	phase	vehicle
compelled	enthusiasm	itemized	pleasure	vendor
competent	favorable	justifiable	precision	visible
complement	furthermore	leisure	preferable	voluntary
compliment	grievance	letterhead	prejudice	volunteer
compromise	harass	library	premium	survey

Fifth Hundred Most Commonly Misspelled Words

accede	competitor	device	intercede	remember
accumulate	conceivable	devise	irrelevant	responsibility
acquiesce	concession	disappear	itinerary	ridiculous
acquire	concurred	discrepancy	jeopardize	salable
address	confidential	efficiency	liaison	serviceable
advertisement	conscience	enclose	likable	siege
allotted	conscious	enterprise	livelihood	sincerity
all right	consensus	environment	memorandum	statistics
amendment	consistent	etiquette	mileage	supervisor
announce	corporation	expedite	mischievous	tragedy
announcement	creditor	expense	ninety	transferred
apparel	current	fascinate	ninth	ultimately
applicable	debtor	favorite	official	unanimous
appropriate	deceive	forcible	percent	unfortunately
associate	decide	forfeit	physician	vacuum
assured	defendant	freight	prominent	volume
attention	definitely	friend	prosecute	weather
canceled	dependent	hoping	realize	writing
clientele	describe	incurred	recurrence	yield
commitment	deteriorate	intention	regrettable	pursue

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ILLUSTRATION OF TAPE IDENTIFICATION SHEET FOR ELECTRONIC CLASSROOM

CARTRIDGE	SIDE	W A M	LETTERS USED	MINUTES PER SIDE
1	1	60	2, 4	14:27
		60	12, 13, 14, 15	
1	1	70	2, 4, 5	
		70	12, 13, 14, 15	14:57
1	1	80	2, 4, 5	
		80	12, 13, 14, 15, 16	15:00
1 A		60	20, 21, 22	
		60	27, 28, 29	14:07
1 B	2	70	20, 21, 22, 23	
		70	27, 28, 29, 30	15:08
1 C		80	20, 21, 22, 23	
		80	27, 28, 29, 30, 31	15:00
2 A		60	34, 35, 36	
		60	41, 43, 44, 45	14:48
2 B	1	70	34, 35, 36, 37	
		70	41, 43, 44, 45	14:48
2 C		80	34, 35, 36, 37	
		80	41, 43, 44, 45, 46	14:35
2 A		60	52, 53, 54	
		60	61, 62, 63	14:53
2 B	2	70	52, 53, 54, 55	
		70	61, 62, 63	14:05
2 C		80	52, 53, 54, 55, 56	
		80	61, 62, 63	14:52
3 A		60	68, 69, 70	
		60	76, 77	14:16
3 B	1	70	68, 69, 70	
		70	76, 77, 78	14:00
3 C		80	68, 69, 70, 71, 73	
		80	76, 77, 78	14:38

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ILLUSTRATION OF INSTRUCTION SHEET FOR OPERATING THE ELECTRONIC LABORATORY

Students' Equipment

STUDENT RECEIVER: Small machine used by students to receive dictation

HEADSET: Located in cardboard box

Teacher's Equipment

CONSOLE: Large portable system containing sub units

POWER UNIT: Largest machine, located on left-hand side of stand

THREE DICTATION UNITS: Three small flat machines (Marked *A, B, C*). These serve as recorders into which the tapes are inserted.

MICROPHONE: To be plugged into center of power unit

STUDENT RECEIVER and HEADSET: To be used by teacher in monitoring dictation being received by students

To Operate:

Distribute to each student one student receiver and one box containing a headset.

Plug into wall outlets the two cords coming from the rear of the console.

On the front of the power unit.

Turn the power switch to the *on* position.

Flip up the three microphone *channel* switches.

Never turn the switches marked *A, B,* and *C,* located near the bottom of the power unit marked *dictation unit volume.*

Have students do the following with their headsets and student receivers:

Plug headset into the receptacle marked *student* at the side of the receiver.

Put the headset on, with the plugs in the ears and the rounded loop under the chin.

On the front of the student receiver, click the volume switch clockwise from *off* until the red dot points upwards. This

turns the machine on and makes it possible for students to hear.

Plug the microphone in to mike in the center of the power unit.

Talk into the microphone to the students to be certain that all can hear you. Have them adjust their volume switch to the desired listening level.

Explain to the students how the machine operates

Describe how they can select Channels *A, B,* or *C* for the three speeds of dictation.

Tell them the speeds of dictation on each channel.

Have each student turn the *channel* selector to *A, B,* or *C* depending on the speed desired.

Flip down the three microphone channels to *off*.

On the teacher's three dictation units (Marked in brush pen *A, B,* or *C)* turn each *channel* selector to the proper channel (from 1-20). See duplicated list of letters and speeds available on each channel.

On the power unit, flip up the three dictation units — power switches *(A, B, C),* and the dictation will begin shortly. (If you wish, only *A* or *B* or *C* switches may be used.)

During the dictation, you can stop the dictation flow by flipping down any or all dictation units — *power* switches to *off*. You can then speak over the microphone to any or all groups by flipping up any or all of the microphone — *channels* switches.

Instructions for Returning Tape to Beginning of Reel

Remove rubber stopper from the *Listen-Talk* keys.

Press forward the blue *Rewind* key on *A, B,* and *C* and keep depressed until you hear a thump.

Remember to replace the rubber stopper behind the *Listen-Talk* keys when you wish to start the dictation.

Instructions After Completing Use of Electronic Laboratory

On the power unit, depress the dictation units — *power* and *microphone* — channels switches to the *off* position.

Ask students to:

Turn volume control to *off*. (Very important or battery will be drained.)

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Detach headset from the side of the student receiver and return headset to the cardboard box.

Collect all materials from students and store in cabinet.

Have electronic laboratory wheeled to Room 410 and placed flush against the front of the file.

ILLUSTRATION OF SCHEDULE FOR USE OF ELECTRONIC LABORATORY

Changes in schedules may be made in consultation with chairman.

Additional periods may be scheduled at the option of teachers.

Pd.	Monday	Tuesday	Wednesday	Thursday	Friday
1		Sten. 601 Rm. 301	Sten. 4012 Rm. 302 OR		Sten. 501 Rm. 302
2	Sten. 602 Rm. 302	Sten. 4023 Rm. 304			
3	Sten. 4034 Rm. 301			Sten. 404 Rm. 409	Sten. 4034 Rm. 302 OR
4			Sten. 4045 Rm. 301 OR		
5		Sten. 605 Rm. 409		Sten. 415 Rm. 304	
6					Sten. 606 Rm. 302

N. B. Teachers whose classes are listed with an arrow may use the electronic laboratory during either period, both periods, or overlapping periods.

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SPEED DICTATION CHARTS

SPEED DICTATION INTERVALS
(Number of Seconds for 20-Word Groups)

Words a Minute									
50	60	70	80	90	100	110	120	130	140
Seconds									
24	20	17	15	13	12	11	10	09	08
48	40	34	30	26	24	22	20	18	17
12	60	51	45	40	36	33	30	27	25
36		08	60	53	48	44	40	37	34
60		25		06	60	55	50	46	42
		42		20		06	60	55	51
		60		33		17		04	60
				46		28		14	
				60		39		23	
						50		32	
						60		41	
								51	
								60	

The chart above is based on material counted in 20-word groups. Dictating at a speed of 50 words per minute, the first 20 words is dictated within 24 seconds, the second group of 20 words is dictated by the time the hand on the stop watch reaches 48 seconds, etc.

WORD-COUNT TABLE
(For ¼-Minute Intervals)

	Words a Minute									
	56	60	64	68	72	76	80	84	88	92
¼ minute	14	15	16	17	18	19	20	21	22	23
½ minute	28	30	32	34	36	38	40	42	44	46
¾ minute	42	45	48	51	54	57	60	63	66	69
1 minute	56	60	64	68	72	76	80	84	88	92
1¼ minute	70	75	80	85	90	95	100	105	110	115
1½ minute	84	90	96	102	108	114	120	126	132	138
1¾ minute	98	105	112	119	126	133	140	147	154	161
2 minutes	112	120	128	136	144	152	160	168	176	184

2477

VT 012 005
Aerospace Educational Materials.

General Aviation Manufacturers Association, Washington, D.C.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 13p.

DESCRIPTORS - *REFERENCE MATERIALS; *INSTRUCTIONAL MATERIALS; *AEROSPACE TECHNOLOGY; *AEROSPACE INDUSTRY; *AVIATION TECHNOLOGY; AVIATION MECHANICS; SCIENCE CURRICULUM; TECHNICAL EDUCATION

ABSTRACT - This publication of the General Aviation Manufacturers Association provides a listing of aerospace educational materials available for use by teachers and administrators in planning and conducting aviation and science curriculums at all levels. Listings are in alphabetical order by member manufacturer and provide such information as types of items available, number, educational level, prices, and addresses from which the materials may be ordered. Materials listed include flyers, brochures, booklets, films, filmstrips, kits, manuals, course guides, posters, and charts. (AW)

VT 012 005

ED0 56238

Aerospace Educational Materials

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General Aviation Manufacturers Association

SUITE 1200-A
1025 CONNECTICUT AVENUE, N.W.
WASHINGTON, D.C. 20036

VT012005

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MEMBERS

GENERAL AVIATION MANUFACTURERS ASSOCIATION

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Williamsport Plant
652 Oliver Street
Williamsport, Pennsylvania 17701

Beech Aircraft Corporation
Wichita, Kansas 67201

The Bendix Corporation
The Bendix Center
Southfield, Michigan 48075

Cessna Aircraft Company
Post Office Box 1521
Wichita, Kansas 67201

Collins Radio Company
5225 C Avenue, N.E.
Building 120-111
Cedar Rapids, Iowa 52406

The Garrett Corporation
9851 Sepulveda Boulevard
Los Angeles, California 90009

Gates Learjet Corporation
Post Office Box 1280
Wichita, Kansas 67201

General Electric Company
Aircraft Engine Group
Cincinnati, Ohio 45215

Grumman Aerospace Corporation
Bethpage, Long Island,
New York 11714

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Olathe, Kansas 66061

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Commerce Drive
Fort Washington, Pennsylvania 19034

North American Rockwell Corporation
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5001 North Rockwell Avenue
Bethany, Oklahoma 73008

Piper Aircraft Corporation
Lock Haven, Pennsylvania 17745

RCA Corporation
Aviation Equipment Division
11819 W. Olympic Boulevard
Los Angeles, California 90064

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Flight Systems Division
21, 111 North 19th Avenue
Box 2529
Phoenix, Arizona 85024

Swearingen Aircraft
P.O. Box 32486
San Antonio, Texas 78216

Teledyne Continental Motors
30500 Van Dyke Avenue
Warren, Michigan 48093

United Aircraft Corporation
(United Aircraft Corporation
of Canada, Ltd.)
Post Office Box Ten
Longueuil, P.Q., Canada

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PREFACE

Aerospace education is not new. Each school year approximately 4,500 elementary school teachers use aerospace education materials as part of regularly planned science programs. More than 600 high schools across the country offer aviation courses for credit. The FAA Office of General Aviation Affairs lists over three hundred colleges and universities that offer degree programs in such fields as aerospace engineering, agricultural aviation, airport operation, aviation electronics, aviation management/administration, aviation mechanics and air traffic control.

The member companies of the General Aviation Manufacturers Association offer a variety of aerospace educational materials to complement aviation and science curriculums at all levels. These materials, available to teachers, instructors and administrators, may be ordered in limited quantities by writing directly to the manufacturers.

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AVCO LYCOMING DIVISION
WILLIAMSPORT, PENNSYLVANIA 17701, TELEPHONE (717) 323-6181

EDUCATIONAL MATERIALS

1 each	Service Directory List
1	Service Letter L114G
1 each	List of Avco Lycoming Certificated Aircraft and Helicopter Engines
1	Schematic Turbocharger Chart E & A Series 541
1	Schematic Turbocharger Chart Series 540
1	Schematic Bendix Fuel Injector
1	Bendix 1200 Mag Chart
1	ABC's Shower of Sparks
1	Bendix RSA-5 and RSA-10 Fuel Injection Systems Operation and Service Manual
1	Direct Drive Engine Operation Manual
1 each	Avco Lycoming Flyers
1	Training Manual

The enclosed list of Avco Lycoming distributors will give the name of a distributor in your locality from whom publications as listed in Service Letter L114G can be purchased.

The following filmstrips, with records, for use with a DuKane projector, are available at the prices as shown below:

If manuals are desired on alternators, starters, generators, etc., they can be obtained from the respective companies at the addresses shown below:

Delco Remy Division
2401 Columbus Ave.
Anderson, Ind. 46011

The Prestolite Co.
Box 931
511 Hamilton St.
Toledo, Ohio 43601

Spark plug information is available from Champion Spark Plug Co., at 900 Upton Ave., Toledo, Ohio, Zip Code 43601.

We trust these enclosures will be helpful to you.

Also in addition to the filmstrips which are mentioned in this letter, we have available 35mm slides and two-track cartridge tape on the lightweight ignition system. The price is $25.00 for 106 slides and the tape.

Beech Aircraft Corporation
Wichita, Kansas 67201
U. S. A.

Educational Materials Available
from Beech Aircraft Corporation

Beech Aircraft supplies materials on four levels as follows:

1. Elementary--Aviation Education Kit depicting the history of Beech Aircraft Corporation with pictorial representation of aircraft now being produced by the Wichita, Salina, and Liberal facilities. This kit also contains information on fundamentals of flight, parts of an aircraft, an instrument panel and other educational information.

2. Secondary--a sample syllabus for high school aviation courses is supplied to school administrators, and school board members upon request. The type of high school course recommended by Beech Aircraft is an introductory, exploratory, careers-type program to acquaint the students with the overall impact of aviation upon the world today. Also available on the high school level is careers information as well as lithographs of Beech Aircraft's current models.

3. College level--a Beech Aircraft publication "Aviation/Aerospace Courses at Institutions of Higher Learning" is available to college administrators upon request. Free consulting service to those colleges wishing to consider the addition of or future development of aviation education programs is also available. These programs have been developed by numerous colleges throughout the nation ranging in scope from basic ground school through an entire B.S. Degree in Aviation Administration. Also, careers materials and lithographs are available upon request.

4. Vocational/Technical Institutes--limited number of shop manuals and surplus material is available to FAA/VA approved public vocational schools.

Additional materials such as films, filmstrips and slides, blueprints, charts, diagrams, and other historical information is available on all levels upon request. Many films are available from local dealers.

CABLE ADDRESS
CESSCO-WICHITA

Cessna® AIRCRAFT COMPANY

Wichita, Kansas 67201

MARKETING DIVISION
COMMERCIAL AIRCRAFT

Cessna Aircraft Company has developed four levels of aviation education programs for schools described below and available from the following address:

Air Age Education Division
Cessna Aircraft Company
P. O. Box 1521
Wichita, Kansas 67201

ELEMENTARY:

1. (Free Flyer) informative brochure describing the Cessna Elementary Teacher's Kit. Also contains a sample lesson which the teacher may use in the classroom.

2. An especially designed kit of Air Age Education materials for elementary teachers contains dozens of items--posters--diagrams--booklets--charts--games--full-color pictures--demonstration model airplane--to everything needed to support a professionally developed unit guide on general aviation for social studies and science. In addition, the Kit provides a free subscription to a teacher newsletter of ideas and sources and a special free-loan film list keyed to the materials in the Kit. Education price only--$4.95 per Kit.

HIGH SCHOOL:

1. A special booklet A Need--An Answer is offered free to teachers and administrators interested in planning an introductory course in aviation for the high school level. Booklet describes Cessna materials and services offered to high school teachers including resources and a step-by-step procedure on how to establish a program based on the experiences of over 500 high schools.

2. An Introductory Aviation Course Guide contains a detailed teaching outline for the teacher including extensive resources especially designed for a high school course. Many free and low-cost materials are referenced for both ground school subjects and general information about the industry.

PAVE:

1. Programmed Assistance to Vocational Education (PAVE) is an especially designed program for vocational and technical training programs in aviation offering training materials and service information on a free-loan basis or at special school prices. Information on enrolling in PAVE is available upon request.

COLLEGE:

1. Cessna makes available selected materials and consultation tailored to meet the needs of the individual college including examples of successful college courses and company resources.

GENERAL:

1. Cessna provides a special free packet on learning to fly and Cessna products by writing directly to:

   Cessna Aircraft Company
   Department 783
   P. O. Box 1521
   Wichita, Kansas 67201

2. Free-loan films are available for all age groups on the fun of flying and the use of general aviation aircraft. Send film requests to:

   Modern Talking Picture Service, Inc.
   1909 Prudential Plaza
   Chicago, Illinois 60601

THE GARRETT CORPORATION
9851-9951 SEPULVEDA BOULEVARD · LOS ANGELES, CALIFORNIA 90009
TELEPHONE: (213) 776-1010, 670-0131 · CABLE: GARRETTAIR LOS ANGELES

EDUCATIONAL MATERIALS AVAILABLE

Illustrated poster "The Gas Turbine Engine."

This 17 in. by 22 in. sheet on heavy stock demonstrates how jet engines work. Junior and senior high school level.

Booklet "Pilot's Brief."

A well-illustrated little volume that tells how the TPE 331 turboprop engine works and what a pilot must do to operate it. Senior high school level.

Brochure "Garrett Turbofan Powerplant."

A four-color document that shows what an advanced turbofan engine looks like and describes how it works. Senior high school level.

GENERAL ELECTRIC COMPANY

AIRCRAFT ENGINE GROUP

1000 WESTERN AVENUE, WEST LYNN, MASSACHUSETTS 01905 . . . TELEPHONE (617) 594-0100

CJ610 JET POWER
Features and applications of the CJ610 turbojet engine for business jet aircraft.

THE POWER BEHIND THE FAN JET FALCON
Features of the CF700 turbofan engine.

CT58 TURBOSHAFT ENGINE
Facts about the engine and its commercial helicopter applications.

CUTAWAY DRAWINGS
CJ610 Turbojet, 16 x 20 inches
CF700 Turbofan, 16 x 20 inches

THE UNITED STATES SST - "WASHINGTON TO LONDON"
A brief dramatic account of the first projected supersonic transport flight from Washington to London.

GE4 PROGRESS REPORT
A summary report describing the progress of the engine development program for the SST.

TESTING FOR TOMORROW
A pictorial presentation touching upon the variety of tests undergone by modern jet engines as they progress from development to flight status.

JET PROPULSION
A history of GE achievements in the field of jet engines, including a diagrammatic explanation of how a jet engine operates.

THE TF39 FOR THE USAF C-5
A status report on the development and testing of the TF39 engine for the C-5 Galaxy Transport. Includes engine cutaway drawing.

GENERAL ELECTRIC JET ENGINES GO TO SEA
Specifications and applications of GE aircraft gas turbines adapted to marine use.

AIRCRAFT ENGINES

NARCO AVIONICS

A DIVISION OF NARCO SCIENTIFIC INDUSTRIES

1. Individual NARCO Equipment Pilot's Guides
2. Individual NARCO Equipment Brochures
3. Individual NARCO Equipment Glossy Photographs
4. How to Fly Omni Booklets

- -

Slides and related materials are also available for purchase on various subjects. For further information on any of this material please contact the undersigned.

COMMERCE DRIVE, FORT WASHINGTON, PENNSYLVANIA 19034 ☐ 215 643-2900

Piper Aircraft Corporation

Lock Haven, Pennsylvania, U.S.A. 17745

TELEX 841412 AREA CODE 717 748-6711

CABLE ADDRESS: CUB

PIPER EDUCATIONAL SERVICES

AVIATION CURRICULUM PLANNING

The Air Science Education Department working in cooperation with the Piper dealer organization will assist educational institutions in planning and implementing aviation programs at all levels. Every effort is made to guide program development according to accepted educational procedures as established by accrediting agencies, state departments of public instruction and other governing bodies.

AVIATION EDUCATION KIT

This special packet of information is designed to acquaint teachers and educators with the Piper Corporation, products and services. Aviation education articles, case histories, sample curriculums, guidelines for flight experience programs and other instructional materials are included. (ASE KIT 995-587)

PIPER AVIATION FILMS

Piper offers a selection of 16 mm color sound films for interest-boosting audio visual presentations. Topics include unusual and routine applications of general aviation aircraft and the flight instruction process in a number of geographic settings.

INSTRUCTIONAL WALL CHARTS

A series of instructional wall charts is available for classroom use, including a cut-a-way view of the Piper Cherokee Six, a flow chart of the Vero Beach manufacturing facility, and the Cherokee Arrow instrument panel. (ASE KIT 995-657)

SERVICE PUBLICATIONS FOR TECHNICAL SCHOOLS

A special package of selected service manuals and other maintenance data is available to schools offering bonafide airframe and powerplant mechanics training or aeronautical engineering. The purpose of these materials is to acquaint students with maintenance procedures on modern general aviation aircraft and engines. (ASE KIT 760-344)

PIPER EMPLOYMENT NEWS SERVICE

This service is available to technical schools and colleges offering vocational and degree programs in aviation. The program is designed to assist aviation schools in the placement of graduates and to attract more qualified applicants to the general aviation industry. A bi-monthly listing of employment opportunities within the Piper organization is distributed to placement bureaus and aviation directors at institutions subscribing to the service.

Piper Aircraft Corporation
Lock Haven, Pennsylvania, U.S.A. 17745
TELEX 841412 AREA CODE 717 748-6711
CABLE ADDRESS: CUB

PIPER EDUCATIONAL SERVICES - (continued)

PLANT TOURS

Educators and school groups are welcome to take advantage of the daily guided tours conducted Monday through Friday at the Piper manufacturing facilities in Lock Haven, Pennsylvania and Vero Beach, Florida. In some instances special interest groups may desire presentations on a specific phase of aircraft manufacturing such as engineering or briefings on the general aviation industry.

EDUCATIONAL MAILING LIST

High schools, colleges and technical schools offering continuing programs in aviation may request placement on the Piper educational mailing list to receive periodic information related to aviation education, Piper products, and educational services. Schools requesting this service are asked to complete an information form to insure placement on the proper mailing list.

PIPER DEALER AND FLITE CENTER SERVICES

The most valuable and effective sources of assistance to educational institutions are the services available from over 600 Piper dealers and Flite Centers in the United States and 100 foreign countries. Arrangements can be made for orientation flights, field trips to general aviation facilities, career day presentations, and other programs to acquaint students and teachers with general aviation services. Apprentice mechanic training, work-study and other co-operative programs have been established in many localities.

FOR ADDITIONAL INFORMATION CONTACT:

Air Science Education Department
Piper Aircraft Corporation
Lock Haven, Pennsylvania 17745

SPERRY RAND CORPORATION

SPERRY FLIGHT SYSTEMS DIVISION

P.O. BOX 2529, PHOENIX, ARIZONA 85002 • TEL. (602) 942-2311

The Gyroscope Through The Ages

A twenty-three page brochure on the use of gyroscopes in aerospace vehicles. Includes information on development of the gyroscope, principles of the gyroscope, instrument flying and inertial guidance. (Free)

CABLE: SPERRYFLIGHT PHX • TWX: 602-582-2312 • TELEX. 6-6705

2491

VT 012 102
Basic Firefighting Practices.

Alaska State Dept. of Education, Juneau. Div. of Vocational Education.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - Sep69 156p.

DESCRIPTORS - *STUDY GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *FIRE FIGHTERS; *FIRE SCIENCE EDUCATION; *FIRE PROTECTION; SAFETY EDUCATION; ADULT VOCATIONAL EDUCATION; INSTRUCTIONAL MATERIALS

ABSTRACT - Prepared by the Alaska State Division of Vocational Education Fire Service Training Program in cooperation with the Alaska State Firefighters Association, this manual is designed primarily to aid in preparing volunteer and paid firemen to deal with the practical problems of fire suppression. Sections presenting the fundamental practices and techniques necessary for effective fire scene operations cover: (1) Fire Department Safety, (2) Behavior of Fire, (3) First Aid Fire Extinguishers, (4) Hose Practices, (5) Pumper Operation, (6) Fire Service Ladders, (7) Forcible Entry, (8) Ventilation, (9) Salvage and Overhaul, and (10) Strategy, Tactics, and Pre-fire Planning. Numerous photographs, line drawings, diagrams, and charts are included. The manual may also be used as a guide for fire departments needing a review of basic skills and as an information source for those intending to teach the subject in Alaska. (AW)

VT 012 102

U.S. DEPARTMENT OF HEALTH,
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ED0 56238

Basic Firefighting Practices

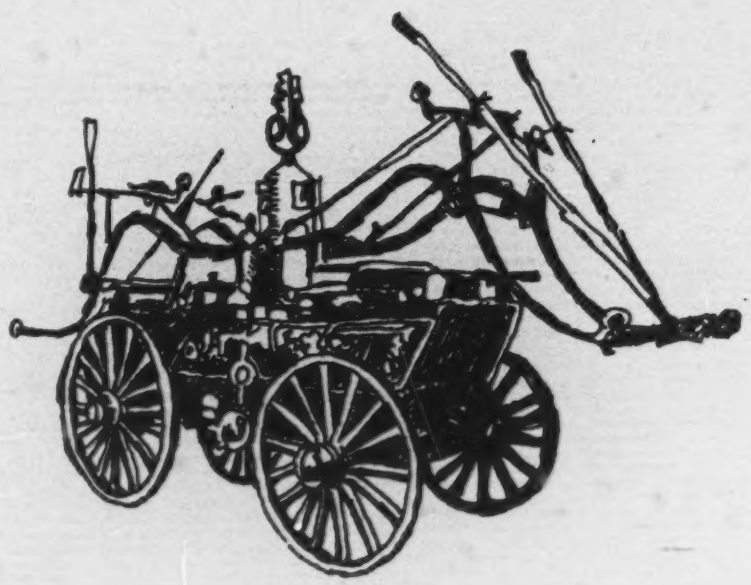

ALASKA DEPARTMENT of EDUCATION
Cliff R. Hartman, Commissioner
DIVISION of VOCATIONAL EDUCATION
Louis D. Ridle, Director

January, 1970

VT012102

2493

To do anything in this world worth doing, we must not stand back shivering and thinking of the cold and danger, but jump in, and scramble through as well as we can. --- Sydney Smith

BASIC FIREFIGHTING PRACTICES

Alaska Department of Education
Division of Vocational Education
Louis D. Ridle, Director
William A. Hagevig, Supervisor
Fire Service Training Program

September, 1969

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FOREWORD

The Alaska State Division of Vocational Education Fire Service Training Program, in cooperation with the Alaska State Firefighters Association, has produced this manual for volunteer and paid firemen alike whose work compels them to meet the practical problems of fire suppression on a day-to-day basis.

Basic Firefighting Practices is a manual designed to teach new firefighters those fundamental practices and techniques needed as a basis for effective fire scene operations.

It is also designed as a simplified guide for departments needing a review of basic skills and as a source of information for those intending to teach the subject in Alaska.

No effort has been made to involve the highly technical aspects of the science of firefighting. Emphasis has been placed on the production of a manual which will be of value to fire departments throughout the State, regardless of size and level of proficiency.

Sincere appreciation is extended to the State Fire Marshal's Office, Department of Public Safety; to Mr. Lyle Goodrich, Supervisor of Fire Service Training for the State of Washington and his staff; and to the many members of the fire service all over Alaska who have provided information, made suggestions, and offered the constructive criticism necessary to the successful completion of this project.

Louis D. Ridle, Director
Vocational Education

William A. Hagevig, Supervisor
Fire Service Training

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FIRE DEPARTMENT SAFETY

Safety is defined as "the state or condition of freedom from danger or risk."

There are many unsafe acts being performed by firemen in their course of operations; some of these are necessary during the performance of their operations at the fire scene; some are foolish acts that cause accidents not only to the person performing these acts but can also endanger others.

Therefore, fire department safety must be given top priority if needless accidents are to be prevented.

Accidents At The Station: Accidents that happen at the fire station are needless; however, these accidents lead the other groups and can be attributed to these causes:

1. Horse Play
2. Lifting
3. Slipping
4. Improper use of power tools
5. Failure to wear proper protective clothing and accessories when drilling or working around the station
6. Poor physical condition
7. Lack of training
8. Inadequate lighting
9. Defective equipment

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8CPS

Accidents Enroute To And Returning From Fire: Accidents going to and returning from fires are next in number to accidents that occur in fire stations. These accidents also can be avoided. Caution should be practiced. The axiom, "Haste makes waste," is just as true here as any place. Some of the common causes of accidents going to and returning from fires are:

1. Careless or fast push out of fire apparatus
2. Failure to maintain complete control of apparatus
3. Excessive speed
4. Failure to proceed cautiously
5. Failure of fire personnel to be alert to their own safety and safety of others
6. Failure to secure safety belts
7. Putting on clothing and equipment on the way to the fire
8. Mounting or alighting from apparatus
9. Arbitrary acceptance of right way
10. Failure of personnel to secure themselves properly to apparatus
11. Failure to halt traffic or properly guide apparatus when backing into quarters

Accidents Occurring At The Scene: Accidents that occur at the fire scene occur less than those at the station; however, these accidents are usually more severe to the person who is hurt. Some of these accidents cannot be avoided; but, with due care and caution some can be avoided. Foolhardiness at the fire scene is not good firemanship but carelessness and should be discouraged by the fire officers of the department.

Some of the leading causes for accidents at the fire scene are:

1. Taking hydrants too fast
2. Dropping couplings on toes
3. Straddling hose ahead of hose clamp or straddling of charged lines
4. Too much pressure on lines
5. Hydrant man turning on hydrant before the hose clamp is in place
6. Moving charged line without shutting off the nozzle

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7. Charging of the line while firemen are taking hose up ladders or stairways

8. Taking charged lines up ladders

9. Kicking hose clamps open

10. Laying hose too fast

11. Improperly secured ladders

12. Improper climbing angle

13. Raising ladders into overhead obstructions

14. Incorrect lifting

15. Lack of protective clothing (coat, helmet, gloves, etc.)

16. Improper use of tools (axes, pike poles, etc.)

17. Not using respiratory equipment

18. Lack of hand lights or flashlights

19. Improperly secured tools and equipment when being raised to upper floors

20. Trying to hurry

21. Poor physical condition

WORK WITHOUT STRAINING

Your muscles, that is. Whether you have a pulled muscle, sprain, Charley horse or a backache chances are you could have prevented it. Anybody who has ever suffered a sprained ankle knows how much pain can come from a ligament stretched too far. Anybody who has suffered from a Charley horse knows the pain of a muscle spasm. Anybody who has cracked his funny bone knows how pain radiates along a squeezed nerve.

Most common source of muscular aches and pains are poor lifting methods. In fact one work injury out of four results from poor handling of materials. Just consider that when you straighten up from a bent over position with a weight, the strain on the muscles, vertebrae, ligaments and discs in your back is 15 times or more the weight of the object.

Follow these four simple rules and you'll find yourself working and playing without strain:

1. Use your strong leg and arm muscles when you lift--not your back. Your back has enough to do just supporting you and allowing you to bend.

2. Gear your activity to your age and physical condition. Physical effort in moderation is an excellent body builder but don't carry it to excess. Stop and rest when you feel the danger signals of fatigue.

3. Build up your muscles--but in easy stages. And don't just concentrate on your biceps; get as many of your muscles as you can into the act.

4. Change your working position as often as you can. If your job is a sedentary and stationary one, watch your posture. Periodically rest the set of muscles in constant use; don't let yourself get tense.

SAFE LIFTING METHODS

Do the following:

1. Inspect load to make sure you can handle it yourself and decide the best way to grasp it.

2. Get a firm footing close to the object to be lifted; feet the length of a shoe apart for balance.

3. Bend knees and crouch down to the object.

4. Keep the back almost vertical and feet apart.

5. Get a good grip.

6. Straighten the knees slowly; rise, keeping load close to the body and directly over feet.

7. Lower load just as you lifted it.

8. Lift the load waist high and rest it on a support to get a better grip before raising it to shoulder height. Bend the knees to give added power for the final lift.

9. Rest frequently when carrying load for a long time. A tired person is more subject to strain, tripping and loss of balance.

10. Stop, reduce the load by making more trips or get help when you feel strain or pull.

11. Grasp sacked material by diagonal corners and swing to one shoulder with a boost from the knee.

12. Take care of muscular aches and pains immediately.

ELECTRICAL HAZARDS

The following statements among others are often offered as explanations by firemen who find themselves in trouble with electrically charged wires. When dealing with electrical power the fireman may never get a chance to tell how the accident happened. It merely happened and the roster of the department is short one man. In view of the dangers, even for experts, in handling electrical equipment and since firemen may be called upon to deal with charged wires at any time, every efficient fireman should be thoroughly familiar with what he may do safely. He should know also that whatever he does must be done with the utmost caution at all times.

When an accident occurs, the victim and often those responsible for it are likely to excuse themselves with statements which are far from convincing. Among the most common explanations are the following:

"But it was the first time.
"Sure, I knew better.
"It slipped and I went over.
"I didn't know the wire was hot.
"I knew it wasn't the right method, but--.
"We have done it that way for many years.
"It was only a low-voltage wire.
"He hadn't been trained.
"The pole was almost long enough.
"I was thinking of something else.
"I thought it was only a telephone wire.
"I didn't know that.
"Why didn't someone tell us--?"

Always assume that all wires and equipment are alive and dangerous and that they may cause serious bodily harm.

Be careful to avoid bodily contact with wires. Do not attempt to handle wires unless properly equipped and trained.

BEHAVIOR OF FIRE

During post-fire discussions we have often heard these remarks made, and we quote, "That sure was a stubborn fire to extinguish" or to the contrary, "We sure knocked that one out quickly." Yet, too often, we fail to hear any remarks relative to why the fire may have been classed as being stubborn or one that was easily extinguished.

In order to clarify such situations, we must have a basic understanding of how a fire starts and the way it travels from its place of origin to adjacent areas. The so-called art of extinguishment and the rapidity with which we can accomplish that particular phase of fire control cannot be exercised properly without first having a basic knowledge of fire itself.

The techniques employed in fire control are based on teachings of firemanship and in one way or another are tied directly to the behavior of fire. Your welfare and the safety of others will be determined by your knowledge of the many complex situations arising from a fire control problem. One of the most important factors to be considered is the behavior of fire itself.

The general concept of fire is based around the familiar triangle where oxygen, fuel and heat are the necessary essentials required to support combustion. With a good understanding of these basic needs we can go into greater detail relative to fuel, its characteristics and many other factors that contribute to fire behavior. Other than the basic factors involved around the triangle of fire, most discussions could be considered as being under the heading of sub-divisions of fire.

Fire is usually caused from the hazards created by people. The title of this subject seems to indicate to the layman or the average worker that we are simply going to discuss how and where a fire might start in a particular place, what to look for or the dangers involved if fire does start.

Basically, these very topics will be covered; but fundamentally, the purpose is to explain how and why fire starts and its reaction once it has started so that you might recognize better those things in your own departments which might cause a fire and so that you will be able to correct unnecessary hazards and learn how to cope with those that are necessary. To function efficiently, a fire brigade must know something of the causes of fire and the conditions under which fire may be expected.

The study of what causes fire is known as the chemistry of fire. Once one learns the causes of fire, the prevention of it is much easier. For that

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reason I will attempt to point out some of the simpler aspects of what happens and how it happens when fire occurs.

Surely we are all familiar with the fire triangle. We realize that in order to have fire, three things must be present, oxygen, heat and fuel. Take away any one of the three and the fire goes out. That, on the whole, is the secret of the suppression or extinguishment of fire. All fires, large or small, are eventually put out in this manner.

Yes, we are all familiar with the triangle of fire andhow it works. We know these things concerning the triangle to be true but do we know why. For instance, use fuel as an example. When one thinks of fuel, he thinks of a combustible material or a material made up of the elements that will ignite when united with oxygen and heat in temperature and quantity.

The combination of a fuel or a substance with oxygen is called oxidation and is continually taking place in all matter. It may occur slowly, such as rust or iron, the rotting of wood or a sliced apple turning brown; or rapidly, and even instantaneously, as in an explosion. As oxidation occurs, heat is given off and when the temperature and quantity of heat become high enough, fire occurs. Fire is a rapidly occurring chemical reaction in which the element, oxygen, combines with other available elements to produce light in the form of visible flame and heat in the forms of high temperatures.

Since fire is a rapid chemical combination between a fuel and oxygen, let's first take up the effect that oxygen has on fire in the fire triangle. It is the oxygen in the air that causes oxidation of all substances which causes combustion. The air we breathe contains about 21% oxygen and 78% nitrogen and a small percentage of other gases. However, it is only the oxygen in the air that is important to fire.

To demonstrate this importance of oxygen to fire one may use a lighted candle and a water glass. As you place the glass over the burning candle, shutting off the outside air, the flame grows smaller and finally goes out. The flame is extinguished because it has used up all of the oxygen within the glass. When oxygen content drops below 15%, combustion ceases. Thus, if we takeaway or eliminate oxygen or one leg of the triangle, fire ceases to exist. The amount of oxygen available is a factor in the length of time the fire will burn. By the same token, if you increase the percentage of oxygen, the fire will burn more violently. For example, an acetylene torch using acetylene gas for fuel and 100% oxygen produces an intense flame.

Certain materials such as plastics, gunpowder, rayon, etc., contain oxygen and burn violently. In other words, when materials such as these become ignited, they give off oxygen which intensifies the flame. Still others may appear as fire safe because they are not a fuel in themselves; but when heated, they give off oxygen and cause surrounding fuels to burn with fury. Naturally, these items should be stored away from combustibles. They will be marked by a yellow I.C.C. tag by the manufacturer. These materials are such things as nitrates, chlorates and peroxides which are used to manufacture items such as fertilizers, dyes and bleaching compounds. Yes, oxygen is necessary for fire to exist the same as it is necessary for life to exist. Take oxygen away from either and it is impossible for them to survive.

2503

Fire's second leg of the triangle is fuel. Without something to burn, there can be no fire. Fuel exists in one of three forms--as a solid, as a liquid or as a gas. Most material can exist in more than one state. Water, which is normally a liquid, becomes a solid, ice, when frozen; or gives off a vapor or gas in the form of steam when heated.

Inasmuch as oxygen is a gas, the fuel must also be in a gaseous state in order for combustion to occur. Conversion of a solid or liquid to a gas can be accomplished by heating the material. This may be explained by again using a lighted candle for an example. By extinguishing the flame and quickly holding a lighted match to the rising vapors, the flame will follow downward until the candle again burns. Burning vapor can be seen by looking closely at a candle flame. Notice the space between the wick and the flame. This is because the heated fuel vapor spreads outward and upward until contact is made with the oxygen in the air and then combustion occurs. This also illustrates the fact that when gases are heated, they expand and therefore rise.

It is important to know that only the vapor burns, not the fuel. In order to burn readily, the vapors must be able to combine with oxygen. The principle fuel elements are hydrogen, carbon and a little sulphur. There are more compounds of carbon than any other element. If the mixture of the vapors and oxygen is unbalanced (as it might be) and conditions are such where there is heat enough to produce a carbon vapor, but not enough oxygen to support combustion, a deadly gas is given off in the form of carbon monoxide. This is nothing more than a product of incomplete combustion. And if these gases are confined, a dangerous condition can develop. For with an admittance of additional air from some external source, a very rapid combustion or explosion occurs. This condition is known to firemen as a backdraft.

The size of the fuel particles also plays an important part in fire behavior. For an example, if one takes a block of wood and holds a match under it, does it catch fire? No. Why? Because the heat from the match is so small that it is dissipated before the large block can provide enough vapor to support combustion. In other words, there is such a small area of the large block exposed to the match, it will not produce vapors enough to support combustion. But if one takes his knife and makes kindling of this block, the match will then readily ignite this fuel. The obvious reason is that there is a much larger area exposed to the heat; therefore, it ignites immediately. The relation of fuel size to burning violence is the reason dust explosions occur. Minute particles of fuel, entirely contacted with oxygen, produce instant combustion when brought in contact with an ignition source.

Another factor that enters into the fire picture so far as fuel is concerned is the area involved. The area of the fuel determines the size of the fire. For an example, use a small can of gas. If you light it, the size of the flame is limited to the size of the can; but if you pour the gas into a larger pan, the area of the fire is much greater. Consequently, the fuel will be consumed much faster. Therefore, the length of time the fuel will burn is determined by the rate at which the vapors can contact oxygen.

The arrangement of the fuel also determines the speed at which it will burn. If you take a match and strike it and hold it with the flame at the top, burning will be slow because the heat rises away from the match. But if you

reverse this and hold the flame down, the fuel is preheated and readily vaporized and is consumed by fire immediately. Yes, fuel is necessary for fire to exist. Remove the fuel from fire and we have no fire.

The third and final leg of the triangle of fire is heat. Perhaps the first thing that should be made clear is the difference between temperature and heat. A degree of temperature is not a measure of volume or quantity. A welding torch flame has a temperature of 5000°; yet you could not heat the room with a welding torch. However, a radiator that can be touched with the bare hand will do an excellent job of heating the room. The reason is that the amount of heat in relationship to the area to be heated is different in each case. In the torch instance, the area to be heated was concentrated in a very small spot. In the radiator example, the heat was distributed over a very large area. Thus, it can be seen that there is a factor involved other than temperature.

Heat is measured by the British Thermal Unit, BTU. A BTU is the amount of heat necessary to raise one pound of water one degree in temperature. In order for burning to take place, there must be a point at which continuing, rapid combustion starts. This is called the ignition temperature. This ignition temperature varies because of certain circumstances such as the surface exposed, the length of time it is exposed to heat, the intensity of heat, etc. When a fuel reaches its ignition temperature, it will ignite. It is not necessary to have a spark or flame present.

Flammable liquids usually produce vapors. The lowest temperature at which a flammable liquid gives off sufficient vapor to support combustion is the flash point of that liquid. Gases do not have a flash point because they are in a vapor state.

Two other factors concerning heat are:

1. When most materials are heated, they expand.
2. When air is heated, it expands, loses weight and rises.

These facts are evident to most of us. Heat will normally flow from a warm object to a cold one. Cold is merely the absence of heat.

There are three ways that heat may be transmitted from its point of origin; by convection, by conduction and by radiation.

During convection heat is transmitted or transferred by a circulating medium. As we know, heat rises. So when fire occurs, the rapidly rising heated gases raise the temperature of a fuel, often far removed from and above the original fire, above its ignition temperature, resulting in a second fire.

Conduction is the physical flow of heat through a material. An example might be seen if one put a key in the flame of a candle. The heat of the candle has moved away from the high heat area to the cold key, causing it to become hot. Different materials have different conductivity so far as heat transmission is concerned.

2505

During radiation, heat is transferred from one body to another by heat rays through space, much the same as light is transferred by light rays. There is no physical movement of the heat itself. An example of how radiation causes fires might be when a wooden box sitting close to a burning stove ignites. Heat is radiated from the stove to the box and contents which heats them above their ignition point causing fire. Thus, heat also plays an important part in fire. Remove the heat from the triangle and there will be no fire.

There are many other ways heat can be produced than by an open flame. Heat can be produced by spontaneous ignition, which is a result of rapid oxidation. Furthermore, heat is produced by chemical reaction--a result of unslacked lime and water, by friction--a result of rubbing belts, etc., by electricity--a result of an overloaded or short circuit, by percussion--a result of explosives, and by compression--a result of compressed gas. All of these causes are self-explaining and time need not be taken at this time to delve into each.

So now we know what causes fire and how it develops. And when we have a better understanding of this, fire prevention becomes much easier.

Because we understand how fire reacts once it starts, we are better able to recognize the hazards that cause fires. Most of the fire hazards in a plant can be removed. They are usually the result of improper construction, poor housekeeping, improper storage of materials, poor installation of machinery, etc. These hazards can be eliminated. Others, such as electricity, inflammable liquids, dust scrap materials, etc. are what we call necessary hazards. We cannot remove them because they are a part of our production within the plant. But <u>we can control them</u> through proper installation, through proper storage and through proper care. They need not become fire hazards. Each and everyone of us know of several hazards in our department which might cause fire. Let's eliminate them and let's control the necessary hazards. Let's not give fire a place to start.

Fire, as we have been taught, is a result of many things; but chiefly, fire is a result of carelessness. To overlook or ignore something that might be a fire hazard or cause a fire in your department, is nothing more than carelessness. No, fires don't just happen, they are caused.

FIRST AID FIRE EXTINGUISHERS

INTRODUCTION

The operation of first aid fire extinguishers is of prime importance to firemen for several reasons. First, extinguishers in many public and industrial establishments may hold the fire in check in its incipient stages. Secondly, firemen, themselves, need to be familiar with the operation of extinguishers since they are very valuable in attacking special types of fires and in reducing water damage. Extinguishers are only as good as the operators using them.

Also, it has become the responsibility of the firemen to recommend to citizens of their communities the best type of fire extinguisher for their needs.

Do not expect to extinguish larger fires than those for which the equipment is designed.

Fire departments should always recommend approved types of extinguishers. Be sure that you recommend equipment approved by the National Board of Fire Underwriters.

CLASSES OF FIRES

So that firemen will recognize and use the type of extinguisher best suited for the type of fire being attacked they must know the classes of fires.

"A" Fires in combustible materials such as wood, paper and trash, material that usually leaves coals and requires removal of heat and quenching to extinguish.

"B" Fires in flammable liquids such as gasoline, oils, paints, fats, greases or other flammable liquids where a blanketing or smothering effect is essential.

"C" Fires that are involved with electrical equipment requiring the use of non-conducting extinguishing agents.

Fires in combustible metals such as magnesium, powdered aluminum, zinc, sodium or potassium make up a fourth specialized class. Ordinary extinguishing agents are ineffective on these metal fires which are best controlled by covering with special dry powder or granular materials which include oxygen and will not react or combine adversely with the metal.

EXTINGUISHERS USED FOR CLASS "A" FIRES

1. Pump can and back type pump can
2. Gas water
3. Pressured water
4. Foam (will not penetrate for extinguishment of deep seated fires)
5. Soda and acid

EXTINGUISHERS USED FOR CLASS "B" FIRES

1. Foam
2. Carbon Dioxide
3. Dry Powder

EXTINGUISHERS USED FOR CLASS "C" FIRES

1. Carbon Dioxide
2. Dry Powder

2508

PUMP CAN AND BACK TYPE PUMP CAN

The water pump can (See Figure 1) and back type pump can come in a number of different sizes ranging from 2½ to 5 gallons. The method of operation is to pump the water to the base of the fire by means of a hand pump which is of the double acting type.

These types of extinguishers have an operation time of 40 to 120 seconds duration depending upon the operator. The effective reach is from 30 to 40 feet.

This equipment can be maintained by anyone. Check the water level often, put a few drops of oil on the pump and check the packing around the pump shaft. Do not overtighten; a slight leakage of water around the shaft is desirable, only tighten the packing nut 1/8 turn at a time--hand pressure only--do not use a wrench. If it is necessary to use a wrench, the shaft needs replacing. A graphite string packing is the type to use. Overtightening makes the pump work hard and tires the operator rapidly. As the water pump can ages and anti-freeze is added from time to time, it may be necessary to remove the pump and clean all working parts including the pump shaft and cylinder and ball check valves. After using anti-freeze solution it is wise to clean the container thoroughly as these solutions are corrosive. To make the equipment last a long time and give good service when needed a little service is necessary.

The water pump can may be filled while in use from any source of water supply and may be used any place where a Class "A" extinguisher is required.

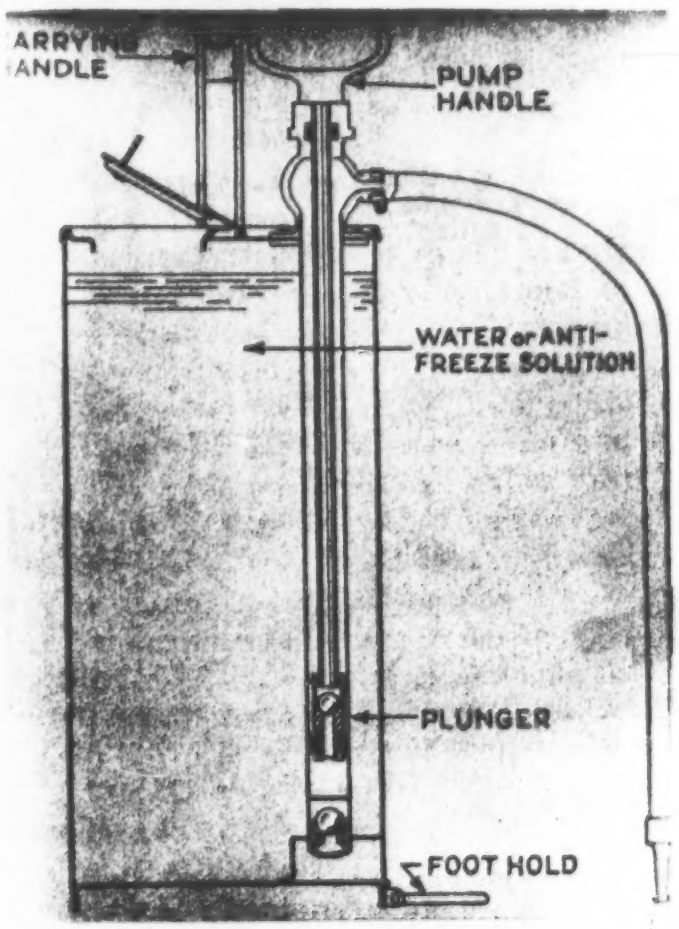

Figure 1

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GAS CARTRIDGE, WATER FILLED

This is an extinguisher (See Figure 2) which uses a cartridge having an inert gas, usually carbon dioxide, which furnishes the pressure to expel the water contained in the tank. It is put into operation by turning upside down and bouncing on the floor, forcing the cartridge to be punctured and causing the gas to enter the container and forcing the water from the extinguisher. Use only cartridge specified by manufacturer.

This type of extinguisher has many advantages. It can be kept sealed and thus the water will remain clean. It can be used in areas where it is subjected to freezing as it can be filled with a calcium chloride solution. It is finding wide acceptance in areas that were formerly covered by soda and acid type extinguishers.

PRESSURED WATER

The pressured water type extinguisher is very similar to the gas cartridge type except that air pressure is used to force out the water from the extinguisher.

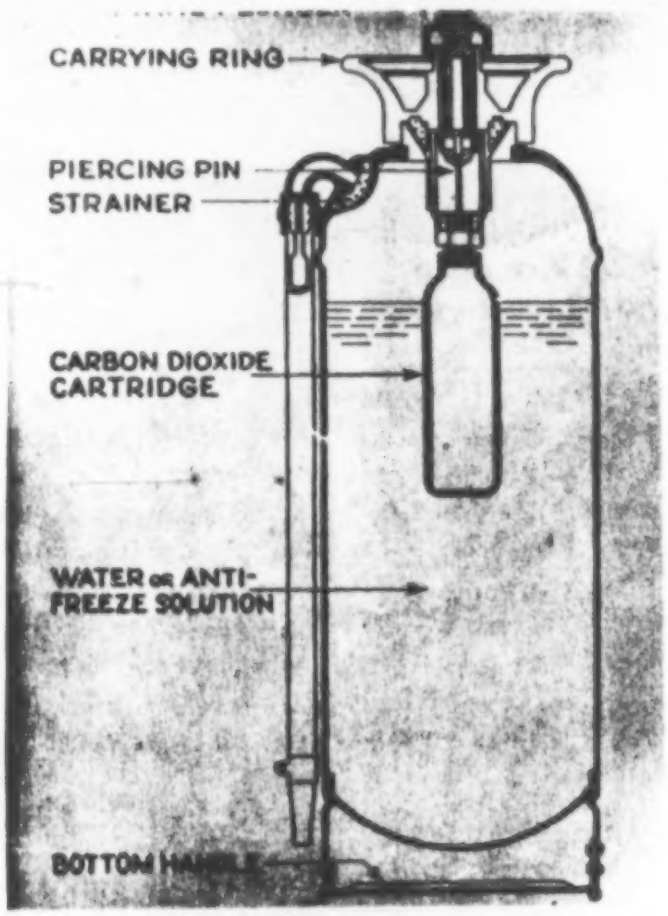

Figure 2

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FOAM

This extinguisher (See Figure 3) is used both on Class "A" and Class "B" fires; however, its best use is for Class "B" fires involving flammable liquids. The outer chamber contains sodium bicarbonate and a foam stabilizer, while the inner chamber contains aluminum sulphate. This extinguisher operates on a chemical reaction theory similar to the soda and acid extinguisher. When the extinguisher is inverted, the aluminum sulphate dissolved in water in the removable chamber is allowed to mix with the foam stabilizer in the outer chamber. With the contact of the two materials an extinguishing agent is formed known as foam. No other chemical should be added to a foam extinguisher as it will nullify the action of the extinguisher.

The application of this foam upon the flammable liquid fire causes a blanket of foam to cover the fire excluding the oxygen and smothering the fire. A cooling effect is also present due to the high moisture content of the foam. The foam extinguisher will deliver approximately 25 gallons of foam for a 2½ gallon type.

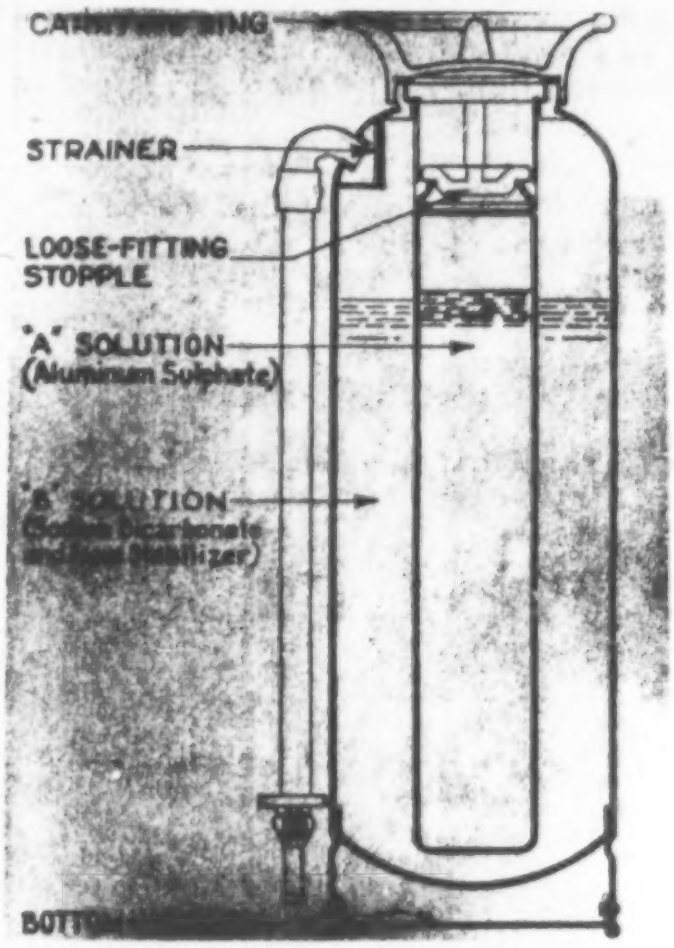

Figure 3

SODA AND ACID

The soda and acid extinguisher (See Figure 4) is perhaps the best known of the many types of extinguishers. It has been used in the fire service for many years and has widespread use on fire apparatus as the expelling agent for booster tank operation; hence, the name of "chemical tank" came into being.

This extinguisher ranges in size from 2½ gallon to 33 gallon capacity. The common 2½ gallon consists of either a brass or stainless steel canister made to withstand the pressure stamped on the label. The 2½-gallon extinguisher contains 2½ gallons of water mixed with bicarbonate of soda and a bottle containing four ounces of sulphuric acid held in a cage at the top of the extinguisher. This bottle has a loose fitting, lead or porcelain stopple which remains in place as long as the extinguisher is in an upright position. To put it in operation the extinguisher is carried to the fire in an upright position. The extinguisher is then inverted with the operator holding the nozzle in one hand and grasping the handle in the bottom with the other. He then plays the stream at the base of the flames.

The soda mixing with the acid forms a CO_2 gas which is the propellant.

The advantage of this extinguisher is the ease and cheapness of maintenance. The pressure generated with a Free Discharge is 60 to 80 pounds which will throw the stream from 30 to 40 feet. However, the discharge time is short, approximately one minute.

The extinguisher should be checked annually and each time it is used for plugged hose or nozzles and leaks. CAUTION, never try to repair a leak in the tank of this extinguisher. Should water fail to be expelled immediately, discard in a safe place as discharge hole could be plugged and extinguisher could rupture violently causing injury.

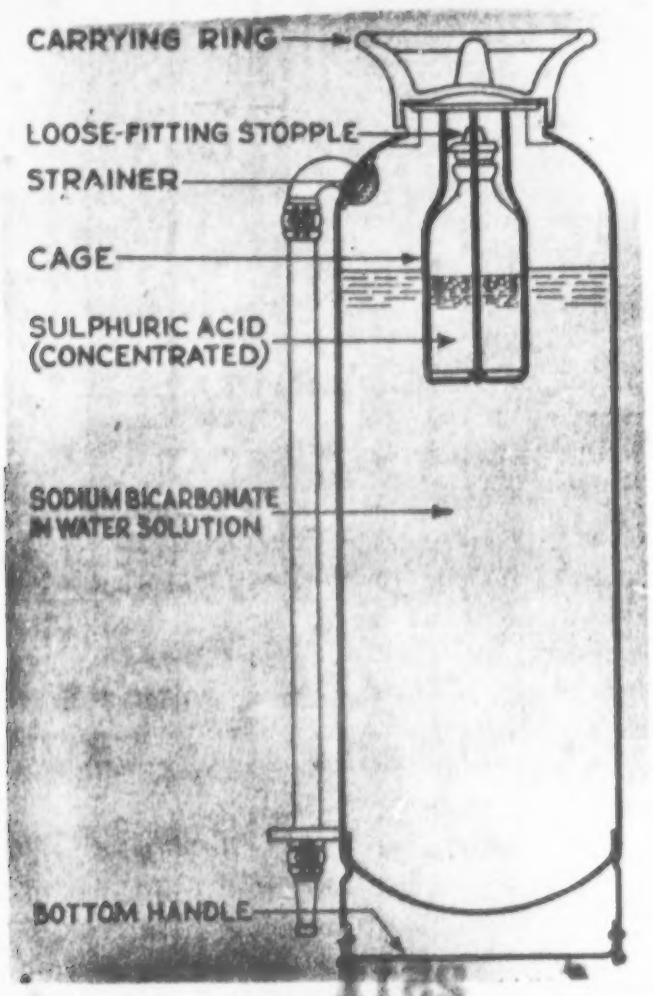

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Figure 4

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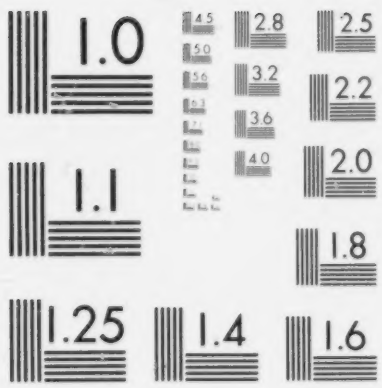

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CARBON DIOXIDE

The carbon dioxide fire extinguisher (See Figures 5a and 5b) is used primarily on Class "B" and Class "C" fires. It is a nonconductor and therefore very suitable for Class "C" fires. The extinguisher is of a sturdily built pressure container in which carbon dioxide is kept in its liquid state under normal room temperature. At 70° F. the internal pressure is approximately 850 P.S.I.

To expel this type of extinguisher a valve or squeeze type release is used and a horn or a hose and a horn are used for applying the carbon dioxide on the fire.

Due to the expansion of the liquid carbon dioxide upon its release at the point of the horn, approximately thirty percent of the CO_2 is converted to "snow" or solidified dry ice. The temperature of this "snow" is approximately -110° F. The gas that is released is heavier than air and when applied will form a blanket over the fire and thus smother the fire. However, caution should be maintained to see that a flashback does not occur. There is little cooling effect and materials that tend to contain heat may cause a flashback where fires are found in flammable liquids of a low flash point rating. A CO_2 extinguisher has an effective range of 2 to 4 feet.

Caution should be used in applying CO_2 in confined areas. It is not toxic, however, it will replace the oxygen in the area. Care should be taken to see that in confined areas oxygen is furnished by ventilation. It is necessary for firemen to use self-contained masks to enter the area.

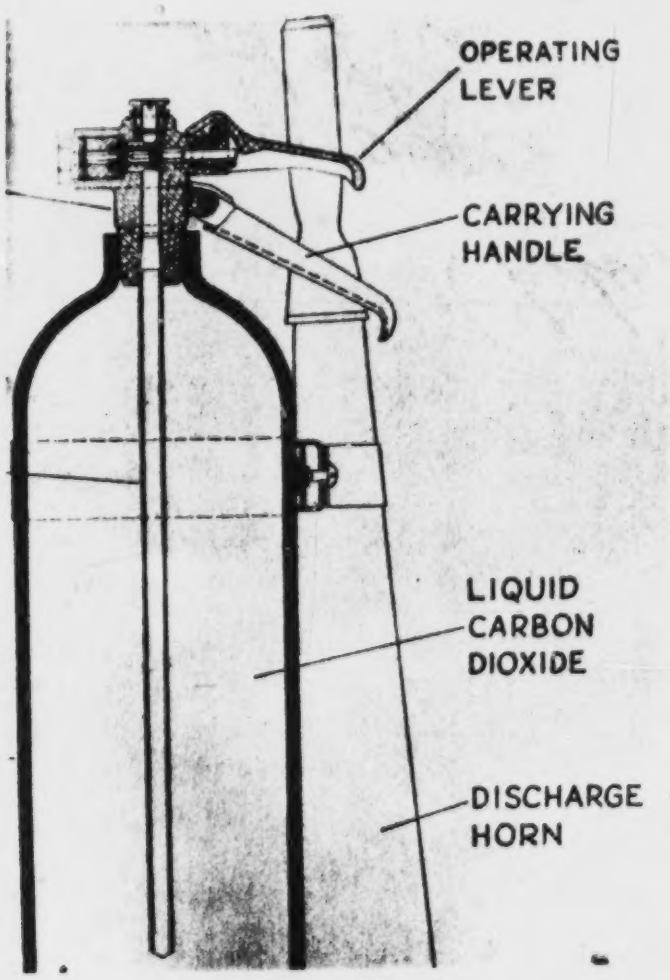

Figure 5a

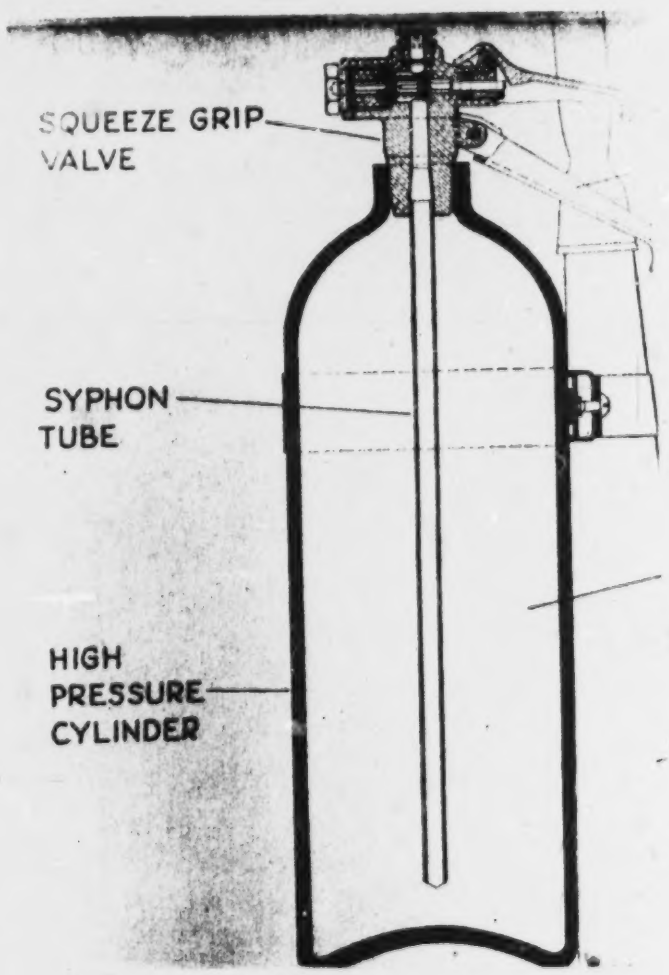

Figure 5b

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SIZE OF CO_2 EXTINGUISHER CONSIDERED ADEQUATE TO USE ON OPEN TANKS OF FLAMMABLE LIQUIDS

EXTINGUISHER SIZE, IN LBS.	GASOLINE & SIMILAR LIQUIDS, SQ. FT.	KEROSENE & SIMILAR LIQUIDS, SQ. FT.	ALCOHOL & SIMILAR LIQUIDS
2 to 3-3/4	1	1	3
4 to 6-1/2	2	3	5
7 to 9-1/2	3	4	8
10 to 14	3	4	8
15 to 29	5	7	13

For tanks inside buildings, because of the difficult approach caused by smoke and heat, portable extinguishers alone should not be relied upon.

DRY POWDER

The dry powder type fire extinguisher (See Figure 6) is used primarily on Class "B" and "C" fires; however, its main use is for flammable liquid fires where its reach and smothering effect is at its best. This type of extinguisher is usually found in the 2½ to 30 pound sizes. The extinguishing principle of this type extinguisher is essentially that of a smothering action. This action results from the fact that the small particles of soda absorb heat and then break down and release carbon dioxide gas and the small particles of soda tend to displace the oxygen around the fire.

The dry compound fire extinguisher consists essentially of a metal shell filled with a specially treated bicarbonate of soda. This soda is treated to prevent its caking and absorbing moisture and to insure a uniform particle size. The dry powder is expelled from the cylinder by the action of a carbon dioxide cartridge, a nitrogen cartridge or air pressure. The extinguisher must be recharged after use. A 10 to 30 pound dry powder extinguisher has an effective range of 6 to 12 feet.

The dry compound type extinguisher has recently been perfected to a point where it has proven very effective in the extinguishment of flammable liquid fires. Some manufacturers have perfected a special type of powder extinguisher that is an adaption of the dry powder extinguisher for use on aluminum and magnesium fires.

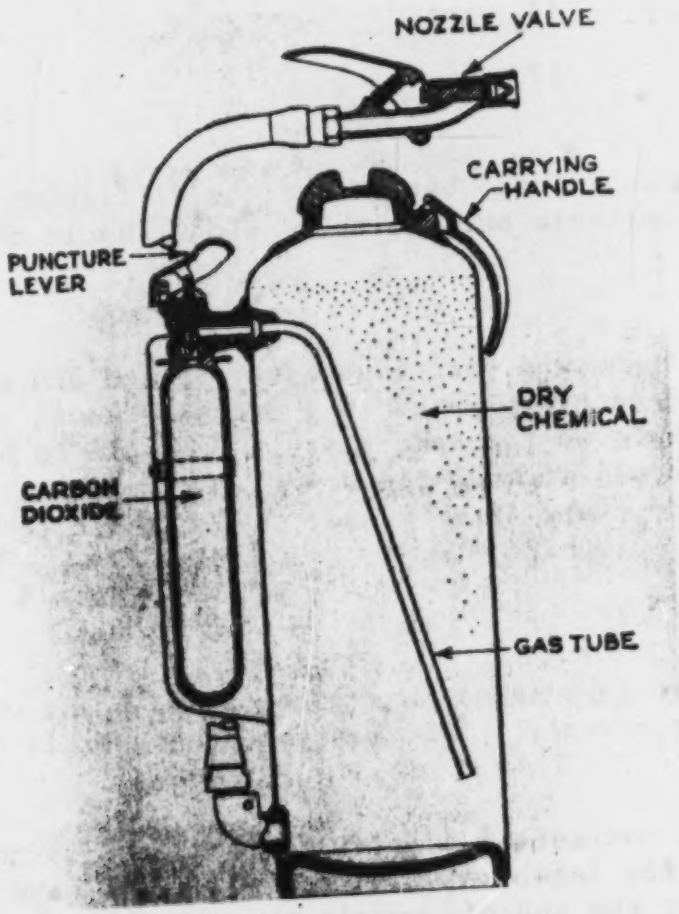

Figure 6

Dry powder extinguishers that are carried on fire apparatus should be inverted once a week to break up any caking that might occur due to the jarring to and from a fire. If the extinguisher is not used within a three-month period, the powder should be removed, aerated and put back in the extinguisher. The hose and nozzle should be checked for plugging.

SIZE OF DRY POWDER EXTINGUISHER CONSIDERED ADEQUATE FOR USE ON OPEN TANKS OF FLAMMABLE LIQUIDS

EXTINGUISHER SIZE, IN LBS.	GASOLINE & SIMILAR LIQUIDS, SQ. FT.	KEROSENE & SIMILAR LIQUIDS, SQ. FT.	ALCOHOL & SIMILAR LIQUIDS, SQ. FT.
4 to 6-1/2	3	4	8
7 to 9-1/2	5	7	13
10 to 14	7	9	18
15 to 19	9	12	23
20 to 24	12	16	30
25 to 29	14	18	35
30 to 34	17	22	35

For tanks inside of buildings, because of the difficulty in approach caused by smoke and heat, portable extinguishers alone should not be relied upon.

HYDROSTATIC TEST

All soda and acid, foam, gas cartridge water filled and pressure water extinguishers should be hydrostated to a pressure equal to but not exceeding the pressure marked on the name plate. Pressure to be held for one minute. The test should include the hose. For safety it is recommended the test be conducted every three years. Hydrostatic test procedure can be found in N.B.F.U. Pamphlet #10.

GARDEN OR JIFFY HOSE

The Class "A" type of fire needs an extinguishing agent which will penetrate and cool the burning material. Of these agents water is the most plentiful and best known.

The garden hose with nozzle and adapter for home use is one of the easiest to handle and needs the least maintenance. You will have a continuous supply of water and by using the shutoff nozzle you are able to control the water damage. With good water pressure the nozzle on spray position can give an effective fog pattern. The reach of the average nozzle in directing a stream of water at a fire is from 25 to 40 feet depending on the water pressure.

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When recommending the use of garden hoses to others, be sure that you specify that they place coil in a place where it is readily available. It should be not less than 50 feet in length.

VAPORIZING LIQUID EXTINGUISHERS

The state fire service discourages the use of this type of extinguisher due to the toxicidity.

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CHARACTERISTICS OF APPROVED FIRE EXTINGUISHERS AND RECOMMENDED APPLICATION

	Carbon Dioxide	Dry Chemical	Foam	Pump Tank	Soda-Acid	Gas Cartridge Water-filled
Class "A" fires Wood, rubbish, paper, textiles	No But will control small fires	No But will control surface fires in textile fibers	No But will control small fires	Yes	Yes	Yes
Class "B" fires Oil, gasoline, grease, etc.	Yes	Yes	Yes	No	No	No
Class "C" fires Electrical equipment	Yes	Yes	No	No	No	No
Capacities and weights fully charged	2½ lb. 20 lb. 5 lb. 32 lb. 10 lb, 15lb 40lb	4-5 lb. 20 lb. 10 lb. 30 lb. 15 lb.	1¼ gal. 20lb. 2½ gal. 35lb.	2½ gal. 40 lb. 4 gal. 50 lb. 5 gal. 65 lb.	1¼ gal. 20lb. 2½ gal. 30lb.	2½ gal. 35 lb.
Normal fire area of gasoline in open tank to be extinguished by non expert operator Maximum Range	2 to 4 ft.	6 to 12 ft.	35 ft.	Not recommended for flammable liquids 30 to 40 ft.	Not recommended for flammable liquids 30 to 40 ft.	Not recommende for flammable liquids 30 to 40 ft.
Discharge Time	15 to 30 sec.	10 to 16 sec.	35 & 60 sec.	2½ - 60 sec. 4 - 95 sec. 5 - 115 sec.	1¼ gal.-35 s. 2½ gal.-60 s.	2½ gal.-50 sec
Means of expelling charge	under 850 psi at 70° temp.	Carbon Dioxide Nitrogen or Air Pressure	Carbon Dioxide formed by Chemical action	Manually operated pump	Carbon Dioxide formed by chemical reaction	Carbon Dioxide cartridge or a pressure
Composition of Extinguisher	Carbon Dioxide	specially treated Sodium Bicarbonate	Aluminum Sulfate, Sodium Bicarbonate & stabilizer	Water or calcium chloride solution	Sodium Bicarbonate and sulfuric acid	Water
Subject to freezing	No	No	Yes below 27°F.	Yes	Yes	Yes
Yearly inspection	weigh annually	check condition weigh	discharge	discharge	discharge	check pressure
Operation	Pull trigger-squeeze	No uniform method	invert	pump	invert	strike knob, press lever, o pump on floor

CONVERSION OF EXTINGUISHER CLASSIFICATIONS

Extinguishing Agent	Extinguisher Type and Size	Old Classification	Approximate Present Classification
Chemical Solution (soda-acid)	1-1/4, 1-1/2 gallon	A-2	1-A
	2-1/2 gallon	A-1	2-A
	17 gallon	A	10-A
	33 gallon	A	20-A
Water	1-1/2, 1-3/4 gallon (pump or pressure)	A-2	1-A
	2-1/2 gallon (pump-press)	A-1	2-A
	4 gallon (pump-press)	A-1	3-A
	5 gallon (pump-press)	A-1	4-A
	17 gallon (pressure)	A	10-A
	33 gallon (pressure)	A	20-A
	5 12 qt. or 6 10 qt. water filled pails; 55 gal. water filled drum with 3 fire pails; 25-55 gal. water filled bucket tank with above 5 or 6 fire pails	A-1	2-A
Loaded Stream	1 gallon	A-2, B-4	1-A
	1-3/4 and 2-1/2 gallon	A-1, B-2	2-A,1/2B*
	33 gallon	A	20-A
Foam	1-1/4 and 1-1/2 gallon	A-2, B-2	1-A, 2-B
	2-1/2 gallon	A-1, B-1	2-A, 4-B
	5 gallon	A-1, B-1	4-A, 6-B
	10 gallon	A, B	6-A, 8-B
	17 gallon	A, B	10-A, 10-B
	33 gallon	A, B	20-A, 20-B
Carbon Dioxide	6 or less lbs. of CO_2	B-2, C-2	1-B, C
	7-1/2 lbs. CO_2	B-2, C-1	2-B, C
	10-12 lbs. CO_2	B-2, C-1	4-B, C
	15-20 lbs. CO_2	B-1, C-1	4-B, C
	25 & 26 lbs. CO_2	B-1, C-1	6-B, C
	50 lbs. CO2	B-1, C-1	10-B, C
	75 lbs. CO_2	B-1, C-1	12-B, C
	100 lbs. CO_2	B, C	12-B, C

NOTE: Carbon dioxide extinguishers with metallic horns will not carry any Class "C" classification.

Dry Chemical	4 to 6-1/4 lbs.	B-2, C-2	4-B, C
	7-1/2 lbs.	B-2, C-1	6-B, C
	10 to 15 lbs.	B-1, C-1	8-B, C
	20 lbs.	B-1, C-1	16-B, C
	30 lbs.	B-1, C-1	20-B,CC
	75 to 350 lbs.	B, C	40-B, C

*NOTE: Portable fire extinguishers with fractional ratings are not considered as meeting the requirements of this section.

BE AN EFFECTIVE NOZZLEMAN

The most important firefighter on the fire scene is the nozzleman. This does not mean that the officers, laddermen and pump operators are not important because they are. Usually however every effort is given just to get the nozzlemen into action on the fire. We know that all other operations are just back-up for the nozzleman for if we didn't supply him with water through the pump the fire would not be extinguished. However in spite of all the good equipment, water system and leadership it is still the actions of the nozzleman in applying water to the fire that will determine how effective the tactics used will be.

It is important therefore that the firefighter has knowledge and skill if he is to be an effective nozzleman. This knowledge and skill can only be achieved through training and actual experience. His experience will however be limited to the number of fires that he works on, therefore training becomes the primary method to teach him the knowledge and skill that he will need if he is to become an EFFECTIVE NOZZLEMAN.

The nozzleman must have an understanding of fire behavior if he is to know the most effective methods for applying water to a fire situation. Besides this knowledge of fire behavior he must also have a knowledge and skill with the tools that he will use with the nozzle.

TYPES OF NOZZLES

As a nozzleman you should understand the many types of nozzles and how they operate. It is just as important to know what the nozzle can deliver and its effective reach, whether it is a solid stream type nozzle or an adjustable type nozzle. There are many variations of the adjustable type nozzle with many different ways of breaking up the water into small droplets of water.

The two basic types however are the nozzle that delivers water in a solid stream and the adjustable type nozzle that has the ability to be changed from a straight stream pattern to a wide fog type pattern.

SELECTING THE RIGHT TYPE NOZZLE

If you desire to apply water in a solid mass with enough kinetic energy to carry it through a strong thermal column and to also reach into a building, then you would select a nozzle capable of a solid stream.

A good solid stream nozzle will be capable of producing the following:

a. A stream that at the limit named has not lost continuity of stream by breaking into showers of spray.

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b. A stream that up to the limit named appeared to shoot nine-tenths of the whole volume of water inside a circle 15 inches in diameter and three quarters of it inside a 10 inch circle, as nearly as can be judged by the eye.

c. A stream that would probably be stiff enough to attain in fair condition the height of the distance named, even though a fresh breeze is blowing.

d. A stream that at the limit named, with no wind, would enter a room through a window opening and strike the ceiling with force enough to spatter well.

THE ADJUSTABLE TYPE NOZZLE

The nozzleman of today has more experience with the adjustable type nozzle than with the solid stream nozzle. This is because with its versatility the adjustable nozzle delivers patterns ranging from a wide angle stream with low velocity to a straight stream with high velocity.

As a nozzleman it is important that you know the mechanics of its operation. The newer type adjustable nozzles give constant flow at all positions. However, it is important that the department check the gallonage for each nozzle to determine that they are capable of the flow desired. The adjustable nozzle operates at about 100 pounds of nozzle pressure regardless of the pattern used. Most new nozzles have marks or notches which serve as a guide to indicate the degree or pattern of the stream. These marks are helpful, but when you are fighting a fire the important thing is not the mark you are on, but whether the fog pattern you are using is correct for the job.

THE NOZZLEMAN SHOULD UNDERSTAND FIRE BEHAVIOR

From your ventilation classes you know that fire usually goes through several stages from its beginning to total involvement. Most fires start with a small flame which may continue until complete involvement takes place.

FLASHOVER

As the fire continues to build up we have a condition called a "flashover" this occurs when all the light materials have reached their ignition point and have ignited. These materials are usually curtains, wallpaper, lamp shades and other easily ignited materials. After the flashover the fire starts to involve the heavier materials and assumes what is known as a "Steady state". That is, the fire has flashed over and has usually vented itself and is now burning quite rapidly. There will be an equal amount of oxygen entering the

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building with heat, gases and smoke being ejected from the building. This steady state will only continue as long as there is this one to one ratio of air entering and smoke, gases and heat leaving. Most firefighters recognize a fire as being in the steady state by referring to it as being in the red. This type of fire will continue until it has burned into the walls and ceilings, thus exposing the structure itself to the fire. When fires reach this state the temperatures will usually run upwards to 1400 degrees. If the fire continues until it has burned through the roof and vented itself this temperature will then drop to about 900 degrees.

Regardless of the condition of the fire the nozzleman should protect himself from the heat. This can be accomplished by adjusting the nozzle to a wide spray pattern and advancing to the point of attack.

THE THREE METHODS OF ATTACK

The nozzleman should know the three methods of attack: Direct, indirect and combination attacks. He should know from the fire situation which method will be most effective.

Using the direct attack method

There are a number of situations that are best handled with the use of either a straight or solid stream attack. If the fire is small and the heat accumulation is low, you will more than likely make a direct attack at the seat of the fire. See figure #1. If the building has already vented itself and you desire reach to get into the fire area, then either the straight stream or the solid stream will be effective. There is one other instance where either the straight or the solid stream is effective and that is when you need either a mass of water or water with enough velocity to carry through the thermal column.

The direct attack water is applied using a straight or solid stream directly at the seat of the fire.

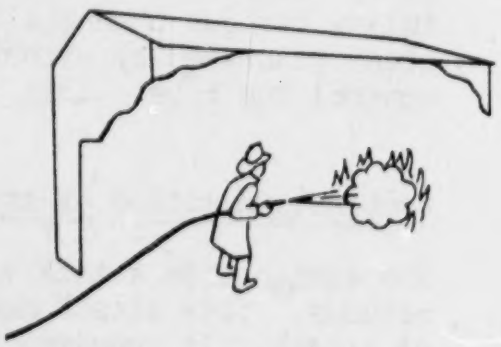

Figure I

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Using the indirect attack method.

An effective method of attack is by using the indirect method where you apply water only to the heated overhead in the involved area. The indirect attack method continues steam production over a longer period of time than either of the other methods.

To apply water by use of the indirect method direct the water into the heated overhead, moving the stream back and forth and changing the pattern as you cover the heated area. This method might be compared to that of painting a ceiling with the water nozzle. An important item to remember in using this method is to reach as far back into the building as possible varying the pattern and then work towards yourself. Figure #2 shows the correct method of applying the indirect attack.

The indirect attack water is applied into the heated overhead.

Figure 2

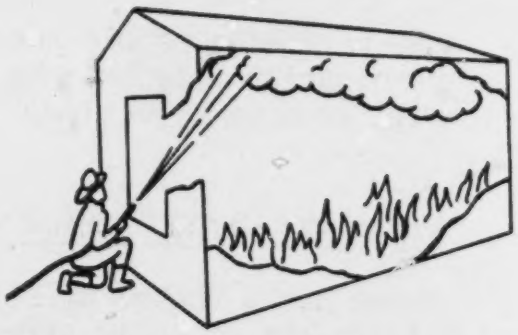

Do not confuse the indirect results with the indirect method. Fire may follow various channels in spreading from one room to another area. The steam generated by either method of attack may follow these channels and control the fire. This is known as an indirect result.

Combination method of attack.

The combination attack is a combination of the direct and indirect attack methods. This attack method has formerly been called the indirect method of attack. It requires that the nozzleman apply water into a heated area and revolve the nozzle in a clockwise method applying water into the heated overhead and also on the burning material. This method will create steam as well as cooling the burning material.

The combination attack is most effective in fires involving one or two rooms. If the attack is made from the outside towards the interior, care must be taken that the application is fast enough and with a large

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enough volume of water to quickly control the fire and to prevent the spread of the fire by underapplication. Figure 3 illustrates the correct method of making this type of attack.

The combination attack water is applied into all parts of the fire area by varying the pattern and revolving the nozzle in a clockwise motion.

Figure #3

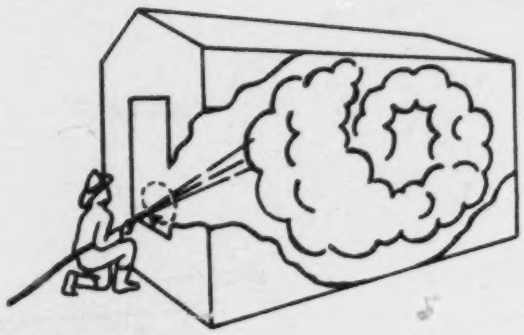

THE NOZZLEMAN NEEDS TO KNOW ABOUT THERMAL BALANCE.

As a nozzleman you will need to know something about thermal balance. What it is and how it can help you. Thermal inbalance will not occur too often but when it does occur you can be sure that the water being applied is not reaching the fire.

Thermal balance then is when an equal amount of air enters the building with an equal amount of gases, heat and smoke being vented out of the building. See Figure #4.

This room is in thermal balance. Air moves in at the bottom while products of combustion move out at the top in a one to one ratio.

Figure #4

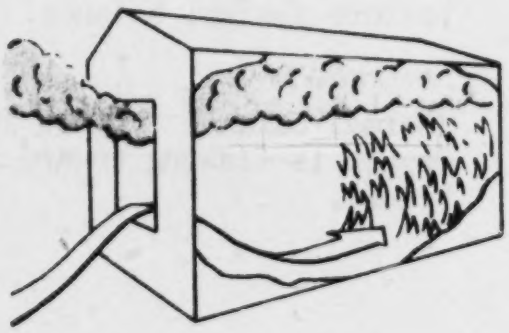

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This thermal balance can be upset by the application of water into the fire area. See Figure #5. What you will see is a cutting off of visibility when the gases, smoke and steam swirl past the opening where water is being applied.

Figure 5

Improper application - use of wide fog at opening. Upsets thermal balance.

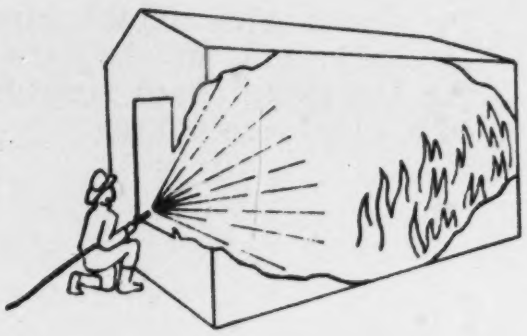

Figure 6

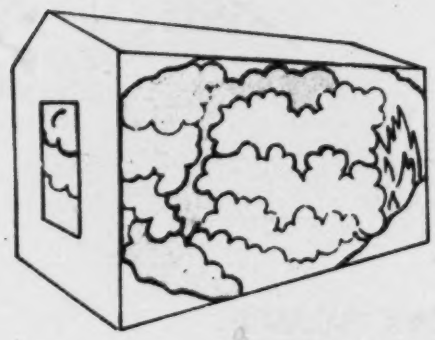

Effect of improper application--a mixture of smoke and steam rolls downward and toward fire. Doesn't actually rea fire which is burning at back of room.

See Figure #6. What caused this change to take place? The hot air gases and smoke are lighter than the cold air. If the products are left undisturbed the products of combustion will be evenly distributed at the top and the cooler air will be at the bottom. Then when you hit this atmosphere these products of combustion cool and cause a circulation of fire gases and steam which revolves from the top to the bottom of the area. This is caused because the application did not reach the fire area and it continued to burn, pulling additional amounts of air as was needed to keep it burning. If the nozzleman will note the direction the swirl is taking, and point the nozzle in a straight or solid stream pattern towards the area that the swirl is pointing to, he can apply water into that area causing the problem and restore thermal balance. See Figure #7.

Thermal balance - cloud is smoke. Oxygen is flowing toward fire from below.

Figure 7

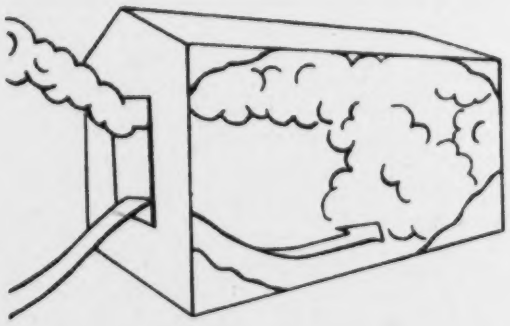

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Thermal balance will not be upset in most fire situations if the proper nozzle pattern is used along with the right size nozzle. If you cool the room evenly, the resulting air currents will ventilate the area.

What is the result of over-applying?

Do not over apply the water. If you do you will cool the area down too much and kill the steam blanket. The time to shut down is when the fire has been blacked out. This will take from ten to thirty seconds of application dependent upon the gpm nozzle used. Move in as soon as possible to prevent the fire from building back up. You will have about four to five minutes before the heat will build up enough to restart the fire.

WHEN SHOULD YOU MOVE IN ON A FIRE?

If the officer determines that the building is safe it is important that you move into the building at once. If you can stand the heat on your face while standing then you should be able to move in by staying close to the floor where there will be less heat and smoke. You should use short bursts of water in a straight stream pattern on those small fires that you see. Using wider patterns might tend to create steam in the area you will be working, thus making the area uncomfortable for working. Care must also be taken not to block the doorway when entering in order to allow all the fresh air possible to enter the fire area.

Many times you can leave a small flame, that is not hurting anything and that cannot blossom into a larger fire, burning as you enter the area, thus using it to help draw air into the area you are working.

You should not spend so much time on small fires after entering. Get as far as possible into the fire area to knock down the larger fires and pick up the smaller fires when you overhaul.

Short bursts of water directed into the heated area can also be used to help reduce the temperature so that entry can be made.

Remember not to apply water into an area from the outside if nozzlemen are working the fire from the interior. Water with its intrained air has a tendency to move fire, heat, gases and smoke ahead of it, also there is a possibility that the steam that is created will either trap the interior nozzlemen or drive them out of the interior.

The effective nozzleman is the firefighter who has the knowledge and skill gained from training and experience and who can apply these efficiently to a fire situation in such a manner that he will get the best results. In the final analysis it is the nozzleman who is the key to the attack.

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HOSE PRACTICES: The techniques and methods used by firemen during drills and at fires consist of certain basic operations or practices which are applied according to the problems encountered. These basic operations have a three-fold objective:

1. Speedy and efficient extinguishment of the fire.
2. Safety to men and equipment.
3. Conservation of energy and manpower.

The Division of Vocational Education is presenting the following basic operations and practice procedures in the hope it will improve the hose work in your department and teach methods to lessen the work involved.

Emphasis is being stressed on "carrying hose"--loading it directly on the shoulder from the hose bed--instead of dumping it on the ground, then dragging or having to pick it up again.

DESCRIPTION OF EQUIPMENT:

FIRE HOSE: Most hose used by fire departments is double-jacketed cotton 2½" and 1½" hose with some 3" and 3½" diameter hose used for special purposes. Other types used by fire departments are:

2. Rubber lined with rubber cover such as chemical or booster hose.
3. Unlined linen hose.
4. Hard suction hoses of different sizes reinforced with steel coils for drafting water.

FITTINGS: Hose work will require the use of special fittings to get the desired layout, the same as a plumber will need fittings to distribute the water supply throughout a building.

Hose accessories most used are:

1. double male couplings
2. double female couplings
3. reducers and increasers
4. adapters for different hose threads
5. hydrant gates
6. gated wyes
7. siameses
8. wrenches and spanners

HOSE CLAMP: The hose clamp is one of the best tools a fireman has for the conservation of energy and manpower. It enables a fireman to get the hose line to the base of the fire without having to strain himself getting a charged line to the fire, instead, by carrying the dry hose on his shoulder, letting it flake off, and at the call for water, the clamp opened to give him water.

Several points to be remembered in the use of the hose clamp are:

1. When clamping line behind the apparatus, place the clamp 20' behind the apparatus.
2. Place the clamp near a coupling (about 3 feet) but not so near that you will have to lift the clamp and a charged line in order to attach the other hose.
3. Be sure the hose is in the center of the clamp before shutting down.
4. When opening the clamp on a charged line, open the clamp slowly so as not to cause water hammer in the hose or not to injure the firemen holding the hose and nozzle.

HOSE BELTS: The hose belt is a device made to assist in heeling hose lines, carrying up a fire escape or ladder, anchoring hose lines to a ladder, stair rail, etc. The type most commonly used consists of:

1. Leather straps; for the body loop and tail piece.
2. Metal parts; buckle, ring, spanner snaps; ladder hook and split link.

NOZZLES: The manufacturers have many types of nozzles being made today. The firemen should learn all they can about each different nozzle such as the best operating pressures, reach, gallons of water used per minute and the proper operation of the control valve.

The firemen must learn to select the proper nozzle for each fire; for instance, using too large a nozzle on a pre-connected 1½" line can empty the booster tank quickly, while at the same time with adequate water supply the nozzle should be adequate discharge to blacken out the fire. Manufacturer's equipment catalogs will give much information in regard to equipment and its use.

LADDER ANCHORS: Firemen working on ladders should be acquainted with the safety features provided by using ladder anchors. A properly anchored ladder will not slip if left unattended and should hose streams be operated from the ladder the anchor will counteract the reaction of the nozzle tending to push the ladder out from the building.

MAKING AND BREAKING COUPLINGS: Basically, all hose work consists of making and and breaking couplings, attaching nozzles, etc. Frequent drills and practice are essential so that this work will be a "natural". Firemen should instinctively know which way to face a coupling (female coupling wears a skirt), which way to turn (turn to right and push down) and whether gasket is in place.

To break a coupling, straddle the hose, facing the female coupling, lift up and hold between legs, grasp the hose beyond the coupling with the left hand and with the right hand turn the swivel to the right, using the thumb to engage the coupling lug for a grip.

To make up a coupling, straddle the hose facing the male coupling, lift up and hold it between the legs, grasp the hose beyond the male coupling, bring them together and with the right hand turn swivel to the right.

To put a nozzle on a section of hose, grasp nozzle with right hand and male coupling with the left hand, then lay barrel of nozzle across thigh (pointing down about 45°) bring them together and turn to the right. For nozzles with leather grips and ladder hooks, it may be advantageous to steady the left hand holding the male coupling against the left thigh and hold the nozzle in the right hand at about a 45° angle. Bring connections together and turn to right. If you want to make the nozzle tighter, place foot on hose just behind male coupling and twist the barrel.

To take off a nozzle place your foot behind the coupling and twist loose with the barrel of nozzle, then lift up nozzle and untwist nozzle same as you put it on.

DIVIDED HOSE BED

One of the most efficient methods of loading hose is to use a divided hose bed for the 2-1/2" hose, with one side being loaded for forward lays and the other side for reverse lays. This arrangement will practically eliminate the use of reverse couplings and prove very adaptable for extension of hose line, using the already flaked hose for "shoulder carrys."

Each side is loaded with the accordion load with the couplings started at the back of the hose bed. The right hose bed is started with the male coupling at the rear of the center dividing board and finished with the female coupling at the top of the load. This side is referred to as the forward load.

The left hose bed is started with the female coupling at the rear of the center dividing board and finished with the male coupling at the top. This side is referred to as the reverse load.

The split or divided hose bed has advantages in that two lines may be laid at one time and when the nozzle is carried attached to the male end of the reverse load, it speeds up laying lines from the fire to the hydrant. By attaching reverse couplings on the starting couplings at the bottom of each load, it is possible to attach the hose from the top of the other side for continuous lays (either forward or reverse lays) which would require the double load of hose.

When lines are laid from the hydrant to the fire and especially when the apparatus cannot get close to the fire, hose from the reverse side (nozzle attached) can be carried to the fire location without guessing how much hose is needed, as the men keep going until they reach the fire, then the man at the apparatus connects the forward and reverse hose lines together. Special couplings will not be needed.

Another advantage of the divided hose bed is apparent when it is necessary to change the hose on the apparatus. Hose can be removed from one compartment and new hose loaded and all during the process the apparatus is available for fire service with at least a half load of hose.

MARKER LOAD

This is simply the accordion load carefully loaded with regard to the location of the couplings. As the flakes of hose are arranged in the apparatus care is

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taken to locate the couplings within two feet of the rear of the hose bed and placed so that the couplings will not have to turn around when the hose is being played off the moving apparatus. Every flake of hose (laid in the hose bed) that contains a coupling is made about four inches longer than the rest of the hose flakes.

These marked flakes of hose are definitely advantageous to the pump operator in estimating hose "laid in" from apparatus and is a definite help in taking off a specific amount of hose from the apparatus, as the fireman simply counts off the long loops, one for each section of hose desired, pulls the loop about two feet, breaks the coupling, then lifts the hose out of the bed. It is then free and clear and the fireman does not have to put down the hose, break it, then pick it up from the ground.

LAYING LINES WITH APPARATUS

Use of the divided hose bed provides many quick and easy methods of laying lines at a fire. The firemen's rule "never pass the hydrant and never pass the fire" can be used to greater advantage.

1. Single Line Forward: This lay consists of laying a line of hose from the hydrant to the fire. Where hydrant pressure and flow are adequate to produce good "gravity" streams, the straight lay has an advantage. The fire truck may then remain at the fire and the equipment carried thereon is available for immediate use.

2. Double Line Forward: Where hydrant pressure and flow are known to be good and the fire requires two lines, these can be laid at the same time from the divided hose bed. Use of the double female at the hydrant and double male for a nozzle will be required on the "reverse" hose lay.

3. Single Line Reverse: In situations where the company gets to the fire before a hydrant is reached or in areas where gravity lines are weak due to low flowing pressures, the pumper must be connected. The reverse lay is good practice because it places the pumper at the hydrant immediately after the line is laid.

4. Double Line Reverse: Should the fire require two lines, another nozzle and a double male coupling is attached to the top of the forward hose bed. It is then possible to lay two hose lines at the same time. This operation is especially good where hydrant flow pressure is low. As the pumper is connected to the hydrant, it is desirable to lay two lines in the first operation and thus save laying lines by hand.

5. Forward Lay and Reverse Overhaul: This lay is used when it is impossible to drive the apparatus close enough to the fire to complete a straight lay, or when the lay from the point the apparatus stops is difficult to estimate, such as with a lumber yard fire where the lay is around piled lumber or inside hallways and stairs.

If the apparatus has a double bed, the hose from the hydrant would be clamped and broken and the extension made with the hose from the reverse side of the hose bed which has nozzle attached. When enough hose has been removed, the

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hose would be broken and attached to the line from the hydrant. It will be noted that double male and female couplings are not needed.

HELPFUL SUGGESTIONS

1. It is good practice when making a reverse lay to send one man to the hydrant with the driver. This is especially true when the pump is to be used. Remove such equipment from the truck as will be needed before it leaves the fire for the hydrant.

2. In laying lines at a fire the hose should be laid close to the curb on the same side of the street as the hydrant which will permit other apparatus to lay to the fire without driving over the hose.

3. On forward lays the apparatus should be driven a short way (50') past the building before stopping, so as not to block other companies coming in.

4. When laying a line for a long overhaul into a lumber yard, dock or across lots, the driver should swing the front end hard away from the fire which will turn the back of the apparatus toward the fire. This will give a much better position for the hose to pull out and is helpful, especially when short of manpower.

5. When responding to alarms and there is a possibility that a line might be required, the line should be laid and charged to the hose clamp. This operation serves the purpose of moving the hydrant closer and makes the hydrant man available sooner. This operation is especially good to back up a fire even though it might be extinguished with a booster line from the truck tank.

MAKING A HYDRANT

Standing on the tailboard of the apparatus the hydrant man grasps the hydrant wrench in the hand closest to the hydrant. The end of the hose with the female coupling is grasped in the other hand.

As the rig approaches the hydrant and slows down, the hydrant man leaves the tailboard of the truck (be sure to face the direction the apparatus is traveling as you can't run backwards). Taking the hose and wrench with him, he proceeds around the outside of the hydrant, holding the hose low, making a snub around the hydrant. Step on the end of the hose that is snubbed around the hydrant and loosen cap on hydrant, facing the fire with the wrench and then place wrench on the operating nut. Finish removing cap, unwrap hose from around hydrant and attach to outlet. Straighten hose and turn on water. Be sure to open the hydrant fully, otherwise the drain valve may be partly open, undermining the hydrant.

For safety reasons, the driver must make sure the hydrant man has secured the hydrant before going ahead. The hydrant man should be trained never to stand in front of hose port caps when removing them nor when opening the hydrant. Remember, the hydrant may be "loaded" or the threads of other caps or the hose may be defective and blow off.

2531

HOSE CARRIES

The use of hose carries in extension of fire fighting lines will eliminate much confusion and needless work. When hose is to be carried to the fire, what is gained by pulling hose on the ground and then picking it up? Why not pull the hose off in such a manner that the flakes stay on the shoulder and still peel off the top when all the slack is drawn out?

When taking hose from the apparatus, put on nozzle (if not already carried attached on the reverse side) pull 50' of hose about half out of the hose bed. Then approaching the load from the open side of the hose bed, turn facing the rear, put shoulder under flaked hose and step away from apparatus. The second man on the load steps in and does the same thing. (This operation could be repeated as many times as there might be men available to carry hose.) When enough hose has been removed from bed, then all men will proceed to fire, the hose will play right off the top of the shoulder load as the line draws tight.

PICKING UP AND LOADING

After the fire is completely out the company shall be put back into service as soon as possible. As only a limited amount of 1½" hose is carried on the apparatus, this should be loaded first.

First one man goes down the hose line breaking all couplings and laying the ends toward the curb so the water will drain away from the hose. Then the hose is picked up and drained in one operation. If working on level ground, start at the coupling furthest from the apparatus, or if on a grade, start at the highest level. It will not make any difference whether the starting coupling is male or female.

Start by placing the coupling in front at about hip level. The fireman then flakes the hose up over his shoulder and down his back until he can touch it with his heel (about a foot above the ground). With about three or four folds on his shoulder, the fireman ends up with both couplings in front of him and proceeds to apparatus. He then determines which coupling is to go into the hose bed, then lays down the hose from either the right or left side so that the proper coupling is toward the apparatus.

Reloading while still at the fire is particularly advantageous for radio equipped apparatus as equipment can be ready for service while still standing by and overhauling. After returning to station, wet hose must be removed and replaced as soon as possible. Equipment will be in service quicker by reloading at the fire as lines are released. Time consumed in loading will be little more than if hose was drained and rolled and stacked on equipment for return to station.

REMOVING EXTRA HOSE FROM APPARATUS

Sometimes it is necessary to remove additional hose from apparatus, such as replacement of burst section, extension of existing hose lines, putting another line to the wye, etc. The following methods, if followed, cut down wear and tear on the hose, dragging couplings and save lifting hose from the ground.

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Third man (if any) does the same thing.

If it is necessary to advance the hose line across the roof or down a hall after it has been carried up a ladder, proceed as follows:

As the first man reaches the top of the ladder, he steps over the hose, turns around, reaches down, pulls up slack and reloads on his left shoulder. As the second man reaches the top of the ladder, he feeds the hose to the first man, then he steps over the hose, turns around and pulls up slack, loading on his left shoulder.

Last man up the ladder feeds hose to the man ahead, then snaps the tail of his hose belt to the rung of the ladder and steps inside.

The men with hose on their shoulders turn around, dropping one-half of a flake, head toward fire, allow hose to peel off shoulder as slack is drawn up tight.

3. When a dry line is to be taken up a ladder without belts, the men carry sufficient flakes of hose to the bottom of ladder, then the first man picks up hose under right arm 4' from the nozzle, brings hose across chest, lays nozzle over his left shoulder so that nozzle hangs down back.

Second man picks up the hose 25' to 50' behind the first man, places the hose on his right shoulder and climbs the ladder with a loop of hose hanging in front of him and outside the right side of the ladder.

Third man (if any) carries hose in the same manner.

If hose is to be stretched across floor or roof, each man will step off the ladder over hose and reload in flakes on his left shoulder. The man with hose on his left shoulder turns around, drops a half flake and allows the hose to peel off his shoulder as the slack is drawn up tight.

OPERATION OF NOZZLES

The man at the nozzle is the director of the fire stream and the men assisting him should be holding or heeling the line in such a way that the nozzleman may devote all his efforts to directing the fire stream.

In operating hand lines the pipeman positions himself on the right side of the nozzle, picks it up, keeping the hose under his left arm and his right hand on the control valve. The backup man positions himself behind the pipeman, wraps his inside arm around the hose, passing his hand under the hose and grasps the wrist of the other arm. He then grasps the hose with his free hand.

Often too little attention is paid to the manner in which controlling nozzles are opened and closed. If a line of hose is under high pressure and the nozzle is opened too quickly, the line may whip away from the men and do damage. On the other hand, if a stream is flowing through a line and the nozzle is closed too quickly, the water hammer or ram, may burst the hose, blow off a coupling or do other damage.

DUTIES OF THE CREW MEMBERS

Whether a department is manned by volunteers or paid firemen, there is a certain amount of work which has to be done. Basing an engine company crew at four men, let's analyze the work and see what the duties of the crew would be.

First, there must be someone in charge, a boss; he might be the Chief, a Captain, a Lieutenant or a fireman acting as an officer. His duties upon arriving at the fire are to decide what is to be done. For this reason, he takes second place on hose lines so he can see where the line is being taken and also watch the hydrant man and driver to see if they are encountering difficulties. In the order of importance and for the purpose of identification let's call him No. 1.

The next man needed is a driver to drive and operate the apparatus. His duties after locating the apparatus are to put on the hose clamp, then any work or making and breaking of couplings that is to be done at or near the apparatus. For purpose of identification he is called No. 2.

The next man needed is a hydrant man. His primary duty is to get the hose on the hydrant and get water. For purpose of identification he is called No. 3.

Finally, a pipeman or nozzleman would be needed. He has one basic job; to get the nozzle into position to hit the fire. For the purpose of identification he is called No. 4.

Looking at a piece of apparatus the position of the men becomes obvious.

No. 2 The driver's spot is at the wheel.

No. 1 The officer is on the side where he can direct the driver and men on rear of apparatus.

No. 3 Hydrant man on right rear which is forward side of double bed.

No. 4 Pipeman is on left rear to take nozzle.

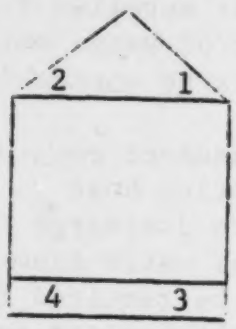

With a fixed or paid crew , the men could be assigned positions with duties accordingly.

With volunteers, the men taking the positions shown would automatically be expected to do the work assigned to these positions. If more men report, they could be used for hose extension, ladders, salvage work, etc. If fewer report, those present would have to advance work until completed or others arrive to help.

BOOSTER TANK OPERATIONS

The increased use of booster tanks, both in rural and city departments, has shown the need for better understanding of their capabilities and limitations.

1. When hydrants are available, even though the fire is to be fought with a booster line, it is good practice to lay a line from the hydrant to the pumper at the fire even though the line is not charged.

2. When the fire is located off the highway or road, making it impossible for more than one piece of apparatus to maneuver, lay a hose line from the highway to the fire with a hose clamp at the highway. Other apparatus with booster tanks can pump their water into the first booster tank without having to get off the road. By clamping the line the second apparatus is free to go after more water.

3. When more than one company (with booster tanks) responds in an area without hydrants, the first company should attack the fire with booster or 1½" line. Other companies arriving should concentrate on keeping the tank of the first apparatus full. Instead of tying up both pumpers with fire fighting lines, the second company should attach their fire lines to the first pumper. These second companies then either lay a hose line to a hydrant or other source of water or empty their booster into the first tanker and run a shuttle service for water supply.

It should be understood that the average rural apparatus has a 500 to 750 gpm pump while the average booster or 1½" hose stream needs from 15 to 80 gpm. It is apparent, therefore, that this first pumper could handle about 8 to 10 lines without any effort.

However, it must be remembered that in operations where flow of water to the pump is supplied from a tank that the pump discharge will be limited to the amount of water which will flow to the pump. This makes it desirable to have large connecting pipes from the tank to the pump.

4. Whenever one tanker is pumping to another, it is desirable to attach 2½" connecting hose to the intake of the pump supplying the fire lines, rather than to discharge the water into the booster tank. This will make all the flow of water from both tanks available for fire fighting. Should less water be required for fire lines, the water from the second tanker will refill the booster tank of the first pumper. Operators should be prepared to close the tank valve to prevent overflowing when tank is filled. When the second tanker is empty, the tank valve will be opened and the connecting line clamped. The second tanker can then go for more water.

5. It should be remembered that in any pumping operation the friction loss in the intake line is equal to the corresponding friction loss in the discharge lines. Therefore, when a long hose line is supplying water at an appreciable GPM, a second pumper must be connected into the line as close to the hydrant as possible to overcome this friction loss.

6. Remember to close the valve from the booster tank to the pump when operating directly from a hydrant or when drafting water.

2536

HOSE PRACTICES,

Drill No. 1 Four men flake 150 feet of 2½" line for inside stairway and then lay the line reverse to pump at hydrant.

Operation:

No. 2 Stops apparatus in front of building.

No. 1 Gives command: "Reverse lay through pump, 150 ft. of play hose and size nozzle."

No. 4 Pulls the pipe (which is attached) and 50' of hose half out of reverse bed, turns back to apparatus, pulls hose clear, keeps it on shoulder and steps away from apparatus.

No. 1 Then steps in and takes a 50' shoulder load in the same manner.

No. 3 Pulls 50' of hose on the ground and gets back on the apparatus.

No. 1 Turns and grasps hose coming out of bed, braces himself and kneeling on hose, gives order to proceed to hydrant.

No. 2 and No. 3 Proceed to hydrant where No. 3 connects soft suction to hydrant while

No. 2 breaks the line and connects it to discharge side of the pump.

No. 4 and No. 1 Proceed to building, stretching out slack hose as they proceed, letting each flake of hose peel off as they proceed through stairway.

(No. 4 keeps hose on shoulder until No. 1 has unloaded and stretched out).

No. 3 After assisting No. 2, proceeds to nozzle, straightening out kinks.

No. 2 Opens discharge valve at call for water.

2537 2538

Drill No. 2 Four men lay line forward from hydrant to building, then take 150' of 2½" line up a ladder and across a roof or through a building.

Operation:

No. 3 Takes the hydrant, gives water as soon as possible and advances to the hose clamp.

No. 2 Lays the line with apparatus just past the building, stops, puts on hose clamp.

No. 4 and No. 1 Remove ladder from apparatus, carry it to position on building and raise ladder (assisted by No. 2 if necessary).

No. 4 Takes nozzle and 50' of hose from reverse bed, carries it to base of ladder.

No. 1 Takes another 50' to the same place.

No. 2 Takes off 50' or enough to reach and carries to base of ladder.

No. 4 Picks up hose line under right arm, across his chest and lays the nozzle over his left shoulder and climbs ladder.

No. 1 Picks up hose just ahead of next coupling and climbs ladder with hose on right shoulder.

No. 3 Advances to ladder from hydrant and picks up hose the same way and follows No. 1 up ladder.

No. 4 When he reaches top of ladder, steps over the hose, turns around, reaches down, pulls up slack and reloads on his left shoulder.

No. 1 Feeds hose to No. 4 when he reaches top, then he steps over the hose, turns around and pulls up slack, reloading on his left shoulder.

No. 3 Feeds hose to No. 1, then he snaps tail of hose belt to rung of ladder and steps inside or on the roof.

No. 4 and No. 1 Proceed to fire, allowing flaked hose to peel off shoulder.

No. 3 Follows on to fire.

No. 2 Breaks forward and reverse lines, connects them together and at the call for water, opens the clamp.

2538 1237

Drill No. 3 Four men lay two lines with apparatus forward from hydrant to building.

Operation:

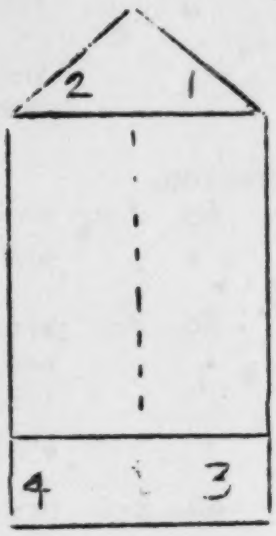

No. 1 Gives order to lay double header.

No. 2 Stops apparatus at hydrant.

No. 3 Takes the hydrant with the forward line,

while

No. 4 Removes the nozzle and takes the hydrant with the reverse line and a double female and gets back on truck.

No. 2 Lays the lines with apparatus to just past the fire and clamps and breaks forward line, throwing end back on hose load.

No. 1 Puts clamp on reverse line.

No. 4 Breaks the reverse line, puts a nozzle on the male end then lays hose and nozzle back in reverse bed to line up flakes. He then pulls 50' in flakes half out of the bed, then turns away from apparatus, puts the hose on his shoulder and pulls hose clear.

No. 1 Pulls the next 50' of hose in the same manner and steps clear.

No. 2 Assists No. 1 and No. 4 by giving enough slack to reach fire, then breaks the line coming out of the reverse side and connects it to the forward line that is charged and clamped.

No. 3 Has in the meantime, made the hydrant, has connected the lines and turned on the water and advanced to the clamps. Then if first line is ready, he opens the clamp on the forward laid line.

No. 4 Is left in charge of this line and No. 1 returns to apparatus.

No. 3 Puts another nozzle on the line in the reverse bed and loads 50' on his shoulder as before.

No. 1 Loads the next 50' of flaked hose on his shoulder as before and heads for the fire.

No. 2 Assists No. 3 and No. 1 by giving enough slack to reach fire, then he breaks hose coming out of reverse bed and connects it to the charge clamped line, using a double male. On the call for water, he opens clamp and proceeds to nozzle to assist No. 4 on the first line.

Note: If off-shift men or volunteers respond after arrival of apparatus, they could speed up putting the second line into operation.

2539

Drill No. 4 · Two companies (A & B) (3 men each) with booster tanks.

First company (A) lay 2½" supply line from the road to the fire, operate 1½" hose line from the booster tank.

Second company (B) carry their own 1½" hose and operate from the first pumper then use their booster tank to supply the first.

Operation:

No. 2-A Turns the apparatus off the highway as directed by No. 1-A and stops.

No. 3-A Removes the hose clamp and 25' of hose from the forward hose bed, heels the line and calls to lay in. When the supply line is stretched in, he places the hose clamp on the line, then proceeds to the apparatus.

No. 2-A Drives to the fire and stops.

No. 1-A (Assisted by No. 2-A) Overhauls the pre-connected 1½" hose and operate on the fire.

No. 2-A Operates the pump at the desired pressure.

No. 3-A Overhauls second 1½" line to fire or assists No. 1-A. No. 2-A would assist if necessary.

No. 2-A Breaks the 2½" supply line and connects it to the intake port.

Apparatus "B" arrives

No. 1-B and

No. 3-B Remove their own 1½" hose, carry it and connect it on apparatus "A" discharge port and lay to the fire.

No. 2-B Picks up the 2½" supply line left by company "A", connects it to his discharge port, operates pump at desired pressure, opens the hose clamp and pumps water from his tank to apparatus "A".

When the tank of apparatus "B" is empty, No. 2-B shuts down the pump, clamps the 2½" supply line, disconnects it from his discharge port, leaves it and drives off for more water.

2540 Texas

HOSE PRACTICES,

Drill No. 1 Four men make a forward lay, take 2½" line up stairway.

No. 3 Takes hydrant and gives water as soon as possible.
No. 2 Lays line with apparatus, stopping where directed by No. 1.
No. 2 Clamps line from hydrant.
No. 4 Shoulder loads 50' of 2½" hose from reverse bed with nozzle attached and steps away from apparatus.
No. 1 Shoulder loads another 50' of 2½" hose then pulls off an extra 50' for slack.
No. 4 and No. 1 Proceed to fire, keeping hose on shoulders until the extra 50' of slack is taken up, then they overhaul line up stairway to fire, flaking the hose off, being sure to keep line taut.
No. 2 Makes sure No. 4 and No. 1 have sufficient hose, then breaks hose line to fire from the reverse bed.
No. 2 Breaks the hydrant line, then couples the two hose lines.
No. 3 After making hydrant, advances to hose clamp, assists No. 2 if necessary, then gives water by opening clamp.
No. 2 and No. 3 Follow hose to pipe, taking out kinks as they go.

Drill No. 2 Three men make a forward lay, take 2½" line up stairway.

No. 3 Takes hydrant and gives water as soon as possible.
No. 2 Clamps the hydrant line.
No. 1 Shoulder loads 50' of hose and nozzle from the reverse bed, steps clear of apparatus.
No. 2 Shoulder loads another 50' of hose, then pulling off 50' for slack, steps away from the apparatus.
No. 1 and No. 2 Overhaul line up stairway to the fire.
No. 3 Advances to back of apparatus, breaks both lines coming out of the hose bed, connects the lines together, at call for water opens the hose clamp.
No. 3 Advances to the pipe.

Drill No. 3 Replace burst section.

No. 1 Stays at nozzle and designates 2 men to replace burst hose.
No. 3 Gets hose clamp and clamps line 3' from coupling of burst section. When water is shut off
No. 1 Closes nozzle, breaks coupling of burst hose nearest the pipe, then returns to the pipe.

meanwhile
No. 4 Pulls first marker, breaks coupling, shoulder loads 50' of hose (being careful to have female coupling on top) follows hose line toward the fire.

As No. 4 passes No. 3 at clamp, No. 3 grasps female coupling from No. 4 and
No. 4 stretches hose along side burst section, makes coupling nearest the pipe and calls for water.

Meanwhile
No. 3 Makes his connection and opens clamp and returns to nozzle.
No. 4 Ties overhead knot in burst section (as a reminder to other firemen that section is defective) and returns to nozzle.

2541

Drill No. 4 <u>Four men make a reverse lay, take a 2½" line up a stairway.</u>

No. 2 Stops as directed by No. 1.
No. 4 Shoulder loads 50' of hose and nozzle from reverse hose bed and steps away from apparatus.
No. 1 Shoulder loads another 50' of hose, steps clear of apparatus.
No. 3 Pulls off sufficient slack hose, puts it on the ground and gets back on the apparatus.
No. 1 Keeps the hose on his shoulder, drops to one knee snubbing the hose where it comes from the reverse hose bed, and orders No. 2 to go ahead.
No. 2 and No. 3 Ride apparatus to hydrant, give water using standard reverse pump hookup.
No. 2 Operates pump, opening discharge valve on call for water.
No. 3 Proceeds back to fire.

NOTE: Where pump is not hooked up the No. 3 man could remain at fire instead of riding to hydrant.

Drill No. 5 <u>Three men make a reverse lay, taking 2½" line up a stairway.</u>

No. 2 Stops apparatus as directed by No. 1.
No. 3 Shoulder loads 50' of hose and nozzle, steps clear of apparatus.
No. 1 Shoulder loads second 50' of hose, turns around, keeps hose on his shoulder, pulls to the ground sufficient slack, snubs the hose where it comes out of apparatus, orders No. 2 to go to hydrant.
No. 2 Proceeds to hydrant, breaks the hose line from apparatus, attaches it to a discharge port, then attaches soft suction to hydrant, turns on water and operates pump.
No. 1 and No. 3 Keep hose on shoulders, flaking it off as they proceed to the fire.

Drill No. 6 <u>Four men make a forward lay, hoisting line with a roof rope.</u>

No. 3 Takes the hydrant and gives water as soon as possible.
No. 2 Lays the line with apparatus and stops as directed by No. 1.
No. 2 Clamps the hydrant line.
No. 4 Takes roof rope and axe and goes to roof or designated floor and throws out the roof rope.
No. 1 Shoulder loads 50' of hose and nozzle from reverse bed and carries it to location where rope is to be dropped.
No. 2 Assist No. 1 by carrying over sufficient slack hose, then breaks hydrant and reverse hose lines and connects them together.
No. 1 Goes to assist No. 4.
No. 2 Goes to nozzle, makes hose knot, slides hose through knot about 8 feet.
No. 1 and No. 4 Using standard "Roof Rope Raise" pull up hose and carry hose to fire.
No. 1 Calls for water.
No. 3 Opens hose clamp.
No. 3 and No. 2 Advance to fire.

2542

Drill No. 7 <u>Four men make a forward lay, carry hose up a vertical fire escape</u>.

No. 3 Takes the hydrant and gives water as soon as possible.
No. 2 Lays the line with apparatus and stops as directed by No. 1.
No. 2 Clamps the hydrant line.
No. 2 Gets baby ladder and places it against bottom of fire escape.
No. 4 Shoulder loads nozzle and 50' of hose from reverse hose bed and steps clear of apparatus.
No. 1 Shoulder loads next 50' and steps clear.
No. 4 and No. 1 Carry hose to the base of fire escape and lay hose on ground.
No. 2 Assists by bringing sufficient slack, then breaking hydrant line and reverse hose line and connecting them together.
No. 4 Snaps belt behind valve of nozzle and climbs the ladder.
No. 1 Spaces out 25' to 50' behind No. 4 and climbs ladder, staying 10 to 15 feet behind No. 4 so as to steer nozzle through fire escape landing.
No. 2 Climbs 25 to 50 feet behind No. 1 and reaching top of fire escape anchors line to fire escape with tailpiece of hose belt.
No. 4 and No. 1 Carry line to fire and call for water.
No. 3 Opens clamp and advances to the fire.

Drill No. 8 <u>Four men make forward lay, with 2½ " hose and take 1½" hose to the fire</u>.

No. 3 Takes the hydrant and gives water as soon as possible.
No. 2 Lays the forward 2½" hose and stops as ordered by No. 1.
No. 4 Shoulder loads first half of 1½" hose and steps clear.
No. 1 Shoulder loads second half of 1½" hose.
No. 4 and No. 1 Proceed toward fire and set down wye outside building.
No. 2 Clamps the hydrant line, pulls off sufficient 2½" hose to reach wye, breaks the hydrant line and connects it to the 1½" wye.
No. 3 Advances to the clamp and at the call for water, opens the clamp.
No. 3 and No. 2 Proceed to the pipe.

In case second line of 1½" hose is called for, No. 3 and No. 2 would shoulder load hose and carry to wye.

2543

Drill No. 9 <u>Four men back up 1½" line with a 2½" line</u> (If 2½" x 1½" wye is used)

No. 1 Stays with 1½" nozzle operating on fire.
No. 2, No. 3, No. 4 Return to apparatus for 2½" hose.
No. 3 Steps up to reverse 2½" hose bed, pulls marker for required amount of hose and breaks coupling.
No. 4 Puts on nozzle if not attached and shoulder loads 50' of 2½" hose and steps away from apparatus.
No. 2 Gets the hose clamp and 2½" x 2½" wye.
No. 3 Shoulder loads second 50' of 2½" hose and steps clear of apparatus.
No. 2 Gives the hose clamp to No. 4 to carry and gives the 2½" wye to No. 3 to carry.
No. 2 Then shoulder loads third 50' of 2½" hose.
No. 4, No. 3, No. 2 Proceed toward fire.
No. 4 Sets down clamp at 1½" wye. No. 3 Sets down 2½" wye next to 1½" wye.
when No. 2 is 25 feet beyond the wye he drops his load and drags the female coupling back to the two wyes, and connects the back-up line to the 2½" wye.
No. 4 and No. 3 Continue overhauling toward fire, where No. 3 has stretched out his hose and returns to assist No. 2.
No. 2 Clamps 2½" charged line, then
No. 2 and No. 3 Disconnect 1½" wye, connect 1½" wye to 2½" wye, and 2½" wye to clamped 2½" line.
No. 4 Calls for water.
No. 2 Opens clamp.
No. 3 Returns to assist No. 4 at nozzle.
No. 2 Returns to pump, (if reverse lay) or to nozzle (if forward lay).

Drill No. 10 <u>Three men take charged 2½" line (laying on the ground) up a ladder and operate into window or on roof.</u>

No. 4 Snaps tailpiece of hose belt 12" behind the pipe and lets is hang down on his right side.
No. 3 Snaps his hose belt 8 feet behind No. 4 and lets it hang on his right side.
No. 1 Snaps his hose belt 10 feet behind No. 3 and lets it hang on his right side.
No. 4 In the lead, all advance to the ladder at a 45° angle from the left and all climb the ladder and
as No. 4 reaches the top, he grasps the rung with his left hand, reaches down with his right hand, pulls up the nozzle, slides it through the rung.
(While No. 3 below No. 4 lifts up the hose)
No. 4 Throws his right foot over the hose, straddling it, then hooks the tail of his belt on the rung above, then locks in with his left leg, throws one arm through the ladder and the other around the ladder and operates the nozzle.
No. 3 Hooks his line straight on the ladder, then climbs up behind No. 4, straddles the line, reaches around No. 4, grasps the beams to hold pipeman in position.
No. 1 Hooks his line straight on the ladder, then climbs down.

PUMPER OPERATION

CENTRIFUGAL TYPE PUMP. The most modern and latest type of fire pump that has been developed and is practically in universal use today is the centrifugal pump. It is perhaps the simplest and develops less trouble than other older types of pumps due to the simplicity of design and with just a few moving parts. Because this is the type that the majority of fire departments use today we will devote more time in describing it and all the accessories that are used in conjunction with it.

This type of pump may be a single stage with one impeller or a multiple stage with up to three impellers and actually could be built with an unlimited amount of impellers if needed. A centrifugal pump has impellers rotating within a metal housing with the outer edge of the impellers just barely clearing the housing. The impeller is circular in shape and hollowed out and divided into sections by curved vanes within this hollow area, the center or eye is large in size and is the inlet opening for water to enter the impeller where, as the impeller is rotated at fairly high speeds the centrifugal force throws the water outward and the vanes channel it out through the discharge vents on the perimeter of the impeller into the discharge chambers and out of the pump into attached hose lines. These impellers vary in size and some of the smaller capacity pumps might have larger impellers than pumps of a greater size. The amount of water being discharged depends on two factors:

1. The size of the impellers and
2. The speed of the impellers.

Thus a 9 inch impeller at 1,000 RPM would not discharge as much water as a 6 inch impeller at 2,500 RPM. So both size and speed of the impellers have a bearing on the discharge potential of any centrifugal pump.

Ordinarily the speed of the pump impellers is from 1½ to 2½ times the RPM of the engine motor. This increase is accomplished by the gear box of the pump transmission. A centrifugal pump is not a positive displacement type pump; in other words, if the pump were running and all discharge ports on the pumper were to be closed there would be a 100% slippage or churning of the water within the pump itself. The motor would not stall due to the slippage within the pump.

There are several methods of engaging pumps in gear depending upon whether the pump is a single stage, multiple stage, electro-matic type and electro-matic type with a failure in the electrical system to the controls, or type of

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priming device used.

First, let us discuss the single stage pump; this is generally a pump with a 500 GPM capacity or less. In all cases, read the manufacturer's operational book, as different manufacturers may vary as to the gear recommended for pumping.

Basically you have arrived at a fire and are going out to put the pump in operation. Take the pump transmission shift lever and change from road position to pump transmission, place the gear shift lever into direct gear. Here your manufacturer's book will tell you which is direct gear - it might be third gear or fourth gear depending upon the gear ratio of your particular apparatus. It also will depend on the type emergency brake as to which and how applied. Some apparatus have the hand emergency brake connected to the drive shaft and if the brake is applied and the pump is put in gear then the minute the clutch is released the motor will stall. Generally speaking, they have an automatic brake lock, either operated manually or by flipping an electric switch.

We will now assume that you have the proper brake applied, the pump transmission engaged and the gearshift lever in the proper gear, then, in this type the main pump is engaged and running. You are connected to a source of water supply and hose lines are attached. Then, all you have to do is advance the throttle to the desired operating pressure.

Next, let us discuss the fully electro-matic type pump. This pump is put into operation in the same manner as the single stage pump.

Next, let us discuss the multiple stage pump with a manually operated gear driven primer pump. In this type you perform the same operation in the cab as for the single stage pump but when you transfer the transmission it does not start the pump to operate but merely transfer the transmission from direct road into the transmission box of the pump unit. As you get out of the cab on the side of the apparatus just above the running board and below the pump operating panel you have another pump lever. This pump lever has three positions:

1. Road position which is where it will be at all times as you get out of the cab.

2. Prime pump position.

3. Main pump position. As you raise this shift lever slightly to clear the notches of each position it automatically depresses the clutch pedal and you move the lever to main pump position and as you lower this lever into the notch it releases the clutch and engages the pump in gear. All you have to do then is advance the throttle to the desired pressure.

Next, let us discuss the electro-matic that has an electrical failure in the wiring to the operating or control panel. Then you would have to operate manually the accessories that work different parts of the pump.

To make a pump and motor elastic in the operation of the pump there are a few accessory appliances incorporated with most pumps and these, if utilized right can give you great efficiency in the pump operation.

<u>TRANSFER VALVE</u>. This valve is found only on pumps that have two or more stages. There are many models and variations but all basically perform the same

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function. By the use of the valve you change the course of the water within the pump from parallel operation to series operation. In series operation you have doubled the potential pressure but halved the volume or quantity of water. Perhaps it might be well at this time to explain the assembly of a two stage pump.

In parallel (VOLUME) operation we have two impellers receiving water from a common intake and each pumping into a common discharge at pressures ranging up to 150#.

When the transfer valve is changed to series (PRESSURE) the water inside the pump is changed so that the water enters one impeller. It leaves the discharge side of this impeller and then enters the inlet of the second impeller which increases the pressure to double that of the first impeller but the capacity (VOLUME) has been decreased by one-half due to the fact that only one impeller is discharging water from the pump. Thus we have doubled the pressure but halved the quantity.

The transfer valve ordinarily should be changed only at pressures of 50# or less. When the transfer valve is changed, two clapper valves at or near the suction intakes on either side close or open. They are open when the valve is in Volume position and closed when the valve is in the Pressure position. This is done in order to direct flow of water into the proper waterways within the pump and is caused by the pressure of the water being discharged by the first stage impeller.

If this Transfer Valve is changed at high pressures, a noise takes place as the metal clappers are banged against the metal housing of the pump. The Transfer Valve (manual) generally requires three or more complete turns to change from one position to the other. Always make sure that the Transfer Valve has been fully opened or closed.

Fire pumps are put into two classes. Class A and Class B.

Class B pumps will pump their rated capacities at 120#. (This will apply to older model pumps.)

Class A pumps (this rating came into being about 10 years ago) will pump their rated capacities at 150# pressure. A flat statement of this type is erroneous because it applies only when pumping at draft, or from tank where the intake suction pressure is practically at zero. If, on the other hand, the pump is connected to a hydrant at 100# pressure then, in theory, you may add this 100# to the volume pressure of 150# and still be able to be in parallel operation and pump the rated capacity at 250# pressure, the only limiting factor being the horsepower of the engine of the fire truck.

Water has weight and it takes horsepower to move this weight and the smaller the horsepower the less water you can pump at given pressures and volumes.

PRIMING PUMPS OR PUMP PRIMERS. Here again we roughly have three different types of priming devices.

1. The gear type priming pump which can be operated by electric energy or engaged manually.

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2. The engine vacuum type where the vacuum created in the intake manifold is utilized as the priming agent.

3. The exhaust primer where the exhaust from the gasoline motor is used through a venturi type tube arrangement to act as the priming agent.

These priming devices must be used to prime a centrifugal pump if we are to draft as a centrifugal pump cannot create a vacuum within the pump itself. A pumper, in order to draft water, must be exhausted of air and completely filled with water. Then and only then can it draft water.

ELECTRIC PRIMER - OPERATION. The main pump discharge valves, drain valves and other pump openings must be closed and the suction hose connected to the suction intake, with the strainer and end of hose immersed in the source of supply. Make sure when the transmission lever is fully in main pump position that the gear shift lever is in the proper gear (direct). Then from the operating panel of the pump push in on the electric priming button and hold it in until the pump is primed. This is a gear type positive displacement priming pump and when you press in on the priming button it immediately starts the priming pump and the main pump, thereby allowing the air or air water mixture to be drawn into the priming pump and out its discharge pipe. It also allows the oil from the priming pump oil reservoir to be drawn into the priming pump and lubricates and seals all air leaks within the priming pump.

Allow the priming pump to run until it discharges a solid stream or perhaps we should say, a continuous stream, as sometimes the discharged water strikes a cross brace or rod under the apparatus and is broken up into a splattering stream. To start with, the air water mixture being discharged is intermittent but gradually becomes continuous if the pump and connections are tight.

If the priming pump does not prime the pump within 30 seconds, stop the priming operations and check for air leaks in the suction hose connections. Also, make sure the priming pump is being lubricated by the priming oil tank. Generally, with the new modern electro-matic pump units, the minute the main pump is primed there is a positive pressure reading on the discharge gauge. After the main pump has been primed it is only a question of using the throttle slightly, making sure there is pressure on the discharge gauge, and then opening the discharge ports to the attached hose lines; then advance the throttle until the correct pump discharge pressure is obtained for the particular hose layout into which you are pumping.

If the electric primer refuses to operate due to electrical trouble you will have to utilize the manual override lever and operate the priming pump by changing the pump transmission lever to the priming pump position and then from the operating panel you will have to pull out the priming valve lever manually.

The priming pump operates the same way as by the electric method.

PRIMING PUMP (Manual Operated Gear Pump). The majority of fire pumps (two-stage) prior to the advent of the electro-matic development of operation use a different system when equipped with a gear driven priming pump. In addition to the pump transmission lever in the cab of the apparatus, there is a pump transmission shift lever on the side of the apparatus at the operating panel. This is a three-position lever:

1. Road or neutral

2. Priming pump

3. Main pump

When drafting or starting to draft, close all discharge ports, drain valves and other pump openings, connect the suction hose to the pump and immerse the strainer and end of the section hose in water. You are then ready to draft.

The pump transmission lever in the cab is put in pump transmission and the gear shift lever in direct drive. Then from the operating panel you raise up on the pump transmission lever; as you raise it from the road or neutral position it activates the clutch and you move the lever to the prime pump position; as the lever drops into the prime pump position it engages the prime pump.

You then pull out on the priming valve (make sure it is fully opened) then advance the throttle to a maximum of about 30% of its peak speed. Then look under the apparatus and watch the discharge from the priming pump. It will act in the same way as described for electro-matic operation. When fully primed, push in on the priming valve lever, reduce the throttle speed and shift the pump transmission lever from priming pump into main pump position. Look at the discharge pressure gauge and at about 50# pressure open the discharge ports slowly (on some apparatus when the discharge ports are opened the pressure gauge will drop down momentarily). Then advance the throttle until the desired pressure and volume are obtained.

ENGINE VACUUM PRIMER. The engine vacuum primer is essentially an air valve designed to prime centrifugal pumps by utilizing the intake manifold vacuum of the truck engine. It consists mainly of a metal body with cover that contains a main float valve assembly, auxiliary float assembly with shut off valve, air vent piping and operating mechanism.

The maximum lift at which it will prime a pump is, therefore, directly dependent upon the available manifold vacuum. Most truck engines, running under "no load" conditions will develop from 18" to 22" HG at speeds ranging to about 35% of peak engine speed. A 20" HG vacuum corresponds to 22 ft. water lift which means that it would be possible to draft water up to this limit. However, if the condition of the motor is poor or ignition, carburetion or valves do not function properly, then the vacuum producing ability of the engine will be decreased.

The shortest priming time is at approximately 35% of peak engine speed. The engine will not produce a greater vacuum at this speed with the primer turned off; it will have a greater "breathing" capacity and will produce a higher vacuum with the primer in operation. The engine vacuum is a semi-automatic device which is put into operation manually at the beginning of the priming sequence and automatically shuts off when pump is primed.

When the engine primer is in the cocked position, the main float is at the bottom of the tank and the air vent to the manifold is open. As the water enters the tank the water causes the float to rise and when it reaches a certain level it closes the air vent, the air from the pump having been exhausted through the air vent. The float valve acts on the lock plate and release plate and moves them to the off position indicating to the operator that the pump is primed.

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If for any reason the primer does not complete the cycle, a further rise of water in the primer will cause the auxiliary float to rise, closing the air vent shut off valve, thus preventing water from entering the engine.

OPERATION. With the pump transmission lever in the cab in pump position and the gear shift lever in direct gear, from the operating panel close all main pump discharge valves, drain valves and other pump openings. Prior to this, of course, the suction hose would have been connected to the suction intake and the strainer and end of the suction hose immersed in the water.

Turn the priming valve to the "On" position, advance the throttle (engine speed) to about 35% of peak, pull the operating rod of the primer out to the limit of its travel, and allow it to return to the midway or "cocked" position. When the operating rod jumps to the "Off" position, immediately turn the priming valve to the "Off" position to prevent the pump from losing prime and to drain the primer. Engage the main pump and advance the throttle slightly. Open the discharge ports slowly and then advance the throttle until the desired pressure and volume are obtained.

EXHAUST PRIMER. The exhaust type primer utilizes the exhaust from the engine to create a vacuum. The primer consists of a metal body, exhaust valve ejector nozzle and body and the priming valve. During the priming operation, the exhaust valve is closed, which causes the exhaust gases to be diverted through the ejector creating a suction which evacuates the air from the pump. This air is evacuated from the pump to the primer when the priming valve is opened. The venturi tube principle of priming is where a small amount of air or water passing through a small orifice at high speed creates a vacuum and pulls a large amount of air and water with it. After the pump is primed, the priming valve is closed and the exhaust valve is opened which allows the exhaust gases to excape in their normal manner.

OPERATION. With the pump transmission lever in pump transmission and the gear shift lever in direct gear, first connect the suction hose to the intake and immerse the strainer and hose into the source of supply. Close all the main pump discharge valves, drain valves and other pump openings. Let the engine idle. Close primer exhaust valve and open the priming valve. Open the throttle to 1/2 to 2/3 of peak speed. When water is first exhausted it will be mixed with air; continue priming for a few seconds until a continuous flow of water appears from the primer exhaust. Close the priming valve, slow the engine to idling speed, engage the main pump, then open the exhaust valve. Advance the throttle until a discharge pressure of 50 to 75 pounds is reached Open the discharge ports slowly and advance the throttle until the desired discharge pressure and volume has been obtained.

PRIMING OIL TANK. The priming pump (gear type) is generally furnished with an oil tank connected by means of metal tubing. The size of the tank may vary from one quart up to a gallon in size. Whenever the priming pump is operated it is lubricated by oil from this tank being drawn from the tank through the metal tubing into the pump itself. This oil acts as a lubricant and also a seal for the pump.

The oil used is generally SAE 30; however, heavier weight oil, 40 or 50 may be used, especially in warm weather. An air vent located at the highest point in this oil line - generally at the top of the elbow on the tank - prevents the oil from being siphoned out of the tank when the priming pump is

shut off. This hole is made with a drill #60 which is .040 in diameter. Be sure that this vent does not get clogged or the oil could be siphoned out of the tank. Do not enlarge the hole or it might prevent the priming pump from drawing oil from the tank.

AUTOMATIC RELIEF VALVE. A relief valve is a device that relieves or governs the amount of pressure being produced on the discharge side of the pump. In the old days and on the gear or piston type pump the main purpose of the relief valve was to prevent the pressure build-up caused by shutting down the nozzles being put against the gears or piston and stalling the pump.

Different manufacturers use different types and sometimes slight variations in the principle of operation but the theory of these relief valves will fall into one of the two basic types. Some are called relief valves and some are called governors; they use entirely different principles in their method of controlling pressures. They are commonly called automatic but before they become automatic in their operation certain manual manipulations of control valves are required to adjust them to proper or desired pressures.

Either of these two types are generally effective at pressures of 100 lbs. or even when they are put into operation.

In the centrifugal pump the relief valve provides an entirely different function than that of the gear or piston type pump relief valve. As the centrifugal pump has the ability to have 100% slippage, shutting down all the lines would not stall the motor. The principle of the relief valve is to prevent pressure surges in one or more lines when other lines attached to the same pump are shut off.

Perhaps the best way to explain is to use an example. Two lines are attached to the pump discharging 500 GPM at a discharge pump pressure of 150 lbs. This requires a given amount of energy being produced from the engine of the pumper. We now shut one line down without the relief valve being used. The amount of energy from the motor is the same but it is now only being used to pump 250 GPM. This energy then immediately produces a sudden sharp increase in pressure on the one line and can knock the men handling the line off their feet. In theory, if we were to disregard friction loss in the hose line the pressure at the nozzle would be doubled.

RELIEF VALVE TYPE. This is a device containing certain valves, tension springs and is built into the pump where a by-pass line connects the discharge side of the pump with the suction or intake side of the pump.

There are several different types made by manufacturers but they all perform the same function and basically do the same things. They are put into operation automatically in some types when the pressure reaches the setting, and others require the opening of a valve before they will operate. They are all classified as spring loaded valves.

Let us take one type the Hale Ideal Relief Valve. Note--in this type the knurled adjusting knob should always be turned to the right as far as it will turn or above any operating pressures at which you will operate the pump. This merely puts the maximum amount of spring tension against the valve piston which is closing off the by-pass tube.

OPERATION. Connect the pump to a source of supply (it makes no difference whether from a hydrant or from draft) then having one or more lines connected, open and discharge water from the discharge ports. The pump is in gear. Advance the throttle until the desired pressure is obtained on the discharge gauge. Location of relief valve will govern method of setting.

If the entire valve assembly except the knurled knob and bleeder cock are within the body of the apparatus, only the following method can be used. Open the bleeder cock which is located just below the knurled knob. A little water may bleed out of it. Then turn the knurled knob to the left until water under pressure comes out of the bleeder cock. Turning the knurled knob too fast probably will cause the pressure to drop 5 to 10 lbs. below what is desired. Gently turn the knob to the right until the water from the bleeder cock loses its pressure. Close the bleeder cock and the valve is operating. You should have 150# of water pressure on one side of the valve and 150# spring tension holding it shut.

When one or more hose lines are shut off, the water pressure builds up and overrides the spring tension, opening the valve and allowing the water to be sent from the discharge side of the pump back into the intake side. When the lines that were shut down are reopened then the spring tension pushes the valve back into place and closes the by-pass. If the knurled knob was turned to the right as far as it would go (highest pressure setting) it would take at least 25 full turns to the left to reach the lowest pressure setting.

If the entire valve assembly is mounted outside the apparatus body, the previously described method can be used. About one-half of the threaded housing is cut away for visibility. On the side of this cut-away pipe you will see a V shaped notch on the left-hand side. The center of the piston head is also in the form of a V. Advance the throttle to the desired pressure, turn the knurled knob to the left and continue turning until the V of the piston plunger is even with the V of cut-away pipe, then the relief valve is set at that pressure.

WATEROUS TYPE. On this type the relief valve remains inoperative until the four way valve (labeled Relief Valve) is moved from the "off" to the "on" position. Than it is only necessary to turn the pilot valve handle to the left until the pressure gauge drops to the desired discharge pressure. Again always make sure the pilot valve is set above any normal working pressure when you shut down the pump.

PRINCIPLE OF OPERATION. All the relief valves are controlled by the pilot valve and are mechanically devised so that the pilot valve will actuate the main relief valve at the desired pressure when the pump operator has it properly adjusted. The Waterous Relief Valve is a spring-actuated device and operates on the same principle as does the Hale Relief Valve with the exception that the Waterous Four-Way Valve must be turned to "on" position to put the relief valve in operation.

OPERATION. After placing pumper at source of supply, connect necessary lines to the discharge ports, open and commence discharging water. The pump is in proper gear. Advance the throttle until you have reached the desired operating discharge pressure. Turn the four-way valve from "off" to "on" position. Turn the pilot valve handle to the left until there is a slight pressure drop on the discharge gauge. Then turn slowly to the right until the pressure is again at

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the desired level.

THROTTLE ACTUATED GOVERNOR (Relief Valve). This operates on an entirely different principle than does the spring loaded relief valve. In the spring loaded type that was described previously, an increase of pressure over the setting of the relief valve merely opens a by-pass valve and relieves the increased pressure by discharging water back into the suction side of the pump and the motor speed tends to remain constant at all times. In the throttle actuated type there is no by-pass valve but through a mechanical arrangement consisting of a metal housing, rubber diaphragm, springs and necessary piping with valves, an increase of pressure closes down the throttle which slows down the motor and drops the pressure back to where the governor has been set.

Here again there are two different types but they perform the same basic fundamentals and operate practically the same.

TYPE 1. On this type there is a metal housing with a rubber diaphragm completely across the center, which divides it into two chambers. One of these chambers is connected to the discharge side of the pump and is full of water. On the other side is a piston which is held against the diaphragm by spring tension. The piston is connected to the carburetor by a shaft and the action of the piston being forced backward by the increase of water pressure on the rubber diaphragm then reduces the speed of the motor. When the increase of water pressure against the diaphragm has been reduced, then the spring tension against the piston forces the diaphragm back, which in turn accelerates the motor.

OPERATION. This type is generally mounted on the pump operation panel and is controlled by three valves. One is the governor drain valve, two is the valve which puts the governor in operation by allowing water under pressure to enter the housing of the governor. Three is the hand wheel which regulates the spring tension on the piston within the governor housing.

After placing the pumper at the source of water supply and placing in operation one or more lines, with the pump in proper gear, advance the throttle until the desired pressure is obtained. Then open the governor operating valve. Then momentarily open the drain valve and close it. Turn the Pressure Regulator Hand Wheel to the left or right (this depends on whether it is a left hand or right hand thread on the valve stem). We will assume that turning to the left is the way to reduce the spring tension. Then turn hand wheel to the left until there is a pressure drop on the discharge pressure gauge. The engine will slow down slightly. If you have turned the handle too far gradually turn to the right until the proper pressure is obtained. (Note: Sometimes the governor lags a little so when readjusting wait momentarily after each adjustment.) When it appears to be at the desired operating pressure, shut down and open a discharge port to make sure it is set where you want it. Pull the throttle all the way out.

TYPE 2. (Used generally on 500 GPM and is generally mounted under the hood and adjacent to the carburetor.) It operates on the same principle as Type 1 except it uses a gear train arrangement to control the speed of the motor. On this type the only valve on the operating panel is the valve wheel that puts the governor in operation. There is no drain valve and the Pressure Regulator Hand Wheel is small and built into the governor assembly under the hood. On

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this type a shaft runs through a housing attached to the carburetor and continues on into the metal housing of the governor. There this shaft is connected to the piston that presses against the rubber diaphragm within the governor housing, the water is in the other chamber pressing against the diaphragm. This shaft where it passes through beneath the carburetor has a gear attached which meshes with a gear that is linked to the motor throttle. Thus as the piston moves back and forth, when pressure changes cause the carburetor to increase or decrease the flow of gasoline, the motor speed changes.

This type is put into operation in the same manner as the other type except it does not have a drain valve and you will have to depend on motor speed to tell when it has reached the proper setting.

RADIATOR COOLER. This is commonly known as a heat exchanger. The water from the radiator runs through a small tank that varies in size from 4" to 8" in diameter and from 10" to several feet in length. All of the water from the cooling system of the motor passes through this tank. Connected to the shell of the tank is small piping and it is coiled throughout the length of the tank. The piping runs from the main pump through the coils within the tank and is discharged to the ground. When the Radiator Cooler Valve is opened the cold water passing through the coils cools the water of the cooling system. It is well to remember that a gasoline motor develops its peak efficiency between 180 degrees and 200 degrees so do not overcool the water in the engine cooling system; when using the cooler valve, open the valve slightly and watch the radiator temperature gauge.

RADIATOR FILL. The radiator is connected to the pump by a small diameter piping and controlled by a valve labeled Radiator Fill. The purpose of this valve and piping is to allow cool water to be introduced into the radiator when the radiator or cooling system has become too hot and boils over and out the overflow tube. This is used where the apparatus is not equipped with a radiator cooler. When using the radiator fill valve just barely open it, the pump may be operating at high pressure and if the radiator fill valve were to be opened fully, the amount of water under pressure may be in excess of the overflow pipe capacity and this excess build-up of pressure would then split the seams of the radiator and you not only would have a costly and time-consuming repair bill but your pump would be out of service at the moment the seams split. Again, let me caution you abour over-cooling your motor.

Do not use Radiator Fill when drafting salt water.

BOOSTER COOLER. This is a piping arrangement whereby a small amount of water is circulated back into the booster tank from the discharge side of the pump when using the booster tank. On some apparatus that have a booster tank fill valve the piping is somewhat larger but it can be used for the same purpose by barely opening the control valve.

This valve is utilized to cool the water within the pump when the pump is merely churning. When a centrifugal pump is running and is not discharging water (this happens quite frequently in the latter stages of a fire) the 100% slippage within the pump allows the impellers to keep on turning; this friction gradually increases the water temperature within the pump, it dissipates to the metal of the pump and if allowed to continue, could damage packing glands and bearings. By using the water from the booster tank and circulating it through the pump and back into the booster tank the heat rise is kept to a minimum.

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PUMP PACKING GLANDS. The pump packing glands should not be cinched up but should only be tight enough so that it does not drip when standing, but when pumping under pressure there will be a very slight drip; this allows the cold water to act as a cooling agent and keep the bearing cool.

PUMP STRAINERS. These are made of a metal mesh and are recess-mounted in all the section openings of the pump. They should be checked after each pumping operation. Their purpose is to prevent debris of any kind from entering the pump and either damaging or lodging in the working parts and causing damage to the pump or causing loss of part of the capacity of the pump.

In reference to losing part of the pump capacity, if a foreign object such as a small stick or piece of paper that is small enough to enter the eye of the centrifugal wheel is then thrown outward but is too large to go out of the discharge opening of the centrifugal wheel it will then lodge and a percentage of the discharge capacity will be lost. Paper, wood, leaves and other obstructive materials can and will be lodged against the strainer screens of the pump.

There is also a strainer on the end of the suction hose; when this is in place the effect is the same as two strainers protecting the working mechanism of the pump.

PUMP DRAINS. All fire pumps are provided with drains at the base and other low spots of the pump. There may be any number from a single drain up to as high as 8 drains. Some manufacturers manifold these drains so that one valve may open a number of drains at the same time. Other manufacturers have a valve for each drain. These drains are used for a number of purposes.

1. To help flush out the pump when salt or other corrosive water has been pumped by the engine.

2. To drain all parts of the pump in extremely cold weather and keep the pump and/or housing from being cracked by the expansion of water being changed into ice.

3. To drain the pump thoroughly prior to running the Underwriter's acceptance test or the yearly service test.

TIPS WHEN DRAFTING. The less the vertical lift, the less time it will take to prime the pump and the less the lift the more it will increase the pump capacity up to a certain point.

The transfer Valve should always be in volume (capacity) position when starting to draft. To find the most efficient point of operation when pumping either from draft or hydrant is to operate the pump at the slowest RPM for the desired discharge pressure. To do this, merely notice the RPM at the desired pressure, drop the pressure to 50#, change the Transfer Valve to the other position, then increase the throttle. If the desired pressure is reached at less RPM's, the position with the Transfer Valve is correct; if the same RPM is reached and the pressure is down, then change back to the original position of the Transfer Valve.

Always check the suction hose for foreign objects in the hose (rope, collapsible ladder, applicators, etc.) before connecting together and

attaching to the pump. Make sure the end of the suction hose is immersed into at least two feet of water. Use the rope from the strainer to support the end of the hose and keep the strain from the couplings.

Make sure that the pump intake is higher than any point in the suction line.

Keep the strainer well clear of the bottom.

When drafting, watch the strainer end of the suction if short of water coverage. Whirlpools may form and if air gets into the end of suction hose, the prime will be lost. Long boards, a ladder, etc., may be used to break up the whirlpool effect.

Pump operators should learn especially to do one thing - practice putting the pump in gear. It is true a number of manufacturers put locks in the cab so that the pump, in theory, can only be locked in the proper gear but many times it also can be locked in the improper gear. Take time to transfer transmissions and put in direct gear and then with the motor idling look at the speedometer. Compare the speed then for direct or pump gear. Doing this at the station or practice when not under strain will perfect technique, then under stress and strain conditions at a fire, a glance at the speedometer will show whether or not the speed is correct.

Remember also, never overcool the motor; 180 degrees to 200 degrees is ideal for pump operation.

Make sure all connections are tight with good gaskets when connecting to the pump.

ANNUAL TEST OF PUMPERS. Pumps are required to be tested annually if full credit is to be given by the Rating Bureau.

The purpose of the annual test is so that a comparison can be made from year ro year of the pump's capabilities. If there is a variance of the different items such as RPM, it gives indications that the pump or motor of the apparatus is losing its efficiency and is in need of maintenance work.

If the pump is not able to deliver its rated capacity and the RPM of the motor is not as high on a service test as it was on the acceptance test or on the previous year's test, the trouble lies in the motor. On the other hand, if the RPM were as high or higher than on the acceptance test or previous year's test, the trouble lies in the pump.

The difference between the acceptance test and the annual service test is the length of time that the pump is tested, plus the fact the intermediate pressure test is eliminated.

Service tests should be made annually and the results and records of these tests should be filed.

PUMPER CLASSIFICATIONS. Pumpers are rated in two classes by the National Board of Fire Underwriters; however, since 1957 the Class "B" specifications, they must be taken into consideration and tested under these conditions. However, if the apparatus has ample horsepower it might be well to determine if

they will meet Class "A" requirements. If they do pass the Class "A" requirements, then continue to test them as Class "B". The Class "A" requirements are more stringent upon the capabilities of the pump.

A Class "A" pump should deliver its rated capacity at 150# pressure: 70% of rated capacity at 200# pressure, and 50% of rated capacity at 250#.

Class "B" pumpers, on the other hand, are only required to pump their capacity at 120# pressure, 50% of capacity at 200# pressure and 33-1/3% of capacity at 250# pressure.

A little time is required in setting up the test.

Various size pumps require different hose layouts and size nozzle tips.

It is necessary to make adjustments between the throttle and the discharge ports in order to discharge the correct amount of water.

Refer to the Fire Engine Tests and Fire Stream Tests book as put out by the National Board of Fire Underwriters for the GPM tables and nozzle tip size.

PUTTING PUMP INTO OPERATION

The State Fire Training instructors have held many meetings to try to decide on a uniform method of operation for fire department pumper operators, knowing full well that any set of rules will have exceptions and that good pump operators may in some instances deviate from these rules in the operation of their individual pumpers. However, it was felt that a broad concept of operational procedure should be adopted. Therefore, the rules given here for putting fire pumpers into operation were designed for good pump operator habits; simple rules to avoid confusion, to bring about a better understanding of pumps and driver-operator responsibilities.

Operation Procedure for Booster Tank

1. Standard Operation Procedure for Pumping (SOP)
   a. Steps necessary before leaving cab
      1. Set emergency
      2. Shift into proper pump gear and lock
      3. Shift from road to pump and lock
      NOTE: On some pumpers it may be necessary to perform operation 3 before shifting into gear.

   b. Steps for operation outside cab
      1. Place wheel blocks in position
      2. Open valve from tank to pump
      3. Prime pump (explain forming of good habits)
      4. Engage pump (NOTE: This step not required for some pumpers)
      5. Setpump for series operation
      6. Advance throttle to desired pressure
      7. Open discharge lines
      8. Check water and pump coolers and shutters
      9. Set relief valve or motor governor (unless in high pressure operation)
      NOTE: Shut down as shown on shut down check sheet.

Operation Procedure for Hydrant

1. Standard Operation Procedure for Operating from Hydrant
   a. Steps necessary before leaving cab
      1. Set emergency
      2. Shift into proper pump gear and lock
      3. Shift from road to pump and lock
      NOTE: On some pumpers it may be necessary to perform operation 3 before shifting into gear.

   b. Steps necessary for operation outside cab
      1. Close all valves
      2. Connect to hydrant
      3. Open hydrant
      4. Check compound gauge for static pressure
      5. Prime pump
      6. Engage pump
      7. Open discharge gates
      8. Check compound gauge for flow pressure

2558

(a) Should gauge drop in pressure 10% from static reading you can take 3 times the amount of water you are now taking. Should pressure drop 20%, you can take 2 times the amount of water you are taking. Should pressure drop 30%, you can duplicate amount you are taking.

9. Set transfer valve for pressure or volume
10. Advance throttle to pressure desired
11. Set relief valve or motor governor
12. Check operation of pump and engine
    NOTE: Shut down as shown on the shut down check sheet.

Operation Procedure for Drafting

1. Standard Operation Procedure for Operating from Draft
   a. Stop and set emergency
   b. Steps for operation at draft
      1. Close all valves (Rotary gear open discharge)
      2. Connect suction and suction strainer as shown in hose manual
      3. Spot for drafting
      4. Reset emergency
      5. Shift into proper gear and lock
      6. Shift from road to pump
      7. Prime pump (watch compound gauge and pressure gauge)
      8. Engage pump (NOTE: This step not required on some pumps)
      9. Bring pressure up to 50 lbs.
      10. Open discharge gates slowly
      11. Set transfer valve to desired position
      12. Bring up to desired pressure--100 lbs. to start
      13. Set relief valve or motor governor
      14. Check list (make out check list, oil, etc.)
          Same as for all operations
          Plus compound gauge

NOTE: Shut down as shown on shut down check sheet.

2559

BOOSTER TANK OPERATION

American LaFrance Ford 750 GPM Two Stage Centrifugal Pump operates on high pressure at 500 PSI with 80 GPM.

Operating as a Booster

1. Place the pumper in position and set the hand brake.

2. Disengage the clutch, shift the road transmission to direct drive and engage the pump by moving the pump shift lever to the pumping position. Engage the clutch. Lock the road transmission and the pump transmission in these gears.

3. Open the "Tank Valve" in the line between the water tank and the pump suction.

4. Check the position of the change over valve. Some manufacturers recommend "Capacity" operation for pressures up to 210 PSI regardless of the volume of discharge. Other manufacturers state that the "Pressure" or series side of the pump should be used for deliveries of less than half the rated capacity of the unit.

   Since booster operation seldom requires a delivery of more than half the pump capacity, most departments use "Pressure" operation for Booster deliveries in order to obtain the benefit of both stages of the pump to develop pressure. In this latter operation the engine RPM is reduced with resulting less wear and tear on the motor.

5. Pull out the primer draft-hydrant valve and the primer control lever.

6. Turn the relief valve handwheel clockwise to the extent of its travel and lock it in this position.

7. Open the hand throttle until the engine speed is approximately 3800 RPM and hold this speed until the pump pressure gauge indicates a stabilized pressure of at least 40 PSI. Push in the primer controls, the draft-hydrant valve, and close the throttle.

8. Open the booster line discharge valve (hose reel valve) and open the throttle to obtain the desired discharge pressure.

9. It normally will not be necessary to set the relief valve during booster operation since the low flow through the booster hose can be shut off without serious pump pressure rise.

10. Always open the "booster line cooling valve" to prevent overheating the pump during this type of operation.

11. To shut down permanently, close the throttle, close the booster discharge valve and close the water tank valve.

Operation as a High Pressure Unit

1. Shift and lock the road transmission in "overdrive".

2. Close the relief valve hydraulic lock and proceed as outlined under "Operating as a Booster".

3. Before priming, turn the change-over valve to its "Pressure" position by turning it clockwise to the full extent of its travel.

4. Always open the "Booster Line Cooling Valve" when using a booster stream in order to prevent overheating the pump.

Comparative Engine Speeds When Operating in Pressure or Capacity
(Booster Operation)

	PSI (Pump)	RPM (Motor)
Pressure:	100 lbs.	1500
	150 lbs.	1800
	200 lbs.	2000
Capacity:	100 lbs.	2100
	150 lbs.	2500
	200 lbs.	3000

S2561

OPERATING PUMPERS FROM DRAFT

One of the chief difficulties of operating fire department pumpers is the operation of pumpers from draft. This is one of the prime responsibilities of the pump operator, as he must obtain water to his pump if he is to supply hose streams. The ability to supply these hose streams is dependent upon the knowledge that the operator has in regards to pumping water. This section will deal with the problem of supplying pumpers from draft and will give the operator information that will assist him to properly maintain water supplies for fire fighting operations.

The conditions that govern the supplying of water into the intake side of the pumper are dependent upon the type or source of water. There are three sources of water supply that are available to the pumper operator.

1. The water supply carried on the apparatus.
2. Water that is supplied under pressure from hydrant or standpipe.
3. Water that is supplied from a static source within reach of the suction hose.

The drafting of water from static sources, except for rural fire departments, is not done too frequently. However, there are problems that will arise that do not occur when taking water from the other sources. It is important that the operator of the pump become thoroughly familiar with the procedure for drafting with the particular model and type of pump which he is called upon to operate.

The ability to draft water and to deliver full performance from the pump is test of the pump itself and its operator. The drafting operation is more difficult than pumping water from a hydrant due to these factors.

1. Slight air leak may cause loss of prime.
2. Priming device is necessary as it can give trouble if not properly maintained.
3. Failure to follow a particular sequence for putting pump into operation.
4. Height of lift, the size and length of suction hose and atmospheric pressure.

Principles and Theory of Drafting

When pumping from draft we are concerned with both hydraulic and atmospheric problems. The entire operation, however, is dependent upon the 14.7 pounds of atmospheric pressure which elevates the water to our pumps after we have removed the air from inside our pumps and suction hose with our priming devices. Any fire pump, after it has been primed, is capable of supplying the desired discharge pressures, utilizing the horsepower of the motor to supply the pressures. The limiting factor of getting the water to the pump is the atmospheric pressure of 14.7 pounds. (See Fig. 18).

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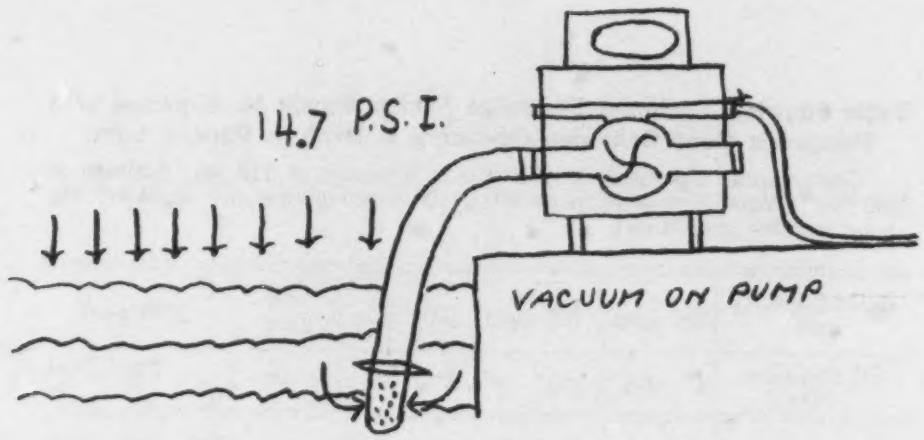

FIG. 18

Important to remember is the maximum distance that water can be drafted. If a priming pump could create a perfect vacuum in the pump and suction hose, a vertical lift of 33.9 ft. could be secured. However, this is impossible, and a fire pump that can "lift" water 25 ft. is considered of excellent design and condition. A more practical limiting factor is the fact that most pumpers are equipped with two 10 ft. lengths of hard suction so that 15 ft. is a more practical limitation of lift for the majority of our pumpers.

When pumping from draft -- we are aware of the fact that all pumpers that pass a Class A acceptance test are capable of providing rated capacity at 150 lbs., net pump pressure through 20 ft. of proper size suction hose at a 10 ft. lift from the surface of the water to the center of the pump. The pump can be expected to do better than this at a lower lift or, during a short spurt test, give rated capacity at 165 lbs., net pump pressure to demonstrate power reserve.

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Table Showing Minimum Discharge Which Should be Expected of a Pumper in Good Condition Operating at Draft at Various Lifts.

CONDITIONS: Operating at Net Pump Pressure of 150 psi; Altitude of 1000 feet; Water Temperature of 60°F; Barometric Pressure of 28.94" Hg (poor weather conditions).

Rated Capacity, Pump		500 gpm		750 gpm		1000 gpm		1250 gpm	1500 gpm		
Suction Hose Size		4"	4½"	4½"	5"	5"	6"	6"	6"	Dual 5"	Dual 6"
Lift in Feet											
4	20' Suction Hose (Two Sections)	590	660	870	945	1160	1345	1435	1735	1990	2250
6		560	630	830	905	1110	1290	1375	1660	1990	2150
8		530	595	790	860	1055	1230	1310	1575	1810	2040
10		500	560	750	820	1000	1170	1250	1500	1720	1935
12		465	520	700	770	935	1105	1175	1410	1615	1820
14		430	480	650	720	870	1045	1100	1325	1520	1710
16		390	430	585	655	790	960	1020	1225	1405	1585
18	30' Suction Hose (Three Sections)	325	370	495	560	670	835	900	1085	1240	1420
20		270	310	425	480	590	725	790	955	1110	1270
22		195	225	340	375	485	590	660	800	950	1085
24		65	70	205	235	340	400	495	590	730	835

NOTES: 1—Net pump pressure is 150 psi. Operation at a lower pressure will result in an increased discharge; operation at a higher pressure, a decreased discharge.

2—Data based on a pumper with ability to discharge rated capacity when drafting at not more than a 10-foot lift. Many pumpers will exceed this performance and therefore will discharge greater quantities than shown at all lifts.

FIG. 19

The ability of a pump to draft water decreases at higher altitudes and for all practical purposes it may be considered that the atmospheric pressure is approximately 1/2 pound less per 1,000 feet of elevation. In addition, the power generated by internal combustion engines decreases about 3.5% for each 1,000 feet elevation above sea level.

2564

If the operator can reach water with 20 feet of suction hose (properly immersed) there is usually no difficulty in pumping rated capacity, provided the pump and motor are in fairly good condition. If water cannot be reached with 20 feet of suction hose, either because of the vertical lift or horizontal distance, we have a different problem. First, we know that with a given flow we will have about 50% more friction loss through the 30 feet of suction hose of the same size. This can be observed by watching the suction gauge while drafting. The increase in friction loss may not be a major factor where the lift is below 8 or 10 feet because there will still be better than 10 pounds of atmospheric pressure left (near sea level) to overcome losses in the hose and the increased friction loss in the extra 10 feet of suction hose.

However, when the height of lift exceeds 10 feet, the amount of water that a pump can lift is cut drastically. Accordingly, if the lift is above 10 feet and it is necessary to use 30 feet of suction hose, it is best to conclude that the pump may not be able to deliver its rated capacity. As the lift increases, more of the atmospheric pressure is used to overcome the elevation, just as more pressure is required to pump water up hill. Less pressure is then available to overcome friction loss in the suction hose and the loss in strainers. The only way we have of reducing the pressure loss is to increase the diameter of the suction hose just as we reduce the friction loss between the pump discharge and the nozzle by using larger hose or using siamesed lines.

At a 10 foot lift 4.33 pounds of the atmospheric pressure are used which at sea level leaves a little over 10 pounds to overcome friction and other losses on the suction side of the pump. At a 20 foot lift 8.66 pounds are lost due to lift, leaving only 6 pounds to overcome other losses.

At this point it may be well to mention that water should reach the impellers at a satisfactory rate for efficient results. If a pump is operated so that it "runs away from water", that is, at an excessive speed considering the capabilities of the suction arrangement, damage may result due to cavitation. This is a turbulence or hammering effect resulting where air cavities are formed about the impellers, resulting in vibrations, loss of efficiency and damage to the pump. Obviously, sufficient pressure is needed at the pump inlet to provide the required velocity of flow for the required volume of discharge. In general, when drafting, it is desirable to have some reserve on the suction side although there may be times when it will be desirable to draft all the water the pump can handle without damage to the pump or engine.

002565

The 4-1/2 inch suction has 26% more waterway area than the 4 inch; the 5 inch has 54% more area than the 4 inch, and 23% more than the 4-1/2 inch. Atmospheric pressure is measured in pounds per square inch. Thus, other things being equal, at given atmospheric pressure, the 4-1/2 inch suction hose provides 26% more work area for the atmospheric pressure under a given vacuum condition than with the 4 inch suction hose. The 5 inch provides almost as much again. Thus while we cannot increase the atmospheric pressure it can be made to work over a larger area through a bigger conductor which also means that because the larger suction hose holds more water we have a lower velocity and reduce the friction loss with a given flow. Nevertheless, we cannot entirely overlook the fact that smaller suction hose is easier to handle where speed would be considered of prime importance.

The use of additional lengths of suction hose for horizontal distances would be limited by the amount of suction hose available, and the factor of added friction loss plus the longer time for extraction of air when first priming the pump.

The loss of pressure in drafting (due both to elevation of the water and friction loss) can be observed by watching the suction or compound gauge on the pump inlet. With an approximate 10 foot suction lift, with the pump primed, but with no hose stream operating, it will be noted that the gauge shows a suction or vacuum reading of about 9 inches of mercury. (The suction side of the gauge is graduated in inches of mercury equivalent to 0.491 pounds feet pressure head.) This shows the loss of atmospheric pressure due to difference in elevation between the surface of the water and the pump chamber. For field practices, an inch of mercury would indicate a capacity of lifting water one foot.

As the flow increases on the discharge side, so will the pressure loss on the suction side increase. This is due to the increase in friction loss in the suction hose and fittings on the suction side of the pump. If we have sufficient flow all of the available atmospheric pressure will be used or the point of maximum capability of the pump to maintain a vacuum will be reached. For a pump in reasonably good condition this may be a vacuum of 22 inches of mercury. If a pump is drafting with a lift of 20 feet it will use about 18 inches of mercury just in overcoming elevations and will have only 4 or 5 inches left on the compound gauge to overcome friction loss.

SHUTTING DOWN

After a pumper has served its purpose of providing pressure to satisfy the hose layout needed to control a fire, a start should be made promptly to get the pumper back in service for another fire call. This should be done as rapidly as is consistent with the need for standing by against possible additional pumping service at the fire. Often, the first practice is to reduce any 2½" lines by attaching the 1½" leader lines normally used for inside service. The engine of the pumper may be idling or the pump may be maintaining 80 to 100 lbs. pressure in the lines used for overhauling. When it is certain that nothing more than a watch line is needed, the hose may be transferred to a hydrant and the pump released.

The following suggestions and precautions apply to the procedure for shutting down:

1. Lower the pressure slowly by retarding the throttle as soon as there is no further need for pump pressure. Do not suddenly increase or decrease engine speed while pumping unless the pump is equipped with a quick action type of engine governor. Even the quick action throttle is intended for emergency protection of the hose crew. Engine and pump speeds should be raised or reduced moderately.

2. If the throttle control is of the screw-in type it should be turned at a moderate pace. If it is a lever working on a quadrant, the lever should be lifted so it does not drag across the teeth of the quadrant.

3. Close the throttle so that the engine is running at a fast idle before disengaging the pump.

4. Close the discharge gates slowly after pressure has been lowered.

5. As soon as the discharge gate is closed, open the bleeder cock to drain water from the hose line.

6. Water to the cooling system should be immediately shut off.

7. Release the pressure governor controls, or reset the relief valve to normal engine house setting.

8. Refill the booster tank with water.

9. Refill the gasoline tank as soon as practical. Replace oil in the priming pump if required.

10. After pumping from the water tank, close the tank valve unless the pump is to be carried full of water.

11. Drain all valves, pump chamber and gauges promptly in cold weather.

2567

SAFE DRIVING SUGGESTIONS FOR FIRE APPARATUS

1. Do not depend on your siren for right-of-way; other emergency vehicles may also respond to alarm.

2. Have apparatus under control at all times; the apparatus and men are dependent upon you.

3. Keep to your side of the road, if possible.

4. Turn corners at "safe speed".

5. "Feel" your brakes before you need them.

6. Do not lug motor--shift down to climb hills. Shift down to descend hills but be careful not to overspeed motor.

7. Do not "jump" truck when starting and don't crowd shifting up gears when starting; give the motor a chance to acquire its RPM.

8. Getting apparatus to the fire is the "first" responsibility. Speed is secondary.

9. Don't attempt to shift gears to reverse direction while apparatus is moving. Remember the weight.

10. Fire apparatus is an emergency vehicle only when responding to an alarm. When returning to station observe all traffic rules.

THINGS TO WATCH WHILE "OPERATING PUMP AT FIRES"

1. Temperatures--Engine, Pump, Transmission, Exhaust.
2. Gauges--Oil, Ammeter, Pressure, Vacuum, Tachometer, Fuel and Water.
3. Fuel--Oil. (Quantity)
4. Leaks--Water, Oil, Grease, Fuel, Exhaust, Suction.
5. Batteries--Keep water in Batteries; watch overheating.
6. Check water level in Booster Tank. (Replenish supply if possible)
7. Make sure "all" equipment is on apparatus and properly secured before leaving the fire.

APPARATUS CHECK ON "RETURN TO QUARTERS"

(Use Regular System of Checking)

VEHICLE

1. Replenish Fuel, Oil and Water
2. Battery (Recharge if under 1,250)
3. Lights and Switches
4. Fan Belt
5. Tires

EQUIPMENT

1. Fill booster tank and P can
2. Hose
3. First Aid Appliances
4. Service Respiratory Protective Devices
5. Salvage equipment and tools

PUMP

1. Primer Tank
2. Lubrication--Valves, Oil Level, Bearings, Packing
3. Drains (When used)

REMARKS:

Apparatus O.K. for service

Signed_____

2568 86

SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	REMEDY
PUMP FAILS TO PRIME OR LOSES PRIME	Air Leaks	Clean and tighten all suction connnections. Make sure suction hoses and gaskets are in good condition. Use the following procedure to locate air leaks: 1. Connect suction hose to pump and attach suction cap to intake end of hose. 2. Close all pump openings. 3. Open priming valve and operate primer until vacuum gauge indicates 20 to 22 inches H. G. (If primer fails to draw specified vacuum, it may be defective or leaks are too large for primer to handle.) 4. Close priming valve and shut off primer. If vacuum drops to less than 12 inches H. G. in ten minutes, serious air leaks are indicated. With engine stopped, air leaks are frequently audible. 5. If leaks cannot be heard, apply engine oil to suspected points and watch for break in film or oil being drawn into pump. 6. Connect suction hose to hydrant or auxiliary pump. Open one discharge valve and run in water until pump is completely filled and all air expelled. Close discharge valves, apply pressure to system and wateh for leaks. A pressure of 100 PSI is sufficient. DO NOT EXCEED RECOMMENDED PRESSURES.
	Dirt on Suction Strainer	Remove all leaves, dirt, and other foreign material from suction strainer. When drafting from shallow water source with mud, sand, or gravel bottom, protect suction strainer in one of the following ways:

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SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	REMEDY
PUMP FAILS TO PRIME OR LOSES PRIME (Contd)	Dirt on Suction Strainer (Contd)	1. Suspend suction strainer from a log or other floating object to keep it off bottom. Anchor float to prevent it from drifting into shallow water. 2. Remove top from a barrel. Sink barrel so open end is below water surface. Place suction strainer inside barrel. 3. Make a suction box, using fine-mesh screen. Place suction strainer inside box.
	No oil in priming tank	With rotary primer oil is required to maintain tight rotor seal. Check priming tank oil supply and replenish, if necessary.
	Defective Priming Gear Valve	A worn or damaged priming valve may leak and cause pump to lose prime. Consult primer instructions for priming valve repairs.
	Improper Clearance in Rotary Primer	After prolonged service, wear may increase primer clearance and reduce efficiency. Refer to primer instruction for adjusting primer clearance.
	Engine Speed Too Low	Refer to instructions supplied with primer for correct priming speeds. Speeds much higher than those recommended do not accelerate priming and may actually damage priming pump.
	Excess Carbon on Exhaust Primer Valve Seats	Refer to exhaust primer instructions for methods of carbon removal.

08570

SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	REMEDY
PUMP FAILS TO PRIME OR LOSES PRIME (Contd)	Suction Lifts Too High	Do not attempt lifts exceeding 22 feet except at low altitudes and with equipment in new condition.
	End of Suction Hose Not Deep Enough	Although suction hose might be immersed enough for priming, pumping large volumes of water may produce whirlpools, which will allow air to be drawn into suction hose. Whenever possible, place end of suction hose at least two feet below water surface.
	High Point in Suction Line	If possible, avoid placing any part of suction hose higher than pump suction inlet. If high point cannot be prevented, close discharge valve as soon as pressure drops, and reprime. This procedure will usually eliminate air pockets in suction line, but it may have to be repeated several times.
	Primer Not Operated Long Enough	Refer to instructions supplied with primer for required priming time. The maximum time for priming should not exceed one-half minute for lifts up to 10 feet.
ENGINE WILL NOT DELIVER CAPACITY A. Engine and Pump Speed Too Low at Full Throttle	Insufficient Engine Power	Engine requires maintenance. Check engine in accordance with manufacturer's instructions supplied with truck.
		Engine operated at high altitudes. Engine power decreases about 3% for every 1000 Ft. increase in altitude above sea level. Adjusting carburetor or changing carburetor jets may improve engine performance. Consult engine manufacturer's instructions.
	Relief Valve Set Improperly	If relief valve is set to relieve below desired operating pressure, water will by-pass and reduce capacity. Adjust relief valve in accordance with manufacturer's instructions.

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SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	REMEDY
ENGINE WILL NOT DELIVER CAPACITY (Contd) A. Contd.	Transfer Valve Set Improperly	Does not apply to single-stage pumps. Place transfer valve in VOLUME (Parallel) position when pumping more than 2/3 rated capacity. For high pressures, turn transfer valve to PRESSURE (Series) position.
		When shifting transfer valve, make sure it travels all the way into new position. Failure of transfer valve to move completely into new position will seriously impair pump efficiency.
	Truck Transmission in Too High a Gear	Consult vehicle instruction for correct pumping gear. Pump usually works best with transmission in direct drive. If truck is equipped with an automatic transmission, be sure to lock into pumping gear.
	Pump Wear Rings Badly Worn	Failure of pump to deliver rated capacity and pressure may be an indication that pump wear rings are badly worn. Excessive wear will allow severe internal leakage from the pressure side of the pump back to suction and reduce net pump capacity.
B. Engine and Pump Speed Higher than Necessary for Desired Pressure and Volume	Suction strainer, Suction Screens, or Impeller Vanes Fouled With Debris	Remove suction strainer and hose and clear away all debris. Pressure backwash will usually clear impeller vanes when pump is stopped.
	Suction Hose Defective	On old suction hoses, the inner liner sometimes becomes so rough it causes enough friction loss to prevent pump from drawing capacity. Sometimes the liner will separate from the outer wall and collapse when drafting. It is usually impossible to detect liner collapse, even with a light. Try drafting with a new suction hose; if pump then delivers capacity, it may be assumed that previous hose was defective.

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SERVICE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	REMEDY
ENGINE WILL NOT DELIVER CAPACITY (Contd) B. Contd.	Suction Hose Too Small	When pumping at higher-than-normal lifts, or at high altitudes, use a larger suction hose.
	Truck Transmission in Too Low a Gear	Consult vehicle instructions for correct pumping gear. Pump usually works best with transmission in direct drive.
PUMP WILL NOT DEVELOP SUFFICIENT PRESSURE		In general the above remedies for low pump capacity will also correct low pump pressure. In addition, check the following possibilities.
	Pump Speed Too Low	Check pump speed with a tachometer. If pump speed is too low, refer to engine manufacturer's instructions for method of adjusting engine speed governor.
	Pump Capacity Limits Pump Pressure	Do not attempt to pump greater volume of water at the desired pressure than the pump is designed to handle. Exceeding pump capacity will reduce pressure in an inverse ratio. Exceeding maximum recommended pump speed will produce cavitation and seriously impair pump efficiency.

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WATER FLOW DIAGRAM

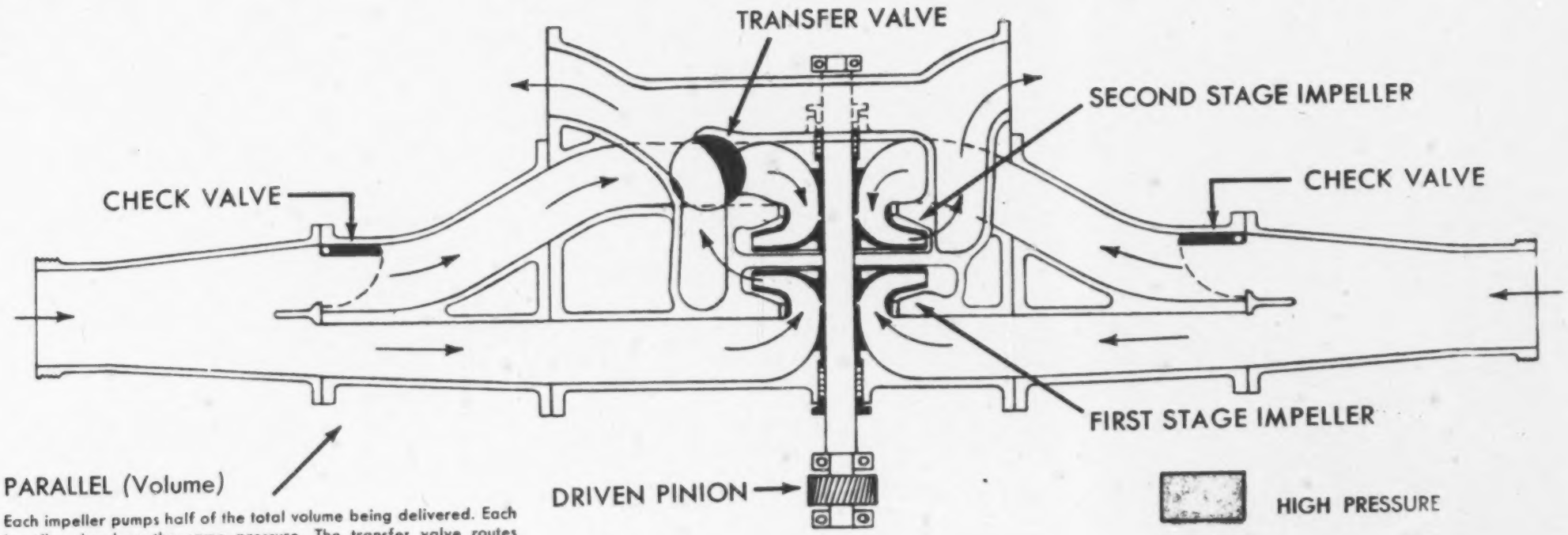

PARALLEL (Volume)

Each impeller pumps half of the total volume being delivered. Each impeller develops the same pressure. The transfer valve routes water from the first stage impeller directly to the pump discharge.

HIGH PRESSURE

INTERMEDIATE PRESSURE

SUCTION

SERIES (Pressure)

Each impeller pumps all of the total volume being delivered. Each impeller develops half of the total pump pressure. The transfer valve routes water from the first stage impeller to the second stage suction. Suction flap valves are closed by this pressure.

At a constant impeller shaft speed, where changing from parallel to series operation, pressure is doubled and volume halved.

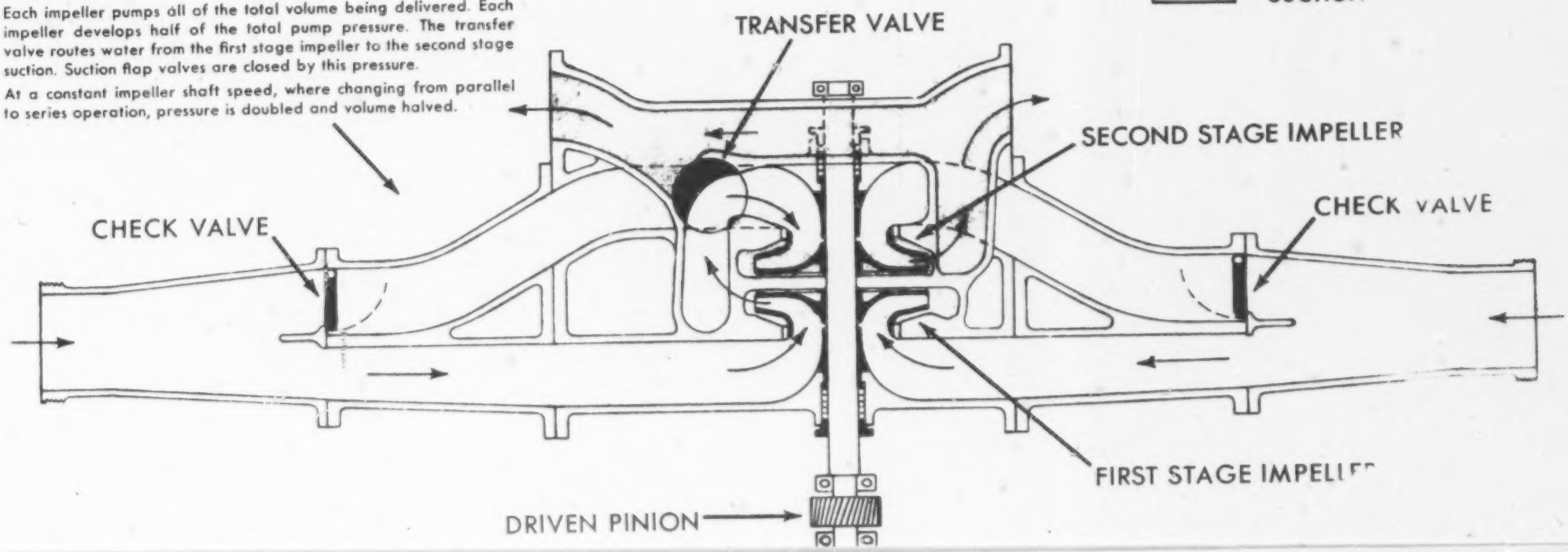

2574

FIRE SERVICE LADDERS

Ground Ladders

One of the most important tools for fire department use is the ground ladder. By ground ladder we mean those ladders specially designed for use by the fire department and those not raised by mechanical means such as the aerial.

It is most important that firemen understand the purposes of ground ladders, their use and limitations.

Ladders, as other equipment used by the fireman, must be ready for use at a moment's notice. Therefore, it is important to the fireman that he examine his ladders thoroughly and often to see that all parts are in good working order and that they are safe for use. He must train often on them so that he will understand proper placement of the ladders to take full advantage of their construction features and to have confidence in their use both for fire fighting and rescue work.

Failure of the fireman to make the proper selection and placement of the ladder could result in additional danger to those being rescued or in their not being rescued at all.

As a fireman, you should know the best methods for using your ladders below ground level, as bridges for crossing from building to building, as a rescue tool and how to use them in fire fighting.

Through continued use and drills you will be able to overcome any fear of height that you might have.

American Insurance Association - Requirements

Fire departments, as you know, are graded by both the American Insurance Association and the Pacific Rating Bureau. These organizations have developed requirements for fire department ladders which are based upon the following:

> Where a ladder company is not required in cities having less than five buildings of three stories or higher, ladder equipment must be provided on other apparatus capable of reaching the roof of buildings.
>
> An aerial ladder must be provided in a district where five buildings are four stories or higher and one ladder truck in every five required shall be aerial.

As we are not concerned with aerial ladders for this class, we shall only list those ladders required for other fire apparatus.

2575

Ground ladders required for ladder truck:

A. 50 ft. extension
B. Two 35 ft. extensions
C. 20 ft. roofer
D. 16 ft. roofer
E. 28 ft. extensions
F. 14 ft. roofer
G. 10 ft. folding

Ground ladders required for pumpers:

A. 14 ft. roofer
B. 24 ft. extension unless otherwise specified by A.I.A. or Rating Bureau.

It is recommended that pumpers also carry the folding ladder for use inside buildings.

Ground ladders for tankers:

A. 12 ft. folding or straight ladder.

Grades of Ladders

There are many types and grades of ladders. All too often in writing fire apparatus specifications the type and grade of ladder is left undetermined and we do not get the type ladder most suited for our particular needs. The type and grade of ladder you wish should be spelled out through your ladder specifications. There are industrial ladders not suited for fire department use on many fire trucks. You should determine and order one of the two or more grades of fire department ladders. When writing specifications for fire apparatus, ladder catalogs may be obtained from all companies.

Construction of Ladders

The fireman should thoroughly understand the construction of fire department ladders. There are many various woods, metal and wood covered fiber glass ladders in use today. In order to determine the kind and type you wish to use we will cover some of the materials used.

Early fire department ladders were of carefully selected air-dried fir lumber in which consideration was given to ring count and grain texture. Rungs of these ladders were either hickory or white ash also carefully selected. Cost and lack of quality fir has allowed for a lesser quality of ladder construction in wooden ladders. Today's wooden ladders, however, are still built of a high grade carefully selected air-dried fir for beams and good grade hickory or white ash for the rungs. Some ladders today are also using high grades of spruce for their beams or rails.

The wooden ladder is fast being replaced with metal ladders of aluminum alloy and in many instances for aerial ladders of stainless steel or steel. The aluminum ladder is popular because of its light weight which allows for ease of handling and low cost of maintenance and repair.

Following is a list of some of the types of ladders in use by fire departments that are constructed either of wood, metal or wood covered fiber glass.

1. Folding or collapsible (See Figure 1)

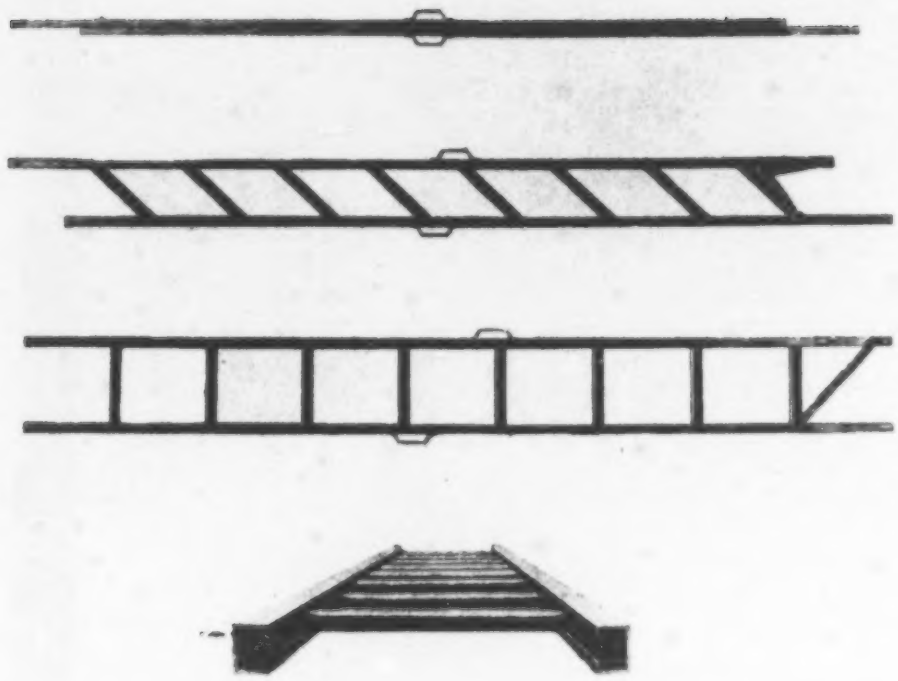

Figure 1

2. Baby extension
3. Wall or straight (See Figures 2 and 3)

The wall or straight
trussed beam ladder.

Solid beam wall
or straight ladder.

Figure 2

Figure 3

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4. Extension (See Figures 4 and 5)

Figure 4

The solid beam single-fly extension ladder.

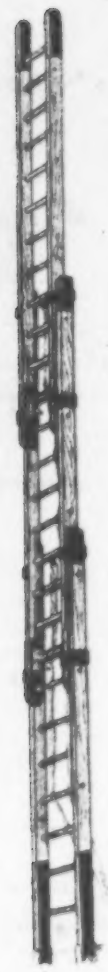

Figure 5

The solid beam two-fly extension ladder.

5. Roofer (See Figures 6 and 7)
6. Bangor (extension with poles) (See Figure 8)
7. Pompier or scaling ladder
8. Aerial ladder

The elevated platform is not listed as a ladder because in position there is not a continuous means of travel from top to bottom.

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Figure 6

The roofer trussed beam ladder.

Figure 7

The solid beam roof ladder.

Figure 8

The bangor trussed beam ladder.

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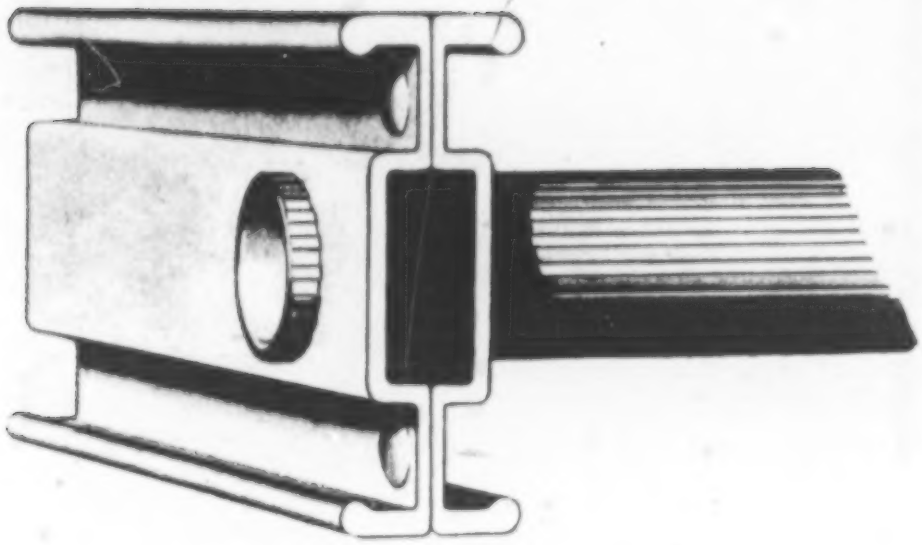

Figure 9

The solid "I" beam metal ladder.

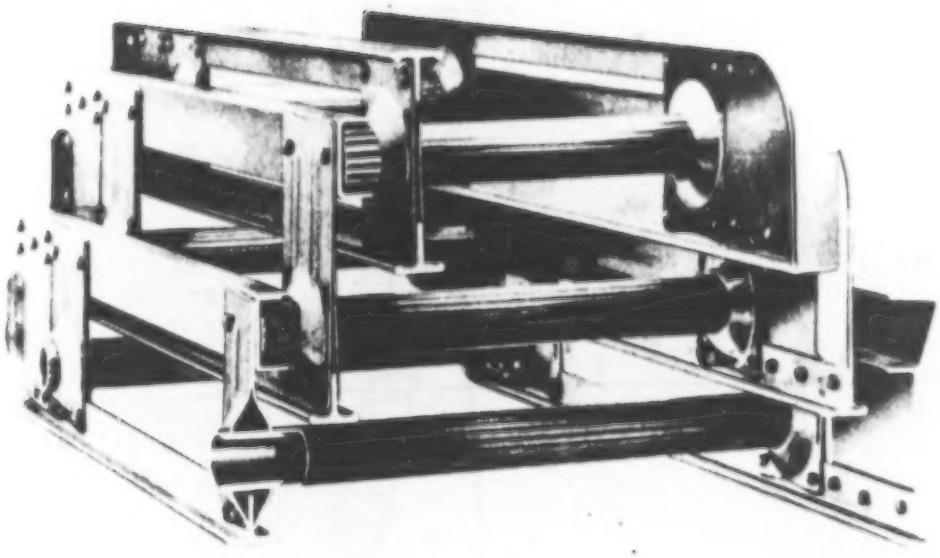

Figure 10

The trussed beam metal ladder.

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Nomenclature

All firemen should know the parts of a ladder so that they can understand ladder commands and so that they are better able to make visual as well as other inspection of the ladder.

Listed below are the parts found in most ladders using the proper terminology for each part:

1. Ladder beams
   These are sometimes referred to as side rails. However, the correct terminology is Beams. You will find two main types in wooden ladders--the solid and trussed beam as shown in Figures 5 and 8. In metal ladders this can vary somewhat, however, they too are also in the solid and trussed, the difference being in the individual manufacturers method of constructing the trussed beam of the ladder. (See Figures 9 and 10)

2. Rungs
   Rungs, of course, are self-explanatory and in most instances are spaced 14 inches apart.

3. Heel plates
   The heel plates are those metal plates upon which the bottom part of the bed ladder sits on when raised. (These are not known as spurs.)

4. Pawls or dogs
   In the fly section of extension ladders is a device which is spring actuated and comes out to hook over the rung of the ladder holding the fly in place so that it will not slide down the ladder. Thus we get the term "dogging the fly".

5. Halyard
   Any rope or line used to raise the fly.

6. Stops
   These are found at the bottom and top of bed ladders and second or third section fly which stop the fly ladders from coming out of the guides and prevents overextending ladders.

7. Guides
   These are found on bed ladders and allow the fly to ride in a groove within the bed ladder. (See Figure 11)

8. Truss blocks
   Used to separate the top and bottom beams.

9. Beam bolts
   Use to tie the top and bottom beams together usually through the truss block only found on wooden ladders.

10. Tie rods
    These also are usually only found on wooden ladders running from beam to beam beneath the rungs thus holding the ladder together.

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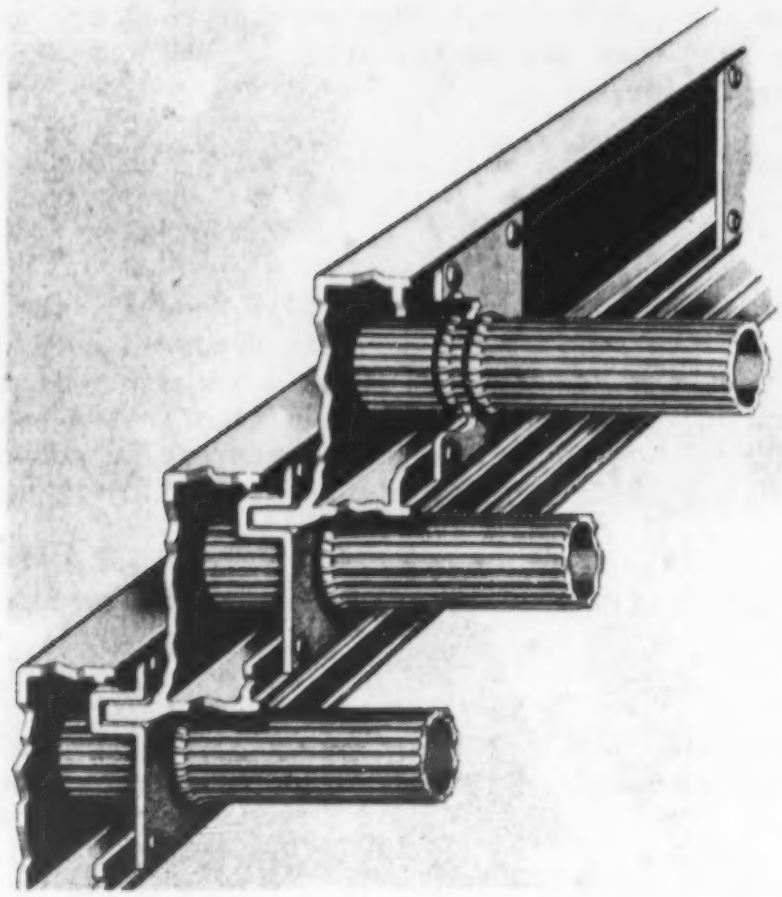

Figure 11

Shows the guides in which the fly ladders ride.

11. Braces
Sometimes small metal pieces are used to assist in supporting the rungs on the beams; they are always used on pompier ladders for supporting rungs.

12. Hooks
There are two types of hooks firemen are concerned with in regards to ladders--those found on pompiers and those on roof ladders. Those found on pompiers are used through the windows and rest upon the window sill. Those on roofers are used to hook over the peak of the roof to keep ladder from slipping off. There are, however, other uses for the hooks on roofers to allow a more versatile use of this type of ladder.

13. Tormenters
These are poles used on bangor ladders which will assist in raising the ladder and are set at right angles to prevent side sway. They should never be used as supports for the ladder itself.

14. Swivel
This is the connecting device to which the tormenter is attached to the beam of the bangor ladder.

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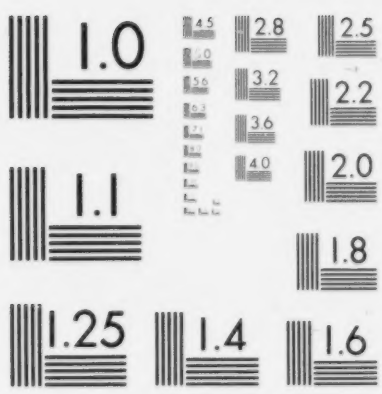

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15. Spikes
These are the metal ends of the tormenter of the bangor ladder.

16. Pulleys
Are found on the bed ladders and are the devices through which the halyard runs.

17. Bed ladder
The main ladder upon which the fly ladder rests and which is always the bottom ladder when the complete ladder is raised.

18. Fly ladder
The fly ladder is that ladder which rests upon the bed ladder and is raised to make an extension of the ladder.

Inspecting the Ladder

All ladders regardless of use must be checked thoroughly after each time they are used and at least once each month. Careful records should be kept when they have been inspected and if any repairs are made and what they were. In checking wooden ladders look for the following:

1. Rungs
   a. looseness
   b. wear
   c. slivers
   d. checks or cracks
   e. dry rot
   f. paint and varnish

2. Beams
   a. slivers
   b. checks or cracks
   c. dry rot
   d. condition of varnish or paint
   e. warping
   f. tie rods and beam bolts

3. Heel plates
   a. defects in metal parts
   b. dullness
   c. cracked parts

4. Halyards
   a. dry rot
   b. weak spots
   c. frayed or worn spots

5. Pulleys and locks
   a. breakage
   b. wear
   c. lubrication
   d. check springs, etc.

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6. Bolts (tie and beam)
   a. tightness
   b. burns or sharp edges

7. Guides for fly
   a. condition (Does fly slide easily. If not, use paraffin on parts that rub together.)

Consider the following items after inspection: Does ladder need revarnishing? Has the top of the ladder been painted white or the bottom black? If not, they should be painted for identification during use.

Ladders must be kept clean and should be washed at least once a month with lukewarm water so that the moisture content of wooden ladders is maintained.

When replacing the halyard be sure to splice; do not tie knots in these lines.

Further inspection of metal ladders requires that you check the following:

1. Rungs
   a. welds
   b. damaged or weakness caused by overloading or banging against a building
   c. looseness
   d. cracks, etc.

2. Beams
   a. welds, rivets and bolts
   b. signs of strain or metal fatigue
   c. deformed from heat or overloading

3. Halyards
   a. same as for wood if rope
   b. cable halyards check for fraying or breaking

Ladder Commands

It is necessary that all crews handling ladders work together as a team. Failure to do so will only result in confusion with the possibility of members of the fire department becoming injured or killed.

Ladder commands must be obeyed; therefore, it is necessary that a level-headed officer or leading fireman take charge of the crews. This in most cases should be an officer well trained in the use of ground ladders.

Commands for operations should begin upon the removal of the ladder from the apparatus and continue until it is replaced.

It is important that all commands be loud and clear.

Remember the person in command will be responsible for choosing the ladder to be used and its placement on the scene.

He is also responsible for the safety of the crew working with him and should always give thought to watching for holes in the ground that crew members might step in, fences, wires, cornices, hose streams, condition of building, etc.

The following ladder commands should be used at all times either on the drill ground or at the fire or rescue scene:

1. Prepare to remove ladder from apparatus
   a. men should assume positions to remove ladder
   b. unlock ladder
   c. remove from rig

2. Prepare to carry
   a. ladder is placed in carrying position with all members ready to go in the same direction

3. Carry
   a. ladder is in carrying position and on way to place it is to be used

4. Lower ladder
   a. ladder is lowered in preparation for raising

Selecting the Proper Ladder

The selecting of the proper ladder for doing a particular job is the responsibility of all firemen. Only in paid departments is this responsibility handled by an officer. In the volunteer department all too often the selection of a ladder or ladders rests upon any available fireman. It is important, therefore, that during drill sessions all firemen have some responsibility for selecting the ladder for a particular job.

Therefore, in determining this selection of a ladder one should give consideration to what he is going to do with the ladder. Here are some uses that ladders may be put to:

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1. Bridging
   a. from one building to another
   b. across holes in floors
   c. to run hose lines over streets, etc.

2. As a battering ram

3. As a framework for a drafting basin

4. As a pry for lifting heavy objects

5. As a platform for a rescue on thin ice or mud

6. As a rack for placing hard suction in water to keep the strainer off the bottom

7. To extend hose line to upper floors

8. For making rescue on upper floors

9. For use inside buildings for reaching fires in hard-to-get places

10. For reaching persons in areas below ground level such as caveins, etc.

In selecting a ladder to reach upper floors it is well for the fireman to remember these simple suggestions or rules:

1. Average distance of one story in height is 12 ft.
   Example: A three-story building would be 36 ft. to the ceiling of the third floor.

2. Average distance from window ledge to floor is three feet.
   Example: Two-story building: to reach second floor window height of ladder needed would be 12 ft. for first floor plus 3 ft. to window ledge or 15 ft.

It is important, therefore, in selecting a ladder to reach a certain height that we are able to make a rapid estimate of the height and select the proper ladder to reach this height allowing for enough length so that the ladder will extend two rungs over the window sill or over the top of the cornice.

Ladder Loading

There is a simple rule for determining the allowable ladder load. Use the first number of the length of ladder and this will give you a rule of thumb.

For determining ladder load:

1.	14 ft.	1 man
2.	24 ft.	2 men
3.	35 ft.	3 men
4.	45 ft.	4 men

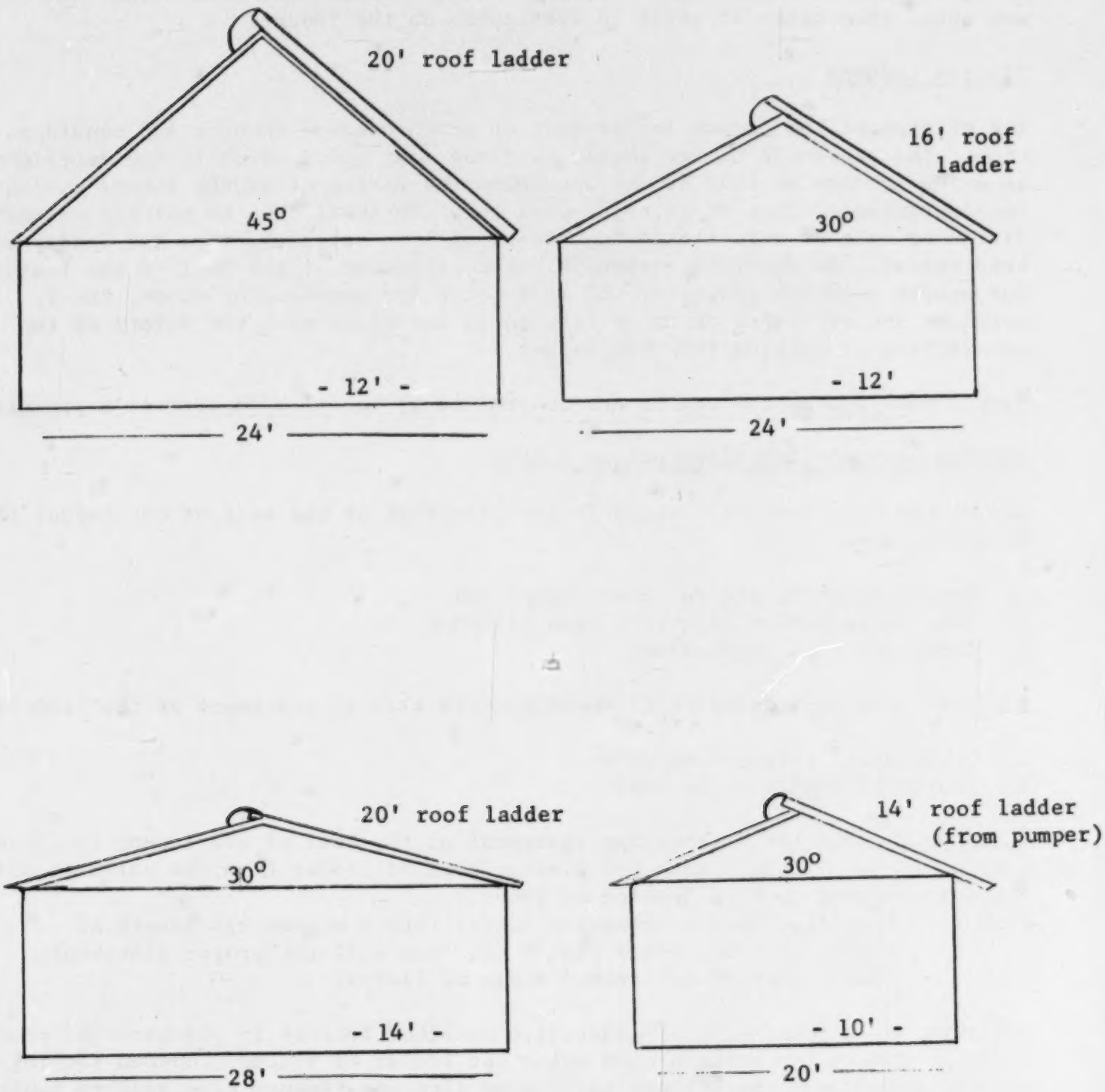

Figure 16

Shows how to determine selection of roof ladder.

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Ladder Loading, contd.

To maintain proper load when climbing a ladder it is recommended that the firemen space themselves at least 10 feet apart on the ladder.

Placing Ladders

The placing of the ground ladder must be given careful thought and consideration. The person in charge should have had many hours of drill and experience in using ladders so that he may determine the placement of the ladder giving consideration to what it is to be used for. He shall have to quickly estimate distances so that very little adjustment will be necessary once the ladder has been raised. He shall be responsible for placement of the heel of the ladder for proper climbing position. He must watch for overhanging wires, trees, cornices and any other obstacle that could interfere with the safety of the men raising or working from the ladder.

Many ladder placements can be pre-determined by the fire department's pre-plan.

Judging Distance for Placement of Ladder

One of the most important steps is the placement of the heel of the ladder if we are to have:

1. Proper climbing stance (See Figure 20)
2. Even distribution of weight when climbing
3. Speed and ease in raising

You must give consideration to these factors also in placement of the ladders:

1. Overhang of cornice and eaves
2. Length of ladder to be used

A simple formula for determining placement of the heel of the ladder is: Use 1/4 the length of the ladder for placing heel of ladder from the building adding any overhang such as cornice or eaves.
Example: Placing a 24 ft. extension ladder into a window 1/4 length of ladder is 6 ft. place heel 6 ft. from wall for proper placement. (See Figure 17 for proper angle of ladder)

You must, of course, give consideration to other factors in placement of your ladder. One is the terrain upon which the ladder is placed. Uneven sloping or soft ground must be allowed for. Some fire departments have ladders equipped with a ladder leveler; others must improvise to level the ladder by using blocks of wood. As this leveling of a ladder at its best is an unsafe practice, great care must be taken when it becomes necessary to block up a ladder so that it is level. In all cases a tie-in hook must be used to tie the top of the ladder in position.

It is recommended that whenever the terrain upon which the ladder is placed is not safe, constant heeling must be kept to prevent the ladder from slipping.

Use extreme care when placing the ladder on ice, asphalt, concrete and soft ground.

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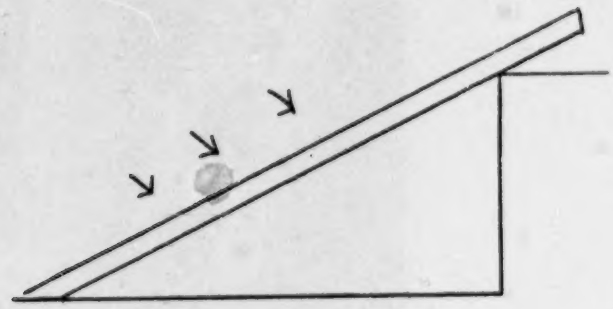

Improper angle
Loads tend to deflect beams

Proper angle
Beams support load

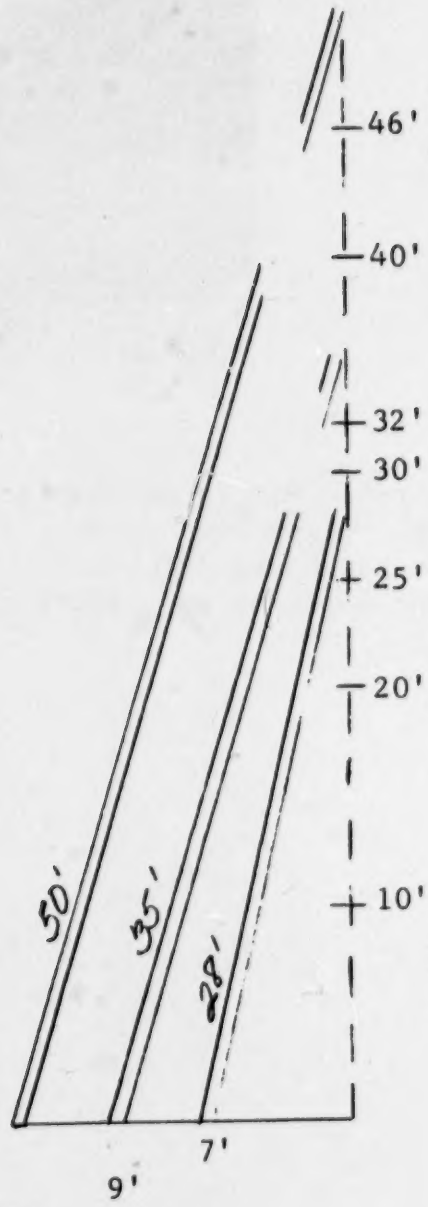

1 to 4 or 75°

Figure 17

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Figure 18

Shows correct way to quickly determine if ladder is at the proper angle for climbing. Place toes against heel of ladder, stretch arms out standing perfectly straight and if you can touch beams with finger tips, the ladder is in proper position for climbing.

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Raising Ladders

It is important that firemen train often in the use of ladders in order that when they are used on the fire scene all members of the department are able to effectively work together as a team.

Some of the raises that are required for fire and rescue operation are:

1. Shooting of the ladder
2. The beam raise
3. The flat raise
4. The hotel raise
5. The auditorium raise
6. Bridging

In raising ladders after proper selection and placement of heel, the firemen who are to raise the ladder should face each other across from each other. Adjustments must be made if one fireman is taller than the other. Figure 19 shows this proper position. Picking of the ladder from the ground must be done with the back muscles and legs keeping the back straight. Lifting this way will prevent any injury to the back. The ladder must be heeled at all times during raising operation and great care should be given to see that proper position for the heeling of the ladder be maintained during raising operations.

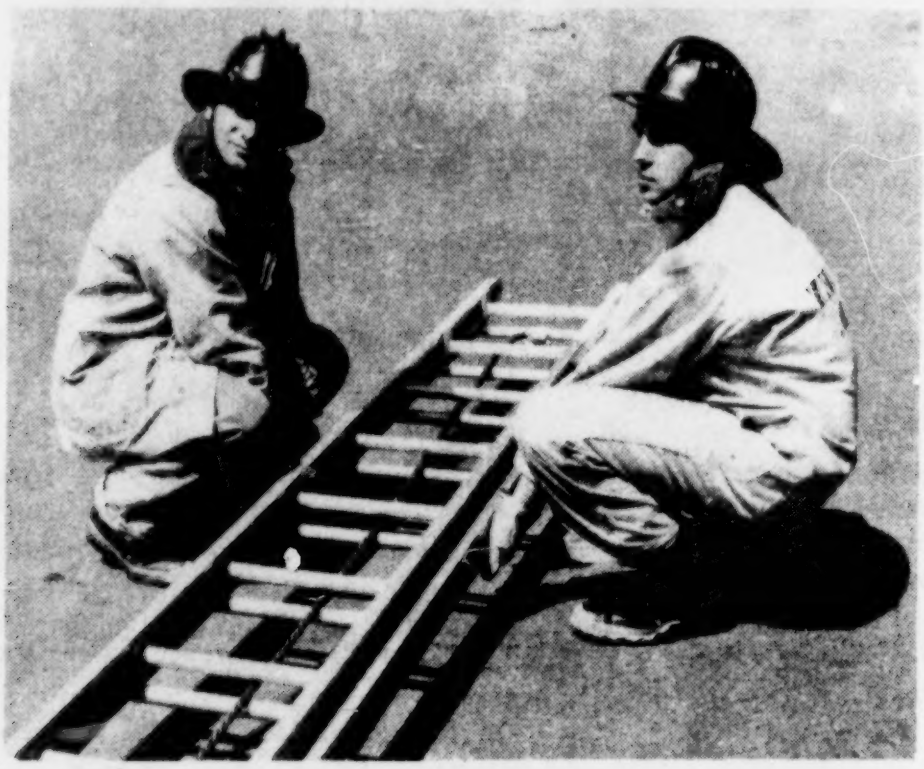

Figure 19

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Climbing the Ladder

In climbing ladders the fireman should climb on the instep of his foot so that the heel of his boot comes in contact with the rung of the ladder. He should climb with his back straight and arms extended as shown in Figure 20.

Figure 20

Tieing In

To tie yourself in on a ladder you put one leg between the rungs allowing the leg to come into contact on the back of the knee then hook the toe of the boot either over the beam of the ladder or over the rung below that rung the inside of the knee rests on.

Use the leg to tie in with opposite the side you wish to work on.

Figure 21

Shows proper tieing in on a ladder.

FORCIBLE ENTRY WITH SMALL TOOLS

Introduction

Somehow it is the habit of fires to start in some out-of-the-way place in a building, and apparently in the most unsuspected places. Because of this fact, fires, when discovered in the early stage, nearly always are inaccessible and forcible means must be used to reach them.

If you just stop and think of some of the common fires, discovered in the first stage, you will realize the meaning of this fireman's term "Forcible Entry." Many fires occur in locked buildings and when the occupants are away from home. The attic fire, for instance, usually requires the roof to be opened up and this must be done by force.

Rescue work, in many instances, calls for forcible entry. Children have a habit of locking themselves in bathrooms, and people overcome by asphyxiation many times are in locked rooms.

The very purpose of locks and inside fasteners, that of the protection of property, becoms a hindrance to the purpose of the Fire Department, that of the protection of life and property, and the protection device must be overcome by forcible entry methods.

Forcible entry, to the fire service, means the opening of doors, windows, roofs, floors, skylights, partitions, walls, etc, by mechanical means. To make such operations possible, tools for this purpose have been devised. Such tools are peculiar to the fire service and are designed for emergency operations. In fact, firemen themselves have made many suggestions and have actually designed these tools to fit their particular need.

Take, for instance, the fire axe as we know it today. It is not the common everyday type of axe that is found for sale, and for use by the average individual. This most important tool is properly called the "fireman's best friend," the pick-headed axe. Its one great advantage over a common axe is the pick on the back of the head. This is used to pull up flooring and roof boards, to remove partitions, and even for pulling lath and plaster in places inaccessible to pike poles. If it were used exclusively for cutting wood free from materials harmful to the blade, a wood chopper's axe would be ideal. However, the many requirements and severe service expected of a fire axe, such as all kinds of prying as well as cutting, make it advisable to have a pick-headed axe. If its blade is extremely sharp and body is ground too thin, pieces of the blade will be broken out when cutting gravel roofs or striking nails and other materials in flooring. If the body is too thick, regardless of the sharpness of the blade, the axe cannot be driven through ordinary flooring. Medium thickness of the body is necessary, the thickness depending upon the grade of steel being used and the experience of the operator. The temper should be such that the blade will not bend easily or break off when nails, gravel, or other foreign matter is struck with the axe.

Thickness should be: 1/4" at 3/4" back from edge, 3/8" at 1-1/4" back from edge and 1/2" at 2" back from edge. (Measure at center of blade.)

The axe should weigh from 5 to 8 pounds. The handle of the axe is left rather thick to prevent breaking should the axe be driven through a floor unexpectedly.

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The grip is thin to provide elasticity and should be smoothed to a polish. Paint or varnish should not be used, but a coat of boiled linseed oil may be used to exclude roughness and warping. The length of the handle is not necessary for the chopping action but is there primarily for leverage in prying.

When cutting with a fire axe, the axe should not be swung as a wood-cutter uses it, but it is used with short, quick strokes. Choke up a little on grip. Using this method, all danger of hitting the other men, catching the axe on overhead obstructions, etc., will be avoided, and the axe will be under complete control at all times.

When cutting flooring, roofing, or sheeting, the cut should be made at an angle to the grain of the wood, instead of straight across it. About a 60-degree angle is correct.

When cutting diagonal sheeting, it should be done, wherever possible, in the direction toward which the sheeting runs, so that the chips will have a tendency to split out as the cut is made.

Wherever possible, cutting should be done across the grain of the board instead of straight down. Also, cut as close to a joist or stud as possible.

FORCIBLE ENTRY METHODS

Suggested methods for opening the following, in respect to Forcible Entry:

Solid Core Door: A solid core door in a wood jamb, frame building, may be opened or forced inward by using a kelly tool, Hux bar, Halligan tool, door opener, an axe, etc., by spreading the door at the lock, away from the jamb and pushing inward.

Plate Glass Door: A plate glass door with wood stile and in a wood jamb, may be opened in the same manner as you would a solid core door if it is not fit too tightly in the jamb. If much forcing is necessary, it would be wise to break the glass for entry as there is a good possibility that it will be broken anyway with the forcing.

2 x 4 Bar Lock: This type of door is usually found to be of a double door type and swinging inward. It may be possible to put the blade of a saw between the two doors and cut or lift the 2 x 4 in the center, then either door should be free to swing open.

Door and Transom: A door and transom combination often affords entry by taking advantage of gaining entry thru the transom rather than forcing the door in cases that would warrant the time for such an operation. Glass in the transom may be broken, cleaned out around the frame, then lower a man down inside the room to open the door from the inside.

Padlock and Hasp: The pick head part of the firemen's axe is used to good advantage here to pop the staple free of the hasp by inserting it in back of the hasp or in the opening of the staple and forcing it outward. Other means of entry would be to turn the padlock over on the staple and strike it a sharp blow to break it or to use a bolt cutter on the staple itself.

Tumbler Lock: A tumbler lock presents a situation that is only met successfully with a special lock picking tool designed especially for such an occasion. It is inserted into the lock and the trigger is pulled. This is a universal tool that meets the occasion for all locks, causing the tumblers to line up in such a position that the tool may then be turned in the same manner as the key would be, thereby affording entry.

Crank Lock on Windows: Not much advantage, if any, is gained here in trying to force the window in a conventional manner, as extensive damage to the frame will be caused needlessly. Break the glass, clean out around the frame and reach through to turn crank for entry after lock has been freed.

Panic Hardware: Panic hardware presents a difficulty in that the normal means of fastening such a door is disregarded in favor of pawls in both the threshold and horizontal part of the door jamb. Unless glass may be broken in the door or other means of entry may be found, the only solution would be to bore or cut a hole in the door some 36" above the threshold, then reach into the opening and trip the panic bar.

Window with sash and twist lock: If this is a double run conventional type of window in a wooden frame, the blade of the axe should be inserted under the bottom sash, between it and the sill, and in direct line with the lock. Twisting the axe will force the window upward and spring the screws free of the lock.

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Metal Overhead Rolling Door: This type of door presents perhaps the most difficult type of door to force open. It is usually found in storage warehouses and places that require that extra ounce of protection from outside entry. The key to opening such a door successfully lies in the release of a chain from its pawl on the jamb of the door, that drives an overhead gear mechanism for raising of the door. The normal position for securing such a chain is approximately 40" above the threshold or floor on the left or right door jamb. (Prefire survey should be most helpful here.) If there is a tell-tale mark or colon on this spot, then entry can be made by cutting through the door here with a cutting torch which will allow the fireman to reach into the area to release the chain, then a bar under the door may be used to force it upward without the mechanical advantage of the gear mechanism being used.

Crawford Type Door: The Crawford type door, usually found in private dwellings consists of may small panels or a panel and glass combination. It is locked by means of a bar or rod running from the lock mechanism to the nearest outside rail. The best and fastest method for entry would be to break a glass near the lock (panel nearest the lock if no glass appears) then reach through, trip the lock, turn handle to open door.

Cement Block Wall: Cement blocks are usually made in two or three-sectioned, hollow core style. In breaching this type of wall, knock out the center section of one block, then work to the outside in much the same manner as you would with a brick wall. Use a heavy mall or the round end of a battering ram for the initial block, then work on the others with the pointed or prong end of the ram or pick part of the axe or hammerhead pick to free succeeding blocks.

Tempered Glass Door: Other means of entry should be explored before using such a door as this for entry into a building, due to the cost of replacement of such a door and the sometimes difficult time in breaking through it. It may be broken by using a Carbon Dioxide fire extinguisher on it for a short period of time, discharging the extinguisher at one corner of the door, then striking it with the pick part of the axe. This type of door has no stile or header rails. It is locked at the threshold. It can never be forced in the usual manner.

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FORCIBLE ENTRY TOOLS

Axe: The number one tool for forcible entry. The pick head axe cuts almost as well as the flat head axe, and when the pick is used, it becomes a very good digging and prying tool. The blade may also be used for prying operations using the handle as a lever.

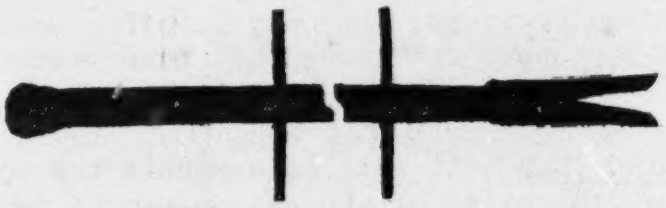

Battering Ram: Its use is for breaching walls and for forcing solid doors. When used on brick walls, the fork end of the ram is used and should be raised just before striking the wall so that a lifting motion is caused at the striking point. For forcing doors, the butt or round end is driven against the door just below the lock on the solid portion of the door (stile,) not against the panel.

Bolt Cutters: Their use is for cutting soft steel, iron bolts, padlocks that DO NOT have tempered steel, and cables of greater size than could fit into the jaws of a cable cutter.

Cable Cutter: A special tool designed for the express purpose of cutting cable. It should not be used for any other purpose. It is designed with a guide so that the material to be cut is held in square alignment with the cutting jaws and one of the cutting jaws is designed to give a shearing action across the cable being cut.

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Crow Bar: A long straight bar with a chisel-like point on one end, used for prying heavy planking and flooring; to open heavy or stongly bolted doors; and any other type of heavy requiring leverage.

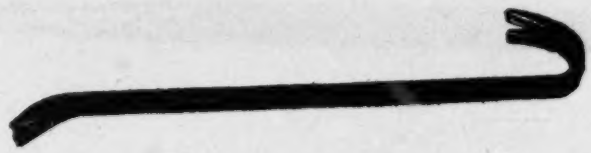

Wrecking Bar: A bar with curved end for offset work, and a nearly straight, chisel-like reverse end, used for breaking locks, opening doors, forcing window, lifting iron shutters, prying up rolling doors, and other uses where a prying action is needed.

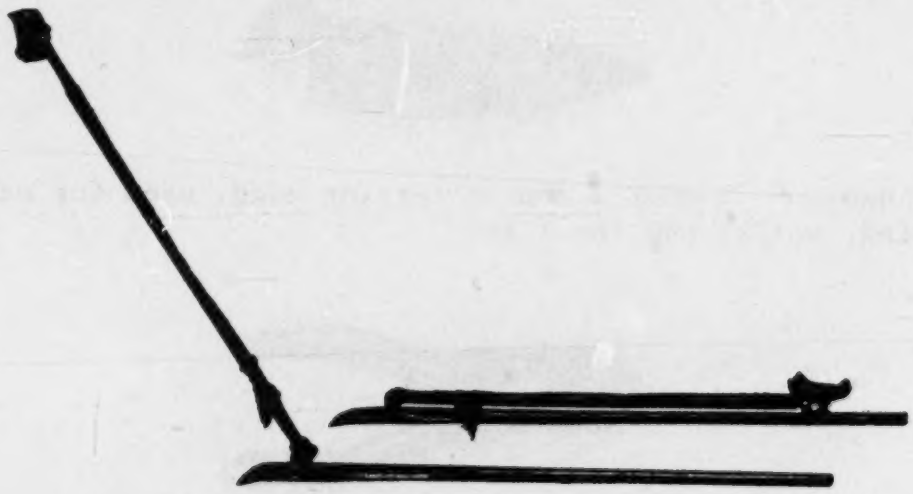

Door Opener: A special tool designed for forcing doors inward. It may also be used as an emergency hose clamp. It has an adjustable arm to fit various heights and is designed is such a way as to give great mechanical advantage to the user. It may also be used as a crowbar.

Sledge Mall: An extra heavy hammer-like tool commonly found in 8, 10, and 12 pound sizes, having a handle about the same length as the fireman's axe. It is used for breaking objects such as deadlights, concrete, tile, walls, floors, roofs, locks, and for bending iron bars or grating.

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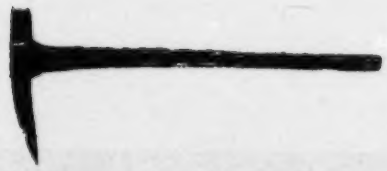

Pick Mall: A tool that incorporates the advantage of both a light sledge and a pick. It may be used in various types of heavy prying and digging operations. The hammer head part of the tool makes it possible for a sledge to be used in combination with it.

Pike Pole: A wooden pole in lengths of 6', 8', 10', or longer lengths with a metal tip used for removing lath from plaster walls and ceilings; corrugated iron walls and roofs; and for pulling down metal ceilings. It may also be used in breaking windows or opening them in hard-to-reach places.

Floor Saw: A hand saw having a convex cutting edge, used for making starting cuts in flooring, walls, and the like.

Wire Cutters: A cutting tool shorter in length and size than a bolt cutter, yet similar in design. It is equipped with a guide for aligning wire into its jaws. It also has soft rubber insulation on the handles. Its jaws are of a softer material so it should never be used on any material other than copper wire.

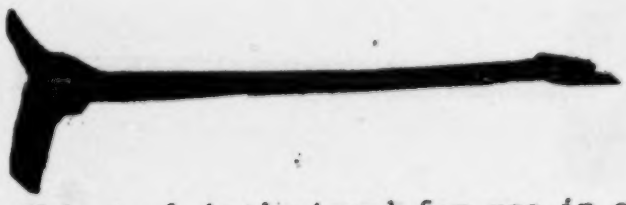

The Halligan Tool: This tool is designed for use in opening doors, locks, floors, baseboards, trim windows and is desinged for use as a prying tool. A sledge hammer and the pick part can be used for opening walls, etc.

The Hux Bar: This tool may be used for opening doors and windows and is also designed for shutting off gas meters.

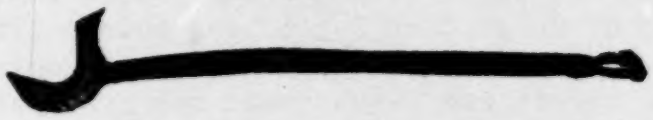

The Roof Cutter: A tool designed for opening metal roofs works much the same as a can opener; very effective for fast opening of metal roofs.

Chisel: Various types include the cold chisel, diamond point, and the punch. They are used in cases where it is necessary to cut metal, steel bolts, rivets or to open sidewalk elevators and the like.

Pliers: Pliers with pastic covered handles are very useful in cutting wires, and have many other uses.

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FORCIBLE ENTRY WITH POWER TOOLS

Introduction

Through the years whenever it has been necessary to force entry into a building, vehicle, or aircraft for the purpose of fire extinguishment or rescue, most of the work has been done manually with axes, bars, battering rams, or special tools that required a great deal of effort by the fireman. This type of work often results in a delay in starting extinguishment on the fire as well as reducing the strength reserve of the firemen at a critical time in the operation.

Just as modern streamlined apparatus has replaced old time pumpers, power tools are now being recognized and used by many of the best rated fire departments to gain entry by force. This is especially necessary when entry must be made to permanent type buildings or those that follow the modern trend of construction with a minimum of windows and doors. The use of power tools provides entry quickly with the least amount of effort and leaves more men available to lay lines or whatever other action is necessary to handle other phases of the emergency. Every fireman should be completely familiar with power equipment at his disposal in order to get full value from it.

Power Sources: All power tools used in the field of fire fighting should be powered by units provided by the fire department as often the source of electricity to the building is already cut or in jeopardy by the time the apparatus arrives. By providing power source there is no scurry under stress or smoke conditions in an effort to find power to operate the equipment. Whatever the source of electric power, sufficient extension cord must be carried to provide access under all anticipated emergencies.

Portable generators offer the best answer to the problem as they can be set off the apparatus and used individually leaving trucks free to lay lines, hook up for pumping, etc. There are a number of highly efficient gasoline powered generators available, most of them now designed for simplicity of operation.

Heavy duty generators can also be provided on the apparatus with plug in connections to be readily available for use with the power tools.

In the absence of generators provided by the department and with power cut off at the building involved, it may be possible to draw on power from neighboring buildings. This generally is not a satisfactory method as locked doors at night may present an additional entry problem.

Porto-Power: The Porto-Power, manually operated but producing terrific power in pushing, pulling or lifting is especially adapted for use in rescue work where injured victims are pinned by fallen timbers, in vehicles, etc. This unit can be purchased to handle from four to fifty tons load. It develops its greatest power in pushing but is easily operated by one man. With proper accessories, the Porto-Power can adapt to almost any position or angle to do its work. Caution must be used in placement for use, as a slip after pressure has been applied can endanger firemen or victims being rescued. Also, care must be taken not to attempt to lift more than the weight designed for the ram as overlifiting can seriously damage the unit.

Sabre-Saw: The Sabre-Saw, which is an electrically powered heavy duty hack saw, has a special variety of uses in the field of Forcible Entry. A wide selection of quick changing blades gives it great versatility in making entry through differing types of metal, wall boards or wood construction.

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The saw works at extremely high speed and if properly operated can make entry even on flat surfaces where no starting hole is available. This is done by starting the blade parallel with the surface and gradually cutting into the surface until the full stroke cut is obtained.

Acetylene Torch: At times it may be necessary to remove heavy metal barriers to gain entry for either rescue work or fire extingushment. To cut out metal window bars, remove heavy locking devices, cut reinforcing steel, or to enter smashed vehicles it may be necessary to use the acetylene cutting torch. Great care must be used, however, to assure against burning trapped victims in rescue work or ignition of gases or gasoline in some types of emergencies. This can be accomplished by use of an asbestos blanket or water fog screen carefully used.

Under hazardous conditions the torch should never be used until fire protection equipment is in place and ready for instant use. When used to gain entry to a building one man should be delegated to make a special check against possible accidental fire start.

A special check should be made periodically to assure that supply bottles are full and the equipment is in instant readiness for use.

Chain Saws: The most versatile of power tools is undoubtedly the chain saw. Either electrically or gasoline powered, it provides ready access through all kinds of wood and wallboard. It is particularly useful in providing entry through heavy warehouse doors, laminated types of construction and removal of heavy timbers. The chain, or cutting edge, is readily removable and a new type of chain permits cutting through a limited number of small nails without seriously damaging the cutting teeth. Most of these saws operate with a centrifugal clutch so must be operated at full throttle.

Operators of a chain saw should gain all possible experience in order to become familiar with special operational problems, how to make the approach for the cut, etc.

At all times when these saws are in use extreme care should be observed in handling them. Other firemen should be instructed to stand clear and no hasty approach should be made near the operator. During the excitement of a fire a slip could result in very serious body injury.

Pre-connected Chain on Apparatus: Of small expense when considering its value in use is a heavy duty chain pre-connected to the frame or a heavy eye bolt at front of apparatus. Slack chain approximately twenty feet in length is stored on a spindle which can be located on the front running board or on a shelf between the front bumper and the truck body. In emergency use, the spindle is lifted off and the chain pays out readily.

It can be used at a moment's notice to remove objects blocking fire access routes, gates or heavy doors that have become jammed or are locked. It is also used to remove burning vehicles to a safer position from inside or outside of exposures, provided at the front of the truck it gives the operator an opportunity to see fully what is taking place. However, care should be taken to make sure no vehicle is pulled away on a down grade as brakes may slip and the vehicle become uncontrollable.

Pre-planning Heavy Equipment: Most small fire departments and fire districts may at some time be faced with emergency situations requiring the breaching of concrete walls or floors or some situation where heavy equipment is needed.

VENTILATION

The use of ventilation as we know it today has been brought about through a study of the control of fires.

The inability of firemen to get into buildings and the explosions that have taken place because of the lack of control through ventilation have caused firemen to give considerable study to this problem. These studies have given us certain facts concerning the effect of proper ventilation of buildings.

In the study of the problem of controlling fires through the use of ventilation it should be kept in mind that the fire that will require ventilation is the one where because of excessive HEAT, GAS and SMOKE the firemen are unable to make entry and extinguish the fire. All firemen will at some time come into contact with a fire of this type.

The usual fire department definition of ventilation is "the removal of dangerous and disagreeable smoke, gases and heat and the replacement with fresh air". The purpose of ventilation is: To clear the building of smoke, gases and heat through the use of directional control so that entrance can be made and hose lines can be advanced.

There will be times that ventilation will not be necessary because of existing conditions. Caution should be used when fire fighting strategy calls for ventilation so that indiscriminate opening does not take place. It is imperative that conditions which will require ventilation of buildings are fully understood.

This class is to help you understand the need for ventilation to control fires and to use ventilation properly so that there will be less fire and water damage, eliminate the life hazard to firemen, control the fire situation to prevent backdraft explosions, mushrooming or spread of fire and to control exposure hazards.

We should keep in mind that fires can and do start in fireproof buildings. Wherever there are people, there will be fires. Conditions exist in building construction over which we do not have control and which will at some time or other cause fires to get out of control with the resultant loss of life and property.

For proper means of ventilation the following methods of operation will be explained:

1. The use of water fog to ventilate
2. Cross ventilation
3. Vertical ventilation
4. Use of mechanical methods

It is well to remember that directional control of fires should be kept in mind at all times where ventilation is used.

VENTILATION WITH WATER FOG

One of the newest methods of attack and fast becoming one of the most popular methods is the "indirect method of attack" applying the principle of extinguishment by the use of water fog.

There have been many fine results from this method of attack; however, very little study has been given to its application where ventilation is desired. To ventilate a building using water fog certain requirements are desired; without these requirements ventilation with water fog will not be effective.

Heat. First, we must have heat in the building; a temperature of not less than 600° is desirable. Water will turn to steam if the temperature is 212° or above; however, because of the rapid cooling of the atmosphere, high temperatures are desired so that a large and continuous amount of steam is generated.

Confined Fire. To be effective the fire should be confined inside the building and not ventilated; however, effective application of water fog has been attained even though the fire has vented itself.

Correct Type Application. To have an effective application fog nozzles should have between a 30 degree and 45 degree pattern and of sufficient discharge to properly cover area of fire.

To have a clear understanding of what takes place inside a building that makes the application of water fog effective let us, step by step, go through this procedure.

We know we must have heat. Assuming that we have a fire confined inside a room or building and that the temperature is above the desired 600°, we will then apply water fog to the interior from the exterior preferably through a small opening such as a window directing the fog pattern into the superheated area near the ceiling of the room rotating the nozzle rapidly in a circular manner.

Water fog upon contact with the superheated area will then turn to steam at the rate of 200 cubic feet of steam for every gallon of water that is applied to the heated area. This steam will absorb heat causing the temperature to drop. However, for the purpose of ventilation what we are interested in is the quantity of steam that is generated. When more than enough steam has been generated so that there is more steam than the area will hold, an internal pressure is built up inside the room or building greater than the outside pressure. This pressure will try to equalize with the inside pressure causing the steam to be forced from the building carrying with it the heat, gases and smoke from inside the room or building thus allowing the firemen to enter and extinguish the remaining fire.

Application of water fog should cease when steam only is excluded from the room or building involved. Continuing of application will only result in water damage.

What to Watch for When Making the Indirect Attack

1. Turbulence caused by rapid expansion of steam carrying steam to all areas of building.

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2. Ejection of smoke from building.
3. Ejection of smoke and steam from building.
4. Ejection of steam from building.

When nothing but steam is being ejected from building or room, the fire has been sufficiently extinguished and ventilation process is complete, shut down lines and wait for atmosphere to clear. This clearing of atmosphere inside building may be hastened by the use of conventional methods of ventilation. Entry may be made soon after atmosphere has become clear.

CROSS VENTILATION

Cross ventilation is accomplished by opening windows or any other opening that will permit the horizontal escape of smokes and gases. Because of the fact that gases stopped from rising will spread outward, opening for escape should be on the leeward or downwind side of the building. This will take advantage of wind currents in getting the heated smoke to the outside.

Modern windowless buildings are a problem as to where to ventilate because of the lack of side wall openings. This leaves only top ventilation as a possibility. Another problem structure is one covering a large ground area such as a warehouse, factory, school, supermarket, barn or church. Each of these is an individual problem that can best be evaluated by a pre-fire inspection.

VERTICAL VENTILATION

Vertical ventilation is done by making an opening above the fire to allow the smokes and gases to escape. Any permanent structural features such as skylights, ventilators, elevator shafts, penthouses or air conditioning ducts can be used effectively for rapidly making an opening. These items are part of the building and may be used because they are usually connected to the interior of the building with no intervening floor or ceiling. In addition the repair afterward will be less costly than if a hole is chopped in the roof.

When an opening must be made in the roof, care should be given to the selection of the point at which the chopping will be done. It is self-evident that the opening should permit escape of the smokes and gases by a direct route. This is not always possible because of structural features or because the escaping heat would directly expose adjoining buildings. In this case the opening is made so the heat must pass through the least part of the involved structure.

In making an opening it is important to make the area large enough to allow passage of heat and gases with little hindrance. One opening 8 feet by 8 feet is the same area as four openings each 4 feet by 4 feet, yet the cost of repair will be little more for the one large opening than for either of the smaller ones. It is a common mistake to make the opening too small.

MECHANICAL METHODS OF VENTILATION

Smoke ejectors and water streams are classed as mechanical methods of ventilation.

Fire departments are finding the use of smoke ejectors very helpful in clearing atmospheres of heat, gases and smoke from buildings. Smoke ejectors should be

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used to force fresh air into smoke filled areas using conventional methods of ventilation to allow smoke, heat and gases to escape. This method is by far more efficient than trying to draw the smoke from these areas.

More efficient operation can be attained using smoke ejectors for cross ventilation by using two or more ejectors, placing one on the lee side drawing smoke to it and one on the windward side forcing fresh air into the area.

Water fog and straight streams can be used effectively to force smoke, heat and gases from buildings by making openings on the lee side and advancing hose lines into area from the windward side. This method should be used only when water damage is not a problem.

ADVANTAGES FROM VENTILATION

The principal results of proper ventilation are:

1. Aids rescue by permitting firemen to gain entrance.
2. Permits quicker location of the fire.
3. Reduces fire, smoke and water damage.
4. Aids salvage and overhauling.
5. Reduces the actual time of fire fighting and equipment out of service.

Additional results are:

1. Sells the fire department to the public by quicker and more efficient fire stops.
2. Reduces operating costs by conserving manpower and equipment.

By clearing the building of smoke, hot air and dangerous gases, ventilation accomplishes these results as follows:

1. Increases visibility permitting prompt and safe entry with rapid search and faster rescues.
2. Permits the fire to show making location quicker and easier.
3. Aids the attack at the seat of the fire thereby preventing spreading; less smoke loss; less water loss.
4. Reduces possibility of back draft; allows dangerous conditions to be seen with less chance for accident.
5. Increases speed and efficiency, fire out quicker, apparatus back in service quicker, lessens work and danger to men.

Smoke is a mixture of gases and fine particles of carbon resulting from incomplete combustion. It will be noticed that large quantities of smoke occur usually at fires that are confined where sufficient oxygen for complete combustion is not present. Basement fires are usually associated with large columns of smoke. Free burning fires result in very little smoke.

What are the conditions inside a building that require ventilation? The interior is filled with smoke. Heated air and unburned gases accumulate at the top and mushroom. The temperature may be upward of 1500 degrees. If the building is of reasonably tight construction, combustion will not be complete and this results in the formation of carbon monoxide.

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What happens when a building is ventilated? Smoke, hot air and gases are removed, pressure of expanding gases is released and mushrooming is prevented. Free burning and rapid combustion follow.

What happens when a building is not ventilated? Eventually it will ventilate itself. The hazard of a back draft is increased. Fire fighting is hindered and the resultant loss will be much greater.

BACK DRAFT

What is a Back Draft? It is an explosion caused by the admission of ordinary air, bearing oxygen, to a fire that has not been burning freely. With such a fire there is usually a large accumulation of flammable gases and the temperature well above the ignition point of these gases. When the right mixture of oxygen and gases occurs, ignition is immediate and a violent explosion may further spread the fire and cause injury to the firemen.

When to suspect a Back Draft. When a fire has been smoldering a long time or where there is a grayish hot yellow smoke, or if the smoke pours out of an opening for a time and then sucks back in.

Protection against injury. If you suspect a back draft, keep low; the explosion may pass over you. When opening up, do not stand directly in an opening; if possible, use pike poles or a long straight ladder to force doors and windows.

When to ventilate? When entrance to the building is impossible due to heat, dense smoke or dangerous gases. Wait until sufficient lines are laid and charged so that you are prepared to fight the fire. After entrance has been made ventilate only as needed.

Where to ventilate? Directly above the fire, if possible. Open elevator shafts, skylights, scuttle holes; cut holes in roof, if necessary; open windows; make openings in walls, ceilings or floors. Do not draw the fire through unaffected parts of the building. Check your wind direction and exposures to adjoining buildings.

GENERAL RULES FOR VENTILATION

Roofs. When you go to a roof to ventilate, be careful to check your way of escape. Note the direction of the wind and work with your back into it. Feel for hot spots to locate travel of fire. Make roof openings good sized. Remove skylight covers and insert a pike pole to break the lower frame which is often found at ceiling level. Investigate for false ceilings below roof openings and, if necessary, punch through it. On dwelling roofs try to cut the first hole near the ridge but not through the ridge timber. A good workmanlike job on all axe work reflects to the credit and efficiency of the fire crew. Cut through the roof boards along the rafter lines.

Windows. Do not open windows indiscriminately on all sides. Note the direction of the wind and work accordingly. Top floor windows may be opened all the way down from the top. A long ladder may be dropped against the glass when entrance to the building is not possible. A pike pole worked from the roof can be used for top floor windows. Lower floor windows are usually opened two-thirds from the top and one-third from the bottom.

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Basement. Basement fires are probably the most difficult to ventilate. In some cases elevator shafts can be used if the elevator is in favorable position. All exterior openings to the basement can be opened including sidewalk scuttles and deadlights, grade level entrance doors and windows. When it is impossible to make sufficient openings at front or rear, a board can be stripped from the floor above the basement. This can be done the entire length of the floor and then windows or doors both front and rear of this floor should be opened. If holes are cut in this floor, they should be near a front or rear window so as to permit the smoke to pass outside. Sometimes it is possible to speed up ventilation by concentrating several lines at the front or rear and driving the heat and smoke in the direction of openings that have been provided.

Residences. Ventilation is desirable if the building is heavily charged with smoke and fire is not in evidence. Additional ventilation is often necessary after the fire is knocked down to facilitate salvage operation and overhauling.

The Necessary Requirements for a fire department to do a first-class job of ventilation are:

1. Some knowledge of the scientific facts concerning fire particularly the travel and expansion of heated gases.

2. Good fire department discipline. The firemen must be so trained that they can work together with a minimum of supervision. There must be good teamwork between the men who lay the lines and those who do the ventilating so that all necessary preparations are made to fight the fire when it shows.

3. A thorough training in all forcible entry tools so that the results will show a workmanlike job.

4. A thorough knowledge of building construction and personal knowledge of buildings that have been rebuilt or modernized. Knowledge of items such as penthouses, skylights and parapets; exterior walls with openings, attachments and offsets; party walls; interior walls; partitions; fire curtains; vertical openings such as stairs, elevator shafts, dumb waiters; air shafts; light wells, etc. Also horizontal openings such as doors, windows, chutes, belt holes, etc.

5. A general knowledge of the type of occupancy and the nature of the contents.

The Hazards Involved in ventilation are:

1. Opening below the fire too soon.
2. Life hazard to firemen.
3. Spreading of fire by improper methods of ventilation.
4. Involvement of exposed buildings.

The Warnings to be Stressed in connection with ventilation are:

1. The ventilation should not proceed beyond the preparation stage until lines are charged and ready.

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2. Do not ventilate when it may involve exposed property until steps have been taken to protect such property.
3. Do not ventilate unnecessarily.
4. Size up the buildings in your district and plan ways and means of ventilating before the fire occurs.

TOXICOLOGY OF CARBON MONOXIDE

Carbon monoxide (CO) is the cause of more deaths than all other gases combined. Carbon monoxide, a colorless, almost odorless, tasteless, nonirritating gas, is produced by the incomplete combustion of fuels, such as coal, wood, gas, oil and gasoline.

Carbon monoxide is absorbed only through the lungs where it enters the blood stream in the same manner as oxygen. It exerts its harmful effects by displacing oxygen in the blood since it has approximately 210 times greater affinity for the hemoglobin in the blood than oxygen has. The resulting compound is carboxyhemoglobin which will not transport oxygen and also inhibits the remaining unbound hemoglobin from its normal function of oxygen transport. As a result, the patient is literally suffocating in the atmosphere containing ample oxygen. Some investigators hold the CO as an actual toxic action but this is not generally accepted.

As little as 0.07% (700 parts per million) of CO is capable over a period of time, of saturating 50% of the blood hemoglobin while a few breaths of 1.0% may cause 60% to 80% saturation and death.

It should be noted that shortness of breath and possibly a slight headache may occur after eight hours in a CO concentration of 100 parts of CO per million parts of air (ppm). This is the "threshold" limit recommended by many agencies for safe exposures eight hours a day, five days a week. Some authorities say that 100 ppm is safe for several hours. Some postwar investigators feel that the generally published "safe levels" may be too high. Again this is controversial. In any case the margin of safety is comparatively small if the working atmosphere is at the threshold limit of 100 ppm for eight hour periods.

Those more apt to be susceptible to CO poisoning are children and small individuals, persons putting forth more physical effort than others and persons with physical defects such as bronchitis, asthma, alcoholism, obesity and chronic heart or vascular disease.

CO asphyxia may occur in two ways. In case of prolonged exposure of high but not massive concentrations of CO, the symptoms are a sensation of tightness across the forehead, dilation of cutaneous blood vessels, frontal and basal headache, throbbing in the temples, weariness, weakness, dizziness, nausea and vomiting, loss of strength and muscular control, increased pulse and respiration, and finally, collapse and loss of consciousness. All of these effects are accelerated by exercise because of the need for additional oxygen. <u>All of the symptoms are seldom experienced by the same individual</u>. In cases where a victim is exposed to a sudden massive dose of CO or when the victim is at rest loss of consciousness may result without any of these warning symptoms. In the later stages of CO poisoning the blood pressure

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falls, muscular control is lost, reflexes are dulled and finally abolished, intermittent convulsions may occur, breathing becomes slow and shallow and finally ceases.

Since CO is not used or destroyed in the body it is eliminated through the lungs when air free of CO is inhaled. This is a slow process which may be hastened by administration of a mixture of 93% oxygen and 7% carbon dioxide (sometimes 95% - 5%).

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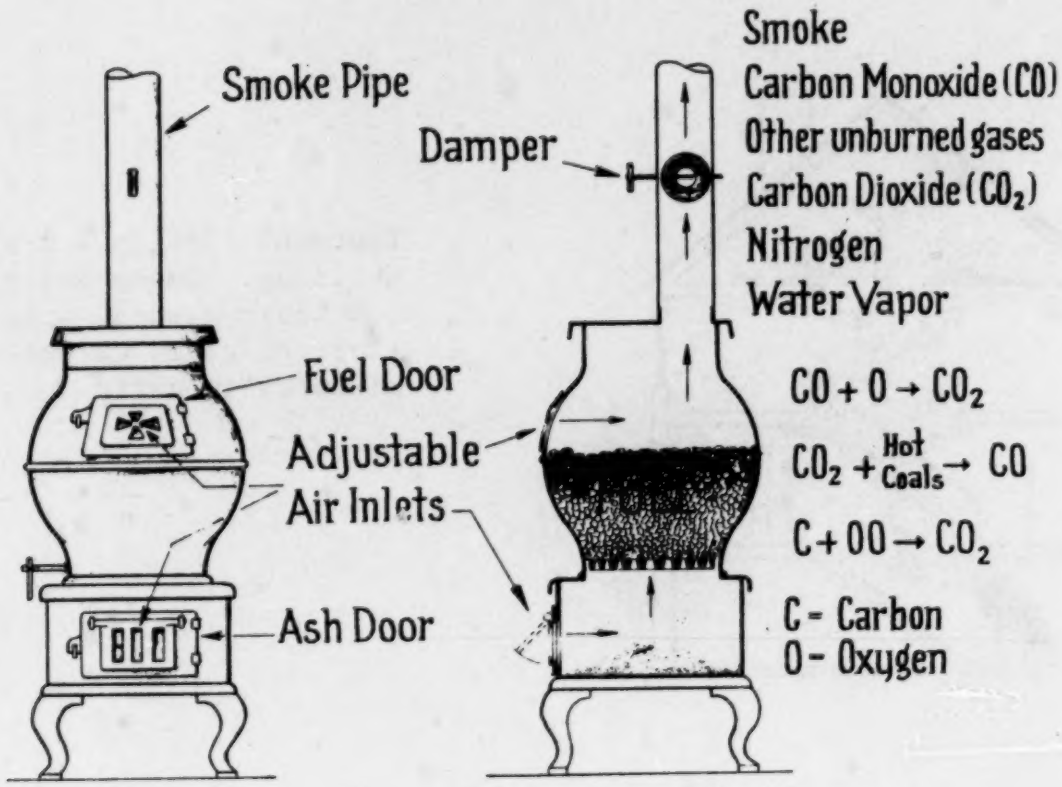

FIG. 1

A closed building may be compared to an ordinary old fashioned "Pot-Bellied" stove, with all doors closed, the damper shut, and a coal fire burning inside. Unless the building is opened at the top first, the opening of a door or window at a lower point is about the same as putting on the draft of the stove without first opening the damper. The oxygen, thus permitted to reach the fire, will increase its intensity and the tendency to generate gases. With a stove shut down and coal gases building up pressure, sudden input of oxygen over hot coals can produce an explosive mixture and blast. Smoke explosions in buildings are generated much the same way.

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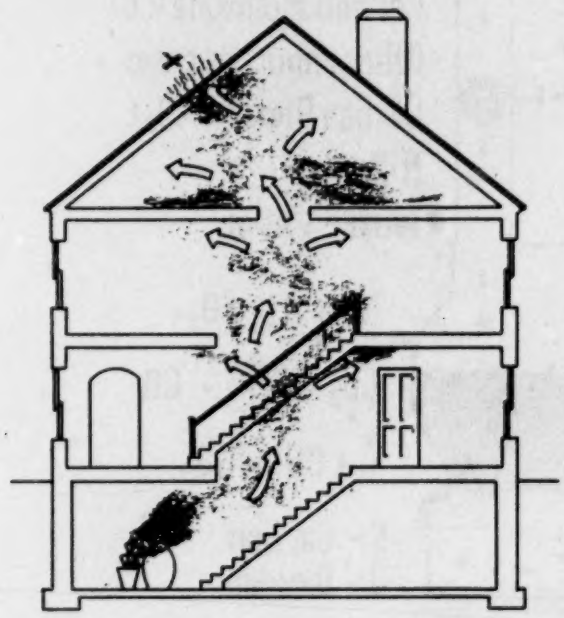

Basement fire in a 2-story and attic dwelling. Smoke and gases ascend via stairways and open doors and trap, to build up heat and explosive mixtures in attic.

FIG. 2

Fire is located on first floor in the kitchen. Smoke condition the same as in Fig. 2. Firemen should begin venting at peak of roof first. The next opening at spot marked "O". This will cause a cross venting of attic and will create a draft causing lower areas to be vented. Do not open below until vertical ventilation has been accomplished.

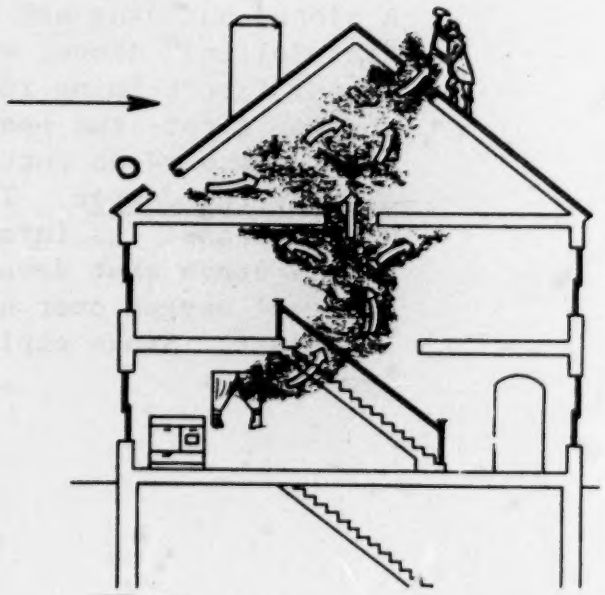

FIG. 3

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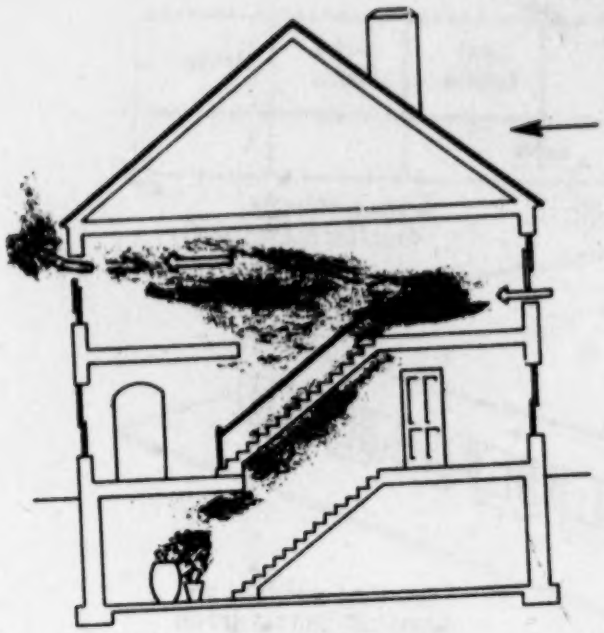

Where attic is sealed off, smoke from basement (or first floor fire) will tend to mushroom on second floor. In this case, natural horizontal (or lateral) ventilation is tried. First open window to leeward at top, then window to windward at bottom. Two circulators can be used to advantage, one pushing and the other pulling fresh air at vents.

FIG. 4

Fires occurring in basement might well travel through concealed areas to upper levels creating an explosive atmosphere. Care should be exercised in opening lower levels until upper areas have been vented.

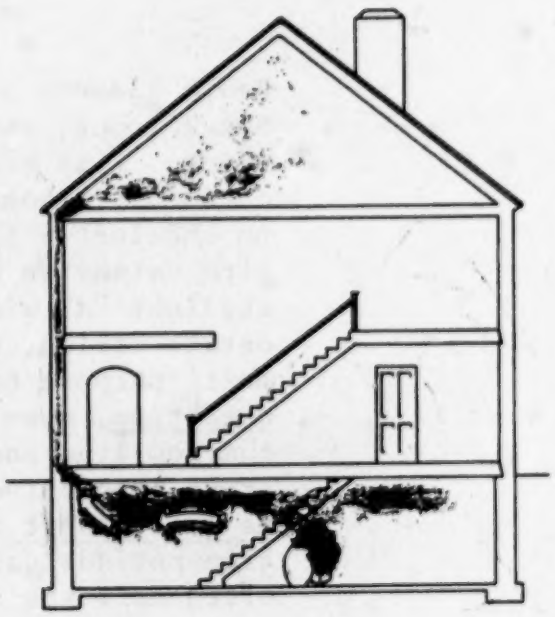

FIG. 5

2614

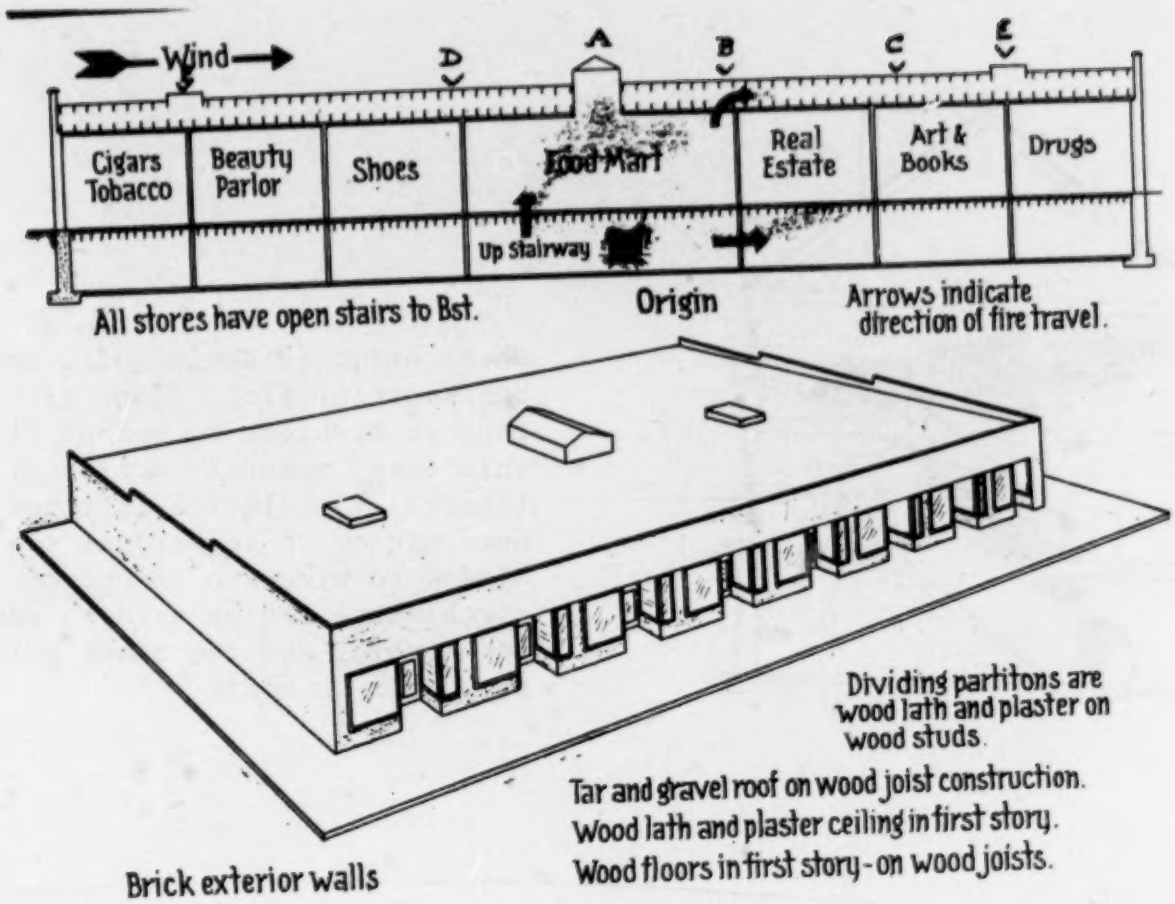

FIG. 6

Rough diagram of typical "Taxpayer" occupying a full block front, six stores, construction as described on slide. Fire originating in basement (X) of food mart extends via basement stairs and unstopped partitions to cockloft - thence to exposures on each side. Fastest fire extension will be with the wind. Initial opening, skylight "A" with any sign of fire extending to real estate office, skip opening "B" and open at "C", with multi-purpose nozzle. Only after charged lines are in operation, open at "E" (Hatchway) and at "D". Another charged line should be positioned at "D". Check on all store basements. Breach food mart basement walls only as last resort to hit fire. Below street level ventilation not advisable. Pulling ceilings from below is often more satisfactory than cutting roofs.

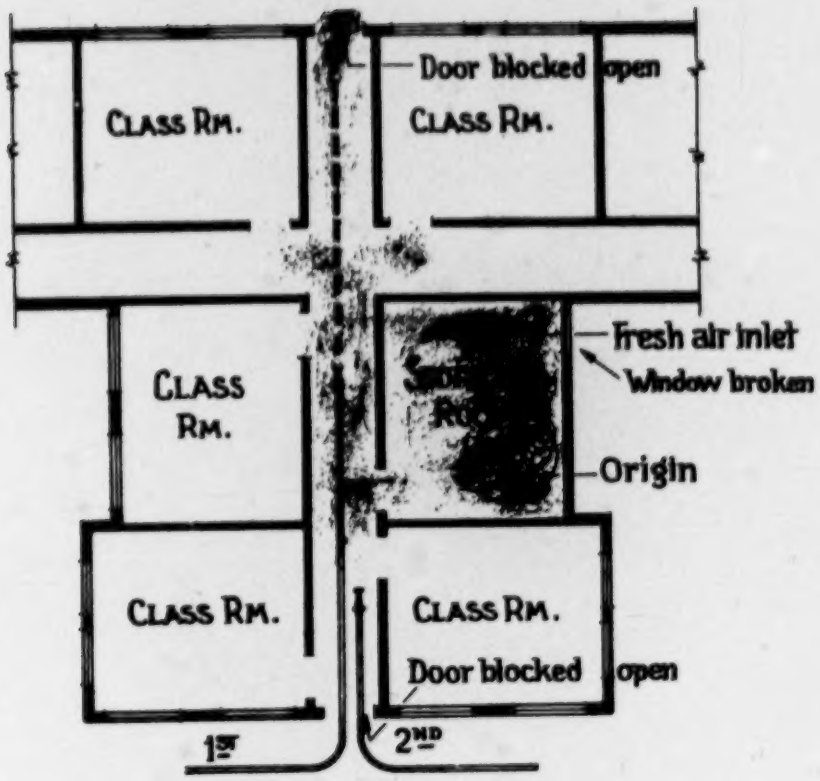

FIG. 7

Water fog used in venting modern concrete and steel school. 500 g.p.m. Fog Nozzle on first line acted as a venturi after passing store room door, sucking heated smoke with it and pushing it ahead out the blocked-open main door. Second line (Fog) covers crew on first line.

SALVAGE

INTRODUCTION

It is difficult to describe salvage briefly and concisely. Webster defines it as "the act of saving, or that which is saved". Whether this saving is accomplished by using a hose stream on a fire or spreading a salvage cover, either constitutes salvage in the strict sense of the word.

Many persons believe the extent of salvage consists in spreading salvage covers over merchandise and removing water from buildings, but there is a great deal more to the subject than meets the eye of the casual observer.

A large portion of the fire waste in this country can be attributed to the operations of fire departments at fires. It is true, of course, that much of the loss from this cause is necessary but a large measure of the damage due to water, damage done in ventilating, overhauling and tracing fires and damage from the elements after a fire can be avoided.

There has been a growing tendency among fire department officers and men to extinguish fires in a systematic and scientific manner thus reducing to a minimum those losses incidental to the act of extinguishing fires.

Salvage needs no salesmen; its principles are sound and its practice pays a dividend in community good will which is an important fact in the welfare of every fire department, large or small.

In the following sections we will deal with only one phase of salvage which is the use of salvage covers in our battle against high losses.

If the officer decides that the water can be held on the floor below the fire, he then orders the floor covered with catchalls. In this procedure the stock and furnishings in the exposed area are always covered first. The floors are then completely covered and the edges of the covers rolled to hold water.

If the water threatens to run over the rolled edges, the covers can be raised by means of chairs, boxes or any other ready means of support. Boards, poles or rods can be used to excellent advantage if any are available in the immediate vicinity.

Officers and men working with salvage covers must be efficient and ingenious enough to make use of the material at hand and show initiative in adapting themselves to the diversified conditions which fires always present.

TYPES OF COVERS

Many different opinions exist among experts on the subject of salvage covers, or tarpaulins, as they are called. All agree, however, that a salvage cover should shed water and at the same time hold water under reasonable pressure when "bagged" or used as a catchall.

There are many types of materials used in salvage covers today. Included are the neoprene and rubber-covered canvas cover. Perhaps the most popular cover used by fire departments is the eight-to ten-ounce canvas cover treated so that it is water repellent. Many fire department salvage companies have also found that an inexpensive cover may be made from plastic or nylon. However, the treated canvas cover is still the most popular and widely used. Properly cared for, this cover material will give years of service.

The most generally accepted size for salvage covers is 12 feet x 18 feet. The cover should be made up of four 36-inch sections which are sewn together so that these sections will run the long way of the cover. Grommets should be spaced a maximum of 24 inches, center to center, along the edges with spacings of 12 inches to 18 inches being more desirable. A small piece of rope approximately 10 inches long can be placed in the corners forming a loop. The small loop will prove useful if pike poles are used in conjuction with the cover for covering vertical exposures.

SALVAGE COVER FOLDS

There are many types of salvage cover folds; each fold is designed for a specific job or for a specific reason. Popular folds used by fire departments are the accordion fold, the do-nut roll and the utility or one-man fold. Perhaps the most popular fold in use is the accordion fold; however, as each fold has its uses, consideration should be given to the value of carrying these other folds.

Accordion Fold: This fold is started with the cover spread out flat on the floor. All wrinkles are removed and the cover is checked to see if it is clean and free of holes. As time is not important in folding covers, take all the time needed to get a good neat fold.

The fold is made by two men grasping the corners in the long way of the cover and folding in a half section at a time to the center of the cover. This process is repeated on the other side until the cover has been folded into a long fold 36 inches wide. One operator on his knees facing down the long way folds the cover into small folds about 8 inches wide by grasping the cover about 8 inches from him and then pulling it toward himself. When completed, the fold should represent an accordion pleat.

To keep this fold in place, large rubber bands cut from a tire inner tube may be placed over each end of the folded cover.

There are many advantages in using the accordion fold but chief among them is the speed with which it may be unfolded. This may be done by the underhand or overhand throw.

The accordion fold is adapted to all cover problems. It may be used as a runner, made into a catchall and used as a cover on furniture or other goods. It should be remembered that when using this type fold for covering, it is a two-man operation.

Do-Nut Roll: The do-nut roll is started by spreading the cover out flat on the floor. Two men face each other, one at each end of the long way of the

cover, grasping the cover and using a slight pulling toward each other, roll the cover as tightly as possible to the center of the cover. Changing to the other side they repeat the process. When both sides have been rolled to the center of the cover, one man then rolls the cover from one end until he has the cover rolled--much the same as a section of hose is rolled.

The do-nut roll is best suited for making water chutes and, by grasping in center and shaking the cover out, it can be used for covering. Its chief use, however, is for removing water.

Utility Fold: The utility or one-man fold has many uses and has the advantage of needing less storage space on apparatus. This fold will not shake apart while apparatus is in motion. Perhaps the best use of the utility fold is in covering merchandise and using for other types of flat covering; it can be placed on object and unfolded by only one man.

Salvage Cover at Fires: The use of salvage covers at fires is one of the most important operations of the fire service. Following are some operations where salvage covers are used:

In mercantile and industrial establishments very little arranging of stock and furnishings can be done. Covers must, therefore, be placed over counters, shelves, cabinets, desks, machines and similar items that could be damaged by water.

In residence or offices the furniture can be gathered into a compact arrangement and then covered. Sometimes better protection can be achieved by placing a cover down and then moving the article onto the cover and covering it.

Covering of automobiles and sides of buildings, including plate glass windows, is sometimes necessary to protect the property from damage by heat and smoke.

Perhaps next to the covering of materials with salvage covers their use as water chutes is next in importance. The do-nut roll is best suited for this job. It might be necessary to use more than one cover to make a water chute from one area to another and to the outside. Be sure where two or more covers are used that water-tight connections are made.

Rural fire departments also use covers to assist in damming up creeks for water supply during pumping operations.

When using salvage covers to cover glass show cases or where salvage covers are covering material that may be broken by people standing on it or by rough handling in removing the covers, placing an object such as a piece of wood on the cover shall indicate to the persons removing the covers that the material underneath is fragile and care should be used in removal of cover.

There are many more uses for salvage covers which have not been covered here. However, good salvage cover work can be accomplished by any fire department. The principal requisite is that they use good judgement and do the things common sense dictates.

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Care of Covers: Good salvage covers are expensive, approximately $40 to $45 each, and like any other type of investments, need certain definite care and handling.

They are subject to rough wear and tear and deterioration, but if properly inspected and kept in repair, their span of service will be many years.

The following rules should be followed to make sure covers give service for maximum number of years.

1. Officers should examine all covers, before folding and placing back in service, make certain the covers are dry and clean and do not contain holes.

2. Covers should not be thrown from roofs, windows or other openings above grade.

3. Folding should be done only where area is free from broken glass, debris or other objects which could cause damage to canvas.

4. Members should exercise care when removing covers from stock or machinery and avoid pulling them over sharp projections which might tear them.

5. Firemen should avoid walking on covers unnecessarily and should remove covers spread on stairways and floors as soon as possible. When it is necessary to fasten stock covers, nails should be placed through grommets only.

6. Covers carried on apparatus and not used for a period of thirty to sixty days should be removed, hung to air and refolded.

7. In covering roofs, men should be careful to remove all nails, sharp or jagged points of tin or anything that is likely to perforate or tear a cover.

8. Covers, after being wet and dirty from fires, should be washed and hung in towers to dry.

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SALVAGE COVERS SPECIFICATIONS

RECOMMENDED MINIMUM SPECIFICATIONS FOR SALVAGE COVERS

1. Minimum weight of 10 oz. to square yard can be used, with a maximum weight of 18 oz. canvas.

2. Sections of canvas should be as nearly equal as possible. (Three sections.)

3. All seams to run long way of canvas, but not in center.

4. The size of the cover to be a standard of 12' X 18' (or 14' X 18' maximum.)

5. Seams to be double lapped with waterproof dressing and minimum of two rows of stitching.

6. Seams and edges of cover to be overlapped with minimum of 1½" width double material with at least two rows of heavy duty stitching, capable of withstanding pressure of water used in bagging operations without leakage with either side up.

7. Corners to be reinforced with maximum of layers of canvas and backed a distance of at least 4".

8. Metal grommets to be installed at least every 18" along outside seam with minimum interior opening of grommet to be at least ½".

9. Four corners of cover should have webbed loop sewn on to corner with at least 6" opening for use in hanging in tower for drying.

10. Covers to be treated with non-flammable waterproofing.

OVERHAUL PRACTICES

INTRODUCTION

Overhaul, by definition, is:

1. Search for and extinguishment of hidden or remaining fires;
2. Placing the building, contents, and fire area in safe condition;
3. Determining cause of the fire;
4. Recognizing and preserving any evidence or arson.

Location of Hidden Fires

Effective overhaul involves a thorough examination of building structure, contents, and debris to locate and extinguish hidden fires. Overhaul does not, in itself, guarantee that a fire will not rekindle. Its practice, however, enables firefighters to detect certain conditions where re-ignition is more likely than others. Where a possibility of rekindling exists, firefighters with adequate "watch lines" should be detailed to watch the property.

Placing Fire Scene in Safe Condition

Facts concerning the degree of safety of a fire damaged structure can be readily gathered during a proper system of overhaul. A number of unsafe and potentially dangerous conditions may be remedied during overhaul practices. The correction of such unsafe conditions such as hazardous processes, damaged utilities, structural defects,fire damaged contents, and unstable objects is of major concern to every fire department.

Determining the Cause

Proper overhaul will often disclose the cause of the fire. The ability of the firefighter to recognize the cause once it is exposed will depend on his training and the degree of care used in examining the fire scene. A fire cause involves the coming together of a "fuel supply" hazard and a "heat source" hazard. When the cause is determined, both the fuel involved and the source of heat which caused the ignition should be stated in the report. In addition to determining fire cause, a thorough practice of overhaul will usually pinpoint the locations and permit its removal to prevent any recurrence.

Recognizing and Preserving Evidence of Arson

Determining the cause of the fire goes hand-in-hand with recognizing and preserving evidence of arson. Among the items to look for in recognizing evidence are: separate fires, suspicious odors, deep wood charring and uneven burning, holes cut in walls and floors, inoperative fire protection devices, footprints, empty

containers, and residues of wax or paraffin. Careful overhaul procedures will permit some evidence to remain undisturbed and will permit the safeguarding of other evidence that cannot be left at the fire scene.

Overhaul Procedure

The extent of the overhauling necessary is determined by the size of the fire, the type of building or structure involved, its contents, and the degree of exposure to which nearby structures have been subjected. After a small, localized fire that has generated comparatively little heat, all that is necessary is to turn over the burned material to see that it does not contain any hidden fire and has cooled below the danger point. Special care in overhauling bedrooms and closet spaces is necessary to determine that no rekindling will occur in bedclothes, mattress stuffing, and wearing apparel.

Following an extensive fire, the procedure is more complicated. If the fire has broken through windows on a court or air shaft opposite another building, or if the fire building is flanked by a higher building exposed to heat and smoke, overhauling should include those additional structures. If sparks have been carried over a wide area, many buildings may need to be examined.

In addition to working over the debris after a fire, window frames should be opened up, ceilings pulled, and walls opened where there is possibility of fire having entered. Thorough inspection of the fire floor as well as floors above and below should be made to guard against rekindle due to concealed fire.

Combustible partitions should be opened at any point blackened by fire or where the surface is too hot to hold the hand. At such points, the fire is usually burning in the underlying woodwork. Such a fire may burn like charcoal, without flame.

A charged line should be readily available as a flare-up is likely to occur when the partition is opened.

Fire weakens a structure, so be careful where heavy materials are stored that a collapse of a floor or other part of the building does not occur. Paper, rags, cotton, excelsior and similar materials will absorb large amounts of water, the added weight of which may cause collapse. A thorough examination should be made before overhauling is begun. Accumulated water should be removed from the floor to relieve it of this weight.

Shut off gas and electricity before overhauling, if this has not been done. If holes have been cut in the floor for ventilating, to reach hidden fire, or to drain off water, or have been burned through by fire, close them or block them off so persons do not fall through. Chairs, desks, or doors are useful for this purpose.

Block entrances to burned out stairways. When articles must be thrown from windows, station a fireman below to keep people from walking into danger. Plan the work so that it will not be necessary to rehandle material.

BASIC FIREFIGHTING STRATEGY, TACTICS,

AND PRE-FIRE PLANNING

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FIRE FIGHTING STRATEGY

PREFACE

It is not the intention to cover the entire subject of fire fighting strategy. An attempt to do so in detail would be impossible. While it can be said that no two fires are alike, there are certain basic rules that can be applied to all fires and standard practices that can be used on certain types of fires. This discussion will be confined to the recommended technique of fighting common types of fires and to the general duties of officers at fires.

LEADERSHIP

It can be assumed that any job involving the use of a number of men can best be accomplished if one man is in charge and directing the operations. This principle holds true in volunteer as well as in the paid departments. It is impossible to organize a systematic coordinated attack without leadership. The selecting of leaders and the setting up of a schedule whereby an officer will answer to every alarm becomes a basic rule of fire fighting strategy.

FIRE PROCEDURE

There are certain rules governing the actions of the officer in charge of a fire. Application of each of these rules is essential to accomplish a successful and complete job on the fire. They are:

Size-Up
Calling for Help
Saving Life
Protection of Exposures
Extinguishment of Fire
Overhaul

1. SIZE-UP. The size-up of a fire is the first responsibility of the first officer arriving at a fire. His orders, given the first few seconds upon arrival, determine the general course to be followed. Attention to detail is necessary so that he is right the first time because a radical change in plans later results in confusion, delay and the necessity of reorganizing broken-up crews.

   Some of the items to be considered in size-up are:

   a. Geographical features of territory--roads, alleys, hills, ravines.
   b. Location of fire within building--probable extent.
   c. Construction of building--height, masonry, frame, mill, open stairways, elevators.
   d. Occupancy--factory, residency, hotel, rest home, hospital, heavy machinery, refrigeration systems, chemical storage, etc. Estimate effect water may have on contents as to expansion, chemical reaction, etc.
   e. Wind, weather, ice.
   f. Exposures--inside and outside means for fire to spread.
   g. Equipment available on building--fire escapes, standpipes, sprinkler systems.

h. Water available--location of hydrants and flowing pressures, creek, lake, river, booster tanks.
i. Life hazard.
j. Accessibility of fire.

Note: It is a fact that the first five minutes of a fire are more important than the next five hours.

2. CALLING FOR HELP. The first officer arriving at a fire should call for help immediately if this is going to be necessary. He should never underestimate a fire and he should have a full knowledge of equipment available not only from his own department but also from neighboring departments. This knowledge should consist of manpower, hose carried, capacity of water carries, pumps, ladders or special equipment.

The kind and amount of help wanted should be specified.

3. SAVING OF LIFE. Although listed third, saving life is the most important duty of a fireman. Size-up and calling for help are usually completed at the time of arrival or a moment thereafter and when life is involved, life-saving operations are commenced immediately although it may mean temporary suspension of fire fighting operations. Frequently, some lines must be brought into use as an aid to getting the occupants to safety or to confine the fire to a part of the structure as other portions are evacuated. Frequently it is necessary to use fire streams to clear a path for rescue operations.

4. COVERING EXPOSURES. The protection of exposures means to use all available methods to keep the fire confined to the area involved at the time the fire department arrives. Exposures may be either external or internal.

a. On external exposures, the officer must consider wind direction, type of buildings that may be involved and the placement of lines to protect the threatened exposure and at the same time lines to operate on the fire.

b. Internal exposures usually mean the protection of all vertical and horizontal openings that lead away from the fire area. These openings must be protected by charged lines.

c. The surest method of preventing spread of fire is a quick concentrated attack on the seat of the fire.

5. EXTINGUISHMENT. The main effort of extinguishment is directed at stopping the spread of fire from room to room, floor to floor, building to building and to confine the fire to as small an area as possible.

6. OVERHAUL. The officer in charge should never underestimate the importance of complete overhaul operations. Some of the objects to be attained are:

a. Make sure all fire is extinguished and thereby prevent re-kindling.

b. Observe evidence that might lead to the cause of the fire such as arson, overloaded wiring, defective heating installations, etc.

c. Aid salvage operations by systematic disposal of partially burned material and debris.

FIRE FIGHTING TACTICS

The term tactics means the deployment of men and equipment in such a manner as to make effective control of a fire situation possible.

This particular section on tactics has been developed to assist you in setting up tactical operations for combatting the residential type fire.

The information given here is to be used as a guide to assist you in determining which type attack line will be most effective.

Emphasis has been placed on the use of 1½" pre-connects and 2½" attack lines in the belief that only limited use of booster lines should be used in attacking fires in residential type buildings.

LIMITATION OF SMALL LINES - Residential Fires

The fire officer is faced with many command decisions when he arrives at a structure fire. One of his first commands must be the designation of the size line or lines to use on the first attack.

Standard operating procedure in most fire departments calls for a 1½ inch attack on a residential or similar sized building. Experience has shown while most dwelling fires can be brought quickly under control with 1½" lines all dwelling fires cannot be successfully fought with small lines and the wise fire officer will always be ready to back up the 1½" lines with a 2½" line.

In many instances the officer should order a 2½" for the first attack if there is any question that the fire power of the smaller lines will not be adequate to control the situation.

There are many variable factors in structure fires but two that should be considered, in relation to the size fire stream to use, are:

Confined Fire

Does the size-up indicate that the fire has been burning over a relatively long period involving the structure as well as the contents? Many firemen have had the experience of fighting a building fire where the attack will black out an area then the line is moved to another target and the flames flash up again. This is because the material has been heated well below the surface making it what we would call a deep-seated fire and combustible gases will continue to be released in the fire area and become reignited from unquenched flames. In comparison to a surface fire of shorter duration the deep-seated fire will require a much greater delivery that may be accomplished better with large attack lines.

Free Burning Fire

Is the fire confined or has it become an open fire? The experienced fireman will know that an 1½" attack has much greater potential in the confined type

of fires where the cooling value of the water can be more fully utilized. The open fire may not involve any more fuel or even heat but its very lack of confinement will require streams of greater capacity both as to gallons per minute and area that must be covered.

FIRE LOADING

In order to better realize the potential fire severity of building fires, including residential, we should take a look at the results of fire tests that have been conducted by the National Bureau of Standards. These tests have been of value in making it possible to express in terms of "fire loading" the severity of a fire hazard as represented by the weight of combustible material involved.

The term, "fire load", means the amount of combustible material in a building and includes both the contents and the combustible parts of the structure. The relationship between fire loading and fire severity in terms of hours duration can then be related to the amount of fire protection required.

Average Weight of Combustibles Per Square Foot (contents)	Hours Duration
5 lbs	1/2 hour
7½ lbs	3/4 hour
10 lbs	1 hour
15 lbs	1-1/2 hour
20 lbs	2 hours
30 lbs	3 hours
40 lbs	4-1/2 hours
50 lbs	6 hours
60 lbs	7-1/2 hours

The Bureau has also made a study of the <u>average</u> fire loading in various occupancies and these figures can be of assistance to pre-plan the size of the attack necessary for these conditions.

Residential	5 to 10 lbs
School	5 to 10 lbs
Institutional	5 to 10 lbs
Assembly	less than 10
Business	10 to 15 lbs
Mercantile	15 to 20 lbs
Industrial	25 plus or minus
Storage	30 plus or minus

All of these tests were conducted in buildings of non-combustible construction and, therefore, in buildings of ordinary construction the possible fire loading could be <u>twice</u> the figures given. In dwellings the fire loading will be greater due to interior finish, exposed wood trim, combustible structural members and storage in basements, attics and closets.

In the older type dwellings considerable fire loading can be added because of wood sheathed walls and ceilings together with felt and wallpaper finish. It can be seen that a totally involved large dwelling could easily approach the

fire severity or exceed that of an average mercantile or business building where a 2½" line would be a standard lay on the first attack.

In a hypothetical situation assume that fire has gained considerable headway in two rooms of an average residence. Experience has shown that heat production of 1,000,000 or more BTU's (British Thermal Units) is very possible. One gallon of water has the heat absorption capacity of 8,000 BTU and a single 1½" line with a discharge of 60 gpm would have a cooling capacity of 480,000 BTU. In this situation the heat is then building up at almost twice this figure. A second line of equal size would be needed for a quick extinguishment.

In another hypothetical situation involving a dwelling the fire area is twice this size. It is an older building and the fire loading is relatively high. Heat production could be in the neighborhood of 2,000,000 BTU or more per minute. The line or lines used on the first situation would have little initial effect.

Assume in the next situation that this older building is totally involved. Heat production is 4,000,000 BTU or more per minute. Here, two 1½" lines at 60 gpm would absorb 1,000,000 BTU per minute. It can be seen that with almost 3,000,000 BTU's in excess of the heat absorption rate the fire would continue to burn out of control. Therefore, fires of this size would require 2½" attack lines or combinations of 1½" with equal heat absorption ability.

While these are only hypothetical situations the points to remember are: (1) Standard operating procedures should recognize the value of the 2½" line with a discharge of 250 gpm or more as being appropriate for certain residential situations, (2) Standard operations should call for two 1½" lines working together on the same target area whenever there is doubt that a single small line will be effective, (3) Tanker or booster operations should be developed to utilize the fire power of the 2½" line.

TACTICS - Effective Use of Nozzles on Hand Lines

Each tactical operation on fires requires teamwork and the nozzleman plays a very important role in his team operation. Together with the anchorman the nozzleman must be quick to grasp the requirements of the situation and then employ the proper tactics to gain control of the fire.

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BACK UP LINES FOR PERSONNEL PROTECTION

SMALLER LINE PROTECTING LARGER LINE

Figure 1

USING BACK UP LINES FOR PERSONNEL PROTECTION

In some fire situations radiated heat may prevent the attacking line from gaining a position of advantage or perhaps holding its position. A smaller second line, booster or 1½", can be used to provide a water curtain for protection of the men on the attacking line. This back up line may be in front, to one side or in the rear just so the spray protects the operator and the other nozzle crew.

As the main attacking line moves in and knocks down the body of the fire, the back up line can be converted to use on spot fires and overhaul.

OPENING UP FOR ATTACK

WRONG METHOD 2630 Figure 2 RIGHT METHOD

OPENING UP FOR THE ATTACK

Fire fighting is generally more effective at close range and the tendency to open the nozzle before getting into position where the stream is on its target wastes water as well as slows up the attack. A line may be quickly advanced to position before it is opened but it becomes difficult to maneuver and hard to keep on target if opened and still being advanced. In general the nozzleman and anchorman should get into a close-up position before opening up.

A nozzleman may wish to open up to clear air from the line as he makes the approach. He may also throw a burst or two in order to set his nozzle pattern before reaching position.

MOVING POSITION WITH CHARGED LINE

INCORRECT PROCEDURE

Figure 3

MOVING FROM ONE POINT OF ATTACK TO ANOTHER

It is good practice to shut down the nozzle when the line is to be moved. This is true with small lines as well as with the large hand lines. While there are exceptions where it is necessary to keep a line in operation it is seldom possible to maintain an effective stream on the target when moving from one point to another. Here, again, the nozzleman is in a position to conserve water when the supply is short and he will also speed up the attack at several points by shutting down when making the moves.

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INDICATIONS OF A SUCCESSFUL ATTACK

The nozzleman is in a position where his judgment and actions during the progress of an attack will improve theefficiency of the entire operation. He should shut down when his portion of the attack has been successful and he can be guided by one or more of the following indications:

a. Blackout of visible fire.
b. Smoke production ceases with water vapor predominating.
c. Both smoke and water vapor exhaust become "lazy" evidence that heat has been reduced to a nominal level.

While the nozzleman himself may not be in the best position to see these signs he can be aided by the anchorman who may be in a better position to observe.

If the reactions as described do not occur after a reasonable time, then he would know that an attack from this point is not effective and he would seek another point of vantage.

CHANGING PATTERN OF FOG STREAM

The nozzleman must be quick to recognize the need to cover as much of the fire area as possible in order to cool evenly and get the most value from his nozzle discharge. This may require him to alter the discharge pattern several times during an attack. Drill practice at handling all nozzles with wet lines will keep firemen familiar with the mechanical features of the combination fog and straight stream nozzles they will use at fires. During hose drills the wet line should always be used whenever possible.

USING HOSE LINE AS A GUIDE LINE FOR INTERIOR OPERATIONS

In interior fire fighting operations the nozzleman should be aware of the need to keep unnecessary slack or play out of the line after it is brought within the building. Confidence in the knowledge that the line furnishes an excellent guide to the outside should interior conditions require a retreat will result in greater aggressiveness at the nozzle end. This is also a fundamental safety requirement. Men who are backing up the nozzle should aid in this respect because they are in a much better position to control the play hose as it is brought in.

OPENING AND CLOSING NOZZLES

Always open a nozzle progressively in order to avoid sudden back pressure that will throw you off target and cause loss of control. Closing down smoothly is equally important since a sharp shut down will put an excessive strain on the hose. This is especially important when relatively large volumes flowing through 2½" hose are suddenly brought to rest. The back pressure may momentarily exceed the service test pressure of the hose.

Pre-Connected Hose Lines

With the universal scarcity of manpower for the first alarm response the pre-connected line is the greatest asset toward a fast attack that has been developed in recent years. Through the use of pre-connects firemen get water on the fire in seconds after arrival and most small building fires are brought under control with the water carried on the pumper. No experienced fire officer will, however, fail to back his attack with a supply line from either a hydrant or a tanker whenever possible.

THE RESIDENTIAL TYPE FIRE

Because most residential fires are handled easily with a minimum use of manpower and equipment it is easy to direct our tactical planning in other, seemingly more important, directions. From the viewpoint of life safety experienced fire officers never take a residential alarm for granted because they know that all too often rescue of trapped occupants is directly contingent upon the success of a fast, mobile and aggressive attack that permits firemen to get in and stay in and get at the people within.

What is the relative importance of residential fires in the total alarm response? For some fire departments serving areas primarily residential most of their alarms to structures are in dwellings or out-buildings and for fire departments as a whole throughout the United States about 70% of all fire fighting activity is directed toward the control of dwelling fires. These fires assume great significance when they are related to the annual fire loss of some $1,500,000,000 when it is realized that about one quarter of this loss is accounted for by residential fires. It follows then that in spite of modern building codes and improvements in construction there is still plenty of combustible material to burn and, of course, the contents in homes are as flammable as ever. We also have a good percentage of dwelling fires occurring in the older home where we have serious fire fighting problems due to antiquated construction and the unusually heavy fire loading that is commonly a characteristic of dwellings built when shiplap was so much cheaper for interior walls than plaster.

Another aspect worth considering is the susceptibility of residential areas to a conflagration hazard. A brief study of the history of major conflagrations will show a high percentage have involved residential districts. The two prime factors have been: (1) the closely built combustible construction characteristic of many residential areas and (2) the use of wooden shingles that literally breed "crown" fires through radiated heat, convection and the fallout of burning brands. Cities both large and small as well as unincorporated living areas may have potential conflagration breeders in residential sections that need only the right conditions of humidity, wind and a fast-burning exposure fire.

The Typical Residential "Target Hazard"

The average modern three bedroom, one story dwelling contains about 26,000 board feet of lumber and the interior will be either plasterboard or plaster on gypsum lath. The fire loading of this residential type will be as follows:

Movable Property	Floors	Exposed Woodwork (Other than floors)	Total
3.4 lbs./sq. ft.	2.6 lbs./sq.ft.	2.8 lbs./sq.ft.	8.8 lbs./sq.ft.

This total average fire load is relatively light and it represents a fire severity of from ½ to 1 hour duration. Because of the plastered (or plasterboard) walls and the small amount of exposed woodwork in the living areas other than floors a total involvement with a "flash-over" effect is seldom seen in this dwelling. All fires in this type of dwelling (Figure 1) will

not be easy to subdue but a pair of 1½" lines working together will do the job except in rare instances when the fire is completely out of control and exposures threatened.

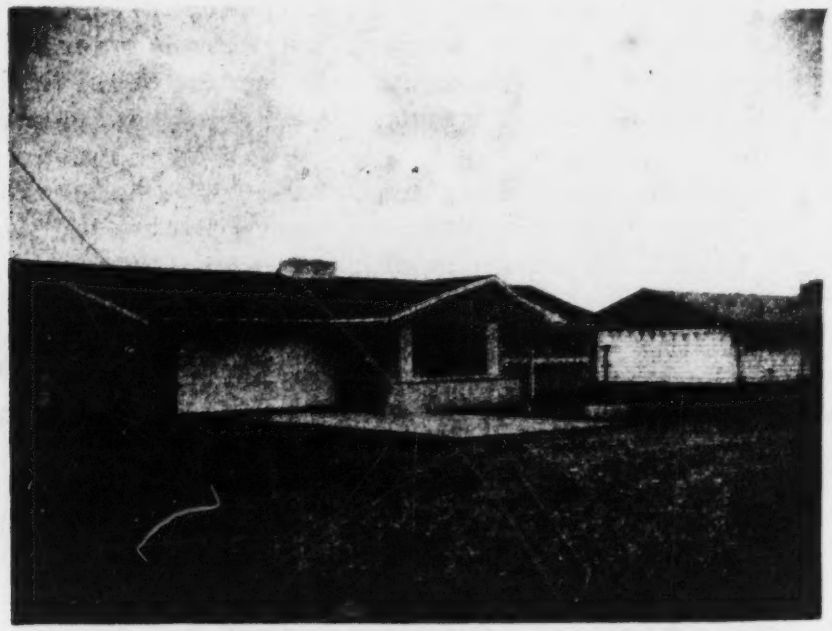

Figure 1

In contrast let us look at the older, two-story residence (Figure 2) many of which have wood sheathing on the interior walls plus felt paper and wallpaper to support a flash-over through all open and interconnected rooms. In this building we will find approximately the same square foot fire loading of combustible contents plus a vastly increased combustible surface area to feed the fire. The exposed woodwork may amount to 13 lbs. or more per square foot bringing the total fire load to 19 lbs. per square foot--more than twice the figure of the newer residence. This is the typical "target hazard" dwelling where we can anticipate the use of a 2½" line to back up the 1½" lines or if the involvement is total, a 2½ for the first attack.

Figure 2

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The potential fire loading in some of the older dwellings may be further illustrated by a comparison of board feet of lumber in the structure as compared to the average one-story ranch type dwelling containing from 18,000 to 25,000 board feet. The dwelling in Figure 3 contained 48,514 board feet of bone dry lumber with much of it exposed on the interior walls and ceilings. The night fire shown in Figure 4 was in a dwelling of this type. The attack was made with one 2½" line equipped with a 300 GPM combination nozzle and two 1½" lines equipped with 70 GPM combination nozzles. This situation was brought under control by the 2½" line with the 1½" lines being used for final extinguishment of spot fires onthe lower floor and the major fire areas on the second floor and attic. Approximately 1000 gallons of water was used in the major attack and 500 gallons to control the fire in the second floor and attic.

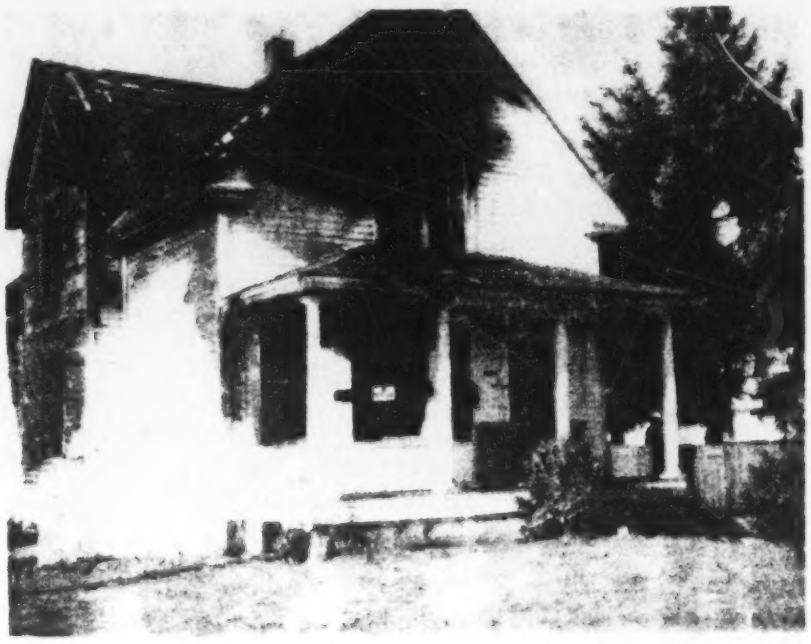

Figure 3

Figure 4

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The 2½" Pre-connect Line. Can two or more 1½" lines with the combined discharge of a single 2½" line equal the larger line in fire power? Theory says yes, but most fire officers have found that it is not an easy thing to keep multiple lines on the same target. Each nozzleman sees his particular target and acts automatically as an individual to fight the part of the fire closest to him. This results in a wider distribution of water and less concentration in the critical area where we want to achieve quick control. The single 2½" line for these conditions might well be a better choice. Another factor that diminishes the effect of several small lines working together on a single target is the effect of air currents in a fast-burning fire. These currents are strongly upward and away from the fire and their force may prevent a smaller line from reaching into the target area. This is not an infrequent occurrence in fires that have developed a strong thermal updraft the effect of which can be overcome by a 2½" line with its larger concentrated delivery--it punches through to the fuel area.

Another advantage of the 2½" pre-connect in residential fire fighting is that a single, quick, large delivery of water covering a span of 15 to 20 seconds will bring the fire down to a size that allows entry to the building and rapid follow-up with 1½" lines for interior operations. Fast entry is one of the key points in fire fighting and most surely the principal aim when rescue is indicated.

When thinking in terms of water delivery and the need to conserve it when supply is short, it is well to reflect that if a 250-300 GPM attack will do the main job in 60 seconds, you may well be using less water than if you fought the same fire with half the discharge for two or three minutes. This is especially true if the smaller attack does not black out its target and you would have to change to either a larger line or add an additional line following the original attack. In the meantime you could have gained considerable headway.

The advantage of the 2½" pre-connect in terms of the time saved is the same as with the 1½" pre-connect--a faster attack in the first few critical minutes when small crews have many things to do all at the same time. If time can be saved in making up a hose line, that time may be used for putting up a badly needed ladder or getting in a second line for a threatened exposure.

Finally, let us take a look at the relative extinguishing capacity of the 1½" line versus the 2½" line:

Size Line	GPM	Heat Absorbed (90% efficiency)
1½	70	560,000 BTUs
1½	100	800,000 BTUs
1½	125	1,000,000 BTUs
2½	200	1,600,000 BTUs
2½	250	2,000,000 BTUs
2½	300	2,400,000 BTUs

Disadvantage of Pre-Connect Lines

The inherent disadvantage of the pre-connect is its fixed length that may not be sufficient for some fire situations. In general it can be said that when longer lines are needed it is quicker to make them up from the free hose in the hose bed rather than run out a pre-connect and then extend it. Of course, hose arrangements will vary from rig to rig and between fire departments and some may prefer to extend the pre-connects.

BASEMENT FIRES

This type of fire, while not spectacular, is usually the worst type of fire you will have to fight. The basement is usually the storage place for quantities of highly flammable material which may, and usually does, produce excessive heat, toxic and explosive gases.

1. First line should be taken in on the floor above the basement and used to cover the opening from the basement to this floor. The line should not leave position at the head of the basement stairway unless it can be used to better advantage on other vertical openings up which fire is spreading. A simultaneous effort to ventilate this floor may be necessary in order for the line to hold its position.

2. Another line should be stretched to the exterior opening to the basement and fought in to the seat of the fire.

3. When the seat of fire cannot be reached, cellar pipes or distributor nozzles should be ordered immediately.

4. Ventilate all floors as quickly as possible to check for vertical extension of fire through partitions, furring strips, vent ducts, etc.

ASSUME THIS FIRE HAS EXTENDED AND INVOLVED STAIRHALL OF MULTIPLE-STORY BUILDING

1. First line stretched to position in entrance hall, direct streams upward to prevent loss of stairway on the upper floors.

2. At same time order roof opened up above stairway to prevent mushroom effect on upper floors.

3. Cover the basement stairway through which fire has extended with the first line if this can be done without leaving the upper part of the stairway unprotected.

4. Stretch in another line to work down the basement stairs or if first line can cover basement opening, stretch second line to basement via an exterior basement stairway.

Note: Remember to order breathing equipment to be used when making an attack on a smoldering basement fire that cannot be quickly ventilated. If you cannot see "live" fire in the burning area, it may be that the oxygen content is too low for firemen to work without self-contained masks.

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CHIMNEY FIRES

1. Determine if the chimney is on a bracket or built to the ground.

2. Send one man to the attic to determine the condition of the chimney and to check for any evidence of a wall fire. If his report is favorable, send the same man back for a final look before leaving.

3. If necessary to extinguish the fire in the chimney, use a pump can or booster line. Application of water at the top of the chimney is usually best although flue holes may be used if the top is not accessible. Unusually hot chimneys may require a rather large amount of water. A small stream of water in a very hot chimney will have little cooling effect.

4. Minor chimney fires may be controlled by the use of salt, soda, dry powder, or even tetrachloride. Application should be at a point where the extinguishing agent can be applied directly on the fire; drafts should then be closed to obtain a smothering effect.

5. Fireplaces should be covered to avoid smoke and soot loss.

6. Check for unused flue openings as these are weak points and may be responsible for a wall fire.

7. Use the same precautions against water damage that you would use on any other fire.

8. Spray roof and gutters for sparks.

9. Leave chimney and pipes clean.

GREASE DUCT FIRES

1. Use same precautions against extension of fire as for chimneys.

2. Extinguishment by the use of water fog is best and the application should be made at a level with or below the fire. Usually a clean-out opening is present--if not, an opening into the duct may be made with the pick end of an axe.

3. Application of CO^2 is seldom effective unless it may be applied in large quantity; otherwise a "flash-back" will occur.

4. Take proper salvage precautions.

ELECTRIC MOTOR FIRES

1. Cut off the current.

2. For minor fires, tetrachloride, dry chemical or CO^2 is effective.

3. Do not use chemical foam.

4. If the wiring is burned out and motor is extremely hot, use a pump can or booster line.

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Note: Caution must be taken to cool the motor cage slowly and avoid sudden contraction that may cause the cage to crack.

PARTITION FIRES

1. Open wall between studs using a tarp to catch debris.
2. Direct line upward and downward.
3. Check wall and floor above the fire.
4. Check attic through ceiling scuttle.

Note: Indications of a wall fire are: blistered paint, live smoke issuing from baseboards on floor above, sound cf fire in wall by placing ear against surface.

ATTIC FIRES

1. An attic fire should be fought from below; that is, by taking a line into the attic through an interior opening such as a ceiling scuttle or a hole cut in the ceiling.
2. As complete overhaul of the attic will be needed, it MAY be necessary to open the roof for ventilation or to stop the fire from mushrooming.
3. Salvage operations should be simultaneous on the floor below.
4. In a few instances it will be practical to make an entrance to the attic through a hole cut in the roof just above the eaves.
5. The main electrical switch should be pulled before men are sent into the attic.
6. Beware of a deficiency of oxygen or accumulated toxic gases and order respiratory equipment used when required.

ROOF FIRES

1. The basic rule is to make a quick check of the attic to see if fire burned through.
2. Surface fire may be quickly knocked down with ground lines or with ladder lines where height is a factor.
3. Protect lee side exposures.
4. Roof ladders must be placed and the burned surface thoroughly overhauled.
5. Salvage operation on the floor below the attic or in the attic itself should be simultaneous with attack on the fire.

FRAME DWELLING HOUSE FIRES

1. The average fire in this type of structure may be handled by two 1½" lines. One line is used to operate directly upon the seat of the fire; the other line to maneuver as needed to protect interior or exterior exposures.

2. Ventilate that part of the building not directly involved to learn if the fire has spread through vertical or horizontal openings in the structure.

3. On night alarms use the first lines to cut off the fire from the sleeping quarters and keep lines of exit open.

4. Observe the direction fire is traveling and open walls and ceilings ahead of the fire to prevent extension.

5. Get above the fire immediately; locate the ceiling scuttle and check the attic space.

6. Begin salvage operations immediately.

7. If fire has involved the structure of the building, cut off the main electric switch.

BUILDING CONSTRUCTED IN ATTACHED ROWS AND MULTIPLE OCCUPANCIES

1. In this type of structure there is a cockloft or open space between the top floor ceiling and the roof. This space may not be fire stopped horizontally.

2. Open up the ceilings on each side of the fire and use lines to stop extension.

3. Make a simultaneous attack on the seat of the fire.

4. Ventilate to prevent fire from mushrooming through the unprotected cockloft space.

5. Begin salvage operations immediately.

FIRE IN FURNISHINGS OF A SINGLE ROOM

1. Use only enough water to knock fire down and remove large pieces of furniture for final overhaul.

2. Ventilate simultaneously with attack on fire.

3. Check immediately for burn into structure of building.

4. Begin salvage operations immediately.

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GENERAL RULES OF FIREFIGHTING

1. There is no substitute for complete knowledge of buildings, contents, water supply, etc., to insure a good job of fire extinguishment.
2. Fit your fire stream to the fire. On certain fires several small streams may be ineffective while a large stream, using the same total delivery, will progressively black out each area of fire within range.
3. Fog lines permit a rapid advancement on a fire when radiated heat is a problem.
4. A fire stream can be 100 per cent effective when directed from a point just within a doorway; two feet back from the doorway may mean a 75 per cent loss in effective reach.
5. Discharging water into smoke when the fire cannot be seen is seldom good practice.
6. A line should always be shut down when the portion of the fire it can reach has been knocked down.
7. When an operating fire stream is moved to another point of vantage, it should be shut off during the transfer.
8. Attic fires should be fought from the inside through a ceiling scuttle or from a hole made in the ceiling.
9. Water fog should be used to cover vertical openings if extension of the fire through these openings is anticipated.
10. Water fog should be used to prevent the rise of heated gases and toxic fumes up vertical openings in multiple storied buildings having a life hazard occupancy.
11. Grease, oil and similar fires should be extinguished with water fog except where water damage is a factor.
12. Water fog is used to reduce heavy concentrations of ammonia fumes.
13. The best angle of penetration for an exterior fire stream is 32°.
14. Ground operated fire streams have very little penetration when used on fires above the second floor.
15. Chemical foam should not be used on charged electrical equipment.
16. Pole fires require the assistance of the power company as a general rule.
17. The first line at a basement fire should be stretched to protect the upper part of the building.
18. Always restore an automatic sprinkler system to full operation before leaving the premises.

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19. When salvage operations are indicated, they should start immediately.

20. Self-contained breathing apparatus should be used on all unventilated fires below the ground level.

21. Fires involving buildings of public assembly, schools, hospitals, hotels, etc., require immediate attention to evacuation proceedings.

22. Deep seated fires in class "A" materials--wood, paper, textiles--require solid streams for complete extinguishment.

23. Rapid extinguishment requires:

    Speed of action
    Operation on the fire at close range
    Quick maneuvering of fire streams

24. Buildings equipped with sprinkler systems--lay two lines immediately to the sprinkler, siamese and keep sprinkler going at top efficiency.

25. For fires in upper stories, work line up inside to obtain a toehold on the floor involved.

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PRE - FIRE PLANNING

Pre-Fire Planning is a standard operation in a number of our departments in this state and across the nation.

The fire departments who have taken advantage of the opportunity available to do a better job of Fire Prevention and Fire Fighting for their communities or cities have been very outspoken in their praise for the advantages and benefits they have received due to their efforts.

This talk is directed to the departments of city, town, or fire district who have not yet tried Pre-Fire Planning or adopted such a program.

Your departments who have not are missing one of the golden opportunities to receive some of the benefits which have come to every department which has made the effort at little or no cost in dollars and cents to the department or others.

Many of you have heard or read of the Nation-wide or State-wide efforts which are being made by the Chiefs' and Firemen's Associations. Millions of words have been written or spoken, with many methods of conducting the program suggested.

We cannot give all the suggestions which have been made or advice which would cover all situations which may be encountered, so will give an overall outline we hope will be of assistance to you in setting up your own program and procedures. You may wish to add to or subtract from to fit your city, town or fire district conditions.

The use of the National Fire Protection Association "Inspection Manual" will give you very good information on what to look for, how to prepare for inspection and make drawings of buildings and surroundings, etc. and will be helpful in answering questions on problems run into in the ordinary line of duty or fires. References are made to other material which may be used to secure information on specific problems.

It is recommended that the inspection for Pre-Fire Planning should be for that specific purpose rather than as a part of, or incident to, the regular fire hazard inspection. The reason for this is that they are conducted for different purposes. One is a Fire Prevention function, while the other is a Fire Protection one. They are two different types of inspections for two different purposes and do not tend to accomplish their specific purposes through a single inspection in areas with larger department and Fire Prevention Divisions.

In smaller departments and districts, Pre-Fire and inspections can be combined if properly applied and handled.

Fire hazard inspections are conducted under special laws designed to eliminate hazardous conditions as causes of fires. They are conducted for the purpose of trying to eliminate the possibility of fire. While on the other hand, a Pre-Fire Inspection is conducted as part of the fire protection program to better enable the Fire Department to combat the fire if it occurs.

PRE-FIRE PLANNING (contd.)

Outstanding benefits to your department available through Pre-Fire Planning are:

1. Better Life Saving and Fire Fighting is possible due to knowledge of building and contents.

2. You will build up good "Public Relations" due to your showing interest in the property of the people you protect.

3. Will bring about better building and content conditions by educating the public in fire prevention in their own homes or buildings.

4. Bring about better personal safety to members of department due to knowledge secured while going through buildings.

5. May help in detection of Arson or prevent Arson attempts.

PREPARATION FOR PRE-FIRE PLANNING:

There is no finer way to bring about good public relations between your department and the people you serve than through personal contact in their homes or places of business. You have the chance to tell them about ways to prevent fires and loss of life or property, right on the spot where the fire may occur.

When the pre-fire inspection is made, it should be with the owner's permission. The purpose for which the inspection is being made should be explained to him. If this is conducted properly, the owner can be made to feel that he is receiving personal consideration; and in effect, he is, because his building represents a specific problem which you are studying to meet. He should learn that you are planning on the best means of meeting his specific problem if it should occur. He learns that as a result of the inspection you are making, that you are preparing yourself to render him prompt and efficient service if he has a fire.

Experience has proven that making advance arrangements or appointments for pre-fire planning visits work out very well.

It has been found that where a business is contacted and arrangements made ahead of time, that the average business owner does not want the firemen to see his premises in poor condition and will make a special effort to have things neat and clean for your visit. If nothing else is accomplished, you have caused housekeeping to improve and trash removed which may have been in place for months or years prior to the visit and have been definite fire hazards.

Arrangements are made in various ways. Some use leaflets, letters or newspaper and radio mediums to reach the home owners, letting them know that companies of firemen will contact them at their homes for check. Home owners are asked to call in for inspections, or members of the fire department will stop at their door and ask if they wish inspection. These methods and others will have to be determined to fit your local conditions.

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PRE-FIRE PLANNING (contd.)

For visits to business or industrial property the approach will have to be different from home inspections with procedures along the following lines being very successful.

The officer who is to be in charge of the Pre-Fire visit makes contact with the owner or occupant of the property and makes an appointment for trip which will be convenient for both parties.

Care must be taken to see that you do not disrupt the normal business any more than necessary during visit.

Written material such as the following is sometimes used to good advantage:

TO WHOM IT MAY CONCERN:

We would like to acquaint you with the purpose of the Pre-Fire Survey conducted by the officers and men of the fire fighting companies of your fire department.

This is not intended as an inspection to find defects but a survey to acquaint all members of the department with the type of building structure, floor plan, stairways, exits, roof openings, electrical switches and equipment, amount and type of merchandise and many other such features.

A knowledge of these facts help the firemen greatly in the saving of life and property and all phases of fire fighting procedure.

These surveys are definitely recommended by both the National Board of Fire Underwriters and the National Fire Protection Association and are carried on by practically all progressive fire departments in the United States.

If there is any special desired time for these surveys, we will be glad to co-operate. END.

Samll properties such as dwellings, one-story stores, service stations and the like may not require much preparation before making inspections. But, any property of any size must be reviewed at least in the inspecting officer's mind before inspection is started. A blueprint of property and processes may be obtained from management of property, prior to inspection and reference books may be consulted.

INTRODUCTION:

Extra effort to create a favorable impression will aid the department in securing courteous recognition and treatment.

Men making the inspection should be neatly dressed with shoes shined and hair in place To secure favorable impression from public, a uniform appearance will be very helpful with men dressed in dress uniform, department coveralls and uniform caps, or whatever your department has as uniform dress.

If these are not available, turnout coats and helmets will be better than ordinary street or work clothes as a uniform appearance will mark you as being a fireman rather then any person they would be apt to see on the street.

PRE-FIRE PLANNING (contd.)

The men should be introduced to the person showing them around the premises and as a group goes through the property, they should stay together and not handle merchandise or make individual side trips.

The officer in charge should be the one to do the talking, with other men speaking or making comments only when necessary. Many men talking at once will create confusion and give poor impression. Listen to all instructions or information the management may give and pay particular attention to any hazardous conditions, processes or storage which may be in or around the building.

You may find it helpful in many cases to go to the top of the tallest building in the area to start the inspection in order to visualize the property as a whole

In each building, it is recommended that you start at the top, but in any case the routing should be systematic, not missing any areas. Every room, closet, attic, concealed space, basement or other out of the way place where fire might start should be inspected. All vertical openings or openings in walls or ceilings should be noted. The group should not take the story about the room with the closed door not having anything in it. That room or closet is usually the one that is loaded with combustible material.

Electrical wiring, heating systems, open flame devices, combustible or hazardous material storage, explosive materials or chemicals, compressed gases, acetylene generators, paint storage, etc., should all come in for careful scrutiny and attention.

One or two men should be assigned to sketch property and buildings with notations made on the sketches for doors, windows, stairs, fire walls, standpipes, sprinklers and control valves or siamese, and any of previously mentioned hazards or other items of special interest. The NFPA "Inspection Manual" will be of much assistance to you in handling this item. These drawings should then be kept in the files at your station for use on Pre-Fire Planning sessions which you have at the fire stations.

EXTERIOR FACTORS TO BE CONSIDERED:

1. A. Distance to nearest hydrants or water supply - Number of feet of hose necessary to reach each building in area - First and second lines.
   B. Number of lines which can be supplied - Gallons per minute available.
   C. Size mains - Hydrants - Flow Pressure-Loop or Dead End systems, etc.

2. Exposures - Buildings on all sides of target building - How fire in target building would affect surrounding buildings - Would it cause a conflagration?

3. Roads and means of access to building and areas - Streets - Alleys - Vacant lots, etc.

4. Where building may be laddered and what length ladders necessary for life saving or fire streams.

5. Nearest Fire Alarm Box or Telephone.

6. Exterior sprinkler - Standpipe - Water Curtain - [illegible] or Siamese.

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PRE-FIRE PLANNING (contd.)

INTERIOR FACTORS TO BE CONSIDERED:

1. Type of Building Construction:

   A. All masonry
   B. Masonry and Wood
   C. Heavy Timber (Mill Type)
   D. Frame (Wood)
   E. Frame (Metal) with wood or metal covering

2. Life Hazard:

   A. Number of persons working or living in building in daytime.
   B. Number of persons working or living in building during night.
   C. Crippled or bedridden persons on premises.
   D. Places of public assembly - Number of persons building will hold and hours occupied.

3. Means of Entrance or Egress:

   A. Doors - Fire Escapes - Stairways, etc., which would be utilized for life saving.
   B. Do corridors or aisles lead directly to means of egress and are they clear of obstructions.

4. Vertical Openings:

   A. Stairs - Open or enclosed - with or without fire doors - Door open inward or outward - Stairs turn right or left - Are fire doors equipped to close automatically.
   B. Elevator shafts - Dumb Waiter shafts - Incinerator and Trash chutes.
      1. Are they enclosed with fire resistive material and equipped with self-closing metal clad doors?
      2. Condition of shaft - Is trash condition present at bottom?
      3. Do tops of shafts stop or open into attic or do they extend through roof?
   C. Vents and Ducts - See if they are enclosed with fire resistive material and pass through attic or upper floors and through roof. If they stop in attic or upper floors, make special notice for fire spread in these areas.
   D. Distances from Entrances or Building Openings to hazard spots. Estimates or measurements should be made of number of feet of hose needed to reach spots most likely to be involved in fire or to points whereholding lines would be needed for life saving.

5. Attics - Check wiring - Chimneys - Type walls (Fire-stopped or balloon) (Open) - Trash or storage of combustible materials - Check for holes in walls between buildings - Vents - Ducts - Shafts which terminate in attic.

6. Ventilation Possibilities: Skylights - Air Shafts - Elevator and other shafts - Ducts - Stairways - Windows - etc., should be noted for speed and efficiency in ventilation. What properties around target building would be exposed under certain ventilating conditions.

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PRE-FIRE PLANNING (contd.)

7. Salvage Possibilities: Is stock off floors on risers or skids - Are floor drains or scuppers marked with overhead markers - Is stock stored with good aisle space and space between walls and stock which will swell from water. Are sprinkler heads clear and stock at proper level below heads. Type of stock which would be most likely to be affected by water and damage easily - Which to be covered with salvage covers first, second, etc.

8. Types of Posts Supporting upper floors: If post of metal - Are they covered with fire resistive material? What kinds of loads are they supporting? If post involved in fire will loads on upper floors cause early collapse?

9. Location of: Main switch boxes - Fuse Box - Gas shutoffs - Water Shutoffs - Oil Shutoffs - Main switches for furnace, air conditioning, blower systems - Furnace room - Hazardous Processes of conditions - Flammable Liquids, etc.

10. Sprinkler systems - Interior and Exterior Standpipes - Interior fire hose, Extinguishers.

11. General Housekeeping: Storage of combustibles - Gases - Flammable Liquids - Chemicals - Acids - Concealed spaces in walls or ceilings - Wall Finishes (Fast burning or fire resistant) Combustible dusts - Materials subject to spontaneous heating - Explosive materials - Oxidizing agents and others.

12. Check principal sources of Ignition Hazards:
    A. Open flames and heaters: Smoking, torches, gas jets, lamps, furnaces, ovens, heaters.
    B. Friction: Hot bearings, rubbing belts, grinding, shredding, picking, polishing, cutting, drilling.
    C. Electricity: Arcs and sparks, including lightning and static, heated resistances.
    D. Chemical reactions, exothermic, endothermic.

FINAL INTERVIEW:

Before leaving the property and the persons who have gone over the buildings or premises with you, be sure and extend the thanks of the men and the department for courtesies shown and for them taking the time to show you around.

Any discussions or suggestions you have made should be reviewed and plans made if another trip is necessary to complete the picture.

We hope that you will try Pre-Fire Planning in your Department and city, town or fire district and know that if tried it will bring you new friends, much knowledge of local conditions and better conditions over a period of time.

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PRE-FIRE SURVEY

Survey By _____ Date _____

Name and Address of Building _____ Phone _____

Type of Occupancy _____ Owner _____

Name and Address of Manager _____ Phone _____

Height in Stories, Front _____ Rear _____ Approximate Age of Building _____ Heat _____ Fuel _____

Construction Features:

Exterior Walls _____ Interior Walls _____

Floors _____ Ceiling _____ Roof _____

Vertical Openings:

Stairways _____ Elevators _____ Chutes _____

Attic Used For _____ Access Where _____

Sprinklered _____ Connections _____ Shut-offs _____

Water Shut-off _____ Gas Shut-off _____ Main Switch _____

Refrigeration Shut-off _____

Nearest Hydrants (2) _____

_____

Remarks:

_____

_____

_____

_____

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Airplane Flight Instructor Written Test Guide.

Federal Aviation Administration, Washington, D.C.
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ABSTRACT - This guide was prepared by the Flight Standards Service of the Federal Aviation Administration to provide information to prospective airplane flight instructors and other persons interested in Federal Aviation Administration certification of flight instructors. Contents include information on certification requirements, reference material, application and testing procedures, and a sample written test with answers and explanations. The manual is illustrated with numerous figures, diagrams, and line drawings. (AW)

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AC 61-11A

Airplane
FLIGHT INSTRUCTOR
Written Test Guide

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DEPARTMENT OF TRANSPORTATION

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FEDERAL AVIATION ADMINISTRATION

AIRPLANE FLIGHT INSTRUCTOR WRITTEN TEST GUIDE

Revised

1967

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FEDERAL AVIATION ADMINISTRATION

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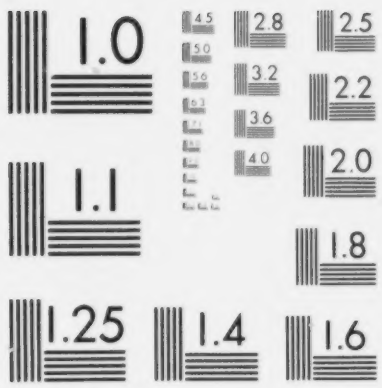

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PREFACE

The Flight Standards Service of the Federal Aviation Administration has issued this *Airplane Flight Instructor Written Test Guide* to provide information to prospective airplane flight instructors and other persons interested in Federal Aviation Administration certification of flight instructors.

The guide contains information about certification requirements, application procedures, and the required Written test. Its purpose is to guide prospective applicants toward a clear understanding of the requirements, reference material, and tests, and the application and testing procedures. A sample test is presented and explanations of the correct answers are given.

Superseding the *Airplane Flight Instructor Examination Guide* dated 1965, the guide is issued as Advisory Circular No. 61–11A.

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AIRPLANE FLIGHT INSTRUCTOR WRITTEN TEST GUIDE

Introduction

This study guide was prepared by the Flight Standards Service of the Federal Aviation Administration to assist applicants who are preparing for the Airplane Flight Instructor Written Test. It was prepared by the same personnel who were responsible for developing the airplane flight instructor written test currently in use.

This guide is not offered as a quick and easy way to obtain the necessary knowledge for passing the written test. There is no quick and easy way to obtain the background of experience, knowledge, and skill that the professional flight instructor should acquire in order to provide the high quality of training necessary to transform today's student into tomorrow's proficient pilot. Rather, the intent of this guide is to define and narrow the field of study, insofar as possible, to the basic knowledge requisite to obtaining a flight instructor certificate.

Certificate Requirements

The general qualifications for an airplane flight instructor certificate require of the applicant a combination of experience, knowledge, and skill. An applicant for a flight instructor certificate with an airplane rating should carefully review the applicable sections of Federal Aviation Regulations Part 61 for detailed information pertaining to this subject.

Type of Written Test

The Airplane Flight Instructor Written Test is necessarily comprehensive because the flight instructor should be knowledgeable in many areas. He should know not only "what" to do and "how" to do it; he should know also "why" a maneuver is performed in a certain order and what the results may be if the maneuver or procedure is not performed properly. It is generally accepted that a pilot with much knowledge but little skill is not adequately equipped for day-to-day flying, but neither is the pilot who is skillful in only the manipulative techniques of flying and lacking in aviation knowledge.

In addition to his aviation qualifications, the flight instructor should be capable and well versed in one highly important area that is not required for any other pilot certificate. The flight instructor should be a teacher. He should have an understanding of the learning processes, the basic teaching principles, and the general application of these principles to teach his students effectively. There is much truth in the saying, "If there is no learning, there is no teaching."

The airplane flight instructor written test is divided into two sections: Section I "Fundamentals of Flight Instruction" and Section II "Performance and Analysis of Flight Training Maneuvers." A detailed outline of the subject areas covered in each section appears later in this guide.

The time required for the test is approximately 4 hours. Test items are of the objective, multiple-choice type, and each can be answered by the selection of a single item as the correct choice. This method conserves the applicant's time, the scorer's time, and eliminates any element of individual judgment in determining grades.

Taking the Written Test

In addition to being an exercise in the application and use of aeronautical knowledge, a test is also an exercise in communication since it involves the use of written language. Communication between individuals through the use of such abstract symbols as words is indeed a complicated process; so complicated, in fact, that at times communication may

either break down or mislead if care is not exercised. The same word often means different things to different people. Carefully read the information and instructions.

Always bear in mind the following facts when you are taking the test:

1. The test items are not trick questions. Each statement means exactly what it says. Read each question and possible answer carefully, but do not look for hidden meanings. The statement does not concern exceptions to the rule; it refers to the general rule.

2. First, carefully read the test item before you look at the answers listed below it. Be sure that you understand what the question asks. Then decide what the correct answer should be or work out the problem to obtain the answer. Finally, look through the list of alternate answers or phrases and select the one that says the same thing as your answer. Be sure that the one you select answers the question completely.

3. Only one of the alternate answers given is completely correct. The others may be answers that result from incorrect procedure (in a problem, for example) or from lack of knowledge pertaining to the test item, or from popular misconceptions. Understand the question and then select the answer you consider to be the best.

4. If you find that you have considerable difficulty with a particular test item, do not spend too much time on it, but continue with the test and answer those questions which are less difficult. Then go back and reconsider the test items you have passed over. This procedure will enable you to use the total time available to maximum advantage in demonstrating your knowledge and understanding of the subject.

RECOMMENDED STUDY MATERIALS

The applicant for the Airplane Flight Instructor rating will find the publications listed below helpful to him in his preparation for the written test.

The list identifies source material essential to preparing for the test, but does not include all available material on the subjects. Other excellent textbooks, audiovisual training aids, and instruction materials useful in preparing for the test are available at bookstores and libraries.

It is the responsibility of each applicant to obtain the study materials appropriate to his needs.

Airman's Information Manual. This publication has been designed as a pilot's operational manual for use primarily within the conterminous United States. It is divided into three basic parts, each of which may be purchased separately.

PART 1—BASIC FLIGHT MANUAL AND ATC PROCEDURES. (Annual Subscription: $2.00 domestic; $2.50 foreign.) This part is issued quarterly and contains basic fundamentals required to fly in the National Airspace System; adverse factors affecting Safety of Flight; Health and Medical Facts of interest to pilots; Emergency Procedures, and other topics.

PART 2—AIRPORT DIRECTORY. (Annual Subscription: $2.00 domestic; $2.50 foreign.) This part is issued semiannually and contains a Directory of all Airports, Seaplane Bases, and Heliports in the conterminous United States, Puerto Rico, and the Virgin Islands which are available for transient civil use. It includes all of their facilities and services, except communcations, in codified form.

PARTS 3 and 3A—OPERATIONAL DATA AND NOTICES TO AIRMEN. (Annual Subscription: $9.00 domestic; $11.25 foreign.) Part 3 is issued every 28 days and includes an Airport/Facility Directory listing all major airports with communications; a tabulation of Air Navagation Radio Aids and their assigned frequencies, a Sectional Chart Bulletin, which updates sectional charts cumulatively; and other information. Part 3A is issued every 14 days and contains Notices to Airmen considered essential to the safety of flight.

Private Pilot's Handbook of Aeronautical Knowledge, AC 61–23 ($2.75). This text on basic aeronautical knowledge was designed to meet the needs of the private pilot. However, it should be useful as a basic text for reference and for review of most aviation fundamentals, many of which are directly related to questions on the Airplane Flight Instructor Written Test.

Aviation Weather, AC 00–6 ($2.25). Issued jointly by the U.S. Weather Bureau and the Federal Aviation Administration, this publication explains, in nontechnical language, the fundamentals of weather behavior in relation to flying, using many illustrations. It explains the aviation weather services offered to the pilot for his safety in flying and gives information on many other phases of meteorology.

Flight Instructor's Handbook, AC 61–16 (60¢). This revised handbook is one of the primary sources of information and guidance for pilots preparing for the flight instructor certificate and is also valuable as a reference text for certificated flight instructors. It is basically a book which deals with accepted theories and practices applicable to teaching and the learning process. As such, it is the primary reference text when preparing for the "Fundamentals of Instruction" section of the Flight Instructor's Written Test. It also deals with selected topics of aerodynamics which will be useful to the flight instructor, gives a comprehensive outline of flight training maneuvers currently in use, and includes a sample Private Pilot Flight Syllabus.

8285 2657

Flight Training Handbook, AC 61–21 (70¢). This text deals with basic flight information such as load factor principles, weight and balance, and related aerodynamic aspects of flight, as well as principles of safe flight. The balance of the book provides information and direction in the introduction and performance of training maneuvers. Thus it serves as a text for student pilots, pilots improving their qualifications or preparing for additional ratings, and flight instructors who are teaching.

Federal Aviation Regulations

PART 1—DEFINITIONS AND ABBREVIATIONS (25¢). This Part contains all needed definitions, abbreviations, symbols, and rules of construction which apply to all Parts of the Federal Aviation Regulations.

PART 61—CERTIFICATION: PILOTS AND FLIGHT INSTRUCTORS (60¢). The applicant is responsible for the items in this Part which fall within the scope of knowledge required for his certification as a flight instructor.

PART 91—GENERAL OPERATING AND FLIGHT RULES (70¢). It is imperative that the applicant be familiar with all the information in this Part except that which pertains to instrument flight.

PART 23—AIRWORTHINESS STANDARDS-NORMAL, UTILITY, AND ACROBATIC CATEGORY AIRPLANES (65¢). Certain sections of this Part will prove most useful as a source of detailed information on the requirements pertaining to aircraft characteristics, performance, and operation.

National Transportation Safety Board, Safety Investigation Regulations, Part 430 (5¢). This NTSB publication deals with procedures required in dealing with accidents and lost or overdue aircraft in the United States and outlying areas.

Airplane Flight Manuals and Owners Manuals. Aircraft manufacturers issue manuals for each aircraft model. These may be obtained from individual aircraft manufacturing companies or from local dealers and distributors.

Plane Sense, AC 20–5A (Free). This booklet helps to acquaint the prospective airplane owner with some fundamentals of owning and operating an airplane. Upon request, it is free from the Federal Aviation Administration Washington, D.C. 20590.

Facts of Flight, AC 00–4 (50¢). This publication explains in nontechnical language why an airplane flies; the effect of the controls; stalls and spins; facts about airplane structure and engine operation; and proper technique in takeoff, cruising, and landing.

Path of Flight, AC 00–5 (70¢). An illustrated publication for the student and novice pilots, it contains practical information about navigation of aircraft, radio communication, radio aids, and flight planning.

Realm of Flight, AC 00–3 (75¢). Written for the private pilot, this is a condensed elementary text on weather characteristics affecting flying. Many color pictures are included to illustrate atmospheric pressure, clouds, winds, fronts, and other weather phenomena.

VFR Pilot Exam-O-Grams. Dealing with selected topics of particular importance to safety in flight operations, these précis provide concise information on the specific subjects which pilot tests have indicated need clarification to correct common mistakes, misconceptions, and lack of information. A list of the currently available Exam-O-Grams appears in the Appendix. They are available free of charge from:

FAA Aeronautical Center
Flight Standards Technical Division
Operations Branch, AC–240
Post Office Box 25082
Oklahoma City, Okla. 73125

How To Obtain Study Materials

All study materials listed above except *Airplane Flight Manuals or Owner's Manuals, Plane Sense,* and *VFR Pilot Exam-O-Grams* may be obtained by remitting check or money order to:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

In many instances, these publications may also be obtained at airports or bookstores.

NOTE: The items listed were available at the time this publication went to press.

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STUDY OUTLINE FOR THE AIRPLANE FLIGHT INSTRUCTOR WRITTEN TEST

SECTION I. FUNDAMENTALS OF FLIGHT INSTRUCTION

A. PRINCIPLES OF TEACHING AND LEARNING

1. *How People Learn.*

a. Perception—Understand its role in relation to learning and the important factors which affect a student's perception, such as—

(1) Individual mental, emotional, and physiological characteristics.

(2) Needs and requirements.

(3) Goals and values.

(4) Self-concept.

(5) Time and opportunity to perceive.

(6) The element of threat.

b. Insight—Understand its relationship to perception and the instructor's role in—

(1) Cultivating receptiveness to new experiences.

(2) Organizing demonstrations, explanations, and directed student practice.

(3) Pointing out related perceptions as they occur.

(4) Supervising the "trial and error" process.

(5) Assisting the student to group associated perceptions into meaningful wholes or "blocks" of learning.

c. Motivation—Understand its dominant role in relation to student progress and ability to learn

(1) Types of motivation.

(a) Negative motivation.

(b) Positive motivation.

(c) Tangible motivation.

(d) Intangible motivation.

(2) Use of factors which affect motivation.

(a) Gain or reward.

(b) Comfort and security.

(c) Favorable self-image.

(d) Group approval.

(e) Short and long-range goals.

(f) Praise.

(g) Criticism.

d. Obstacles to learning—Understand the effect of each of the following on the learning process and how they may be modified or eliminated

(1) Self-consciousness.

(2) Antagonism or feeling of unfair treatment.

(3) Impatience.

(4) Worry or lack of interest.

(5) Physical discomfort, fatigue, and illness.

(6) Apathy fostered by poor instruction.

(7) Fear, anxiety, and timidity.

(8) Lack of confidence.

(9) Airsickness.

e. Habits and transfer—Understand the influence of perceptions and insight on the development of performance habits and the influence of such habits in subsequent learning and transfer of learning.

(1) The importance of the formation of correct habit patterns.

(2) The importance of habit patterns in aircraft control.

(3) The promotion of transfer of learning through use of the flight syllabus.
(4) Positive transfer.
(5) Negative transfer.
(6) The influence of the "building block" technique of instruction in habit development.

2. *Levels of Learning.* Understand the progressive levels of learning as exemplified by the "building block" concept.
   a. Rote performance.
   b. True understanding.
   c. Correlation of previous learning, understanding, and skill with new tasks, problems, techniques, and procedures.
3. *Rates of Learning.*
   Have a knowledge and understanding of—
   a. The characteristics of a typical learning curve.
      (1) Initial learning rate.
      (2) Slumps or plateaus and their causes.
      (3) Reversals and their causes.
   b. The role of memory and the effect of forgetting in the achievement of satisfactory student progress.
      (1) Relationship between memory and habit patterns.
      (2) Usefulness of drill, recitation, and quizzing.
      (3) Continued usage, practice, and application.
   c. Significant principles which reinforce memory.
      (1) Praise.
      (2) Association.
      (3) Favorable attitude.
      (4) Learning with all the senses.
      (5) Meaningful repetition.
4. *Common Misconceptions About Learning.*
   a. Fear is the best motivator.
   b. Making it easy to learn is contrary to the principles of sound teaching.
   c. Pictures, illustrations, and diagrams are, per se, more effective than written or verbal presentations of information.
   d. The greater the experience, the better the performance.
   e. The impersonal approach is more effective than the friendly attitude in teaching.
   f. Competition is the key to successful learning.
   g. Frustration and failure are essential to learning.

B. HOW TO GUIDE THE LEARNING PROCESS

1. *Plan the Instructional Activity.*
   a. Establish clear objectives or goals.
   b. Identify the block of learning.
   c. Provide for student participation.
   d. Diagnose student ability.
   e. Use a teaching sequence that "makes sense."
   f. Work from the known to the unknown.
   g. Work from the easy to the difficult.
   h. Plan so the student will see the necessity and logic of each succeeding step.
2. *The Flight Training Syllabus.*
   a. Arrange for efficient sequence in "blocks" of training.
   b. Use syllabus as a guide.
   c. Keep flexibility in teaching procedures.
3. *The Lesson Plan.*
   a. Lesson planning is essential to teaching success.
   b. Items to include in lesson plan—
      (1) Lesson objectives.
      (2) Elements involved in satisfactory fulfillment of lesson objectives.
      (3) Allocation of time available.
      (4) Equipment needed.
      (5) Activity required of the instructor.
      (6) Activity required of the student.
      (7) Evaluation of student performance.
4. *The Flight Instruction Breakdown.*
   a. Useful in preparing meaningful lesson plans.

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b. Useful for guidance in offering effective instruction.
c. Requires personal analysis of maneuver.
d. Requires personal analysis of proposed procedure for teaching maneuver.

5. *Presentation of the Instruction Material.*
a. Establish atmosphere of cooperation.
b. Explain, demonstrate, and direct.
c. Require student participation.
d. Keep goal in sight.
e. Be brief, clear, and to the point in explanations.
f. Use analogies as link between known and unknown.
g. Question technique: use and importance.
h. Deal with the individual needs of both poor students and apt students.
i. Use training aids.

6. *Performance.*
a. Usually integrated with presentation.
b. Require discipline.
c. Make it realistic.
d. Guide student efforts.
e. Progress from easy to difficult.
f. Relate to previous explanations and practice.
g. Provide adequate practice but control blind "trial and error."
h. Understand factors relating to length and frequency of practices.
i. Use of briefings and critiques.
j. Skill versus knowledge.
k. Role of repetition in learning and retention.

7. *Evaluate the Performance.*
a. An integral part of each lesson.
b. Establishes need for selective reteaching or review.
c. Acquaints student with his progress.
d. Should include evaluation of things previously learned.
e. Should be based on standards established by the training syllabus.

C. ANALYSIS OF EFFECTIVE TEACHING METHODS AND TECHNIQUES

1. *The Four Basic Steps in the Teaching Process.*
a. Preparation (See Section IB, "How to Guide the Learning Process").
b. Presentation.
(1) Telling or explaining—the lecture method
(a) Does not permit student participation.
(b) Can be combined with other methods for greater effectiveness.
(2) Techniques of discussion
(a) Develop cooperative spirit.
(b) Clarify problems.
(c) Encourage participation.
(d) Avoid dominating discussion.
(e) Summarize frequently.
(3) Demonstration or showing
(a) Usually combined with explanations.
(b) Makes explanations concrete.
(c) Aids student understanding.
(d) Saves learning time.
(e) Effective with both large and small groups.
(f) Gives student overall perspective.
(g) Appeals to several senses.
(h) Has dramatic appeal.
c. Doing—trial and practice
(1) Essential to the learning process.
(2) Constitutes student's activity based on instructor's preparation and presentation.
(3) Requires careful guidance and correction.
(4) Requires student and instructor evaluation.
(5) Concentrate on strengthening weak points of performance.
d. Review and evaluation
(1) Review organizes thinking.
(2) Review develops understanding of basic principles.

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(3) Help the student to see relationships.
(4) Evaluations are measures of the success of a teaching program.
(5) Test for both understanding and performance.
(6) Characteristics of good evaluation.
  (a) Validity—does it measure what it is supposed to measure?
  (b) Reliability—are the results consistent?
  (c) Objectivity—does it limit the undesirable errors introduced by personal judgment in grading?
  (d) Differentiation or discrimination—does it identify small but significant differences in achievement?
  (e) Comprehensiveness—does it provide adequate sampling of the skill or proficiency being graded?
(7) Common techniques of evaluation
  (a) Oral and written quizzes.
  (b) Demonstrations of ability.
  (c) Examination and tests.

D. HELPING STUDENTS TO LEARN—THE FLIGHT INSTRUCTOR'S ROLE

1. *Be a Professional*
  a. Train and prepare.
  b. Follow a program of self-improvement.
  c. Adhere to ethical standards.
  d. Be of real service.
  e. Believe in your work.
  f. Maintain a positive attitude—be sincere, enthusiastic, friendly, and patient.
  g. Be proficient as a pilot.
  h. Be proficient as a teacher.
2. *The Instructor-Student Relationship*
  a. Gain the student's confidence.
  b. Appreciate the student's problems.
  c. Assess the student's personality, thinking, and ability.
  d. Allow for individual differences.
  e. Keep student aware of progress.
3. *Safety Practices*
  a. Practice what you preach
    (1) Use the checklists.
    (2) Observe established safety practices.
    (3) Observe regulations.
    (4) Teach respect for limitations of self and equipment.
4. *Use of Training Aids*
  Choose with care—
  a. Models.
  b. Charts, diagrams, and performance tables.
  c. Audiovisual courses.
  d. Programmed instruction.
  e. "Handees" (gestures and improvisations).

E. MAINTAIN STUDENT INTEREST AND MOTIVATION

1. *Motivation—Basic to All Learning*
  a. Utilize interests noted during analysis of the student.
  b. Direct and control student's attention.
  c. Appeal to all the student's senses.
  d. Contrive interesting experiences.
  e. Teach from the known to the unknown.
  f. "Watch your language"—explain technical terms.
  g. Emphasize the positive.
  h. Utilize the incentive provided by rewards.

F. IMPORTANT AEROMEDICAL INFORMATION

1. *The General Health Factor.*
2. *Specific Aeromedical Factors—Their Symptoms and Control*
  a. Fatigue, boredom, inattention.
  b. Hypoxia.
  c. Alcohol.
  d. Drugs.
  e. Vertigo.
  f. Carbon monoxide.
  g. Vision.
  h. Middle ear discomfort.
3. *Scuba Diving*—"Airman's Bends."
4. *Psychological Factors in Flying*

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a. Anxiety.
b. Normal and abnormal reactions to stress.
c. The "difficult" student.
d. The seriously abnormal student.

G. FLIGHT INSTRUCTOR RESPONSIBILITIES

1. *Foster Student Learning*
   a. Know the objective.
   b. Devise a plan of action.
   c. Create a positive instructor-student relationship.
   d. Present information and guidance effectively.
   e. Transfer responsibility to the student as he learns.
   f. Evaluate teaching effectiveness through evaluation of student's learning and proficiency.
2. *Instruction of Student Pilots*
   a. Provide adequate instruction.
   b. Require an adequate standard of performance.
   c. Give adequate supervision.
   d. Endorse student pilot certificates.
   e. Endcrse student logbooks.
   f. Maintain adequate records.
3. *Flight Test Recommendations.*
4. *Aircraft Checkouts*
   a. Use appropriate guides.
   b. Be fully qualified.
5. *Refresher Training*
   a. Know the objectives.
   b. Know the standards.
6. *The Flight Instructor Image*
   a. Be sincere.
   b. Accept the student as he is.
   c. Maintain professional appearance and habits.
   d. Avoid objectionable language.
   e. Develop and maintain a calm, thoughtful, and disciplined demeanor.

SECTION II. THE PERFORMANCE AND ANALYSIS OF FLIGHT TRAINING MANEUVERS

A. AERODYNAMICS. Have a knowledge and understanding of—

1. *Aerodynamic terms and definitions.*
2. *Airplane loading*
   a. Weight and balance and flight performance.
   b. Effects of load on airplane structure.
   c. Effects of loading on stability and controllability.
   d. Load factor principles.
      (1) Load factors and stalling speeds.
      (2) Load factors and flight maneuvers.
3. *Forces Acting on an Airplane in Flight.*
4. *The Airplane's Axes of Rotation.*
5. *Functions of the Control Surfaces and Trim Tabs.*
6. *Use of Flaps*
   a. Effects on flight performance.
   b. Effects on stability.
7. *Angle of Attack*
   a. In stalls.
   b. As an index of performance.
8. *Airspeed*
   a. Control effectiveness.
   b. Maximum performance speeds.
      (1) Slow flight.
      (2) Cruise.
      (3) Best rate-of-climb (V_y).
      (4) Best angle-of-climb (V_x).
      (5) Relationship between speed, angle of bank, and rate of turn.
9. *Turns*
   a. Forces acting on an aircraft in a normal turn.
   b. Changes of lift in a turn.
   c. Increase of drag in a turn.
10. *Ground Effect*
    a. As a factor in takeoffs.
    b. As a factor in landings.
    c. Its use in emergencies.
11. *Torque and "P" Factor*
    a. Aircraft rigging.
    b. Asymmetrical loading of the propeller.
    c. Action of the spiral slipstream.
    d. Gyroscopic action of the propeller.
    e. Torque reaction.
12. *Controllable Propellers*
    a. How a propeller works.
    b. Purpose of controllable propellers.
    c. Operation of controllable propellers —The relationship between mani-

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fold pressure, RPM, and Brake Mean Effective Pressure (BMEP).

B. FLIGHT TRAINING MANEUVERS AND PROCEDURES

1. *Know How and When to Introduce Maneuvers and Procedures* (Item 5 below).
2. *Know the Correct Technique for the Maneuvers and Procedures.*
3. *Be Able to Recognize and Analyze Common Student Errors.*
4. *Be Familiar with Effective Methods of Correcting Student Errors.*
5. *Know the Required Maneuvers and Procedures*
   a. Preflight (including check of airplane documents and records), starting, warm-up, taxi, before takeoff, inflight, and postflight checks and procedures.
   b. Use of radio for voice communication.
   c. Straight-and-level flight, turns (including slips and skids), and confidence maneuvers.
   d. Climbs and glides (including powered descents).
   e. Ground track maneuvers
      (1) "S" turns across a road.
      (2) Turns about a point, including 720° steep turns.
      (3) Rectangular courses.
      (4) Traffic patterns.
   f. Stalls, stall recoveries, and flight at minimum controllable speeds.
   g. Takeoffs and landings
      (1) Normal.
      (2) Crosswind.
      (3) Short, soft and rough-field.
      (4) Slips, and slips to a landing.
      (5) Downwind landings.
      (6) Power approaches.
      (7) Touch and go landings.
      (8) Wheel landings (tail-wheel type airplanes), stall landings (nosewheel-type airplanes).
      (9) Go-arounds.
      (10) Emergencies, including those applicable to multiengine aircraft.
      (11) Solo flight.
   h. Eights on pylons (shallow and steep).
   i. Chandelles and lazy 8's.
   j. Steep turns (including 720° power turns).
   k. Constant radius power-off spirals.
   l. Spins.
   m. Post solo emergencies.
6. *Cross-country Flying*
   a. Planning.
   b. Pilotage.
   c. Dead reckoning.
   d. Use of radio aids. (See Section E, "Use of Radio.")
   e. Cross-country emergencies.
      (1) Lost.
      (2) Engine failure.
      (3) Adverse or marginal weather.
      (4) Icing.
      (5) Loss of or restriction to visual references.
      (6) Imminent fuel exhaustion.

C. THE INTEGRATION OF INSTRUCTION IN VISUAL AND INSTRUMENT FLYING.

1. *Flight Instructor Qualifications.*
2. *Objectives.*
   a. Development of habit patterns.
   b. Accuracy of flight control.
   c. Operating efficiency.
   d. Emergency capability.
3. *Procedures.*
4. *Safety Precautions.*

D. FUNDAMENTALS OF INSTRUMENT FLIGHT

1. *The Three Major Components of Attitude Instrument Flight*
   a. Instrument coverage (cross-check).
   b. Instrument interpretation.
   c. Aircraft control.
2. *Instrument Characteristics*
   a. Attitude indicator (artificial or gyro horizon).
   b. Heading indicator (directional gyro or gyro compass).
   c. Vertical speed indicator.
   d. Turn-and-slip indicator.
   e. Airspeed indicator.
   f. Altimeter.
   g. Magnetic compass.

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3. *How to determine Attitude by Instrument Indications.*
4. *How to Recognize Incorrect Use of Controls by Flight Instrument References.*
5. *The Relationship Between Rate of Turn, Radius of Turn, True Airspeed, and Angle of Bank.*
6. *Standard Rate Turns.*
7. *Physiological Reactions and Sensory Illusions.*
8. *Required Maneuvers*
   a. Straight and level.
   b. Normal turns of at least 180°, left and right, to within 20° of a preselected heading.
   c. Shallow climbing turns to a predetermined altitude.
   d. Shallow descending turns at reduced power to a predetermined heading.
   e. Recovery from the approach to a climbing stall.
   f. Recovery from the start of a power-on spiral.

E. USE OF RADIO—Understand the basic characteristics, operations, frequency spectrum, advantages, and limitations of—

1. *VHF Communications Equipment*
   a. The "line-of-sight" range of transmissions.
   b. Understand how to utilize VHF/DF (direction finding) service and radar assistance from ground stations.

2. *VOR Equipment*
   a. Understand the meaning of the radio class designations of "H", "L", and "T" for VOR/VORTAC/TACAN stations.
   b. Know the components of the VOR receiver.
   c. Understand a radial as a line of magnetic bearing extending from a VOR station.
   d. Understand how to determine your approximate position relative to the station by interpreting the setting of the bearing selector, the position of the LEFT-RIGHT Needle, and the indication of the TO-FROM indicator.
   e. Understand the use of VOR for time and distance checks and for off-course navigation.
   f. Understand the methods of checking VOR receiver accuracy.
3. *L/MF Range and ADF Equipment*
   Understand—
   a. How to determine the magnetic directions of the four legs of L/MF radio ranges and the relative positions of the "A" and "N" quadrants.
   b. How to interpret bi-signals and on-course and off-course signals.
   c. The importance of the station identification signal in quadrant identification and orientation problems.
   d. How to interpret bearing information when using ADF.
   e. The use of ADF in checking time and distance to radio stations.
   f. Tracking outbound and inbound on ADF.
   g. Operational characteristics and precautions to observe in use of L/F radio equipment.

F. USE OF PILOT INFORMATION PUBLICATIONS

1. *Airman's Information Manual*—Know how to use and interpret the data contained in this important publication, such as—
   a. Air navigation radio aids (NAVAIDS).
   b. Airport and air navigation lighting and marking aids.
   c. Altimetry.
   d. Good operating practices.
   e. Radar.
   f. Radiotelephone phraseology and techniques.
   g. Safety of flight.
   h. Weather.
   i. ATC operations and procedures.
   j. Flight data and special operations.
   k. Notice to Airmen (NOTAMS).

l. Airport directory.
m. Airport/Facility Directory.

2. *Airplane Flight Manual and Owner's Manual*—As applicable to the airplane(s) in the instruction program, understand the material in these manuals and how to use it.
   a. Know how to consult the weight and balance data to determine that the aircraft is properly loaded. Know how to compute empty weight, useful load, and gross weight. Know how to compute moments from weights and center of gravity arms.
   b. Know the grade and quantity of fuel and oil required.
   c. Know flight load factor limitations and airspeed limitations.
   d. Be able to use performance charts as required for:
      (1) Takeoff data.
      (2) Climb data.
      (3) Landing distance data.
      (4) Cruise performance data (cruise power settings, approximate true airspeeds, fuel consumption rate).
   e. Be able to use tables such as:
      (1) Stall speed versus angle-of-bank table.
      (2) Airspeed calibration table.

3. *Federal Regulations Governing Aviation*
   The Airplane Flight Instructor should be familiar with the following National Transportation Safety Board Regulations and Federal Aviation Regulations:
   a. National Transportation Safety Board, Safety Investigation Regulations, Part 430.
   b. Federal Aviation Regulations
      (1) Part 1, "Definition and Abbreviations."
      (2) Part 61, "Certification: Pilots and Flight Instructors."
      (3) Part 91, "General Operating and Flight Rules."

G. AIRFRAME AND POWERPLANT—Have a working knowledge of—

1. Aircraft structures.
2. Airframe components and control surfaces.
3. Fuel and fuel systems.
4. Oil and oil systems.
5. Electrical system fundamentals.
6. Reciprocating engine principles and components.
7. Carburetion and fuel injection.
8. Ignition.
9. Propellers.
10. Engine instruments.

H. OTHER AREAS OF IMPORTANCE

1. *The Altimeter*
   a. Know the effect of nonstandard temperature and pressure on the indications of the altimeter.
   b. Understand how to apply altimeter settings to the Kollsman window of the altimeter.
   c. Understand how to obtain the pressure altitude.
   d. Be able to interpret the indications of the altimeter at all altitudes (including altitudes above 10,000 feet).

2. *The Airspeed Indicator*
   a. Know the eight airspeed ranges and limitations that are reflected by the standard marking system on the face of the airspeed indicator (white, green, and yellow arcs, and the red line).
      (1) Flap operating range.
      (2) Normal operating range.
      (3) Caution range.
      (4) Power-off stalling speed with the wing flaps and the landing gear in the landing position (V_{SO}).
      (5) Power-off stalling speed. "Clean"—wing flaps and landing gear retracted (V_{S_1}), if retractable-gear type.
      (6) Maximum flap extended speed (V_{FE}).
      (7) Maximum structural cruising speed (V_{NO}).
      (8) Never-exceed speed (V_{NE}).
   b. Know and understand the reason for other pertinent airspeed limitations such as the design maneuvering speed (V_A).

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3. *Aircraft Stability*—Understand both static and dynamic stability.

4. *Meaning of Colored Lights at an Airport.*
   a. Runway.
   b. Taxiway.
   c. Threshold.
   d. Beacon.
   e. Visual approach slope indicator.
   f. Nonstandard traffic light (controlled airports).
   g. Obstruction.

5. *Special Procedures for Multiengine Instruction.* Understand the importance of—
   a. Minimum control speed (V_{MC}) for single-engine operation.
   b. Proper use of single-engine best angle of climb speed and best rate of climb speed (single-engine V_X and V_Y).
   c. Maneuvers and standards stipulated in *Multiengine Airplane Class or Type Rating Flight Test Guide,* AC No. 61–4A.

6. *Understand the Special Procedures for Seaplane Instruction.*

7. *Understand and Be Able to Use Pertinent Charts,* such as—
   a. Density altitude charts.
   b. Load factor chart.
   c. Oxygen duration charts.

8. *Safe Flying Practices.* Have a thorough understanding of
   a. Density altitude and its effects on aircraft performance
      (1) Understand that density altitude INCREASES with a decrease in pressure, increase in temperature, or an increase in relative humidity.
      (2) Understand that if density altitude increases, aircraft performance DECREASES.
   b. Carburetor icing
      (1) Symptoms in aircraft with fixed-pitch propellers and with constant-speed propellers.
      (2) Use of carburetor heat.
   c. Know the effects of snow, ice, and frost on an airfoil, and realize the importance of their removal prior to flight.
   d. Dangers associated with aircraft wake turbulence, i.e., wing-tip vortices; propeller, jet engine, and helicopter rotor wash—
      (1) Conditions and circumstances most conducive to such turbulence.
      (2) How to avoid these dangers.
      (3) Procedure to use if inadvertently encountered.
   e. Fuel contamination
      (1) Causes.
      (2) Precautions to take.

SAMPLE TEST

The following test items are only samples to indicate the general form of those used in the actual test. They are included for one purpose—to familiarize you with the type of test items you may expect to find on the FAA tests. Ability to answer these sample items *does not* indicate that you are fully prepared to take the test since all topics on which you will be tested are not included.

You should concentrate on the section of this study guide entitled "Study Outline for the Airplane Flight Instructor Written Test." A knowledge of all the topics mentioned in this outline—not just the mastery of the sample test items—should be used as the criterion for determining that you are properly prepared to take the FAA written test. Proper preparation requires considerable time, effort, and the guidance of a competent instructor.

Correct answers to the sample test items, along with an explanation of each test item, are on pages 20 through 25. In some sample test items reference will be made to certain illustrations. These illustrations will be found in the Appendix of this guide. These are representative of illustrations which may be found in the written test and with which the applicant should be familiar.

SECTION I. FUNDAMENTALS OF FLIGHT INSTRUCTION

1. In a good flight curriculum, the presentation of maneuvers should be arranged—
   1—In the order in which they are used in normal flight.
   2—In groups or stages to systematize flight instruction.
   3—So that each successive maneuver is less difficult than the last.
   4—So that each teaches an extension of the principles of previous ones.

2. On which of the following is the teaching success of a flight instructor considered to be most dependent?
   1—Personality of the instructor.
   2—Presentation by the instructor.
   3—Flying ability and flight experience.
   4—Proper planning of lessons.

3. Motivation is a key factor in learning. In properly motivating students, a flight instructor should remember that—
   1—Students are innately able to evaluate their proficiency and rate of progress and will instinctively tend to arrive at correct self-concepts if properly motivated.
   2—It is best to emphasize long range goals more than short range goals.
   3—Positive motivations are characteristically more effective than negative motivations.
   4—All of the above statements are considered true.

4. Worry and emotional difficulties which are sometimes associated with flight training are usually a result of—
   1—Personality problems of the student affected.
   2—Inadequacies in the training course or flight instructor.
   3—Personality conflicts between student and instructor.
   4—The type of maneuvers, or the phase of training with which the student is concerned at the time the difficulties arise.

5. The flight instructor's first step in teaching is to—
   1—Gain the student's confidence.
   2—Determine whether the student really wants to learn to fly.

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3—Teach the student to fly straight and level.

4—Require the student to complete a short verbal or written quiz to test his ability to assimilate instruction.

6. If a student shows slow progress in learning to perform normal landings because of lack of confidence, his flight instructor should—

1—Continue the instruction on the landings but in a more energetic manner so that the student will apply himself with greater diligence.

2—Use praise to a greater extent after each landing attempt.

3—Assign him goals that are less difficult.

4—Point out the student's errors by exaggerated demonstrations of the errors.

7. A student who has been very quick to absorb instruction and has made few mistakes, suddenly begins to perform poorly during his dual instruction flights. The instructor correctly analyzes this poor performance to be a result of student overconfidence. The proper corrective action by the instructor would be to—

1—Lower the standard of performance expected by the student.

2—Demand greater effort from the student by raising the standard of performance on each lesson.

3—Praise the student only when he deserves it.

4—Do nothing, as this phase in learning is normal for this type of student and will correct itself in time.

8. The integration of instruction in aircraft control, through the use of outside visual references and through use of flight instruments only—

1—Tends to inhibit student progress if introduced prior to solo flight.

2—Is best accomplished during dual cross-country flights.

3—Will improve a student's precision, efficiency, and safety in flight.

4—Prepares a student pilot for extended operations in difficult weather situations.

9. The most effective level of communication (teaching) normally occurs when an instructor provides the student with—

1—All facts and knowledge pertaining to a learning problem.

2—Appropriate facts and knowledge in a manner which assures that the student receives it accurately.

3—Appropriate facts and knowledge in a manner which assures student understanding.

4—Facts and knowledge in such a way that his behavior is properly affected.

10. In what way is a negative self-concept likely to affect a student? A negative self-concept may introduce psychological factors which—

1—Can affect unfavorably a student's ability to receive perceptions and inhibit his ability to perform after perceiving.

2—Can affect unfavorably a student's ability to receive perceptions but, once he perceives, will have no effect on his ability to do or perform.

3—Will have negligible effect on a student's ability to receive perceptions or on his ability to perform.

4—Will result in a student being less "on the defensive."

11. The use of training films, slides, charts, models, mockups, etc. is—

1—Generally considered good teaching practice because their use lightens the load on the flight instructor.

2—Justified only if the students feel that they are useful and the instructor has time to include them in the course.

3—Justified when they are used as aids to teaching and are utilized in a meaningful manner along with other teaching methods.

4—Justified if they have been approved by the Federal Aviation Administration.

12. Criticism of a poor or unsatisfactory flight performance—

1—Is the most dependable method of forcing flight students to apply themselves more diligently.

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2—Has no place in a good flight instruction program.
3—May completely subdue and destroy the initiative of a timid student.
4—Will cause reactions which the good instructor can utilize to determine if the student is highly motivated.

13. Lesson plans or course syllabuses should be—
1—Followed exactly if maximum benefit is to be derived from their use.
2—Adapted to the learning situation and changed when necessary.
3—Used primarily by inexperienced instructors.
4—Used primarily by those instructors who must teach students who have already received part of their flight training from another instructor.

14. The responsibilities of today's flight instructor are very real and very complex. The instructor can best live up to these responsibilities by—
1—Requiring a high standard of proficiency in his students.
2—Establishing his effectiveness as an instructor on the basis of an objective evaluation of his own flying proficiency.
3—Discouraging from further instruction those students who do not have a natural physical and mental capacity to fly.
4—A keen analysis of his students and a deep personal interest in their welfare.

15. The four basic steps in effective instruction are—
1—Straight and level, climbs, glides, and turns.
2—Preflight, air work, traffic patterns, and emergencies.
3—Preparation, explanation and demonstration, trial and practice, and review and evaluation.
4—Analysis, explanation, performance, and practice.

SECTION II. PERFORMANCE AND ANALYSIS OF FLIGHT TRAINING MANEUVERS

16. Prior to takeoff, a pilot sets his sensitive altimeter to the current altimeter setting at the airport from which the takeoff is being made. His altimeter then reads the same as the one illustrated in Figure 3 in the appendix. Assume that the terrain along the route which the pilot will be flying has the same elevation as the airport. Which of the following altitudes would satisfy FARs for VFR operations if the route of flight has a magnetic course of 135°?
A. 4,500 feet MSL.
B. 5,000 feet MSL.
C. 7,500 feet MSL.
1—A only.
2—B only.
3—B and C only.
4—A, B, and C.

17. A pilot is involved in a landing accident due to the inflight failure of an engine component of a *light airplane* (12,500 pounds or less). Following the accident, he wishes to check the appropriate Regulation to determine the procedure he should follow. Which of the following correctly gives the Regulation he should check and the complete procedure he should follow if the damage is considered as substantial?
1—National Transportation Safety Board, Safety Investigation Regulations, Part 430. He must notify the NTSB immediately and within 10 days file a report of the accident with NTSB.
2—Federal Aviation Regulations, Part 61. He must report the accident immediately to the NTSB.
3—Federal Aviation Regulations, Part 91. He has 7 days in which to report the accident to the Federal Aviation Administration if the damage to the engine is more than $100.
4—National Transportation Safety Board, Safety Investigation Regulations, Part 430. He must notify either the FAA or the NTSB of the accident within 2 weeks of the occurence.

18. Referring to the excerpt from the *Airman's Information Manual* (see Figures 32 through 35 in the Appendix), you examine information for the following airports:
A. Tulsa International Airport, Tulsa, Okla.

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B. Will Rogers World Airport, Oklahoma City, Okla.

C. Wiley Post Airport, Oklahoma City, Okla.

You find that a Visual Approach Slope Indicator (VASI), an FAA-operated control tower, UNICOM facilities, and ground control are all available at—

1—Airport A only.

2—Airport B only.

3—Airports A and B only.

4—Airports A, B, and C.

19. A correct performance of "S" turns across a road and turns about a point requires that the bank must be steepest when—

1—Flying directly downwind.

2—Flying directly crosswind on the downwind side.

3—Entering the turn on the upwind side.

4—Flying directly crosswind on the upwind side.

20. Because of various factors which can cause a tailwheel-type airplane to deviate from the desired direction on the takeoff roll, many beginner students experience considerable difficulty on takeoff in such airplanes. To help the student overcome this difficulty, it would be best for the instructor to—

1—Thoroughly explain "P" factor (asymmetrical thrust).

2—Make certain that the student understands the relationship between control effectiveness and speed.

3—Give repeated demonstrations of the correct technique.

4—Demonstrate how crosswinds influence directional control on the ground.

21. Which of the following statements pertaining to angle of attack is correct?

1—If a constant airspeed can be maintained, the angle of attack will increase as the pitch is increased.

2—It is possible for the wing of an airplane to pass through the air at a high angle of attack even though a constant altitude is maintained.

3—An airplane in a power-off descent will normally have a negative angle of attack.

4—Regardless of the angle of attack, stalls will occur only at low or comparatively low airspeeds.

22. When performing the maneuver "eights on pylons" at a constant throttle setting during a strong wind, the pivotal altitude will—

1—Remain constant.

2—Decrease slightly when flying into the wind in the turns.

3—Increase slightly when flying into the wind in the turns.

4—Decrease slightly when flying downwind in the turns.

23. Although spins are not required on flight tests for private or commercial pilot certificates, airplane flight instructors should be familiar with the principles of spins and with spin performance and recovery procedures. A spin can be entered—

1—Only if the airplane first enters a stall.

2—Without first stalling the airplane if the pilot wishes to force it into the spin.

3—Only from a stall encountered at a high pitch attitude.

4—Without first stalling the airplane only when the entry is made from a tight diving spiral.

24. After scanning the instrument group which appears in Figure 25 in the Appendix, a pilot normally should interpret these indications to mean that the airplane is—

1—Descending, but because the primary instrument and supporting instruments for the turn do not agree, it is impossible to determine the direction without cross-checking the directional gyro or the compass.

2—Descending in a standard rate turn to the right.

3—Descending at 1,200 feet per minute with a bank of approximately 23° to the left.

4—Descending in a slipping turn to the left.

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25. In order to impress students with the importance of the performance charts in the *Airplane Flight Manual,* a flight instructor requires his students to compute the take-off distance at two separate airports. The conditions at these two airports are assumed to be as follows:

	Airport "A"	*Airport "B"*
Elevation of Airport	30 feet	6,250 feet.
Temperature	84° F	36.5° F.
Windspeed (headwind component).	15 m.p.h	Calm.
Runway	Hard surface	Hard surface.
Gross weight	1,900 pounds	2,200 pounds

Assuming normal engine operation and normal pilot technique, the distance that the airplane travels from the beginning of the takeoff roll until it reaches an altitude of 50 feet (above the runway) is approximately (refer to Figure 4 in the Appendix)—

1—370 feet for takeoff at Airport "A" and 1,300 feet for takeoff at Airport "B."
2—One and one-half times as long for takeoff at Airport "B" as for takeoff at Airport "A."
3—Twice as long for takeoff at Airport "B" as for takeoff at Airport "A."
4—Three times as long for takeoff at Airport "B" as for takeoff at Airport "A."

On the student's first cross-country flight, you wish to demonstrate the peculiarities of the magnetic compass while maneuvering on different headings. In order to stress the importance of maintaining straight-and-level, unaccelerated flight while reading the magnetic compass, you accomplish the demonstrations that follow: On the outbound leg which is on a northerly heading, you make shallow banked turns to the left and right and have the student observe the reaction of the magnetic compass; you repeat the same demonstration on the return flight which is on a southerly heading.

26. As the *entry into a left turn* is made on each of the above demonstrations, the student would most likely observe an indication on the magnetic compass as illustrated in (refer to Figure 9 in the Appendix).

1—MC–1 when on a north heading; MC–3 when on a south heading.
2—MC–1 when on a north heading; MC–4 when on a south heading.
3—MC–2 when on a north heading; MC–4 when on a south heading.
4—MC–2 when on a north heading; MC–3 when on a south heading.

27. Referring to Figure 7 in the Appendix, assume that the sets of instruments labelled A, B, and C are located in three different airplanes. Each airplane is flying at the same altitude and in the same atmospheric conditions. Match each set of instruments (airspeed and attitude indicator) with the turn-and-slip indicator which most nearly represents its rate of turn. The correct combination is—

1—(A, N–2), (B, N–2), (C, N–2).
2—(A, N–3), (B, N–1), C, N–1).
3—(A, N–3), (B, N–2), (C, N–1).
4—(A, N–1), (B, N–2), (C, N–3).

28. Assume that the Airplane Flight Manual lists the following airspeeds for a light twin-engine airplane:

	Both engines operating (mph)	*One engine out (mph)*
Best rate-of-climb speed	150	100
Best angle-of-climb speed	80	95
V_{mc} (minimum control speed)	—	87

If one engine of this light twin becomes inoperative during flight, the pilot will lose altitude at the slowest rate, or gain altitude as quickly as possible if he establishes an airspeed of—

1—87 mph.
2—95 mph.
3—100 mph.
4—150 mph.

29. On a cross-country flight, you are demonstrating the use of the VOR as an aid to navigation to your student who is working toward a commercial pilot certificate. You are approaching the VOR station from the east, and are north of the 090° radial; the course (omnibearing) selector is set to 270°; and your omnireceiver indications are as depicted in illustration "OR–3" (Figure 8 in the Appendix). You make a 180° turn to the right to an easterly heading. The

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ANSWERS TO SAMPLE TEST ITEMS

Item	*Answer*	*Item*	*Answer*
1	4	16	4
2	4	17	1
3	3	18	3
4	2	19	1
5	1	20	2
6	3	21	2
7	2	22	2
8	3	23	1
9	4	24	2
10	1	25	4
11	3	26	4
12	3	27	3
13	2	28	3
14	4	29	3
15	3	30	1

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ANALYSIS OF ANSWERS TO SAMPLE TEST ITEMS

Item	Answer	
1	4	The *Flight Instructor's Handbook*, AC 61–16, states, "The procedure and elements mastered in each step should be identified in demonstrating the performance of the subsequent step . . . each lesson should also require the student to recall and apply previous learning . . . a maneuver which incorporates the elements used in the preceding maneuver and extends their application or associates them with other flight elements, provides much more effective training than does a maneuver which is completely foreign to the preceding maneuvers."
2	4	The *Flight Instructor's Handbook*, AC 61–16, states, "Teaching success depends more upon lesson planning than it does on presentation, personality, flying ability, or experience."
3	3	The *Flight Instructor's Handbook*, AC 61–16, states, "Negative motivations . . . are not characteristically as effective in promoting efficient learning as are positive motivations."
4	2	The *Flight Instructor's Handbook*, AC 61–16, states, "Worries and emotional upsets which result from the course at hand can be remedied. Such occurrences are usually evidence of inadequacies on the part of the course or of the instructor concerned."
5	1	The *Flight Instructor's Handbook*, AC 61–16, states, "The flight instructor's first step in teaching is to gain the student's confidence."
6	3	The *Flight Instructor's Handbook*, AC 61–16, states, "A student whose slow progress is found to be due to lack of confidence should be assigned subgoals which can be achieved easily."
7	2	The *Flight Instructor's Handbook*, AC 61–16, states, "For such a student the good instructor will continually raise the standard of performance for each lesson, demanding a greater effort from the student."
8	3	The *Flight Instructor's Handbook*, AC 61–16, states, ". . . it was soon recognized that students trained in this manner are more precise in their flight maneuvers and operations . . . the performance he obtains from an airplane increases noticeably . . . integrated flight instruction provides the student with the ability to control an airplane in flight for limited periods under favorable circumstances . . . this ability could save the pilot's life and those of his passengers . . ."
9	4	The *Flight Instructor's Handbook*, AC 61–16, states, "Communication at the understanding level goes far beyond the receipt of information; ideas must be comprehended. Understanding is a higher type of communication than is the mere acquisition of facts. To be effective, however, the flight instructor must go beyond this level of communication. Effective communication requires that information be provided

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Item	Answer	
		in such a way that it affects the behavior of the student."
10	1	The *Flight Instructor's Handbook*, AC 61–16, states, "Negative self-concepts inhibit the perceptual processes by introducing psychological barriers which tend to keep the student from receiving them and then perceiving what the instructor intends. They may even inhibit the ability to properly implement that which is perceived. That is, they affect unfavorably the 'ability to do.' Learners who view themselves positively, on the other hand, are less defensive. . . ."
11	3	The *Flight Instructor's Handbook*, AC 61–16, points out that ". . . they are valuable only as aids to good instruction; and none has yet been devised which successfully eliminated the need for an instructor."
12	3	The *Flight Instructor's Handbook*, AC 61–16, states. "Too much criticism of his flight performance may completely subdue a timid person."
13	2	The *Flight Instructor's Handbook*, AC 61–16, states, "Any practical flight training syllabus must be flexible, and should be used primarily as a guide. The order of training can and should be altered, when necessary, to suit the progress of the student and the exigencies of special circumstances."
14	4	The *Flight Instructor's Handbook*, AC 61–16, states, "Only by a keen analysis of his students, and a continuing deep interest in them, can he live up to his responsibilities and be an effective flight instructor."
15	3	The *Flight Instructor's Handbook*, AC 61–16, states, "There are four basic steps in the teaching process, without which effective instruction is impossible. They are (1) preparation, (2) explanation and demonstration, (3) trial and practice, (4) review and evaluation."
16	4	The altitude indicated on the altimeter in Figure 3 in the Appendix is 2,500 feet MSL. This is also assumed to be the elevation of the terrain along the route. Altitude "A" of 4,500 feet and Altitude "B" of 5,000 feet MSL are both less than 3,000 feet, but more than 500 feet above the surface, and therefore VFR flight at either of these two altitudes on a magnetic course of 135° would normally comply with Regulations. With an altitude of 7,500 feet, however, the flight would be *at* an altitude of 3,000 feet above the surface; therefore, subject to the provisions of FAR 91.109 which state in part ". . . each person operating an aircraft under VFR in level cruising flight *at or above* 3,000 feet above the surface, shall maintain the appropriate altitude prescribed below: "(a) When operating below 18,000 feet MSL, and— "(1) on a magnetic course of zero degrees through 179 degrees, any odd thousand foot MSL altitude +500 feet (such as 3,500, 5,500, or 7,500); or "(2) on a magnetic course of 180 degrees through 359 degrees, any even thousand foot MSL altitude +500 feet (such as 4,500, 6,500, or 8,500)." It is apparent, therefore, that Altitude "C" also complies with FAR 91.109(a)(1). Hence, the fourth alternate response would be the correct answer.
17	1	The National Transportation Safety Board, Safety Investigation Regulations, Part 430 (formerly CAB, Part 320), requires that the NTSB be notified immediately of any accident involving "substantial damage" to the aircraft (damage or structural failure which adversely affects the structural strength,

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Item Answer

performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component). Additionally, a written report must be submitted to the NTSB within 10 days after the occurrence.

18 3 A check of the Airport/Facility Directory of the *Airman's Information Manual* (see excerpts in the Appendix) reveals that Will Rogers World and Tulsa Airports list as available each of the services listed in the test item.

19 1 In any ground track maneuver in which a constant radius of turn is to be maintained, the angle of bank should be directly proportional to the groundspeed. The faster the groundspeed, the steeper the bank; the slower the groundspeed, the shallower the bank. The *Flight Training Handbook* states, "The steepest bank will be the point at which the groundspeed is highest." In "S" turns across the road, this point will be when entering the turn on the downwind side. This assumes that the wind direction is perpendicular to the road and the airplane is going directly downwind with a groundspeed greater than at any other point in the maneuver. This same rule would apply to constant radius turns about a point.

The *Flight Training Handbook* further states, "Throughout the maneuver (turns about a point), the bank required at any given position is proportional to the groundspeed; the faster the groundspeed, the steeper the bank; the slower the groundspeed, the shallower the bank . . . it follows then that the steepest bank is required when the airplane is headed directly downwind. . . ."

20 2 "P" factor and crosswinds certainly play a part in the problems

Item Answer

of directional control on takeoffs, but an understanding of these factors will not in itself correct the difficulties involved if the student does not have a clear concept of the *use of controls* and *how their effectiveness* changes with speed. The same thing is true in regard to repeated demonstrations. Therefore, alternate response 2 is the correct answer. (See *Flight Training Handbook.*)

21 2 The *Flight Instructor's Handbook,* AC 61–16, states, "It is possible for the wing to pass through the air at a high angle of attack when the airplane descends in a level flight attitude. Conversely, the angle of attack may be near zero in a steep dive." If, through analysis of the information contained in figure 31 in the Appendix, we can accept the validity of this statement, then we can perceive that when using low power settings and slow speed, it will also be necessary to use a high angle of attack in order to maintain a constant altitude. (See *Flight Training Handbook* and Exam-O-Gram No. 28.)

22 2 The *Flight Training Handbook* states, "Since the headings throughout the turn vary from downwind to directly into the wind, the groundspeed will never be constant when there is a wind. This may result in variations in the pivotal altitude throughout the eight." A careful study of the material presented in the *Flight Training Handbook* will clarify the fact that, in the performance of pylon 8's in a stiff breeze, ". . . the average pivotal altitude will be slightly lower . . ." than when flying at the same airspeed in calm or light winds.

23 1 The *Flight Training Handbook* defines a spin as an aggravated stall that results in autorotation. It also states that "Care must be

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Item	Answer	
		taken to completely stall the airplane; otherwise it may not spin and the only result will be a skidding spiral of increasing speed. If such a maneuver results, it is useless to continue in the hope of eventually spinning the airplane . . . Any tendency to relax on the controls after the spin is in progress will result in a sloppy spin and in many cases will completely stop the spin."
24	2	The airplane is descending in a turn to the right. The descent is confirmed by: a. The nose down indication on the gyro-horizon. b. The decreasing altitude as indicated on the altimeter. c. The down trend indicated by the vertical speed indicator. d. The increasing airspeed as shown by the airspeed indicator. The right turn is confirmed by: a. The turn needle of the turn-and-slip indicator. b. The bank to the right as indicated by the attitude of the wings in relation to the horizon on the gyro-horizon. On most gyro-horizons in use with light airplanes today, the degree of bank index at the top of the instrument moves OPPOSITE to the direction of bank and turn. (See *Flight Training Handbook* and *Private Pilot's Handbook of Aeronautical Knowledge.*)
25	4	In determining the takeoff distance at Airport "A," locate the "1,900 pound–15 mph" row on the Takeoff Data Chart, Figure 4 in the Appendix. Follow this row to the "At sea level and 59° F—Clear 50′ obstacle" column where you read 675 feet. Since the temperature at Airport "A" is 25° above standard, this distance will have to be increased by 10 percent (see Note at bottom of chart). Ten percent of 675 is 68 feet. 675 plus 68 feet gives a total takeoff distance at Airport "A" of 743 feet. In computing the takeoff distance at Airport "B," locate the "2,200 pound zero mph wind" row. 6,250 feet, 36½° F falls halfway between the "5,000-foot and 41° column" and the "7,500-foot and 32° F" column. Therefore, you will have to interpolate between the values found in these two columns. Follow the selected row out to these 2 columns ("to clear 50′ obstacle" portion) where you read 1,995 feet and 2,495 feet. The distance halfway between these two distances is 2,245 feet. The takeoff distance at Airport "B" is 2,245 feet which is approximately 3 times the takeoff distance of 743 feet at Airport "A." (See *Private Pilot's Handbook of Aeronautical Knowledge.*)
26	4	If a turn is made from a north heading, the magnetic compass will normally indicate a turn in the opposite direction, and then will lag behind the turn. If a turn is made from a south heading, the magnetic compass will indicate a turn in the same direction, but a much greater amount of turn than has actually been made. Therefore, as you enter a left turn from a north heading, the magnetic compass will indicate a turn toward the east. As you enter a left turn from a south heading, the magnetic compass will indicate a turn toward the east, but a much greater amount of turn than you have actually made. (See Exam-O-Gram No. 12.)
27	3	The rate of turn of an airplane is directly proportional to the angle of bank and inversely proportional to the true airspeed. Therefore, as the angle of bank increases, the rate of turn increases, and as the airspeed increases, the rate of turn

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Item	Answer	
		decreases. The angle of bank is the same for all three airplanes. Therefore, the rate of turn will depend upon the airspeed. Since Airplane "A" has the lowest airspeed, its rate of turn will be the greatest; Airplane "C" is flying at the highest airspeed, so its rate of turn will be the least; and the rate of turn for Airplane "B" will fall somewhere between that of "A" and "C." (See "Standard Rate, Level Turns" in *Flight Training Handbook.*)
28	3	If one engine of a light twin-engine airplane becomes inoperative, the pilot will be able to gain altitude at the best rate or lose altitude at the slowest rate if he maintains the best single-engine rate-of-climb speed. The *Flight Training Handbook* states that "The engine-out best rate-of-climb speed is found in the Airplane Flight Manual . . . it is the airspeed which results in the greatest increase in altitude in a unit of time."
29	3	The indications on the TO-FROM Indicator and the LEFT-RIGHT needle are dependent *only* upon the setting of the omnibearing selector and your position relative to the VOR station. The indications are not dependent on the heading of the aircraft with respect to the VOR station. Therefore, regardless of the heading to which Aircraft "A" turns, the TO-FROM indicator and the LEFT-RIGHT Needle will not change their indications as long as the omnibearing selector setting remains constant and the aircraft remains north of the 090° radial and east of the 360° radial. The *Flight Training Handbook* states, "The vertical or deviation needle shows the position of the aircraft without any reference to its heading . . . the VOR bearing selector and the TO-FROM indicator always show correctly the position of the airplane in relation to the station, regardless of the heading of the airplane." Also refer to the *Private Pilot's Handbook of Aeronautical Knowledge.*
30	1	The following rules apply: a. The force of lift always acts in a direction perpendicular to the relative wind and to the lateral axis of the aircraft (wingtip to wingtip axis). b. The direction of weight is always toward the center of the earth and does not change even though the aircraft changes attitudes and flight paths. c. For all practical purposes, thrust acts parallel to the longitudinal axis of the aircraft. d. Drag acts in the opposite direction to the flight of the aircraft, and it is parallel to the relative wind. References to the forces which act on an airplane in flight may be found in the *Flight Training Handbook* and in the *Private Pilot's Handbook of Aeronautical Knowledge.*

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APPENDIX

All of the charts, illustrations, and selected EXAM-O-GRAMS presented in this Appendix are of value to the student preparing for the test for the Flight Instructor Certificate. Users of this Guide should not assume that the questions appearing in the sample test make full use of the material in the Appendix. This would seriously limit the benefits to be derived from the Appendix material. Every chart or illustration can be related to topics covered in the Study Outline. Even more important is the fact that many charts or illustrations in the Appendix are either directly or indirectly related to the charts, illustrations, and questions that appear in the actual test. Study all of them.

Several VFR Exam-O-Grams have been reprinted here for the convenience of those interested in the rating of airplane flight instructor. These particular study aids have been selected because the information they contain is especially pertinent to this test.

It should be noted that EXAM-O-GRAMS are nondirective in nature, and are issued solely as an information service to individuals interested in Airman Written Tests.

A list of all the VFR Exam-O-Grams available from the Federal Aviation Administration is also included.

2679 2680

FIGURE 1. *Airspeed indicator with color-coded markings for single-engine airplanes.*

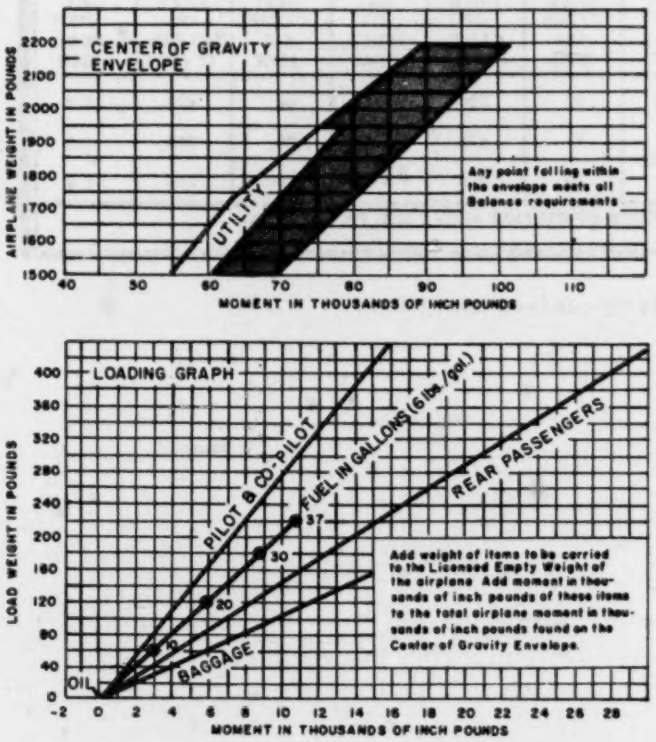

FIGURE 2. *Loading graph and center-of-gravity envelope.*

FIGURE 3. *Altimeter.*

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TAKE OFF DATA

TAKE-OFF DISTANCE WITH FLAPS UP FROM HARD SURFACE RUNWAY

GROSS WEIGHT LBS.	IAS AT 50 FT.	HEAD WIND MPH	AT SEA LEVEL & 59°F		AT 2500 FT. & 50°F		AT 5000 FT. & 41°F		AT 7500 FT. & 32°F	
			GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE	GROUND RUN	TO CLEAR 50' OBSTACLE
1600	56	0	380	725	460	845	555	1000	680	1205
		15	215	470	265	560	330	670	415	820
		30	95	265	125	320	160	395	210	495
1900	61	0	560	1000	675	1185	820	1420	1015	1755
		15	335	675	415	805	515	980	645	1230
		30	165	400	210	490	275	610	360	785
2200	66	0	780	1370	945	1615	1155	1995	1435	2495
		15	490	945	605	1130	750	1410	950	1805
		30	260	590	330	710	425	915	560	1205

NOTE: INCREASE DISTANCE 10% FOR EACH 25°F. ABOVE STANDARD TEMPERATURE FOR PARTICULAR ALTITUDE.

CLIMB DATA

GROSS WEIGHT LBS.	AT SEA LEVEL & 59°F			AT 5000 FT. & 41°F			AT 10000 FT. & 23°F			AT 15000 FT. & 50°F		
	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED	BEST CLIMB IAS MPH	RATE OF CLIMB FT/MIN	GAL. OF FUEL USED
1600	71	1220	1.0	69	955	1.8	67	690	2.6	65	425	3.8
1900	75	940	1.0	73	710	2.1	71	475	3.3	69	245	5.2
2200	78	730	1.0	77	530	2.4	75	310	4.1	74	105	7.6

NOTE: FLAPS UP, FULL THROTTLE, AND MIXTURE LEANED FOR SMOOTH OPERATION ABOVE 5000 FT.
FUEL USED INCLUDES WARM-UP AND TAKEOFF ALLOWANCE.

FIGURE 4. *Performance charts—takeoff and climb.*

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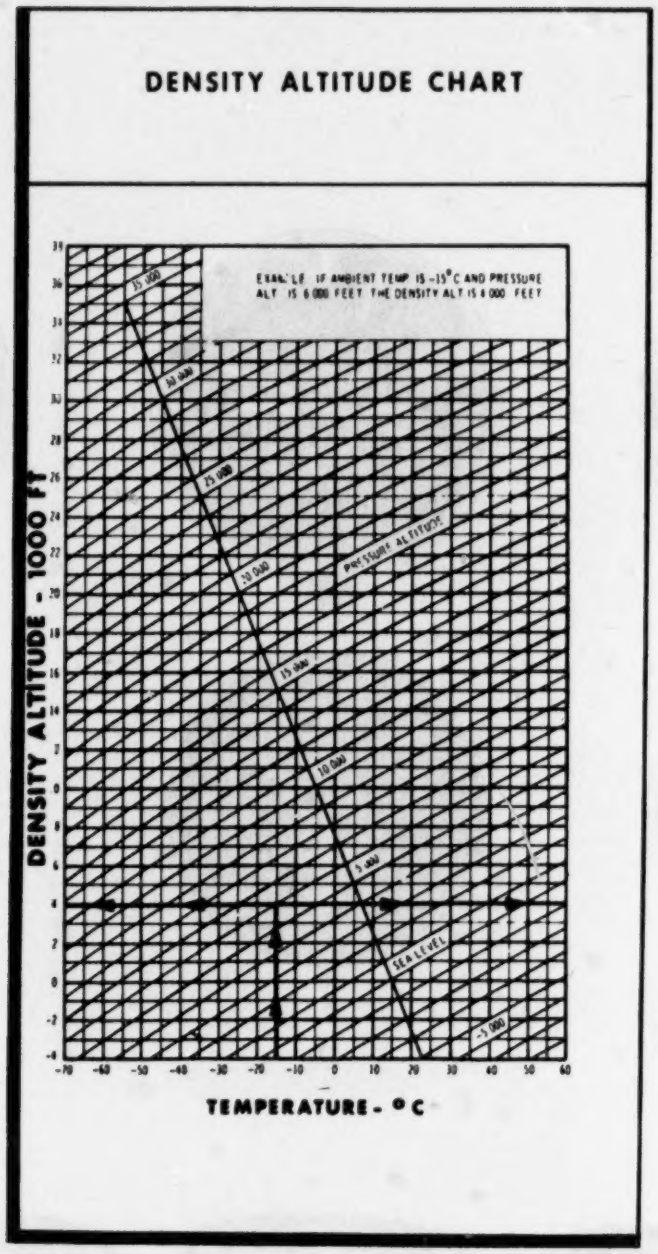

FIGURE 5. *Density altitude chart.*

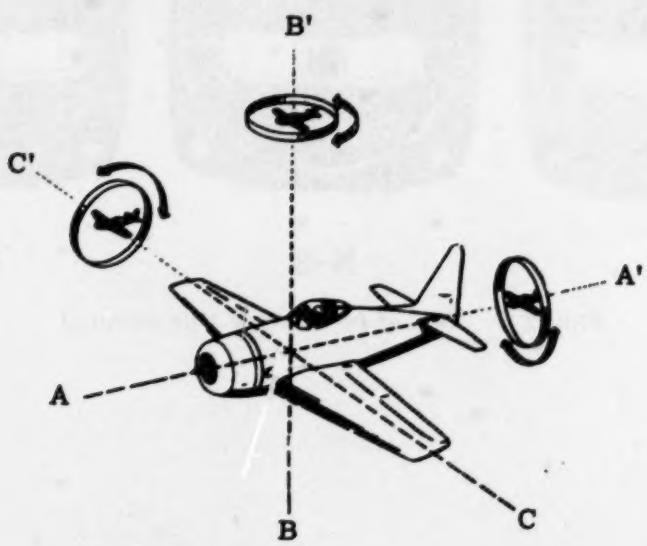

FIGURE 6. *Control axes of an airplane.*

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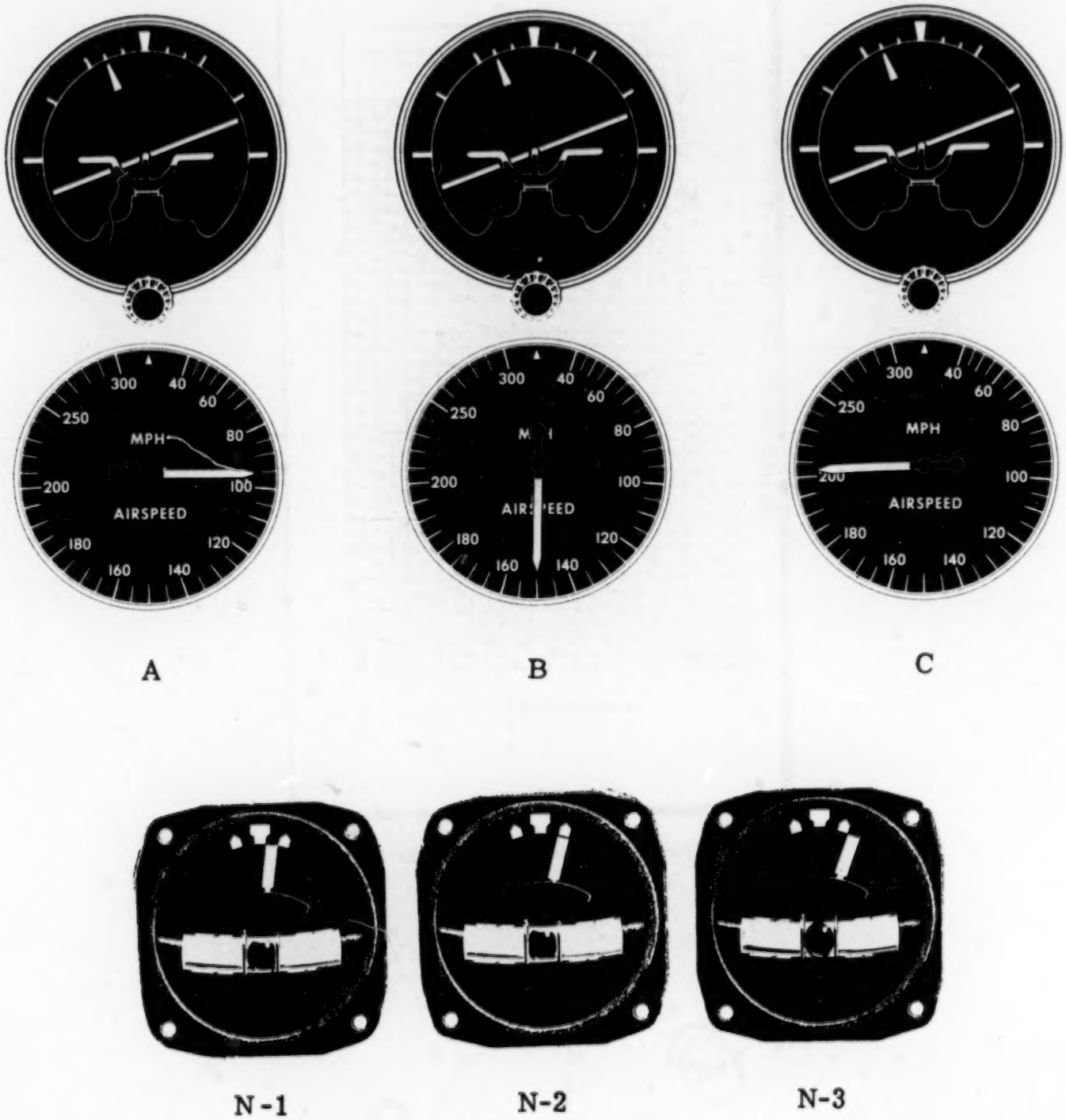

FIGURE 7. *Rate of turn versus true airspeed.*

2684

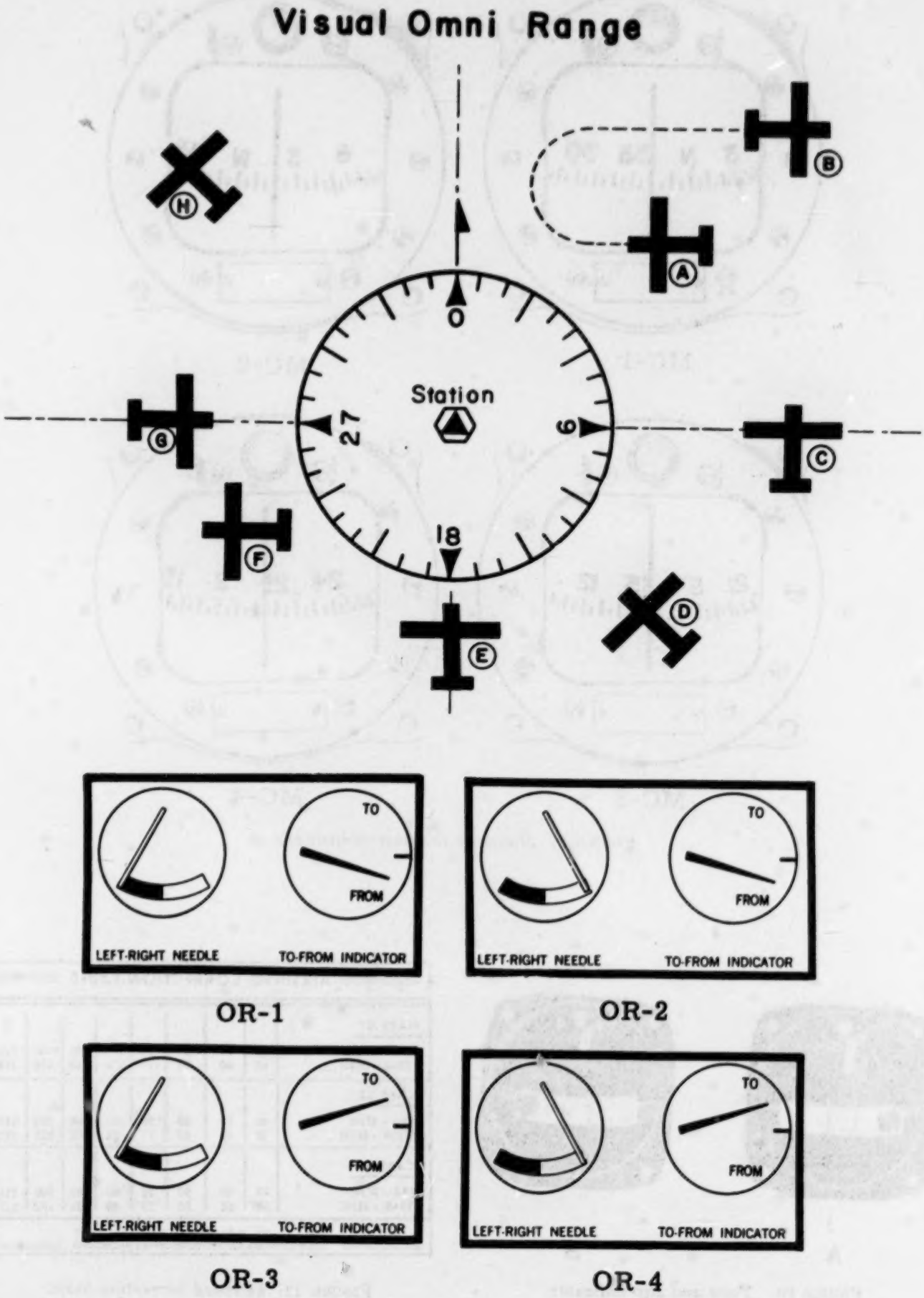

FIGURE 8. *VOR orientation and omnireceiver instrument indications.*

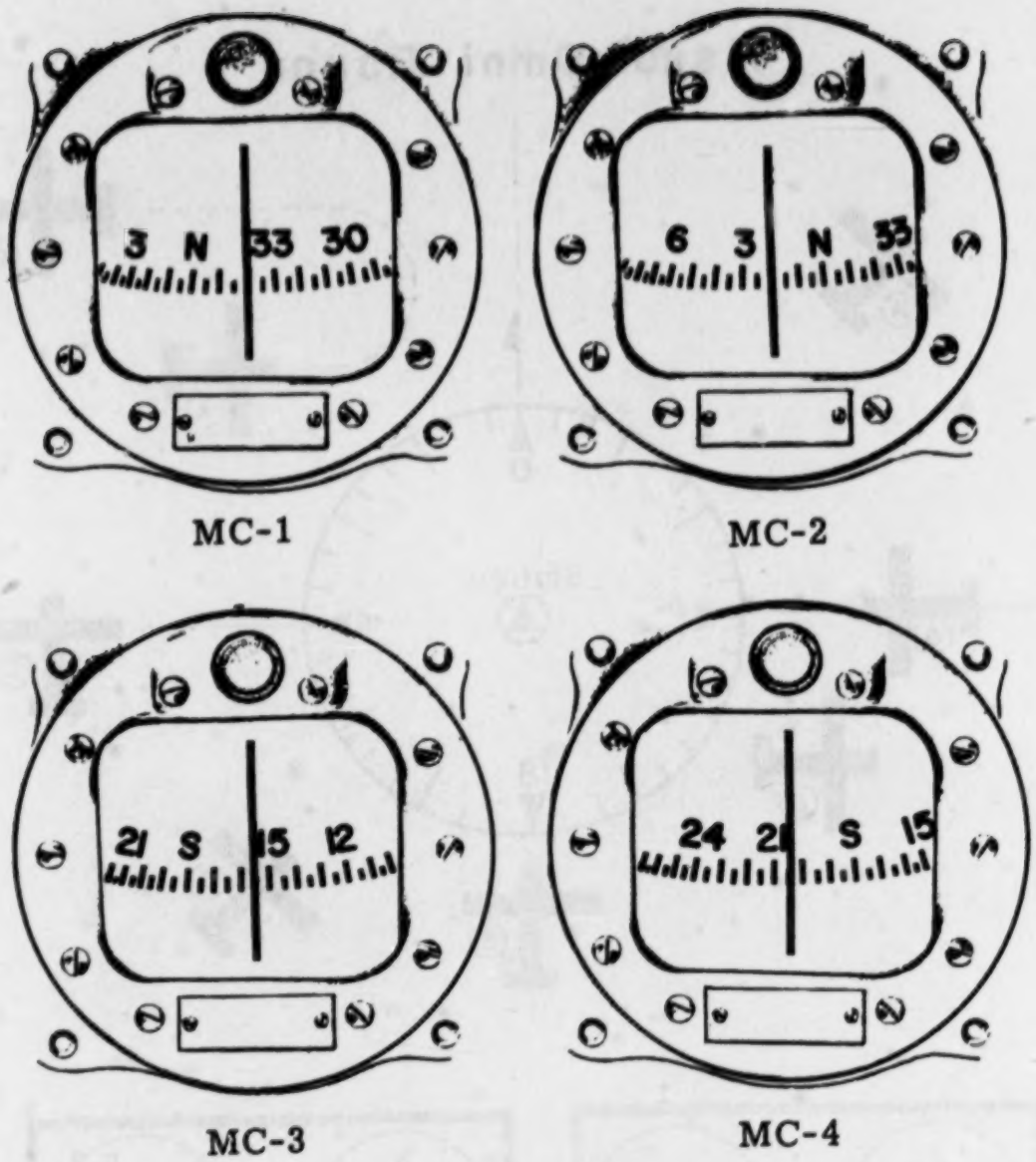

FIGURE 9. *Magnetic compass indications.*

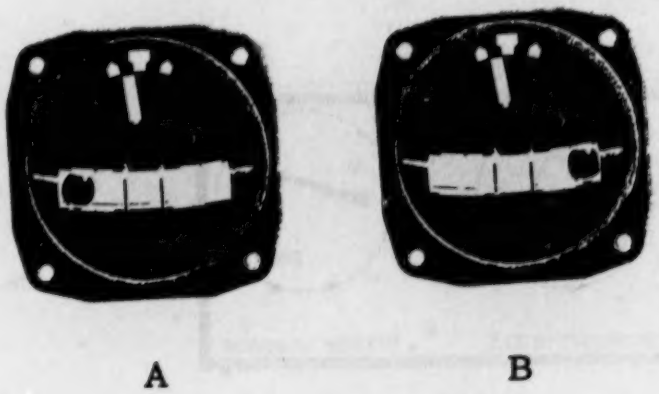

FIGURE 10. *Turn and slip indicator.*

AIRSPEED CORRECTION TABLE

FLAPS 0°								
IAS - MPH	60	80	100	120	140	160	180	200
TIAS - MPH	66	80	97	117	137	158	178	198
***FLAPS 20°**								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	59	62	67	73	81	91	101	111
***FLAPS 40°**								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	58	62	66	73	82	92	102	112

*Maximum flap speed 110 MPH-TIAS

FIGURE 11. *Airspeed correction table.*

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STALL SPEED, POWER OFF

Gross Weight 2900 lbs.	ANGLE OF BANK			
CONFIGURATION	0°	20°	40°	60°
GEAR & FLAPS UP	65	67	75	82
GEAR DOWN FLAPS 20°	58	62	68	84
GEAR DOWN FLAPS 40°	58	61	67	83

SPEEDS ARE MPH, TIAS (CAS)

FIGURE 12. *Stall speed versus angle of bank for various configurations (power off).*

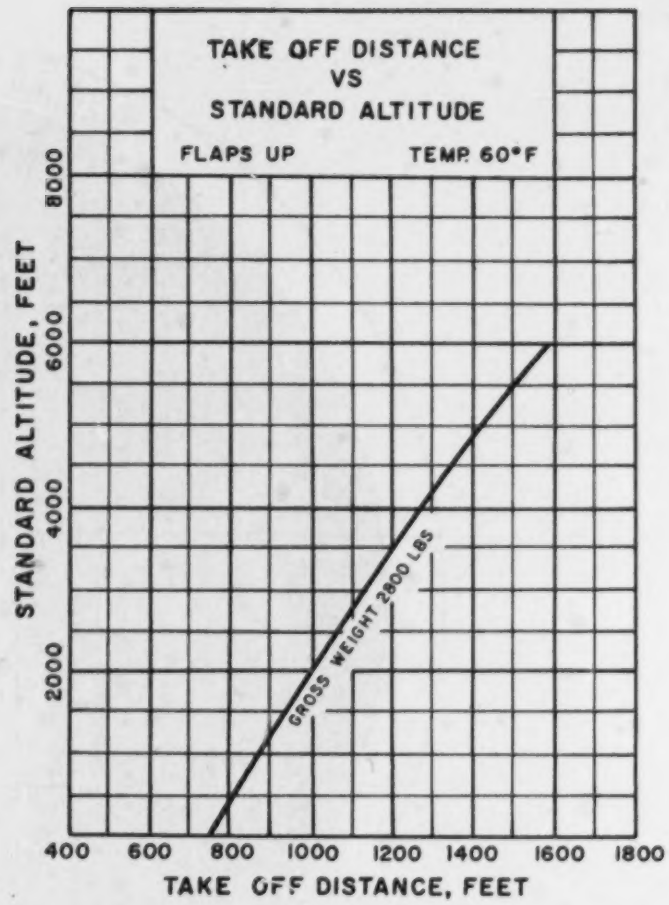

FIGURE 14. *Takeoff distance versus standard altitude.*

Power Setting Table –

Press. Alt. 1000 Feet	Std. Alt. Temp. °F	138 HP – 55% Rated Approx. Fuel 10.3 Gal./Hr. RPM AND MAN. PRESS.				163 HP – 65% Rated Approx. Fuel 12.3 Gal. Hr. RPM AND MAN. PRESS.				188 HP – 75% Rated Approx. Fuel 14.0 Gal./Hr. RPM AND MAN. PRESS.		
		2100	2200	2300	2400	2100	2200	2300	2400	2200	2300	2400
SL	59	21.6	20.8	20.2	19.6	24.2	23.3	22.6	22.0	25.8	25.1	24.3
1	55	21.4	20.6	20.0	19.3	23.9	23.0	22.4	21.8	25.5	24.8	24.1
2	52	21.1	20.4	19.7	19.1	23.7	22.8	22.2	21.5	25.3	24.6	23.8
3	48	20.9	20.1	19.5	18.9	23.4	22.5	21.9	21.3	25.0	24.3	23.6
4	45	20.6	19.9	19.3	18.7	23.1	22.3	21.7	21.0	24.8	24.1	23.3
5	41	20.4	19.7	19.1	18.5	22.9	22.0	21.4	20.8	—	23.8	23.0
6	38	20.1	19.5	18.9	18.3	22.6	21.8	21.2	20.6	—	—	22.8
7	34	19.9	19.2	18.6	18.0	22.3	21.5	21.0	20.4	—	—	—
9	27	19.4	18.8	18.2	17.6	—	21.3	20.7	20.1			
8	31	19.6	19.0	18.4	17.8	—	—	20.5	19.9			
10	23	19.1	18.6	18.0	17.4	—	—	—	19.6			
11	19	18.9	18.3	17.8	17.2	—	—	—	—			
12	16	18.6	18.1	17.5	17.0	—	—	—	—			
13	12	—	17.9	17.3	16.8							
14	9	—	—	17.1	16.5							
15	5	—	—	—	16.3							

To maintain constant power, correct manifold pressure approximately 0.17" Hg for each 10° F. variation in carburetor air temperature from standard altitude temperature. Add manifold pressure for air temperatures above standard; subtract for temperatures below standard.

FIGURE 13. *Power setting table and cruise performance chart.*

2687

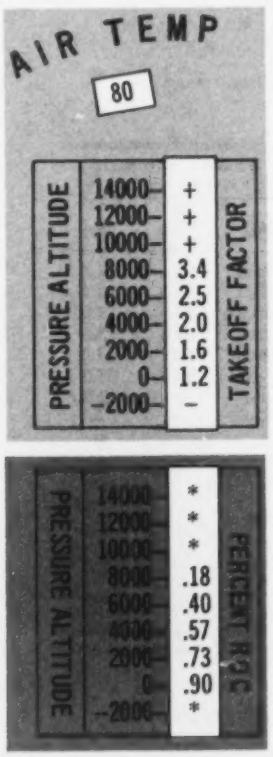

NOTES:

+ = **Much greater than normal;** check manufacturer's specifications.

– = Less than normal; check manufacturer's specifications.

* = General data not pertinent; check manufacturer's specifications.

† This computer has been developed by the Federal Aviation Agency. It is intended to supplement and **NOT** replace manufacturer's published performance information.

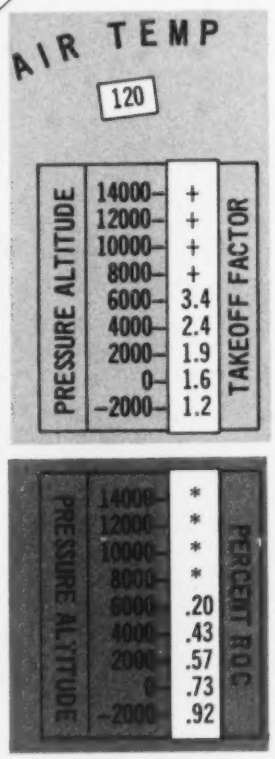

FIGURE 15. *DENALT Performance Computer for airplanes with fixed-pitch propellers. (There is also one for variable-pitch propeller airplanes.)*

2688

CRUISE PERFORMANCE **10000**

NORMAL LEAN MIXTURE

Standard Atmosphere
Zero Wind

Gross Weight - 2900 Pounds
55 Gallons - No Reserve

10,000 FEET

RPM	MP	% BHP	Fuel Press.	MPH TAS	Gal/ Hour	Endurance Hours	Range Sta. Miles
2450	20	65	7.5	184	12.2	4.5	830
	19	60	6.8	179	11.4	4.8	880
	18	56	6.2	174	10.6	5.2	900
	17	52	5.6	169	9.9	5.6	940
2300	20	59	6.5	177	11.0	5.0	885
	19	55	6.0	172	10.4	5.3	910
	18	51	5.5	167	9.7	5.7	950
	17	47	5.1	162	9.1	6.0	975
2200	20	55	5.9	172	10.3	5.3	915
	19	51	5.5	168	9.8	5.6	940
	18	48	5.1	163	9.1	6.0	985
	17	44	4.8	157	8.6	6.4	1005
2100	20	50	5.3	165	9.5	5.8	955
	19	47	5.0	161	9.0	6.1	980
	18	43	4.7	156	8.5	6.5	1010
	17	40	4.4	151	8.0	6.9	1035
	16	37	4.2	145	7.6	7.2	1050
	15	34	4.0	138	7.1	7.8	1070
	14	30	3.8	129	6.6	8.3	1075

FIGURE 16. *Cruise performance chart.*

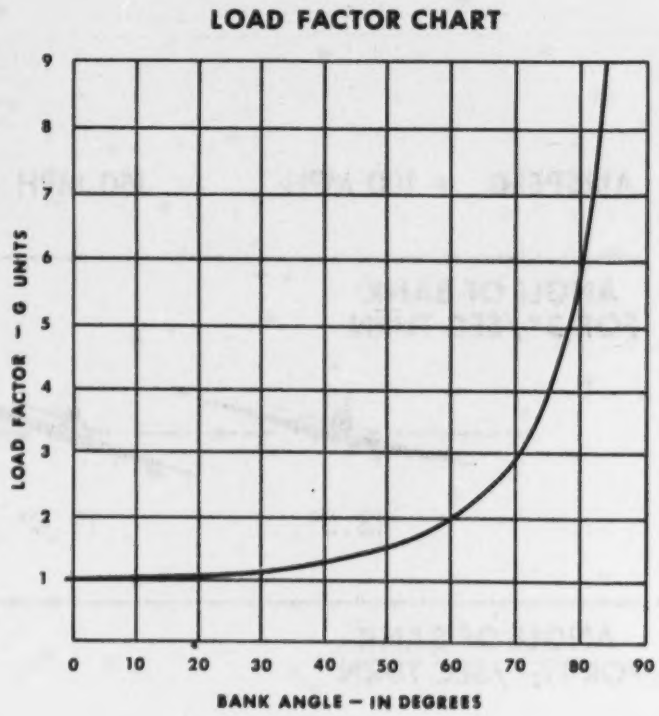

FIGURE 17. *Load factor chart.*

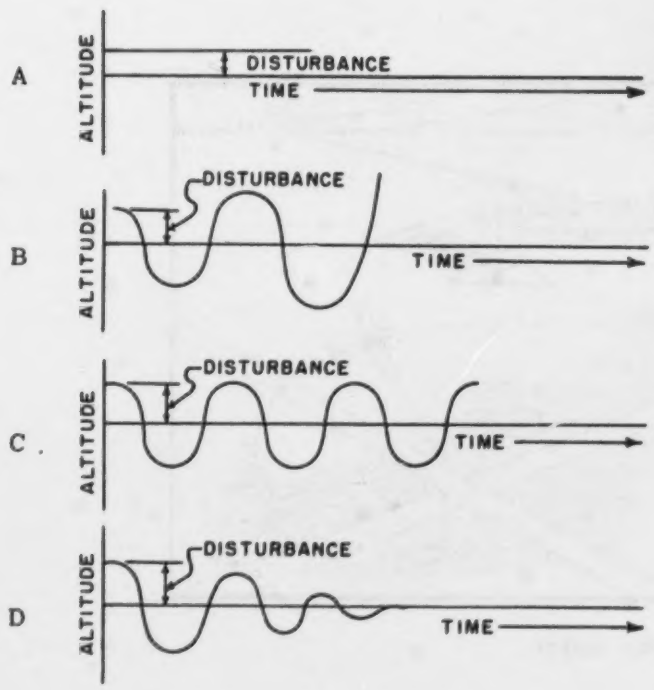

FIGURE 18. *Stability graphs.*

FIGURE 19. *Artificial horizon (attitude indicator) indications.*

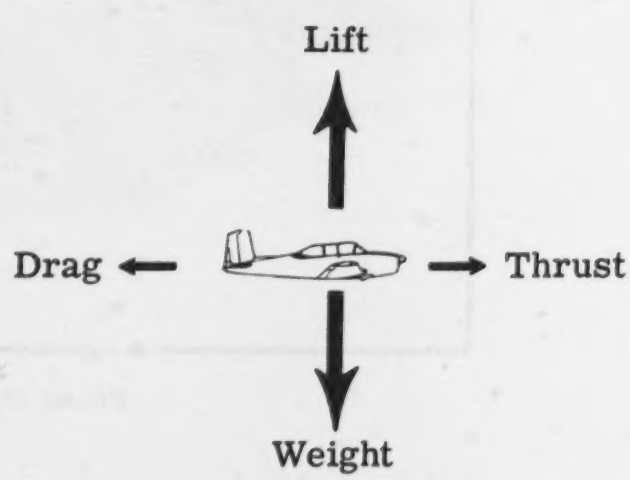

FIGURE 20. *Forces acting on an aircraft in straight-and-level unaccelerated flight.*

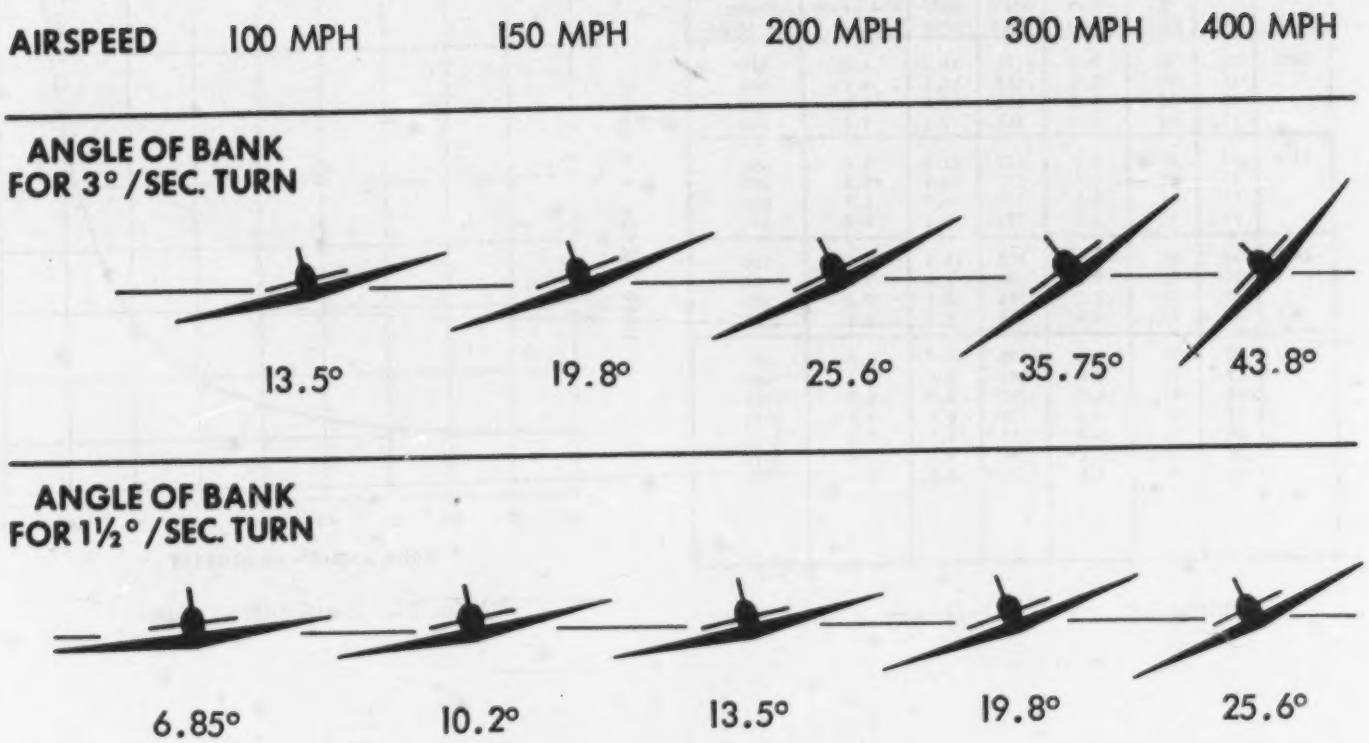

FIGURE 21. *Speed, bank, and rate of turn.*

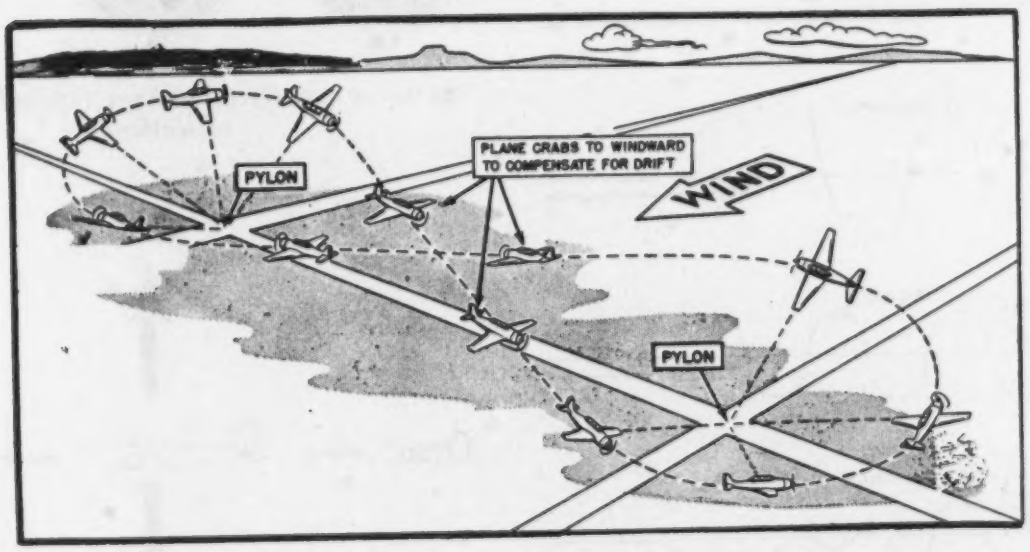

FIGURE 22. *Pylon eights.*

2690

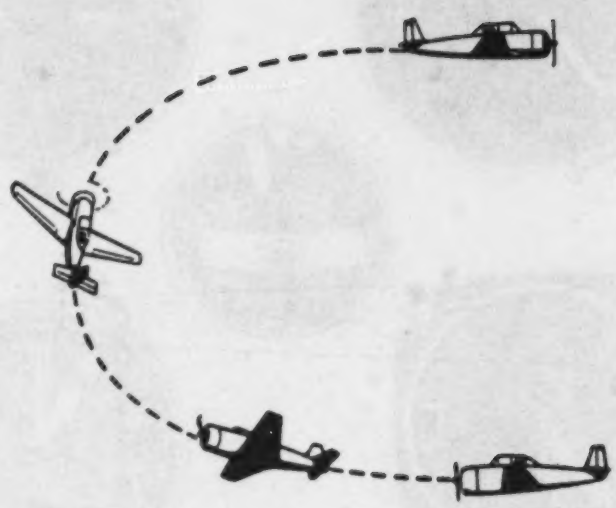

FIGURE 23. *Chandelle.*

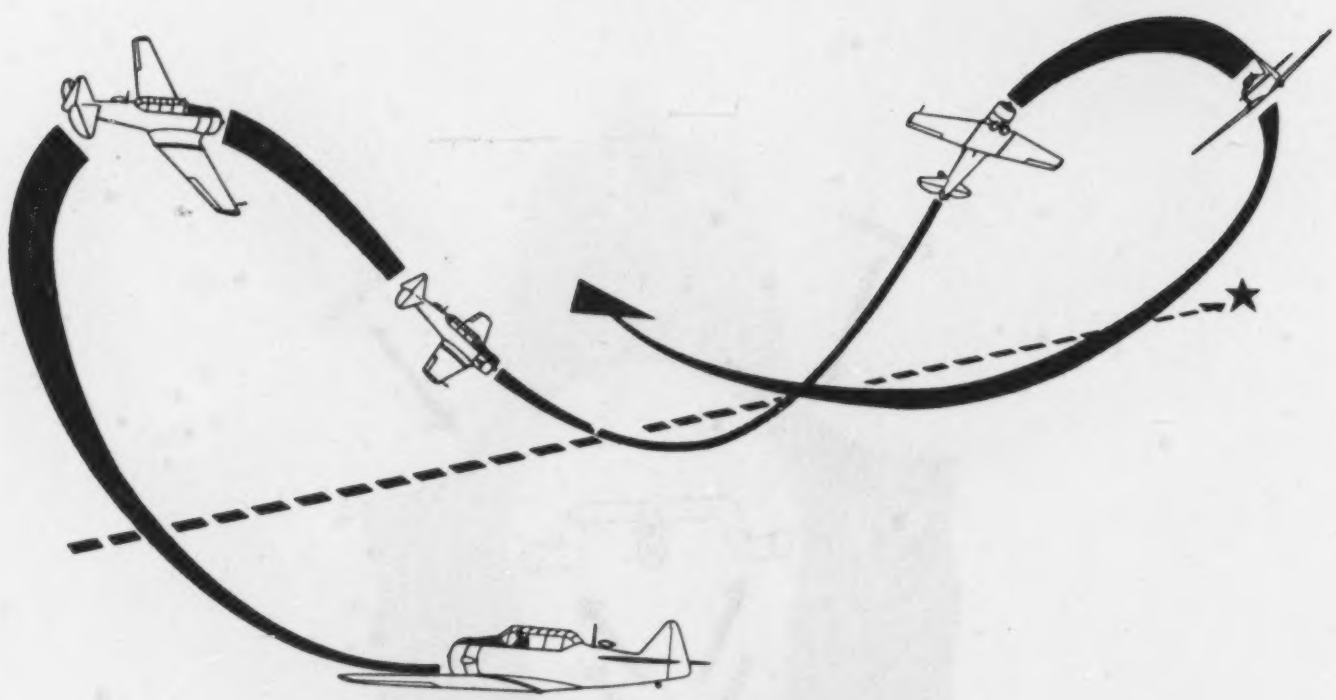

FIGURE 24. *Lazy eights.*

2691

FIGURE 25. *Instrument Group.*

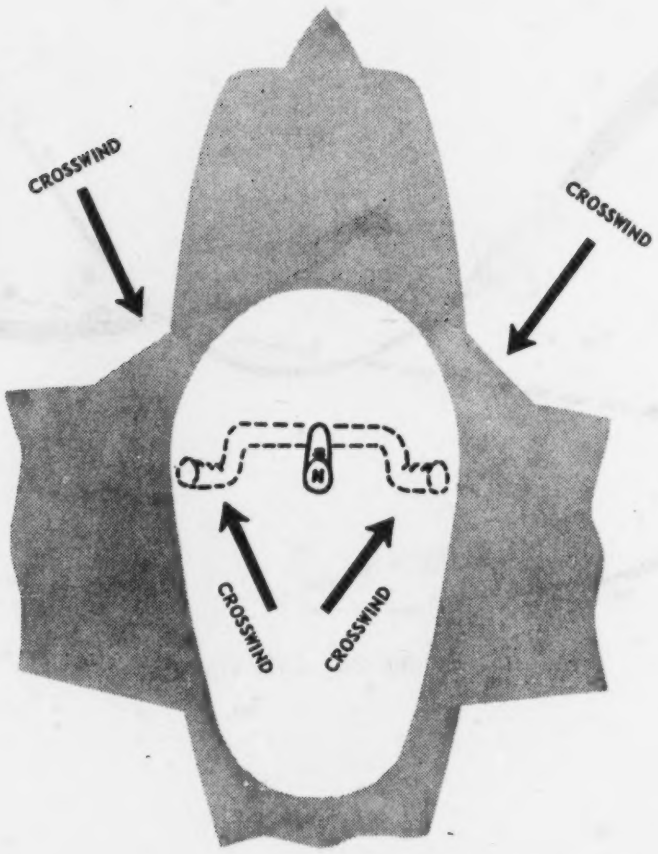

FIGURE 26. *Positioning of aileron controls while taxiing.*

2692

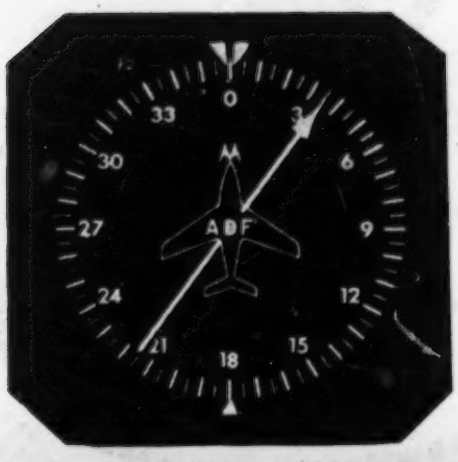

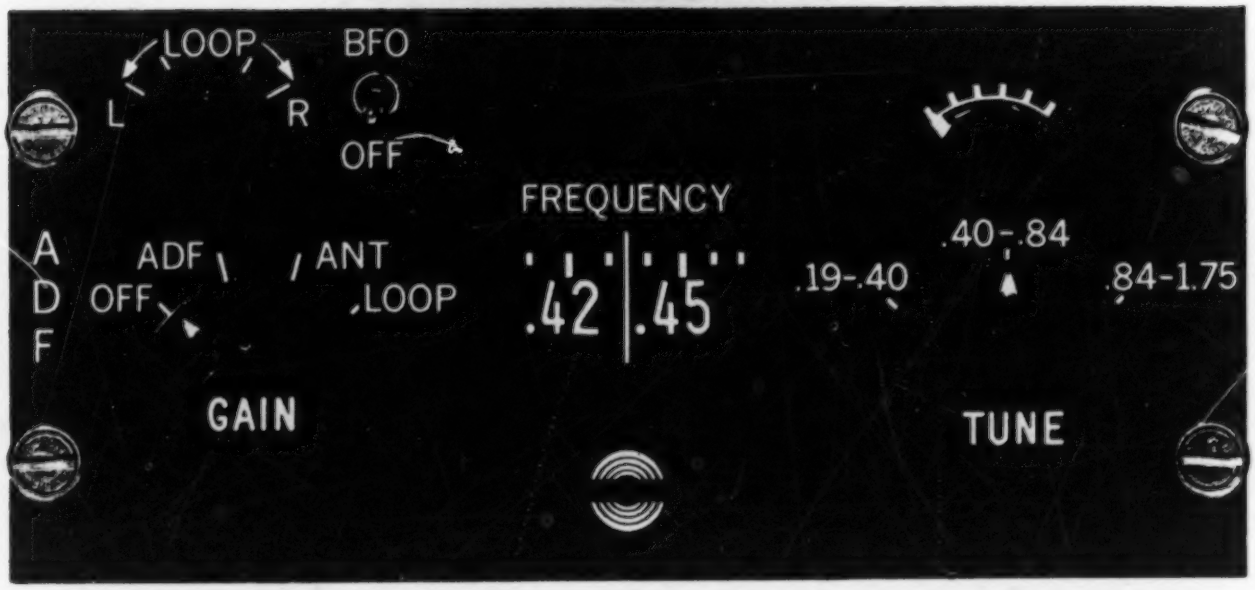

FIGURE 27. *Radiocompass (ADF)*

2693

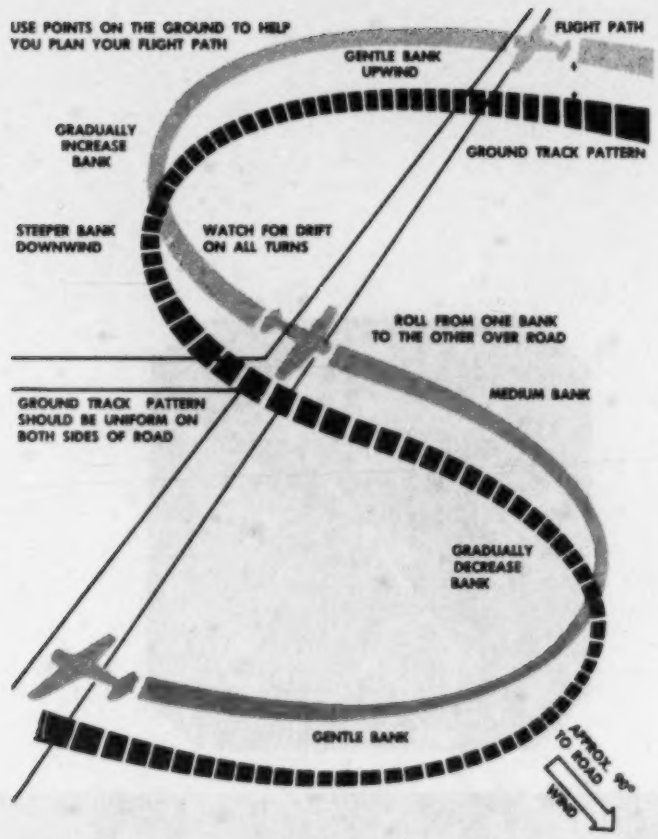

FIGURE 28. *S-turns across a road.*

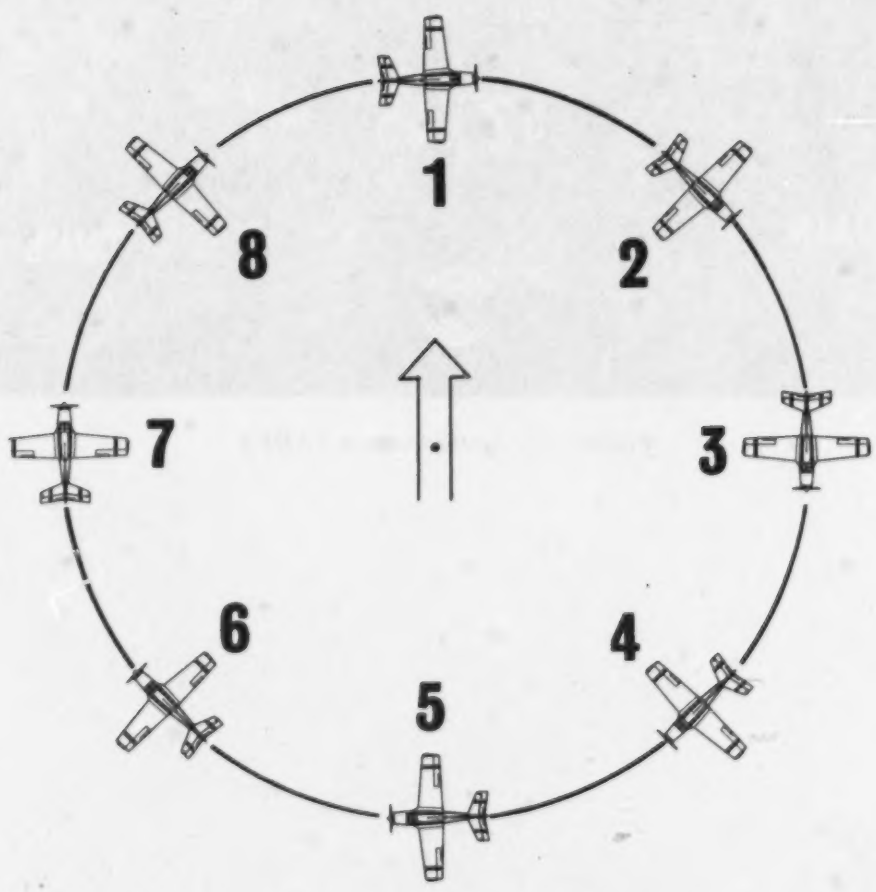

FIGURE 29. *Turns about a point.*

2694

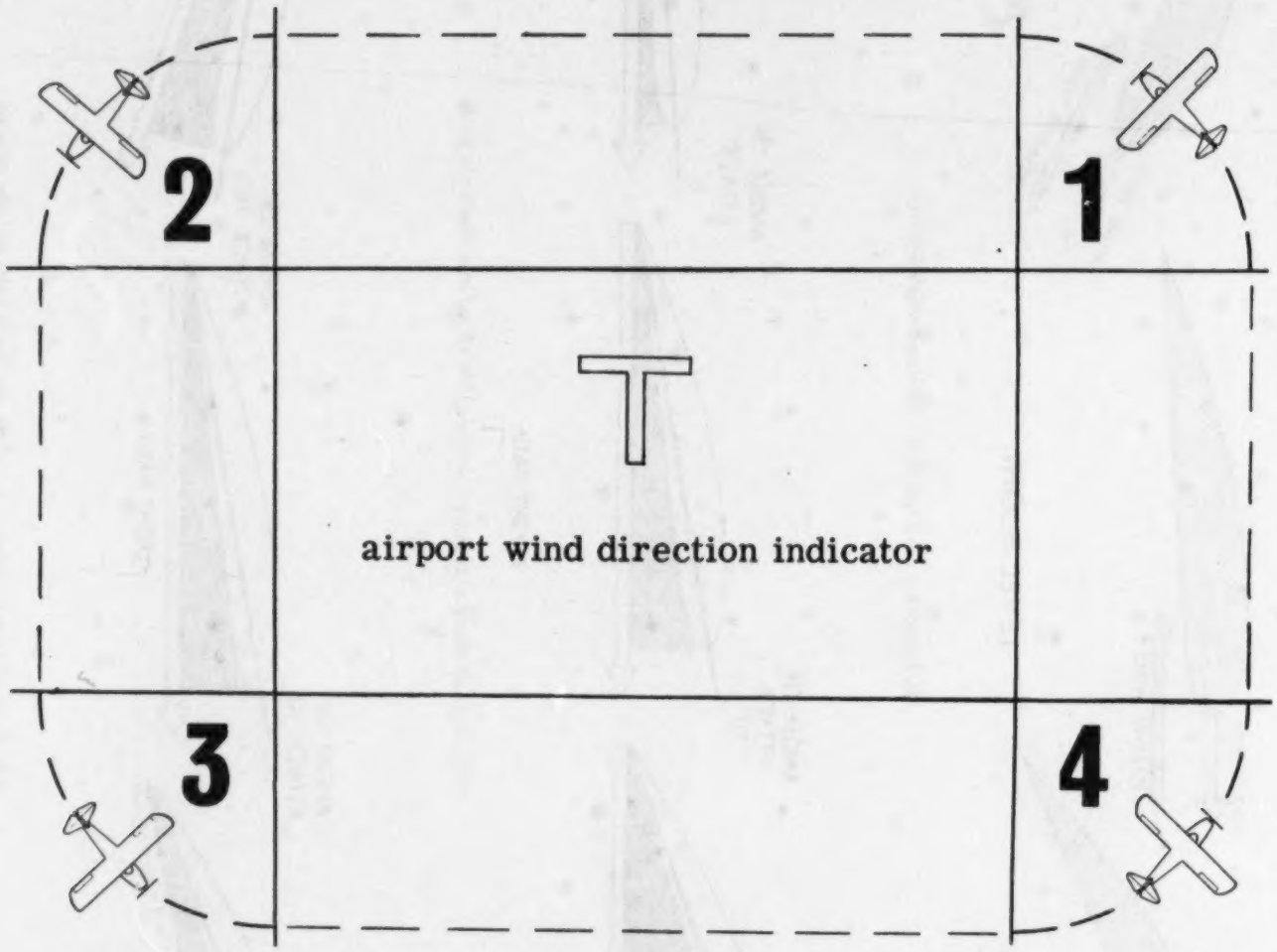

FIGURE 30. *Rectangular course.*

2695

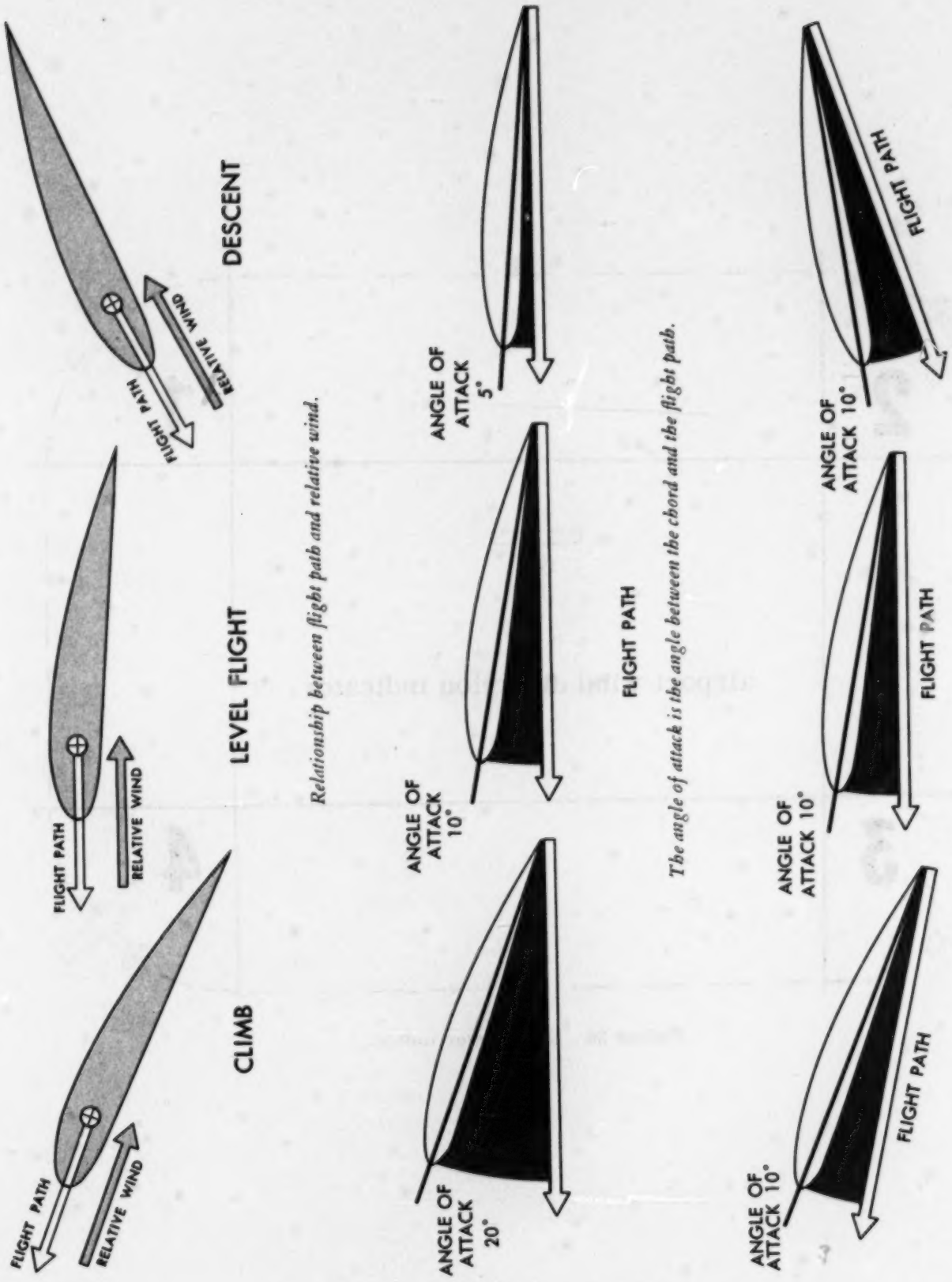

FIGURE 31. *Angle of Attack.*

2696

AIRPORT/FACILITY DIRECTORY LEGEND

LOCATION

The airport location is given in nautical miles (to the nearest mile) and direction from center of referenced city.

ELEVATION

Elevation is given in feet above mean sea level and is based on highest usable portion of the landing area. When elevation is sea level, elevation will be indicated as "00." When elevation is below sea level, a minus sign (−) will precede the figure.

RUNWAYS

The runway surface length, and weight bearing capacity are listed for the longest instrument runway or sealane, or the longest active landing portion of the runway or strip, given to the nearest hundred feet, using 70 feet as the division point, i.e., 1468 feet would be shown as "14"; 1474 feet would be shown as "15". Runway lengths prefixed by the letter "H" indicates that runways are hard surfaced (concrete; asphalt; bitumen, or macadam with a seal coat). If the runway length is not prefixed, the surface is sod, clay, etc. The total number of runways available is shown in parenthesis. (However, only hard surfaced runways are counted at airfields with both hard surfaced and sod runways.)

RUNWAY WEIGHT BEARING CAPACITY

Add 000 to figure following S, T, TT and MAX for gross weight capacity, e.g., (S-000).

S-Runway weight bearing capacity for aircraft with single-wheel type landing gear. (DC-3), etc.

T-Runway weight bearing capacity for aircraft with twin-wheel type landing gear. (DC-6), etc.

TT-Runway weight bearing capacity for aircraft with twin-tandem type landing gear. (707), etc.

Quadricycle and twin-tandem are considered virtually equal for runway weight bearing considerations, as are single-tandem and twin-wheel.

A blank space following the letter designation is used to indicate the runway weight bearing capacity to sustain aircraft with the same type landing gear, although definite figures are not available, e.g., (T-).

Omission of weight bearing capacity indicates information unknown. Footnote remarks are used to indicate a runway with a weight bearing greater than the longest runway.

LIGHTING

B: Rotating Light (Rotating beacon). (Green and white, split-beam and other types.) Omission of **B** indicates rotating light is either not available or not operating standard hours (sunset-sunrise).

NOTE.—Code lights are not codified, and are carried in Remarks.

L: Field Lighting. An asterisk (*) preceding an element indicates that it operates on prior request only (by phone call, telegram or letter). Where the asterisk is not shown, the lights are in operation or available sunset to sunrise or by request (radio call). **L** by itself indicates temporary lighting, such as flares, smudge pots, lanterns.

1—Strip lights or portable runway lights (electrical)

2—Boundary

3—Runway Floods

4—Low Intensity Runway

5—Medium Intensity Runway

6—High Intensity Runway

7—Instrument Approach (neon)

8A, B, or C—High Intensity Instrument Approach

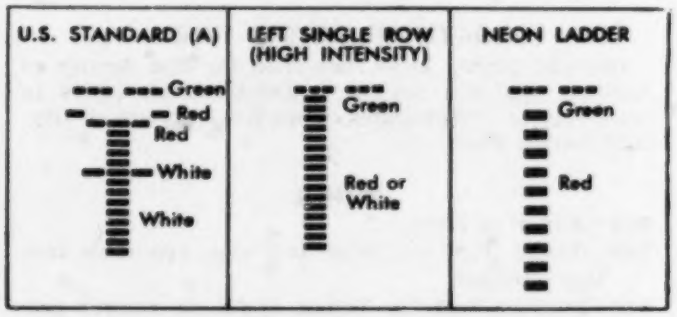

9—Sequence Flashing Lights (3,000′ out unless otherwise stated)

10—Visual Approach Slope Indicator (VASI)

11—Runway end identification lights (threshold strobe) (REIL)

12—Short approach light systems (SALS)

13—Runway alignment lights (RAIL)

14—Runway centerline

15—Touchdown zone

Because the obstructions on virtually all lighted fields are lighted, obstruction lights have not been included in the codification.

FIGURE 32. Airman's Information Manual—*Airport/Facility Directory Legend Excerpt.*

8e9g 2697

AIRPORT/FACILITY DIRECTORY

SERVICING

S1: Storage.
S2: Storage, minor airframe repairs.
S3: Storage, minor airframe and minor powerplant repairs.
S4: Storage, major airframe and minor powerplant repairs.
S5: Storage, major airframe and major powerplant repairs.

FUEL

Code (old)	Grade
F1	80 oct., at least.
F2	80/87 oct.
F3	91/96 oct.
F4	100/130 performance rating.
F5	115/145 performance rating.

TURBINE FUELS

TP-1 650 turbine fuels for civil jets.
JP-1 (Kerosene), JP-3, JP-4, JP-5.

●Code (new)		Grade
F12		80/87
F15		91/98
F18		100/130
F22		115/145
	*ASTM	
F30	Jet A	Kerosene, freeze point −40°F
F34	Jet A-1	Kerosene, freeze point −58°F
F40	**JP-4	Wide-cut gasoline, freeze point −60°F
F45	Jet B	Wide-cut gasoline without icing inhibitor freeze point −60°F

*American Society for Testing Materials.
**Military fuel similar to F45 except *contains* icing inhibitor unless otherwise specified in REMARKS.

DAYLIGHT SAVING TIME

Daylight Saving Time runs from the last Sunday in April to the last Sunday in October. All states in conterminous United States except Kentucky are on Daylight Saving Time.

OTHER

AOE—Airport of Entry.
VASI—Visual Approach Slope Indicator, applicable runway provided.
RVV—Runway Visibility Values, applicable runway provided.
RVR—Runway Visual Range, applicable runway provided.

FLIGHT SERVICE STATION

FSS—The name of the associated FSS is shown in all instances. When the FSS is located on the named airport, "on fld" is shown following the FSS name. When the FSS can be called through the local telephone exchange, (Foreign Exchange) at the cost of a local call, it is indicated by "(LC)" (local call) with the phone number immediately following the name of the FSS, i.e., "FSS: WICHITA (LC481-5867)." When an Interphone line exists between the field and the FSS, it is indicated by "(DL)" (direct line) immediately following the name of the FSS, i.e., "FSS: OTTO (DL)."

AIRPORT REMARKS

"FEE" indicates landing charges for private or non-revenue producing aircraft. In addition, fees may be charged for planes that remain over a couple of hours and buy no services, or at major airline terminals for all aircraft.

"Rgt tfc 13–31" indicates right turns should be made on landings and takeoffs on runways 13 and 31.

Remarks data is confined to operational items affecting the status and usability of the airport, traffic patterns and departure procedures.

Obstructions.—Because of space limitations only the more dangerous obstructions are indicated. Natural obstructions, such as trees, clearly discernible for contact operations, are frequently omitted. On the other hand, all pole lines within at least 15:1 glide angle are indicated.

COMMUNICATIONS

Clearance is required prior to taxiing on a runway, taking off, or landing at a tower controlled airport.

When operating at an airport where the control tower is operated by the U.S. Government, two-way radio communication is required unless otherwise authorized by the tower. (When the tower is operated by someone other than the U.S. Government, two-way radio communication is required if the aircraft has the necessary equipment.)

Frequencies transmit and receive unless specified as: T—Transmit only, R—Receive only, X—On request. Primary frequencies are listed first in each frequency grouping, i.e., VHF, LF. Emergency frequency 121.5 is available at all TOWER, APPROACH CONTROL and RADAR facilities, unless indicated otherwise by a cross-out: ~~121.5~~

Radar available is listed under "RADAR SERVICES" Radar beacons are indicated by "(BCN)" after "RADAR SERVICES", when available.

COMMUNICATIONS REMARKS

Remarks data are confined to operational items affecting the status and usability of navigational aids, such as: ILS component restrictions, part time tower hours of operation, frequency sectorization, VOT frequencies, proposed changes to navigational aids, etc.

VOICE CALL

The voice call for contact with the traffic control services listed at each airport is the airport name followed by the call of the particular service desired, i.e., "LAGUARDIA TOWER." In these instances, only the name of the service is listed. When the voice call of the facility is not the same as the airport name, the complete voice call is listed.

SERVICES AVAILABLE

TOWER

Pre-Taxi Clearance Procedure
Clearance Delivery (CLRNC DEL).
Approach Control (APP CON) Radar and Non-Radar.

FIGURE 33. Airman's Information Manual—*Airport/Facility Directory Legend Excerpt.*—Continued.

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Departure Control (DEP CON) Radar and Non-Radar.
VFR Advisory Service (VFR ADV) Non-Radar.
Traffic Information Service (TFC INFO) Radar.
Surveillance Radar Approach (ASR).
Precision Radar Approach (PAR).
Ground Control (GND CON).
VHF Direction Finding (VHF/DF).

RADIO NAVIGATION AIDS

Included in this section is a tabulation of all Air Navigation Radio Aids in the National Airspace System and those upon which the FAA has approved an instrument approach. Private or military Navigation Radio Aids not in the National Airspace System are not tabulated.

AUTOMATIC TERMINAL INFORMATION SERVICE (ATIS)

ATIS is continuous broadcast of recorded non-control information in selected areas of high activity. See Part 1.

RADAR APPROACH PROCEDURE MINIMA

Weather minima for precision and surveillance radar approaches (PAR/ASR) specify only the lowest straight-in authorized for the approach.

FLIGHT SERVICE STATION (FSS)

Airport Advisory Service (AAS).
Island, Mountain and Lake Reporting Service.

UNICOM

A private aeronautical advisory communications facility operated for purposes other than air traffic control, transmits and receives on one of the following frequencies:

U-1—122.8 for Landing Areas (except heliports) without an ATC Tower or FSS;
U-2—123.0 for Landing Areas (except heliports with an ATC Tower or FSS;
U-3—123.05 for heliports.

SAMPLE

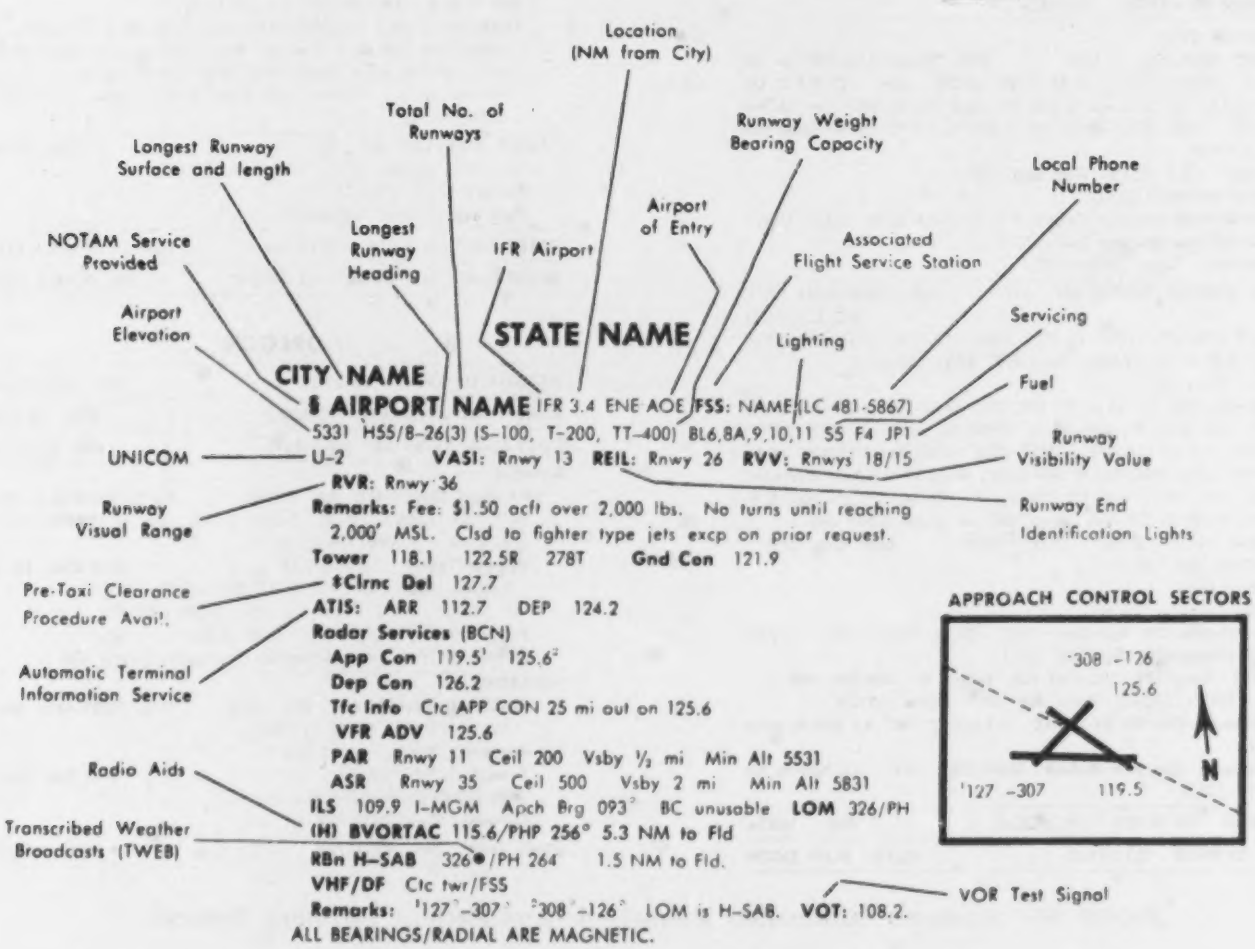

FIGURE 34. Airman's Information Manual—*Airport/Facility Directory Legend Excerpt.*—Continued.

2699

AIRPORT/FACILITY DIRECTORY

OKLAHOMA

ALTUS (L) VORW 109.8/LTS

ARDMORE (L) BVORTAC 116.7/ADM **FSS:** ARDMORE
RBn BMH 400/ADM

BARTLESVILLE (L) BVORTAC 117.9/BVO **FSS:** TULSA

BETHANY, WILEY POST (T) 110.8/PWA **FSS:** OKLAHOMA CITY

BURNS FLAT (L) VOR 110.0/BFV

DUNCAN (L) BVOR 111.0/DUC **FSS:** ARDMORE

GAGE (H) BVORTAC 115.6/GAG **FSS:** GAGE

HENRY POST RBn MHWZ 308/PFL

HOBART (L) BVOR 111.8/HBR **FSS:** HOBART

KINGFISHER (L) BVORTAC 114.2/IFI **FSS:** OKLAHOMA CITY

§LAWTON MUNI *IFR* 2 S **FSS:** WICHITA FALLS (LC EL5–1323)
1109 H54/17–35(1) (S–50, T–75, TT–135) BL4 S5 F22,30 U2
Remarks: P-line, ant NE
Tower[1] 119.9 122.5R **Gnd Con** 121.9
Fort Sill App Con 118.6 122.7R
Fort Sill Dep Con 118.6
Tfc Info Ctc Fort Sill App Con 118.6 122.7R
ASR Rnwy 35 Ceil 400 Vsby 1 mi Min Alt 1509
(L) BVOR 108.2/LAW 347° 4.1 NM to fld
Remarks: [1]Oper 0630–2230 lcl time.

McALESTER (L) BVORTAC 112.0/MLC **FSS:** McALESTER

MUSKOGEE RBn MHW 306/MKO

OKLAHOMA CITY
$WILEY POST *IFR* 7 NW **FSS:** OKLAHOMA CITY on fld
1299 H58/17–35(2) (S–15, T–20, TT–30) BL4, S5 F18,40 U2
Remarks: Rgt tfc rnwys 12 and 17. 1596′ (2749′ MSL) twr 7.5 NM ENE. 1563′ (2726′ MSL) twr 7 NM E. 1572′ (2726′ MSL) twr 7.5 NM E.
Tower[1] 119.7 122.5R **Gnd Con** 121.7
Radar Services: (BCN)
Oklahoma City App Con 119.3 134.1x 122.5R 124.2 115.0T
Oklahoma City Dep Con 121.1
Remarks: [1]Oper 1200–0400Z.

$WILL ROGERS WORLD *IFR* 6W **FSS:** OKLAHOMA CITY (LC SU9–7452)
1284 H98/17R–35L(4) (S–100, T–180, TT–350) BL5,6,8A,9,10,11 S5 F22,30,40 U2 **VASI:** Rnwy 17R **REIL:** Rnwy 12
RVR: Rnwy 35L
Remarks: Rgt tfc rnwys 12, 17R, 21. Rnwy 3–21 and txwy (C–1) W side rnwy 3 restricted to 15000 lbs or less. 1572′ (2726′ MSL) twr 10 NM NE. 1563′ (2726′ MSL) twr 10.5 NM NNE. 1596′ (2749′ MSL) twr 11 NM NNE. Rnwy 21 threshold displaced 650′ NE end. Rnwy 17L–35R clsd to turbojet acft for lndg S & tkof N. 17L–35R clsd to jets and air carrier when wet.
Tower 118.3 126.2R 122.7R 109.9T **Gnd Con** 121.9
‡Clrnc Del 121.9
ATIS: 109.9
Radar Services: (BCN)
Oklahoma City App Con 119.3 134.1x 122.5R 124.2 115.0T
Oklahoma City Dep Con 121.1
ASR Rnwy 17R, 35L, Ceil 400 Vsby 1 mi Min Alt 1684
ILS 109.9 I–OKC Apch Brg 351° **LOM:** 219/OK
Oklahoma City (H) BVORTAC 115.0/OKC 098° 8.1 NM to rnwy 12.
Oklahoma City RBn H–SAB 350●/OKC 092° 1.6 NM to fld
VOT: 108.8

OKMULGEE (L) BVOR 112.2/OKM **FSS:** TULSA

PAGE (L) BVOR 113.5/PGO **CS/T:** FORT SMITH

OKLAHOMA—*Continued*

PONCA CITY (H) BVORTAC 113.2/PNC **FSS:** PONCA CITY
RBn BMH 368/PNC

SAYRE (L) BVOR 115.2/SYO **FSS:** HOBART

STILLWATER (T) BVOR 108.4/SWO **FSS:** OKLAHOMA CITY (LC FR 2–4935)

TINKER AFB RBn HW 394/TIK

TULAKES RBn MHW 406/TWO **FSS:** OKLAHOMA CITY

§TULSA INTL *IFR* 5NE **FSS:** TULSA on Fld
674 H100/17L–35R(5) (S–50, T–75, TT–135)* BL4, 6, 8A, 9, 10 S5 F22,30,40 U2 **RVR:** Rnwy 35R
Remarks: Rgt tfc rnwys 17R, 21R. Rnwy 35L threshold displaced 560′ SE end. Rnwy 8 threshold displaced 924′ W end. 1175′ (2147′ MSL) twr 9.5 NM W. Rnwy 21R unlgtd. 4000′ blacktop track 1.5 NM E rnwy 26 — **do not** mistake for rnwy. *Rnwy 17R–35L: (S–100, T–200, TT–400).
Tower 118.7 122.5R **Gnd Con** 121.9
‡Clrnc Del 121.2
ATIS[2] 114.4
Radar Services: (BCN)
App Con 119.1 124.0 122.5Rx 110.3T **Dep Con** 120.7
Tfc Info Ctc App Con 25 mi out on 119.1
ASR Rnwys 17L, 26[1], 35R Ceil 400 Vsby 1 mi Min Alt 1074
ILS 109.7 I–DWE Apch Brg 175X BC unusable **LOM:** 245/DW 110.3 I–TUL[2] Apch Brg 355° **LOM:** 338/TU
(H) VORTAC 114.4/TUL 260° 4.3 NM to rnwy 26
RBn H–SAB 245●/DW 175° 5.6 NM to fld.
Remarks: [1]500–1 required when apch is made until position is estab over 910 stack 3 mi E. [2]Front crs unusable above 6600′ MSL. BC unusable above 4600′ MSL. Both systems not operd simultaneously. [3]Oper 0800–2300 CDT. LOM is H–SAB. **VOT:** 109.0.

§TULSA RIVERSIDE *IFR* 5S **FSS:** TULSA
624 H40/18–36(1) (S–50, T–60) BL4 S5 F18 U2
Tower:[1] 118.1 122.7R
Remarks: [1]Oper 1200–0400Z.

WILEY POST (T) BVOR 110.8/PWA **FSS:** OKLAHOMA CITY

WOODRING (T) BVOR 109.0/ODG **FSS:** PONCA CITY

OREGON

ASTORIA (L) BVOR 114.0/AST **FSS:** HOQUIAM

BAKER (L) BVORTAC 115.3/BKE **FSS:** BAKER

CORVALLIS (L) BVOR 108.4/CVO **FSS:** EUGENE

EUGENE
$MAHLON-SWEET FLD *IFR* 7 NW **CS/T:** EUGENE on Fld
365 H55/16–34(2) (S–80, T–120, T–190) BL4, 6, 8A, 9 S5 F18,30 U2 **RVR:** Rnwy 16
Eugene Tower 118.9 122.5R **Gnd Con** 121.9
Eugene App Con 119.6 122.5R 112.9T 109.5T
ILS[1] 109.5 I–EUG Apch Brg 159° **LOM:** 227/EU
Eugene (L) BVORTAC 112.9/EUG on fld.
Remarks: [1]Will be shutdown for relctn until aprxly Oct 1.

HILLSBORO
PORTLAND-HILLSBORO *IFR* 2NE **FSS:** PORTLAND (DL)
204 H40/2–20(2) BL4 S5 F12,18 U2
Remarks: Rgt tfc rnwys 2 and 30.
Tower[1] 119.3 122.4R **Gnd Con** 121.7
VFR ADV: Ctc Portland App Con
Remarks: [1]Oper 0700–2300 lcl time.

JOHN DAY (H) BVORTAC 115.6/JDA **FSS:** BAKER

FIGURE 35. Airman's Information Manual—*Airport/Facility Directory Excerpt.*

2700

VFR EXAM-O-GRAM NO. 3

AN INVISIBLE HAZARD TO LIGHT AIRCRAFT

The Civil Aeronautics Board listed the probable cause of a recent fatal light aircraft accident as structural failure of a light aircraft resulting from excessive airloads created by wingtip vortices behind a large aircraft. The report also states: "The dangers of wake or vortex turbulence are still unknown to many pilots."

Discussion of Wingtip Vortices

1. WHAT ARE WINGTIP VORTICES? It is unfortunate that vortices are invisible. If you could see them, they would look like a pair of horizontal tornadoes stretching back from each wingtip. These violent, compact, and fast-spinning air masses extend behind an aircraft for miles. Many pilots refer to this phenomenon as "propwash" or "jetwash," but engineering studies have revealed this term a misnomer. The main source of this disturbance is not from the powerplant; it is from the wingtip.

2. WHY ARE THEY DANGEROUS? They are dangerous because all tests to date indicate that *structural failure in the air* can occur in light aircraft upon penetration of the vortices behind larger transport aircraft. During takeoff or landing, care should be taken to *avoid vortex disturbance.* Loss of control could be the result at a critical time when control is of prime importance to safety.

3. UNDER WHAT CONDITIONS ARE THEY MOST DANGEROUS? There are many factors affecting the intensity of a wingtip vortex, but it is a safe and practical generalization that *the bigger the airplane the more violent and long-lived* will be the vortex disturbance. The source of this insidious danger can be out of sight by the time you encounter the wake. For example: A large aircraft could take off and be out of sight, or land and be on the ramp and the turbulence could still be present near the runway. No practical rule involving a time interval for one aircraft to fly behind another will assure avoidance of the turbulence generated by the first. The heavier and slower the aircraft, the greater the intensity of the air circulation in the vortex core. A modern large transport aircraft will create vortices of maximum turbulence *during takeoffs and landings at near maximum gross weights.*

4. WHAT ACTION CAN THE PILOT TAKE TO AVOID OR REDUCE THIS HAZARD?

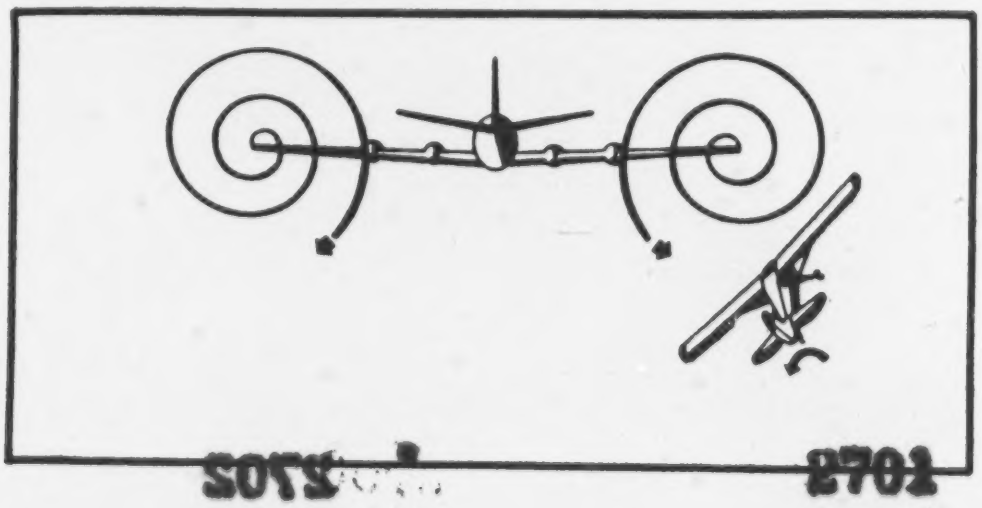

a. Avoid passing behind any large aircraft.
b. Avoid, when possible, places and altitudes frequented by large aircraft. Constantly monitor your radio for location of such aircraft.
c. When it is necessary to operate behind a large, heavy aircraft, remain *above* the flight path of that aircraft. Vortices settle downward toward the surface. They are also affected by the wind and move with the encompassing air mass.
d. When taking off or landing behind large aircraft, be on the alert for the first sign of turbulence and allow adequate spacing.
e. The best way of avoiding the turbulence hazard is to know where they are most likely to be encountered and act accordingly. Since vortices are not formed until lift is produced, they will not be generated by an aircraft taking off until just before lift off—at the point where rotation is made. Vortices cease to be generated by a landing aircraft when its wings cease to produce lift—when it has actually landed.

5. RECOMMENDED READING FOR ALL PILOTS. Your attention is invited to the Safety of Flight Section of the *Airman's Information Manual* which thoroughly and completely explains "Wake Turbulence." This article has been reprinted in FAA Advisory Circular AC 90–23A (which may be obtained free of charge from: Distribution Unit, HQ–438, Federal Aviation Administration, Washington, D.C. 20590). We recommend that *all pilots read, study,* and *think* through the contents of this "Wake Turbulence" article.

2702 • 2702

VFR EXAM-O-GRAM NO. 10

FUEL CONTAMINATION

EXCERPTS FROM A RECENT AIRCRAFT ACCIDENT REPORT: ". . . Subsequent examination of the engine and its components revealed large deposits of foreign material, sediment, and water in the fuel strainer, carburetor bowl, and fuel pump in sufficient quantities to cause stoppage. . . . Probable cause of accident: Inadequate preflight action by the pilot; subsequent *engine failure due to fuel contamination. . . .*"

DO YOU KNOW—AND PRACTICE—THE PRECAUTIONS YOU SHOULD TAKE TO AVOID FUEL CONTAMINATION? Perhaps you do, but there are many pilots who obviously do not—*as evidenced by the alarming increase in the number of accidents caused by fuel contamination.* The modern aircraft engine is a remarkably reliable and dependable mechanism, but it will not run on water, dirt particles, and other noncombustibles. Let's review this insidious problem by asking—and answering—a couple of rather pointed questions about this subject.

1. *WHAT CAUSES FUEL CONTAMINATION?*

   A. *Storing the aircraft with partially filled fuel tanks may cause condensation and water contamination.* You have, no doubt, often noticed moisture (or dew) on the outside of your aircraft early in the morning. When you noticed this, did it occur to you that this same moisture could form on the inside walls of your fuel tanks? Water is the worst offender in these contamination cases, and condensation inside the tank is one of the methods by which it finds its way into your fuel system.

   B. *Servicing the aircraft from improperly filtered tanks, particularly small tanks or drums, is another principal source of fuel contamination.* This practice frequently introduces both dirt and water into the aircraft fuel system.

2. *WHAT PRECAUTIONS SHOULD THE PILOT TAKE TO AVOID FUEL CONTAMINATION?*

   A. PRELIGHT ACTION: Drain a generous sample of fuel (several ounces—not just a trickle or two) into a transparent container from each of the fuel sumps. (Notice that we specified each of the fuel sumps. This includes not only the main gascolator, but also the wing tank sumps.) Examine the sample of fuel from each sump for water and dirt contamination. Water *will not mix* with gasoline. If present, it will collect at the bottom of the transparent container and will be easily detected. If water or dirt appears, continue to drain fuel from that sump until you are sure the system is clear of all water and dirt. (NOTE: If your aircraft is not equipped with wing tank quick-drain petcocks, it is recommended they be installed. This can make the preflight check of the wing tank sumps much more convenient, as the frequent removal and replacement of wing tank sump drain plugs can be a time-consuming operation.)

2703

B. POSTFLIGHT ACTION: (1) *Top off your tanks at the end of the day to avoid condensation and water contamination inside your fuel tanks.* Although this is a desirable procedure to follow at the end of each flying day (assuming your loading schedule for the next day will permit a full load of fuel), it is particularly important that this is done if the aircraft is to stand idle for several days—whether it is tied down out-of-doors or stored in a hangar. (2) Avoid, if possible, servicing your aircraft from small tanks or drums. *Should this become necessary, the fuel should always be strained through a chamois skin that is in good condition.*

C. PRECAUTIONARY MAINTENANCE ACTION: In addition to the previously discussed precautions, the following maintenance precautions should be performed on your aircraft at periodic intervals:
(1) Inspect and clean the tank fuel outlet finger strainer.
(2) Inspect and clean the inlet carburetor screen.
(3) Flush the carburetor bowl.

BY FOLLOWING ALL OF THESE PRECAUTIONS, YOU CAN GREATLY REDUCE THE HAZARD OF ENGINE FAILURE DUE TO FUEL CONTAMINATION.

To better understand the reasons for the PREFLIGHT ACTION we have recommended, let's take a brief look at an actual water contamination test recently conducted by FAA—it's a real eye opener!

After all water was removed from the fuel system of a popular make high-wing monoplane, three gallons of water were added to the half-full fuel tank. After a few minutes, the fuel strainer (gascolator) was checked for water. *It was necessary to drain 10 liquid ounces of fuel before any water appeared.* This is considerably more than most pilots drain when checking for water.

In a second test with the same aircraft in flying attitude (to simulate a later tricycle geared model), the fuel system was again cleared of all water; then one gallon of water was added to the half-full tank. Upon checking the fuel strainer (gascolator) quick drain, *more than a quart of fuel was drained before any water appeared.*

In both of the above-described tests, about nine ounces of water remained in the fuel tank after the belly drain and the fuel strainer (gascolator) had ceased to show any trace of water. *This residual water could be removed only by draining the tank sumps.*

Two significant findings emerged from the above tests and from tests made on a plastic mockup of a similar fuel system:

1—When water was introduced into the fuel tank, it immediately settled to the bottom, but did not flow down the fuel lines to the fuel strainer until all fuel was drained from the lines. Remember the fuel tank must be turned ON to drain the tank lines through the gascolator.

2—Since it was found impossible to drain all water from the tank through the fuel lines, it was necessary to drain the fuel tank sumps in order to remove all water from the system.

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VFR EXAM-O-GRAM NO. 11

DENSITY ALTITUDE AND ITS EFFECT ON AIRCRAFT PERFORMANCE

A report of a recent accident was stated in the following words: "Takeoff was attempted on a 1,600-foot strip; the airplane cleared the fences but sank back and struck a ditch." The pilot states that he failed to consider the effect of the grassy, rough field, the *90° temperature*, heavy load of fuel and passengers, and the calm wind.

This EXAM-O-GRAM discusses the effect that high temperature and other factors had on this takeoff.

1. *WHAT IS DENSITY ALTITUDE?* It is a measure of air density. Under non-standard conditions, density altitude will differ from the elevation. As the air density decreases (i.e., air becomes thinner), density altitude increases, and vice versa. *Low atmospheric pressure, high temperature,* and *high humidity* all result in a decrease in air density and an *increase in density altitude.* (Contrary to prevailing opinion, *moist air is less dense than dry air.* Water vapor actually weighs less than dry air—approximately 5/8 as much).

2. *WHAT EFFECT DOES AN INCREASE IN DENSITY ALTITUDE HAVE ON AIRCRAFT TAKEOFF PERFORMANCE?*

   A. Engine horsepower decreases (unless it is a supercharged engine).

   B. The propeller loses some of its efficiency as it will not take as much of a bite out of the thinner air.

   C. Takeoff distance is increased and rate of climb is decreased because of the loss of engine power and propeller efficiency, and the higher true airspeed necessary to obtain the required lift in the thinner air. (In other words, if the density altitude is 8,000 feet at an elevation of 5,000 feet, the aircraft flies as though it were at 8,000 feet.)

3. *UNDER WHAT CONDITIONS IS A HIGH "DENSITY ALTITUDE" MOST HAZARDOUS?* When it is present with other factors that tend to increase the takeoff distance or require that this distance be limited such as: heavy load; calm wind conditions; short runway; obstructions at or near the end of the runway; and unfavorable runway conditions (rough, tall grass, soft, snow, upgrade, etc.).

4. *HOW MUCH CAN THE DENSITY ALTITUDE VARY AT A GIVEN AIRPORT DURING SEASONAL*

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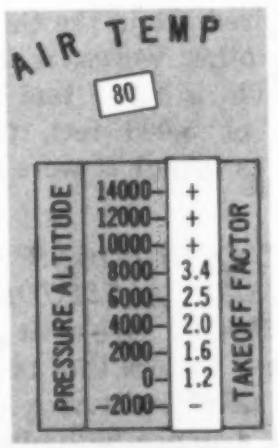

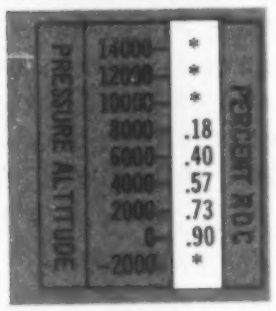

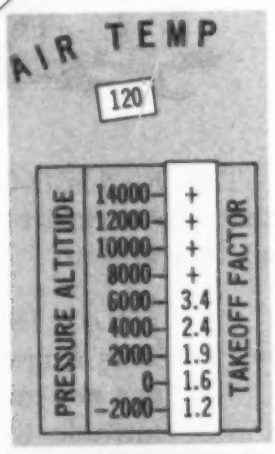

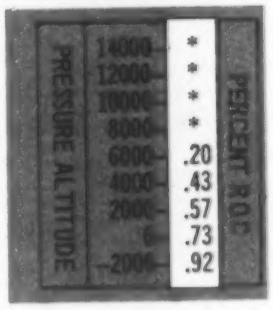

NOTES:

+ = **Much greater than normal;** check manufacturer's specifications.

− = Less than normal; check manufacturer's specifications.

* = General data not pertinent; check manufacturer's specifications.

† This computer has been developed by the Federal Aviation Agency. It is intended to supplement and **NOT** replace manufacturer's published performance information.

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EXTREMES? This depends mostly on the extremes in temperature variation. From a density altitude chart, it can be determined that, at an elevation of 5,000 feet, temperature –6°F, the density altitude would be approximately 2,200 feet; at a temperature of 104°F, the density altitude would be approximately 8,900 feet. These figures do not include the increase due to a high relative humidity on the 104° day. *Do not let the performance of your airplane on a cold winter day lull you into a sense of security when taking off on a hot, humid summer day.* (Note the pilot's remarks in the cartoon.)

5. *IF AN AIRPLANE REQUIRES A DISTANCE OF 1,200 FEET FOR TAKEOFF AT SEA LEVEL UNDER STANDARD CONDITIONS, WHAT DISTANCE IS REQUIRED AT A PRESSURE ALTITUDE OF 4,000 FEET, TEMPERATURE 100°F?* Referring to the DENALT Performance Computer, you find, for these conditions, a takeoff factor of 2.2. Therefore, the takeoff distance would be 1200′ x 2.2 which equals 2,640′. (Note: This computer shows figures for each 10° of temperature from −40°F to 120°F.)

Under the conditions presented in Item 5, it can be seen that the takeoff distance on a hot summer day at 4,000 feet pressure altitude, was 1,440 feet more than at sea level under standard conditions.

The DENALT computer has been recently developed by the Federal Aviation Administration to replace the Koch Chart. Two versions are available. One is for fixed-pitch propeller aircraft, and the other is for variable pitch propellers. Both versions are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The price is 50¢ each. When ordering, specify either fixed pitch or variable pitch.

BEWARE OF
HIGH, HOT, AND HUMID CONDITIONS

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VFR EXAM-O-GRAM NO. 12

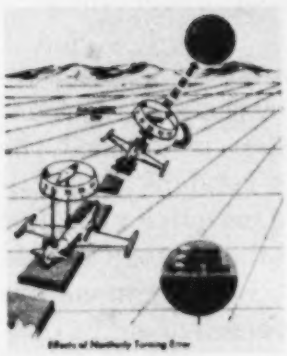

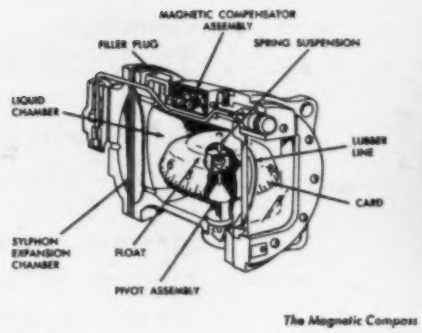

The Magnetic Compass

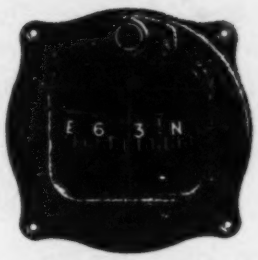

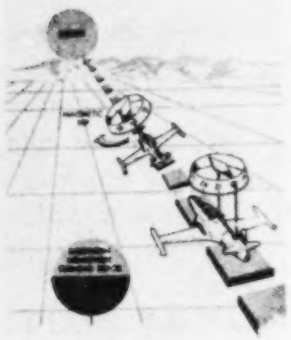

THE MAGNETIC COMPASS

The magnetic compass, in terms of its errors, limitations, and in-flight characteristics, is one of those aeronautical subjects in which consistently large numbers of pilots fare poorly on FAA written tests. There is evidence that this veteran instrument—it was one of the first to be installed in an aircraft—is one of the least understood instruments in the cockpit of today's modern general aviation aircraft. Many pilots seem to operate on the premise that it is easier to ignore this instrument's errors than to learn them. However, it should be remembered that (1) this is the only directional-seeking instrument in the cockpit of most general aviation aircraft, and (2) it is mechanically a simple, self-contained unit (independent of external suction or electrical power for its operation) that is likely to remain reliable at all times—reliable, that is, if the pilot understands its inherent errors.

WHAT ARE SOME OF THE COMPASS ERRORS THAT THE PILOT SHOULD UNDERSTAND?

The pilot should understand:

I. VARIATION—This is the angular difference between *true north* and *magnetic north* which is plotted on charts in *degrees east or west.* The pilot should understand perfectly *which to add and which to subtract* when converting from true headings or courses to magnetic headings or courses and vice versa. (Many pilots find such memory aids as "east is least and west is best" helpful in remembering that *east is subtracted* and *west is added* when going from *true* to *magnetic.*)

II. DEVIATION—This is the deflection of the compass needle from a position of magnetic north as a result of local magnetic disturbances in the aircraft. To reduce this deviation, the compass has a compensating device consisting of small adjustable magnets. The compass should be checked and compensated periodically. The errors remaining after "swinging" the compass should be recorded on a compass correction card which should be installed in the cockpit within the view of the pilot. (NOTE: Avoid placing metallic objects such as metal computers, flashlights, etc., on top of the instrument panel near the magnetic compass as this practice may induce large amounts of deviation and seriously affect the instrument's accuracy.)

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In addition to these errors, the pilot should have a *working knowledge* of the following in-flight errors:

III. OSCILLATION ERROR—The erratic swinging of the compass card which may be the result of turbulence or rough pilot technique.

IV. MAGNETIC DIP—The tendency of the magnetic compass to point down as well as north in certain latitudes. This tendency is responsible for:

A. Northerly Turn Error—*This error is the most pronounced of the in-flight errors.* It is most apparent when turning to or from headings of north and south.

B. Acceleration Error—An error that can occur during airspeed changes. It is most apparent on headings of east and west.

As a quick refresher on this instrument's in-flight dip error, we invite you to accompany us on a simulated demonstration flight around the compass rose. Unless otherwise noted, we will limit our bank during turns to a gentle bank. Also, we will assume that we are in the northern hemisphere because the characteristics which we will observe would not be present at the magnetic equator, and would be reversed in the southern hemisphere.

DEMONSTRATION NO. 1 (Heading—North; Error—Northerly Turn Error). As we start a turn in either direction from this heading, we notice that momentarily the compass *gives an indication of a turn opposite the direction of the actual turn.* (While the compass card is in a banked attitude, the vertical component of the earth's magnetic field causes the north-seeking end of the compass to dip to the low side of the turn, giving the pilot an erroneous turn indication). If we continue the turn toward east or west, the compass card will begin to indicate a turn in the correct direction, *but will lag behind the actual turn*—at a diminishing rate—until we are within a few degrees of east or west. One additional demonstration which we will cover before leaving north is the Slow Turn Error. If, while holding a compass indication of north, we sneak into a very gradual and shallow banked turn—say 3° or 4° of bank—it is possible to change the actual heading of the aircraft by 20° or more *while still maintaining an indication of north by the compass.*

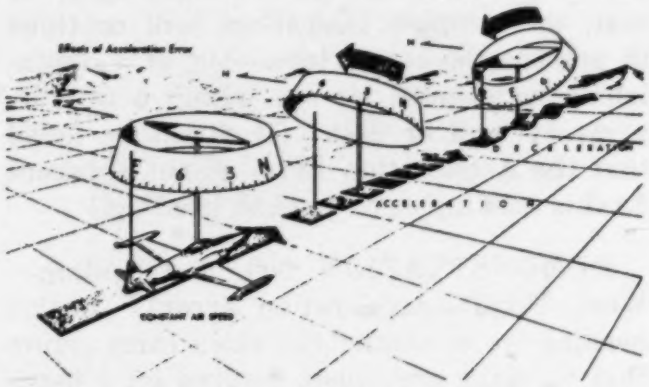

DEMONSTRATION NO. 2 (Heading—East; Error–Acceleration Error). The Northerly Turn Error that we previously experienced is not apparent on this heading (or on a west heading). However, let's see what happens when we accelerate and decelerate by changing the airspeed. With the wings level, we will *increase* the airspeed by increasing the power setting or by lowering the nose—or both. Result—although we are holding the nose of the aircraft straight ahead, our compass card erroneously indicates a turn toward *north.* On the other hand, if we *decrease* the airspeed by reducing the power setting or raising the nose of the aircraft—or both, the compass will give an erroneous indication of a turn toward *south.* (Because of the pendulous-type mounting, the end of the compass card which the pilot sees is tilted upward while accelerating, and downward while decelerating during changes of airspeed. This momentary deflection of the compass card from the horizontal, results in an error that is most apparent on headings of east and west).

DEMONSTRATION NO. 3 (Heading—South; Error—Northerly Turn Error). Again we are presented with the Northerly Turn Error problem that we encountered in Demonstration No. 1. Although the same set of forces that caused the erroneous indi-

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cation when we banked the aircraft while on a north heading will likewise be working against us on this heading, the compass indications will appear quite different. For example, as we roll into a turn in either direction, the compass gives us an indication of a turn in the *correct direction* but at a *much faster rate than is actually being turned.* As we continue our turn toward west or east, the compass indications will continue to precede the actual turn—but at a diminishing rate—until we are within a few degrees of west or east. (It might be noted that the Acceleration Error is not apparent on this heading or on a north heading.)

DEMONSTRATION NO. 4 (Heading—West; Error—Acceleration Error). On this heading we encounter the exact same errors that we have previously covered on a heading of east in Demonstration No. 2. If we *increase the airspeed,* we will get an erroneous indication of a *turn toward north.* If we *decrease the airspeed,* we will get an erroneous indication of a *turn toward south.* (A memory aid that might assist you in recalling this relationship between airspeed change and direction of the error is the word "ANDS"—*A*ccelerate-*N*orth, *D*ecelerate-*S*outh.)

WHAT ARE THE MAIN POINTS THAT SHOULD BE REMEMBERED CONCERNING THESE FOUR DEMONSTRATIONS?

The points we are trying to get across are these: (1) WHEN TAKING READINGS FROM THE MAGNETIC COMPASS WHILE ON A NORTHERLY OR SOUTHERLY HEADING (for establishing a course, setting the gyro-driven heading indicator, etc.), REMEMBER THAT IT IS ESSENTIAL TO HAVE THE WINGS PERFECTLY LEVEL FOR SEVERAL SECONDS PRIOR TO TAKING THE READING. (2) IF YOU ARE ON AN EASTERLY OR WESTERLY HEADING, IT IS IMPORTANT THAT THE AIRSPEED IS CONSTANT IN ORDER TO GET AN ACCURATE READING. (3) ON AN INTERMEDIATE HEADING, BOTH OF THE ABOVE CONDITIONS SHOULD BE MET. (NOTE: If your aircraft is equipped with a gyro-driven heading indicator, check it frequently with your magnetic compass.)

TURNS TO HEADINGS BY REFERENCE TO THE MAGNETIC COMPASS

For the pilot who would like a general set of rules for determining his lead point for making turns by reference to the magnetic compass, the following is submitted:

(NOTE: The angle of bank should not exceed 15° in order to minimize dip error.)

1. *When turning to a heading of north, you must allow in addition to your normal lead, a number of degrees approximately equal to the latitude at which you are flying. Example:* You are making a left turn to a heading of north in a locality where the latitude is 30° N. You have previously determined your normal lead to be approximately 5° for this particular angle of bank. In this case, you should start your roll-out when the compass reads approximately 35°
2. *When turning to a heading of south, you must turn past your normal lead point by a number of degrees approximately equal to the latitude at which you are flying. Example:* You are making a right turn to a heading of south in a locality where the latitude is 30° N. You have previously determined your normal lead to be approximately 5° for this particular angle of bank. In this case, you should turn past your normal lead point of 175° (180°—5°) by 30°, and start your roll-out when the compass reads approximately 205°.
3. *The error is negligible when turning to east or west, therefore, use the normal amount of lead when turning to an east or west heading.*
4. *For intermediate headings that lie between the cardinal headings, use*

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an approximation based on the heading's proximity to north or south, the direction of the turn, and your knowledge of the compass's lead and lag characteristics in these areas. In other words, use an "educated guesstimate."

We won't guarantee you that the above method will roll you out on the exact heading every time—at best, it is an approximate method. But it will get you reasonably close to your desired heading, and this beats having no method at all.

KNOW YOUR MAGNETIC COMPASS

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VFR EXAM-O-GRAM NO. 13

WEIGHT AND BALANCE

Loading the family automobile for a trip requires little serious planning. You can C-R-A-M as much luggage into the trunk as you have space, squeeze as many persons into the seats as you have room, and top off the gas tank with no thought given to Gross Weight or Center of Gravity. A similar approach to loading your "flying machine" could result in a serious accident.

WHAT IS EXCESSIVE WEIGHT? Assume that your airplane is a 4-place airplane with a baggage allowance of 120 pounds, a usable fuel capacity of 39 gallons, and an oil supply of 8 quarts. On a hypothetical flight you take on full fuel and oil servicing, toss the suitcases in the baggage compartment, and you and your three passengers eagerly climb aboard. This seems like a reasonable load, but if you had placed each of them on the scales you might have found that you and the passengers average 180 lbs. each (720 lbs.), and the four suitcases, 30 lbs. each (120 lbs.). The usable fuel load weighs 234 lbs. and the oil 15 lbs. Assume, also, that the Weight and Balance Data for the airplane shows an *empty weight* of 1325 lbs. and a maximum allowable gross weight of 2200 lbs. NOW, add the weight of the useful load to the empty weight and compare the total to the allowable gross weight. . . . (1089 lbs. +1325 lbs.=2414 lbs. . . . *214 lbs. excess!*

WHAT RESTRICTIONS ARE THERE ON WEIGHT AND BALANCE? In many civilian airplanes it is not possible to fill all seats, baggage compartment, and tanks, and still remain within the approved weight and balance limits. If you do not wish to leave a passenger behind (a normal reaction), you must reduce your fuel load and plan on shorter legs en route or cut down on the baggage carried, or both. Frequently, restrictions are placed on rear seat occupancy with maximum baggage allowance aboard. By all means, follow the Airplane Weight and Balance Form restrictions. The loading conditions and the empty weight of your particular airplane may differ from those shown in the Owner's Manual, especially if modifications have been made or equipment has been added to the basic airplane.

IS CRUISE PERFORMANCE AFFECTED BY AN EXCESS LOAD? At normal weight, the airplane requires a certain angle of attack to maintain straight-and-level flight at a given airspeed. To sustain a heavier load at that same airspeed, the angle of attack must be greater to provide the increased lift that is necessary. More power must be added to overcome the increased drag which results from the increased angle of attack. Additional power, in turn, burns more fuel, thereby reducing the range of the aircraft.

IS CLIMB PERFORMANCE AFFECTED BY AN EXCESS LOAD? Time to climb to a given altitude is lengthened, because extra thrust required to carry the additional weight limits the rate of climb and may limit the climbing speed, since this depends on the surplus power available. The additional time in climbing at the higher power setting also increases the fuel consumption.

IS "G" FORCE TOLERANCE AFFECTED? Assume that your airplane has

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a limit-load factor of 3.8 "G's". If the allowable gross weight is not exceeded, this means the wings can safely support 3.8 times the weight of the airplane and its contents. In accelerated flight (pull-ups, turns, turbulent air), the actual load on the wings would be much greater than the normal load, which of course results in much greater stresses in the wing structure. Overloading, therefore, has the effect of decreasing the "G" load capability of the aircraft and thus could result in the wing being stressed to the point of popped rivets, permanent distortion, or structural failure.

HOW IS AN AIRPLANE BALANCED? An airplane, like a steelyard scale, is in perfect balance when the weight is distributed in such a manner that it remains level when freely suspended. In an airplane, however, as long as the center of gravity lies anywhere within specified limits, balance can be maintained in flight. Flight with the CG outside of this range results in unsatisfactory or *dangerous flight characteristics.* Loading an airplane then, is simply a matter of distributing the load so that the CG falls within the allowable range. This can be accomplished by arranging the load in accordance with the Center of Gravity Envelope provided for each airplane.

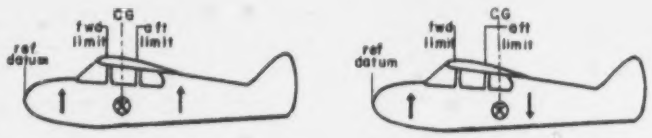

WEIGHT PROPERLY DISTRIBUTED

EXCESS WEIGHT PLACED AFT

DOES IMPROPER LOADING AFFECT SAFETY? YES! When loading conditions cause the center of gravity to fall outside allowable limits, stability is adversely affected and erratic control forces may develop. Stalling speed, takeoff distance, and landing speed may be increased to the point of *actual danger.*

Due to the size of many baggage compartments there might be a tendency to fill them to capacity, ignoring the placarded baggage weight limitations. This could produce a center of gravity aft of allowable limits creating a highly dangerous flight condition. The result would be a nose high attitude which could lead to a stall from which recovery might not be effected due to inadequate elevator control.

AN AIRPLANE'S BEHAVIOR IN THE AIR IS DEPENDENT ON WEIGHT AND BALANCE!

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VFR EXAM-O-GRAM NO. 17

COMMON MISCONCEPTIONS (Series 1)

The following are actual excerpts from a pilot's written report of an accident in which he was involved.

> "I was climbing at an airspeed of 60 mph. I started a climbing turn to the right. The wind now became a cross wind instead of a head wind. This (lack of head wind) caused the airplane to stall—to recover from the stall I turned the airplane back into the wind . . . (Later) I was in a quartering tailwind from the right . . . Went into a second stall . . . This is all I remember."

This pilot had over 100 hours, yet stalled and crashed due to an apparent misuse of controls at a slow airspeed (high angle of attack). The inspector who took this pilot's statement decided to pursue this theory with a group of student pilots. He posed this question to them.

> "If the aircraft's stalling speed was 60 mph and you were flying at an airspeed of 70 mph into a 30 mph wind, what would happen if you maintained this airspeed of 70 mph but turned downwind?"

Five of the six students said the airplane would stall.

IS THIS ANSWER CORRECT? *No.*

IS THE STALLING SPEED OF AN AIRPLANE A FUNCTION OF THE AIRSPEED OR THE GROUND SPEED? *The airspeed.*

DOES THE DIRECTION OF THE WIND HAVE ANY EFFECT ON THE AIRSPEED OF AN AIRCRAFT IN FLIGHT? *No.*

Now to summarize our point: Airspeed is the only speed which holds any significance for an airplane. Once it is off the ground, an airplane feels nothing but its own speed through the air. It makes absolutely no difference what its speed happens to be in relation to the ground. The aircraft in flight feels no wind. It simply proceeds, operating

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with the same mechanical efficiency, upwind, downwind, crosswind, or in no wind at all. (NOTE: We are referring here to a steady wind. Turbulence, gusts, or wind shears can lead to stalls even though airspeed is being maintained above the normal stalling speed. In such conditions it is wise to add a safe margin to normal climbout or approach speeds.)

Based on the performance of many applicants on the Private Pilot Written Test, here are some other common misconceptions.

IF IT IS NECESSARY TO CLEAR OBSTRUCTIONS IMMEDIATELY AFTER TAKEOFF, SHOULD YOU USE BEST ANGLE-OF-CLIMB SPEED OR BEST RATE-OF-CLIMB SPEED? *Best angle-of-climb speed.* Simply stated, the difference is this. The best angle-of-climb speed produces the greatest climb in a given distance; the best rate-of-climb speed produces the greatest climb in a given time. Distance, of course, is the determining factor for takeoff obstruction clearance.

DO ALL WIND REPORTS INDICATE A TRUE DIRECTION? *No.* The wind direction, as reported by a control tower in pilot instructions, is magnetic. All other wind directions (Sequence Reports, Terminal Forecasts, Winds Aloft Forecasts, etc.) are true.

WHAT IS THE HEIGHT OF A CLOUD CEILING BASED ON? *The height of the clouds above the ground, not the height above sea level (MSL).* For example, let's examine the following weather report: ABQ M30⊕. The station is Albuquerque, N.M., which has an elevation of 5,352 feet above sea level. The ceiling is reported as a 3,000-foot overcast. Using the current Albuquerque altimeter setting, your altimeter would indicate approximately 8,352 feet at the base of the clouds when over the airport, but your height above the ground would be 3,000 feet. As a word of caution, the 10,000-foot plus mountains a few miles east of the city would probably extend up into the clouds since this ceiling report is based on an observation taken over the airport.

WHICH IS MORE DENSE—MOIST AIR OR DRY AIR? *Dry air.* It is generally understood that high temperatures and high elevations result in a higher density altitude, but there seems to be a general impression that moist air has the reverse effect. The common misconception is that moist air is heavier than dry air. This is not true! Water vapor weighs less than an equal amount of dry air. Dry air is therefore denser and heavier than moist air. Since both engine and aircraft performance decrease with an increase in density altitude, you should remember that high relative humidities (small spreads between temperature and dew point), especially on hot summer days, will result in longer takeoff runs.

IS AN AIRCRAFT CRUISING VFR AT 5,500 FEET MSL ALWAYS GOVERNED BY THE VFR CRUISING ALTITUDE REQUIREMENTS? *Not necessarily.* The rule pertains to aircraft operated in level cruising flight at 3,000 feet or more above the surface. The aircraft in this case (5,500 feet MSL) might be operating above a surface elevation of 3,500 feet. The rule would not apply.

* * * * *

These are, by no means, all of the common misconceptions that prevail among student pilots; but as we stated earlier, a trend has become apparent in the Private Pilot Written Test results which high-lights these that are discussed. Additional misconceptions are discussed in Exam-O-Gram No. 26.

VFR EXAM-O-GRAM NO. 26

COMMON MISCONCEPTIONS (SERIES 2)

Each question in FAA Airman Written Tests offers the examinee a group of four answers from which to select the answer he believes to be correct. Applicant's comments and the analyses of the answer sheets indicate that particular incorrect answers are frequently being chosen because of a misconception regarding certain items of required aeronautical knowledge. This Exam-O-Gram and Exam-O-Gram No. 17 attempt to correct a few of these preconceived ideas.

WHAT INDICATED AIRSPEED SHOULD BE USED FOR LANDING APPROACHES TO FIELDS OF HIGHER ELEVATIONS? For all practical purposes, use the SAME indication as you use at fields of lower elevations.

WILL THE SAME INDICATED APPROACH SPEED BE SAFE AT HIGH ELEVATIONS? YES, in relatively smooth air. We all know that as altitude increases, the air becomes less dense, and consequently with decreased drag the airplane travels faster through the air. However, this faster speed creates no increase in impact pressure on the airspeed pitot system because of the lesser air density. In other words, we get a higher True Airspeed (TAS) with the same Indicated Airspeed.

Although the True Airspeed at which an airplane stalls in thinner air is higher, the margin of safety is unaffected since the airplane is actually flying at a higher True Airspeed. Nevertheless, for the purpose of maintaining positive control in unstable air, the use of a higher than normal indicated speed is recommended for approaches during the turbulent or gusty conditions prevalent in mountainous areas, just as is used at fields of lower elevations in these conditions.

WHAT EFFECT DOES THINNER AIR HAVE ON APPROACH AND LANDING? Even though using the same *indicated* airspeed that is appropriate for sea level operations, the True Airspeed is faster, resulting in a faster groundspeed (with a given wind condition). This increase in groundspeed naturally makes the landing distance longer and should be carefully considered when landing at high elevation fields, particularly if the field is short.

WHAT INDICATED AIRSPEED SHOULD BE USED ON TAKEOFF AT HIGH ELEVATIONS? Just as in landing, the groundspeed, as well as the takeoff distance, will be greater at high elevation fields. However, don't let this mislead you into P-U-L-L-I-N-G the airplane off the ground. If you do, the airplane will mush and settle back to the ground in a stalled condition. Use the same indicated airspeed as you use for takeoff at fields with lower elevations.

WHAT WOULD YOU THINK IF YOU OVERHEARD THIS AIRPLANE "DISCREPANCY" REPORT? "Hey, Chief, fix this goofed-up airspeed indicator! I was practicing power-off stalls with the gear and

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flaps down, but the airplane didn't stall until the pointer was 10 mph less than the white arc painted on the dial."

IS THE AIRSPEED INDICATOR FAULTY OR IS THE WHITE ARC MISPLACED? Not necessarily either one! Remember, the colored arcs on the airspeed dial (see Exam-O-Gram No. 8) mark the *Calibrated* Airspeed (CAS) and not merely the observed Indicated Airspeed (IAS) limitations.

WHAT IS CALIBRATED AIRSPEED? Calibrated Airspeed, frequently called True Indicated Airspeed (TIAS), is Indicated Airspeed corrected for installation and instrument error. A wide difference between these speeds may exist, particularly at low airspeeds or under landing conditions. Installation error is caused when the relative wind or impact air in certain pitch attitudes does not enter the pitot-tube opening as it would under normal cruising conditions. Check the airspeed correction data for each airplane. You may find (as in the typical table below) that an IAS of 60 mph is actually a CAS (or TIAS) of 69 mph. (TRUE INDICATED AIRSPEED is not to be confused with TRUE AIRSPEED which is the actual speed of the airplane through the air.)

WHAT IS THE RELATIONSHIP BETWEEN AIRSPEED INDICATOR COLORED ARCS AND STALLING SPEEDS? In the illustration below, the white arc shows a stalling speed of 57 mph (TIAS or CAS), but because of installation error (reflected in the table), this airplane may not stall with power-off and gear and flaps down until the pointer is on 40 mph (IAS).

A similar variation is noted for the green arc and stalling speed with gear and flaps UP. Since an airplane in flight is operated most of the time within the upper speed range, installation error is normally adjusted so as to be at a minimum in that range. This results in the greatest error at the lower speed range, but provides a corresponding increase in the margin of safety at the critical lower airspeeds.

* * * * *

CAN NORMAL IN-FLIGHT ASSISTANCE BE RECEIVED FROM ALL VOR STATIONS? NO. Many VOR stations can be used only for navigation purposes. These stations with no capability to transmit voice signals are so marked on the chart with the notation "NO VOICE." Stations of this type cannot be used for weather information, position reporting, flight plans, or emergency assistance.

IN TERMINAL FORECASTS DOES THE LETTER "C" MEAN CLEAR SKIES? NO. When used in the cloud group of the forecast, it indicates the cloud layer that constitutes the CEILING.

IS THE WIND ALWAYS SHOWN IN

AIRSPEED CORRECTION TABLE

FLAPS 0°								
IAS - MPH	60	80	100	120	140	160	180	200
TIAS - MPH	69	82	100	119	139	160	181	202
***FLAPS 20°**								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	57	62	68	75	84	93	102	112
***FLAPS 40°**								
IAS - MPH	40	50	60	70	80	90	100	110
TIAS - MPH	57	62	68	75	83	92	102	111

*Maximum flap speed 110 MPH-TIAS

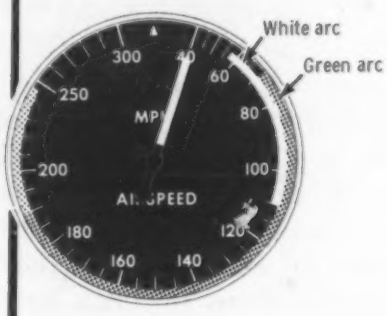

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TERMINAL FORECASTS? NO. If the wind is forecast to be less than 10 knots, it is omitted.

IS THE VISIBILITY ALWAYS SHOWN IN TERMINAL FORECASTS? NO. If the visibility is forecast to be more than 8 miles, it is omitted.

IS THE HEIGHT OF CLOUD TOPS PREDICTED IN TERMINAL FORECASTS? NO. Only the base of the clouds above the surface is predicted. Cloud tops are usually found in Pilot Reports (PIREPS), and often in Area Forecasts.

ARE ICING AND TURBULENT CONDITIONS PREDICTED IN TERMINAL FORECASTS? NO. This information may be found in the Area Forecasts. However, a prediction of gusty surface conditions may be included in the wind group of Terminal Forecasts. A report of existing icing and turbulence at flight levels may be found in PIREPS.

* * * * *

IN TELETYPE FORECASTS AND REPORTS, IS THE WIND INFORMATION RELATIVE TO *TRUE* NORTH OR *MAGNETIC* NORTH? All printed weather information, such as Area Forecasts, Terminal Forecasts, Aviation Weather Sequence Reports, Winds Aloft Forecasts, etc., presents the wind direction as measured from TRUE NORTH. To use this wind direction for the computations of problems in which magnetic values are required, magnetic variation should be applied. That is, add or subtract variation as appropriate to the area involved, when magnetic headings are desired.

IN RADIO BROADCASTS, IS THE WIND DIRECTION RELATIVE TO *TRUE* NORTH OR *MAGNETIC* NORTH? Surface wind direction given in traffic instructions by the tower, or in airport advisories by an FSS, is always given as MAGNETIC direction, so as to be readily related to the runway number which is also a magnetic direction. In scheduled weather broadcasts, the wind is given in True direction for all reported stations except that of the station making the broadcast, in which case the wind is reported in Magnetic direction.

CAN THE DATE AN ANNUAL INSPECTION IS DUE BE DETERMINED FROM AIRWORTHINESS CERTIFICATES? NO. With regard to the due date of an Annual Inspection, the Airworthiness Certificate is of no value unless it was issued within the preceding 12 calendar months. This certificate is issued only when the aircraft is certificated as being airworthy at the time of original manufacture (or after being substantially altered or repaired), and in most cases is issued only once in the lifetime of the aircraft.

FROM WHICH DOCUMENTS CAN THE DUE DATE OF AN ANNUAL INSPECTION BE DETERMINED? By checking the entries in the aircraft and engine maintenance records (in most cases aircraft and engine logbooks) certifying the latest Annual Inspection. If the records show the preceding inspection was performed on April 5, 1967, then the next inspection is due at the end of the 12th month subsequent to the date; that is, by the end of April 30, 1968.

IS THERE A DIFFERENCE BETWEEN AN AIRPORT TRAFFIC AREA AND A CONTROL ZONE? YES, definitely; although in some cases they coincide laterally, in which case rules applicable to each are in effect.

WHAT IS AN AIRPORT TRAFFIC AREA? An Airport Traffic Area is the airspace surrounding an airport at which there is an operating control tower.

The traffic area extends from the surface upward to 2,000 feet, and although not marked on the chart (except by the presence of control tower frequencies), it includes the area within a 5-mile radius from that airport (see Fig. A). When operating within the Airport Traffic Area, a pilot is required, unless otherwise authorized, to maintain two-way radio communications with the tower. This does not apply when operating for the purpose of taking off or landing at airports without a control tower that happen to be within the Airport Traffic Area of another airport. This rule is also not applicable when the tower is *not* in operation nor at airports without control towers outside of an Airport Traffic Area (see Fig. B). The airport traffic *pattern* of an airport is

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Airport Traffic Area

(Tower Frequencies)

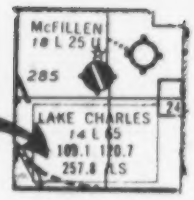

FIGURE A.

No Airport Traffic Area

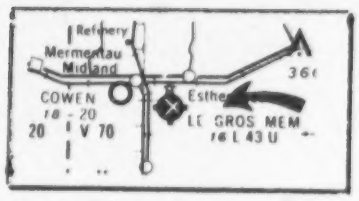

FIGURE B.

not to be confused with an Airport Traffic *Area.*

WHAT IS A CONTROL ZONE? A control zone is an airspace, surrounding one or more airports, within which rules additional to those governing flight in control areas and "airport traffic areas," apply for the protection of air traffic. Normally, an aircraft shall not be operated under Visual Flight Rules within a Control Zone *beneath a ceiling of less than 1,000 feet or with a visibility of less than 3 miles.* To do so requires a *special VFR clearance from Air Traffic Control.*

If the airport lies within a Control Zone as well as an Airport Traffic Area (see Fig. C), this clearance is obtained through the control tower. However, *all Control Zones do not have a control tower* or lie within an Airport Traffic Area (see Fig. D). In this case arriving and departing traffic is controlled by ATC either by direct communication between the control center and the pilot, or through an appropriate radio facility. Frequently, clearances are conveyed to an aircraft by a nearby Flight Service Station (FSS). All Control Zones are marked on charts by a circular broken line, normally a 5-mile radius with extensions as necessary for IFR approaches, extending from the *surface upward* (*with no vertical limits*), and may encompass more than one airport. These special rules are also applicable to the other airports within the Control Zone boundaries.

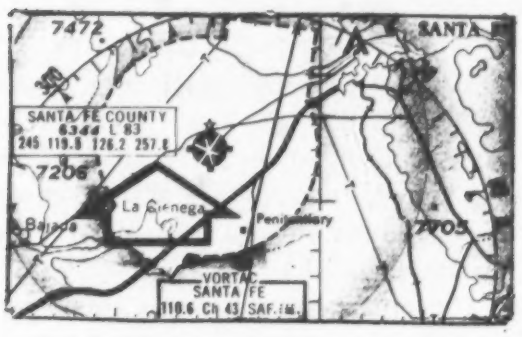

FIGURE C.

FIGURE D.

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VFR EXAM-O-GRAM NO. 28

FACTORS AFFECTING STALL SPEED

A recent report indicates that approximately 80 percent of all accidents are pilot caused. The major cause of fatal accidents is listed as "failed to maintain airspeed (or flying speed) resulting in a stall." Although many of these stalls may have occurred under the stress and duress of other problems such as disorientation during limited visibility or at night, improper division of attention, etc., statistical analyses of written tests indicate a lack of knowledge and understanding of the various factors that can cause or contribute to a stall.

This Exam-O-Gram discusses some of the more important, ever-present factors of which the pilot must have an understanding so that he will instinctively avoid or compensate for situations, conditions, and attitudes that may lead to a stall—even under the stress and duress of additional problems he may encounter in flight.

WHAT CAUSES AN AIRPLANE TO STALL? All stalls are caused by exceeding the critical angle of attack. Knowing this particular fact does not necessarily help the pilot. What is more important to the pilot is to know what factors are likely to contribute to or cause this angle of attack to be exceeded.

IS IT NECESSARY FOR THE AIRPLANE TO HAVE A RELATIVELY LOW AIRSPEED IN ORDER FOR IT TO STALL? No. An airplane can be stalled *at any airspeed.* All that is necessary is to exceed the critical angle of attack. This can be done at any airspeed if the pilot applies abrupt or excessive back pressure on the elevator control. A stall that occurs at a relatively high speed is referred to as an accelerated or high speed stall.

IS IT NECESSARY FOR THE AIRPLANE TO HAVE A RELATIVELY HIGH PITCH ATTITUDE IN ORDER FOR IT TO STALL? No. An airplane can be stalled *at any attitude.* Repeating again the statement made above—all that is necessary is to exceed the critical angle of attack. This can occur in any attitude by application of abrupt or excessive back pressure on the elevator control.

DOES WEIGHT AFFECT THE STALLING SPEED? Yes. As the weight of the airplane is increased, the stall speed increases. Due to the greater weight, a higher angle of attack must be maintained to produce the additional lift to support the additional weight in flight. Therefore, the critical angle of attack will be reached at a higher airspeed when loaded to maximum gross weight than when flying solo with no baggage. (See Exam-O-Gram No. 13.)

DOES THE CENTER-OF-GRAVITY LOCATION (WEIGHT DISTRIBUTION) AFFECT STALL SPEED? Yes. The farther forward the center of gravity, the higher the stalling speed. The farther aft the center of gravity, the lower the stalling speed. (See Exam-O-Gram No. 13.)

DOES THIS MEAN THAT THE WEIGHT SHOULD BE DISTRIBUTED IN THE AIRPLANE SO THAT THE CG IS AS FAR TO THE REAR AS POSSIBLE? No. This may present problems with stability that will far outweigh any advantages obtained by the decrease in stall speed. (See Exam-O-Gram No. 13.)

DO FLAPS AFFECT STALLING SPEED? Yes. The use of flaps reduces stalling speed. The Stall Speed Chart on the next page, which is excerpted from an airplane flight manual illustrates this fact. This also can be readily verified by checking the color coding on any airspeed indicator.

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The lower airspeed limit of the white arc (power-off stalling speed with gear and flaps in the landing configuration) is less than the lower airspeed limit of the green arc (power-off stalling speed in the clean configuration). (See Exam-O-Gram No. 8.) This fact is important to the pilot in that when making no-flap landings, a higher indicated airspeed should be maintained than when landing with flaps.

The manufacturers' recommendations should be adhered to as to approach speeds with various configurations.

DOES AN ACCUMULATION OF FROST, SNOW, OR ICE ON THE WINGS AFFECT STALLING SPEED? Yes. Even a light accumulation of frost, snow, or ice on the wings can cause a significant increase in stalling speed. It can increase it so much that the airplane is unable to take off. The accumulation disrupts the smooth flow of air over the wing thus decreasing the lift it produces. To make up for the lost lift, a higher angle of attack must be used or a higher speed must be attained on the takeoff roll.

The runway may not be long enough to attain the necessary speed and even though the airplane may become airborne, it could be so close to the stall speed that it would not be possible to maintain flight once the airplane climbs above the comparatively shallow zone where ground effect prevails. DO NOT TAKE OFF UNTIL ALL FROST, SNOW, AND ICE HAS MELTED OR BEEN REMOVED FROM THE AIRPLANE.

DOES AN INCREASE IN ALTITUDE AFFECT THE INDICATED AIRSPEED AT WHICH AN AIRPLANE STALLS? An increase in altitude has no effect on the *indicated airspeed* at which an airplane stalls at altitudes normally used by general aviation aircraft. That is, for all practical purposes, the indicated stalling speed remains the same regardless of altitude in this range. This fact is important to the pilot in that the same indicated airspeed should be maintained during the landing approach regardless of the elevation or the density altitude at the airport of landing. (Follow the manufacturer's recommendations in this regard.) If higher than normal approach airspeed is used, a longer landing distance will be required.

DOES AN INCREASE IN ALTITUDE AFFECT THE TRUE AIRSPEED AT WHICH AN AIRPLANE STALLS? Since true airspeed normally increases as altitude increases (for a given indicated airspeed), then true airspeed at which an airplane stalls generally increases with an increase in altitude. Under nonstandard conditions (temperature warmer than standard) there is an additional increase in true airspeed above the indicated airspeed.

OF WHAT SIGNIFICANCE IS THIS TO THE PILOT? It is significant in that when landing at higher elevations or under higher density altitudes, he is operating at higher true airspeeds (and therefore higher groundspeeds) throughout the approach, touchdown, and landing roll. This results in a greater distance to clear obstacles during the approach, a longer ground roll, and consequently, the need for a longer runway. If, in addition, the pilot is operating under the misconception that a higher than normal indicated airspeed should be used under these conditions, the situation is further compounded due to the additional increase in groundspeed (See Exam-O-Gram No. 26.)

DOES TURBULENCE AFFECT STALLING SPEED? Yes! Turbulence can cause a big increase in stalling speed. Encountering an upward vertical gust causes an abrupt change in relative wind. This results in an equally abrupt increase in angle of attack which could result in a stall. This fact is important to the pilot in that when making an approach under turbulent conditions, a higher than normal approach speed should be maintained. Also, in moderate or greater turbulence, an airplane should not be flown above maneuvering speed. (See Exam-O-Gram No. 8.) At the same time, it should not be flown too far below maneuvering speed since a sudden severe vertical gust may cause an inadvertent stall due to the higher angle of attack at which it will already be flying.

DOES ANGLE OF BANK AFFECT STALLING SPEED? Yes. As the angle of

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bank increases in a constant altitude turn, the stalling speed increases. This is easily seen from the STALL SPEED CHARTS which show the increase in stall speed as the angle of bank increases, one in the actual values for one airplane, and the other in terms of percent. At a 60° bank, stalling speed is 40 percent greater than in straight-and-level flight (25–27 mph for the specific example.) At angles of bank above 60°, stall speed increases very rapidly, and at approximately 75° it is doubled with respect to straight-and-level stall speed. (See Stall Speed Chart below.)

STALL SPEED, POWER OFF

Gross Weight 3000 *lbs.*	ANGLE OF BANK			
CONFIGURATION	0°	20°	40°	60°
GEAR & FLAPS UP	65	67	74	92
GEAR DOWN, FLAPS 20°	61	63	70	86
GEAR DOWN, FLAPS 40°	60	62	69	85

SPEEDS ARE MPH, TIAS

DOES LOAD FACTOR AFFECT STALLING SPEED? Yes. As the load factor increases, stalling speed increases. When the load factor is high, stalling speed is high. A comparison of the load factor and stall speed charts should easily show this relationship. Load factor is the ratio of the load supported by the wings to the actual weight of the airplane. At a load factor of 2, the wings support twice the weight of the airplane; at a load factor of 4, they support four times the weight of the airplane. Normal category airplanes with a maximum gross weight of less than 4,000 pounds are required to have a minimum limit load factor of 3.8. (The limit load factor is that load factor an airplane can sustain without taking a permanent set in the structure.) Note from the load factor chart that this minimum limit load factor is attained in a constant altitude turn at a bank of approximately 75°.

Also note from the Stall Speed Chart below that at this angle of bank, the stall speed is twice as great as in straight-and-level flight.

There are two reasons then why excessively steep banks should be avoided: an airplane will stall at a much higher airspeed and the limit load factor can be exceeded. The danger can be compounded when the nose gets down in a steep turn if the pilot attempts to raise it to the level flight attitude without shallowing the bank since the load factor may be increased even more. This is the situation as it generally exists when, due to disorientation, the pilot enters a diving spiral (often referred to as the "graveyard spiral") and attempts to recover with elevator pressure alone.

WHAT FACTORS CAUSE AN INCREASE IN LOAD FACTOR? Any maneuvering of the airplane that produces an increase in centrifugal force will cause an increase in load factor. Turning the airplane or pulling out of a dive are examples of maneuvering that will increase the centrifugal force and thus produce an increase in load factor. When you have a combination of turning and pulling out of a dive, such as recovering from a diving spiral, you are, in effect, placing yourself in double jeopardy. This is why you must avoid high-speed diving spirals or if you accidentally get into one—be careful how you recover. Turbulence also can produce large load factors. This is why an airplane should be slowed to maneuvering speed when encountering moderate or greater turbulence.

STALL SPEED CHART

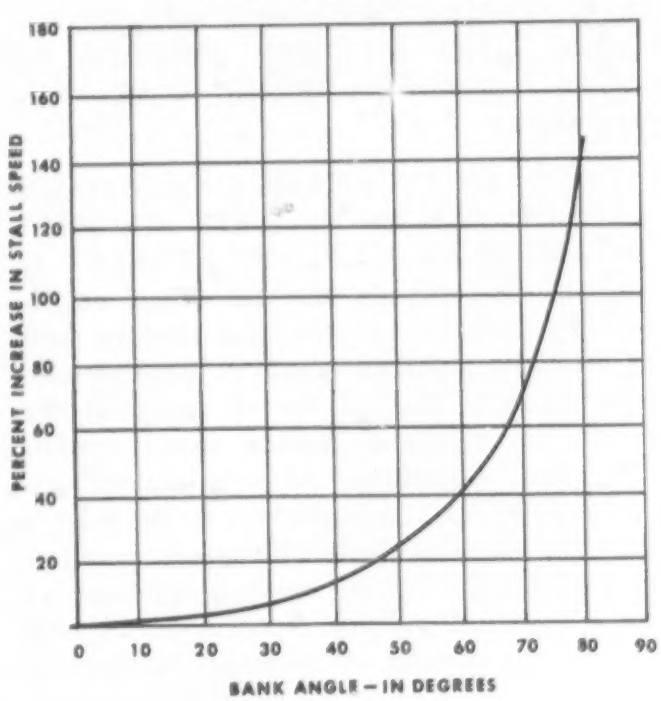

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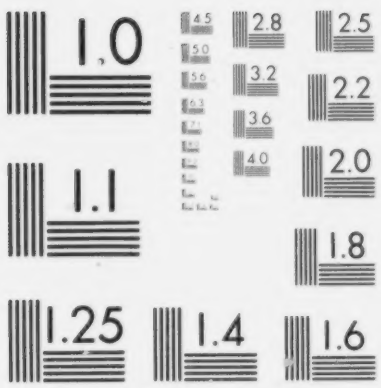

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

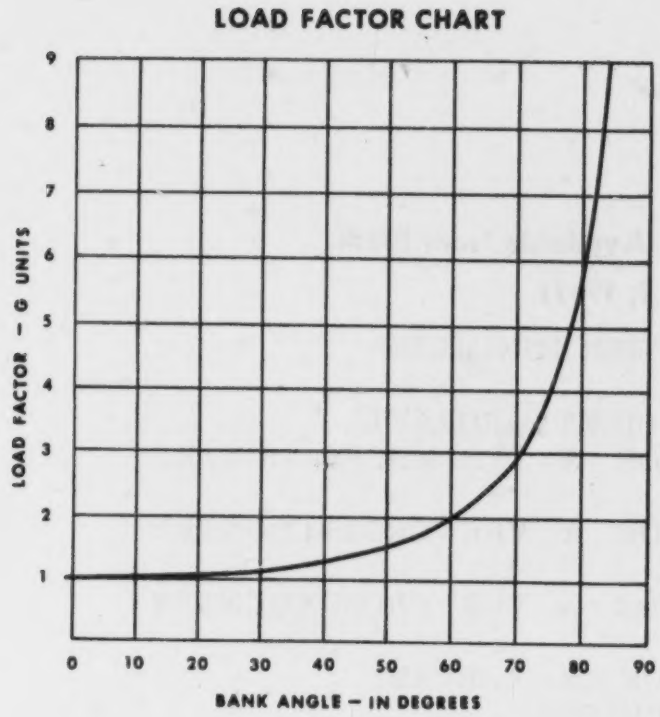

CAN THE PILOT RECOGNIZE WHEN THERE IS AN INCREASE IN LOAD FACTOR? Yes. He can recognize it by the feeling of increased body weight or the feeling that he is being forced down into the seat—the greater the load factor the greater this feeling of increased weight or of being forced down in the seat. It is the same feeling one has when riding the roller coaster at the bottom of a dip or going around a banked curve. This feeling of increased body weight is important to the pilot because it should, if it becomes excessive, have the immediate effect of a red flag being waved in his face to warn him that the airplane will now stall at a higher airspeed or that the limit load factor can be exceeded, resulting in structural failure.

DOES SPEED AFFECT LOAD FACTOR? Speed does not, in itself, affect load factor. However, it has a pronounced effect on how much of an increase in load factor can be produced by strong vertical gusts, or by the pilot through abrupt or excessive application of back pressure on the elevator control. This is why airspeed should be reduced to design maneuvering speed if moderate or greater turbulence is encountered.

At maneuvering speed, the airplane is stressed to handle any vertical gust that will normally be encountered. Also, at or below this speed, the pilot can make abrupt full deflection of the elevator control and not exceed the maximum load factor for which the airplane is stressed. However, it should be noted that the reason this is possible is because the airplane will stall, thus relieving the load factor. At airspeeds above maneuvering speed, abrupt full deflection of the elevator control or strong vertical gusts can cause the limit load factor to be exceeded. As airspeed continues to increase above maneuvering speed, the limit load factor can be exceeded with less and less turbulence or abrupt use or deflection of the controls.

WHAT IS THE RELATIONSHIP BETWEEN A HIGH-SPEED (ACCELERATED) STALL AND LOAD FACTOR? The higher the airspeed when an airplane is stalled, the greater the load factor. When an airplane stalls at a slow airspeed, the load factor will be very little more than one. When stalled at an airspeed twice as great as the normal stall speed, the limit load factor for normal category airplanes probably will be exceeded. This fact can be determined from the stall speed and load factor charts. See also the discussion of "How Does Load Factor Affect Stalling Speed."

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VFR EXAM-O-GRAMS Available from FAA

(As of July 1, 1967)

No.	
1	CONTROL ZONE VFR WEATHER MINIMUMS
2	VFR CRUISING ALTITUDES
3	AN INVISIBLE HAZARD TO LIGHT AIRCRAFT
4	PREFLIGHT PLANNING FOR A VFR CROSS-COUNTRY FLIGHT (Series 1)
5	PREFLIGHT PLANNING FOR A VFR CROSS-COUNTRY FLIGHT (Series 2)
6	PREFLIGHT PLANNING FOR A VFR CROSS-COUNTRY FLIGHT (Series 3)
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11	DENSITY ALTITUDE AND ITS EFFECT ON AIRCRAFT PERFORMANCE
12	THE MAGNETIC COMPASS
13	WEIGHT AND BALANCE
14	RADIO COMMUNICATIONS FREQUENCIES
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16	HOW TO USE VOR (Series 2)
17	COMMON MISCONCEPTIONS (Series 1)
18	LOST PROCEDURES—PILOTAGE
19	EMERGENCY OR LOST PROCEDURES (RADIO)
20	CEILINGS AND VISIBILITY
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27	THE EFFECT OF WIND ON AN AIRPLANE
28	FACTORS AFFECTING STALL SPEED
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33	USE OF PERFORMANCE CHARTS
34	HOW TO OBTAIN PROPER WEATHER BRIEFING
35	UNICOM FREQUENCIES AND USES
36	COMMONLY MISUNDERSTOOD AREAS OF AERONAUTICAL KNOWLEDGE (Series 1)
37	COMMONLY MISUNDERSTOOD AREAS OF AERONAUTICAL KNOWLEDGE (Series 2)
38	MIXTURE CONTROL—FUEL/AIR RATIO

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IDENTIFIERS - *MULTIENGINE AIRPLANES

ABSTRACT - Developed by the Flight Standards Service of the Federal Aviation Administration to assist applicants for multiengine ratings in preparing for certification or rating flight tests, this guide provides explanations of the procedures and maneuvers required for a pilot flight test in a multiengine airplane. Following general information on the guide, each of the three phases of the test presents a number of required items with each requirement discussed in terms of its objective, description, and acceptable performance. Phases are (1) Oral Operational Test (six requirements), (2) Basic Piloting Techniques (eight requirements), and (3) Multiengine Emergency Procedures (six requirements). The guide may be used by both prospective flight test applicants and their flight instructors. (AW)

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PREFACE

This Guide has been developed by the Flight Standards Service of the Federal Aviation Administration to assist the applicant for a multiengine rating in preparing for his certification or rating flight test.

It provides explanations of the procedures and maneuvers required by Part 61 of the Federal Aviation Regulations for a pilot flight test in a multiengine airplane, which should make it helpful to both prospective flight test applicants and their flight instructors.

This edition revises and supersedes the edition dated 1966, and all other previous issuances concerning multiengine flight tests, including Advisory Circular No. 61-40, *Performance of Stalls on Pilot Flight Tests*, as it applies to tests in multiengine airplanes.

Persons using this Guide to prepare for a pilot flight test should refer to the latest revisions of Part 61 for the procedures and maneuvers which will be required.

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MULTIENGINE AIRPLANE CLASS OR TYPE RATING

This Guide describes the acceptable performance of flight maneuvers and procedures on flight tests for the addition of multiengine ratings to Private and Commercial Pilot Certificates. Flight tests in multiengine airplanes for the issuance of Private and Commercial Pilot Certificates will be conducted in accordance with the appropriate *Private Pilot* or *Commercial Pilot Flight Test Guide*, using the descriptions contained in this Guide for the performance of those of the required maneuvers which are different for multiengine airplanes. The flight maneuvers and procedures required for Private and Commercial Pilot Certificates are prescribed in Sections 61.87 and 61.117 of the Federal Aviation Regulations.

The multiengine rating flight test described in this Guide is arranged in three phases: *Oral Operational Test*, *Basic Piloting Technique*, and *Multiengine Emergency Procedures*. The failure of any required item constitutes the failure of the phase involved, and of the flight test. A flight test may be discontinued at any time by the examiner or the applicant, but in the event of failure or an incomplete test, credit will be allowed on sub-

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sequent reexamination for each successfully completed phase.

The section on each procedure or maneuver contains three paragraphs: *Objective*, *Description*, and *Acceptable Performance:*

The *Objective* states briefly the reason why the procedure or maneuver is required on the flight test. It specifies the principles which the applicant must apply, and the piloting operations which he must perform properly to demonstrate that he has mastered this element of pilot qualification.

The *Description* explains the procedure and means which have been found most effective in accomplishing and demonstrating the objectives of the procedure or maneuver. These descriptions must not be confused with the objectives. How one enters a stall, for example, is not so important as is his demonstration of the ability to recognize stalls and to use the proper recovery techniques, which are the objectives of the maneuver.

The *Acceptable Performance* describes the factors which are taken into account by the examiner in deciding whether the applicant has met the objectives of the procedure or maneuver. The airspeed, altitude, and heading tolerances are not hard-and-fast, but represent the performance to be expected in good flying conditions in a typical personal type airplane. The practice of consistently exceeding these tolerances before corrective

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action is initiated, however, is indicative of an unsatisfactory performance.

For flight tests conducted in multiengine airplanes with engines in tandem on or near the centerline of the fuselage, engines geared to a single propeller, or airplanes with jet engines in or on the fuselage, flight test procedures appropriate to the airplane type will be required.

A flight instructor's written recommendation is required by FAR 61.21 for each pilot flight test, except a test for the addition of a type rating only to a pilot certificate.

The applicant is required to provide a properly certificated airplane, bearing no limitations or restrictions which prevent its use for the test. A military aircraft on operational status is acceptable, provided its use is authorized by the appropriate military authority. The airplane should be equipped with such radio, instrumentation, and check list as is necessary for the required flight test operations. Fully functioning dual controls are required by FAR 61.25(b), unless, after considering all factors, the examiner determines that the flight test can be conducted safely without them.

PHASE I.

ORAL OPERATIONAL TEST

1. Airplane Registration, Airworthiness, and Equipment Documents

a. *Objective.* To determine that the applicant can identify and find the documents required in a certificated airplane.

b. *Description.* The applicant will be requested to present or point out in the airplane the aircraft registration, airworthiness certificate, *Airplane Flight Manual* (if required), equipment list, and weight and balance documents required to be carried in the airplane.

c. *Acceptable Performance.* The applicant should be able to identify, find, and explain the purpose and significance of each required document.

2. Airplane Logbooks and Airworthiness Inspection Records

a. *Objective.* To determine that the applicant knows what airworthiness inspections are required for a certificated airplane, and what evidence of these inspections is acceptable for flight operations.

b. *Description.* The applicant will be required to present and explain the aircraft and engine logbooks, or other required airworthiness inspection reports.

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c. *Acceptable Performance.* The applicant should be able to identify, find, and explain the significance, to the pilot, of the required inspection reports.

3. Airplane Performance, Range, and Operation

a. *Objective.* To determine that the applicant knows what performance data and operating information is important to the pilot, and can obtain them for the airplane to be used for the test.

b. *Description.* The applicant will be required to demonstrate a practical knowledge of the performance capabilities, approved operating procedures, and limitations for the airplane furnished. This includes power settings, placard speeds, range, fuel and oil requirements, the operation of aircraft systems and special equipment, critical engine-out control and climb speeds, and other emergency procedures.

The applicant will be expected to use the *Airplane Flight Manual*, if available, to determine the effects of temperature, density altitude, wind, surface conditions, and gross weight on flight performance. He is expected to be familiar with the effects of power settings and altitude on the cruising range, and to know the airspeeds for best performance in the airplane used. Special attention will be devoted to the performance data on flight control and performance with an engine inoperative.

A practical knowledge of the control system; the fuel, lubrication, hydraulic,

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and electrical systems; the operation of the supercharger(s), landing gear, and flaps, radio, pressurization, heating, and ventilation installations; and of the fire control, deicing and anti-icing, and other emergency equipment appropriate to the type of airplane used will be required.

c. *Acceptable Performance.* The inability to obtain essential pilot information which is available in the airplane, or a faulty knowledge of operating data or procedures is disqualifying.

4. Airplane Loading, Including Fuel, Oil, and Baggage Capacities

a. *Objective.* To determine that the applicant can make practical, accurate determinations of permissible loading and load distribution in an airplane.

b. *Description.* The applicant will be required to apply the approved weight and balance data for the airplane used on the test to make practical computations of the permissible fuel and payload distribution. A loading graph or computer designed for the airplane may be used for this purpose.

c. *Acceptable Performance.* The applicant should be able to make accurate determinations of permissible gross weight loadings, and load distribution.

5. Airplane Line Check

a. *Objective.* To establish that the applicant can make a practical determination that the airplane is ready for flight.

b. *Description.* The applicant will be

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expected to use an orderly procedure in conducting a preflight check of the airplane, preferably in accordance with a check list provided by the manufacturer or operator. This check covers the airplane's readiness for flight, including fuel and oil supply, the presence of all required equipment and documents, and its airworthiness so far as can be determined by external inspection.

c. *Acceptable Performance.* The applicant should know the significance of each item checked, and not overlook any obvious unairworthy condition. He should know the appropriate remedial action for a pilot to initiate for the correction of each unsatisfactory item detected.

6. Use of Radio for Voice Communication.

a. *Objective.* To determine that the applicant can use two-way radio effectively for ground and flight communications.

b. *Description.* During his flight test, the applicant will be expected to use two-way radio for information, clearances, and requests pertinent to the flight.

c. *Acceptable Performance.* Performance will be evaluated on the basis of the applicant's ability to determine and tune in the correct radio frequencies, and his use of appropriate radio procedures and phraseology.

PHASE II.

BASIC PILOTING TECHNIQUES

1. Preflight Operations

a. *Objective.* To determine that the applicant knows how to start and warm up the engines, and to determine the airplane's immediate readiness for flight.

b. *Description.* The applicant will be expected to perform the proper procedures for the airplane used in engine starting, warmup, and runup; the setting of the airplane systems and equipment; and the check of the flight controls.

c. *Acceptable Performance.* The procedures used should be correct and thorough, and should be conducted in accordance with an appropriate checklist. Performance will be evaluated on the basis of the accuracy of the procedures used, and the thoroughness of the engine, systems, and airplane checks.

2. Taxiing, or Sailing and Docking

a. *Objective.* To determine that the applicant has the ability to maneuver the airplane expeditiously and safely on the surface.

b. *Description.* The demonstration of taxiing will include the operation of the airplane on the surface, the initial and continuing determination that the taxi

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path is clear of obstructions, and compliance with local taxi rules and control tower instructions.

Seaplane applicants will be required to demonstrate taxiing at slow speeds and on the step, sailing, docking, a simulated or actual approach to a buoy, and turns to downwind headings.

c. *Acceptable Performance.* Performance will be evaluated on the basis of the accuracy of taxi operations; safety; consideration for other aircraft and personnel on ramps and taxiways; the use of power, brake, and flight controls for directional control; and the proper use of nosewheel steering, tailwheel lock, or water rudder, if the airplane is so equipped.

3. Normal and Crosswind Takeoffs and Landings

a. *Objective.* To determine that the applicant is able to make consistently safe takeoffs and landings under all normally anticipated conditions.

b. *Description.* The applicant will be required to demonstrate normal and crosswind takeoffs and landings. If all takeoffs and landings must be made with sufficent crosswind to require the use of crosswind techniques, no separate demonstrations will be required. For safety, crosswind takeoffs and landings must be performed with full consideration for other air traffic, and in strict compliance with the crosswind component limitations for landings in the airplane used.

Landings will be required at various

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flap settings, including a no-flap landing if permitted by the airplane's operating limitations.

The applicant will also be required to demonstrate maximum performance (short field) takeoffs and landings. Lift-off should be initiated just below the all-engine best angle of climb speed, unless it is slower than the engine-out minimum control speed, in which case the engine-out minimum control speed should be used. The best all-engine angle of climb speed should be attained, and maintained to the height of an assumed obstruction, such as a fence or row of trees, after which normal climb speed should be smoothly attained.

For short field landings, the final approach from an altitude of at least 50 feet above the surface should be made at approximately 1.3 times the power-off stalling speed with gear and flaps extended. Descent should be controlled primarily with the throttles and the airspeed with the elevators. The round-out for landing should be accompanied by a smooth closing of the throttles, and result in little or no floating.

c. *Acceptable Performance.* Performance will be evaluated on the basis of takeoff and landing technique, judgment, observance of traffic patterns and control tower instructions, drift correction, coordination, and smoothness. Excessive maneuvering, faulty operation of aircraft controls or systems, or the use of improper airspeeds will be disqualifying.

4. Emergency Go-arounds

a. *Objective.* To determine that the applicant can operate all systems correctly when abandoning a landing approach and going around again in the event of an emergency, such as an unexpected obstruction on the runway.

b. *Description.* Just prior to touchdown in landing configuration, the examiner will direct the applicant to execute a go-around without prior notice. The execution of a go-around with a simulated engine failure will not be required.

c. *Acceptable Performance.* The applicant's performance will be evaluated on the basis of his ability to maintain the appropriate airplane control and performance speeds, the correct handling of the flaps and gear, and the use of correct power and trim settings. Climbing higher than necessary to clear immediate obstructions at less than the minimum engine-out control speed will be disqualifying.

5. Maneuvering at Minimum Controllable Airspeed

a. *Objective.* To determine the applicant's ability to recognize and maintain safe flight control at marginally slow airspeeds, and to make the transition from cruising to landing approach speeds smoothly.

b. *Description.* The applicant will be required to maneuver the airplane at an airspeed not more than 10 knots above the stalling speed in cruise and in landing

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configurations. The transition from and to cruising configuration and airspeed in straight and level flight will be required.

c. *Acceptable Performance.* During maneuvers at minimum controllable airspeed, the applicant will be expected to maintain a speed within 5 knots of the desired airspeed, and an altitude within 100 feet of the original altitude. In straight and level flight and during the transition to and from the minimum controllable airspeed, he will be expected to maintain a heading within 10 degrees of the original heading. Consideration will be given to the applicant's use of the proper trim and power settings. Any unintentional stall will be disqualifying.

6. Stalls and Partial Stalls

a. *Objective.* To determine that the applicant can recognize a partial stall, and make prompt, effective recoveries from partial and complete stalls.

b. *Description.* The applicant will be required to demonstrate stalls entered with at least 65 percent power and with power reduced on all engines, in landing and in cruising configurations. Stalls should be entered by increasing the angle of attack smoothly, so that the airspeed decreases at a uniform rate. Sufficient power may be used throughout all stalls to keep the engines running smoothly.

No stall will be required with any engine throttled or cut off and the other engine(s) developing effective power. Abrupt pitch changes during stall dem-

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onstrations, and all other maneuvers, should be avoided in airplanes with extensions between the engine and the propeller, because of the high gyroscopic loads induced.

Recoveries should be initiated at the first physical indication of a stall, such as uncontrollable pitching, buffeting, rapid decay of control effectiveness, or the application of full back elevator without producing further stall development. The applicant should control the attitude of the airplane to the maximum extent possible throughout the stall and recovery by the normal use of the flight controls. Emphasis will be placed on the recovery from a stabilized high rate of descent in a high pitch attitude, if this condition develops in some flight situations in the airplane used.

Stall recoveries should be accomplished positively and smoothly, with coordinated flight control usage, the smooth application of power, and the least loss of altitude consistent with the prompt recovery of control effectiveness.

c. *Acceptable Performance.* Throughout stall demonstrations, the applicant will be expected to use prompt and correct control applications to achieve the desired attitudes and maintain the desired heading. Consideration will be given to the applicant's positive action and smoothness. Failure to initiate corrective action on partial stalls before the nose pitches uncontrollably, indications of a secondary

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b. *Description.* The applicant for a type rating will be required to demonstrate the competent performance of the following procedures and maneuvers solely by reference to instruments:

i. Recovery from unusual flight attitudes,

ii. Stall recoveries,

iii. A standard instrument approach,

iv. Maneuvering with one engine inoperative—propeller feathered or power reduced to simulate the drag of a feathered propeller—, and

v. Instrument emergencies.

c. *Acceptable Performance.* The standards for the performance of these procedures and maneuvers will be in accordance with those in the FAA *Instrument Pilot Flight Test Guide.*

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PHASE III.
MULTIENGINE EMERGENCY PROCEDURES

1. Maneuvering with One Engine Out (Feathered if Possible)

a. *Objective.* To determine that the applicant can use the correct procedures for feathering or shutting down an engine in flight, and that he can maneuver an airplane effectively and safely with an engine inoperative.

b. *Description.* The feathering of one propeller will be required on a flight test in any multiengine airplane equipped with propellers which can be safely feathered and unfeathered in flight. Feathering for pilot flight test purposes will be required only under such conditions and at such altitudes and positions where safe landings on established airports can be readily accomplished in the event difficulty is encountered in unfeathering.*

If the airplane used is not equipped with propellers which can be safely feath-

*NOTE: The regulations do not specifically require an applicant to unfeather a propeller on a flight test. Accordingly, he will not be required to do so if he elects to land with a propeller feathered. If he desires to use this procedure, he should arrange it in advance with the examiner concerned, who will permit it unless he considers that an undue hazard would be involved.

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ered or unfeathered in flight, the applicant will be required to shut down one engine in flight in accordance with the procedures in the *Airplane Flight Manual.*

While one engine is feathered or shut down, the applicant will be required to demonstrate straight and level flight, and 20° to 30° banked turns toward and away from the inoperative engine. Climbs and descents to prescribed altitudes will be required in airplanes which are capable of climbing under the existing conditions.

The prescribed propeller operation procedures will be expected, as well as the emergency settings of all ignition, fuel, electrical, hydraulic, and fire extinguishing systems appropriate to an engine failure.

c. *Acceptable Performance.* The applicant's performance will be evaluated on the basis of his ability to maintain his heading within 20 degrees of the original heading during his feathering and unfeathering procedures, and his altitude within 100 feet of the original altitude if it is within the capability of the airplane used; prompt indentification of the inoperative engine after a simulated power failure; and the accuracy of his shutdown and restart procedures, as prescribed in the *Airplane Flight Manual.* In an airplane not capable of maintaining altitude with an engine inoperative under existing circumstances, the applicant will be ex-

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pected to maintain an airspeed within 5 knots of the engine-out best rate-of-climb speed. The use of prescribed operating procedures, proper trim settings, and smoothness will be emphasized.

2. Engine-Out Minimum Control Speed Demonstration

a. *Objective.* To determine that the applicant knows the significance of the engine-out minimum control speed, and the effect of attempts to maintain flight at a slower speed with an engine inoperative.

b. *Description.* With the critical engine (usually the left) windmilling (not cut off), and the operating engine(s) producing as near takeoff rated power as possible, the airspeed should be reduced slowly with the elevators until an uncontrollable turn or bank toward the inoperative engine or indication of a stall is encountered, whichever occurs first. The airspeed at which uncontrollable turning or banking occurs is the engine-out minimum control speed for the conditions under which the demonstration is conducted. Continued controlled flight is impossible at a slower airspeed unless the difference between the power produced by the engines is reduced. Recovery should be effected by reducing the power on the operating engine and effectively reducing the angle of attack by lowering the nose slightly.

Great caution must be observed when it is seen that the engine-out minimum control speed under existing conditions is

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very close to the stalling speed. Loss of directional control at the instant of a stall can lead to a sudden power spin.

To obtain an engine-out minimum control speed as far as possible above the stalling speed, it is necessary to perform this demonstration under conditions in which the engines will produce as nearly their rated power as possible. For this reason, it is most effective to use as low an altitude as is operationally safe in airplanes with unsupercharged engines. The examiner will arrange to start this demonstration at such an altitude that the engine-out minimum control speed is not attained below 500 feet above the ground.

In all unsupercharged airplanes, there is a density altitude above which the stalling speed is higher than the engine-out minimum control speed. When this is the case because of the high elevation or temperature at which the flight test must be given, an effective demonstration of the engine-out minimum control speed is impossible and will not be attempted.

c. *Acceptable Performance.* The engine-out minimum control speed demonstration is subject to so much variation because of the differences in airplane characteristics, circumstances of flight, and elevation of terrain over which flight tests are conducted that definitive standards cannot be established. Any attempt, however, to continue level or climbing flight with an engine inoperative during the flight test at less than the engine-out

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minimum control speed will be disqualifying.

3. Use of Engine-Out Best Rate-of-Climb

a. *Objective.* To determine that the applicant knows and can effectively apply the best rate-of-climb airspeed for the airplane used.

b. *Description.* The applicant will be required to establish and maintain the best possible rate of climb (or minimum rate of sink) with one engine throttled to simulate the drag of a feathered propeller, or with a propeller feathered by mutual agreement between the applicant and examiner. This climb should be maintained for at least three minutes after the airspeed is established, at maximum continuous power, and the resulting climb carefully noted. He may then be asked to attempt to gain more altitude at higher or lower airspeeds of his own choosing or selected by the examiner, for comparison with the airspeed initially selected.

c. *Acceptable Performance.* Performance will be evaluated on the basis of the applicant's ability to determine (from the *Airplane Flight Manual*) and maintain the prescribed engine-out best rate-of-climb speed. He will be expected to maintain a climb within 5 knots of the best rate-of-climb speed within 10 degrees of the desired heading.

4. Effects of Airplane Configuration on Engine-Out Performance

a. *Objective.* To determine that the

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applicant is aware of the detrimental effects on engine-out performance of various common airplane configurations, and to prepare him to evaluate these effects in unfamiliar airplanes.

b. *Description.* The airplane should be trimmed to its engine-out best rate-of-climb speed with the power on one engine throttled to simulate the drag of a feathered propeller, or with a propeller feathered. The effects of the extension of the landing gear, the flaps, and both; the application of carburetor heat on the operating engine(s); and the windmilling of the inoperative engine should be observed and the resulting climb or descent carefully noted. The difference between the gear and the flap extension drag should be emphasized. Each configuration will be maintained long enough to allow its effect to stabilize before the resulting climb or descent is measured. Prolonged use of carburetor heat should be avoided at high power settings.

c. *Acceptable Performance.* Performance will be evaluated on the basis of the accuracy of operations and trim procedures used, and on the applicant's ability to maintain an airspeed within 5 knots of the best rate-of-climb speed and a heading within 10 degrees of the assigned heading.

5. Engine-Out Approach and Landing

a. *Objective.* To determine the applicant's ability to execute a safe approach and landing after the failure of an engine.

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b. *Description.* The applicant will be required to demonstrate an approach and landing with one engine inoperative. In the event the applicant has elected to land with a propeller feathered after demonstrating propeller feathering under paragraph 1 of Phase III, no further demonstration will be required. Otherwise, the landing may be made with an engine throttled to simulate the drag of a feathered propeller or, if feathering propellers are not installed, with an engine throttled to idling. The approach will be continued to a normal landing, and no go-around with an engine out will be required unless there is an actual emergency.

c. *Acceptable Performance.* Performance will be evaluated on the basis of the correct operation of the airplane systems, the use of appropriate trim settings, observance of the regular traffic pattern or approach path, airspeed and altitude control, accuracy of touchdown, and control during rollout. Any reduction of airspeed below the engine-out minimum control speed before the landing flare is initiated will be disqualifying.

6. Emergency Operations (Aircraft Systems)

a. *Objective.* To determine that the applicant is familiar with the emergency operation of all regular and special systems in the airplane used for the test.

b. *Description.* The applicant will be required to demonstrate the actual emergency operation of the retractable gear;

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flaps; and electrical, fuel, deicing, and hydraulic systems. Emergency operations such as the use of CO_2 pressure for gear extension, or the discharge of a pressure fire extinguisher system will be simulated only.

On flight tests in pressurized airplanes, the applicant will be required to execute an emergency descent, as might be necessitated by a loss of pressurization, in accordance with the procedures prescribed by the *Airplane Flight Manual.* The descent will be initiated and stabilized, but no prolonged descent will be required. The airspeed or Mach number used for the demonstration of an emergency descent will be approximately 10 percent less than the airplane's structural limitation, to provide a margin for error. When a Mach limitation is controlling at operational altitudes for the airplane used, the descent will be arranged, if practicable, to require the transition from the observance of the Mach limitation to an airspeed limitation. No simulated emergency descent will be permitted through or near clouds.

c. *Acceptable Performance.* Performance will be evaluated on the basis of the applicant's knowledge of the emergency procedures for the airplane used, the judgment displayed, and the accuracy of his operations.

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Fire Fighting Manual for Tank Vessels.

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ABSTRACT - Prepared jointly by the American Petroleum Institute and the U.S. Coast Guard, this manual is intended to aid seagoing personnel in familiarizing themselves with the nature and hazards of fire, the characteristics and limitations of different types of fire-fighting equipment, and methods by which various fire hazards may be controlled most effectively. Chapters are: (1) The Chemistry of Fire and Fire Fighting, (2) Characteristics of Cargo, (3) Fire Fighting Agents and Equipment, (4) Fighting Fires, and (5) Case Histories of Tanker and Barge Fires and Explosions. A listing of Coast Guard District Commanders and Merchant Marine Activities is appended. The manual is illustrated with numerous figures, diagrams, drawings, and photographs. Recommended supplementary materials are "Rules and Regulations for Tank Vessels," Subchapter D, CG-123, which is available upon request from local Coast Guard Marine Inspection Offices, the annual Dangerous Cargo Regulations section of the Code of Federal Regulations, and the pamphlet, "Chemical Data Guide For Bulk Shipment by Water," CG-388, the latter two available from the Superintendent of Documents, Government Printing Office, Washington, D.C., for $2.50 and $1.25 respectively. (AW)

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COAST GUARD

FIRE FIGHTING MANUAL

FOR

TANK VESSELS

JULY 1, 1968

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDANT (CMC)
U.S. COAST GUARD
WASHINGTON, D.C.
20591

July 1, 1968

FOREWORD

The "Fire Fighting Manual for Tank Vessels" is intended to aid and help seagoing personnel to familiarize themselves with the nature and hazards of fire, the characteristics and limitations of different types of fire-fighting equipment, and the methods by which various fire hazards may be controlled most effectively. Certain portable and fixed fire-fighting equipment are required to be provided on tank vessels. The use and operation of shipboard fire-fighting equipment are responsibilities of the Master and his crew.

Readers are urged to supplement the material contained in this manual with the "Rules and Regulations for Tank Vessels," Subchapter D, CG-123, which may be obtained upon request from the local Coast Guard Marine Inspection Office. The regulations governing carriage of flammable and combustible liquids, liquefied flammable gases and other dangerous commodities in drums, barrels, cases and other packages are contained in Subchapter N—Dangerous Cargoes of Chapter 1 of Title 46 of the Code of Federal Regulations. These Dangerous Cargo Regulations are published annually, with the latest edition having an effective date of January 1, 1968, and cost $2.50 per copy. Another helpful pamphlet is the "Chemical Data Guide for Bulk Shipment by Water," CG-388, and it costs $1.25 per copy. These sales publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

The "Fire Fighting Manual for Tank Vessels" replaces the prior edition of April 1, 1958. This Manual was prepared jointly by the American Petroleum Institute and the U.S. Coast Guard. The Group on Fire Protection, Safety, and Lifesaving of the American Petroleum Institute's Committee on Tank Vessels has rendered a valuable service to all tank vessel personnel in assisting in the preparation of this publication. It was compiled from carefully evaluated reports and practices, which cover actual shipboard use of fire-fighting apparatus.

Comments are invited from users of this Manual.

P E Trimble

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Vice Admiral, U.S. Coast Guard,
Acting Commandant.

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INTRODUCTION

This Manual has been prepared for the purpose of familiarizing seagoing personnel with the nature of fire and fire-fighting equipment and methods with which this hazard can most effectively be controlled.

The fires that never start are the ones that do no damage and kill no people. The job of keeping fires from starting is one job that should be the business of each and every man on all ships. Cleanliness and carefulness is a team which can prevent most fires. When you see any condition which could cause a fire, report it at once. Remember that the fire you prevent may save your life.

A fire, regardless of size, location or time, demands immediate action. All seamen, through their study of this Manual and their training, should be prepared for a fire emergency and know what immediate action should be taken if a fire occurs.

Speed is the most important item because in most cases the longer a fire burns the "hotter" it gets. If you can keep a fire from spreading or "get it under control," you are keeping it from getting "hotter." Getting a fire under control may be done by moving other things that will burn away from the fire, but this is not always possible. The next best thing would be to keep these things from catching fire. To do this you must remember that a flame or spark is not always necessary to start something burning. It may get hot enough to burn because it is too close to the fire or because it is against a bulkhead that is heated by the fire or by hot air or other gases given off by the fire. If you do not take these things into account, you may have two or three fires to fight instead of one. When any fire is under control, it is much easier and simpler to cool it or smother it and thereby put it out.

Fire fighting anywhere and any time is a highly specialized job, and for this reason it is necessary for the person who is to fight the fire to know his job. A general knowledge of the theory of combustion and the hazards and precautions involved in the safe handling of petroleum products will enable seagoing personnel to more intelligently make use of the equipment required in the technique of fire fighting. Water, foam, carbon dioxide (CO_2), dry chemicals and steam are conveyed to the fire scene where they are converted by the equipment described in this Manual into the most convenient form for efficient use in extinguishing fires. Without such equipment and a knowledge of its proper application in an emergency, the extinguishing agent is likely to be ineffective.

It is essential for the safety of "all hands" and the vessel itself, that all fire-fighting equipment be properly maintained and kept in its proper place, clean and in first-class condition ready for instant use. After being used, either for drill or for actual fire fighting, equipment should be inspected, reconditioned or renewed, if necessary, and returned to its designated location.

Inspection of fire-fighting equipment at regular intervals is a basic requirement for proper maintenance. An appropriate time for this inspection would be at the time of weekly fire and lifeboat drills. Furthermore, consciousness of the condition and maintenance of fire-fighting equipment should be a constant concern to all in the normal course of duty. The absence of proper maintenance is equivalent to no protection.

It is also important for a fire fighter to protect himself if he is to do a good job. It is common knowledge that fire will burn you, but there are other factors that must be thought of. A fire in a closed or unventilated compartment may have used up so much of the oxygen from the air that you could not live by breathing it. If this is thought to be the case, no one should enter without wearing suitable breathing apparatus. You can snuff out a life as well as a fire by cutting off the supply of oxygen. Also, an explosion may occur if air is admitted suddenly into a closed compartment in which there is a fire. The firefighter must BE CAREFUL—He Must Think as He Works.

All possible assistance should be given the United States Coast Guard inspectors when carrying out inspections of fire-fighting equipment and all tests should be conducted in a spirit of cooperation.

A plan of action should be formulated in advance. If fire strikes, act quickly! Lives depend on proper action being taken instantly.

Avoid recklessly abandoning a burning vessel. More lives have been lost by premature boat launchings and men going over the side in panic than have ever been lost on deck.

Fight the fire always, if only as a rear guard action. It will increase the chances of survival.

Chapter 1

THE CHEMISTRY OF FIRE AND FIRE FIGHTING

Section 1. THEORY

1–1–1. Elements of Fire

The phenomena of fire are so complex that they cannot be adequately represented by any simple diagram. Basically it consists of four components: fuel, heat, oxygen, and chain reaction.

When the temperature of a substance is raised to its 'ignition temperature' in the presence of oxygen, certain chemical reactions take place. Gases are generated and released. These gases go through a series of intermediate stages called chain reactions which result in heat and flames. To the observer, flame, smoke, and, if he is close enough to the fire, heat, which have been generated by the chain reactions, are apparent. These physical reactions have been matters of common knowledge ever since man learned how to make fire. It remained for scientific inquiry to reveal exactly what takes place in fire.

The control and extinguishment of ordinary fires in general is brought about by eliminating any one of the components. If oxygen (air) can be diluted or smothered out, the flame will go out. If heat can be taken away by cooling the fuel to a temperature below that at which it will take fire, then the fire can no longer exist. If the chain reaction can be interrupted, flame and heat cannot be formed; therefore, there will be no fire. For the purposes of this manual, it is assumed aboard ship that, except in rare cases, it will be impossible to remove the fuel from the heat and the oxygen in order to put the fire out. Therefore, the task of the fire fighter will be to reduce the temperature (to cool the fire), to isolate the fire from its supply of oxygen (to smother the fire), or to interrupt the chain reaction, and to accomplish these with the greatest possible speed.

1–1–2. Removal of Fuel

When dealing with the removal of the fuel, the fire fighter on board ship must take whatever measures possible to prevent additional fuel from coming into contact with the fire since he cannot in most cases entirely separate the combustibles from the fire. Fire fighters must be ready at all times to shift combustibles to safe areas.

1–1–3. Removal of Heat

Another method of extinguishing fire is to deal with the second component—heat. As will be explained later, heat may be transmitted in three ways, by radiation, by conduction, and by convection. Obviously, the removal of heat is best carried out by the use of water and water sprays. Also by ventilating to outside areas except in compartments where it is possible to close off openings and thus smother the fire.

1–1–4. Control of Air (Oxygen)

The third component of fire, air, is difficult to control. In most cases it is practically impossible to remove air from the atmosphere surrounding the fire. However, it can be diluted with other gases which are noncombustible, such as carbon dioxide, or excluded (smothered) with foam, so that extinguishment of the fire will occur.

1–1–5. Combustion Inhibitors

Although the actions of certain extinguishing dusts, powders, or finely divided dry chemicals are not fully understood, sufficient work has been done to indicate that the vapors from burning substances progress through a chain of chemical reactions and the introduction of an inhibiting powder is able to break the progress from link to link of the chain so that the chemical reactions culminating in the flame stop and the fire ceases to burn.

1–1–6. Ignition Temperature

The "ignition temperature" of a substance is the lowest temperature at which its vapor, usually a gas generated through the application of heat, will ig-

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nite independently of any external source of ignition. A substance or its vapor, however, does not have to be heated to its "ignition temperature" throughout in order that it may be ignited with an external source of ignition.

Petroleum oils ignite, without any external source of ignition at 490° F. to 765° F., which is several hundred degrees higher than their "flash points"; butter and cooking greases ignite at 650° F. to 750° F. and "flash" at lower temperatures; wood ignites at 450° F. to 520° F. Each substance has different "fire" and "flash points," neither of which has any relationship to the other. The fire fighter, fortunately, does not have to memorize these temperatures, but a general knowledge of them serves as a constant reminder that combustibles in the vicinity of a fire have, in comparison with the heat of the fire, relatively low "ignition temperatures" and that in consequence there is an ever-present danger that fire will spread to them.

1-1-7. Fire Point

The "fire point" is the lowest temperature at which a substance will give off vapors which when ignited will continue to burn. The "fire point" is generally slightly above the "flash point."

1-1-8. Flash Point

The "flash point" is the lowest temperature at which a substance will give off enough vapors to form flammable mixture of vapors and air (oxygen) immediately above its surface. The temperature at which this mixture will "flash" across the surface (but not burn) if a source of ignition is applied, is the "flash point."

In the case of the "flash point," the temperature is not high enough to increase the rate of "vaporization" to the point where it will generate a constant supply of fuel.

1-1-9. Vaporization

The rate of "vaporization" depends on the vapor pressure, which increases with the temperature. A flammable substance is, therefore, more hazardous at an elevated temperature than at normal temperature. It is pointed out that the solid or liquid substances do not burn; only the vapor which has combined with the oxygen in the air burns. The oxygen must be present to unite with the vapor in flame. Without oxygen the flame will smother.

The tendency of a liquid to vaporize is indicated by its "flash point" and "fire point." The heat of a fire once started naturally increases the temperature of the liquid up to its boiling point. At this point the fire may no longer increase greatly in intensity because the heat supplied to the liquid by radiation from the fire approaches a maximum value which is balanced by the heat used up in vaporizing or boiling the liquid. When a liquid is burning, its exposed surface is at, or above, the temperature corresponding to its "fire point." If the burning liquid can be cooled below this temperature, the rate of "vaporization" will not provide sufficient fuel (vapor) to support continuous combustion.

1-1-10. Explosive Range

The temperature at which a flammable substance begins to burn is not necessarily the point at which it will explode. Although heat is a factor in causing explosions, the concentration of certain explosive gases in air within a container or enclosure is a determining cause of the explosion. In the case of gasoline, a vapor-air (oxygen) mixture containing more than 6 percent vapor is too "rich" to explode, and a mixture of less than 1.4 percent is too "lean" to explode. The range from 1.4 to 6 percent is the "explosive range" for gasoline. Concentrations "below" or "above" this range are said to be either "too lean" or "too rich" to explode. The concentration varies among explosive gases and it varies for the same gas under different conditions.

1-1-11. Spontaneous Ignition or Combustion

When heat is generated by chemical action within a substance and the process continues to a point of ignition, the phenomenon is known as "spontaneous ignition" or "spontaneous combustion." Usually, spontaneous heating begins with a slow oxidation which generates heat. As the heat increases the chemical action takes place at a progressively increasing rate until the "ignition temperature" is reached. Some substances reach the "ignition temperature" rapidly; other substances

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may take hours or days or even months; while other substances are not subject to "spontaneous combustion." Substances subject to "spontaneous combustion" will differ in the degree of probability with which it will occur, but every such substance has a point in the scale of temperatures at which it will begin to burn. Oils that combine readily with the oxygen in the air are subject to spontaneous heating.

When such oils (chiefly of animal or vegetable origin) are present in waste, rubbish or other material, under conditions in which heat is produced faster than it is dissipated, the temperature rises and ignition may occur.

1–1–12. Radiation—Conduction—Convection

Fire is spread or extended to wider boundaries or adjacent areas by one or more of the three (3) physical phenomena by which heat is transmitted, namely—RADIATION, CONDUCTION OR CONVECTION.

Through radiation heat is sent forth in direct rays, equally in all directions. Decks and bulkheads are heated by radiation. The heat passes through them by conduction to ignite combustibles on the opposite side of these partitions, either directly by conduction, or by radiation or convection.

In conduction, heat is transmitted through solids, liquids, and gases and is the process in which the molecules of a substance are heated by molecules having a higher temperature with which they are in contact. Conduction of heat does not proceed with equal facility in all substances. Some substances conduct heat more readily than others. Substances with a very high "ignition temperature" will serve simply as conductors and will remain unaffected. Steel bulkheads, decks, pipes, and similar structural members may serve in this way as conductors of heat to dangerous combustibles.

In convection, portions of gases and liquids that are heated to a higher temperature than the rest of their mass become lighter in weight and move upward into the cooler portions above. It is by convection that heated air and other heated gases rise over a fire and are carried by the wind to ignite combustibles at some distance away. This process is particularly applicable to ventilation systems aboard ships which may carry the heated gases to places far removed from the fire.

Section 2. CLASS OF FIRES

1–2–1. Types of Fires

Fire may be classified in three groups; namely,

Class A: Fires in ordinary combustible materials, such as mattresses, dunnage, piles of wood and shavings, canvas, etc. These fires are best extinguished by the quenching and cooling effects of quantities of water or water fog.

Class B: Fires in substances such as gasoline, oil, lubricating oil, Diesel oil, tar, greases, etc. Here the blanketing or smothering effect of the extinguishing agent is of primary importance.

Class C: Fires in live electrical equipment, such as switchboard insulation, transformer terminals, etc. Here the extinguishing agents *must be nonconducting* so that electrical shock is not experienced by the fire fighter.

Class D: Fires in combustible metals such as magnesium, sodium, titanium, lithium, etc.

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Chapter 2

CHARACTERISTICS OF CARGO

Section 1. CARGO CLASSIFICATION

2–1–1. Types of Liquid Cargo

Liquid cargoes, which are at the present time carried in bulk on tank vessels, are not only petroleum products, but several other kinds of flammable or combustible liquids, certain mixtures of flammable liquefied gases, flammable or combustible liquids having lethal characteristics and many nonflammable liquid chemicals such as chloroform, caustic soda, ethylene perchloride, etc. The great majority of liquid cargoes transported on tank vessels are oils which in general may be divided into petroleum base, coal base, vegetable oil, marine animal and fish oil and animal oil. Oils produced from crude petroleum are by far the most important because of the tremendous quantities which are being carried. With proper equipment, reasonable diligence and adequate knowledge, this kind of cargo in bulk or package may be handled safely and with remarkable freedom from fire and/or explosion.

The rapid development of the petroleum industry has created a demand for water transportation of many new materials which may have other properties. The probability of a vessel carrying one of these may be remote, but if any of these materials are to be carried, the vessel will be fully advised of any special hazards and necessary precautions.

2–1–2. Classification of Oils

For the purpose of regulating tank vessels, the regulations of the U.S. Coast Guard divide petroleum products into flammable liquids, combustible liquids and flammable liquefied gases.

Flammable liquids are liquids which will give off flammable vapors at or below 80° F., or the liquids will flash in contact with flame when its temperature is at or below 80° F. Flammable liquids are divided into three grades as follows:

Grade A.—Any flammable liquid having a Reid vapor pressure of 14 pounds or more.

(The Reid method of measuring vapor pressure consists of placing a small amount of liquid into container with pressure gauge, and after closing tight, heating liquid to a temperature of 100° F. and measuring the vapor pressure, which is expressed in pounds per square inch absolute.)

This group includes: casinghead, natural gasoline, very light naphtha, butane blend gasoline, etc.

Grade B.—Any flammable liquid having a Reid vapor pressure under 14 pounds and over 8½ pounds. This group includes most motor gasolines.

Grade C.—Any flammable liquids having a Reid vapor pressure of 8½ pounds or less and a flash point of 80° F. or below. This group includes most of crude oils, "cut back" asphalt, creosote, benzol, toluol, alcohol, aviation gasoline, some jet fuel, etc.

Combustible liquids are liquids which will give off flammable vapors only above 80° F. or liquids having a flash point above 80° F. Combustible liquids are divided into two grades as follows:

Grade D.—Any combustible liquid having a flash point below 150° F. and above 80° F. This group includes: Kerosene, light fuel oils, few very heavy crude oils, some jet fuel, etc.

Grade E.—Any combustible liquid having a flash point of 150° F. or above. This group includes: heavy fuel oils, "Bunker C," Diesel fuel, road oil, lubricating oil, asphalt, coal tar and fish, animal and vegetable oils.

Flammable Liquefied Gas.—Means gas having a Reid vapor pressure exceeding 40 pounds which has been compressed and liquefied.

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Chapter 3

FIRE–FIGHTING AGENTS AND EQUIPMENT

Section 1. FIRE MAIN SYSTEM

3–1–1. General

The fire main system aboard tankers is a system of permanent piping which receives water pumped from the sea and delivers it to fire hydrants strategically located throughout the vessel. Any part of the living quarters, weather decks, machinery spaces, stores and working spaces, and any part of cargo decks accessible to the crew at sea must be able to be reached with two (2) streams of water, one of which is from a single 50-foot length of hose.

All portions of the main machinery spaces shall be capable of being reached by at least two effective spray patterns of water each from a single 50′ length of hose from different outlets.

Each and every seaman aboard ship is a fire fighter when the emergency arises. Therefore, each seaman should have a working knowledge of the fire main piping system, its master control and cutout valves and fire hydrant outlets. Each fire drill should serve the dual purpose of not only instruction in the proper and effective use of fire fighting agents and equipment, but also the procedures for localizing and offsetting the effects of damage to the fire main system.

3–1–2. Types of Fire Mains

Most fire main systems installed on tankers are one of two types: the single main or the horizontal loop system. The single main system consists of a single main extending fore and aft above the main deck. This main is led near the center line of the vessel and extends as far forward or aft as necessary to supply the various services. The horizontal loop system consists of two cross-connected mains extending fore and aft above the main deck. At their extremities the two mains are connected to form a loop. The advantage of the horizontal loop system is its versatility of use in any emergency.

Fire main piping is usually 5 or 6 inches in diameter with branch lines of smaller diameter leading off to fire hydrants of 2½-inch or 1½-inch diameter.

3–1–3. Fire Hydrants

Each fire hydrant is equipped with a valve so that the fire hose may be removed while there is pressure on the fire main. Fire hose must be connected to the hydrant at all times except on open decks where the location of the fire hydrants is such that no protection is afforded for the hose in heavy weather. One other exception when hose may be temporarily disconnected from the hydrants is where such connection interferes with cargo handling.

When the fire hydrant is unprotected by the hose being disconnected, it is advisable to use protective screw caps and a thin coating of light grease on the threads of the hydrant outlet.

3–1–4. Fire Main Piping

The fire main system is part of the vessel's permanent piping system and should be maintained in the same manner as other deck piping. Should it appear that any part or parts of the piping has deteriorated to the extent that there is any likelihood of its not being strong enough to withstand the working pressure, such part should be replaced.

The interior of the fire main piping is likely to collect rust and incrustation. The best way to reduce this condition is to flush out the entire system regularly by holding fire drills at different locations each week. It is suggested that once every 5 to 7 drills the fire hydrants below decks be flushed out at maximum pressure. Fresh water flushing will destroy any marine growth and this fact should be taken advantage of whenever possible.

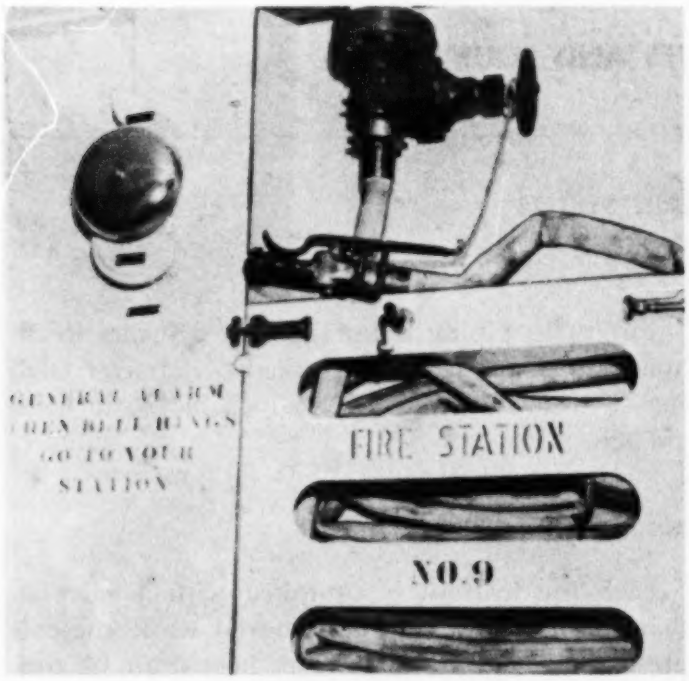

Inside station

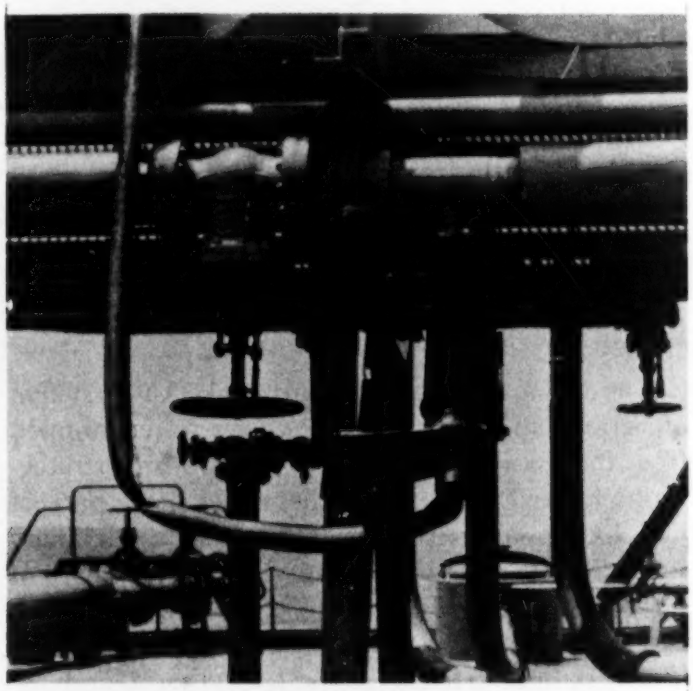

Outside station

Figure 1.—Fire hydrants.

3-1-5. Quick Cleaning Strainer

Unless a quick cleaning strainer is contained within the nozzle itself, a self-cleaning strainer shall be attached to the fire hydrant directly or by means of a short length of hose. These strainers trap foreign substances such as rust and other particles that accumulate in the fire main. Without the strainer, the foreign matter clogs the small orifices in the applicator heads and reduces their capacity to make fog, except where high and low velocity spray heads have large orifice openings.

3-1-6. Fire Hose

Fire hose in use aboard tanker vessels is usually of two types, single or double cotton jacketed rubber lined or synthetic rubber covered with rubber lining and is Underwriters' Laboratories Inc., labeled or equivalent. Fire hose (for tankers) usually comes in 50-foot lengths of two diameter sizes, 1½-inch and 2½-inch. Generally fire hoses on the weather decks are long enough to be goose-necked over the side.

The 2½-inch hose is usually used on weather decks on large vessels. It has been demonstrated that 1½-inch hose is much easier to handle.

Fire hose couplings are of bronze, brass, or other equivalent metal having male and female threads. When 1½-inch hose is used on 2½-inch fire hydrants, it is necessary to attach reducing connections, using the single (straight type) or double (Wyegate) type outlets.

Fire hose should be kept in clean condition. Washing the hose is not recommended except when

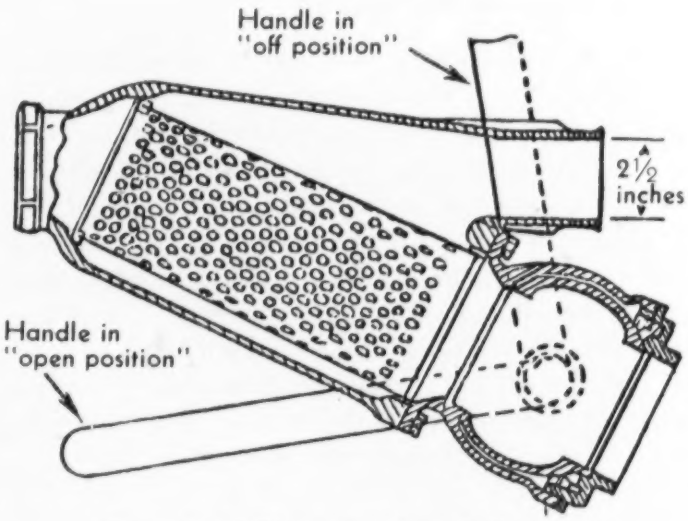

Figure 2.—Self-cleaning strainer (half section).

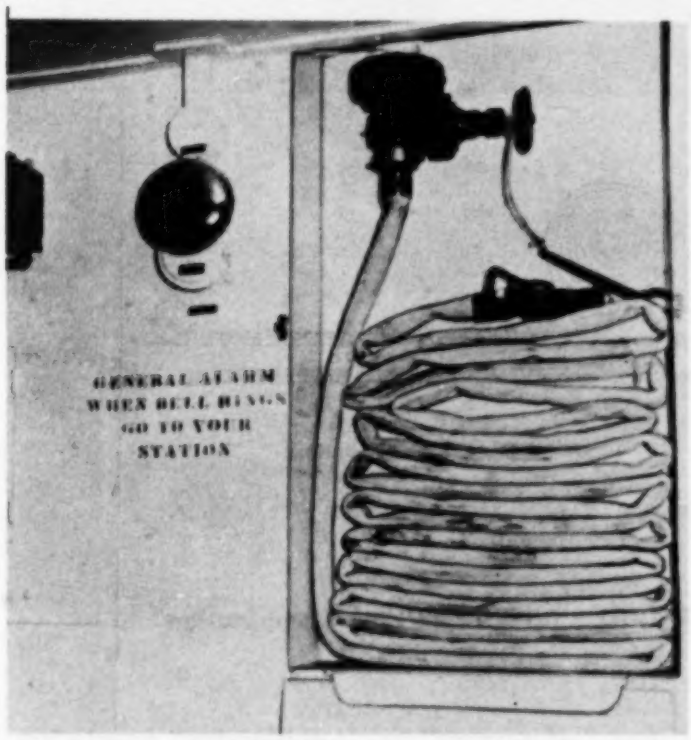

Figure 3.—Faking fire hose at inside station.

the cotton cover becomes oily or greasy. Oil or grease should be washed off the hose with fresh water, using a soft-bristled brush and a mild soap. Wire brushes, holystones, sand or strong caustic soap should not be used. After washing or using hose, it should be thoroughly drained and dried at ordinary temperatures before restowing. Hose should never be dried at high temperatures as this tends to harden the rubber lining.

Fire hose should never be painted nor should paint, grease or oil be applied to the couplings. The swivel on the female coupling should be kept free turning and shall always have a gasket or washer inserted. To lubricate the swivel or to remove corrosion a stiff bristled brush with fresh water and soap should be used. The couplings, thread and gasket should be kept in good condition so that the hose may be coupled tight enough by hand to make a water tight connection. This is an advantage and a precaution as it may be necessary to uncouple the hose in an emergency.

Couplings are made of soft alloy metals and are easily damaged by iron tools, dropping or careless handling. For this reason hose couplings should never be allowed to drag over the deck except when necessary in an emergency.

Fire hose may be stowed in either of two ways, depending on the type of hose and the bracket or rack provided. Synthetic rubber hose is usually rolled and stowed on reels. Cotton hose can be rolled or faked according to the rack design. Whether the hose is faked, rolled, reeled, etc., it should be stored in a manner which will allow the nozzle end to be run out to the fire, leaving the female end attached to the fire hydrant outlet.

Fire hose should not remain faked, rolled or reeled for too long a period. When re-faked or re-rolled, the hose should not be doubled or bent in the same bight as before so that the rubber liner will not become "formed." The bottom of the roll or fold should be at least 6 inches above the deck to avoid exposure to swabbing, seawater or painting. Hose should be inspected each time it is run out. When water seepage shows through the jacket or at the couplings, cuts, cracks or abrasions or shows other obvious defects, such hose should be set aside and replaced with a spare.

3–1–7. Pressure Loss Due to Friction

The lateral pressure of water on the walls of fire hose (and fire main piping) causes friction which reduces the pressure between the fire main pumps and the hose nozzles. The fire fighter should understand what happens when he connects additional hose, or reduces a single line to two smaller lines, or makes other adjustments. He will know, for example, that a fire main pressure of 100 p.s.i. delivers only 83 p.s.i. to a 1-inch nozzle outlet at the end of 2 lengths (100 feet) of 2½-inch hose; and delivers only 70 p.s.i. to a ⅝-inch nozzle outlet at the end of 2 lengths (100 feet) of 1½-inch hose. Knowing this, he should be able to lay out his hose lines intelligently. A few properly charged hose lines are more effective than many undercharged hose lines.

3–1–8. Fire Hose Attachments

The straight and Y-gate reducers, the plain and "all-purpose" nozzles, the low-velocity "applicators" and hose spanners when not in use, should be kept in the clips or racks provided and their valves, threads, joints and unpainted surfaces kept free of corrosion. The high-velocity nozzle tip should always be attached to the "all-purpose" nozzle by the chain and snapped in the fog outlet on the nozzle.

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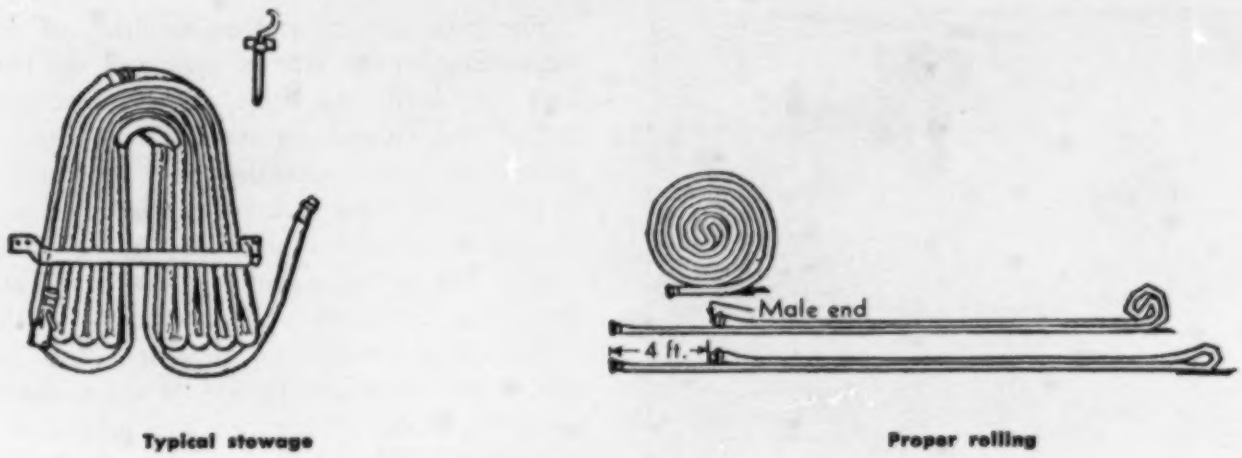

Typical stowage

Proper rolling

Figure 4.—Fire hose.

The bayonet joint in the "all-purpose" nozzle, the nozzle tip, joint end and the head of the "applicator" should be coated with a light grease. Heavy grease or grease that congeals should not be used for this purpose. The joint end and the head of the "applicator" should be suitably protected by a canvas sock or other means when not in use. The "applicators" should not be left attached to the "all-purpose" nozzles when racked. The outlets (holes) in the "applicator" head must be kept free of corrosion, hard grease or any other obstruction that might impede the free flow of the water stream. Hose spanners are usually galvanized or made of some other rust resistant metal.

3–1–9. Nozzles and Applicators

There are two types of bronze nozzles currently in use, the funnel shaped plain or common type, which emits a solid stream, and the "all-purpose" or "combination" type, which emits either a solid stream or high-velocity fog. Both types come in 1½-inch and 2½-inch sizes.

The plain or common type nozzle has been in use for many years. It is used chiefly in fighting "class A" fires, for cooling decks and bulkheads and for diverting the flow of oil. For safe operation three men are necessary to control the 2½-inch straight or all-purpose type nozzle during operation when the pressure on the hose is approximately 100 p.s.i. Under the same conditions two men are necessary on 1½-inch hose. In either case the nozzle men should be backed up by enough additional men to spell them at the nozzle and assist in handling the hose.

3–1–10. "All-Purpose" or "Combination" Nozzle

The "all-purpose" or "combination" nozzle has two outlets and a single valve. To operate the nozzle, the valve handle is pulled back from the shut position (forward), to the fog position (vertical), to the open or solid stream position (back) and vice versa. The use of the nozzle is flexible. The fire fighter can turn on the fog and turn it off, or he can turn on the fog and then the solid stream, and then by passing the handle through the fog position, shut the valve.

Caution should be exercised by the men at the nozzle when switching from "off" to "solid stream" and from "fog" to "solid stream" positions. Considerable thrust is exerted by the change in pressure when switching positions at the nozzle, which causes the nozzle to slip.

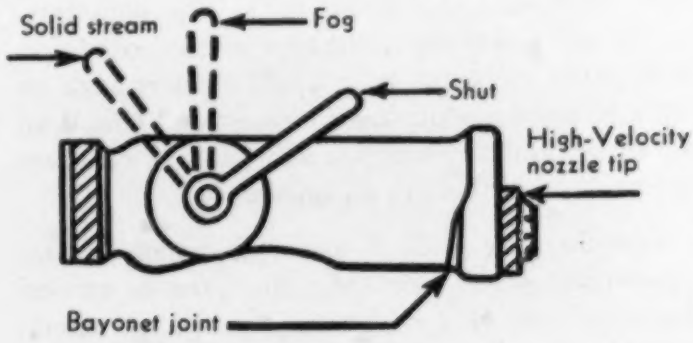

Figure 5.—"All-purpose" nozzle showing three handle positions.

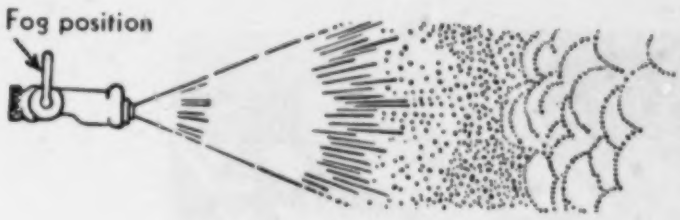

Figure 6.—High velocity fog.

3–1–11. High- and Low-Velocity Tips and Applicators

When high-velocity fog is desired, the high-velocity bronze nozzle tip, attached by a short chain, shall be left in place in the fog outlet on the "all-purpose" nozzle. When low-velocity fog is desired, the high-velocity nozzle tip is removed and an "applicator" equipped with a low-velocity head is snapped into place in the fog outlet of the "all-purpose" nozzle. A bayonet joint holds the "applicator" in the all-purpose nozzle. Control of this velocity is desirable as for some fire-fighting tasks a low-velocity fog is preferable and for others, a high-velocity fog.

For both the high-velocity nozzle tip and the low-velocity "applicator" head, the water pressure is the same, since pressure is not the differentiating factor in the velocity achieved by the two. For the best results with either, the water pressure at the nozzle should be maintained as close to 100 p.s.i. as possible and no lower than 60 p.s.i.

The fog stream is projected more than 20 feet from the 1½-inch nozzle with the high-velocity tip and more than 35 feet from the 2½-inch nozzle with the high-velocity tip.

When using the low velocity "applicator" head, the water stream is broken down into finer particles. The water particles (fog) do not have force for more than a few feet from the fog head; therefore, a suitable "applicator" length must be used (*See Figure 8*). The applicator enables the fire fighter to reach over or around obstructions in order to place a cooling, smothering blanket of fog on the fire.

Applicators come in lengths from 4 to 12 feet and in diameters from ¾ to 1½ inches with 60° or 90° curves at the outlet end (*See Figure 8*). Usually ¾- and 1-inch diameter applicators are used in 1½-inch all-purpose nozzles and 1½-inch diameter applicators in 2½-inch nozzles. The fog head is screwed into the outlet end of the applicator, the applicator in turn snaps into the bayonet joint in the fog outlet on the all-purpose nozzle (*See Figure 9*).

The all-purpose nozzle when equipped with the applicator and low-velocity fog head projects a fog having the maximum diffusion; therefore, one that presents the maximum total surface for the absorption of heat. The fog pattern from the fog head is at its most effective dimensions 5 or 6 feet from the outlet tip of the applicator. The high-velocity nozzle tip on the 1½-inch "all-purpose" nozzle sends a stream of fog several times this distance and on the 2½-inch nozzle 5 or 6 times this distance. High-velocity fog has a lower degree of diffusion, but it provides force and range. Whether from a low-velocity head or a high-velocity tip, the fog extinguishes fire by absorbing heat and by reducing the supply of oxygen through infiltration above the fire.

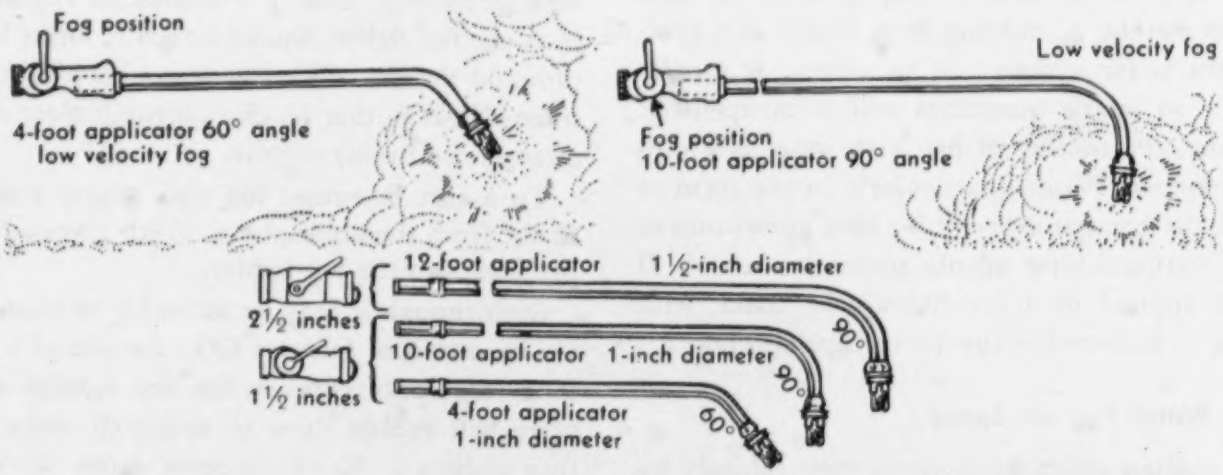

Figure 7.—Applicators.

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Figure 8.—Inserting low-velocity applicator into "all-purpose" nozzle, high-velocity nozzle tip removed.

When the valve of the 1½-inch or 2½-inch "all-purpose" nozzle is moved into the open or solid stream position, the nozzle of the 1½-inch size releases a solid stream of water through an outlet ⅝-inches in diameter and the nozzle of the 2½-inch size through an outlet 1 inch in diameter. At 100 p.s.i. at the fire hydrant either size nozzle will project a solid stream of water a distance of about 75 feet.

Section 2. WATER

3–2–1. Cooling

The use of water as a cooling agent is the most common method of fighting fires. Water as a cooling agent is far superior to all others, is usually available in ample quantities and is inexpensive. Therefore, the cooling of fire with water is a universal practice. Water (particularly in the form of fog) has the greatest capacity for heat absorption of all the extinguishing agents presently in use. It may be applied to a fire directly by hand, with buckets, or delivered to the fire by pipe and hose.

3–2–2. Water Fog Or Spray

The cooling ability of water is tremendously increased when it has been converted into fog by the use of the "all-purpose" nozzle. These nozzles diffuse each gallon of water into millions of particles. As a result, the vastly increased total surface for the absorption of heat makes fog an extremely efficient cooling agent. Besides its capacity for cooling fire, fog also dilutes combustible vapors. When fog is turned to steam by the heat of the fire, it forces air away from the fire, thereby removing the oxygen needed to support combustion.

Fog can be used successfully on oil fires to knock down the flames and act as a barrier against radiant heat from hot bulkheads and other metal structures. Also, it is a more desirable agent than a solid stream of water in situations where water damage must be held to a minimum. Fog also protects the fire fighter by the screen it forms between him and the fire. This screen shields him from the intense heat so that he can approach close or stand away as conditions require.

To a certain extent fog also washes fumes and smoke from the atmosphere, which gives additional protection to the fire fighter.

Even though it may be advisable to extinguish a fire by means of foam or CO_2, the use of a low-velocity fog spray between the fire fighters and the blaze will enable them to approach more closely, thus adding to the effectiveness of the actual extinguishing agent.

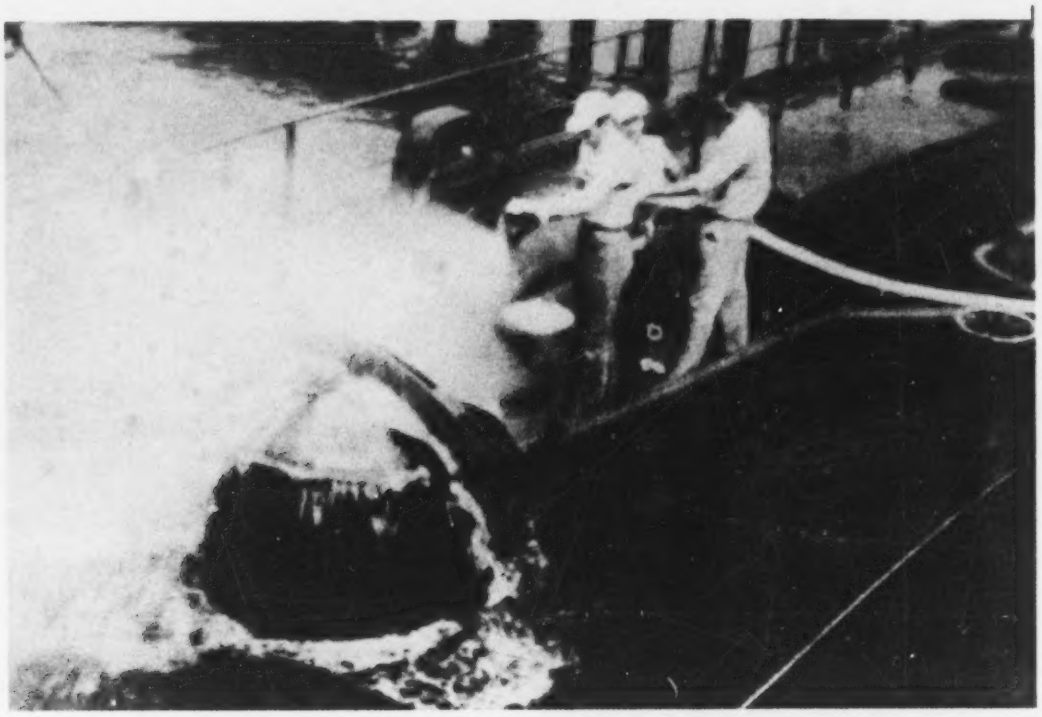

Figure 9.—High-velocity water fog, operating the 2½-inch "all-purpose" nozzle (handle vertical).

3–2–3. Application of Water

The technique employed in fighting a fire with water is a matter of using common sense. In order to place the water stream or fog where it will do the most good, the fire fighter must approach the fire protected from the heat, fumes, and smoke generated. For this reason, the nozzle men should bend forward as they approach a fire, keeping their faces as close as practicable to the deck where the heat is somewhat less intense. The rushing stream has a cooling effect and creates a void into which fresh air is drawn.

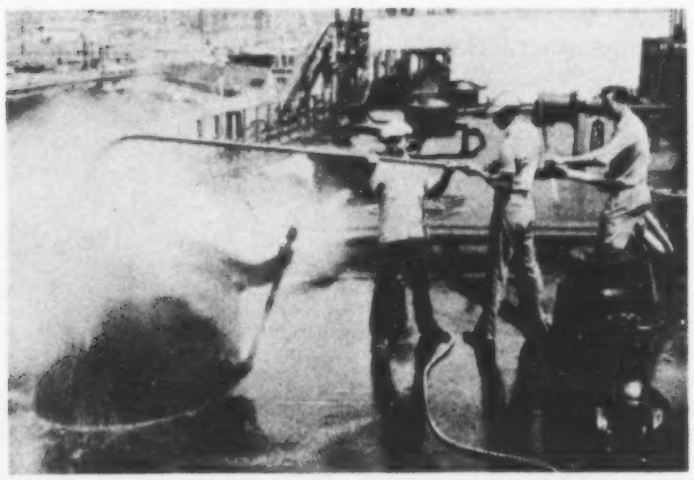

Figure 10.—Low-velocity water fog operating the 2½-inch "all purpose" nozzle with 12-foot low-velocity fog applicator (handle vertical).

To beat back the heat, fumes and smoke of the fire, water fog should be brought into play to protect the fire fighters by forming a barrier between them and the fire. This allows them to move forward and approach the seat of the fire. The fire fighter must remember to *keep the fog between himself and the fire.*

No hard and fast rule can be set on whether to use high- or low-velocity water fog to protect the fire fighters. If the fire is approached from windward and the fuel is less volatile than gasoline, low-velocity is recommended. If it is necessary to approach the fire from leeward or if the fuel is as volatile as gasoline or greater, high-velocity is recommended. These recommendations are based on the fact that high-velocity water fog has greater directional force and would tend to deflect the flame, heat, and gases away from the fire fighters. The "all-purpose" nozzle permits the use of a solid stream or a high-velocity fog at intervals, changing from one to the other as conditions warrant. The solid stream is most efficient for getting at the seat of "class A" fires while the surrounding area is protected by using high or low-velocity fog as a cooling medium. Such cooling will remove or reduce

the danger of heat passing through adjacent decks and bulkheads by conduction, thus igniting combustibles in adjoining compartments.

3–2–4. Water Spray Systems

The fixed spray system consists of fixed piping within the space protected, which usually takes its water supply off the main fire line. The branch lines within the space protected are fitted with water fog heads so arranged as to provide a uniform distribution of water spray over the entire area of the space to be protected.

The control valve (only one is installed) for the system is of the deluge type and is accessible from outside the space protected. Drains, strainers and dirt traps are fitted wherever necessary to prevent the accumulation of dirt or moisture.

The pump supplying water for the system may be either reserved exclusively for the system or it may be one of the fire pumps. The amount and pressure of the water required for any particular system depends directly on the type and number of water spray heads in the system and the pressure drop in the supply piping.

Section 3.—FOAM

3–3–1. General

Foam is one of the most effective agents for extinguishing "class B" fires (oil, grease, paint, etc.) and to some extent "class A" fires (woodwork, bedding, clothes, stores, etc.). Disadvantages: it *will* conduct electricity, is not always effective on flowing liquids and it is not effective at extremely low temperatures (under 10° F.).

Foam for fire-extinguishing purposes on board tank vessels is of two types, chemical and mechanical. The characteristic difference in the equipment for producing the two kinds of foam is that the nozzle used for mechanical foam adds air to the chemical bearing stream after the chemicals have been dissolved in it. The equipment for chemical foam does not add air to the chemical-bearing stream.

Although classified as chemical foam and mechanical foam, both are made with chemicals and at the time of the fire, mechanical foam, more recently developed than chemical, has qualities that

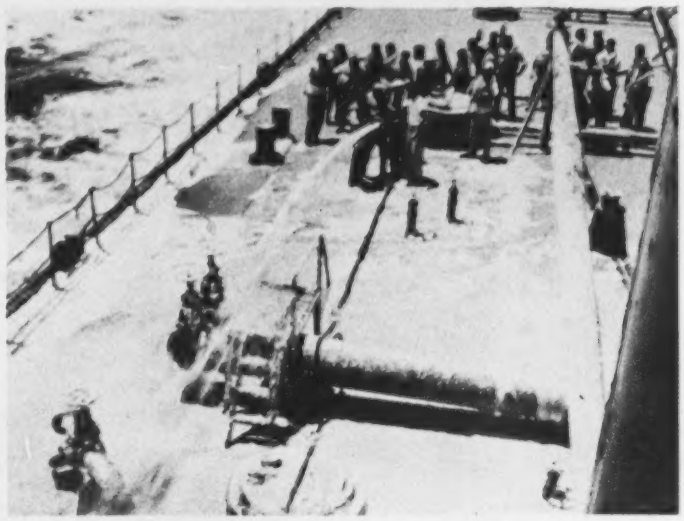

Figure 11.

derive from the mechanical effects of the entrainment of air at the nozzle. It is produced with a foam-chemical solution. Chemical foam is produced with dry chemicals (except in the two-solution tank system). Both kinds have individual advantages and both have limitations.

3–3–2. Chemical Foam

The chemical-foam blanket is composed of water film globules filled with carbon dioxide. It is the result of a chemical reaction of bicarbonate of soda, aluminum sulfate (or ferric sulfate), and a "foam stabilizer." It has more body than mechanical foam and consequently builds up a stouter cover over a fire. Since it will pile up against and cling to vertical structures, it will reach and cover, on occasions, combustibles burning a foot or two above the deck. It will not, however, pass freely around obstructions.

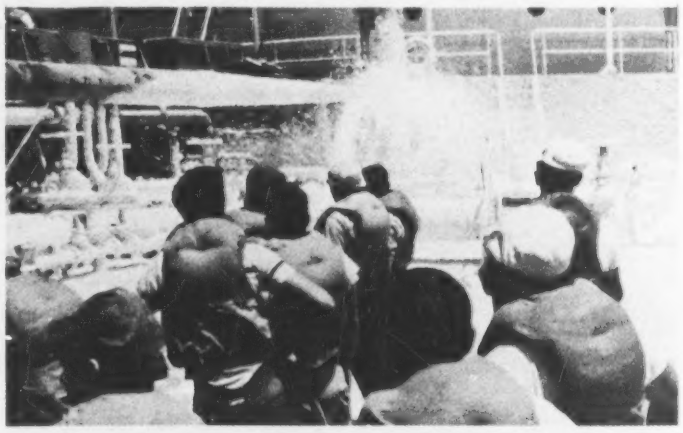

Figure 12.

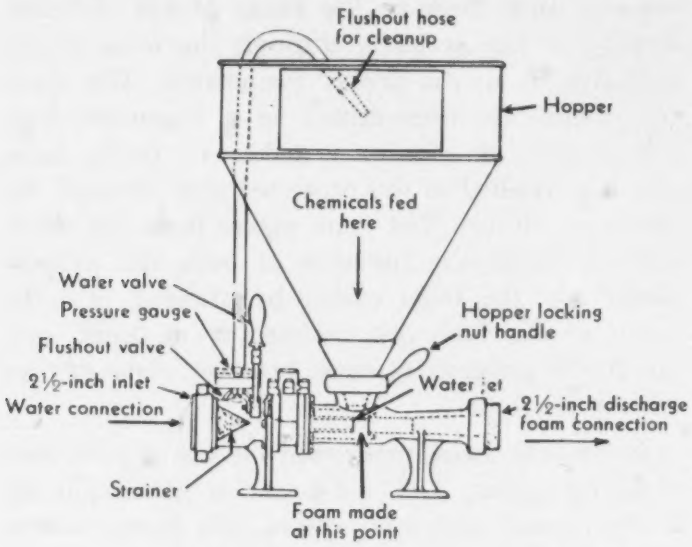

Figure 13.—Chemical foam hopper.

3–3–3. Producing Chemical Foam

A continuous-type generator (figure 19, fixed or portable) is used in the production of chemical foam. It consists of a hopper having a so-called "ejector" inside the bottom, which serves as a means of dissolving dry-foam chemicals in the stream of water. After the water (at 75 to 100 p.s.i. pressure) has been started through the generator, the dry chemical mixture is poured into the hopper. Where the powders are stored in the hopper, chemical control valve levers are opened to release both chemical powders to the ejector. The chemicals are drawn into the water stream as it rushes past the ejector gap into the fire main or hose line. The piping, or hose line of 100 feet for ordinary conditions, provide a channel for the chemical action necessary for effective foam production. The length of 2½-inch hose line used for discharging the foam should vary in length according to the temperature of the water but should never exceed 150 feet. The hose should have a nozzle on the outlet end 1½ inches in diameter (the diameter required for the most effective discharge).

In the large hopper type of generator the chemical foam powders are usually stored in the twin compartments of the hopper, ready for immediate use. This type is usually equipped with a mechanical turning device which should be turned occasionally to unpack and free up the powders which may settle due to the vessel's vibration. Extra chemicals are usually stored in containers holding 50 pounds each. These containers must be kept sealed and stored in a cool dry place until used. Containers should be inverted periodically. The continuous type generator is also made in a two hopper style, which is, as the name implies, one in which the dry chemicals are dissolved separately in two streams of water which are brought together at the discharge outlet to produce foam.

In the twin solution type of foam generator, bicarbonate of soda and foam chemicals are held in solution in one cylinder and aluminum sulfate is held in solution in the other. The contents of the two cylinders are pumped separately to discharge outlets in which the solutions mix to produce and discharge foam on the area being protected.

Referring back to the continuous-type generator, the rate of consumption of foam powder is approximately 100 pounds per minute with either fresh or salt water at 70° F. Since each pound of foam powder produces about 8 gallons of foam, the foam produced per minute is 800 gallons. Seven and a half gallons of the chemical foam are equivalent to 1 cubic foot in bulk. The production per minute in bulk, therefore, is 106 cubic feet. For an application 3 inches thick per minute, 106 cubic feet per minute provides coverage for 400 square feet of surface or a surface area measuring 20 x 20 feet.

Instructing personnel during fire drill in the quick and most efficient use of this equipment will avoid costly mistakes at time of fire.

3–3–4. Mechanical Foam

Mechanical foam when applied to a surface makes a blanket of closely-knit, tiny, air-filled bubbles that readily floats on the lightest flammable liquids thus cutting off the air supply and smothering the fire. Foam acts in such a way as to extinguish the fire progressively. It is not easily dissipated. It flows readily across the burning liquid and forms a tight, smothering blanket which remains intact after extinguishment to prevent re-ignition.

3–3–5. Concentrated Foam Liquid

Foam liquid used to make mechanical foam is a concentrated aqueous solution and when mixed with water at the rate of 6 parts liquid to 94 parts water, (3 parts to 97 parts water in the case of 3% liquid) the amount of foam produced will be ap-

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proximately 10 times the amount of solution used. Foam liquid should be protected from a temperature below 20° F. and above 100° F. If the liquid is frozen, however, it can be thawed out again with no harmful effects. Special foam liquids are available where extreme cold temperatures are a problem. They maintain their mobility and are ready for use at temperatures down to −20° F.

There are certain flammable liquids which destroy regular foam. These include among others amines, ethers, alcohols, esters, aldehydes, and ketones. Recently a new foam has been developed which is effective on these liquids and which can be used with little change to existing foam installations.

3–3–6. Producing Mechanical Foam

Mechanical foam is produced by bringing together in a turbulent state three ingredients: water, concentrated foam liquid and air. When these three ingredients are thoroughly mixed, foam is produced.

The three basic component parts of a foam system are the "Proportioner", the "Foam Maker", and the "Discharge Outlet". The Proportioner introduces concentrated foam liquid into the water discharge from the fire pump in the ratio of approximately 6 parts liquid to 94 parts water for a 6% system, and 3 parts concentrated liquid to 97 parts water for a 3% system. This solution under pressure then flows to the Foam Maker. Solution flowing at high velocity through the foam maker aspirates air in the proper proportion. The three ingredients are thus mixed in a turbulent state downstream of the foam maker to create foam which is applied to the protected area through the discharge outlets. The foam maker itself can sometimes perform the function of both the proportioner and the foam maker by drawing into the water stream both concentrated foam liquid and air. In the majority of cases, however, these devices will be separate.

In general, foam protection on vessels falls into three categories: 1. Fixed piped-in protection for boiler rooms, machinery spaces, and pump rooms; 2. Deck foam system for cargo tank area; 3. Portable first aid or supplementary protection. (See sketch of each type).

3–3–7. Fixed Foam Systems

Fixed foam protection for Boiler Rooms, Machinery Spaces, and Pump Rooms require a fixed (completely piped) system which floods the protected area (s) at a minimum solution rate 1.6 gpm per 10 sq. ft. for at least 3 minutes.

The approved foam discharge devices for these areas are the Marine Floor Nozzle and the Overhead Spray Deflector. Usually the floor nozzle is found in the boiler room and machinery spaces, and the overhead spray deflector in pump rooms.

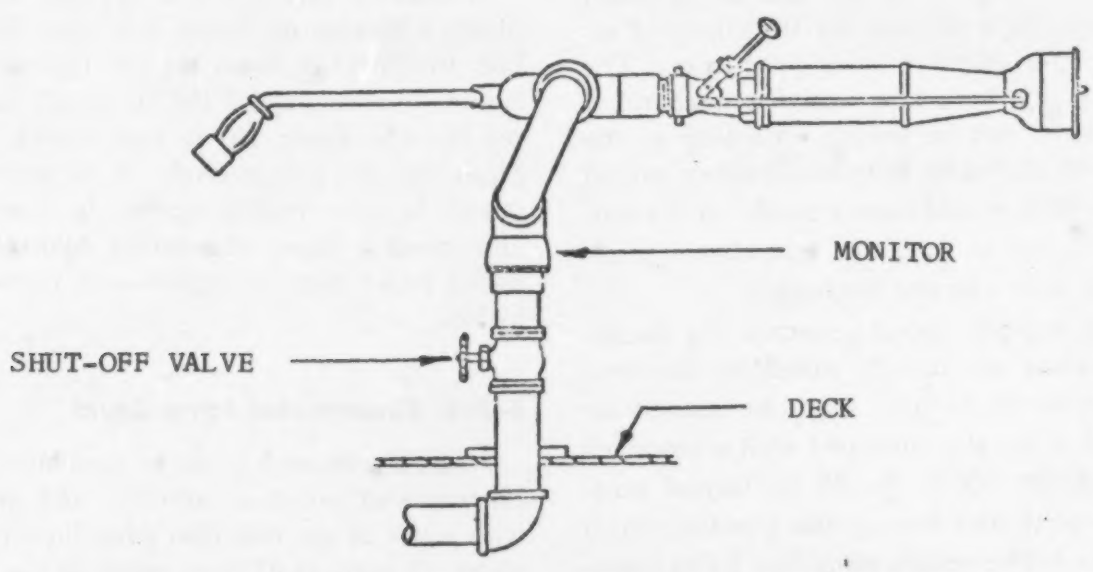

Figure 14. Monitor Nozzle.

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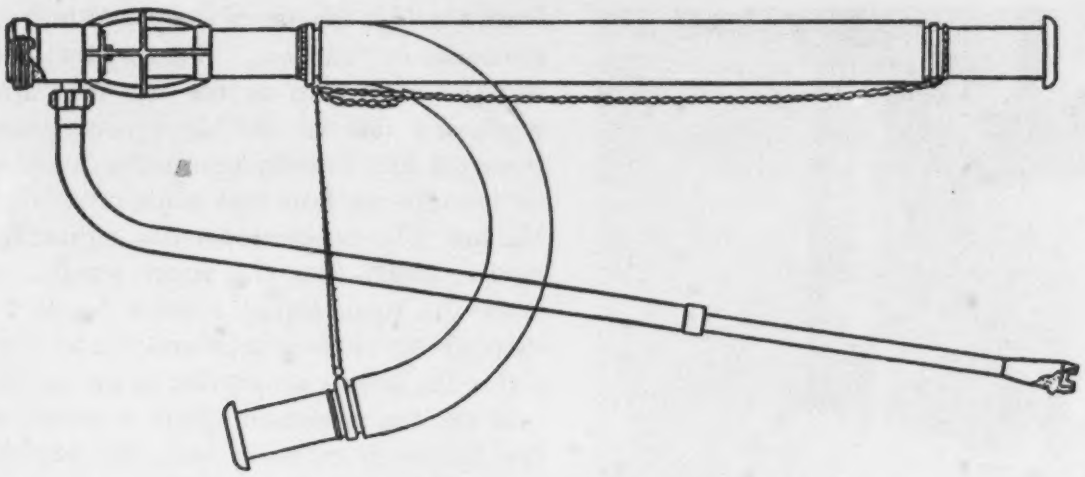

Figure 15.—Mechanical foam nozzle with pickup tube.

Although either device (or combination of both) can be used in any of these locations.

In most cases the foam liquid proportioning will be done from a central location by either a Pressure Proportioner, a Positive Displacement (Water Motor) Proportioner, or a Balanced Pressure Proportioner.

3–3–8. Deck Foam Cargo Tank Protection

On tank vessels, foam protection for cargo tanks includes a centrally located proportioner (or proportioners), a fixed foam solution main, and sufficient monitors and/or foam hydrants connected to the main for operation of monitor mounted or portable nozzles at a minimum solution rate of .016 gpm per sq. ft. of total cargo area for at least 15 minutes without recharging. Either monitors or portable nozzles or any combination may be used to provide the requirements for flow rate, coverage, etc. (*See Figure 14*).

3–3–9. Portable First Aid or Supplementary Protection

While not necessarily required, portable foam devices in addition to the fixed systems are valuable for first aid protection and to supplement the protection provided by the fixed systems.

3–3–10. Mechanical Foam Nozzles With Pick-up Tube

The mechanical foam nozzle with pick-up tube is designed such that it entrains air through an aspirating cage in its butt end and introduces mechanical foam liquid into the water stream through a device called the pick-up tube with the resulting foam passing through the nozzle portion. One type consists of a 21-inch piece of flexible metal, or asbestos composition hose, 2 inches in diameter with a solid metal nozzle outlet and, in the butt end, a suction chamber and an air port which forms the aspirating cage. The pick-up tube consists of a

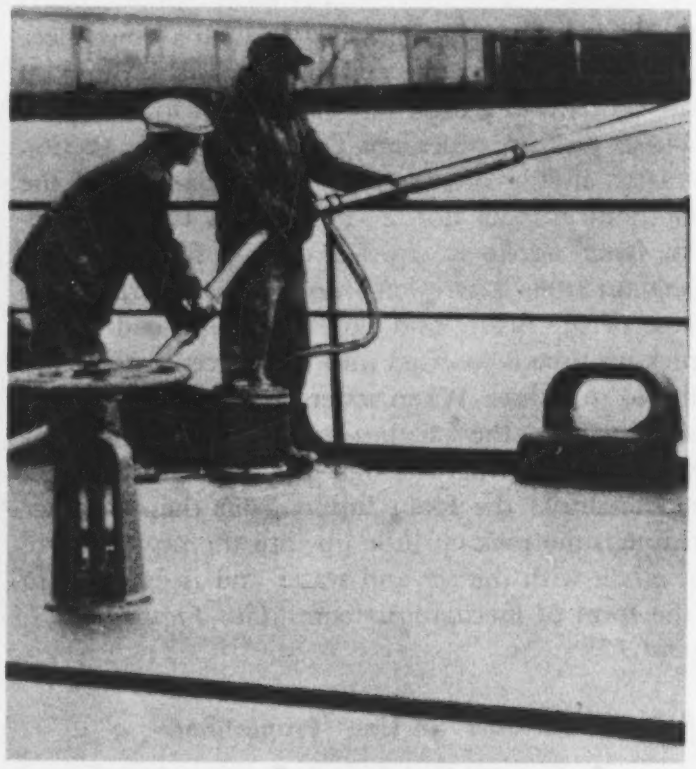

Figure 16.—Operating the mechanical foam "pick up" unit.

Figure 17.—Mechanical foam "pick up" unit and 5-gallon foam liquid containers; 2½-gallon chemical foam extinguisher in background.

short piece of ⅝-inch metal pipe with a short piece of rubber hose on one end and is used to draw up the contents of a 5-gallon container of foam liquid. These pick-up tubes are actuated by the suction created in the suction proportion chamber of the mechanical foam nozzle. To operate, the mechanical foam nozzle is screwed on the fire hose, the pick-up tube is screwed into the side port in the base of the nozzle and the metal pipe end of the pick-up tube is inserted into the concentrated foam liquid container. When water pressure is applied to the fire hose, the vacuum-syphon effect created by the water passing through the mechanical foam nozzle draws the foam liquid from the container through the pick-up tube up into the nozzle where it mixes with the air and water and is expelled in the form of mechanical foam. (*See Figures 15, 16 and 17.*)

3–3–11. Portable "In Line" Proportioner

Another method of getting foam to the fire and permitting more flexible use of the mechanical foam nozzle is the use of the portable "in-line" proportioner or "eductor." This proportioner may be installed anywhere in the fire hose lines to the windward side of and at a convenient distance from the fire, thereby permitting foam solution to be fed into the hose line while clear of the heat of the fire. The proportioner is a lightweight venturi device which uses the water stream pressure to draw the foam liquid from a 5-gallon container through the pick-up tube and induce the foam liquid in the proper proportion to the fire hose line.

If the fire is located where it would expose the fire fighter to excessive heat, the portable in line proportioner can be used. The male end of the fire hose feeding water to the proportioner is screwed into the female end (gage end) of the proportioner; the pickup tube is screwed into the top center of the proportioner. The male end of the fire fighting hose is led to the fire site and the mechanical foam nozzle is screwed on. The female end of this hose is connected up to the discharge end (male) of the proportioner. When the water pressure on the inlet side of the proportioner reaches 65 p.s.i. (shown on gage) or higher, insert the suction end of the pick-up tube into the foam solution container.

Whether using the pick-up tube directly off the mechanical foam nozzle or off the in-line proportioner, extra cans of liquid foam should be opened and kept on hand so that the pick-up tube can be quickly transferred from an empty can to a full one. Time limitations of a full 5-gallon container of liquid foam makes this precaution necessary. At

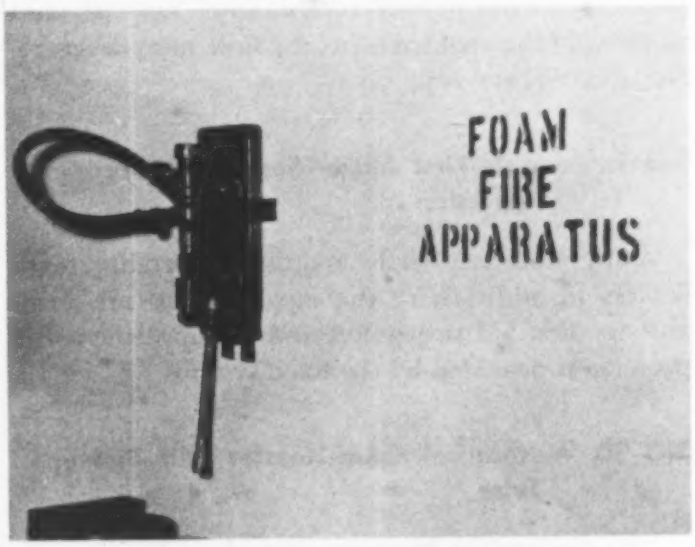

Figure 18. Portable "in-line" proportioner.

50 p.s.i. water pressure, one 5-gallon can of liquid foam will last approximately 2½ minutes; at 100 p.s.i. water pressure the same can of concentrated foam liquid will last about 1½ minutes.

3–3–12. Application of Foam

The application of foam to a fire is extremely important. In most cases, using either mechanical or chemical foam, a stream of foam should be deflected from a bulkhead or other vertical surface in such a way as to avoid undue agitation of the burning surface. The fire fighter must remember that foam is only efficient when it covers the top of burning combustibles. Therefore, he must hold the foam stream sufficiently above the deck in order to break the stream's force before it flows over the fire. Since the rate of application is important, several streams of foam should be placed in operation as soon as possible. The operation is continued until the burning area is completely covered with a foam blanket thick enough to smother the fire. No exact rule for the thickness of the foam blanket can be formulated except that the fire fighter should remember that the roll and pitch of the ship may cause breaks in a thin cover which might result in the reignition of the flammable liquid beneath.

If the fire is on deck, or is a running fire, it is most effective to play the foam stream ahead of the burning liquid and bounce it on the fire. If the liquid continues running, it can be diked with foam, which will hold it until a blanket of foam can be spread on the surface.

3–3–13. Foam Versus Water Fog

Water in the form of fog is effective on oils having a high flash point, provided the whole burning surface can be reached, or the burning surface can be "walked" or forced into a relatively small surface area. Water fog is also effective on oils having a low flash point, provided a fresh supply of air (oxygen) can be excluded.

Oil and grease burn only on the surface; therefore, the smothering effect is most advantageous for extinguishment. On such fires, foam flows over the surface and provides a tight cover, isolates the fire from its source of air and checks rekindling as might otherwise be caused by hot bulkheads or fire in the vicinity. Foam also retards the formation of vapor on the surface of the oil and thus hastens extinguishment. The cooling effect of foam on a fire, because of its water content, reduces the fire's radiant heat. Vapors cannot penetrate to reignite above the foam blanket and radiate back to the oil to give it the heat required for combustion. On occasions, a low-velocity water fog may be used in conjunction with (but not in the same spot) the foam in order to beat down the heat of the fire and permit closer approach with foam equipment. Low-velocity water fog will also lower the temperature of the burning liquid and hasten the formation of a protective foam blanket. Once formed, the foam blanket will usually remain effective for several hours, (if thick enough) and thus allow the surrounding structures to cool.

Section 4. CARBON DIOXIDE (CO_2)

3–4–1. Extinguishing Qualities

Carbon dioxide (CO_2) is an excellent smothering agent for extinguishing "class B" (oil, grease, paint, etc.) and "class C" (electrical apparatus) fires in situations where it will not be widely diffused or, if the fire is beyond the incipient stage, where it will not be blown away by drafts. It is most effective when applied where it will remain as a cover long enough to reduce the amount of oxygen in the air over the fire to a point below which combustion is not possible. The normal oxygen content of the air is 21 percent by volume. If carbon dioxide replaces the oxygen in the air to an extent sufficient to bring the oxygen content down to 15 percent or lower by volume, not enough oxygen remains in the air to support combustion. As carbon dioxide is 1½ times heavier than air, it flows down and over a fire and, if of sufficient concentration and not disturbed by air currents, it will hover long enough to extinguish the fire.

3–4–2. Rekindling Danger

It should always be borne in mind that fire extinguished by carbon dioxide may be rekindled if the carbon dioxide is in turn replaced by sufficient air to bring the oxygen content of the air above 15 percent. Rekindling by restored oxygen occurs when the temperature of the combustible has not been reduced below its ignition temperature or when this required temperature is quickly reached

again because of heat radiated from other burning substances or hot structures nearby. *It is therefore important that all openings through which air can enter be secured. This includes hatches, doors and ventilation systems.*

3–4–3. Use Around Machinery and Electricity

Carbon dioxide is an inert gas that is noncorrosive, a nonconductor of electricity, and can penetrate into voids and spaces in and around machinery. It is particularly effective in the pump room, fire room, engine room, and in such other locations where machinery is at floor plate level. It will not damage the most delicate machinery or instrument and being a nonconductor, it can be safely used in fighting fires around energized electrical equipment that would otherwise present the additional hazard of electric shock.

Carbon dioxide is equally effective at all temperatures. It does not freeze, leaves no residue, and can be quickly and easily removed by ventilation. (See: section 3–4–6 on Dangerous Qualities.)

3–4–4. Use on Oil Fires

Applied *promptly,* carbon dioxide is effective on burning oil. Its effectiveness lies in the fact that the combustion of oil occurs only at the surface. Except for a layer there, the bulk of the oil is comparatively cool in the early stages of a fire; and there is *less* danger of rekindling from hot bulkheads or other metal structures in the event the carbon dioxide should be drawn away from the surface.

3–4–5. Storage

Whether in a fixed installation or portable, carbon dioxide is stored in steel cylinders at a pressure of about 850 p.s.i at 70° F. Under this pressure, about two-thirds of the carbon dioxide is in a liquid state. When discharged, it rapidly expands to 450 times its stored volume. Due to this rapid expansion, it is immediately reduced in temperature to 110° below zero F. and the liquid is vaporized to an invisible carbon dioxide gas. Some of it, however, has the appearance of snow before it returns to the gaseous state. Due to its extremely low temperature, *the snow will blister the skin and cause painful burns* if it is not removed promptly. Even with the low temperature of the expanding carbon dioxide as it leaves the cylinder, its cooling effect on fire is slight. This is explained by the fact that the total cooling effect of the gas and "snow" released is about 100 B.t.u. per pound. This is small compared with water, which has a theoretical cooling effect of about 1,000 B.t.u. per pound, assuming that it is all evaporated into steam.

3–4–6. Dangerous Qualities

The very qualities which make carbon dioxide a valuable extinguishing agent also *make it dangerous to life.* When it replaces oxygen in the air to the extent that combustion cannot be sustained, respiration cannot be sustained either. Prolonged exposure to air laden with carbon dioxide causes suffocation, very much as immersion in water does when a person drowns. *Carbon dioxide cannot be seen nor smelled* and, therefore, gives no warning of its presence that can be recognized by the senses. Since it is heavier than air, it does not rise, but remains close to the surface in a deep or shallow pool, according to the area covered and the amount used. With a 15-pound portable carbon dioxide extinguisher there is practically no danger, inasmuch as its 135 cubic feet content in the average compartment lies in a shallow pool, well below the normal breathing level. However, the concentration of carbon dioxide released in a compartment from a fixed system would be extremely dangerous to personnel. Therefore, all compartments so served have a self-actuated alarm which automatically sounds off (gives warning) when the valve releasing the gas in the compartment is opened. When a person enters a compartment that contains, or there is reason to believe contains, carbon dioxide in a dangerous concentration, he must wear suitable breathing apparatus and be fitted with a suitable life line, tended by another person outside the compartment, under the supervision of a licensed officer.

3–4–7. Portable, Semiportable or Fixed Equipment

Carbon dioxide fire-fighting equipment is either portable, semiportable or fixed. The majority of vessels are equipped with the portable, so-called "15-pound" type and the "50-, 75-, or 100-pound" cylinders are referred to as the fixed type or as semiportable if fitted with a hose on a rack or reel which permits application to any point in the space

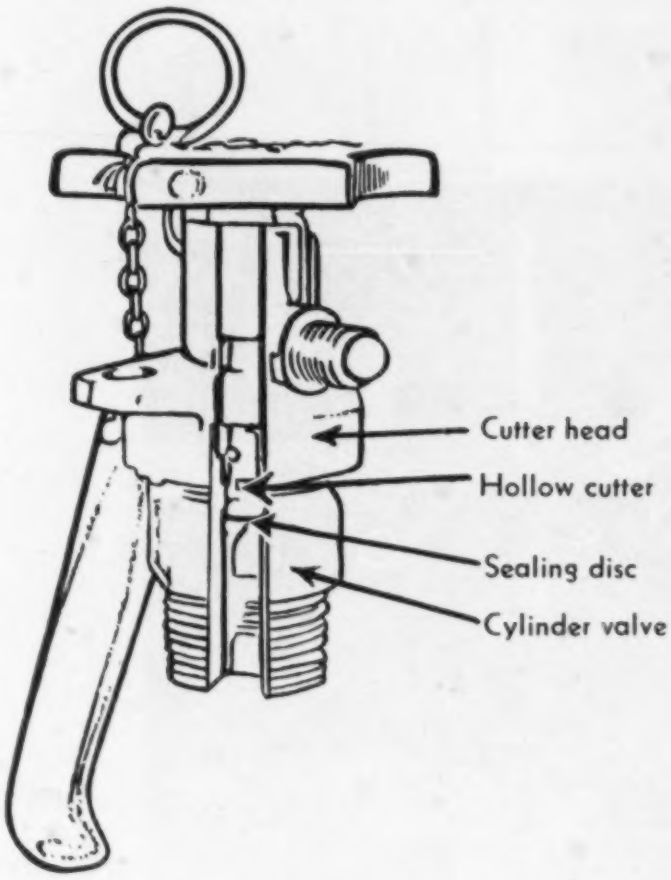

Figure 19a.—Disc type.

protected. The size (pounds) of carbon dioxide cylinders represents the weight of the carbon dioxide they can hold—it has no bearing on the weight of the cylinder. Whether portable, semiportable or fixed, every carbon dioxide cylinder is constructed of seamless steel with a valve at the top for discharging its contents and a safety pressure disc to safeguard against the possibility of the cylinder bursting if excessive pressure should develop as a result of heat. The cylinders are normally held under a pressure of about 850 pounds per square inch at 70° F. The safety discs are set to release the pressure at 2,700 p.s.i. This pressure will be reached within the cylinder at approximately 135° F.

3–4–8. Fifteen-pound Co_2 Extinguishers

The portable "15-pound" carbon dioxide (CO_2) extinguishers are hung on bulkhead brackets located in spaces where "class B" (oil, grease, paint, etc.) and "class C" (electrical apparatus) fires are most likely to occur, such as the machinery spaces, pump rooms, radio room, galley and forecastle head enclosure. They are the familiar fire extinguisher design, with locking pin, release valve and safety disc on the top and a short discharge hose to which is attached a bakelite horn-shaped nozzle. These extinguishers are of two types, the "disc-type release valve" (*See Figure 19a*) which is operated by a small wheel at the top, and the "squeeze-grip-type release valve" (*See Figure 19b*) which is operated by a simple squeeze grip.

Carbon dioxide extinguishers should not be removed from their brackets except for inspection use, recharging (ashore) and when it is necessary to paint or wash behind them. When removing the extinguisher from the brackets, care should be exercised not to pull the locking pin, otherwise the extinguisher may be accidentally discharged. The holding bracket, name plate, locking pin and release valve with handle should be maintained free of corrosion and paint and coated with light oil. The horn-shaped nozzle should be pressed in the clip on the side of the extinguisher so that the hose and nozzle do not hang free.

As the extinguisher cannot be recharged on shipboard, when one has been discharged, or partly so, *it should immediately be replaced with a spare.* Extinguishers that have been discharged, or partly so, should be tagged or clearly marked *"empty"* and stowed in a location where they will not be mistaken for charged extinguishers. At the time of the United States Coast Guard periodic inspection, all extinguishers aboard the vessel are weighed and either certified to contain the required amount (15

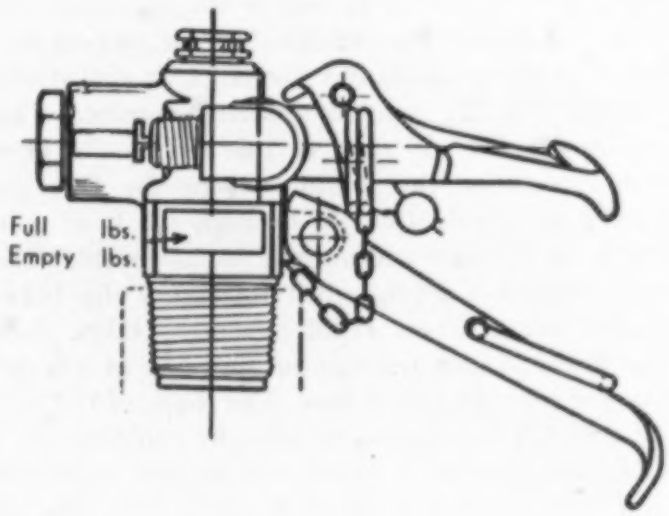

Figure 19b.—Squeeze grip.

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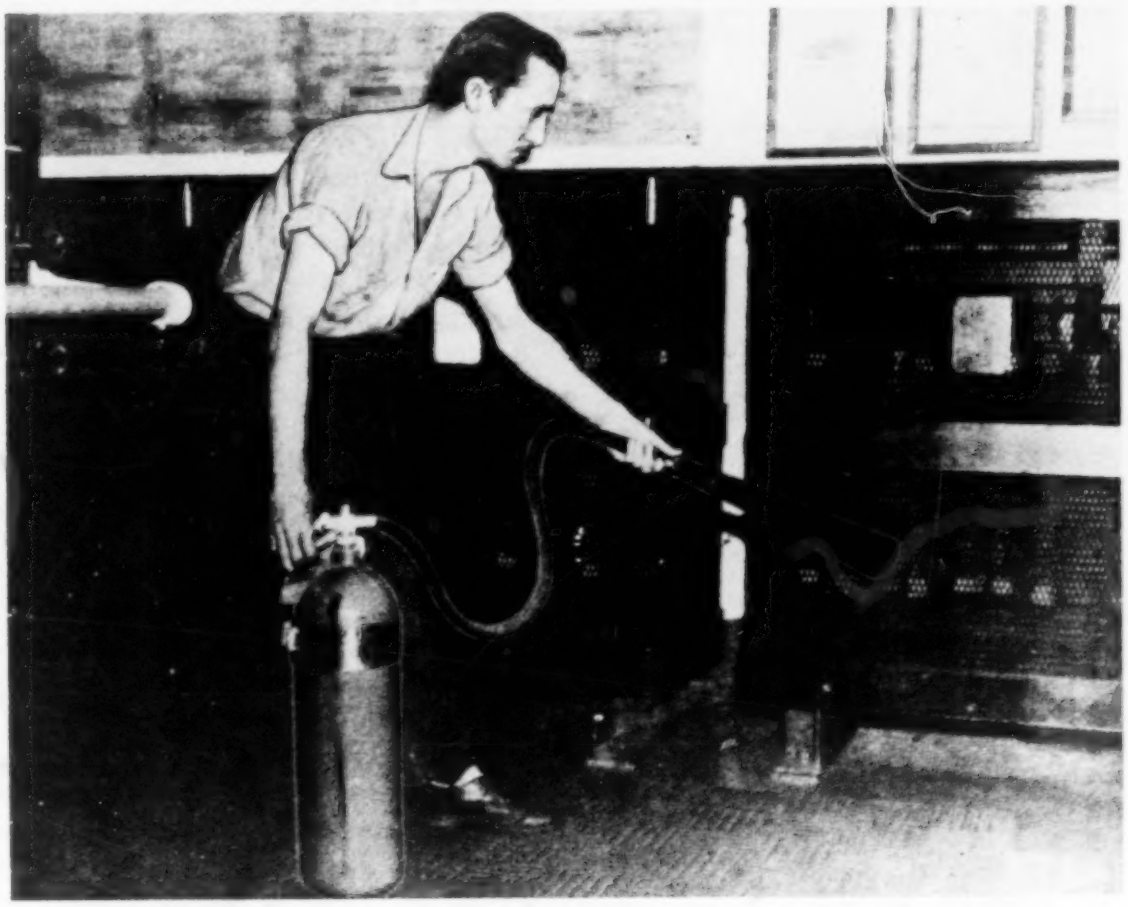

Figure 20.—Operating the portable "15-pound" carbon dioxide (CO_2) extinguisher.

pounds) of carbon dioxide, or recharged or replaced with a fresh extinguisher.

The "squeeze-grip-type release valve" has two (2) handles. The lower handle is for carrying purposes, and the upper handle is for operating the valve. To operate the extinguisher, the locking pin, which prevents accidental discharge, is pulled out and the two (2) handles squeezed together. The carbon dioxide will then be released by the pressure exerted on the liquid CO_2 by the CO_2 gas forcing the liquid CO_2 up through the brass tubing in the cylinder and out the discharge hose. The CO_2 remains a liquid until it reaches the horn-shaped nozzle where rapid expansion takes place due to the sudden reduction in pressure as it is discharged into the atmosphere. The shape of the nozzle confines the expansion, thereby building up a CO_2 cloud which is forced out by this expansion and then directed to the base of the fire. The advantage of the "squeeze-grip-type release valve" lies in the fact that the valve can be opened and closed intermittently. If continuous operation is desired, the "D yoke" ring in the carrying (lower) handle can be slipped over the operating (upper) handle when the latter is depressed.

In continuous operation, the effective range of the "15-pound" extinguisher is limited to between 8 and 10 feet for a duration of between 42 and 45 seconds. Due to these limitations, it is essential to move as close to the seat of the fire as possible before commencing to discharge the cylinder.

3–4–9. Semiportable CO_2 Extinguishers

Semiportable carbon dioxide extinguishers are usually located in the machinery spaces and provide means for applying carbon dioxide gas and snow through the nozzle on the end of the hose to any point in the space protected. The carbon dioxide is contained in one or more cylinders bracketed to the vessel's structure. The hose reel or rack may be located immediately adjacent to the cylinders or connected by piping to another location usually adjacent to an exit of the space. The extinguisher is

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ordinarily actuated by pulling the handle in a pull box adjacent to the hose reel or rack, running out sufficient hose to reach the fire, and by squeezing the valve lever on the nozzle. The discharge of carbon dioxide snow and gas should be applied from the nozzle closely to the base of the flames in a slow sweeping motion, working the fire into a corner where it can be extinguished without backlash.

3–4–10. Fixed CO_2 System

Fixed carbon dioxide (CO_2) systems are installed in vessels in order to provide a dependable and ready means of flooding a compartment or inaccessible space with this smothering gas. Tank vessels equipped with this system also have it connected to certain pieces of electrical equipment.

The fixed carbon dioxide cylinders are arranged in batteries bolted in frames to the vessel's structure. The number of cylinders in a battery varies, depending on the size of the compartments they serve and the class of the vessel. Valve mechanisms in a battery are connected together in groups. Each group is actuated by remote controlled cable (s) and are connected to the compartment or electrical equipment they serve by fixed piping. This piping terminates in a series of fixed jets, horn-shaped outlets, or perforated pipes, in the fire room, engine rooms, and main pump room.

On certain type vessels the main generator, propulsion motor, main switchboard and cargo pump cubicles are protected by a fixed carbon dioxide system, which can be operated by remote control independent of the fixed carbon dioxide system protecting the machinery spaces. It has its own remote control directional valve station and individual valves that direct the flow of carbon dioxide to the aforementioned electrical equipment. Because of the comparatively small volume of CO_2 released, it is not necessary for personnel to evacuate the machinery spaces when this part of the fixed system is activated to flood only the electrical equipment.

3–4–11. Remote Control Directional Valve Station

The remote control directional valve station is a manifold consisting of a cylinder release and a series of valves that direct the flow of carbon dioxide to the various individual compartments protected. Each valve should be plainly marked with the name of the compartment or electrical equipment it serves. To operate the system, that is—flood a compartment or piece of electrical equipment with carbon dioxide, the cylinder release is first operated then the directional valve serving the compartment or equipment.

3–4–12. Operating Instructions, Fixed System

The operation of fixed carbon dioxide fire extinguishing equipment is quite simple and usually detailed in instruction books aboard each vessel so equipped. All ship's officers should thoroughly familiarize themselves with not only the location of pull boxes, but that portion of the system activated by each box. As explained in "Dangerous Qualities," carbon dioxide is not poisonous, but in sufficient quantities it is suffocating. Therefore, when CO_2 fixed systems are activated into compartments normally worked in or occupied by personnel, an alarm is simultaneously sounded with the release of the gas. All personnel should immediately evacuate the compartment. If the hatches or doorways of the protected area are open when the fire breaks out, close them, provided they can be closed quickly; also secure ventilation system.

3–4–13. Application of Carbon Dioxide (CO_2)

When practicable, *Fires on weather decks should be attacked from the windward side,* so that the wind will blow the heat away from the operator and at the same time carry the gas over the fire. The stream should be directed back and forth slowly across the base of the fire, opening and closing the release valve in the handle as conditions require. When the flame has been extinguished, the entire surface involved in the flame should be coated with carbon dioxide "snow," in order to check incandescense and thereby prevent reflash. When fighting fire in electrical equipment, or on a bulkhead, the stream should be directed at the bottom of the flaming area, moving the horn from side to side and following the flames upward as they recede. While the "15-pound" carbon dioxide extinguishers are designed for hand application, they can be used in a small compartment to provide partial flooding. One or more extinguishers can be placed in continuous operation by slipping the "D yoke" over the depressed operating handle and the

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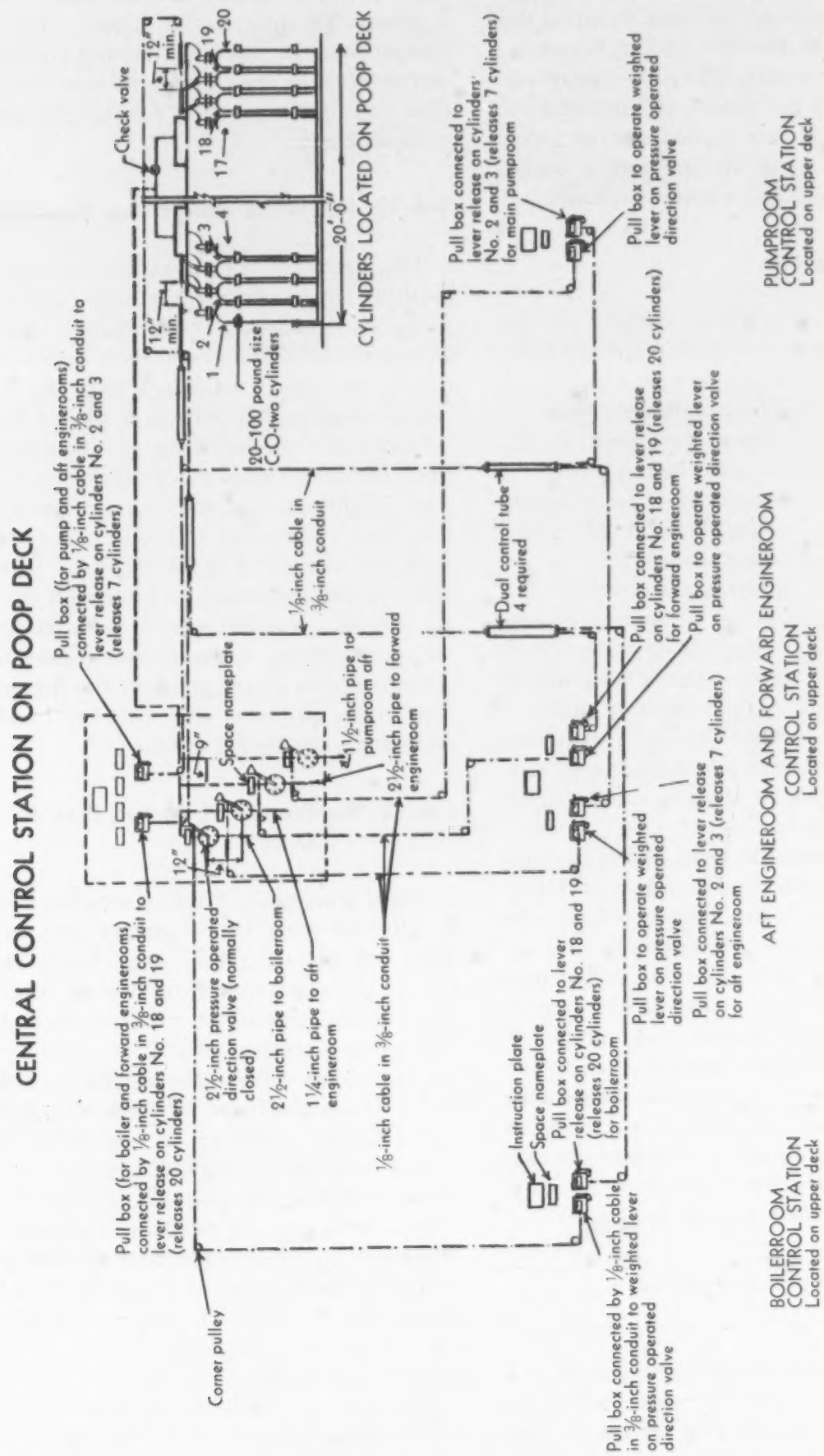

Figure 21.—Typical fixed CO_2 system.

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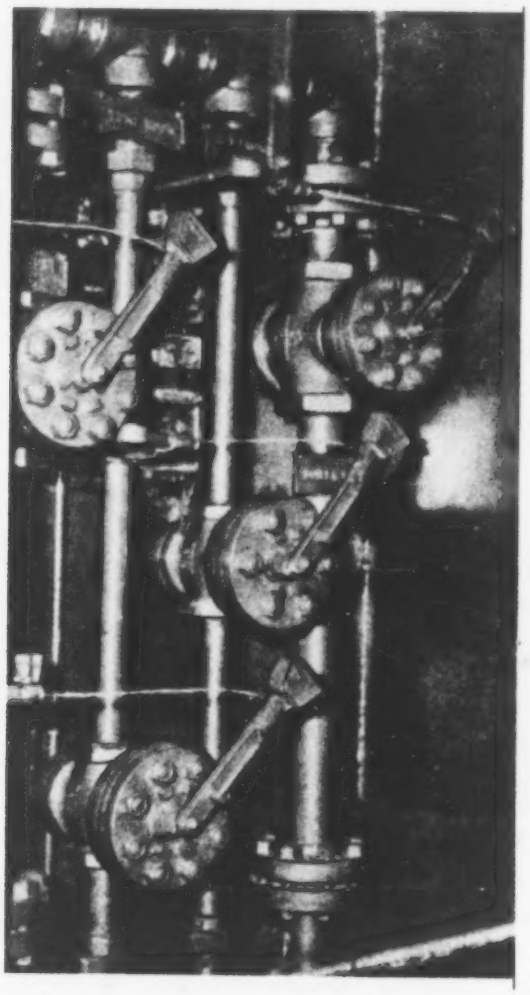

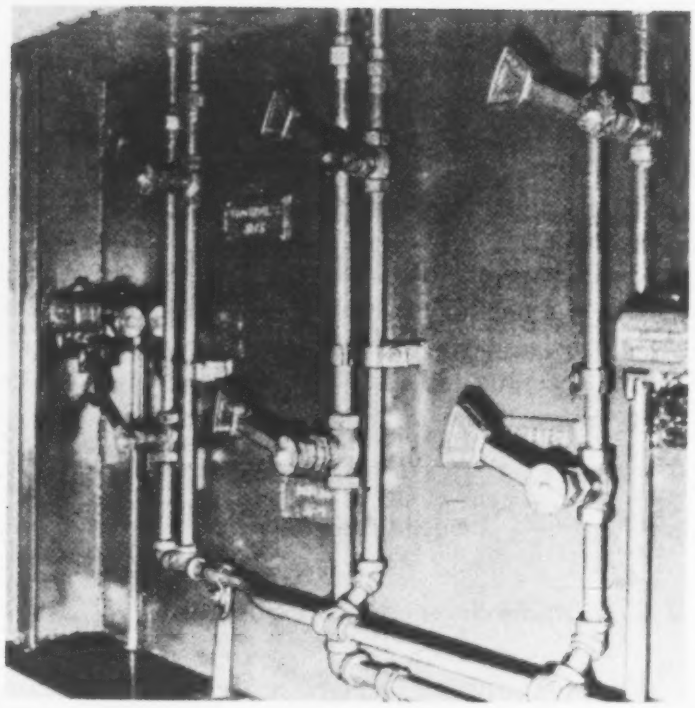

Figure 22.—Remote control directional valve stations.

extinguisher (s) tossed in the compartment, after which the door (s) should be closed. If the compartment is not too large, roughly one extinguisher will cover the bottom of a compartment 11 feet by 12 feet to a depth of 1 foot; this amount of gas will extinguish a fire of proportionate size.

If the fire is in the boiler room, *it is recommended that the fixed carbon dioxide system should be used only as a last recourse.* As carbon dioxide will support neither life nor combustion, before operating the fixed system, all personnel must leave spaces to which the system is connected. Fires must be extinguished and the auxiliaries stopped. Also, to prevent the loss of the carbon dioxide, the ventilation system should be shut down and all openings into the spaces closed. Although the valves in the system may be manipulated to shut off or direct the flow of gas to connected spaces, it is not practicable to shut off the entire system once the cylinder seals are broken when the system is placed in operation.

3–4–14. Recharging Fixed Co_2 Cylinders

Fixed carbon dioxide cylinders are not normally recharged aboard ship. At inspection by the United States Coast Guard, the cylinders are weighed and replaced if not standard. Necessary repairs and adjustments can be made at this time.

3–4–15. Precautionary Maintenance of Fixed CO_2 System

Certain precautionary maintenance measures are necessary to insure that a CO_2 system is ready to extinguish fires. A few of the most important are:

1. Keep the hammer on the chain attached to the pull box and never paint the glass.

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2. Never break the glass in a pull box except in an emergency.

3. Keep door (where equipped) at remote control directional valve station closed with lock and hinges working freely.

4. Do not paint name plates, valve stems, cables, sheaves, cylinder valves or other moving parts.

5. Do not adjust piping, valves, levers or attached cable.

6. Inspect fixed jet, horn outlets and perforated piping in system regularly to insure they are in place and clear.

7. Inspect wires and sheaves in system regularly to insure they are clear and appear operative and have not corroded.

The self-actuated carbon dioxide (CO_2) alarms in the compartments served by the fixed system should be tested with compressed air at each periodic inspection (and at 6-month intervals if possible) to insure they are operating properly.

Section 5. STEAM

3–5–1. Steam Smothering in General

Steam smothering systems are generally not installed on new vessels. With the exception of the fire main, the steam-smothering system is the oldest type of fire-fighting equipment installed aboard oil tankers. Its primary purpose is to smother fires in enclosed or confined spaces, during the course of which it tends to isolate the fire from its supply of air (oxygen). Steam also cools the fire and dilutes vapor-air mixtures to the point where they are too lean to burn or explode. The exhaust effect of steam in a tank or other compartment will expel flammable vapors through hatch openings, ullage holes and ruptures. This causes the flame lick to hover above and away from such openings with considerably reduced radiant heat.

Steam is an efficient extinguishing agent for "class A" and "class B" fires, provided there is no appreciable access for air near the surface of the burning fuel. When the steam is shut off, a vacuum is created (due to condensation) in the space surrounding the fuel, which causes fresh air to be drawn in in considerable amounts. Unless the fire is completely extinguished and surrounding surfaces sufficiently cooled, this fresh supply of air will cause the smouldering fire to flare up. Water or another extinguishing agent should be applied before or just after the steam is shut off. This tends to cool the fuel below its ignition temperature and prevent rekindling of the fire.

3–5–2. Steam Smothering System

The main line varies in size up to 5 inches in diameter, depending on the size of the vessel. The main is gradually reduced to a point where the open branch extremities are not less than 1½-inch diameter in any tank and are large enough to adequately flood the tank or other compartment in which it terminates. The United States Coast Guard Tank Vessel Regulations requires that a constant steam pressure of 100 p.s.i. be maintained at the master control valve for fire-extinguishing purposes.

3–5–3. Master Control Valve

The master control valve is located at main deck level either in the engine room spaces or adjacent to the athwartship passageway inside at the forward end of the after house. The location of all master control valves is indicated by a large sign with a "pointer arrow" painted in a conspicuous location adjacent to the valve. The "pointer arrow" should never be painted out. On certain vessels the master control valve may be operated not only at the valve, but also by means of a reach rod extended to the boat deck level.

3–5–4. Piping of Steam-Smothering System

The main steam smothering line extends forward from the master control valve. The line is supported by brackets either above deck or under the fore and aft walkway. It has lines branching off that service cargo and bunker tanks and cofferdams. Branch lines leading from manifolds located along the main line enter the tank or compartment it serves through the deck, except the pumprooms, where the branch lines enter the bilges. All branch lines have individual valves at deck manifolds. The lines are open ended inside the tank or compartment they serve.

Steam-smothering lines leading to forward compartments (paint locker, fore hold, etc.) are usually taken off a branch of the deck steam line. Like the main system, each compartment has its individual valve at a manifold located on the main deck level. Lines leading to forward and after pump

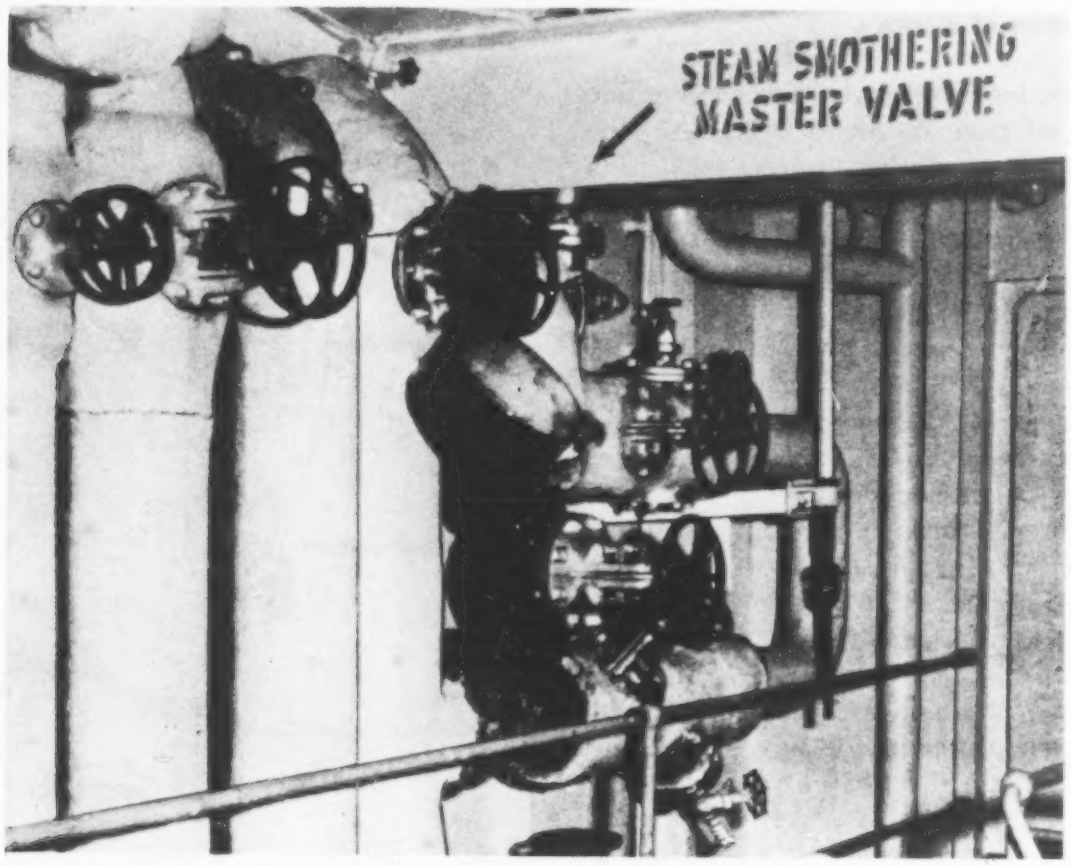

Figure 23.—Steam-smothering master control valve with cover open.

rooms are taken off a branch of the deck steam line and each has its own valve at main deck level outside the pump room it serves.

Steam-smothering lines leading to the engineer's paint locker and the air ducts beneath the furnaces each have their individual valves adjacent to the space protected and are usually taken off the auxiliary steam line in the fire room.

3–5–5. Maintenance of Steam-Smothering System

The steam-smothering system is a part of the vessel's permanent piping system and should be maintained in the same manner as other deck piping.

One of the methods found satisfactory for properly maintaining a steam-smothering system is regular inspection and test every 2 months. At this time and on a ballast voyage, the entire system up to the branch valves should be tested with steam at 100 p.s.i. After a reasonable time and upon finding the system "tight," the pressure is reduced and the branch lines blown through with steam to clear scale, etc.

Low points in the system should be protected from damage due to freezing by opening the drain valves during freezing weather.

3–5–6. Setting Valves on Steam-Smothering System

Steam-smothering lines to cargo tanks, cofferdams and fore deep tanks should be set as follows:

(a) Master control valve shut.

(b) Valves to individual tanks open at all times (except that valves may be closed when necessary to avoid cargo contamination. Also the valve to the fore deep should be kept closed when its being open would result in the fore deep being continuously smothered with steam).

The separate steam-smothering lines to the pump rooms, paint locker, forward compartments, and forehold should be set as follows:

(a) Master control valve shut.

(b) Valves to individual compartments open at all times, except when a valve being open would result in a compartment being continuously smothered with steam.

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3–5–7. Application of Steam

Steam as an extinguishing agent has definite limitations. It is effective on small "class A" fires (woodwork, bedding, clothes, stores, etc.) in a closed compartment. However, if the "class A" fire is deep seated, it will only beat down and control the fire, and a solid stream of water will be required to extinguish the embers.

Steam is effective on "class B" fires (oil, grease, paint, etc.) in a closed compartment, but in an open compartment it is likely to be dissipated. Steam acts in a manner similar to that of water fog but with much less cooling effect. Water fog cools the oil as it absorbs heat and is converted into steam and the steam then acts as a smothering agent. The smothering effect is achieved because steam displaces the oxygen of the air that is required for combustion.

In the absence of another extinguishing agent being immediately available, the steam-smothering system should be turned on—if only temporarily—regardless of conditions.

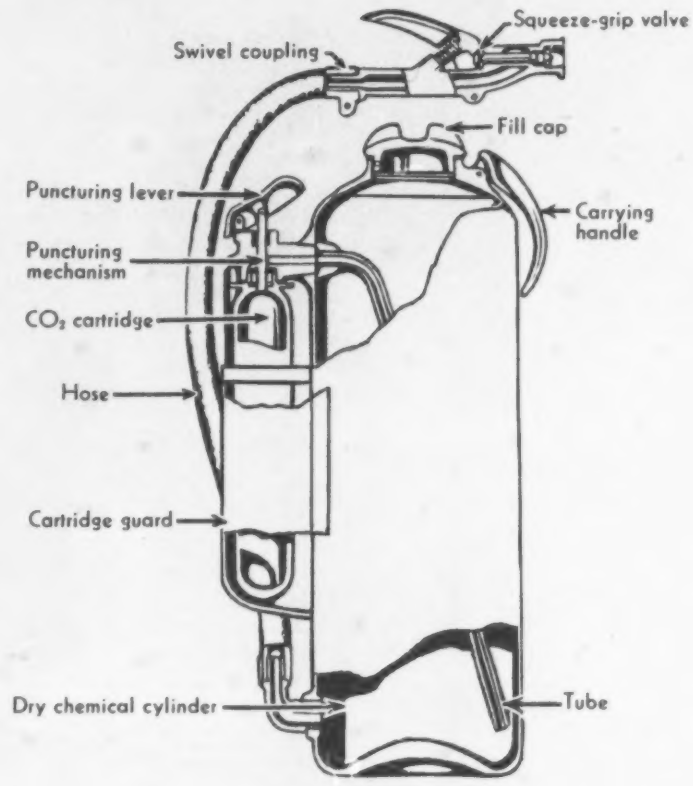

Figure 24—"30-pound" dry chemical extinguisher sectional view.

Section 6. DRY CHEMICAL

3–6–1. General

A development in the field of fire fighting agents aboard oil tankers is the use of dry chemical. The extinguishers are placed strategically throughout vessels where minor "class B or C" fires are more likely to occur.

Dry chemical extinguishers are effective on all "class B" fires (oil, grease, paint, etc.) and "class C" fires (electrical apparatus). The main objection to its use on "class C" fires is the fact that excess dry chemical used leaves a powder residue that may render electrical contacts or relays inoperative. While this powder may be blown or wiped off, such cleaning may be complicated by the delicacy of the electrical circuit or mechanism.

Two of the advantages it has over the carbon dioxide extinguisher are (1) greater range and (2) its stream provides an excellent shield for the operator. In fighting an oil spill fire in the open, the fire is as likely to rekindle or flashback when using a CO_2 extinguisher as when using a dry chemical extinguisher. Other advantages are the ability to recharge cartridge types aboard the vessel and it is non-toxic.

3–6–2. Dry Chemical Extinguisher

The dry chemical extinguisher presently in use is a seamless steel cylinder generally containing foam compatible dry chemical which has been processed to prevent caking and a charge of expellant gas. The charge of expellant gas may be stored in the cylinder or contained in an attached cartridge with pucturing mechanism. The newer stored pressure extinguishers are equipped with a pressure gage so that their condition can be ascertained at any time.

As neither the dry chemical charge nor the expellant gas are affected by normal temperature extremes and do not deteriorate or evaporate, periodic recharging is not necessary. At the United States Coast Guard inspection, extinguishers and cartridges are visually inspected and weighed to assure that they contain the required amount of dry chemical and gas.

Because there are many different methods of operating dry chemical extinguishers only a general description will be given here. Usually there is a locking device to prevent the accidental discharge of the extinguisher. This will have to be unlocked.

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It may be in the form of a pull ring pin; it may be that the hose will have to be removed from its stored position; or, it may take some other form. After the locking device is unlocked, then the operating device can be actuated. The operating device is more often a lever which will have to be depressed. On the small models there may not be a hose but the larger sizes generally have a hose with either a nozzle or a cone. Most of the nozzles are of the squeeze grip type which gives control of both direction and flow of the dry chemical.

To recharge the cartridge operated extinguisher, it is inverted and any remaining gas pressure in the cylinder is released by operating the squeeze-grip valve nozzle. The fill cap is then removed and the cylinder refilled with dry chemical powder in accordance with instructions on the name plate. *It is necessary to use the same kind of dry chemical powder to avoid a reaction between different powders which could cause caking.* The expended carbon dioxide cartridge is replaced with a fresh one and after reassembling the cartridge guard, cap and puncturing mechanism, the wire seals are replaced on the cap and ring pin. If a portion of the dry chemical has been discharged, it is only necessary to replace the expended portion: however, the gas pressure must first be released and then a fresh cartridge inserted. It should be noted that some carbon dioxide cartridges have left hand threads. After using, the hose and nozzle should be inspected to assure that they are clear.

Some of the stored pressure type will have to be sent ashore for refilling unless the vessel is equipped with a large tank of the expellant gas and the necessary equipment for recharging.

Care should be exercised when handling dry chemical extinguishers to avoid accidental pulling of the ring pin. The name plate, fill cap, carrying handle, cartridge puncturing mechanism and ring pin and nozzle with valve should be maintained free of corrosion and paint and coated with a light oil or clear grease.

3–6–3. Application of Dry Chemical

Dry chemical should be applied in a manner similar to carbon dioxide (CO_2), except that the powdery chemical must reach the base of the fire.

When practicable, the fire should be attacked from the windward side so that the wind will blow the heat away from the operator and at the same time carry the powder into the fire. If the chemical cannot be discharged to windward of the fire, the operator would still be afforded some protection as the cloud of powder will act as a heat shield. The stream should be directed at the base of the fire.

Section 7.—TYPES OF EXTINGUISHERS

3–7–1. Operation and Instructions

All portable fire-fighting equipment can be placed in the category of first-aid devices, which are provided close at hand for immediate use when needed. It should be understood that they are designed to cope with fires in their incipiency and are considered necessary despite the fact that fixed fire-fighting systems may be installed.

While the methods of operation of the various types of appliances are generally apparent from their very nature, and are indicated prominently on each extinguisher, it is important to give instructions to the ships' crews in order that through familiarity they may more intelligently and more confidently handle appliances during the excitement of a fire and thus accomplish the maximum of fire extinguishment in the minimum of time. These instructions should be supplemented by frequent demonstrations. It is extremely important that the instructions regarding maintenance be carefully followed so that the appliances will be always fully charged, in their designated places at all times, and in such a condition which will permit efficient operation at any moment without delay.

Each type fire extinguisher is of value, but all are not equally effective on various kinds of fires. On this account, consideration should be given to the class of fire which could occur.

All types of portable extinguishers should be properly recharged as soon as practicable after having been actuated and prior to returning to station.

3–7–2. Types of Portable Fire Extinguishers

The types of portable fire extinguishers used on board ships are listed in the following table, which shows the classes of fire each extinguisher is designed for and explains how to operate and maintain each type of extinguisher. This information is being presented in the simplest possible form to prevent any confusion or misunderstanding.

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Type of extinguisher	Class of fire: A Ordinary combustibles such as paper or rubbish	B Flammable liquids	C Electrical fires	How operated	Yearly maintenance	Remarks
Water or antifreeze (stored pressure type)	Yes	No	No	Pull locking pin and squeeze valve lever. Direct stream at source of fire. Discharge time is about 45-55 seconds. Range of stream is approximately 30 feet.	Determine that pressure gauge is in operating range and full liquid charge is in extinguisher. Recharge if pressure is low or liquid is needed.	Should never be located where continued temperatures lower than 40°F. may be encountered unless a special chemical charge is used rather than water.
Water, antifreeze or loaded stream (cartridge-operated type)	Yes	No	No	Turn bottom up and bump on deck or pull locking pin and squeeze lever. Direct stream at source of fire. Discharge time is about 45-55 seconds. Range is approximately 30'.	Weigh pressure cartridge and replace if end is punctured or weight is ½ ounce less than stamped on cartridge. Inspect hose to see it is clear. Add liquid to bring contents to fill marker or replace contents. Insert charged cartridge.	Should never be located where continued temperatures lower than 40°F. may be encountered unless a special chemical charge is used rather than water.
Foam	Yes	Yes	No	Turn bottom up. Best results are obtained when discharged against bulkhead just above burning surface so as to permit easy flow over the burning liquid. Stream should never be directed into burning liquid because it would increase chance of spread. The 2½-gallon extinguisher discharges an effective stream of foam for approximately one minute. The range is about 30 feet.	Discharge. Clean inside and hose thoroughly. Recharge.	Should never be located where continued temperatures lower than 40°F. may be encountered. Antifreeze ingredients such as common salt, calcium chloride, etc. *Must not be used* as they may either reduce the effectiveness of the discharge or change the nature of the discharge, or they may corrode extinguishers so as to make them dangerous for use.
Carbon dioxide	No	Yes	Yes	On squeeze grip type pull locking pin and squeeze trigger. On cutter disc type, after unlocking, valve is turned. Direct discharge at base of flames in slow sweeping motion. 15 pound CO_2 bottle will last approximately 12-20 seconds. Discharge has an effective range of approximately 2-5 feet.	Weigh. Recharge if weight loss exceeds 10 percent of weight of charge. Inspect hose and horn to see they are clear.	Although primarily for Class B and C fires, CO_2 can be of value on Class A fires. CO_2 can hold surface flames in check until such time as water arrives at the scene. Pressure inside bottle at normal temperature is about 850 pounds. Safety seal or relief valve is set to go off at 2,700 pounds, which is reached in temperature of approximately 140°F.
Dry chemical (stored pressure type)	No	Yes	Yes	Unlock locking device. Control discharge with operating lever. Direct discharge at base of flames in sweeping motion. Discharge is usually 12 to 20 seconds. Effective range is approximately 10-20 feet.	See that pressure gauge is in operating range. Weigh or otherwise determine that full charge is in extinguisher. Recharge if pressure is low or if dry chemical is needed.	Dry chemical is not affected by abnormal temperatures and is nontoxic. Although principally for Class B and C fires, Class A surface fires may be effectively controlled. In this application, dry chemical should be supplemented with water to extinguish any deeper seated fire which may be present.
Dry chemical (cartridge-operated type)	No	Yes	Yes	Operate pressure cartridge release and control discharge with squeeze grip nozzle. Direct discharge at base of flames in sweeping motion. A 20-pound unit will last approximately 10-16 seconds. Discharge has an effective range of approximately 6-20 feet.	Weigh pressure cartridge and replace if end is punctured or weight is ½ ounce less than stamped on cartridge. Inspect hose and nozzle to see they are clear. Insert charged cartridge. Be sure dry chemical is free flowing (not caked) and chamber contains full charge.	Dry chemical is not affected by abnormal temperatures and is nontoxic. Although principally for Class B and C fires, Class A surface fires may be effectively controlled. In this application, dry chemical should be supplemented with water to extinguish any deeper seated fire which may be present. One great advantage is that this type extinguisher is very simply recharged aboard ship in a minimum time.

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Chapter 4

FIGHTING FIRES

Section 1. BASIC STEPS

4–1–1. Detection and Speed

Early detection of a fire is of prime importance if successful fire fighting is to be accomplished. If a fire is detected while still in the incipient state and if the fire can be quickly reached with the proper fire-fighting agent and equipment, there would be little trouble in its extinguishment. Serious fires are often the result of small fires which have not been detected or acted upon quickly and which, reaching dangerous proportions, overpower and overtax the ability of personnel and available equipment.

"Speed" is the essence of fire and likewise the all important requisite of fire fighting. With an understanding of information previously presented in this manual explaining what fire is and describing firefighting agents and equipment, the fire fighter is prepared to review the methods and techniques for its actual control and extinguishment. With little or no experience in fire fighting, he knows in a general way what his task is and he is familiar with the tools and what he can accomplish with them. It remains then for him to apply this knowledge to problems confronting him on shipboard.

The basic steps in *successful* fire fighting are:

1. Locate fire and give alarm.
2. Get fire under control.
3. Extinguish fire.

After sounding the alarm, the fire fighter must quickly determine the following:

1. Where the fire is.
2. What is burning.
3. What is the extent of the fire.
4. What combustibles are in the immediate vicinity—in all surrounding spaces and in the compartments above and below.
5. What vents and other channels are present that would facilitate the spread of the fire.
6. What method of extinguishment is indicated.
7. What is the best technique to prevent the spread of the fire and to extinguish it.

4–1–2. Line of Action

Having learned where the fire is, the fire fighter determines what is burning and how extensive the fire is. In small or incipient fires he would proceed to extinguish without taking extensive measures to keep the fire from spreading, as such measures probably would not be necessary. For the purpose of this chapter, the supposition will be that the fire fighter has to deal with fires that have progressed beyond the incipient stage.

Upon learning where the fire is, what is burning, and the extent of the fire, a fire area is established. Within those boundaries, tanks, hatches and ports are closed. Ullage hole covers, Butterworth plates, tank tops, ventilation ducts, and all other vents not already closed are closed and secured throughout the vessel. Electrical circuits in the vicinity of the fire should be deenergized.

If handling cargo, bunkers or ballast, or if tank cleaning, all operations shall be terminated, valves closed and hose disconnected.

Insofar as practicable fires should be attacked from the windward side. By so doing, wind will carry flames with smoke and fumes away from the fire fighter and at the same time carry the extinguishing agent into the fire. This practice can be of immeasurable assistance, as fires are very likely to get out of control unless the fire fighter can get close enough to use the agents and equipment properly.

Section 2. EXTINGUISHING FIRES

4–2–1. Getting Fire Under Control

Getting the fire under control means the checking of the acceleration in the rate of increase and intensity and is attained largely through preventing ignition of additional combustibles. The fire fighter has all but conquered a fire at the moment he has confined it within the boundaries of an area

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he can take care of with the means available and has stopped its further development.

While the work of preventing the spread of fire is underway, the work of extinguishing is not neglected. The two are undertaken simultaneously and they are equally important. The experienced fire fighter would probably say that confining a fire within bounds is the more important of the two. He would consider that a fire so confined is definitely under control. His main problem would then be to put the fire out. The selection of the method of extinguishment is by far the most important decision which must be made by the fire fighter using his knowledge and experience as well as the devices available to him for shipboard fire fighting.

4–2–2. Fighting "Class A" Fires

"Class A" fires in bedding, clothing, wood, canvas, rope, paper, etc., are dealt with by cooling the fire to below its ignition temperature. All "class A" fires leave embers which are likely to rekindle when air finds its way under them. Hence the entire mass must be cooled thoroughly. For this purpose, water is the most effective extinguishing agent. If this were not done and the burning embers below the surface of the combustibles were left uncooled, the smothering fire would raise the temperature of the matter to the ignition point and the fire would break out again. Smothering with steam, CO_2 or dry chemical is not effective in completely extinguishing "class A " fires. However, in an emergency when any of these agents are more readily available than water, any one or more may be used to smother the surface and retard the propagation of the flame.

High and/or low velocity water fog may be used in the initial stages of the fire to get it under control. The fog will also serve a useful purpose in shielding the fire fighter from the heat, and to a limited extent in dispersing fumes and smoke. The solid water stream should always be used for final extinguishment and, if of sufficient pressure, will assist in pulling the burning or smothering combustibles part. In all "class A" fires it is essential that the combustibles be pulled apart to make certain that the extinguishing agent, water, can penetrate and thoroughly saturate all parts of the materials, even though the fire is apparently extinguished.

"Class A" fires are most often attacked from within a compartment. In this situation, if the fire fighter has to enter a hatch or has to advance more than a few paces within a compartment, he should be equipped with a life line. His purpose would be to locate the fire and get close enough to direct the stream and to insure thorough wetting of the burning materials.

On the modern oil tanker the greatest hazard presented by a "class A" fire is the possibility of its spreading to the vessel's cargo or, if in ballast and not gas free, to the explosive vapors in the tanks. Therefore, in putting hose lines into action against the fire, the fighter considers first the direction in which the greatest exposure or hazard lies. If he can do so, he begins operations between the fire and this hazard. From this point first and then from others, water is directed on the fire. When the fire has been extinguished, the fire fighter should stand by to watch for rekindling.

4–2–3. Fighting "Class B" Fires

"Class B" fires are those in flammable liquids such as alcohol, paint, turpentine, grease and all petroleum products where a smothering or blanketing method of extinguishment is essential to cut off the supply of air (oxygen). The extinguishing agents recommended are water, fog, steam, foam, carbon dioxide and dry chemicals. The particular agent or combination of agents will depend in each case on the nature and location of the fire.

When it is said that "class B" fires are those in combustibles that do not leave embers, it should not be concluded that these fires cannot be rekindled. When burning petroleum or other liquid has been extinguished, it may rekindle because of heat radiated from the vessel's structure or other object or from fire in the vicinity if it is more or less at its ignition temperature and its surface is exposed. To avoid rekindling under these conditions, a barrier such as foam, steam or water fog must be maintained between the liquid surfaces and the radiating heat.

"Class B" combustibles release vapors on the surface and, as in the case of all fires, it is the vapor air mixture that burns when the temperature of an object is raised to its "ignition temperature" in the presence of a source of ignition such as a spark or flame. The fire then is all on the surface and when the supply of air is cut off, the fire goes out. It may be that while fire is burning over the surface, only a shallow layer of the combustible is heated to its ignition temperature. In fact, the rate of heat pene-

tration in fuel oil is slow. Fuel oil burning for 10 to 12 minutes may have only an inch deep layer of oil heated to its ignition temperature. The longer a fire burns, the deeper the heated layer of oil will be, with corresponding increased intensity of fire. The problem of extinguishing a fire of this type is aggravated to a considerable degree the longer it burns. The answer is control and extinguishment in the early stage of the fire.

4–2–4. Fire in Cargo or Bunker Tank

To extinguish a fire in a cargo or bunker tank, an attempt should first be made to completely shut off the supply of air (oxygen). This may be accomplished by closing the tank tops, ullage hole covers, Butterworth plates and any other tank opening. In the case of a ruptured tank, thoroughly wetted canvas, bedding or similar material should be used to plug the opening if it is not too large. If this can be done, the steam smothering system (or, in the case of vessels so equipped, the fixed carbon dioxide (CO_2) or foam systems) should be used. Steam smothering valves on branch lines leading to pump rooms, cofferdams or tanks *not* on fire and which are *not* adjacent to such tanks, which are on fire, should then be closed. Water in the form of a solid stream or high and/or low-velocity water fog should then be used to cool the surrounding decks, bulkheads and other structural members. All "class A" combustibles (wood, bedding, stores, rope, etc.) and "class B" combustibles (paint, turpentine, grease and petroleum products) in containers in the vicinity should be removed to a safe distance if possible or, if not possible, thoroughly wet down and shielded from the fire.

If the supply of air cannot be shut off from the fire by closing tank openings, or if the tank is ruptured, foam (special foam must be used for alcohol or other products that mix with water) should be directed into the tank. For this purpose, either the "pick-up" unit or fixed foam system may be used to blanket the burning surface.

Foam applied on "class B" fires forms a stout smothering blanket, the thickness of which is determined by the character and the temperature of the oil beneath it. Oil burning for some time may be heated throughout. When this stage is reached, the foam has a greater tendency to break down and a larger quantity of foam must be applied. In this case, water fog may first be applied sparingly to cool the liquid and when the surface is cooled sufficiently, foam may be applied.

Foam serves exclusively as an extinguishing agent. It affords little protection to the fire fighter against the heat and fumes of the fire and it is not effective for cooling the hot structure of the vessel even after the fire has been extinguished. High-or low-velocity water fog, however, performs both of the latter functions and extinguishes fire as well.

High-or low-velocity water fog is effective for extinguishing high flash point oils by cooling them below their flash point or causing the quick formation of steam, which will drive the oxygen away from the combustion area. On low flash point oils, water fog must completely cover the burning surface and dilute the vapor-air mixture sufficiently to extinguish the fire. In both cases, water fog will slow combustion and absorb radiant heat.

On "class B" fires, steam acts in a manner similar to that of water fog but with very much less cooling effect; also, if injected in an open or ruptured tank, it may escape through the opening (s) to such an extent that it interferes with the fire fighters. It will, however, act as a smothering agent by displacing the oxygen of the air that is required for combustion.

It is accordingly recommended that as a first choice, water fog, or as a second choice, steam, be used in conjunction with foam whenever practicable. Water fog, however, should not be applied simultaneously with or on the foam, particularly if working at close range, as it will tend to dilute and disintegrate the foam blanket.

4–2–5. Fire in Pumproom

In view of the fact that most fires in the pumproom occur in the bilges or at pump level, it is difficult for fire fighters to approach the fire. If the fire is small or in its incipient stage, the portable foam, dry chemical or carbon dioxide (CO_2) extinguishers can be used effectively. Fires in the lower pumproom may also be extinguished by lowering from the main deck level one (1) or more hose fitted with "all-purpose" nozzles and high-velocity fog tips. When available, "fog foam" nozzles with "foam shaper" or "screen assembly" attached, used in conjunction with a fixed foam system, may be used in the same manner. If, however, the intensity of the fire prevents close approach, the pumproom should be sealed by tightly closing all openings and

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shutting down the mechanical ventilation system. On ships fitted only with steam smothering, the system should be turned on and the valves on branch lines leading to cofferdams or tanks *not* on fire and that are *not* adjacent to the pumproom should then be closed.

On ships so fitted, the fixed carbon dioxide, water fog or foam system should be turned on. Steam, if available, should be turned on in adjacent tanks and cofferdams.

Regardless of the extinguishing agent used, all tank openings throughout the vessel should be closed as quickly as possible and high and/or low-velocity water fog (or monitors if fitted) should be used to cool the surrounding decks, bulkheads, and other structural members.

4–2–6. Fire on Deck

Such fires may result from cargo overflow, bursting hose or leaking pipeline. The first action should be to shut off the supply of fuel if possible. Foam, if available, should then be applied, using either the "pick-up" unit or the fixed foam system. In such fires it is extremely important that the foam stream be played against a nearby vertical structure of the vessel; this will cause the foam to run down the structure and spread evenly over the fire. Foam can also be "bounced" off the deck ahead of the flowing fuel to splash gently over the fire. A foam stream played directly on the burning oil would cause it to scatter over the deck or dock, thus spreading the fire.

Foam is not effective on flowing liquids as the movement of the liquid prevents its forming a blanket. Therefore, if the supply of the fuel cannot be shut off and it is burning at its source, some other extinguishing agent must be used to extinguish the burning stream. For this purpose, portable carbon dioxide (CO_2) or dry chemical extinguishers or water fog are effective when applied directly on the burning fuel as it emerges from the opening. Foam should be sprayed ahead of the flowing fuel to form a dam and thereby prevent the spreading of the fire.

High- and/or low-velocity water fog should be used to augment the foam and to cool the surrounding structure of the vessel and to protect the fire fighters using the foam, thereby permitting them to approach closer to the fire. However, the water fog should be used in such a manner so as not to affect the firmness of the foam blanket or dam.

All tank openings throughout the vessel and the pump rooms should be closed as quickly as possible.

4–2–7. Fire in Machinery Spaces

To extinguish a fire of this type, an attempt should first be made to extinguish it by means of the portable foam, dry chemical, or carbon dioxide (CO_2) extinguishers or foam "pick-up" unit (or fixed foam system) or waterfog, depending on the location and type of fire. *The fixed carbon dioxide system should be used only as a last recourse when all other means of extinguishment have failed.*

As carbon dioxide will support neither life nor combustion, before operating the fixed system, all personnel must leave spaces to which the system is connected; the boiler fires must be extinguished and the auxiliaries stopped. Also, to prevent the loss of the carbon dioxide, the ventilation system should be shut down and all openings into the spaces closed. Except in an emergency, spaces that have been flooded with carbon dioxide should not be opened for at least 10 minutes after flooding. This is a precautionary measure to allow burning substances time to cool down below their ignition temperatures and thereby prevent their reignition upon the admission of fresh air (oxygen).

Regardless of the type of extinguishing agent or equipment employed, waterfog should be used when necessary to protect the fire fighters and to cool the hot structure of the vessel.

4–2–8. Bilge Fires

Since it is difficult to gain access to this type of fire, low-velocity waterfog should be used with an applicator in conjunction with foam applied as described under *Fire on Deck.*

4–2–9. Spill Fires on Floor Plates

As this type of fire is usually due to a ruptured fuel line or leaking connection to burner, the source of the supply should first be shut off. The fire can then usually be extinguished with a portable foam, dry chemical, or carbon dioxide (CO_2) extinguisher or, if necessary, waterfog. In this case, low-velocity is more effective and is recommended over high-velocity fog.

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Small or incipient fires in the fire room can often be extinguished with sand spread with the scoop.

4–2–10. Burning Oil on Water Surrounding Vessel

The most effective manner of fighting a fire of this type is to apply foam as described under *Fire on Deck*. If possible, the foam stream should be directed against or as close as possible to the side of the vessel. This will cause the foam to flow outboard over the surface of the burning oil in an even blanket.

In the event sufficient foam is not available, solid streams of water should be directed at the edges of the burning oil, thus setting up a surface current which may carry the oil clear of the vessel.

When applying foam and/or water as described above, wind and current conditions must be taken into account. If the wind is blowing in the *same* direction as the current is flowing, the application should be to windward and above the oil. If, however, the wind is blowing *opposite* to the flow of the current, the application will depend on which is the stronger. The object is to apply the foam and/or water so that it flows down on the oil carrying it away from the vessel.

Preparations should be made to get underway; if advisable, the vessel should steam clear of the burning oil.

4–2–11. Fighting "Class C" Fires

"Class C" fires are those in electrical equipment that may be caused by short circuits, overheating, or the spreading of "class A" or "class B" fires. When equipment so involved cannot be deenergized, the danger of electrical shock and short circuiting must be guarded against. Pure distilled water is not a conductor of electricity; fresh water usually is because it contains minerals. The conductivity of sea water is many times greater than that of fresh water.

In view of the above, a solid stream of water must never be used to extinguish fires in electrical equipment that is energized. The hazard is reduced, but not entirely removed, when water is applied with the high-velocity fog tip on the "all purpose" nozzle and further reduced when applied with the low velocity fog head on the "applicator." Therefore, in so far as practicable, electrical circuits should be deenergized before any extinguishing agent is applied.

The portable carbon dioxide (CO_2) extinguisher is usually the most readily available extinguishing agent and is recommended as first choice as it is a nonconductor of electricity, offers protection to the fire fighter against electric shock and is less likely to damage equipment.

The fixed 50-, 75-, or 100-pound carbon dioxide (CO_2) cylinders, where installed should be used when required. However, the fixed system protecting the machinery spaces should only be used as a last recourse, when all other means of extinguishment have failed.

Dry chemical, if available, is an excellent extinguishing agent. However, it is not as satisfactory as carbon dioxide as it leaves a residue.

On "class C" fires (electrical apparatus) when the equipment is deenergized and when neither carbon dioxide nor dry chemical is available, waterfog or foam may be used.

4–2–12. Liquefied Flammable Gas Fires

Methods of combatting liquefied flammable gas fires aboard ship depend primarily on the equipment aboard the individual vessel. However, fires of escaping liquefied flammable gas should generally be extinguished only by stopping the flow of gas. At the same time water spray should be used to cool surrounding material while shutoff efforts are underway. Extinguishing a large LPG or LNG fire and permitting the gas to continue flowing can be dangerous in that a flammable mixture may be formed in the air—the ignition of which may cause far greater damage than if the original fire had been allowed to burn.

Flames from small leaks may be extinguished by utilizing carbon dioxide or dry chemical extinguishers, provided so doing permits closing valves to stop the flow of gas.

If fire is adjacent to an LPG container, but no gas is escaping, immediate steps should be taken to keep the container cool, thus diminishing the possibility of a buildup of pressure, or the container should be removed immediately from the fire area if this is possible.

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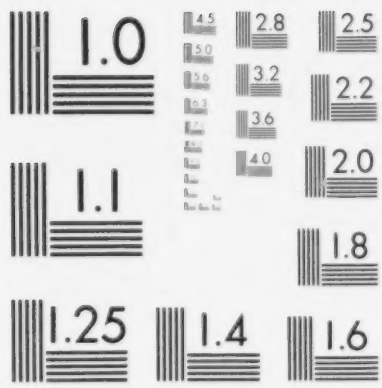

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Chapter 5

CASE HISTORIES OF TANKER AND BARGE FIRES AND EXPLOSIONS

Section 1. CAUSE AND EFFECT, METHODS OF EXTINGUISHMENT

5–1–1. General

In this chapter we will consider some case histories of fires involving petroleum tank vessels and barges. We will discuss various methods of extinguishment, comment on prevention of that type of fire and touch on various lessons to be learned from the fire under consideration.

Prior to proceeding to tales of flame and destruction, consider the fact that will help you to evaluate the pictures we are about to draw. This fact is that the handling of petroleum products in tank vessels and barges can be done with utmost safety if certain well known precautions are taken. Hundreds of thousands of barrels of flammable products are handled daily without incident.

Where fires do occur, the basic cause can usually be traced back to human failure—a failure to do something or a failure not to do something.

5–1–2. Smoking

Examples of fires will be discussed in the approximate frequency of their occurrence. Most fires aboard tank vessels and barges occur in the living quarters where the contents of wastebaskets are ignited by discarded smoking materials. Such fires rarely do much damage. They may be readily extinguished by placing the basket in a shower or by use of the nearest hand fire extinguisher. This type of fire can easily be prevented by keeping the quarters shipshape, by keeping wastebaskets cleaned out and by the disposal of smoking material into ashtrays or specially designated containers.

Experience has shown that it is a good idea to have metal wastebaskets. They should not be wire mesh nor fiber of the type that may burn. One vessel we know of had 3 fires in 1 night in wastebaskets—a sad reflection on the standards of housekeeping found on that ship.

Probably the next most frequent fire is that of mattresses or bedclothing igniting from smoking in bed. A man exhausted from lack of sleep might become involved in such a fire. Likewise, there are a few individuals who are abnormally hard to waken. They, too, might be unaware of burning bedclothes. Then there is always the suspicion that the person involved had a few drinks; not drunk perhaps, but with "sufficient aboard" to dull his senses. Generally, some one smells the smoke and hauls the sleeper out; here's a case where they didn't get there in time.

A master lost his life from smoking in bed. The ship was in port alongside a wharf. Smoke was detected on the bridge, coming from the speaking tube leading to the master's quarters. The door to the quarters was opened and his body was found on the deck. The mattress was on fire. An autopsy revealed that he had died from lack of oxygen. It also showed that he had had a few drinks but that he was not drunk. The fire had consumed the oxygen in the air. The man had apparently attempted to reach the door but hadn't made it.

Extinguishment of fires in mattresses is extremely difficult. We know of one case where a mattress caught on fire. Our hero, stimulated by having a large hole burned in his shorts, sprang from bed, threw the mattress into the nearest shower and soaked it thoroughly. He then placed it on a steel deck. Next morning all that remained were the steel springs. Deep-seated fires in mattresses should be extinguished with plenty of water and by pulling the stuffing out. Since the mattress would be ruined, it is probably better to throw it overboard. *This should not be done in port.* Some ships prohibit smoking in bed. Others concentrate on seeing that adequate ashtrays are on hand. It is excellent practice to have routine fire inspection made of the quarters, paint lockers, and storerooms during the night watches when people are not up and around.

There have been occasional fires in linen lockers on tankers. Here is an example.

At approximately 1100, while the ship was in port, a mess man was sorting ship's linen to be sent

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ashore for laundering. He was smoking and hot ash was accidentally knocked from the cigarette. After what he thought was a careful search he concluded it was not in the laundry pile.

At 1225 the steward was in the adjacent passageway. He smelled smoke, investigated and found the soiled linen and wood-covered bulkheads aflame. He passed the word and the general alarm was sounded. The officers and members of the crew used a few buckets of water and the fire was extinguished. The fire hoses were extended in readiness but were not used.

Damage, amounting to approximately $2,000, was confined to paint, steampipe lagging, electric wiring, 20 sets of linen, and the wood-covered section of bulkhead.

5–1–3. Galley Fires

Accidental fires in the galley are not numerous but they do occur. Here is an example.

The fuel tank for the galley range was located on the starboard side of the poopdeck, above and slightly to the stern of the galley skylight. At 1800, while this tank was being filled with kerosene, the kerosene spilled over, mostly onto the deck underneath the tank. Some of the kerosene splashed through the open skylight onto the hot galley range, ignited and communicated the flames to the kerosene on the poopdeck.

The fire on the deck was extinguished with water hoses within 6 minutes. The fire on the galley range involved the range's grease trough but was extinguished with a 2½-gallon foam extinguisher.

Here's what happened. Kerosene had been loaded into the galley bunker tank, leaving 7- or 8-inch outage. The ship's filling line valve had been closed at 1815.

A few minutes later, the wharfman on the dock asked the boatswain to open the galley bunker line valve so the dock hose could be airblown. The boatswain complied. When the hose was blown, the extra product in the line was blown into the tank where it overflowed. The fire was discovered by the mate, who was on the bridge wing. The mate sounded the alarm, and called the engineroom, ordering the fire pumps started. The ship's officers and men manned three hoses. On arrival on deck in response to the alarm, the chief mate ordered the dock to shut down all cargo loading. He ordered the seamen on deck at the risers to shut down the ship's risers and disconnect the cargo hose. He also ordered the boatswain to turn on the steam smothering to the cargo tanks.

Damage amounted to $1,500. It included severe damage to the handwheel, the taffrail, the log rotator and connector, the vegetable bins, and electric wiring to the binnacle. Paint on the deck, bulkheads, emergency wheel, engineroom telegraphs, rudder indicator, and bunker tank was charred, blistered, and smoked up in varying degrees.

Fire in galley ranges using diesel, stove oil, furnace oil, or kerosene as fuel may be readily extinguished with waterfog.

Another type of galley fire is sometimes found where bottled gas is used as fuel. Here is a case.

The cook turned the oven on approximately 20 minutes before the accident to prepare for baking. There were also one or more burners going on top of the stove. When he opened the oven to place a tray of cookies inside, a flashback took place. The man was burned about the arms and face. Apparently the pilot light to the oven was out when the man turned the gas on. It became ignited from the burner fires on the top of the stove. Explosions of this type may be prevented by proper maintenance of pilot lights, by shielding from drafts and, above all, by personnel making sure that ovens are lit.

5–1–4. Spontaneous Combustion Fires

A source of fire against which seamen must be constantly on guard is that of a spontaneous combustion. Spontaneous combustion occurs when vegetable oils or paints oxidize under conditions that permit the heat of oxidization to be retained and to build up to the point where something is set on fire. The usual case is an oil-soaked rag. Here is an example of such a fire in the deck paint locker on a T–2. This compartment is located under the fo'c's'le head. Details are given in the master's report.

DEAR SIR: This is to inform you that while this vessel was proceeding from Honolulu towards San Pedro on the morning December 18th at 1 A. M., smoke was detected from the bridge coming from forward. A man was sent to investigate and reported a blaze in the paint locker. The general alarm was sounded, the vessel was stopped and run before the wind. Bulkhead doors were closed, steam smothering lines opened, and water turned on main fire lines. Due to quick action, the fire was extinguished in a few minutes with minor damage. Upon investigation, it was found that the fire was caused by spontaneous combustion of waste paint

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rags, and could have been serious under certain conditions.

The crew were assembled at quarters the following day and lectured on the hazards of leaving rags and other waste material in all parts of the ship, including excess wastepaper in the baskets in their quarters. Officers were cautioned to see that periodic rounds of the ship on their respective watches were made during the night.

If the crew will take the above instructions to heart one-half as much as they do their overtime, I believe we will have no more fires from this cause.

Respectfully,

_____ _____
Master

The letter outlines methods of extinguishment. While the letter doesn't say so, water fog was also used. This type of fire may be prevented by keeping paint lockers shipshape or, to use another term, by good housekeeping; *Specifically, waste materials, oily rags, etc. should be disposed of properly.*

5–1–5. Boilerroom Fires

Here's an example as told by a chief engineer:

Once upon a time there was a fireman that fried himself. We were headed home from the Canal when it happened. The 12-4 fireman put in a burner and didn't get it in quite straight. When he turned on the oil, a little leaked out. Instead of shutting off the oil, which was easy—there was a valve right at his fingertips—he slacked off on the yoke and tried to straighten the burner. That did it. Oil blew out in a fan and caught fire. The fuel pump took off. I was up forward at the time. When I got down below the second was trying to get into the fireroom. There was quite a blaze going by this time. The bitumastic on the fireroom tank tops melted and caught fire. We secured the engines to keep our steam, laid out fire hose and started to move in. At the same time we shut off the fuel pumps with the reach rods that run to the boat deck. We soon got the fire out.

We found the fireman. He had gone up the escape, crossed over the back of the boilers and was down on one of the gratings. He was a mess—burns and fuel oil—but still alive. We got him out of there and started to work on him.

Sparks was pounding the key, and as luck would have it, raised a battleship. She was just a few miles from us, hull down on the horizon. We both headed for each other and in short order one of the battleship's boats was alongside. We got the fireman onto a stretcher and into the boat. They were able to save him. I saw him about a year later. He was all right except for a few scars. Bet he never pulled a live burner again.

This type of fire can be prevented by firemen shutting off the oil before slacking off burners. There are also several mechanical devices that can be installed in the burners which will limit the flow of oil and, in most cases, stop the flow of oil if a fireman pulls a live burner.

Duplex fuel oil strainers have also been the seat of fires when, through mistake, the cover has been partially removed from the strainer in use. Removal of the wrong cover may be prevented by installing a flat shield on the switchover lever. Strainers should be so located that hot furnace fronts will not be sprayed with oil should a cover warp or otherwise spring a leak. A Liberty was lost several years ago when a fire occurred in her fireroom. Something happened to the cover on the strainer and fuel oil sprayed onto the furnace fronts and ignited. The loss of a vessel from a fireroom fire is a story in itself but it leads us logically to a consideration of how such fires can be controlled.

We can group both of the examples cited above under the heading of spilled oil and make these general statements. If the spill of fuel oil is small, the fire may be fought with hand extinguishers or sand. If the fire is being fed with oil under pressure, *the flow of oil must be stopped* before the fire can be extinguished. Action required in each case must be decided on the spot. Many things may need to be done almost simultaneously. If underway, the main engine may have to be stopped, the chief engineer and the bridge notified, a general alarm sounded, the induced and forced ventilation in the fireroom stopped, the fire pump started, the fuel pump shut off and the fire attacked. Water fog or foam are particularly effective in fighting fires in fuel oil. If the fire cannot be extinguished with water fog or foam, then the space should be sealed and the CO_2 flooding system used if provided.

Here's another example of fire in a fireroom.

A motorship was moored to a refinery dock and was discharging heavy residual fuel to shore tankage. At 1110 a fire occurred in the air ducts of the motorship's auxiliary boiler, which furnished steam to the cargo pumps.

Fuel oil drippings, from burner changing operations, had been allowed to accumulate for a considerable period. The burners had been changed just before this fire, and some hot oil had been permitted to drip into the duct. When the burner was lighted again, a flareback ignited the vapors from the hot oil in the duct.

The first assistant engineer decided to control the fire in the duct with CO_2 from hand-portable fire extinguishers and with water fog nozzles, and allow it to burn out. The dock man was notified after the fire had burned for approximately 1 hour and when replacement of the contents of the sev-

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eral fire extinguishers used was obviously required. The dockman transmitted the problem to the refinery fire chief, who responded with a supply of replacement extinguishers and a small crew. These augmented the efforts of the first assistant engineer and his men, materially assisted in keeping the fire under control, and prevented further damage.

The oil accumulation in the duct was larger and more extensively spread than the first assistant engineer had thought. The fire gradually spread and involved almost the entire area of the duct under the boiler.

The heat of the fire warped, buckled and damaged the duct plates, the boiler front casing, its supports and the front brick-supporting plates of the firebox, to the extent of $12,500.

Lessons: Proper instruction in burner-changing operations by the engineers would have prevented oil dripping into the duct, or at least would have *required oil drippings to be cleaned up* on occurrence, thus preventing accumulation and subsequent ignition.

Judgment on the part of the first assistant engineer in this case should have dictated; rather than letting the fire in the ducts burn—immediate extinguishment, boiler shutdown and cooling the fireboxes, followed by thorough cleaning of the air ducts.

5–1–6. Air Heaters

The next topic that might be taken up is fires in the uptakes of boilers fitted with air heaters. Here is what a chief engineer has to say on the subject.

On numerous occasions, fires have occurred in air heaters of water tube boilers resulting in considerable damage and resultant delay of vessels for repairs. The majority of these casualties undoubtedly were due to neglect on the part of those responsible for the upkeep of the boilers, in that soot blowers were not properly used.

In most cases where fires have occurred, it was found that the soot blowers had not been used frequently enough. This is particularly liable to happen on vessels that have been in port for an extended period of time. Poor combustion and unsatisfactory cleaning of boiler heating surfaces during repair periods are contributing factors in air heater fires. If soot deposits are allowed to accumulate in the uptakes and stacks, they may be loosened by mild explosions or vibrations and drop onto the tops of the air heaters where they may become ignited and burn, melting the air heater tubes. The mild explosions referred to may be caused by the practice of lighting burners from hot brickwork or from inserting a torch in a gassy furnace without first purging the furnace by opening the air registers. A mild explosion in a dirty furnace may produce a serious explosion in the following manner:

The first explosion dislodges soot and carbon which floats in the air like a cloud of dust. This material then ignites and explodes with considerable violence. Incandescent carbon particles, due to incomplete combustion; are carried through the gas passages of the boiler, settling on air heater tubes, and start burning when disturbed by excess draft.

Fires in air heaters may be prevented by maintaining good combustion and knowing the normal temperature above and below air heaters and immediately investigating any abnormal difference. Soot blowers should be frequently and properly used, especially when there is a light load on the boilers. When using soot blowers, blow air heaters first then start at the bottom and work up, finishing with blowing air heaters for the second time as outlined in instruction books. Increase the forced draft fan pressure approximately one inch while blowers are in use. Hand torches should be used when lighting off burners, and oil should be recirculated so that immediate ignition takes place when the torch is applied. Frequent inspection of the heating surfaces for soot accumulation should be made, especially of those parts not cleared by the soot blowers. When hand-cleaning the surfaces of boilers, start at the top and work down.

In the event of a fire starting in the air heater of a boiler, immediate action is to shut down the boiler by shutting off the oil supply. All burners should be removed, air registers shut, forced draft fan stopped and inlet damper closed. The water level in the drum should be raised to a full glass and, if the vessel is underway, the bridge should be notified that the vessel's speed and maneuvering ability will be restricted. Locate the fire by opening the access doors in the uptakes and flood the area with CO_2 gas or other fire extinguishers. Water may be used if no other means of extinguishing the fire are available. Don't flood the engine room with CO_2 gas as was done on one ship.

Do not use soot blowers to extinguish the fire as such action may stir up a carbon dust cloud, which might ignite and explode.

Fires in stacks are not common in the modern-day vessel. What may be referred to as a stack fire is more probably a fire in the economizers or air heaters. As noted above, these may be fought with CO_2 or, as a last measure, with water. As with most fires, they are easier to prevent than they are to extinguish. Faithful use of the soot blowers will prevent conditions in air heaters, economizers and stacks that will make fires possible.

5–1–7. Fires From Using Gasoline To Clean Clothes

Since it is possible for crew members to surreptitiously obtain petroleum products from the cargo, there have been fires from using improper cleaning oils.

A tanker was discharging casinghead gasoline. At 1215 an explosion took place in the after quarters. Fortunately no one was injured and the damage to the ship was slight. The potential hazard, however,

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was very great. Had the fire spread to the cargo, it could have been a catastrophe.

Here's what happened. The engineer on watch and the oiler, on hearing the blast, checked over the engineroom and finding everything in proper order, investigated and found a fire in the laundry room on the port side. The fire seemed to be around the washing machine and in the forward outboard corner of the room. Some rags or clothes were burning on the deck of the laundry. The engineer and the oiler grabbed a 2½-gallon foam extinguisher from a bracket in the alleyway and put the fire out. By this time, the deck gang had shut down discharging and joined the fire fighters.

The washing machine was found to be about one-quarter full of a liquid which gave off a strong, gassy odor. A sample of this liquid was tested in a lab and found to be pure casinghead gasoline. The casinghead was drained out of the machine and the space was ventilated. The discharging of the cargo was resumed.

Accidents are investigated so that we may learn how to prevent similar accidents; therefore, let us consider what lessons this fire teaches.

First and most important:

Never use gasoline for cleaning purposes.

Clothes should never be washed in a ship's washing machine with a petroleum product. Any petroleum product heated above its flashpoint will give off vapors that can be ignited. Kerosene is thought of as being comparatively harmless. Put it in a washing machine, mix with hot water and the kerosene will give off vapors that can be exploded quite as readily as those of casinghead.

Here is another case. A tankship had been loading gasoline for about 6 hours at 3,000 BPH.

A crewman secured a bucket of gasoline for cleaning clothes and was doing the cleaning in the after quarters. The gasoline vapor ignited from some unknown cause. Apparently considerable vapor had accumulated because in the vapor flash, 10 men were injured, 4 fatally. One of the men ran out on deck on fire and in passing the tank tops with open ullages, four of the ullages ignited.

Under considerable difficulty because of smoke, the fires in the quarters were extinguished with water streams. The ullage fires quickly subsided as loading was shut down and the subsequent small vapor fires were readily extinguished as the plugs were closed.

5–1–8. Pumproom Fires

Any fires involving cargo are extremely serious. In many cases the fire may be preceded by an explosion.

The most likely location for a cargo fire to occur is in the pumproom. This is because there are generally small leakages of fuel from, say, pump glands. On occasion there may be larger releases of fuel, either through accident or during normal operations. Changing blank flanges sometimes allows petroleum products to drain out of the lines. There are potential sources of ignition in rapidly rotating machinery. Then there is the human factor. Since this is a space which men enter, they may do something that provides a source of ignition. Here is a case.

Case I:

The ship was at sea with a full load of casinghead gasoline. A new second pumpman had been hired at the previous port. He had been instructed clearly regarding smoking rules on the ship.

After the ship had been at sea, he had been given the job of cleaning a strainer on a suction line to one of the pumps in the pumproom. While he was removing the cover plate on the strainer, a flash fire occurred in the bilge. There was no explosion. He escaped with serious but not fatal injuries.

Smothering steam was opened to the pumproom and three water hoses played into the open door at 0903. Heavy smoke continued and at 1010, the ventilators were covered with wet canvas to aid in smothering the fire. At 1045, a heavy explosion blew out one skylight cover and sprung the other. Shortly afterward a second explosion of lesser intensity occurred. At no time was there any flame visible on deck. At 1233, the ship arrived at port and was anchored. By 1250 the fire burned itself out.

The investigation indicated that presumably a valve packing gland leak or gasket leak had caused a small skin of gasoline to collect in one part of the bilge but not where the man was working. Apparently he left the job, where he put his tools down in orderly fashion, and walked over to where he could see above and then stepped back and lit a cigarette.

Evidently the small bilge flash and fire ignited paint which did not respond to the remote water streams or steam smothering. There was no evidence of fire where the man had been working near the pump. Very likely the fire heated closed-in pipelines containing the gasoline and the pressure caused a gasket to fail at a point some distance from the flame. The delayed ignition caused the low grade explosion.

The lessons that can be learned from this fire are obvious. Tankermen will find it hard to believe that anyone would smoke in a pumproom but it did happen and it's not the only case. We know of another tanker where a chief engineer was killed in a pumproom explosion. Once again the source of ignition was smoking.

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Case II

Here's another case of a pumproom explosion.

A vessel was discharging a cargo of natural gasoline. Early in the morning, the starboard main cargo pump was shut down because of a broken steam valve rod. It was necessary to repair the starboard pump in order to complete discharging the cargo. Accordingly, at 1015, the vessel shut down and started circulating the lines in the pumproom in order to flush out the gasoline. About 1100, seven men were in the pumproom. One man was making a survey of the repair work, the others were washing the bilges preparatory to their being tested by a yard chemist.

At 1113, an explosion occurred in the pumproom that shook the ship and was audible at some distance.

Two of the men were killed by the explosion and the others were burned. They were hospitalized and recovered.

Investigation showed that the source of ignition was a portable electric extension light which had been dropped in the bilges. The source of fuel was a small amount of natural gasoline in the bilges.

This casualty emphasizes the necessity for certain pumproom precautions. First, when the vessel is not gas-free no portable electrical equipment is permitted in cargo or fuel oil tanks, or cargo pumprooms, or in any enclosed space immediately above or adjacent to the bulk cargo tanks, except that lighting may be obtained by the use of approved explosion proof self contained, battery-fed lamps. Second, such spaces should be tested with a gas indicator when there is any doubt it contains explosive mixtures of petroleum products. Third, it shows the importance of keeping the bilges clean.

Another lesson taught is the need for good ventilation in pumprooms. This need has been answered in modern pumprooms with power ventilation taking suction in the bilges and gratings instead of floorplates to promote good ventilation.

5–1–9. Cargo Tank Fires

Fires in cargo tanks are unusual but when they do occur the results may be tragic.

Case I

A T-3 tanker was loading butane blend (a synthetic casinghead gasoline) into a number of tanks. Other tanks had already been loaded with a variety of petroleum products, aviation gasoline, ethyl gasoline, and diesel and stove oil. Two tanks were empty. Loading continued without incident from 1600 until 0200. At that time, there were two extremely severe explosions.

Shortly after the explosion, fire-fighting parties reported to the scene.

As a result of their efforts and the fact that there was no current and no wind, the fire was held in check and by mid-afternoon was extinguished.

Thirteen lives were lost, the vessel was a total loss and the wharf was destroyed.

Here is how we reconstruct events. It was an unusually calm night. The butane blend was being handled at or above its boiling point so that unusual amounts of vapor were being released through the ullage holes. A vapor cloud formed on deck so dense that men could not work in it. Inevitably this cloud reached a source of ignition, probably in the midship house in the quarters. The flash fire was communicated to the empty tanks through the open unscreened ullage holes. The tanks exploded and ruptured adjacent bulkheads, releasing fuel to the fire. The fire spread on the water over a large area and burned itself out.

The residual fire on the ship was extinguished with water.

There are two lessons to be learned from this casualty. Should vapors accumulate on deck, all cargo handling should stop. Empty tanks into which no cargo is being loaded should have their ullage plugs dogged down.

Here is a case. Two supertankers collided in inland waters. One vessel was empty. She caught fire and exploded. The fires on her soon died out as the fuel was consumed. The other vessel was loaded with 160,000 barrels of gasoline. She caught fire forward and ultimately all eight gasoline cargo tanks were aflame. Flames were coming from cracks in the deck plating, from vents and from cargo hatches.

The task of extinguishing the fire became too great for local fire officials. After the fire had burned for 3 days, a Navy tug and a U.S. Navy fire-fighting party took on the task of extinguishing the fire. Two slow passes were made alongside the tanker while four monitors on the tug sprayed the decks of the tanker with sea water for cooling purposes. A third pass was made using foam from the tug. Fires were extinguished forward on the tanker enough to allow boarding her forward and fight the fire close at hand. Foam was introduced through small openings in the tank tops. The blanketing of the liquid surface in the tanks with foam soon had the fires extinguished. Other parties extinguished minor class A fires in the forecastle and, later, the poopdeck area.

Fire-fighting evolutions were halted for approximately 4 hours at one period due to an insufficient foam supply. Cooling down operations were conducted during the interim to reduce the possibility of a reflash.

While reportedly some 92 percent of the cargo was saved, the economic loss from the collision was about $12 million.

The navigational aspects of this accident are beyond the scope of this manual. One lesson taught, and a most important one, is that trained men with proper equipment and under favorable conditions can extinguish a major oil fire in cargo tanks.

Case II:

Here is a report from a tanker.

During routine tank cleaning in a ship, one of the tank washing machine nozzles in use became trapped. Unsuccessful efforts were made to clear it from on deck and it was soon obvious that someone would have to go down in the tank, which was known to be gassy. An air line mask was rigged and one of the crew, wearing breathing apparatus and harness, with a lifeline attached, started off down into the tank with a companion handling his lifeline and air hose. The line tender leaned over the tank hatch to keep his man in sight. As he did so his cigarette lighter fell from his shirtpocket, struck the bottom of the tank and ignited the vapors generated from a small quantity of oil. The intensity of the fire which followed burned both lifeline and air hose.

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The men on deck could do nothing for the man in the tank, except put out the fire and wait for the tank to become cool enough to recover his body.

Men engaged in tank cleaning, cargo handling, and pumproom work should not carry smoking materials. Some habitual smokers may, on occasion, light up without thinking and without regard to location.

5–1–10. Tanker Fires in Shipyard

Tank explosions in shipyards can be disastrous. Here is a report.

While a tanker was at a shipyard, No. 7 tank was tested and found gas free. Three days later, it was considered necessary to burn the bonnet off a "frozen" valve in this tank. In preparation for the burning, a ship's engineer removed the drain plug from the valve and tasted water. Next morning the engineer, the yard foreman, and a burnerman entered the tank. Apparently there was nothing that indicated danger to these men. The burnerman lit his torch and there was an explosion that burned him so badly that he later died. A chemist made an inspection immediately after the accident and found gasoline dripping from the valve.

This accident illustrates the results of a poor job of cleaning the ship for the yard. It demonstrates that pipelines are difficult to gas free. Pipelines should always be suspected until proven otherwise. The accident emphasizes the fact that a gas-free test is only good for the moment that it is made. Good practice requires that additional tests be made with a gas detector when sediment in tanks or compartments is disturbed, ballast shifted, pipelines disconnected, tank tops closed, or when other conditions arise which would affect the vapor content.

5–1–11. Barge Fires

Fires in petroleum barges follow the same pattern as those in tankships. This case is an excellent example of the right and wrong way of attacking a fire.

The barge was nonpropelled with gasoline engines for the pumps. These engines were housed in an engine room aft on the main deck. The pumps were a deck down in another compartment and were separated from the engines by a gas-tight bulkhead. The engines drove the pumps through the medium of V-belts. The gasoline pump engines were fed fuel by gravity from a tank situated on the top of the engineroom house in the open. Flexible feed lines ran from the tank to the engines. One day one of these lines broke from vibration and sprayed the engine with gasoline. It ignited. The barge crew discharged the contents of a 40-gallon extinguisher into the engineroom. As might be expected, this failed to put the fire out. The crew then cast the barge off the wharf. Her launch took her in tow on a headline. All hands got on the tug. They let the towline out as far as it would go and hauled the burning barge back to the home port, a distance of some 40 miles. Here a tug heavily equipped with fire-fighting gear put the fire out. They led three 2½-inch hose streams into the engineroom and blasted the fire out in nothing flat. Hauling the barge home was the wrong way to handle this type of fire.

Ten years later—same barge—different crew. Despite improvements in the feed line, exactly the same thing happened. The feed line broke and sprayed an engine with gasoline. It ignited. The barge master did the right thing and the thing that should be done with all petroleum fires of this type —he shut off the flow of fuel into the fire by closing the valve at the base of the fuel tank on the top of the engineroom house. He then was able to extinguish the fire quickly with a 40-gallon foam extinguisher.

5–1–12. Summary

We could go on at length describing fires; however, we have touched on the main types. One distinction should be made. In the small fire, fire fighting can control the fire. In those rare and catastrophic fires, all the damage is done in the first moments and fire fighting is sort of a mopping-up operation.

Precautions taken to prevent fire loss can normally be justified in greater detail on tankships and barges. This is because of the intrinsic value of the equipment, and because the crew may not be able to escape the fire area without considerable added risk to themselves. Fires on tankships and barges may occur in the quarters, in the galley and storerooms, paint locker, engineroom, pumproom, or in the cargo tanks. Fire in the quarters is most frequent and usually results from improper disposal of smoking materials.

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APPENDIX

COAST GUARD DISTRICT COMMANDERS AND MERCHANT MARINE ACTIVITIES

District	Title	City	State	Address
1st	Commander, 1st Coast Guard District	Boston	Mass. 02203	J. F. Kennedy Federal Bldg., Government Center.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	Mass. 02109	427 Commercial St.
	do	Portland	Maine 04112	P.O. Box 108, Pearl St. Station.
	do	Providence	R.I. 02903	104 Customhouse.
2d	Commander, 2d Coast Guard District	St. Louis	Mo. 63103	Federal Bldg., 1520 Market St.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	Mo. 63102	Suite 1210 208 N. Broadway.
	do	Cairo	Ill. 62914	P.O. Box 391.
	do	Dubuque	Iowa 52001	Box 695.
	do	Cincinnati	Ohio 54202	8413 Federal Office Bldg., 550 Main St.
	do	Louisville	Ky. 40202	254 Francis Bldg., 4th and Chestnut Sts.
	do	Memphis	Tenn. 38103	856 Federal Bldg., 167 No. Main St.
	do	Nashville	Tenn. 37203	670 U.S. Court House, 801 Broadway.
	do	Pittsburgh	Pa. 15219	1032 U.S. Post Office and Courthouse Bldg.
	do	Huntington	W. Va. 25701	328 Post Office and Federal Court House Bldg., 5th Ave., and 9th St.
3d	Commander, 3d Coast Guard District	New York	N.Y. 10004	Governors Island
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	do	Battery Park Bldg.
	do	Albany	N.Y. 12207	313 Federal Bldg.
	do	Philadelphia	Pa. 19106	Customhouse.
5th	Commander, 5th Coast Guard District	Portsmouth	Va. 23705	Federal Bldg., 431 Crawford St.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	do	200 Federal Bldg.
	do	Wilmington	N.C. 28401	Room 101, Federal Bldg
	do	Baltimore	Md. 21202	Customhouse.
7th	Commander, 7th Coast Guard District	Miami	Fla. 33130	1018 Federal Bldg., 51 SW. 1st Ave.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	Fla. 33132	501 NE. 1st Ave.
	do	Tampa	Fla. 33601	Room 210, 500 Zack St. P.O. Box 3172.
	do	Charleston	S.C. 29403	625 Federal Bldg., 334 Meeting St.
	do	Savannah	Ga. 31402	P.O. Box 8191.
	do	Jacksonville	Fla. 32202	Room 552, 400 W. Bay St., Box 35064.
	do	San Juan	P.R. 00904	P.O. Box 3666, 302 Federal Bldg.
8th	Commander, 8th Coast Guard District	New Orleans	La. 70130	Customhouse.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	do	201 Gateway Bldg., 124 Camp St.
	do	Mobile	Ala. 36602	563 Federal Bldg.
	do	Port Arthur	Tex. 77640	Federal Bldg. Customhouse, 5th and Austin Ave.
	do	Galveston	Tex. 77550	234 Customhouse.
	do	Corpus Christi	Tex. 78403	P.O. Box 1621, 723 N Upper Broadway.
	do	Houston	Tex. 77011	7300 Wingate St.

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Appendix

COAST GUARD DISTRICT COMMANDERS AND MERCHANT MARINE ACTIVITIES—Continued

District	Title	City	State	Address
9th	Commander, 9th Coast Guard District	Cleveland	Ohio 44199	1240 East 9th St.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	Ohio 44114	1055 East 9th St.
	do	Buffalo	N.Y. 14203	440 Federal Bldg., 121 Ellicott St.
	do	Oswego	N.Y. 13126	208 Federal Bldg.
	do	Detroit	Mich. 48226	424 Federal and Courthouse Bldg.
	do	Duluth	Minn. 55802	Canal Park.
	do	Toledo	Ohio 43604	5101 Federal Bldg., 234 Summit St.
	do	Saint Ignace	Mich. 49781	Municipal Bldg.
	do	Chicago	Ill. 60617	10101 South Ewing Ave.
	do	Ludington	Mich. 49431	P.O. Box 308.
	do	Milwaukee	Wis. 53203	Room 400, 135 West Wells St.
11th	Commander, 11th Coast Guard District	Long Beach	Calif. 90802	Heartwell Bldg., 19 Pine Ave.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	San Pedro	Calif. 90731	(Los Angeles-Long Beach) 2035 Customhouse, 300 S. Ferry St.
	do	San Diego	Calif. 92101	Room 12A, B St. Pier.
12th	Commander, 12th Coast Guard District	San Francisco	Calif. 94126	630 Sansome St.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	do	Station B, Box 2029.
13th	Commander, 13th Coast Guard District	Seattle	Wash. 98104	618 2d Ave.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	do	Do.
	do	Portland	Oreg. 97209	496 Federal Bldg., 511 NW Broadway.
14th	Commander, 14th Coast Guard District	Honolulu	Hawaii 96813	677 Ala Moana Blvd.
	Chief, Merchant Marine Safety Division	do	do	610 Fort St.
	Officer in Charge, Marine Inspection	do	do	Do.
	do	Guam		Marianas.
17th	Commander, 17th Coast Guard District	Juneau	Alaska 99801	P.O. Box 3-5000.
	Chief, Merchant Marine Safety Division	do	do	Do.
	Officer in Charge, Marine Inspection	do	do	Do.
	do	Anchorage	Alaska 99501	P.O. Box 1286.

Merchant marine details	Local addresses
LONDON	Commander, Coast Guard Activities, Europe Staff Box 5, 7, North Audley Street, LONDON, W.1, England.
BREMEN	Merchant Marine Detail Officer, USCG American Consulate General, 1, President Kennedy Platz, BREMEN, Germany.
NAPLES	Merchant Marine Detail Officer, USCG American Consulate General, Piazza Principe di Napoli, NAPLES, Italy.
ROTTERDAM	Merchant Marine Detail Officer, USCG American Consulate General, Vlasmarkt 1, ROTTERDAM, Netherlands.
YOKOHAMA	Merchant Marine Detail Officer, USCG North Pier, YOKOHAMA, Japan.
SAIGON	Merchant Marine Detail Officer, USCG American Embassy 4 Thong Nhut SAIGON, Viet Nam.

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ABSTRACT - Developed by business educators for use in teaching office machines, this document contains a series of tests for the beginning unit covering calculating machines. Designed to evaluate student performance in relation to stated terminal objectives, the tests cover: (1) the full-keyboard adding listing machine, (2) the key-driven calculator, (3) the ten-key adding listing machine, (4) the rotary calculator, and (5) the printing calculator. Also included is a suggested grading scale. Unit two is available as VT 012 222, also in this issue. (JS)

VT 012 221

ED0 56238

SAN MATEO UNION HIGH SCHOOL DISTRICT
SAN MATEO, CALIFORNIA

CALCULATING MACHINES I

(Working Draft 3-9-70)

TERMINAL PERFORMANCE OBJECTIVES:

WHERE IS THE STUDENT GOING?

UNDER WHAT CONDITIONS?

HOW WILL HE KNOW HE'S ARRIVED?

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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VT012221

CALCULATING MACHINES I

8.0.0 TERMINAL PERFORMANCE OBJECTIVES: The following objectives are a precise statement of the minimum performance required of students who successfully complete Calculating Machines I. It is important to note that there are other performance requirements within this course, and that they will be reflected in the "intermediate" performance objectives included in the learning activities for the Calculating Machines program.

CALCULATING MACHINES I

8.1.0 FULL-KEYBOARD ADDING LISTING MACHINE: Given Instruction in [redacted] operating the Full-Keyboard Adding Listing Machine, the student will demonstrate mastery of this machine by completing a 40 item post-test with at least 60% accuracy within a 40 minute period.

8.1.1 The test will consist of problems involving:

1) Addition
2) Subtraction
3) Multiplication
4) Horizontal and Vertical Addition
5) Simple Discounting

8.1.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES I
Full-Keyboard Adding Listing Machine
Test One

Directions: Do not write on test sheet. Use an answer sheet.

1.	2.	3.	4.	5.
8.28	1376	726.21	5,931.56	899.20
9.12	4652	239.51	1,932.46	899.20
6.13	8927	577.13	3,854.68	899.20
9.34	3259	317.98	9,133.35	899.20
8.35	7638	829.87	2,752.58	675.40
6.24	7942	715.79	8,938.21	675.40
7.21	2184	872.97	9,251.52	675.40
8.34	7422	394.67	6,324.95	675.40
8.14	5715	542.98	8,324.95	338.75
6.25	6276	684.19	5,675.12	338.75
9.15	5273	862.43	8,295.23	338.75
7.25	4199	194.87	5,243.26	642.90
8.14	8345	373.59	6,576.39	642.90
6.51	9126	724.52	4,761.89	642.90
8.79	7425	483.61	9,812.79	115.60
9.23	6078	178.25	2,603.57	115.60
6.43	9306	836.89	5,787.30	115.60
7.41	7249	749.13	7,408.26	115.60
____	____	_____	_____	_____

6.	7.	8.	9.	10.
21.89	167.12	289.49	482.95	1,486.75
-3.01	-83.15	-310.05	-13.05	-283.25
____	_____	_____	_____	_____

11. 610 x 257 _____
12. 299 x 25 _____
13. 582 x 184 _____
14. 387 x 429 _____
15. 477 x 267 _____
16. 680 x 450 _____
17. 298 x 405 _____
18. 359 x 123 _____
19. 6.82 x 36 _____
20. 11.6 x .09 _____

CALCULATING MACHINES 1
Full-Keyboard Adding Listing Machine
Page two

Complete the following by adding horizontally and vertically:

A B C COMPANY

Sales for the First Five Months Ending
June 31, 197-

	Jan.	Feb.	March	April	May	Total Sales	
Beavers, E.	164.08	175.98	202.50	165.47	210.26	_____	21.
Briggs, J.	281.04	250.32	198.67	286.40	225.45	_____	22.
Crosby, N.	491.80	475.40	505.70	556.75	598.16	_____	23.
Duncan, T.	615.19	600.95	545.00	596.50	------	_____	24.
Feitz, K.	507.85	573.50	500.75	535.10	489.20	_____	25.
Jaymes, L.	437.05	437.05	457.12	488.55	475.46	_____	26.
Lockwood, G.	300.50	318.64	315.89	299.50	296.45	_____	27.
Mays, W.	203.40	49.50	------	188.70	256.00	_____	28.
Stone, K.	211.06	299.50	387.40	312.05	390.40	_____	29.
Thoms, D.	435.07	500.45	399.80	206.35	410.09	_____	30.
Totals:	_____ 31.	_____ 32.	_____ 33.	_____ 34.	_____ 35.	_____ 36.	

Complete the following discount problems:

	Discount	Net Amount
37. $240.50 less 12 1/2 %	_____	_____
38. $385.90 less 25%	_____	_____

CALCULATING MACHINES I

8.2.0 KEY-DRIVEN CALCULATOR: Given instruction in the touch method of operating the Key-Driven Calculator, the student will demonstrate mastery of this machine by completing a 35 item post-test with at least 60% accuracy within a 40 minute period.

8.2.1 The test will consist of problems involving:

1) Addition
2) Subtraction
3) Multiplication
4) Division
5) Horizontal and Vertical Addition
6) Trial-Divisor Division

8.2.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 1
Key-Driven Calculator
Test One

DIRECTIONS: Do not write on test questions. Use an answer sheet.

(1)	(2)	(3)	(4)	(5)
.34	.45	2.13	4.72	3.87
.58	.31	.72	1.12	6.12
.61	1.26	.45	3.64	8.67
.27	3.70	9.30	9.70	1.41
.93	.49	.68	8.43	6.42
.69	8.62	7.21	2.02	7.45
.82	.53	.14	6.36	6.02
.14	6.42	8.53	4.87	5.10
.47	.31	3.42	5.98	7.29
.30	.28	.37	3.03	3.58
.25	4.93	.89	6.32	9.68
.73	.40	.20	7.67	9.12
_____	_____	_____	_____	_____

(6) 1,825 x .043= _____ (8) 3,442 x 66= _____ (10) 6,413 x 25= _____

(7) 3,586 x 24= _____ (9) 7,122 x 13= _____ (11) 4,554 x 63= _____

(12)	(13)	(14)	(15)
649	874	979	147
-283	-113	-583	- 84
_____	_____	_____	_____

(16) 832 -:- 26= _____ (18) 748 -:- 34= _____

(17) 3,815 -:- 545= _____ (19) 5,056 -:- 632= _____

(20) 3.28 + 6.27 + 4.10 + 6.38 + 2.96 = _____

(21) 1.21 + 2.36 + 3.40 + 4.77 + .83 = _____

(22) 4.59 + .43 + 2.32 + 1.10 + 3.33 = _____

(23) 3.50 + .98 + 3.45 + 5.09 + .83 = _____

CALCULATING MACHINES 1
Key-Driven Calculator
Test One
Page two

(24)	(25)	(26)	(27)	(28)
7.08	2.09	4.37	7.68	4.79
4.46	2.43	7.98	2.04	5.37
4.17	8.47	7.65	1.71	1.88
6.26	4.60	7.72	2.32	2.01
4.15	6.30	9.29	4.20	6.90
2.53	9.57	1.05	5.17	4.59
4.23	6.40	2.88	5.11	8.31
6.87	4.79	6.40	1.00	5.79
3.28	8.16	2.64	9.92	5.58
5.49	9.07	3.08	3.74	2.55
9.41	6.92	3.05	1.30	4.10
7.92	4.25	6.51	9.59	4.28
_____	_____	_____	_____	_____

(29) 1,624 x 92 = _____

(30) 4,628 x 83 = _____

(31) 1,232 x 62 = _____

(32) 7,986 x .23 = _____

(33) 835 x 41.4 = _____

(34) 467 x .242 = _____

(35) 146 x 7.52 = _____

CALCULATING MACHINES I

8.3.0 TEN-KEY ADDING LISTING MACHINE: Given instruction in the touch method of operating the Ten-Key Adding Listing Machine, the student will demonstrate mastery of this machine by completing a 44 item post-test with at least 60% accuracy within a 40 minute period.

8.3.1 The test will consist of problems involving:

1) Addition
2) Subtraction
3) Multiplication
4) Division
5) Subtotaling
6) Simple Discounting
7) Addition of Fractions
8) Multiplication of Fractions
9) Completing Simple Invoices

8.3.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 1
Ten-Key Adding Listing Machine
Test One

Directions: Do not write on test sheet, please use an answer sheet.

1.	2.	3.	4.	5.
8.84	62.83	438.70	.25	7,812.85
5.77	28.84	165.93	7,812.90	2,014.64
9.29	16.86	360.21	184.38	7,094.68
4.49	29.90	646.85	68.62	9,218.00
9.40	21.08-	462.80	5.51	2,049.10
1.70	81.61	821.60	54.97	9,154.67
9.04	31.06	353.06	3.08	2,658.34
9.39	48.63	410.16	.64	5,731.41
7.88	33.56	293.07	626.97	3,529.83
3.77	46.50	804.15	.12	3,539.83
6.86	17.85-	676.52	32.98	2,155.78
3.11	49.15	899.84	31.39	9,832.29
4.88	12.72-	309.51	1.29	6,352.20
1.21	29.51-	209.39	624.12	7,030.75
8.59	39.38	489.60	.03	9,845.23
5.95	31.41	827.54	63.52	6,981.71
2.72	16.33	784.12	205.06	5,459.05
			46.87	9,200.25
____	____	____	____	____

6. 568 x 435 _____

7. 1.541 x 81 _____

8. 25.47 x .89 _____

9. .953 x .124 _____

10. 28.1 x 78 _____

11. 500 x 145 _____

12. .89 x .064 _____

13. 4,013 -:- 80 _____
(Reciprocal of 80 is .0125)

14. 955 -:- 25 _____
(Reciprocal of 25 is .04)

15. 3,711 -:- 500 _____
(Reciprocal of 500 is .002)

16. 7,189 -:- 40 _____
(Reciprocal of 40 is .025)

17. 304 -:- 16 _____
(Reciprocal of 16 is .0625)

18.	19.	20.	21.	22.
5.03	69.47	457.74	4.50	95.88
-2.14	-2.49	-65.11	-5.59	-74.17
____	____	____	____	____

8.4.0 ROTARY CALCULATOR: Given instruction in the operation of the Rotary Calculator, the student will demonstrate mastery of this machine by completing a 34 item post-test and a 46 item post-test with at least 60% accuracy within a 40 minute period on each test.

8.4.1 The 34 item test will be administered after the student has completed approximately half of the learning activities in this unit and will consist of problems involving:

1) Addition
2) Adding Constants
3) Subtraction
4) Subtracting Constants
5) Multiplication
6) Division
7) Accumulative Multiplication
8) Accumulative Total Solving
9) Repeated Addition
10) Completing Simple Invoices
11) Simple Discounting

8.4.2 The 46 item test will be administered after the student has completed all of the learning activities in this unit and will consist of problems involving:

1) Addition
2) Subtotal Key Use
3) Subtraction
4) Credit Balances
5) Multiplication
6) Multiplication of Fractions
7) Multiplication by Decimals
8) Multiplication Over a Fixed Decimal Point
9) Negative Multiplication
10) Accumulative Multiplication
11) Division, Whole Numbers
12) Division Over a Fixed Decimal Point
13) Percentage Calculation
14) Simple Discounting
15) Chain Discounting
16) Trade Discounting
17) Three-Factor Multiplication
18) Percent of Increase Calculation

8.4.3 Each test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES I
Rotary Calculator
Test One

DIRECTIONS: Do not write on test. Use an answer sheet.

Addition:

(1)	(2)	(3)	(4)	(5)
6.17	220	1.07	999	3.79
2.93	808	4.60	1,200	48.28
4.83	24	.23	232	8,958.42
4.29	607	9.60	343	808.38
7.35	340	1.10	5,750	4,868.46
8.25	608	6.02	6,086	68.85
7.86	35	.16	242	.89
5.16	45	4.40	454	888.29
2.67	203	.47	566	988.23
7.38	780	8.07	4,405	.81
6.23	440	1.60	250	5,867.87
2.18	507	.27	750	838.55
				6.88
				88.00
				4.89

(6) Adding Constants:

8.03 + .29
2.00 + .29
.34 + .29
.27 + .29
1.22 + .29
Total _____

Subtraction:

(7)	(8)	(9)	(10)	(11)
809	730	6.40	386	2,728
-41	-109	-3.44	-796	-4,961

(12) Subtracting Constants:

622 - 27
309 - 27
565 - 27
677 - 27
280 - 27
Total _____

Multiplication (Do not round):

(13) 276 x 46 =
(14) 331 x 670 =
(15) 254 x 129 =
(16) 5.66 x 2.13 =
(17) 3.8125 x 8.875 =
(18) 42.87 x 16.201 =

Division (Round out to two decimal places):

(19) 8.40 -:- 3.5 =
(20) 1,440 -:- 65.5 =
(21) 93.24 -:- 63 =
(22) 8,761 -:- 75 =
(23) 7.396 -:- 27.4 =
(24) 7,512 -:- 67 =

(25) Accumulative multiplication:

6.36 feet @ $ .38 per foot
51.4 feet @ .38 per foot
.791 feet @ .38 per foot
658. feet @ .38 per foot
339. feet @ .38 per foot

Accumulated Total $_____

(26) 6.75 yards @ $4.85 per yard
3.125 yards @ 3.90 per yard
7.5 yards @ 7.25 per yard

Accumulated Total $_____

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CALCULATING MACHINES I
Rotary Calculator
Test 1, Page 2

(27)	(28)		Bal. Fwd.	Purchased	Payments	Return	Bal. Due
843.99	274.11	(29)	48.99	35.73	11.23		
843.99	274.11			174.09	48.99		_____
843.99	274.11						
111.28	440.64	(30)	274.08	85.95	274.08	15.80	
111.28	440.64				504.95	9.50	_____
111.28	843.00-						
111.28	843.00-						
111.28	843.00-						
882.11	333.90-						
882.11	333.90-						

Record Amount of Cash discount:

31. $ 285.60 8% _____

32. $ 395.45 12% _____

33. $ 928.10 21% _____

34. $1,347.51 32% _____

CALCULATING MACHINES I
Rotary Calculator
Test 2, Page 1

DIRECTIONS: Do not write on test questions. Use an answer sheet. Unless otherwise instructed, round division problems to two decimal places.

(1)	(2)	(3)
$5.44	$ 2,135.55	897
6.33	470.50	390
5.25	33,050.05	842
7.55	290.80	984
8.76	12,500.00	630
9.88	275.25	123
5.55	4,235.09	930
8.08	3,823.25	249
9.90	394.50	599
5.00	1,515.05	102
8.45	2,102.84	458
S	942.26	550
	17,020.55	328
9.95	5,531.51	774
4.47	34,497.96	454
2.33		
1.10		
$ T		

(4)
$12,246.30
-9,055.64

(5)
$12,770.25
-15,809.02

(6)
$55.120.95
-36,982.20

(7)
12,775
x 93

(8)
24,43375
x 8.6875

(9)
27 1/4
x4 1/2

(10)
(148 x 64) - (136 x 52) =

(11)
18.25 x 79.45
9.50 x 7.75
39.95 x 5.25
8. x 35.55= _____

(12)
37 x 8.75 x 2.55 =

(13)
$\frac{149.008}{536}$ =

(14)
$\frac{49,345}{887.50}$ =

In problems 15 and 16, determine what percentage the amount is of the second amount. Round to nearest whole percent.

15. $3.25 is what percent of $65.00 _____

16. $4.25 is what percent of $85.00 _____

17. $ 776.50 less 2% =

18. 2,404.00 less 2 1/4% =

19. 977.21 less 3% =

20. $ 778.00 less 10%, 5% =

21. 3,960.00 less 25%, 3% =

	Quantity	Unit	Description	Price	Extension
22.	800	each	Legal envelopes	$ 7.85 per C	$_____
23.	750	each	Window envelopes	8.60 per C	_____
24.	7,500	each	Standard Envelopes	33.75 per M	_____
25.	9	gross	Mandarin medium pencils	8.95 per gross	_____
26.	18	each	Pencil sharpeners	6.25 each	_____
27.	2,500	each	Manila envelopes	27.88 per M	_____
28.	775	each	Clasp envelopes	7.60 per C	_____
29.				Gross Amount	$_____
30.				Less 35% Trade Discount	_____
				Net Amount	$_____

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	Unit Price	Plus Sales Tax	
32.	$78.50	2%	= $_____
33.	$6,300	4%	= $_____
34.	$3,200	1-1/2%	= $_____
35.	$4,500	2-1/2%	= $_____

Finding Percent of Increase

	Selling Price	Cost Price	Amount of Increase	Per Cent of Increase
36.	$28.80	$24.00	$_____	_____
37.	$22.50	$15.00	$_____	_____
38.	$30.00	$22.50	$_____	_____
39.	$58.42	$50.80	$_____	_____
40.	$34.10	$27.50	$_____	_____

8.5.0 PRINTING CALCULATORS: Given instruction in the touch method of operating the Printing Calculator, the student will demonstrate mastery of this machine by completing a 33 item post-test and a 43 item post-test with at least 60% accuracy within a 40 minute period on each test.

8.5.1 The 33 item test will be administered after the student has completed approximately half of the learning activities in this unit and will consist of problems involving:

1) Addition
2) Repeated Addition
3) Subtraction
4) Credit Balance
5) Multiplication
6) Multiplication by Decimals
7) Accumulative Multiplication
8) Division
9) Decimals in Division
10) Three-Factor Multiplication
11) Adding Constants

8.5.2 The 43 item test will be administered after the student has completed all of the learning activities in this unit and will consist of problems involving:

1) Addition
2) Repeated Addition
3) Subtotal Key Use
4) Multiplication
5) Multiplication by Decimals
6) Multiplication of Fractions
7) Simple Discounting
8) Chain Discounting
9) Division
10) Decimals in Division
11) Percent of Increase or Decrease Calculation
12) Payroll Solving
13) Completing Simple Invoices
14) Fixed Decimal Point Addition

8.5.3 Each test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 1
Printing Calculator
Test One

Directions: Do not write on test sheet, please use an answer sheet.

1.	2.	3.	4.	5.	6.	7.
5.55	.71	8.85	.78	30.64	649	842
4.50	3.83	.26	402.72	30.64	-291	-975
3.45	.38	4.05	.18	30.64		
2.30	.24	56.55	.07	30.64		
6.78	.67	5.20	3.64	-26.11		
	2.65	1.92	1.21	-26.11		
3.50	5.80	1.12	15.58	78.89	8.	9.
2.24				78.89		
1.25	3.48	.25	2.43	78.89	754	5,440
1.40	.97	3.32	4.73	78.89	-998	-8,330
6.90	.05	5.89	.76	78.89		
	3.47	2.46	.07	-1.05		
1.23	5.79	6.01	.18	-1.05		
3.44	7.62	.66	.39	-1.05		
5.50	.24	8.73	.11			
6.88						
7.89						

Multiplication (do not round):

10. 474 x 267 = _____

11. 9.25 x 867.1 = _____

12. .2792 x 92.6 = _____

13. 10.333 x 8.678 = _____

In problems 14 & 15 (do not round), use accumulative multiplication:

14. (132.8 x 15.00) + (42.17 x .72) = _____

15. (127.8 x 13.27) + (8.12 x 3.70) = _____

16. (44.92 x 9.82) = _____

17. (7.93 x 7.94) = _____

18. (8.26 x .125) = _____

19. (2.93 x 1.37) = _____

Carry answers to three decimals and record to two decimal places:

20. 26.928 -:- 3.45 = _____

21. 127.49 -:- 37.3 = _____

22. 63.824 -:- 37.3 = _____

23. 307.4 -:- 48.34 = _____

24. 44.234 -:- 2.432 = _____

25. 248 -:- 35.5 = _____

26. 184.76 -:- 105 = _____

CALCULATING MACHINES 1
Printing Calculator
Test One - Page 2

27. 83 x 16 x 5 = _____

28. 98 x 25 x 41 = _____

29. 2.56 x 8.03 x 10 = _____

Adding a Constant:

	Original Amount	Amount to be Added	
30.	$678.40	$15.50	$_____
31.	395.81	15.50	$_____
32.	476.92	15.50	$_____
33.	755.65	15.50	$_____

CALCULATING MACHINES I
Printing Calculator
Test 2

Directions: Do not write on test sheet, please use an answer sheet.

1.	2.
650.30	118.60
650.30	81.08
375.40	13.46
360.80	7.88
505.75	65.78
257.80	9.00
300.65	
	S
198.75	445.00
378.40	117.34
132.50	8.11
872.45	
180.78	S
475.21	34.41
422.99	34.41
	34.41
	8.45
	.98

6. 15.5 x 8.625 = _____

7. .84 x .14 = _____

8. 4.0833 x 16 = _____

9. 12.3 x 24.375 = _____

10. 7.61 x 3.6 = _____

11. 24 1/2 x 8 1/2 = _____

12. 20 1/4 x 14 1/2 = _____

13. 37 3/4 x 6 1/5 = _____

14. $3.10 x 9 1/4 = _____

15. $247.60 x 5% = _____

	Net Amount	Discount
16. $15.90 less 12 1/2%	_____	_____
17. $165.75 less 7%	_____	_____
18. $840.20 less 1 1/4%	_____	_____

For chain discounts, you may use text chart.

19. $725.25 less 20%, 10% _____

20. $450.00 less 30%, 10%, 5% _____

21. $165.90 less 10%, 10%, 5% _____

Round to two decimal places:

22. 4,749 -:- 14 = _____

23. 18.65 -:- 2.6 = _____

24. 31.149 -:- 1.49 = _____

3.	4.
1,678.50	346.72
668.40	790.13
1,749.25-	635.55-
294.50	948.45-
2,975.43	293.75
455.70	50.80
820.05	40.80
463.95	9,181.31-
231.70-	906.20
502.65	56.02
831.91	70.32
55.65	634.59-
845.49	920.05
76.43	49.71

Find percentage and amount of increase (+) or decrease (-) and indicate. Round to nearest whole percent.

	Last Week	This Week	Amount of + or -	% of Increase or Decrease
25.	$820	$860	a. _____	b. _____
26.	$600	$550	a. _____	b. _____

5. 9.4012 + .62 + .3526 + .53754 + 1.43 +12.01134 = ___

Calculate the following payroll problem to find Net Pay.

Employee #302 -- Hours worked - 46

27. Regular Hours: 40 Hours @ $3.25 = $_____

28. Overtime hours: 6 Hours @ 3.25 = $_____

29. Gross Pay $_____

30. Deductions: Withholding Tax @ 15% $_____

F.I.C.A.	3.25
Hospitalization	2.25
Union Dues	1.10

31. Total Deduction $

32. Net Pay $_____

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CALCULATING MACHINES I
Printing Calculator
Test 2, Page 2

Extend the following invoice:

Quantity	Price
30 lb.	$4.15
15 lb.	3.75
42 lb.	5.15
65 lb.	9.45

33. Total Weight _____

34. Gross $_____

35. Average Price per lb. _____

VT 012 222
Chabolla, Richard M., And Others
Calculating Machines 2.

San Mateo Union High School District, Calif.
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DESCRIPTORS - *BUSINESS EDUCATION; *TESTS; *BEHAVIORAL OBJECTIVES; *STUDENT EVALUATION; *OFFICE MACHINES; RESOURCE MATERIALS; EDUCATIONAL OBJECTIVES; INSTRUCTIONAL MATERIALS; SECONDARY EDUCATION; GRADING

ABSTRACT - Developed by business educators for use in teaching office machines, this document contains a series of tests for the second unit covering calculating machines. Designed to evaluate student performance in relation to stated terminal objectives, these tests cover: (1) the full-keyboard adding listing machine, (2) the key-driven calculator, (3) the ten-key adding listing machine, (4) the rotary calculator, and (5) the printing calculator. Also included is a suggested grading scale. Unit one is available as VT 012 221, also in this issue. (JS)

VT 012 222

ED056238

CALCULATING MACHINES 2

(Working Draft 5-11-70)

		9.87
		9.54
		6.54
		9.80
		9.01
	6.84	1.11
	5.44	4.91
	7.87	1.19
	3.93	3.29
	9.18	7.52
	3.94	62.78 T
	4.82	
4.79	4.81	6.86
4.59	4.31	3.82
5.42	9.82	1.23
1.17	60.96 T	3.11
2.29		6.65
2.33	6.78	1.90
6.79	2.34	5.18
6.56	9.87	5.89
6.76	2.81	5.61
5.56	6.01	3.45
46.26 T	2.24	43.70 T
	4.85	
	3.31	3.19
	2.14	9.85
	9.45	2.22
	49.80 T	5.61
		7.84
		8.95
		1.48
		4.89
		4.11
		9.40
		57.54 T

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VT012222

CALCULATING MACHINES 2

9.0.0 TERMINAL PERFORMANCE OBJECTIVES: The following objectives are a precise statement of the minimum performance required of students who successfully complete Calculating Machines 2. It is important to note that there are other performance requirements within this course, and that they will be reflected in the "intermediate" performance objectives included in the learning activities for the Calculating Machines 2 program.

CALCULATING MACHINES 2

9.1.0 FULL-KEYBOARD ADDING LISTING MACHINES: Given instruction in the operation of the Full-Keyboard Adding Listing Machine, the student will demonstrate mastery of this machine by completing a 39 item post-test with at least 60% accuracy within a 40-minute period.

9.1.1 The test will consist of problems involving:

1) Addition
2) Subtotal Key
3) Addition with Fractions
4) Repeated Addition
5) Subtraction & Credit Balance
6) Simple Percentages
7) Multiplication
8) Simple Discount & Net Amount
9) Division
10) Division (Decimals in Dividend & Divisor)
11) Crossfooting
12) Fixed Decimal Point Addition
13) Business Application Assignment (Credit Balance)

9.1.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Full-Keyboard Adding Listing Machine
Test One

1.	2.	3.	4.	5.	6.	7.
8.49	4,359.17	24.63	93.74	400	87.50	38.95
1.89	7,627.34	93.46	26.98	162	87.50	- 18.40
2.57	2,931.68	3,296.57	69.41	465	87.50	
2.92	5,861.89	19.42	26.67	514	87.50	
4.91	6,569.71	.37	5.04	129 1/2	87.50	
3.94	1,754.36	97.51	32.60	284	33.69	8.
5.21	7,428.26	2,681.23	6.06	423	33.69	
1.39	6,787.23	8.53	52.98	749 1/4	33.69	1,940.46
2.79	9,514.77	.64	14.98	2	33.69	-2,801.39
6.75	6,631.27	6.85	12.71	957	81.95	
7.37	3,526.69	.77	68.43	372 7/8	81.95	
1.54	2,298.79	8.25	26.94	419	44.75	
6.81	8,938.21	2,754.96		987	44.75	
2.79	2,752.58	561.18	S	246 3/5	44.75	9.
9.23	6,133.35	.34	78.62	975	44.75	
7.21	3,854.68	.21	45.95		44.75	155.93
3.59	1,932.46	7.32	97.23		44.75	- 148.02
9.65	5,981.56	12.95	15.89		44.75	
8.69	2,631.57	5,733.97	67.33		44.75	
1.39	9,812.79	2,347.33	55.00		79.32	
1.95	4,761.89	536.82	55.00		98.40	
6.41	5,825.16	8.12	55.00		98.40	
9.31	6,576.39	9,219.67	55.00		98.40	
2.78	5,324.26	1.62			98.40	
4.51	8,295.23	6.34	S		98.40	
7.32	5,765.12	.81	14.86		11.76	
3.54	3,643.15	6,689.26	.39		11.76	
6.79	7,135.91	93.16	5.29		3.03	
8.23	6,324.52		98.30		3.03	
	9,251.45				2.55	

10. 15% of $626.84 = $_____

11. 25% of $905.80 = $_____

12. 387 x 22 = _____

13. 699 x 429 = _____

14. 3.08 x 5.7 = _____

15. 88 1/4 x 22 = _____

16. 98 7/8 x 29 = _____

17. 70 1/2 x 76 1/4 = _____

18. 899 x 789 = _____

19. 593 x 199 = _____

20. 298 x 918 = _____

21. 547 x 367 = _____

22. 993 x 339 = _____

		Discount	Net Amount
23.	$388.15 less 40%	a._____	b._____
24.	$505.10 less 10%	a._____	b._____
25.	$629.23 less 7 1/5%	a._____	b._____

26. 421 -:- 39 = _____

27. 1,298 -:- 127 = _____

28. 47.263 -:- .471 = _____

29. 70.56 + 6.08 + 33.40 + 30.70 + 9.89 + 5.09 = _____

30. 93.06 + 37.61 + 12.91 + 40.20 + 70.96 + 8.72 = _____

31.
7.960
420
830.1
53.09
5.707
7.301
24.40
390.2
6.709
140.8

ACCOUNTS RECEIVABLE LEDGER SHEET

Date		Charge	Date		Credit	Balance
19--			19--			
Jan 4	3840	287.40	Jan 11	Check	185.00	
Jan 5	3892	401.30	Jan 13	Check	215.00	
Jan 6	3904	199.50	Jan 18	Check	287.40	
Jan 7	3913	470.00	Jan 19	Check	199.50	
Jan 8	3944	54.60				
Jan 9	3953	420.75				
		Total $_____ 32.		Total	$_____ 33.	$_____ 34.

CALCULATING MACHINES 2

9.2.0 KEY-DRIVEN CALCULATOR: Given instruction in the touch method of operating the Key-Driven Calculator, the student will demonstrate mastery of this machine by completing a 43 item post-test with at least 60% accuracy within a 40-minute period.

9.2.1 The test will consist of problems involving:

1) Addition
2) Subtraction & Credit Balance
3) Multiplication
4) Multiplication (Decimals)
5) Division
6) Division (Trial-Division Method)
7) Multiplication (Cross-Hand Method)
8) Multiplication (Accumulation of Products)
9) Multiplication (Fixed Decimal)
10) Inventories (C, M, and CWT.)
11) Crossfooting
12) Multiplication (Fractions)

9.2.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Key-Driven Calculator
Test One

1.	2.	3.	4.	5.
7.08	2.09	4.37	7.68	4.79
4.46	2.43	7.98	2.04	5.37
4.17	8.47	7.65	1.71	1.88
6.26	4.60	3.00	2.32	2.01
4.15	6.30	7.72	4.20	6.90
2.53	9.57	9.29	5.17	4.59
4.23	6.40	1.05	5.13	8.31
6.87	4.79	2.88	7.50	5.79
3.28	8.16	6.40	9.92	5.58
5.49	9.07	2.64	3.74	2.55
9.41	6.92	3.08	1.30	4.10
7.92	4.25	3.05	9.59	4.28

6.	7.	8.	9.
301	726	177	283
-191	-397	-290	-775

10.	11.	12.
899	873	735
1,113-	x 90	x340

13.	14.	15.
218	306	850
x 7.01	x 40	x .03

16. 876 x 8.45 = _____

17. 592 x 670 = _____

18. 966 -:- 23 = _____

19. 924 -:- 42 = _____

20. 3,876 -:- 51 = _____

21. 1,386 x 43 = _____

22. 2,476
x 77

23.
24 x 34
57 x 35
68 x 23

24.
23 x 27.4
213 x 6.8
3 x 3.0
8 x 7.9

25. 567 at $.45 per C = _____

26. 2,300 at $.68 per M = _____

27. 678 at $1.20 per C = _____

28. 6,200 lbs. at $.78 per CWT. = _____

29. 4,300 at $.68 per M = _____

30. 24.763 x 7.2 = _____

31. 19.037 x 21 = _____

32. 684 x .16 = _____

33. 28% of $370.00 =$_____

34. 48% of $74.73 =$_____

35. 4.04 + 3.21 + 5.94 + 4.45 + 4.59 + 2.64 = _____

36. 8.72 + 4.82 + 4.19 + 4.76 + 4.36 + 2.09 = _____

37. 79 1/2 x 3 1/4 = _____

38. 14 3/4 x 6 1/8 = _____

39. 1.08 x 2.16 = _____

Total the following:

	Dept. A	Dept. B	Dept. C	Dept. D
April	3.87	1.68	5.43	2.81
May	4.25	2.47	6.29	4.35
June	3.68	7.63	5.04	3.34
July	3.45	5.44	2.34	5.88
Aug.	1.43	5.45	4.32	3.23
Sept.	3.45	3.55	7.44	4.02
Oct.	7.60	8.63	4.35	1.86
Nov.	5.43	4.50	6.60	5.88
TOTAL:	____	____	____	____
	40.	41.	42.	43.

9.3.0 TEN-KEY ADDING LISTING MACHINE: Given instruction in the touch method of operating the Ten-Key Adding Listing Machine, the student will demonstrate a mastery of this machine by completing a 34 item post-test with at least 60% accuracy within a 40-minute period.

9.3.1 The test will consist of problems involving:

1) Addition
2) Repeated Addition
3) Subtraction
4) Subtraction (Credit Balances)
5) Multiplication
6) Multiplication (Decimals)
7) Multiplication (Fractions)
8) Subtotal

9.3.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Ten-Key Adding Listing Machine
Test One

1.	2.	3.	4.	5.	6.
8.84	62.83	438.70	7,274.85	7,812.90	83.50
5.77	28.84	165.93	2,014.64	.25	83.50
9.29	16.86	360.21	7,094.68	184.38	83.50
4.49	31.22	646.85	9,218.00	68.82	83.50
9.40	21.08	462.80	2,049.10	5.54	83.50
1.70	81.61	845.22	9,154.67	33.84	83.50
9.04	31.05	353.06	2,658.34	.64	83.50
9.39	48.63	410.16	5,731.41	626.97	11.98
7.88	33.56	393.07	3,539.84	.12	11.98
3.77	46.50	804.15	2,155.78	32.98	11.98
7.43	17.85	676.52	9,832.29	31.39	54.32
3.11	49.15	899.84	6,352.20	1.92	54.32
4.88	12.72	309.51	7,030.75	1,264.12	77.41
1.21	29.51	209.39	9,845.23	1.28	77.41
8.58	39.38	489.60	6,981.71	63.52	77.41
5.95	41.41	827.54	5,459.05	205.06	77.41
7.72	16.33	784.12	9,305.25	64.87	77.41

7.	8.	9.	10.	11.	12.
11.43	29.78	184.32	3.79	79.29	291.52
- 2.14	- 2.49	- 65.11	- 5.59	- 94.17	- 27.06

13.	14.	15.	16.	17.	18.
45.07	64.88	897.43	28.50	26.42	99.83
-65.07	- 75.62	- 197.44	- 2.75	- 68.02	- 103.53

19. 658 x 435 = _____

20. 5,141 x 853 = _____

21. 4,257 x 859.1 = _____

22. 3,959 x 74.3 = _____

23. 64.87 x 50.60 = _____

24. 33.65 x 9.43 = _____

25. 385.2 x .78 = _____

26. 935.0 x .118 = _____

27. 28 1/4 x .118 = _____

28. 45 1/2 x 62 1/4 = _____

29.

3,353.06	5.40
85.27	87.26
981.87	.60
10.16	4.92
2.93	7.27
.07	561.74
8,004.15	102.04
67.67	67.90
2.52	2.58
1,899.84	93.64
	6,367.90
S	6.15
3.91	13.48
219.12	117.96
42.29	7.65
856.36	5,358.43
93.08	
7.47	S
19.38	.85
9,069.47	9,069.47
138.81	38.21
55.10	505.15
472.05	80.90
1.45	1,264.12
(Continued)	T

30.

7,247.85	.73
22.14	18.38
.64	192.65
70.94	331.27
9,218.99	
12.04	S
90.10	7,812.99
- 13.71	54.97
	53.08
S	43.64
3,539.83	26.97
55.75	- 100.83
.12	7.64
32.98	7.58
- 31.39	4,170.19
1.92	1.57
241.21	162.61
- 2.05	6,345.27
- 63.52	118.30
205.06	239.14
64.78	42.84
703.07	159.57
8.76	920.02
- 9.50	- .16
(Continued)	T

9.4.0 TEN-KEY ADDING LISTING MACHINE: Given instruction in the touch method of operating the Ten-Key Adding Listing Machine, the student will demonstrate mastery of this machine by completing a 41 item post-test with at least 60% accuracy within a 40-minute period.

9.4.1 The test will consist of problems involving:

1) Addition
2) Subtotal
3) Credit Balance
4) Repeated Addition
5) Subtraction
6) Multiplication (Decimals)
7) Multiplication (Fractions)
8) Percentages
9) Simple Discounts
10) Chain Discounts
11) Division
12) Addition (Fixed Decimal Point)
13) Reconciliation - Bank Statement

9.4.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Ten-Key Adding Listing Machine
Test Two

1.	2.	3.	4.	5.
7.85	8.16	1,894.36	2.69	120.00
.08	8.50	6.22	.89 -	120.00
4.48	.02	.14	67.53 -	120.00
91.77	366.96	.11	9.11	87.45
652.37	2.53	7,482.44 -	2.15 -	87.45
.67	21.71	771.55	.38 -	389.12
43.18	4.43	10.83 -	684.29	389.12
7.28	.12	.44	8.96	389.12
2.08	5.78	2.79	9.71	389.12
24.94		9.25	987.42 -	65.30
9.11	S	.36 -	.03	65.30
.55	554.04	20.51 -	2.14	65.30
382.56	268.15	1,182.58	.08	65.30
.93	.86			65.30
5.54	28.73			11.95
.03				11.95
353.70	S			452.73
.97	3.68			452.73
7.47	3.68			452.72
56.39	3.68			452.72
	3.68			452.72
	.46			452.72
	9.18			452.72
	.09			452.72

6. 82.54 x .32 = _____
7. 1.483 x 1.96 = _____
8. 807.219 x 1.2 = _____
9. 25.2 x 2.9 = _____
10. 93.4 x .68 = _____
11. 7,489 x 59 1/8 = _____
12. 65 1/4 x 38 3/5 = _____
13. 5% of $6,340.50 = $_____
14. 12 1/2% of $384 = $_____
15. 15% of $302.95 = $_____
16. $ 605.75 less 37 1/2% = _____
17. $4321.35 less 16 3/4% = _____
18. $678.92 less 10%, 10%, 10% = _____
19. $876.49 less 25%, 10%, 5% = _____
20. 935 -:- 25 = _____
21. 4,115 -:- 80 = _____
22. 3,852 -:- 500 = _____

Ten-Key Adding Listing Machine
Test Two

23.	24.	25.
496.30	1,488.32	791.50
117.82 -	1,690.14 -	1,825.43 -

26. .384 + 91.3 + .76829 + 46.81 + 2.207 + .55 = _____

27. 7.8041 + 97.601 + 416.1 + 3.245 + .07 + 83.6 = _____

Reconciliation of Bank Account
January 31, 19--

Checkbook Balance		$380.90	
Additions:			
Money Collected	$400.00		
Deposit Omitted	390.00	$_____	28.
		$_____	29.
Deductions:			
Service Charge	$ 4.00		
Error	13.00	$_____	30.
Adjusted Checkbook Balance		$_____	31.
Bank Balance		$260.80	
Additions:			
Deposit		$500.00	
		$_____	32.
Deductions:			
Outstanding Checks #			
150.00			
93.10			
60.00			
90.00		$_____	33.
Adjusted Bank Balance		$_____	34.

35. 3 doz Hammer, 1808-D @ $26.80 each = _____

36. 16 doz Hammer, 1911-A @ $32.40 each = _____

37. 5 1/2 doz Hammer, 2100-B @ $14.00 each = _____

38. 38 1/4 doz Hammer, 800-Z @ $ 6.50 each = _____

Total: $_____

CALCULATING MACHINES 2

9.5.0 ROTARY CALCULATOR: Given instruction in the operation of the Rotary Calculator, the student will demonstrate mastery of this machine by completing a 42 item post-test and with at least 60% accuracy within a 40-minute period.

9.5.1 The 42-item test will be administered after the student has completed approximately half of the learning activities in this unit and will consist of problems involving·

1) Addition
2) Debit & Credit Balances
3) Subtraction (Credit Balance)
4) Multiplication
5) Multiplication (Fractions)
6) Multiplication (Decimals)
7) Division
8) Division (Decimals)
9) Accumulative Multiplication
10) Vertical & Horizontal Addition

9.5.2 The test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Rotary Calculator
Test One

1.	2.	3.	4.	5.	6.
5,447	49,871	912.15	8,913.46	273.19	522.30
13,803	9,268	71.14	6,426.04	8.75	77.51
24,438	12,751	6,303.61	101.86	440.10 -	646.20 -
2,665	5,153	55.86	3,409.50	74.74	28.38 -
91,714	99,477	1,229.55	1,189.17	384.18 -	185.01 -
9,875	151	547.50	373.07		
32,811	4,550	3.07	4,090.06		
4,926	48	40.74	284.28	7.	8.
53,039	45,706	1.55	799.17		
2,877	3,135	3,264.83	2,906.06	110,124	200.35
				88,620 -	414.55 -

Multiplication (Do Not Round):

9. 241 x 17 = _____
10. 5,392 x 411 = _____
11. 1311 x 84 = _____
12. 9,186 x 256 = _____
13. 18 1/2 x 21 7/8 = _____
14. 2 3/4 x 7 1/4 = _____
15. 20 5/8 x 36 = _____
16. 40.9167 x 6.75 = _____
17. 6.6624 x .0096 = _____
18. 52.5 x 60.756 = _____
19. 9.0625 x 8.0333 = _____
20. 27.2 x 76.40 = _____

Division (Round to 3 Decimals):

21. 456 -:- 63 = _____
22. 3,960 -:- 110 = _____
23. 8,429 -:- 65 = _____
24. 884.05 -:- 6.278 = _____
25. 71.140 -:- 23.658 = _____
26. .0654 -:- 7.143 = _____
27. 9,845.4 -:- 46.17 = _____

Accumulative Multiplication (Round to Nearest Cent):

28.
1346	x	$7.46
12	x	.47 1/8
320 1/2	x	1.12 1/4
99	x	.09
877	x	5.60

29. 623 lbs @ $125.50 = _____
30. 129 lbs @ $.17 1/4 = _____

Adding Vertically & Horizontally:

Sales by Quarters

	Jan-Mar	Apr-June	July-Sept	Oct-Dec	Annual	
Belmont	$475	$568	$574	$647	$_____	31.
Burlingame	545	665	594	586	$_____	32.
Foster City	485	499	656	676	$_____	33.
Millbrae	654	584	459	645	$_____	34.
San Bruno	579	475	594	575	$_____	35.
San Carlos	567	894	544	476	$_____	36.
San Mateo	959	686	995	998	$_____	37.
Totals:	___	___	___	___	$_____	
	38.	39.	40.	41.	42.	

9.6.0 ROTARY CALCULATOR: Given instruction in the operation of the Rotary Calculator, the student will demonstrate mastery of this machine by completing a 52 item post-test with at least 60% accuracy within a 40-minute period.

9.6.1 The 52-item test will be administered after the student has completed all of the learning activities in this unit and will consist of problems involving:

1) Addition
2) Debit & Credit Balances
3) Percentage
4) Simple Discount
5) Division (Decimals)
6) Mark-ups
7) Extensions & Total
8) Multiplication (M, C, CWT.)

9.6.2 Each test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Rotary Calculator
Test Two

1.	2.	3.	4.	5.
7.81	651.92	69.75	99.25	510.00
32.55	90.66	8.75	975.20	3.12
9.09 -	589.27	449.81 -	162.50 -	241.15 -
16.27	862.34	8.69 -	76.27	9,471.00
3.13	56.54	281.42	5,650.92 -	970.10
50.75 -	125.02	75.86	6.83	78.25
11.90	1,201.67 -	7,145.91 -	500.76 -	80.66
41.98 -	52.56	9,816.87	417.93	109.22
19.82	1,092.44 -	786.40	55.62	1,244.67 -
27.53	867.34 -	40.15	4,119.87 -	783.45

Complete as indicated:

6. 25% of 320 is _____

7. 10% of $85 is $_____

8. 3 1/4% of 1,919 is _____

9. 3 1/8% of $2,250 is $_____

10. 32 1/2% of 450 equals _____

Find the discount and net amount of the following:

		Amount of Discount	Net Amount
11.	$6,742.50 less 18%	a.$_____	b.$_____
12.	212.88 less 28%	a. _____	b. _____
13.	39.04 less 2%	a. _____	b. _____
14.	270.40 less 20, 2%	a. _____	b. _____
15.	243.30 less 15, 7, 2%	a. _____	b. _____
16.	122.87 less 60, 5, 2 1/2%	a. _____	b. _____

Division (Round to 3 Decimal Places):

17. 9.7406 -:- .563 = _____

18. .1378 -:- 42.07 = _____

19. 71.140 -:- 23.685 = _____

20. 83.56 -:- 3.91 = _____

21. 884.05 -:- 62.78 = _____

Find the percent of mark-up based on cost, round to a whole percent.

22. Cost: $212.89 Retail: $234.18 Percent Mark-up: _____%

23. Cost: $ 16.53 Retail: $ 22.04 Percent Mark-up: _____%

24. Cost: $ 59.88 Retail: $ 69.84 Percent Mark-up: _____%

	Department	Per Cent of $7,500 Advertising Budget	Amount of Advertising Budget
25.	Appliances	17 %	$_____
26.	Books	13 %	$_____
27.	Cosmetics	11.6 %	$_____
28.	Furniture	12.5 %	$_____
29.	Jewelry	9.6 %	$_____
30.	Men's Wear	8.4 %	$_____
31.	Radio and T.V.	7.8 %	$_____
32.	Shoes	6.7 %	$_____
33.	Women's Wear	13.4 %	$_____
	Total:	100.0 %	$ 7,500.00

Compute the following extensions and total:

	Quantity		Price	Extension
34.	284	items	$ .07 ea.	$_____
35.	39	items	2.15 per C	$_____
36.	87 1/4	lbs.	.75 per lb.	$_____
37.	6534	items	5.75 per C	$_____
38.	267	lbs.	7.53 per CWT.	$_____
39.	1345	lbs.	15.65 per CWT.	$_____
40.	12	boxes	.47 per box	$_____
41.	16	items	15.60 per M	$_____
42.	1527	lbs.	6.00 per CWT.	$_____
43.	48	items	1.75 per doz.	$_____
44.			Total:	$_____
45.			Less 5%	_____
46.			Net Amount	$_____

9.7.0 PRINTING CALCULATOR: Given instruction in the touch method of operating the Printing Calculator, the student will demonstrate mastery of this machine by completing a 44 item post-test with at least 60% accuracy within a 40-minute period.

9.7.1 The 44 item post test will be administered after the student has completed approximately half of the learning activities in this unit and will consist of problems involving:

1) Addition
2) Addition (Subtotals)
3) Addition + Subtraction
4) Subtraction (Credit Balance)
5) Subtraction of Constants
6) Multiplication
7) Multiplication (Decimals)
8) Multiplication (Fractions)
9) Multiplication (Constant Factors)
10) Multiplication (Multiple Factors)
11) Invoice
12) Division
13) Division (Decimals)

9.7.2 This test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Printing Calculator
Test One

1.	2.	3.	4.	5.	6.
987.01	271.40	100.01	1,472.19	87.39	42.16
107.68	349.50	400.04	853.64	23.29	781.35
12.36	87.50	700.07	106.52	8.06	.56
8.92	140.82	200.02	25.00	16.45	25.00
453.16	25.00	500.05	41.19	603.33	
3.81	16.45	700.06	172.70	11.05	S
16.89	209.93	400.07	3,000.59	316.20	.37
201.83	87.77	450.00	260.11		9.01
3180.92	620.09	900.06	61.50	S	58.45
251.37	146.42	870.00	309.87	.06	416.35
5.33	1.45	560.00	82.90	11.34	132.06
80.21	10.05	900.07	300.05	7.09	79.31
53.84	2.57	6000.87	18.06	580.00	8.06
				65.20	114.90
					37.85
				S	50.08
				2.40	
				3.78	
				58.60	

7.	8.	9.	10.	11.	12.
42.16	418.85	27.16	981.06	1,408	507.43
781.35	72.51	2.56-	150.07-	921-	661.18-
.56	25.88-	811.00			
25.88-	86.55-	2.81			
6.00	3.00	19.26-			
61.30	178.80-	200.78-			
44.09-	23.30	7.58			
8.09-	605.67-	8.16			
145.00-	4.44	10.26			
15.36	81.68	218.62			
2.07	213.82-				

13.

41,500 - 9,950 = _____
38,750 - 9,950 = _____
22,640 - 9,950 = _____
40,980 - 9,950 = _____

Total: _____

14. 974 x 381 = _____

15. 215 x 540 = _____

16. 75.21 x .99 = _____

17. 1.08 1/4 x 26 1/2 = _____

18.

445 x 327 = _____
545 x 327 = _____
841 x 327 = _____
212 x 327 = _____
1234 x 327 = _____

Total: _____

19. 14 x 12 x .79 = _____

20. 16 x 16 x .84 = _____

21. 6.56 x 42.3 x 45 = _____

Complete the following extension and total:

Quantity	Price	Extension	
3,150 units	$8.40 per M	$_____	22.
325 lbs.	.67 per CWT.	_____	23.
98 lbs.	.12 1/2 per lb.	_____	24.
	Total:	$_____	25.

Complete the following invoices:

26. 2,785 @ $1.75 per C = $_____

27. 75 @ $96.55 per C =$_____

28. 1,115 @ $11.50 per CWT = $_____

Round answers to three decimals:

29. 25069 -:- 234 = _____

30. 9786 -:- 67 = _____

31. 219.5 -:- 302.55 = _____

32. 37.081 -:- 14.25 = _____

33. 319 -:- 5.89 = _____

9.8.0 PRINTING CALCULATOR: Given instruction in the touch method of operating the Printing Calculator, the student will demonstrate mastery of this machine by completing a 48 item post-test with at least 60% accuracy within a 40-minute period.

9.8.1 The 48 item post-test will be administered after the student has completed all of the learning activities in this unit and will consist of problems involving:

1) Addition
2) Multiplication (Decimals)
3) Multiplication (Fractions)
4) Division
5) Division (Decimals)
6) Percentage
7) Discount & Net Amount
8) Chain Discounts
9) Percentage (Increase or Decrease)
10) Markup or Markdown
11) Interest (Time)
12) Invoice (C)

9.8.2 Each test will be graded according to the following scale:

1) 90 - 100% = A
2) 80 - 89% = B
3) 70 - 79% = C
4) 60 - 69% = D

CALCULATING MACHINES 2
Printing Calculator
Test Two

1.	2.	3.	4.
374.76	239.50	584.22	561.59
667.62	5.75	700.79	994.85
543.09	935.41	883.69-	155.09-
98.54	316.82	98.35-	51.99-
598.63	224.77	110.61	383.82-
71.09	812.46	241.80	46.49
810.79	675.78	39.14-	695.16
322.03	713.31	328.83	382.37-
129.89	904.69	93.96-	700.05
949.67	30.21	493.16-	669.15

5. 1.483 x 1.96 = _____

6. 82.54 x 73 = _____

7. 65 1/4 x 38 3/5 = _____

8. 3,189 -:- 41 = _____

9. 307.4 -:- 48.3 = _____

10. 5% of $6,340.50 = _____

11. 15 1/5% of $834.00 = _____

	Discount	Net Amount
12. $605.75 less 37 1/2% =	(a) _____	(b) _____
13. $583.50 less 17 1/2% =	(a) _____	(b) _____

Chain Discounts: (Use text table for Chain Discount Equivalents, p. 462.

14. $678.92 less 10%, 10%, 10% = $_____

15. $876.49 less 25%, 10%, 5% = $_____

Find amount of Increase or Decrease and percent of Increase or Decrease, indicate + or - in answer. Round to nearest whole percent.

	Last Year	This Year	Amount of Change	% of Change
16.	$17,705.49	$19,206.00	(a) _____	(b) _____
17.	3,821.30	5,216.35	(a) _____	(b) _____
18.	28,005.45	27,345.23	(a) _____	(b) _____
19.	8,924.03	9,065.00	(a) _____	(b) _____
20.	850.06	649.99	(a) _____	(b) _____

Markup/Markdown:

	Cost Price	Selling Price	Markup	Percent Markup or Markdown
21.	$120	$165	$_____	_____%
22.	$350	$315.50	$_____	_____%

Find the interest on the following. Use a 360-day year and text table of interest, page 347.

23.	$246.80	46 days	@ 4%	$_____
24.	$187.90	25 days	@ 6%	$_____

Calculate the price of each and total:

	Quantity	Description	Price	Amount
25.	750	Envelopes, Window	$2.75 per C	$_____
26.	1,500	Envelopes, Large	3.35 per C	$_____
27.	450	Envelopes, Manila	10.80 per C	$_____
28.	650	Envelopes, Legal	5.20 per C	$_____
29.	285	Envelopes, Reg.	3.60 per C	$_____
30.			Total:	$_____

Calculate the following:

	Quantity	Price	Extension
31.	115	$3.75	$_____
32.	49	1.85	$_____
33.	225	4.35	$_____
34.	68	5.20	$_____
35.		Total:	$_____
36.		Discount 3%	_____%
37.		Net Total	$_____
38.		Plus 5% Tax	$_____
39.		Gross Total:	$_____

VT 012 223
Minnesota School Bus Driver's Handbook.

Minnesota State Dept. of Education, St. Paul. School Transportation Section.
Minnesota State Dept. of Highways, St. Paul.
MF AVAILABLE IN VT-ERIC SET.
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IDENTIFIERS - *SCHOOL BUS DRIVERS

ABSTRACT - Prepared by the Minnesota State Department of Education and Highway Department, this handbook provides school bus drivers and school officials with information relating to the safe and efficient transportation of pupils. Information is provided for: (1) licensing and physical examination requirements, (2) driver contract obligations, (3) care, use, equipment, and inspection of vehicles, (4) regulations concerning speed limits, lighted headlamps, railroad crossings, and signals, and (5) responsibility and tips for handling children. Application blanks and forms for physical examination can be obtained from the source of availability cited above. (PM)

VT 012 223

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MINNESOTA SCHOOL BUS DRIVER'S HANDBOOK

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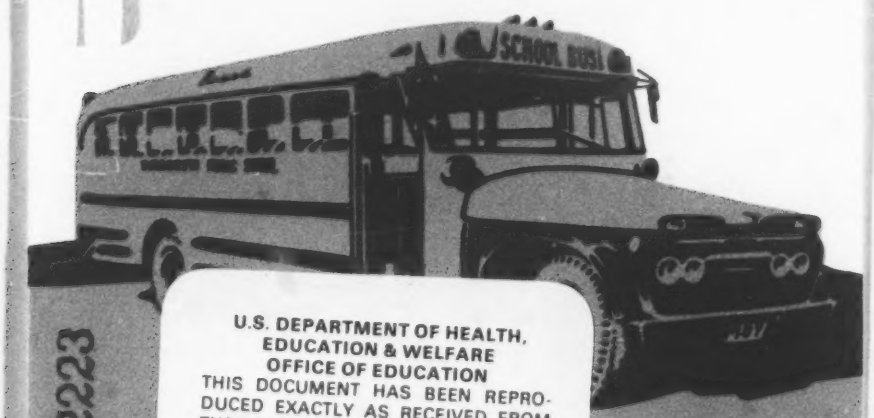

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VT712223

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MINNESOTA SCHOOL BUS DRIVER'S HANDBOOK

Prepared
by

School Transportation Section
Minnesota Department of Education
Safety Division

and

Minnesota Department of Highways
St. Paul, Minnesota 55101

November, 1969

14 2853

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PREFACE

The Minnesota School Bus Driver's Handbook has been prepared and published by the Minnesota Department of Education and the Minnesota Highway Department for the purpose of providing school bus drivers and school officials with definite information relating to the safe and efficient transportation of pupils.

Every school bus driver applicant should become thoroughly familiar with all sections of this handbook. It will also serve as an excellent review for experienced drivers, and should be referred to frequently.

The written test will include questions on operating both the regular school buses and the smaller vehicles.

The professional school bus driver is charged with an important responsibility in transporting pupils to and from school. He is the guardian of the safety of the children whose lives are entrusted to his care.

Administrative Officers can offer a valuable assist to the drivers if, at the beginning of each school year, they arrange for the parents of the pupil-passengers to meet their driver and inspect the bus.

This type of meeting, in addition to being of interest to the parents, will give the driver an opportunity to learn something about the children and any peculiar problems which he may encounter in the coming year.

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An interesting side benefit is the effect such a meeting has on the children (who should not be present at the meeting). A child is usually much better behaved when he knows that the driver has met and talked with his parents.

This handbook is distributed without charge to all school bus drivers and those who are preparing to take the school bus driver examination. The handbook, application blanks and forms for physical examinations are also available from all motor vehicle registrars throughout Minnesota.

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GENERAL REQUIREMENTS

Except as otherwise noted, the following general requirements will apply to both the regular school buses and small vehicles. Regular school buses are those which carry 12 or more passengers. Small vehicles carry less than 12 passengers, and may be automobiles, station wagons, carryalls, or suburbans not over 10 years old.

License Requirements. A school bus driver's license examination shall be required of every person operating any motor vehicle used in the transportation of children to or from public, private or parochial schools and owned by:

1. A governmental agency; or
2. A person, firm, association or corporation; or
3. Private or parochial school, corporations or agencies.

Application for examination and license shall be in writing upon such forms and shall contain such information as the Secretary of State may prescribe, and shall be accompanied by the payment of an examination and license fee of $4.00. The fee for renewal of a school bus driver's license shall be $2.50.

The test or examination shall be a written test based upon the provisions of the Highway Traffic Regulations Act, rules and regulations relating to school bus operations prescribed by the State Board of Education, and a general knowledge of the operation of school buses.

School bus drivers' licenses shall be issued for the fiscal year ending on June 30 of each year.

Small Vehicle Driver Requirements. Drivers of small vehicles, including automobiles, station wagons, carryalls, or suburbans which carry 12 or less pupil-passengers must hold a current valid

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Minnesota school bus license when transporting children to and from school or on a school-related trip or activity.

Exception: A school bus driver's license is not required but the driver must hold a valid driver's license:

1. When transporting his own children to and from school under contract.
2. When operating **only a passenger automobile** or **station wagon** for an occasional school-related trip or activity (but not to and from school).

Physical Examination. The applicant for a school bus driver's license shall be in good physical and mental health, be able-bodied, and free from communicable disease. As evidence of his physical fitness and mental alertness the applicant shall submit to a physical examination upon initial application and each year upon renewal by reputable physicians designated by the local school authorities; and the licensed medical doctor's certificate of physical fitness shall accompany the application for school bus driver's license when presented to the Chauffeur's License Division. A physical examination may be required more often upon demand of any school district. Such extra examination shall be paid for by the district demanding it of any driver. A licensed school bus driver may also operate a motor vehicle as a chauffeur.

One or more of the following deficiencies will disqualify the applicant for a school bus driver's license:

1. Visual acuity less than 20/40 in either eye corrected. Total form fields of vision in the horizontal meridian of less than 140 degrees

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in either eye (with or without corrective lenses).

2. Hearing less than 10/20 in the better ear (with or without hearing aid).
3. Inebriates or users of narcotics.
4. Any indication of coronary or heart ailment likely to interfere with safe driving (electrocardiogram is required when other findings indicate desirability).
5. Blood pressure over 160/90.
6. Failure to have a satisfactory Mantoux or chest x-ray within the past six months.
7. Any communicable disease (as listed in Minnesota Health Department Regulations 10795 and 10812).
8. Loss of foot, leg, hand, arm or other structural defect or limitation of movement likely to interfere with safe driving.
9. Any mental, nervous, organic or functional disease likely to interfere with safe driving.
10. Diabetes unless controlled by diet only.
11. Epilepsy or other episodic (paroxysmal) periods of unconsciousness.
12. Use of any medication which the examining physician determines is likely to interfere with safe driving.
13. Applicant not of good general health.

The certificate to be used by the physician for reporting the physical condition of the applicant shall be one prescribed by the Secretary of State and may be obtained from the Chauffeur's Section, Motor Vehicle Division, or from any authorized Deputy Motor Vehicle Division or from any authorized Deputy Motor Vehicle Registrar throughout the state.

Character. The driver shall be of good moral character and conduct himself in such a manner as to exercise good influence over the pupils.

Experience. Regardless of prior driving experience it is recommended that all school bus drivers, before transporting pupils, receive adequate basic instruction for the operation of a school bus, including a performance test in the vehicle. It is also recommended that all school bus drivers take the eight-hour National Safety Council Defensive Driving Course and the Medical Self Help Course (Dept. of Health).

Age. The driver shall be at least 18 years of age and have a good driving record. No maximum age is set by law; however, some school districts or private contractors may have a mandatory retirement age.

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CONTRACT PROVISIONS — DRIVER OBLIGATIONS

Contracts: The contract form as prepared by the State Board of Education and approved by the State Attorney General contains provisions which must be observed by the school bus driver.

The driver must agree to faithfully fulfill the following general obligations and such special duties as may be added to the contract by both parties:

1. To travel over the route and make stops according to the timetable designated by the School Board and/or Administrative Officer.
2. To keep the conveyance and other property used in transporting pupils clean and under shelter at all times when not in actual use and to exercise reasonable care in the use of such equipment.
3. To use the bus and all other property for no other purpose than the transportation of pupils over routes designated without special permission from the School Board and/or Administrative Officer.
4. To allow no other person to drive the vehicle without the proper license and without special permission from the School Board and/or Administrative Officer.
5. To exercise the utmost care in protecting children from injury or exposure.
6. To stop the bus at all railroad crossings. (Railroad crossings are only to be flagged when designated by the Administrative Officer.)
7. To supervise the safety of pupils when they cross the highway before entering or leaving the school bus.

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8. To be alert and observe all laws and rules relating to travel on the public roads.

9. To observe all operating rules adopted by the State Board of Education, Commissioner of Highways, and local School Board.

10. To maintain order among the pupils at all times; to allow them to enter and to leave the bus only at pupil station stops designated by the Administrative Officer; and to report all cases of disobedience, improper conduct, speech and cases of tardiness to the Administrative Officer.

11. To use no profane or indecent language within hearing of the pupils and to tolerate none from them.

12. To abstain from the use of tobacco when driving the bus and allow no children to use tobacco in any form.

13. To abstain absolutely from the use of intoxicating beverages on days when he transports children.

14. To make such daily and weekly reports to the Administrative Officer as shall be required, and other reports to the designated authorities.

15. To attend all meetings of school bus drivers called by the Superintendent or Administrative Officer.

16. To attend one county or regional school bus driver's school of instruction, and to bring the vehicle used for transportation of pupils for inspection to the county school bus clinics when such meetings are called by the State Department of Education.

17. To post a copy of the "School Bus Passenger's Pledge" in the bus so that it can be read and referred to by all pupils.

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42 OF 327

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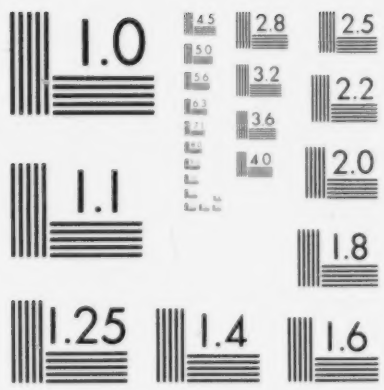

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

GENERAL OPERATING RULES

1. Only pupils assigned to the school bus by the School Board or designated Administrative Officer of the school district shall be transported at district expense. The number of pupils or other authorized passengers transported in or assigned to a school bus shall not be more than the number of pupils or passengers that can be seated, and no person shall stand when the bus is in motion.

2. Pupils are not to be evicted from the bus along the route for a breach of discipline; all such breaches shall be reported by the bus driver to the Administrative Officer. (Discipline in the bus is the responsibility of the driver).

3. Safety drills for the pupil-passengers, using the entrance door and the emergency exit door on large buses, shall be conducted at least twice a year by the driver under the supervision of the Administrative Officer.

4. The Administrative Officer shall see that no materials including: guns, loaded or unloaded; gasoline cans, empty or full; animals or any other object of a dangerous or objectionable nature are transported in the school bus when children are being conveyed.

5. Immediate report of all accidents, however slight, involving the school bus shall be made by the driver to the Administrative Officer and to such other authorities as required by law, rule or regulation. The driver shall prepare and keep all records and reports required by the Administrative Officer.

6. There shall be no pupils in the bus while the gas tank is being filled. On leaving the vehicle, when children are in the bus, the driver shall stop the bus, remove the ignition key, set the brakes and otherwise render the bus immobile.

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7. Buses shall not be run backwards on the school grounds or any other point if it can be avoided. If it is necessary to run a bus backwards, the driver shall have another responsible person act as a guard flagman in back of the bus to keep other persons out of the path and to issue warnings to the drivers of approaching traffic.

8. When arriving or leaving the school grounds, the driver must not travel closer than 50 feet to the bus directly in front of him nor closer than 500 feet when traveling on the highway (this rule applies to the large buses only).

9. No school bus shall pull any trailer when children are being transported to or from school or on extracurricular trips.

10. In case of an accident or breakdown of the bus, the driver shall not leave the bus but send two of the patrol boys or other responsible pupils to the nearest house to summon help.

11. The School Board may adopt such additional operating rules as deemed necessary to meet local conditions and needs, provided they do not conflict with state laws and regulations.

SPEED LIMITS, SEATBELTS, LIGHTED HEADLAMPS AND RAILROAD CROSSINGS

Speed Limits: The driver shall not exceed the speed of 50 miles per hour on a regular school bus route to or from school.

1. The driver will not exceed the posted speed limits on extracurricular trips.
2. He will never drive at a speed that is faster than reasonable under existing conditions. (Never operate any school bus improperly equipped or in an unsafe condition).

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Seatbelts: All school bus drivers shall be required to use the driver seatbelt at all times when the vehicle is so equipped.

Lighted Headlamps: The driver shall display lighted headlamps (low beam) during daylight hours when transporting children.

Railroad Crossings: All school buses, whether carrying passengers or not, are required to stop at all railroad crossings when the school bus sign is displayed on the vehicle. Red flashing stop signals or alternately flashing amber signals shall not be used at railroad crossings. (It is recommended that flashing amber four-way hazard warning signals be used). A school bus shall not be flagged across railroad grade crossings except at such crossings as the local school Administrative Officer may designate. At such crossings, at least a sixth grade student shall flag the school bus across the railroad tracks (see page 21 for proper procedures). The driver must be sure that the pupil has checked for approaching trains before driving across the tracks.

LOADING OR UNLOADING

1. Never load or unload pupils where the view is obstructed to other motorists for 500 feet in either direction.

2. Never permit pupils to get up from their seats or get on or off the bus while it is in motion.

3. Bring the bus to a full stop and disengage gears by shifting gear shift lever into neutral position or selector into neutral or park position before loading or unloading pupils.

4. Regular buses shall load and unload in the right lane of the roadway and only at pupil stations designated by the Administrative Officer on approved bus routes. In no event shall buses load

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or unload pupils in a **DESIGNATED TURN LANE** or in a lane immediately adjacent to a **DESIGNATED TURN LANE.**

5. Small vehicles shall not stop in the right lane to load or unload pupils, but clear of the main traveled portion of the roadway.

6. For small vehicles, pupils shall load or unload only from the right hand side of the vehicle, except on a one-way street, where the nontraffic side of the vehicle may be used.

USE OF SIGNALS, LOADING OR UNLOADING
(Regular Buses)

1. The driver shall actuate the flashing red signals of the bus at least 300 feet before stopping to load or unload pupils when outside an incorporated municipality, and 100 feet when operating within an incorporated municipality, and shall not extinguish such lights until loading or unloading is completed and persons who must cross the highway are safely across.

2. Bring the vehicle to a complete stop in the right hand lane of the roadway parallel to the centerline.

3. Extend the stop signal arm upon stopping and continue to activate the flashing red signals.

4. Open door to discharge pupils only after all traffic (front and rear) has come to a complete stop.

5. Keep stop signal arm extended until all pupils have been loaded or unloaded safely or have crossed the road.

6. Keep flashing red signals activated until loading or unloading of pupils has been safely completed, stop arm retracted and bus in motion.

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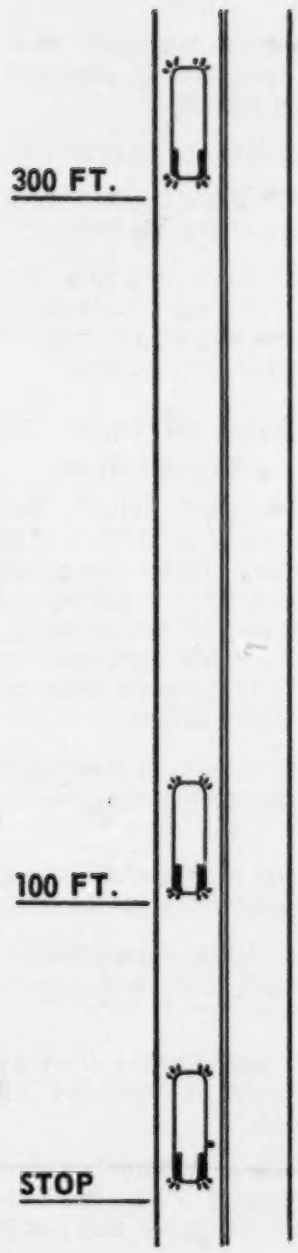

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STOP SIGNALS NOT USED

The driver shall **not** use stop signals in the following:

1. In special school bus loading areas where the bus is entirely off the traveled portion of the road.
2. In residence or business districts of cities, villages, or boroughs, except when directed by the school Administrative Officer. (Examples: narrow 2-lane roadway, roadway obstructed, or where school bus must stop in the traveled lanes of roadway.)
3. When a school bus is being used for other purposes; such as charter service (in which event, the school bus signs, front and rear, must be removed or completely concealed).

EQUIPMENT FOR SMALL VEHICLES

Reflectorized school bus sign required — To comply with standards set by the Commissioner of Highways.

Sign used — the school bus sign shall be displayed (front and rear) at all times when the vehicle is in use as a school bus.

Sign not used — the school bus sign shall **not** be displayed when the vehicle is not in use as a school bus.

Alternately flashing amber signals required — to comply with standards set by the Commissioner of Highways.

Amber signals required and used:

1. The driver will signal his intention to stop by activating the alternately flashing amber signals (only when operating outside city limits).

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2. He will keep alternately flashing amber signals activated until loading or unloading of pupils has been safely completed and the vehicle is in motion (only when operating outside city limits).

Alternately flashing amber signals not required or used — vehicles transporting school children to and from school operating within an incorporated municipality (only reflectorized school bus sign is required).

DRIVER RESPONSIBILITY

For Regular Buses: The driver shall be responsible for safely delivering the pupils who must cross the highway by one of the following methods:

1. Pupils shall pass approximately 10 feet in front of the school bus so as to be seen by the driver and cross the road only upon receiving word from the driver, or
2. The pupil shall pass approximately 10 feet in front of the bus so as to be seen by the driver and be conducted across the road by the School Bus Patrol, or
3. The driver shall personally conduct the pupils across the road.
4. The driver shall visually ascertain that alighting children not crossing the road shall be a safe distance from the bus before moving the vehicle.

For Small Vehicles: He should load or unload, except where impractical, where the child need not have to cross the road.

When a child **must** cross the road, it is the responsibility of the driver to escort him across, after first:

(a) Stopping the motor

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(b) Removing the ignition key

(c) Setting the brakes

(d) Otherwise rendering the vehicle immobile.

REPORTS

The driver shall make the following reports:

1. Daily or weekly reports as requested by the Superintendent.
2. He must report all accidents, however slight, to the Superintendent, who in turn shall complete the school bus accident report and transmit to the Department of Education.
3. He must report all accidents involving personal injury or death, and/or property damage of $100 or more to the State Commissioner of Highways (this is in addition to the report required by the Department of Education).
4. All discipline cases shall be reported to the Superintendent.
5. Time schedules shall be posted in buses, together with a list of assigned pupil riders.

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SCHOOL BUS PATROL

1. The organization and use of a School Bus Patrol is recommended to assist the bus driver in the safe operation of the vehicle. These patrols can be very helpful in maintaining order and preventing accidents on buses and in assisting pupils safely across highways.

2. School Safety Patrols for buses should be appointed, organized and governed in the same manner as regular School Safety Patrols.

The school bus driver should be present at the organization of the School Bus Safety Patrol and should be familiar with all rules and regulations governing the duties of Patrol members.

When it appears that the Patrol member is having difficulty carrying out his duties, the driver shall promptly give necessary assistance. The driver shall maintain supervision over the School Bus Safety Patrol. He is responsible for the safety of the pupils, and the presence of a School Safety Patrol member in no way relieves him from such responsibility.

When selecting members for a School Bus Safety Patrol, personality, strength and physical size should be taken into consideration. Alternates should be appointed to serve on days when Patrol members are absent, before the regular Patrol member enters the bus or after he leaves the bus near his home. There should be two regular members of the School Safety Patrol for each bus — one in the rear of the bus near the emergency door and the other to supervise the operation of the regular entrance door and perform other duties that may be assigned to his position.

3. The duties of the School Bus Safety Patrol are:

(a) To supervise loading and unloading of the pupils in an orderly and safe man-

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ner. Pupils should enter and leave the bus in single file.

(b) To see that all pupils are provided with a seat and are seated before the bus leaves the school grounds.

(c) To prevent pupils from getting on or off when the bus is in motion.

(d) To prevent pupils from moving around while the bus is in motion.

(e) To assist the bus driver in checking attendance.

(f) To keep aisles free of books, lunch buckets, etc.

(g) To prevent pupils from tampering with emergency door or other safety devices.

(h) To prevent pupils from putting their hands, arms, heads or bodies out of the windows.

(i) To flag the bus across railroad tracks in the following manner:

(1) The Patrol shall take position as to have a clear view of the railroad tracks in both directions.

(2) If a train is approaching the crossing, the Patrol member shall not cross the tracks but shall face the bus at a safe distance from the tracks and give the signal for the bus to not proceed by holding up both hands above his head.

(3) If the track is clear and safe for crossing, he shall signal with a forward motion of his upraised arm (after proceeding across the tracks)

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for the driver to proceed across the tracks to a point at least two and a half bus lengths beyond the tracks where the pupil shall re-enter the bus.

(j) Direct pupils across the roadway after alighting from the bus in the following manner:

(1) The Patrol member shall lead the pupils to a position approximately 10 feet in front of the bus so they can be seen by the driver where he shall hold them in readiness to cross until it is safe to permit them to do so. Crossing the highway behind buses shall never be permitted.

(2) The Patrol member shall not escort each pupil across the highway but shall remain at his post near the front of the bus.

(k) Call the driver's attention to hangers-on or persons attempting to get a ride on the outside of the bus.

(l) Follow the directions of the driver and assist him in case of accident or other emergency. In case the driver is seriously injured, the Patrol member shall follow emergency procedures previously agreed upon to safeguard the children in the bus. He should know emergency procedures and telephone locations.

(m) Assist in maintaining discipline and order on the bus.

4. School Bus Safety Patrols should also be used during extracurricular activities involving

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use of the bus and school children. A well-organized School Bus Safety Patrol is a great assistance in the safe transportation of pupils.

EMERGENCY DRILLS

Due to the increased number of pupils being transported in the present day traffic with a potential increase in accident hazards, it is suggested that an emergency drill be practiced regularly by all pupils transported to the school by motor vehicles.

1. Emergency drills for school buses should be organized in a manner similar to the fire drills held regularly in school. The children should be taught to vacate a school bus quickly and in an orderly fashion in case of an emergency.

2. The bus driver is responsible for the safety of the pupils. However, in an emergency, the driver might be incapacitated so that he would not be able to evacuate the children. Therefore, school Safety Patrol members or other designated pupils should be used to direct these drills. It is extremely important to have regular substitutes so that leaders will always be available.

3. Emergency drills should be held regularly, at least twice a year or perhaps more often during the fall and spring months; and preferably when the loaded bus arrives at the school building.

4. The bus driver shall direct the emergency drill. When the bus arrives at the school, the drill will be conducted by one of the following methods:

   (a) Everyone exits through the rear emergency door.

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(b) Everyone exits through the front entrance door.

(c) The front half exits through the front entrance door and the rear half exits through the rear emergency exit door.

5. The pupils should go to a distance of at least 100 feet from the bus in an emergency drill and remain there in a group until given further directions by the leader.

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VEHICLE INSPECTION

Before starting his day's work, the driver should inspect his vehicle. Waiting until the bus is in motion or pupils are loaded could be too late and extremely hazardous.

The following daily inspection is recommended:

CHECK: (Prior to starting vehicle)

a. Tire pressures
b. Water in radiator
c. Gasoline
d. Oil in crankcase
e. All lights, for operation and cleanness
f. Horn
g. Rear-vision mirrors
h. Windshields and all windows for cleanness
i. Signal arm
j. Equipment, such as flags and flares, first aid kit, winter emergency equipment, fire extinguisher
k. Operation of front door and emergency door

(After starting the engine)

a. Oil gauge
b. Water temperature
c. Windshield wiper
d. Peculiar engine noises
e. Ammeter
f. Heater and defrosters

(Weekly)

a. Tire inflation (with gauge)
b. Battery
c. Anti-freeze in radiator
d. Condition of hoses and belts
e. Tires for cuts, imbedded stones, or sign of wear
f. Exhaust system

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TIPS ON HANDLING CHILDREN

1. Show the children that you love them. Look for the good qualities — all children have them.

2. Never give an order you do not mean to enforce.

3. Do not punish the whole bus load for the behavior of one rider.

4. Let the pupils sit with their friends, if possible.

5. Learn the children's names and greet them each morning and evening.

6. Show a sense of humor, but be able to control it.

7. Remember that you are dealing with children, not adults.

8. Show an interest in the children and their school.

9. Answer any questions that may be asked sensibly and intelligently.

10. If you have problems with the riders, try to solve them without going to school authorities or parents.

11. Ask all students to read the School Bus Passenger's Pledge. Explain that you also have many responsibilities toward them.

12. Listen to suggestions.

13. Set a good example by your conduct, dress, and by living up to the "rules of the road".

14. The safety and well-being of your passengers is your responsibility. Put your heart into it.

15. Be patient. It takes a lot of patience when there is a large group of healthy, lively youngsters.

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SCHOOL BUS PASSENGER'S PLEDGE

1. I always walk single file on the left side of the highway facing traffic, when there are no sidewalks.

2. I do not play games on the street or highway while waiting for the school bus.

3. I start to school in time so that I'm always on time for the school bus.

4. I never ask for or accept rides from strangers.

5. I always wait for the bus to come to a full stop before I attempt to get on the bus, or before I get up from my seat to leave the bus.

6. I go immediately to my seat and stay there until the bus comes to a complete halt at my assigned stop or at the school.

7. I do not put books, lunch, or anything in the aisles of the bus; and I do not leave wrappers or other waste on the bus when I get off.

8. I never tamper with the bus or with any of its equipment.

9. I never tamper with the windows; I never put my hands, arms, legs or any part of my body out of the windows.

10. I always observe classroom conduct in the bus.

11. I do not talk with the driver while the bus is in motion.

12. I report immediately to the driver any damages to the bus.

13. I am always a courteous traveler.

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14. I always obey and cooperate with the driver and the school bus patrol members.

15. I leave the bus at other than my assigned stop only with the consent of the school authorities and the driver.

16. When I get off the bus to cross the road, I always cross 10 feet in front of the bus so I can be seen by the driver.

17. I cross the street or highway only when the driver or school bus patrol has signalled that the way is clear, and I have looked carefully in both directions. I always walk, not run across the road.

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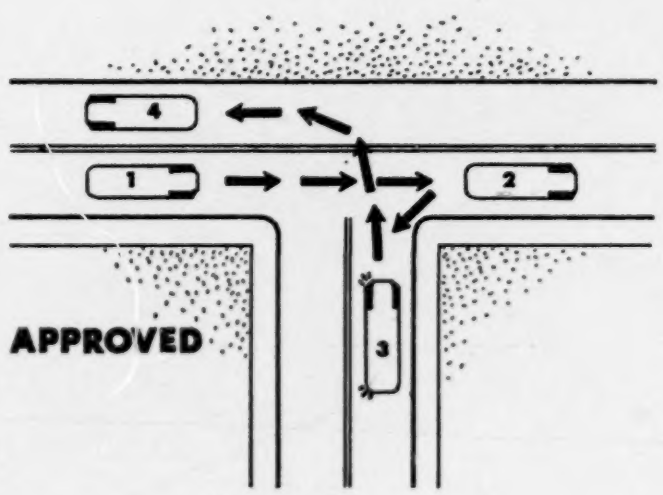

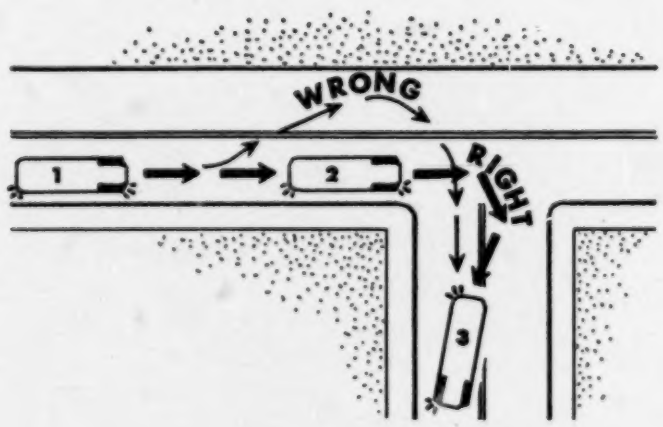

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ABSTRACT - This 16-week course was developed by the Chicago Board of Education and the Joint Board for Long-Term Care to aid teachers in upgrading cooks in nursing homes and other long-term care facilities. Students are selected by the cooperating agency and must have been employed in a nursing home for at least 6 months. Pretests are given to determine a student's reading and ability level and his knowledge of cooking skills, followed by instruction in these units: (1) Introduction, (2) Fundamentals of Nutrition, (3) Principles of Food Preparation and Service, (4) Therapeutic Diets, (5) Environmental Control, and (6) Techniques of Ordering and Inventory Control. Objectives, concepts, content, and activities are included with each unit, and instructional and resource materials are appended. (SB)

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CURRICULUM GUIDE FOR HEALTH OCCUPATIONS

SHORT-TERM COURSE FOR COOKS IN LONG-TERM CARE FACILITIES

JAMES F. REDMOND

General Superintendent of Schools

BOARD OF EDUCATION

CITY OF CHICAGO

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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FOREWORD

The curriculum guide for use in the Short-Term Course for Cooks in Long-Term-Care Facilities was developed to assist teachers working with cooks in nursing homes and other long-term facilities.

Food is a very important part of the physical and psychological well-being of patients in these institutions. This guide takes into consideration the fact that the people responsible for the food services in these facilities sometimes have limited preparation for their jobs.

Efforts to improve food services for the increasing number of people needing long-term care should result in improved nutrition for the patients and increased job satisfaction for the cook employees.

JAMES F. REDMOND
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INTRODUCTION

The Short-Term Course for Cooks in Long-Term-Care Facilities is a cooperative effort of the Chicago Board of Education and the Joint Board for Long-Term Care to upgrade the person working as a cook in the Chicago area nursing homes and other long-term-care facilities. This course is one phase of a demonstration project in health occupation which was funded by the Research Coordinating Unit of the State of Illinois Department of Vocational Education and Rehabilitation. An advisory committee is composed of representatives from the community.

The prospective student for the program is selected by the cooperating agency. The requirements for the student include successful employment in a nursing home for at least six months. A pretest to determine the student's reading and ability level is given for guidance purposes in teaching. Another pretest is given to the student to determine her knowledge of cooking skills.

The information gleaned from the pretesting of students and the task analysis of the food service job provided much of the substance for the guide.

The program is twofold, challenging the ability of the student to follow directions and to improvise while she is cooking in her place of employment. Evidence of this is evaluated in the final cooking practicum. At the completion of the program, the pretest is repeated as a retest to measure and evaluate the results of the student's understanding of cooking principles.

Because of the distance between participating nursing homes, the average student load has been set at 15. The length of the course is 16 weeks and consists of one formal three-hour class a week, which includes lectures, demonstrations, and illustrative materials.

A follow-up study three months after completion of the first class indicated that all the students who completed the course were still employed in the same job. Plans include a continuation of follow-up studies to determine behavorial changes occurring in the student and the length of time the employee stays on her job after completion of the course.

Adaptability of the teacher is of paramount importance because of the necessity for frequent improvising while teaching in this program. Formal classes are sometimes held in ill-equipped classrooms and the laboratory demonstrations are performed in inadequately supplied kitchens in the various settings of the nursing homes. The teacher cooperates with the nursing home administration to provide an in-service education and, when necessary, to recommend ways of improving food service.

OBJECTIVES

General

To apply proper methods to food preparation and service for the improvement of the food service in long-term-care facilities

Contributing

To gain an understanding of the duties and responsibilities of the job as related to the care of the geriatric patients

To develop an ability to recognize quality foods

To learn the correct techniques and an understanding of the basic principles necessary to produce and serve quality foods

To acquire the ability to establish and maintain good personal relationships with co-workers and patients

To develop self-confidence by increasing job satisfaction and personal growth.

SHORT-TERM COURSE FOR COOKS IN LONG-TERM-CARE FACILITIES

UNIT I: INTRODUCTION

CONCEPTS	CONTENT
Satisfactory achievement of the goals of the geriatric cook program is dependent upon the student-learner's understanding of the requirements and the operation of the program.	A. Introduction of personnel 1. Classroom teacher 2. Fellow students in the class 3. Supervisory personnel a. Program b. Facility
Introduction of the students to the teacher, the classmates, and other personnel helps to promote a desirable learning atmosphere.	
The understanding of the nature of the geriatric cook program contributes to the development of student co-operation.	B. Description of course 1. Origin of program 2. Purpose 3. Qualifications for certification 4. Content 5. Length 6. Pretest-retest 7. Methods of teaching a. Classroom b. Laboratory c. Individual guidance 8. Evaluation a. Classroom performance (by teacher) b. Practicum (by teacher representatives from nursing homes, Chicago Board of Education, and Chicago Board of Health)

ACTIVITIES

A. Introduction of Personnel

Tell the teacher's name and write it on the chalkboard.

Ask each student to stand and introduce himself.

Ask each student to tell where he is employed and to describe the nursing home in which he works.

B. Description of Course

Use simple language. Explain new terms. Encourage student participation and pause for student questions and discussion.

Have the students describe their expectations of the course.

Point out the need for well-trained cooks and explain the benefits of the course. (See Appendix for "Qualifications for Certification.")

Explain the following aspects of the program:

history
functions of the advisory committee
structure.

Explain the student responsibilities in the program.

Explain the teacher's role in counseling students. Emphasize that the students should feel free to seek guidance from the teacher.

Review the evaluation procedures that will be used. (See Appendix for the forms "Cook-Trainee Evaluation" and "Cook-Trainee Practicum Evaluation.")

Prepare a class schedule and give a copy to each student.

Instruct each student to get a looseleaf notebook (8 1/2" x 11") to bring to each class. Explain that this is to be used for student handouts and for class assignments.

Explain the purpose of the pretest and administer it to the students.

CONCEPTS	CONTENT
In order for any institution to operate efficiently, all employees need to understand and adhere to the rules and regulations that govern the institution.	C. Regulations 1. Attendance a. Absenteeism b. Tardiness
Safe food preparation and a feeling of self-esteem result from excellent performance on the job and understanding of desirable personal guidelines for cook performance.	D. Guidelines for a cook's performance 1. Basic health and safety a. Clean environment b. Safe environment 2. Personal appearance 3. Personal health habits a. Handwashing b. Other health habits 4. Behavior a. Good manners b. Inappropriate behavior

ACTIVITIES

C. Regulations

Discuss the importance of being on time, both at work and for class. Explain the controls which are in the program to combat excessive absence and tardiness.

Have the students tell about situations in which tardiness or absence has hindered them in the past.

Conduct discussions of the following questions:

Why is it important not to work with foods if you have a cold or a contagious disease?

Why are cooks not permitted to smoke while working in the kitchen?

What should you do if you have a sore or cut on your finger?

Why is there a regulation that every kitchen employee have a chest X ray, stool specimen, and blood test prior to employment and then periodically during employment?

Who is responsible for enforcing the regulations?

D. Guidelines for a Cook's Performance

Develop with the students a list of desirable work habits, such as reporting to work on time and being well-groomed.

Have the student identify the procedures necessary for maintaining a clean and/or safe environment.

Ask the students to give examples of desirable personal cleanliness traits. Write the traits on the chalkboard or ask a student to do so.

Call upon the students to give examples of good and poor personal habits of workers who handle food.

Ask the student to explain why a worker's failure to cover his mouth when he coughs or sneezes and his failure to wash his hands after touching his hair or handkerchief are objectionable to others and can contaminate food.

Lead a general discussion with the students to investigate the importance of such habits as dependability, courtesy, and promptness.

Demonstrate the proper procedure for washing the hands. Have the students practice the procedure.

CONCEPTS	CONTENT
Improved ability to work harmoniously with others results in personal growth and satisfaction.	E. Interpersonal relations 1. Co-workers 2. Patients 3. Consultants

ACTIVITIES

Have students rehearse hygienic work procedures in preparation for working with food, such as preparing a clean work surface.

Ask a student to describe a well-groomed look. Follow the description with a student uniform inspection. Use a good grooming poster as a uniform checklist for cooks.

E. Interpersonal Relations

Ask the students to make suggestions for ways of improving one's relations with others. Write the suggestions which the class decides are useful on the chalkboard, or ask a student to do so.

Ask the students to point out personal characteristics which they like in others.

Show appropriate films and filmstrips to enrich the student's understanding of specific concepts in the unit. Before a film presentation, prepare the students to look for the pertinent facts which are shown in the film or filmstrip. Follow each film presentation with a general discussion.

SHORT-TERM COURSE FOR COOKS IN LONG-TERM-CARE FACILITIES

UNIT II: FUNDAMENTALS OF NUTRITION

CONCEPTS	CONTENT
A study of nutrition will assist the employee in a health facility to understand various aspects of his vocation and to provide improved food service to patients.	A. Nutrients and their effect on the body
Foods supply living things with energy, the raw materials for growth and repair of tissues, and protective chemicals for the sustenance of life.	1. Definition of nutrition (Nutrition is the act or process by which living things take in food and use it.)
A knowledge of foods and nutrition will help the student move towards personal and family health and possibly overcome defects caused by poor nutrition.	2. Relation of nutrition to good health a. Personal b. Family c. Patient
	3. Characteristics of good nutrition

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ACTIVITIES

A. Nutrients and Their Effect on the Body

Have the students discuss the following questions:

What determines your choice of foods or snacks?
What part do food habits play in your choice of foods?
What part do favorite foods play in your choice of foods?

Ask the students to explain the sentence "You are what you eat" by identifying the kind of person it fits, such as the person who consumes too many calories and is therefore overweight.

Ask the students to list some physical characteristics that may be caused by an inadequate diet, such as dry skin or soft, broken fingernails.

Have the students give examples of some eating habits which contribute toward good nutrition, such as the eating of three well-balanced meals a day, and some poor eating habits, such as eating between meals or having a bedtime snack of pastries.

Discuss with the students the mental and emotional effects on an individual resulting from poor nutrition, such as low energy, dull expression, chronic fatigue, and lack of patience.

Ask the students to make a list of what they could do to improve their own eating habits, for example: Always eat a well-balanced breakfast.

Have the students bring pictures of well and poorly nourished individuals and display the pictures on the flannel board. Conduct a general discussion by having the students identify the characteristics of each.

CONCEPTS	CONTENT
Foods contain useful substances called nutrients.	B. Nutrients
An adequate diet will include the necessary nutrients in sufficient quantity and be balanced to provide optimum health.	1. Carbohydrates 2. Proteins 3. Fats 4. Vitamins 5. Minerals 6. Water
A properly balanced diet contains foods from the milk, meat, vegetable-fruit, and the bread-cereal groups.	C. The basic four food groups 1. Milk 2. Meat 3. Vegetable-fruit 4. Bread-cereal

ACTIVITIES

B. Nutrients

Have the student name five nutrients. Write them on the chalkboard or request a student to do so.

Discuss the meaning of the terms complete protein and incomplete protein.

Have the students name ten foods that are complete proteins and two that are incomplete proteins.

Ask the students to list a typical day's supply of the foods that contain the following:

fats
carbohydrates--identifying which are sugars and which are starches

vitamins
minerals.

Discuss the function of each of the above foods in the body.

Have the students list four foods that are a good source of each of the following:

vitamin C
vitamin A
calcium
riboflavin.

C. The Basic Four Food Groups

Ask each student to list ten foods that he enjoys eating and identify the food group to which each belongs. Point out and discuss the caloric content of each food.

Have each student plan a balanced menu for a day using pictures to illustrate it. Ask the students to display the pictures on the flannel board and explain to which food group each food belongs.

Have each student prepare a notebook about the basic four food groups, using picture illustrations of each group.

Ask the students to list ways to include milk in the diet other than as a beverage.

CONCEPTS	CONTENT
Different people use up varying amounts of heat energy depending upon the age, height, weight, and the kind and amount of physical activity in which each individual engages.	D. Calories 1. Energy requirements 2. Measurement

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ACTIVITIES

D. Calories

As each student tells what he had for breakfast that morning, list the items on the chalkboard or place pictures of them on the flannel board. Keep the list or the pictures in view while the class evaluates the student's breakfast.

Explain to the students how the energy supplied by food can be measured in terms of the amount of heat given off when the food is burned and that this heat energy is measured in terms of heat units called calories.

Request each student to keep a record for three days of the foods, including snacks, which he eats. List the foods on the chalkboard and have each student figure out the number of calories he has consumed in the three days. Have him compare this total with the desired caloric intake for a person of his particular size.

Ask the students to list some foods that could be used for snacks between meals and that would not add many calories to the day's intake.

Compare for the students the caloric values of the following pairs of foods by writing the values on the chalkboard:

chocolate cake	---	carrot sticks
apple pie	---	celery
chocolate eclair	---	apple

SHORT-TERM COURSE FOR COOKS IN LONG-TERM-CARE FACILITIES

UNIT III: PRINCIPLES OF FOOD PREPARATION AND SERVICE

CONCEPTS	CONTENT
A knowledge of the basic principles of food preparation and service is a necessary qualification for the geriatric cook whose responsibility is to prepare and serve nutritionally adequate and attractive meals in an institution.	A. Preparation 1. Institutional equipment a. Use b. Care c Safety precautions required
The correct use and care of suitable cooking equipment are necessary for the proper preparation and servicing of food.	

ACTIVITIES

A. Preparation

Plan a class field trip to the restaurant show when it is in the city.

Demonstrate the common small equipment essential for proper preparation of foods, by showing actual examples and pictures of such items as the following:

knives	tongs
pastry blenders	rolling pin
mincer	pastry brush
chopper	measuring cups
egg beater	measuring spoons
pancake turner	mixing bowls

Have each student compile a list of the small kitchen equipment that he feels is most useful in his place of employment.

Demonstrate the proper use and care of electrical equipment, such as the toaster, mixer, blender, meat slicer, and chopper.

Discuss the safety procedures which are important in the kitchen in the prevention of accidents, including the following:

proper handling of hot containers
proper use and storage of knives
disconnecting of electrical equipment before cleaning
cleaning up of spilled fluids or foods immediately
alertness to defective glass and china and their disposal.

CONCEPTS	CONTENT
The knowledge and use of standardized recipes are necessary to assure a quality product.	2. Use of recipes a. Measurements b. Standardization of recipes

ACTIVITIES

Hand out "Table of Measurements" to students. (See Appendix.) Conduct a demonstration of liquid and dry measurements as follows:

Dry measurements, using flour, sugar (granulated and brown), baking powder, and salt. Measure 1/2 T., 1/8 t., 1/3 cup, 3/4 cup.

Liquid measurements, using water. Measure 1/4 teaspoon, 1 tablespoon, 2/3 cup, 1/4 cup, 1 1/2 cups.

Hold a session for the students to practice making liquid and dry measurements. Ask each student to bring liquid and dry measurement cups and measuring spoons to class.

Follow the measurement practice session with an oral or written quiz on measurements. (The choice depends on the ability level of the students.)

Schedule a practice session for students to increase and decrease such recipes as the following:

Jeweled Rice Pudding

Servings	25	50	100
Fruit cocktail	1/2-#10 can	1-#10 can	2-#10 cans
Orange juice	1/4 C.	1/2 C.	1 C.
Water as needed to make	1 qt.	1/2 gal.	1 gal.
Rice, dry	2 C.	4 C.	8 C.
Salt	2 t.	4 t.	2 T. + 2 t.
Butter or margarine	2 T.	1/4 C.	1/2 C.
Sweetened whipped topping	1/2 gal.	1 gal.	2 gal.

Procedure:

1. Drain fruit cocktail, saving syrup.
2. Add orange juice and water to syrup to measure amount as given above.
3. Add rice, salt, and butter or margarine to syrup-water-juice mixture. Bring to boil, reduce heat, and simmer until all liquid is absorbed and rice is tender.
4. Fold rice and fruit cocktail into topping; chill.

Follow up the increasing and decreasing of recipes with practice sessions in the classroom and then individually in the nursing home kitchen settings.

CONCEPTS	CONTENT
When scientific principles are applied to food preparation, the nutritive value, flavor, color, and texture are preserved. Milk is known as the "almost perfect food," because it contains more of the nutrients needed by the body than any other food, and it can be used in a great variety of ways in all food categories.	B. Principles of cookery 1. Milk and cheese a. Nutritional value b. Use c. Kinds d. Storage
Meats, eggs, poultry, and fish are excellent sources of complete protein, which are best preserved by low temperature cooking	2. Meat, eggs, poultry, and fish a. Beef, lamb, pork, veal Nutritional value Methods of cooking Kinds Storage b. Eggs Nutritional value Methods of cooking Kinds Storage

ACTIVITIES

B. Principles of Cookery

Have the students collect pictures of various kinds of cheese for a display on the bulletin board.

Ask the students to use milk and milk products in the preparation of new menu items that may be used in each nursing home.

Have small groups of students prepare assorted cheese trays.

Ask each student to write two menus, using cheese as the main entree.

Discuss the importance of the following aspects of milk storage:

cleaning bottles
placing bottles in coldest place in refrigerator
keeping milk in refrigerator at all times when not in use
preventing absorption of odors
avoiding the mixing of old and new milk.

Ask the students to identify retail cuts of beef, lamb, pork, and veal on a meat chart.

Have the students bring to class four recipes which use ground beef in ways other than with spaghetti, in meat loaf, and chili.

Explain the dry and moist heat methods of cooking meats. Ask the students to give examples of each.

Conduct a demonstration to show the characteristics of the various grades of eggs.

Demonstrate the procedure of beating egg whites at room temperature and then chilling.

CONCEPTS	CONTENT
	c. Poultry Nutritional value Kinds Methods of cooking d. Fish Nutritional value Kinds Methods of cooking
The main principle in vegetable and fruit cookery is to cook only until tender in order to preserve nutritive value, color, flavor, and texture.	3. Vegetables and fruits a. Role of vegetables and fruits in menu planning b. Nutritional values c. Types: fresh, canned, frozen, dried d. Criteria for buying e. Uses f. Storage g. Salads h. Dressings Kinds Preparation Use i. Garnishes

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ACTIVITIES

Explain the importance of the following aspects of meat storage:

covering fresh meats with wax paper and leaving the ends open

storing ground meats, stew meats, and variety meats for NOT more than 24 hours

placing frozen meats in the freezer as soon as they arrive

wrapping cooked meat for storage.

Conduct a follow-up with each student in her place of employment on the following methods of preparation: roasting, braising, stewing, and frying.

Point out the importance of the proper seasonings of meats, such as rubbing a roast with salt and pepper before placing it in the oven or rubbing the cavity of poultry with seasoning before roasting.

Arrange a field trip to a wholesale fruit and vegetable market. As part of the preparation of the students for the trip, include directions of what to look for and be ready to discuss afterward, such as the following:

Observe the care which the salesmen give to telephone orders for produce.

Learn the meaning of specifications by "grade" for produce.

Observe the total operation from the time produce arrives in big trucks until it is readied for delivery to kitchens, such as your place of employment.

Find out the cost to the wholesaler of filling one order.

Determine why those who provide quantity food service routinely order their food supplies by telephone rather than shop directly in person as a housewife does.

Have the students make a price comparison of fresh, frozen, and canned vegetables and fruits.

Have the students write lunch and dinner menus for one week, using fruit in a variety of ways. Follow this assignment with a class discussion of the menus handed in.

To test the ability of the students to identify the varieties of apples which are best for cooking and those which are best for eating, use the following devices: pictures of apples in magazine and cookbook pictures, a class visit to a fruit market display, and an oral test.

CONCEPTS	CONTENT
Whole grain or enriched cereals and breads, essentially starch or energy foods, are economical sources also of protein, iron, and B vitamins.	4. Breads and cereals a. Nutritional value b. Kinds c. Purchase d. Storage
The use of various fats in the diet provides the main store of reserve food supply.	5. Fats a. Nutritional value b. Source Vegetable Animal c. Consistency Liquid Solid d. Storage
Desserts of a large variety in kind and nutritional value provide a feeling of satisfaction and pleasure at the end of a meal.	6. Desserts a. Nutritional value b. Kinds c. Garnishes

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ACTIVITIES

Demonstrate the proper cooking of various fresh, frozen, and canned vegetables; the preparation of a salad; and the preparation of various vegetable and fruit garnishes.

After the demonstrations have been completed, have the students demonstrate the preparation of vegetables and garnishes in their places of employment.

Ask the students to list various different ways of using cereal in the preparation of food.

Call for volunteers to check several stores for prices of ready-to-eat cereals in large boxes compared with the prices of the same cereal packaged in individual-sized boxes, and prepare a report to give to the class.

In order to help students learn to differentiate between yeast breads and quick breads, have them clip magazine pictures of the two kinds of bread to mount, label, and place in their notebooks.

Demonstrate two leavening agents: baking powder added to hot water and soda added to sour milk.

Explain the necessity for some fat in the diet: for energy and for the utilization of the fat soluble vitamins -- A, D, E, and K.

Have the students name and explain the uses of some of the vegetable fats, such as corn oil, margarine, and hydrogenated shortening, and some of the animal fats, such as butter and lard.

Ask for a student volunteer to demonstrate the water method of measuring solid shortening by measuring 1/2 cup of solid shortening in the following steps:

Fill a cup half full of water.

Add shortening to the water until the cup is filled to the one-cup level.

Have the students keep a list of the desserts which they have eaten during one week. Help the students decide which dessert contains the most vitamins and minerals and which, the most calories.

Conduct a student contest to see who can write the longest list of fruit desserts within a time limit.

Have the students bring to class two dessert recipes which contain a large amount of milk. Have each student select one recipe to prepare as a demonstration in her nursing-home kitchen.

CONCEPTS	CONTENT
Mealtime should be enjoyable experience and can be enhanced by courteous and proper service.	C. Food services 1. Tray service 2. Table setting

CONCEPTS	CONTENT

Display in class a variety of prepared puddings and desserts, which are available in the stores, including gelatins, puddings, and prepared mixes.

Ask each student to select pictures of two desserts for each of the four basic food groups, choosing for eye appeal as well as for nutritional value because the dessert is frequently the highlight of the tray. Each student should have the following information about each dessert and be prepared to discuss it in class:

nutritional value to the patient

age and physical condition of the patient to whom it would be served

special considerations in relation to serving the item

size of serving in relation to the patient's need.

Demonstrate the preparation of a pudding, showing a variety of ways to garnish with a whipped topping, coconut, nuts, cherries, or fruit.

Have each student select a pudding and garnish to prepare for approval in her place of employment.

Demonstrate the proper setting of a tray and a table service, including the silver, dishes, napkin, and glasses.

Have each student show her understanding of the proper tray and table setting by preparing a return demonstration in the nursing home where she works.

Call upon a student to demonstrate the proper handling of dishes and utensils, such as picking up silver by the handles, picking up cups by the handles, and handling glassware without touching the rims.

Ask the students to suggest reasons for the following:

avoidance of placing watery foods together on a plate
attractive placement of food on a plate
prevention of spilled coffee or tea in a saucer.

Have the members of the class discuss the importance of the following aspects of food service:

serving hot food hot and cold foods cold
keeping chilled foods in the refrigerator until the time to serve
serving iced desserts after the patients have finished the entree
pouring the coffee or milk at the time of service.

ACTIVITIES

Conduct a discussion of the following aspects of the removal of trays from a patient's bedside or table:

picking up the trays on time
disposing of the leftover food.

As preparation for a role-playing session on the delivery of a tray to a patient and with students assuming the roles of the cook and the patient, have the students discuss the importance of the following:

proper placement of the tray
courteous service
cooperation with the nursing staff in the matter of timing.

SHORT-TERM COURSE FOR COOKS IN LONG-TERM-CARE FACILITIES

UNIT IV: THERAPEUTIC DIETS

CONCEPTS	CONTENT
An understanding of basic principles of therapeutic diets helps the cook in the preparation of food for patients for whom these diets are prescribed.	A. Definition
Normal food recommendations are changed for special diets to meet alterations in the nutritional requirement and/or in the physical characteristics of the diet.	B. Types 1. Normal diets changed in caloric content 2. Normal diets changed in physical characteristics a. Liquid b. Soft c. Low residue d. Bland e. Blended f. Pureed 3. Diabetic diets

ACTIVITIES

A. Definition

With the class develop the following or a similar definition of diet therapy:

> Diet therapy is the science of modifying the normal diet to correct nutritional deficiencies, to afford rest to the whole body or to certain organs, to adjust the food intake to the body's ability to metabolize the nutrients, or to bring about change in the body weight.

B. Types

Have the students list foods that are allowed on a clear liquid diet, such as gelatin, tea, and broth.

With aid of pictures on a flannel board, demonstrate the use of the exchange lists in planning diabetic diets (See "Food Exchange Lists for Diabetic Diets" in the appendix) of the following caloric content values:

1200 calories	1800 calories
1500 calories	2000 calories

Sample meal pattern for a 1500-calorie diabetic diet:

Breakfast

Exchange	Food
1 fruit exchange	1/2 cup orange juice
1 meat exchange	1 poached egg
1 milk exchange	8 oz. glass whole milk
2 bread exchanges	(1/2 cup oatmeal or (1 slice toast
2 fat exchanges	1 teaspoon butter coffee or tea

Lunch

Exchange	Food
2 meat exchanges	2 oz. roast beef
"A" vegetable exchange	lettuce with zero dressing
"B" vegetable exchange	1/2 cup carrots
2 bread exchanges	(1 small baked potato or (1 slice bread
1 fruit exchange	1/2 cup applesauce
2 fat exchanges	2 teaspoons butter coffee or tea

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ACTIVITIES

Supper

Exchange	Food
3 meat exchanges	3 oz. baked chicken
vegetable as desired	green beans
"A" vegetable exchange	
2 bread exchanges	1/2 cup rice or 1 slice bread
1 fruit exchange	1 cup strawberries
1 fat exchange	1 teaspoon butter
1/2 milk exchange	4 oz. glass milk
	coffee or tea

8:00 p.m. Nourishment

1 bread exchange	1 slice bread	) Make a
1 meat exchange	1 oz. lunch meat	) sandwich.
1 fat exchange	1 teaspoon mayonnaise)	
1/2 milk exchange	4 oz. glass whole milk	

Give each student a copy of the lists of types of foods that are excluded in the following special diets. Conduct a discussion of plausible reasons for the use of each diet.

Special Diet	Excluded Foods	Reasons for Diet
Low Salt Diet	ham bacon luncheon meats	cardiac disease arteriosclerosis
Low Fat Diet	whole milk cream butter cream soups rich pastries desserts	gall bladder disturbances
Bland Diet	fried foods high seasoned foods raw fruits (except bananas) raw vegetables	ulcers gastrointestinal disturbances
Pureed Foods Diet	solid foods	problems with chewing, swallowing, or digestion
Low Calorie Diet	desserts gravies sauces fried foods	overweight

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SHORT-TERM COURSE FOR COOKS IN LONG-TERM-CARE FACILITIES

UNIT V: ENVIRONMENTAL CONTROL

CONCEPTS	CONTENT
Knowledge of the germ theory of disease promotes and understanding of sanitary food procedures and regulations.	A. Sanitation 1. Microorganisms a. What their general characteristics are b. Which kinds multiply in food c. How they are transferred from place to place Hands Clothes Utensils Dishes Food Work area d. How they may be destroyed Heat Chemical agents e. How cleanliness prevents them from spreading f. How their growth in food is controlled Production Tasting techniques Care of work area Refrigeration Storage Service 2. Community health a. Food legislation b. Health examination for food handlers c. Insect and rodent control d. Water supply controls
Good housekeeping controls promote a sanitary environment.	B. Housekeeping

ACTIVITIES

A. Sanitation

Have each student report on a phase of community health which has a direct bearing on his job as a cook, such as the following:

the Board of Health ruling that food handlers must wash their hands after using the toilet and before returning to work

what the health examination for food handlers includes

what the Board of Health inspectors look for when they inspect a kitchen in a nursing home.

Ask the student volunteers to demonstrate and explain the following techniques:

proper tasting techniques
use of throw-away gloves for making salads.

Invite a representative from the Chicago Board of Health to give a blacklight demonstration, using the following examples:

dishes and utensils which have not been sanitized, so that students may see the bacteria on unclean articles

dishes that haveen sanitized but have been improperly stored

glasses and cups that have been handled by the rims

silverware that has been handled by the bowls, tines, and blades.

Demonstrate ways of preventing contamination in preparation, handling, and storage of such foods as salads made with mayonnaise, custards and puddings, and cream sauces.

B. Housekeeping

Invite a representative from a company, such as a detergent manufacturer, to give a lecture and demonstration on the proper methods of hand and machine dishwashing. Ask the speaker to include washing, rinsing, temperature control, and the type and amount of detergent to use.

CONCEPTS	CONTENT
	b. Dishwashing Hand Machine Pot washing c. Garbage disposal
Habits and attitudes which will tend to eliminate accidents can be developed in the individual.	C. Safety 1. Causes of accidents a. Lifting hot pans without pot holders b. Greasy hands c. Wet hands d. Improper use of a knife e. Poor body mechanics in lifting f. Spilled food on the floor 2. Attitudes and accident prevention a. "Think before you leap." b. "Haste makes waste." c. "Better safe than sorry." d. "A stitch in time saves nine." e. <u>Rules of the Road</u>

ACTIVITIES

C. Safety

Ask the students to mention some common accidents and tell how each one might be avoided.

Example: Knife cuts

Cut away from yourself.

Never use a knife to open a jar or can.

Hold both a knife and food in such a way that, if the knife slips, you will avoid cutting your fingers.

Example: Falls

Wipe up immediately anything that is spilled on the floor.

Stand on a stepladder or step stoal to reach for an item on a high shelf.

Do not carry such large objects that you cannot see where you are going.

Ask for a student to volunteer to demonstrate how to perform the following tasks in such a way as to avoid burns:

lifting of lids from saucepans
pouring of hot liquids from saucepans
adding of liquid to hot fat
handling of electrical appliance cords.

SHORT-TERM COURSE FOR COOKS IN LONG-TERM-CARE FACILITIES

UNIT VI: ORDERING TECHNIQUES AND INVENTORY CONTROL

CONCEPTS	CONTENT
Careful planning and good judgment are necessary in order to make satisfactory food purchases.	A. Procurement of food 1. Establishment of buying schedule a. Daily b. Weekly c. Monthly d. Yearly 2. Factors affecting buying schedules a. Menu requirements b. Available storage space c. Available funds 3. Elimination of emergency buying (except seasonal goods) 4. Determination of proper quantity a. Standard recipe or yield table b. Wholesale buying 5. Receiving ordered goods a. Checking Quality Count Weight b. Immediate storage
Proper storage and inventory control cuts food costs and prevents unnecessary purchases.	B. Storeroom organization 1. Continuous rotation of stock 2. Types of storeroom inventories a. Perpetual b. Daily

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ACTIVITIES

A. Procurement of Food

Lead the students into a general discussion of the factors to consider in the buying of food, such as the season, schedule, requirements, storage space, and funds available.

Have the students explain what foods may be purchased in large quantities and what ones in small quantities.

Conduct a discussion on the wisest time to purchase each of the different forms of foods: fresh, frozen, canned, and dried.

B. Storeroom Organization

Ask the students to suggest good rules for an efficient storeroom organization, such as rotation of stock; orderliness, including labeling; and cleanliness.

Explain the types of inventory and the advantages and disadvantages of each type, for example, physical inventory and perpetual.

ACTIVITIES

Have the students, with teacher assistance, set up an ordering and inventory form that could be used in the storeroom of the nursing homes in which they are employed.

Supervise each student's arrangement of the storeroom in the nursing home in which she is employed, so that foods are placed according to kind -- fruits, vegetables, juices, cereals.

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APPENDIX

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QUALIFICATION FOR CERTIFICATION

I. Attendance

No more than six (6) absences will be permitted during the twenty-four week period.

II. Theory

The student must show some improvement from test to retest. (Written or oral tests are given, depending on the reading and writing abilities of the student.)

III. Performance

The student should have received a satisfactory rating in the teacher's evaluation of her performance. She is expected to show progress in the following areas:

Attendance	Attitude
Personal appearance	Work performance

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COOK-TRAINEE EVALUATION

NAME OF TRAINEE _____ NURSING HOME _____

DATE OF EVALUATION _____ EVALUATED BY _____

	Improvement needed				
	None	Slight	Some	Much	Remarks
I. ATTENDANCE					
A. On the job					
B. At the weekly class					
II. PERSONAL APPEARANCE					
A. Uniform - Neat and Clean					
B. Shoes polished					
C. Hair neat with hair net					
D. Fingernails, clean and trimmed					
III. ATTITUDE					
A. Toward job					
B. Toward patients					
C. Toward course					
IV. WORK PERFORMANCE					
A. Trainee's organization of daily duties					

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	Improvement needed				
	None	Slight	Some	Much	Remarks
B. Trainee's working relationship with co-workers					
C. Trainee's use of advance preparation (such as making gelatin or chopping vegetables) to facilitate production time					
D. Trainee's efficiency in following instructions 1. Menu 2. Minimum daily requirements 3. Directions of food preparation 4. Accurate measurements					
E. Trainee gives clear, precise instructions to her co-workers.					
F. Trainee checks menu for following day to make sure necessary food supplies are on hand.					
G. Trainee checks food items, such as meat, for quality and amount on delivery.					

V. THERAPEUTIC DIETS

A. Trainee has a working knowledge of special diets used most often (such as diabetic, bland, low salt and low fat).					

	Improvement needed				
	None	Slight	Some	Much	Remarks
B. Trainee follows through on diet orders as given by doctor and dietitian.					
VI. EQUIPMENT					
A. Trainee has necessary equipment to perform her duties efficiently or she is able to improvise.					
B. Trainee requests special pieces of equipment and justifies their need.					
VII. SANITATION					
A. Kitchen and surrounding areas are clean (work tables, walls, counters, floors).					
B. Kitchen equipment is clean (mixers, toasters, utensils).					
C. Trainee uses correct method of dishwashing (hand or machine).					

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	Improvement needed				
	None	Slight	Some	Much	Remarks
VIII. PREPARATION OF FOOD TO PRESERVE AESTHETIC VALUE					
A. Does trainee use garnishes?					
B. Does trainee consider color combinations?					
C. Does trainee arrange food attractively on plate?					
IX. TRAINEE'S CONSIDERATION OF PATIENT PREFERENCES					
X. TRAINEE'S USE OF NEW RECIPES AND IDEAS LEARNED IN WEEKLY CLASS					

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COOK-TRAINEE PRACTICUM EVALUATION

Prepared Item_____

Circle the choice grade. Food Preparation

Points

Appearance and Aesthetic Value

4--A
3--B
2--C
1--D

Texture (consistency and temperature)

4--A
3--B
2--C
1--D

Taste (aroma)

4--A
3--B
2--C
1--D

Suitability for Nursing Home_____

Standarized recipe care Yes_____No_____

Average grade_____

Cook Trainee_____
(Name)

TABLE OF MEASUREMENTS

3 teaspoons	=	1 tablespoon
2 tablespoons	=	1/8 cup
4 tablespoons	=	1/4 cup
16 tablespoons	=	1 cup
1 cup	=	1/2 pint
2 cups	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon
8 ounces	=	1/2 pound
16 ounces	=	1 pound

Abbreviations Most Commonly Used

teaspoon	-	t. or tsp.
tablespoon	-	T. or Tbsp.
cup	-	c.
pint	-	pt.
quart	-	qt.
ounce	-	oz.
pound	-	lb. or #

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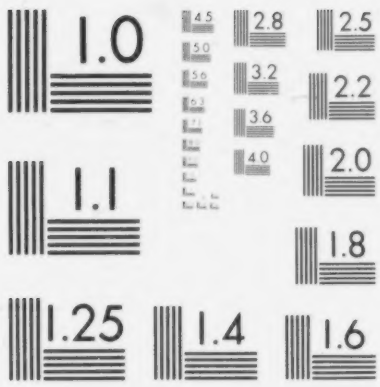

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

FOOD EXCHANGE LISTS FOR DIABETIC DIET[1]

Milk Exchanges (list 1)

One milk exchange contains 12 grams carbohydrates, 8 grams protein, 10 grams fat, and 170 calories. Milk is one of our most important foods. Use the milk on the meal plan to drink in coffee, on cereal, or with other foods. This list shows the different types of milk to use for one exchange.

Whole milk (plain or homogenized)	1 cup (1/2 pint or 8 oz.)
Skim milk	1 cup
Evaporated milk	1/2 cup
Powdered skim milk (nonfat dry milk)	1/3 cup of instant type or 1/4 cup of regular type (Read directions on box.)
Buttermilk, cultured or churned (made from skim milk)	1 cup
Buttermilk, Bulgarian (made from whole milk)	1 cup
Cocoa or chocolate milk (made from 1 cup milk, 2 teaspoons cocoa, artificial sweetener), no more than once daily	1 cup

One type of milk may be used instead of another, for example, 1/2 cup evaporated milk in place of 1 cup of whole milk. When skim milk or buttermilk made from skim milk is used in place of whole milk, add two fat exchanges to the meal to get the same food value.

Vegetable Exchanges (List 2)

All vegetables contain sugar but some have more sugar than others. The vegetables have been divided into three groups according to the amount of sugar they contain, as follows:

vegetables having the smallest amount of sugar in List 2A
vegetables containing more sugar in List 2B
vegetables having a large amount of sugar included in List 4.

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[1]The meal planning with exchange lists in this manual are based on material in "Meal Planning with Exchange Lists" prepared by a Joint Committee of the Diabetes Association, Inc., and the American Dietetic Association, in cooperation with the Diabetes and Arthritis Control Program, National Center for Chronic Disease Control, Public Health Service, Department of Health, Education, and Welfare.

Vegetable Exchanges (List 2A)

Containing little carbohydrate or protein and few calories, these vegetables, in raw form, may be eaten as desired in ordinary amounts. If cooked, no more than 1 cup at a time may be used.

Asparagus
Broccoli
Brussels sprouts
Cabbage
Cauliflower
Celery
Cucumbers
Eggplant
Endive
Escarole
Green beans, young
Green pepper
Greens
- Beet greens
- Chard
- Collards
- Dandelion
- Kale
- Mustard
- Poke
- Spinach
- Turnip greens

Mushrooms
Okra
Onions, green, young
Radishes
Romaine
Sauerkraut
Squash, summer (white, yellow, zucchini)
Tomato juice and tomatoes (limit to 1/2 cup or 1 tomato per meal)
Watercress

Vegetable Exchanges (List 2B)

One-half cup of each of these vegetables equals one exchange and contains 7 grams of carbohydrate, 2 grams of protein, and 35 calories. These vegetables contain more sugar than vegetables in List 2A. Use these vegetables raw or cooked.

Artichoke, 1 medium
Beets
Carrots
Green beans, mature
Mixed vegetables, frozen
Onions, dry
Peas, green
Pumpkin
Rutabagas
Squash, winter (acorn, hubbard, butternut)
Tomato soup: 1/4 cup as it comes from the can
Turnips
Vegetarian vegetable soup: 1/2 cup as it comes from the can

Any of the following may be substituted for 1 vegetable exchange 2B: 1 cup of List 2A raw vegetables, 1/2 bread exchange (List 4).

Fruit Exchanges (List 3)

One fruit exchange contains 10 grams carbohydrate and 40 calories. Use fresh, dried, cooked, unsweetened frozen, or unsweetened canned fruit. Canned fruit may be water packed or juice packed (but not packed in syrup). A serving of canned fruit is considered as the solid portion with its share of liquid from the can.

Kind of Fruit	Amount To Use
Apple (2"diameter)	1 small
Applesauce	1/2 cup
Apple juice	1/3 cup
Appricots, fresh	2 medium

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Apricots, dried	4 halves
Banana	1/2 small
Blackberries, raspberries, strawberries	1 cup
Blueberries	2/3 cup
Cantaloupe (6" diameter)	1/4
Cherries	10 large
Dates	2
Figs, fresh	2 large
Figs, dried	2
Gooseberries	1/2 cup
Grapefruit	1/2 small
Grapefruit juice	1/2 cup
Grapes	12
Grape juice	1/4 cup
Honeydew melon (7" diameter)	1/8
Orange	1 small
Orange juice	1/2 cup
Peach	1 medium
Pear	1 small
Pineapple	1/2 cup (or 2 slices)
Pineapple juice	1/3 cup
Plums	2 medium
Prune juice	1/4 cup
Prunes, dried	2 medium
Raisins	2 tablespoons
Tangerine	1 large
Watermelon	1 cup

Bread Exchanges (List 4)

One bread exchange contains 15 grams carbohydrate, 2 grams protein, and 68 calories. Measure all the foods on this list after they have been cooked.

	Amount To Use
Bread (all kinds except raisin bread and gluten bread)	1 slice
Biscuit, roll (2" diameter)	1
Cornbread (1 1/2" cube)	1
Hot dog or hamburger bun	1/2 bun
Melba toast, oblong	4
Melba toast, round	8
Muffin (2" diameter)	1
Pancake (5 1/2" diameter), omit 1 fat exchange	1
Waffle (5 1/2" diameter); omit 1 fat exchange	1/2
Cereals (cooked)	1/2 cup
Dry, flake and puff types (plain unsweetened)	3/4 cup
Shredded wheat	1 biscuit
Rice, grits, cooked	1/2 cup

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Spaghetti, macaroni, noodles cooked	1/2 cup
Crackers, graham (2 1/2"square)	2
Oyster crackers (1/2 cup)	20
Ry-krisp, double square wafer	3
Saltines (2" square)	5
Soda (2 1/2" square)	3
Round, thin (1 1/2" diameter)	6-8
Wheat thins	12
Flour	2 1/2 tablespoons, level
Cornstarch	2 tablespoons, level
Vegetables	
Beans and peas, dried, cooked (lima, navy, pintos, split peas, cowpeas, blackeyed, etc.)	1/2 cup
Beans, lima, fresh or frozen	1/2 cup
Baked beans, no pork	1/4 cup
Corn	1/3 cup
Corn on cob (4"long)	1 ear
Hominy	1/2 cup
Parsnips	2/3 cup
Popcorn	1 cup
Potato chips, large (3" diameter); omit 2 fat exchanges	10
Potatoes, white, baked, boiled (2" diameter)	1
Potatoes, white, mashed	1/2 cup
Potatoes, sweet or yams	1/4 cup
Sponge cake, plain (1 1/2" cube)	1
Ice cream (omit 2 fat exchanges)	1/2 cup
Ice milk (omit 1 fat exchange)	1/2 cup

Meat Exchanges (List 5)

One meat exchange contains 7 grams protein, 5 grams fat, and 73 calories. Meat should be measured after it is cooked. Remove bones and extra fat before measuring. One fourth of a pound (4 oz.) of raw meat without bones and fat usually weighs 3 ounces after cooking. An average size serving of meat would be 3 meat exchanges (or 2 meat balls, a small steak which weighed 1/4 lb. before cooking, 1 pork chop, 1 veal chop, 2 lamb chops, or 3 of any of the foods listed below.) A 3 oz. slice of cooked meat measures approximately 3 x 2 x 1/2 inches; a 2 oz. slice, 2 x 2 x 1/2 inches.

	Amount To Use
Meat and poultry (medium fat) (beef, veal, lamb, pork, liver, game, chicken, etc.)	1 oz.
Cold cuts (4 1/2 inch square--1/8 inch thick) (all-meat type) (salami, minced ham, bologna, liverwurst, luncheon loaf)	1 slice
Frankfurter (8 or 9 per lb.) (all-meat type)	1 slice

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Fish:	
Catfish, perch, bass, trout, etc.	1 oz.
Salmon, tuna, lobster, mackerel--fresh, frozen, or canned (with or without oil)	1/4 cup
Shrimp, clams, oysters, etc.	5 small
Sardines	3 medium
Cheese:	
Cheddar or American	1 oz.
Cottage cheese, creamed	1/4 cup
Egg	1
Peanut butter	2 tablespoons

Fat Exchanges (List 6)

One fat exchange contains 5 grams fat and 45 calories. The fat exchanges may be used in cooking. For example, a teaspoon of fat (1 fat exchange) may be used to fry an egg or to season a serving of vegetables, if the meal plan permits.

	Amount To Use
Butter or margarine	1 teaspoon or 1/2 pat
Bacon, crisp	1 slice
Coconut, grated	2 1/2 tablespoons
Cream, light, half and half	2 tablespoons
Cream, heavy, 40% (whipping cream)	1 tablespoon
Cream cheese	1 tablespoon
Avocado (4"diameter)	1/8
French dressing	1 tablespoon
Mayonnaise	1 teaspoon
Oil or cooking fat (as bacon grease)	1 teaspoon
Nuts	6 small
Olives	5 small
Sour cream	2 tablespoons

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RESOURCE MATERIALS

Reference Books for the Teacher

Adams, Charlotte. 1001 Questions Answered about Cooking. New York: Dodd, Mead & Co., 1963.

Carson, Byrta, and Ramee, Marue. How You Plan and Prepare Meals. New York: McGraw-Hill Book Co., 1962.

Kotschevar, Lindal H. Quantity Food Purchasing. New York: John Wiley & Sons, Inc., 1961.

Lundberg, Donald E., and Kotschevar, Lindal H. Understanding Cooking. Amherst: University of Massachusetts Press, 1965.

Proudfit, Fairfax T., and Robinson, C. H. Normal and Therapeutic Nutrition. 13th ed. New York: Macmillan Co., 1967.

White, Ruth Bennett. You and Your Food. 2d ed. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1966.

Films

Eat Well, Grow Well. Illinois Department of Public Health, 1963. 11 min. color.

Focus on Food. H. J. Heinz Co., 26 min. color.

Food, the Color of Life. Illinois Department of Public Health, 1965. 22 1/2 min. color.

Four Food Groups. Illinois Department of Public Health. 11 min. color.

It's Lamb Time. Wilding Picture Productions, 1956. 15 min. color

Kitchen Habits. Illinois Department of Public Health, 1954. 12 min. b&w.

Let's Keep Food Safe To Eat. Illinois Department of Public Health, 1963. 11 min. color.

Macaroni Menu Magic. Sterling Movies. 15 min. color.

Meat on the Move. Swift & Co., 22 min. color.

More than Food. Illinois Department of Public Health, 1955. 10 min. color.

One Loaf of Bread. General Mills Film Library. 11 min. color

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Outbreak of Salmonella. Illinois Department of Public Health, 1954. 13 min. color.

Pork Round the Clock. Wilding Picture Productions. 15 min. color.

Pro-Ten Beef. Swift & Co., 22 min. color.

Public Well Served. Illinois Department of Public Health, 1964. 10 min. color.

Sanitary Milk Production on the Farm. Illinois Department of Public Health, 1950. 13 1/2 min. color.

Thanks to Beef. Wilding Picture Productions, 1956. 15 min. color

This Is Betty Crocker. General Mills Film Library. 26 min. color.

Why Foods Spoil. Illinois Department of Public Health, 1957. 14 min. b&w.

Filmstrips

Avoiding Germs. Curriculum Filmstrips. color.

Cleanliness. Curriculum Filmstrip. color.

Food for Good Health. Encyclopaedia Britannia. color.

How Is Your Sense of Taste. H. J. Heinz Co. color.

Keeping Food from Spoiling. Encyclopaedia Britannica. color.

Kinds of Food. Encyclopaedia Britannica. color.

Planning Meals for Nutrition. McGraw-Hill Book Co. color.

Serving Meals Attractively. McGraw-Hill Book Co. color.

Song of the Salad. H. J. Heinz Co., color.

Where Food Comes From. Encyclopaedia Britannica. color.

Your and Your Food. Walt Disney. color.

Your Sense of Smell and Taste. Walt Disney. color.

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Free and Inexpensive Materials

American Meat Institute
59 East Van Buren Street
Chicago, Illinois 60605

Armour and Company
401 North Wabash Avenue
Chicago, Illinois 60611

Evaporated Milk Association
910 - 17th Street N. W.
Washington, D. C. 20006

Illinois Department of Public Health
Division of Hospitals and Chronic Illness
Springfield, Illinois 62706

Milk Foundation
28 East Huron Street
Chicago, Illinois 60611

National Livestock and Meat Board
36 South Wabash Avenue
Chicago, Illinois 60603

National Restaurant Association
1530 North Lakeshore Drive
Chicago, Illinois 60610

Quaker Oats Company
Home Economic Department
Merchandise Mart Plaza
Chicago, Illinois 60657

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and Welfare
Washington, D. C. 20204

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ABSTRACT - Prepared by the Nursing Home Branch of the Division of Health Resources, this handbook provides guidelines for activities supervisors in long-term care facilities. Topics are: (1) Qualifications of an Activities Supervisor, (2) Activities in General, which describes the six general types of activities and group and individual activities, (3) Establishing the Program, which suggests ways of finding interests and discusses budgeting, space, and equipment requirements, (4) Organizing and Running the Program, which provides information about the role of the administrator, consultants available to the supervisor, staff and volunteers needed, using volunteers effectively, developing an activities schedule, k eping records, and maintaining an effective program, and (5) Instructions for Selected Activities, which suggest ways to motivate participants, teach an activity, and includes several activities and resources. A discussion of health problems requiring long-term care and suggested readings are appended. (SB)

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Activities Supervisor's Guide

A Handbook For Activities Supervisors In Long-Term Care Facilities

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Health Services and Mental Health Administration
Community Health Service
Division of Health Resources
Nursing Home Branch

1969

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Preface

All major Federal health programs are concerned with long-term care, and patient activities constitute an essential feature of that type of medical care.

Since no comprehensive manual covering this important field has been available, the Nursing Home Branch of the Division of Health Resources has developed this handbook for the guidance of Activities Supervisors in long-term care facilities.

All aspects of patient activities are covered, from the rationale for such programs to instructions for selected activities. It is hoped that the guide will not only prove useful to individuals directly responsible for activities programs but will serve as a valuable reference for all professional personnel engaged in the rapidly growing field of long-term medical care.

John Cashman, M.D.

John W. Cashman, M.D.
Assistant Surgeon General
Director, Community Health Service

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Introduction

As activities supervisor in a long-term care facility you play a vital role in helping individuals return to normal, active lives. This is a great responsibility, for in many instances, the effectiveness of your activities program can make the difference between living . . . and just existing. The purpose of long-term care differs from that of acute care. In acute care facilities physicians and others do things *for* patients; in long-term care facilities patients are encouraged to do things, once again, for *themselves*.

Life itself is an unplanned, unscheduled, uncoordinated activities program. Everything we do, from breathing to bathing, from singing to seeing, can be considered an activity.

And everything we do also can be considered an exercise for whenever we participate in an activity, no matter what, we are exercising our ability to master the activity. When we walk, we exercise our *ability* to walk. When we read, we exercise our *ability* to read. When we talk with others, we exercise our *ability* to be sociable and friendly.

Long-term illness can remove a person from the everyday world where normal activity and exercise is completely taken for granted. And if the reasons for exercising which were present in the everyday world no longer exist, the individual simply may stop exercising. When a person stops exercising, he begins to lose his ability to do things. If a person no longer wants to walk, because it is easier to move in a wheelchair, he eventually may not be able to walk because his muscles have atrophied from lack of use. In fact, he may throw away his ability.

The purpose of an activities program is to create as near to a normal environment as possible, thereby encouraging persons in a long-term care facility to exercise their abilities. An activities program provides physical, intellectual, social, spiritual and emotional challenges much in the same way that everyday life in the community provides such challenges. But there is a difference.

An activities program provides these challenges in a planned, coordinated, structured manner. The activities provided are carefully selected so that they not only are enjoyable, but also are especially beneficial in overcoming specific problems. For example, a stroke victim participates in enjoyable activities which not only conserve and strengthen the abilities which have not been affected, but which also exercise and encourage use of those faculties which have been impaired. Without an activities program, such a person would not use the impaired faculties and, perhaps through depression and withdrawal, might not want to do anything at all. He would, therefore, lose even what abilities he had left. Without an activities program, he eventually would lose all hope.

The most challenging part of your job, therefore, is to encourage people to participate—to get them involved. You can have the most varied and exciting activities program in the world, but if a person does not want to participate, he obviously receives no benefits.

So your job is to provide activities which present a challenge, which make people want to participate, and to achieve. For just as activity is the sign of life, achievement is the purpose of life. No matter how small the achievement, it is still an achievement. Achievement brings with it dignity, self-respect and self-reliance. And it brings with it the desire to achieve more. The desire to achieve more means participation in even more activities.

The more activities, the more exercise; the more exercise, the more a person has the ability to do.

In the last analysis, then, an activities program is the environment of challenge, of achievement and hope. An activities program can help a person along on the road to recovery. It brings with it a dignity of life. It creates a purpose for living —to go on, to do more, to achieve more. It is your job to create this environment for others. That is your challenge. It is a challenge marked by many achievements, and just as you can help make life worthwhile for those you serve, their accomplishments can help make your life richer and fuller than you ever thought possible.

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Qualifications of an Activities Supervisor

It takes skill to carry out an effective activities program. But even more important than skill are certain personal qualities. Skills can be learned—that is one of the purposes of this guide—but personal qualities are attributes that you either have, or don't have. You don't learn them.

First and foremost, you must have absolute faith that engaging in meaningful activity is necessary for all people. From this comes your desire to work with the ill, aged and disabled.

You must have the ability to establish and maintain effective working relationships with the administrator, consultant, nurses, food service personnel, nurse's aides, volunteers and the individuals you serve.

You must be able to assume responsibility for planning and carrying out an activities program.

You must be flexible enough to change plans when the situation warrants.

You must have enthusiasm and a willingness to learn new ideas and new skills.

You must be able to understand where your job ends, and another's begins.

And you also must have imagination, initiative, a sense of humor, friendliness, conscientiousness and patience.

Without these attributes you cannot succeed. With them, you cannot fail. With them you will be able to learn the basics—the knowledge and philosophy of rehabilitation and the knowledge of the activities to be used.

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Activities in General

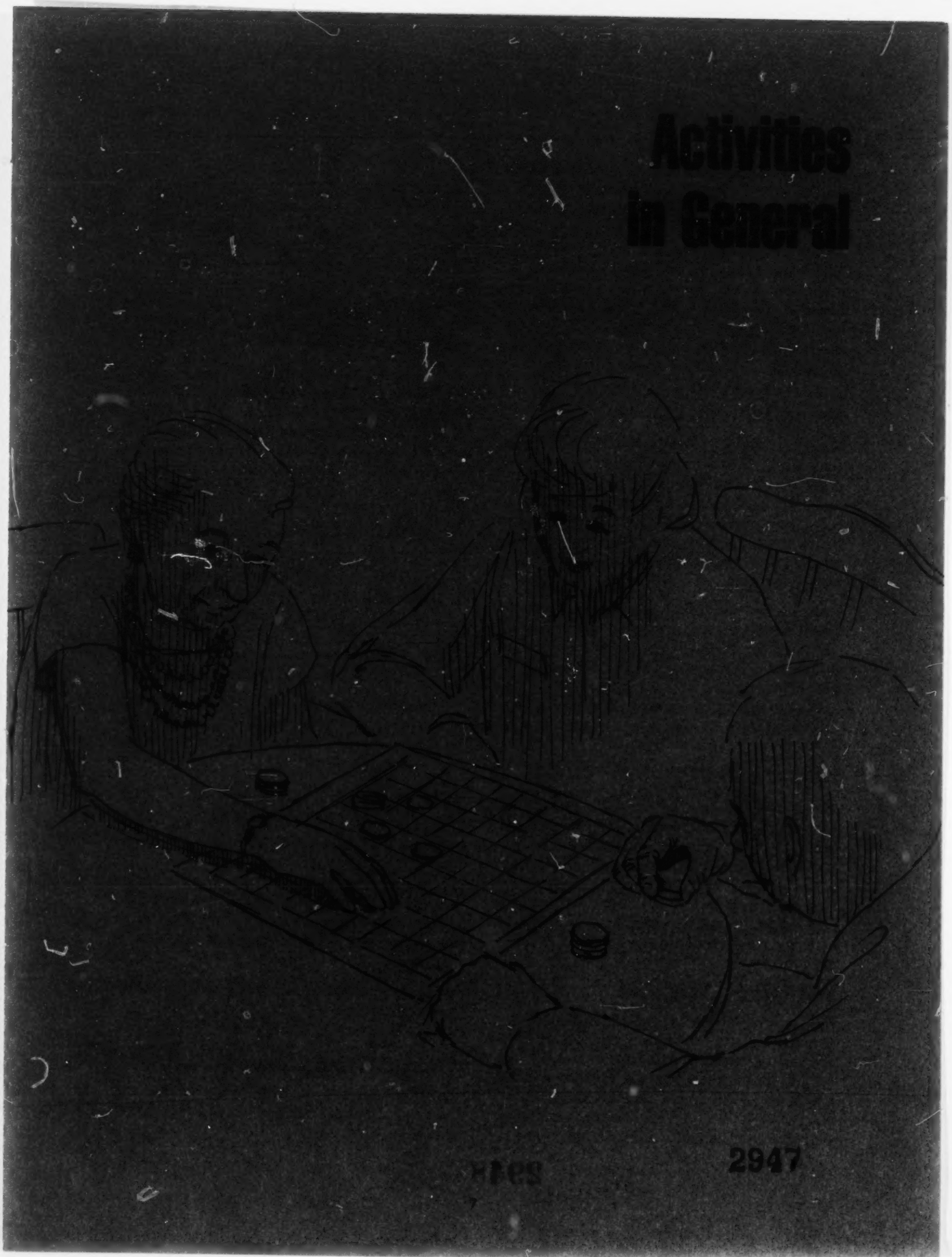

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Types of Activities

There are six general types of activities which may be adapted for your program in the nursing home setting. Specific activities within any one of the six types may range from the very simple to the very complex; from passive involvement to heavy active involvement; from individual participation to group participation. For an activity program to meet all the diverse needs of those involved, all six types of activities must be provided with as many variations as possible. The six types of activities are:

Social Activities

Social activities can help minimize self-consciousness, increase self-confidence, and stimulate interest and friendships by providing fun and enjoyment for those who take part. Typical social activities include square, folk and round dancing, group singing, horseshoes or quoits, adapted bowling, charades, cards, checkers and bingo.

Recreational activities with an emphasis on social aspects include outings to places of interest such as historic places, museums, ball games, fairs, and parks. You also can encourage persons in your care to join community groups and religious organizations, helping them to take a more active role in community life.

Diversional Activities

Diversional activities place the emphasis on individual accomplishment rather than sociability and fun. Such activities serve to take an individual's mind off worries and help him to adjust to long-term illness and long-term care. Typical diversional activities include braiding rugs, sewing, painting, refinishing furniture, and repairing or making toys.

Work-Type Activities

People need a balance between work and play. It is particularly important when leisure hours are great in number to include some work substitute. In addition, many people have grown up in an environment where leisure is considered only for the idle wealthy and where play bordered on the sinful. Do not try to remake the opinions and habits of a lifetime. Work with them. Provide activity which can be regarded as meaningful work.

Depending on the individual involved and his abilities, work-type activities can range from making a bed and ironing personal laundry to a completely structured workday—repair shop work, general ironing, bedmaking, dusting, etc. *Do not become involved in paying individuals for work-type activities without first consulting legal counsel. Legal, welfare and labor relations considerations all are involved.*

You also might investigate the possibility of establishing a sheltered workshop. Local wholesalers or manufacturers pay people for simple assembly procedures or for repairing damaged articles. Some state parks also pay for making simple items.

Volunteer Service Activities

Volunteer service activities are similar to work-type activities except volunteer aspects are stressed. Typical service activities are folding and mailing church literature, preparing material for a community fund drive, wrapping bandages, or making or repairing toys for underprivileged or orphaned children.

There also are buddy-system activities in which one person assists another in activities such as eating, dressing, reading, ambulation, playing games, etc.

Intellectual Activities

There must be activities for intellectual and creative expression. Some obvious activities are discussion groups, voting, book reviews, sketching, drama, and music appreciation. Consult your local library for availability of such materials as books, talking books, records and films.

Other vehicles for intellectual activity are clubs and committees.

Spiritual and Religious Activities

Spiritual and religious activities are especially important as religious convictions tend to increase in later years.

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NO INDIVIDUAL SHOULD BE REQUIRED TO PARTICIPATE IN ANY ACTIVITY.

NO INDIVIDUAL WITH A MEDICAL PROBLEM SHOULD PARTICIPATE IN ANY PHYSICAL ACTIVITY WITHOUT WRITTEN APPROVAL FROM THE ATTENDING PHYSICIAN.

Group Activities

Group activities, the involvement of a number of people in physical and mental interaction, are vital to an effective program. There are several reasons for this. Most obvious is the fact that group participation results in maximizing your resources—enabling you to involve many people within a specified budget of time and money. Less obvious, but perhaps more important, group activities promote social interaction. Having several people involved in one activity promotes communication which helps the development of friendships. In this light, group activity can help overcome feelings of loneliness, isolation and self-pity which all too frequently accompany long-term illness and long-term care.

The degree of social interaction created by a group activity is directly related to the amount of involvement of each individual both with the activity itself and with other members of the group. Generally speaking, group activities can be divided into five general categories based on degree of involvement. These five involvement categories are:

1. **Spectator group activity,** such as attending an athletic contest or a movie, where members of the group are passively involved, not actively participating;
2. **Performing group activity,** such as dancing or singing, where people are performing for themselves or for others;
3. **Independent group activity,** where each individual in a group is working on his own project;
4. **Independent/Interdependent group activity,** such as making dressings for the Cancer Society, where the total project is dependent on each group participant making the same item or performing the same task as all other members of the group, and;
5. **Interdependent group activity,** such as publishing a newspaper, where the completion and success of the total project is dependent on each participant completing a separate and distinct part of the total project.

Just as the greatest degree of involvement will produce the most beneficial results in terms of social interaction, inability or failure to perform at a high degree of involvement can produce undesirable results. Conversely, failure or inability to perform at the lowest degree of involvement will cause the least harmful results. As an example, falling asleep at a spectator group activity such as a lecture will cause no problems for the group. On the other hand, falling asleep while the group is trying to meet a deadline for completing an interdependent activity can cause major problems. It could lead to guilt feelings and withdrawal from self-ridicule or from the ridicule of other members of the group, not to mention causing possible total disruption of the activity. Thus, it is of utmost importance that you place an individual in that group activity in which he is best able to participate physically, mentally and emotionally.

Individual Activities

Because everyone has a need for personal identity, and because some in your home are unable to participate in group activities, you must provide individual activities.

For those who need individual activities as another part of an overall program, activities such as reading aloud or painting a picture virtually are unlimited. But for those who are unable to attend group activities, the scope of activity is more limited, and merits careful selection.

For those whose physical disabilities prohibit

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movement to a group activity area, your individual activity program must provide:

1. activities which make maximum use of each individual's physical and mental capabilities;
2. activities which are interesting to and involve the individual, and which present a challenge that can be met, and;
3. activities *which do not interfere with* scheduled nursing and housekeeping routine.

For those who have severe emotional problems or are not alert enough to become part of a group, your program must provide:

1. activities which are basically uncomplicated, but which can become more elaborate to accommodate increased ability, such as making yarn animals or games like checkers or dominoes;
2. short periods of concentration to avoid frustration, and;
3. enough time for you to develop a close relationship with the person involved, allowing you to recall his attention should his mind wander.

Obviously an individual activities program cannot provide the social interaction which is the key "fringe benefit" of group activities. Therefore, a major goal of your individual activities program should be the eventual involvement of the person in group activities if at all possible.

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Finding the Interests of Individuals

The development and implementation of your program depends primarily on what the individuals themselves want to do. Do not ride roughshod over individual preferences. In some cases one of your biggest challenges will be channeling an interest into an activity.

There are several ways to determine what general interests are.

The first and most obvious method is to make a list of those activities which are available or which could be made available and interview each person to solicit preferences. This same technique could be used with an individual's family which could indicate past interests.

Another technique is to refer to admission forms and records, but only with approval of the administrator. Past experiences of the individual can suggest ideas for current activities. A former sheet metal worker, for example, might be very interested in metalcrafts. In addition, having knowledge of past experience provides the basis for conversation, and putting into contact with each other those who have shared past interests.

Another source of information is staff and volunteers, to whom an individual may have mentioned a desire for trying one form of activity or another.

In general, learning an individual's interests is the key to planning the start of the program, and just as important, it is the key to keeping your program continually effective.

A past interest, however, does not mean that a person necessarily will want to take up something similar now. This could be due to feelings of inadequacy, general depression, desire to learn something different or physical or emotional limitation.

Lists of Possible Activities

The following alphabetical lists of activities are partial only and should be used to stimulate your own thinking. They also can be used to locate areas of interest of individuals entering the activities program, as well as for volunteers.

Adapted Basketball
Adapted Bowling
Art
Art Foam Projects
Anagrams
Auctions and Craft Sales
Auto Rides
Backgammon
Badminton
Balloon Volleyball
Band
Bandage Making
Basketry
Bean Bag Toss
Bedmaking
Bible Class
Billiards
Bingo
Birdfeeder Construction
Bird Feeding
Bird Watching and Walks
Block Printing
Blueprinting
Bookbinding and Repair
Book Reviews
Box Hockey
Bowling
Braiding
Braid Weaving
Bridge
"Buddy System" Work
Bumper Pool
Bunco
Candlemaking
Cards
Caroms
Carpentry
Carving (Soap and Wood)
Ceramics
Charades
Checkers
Chenille Craft
Chess
Chinese Checkers
Church Services
Clay and Plastercraft
Clubs (Camera, Garden, Book, Choral, etc.)
Colonial Mat Making
Collecting (Stamps, Coins, Rocks, etc.)
Community Service
Cooking
Cootie
Copper Tooling
Cork Craft
Cribbage
Crocheting
Croquet
Crossword Puzzles
Dancing
Darts
Decorations
Discussion Groups (Current Events, Literary, Sports, Bible, etc.)
Dominoes
Drawing
Dramatics
Education
Embroidery
Flower Arranging
Flower Making
Fly Tying
Furniture Refinishing
Games (Table, Active, Guessing, etc.)

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Bingo
Bowling
Bumper Pool
Caroms
Charades
Crossword Puzzles
Dominoes
Darts
Horseshoes
Miniature Golf
Pool (Pocket Billiards)
Relays
Shuffleboard
Table Shuffleboard
Volleyball

CARD GAMES

Bridge
Cribbage
Hearts
Pinochle
Poker
Rummy
Sheephead
Whist

WOODWORKING

Birdfeeders
Carving and Whittling
Fences
Game Boards
Lamps
Picture Frames
Reachers

Activities for Ambulatory Confused Individuals

GENERAL

Auto Rides
Bird Feeding
Bird Watching
Books (Illustrated)
Church
Community Service
Dancing
Discussion Groups (Remotivation)
Gardening
Movies and Slides
Nature Walks
Parties
Pets (Birds and Fish)
Picnics
Radio (Select program AM & FM)
Records
Singing
Spectator Sports
Stories (Read aloud)
Television (Guided)

HOMEMAKING

Bed Making
Dusting
Mending
Sweeping
Table Setting/Clearing
Washing

CRAFTS

Block Printing
Braiding
Ceramics
Crocheting
Decorations, for parties
Embroidery
Jewelry (Simple)
Mosaics (Gravel)
Needlecraft
Pom Pom Rugs
Rug Making
Stencilling
Weaving (Two Harness)
Woodworking
Yarn Animals

GAMES

Ball
Bean Bag Toss
Bingo (Magazine and Music)
Bowling
Guessing Games
Horseshoes
Relays
Ring Toss
Shuffleboard
Spelling Bee
Washers

Activities for Physically Disabled and Confused Individuals

GENERAL

Bird Watching
Books (Illustrated)
Church
Discussion Groups (Remotivation)
Gardening (Indoors)
Movies and Slides
Nature Studies
Parties
Pets (Birds and Fish)
Picnics
Radio (Select programs AM & FM)
Stories (Read Aloud)
Records
Singing (With Records or Group)
Spectator Sports
Television (Select Programs)

HOMEMAKING

Dusting
Mending
Washing

CRAFTS

Block Printing
Braiding
Ceramics
Crocheting
Decorations (For Parties)
Embroidery
Jewelry (Simple)
Mosaics (Gravel)
Needlecraft
Pom Pom Rugs
Rug Making
Stencilling
Weaving (Two Harness)
Woodworking
Yarn Animals

GAMES

Ball
Bean Bag Toss
Bingo (Magazine and Music)
Bowling
Guessing Games
Horseshoes
Relays
Ring Toss

Budgeting Requirements

The budget for your activities program must be prepared in cooperation with the administrator. It is up to you, however, to prepare a basic suggested budget which will cover equipment,

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supplies, and salaries. In this manner the administrator will be able to best determine budgetary limits.

Your budget is divided between nonexpendables and expendables. Nonexpendables include basic furnishings (tables, chairs, etc.) and basic equipment (phonograph, table looms, etc.) Expendables are comprised of general supplies (paper, paints, etc.) and personnel salaries and wages.

Your budget, of course, is limited. It is up to you, therefore, to make maximum use of funds available. Since your heaviest expenses are likely to be for nonexpendables, determine what your immediate needs are, and what items can be purchased sometime in the future. For example, if a few persons are interested in ceramics, the kiln at a high school, community center or hobby shop may be used rather than purchasing one of your own. Investigate what nonexpendables are already on hand. Do not purchase additional tables and chairs, for example, if some are available or could be adapted easily. Investigate the possibility of purchasing good used equipment. Determine if some equipment possibly could be donated. By all means, shop around to determine the best value before purchasing.

Budgetary allowances for expendables also must be based on the interests of program participants. If there is widespread interest in painting, for example, you must order and reorder items such as canvases, paints, brushes, etc. Determine if costs of such items will be borne entirely by program participants, by your facility, or shared. See if local merchants might be willing to offer special discounts. Some might be willing to make donations. Do not overlook purchasing from mail-order houses and shopping around for volume discounts.

A basic determination also must be made regarding the sale of crafts projects. Revenue can be obtained from the sale of toys, paintings, ashtrays, etc. Depending on basic fiscal policy of your facility or agreements established between facility and patient, part or all of such revenues might be returned to the individual or used by a patient council for the purchase of more supplies and/or equipment.

As in all other phases of your activities program, therefore, maximizing your basic resources depends on your own effective planning and resourcefulness.

Space Requirements

IT IS THE RESPONSIBILITY OF THE ACTIVITIES SUPERVISOR TO BE AWARE OF ALL POLICIES REGARDING ACCIDENT AND FIRE PREVENTION AND EMERGENCY PROCEDURES AND PRECAUTIONS.

The more space available to your activities program, the better. In most cases, however, space will be limited and it will be up to you to use to its fullest advantage the space that is available.

Basically there are nine kinds of space needed. One area may serve several purposes.

Spectator Group Activities Area

Such an area could be used for large social, intellectual, religious, clean craft and like activities in conjunction with a dining room, lounge, or other area whose purpose is other than program-related activities. The area can be used only when not interfering with normally-scheduled events. It should be large enough to seat three-fourths of all those in the facility for events such as movies, concerts, Christmas programs, lectures, etc. Special planning must consider set-up and clean-up times involved, as well as other scheduled uses of the area.

Personal Activities Area

A personal activities area could be a day room near to bedrooms where there is a TV and comfortable chairs for reading or letter writing. It also could be used for activities such as individual crafts or games, and therefore should have tables to seat four people.

Quiet, Private Area

There should be a room which is comfortable and can allow for quiet and privacy, if desired, for club and committee meetings, clean crafts

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and quiet group games. Depending on the activity to be performed, some storage area might be necessary. Such an area also could be used as a day room, library, staff meeting room, etc. Good lighting is essential. In large homes especially, several such areas should be available.

Noisy Recreation Area

Provision should be made for an uncluttered area, removed from bedroom areas, and near the hub of the facility's activities to permit noisy recreation. Size of such an area depends on the number of persons who would be participating there and the types of activities planned, such as pool, indoor horse shoes, shuffleboard, rhythm band, etc.

Preparation Area

Preparation area is space where donated supplies can be examined, labeled and otherwise prepared for storage or program use; where party decorations can be left to dry, and where all power equipment would be kept. Such an area could be part of a larger activities area.

Area for Diversional, Work-Type and Volunteer Service Activities Which Tend To Create Clutter, Dust and Noise

If you intend to include a program of noisy, "dirty" crafts, you need an area that can be used solely for your program. Multiple usage (also being a dining room, for example) creates inconvenient time and clean-up requirements which would defeat the purpose of the room. Because of the variety of equipment which would be needed, the Public Health Service's Nursing Home Branch advises allowance of 36 square feet per person who would be in the area at one time.

Such an area should be near lavatories but removed from bedroom areas. It also should meet the following considerations if applicable:

LIGHTING

It is recommended that a combination of natural, flourescent and incandescent lighting be used. Flourescent alone tends to distort and confuse distance judgment due to the absence of shadow. More light is needed where high eye-hand coordination is required, such as in woodworking, sewing, etc.

CLIMATE CONTROL AND VENTILATION

Provision should be made for even heating and cooling. Special consideration should be given for the removal of noxious odors and dust, especially in craft areas.

ELECTRICAL WIRING

Sufficient electrical outlets should be allowed for maximum mobility of equipment. Placing outlets at six-foot intervals is recommended. The planning for a 220-volt outlet, as required by an electric kiln, must take into consideration traffic patterns and the heat generated by the equipment using the outlet. A light warning system in the corridor should be installed to indicate when 220-volt equipment is in use.

SPACING

Aisles and work areas must be large enough to permit wheelchairs to pass one another.

COMMUNICATIONS

A telephone should be installed to permit staff or volunteers to place or receive calls without leaving the work area as well as for emergency communication.

Outdoor Recreation Area

An outdoor recreation area should have a smooth, paved surface and be level to permit individuals to walk without tripping. There should be an easy transition from paved areas to grassy areas to prevent tripping. Grassy areas also should be level.

The outdoor recreation area can be used for picnics, shuffleboard, horseshoes, croquet, gardening, religious activities, etc.

Furniture for the area should be sturdy and nontippable.

Office Area

An office area should be provided for you to keep track of records, correspondence, etc. A telephone and a writing surface are needed as well as a lockable drawer in a desk, or a lockable file cabinet to keep privileged information.

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Storage Space

It is essential that adequate storage space be available. The amount required depends on the type program being undertaken. All regularly-used items which cannot be left out must be stored in an area near where they are used. Those items which are used only on occasion can be stored relatively distant from their areas of use. Special storage areas must be provided for storage of edged or otherwise dangerous equipment.

Flammables, for example, must be stored in metal cabinets. Large metal cabinets also may prove useful for storage in areas where additional space is needed.

Basic Equipment

Some of the basic equipment you will need includes:

TABLES

Tables should be at a comfortable working height and tall enough to accommodate a wheelchair.

CHAIRS

Chairs with and without armrests, should be sturdy, nontippable and have a straight back for support and proper posture.

DESK

You should have your own desk for storage of files and personal items.

CUPBOARDS AND CABINETS

WOODWORK BENCH

BULLETIN BOARD

PORTABLE BLACKBOARD

SINK

One which is cleaned easily and which has counter space on both sides.

SEWING MACHINE

Some enjoy the treadle type, but electric also are necessary.

TABLE LOOMS

Also consider storage area they require when not in use.

NEEDLECRAFT EQUIPMENT

Some needlecraft equipment includes sewing and knitting needles, scissors, embroidery hoops, crochet hooks, thimbles, etc.

WOODWORKING TOOLS

Some basic hand woodworking tools include a cross-cut saw, hammers, mitre box, screwdrivers, planes, hand drills, sanding blocks, C-clamps, etc. If power tools are used, they must have locks to prevent them from being turned on without knowledge of the person in charge.

MISCELLANEOUS CRAFT EQUIPMENT

Some miscellaneous craft equipment includes paint brushes, leather working tools, etc.

Another basic craft program is ceramics. If sufficient individual enthusiasm is noted, a kiln should be included as a basic craft need.

MISCELLANEOUS NONCRAFT EQUIPMENT

Some miscellaneous noncraft equipment includes:

Piano

Phonograph and Records
An inexpensive, reliable portable might be an appropriate first purchase. Be sure service is available.

Sound Movie Projector and Screen

Jigsaw Puzzles
For patients with poor vision, adult puzzles with large pieces.

Games
Some basic games include bingo, dominoes, cards (regular and jumbo), checkers, cribbage, horseshoes, adapted bowling, Scrabble, etc.

Party Equipment
Barbecue grill, ice cream freezer, popcorn popper.

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The Role of the Administrator

The administrator sets policy for every aspect of activity in the long-term care facility. He determines basically what is available in terms of funds, space, equipment and supplies. He should be kept informed of the progress of the activities program. Approval of the administrator is necessary for any major undertakings such as parties, open houses, art shows and similar activities. *He also must approve any activities which involve individuals leaving the facility for tours, outings, picnics, etc. As this may involve insurance and legal policies be sure to allow plenty of lead time.*

Consultants Available to the Supervisor

In carrying out an activities program, questions arise that need answering. Do not guess. Do not assume. Check with the person who is best able to answer your question.

In addition to the administrator, the following people are your consultants.

Physician

It is necessary to obtain a physician's approval (in writing) for including anyone in activities which require active participation. A physician can suggest types of activities which could prove most beneficial, as well as those to be avoided. Any physical or emotional changes you note in an individual participating in your program should be reported according to the policy in the facility.

Social Worker

A social worker can help interpret the causes and effects of a person's emotional problem, as well as suggest methods of involving an individual in an activity which will help overcome the problem. The social worker also can advise on methods for promoting more effective social interaction in group activities.

Charge Nurse

It is the charge nurse's responsibility to know a person's physical condition before and after activity participation. Very often the charge nurse is the most knowledgeable health professional available and therefore should be advised of physical or emotional changes you note in activity participants. In addition, check with the charge nurse prior to scheduling activities to avoid any schedule conflicts.

Occupational Therapist Registered (OTR)

The OTR may be your primary consultant and can evaluate an individual and determine his capacities, abilities and potential, and help you establish specific activities and goals. The OTR shows you specific techniques of remotivation and rehabilitation and answers questions about improving responses of activities participants.

Physical Therapist

Like the OTR, the qualified physical therapist can help you determine which activities are most beneficial in helping an individual to overcome a specific physical handicap or disability. He may suggest adaptations to regular activities which will make them even more beneficial. The physical therapist also may advise you of individual capacities, limitations and potential, and may help you align the goals of your activities program with the goals of the patient's physical therapy program.

Therapeutic Recreation Specialist

The therapeutic recreation specialist advises you of activities which will most interest a person. He also can advise on specific methods of motivating a person to join in group activities, or on adapting the activity to the person's limitations. In addition, he can advise on community and volunteer resources.

The above list is partial. Many others might be on hand and be able to act as consultants. By the same token, fewer than the above may be available. In either case, seek advice from all available. In no case, should you proceed if you

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are unable to find satisfactory answers to key questions.

Staff and Volunteers Needed

The range and diversity of your activities program will be shaped to a great extent by the manpower available for its implementation. Because individual needs and requirements vary, as well as participants' general abilities, only an estimate can be made of hours which can be allotted per person per week. What is right for your program and your facility can be determined only by you and your own experience.

Using Volunteers Effectively

(Note: For a fuller discussion, refer to publications of the American Nursing Home Association, the American Red Cross, and the American Hospital Association.)

We cannot overemphasize the importance of having volunteers in an activities program. Volunteers form a necessary and vital link between the community and those in your facility. Volunteers bring with them an unselfish concern which tells those they serve that the community has not forgotten.

You may be called upon to establish and/or direct the volunteer program in your facility. This requires planning. Legal and insurance aspects of using volunteers should be cleared before a program is begun in any way. The administrator, charge nurse and consultants should be brought in on planning and implementation. Policies regarding the facility and volunteers' rights and responsibilities need to be established, written and distributed.

The next step is to recruit volunteers. Know how many are needed. Do not recruit more than you properly can train, supervise and utilize.

Sources of volunteers are: your own personal friends, friends of staff and patients, community groups, religious organizations, etc.

First contact should be made in person or by phone. If not enough prospects can be found, then go to the less selective method of distributing press releases to local newspapers and radio stations stating your desire to obtain volunteers.

It is imperative that each prospect be carefully interviewed and screened. At the initial interview, inquire of the prospect's background—education, physical fitness, other volunteer work and reason for volunteering now. Determine what hours the prospective volunteer will be able to work, and the dependability of transportation. Also, pinpoint the prospective volunteer's areas of interest by using a general list of activities offered by your program.

Most volunteers need initial orientation—to the facility itself and to the rationale and philosophy of your activities program.

Give volunteers a tour of the facility and introduce them to personnel with whom they might come into contact. Discuss what it means to have a long-term illness. Carefully detail standards you expect from volunteers, especially regarding relationships with program participants and being faithful to promised time allotments. Volunteers must be made to feel that many people are depending on them, and, because they are volunteers, that they provide an intangible emotional reassurance to individuals in your facility which paid staff members cannot duplicate. Emphasize that by becoming volunteers, they have assumed a responsibility.

The time a volunteer can give and general ability of each determines the amount of responsibility which can be assigned. For those with limited time or ability, the role of friendly visitor is most suited—mainly talking with people, writing letters, and other person-to-person functions. To maximize beneficial results, try to match areas of volunteer interest with interests of those being assisted.

Before volunteers can take on more responsible duties, they must be trained. This requires understanding and patience on your part. There are, however, practical limits to the duties and responsibilities assigned volunteers. They should not, for example, be given sole responsibility for any long-term activity.

In no case may a volunteer have access to pa-

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tients' charts and records. Such materials contain privileged information.

For volunteers to work at their peak, they must be enthused about their work. Interest can be initiated by matching the volunteer's job with areas of expressed interest or past experience. Continually observe volunteer attendance sheets. In case of absenteeism, inquire of the cause. It could mean loss of interest.

To keep interest high, set up long-range goals in terms of short-range projects. In this way the time between project beginning and completion is marked by many small successes. The one or two inevitable failures or frustrations can be overcome easily.

It is also necessary to maintain effective communication and planning. At regular meetings request ideas and suggestions for improvement or change. You might wish to change or increase the duties of volunteers to present them with greater challenges.

Another essential factor in encouraging volunteers is reward. They find satisfaction in the work itself. Nonetheless, volunteers receive a special satisfaction when their ability to help others is recognized. You might wish to honor your volunteers with special ceremonies, a party, or perhaps by the presentation of a small award or present. Remember to thank each volunteer at the end of each day's work.

Developing an Activities Schedule

Effective activities schedules are not subject to hard and fast rules. There are too many variables—number of participants, their abilities and disabilities, staff and volunteers available, equipment and supplies on hand, etc.

Nonetheless, there are certain steps you can take to make your activities schedule as responsive as possible in terms of what is needed and what is available.

Criteria for Selecting Activities

In selecting an activity, either for individual or group participation, there are certain criteria which must be considered. These criteria can be analyzed in terms of what the individual needs and what a certain activity can provide. This analysis can be used for deciding to put an individual into a certain group, or for programming an activity for specific needs. Analysis is broken down as follows:

PHYSICAL CONSIDERATIONS

1. Does the individual need
   a. action rather than position?
   b. repetition of motion?
   c. graduation from easy to difficult, or the reverse?
   d. strengthening?
2. Are the demands of the activity compatible with or adaptable to individual ability regarding
   a. motions required?
   b. endurance required?
   c. coordination required?
   d. dexterity required?
3. Does the activity fulfill the individual's physical needs?

EMOTIONAL CONSIDERATIONS

1. Does the individual need
   a. mental stimulation or calming?
   b. release from tension or anger?
   c. an opportunity for social interaction?
2. Are the demands of the activity compatible with or adaptable to individual ability regarding
   a. degree of complexity involved?
   b. degree of creativity required?
   c. attention span required?
   d. understanding of directions (written and/or spoken) required?
3. Does the activity fulfill the individual's emotional needs?

In addition, each activity should be:

1. compatible with budget and space limitations
2. interesting to the participants involved
3. free from danger and annoyance (such as noise, odor and dust)
4. adaptable to the individual's working position and location
5. flexible to allow for creativity of participant(s)

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Once individuals have been matched with activities, all with the physician's approval, begin planning on a large blank calendar for the upcoming month.

Establish who will be available to work with the activities program, on what days, and for how long. This includes yourself, your staff and volunteers. In the case of volunteers, also indicate their areas of interest and competence. In addition, generally be aware of workload and staffing patterns of nursing, food service and maintenance personnel.

Scheduling the Activities

Determine which persons will require individual attention, on what days, for how long, and who will supervise the activities. Coordinate individual activity with nursing and housekeeping routine.

The next step involves scheduling group activities. Ascertain which participants have no time restrictions and which do. For those with time restrictions, limitations will be in the form either of prior commitments, such as regularly scheduled physical therapy, or physical and/or mental disability (the person easily may be fatigued or confused.)

Those whose time limitations consist of prior commitments pose no problem in scheduling. Certain hours simply are not available. For those whose limitations are mental and/or physical, activity scheduling requires careful planning. Activities must be spaced throughout the day so as not to use up all available time and energy at once, thereby creating long periods of boredom for the remainder of the day. At the same time, consider (or consult others regarding) which activities are most appropriate, as one fifteen-minute activity might require more energy than an hour-long activity.

In filling out your schedule for group activity, always indicate amount of preparation and clean-up time necessary. This requires your knowledge of housekeeping schedules, kitchen staff schedules, etc.

Your initial step is to indicate those activities which of themselves necessitate scheduling at certain times in certain areas. As examples, religious activities take place on Sunday, with perhaps regularly-scheduled Bible readings or discussion every Wednesday. There might be a movie scheduled every Friday evening. The facility newspaper, if monthly, requires certain preparatory activities on specific days. Similar regularly scheduled activities might include club and committee meetings, music activities, or a monthly party for all celebrating a holiday in the month.

In addition, there are seasonal activities which require certain planning periods. Such activities are picnics, open houses, outings, political events, tournaments, award functions, etc.

Once all regular scheduled activities have been indicated, along with the personnel necessary for their supervision, other group activities can be planned.

In choosing activities, make selections based on their interest to the participants, time, space and manpower required for their supervision. Once you have determined what types of activities are best (crafts, recreation, etc.), let the individuals select specific activities.

Recreational games are the most flexible, as they can be geared to virtually any situation.

Crafts also are flexible, but usually are limited by degree of difficulty, location and clean-up time necessary. A craft project can be completed either at one sitting, or could require several periods. In case of a long-term project, carefully check that ultimate completion is not delayed by conflict with another activity. Accomplishment is a vital part of your activity program, and its beneficial effect should not be put off and possibly lost.

Finally, do not forget the important individual need for personal activities such as solitaire, puzzles, letter writing and reading. Such activities also are especially useful as "fillers" when supervisory staff is pressed for time.

Integration into Total Facility Program

Once the schedule has been completed, it is subject to review by the administrator and heads of the various departments, or their representatives.

Just as virtually everyone in your facility somehow is affected by your activities program, virtually everyone in the facility has an effect on its success. Therefore, the administrator and department heads should be given the consideration of viewing the schedule and making suggestions.

Your major concerns are to enlist their enthusiasm and support and to avoid conflicts with other schedules. As examples:

Is the time you have selected for cooking activities best for the dietary department?

Are craft area hours convenient for the housekeeping department?

Will sufficient food service and nursing personnel be on hand to help you with a party or open house?

Do not make assumptions which later could cause "hard feelings" or confusing last-minute schedule changes.

Once the schedule has been approved by all affected department heads, have copies made and distribute them to the various departments. In addition, post copies on appropriate bulletin boards.

Remember, an activity which requires use of the supplies, equipment or personnel of any other department must not be undertaken without prior approval of the person in charge of the affected department.

Assigning Volunteers and Staff

Once the program schedule has been approved, it is necessary to implement it. The key to successful implementation, again, is thorough planning on your part, and communication.

First, with planning, each scheduled activity must be divided into jobs. For example, a group activity might require three basic jobs – giving instruction, supervision and clean-up. You might want to give instructions, but then let one or two others supervise, and assist in the clean-up. Another activity might require five or six basic jobs, but they all might be carried out by one person.

Therefore, assign staff and volunteers to jobs within the activity. Clearly indicate who is responsible for what, and who will be supervisor for the activity.

Be as precise as possible in determining time allowances for the performance of each job and each activity.

At the beginning of each day, go over the day's scheduled activities and inquire about the events of the previous day. Request "feedback" from volunteers and staff. Check to see if the time allowance was sufficient. If the activity or job took longer or shorter than planned, make proper adjustments in the time allowance for the future. Ask about any problems that might have been experienced. Ask for ideas on how the job or activity could be improved. Through observation, check if those who supervise or have responsibility for a job or activity are interested and capable. Some might be ready for more difficult duties.

By combining planning for long-range goals in a system of short-range, specified jobs and activities, you will ensure maximum utilization from the manpower available to you.

Records

Records are an invaluable element in the planning, implementation and evaluation of your program.

In addition to budgetary, equipment and supply records, there are four basic forms which can be used.

Your facility's "Patient Care Referral" form (fig. 1) and "Patient Information" form (fig. 2) both contain valuable information which can help define the individual's needs, abilities, disabilities and interests. Information from both should be made available to you as soon after admission as possible.

The "Activities Program Attendance" form (fig. 3) is used to record an individual's daily participation in activities. By checking this form you can gauge the interest of the total population in different activities as well as the overall participation of any individual.

The "Activities Program Monthly Calendar of Events" (fig. 4) is used to indicate the complete plan of activities for the upcoming month. The activities should have been checked previously

at an organizational meeting to ensure that the activities in question create no conflicts with the smooth running of the facility. Such a program should be posted on a central bulletin board and be given to the various department heads, your consultants, and others directly involved, including volunteers. It also can be used in conjunction with the individual "Activities Program Attendance" form to cross-check what specific activities were participated in.

Keeping the Program Effective

The continuing effectiveness of your program requires constant alertness and growth on your part.

Records must be checked on a regular basis to ensure that interest is being maintained by all participants. At the same time, those individuals who have shown steady progress should not be limited. New, more advanced activities should be planned, both in the scheduling and training of personnel involved and in budgetary considerations.

You also should make efforts to increase your own knowledge and skill. Whenever possible, read what literature is available, attend educational or training sessions and visit other facilities to see what other activities supervisors are doing in their programs.

You also might wish to formalize certain programs to give them an independent basis. For example, tournaments might be held, developing into seasonal or even annual events. Award systems might be developed for volunteers and other staff members. By establishing such formalized activities, some planning is made automatic to give you more time for planning and development elsewhere. At the same time, of course, always seek means to improve such activities, as they might tend to become stagnant.

The key to keeping your program effective, therefore, is to make it a constant challenge for individual participants. New projects and activities should be tried. Simple repetition of activities which have been mastered day after day, too often can lead to the very boredom and dullness which the activities program, in large part, is intended to overcome.

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I.

PATIENT CARE REFERRAL

Name_____ (Last) (First)
Birth Date_____ Sex___ S.M.W.D._____ (Religion)
Home Address_____

Directions_____

Floor_____ Apt._____ Tel._____
Responsible Relative or Guardian_____ (Relation)
Address_____ Tel._____
Physician in Charge After Transfer_____

Hospital No._____
Transferred From_____ Station or Clinic_____
Address_____
Date of Admission_____ Date of Transfer_____
Transferred to_____ (Hosp., Nursing Home, Agency)
Address_____ Claim No._____
Clinic Appt._____ Date_____
M.D., City_____

II. Advised of transfer and consent given by_____ (Name) (Relation) Date_____

III.
(Check, explain)

Disabilities		Impairments	
Amputation	__	Mentality	__
Paresis	__	Speech	__
Contracture	__	Hearing	__
Decub. Ulcer	__	Vision	__
		Sensation	__
Incontinence			
Bowel	__	Bladder	__

Activity Tolerance Limitations
None___ Moderate___ Severe___

ORDERS FOR ACTIVE CARE

BED
Position in good body alignment and change position every_____hrs.
Avoid _____ position.
Prone position_____times/day as tolerated.
SIT IN CHAIR___hrs.___times/day.
Increase as tolerated_____.

SELF CARE
Maintain___ Improve___ Level.
Interpret progress to family_____.

WEIGHT BEARING
Full___ Partial___ None___
on_____leg.

LOCOMOTION
Walk_____times/day.
Increase as tolerated_____.

EXERCISES
Range of motion_____times/day
to_____
by patient___ nurse___ family___.
Other as outlined or attached_____.
Stand____Min.____times/day.

SOCIAL ACTIVITIES
Encourage group___ individual___
within___ outside___ home.

Transport: Ambulance___ Car___
Car for handicapped___ Bus___

Patient knows diagnosis?_____ Last Chest X-ray Date_____
Attachments: Diet List___ Lab. Report___ Exercise Program___ X-ray Report___
(Give Dates) IMPORTANT MEDICAL HISTORY AND PROGNOSIS (State allergies if any)

MAJOR DIAGNOSES

PHYSICIAN'S ORDER (Diet, Drugs, etc.)

Developed by Minneapolis Health Department 1966. Physician's Sig._____ Date_____

FIGURE 1.—"Patient Care Referral" form.

PATIENT INFORMATION

SELF CARE STATUS

Check level of performance. Use S in column for supervision only. Draw line when item is currently inapplicable.

In blank space explain assistance needed in care. Use number from table to identify area discussed. Therapists and social workers include title with signature.

	Independent	Needs Assistance	Unable to do	
Bed Activity				1. Turns
				2. Sits
Personal Hygiene				3. Face, Hair, Arms
				4. Trunk & Perineum
				5. Lower Extremities
				6. Bladder Program
				7. Bowel Program
Dressing				8. Upper Trunk, Arms
				9. Lower Trunk, Legs
				10. Appliance, Splint
				11. Feeding
Transfer				12. Sitting
				13. Standing
				14. Tub
				15. Toilet
Locomotion				16. Wheelchair
				17. Walking
				18. Stairs

19. PERSONAL INTERESTS Music___
Group Singing___ Group Games___
Crafts___ Radio and TV___ Art___
Plays Instrument___ Other___

20. MENTAL STATUS Lonely___
Alert___ Forgetful___ Confused___
Other___

21. COMMUNICATIONS ABILITY (Yes, No)
Speaks and Understands ___
Writes Intelligibly ___
Understands Writing ___
(If No or any limitations, describe)
Responds to Gestures (describe) ___

22. OTHER NURSING INFORMATION
about diagnosis, medications, treatments, medical history, habits, preferences, condition on discharge, etc.

23. EQUIPMENT
Side Rails Bedboard___ Footboard___
Long: R___ L___ Short: R___ L___

24. BED: Low___ Mattress: Firm___ Reg.___
Other___

Nurse's Sig. _____ Tel. _____

V. SOCIAL INFORMATION (Adjustment to disability, emotional support from family, motivation for self care, socializing ability, financial plan, family health problem, etc.)

Agencies Active _____ Sig. _____

FIGURE 2.—"Patient Information" form.

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ACTIVITIES PROGRAM ATTENDANCE

DATE _____ THROUGH _____ ACTIVITIES SUPERVISOR _____

RESIDENTS	SUNDAY				MONDAY				TUESDAY				WEDNESDAY				THURSDAY				FRIDAY				SATURDAY			
	Spiritual	Social	Education	Work-type	Spiritual	Social	Education	Work-type	Spiritual	Social	Education	Work-type	Spiritual	Social	Education	Work-type	Spiritual	Social	Education	Work-type	Spiritual	Social	Education	Work-type	Spiritual	Social	Education	Work-type

ACTIVITIES PROGRAM MONTHLY CALENDAR OF EVENTS

Month_____, 19____

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
AM PM EVE.							
AM PM EVE.							
AM PM EVE.							
AM PM EVE.							
AM PM EVE.							
AM PM EVE.							

FIGURE 4.—Activities program monthly calendar of events.

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Instructions for Selected Activities

Motivating an Individual To Participate

NO INDIVIDUAL SHOULD BE REQUIRED TO PARTICIPATE IN ANY ACTIVITY.

Knowing a person's interests, past or present, does not guarantee that he will want to participate in an activity of similar nature. There are a variety of reasons why he might be disinterested. He may lack confidence, fear failure or being laughed at, or he may just be completely withdrawn into his own problems, real and imagined.

There are several avenues open for you to involve an uninterested individual in activities.

First, you must show enthusiasm and the conviction that the individual can participate on a par with others. If attempts at persuasion fail, and if the activity is of particular interest to the individual in light of his past experience, and present abilities, ask him, for example, to help explain facets of procedure to you. Your own helplessness might encourage him to demonstrate for you. He then might be willing to demonstrate other steps, and, before long, realize his own capabilities and be willing to join in. You also may ask him to help someone else in the activity, acting as an assistant instructor.

Another method of involving a reluctant individual requires investiveness and subtlety. If, for example, an individual wants absolutely nothing to do with any activities and only wants to sit and watch television all day long, you can stimulate his involvement by using his own desires. You might question him about the program he just watched, asking him what he felt about certain characters. You might have several people watch the program and conduct a discussion group afterward. If a game show is watched, you might wish to perform the game show in your facility. In other words, you must find a way of channeling an individual's immediate desires into related activities which eventually can lead the way to more general activities and social interaction.

Remember, it is imperative that an individual's interests be maintained. Initial interest is no guarantee of continued interest. You should attempt to make a program as varied and involving to a person as possible.

To ensure that a participant's interest is being maintained, check his activity record. If there are periods of unexplained absence, it could indicate a lack of interest or perhaps a problem with one member of the group. Ask the individual what the problem is and seek solutions.

Also, be sure to check with staff, volunteers, other program participants and family if the person involved may have mentioned something about a like or dislike in the activities program. Constantly help an individual to participate, to meet challenges, and to succeed.

Teaching an Activity

There are five basic steps in teaching to be followed for either individual or group instruction. The five steps are:

Preparation

It is essential that you be thoroughly prepared for teaching the activity. Know your subject well, be it a craft or a game. Have at hand all the equipment you will need – materials, tools, or recreational necessities such as balls, blindfolds, etc.

Orientation

Explain the purpose or general idea of the activity. If a craft is involved, show the finished object and explain what tools are used and how they are used in making the product. If a recreational activity is involved, explain the goal. For example, in Chinese Checkers, the goal is to move your marbles from one point of a star to another.

Demonstration

Show the procedure. Go through the process step-by-step, explaining what the purpose is for each step. If there are some shortcuts that can be taken, demonstrate them only if the person learning will not become confused. If possible,

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incorporate a shortcut into the actual demonstration, showing the one shortcut without demonstrating the normal routine.

Initial Supervision

Once you have demonstrated, have those involved go through the procedure step-by-step, until it is done correctly. You might have to have participants try each step after you demonstrate, then go through the process again.

Summation

Go through the procedures again, have the individuals go through again, and ask for any questions.

There are several "tricks of the trade" which will make the teaching process simpler and more effective.

1. Double and triple check your preparation.
2. If applicable, seat participants in a comfortable position with good lighting for work.
3. If possible, sit beside an individual so that he can see what your hands are doing, hear what you are saying, and does not feel rushed.
4. Give encouragement and honest praise. Some persons are apt to be very critical of their performance and can tell quickly when your praise is insincere.
5. Be patient. If a mistake is made in one of the steps, reteach the step. You may wish to reteach the step for an entire group if you feel several are having a problem with it. Do not demonstrate what might happen if something is performed incorrectly. This only leads to confusion.
6. In case of crafts, have several designs on hand for individuals to work from. If original designs must be created, it could be very discouraging for those unable to create, or who feel their design to be inferior.
7. Have a sense of humor. Keep the situation light. Remind the individual that if he makes a mistake, "so what." At the same time, do not make fun of a person, or of his efforts.

Five Recreational Activities

1. Adapted Bowling

Materials Needed: Table (30 inches high); Masonite sheet (two feet by eight feet); half-inch thick plywood sheet (two feet by eight feet); ten large wax paper milkshake containers; two rubber balls (three inch diameter).

Construction Required: The adapted bowling alley is constructed by nailing or gluing the Masonite to the half-inch plywood. You may wish to embellish the Masonite with paint.

Number of Participants Involved: The number of participants who can be involved is almost unlimited, although it is suggested that the number be kept to no more than fifteen or twenty, depending on the rules you establish.

Rules of Play: The rules of play can vary considerably. In general, participants are in a circle around the bowling alley (fig. 5), the alley being turned to face each individual, rather than having the individual move.

Each person has five turns, one turn at a time in rotation. He throws two balls on each turn. In

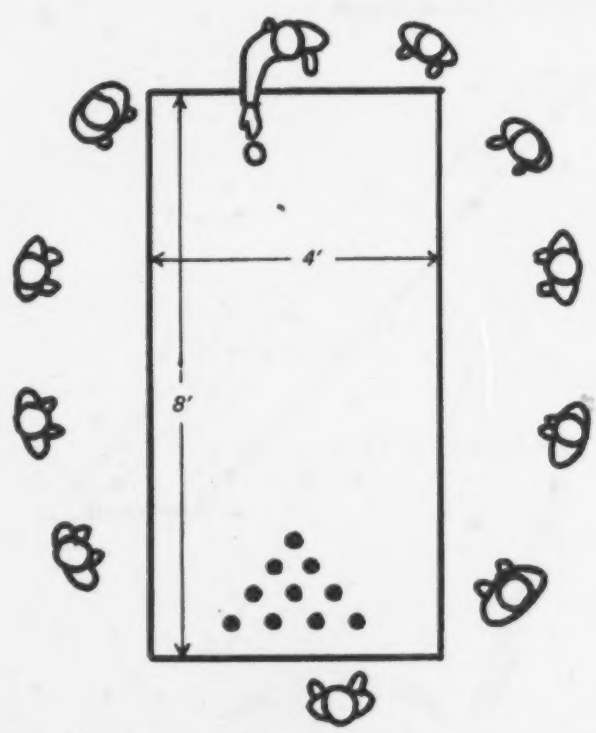

FIGURE 5.—Adapted bowling alley and players. Alley rotates to accommodate players.

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scoring, a point is received for each pin knocked down, except that twenty points are given if all ten pins are kocked down on the first roll of the ball in any given turn. A total of one hundred points is possible. Participants can play as individuals, or in teams.

2. Shuffleboard

Materials Needed: Eight wooden discs (quoits) (eight inch diameter, 3/4 to one inch thick); four shuffleboard sticks (purchased or made); paint.

Construction Required: *Discs* are simply made in crafts or by a carpenter. Four are painted red, four blue.

Shuffleboard sticks can be purchased or made by affixing to the end of a mop or broom handle a block of wood eight and one-half inches wide by six inches long by one and one-quarter inches thick, one end being made concave to fit outer edge of disc, with the bottom of the shooting end planed to a forty-five degree angle (fig. 6).

Shuffleboard base usually is a floor inside or a concrete surface outside (heavy oil cloth or plastic also can be used). The diagram is painted (fig. 7). Note that length of area can be shortened if necessary.

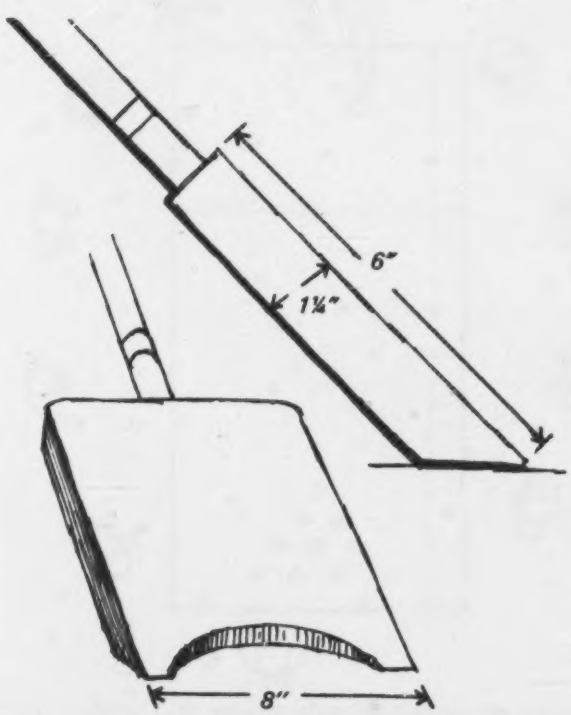

FIGURE 6.—Shuffleboard stick head.

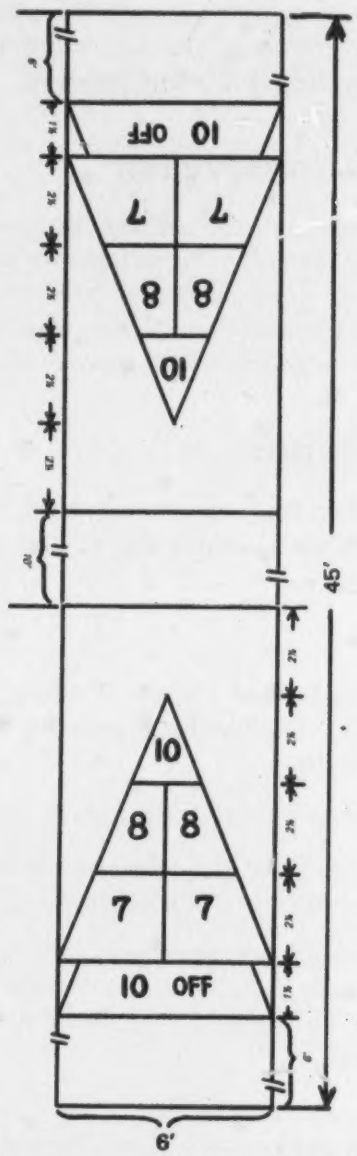

FIGURE 7.—Shuffleboard diagram and dimensions.

Rules of Play: Four persons play at one time, two being designated the blue team, two as the red. One blue player and one red player are at either end of the court. All eight discs are at one end of the court. Players alternate pushing the discs, first one blue disc, then one red disc, one blue, etc. If the red player is first to play a disc, then blue player on other end of board pushes disc first when play begins at that end of board. Such alternation is necessary as a player may hit opponent's discs out of scoring position with his disc.

Scoring is determined by position of discs after all eight have been played. Discs which are on the line receive the lower of the two scores indicated. The game is complete after 21 points (or whatever specified sum is set) is reached.

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3. Balloon Valleyball

Materials Needed: Net (or cord) long enough to be suspended between two walls; large, bright colored, round balloons.

Construction Required: The net or cord must be suspended between two walls at a height of four to four and one-half feet from the ground.

Number of Participants Involved: The maximum number of participants involved is 18, nine to a side in rows of three.

Rules of Play: A like number of individuals is on either side of the net. Play starts when server taps balloon into the air with the object of getting it over the net. If the balloon does not go over the net on the initial serve, two more taps are allowed to other players. If the team which serves fails to get the balloon over the net in three taps, or if the balloon touches the floor, or if the balloon is tapped by the same person twice in succession, the team which is serving loses the balloon and the other side has the serve. No points are scored. If the team which is *receiving* fails to return the balloon within three taps, or if it drops the balloon or has a player touch the balloon twice in succession, then the team which is serving receives a point and serves again. Only the team which is serving is eligible to score points.

If conditions merit, players may rotate position. The game is won by the team scoring 21 points, or whatever number is agreed upon.

4. Relays

A relay is an active group game in which mild competition and team spirit can be developed.

There are several varying types of relays, with the only equipment needed a baton, which could be a cut-off broomstick, a ball or some similar relaying device.

The specific relay which you choose depends on the general physical abilities of those involved. Some relays involve more endurance and/or dexterity than others.

As shown in fig. 8, two teams face one another man-for-man. The baton is moved from left to right, then, once having gone from one end to the other, moves back to its original position. A variation of this relay, demanding a great deal more dexterity, requires that the baton (a shoestring) be loosely tied by the "passer" around the "passee's" wrist. "Passee" then unties the baton and carries out the passer function. As usual, winning team is signified by the one whose lead-off man is first to regain possession of the baton.

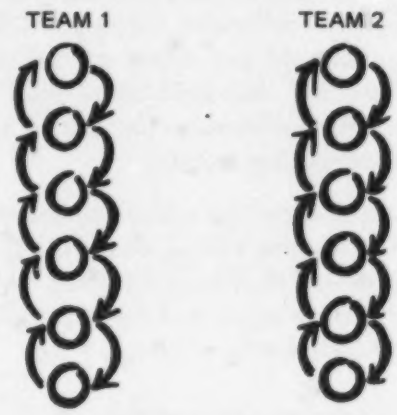

FIGURE 8.—In this type relay, the baton is passed from left to right, from one end of the line to the other, then back again. A shoestring-tying variation requires more dexterity.

The relay shown in fig. 9 requires more movement than above, but can be played by less players. The teams are side by side, each lead-off man equidistant from a wall, chair or similar device. The lead-off man takes the baton, moves to the goal, touches it, returns and hands the baton to the next in line, then proceeds to the end of the line. The team whose lead-off man is first to return to the head of the line, wins.

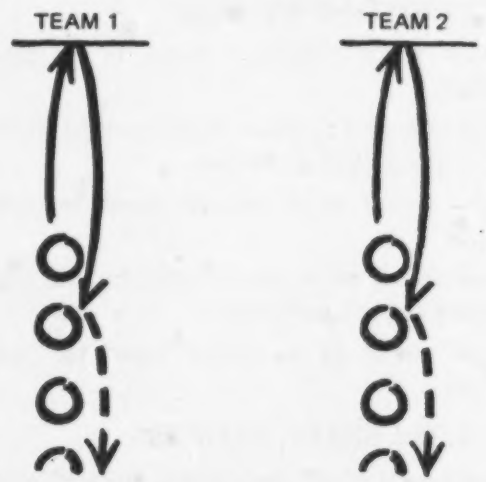

FIGURE 9.—In this type relay, lead-off man takes baton, goes to and touches goal, then returns and passes off baton to next person in line. Lead-off man goes to the end of the line, while relay action continues. Game is over when lead-off man returns to front of line.

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5. Group Exercises

Group exercises are used to maintain and promote general physical fitness and mobility. The amount of time spent on exercising depends on the composition of the group involved. Remember that energy expended by an individual must be conserved to provide ability to participate in various activities throughout the day. At no time should you allow an individual to become fatigued. No individual may participate in exercises without prior written approval of the attending physician.

The following exercises can be performed from either a standing or sitting position. Those unsteady on their feet should sit. Each individual needs side space equal to fingertip-to-fingertip distance of outstretched arms.

DEEP BREATHING EXERCISE

Participants inhale while leader counts to four.
Participants exhale while leader counts to four.

HEAD BOWING EXERCISE

On the word "ready," head is in upright position.

On the count of 1, lower head until chin touches chest.

On the count of 2, raise head to "ready" position.

On the count of 3, put head back as far as possible.

On the count of 4, return head to "ready" position.

HEAD TWISTING EXERCISE

On the word "ready," head is in upright position.

On the count of 1, move head to right, right ear approaching right shoulder.

On the count of 2, return head to "ready" position.

On the count of 3, move head to left, left ear approaching left shoulder.

On the count of 4, return head to "ready" position.

SHOULDER SHRUG EXERCISE

On the count of 1, participants raise shoulders.

On the count of 2, participants lower shoulders.

SHOULDER EXERCISE

On the word "ready", arms are by side.

On the count of 1, raise arms in front of body, parallel with feet.

On the count of 2, move arms to the side, perpendicular to legs.

On the count of 3, raise arms over head, palms touching.

On the count of 4, return arms to "ready" position.

ELBOW AND SHOULDER EXERCISE

On the word "ready," arms are by side.

On the count of 1, raise arms in front of body, palms upward, parallel to feet.

On the count of 2, bend elbows and touch finger tips to shoulders.

On the count of 3, return arms to #1 position.

On the count of 4, return arms to "ready" position.

CLOSE AND OPEN HAND EXERCISE

On the count of 1, make fist.

On the count of 2, open hand and spread fingers.

CHOPPING MOTION EXERCISE

On the word "ready," fold hands together on lap.

On the count of 1, swing hands upward over right shoulder.

On the count of 2, return hands to "ready" position.

On the count of 3, swing hands upward over left shoulder.

On the count of 4, return hands to "ready" position.

TRUNK TWISTING EXERCISE

On the word "ready," hands by side if sitting, on hips if standing.

On the count of 1, twist body from waist up to right.

On the count of 2, return to "ready" position.

On the count of 3, twist body from waist up to left.

On the count of 4, return to "ready" position.

TOE TAPPING EXERCISE

On the word "ready," feet are flat on floor.

On the count of 1, left heel remains on floor, raise left toes.

On the count of 2, return to "ready" position.

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On the count of 3, right heel remains on floor, raise right toes.

On the count of 4, return to "ready" position.

MARCHING IN PLACE EXERCISE

On the word "ready," both feet are flat on floor.

On the count of 1, raise left foot off floor.

On the count of 2, return to "ready" position.

On the count of 3, raise right foot off floor.

On the count of 4, return to "ready" position.

The following two exercises are used only in a sitting position.

LEG ABDUCTION AND ADDUCTION

On the word "ready," sit with knees about eight inches apart, feet flat on floor.

On the count of 1, spread knees apart.

On the count of 2, bring knees together.

KNEE STRAIGHTENING EXERCISE

On the word "ready," sit with knees about eight inches apart, feet flat on floor.

On the count of 1, straighten and raise left leg.

On the count of 2, return to "ready" position.

On the count of 3, straighten and raise right leg.

On the count of 4, return to "ready" position.

Five Crafts

ALL CRAFTS WHICH TEND TO CREATE DUST AND/OR ODORS MUST BE CONDUCTED IN WELL-VENTILATED AREAS.

1. Woodworking

Woodworking can be as simple as making blocks for children, or as complicated as building a house. When selecting a project, keep the participant's ability in mind. Do not suggest overly simple projects for men with past experience and present ability to complete more involved projects.

In some cases, someone from the facility's maintenance department, from a school industrial arts department or a retired carpenter may be willing to cut out projects for woodworking participants, thereby avoiding expense and exposure to hazards.

PROJECT A: CHILDREN'S BLOCKS

Goal: To produce varying sized blocks for children which will not be harmful if chewed upon

Equipment needed: Sanding block; paint brush; (C-clamp)

Materials Needed: Small pieces of scrap lumber (not plywood); sandpaper, coarse and fine; vegetable coloring or nontoxic paint

Procedure: Using the coarse sandpaper, sand the wood block completely, being careful to smooth all corners and edges and to remove any loose slivers. Repeat the process using the fine sandpaper. (For a person with the use of one arm only, fasten the block to the table by means of a C-clamp.)

Clean the block by brushing.

Color the block with vegetable color or with nontoxic paint. *Do not use any materials which, if swallowed, might prove harmful.*

When 12 or 18 blocks have been completed, bag them in a mesh bag and use as gifts for children of friends or relatives, orphanages, etc.

PROJECT B: LAMP

Goal: To make an attractive lamp that can be used in the individual's room (This project can be long-range, also encompassing other crafts, as done here with "Mosaics—Project A".)

Equipment Needed: Saw; hand drill (brace); bits; hammer; pliers (to strip cord); screwdriver; vice (wooden); sanding block; scissors; paint brush; ruler; pencil; equipment cited under "Mosaics—Project A."

Materials Needed: 1 sheet ¼" plywood (capable of being cut into dimensions given below); 1 piece scrap ½" wood (capable of being cut into dimensions given below); 1 piece scrap 1" pine (at least 8" square); nails; sandpaper (coarse and fine); light fixture (new or old, including extension rod, socket and pull chain, brass rod, coupling, washer, threaded pipe, washer and nut, as shown in fig. 15); electrical cord; plug; felt; white all-purpose glue; paint; materials cited under "Mosaics—Project A."

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Procedure: Cut wood into desired proportions, as follows:

¼" plywood—4 pieces, each 7" x 14"
½" wood—2 pieces, each 6⅜" x 6⅜"
1" pine—1 piece, 8" x 8"

Sand outer surfaces of wood to remove any splinters, bumps, etc. Sand edges and corners of 1" pine only.

Taking the ruler and pencil, make small, light marks on the edge of the top of the 1" pine, at the 2", 4", and 6" points. Repeat this for the other three edges. From each of these points on the edge, make a mark at 13/16" toward center. These marks form a perfectly centered outline for one of the 6⅜" squares. (See fig. 10.)

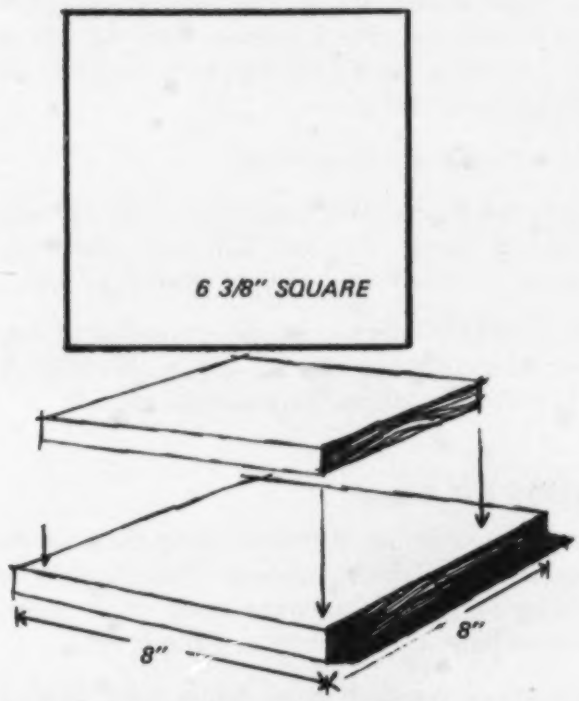

FIGURE 10.—6⅜" square centered and placed on 8" square.

Center the 6⅜" square in the outline you have just made. Nail it to the pine base.

On each 6⅜" square, mark the half-way point of each edge, 3³⁄₁₆". Draw one horizontal line, from point to point, and one vertical line, from point to point, for each 6⅜" square. The perfect center is indicated where the lines intersect.

At the point of intersection, drill a hole with a bit whose diameter is equal to or slightly larger than the diameter of the threaded pipe of the fixture. Do this for both 6⅜" squares, and drill through the 1" pine base for the 6⅜" square which is mounted to it.

Taking your ruler and pencil, draw a line on the bottom of the 8" square from the hole you have just drilled to a point marked at 4" on edge of base bottom.

Mount the base in a wood vice. If a wood vice is not available, use a metal vice with pieces of wood in clamp area to prevent gouging. With a saw, saw a small channel along the line you have drawn. This will form the channel for the electric cord. Then with a ¾" diameter bit, drill a hole ½" deep only in center of base. (See fig. 11.)

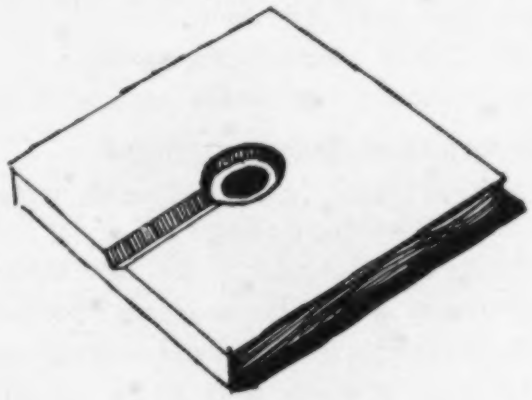

FIGURE 11.—Showing channel and fixture well.

Place one piece of the ¼" plywood in the vice, longest edge up. Lay another piece of the ¼" plywood on top, the edge of the top piece being even with the side of the piece in the vice. Nail the two pieces together. (See fig. 12.)

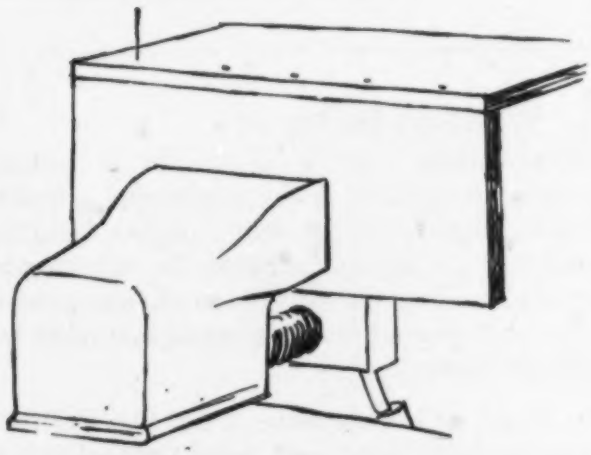

FIGURE 12.—Showing first two sides in vice, nailed.

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Place the unattached 6⅜" square in the vice. Put the two pieces of ¼" plywood into position. Nail together (See fig. 13.)

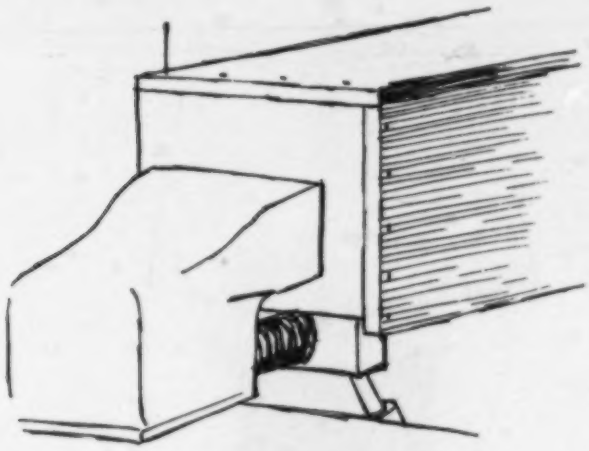

FIGURE 13.—Showing top mounted to two sides.

Place the 6⅜" square and attached 8" square in vice. Nail to the 6⅜" square what has been assembled so far. (See fig. 14.)

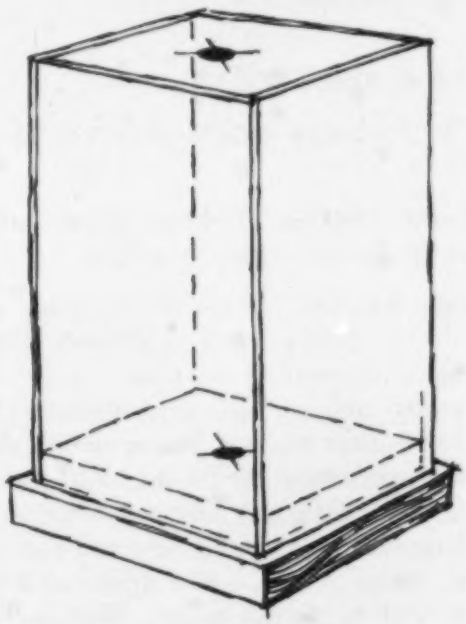

FIGURE 14.—Showing base mounted to two sides and top.

Now nail the two remaining pieces of ¼" plywood into position.

The next step would be to decorate the box-like structure. For our purposes, we have chosen to use mosaics, and this is described as Project A, under "Mosaics"—the next section. There are many other possibilities. You will wish to paint or stain the base, however, and now is the time to do so, choosing the desired color.

Once the lamp is decorated, perform the necessary wiring for the light fixture. *If you are using an old fixture, use new cord. Do not use old cord.* The wiring should be done by someone who knows what he is doing (fig. 15).

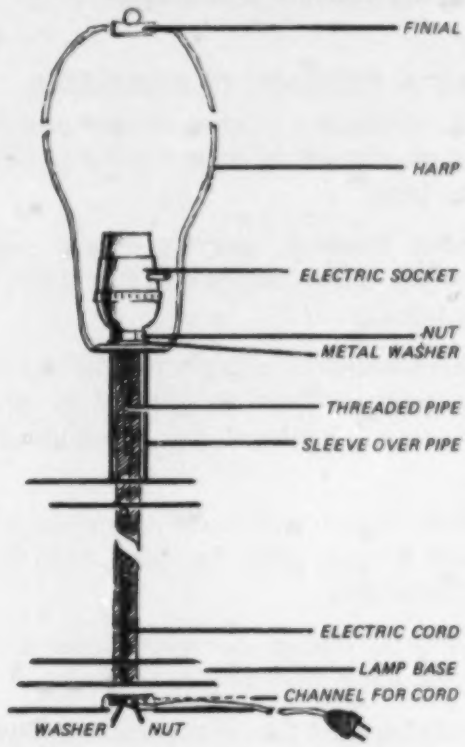

FIGURE 15.—Light fixture.

Once wiring is complete, insert cord through appropriate holes; place fixture in position with nut and washer at top; slip another washer and nut over base of cord, fasten top and bottom nuts; attach the plug to the end of the cord. Insert bulb and attach shade. (You may wish to make shade another project.) Test the lamp carefully for wiring defects. (For illustration of complete lamp, see fig. 16.)

ALL ELECTRICAL WORK SHOULD BE DONE BY AN EXPERT IN THE MAINTENANCE DEPARTMENT. DO NOT DO IT YOURSELF UNLESS YOU HAVE BEEN SHOWN HOW AND ARE FULLY CAPABLE.

Once wiring is complete, cut out an 8" square piece of felt and, with all-purpose white glue, attach to bottom of lamp base.

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2. Mosaics

The use of mosaics is an ancient art form. It can be done in bits of marble, glass, ceramic tile, egg shells, seeds, etc. It allows for great creative expression, but, because some might have trouble creating an original design, useful model designs should be available.

PROJECT A: CERAMIC TILE MOSAICS

Goal: To produce a mosaic design on a lamp made in woodworking project, prior to electrifying the lamp

Equipment Needed: Sanding block; pencil; ruler; empty coffee can; brush; soft cloth; canvas bag; hammer

Materials Needed: Sandpaper (coarse and fine); surplus ceramic tiles (not glazed) in several different colors; white, all-purpose glue; grout; wax

Procedure: Sand surface on which mosaics will be placed. (This already has been done in the case of the lamp.)

Trace desired design on wood, determining how much of any one color is needed.

Take scrap ceramic tiles of one color in desired quantity and place in canvas bag. Smash tiles with hammer, being careful not to break tiles too small. Remove tiles from bag. Repeat for other colors.

Making sure the surface is clean, place a small portion of the total design into place. Once it is determined that this is the design desired, glue pieces into place with white, all-purpose glue. Repeat for total design, one small area at a time.

Once all pieces of ceramic tile have been glued in place, top included, mix grout in empty coffee can. Mix grout until it arrives at a creamy consistency. (Directions are on package.)

Using a brush, brush the grout over all areas where mosaics have been placed, being especially careful to get the grout into spaces between pieces. Get out all air bubbles. Let grout dry.

Once the grout is dry, wipe the entire design with a clean, soft cloth, getting grout off all mosaics, leaving it only between pieces. Wipe until smooth.

Now apply wax and polish. A finished lamp is seen in fig. 16.

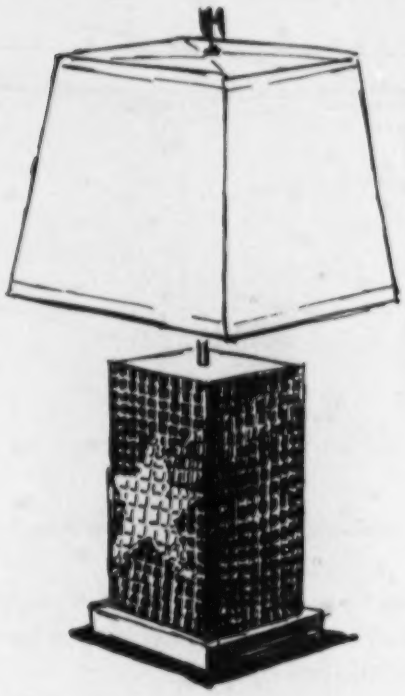

FIGURE 16.—Completed lamp.

PROJECT B: SEED MOSAIC

Goal: To reproduce a favorite picture in seed mosaics

Equipment Needed: Tracing paper; pencil; ruler; carbon paper; brush; tweezers

Materials Needed: White all purpose glue; clear plastic spray; heavy cardboard; various color seeds depending on colors to be used. Some seeds include: bird seed, various types; split peas; pistachio nut shells; celery seeds; sunflower seeds and shells; etc. Note: Rice can be dyed many different colors, if desired. Mix a small amount of vegetable coloring and water together. Drop in rice, a few grains at a time. Remove with a slotted spoon. Blot on paper toweling, and let dry on waxed paper.

Procedure: Place tracing paper on smooth surface and mark off in squares. Place marked paper over photo or magazine illustration, etc., to be copied. Trace outline. (See fig. 17.)

If figure is to be reduced, or enlarged for mosaic, mark off paper in squares corresponding to new size desired. For example, if the seed mosaic is to be twice as large as the picture

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from which it is taken, and if ½" squares originally were used, make up new paper with 1" squares.

The design is transferred from one piece of paper to the other block by block (fig. 18).

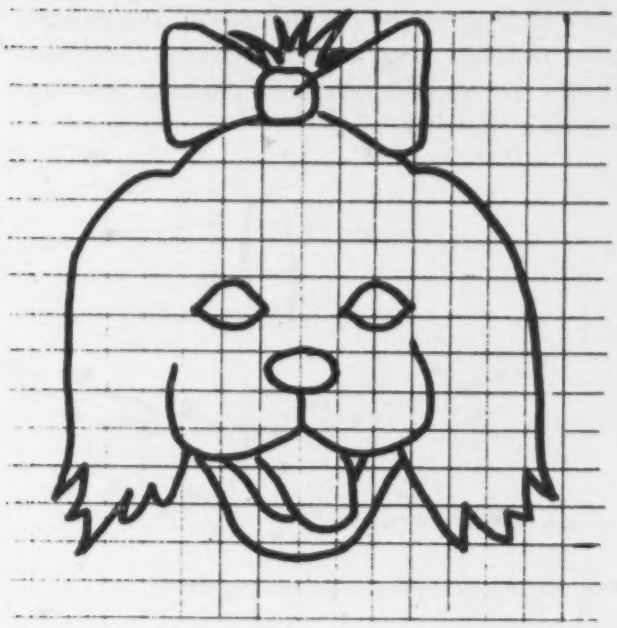

FIGURE 17.—Showing traced picture and square grid.

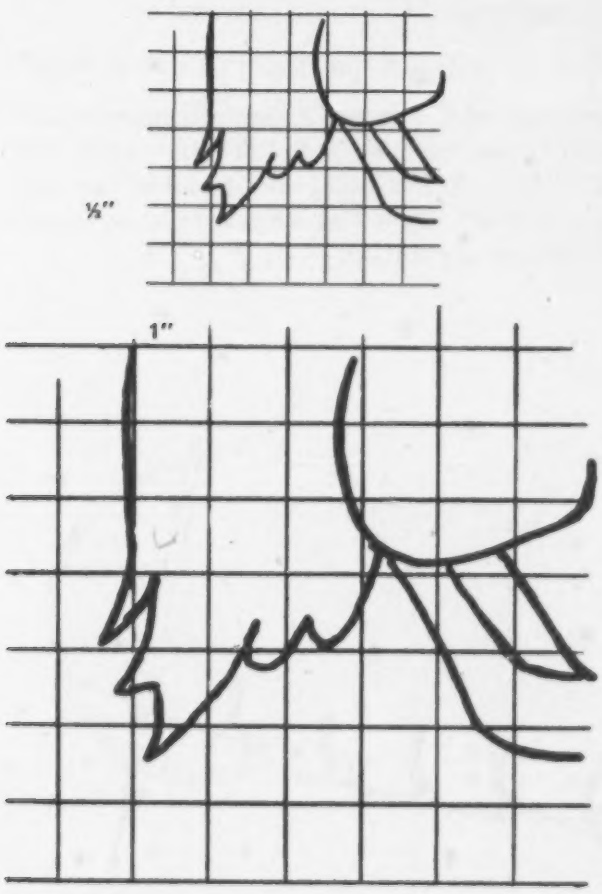

FIGURE 18.—Showing transferring of small to large.

Once the desired design is done in correct size, place carbon paper, carbon side down, on the surface on which the mosaic will be placed. Place the paper with the design over the carbon paper, and, with a dull pencil, sketch the outline of the design. Do not trace squares.

Once the design has been transferred to the surface, select a small area near the center. Cover area with white, all-purpose glue, and, using only one color at a time, place seeds in position with tweezers. Repeat for entire project, one area at a time.

Once the project (fig. 19) is complete, let dry thoroughly. Spray with several coats of clear plastic, letting one coat dry before applying the next. *Note: Be sure that spray is applied only in extremely well-ventilated areas, preferably outside.*

Once completed, frame as desired.

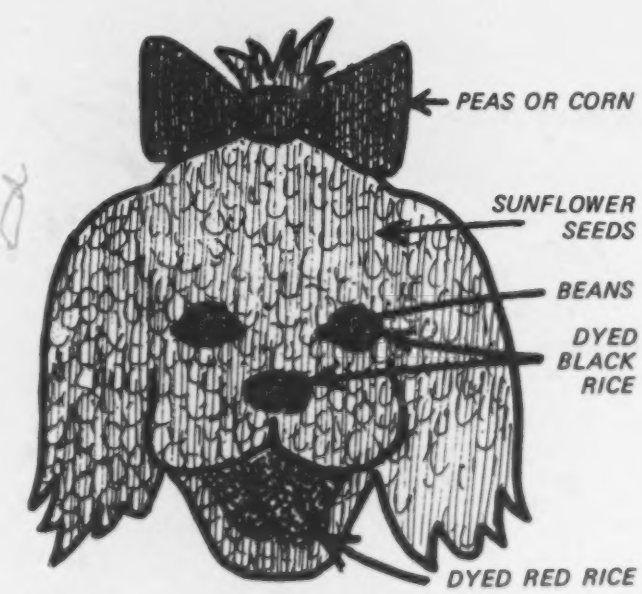

FIGURE 19.—Showing dog of seed mosaic.

3. Simple Quilts

Goal: To produce a multi-colored, tufted laprobe 45" x 70"

Equipment Needed: Tapestry needle size #18 or #19; embroidery needle size #5 or #6; scissors

Materials Needed: 252 6" square pieces of nonravelling, colorfast, washable, opaque material, all material of the same weight; #3 or #5 pearl

cotton thread; embroidery thread or nylon sock and sweater yarn; old nylon hose.

Procedure: Determine pattern. For laprobe, 45" x 70", 126 5" squares are needed. Determine what color these squares are to be. Make one square at a time.

To make a completed 5" square, cut out two 6" squares of the same material. On the face of each square, with a piece of chalk, mark the center.

Turn the two pieces of material so that the outside faces are touching. Using a small running stitch (fig. 20), start sewing two inches from right corner of one side, turn corner, sew three complete sides, and then sew one inch of side where two inches already have been completed, leaving approximately a two inch opening on that side. (See fig. 21.)

Once sewing is complete, clip corners.

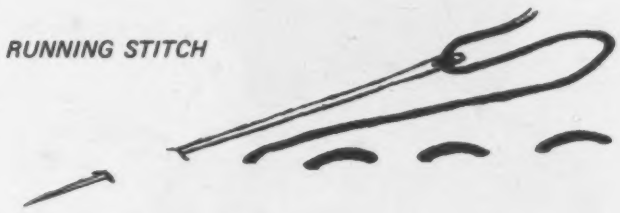

FIGURE 20.—Running stitch.

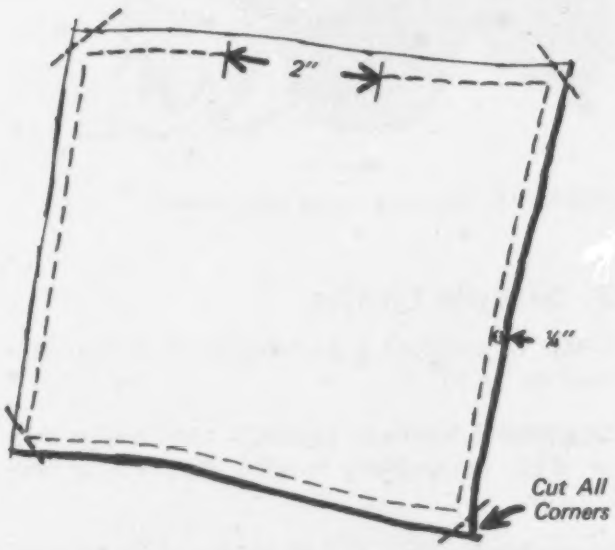

FIGURE 21.—Showing completed first-stage sewing and clipped corners.

Turn rightside out.

Take one old, clean nylon stocking, gather down to the toe, and insert into quilt square through opening, placing the nylon into the center of the square.

Thread three strands of nylon sock and sweater yarn through large tapestry needle. Take one stitch in marked center of square, securing stocking. (See fig. 22.)

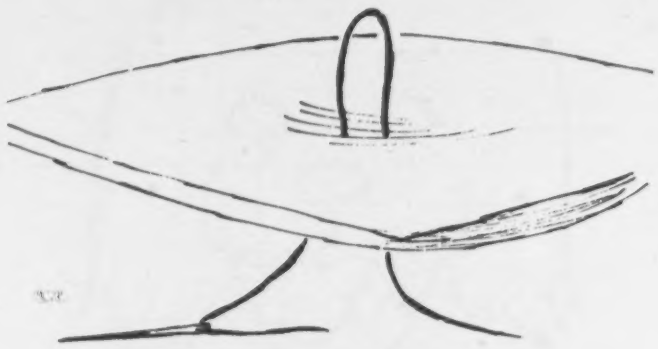

FIGURE 22.—Showing center tacking stitch.

Tie the thread in a square knot and cut.

Close the two-inch opening with a blind stitch.

Once the total number of required squares have been made, crochet or button-hole stitch (fig. 23) them together using one strand of the yarn used for tacking, #3 or #5 pearl cotton thread or embroidery thread.

FIGURE 23.—Buttonhole stitch.

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4. Simple Pom-Pom Animals

Goal: To make a simple, pom-pom owl

Equipment Needed: scissors; compass

Materials Needed: yarn; scrap felt; thread; white, all-purpose glue; cardboard

Procedure: With a compass, draw a circle three inches in diameter on a piece of cardboard. Using the same center, draw another circle one inch in diameter. Cut out center one-inch circle. Cut out three inch circle. This gives you a doughnut-shaped piece of cardboard. Duplicate using disc as your guide.

Repeat the procedure above, except outer circle is 1¾" in diameter, with inner circle being ¾" in diameter. Make two. Make a slit in each disc. (See fig. 24.)

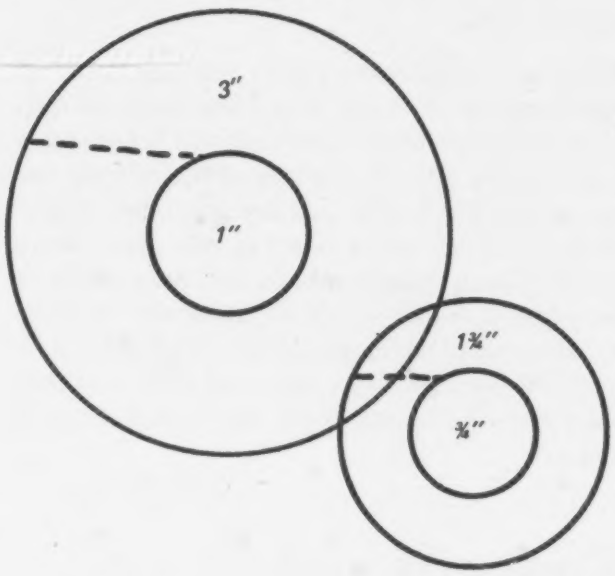

FIGURE 24.—Showing discs with slits.

Place the two large discs together, the slits being 180 degrees from one another. Wrap yarn through (approximately 110") and around discs until no more can be wrapped. (See fig. 25.) Repeat this procedure for the smaller discs (approximately 85").

Once no more yarn can be fit, insert the scissors between the discs, and cut all the way around the edge. Separate the discs a little and, with a piece of heavy-duty thread, secure the yarn in the center, leaving enough extra to tie the pom-poms together. (See fig. 26.) Repeat for the smaller disc.

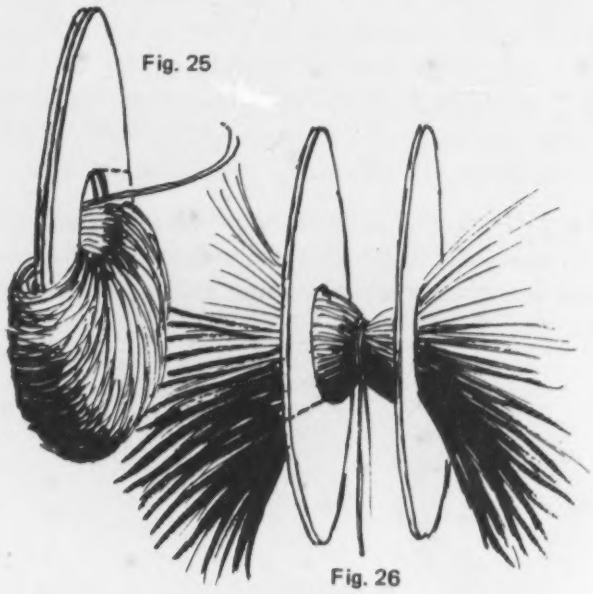

FIGURES 25 & 26.—Yarn is wrapped around disc until no more can fit. Yarn then is cut and discs spread.

Once both pom-poms are secured, remove discs. With the excess thread, tie the two pom-poms together (fig. 27).

With scissors, trim larger pom-pom to give it a slightly oval shape and flatten front of smaller pom-pom "head." (See fig. 28.)

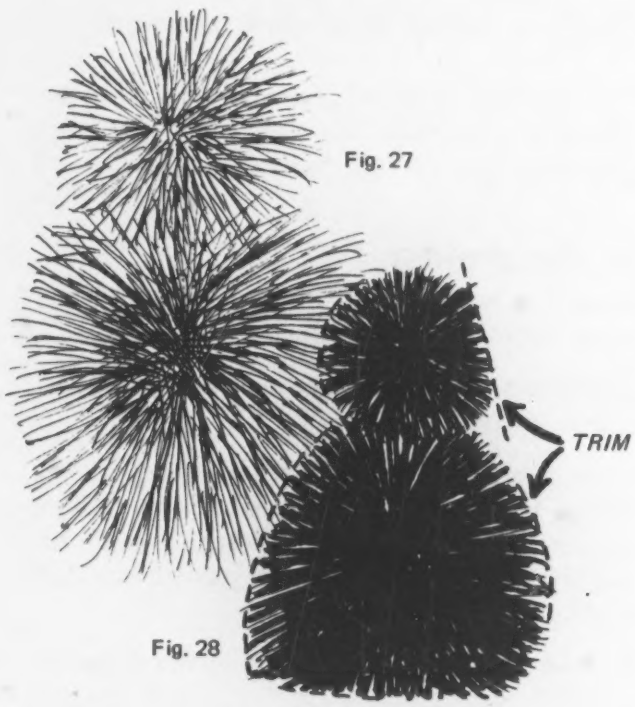

FIGURES 27 & 28.—Pom-poms are tied together and trimmed.

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For the eyes, cut out two large, dark circles of felt. Thread a needle with piece of yarn. Knot one end, insert needle through center of felt, and run through head. Repeat for other eye, and tie the two ends of the yarn together in the back of the head. Cut off excess yarn. (See fig. 29.)

For the beak, cut out a diamond-shaped piece of felt and fold. Use same procedure as for eyes, with knots appearing at either side of beak. (See fig. 29.)

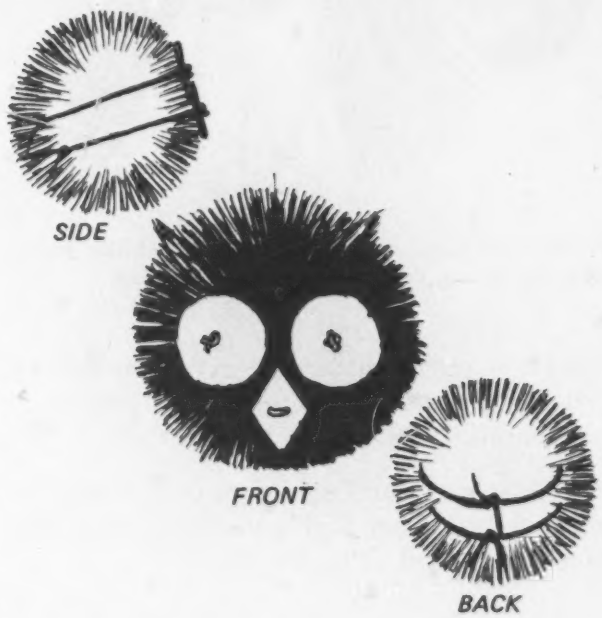

FIGURE 29.—Eyes and beak mounted to pom-pom head.

Owl now can be attached to a handbag or blanket, or may be made free-standing by flattening bottom or by attaching to simple felt base.

5. Decoupage

Goal: To make an old metal tray into a once-again useful, decorative piece

Equipment Needed: sanding block; scissors; paintbrushes; sponge

Materials Needed: old metal tray; old greeting cards; tissue paper; pencil; sandpaper (fine); emery cloth (fine); steel wool; white, all-purpose glue; rubber cement; paint; clear deck varnish; turpentine

Procedure: Select and cut out design materials.

Make sure that the surface of the tray is clean and smooth. Use steel wool, sandpaper, emery cloth to remove any rust, flaking paint, etc. Choose the background color and select a corresponding flat paint. Paint the surface to be decorated. Let dry 24 hours, sand smooth, apply another coat. If desired, repeat again. After the final coat has been applied, and has dried for 24 hours, prepare the surface by rubbing with a damp emery cloth, fine grade.

With the tissue paper, outline the surface to be decorated. Place cutouts on paper, moving them into an appealing arrangement. When satisfied with an arrangement, dot the back of each cutout with rubber cement and place on outline. If it is satisfactory, prepare to mount the cutouts on the tray.

Brush the back of your first cutout with a thin coat of white, all-purpose glue. Place the cutout in position. Press it to the tray with a damp sponge, moving the sponge from the center of the cutout to the edges. Repeat for all cutouts, one at a time.

When all cutouts are glued, you are ready to seal them to the tray. Mix clear deck varnish with sufficient turpentine so that it flows easily and evenly. Seal the surface of the cutouts using a soft, flat brush. Let dry 24 hours. Thereafter, apply as many coats as necessary (from five to fifteen) to completely seal the cutouts so no edges can be felt. Wait 24 hours between application of each coat. When the final coat is applied, wait 24 hours and sand with very fine sandpaper or emery cloth until the surface is smooth.

Councils and Committees

Through participation in councils, committees and clubs, a significant degree of independence, purpose and sociability can be restored to individuals.

With councils and committees, the emphasis is on individuals having a role in the decision-making process. Committees and councils allow individuals to have an effect on what is going to be undertaken. Many facilities have had excellent results by giving individuals a voice in the running of the activities program.

An activity committee's role would be supple-

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mentary to your own. For example, a committee might suggest a specific date for an open house, or what to give as an award or gift, or what movies are to be shown, etc. In other words, the overall planning is still your responsibility, but determination of some specific detail is left up to those who are most affected by that detail.

As in any close community, there are bound to be petty jealousies, hurt feelings, leaders and followers. In this light, it is best if all individuals are somehow involved in activities committees. You might wish to establish an awards and gift committee, to determine what type of award should be given a volunteer or guest speaker; a movie committee, to select what movies should be shown; a decorating committee, to work on decorations for a party or open house; a party committee, to select specific dates for certain events and possible themes, and other committees with overall scope as wide and as varied as your overall program.

Selection of the people to work on the committees is best made on a random basis—perhaps by pulling names from a hat, with a specified number to work on each committee. Trading committee posts among and by individuals should be allowed. Bear in mind that there may be those who might not wish to participate in committee work due to other obligations such as clubs, or crafts projects, etc. Those who do not wish to participate because they feel inferior or afraid that they could not contribute, however, should be urged to join in, if only to watch. Nonetheless, do not force an individual to do something which he absolutely does not want to do.

Meetings of the committees can vary, according to the nature of the committee's purpose. If possible, the meeting should take place in a special room which affords quiet and privacy. A chairman who is able to do the job and, preferably, who has not chaired a meeting in the recent past, should be selected by committee members at each meeting.

Some set of rules should be observed, based more on politeness and common sense than strict parliamentary procedure. Individuals should not interrupt a speaker, and individuals must speak in turn.

You or a member of your staff or a volunteer should be present at meetings to answer any questions, give assistance where necessary, and to observe. Do not interfere or run the meeting. To as great an extent as possible, committee meetings are activities where individuals do for themselves.

Depending on the committee's realm, some decisions should be referred for vote by all concerned. For example, in selection of movies, committee members might select ten movies from a list of one hundred, then have all individuals in the program vote to determine the five most desired from the list of ten.

Be cautious in dealing with committees. Outline their responsibilities carefully so you do not have to override their decisions. You might wish to make general suggestions or advise that a potential committee decision might be contrary to facility regulations. If you must veto a committee judgment, do so as mildly as possible and with full explanation. Remember, committee activity is not a game for those involved. If a committee is established properly it is engaged in earnest, serious work and should be treated accordingly.

Clubs

Unlike councils and committees, clubs composed of individuals in the facility usually do not engage in decision-making.

Clubs are composed of persons with interests in common, such as coin or stamp collecting, gardening, volunteer work, welcoming new individuals to the facility, etc.

Establishment of a club is your responsibility. You might wish to check over records to see where interests lie, or perhaps compose a list of possible clubs, questioning individuals about their interest in specific areas.

Club meetings usually take place on a regular basis. Meetings should be open to all who might wish to observe or participate, however, since some may have a latent interest which observance of a club meeting might encourage them to develop.

Club activities involve reading or suggesting books and magazines to read, reading aloud, discussing unusual facts associated with the

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subject at hand, or displaying, as with coins or stamps, certain rarities in the possession of individuals.

Clubs also give members the opportunity to expand their activities and involve the community. Guest speakers can be invited in from the community at large, trips can be made to museums or other locations pertinent to the club's interest, and clubs in the community with interests complementing those of club members in the home might be encouraged to meet occasionally in the facility or to invite facility club members to general meetings in the community.

Your role in club activities, aside from being the person responsible for originating them, is primarily as an observer. Again, the goal is to have club members do and act for themselves. You or a representative from your office should be on hand, however, to answer any specific questions or respond to any specific requests.

In general, it can be said that measures to give individuals roles in independent thinking encourage them to assume roles in the community at large where independent thinking and decision-making are necessities for existence.

Facility Library

Most people enjoy reading and should have access to current publications—periodicals and books. Reading stimulates mental alertness and can provide the basis for many beneficial forms of social interaction.

In establishing a library for those in your facility, consult your community librarian. She may know the reading tastes of many in your program, as well as being familiar with the theory for establishing a simple, yet effective distribution control system.

You might be able to get a direct stop at the facility from your community library's Bookmobile, if available, or a bulk delivery of books from the library for your participants' use on a monthly or six-week basis.

Some magazines may be subscribed to, although this can lead to expense and perhaps some incidents about who is to keep which magazine for how long. Many homes have found great success when volunteers bring in recent (one week old) editions of popular magazines, enabling individuals to have their own personal copy of a favorite publication.

Bookcases should be placed where staff easily can supervise take-out and return procedures. Hours must be established. One or several patients may wish to volunteer their services as librarian(s).

In case of partially-sighted or blind individuals, Talking Books, large print and Braille books are available from the Library of Congress, Division for the Blind and Physically Handicapped (1291 Taylor Street, N.W., Washington, D. C. 20011 or from a regional office and other sources.)

Patients no longer able to read but who are sighted enjoy primarily pictorial publications such as *Look, Life, Ebony,* etc.

Facility Newspaper

One of the most absorbing and rewarding activities for individuals is the writing and publication of a facility newspaper.

Because there will be some expense involved, budgetary considerations and approval must be obtained from the administrator. Outside of items such as writing paper, pencils, art supplies, scissors, etc., the main cost will be for the actual printing itself.

As in the formation of the club, it is up to you to generate initial enthusiasm for the project by inquiring of individuals if they would be interested in the project. If there is a sufficient show of interest, try to encourage more to join in as a job of one sort or another can be found for almost all wishing to participate. Talents especially needed are writing and illustrating. Some of those areas where no real previous experience is necessary includes pasting up, reporting, distributing, and selection of those stories to be used and those which can be omitted. Check through records to see if there are those who might have had past experience or ability to assist. Encourage such a person to join in, possibly by asking for an evaluation of the overall plan for the publication.

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Once you have the names of those who want to participate, call an organizational meeting. At this meeting it might be possible to have a guest speaker, a writer for a local newspaper, perhaps, to outline some of the major areas of concern and some of the work that will have to be done. If it is impossible to get such a guest lecturer, you could have an interview with a writer at his place of work to ask pertinent questions. Relay the information to those attending the initial meeting to give them an opportunity to decide where their maximum ability or interest lies.

It will be up to you or a volunteer or staff member to assist in the development of the newspaper. A list of possible initial assignments could be made up and discussed at a second organizational meeting. There will be a need for writer/editors; illustrators; reporters, who only have to bring in notes or verbal information; columnists to write continuing features such as "I Remember When" or "Comment on Current Events;" layout designers, and other positions about which you should obtain more information.

The scope of the newspaper should be facility-wide. Ask for the cooperation of various department members to act as correspondents, sending in notes about events or happenings in their departments.

The main emphasis of the newspaper will be on those you serve. Some of the items that could be reported include birthdays; new arrivals; coming events, such as parties and holiday celebrations; "patient of the month," selected on random basis giving a biography and current interests of an individual, poetry, as well as any articles pertaining to any major changes that will affect daily living in the facility. Other possibilities include welcome to new volunteers and employees, employee birthdays, words from the administrator, reports from the various departments, etc. Also possible are surveys which analyze individuals' views of certain issues, and compilations of unusual past experiences.

The style of writing for the facility newspaper need not be the formalized newspaper jargon that you read in daily newspapers. The style can be casual, almost as if writing a letter. Nonetheless, it is important for articles of any length to be well outlined so they maintain their interest and readability.

Selection of articles can be made by several editors who can pass judgment effectively. Final typing can be done by a volunteer or member of the facility's clerical staff. Actual paste-up, if required, can be done in a craft area.

The cost of printing the newspaper should be investigated before beginning the project. It would be best to consult a local printer, explain the situation and ask his advice. Chances are he would be more than happy to cooperate. In addition, you might investigate the actual cost of printing on the facility's duplicating or mimeograph machine. Also check with a local high school as many have print shop facilities. Local community organizations might have printing equipment you can use free of charge. It is up to you to ascertain the best and least expensive means of printing as this will be the most expensive part of the project.

Should the newspaper be printed "in house" on a duplicating machine, the originals should permit easy reading by those who are visually impaired. You can use all upper case letters, SUCH AS THIS, or, if there is an IBM Selectric Typewriter in the facility, you might be able to secure a special large type speech font.

Distribution of the newsletter also can be carried out by individuals in your care. Copies should be given to all in the facility, including staff, volunteers, etc., to visitors. Copies also could be sent to families of individuals in the facility.

Remember, the finished product does not have to be the finest piece of work ever done. It is not expected to compete with a daily newspaper. But to those who participate in its publication, a newspaper of their own is an achievement of immense pride and satisfaction.

Rhythm Band

The rhythm band is an excellent activity to promote both mental and physical exercise. Much of the equipment can be made in your facility as craft projects, and other materials can be purchased very inexpensively or donated to your facility.

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To initiate enthusiasm, determine what songs are favorites for individuals. Secure records of one or two "peppy" songs and with one or two instruments, indicate how the rhythm band functions, picking up the beat of the song. Invite several to try.

You can begin with a very few persons, eventually encouraging all able to do so to join in. A phonograph and records are needed.

Some of the manufactured instruments that can be used include:

Bells (obtained from a dime store)

Drums (toy military drums and bongo drums)

Cymbals (small)

Maracas

Tambourine

Triangle

Several of these manufactured items can be made in craft activity as well as other items used for the rhythm band. These include:

Bells (sew 10 "jinglebells" to a piece of grosgrain ribbon)

Chop Blocks (glue fine sandpaper to one side of two small blocks—rub together)

Cymbals (two pot lids)

Drum (oatmeal box covered with paper and shellac; drumstick—12-inch dowel with cork fishing bobber glued to one end)

Rattles (sealed bandaid box filled with pebbles, or; pingpong paddle with soda caps loosely nailed, two-to-a-side, or; two aluminum tart pans, filled with metal buttons, glued taped or laced together with popsickle stick handles)

Rhythm Sticks (two ten-inch pieces of dowel)

Tambourine (punch eight holes in the rim of an aluminum pie pan and string metal buttons (three in a group) through holes)

Xylophone (glass bottles filled to various levels struck by a spoon)

In addition to performing regularly, the band can be a center of attraction at parties, requiring posters to be made, etc. To keep interest high, play to different records, encourage individuals to change instruments, or try forming a marching rhythm band if enough band members are ambulatory. A high school music instructor might be willing to give you consultation.

Gardening

Over the years individuals in long-term health care facilities have shown continuing interest in gardening. In essence, gardening involves the responsibility of caring for a form of life, and a chance for the creation of visual beauty.

Gardening itself can range from simple to complex. It might involve a single plant in an individual's room, a window box, or, as happens in many instances, planting and upkeep of flowers on the grounds of your facility.

In beginning general gardening activities, a variety of equipment must be on hand, depending on the scope of the project. In selecting the necessary materials, much of which probably is in possession of the maintenance department, consult with individuals in the program who have had experience. Let them make listings of suggested tools such as trowels, hoes, etc., as well as supplies such as peat moss, and of course, the flowers themselves.

If the budget allows, plants in each individual's room, cared for by the individual or with the help of an experienced "gardener" not only brighten rooms, but might spark a new area of interest or some degree of social interaction where neither have existed before.

Scheduling gardening activities poses no problems, especially during the summer months or in areas where outdoor activity is possible year-round.

The activity suggests many other possibilities.

A gardening club easily could be established, where literature could be read aloud, movies shown, lectures given by florists or horticulturists, etc. Also possible are trips to botanical or horticultural gardens or trips to museums with botanical or horticultural exhibits. During open house, inspection of the facility's gardens is another possibility. Nor should you overlook the possibility of newspaper publicity for individuals who might enter contests or experiment with new strains of flowers. Contact with the community's garden club or society also is encouraged.

Therefore, as with many specialized activities, gardening can generate widespread enthusiasm and enjoyment for those individuals involved

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in the actual performance, as well as in the many activities directly associated with it.

Religious Activities

NO ONE SHOULD BE FORCED TO PARTICIPATE IN ANY RELIGIOUS ACTIVITIES

Religious activities are of particular importance to most people. In establishing programs in your facility, consult with community religious leaders of all faiths. Be sure to check with the administrator to determine facility policy regarding seeking of converts by groups which emphasize proselytizing. This policy should be relayed to those whom you consult.

Services

The basic religious activity is the conducting of services. One religious leader, or perhaps several in rotation, might be willing to come to your facility on Sunday to conduct nonsectarian services. If there are distinct groups of one religion or another, special services might be held, followed or preceded by general, nonsectarian services. If there are several groups, several corresponding religious leaders might be willing to come out to the facility to conduct special services. *It is important, in the conduct of services, that no one is overlooked and that no one is forced to participate.*

Another possibility, and one that is especially beneficial, involves one or several members of a religious group being picked up by relatives, friends or volunteer members of the congregation to be taken to community services. This possibility easily is investigated by discussing the matter with volunteers in your home, or by calling the head of the affected congregation.

Still another possibility, especially for facilities whose patients are predominantly of one particular faith, would be the holding of outdoor services with members of the regular congregation being invited—bringing the community to the facility. Such activities could be followed with refreshments and perhaps an open house.

Other Activities

In addition to services, there are many other activities related to religion, including:

Bible Classes—Representatives of many religions would be willing to come to the facility in the middle of the week, or perhaps several times a week, to conduct Bible readings and explanations of Biblical meanings.

Bible Study Group—A Bible Study Group similar to a club, and could be led either by a representative of a religious group, or by a patient. Such a group need not be affiliated directly with any one particular religion or another.

Church Volunteer Work—Many volunteer projects might be undertaken for church-related charities, such as an orphanage, hospital, etc.

Church Social—Individuals from the facility might be taken to church socials, or might be able to have a church social in the home.

Church Fraternal Groups—Individuals from the facility might be encouraged to join or to maintain membership in religious fraternal groups affiliated with their religion, such as the Knights of Columbus or B'nai B'rith.

Remember, the possibilities for related religious activities are almost endless. Discuss ideas and possibilities with many religious leaders in the community. They will be happy to help you to develop a meaningful program for all those in your facility.

DO NOT OVERLOOK ANY INDIVIDUAL DO NOT IGNORE HIS PREFERENCE.

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Some Community Resources

The following listings should be used to stimulate your own thoughts and the thoughts of others. This list is not the be-all and end-all. Use it for ideas, for, in the last analysis, ideas are your greatest resource.

Crafts

FROM YOUR LONG-TERM CARE FACILITY

Scrap yard goods, tongue depressors, tape, tin cans, empty Clorox bottles, tissue paper, milk cartons, paper cups, gauze, cotton batting, etc.

FROM THE STAFF, INDIVIDUALS BEING CARED FOR AND THEIR FAMILIES

Scrap yard goods, old nylon hose, old jewelry, old greeting cards, old books, old furniture, old picture frames, old toys and dolls, etc.

FROM THE COMMUNITY AT LARGE

Surplus goods, such as scrap lumber from a lumber yard, scrap leather from a shoe and glove manufacturer, scrap yard goods from fabric retailers, scrap yard goods and old burlap bags from mills. Also donations from clubs, organizations, civic groups, etc.

Games

FROM YOUR LONG-TERM CARE FACILITY

Tables, chairs, brooms, specific games, as well as prizes such as fruit, small trophies, etc.

FROM THE STAFF, INDIVIDUALS BEING CARED FOR, AND THEIR FAMILIES

Games no longer used, prizes, ideas for games, tournaments, etc.

FROM THE COMMUNITY AT LARGE

From retailers and community groups, the donation or loan of special equipment, and the donation of prizes.

Other Activities

FROM CHURCHES

Religious services, Bible readings and discussions, lectures, ice cream socials, missionary groups, etc.

FROM CLUBS AND ORGANIZATIONS

Lectures, assistance in project development, meetings, community drama groups, etc.

FROM MUNICIPALITIES

Visits to the museum, zoo, planetarium, aquarium, civic concerts, libraries (books, movies, records), public schools (music and drama groups), city recreational programs, parks (fishing, picnics), etc.

PRIVATE INDUSTRY

Sheltered workshop, field trips, movies, etc.

EXHIBITIONS

Sports, art, flowers, automobiles, etc.

PRIVATE SCHOOLS

Dance recitals, judo and karate exhibitions, band recitals, etc.

Creative Use of Odds and Ends

This list is very partial and is used to illustrate some possibilities for the creative use of odds and ends. The possibilities number in the hundreds of thousands, limited only by your own imagination and inventiveness.

BOTTLES (plastic and glass)

paint containers, vases, lamps, desk sets, piggy banks, games (bowling pins and bean bags), door stops, bubble bath containers, paper weights, dolls.

BROOM HANDLES

playing pieces for games (checkers), table legs, toy wheels, handles (old tools).

BURLAP (ravelled and dyed if wanted)

foundation (for rugs, handbags, and pillows), place mats, wall hangings, colonial door mats, braiding (rugs), block printing.

CANS

vases, desk sets, pin cushions, kitchen utensils (funnel, scoop, cutter), toys, foot stools.

CARDBOARD

posters, shuttles for weaving, picture and puz-

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zle mounting, toys, waste baskets, patterns, small frames.

CARPET

ravelled and woven, doll house rugs, door mats.

CHRISTMAS AND GREETING CARDS

applique on bottles, tinware and woodenware, bead chains, flowers, jigsaw puzzles, scrapbooks, posters, decorations.

COTTON (batting)

stuffing for toys, quilts, decorations.

COTTON (cloth)

applique, dolls, aprons, slippers, rugs, quilts.

EGG SHELLS

ornaments, mosaics.

FELT

stuffed animals, applique, wall hangings, bookend silencers, backing for ceramic pieces.

FURS

slippers, doll dress trimmings, toy animals.

GLASS

tea tiles, mosaics, paint pallets.

LEATHER

book marks, hinges, containers (tobacco, knives, change), parts for toy animals.

LINOLEUM

block printing, mosaics, doll house furnishings.

MAGAZINES AND CATALOGS

resource material (questioning advertisers about films available, etc.), paper mache, scrapbooks, patterns, wastebaskets.

MARBLES

mosaics, jewelry.

NEWSPAPERS

paper mache, shakers and fly fans.

PLASTIC BAGS

Christmas wreaths, poodle dogs, weaving strips.

POOL CUES

furniture legs, curtain rollers, mallets.

SANDPAPER

clop blocks (rhythm band), match scratchers.

SPOOLS

spool animals and dolls, wheels for toys, beads, spool knitters.

STOCKINGS (nylon and cotton)

stocking animals, rugs, stuffing for toys and pillows, spool knitting.

STRING

knitting, knotting, curtain pulls, fringe, washcloths, colonial mats.

VELVET

greeting cards, box linings, pictures, doll clothes, applique, rugs.

WALLPAPER

bookbinding, covering boxes, vases (covering), lamp shades, patterns, paper mache, posters, jigsaw puzzles.

WOOL

quilts, rugs, bedsocks, animals.

WIRE

coat hangers, fly swatter stems, armature (clay sculpture), flower stems, jewelry.

WINDOW SHADES

canvas for painting scrolls, patterns, bookbinding.

WOOD

games, shuttles, bean bag boards, foot stools, bread boards, basket bases, bird cages, flower boxes, frames, toys, bookends.

Companies That Furnish Films

To obtain the names of film distributors near you, consult your Yellow Pages under Motion Picture Film Libraries and Motion Picture Film Distributors. If you are located in a rural area, simply ask an operator in the nearest large urban area to consult the Yellow Pages for you. She will be happy to perform this service.

One major source of all type films and audio-visual equipment is your own community library, nearby college library, or nearby city

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library. Your librarian, or local photographic equipment supplier also may know a community camera or movie club whose members might be willing to show and discuss some of their own films.

In addition to "regular" movies, check into industrial films. These motion pictures are produced for organizations of all types and tell stories pertinent to each organization. The possible list of subjects is as varied as man's activity has been, is, and will be in the future. Most of these films are modern, in color and available free.

Literally thousands of organizations have had films made. It might be a good project to gather information on the availability of such films. Some companies producing them are virtually all those listed on the New York and American Stock Exchanges; telephone companies, airlines, health associations such as the American Cancer Society; colleges and universities; insurance companies; museums; foreign embassies; religious organizations; nationally based civic associations and organizations; all branches of the Federal Government, such as the Public Health Service, National Medical Audiovisual Center, Communicable Disease Center, P.H.S., Atlanta, Georgia; NASA; the Atomic Energy Commission, etc.; tourist bureaus of large cities; state farm extension services; local agricultural clubs; trade associations, and, of course, your local library.

When writing to these organizations, address letters to the Public Relations Director, or the Public Information Officer. Request a listing of films available, how shipping is arranged, etc.

Equipment and Supply Companies

To obtain equipment and supplies, consult your local Yellow Pages, as well as those of nearby cities, under headings such as "Arts and Crafts Supplies," "Hardware," "Hobbies," "Lumber," and "Sporting Goods."

When purchasing, shop around. Consider availabilities of services if needed as well as price.

For lists of suppliers on a national basis, write to the following and request lists of suppliers:

American Occupational Therapy Association
251 Park Avenue South
New York, New York 10010

National Recreation and Park Association
1700 Pennsylvania Avenue, N.W.
Washington, D. C. 20006

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Appendix A

Common Health Problems Requiring Long-Term Care

Arteriosclerosis

Blood vessels are the pipes of the body's plumbing system. The heart pumps blood through the arteries to all parts of the body. Blood distributes oxygen to the body's cells. Blood is returned to the heart in veins. The arteries have thicker walls than veins and they pulsate. These arteries can be affected by a disease called arteriosclerosis. Arteriosclerosis also is known as "hardening of the arteries." It is characterized by a fatty substance in the blood sticking to the inner wall of an artery (fig. 30).

The fatty lesion on the inner wall of the artery causes a thickening of the other two layers of the artery – the middle wall and the outer wall. This causes arteries to lose their elasticity and become rigid, known as "pipe stem" arteries.

This disease can affect arteries in any part of the body. When it affects a certain part of the body or organ, the name of the affected area or organ is placed first. For example, cerebral arteriosclerosis signifies arteriosclerosis in the arteries of the brain.

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The causes of arteriosclerosis are not completely known, but it is known that smoking, overweight, diabetes, and high blood pressure make the disease proceed faster. With proper care an individual with this disease can live many years, leading an active, useful life.

An activities program, including some physical activity, can provide physical and mental stimulation. Routine activities can be helpful to the confused or forgetful individual.

Remember, any secondary problems, such as a heart condition or diabetes, etc., also must be considered before any type activity is entered into.

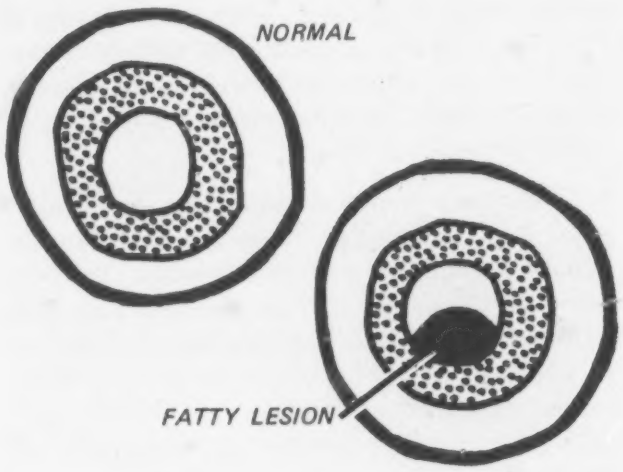

Figure 30.—Arteriosclerosis results when fatty substances build up on the inner wall of an artery.

Heart Disease

There are many different types of heart diseases, caused by many different conditions. Many of these conditions are caused by interruption or slowdown of the flow of blood to the heart, and, because the heart is the body's blood "pump," this can result in changes in the flow of blood.

Although many diseases of the heart are gradual, taking place over the years, symptoms can come on suddenly—completely unexpectedly. As Activities Supervisor you should be aware of some of the signs of heart problems. They include dizziness, unusual tiredness or fatigue, nervousness, rapid heart beating, difficult breathing, weakness, blueness of the skin, lips and fingernails, pains in the chest or the left arm, headache, urinary complications and insomnia. Many of these problems are not always caused by heart disease, but, should you note any of these symptoms, report them to the charge nurse or physician immediately.

An activities program can help heart disease victims through encouraging relaxation, mental stimulation, and, where appropriate, by encouraging the individual to adjust to his limitations. The person with a known heart condition should not participate in physically active activities, or those requiring raising the arms more than chest high, without the written approval of the attending physician.

Stroke

Stroke is also referred to as cerebral vascular accident or "C.V.A." A stroke occurs when the flow of blood to the brain is somehow interrupted.

The brain is divided into several areas. The cerebrum is the major area and it controls most of the functions of the body. In turn, the cerebrum is divided into several areas, or zones, each zone having control over a specific function of the body (fig. 31).

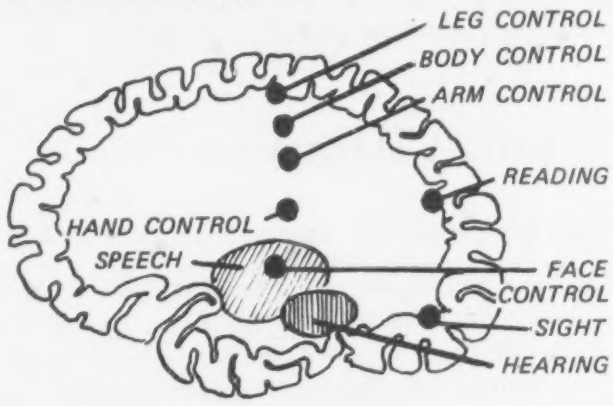

Figure 31.—Zones of the cerebrum.

If the flow of blood is interrupted to one or any number of the control zones of the cerebrum, the part of the body over which the affected area has control cannot function. The flow of blood can be interrupted by blockage, as caused by arteriosclerosis, or by a blood clot, or by a hemorrhage, where the artery breaks and the blood flows out, or by compression caused by a small tumor pressing on the outer wall of the artery causing it to close (fig. 32).

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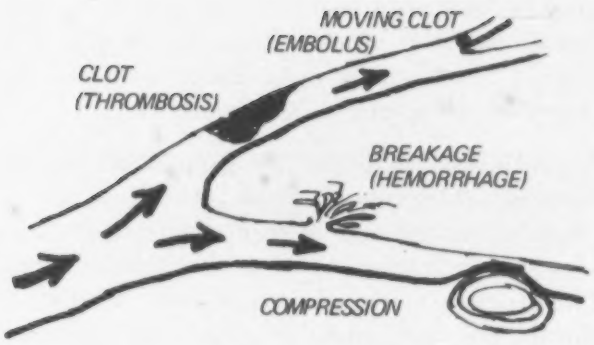

Figure 32.—If the flow of blood to a zone or zones of the cerebrum is interrupted, by blockage, breakage or compression, the part of the body controlled by that part of the cerebrum is affected.

There are many precautions that must be observed in the care of the stroke patient which can be explained to you by a physician or nurse.

An activities program can provide much for the stroke victim in the way of rehabilitation. The individual affected may feel like an outcast, and the activities program can overcome this through social interaction. Activities also will encourage speech and self-care in functions of daily living, maintain or increase strength and coordination in unaffected as well as affected areas, and increase self-confidence through mastering activities geared to abilities.

Mental Illness

Mental illnesses are "organic" or "functional."

Organic mental illness refers to mental disorders which result from physical damage to the brain, from cerebral arteriosclerosis, infection, poisons in the body such as alcohol or barbiturates, severe blows to the head, etc. Older persons, because of lowered resistance, are more likely to suffer organic mental illness than their juniors.

Functional mental illness is related to emotional problems. Frustration caused by waning physical ability, loneliness, rejection and fear of death often can create symptoms as severe as those caused by organic illness.

Response to treatment of either type of mental disorder for those 65 and older is virtually the same as for other age groups. Two-thirds may be expected to recover almost completely or to improve significantly.

Depending on the type and severity of the disorder, an activities program can prove of great value, especially in helping to direct individual tensions and energies to worthwhile accomplishments. A sense of belonging and importance can be established through effective group activity, particularly when community volunteers are involved.

Senility

Senility usually is the result of organic brain disease. The two chief chronic brain killers are cerebral arteriosclerosis, wherein hardening of the arteries in the brain prevent sufficient oxygen from reaching it, and senile brain disease, where the brain simply wastes away. In both cases, cause is unknown.

Both diseases foster memory loss and confusion. Experts disagree, however, as to the inevitable progression of the diseases. In some cases, the progress of the diseases has been halted. In addition to memory loss, individuals so afflicted tend to become irritable, lose interest in appearance, tend to live in the past, behave in childlike fashion, and eventually become incontinent.

An activities program can help those afflicted by providing group activity to help maintain the individual's awareness of others and a secure atmosphere involving pleasant activities which are simple, repetitive and possibly associated with familiar activities of the past.

Parkinson's Disease

Parkinson's Disease is not really a disease but rather a group of symptoms.

Parkinson's symptoms include a progressively worsening shaking of the hands, stiffening of the muscles, a masklike appearance of the face, and a shuffling gait when walking. Parkinson's is not contagious nor is it fatal. While it does not paralyze, it can cause muscle tissue to change through disuse.

It is important to note that Parkinson's has no effect on mental ability. A person's intellect remains sharp and clear. As a result, the indi-

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vidual with Parkinson's easily can become embarrassed through inability, drooling, etc. While embarrassment does not cause symptoms, it can aggravate them. Therefore, a victim of Parkinson's disease needs sympathetic reassurance and understanding.

There is no cure for Parkinson's Disease. In some selected cases the disease symptoms may be removed through surgery, but in most cases one must rely on physical and occupational therapy to maintain mental and physical ability at the highest possible peak.

Obviously an activities program is desirable in the rehabilitation of the victim of Parkinson's Disease. Physical activity can maintain maximum flexibility and use of all muscles. Group activities can spur social interaction and conversation. Activities which will bring a sense of self-reliance and self-respect to the afflicted individual should be encouraged.

Aphasia

Aphasia is an organic condition of the brain which can result from different forms of other brain diseases or injuries such as hemorrhage, arteriosclerosis, etc.

Aphasia results in speech disorders which can be classed as "motor aphasia" or "sensory aphasia."

Motor aphasia is characterized by the inability of the afflicted individual to express himself in words. He can understand what is said to him, but can only use gestures in reply.

Sensory aphasia is characterized by the inability of the afflicted person to understand what he can see or hear. In some cases, an individual cannot distinguish words from other sounds—all is noise without meaning. In other cases, the individual can distinguish words from other sounds, but they have no meaning—as if someone were addressing him in a completely foreign language.

Treatment for aphasia is primarily speech therapy.

An activities program can provide the afflicted person with challenges easily met and accomplished. Depending on the seriousness and type of aphasia involved, giving or demonstrating instructions is a key element in involving the individual in the activity.

Hearing Loss and Deafness

Hearing loss or deafness can result when the hearing mechanism (fig. 33) is somehow disrupted. The ability to hear is dependent on a series of functions. Basically, a noise gives off sound waves or vibrations. These vibrations beat on the ear drum. The vibrations given off by the ear drum are carried to the middle ear which is composed of three delicate bones. The bones pass the vibrations from one to the other. The third bone, the stapes (pronounced staypeez), connects to the inner ear. When the stapes vibrates, it creates waves in the fluid of the inner ear. These waves are detected by microscopic hairs which create an electrical impulse in the hearing nerve. This impulse is carried to the brain, and the brain gives the impulse meaning. An impairment in any one of these functions can cause a hearing loss, or, in some cases, total deafness. This impairment could be blockage in the auditory canal, a broken ear drum, or brain damage, among many others.

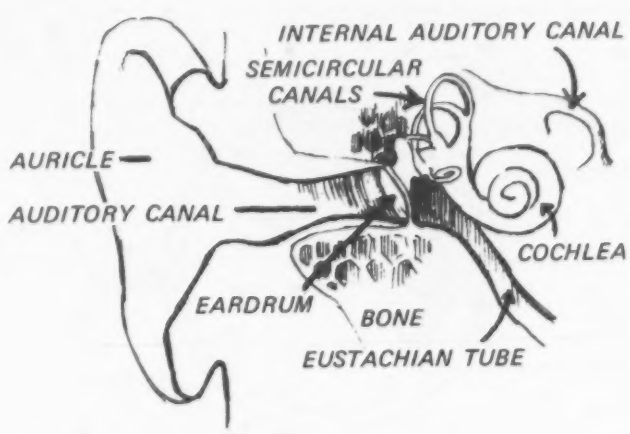

FIGURE 33.—Hearing mechanism.

Hearing loss is especially common in old age. The exact cause for this loss is unknown, although some think it is due to changes in the brain's ability to give full meaning to the electrical impulses received. Usually it involves

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less and less ability to hear higher tones. This lessening ability takes place over many years.

An activities program cannot restore hearing. Participation in activities, however, can help an individual to overcome some of the problems which are associated with hearing loss or deafness. An activities program will help the hard-of-hearing or deaf individual to socialize and accomplish worthwhile tasks which impart a sense of self-reliance and self-respect.

When speaking to such individuals, make sure that background noise is as low as possible. Speak with your face and lips facing the individual. Talk slowly and distinctly with a little pause between words and sentences. Speak slightly louder than normal and lower your voice to keep tones as low as possible. Remember—be patient and include the hard-of-hearing or deaf person in as many activities as other afflictions permit.

Blindness

About half the people who are unable to see today are 65 years of age or older. Important causes for blindness in adults are cataracts and glaucoma. A cataract is the clouding of the lens of the eye, and glaucoma is characterized by pressure of liquid in the eyeball which can crush the optic nerve (fig. 34). The specific cause for each is unknown.

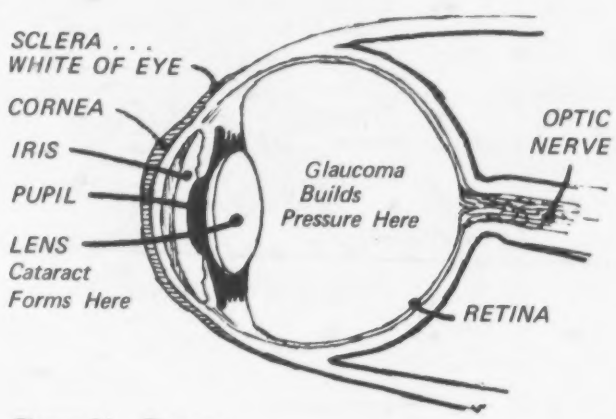

Figure 34.—The eye.

In both cases, considering modern and steadily improving surgical and other treatment techniques, there is an increasingly greater chance that vision can be restored.

For those who have been afflicted in later years and who do not have a chance for the restoration of sight, an activities program can become a major element in readjustment and rehabilitation.

Activities will be especially helpful in developing social interaction for the blind individual, and can help in the development of other senses, especially touch and hearing, which in turn can encourage self-confidence through activities that are useful and worthwhile. For help in setting up a special activities program for a blind individual, contact your local agency for the blind.

Emphysema

Emphysema is a disease of the lungs which strains the heart and, in some cases, can cause death.

In healthy breathing, lungs efficiently extract waste gas, carbon dioxide, from the blood as it circulates through blood vessels in the lungs. Then like a bellows, the lungs exchange the carbon dioxide with fresh air from which oxygen is extracted. The oxygen then is distributed throughout many air spaces in the lungs by a tree-like arrangement of tubes called the "bronchial tree." (See fig. 35.)

The tubes end as tiny "bronchioles" that feed elastic, bulb-shaped air sacs called "alevioli." Healthy bronchioles and alevioli have elastic properties that allow them to expand or contract giving the lungs the bellows effect.

Covering all passageways from the nose to the lungs is a thin mucous blanket. Beneath the mucous blanket are microscopic hairs called cilia which are constantly in motion. Together the mucous and cilia protect the tissue of the lungs by propelling foreign matter (dust, pollen, etc.) to the throat where it is removed by "clearing the throat."

Emphysema, for causes unknown, penetrates the mucous layer and destroys the cilia. Walls of the alevioli are destroyed creating large, inefficient air spaces. It is more difficult to remove waste gasses, and more difficult to bring in fresh oxygen. As a result, the heart has to work harder to pump oxygen-poor blood

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through the system. Without adequate treatment, death may result from suffocation and an overworked heart. It is believed that cigarette smoking has much to do with emphysema.

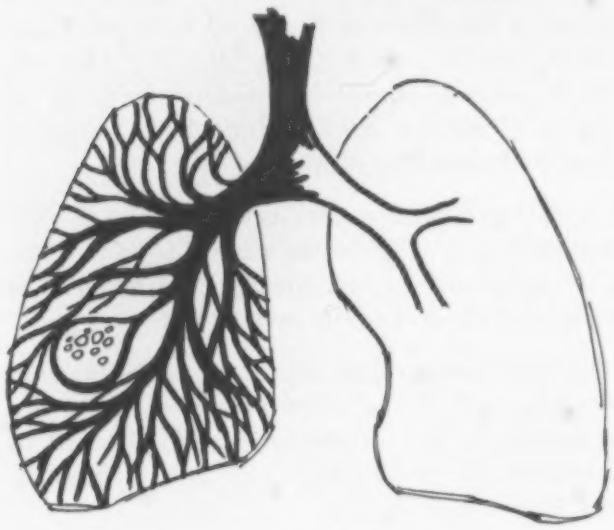

FIGURE 35.—Lungs and bronchial tree.

Because it is likely that emphysema will accompany some other affliction, activities should be devised which meet requirements of the prime affliction and also avoid any undue strain on the heart or any type of overexertion. Also to be avoided are dust, smoke, insecticides or any other type chemical irritant.

Diabetes

Diabetes is a condition in which the body does not produce enough insulin to use properly the sugar contained in food which is eaten. As a result, extra sugar collects in the blood.

The cause for diabetes is unknown. There is no cure. Treatment consists primarily of providing insulin to the afflicted individual. This treatment can keep diabetes under control indefinitely, allowing the diabetic person to live an active, normal life.

As Activities Supervisor, you should be aware of some of the problems associated with diabetes which can attack an individual suddenly and without warning. If the sugar in the blood becomes too low, an insulin reaction may occur. Symptoms of insulin reaction are impatience and crankiness, headache, sweating, trembling and hunger.

If the sugar level in the blood becomes too high, there is danger of diabetic coma. Symptoms of approaching coma are increased thirst and dry mouth, dry skin and flushed face, nausea, vomiting and drowsiness. In case any of the symptoms are observed, the nurse should be called immediately. Bear in mind that in some cases a diabetic may have sensory damage and the sense of touch (heat and cold) may be lost or impaired.

Unless otherwise specified by physician, the individual afflicted with diabetes can participate in activities not limited by any other afflictions. It is imperative that those activities involving physical effort be checked first with a physician or nurse, however, as the amount of energy expended affects the body's use of sugar.

Multiple Sclerosis

Multiple sclerosis (MS) is a disease of the central nervous system characterized by patches of degeneration in the brain and spinal cord. Typically, MS strikes men and women in the 20-40 age bracket. Depending on the frequency and severity of attacks, stricken individuals may live for as long as 25 years after the first attack. There is, as yet, no cure. The cause of MS is unknown.

Some of the most noticeable MS symptoms are uncontrolled rolling movements of the eyeballs, uncontrolled sudden emotions, incoordination, stiffness of the lower extremeties, short attention span and incontinency. MS may strike suddenly, disappear then strike again more violently.

Efforts in rehabilitation primarily are directed toward preservation of as much muscle tone and control and mental alertness as possible. Much of this is carried out through planned programs of physical and occupational therapy.

An activities program for the person with MS usually is carried out in consultation with therapists. Chief goals of an activities program are social interaction, as many MS victims tend to suffer from depression, as well as encouraging maximum use of and retention of physical and mental dexterity.

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Osteoporosis

Osteoporosis is a disorder affecting middle aged and aged persons which causes a gradual decrease in the amount and strength of bone tissue. Osteoporotic individuals experience a gradual "thinning out" of bones which become less dense, or more porous, tending to lose their normal strength (fig. 36).

It is believed that osteoporosis in old age is caused by the decreased activity of glands producing hormones. Through life, human bones renew themselves. Old bone is continually absorbed by the body and new bone produced to replace it. Slowed hormone production slows the ability to produce new bone, hence there is a process of deterioration without renewal. It also is felt that insufficient intake of calcium in food and drink over long periods of years may cause osteoporosis, since the body is dependent on the intake of calcium for production of new bone.

FIGURE 36.—Normal bone and one with osteoporosis.

Current treatment for osteoporosis includes the prescription of medications containing hormones as well as diets which are rich in calcium.

An activities program for an individual with osteoporosis should avoid requiring an individual to stand for long periods. The risk of accident with any heavy object also should be avoided, as well as the lifting of any relatively heavy object even in routine activities.

Fractured Hip

The term "fractured hip," as used regarding the aged, usually means that the femur, or long bone in the thigh is fractured where it is attached to the pelvis or hip (fig. 37). The two most common places for the fracture to occur are at either the neck or top of the femur or slightly below that point.

Often the fracture occurs as a result of a general weakening of the bones called osteoporosis. The bones of the hip simply cannot bear the weight of the rest of the body.

The cure for a broken hip in the aged involves surgery—either the insertion of a metal pin between the top of the femur and the rest of the bone, or the placing of an artificial top on the femur. (See fig. 38.)

Activities can help an individual overcome problems of daily living, either on a temporary basis until recovery is completed, or on a permanent basis if surgery is not attempted. Activities can restore a sense of self-confidence and self-reliance.

FIGURE 37.—Types of hip fractures.

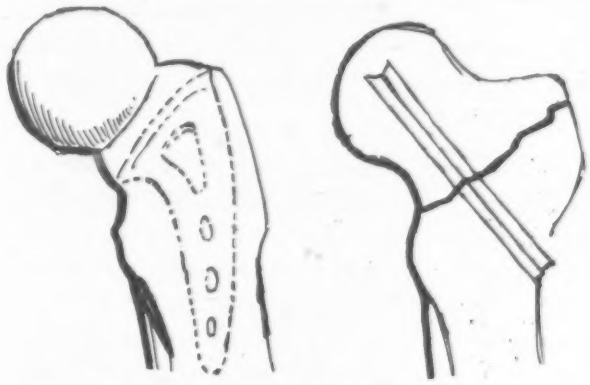

FIGURE 38.—Repairs of hip fractures.

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Appendix B Suggested Reading

The following lists of books and periodicals represent some of the many works that are of value to your program. Those books marked by an asterisk (*) should be purchased for permanent reference.

General Information

AMERICAN STANDARD SPECIFICATIONS FOR MAKING BUILDINGS AND FACILITIES ACCESSIBLE TO, AND USABLE BY, THE PHYSICALLY HANDICAPPED, American Standards Association, Inc., National Society for Crippled Children and Adults, Inc., 2023 West Ogden Ave., Chicago, Illinois, 1961.

*BRAILLE BOOKS FROM LIBRARY OF CONGRESS, Division for the Blind and Physically Handicapped, 1291 Taylor St., N.W., Washington, D. C. 20011.

COMMUNITY RELATIONS HANDBOOK, Hoffman, Charles, American Nursing Home Association, Washington, D. C., 1970.

CONDUCTING WORKSHOPS AND INSTITUTES, Adult Education Association of the USA, P9, 1225 19th St., N.W., Washington, D. C. 20036.

*CURRENT LITERATURE ON AGING, National Council on the Aging, 315 Park Ave. South, New York, New York 10010.

*CYCLOPEDIC MEDICAL DICTIONARY, Taber, Clarence W., ed., Davis Publishing Co., 1965.

EDUCATION FOR AGING, Adult Education Association of the USA, P17, 1225 19th St., N.W., Washington, D. C. 20036.

EFFECTIVE PUBLIC RELATIONS, Adult Education Association of the USA, P13, 1225 19th St., N.W., Washington, D. C. 20036.

*FIRE AND SAFETY CODE FOR YOUR STATE, Appropriate state agency.

*GUIDE TO . . . BOOKS ON RECREATION, A, National Recreation & Park Association, 1700 Pennsylvania Ave., N.W., Washington, D. C. 20036.

HOW TO USE ROLE PLAYING, Adult Education Association of the USA, P6, 1225 19th St., N.W., Washington, D. C. 20036.

HOW TO WORK WITH OLDER PEOPLE, Vickery, Florence E., Division of Recreation, Dept. of Natural Resources, State of California, Publication No. 59-3, 1960.

*LICENSING CODE FOR YOUR STATE, Appropriate state agency.

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PRESS RELATIONS HANDBOOK, Hoffman, Charles, American Nursing Home Association, Washington, D. C., 1967.

WHEELCHAIR SELECTION: MORE THAN CHOOSING A CHAIR WITH WHEELS, Fahland, Beverly and Grendahl, Rehabilitation Publication No. 713, American Rehabilitation Foundation, 1800 Chicago Ave., Minneapolis, Minnesota 55404.

General Periodicals

AGING, U. S. Dept. of Health, Education and Welfare, Special Staff on Aging, Supt. of Documents, U. S. Govt. Print. Office, Washington, D. C. $1.00 per year.

GERIATRIC FOCUS, Knoll Pharmaceutical Company, Orange, New Jersey.

MODERN MATURITY, AARP Membership Dept. 406 East Grand Ave., Ojai, California 93023.

NURSING HOMES, Professional Publications, Inc., 4015 West 65th St., Minneapolis, Minnesota 55435.

Activity Programming

ACTIVITIES FOR THE AGED AND INFIRM, A HANDBOOK FOR THE UNTRAINED WORKER, Merrill, Toni, M.A., Charles C. Thomas, Springfield, Illinois, 1967.

GROUP WORK WITH THE AGED, Kubie, Susan, International University Press, New York, New York, 1953.

GUIDE TO PLANNING AND EQUIPPING A HANDICRAFT FACILITY FOR A NURSING HOME, Bengson, Evelyn, O.T.R., Rehabilitation Education Service Unit, State Dept. of Health, Olympia, Washington.

*HOW TO TEACH ADULTS, Adult Education Association of the USA, P5, 1225 19th St., N.W., Washington, D. C. 20036, 1955.

LEADER'S GUIDE TO NATURE-ORIENTED ACTIVITIES, Van der Smissen, Betty and Goering, Oswald H., National Recreation and Park Association.[1]

OCCUPATIONAL THERAPY ASSISTANTS PROGRAM, Wisconsin State Board of Health, P.O. Box 309, Madison, Wisconsin 53701.

PHYSICAL REHABILITATION FOR DAILY LIVING, Buchwald, Edith, McGraw-Hill Publishing Company, New York, New York, 1963.

PLANNING AREAS AND FACILITIES FOR HEALTH, PHYSICAL EDUCATION AND RECREATION, Participants in National Facilities Conference, The Athletic Institute.

PLANNING BETTER PROGRAMS, Adult Education Association of the USA, P2, 1225 19th St., N.W., Washington, D. C. 20036.

TIPS—HANDBOOK, National Association of Manufacturers, 277 Park Ave., New York, New York 10017.

TRAINING GROUP LEADERS, Adult Education Association of the USA, P8, 1225 19th St., N.W., Washington, D. C. 20036.

*UNDERSTANDING HOW GROUPS WORK, Adult Education Association of the USA, P4, 1225 19th St., N.W., Washington, D. C. 20036.

Crafts

ADVENTURES IN THE ARTS, National Recreation and Park Association, National Therapeutic Recreation Society, National Institute of Education.[1]

ART OF CREATIVE KNOTTING, THE, Harvey, Virginia I., Reinhold Book Corporation.[1]

ART OF FLOWER PRESENTATION, THE, Condon, G., Lane Magazine and Book Publishing Company, Menlo Park, California, 1962.

*AT YOUR FINGERTIPS, Colorado Occupational Therapy Association, Smith-Brooks Printing Company, 2130 Wilton St., Denver, Colorado, Rev. 1954.

BEGINNERS BOOK OF OIL PAINTING, THE, Hill, Adrian, Emerson Books, Inc., Publishers.[1]

CLAY, WOOD AND WIRE, Weiss, Harvey, William R. Scott Inc., New York, New York.

COLLECT, PRINT AND PAINT FROM NATURE, Albert Whitman & Company.[1]

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CONSTANTINE'S CATALOGUE AND MANUAL FOR WOODWORKERS, Constantine Company, 2050 Eastchester Rd., Bronx, New York 10461.

CREATING WITH CORRUGATED PAPER, Hartung, R., Reinhold Book Corporation.

CREATIVE CLAY DESIGN, Rottger, F., Reinhold Book Corporation.

CREATIVE CRAFTS FOR EVERYONE, Turner, G. Allan, Viking Press Inc., Publishers.[1]

CREATIVE DRAWING (LINE AND DOT), Rottger and Klante, Reinhold Book Corporation.

CREATIVE HANDBOOK IDEAS, Ellis, Mary Jackson, T. S. Denison & Son Inc.[1]

CREATIVE PAPER DESIGN, Rottger, E., Reinhold Book Corporation.

CREATIVE TEXTILE DESIGN (THREAD & FABRIC), Hartung, R., Reinhold Book Corporation.

CREATIVE WOOD DESIGN, Rottger, E., Reinhold Book Corporation.

DECORATING WITH PODS & CONES, Van Rensselaer, Eleanor D., Van Nostrand Company, Inc.[1]

*DECORATIVE STITCHERY, May, Marian, Lane Magazine & Book Company, Menlo Park, California, 1965.

*DENNISON PAPER ARTS AND CRAFTS, Dennison Manufacturing Company, Framingham, Massachusetts.

DOLL HOUSE, THE, Warrell, Estelle Ansley, D. Van Nostrand Company, Inc.[1]

GENERAL LEATHER CRAFTS, Cherry, Raymond, McKnight & McKnight Publishing Company.[1]

GIFTS YOU CAN MAKE, Lane Magazine & Book Company, Menlo Park, California, 1965.

HANDCRAFT WITH DENNISON CREPE PAPER, Dennison Manufacturing Company, Framingham, Massachusetts, 1951.

HANDICRAFT SIMPLIFIED, Anon, Martha Ruth and Rawson, Ruth, McKnight & McKnight, Bloomington, Illinois.

*HANDMADE RUGS, Aller, Doris, Lane Publishing Company, Menlo Park, California.

HANDY CRAFTS FROM SCRAPS, Howie, Olive, T.S. Denison & Son Inc.[1]

HOW TO MAKE COLLAGES, Lynch, John, Viking Press, Inc., Publishers.[1]

HOW TO MAKE MOBILES, Lynch, John, Viking Press, Inc., Publishers.[1]

HOW TO MAKE POTTERY AND CERAMIC SCULPTURE, Sander, Herbert H., Lane Magazine and Book Company, Menlo Park, California, 1964.

HOW TO USE HAND AND POWER TOOLS, Daniels, George, Harper & Row, Publishers, Inc.[1]

JEWELRY MAKING FOR FUN AND PROFIT, Clagg, Helen and Larow, Mary, David McKay Company, Inc., New York, New York, 1961.

JEWELRY MAKING FOR THE BEGINNING CRAFTSMAN, Pack, Greta, D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, New Jersey 08540.

*LEARN HOW BOOK, Coats and Clark's Sales Corporation, 430 Park Ave., New York, New York 10022, Book No. 170-B, Rev.

LEATHER CRAFT, Aller, Doris, Lane Publishing Company, Menlo Park, California.

McCALL'S NEEDLEWORK TREASURY, Random House, 1964.

MAKING POTTERY WITHOUT A WHEEL: TEXTURE AND FORM IN CLAY, Ball, F. Carlton and Lavoos, Janice, Reinhold Book Corporation.[1]

MODERN ART OF CANDLE CREATING, Olien, Don & Ray, A. S. Barnes & Company, Inc.[1]

MORE TO COLLECT, PRINT AND PAINT FROM NATURE, Albert Whitman & Company.[1]

MORE CREATIVE TEXTILE DESIGN (COLOR & TEXTURE), Hartung, E., Reinhold Book Corporation.

*MOSAICS, Aller, Doris and Diane Lee, Lane Magazine and Book Company, Menlo Park, California, 1959.

MOSAICS AND MOS-AIDS, Pacific Arts and Crafts, P.O. Box 2101, Inglewood, California 90305.

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MOSAIC TECHNIQUES, Stribling, Mary Lou, Crown Publishers Inc.[1]

PAINT NOW, LEARN LATER, Williams, Guy R.[1]

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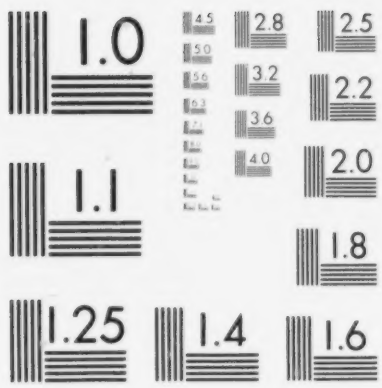

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VT 012 260
Vocational Programs in Home Economics.

Northern Illinois Univ., DeKalb. Dept. of Home Economics.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 70 365p.Report of a Workshop (Northern Illinois Univ., DeKalb, Jul. 20-31, 1970).

DESCRIPTORS - *OCCUPATIONAL HOME ECONOMICS; *WORKSHOPS; *INSTRUCTIONAL MATERIALS; EDUCATIONAL PROGRAMS; PROGRAM DEVELOPMENT; COOPERATIVE PROGRAMS; WORK STUDY PROGRAMS; ADVISORY COMMITTEES; *RESOURCE UNITS; CHILD CARE OCCUPATIONS; FOOD SERVICE OCCUPATIONS; HOME FURNISHINGS; SERVICE OCCUPATIONS; SECONDARY GRADES

ABSTRACT - A 12-day workshop attended by 37 participants focused on the establishment and development of vocational home economics programs, including cooperative and work-study programs, at the junior and senior high school level. Materials were developed for school administrator use in developing programs and for teacher use in planning and conducting programs. Projects resulting from the workshop and provided in this document are: (1) Initiating a Cooperative Vocational Home Economics Program in a Small School, (2) The Advisory Committee, a description of the formation, selection of membership, and functions of the committee, (3) Being a Better Friend and Employee, a 3-week teaching unit for an introductory course to vocational home economics at the eighth grade level, and (4) several resource units for wage earning programs in child care, clothing, foods, home furnishings, personal services, and home economics related occupations. (SB)

VT 012 260

Vocational Programs

in

Home Economics

Sponsored by

Northern Illinois University

DeKalb, Illinois

July 20-31, 1970

Workshop Director: Dr. Miriam Louise Smith
Assistant Professor
of Home Economics Education
Northern Illinois University

Guest Speakers: Mrs. Marian Baker, Sycamore High School
Home Economics Teacher and Coordinator
of Cooperative Work Experience in Home
Economics

Miss June Bergquist, Adlai Stevenson
High School Home Economics Teacher
and Coordinator of Cooperative Work
Experience in Home Economics

Mr. Kenneth C. Brumm, Superintendent
of Kaneland School District #302,
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Business Education Department

Mr. Lonnie M. Hart, Professional and
Curriculum Development Unit,
Division of Vocational and Technical
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Mr. Peter Johnson, Sycamore High School Principal and Director of Cooperative Vocational Programs

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Vicki Finch, graduate assistant, for her help in assembling the bibliography and the publications for use during the workshop and for assistance in recording speeches and making luncheon arrangements.

Pam Micheletti and Penny Conger for competent help in securing materials for the workshop and typing and assembling this booklet.

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WORKSHOP

VOCATIONAL PROGRAMS IN HOME ECONOMICS

The workshop focused on the establishment and development of vocational programs in home economics including cooperative and work-study. Legislation affecting occupational education was reviewed. Participants became aware of services and publications of the state department and national agencies, as well as university and other resources.

Speakers furnished basic information on the structure of vocational education today and gave examples of functioning occupational programs in Illinois. Other learning experiences included visitation of the Mid-Valley Area Vocational Center at Kaneville, Illinois and a lecture demonstration by Dr. Robert Hoppocks on occupational guidance and counseling.

Miriam Louise Smith - Director

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Workshop Projects Included In This Booklet

I. "Initiating a Cooperative Vocational Home Economics Program in a Small School"
Nancy Bridgman
Judy Bowers
Ione Meissen
Candice McLean
Elaine Todd

II. "The Advisory Committee"
Betty Schindel

III. "Introduction to Home Economics - Eighth Grade - A teaching unit titled - Being a Better Friend and Employee"
Carol Rehfuss
Murriel Riedesel

IV. Resource Units for Wage-Earning Programs in Home Economics

A. Child Care

1. "Child Care Occupations: Classroom" (length - 1 year)
Doris O'Hara

2. "Job Oriented Child Care" (length - 1 semester)
Jacqulyn J. Albright
Mary Alice Husfeldt

3. "Child Care Aide - DeKalb Senior High School"
Karen Radde

4. "Curriculum Resource List for Child Care Occupations"
Tranetta McComb

B. Clothing

"Curriculum Guide for Occupational Orientation Course in Clothing Construction."
Patricia Gasparini

C. Foods

1. "Occupational Orientation Food Service Course Outline"
Barbara Mowers
Lou Ann Hinton
Mary Lee Frank

2. "Plans for an Orientation Course Entitled, I Home Economics Occupations for Evanston Township High School"
Ruth Wheeler

D. Home Furnishings

1. "Work Orientation Survey Unit Related to Housing, Home Furnishings, and Equipment."
Nancy Davis

2. "Some Suggestions for Establishing a Cooperative Gainful Employment Program in the Area of Home Furnishings"
Jane Prokop

E. Personal Services

"Preparation For a Pre-Vocational Course in Personal Service-Hospital and Nursing Aide"
Marjorie Hall
Betty Ottwell

F. Home Economics Related Occupations

1. "Survey of Potential Employment and Training Needs"
Tranetta McComb

2. "General Course Outline of Related Classroom Instruction"
Mary Martzke
Sandrya Link

3. "An Outline For Job Analysis"
Tranetta McComb

INITIATING A COOPERATIVE VOCATIONAL HOME ECONOMICS PROGRAM in a SMALL SCHOOL

Judy Bowers
Nancy Bridgman
Candy McLean
Ione Meissen
Elaine Todd

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I.

PHILOSOPHY

Congress has challenged vocational education to emphasize new job program and concepts such as the "cluster concept," where you teach the child several related skills so that he will not be tied down later to one job.[1]

Congress also challenged home economics to get into the new area of training for the dual role of homemaking and wage earning. Traditionally, home economics has been challenged to train people for homemaking, but now it is being called upon also to train people for jobs.[1]

With these challenges in mind, home economics programs should revise their curriculums to meet the need of the dual role and better prepare the individual for the changes in our society.

Source:

[1]Jennings, John F., "Legislation Affecting Auxiliary Personnel" Journal of Home Economics, Vol. 62, No. 2, February 1970. p. 95.

II.

RATIONALE

Many youths do not obtain education beyond high school; thereby making it necessary that the high school must provide a comprehensive program consisting of a general program, a college-entrance program, and a vocational entrance program. It is in the latter area that many high school curricular programs fall far short and this is especially true in the small school.[1]

One of the continuing functions of leadership in programs of vocational education is the planning function. Without successful planning a program drifts into a state of ad hoc decison making without recognized goals or purposes, and neither the community nor the staff will find such a process satisfactory. It is not possible to maintain staff morale or a sense of direction in an enterprise which appears to be governed by expendiency, or which seems to be out of touch with the realities of the world of work. Lack of planning usually results in a status quo program which becomes more and more inadequate as time goes on, and may eventually have to be completely reorganized.[2]

Sources:

[1]Griessman, Eugene B., Densley, Kenneth G., Vocational Education in Rural Areas, ERIC Clearinghouse, The Center for Vocational and Technical Education, The Ohio State University, 1900 Kenny Road, Columbus, Ohio 43210, p. 50.

[2]Organization and Operation of a Local Program of Vocational Education, U. S. Dept. of Health, Education, and Welfare/Office of Education, Instructional Materials Laboratory, Trade and Industrial Education, The Ohio State University, 1885 Neil Avenue, Columbus, Ohio 43210, p. 21.

High school vocational curricular offerings are limited and have received little attention. In this paper we have tried to tie together the need of the small school with the necessity of good planning to provide a basis which will encourage more small schools to expand their offerings.

III.

OBJECTIVES FOR GROUP PROJECT

A. To prepare the basis for a program that meets the needs of the student at present and prepares him for the future.

B. To establish an outline for the formation of an advisory committee which will be a vital part of the total program.

C. To formulate a plan to involve and interest the community in the establishment of the program.

D. To devise a list of the people needed to be informed about the program and methods of doing so.

E. To make guidelines for student selection that places the student with the needs in the program.

F. To make guidelines for training stations that will give the most educational value to the program.

G. To suggest a schedule of activities for planning and establishing a cooperative vocational educational program.

IV. VALUES AND GOALS - HOW TO APPROACH THEM:

In introducing students to the values and goals of finding a job or occupation that they will enjoy, I would begin by giving them a background in our changing economy. I would emphasize, also, future changes that they can expect.

A. Recent changes in our economy since World War II.
   1. Urbanization
   2. Improved living standards
   3. Changing Patterns of consumption
   4. New products and new processes
   5. Changing patterns of employment - automation
   6. more leisure time

B. How do these changes affect YOU as a student and future homemaker?
   (These are some of the important things to bring out)

We can certainly expect many changes in the future and with the changes will come new problems to be solved. An increasing population and growing urbanization will present us with problems of city planning. Highly technical consumer products that make our lives more pleasant may also make our lives a bit more harried if we cannot repair them ourselves and if there are not enough skilled servicemen to care for them. What will Americans do with their increased wealth and leisure time? Will they use them to enrich their lives? We can certainly expect dislocation of labor in the future, but we can also expect that new job opportunities will develop to satisfy the new needs and wants of a changing society. These new jobs, however, will be for the adept; they will be for those who prepare now.

Here are three important things that YOU as a student can do now to prepare your self to cope with these changes.
   1. Invest in yourself
   2. Invest in your education
   3. Invest in your leisure time

It is ~~good for~~ imperative that Home Economists ~~to~~ bring in the consumer area when discussing future goals. ~~One of the better books to use is~~ Suggested References: CONSUMER ECONOMICS by Wilhelms, Heimerl and Jelley, published by McGraw-Hill Book Company. This book also has some basic budgeting problems and offers a beginning understanding in the area of money management.

C. The key to the future.

VOCATIONAL

SELECTION

You now hold the key to your future in your hand. Let js look at what this means. If you will examine it closely, you will see that there are little bumps and valleys that are used to unlock the lock. In your life, we may interpret these peaks as abilities that you have. No two persons have the same degrees of abilities in the same areas. Also, everyone has certain valleys, or disabilities and things that he cannot do as well as other people.

Now to find the key for you to unlock your future, we find that in life there are many vocational and occupational choices. Each of these occupations is different in some respect from the one next to it, and requires certain abilities. If an individual is to be well adjusted, he must fit the requirements of the job just as the key has the proper tumblers in the lock. When the peaks and valleys meet the same pattern in the lock, we can unlock the future and a success is assured.

To go just a step futher, it is not necessary for the key to have high peaks throughout in order to fit a specific lock or occupation, nor will certain disabilities prevent a person from entering an occupation. Some jobs require a lot of one thing - but require a small amount of what we now consider "abstract" intelligence.

It is up to each individual to evaluate his own peaks and valleys and match these peaks with requirements necessary to preform a specific job.

This drawing and the ideas are found in PSYCHOLOGY FOR BETTER LIVING by Lyle Tussing, published by John Wiley & Sons, Inc., New York.

D. Relationship between goals, values and standards.
The student needs to be aware of these three words and what they mean to him/her in relation to job selection. First of all Values is the key as the other two stem from your values. Values are generalized concepts which are important to the individual such as happiness of health. The term Goal - a more specific - is it signifies something definite toward which one works. A standard in its most general sense defines as something used as a basis of comparison.

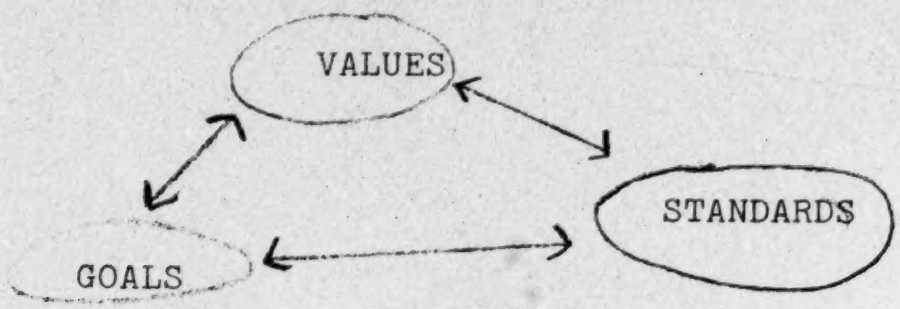

E. Some values necessary to win the job and be successful there.
1. Proper grooming for work
2. Proper dress for work
3. Job etiquette in a business manner
4. Promptness in everything
5. Relationship with enployeer and fellow employees
6. Maintaining personal health
7. GOOD ADDITUDE TOWARD WORK CRITICISM
8. What is meant by job ethics
9. Awareness of self evaluation and how to correct self
10. What decision making involves
11. What an interview consists of doing
12. How to apply for a job
13. An awareness of characteristics that are developed through job experience
14. Awareness of personal abilities, interests and motivation
15. Possibilities for advancement
16. A desire to be dedicated to a chosen job or profession
17. Knowing how to deal with self tensions in work

MANAGEMENT FOR MODERN FAMILIES by Gross and Crandall, published by Appleton-Century, New York, has information that is useful in discussing these values.

F. Ways that students can learn more about jobs.
It is important for students to value having a job that they will enjoy and will be happy doing. By looking into some of the following suggestions, students may approach a vocation with more assurance.

1. By doing a job description
2. By describing some good and bad experiences in jobs that she is familiar with either by her own experience or by the experience of someone she knows.
3. By demonstrating a skill that is necessary for a certain job.
4. By writing a description of a good worker for her job description.
5. By doing a work simplification project related to job.
6. By doing role-playing of the work situation.
7. By having someone from this area of work being investigated in to talk with the class.
8. By visiting a job situation and observing what a worker does in a typical day.
9. By seeing slides or a film of jobs.

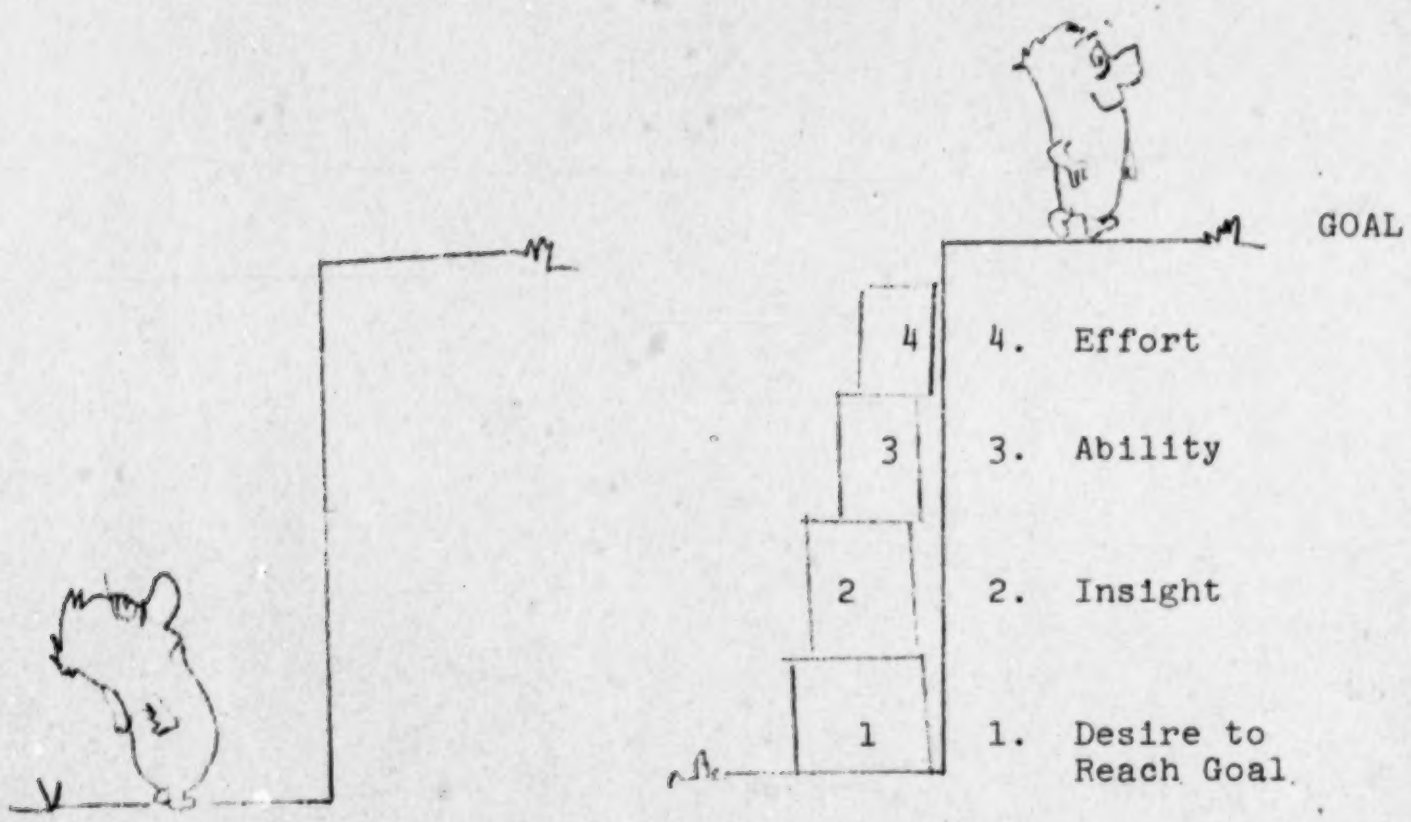

ILLUSTRATIONS THAT CAN BE REPRODUCED FOR A VISUAL AID

WHAT JOB ARE YOU QUALIFIED FOR?

DO YOU HAVE MECHANICAL ABILITY?

DO YOU FIND TROUBLE IN DECIDING WHICH DIRECTION TO GO?

TALK WITH SOMEONE WHO IS WORKING IN THE AREA YOU ARE CONSIDERING.

DRAWINGS TAKEN FROM PSYCHOLOGY FOR BETTER LIVING by Lyle Tussing, John Wiley & Sons, Inc., New York

READ CURRENT
INFORMATION ABOUT
CAREERS

INVESTIGATE ALL ASPECTS OF CAREER

THE FINAL DECISION IS YOURS.
PARENTS SHOULD HAVE CONFIDENCE
IN YOUR DECISION.

WHAT WILL BE YOUR REAL REASON FOR
TAKING A JOB?

1. MONEY?

2. HIGHER
SOCIAL
LEVEL

VI. The Community

A. Surveying the Community Needs fore Vocational Program

1. Survey the community for youth's needs for future employment

2. Survey the community for job or resource places for employment in the community

B. Getting the Community Interested

1. Form a committe of interested and hopefully informed people to get together for the purpose of stimulating community interest.

2. Talk to influential people and community leaders. Show them the survey findings and ask for their ideas for providing the needs. Also enlist their help for getting the community interested and invovled.

3. Discuss survey results and possible plans with the School Board and school administers. The working committee will need their approval and support.

4. Have a special school faculty and staff meeting to inform them of the student's needs and future plans. Many of these people will want to help create interest and support in the community.

5. Conduct a meeting with all the extra curricular activities presidents. Tell them about the possible program and find out them interests.

6. Provide a member of the working committee to talk to each school club about the new program and what it will mean to them. If the high school student, who the program is primarily designed for, wants the vocational program, he can be persuasive in convincing adults. The teenagers will talk about it at home. Then the adults will begin discussing it with each other.

C. How to Convince the Community That They Need a Vocational Program

1. At PTA, adult and youth church functions, and clubs and organizations such as Rotary, Lions, etc, have a committe member tell about the survey results and how the vocational program can meet these needs. Point out how everyone is needed to make the program successful.

2. Advertise with radio announcements and posters in downtown windos about the community needs, vocational programs and its benefits.

3. Publicize and have a general meeting for all these concerned and interested in the vocational program.

4. In presenting the proposal, be well supported with facts. The plan should show the rationale that underlines the program, the structure of the program, phases of development, evaluation of the program, costs and benefits it offers to the high school students, businesses and the community.

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United States Department of Health, Education, and Welfare, Wilbur J. Cohen, Secretary. Organization and Operation Of aLocal Program of Vocational Education, 1968.

VII. PUBLIC RELATIONS

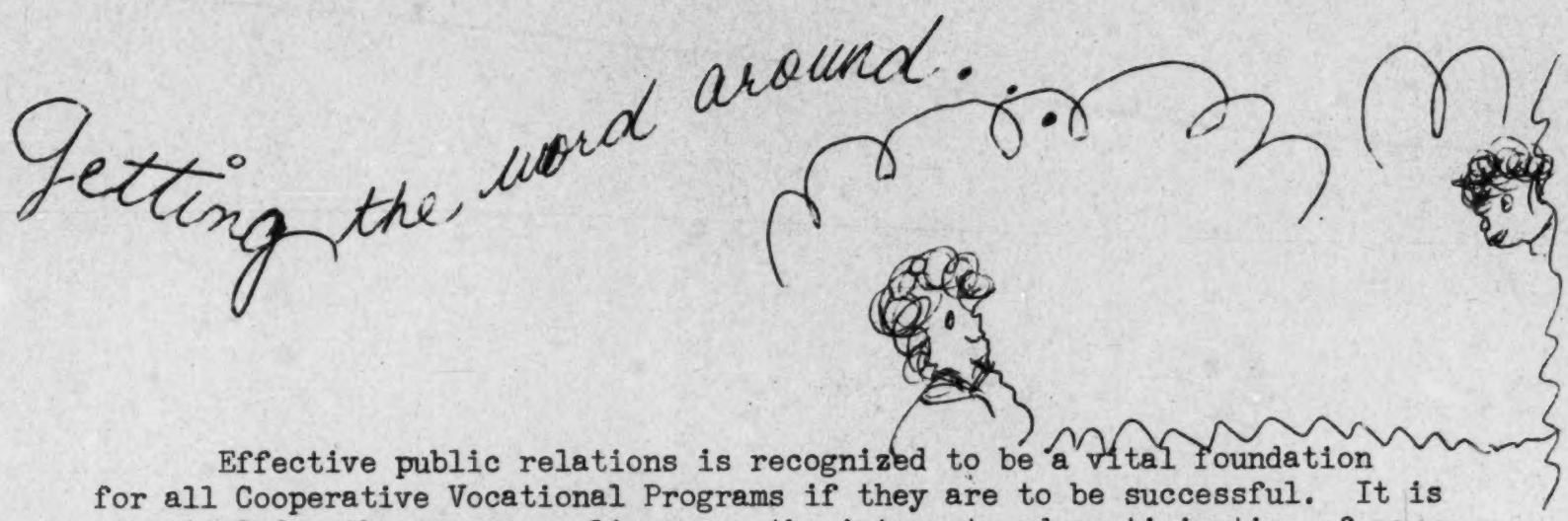

Effective public relations is recognized to be a vital foundation for all Cooperative Vocational Programs if they are to be successful. It is essential for the program relies upon the interest and participation of many groups of people within a community.

Program purposes, benefits, objectives, policies, procedures, and activities should be communicated to a wide variety of audiences through various media. In order to produce desired results, the publicity must take into account the concerns of the audiences to be reached and the media and methods which will best convey the message to them.

It would appear that, in a rural community, the word would "get around" easily, but publicity done haphazardly could very well lead to inadequate or misinformation. Also, an understanding of the total plan will help those we're seeking to involve to recognized their part in the program, and make it less likely that they will expect it all to "roll" the first year in operation but will require their continued support to succeed.

From the onset the school administrator will be eager to help formulate the local vocational plan. He, and the school board to whom he is accountable, should be aware of the proposed program change before any feasibility studies are made, either those assessing the needs of the students who will be involved or the manpower needs of the community. After the ground work has been done and the program begins to take shape, the coordinator should present it to the school administrator and the board with the help of information collected by an advisory council in regard to need, objectives, immediate and long-range plans, and expected outcomes. As the new endeavor progresses, the administrator will be interested in the development and may appreciate an offer to observe it in operation in the classroom or at the training stations. It is essential that he learn what problems the program faces and what assistance is needed in order to make it function.

Reports to the administrator and the school board must be prepared carefully so that valuable conference time is used to the best advantage. A Cooperative Vocational Program is a real challenge to a small community, and it will be a "feather in the administrator's cap" if it is successful. It will not be difficult to gain his support. Keep him informed and value his guidance.

The total school faculty must be "in the know" in regard to the vocational program, not just those who operate closest to the departments involved. In a small school many of the faculty members will be needed to lend their special talents in one way or another. Team teaching may very well may very well strengthen the classroom instruction offered in the program. Special or remedial help needed in specific areas of learning will involve some faculty members. We may even find our training stations within the school, teaching students in the skills and attitudes necessary to become teacher or child care aides or food service personnel.

The school guidance counselor is a key figure in the initiation and continued operation of any vocational program. It is through him that much of our students' needs and interests can be acquired. He must know the objectives, the policies, the sequential set-up, and the course requirements in order to acquaint students and their parents with what they may gain from choosing the route of the cooperative program as they may go through high school. The counselor may also make available up-to-date career information and see that he is available to discuss it with interested students.

The school nurse may be a valuable resource person in the areas of health occupations, child care, and aid to the elderly. In a small school, where field trips to hospitals, clinics, nursing homes, or child care centers may not be advisable or possible, the school nurse may be a real asset for specific instruction and guidance.

All students in the school should have the opportunity to learn about the program and what it has to offer them. Publicity offered to teenagers must appeal to their interests and their goals. It should be presented to them in a manner which will gain their attention and thoughtful consideration. Peer-group opinion is a critical factor in the way the program is perceived by students. Satisfied and successful cooperative education graduates are the one best advertisement the program can have. Suggested approaches to students are given on a chart following this article.

Parents have considerable influence in the students' choices of courses and their educational plans. They are frequently uninformed of the opportunities in cooperative vocational education for their adolescents, or they may be misinformed about its purposes and values. Their most common misconception is that sutdents who enroll in the "coop" program cannot meet college entrance requirements. Parents not only want their children to have a good education, but to be part of the upper strata in the school. In order to have the endorsement of parents, the program must be conceived as being educationally sound and socially acceptable. Parents are reached through parent-teacher meetings, direct mail, spaced publicity in newspapers, business sponsored meetings, and personal contact with the program coordinator.[1] In a small school one of the finest ways to reach parents is by home visitation. Personal contact with those who'll be directly affected by the program is one of the coordinator's best means of publicity. Continued conferences with parents, as their students progress in the program will strengthen their endorsement and support. Further suggested approaches to parents are given on the chart following this article.

Those employers in a commu nity who undertake to train the pupils must be well informed concerning the total program. Ideally they have been included

in the shaping of it. In a small community they may very well be a part of the advisory council and the public relations team itself. It must be remembered that their knowledge of the jobs for which we're training and their advise is vital to the learning process. If they are made to recognize that they are an invaluable part of the program, they'll make every effort to lend it their backing.

In any active community there are organizations concerned with community development and eager to help initiate a program particularly suited to the specific needs of the area. Members of civic and professional organizations, welfare agencies, service clubs, and other community groups welcome students and faculty at their meetings to tell of proposed curriculum changes or progress made in programs underway. The vocational coordinator and student youth groups may also establish sound public relations by contributing their efforts toward community-wide goals and service projects.

On the following page is charted some of the ways that, in a small community, we may "get the word around" to those who will share in the responsibility of initiating a Cooperative Vocational Program. The best publicity any program can have, however, will be the graduates coming from it--satisfied and successful young men and women who have found a meaningful place in the world of work.

[1] University of Minnesota, A Guide for Cooperative Vocational Education, 1969.

Getting the Word Around

To whom?

How?

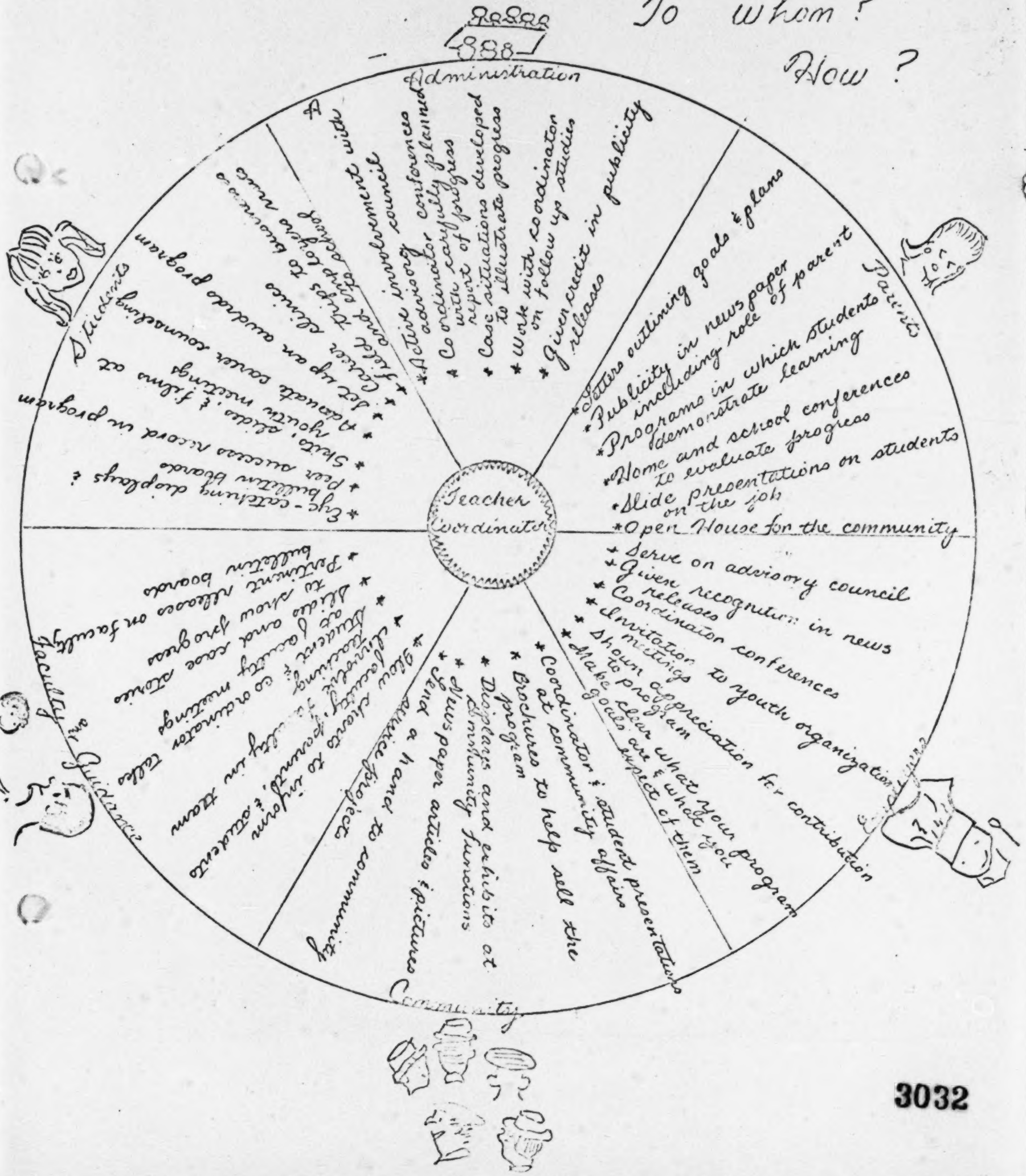

PUBLICITY CHART[1]

MEDIA OF PUBLICITY	Before school opening	At school opening	Each semester	Once during year	At end of school
Newspaper articles	X	X	X		
School publications			X		
School assembly program				X	
Talks to civic clubs	X		X		
Future Homemaker activities			X		
Talk to Parent-Teacher groups				X	
Interpret program to home-making teachers and students				X	
School exhibits and posters		X	X		
School public address system				X	
Free radio and television time				X	
Section in school yearbook				X	
Letters to students and parents	X				
Employer-employee banquet				X	
Letters of appreciation to employers and parents					X
Appreciation certificates to employers				X	
Pictures		X	X		

[1]Adapted from Industrial Cooperative Training Handbook. College Station, Texas. Texas A& M University. May, 1968. p. 104.

Figure 40

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GENERAL GUIDELINES WHEN PLANNING PUBLICITY[1]

I. Source approval of superintendent or publicity director for the entire publicity program or each item as it is to be released.

II. Publicize what has been done more than what is planned to be done.

III. Give due credit to all people involved.

One of the most essential elements in a publicity program is timing. A chart similar to the one shown on the following page, listing the types of publicity planned and the time when they would be most effective might be helpful in organizing the publicity program.

When writing news articles remember that the opening paragraph is most important. Many readers do not read further than this, so WHO? WHY? WHEN? and WHERE? should be answered in the first sentences. Photographs attract reader interest so should be used whenever possible.

Feature or "spot" stories throughout the year might be written about the students' views and reactions to their jobs; the awarding of annual training certificates, interviews with employers, student youth activities at their organization meetings, including photographs when possible. The public is interested in its schools and enjoys reading about the achivements of young people in the community.

Letters to prospective students and selected businessmen have a persnal touch which is not characteristic of other forms of publicity. Letters to businessmen may be more valuable if signed by the superintendent.

On the following pages are sample news releases and a letter to businessmen which may be adapted to be used in a specific situation.

[1] Adapted from Industrial Cooperative Training Handbook, College Station, Texas. Texas A & M University. 1968.

SAMPLE NEWSPAPER ARTICLES

NEW VOCATIONAL PROGRAM IN HIGH SCHOOL

Classes in Home Economics Cooperative Education are the most recent addition to Blank High School curriculum according to a recent announcement by Superintendent R. N. Pearson.

These classes afford students of Junior and Senior standing both on-the-job and classroom education in a variety of occupations. Practical work experience is provided the student through part-time employment at some cooperating business within the city.

The course is set up for one or two years and carries two credits each year. Students receive pay comparable to that paid beginning workers in the same occupations.

Typical occupations in the program are brical consultant, child care aide, companion to elderly, clothing assistant, dietitian aide, fabric coordinator, floral designer, food caterer, food service employee, home furnishings aide, housekeeping-management assistant, millinery aide, and tester of foods, equipment or textiles.

The program will operate under the direction of Mrs. Jane Williams, teacher-coordinator. Mrs. Williams will be responsible for the selection and placement of students and will correlate their classroom and practical education. An advisory committee of local business people will be set up by the school to assist Mrs. Williams in organizing and operating the new program.

The addition of this type of program will do much to provide the youth of Anytown with a well-rounded educational program that will fulfill the need for practical and useful training. It is hoped it will enable a large portion of our students who desire to become occupationally competent to enter full-time employment upon graduating from high school.

Figure 37

ADVISORY PANEL

Mr. R. N. Pearson, Superintendent of Blank Public Schools, has released the names of five citizens who have been selected to serve in an advisory capacity to the Home Economics Cooperative Program for the 1969-70 school year. They are Mrs. Dorothy Joiner, Utility Company, Mrs. M. C. Duncan, Northeast General Hospital; Mrs. C. G. Whatley, Brook's Day Nursery; Mrs. Ann Smith, Rawl's Ready-to-Wear; Mrs. A. B. Cantrell, Circle Inn Motel; Mr. Jack R. Banks, Chamber of Commerce; and Mr. R. N. Pearson, Superintendent of Schools.

Students in Home Economics Cooperative Education receive on-the-job training in home economics related occupations. The advisory committee makes recommendations for improvement of the program, aids in publicizing and promoting the program, helps select training stations, assists in evaluation of the program, and provides general advice as needed.

The program is under the direction of Mrs. Ruth Duncan, teacher-coordinator.

Figure 38

SAMPLE LETTER TO BUSINESSMEN[1]

Date

Business Address

Dear Mr.

We are taking this means of acquainting various employers who are engaged in home economics related occupations within our community of a new course--Home Economics Cooperative Education -- which has been added to our high school curriculum. It is intended to enable our school to render a more complete service to our local businesses and institutions by supplying them with better trained personnel from among our graduates.

The Board of Education feels that the inclusion of this type of program will do much to provide the youth of (Name of Town) with a well-rounded educational program that will fulfill the need for practical, down-to earth training. It will enable that large percentage of our students who desire to become occupationally competent to enter full-time employment upon graduation, or supplement their incomes while attending college or a vocational school.

As the name of this course suggests, it is carried on through a cooperative arrangement between businesses and institutions of our community and the local school. Practical work experiences are gained by the student through part-time employment in some place of business -- such as yours -- during each morning or afternoon. Information related to the students' occupation is provided by our high school in a special class scheduled each morning or afternoon. Students must be of Junior or Senior standing and must be at least sixteen years of age to participate in this program.

(Name of teacher-coordinator), teacher coordinator of this program, will make every effort to visit you in the near future and explain the operation of this program more in detail. If you decide that your place of business will be in a position to cooperate in training one or more students, we shall be very happy to include you on our "faculty".

Very truly yours,

(Name of Superintendent)
(Name of School)

1. Adapted from Industrial Cooperative Training Handbook. College Station, Texas, Texas A & M University. May 1968. p. 102

VIII. Student Selection

It is most important to select good quality students for the program. This does not necessarily mean they must be "A" or "B" students, but they should have the aptitudes and qualifications necessary for success in a given occupational area. The student should have established a broad career goal.

A. Eligibility

Junior and seniors who are 16 years of age or older are usually selected. Most schools prefer students to have had some pre-vocational course. Students should make their desire to receive training known in the school guidance office and be approved by Vocational Home Economics Department.

B. Factors to Consider When Selecting Students

The following factors can be used as guidelines for selecting students for a Home Economics Cooperative Education program as suggested in the Texas Technical University, Home Economics Cooperative Handbook.

1. Interest in receiving training
2. Physical suitability (good health and stamina)
3. Disciplinary record
4. School attendance records
5. Hobbies
6. Past work experience
7. Personality characteristics
   - a) punctuality
   - b) honesty
   - c) loyalty
   - d) alertness
   - e) accuracy
   - f) perserverance
   - g) cooperation
   - h) initiative
   - i) sincerity
   - j) willingness to work
8. Recommendations
9. Past employers' opinions
10. Other school activities
11. Personal appearance
12. Grades in high school

C. Contacting Students

Spring recruitment is the best. It may be possible to contact students by examining student record cards and mail a letter and interview schedule to all eligible students. (See Figure 3)

Students who show an interest can then be interviewed personally.

An assembly program might be held or the coordinator might talk to a particular class and have the students fill in an application form.

Application forms asking for the following information can be given to the students prior to the interview.

1. Occupation desired
2. Reason for choice
3. Possible training stations
4. Resume' of school credits
5. Four references
6. Signature of parent
7. Signature of student
8. Agreement to join Future Homemakers of America

An example of an Application For and Acceptance and Placement Policies will be found in Figures 4 and 5. If any of the occupations are not available in a particular city, they should be deleted.

D. Securing Recommendations

Student rating sheets should then be sent to the teachers the students listed as references. (See Figure 6) Further information about attitudes, character, and ability to get along with others in a working situation can be obtained from interviews with former teachers, principals, and/or employers.

LETTER TO STUDENTS

Date_____

Dear_____

A new program of Home Economics Cooperative Education has recently been added to the list of high school subjects. In this program the student will be employed a minimum of fifteen hours a week in a place of business in the city. The student will spend half of each day in the study of regular high school subjects including a special class related to occupational education. In addition to receiving practical work experiences, the student will be paid for work performed while acquiring training in an occupation of his choice.

This is primarily a two-year course for which a student may achieve two credits per year. This plan enables the student to prepare himself for full time employment and at the same time satisfy graduation requirements. Training in approximately thirteen occupations will be available this year. In general, choices may be made from the following types of occupations: bridal consultant, child care aide, companion to elderly, clothing assistant, dietitian aide, fabric coordinator, floral designer, food caterer, food service employee, home furnishings aide, housekeeping management assistant, millinery aide, and tester of foods, equipment, or textiles. The occupation selected by a student will depend upon his interests and abilities.

If you are interested in obtaining further information regarding the program, you may contact (Teacher-Coordinator) at the (Name of High School) any morning during the week of (Date) from (Time). If it is not possible for you to come in person, you may mail the attached blank to (Teacher-Coordinator) at the (Name of High School).

Sincerely yours,

(Name of Principal)

Figure 3

Taken from: Handbook, Texas Technical University, School of Home Economics, Department of Home Economics, Lubbock, Texas, September 1969.

Page 2

Name _____ Age _____

Address _____ Phone _____

Occupation in which you are interested _____

_____

Are you working now? _____

If so, where? _____

Return to: (Teacher-Coordinator's name)

(Address) _____

_____

Figure 3 (continued)

Taken from: Handbook, Texas Technical University.

Attach a recent photograph in this blank

APPLICATION FORM

APPLICATION FOR ENROLLMENT

HOME ECONOMICS COOPERATIVE EDUCATION

Name _____ Classification _____

Phone _____ Birth Date _____

Age _____ Weight _____ Height _____

Application Date _____

Home Room Teacher _____ Home Room Number _____

Father's Name _____ Mother's Name _____

Address _____

Occupation of Father _____ Firm _____

Occupation of Mother _____ Firm _____

Are you the only child at home? _____

Names and ages of brothers and sisters _____

_____

_____

_____

Do you get along well with your parents? _____ Explain _____

_____

Do you live with both parents? _____ Who do you live with if you do not live with your parents? _____

_____

Do you have any physical disabilities? _____ If so, what? _____

_____

Figure 4

Taken from: Handbook, Texas Technical University.

(Note: Physical disabilities include asthma, diabetes, epilepsy, fainting spells, poor hearing, weak eyes, or others. These disabilities can be very hazardous on many jobs. Please be very accurate in answering this question.)

Are you married or single? Single_____ Married_____

If married, since when?_____ Any children?_____

Are you engaged to be married? Yes_____ No_____
If so, to whom?_____

Do you plan on getting married before finishing high school?
Yes_____ No_____ If so, when?_____

What is your opinion of marriage for students before they finish high school?_____

What required subjects do you lack for graduation?

_____ _____ _____

_____ _____ _____

Do you plan to go to college? Yes_____ No_____

If you go to college, will you need to work to pay part or all of your expenses? None_____ Part_____ All_____

What are your activity interests? (Hobbies, organizations, sports, extracurricular)

_____ _____ _____

How did you become interested in this program? Why do you want to enroll in this program?_____

Have you ever been suspended from school? Yes_____ No_____ If so, when and for what reason?_____

What arrangements will you have available for transportation to and from interviews and to and from work?
Public Bus_____ Car Pool_____ Family Car_____ Own Car_____

Figure 4 (continued)
Taken from: Handbook, Texas Technical University.

Will you agree to get the approval of your coordinator before quitting a job or changing training stations? Yes_____No_____

Will you agree to give your employer a full two weeks' notice before quitting your job under any circumstances, unless your coordinator approves a shorter notice? Yes_____No_____

Will you be willing and able to attend and participate in Future Homemakers of America activities as a part of this course? Yes_____No_____.

Are you willing to pay Future Homemakers of America dues? Yes_____ No_____

The occupations for which training will be available are listed below. Please indicate your three occupational choices: Put the figure 1 before your first choice, 2 before your second choice, and 3 before your third choice.

___Bridal Consultant (assist with making selections and arrangements for weddings)

___Child Care Aide (assist in the care of young children in establishments meeting minimum standards for licensing child care centers)

___Companion to Elderly (assist with personal grooming, care, and activity of elderly person)

___Clothing Assistant (alter, clean, press, repair, and construct garments)

___Dietitian Aide (work under the direction of a dietitian in a hospital or home for elderly citizens)

___Fabric Coordinator (assist with selection and combinations of fabrics and notions)

___Floral Designer (assist with flower arrangement and other responsibilities of a florist)

___Food Caterer (assist in preparing and catering of food)

___Food Service Employee (assist in preparing and serving foods)

___Home Furnishings Aide (help in the construction of draperies and/or accessories for the home)

___Housekeeping Management Assistant (performance of household duties in home or business)

___Millinery Aide (assist in making hats and other accessories)

___Tester of Foods, Equipment, or Textiles (assist in testing under the direction of a professional worker)

School subjects you like most_____

_____

What homemaking courses are you taking now?_____

_____

What homemaking courses will you take next Fall?_____

_____

Figure 4 (continued)

Taken from: Handbook, Texas Technical University.

Please check the homemaking courses listed below which you have taken and give the names of the teachers who taught the courses.

Homemaking I _____
Homemaking II _____
Homemaking III _____
Homemaking IV _____
Summer Projects _____

Child Development _____
Home Nursing _____
Home and Family Living _____
Home Management _____
Home Furnishings _____
Consumer Education _____

Is there any particular shop or place of business where you prefer to work? If so, give the name of place and employer:

Firm _____ Location _____

Manager _____ Phone _____

Are you now working? _____ Firm _____

Previous Employment	Location	Manager

Class Schedule

Period	Course	Room No.	Teacher
HR			
1			
2			
3			
4			
5			
6			

Will you be ready to interview prospective employers and to begin work by the middle of next August? Yes___No___. If not, why? And when will you be ready?

Have you discussed the advisability of your enrolling in this program with your parents or guardian? Yes___No___

Figure 4 (continued)

Taken from: Handbook, Texas Technical University.

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List the names of four teacher references. (Major subject teachers only.) Homeroom teacher reference is not acceptable.

_____

_____

_____

_____

Approved: _____ (Parent or Guardian)

Signed: _____ (Student)

Figure 4 (continued)

Taken from: Handbook, Texas Technical University.

ACCEPTANCE AND PLACEMENT POLICIES

The very nature of the Cooperative Home Economics Education program makes it necessary for students to possess certain qualifications. The following statement of the principles concerning the necessary qualification is made in an effort to inform students so they will receive the intended vocational benefit from the course.

ATTENDANCE -- All students are employed in some occupation. The businesses that employ students must make adjustments in schedules to provide training stations. This makes it necessary that the student have a good attendance record and continue in regular attendance.

GRADES -- Students may not have a period for study hall in their schedules. Therefore, they will have to budget their time so they can study. Students who make good grades will be more able to make this necessary adjustment.

CITIZENSHIP -- When students are employed they represent the business, the school, their family, and themselves. Employers want good citizens. Only students with excellent citizenship records should represent the school to the businesses.

EMPLOYABLE -- All students must be recommended to the employer by the coordinator. A professional recommendation of this type can only be made when the coordinator believes that the student has the necessary qualifications for a specific job in a specific business. Since the coordinator's responsibility is to place the right student in the right training station, it is necessary for her to use every means at her disposal so that the student may receive the maximum benefit from the course.

Do you understand that acceptance into the course depends upon placement in an approved training station?_____Have you read the "ACCEPTANCE AND PLACEMENT POLICIES" above?_____

_____ _____
Your Signature Date

_____
Signature of Parent or Guardian

Figure 5
Taken from: Handbook, Texas Technical University.

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Students' Rating Sheet[1]

Date _____

Dear _____

(Student's Name) has made application for admittance into the Home Economics Cooperative Education program. Your evaluation of the rating of this student in relation to the following characteristics will be greatly appreciated.

Rating: E - Excellent; G - Good; F - Fair; P - Poor

	E	G	F	P
Honesty				
Dependability				
Willingness to work				
Capacity to do work				
Quality of work				
Attitude toward school				
Personal appearance				

Signed: _____

Figure 6

[1]Adapted from: Industrial Cooperative Training Handbook, College Station, Texas: Texas A & M University. Page 21.

IX. Selection of Training Employers

Training stations that will give the most educational value to the cooperative vocational education student-learner must be selected.

The training employer and his employees should have a favorable attitude toward the cooperative education program.

There needs to be a survey to determine if there are a sufficient number of employers who are capable and willing to deliver quality on-th-job training.

A. Criteria in Selecting Training Stations

1. Potential to provide training for occupation that are challenging and worthy of the students learning time and efforts.

2. Competence of employer in their occupation.

3. Respectability of community and reputation of employer is excellent.

4. Good standards of workmanship.

5. Work environment is conductive to good health, to safety, and to development of job satisfaction.

6. Adequacy and appreciation of equipment.

7. Volume of business

8. Policies of the company toward occupational training.

9. Existing employer-employee relationships.

The employer should be able to provide a job throughout the school year. Students should be able to rotate from one task to another as they become skilled. The wages received should be comparable to those received by other beginners in that occupation.

The training stations should be easily accessible. It should have suitable hours of work, an opportunity for learning and advancement, and an availability of instructional materials for the occupational area.

State regulations regarding the employment of minors should be carefully considered.

X.

A SUGGESTED SCHEDULE OF ACTIVITIES FOR

PLANNING AND ESTABLISHING

A COOPERATIVE VOCATIONAL EDUCATIONAL PROGRAM

Activities	Suggested Time for Accomplishment
A. Survey of businesses in the community	February or March
B. Complete application and student agreement form.	March or April
C. Interview students who completed application forms to identify more specifically the kinds of businesses in which students are interested.	March or April
D. Review information obtained in step A, to identify businesses which could provide training situations to meet student needs and interests.	April or May
E. Contact businesses identified as possible training situations to determine willingness of businessmen to accept student-learners.	May or June
F. Use information obtained to outline tentative training plan which the student would follow.	Summer
G. Contact local businessmen to review tentative training plan to make necessary adjustments to fit program to the needs and abilities of the student.	Summer
H. Arrange for students to be interviewed by prospective employers for employment as student-learners.	September
I. After employer agrees to employ a student, the coordinator, the employer, the student, and the parent (s) meet to review, and revise the training agreement.	September

Source: Guidelines for Cooperative Vocational Education, Bulletin No. 9-570. Board of Vocational Education and Rehabilitation - Division of Vocational and Technical Education, Springfield, Illinois.

References used:

Handbook, Home Economics Cooperative, Texas Technical University, School of Home Economics, Department of Home Economics Education, Lubbock, Texas, September, 1969.

Home Economics Philosophy of Sycamore High School, Sycamore, Illinois.

Guidelines for Cooperative Vocational Education, Bulletin No. 9-570, State of Illinois, Board of Vocational Education and Rehabilitation Division of Vocational and Technical Education, 405 Centennial Building, Springfield, Illinois 62706.

A Guide for Cooperative Vocational Education, College of Education, Division of Vocational and Tehnical Education, University of Minnesota, Minneapolis, Minnesota, September 1967, page 59.

THE ADVISORY COMMITTEE

By Betty Schindel
Presented to Dr. Smith
July 30, 1970
Home Economics 450

3051

The advisory committee is not new to vocational home economics. However, its use has been limited due to the fact that some administrators and boards of education are of the misconception that advisory committees make the decisions for the school. If this misconception is cleared, perhaps advisory committees will be one of the best known phrases of the seventies. The changes brought about in community concern by various events in the sixties, will probably bring more community concern in the seventies. Since the advisory committee is developed from the community, it fits in with our time. With teacher's salaries increasing and with discriminations mounting, the community cannot simply stand by and watch the schools making decisions. They, instead, must take an active part in the happening. A way in which the community can take part is through the advisory committee. In this paper, the advisory committee has been divided into three main topics. They are as follows:

1. Forming a committee
2. Membership
3. The function of an advisory committee

The separate words advisory and committee are heard quite frequently, however, for the purpose of this paper, a definition is in order. The word "advisory" is defined as "exercising the power to advise."[1] What is "to advise?" "Advise" is "to council, caution or warn, recommend, inform or consult."[2] A committee is defined as "a body of persons delegated to consider, investigate, take action on, or report on some matter."[3] An advisory committee is a body of people delegated to exercise the power of counseling, cautioning or warning, recommending, informing and consulting on certain matters having to do with education.

The need of the advisory committee to our educational system is becoming more evident as time passes. There is friction mounting between educational administrators and the community which they represent because of misunderstandings. The community is concerned as to where tax money is being used. The community is also curious as to why so many students are not being educated to fill the many needs of society. On the other hand, the educators want to know what the parents of the community expect from the school system. Suggestions are needed on how to keep students in the school and off the streets. The educators need suggestions on community needs and useful course material. They also need evaluation reports on the efficiency of the program. The community and the school system must communicate. "We must listen to the people we are trying to serve and enlist their support not just as spectators, but as active participants in the decision making process."[4] How can this be done? The answer to this question is found through giving the community, both parties must work together. When each one becomes aware of the needs of the other, it becomes much easier to solve the problem. If the groups of the community would join together for a common cause, they could become more effective in limiting their problems instead of each on striking out on its own.

There are many types of advisory committees. They range from national to state to local. Under the local advisory committee, there are such committees as the steering committee, the general advisory committee, the departmental and the specific occupation advisory committee. The National Advisory groups "have been responsible for presenting to the Congress recommendations which have shaped two of the most important pieces of Vocational Education Legislation passed

in recent years."[5] These two pieces of legislation were the Vocational Act of 1963 and the Vocational Educational Amendments of 1968. The Vocational Education Act of 1963 called for a periodically assembling of an advisory council to review the nations' programs, to report the findings, and to make recommendations. The first council of this nature assembled on November 22, 1966 and presented their recommendations on December 11, 1967. These recommendations were formulated in the Vocational Educational Amendments of 1968. As a result of these amendments, a National Advisory Council, as well as state councils, was formed. The newly formed National Advisory Council was to advise, evaluate, and make recommendations to the Secretary of Health, Education, and Welfare, these recommendations would then be submitted to Congress. This National Council was to consist of twenty-one members, of which no less than 1/3 was to be the general public representatives. The remaining members of the council was to be persons familiar with "Vocational Education needs and other problems of management and labor; manpower problems and administration of manpower programs; administration of state and local vocational education programs; problems of handicapped; problems of the disadvantaged; and post-secondary and adult programs."[6] These members and the general public representatives are to meet at least four times a year.

As stated before, the Vocational Amendments of 1968 permitted the forming of State Advisory Committees. However, in order for the state to receive any money from the Federal Government, a committee must be formed to perform the following three functions:

1. "Advise the state board on the development of policy matters arising in the administration of state plans.

2. Evaluate programs, services and activities.

3. Submit to the commissioner of Education and the National Advisory Council an annual report on the effectiveness of Vocational Education, with recommendations for such changes which may be warranted."[7]

With these funds received from the Federal Government, needed studies may be carried out by the council. Also, staff members may be hired, and other authorized activities may be taken care of. The public is not eliminated from the duties of the council. The council must meet at least once a year. At this meeting, the public is allowed to express its' views.

The first which expresses the community need for the advisory committee is called the Steering Committee. The job of this committee is clearly one of guiding and assisting in the process of translating community need. This duty is accomplished by the following five responsibilities:

1. "Ascertain the interest of the community in vocational education.

2. Assess the specific needs of the area.

3. Set up standards for equipment and instruction.

4. Review instruction content.

5. Assist in the determination of selection criteria for pupils and teachers."[8]

When the steering group has established a program need, "it should be dissolved after a decision is made as to whether to start a cooperative education program."[9] The members of this committee are usually people of the community who represent labor and management. The members are also from social groups and other active individuals in the community. There is no set number for the membership, but twenty-five members have been found to work extremely well in larger communities. In smaller communities the number should be lessened.

Once the Steering Committee has been dissolved, an Advisory Committee should be appointed. The duty of the committee is still only to advise. It may advise on training stations, sources, types of instructional material, assist its youth club activities, provide related speakers to classrooms and studies, assist with banquets, investigate the need for adult education and help set standards for students. Some of the members of the Steering Committee may be asked to form the advisory committee. The co-ordinator and other educators, along with training station employers are the most likely to remain on the committee. The membership of the committee is reduced from twenty-five to a range of seven to twelve people. Staggered terms of membership help to keep some experienced members at all times.

A committee developed to fill the need of the entire vocational program is called the General Advisory Committee. Its members are selected from all the occupations represented in the program of the school. The duties of this committee are to decide the needs of individuals and community; help find the requirements of the area labor markets; make sure the programs offered are realistic and practical for the students; help build up the respect and prestige of vocational education programs; and work on the planning of long range goals.

The final advisory committee that will be mentioned in this paper is the Advisory Committee for specific occupations. It is concerned with the content and experiences involved in a specific occupation. "These may be food merchandising, child care, ornamental horticulture, or carpentry."[10] The members of these committees are often times responsible for donations of materials and supplies at a reduced cost or free.

The purposes of advisory committees are the same. That is to say that all advisory committees try to provide and identify usable advice to the educative administration. They are to work together in producing the best education, equipment and instructional material for their community needs. Another of their duties is that of "increasing the involvement of the community and parents."[11] It has been said many times that "it is regretable that the advisory committees are often seen only as a public relations device. They may serve this purpose - providing information to the public, acting as a reflection of probable public reaction to school policies or decisions, or being a group to share the blame for unpopular action. But the basic purpose of the advisory committees should be to provide usable advices, to have new ideas and to bring fresh judgment. They are expected to be creative."[12] To me, much of this quote is a view from the fifties or later era. We now look upon advisory committees as partners in the education of our children and not just public relations men.

After research, it appears that the main purposes of an advisory committee are as follows:

1. To assist the schools in identifying needs.
2. To evaluate the effectiveness of school programs.
3. To communicate information to the public.
4. To act as sounding boards.
5. To act as vehicles through which members of community can voice their opinions.
6. To insure concentrated effort of all available resources.
7. "The net work of advisory committees serve as valuable resources for improvement."[13]

The members of the advisory committees are appointed and approved by the Board of Education. Sometimes the board appoints a representative to act in its name. This may be the vocational director, superintendent, or even the principal. Whoever is chosen acts in the name of the highest school authority. This is a good point to have understood by the appointed committee members. Their job is to advise, and the board is to have the final word in all matters. When the representative of the board is looking for suitable members, he should keep in mind that this committee is to represent the community, and the total committee is made up of laymen. The co-ordinator is only a liaison between committee and school. Another important qualification of the members is experience and enthusiasm. Each member must show substantial interest in the program and must have had recent firsthand, practical experience in the area of concern. The age of the members should not be limited. It could be a rash mistake if the young or the old were eliminated from the committee. Character is another quality which should be examined in selecting the committee members. "Candidates for membership should be people of intelligence, integrity, and courage. They should be responsible, civic minded, and co-operative."[14] Many times, it is thought that the aggressive and ambitious people make the best committee members. This is only true if their ambition and aggressiveness is used toward their common goal. This will be a foreful committee member. Another factor which is very important in selecting a committee member is the time which this person will have to contribute toward the committee. Each member must be available for frequent meetings and should be prepared in advance for these meetings. If it is difficult to find people with available time, it is acceptable to have alternates. This applies especially if the person is representing some group. Balanced representation of all groups effected by the committee

or affecting the committee is of most importance. They must all have a voice in the program. When the committee becomes one sided, it becomes dangerous. This quality of being one sided could stimulate groups to a point where they refuse to help or cooperate. This destroys most of the work that an advisory committee is striving toward.

The committee size is an important factor is dictating the success of the advisory committee. There is no set number for membership in a committee of this nature. Each school must determine the number of members which it feels is necessary. There are several factors to be considered in the size of the advisory committee. They are as follows:

1. "The proposed function of the committee.
2. The size of the program and community.
3. The realization that working groups find decision making difficult.
4. The fact that informal constructive discussion is hindered if the group is too large."[15]

It is just as harmful to have too many members as it is to have to few. "Studies have indicated that as size increases, there will be decreasing group cohesiveness and increasing organization and division of labor in the group, along with development of cliques and possibly of factions."[16] Even though the size of the committee is left up to the board, there are a few committee sizes which have proven very effective. The first of them is that of the Steering Committee which has a membership of around twenty-five. The General Advisory Committee, representing an entire vocational education program, is most effective at around twelve to fifteen members. Six to ten members is thought to be adequate for the Specific Occupational Committee. The Departmental Advisory Committee, which is formed after the Steering Committee has been dissolved, seems to function best with seven to twelve members. However, these are only

guidelines, and each school should decide on the membership size which would function properly. In a smaller community the advisory committee would consist of fewer members than that of a larger community. Also, in the small community there probably would not be a need for the Specific Occupational Committee, and in some instances there may not be a need for the Departmental Advisory Committee. However, I feel the Departmental Advisory Committee should always be encouraged.

It is very difficult to set hard and fast rules on policies and procedures for the operation of advisory committees throughout the United States. Only generalizations can be made, and one must choose those rules which apply to his situation. It appears that the successful committee works best if selection of a formal or informal procedure is suggested by the community and the school situation. The formal policy has advantages because its rules and procedures can clarify purpose and create an atmosphere of stability. Many times some people are more willing to work in such a group than in an informal atmosphere. The danger that it possesses is that often times too rigid of rules are set up and this could slow down the initiative of the committee members as well as make it difficult for the committee to function. Policies should be only the provisions necessary for efficient operation. The informal view has been successful in many situations. This is because it possesses the flexibility needed to fit different circumstances. Regardless of how informal the policy being used is, a set of guidelines and responsibilities should be drafted to give the committee direction and to clarify the correct position of the committee within the school system.

What exactly are the duties of an advisory committee? This is not a simple question to answer. Every day educators and committee members are finding new and helpful uses for the advisory committee. The following list will give the most common uses of this committee, but these are far from being the only uses.

on next sheet - it should follow immediately

1. Accept committee assignment
   a. Organizational meeting
   b. Hear explanation of home economics program

2. Determine community needs
   a. For high school and post-high school cooperative programs
   b. For adult classes

3. Evaluate program
   a. Advise whether or not program is providing the kind of training life situations demand
   b. Review curriculum and objectives of program
   c. Review adult classes
   d. Secure opinions from business people
   e. Review all features of the program including the various forms used

4. Assist in the preparation and selection of course material
   a. Establish need for a course
   b. Review present course outlines and texts used
   c. Suggest revisions or additions
   d. Review objectives

5. Help select and place students
   a. Review applications
   b. Suggest training stations
   c. Suggest placements
   d. Suggest placements for graduates

6. Help select instructors and serve as instructors
   a. Teacher-coordinators
   b. Adult instructors
   c. Serve as instructor when coordinator is out of town

7. Guide and support coordinator
   a. Give encouragement and stimulation
   b. Without committee, coordinator may feel he is almost an isolated worker
   c. Coordinator can adjust activities by hearing commendations and criticisms

8. Assist in surveys
   a. Determine data to be gathered
   b. Suggest means for securing data
   c. Help secure certain information
   d. Assist in data interpretation

9. Help to provide continuity
   a. Program of work maintained even though there is a change in coordinators

10. Provide financial and legislative support
    a. Arrange for donations
    b. Set up scholarships, awards for honor students

c. Support school administrators for local appropriations
d. Support state and national legislation affecting vocational education

11. Provide public relations service
    a. Interpret program in community
    b. Provide information for counselors
    c. Arrange for exhibits at meetings and in store windows
    d. Develop plans for recognizing students, such as in store advertisements
    e. Arrange to have coordinator present talks before community groups
    f. Help prepare or review brochures explaining the home economics program
    g. Advise on other forms of program promotion

12. Recommend policies for cooperative program
    a. Minimum wages to be paid
    b. Regulations for employment of students
    c. Type of students to be selected
    d. Releasing students after employment
    e. Student ratings

13. Help secure equipment, supplies and instructional material
    a. Arrange for purchase or by gift
    b. Locate instructional materials from local stores

14. Assist in club work (HERO)
    a. Suggest means of raising club funds
    b. Help secure speakers
    c. Provide financial aid for individual members to attend state or national conferences
    d. Serve as judges for local awards and contests
    e. Attend installation ceremony of local officers

15. Assist in securing meeting places
    a. For adult classes
    b. For advisory committee meetings
    c. For field trips, special demonstrations

16. Help plan special events
    a. Banquet and other social activities
    b. Special events participation 17

It is quite evident that the members of the advisory committee do not just walk in and begin working on evaluation programs, surveys, or any other functions of the committee. It would stand to reason that many of the new members will not have a complete understanding of the program. The responsibility to make sure that new members and old members are kept abreast of things is the coordinators. The following list is an outline for coordinators to follow:

1. Develop an understanding of the program
   a. Committee members can then interpret the school's program to the community
   b. Operating policies (including State Plan) can be presented as part of the orientation.

2. Develop responsibility for the program
   a. Keep committee informed on progress in meeting objective of the program
   b. Solicit sincere cooperation and interest by accepting members af full-fledged partners in the program.

3. Keep the committee busy
   a. Improvements and expansion possible when committee's suggestions are considered and accepted.

4. Do not waste member's time
   a. Members should not be asked to do routine jobs
   b. Nor should they be asked to solve problems which they do not have the background to consider intelligently
   c. Plan worthwhile agenda - and send out in advance
   d. Coordinator has all the facts needed for discussions
   e. Distribute minutes to members

5. Give recognition for assistance
   a. Present certificate to members stating their membership on the advisory committee
   b. Provide follow-up reports on committee recommendations on action taken or not taken by the school.
   c. Recognize individual members in printed material
   d. Send letter of commendations at the close of the school year

6. Accept committee recommendations
   a. A source of constructive criticism
   b. Should not organize committee if the school does not act upon its advice. 18.

The first meeting of the newly formed committee is one of the most crucial parts of the entire program. If the coordinator does not produce an enthusiastic view in the members of the committee, he is in for a long and difficult time. To begin the first meeting, the coordinator should have a member of the board, or the superintendent give a message of welcome to the members of the committee. He should make them feel that he is not trying to take over the committee. It is feasible for the coordinator to write this message for the board member. The coordinator will find it helpful to contact a few members before the first meeting whom he feels are interested in the program. At this time, those contacted members and the coordinator go over the agenda for the meeting. Because of this effort, the laymen appear to be in charge of this meeting. When the coordinator prepares the agenda, he places at the beginning the phrase "For Discussion Purposes Only." The reason for this is to give the committee full authority from the beginning. The chairman and other officers are chosen at the first meeting by the members. This is a very critical step for the reason that much of the committee's success will depend on their chairman. After the chairman has been elected, he presides over the committee. Before the meetings thereafter, it is the duty of the coordinator and the chairman to go over the agenda. They must make sure that each member of the committee receives a copy of the agenda well in advance of the meeting. The purpose of this is to familiarize each member with what will be taking place at their next meeting. It will also inform the members of the meeting date.

An advisory committee does not guarantee a successful program. It will not guarantee the committee to be without problems or conflicts. However, a school that is aware of what such groups contribute, can draw from the experience that it takes to build and keep a sound program.

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When this advisory role is not filled, the benefits that the educators and community members can contribute is lost. Many times, these benefits press programs to more effective operation. Without the advisory committee, the maximum potential of the program is not reached. ~~It is the students who are hurt without these advisory committees functioning for them.~~

FOOTNOTES

[1] Webster, Daniel. Webster's Seventh New Collegiate Dictionary, Page 14.

[2] Ibid, page 14.

[3] Ibid, page 167.

[4] Howe, Harold, "Vital Speeches," page 178.

[5] American Vocational Association, "The Advisory Committee and Vocational Education," page 11.

[6] Ibid, page 12.

[7] Ibid, page 11.

[8] Ibid, page 13.

[9] Mason, Ralph E. and Peter G. Haines, Cooperative Education and Work Experience in the Curriculum, page 164.

[10] American Vocational Association, page 14 and 15.

[11] Riles, Wilson C., American Education, page 24.

[12] Stauffer, Harold, How to Work With Citizens Advisory Committees for Better Schools, page 14.

[13] Annual Descriptive Report, "Fiscal Year Ending," page 37.

[14] American Vocational Association, page 25.

[15] Ibid, page 27.

[16] Thomas and Fink, "Effects of Group Size," page 375.

[17] Harris, Edward E., ~~Class Handout~~, "What Advisory Committees Can Do."

[18] Harris, Edward E., ~~Class Handout~~, "Responsibilities of Coordinator in Working With an Advisory Committee."

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"BEING A BETTER FRIEND AND EMPLOYEE"

Three Weeks

Junior High School

8th grade

Vocational Home Economics
450

Summer 1970

Dr. Louise Smith

Submitted by:

Carol Rehfuss

Murriel Riedesel

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"BEING A BETTER FRIEND AND EMPLOYEE"

I. OVERVIEW

A. Rational
B. List of evaluation devices

II. Objectives

A. Student
B. Teacher

III. Content and Learning Experiences

A. Week I
B. Week II
C. Week III

IV. Bibliography

A. Books
B. Periodicals
C. Curriculum

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RATIONALE

With technological change, increase in population, more education needed for certain jobs, and advanced skills needed for other jobs, it is important to help a student think of choices vocationally at an earlier age so he or she is better prepared for our rapidly changing society and the realities of work.

An introduction to vocational home economics at the Junior High School level is important for students to start thinking about the things they are interested in for a possible life work. This study, in turn, shows them the relevance between related skills, qualities, abilities, traits, and characteristics as applied to both friendship and employability.

STUDENT OBJECTIVES

Know names of jobs that use home economics skills

Learn the requirements for these jobs

Learn things I like and don't like about these jobs

Learn how to write letters of application for jobs by study an d and practice.

Role playing to learn interviews

Know characteristics for valued friends and employees

Learn the amount of education I need for different jobs.

Know requirements and restrictions in employment

TEACHER OBJECTIVES

Interest students in developing skills for the work world

Guide students in developing personal characteristics necessary in the world of work.

Alert students to job opportunities that exist at the service and technical level in home economics

Identification of pupil interest, aptitude and potential.

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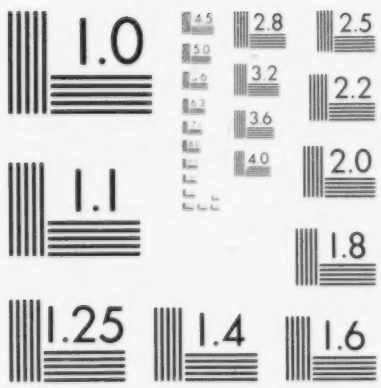

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OVERVIEW-LIST OF EVALUATION DEVICES

I. 1. Personal traits check list
   2. List of habits related to employability
   3. List of hobbies related to employability
   4. Essay on occupations that interest you
   5. List of values

II. 1. Essay on life in 10 years
   2. Job application form
   3. Resume
   4. Opinion poll

III. 1. Bulletin board evaluation
   2. Panel discussion evaluation
   3. Evaluate class discussion
   4. Particiaption in speaker
   5. Comprehension of material
   6. Mastery test

CONTENT	LEARNING EXPERIENCES
WEEK I	
Day 1	
Understand relationship of traits and characteristics as a basis for employability are the same as for friendships.	Review characteristics studied in 7th grade.
Analyze the relationship between personal habits and employability.	Do check list of personal traits.
People differ from one another in many ways.	Go over which traits please and which displease others.
Personal habits are related to making friends and being employable such as neatness, cleanliness, freedom from mannerisms, careful use of time and management of money and energy.	List habits that are related to friendships and employability.
Day 2	
Find out and become aware of sources of vocational and occupational information.	Field trip to Library.
Learn to use these available sources.	Investigate information available on vocations.
	Investigate one job area that you are interested in.
Day 3	
Work on developing qualities for friendships and employability.	Read and study outline of background material.
Learn about self.	List hobbies, activities and habits.
Know some characteristics of emotional maturity.	Work out a bulletin board on teen interests.
Know the meaning of terms used in the handout.	Divide interested parties into a panel on working mothers vs non-working mothers.
The range of job opportunities available to a person is limited by the kind and level of his education.	

CHECK LIST OF PERSONAL TRAITS

Check yourself in the appropriate column according to how frequently you show the trait.

	always	often	seldom	Give an example of how you have shown each trait.
Promptness				
Acceptance of criticism				
Sense of responsibility				
Dependability				
Friendliness				
Enthusiasm for learning				
Respect for others				
Sense of humor				
Honesty				
Fairness				
Initiative				
Others (specify)				

RATING MYSELF ON EMPLOYABILITY

Directions: Write "yes" in the blanks on the left of the ones you do.
Write "no" in the blanks to the left of the ones you do not do.
Make a check (✓) beside those which you could improve.

_____ 1. Do I usually enjoy metting People?

_____ 2. Do I usually like to make new friends?

_____ 3. Do I usually remember peoples" names?

_____ 4. Do I usually smile easily?

_____ 5. Do I usually enjoy talking with people over the phone?
6.

_____ 6. Do I usually speak pleasantly to people?

_____ 7. Do I usually find it hard to think of things to say when talking to a person whom I do not know well?

_____ 8. Do I usually try to find out other people's interests?

_____ 9. Do I usually want to talk about my own interests?

_____ 10. Do I usually like to share my interests?

HAND-OUT

I. VOCATIONS

1. Guidelines for making a vocational decision

A. Interests and abilities
   1. Physical requirements
   2. Mental health status
   3. Emotional maturity
   4. Degree and kind of mental abilities
   5. Degree of interests and abilities
   6. Degree of socialization required

B. Educational and training requirements
   1. General education
   2. Employment education:
      High school, vocational school, technical college, graduate study, special courses, adult education, apprenticeship, internship, on-the-job training.

C. Restrictions in occupations
   1. Requirements for licenses, certificates, union or professional affiliations
   2. Special restrictions:
      Age, marital status, dependents, experience, physical limitations, appearance

D. Working conditions
   1. Monetary factors:
      pay scales, tips, commissions, discounts, profit sharing
   2. Time factors:
      Working hours, overtime, vacation
   3. Physical activity
   4. Tools and machines
   5. Safety factors
   6. Opportunities for friendship
   7. Benefits:
      retirement, pension, sick leave, maternity leave
   8. Services:
      health, counseling, meals, parking

E. Entrance into an occupation
   1. Methods used in location employment
   2. Entrance into occupations on trial basis

HAND OUT

Contributions of Home Economics in Preparing Women for Varied Roles

1. Educates for establisning a satisfying personal and family life.
2. Provides knowlidge and skill for wage earning.
3. Offers training at all levels of aspiration.
4. Helps in managing work at home and on the job.
5. Provides for creative and leisure time activities.

Occupations Requiring Home Economics' Knowledges and skills

1. Occupations requiring high school training
2. Occupations requiring post high school or professional training
3. Location of jobs requiring home economics' knowledges and skills
4. Job clusters within areas of home economics:
   a. Care and guidance of children
   b. Home and industrial management and supporting services
   c. Food and industrial management and supporting services
   d. Combination of home furnishings, equipment and services
   e. Clothing management, production, and services
   f. Combination of areas and other related occupations

HAND-OUT

1. Working Women

   A. Characteristics of women in labor force
      1. Number
      2. Age
      3. Family status
      4. Work patterns
      5. Earnings
      6. Types of occupations held
      7. Race
   B. Family adjustments necessitated by employment of homemaker
      1. Scheduling of meals
      2. Scheduling of entertaining and relaxation
      3. Changing patterns of responsibilities
   C. Motivations for women working
      1. Need to provide financial support
      2. Wish to improve family standard of living
      3. Interest in work and posession of skills
      4. Attitudes and expectations of husband
      5. Desire for personal satisfaction
      6. Desire to make contribution to society
      7. Escape from home responsibilities
      8. Desire for independence
   D. Factors which influence a girl's vocational plans
      1. Marriage
      2. Expectations of husband
   E. Changes affecting employment of women
      1. Shift of family to producing unit
      2. Earlier marriage and parenthood
      3. Agencies to care for children
      4. Development of labor-saving equipment and products
      5. Increase in opportunity for education
      6. Increase in job opportunity
   F. Changes in status of women
      1. More job openings
      2. Comparable salary with men
      3. Less restrictive dress codes
      4. Opportunity for advancement
   G. Roles of women
      1. Assume multiple roles
      2. Increased emphasis on role as a wage earner
      3. Less differentiation between roles of men and women

WEEK II

Day 1

Generalize relationships of traits, abilities, aptitudes, and interests, experiences and habits that make one better employee and friend.

Define each of the qualities showing considerations of others that make for friendship and employability.

Educational experiences contribute to a persons qualifications for employment.

One needs more than interest to suceed in a job.

Discuss why students leave school.

Relate to employment barriers and lack of wages.

What are ways to encourage young people to stay in school. What would they do if they dropped out?

Work on bulletin board and panel.

Day 2

Be aware of legal requirements for working--social security, age, hours, income tax, as applied to students.

What traits do employers look for in you?

Experience in part time and summer jobs helps students choose vocations wisely.

Why is resume important to you and to employer.

Be aware that an employer expects return for money you are paid.

Securing a job is easier when one is familiar with the methods used in locating employment and when one has knowledge of the requirements.

Discuss resume and job application forms.

Write a resume. Look at examples.

Fill out job applications.

Collect essays on jobs or job areas.

Day 3

Know about Social Security numbers and how to obtain them.

Know about work permits, where and how to obtain.

Physical restrictions apply to certain jobs--marital status, age, dependents, experience, physical limitations, appearance, unions.

When one has knowledge of conditions his job choices are more likely to be rewarding.

How monetary factors such as pay, tips, commissions, discounts, effect occuaptional choice.

Time factors such as hours, overtime, vacations, physical activity, tools, and machines to be used.

Opportunities for friendships and personal satisfactions may influence choice.

Benefits such as sick leave, maternity leave and pensions effect choice.

Hand out ditto sheets on women's working.

Discuss the forms in light of content.

Discuss the interview for a job.

Have an employment agency representative give views on obtaining a job and interviews.

Written questions from class on vocations.

This to be dittoed and handed out at end of period to students as outline and suggestions for discussion

Student: Read and study the following material

DEVELOPING QUALITIES FOR FRIENDSHIPS AND EMPLOYABILITY

I.. Developing self-knowledge related to qualities for friendships and employability

A. Sources of personal informations
   1. Teachers, counselors, and others
   2. Records of attendance, grades, behavior
   3. Tests of achievement, intelligence, abilities, interests, personality
   4. Intuition

B. Sources of occupational information and guidance
   1. Counselors, employers, workers, and others
   2. Advertisements, pamphlets, books
   3. Public and private employment agencies, placement office.

C. Personal qualities related to friendships and employability
   1. Physical qualities which affect friendships and employability
      a. health status
      b. Strength, energy, stamina
      c. Age
      d. Height and weight
      e. Posture
      f. Voice and speech
      g. Appearance, grooming
      h. Physical handicaps
   2. Psychological resources for friendships and employability
      a. Mental health
         1. self-confidence
         2. optimism
         3. Freedom from fears, tensions, anxieties
         4. Freedom from jealousies, resentments
      b. Intelligence, general mechanical ability to follow directions
      c. Emotional maturity
         1. Self-dicipline
         2. Judgment
         3. Initiative
         4. Acceptance of criticism
         5. Responsibility
      d. Attitudes toward people, things, school, work
         1. Respect
         2. Enthusiasm
         3. Sense of humor
         4. Other
      e. Character traits
         1. Honesty
         2. Integrity
         3. Fairness
         4. Trustworthiness

3. Social capabilities which influence friendships and employability
   a. Ability to communicate
   b. Enjoyment of people
   c. Leadership
   d. Consideration for others
      1. Empathy
      2. Courtesy
      3. Tact
      4. Loyalty
      5. Tolerance
      6. Acceptance of differences
      7. Manners
      8. Patience
      9. Generosity
4. Habits which influence friendships and employability
   a. Neatness and cleanliness
   b. Mannerisms
   c. Use of time, punctuality
   d. Management of money and energy
5. Interests and preferences which contribute to friendships and employability
   a. Reading
   b. Recreation
   c. Groups/clubs, activities
6. Special skills and abilities which contribute to friendships and employability
   a. Sports
   b. Art
   c. Music
   d. Drama
   e. Dancing
   f. Cooking
   g. Sewing
   h. Woodworking
   i. Others
   j. Relation of interests and abilities
7. Experience and opportunities for developing qualities for being a friend and an employee.
   a. Education and training
   b. Activities at school, home, and in groups
   c. Travel
   d. Wage earning experiences
   e. Acquaintances with variety of people
   f. Financial resources
8. Personal values that relate to employability and the development of friendships
   a. Ethical principles
   b. Outlook on life, purposes, and goals
   c. Expectations for home and occupational life
   d. Concept of success

II. Making a self-assessment in relation to being a friend and obtaining employment
   A. Assessment of qualifications
      1. Assets, strengths
      2. Weaknesses, handicaps, deficiencies
   B. Acceptance of strengths and limitations
   C. Exploring occupational preferences
      1. Identifying areas of interest
      2. Analyzing qualifications
      3. Making tentative decisions
      4. Planning for decisions making

III. Using self understanding to develop qualities for keeping friends and holding a job
   A. Overcoming dificiencies
   B. Changing habits
   C. Developing new strengths
   D. Expanding interests

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* Illinois Teacher of Home Economics, Vol. XI:4, Spring 1967-68, pp. 263-265

GENERAL (USED FOR WOMEN)

APPLICATION FOR SALARIED EMPLOYMENT

REYNOLDS METALS COMPANY AND SUBSIDIARIES

FORM R-253 (REV. 3-61)

CLASSIFICATION 80

INSTRUCTIONS: PLEASE USE TYPEWRITER, BLACK PENCIL, OR PEN WITH BLACK, CARBON BASED INK.

POSITION DESIRED (OR TYPE OF WORK) ..... DATE .....

NAME ..... SOCIAL SECURITY NO. .....

ADDRESS ..... PHONE .....
NO. STREET CITY & STATE

LENGTH OF TIME AT THIS ADDRESS ..... BIRTH DATE .....

HEIGHT ..... WEIGHT ..... PHYSICAL DISABILITIES .....

MARITAL STATUS ..... NO. DEPENDENTS ..... CHILDREN'S AGES ..... , ... , ... , ... , ... , ... , ... ,

WIFE'S - HUSBAND'S NAME ..... OCCUPATION ..... LOCATION .....

FATHER'S NAME ..... OCCUPATION ..... LOCATION .....

MOTHER'S NAME ..... OCCUPATION ..... LOCATION .....

ARE YOU A U. S. CITIZEN? ..... FRIENDS-RELATIVES IN OUR EMPLOY .....

.....

HAVE YOU MADE APPLICATION TO REYNOLDS BEFORE? ..... DATE ..... LOCATION .....

ACCEPTABLE STARTING SALARY ..... DATE AVAILABLE .....

U. S. MILITARY SERVICE

PRESENT DRAFT STATUS ..... RESERVE STATUS ..... NAT. GUARD .....

DATES		BRANCH OF SERVICE	RANK	SPECIALTY	COUNTRIES	TYPE OF DISCHARGE
FROM	TO					

EDUCATION

	NAME AND LOCATION	ATTENDED		GRADUATE?	COURSE OF STUDY
		FROM YR.	TO YR.		
HIGH SCHOOL					
COLLEGE				Degree	
BUSINESS SCHOOL					
OTHER					

GRADE AVERAGE ..... SCHOLASTIC HONORS .....

EXTRACURRICULAR ACTIVITIES .....

COURSES RELATIVE TO POSITION DESIRED .....

MACHINES OPERATED:

	✓		✓
ADDING MACHINE		DUPLICATING	
BILLING MACHINE		MIMEOGRAPH	
CALCULATOR OR COMPTOMETER		KEY PUNCH	
TABULATING MACHINE		PHOTOSTAT	
TYPEWRITER		SWITCHBOARD	

TYPING SPEED .....

SHORTHAND SPEED .....

OTHER 3085

.....

.....

EXPERIENCE

NOTE: LIST PRESENT OR LAST POSITION IN NO. 1 AND CONTINUE IN REVERSE ORDER. ADD EXTRA SHEET IF ADDITIONAL SPACE REQUIRED. IF NO PREVIOUS EXPERIENCE, LIST NAMES AND ADDRESSES OF 3 REFERENCES UNDER EMPLOYER IN 1, 2, AND 3.

NO.	DATE FROM	DATE TO	EMPLOYER NAME-ADDRESS-CITY	BASE SALARY	BONUS OR O'TIME	REASON FOR LEAVING	JOB DESCRIPTION DESCRIBE DUTIES OF YOUR POSITION
1			SUPVR.:				JOB TITLE:
2			SUPVR.:				JOB TITLE:
3			SUPVR.:				JOB TITLE:
4			SUPVR.:				JOB TITLE:
5			SUPVR.:				JOB TITLE:

WHICH OF THE ABOVE JOBS DID YOU LIKE BEST? NO. ..... WHY?.....

FOR WHAT JOB ARE YOU BEST QUALIFIED, IN YOUR OPINION?.....

SPACE BELOW FOR COMPANY USE

COMMENTS:	TEST RESULTS
INVESTIGATION:	
CREDIT: PHYSICAL EXAM:	
POLICE:	

THE COMPANY MAY INVESTIGATE MY BACKGROUND AND EMPLOYMENT RECORD, AND I AUTHORIZE ANY PERSON OR COMPANY TO FURNISH INFORMATION IN THEIR POSSESSION WITHOUT LIABILITY. I CERTIFY THAT ALL STATEMENTS MADE BY ME IN THIS APPLICATION ARE TRUE.

..... DATE ..... SIGNATURE

30806

SPECIAL (USED FOR MEN)

APPLICATION FOR SALARIED EMPLOYMENT

REYNOLDS METALS COMPANY AND SUBSIDIARIES

FORM R-253-2 (REV. 3-61)

CLASSIFICATION 82

INSTRUCTIONS: THE INFORMATION CONTAINED HEREIN IS CONFIDENTIAL. YOUR COOPERATION IN SUPPLYING IT ACCURATELY, FULLY AND WITHOUT REFERENCE TO RESUMES IS REQUESTED. ADDITIONAL INFORMATION MAY BE ATTACHED IF NECESSARY. PLEASE USE PEN WITH BLACK, CARBON BASED INK, TYPEWRITER, OR BLACK PENCIL.

POSITION DESIRED (OR TYPE OF WORK) .....

FULL NAME .....

PRESENT ADDRESS ..... PHONE .....
No. St. City State

PREVIOUS ADDRESS ..... FROM ..... TO .....

TODAY'S DATE .....

SOC. SEC. NO. .....

BIRTH DATE .....

HEIGHT .....

WEIGHT .....

COLOR—EYES .....

—HAIR .....

MARITAL STATUS:

SINGLE ☐

	DATES
MARRIED	
DIVORCED	
SEPARATED	
WIDOW(ER)	
RE-MARRIED	

CHILDREN'S AGES:

....., ..., ..., ..., ..., ..., ...

NO. DEPENDENTS .....

BUYING HOME ☐

RENT ☐

U. S. CITIZEN? .....

LANGUAGES SPOKEN:

....

....

EVER REFUSED BOND? .....

WOULD YOU TRAVEL? .....

RELOCATE? .....

NAME & YR. CAR OWNED:

.....

SALARY REQUIRED .....

DATE AVAILABLE .....

MAY WE CONTACT PRESENT EMPLOYER? .....

PHYSICAL DISABILITIES .....

DATE LAST PHYSICAL EXAM ..... RESULTS .....

FRIENDS IN OUR EMPLOY .....

RELATIVES IN OUR EMPLOY .....

WHAT CAUSED YOU TO CONTACT REYNOLDS? .....

.....

FATHER'S OCCUPATION .....

MILITARY STATUS ..... BRANCH OF SERVICE ..... RANK .....

LOCATION RESTRICTIONS .....

REFERENCES, OTHER THAN EMPLOYERS OR RELATIVES, WHOM YOU HAVE KNOWN 5 OR MORE YEARS

NAME	ADDRESS	CITY	POSITION

EDUCATION

LAST GRADE-SCHOOL ATTENDED (NAME) .....

LOCATION .....

HIGH SCHOOL ..... LOCATION .....

DATES: ..... TO ..... GRADUATE? .....

COLLEGE OR SPECIAL TRAINING:

NAME & LOCATION	DATES		COURSE TAKEN & DEGREE REC'D
		TO	

GRADE AVERAGE ..... HONORS .....

EXTRACURRICULAR ACTIVITIES .....

.....

.....

.....

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EMPLOYMENT RECORD

LIST PRESENT OR LAST POSITION IN NO. 1,
AND CONTINUE IN REVERSE ORDER (INCLUDE MILITARY SERVICE)

NO.	DATE FROM	DATE TO	EMPLOYER NAME—ST. ADDRESS—CITY	NATURE OF BUSINESS (PRODUCTS)	MONTHLY BASE SALARY	NO. PEOPLE SUPERVISED	REASON FOR LEAVING OR DESIRING CHANGE	POSITION DESCRIPTION DESCRIBE DUTIES OF YOUR POSITION (IF SALES, ALSO GIVE AREA COVERED)
1					First:			JOB TITLE:
					Last or Pres.:			
			SUPVR.		Add. Comp.:			
2					First:			JOB TITLE:
					Last:			
			SUPVR.		Add. Comp.:			
3					First:			JOB TITLE:
					Last:			
			SUPVR.		Add. Comp.:			
4					First:			JOB TITLE:
					Last:			
			SUPVR.		Add. Comp.:			
5					First:			JOB TITLE:
					Last:			
			SUPVR.		Add. Comp.:			

3088

ADDITIONAL INFORMATION NECESSARY FOR A COMPLETE PRESENTATION OF YOUR QUALIFICATIONS: .....

.....

.....

.....

LEISURE TIME ACTIVITIES, HOBBIES, ETC.:

SPACE BELOW FOR COMPANY USE

COMMENTS:	TEST RESULTS
	INVESTIGATION:
INTERVIEWER:	PHYSICAL EXAM:
INTERVIEWER:	TESTS:

THE COMPANY MAY INVESTIGATE MY BACKGROUND AN
EMPLOYMENT RECORD, AND I AUTHORIZE ANY PERSON C
COMPANY TO FURNISH INFORMATION IN THEIR POSSESSIC
WITHOUT LIABILITY. I CERTIFY THAT ALL STATEMENTS MADE I
ME IN THIS APPLICATION ARE TRUE.

83

DATE ..... SIGNATURE .....

FORM R-253-2 BACK (REV.3-61)

INTERVIEWERS IMPRESSIONS

	Excellent	Good	Fair	Poor	Transportatior
Appearance					Has car
Dress					Walks
Personality					Wants ride
Aggresiveness					
Speech					
Intellegence					
Ambition					
Education					
Job Preference					

Remarks:

Interviewed by: Date:

WEEK III

Day 1

Job differ in requirements such as intelligence, mechanical ability and ability to follow directions.

When person knows abilities he has a basis for making appropriate plans relating to occupations.

One indicates through preferences his values.

One's qualifications are enhanced by special skills and abilities in areas of sports, arts, music, drama, dancing, cooking, sewing, woodworking, etc.

Class discussion.

List interests.

Show how interests might relate to an occupational area.

Do a job opinion poll.

For following class period: one page essay "What My Life Will Be Like In 10 Years From Now."

Day 2

Realize that each family is individual.

Mothers working outside the home cause differences and problems.

Identify role of women in world of work.

Relate trend toward early marrage and parenthood.

Outside agencies have assumed responsibility to care for children at an earlier age.

The changing status of women is resulting in greater freedom and equality in vocational opportunities.

More jobs are being opened to women.

Though marriage is a major goal for many girls, deeper considerations is being given to the development of vocational skills which will serve them before and after marriage.

Panel by students on working and nonworking mothers.

Why do women work?

Are women too independent today?

What about the women's liberations movement?

What are poor reasons for seeking employment?

Under what conditions would it be understandable for women to seek employment?

What values cause women to seek employment?

What extra expenses result from women working?

Relate unit.

Day 3

Evaluation

Mastery Test

OPINION POLL -- A SUGGESTED EVALUATION DEVICE

Directions: This opinion poll is concerned with your feelings about working situations. Check those statements with which you tend to agree in the first column; check those with which you tend to disagree in the second column.

	Tend to Agree	Tend to Disagree
1. Pay is the most important consideration when deciding upon a job.		
2. If a typist gets her required work done ahead of time she should be able to leave the office early.		
3. Being an "eager beaver" is the way to succedd on a new job.		
4. Supervisors have the right to criticize employees about their clothes.		
5. Sales people should be allowed to chew gum if they enjoy it.		
6. It takes careful planning to be punctual.		
7. Wearing metal hair clips to work is considered poor grooming.		
8. One should attempt to establish close relationships with co-workers early in employment.		
9. It should be permissible to make personal phone calls if work slackens.		
10. A worker's criticism of a superior is harmless, providing it is done in private.		
11. Employees have the right to talk back to their employers whenever they feel they have been treated unjustly.		
12. Employees should be able to have inexpensive business supplies for personal use without feeling guilty.		
13. Failure to notify an employer when absent from work is a major offense.		
14. Getting along well with people is just as important as the ability to do a job well.		
15. Griping is a harmless way of getting rid of unhealthy emotions.		

	Agree	Disagree
16. Most jobs are boring.		
17. During periods when work slackens it is wise to "look busy".		
18. Education and training are over-estimated by employers.		
19. Workers should not attempt to do something unless they are specifically told to do so.		

This may be used as a pre-test of student attitudes.
Can be used as a guide for class descussion.

3. Dietician
4. Institutional food service manager
5. Caterer
6. Technician in food research laboratory
7. School lunch manager
8. Home economist for business enterprise, demonstrator
9. Cooking school teacher, director
10. Teacher of adult education courses in foods
11. College teacher of foods, nutrition
12. Nutrition consultant for social agencies, businesses

III. Home and Industrial Management and Supporting Services

A. Accupations requiring High School training
1. Homemaker's assistant part or full time in private home
2. Housekeeping aide in nursing or rest home
3. Hospital housekeeping aide
4. Hotel or motel housekeeping aide
5. Visiting homemaker for elderly or handicapped person
6. Management aide in public housing project
7. Manager of home in absence of wife or mother
8. Personal shopper
9. Companion for elderly person
10. Information clerk in nospital
11. Receptionist in hospital or nursing home

B. Occupations requiring advanced training or higher education
1. Supervisor, manager of rest home
2. Family financial advisor
3. Teacher of adult education course in management
4. College teacher of home management house
5. Director of home management house
6. Manager in public housing project

IV. Home Furnishings, Equipment, and Services

A. Occupations requiring Hign School training
1. Sales person in furniture store
2. Florist helper
3. Demonstrator of equipment and products
4. Research technician in laboratory testing products and equipment
5. Appliance sales person
6. Assistant to drapery or slip cover seamstress
7. Sales person in fabric shop
8. Drapery, slip cover seamstress, self-employed
9. Upholsterer helper
10. Sales person in drapery shop

B. Occupations requiring advanced training or higher education
1. Manager of small home furnishing business
2. Buyer of home furnishings in department store
3. Interior designer, consultant
4. Kitchen planner, consultant
5. Furniture designer
6. Landscape planner
7. Floral designer
8. Consultant for manufacturer of equipment
9. Research technician in equipment testing laboratory
10. Window trimmer
11. Real estate consultant

V. Clothing Management, Production, and Services

A. Occupations requiring High School training
1. Fitter or seamstress in clothing alteration
2. Clothing service aide
3. Dressmaker's assistant
4. Dressmaker,,self-employed
5. Worker in a garment factory
6. Worker in laundry, cleaning establishment (alterations)
7. Manager of coin-operated dry cleaning establishment
8. Sales person in dress shop
9. Sewing machine demonstrator
10. Fashion model

B. Occupations requiring advanced training or higher education
1. Research assistant in textile laboratory
2. Textile designer
3. Buyer of dresses in department store or dress shop
4. Fashion designer
5. Fashion journalist
6. Consultant to manufacturer of laundry products and equipment
7. Manager of dress shop

VI. Combination of Home Economics Areas

A. Occupations requiring advanced training or higher education
1. Teacher of home economics classes in high school, college, or adult education
2. Extension worker, home adviser
3. Editor or assistant in publishing magazines, newspapers, business literature
4. Advertising editor, writer
5. Coordinator, writer for radio and television programs
6. Demonstrator on television
7. Homemaking consultant
8. Writer of women's columns, homemaking books.

VII. Other Related Occupations

A. Occupations requiring High School training
   1. Cosmetology, hairdresser apprentice
   2. Welcome Wagon hostess, visitor of newcomers
   3. Salesperson, demonstrator of cosmetics
   4. Gift wrapper

B. Occupations requiring advanced training or higher education
   1. Airline, bus, or train hostess
   2. Cosetologist, hairdresser
   3. Manager of beauty shop
   4. Window trimmer
   5. Floral designer
   6. Adult teacher of flower arranging

U.S. Department of Labor, Dictionary of Occupational Titles, 3rd ed. (Washington D.C., USGPO, 1965.

BIBLIOGRAPHY

I. Books

Bass, Ruth. Teen Career Guide. New York: MACO Publishers, 1967.

Ludwig, Amber C. The Bissell Guide to House-Keeping for Young Homemakers. New York: Bantam Book, 1967.

Venn, Grant. Man, Education, and Work. American Council on Education. Washington, D.C., 1969.

II. Periodicals

"Career Opportunities." New York Life Insurance Company, New York, 1958.

"Descriptions, Definitions and Occupational Coding System." State of Illinois, Springfield, Illinois.

"Pre-Employment Unit, Grade 7." Illinois Teacher of Home Economics, Vol. XI, No. 4, Spring 1967-68.

"Pre-Employment Unit, Grade 8." Illinois Teacher of Home Economics, Vol. XI, No. 5, Spring 1967-68.

"The Family Today." White House Conference on Children and Youth, Department of Home Economics--NEA, Washington, D.C., 1960.

III. Curriculum Guides

Home Economics, A Tentative Guide Curriculm for Junior H.S.. Palm Beach County School. Palm Beach, Florida. 1966.

Industrial Notes for Homemaking. Grade 7-12. 1967. Evansville-Vanderburgh School Corporation. Evansville, Indiana. 1967.

CHILD CARE OCCUPATIONS: CLASSROOM

A Paper

Presented to

Dr. Louise Smith

Northern Illinois University

By

Doris O'Hara

3098

RATIONALE

Students who leave high school today must find a job in our society. Boys and many girls need to find a rewarding job in which they will spend many days of their lives earning money. Training for a job related to child care occupations offers a student an excellent opportunity for employment after high school and valuable experience for their future families.

This course is designed for juniors as a prerequisite to the home economics occupations on-the-job training program in child care offered to 12th grade level students at the Whiteside Area Vocational Center (WAVC). Students at the WAVC will receive classroom instruction and on-the-job training in nurseries and day care centers in the Sterling-Rock Falls area. Some students will receive training at the Dixon State School for the mentally retarded. The students will work with children 14 years of age and under.

The course content and textbooks were decided at an all day meeting of all home economics teachers teaching in schools that participate in the WAVC. The students in each school will receive approximately the same instruction. This will help to give the students the proper start toward their on-the-job training the following year.

The developmental tasks from Developmental Tasks and Education by Robert H. Havighurst which apply to this course are:

1. achieving assurance of economic independence.
2. selecting and preparing for an occupation.
3. preparing for marriage and family life.

After completing this course, the students should have a start toward mastering these developmental tasks of adolescence. In addition, the students will be familar with the developmental tasks children must accomplish as they grow.

The text used for the course is entitled Child Care and Development by

Louise Bates Ames. The text was first printed Spring of 1970 and is presented in a unique manner. The book is written to tell the students things they need to know about young children and about the students themselves because human behavior is all of one piece. It states its information from the developmental point of view. There is no division by ages. Instead the child grows up all in one piece. The text was chosen because of this approach to child care and the developmental tasks of children.

There is no prerequisite for this course in child care occupations. It is open to both boys and girls of junior and senior standing. The juniors will be the only ones who can participate in the training program. However, the seniors taking the course will receive valuable information about caring for children and give them a knowledge of employment opportunities. The class will meet everyday for 80 minutes.

In the immediate Tampico area there are very few opportunities for employment. Most high school students earn money by babysitting. Many mothers work in nearby factories such as General Electric or clerk in stores in Sterling-Rock Falls. Students babysit after school and all day during the summer. This course will also help students with future employment experiences while in high school.

OVERALL OBJECTIVES

1. Have a functional understanding of the basic concepts of child development.
2. Develop a positive attitude toward children.
3. Accept children as individuals.
4. Understanding of the continuing effects of both heredity and environment.
5. Have the ability to plan, prepare, and serve simple nourishing meals and and snacks for children.
6. Be capable of directing individual or group activities of children such as story telling, games, play, and various creative experiences.
7. Understand the selection, use, and care of various games, play apparatus, toys, and supplies.
8. Recognize that caring for children is an important worthwhile job.
9. Be familiar with employment opportunities in this field.
10. Have an acquaintance with various types of child care facilities and standards required.

BASIC CONCEPTS

1. Behavior cycles
2. Individuality
3. Prenatal Development
4. Physical Development
5. Intellectual Development
6. Emotional Development
7. Routines in a child's life
8. Living in a family unit
9. School and the child
10. The child with problems
11. Employment opportunities

BLOCK PLAN--CHILD CARE OCCUPATIONS: CLASSROOM

PART ONE--The Child Himself

- Ages and Stages
- Every Child an Individual
- The Nine Months Before Birth
- The First Year of Life
- The Child's Body
- Sense of Self
- The Child's Emotions

PART TWO--The Child in His Home: Routines

- Infant Care
- Eating Behavior
- Sleeping
- Toilet Training

PART THREE--The Child in His Home: Family Living

- Mothers and Fathers
- Brothers and Sisters
- Discipline
- Guiding the Child's Play
- Family Size and Structure
- Family Living

PART FOUR--The Child in School

- Nursery School Experiences
- Nursery School Techniques
- Kindergarten and Primary School
- Tests

PART FIVE--The Child With Problems

- The Child's Health
- Tensional Outlets
- Behavior Problems

PART SIX--Employment Opportunities

- Foster Homes--Adoption Agencies
- Licensed Day Care Centers
- Licensed Day Care Homes
- Nursery Schools
- State School and Institutions

JOB-ORIENTED CHILD-CARE

(A Semester Course)

"This is Reginald—good luck and God bless you."

Home Economics 450

Dr. Louise Smith
Northern Ill. U.

July 30, 1970

Jacqulyn J. Albright

Mary Alice Husfeldt

JOB-ORIENTED CHILD-CARE

Overview

Job-oriented child care has been developed to extend the curriculum into the area of gainful employment in accordance with the vocational acts of 1963 and 1968.

The course, available to girls in grades 10, 11, and 12, will deal with the 2-5 year old child only as this is the greatest age group found in most child care centers.

This unit is one semester, two hours daily. A following unit will take the student into child care centers for the work related cooperative program.

UNIT I

RELATIONSHIP WITH CHILDREN

"If you're serious about building a better relationship, stop calling him Charley—his name is Fred."

JOB-ORIENTED CHILD CARE

(A Semester Course)

10th, 11th, 12th Grade Level

UNIT I: RELATIONSHIP WITH CHILDREN

Major Concept: The primary purpose of the family and society is the total development of the individual from infancy to maturity.

Objectives:

1. To recognize the relationship of the family background to the adjustment of the individual into society.
2. To appreciate the role which the family substitute may play in the care of the child in our society.
3. To be aware of the various employment opportunities related to the care of the child and his development.

Generalizations	Course Content
In all known societies there is a recognized unit that assumes the functions of child bearing, regulation of behavior, and economic support.	I. Relationship with Children A. Responsibilities of the family toward the development of the child. 1. Physical responsibilities 2. Cultural & Economic responsibilities
The family is the fundamental unit of our society.	B. Responsibilities of family substitutes toward the development of the child.
Family life provides an avenue for the transmission of cultural patterns from one generation to another.	1. Why family substitutes are necessary a. Economic Reasons b. Physical & Health Causes c. Moral & Cultural Influences
The degree of security which a child develops is determined by the atmosphere of adequacy and acceptance expressed in the family.	2. How the family substitute functions a. Part time assistance b. Full time institutions
The complexity of modern life sometimes makes it necessary for the family to call on others to assist with the care of children.	

Society provides various agencies and individuals to help with the rearing of children.

Good rapport with children will increase the effectiveness of the family substitute. employee.

C. Responsibilities of the family substitute employee toward the development of the child.

1. Sincere liking for children
2. Ability to work cooperatively
3. Ability to communicate with children.
4. Understanding of child development and behavior
5. Skill in directing appropriate activities for children of all ages.

Student Activities:

Read Chapter I of The Developing Child by Brisbane. (This is the student text). Discuss the statement "The Child is the Father of the Man."

View and discuss the following films in relation to responsibilities toward the developing child.

"From Generation to Generation."; McGraw Hill Films, 330 W. 42nd Street, New York
(Shows basic facts of human reproduction using animation.)

"The Deep Well"; Health, Education & Welfare Center, 10 E. 44th St., New York
(Shows foster home program and how to use it.)

Listen to a parent of an adopted child tell of values and problems of adoption

Visit a day care center. Evaluate the role it plays in the development of a child. List the qualities that a worker there needs to successfully do her job.

Evaluation:

In essay form, compare the role of the family substitute to the role of the parent. (This could also be done in graphic form if the student is creative.)

Student References:

Ames, Louise Bates, Child Care and Development, Lippincott & Co., Philadelphia, Chapter 18, pp 254-272.

***Brisbane, Holly; Riker, The Developing Child, Chas. Bennett, Co., Inc., Peoria, Ill., 1965 Chapter 1, pp 12-25.

Hurlock, Elizabeth, Child Growth and Development, McGraw Hill, New York, 1956. Introduction, pp xiii-xvii.

Shuey, Rebekah, M, Woods, & Young, Learning About Children, Lippincott & Co., Chicago, 1958. Part I, pp 3-30 Your Role with Children; Part II, pp 31-78..The Family & Living Today.

***Text for Class.

Teacher References:

Becker, Howard, & Hill, Family, Marriage and Parenthood, D. C. Heath, Boston, 1955. Chapters 5, 21, 22, 23.

Hurlock, Elizabeth, Child Development, McGraw Hill, Co., New York, 1964. Chapter 14, pp649-703.

UNIT II

DEVELOPMENT OF THE CHILD

SPOON-FEEDING RHYME

By GEORGIE STARBUCK GALBRAITH

One for the baby;
Two for the floor;
Three for the high chair;
Oops! . . . dropped *four*.

One for his left ear;
Two for his chin;
Three for the baby . . .
I got *that* in!

UNIT II: DEVELOPMENT OF THE CHILD

Major Concept A: The total growth process is affected by the interaction of heredity and environment.

Objectives:

1. To understand the role of heredity and environment in the growth process.

2. To appreciate the type of environment which will best suit the child in his quest to satisfy basic needs and reach full maturity.

3. To contribute to the establishment of a favorable environment which will facilitate growth in the child.

Generalizations	Course Content
The basic pattern of human growth is determined through laws of heredity.	II. Development of the Child A. Heredity and its role in the growth processes of the child. 1. Physical hereditary factors 2. Mental hereditary factors
Patterns of human growth are altered through varying effects of environmental conditions.	B. Environment and its role in the growth process of the child 1. The home environment a. Economic influences b. Cultural influences
The responsibility of the parent is to provide an environment which will lead to satisfaction of the child's needs.	2. The geographical environment a. Climatic influences b. Community influences
The environment of a child care center should reinforce and/or contribute to the satisfactory fullfillment of a child's growth toward maturity.	(1) School (2) Societies & Organizations

Student Activities:

Read and discuss Chapter 2 of Brisbane's The Developing Child, pp 27-30.

View and discuss the following films:

"Baby Meets His Parents", (U of Ill.)
(Shows relation of heredity and environment to personality.)

"Children Around the Globe", (Eye Gate Co.,)
(Showing hereditary and environmental influences.)

Read from numerous books, pamphlets, and articles relating to human reproduction. Write brief summaries of the articles or give oral reports.

Chart hereditary characteristics in the family or bring pictures of family members and point our hereditary characteristics.

Listen to a foreign exhhange student tell of environmental influences on his growth pattern.

Prepare a bulletin board of pictures of children from around the world. Point our influences of heredity and environment.

Evaluation:

Debate the importance of hereditary vs. environment in the development of children.

Major Concept B: In the developmental process, growth is physical, intellectual, emotional, and social, and all are interrelated.

Objectives:

1. To recognize the interrelationship of all appects of growth.
2. To appreciate the laws of sequence and maturation which accomplish general similarities and basic trends of development.
3. To be aware of the patterns of personality development.
4. To discriminate between acceptable and unacceptable behavior patterns...and to help the child learn to discriminate.
5. To assume responsibility for limits of children's behavior and to enforce them at times when the child is too immature to judge consequences of his own behavior.
6. To understand the nutritional needd of children.
7. To assist children in the formation of desirable food habits.
8. To be able to prepare and serve nutritious and appealing meals for children.

Generalizations	Course Content
Each child has a rate and pattern of growth which is individually his.	C. Patterns in the growth process 1. Sequential 2. Individual
Growth follows in basic	D. Parental responsibilities toward creating a satisfactory environment

trends due to laws of sequence and maturation

Clothing for children should be easy to clean not cumbersome, and simple enough for the child to manage.

The home should offer each individual a haven in which he may develop his individual personality.

Play activities are developmental activities and should be so constructed as to lead toward maturity and security in the society.

The child grows as an integrated whole--all aspects of growth are interrelated.

Learning to eat and enjoy a variety of nutritions foods is an important part of a child's development.

Meals for children should be simple, nutritious, attractive and carefully planned.

Personality patterns are influenced by many factors.

Emotions are an integral part of behavior

Adults who understand the growth processes that a child is experiencing are more capable of guiding him effectively.

There is a reciprical relationship between the family and society.

Each individual member affects and is affected by his family.

1. Meeting the child's physical needs.

   a. Food for children
   b. Clothing for children
   c. Housing for children
   d. Activities for children

2. Meeting the child's social needs.

   a. In the family
   b. In peer groups
   c. In the community

3. Meeting the child's intellectual needs.

   a. Speech and language skills

      (1) Reading
      (2) Drama

   b. Cultural development

      (1) music
      (2) science
      (3) art

   c. Creative development

      (1) Crafts
      (2) Imaginative activities

4. Meeting the child's emotional needs.

   a. Sibling security
   b. Parental acceptance

      (1) Discipline
      (2) Behavior

   c. Community contacts

      (1) Church
      (2) Civic Programs

Student Activities:

Following a lecture reviewing growth from birth through two years of age, read and discuss Chapters 10, 11, and 12 in Brisbane's The Developing Child concerning development in ages three to six.

View and discuss the following films:

"Principles of Development", U of Ill.
(Basic laws and patterns of growth.)

"The Terrible Twos and Trusting Threes" and/or
"The Frustrating Fours and Fascinating Fives" U. Of Ill.
(Show personality pattern development)

"Preface to a Life".
(Shows contrast between democratic and autocratic techniques in giving directions and how they relate to behavior)
"Helping a Child Accept the Do's and Don'ts".
(Discipline)
(Both of the above films are available from the Dept of Public Welfare in most states.)

Listen to a librarian talk on children's books. Prepare a book exhibit for parents.

Secure a table of normal heights and weights for young children. Compare with those of children who are in play school group or with a kindergarten group in the school system. Discuss variations in growth and other aspects not so easily measured.

Are we being realistic when we ask all second grade students to buy second grade readers, math books, and size 8 tennis shoes?

View and discuss the filmstrip "Your Child's Intelligence", N.E.A., Washington, D. C., $7.00 with recording of script.

Observe the eating habits of a group in the school lunch program of a primary school. Use the observation for class discussion to identify desirable and undesirable eating habits. Class may develop ways to encourage desirable habits.

Discuss punishment and decide on criteria which might be used to determine whether a certain type of punishment is desirable or undesirable. Use the criteria to evaluate the following:

physical punishment	threats
humiliation	isolation
praise	removal of priviledge
rewards	natural consequences

Evaluation:

A test of the following type may be used as a pre-test and again as an end test to evaluate student values and growth.

TEST ON INDIVIDUAL DIFFERENCES

Directions:

If you strongly agree with the statement, place a "2" in the Agree column.

If you somewhat agree, place a "1" in the Agree column.

If you strongly disagree, place a "2" in the Disagree column.

If you somewhat disagree, place a "1" in the Disagree column.

If you are puzzled as to whether you agree or disagree, place a question mark between the two columns.

Agree	Disagree		
( )	( )	1.	Each child has a tempo and style of growth which are as characteristic of his individuality as are the features of his face or his finger-prints.
( )	( )	2.	The basic pattern of development is the same for all children.
( )	( )	3.	Brothers and sisters in the same family are usually so similar that it is possible to treat them all alike.
( )	( )	4.	Infants are individuals from the moment of birth.
( )	( )	5.	Scientific studies show that the individual charagteristics of infants do not persist into later life.
( )	( )	6.	By the time a child reaches school (5 or 6 years of age) has ways of thinking and working are basically formed.
( )	( )	7.	Children who are intellectually ambitious in their early years tend to remain so as adults.
( )	( )	8.	Very little learning takes place during the pre-school years because the child is too immature.
( )	( )	9.	It is difficult to measure human growth precisely because of its many variations.
( )	( )	10.	Babies are very much alike at birth-the differences which become apparent as they mature are due entirely to environmental factors.

Directions for scoring:

1. Mark statements 1,4,6,7, and 9 as true statements on your

key copy. Mark statements 2,3,5,8, and 10 as false statements on your key copy.

2. On true statements give 10 points for each "2" in the Agree column and 5 points for each "1" in the Agree column.

3. On false statements give 10 points for each "2" in the Disagree column and 5 points for each "1" in the Disagree column.

4. Give no score for question marks.

WHAT WOULD YOU SAY?

(A means of evaluating pupil concepts)

One Pennsylvania teacher devised a quick and subtle way to evaluate pupil concepts. She merely described a simple situation and asked the pupils what they would say to the child involved. Their responses were then placed on the blackboard (without names) and used as the basis for class discussion.

Following is a sampling of some responses which revealed some very inadequate concepts concerning the nature of a two year old:

The situation:

Johnny (age 2½) was so busy playing he forgot to go to the toilet. Now his pants are wet and there is a puddle on the floor where he was playing. WHAT WOULD YOU SAY TO JOHNNY?

"Johnny, be good and try to make it next time."

"Oh, Johnny, you were working so hard that you forgot to go to the bathroom! Try and remember next time. You're getting to be a big boy now."

"Johnny, you should have gone to the bathroom. Now go and change, and then clean it up."

"Don't be ashamed. All little ones do it."

"That's all right, Johnny, I'll clean it up."

"I would ask him to try and be careful, and I would say that he should not play unless he knows when to stop."

"I would say, Johnny, why didn't you tell me so that I could have taken you to the bathroom? The next time you tell me."

"I would say to Johnny that he is a big boy-and big boys don't do that. Tell me next time."

Both evaluation devices taken from Preparing for Employment in Child Care Services in Pennsylvania, pp 49-51.

Major Concept C: Play is the business of children--moving them toward development of full potential.

Objectives:

1. To understand the role of play in the total growth process.
2. To be able to select play materials suited to the age, interest, and ability levels of the children concerned.
3. To learn how to improvize play materials from inexpensive, commonplace materials.
4. To engage in the supervision of creative experiences.
5. To cooperate with children in developing meaningful play activities.
6. To gain the cooperation of children in caring for play materials.
7. To establish a cooperative working relationship with parents in helping toward development of the child.

Generalizations	Course Content
Through play a child discovers his senses and his muscles.	E. The role of play and play equipment in the growth process
Pre-school children need many opportunities for free play.	1. Selecting play materials a. Motor b. Mental
Safety is important when selecting toys for children.	2. Creating play materials
Through play, children learn to cope with their environment.	3. Directing meaningful play a. Safety b. Rules
A child's creativity and imagination can be fostered through experiences with books.	4. Sharing related play ideas with parents
Adult standards and ideas should not be imposed on the child.	
Music activities provide creative outlets for preschool children.	

Student Activities:

Evaluate children's books...bring one to class and report on its value in relation to standards established by the class.

Have a skillful storyteller present a demonstration of story telling to the class.

Practice reading stories orally.

Establish criteria for selection of toys and play materials. Bring a toy to class and evaluate it according to the standards.

Report on one of the following personality characteristics and relate how play could be used to overcome the problem.

shyness	stuttering
baby talk	fear

Participate in the story hour at the public library.

Prepare a simple toy or homemade play media. Examples:

can stilts	gingerbread baking
fingerpaint	rhythum band
candlewax modeling	cutting and pasting

Practice fingerplays and nonsense rhymes to use with children.

Assist in playground supervision.

Evaluation:

A number of the above activities could be used to evaluate the student's understanding of principles of play and of selecting play equipment.

Student References:

Brisbane, Holly, and Riker, The Developing Child, Chapters 10, 11, 12, and 16.

Ellis, Mary Jackson, Fingerplay Approach to Dramitization.

Goda, Sawako, Fun with Junk.

Shuey, Rebekah M., and Wood, and Young, Learning about Children, Part 4, Two to Six Years.

Wycoff, Joan, Do It Book, Golden Press, New York.

Child Bureau Publications:

Accidents and Children
Food for Groups of Young Children Cared for During the Day
Home Play and Equipment
Your Child from One to Six

A Healthy Personality for Your Child

Tots at the Table...Food Guide for Children 1-6, National Live-Stock and Meat Board, Chicago.

Sears Roebuck & Co, Infants' and Children's Clothing, Equipment, and Toys.

Ross Laboratories, "When Your Child is Unruly", Ross Laboratories, Columbus Ohio, 43216, 1965.

Teacher References:

Becker, Howard, & Hill, Family, Marriage and Parenthood, D. C. Heath, Boston, 1955. Chapters 14, 16, 20.

UNIT III

RESPONSIBILITIES IN CARING FOR CHILDREN

"He's awfully quiet. You'd better see what he's doing in the bathroom."

THE SATURDAY EVENING POST

UNIT III RESPONSIBILITIES IN CARING FOR THE CHILD

Major Concept: An effective child care center provides for the entire personailty development of the child and requires teamwork on the part of all persons participating in it.

Objectives:

1. To establish guides for developing a quality child care center.
2. To be able to work cooperatively with others.
3. To learn objectivity in observation.
4. To appreciate desirable activities for child care participants.
5. To develop creativity in planning activities for a child care program.

Generalizations	Course Content
All people have intellectual, emotional & physicalneeds. The school is one institution formed by man to meet these needs.	III. Responsibilities in caring for the child (relating to child care centers).
	A. Purposes of the Child Care Center
	1. Social Experiences
	2. Personal Growth
	a. Self-identity b. Self-reliance
	3. Cultural Enrichment
	4. Safety for the Child
Pre-school attendance can reduce sibling rivalry.	
Pre-school participation may offer cultural enrichment.	
Participation in planning increases interest in a project.	
Participation in planning develops an awareness in problems and objectives.	
Written records provide (1) means of communication, and (2) form a basis for evaluation of a child's progress.	
Objectivity is an important consideration when reporting play school observations.	
	B. Physical Preparation of the Child Care Center
	1. Activity areas
	a. Indoor
	(1) Supervised Activities (2) Free Play (3) Group Activities
	b. Outdoor areas
	(1) Playground equipment (2) Gardens (3) Animal Shelters
	2. Rest

Opportunities for free activity enables a child to develop and explore h his own interests.

Provision for free activity requires variety in and serveal choices among material, equipment, and environment.

A child engages in many different types of activities which contribute to various aspects of development.

The type of storage facilities for equipment and materials affects their condition and accessibility.

Prompt and adequate clean-up at the conclusion of a play time contributes to growth and development of children and to the operation of a child-care center.

Records of health, attendance, field trips, amount of food purchased for a snack or meal affect the operation of a child-care center.

3. Toilet Areas

4. Observation Arrangements

5. Storage Facilities

C. Employee Responsibilities

1. Participation

a. Supervision

b. Observation

c. Operational

2. Objectivity

3. Cooperation

D. Program Development

1. To suit needs of child enrolled

2. To fit into schedule of school program

3. Flexible but planned

Student Activities:

Visit a child-care facility when it is not in operation to inspect the types of equipment and materials included and to evaluate them for a child-care activity in school.

Practice writing brief objective anecdotal reports of incidents occurring in the nursery school. Use them for class discussion and evaluation.

Formulate a guide for trainees to use when guiding play activities in the child-care center.

Develop "Guides for the Observer".

Observe a child, using the observation guide and report findings.

Evaluation:

Observe students as they guide children's activities.

Each student lists ways she uses principles of guidance when supervising the children.

Student References:

Brisbane, Holly, The Developing Child, Chapter 17, Health and Safety.

Children's Rooms and Play Yards. A Sunset Book; Lane Book Co. Menlo Park, Calif.

Hatcher, Hazel and Andrews, Adventuring in Home Living, D.C. Heath Co., Boston

Read, Katherine M., The Nursery School. W.B. Sanders Co., Philadelphia

Teacher References:

Budget Guides for Day Care Centers. State of Ill., Dept. of Children and Family Services.

Wylie, Joanne, A Creative Guide for Pre-School Teachers.

UNIT IV

OCCUPATIONS RELATED TO CHILD CARE

"I'm the sitter. They're donating their services."

UNIT IV OCCUPATIONS RELATED TO CHILD CARE

Major Concept: Child Care Occupations offer a range of work potential in most communities to an individual with less than professional training.

Objectives:

1. To examine the possible phases of child care occupations.
2. To determine the skills needed by an employee in child care occupations.
3. To develop effective skills for an employee of child care institutions.
4. To evaluate the security of occupations which relate to child care.
5. To develop habits and attitudes which will lead to successful employment.

Generalizations	Course Content
Legal regulations control agencies and institutional groups which have assumed functions previously performed by families.	IV. Occupations Related to Child Care A. In the home 1. Sitter
Characteristics of physical, social, emotional, and mental development contribute to employability.	2. Parent Helper 3. Foster Parent
An understanding of other people's viewpoints is conducive to harmony in human relations.	B. In Centers 1. Day Care 2. Institutions a. Orphanages b. Hospitals
Understanding of employer-employee roles clarifies responsibilities and duties of personnel.	C. Criteria for child care employee 1. Personal Qualities a. Grooming
In the process of self-development the individual builds up a set of values which are important criteris for his working relations with others.	b. Personality c. Work Habits
Some of the most influential and compelling values are held unconsciously.	d. Social Standards

Grooming and personality will directly relate to the acceptance of a potential employee.

D. Employee-Employer Relations

1. He is boss
2. He is human
3. Rules of work
   a. What he may expect of you
   b. What you may expect of him

Student Activities:

Write a resume of your qualifications which make you a desirable employee.

Do a term paper evaluating one occupation relating to child care in depth.

Interview child-care employees and/or employers of various levels of responsibilities to determine kind and amount of training, education, and experience needed for employment.

Study references for requirements for various job levels.

Evaluation:

Student reacts to "How I Feel about Working with Children as Long Range Employment."

An end test including test questions of the following type would begin to establish evidence of student acceptance of the standards in the world of work.

T F

___ ___ 1. Occupational requirement ratings and our own ratings should compare favorable in most areas before we decide to pursue the occupation.

___ ___ 2. Publications such as magazines, newspapers, and pamphlets are good sources for judging occupational trends.

___ ___ 3. The primary issue or consideration in choice of an occupation should be the starting salary or wage.

___ ___ 4. We may find that our choice of vocation is a poor one because it does not adequately challenge us, a possibility that would be indicated on a rating chart of abilities when our personal ratings are higher than the demands of the job.

T F

___ ___ 5. There is little value in studying an occupation carefully and then discarding it as an unlikely choice.

Adapted from Workbook for Successful Living, by Eleanor M. Peterson, page 109

Student References:

Peterson, Eleanor M. Successful Living and Workbook to accompany text., Allen and Bacon, Inc. Chicago

French, Marilyn, The Dartnell Check List for Secretaries

General Related Study Guide from Missouri.

Gilles, Lambert L. Charting Your Job Future. SRA

The Job Ahead; State of Ill. Board of Voc. Ed.

Teacher References:

How to Train, Job Instruction Guide. Standard Brands, Inc.

Illinois Teacher of Home Economics Volume I #7; Volume VIII #2,3,4; Volume XII #1

Manpower-Development and Training Program, U.S. Printing Office

Part-Time Industrial Cooperative Education in Illinois, Bulletin #198. Vocational and Technical Ed. Division, Springfield, Ill.

A P P E N D I X

Train up a child in the way he should go, and walk there yourself, once in a while. —JOSH BILLINGS

SUGGESTED OUTLINE FOR THE STUDY OF AN OCCUPATION

1. Defination and code number of the occupation.
Use the definition given in the Dictionary of Occupational Titles, but interpret the definition in your own words.

2. What does the worker do?
The information given in the Dictionary of Occupational Titles describes what workers do generally in the United States. Look up other sources for the same kind of information. Visit local workers to get first-hand information about the tools and equipment they use. Explain what products or services result from this occupation.

3. U.S. Census data.
Find the most recent data about the number of men and women employed in this occupation. The Bureau of the Census furnishes occupational summaries for states, and for cities of 100,000 population and over. Consult your librarian for Census materials. The local Chamber of Commerce will supply data on local jobs.

4. Outlook for this occupation.
Consult the Occupational Outlook Handbook for references which will help in estimating the supply of workers, the changes likely to be made in the occupation in the future, the chief locations of the work and the trends expected.

5. Licensing and certification.
Does this occupation require workers to be licensed or certified? If so, what are the requirements in your community? Some occupations have no requirements of this type. Is this occupation unionized?

6. Geographical location of work.
Is this occupation open in your community or state? Must you move to another location for employment? Does the size of your community affect the availability of this occupation?

7. Working conditions.
Describe briefly the nature of the place in which the employee works...noisy, quiet, hot, cold, humid, dry, clean, dirty, etc. Note whether the work is seasonal. Are there busy times and dull seasons? Mention the hours of work, amount of night work, work in bad weather, unemployment, health risks, hazards, accident records, safety measures, and similar factors.

8. Pay and promotion.
Earnings are difficult to estimate unless recent studies of salaries have been made. Employers seldom reveal salaries, except in the range for beginning workers. Beginning wages should, therefore, be expressed in ranges "from$__ to $__." Also mention whether the pay includes tips, comissions, and other extras. What are the possibilities for advancement? What expeeience is necessary for the first promotion? What related occupations could this job lead to?

9. Requirements for the job.
These would include age, physical requirements, mental requirements, educational requirements and schooling. Do employers use tests of aptitude or ability for selecting workers? Are there requirements as to skill, initiative, judgement, and so forth?

10. Preparation for the job.
How should a person prepare for this occupation? What school courses are necessary and what are the tuition costs? Can the work be learned through vocational schools, work-experience programs, or apprenticeship? How long is the training program? What hobbies contribute to the preparation? What agencies can give information about training? Make a list of the schools in your state that offer instruction in this work.

11. How is employment found?
How do applicants for this work get their jobs--by personal application? by examination? through friends? through the employment office?

12. References for further study.
List the books and pamphlets that you have used in making this study. List associations and agencies that promote the work and provide information as a public relations service. List the names of local individuals who are likely to help young people with information about this occupations.

Adapted from suggested outline by Walter Greenleaf in Occupations and Careers, pp 156-157.

FINGER PLAYS and NONSENSE RHYMES

Good Morning

One day I saw a downy duck,
With feathers on his back;
I said, "Good-morning, downy duck,"
and he said, "Quack, quack, quack."

One day I saw a timid mouse,
He was so shy and meek;
I said, "Good-morning, timid mouse,"
And he said, "Squeak, squeak, squeak."

One day I saw a curly dog,
I met him with a bow;
I said, "Good morning, curly dog,"
and he said, "Bow-wow-wow."

One day I saw a scarlet bird,
He woke me from my sleep;
I said, "Good-morning, scarlet bird,"
And he said, "Cheep, cheep, cheep."

My Garden

I dig, dig, dig;
I plant some seeds,
I rake, rake, rake;
I hoe some weeds.
I wait and watch,
And soon right there
My garden sprouts---
It's in God's care.

Two Little Blackbirds

Two little blackbirds sitting on a hill,
(Hands closed with thumbs straight up for birds.)
One named Jack, (Wiggle one thumb)
The other named Jill, (Wiggle other thumb).

Fly away Jack, Fly away Jill
(Toss one hand at a time over shoulder)
Come back Jack, Come back Jill.
(Bring hands back one at a time.)

Bunny Song

Here is my bunny with ears so funny
And here is his hole in the ground.
When a noise he hears,
He pricks up his ears,
And jumps in his hole with a bound.

(Right fist forms bunny and two fingers his ears. Left hand closes to make a "hole".)

HOMEMADE PLAYTHINGS FOR THE PRESCHOOL CHILD

Hilda Dudieiak
University of Illinois

Train

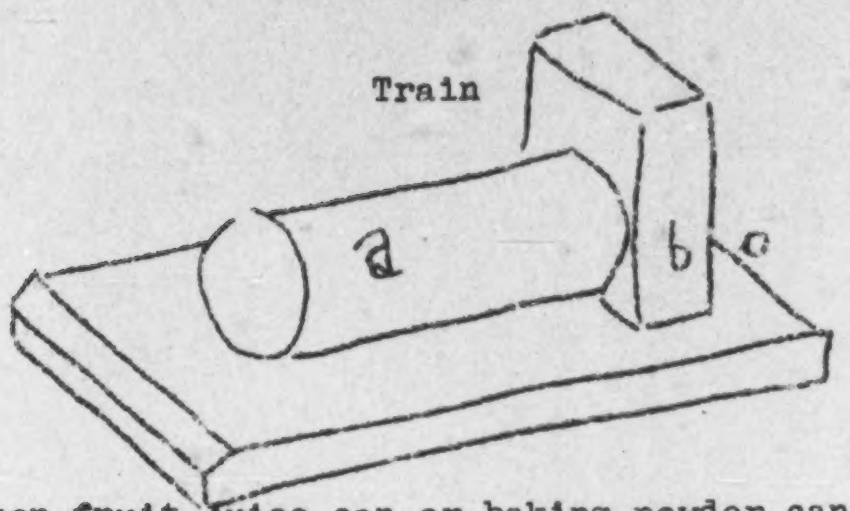

A. Frozen fruit juice can or baking powder can
B. Band aid can, spice can or cocoa can

Sand board, glue on cans and paint. A strong cement will last if it is given enough time to dry thoroughly. Add a screw eye. The hook is put on the next part of the train. Similiarly, on oil tank car or coal car, using a sardine can, may be made. Use floor gliders or upholstry nails on the bottom of the boards for easy maneuvering. Wheels may be added if desired.

Take-Apart Tug Boat

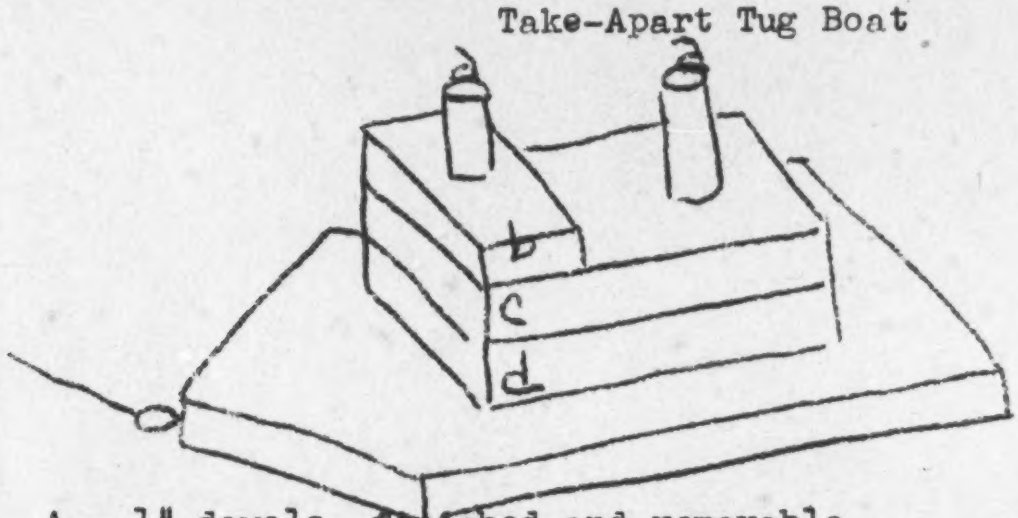

A...1" dowels, finished and removable
B,C,D...each piece of wood finished, proportioned to the piece used as the base.

Sand wood so there will be no sharp corners. Finish with varnish, paint or lacquer. Add a screw eye for string or cord, and gliders. Holes for dowels should be sanded so that dowels will slip in and out easily. Bore holes into base piece only ½ of the way so dowels will not slip through. Cost depends upon tools and supplies on hand.

margie

BY WENDE AND HARRY DEVLIN

"Sugar, Jerry?"

"More sugar?"

"More?"

"Is that too sweet enough?"

A Play Test Worth Giving

A toddler's readiness for the 3 R's can be shown by the 4 E's

Age 4 years is the suggested time to play the game and test.

As a game the 4 E's is fun! It offers a child the psychological lollipop of mother's undivided attention and, if the child wins (3 out of 4 do so easily), a sense of accomplishment.

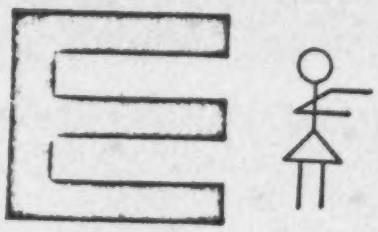

As a test the 4 E game has a double purpose:

1) If the child wins you have the welcome reassurance that his eyes are as sharp as they are shining—that he sees as well as most children do—and, most of all, sees well with both eyes.

2) If the child fails to win—can't see the smallest of the 4 E's at a distance of 20 feet—you have a timely warning that his vision is not up to par and should be checked out by a medical eye examination.

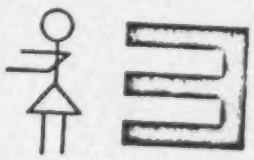

Here's how to play the 4 E game:

Step 1: You order the official game and full directions by mail (see box at the end of this article) and prepare an eye cover card according to directions.

Step 2: You show the child (who keeps both eyes open) how to perform his part by doing it yourself and helping him copy-cat your motions (see directions).

Step 3: And this is both the game and the test, given with one of the child's eyes covered. You display the 4 E's in four different positions (legs up, down, to the right and to the left) at the distance of 20 feet. In each instance the child shows with his arm the direction in which the legs are pointing.

Some children will complete the game first time around. Others will start well and then goof-off. When this happens it's best not to urge. Try again!

Goal: for the child to see the littlest E in all 4 positions. It's a cinch for some children.

Of course, some can't win! It goes without saying that even though you will be naturally concerned at failure, the child should not be made to feel out-of-it!

The same day you play the 4 E game is none too soon to start arranging for an examination for the child who can't win. You will probably want to talk first with your pediatrician and follow his recommendations as to an eye specialist or an eye clinic.

To get the game which includes a chart of the four E's and directions for use: Send 25¢ to Prevention of Blindness Society, 917 15th St., N.W., Washington 5, D.C., requesting "Check Your Eyes."

3132

GROWTH AND DEVELOPMENT

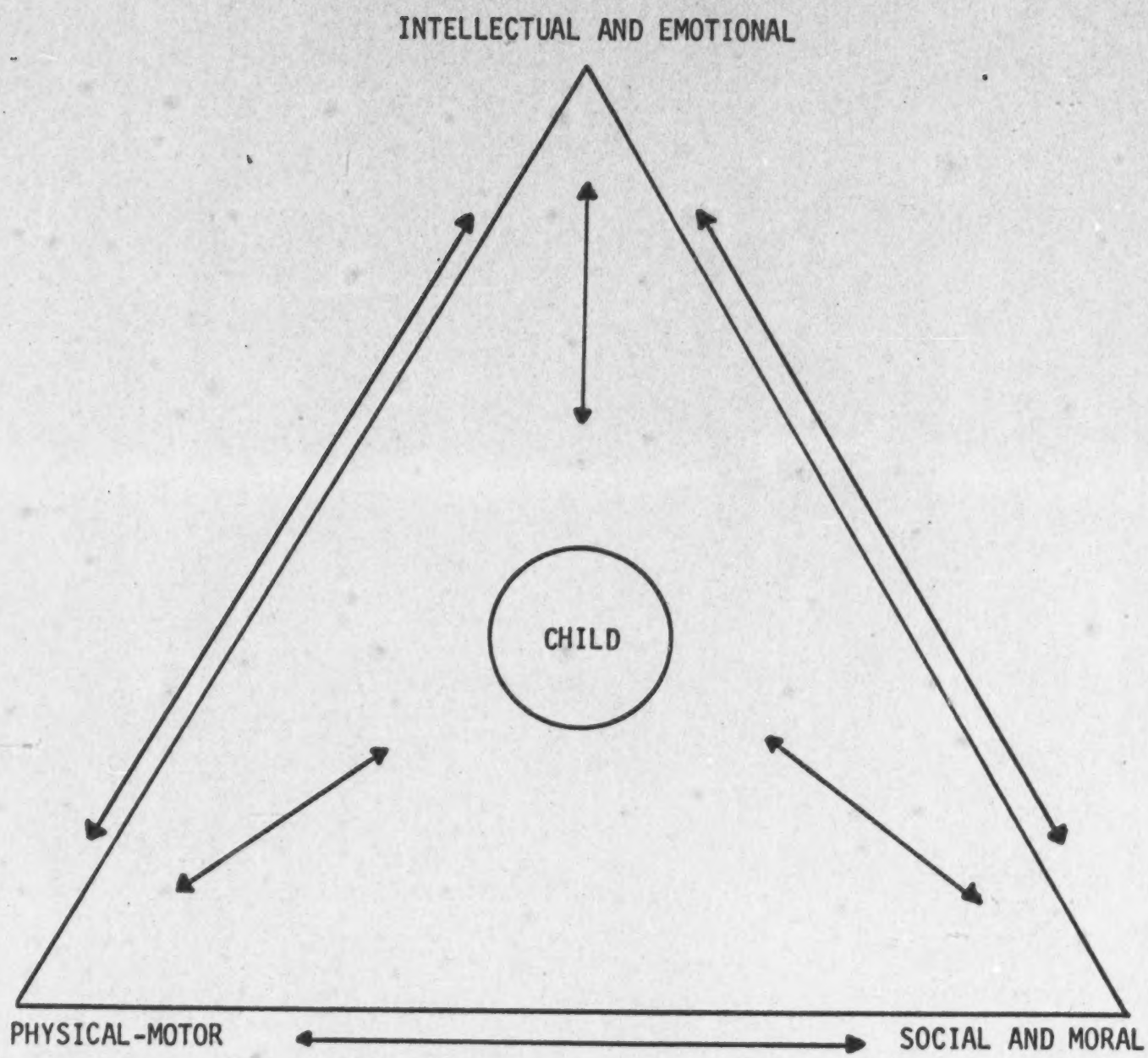

PRINCIPLES OF DEVELOPMENT

It is important that you, as a child care aide, have an understanding of the basic characteristics or principles of development. These principles are:

* Development is similar for all--The infant's head becomes functional before his hands. He uses his mouth, eyes, and ears before he can grasp objects. He becomes somewhat skillful in using his hands before he learns to control his feet.

* Development proceeds from general to specific responses--The baby waves his arms freely before he is capable of reaching for a specific object.

Here are the five little pigs who went off to market, Fig. 1 --the small one who cried all the way home, Fig. 2, and the four more jolly-looking members of his family, Figs. 3-6.

Trace the pigs and color them. They look well with rosy cheeks and pink noses and ears. Choose a color for the bow in the first pig's bonnet, Fig. 3. Then fold each head along the dotted lines, pasting each tab inside the back section and also pasting together the ears of the two sections. When the paste has dried, put each head over the proper fing and you are ready to tell the story of the five little pi Fig. 7.

With a set of pigs finished, try drawing rabbits, nam them Flopsy, Mopsy, Cotton-tail, Mrs. Rabbit, and Pet like the characters in "The Tale of Peter Rabbit." (CHILDCRAFT, volume 3, pages 37-42.) Then you can pa the heads and use your puppets to tell the story of Pe Rabbit.

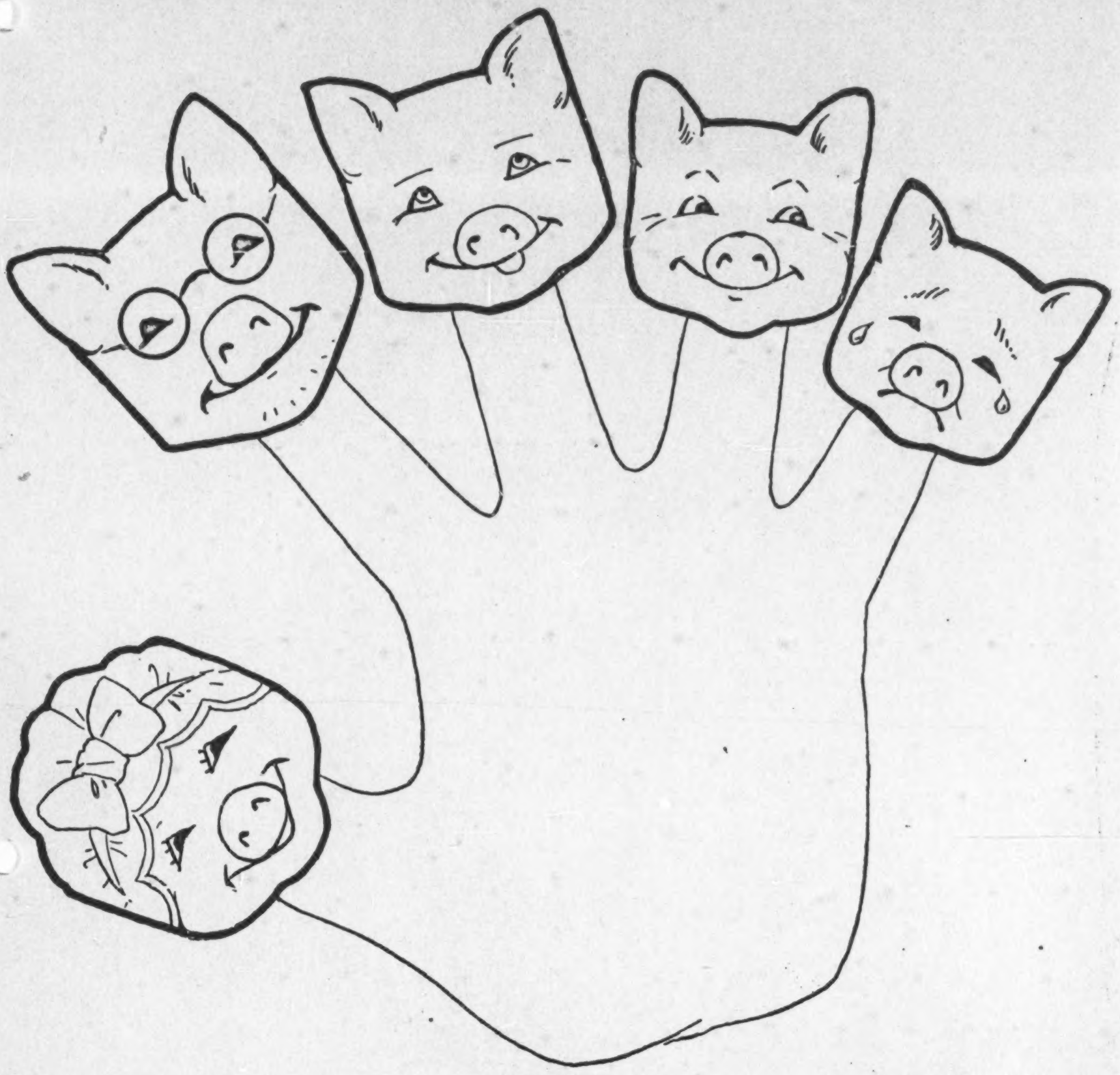

Fig. 1

How Much Money Have You Thrown Away Today?

MINUTES ARE MONEY!

WHAT "ONLY FIVE (5) MINUTES" LOST TIME EACH DAY, COSTS!*

HOURLY RATE	5 EMPLOYEES	10 EMPLOYEES	25 EMPLOYEES	50 EMPLOYEES	100 EMPLOYEES	500 EMPLOYEES
$1.25	265.60	531.20	1,328.00	2,656.00	5,312.00	26,560.00
1.50	318.80	637.50	1,594.00	3,180.00	6,376.00	31,880.00
1.75	371.90	743.80	1,859.40	3,719.00	7,438.00	37,190.00
2.00	425.00	850.00	2,125.00	4,250.00	8,500.00	42,500.00
2.25	478.10	956.20	2,390.50	4,781.00	9,562.00	47,810.00
2.50	531.30	1,062.50	2,656.50	5,313.00	10,626.00	53,130.00
2.75	584.40	1,168.80	2,922.00	5,844.00	11,688.00	58,440.00
3.00	637.50	1,275.00	3,187.50	6,375.00	12,750.00	63,750.00

*BASED ON 8 HR. DAY, 5 DAY WEEK, 255 WORKING DAYS PER YEAR, OVERHEAD COST TAKEN EQUAL TO HOURLY RATE

Cincinnati
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PROPOSAL FOR
PROGRAM RESTRUCTURING
FOR
EXPANDING OPTIONS IN
HOME ECONOMICS RELATED OCCUPATIONS
CHILD CARE AID
DEKALB SENIOR HIGH SCHOOL
DEKALB, ILLINOIS

HOME ECONOMICS 450
Dr. Louise Smith
July 30,1970

Submitted by:
Karen L. Radde

46 OF 327

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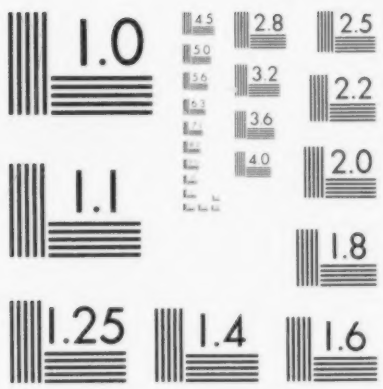

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Introduction

When vocational home economics programs were introduced more than 50 years ago, recognition was given to the importance of studying children in the family and to the role of the family in nurturing and protecting them. In the past years, American society has emphsized the importance of education for parenthood.

We have recognized the importance of the study of children in the family as witnessed by the newly implemented child development program offered to students at the secondary level. At this time, it is felt that this course and laboratory situation can further help in meeting the needs of students.

That need is for exposure to varying fields of gainful employment. Along with the exposure to various fields should come an opportunity to receive training for entry into a chosen occupation. It is also possible that this training would open the door to further education or training in a related field.

In addition to the child care related instruction, students in the program will be given information concerning work habits, attitudes, maney management, and job acquiring skills.

This proposal is for the introduction of a cooperative work-training program into the high school home economics curriculum.

Need

Student need in the community for increased opportunity has been demonstrated by the number of students graduating from high school without any plan for further training, education or employment. Many local students are unemployed or underemployed as a result of dropping out of school before graduation. We have a significant number of basic

humanities students who would benefit fron this exposure to and opportunity for training.

There is a growing need for child care workers in this community. At present, there are four licensed day care centers, 3 co-op nursery schools, 1 full-time migrant nursery school and two church nursery schools operating, in addition to the kindergartens of the school district. All facilities have expressed a desire for trained child care aids to be added to their staff. In addition, home care is also becoming more desired.

The need for trained woman-power is increasingly recognized as critical as women of today assume their dual role as homemaker-employee. In keeping with the philosophy of home economics education, it is our responsibility to provide training for gainful employment to these women.

Local school interest has been instrumental in encouraging this program. Counselors have expressed a need for more co-operative work programs for the girls in the student body. Administrators, particularly at the primary levels advocate the training program as they recognize the need for more adequate pre-school care and training.

The students, both boys and girls, have enrolled in the child development program to the extent that enrollment has been limited. Many students have expressed a desire to enter into a cooperative work training program in a child development-related area.

Survey

A home economics advisory committee should be formed to function in an advisory capacity in program policy, content and direction. It would be desireable to have one member of this committee also serve on the vocational advisory committee.

A survey of the student body and the community will also help in determining more concrete direction for the program. Included are possible surveys to be used.

The state employment office, community organizations and tentative employers will also serve as invaluable resource people for this program.

Implementation

Implementation of the program would include two distinct phases. Phase I of the program would go into effect during the 1970-71 school year. General home economicsI, currently offered to freshman students, would be restructured to include emphasis in vocational orientation, in all home economics areas, including day care. Job description, personal characteristics and job opportunity will be stressed.

Child development IIA and IIB would be offered, as planned. Again, emphasis on vocational orientation and opportunity along with marketable skills would be emphasized in the program.

Phase II would be initiated in the 1971-72 school year. Level III and IV of the child development program would be added to the curricul cirriculum. This would include the cooperative work program with related classroom experience.

Scope

Level I child care will be included in the general home economics I course at the ninth grade level. Areas in foods and nutrition, clothing grooming, personal relationships , home furnishings and management and child care will include introductory occupational information and experiences.

Level II Child Care will be included in specific semester courses with further orientation to occupational opportunities and skills.

Major emphasis in child careIIA will be needs,growth, development, behavior and guidance of children from the ages of 2-5, types of

care services in this community and skills needed to enter these 141 occupations.

Child care IIB will focus on the needs, development, behavior and guidance of the child from conception to the age of two. The parental role and responsibility will be used for reference.

Level III Child development and care will allow for cooperative employment in a local school district facility. Ideally, this facility would a nursery school or kindergarten.

Level IV child care and development will provide the student an opportunity for employment in a local community facility such as a nursery school, church nursery school, co-operative nursery school or in private homemaker service.

Both level III and IV training will include related classroom experiences in areas of needs, growth, development and guidance of the 6-12 year old child. Areas of special interest such as working with disadvantaged, handicapped, infant nutrition, art activities, science activities, first aid, etc., will be offered to meet individual student needs.

Actual orientation to the occupational world will be carried out in a team teaching situation with other cooperative students and supervisors from the fields of business, agriculture, industrial arts, and health services.

It may be noted that any junior or senior student currently following a college preparatory cirriculum may also elect to participate in this p rogram at any level. Especially at Level III and IV, the student may participate in the work related classroom activity, without entering into a cooperative work agreement. This student will complete an independent study agreement and pursue additional materials of interest, related to his chosen field in child development.

OVERALL OBJECTIVES FOR THE CHILD CARE AID TRAINING PROGRAM
LEVELS I- IV

To develop an increased awareness of the various job opportunities available to a child care aid.

To develop an awareness of and a desire to develop personal characteristics and qualities needed to succeed in a job.

To develop positive attitudes toward work as a part of life and a desireable part of education.

To acquire basic knowledge of needs, growth, development, behavior and guidance of children.

To develop a desire to obtain a job as a child care aid upon completion of the training program or to continue education to obtain a more technical job or profession in child care or in a related field.

JOB DESCRIPTION

Child Care Aid
Under the supervision of a professionally trained child development specialist helps children accept the day-care center and participate in activities suited to their age groups. Helps children remove outer garments and put them in designated places. Supervises children in play activities and creative activities such as painting, clay molding and puppet play. Supervises children in eating, resting, and toileting. Helps children develop habits of caring for own clothing, picking up and putting away toys and books. Helps keep the day-care center clean and attractive. Practices accident prevention and simple first aid.

Curriculum- Level I

EXPLORING EMPLOYMENT POSSIBILITIES AND REQUIREMENTS IN THE FIELD OF CHILD CARE

Unit length: 1 week, to introduce the child development unit

Major Objectives:

To learn charactersiticsand responsibilities of a skilled employee in child care service.

To increase in knowledge of the requirements and responsibilities for employment in the field of child care.

To become familiar with various opportunities for employment in the field of child care.

Major Generalizations:

Child care is a rapidly expanding field for employment demanding proper training of people seeking accupations in the field.

The amount of education, experience and responsibility of employees in child care occupations varies, resulting in different programs and child care facilities.

The special characteristics which help one to work well with children may be developed through study and work experience.

Content:

I Purposes of and needs for child care services
- A. History of the nursery school
- B. Definition of child care services
- C. Purposes of child care
- D. Local child care facilities

II Opportunities for employment
- A. Level of training
- B. Places of employment
- C. Job descriptions and responsibility

III Personal qualifications of employee
- A. Health
- B. Personal habits
- C. Appearance
- D. Communication Skills
- E. Emotional behavior

Curriculum- Level IIA

Course length: 1 semester

THE DEVELOPING CHILD - TWO THROUGH FIVE

Content:

I Reasons for developing skill in caring for children
- A. Benefit to child
- B. Contribution to preparation for adult role
- C. Contribution to teenagers' self understanding
- D. Contribution to preparation for child care training
  1. Community needs
  2. Employment opportunity
  3. Training necessary

II Development of the child through play
- A. Meaning of development
- B. Types and changes of development
- C. Causes for development
- D. Rate of development
- E. Characteristics of development
- F. Importance of play
  1. Types and stages of play
  2. Toys and play equipment
     - a. Selection
     - b. Safety

III Needs of the preschool child
- A. Physical
  1. Nutrition
  2. Sleep/rest
  3. Exercise
  4. Toileting
- B. Intellectual needs
- C. Emotional needs
  1. Security
  2. Other needs, including love, protection, independence, guidance, control, faith.
- D. Sociological
  1. Cultural demands
  2. Hereditary influences
  3. Environmental influences

IV Development of the preschool child
- A. Physical growth and development
  1. Definition of physical growth and development
  2. Sequential pattern of physical development
  3. Individual differences
  4. Interrelationships of physical development with intellectual, social and emotional development
- B. Motor development
  1. Definition of motor development
  2. Interrelationship with maturation and intellectual development
  3. Need for motor development
  4. Motor development of different body parts

5. Motor skills
   a. Hand skills
   b. Feeding
   c. Dressing
   d. Writing
   e. Ball throwing and catching
   f. Block building
   g. Walking

C. Emotional Development
   1. Role in child's life
   2. Pattern of development
   3. Characteristics of emotions of children
   4. Common childhood emotions
      a. Fear
      b. Anger
      c. Jealousy
   5. Factors influencing emotions
   6. Coping with emotional situations
   7. Supporting emotional development through play

D. Social development
   1. Definition of social development
   2. Patterns of social development
   3. Ways children learn social development
   4. Individual differences
   5. Sequence of social development
   6. Aiding social development through play

E. Intellectual development
   1. Determining intellectual development
   2. Factors in intellectual development
      a. Language development
      b. Development of reasoning power
      c. Development of creativity
   3. Sequential patterns of intellectual development
   4. Individual differences
   5. Encouraging intellectual development through play

F. Speech development
   1. Pre-speech
   2. Learning to speak
   3. Patterns of development
   4. Tasks of speech development
   5. Factors in speech development and variation
      a. Health
      b. Intelligence
      c. Socio-economic status
      d. Sex
      e. Family relationships
      f. Bi-lingualism

V Routine care for the young child

A. Eating habits
   1. Adequate diet
   2. Form and amount of food
   3. Flavor of food

B. Toileting routines

C. Cleanliness
   1. Need for established routines
   2. Bathing
   3. Dental hygiene
D. Sleep routines
   1. Regulation of routine
   2. Bedtime fears
   3. Physical conditions for sleep
E. Dressing routine
   1. Developing independence
   2. Clothing selection for young children

VI Learning Experiences at the preschool level
A. Art experiences
   1. Variety of experiences
   2. Equipment and supplies
B. Science experiences
C. Musical experiences
   1. Selection of experiences
   2. Rhythm instruments
D. Arithmetic experiences
E. Language development experiences
F. Health experiences
G. Field trips
H. Children's literature
   1. Book selection
   2. Story telling
   3. Types of literature

VII Child Safety
A. Burns
B. Poisoning
C. Falls
D. Falls in water
E. Cuts
F. Respiratory trouble
G. Bites
H. Traffic accidents
I. Electrical shock
J. Health emergencies in the day care center or nursery school

Curriculum- Level IIA
Objectives and Generalizations

I To value gaining skill in caring for young children
To sense how caring for children can help a teenager gain self understanding
To comprehend that the experience of caring for young children can provide a basis for parenthood and adult occupations

When teenagers are skilled in caring for small children, both the children and teenagers benefit from the experience.

Experience in caring for children can provide valuable background for parenthood and future occupations.

Experience in caring for children can provide opportunity to develop self-understanding.

II To realize that each child is individual in his growth and development
To comprehend that growth and development of each child is influenced by his biological inheritance and the opportunities provided by his culture.
To use information about the growth and development of 2-5 year old children in caring for them during play.
To value the contribution of play to growth and development of children

The growth and development of a 2-5 year old child is physical, intellectual, emotional and social.
-physical:changes in his body structure and in his ability to manipulate his body
-intellectual: gains in ability to interpret or understand people and situations and to profit by experience in dealing with them
-emotional: progression in expression of feelings and attitudes
-social: increase in ability to perform the behaviors required by his culture.

A child's growth and development is influenced by his biological heritage and by his culture influences.

Child's play which provides opportunities and encouragement for learning appropriate physical, intellectual, emotional and social skills will favorably influence growth and development.

III To become aware of the basic needs of children
To recognize how needs influence behavior of children
To learn ways of providing for the basic needs of children

All children have needs which influence their behavior and develop ment.

Programs and facilities for children should be based on an understanding of the needs of children.

IV To acquire increased knowledge and understanding of the growth and development of children.

To increase understanding of child through observation.

To develop an appreciation for the individual differences in children.

To become aware of how child care workers and child care centers can contribute to the development of children.

Understanding the principles of development gives individuals a basis for guiding children.

The various areas of development are interrelated so that a study of the "whole child" contributes to understanding of children's growth and behavior.

Children need opportunities for experiences which promote their development.

V To apply information about the development of young children in handling situations in their routine care.

To be able to carry out procedures in the routine care of children.

To recognize the importance of maintaining established routines in caring for children.

Routine care of a child, carried out in ways that maintain health and safety, aids in development.

Basic knowledge of routine skills in the child care center, carried out in ways appropriate to a child's stage of development, contributes to his total growth and development.

VI To become familiar with materials and activities suitable for children of various ages.

To develop and increase skill in guiding children's play activities.

To gain more skill in selecting meaningful learning experiences for the preschool child.

Play is one means through which children learn.

The type of play in which children engage is related to their stage of development.

Guidance of play activities requires alterness to provide for both safety and enrichment for the children.

VII To be alert to things in young children's play areas which may be harmful to him.

To comprehend what treatment will minimize the ill effects of various accidents to children.

To be committed to careful supervision of children during play

When a child is taught what things may be dangerous to him and how to deal with them, his health and safety are protected.

When children do have accidents, quick and appropriate treatment can minimize the ill effects of them.

When a person who cares for children can deal with home health emergencies quickly, sensibly and calmly, the child's safety is protected.

Cirriculum- Level IIB

THE CHILD FROM CONCEPTION TILL THE AGE OF TWO- PARENTAL RESPONSIBILITY

Course length: 1 semester

Major Objectives:

To comprehend that all societies recognize the family to assume the function of child bearing, rearing, guidance and economic support.

To understand that the responsibility of parents for their children begins before conception.

To comprehend factors which influence the preparation by parents for a child's birth

To comprehend why adults need to understand the developmental needs of children in their first and second year.

To comprehend that parents have the same kinds of responsibility for children who become members of the family by adoption, foster placement, or remarriage as they do for children born into the family.

To value the contributions which a child and his family can make to one another.

Major Generalizations:

Every society recognizes a unit to assume the function of child bearing, rearing, guidance, and economic support.

Parental responsibility toward children begins before conception.

Parental economics standards,values,cultural background and community facilities influence the preparations made for the birth of a child.

Adults who understand the needs of a child in his first and second year of growth and act to satisfy these needs, contribute to the fullest development of the child.

Parents have the same kind of responsibility for the development of a foster child, stepchild or adopted child.

A family and child stand in an interrelationship with one another in which each gives to and receives from the other.

Content:

I Family setting of the new-born and toddler
  A. Functions of the family for children
  B. Variety in the way responsibility is assumed
  C. Variation in the family life cycle with the entry of children
  D. Ways children become family members

II Adult responsibility for unborn children
  A. Responsibility before conception
  B. Process of conception

III Guidelines for health in pregnancy

IV Adjustment in the family due to pregnancy

V Prenatal Development

VI Adult Responsibility at birth of child
- A. Preparation before delivery
- B. Cost of preparation
- C. Family resources

VII Delivery Process

VIII Responsibility in child's first year
- A. Hospital post-natal care
- B. Care for the baby at home
- C. Physical growth and development the first year
- D. Social and emotional development in the first year
- E. Intellectual development in the first year

IX Adult responsibility the second year
- A. Physical care for toddlers
- B. Interaction of further development
  1. Physical
  2. Emotional
  3. Social
  4. Intellectual

X Responsibility when child enters family other than by birth

XI Contributions of family and child to one another

Curriculum- Level III and/or IV

OVERVIEW TO THE WORLD OF WORK

Major Objectives:

To become interested in the development of competencies for employment

To develop some understanding of today's world of work and the socio-economic conditions and technological developments involved.

To recognize and develop qualities which contribute to securing and holding a job.

To develop some skill in serving effectively in the world of work.

To develop a positive attitude toward work as a part of life and a desireable segment of education.

Major Generalizations:

The occupational revolution has resulted in large numbers of women and youth entering the labor market.

Current Technological changes require training and retraining in order to hold a job.

Effective application procedures contribute to success in acquiring a job.

Being well groomed results in increased self-confidence and respect from others.

Acceptable work relationships contributes to success on the job.

Successful money management contributes to security.

Content:

I Today's Labor Force
- A. Gainful employment
- B. Youth in the labor force
- C. Women in the labor force

II Securing a Job
- A. Job opportunities
- B. Job applications
- C. Community resources

III Success on the Job
- A. Personal appearance
- B. Personal development and attitudes
- C. Payroll deductions
- D. Money management
- E. Labor laws

Cirriculum- Level III and/or IV

THE CHILD AND HIS CULTURE- SIX THROUGH TWELVE

Major Objectives:

To comprehend that a child's development is influenced by the cultural environment in which he grows up.

To comprehend the sequence of physical growth and development that is characteristic of 6 through 12 year old children.

To comprehend that the 6 through 12 year period is especially significant in the total process of a person's intellectual development.

To be able to devise ways of manipulating a child's environment to aid to his emotional development.

To comprehend the significance to a child's total development of his achievement of social maturity at each successive stage of his development

To be able to realize the interrelationshipsof physical, intellectual, emotional and social development.

Major Generalizations:

The cultural environment of a child influences his development.

As children grow and develop, they go through continuous stages of 1 physical growth that follow somewhat,chronological age.

The intellectual development of an individual is typically great and rapid during the 6 through 12 period.

When an adult recognizes his own emotional response to a child's emotions, he tends to be better able to cope with those emotions.

Achieving social maturity- social characteristics and behaviors acceptable in the child's culture at his stage of development- contributes to the child's well-being and to his ability to proceed to the next stage of development..

The physical, intellectual, emotional and social aspects of a child's development are interrelated, each affecting the other.

Content:

I The child, 6-12 Introduction

II Physical Growth and Development of the 6-12 year old child

III Areas of significant intellectual development in the 6-12 year old

IV Emotional development of the 6-12 year old

V Social Development of the 6-12 year old child

VI Special needs and interests

To be decided according to student need, interest, and abilities

A. Art experiences for the pre-school child
B. Science experiences for the pre-school child
C. Music activity for the pre-school child
D. Pre-school nutrition/ food service
E. Working with the handicapped child
F. Working with the mentally retarded child
G. Working with the culturally deprived child
H. In-home care
I. First aid and health education for the pre-school child
J. Teacher aid responsibility in the public school

INTERVIEW SCHEDULE FOR PERSONNEL OF CHILD CARE CENTERS

PERSONAL INFORMATION OF INTERVIEWEE

1. Name_____ 2. Position_____

3. Agency_____ 4. Address_____

5. Telep hone_____

6. List previous experience and/or training which you feel qualifies you for your present position._____

_____

GENERAL INFORMATION FOR THE CENTER

1. Type of care: Infant care_____ Play school_____ Day care_____

Nursery school_____ Kindergarten_____

2. Age of children served: (circle and include number of each age level)

1____ 2____ 2½____ 3____ 3½____ 4____ 4½____ 5____ 5½____ 6____ School age____

3. Total number of children: All day_____ Weekly_____
Morning_____ Drop-ins_____
Afternoon_____

4. Fees charged: Basis and rate of pay.
By the hour_____ By the week _____

By the day_____ By the month_____

5. Do any of the following factors affect fee charges?
Several children in one family_____ Drop-ins_____
Overtime _____ Meals included_____
Irregular schedule _____ Day or night_____
Other (Please specify) _____

6. Total number of staff:
Full time_____ Volunteer_____
Paid_____ Part time_____

7. Rate of pay for the staff:
By the hour_____ By the week_____
By the day_____ By the month_____

WILLINGNESS TO COOPERATE AND PARTICIPATE IN THE TRAINING PROGRAM

Check the desired response or indicate answer for the question in the spaces provided.

1. Do you feel that there is a need for trained child care worker in Dekalb? Yes_____ No_____

2. Would you be willing to work with the local schools in developing a training program? Yes_____ No_____

   If so, in which of the following capacities?
   Serving on an advisory committee_____
   Serving as consultant for class or individuals_____
   Coo erating in providing observation or field trip esperiences_____
   Providing opportunity for work experience_____
   Supervising the development and improvement of skills_____
   Assisting with evaluation of total program_____
   Other _____

3. Would you be will to allow students to observe and assist without pay for a short time? Yes_____ No_____

4. Would you be willing to cooperate in a work experience program for the trainees? Yes_____ No_____

5. What hours would you prefer to use the student trainees?
   Before school _____ After school_____
   Morning_____ Evenings_____
   Noon hour_____ Weekends_____
   Afternoons_____

6. Would it be p ossible for you to cooperate with the trainee in arranging a work schedule to fit her class schedule? Yes_____ No_____

7. How many students could you employ at one time? _____
   Qualify_____

8. Would you be willing to pay the student a fair price or the going rate for child care services? Yes_____ No_____

9. How much would you be willing to pay the student workers?
   By the hour_____ By the week_____
   By the day_____ By the month_____

10. What percentage of a worker's day in your preschool would be spent working directly with the children? _____

11. What p ercentage of a worker's day in your preschool would be spent in taking care of physical facilities or arrangements?_____

12. With which of the two main ty es of duties listed do you need most help? Working with children_____or Care of facilities_____

13. Would the trainee ever have the sole responsibility of the group or for an individual child? Yes_____ No_____

14. If yes, for how long?
For a few minutes_____ For 30-60minutes_____
For 15-30 minutes_____ For more than an hour_____

15. What other duties or responsibilities would a worker have?
_____
_____

16. Do you have difficulty in filling vacancies with qualified persons?
Yes_____ No_____

17. Would you be willing to hire a person who has completed the gainful employment program if you had an opening? Yes_____ No_____

18. Would a worker have an opprotunity for advancement with additional training? Yes_____ No_____

19. How many hours a week is the average worker employed?_____

20. What types of training do your present employees have in the areas of child care and development?_____
_____

CHARACTERISTICS OF STUDENTS AND TRAINING PROGRAM

1. For which of the following groups do you feel this training would be most valuable based on your preference for employing?
High school students_____ Recent high school non-graduates_
Recent high school graduates_____ Adults(20-50 years)_____
Older adults (over 50 years)_____

2. Which of the following characteristics do you feel are important to consider when employing? Check and comment
Appearance_____ _____
Education_____ _____
Experience_____ _____
Marital Status_____ _____
Personality_____ _____
Training_____ _____
Love for children_____ _____
Understanding children_____ _____
Age_____ _____
Other_____ _____

3. Which of the following topics do you think would be important for classroom study or laboratory instruction in this training program?
First aid and safety_____ Principles of child development__
Foods and nutrition for children_____ Personal grooming & health_____
Work orientation_____ Planning activities_____
Preparation and use of material and equipment_____ Preschool development and organization _____
Other_____

4. Comments or other reactions:

Adapted from "A Suggested Cirriculum Guide For Preparing Child Care Workers For Entry Level Jobs", Oklahoma State University Stillwater, Oklahoma, 1968.

12. What hours could a student work in your home?

Weekdays _____ Weekends _____ On call _____

Morning _____ Afternoons _____ Evenings _____

Others _____

13. Estimate the number of hours this would entail per week? _____
per month? _____

14. How many trainees could be employed at one time?

Qualify or explain: _____

15. Would you be willing to pay the student a fair price or the "going rate" for such services? Yes_____ No_____

16. How much would you be willing to pay workers?

By the hour _____
By the day _____
By the week _____
By the month _____
Other _____

17. Would you be willing to be contacted later concerning students working in your home? Yes _____ No _____

DESIRED CHARACTERISTICS OF STUDENTS FOR TRAINING PROGRAM

18. For which of the following groups do you feel this training would be most valuable based on your preference for employing?

High school students _____
Recent high school graduates _____
Recent non-high school graduates _____
Adults (20-50 years of age) _____
Older adults (Over 50 years of age) _____

19. Which of the following characteristics do you feel are important to consider in employing some one to care for your child or children?

Appearance	_____
Education	_____
Experience	_____
Marital Status	_____
Personality	_____
Training	_____
Love for Children	_____
Understanding of Children	_____
Age	_____
_____	_____
_____	_____

20. What responsibilities or activities would you expect the student to perform while on the job?

Taking care of the child	_____
Cooking meals	_____
Straightening rooms	_____
Playing with child	_____
Dressing child	_____
Bathing child	_____
Putting child to bed	_____
Administering first aid	_____
Feeding child snacks or meals	_____
Other housekeeping tasks	_____

21. Comments or Reactions:

Adapted from " A Suggested Cirriculum Guide For Preparing Child Care Workers For Entry Level Jobs," Oklahoma State University; Stillwater, Oklahoma, 1968.

Training Agreement with Employer

Date _____

_____
(High School) (City and State)

I. The _____ will cooperate with the Home Economics Department
(training agency)
of Dekalb High School by providing work experience for a student in the gainful employment program for the purpose of gaining knowledge and experience as a _____
(Job Title)
under the direct supervision of _____.
(Supervisor)

II. The gainful employment program is designed in such a way that a minimum of 15 hours and a maximum of 40 hours per week will be spent in work experiences.

III. The student is expected to be enrolled in Dekalb High School taking _____ courses per school day in addition to the employment course.

IV. The student will receive ___ credit (s) toward graduation if he has has satisfactorily completed the employment course, which includes a related class and on-the-job work experience.

V. The rate of pay for the student shall be within a reasonable range of compensation for a beginning employee in the same job, since he is expected to fulfill the initial responsibilities of a beginner. A scale of wage progression for the trainee shall approximate those progressions available to regular employees.

VI. If the student does not fulfill his job responsibilities, the employment may be terminated by the employer after consultation with the coordinator.

VII. Termination of the training experience by the student without

approval of the coordinator shall result in the forfeiture of credit for the employment course.

VIII. Personal conduct while participating in the work experience shall be the responsibility of the student and shall comply with the rules and regulations established by the employer and Dekalb High School.

IX. While participating in the work experience, the student will retain the status of student, and it is understood that he will not displace a regular worker.

X. The student-trainee will be given a trial period on the job to show evidence of proficiency, aptitude, and acceptable attitudes toward work.

XI. The student must assume responsibility for notifying the employer and the coordinator if he is unable to work because of an illness or other emergency. He must submit a request for absence, signed by the coordinator, to the employer in advance of any required school commitments that would conflict with working hours.

XII. The student-trainee is expected to fulfill the time requirements of the job, regardless of school vacations.

XIII. The coordinator, with the assistance of the employer or someone delegated by him, shall determine objectives for training on the job.

XIV. The coordinator shall make periodic visits to the place of employment to observe student progress.

XV. Grievances of the employer or the student shall be discussed with the coordinator for consideration and adjustment.

XVI. The coordinator and the employer shall have periodic evaluation conferences related to student progress. The teacher has final

responsibility for the grade assigned the student for the work experience, since this is a part of a school course.

Dates of employment from: _____ to: _____

Probationary period from: _____ to: _____

Beginning wage _____

_____ (Coordinator)

_____ (Student)

_____ (Employer)

_____ (Parent or Guardian)

Adapted from: "Forms For Use in an Employment Program" Illinois Teacher of Home Economics, Vol.X, No. 3, Winter 1966-1967.

Observation Sheet for Child Care Unit*

Name of establishment _____ Observer _____

Address _____ Date _____

Number of children in unit _____ Age range _____

FACILITIES:

Food:

___ Kitchen

___ Storage

___ Service

Water:

___ Outdoor

___ Indoor

___ Fountain

Rest:

___ Separate room

___ Beds or cribs

___ Bedding

___ Darkened area

Illness:

___ Separate room

___ First aid kit

Bathroom:

___ Child-size toilet

___ Low sink

___ Steps or blocks

*This form, in addition to the interview schedule, may be used when visiting a prospective training station.

PROVISIONS FOR ACTIVITIES

___ Hard surface patio
___ Sandbox
___ Tricycles
___ Step-slide
___ Record player
___ Clay
___ Others (specify)

Safety features:

___ Fenced-in play area
___ Protected window
___ Firmly placed equipment
___ Others (specify)

Personnel (indicate number in each position):

___ Director
___ Teachers
___ Assistants
___ Trainees
___ Nurse
___ Janitors
___ Cook
___ Chauffeurs
___ Volunteers

Impressions of establishments and personnel:

Atmosphere

Personal appearance

Management

Sanitary Procedures

Guidance Information Summary

CONFIDENTIAL

Student's Name _____
Last First Middle

Courses Completed by Student:

1st Sem.	Course	Grade	2nd Sem.	Course	Grade	Summer Sch.
Freshman	English			English		
	P.E.			P.E.		
	Music					
Credits	Earned					
Sophomore	English			English		
	P.E.			P.E.		
	Music			Music		
Credits	Earned					
Junior	English			English		
	P.E.					
Credits	Earned					

Tests, Scores, Dates of Administration, Other Related Information:

Vocational Interests of Student:

Problems that May Affect Employment:

School problems:

Home problems:

Personal problems:

Additional Comments:

_____ Signature of Counselor

References: (only one may be a teacher)

	Name	Address	Phone	Occupation
1.				
2.				
3.				

List your outstanding abilities, talents and strong points: _____

_____

List your weak points: _____

What do you like to do in your spare time?

What school subjects do you enjoy most? Why?

What school subjects do you enjoy least? Why?

List Home Economics courses you are taking or have taken:

_____ _____ _____

_____ _____

List clubs and organizations of which you are a member (in and out of school):

_____ _____

_____ _____

Jobs you would like to train for in Home Economics Related Occupations:

First choice_____ Why interested?_____

Second choice_____ Why interested?_____

Third choice_____ Why interested?_____

Do you have transportation available for a job? _____Yes _____No

What do you plan to do after high school? (Please check)

_____job _____college _____marriage _____further training (specify)

HOME VISIT SCHEDULE FOR COOPERATIVE WORK TRAINING PROGRAM

1. Student Name_____

2. Student Address_____Telephone_____

3. Parent's Name_____
(Guardian)

4. Area of enrollment:
Child care service_____ Housing and home furnishings service____
Clothing Service_____ Food service_____

5. Hours of work preferred by student and/or family:
Afternoons after school _____ Mornings before school_____
Noon hour _____ Evenings _____
Saturdays _____ Sundays _____
School hours _____ Other_____

6. Student has had previous experience in:
Child care_____ Housing and home furnishings service____
Clothing service_____ Food service ____
Brief description of duties and experiences_____

_____

REACTIONS OR ADDITIONAL COMMENTS:

TOPICS TO BE DISCUSSED DURING VISIT:
Explanation of total program
Explanation of specific services
Work requirements for credit
Student responsibility
Three references
Fees and equipment to be furnished by student
Transportation arrangements

Teacher_____

Date_____

Name: _____
Date: _____

WHAT HAVE YOU GOT TO OFFER?

		Yes	No
1.	Do you have a real willingness and desire to learn new skills and new ways of doing things?	___	___
2.	Are you neat in your personal appearance and work habits?	___	___
3.	Are you punctual?	___	___
4.	Can you apply yourself to a job without being easily bored or distracted?	___	___
5.	Can you adapt to new and unexpected situations easily?	___	___
6.	Can you work under pressure, when necessary, without becoming nervous and upset?	___	___
7.	Do you have confidence in your abilities?	___	___
8.	Are you emotionally stable, capable of taking things in your stride?	___	___
9.	Have you enough initiative to be able to work on your own?	___	___
10.	Are your job plans in keeping with your own capacities and the opportunities employers have to offer?	___	___
11.	Do you have a sense of duty and responsibility?	___	___
12.	Are you reliable? Can you be depended on to do a job satisfactorily?	___	___
13.	Can you gain the freindship and respect of fellow workers?	___	___
14.	Can you cooperate with fellow workers?	___	___
15.	Can you cooperate with supervision and management?	___	___
16.	Can you follow directions willingly and without argument because you respect authority?	___	___
17.	Can you understand instructions and carry them out accurately?	___	___
18.	Can you accept criticism without feeling hurt?	___	___
19.	Can you work without constant supervision?	___	___
20.	Do you ask questions about things you don't understand?	___	___
21.	Can you complete a job once you start it?	___	___
22.	Are you a pleasant person to work with?	___	___
23.	Do you like people?	___	___
24.	Are you friendly and congenial?	___	___

BOOSTING THE SCORE

How did you do? If you answered yes to most of the questions, you have the makings of a good employee. All you need now are the necessary skills and training.

If on the other hand, you answered no to more than a few of the questions, you have some work to do. These are your weak spots, the things about you that can stand improvement. You can go into your "job training" right now by changing those things about yourself and your way of doing things that will help make your career successful.

OTHER SOURCES OF MATERIALS FOR CHILD CARE SERVICES

Association for Childhood Education
1200 Fifteeth St.
Washington, D. C.

Association for Childhood Education
International
3615 Wisconsin Avenue, N. W.

Association for Family Living
28 E. Jackson Blvd.
Chicago 4, Ill.

Children's Bureau of Publications
Superintendent of Documents
Government Printing Office
Washington 25, D. C. 20402

Child Study Association of America
132 East 74th Street
New York 21, N. Y.

Child Welfare League of America
24 W. 40th St.
New York 18, N. Y.

Colorado Association of Future
Homemakers of America
510 State Office Building
Denver, Colorado

Committee on Mental Health of State
Charities Aid Association
105 E. 22nd St.
New York 10, N. Y.

Department of Health
The City of New York
125 Worth Street
New York 13, N. Y.

Julias Rosenwald
4901 Ellis Ave.
Chicago, Illinois

Mental Health Materials Center, Inc.
104 E. 25th Street
New York 10, N.Y.

Metropolitan Life Insurance Co.
Advisory Educational Group
1 Madison Ave.
New York, N. Y.

National Association of Mental Health
1790 Broadway
New York 19, New York

National Safety Council
425 N. Michigan Ave.
Chicago, 11, Illinois

New York City Department of Welfare
Division of Day Care
Information and Counseling Service
601 E. 9th St.
New York, New York

Public Affairs Committee
22 East 38th St.
New York 16, N. Y.

Ross Laboratories
Columbus 16, Ohio

Science Research Associates, Inc.
259 East Erie Street
Chicago 11, Illinois

Texas State Department of Public
Welfare
Child Welfare Division
2nd Floor, Old Court House
Dallas, Texas

Teachers College Columbia University
Bureau of Publications
New York 19, N. Y.

The Division of Day Care and Foster
Homes
Bureau of Child Health
Room 1420 A, 100 Centre St.
New York 13, N. Y.

The Play School Association
120 W. 57th St.
New York 10, N. Y.

RESOURCE GROUPS AND INDIVIDUALS
FOR CHILD CARE SERVICES

Schools, Colleges, Universities	Advisory Committee	Community Survey	Curriculum	Work Experience	Teaching Resource Person	Materials, Equipment	Placement	Evaluation	Public Relations
School Superintendent	x						x	x	x
School Principal	x		x				x	x	x
School Board		x						x	x
Guidance Counselor	x		x	x	x		x	x	
Home Economics Teacher	x	x	x	x	x	x	x	x	x
Business Education Teacher					x				
Distributive Education Teacher					x	x			
Industrial Arts & Vocational Agriculture Teacher						x			
Art, Music, and Physical Education Teacher					x	x			
Public Kindergarten	x		x	x	x	x		x	x
School Nurse, Doctor, Dietitian					x				
School Secretary or Bookkeeper					x				
University or College Nursery Schools or Kindergarten		x		x	x	x		x	
Parents-Teachers Association	x	x					x		x
Future Homemakers of America Students						x			x
Parents of Students		x					x	x	x
Public Agencies and Groups									
Employment Bureau	x	x		x			x		
Child Welfare Bureau	x		x	x	x	x			
State Supervisory Staff for Vocational Home Economics		x	x	x				x	
U. S. Office of Education and Children's Bureau			x			x		x	
U. S. Bureau of Employment Security			x			x			
Public Health Service			x		x	x			
Red Cross					x	x			
Visiting Nurse Association					x				
Children's Institutions and Hospitals		x		x			x		
Extension Service		x	x		x	x			x

Private Groups and Individuals	Child Care Centers	Child Care Homes and Play Schools	Nursery Schools and Kindergartens	Business Establishments Offering Child Care to Patrons	Working Mothers	Men's and Women's Clubs and Organizations	Chamber of Commerce	Churches	Youth Groups	
Advisory Committee	x			x		x		x		
Community Survey	x	x	x	x	x		x	x	x	
Curriculum						x	x		x	
Work Experience					x		x	x	x	
Teaching Resource Person					x	x	x		x	
Materials, Equipment					x		x		x	
Placement							x	x	x	
Evaluation						x	x		x	
Public Relations							x		x	

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FINAL APPRAISAL FORM

CHILD CARE SERVICES

A HOME ECONOMICS OCCUPATIONAL EDUCATION PROGRAM*

NAME OF STUDENT-LEARNER _____

POSITION _____

EMPLOYER _____

IMMEDIATE SUPERVISOR _____

Since the gainful employment program is a cooperative effort between an employer and the school, the completion of this rating or appraisal sheet by encircling a number will help us determine a grade for the student. Please use the reverse side of this sheet for any comments that would aid in evaluating the student's work. Thanks.

Traits for Holding a Job in Child Care Services	Not Applicable	Deficient	Fair	Average	Exceptionally Good
Gets along well with others	____	0	1 2 3	4 5 6	7 8 9
Is dependable - reliable	____	0	1 2 3	4 5 6	7 8 9
Is well groomed for the job	____	0	1 2 3	4 5 6	7 8 9
Is able to follow instructions	____	0	1 2 3	4 5 6	7 8 9
Is cooperative	____	0	1 2 3	4 5 6	7 8 9
Shows initiative	____	0	1 2 3	4 5 6	7 8 9
Shows ability to work independently	____	0	1 2 3	4 5 6	7 8 9
Has toleration for distractions	____	0	1 2 3	4 5 6	7 8 9
Has ability to adjust to change and pressure	____	0	1 2 3	4 5 6	7 8 9
Has physical stamina required	____	0	1 2 3	4 5 6	7 8 9
Possesses emotional stability	____	0	1 2 3	4 5 6	7 8 9
Is able to accept criticism	____	0	1 2 3	4 5 6	7 8 9
Is cheerful	____	0	1 2 3	4 5 6	7 8 9
Has understanding of children	____	0	1 2 3	4 5 6	7 8 9
Has skill in communication with children	____	0	1 2 3	4 5 6	7 8 9
Possesses personal qualities desirable of workers with children	____	0	1 2 3	4 5 6	7 8 9
Shows an interest in her work	____	0	1 2 3	4 5 6	7 8 9

Rank (If applicable) _____ Score _____

Suggested Letter Grade _____ Date _____

Signed: _____

*Adapted from: Lorine Bombkamp. " A Cooperative Office Education Program", The Balance Sheet, XLVII, February, 1967.

....Curriculum Guide in Child Development. Pheonix,Arizona: Department of Vocational Education,1968.

Brisbane, Holly E. and Audrey Palm Riker, The Developing Child. Peoria, Illinois,Carles A. Bennett, 1965.

....Cassani, John, Vocational Counselor, DeKalb Senior High School.

....Pre-School Child Development. Athens, Georgia: University of Georgia, 1964.

....Halverson, Dawn, Home Economics Instructor, DeKalb Senior High School

...."Forms for Use in an Employment Program," Illinois Teacher of Home Economics. Volume X,No. 3;Winter 1966-67. Urbana, Illinois.

....A Suggested Curriculum Guide for Preparing Child Care Workers For Entry Level Jobs. Stillwater,Oklahoma; Oklahoma State University Extension,1968.

....Home Economics Curriculum Guide for Ohio. Columbus,Ohio; Vocationsl Education Division,1966.

....Program Guide for Day Care. Department of Mental Health, State of Illinois, Springfield, Illinois.

....Your Child From 1-6. U.S. Department of Health, Education, and Welfare; Superintendent of Documents, U.S. Goverment Printing Office, Washington, D.C.

Tranetta L. McComb

CURRICULUM RESOURCE LIST FOR CHILD CARE - OCCUPATIONAL

Home Economics 4 - Child Development
North Syracuse Central Schools Grade 11-12
Office of Curriculum & Instruction
305 South Main Street
North Syracuse, New York
1967

Syllabus for a Comprehensive Program-
Home Economics Education
University of the State of N.Y.
State Education Dept. - Bureau of H. E.
Albany, N.Y.
1965 ($1.25 in state) ~~(This guide has behavioral objectives)~~

Preparing for Employment in Child Care Services
in Pennsylvania Schools
Commonwealth of Pa.
Dept. of Public Instruction
Harrisburg, Pa.
1966

Colorado Program Planning Guide for
Home Ec. Educ. - Secondary, Adult & Occupation
State Board of Voc. Education
32 State Services Building
Denver, Colorado 80203

Child Care Services: A Suggested Guide
State Dept. of Education
Div. of Voc., Technical and Advanced Educ.
Home Economics Section
Tallahassee, Florida
March 1969

Outline for Occupational Home Economics Course
in Child Development Occupations
Home Economics Education, Voc. Division
State Department of Education
Montgomery, Alabama

Home Economics Occupational Education:
Child Care Service Training Guide
University of State of N. Y.
State Education Department
Bureau of Secondary Curriculum Development
Albany, New York
1969

DAY CARE AIDES: A GUIDE FOR IN-SERVICE TRAINING
(TEACHER-TRAINER EDITION)
NATIONAL FEDERATION OF SETTLEMENTS & NEIGHBORHOOD CENTERS
232 MADISON
NEW YORK CITY, N. Y. 10016
($2 PER COPY)

CURRICULUM DEVELOPMENT PROGRAM FOR PRE-SCHOOL TEACHER AIDES
U.S. DEPARTMENT OF H.E. & W.
OFFICE OF EDUCATION
BUR. OF RES.
WASHINGTON, D.C.

CHILD CARE AIDE,
HOME ECONOMICS INSTRUCTIONAL MATERIALS CENTER
TEXAS TECH UNIVERSITY
P. O. BOX 4067
LUBBOCK, TEXAS 79409

12 UNITS OF INSTRUCTIONAL MATERIALS IN THIS COURSE OF STUDY INCLUDE JOB-ORIENTED INFORMATION DESIGNED TO PREPARE STUDENTS FOR EMPLOYMENT IN CHILD CARE CENTERS.
TEACHER'S COPY -510 PP. -$10.00
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CURRICULUM GUIDE FOR OCCUPATIONAL ORIENTATION COURSE

IN

CLOTHING CONSTRUCTION

A paper

presented to

Dr. Louise Smith of this Dept. of Home Economics

Northern Illinois University

In partial fulfillment

of the requirements for the course

Vocational Programs in Home Economics

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by

Patricia Gasparini

July, 1970

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RATIONALE

Today's world of rapid technological change has enabled us to become a relatively affluent society, has eliminated much of the back-breaking work from living, and has increased leisure time. Such change adds new jobs and eliminates others in much shorter periods of time than ever expected by past generations. Those persons with little education are finding it increasingly difficult to find jobs because more and more unskilled jobs are being done by machines. On the other hand, there is also an ever mounting demand for persons with skills to operate these machines and to perform services which cannot be performed by mass production.

This new job world offers endless vital jobs for all kinds of people with varying skills and interests. Each needs to be helped to find some form of skilled work which will be of interest to her, and she needs training to help her use her leisure time to develop her creative individuality in some of the endless ways now available. This dual task brings ever new challenges to teachers.

Technological changes have greatly affected the role of the woman, freeing her from many of the time-consuming and back-breaking household chores. The attitude of society has also led to an increased number of women in the labor force. Woman is now considered an independent being who has time to pursue her interests outside the home while still being regarded as a wife and mother. The effect of new opportunities and woman's desire for psychological and social reasons for independence is indirectly seen in the following statistics.

> In 1890, of all United States women over age 10, about 17% were employed. Nineteen sixty-five figures indicated that 37.3% of all women in the United States over the age of 14 were employed...By 1965, about 33% of married women were employed.

Half of all working wives earned about one quarter of their families' total income.

The median income of women by years completed in school shows that the more years of school the higher income a woman is likely to obtain.

There is a greater likelihood that a married woman whose husband's annual income is below $7,500 will work. However, 32% of all married women whose husbands earn about $10,000 annually work.

Such figures as the above indicated that most women will be a part of the working force at some time in their lives, many for a long period of time. Programs must therefore be provided that will prepare students for new and emerging careers with some assurance they will be gainfully employed.

Anyone shopping in a department store or any type of clothing store is able to see racks and racks of garments ranging in sizes. Many persons are not able to find a pre-sized garment which is acceptable in terms of good individual fit. The problem may well become more acute when the clothing industry standardizes all sizes since individual manufacturers may no longer have particular specifications for garment sizes thus diminishing the number of sizes available.

There is a need for persons with construction skills to adapt and sew garments for those persons who cannot possibly buy well-fitting and suitable ready-to-wear. There will also continue to be those who desire to have their clothing custom-made. Thus, the need for persons who have a wide variety of skills in the seamstress-dressmaker-alterationist area is greater than ever.

Although pre-constructed items such as bedspreads, draperies and slip-covers are available to the consumer in a great variety of fabrics, colors, and price ranges, many times the customer is unable to find the exact size and design she is looking for in a price range that is within her budget. These needs help to increase the opportunities for persons with sewing skills who can make or adapt pre-constructed items to fit the individual needs of a customer.

So often home economics teachers and others have wished that fabrics salespeople knew more about fabrics and would help the customers more in their selections. With the increasing trend toward home sewing, new fabrics appearing on the market in greater numbers, and new problems occuring, the demand for well-trained fabric salespeople will continue to rise.

Every young person has to contemplate the next steps in life, and these steps will vary from individual to individual. Many times young people graduate from high school and are at a loss because they have had no specific training with which to enter the world of work. The clothing program is one which would provide at least some of these young people with the skills needed to obtain employment in a worthwhile field.

[1] Preparing for Employment in Clothing and Home Furnishings Services. A Resource Guide for Curriculum Development, Pennsylvania Department of Public Instruction, Harrisburg - 1968, p. 50.

Course Name: Pre-Vocational Clothing Construction

Grade Level: Sophomore and Junior girls

Prerequisites: Comprehensive Home Ec. I (occupational orientation survey course) and/or consent of instructor

Length of Course: One semester.

Clas Time: 55 minute period 5 days a week

COURSE DESCRIPTION

Pre-vocational Clothing Construction is a one-semester course offered to 10th and 11th grade students who may or may not have had previous home economics courses but who do possess basic sewing skills. Although it is primarily a pre-vocational course, it might also be taken by the student who merely wishes to improve present sewing skills without any intention of taking other clothing courses or in preparation for Advanced Clothing, a non-vocational course which emphasizes basic tailoring techniques.

The course consists primarily of four basic units of study: textiles, consumer buying of clothing, clothing construction techniques, and career opportunities in the areas of clothing and textiles. A rationale has been presented for each unit to show in what ways the unit applies to various occupational situations. Because this is only a one-semester course, it is not intended in any way to completely train a student for her on-th-job experience. Rather, the units of study are meant to provide a strong background in the knowledge, skills, and situations which will be needed for the various job situations students will encounter.

EXPLANATION OF PERSONAL INVENTORY SHEET

The following questionnaire is to be filled out by the students the first day of class. It is designed to serve two main purposes. First, it gives a general view of the class's abilities and experiences, providing the teacher with a basis on which to plan the course. Secondly, it gives specific information about each individual students which will help the teacher better understand problems that individuals may encounter in the course.

Because of the wide variety of experiences the students will have, questions have been constructed which will help the teacher determine how varied students' skills really are and plan accordingly where most emphasis needs to be placed. Such information also enables the teacher to know which students may need extra help and which she should be able to expect better work from. Questions such as those concerning outside work and the availability of a sewing machine should be used in determining how much outside work to expect of the students, if any.

Instead of asking students to list types of garments made, a checklist has been devised. This has the advantage of being easier to tabulate and of giving the teacher a better idea of the extent to which specific skills have been mastered, although it should be pointed out that this is far from being an accurate evaluation of student abilities. It also can be useful in assessing reasons for having certain difficulties with specific students later in the course. If a student has indicated, for example, that she can hem a garment very well, but hands in a skirt in which the hem is uneven in width or the stitches are pulled too tightly, this may indicate a need for discussing what the qualities of a well-constructed garment are.

PERSONAL INVENTORY

Name Grade

Address Phone

List your brothers and sisters and their ages. Check if they live away from home.

NAME	AGE	LIVE AWAY

Do you have a job after school? _____ on the weekends?_____

if so, how many hours per week do you work?_____

Circle the statement or statements which best describe your plans for the future:

1. I am planning to continue my education after high school.
2. I am planning to work shortly after graduation.
3. I am planning to be married within a year after graduation.
4. I plan to marry and continue to work.
5. I do not have definite plans for my future.

Do you have a sewing machine at home? Yes_____ No_____

Indicate below the number of years of sewing experience you have had in each of the following:

_____School _____Girl Scouts

_____Home _____Singer sewing classes

_____4-H _____Other (specify)_____

In the blank at the left, write the number which you feel most adequately describes your experience or ability in doing each of the following skills described.

1. Can do very well.
2. Have done before but needs improving.
3. Have never done.

____ 1. Laying out a pattern correctly without assistance.

____ 2. Laying out a pattern on plaid material correctly.

____ 3. Reading and following a guide sheet.

____ 4. Sewing with wool fabric.

____ 5. Using interfacing in a garment.

____ 6. Inserting set-in sleeves.

____ 7. Applying a lapped zipper in a garment.

____ 8. Making a garment with a collar.

____ 9. Lining a garment.

____10. Applying a waistband to a garment.

____11. Hemming a garment.

____12. Applying lace, braid, or rickrack to a garment.

____13. Making machine buttonholes.

____14. Making bound buttonholes.

____15. Finishing seams of garments in more than one way.

Which have been your greatest problems in sewing?

Would you be seriously interested in taking a course next year in which you would receive on-the-job training in an occupation related to clothing and textiles?

_____ Yes _____ No

If so, which of the following areas interests you most?

____ 1. Salesperson in ready-to-wear

____ 2. Salesperson in fabric dept. or store

____ 3. Alterationist (home or department store)

____ 4. Dressmaker

____ 5. Clothing repair (laundry or dry cleaners)

____ 6. Stock clerk

____ 7. Industrial sewing

____ 8. Other (list) _____

Explain below why you are interested in this occupation.

TEXTILES

- 2½ Week Unit -

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OVERVIEW

Anyone who plans to enter any business that deals with clothing and textiles - whether designing and making clothing, buying and selling yard goods, or ready-to-wear, or working in the alteration or clothing maintainance area - needs a knowledge of fabrics.

Designers need to know how fabrics "behave". Will the fabric fall in a soft drape or stand out stiffly? Does it hold a crease well? Can it be shaped? Is it too bulky for fathers or too soft to hold a certain line? Only by knowing the fabric's characteristics can fabric and design be matched successfully in a garment.

Those who sew, whether in production or alteration of clothing, have to know how to handle fabric successfully. Does the fabric require special care in handling? Should the stich on the machine be adjusted? Does the tension need adjustment? What kind of thread should be used? How should the fabric be pressed?

Those working in clothing maintainance must have basic fabric knowledge. Can it be washed? Will it shrink? Does it stretch easily? Does it water spot? Will certain chemicals damage it? A garment may be damaged permanently because of improper treatment.

A successful salesperson is thoroughly familiar with merchandise. Customers want information about the fabric: what is it? how will it wear? how do you care for it? are there any precautions to take in using it or cleaning it? A salesperson with fabric knowledge background knows the selling points and can make recommendations. He or she can answer the customers' questions intelligently, and give valuable information that will help the customer obtain satisfaction from her purchase. As a result, sales increase and both customer and employer are pleased.

The study of textile fibers and their characteristics is intended to help the student become familiar with the textiles on the market today. Each major fiber should be studied in detail including its origin and history, identification, properties, recommended uses, and handling and care of fabrics made from the fiber. Such basic textile information will be of value to the student not only in his work but also as a consumer since such a study will help them judge the quality of fabrics, select them wisely for specific purposes, and care for them properly.

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Objectives:

To know how fabrics are constructed and how their construction affects the appearance, strength, and durability of cloth.

To analyze the relationship between fabric construction and use and determine the affect this should have on garment selection for specific purposes.

Generalizations	Learning Experiences
Differences in fabrics are due to fibers, yarns, and fabric construction.	Display different kinds of fabric. List kinds of fabric with which class is familiar.
Yarns are made by twisting individual fibers.	Unravel sample of woven fabric to obtain a yarn. Untwist the yarn. Note how it separates into individual strands.
Most fabrics are made from yarns.	
The degree to which fibers are twisted affects both appearance and strength of fabrics.	Twist together a few strands of cotton batting. Twist loosely, then tightly. Note difference in strength and appearance. Experiment with breaking loosely and tightly twisted yarns.
Fabrics can be constructed by several processes including weaving, knitting, and felting.	Examine several fabric swatches to identify method of construction.
Fabric construction is a determinant of the properties of an end product; fabrics produced by different methods have definable characteristics.	Discuss different kinds of weaves. Practice "paper weaving". Discuss advantages and disadvantages as related to how fabrics might wear and uses for which they were intended.
	Compare woven, knitted, and felted fabrics. Determine advantages and disadvantages of each.
	If possible, visit textile mill to observe how cloth is produced and a knitting mill to observe commercial knitting.
	Look at variety of fabrics under microscope to see how they differ in construction. (Can also use in seeing differences in fiber structure by using various types of fibers - wool, cotton, etc.)

Objectives:

To identify the characteristics of the basic natural and synthetic fibers and be able to apply this knowledge in choosing fabrics for particular situations.

Generalizations	Learning Experiences
Each fiber has chemical and physical characteristics which affect its performance and care.	Discuss classification of fibers: 1. Natural - plant animal 2. Man-made 3. Synthetic
Knowledge of physical and chemical properties of textiles helps individuals predict their performance and gain increased satisfaction from selection, use, and care of textile products.	Discuss differences in characteristics and care procedures of natural and synthetic fibers. Show and discuss films/filmstrips. Study origin, characteristics, advantages and disadvantages, care and handling of groups to which variety of fabrics belong (cotton, linen, wool, polyester, etc.) Make chart outlining fabric properties, use, and care - attach fabric samples for classroom display. Divide class into committees to collect and present to clas samples of various types of fabrics made of the same fiber (Ex: cotton - corduroy, suedecloth, poplin, voile, etc.) Compare fabrics with similar characteristics for appearance, performance, use and expense (wool and acrylic, rayon and silk, rayon and linen, polyester and silk, etc.) Learn names of commonly used fabrics and be able to identify them (could use samples from committee findings of above project)
Certain fabrics are more appropriate for some design features than others.	Try pleating, gathering, etc. of opposite kinds of fabrics - rough and smooth, thick and thin, etc. How do these react? Would all be suitable for same garment? Display patterns involving different construction techniques and choose type of fabric most suitable for each.

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Blending combines the desirable characteristics of two or more fibers.	Discuss advantages of blends. Do group comparative studies with samples of blend fabrics and those of only 1 fiber. Present findings to class using charts and visual aids to show results.
	Role-play decision-making situations involving purchase of garment or other textile product basing choices on use, performance, care required, and cost. Discuss decisions made by individuals.
	Test effect of treating different fabrics to various care procedures - laundering, bleaching, ironing at various temperature settings, etc.

Objective:

To be able to distinguish the characteristics of fabric finishes in order to realize their advantages and effect on garments.

Generalizations	Learning Experiences
Finishing processes help to give the fabric special qualities it would otherwise not possess.	List finishes and trade names of finishes and state reasons for their development. Discuss advantages and disadvantages of various types of finishes (EX: permanent press leaves crease when altering garment)
The appearance and usefulness of a fabric is affected by different finishing processes.	Feel and compare fabrics with different kinds of finishes (EX: bleached and unbleached muslin, fabrics with varying amounts of sizing, etc.)
	Interpret residual shrinkage figures into number of inches a certain size of garment or length of fabric may shrink.
	Test samples of cloth for sizing, shrinking, crocking, etc. (see following page for suggested performance tests) This may be done as group projects rather than as whole class if time is limited or class is large.

SUGGESTED PERFORMANCE TESTS FOR FABRIC FINISHES

Shrinkage:

Launder fabric samples in hot soapy water. Compare the measurements of the washed sample with those of unwashed samples.

Sizing:

Examine cotton fabrics of different price ranges to determine the presence of sizing. Wash fabrics that contain sizing and compare with unwashed samples of the same fabric.

Crooking:

Rub the dry fabric against a white cloth. Repeat the test with a wet piece of the fabric. Notice whether the color rubs off on the white cloth.

Colorfastness to Perspiration:

Soak each sample in a weak acetic acid solution for 10 min. Roll it in a piece of undyed cloth and permit it to dry gradually. Check for dye on the undyed cloth.

Colorfastness to Washing:

Launder a sample of colored fabric and compare it with the original fabric that has not been laundered.

Sew a sample of colored fabric to a piece of white cloth; wash it. Check for bleeding onto the white cloth.

Immerse sample of colored fabric into water containing bleach or strong compounds similar to those used in commercial laundry. Compare with original fabric that has not been laundered.

Colorfastness to Light:

Cover half a piece of fabric with opaque paper. Expose the other half to outdoor light for two weeks. Compare the two.

Wrinkle Resistance:

Using samples of treated and untreated cloth, fold samples a number of times and fasten them with a clothes pin. Leave overnight. Unfasten and note whether or not wrinkles disappear or hang out.

Wash-and-Wear:

Compare results of drip-drying, spin-drying, and dryer-drying (tumble-drying) samples of a Wash-andWear fabric.

Stain-Resistance:

Subject samples to both oil and water stains. Determine effectiveness of finish. Determine performance of finish by washing fabrics and again subjecting them to spots and stains. Clean once more.

CONSUMER BUYING OF CLOTHING

- 2 Week Unit -

OVERVIEW

Today's teenager belongs to a segment of the population characterized by wealth. Representing approximately 12% of the total population in 1966, young people from the age of 13 through 19 were spending an estimated $18 billion. Teen-age dollars are of real importance to the nation's economy, but they are of even greater importance to the individual who is spending them. In training students to be employable upon high school graduation, it is also necessary to train them in exercising principles of wise money management in using the money they will be receiving as a result of this employment.

The American consumer faces some perplexing problems. While it is true he has more money to spend than ever before, it's also true there are more things to spend the money for. The purpose of consumer buying is to obtain goods that will be most completely satisfying for the greatest number of wants recognized as important. There are a number of problems to face in attempting to use purchasing power for this purpose, but all revolve around the basic problem of "what to buy". In solving this problem, the consumer needs to realize the importance of identifying his wants and the means by which such wants can be satisfied. He must learn to satisfy his unlimited wants with the resources available to him.

Today's buyer of clothes must have, in addition to cash or credit, certain skills and information avout the product he expects to buy. It's time-consuming to examine merchandise in many stores in order to compare values and be certain you are receiving the best value for the amount you can afford to spend. Experience helps in making wise selections, but this is something which the young shopper naturally has not had the opportunity to acquire. Lack of time and experience can be overcome somewhat if the student is trained to observe carefully, to compare similar articles and weigh their obvious values as well as to consider those that are less apparent at the moment. Such training in

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observation and comparison is valuable to all who need to buy. The student also needs to be made aware of factors such as best time and place at which to buy, best method of payment under various circumstances, where and how to obtain information about expected purchases, and shopping ethics. Knowledge in such areas as these is essential if we are to develop in our students better consumer practices.

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IMPORTANCE OF CLOTHING

Objectives:

To recognize the importance of clothing in relation to one's self-concept and family values.

To realize how values and goals affect spending habits.

To set priorities on personal needs, wants, and goals.

Generalizations	Learning Experience
Choices made when buying clothing are influenced by one's value patterns and the realative importance of his clothing goals.	Discuss wants met through clothing: protection, prestige, decency, self-expression, etc. What is first thing you notice about clothes others wear? Discuss first impressions resulting from clothing being worn. Use example of proper dress for job interviews. How do you feel when wearing clothing that you are not comfortable in? Debate: Clothing Makes the Girl.
Spending for one item may limit or eliminate the availability of money to spend on other items.	Explain how the principle of opportunity costs applies to personal planning when buying clothes. Write down 5 ways you would spend $10. Assume that if you choose 1 of these you cannot spend the money in any of the other ways. How would you make your choice? What values or goals influence it?

BUYING PROCEDURES

Objectives:

To develop the ability to make wise choices in selecting garments.

To be able to evaluate differences in quality, construction and cost.

To realize that price is not always an indication of quality.

To understand how to use limited resources to obtain maximum satisfaction in the purchase of clothing.

To develop some ability to decide when to purchase and when to make garments.

Generalizations	Learning Experiences
	Discuss qualities considered when selecting clothing: Workmanship Durability Comfort and fit Becomingness Suitability Care required Cost
	Bring to class poorly selected garment and tell why choice was not a good one.
	Discuss impulse buying.
	Debate: "One cannot afford cheap clothing."
	Discuss "When is a Bargain not a Bargain."
	Devise check sheet on criteria for judging a good bargain.
	Display purchased garments using examples of good and poor purchases. Let students evaluate. Follow by careful examination and study of construction, style, color, etc.
Comparison shopping is one way to find the best value. Price is not always an accurate indication of quality.	Have student shop for specific item of apparel in several stores comparing cost and quality. Set up evaluation sheet to use in comparing construction techniques (which can later be used for student evaluation of own projects) Report to class on findings.
	Discuss value of making own clothing - cost, fit, style, etc.
	Generalize importance of many factors in purchasing clothing: time, energy, money, creativity, knowledge, skills, etc.
	Compare cost, construction, time involvement and appearance of readyto-wear and sewn garments. Decide when to buy and when to construct garments.

WHEN AND WHERE TO BUY

Objectives:

To realize the effect that type of store and time pf purchase have on the cost, quality, and reliability of products and to apply this knowledge when shopping.

To become aware of the services offered by stores in one's locality.

Generalization	Learning Experience
The best time for shopping varies with individual situations seasonal changes, and sales.	Discuss how seasonal changes affect prices, quality and selection.
Retail outlets differ in policies, merchandize, services, and prices.	Analyze reasons for various types of sales.
Consideration of factors such as type of store and time of purchase can aid in better choice of products with resources available.	Investigate and report on advantages and disadvantages of buying from various types of stores.
Attitudes toward salespeople, merchandize and store services affect buying decisions.	Conduct local surveys or interviews to find out services various stores offer, hours stores are open and least crowded, sales and promotions scheduled by different stores, kinds and amounts of merchandise carried. Report to class on findings.
	Conduct survey on students' favorite store for purchase of specific item. Discuss reasons for each choice.

BUYING GUIDES

Objectives:

To understand sources of information available to the consumer in making choices on the market.

To recognize and use labels as guides in buying.

Generalizations	Learning Experiences
Labels often provide valuable buying, use, and care information.	Give questionnaire concerning labels to students. Discuss results. Do people let retailer know if performance of garment is unsatisfactory? Why is this a good practice?
If performance of a garment is unsatisfactory the consumer should inform the retailer.	

Collecting and studying information before buying contributes to making effective decisions.	Bring to class clothing labels from home and discuss information on labels. List characteristics of good informative label.
Brand names may imply a guarantee of satisfaction of use.	Plan method for filing labels and other tags from ready-made garments. Discuss connotations of familiar brand names in clothing. Discuss relationship to quality and performance standards of garment.
Product information is available from a number of sources including business, government, and trade associations.	Find out various sources on consumer information. Have display of pamphlets and periodicals related to consumer buying. Study and discuss local, state- and federal laws that might affect consumers.

HOW TO PAY

Objectives:

To appreciate the importance of consumer credit as a financial tool.

To become aware of the advantages and disadvantages of using various types of payments.

To become more responsible in the use of credit.

Generalizations	Learning Experiences
Awareness of the different forms of credit makes it possible for consumers to choose the one best suited to their particular needs.	Study methods pf payments: cash, check checking accounts, lay-away plans, etc. Discuss advantages and disadvantages of each in various situations.
Consumer credit permits the use of future income to satisfy present wants and needs.	What is value of establishing a good credit rating? Discuss factors which should be considered before opening a charge account.

The advantages and disadvantages of using credit are closely related to the financial resources and responsibility of the consumer.

Wisely used credit can help consumers raise their level of living.

Misuse of credit can cause financial distress to the debtor, creditor, the community, and the economy.

Knowing the cost of credit contributes to using it intelligently.

Obtain credit applications from retail store. What does form tell about your character, capacity to pay, and capital.

Set up criteria for using credit wisely. Discuss the consequences of failing to meet obligations.

Compute the cost of credit under various situations.

How can consumers decide how much credit they can safely use?

SHOPPING ETHICS

Objectives:

To develop an appreciation of the various services and conveniences offered by stores.

To realize the importance of handling merchandise carefully and assuming responsiblity for damaging of goods.

To develop responsible attitudes and use ethical practices in the return or exchange of purchases.

To act in a respectful, courteous manner with store employees.

Generalizations

Consumer and retailers both have rights and responsiblities.

Most consumers find it necessary at some time to return or exchange merchandise.

Both consumers and retailers benefit when returns and exchanges are handled properly.

Learning Experiences

Have class set up "Rules of Conduct" one should use while shopping.

Role-play situations such as returning of an unsatisfactory purchase, issuing of a complaint, etc. Note handling of problem by consumer and retailer.

Discuss fair practices in returning merchandize. Give examples of ways shoppers use privileges of buying on approval.

Consumers protect their own interests by finding out a store's policy on returns and excanges before buying.	Find out the policy on returns and exchanges in several local stores.
	Discuss the problems and expense returns and exchanges cause for the store.
Good shopping habits add to the pleasure and satisfaction gained from shopping and save time and energy.	Discuss how shopping habits can be improved. Give specific examples of how to be a courteous shopper.
	Use buzz sessions to debate whether or not stores should allow buying on approval.
Unethical and irresponsible shopping practices contribute to increases in costs of goods.	Invite resource person to discuss effect of unethical or irresponsible consumer shopping practices on cost and policies of stores.

LABELING AND CONSUMER PRACTICES

1. In purchasing a garment, do you look for a label?

   _____ Yes _____ No _____ Sometimes

2. Would you buy a garment that did not have a label or hang tag with washing instructions, type of fabric, performance of other similar information?

   _____ Yes _____ No _____ Sometimes

3. If you buy a garment with special washing instructions, do you:

   _____ Read it and throw it away?
   _____ Read it and keep it for further reference?
   _____ Throw it away without reading it?

4. If a dress shrank after washing, would you:

   _____ Return it to the store and complain?
   _____ Keep it or give it away?
   _____ Alter it?
   _____ Keep it but never buy that brand again?

5. Would you prefer information on garments to appear:

   _____ As labels sewn in garments?
   _____ On hang tags?
   _____ Have no preference

6. Assume you are deciding between two garments, both made by well-known manufacturers, similar in all respects but price. Would you buy the slightly higher-priced garment if its brand name had a higher prestige value?

   _____ Yes _____ No _____ Sometimes

CLOTHING CONSTRUCTION

- 12 Week Unit -

OVERVIEW

Learning to sew well enough to be employed in any aspect of clothing construction requires mastering of certain basic sewing skills. Speed is important, especially in mass production, but an understanding of various construction techiques amd the proficiency in performing them is also important since it determines the quality of construction of the wearing apparel that is produced.

For mass production work, the student's job will most likely consist of section work in which a stitching process is repeated over and over again. Although mainly concerned with one stitching operation, an understanding of all construction techniques helps the worker perform a job accurately and with pride, enables him to detect irregularities or mistakes in workmanship, and is essential for those interested in advancement. With superior skill and ability, one may advance to a more complicated operation, to specialized construction work - perhaps making entire garments as samples - or to supervisory work.

In custom work, one may be creating garments for specific individuals. All aspects of construction are, of course, involved here. Your success in such a job and the amount of money you earn depend very largely on the skill achieved in this area. As an alterationist it is necessary to be just as familiar with all the techniques of clothing construction as you would if clothing were made from start to finish. Alterations may sometimes involve almost remaking a garment. It is especially necessary to be expert in fitting techniques and it is just as important to know whether or not an alteration can even be made as it is to know how to make it.

In selling of fabric, an understanding of clothing construction is necessary if one is to be able to advise others. It is also regarded an advantage for fabric salespersons to wear clothes they have made. Salespeople

in ready-to-wear are better able to point out good construction techniques to customers of the merchandise they are selling. Being able to use merchandise information as selling points that will help customers reach wise decisions gives a salesperson confidence and in turn customers gain confidence in the salesperson.

People with sewing ability are also often employed by laundries and dry cleaning establishments to make repairs on articles of clothing they handle. Skill in performing a variety of basic hand and machine sewing techniques are necessary to know in such occupations.

Garments chosen for this unit should include a variety of construction techniques so the student will be prepared for the variety of on-the-job experiences he is likely to encounter. Besides the basic techniques presumably mastered in the previous comprehensive Home Ec. I course, skill in the following are emphasized:

Application of waistband
Insertion of set-in sleeves
Collar application
Lining body of dress
Ability to know and apply correct seam finish
Various hemming techniques
Various basic hand stitches
Sewing on various types of fasterners
Zipper application
Facing application

SEWING EQUIPMENT

Objectives:

To recognize and select wisely the type of sewing equipment necessary for clothing construction.

To understand and practice good safety procedures in use of sewing equipment.

To be able to identify and locate basic parts of a sewing machine and the function of these parts.

To properly thread and operate a sewing machine.

To be able to recognize possible causes of machine difficulty and know how to prevent and correct such difficulties.

Generalizations	Learning Experience
Selection, use, and care of sewing equipment influences the quality of workmanship and satisfaction derived from sewing.	Pre-test knowledge of equipment.
Proper use of equipment extends their life and efficiency.	Prepare bulletin board display of small sewing equipment.
The correct use of terms regarding equipment and parts of the sewing machine increases effective communication.	Discuss buying of thread, difference in shears and scissors, tailors chalk, etc. if necessary (indicated by pre-test)
Knowledge of parts of the machine and their function, skill in operation of it, and ability to prevent and correct machine difficulties contributes to correct performance and increased satisfaction in constructing garments.	Hand out list of necessary equipment for class.
	Review parts of sewing machine and their purpose.
	Practice threading and operating machine.
	Discuss possible difficulties with machine, their causes, how to prevent and correct them.

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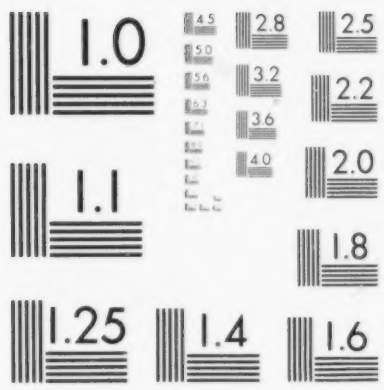

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PATTERN SELECTION AND FABRIC PREPARATION

Objectives:

To be able to take accurate body measurements and relate these to the purchase of correct figure type and size.

To be able to identify pattern pieces and pattern markings.

To become proficient in reading the pattern envelope.

To perform necessary steps in preparing fabric for cutting.

To understand the meaning of basic terms relating to fabric such as grain-perfect, evenness of ends, and selvage.

Generalizations	Learning Experiences
Patterns are available in a variety of sizes and figure types.	Discussion of project (based on previous experience indicated in personal inventory questionnaires filled out first day of class).
Selection of pattern with regard to figure type and accurate measurements facilitates proper fit with fewer adjustments.	Using visual aids, show differences in body builds for various figure types. Discuss differences and similarities in body measurements for each size.
	Demonstrate correct way to take measurements and how to select pattern size from these measurements.
Knowledge of how to interpret information on the pattern envelope aids the consumer in making more satisfactory purchases.	Have girls work in pairs taking and recording each others measurements, choosing pattern and pattern size. Check these.
An understanding of pattern symbols is necessary for successful cutting and sewing techniques.	Discuss how to read pattern envelope for information necessary when purchasing materials for construction of a garment.
	Study pattern pieces and learn to recognize markings.
Preparation of fabric is an essential step in the construction of any garment; fabric should be grain-perfect before it is cut.	Discuss meaning of grain, selvage, etc. View filmstrip on "Grain".
	Demonstrate ways of straightening ends of material and checking grain. Discuss how methods of correcting off-grain fabrics differ and when to use each. Prepare own fabric for cutting.

PATTERN ALTERATION

Objectives:

To determine whether pattern alterations are necessary.

To be able to alter the paper pattern to fit individual measurements.

Generalizations	Learning Experiences
Properly fitted clothes enhance the appearance of the individual as well as give him an added feeling of confidence.	Discuss the importance of good fit in garments. Is there any difference in the feelings of the individual when he has a well-fitting garment and when he does not?
People need to feel comfortable in their clothes.	Compare pieces of tissue paper and pieces of fabric. In what ways do they differ? How does this apply when fitting the paper pattern?
The paper pattern pieces should be properly prepared for accurate fitting.	Demonstrate fitting pattern on the body. Show points to check. What measurements cannot be checked in this way? Why not?
One needs to be able to decide whether alterations are necessary when the pattern is placed on the body.	Demonstrate preparing the pattern for fitting (lengthening of grain-line, pressing, pinning parts together).
Altering a pattern consists of adding or taking out fullness within the pattern piece at the place where more or less fullness in needed.	See how patterns fit other students. Which ones will need alterations?
Alteration of pattern before layout reduces later fitting problems.	Use blouse shells to demonstrate fit. These could be placed on dress forms or students for which some are too large and some are too small in order to demonstrate the difference in the kind of wrinkles which occur when garments are too large and too small.
	Demonstrate making alterations for the most common figure faults. Each class member duplicate these alterations on small scale patterns and keep them for future reference.
	Record individual alterations which need to be done. Discuss with instructor how you will do these.
	Discuss remaining measurements which need to be checked and demonstrate how these are to be done by flat pattern technique.

LAYOUT, CUTTING, AND MARKING

Objectives:

To be able to interpret any pattern layout.

To know how to layout and cut a pattern accurately and with as little waste as possible.

To know basic techniques involved in laying out pattern on plaid fabrics.

To be aware of and use correct marking techniques for a variety of types of fabric.

Generalizations	Learning Experiences
The guide sheet provides information on layout of pattern pieces according to size and width of fabric.	Analyze a variety of pattern layouts. Determine type of garment being constructed, if it is placed correctly, if any changes need to be made, if there could be better use of fabric, etc.
The way in which a pattern is laid when working with plaid material determines to a large extent the beauty of the finished garment.	Demonstrate how to lay out a pattern on plaid material. Test students' knowledge of having each lay out half-size pattern on sample fabric.
Accuracy in cutting and marking is necessary in order to construct a garment which duplicates the design of the pattern.	Discuss and list general layout, making suggestions to follow: - Use sharp shears, not pinking. - Keep fabric flat on table. - Cut with long strokes of shears. - Follow cutting line carefully, never cut fold lines. - Cut notches outward. - Measure from both ends of grain line to selvage of fabric. - Overlap margins of pattern pieces. - Use enough pins to hold pattern securely but not so many that fabric bulges. - Place pins perpendicular to cutting line with point outward.
All patterns have markings which are important and should be transferred to the fabric.	Have each student layout pattern, check it before cutting.
The method of marking used is often dependent on the type of material used.	Discuss various methods of marking, advantages and disadvantages of each, type of fabric to use on, what needs to be marked, etc. Demonstrate various methods. Have students mark.

CONSTRUCTION TECHNIQUES

Objectives:

To gain an understanding of and to value the unit method of construction as an organized and efficient way of assembling a garment.

To develop and in some cases perfect skill in a number of construction techniques.

To practice and develop skills of hand sewing techniques such as hemming, attaching proper fasterners, etc.

To recognize characteristics of a well-constructed garment.

To be able to evaluate a completed garment and recognize possible improvements that could be made.

Generalizations:

The construction of a garment needs to prceed as a series of steps.

Each section of a garment should be finished as far as possible before going on with another section.

Construction should be completed in small areas and then these are joined to form larger areas.

A worker who reads and follows instructions will learn self-help methods and require less supervision.

Appearance, quality, and durability of garment construction depend on accuracy in details of workmanship.

A well-made product gives the individual a sense of satisfaction.

Learning Experiences:

Devise plan of work with students in which as many sewing operations as possible can be completed in one sitting. (See plan for skirt construction at end of unit)

Demostrate techniques as they are needed during construction. Dittoed sheets on various construction methods are handed out as techniques are demonstrated. These are to be kept in student's notebook for reference if necessary. Illustrative display materials and resource materials are provided so girls will develop habits of self-direction. Teacher is present to provide guidance and help when student cannot solve problem through other resources.

Discuss and illustrate different types of seam finishes and hemming techniques for various types of fabrics or pattern design details. Students practice techniques other than just those that apply to their particular garment.

Use list of standards formulated in unit on consumer buymanship to evaluate own garments.

Hand in garment information sheets after figuring cost, etc. Discuss problems encountered, how they were solved, how next garment should be constructed, etc.

****

Basic construction processes for first garment (wool skirt, culotte, slacks, etc.) - approximately 5-week unit:

Stay-stitching
Darts
Seams and seam finishes
Zipper application
Waistband application
Hemming
Fasteners
Pockers (optional)
Pressing

Additional construction processes for second garment (lined dress with collar, set-in sleeves, and zipper) - approx. 7-week unit:

Collar application
Set-in sleeves
Facings
Interfacings
Lining
Trims (optional)

The above garments were chosen because of the variety of construction techniques they involve. Although requirements are set up for each project so class demonstrations can correlate with the students' construction processes, the student still has flexibility in choice of pattern. The first garment involves perfecting to a high degree techniques learned through past experiences in sewing. It should be able to be completed quickly but accurately. The second garment involves techniques that fewer students would be as familiar with so that more emphasis is placed on the acquiring of new techniques.

UNIT CONSTRUCTION OF SKIRT

To construct your skirt by units, check to see if you follow the outline below. Note that if you are well organized, you need leave the sewing machine only once before doing the hand work. Organizing your sewing in such a way can save considerable time.

Skirt Back and Front - machine

_____ 1. Stay stich waistline and side seams from hip to waist of each skirt section.
_____ 2. Stitch all darts.
_____ 3. Stitch center back seam. Seam finish if it involves machine-stitching. (Can omit if it was selvage edge)
_____ 4. Measure placker opening on left side. Stitch up to this point; machine-baste placket opening shut.
_____ 5. Change to zipper foot, regular stitch.

Pressing - ironing board

_____ 6. Press darts toward center, using hem.
_____ 7. Press back and left side seams open.
_____ 8. Press 1/8 - $\frac{1}{4}$" fold in left seam allowance of side seam for zipper application.

Zipper and Waistband Applications - machine

_____ 9. Place zipper face up under folded seam allowance; stitch through zipper and seam allowance.
_____10. Turn zipper face down over opposite seam allowance; sew down right side through zipper, right seam allowance, and garment and across end. Tie knot. Rip out basting.
_____11. Place grosgrain ribbon (or interfacing) on waistband; stitch in place as directed on ditto sheet.
_____12. Fold ends of band over and stich both ends; trim; turn.
_____13. Pin band to skirt, stitch, and grade seam.

Hand Sewing - table and ironing board

_____14. Press waistband to inside; finish by hand.
_____15. Hem the skirt.
_____16. Sew on fasteners.
_____17. Give completed garment final pressing.

Note: The following is used only to show the student how her work should be organizes and how far she has progressed. By studying this as a class beforehand, each student gains a better understanding of the processes involved in the construction of her garment. It is not meant in any way to be used in instructing the student how to construct her garment.

CAREER OPPORTUNITIES IN CLOTHING AND TEXTILES

- 1½ Week Unit-

OVERVIEW

Choosing the way to earn a living is one of the most important decisions a person will make in his lifetime. The student who has had training in the area of clothing and textiles could expect to find employment in a variety of jobs. If he is to make an intelligent decision in his choice of an occupation, however, this individual needs to be made aware of the kinds of jobs available and the kind of education and training these jobs require. He also needs to make an honest appraisal of his abilities, aptitudes and interests and he should be aware of how great the competition from other people for openings is in the field he chooses for a career. In the long-range preparation for a job, students should be helped to analyze their strengths and weaknesses. This is needed so that the training program may help the person to maximize his strengths and minimize his weaknesses.

The following unit is intended to help students to know that employment opportunities they can prepare themselves for in the clothing and textiles area, to discover to some extent the types of satisfactions possible through such jobs, and to learn the kinds of characteristics which will help in getting and keeping a job. The teacher in role in this unit is also to make students aware of the importance of their skills and knowledge. Gaining confidence in some ability will in itself make a person more interested in areas in which she will be able to use these abilities. Such interests will, in turn, motivate the student to become gainfully employed in some occupation that will make her a productive member of society and to see the value of her product.

Objectives:

To realize the opportunities for employment in the clothing and textiles area.

To develop some understanding of the duries and responsibilities, working conditions, and skills involved in becoming an employee of specific occupations in the clothing and textiles area.

To develop some judgment in analyzing to what extent personal qualifications and occupational goals related to this area are compatible.

Generalizations	Learning Experiences
An increased awareness of job opportunities in a specific field can lead to serious consideration of a career in it.	Investigate all employment opportunities in your particular locality in which knowledge of clothing and textiles would be of value.
	Use resources such as Occupational Outlook Handbook, etc. to develop list of all jobs related to this field.
In deciding on a career, consideration needs to be given to educational requirements work opportunities, personal qualifications, duties and responsibilities of the job, job satisfaction and opportunities for advancement.	Select an area of clothing field in which you are particularly interested and investigate it in furthe detail. Consider businesses in the area that employ people in the field, types of positions open, of jobs available, hours, wages, working conditions.
Analysis of personal aptitudes and desires helps a person determine a suitable occupation.	Make field trips to clothing manufacturer, dry cleaning establishment, etc. if possible.
	Invite resource people to class to discuss advantages and disadvantages of job, personal qualities and skills needed, advancement possiblities. etc.
	View films, Getting a Job and How to Keep a Job. Have class discuss how personality traits help one get and keep a job.
	Redistribute last pg. of personal inventory filled out at beginning of semester. Fill out second one. Discuss changes in occupational interests and goals.

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OCCUPATIONAL ORIENTATION
FOOD SERVICE COURSE OUTLINE

WORKSHOP PROJECT
HOME ECONOMICS 450
DR. LOUISE SMITH
JULY, 1970

by

Barbara Mowers Huntly High School
Lou Ann Hinton Lake Zurich High School
Marylee Frank Belvidere High School

OVERVIEW

Today's process of change adds new job opportunities and limits others. Those persons with little education find it increasingly difficult to find jobs. Thus the need for occupational training has arisen.

The purpose of this course is to prepare students for gainful employment in an occupation which uses home economics knowledge and skills in the food service area. The course content is to be used in one semester with a fifty-five minute period. The class will be composed of both boys and girls at the tenth and eleventh grade levels with a varying amount of background knowledge. The existing classrooms and equipment will be used with occasional use of the school cafeteria.

If this class were to be expanded to a one year course, the following areas could be encorporated: problems of management dealing with quality control, scheduling of employees, reduction of food waste, and profit sharing; consumer education; money and inventory management; job employability including interviewing, applications, employment agencies; and a further depth of the course content material covered.

OBJECTIVES

To provide students with opportunities to explore and to obtain information about food service occupations

To have an appreciation of status and dignity attainable in the food service field

To be able to appreciate professional compentencies and high standards of workmanship

To develop a sense of responsibility toward a job

To develop a sense of loyalty and obligation to the public and employer

To cultivate personal qualities needed for job success

To develop an attitude of respect for and knowledge of the use and care of material and equipment

To further an interest in continued training, education, and advancement

To develop an understanding and appreciation of the importance of safety, personal hygiene, and sanitation

To develop the ability to master various skills necessary to enter the field at a reasonable level

To develop the value of time and energy saving methods

To develop the ability to recognize acceptable work standards

To develop the ability to follow directions and accept suggestions or criticisms

COURSE OUTLINE

I. Orientation

To familiarize students with the food service industry
To familiarize students with the management role
To familiarize students with their role and the union's role
To familiarize students with the opportunities in food services

A. Types of establishments
B. Job opportunities
C. Management
D. Unions

II. Duties and working relations

To familiarize students with the job analysis of the specific jobs to be studied
To realize the importance of knowing and maintaining good work relationships

A. Specific duties of
   1. Waiter, waitress
   2. Busboys
   3. Counter workers, cooks, pantry and counter cooks, salad makers and bakers
   4. Chef
   5. Dish washer
   6. Store keeper
B. How to get along with fellow workers
C. How to get along with customers

III. Safety and Sanitation

To develop an awareness of the importance of personal health and cleanliness
To develop an awareness of the importance of sanitary handling practices and safety

A. Personal appearance and hygiene
B. Food borne diseases
C. Food protection and storage
D. Sanitary handling of food and equipment
E. Management practices
   1. Disposal of waste
   2. Insects and rodents
   3. Cleaning work area and equipment

F. Health laws and regulations
   1. State
   2. Local
G. Safety on the job
   1. Accident prevention
   2. First aid

IV. Basic arithmetic and cooking terms

To review the fundamentals of arithmetic for accuracy in billing customers and in preparation of food
To understand the importance of correct use of weights and measures to insure a uniform product
To learn fundamental cooking terms

A. General review of arithmetic
B. Cash register operations
C. Making out order slips
D. Use of scale
E. Use of weights and volume measurements in cooking
F. Cooking terms

V. Basic nutrition

To create an awareness in the student of the importanceof good nutrition
To recognize the four food groups and to know their relation to good health
To provide background material for the approach to cooking principles and the maximum retention to food values by proper food handling, cooking, and storage
To be able to plan attractive and practical meals

A. Good nutrition versus poor nutrition - health and appearance
B. Role of the four food groups
C. Proper handling, cooking, and storage of food
D. Planning meals to meet various situations

VI. Use and care of equipment

To be aware of the types of equipment used in quantitative cooking
To realize the importance of following directions in use and care of equipment
To learn to use the right tool for the job
To perfect skills in the use of hand tools

A. Heavy equipment
B. Light equipment
C. Hand tools
   1. Wire wisk
   2. Knives and other tools
D. Dishwasher

VII. Mechanics of meal preparation and service

To allow students to practice duties and procedures needed to prepare, serve and clean-up meals

To get a feeling of the importance of team work in a work situation

To gain knowledge of skills required

To see the value of each job in relation to the finished performance

A. Plan, prepare, and serve various meals in a series of different situations

B. Rotate jobs to gain knowledge and skills in several areas

C. Prepare and serve the following using quantity food preparation and techniques

   1. Salads
   2. Sandwiches
   3. Beverages - coffee, fountain
   4. Vegetables - sauces
   5. Garnishes
   6. Pastries - desserts
   7. Pastas
   8. Breads -quick, yeast
   9. Entrees - meat, fish, poultry

VIII. Table services and procedures

To learn the various types of services and procedures

A. Restaurants

   1. Counter
   2. Table
   3. Booth
   4. Buffet

B. Institutional

   1. Cafeteria
   2. Tray

C. Etiquette

IX. Evaluation

To be evaluated continuously
To evaluate using a variety of methods

A. Performance
   1. Attitudes
   2. Product
   3. Work habits
B. Written
C. Employability

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PLANS FOR ORIENTATION COURSE

ENTITLED

1 HOME ECONOMICS OCCUPATIONS

FOR

EVANSTON TOWNSHIP HIGH SCHOOL

Submitted in fulfillment of
Home Economics 450 Workshop
Project by Ruth Wheeler
July 29, 1970.

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Philosophy and Objectives of the Home Economics Department of Evanston Township High School

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Background

Evanston Township High School had had vocations programs in Distributive Education, Diversified Occupations, Cooperative Work Training (called Vocational Experience at ETHS) and Office Occupations. Until this past year these programs, particularly Vocational Experience, have taken care of home economics students.

However, this past year the director of the Vocational Experience program and I have discussed the need for a program to train for home economics related occupations. There were more students enrolling in Vocational Experience who were interest in home economics related occupations and more students than they could handle in Vocational Experience.

In the meantime the four teachers who work with the introductory 1 Home Economics classes for freshmen were discussing the needs of a special group of students about whom they were concerned. One factor that these students have in common is their enjoyment and sense of accomplishment when involved in laboratory activities in the foods lab. They need to learn by doing....understanding through discussion and reading is meaningless and boring to them. For some reading is difficult and for others it is just one of the tasks that they do not like to do but they can read. Other common factors are lack of diplomacy with both peers and adults as well as a low level of motivation.

As the teachers discussed the ways to motivate and interest these special students, the suggestion was presented to adapt a course so that is was almost entirely laboratory. These students would ordinarily enroll in 2 Homemaking which includes extensive units in Consumer Education (non lab), Home Furnishing (non lab), Clothing and Foods. And then in 3 Homemaking these students would study Marriage and Child Care (non lab), Home Management (non lab), Foods and Clothing.

The nursery school segment of the Child Development course is actually a work program based in the school. So why couldn't we adapt a work program for tenth and eleventh graders in the school? We could. Suggestions included a tea room type of setup utilizing the foods lab and living room or a boutique using clothing lab facilities to sew gift items and to do clothing alteration.

Because of the student interest in foods it was decided to explore the tearoom idea. Some of the thoughts were that charges would need to be made to cover the cost of the foods but that students could get excellent mathematical training in computing the cost of food and that consumer education would be involved in shopping decisions. If a small percentage over the cost of the food were charged, the excess might fo into a fund for field trips to local restaurants, hospitals, dormitories and other food service centers in the community. Not only would students be exposed to food service occupations but the know-how of eating in a type of restaurant other than a hamburger stand would be gained.

Students involved in the discussions seemed positive and many staff members from other departments wanted to purchase tickets for the tea room righ then. In fact the enthisiastic response of the staff helped us realize the potential we had. They suggested that students might wish to provide refreshments for after school meetings. The cafeteria manager voiced no opposition--in fact the small number that can be handled by home economics would make only a small dent in her 5,000 plus meals.

Thus, a new exploratory course, 1 Home Economics Occupations, was set up to meet the particular needs of the students previously mentioned. The attached proposal was presented to the Curriculum Committee. The Curriculum Committee was informed of future plans for cooperative vocational home economics with a staff coordinator.

The only concern of the Curriculum Committee was that it might overlap existing courses. After they were satisfied that this was not true, it was accepted if it could be handled by existing staff. 3 Homemaking is being eliminated from the course offerings in home economics so a staff was released.

At the suggestion of a counselor invitations (see attached) were sent to students enrolled in 1 Home Economics who seemed to be the kind of student the teachers were concered about. All students in 1 Home Economics were informed about this course as well as other courses in the department.

The counselors were given the following criteria for 1 Home Economics Occupations students. Students have:

completed 1 Home Economics
an interest in foods and food service
an interest in cooperative work program next school year
the characteristics of dependability and responsibility
good school attendance
good attitude toward this course even though their academic skills may be weak.

A permit from the department is possible for those to obtain who meet the above criteria except have not taken 1 Home Economics.

EVANSTON TOWNSHIP HIGH SCHOOL

Curriculum Proposal for Home Economics

I. Course Title - 1 Home Economics Occupations
(Eventually may replace 2 Homemaking)

II. Submitted by the Home Economics Department

III. Course Objectives

1. To explore opportunities in and requirements of occupations related to home economics

   To develop personal qualities which will increase employability

   To gain skills which will prepare for entering home economics or related occupations through "employment" within the school

   To purchase and use goods and services intelligently

   To grow in ability to budget time wisely and use leisure time for personal satisfaction and social usefulness

   To grow in ability to think rationally, to express thoughts clearly, and to read and listen with understanding

   To gain satisfaction from carrying out responsibilities diligently and well

2. There is no other course in the department to fulfill this need. It is to be expected that students will elect this in place of 2 Homemaking although for the school year 1970-71 the department would like to offer both courses.

IV. Need
In 1971-72 a sequel course would be offered and it would be called 2 Home Economics Occupations. This course would involve some of the students now enrolled in Vocational Experience.

This course is designed to meet the needs of students whom we are not now reaching and who are too young to work outside school.

V. A. Amount of credit - 1 unit

B. Course structure - two 2-mod, two 4-mod

C. Time - year

D. Grade level - 10 and 11 and 12

E. Prerequisite - 1 Home Economics or permit

1 Home Economics Occupations

Both the school and department objectives emphasize the need to prepare students to develop self-identification and self-direction as well as to develop occupational concepts and skills. It is toward these two major docuses that the teacher objectives of 1 Home Economics Occupations are aimed.

As Dr. Brune Bettelheim, professor of psychology and psychiatry at the University of Chicago, was quoted in the Dec. 2, 1969 issue of the Chicago Tribune, "Students should be provided with combination work and study programs so they won't have time to take part in sit-ins and demonstrations." "Kids today feel like parasites and despise the world of parents and the establishment because they continually take from their parents and society and have no way of giving." In 1 Home Economics Occupations we hope to provide a way of taking and giving.

The following plans are made with the understanding that they can and will be revised. It is possible that due to student interest and first semester experience the clothing related occupations can be explored in the second semester.

As the class meets four mods (75 minutes) twice a week (Mondays and Fridays) it will be possible to serve luncheons, buffets or other noon-time meals. The two mod (35 minutes) class meetings will be primarily demonstrations, instruction and planning (Tuesdays and Thursdays). Although there will be experiences from the beginning, meals will not be served until the class and teacher feel ready. At the outset only staff members will be invited to purchase tickets. It is the feeling that staff members will be more understanding of the initial efforts of the students and will set a standard of mannerly conduct. As the class members become more proficient and as the tone and atmosphere of the luncheons is set, students will be invited to become customers and fraternize with the faculty.

The attached chart explains the three levels of work experience available to students. The job analyses will be revised by students and teacher as they are used. All students enrolled should accomplish the entry level but all will be encouraged to proceed through all three levels.

In the following pages I am presenting preliminary plans for the course for 1970-71. The form used is identical to that of the ETHS Home Economics Curriculum Guide--generalizations, objectives, learning experiences and evaluative activities. The tentative block plan is included. As much as possible, evaluations will be on-the-job and self evaluation rather than paper-pencil tests. All of these plans are tentative and subject to change.

JOB DESCRIPTIONS AT THREE COMPETENCY LEVELS*

ENTRY

Maintains work areas by washing, sweeping, mopping or vacuuming

Washes and cares for dishes, utensils and equipment

Assists cook with food preparation

Prepares fresh produce

Assembles orders for serving

Transports food & supplies between kitchen & serving area

Maintains serving station with clean supplies

Sets tables appropriately & attractively

Removes table settings & linens from tables

Welcomes guests

Places beverage orders in kitchen

Prepares menu folder

Serves food

Sells food tickets

Balances number of tickets sold with cash received

SKILLED

Excels in table service

Plans and/or adapts menus

Prepares a variety of foods

Schedules work to produce work at predetermined times

Cooks or holds food at proper temperatures

Practices safe and sanitary methods in food preparation

Judges food quality by sight, odor, taste

Understands importance of visual appeal & appropriate combination of foods

Uses standard measurements

Understands and follows standardized recipes

ADVANCED

Keeps financial and work records

Selects and orders food, supplies and equipment

Checks and maintains food and equipment inventories

Trains other students

Supervises other students

Coordinates production and service

* adapted from "Food Service Employee", Texas Tech Univ., School of Home Economics, Dept. of Home Economics Education, Lubbock, Texas .1969.

Generalizations

1. An understanding of self contributes to understanding and accepting others.

2. Ability to recognize own feelings and control own actions contributes to personal satisfaction and acceptance by others.

3. It is easier to make and keep friends if one develops certain attitudes such as: interest in other people, friendliness, cheerfulness.

4. If responsibilities are accepted, privileges are more likely to be granted.

5. As life and society become more complex, human beings are more in need than ever of the capabilities to understand and live with minimum friction among each other.

6. Communication is a vital factor in all interpersonal relations. And it can occur in so many different ways; two major forms are verbal and non-verbal.

7. A large number of women are employed outside the home and it seems likely that this situation will continue.

8. There is a sharply dropping proportion of jobs that may be done by unskilled workers. Home economics has potential for contributin to preparation for occupations.

9. There has been an increase in service occupations, both in private households andoutside the home, and many of these service occupations have a relationship to home economics.

10. Participation in planning, preparing and serving meals can be a source of pleasure and satisfaction, and can provide an opportunity for aesthetic and creative expression.

11. Skill in food planning and preparation can be used for gainful employment.

12. Similarities in the physical structure and chemical composition of foods are the bases for their classification, handling and processing.

13. The appearance, texture, nutritive value and safety of foods may be altered by change in temperature, kind of manipulation, preseence of water, oxygen and other chemical substances.(Change in physical & chemical environment)

14. Directions for obtaining a product of given characteristics are reliable only when the nature of the original food or food mixture and the effect of the physical and chemical processes to which it will be subjected are considered.

15. Realistic management of time is based upon one's goals, values and resources.

16. The resources available for meeting consumer needs include available foods and services, purchasing power, personal information, ability, time and energy.

17. The choice of which resource to use in providing food depends on the following: quantity of each resource available
cost of alternatives
effectiveness of alternatives in producing the desired result
ability of the user to employ the resources for the purpose desired.

18. The organization of activities in providing food involves planning and coordinating of resources and demands of those to be fed.

19. Performance of routine tasks according to a plan designed for repeated use facilitates planning, preparing and serving food.

20. Selection of foods for daily diet should contribute a balance of nutrients as well as meet food budget and personal preference.

21. Safety of food is determined by the following:
natural qualities
procedures used in the production and processing
sanitary measures used in the handling and storing of food in the market and in the place of use.

22. Federal, state and local agencies work toward the protection and guidance of consumers in their purchase of certain foods by assuring the wholesomeness of these foods and their freedom from adulteration,,by establishing standards of identity, and by requiring truthful labeling and by prohibiting false statements in advertising.

Objective

To develop personal qualities which will increase employability.

Generalizations	Learning Experiences	Evaluative Activities
#1, 2, 3	Complete "Check List for Self Improvement"* in Sept.	Complete "Check List ——" in Feb & May
	Guest speakers—a personnel manager, counselor from Ill. Employment Service	Complete "Sensitivity Checkup"* & set goals for improvement
	Class prepare own rulebook for class deportment	Complete "Work Attitude Inventory"*
	Tape record an employment interview and analyze questions about personal qualities	Rate self & one another for standards of performance
	Class set up standards of performance	
	Discuss "Short Course in Human Relations"*	
	Role play giving directions to others	
	Practice verbal and non-verbal communication	

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Short Course in Human Relations*

The 6 most important words:

"I admit I made a mistake."

The 5 most important words:

"You did a good job."

The 4 most important words:

"What is your opinion?"

The 3 most important words:

"If you please."

The 2 most important words:

"Thank you"

The 1 most important word:

"We"

The least important word:

"I"

*adapted from Southwestern Bell Telephone Company in "Dietitian Aide", Texas Tech Univ., School of Home Econ., Lubbock, Texas. 1969

Work Attitude Inventory*

	Agree	Undecided	Disagree
1. All fathers should have a job.			
2. Work means physical labor.			
3. People enjoy work			
4. Mothers should not work outside the home.			
5. The only thing a person gets from his job is the money he makes.			
6. Teenagers should not work part time while in high school.			
7. Teenagers should not work full time while in high school.			
8. People are unemployed because they don't want to do the type of work available.			
9. People are unemployed because they don't want to work.			
10. People are unemployed because there are not enough jobs.			
11. People are unemployed because they lack educationand training to do the type of work which is available.			
12. People who sit at desks are actually not working.			

*from Illinois Teacher, Vol. IX, bonus issue, pp. 25-26.

Sensitivity*

Am I sensitive? Ask yourself these question:

1. Who can talk to me about his inner feelings of anger and be understood and respected by me?

2. Who can talk to me about his inner feelings of anger toward me and be respected by me?

3. Who can talk to me about his inner feelings of fear and be understood and respected by me?

4. Who can talk to me about his inner feelings of tenderness and be understood and respected by me?

5. Who can talk to me about his inner feelings of pride and be understood and respected by me?

6. Who can talk to me about his despair and sadness and grief and be understood and respected by me?

7. Who can talk to me about his joy and be understood and respected by me?

8. Who can talk to me about his poetic and lyrical feelings and be understood and respected by me?

Now turn these questions around and ask yourself:

1. Who can I talk to about my inner feelings of anger and be understood and respected by him?

2. Who can I talk to about my inner feelings of anger toward him and be understood and respected by him?

3. Who can I talk to about my inner feelings of fear and be understood and respected by him?

4. Who can I talk to about my inner feelings of tenderness and be understood and respected by him?

5. Who can I talk to about my inner feelings of pride and be understood and respected by him?

6. Who can I talk to about my despair and sadness and grief and be understood and respected by him?

7. Who can I talk to about my joy and be understood and respected by him?

8. Who can I talk to about my poetic and lyrical feelings and be understood and respected by hime?

*adapted from Penney's Forum, spring-summer 1970, p. 3.

Checklist for Self Improvement*

Check either yes or no.

	Yes	No
1. Do you report to class on time?		
2. Are you able to do your work without becoming bored or distracted?		
3. Can you make adjustments to changes and unexpected situations?		
4. Are you careful about your personal appearance?		
5. Do you work in a neat and orderly manner?		
6. Can you keep from becoming nervous and "falling apart" when working under pressure?		
7. Can you work without constant supervision?		
8. Are you willing to do whatever job is assigned to you?		
9. Do you have a sense of responsibility?		
10. Are you dependable? Can you be told to do a job and do it satisfactorily?		
11. Have you gained the friendship and respect of those with whom you work?		
12. Do you respect the authority of those who supervise your work?		
13. Do you pay attention to instructions and carry them out accurately?		
14. Are you willing to ask questions when you are not sure of what is expected of you?		
15. Do you accept criticism and use it in a program of self-improvement?		
16. Do you remain pleasant as you work?		
17. Are you friendly to those with whom you come in contact?		
18. Do you have an attitude of loyalty toward this course and your fellow students?		

*adapted from "Dietitian Aide", Texas Tech Univ., Schoo[redacted] Home Econ., Lubbock, T[redacted]69

Objective

To gain skills which will prepare for entering home economics or related occupations through "employment" within the school.

Generalizations	Learning Experiences	Evaluative Activities
# 13, 14, 15, 16, 17	Serves as asst. cook, waitress, kitchen helper, hostess	Uses score sheets to evaluate products
	Some serve as cook, head cook, supervisor, manager	Uses student made job description to evaluate self
	Coordinates food production and service	Prepare an audio tape of recommendations for next year's class
	Demonstrates to class proper use of selected equipment—knives, blender, mixer, etc.	
	Prepares a variety of foods—main dish, salads, vegetables, desserts, appetizers, breads, beverages, etc.	
	Prepares menu folder	
	Plans and/or adapts menu	
	Uses substitutes in recipes	
	Demonstrates creating an attractive centerpiece	
	Guest speaker from health dept on food and sanitation	
	Guest speaker on quantity foods	
	Field trip to observe commerdal food service	
	Prepares job descriptions	

Objective

To gain satisfaction from carrying out responsibilities diligently and well.

Generalizations	Learning Experiences	Evaluative Activities
# 4, 10	Students take turns reading aloud thank you notes received from guests	Give a special award or pin to students who carry out a responsibility unusually well.
	Lists his/her contributions to the guest meals	
	Each student photograph a table setting, centerpiece or a guest meal that he/she would like to keep	Keep scrap book of thank you notes, pictures, menus, etc.
	List non-financial rewards from home economics related occupations	
	Go to lunch at a restaurant on proceeds of class meals	

Objective

To grow in ability to budget time wisely and use leisure time for personal satisfaction and social usefulness.

Generalizations	Learning Experiences	Evaluative Activities
# 15, 16, 17, 18, 19	Schedules work to produce a specific food at a predetermined time	Evaluates guest meals for timing
	Schedules work to produce an entire meal at a predetermined time	Completes a time plan for a given situation
	Experiments with short cut methods of food prep	Prepare "My Goals, Values and Standards" after class discussion
	Interview an acquaintance with many responsibilities how does he or she manage?	
	Completes a work record for oneself	
	Prepare a school time plan for oneself	Evaluate plan on basis of workability
	Prepare a weekend time plan for oneself	" " "
	Discuss time as related to energy, ability, products available, services available, and one's values and goals	
	Compare process of time planning in class with planning one's own time	
	Collect helpful short cuts from newspapers, magazines--post and discuss	
	Define goals, values, standards, time as a resource, energy as a resource, ability as a resource, available goods & services, purchasing power	
	Complete time and motion studies on selected routine tasks	
	Work with music	Evaluate effect of working with music

Objective

To grow in ability to think rationally, to express thoughts clearly, and to read and to listen with understanding.

Generalizations	Learning Experiences	Evaluative Activities
# 3, 5, 6	Welcomes guests	Balance food tickets & money
	Takes orders for beverages	Analyze tape recording of guest conversation for ability to express thoughts clearly
	Sells food tickets	
	Follows directions of teacher or supervisor	
	Follows standardized recipes	
	Increases or decreases recipes	
	Works with and, in some cases trains & supervies, other students	
	Guest speakers--business teacher on keeping accounts, reading teacher on reading directions, speech teacher on making oneself understood	
	Field trip--order own luncheon, observe waiter or waitress	
	Tape record conversation with a guest	
	Plan a meal together as a class and analyze thought processes	
	Keeps accounts	
	Keeps own work records	

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Objective

To purchase and use goods and services intelligently.

Generalizations	Learning Experiences	Evaluative Activities
# 18, 19,20, 21	Selects and orders food	Evaluate quality & effective usefulness of present equipment
22	Selects and orders supplies	
	Selects and orders equipment	Make recommendations for equipment to buy next year
	Checks and maintains food and equipment inventories	
	Field trip—guided tour of grocery store	
	Guest speaker--representative of local consumer fraud office re food products	
	Cares for dishes, utensils and equipment	
	Cares for food supplies	

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Objective

To explore opportunities in and requirements of occupations related to home economics.

Generalizations	Learning Experiences	Evaluative Activities
# 7, 8, 9, 12	Panel of women workers on "Why I Work"	Complete "Outline for Studying Occupations"* after field trips
	Guest speaker--asst. director of ETHS cafeteria who started as a line worker	Prepare a bulletin board on home ec related occupations
	Field trips--hospital food service, restaurant, homes for senior citizens, Northwestern dorm, Jewel food or other store with home economist, Sara Lee Bakeries, etc.	Present a program on home ec realted occupations to freshman classes
	Do a community study of mothers who work--how many work full time? part time? in home ec related occupations?	
	Keep a scrapbook of newspaper, magazine articles about home ec related occupations with name of contributor recorded	
	List home ec related occupations using USOE Occupations Handbook	

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Outline for Studying an Occupation*

Conditions within the occupation

What are the duties one performs in the occupation?
What are the divisions or separate fields in the occupation?
What is the job in which one usually begins?
What are the steps through which one advances to higher positions?
What are the hours of work?
Is the work seasonal? If so, which are the busy months? Which the slack months?
Are there any particularly unhealthful features about the work?
Are there any unethical features?
How many persons are engaged in the work?
Is the occupation overcrowded?
Is it likely to grow?
Is it unionized?
What is the best way to get a job in this field?

Requirements of the occupation

How old must one be in order to enter the occupation?
Are there any special requirements as to height, weight, strength, etc.?
Are any of the special senses particularly involved?
What personal traits are most often mentioned in connection with the occupation?
Is the activity involved chiefly mental or physical?
Does it require more than average intelligence?
Is it predominantly social--that is, does it require one to deal largely with people?
How much general education is necessary?
What kind of special training is needed?
How long a time is required for special training?
Where can special training be obtained? How much in educational institutions?
How much on the job?
How much will preparation cost?

Rewards obtainable

On what basis is a worker paid in this occupation--by the hour, piece, day, week or month?
How much can one earn by overtime work?
Is a bonus paid?
How much is the average pay--on a beginner's job and at later stages of advancement?
How much might one expect to earn after ten years of service in the occupation?
Are there provisions for sick benefits, profit sharing, pension, workmen's compensation?
How much vacation is given with pay?
What are the chief rewards of a nonfinancial nature?

*Illinois Teacher, Vol. VIII, No. 3, pp. 136-7

1 Home Economics Occupations
Tentative Block Plan

	Objective	Monday (4 mods)	Tuesday (2 mods)	Thursday (2 mods)	Friday (4 mods)
ept. 7	Orientation	Labor Day	Institute Day	Orientation Describe Class Get Acquainted	Practice Lab
14	Orientation Skills	Plan Simple Meal to Serve Ourselves	Orientation - Prepare Class Rulebook	Set up Evaluation for Tomorrow's Meal	Prepare and Evalua Meal
21	Skills	Practice Lab Concentrate on Skills	Divide into Groups to prepare job Descriptions	Finish job descriptions - How evaluate?	Prepare same meal as last Friday with improvements
28	Personal qualities time management	Evaluate Friday's lab using job descriptions	Techniques - measurements and terms	Personal qualities "Customer Needs"	Plan 1st and 2nd guest meals
)ct. 5	Skills Table Service Time management	Practice guest meal	Evaluate meal emphasis on food quality & timing	Table Service	1st guest meal
12	Skills Time mgmt	Columbus Day	Practice 2nd guest meal	Practice 2nd guest meal	2nd guest meal
19	Consumer Skills	Plan guest meal	Table Service	Ordering Food	3rd guest meal
26	Consumer skills	Plan meals by dividing into 2 teams	Discuss purchasing food	Caring for supplies	Guest meal team 1 (Team 2 - planning
. 2	Home Ec. Related Occupations Skills	Field trip to Home Ec. related occupation	Discuss field trip	Complete outline for studying occupations	Guest meal team 2 (Team 1 - planning
9	Thinking skills	Practice lab on on needed skills	Discuss thought processes in planning	Demonstrate new skill	Guest meal team 1 (Team 2 - planning

	Objectives	Monday (4 mods)	Tuesday (2 mods)	Thursday (2 mods)	Friday (4 mods)
ov. 16	Expressing self Time management skills	Experiment with short cuts	Define and discuss values, time as resource, etc.	Class interview acquaintances with many resp.	Guest meal
23	Satisfactions expressing self	Field trip - go to lunch at restaurant	Guest speaker - reading teacher	Thanksgiving	
30	Reading skills	Institute Day	Guest speaker - reading teacher	Demonstrate center-pieces	Guest meal
Dec. 7	Skills	Practice vegetable cookery	Discuss vegetable cookery	Discuss protein cookery	Guest meal
14	Sanitation skills	Practice protein cookery	Safe and sanitary practices	Guest speaker - Evanston Health Dept.	Guest meal
Jan. 4	Consumer time mgmt. skills	Field trip to grocery	Purchase and use of food	Plan foods to make ahead	Guest meal
11	Skills satisfactions Personal qualities	"Make ahead and freeze" lab	Personal qualities Verbal & Nonverbal comm.	Satisfactions - scrap book (Student awards thank you's, etc.)	Institute Day
18	Home Ec. related group skills	Practice yeast bread	Home Ec. related occup. guest speaker from ETHS cafeteria	Home Ec. related occup. panel of women workers	Guest meal
25	Home Ec. related occupations	Field trip to related occupations	Exams	Exams	Exams
b.	Time management	President's Day	Grading Day	Discuss time mgmt. as related to other resources	Guest meal

	Objectives	Monday (4 mods)	Tuesday (2 mods)	Thursday (2 mods)	Friday (4 mods
eb. 8	Thinking Time mgmt. skills	Plan meals ahead	Guest speaker Business teacher on acct. keeping	Class work on accounts	Guest meal
15	Consumer skills	"Make ahead and freeze lab"	Inventory food supplies	Prepare food orders	Guest meal
22	Expressing personal quality skills	Practice lab desserts	Role play - giving directions to others	Check list for self improvement - 2nd check	Guest meal
ar. 1	Satisfactions skills	Field trip to restaurant	Revise job descriptions	Plan for special guest meal	Guest meal
8	Consumer skills	Special guest meal - counselors	Evaluate special guest meal	Purchase and use of equipment	Guest meal
15	Consumer skills	Practice lab beverages	Purchase and use of food	Plan for 2nd special guest meal	Guest meal
22	Sanitation skills	Special guest meal - advisory council	Demonstrate safe handling of foods	Demonstrate sanitary methods	Guest meal
29	Personal qual. skills	Practice lab salads	Discuss short course in human relations	Guest speaker - Ill. Employment Service	Guest meal
Apr[illegible]	Home Ec related occup.	Field trip to H.E. related occup.	Work on outline for H.E. related occup.	Work on outline for H.E. related occup.	~~Good Friday~~
19	Consumer time mgmt. skills	Plan ahead for special meals	Do grocery orders ahead	Store food	Guest meal

	Objectives	Monday (4 mods)	Tuesday (2 mods)	Thursday (2 mods)	Friday (4 mods)
Apr. 26	Time management skills	Make ahead and freeze lab	Prepare a personal time plan for Wednesday	Evaluate Wednesday's time plan	Guest meal
May 3	Skills	Special guest meal for administration	Guest speaker - Centerpieces	Prepare a tape of recommendations for 1971-72 class	Guest meal
10	Consumer skills	Practice lab	Guest speaker on consumer fraud	Work on scrapbook	Guest meal
17	Consumer skills	Special guesl meal	Evaluate class rulebook	Decide on equipment to buy 1971-72	Guest meal
24	Home Ec. related occupations	Field trip to related occupations	Checklist for self improvement - final rating	Satisfactions - giving awards	Final meal!
31	Home Ec. related occupations	Memorial Day	Complete outlines of Home Ec. related occupations	End of year finishing up	Exams
June 7		Exams	Exams	Exams	Institute Day Faculty Breakfast

FUTURE PLANS

In the school year 1971-72 it is expected that there will be enough enrollment (and money) to employ a coordinator to carry on the cooperative vocational Home Economics Related Occupations (HERO) program. Students would be eligible for HERO by taking home economics courses. For example, the seniors who have enrolled in Child Development as juniors would be eligible to be placed in community nursery schools. A continuation of the Child Development course observation-participation in elementary schools might be developed into a teacher aide program in the elementary schools. Other courses that could provide possible occupational background are Clothing and Advanced Clothing. There is need for alteration and dress making services in our area. Students who have had Home Planning and Furnishing might be interested in employment in furniture or interior decorating establishments. The semester Foods course would provide some occupational background if the student had not enrolled in 1 Home Economics Occupations.

During the school year 1970-71 a Home Economics Advisory Council will be selected. It will have as members student, parent and business representatives. The business representatives will be a part of the home ec council but will meet separately to make plans and decisions regarding the cooperative program. A business member of the Home Economics Advisory Council will be a member of the advisory council for all the cooperative programs in the school.

Every opportunity to explain Home Economics Related Occupations (HERO) to students, parents, faculty and prospective employers will be taken. As the time comes to set up schedules for courses in 1971-72, it will be important to investigate the possiblity of arranging class to meet at the same time as Vocational Experience so team teaching will be possible.

The coordinator will be employed in July to make contacts with students, and their parents and to prepare an employer survey. The local branch of the Illinois Employment Service is a logical beginning for surveying community work needs. Cooperations with the other coordinators in the school is imperative to prevent duplication of job stations and hard feelings.

Other summer responsibilities for the coordinator include:

- interview with student and prospective employer
- job analysis with student, employer and coordinator together
- an agreement to provide training and experiences agreed upon that is signed by the student
- an agreement to fulfill the responsibilities agreed upon that is signed by the student
- an agreement to provide the instruction agreed upon that is is signed by the coordinator
- evaluative procedures - how student is to be rated by employer, how often the coordinator visits, how frequently three way evaluative conferences will be held, etc.

Although instructional materials are already being collected, there needs to be constant attention to this phase of the program next year.

Plans for the youth organization are part of the focus for 1970-71. It seems to be sensible to meet during class periods and have a special HERO club at ETHS. Student responsibility for the club will ad the development of initiative, reliability and dependability.

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WORK ORIENTATION SURVEY UNIT
RELATED TO
HOUSING, HOME FURNISHINGS, EQUIPMENT

Workshop

Vocational Programs In Home Economics

Home Economics 450

Nancy W. Davis

OVERVIEW

This work orientation survey unit is designed to be taught in coordination with a one semester curriculum entitled Housing and Home Furnishings. The curriculum will be open to both boys and girls who are in their Junior or Senior year in high school. The curriculum will be taught by the Home Economics Department but is listed in the school course catalog under the areas of Home Economics, Art and the Industrial Arts Departments. Therefore, students with a vast range of learning experiences will be enrolled in the course with a strong common interest in the area of Housing and Home Furnishings.

The general behavorial objectives of the unit were predetermined as a part of Palatine Community School District #211 Plan for Vocational and Technical Education.when the school's plans were written for the States consideration for vocational reinbursement. In keeping with the behavorial objectives, a concept was formulated to provide a basic structure for the learning process. The generalizations , as stated in the unit, are what the instructor expects to be part of the immediate behavorial outcomes and will also be used in the future as a bases for serious consideration concerning occupational goals. Specific behavorial objectives were then created to lead to definite measurable learning experiences.

The underlying rationale of the unit is based on developmental characteristics of the late adolescent. They are " more attention given to ways of earning a living"(1), "Eagerness to become self sufficient and self supporting"(1) and "Selecting and preparing for a occupation"(2). It is important for students to explore many career possibilities before he begins to narrow down the choices that could lead to a successful occupational befitting his interests. Since the curriculum

being studied covers the area of Housing and Interior Design, the work orientation survey will focus in on many of the varied yet related skilled and professional occupations. It is possible to explore these occupations by various methods such as a survey method, a research study, reading on occupational information, personal observations and individual interviews. The unit was designed to contain all of the above learning experiences.in the exploration of the possible occupations.

It is the goal of this work orientation survey to not only increase the occupational awareness of the students but to develop a program in tune with the needs of the community so that the student can achieve civic competence and the community can benefit to the greatest extent possible.

(1) Working Guide for Developing Homemaking Education Curriculum in Local Communities. Austin: Texas Education Agency, Vocational Education, Home and Family Education, 1957, pp. 5-6.

(2) Havighurst, R. J., Developmental Tasks and Education, New York: Longmans Green and Co., 1952.

Concept

The fields of housing and interior design have a wide range of possible occupations to meet the personal satisfactions of both the skilled and professional person.

Generalizations

The need for a work orientation interest survey is important in aiding a student to begin to evaluate his future occupational goals.

A relationship exists between a high school curriculum and occupational goals in the wise use of learning experiences.

An individuals choice of occupation ultimately determines his education, his skills, social and economic level.

An individuals future is identified in part by his choice of an occupation.

To succeed in any occupation a person must havesatisfaction from his labors and beable to work with others.

Broad General Behavorial Objectives

To identify the occupations and future trends in housing, home furnishings and equipment.

To gain knowledge and appreciation of services available in the fields of housing, home furnishings and equipment.

To cultivate personal qualities needed for job success.

General Behavorial Objective

To identify the occupations and future trends in housing, home furnishings and equipment.

Specific Behavorial Objectives

To list occupations and trends in the area of housing and home furnishings and equipment by conducting a survey of related occupations in the local area.

To research, in groups of 2-4, related occupations in the area of housing, home furnishings and equipment that were identified by the class survey.

Learning Experiences

Class discussion on possible related occupations. Use The Dictonary of Occupational Titles and the Illinois State publication, Descriptions, Definitions and Occupational Coding System. Speaker-Guidence Counselor

Students survey the local area through the use of the occupational survey form.

Students compile the results of the occupational survey; select a occupation that they are interested in to research in small groups with other students. Occupations not selected to be research can be studied through the use of related films, field trips or guest speakers.

Resources

School Guidence Counselor
District 211 Vocational Education Coordinator
Illinois Employment Service
Career Center- School Library
Telephone Directory
Paddock Publications Directory
Local Resource People

Evaluation

Occupational Reasearch Project

General Behavorial Objective

To gain knowledge and appreciation of services available in the fields of housing, home furnishings and equipment.

Specific Behavorial Objectives

To analyze occupational information gained through research by presenting a project on the related occupations to the class.

To list occupations that relate to knowledge gained from the Satisfaction Questionnaire and the study of the occupational projects.

Learning Experiences

Students divide in small groups to select and research a related occupation. Upon completion of the project, the groups will give a written copy to the instructor and then present the project to the class. Presentations may be in the form of a panel or a visual presentation with oral explanation.

Students diagram or make a chart of occupations showing the relationships between the the knowledge gained from the research projects and the understanding gained on the Satisfaction Questionnaire. This will show occupations that will lead to success for that student.

Resources

Job Analysis Project Sheet
Career Center-School Library
State Employment Service Office
Local Resource People
School Guidence Counselor
Information gained on occupational survey

Evaluation

Research Project

Student occupational satisfaction diagram

General Behavorial Objectives

To cultivate personal qualities needed for job sucess.

Specific Behavorial Objectives

To identify personal needs to be served by an occupation the student will complete a Occupational Satisfaction Questionnaire.

To practice personal interrelationships by participating in an Occupational Research Project.

To write a self-evaluation of participation in group dymanics while working on the research project.

Learning Experiences

Students will answer Satisfaction Questionnaire and study the results.

Assign readings on group dymanics and self-understanding. Class discussion on readings. Groups then elect project leader and assign tasks necessary to complete porject.

Students interview a community resourse person related to their project.

Upon completion of research project, each student write a reaction paper to his participation in t he project.

Resources

"Your Attidudes are Showing"
"Everyday Human Relations"
Student Manual for Occupational Relations Chapter three
Occupations and Careers
" Planning Yor Life's Work"
Successful Living
SRA Series on Personal Development

Evaluation
Group dymanics through project reaearch and presentation.
Written reaction paper of group dymanics during reseerch project.

Student Occupational Survey
Housing and Interior Design
Vocational Education Program
_____ High School
_____, Illinois

Name of Firm or Individual _____

Address _____

Purpose

The purpose of this survey is to determine what occupational needs exist in the fields of Housing and Interior Design. The field of "Housing" encompasses those occupations that deal with home building, design or sales. The field of "Interior Design" would include occupations involving the interior functioning of a home.

Housing

Do you or does your firm employ persons in the following occupations. (Please note number of persons in spaces provided.)

_____ Architect
_____ Carpenter
_____ Blue Print Technician
_____ Plumber
_____ Drywall Specialist
_____ Appliance Repairman
_____ Real Estate Agent
_____ Property Appraiser

_____ Electrician
_____ Carpet/Tile Installer
_____ Bricklayers/Masons
_____ Roofers
_____ Painter/Wall Paperer
_____ Other: _____
_____
_____

Interior Design

Do you or does your firm employ persons in the following occupations? (Please note number of persons in spaces provided.)

_____ Interior Designer
_____ Interior Decorator
_____ Color Consultant
_____ Remodeling Consultant
_____ Other Design _____
_____

_____ Home Furnishings Consultant
_____ Home Furnishings Sales: (Note Below)

___ Carpet Sales
___ Paint/Wallpaper Sales
___ Drapery Sales
___ Appliance Sales
___ Other Furnishings Sales

Future Trends

Do you foresee new occupations or specializations influencing your needs in the near future? _____ If "Yes", give general description(s).

_____

_____

_____

_____

Availability

Would you or other members of your firm:

_____ Be available to speak in person to school class.
_____ Be available for interview by a student.
_____ Be able to provide pamphlets or brochures on occupations in housing or interior design.
_____ Be available to discuss development and expansion of housing and design programs in local schools.

Comment and Critique

Do you have any additional comments or ideas to express? _____

_____

_____

Thank you very much for your time. It is our desire to develop programs in your schools in tune with the specific needs of the community. The information you have provided will be included in our program planning.

_____
(Identification)

_____
(School)

Occupational Satisfaction Questionnaire

	Important	Unimportant
1. Liking the work you do	_____	_____
2. Using your capabilities	_____	_____
3. Feeling suited to your work	_____	_____
4. Working with numbers	_____	_____
5. Working with words	_____	_____
6. Working with things	_____	_____
7. Working with your hands	_____	_____
8. Working fast	_____	_____
9. Working slowly	_____	_____
10. Doing precise work	_____	_____
11. Doing things skillfully	_____	_____
12. Doing things others can't do	_____	_____
13. Competing with others	_____	_____
14. Doing routine work	_____	_____
15. Always knowing what's next	_____	_____
16. Doing a variety of things	_____	_____
17. Encountering unexpected tasks	_____	_____
18. Being creative or original	_____	_____
19. Gaining esthetic enjoyment	_____	_____
20. Dealing with people	_____	_____
21. Influencing people	_____	_____
22. Dealing with ideas	_____	_____
23. Being challenged intellectually	_____	_____
24. Mastering an area of knowledge	_____	_____
25. Knowing why you're doing something	_____	_____
26. Seeing the product of your work	_____	_____

	Important	Unimportant
27. Enjoying daily accomplishment	_____	_____
28. Releasing energy through activity	_____	_____
29. Moving about at your work	_____	_____
30. Traveling as part of your work	_____	_____
31. Running occasional risks	_____	_____
32. Feeling safe from accidents	_____	_____
33. Having convenient working hours	_____	_____
34. Working in pleasant surroundings	_____	_____
35. Having time and energy for other activities	_____	_____
36. Doing an honest day's work	_____	_____
37. Sensing order in your life	_____	_____
38. Feeling sure of keeping your job	_____	_____
39. Feeling independent	_____	_____
40. Having responsibility	_____	_____
41. Not having responsibility	_____	_____
42. Feeling useful and needed	_____	_____
43. Getting attention	_____	_____
44. Being judged fairly	_____	_____
45. Being treated like a person	_____	_____
46. Having your work praised	_____	_____
47. Feeling proud of yourself	_____	_____
48. Being able to express your ideas	_____	_____
49. Feeling self-confident	_____	_____
50. Feeling important	_____	_____
51. Having authority over others	_____	_____
52. Telling others what to do	_____	_____
53. Being told what to do	_____	_____

	Important	Unimportant
54. Doing things on your own	_____	_____
55. Exercising leadership	_____	_____
56. Being promoted	_____	_____
57. Being a member of a group	_____	_____
58. Being with other people	_____	_____
59. Working by yourself	_____	_____
60. Talking to co-workers	_____	_____
61. Talking to others	_____	_____
62. Liking your co-workers	_____	_____
63. Being liked by co-workers	_____	_____
64. Feeling loyal to others	_____	_____
65. Helping other people	_____	_____
66. Doing work of value to society	_____	_____
67. Feeling part of something big	_____	_____
68. Feeling enthusiastic	_____	_____
69. Feeling morally worthy	_____	_____
70. Achieving your ambition	_____	_____
71. Making your family proud of you	_____	_____
72. Gaining prestige in your community	_____	_____
73. Becoming well known	_____	_____

Housing, Home Furnishing and Equipment

Job Analysis

Project

Group research and presentation on a related occupation to the semester course of study. Base inquiry on the following points. Present in completed form to instructor and then present to class by either a panel discussion method or by a visual presentation with some oral explanation.

1. List job title - DOT Title or DOT Code Number. Give a description of occupation.

2. History, development, and probable future trends of the occupation.

3. Duties of worker. Daily or periodic tasks performed by a person in this occupation. What have you found to be included in a typical day's work?

4. Requirements of the worker for entering and succeeding in the occupation. Education and special training necessary. Where secured. Entrance requirements of those schools. High school courses that are essentials for that occupation. School courses that are recommended as desirables. School courses that are recommended as preparation for a college course that offers training for this occupation. Union organization and requirements. Licenses required. Examinations required. Civil Service requirements.

5. Qualifications of the worker. Personal qualities desirable (such as age or sex), personality traits, physical qualifications necessary. Hobbies that are especially relevant to this occupation.

6. Economic demand. Number of workers in this occupation according to the United States Census report and Occupational Outlook. Yearly turnover of workers in this industry. Why? Number of male workers in this occupation. Of women. Number of workers ten years ago. Is this occupation growing in importance? Is the field crowded? Is the work seasonal? Is work in this field necessary in times of depression, of war? Is work geographically limited? Average salary of men and of women? Average salary of beginning workers, of experienced workers?

7. Conditions of work. Hours. Health and accident hazards. Regularity of employment. Effect of this work on the lives of the workers.

8. Opportunities for placement. For experience. For apprenticeship. For advancement. Related occupations to which one might seek promotion. Opportunities for social or mentary rewards. Opportunities for profit sharing, bonuses, annuity or retirement insurance, sick benefits, vacations, discounts on goods purchased from the employer. Opportunities for home life, recreation, cultural growth, and participation in community affairs. What service useful to society does the worker perform?

9. Advantages of the occupation. What workers in this occupation like best about it.

10. Disadvantages and special problems. What workers in this occupation like least about it.

11. Report of a personal interview with a worker in this occupation.

12. Related newspaper clippings or magazine articles, pamphlets, and pictures.

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SOME SUGGESTIONS FOR ESTABLISHING A COOPERATIVE GAINFUL EMPLOYMENT PROGRAM IN THE AREA OF HOME FURNISHINGS

by

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Marengo, Illinois

Vocational Home Economics Workshop
Home Economics #450
Dr. Smith

Nothern Illinois University
Summer, 1970

Suggestion for Developing a Vocational Education Program
in the area of Home Furnishings

I. Set up an Advisory Committee:
- A Home Economist
- An Interior Decorator
- Department Store Manager
- Drapery Shop Owner
- Furniture Uphosterer
- County Extension Agent
- Antique Shop Owner
- Slip Cover Seamstress
- Green House Owner

II. Secure Information on opportunities for employment:
- A. Analyze material collected by:
  - State Employment Service
  - Bureau of Census
  - Chamber of Commerce
  - Others
- B. Secure additional information if needed through occupational survey.

III. Determine number of potential students and their interest:
(through the use of a student survey)

IV. Define or describe Job Analysis:

V. Develop a Syllabus:
- Objectives
- Concepts
- Generalizations
- Learning Experiences
- Teaching Aids
- References

V. Determine what facilities and equipment are needed

VI. Evaluation of the Program

Cover Letter for a Community Survey

Dear Mr. Employer:

We are conducting a survey to determine a need for a gainful employment program in the area of Home Furnishings Services. We are investigating the present supply and the future demand for trained workers in this area.

An advisory committee and myself will summarize the answers from the questionaires so that we will have some basis for developing our Vocational Home Economics Program.

Your answers to the questions do not obligate you in any way at anytime.

We have enclosed a self-addressed, stamped envelope and ask that you return it to us by _____ .
(date)

Thank you very much for your co-operation in participating in the survey.

Sincerely yours,

SURVEY QUESTIONAIRE

(Survey of managers and owners of drapery and upholstery workrooms, interior design studios, department stores, furniture stores, antique shops, green houses and slip cover seamstresses.)

Name of Establishment _____

Address _____

Phone _____-

Number of employees: full time:_____
part time_____

1. Age requirements for trainees: Males_____
Females_____

2. Are you interested sufficiently in a co-operative work program to employ a student worker in your establishment?
Yes _____ No _____ Maybe _____

3. If you were interviewing persons of about equal personal qualities, would you prefer to hire the one who had high school Home Furnishings training? yes_____ No_____
Comments_____

4. What types of situations could you use a Home Furnishings Aide?

5. What personal characteristics would you expect in a worker?

appearance

dependability

grooming

follows instructions

attitudes

6. What type of equipment do you expect employees to operate?

7. Check which of the following tasks or responsibilities you would expect the trainee to do:

_____ familiarize self with policies and procedures of business operations.

_____ accepts instruction and guidance from employer.

_____ performs clerical duties of any kind.

_____ organizes and files sample catalogs.

_____ marks new merchandise.

_____ assists in taking inventory

_____ assists in arranging window or store displays

_____ assists in planning and arranging of furniture in the store

_____ assists in wall paper department by arranging samples, fabrics or catalogs

_____ keeps drapery and upholstery samples in order.

_____ measure, cuts and mails fabrics

_____ assists interior decorator

_____ sews draperies - if so, what parts

_____ installs draperies

_____ assists in repairing or altering draperies, curtains, shades or blinds

_____ Constructs the following:

- ___ bedspreads
- ___ lamp shades
- ___ window shades
- ___ pillows
- ___ slip covers
- ___ reupholster furniture
- ___ flower arrangements
- ___ Others

_____ assists in upholstery furniture remodeling

_____ assists in maintence of work area

_____ assists in refinishing furniture

_____ conducts sales work

SURVEY OF STUDENT'S INTEREST

Home Furnishings:

Please rate the following units that you might be covering in a Home Furnishings course.

1. would like to study in detail and perhaps gain work experience
2. would like to study for general knowledge
3. would not like to study

_____ Drapery Construction

_____ Curtain Construction

_____ Shades and blinds

_____ Principles of Color and Design

_____ Arrangement of Furniture

_____ Period Furniture

_____ Preparing Window and Store Displays

_____ Furniture Construction

_____ Refinishing Furniture

_____ Slip Cover Construction

_____ Bedspread - Table Coverings Construction

_____ Merchandising

_____ Functional and Decorative Lighting

_____ Floor Coverings

_____ Flower Arrangement

_____ Others

Comments:

Home Furnishings Aide

09.0204 (Office of Ed. Titles)

The occupation of Home Furnishings Aide is one suggested for the student who is interested and possesses the ability in interior designing. The skilled student must appear to be imaginative and understand tasks involved in being employed in the various Home Furnishing occupations.

Homaking Occupations I is a prerequisite for the Home Furnishings unit. It is suggested that the student have some degree of skill in sewing since the job might involve sewing.

A student employed by an Interior Designer or in the Home Furnishings department of a store will need an understanding of Art and Design principles as well as sales procedures and arranging displays. Other duties might be keeping files and samples.

The Home Furnishings Aide in a drapery, upholstery or slipcover workroom would assist in the construction process. The student must have a thorough understanding of drapery construction, highly developed skills of sewing and the imaginative ability to design different window treatments and slip covers.

The student employed in a green house will need a knowledge of different plants and flowers and an understanding of art and design principles related to flower arranging.

The student employed in a furniture store might need to understand principles of furniture arrangement, period furniture, lighting principles and knowledge of floor coverings. Here the student's salesmanship qualities are important to consider.

BROAD COURSE OBJECTIVES

A. To recognize opportunities afforded in the Home Furnishings field.

B. To evaluate and appreciate the personal characteristics that contribute to success of the wage earner.

C. To understand the principles of interior design needed by workers in the Home Furnishings related occupations.

D. To develop abilities and skills needed for employment in the Home Furnishings related occupations.

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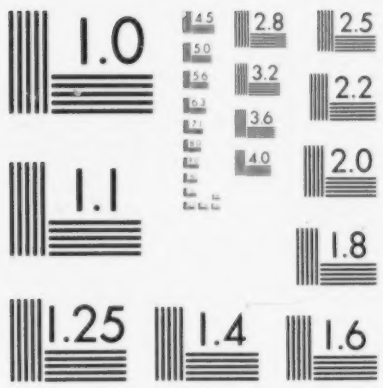

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SPECIFIC OBJECTIVES

After a person has completed this class he/she will be better able to:

1. Recognize the characteristics of careers in Home Furnishings.
2. Identify and develop desirable personal attributes for employment.
3. To gain an understanding and development of some knowledges and skills necessary for selecting and keeping a job.
4. To interpret and perform the fundamental principles, practices and skills of Home Furnishings services for those who preceive it as a possible terminal vocation after high school.
5. Apply principles of art and design.
6. Develop acceptable work habits and co-operative relationships with employers, employees and customers.
7. To apply principles of design in arranging furniture displays.
8. To apply principles of art and design in the construction of a) slip covers b) bedspreads c) shades d)curtains e) draperies and f) flower arrangements.
9. Apply principles of functional and decorative lighting.
10. Plan and perform effective management practices in the use of time, energy and money.
11. Identify and perform safe practices while on the job.
12. Identify and perform sanitary practices while on the job.
13. Use the basic equipment in the particular related areas of Home Furnishings.
14. Use of correct terminology in the area of Home Furnishings.
15. Recognize various period furniture and be able to use this knowledge in the sales, arrangement and construction of furniture and related materials.

HOME FURNISHINGS

MAJOR CONCEPT: Selecting and Keeping a Job

I. Minor Concept: Being aware of occupations related to the Home Furnishings area.

A. Kinds of jobs available
1. drapery workroom
2. slip cover workroom
3. furniture store
4. interior design studio
5. green houses
6. antique shop

B. Scope of job
1. local
2. national
3. international

C. Advancement opportunities
1. apprentice program
2. rate of advancement
3. setting goals

II. Minor Concept: Recognizes and adapts important traits for being employable

A. Personal traits
1. health
a. government standards
b. employers standards
c. personal standards

B. 2. grooming and good manners
a. health practices
b. public relations
c. personal satisfaction

MAJOR CONCEPT: Understanding the use of color and design
III. Minor concept: Understanding the use of design elements

A. Design is the organization of basic elements
1. knowledge promoting good taste
a. recognizing
b. selecting
c. creating

2. form

3. shape

4. texture

5. color

6. space

7. line

II. Minor concept: Understanding classifications of design

A. structural design

B. decorative design

III. Minor concept: Studying Principles of design

A. Definitions
B. Types
   1. functional
   2. decorative

C. Principles
   1. proportion
   2. balance
      a. symetrical
      b. asymetrical
      c. radial
   3. Rhythm
      a. repetititon
      b. gradiation
      c. opposition
      d. transition
      e. radiation
   4. emphasis
      a. what to use
      b. where to use it
   5. unity (harmony)

IV. Minor concept: Learning about color

A. Practical choice
   1. psychologically
   2. artistically

B. Reflection - Absorbtion

C. Emotional appeal

D. Qualities of color
   1. value
   2. intensity
   3. hue
      a. shades
      b. tints

V. Minor Concept: Using color successfully

A. color wheel
B. color schemes
1. analagous
2. complimentary
3. triad
4. mono chromatic
5. split complimentary
6. neutral - accented

C. Creating effects and illusions

D. Backgrounds
1. reshape
2. resize
3. accent

VI. Minor concept: Harmony attained through application

A. Background
1. walls
2. ceilings
3. floors
4. window treatments

B. Furnishings
1. individual items
2. arrange in relation to total area
a. convenience
b. beauty

C. Accessories

1 1. individuality
2. relating to total area

MAJOR CONCEPT: Developing ability to select Home Furnishings

I. Minor concept: Furnishings may be chosen through a wide variety of styles

A. Traditional Furniture
1. Early American
2. Colonial
3. Federal
4. Queen Anne
5. Chippendale
6. Sheraton
7. French Provincial

B. Modern and Temporary
   1. Danish and other national trends
   2. free forms

C. In proportion of area to be furnished

D. Function for the Family
   1. number
   2. strength - soze
   3. care

II. Minor concept: Knowledge of quality workmanship is useful

A. Woods - finishing
   1. quality
      a. solids
      b. veneers
      c. laminated

   2. types
      a. fruitwoods
         1) maple
         2) cherry
         3) walnut
         4) pecan
      b. oak
      c. birch
      d. mahogany

   3. Construction
      a. joints
      b. corners
      c. drawers

B. Refinishing furniture

   1. removing old finish
      a. techniques
      b. supplies
   2. bleaching
      a. techniques
      b. supplies
   3. sanding
      a. mateials needed
      b. procedure
   4. staining
      a. wiping stains
      b. water stains
      c. varnish stains
   5. finishing
      a. a. types
      b. techniques

C. Upholstered Furniture
   1. frame
   2. cushions
   3. springs
   4. fillings
   5. under construction
   6. finishing fabrics
   7. fabric finishes

D. Labels and Tags
   1. information
   2. seals of approval

III. Minor concept: Accessories contribute to mood

A. Mood
   1. gaiety
   2. indiviuality
   3. serenity
   4. dignity
   5. period of furnishings

B. Items Used
   1. lamps
   2. pictures
   3. mirrors
   4. clocks
   5. plants
   6. rugs
   7. unusual objects

MAJOR CONCEPT: Every home should have good lighting

I. Minor concept: Adequate lighting is essential

A. Functional puppose
   1. sight saving
   2. comfort
   3. convenience
   4. safety

B. Decorating purposes
   1. beauty
   2. accent
   3. atmosphere
   4. effect on colors used

II. Minor concept: analyze light needs

A. Tasks to be done

B. Design in work areas

C. Safeguarding people

D. Decorating
1. seasonal decorating
2. beauty spots
3. accents

III. Minor concepts Meeting Home lighting needs

A. Background lighting
1. cove
2. cornice
3. valance

B. Overhead lighting
1. general
2. hard to see areas

C. Determining amount of light needed

MAJOR CONCEPT: Individual Related occupations

I. Minor concept: Construction of Slipcovers and Bedspreads are jobs related to Home Furnishings

A. Constructing Slipcovers
1. fabrics
2. material and equipment needed
3. measuring
4. fitting - placememt of design
5. cutting
6. seam finishing
7. stitching
8. covering cushions

B. Construction Bedsreads
1. fabrics
2. types
3. measuring
4. sewing
5. decorative touches

II. Minor concept: Construction of vaious window treatments may be a valuable skill.

A. Types
1. double sash
2. arched
3. dormer
4. picture
5. casement
6. jalousie
7. wood
8. metal

B. Draperies
1. fabrics
2. operating equipment
3. measuring
4. cutting
5. sewing techniques
6. types of pleats
7. drapery hardware
8. terminology
9. attaching lining

Curtain construction
1. types
2. equipment needed
3. fabrics
4. measuring
5. matting
6. lining
7. finishing - trims

D. Shades
1. fabrics
2. types
3. measuring
4. cutting
5. sewing and construction techniques
6. trimmings

III. Minor concept: Knowledge in the area of floor covering can be useful in a home furnishings related occupation

A. Factors to consider
1. durability
2. economomy of up keep
3. resience
4. warmth
5. light reflection
6. sound absorbtion
7. appearance

B. Types
1. linoleum
2. tile

a. asphalt
b. cork
c. vinyl
d. ceramic
e. rubber
3. wood
4. carpet
5. rugs

IV. Minor concept: Flower arranging is an useful and profitable art.

A. Equipment needed
1. holders
2. container

B. Arrangement for:
1. formal rooms
2. informal or Early American
3. modern rooms

C. Rules

SOME SUGGESTIONS FOR DEVELOPING THE COLOR AND DESIGN UNIT

MAJOR CONCEPT: IDENTIFY ELEMENTS OF DESIGN

Generalizations	Learning Experiences
Good design is the result of highly creative thinking process. Lines have certain psychological effects upon the observer. Combination of different types of lines creates form or shape.	1. Listen to lecture and observe illustrative material on the elements of design. 2. Clip and mount examples illustrating design elements in a feminine room masculine room 3. Create a collage related to design elements. 4. Explore what different types of lines do to you. What feeling do you get? vertical horizontal curved 5. Identify different lines in rooms and decide which predominates

CONCEPT: UNDERSTANDING CLASSIFICATION OF DESIGN

Generalizations	Learning Experiences
Good structural and decorative design shows an orderly arrangement of material used and creates beauty in the finished product.	1. Listen to lecture and observe illustrative material. 2. Clip and mount illustrations of good structural and decorative designs. 3. Analyze situations (Home Economics department, pictures, your home)

Generalizations	Learning Experiences
Structural design is essential to every object, while decorating is the 'luxury' design.	4. Study three types of design natural conventional abstract
The purpose of decorative design is to enrich the surface and make it more beautiful.	5. Collect examples of each type of designs

CONCEPT: STUDYING PRINCIPLES OF DESIGN

Generalizations	Learning Experiences
Principles of design are laws governing the use of the elements of design.	1. Listen to lecture and observes illustrative materials of design principles.
Proportion is the law that governs the use of space. Divisions must be pleasingly related to each other and to the whole.	2. Clips and mounts illustrations of : formal balance informal balance lack of balance rhythm emphasis over emphasis room expressing moods
Unequal space divisions are more interesting than equal.	3. Project: Make a notebook of the design principles.
Balance produces a feeling of rest and contentment.	4. Evaluate different rooms on the basis of design principles. (Home Ec. room)
A room should have at least one wall with formal balance - never more than two.	
Balance is considered not only side to side but top to bottom.	
Rhythm is the law governing movement of the eye.	5. Observe your eye movement in different rooms.

Generalizations	Learning Experiences
The center of emphasis should be located on the wall opposite the door.	6. Find examples of emphasis and discuss just how it is achieved
Harmony is the law that governs use of the principles of design to produce pleasing effects.	7. Collect examples of Harmony, in class show just how the room achieved harmony. Give examples of rooms that do not have harmony.

CONCEPT: LEARNING FACTS ABOUT COLOR

Generalizations	Learning Experiences
We can make practical choice of color if we keep in mind the contributions of psychologists and artists.	1. Listen to lecture and observe illustrative materials, on the qualities, properties, classification, light reflection of color.
Eye strain may be reduced by use of colors correctly.	2. Make a color wheel.
Color has emotional appeal and consciously or sub-consciously. One associates it with a feeling or thing.	3. Experiment with changing values and intensities.
	4. Using paints, experiement with producing different colors.
Light or high values are usually good wall colors.	5. Experiement with a prism for the source of light.
Darker colors called shades make good rug colors .	6. Read additional references.
Warm colors advance and cool colors recede.	7. Experiement with different floor coverings and wall coverings to see the effect of color and texture.
	8. Disscuss terminology.

CONCEPT: USING COLOR SUCCESSFULLY

Generalizations	Learning Experiences
Ability to create beautiful color schemes can be developed through study. A color scheme is a combination of colors which look well together. A room should have one predominate color. Transition from room should be gradual and colors keyed. Colors may hide of create defeats. Light, dark, dull colors used in largest amounts, slightly grayed next and intense least. White, black and grey may be used in any part of any harmony.	1. Listen to lecture. 2. Make an examples of each color harmony. 3. Study other sources to see color schemes in them. textiles scenes wall paper paintings 4. Plan a room using the harmony principle. 5. Discuss what rooms use warm colors and what rooms use cool colors to their advantage. 6. Discuss terminology related to Color.

CONCEPT: ACCESSORIES CONTRIBUTE TO PLEASING ARRANGEMENTS

Generallzations	Learning Experiences
Artistic use of accessories contribute to a better overall design.	1. Collect and display accessories ideas for family rooms. Discuss functions, beauty and harmony with rooms furnishings. 2. Project: Every one make some accessory for any room in the house. 3. Develop criteria for arranging focal point eye to follow one part to another

good proportion
holding objects together

4. Exhibit: assign groups to plan arrangement in the department.

CONCEPT: ARRANGING FURNITURE SUCCESSFULLY

Generalizations	Learning Experiences
Smaller pieces may be placed at right angles to a wall to achieve grouping.	1. Identify rules governing furniture arrangement.
Habits can be encouraged or discouraged through the use of arranging furniture.	2. Observe rules on the opaque projector.
Large pieces of furniture should be placed paralled to the structure of room.	3. Arrange furniture in the department as well as on paper.
Group together pieces of furniture used for one activity.	4. Mount pictures showing correct and incorrect arrangement of furniture
Try to place conversation grouping away from traffic flows.	5. Field Trip to Burniture store. 6. Evaluate groupings. Evaluate other rooms.
Balance furnitre. All heavy around room . Main seating group points to one interest.	7. Make room arrangements for every room in the house. Observe rules.

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Decorating with Sheets
Decorating Made Easy
Fashions in Dining
Furniture Styles and Selection
Decorate a Bathroom
Major Home Appliances
Window Treatments
Space Age Kitchen
Floor Coverings
Paint and Wallcoverings
(filmstrips also available in co-ordination with booklets)

Good Housekeeping Bulletin Service. 57th. St. at 8th. Ave. New York.
Furniture Chart
Guide to New Carperting
Book of Flower Arrangements

Virginia Public Instruction Service Extension, Blacksburg, Virginia.
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Chemstrand, 350 Fifth Ave. New York
Beautiful and Pratical Acrilan
Know Your Nylon Carpet

Armstrong Cork Company , 1010 Concord St. Lancaster, Penn.
Texture and Color
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Alexander Smith and Sons Carpet Company, Yonkers, New York
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- Color Ideas - Key to Good Decorating
- Furniture Arrangements Ideas
- Ideas for Bedroom and Bathroom Beauty
- Well dressed Windows

General Electric Lighting Laboratories, Cleveland, Ohio.
' See Your Home in a New Light.'

Armstrong Cork Company, Lancaster, Penn.
'Inside Your Home' (filmstrips)
'Decorate with Flowers'

Sears & Roebruck Company Consumer Ed. Dept. Div. D / 703 , 925 S. Homan Ave. Chicago, Ill.
Series of filmstrips with booklets

J.C. Penny Company
'Color in Home Furnishings' (filmstrip)

Periodicals

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Better Homes & Gardens
Changing Times
Consumers Report
Consumer Research Bulletin
Family Circle
Good Housekeeping
House Beautiful
House & Garden
Illinois Teacher
Ladies Home Journal
McCalls
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Whats New in Home Ecnnmmics
Seventeen
Woman's Day

Evaluation

Evaluation should be made to give the teacher a basis for developing learning experiences, modify course plans and selecting appropriate references and teaching materials.

An integral part of planning a course is selecting some means for checking the progress of each trainee. The course should include:

1. ways of observing each trainee's progress toward achieving objectives and goals.
2. methods of recording observations so progress can be assessed.

Evaluation of trainee accpmplishments should be compiled throughout the training course. Observations made in realistic situations are more valid. Evaluations should take place in the laboratory and practice sessions.

Out on the job the employer can help you evaluate the trainee's progress and will be a direct feed back for you. Most employers find that a rating scale 1,2,3,4,5 is an easier one.

STUDENT'S PERSONAL EVALUATION

Check the appropriate squares: Learning Experiences:	Used everyday	Occas-sionaly	Not Needed	Need More
1. Learning to work and being cooperative with others				
2. Learning to work with employer				
3. Understanding my personal characteristics				
4. Meeting people outside the home				
5. Operating sewing machines				
6. Performed clerical duties				
7. Filing samples or catalogs				
8. Cleaning work area				
9, Taking inventory				
10. Arranging furniture				
11. Preparing displays				
12. Working in wallpapering dept.				
13. Pricing merchandise				
14. cutting material				
15. Installing curtains or drapes				
16. Repair work on furniture				
17. Alterrations in drapes or cubtains				
18. Constructing bedspreads				
19. Constructing curtains				
20. Arranging flowers				
21. Learning sales procedures				
22. Advise customers on products.				
23. Demonstrate equipment or product				
24. Used knowledge concerning laws of labor				

Employer's Rating Sheet

Student Learner _____ Date _____

Training Station _____ Rated by _____

Characteristics:	1	2	3	4	5 (superior)
1. follows instruction					
2. speaks clearly					
3. accurate					
4. alert					
5. co-operative					
6. courteous					
7. enthusiastic					
8. initiative					
9. imaginative					
10. learning ability					
11. hand writing					
12. loyalty					
13. mathematical ability					
14. personal ability					
15. personal appearance					
16. punctuality					
17. self control					
18. self confident					
19. tactful					

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HOME ECONOMICS
450

PREPARATION FOR A PRE-VOCATIONAL COURSE IN PERSONAL SERVICE

Marjorie Hall

Betty Ottwell

3309

OVERVIEW

This Personal Service curriculum outline is designed to prepare students for employment.

We feel there is a need for the type of service because of the changing families and the role of women in todays society.

With the trend of older people no longer being cared for in the home of their children because of the mobility of the population, and because of the large percentage of women working, the nursing home has become the answer of many older people.

The studies done by Edwin Goldfield show that 44.4 percent of people over sixty five years of age require home care, 24.8 per cent require constant home care and 19.6 per cent require part time home care.

Some recent statistics show that 288,268 women are employed as attendants in hospitals and other nursing type institutions. As a result of this we feel training of young people presents many employment possibilities for them, and that they can be an asset to institutions as well.

Objectives

1. To provide students an opportunity to explore and gain knowledge and information about duties performed in hospitals, nursing homes and homes for the aged. About housekeeping duties, personal services, food services and other areas of employment within these types of institutions.
2. To help students feel the importance of work and improve attitudes toward unselfishly giving of themselves to help others.
3. To help students gain confidence in their work by having solid entry level skills acquired in a classroom situation first.

SEQUENCE OF STEPS TO SETTING UP A PRE-VOCATIONAL CLASS AND PROGRAM

	I.	There would be a level of communication among the administrators, teachers and general public to the extent that would assure that such a need to explore possibilities for a class existed.
Jan.	II.	Choosing a steering committee
	III.	Dissolving of the steering committee
	IV.	Forming the advisory committee
	V.	Survey of the community needs and interests
	VI.	Survey of the students needs and interests
	VII.	Review community survey and identify opportunities for training stations
	VIII.	Send letters and make personal contacts for work stations
Mar.	IX.	Recruitment and selection of student learner
	X.	Complete student applications
	XI.	Interview students and identify more clearly specific opportunities
Apr. to Sept.	XII.	Preparation of training plans
May	XIII.	Forming a Pre-Vocational class
Sept.	XIV.	Forming an activity program (clubs)
	XV.	Use of training plans during school year

STUDENT SURVEY

1. Name_____Sex____ Year in school____Age_____

2. Are you working?_____

3. If number 2 is yes, do you feel you had adequate training to do a good job?_____

4. Would you like to have had more training? Yes_____No._____

5. Do you plan to go to college ? Yes____No_____. Do you plan to go to a vocational school? Yes_____No_____.

6. Do you plan to work after high school? Yes_____No_____.

7. Would you register for a course that would train you for employment in one of the following areas? Yes_____No_____.

PLEASE INDICATE YOUR 1st, 2nd, 3rd, and 4th choice.

Child Development

____ Nursery school assistant
____ Home care of children
____ Child care center aid
____ Community recreation assistant
____ Recreational center aid
____ Home placement service

Clothing

____ Textiles
____ Clerk
____ Alterationist
____ Model
____ Dressmaker
____ Personal shopper
____ Laundry-dry cleaning establishment

Meal Management

____ Salad maker
____ Waitress
____ Hostess
____ Short order cook
____ Bakery-delicatessen assistant
____ Food and/or appliance demonstrator
____ Cook--special phase
____ Hospital Dietetic aide
____ Tray Room Supervisor
____ Institutional cook

Housing, Home Furnishing

____ Clerk in furniture store
____ Gift wrapper
____ Florist's assistant
____ Maintenance worker, housekeeper, custodian
____ Maid (hotel, motel, etc.)
____ Real estate interviewer
____ Landscape helper
____ Window dresser
____ Demonstrator of appliances

Home Management

____ Linen room supervisor
____ Insitutional housekeeper (hospitals, hotels, motels, etc.

____

General

____ Homemaker's service
____ Home employment
____ Personal shopper

Personal Services

____ Nursing home aide
____ Hospital aide
____ Private employment for aged
____ Home patient personal care

This outline is prepared to show the type of training to be done in the classroom, and that which one would expect to be practiced at the training station. Adequate and continuing communication with the tentative employers could assure the teacher that skills and facts to be used on the job were being covered in the pre-vocational classes.

I. Orientation to the wold of work covering such topics as:

1. How to apply for a job
2. Employee responsibilities
3. Development of good wirk habits
4. The importance of proper grooming
5. Laws and regulations affecting the worker
6. Social security
7. Income tax
8. The elements of proper communications
9. Insurance
10. Attitudes concerning work

II. As this prevocational training is clustered around skills and jobs as they relate to the care and service to the aged there would be a block of work to acquaint the student with 1, number and conditions, 2, philosophy 3, characteristics 4, nutrional needs 5, psychological orientation of the aged. There also would be a research of all the possible areas of work that could be expoored for future employment as they relate to the aged.

We need to be educated to accept old age as part of a normal life span. The following are the developmental tasks of older maturity as outlined by Havighurst. Briefly these are:

1. Adjusting to retirement and reduced income
2. Adjusting to decreasing physical strength and health
3. Adjusting to death of spouse
4. Establishing an explicit affiliation with one's age group
5. Meeting social and civic obligations
6. Establishing satisfactory physical living arrangements*

Objectives as they apply to vocational training could be:

1. To have the students understand that ageing is a normal process, and not a separate phase of the life cycle. (Throught programs, specific programs, in the schools we must encourage students to develope interests and abilities which will enhance their later years.)
2. To reject the idea that older persons no longer have a useful function in our society
3. To encourage a more positive stand on the necessity for utilizing the capacities of the older citizen in our communities and society in general
4. To bring about an awareness of the many needs of the older men and women, especially the social, recreational and nutritional needs

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*Havinghurst, Robert J. Developmental Tasks and Education. Univ. of Chicago Press, 1948 p.65

To bring about some concept of aging, the aging process and of being old, many experiences (field trips, interviews, movies, etc.) would be provided. Also a broad offering of readings should be available to the student. The following bibliography written by Beverly H. Gentis in partial fulfillment of the course requirements for Psychology 465 at Northern Illinois University.

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RESOURCE MATERIALS ON AGING

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ADDITIONAL BIBLIOGRAPHY

American Craftsman Council. Crafts for the Aging: A Working Manual for Directors of Handicraft Programs for Older People. New York: American Craftsman Council, 1962.

Fulton, Robert (ed.). Death and Identity. New York: John Wiley & Sons, 1965.

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Kent, Donald P. Meeting the Needs of Older People at the Community Level. Washington: U.S. Government Printing Office, 1965.

Loether, Herman J. Problems of Aging: Sociological and Social Psychological Perspectives. Belmont, California: Dickenson Publishing Company, Inc., 1967.

Mahers, David O. Life Enrichment Needs of Older People. Washington: Adult Leadership, December, 1962.

May, S.H. The Crowning Years. New York: Lippincott, 1969.

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Moss, Bertram. Caring for the Aged. New York: Doubleday, 1966.

Neugarten, Bernice L. Middle Age and Aging. Chicago, Ill.: The University of Chicago Press, 1967.

Rabe, Henrietta F. Recreation and Education Services for the Aging and the Aged. Irving L. Weber (ed.). Gainesville: University of Florida Press, 1957.

Routh, Thomas A. Nursing Homes: A Blessing or a Curse. Tampa, Fla.: Charles C. Thomas, 1968.

Strauss, A.L., and B.G. Glaser. Time for Dying. Chicago: Aldine, 1968.

U.S. Bureau of Family Service. Foster Family Care for the Aged. Washington: U.S. Government Printing Office, 1965.

OUTLINE OF AREAS OF INSTRUCTION

FOOD SERVICE

Food service could be team teaching with the foods teacher to acquire basic skills in institutional cookery.

1. Cook's helper
2. Baker
3. Salad maker

DISHWASHER

1. Use of time-study and motion experiments to determine efficiency
2. Use of different dishwashing equipment and efficiency in use
3. Sterilization

	XVI.	Complete application and student agreement form
End of term	XVII.	Evaluate training plans and program. Communicate with advisory committee, administrators, and student tentative employers
Summer	XVIII	Contact local businessmen and assure training stations. Review tentative training plans. Make adjustments to fit program to needs and abilities of students.
Sept.	XIX.	Arrange for students to be interviewed by prospective employers for employment as student learners.
	XX.	When employer has agreed to employ a student, there is a joint meeting of the coordinator, the employer, the student and parent (s) to review and revise the agreement.

CRAFTS

1. Survey of interest
2. Exploring types
3. Becoming acquainted with resources (manuals etc.)
4. Locating and assembling materials
5. Development of some manual skills
6. Developing some skill in teaching others
7. A supply of offerings to fulfill the time, talents and interest of the aged

SERVICE OF FOOD AND DRINK

1. Feed persons when necessary
2. Help ambulatory persons to central dining room
3. Help person to chair and be in room when necessary
4. Arrange attractive trays, serve snacks and juices as needed
5. Keep water pitchers full

LAUNDRY SERVICE

1. Fold and store linens
2. Distribute linens to room
3. Keep inventory of linens

BED MAKING

Hospital method of:

1. Bed making (with and without patient)
2. Removal of soiled linen
3. Making patient comfortable

PERSONAL SERVICES

1. Attend to personal needs
2. Attend to comfort needs
3. Write letters
4. Answer telephones
5. Answer call buttons
6. Take persons shopping
7. Take persons on tours
8. Take persons to visit friends
9. Read to individuals
10. Do personal shopping for persons
11. Listen and communicate
12. Raise and lower head or foot of bed
13. Provide help to showers as required
14. Prepare bath water and equipment and bathe persons when necessary

MAID SERVICE

1. Arragement of flowers
2. Dust furniture and rooms
3. Dust floors
4. Arrange furniture for comfort of person (chairs, tables etc)
5. Control temperature, windows, light and ventilation for comfort of person
6. Clean rooms of discharged persons. Disinfecting when necessary

XXI. There is a continuing functioning of the advisory committee teacher, employer trainer of student, interacting communication of parents, administrators students, teachers, employers and guidance throughout the year.

XXII. The activities program is used to cohese the program.

Spring XXIII. Evaluation of the entire program.

Evaluation

The program will be continually evaluated by the Advisory committee, by the training station personnel, teacher coordinator and students.

The on the job trainer will hold conferences with the student, the coordinator individually and the three persons together will hold conferences and evaluate the trainee and the program. The trainer will not give a final grade but rather evaluate many various aspects, which in turn will be averaged out for the on the job grade.

COVER LETTER FOR

SURVEY OF POTENTIAL EMPLOYMENT AND TRAINING NEEDS

Dear Mr. (Director of Personnel)

We are conducting a survey to determine if (Name of High School) should offer a training program. We are investigating the present supply and demand for trained workers in this area. Your answers will contribute greatly in determining needs for a program.

An advisory committee will summarize the facts from the enclosed questionnaire so that we can determine if there is need for a training program.

Your answers to these questions do not obligate you in anyway. A self-addressed, stamped envelope is enclosed for your use in returning the questionnaire by _____.
(Date)

I wish to thank you for your kind attention and cooperation.

Sincerely yours,

Home Economics Coordinator

SURVEY OF POTENTIAL EMPLOYMENT AND TRAINING NEEDS

By High School

_____, ILLINOIS 0000000

Telephone Number

NAME OF ESTABLISHMENT_____ DATE_____

TYPE OF BUSINESS_____ TELEPHONE_____

ADDRESS_____

YOUR NAME_____ TITLE_____

NATURE OF EMPLOYMENT:

A. NUMBER OF PERSONS EMPLOYED: M_____ F_____

B. AGE RANGE OF EMPLOYEES _____ TO_____

C. TYPES OF JOBS (EXAMPLE: FOOD SERVICE ESTABLISHMENT HAS CHEFS, COOKS, WAITER/WAITRESS BUS BOY OR GIRL, ETC.)

JOB	HOW MANY	EDUCATION, EXPERIENCE OR TRAINING REQUIRED	DRESS REQUIREMENTS	PROVIDED BY WHOM?	BEGINNING WAGE	HOURS/ WEEK

	Yes	No
1. Do workers need special training or experience to qualify for jobs in your business?	___	___
2. Does your establishment give training? If yes, please check type of training:	___	___

___Inductive
___Orientation
___Inservice
___Other (Please specify)

3. Do you feel that there is a need for trained high school workers in this community?

4. Do you have difficulty in filling vacancies with qualified persons? ___ ___

	Yes	No
5. Could _____High School aid in a training program for work in your business? If yes, what type of training would be most useful? (Specify area)	___	___
6. Would you be willing to work with_____High School in developing a training program?	___	___
7. Would you be willing to hire a person who has completed a training program if you had an opening?	___	___
8. Would a worker have an opportunity for advancement with additional training?	___	___
9. If you were employing persons of equal work experience, would you pay the person with training a higher beginning salary?	___	___
10. If_____High School had a training program would you be willing to cooperate with a work experience program for the trainees?	___	___

___General work habits
___Personal qualities
___Personal appearance
___Relationships with others
___Safety and sanitation
___Knowledge
___Principles
___Manipulative skills
___Procedures
___Others

If yes, in what capacity?

___A. Advising
___B. Counseling
___C. Consulting
___D. Assisting in skill development
___E. Evaluating
___F. Other (Please specify)_____

HOME ECONOMICS RELATED OCCUPATIONS

GENERAL COURSE OUTLINE

OF

RELATED CLASSROOM INSTRUCTION

for

Dr. Louise Smith

HOME ECONOMICS WORKSHOP # 450

by

Mary Martzke
Sandrya Link

INDEX

PROGRAM GUIDES

Job Orientation
Success on the Job
World of Work
Management of Resources
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H.E.R.O. FORMS

Application
Health and Absence Record
How To Study Occupations
In-Progress Report
Job Activity Report
Medical Release
Notification of Program Violation
Occupation Notebook
Parent Letter
Personal Inventory
Student Agreement
Student Introduction Card to Employer
Student-Trainee 10 Point Evaluation
Subjective Appraisal of Applicant
Trainee Agreement
Trainee Evaluation

OVERVIEW

We will both be conducting a Home Economics Related Occupations course in our respective high schools during the 1970-71 school year. This course will include a related class plus on-the-job training. Due to the newness of such programs and the lack ofwritten materials, we felt it essential to develop a general course outline for the related class, including a few good basic references and suggestions for resource persons. We did not number the units or suggest a time limit for each since we felt to do this would make the guide inflexible and less useful to various school structures. We have listed references after each unit that we felt were particularly helpful. There wasn't time or space to list all the possible references such as many general textbooks already present in home ec departments. There is a general reference list of some books and pamplets at the back of the outline. Also included are samples of many forms, application blanks and evaluation devices which might be used in such a program. These are labeled and described when it seemed necessary. Additional class studies relating to the students' on-the-job training would be included as needed depending on the types of jobs and individual needs. We did not attempt to include these studies in this guide.

JOB ORIENTATION

At the end of this unit, the student should be able to:

EXPLAIN THE COOPERATIVE VOCATIONAL EDUCATION PROGRAM IN OUR SCHOOL.
CORRECTLY COMPLETE THE NECESSARY FORMS IN THE PROGRAM.
RECOGNIZE THE IMPORTANCE OF RULES AND REGULATIONS IN A PROGRAM OF THIS TYPE.

A. What is vocational education?
   1. Purpose
   2. Objectives
   3. Types of programs in our school
   4. Coordinators -- who are they? What do they do?
   5. Role of State of Illinois in vocational education

B. Working rules for the H.E.R.O. program.
   1. Training agreement
   2. Detention policy
   3. Absence procedures
   4. No school-no work policy
   5. Quitting or being fired from job
   6. Daily work forms and procedures

C. H.E.R.O. Club
   1. Function
   2. Meetings -- time, place, etc.
   3. Possible projects

D. Occupational notebook

E. Work permits
   1. How to obtain them
   2. Why they are necessary
   3. What to do with them

F. Transportation to and from job
   1. Student must provide
   2. Necessity for safety -- driving, bicycling, walking
   3. Expenses involved in types of transportation

G. Records and forms
   1. Card for coordinator's file
   2. Personal inventory sheet
   3. Other school requirements

H. Student introductions in class
   1. Name and year in school
   2. Year in HERO
   3. Place of employment and explanation of duties of title

I. Student-Coordinator relationship
   1. Related class content--suggestions from students
   2. Importance of bringing job problems to the attention of the coordinator

J. Importance of the World of Work
   1. Statistics to show need for training
   2. Brief overview of labor picture (additional information under World of Work unit)

REFERENCES:

1. Various forms, records and training agreement included.

2. State of Illinois pamphlets:
   a. Bulletin #7-470, Advisory Committees
   b. Vocational Youth Organizations
   c. Guidelines for Cooperative Vocational Education, Bulletin #9-570.

SUCCESS ON THE JOB

At the end of this unit, a student should be able to:

ACCEPT THE IMPORTANCE OF GOOD HEALTH AND SAFETY PRACTICES.
RECOGNIZE THE NEED FOR SELF-IMPROVEMENT AND ITS INFLUENCE ON JOB SUCCESS.
RELATE THE RELATIONSHIP OF ATTITUDES TOWARD WORK TO SUCCESSFUL EMPLOYMENT.

A. Job Safety
   1. Doctor's release signed by parents (see example of form)
   2. Clothing in regard to particular job and safety
   3. Hazards in particular jobs--how to identify them--fumes, acids, glass, etc.
   4. Simple accident procedures
   5. When and where is smoking permitted?

B. Getting a Good Start
   1. Listen to instructions. Write down things you may forget.
   2. Ask questions not covered or understood.
   3. Acceptance of responsibilities. Be sure your responsibilities are carefully understood.
   4. Spirit of competetion
   5. Desire to improve on the job.
   6. Interest, cooperation, enthusiasm
   7. Consider how worker may be a risk to employer
   8. Negative traits to avoid:
      a. Using a "better" method rather than the one employer prefers
      b. Using company time for personal business
      c. Taking supplies or "samples"
      d. Laziness

C. Know Rules and Regulations on the Job
   1. Care and maintenance of equipment and supplies--learn names and how to spell these.
   2. Hours of work, absences, leaves, time off
   3. Building and grounds maintenance
   4. Regulations for parking your car--also rules for coordinator while visiting on the job.
   5. Unions! Must you join?
   6. Are any jobs forbidden to you do to hazards? Due to special skills or training that you do not have?

D. Job ethics and attitudes
   1. Trade secrets
   2. Confidential reports and transactions
   3. Short-cuts and formulas
   4. Honesty
   5. Loyalty
   6. Willingness to learn and cooperate
   7. Being anon-gossiper
   8. Sell yourself--you are your best asset
   9. Punctuality

E. Grooming
   1. Self-appraisal--what are individual needs for improvement
   2. Habits to avoid
   3. Personal cleanliness
   4. Oral hygiene
   5. Care of skin and hair
   6. Grooming checklists

F. Good Manners
   1. Etiquette versus manners
   2. Manners and Common sense
   3. Why good manners
   4. Manners in the family
   5. Manners in public
   6. Manners on a date
   7. Table manners
   8. How and when to tip
   9. How to make an introduction
   10. Social correspondence
   11. Telephone manners
   12. Ethical conduct

G. Personal Math
   1. Weights and measures
   2. Computing car gas mileage
   3. Working with fractions
   4. Transferring percentages into parts of the whole
   5. Computing weekly gross pay from rate and hours
   6. Computing hourly rate from gross pay and hours
   7. Computing and verifying overtime pay
   8. Computing social security and tax deductions
   9. Computing discounts

H. Personal Spelling
   1. Submit a list of 50 commonly used words on job
   2. Prepare a list of words often used in writing a letter of application
   3. Learn to spell these words until mastered.

I. Working Relationships
   1. Cooperation with co-workers
   2. Work agreements to avoid conflicts
   3. Effect of disposition on working relations
   4. Personality types--how they differ
   5. Methods of releasing tensions effectively
   6. Developing maturity--the whole key to success

REFERENCES:

1. Bracken, Peg. I Try To Behave Myself.

2. Kupsinel, Penelope E. Home Economics Related Occupations. The Interstate Printers.- Danville, Illinois.

3. Head, Edith. How to Dress for Success. Random House. 1967.

4. Peterson, Eleanor. Successful Living. Allyn and Bacon, Inc. 1968.

References, Con't. (Success on the Job)

5. Coordinator's Guide for Occupational Relations. College of Education. University of Minnesota.

6. Student Manual for Occupational Relations. College of Education. University of Minnesota.

7. Grooming chapters of any good basic home economics textbooks.

Resource Persons:

1. A local industrial safety supervisor.

2. A local personnel director to talk about grooming for employment.

3. A cosmetologist for grooming--be selective in choice.

WORLD OF WORK

To develop the ability to relate employment trends to individual goals and choices.

To develop an interest in local, state and national legislation which subsequently affects job opportunities.

To recognize occupational needs and opportunities of the community.

To recognize and understand the various methods of job advertisements for employment.

A. Employment in major occupational groups by sex.

B. Employment by class of worker(private, government, etc.)

C. Industrial profile of employment.

D. Employment trends of the future.

E. Decision to work.
   1. Preparation for the future
   2. Feeling of personal satisfaction and sefl-development.
   3. Acceptance of responsibility
   4. Opportunity for recognition

F. Self-perception in relation to occupational choice

G. Study how State and Federal legislative acts affect employment.

References:

Speakers: Representative of various people engaged in assisting people to become employed.

Occupations and Careers

Careers in Home Economics

MANAGEMENT OF RESOURCES

At the end of this unit, a student should be able to:

USE ANY OR ALL BANKING SERVICES TO THE BEST ADVANTAGE.
PURCHASE AND PLAN FUTURE INSURANCE NEEDS INTELLIGENTLY.
UNDERSTAND NEED FOR RETIREMENT PLANNING.
UNDERSTAND THE GOOD ANDBAD EFFECTS OF CREDIT IN OUR SOCIETY.
PREPARE INCOME TAX RETURN CORRECTLY.

A. Banks and Banking
   1. Types of banks
   2. Opening an account
   3. Writing checks
   4. Cashing checks
   5. Making deposits
   6. Bank books
   7. Federal Reserve Banks and clearink houses
   8. Checks that come back to you
   9. Service charges
   10. Your bank balance
   11. Protect your cancelled checks
   12. Cashier's check, certified check, traveler's check
   13. Safety deposit boxes and other services

B. Credit and the consumer
   1. Different ways to pay for what you buy
   2. Figuring credit charges
   3. Borrowing money--how and where
   4. How to obtain and keep a good credit rating
   5. Guides to installment buying

C. Insurance
   1. Life insurance
      a. Who needs it?
      b. What are the different types?
      c. When should you buy it?
      d. How much is enough?
      e. Selecting an agent and a company
   2. Health insurance
      a. Who needs it?
      b. Individual versus group
      c. How much is enough?
      d. What does health insurance cost?
   3. Liability insurance
      a. Automobile
      b. Homeowners or renters
      c. Fire and theft
      d. Other

D. Social Security
   1. The "why" ofsocial security
   2. Deductions
   3. Who is covered
   4. How coverage is determined
   5. Old age benefits
   6. Benefits in case of death
   7. Children's benefits
   8. Speaker from local social security office

E. Federal and State income taxes
   1. Brief history of taxes
   2. Speaker from local IRS office—in January if possible
   3. Each student prepares own tax return as project for unit.

F. You and the Law
   1. Getting a lawyer
   2. The rights of an arrested person
   3. Common problems with civil law
   4. Contracts
   5. Fraud
   6. Why young persons need a will

REFERENCES:

1. The American Bankers Association. 90 Park Avenue, New York. 10016.
List of money management teaching aids.

2. Continental Illinois National Bank, Chicago, Illinois. "Managing Personal Income." Teacher and Student Manuals.
"Accepting Credit Responsibility". Teacher and Student Manuals.

3. Institute of Life Insurance and Health Insurance Institute. Educational Division. 277 Park Avenue, New York. 10017.
Free Catalog of teaching aides. Numerous booklets and films.

4. Money Management Institute of Household Finance Corporation. Prudential Plaza, Chicago, Illinois.
Money management and consumer credit materials and filmstrips.

5. Troelstrup, Arch. Consumer Problems and Personal Finance. McGraw-Hill. 1966.

6. Wilhelms, Fred, Heimerl, Ramon P., and Jelley, Hubert M. Consumer Economics. McGraw-Hill. 1966.

RESOURCE PERSONS:

1. Representative from local bank and/or savings institutions.
2. Representative from local reputable insurance establishment.
3. Representative from local social security office.
4. Internal Revenue representative.
5. A local lawyer.

CONSUMER ECONOMICS

At the end of this unit, a student should be able to:

MAKE WISER DECISIONS IN THE PURCHASING OF GOODS AND SERVICES.
BEGIN TO SEPARATE REALISM FROM EMOTIONALISM IN ADVERTISING.

A. Ways to shop
   1. Number, size and price
   2. Guaranteed--or your money back
   3. Coupons and catalogs -- buying by mail
   4. And now a word from our sponsor
   5. The language of labels
   6. It is the policy of this store
   7. How to deal with a salesman

B. Cars, Furniture and Appliances
   1. Checking out a used car
   2. The cost of running a car
   3. Car insurance (see also unit on insurance)
   4. Furniture
   5. Appliances

C. Food, Clothing and Shelter
   1. Best food buys
   2. Food planning
   3. Ready-to-wear
   4. Suit yourself
   5. You andyour landlord
   6. A home of your own

REFERENCES:

1. Troelstrup, Arch. Consumer Problems and Personal Finance. McGraw-Hill. 1965.

2. Wilhelms, Heimerl, and Jelley. Consumer Economics. McGraw-Hill. 1966.

3. Sears, Roebuck and Company. "Hidden Value Series." Dept. 703--Public Relations, Chicago, Illinois 60611.

4. Money Management Institute of Household Finance Corporation. Prudential Plaza, Chicago, Illinois.

5. Various good periodicals such as:
   a. Changing Times
   b. Consumer Reports
   c. Good Housekeeping

OCCUPATIONAL STUDIES

To develop an awareness of available and reliable sources of information related to Home Economics occupations.

To develop an understanding of qualifications and competences of people in specific occupations.

To recognize the relationship of education and training as requisite to successful job performance.

A. Characteristics of jobs

B. Qualifications needed by people for the jobs

C. School subjects and training necessary for various jobs

D. Why and how to study occupations

E. Jobs for which:
   1. A high school education if preferred
   2. A high school education is generally required
   3. A junior college, technical institute, or other training is required

F. Armed services and your career

G. Careers for the handicapped

References:

Counseling department: Occupational survey kits

Careers In Home Economics, Ruth Hoeflin

Occupations and Careers; Feingold & Swerdloff; McGraw Hill Book Co; 1969

Study sheet: How To Study Occupations

Speakers representing occupations and training centers in the area.

Field trips to industry and various area training centers.

SEEKING EMPLOYMENT

To become aware of acceptable and pleasing appearance as a basic consideration in seeking employment and in remaining employable.

To be made aware of the importance of personal attributes in securing and advancing in an occupation

To achieve a skill in planning as basic to choice of job.

I. Applying for a job

A. Where to find the job
1. State employment service
2. Voluntary organizations
3. School and other educational institutions
4. Commercial employment agencies
5. Friends and relatives
6. Want ads
7. Directories

B. Needed credentials
1. Birth certificate
2. Health certificate
3. Social security card
4. Work permit
5. Resume
a. Name, address, and telephone number
b. Position desired
c. Salary desired
d. Age
e. Education
f. Previous employment
g. Personal information
h. References

C. Application
1. Purpose of application
a. Aid in selection
b. Record
2. Indicates to employer
a. Interests
b. Training
c. Work experience
d. Habits
e. Personal background
3. Information about character
a. Neatness and character of penmanship
b. Thoroughness of answering each question in detail
4. Application blank
a. Follow directions
b. Work out details
c. Answer each question completely and accurately
d. Answer each question truthfully
e. Fill the blanks neatly
f. Use an ink pen

D. The Interview
   1. Be at your best
      a. Physically
      b. Mentally
   2. Appearance
      a. Suitably dressed
      b. Properly groomed
   3. Attitude
      a. Interest
      b. Confidence
      c. Sincerity
      d. Alertness
      e. Enthusiasm
      f. Tact
      g. Courtesy
      h. Cheerfulness
      i. Friendliness
   4. Be punctual
   5. Go to interview by yourself
   6. First impressions are lasting
   7. Procedure for interview
      a. Be poised
      b. Speak freely, distinctly, positively, correctly, and to the point
      c. Be a good listener
      d. Understand clearly about wages
      e. When interview is over, bring to a close promptly
      f. Express sincere appreciation and thanks to employer for his time and consideration
      g. Re-emphasize interest in job
      h. Take you leave in businesslike manner.

E. The Follow-up
   1. Second interview
      a. In person
      b. By telephone
      c. In writing
   2. If position is offered--search is over
   3. If rejected, analyze interview thoroughly to try to discover flaws in behavior or appearance. Try again, profit from failure.

References:

You and Your Job Series;J.G. Ferguson Publishing Co.;6North Michigan Avenue; Chicago,Il 60602

Spotlight On You, How to prepare for a personal interview - (filmstrip)

Applying For a Job; Interstate Press; Danville, Illinois.

APPLICATION FOR H.E.R.O. PROGRAM

Name _____ Date _____
last first middle

Address _____ Phone _____
no. street city

Date of Birth _____ Age _____ Soc. Sec. No. _____
mo. day yr.

Height _____ Weight _____ Physical Handicaps _____

Presently: FR. SO. JR. SR.

List of High School Subjects and Grades

Freshman Year			Sophomore Year			Junior Year		
Subject	Sem. Grade		Subject	Sem. Grade		Subject	Sem. Grade	

In what occupation do you desire training while attending high school?

1st choice _____ 3rd choice _____

2nd choice _____

What is your career objective? _____

What do you plan to do after graduation? Bus. School ____ Tech. School ____ Work ____ College ____ Undecided ____

List your study halls in order that you can be easily contacted for an interview:
Per. ___ Rm. No. ___; Per. ___ Rm. No. ___; Per. ___ Rm. No. ___; Per. ___ Rm. No. ___

Attendance Record: Days missed so far this year ____ Days missed year before last ____
Days missed last year ____

_____ _____
Student's signature Parent's or guardian's signature
(represents approval)

Return this form to Mr. Baldwin, Director of Vocational Education, or to your counselor.

Central File Card 3345
Initial

F1-R70

STUDENT ABSENCE AND HEALTH RECORDS

Student's Name _____ Date _____
Last First

	Freshman Year	Sophomore Year	Junior Year	Senior Year
Absences				
Tardies				
Detentions				

Special comments on student's discipline or conduct:

_____

_____

_____

_____

Date _____

_____
Assistant Principal for Discipline and Attendance

HEALTH RECORD:

Is the above name student in good health? _____

List any physical defects or limitations which would have any effect on his or her placement in the Cooperative Education Program of Diversified Occupations.

_____

_____

_____

_____

Date _____

_____
School Nurse

Return this form to: , Coordinator

HOW TO STUDY OCCUPATIONS

C O N S I D E R :

A. Nature of the Work

1. What are the activities, duties and responsibilities of the worker in this occupation?
2. What kind of interests underlie the occupation?

B. Mental Requirements

1. Which of the following special abilities are required?

   a. verbal comprehension
   b. reasoning
   c. number ability
   d. space ability
   e. mechanical ability

C. Personality Requirements

1. Will the job require you to be:

   a. sociable?
   b. energetic?
   c. persuasive?
   d. careful about details?
   e. persistent?

D. Educational and Training Requirements

1. What kind of education is necessary?

   a. prefessional
   b. technical
   c. general

2. What level of education is necessary?

   a. graduate study (M.A. - Ph.D.)
   b. college (what degree)
   c. technical - vocational school
   d. high school

3. Apprenticeship necessary?

4. In-service training on-the-job?

5. How gain admission into various types of training?
   How much will it cost?
   How many admitted?

E. Entrance into Occupation

1. Certificate or license needed

   a. formal exam required?
   b. who conducts exam?
   c. how - when apply for exam?

2. Membership in union or professional society necessary?

3. Any special agencies used for employing?

F. Working Conditions

1. Physical conditions

   a. hours
   b. overtime
   c. indoor - outdoor
   d. physical activity - standing or sitting

2. Other conditions

   a. routine
   b. creative
   c. would you work alone

G. Supply and Demand

1. How badly are workers needed in these fields?

H. Income, Promotion, Security

I. Factors (about you) that might affect your admission to the job:

1. Age
2. Sex
3. Health
4. Height
5. Weight
6. Appearance

From filled out by teachers of academic subjects during the school year as a check on the students progress.

IN-PROGRESS REPORT OF COOP STUDENTS

Teacher_____ Date_____

The teacher-coordinators are trying every way possible to help students find success in their on-the-job training, classroom work and be good citizens in your classroom.

Will you please take time to evaluate _____.

Yes No 1. Is this student in danger of failing?

Yes No 2. Does this student actively participate in class discussions?

Yes No 3. Does this student come to class prepared?

Yes No 4. Does this student seem interested in the subject matter?

Yes No 5. Does this student seem to have too many absences in order to find success?

Yes No 6. Does this student voluntarily make up his work?

Yes No 7. Is a slower section in your subject area available?

Yes No 8. Has this student ever used his job as an excuse for not getting work prepared on time?

Yes No 9. May I have a conference with you to discuss this student's situation?

Comments: _____

Please return this form to: _____
Coordinator

JOB ACTIVITY REPORT

Training Station_____ Name_____

Department_____ Week Dates_____

Monday

Time Worked____to____ Total Hours____

Tuesday

Time Worked____to____ Total Hours____

Wednesday

Time Worked____to____ Total Hours____

Thursday

Time worked____to____ Total Hours____

Friday

Time Worked____to____ Total Hours____

Saturday

Time Worked____to____ Total Hours____

Sunday

Time Worked____to____ Total Hours____

Total Hours for Week____

While you were working this week, did you have any problems? Did you receive any compliments?

_____

_____

Supervisor_____ Student_____

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Information card kept by the coordinator in a file for quick and easy reference.

Company _____ Phone _____

Address _____ Trainer _____

Student _____ Phone _____
last first initial

Address _____ age ____ Date Birth / /

Year in School 9 10 11 12 Year in Coop Program 1 2 3 4

Job Title & O.E. Code _____

Ave. Hours Worked per Week _____ Hourly Rate _____

Date Started Work _____ Date Stopped _____

Reason _____

Coordinator _____
last

Card carried by the student to the interview

This will introduce _____

He/She has signed up to be in our _____ program for the _____ school year. The success of our vocational program hinges on community support. Therefore, any consideration that you can give this applicant will be appreciated.

_____
coordinator

Medical release form signed by the parent and kept on file by the employee.

THE UNDERSIGNED EMPLOYEE OF: _____

_____

BEING A MINOR HAS MY PERMISSION TO BE TREATED BY ANY DOCTOR PROVIDED BY THE COMPANY IN CASE OF EMERGENCY OR ACCIDENT.

SIGNED: _____ DATE: _____

NOTIFICATION OF WORK PROGRAM VIOLATIONS

1. Working at the training station is not allowed unless school is attended that same day. If there are extenuating circumstances, the student must contact his teacher-coordinator and might get permission to work without receiving a penalty. Violations of this rule will result in the following penalties:

FIRST OFFENSE: a warning

_____ student's signature _____ date

SECOND OFFENSE: grade reduction

_____ student's signature _____ date

THIRD OFFENSE: drop from program

_____ student's signature _____ date

2. Quitting a job without the coordinator's permission is not allowed in our work program. Unless there are extenuating circumstances, violations will be dealt with as follows:

Student must stay at school under the coordinator's guidance for the remainder of the school day. After school the student must find a job that is acceptable to the coordinator within 10 school days or be dropped from our work program for the remainder of the term.

_____ student's signature _____ date

3. Each trainee must call his coordinator and trainer on days and/or class periods that he is absent from school. Failure to comply with this requirement will result in demerits that will result in a lower class grade.

date student did not call coordinator	date student did not call trainer

49 OF 327

ED

056 238

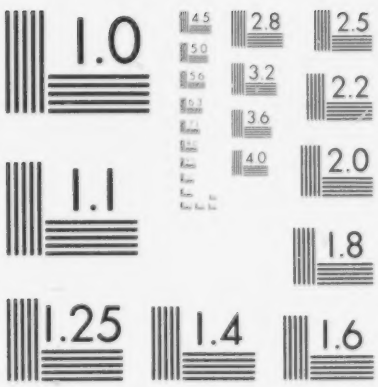

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OCCUPATIONAL NOTEBOOK CONTENT

Use a loose leaf notebook and compile the following information, not necessarily in this order:

Name and location of company

History and size of company

Organization pattern

Relationship of firm to community

Products manufactured or services rendered

Names of important people

Company rules and regulations

Prepare drawing of plant

Prepare a list of words (See unit on job success)

Prepare a list of names of people in your department or area

Fill out a sample job application form

Fill out a personal data sheet

Describe your job interview

What questions did you ask?

What questions did you later wish that you had asked?

Write an account of your first day on the job

Do a page on the background of your boss

Interview a fellow employee who has been with the company several years

What are the safety rules where you work?

Summarize by week or month your total earnings, net pay, deductions, etc.

After the first week, keep a weekly log of new things learned on the job.

Keep a list of mistakes that you make on the job.

Keep film notes, class notes, valuable tests in second half of notebook

PARENT LETTER

Dear Parent:

This letter is to introduce you to the Home Economics Related Occupations program. The program is designed to prepare students for work in the field of Home Economics. The program is planned with all students in mind, so they may gain technical and practical experience during high school.

The Home Economics Realated Occupations program in the secondary school is a cooperative plan of action between the school and business where the student is employed during half of his school day. Learning occurs both in the classroom, where related instruction is given, and also on-the-job.

The student's coordinator (a member of the school staff), and his on-the-job supervisor (a person employed by the cooperating business), develop the step-by-step training plan. Together they determine the skills and knowledge the student will experience during his employment.

I am looking forward to a successful year with the Home Economics Related Occupations program. If you have any questions or wish further information, please feel free to contact me.

Sincerely,

Home Economics Related Occupations,
Coordinator

STUDENT PERSONAL INVENTORY

Name _____ Date _____

Father's Name _____ Age ___ Birthplace _____

Mother's Name _____ Age ___ Birthplace _____

Father & Mother are: Living together __ Living apart __ Separated _____
Divorced __ Father deceased __ Mother deceased _____
Father has remarried ___ Mother has remarried _____

Are you living with someone other than your parents? ____
If yes, who? _____

Is this person your legal guardian? ____
Their address? _____

Father's Occupation _____ Employed by _____

Mother's Occupation _____ Employed by _____

Father's Education _____ Mother's Education _____

Number of Brothers ___ Their ages are _____ Number of Sisters ___ Their ages are _____

Do you have any chores assigned to you? ___ What are these chores? _____

_____

Do you prefer working with others or by yourself? _____

Do you attend Sunday School or Church? ___ Name Church _____

What school organizations do you belong to? _____

Offices held _____

Name special talents that you possess _____

What foreign language can you speak? _____

Write? _____ Understand? _____

What sports do you enjoy watching and/or playing? _____

_____

Do you own a car? ___ Is it paid for? ___ Do you have any debts to pay? ___ How much do your parents contribute to your support? _____

Is it a necessity that you work? ___ Will you have regular financial obligations to meet next year? ___

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How often do you attend the movies each month? _____

Do you have a savings account? ____

Have you had any serious illness recently? ___ Name of illness _____

Do you enjoy reading? ___ What? _____

High school subject you enjoyed most _____ Least _____

Activities you and your father do together _____

Activities you and your mother do together _____

Activities you and your friends do together _____

Which do you prefer? Entertaining friends in your home _____
Going to parties in friends' homes _____

What jobs have you enjoyed doing the most? _____

_____

What do you know about the occupation you stated as being your career objective? (Opportunities for advancement, salary, self-satisfaction, etc.) _____

_____

_____

How have you acquired the previous information? (By reading, experience, observation, etc.) _____

Are you interested in getting a job or training for a career in our on-the-job program? _____

List six of your recent teachers.

1. _____ 3. _____ 5. _____

2. _____ 4. _____ 6. _____

Will you go to college? ____ When do you plan to go? _____

What college will you attend? _____

What type of course do you want to study? _____

Will you have to pay some of your expenses while in college? _____

If you had a choice of the following, what occupation would you like to enter? (Art, Music, Engineering, Teaching, Medical, Selling, Office, Mechanics, etc.) _____ Why? _____

_____

List the places where you have been employed before:

Place Where You Worked	Person For Whom You Worked	How Long?

In what size company do you desire to work? _____

What particular company would you prefer to work for if you have the opportunity? _____

Will getting to and from your work station be a problem? Yes ___ No ___

Will you give your support to a club -- pay dues, work on projects?
Yes ___ No ___

Will you be willing to come in for one or two orientation meetings that would be held after school sometime in the Spring? Yes ___ No ___

Do you want a summer job? ____

How far do you live from school? ____ miles/and, how can your house be located? _____

_____

Have you taken driver training? Classroom? ____ Behind the wheel? _____

Do you have a driver's license? ____

Would you rather work mornings or afternoons? _____

_____
Signature of Student

Impressions by coordinator: Appearances, attitude and personality

STUDENT AGREEMENT

The Cooperative Vocational Education program is planned to develop a student academically, economically, and socially. To meet the goal, there are responsibilities the student must realize and he must agree to cooperate in carrying them out to the fullest extent. As a participant in the program, are you willing to assume these responsibilities in the program?

1. To realize that I am under the jurisdiction of the school throughout the school day.

2. To know that the Coordinator is the recognized authority for making adjustments or changes in the training on the job.

3. To know that it is my responsibility throughout the year to be well-dressed and groomed both in school and on the job.

4. To carry out my training on the job in such a manner that I will reflect credit upon myself and upon the Cooperative Vocational Educational Program

5. To perform all my duties in a commendable manner and perform related study assignments with earnestness and sincerity.

6. To work toward the group and individual achievement goals.

7. To be regular in attendance in school and on the job. (This includes days on the job when school is not in session such as: teachers' meeting, Christmas vacations, etc.) Set grade point deduction for absenteeism.

8. To be on time at school and on the job.(Grade point deduction)

9. To notify the coordinator as early in the day as possible on days that I am absent from school.

10. To notify the employer as soon as I know that I will be absent from work.

11. If I am absent from school I must also be absent from work on that day.

12. To know that if I use a car as transportation to and from my work, I will observe all traffic regulations and school policies with extreme care. Any infraction of the traffic laws may be sufficient cause to terminate the use of my car in connection with the Cooperative Vocational Education program.

13. To conduct myself in a satisfactory manner, both on the job and in the classroom or my training may be discontinued and I may be removed from the program.

14. To know that if I am removed from the program due to failure either in the class instruction or work experience that I will receive a failing grade for the program and will lose both credits.

15. To understand that if I am required to leave school because of any disciplinary reasons. I understand that I cannot report to my training station as this is the same as any other classroom subject in which I am enrolled. NOTE: A cooperative training student is not exempt from any disciplinary action levied by the school administration or other teachers.

16. To agree to not quite or change jobs without first talking the situation over with my parents and coordinator.

I fully understand the above statements, and I agree to cooperate in carrying them out to the fullest extent.

Date_____ School Year 19___19___

Student's Signature_____

Parent's Signature_____

Principal's or Division Chairman's Signature_____

Coordinator's Signature_____

STUDENT-TRAINEE TEN POINT EVALUATION SHEET

NAME_____DATE_____

TRAINING STATION_____

The purpose of this evaluation sheet is threefold:

1. To help the employed student learner know his weaknesses and improve;

2. To aid the coordinator in his selection of material for instruction;

3. To enable the employer to know the exact status of the employee.

INSTRUCTIONS: Circle the number which best describes the employee. If you feel that the rating should be between two numbers, circle both numbers. The numbers after each question correspond to the following ratings:

5 - Outstanding
4 - Above average
3 - Average
2 - Below average
1 - Unsatisfactory

1. PERSONAL IMPRESSION: Is the employee consistently neat and clean or personally well-groomed for the standards of the job?
   1 2 3 4 5

2. PERSONAL DISPOSITION AND TEMPERAMENT: Through the eyes of the other employees is this employee friendly, considerate, well-liked, helpful and cooperative?
   1 2 3 4 5

3. ATTITUDE TOWARD JOB: Is the employee enthusiastic, loyal, interested? Does the employee have a wholesome outlook on work and its importance in life?
   1 2 3 4 5

4. ABILITY TO LEARN: Does the employee learn and adapt to new duties and ideas quickly?
   1 2 3 4 5

5. RELIABILITY: Can the employee be counted on when needed? Is an assignment usually carried out properly?
   1 2 3 4 5

6. QUALITY OF WORK: Does the employee maintain the standards desired by the company and take pride in a job well-done?
   1 2 3 4 5

7. QUANTITY OF WORK: Does the employee usually produce the amount of work desired by the company -- does the employee use every minute of the work-day to the best advantage?
   1 2 3 4 5

8. ATTENDANCE AND PUNCTUALITY: Can the employee be depended upon to be on the job and on time? If absent, does the individual always call in to report? Are the reasons for absence justifiable?
   1 2 3 4 5

9. AUTHORITY AND CRITICISM: Does the employee respect the authority of a supervisor and not resent taking orders or criticism?
   1 2 3 4 5

10. DEVELOPMENT:
    A. In what areas do you plan to train this employee?

_____

_____

    B. In what subject areas can the coordinator further train this individual in the classroom?

_____

_____

    C. Does the employee have any shortcomings or weaknesses? How can the school help this person improve?

_____

_____

    D. What do you like most about this employee?

_____

_____

OVERALL RATING: After considering all the previous factors and opinions, indicate your overall rating of this employee:
1 2 3 4 5

Number of days student was absent from regularly scheduled work days during this period:
_____ to _____, _____ days.

Supervisor's signature _____

Coordinator's signature _____

Student's signature _____

EMPLOYER EVALUATION FORM

Student _____ Date _____ D.O. ___

Training Station _____ C.W.T. ___

Instructions: Check only the items that apply and add topics if needed. This evaluation covers 6 weeks.

Work Performance & Job Attitudes	Outstanding	Satisfactory	Unsatisfactory
Number of days missed ____ ATTENDANCE			
Punctuality			
Quality of Work			
Quantity of Work			
Knowledge of Job			
Follows Instructions			
Safety Practice			
Care of Equipment			
Personal Appearance			
Personal Habits			
Judgment			
Dependability			
Honesty			
Teamwork - Cooperation			
Adaptability			
Initiative			
Courtesy			

PLEASE INDICATE OVERALL GRADE - A B C D F

Comments: _____

_____

This report was discussed with the trainee. Yes __ No __

TO _____

FROM _____

This form would be given to teachers previously having had the student in class. It would be used to evaluate the student as to whether he/she would benefit from the program.

VOCATIONAL COOPERATIVE EDUCATION
Subjective Appraisal

_____ has applied for admission into the vocational cooperative education program. Your evaluation of this student will greatly assist us in placing this student in an appropriate training station.

Please check the column after each characteristic listed below that best describes this student and return at your earliest convenience.

	Above Average	Average	Below Average
1. Ability to Learn			
2. Capacity for Work			
3. Judgment			
4. Initiative			
5. Personal Appearance			
6. Leadership Quality			
7. Ability to Take Orders			
8. Reliability			
9. Perseverance			
10. Accepts Criticism			
11. Ability to Mix			
12. General Conduct			

If you were an employer, would you hire this student? _____

How long have you known this student? _____

COMMENTS: _____

_____

H.E.R.O. PROGRAM TRAINING AGREEMENT

1. _____ will permit _____
(training agency) (student)
to enter their establishment for the purpose of gaining knowledge and experience as a/an _____.
(occupation)

2. The course of training is designed to run for one school year with a minimum of fifteen hours per week, exclusive of Saturday and Sunday and not to exceed _____ hours.

3. The training will be based on a realistic step-by-step training plan developed by the coordinator and the designated trainer. The student should not be permitted, in the process of gaining occupational experience, to remain in any one operation, job or phase of the operation, beyond the period of time where such experience is of educational value.

4. The school will make provision for the student to meet daily with the teacher-coordinator for related and technical instruction.

5. The student (trainee) will dress to meet the requirements of the job, be loyal and work for the best interests of the employer, maintain a good attendance record, notify the teacher-coordinator and the employer of anticipated absences, and live up to all rules and regulations established by theemployer and the coordinator.

6. All complaints shall be made to and adjusted by the coordinator.

7. The coordinator shall have authority to transfer or withdraw the student when he deems such action to be in the best interest of those concerned.

8. The schedule of compensation shall be agreed on by the training agency and the coordinator in accordance with existing local standards, labor laws, and policies.

9. It will be the duty of the trainer to make a periodic evaluation of the trainee's progress since the trainee will receive one credit towards a high school diploma with the successful completion of the agreement.

10. The parent or guardian will be responsible for helping the student to live up to this agreement.

11. This agreement may be cancelled for sufficient cause provided due notice is given to all parties concerned.

_____ _____
(Employer) (Parent of Guardian)

_____ _____
(Coordinator) (Student)

Date _____

SOME SUGGESTED STUDENT AND TEACHER REFERENCES

BUDGETING:

MONEY MANAGEMENT LIBRARY 13 booklets

YOUR FAMILY FINANCES, Simons and Howell. Iowa State Univ Press. 1950.

DENTAL ASSISTANT:

DENTAL ASSISTANT
Department of Industrial Education, College of Education
University of Missouri. 1968

EFFECTIVE DENTAL ASSISTING
Schwarzrock and Schwarzrock
Pulished by Wm. C. Brown Company. 1967

FLORISTRY:

THE ART OF FLOWER ARRANGEMENT
Falsuo Ishimoto
Pub: Crown Publishers Inc. 1965

FLORISTRY A COURSE OF STUDY
Department of Industrial Education, College of Education
University of Missouri. 1967

FLOWERS: GEOMETRIC FORM
M. Benz
San Jacinto Publishing Company. 1966

FOOD SERVICE:

FOOD SERVICE INDUSTRY TRAINING PROGRAMS AND FACILITIES
U.S. Department of Health, Education, and Welfare
United States Government Printing Office
Washington D. C. 1961

HANDBOOK OF FOOD PREPARATION
The American Home Economics Association. 1964.

CHEF - COOPERATIVE VOCATIONAL STUDY
Department of Industrial Education, College of Education
University of Missouri

THE CORREST WAITRESS
Susan M. Dietz
Ahrens Book Company, Inc.

FOOD SERVICE - A COURSE OF STUDY
Department of Industrial Education, College of Education
University of Missouri. 1966.

SUPERVISED FOOD SERVICE WORKER
U.S. Department of Health Education and Welfare
U.S. Government Printing Office

DICTIONARY OF MENU TERMS
Instructional Materials Laboratory, Distributive Education Department
Division of Extension, The University of Texas. 1967.

GROOMING:

GUIDE TO GOOD GROOMING
Patticia Stevens
Science Research Associates, Inc.

HOW YOU LOOK AND DRESS
Helen Judy Bond
McGraw-Hill, Inc. 1959.
A MAN'S GUIDE TO BUSINESS AND SOCIAL SUCCESS
Barry James
Milady Publishing Corporation. 1966.
CHARM - "The Career Girl's Guide to Business and Personal Success"
Whitcomb and Land
McGraw-Hill, Inc. 1964.

HOMEMAKER'S ASSISTANT:
THE CORRECT MAID - FOR HOTELS AND MOTELS
Pfeiffer and Voegele
Hyden Book Company. 1966

INTERIOR DECORATING:

LET'S TALK ABOUT FURNITURE STYLING Kroehler.

LET'S TALK ABOUT UPHOLSTERY FABRICS Kroehler.

LET'S TALK ABOUT FURNITURE QUALITY AND CONSTRUCTION Kroehler.

HOME FURNISHINGS SALES TRAINING KIT

NURSERY SCHOOL:

THE NURSERY SCHOOL - A Human Relationships Laboratory
Katherine H. Read
W. B. Saunders Company 1964
THE WORLD OFCHILDREN
Marcella H. Ellett
Burgess Publishing Company 1965
THE YEARS BEFORE SCHOOL: Guiding Preschool Children
Vivian Edmiston Todd andHelen Heffernan
Macmillan Company. 1965
PROGRAM GUIDES FOR DAY CARE CENTERS
State of Illinois. June 1966.

NURSING ASSISTANT:

HANDBOOK FOR NURSING AIDESIN HOSPITALS
Betty McGolrick and Dorothy Sutherland
American Hospital Association, Council on Professional Practice
NURSES AID
Trade and Industrial Education Department
Alabama State Department of Education
University of Alabama
NURSING ASSISTANT
Department of Industrial Education, College of Education
University of Missouri
TEXTBOOK OF BASIC NURSING
Thompson Murphy
J.B. Lippincott Company 1966.

PERSONALITY:

PSYCHOLOGY FOR LIVING
Sorenson and Malm
McGraw-Hill Book Company. 1964
YOUR PERSONALITY ANDYOUR JOB
Daniel Sinick
Science Research Associates, Inc.
HOW TO INCREASE YOUR SELF-CONFIDENCE
C. Gilbert Wrenn
Science Research Associates, Inc.
GETTING ALONG WITH OTHERS
Helen Schacter
Science Research Associates, Inc.
YOU AND YOUR ABILITIES
John Byrne andKatharine Byrne
Science Research Associates, Inc.
EXPLORING YOUR PERSONALITY
William E. Henry
Science Research Associates, Inc.
DISCOVERING YOUR REAL INTERESTS
Blanche B. Paulson
Science Research Associates, Inc.
YOUR ATTITUDE IS SHOWING
Elwood N. Chapman
Science Research Associates, Inc.
DISCOVERING YOURSELF
Marjorie C. Cosgrove andIrma Unruh
Science Research Associates Inc.
MY EDUCATIONAL PLANS
Harold L. Munson
Science Research Associates, Inc.
PERSONALITY AND HUMAN RELATIONS
Sferra, Wright and Rice
McGraw-Hill 1961.

RETAILING:

FACTS ABOUT MERCHANDISE
Logan and Moon
Prentice-Hall, Inc. 1962
LET'S SELL READY-TO-WEAR
University of Texas. 1965
THE QUAKER OATS COMPANY
SELF-STUDY PROGRAM IN RETAIL FOOD STORE OPERATIONS

MODERN SUPERMARKET OPERATION
Instructional Materials Laboratory
Division of Extension
University of Texas
KNOW YOURMERCHANDISE
Wingate, Gillespie and Addison
McGraw-Hill. 1964

AN OUTLINE FOR A JOB ANALYSIS — Granetta McComb

1. Job Title
2. Classification Title
   This refers to any classification system being used in the center for which the job analysis is being done; for example, the Dictionary of Occupational Titles.
3. Name of place or establishment
4. Number employed
5. Number hired last year
6. Number quitting last year
7. Absences
8. Supervision
   A. Specific and close or general and free
   B. From whom
9. Work performed (list of duties)
10. Level of Difficulty and Complexity
    A. Responsibilities
       (1) Work of self and others
       (2) Tools and equipment
       (3) Safety
       (4) Handling money
       (5) Interpersonal relations - workers and customers
    B. Knowledge
    C. Initiative and resourcefulness
    D. Mental alertness
    E. Mental ability
    F. Judgment
    G. Dexterity
    H. Accuracy
11. Pay rate
12. Pay schedule
13. Length of work day
14. Output standards
15. Job combination or breakdown
    A. Sequencing
    B. Time and motion
16. Job Relationships
    A. Vertical--such as promotional possibilities
    B. Horizontal--transfer of training to other jobs in same establishment; in different establishment
17. Machines, tools, equipment, materials, and supplies used
18. Working conditions
    A. Outdoor-indoor
    B. Fumes - odors
    C. Noise
    D. Pressure
    E. Danger
    F. Heat-cold
    G. Size of working area
19. Social Environment
20. Physical demands
    A. Stamina-strength
    B. Variety of Activities
    C. Opportunities for physically handicapped

VT 012 266
Training Program for Housing Maintenance Employees.

New Orleans Housing Authority, La.
National Association of Housing and Redevelopment Officials, Washington, D.C.
MF AVAILABLE IN VT-ERIC SET.
NAHRO Pub-No-N544
National Association of Housing and Redevelopment Officials, 2600 Virginia Avenue, N.W., Washington, D.C. 20037 ($2.50).
PUB DATE - Jun70 34p.

DESCRIPTORS - *CURRICULUM GUIDES; EDUCATIONAL PROGRAMS; *BUILDING TRADES; *SKILLED OCCUPATIONS; *MAINTENANCE; *TRADE AND INDUSTRIAL EDUCATION
IDENTIFIERS - *HOUSING MAINTENANCE

ABSTRACT - This 6-month training program is designed to bring into the Housing Authority of New Orleans (HANO) young, unskilled maintenance trainees having potential for advancement to higher skilled maintenance positions and to provide them training in the specialized type of building maintenance required by the housing authority. The program consists of 158 hours of instruction in 11 categories of building maintenance, upon completion of which trainees must be able to perform the 79 jobs that make up the position of maintenance repairman for HANO. Contents include: (1) brief introductory information, (2) program standards, (3) student selection and qualifications and general information on the program, (4) course outline, and (5) training program schedule, listing time, day, and date of training, category and job number, hours per instructional unit, and instructor. Directions for instructors and various sample forms are also provided. (AW)

VT 012 266

Training Program for Housing Maintenance Employees

ED0 56238

VT012266

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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NAHRO

Training Program for Housing Maintenance Employees

Developed and Prepared by the Housing Authority of New Orleans

National Association of Housing and Redevelopment Officials
2600 Virginia Avenue, N.W., Washington, D.C. 20037
NAHRO Publication Number N544
June 1970 $2.50 (NAHRO member price: $1.50)

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NAHRO acknowledges with appreciation the support and sponsorship of the Moen Division of Stanadyne in the production of this publication.

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Designed by John Bradford

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Introduction

The Housing Divisional Committee of NAHRO has spent a major portion of the past few years dealing with matters pertaining to the fiscal plight of the management operation of local housing authorities. During these times of ever-increasing costs, it has become apparent that local maintenance people will have to get the maximum benefit from the limited budget funds that are available. A reduction in present maintenance services today can only lead to bigger repair problems tomorrow.

In an effort to assist local management personnel in seeking ways to improve their maintenance programs, NAHRO is publishing this training program format developed and used by the New Orleans housing authority. NAHRO believes this format can serve many LHA's as a guide for developing a similar program.

Because of climate and other factors in different parts of the country, the maintenance needs and training of maintenance personnel may vary from one LHA to another. Nevertheless, NAHRO believes the format of the training program of the New Orleans housing authority is a valid and particularly useful one for any large or medium-size LHA that is concerned with reducing maintenance costs without reducing maintenance services.

A training program of this nature does not have practical application for a very small housing authority. However, the maintenance staff person of such an authority may well be the one who can benefit the most from a training program of this type. A combined training program that could be developed for a large group of small LHA's might be the answer for this need. The necessary vehicle to accomplish this could be any of the following organizations:

1—A large LHA in the area;

2—A state or county agency;

3—A local educational institution;

4—A large industrial or manufacturing concern; or

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5—State or regional chapters of NAHRO.

The Southwest region of NAHRO scheduled a series of "shirt sleeve clinics" that have served this purpose. Perhaps something similar would be of benefit in other regions.

GEORGE R. GENUNG, JR.
Associate Director/Housing
NAHRO

Washington, D. C.
May 1970

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Preface

Training of the New Orleans housing authority's maintenance personnel began prior to 1954. At various times throughout the years, we scheduled individual training programs with various manufacturers of equipment in use at the authority. At these sessions, the manufacturers discussed particular techniques that we could employ to better service and maintain the items they produced. Although this is an excellent method by which maintenance employees are exposed to the methods of repair and upkeep of major items of equipment, it does not train them to do the many other important maintenance jobs that are required.

In 1958, we recognized the need for a comprehensive training program that would be geared to the individual needs of the Housing Authority of New Orleans—a training program that teaches the varied skills that are required of a housing authority maintenance man. Our initial training program was developed in cooperation with the New Orleans Area Vocational and Technical School. It was a program divided into four sections, covering a period of 18 months, with 200 hours of related and supplemental instructions.

In 1960, we revised our original program, with a view toward improving the quality of instruction and formalizing the on-the-job training phase of the program. At this same time, we began our association with the Jefferson Parish Training School, which provided the teaching staff, as had the New Orleans Area Vocational and Technical School.

In 1963, some of our maintenance personnel themselves proposed the present concept. They felt that the travel time involved in going to and from the Trade School and type of instruction presented could best be accomplished at one of our project sites and with HANO personnel. We agreed and, in 1964, we incorporated some of these suggestions into our present training standards. We selected some of our more experienced maintenance personnel, both skilled and supervisory and gave them the job of preparing instructional material for the program. The response could not have been foreseen. They prepared mockups, displays, and training aids that reflect the ingenuity and technical experience of the instructors. Our training room is a permanent set-up in the William J. Guste Homes project.

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We have limited the number of students to 15 and the program runs approximately six months. We have found that 15 is about the optimum number for this type of training.

In conjunction with our training program, we have attempted to promote trainees who have successfully completed the instruction and have arranged for State Civil Service merit examinations to be given them at various project sites. From the test results, we have established promotional registers from which skilled and semi-skilled maintenance vacancies have been filled.

From its very limited beginning, the HANO maintenance training program has evolved into an integral part of our overall maintenance program. Frankly, without it we could not have begun to service the needs of our tenants.

J. GILBERT SCHEIB
Executive Director
Housing Authority of
New Orleans

May 1970

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I. Maintenance Training Program Standards

Foreword

The Housing Authority of New Orleans has developed a training course in building maintenance tailored to the job of a maintenance repairman. The course is conducted by qualified authority maintenance personnel in an authority-owned training center; it stresses the demonstration and application method of instruction. The authority uses this course as a means of improving the quality of maintenance work done on all projects.

Objectives

The objective of this training program is to develop a thoroughly capable work force, well-versed in the theory and practice of building maintenance. It provides an orderly and accurate method of instructing employees interested in upgrading themselves in the acquisition of the necessary skills to do the jobs required of a maintenance repairman and to do them well. It serves as an orderly and uniform method of instructing new employees in the acquisition of similar skills.

Content

The training program consists of 158 hours of instruction in 11 categories of building maintenance. A trainee who completes the course will have been shown how to do—and will have demonstrated the ability to do—the 79 jobs that make up the job of a maintenance repairman of the Housing Authority of New Orleans.

Maintenance Training Committee

The training program is administered by a Maintenance Training Committee composed of the key maintenance and management supervisory employees, as appointed by the General Housing Manager of the authority. Duties of the Maintenance Training Committee are:

1. To review applications for the training program and to place accepted applicants under agreement;
2. To designate employee-instructors and to assign these employees units of instruction;
3. To establish minimum requirements for classroom instruction;
4. To periodically examine trainees to determine their progress in school;

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5. To maintain records of trainees' progress in the program;
6. To hear and adjust all trainees' complaints;
7. To assume responsibility for any other duties that will contribute to proper training.

Organization

Each of the 79 jobs is considered a unit of instruction. Employee-instructors are assigned one or more units of instruction.

It is the instructor's responsibility to prepare a lesson plan; to procure the necessary training aids; to arrange for facilities to conduct the instruction; and to certify trainees who have satisfactorily completed the unit of instruction.

Each of the 11 categories has been assigned to a maintenance supervisory official whose responsibility will be to supervise the preparation and conduct of all units of instructors in that category.

In the administration of this program, employee-instructors are directly responsible to category coordinators and the category coordinators are directly responsible to the Maintenance Training Committee.

Required Instruction

Classes meet in accordance with a published training schedule. A trainee is required to attend each unit of instruction scheduled.

As each unit of instruction is completed, the instructor certifies a trainee, if the trainee has attended the required hours in the unit and has *demonstrated* his ability to do the job.

Trainees who are absent or trainees who are unable to demonstrate the ability to do the job are given additional make-up instruction at the end of the normal term of training.

Selection Of Trainees

All maintenance employees on a permanent or provisional appointment basis are eligible to enroll as trainees on a voluntary basis. Completion of the program is considered evidence that an employee seeking promotion is trained for the job. All new employees appointed to the class of Maintenance Repairman I or II, who are to be assigned duties in building maintenance, are required to enroll in the training program as a condition of employment, unless excused by the training committee. Applications for enrollment are filed with the Maintenance Training Committee. If accepted, the application is considered a

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signed agreement, the essence of which is that the authority may release a new employee for failure to maintain satisfactory progress in the school.

Qualifications Of Trainees

Trainees must meet the minimum Civil Service qualifications of the class to which they are appointed and, in addition, possess sufficient intelligence to satisfactorily complete the required instructions.

Term Of Training

The normal term of training is 158 hours, given over a six-month period. Other special terms may be instituted by the committee to cover special situations. Training is scheduled for six hours a week, four hours one morning a week and two hours one night a week. Time devoted to instruction after normal work hours is not considered as hours of work; trainee is not paid for such time.

Periodic Examination

A review of a trainee's status in relation to his progress in the required instructions is made periodically by the training committee. In the event a trainee does not show satisfactory progress, the committee has the power to recommend his removal from employment with the authority or to take such lesser action as is deemed appropriate.

Certificate Of Completion

Completion of the training program is predicated upon certification by the instructor that the trainee has satisfactorily completed all prescribed hours of instruction and has demonstrated ability to do the job. The Maintenance Training Committee issues a certificate that the trainee has completed his training and is a qualified maintenance repairman.

Records

A record of attendance and completion of each unit of instruction is maintained by the individual instructors. A master record of the trainee's progress is maintained by the joint committee. Trainees are encouraged to maintain their own records.

Adjustment Of Differences

Any disagreement or complaint relating to the training program is taken up with the training committee.

Modification

These standards may be modified at any time by action of the committee.

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II. Training Program for Maintenance Trainees

Reason For Training

The purpose of this program is to bring into the Housing Authority of New Orleans young, unskilled maintenance trainees who have potential for advancement to higher skilled maintenance positions and to give them training in the specialized type of building maintenance required by the Housing Authority of New Orleans. A program of this type is deemed essential in view of the variety of skills a maintenance employee must possess to adequately perform repairs in all of the several building trades.

Classification And Pay

The employee to be trained is appointed to the State Civil Service class of "Laborer, Utility." Trainees enter at the entrance rate for this class and, upon satisfactorily completing the training program, are advanced to the Civil Service class of Maintenance Repairman I, with an accompanying increase in salary.

Rates of pay are based on the current wage determinations of the Department of Housing and Urban Development.

Qualification Requirements

Applicants for trainee positions must have at least two years of high school education; must be at least 18 years of age, but must not have reached their 30th birthday; must be physically fit to perform the duties required of a maintenance repairman; and must possess aptitude for this work.

Method Of Selection

Under authority granted by the Department of State Civil Service, trainees are secured from the open market through the Louisiana Employment Service. Applicants furnished by the employment service must meet the basic qualification requirements and must have passed a test designed to measure aptitude for this work. Selection is based upon a suitability investigation, personal interview, and indication of a positive interest in a career with the housing authority. In selection, preference is given to applicants who have completed active military service or who are discharging their obligated military service through service in an armed forces reserve component.

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Length Of Training

The training program last six months, during which time the trainee is required to complete the authority's currently approved course in building maintenance, which is taught in the authority's Maintenance Training Center and, in addition, to complete six months of intensive on-the-job training under the guidance of a skilled maintenance mechanic. Formal training ends upon certification by the authority that the trainee has completed the on-the-job training phase and the related instruction. The trainee is then promoted to the class of Maintenance Repairman I. Further advancement and retention depends on the employee's demonstrated abilities and the needs of the authority.

Outline Of Training

1. General Orientation Training

A trainee is given extensive orientation training to familiarize him with authority policies and procedures which affect him. In general, this training follows the guide used to orient a new employee, with special emphasis on the trainee's obligation as a trainee. This training is conducted by the chief of maintenance.

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2. Specific Orientation

In addition to this general orientation, the trainee is given specific orientation to those things that a Maintenance Repairman I must know, but which are not otherwise covered in the training to follow, such as accounting for materials and supplies; job layout; labor distribution. This orientation is the responsibility of the trainee's immediate supervisor.

3. Building Maintenance Course

Trainees are required to complete the course of instruction which are described in the authority's Maintenance Training Standards (Part I) and detailed in Parts III and IV.

4. On-the-Job Training

When not attending group instruction, trainees work alongside a skilled maintenance mechanic, functioning as a helper to this mechanic in the performance of the mechanic's regular duties.

Records and Reports

Trainees are required to maintain normal records of labor distribution. Whenever work is performed as a helper to a mechanic as part of the on-the-job training phase, the mechanic doing the training initials that entry on the daily work record of the trainee.

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Records of attendance and training in the course of instruction in building maintenance are kept, as specified in the Maintenance Training Standards (Part I).

Trainees are evaluated by the maintenance foreman at the end of the first two months of training, at the end of four months of training, and just prior to the end of the sixth month of training on a form specially provided for this evaluation (see page 32).

Project managers meet regularly with trainees to counsel them as to their progress. They endorse the evaluation reports of maintenance foremen.

The chief of maintenance reviews the trainee's complete file immediately prior to the end of the sixth month of training. Particular attention is given to:

1. The maintenance foreman's evaluation;
2. The trainee's progress in on-the-job training;
3. The trainee's progress in related instruction in the training center; and
4. Comments of the project manager.

The chief of maintenance then recommends to the general housing manager that the trainee be advanced to Maintenance Repairman I, or—in the event of unsatisfactory progress—some other action.

The following are considered to be evidences of unsatisfactory progress:

1. Demonstrated lack of interest;
2. Sub-standard performance of practical assignments in on-the-job training; or
3. Inability to absorb course material in related instruction.

Completion Of Training

After final evaluation by the chief of maintenance and concurrence therein by the general housing manager, the trainee is promoted to the class of Maintenance Repairman I.

Disposition Of Trainees Determined Unsatisfactory

At any time during the training period that it becomes evident that a trainee is not progressing satisfactorily, he is dropped from the training program and demoted to an unskilled position, if one is available, or removed from employment.

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III. Maintenance Training Course Outline

Instructional Units		*Hours*
Carpentry		
Job 1.	Re-hanging screen doors and windows (wood and aluminum)	2
Job 2.	Re-wiring screen doors and windows	2
Job 3.	Replacing door stiles and rails on screen doors, windows	3
Job 4.	Repairing and re-hanging doors (wood and metal)	2
Job 5.	Repairing and replacing door frames	3
Job 6.	Repairing and replacing door closers	2
Job 7.	Repairing door locks, closers	1
Job 8.	Replacing door knobs, locks, and hinges	1
Job 9.	Repairing and replacing thresholds and weather-stripping on doors and windows	1
Job 10.	Installing window sash (wood and aluminum)	2
Job 11.	Replacing sash balances and other hardware	2
Job 12.	Glazing window lights	1
Job 13.	Removing and replacing wood block tiles	2
Job 14.	Removing and replacing wood strip flooring	2
Job 15.	Sanding and re-finishing wood flooring	2
Job 16.	Installing asphalt tile flooring	2
Job 17.	Replacing baseboard and baseboard molding	1
Job 18.	Replacing wooden and metal stair rails	2
Job 19.	Repairing kitchen cabinets—doors and shelves	3
Job 20.	Repairing kitchen work-tables	2
Job 21.	Replacing medicine cabinet mirrors and doors	1
	Total	39

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Masonry

		Hours
Job 1.	Patching cracked or damaged plaster	2
Job 2.	Repairing or replacing cement blocks	2
Job 3.	Replacing ceramic tiles	2
Job 4.	Replacing cracked or loose brick	2
Job 5.	Tuck pointing loose mortar joints	2
Job 6.	Re-caulking around windows, doors, and lintels	2
Job 7.	Repairing chipped concrete steps and porches	2
Job 8.	Paving or patching small paved areas	2
Job 9.	Replacing access doors and grills	2
	Total	18

Roofing

Job 1.	Replacing clay tile and asbestos shingles on roof	2
Job 2.	Repairing built up roofs	3
Job 3.	Repair and replacing of gutters, downspouts	2
Job 4.	Repairing and replacing flashing	2
	Total	9

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Painting

		Hours
Job 1.	Preparation of walls for application of paint	2
Job 2.	Applying paint to interior and exterior walls and to surfaces of appliances	4
Job 3.	Repairs to metal porch rails and columns	2
	Total	8

Space Heaters

Job 1.	Removing and installing space heaters	1
Job 2.	Cleaning and adjusting main burner and flame	1
Job 3.	Removing and replacing thermostat control	1
Job 4.	Testing for gas leaks	1
	Total	4

Hot Water Heaters

Job 1.	Removing and installing hot water heaters, testing for gas leaks	3
Job 2.	Replacing temperature and pressure relief valve	2
Job 3.	Repairing, adjusting, or replacing thermostats	2
Job 4.	Adjusting pilot and main burners	1
	Total	8

Ranges

Job 1.	Removal and installation of gas and electric ranges	1
Job 2.	Adjusting top and oven burners	1
Job 3.	Adjusting oven thermostats	2
Job 4.	Reconditioning gas ranges	2
	Total	6

Refrigerators

Job 1.	Trouble shooting malfunctions of refrigerators	4
Job 2.	Checking temperature controls and motor circuits	4
Job 3.	Replace switches, thermostats, and relays	3
Job 4.	Replacing door seals and door handles	2
Job 5.	Replacing light switches and supply cords	1
	Total	14

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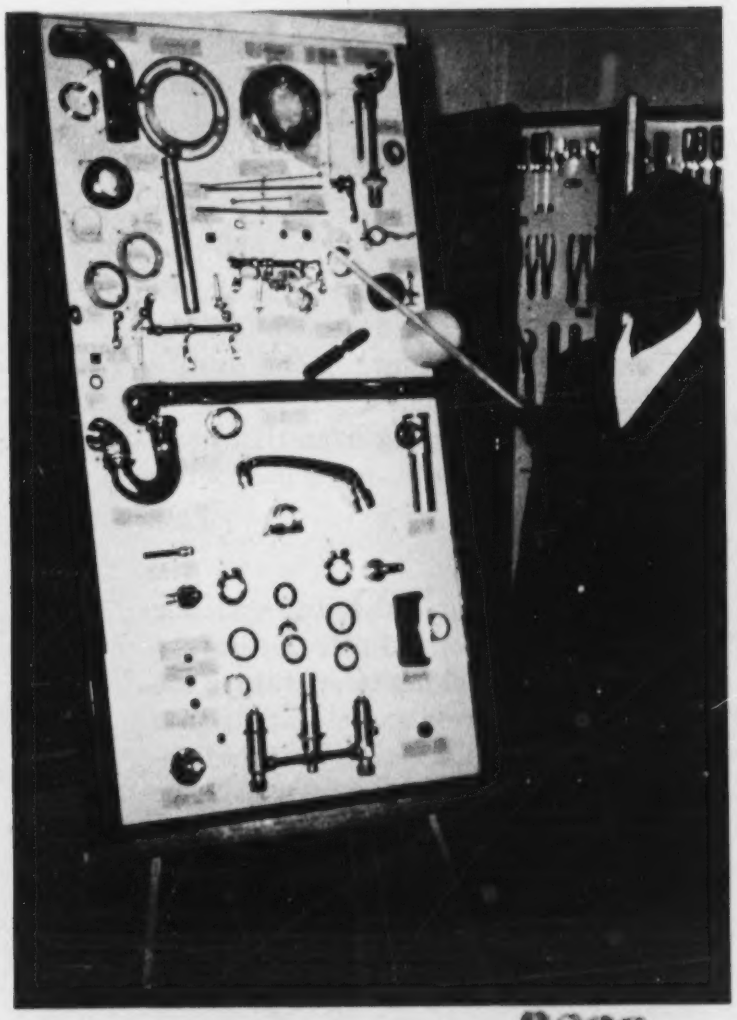

Plumbing		*Hours*
Job 1.	Unstopping, repairing, and replacing water closets—including tank, flush assembly, and seat	4
Job 2.	Replacing water faucets, washers in faucets and re-dressing bad faucet seats	4
Job 3.	Repairing and replacing continuous waste on sink	2
Job 4.	Repair and replacing of p-trap on p.o. plug face bowl	
Job 5.	Repairing and replacing copper and galvanized water pipe	3
Job 6.	Repairing lead joints (soil pipe)	2
Job 7.	Replacing broken gas lines to gas-fired equipment	2
Job 8.	Testing for gas leaks—interior and exterior	1
Job 9.	Repairs to sub-surface drain lines (terra cotta soil pipe)	2
	Total	26

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Electricity		*Hours*
Job 1.	Introduction to electricity	1
Job 2.	Replacing switch boxes and outlet boxes	2
Job 3.	Replacing interior wiring	2
Job 4.	Replacing and repairing fixtures	2
Job 5.	Replacing convenience outlets and wall switches	1
Job 6.	Replacing three-way switches	1
Job 7.	Servicing fluorescent fixtures	2
Job 8.	Tracing and locating shorts in circuits	3
Job 9.	Handling hot wires in absence of disconnect	1
Job 10.	Setting and replacing time clocks	1
Job 11.	Repairing and replacing relays	2
	Total	18
Safety		
Job 1.	Safety on the job	4
Job 2.	First aid	2
Job 3.	Fire prevention and extinguishment	2
	Total	8
	Grand Total	158

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IV. Maintenance Training Program Schedule

Class No. 3: Maintenance Training Center, William J. Guste Homes, La. 1-15
Starting Date: February 5, 1969; Completion Date: October 22, 1969

Ronald R. Brignac, Deputy Executive Officer
J. M. Orlesh, Jr., Personnel Officer
R. Evans, Chief of Maintenance
B. W. Cooper, Administrative Officer
M. A. Edwards, Jr., Administrative Officer
J. Gilbert Scheib, Executive Director (ex-officio)

Administrative Training Staff:
William J. Theard, HANO, Coordinator
Robert Marti, HANO, Assistant Coordinator
George Tumey, Central Repair Department (CRD), Assistant Coordinator

Shop Training: Carpentry, Plumbing, Gas Safety, Painting, Electricity, Space Heaters, Water Heaters, Refrigerators, Masonry and Roofs

Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 5:00 p.m. Wednesday 2/5/69	1. Opening Ceremonies 2. Indoctrination 3. Film—		2	William J. Theard
	Accident Prevention— Lifting and Strain— Types of Injuries		2	William McCray
1:00 p.m. - 3:00 p.m.	Carpentry Job #1	Repairing and replacing door frame and trim.	2	B. Sholl La. 1-3
3:00 p.m. - 5:00 p.m. Wednesday 2/12/69	Carpentry Job #2	Replacing stiles and rails on window and door screens.	2	
1:00 p.m. - 3:00 p.m.	Carpentry Job #3	Rewiring screen doors and windows (wood and aluminum).	2	P. Gaudin, Jr. La. 1-2
3:00 p.m. - 5:00 p.m. Wednesday 2/19/69	Carpentry Job #4	Repairing and rehanging screen doors.	2	

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Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 3:00 p.m.	Carpentry Job #5	Re-hanging window screens (wood and aluminum).	2	L. Marshall La. 1-14
3:00 p.m. - 5:00 p.m. Wednesday 2/26/69	Carpentry Job #6	Repairing and replacing door closers.	2	
1:00 p.m. - 5:00 p.m. Wednesday 3/5/69	Carpentry Job #7	Installing and replacing mortise type door locks.	4	B. Sholl La. 1-3
1:00 p.m. - 3:00 p.m.	Carpentry Job #8	Installing and replacing bore type locks.	2	A. Bibbens La. 1-16
3:00 p.m. - 5:00 p.m. Wednesday 3/12/69	Carpentry Job #9	Repairing door locks (mortise and bore type).	2	
1:00 p.m. - 3:00 p.m.	Carpentry Job #10	Installing window sashes (wood and aluminum).	2	P. Gaudin, Jr. La. 1-2
3:00 p.m. - 5:00 p.m. Wednesday 3/19/69	Carpentry Job #11	Replacing sash balances and window latches.	2	
1:00 p.m. - 3:00 p.m.	Carpentry Job #12	Glazing window lights.	2	B. Sholl La. 1-3
3:00 p.m. - 5:00 p.m. Wednesday 3/26/69	Carpentry Job #13	Repairing bathroom medicine cabinets.	2	

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Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 3:00 p.m.	Carpentry Job #14	Replacing thresholds and installing weather stripping on doors and window frames.	2	A. Bibbens La. 1-16
3:00 p.m. - 5:00 p.m. Wednesday 4/2/69	Carpentry Job #17	Repair and replacing of metal stair hand rails.	2	
1:00 p.m. - 3:00 p.m.	Carpentry Job #15	Repairing kitchen work tables.	2	B. Sholl La. 1-3
3:00 p.m. - 5:00 p.m. Wednesday 4/9/69	Carpentry Job #16	Repairing wall-type kitchen cabinets.	2	
1:00 p.m. - 3:00 p.m.	Flooring Job #1	Removing and replacing wood strip flooring.	2	C. Stevens CRD
3:00 p.m. - 5:00 p.m. Wednesday 4/16/69	Flooring Job #2	Removing and replacing wood floor blocks.	2	
1:00 p.m. - 3:00 p.m.	Flooring Job #3	Sanding and preparing floors for refinishing.	2	F. Young CRD
3:00 p.m. - 5:00 p.m. Wednesday 4/23/69	Flooring Job #4	Replacing baseboard and molding.	2	
1:00 p.m. - 3:00 p.m.	Flooring Job #5	Refinishing wood block flooring.	2	F. Young CRD
3:00 p.m. - 5:00 p.m. Wednesday 4/30/69	Flooring Job #6	Installing asphalt tile floors.	2	

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Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 5:00 p.m. Wednesday 5/7/69	Plumbing Job #1	Measuring, cutting and threading pipe. Repairing and replacing copper and galvanized water pipe.	4	A. Cheron CRD
1:00 p.m. - 3:00 p.m.	Plumbing Job #2	Replacing and repairing gas lines to gas fired equipment and testing for gas leaks.	2	A. Cheron CRD
3:00 p.m. - 5:00 p.m. Wednesday 5/14/69	Plumbing Job #3	Repairing and replacing continuous waste on sinks.	2	
1:00 p.m. - 5:00 p.m. Wednesday 5/21/69	Plumbing Job #4	Unstopping, repairing and replacing water closets, including tanks, flush assembly and seats.	4	W. Gerard La. 1-15
1:00 p.m. - 4:00 p.m.	Plumbing Job #5	Replacing faucets, faucet washers, diverter and swing type spouts. Repairs and redressing bad faucet seats.	3	A. Cousins La. 1-5
4:00 p.m. - 5:00 p.m. Wednesday 5/28/69	Plumbing Job #6	Repairing and replacing "p" traps and P.O. plugs on face bowl.	1	

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Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 3:00 p.m.	Plumbing Job #7	Repairing and replacing cast iron soil pipe.	2	A. Cheron CRD
3:00 p.m. - 5:00 p.m. Wednesday 6/4/69	Plumbing Job #8	Repairing and replacing sub-surface drain lines (terra-cotta and cast iron).	2	
1:00 p.m. - 3:00 p.m.	Refrigerator Job #1	Checking and replacing of temperature controls and cabinet light switches.	2	D. Farrell CRD
3:00 p.m. - 5:00 p.m. Wednesday 6/11/69	Refrigerator Job #4	Replacing and adjusting door seals and door locks.	2	
1:00 p.m. - 5:00 p.m. Wednesday 6/18/69	Refrigerator Job #2	Malfunctions and trouble shooting.	4	D. Farrell CRD
1:00 p.m. - 5:00 p.m. Wednesday 6/25/69	Refrigerator Job #3	Replacing relays and checking motor circuits.	4	D. Farrell CRD
1:00 p.m. - 2:00 p.m.	Space Heaters Job #1	Removing and installing (testing for leaks)	1	A. Cheron CRD
2:00 p.m. - 3:00 p.m.	Space Heaters Job #2	Cleaning and adjusting burner flame.	1	
3:00 p.m. - 5:00 p.m. Wednesday 7/2/69	Space Heaters Job #3	Replacing and adjusting thermostat controls.	2	

Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 2:00 p.m.	Ranges Job #1	Removing and installing electric ranges.	1	G. Williams La. 1-15
2:00 p.m. - 3:00 p.m.	Ranges Job #2	Adjusting top and oven burners.	1	
3:00 p.m. - 5:00 p.m. Wednesday 7/9/69	Ranges Job #3	Reconditioning gas and electric ranges.	2	
1:00 p.m. - 3:00 p.m.	Ranges Job #4	Adjusting oven thermostats.	2	A. Cheron CRD
3:00 p.m. - 5:00 p.m. Wednesday 7/16/69	Hot Water Heaters Job #1	Removing, installing and testing for gas and water leaks.	2	
1:00 p.m. - 2:00 p.m.	Hot Water Heaters Job #2	Adjusting pilot and main burner.	1	A. Cheron CRD
2:00 p.m. - 3:00 p.m.	Hot Water Heaters Job #3	Replacing and adjusting T&P valves.	1	
3:00 p.m. - 5:00 p.m. Wednesday 7/23/69	Hot Water Heaters Job #4	Repairing, adjusting and replacing thermostats.	2	
1:00 p.m. - 5:00 p.m. Wednesday 7/30/69	Masonry Job #1	Patching cracked or damaged plaster.	4	J. Morris La. 1-15

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Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 3:00 p.m.	Masonry Job #2	Plastering on masonry and metal lath walls.	2	J. Morris La. 1-15
3:00 p.m. - 5:00 p.m. Wednesday 8/6/69	Masonry Job #3	Plastering large areas of walls and ceilings.	2	
1:00 p.m. - 3:00 p.m.	Masonry Job #4	Replacing and repairing cement blocks.	2	L. Poree La. 1-7
3:00 p.m. - 5:00 p.m. Wednesday 8/13/69	Masonry Job #5	Replacing cracked or loose bricks and tuck pointing mortar joints.	2	
1:00 p.m. - 3:00 p.m.	Masonry Job #6	Repairing chipped concrete porches and steps.	2	J. Labostrie La. 1-8
3:00 p.m. - 5:00 p.m. Wednesday 8/20/69	Masonry Job #7	Paving and patching small paved areas.	2	
1:00 p.m. - 3:00 p.m.	Masonry Job #8	Replacing ceramic tiles.	2	L. Poree La. 1-7
3:00 p.m. - 5:00 p.m. Wednesday 8/27/69	Masonry Job #9	Recaulking around windows, doors, and lintels.	2	
1:00 p.m. - 3:00 p.m.	Roofing Job #1	Repairing built-up roofs.	2	E. L. Sorina CRD
3:00 p.m. - 5:00 p.m. Wednesday 9/3/69	Roofing Job #2	Replacing clay tiles and asbestos shingles.	2	
1:00 p.m. - 5:00 p.m. Wednesday 9/10/69	Roofing Job #3	Repairing and replacing flashing, gutters, and downspouts.	4	E. Braud La. 1-8

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Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 3:00 p.m.	Painting Job #1	Interior and exterior painting, wood and metal (types of paint and their application).	2	C. E. Harrell La. 1-7
3:00 p.m. - 4:00 p.m.	Painting Job #2	Surface preparation and paint application.	1	
4:00 p.m. - 5:00 p.m. Wednesday 9/17/69	Painting Job #3	Refinishing of wood trim, wood and metal cabinets and appliances.	1	
1:00 p.m. - 3:00 p.m.	Electricity Job #1	Introduction to electricity and basic electric wiring.	2	T. Jeffrion, Jr. C.R.D.
3:00 p.m. - 4:00 p.m.	Electricity Job #2	Interior electric wiring systems.	1	
4:00 p.m. - 5:00 p.m. Wednesday 9/24/69	Electricity Job #3	Safety in handling live conductors.	1	
1:00 p.m. - 3:00 p.m.	Electricity Job #5	Tracing and locating short circuits.	2	E. Nickerson La. 1-14
3:00 p.m. - 5:00 p.m. Wednesday 10/1/69	Electricity Job #6	Replacing interior wiring.	2	
1:00 p.m. - 3:00 p.m.	Electricity Job #7	Servicing and installing fluorescent fixtures.	2	J. Grant La. 1-8
3:00 p.m. - 5:00 p.m. Wednesday 10/8/69	Electricity Job #4	Replacing convenience outlets, 3-way switches, ceiling and bracket fixtures.	2	

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Time, Day, Date	*Category and Job Number*		*Hours*	*Instructor*
1:00 p.m. - 2:00 p.m.	Electricity Job #8	Setting, adjusting and connecting time clocks.	1	E. Nickerson La. 1-14
2:00 p.m. - 3:00 p.m.	Electricity Job #9	Wiring and controls for exterior lighting.	1	
3:00 p.m. - 5:00 p.m. Wednesday 10/15/69	Heating Job #1	Administration building (low-rise) boiler operation and controls. Hot water and hot air heating.	2	G. Williams La. 1-15
1:00 p.m. - 3:00 p.m.	Safety Job #1	Accident Prevention	2	Wm. McCray La. 1-5
3:00 p.m. - 5:00 p.m. Wednesday 10/22/69	Safety Job #4	First Aid	2	

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V. Directions for Instructors

Effective Instruction

1. The supervisor who has not devoted some conscious thought and planning to the techniques of how to instruct is often an ineffective teacher for some of the following reasons:

—He teaches his job in the way he learned it.

—The instructor may think of his work in bigger units than the trainee can readily grasp.

—The instructor may neglect to teach the entire operation.

—The instructor may stress the things that seem important to him.

—He may forget why a thing is done a certain way.

—Because he is used to *doing* rather than *teaching*, the instructor may become impatient with a trainee who fails to learn quickly.

—The instructor may find it difficult to teach easily, as he is not skilled in using the most appropriate words to convey his thoughts.

—He may not properly prepare himself before instructing.

—The instructor may be deficient in a knowledge of human relations and, hence, may antagonize his learner.

2. To be effective, a job instructor should know something about teaching methods and must be skilled in instructional techniques to get the most from his men.

3398

Steps in Instructing

Step 1:

Prepare the Employee for Instruction

Put him at ease.

Explain the job thoroughly and what it means.

Create an interest in the class.

Step 2:

Present the Job—Tell and Show Him

Follow your job breakdowns.

Explain the job thoroughly, each phase at a time.

Stress all important points.

Don't teach too much at one time.

Use words that are easily understood.

Give student a chance to do the talking.

Set an interest in the class that will hold students' attention.

Give reasons that will be beneficial to students.

Show one thing at a time.

Teach everything you will expect him to learn in return.

3399

Step 3: Try Out Performance

Have him perform the job.

Have him give you the entire breakdown on specific job that he has learned.

Correct errors and omissions as he progresses, keeping the following points in mind:

- Set student at ease and avoid criticism;
- Explain before you correct;
- Let the trainee prove himself;
- Don't go above trainee's knowledge;
- Don't challenge student in front of others;
- Don't hold trainee for mistakes.

Encourage him.

Get him to learn what he has missed.

Continue with your student until you know he qualifies.

Step 4: Follow-Through

Give him the chance to do the job himself.

Give students a chance to ask questions and encourage them to follow through on what they don't understand.

Check student constantly and encourage him.

Let him know how he is doing and give him a chance to express himself at free will.

VI. Forms

A. Application—Training Agreement

Name _____ Date _____

Address _____

Education (Circle highest grade completed)

1 2 3 4 5 6 7 8 9 10 11 12

Other Trade, Technical or Service Schooling:

_____

_____

I hereby apply for enrollment in the training program under the terms and conditions of the Authority's Maintenance Training Program Standards, which are incorporated and made a part of this Application-Agreement. I understand and agree that I will pursue the prescribed course of instruction and that I must maintain satisfactory progress as determined by the Maintenance Training Committee as a condition of my continued employment.

_____

Signature of Applicant

Maintenance Training Committee

Application Accepted (date) _____

Began Work (date) _____

Class Title _____

Project _____

Supervisor _____

☐ Condition of Employment
☐ Voluntary Application

cc:
Executive Director
Project Manager
Immediate Supervisor
Maintenance Training Committee

_____

Chairman,
Maintenance Training Committee

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B. Periodic Evaluation of Trainee in HANO Maintenance Training Program

1. Evaluation of:

Name _____ Project _____

Date Entered Training _____ Month Completed _____

2. On-the-Job-Training:

Category	*Hours Completed To Date*	*Category*	*Hours Completed To Date*
Grounds—Appurtenances		Hot Water Heaters	
Structural Maintenance		Electrical	
Plastering		Space Heaters	
Painting		Ranges	
Plumbing		Refrigerators	
		Total	

3. Evaluation:

Factor	*Excellent*	*Satisfactory*	*Poor*
Conduct			
Attitude and Interest			
Appearance			
Ability to Work with Others			
Ability to Observe			
Safety Consciousness			
Tenant-Relations Consciousness			
Quality of Work Produced			
Quantity of Work Produced			

3400

Periodic Evaluation of Trainee in HANO Maintenance Training Program *(continued)*

4. Comments:

Date_____ _____

Maintenance Foreman

5. Comment of Project Manager:

Date_____ _____

Project Manager

6. Action of Chief of Maintenance:

Date_____ _____

Chief of Maintenance

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C. Diploma

HOUSING AUTHORITY OF NEW ORLEANS

Certificate of Achievement

PRESENTED TO

_____

FOR HAVING SATISFACTORILY COMPLETED A COURSE IN

_____

GIVEN THIS_____DAY OF_____19____,
AT NEW ORLEANS, LA.

COURSE DIRECTOR EXECUTIVE DIRECTOR

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VT 012 271
Guidelines for Family Life and Sex Education, Grades K-12. Curriculum Bulletin No. 32.

Minnesota State Dept. of Education, St. Paul.
MF AVAILABLE IN VT-ERIC SET.
Documents Section, Minnesota State Dept. of Education, Room 140, Centennial Building, St. Paul, Minnesota 55101.
PUB DATE - 70 101p.

DESCRIPTORS - *FAMILY LIFE EDUCATION; *SEX EDUCATION; *CURRICULUM GUIDES; ELEMENTARY GRADES; INTERMEDIATE GRADES; BEHAVIORAL OBJECTIVES; EDUCATIONAL OBJECTIVES; LEARNING ACTIVITIES; RESOURCE MATERIALS; TEACHER WORKSHOPS; SECONDARY GRADES

ABSTRACT - Developed during elementary and secondary teacher workshops and reviewed by a State coordinating committee, this curriculum guide contains suggested long-range behavior goals and content for the primary, intermediate, junior high, and senior high grade levels. An introductory section covers philosophy, need, suggestions for teachers, implementation, handling controversial issues, preservice and inservice education, and assessing the program. Generalizations, learning experiences, resources, and evaluation techniques for each grade level accompanying these goals: (1) Acquire a maturing self-image, (2) Understand the nature, purpose and roles of the family and its members, (3) Demonstrate a pattern of relationships based upon responsibilities to oneself and others, (4) Understand the influences of political, philosophical, religious, and cultural ideologies on sexuality, (5) Develop and employ a personal code of ethics, (6) Accept personal responsibility for positive and constructive influences on society's concerns for family living and sexuality, (7) Employ suitable and effective communication about human sexuality, and (8) Understand anatomical, physiological, psychological, and sociological maturation as related to human sexuality. Printed and audio-visual resources and sources for informational materials are included. (SB)

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VT 012 271

Code VIII

Code VIII-A-E-C-7

ED 056 238

GUIDELINES FOR
FAMILY LIFE AND SEX EDUCATION

GRADES K-12

CURRICULUM BULLETIN NO. 32

STATE OF MINNESOTA

DEPARTMENT OF EDUCATION

St. Paul

VT 012271

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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In Memoriam

These guidelines are dedicated to the memory of Dr. Helen Starr who served as the chairman of the State Coordinating Committee on Family Life and Sex Education and the teacher workshops. This publication evolved under her direction.

Until her untimely death, February 18, 1969, Dr. Starr gave unselfishly of her time and talents to promote a more effective educational program for Minnesota children and youth.

May these guidelines help teachers and students exemplify the model she portrayed.

Commissioner of Education

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Preface

The development of *Guidelines for Family Life and Sex Education, Grades K-12*, was made possible through funds from Title V, Elementary and Secondary Education Act. Significant contributions to the development of these guidelines were made by the teacher workshop committees on family life and sex education and the State Coordinating Committee on Family Life and Sex Education.

Elementary and secondary teacher workshops were conducted to develop the suggested content for each grade level. After being reviewed by the teacher workshop committees, the suggested content was then further reviewed by the State Coordinating Committee on Family Life and Sex Education. This committee also made specific suggestions for the long-range goals.

The State Department of Education considered it essential to develop these guidelines as a followup to the Position Statement on Family Life and Sex Education which was adopted by the Minnesota State Board of Education, November 1966. It is hoped that this publication will present a framework for developing the best comprehensive program possible to help meet the needs of children and youth in a highly complex society.

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State Coordinating Committee on Family Life and Sex Education

Helen Starr (Deceased), Chairman

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Wayne J. Anderson..... Professor of Family Living, University of Minnesota, Minneapolis
Lee Ball ..... Former Director of Health and Physical Education, Mankato Public Schools
David Conover ..... Coordinator of Pupil Personnel Services, Mounds View Public Schools
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Russell Goodman ..... Family Life Consultant, Department of Public Welfare, St. Paul
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Lyla Mallough ..... Supervisor of Home Economics Education, State Department of Education, St. Paul
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D. A. Torbenson..... Minnesota Association of School Administrators, Superintendent of Paynesville Public Schools
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Carol Stark, Editor

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David Kothe, Willmar Public Schools

Dale Larson, Mounds View Public Schools

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Suggested Long-Range Behavior Goals

Primary Grades

Intermediate Grades

Junior High School

Senior High School

Appendix

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Introduction

Philosophy

An increasingly complex society is making increasingly complex demands upon children and youth in family life and sex education. Our society has stimulated young people to reach an early superficial maturity. The blatant sex in society has its impact through mass media which contributes little to the development of desirable attitudes. This has caused a greater need for guidance and education to foster correct information and desirable attitudes, behavior, and values in human sexuality. The basic issue is not whether or not Minnesota children and youth should have family life and sex education — they will receive it one way or another. The basic issue is whether they receive it from their peer group, from the street, and from experience alone or whether they get it from the home, church, and school working cooperatively.

The dignity of the person requires that each individual receive an education in family life and sex education. Helping individuals attain maturity in human sexuality and to understand human sexuality is a privilege and responsibility of every age. Parents have the prime responsibility for the inculcation of moral values to their children, but the school needs to support and supplement the parents. One way to provide a more meaningful life experience is to provide school children with an opportunity to come to grips with the problems and issues inherent in family life and sexual behavior before they become problems to the individual and society and before the individual is faced with situations for which he is not equipped to make desirable and socially acceptable judgments.

Education for family life and sex education, in its broadest form, is concerned not only with physical relations but, more importantly, with emotional and social interrelationships. Within this context, these guidelines are provided as an initial step to strengthen instruction in wholesome attitudes and respect for all cultures in the area of family life and sex education and to focus attention on the understanding of the self within the context of human growth and development.

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[1]"The Growing Toll of America's 'Broken Homes.'" *U.S. News and World Report,* Vol. LVX, No. 6 (August 5, 1968),

[2]*Ibid.,* 93.

[3]*School Health Education Study,* Summary Report of a Nationwide Study of Health Instruction in the Public Sch
16th St. N.W., Washington, D.C. 20036. p. 39.

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Introduction

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The Need

Young people are growing up in a pluralistic, democratic society wherein many traditional cultural patterns and standards are being challenged. They need help and guidance in relation to current problems, issues, and sociocultural conditions related to sexual conduct and behavior.

Home and family living needs to be strengthened in our society. Teenage marriages have increased at a rapid rate, with three fourths of them breaking up. There is also an upward trend in the number of divorces granted for the population as a whole. *U.S. News and World Report* magazine states that "More than 7 million children under 18, or about 1 in 10, are being raised in fatherless homes."[1] The magazine goes on to report that, according to sociologists and psychiatrists, "Boys can suffer much emotional damage if there is no 'male model' on which to pattern themselves."[2]

Accurate information from reliable sources is necessary if children and youth are to successfully cope with the pressures of today's society. However, a national survey on school health education practices reported that "Questions about sex asked by fifth and sixth grade children in anonymous surveys reflect distorted facts and a need for accurate information."[3]

Every community has some type of a family life and sex education program, but it is the responsibility of concerned citizens to determine the quality of it.

Implementation

The public school must assert leadership in the community relative to implementing a comprehensive family life and sex education program. School boards, school administrators, and teachers need to become involved with parents, churches, and other community agencies

erica's 'Broken Homes.'" *U.S. News and World Report*, Vol. LVX, No. 6 (August 5, 1968), 92.

Study, Summary Report of a Nationwide Study of Health Instruction in the Public Schools. 1964. School Health Education Study, 1201 20036. p. 39.

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to gain support and acceptance of the program. However, the school cannot wait until all citizens are ready before inaugurating this necessary curricular development.

It is recommended that the board of education and superintendent initiate a family life and sex education program by organizing a citizens' committee composed of educators, clergymen, representatives of the medical field, members of the school board, and members of the P.T.A. All aspects of the program should be studied, including:

1. Community needs and attitudes (A poll or survey should be taken for future reference.)
2. Student needs and attitudes
3. Reference materials and curriculum guides available

One educator should be given authority and time to direct and coordinate this committee work. The committee should recommend an appropriate course of action to the board of education relative to curriculum development.

After the board of education has endorsed the program, the same committee or a separate committee of educators should develop a sequential and coordinated program (vertical and horizontal) for grades K-12, based upon these guidelines. A summer writing team will facilitate curriculum development. Emphasis should not only be given to the physiological aspects of sexuality, but to the psychological, sociological, and economic aspects as well. These curriculum experiences should be integrated into specific and appropriate courses at all grade levels. However, there is a need to consider the merits of a separate course on family living for 11th or 12th grade pupils with special emphasis on preparation for marriage, parenthood, and family life.

The nature of the program dictates that boys and girls be scheduled together as a general practice if it is to be most meaningful and effective and considered a part of the regular curriculum. However, occasionally it may be desirable to schedule boys and girls separately to discuss specific aspects of body cleanliness. Team teaching can provide for effective staff utilization in emphasizing the various aspects of the program.

The approach to implementing the program into the curriculum may vary in each school district. However, it is vital for parents to be involved if the school is to support and supplement the home. A district should give consideration to the approach that will enable it to establish a successful and meaningful program. The pilot teacher plan and district-wide plan are examples of implementation procedures.

Pilot Teacher Plan. Sel
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Pilot Teacher Plan. Select teachers at each grade level who have a high level of interest, insight, understanding, empathy, and knowledge and who can help pupils develop healthy moral attitudes. These teachers will evaluate the program at the conclusion of the year and prepare a revised curriculum for implementation the second year. Inservice education is provided for all teachers.

District-Wide Plan. All teachers are urged to become involved in teaching family life and sex education. The recommended content is taught sometime during the school year. Inservice education is provided prior to beginning the program.

General Suggestions for Teachers

The instructor should at all times be strictly honest in all statements, ready to encourage and to answer all legitimate questions, and careful to distinguish fact from belief or interpretation.

The personality of the instructor, the manner in which he imparts information, and the degree of confidence which students have in him are as important as what he says in formulating the ideals of his students.

Controversial Issues

Certain areas of family life and sex education are controversial and need special precautions. These areas and precautions are as follows:

1. Sexual techniques should not be included in the program.
2. Sexual perversion should not be included as a major topic. However, it is desirable that appropriate instruction be given to protect children and youth against sexual deviates.
3. Birth control is a very sensitive area. Birth control methods may be discussed, but advocating types of birth control should not be included in the program. This is a responsibility of the parents and church.

Children and youth may express specific deviate behavior related to sexual behavior by either direct question or teacher observation. Teachers should refer these pupils to other specially trained personnel for followup work and consultation, rather than jeopardize the welfare of the particular pupil and of the rest of the class.

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Preservice Education

Teacher education institutions have an important role in the development of an effective family life and sex education program. The following levels of preparation are recommended.

1. All elementary and secondary school teachers should have at least a basic course in family life and sex education.
2. Special preparation for secondary school health, home economics, science, and social studies should consist of 9 credits in family life and sex education.
3. A family life educator should have at least a minor in family life. This educator could serve as a school district consultant.

Inservice Education

Inservice education is a continuing process. Parents, as well as teachers, can benefit from such a program. It would be desirable to have teachers enroll in at least one course or workshop in family life and sex education. However, if this is not feasible the following areas, suggested in the New Jersey *Guidelines for Developing School Programs in Sex Education,*[4] should be included in a local inservice program.

1. Need for the program
2. Concept of human sexuality
3. Psycho-sexual development
4. Reproduction
5. Relationships of heredity and environment
6. Preparation for marriage and the family
7. Special topics such as venereal disease, homosexuality, masturbation, and illegitimacy
8. Family life and sex education curriculum content and resources

Inservice education can be held during the preschool teacher workshop to introduce teachers to the program. Inservice institutes for one session per week are very desirable for factual information.

Assessing the

A cognitive appraisal of family life
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guidelines,[5] will help the classroom te
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and sex education regarding attitudes

1. Extent of interpersonal relationsh
2. Extent of overt sexual behavior
3. Extent of covert sexual behavior
4. Choice of reading materials
5. Choice of free-time activities
6. Type of behavior in lavatories
7. Reaction to classroom discussion
8. Participation in discussions
9. Discretion employed in speech, d
10. Amount of self-discipline
11. Correct use of terminology
12. Responsibility to self and for oth
13. Frequency of pornography broug
14. Incidence of toilet markings with
15. Degree of respect for and coope posite sex

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Scope and Sequence

The suggested content of the prog
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[4]*Guidelines for Developing School Programs in Sex Education.* New Jersey State Department of Education, 1967. pp. 14-16.

[5]*Ibid.*, p. 36.

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eservice Education

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Assessing the Program

A cognitive appraisal of family life and sex education is a relatively common and comparatively simple process. However, this type of appraisal is important only to the degree that knowledge influences attitudes and behavior. The following criteria, suggested in the New Jersey guidelines,[8] will help the classroom teacher and parents to determine the effectiveness of an organized instructional program in family life and sex education regarding attitudes and behavior.

1. Extent of interpersonal relationships with peers
2. Extent of overt sexual behavior
3. Extent of covert sexual behavior
4. Choice of reading materials
5. Choice of free-time activities
6. Type of behavior in lavatories
7. Reaction to classroom discussion
8. Participation in discussions
9. Discretion employed in speech, dress, and behavior
10. Amount of self-discipline
11. Correct use of terminology
12. Responsibility to self and for others
13. Frequency of pornography brought into class
14. Incidence of toilet markings with obscene theme
15. Degree of respect for and cooperation with members of the opposite sex

Significant evaluation of the family life and sex education program may be possible only after the passing of many years when the effects of wholesome sexuality attitudes are reflected in the success of these students in rearing their own children.

Scope and Sequence for Grades K-12

The suggested content of the program is organized by grade levels, that is, primary, intermediate, junior high school, and senior high

g School Programs in Sex Education. New Jersey State Department of Education, 1967. pp. 14-16.

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school. Flexibility has been allowed for school districts to determine the specific grades or subjects in which the content is to be emphasized.

Eight goals have been identified to focus emphasis on the many aspects of a comprehensive family life and sex education program. However, school districts may want to combine the content for certain goals into one unit of instruction. Certain goals may be emphasized more at one grade level than at another.

Reference Materials

Suggested reference materials have been listed for each grade level. The materials have been classified as printed resources (student books, professional books, charts, pamphlet
visual resources (filmstrips, transpare

The references for each grade leve
that section, have been numbered so t
can be made in the "Resources" colu

In the sections for primary grades
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under the particular goal. In the sec
senior high school, the numbers refe
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The references for each grade level, located in the closing pages of that section, have been numbered so that referrals to specific materials can be made in the "Resources" column.

In the sections for primary grades and elementary grades, the numbers apply to all points listed in the "Learning Experiences" column under the particular goal. In the sections for junior high school and senior high school, the numbers refer only to specific points in the "Learning Experiences" column.

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Suggested Long-Range Behavior Goals

The suggested teaching generalizations for each grade level are based upon the long-range behavior goals for family life and sex education. These goals are necessary if we are to know where we are going; otherwise, we are concerned chiefly with the short-range objectives. By the completion of the 12th grade, each individual to the limits of his capacity should:

1. Acquire a maturing self-image which enables the individual to live out his sexuality in a responsible and creative way as a male or female
2. Understand the nature and purpose of the family as the basic unit in society and the roles played by the family and its members
3. Demonstrate a pattern of relationships based upon insight and understanding of one's obligations and responsibilities to himself and others
4. Understand the influences on sexuality of political, philosophical, religious, and cultural ideologies including beliefs, customs, and laws in a pluralistic society
5. Develop and employ a personal code of ethics which recognizes that human values and beliefs vary among different groups and individuals within a pluralistic society
6. Accept a personal responsibility for positive and constructive influences on society's concerns for family living and sexuality
7. Employ suitable and effective communication about human sexuality in various situations and settings
8. Understand anatomical, physiological, psychological, and sociological maturation as related to human sexuality

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Scope and Sequence for Family Life and Sex Education

PRIMARY GRADES

6/7

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Introduction

Philosophy

An increasingly complex society is making increasingly complex demands upon children and youth in family life and sex education. Our society has stimulated young people to reach an early superficial maturity. The blatant sex in society has its impact through mass media which contributes little to the development of desirable attitudes. This has caused a greater need for guidance and education to foster correct information and desirable attitudes, behavior, and values in human sexuality. The basic issue is not whether or not Minnesota children and youth should have family life and sex education — they will receive it one way or another. The basic issue is whether they receive it from their peer group, from the street, and from experience alone or whether they get it from the home, church, and school working cooperatively.

The dignity of the person requires that each individual receive an education in family life and sex education. Helping individuals attain maturity in human sexuality and to understand human sexuality is a privilege and responsibility of every age. Parents have the prime responsibility for the inculcation of moral values to their children, but the school needs to support and supplement the parents. One way to provide a more meaningful life experience is to provide school children with an opportunity to come to grips with the problems and issues inherent in family life and sexual behavior before they become problems to the individual and society and before the individual is faced with situations for which he is not equipped to make desirable and socially acceptable judgments.

Education for family life and sex education, in its broadest form, is concerned not only with physical relations but, more importantly, with emotional and social interrelationships. Within this context, these guidelines are provided as an initial step to strengthen instruction in wholesome attitudes and respect for all cultures in the area of family life and sex education and to focus attention on the understanding of the self within the context of human growth and development.

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[1]"The Growing Toll of America's 'Broken Homes.'" *U.S. News and World Report*, Vol. LVX, No. 6 (August 5, 1968), 92.

[2]*Ibid.*, 93.

[3]*School Health Education Study*, Summary Report of a Nationwide Study of Health Instruction in the Public Schools. 1964. Scho
16th St. N.W., Washington, D.C. 20036. p. 39.

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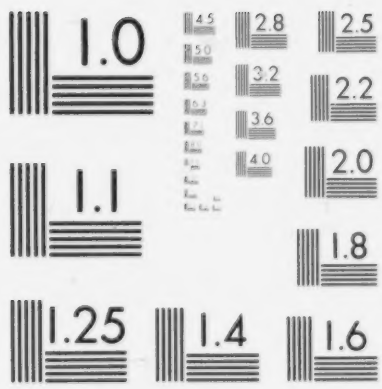

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Introduction

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The Need

Young people are growing up in a pluralistic, democratic society wherein many traditional cultural patterns and standards are being challenged. They need help and guidance in relation to current problems, issues, and sociocultural conditions related to sexual conduct and behavior.

Home and family living needs to be strengthened in our society. Teenage marriages have increased at a rapid rate, with three fourths of them breaking up. There is also an upward trend in the number of divorces granted for the population as a whole. *U.S. News and World Report* magazine states that "More than 7 million children under 18, or about 1 in 10, are being raised in fatherless homes."[1] The magazine goes on to report that, according to sociologists and psychiatrists, "Boys can suffer much emotional damage if there is no 'male model' on which to pattern themselves."[2]

Accurate information from reliable sources is necessary if children and youth are to successfully cope with the pressures of today's society. However, a national survey on school health education practices reported that "Questions about sex asked by fifth and sixth grade children in anonymous surveys reflect distorted facts and a need for accurate information."[3]

Every community has some type of a family life and sex education program, but it is the responsibility of concerned citizens to determine the quality of it.

Implementation

The public school must assert leadership in the community relative to implementing a comprehensive family life and sex education program. School boards, school administrators, and teachers need to become involved with parents, churches, and other community agencies

' *U.S. News and World Report*, Vol. LVX, No. 6 (August 5, 1968), 92.

of a Nationwide Study of Health Instruction in the Public Schools. 1964. School Health Education Study, 1201

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to gain support and acceptance of the program. However, the school cannot wait until all citizens are ready before inaugurating this necessary curricular development.

It is recommended that the board of education and superintendent initiate a family life and sex education program by organizing a citizens' committee composed of educators, clergymen, representatives of the medical field, members of the school board, and members of the P.T.A. All aspects of the program should be studied, including:

1. Community needs and attitudes (A poll or survey should be taken for future reference.)
2. Student needs and attitudes
3. Reference materials and curriculum guides available

One educator should be given authority and time to direct and coordinate this committee work. The committee should recommend an appropriate course of action to the board of education relative to curriculum development.

After the board of education has endorsed the program, the same committee or a separate committee of educators should develop a sequential and coordinated program (vertical and horizontal) for grades K-12, based upon these guidelines. A summer writing team will facilitate curriculum development. Emphasis should not only be given to the physiological aspects of sexuality, but to the psychological, sociological, and economic aspects as well. These curriculum experiences should be integrated into specific and appropriate courses at all grade levels. However, there is a need to consider the merits of a separate course on family living for 11th or 12th grade pupils with special emphasis on preparation for marriage, parenthood, and family life.

The nature of the program dictates that boys and girls be scheduled together as a general practice if it is to be most meaningful and effective and considered a part of the regular curriculum. However, occasionally it may be desirable to schedule boys and girls separately to discuss specific aspects of body cleanliness. Team teaching can provide for effective staff utilization in emphasizing the various aspects of the program.

The approach to implementing the program into the curriculum may vary in each school district. However, it is vital for parents to be involved if the school is to support and supplement the home. A district should give consideration to the approach that will enable it to establish a successful and meaningful program. The pilot teacher plan and district-wide plan are examples of implementation procedures.

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Pilot Teacher Plan. Select teachers at each grade level who have a high level of interest, insight, understanding, empathy, and knowledge and who can help pupils develop healthy moral attitudes. These teachers will evaluate the program at the conclusion of the year and prepare a revised curriculum for implementation the second year. Inservice education is provided for all teachers.

District-Wide Plan. All teachers are urged to become involved in teaching family life and sex education. The recommended content is taught sometime during the school year. Inservice education is provided prior to beginning the program.

General Suggestions for Teachers

The instructor should at all times be strictly honest in all statements, ready to encourage and to answer all legitimate questions, and careful to distinguish fact from belief or interpretation.

The personality of the instructor, the manner in which he imparts information, and the degree of confidence which students have in him are as important as what he says in formulating the ideals of his students.

Controversial Issues

Certain areas of family life and sex education are controversial and need special precautions. These areas and precautions are as follows:

1. Sexual techniques should not be included in the program.
2. Sexual perversion should not be included as a major topic. However, it is desirable that appropriate instruction be given to protect children and youth against sexual deviates.
3. Birth control is a very sensitive area. Birth control methods may be discussed, but advocating types of birth control should not be included in the program. This is a responsibility of the parents and church.

Children and youth may express specific deviate behavior related to sexual behavior by either direct question or teacher observation. Teachers should refer these pupils to other specially trained personnel for followup work and consultation, rather than jeopardize the welfare of the particular pupil and of the rest of the class.

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Preservice Education

Teacher education institutions have an important role in the development of an effective family life and sex education program. The following levels of preparation are recommended.

1. All elementary and secondary school teachers should have at least a basic course in family life and sex education.
2. Special preparation for secondary school health, home economics, science, and social studies should consist of 9 credits in family life and sex education.
3. A family life educator should have at least a minor in family life. This educator could serve as a school district consultant.

Inservice Education

Inservice education is a continuing process. Parents, as well as teachers, can benefit from such a program. It would be desirable to have teachers enroll in at least one course or workshop in family life and sex education. However, if this is not feasible the following areas, suggested in the New Jersey *Guidelines for Developing School Programs in Sex Education,*[4] should be included in a local inservice program.

1. Need for the program
2. Concept of human sexuality
3. Psycho-sexual development
4. Reproduction
5. Relationships of heredity and environment
6. Preparation for marriage and the family
7. Special topics such as venereal disease, homosexuality, masturbation, and illegitimacy
8. Family life and sex education curriculum content and resources

Inservice education can be held during the preschool teacher workshop to introduce teachers to the program. Inservice institutes for one session per week are very desirable for factual information.

Assessing

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10. Amount of self-discipline
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12. Responsibility to self and f
13. Frequency of pornography
14. Incidence of toilet marking
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[4]*Guidelines for Developing School Programs in Sex Education.* New Jersey State Department of Education, 1967. pp. 14-

[5]*Ibid.*, p. 36.

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Assessing the Program

A cognitive appraisal of family life and sex education is a relatively common and comparatively simple process. However, this type of appraisal is important only to the degree that knowledge influences attitudes and behavior. The following criteria, suggested in the New Jersey guidelines,[5] will help the classroom teacher and parents to determine the effectiveness of an organized instructional program in family life and sex education regarding attitudes and behavior.

1. Extent of interpersonal relationships with peers
2. Extent of overt sexual behavior
3. Extent of covert sexual behavior
4. Choice of reading materials
5. Choice of free-time activities
6. Type of behavior in lavatories
7. Reaction to classroom discussion
8. Participation in discussions
9. Discretion employed in speech, dress, and behavior
10. Amount of self-discipline
11. Correct use of terminology
12. Responsibility to self and for others
13. Frequency of pornography brought into class
14. Incidence of toilet markings with obscene theme
15. Degree of respect for and cooperation with members of the opposite sex

Significant evaluation of the family life and sex education program may be possible only after the passing of many years when the effects of wholesome sexuality attitudes are reflected in the success of these students in rearing their own children.

Scope and Sequence for Grades K-12

The suggested content of the program is organized by grade levels, that is, primary, intermediate, junior high school, and senior high

in Sex Education. New Jersey State Department of Education, 1967. pp. 14-16.

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school. Flexibility has been allowed for school districts to determine the specific grades or subjects in which the content is to be emphasized.

Eight goals have been identified to focus emphasis on the many aspects of a comprehensive family life and sex education program. However, school districts may want to combine the content for certain goals into one unit of instruction. Certain goals may be emphasized more at one grade level than at another.

Reference Materials

Suggested reference materials have been listed for each grade level. The materials have been classified as printed resources (student books, professional books, ch
visual resources (films

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Suggested Long-Range Behavior Goals

The suggested teaching generalizations for each grade level are based upon the long-range behavior goals for family life and sex education. These goals are necessary if we are to know where we are going; otherwise, we are concerned chiefly with the short-range objectives. By the completion of the 12th grade, each individual to the limits of his capacity should:

1. Acquire a maturing self-image which enables the individual to live out his sexuality in a responsible and creative way as a male or female
2. Understand the nature and purpose of the family as the basic unit in society and the roles played by the family and its members
3. Demonstrate a pattern of relationships based upon insight and understanding of one's obligations and responsibilities to himself and others
4. Understand the influences on sexuality of political, philosophical, religious, and cultural ideologies including beliefs, customs, and laws in a pluralistic society
5. Develop and employ a personal code of ethics which recognizes that human values and beliefs vary among different groups and individuals within a pluralistic society
6. Accept a personal responsibility for positive and constructive influences on society's concerns for family living and sexuality
7. Employ suitable and effective communication about human sexuality in various situations and settings
8. Understand anatomical, physiological, psychological, and sociological maturation as related to human sexuality

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Scope and Sequence for Family Life and Sex Education

PRIMARY GRADES

6/7

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Goal I: To acquire a maturing self-image which enables the individual to live out his s as a male or female

Concept A: Relationship of an individual's sexuality to his tal personality develop

GENERALIZATIONS	LEARNING EXPERIENCES	RESOU
1. Liking and accepting oneself as an individual is basic to the development of a healthy personality.	1. Discuss meaning of personality and traits.	PRINTED: 1, 8, 1 24a, 26a
2. Personality is influenced by one's sex.	2. Role-play activities which show a pleasant personality such as happiness, kindness, sense of humor, consideration for others, and sharing; and an unpleasant personality such as irritability, selfishness, unkindness, and poor manners.	AUDIO-VISUAL:
3. Boys and girls are similar and different physically, emotionally, socially, and mentally.	3. Have each child describe his strengths and ways he can improve himself.	
4. Each one has a unique personality which is shown by behavior and feelings.	4. Have each child write, discuss, or explain what he or she likes about being a boy or girl.	
5. Diversity must be respected, not just tolerated.	5. Explore different and similar behavior in sexes from the standpoint of interests, abilities, activities, and personality traits. Example: Boys who want to be like father learn the masculine role, and girls who want to be like mother learn the feminine role.	
6. Recognizing and improving strengths and overcoming shortcomings contribute to the development of a healthy personality.	6. Motivate children to select models whom they admire and would want to be like.	
7. One's self-image and feelings of self-worth result from the extent to which physical and emotional needs are met or unmet.	7. Demonstrate ways personality of boys and girls are different in manners, interests, and behavior.	
8. Expression of feelings or emotions can be constructive or destructive to self and others; feelings are expressed by action and words; feelings help one learn about oneself.	8. Discuss basic needs such as security, love, and the need to belong. Have children describe ways these needs are met and how the meeting of these needs helps one develop respect for oneself and others.	

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of an individual's sexuality to his total personality development

LEARNING EXPERIENCES	RESOURCES	EVALUATION
1. Discuss meaning of personality and traits.	PRINTED: 1, 8, 13, 14, 20, 22, 24a, 26a	1. Observe improvement in behavior of children as they gain more understanding of the reasons for treating others and self with respect and consideration.
2. Role-play activities which show a pleasant personality such as happiness, kindness, sense of humor, consideration for others, and sharing; and an unpleasant personality such as irritability, selfishness, unkindness, and poor manners.	AUDIO-VISUAL: 3, 4a	2. Observe improvements in vocabulary.
3. Have each child describe his strengths and ways he can improve himself.		3. Check on children's understanding of likes and differences of boys and girls in terms of roles in life, interests, and activities.
4. Have each child write, discuss, or explain what he or she likes about being a boy or girl.		4. Realizes that each one can choose activities which appeal to his interests.
5. Explore different and similar behavior in sexes from the standpoint of interests, abilities, activities, and personality traits. Example: Boys who want to be like father learn the masculine role, and girls who want to be like mother learn the feminine role.		5. Note type of models children choose.
6. Motivate children to select models whom they admire and would want to be like.		6. Shows growth in use of proper manners.
7. Demonstrate ways personality of boys and girls are different in manners, interests, and behavior.		7. Realizes that there are activities which boys like to do with boys and girls with girls, as well as activities boys and girls enjoy together.
8. Discuss basic needs such as security, love, and the need to belong. Have children describe ways these needs are met and how the meeting of these needs helps one develop respect for oneself and others.		8. Note improvement in children in feelings of self-worth and trust as certain basic needs are met.

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
9. Living healthfully and maintaining body cleanliness help one feel good.	9. Ask children to tell how behavior of boys and girls is learned.	
10. It is normal to be curious about sexual differences.		
11. Modesty in act, speech, or dress is behaving according to what is proper and acceptable in our society.		

Goal II: To understand the nature and purpose of the family as the basic unit in society a its members

Concept B: Family's role in human sexuality

1. The family is the basic unit in our society.	1. Discuss what a family is, how it begins, and how it maintains itself as a family unit.	PRINTED: 2, 7, 9, 17, 2
2. A group of persons living in the household is a family.	2. Have children draw pictures of various families, noting that there are many kinds of families such as one parent, two parents, large and small, adoptions, stepfather and stepmother, and foster parents. Bring out positive aspects of each kind of family.	AUDIO-VISUAL: 1a, 3,
3. Families differ and there are many kinds of families.	3. Have each child develop a family tree of the immediate social family. (Not necessarily genetic. Use good judgment in using this experience.)	
4. Most families include a man and woman who marry, love each other, and want and have children. (Teacher has to be sensitive to student needs.)	4. Develop and use "All About Me" data sheet.	
5. A child identifies with the parent's role he would like to take, ie., boy wants to be like father's image, girl wants to be like mother's image.	5. Draw pictures and explain how one's responsibility in the family changes as one grows older.	

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EARNING EXPERIENCES	RESOURCES	EVALUATION
x children to tell how behavior of s and girls is learned.		9. Observe willingness of children to try tasks again and again until some satisfaction has been achieved. 10. Awareness that masculine and feminine behavior is copied or imitated from those the person is with the most or admires.

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cuss what a family is, how it ins, and how it maintains itself as mily unit. ve children draw pictures of ious families, noting that there many kinds of families such as parent, two parents, large and ll, adoptions, stepfather and mother, and foster parents. ng out positive aspects of each d of family. ve each child develop a family of the immediate social family. t necessarily genetic. Use good gment in using this experience.) velop and use "All About Me" a sheet. w pictures and explain how one's onsibility in the family changes ne grows older.	PRINTED: 2, 7, 9, 17, 27a AUDIO-VISUAL: 1a, 3, 4a	1. Appreciates differences in families and values own family. 2. Willingness to take responsibility for one's role in the family. 3. Accepts authority of parents or guardians by obeying rules and accepting standards. 4. Growth in realizing function and purpose of the family. 5. Realizes how the family prepares for, cares for, loves, and wants the new baby. 6. Recognizes that discipline and respect are important factors in family living.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOUR
6. Family living can prepare one for life in a democratic society, each one expressing his point of view but abiding by rules and respect for authority.	6. Dramatize roles of various family members.	
7. Each member of the family is an important, contributing member with various roles and responsibilities, including the world of work.	7. Invite mothers with newborn babies to visit the classroom to discuss baby care.	
8. Parents or guardians are responsible for the health and well-being of family members.	8. Have children draw pictures of ways they can help at home and what parents do for their children.	
9. Love, security, companionship, and protection are provided to most children by their family.	9. Discuss the meaning of love within the family and ways it is shown by parents and children.	
10. Children are dependent upon parents or guardians for a long period of time.	10. Have children discuss what they know about feminine and masculine behavior. Explore the sources of influences. Review merits of being a boy or girl.	
11. Parents or guardians should expect certain things from their children and children, in turn, should expect certain things from their parents or guardians.	11. Read stories about various kinds of families; help children realize that every family has happy times, sad times, quarrels, and problems to face and solve. Stress the importance of all working together and that each one doing his part makes for a better family.	
12. There are many kinds of love such as maternal, paternal, and sibling.	12. Study ways of planning for the arrival of a baby and how it is cared for after birth. Have children tell ways they help at home. Use film or draw pictures which show ways children help.	
13. One needs to realize that the development of one's talents during school years is important for preparation for the world of work.	13. Discuss health care of the mother; why the mother goes to the hospital to have the baby.	
	14. Review and explain meaning of love, particularly maternal, paternal, and sibling love. Have children tell ways that love is shown in the family and what they do to show love to their parents, brothers, and sisters. Read	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Dramatize roles of various family members.		7. Realizes that family loyalty, respect, and love can result when each member carries out duties and responsibilities.
Invite mothers with newborn babies to visit the classroom to discuss baby care.		8. Shows evidence of helping at home and being a better family member.
Have children draw pictures of ways they can help at home and what parents do for their children.		9. Development of attitudes and activities which help make the home a more pleasant place.
Discuss the meaning of love within the family and ways it is shown by parents and children.		
Have children discuss what they know about feminine and masculine behavior. Explore the sources of influences. Review merits of being a boy or girl.		
Read stories about various kinds of families; help children realize that every family has happy times, sad times, quarrels, and problems to face and solve. Stress the importance of all working together and that each one doing his part makes for a better family.		
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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
	stories or poems, discuss pictures. Have children draw pictures of how they show love to family members.	
	15. Dramatize the importance of discipline, respect, and authority in the family.	
	16. Make a list of things parents expect from children and a list of things children expect from parents.	
	17. Role-play or draw pictures of the ways each one can help develop good relations with brothers and sisters. Example: courtesy and kindness.	
	18. Discuss ways by which the family helps children keep healthy, develop correct health and safety practices, and learn about the meaning of sexuality.	

Goal III: Demonstrate a pattern of relationships based upon insight and understanding of one's to himself and others

Concept C: Effective interpersonal relationships

1. Proper manners and actions of boys and girls may be alike and may be different in various situations.	1. Role-play proper manners of young people toward adults, boys and girls toward each other, and individuals toward group members in family, school, and community. Include how to accept and refuse invitations from friends.	PRINTED: 1, 2, 3, 4, 12, 18 AUDIO-VISUAL: 1b, 2b, 6c
2. Proper manners show respect for oneself and others.	2. Provide reading and research materials on the history of reasons (such as safety, respect, and protection) for many present-day manners.	
3. Actions tell a great deal about one's respect for self and others.	3. Give examples of how one's actions show respect or disrespect for others, and discuss ways to improve one's actions.	

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RNING EXPERIENCES	RESOURCES	EVALUATION
s or poems, discuss pictures. children draw pictures of how how love to family members.		
atize the importance of line, respect, and authority in mily.		
a list of things parents expect children and a list of things en expect from parents.		
lay or draw pictures of the each one can help develop good ns with brothers and sisters. ple: courtesy and kindness.		
ss ways by which the family children keep healthy, develop t health and safety practices, arn about the meaning of ity.		

ionships based upon insight and understanding of one's obligations and responsibilities

onships

lay proper manners of young toward adults, boys and girls l each other, and individuals l group members in family, , and community. Include how ept and refuse invitations from s.	PRINTED: 1, 2, 3, 4, 12, 18 AUDIO-VISUAL: 1b, 2b, 6c	1. Shows evidence of growth in cooperation and in respect for others. 2. Observe improvement of socialization in group activities.
le reading and research als on the history of reasons as safety, respect, and protec- for many present-day manners.		3. Look for signs of positive feelings, such as happiness when things go right with self and others.
xamples of how one's actions respect or disrespect for others, scuss ways to improve one's s.		4. Evidence of respect for own and other sex. 5. Demonstration of proper manners.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURC
4. Personal satisfaction is gained from giving, sharing, trusting, helping, enjoying, liking, and being courteous to others.	4. Review meaning of sharing, trusting, and courtesy. Role-play or dramatize situations which involve children using these skills.	
5. An individual's feelings toward others affect the way he treats them.	5. Creative Writing: "How Can I Improve My Actions Toward Others?"	
6. Expressing negative feelings without feeling guilty or causing others to be hurt should improve with maturity.	6. Briefly discuss the meaning of emotions and how they affect others as well as self. Give examples of positive feelings and negative feelings and how they are expressed. Have children keep a record of the things they did for others which made them feel good and why.	
7. Admitting error and apologizing when one makes mistakes contribute to good interpersonal relations.	7. Dramatize ways to express negative feelings without hurting others or making one feel guilty or unhappy.	
8. One should recognize that one cannot always have his own way.	8. Read case studies or stories in which a child made a mistake and how he handled it. Dramatize ways to apologize and admit error for one's mistakes.	
9. Choice of behavior can be kind or unkind, safe or dangerous, fair or unfair, depending upon one's concern and respect for self and others.	9. Examine the difference between "always wanting your own way" and obeying rules and standards set up by family and school. Give examples of the meaning of "give and take." Role-play situations involving "always wanting your own way."	
10. Selecting and keeping friends and maintaining one's integrity are essential.	10. Draw pictures showing how choice of behavior shows concern and respect for self and others. Example: behavior in safety, manners, and treatment of others.	
11. Caring for others, being trustworthy, and showing responsibility are signs of a desire to help others.	11. Establish standards to guide choices of proper behavior. Examine meaning of friendships, characteristics of good friends, false friends, dangerous friends, and strangers. (Avoid discussing or describing perversion	
12. Good grooming, neatness, and cleanliness are important to being accepted by others.		

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
4. Review meaning of sharing, trusting, and courtesy. Role-play or dramatize situations which involve children using these skills.		6. Is willing to take turns, share, and help others.
5. Creative Writing: "How Can I Improve My Actions Toward Others?"		7. Shows improvement in cooperation, committee work, and project work.
6. Briefly discuss the meaning of emotions and how they affect others as well as self. Give examples of positive feelings and negative feelings and how they are expressed. Have children keep a record of the things they did for others which made them feel good and why.		8. Realizes importance of fulfilling individual responsibilities in group activities.
7. Dramatize ways to express negative feelings without hurting others or making one feel guilty or unhappy.		9. Realization that using good manners is a sign of growth and respect for others.
8. Read case studies or stories in which a child made a mistake and how he handled it. Dramatize ways to apologize and admit error for one's mistakes.		10. Set up situations in which children are approached by a stranger. Have children role-play their behavior. Evaluate in terms of standards set up in class.
9. Examine the difference between "always wanting your own way" and obeying rules and standards set up by family and school. Give examples of the meaning of "give and take." Role-play situations involving "always wanting your own way."		11. Have children evaluate situations in which they receive invitations from other pupils and persons they know.
10. Draw pictures showing how choice of behavior shows concern and respect for self and others. Example: behavior in safety, manners, and treatment of others.		12. Check on children's understanding of reasons why it is unwise to take gifts from strangers.
11. Establish standards to guide choices of proper behavior. Examine meaning of friendships, characteristics of good friends, false friends, dangerous friends, and strangers. (Avoid discussing or describing perversion		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
13. Enjoyment of solitary and group activities, as well as receiving satisfaction from creative and original activities, is normal.	or sex molesting.) Motivate children to discuss standards of behavior with parents or guardians. From this discussion, summarize qualities of a good friend. Plan a discussion around the questions: a. Can we tell a good friend by appearance? b. How are you going to select your friends? c. How are you going to behave toward false friends and strangers? 12. Encourage children to report unusual situations to parents or teacher. Example: advances of older children, friends, or strangers to participate in sexual activities or improper conduct. 13. Establish rules and guidelines for selecting good friends and avoiding false friends and dangerous strangers. 14. Role-play ways by which children can help others. 15. Develop good grooming standards; dramatize importance of neatness and cleanliness in being pleasing to others. (Avoid embarrassment of children and stress things everyone can do regardless of individual differences and circumstances.) 16. Ask children to complete sentences or tape-record answers to the following: Happiness is _____ I feel good when_____ A good friend is _____ I wish_____	

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Goal IV: To understand the influences on sexuality of political, philosophical, re
liefs, customs, and laws in a pluralistic society

Concept D: Factors affecting society's values on sexuality

GENERALIZATIONS	LEARNING EXPERIENCES	RES
1. In our society, families with similar and different religious beliefs, ways of behaving, customs, resources, standards, and values can get along together.	1. Review the meaning of a family and various kinds of families. Help children understand the meaning of "uniqueness" and "differences" and "similarities" when describing a family. Ask each child to write a paragraph about the customs and beliefs of his family in connection with rules and regulations within his family. Summarize and discuss similarities and differences. Have children discuss the questions: "How do children from families with different beliefs learn to get along together?" "What is the meaning of respecting rights of self and others?"	
2. The kind of behavior learned in the family affects the way one behaves in the school and community.	2. Role-play ways to maintain own standards of behavior and resist pressure from others.	
3. Boys and girls usually desire to adopt patterns and behavior in keeping with their sex role in the culture.	3. Dramatize how behavior learned at home helps one get along well in school and community. Example: responsibility, tolerance, respect for self and others, courtesy, modesty, and behavior in classroom and in public.	
4. The family, school, community, and nation have rules and standards which help to guide and to direct individual behavior.	4. Discussion Questions: "How is family living similar to and different from school and community living?" (Example: responsibility and authority.) "Does freedom mean to do as you please?" "What does responsibility mean?"	
5. Changes in the pattern for family life have increased.	5. Compare present-day family living to that of the pioneers. Project living into the future.	
6. Families who are not able to properly provide for children's needs sometimes need assistance.		
7. People in various parts of the world have different manners, ways of dressing, responsibilities to the family, sex roles, amounts of freedom, and language.		

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nd the influences on sexuality of political, philosophical, religious, and cultural ideologies including be-
ns, and laws in a pluralistic society

ffecting society's values on sexuality

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
1. Review the meaning of a family and various kinds of families. Help children understand the meaning of "uniqueness" and "differences" and "similarities" when describing a family. Ask each child to write a paragraph about the customs and beliefs of his family in connection with rules and regulations within his family. Summarize and discuss similarities and differences. Have children discuss the questions: "How do children from families with different beliefs learn to get along together?" "What is the meaning of respecting rights of self and others?"		1. Accepts rights of others in our society to believe and behave differently.
2. Role-play ways to maintain own standards of behavior and resist pressure from others.		2. Shows growth in tolerance and understanding of others.
3. Dramatize how behavior learned at home helps one get along well in school and community. Example: responsibility, tolerance, respect for self and others, courtesy, modesty, and behavior in classroom and in public.		3. Acceptance of guidance and authority of trustworthy personnel in school and community.
4. Discussion Questions: "How is family living similar to and different from school and community living?" (Example: responsibility and authority.) "Does freedom mean to do as you please?" "What does responsibility mean?"		4. Awareness of the many ways families are helped by community agencies.
5. Compare present-day family living to that of the pioneers. Project living into the future.		5. Awareness of the different behavior of boys and girls in other countries.
		6. Understands that most family, school, and community rules protect one's health and safety and should be obeyed.
		7. Has ability to express feelings about differences in customs of families and is able to participate in arriving at reasonable decisions when suitable.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
8. Behavior of boys and girls is acquired from what their family, community, and nation expect of them.	6. Investigate community helpers (such as welfare and health) and how they help families in need. 7. Explore meaning of customs; compare dress, manners, and activities of boys and girls in this country to those of other countries. 8. Read stories about families of the world; compare the various family customs and the sex roles of members of other families with those of the American family.	

Goal V: To develop and employ a personal code of ethics which recognizes that human values a groups and individuals within a pluralistic society

Concept E: A code of sexual behavior as part of a total value system

1. Each one can develop controls to guide his behavior in order to avoid hurting others or getting into trouble. 2. Each one has acquired a set of values which may be similar and different from those of others. 3. Respect for rules of behavior is basic to the success of cooperative group work. 4. Development of a set of positive values helps one make wise choices and helps to establish standards which influence them. 5. Moral values of societies and families differ according to what is considered "right or wrong" by each one.	1. Discuss the meaning of values, judgment, and choices of behavior controls. Encourage children to give examples of actions or objects they value and why. 2. Provide reading which helps children to select good models from which to pattern behavior and acquire values. 3. Creative Writing or Taped Discussion: "How Do I Know Right from Wrong?" (Teacher needs to use judgment in discussing information.) 4. Establish controls to guide behavior so as not to hurt others. 5. Role-play: "Making Sound Choices in Various Situations." 6. Discuss importance of getting help in making behavior choices. 7. Examine ways our values show respect for ourselves and others.	PRINTED: 4, 13, 18, 19 AUDIO-VISUAL: 3, 4a

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
6. Investigate community helpers (such as welfare and health) and how they help families in need.		
7. Explore meaning of customs; compare dress, manners, and activities of boys and girls in this country to those of other countries.		
8. Read stories about families of the world; compare the various family customs and the sex roles of members of other families with those of the American family.		

oy a personal code of ethics which recognizes that human values and beliefs vary among different ls within a pluralistic society

behavior as part of a total value system

1. Discuss the meaning of values, judgment, and choices of behavior controls. Encourage children to give examples of actions or objects they value and why.	PRINTED: 4, 13, 18, 19 AUDIO-VISUAL: 3, 4a	1. Look for improvement in value judgment in ways children deal with each other.
2. Provide reading which helps children to select good models from which to pattern behavior and acquire values.		2. Observe increasing ability to improve value judgments.
3. Creative Writing or Taped Discussion: "How Do I Know Right from Wrong?" (Teacher needs to use judgment in discussing information.)		3. Observe acquisition of a set of values.
4. Establish controls to guide behavior so as not to hurt others.		4. Understands meaning of "value" for age level.
5. Role-play: "Making Sound Choices in Various Situations."		
6. Discuss importance of getting help in making behavior choices.		
7. Examine ways our values show respect for ourselves and others.		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
6. One develops or acquires values, standards, and behavior from a variety of sources—from being with and copying others and from how one is rewarded or punished by society, parents, other children, or other adults.		
7. Values direct limits to one's behavior relative to oneself and others.		
8. Individuals can have different values and still be accepted members of society.		

Goal VI: To accept a personal responsibility for positive and constructive influences on societ sexuality

Concept F: Individual obligation and group responsibility regarding family living

1. Safety, health, and behavior guides and rules are established to prevent harm to oneself and to others.	1. Include correct vocabulary that is necessary.	PRINTED: 2, 3, 7, 8, 10, 17, 28a
2. It is important to seek help with problems, questions, and fears from trustworthy persons.	2. Explain proper manners and actions in the lavatory. Examples: allowing for privacy, flushing the toilet, reason for different positions of boys and girls when urinating, leaving the toilet clean and neat, and washing hands.	AUDIO-VISUAL: 1a, 1b, 4a, 6b
3. Community agencies help families and individuals in many ways.	3. Develop a proper set of guidelines for bathroom procedures from standpoint of health, modesty, privacy, and proper conduct. Include proper vocabulary.	
4. One's example may influence others.	4. Tour the school building, including the boys' and girls' lavatories.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
esponsibility for positive and constructive influences on society's concerns for family living and		
n and group responsibility regarding family living		
1. Include correct vocabulary that is necessary.	PRINTED: 2, 3, 7, 8, 10, 17, 28a	1. Note improved vocabulary.
2. Explain proper manners and actions in the lavatory. Examples: allowing for privacy, flushing the toilet, reason for different positions of boys and girls when urinating, leaving the toilet clean and neat, and washing hands.	AUDIO-VISUAL: 1a, 1b, 4a, 6b	2. Observe use of correct toilet manners and behavior.
3. Develop a proper set of guidelines for bathroom procedures from standpoint of health, modesty, privacy, and proper conduct. Include proper vocabulary.		3. Observe number of children who ask for help with problems, fears, and questions regarding sexuality.
4. Tour the school building, including the boys' and girls' lavatories.		4. Observe increased individual responsibility for keeping lavatories clean and neat.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
5. Each individual should contribute and be responsible to family, school, and community living.	5. Discuss importance of proper bathroom practices to the welfare of self and to others.	
6. Teamwork contributes to a pleasant, healthy environment.	6. Provide opportunities for children to talk freely with parents, teacher, and policemen.	
7. Each one has a desire for and a right to privacy in certain situations and at certain times.	7. Invite doctor or nurse to discuss ways to prevent spread of diseases by following proper personal habits, including toilet habits.	
	8. Discussion Topics: a. Ways to set good examples in actions, manners, speech, and appearance. b. Examples of what could happen when poor examples are set.	
	9. Discuss various safety rules in games, traffic, and fire prevention. Compare these with importance of safety in personal conduct such as walking on lighted streets.	
	10. Point out that obedience to safety rules shows that children are becoming people who can direct and be responsible for their own behavior.	
	11. Examine ways children can help with health and safety activities in the home.	
	12. Discuss each one's responsibilities for correct behavior in the school and in public buildings.	
	13. Construct murals of children working together.	
	14. Dramatize ways to take more responsibility for one's health and safety.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
5. Discuss importance of proper bathroom practices to the welfare of self and to others.		5. Awareness of children copying and setting good examples and avoiding the copying or setting of poor examples in behavior.
6. Provide opportunities for children to talk freely with parents, teacher, and policemen.		6. Realizes each one's responsibility in preventing spread of disease and in reporting unsafe or dangerous situations to trustworthy and proper authority.
7. Invite doctor or nurse to discuss ways to prevent spread of diseases by following proper personal habits, including toilet habits.		7. Note suggestions for improving classroom and toilet procedures and willingness to take individual responsibility as a team member.
8. Discussion Topics: a. Ways to set good examples in actions, manners, speech, and appearance. b. Examples of what could happen when poor examples are set.		
9. Discuss various safety rules in games, traffic, and fire prevention. Compare these with importance of safety in personal conduct such as walking on lighted streets.		
10. Point out that obedience to safety rules shows that children are becoming people who can direct and be responsible for their own behavior.		
11. Examine ways children can help with health and safety activities in the home.		
12. Discuss each one's responsibilities for correct behavior in the school and in public buildings.		
13. Construct murals of children working together.		
14. Dramatize ways to take more responsibility for one's health and safety.		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
	Teacher Information The following special safety rules for children, taken from the book *Personal Safety and Defense for Women,* should be emphasized.[1] 1. Never take a ride with a stranger in the family car or any strange car even if he tells you your parents want you, or that your brother asked him to give you a ride home. 2. Always take a friend with you if you are selling candy, cookies, magazine subscriptions, Christmas cards, or any other items. 3. Never play in or near public restrooms, in theaters, alleys, empty buildings, or any lonely or isolated places. 4. Never go to a movie theater alone. If anyone tries to touch you, get out of your seat immediately. Tell the usher or the man in charge of the theater. Never go with such a person to the bathroom or for a ride. 5. If a stranger asks you for directions, keep your distance; and under no circumstances should you enter the car. 6. Never accept candy, ice cream, or any other items from a stranger, no matter how friendly or insistent. 7. Never go into the house or room of a stranger or casual acquaintance even if he tells you that he has something pretty or nice to give or show you. 8. If someone does try to get you or your playmate into a strange automobile, write down the license number by scratching it on the ground with a stick if you do not have a pencil or paper. Tell your parents and the police immediately. 9. Never take shortcuts that go through alleys, long dark streets, or empty lots where trees, low bushes, or tall grass are growing. 10. Never allow anyone, including friends or relatives, to touch or fondle intimate parts of your body. If someone tries to caress your body, whether you know them or not run as quickly as you can and inform your parents and the police.	

[1]Stock, F. Patricia Pechanec. *Personal Safety and Defense for Women.* Burgess, 1968. p. 48.

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LEARNING EXPERIENCES	RESOURCES	EVALUATION

Teacher Information

The following special safety rules for children, taken from the book *Personal Safety and Defense for Women,* should be emphasized.[1]

1. **Never take a ride with a stranger in the family car or any strange car even if he tells you your parents want you, or that your brother asked him to give you a ride home.**
2. **Always take a friend with you if you are selling candy, cookies, magazine subscriptions, Christmas cards, or any other items.**
3. **Never play in or near public restrooms, in theaters, alleys, empty buildings, or any lonely or isolated places.**
4. **Never go to a movie theater alone. If anyone tries to touch you, get out of your seat immediately. Tell the usher or the man in charge of the theater. Never go with such a person to the bathroom or for a ride.**
5. **If a stranger asks you for directions, keep your distance; and under no circumstances should you enter the car.**
6. **Never accept candy, ice cream, or any other items from a stranger, no matter how friendly or insistent.**
7. **Never go into the house or room of a stranger or casual acquaintance even if he tells you that he has something pretty or nice to give or show you.**
8. **If someone does try to get you or your playmate into a strange automobile, write down the license number by scratching it on the ground with a stick if you do not have a pencil or paper. Tell your parents and the police immediately.**
9. **Never take shortcuts that go through alleys, long dark streets, or empty lots where trees, low bushes, or tall grass are growing.**
10. **Never allow anyone, including friends or relatives, to touch or fondle intimate parts of your body. If someone tries to caress your body, whether you know them or not run as quickly as you can and inform your parents and the police.**

***Safety and Defense for Women.* Burgess, 1968. p. 48.**

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Goal VII: To employ suitable and effective communication about human sexuality in vari

Concept G: Effective communication

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. Use of the correct terms for body functions and parts is proper; one should not be sensitive to using them. 2. Correct terms for various body functions and parts show respect for self and others. 3. Feelings and attitudes are shown toward others by actions, facial expressions, and treatment, as well as with words. 4. Respect for one another is shown by manners, words, and actions.	Note: It is recommended that the development of a proper vocabulary should be a part of the specific learning experience to which the words pertain rather than an isolated and separate skill. Providing an atmosphere where children can talk openly about their feelings and concern is important. 1. Help pupils build a basic scientific and acceptable vocabulary for level concerned. 2. Avoid embarrassing or shaming child who uses improper terms for body functions and parts. Anticipate this by helping children learn proper words early in their school experience. Examples: lavatory, bathroom, or toilet; bowel movement and urinate. 3. Dramatize how manners and actions toward others communicate feelings and respect. 4. Role-play a given situation without use of words. Have children explain the situation with words. Summarize the many meanings of communication.	AUDIO-VISUAL: 3, 4a

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able and effective communication about human sexuality in various situations and settings

munication

LEARNING EXPERIENCES	RESOURCES	EVALUATION
Note: It is recommended that the development of a proper vocabulary should be a part of the specific learning experience to which the words pertain rather than an isolated and separate skill. Providing an atmosphere where children can talk openly about their feelings and concern is important.	AUDIO-VISUAL: 3, 4a	1. Note improvement in use of vocabulary. 2. Observe lack of shame and embarrassment in use of proper vocabulary. 3. Realize that actions express meanings to others. 4. Observe avoidance of laughing at another's mistake in word usage or actions.
1. Help pupils build a basic scientific and acceptable vocabulary for level concerned.		
2. Avoid embarrassing or shaming child who uses improper terms for body functions and parts. Anticipate this by helping children learn proper words early in their school experience. Examples: lavatory, bathroom, or toilet; bowel movement and urinate.		
3. Dramatize how manners and actions toward others communicate feelings and respect.		
4. Role-play a given situation without use of words. Have children explain the situation with words. Summarize the many meanings of communication.		

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Goal VIII: To understand anatomical, physiological, psychological, and sociological matu

Concept H: Human growth and development

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. All living things reproduce; life comes from life, and like produces like. 2. New life (and how new life begins) is a wonder. 3. There are similarities and differences in animal and human reproduction and care of the young. 4. Respect for oneself and others as human beings is important. 5. Rate of growth is different for each one, but all go through the same stages. 6. Growth is physical, mental, emotional, social, and moral. 7. Each one is unique. 8. There are both sexual differences and similarities between boys and girls. 9. Elementary anatomy and physiology of the reproductive and urinary systems should be understood. 10. The genitals are sensitive areas of the body.	1. Develop vocabulary as needed. 2. Study process of reproduction of plant and animal life. Conduct experiments with growth of various kinds of seeds, demonstrating that the new or baby plants are like the plant which produced them. Explain the importance for all living things to reproduce themselves. Introduce meaning of cell and cell growth. 3. Explain that it is necessary for humans and higher animals to have a mother and a father to begin life; this includes the human baby. 4. Examine various ways animals produce their young. Examples: hatching, being born alive. Relate to human baby, using film, filmstrip, and stories. 5. Impress upon the children the wonder of new life as one of nature's greatest miracles. 6. Examine the similarities and differences between animal and human reproduction. Use a film, filmstrip, or pictures. 7. Present in brief, simple manner how the human baby grows inside the mother, is born, and is cared for. Use transparencies and pictures. 8. Use transparencies, charts, or books to present an elementary introduction to the reproductive and urinary systems, including the sexual differences of boys and girls and the	PRINTED: 1, 2, 3, 4, 5 14, 15, 16, 17, 20, 21, 23, 24a, 25a, 26a, 26b AUDIO-VISUAL: 2a, 3 5a, 5b, 6d

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ical, physiological, psychological, and sociological maturation as related to sexuality

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Develop vocabulary as needed.	PRINTED: 1, 2, 3, 4, 5, 6, 11, 14, 15, 16, 17, 20, 21, 22, 23, 24a, 25a, 26a, 26b, 27a	1. Understands simple reproduction of living things.
Study process of reproduction of plant and animal life. Conduct experiments with growth of various kinds of seeds, demonstrating that the new or baby plants are like the plant which produced them. Explain the importance for all living things to reproduce themselves. Introduce meaning of cell and cell growth.	AUDIO-VISUAL: 2a, 3, 4a, 5a, 5b, 6d	2. Appreciation of the differences in animal and human growth and reproduction.
Explain that it is necessary for humans and higher animals to have a mother and a father to begin life; this includes the human baby.		3. Uses proper vocabulary for this level.
Examine various ways animals produce their young. Examples: hatching, being born alive. Relate to human baby, using film, filmstrip, and stories.		4. Realizes that one grows in many ways at different rates, but that all go through the same life cycle.
Impress upon the children the wonder of new life as one of nature's greatest miracles.		5. Shows respect for self and others in body care, manners, and safety.
Examine the similarities and differences between animal and human reproduction. Use a film, filmstrip, or pictures.		
Present in brief, simple manner how the human baby grows inside the mother, is born, and is cared for. Use transparencies and pictures.		
Use transparencies, charts, or books to present an elementary introduction to the reproductive and urinary systems, including the sexual differences of boys and girls and the		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	care and safety of external genitals. Impress children with the fact that kicking or striking a person's genitalia can cause injury.		
	9. Discuss the reasons why one should accept and understand parts of the body, but that certain parts of the body are private and kept covered in our society.		
	10. Examine the meaning of physical, mental, emotional, social, and moral growth. Ask each child to show or tell how he has grown in each area. Example: measuring height and weight, making decisions, acquiring new learning, getting along with one another. Use visual aids, role-playing, dramatization, creative writing, and auditory aids.		
	11. Make a time-line depicting growth. Review life cycles of growth; study about the present stage and briefly examine the stage children will soon be entering.		
	12. Help each child understand his uniqueness and his individual differences and the effect of heredity and environment on his growth. Impress upon each child that each member of the class looks and is different.		
	Teacher Information		
	1. Note children who handle and fondle their genitalia. Avoid making a child feel guilty or ashamed. Redirect activity and secure help from qualified personnel if behavior persists.		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	2. Emphasize that children should avoid allowing others to touch or fondle parts of body such as the genitalia, also they should avoid touching private parts of another person's body.		
	3. Fondling and touching the genitalia bring satisfaction and enjoyment; such sensations are a natural characteristic of the physiological and psychological makeup of individuals.		
	4. Individuals can learn to control and to redirect sexual desires and drives such as sex play and infantile masturbation.		
	5. Habitual handling or fondling of the genitalia can be a symptom of a problem or lead to undesirable habits.		

Printed Resources

BOOKS FOR PRIMARY GRADES

1. Anglund, Joan. *Love Is a Special Way of Feeling.* Harcourt, 1960. $1.95 Grades K-1.
2. Beim, Jerald. *Smallest Boy in Class.* Morrow, 1949. Lib. ed., $2.94 Grades 1-3.
3. Beim, Lorraine and Jerald. *Two Is a Team.* Harcourt, 1945. $2.75 Grades 1-3.
4. Bonsall, Crosby. *It's Mine, a Greedy Book.* Harper, 1964. Paper covered boards, $1.95 Grades K-1.
5. Buck, Pearl. *Johnny Jack and His Beginnings.* John Day, 1954. $2.95
6. Ets, Marie H. *The Story of a Baby.* Viking, 1939. Lib. ed., $3.77 Grades K-3.
7. Hanna, Paul R., and Genevieve A. Hoyt. *At Home.* Scott Foresman, 1965. $1.96; teachers manual, $1.96 Grade 1.
8. Irwin, Leslie, and others. *All About You.* Lyons, 1967. $2.24; teachers manual, $2.24 Grade 1.
9. Keats, E. J. *Peter's Chair.* Harper, 1967. Lib. ed., $3.79 Grades K-1.
10. Krauss, Ruth. *Big World and the Little House.* Harper, 1956. $3.25 Grades K-2.
11. Krauss, Ruth. *The Growing Story.* Harper, 1947. $3.95 Grades K-1.
12. Leaf, Munro. *Manners Can Be Fun.* Rev. ed. Lippincott, 1958. $2.95 (395) Grades 2-4.
13. Lexau, Jean. *I Should Have Stayed in Bed.* Hale, 1965. Lib. ed., $2.31 Grades K-2.
14. Meilach, D., and Elias Mandel. *A Doctor Talks to Five to Eight Year Olds.* Budlong, 1967. $1.50
15. Selsam, Millicent. *All About Eggs and How They Change into Animals.* W. R. Scott, 1952. $2.75 Grades K-3.
16. Selsam, Millicent. *All Kinds of Babies.* Rev. ed. Four Winds Press, 1967. $3.56
17. Silverstein, Shel. *The Giving Tree.* Harper, 1964. Lib. ed., $3.79 Grades K-3.
18. Udry, Janice. *Let's Be Enemies.* Harper, 1961. $1.95 Grades K-1.
19. Zolotow, Charlotte. *The White Marble.* Abelard, 1963. Lib. ed., $2.73 Grades K-3.

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PROFESSIONAL BOOKS

20. Child Study Association of America. *What To Tell Your Child About Sex.* Rev. ed. Duell, 1964. $2.95 (612.6)

21. Gruenberg, Sidonie. *A Wonderful Story of How You Were Born.* Rev. ed. Doubleday, 1959. Paper covered boards, $2.95 (612.6) Grades 5-7; parts are suitable for reading aloud to primary grades.

22. Hurlock, Elizabeth. *Child Growth and Development.* 3rd ed. Webster/McGraw, 1969. Text ed., $6.96; teachers manual, $1.00 (372.1)

23. Levine, Milton, and Jean Seligmann. *A Baby Is Born: The Story of How Life Begins.* Godlen Press, 1949. $1.95 (612.6) Grades 4-6; parts are suitable for use with primary grades.

CHARTS, PAMPHLETS, AND PERIODICALS

24. Kimberly-Clark Corporation, Neenah, Wisconsin 54956
    a. *The Miracle of You.* Free. Designed for student use.

25. *Life* Magazine
    a. "Drama of Life Before Birth." Vol. 58 (April 30, 1965) 62-69.

26. Minnesota Department of Health, Shipping Department, 717 Delaware Street S.E., Minneapolis, Minnesota 55440
    a. *Facts Aren't Enough* by Marion O. Lerrigo and M. A. Southard. AMA-NEA series. Free in small quantities; large quantities must be ordered from the AMA or NEA at 50¢ per copy. Adult reference.
    b. *The Story About You* by Marion O. Lerrigo and M. A. Southard. AMA-NEA series. Free in small quantities; large quantities must be ordered from the AMA or NEA at 50¢ per copy. Grades 4-6; some sections are suitable for use with primary grades.

27. Scott, Foresman and Company, 1900 East Lake Avenue, Glenview, Illinois 60025
    a. *Beginning the Human Story: A New Baby in the Family.* 12 color photo charts, teachers guide. $14.25 Grade 1.

28. Sex Information and Education Council of the U.S., 1855 Broadway, New York, New York 10093
    a. *Homosexuality.* Study Guide No. 2. Adult reference.

29. Silver Burdett Company, Park Avenue and Columbia Road, Morristown, New Jersey 07960
    a. *Families Around the World.* Picture packets. 5 sets. $10.50 each; teachers manual, 60¢ Grade K.

Audio-Visual Resources

FILMSTRIPS

1. Encyclopaedia Britannica Educational Corporation, 425 North Michigan, Chicago, Illinois 60601.
   a. *Home Community* series.
      "Brothers and Sisters." $6.00
   b. *School Community* series.
      "Our Job in School." $6.00
      "School Courtesy." $6.00
2. Eye-Gate House, Inc., 145-01 Archer, Jamaica, New York 11435
   a. *Life Begins* series.
      "Miss Brown's Class Goes to the Zoo." } 2 filmstrips, 1 record. $17.00
      "The Zoo Trip 'Show and Tell.'" }
   b. *You and Safety* series.
      "Safety Coming to School and in School." $5.00

TRANSPARENCIES

3. Fox, James Rogers, and Helen Starr. *Human Sexuality Education*. Teaching kit containing guide to resources, transparencies, tapes, booklets. Primary level, $50.00 Available from Teaching Aids Medically Authenticated, Suite 795, 608 2nd Avenue South, Minneapolis, Minnesota 55402.
4. Minnesota Mining and Manufacturing Company, Visual Products Division, 3M Center, P.O. Box 3344, St. Paul, Minnesota 55101
   a. *The Family Serves To Perpetuate Man and To Fulfill Certain Health Needs*. Concept No. 6. Level I. 4 sets, 20 transparencies each. Set, $35.00

FILMS

5. Minnesota Department of Health, Film Library, 717 Delaware Street S.E., Minneapolis, Minnesota 55440
   a. *Human and Animal Beginnings*. 13 min. Color. Free on loan.
   b. *Mother Hen's Family: The Wonder of Birth*. 11 min. Free on loan.
6. University of Minnesota, Audio-Visual Extension Service, General Extension Division, 2037 University Avenue S.E., Minneapolis, Minnesota 55455
   a. *Allen Is My Brother*. 11 min. Color. Rental: $3.25
   b. *Beginning Responsibility: Taking Care of Things*. 10 min. Rental: $2.00
   c. *Courtesy for Beginners*. 11 min. Color. Rental: $2.00
   d. *Growing Up Day by Day*. 10 min. Rental: $2.00

Scope and Sequence for
Family Life and Sex Education

INTERMEDIATE GRADES

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Goal I: To acquire a maturing self-image which enables the individual to live out his sexualit as a male or female

Concept A: Relationship of an individual's sexuality to his total personality development

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. Personality is expressed by one's self-image. 2. Actions and reactions in various situations show one's self-image or feelings of self-worth just as seeing oneself in a mirror reflects stature and appearance. 3. The self-image is strengthened or weakened by the way one is treated or accepted by others and to the extent basic physical and emotional needs are met. 4. Grooming, manners, dress, the expression of one's sexuality, and feelings about one's sex role reveal personality and security. 5. Diversity must be respected, not just tolerated. 6. Growth in recognizing one's strengths and weaknesses is a sign of maturity. 7. Interests change as one grows and matures. 8. Each individual has a responsibility to perform to his maximum potential as he grows and matures.	1. Develop meaning of the "self-image." How can the comparison be made with seeing oneself in a mirror? 2. Ask pupils to write a paper on what they like about themselves and how they feel they can improve. 3. Creative Writing: "What Is It Like To Be a Boy or a Girl?" 4. Role-play various personality traits and observe effect on others. 5. Discuss why it is necessary to like and respect oneself before one can respect and like others. 6. Explore factors that affect personality. 7. Interview Using Tape Recorder: "The Kind of Person I Want To Become." 8. List desirable personality traits. Select a hero or model who shows these traits. 9. Help pupils to understand that each one is unique and to accept individual differences. 10. Review the basic physical and emotional needs and how these needs affect the individual when they are met or unmet. 11. Study basic principles of good mental health.	PRINTED: 1, 5, 10c, 12 13a, 14a AUDIO-VISUAL: 1b, 3, 5a 6g

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nage which enables the individual to live out his sexuality in a responsible and creative way

idual's sexuality to his total personality development

LEARNING EXPERIENCES	RESOURCES	EVALUATION
evelop meaning of the "self-image." ow can the comparison be made ith seeing oneself in a mirror? sk pupils to write a paper on what ey like about themselves and how ey feel they can improve. reative Writing: "What Is It Like o Be a Boy or a Girl?" ole-play various personality traits nd observe effect on others. iscuss why it is necessary to like nd respect oneself before one can espect and like others. xplore factors that affect ersonality. nterview Using Tape Recorder: "The Kind of Person I Want To Become." List desirable personality traits. Select a hero or model who shows these traits. Help pupils to understand that each one is unique and to accept individual differences. Review the basic physical and emotional needs and how these needs affect the individual when they are met or unmet. Study basic principles of good mental health.	PRINTED: 1, 5, 10c, 12a, 13a, 14a AUDIO-VISUAL: 1b, 3, 5a, 6g	1. Understands the meaning of self-image. 2. Demonstrates an awareness of strengths and ways to improve one's personality. 3. Gains insight into need for long-range goals. 4. Demonstrates confidence and trust in oneself. 5. Acquires an understanding of good mental health practices. 6. Demonstrates an awareness of sexual differences and similarities. 7. Realizes that the range of choices of activities for either sex is based upon individual choice, work, and to some extent on one's sex. 8. Uses sources of help in solving personality and health problems. 9. Shows respect for and acceptance of others.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
9. Each individual experiences "ups" and "downs" in life and makes mistakes; these experiences are reflected in one's personality pattern.	12. Plan ways to help individuals develop a good self-image as well as respect for and trust in self and others.	
10. There are constructive and destructive ways of expressing emotions.	13. Panel Discussion: "How Feelings and Expressions of One's Sexuality Are Similar and Different in Boys and Girls."	
11. Self-respect and respect for others are demonstrated in choice of behavior.	14. Establish standards for acceptable behavior and manner for each sex.	
12. The manner in which one deals with sexual drives and feelings can have a positive or negative effect on one's personality.	15. Panel Discussion: "What Are Activities That Only Boys Can Do and Only Girls Can Do and 'Why'?" "Is a Boy a 'Sissy' If He Likes To Do Some 'So Called' Feminine Activities?" "Is a Girl a 'Tom Boy' If She Likes To Do Some Masculine Activities?" Summarize the discussion by basing selection of activities on individual interests, abilities, and likes and differences and by suggesting that masculine and feminine behavior is copied and learned to a great extent from peers and adults.	
13. Acceptance of one's sexuality and sensitivity to the sexual behavior of the other sex is important.		
14. Masculine and feminine behavior is expressed in relationship to one's sex.		

Goal II: To understand the nature and purpose of the family as the basic unit in society and its members

Concept B: Family's role in human sexuality

1. Family members are important and have a potential contribution to the well-being of the whole family.	1. Write a paragraph on "How I See Myself as an Important and Contributing Member of My Family."	PRINTED: 1 AUDIO-VISUAL: 2a, 3, 4a
2. Family membership involves responsibilities and privileges.	2. Explain the various stages of the life cycle, indicating role and responsibility in each stage.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
12. Plan ways to help individuals develop a good self-image as well as respect for and trust in self and others.		
13. Panel Discussion: "How Feelings and Expressions of One's Sexuality Are Similar and Different in Boys and Girls."		
14. Establish standards for acceptable behavior and manner for each sex.		
15. Panel Discussion: "What Are Activities That Only Boys Can Do and Only Girls Can Do and 'Why'?" "Is a Boy a 'Sissy' If He Likes To Do Some 'So Called' Feminine Activities?" "Is a Girl a 'Tom Boy' If She Likes To Do Some Masculine Activities?" Summarize the discussion by basing selection of activities on individual interests, abilities, and likes and differences and by suggesting that masculine and feminine behavior is copied and learned to a great extent from peers and adults.		

the nature and purpose of the family as the basic unit in society and the roles played by the family and

e in human sexuality

1. Write a paragraph on "How I See Myself as an Important and Contributing Member of My Family."	PRINTED: 1	1. Recognizes importance and responsibility of a family member.
2. Explain the various stages of the life cycle, indicating role and responsibility in each stage.	AUDIO-VISUAL: 2a, 3, 4a	2. Understands the stages in the life cycle of a family.
		3. Realizes value of family customs and celebrations.

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GENERALIZATIONS	LEARNING EXPERIENCES	RES
3. The life cycle of the individual within the family structure involves a series of changes.	3. Role-play: (a) Setting examples of good behavior. (b) Ways to solve individual and group problems. (c) How to get along with brothers and sisters within the family group.	
4. Family functions and roles are different.	4. Discuss family celebrations and customs and describe how they help in developing and maintaining family unity.	
5. Family celebrations, customs, and traditions contribute to developing family loyalty and unity.	5. Creative Writing: "How Members of My Family Help Me and How I Help Them."	
6. The family influences individual members and the individual member influences the family.	6. Panel: "How Families Are Alike and Different." (Recall that a family is a group of people living in the same house.) Note: Use judgment in planning and presenting this topic.	
7. Masculinity and femininity characteristics, traits, and sexual role are learned primarily in the home.	7. Discuss the many ways the family meets basic needs of the members such as security, belonging, providing love, trust, and protection. Explain reasons why some families can do this better than others.	
8. The family meets basic needs of members in many ways; some families do this better than others.	8. Analyze need for authority, discipline, and respect within the family.	
9. Discipline and authority should be provided within the family.	9. Invite resource person to discuss responsibilities for child care for this age level.	
10. Family members resemble one another, yet each one is different.		
11. Older family members have a responsibility for younger family members.		
12. Creating a life is a privilege of a husband and wife.		

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
3. Role-play: (a) Setting examples of good behavior. (b) Ways to solve individual and group problems. (c) How to get along with brothers and sisters within the family group.		4. Understands that families differ in many ways.
4. Discuss family celebrations and customs and describe how they help in developing and maintaining family unity.		5. Appreciates individual differences of family members and differences of their family unit as compared to others in society.
5. Creative Writing: "How Members of My Family Help Me and How I Help Them."		6. Realizes that masculine and feminine behavior is learned from various sources.
6. Panel: "How Families Are Alike and Different." (Recall that a family is a group of people living in the same house.) *Note: Use judgment in* planning and presenting this topic.		7. Accepts family authority and discipline and sees value in cooperating and getting along with others.
7. Discuss the many ways the family meets basic needs of the members such as security, belonging, providing love, trust, and protection. Explain reasons why some families can do this better than others.		8. Demonstrates a willingness to assist with care of young children in the home.
8. Analyze need for authority, discipline, and respect within the family.		
9. Invite resource person to discuss responsibilities for child care for this age level.		

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Goal III: To demonstrate a pattern of relationships based upon insight and understanding of c
to himself and others

Concept C: Effective interpersonal relations

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. One's behavior has an effect on others.	1. Role-play: Group problem solving, including examples of cooperation and respect for rights of others.	PRINTED: 1, 4 AUDIO-VISUAL: 1b, 4a
2. Rights of others need to be recognized.	2. Have each pupil keep a record for a period of time, reporting things he has done to help others or make others feel happier and also recording what others have done for him. Summarize, without personalizing reports, how this type of behavior affects in a positive way. Contrast this to negative behavior.	
3. Accepting responsibility for one's behavior and control of one's impulses and feelings should improve with maturity.	3. List types of activities that boys and girls can enjoy together.	
4. One cannot always have his own way.	4. Dramatize and role-play courtesy and manners which boys should show toward girls, girls toward boys, young people toward adults, and young people toward each other.	
5. Selection of wholesome leisure-time activities is important.	5. Discuss: (a) Characteristics that make you want to know a person. (b) Different kinds of friends. (c) How friends increase and change as one grows older and interests change.	
6. Adhering to social customs helps people feel comfortable with one another.	6. Role-play or dramatize how actions can set a good or poor example.	
7. Just as one's friends can be good or false, each person can be a good or false friend.	7. Discuss why individuals react differently to others.	
8. Practices followed and habits formed can be helpful or harmful to self and others.	8. Study ways of rejecting others' actions which are against one's principles. Discuss how to say "no."	
9. Family life contributes to helping one learn to get along with others.	9. Review reasons for avoiding invitations of friendly strangers.	
10. There are many kinds of love and definitions of love.		
11. Wholesome boy-girl relationships contribute to social adjustment.		

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rate a pattern of relationships based upon insight and understanding of one's obligations and responsibilities nd others

interpersonal relations

S	LEARNING EXPERIENCES	RESOURCES	EVALUATION
n l to lity d lses ty. ave me s is ustoms nfort- r. can h l or nd e o self tes to get ds of of love. bute to	1. Role-play: Group problem solving, including examples of cooperation and respect for rights of others. 2. Have each pupil keep a record for a period of time, reporting things he has done to help others or make others feel happier and also recording what others have done for him. Summarize, without personalizing reports, how this type of behavior affects in a positive way. Contrast this to negative behavior. 3. List types of activities that boys and girls can enjoy together. 4. Dramatize and role-play courtesy and manners which boys should show toward girls, girls toward boys, young people toward adults, and young people toward each other. 5. Discuss: (a) Characteristics that make you want to know a person. (b) Different kinds of friends. (c) How friends increase and change as one grows older and interests change. 6. Role-play or dramatize how actions can set a good or poor example. 7. Discuss why individuals react differently to others. 8. Study ways of rejecting others' actions which are against one's principles. Discuss how to say "no." 9. Review reasons for avoiding invitations of friendly strangers.	PRINTED: 1, 4 AUDIO-VISUAL: 1b, 4a	1. Have each child discuss on tape how he is growing and improving in his relations with others and still maintaining his standards. 2. Shows evidence of assuming more responsibility for self and others. 3. Shows evidence of self-discipline and self-control when working or playing with others. 4. Shows evidence of improvement in manners and courtesy. 5. Shows respect for other sex. 6. Demonstrates awareness of the qualities of a good friend. 7. Realizes importance of setting good example for others. 8. Receives pleasure and satisfaction from many activities and with various groups. Observe extent of pupil participation in wholesome activity. 9. Enjoys participation with other sex in group activities.

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GENERALIZATIONS	LEARNING EXPERIENCES
12. Setting a good example is important.	10. Use a question or problem box to find out the reality of feelings.
13. Group friendship contributes to the development of interpersonal relations.	11. Discuss meanings, problems, and implications of friendship, flirting, dating, puppy love, parties, dress, and actions. Develop guidelines for boy-girl behavior at this level. (Note: Do not belittle puppy love.)
	12. Discuss recreational activities boys and girls enjoy at this age.
	13. Plan a hobby show. Note similarities and differences in hobbies of boys and girls.
	14. Have children write on the topic "What Love Means to Me."
	15. Encourage family camping and other family activities to help promote an understanding between older and younger generations.

Goal IV: To understand the influences on sexuality of political, philosophical, liefs, customs, and laws in a pluralistic society

Concept D: Factors affecting societal values on sexuality

1. The form of government of a nation affects individual and group freedom to make choices in terms of beliefs and behavior.	1. Contrast the freedom of making choices in a pluralistic democracy to that of an authoritarian government.
2. There are differences and similarities of families of the community, the nation, and the world, including customs, mores, and roles of family members which need tolerance and acceptance.	2. Creative Writing: "In Which Type of Society Does the Individual Have Greater Responsibility for Behavior?"
3. Roles of the sexes and standards of conduct vary	3. Examine and compare roles, functions, and customs of families in our culture to those of other cultures. Example: Tribal and state control.

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
10. Use a question or problem box to find out the reality of feelings.		
11. Discuss meanings, problems, and implications of friendship, flirting, dating, puppy love, parties, dress, and actions. Develop guidelines for boy-girl behavior at this level. (Note: Do not belittle puppy love.)		
12. Discuss recreational activities boys and girls enjoy at this age.		
13. Plan a hobby show. Note similarities and differences in hobbies of boys and girls.		
14. Have children write on the topic "What Love Means to Me."		
15. Encourage family camping and other family activities to help promote an understanding between older and younger generations.		

nfluences on sexuality of political, philosophical, religious, and cultural ideologies including be-
ws in a pluralistic society

societal values on sexuality

1. Contrast the freedom of making choices in a pluralistic democracy to that of an authoritarian government.		1. Realizes that in a pluralistic democracy, individuals must learn to live with those who believe differently than they do.
2. Creative Writing: "In Which Type of Society Does the Individual Have Greater Responsibility for Behavior?"		2. Understands that in our society each one has the privilege and responsibility —within limits of the Constitution—to select values and behavior, including sexual behavior.
3. Examine and compare roles, functions, and customs of families in our culture to those of other cultures. Example: Tribal and state control.		3. Realizes that standards of modesty vary from country to country.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
in different societies and cultures.	4. Compare sexual roles of family members in various cultures, such as patriarchal and matriarchal, with those in our present-day structure.	
4. Boys and girls usually desire to adopt patterns and behaviors in keeping with their sex role in the culture.	5. Study ways that family life has changed in the U.S. since the pioneer days. How have these changes affected role and responsibility of family members? What might they anticipate for the future?	
5. Technological change has been a factor affecting the attitudes, structure, and incentives of the family unit.	6. Conduct research about nation and world families.	
6. Individuals and groups hold different beliefs in our society.		
7. Religious beliefs of individuals influence their standards of behavior.		
8. Behavior learned in the family affects the conduct of individuals in the school, community, and nation.		
9. Modesty is the propriety of dress, manners, speech, and actions accepted by a society.		

Goal V: To develop and employ a personal code of ethics which recognizes that human value groups and individuals within a pluralistic society

Concept E: A code of personal sexual behavior as a part of a total value system

1. A value is that which is desirable or worthy of esteem for its own sake; a standard is a basis for judging values.	1. Discuss and give examples of a value and a standard.	PRINTED: 12b AUDIO-VISUAL: 3, 4a
2. A code of ethics includes values, standards, and goals which have been	2. Discuss and show filmstrip about use of values in making decisions.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
4. Compare sexual roles of family members in various cultures, such as patriarchal and matriarchal, with those in our present-day structure.		
5. Study ways that family life has changed in the U.S. since the pioneer days. How have these changes affected role and responsibility of family members? What might they anticipate for the future?		
6. Conduct research about nation and world families.		

nploy a personal code of ethics which recognizes that human values and beliefs vary among different duals within a pluralistic society

onal sexual behavior as a part of a total value system

1. Discuss and give examples of a value and a standard.	PRINTED: 12b AUDIO-VISUAL: 3, 4a	1. Understands meaning and use of values in directing behavior and in making choices and decisions.
2. Discuss and show filmstrip about use of values in making decisions.		2. Demonstrates ability to select good models.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESO
accepted as one's own to guide relationships between people, including sexual behavior.	3. Creative Writing: "My Values and Why." (Summarize and use for class reaction and evaluation, without personal identification.)	
3. Many values are acquired from important persons in one's life.	4. Have pupils discuss choices made when younger. Compare with choices made at this age. Are they making better decisions? Why?	
4. A model influences the quality of one's values and direction of behavior	5. Discuss: "What You Are Like Today Affects What You Will Be Like Tomorrow."	
5. Self-discipline is needed to withstand pressure to act contrary to one's values or standards.	6. Analyze appeal of advertising and how it affects values and decision making.	
6. Many values and standards are gained in the way one is dealt with and the way one deals with others.	7. Discuss: "Everybody Does It." Is this a valid criteria for choosing behavior? Who is everybody? What are their credentials and what is their criteria?	
7. Individuals in our society have the right to hold different values within the limits of our Constitution.	8. Summarize discussion relating to use of values and standards in decision making and choice of alternates.	
8. Labeling a person is like judging him.	9. Read stories and discuss behavior of characters in terms of values and choices. How do they agree or disagree with others? Give examples of differing values.	
9. Values need to be examined and tested.	10. Essay: "Why Is Exercising Control and Direction of One's Behavior Important?"	
10. Values mean limits, not license.	11. Read biographies of famous people. Ask pupils to select values of these people which they think are good.	
	12. Discuss things which influence our judgment of what another person is like.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Creative Writing: "My Values and Why." (Summarize and use for class reaction and evaluation, without personal identification.)		3. Realizes that individuals have differing values.
Have pupils discuss choices made when younger. Compare with choices made at this age. Are they making better decisions? Why?		4. Growth in self-discipline in holding to one's values and standards.
Discuss: "What You Are Like Today Affects What You Will Be Like Tomorrow."		5. Asks for help in making decisions and choices.
Analyze appeal of advertising and how it affects values and decision making.		
Discuss: "Everybody Does It." Is this a valid criteria for choosing behavior? Who is everybody? What are their credentials and what is their criteria?		
Summarize discussion relating to use of values and standards in decision making and choice of alternates.		
Read stories and discuss behavior of characters in terms of values and choices. How do they agree or disagree with others? Give examples of differing values.		
Essay: "Why Is Exercising Control and Direction of One's Behavior Important?"		
Read biographies of famous people. Ask pupils to select values of these people which they think are good.		
Discuss things which influence our judgment of what another person is like.		

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Goal VI: To accept a personal responsibility for positive and constructive influences on soc sexuality

Concept F: Individual obligation and group responsibility regarding family living and sexua

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. Service and leadership in school and community activities suitable to this level should increase.	1. Survey school or community activities suitable for children at this age level. Encourage participation in these activities.	PRINTED: 14a, 15a AUDIO-VISUAL: 2a, 6b
2. To be concerned about others as human beings is an obligation of each person.	2. Participate in community and school services suitable for this level through which others are helped.	
3. Setting an example for others can have positive or negative effects.	3. Discuss ways individuals set good or poor examples.	
4. One's health contributes positively or negatively to the family's health.	4. List activities and services which contribute to a healthy family.	
5. Agencies assist families in need in many ways.	5. Learn about community health and welfare agencies, including services and financing.	
6. Growth in respect for oneself, right of privacy, proper manners, and modesty should improve with maturity.	6. Refer to procedures in earlier grades related to privacy and modesty.	
7. One should be responsible for behavior in public and private facilities.	7. Review toilet manners and standards of proper behavior in use of community facilities.	
8. Routine and referral health examinations contribute to good health.	8. Discuss importance of health examinations.	
9. Some individuals express sexual desires in a deviant manner.	9. Assign reading or invite a resource person to discuss proper care of young children and job responsibility.	
10. There are important techniques and responsibilities for baby sitting.	10. Review practices to prevent spread of diseases, including cleanliness and health care of self.	

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rsonal responsibility for positive and constructive influences on society's concerns for family living and

oligation and group responsibility regarding family living and sexuality

	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	1. Survey school or community activities suitable for children at this age level. Encourage participation in these activities.	PRINTED: 14a, 15a AUDIO-VISUAL: 2a, 6b, 6c	1. Participates in wholesome activities as a leader and as a responsible group member.
	2. Participate in community and school services suitable for this level through which others are helped.		2. Serves in a voluntary capacity to help others.
	3. Discuss ways individuals set good or poor examples.		3. Understands and practices principles of disease prevention.
	4. List activities and services which contribute to a healthy family.		4. Appreciation of healthful family living.
	5. Learn about community health and welfare agencies, including services and financing.		5. Seeks help with personal problems, including those of a sexual nature.
	6. Refer to procedures in earlier grades related to privacy and modesty.		6. Demonstrates improved behavior and responsibility in school lavatories.
	7. Review toilet manners and standards of proper behavior in use of community facilities.		7. Realizes responsibility in such activities as baby sitting and setting good examples.
	8. Discuss importance of health examinations.		
	9. Assign reading or invite a resource person to discuss proper care of young children and job responsibility.		
	10. Review practices to prevent spread of diseases, including cleanliness and health care of self.		

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GENERALIZATIONS	LEARNING EXPERIENCES	RE
11. Responsibility for prevention of disease is each person's responsibility.		
12. Protection of self and others from persons and situations that may cause harm is important.		

Goal VII: To employ suitable and effective communication about human sexuali

Concept G: Effective communication

		AUDIO-VIS
1. Proper vocabulary shows respect for self and others.	Note: It is recommended that the development of a proper vocabulary should be a part of the specific learning experience to which the words pertain rather than an isolated and separate skill. Providing an atmosphere where children can talk openly about their feelings and concern is important.	
2. Individuals communicate with one another through speech, manners, and actions.	1. Spend sufficient time on new words in the units to allow pupils to become well acquainted with them, their meaning, and their pronunciation.	
3. Mass media influence behavior.	2. In preparation for using visual aids, take time to develop the vocabulary.	
4. Selections of clothing, manners, and actions affect the way others respect you and show your own self-respect.	3. Discuss ways individuals communicate with one another positively and negatively through speech, actions, manners, and dress.	
	4. Analyze the many ways in which mass media communicate various messages to individuals, often directing behavior unless properly evaluated.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
e and effective communication about human sexuality in various situations and settings		
nication		
Note: It is recommended that the development of a proper vocabulary should be a part of the specific learning experience to which the words pertain rather than an isolated and separate skill. Providing an atmosphere where children can talk openly about their feelings and concern is important. 1. Spend sufficient time on new words in the units to allow pupils to become well acquainted with them, their meaning, and their pronunciation. 2. In preparation for using visual aids, take time to develop the vocabulary. 3. Discuss ways individuals communicate with one another positively and negatively through speech, actions, manners, and dress. 4. Analyze the many ways in which mass media communicate various messages to individuals, often directing behavior unless properly evaluated.	AUDIO-VISUAL: 3	1. Shows evidence of growth in use of correct vocabulary. 2. Realizes that feelings toward self and others can be expressed in many ways. 3. Realizes that one must evaluate information received from mass media and other sources.

Goal VIII: To understand anatomical, physiological, psychological, and sociological maturat

Concept H: Human growth and development

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. Growth is physical, emotional, social, mental, and ethical. 2. Adolescence is the period of growth from childhood to maturity. 3. Each person is unique and different, but all go through the same stages of growth from childhood to adulthood according to individual growth patterns. 4. Creation of new life is one of nature's greatest miracles. 5. Heredity and environment determine to a great extent what a person becomes; individual goals and wants are also important factors. 6. Heredity refers to those personal characteristics that have been passed on to an individual from his parents through chromosomes and genes. 7. Growth of the human baby inside its mother, process of birth, and care of mother and child should be understood. 8. Heredity, chance, and certain medications are factors influencing multiple births.	1. Utilize various techniques to demonstrate physical, mental, emotional, and ethical growth. These could include a review of individual growth patterns or use of growth charts and other evidence regarding maturation in each aspect of growth. 2. Study individual differences in terms of growth stages. Stress physical growth changes and secondary sex characteristics during puberty. 3. Discuss the fact that scientists have not created or manufactured any sort of complex life organisms from something that is not living. (Review previous study about life comes from life, and like produces like). 4. Examine the inherited traits and characteristics and the effect of environment on one's development. Summarize the importance of realistic goals for oneself. Assign committees to investigate and report on each topic. Examine the similarities and differences in plant, animal, and human reproduction. 5. Have each pupil make a list of his inherited characteristics such as color of eyes and color of hair. Trace characteristics as far back through his parents as possible; include parents, brothers, sisters, cousins, aunts, uncles, and grandparents.	PRINTED: 2, 3, 5, 6, 7, 8 10a, 10b, 11, 12a, 13a, AUDIO-VISUAL: 1a, 2a, 6a, 6e, 6f, 6g, 6h, 7a, 8a

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cal, physiological, psychological, and sociological maturation as related to sexuality

evelopment

LEARNING EXPERIENCES	RESOURCES	EVALUATION
Utilize various techniques to demonstrate physical, mental, emotional, and ethical growth. These could include a review of individual growth patterns or use of growth charts and other evidence regarding maturation in each aspect of growth. Study individual differences in terms of growth stages. Stress physical growth changes and secondary sex characteristics during puberty. Discuss the fact that scientists have not created or manufactured any sort of complex life organisms from something that is not living. (Review previous study about life comes from life, and like produces like). Examine the inherited traits and characteristics and the effect of environment on one's development. Summarize the importance of realistic goals for oneself. Assign committees to investigate and report on each topic. Examine the similarities and differences in plant, animal, and human reproduction. Have each pupil make a list of his inherited characteristics such as color of eyes and color of hair. Trace characteristics as far back through his parents as possible; include parents, brothers, sisters, cousins, aunts, uncles, and grandparents.	PRINTED: 2, 3, 5, 6, 7, 8, 9a, 10a, 10b, 11, 12a, 13a, 14b AUDIO-VISUAL: 1a, 2a, 3, 6a, 6e, 6f, 6g, 6h, 7a, 8a	1. Realizes that there is a relationship between all aspects of growth; however, one aspect may be dominant at a certain stage such as the physical aspect during puberty. 2. Recognizes that each one is unique and grows at a different rate. 3. Increased appreciation of the wonder and beauty of new life. 4. Awareness of role of heredity, environment, and goals in shaping one's growth and development. 5. Realization that one's sex is determined when ovum is fertilized; most masculine and feminine behavior is learned from one's environment. 6. Understands the anatomy and physiology of the reproductive systems of the male and female. 7. Realizes signs of puberty in self and understands their meaning. 8. Understands importance of controlling and directing one's sex drive in a wholesome manner, as well as with other feelings.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATIO
9. Maleness and femaleness refer to the sex one is born; masculinity and feminity refer to sexual behavior learned from the environment, including culture and customs.	6. Study growth and development of the human baby, including cell division and cell differentiation.		
10. Each one's makeup contains some male and female characteristics.	7. Secure pupil description of masculine and feminine behavior. How do these relate to being male and being a female?		
11. The reproductive system of the boy and that of the girl are different and complementary in terms of functions and organs.	8. Study the anatomy and physiology of the human reproductive system of the male and the female. Use visual aids such as films and filmstrips. Impress children with the fact that kicking or striking a person's genitals can cause injury.		
12. Puberty marks the end of childhood and the beginning of youth; it is that stage of physical development when it is first possible to create human life.	9. Discuss management of sexual drives which requires self-worth and a consideration for rights of others.		
13. Secretions from the glands of the endocrine system cause to a great degree the growth changes during puberty, including the sex drive.	10. Explain that the presence of sexual desires and feelings, menstruation, and seminal emissions are signs of puberty. Use visual aids, reading materials, and discussion to aid pupils in securing an understanding of the sex drive, its purpose in creating new life, the purpose of menstruation, and the meaning of seminal emissions. (Note: Use judgment in discussing human mating or intercourse; develop proper vocabulary.)		
14. The sex drive is a normal and natural part of each one's makeup.	11. Review and expand study of emotions and how they affect behavior.		
15. Life of human beings and animals begins with the union of two cells, the sperm cell from the male and the ovum or egg cell from the female; this union is called fertilization.	12. Review importance of personal hygiene, cleanliness of wearing apparel, and use of deodorants.		
	13. Explain the meaning of masturbation in a nonjudgmental manner. Note: Check with local school policy as to procedures and extent of teaching at this level.		

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATIO
16. The genitals are sensitive areas of the body; therefore, sexual feelings and sensations are aroused by touch, actions, pictures, speech, and the like. Such sensations are a natural characteristic of the physiological and psychological makeup of individuals.	14. Ask resource person (physician or physical education teacher) to explain ways to prevent injury to the genitals of boys and to breasts of girls.		
17. The genitalia and other sensitive parts of one's body need protection.	**Teacher Information** According to most medical authorities, masturbation does not cause physical or physiological harm but often causes mental and emotional concerns or guilt feelings, depending upon one's beliefs. However, deliberate or compulsive masturbation can be a symptom of a problem or lead to an undesirable habit.		
18. Emotions are natural human feelings which affect body functions and human behavior, including the sex drive.			
19. Personal hygiene should be practiced.			

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Printed Resources

BOOKS FOR INTERMEDIATE GRADES

1. Anglund, Joan. *Love Is a Special Way of Feeling.* Harcourt, 1960. $1.95
2. Hofstein, Sadie. *The Human Story: Facts on Birth, Growth, and Reproduction.* Scott Foresman, n.d. 78¢; teacher resource book, 24¢
3. Julian, C., and Elizabeth Jackson. *Modern Sex Education.* Holt, 1967. Paper, $2.00; teachers guide, 64¢ (612.6)
4. Leaf, Munro. *Manners Can Be Fun.* Rev. ed. Lippincott, 1958. $2.95 (395) Grades 2-4.
5. Lerrigo, Marion, and Michael Cassidy. *A Doctor Talks to Nine to Twelve Year Olds.* Budlong, 1967. $1.50 (612.6)
6. Levine, Milton, and Jean Seligmann. *Human Reproduction.* Science Unitext. Harper, n.d. 56¢ (612.6)
7. Morrison, Thomas F. *Human Reproduction.* Holt, 1963. 72¢ (612.6)

PROFESSIONAL BOOKS

8. Flanagan, Geraldine. *The First Nine Months of Life.* Simon and Schuster, 1962. $3.95 (611.01)

PAMPHLETS AND PERIODICALS

9. American Medical Association, 533 North Dearborn Street, Chicago, Illinois 60610
   a. *The Miracle of Life.* 20¢ each; orders over 100, 15¢ each.
10. Kimberly-Clark Corporation, Neenah, Wisconsin 54956
    a. *How To Tell the Retarded Girl About Menstruation.* Free. Teacher reference.
    b. *You and Your Daughter, Asked and Unasked Questions.* Free. Teacher reference.
    c. *Your Years of Self Discovery.* Free. Student reference.
11. *Life* Magazine
    a. "Drama of Life Before Birth." Vol. 58 (April 30, 1965) 62-69.
12. Minnesota Department of Health, Shipping Department, 717 Delaware Street S.E., Minneapolis, Minnesota 55440
    a. *Facts Aren't Enough* by Marion O. Lerrigo and M. A. Southard. AMA-

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NEA series. Free in small quantities; large quantities must be ordered from the AMA or NEA at 50¢ per copy. Adult reference.

b. *Finding Yourself* by Marion O. Lerrigo and M. A. Southard. AMA-NEA series. Free in small quantities; large quantities must be ordered from the AMA or NEA at 50¢ per copy. Student reference.

13. Scott Paper Company, Home Service Center, International Airport, Philadelphia, Pennsylvania 19113

    a. *It Is Wonderful Being a Girl.* Free. Student reference.

14. Sex Information and Education Council of the U.S., 1855 Broadway, New York, New York 10023

    a. *Homosexuality.* Study Guide No. 2. 50¢ Adult reference.

    b. *Masturbation.* Study Guide No. 3. 50¢ Adult reference.

15. U.S. Department of Health, Education, and Welfare. Order from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

    a. *When Teenagers Take Care of Children.* 25¢

Audio-Visual Resources

FILMSTRIPS

1. Eye-Gate House, Inc., 145-01 Archer, Jamaica, New York 11435

    a. *Life Begins* series
    "Reproduction in Flowers." } 2 filmstrips, 1 record. $17.00
    "Human Reproduction." }

    b. *Me, Myself and I* series. 6 filmstrips, 3 records, teachers manual. $37.50

2. Glenn Educational Films, Inc., P.O. Box 371, Monsey, New York 10952

    a. *Health Guidance in Family Living and Sex Education* series

    "About Your Life and You."

TRANSPARENCIES

3. Fox, James Rogers, and Helen Starr. *Human Sexuality Education.* Teaching kit containing teachers guide to resources, transparencies, tapes, student booklets. Intermediate level, $65.00 Available from Teaching Aids Medically Authenticated, Suite 795, 608 2nd Avenue South, Minneapolis, Minnesota 55402.

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4. Minnesota Mining and Manufacturing Company, Visual Products Division, 3M Center, P.O. Box 3344, St. Paul, Minnesota 55101

   a. *The Family Serves To Perpetuate Man and To Fulfill Certain Health Needs.* Concept No. 6. Level II. 5 sets, 20 transparencies each. Set, $35.00

5. General Mills, Inc., 9200 Wayzata Boulevard, Minneapolis, Minnesota 55440

   a. *Will of a Champion.* Free on loan.

6. Minnesota Department of Health, Film Library, 717 Delaware Street S.E., Minneapolis, Minnesota 55440

   a. *ABC's of Babysitting.* 10 min. Free on loan.

   b. *Boy to Man.* 16 min. Color. Free on loan.

   c. *Girl to Woman.* 16 min. Color. Free on loan.

   d. *Heredity and Environment.* 10 min. Free on loan.

   e. *Human Growth.* 20 min. Color. Free on loan.

   f. *It's Wonderful Being a Girl.* 18 min. Color. Free on loan.

   g. *Roots of Happiness.* 24 min. Free on loan.

   h. *The Story of Menstruation.* 10 min. Free on loan.

MODELS

7. Cleveland Health Museum, 8911 Euclid Avenue, Cleveland, Ohio 44106

   a. *Birth Models.* 6 models. $225.00

8. Denoyer-Geppert, Ravenswood Avenue, Chicago, Illinois 60640

   a. *Human Development Models.* 8 models. $145.00

Scope and Sequence for Family Life and Sex Education

JUNIOR HIGH SCHOOL

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Goal I: To acquire a maturing self-image which enables the individual to live out
way as a male or female

Concept A: Relationship of an individual's sexuality to his total personality develop

GENERALIZATIONS	LEARNING EXPERIENCES	RESO
1. One's self-identity may be different from one's self-image and one's reputation.	1. Review the meaning of personality and how one's sexuality affects personality.	PRINTED: 4, 2 AUDIO-VISUA
2. Signs of growth toward independence and maturity are recognizing and controlling one's feelings, making wise choices, accepting consequences of behavior, having ability to carry increased responsibility, and using good judgment.	2. Develop a personality check list.	
3. Respect for oneself and liking oneself are important in developing a good self-image.	3. Discuss importance of establishing one's identity.	
4. The self-image may be improved or injured to the extent one's sexuality is recognized by the other sex.	4. Creative Writing: "Who Am I?" (A short autobiography about self-identification. Information to be kept in confidence by teacher.) Utilize this technique to help pupils understand the importance of self-discovery in answering the question "Who Am I?"	
5. Physical and mental health contribute to personal attractiveness and a pleasant personality.	5. Show the film *How Are You?* and discuss.	AUDIO-VISUA
6. Sexuality is an integral part of one's personality; acceptance of one's sex and sexual role is essential to health and well-being.	6. Role-play the actions of an immature and a mature person in given situations.	
7. Interest and curiosity about sex are normal.	7. Plan a panel discussion on the importance of physical fitness, proper health practices, good grooming, and sound human relationships to the development of a wholesome personality.	PRINTED: 21
	8. Panel Discussion: "What Is Meant by the Self-Image (as you see yourself), Self-Identity (as you really are), and Popularity (as others see you)?" "What Characteristics Make a Person Liked and Respected?" "Does Physical Beauty in a Girl and Strong Physique in a Boy Assure Popularity?"	

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g self-image which enables the individual to live out his sexuality in a responsible and creative ıale

n individual's sexuality to his total personality development

LEARNING EXPERIENCES	RESOURCES	EVALUATION
1. Review the meaning of personality and how one's sexuality affects personality.	PRINTED: 4, 20a, 25a AUDIO-VISUAL: 3b, 3c	1. Demonstrates interest and desire in learning about and improving oneself.
2. Develop a personality check list.		2. Realizes that sexuality is an integral part of one's personality and can be expressed in a wholesome manner.
3. Discuss importance of establishing one's identity.		3. Accepts self, shows growth in discovering self-identity, and demonstrates improvement and consistency in identification of one's real self with various groups and in various situations.
4. Creative Writing: "Who Am I?" (A short autobiography about self-identification. Information to be kept in confidence by teacher.) Utilize this technique to help pupils understand the importance of self-discovery in answering the question "Who Am I?"		
5. Show the film *How Are You?* and discuss.	AUDIO-VISUAL: 10a	
6. Role-play the actions of an immature and a mature person in given situations.		4. Realizes the importance of a wholesome personality in achieving popularity and respect.
7. Plan a panel discussion on the importance of physical fitness, proper health practices, good grooming, and sound human relationships to the development of a wholesome personality.	PRINTED: 21a, 21b	5. Realizes that many factors can affect one's personality.
8. Panel Discussion: "What Is Meant by the Self-Image (as you see yourself), Self-Identity (as you really are), and Popularity (as others see you)?" "What Characteristics Make a Person Liked and Respected?" "Does Physical Beauty in a Girl and Strong Physique in a Boy Assure Popularity?"		6. Shows growth in self-improvement (physical and mental).
		7. Realization of socially acceptable ways to prove masculinity or femininity.
		8. Shows growth in accepting socially approved masculinity and femininity roles.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCE
8. Sexual feelings are natural and can be controlled without harm to health or personality.	9. Review basic human needs. Examine how one's personality can be affected when such needs are met or unmet.	PRINTED: 3, 20a AUDIO-VISUAL: 8a
9. Fluctuations of moods and feelings are natural during adolescence.	10. Panel Discussion: "What Are Some Reasons Why Individuals Behave in Various Ways?" Examples: Self-centered, generous, considerate or inconsiderate, secure or insecure, exploiting others, and engaging in promiscuous sexual behavior.	
10. Control of emotions, including the sex drive, helps prepare one to deal with problems constructively.	11. Explore the meaning of mental and emotional health. Apply findings to ways of meeting and coping with one's problems.	PRINTED: 25a AUDIO-VISUAL: 8a
11. Proving masculinity or femininity through promiscuous sexual behavior, besides damaging another individual, can be harmful to the self-image, and may affect one's personality.	12. Examine appropriate ways to express one's sexuality.	AUDIO-VISUAL: 3c
	13. Discuss similarities and differences in the masculine and feminine roles.	AUDIO-VISUAL: 3d,
	14. Committee Assignment: "Ways to Correct a Weakness or a Fault."	
	15. Discuss meaning of promiscuous behavior. Explore questions such as "Why Do Some People Feel a Need To Prove Their Masculinity and Femininity by Sexual Activity?" and "What Are Positive Ways To Express Masculinity and Femininity?"	PRINTED: 4, 25a
	16. Make a survey of available sources where help with problems can be secured.	
	17. Make use of a question box. (Preview for relevance and appropriateness.)	

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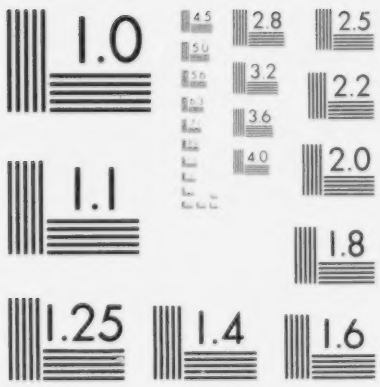

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

LEARNING EXPERIENCES	RESOURCES	EVALUATION
9. Review basic human needs. Examine how one's personality can be affected when such needs are met or unmet.	PRINTED: 3, 20a AUDIO-VISUAL: 8a	9. Seeks help with problems from trustworthy individuals.
10. Panel Discussion: "What Are Some Reasons Why Individuals Behave in Various Ways?" Examples: Self-centered, generous, considerate or inconsiderate, secure or insecure, exploiting others, and engaging in promiscuous sexual behavior.		
11. Explore the meaning of mental and emotional health. Apply findings to ways of meeting and coping with one's problems.	PRINTED: 25a AUDIO-VISUAL: 8a	
12. Examine appropriate ways to express one's sexuality.	AUDIO-VISUAL: 3c	
13. Discuss similarities and differences in the masculine and feminine roles.	AUDIO-VISUAL: 3d, 6a, 9h	
14. Committee Assignment: "Ways to Correct a Weakness or a Fault."		
15. Discuss meaning of promiscuous behavior. Explore questions such as "Why Do Some People Feel a Need To Prove Their Masculinity and Femininity by Sexual Activity?" and "What Are Positive Ways To Express Masculinity and Femininity?"	PRINTED: 4, 25a	
16. Make a survey of available sources where help with problems can be secured.		
17. Make use of a question box. (Preview for relevance and appropriateness.)		

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Goal II: To understand the nature and purpose of the family as the basic unit in society a its members

Concept B: Family's role in human sexuality

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. Families provide an environment in which children grow and mature until they become independent.	1. Develop vocabulary as needed.	
2. The family is a basic setting for human development and a laboratory for acquiring skills of human relationships.	2. Examine the meaning of "family life cycle." Briefly examine the various stages such as those recommended by the American Social Health Association: (a) newly married couple, (b) expectant parents, (c) parenthood (first child), (d) the crowded years, (g) the launching years, (h) the empty nest, and (i) the aging years. Describe the characteristics of an individual who is in the stage related to adolescent years; compare to earlier and later stages.	PRINTED: 18b, 18c AUDIO-VISUAL: 6a
3. Self-identity is acquired in the family setting.		
4. The family framework provides opportunities to express and to control one's emotions.	3. Creative Writing or Panel: "What Should Parents Expect of Me as I Become Independent?" Discuss meaning of independency and dependency in achieving maturity.	AUDIO-VISUAL: 1b, 6
5. The family life cycle consists of a pattern of the growth stages of its members; it is common to all families.	4. Examine ways in which the family helps one achieve self-identity and trust and also ways in which the family can help meet the basic human needs of its members.	
6. Family rules and policies change as members of the family grow and mature.	5. Plan a "Be Nice to Parents Week" without parents knowing it. Report results to class. Select those which demonstrate good human relations.	
7. There are ways to help solve individual and group problems within the family setting.	6. Study the kinds of love which are a vital part of family life such as parental love, sibling love, married love, and sexual love.	AUDIO-VISUAL: 6a
8. Families have adjustments to make and all members must work toward satisfactory solutions or		

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ure and purpose of the family as the basic unit in society and the roles played by the family and

han sexuality

LEARNING EXPERIENCES	RESOURCES	EVALUATION
1. Develop vocabulary as needed.		1. Understands the relationship between dependent and independent behavior.
2. Examine the meaning of "family life cycle." Briefly examine the various stages such as those recommended by the American Social Health Association: (a) newly married couple, (b) expectant parents, (c) parenthood (first child), (d) the crowded years, (g) the launching years, (h) the empty nest, and (i) the aging years. Describe the characteristics of an individual who is in the stage related to adolescent years; compare to earlier and later stages.	PRINTED: 18b, 18c AUDIO-VISUAL: 6a	2. Understands role and responsibility in the family. 3. Understands need for behavior guidelines and limits. 4. Appreciates importance of setting a good example for younger family members.
3. Creative Writing or Panel: "What Should Parents Expect of Me as I Become Independent?" Discuss meaning of independency and dependency in achieving maturity.	AUDIO-VISUAL: 1b, 6a	5. Realizes the role of family in meeting an individual's needs.
4. Examine ways in which the family helps one achieve self-identity and trust and also ways in which the family can help meet the basic human needs of its members.		6. Demonstrates an awareness of the stages of growth within the family setting.
5. Plan a "Be Nice to Parents Week" without parents knowing it. Report results to class. Select those which demonstrate good human relations.		7. Recognizes that gradual independence from the family is a desirable part of the maturation process.
6. Study the kinds of love which are a vital part of family life such as parental love, sibling love, married love, and sexual love.	AUDIO-VISUAL: 6a	8. Recognizes that families differ in many ways.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
adaptations; students should be aware that youth has a responsibility.	7. Role-play: "Ways To Meet and Solve Individual and Group Problems Within the Family Setting."	AUDIO-VISUAL: 1b	
. Accepting responsibility and having respect for authority within the family, according to age and ability, are basic to family stability.	8. Discuss need for changes in family policies as one grows and matures. Discussion Questions: (a) Why is it important to have family rules and regulations? (b) What limits or guidelines should be set by the family for young adolescents?	AUDIO-VISUAL: 1b	
. The behavior of each family member influences the quality of family life for all family members.	9. Examine the role and responsibility of the family in child bearing, rearing, protection, security, and authority.	AUDIO-VISUAL: 6a, 9d	
. Families differ in customs of modesty and in providing for privacy of members.	10. Committee Topics: (a) "The Characteristics of an Ideal Family." (b) "Factors Which May Prevent a Family from Achieving These." (c) "How a Family Can Make Adjustments and Adapt to Changing Conditions."		
. Attitudes formed in the family setting regarding marriage, love (including sexual love), respect for others, and respect for oneself as a total human being affect one's relationship with the other sex.	11. Explain that family planning may include limiting, increasing, or spacing number of children; also, that medical and nonmedical assistance is available to husband and wife from professional sources. (Use judgment in presenting types of birth control, including contraceptives. Clear with school and state policy and regulations.)	PRINTED: 9	
. Attitudes toward the total human being as being beautiful, as being obscene, or as being pornographic in nature are developed within the family setting and peer group.	12. Discuss the meaning and process of adoption.	PRINTED: 2	
. Marriage as a social institution is subject to laws and regulations.			
. A stable, happy marriage contributes to strong family life.			

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCE
16. Parenthood is a responsibility and a privilege of husband and wife.		
17. Parents have the freedom of choice to select a method of family planning which is in keeping with their beliefs and with standards of society.		

Goal III: To demonstrate a pattern of relationships based upon insight and understandin to himself and others

Concept C: Effective interpersonal relations

1. Companionship of both sexes in a variety of wholesome activities helps individuals learn to understand others, to enjoy others, and to gain skills in sound human relations.	1. Develop vocabulary that is suitable and needed.	
	2. Panel Discussion Topics: "What Can I Do To Be a Good Friend?" "What Do I Want in a Friend?" "How Can I Get Along with My Friends?"	PRINTED: 20b
2. Broadening the scope of friendships tends to increase understanding of others.	3. Examine ways in which broadening friendships can increase understandings of others, such as helping to choose friends wisely, increasing range of contacts and interests, providing for social enjoyment, and becoming aware of standards of others.	PRINTED: 10, 18a, AUDIO-VISUAL: 6a
3. Dating is a period of becoming better acquainted with members of the other sex.		
4. Behavior in dating can affect interpersonal relationships now and at a later time in life.	4. Panel Discussions: (a) "Group and Double Dating Versus Single Dating." (b) "Qualities to Look for in a Date." (c) "How To Ask for, Accept, or Refuse a Date." (d) "Appropriate Activities on a Date." (e) "Standards for Dating Behavior." (f) "Importance of Similar Interests and Hobbies in Dating Groups." (g) "What Opposite Sex Looks for,	PRINTED: 1, 18a
5. Understanding of parent's concern for dating practices is a sign of maturity and respect.		

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
a pattern of relationships based upon insight and understanding of one's obligations and responsibilities hers		
personal relations		
1. Develop vocabulary that is suitable and needed.		1. Shows improvement in the use of an acceptable vocabulary.
2. Panel Discussion Topics: "What Can I Do To Be a Good Friend?" "What Do I Want in a Friend?" "How Can I Get Along with My Friends?"	PRINTED: 20b	2. Demonstrates an improved ability to discuss problems and questions relating to sexuality in a dignified and positive manner.
3. Examine ways in which broadening friendships can increase understandings of others, such as helping to choose friends wisely, increasing range of contacts and interests, providing for social enjoyment, and becoming aware of standards of others.	PRINTED: 10, 18a, 20b AUDIO-VISUAL: 6a	3. Realizes that one's behavior is often copied especially from those one is with the most.
4. Panel Discussions: (a) "Group and Double Dating Versus Single Dating." (b) "Qualities to Look for in a Date." (c) "How To Ask for, Accept, or Refuse a Date." (d) "Appropriate Activities on a Date." (e) "Standards for Dating Behavior." (f) "Importance of Similar Interests and Hobbies in Dating Groups." (g) "W[illegible]posite Sex Looks for,	PRINTED: 1, 18a	4. Realizes that self-control, recognition of the rights of others, tolerance, cooperation, respect for rules and regulations, liking others, and a sense of humor are basic to getting along with others in a constructive and satisfying manner.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
	Expects, or Dislikes in Terms of Behavior."	
6. Values, standards, and goals affect one's attitudes and behavior toward premarital sexual permissiveness and sexual behavior.	5. Study emotions, their control and expression.	PRINTED: 1, 9 AUDIO-VISUAL: 9c, 9h
7. Choice of behavior shows maturity or immaturity.	6. Discuss differences in sexual feelings and desires of boys and of girls. Apply to such activities as necking, petting, and sexual stimuli.	PRINTED: 7, 9, 20b AUDIO-VISUAL: 6a
8. Petting, necking, and other means of sexual stimulation can lead to sexual intercourse or sexual relationships.	7. Panel Discussion: (a) "Does Physical Expression of Affection Always Lead to Sexual Feelings and Desires?" (b) "How Does Choice of Behavior Show Maturity or Immaturity?" (c) "What Is Meant by Sexual Exploitation of Another?" (d) "Why Are Parents Concerned About Dating Behavior?" (e) "What Is the Meaning of the 'Single' and 'Double Standard' in Relation to Sexual Behavior of Both Sexes?"	PRINTED: 4, 7, 9 AUDIO-VISUAL: 6a
9. Premarital sexual relationships or intercourse can result in personal, emotional, and social problems.	8. Discuss the effects of responsible and irresponsible sexual behavior on oneself and others, the importance of self-respect, and concern for others as a factor in making wise decisions and choosing alternates.	PRINTED: 4, 9, 10
10. Premarital and extramarital sexual relationships and sexual permissiveness are not accepted by prevailing moral, legal, and social codes in our society.	9. Discuss appropriate and inappropriate sexual behavior.	PRINTED: 20b
11. Sexual exploitation of another shows irresponsible behavior and lack of concern for the welfare of the individual.	10. Write your definition of promiscuous behavior.	
12. The desire to express feelings of affection is common to both sexes.	11. Brainstorm: Problems associated with premarital sexual relations such as fear, guilt, shame, lack of trust, disruption of long-range goals and plans, pregnancy, abortion, unsuitable early marriage, illegitimate children, and responsibility of both parties in caring for the child.	PRINTED: 4, 9
13. Love is given to individuals in different ways; each kind of love has a responsibility and an obligation.		

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Expects, or Dislikes in Terms of Behavior."		
5. Study emotions, their control and expression.	PRINTED: 1, 9 AUDIO-VISUAL: 9c, 9h	5. Demonstrates an understanding of the differences in stimulation and expression of the sex drive in a boy and in a girl.
6. Discuss differences in sexual feelings and desires of boys and of girls. Apply to such activities as necking, petting, and sexual stimuli.	PRINTED: 7, 9, 20b AUDIO-VISUAL: 6a	6. Realizes that the ability to make wise choices of sexual behavior and to accept responsibility for one's behavior shows growth toward maturity.
7. Panel Discussion: (a) "Does Physical Expression of Affection Always Lead to Sexual Feelings and Desires?" (b) "How Does Choice of Behavior Show Maturity or Immaturity?" (c) "What Is Meant by Sexual Exploitation of Another?" (d) "Why Are Parents Concerned About Dating Behavior?" (e) "What Is the Meaning of the 'Single' and 'Double Standard' in Relation to Sexual Behavior of Both Sexes?"	PRINTED: 4, 7, 9 AUDIO-VISUAL: 6a	7. Realizes the importance of developing sound friendships and good human relationships.
8. Discuss the effects of responsible and irresponsible sexual behavior on oneself and others, the importance of self-respect, and concern for others as a factor in making wise decisions and choosing alternates.	PRINTED: 4, 9, 10	8. Realizes that premarital sexual relationships may cause problems to self and to others.
9. Discuss appropriate and inappropriate sexual behavior.	PRINTED: 20b	9. Understands that concern for self and respect for the other person determine actions in a dating situation.
10. Write your definition of promiscuous behavior.		
11. Brainstorm: Problems associated with premarital sexual relations such as fear, guilt, shame, lack of trust, disruption of long-range goals and plans, pregnancy, abortion, unsuitable early marriage, illegitimate children, and responsibility of both parties in caring for the child.	PRINTED: 4, 9	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATIO
4. Full expression of sexual love is best reserved for marriage.	12. Discuss love as a basic human need. Note the many ways it is expressed such as parental love, sibling love, friendship, "puppy love," "crush," romantic love, sexual love, and married love.	PRINTED: 9 AUDIO-VISUAL: 6a	
5. Behavior sets an example to peers and young children.	13. Study the differences of love for a friend, love of work or a hobby, romantic love, and married love.		
	14. Brainstorm: "How Do Values and Standards of the Family, Peer Group, Friends, Religion, and Society Affect Sexual Behavior and Attitudes?"	PRINTED: 7 AUDIO-VISUAL: 3e	
	15. Discuss transitory nature of childish relationships as compared with long-term relationships. Relate to personalities who have not learned adult long-term relationships.	PRINTED: 10, 20b	
	16. Develop a set of behavior guidelines and the need for self-discipline and control in following them.		
	17. Explain meaning of heterosexual and homosexual relationships.	PRINTED: 4, 24a	
	18. Discuss qualification of friends, how friends are chosen, the effect of friends on one's behavior, and qualities that lead to mature friendships. Discussion Questions: (a) "What Is Popularity?" (b) "Is One Abnormal If Not Interested in Dating or Going Steady?"	PRINTED: 10, 20b	

Teacher Information

Relative to heterosexual and homosexual relationships avoid generalizations, deductions, or confusion about wholesome friendships of the same sex as compared with homosexuality.

Goal IV: To understand the influences on sexuality of political, philosophical, religious, customs, and laws in a pluralistic society

Concept D: Factors affecting societal values on sexuality

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURC
1. Under various forms of government, an individual's rights and responsibilities differ.	1. Contrast the freedom of individuals in an authoritarian form of government with a pluralistic democracy such as ours. Explore the following: a. How does our society protect the rights of the individuals? b. Explain the statement that "For every right there is a responsibility." c. How do the responsibilities and rights of individuals relate to choice of one's sexual behavior?	
2. Our society includes many types of cultures.	2. Study dating, engagement, and marriage customs in various countries and cultures. (Use American Field Service students or servicemen's wives as sources of information.)	
3. Patterns of sexual behavior differ among individuals, countries, groups, and cultures.	3. Study the influences that various people such as parents, other adults, siblings, peers and friends, and cultural groups have on one's behavior.	
4. Sensitivity to differences in people and their customs helps one understand them.	4. Study influences of mass media and advertising on one's sexual behavior.	
5. Culture and religious beliefs may have an effect on one's behavior, including sexual behavior.	5. Discuss current movies, music, or television programs relative to their effect upon attitudes and behavior.	
6. Dating, engagement, and marriage customs vary from one country to another and from one culture to another.	6. Have students read appropriate short stories recommended by the language arts department.	
7. Many factors and forces influence the status of the family.	7. Examine forces and pressures which affect families and cultures in our society. Have groups of students	PRINTED: 7, 22a,
8. Overpopulation and population control are world-wide problems.		

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influences on sexuality of political, philosophical, religious, and cultural ideologies including beliefs, n a pluralistic society

societal values on sexuality

LEARNING EXPERIENCES	RESOURCES	EVALUATION
1. Contrast the freedom of individuals in an authoritarian form of government with a pluralistic democracy such as ours. Explore the following: a. How does our society protect the rights of the individuals? b. Explain the statement that "For every right there is a responsibility." c. How do the responsibilities and rights of individuals relate to choice of one's sexual behavior?		1. Realizes the influence of the church, peer group, and other forces on one's philosophy and sexuality. 2. Present a specific problem such as "Advertising Affects Behavior" and have students write about ways advertising can affect behavior.
2. Study dating, engagement, and marriage customs in various countries and cultures. (Use American Field Service students or servicemen's wives as sources of information.)		
3. Study the influences that various people such as parents, other adults, siblings, peers and friends, and cultural groups have on one's behavior.		
4. Study influences of mass media and advertising on one's sexual behavior.		
5. Discuss current movies, music, or television programs relative to their effect upon attitudes and behavior.		
6. Have students read appropriate short stories recommended by the language arts department.		
7. Examine forces and pressures which affect families and cultures in our society. Have groups of students	PRINTED: 7, 22a, 22b	

GENERALIZATIONS	LEARNING EXPERIENCES	RE
	construct a 3-foot by 4-foot poster or montage. The only instructions should be to "put on the poster what you think society is and what your problems in society are." Each group should interpret its poster.	
	8. Discuss the influences on the family of working mothers, mobility of population, and industry moving families at regular intervals.	

Goal V: To develop and employ a personal code of ethics which recognizes that groups and individuals within a pluralistic society

Concept E: A code of personal sexual behavior as part of a total value system

1. Societal values are desirable or worthy for the preservation of civilization; goals and standards are influenced by values.	1. Have each student develop a statement on a value and show how this value can affect his sexual behavior. Example: "I Believe That Sex Is . . ." or "Why I Support the Golden Rule." (Statements can be anonymous.)	PRINTED
2. Personal values are gained from many sources and may change throughout life.	2. Explore ways personal values are gained through direct and indirect methods and sources such as home, church, community, and peers.	PRINTED AUDIO-V 6a
3. Values and standards apply to all human relationships, including sexual behavior.	3. Study and demonstrate the steps in the decision-making process. Example: identification of problem, research, and solution or decision.	
4. Selection of standards reflects values and influences behavior; also values have meaning in how we deal with one another.	4. Present several "open end" problem situations regarding decision making and have students suggest solutions. (Use case histories.) Analyze consistency and choice of alternatives and values.	PRINTED
5. Decision making involves many factors; making wise decisions is a sign of maturity.	5. Analyze values presented in a recent movie, book, or television program.	AUDIO-V

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
construct a 3-foot by 4-foot poster or montage. The only instructions should be to "put on the poster what you think society is and what your problems in society are." Each group should interpret its poster.		
8. Discuss the influences on the family of working mothers, mobility of population, and industry moving families at regular intervals.		

and employ a personal code of ethics which recognizes that human values and beliefs vary among different individuals within a pluralistic society

f personal sexual behavior as part of a total value system

1. Have each student develop a statement on a value and show how this value can affect his sexual behavior. Example: "I Believe That Sex Is . . ." or "Why I Support the Golden Rule." (Statements can be anonymous.)	PRINTED: 7, 10, 13	1. Appreciates the importance of responsible sexual behavior.
2. Explore ways personal values are gained through direct and indirect methods and sources such as home, church, community, and peers.	PRINTED: 6, 9 AUDIO-VISUAL: 3c, 3e, 3f, 6a	2. Shows evidence of following acceptable standards to guide behavior.
3. Study and demonstrate the steps in the decision-making process. Example: identification of problem, research, and solution or decision.		3. Shows positive attitudes toward recognized authority and shares in establishing behavior guidelines and limits.
4. Present several "open end" problem situations regarding decision making and have students suggest solutions. (Use case histories.) Analyze consistency and choice of alternatives and values.	PRINTED: 15	4. Shows evidence of application of values and standards to decision making.
5. Analyze values presented in a recent movie, book, or television program.	AUDIO-VISUAL: 9g	5. Realizes that improving one's behavior is dependent upon an understanding of oneself, a desire to improve, and a plan of action.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCE
6. A philosophy of life can serve as a guide for consistency and quality of choices of behavior in our pluralistic society.	Note agreement, disagreement, and ability to select values.	
	6. Brainstorm: "How Do 'Models' or Persons You Admire Influence Behavior?"	PRINTED: 1, 10, 23a
7. Human beings having freedom to make choices of behavior, including sexual behavior, must accept responsibility for such choices and behavior.	7. Explain the meaning of a personal philosophy. Ask each student to write his. Summarize by relating a philosophy of life to values and standards.	PRINTED: 13, 14, 15
8. Opportunity and responsibility to direct behavior according to one's ability can help one cope with sexual feelings and desires.	8. Panel Discussion Topics: a. "What Are Guilt Feelings?" b. "Should Boys and Girls Have Different Standards of Sexual Behavior?" c. "Do You Have a Responsibility for Other Members of Society?" d. "Do Values and Standards of Famous People Have an Effect on Your Life?" e. "Why Do Values and Standards of People Differ?"	AUDIO-VISUAL: 3f
9. Errors in personal judgment and mistakes can be overcome.	9. Discussion Topic: "Why Do I Act the Way I Do?"	
10. Sexual behavior is neither good nor bad in itself; the way sexuality is used makes it good or bad; it can bring joy and pleasure or sorrow and unhappiness.	10. Creative Writing: "The Kinds of People I Admire and Why" or "My Most Unforgettable People." Analyze their characteristics.	
11. Guidance and defined boundary lines can help to develop or apply positive behavior controls.	11. Develop a set of standards to guide sexual behavior in a positive, constructive manner.	PRINTED: 1, 9, 20b AUDIO-VISUAL: 3a
12. Physical maturity, the ability of the individual to reproduce, is but one aspect of total maturity.	12. Topics for Committee Work and Panel Discussion: a. What is the difference between immediate and long-range goals? b. What is meant by responsible sexual behavior?	PRINTED: 10, 13, 20

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Note agreement, disagreement, and ability to select values.		6. Shows growth in recognizing problems and securing help from trustworthy sources.
6. Brainstorm: "How Do 'Models' or Persons You Admire Influence Behavior?"	PRINTED: 1, 10, 23a	
7. Explain the meaning of a personal philosophy. Ask each student to write his. Summarize by relating a philosophy of life to values and standards.	PRINTED: 13, 14, 15	
8. Panel Discussion Topics:	AUDIO-VISUAL: 3f	
a. "What Are Guilt Feelings?"		
b. "Should Boys and Girls Have Different Standards of Sexual Behavior?"		
c. "Do You Have a Responsibility for Other Members of Society?"		
d. "Do Values and Standards of Famous People Have an Effect on Your Life?"		
e. "Why Do Values and Standards of People Differ?"		
9. Discussion Topic: "Why Do I Act the Way I Do?"		
10. Creative Writing: "The Kinds of People I Admire and Why" or "My Most Unforgettable People." Analyze their characteristics.		
11. Develop a set of standards to guide sexual behavior in a positive, constructive manner.	PRINTED: 1, 9, 20b AUDIO-VISUAL: 3a	
12. Topics for Committee Work and Panel Discussion:	PRINTED: 10, 13, 20b	
a. What is the difference between immediate and long-range goals?		
b. What is meant by responsible sexual behavior?		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
	c. What is meant by choosing alternatives and acceptance of consequences of behavior?	
	d. What is involved in correcting a mistake?	
	e. Demonstrate process of solving a problem.	
	13. Creative Writing: "What Do I Want To Do and Be?" (Statements can be anonymous.) Note: Cooperate with language arts department.	
	14. Panel Discussion: "How Can I Help Others Realize Their Goals and Aspirations?" (This discussion includes a review of the basic human needs and how one can help others.)	PRINTED: 10, 14 AUDIO-VISUAL: 9g

Goal VI: To accept a personal responsibility for positive and constructive influences on socie sexuality

Concept F: Individual obligation and group responsibility regarding family living

1. Participation in wholesome school and community activities is a sign of responsible citizenship.	1. Make a survey of valuable or suitable school and community activities which give one an opportunity to carry responsibilities and leadership. Examples: recreation, 4-H, YMCA, or YWCA.	
2. Each one has a responsibility to help make the community a healthy place in which to live.	2. Discuss meaning of deviant behavior. Explain that deviant behavior does not only involve sexual behavior. Include the meaning of homosexuality, rape, exhibitionism, and child molesting.	PRINTED: 4, 10, 24a
3. In addition to being a private and personal matter, sexual behavior also carries public responsibility.	3. Examine ways to deal with individuals who show deviant sexual behavior. Invite a resource person such as a social worker or Mental	
4. Inappropriate and unhealthful sexual		

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
c. What is meant by choosing alternatives and acceptance of consequences of behavior?		
d. What is involved in correcting a mistake?		
e. Demonstrate process of solving a problem.		
13. Creative Writing: "What Do I Want To Do and Be?" (Statements can be anonymous.) Note: Cooperate with language arts department.		
14. Panel Discussion: "How Can I Help Others Realize Their Goals and Aspirations?" (This discussion includes a review of the basic human needs and how one can help others.)	PRINTED: 10, 14 AUDIO-VISUAL: 9g	

al responsibility for positive and constructive influences on society's concerns for family living and

ation and group responsibility regarding family living

1. Make a survey of valuable or suitable school and community activities which give one an opportunity to carry responsibilities and leadership. Examples: recreation, 4-H, YMCA, or YWCA.		1. Participates in wholesome school and community activities to the best of his ability.
2. Discuss meaning of deviant behavior. Explain that deviant behavior does not only involve sexual behavior. Include the meaning of homosexuality, rape, exhibitionism, and child molesting.	PRINTED: 4, 10, 24a	2. Helps make the home, school, and community better places in which to be.
3. Examine ways to deal with individuals who show deviant sexual behavior. Invite a resource person such as a social worker or Mental		3. Realizes that individuals who show deviant behavior may be ill and need help.
		4. Realizes that one can contact venereal disease through sexual relation-

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
behavior can create problems for oneself, others, and society.	Health Center staff member to discuss the topic.	
5. Some families have more difficulty in carrying out their roles and meeting responsibility than others because of circumstances beyond their control; these families may need help from health and welfare agencies.	4. Study the nature, spread, control, treatment, and prevention of venereal disease. Explain reasons for a blood test before marriage.	PRINTED: 1, 10, 20c
	5. Discuss how one's judgment and behavior are affected by alcohol and dangerous drugs. Collect information on the effect of alcohol and drugs on behavior and personality, including sexual behavior.	AUDIO-VISUAL: 9g
6. Venereal diseases can be contracted through sexual relationships.	6. Panel Discussion: "Ways We Can Help Others in Our Community."	
7. Some individuals show deviant sexual behavior.	7. Make a survey of health and welfare agencies in the community.	
8. Judgment and behavior can be affected by alcohol and dangerous drugs.	8. Examine the effects of promiscuous and permissive sexual behavior on the individual and society. Effects include premarital pregnancy, illegitimacy, spread of veneral disease, and possible injury (mental, physical, social, ethical) to individuals.	PRINTED: 1, 4 AUDIO-VISUAL: 9g, 9i
9. Providing correct information about contraceptives is a responsibility of various professional and religious groups.	9. Explain that medically approved contraceptives are available from medical sources on a prescription basis. Avoidance of premarital sexual relations can protect one from personal harm, risks, and guilt feelings because sexual relations involve the total individual not just the physical being.	
	10. Discuss ways by which a person shows respect for self as a total human being; include respect for and beauty of the body as part of the total self.	PRINTED: 10, 23a AUDIO-VISUAL: 3c
	11. Creative Writing: "How Does Abstinence in Premarital Relation-	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Health Center staff member to discuss the topic.		ships with an infected person.
4. Study the nature, spread, control, treatment, and prevention of venereal disease. Explain reasons for a blood test before marriage.	PRINTED: 1, 10, 20c	5. Understands the importance of blood tests before marriage as a means of detecting syphilis.
5. Discuss how one's judgment and behavior are affected by alcohol and dangerous drugs. Collect information on the effect of alcohol and drugs on behavior and personality, including sexual behavior.	AUDIO-VISUAL: 9g	6. Understands that venereal disease should be diagnosed and treated medically.
6. Panel Discussion: "Ways We Can Help Others in Our Community."		7. Knows of sources of help in the area of health, welfare, and other personal and group services.
7. Make a survey of health and welfare agencies in the community.		8. Secures help with personal problems.
8. Examine the effects of promiscuous and permissive sexual behavior on the individual and society. Effects include premarital pregnancy, illegitimacy, spread of veneral disease, and possible injury (mental, physical, social, ethical) to individuals.	PRINTED: 1, 4 AUDIO-VISUAL: 9g, 9i	9. Realizes the effect of alcohol and drugs on behavior.
9. Explain that medically approved contraceptives are available from medical sources on a prescription basis. Avoidance of premarital sexual relations can protect one from personal harm, risks, and guilt feelings because sexual relations involve the total individual not just the physical being.		10. Is aware of the cost to the individual and to society of promiscuous sexual behavior.
10. Discuss ways by which a person shows respect for self as a total human being; include respect for and beauty of the body as part of the total self.	PRINTED: 10, 23a AUDIO-VISUAL: 3c	
11. Creative Writing: "How Does Abstinence in Premarital Relation-		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESO
	ships Show Positive Values and Constructive Use of One's Sexuality?"	
	Teacher Information	
	Teacher should use judgment in discussing homosexuality as it is natural for boys and girls to feel friendly toward the same sex. Also, judgment should be used in describing characteristics or differences in appearance of a homosexual.	

Goal VII: To employ suitable and effective communication about human sexuality

Concept G: Effective communication

GENERALIZATIONS	LEARNING EXPERIENCES	RESO
1. Correct and proper vocabulary facilitates verbal communication.	Note: It is recommended that the development of a proper vocabulary should be a part of the specific learning experience to which the words pertain rather than an isolated and separate skill.	
2. The beauty and goodness of the total human being can be expressed in many ways.	1. Develop appropriate vocabulary for all areas. Check on knowledge and usage of vocabulary by written tests, questions and answers, and discussions.	
3. Sexuality may be expressed in verbal and nonverbal ways.	2. Contrast the meaning of beauty and truth in the arts to the purpose of pornographic and obscene material.	
4. The family setting serves as a laboratory for learning communication.	3. Examine verbal ways to express one's sexuality.	PRINTED: 8 AUDIO-VISU
5. Words are often assigned to build a slang or double meaning vocabulary; meanings of words may change.	4. Examine nonverbal ways to express sexuality such as manners, dress, behavior, and treatment of and relationships to others.	PRINTED: 6
6. Sexual feelings can be stimulated and aroused through the senses.	5. Give examples of direct and indirect sl[illegible]motions based on sex.	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
7. Obscene and profane words directed at a person may be used as a weapon to cause injury or to express anger; they may result in hostile or aggressive behavior.	6. Panel Discussion: "Effect of Mass Media on One's Standards, Behavior, and Sexual Feelings."	
	7. Discuss good and poor qualities of movies, books, recordings, and television.	
8. Some sale promotions are based on sex and may directly or indirectly affect attitudes toward sex. They are often genital centered.	8. Question: "Do Actions Speak Louder Than Words?"	
	9. Dramatize various means of communication such as speech and manners.	
9. Open communication among groups or individuals provides for interaction, testing of ideas, and a process for growth.		

Goal VIII: To understand anatomical, physiological, psychological, and sociological maturati

Concept H: Human growth and development

1. Adolescence is that period of growth when one moves from childhood to adulthood; puberty marks the onset of adolescence.	1. Explain that growth patterns vary for individuals, but all go through the same stages in an orderly sequence. All parts of the body grow and change, but not at the same rate.	PRINTED: 10, 20b, 21a, 2 AUDIO-VISUAL: 6a, 7a
2. Many changes in the physical, psychological, and sociological development of boys and girls occur during adolescence; these changes proceed in an orderly fashion, alternating between fast and slow.	2. Discuss the growth changes for boys and for girls which take place during adolescence, including the secondary sex characteristics, awakening of sexual feelings, and interest in the other sex.	PRINTED: 10, 20b, 21a, 2
3. Individuals grow and develop at varying rates.	3. Study the growth changes which characterize puberty such as physiological readiness for a boy to become a father and a girl to become a mother.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Panel Discussion: "Effect of Mass Media on One's Standards, Behavior, and Sexual Feelings."		7. Awareness of the difference between art, pornography, and obscenity.
Discuss good and poor qualities of movies, books, recordings, and television.		
Question: "Do Actions Speak Louder Than Words?"		
Dramatize various means of communication such as speech and manners.		

nical, physiological, psychological, and sociological maturation as related to sexuality

levelopment

. Explain that growth patterns vary for individuals, but all go through the same stages in an orderly sequence. All parts of the body grow and change, but not at the same rate.	PRINTED: 10, 20b, 21a, 21b AUDIO-VISUAL: 6a, 7a	1. Realizes that the period of adolescence marks the second greatest growth change of an individual. 2. Demonstrates an awareness that growth patterns vary.
. Discuss the growth changes for boys and for girls which take place during adolescence, including the secondary sex characteristics, awakening of sexual feelings, and interest in the other sex.	PRINTED: 10, 20b, 21a, 21b	3. Awareness of the miracle of creating a new life. 4. Understands the roles of the female and the male in conception and fertilization.
. Study the growth changes which characterize puberty such as physiological readiness for a boy to become a father and a girl to become a mother.		5. Realizes that each individual, whether male or

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
4. Girls usually enter puberty earlier than boys and, therefore, experience rapid growth changes ahead of boys; later, growth in girls levels off while boys continue their growth changes.	4. Compare the rate and nature of growth changes in boys and in girls.	PRINTED: 21a, 21b AUDIO-VISUAL: 6a
	5. Question: "What Do These Growth Changes Mean in Terms of Interests, Activities, and Relationships?"	PRINTED: 10
	6. Examine the particular function of the pituitary gland in growth changes.	PRINTED: 20b AUDIO-VISUAL: 12a
5. Hormones secreted by various glands of the body cause the development of secondary sex characteristics which result in physical maturity.	7. Briefly study the endocrine system, including the functions and location of the various glands.	PRINTED: 20b AUDIO-VISUAL: 12a
6. Conception is the union of a sperm cell from the male and the ovum from the female.	8. Questions: (a) "What Is Meant by the Growth Spurt?" (b) "Do All Adolescent Changes Such as Physical and Psychological Take Place at the Same Time?" (c) "Is It Normal at This Period To Have Sudden Changes of Moods and Feelings?"	PRINTED: 10, 20b, 21a, 2 AUDIO-VISUAL: 6a
7. People are born male or female, but learn masculinity and femininity to different degrees.	9. Discuss the importance of total growth and development, including social, mental, physical, spiritual, and sexual. Use different colored strings to demonstrate importance of total development. (A single string breaks easily. Two or more intertwined are more difficult to break.)	
8. Each one is unique; heredity and environmental influences are significant in determining this uniqueness.	10. Explain conception and fertilization as the beginning of new life.	PRINTED: 9, 11, 17a, 20a AUDIO-VISUAL: 9f, 11a
9. The reproductive systems of the male and the female are different because each has a special function to perform.	11. Study cell division, including cell specialization; study in particular the reproductive cells, the sperm and the ovum.	PRINTED: 1
10. The reproductive system is present at birth, but, unlike the other systems of the body, does not function and mature until adolescence.	12. Explain role of genes and chromosomes in determining heredity factors, sex of baby, and presence of particular female and male characteristics in the individual.	PRINTED: 1, 10, 12, 17a
11. The sex drive is a normal, powerful urge which	13. Discuss the miracle of a new life.	PRINTED: 17a AUDIO-VISUAL: 9d

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Compare the rate and nature of growth changes in boys and in girls.	PRINTED: 21a, 21b AUDIO-VISUAL: 6a	female, inherits some male and female traits.
Question: "What Do These Growth Changes Mean in Terms of Interests, Activities, and Relationships?"	PRINTED: 10	6. Realizes some of the factors which may prevent fertilization of the human ovum.
Examine the particular function of the pituitary gland in growth changes.	PRINTED: 20b AUDIO-VISUAL: 12a	7. Realizes the meaning of uniqueness.
Briefly study the endocrine system, including the functions and location of the various glands.	PRINTED: 20b AUDIO-VISUAL: 12a	8. Recognizes the basis for and accepts individual differences.
Questions: (a) "What Is Meant by the Growth Spurt?" (b) "Do All Adolescent Changes Such as Physical and Psychological Take Place at the Same Time?" (c) "Is It Normal at This Period To Have Sudden Changes of Moods and Feelings?"	PRINTED: 10, 20b, 21a, 21b AUDIO-VISUAL: 6a	9. Realizes that one can improve in many ways and that few individuals reach their maximum potential.
		10. Respects one's own family heritage and those of others.
		11. Uses proper vocabulary.
Discuss the importance of total growth and development, including social, mental, physical, spiritual, and sexual. Use different colored strings to demonstrate importance of total development. (A single string breaks easily. Two or more intertwined are more difficult to break.)		12. Understands the anatomy and physiology of the male and female reproductive system as evidenced by a pencil-paper test, discussions, explanation of charts, and various other evaluative techniques.
Explain conception and fertilization as the beginning of new life.	PRINTED: 9, 11, 17a, 20a AUDIO-VISUAL: 9f, 11a	
Study cell division, including cell specialization; study in particular the reproductive cells, the sperm and the ovum.	PRINTED: 1	13. Understands that sexual feelings and desires are normal.
Explain role of genes and chromosomes in determining heredity factors, sex of baby, and presence of particular female and male characteristics in the individual.	PRINTED: 1, 10, 12, 17a, 20b	14. Appreciates the differences between sexual behavior of human beings and animals.
Discuss the miracle of a new life.	PRINTED: 17a AUDIO-VISUAL: 9d	15. Realizes that sexual activity can become a problem and that there are

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
insures perpetuation of the human race. Positive expression of the sex drive can enrich one's life, bringing satisfaction, joy, and fulfillment to husband and wife.	14. Explain the growth and development of a single child, twins, and multiple births. Make use of models, transparencies, pictures, and reading materials. (Siamese twins may be included.)	PRINTED: 10, 17a
12. Psycho-sexual differences in men and women are demonstrated in their personalities, behavior, and desires.	15. Explain that fertilization may not occur each time that individuals have sexual relationships. This can be due to many reasons. Note: Use judgment when discussing the reasons.	
13. Freedom of the individual to choose whether or not to have sexual relationships carries responsibility for behavior.	16. Construct a family tree and follow certain family traits or characters such as color blindness through several generations.	
14. Sexual restraint and management does not harm one or cause one to be unhealthy.	17. Explore how these traits or characters are acquired from parents and passed on from generation to generation.	PRINTED: 9 AUDIO-VISUAL: 11a
15. Masturbation will not cause physical harm. Presence of emotional factors (fear or guilt), violation of religious beliefs, and concern for social attitudes may result in personal problems.	18. Explain the function of genes and chromosomes in determining the pattern of each individual. Question: "Why Are No Two Individuals Exactly Alike?"	PRINTED: 9
16. The development of the unborn baby from fertilization to birth follows a complex and orderly pattern of growth.	19. Study how the environment—including family, friends, community, and school—influences the type of person one becomes.	
	20. Study various additional factors which influence individual development; these would include disease, poor nutrition, poor health habits, improper functioning of various parts of the body, and accidents.	
	21. Questions: (a) "Does Heredity or Environment Have the Most Influence on Personality and Character Development?" (b) "Can Desire To Improve and Willingness	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
14. Explain the growth and development of a single child, twins, and multiple births. Make use of models, transparencies, pictures, and reading materials. (Siamese twins may be included.)	PRINTED: 10, 17a	ways to cope with such problems.
15. Explain that fertilization may not occur each time that individuals have sexual relationships. This can be due to many reasons. Note: Use judgment when discussing the reasons.		16. Awareness that expression of physical affection between sexes is not wrong, but can lead to sexual arousal.
16. Construct a family tree and follow certain family traits or characters such as color blindness through several generations.		17. Realizes that masturbation does not cause physical harm; rather, it is the attitude of the individual concerned which may cause a problem.
17. Explore how these traits or characters are acquired from parents and passed on from generation to generation.	PRINTED: 9 AUDIO-VISUAL: 11a	18. Understands the differences in sexual feelings and desires in boys and in girls and that considering these differences can help build happiness and respect between the sexes.
18. Explain the function of genes and chromosomes in determining the pattern of each individual. Question: "Why Are No Two Individuals Exactly Alike?"	PRINTED: 9	19. Demonstrates an awareness of trustworthy and reliable sources from which to seek help with problems.
19. Study how the environment—including family, friends, community, and school—influences the type of person one becomes.		20. Understands the miracle of birth.
20. Study various additional factors which influence individual development: these would include disease, poor nutrition, poor health habits, improper functioning of various parts of the body, and accidents.		
21. Questions: (a) "Does Heredity or Environment Have the Most Influence on Personality and Character Development?" (b) "Can Desire To Improve and Willingness		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	To Correct Liabilities Help To Overcome Influences of One's Heredity or Environment?"		
	22. Study in detail the anatomy and physiology of the male and the female reproductive systems, including menstruation, menopause, seminal emissions, and erection.	PRINTED: 1, 9, 10, 11, 20a, 20b AUDIO-VISUAL: 3c, 6a, 9b, 9e	
	23. Make use of visual aids such as films, transparencies, and charts in presenting this topic.		
	24. Develop proper vocabulary.		
	25. Explain that the sex drive is a natural part of each individual, just as eating and breathing.		
	26. Questions: (a) "If One Does Not Give Expression to the Sexual Drive Over a Period of Time, Does Sexual Power Diminish?" (b) "What Are Ways to Sublimate Sexual Feelings?"		
	27. Discuss the differences in sexual response of boys and girls. Example: Boys' sexual feelings are aroused quickly and immediate sexual satisfaction is desired, whereas a girls' sexual feelings are aroused more slowly, with romantic love, rather than immediate sexual response, desired.		
	28. Panel Discussion: "Physiological and Psychological Sex Differences in Boys and Girls."		
	29. Question: "What Are Ways of Coping with Expressions of Feelings and Drives in Self and Others?"		
	30. Compare freedom and responsibility of human beings and animals in sexual behavior and concern and care of offspring.	PRINTED: 9	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	31. Explain masturbation. Ask pupils to consider its effect on the total individual.	PRINTED: 24b	
	32. Discussion: (a) "What Are Reasons for Not Satisfying the Sexual Drive Before Marriage?" (b) "Can the Expression of Affection Through Physical Contact with Another Person Result in Sexual Arousal?" (c) "What Are Types of Sexual Problems Which Can Face Adolescents?"	PRINTED: 20b	
	33. Explain the meaning of the following terms or words in preparation for study: prenatal period, postnatal period, gestation, pregnancy, embryo, fetus, conception, fertilization, labor, umbilical cord, and afterbirth.	PRINTED: 20a	
	34. Use models, transparencies, films, and reading materials to study and chart the growth of the baby during the approximate nine months of the prenatal period.	PRINTED: 9, 16, 17a AUDIO-VISUAL: 9a, 13a	
	35. Discuss the health care needed by the mother during this period.		
	36. Explain the process of birth of the baby. Use models, charts, and transparencies.	PRINTED: 9	
	37. Discuss ways in which the mother is helped before, during, and after the birth of the baby.		
	38. Explore ways that members of the family can help during the time the mother is pregnant and after the baby is born.		
	39. Questions: (a) "What Is a Miscarriage?" (b) "What Is the Difference Between Natural and Induced Abortion?"		

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Printed Resources

BOOKS FOR JUNIOR HIGH SCHOOL

1. Boyer, Donald Allen. *For Youth To Know*. Laidlaw, 1966.
2. Buck, Pearl S. *Children for Adoption*. Random, 1965. $4.95 (362.7)
3. Engle, T. L. *Psychology: Its Principles and Application*. 4th ed. Harcourt, 1964. $4.20; workbook, $1.95; teachers manual and objective tests with answers, 60¢
4. Glassberg, Bert. *Barron's Teen-age Sex Counselor*. Barron's, 1965. $3.75; paper, $1.75
5. Gottleib, David, and Charles Ramsey. *American Adolescent*. Dorsey, 1964. $10.00; text ed., $7.50 (301.4)
6. Hall, Edward. *The Silent Language*. Fawcett, 1961. Paper, 60¢ (301.2)
7. Hettlinger, Richard. *Living with Sex: The Student's Dilemma*. Seabury, 1966. Paper, $1.95 (392.6)
8. Johnson, Eric. *How To Live Through Junior High School*. Lippincott, 1959. Paper, $4.95
9. Johnson, Eric. *Love and Sex in Plain Language*. Rev. ed. Lippincott, 1967. $3.50 (612.6)
10. Julian, C., and Elizabeth Jackson. *Modern Sex Education*. Holt, 1967. Paper, $2.00; teachers guide, 64¢ (612.6)
11. Morrison, Thomas. *Human Reproduction*. Holt, 1963. Paper, 72¢ (612.6)
12. Schienfeld, Amram. *Your Heredity and Environment*. Lippincott, 1965. (575.1)

PROFESSIONAL BOOKS

13. Anderson, Wayne. *How To Understand Sex*. Denison, 1966. $6.95 (392.6)
14. Bettelheim, Bruno. *Love Is Not Enough: The Treatment of Emotionally Disturbed Children*. Collier-Macmillian, n.d. Paper, $1.50 (372.16)
15. Duvall, Evelyn. *Today's Teenagers*. Association Press, 1966. $4.95 (372.12)
16. Flanagan, Geraldine. *The First Nine Months of Life*. Simon and Schuster, 1962. $3.95 (611.013)

CHARTS, PAMPHLETS, AND PERIODICALS

17. American Medical Association, 533 North Dearborn Street, Chicago, Illinois 60610
    a. *The Miracle of Life*. 20¢ each; orders over 100, 15¢ each.

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18. American Social Health Association, 1790 Broadway, New York, New York 10019
    a. *The Dating Ladder*. Poster.
    b. *Family Life Concern*. Chart. $1.00
    c. *Family Life Cycle*. Chart. $1.00
19. *Life* Magazine
    a. "Drama of Life Before Birth." Vol. 58 (April 30, 1965) 62-69.
20. Minnesota Department of Health, Shipping Department, 717 Delaware Street S.E., Minneapolis, Minnesota 55440
    a. *Facts Aren't Enough* by Marion O. Lerrigo and M. A. Southard. AMA-NEA series. Free in small quantities; large quantities must be ordered from the AMA or NEA at 50¢ per copy. Adult reference.
    b. *Finding Yourself* by Marion O. Lerrigo and M. A. Southard. AMA-NEA series. Free in small quantities; large quantities must be ordered from the AMA or NEA at 50¢ per copy. Student reference.
    c. *Venereal Disease Education: A Teaching Guide*. Free to teachers.
21. National Dairy Council, 111 North Canal Street, Chicago, Illinois 60606
    a. *A Boy and His Physique*. Free to teachers; write for prices on quantity orders. Student reference.
    b. *A Girl and Her Figure*. Free to teachers; write for prices on quantity orders. Student reference.
22. *Phi Delta Kappan* Magazine
    a. "The Pill, the Sexual Revolution, and the Schools" by A. Montagu. Vol. 49 (May 1968) 480-484.
    b. "Too Many People: Can Educators Find an Answer?" by Walter Pitkin, Jr. Vol. 49 (May 1968) 473-479.
23. Public Affairs Pamphlets, 22 East 38th Street, New York, New York 10046
    a. *Coming of Age: Problems for Teenagers* by Paul Landis. Pamphlet No. 234. 25¢
24. Sex Information and Education Council of the U.S., 1855 Broadway, New York, New York 10023
    a. *Homosexuality*. Study Guide No. 2. 50¢ Adult reference.
    b. *Masturbation*. Study Guide No. 3. 50¢ Adult reference.
25. Science Research Associates, 228 South Wabasha, Chicago, Illinois 60600
    a. *Understanding Yourself* by William Menninger. 80¢; more than 25 copies, 75¢

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Audio-Visual Resources

FILMSTRIPS

1. Cathedral Films, Inc., 2921 Alameda Avenue, Burbank, California 91505 (Northern Distributors, 109 Lea Place, Albert Lea, Minnesota 56007)
   a. *Love and the Facts of Life.* 5 filmstrips, 3 records. $46.00
   b. *Teen/Parent Relationships.* 6 filmstrips, 3 records. $51.50
2. Glenn Educational Films, P.O. Box 371, Monsey, New York 10952
   a. *Health Guidance in Family Living and Sex Education.*
      "About Boys." Sound filmstrip.
      "About Girls." Sound filmstrip.
3. Guidance Associates, Pleasantville, New York 10570
   a. *Dare To Be Different.* Parts I and II. 2 filmstrips, 2 records, teachers manual. $40.00
   b. *Developing Your Personality.* 2 filmstrips, 2 records, teachers manual. $40.00
   c. *Learning About Sex.* 1 filmstrip, 1 record, teachers manual. $20.00
   d. *Masculinity and Femininity.* 2 filmstrips, 2 records, teachers manual. $40.00
   e. *Sex: A Moral Dilemma for Teenagers.* Parts I and II. 2 filmstrips, 2 records, teachers manual. $40.00
   f. *Sexual Values in Society.* 2 filmstrips, 2 records, teachers manual. $40.00
4. Stephen Bosustow Productions, Malibu, California 90265
   a. *A Basis for Sex Morality.* 6 filmstrips, 3 records. $45.90 Secular version.

TRANSPARENCIES

5. Fox, James Rogers, and Helen Starr. *Human Sexuality Education.* Teaching kit containing guide to resources, transparencies, tapes, booklets. In preparation. Will be available from Teaching Aids Medically Authenticated, Suite 795, 608 2nd Avenue South, Minneapolis, Minnesota 55402.
6. Minnesota Mining and Manufacturing Company, Visual Products Division, 3M Center, P.O. Box 3344, St. Paul, Minnesota 55101
   a. *The Family Serves To Perpetuate Man and To Fulfill Certain Health Needs.* Concept No. 6. Level III. 5 sets, 20 transparencies each. Set, $35.00

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FILMS

7. Henk Newenhouse, Inc., 1825 Willow Road, Northfield, Illinois 60093
   a. *Human Growth.* Three 4-minute color cartridge films. $37.50
8. McGraw-Hill Book Company, 330 West 42nd Street, New York, New York 10036
   a. *You're No Good.* 28 min. Rental: $8.00
9. Minnesota Department of Health, Film Library, 717 Delaware Street S.E. Minneapolis, Minnesota 55440
   a. *Biography of the Unborn.* 15 min. Free on loan.
   b. *Boy to Man.* 16 min. Free on loan.
   c. *Early Marriage.* 26 min. Free on loan.
   d. *From Generation to Generation.* 30 min. Free on loan.
   e. *Girl to Woman.* 16 min. Free on loan.
   f. *Human Reproduction.* 2nd ed. 20 min. Free on loan.
   g. *The Innocent Party.* 17 min. Free on loan.
   h. *Psychological Differences Between the Sexes.* 19 min. Free on loan.
   i. *Quarter Million Teenagers.* 16 min. Free on loan.
10. Minnesota Department of Public Welfare, 500 Centennial Building, St. Paul, Minnesota 55101
    a. *How Are You?* 16 min. Free on loan.
11. Northwestern Bell Telephone Company, Film Library, 224 South 5th Street, Minneapolis, Minnesota 55402
    a. *The Thread of Life.* 59 min.
12. Univerity of Minnesota, Audio-Visual Extension Service, General Extension Division, 2037 University Avenue S.E., Minneapolis, Minnesota 55455
    a. *Endocrine Glands — How They Affect You.* 15 min. Rental: $2.50

MODELS

13. Denoyer-Geppert, Ravenswood Avenue, Chicago, Illinois 60640
    a. *Human Development Models.* 8 models. $145.00

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Scope and Sequence for Family Life and Sex Education

SENIOR HIGH SCHOOL

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Goal I: To acquire a maturing self-image which enables the individual to live out his as a male or female

Concept A: Relationship of an individual's sexuality to his total personality developi

GENERALIZATIONS	LEARNING EXPERIENCES	RESOU
1. Personality is complex, ever changing, and expanding.	1. Review meaning of personality, including factors which help one develop a positive self-image and gain acceptance by others.	PRINTED: 24
2. The development of a sense of "self" is a gradual and continuing process.	2. Discuss effect of heredity and environment on one's personality and well-being.	PRINTED: 5
3. An understanding of and acceptance of one's self are basic to the understanding and acceptance of others.	3. Brainstorm Session Topics: (a) "Compare Personality Changes Since the Junior High School Years." (b) "Changes in Attitudes Towards Sexuality."	
4. Growth in the development of a positive and constructive philosophy of life is indicative of a maturing personality.	4. Creative Writing: "My Personality Assets and Liabilities and the Skills Which I Have Developed."	
5. Sexuality is an integral part of life and a vital part of personality.	5. Examine case studies to find evidence of positive and negative personality traits of individuals concerned.	
	6. Panel Discussion: "How Did I Develop My Sexual Identity?"	PRINTED: 11
	7. Creative Writing: (a) "How Did I Become the Person I Am?" (b) "Influences in My Life."	
	8. Discussion Questions: "What Is Meant by Maturity?" "Sexual Maturity?"	
	9. Question: "What Are the Personality Traits of an Emotionally Mature Personality?"	
	10. Discussion Questions: (a) "Is It Normal To Have an Erotic Dream?" (b) "Is It Normal To Have Seminal Emissions?"	

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re a maturing self-image which enables the individual to live out his sexuality in a responsible and creative way
or female

tionship of an individual's sexuality to his total personality development

TIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
omplex, nd	1. Review meaning of personality, including factors which help one develop a positive self-image and gain acceptance by others.	PRINTED: 24	1. Realizes that personality can change and improve.
t of a a gradual process.	2. Discuss effect of heredity and environment on one's personality and well-being.	PRINTED: 5	2. Realizes meaning of the "self" and factors which contribute to one's total development.
ng of and e's self are erstanding of others.	3. Brainstorm Session Topics: (a) "Compare Personality Changes Since the Junior High School Years." (b) "Changes in Attitudes Towards Sexuality."		3. Realizes importance of self-worth and responsibility in being the kind of person one wants to be.
evelop- ve and losophy of of a nality.	4. Creative Writing: "My Personality Assets and Liabilities and the Skills Which I Have Developed."		4. Shows tolerance toward others.
ntegral a vital part	5. Examine case studies to find evidence of positive and negative personality traits of individuals concerned.		5. Demonstrates acceptance of oneself and a positive self-image.
	6. Panel Discussion: "How Did I Develop My Sexual Identity?"	PRINTED: 11	6. Develops an awareness of the importance of maintaining consistency between goals set for oneself and one's actions in the development of a healthy personality.
	7. Creative Writing: (a) "How Did I Become the Person I Am?" (b) "Influences in My Life."		7. Perceives the relationship of responsible sexual behavior to a philosophy of life.
	8. Discussion Questions: "What Is Meant by Maturity?" "Sexual Maturity?"		8. Possesses a set of behavior guidelines, including sexual behavior.
	9. Question: "What Are the Personality Traits of an Emotionally Mature Personality?"		9. Understands the relationship of one's sexuality to total personality development; understands
	10. Discussion Questions: (a) "Is It Normal To Have an Erotic Dream?" (b) "Is It Normal To Have Seminal Emissions?"		

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ENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	11. Show a film (such as *How Are You?*) which emphasizes a positive and a negative self-image.	AUDIO-VISUAL: 9a	that one's personality is an image of oneself.
	12. Review basic human needs and how they affect one's self-image and worth.	PRINTED: 9 AUDIO-VISUAL: 2d, 6a	10. Seeks help with problem from trustworthy and professional sources.
	13. Explain that feelings of self-worth are dependent upon the extent that basic human needs of the individual have been met.	PRINTED: 15	11. Understands the importance of acceptanc of one's sexuality to one well-being.
	14. Discuss meaning of self-actualization. (Development of the motivation to do creative work according to the individual's abilities and interests.) Why is self-actualization basic to self-understanding and accepting oneself?	PRINTED: 18	
	15. Role-play: Present several situations which show an individual's lack of understanding of others. Assign roles to students to demonstrate how they would deal with the situations. Evaluate in terms of consideration of basic human needs of self and others.	AUDIO-VISUAL: 10b	
	16. Creative Writing: (a) "What Do I Expect To Be Ten Years from Now?" (b) "What Are Barriers Between Me and My Goal?" (c) "How Am I Planning To Overcome These Barriers?" (Teacher should use information in confidence.)	PRINTED: 32d, 32f	
	17. Panel Discussion: (a) "What Is Meant by and Included in a Personal Philosophy of Life?" (b) "How Does One Develop a Philosophy of Life?" (The school counselor may be used as a resource person.)	PRINTED: 22, 29	
	18. Brainstorm Session: "Sexual Behavior as a Part of a Philosophy of Life."	PRINTED: 22	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOUR
	19. Theme: "My Long-Range Goals and How I Plan To Achieve Them." (English department may become involved.)	
	20. Read biographies about other people to develop personality. Example: Astronauts have listed 20 ways of self-identity with "Who Am I?"	
	21. Discuss the facets of wholesome sexuality. Examples: manners, personality, human relationships, physical and mental development, role in society.	PRINTED: 34b
	22. Panel: "In What Ways Are the Masculine and Feminine Roles in Our Society Different and Ever Changing?"	AUDIO-VISUAL:
	23. Conduct study and research on the biological and psychological basis for the similarities and differences in masculine and feminine roles.	

Goal II: To understand the nature and purpose of the family as the basic unit in soci its members

Concept B: Family's role in human sexuality

1. The family is the basic unit of our society.	1. Examine the meaning and purpose of the family in our society through use of panel discussions, reading, research, and special personnel.	PRINTED: 2, 21, AUDIO-VISUAL:
2. The family serves to perpetuate man, to fulfill human needs, and to transmit cultural patterns from generation to generation.	2. Discuss the changing structure of the family in our society.	PRINTED: 7, 17
3. Functions and responsibilities of the family regarding child bearing and rearing include control of	3. Discuss factors that strengthen or threaten the stability and integrity of the family today.	PRINTED: 21 AUDIO-VISUAL:
	4. Role-play: Set up several situations concerned with parental decisions about behavior of children, such as	PRINTED: 4

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
19. Theme: "My Long-Range Goals and How I Plan To Achieve Them." (English department may become involved.)		
20. Read biographies about other people to develop personality. Example: Astronauts have listed 20 ways of self-identity with "Who Am I?"		
21. Discuss the facets of wholesome sexuality. Examples: manners, personality, human relationships, physical and mental development, role in society.	PRINTED: 34b	
22. Panel: "In What Ways Are the Masculine and Feminine Roles in Our Society Different and Ever Changing?"	AUDIO-VISUAL: 2b, 2c	
23. Conduct study and research on the biological and psychological basis for the similarities and differences in masculine and feminine roles.		

nature and purpose of the family as the basic unit in society and the roles played by the family and

human sexuality

1. Examine the meaning and purpose of the family in our society through use of panel discussions, reading, research, and special personnel.	PRINTED: 2, 21, 32b, 32c AUDIO-VISUAL: 6a	1. Shows more mature understanding of the importance of the family in our society and the potential contributions of each member to its success.
2. Discuss the changing structure of the family in our society.	PRINTED: 7, 17	
3. Discuss factors that strengthen or threaten the stability and integrity of the family today.	PRINTED: 21 AUDIO-VISUAL: 8f	2. Realizes that a family needs to provide an atmosphere for the development of family and individual goals if it is to achieve its purpose in
4. Role-play: Set up several situations concerned with parental decisions about behavior of children, such as	PRINTED: 4	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
behavior, economic support, and securing health, welfare, and spiritual needs.	dating, choice of friends, selection of clothing, and sexual behavior. Assign students to role-play the various members. Summarize by developing a set of principles to help in developing sound parent-child relationships and standards of behavior.	
4. Each family member, regardless of the structure of his family, should be helped to recognize and respect the changing feelings and needs of others in the family environment.	5. Creative Writing: (a) "How Has My Family Helped Me To Select a Set of Goals?" (b) "What Values and Behavior Standards Have I Learned from My Family?"	AUDIO-VISUAL: 8e
5. Regardless of the individual family pattern, each member experiences the progressive stages of the family life cycle.	6. Carefully review stages in the family life cycle. Provide reading and research references.	PRINTED: 1, 32b, 32c
6. The various family patterns, with their similarities and differences, influence the development of an individual's sexuality.	7. Panel Discussion: (a) "Role and Responsibility of Class Member at the Present Stage in the Family Life Cycle and at Future Stages." (b) "How Do I Change My Family?"	PRINTED: 5, 32e AUDIO-VISUAL: 8f
7. Through psycho-sexual relationships, marriage provides the husband and wife a means to express their deep love for one another in a rich, positive, and meaningful way.	8. Creative Writing: "What Is My Responsibility as an Older Adolescent or Young Adult To Help My Family Achieve Its Goals and Purposes?"	AUDIO-VISUAL: 2i
8. There are various approaches to solving family problems and to improving marital health.	9. Review the meaning of sexuality and ways in which the family affects one's sexuality. Summarize ways in which standards and customs of the family affect one's personality, including sexuality.	PRINTED: 1
9. Family planning includes the selection of methods relating to and the agreement by husband and wife on number and spacing of children according to individual beliefs and standards.	10. Examine many kinds of family patterns. Summarize how they are affected by environment.	PRINTED: 1, 21 AUDIO-VISUAL: 10a
	11. Creative Writing: "What I Think Marriage Is Like?"	
	12. Investigate sources from which married couples can receive counseling and help to overcome problems	

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RNING EXPERIENCES	RESOURCES	EVALUATION
choice of friends, selection of g, and sexual behavior. Assign ts to role-play the various rs. Summarize by developing principles to help in develop- nd parent-child relationships ndards of behavior.		giving support and love to its members.
ve Writing: (a) "How Has mily Helped Me To Select a Goals?" (b) "What Values havior Standards Have I d from My Family?"	AUDIO-VISUAL: 8e	3. Shows increasing respect for one's family, recognizing its strengths, its problems, and that there are ways of improving one's family.
lly review stages in the family le. Provide reading and h references.	PRINTED: 1, 32b, 32c	4. Demonstrates an awareness of the responsibility of the family for its members.
Discussion: (a) "Role and sibility of Class Member at sent Stage in the Family Life nd at Future Stages." (b) Do I Change My Family?"	PRINTED: 5, 32e AUDIO-VISUAL: 8f	5. Appreciates the importance of family standards and guidelines.
ve Writing: "What Is My sibility as an Older Ado- or Young Adult To Help My Achieve Its Goals and Pur- "	AUDIO-VISUAL: 2i	6. Demonstrates an awareness of sources of help for families.
the meaning of sexuality and n which the family affects one's ity. Summarize ways in which rds and customs of the family one's personality, including ity.	PRINTED: 1	7. Realizes that one's sexuality — including positive and negative attitudes and standards to guide one's sexual behavior — is acquired primarily in the family.
ne many kinds of family pat- Summarize how they are d by environment.	PRINTED: 1, 21 AUDIO-VISUAL: 10a	8. Realizes that complete sexual expression includes more than physical or genital sex relationships.
ve Writing: "What I Think ge Is Like?"		9. Recognizes the right of the family to choose a method of family planning.
igate sources from which mar- uples can receive counseling lp to overcome problems		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOU
	which affect marital health and happiness.	
	13. Have students determine the real interest rates when purchasing goods on installments. (Involve the mathematics department.)	PRINTED: 2, 4
	14. Explain the meaning of family planning. Summarize each family's right to choose its own method. Investigate the places of religion, medicine, welfare, and counseling as sources of help. Explain the meaning of contraception and the various types. (Check with school administration regarding policies.) Emphasis should be placed upon kinds of contraception and not how to use such measures.	

Goal III: To demonstrate a pattern of relationships based upon insight and unders bilities to himself and others

Concept C: Effective interpersonal relationships

1. Interpersonal relationships are dynamic and ever changing; responsibility for the quality of interpersonal relationships is shared by both sexes in such activities as dating.	1. Discuss purposes of dating; asking for, accepting, or refusing a date; pros and cons of group and couple dating and of going steady; sexual behavior on dates such as necking and petting.	PRINTED: 1, 2, AUDIO-VISUAL
2. Accepting the implications of one's behavior is a first consideration for building sound interpersonal relationships.	2. Discuss the dating ladder and the purposes of each level of male-female relationships.	PRINTED: 4, 3
3. Utilizing sexuality effectively increases competence in mutually satisfying interpersonal relationships.	3. Encourage students to present dating situations and a problem in writing. (Statements can be anonymous.) Conduct class discussion on ways to cope with the situation. Summarize by analyzing standards and values.	PRINTED: 6
	4. Discuss: "Is It Not Normal to Date?"	PRINTED: 2

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
which affect marital health and happiness.		
13. Have students determine the real interest rates when purchasing goods on installments. (Involve the mathematics department.)	PRINTED: 2, 4	
14. Explain the meaning of family planning. Summarize each family's right to choose its own method. Investigate the places of religion, medicine, welfare, and counseling as sources of help. Explain the meaning of contraception and the various types. (Check with school administration regarding policies.) Emphasis should be placed upon kinds of contraception and not how to use such measures.		

ttern of relationships based upon insight and understanding of one's obligations and responsi-
others

onal relationships

1. Discuss purposes of dating; asking for, accepting, or refusing a date; pros and cons of group and couple dating and of going steady; sexual behavior on dates such as necking and petting.	PRINTED: 1, 2, 5, 6, 11, 34a AUDIO-VISUAL: 6a	1. Shows respect for self and others through sound interpersonal relationships. 2. Understands the meaning of various kinds of love.
2. Discuss the dating ladder and the purposes of each level of male-female relationships.	PRINTED: 4, 32a	3. Realizes the effect of one's sexual standards on oneself and others throughout life.
3. Encourage students to present dating situations and a problem in writing. (Statements can be anonymous.) Conduct class discussion on ways to cope with the situation. Summarize by analyzing standards and values.	PRINTED: 6	4. Demonstrates an awareness of resources and willingness to seek help with personal problems.
4. Discuss: "Is It Not Normal to Date?"	PRINTED: 2	5. Demonstrates an awareness of importance of

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
4. Selection of friends and associates has an effect on one's behavior, values, and standards.	5. Creative Writing: "Ways in Which Individuals I Admire Have Influenced My Behavior."	
5. Love is a concern for others; each one must learn meaning and expression of love, which is a concern for others, if sound human relationships are to be developed and maintained.	6. Small Group Discussion: Give each group several questions or problems received from class members to answer or solve. Report solutions to class.	
6. There are many kinds of love, each one carrying a responsibility and an obligation to oneself and others.	7. Discussion: (a) "Differences Between Meaning of 'Sexuality' and 'Sex.'" (b) "Differences Between Love and Sex." (c) "Differences Between Love and Romance."	PRINTED: 2, 4, 11 AUDIO-VISUAL: 12a
7. Promiscuity is socially irresponsible behavior.	8. Play different types of current music recordings and react.	
	9. Encourage students with problems to seek help from trustworthy sources.	
8. Premarital relationships may damage a relationship or a potentially sound marriage.	10. Review and give examples of the many kinds of love.	PRINTED: 1
9. There are socially acceptable and constructive ways to channel one's sexual drive.	11. Panel Discussion: (a) "Romantic Love Versus Mature Love." (b) "Love at First Sight." (c) "Love as a Concern for Others." (d) "How Do You Know You Are in Love?" (Consider such areas as physically attracted, mentally stimulating, spiritually in harmony, and wanting to do things for the other person.)	PRINTED: 1, 4 AUDIO-VISUAL: 1c, 2a, 2e
10. Marriage as a social institution gives legal, social, and religious approval to the desires of the husband and wife for having and rearing children, enjoyment of sexual relationships, and emotional and physical closeness.	12. Explain meaning of sound human relationships in dealing with others.	PRINTED: 1 AUDIO-VISUAL: 2e
	13. Creative Writing: "How Do I Show Sound Relationships with Others?"	AUDIO-VISUAL: 6a
	14. Question: "What Is Love?"	PRINTED: 4 AUDIO-VISUAL: 7a
11. Time is needed to develop trust, confidence, and knowledge of one another	15. Question: "Why Should Limits of Behavior on a Date Be Determined Beforehand?"	PRINTED: 6

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3

LEARNING EXPERIENCES	RESOURCES	EVALUATION
. Creative Writing: "Ways in Which Individuals I Admire Have Influenced My Behavior."		premarital and marital counseling.
. Small Group Discussion: Give each group several questions or problems received from class members to answer or solve. Report solutions to class.		6. Realizes the responsibilities and privileges of marriage.
. Discussion: (a) "Differences Between Meaning of 'Sexuality' and 'Sex.'" (b) "Differences Between Love and Sex." (c) "Differences Between Love and Romance."	PRINTED: 2, 4, 11 AUDIO-VISUAL: 12a	
. Play different types of current music recordings and react.		
. Encourage students with problems to seek help from trustworthy sources.		
. Review and give examples of the many kinds of love.	PRINTED: 1	
. Panel Discussion: (a) "Romantic Love Versus Mature Love." (b) "Love at First Sight." (c) "Love as a Concern for Others." (d) "How Do You Know You Are in Love?" (Consider such areas as physically attracted, mentally stimulating, spiritually in harmony, and wanting to do things for the other person.)	PRINTED: 1, 4 AUDIO-VISUAL: 1c, 2a, 2e	
. Explain meaning of sound human relationships in dealing with others.	PRINTED: 1 AUDIO-VISUAL: 2e	
. Creative Writing: "How Do I Show Sound Relationships with Others?"	AUDIO-VISUAL: 6a	
. Question: "What Is Love?"	PRINTED: 4 AUDIO-VISUAL: 7a	
. Question: "Why Should Limits of Behavior on a Date Be Determined Beforehand?"	PRINTED: 6	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
if both parties are to acquire the deep and long time personal relationships needed in marriage.	16. Examine pros and cons of premarital sex relationships. Read case studies, examine research, and discuss with a qualified resource person.	PRINTED: 1, 2, 4, 5, 31, 34a, 39c AUDIO-VISUAL: 8b	
There are many ways to hold a marriage together and many ways to separate a marriage.	17. Review psycho-sexual differences of the male and female.	AUDIO-VISUAL: 2a, 2b, 2c, 2e, 8b	
Early marriage can present difficult problems to parties involved, to children, and to society.	18. Develop a set of guidelines and limits for dating behavior which shows respect for oneself and concern for the other person.	PRINTED: 1	
	19. Explain the meaning and implications of the "double" and "single" standards of sexual behavior.		
	20. Panel Discussion: "Ways to Cope with Undesirable Behavior of a Dating Partner."		
	21. Examine existing laws regarding marriage in different states. Discuss various marriage ceremonies, or use various church resource people, or do research. Plan a panel discussion about the rights of individuals in marriage and the ways to hold a marriage together.	PRINTED: 2	
	22. Assign reading topics on preparation for marriage, including personal readiness, mate selection, engagement period, and marriage counseling. Plan followup discussion and summary. (What are important considerations in choosing a mate?)	PRINTED: 1, 2, 4, 5, 8, 12, 16, 34a AUDIO-VISUAL: 6a	
	23. Show and examine messages of films and filmstrips covering aspects of boy-girl relationships and marriage.	AUDIO-VISUAL: 1c, 2b, 2c, 2e, 8g	
	24. Invite a marriage counselor to class to discuss marriage and marital health.	PRINTED: 4, 16	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	25. Question: "What Role Does the Single Person Have in Society?"		
	26. Review ways a marriage can be terminated such as legal separation, divorce, and other means. Consider ethical, social, and religious beliefs of parties concerned.	PRINTED: 2	
	27. Review case studies of early marriage; discuss factors which contribute to the success and failure of such marriages.		
	28. Assign reading and research materials on factors which affect success and failure in marriage. Follow with a discussion on the pros and cons of marriage where individuals have similar and dissimilar backgrounds.	PRINTED: 1, 2, 12, 16, 34a	
	29. Brainstorm Session: "How May Early Marriage Affect One's Immediate and Long-Range Goals?"	PRINTED: 2	
	30. Conduct Research on the Questions: (a) "What Are the Chances That an Early Marriage Will Be Successful?" (b) "Unsuccessful and Why?" (c) "Why Is Society Concerned About Early Marriages?"	AUDIO-VISUAL: 2a, 8g	
	31. Discuss the importance of individuals who plan marriage attending a premarital counseling course or premarriage course.	AUDIO-VISUAL: 2e	
	32. Case Studies: "Should They Get Married?" (List a number of circumstances and have class make the decision.)		
	33. Creative Writing: "What Is a Marriage?"	PRINTED: 1, 2	

Goal IV: To understand the influences on sexuality of political, philosop liefs, customs, and laws in a pluralistic society

Concept D: Factors affecting societal values on sexuality

GENERALIZATIONS	LEARNING EXPERIENCES
1. Political, philosophical, religious, and cultural beliefs influence patterns of sexual behavior.	1. Review the various forms of political ideologies. Compare them with a democratic pluralistic ideology in regards to existing laws related to sexual behavior. Examples: abortion laws, marriage laws, population control and birth control, and deviant sexual behavior. (Examine reference materials.)
2. Examination of various individual and societal beliefs relating to sexual behavior will increase a person's understanding of the need for a personal code of behavior to assist in adjustment to societal influences and demands.	2. Debate the existing laws related to sexual behavior.
3. Varying religious beliefs affect standards of sexual behavior.	3. Examine philosophical beliefs apparent in a society and the effect on an individual's personal philosophy of life and development of personal value system. Example: identification and knowledge of the various beliefs of sexual behavior such as asceticism, humanism, or anarchy.
4. The family system is interrelated with and affects other parts of the culture; other parts affect the family in terms of economic, religious, political and familial; if one system changes, the others are affected.	4. Explain how varying religious beliefs determine standards of sexual behavior. (Resource people may be used. The Minnesota Council of Churches, 122 W. Franklin Avenue, Minneapolis, Minnesota 55404, will provide information.)
	5. Debate for or against censorship in the area of sexual information or misinformation.
	6. Study cultures and subcultures in society to better understand different standards of conduct in sexual behavior. Examples: double and single standard, identification of subcultures, and social class and religion.

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the influences on sexuality of political, philosophical, religious, and cultural ideologies including be-
nd laws in a pluralistic society

ting societal values on sexuality

LEARNING EXPERIENCES	RESOURCES	EVALUATION
1. Review the various forms of political ideologies. Compare them with a democratic pluralistic ideology in regards to existing laws related to sexual behavior. Examples: abortion laws, marriage laws, population control and birth control, and deviant sexual behavior. (Examine reference materials.)		1. Realizes that there are various standards of sexual behavior in our society.
2. Debate the existing laws related to sexual behavior.		2. Formulate some possible solutions to the many unsolved problems relating to family living and sexual behavior.
3. Examine philosophical beliefs apparent in a society and the effect on an individual's personal philosophy of life and development of personal value system. Example: identification and knowledge of the various beliefs of sexual behavior such as asceticism, humanism, or anarchy.		3. Appreciates the lack of agreement in the solution of these problems.
		4. Respects the right of others to have different beliefs and opinions.
		5. Recognizes the ways in which the role of the family is influenced by the various forces in our society.
4. Explain how varying religious beliefs determine standards of sexual behavior. (Resource people may be used. The Minnesota Council of Churches, 122 W. Franklin Avenue, Minneapolis, Minnesota 55404, will provide information.)	PRINTED: 14	
5. Debate for or against censorship in the area of sexual information or misinformation.	PRINTED: 14	
6. Study cultures and subcultures in society to better understand different standards of conduct in sexual behavior. Examples: double and single standard, identification of subcultures, and social class and religion.	AUDIO-VISUAL: 12a	

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
	7. Brainstorm Session: "What Are Problems and Issues Facing Our Society in the Area of Family Life and Sexuality?"	PRINTED: 17, 30, 31, 36a, 36b, 37a, 39c
	8. Independent Study and Research: "How the Role of the Family in Our Society Has Changed Due to Economic Influences, Urbanization, and Cultural Influences."	PRINTED: 4
	9. Small Group Discussions and Class Reports: (a) "What Social Forces Are Affecting the Stability of the Family? (b) "How Does Trial Marriage Affect Family Stability?" (c) "What Are the Effects of an Interfaith Marriage?" (d) "What Is the Effect of Mutuality in Marriage?" (What effects do political, socioeconomic, and religious differences have on marriage?)	PRINTED: 15

Goal V: To develop and employ a personal code of ethics which recognizes that human valu groups and individuals within a pluralistic society

Concept E: A code of personal sexual behavior as part of a total value system

1. Democratic freedom provides an opportunity and a responsibility for each individual to develop and to make decisions according to his personal value system, providing that the rights and freedoms of others are not violated.	1. Review the meaning of a code of values and the relationship of values, standards, and behavior.	PRINTED: 2, 4, 11, 13, 24, 36a, 36b AUDIO-VISUAL: 12a
	2. Independent Study: Ask each student to express in writing a personal code of value on topics such as dating behavior, family planning, interracial dating or marriage, and treatment and opportunities for unwed mothers. (Statements may be anonymous.)	
2. Each individual needs to accept the responsibility for a personal code of ethics in keeping with his value system, society's	3. Brainstorm: (a) "Is Every Individual Capable of Planning His Sexual Behavior?" (b) "May circumstances	PRINTED: 14, 31 AUDIO-VISUAL: 8b

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
7. Brainstorm Session: "What Are Problems and Issues Facing Our Society in the Area of Family Life and Sexuality?"	PRINTED: 17, 30, 31, 36a, 36b, 37a, 39c	
8. Independent Study and Research: "How the Role of the Family in Our Society Has Changed Due to Economic Influences, Urbanization, and Cultural Influences."	PRINTED: 4	
9. Small Group Discussions and Class Reports: (a) "What Social Forces Are Affecting the Stability of the Family? (b) "How Does Trial Marriage Affect Family Stability?" (c) "What Are the Effects of an Interfaith Marriage?" (d) "What Is the Effect of Mutuality in Marriage?" (What effects do political, socioeconomic, and religious differences have on marriage?)	PRINTED: 15	

loy a personal code of ethics which recognizes that human values and beliefs vary among different als within a pluralistic society

al sexual behavior as part of a total value system

1. Review the meaning of a code of values and the relationship of values, standards, and behavior.	PRINTED: 2, 4, 11, 13, 24, 36a, 36b AUDIO-VISUAL: 12a	1. Realizes that in a pluralistic democracy individuals may have different value systems.
2. Independent Study: Ask each student to express in writing a personal code of value on topics such as dating behavior, family planning, interracial dating or marriage, and treatment and opportunities for unwed mothers. (Statements may be anonymous.)		2. Appreciates the importance of a personal system of values in choosing alternates and making decisions regarding sexual behavior.
3. Brainstorm: (a) "Is Every Individual Capable of Planning His Sexual Behavior?" (b) "May circumstances	PRINTED: 14, 31 AUDIO-VISUAL: 8b	3. Demonstrates an awareness that one's standards of sexual behavior are

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCE
standards, and rights of others.	Beyond an Individual's Control Determine His Behavior?" (Example: A boy may be responsible for his girl friend's pregnancy but may not want to accept responsibility for his actions.)	
3. An individual who has developed a personal system of values is willing to make sacrifices to progress toward accepted goals which are in harmony with such values.	4. Small Group Discussions: (a) "What Factors Are Involved in Decision Making Regarding Sexual Behavior?" (b) "What Social Pressures Operate To Influence Sexual Expression?"	PRINTED: 4, 8, 14, 3 AUDIO-VISUAL: 1c,
4. In a democratic pluralistic society, one has the responsibility to recognize the right of individuals to adopt and follow different codes of ethics.	5. Panel Discussion: (a) "What Is Morality? Does It Change?" (b) "How Do Self-Integrity, Values, and Respect and Concern for Others Affect One's Moral Judgments in Regard to Sexual Behavior?" (c) "Contrast Moral and Immoral Behavior." (d) "Ways To Handle Conflicting Value Systems."	PRINTED: 30 AUDIO-VISUAL: 1a,
5. Any rules or standards of behavior should protect the individual's right to question them. Realistically, rules will sometimes be broken and standards sometimes will not be upheld. It must be recognized that an individual's mental stability frequently depends upon being able to rationalize behavior which is contrary to rules and standards.	6. Review and analyze current movies regarding effect upon values.	
6. Moral behavior implies that all relationships between people should be meaningful, substantial, and mutually valued.	7. Discuss the hedonistic point of view advocated by Hugh Hefner.	PRINTED: 14
7. Signs of maturity are meeting problems, making decisions, facing and dealing with guilt, and accepting responsibility.		

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
Beyond an Individual's Control Determine His Behavior?" (Example: A boy may be responsible for his girl friend's pregnancy but may not want to accept responsibility for his actions.)		part of one's total value system.
4. Small Group Discussions: (a) "What Factors Are Involved in Decision Making Regarding Sexual Behavior?" (b) "What Social Pressures Operate To Influence Sexual Expression?"	PRINTED: 4, 8, 14, 32d, 32f AUDIO-VISUAL: 1c, 8d, 12a	4. Accepts the rights of others in our society to have different values.
5. Panel Discussion: (a) "What Is Morality? Does It Change?" (b) "How Do Self-Integrity, Values, and Respect and Concern for Others Affect One's Moral Judgments in Regard to Sexual Behavior?" (c) "Contrast Moral and Immoral Behavior." (d) "Ways To Handle Conflicting Value Systems."	PRINTED: 30 AUDIO-VISUAL: 1a, 2h	5. Realizes that moral behavior involves making a distinction between right and wrong conduct relating to self and others.
6. Review and analyze current movies regarding effect upon values.		6. Understands that one can correct most mistakes by facing and accepting consequences.
7. Discuss the hedonistic point of view advocated by Hugh Hefner.	PRINTED: 14	7. Understands the importance of a personal set of values in choosing alternatives and making decisions.

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Goal VI: To accept a personal responsibility for positive and constructive influences on society's co sexuality

Concept F: Individual obligation and group responsibility regarding family living

GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES
1. Each individual as a member of a family, community, state, and nation has a responsibility for raising issues and coping in a constructive manner with worldwide problems of sexuality. These include moral standards, population control, sexual exploitation, sexual deviancy, venereal disease, illegitimacy, family breakdown, abortion, and legal regulation of sexual behavior.	1. Assign a research committee to report to class on the responsibilities that individuals and society have in coping with issues and problems such as (a) population control and explosion, (b) abortion, (c) venereal disease, prevention and control, (d) contraception, (e) prostitution, (f) illegitimacy, and (g) family breakdown.	PRINTED: 23, 35a, 36a, 36b, 37a AUDIO-VISUAL: 2g, 9b
2. Health, education, welfare, religious, and medical programs, official and nonofficial, have a responsibility to provide services for individuals with needs and problems, including those dealing with sexuality and family living.	2. Seminar Discussion: (a) "How Can People Be Helped To Take Responsibility for Facing and Solving These Problems in Our Society?" (b) "How Can Education Help?"	
	3. Justify: (a) "Sexual Behavior Is a Matter of Public Concern as Well as a Private Matter." (b) "Whose Business Is My Behavior?" (c) "What I Do Is My Own Business."	
	4. Creative Writing: "What Are the Implications of Irresponsible Sexual Behavior?"	
	5. Question: "What Contributes to Deviant Behavior?"	
3. An understanding of the misuse of sexuality helps one to protect himself and others against exploitation by others and injury to physical, emotional, and moral health.	6. Independent Study: "What Social and Governmental Institutions Should Have Responsibilities and What Should They Do in Regard to Meeting Needs of Individuals in the Area of Family Life and Sex Education?"	PRINTED: 3
4. Use of alcohol and drugs influences human behavior, including sexual behavior.	7. Survey resources in the school and community — such as a psychiatrist,	

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responsibility for positive and constructive influences on society's concerns for family living and

ion and group responsibility regarding family living

LEARNING EXPERIENCES	RESOURCES	EVALUATION
1. Assign a research committee to report to class on the responsibilities that individuals and society have in coping with issues and problems such as (a) population control and explosion, (b) abortion, (c) venereal disease, prevention and control, (d) contraception, (e) prostitution, (f) illegitimacy, and (g) family breakdown.	PRINTED: 23, 35a, 36a, 36b, 37a AUDIO-VISUAL: 2g, 9b	1. Realizes that each individual has a responsibility to help make his community a better place in which to live. 2. Demonstrates willingness to take an active role in facing issues and solving problems which make for human betterment.
2. Seminar Discussion: (a) "How Can People Be Helped To Take Responsibility for Facing and Solving These Problems in Our Society?" (b) "How Can Education Help?"		3. Demonstrates an awareness that individuals and groups do not agree on solutions to problems.
3. Justify: (a) "Sexual Behavior Is a Matter of Public Concern as Well as a Private Matter." (b) "Whose Business Is My Behavior?" (c) "What I Do Is My Own Business."		4. Realizes that venereal disease is a social and health problem in our society.
4. Creative Writing: "What Are the Implications of Irresponsible Sexual Behavior?"		5. Has knowledge of school and community resources where help can be secured.
5. Question: "What Contributes to Deviant Behavior?"		6. Understands the more common types of deviant sexual behavior and knows ways to cope with individuals who show such behavior.
6. Independent Study: "What Social and Governmental Institutions Should Have Responsibilities and What Should They Do in Regard to Meeting Needs of Individuals in the Area of Family Life and Sex Education?"	PRINTED: 3	7. Demonstrates an awareness that one's control of sexual behavior may be affected by alcohol and certain drugs.
7. Survey resources in the school and community — such as a psychiatrist,		

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	marriage counselor, mental health center, and social service agency — where individuals can secure help with problems relating to sexuality.		
	8. Invite resource people from various agencies of family living to discuss functions, responsibilities, and problems of the family in our society and to outline the assistance that is available to families in need.		
	9. Round Table Discussion: (a) "Where, How, and by Whom Should Sex Education Be Taught in Schools?" (b) "What Are Assets and Limitations of Such a Program?"		
	10. Group Project: Plan a program of family life and sex education for a school, K-12, showing a sequential pattern of study in terms of student needs.		
	11. Group Project: Have students evaluate their school education program in family life and sex education.		
	12. Investigate laws in the state regarding rape, incest, exhibitionism, homosexuality, and other sexual behavior.		
	13. Questions: (a) "Are the Laws Fair Regarding Sexual Behavior?" (b) "Can Sexual Behavior Be Legislated?" (c) "What Are Rights of Individuals in Our Society in Contrast to the Common Good?" (d) "Where Does Decision Making Lie?" (e) "Is Sexual Deviancy Criminal Behavior?"		
	14. Invite resource personnel to discuss effect of alcohol and drugs on one's behavior, including sexual behavior.	AUDIO-VISUAL: 2d	

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Goal VII: To employ suitable and effective communication about human sexuality

Concept G: Effective communication

GENERALIZATIONS	LEARNING EXPERIENCES	RESO
1. Effective communication may be verbal or non-verbal.	Note: It is recommended that the development of a proper vocabulary should be a part of the specific learning experience to which the words pertain rather than an isolated and separate skill.	
2. Utilization of correct terminology in the area of human sexuality can be a strengthening factor for respect of self and others.	1. List methods of verbal and non-verbal communication such as art appreciation, sense of humor, and pornography. Analyze stories in magazines and interpret music of teenagers.	
3. Verbal and nonverbal techniques are powerful tools for use in reacting to others.	2. Review court decisions on pornography and obscenity.	
4. Effective communication between individuals is of primary importance in preventing serious problems.	3. Discuss: "Why Are 'Dirty' or 'Off-Color' Jokes Told?"	
5. Failure of youth and adults to communicate about problems and needs is caused by a lack of openness, receptivity, and honesty about sexuality.	4. Discussion Topic: "The Role of Modeling (setting example) in Sexual Communication."	
6. Participating in gossip, spreading rumors, or spreading information about sexual behavior of a person as a result of hearsay, observation, or deduction of behavior can cause serious damage to a person's reputation.	5. Buzz Group Topic: "The Importance of Free and Honest Communication in Interpersonal Relations Relative to a Couple's Responsibility to One Another."	
7. Sexual aspects of personality are revealed or concealed by such things as	6. Discuss the results of a breakdown of communication such as marriage conflicts, divorce, impotency, adultery, and extramarital relationships.	AUDIO-VISU
	7. Discussion Topics: (a) "The Importance of Providing an Environment for Communication with One Another." (b) "How Can the Communication Gap Between Different Age Groups Be Narrowed or Eliminated?" (c) "What Condi-	AUDIO-VISU

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ble and effective communication about human sexuality in various situations and settings

nunication

LEARNING EXPERIENCES	RESOURCES	EVALUATION
Note: It is recommended that the development of a proper vocabulary should be a part of the specific learning experience to which the words pertain rather than an isolated and separate skill.		1. Uses correct vocabulary.
1. List methods of verbal and non-verbal communication such as art appreciation, sense of humor, and pornography. Analyze stories in magazines and interpret music of teenagers.		2. Realizes that verbal communications in areas of sexuality can be facilitated with the use of proper vocabulary.
2. Review court decisions on pornography and obscenity.		3. Understands that sexual feelings can be indirectly aroused in many ways.
3. Discuss: "Why Are 'Dirty' or 'Off-Color' Jokes Told?"		4. Values open communication.
4. Discussion Topic: "The Role of Modeling (setting example) in Sexual Communication."		5. Appreciates the importance of communication in the family setting.
5. Buzz Group Topic: "The Importance of Free and Honest Communication in Interpersonal Relations Relative to a Couple's Responsibility to One Another."		6. Realizes that gossip and rumors can be injurious to others.
6. Discuss the results of a breakdown of communication such as marriage conflicts, divorce, impotency, adultery, and extramarital relationships.	AUDIO-VISUAL: 8c	
7. Discussion Topics: (a) "The Importance of Providing an Environment for Communication with One Another." (b) "How Can the Communication Gap Between Different Age Groups Be Narrowed or Eliminated?" (c) "What Condi-	AUDIO-VISUAL: 8f	

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GENERALIZATIONS	LEARNING EXPERIENCES	RES
speech, gestures, thoughts, actions, appearance, and manners.	tions or Circumstances Can Make It Difficult for Parents and Adolescents to Communicate?"	
	8. Investigate the problem of the generation gap. Develop a panel discussion involving parents and students.	AUDIO-VISU
	9. Show a sound filmstrip or discuss a movie on the generation gap.	AUDIO-VISU
	10. Buzz Group Topics: (a) "Why Is the Reputation of the Girl More Easily Damaged Than That of the Boy as a Result of Sexual Gossip or Rumors?" (b) "Does the 'Double Standard' Have Implications?"	

Goal VIII: To understand anatomical, physiological, psychological, and sociologic

Concept H: Human growth and development

1. Maturation proceeds on an individual basis in an orderly sequence; however, each individual is unique.	1. Discussion Topic: "The Importance of an Individual Going Through a Sequence of Orderly Development and How Short Circuiting May Tend To Interfere with These Developments."	
2. Each individual should understand the anatomical, physiological, and psychological functions of human reproduction and should understand that there are similarities and differences between human and animal reproduction.	2. Debate Question: "Can Man Create Life?"	
	3. Discussion Question: "Do All Types of Maturity Such as Physical, Emotional, and Social Proceed at the Same Rate?"	PRINTED: 3 AUDIO-VIS
	4. Use charts and graphs to show different rates of growth.	
3. Developmental stages of individuals and the family life cycle are basic to a study of human reproduction.	5. Review the anatomy and physiology of the male and female reproductive systems.	PRINTED: 2 32c, 34b AUDIO-VIS
	6. Make use of charts and visual aids in presenting this topic.	

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NS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
ughts, and	tions or Circumstances Can Make It Difficult for Parents and Adolescents to Communicate?"		
	8. Investigate the problem of the generation gap. Develop a panel discussion involving parents and students.	AUDIO-VISUAL: 2i	
	9. Show a sound filmstrip or discuss a movie on the generation gap.	AUDIO-VISUAL: 8f	
	10. Buzz Group Topics: (a) "Why Is the Reputation of the Girl More Easily Damaged Than That of the Boy as a Result of Sexual Gossip or Rumors?" (b) "Does the 'Double Standard' Have Implications?"		

rstand anatomical, physiological, psychological, and sociological maturation as related to sexuality

growth and development

s on an n ow- l is	1. Discussion Topic: "The Importance of an Individual Going Through a Sequence of Orderly Development and How Short Circuiting May Tend To Interfere with These Developments."		1. Realizes the meaning of uniqueness.
uld omical, sycho- human ould re are erences ani-	2. Debate Question: "Can Man Create Life?"		2. Recognizes the basis for and accepts individual differences.
	3. Discussion Question: "Do All Types of Maturity Such as Physical, Emotional, and Social Proceed at the Same Rate?"	PRINTED: 32b, 32c AUDIO-VISUAL: 2b, 2c	3. Realizes that one can improve in many ways.
	4. Use charts and graphs to show different rates of growth.		4. Uses proper vocabulary.
es of family o a roduc-	5. Review the anatomy and physiology of the male and female reproductive systems.	PRINTED: 2, 4, 5, 11, 32b, 32c, 34b AUDIO-VISUAL: 6a	5. Demonstrates growth in understanding similarities, differences, and complimentary nature of sexes.
	6. Make use of charts and visual aids in presenting this topic.		6. Realizes that the creation of a new life is one of nature's greatest miracles.
			7. Understands the stages in the family life cycle.

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GENERALIZATIONS	LEARNING EXPERIENCES	RESOU
4. Sexuality can be expressed in many ways, not only in terms of genitality.	7. Question: "How Does Knowledge Related to Reproduction Contribute to the Development of Wholesome Attitudes?"	PRINTED: 32b
5. An understanding of the basic concepts of human genetics is important in preparing young people for marriage, parenthood, and family life.	8. Have students discuss how they would answer questions of children 5 to 8 years of age about reproduction.	PRINTED: 34a
	9. Discuss the meaning of menopause.	PRINTED: 2
6. It is important to secure frequent health and medical care throughout life; this care has a special significance for mothers during the prenatal and postnatal periods and for couples planning to be married.	10. Discussion Question: "What Is the Difference Between a Spontaneous and an Induced Abortion?"	
	11. Take a field trip to the maternity ward of a hospital to see the nursery, labor room, delivery room, and equipment.	
	12. Use charts to study the family life cycle.	
7. The individual's sex drive is a natural, powerful drive that can be controlled and directed in a responsible manner through self-understanding and self-discipline in keeping with personal values and standards.	13. Have students write a short paper regarding the meaning of sexuality. Use this information for group work or class discussion.	
	14. Stress the importance of studying an individual's chromosomes, family history, and other data in determining whether parents may have an abnormal child.	PRINTED: 5
8. Man, due to his highly developed nervous system, is able to exercise conscious control over much of his behavior; he is capable of self-directed behavior by use of reason.	15. Explain that each sperm and ovum have stored chemical chromosomes which contain a code of directions that determine the heredity of a child.	PRINTED: 2
	16. Study the meaning and importance of DNA molecules. Have students construct models of DNA.	PRINTED: 2
9. Understanding the growth patterns of children is essential for successful child rearing.	17. Design a chart showing common human traits or characters, noting which ones are dominant and recessive.	PRINTED: 27

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
7. Question: "How Does Knowledge Related to Reproduction Contribute to the Development of Wholesome Attitudes?"	PRINTED: 32b, 32c	8. Understands the full meaning of sexuality.
8. Have students discuss how they would answer questions of children 5 to 8 years of age about reproduction.	PRINTED: 34a	9. Realizes the importance of genetics as a part of family planning.
9. Discuss the meaning of menopause.	PRINTED: 2	10. Shows respect for one's own family heritage and the heritage of others.
10. Discussion Question: "What Is the Difference Between a Spontaneous and an Induced Abortion?"		11. Recognizes that annual health examinations are important in protecting the individual and society.
11. Take a field trip to the maternity ward of a hospital to see the nursery, labor room, delivery room, and equipment.		12. Appreciates the difference between sexual behavior of human beings and animals.
12. Use charts to study the family life cycle.		13. Demonstrates an awareness that expression of physical affection between the sexes is not wrong, but that it can lead to sexual arousal if not controlled.
13. Have students write a short paper regarding the meaning of sexuality. Use this information for group work or class discussion.		14. Understands the differences in sexual feelings and desires in boys and girls and that considering these differences can help build happiness and respect between the sexes.
14. Stress the importance of studying an individual's chromosomes, family history, and other data in determining whether parents may have an abnormal child.	PRINTED: 5	15. Demonstrates an awareness of trustworthy and reliable sources from which to seek help with problems.
15. Explain that each sperm and ovum have stored chemical chromosomes which contain a code of directions that determine the heredity of a child.	PRINTED: 2	16. Understands the growth patterns and their
16. Study the meaning and importance of DNA molecules. Have students construct models of DNA.	PRINTED: 2	
17. Design a chart showing common human traits or characters, noting which ones are dominant and recessive.	PRINTED: 27	

3491A

GENERALIZATIONS	LEARNING EXPERIENCES	RES
10. Understanding the sex role in our society is important to healthy psycho-sexual development.	18. Discuss genetic concepts important for young people planning to marry.	PRINTED: 5, AUDIO-VISU
	19. Have a resource person such as a school nurse to discuss what is involved in good prenatal and post-natal care. (Include the Pap smear and proper nutrition.)	PRINTED: 5, AUDIO-VISU
	20. Review the junior high school material on the sex drive.	
	21. Use films and filmstrips to serve as discussion framework for venereal disease education.	PRINTED: 3
	22. List and discuss emotional needs of infants and young children.	
	23. Observe a young child you know for ways in which he displays feelings toward environment and family. What level of success should we expect of an infant (1 year old and 2 years old) in controlling feelings?	
	24. Formulate guidelines for disciplining a child.	PRINTED: 3
	25. Panel Discussion: "Are Masculinity and Femininity Traits Inborn?"	AUDIO-VISU
	26. Discuss the importance of experiences in the first years of life.	PRINTED: 3
	27. Review stages in life when a child is most vulnerable to imprinting gender role and identity.	
	28. Stress the importance of learning about child care and development. Present a unit of study for all students.	PRINTED: 3
	29. Motivate students to gain experience in child care by working with younger children.	

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LEARNING EXPERIENCES	RESOURCES	EVALUATION
18. Discuss genetic concepts important for young people planning to marry.	PRINTED: 5, 26, 27 AUDIO-VISUAL: 3a	importance to child bearing.
19. Have a resource person such as a school nurse to discuss what is involved in good prenatal and post-natal care. (Include the Pap smear and proper nutrition.)	PRINTED: 5, 9, 19, 20 AUDIO-VISUAL: 3a, 8a, 11a	17. Realizes the needs of individuals at various ages.
20. Review the junior high school material on the sex drive.		
21. Use films and filmstrips to serve as discussion framework for venereal disease education.	PRINTED: 34c, 40a, 40b	
22. List and discuss emotional needs of infants and young children.		
23. Observe a young child you know for ways in which he displays feelings toward environment and family. What level of success should we expect of an infant (1 year old and 2 years old) in controlling feelings?		
24. Formulate guidelines for disciplining a child.	PRINTED: 32b, 32c	
25. Panel Discussion: "Are Masculinity and Femininity Traits Inborn?"	AUDIO-VISUAL: 2f	
26. Discuss the importance of experiences in the first years of life.	PRINTED: 33a	
27. Review stages in life when a child is most vulnerable to imprinting gender role and identity.		
28. Stress the importance of learning about child care and development. Present a unit of study for all students.	PRINTED: 32b, 32c, 33a	
29. Motivate students to gain experience in child care by working with younger children.		

3492 A

ENERALIZATIONS	LEARNING EXPERIENCES	RESOURCES	EVALUATION
	30. Review characteristics of development of children from late childhood to puberty.	PRINTED: 34a	
	31. Panel Discussion Topic: "Why Is Adolescence a Difficult Period in Life?"	PRINTED: 32b, 32c	
	32. Buzz Group Topic: "What Is the Difference Between True Adulthood and Young Adulthood?"	PRINTED: 34a	

Printed Resources

BOOKS FOR SENIOR HIGH SCHOOL

1. Anderson, Wayne. *Design for Family Living.* Denison, 1964. $6.96 (392)
2. Bowman, Henry. *Marriage for Moderns.* 5th ed. McGraw, 1965. $8.50 (392.5)
3. Buck, Pearl S. *Children for Adoption.* Random, 1965. $4.95 (362.7)
4. Cox, Frank. *Youth, Marriage and the Seductive Society.* Brown, 1969. (301.42)
5. Diehl, Harold, and others. *Health and Safety for You.* 3rd ed. McGraw, 1969. (613)
6. Duvall, Evelyn. *The Art of Dating.* Rev. ed. Association, 1967. $3.50 (177)
7. Duvall, Evelyn. *Family Development.* 3rd ed. Lippincott, 1967. Text ed., $6.75 (392)
8. Duvall, Evelyn. *Why Wait Till Marriage.* Association, 1965. $2.75 (392.6)
9. Engle, T. L. *Psychology: Its Principles and Application.* 4th ed. Harcourt, 1964. $4.20; workbook, $1.95; teachers manual and objective tests with answers, 60¢
10. Flanagan, Geraldine. *The First Nine Months.* Simon and Schuster, 1962. $3.95 (611.013)
11. Glassberg, Bert. *Barron's Teen-age Sex Counselor.* Barron's, 1965. $3.75; paper, $1.75
12. Glover, Leland. *How To Marry Someone You Can Live with All Your Life.* Prentice-Hall, 1964. $4.95 (392.5)
13. Hanna, Lavone. *Challenge for a Free People.* Rand-McNally, 1964. $6.36
14. Hettlinger, Richard. *Living with Sex: The Student's Dilemma.* Seabury, 1966. Paper, $1.95 (392.6)
15. Konopka, Gisela. *The Adolescent Girl in Conflict.* Prentice-Hall, 1968. $4.95 (364.7)
16. Landis, Judson. *Building a Successful Marriage.* 5th ed. Prentice-Hall, 1968. $8.50 (392.5)
17. Leslie, Gerald. *The Family in Social Context.* Oxford University Press, 1967. $8.00 (392)
18. Maslow, A. H. *Motivation and Personality of Being.* Harpers, 1954. $6.95 (158)

3494

19. Maternity Center Association Editors. *A Baby Is Born.* 3rd ed. $3.95 (612.6) Available from Maternity Center Association, 48 East 92nd Street, New York, New York 10028.

20. Maternity Center Association Editors. *Birth Atlas.* 6th ed. $10.00 (612.6) Available from Maternity Center Association, 48 East 92nd Street, New York, New York 10028.

21. Mead, Margaret, and Ken Heyman. *The Family.* Macmillan, 1965. $10.00 (392)

22. Riesman, David. *The Lonely Crowd.* Rev. ed. Yale University Press, 1950. $10.00; paper, $2.45 (136)

23. Roberts, Robert. *The Unwed Mother.* Harper, 1966. Paper, $3.25 (362.7)

24. Rogers, Carl. *On Becoming a Person.* Houghton-Mifflin, 1961. $8.50; text ed., $6.75 (131)

25. Sanders, Morris. *Classroom Questions: What Kinds?* Harper, 1966. Paper, $2.05

26. Scheinfeld, Amram. *Your Heredity and Environment.* Lippincott, 1965. (575.1)

27. Srb, Adrian, and others. *General Genetics.* 2nd ed. W. H. Freeman, 1952. $9.00 (575.1)

28. Vincent, Clark. *Unmarried Mothers.* Free Press, 1961. Paper, $2.45 (362.7)

29. Whyte, William H. *The Organization Man.* Doubleday, 1952. Paper, $1.75 (301.1)

PROFESSIONAL BOOKS

30. Child Study Association of America. *Sex Education and the New Morality.* Columbia University Press, 1967. Paper, $1.95

31. Reiss, Ira. *Premarital Sex Standards in America.* Free Press, n.d. $6.50; paper, $1.50

CHARTS, PAMPHLETS, AND PERIODICALS

32. American Social Health Association, 1790 Broadway, New York, New York 10019
    a. *The Dating Ladder.* Poster.
    b. *Family Life Concern.* Chart. $1.00
    c. *Family Life Cycle.* Chart. $1.00
    d. *The Girl's Dilemma.* Poster.
    e. *What Should Home Represent to Each Member of the Family.* Poster.
    f. *A Young Man's Dilemma.* Poster.

3495

33. Blue Cross Association, 840 North Lake Shore Drive, Chicago, Illinois 60611

    a. *The Modern Baby*. Free in quantity.

34. Minnesota Department of Health, Shipping Department, 717 Delaware Street S.E., Minneapolis, Minnesota 55440

    a. *Approaching Adulthood* by Marion O. Lerrigo and M. A. Southard. AMA-NEA series. Free in small quantities. Student reference.

    b. *Facts Aren't Enough* by Marion O. Lerrigo and M. A. Southard. AMA-NEA series. Free in small quantities; large quantities must be ordered from the AMA or NEA at 50¢ per copy. Adult reference.

    c. *Venereal Disease Education: A Teaching Guide*. Free to teachers.

35. Minnesota Department of Public Welfare, 500 Centennial Building, St. Paul, Minnesota 55101

    a. *There Is Help for the Unwed Mother*. Free.

36. *Phi Delta Kappan* Magazine

    a. "The Pill, the Sexual Revolution and the Schools" by A. Montagu. Vol. 49 (May 1968) 480-484.

    b. "Too Many People: Can Educators Find an Answer?" by Walter Pitkin, Jr. Vol. 49 (May 1968) 473-479.

37. Planned Parenthood, 515 Madison Avenue, New York, New York 10022

    a. *Family Planning and Population Problems, and the Secondary School Curriculum*. 50¢ Teacher reference.

38. Public Affairs Pamphlets, 381 Park Avenue South, New York, New York 10016

    a. *Syphilis: The Invader*. 25¢ Student reference.

39. Sex Information and Education Council of the U.S., 1855 Broadway, New York, New York 10023

    a. *Homosexuality*. Study Guide No. 2. 50¢ Adult reference.

    b. *Masturbation*. Study Guide No. 3. 50¢ Adult reference.

    c. *Premarital Sex Standards*. 50¢ Adult reference.

40. *Today's Health* Magazine

    a. "Why All the Fuss About Gonorrhea?" Vol. 43 (December 1965) 26-31.

    b. "Why the Rise in Teenage Venereal Disease?" Vol. 43 (September 1965) 18-23.

Audio-Visual Resources

FILMSTRIPS

1. Cathedral Films, Inc., 2921 Alameda Avenue, Burbank, California 91505 (Northern Distributors, 109 Lea Place, Albert Lea, Minnesota 56007)
   a. *A Basis for Sex Morality*. 6 filmstrips, 3 records. $45.90
   b. *About Sex and Growing Up*. 4 filmstrips, 2 records. $36.50
   c. *Love and the Facts of Life*. 5 filmstrips, 3 records. $46.00
   d. *Teen/Parent Relationships*. 6 filmstrips, 3 records. $51.50
2. Guidance Associates, Pleasantville, New York 10570
   a. *And They Lived Happily Ever After? Understanding Teen-age Marriage*. Parts 1 and 2. 2 filmstrips, 2 records, teachers manual. $35.00
   b. *Becoming a Man: Maturation and Growth*. Parts I and II. 2 filmstrips, 2 records, teachers manual. $40.00
   c. *Becoming a Woman: Maturation and Growth*. Parts I and II. 2 filmstrips, 2 records, teachers manual. $40.00
   d. *I Never Looked at It That Way Before*. Parts I and II. 2 filmstrips, 2 records, teachers manual. $35.00
   e. *Love, Marriage and the Family*. 2 filmstrips, 2 records. $40.00 Also available with 2 filmstrips, 2 cassettes. $44.00
   f. *Masculinity and Feminity*. 2 filmstrips, 2 records, teachers manual. $40.00
   g. *Population Explosion*. 2 filmstrips, 2 records, teachers manual. $35.00
   h. *Somebody's Cheating*. 2 filmstrips, 2 records, teachers manual. $35.00 Also available with 2 filmstrips, 2 cassettes. $39.00
   i. *The Tuned Out Generation*. 2 filmstrips, 2 records, teachers manual. $35.00
3. National Foundation — March of Dimes, 6701 Penn Avenue South, Richfield, Minnesota 55423
   a. *More Than Love*. 1 filmstrip, 1 record. Free on loan.
4. Stephen Bosustow Productions, Malibu, California 90265
   a. *A Basis for Sex Morality*. 6 filmstrips, 3 records. $45.90 Secular version.

TRANSPARENCIES

5. Fox, James Rogers, and Helen Starr. *Human Sexuality Education*. Teaching kit containing guide to resources, transparencies, tapes, booklets. In preparation. Will be available from Teaching Aids Medically Authenticated, Suite 795, 608 2nd Avenue South, Minneapolis, Minnesota 55402.

3497

6. Minnesota Mining and Manufacturing Company, Visual Products Division, 3M Center, P.O. Box 3344, St. Paul, Minnesota 55101
   a. *The Family Serves To Perpetuate Man and To Fulfill Certain Health Needs.* Concept No. 6. Level IV. 5 sets, 20 transparencies each. Set, $35.00

FILMS

7. Henk Newenhouse, Inc., 1825 Willow Road, Northfield, Illinois 60093
   a. *How Do I Love Thee?* 28 min. Rental: $12.50
8. Minnesota Department of Health, Film Library, 717 Delaware Street S.E., Minneapolis, Minnesota 55440
   a. *Biography of the Unborn.* 15 min. Free on loan.
   b. *The Game.* 28 min. Free on loan.
   c. *Have I Told You Lately That I Love You?* 16 min. Free on loan.
   d. *Phoebe.* 28 min. Free on loan.
   e. *Roots of Happiness.* 24 min. Free on loan.
   f. *Who Should Decide?* 11 min. Free on loan.
   g. *Worth Waiting For.* 30 min. Free on loan.
9. Minnesota Department of Public Welfare, 500 Centennial Building, St. Paul, Minnesota 55101
   a. *How Are You?* 16 min. Free on loan.
   b. *Unwed Mothers.* Free on loan.
10. University of Minnesota, Audio-Visual Extension Service, General Extension Division, 2037 University Avenue S.E., Minneapolis, Minnesota 55455
   a. *Four Families.* Part I, "India and France." Part II, "Japan and Canada." 30 min. each. Rental: $5.00 each.
   b. *Who's Right.* 20 min. Rental: $3.85
11. University of Wisconsin, Bureau of Audio-Visual Instruction, 1327 University Avenue, Madison, Wisconsin 53701
   a. *Eating for Two.*

TAPES

12. Henk Newenhouse, Inc., 1825 Willow Road, Northfield, Illinois 60093
   a. *The Use of Sex in Human Life.* $8.00

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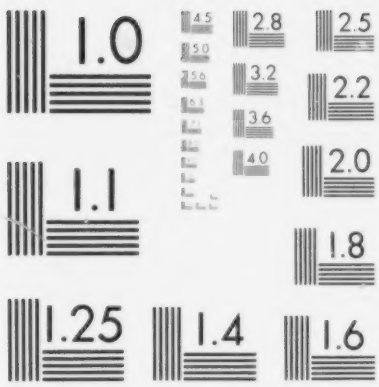

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Appendix

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Selected References for School Administrators

American Association for Health, Physical Education, and Recreation. *A Resource Guide in Sex Education for the Mentally Retarded.* Free. Available from the Association, 1201 16th Street N.W., Washington, D.C. 20036.

Anderson, Wayne J. *Design for Family Living.* Denison, 1964. $5.95 (392)

Hettlinger, Richard. *Living with Sex: The Student's Dilemma.* Seabury, 1966. Paper, $1.95

Hilu, Virginia. *Sex Education and the Schools.* Harper, n.d. $4.50

Manley, Helen. *Family Life and Sex Education in the Elementary School.* $1.00, discount on quantity. Available from National Education Association, 1201 16th Street N.W., Washington, D.C. 20036.

Martinson, Floyd. *Sexual Knowledge, Values, and Behavior Patterns.* Gustavus Adolphus College, n.d. $3.00

Minnesota Council on Family Relations. *Family Life Literature and Films.* An annotated bibliography. $2.00 plus 12¢ postage. Available from the Council, 1219 University Avenue S.E., Minneapolis, Minnesota 55414.

Minnesota Department of Health. *Health Information Materials Catalog.* Free. Available from the Department, 717 Delaware Street S.E., Minneapolis, Minnesota 55440.

Minnesota Department of Health. *Health and Safety Film Catalog.* Free. Available from the Department, 717 Delaware Street S.E., Minneapolis, Minnesota 55440.

National Council on Family Relations. *Journal of Marriage and the Family.* 4 issues a year, $10.00 Available from the Council, 1219 University Avenue S.E., Minneapolis, Minnesota 55414.

Schulz, Esther, and Sally Williams. *Family Life and Sex Education: Curriculum and Instruction.* Harcourt, n.d. Paper, $3.95; text edition, discount on quantity.

Sex Information and Education Council of the U.S. *Siecus Newsletter.* Issued quarterly, $2.00 a year. Available from the Council, 1790 Broadway, New York, New York 10019.

Sources for Informational Material

AGENCIES AND ORGANIZATIONS

American Medical Association
535 North Dearborn Street
Chicago, Illinois 60610

American Social Health Association
1790 Broadway
New York, New York 10019

E. C. Brown Trust Foundation
3170 S.W. 87th Avenue
Portland, Oregon 97225

Minnesota Council on Family Relations
1219 University Avenue S.E.
Minneapolis, Minnesota 55414

Minnesota Department of Education
400 Centennial Building
St. Paul, Minnesota 55101

Minnesota Department of Health
717 Delaware Street S.E.
Minneapolis, Minnesota 55440

COMPANIES

Child Study Association of America
9 East 89th Street
New York, New York 10028

Creative Visuals
Gamco Industries, Inc.
Box 310
Big Spring, Texas 79720

Denoyer-Geppert, Inc.
Ravenswood Avenue
Chicago, Illinois 60640

Eye-Gate House, Inc.
145-01 Archer
Jamaica, New York 11435

Glenn Educational Films, Inc.
P.O. Box 371
Monsey, New York 10952

Guidance Associates
Pleasantville, New York 10570

Hamond, Inc.
Education Division
Maplewood, New Jersey 07040

Henk Newenhouse, Inc.
1825 Willow Road
Northfield, Illinois 60093

Minnesota Mining and Manufacturing Comp
Visual Products Division
3M Center
P.O. Box 3344
St. Paul, Minnesota 55101

Popular Science Publishing Company, Inc.
Audio-Visual Division
355 Lexington Avenue
New York, New York 10017

3501

Sources for Informational Materials

AGENCIES AND ORGANIZATIONS

Minnesota Council on Family Relations
1219 University Avenue S.E.
Minneapolis, Minnesota 55414

Minnesota Department of Education
400 Centennial Building
St. Paul, Minnesota 55101

Minnesota Department of Health
717 Delaware Street S.E.
Minneapolis, Minnesota 55440

National Council on Family Relations
1219 University Avenue S.E.
Minneapolis, Minnesota 55414

Sex Information and Education Council of the U.S.
1790 Broadway
New York, New York 10019

United States Department of Health, Education, and Welfare
Washington, D.C. 20402

COMPANIES

Guidance Associates
Pleasantville, New York 10570

Hamond, Inc.
Education Division
Maplewood, New Jersey 07040

Henk Newenhouse, Inc.
1825 Willow Road
Northfield, Illinois 60093

Minnesota Mining and Manufacturing Company
Visual Products Division
3M Center
P.O. Box 3344
St. Paul, Minnesota 55101

Popular Science Publishing Company, Inc.
Audio-Visual Division
355 Lexington Avenue
New York, New York 10017

Society for Visual Education
1346 Diversey Parkway
Chicago, Illinois 60614

Sterling Educational Films
241 East 34th Street
New York, New York 10016

Teaching Aids Medically Authenticated
Suite 795
608 2nd Avenue South
Minneapolis, Minnesota 55402

Western Publishing Company, Inc.
Education Division
School and Library Department
800 3rd Avenue
New York, New York 10022

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Supportive Statements

American Legion

"Family Life Education" was the 1968 theme of the Legion's Child Welfare Division.

Minnesota Congress of Parents and Teachers, Inc.

The Position Statement on Family Life and Sex Education adopted by the State Board of Education is supported.

It was resolved that local PTA units should implement the resolution adopted in convention, October 11, 1966, and work with their school boards, school administrators, and community leaders in the development of comprehensive family life and sex education programs for K-12.

. . . from a news release issued April 1, 1968, by the publicity chairman of the Minnesota PTA

National School Boards Association and American Association of School Administrators

"The Joint Committee of the National School Boards Association and the American Association of School Administrators is aware of the present emphasis on sex and family life education, as well as the pressures from the many other specialized interests in the health field.

"The Committee is unanimous in its firm belief that the only effective way in which the school can fulfill its responsibility for meeting the health needs of youth is through a comprehensive program of health education in grades K through 12. Such a program establishes the organizational framework for meeting the health needs, interests, and problems of the school-age group as well as preparing them for their role as future parents and citizens.

"Including sex and family life education with the other categorical health topics in one sound, interrelated, and sequential program not only saves time in an already-crowded curriculum, but assures that all topics will be part of a long-range program and will receive more complete and detailed consideration at the appropriate level of the student's development.

"Such a comprehensive approach should be supported by groups interested in a single health area because it assures an orderly and progressive consideration of the separate topics in the context of total health and, hence, offers more effective student exposure through the grades. It avoids 'band wagon' approaches, crash programs, and piecemeal efforts focused on one or a few topics

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that happen to be enjoying popularity or extensive press coverage at a particular time — an approach which on the basis of past experience has proved to be largely ineffective.

"The Committee wishes to emphasize that it must be recognized that the school curriculum is already overloaded. Literally if something new goes in, something must come out. There is neither time nor justification for separate courses in any of the categorical areas advocated by specialized interest groups.

"Health is a unified concept. It must be approached with consideration of the total human being and the complexity of forces that affect health behavior. It is concerned with the health attitudes and behavior of the individual, his family, and the community. It is concerned with knowledge, attitudes, and practices — that is, health behavior in its totality. This cannot be achieved with a piecemeal approach.

"The Committee recommends a coordinated attack on all health problems with a comprehensive health education program extending from K through 12 and encompassing the total scope of such a program.

"Such a program places a responsibility on local school boards and administrators, state departments of education, and teacher training institutions to provide qualified teachers, adequate time for instruction, authoritative and up-to-date materials, and supervisory assistance for health education commensurate with other curriculum offerings."

. . . from *Health Education and Sex/Family Life Education,* a statement by the Joint Committee of the National School Boards Association and the American Association of School Administrators

Minnesota Council of Churches

"The Executive Committee of the Minnesota Council of Churches has spoken out in favor of both public schools and churches in Minnesota conducting programs in sex education and have urged congregations to create a favorable climate of public acceptance of such courses. . . .

"The Executive Committee of the Council adopted the following resolution:

A. That we acknowledge our appreciation to the Department of Education, State of Minnesota, for including representation from the major religious faiths on its Coordinating Committee on Sex Education.

B. That we affirm that the primary place for sex education of children and youth is in the home, but insist that the schools and churches must complement the home in this effort. We commend the public schools, churches and other agencies which are actively seeking to carry out sex education programs. We call upon our churches to help create a favorable climate of acceptance for these endeavors.

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C. That we encourage congregations to familiarize themselves with the programs of sex education carried on in the public schools in their respective communities, so that the church's supplementary programs can be coordinated with the school's program."

. . . from a news release issued by the director of communication for the Minnesota Council of Churches

American Medical Association

"The American Medical Association should inaugurate and support programs of health education, including good maternal and child health practices, family life and sex education and the appropriate use of health care resources."

. . . from a Board of Trustees report approved at a San Francisco meeting, June 1968, by the House of Delegates of the American Medical Association

VT 012 370
Mechanical and Electrical Technology.
Resource Guide for Effective Instruction in
Industrial Arts. Curriculum Bulletin No. 13B.

Minnesota State Dept. of Education, St. Paul.
MF AVAILABLE IN VT-ERIC SET.
Documents Section, Minnesota State Dept. of
Education, Room 140, Centennial Building, St.
Paul, Minnesota 55101.
PUB DATE - 70 121p.

DESCRIPTORS - *CURRICULUM GUIDES; TEACHING
METHODS; EDUCATIONAL INNOVATION; *INDUSTRIAL
ARTS TEACHERS; *INDUSTRIAL ARTS; RESOURCE
GUIDES; *ELECTRICITY; *FLUID POWER EDUCATION;
ENGINES; AFFECTIVE OBJECTIVES; COGNITIVE
OBJECTIVES; PSYCHOMOTOR OBJECTIVES

ABSTRACT - Prepared for industrial arts
teachers, this curriculum guide has been
organized for efficient utilization of
several newer methodological approaches to
teaching. The order in which material is
presented places the psychomotor, cognitive,
and affective domains of learning on a
continuum with implementation procedures.
Arranged in three sections on electronics,
mechanical power, and fluid power technology,
the guide presents material in the categories
of: (1) Skills Students will be Able to
Perform, (2) Concepts Students Will
Understand, (3) Appreciations Students Will
Develop, and (4) Implementation Suggestions.
Sources of resource materials are included.
Two related documents are available as VT 012
371 and VT 012 372, also in this issue. (JS)

VT 012 370

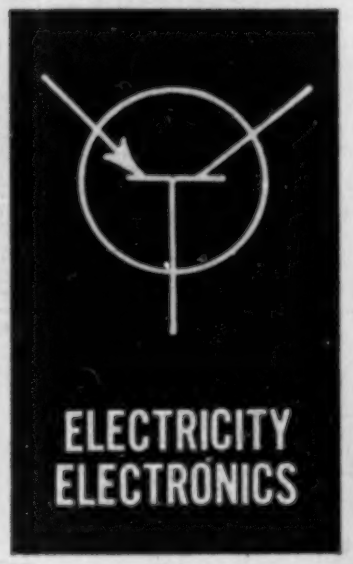

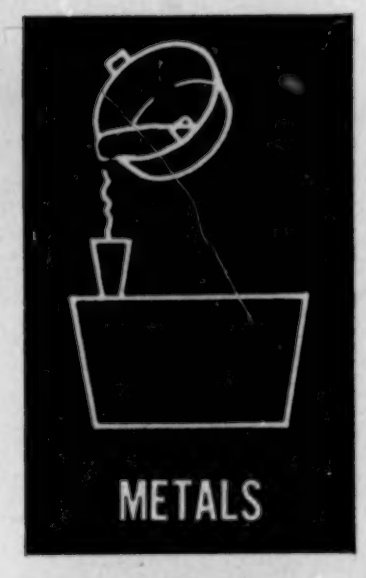

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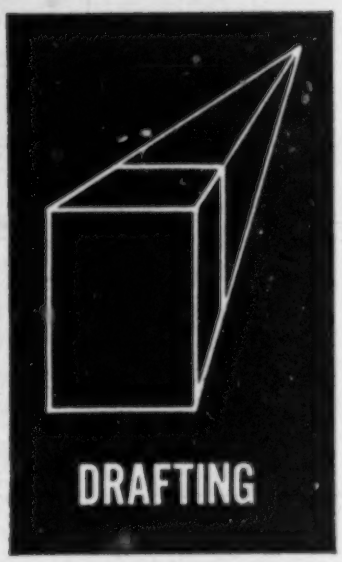

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
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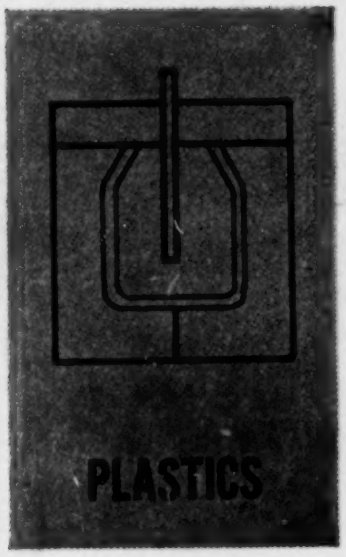

Resource Guide
for
Effective Instruction
in
Industrial Arts

Mechanical and Electrical Technology

State of Minnesota
Department of Education
St. Paul

Curriculum Bulletin No. 13B
Code VIII-A-C-26a

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Code VIII-A-C-26a

RESOURCE GUIDE FOR EFFECTIVE INSTRUCTION IN INDUSTRIAL ARTS

MECHANICAL AND ELECTRICAL TECHNOLOGY

CURRICULUM BULLETIN NO. 13B

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STATE OF MINNESOTA
DEPARTMENT OF EDUCATION
St. Paul
1970

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FOREWORD

Industrial arts students live in a dynamic, ever-changing society. Preparations for their future place multitudinous demands upon education. The numerous changes occurring in our accelerating technology levy demands upon industrial arts teachers. It is simply not enough to train the students to live in a changing world; it is also necessary to transmit to the student a sense of values and the worth of participation in the technological process which is such a vital part of our society. Industrial arts, as an integral part of education, must provide opportunities for individual fulfillment, individual achievement, and individual freedom.

The success of the industrial arts program in providing these opportunities depends upon several factors, of which the course content and the approaches to teaching are vital aspects. Two main purposes of this guide are, therefore, to offer newer content and to suggest several newer approaches to teaching.

Assistant Commissioner of Education,
Division of Instruction

ACKNOWLEDGMENT

Grateful appreciation is extended to Mr. Harold E. PaDelford for his help in coordinating materials for the resource guides on "Visual Communication Technology," "Mechanical and Electrical Technology," and "Materials Technology."

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INDUSTRIAL ARTS CURRICULUM DEVELOPMENT IN MINNESOTA

The State Department of Education has maintained a continuing effort to keep teachers and administrators informed of phenomenal technological and educational advances. The most recent revision of Curriculum Bulletin No. 13, *A Guide for Instruction in Industrial Arts,* was made in 1962.

In the spring of 1967, an effort was initiated to bring industrial arts teachers the latest methods of instruction. Industrial arts education has been under constant evaluation and it was the intent of the steering committee appointed at that time to enlarge upon and bring up to date the content of Curriculum Bulletin No. 13. The committee chose the content, instructional design, and methods used in this guide. Writers were engaged to specifically challenge industrial arts teachers to gain knowledge of and to use the newer approaches to instruction.

The guide has been divided into three issues. These issues are (1) "Visual Communication Technology" with units in drafting and graphic arts, (2) "Mechanical and Electrical Technology" with units in electricity, electronics, and power, and (3) "Materials Technology" with units in woods, metals, and plastics.

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PURPOSE AND VALUE OF THIS GUIDE

This guide has been organized for efficient utilization of several newer methodological approaches to teaching. The primary purpose of the guide is to so arrange the course content that the instructor may more easily adapt his teaching to these new approaches. The order in which material is presented places the psychomotor, cognitive, and affective domains of learning on a continuum with implementation procedures. The psychomotor skills (column one) that students should be able to perform include operations, jobs, problems, and activities. Cognitive understandings (column two) include basic principles, concepts, generalizations, and guidance information. Affective values (column three) involve awareness, organization, attitudes, and appreciation. Implementation suggestions (column four) cover teaching methods and techniques, resources, and expedients. Column four provides the cohesive force for columns one, two, and three. Instructor's notes (column five) provides a place for the instructor to keep his plans and thoughts regarding the units.

This guide is not intended to be a "cook-book" approach. It is intended to serve as a guide and resource for effective teaching. The needs of each particular teaching situation should determine the material that will be used.

METHODOLOGICAL APPROACHES TO TEACHING INDUSTRIAL ARTS

Methodology has sustained the teaching of industrial arts as a subject in general education with several approaches carrying the burden of instruction. However, industry and technology have undergone vast changes in recent years. In an attempt to interpret industry more realistically, several new approaches have been promulgated. Emphasis has been placed on industrial and technological functions and practices. In order to make learning more meaningful, the committee wishes to encourage the use of up-to-date methods of instruction. Complete materials are not available on all approaches, but information is available from the American Industrial Arts Association, the American Vocational Association, and from current publications. Several methodological approaches, each with a short explanation, are presented in the following list.

Mass Production. This is a group undertaking with the intent of understanding industry through the production of a product. Mass production would encompass personnel organization, purchasing, production processes, accounting, and sales. This usually involves the entire class and can be used at any grade level and subject area.

Anthropological Approach. The anthropological approach involves the historical relationships of tools, processes, and products. It can be used as an introduction to a unit of study or as the unit of study. It gives an insight into the massive technologies of the modern industrial complex.

Construction Industry. This approach is a group undertaking to discover the problems in the design and construction of a project. This method would encompass personnel organization, material testing, fastening, and material processing. Students can be grouped into any size of unit according to the complexity of the project.

Unit Method. The unit method employs a limited set of educational experiences. Emphasis is placed on individual achievement through the student's own initiative. Emphasis is also placed on vicarious learning — a sharing of experiences with other students through reports, demonstrations, and other methods of communiation. The unit method allows the student to be creative and unique.

Line Production. The line production technique usually consists of a short production run of a product. The production line, jigs and fixtures, and product are set up with student activity. It is usually a short unit used to teach one aspect of mass production.

Individual Project. The individual project emphasizes the engineering approach and craftsmanship. Experiences are not usually shared with other students. The individual project offers the student an opportunity to see through to completion something of his own making.

Individual Study. Some scheduling systems permit an individual approach to study. Open laboratories, libraries, and other media enable the student to have freedom in his pursuit of knowledge.

Conceptual Approach. To gain an understanding of the technology in industry, concepts are taught with each concept enforcing the next one. This approach relies heavily on the cognitive behavioral patterns. Concepts learned are usually reinforced with some type of followup activity.

Research and Experimentation. The research and experimentation approach enables the student to discover and develop technological advances. The process is much used in industry. Materials testing and new product development are techniques used in the schools. The students usually share their experiences with classmates. Access to source materials is a necessity.

Services. The service industry is large and growing. Students gain an understanding of problems involved in the maintaining and repairing of all industrial products. With the increase of mechanized products in the home and on the farm, every individual needs an understanding of the service industry.

Interdepartmental Approach. Involvement of two or more laboratory activities can be used to advantage in enhancing motivation and improving learning situations. This approach enables students to study and construct a more complex problem or project.

MECHANICAL AND ELECTRICAL TECHNOLOGY

The materials in this guide have been divided into the three areas of electricity — electronics, mechanical power, and fluid power technology. The section on electricity — electronics was written by Lyle Rahn, Instructor, St. Louis Park Public Schools, with assistance from Eugene P. Jereczek. Melvin Johnson, Instructor and Graduate Student, University of Minnesota, prepared the section on mechanical power technology. The section on fluid power technology was prepared by Marlin E. Meyer, Instructor, Waconia Public Schools. These three areas have been grouped in this guide because of similarity and for convenience.

This guide has been arranged so that the instructor, in planning for the teaching of industrial arts, can draw objectives from the first three columns. These objectives can then be achieved by using the suggestions in column four. Some of the implementation suggestions will be considered as startling and provocative procedures. This was intended as the steering committee sought procedures that were forceful, useful, and stimulating. It was further intended that this guide serve as an aid to improve the methodology and content of industrial arts. Methodology has, through the years, sustained industrial arts. Innovations in both content and methodology are offered.

No definite order has been established for the presentation of material. It is more important that each instructor select the particular material which is appropriate for a given teaching situation. The instructor is encouraged to use as much of the appropriate material as possible. Material sufficient for several years of work has been provided. It is hoped that this guide will help the instructor to teach more effectively.

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ELECTRICITY–ELECTRONICS TECHNOLOGY

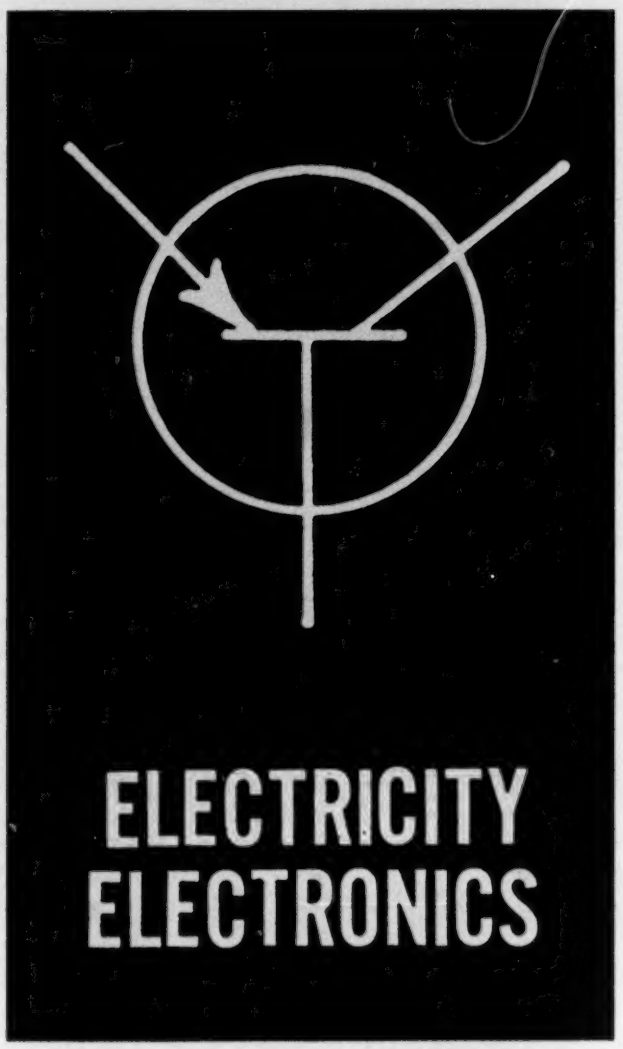

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INTRODUCTION TO ELECTRICITY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify common electrical components. Identify electrical component symbols. Draw and label schematic diagrams. Connect simple circuits from schematic diagrams.	Schematic diagrams: 1. Symbols for components 2. Lines to represent wires 3. Subscripts and codes 4. Diagram layout	Be conscious of the potential danger of electricity. Be conscious of good safety practices and procedures.
Demonstrate the presence of an electrical charge. Explain the basic rules for attraction and repulsion.	Electrostatic: 1. Electrons and charges 2. Static discharge 3. Nuisance problems	Perform shop personnel duties in a workmanlike manner.
Measure DC current.	Nature of current: 1. Electrons in motion 2. Direction of electron movement 3. Use of an ammeter	
Measure DC voltage.	Nature of voltage: 1. Excess of electrons 2. Deficiency of electrons 3. Potential differences 4. Polarity 5. Use of voltmeter	

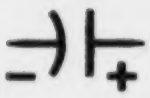

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INTRODUCTION TO ELECTRICITY

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Laboratory Manual Experiments

Buban and Schmitt. *Understanding Electricity and Electronics*. Nos. 1-6.

Fischer. *Investigating Electricity*. No. 1.

Science Electronics, Inc. *Experimental Electricity*. Nos. 1-4.

Gerrish. *Learning Experiences in Electricity*. Nos. 1-3.

Zbar. *Basic Electricity*. Nos. 1-4.

Films

Mass of the Electron. Modern Talking Picture Service.

Static Electricity: Introduction. Hickok Teaching Systems, Inc.

Transparencies

Electronic Symbols. Science Electronics, Inc.

Electron Theory. Lab-Volt Division.

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1Sec

DC CIRCUITS AND POWER

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Construct a primary cell. Construct a secondary cell. Connect dry cells in series and parallel.	Power sources: 1. Action of a primary cell 2. Action of a secondary cell	Follow necessary precautions when performing electro-chemical experiments.
Construct a thermocouple crystal and photocell circuit.	Power sources: 1. Action of a thermocouple 2. Action of a crystal cartridge 3. Action of a photocell	
Read resistor color code. Measure resistance with an ohmmeter.	Use of an ohmmeter. Resistor color code.	Always check a circuit before closing switch.
Prove Ohm's Law.	Circuit essentials: 1. Power source 2. Voltage distribution 3. Controls, switches, fuses	
Connect a series circuit. Connect a parallel circuit. Connect a series-parallel circuit. Varify Kirchhoff's current and voltage laws.	Series circuits: 1. Current same for all parts 2. Voltage drops additive 3. One current path 4. Resistance additive Parallel circuits: 1. Voltage same for all parts 2. Current drops in branch circuits 3. More than one path 4. Parallel power sources 5. Individual control possible Power: 1. Unit of power 2. Calculate power 3. Power in series and parallel circuits	Ask for help if in doubt about a circuit. Be conscious of the potential danger of electricity if improperly handled. Always check to see if a circuit is "hot" before working with circuit components.

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DC CIRCUITS AND POWER

IMPLEMENTATION SUGGESTIONS

Laboratory Manual Experiments

Buban and Schmitt. *Understanding Electricity and Electronics*. Nos. 7-10 and 13-20.

Fischer. *Investigating Electricity*. Nos. 2-11.

Science Electronics, Inc. *Experimental Electricity*. Nos. 5-18.

Gerrish. *Learning Experiences in Electricity*. Nos. 4-16.

Zbar. *Basic Electricity*. Nos. 5-18.

Films

Series and Parallel Circuits. Encyclopaedia Britannica Educational Corporation.

Bell Solar Battery. Northwestern Bell Telephone Company.

The Modern Storage Battery. Bureau of Mines.

Transparencies

Resistor Color Code. Science Electronics, Inc.

Ohm's Law—Series Resistance. Science Electronics, Inc.

Ohm's Law. Lab-Volt Division.

Watt's Law. Lab-Volt Division.

INSTRUCTOR'S NOTES

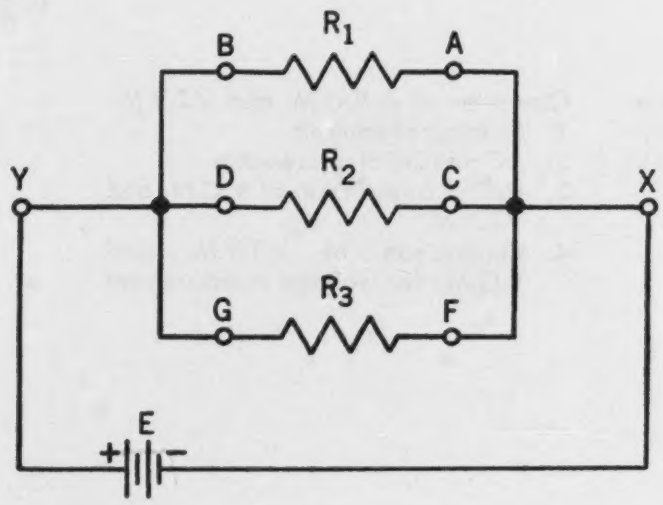

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TEST INSTRUMENTS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Connect basic meter circuitry: 1. Voltmeter 2. Ammeter 3. Ohmmeter	Characteristics of a DC meter movement.	Take necessary precautions when handling a DC meter movement.
Measure or calculate the proper resistances for the different meter ranges.	Development of the basic DC meter movement: 1. Use of multiplier resistors in voltmeter circuitry 2. Loading effect of a voltmeter 3. Use of shunt resistors in an ammeter circuit 4. Effect of meter resistance on current measurements 5. Develop an ohmmeter from a DC meter movement.	Always check circuit before energizing.
Operate an oscilloscope for AC voltage measurements.	Function of the operating controls on an oscilloscope. AC voltage wave forms and measurements. Comparison of DC and AC current and voltage measurements. Graphic development of the sine wave. Common uses of an oscilloscope.	Observe cautions in instruction booklet. Use appropriate instruments for desired measurement.
Operate an audio oscillator to produce desired audio signal.	Function of the operating controls on an audio generator. Use of Lissajous patterns. Characteristics of a square wave. Common uses for an audio oscillator.	Observe proper care in handling test instruments. Take the precaution of checking circuit for proper meter application. Take measurements with care and accuracy.
Operate a volt ohm milliammeter (V.O.M.) and a vacuum tube voltmeter (V.T.V.M.) for AC and DC circuit measurements.	Operation of a V.O.M. and V.T.V.M.: 1. Function of controls 2. AC and DC measurements 3. Use of construction of V.O.M. and V.T.V.M. 4. Comparison of V.T.V.M. and V.O.M. for voltage measurement	

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TEST INSTRUMENTS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Laboratory Manual Experiments

Science Electronics, Inc. *Experimental Electricity*. Nos. 19-25.

Gerrish. *Learning Experiences in Electricity*. Nos. 17-20 and 25.

Zbar. *Basic Electricity*. Nos. 19-25 and 30, 31.

Films

Audio Generators. Tektronix, Inc.

Oscilloscopes. Tektronix, Inc.

Transparencies

Basic Meter Construction. Science Electronics, Inc.

Voltmeters—Ammeters—Ohmmeters. Lab-Volt Division.

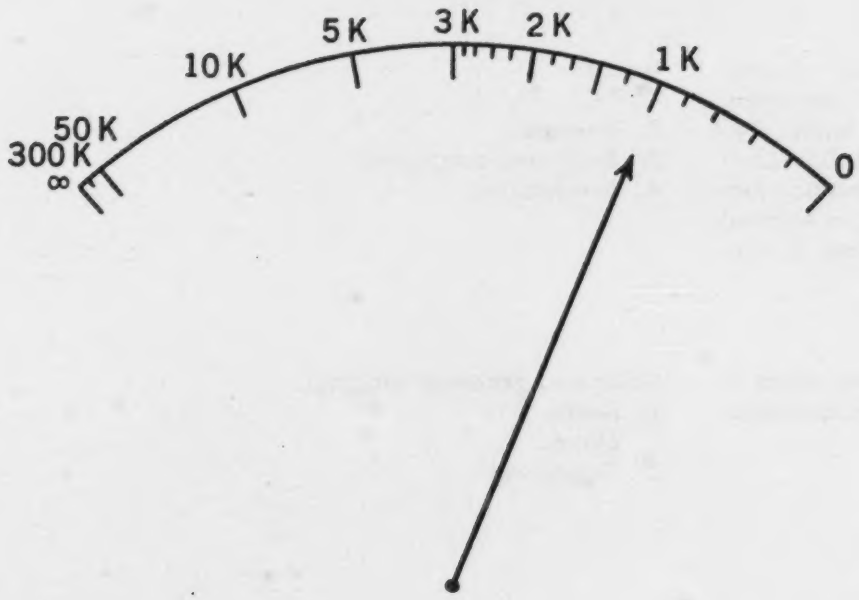

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MAGNETISM—MOTORS—GENERATORS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Perform experiment to observe magnetic laws. Identify magnetic materials. Test the effects of a magnetic field.	Permanent magnets: 1. History 2. Materials common 3. Shape and polarity 4. Attraction and repulsion 5. Electron theory of magnetism 6. Care of magnets	Remove wristwatch when working with strong magnetic fields. Store magnets in proper manner.
Control the strength of an electromagnet. Prove the factors which affect the strength and polarity of an electromagnet.	Electromagnets: 1. Core materials 2. Ampere - turns 3. Current flow and polarity 4. Coil diameter and distance between turns	
Connect a buzzer, relay, circuit breaker, and solenoid.	Applications of electromagnets: 1. Relay 2. Buzzer 3. Solenoid 4. Circuit breaker	
Identify motor parts. Assemble commutator motor. Make a motor operate as a generator.	Principles of generation: 1. Moving coil 2. Moving magnetic field 3. Control of voltage 4. Generating AC 5. Generating DC	Treat motor and generator parts with care. Use only cleaning solvents and abrasives supplied by instructor.
Control speed and direction of commutator motor. Connect a permanent field motor. Operate a series connected motor on AC and DC. Connect and operate a commutator motor with series, shunt, or compound fields. Connect and operate a synchronous motor.	Motors: 1. DC 2. Universal 3. Shunt and compound 4. Synchronous	
Perform experiment to study effect of various loads on motor and generator operation.	Motor and generator loading: 1. Series 2. Shunt 3. Compound	

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MAGNETISM—MOTORS—GENERATORS

IMPLEMENTATION SUGGESTIONS

Laboratory Manual Experiments

Buban and Schmitt. *Understanding Electricity and Electronics.* Nos. 21-34.

Science Electronics, Inc. *Experimental Electricity.* Nos. 26-36.

Gerrish. *Learning Experiences in Electricity.* Nos. 21-23 and 40-43.

Films

Repulsion Motor Principles. University of Illinois.

Transparencies

Magnetism. Science Electronics, Inc.

Transformers. Science Electronics, Inc.

Magnetic Fields. Lab-Volt Division.

DC Generators. Lab-Volt Division.

INSTRUCTOR'S NOTES

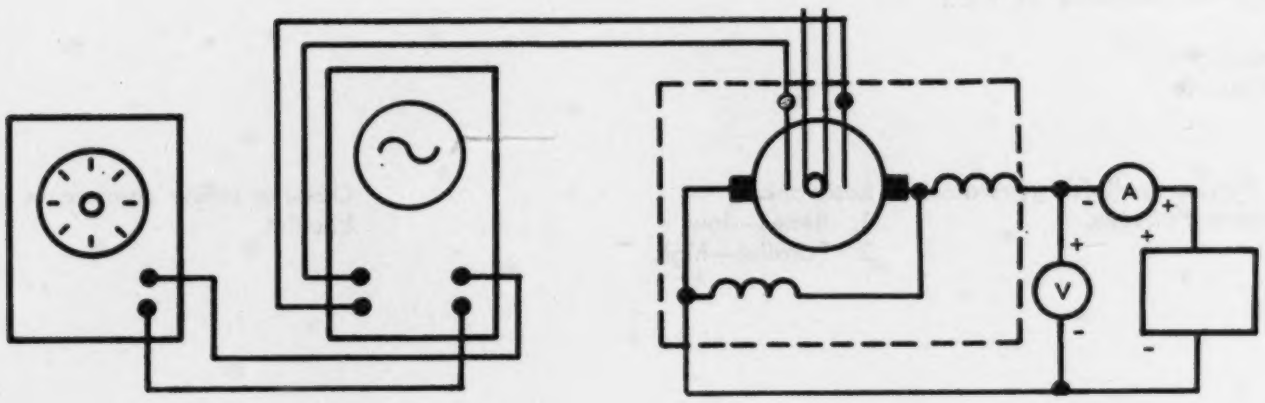

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AC CIRCUITRY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Demonstrate self-inductance and mutual inductance.	Physical and electrical characteristics of inductance: 1. Self-inductance 2. Mutual inductance	Always check circuit before energizing. Ask for help when in doubt about a circuit.
Connect and make measurements in series and parallel inductive circuits.	Inductive reactance: 1. Factors composing inductive reactance 2. Time constants 3. In series circuit 4. In parallel circuit	Use appropriate test instrument for desired measurement.
Test and decode capacitators. Connect and make measurements in series and parallel capacitive circuits.	Capacitors and capacitive reactance: 1. Color code and testing 2. Time constants 3. Factors composing capacitive reactance 4. In series circuit 5. In parallel circuit	Take measurements with care and accuracy.
Connect and make measurements in series and parallel: 1. Resistance inductance (R.L.) circuits 2. Resistance capacitance (R.C.) circuits. 3. Resistance capacitance inductance (R.C.L.) circuits	Impedance: 1. R.L. circuits 2. R.C. circuits 3. R.C.L. circuits	
Check frequency response of R.C.L. circuits: 1. Series circuits 2. Parallel circuits		
Use radio frequency (R.F.) generator to study resonant circuits.	Resonance: 1. Series—low 2. Parallel--high	Observe safety cautions in instruction booklet.

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AC CIRCUITRY

IMPLEMENTATION SUGGESTIONS

Laboratory Manual Experiments

Fischer. *Investigating Electricity*. No. 15.

Buban and Schmitt. *Understanding Electricity and Electronics*. Nos. 12, 30, 31.

Science Electronics, Inc. *Experimental Electricity*. Nos. 37-51.

Gerrish. *Learning Experiences in Electricity*. Nos. 31-39.

Zbar. *Basic Electricity*. Nos. 32-49.

Films

Inductance. University of Indiana.

Capacitance. University of Indiana.

RCL. University of Indiana.

Transparencies

Inductance and Capacitance. Science Electronics, Inc.

Series Resonant Circuits. Science Electronics, Inc.

Parallel Resonant Circuits. Science Electronics, Inc.

AC Inductive Circuits. Lab-Volt Division.

Time Constant Chart. Lab-Volt Division.

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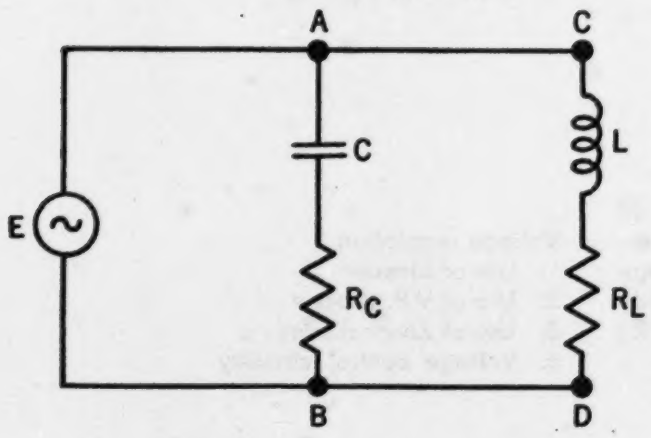

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POWER SUPPLIES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify common symbols used in electronics. Make a diagram of simple atomic structure. Graphically illustrate quantum levels and energy bands.	Diodes-rectification: 1. Tube type 2. Solid state 3. Gas rectifiers	Always use an isolation transformer when working on AC-DC circuits.
Diagram, label, and measure output voltage of power transformer.	Power transformers: 1. Transformer action 2. High-voltage windings 3. Low-voltage windings	Understand the danger of the high voltage encountered in power supplies.
Connect circuit to study parameters of tube, solid state, and dry metal rectifiers.	Transformer power supplies: 1. Half-wave type 2. Full-wave type	
Connect and circuit trace with scope and vacuum tube voltmeter (V.T.V.M.) the following power supply circuits: 1. Transformer half-wave, tube 2. Transformer half-wave, solid state 3. Transformer full-wave, tube 4. Transformer full-wave, solid state 5. AC-DC, solid state 6. Bridge, solid state 7. Cascade voltage doubler, solid state 8. Full-wave voltage doubler, solid state 9. Low-voltage Zener	AC-DC power supplies: 1. Half-wave 2. Full-wave voltage doublers 3. Cascade voltage doublers 4. Bridge rectifier 5. Low-voltage Zener supply	Never assume that a circuit is turned off until checked personally. Never try to eliminate the safety function of a fuse.
Connect and circuit trace with scope and V.T.V.M. the following filter circuits: 1. Resistance capacitance (R.C.) π filters 2. Inductance capacitance (L.C.) π filters 3. Multistage filters 4. Choke input filters 5. Brute force filter	Filter circuits: 1. R.C. filter action 2. L.C. filter action 3. Two-stage π filter 4. Brute force filtering	
Use a scope and V.T.V.M. to determine percent of ripple and voltage regulation. Connect circuit to study parameters of voltage regulator (V.R.) tube.	Voltage regulation: 1. Use of bleeder 2. Use of V.R. tubes 3. Use of Zener diodes 4. Voltage control circuitry	
Connect and circuit trace with scope and V.T.V.M. a full-wave transformer power supply with filter and Zener regulator.	Converters: 1. Vibrators 2. Transistor 3. DC to DC circuitry 4. DC to AC circuitry	

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POWER SUPPLIES

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Laboratory Manual Experiments

Science Electronics, Inc. *Experimental Electronics.* Nos. 1-13.

Gerrish. *Learning Experiences in Electronics.* Nos. 1-5.

Gerrish. *Learning Experiences in Transistors and Semiconductors.* Nos. 1, 2 and 29, 30.

Zbar. *Basic Electronics.* Nos. 1, 2 and 5-12.

Films

Semi-Conductors. University of Minnesota.

Diode: Principles and Applications. University of Illinois.

Transparencies

Transformer Power Supply. Science Electronics, Inc.

Full Wave Voltage Double. Science Electronics, Inc.

Full Wave Rectifier. Lab-Volt Division.

Bridge Rectifier. Lab-Volt Division.

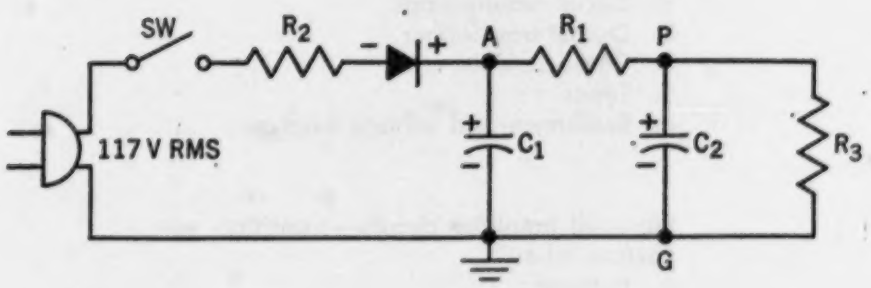

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AUDIO AMPLIFIERS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Diagram mechanical construction and electrical properties of transistors and vacuum tubes. Test DC parameters in vacuum tubes and transistors. Develop characteristic curves for vacuum tube and transistor circuits.	Sound: 1. Nature 2. Transmission 3. Reproduction Voltage and power amplifiers: 1. Vacuum tubes a. Tube elements b. Principles of operation c. Characteristics and data d. Testing 2. Transistors a. Nature of semiconductor b. Characteristics and data c. Testing d. Principles of operation (1) Common-base (2) Common-emitter (3) Common-collector	Realize and appreciate the many uses for audio amplifiers. Use isolation transformer when working on AC-DC circuits. Always check circuit before energizing.
Measure and calculate amplifier gain. Connect a single-stage AC amplifier (transistor and/or vacuum tube). Calculate power output for audio amplifier circuits. Connect and test a multistage amplifier using different methods of biasing and coupling. Check and graph frequency response for an audio amplifier.	Voltage amplifier circuits—transistor-vacuum tube: 1. Classes of operation 2. Biasing methods 3. Load lines 4. Coupling 5. Tone controls 6. Frequency response curve 7. Resistance and voltage analysis	Use appropriate test instrument for desired measurement. Observe proper care when handling semiconductors.
Connect and test a push-pull amplifier.	Power amplifier circuits — transistor-vacuum tubes: 1. Purpose 2. Circuit requirements 3. Output transformer 4. Characteristics 5. Types 6. Resistance and voltage analysis Push-pull amplifier circuits—transistor-vacuum tube: 1. Purpose 2. Biasing methods 3. Operation 4. Frequency response 5. Audio power, decibels	Make measurements with care and accuracy.
Connect and test a phase inverter circuit.	Phase inverter circuits — transistor-vacuum tube: 1. Purpose 2. Types 3. Operation	

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AUDIO AMPLIFIERS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Laboratory Manual Experiments

Science Electronics, Inc. *Experimental Electronics.* Nos. 14-31.

Gerrish. *Learning Experiences in Electronics.* Nos. 6-19.

Gerrish. *Learning Experiences in Transistors and Semiconductors.* Nos. 1-16.

Zbar. *Basic Electronics.* Nos. 13-17 and 19-35.

Films

Semi-Conductors. University of Minnesota.

Transparencies

Classes of Amplifiers. Science Electronics, Inc.

Audio Amplifier. Science Electronics, Inc.

Push-Pull Amplifier. Science Electronics, Inc.

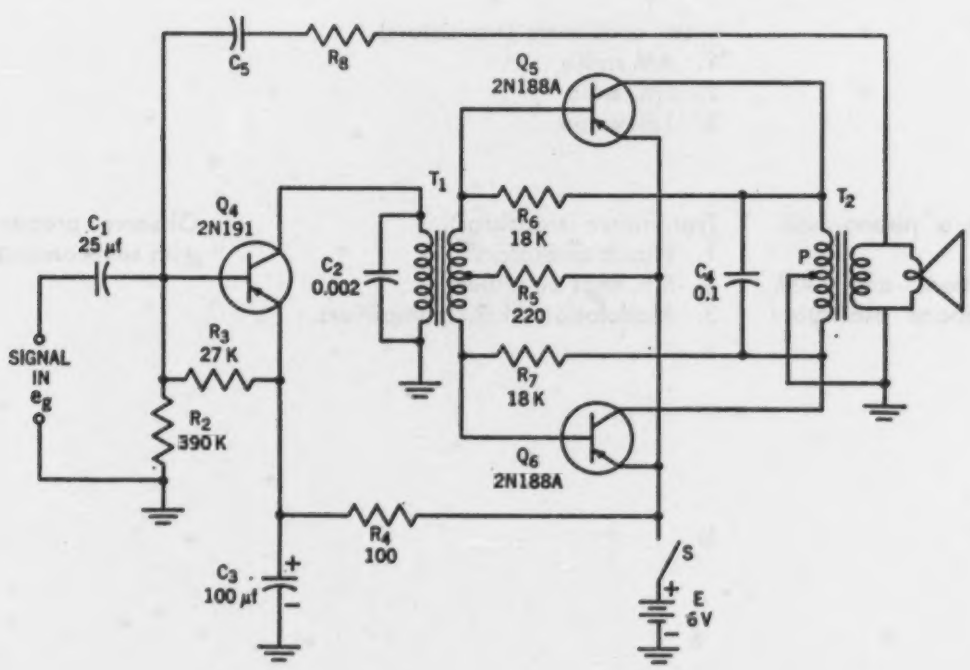

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OSCILLATORS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Use of oscillator circuits in: 1. Radio 2. Television 3. Audio frequency (A.F.) and radio frequency (R.F.) generators 4. Radar 5. Sonar 6. Transmitters	Realize and appreciate the many uses for oscillators.
Connect and analyze a transistorized Hartley oscillator circuit. Connect and analyze a transistorized Armstrong oscillator circuit. Connect and analyze a transistorized Colpitts oscillator circuit. Connect and analyze a transistorized Crystal oscillator circuit. Connect and analyze transistorized Astable and Bistable multivibrator circuits.	Transistor oscillators: 1. Circuit action (frequency) 2. Feedback and circuit action 3. Class C amplifier 4. Series and shunt feed Common types of inductance capacitance (L.C.) oscillators: 1. Hartley 2. Colpitts 3. Crystal-controlled 4. Broadcase-band 5. Blocking 6. Multivibrator Negative-resistance oscillators (tunnel diodes): 1. Emitter controlled 2. Base controlled 3. Collector controlled Local oscillators (transistors): 1. AM radio 2. FM radio 3. Television	Always check circuit before energizing. Make measurements with care and accuracy. Use appropriate test equipment for a desired measurement.
Connect and analyze a phono-oscillator circuit. Demonstrate modulation and AM transmission with a phono oscillator.	Transmitter (transistor): 1. Phono oscillators 2. R.F. final amplifiers 3. Modulation of R.F. amplifiers	Observe proper care when working with semiconductors.

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OSCILLATORS

IMPLEMENTATION SUGGESTIONS

Laboratory Manual Experiments

Science Electronics, Inc. *Experimental Electronics.* Nos. 32-37.

Gerrish. *Learning Experiences in Electronics.* Nos. 20-25.

Gerrish. *Learning Experiences in Transistors and Semiconductors.* Nos. 18-20 and 23, 24.

Zbar. *Basic Electronics.* Nos. 37-41.

Films

Oscillators. University of Indiana.

Transparencies

Hartley Oscillators. Science Electronics, Inc.

Transistor Oscillators. Science Electronics, Inc.

INSTRUCTOR'S NOTES

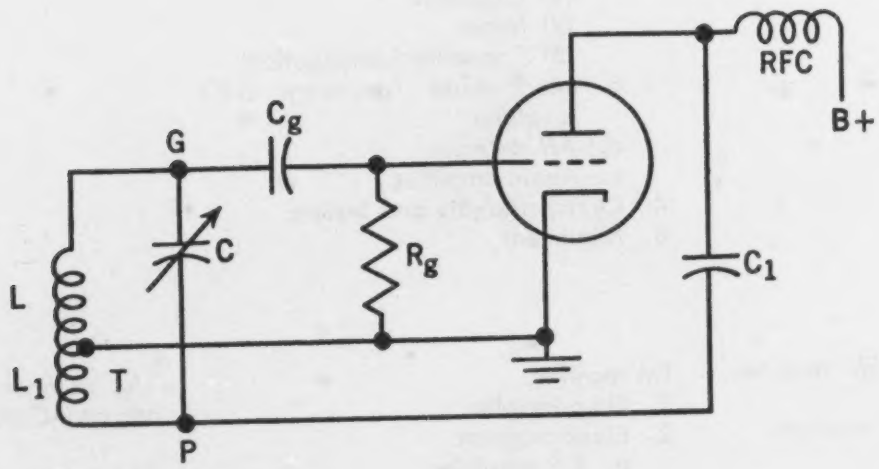

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COMMUNICATIONS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Radio waves: 1. Characteristics 2. Transmission 3. Receiving	Use appropriate test instruments for desired measurements.
Construct a crystal diode receiver.	Crystal receiver: 1. Use 2. Construction	
Connect and test a tuned radio frequency (T.R.F.) receiver. Block diagram a T.R.F. receiver.	T.R.F. receiver: 1. Advantages and disadvantages 2. Block diagram a. Tuner b. Detector c. Audio amplifier	Make measurements with care and accuracy.
Block diagram stage of a superhet receiver. Connect and analyze individual stages of superhet. Troubleshoot superhet receiver. Align a superhet receiver.	Superheterodyne receiver: 1. Advantages and disadvantages 2. Types and operation 3. Block diagram a. Radio frequency (R.F.) amplifier (1) Types and use (2) Analysis b. Mixer-oscillator or converter (1) Oscillator (2) Mixer (3) Converter (combination) c. Intermediate frequency (I.F.) amplifier d. AM detector e. Audio amplifier 4. Circuit analysis and testing 5. Alignment	
Block diagram stages of FM receiver. Localize trouble in a FM receiver. Align FM receiver.	FM receiver: 1. FM principles 2. Block diagram a. R.F. amplifier b. Mixer-oscillator c. I.F. amplifier d. Limiter e. FM detector f. Audio amplifier 3. Circuit analysis and testing 4. Alignment	Use isolation transformer when working on AC-DC circuits. Use proper and safe work habits.
	Other radio receivers.	

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COMMUNICATIONS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Laboratory Manual Experiments

Science Electronics, Inc. *Experimental Electronics.* No. 37.

Gerrish. *Learning Experiences in Electronics.* Nos. 25-33.

Zbar and Schildkraut. *Basic Radio and Radio-Receiver Servicing.* Nos. 53-75.

Zbar and Schildkraut. *Basic Television and Television-Receiver Servicing.* Nos. 1-55.

Films

Sending Radio Messages. University of Minnesota.

Television Systems. University of Minnesota.

Transparencies

Heterodyne Detection. Science Electronics, Inc.

AC - DC Superheterodyne Receiver. Science Electronics, Inc.

3536

COMMUNICATIONS—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Block diagram stages in TV receiver. Clean TV channel selector. Check operating performance of semiconductors and vacuum tubes. Localize trouble in TV receiver.	Television receiver: 1. Television principles 2. Safety precautions 3. Simple block diagram a. Selector b. I.F. amplifier, detectors video amplifier c. Synchronizing (sync) and scanning d. Cathode ray tube (C.R.T.) and high voltage e. Sound section f. Low-voltage supply	Develop consumer knowledge in buying radio and TV equipment. Use safety precautions when working with high voltage. Develop an appreciation for the work of the repairman and technician.

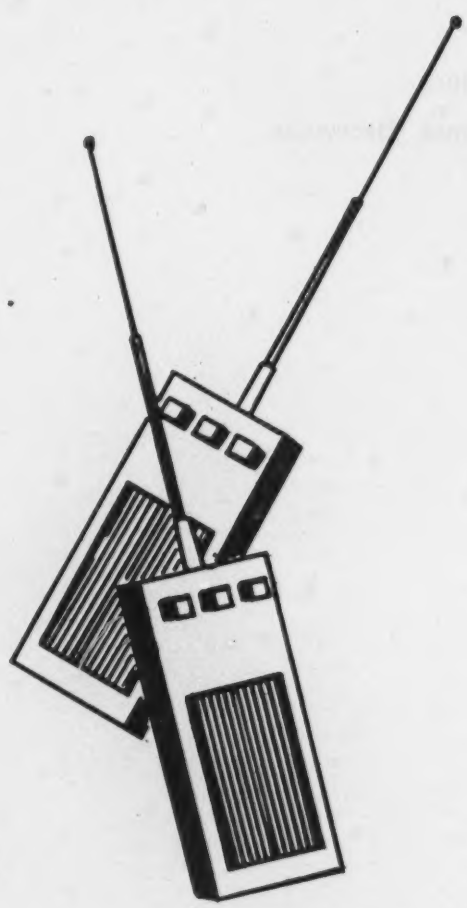

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IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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INTRODUCTION TO INDUSTRIAL ELECTRONICS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Make correct use of the more complicated measuring and testing instruments. Identify common symbols used in industrial electronics. Connect circuits to study parameters of thyratrons, silicon control rectifiers (S.C.R.), thyrectors, thermistors, solid state photoelectric cells, phototubes, humidity sensors, strain gauges, and switching transistors.	Power control circuits: 1. Rectification 2. Power transfer 3. Thyratron characteristics 4. Thyratron control 5. DC to DC concerters 6. Voltage regulation and control 7. Zener diode applications 8. S.C.R. characteristics 9. S.C.R. power control 10. Thyrectors	Be able to correlate theory and lab work. Have an interest in all noncommunication possibilities of electronic devices.
Connect and analyze with proper test equipment the following circuits: 1. DC to DC converter 2. Thyratron control 3. Power supply output control 4. S.C.R. control 5. Photoelectric control		
Connect and analyze with proper test equipment the following sensing circuits: 1. Strain gauge 2. Humidity measurement 3. Noise level measurement 4. Counter	Sensing circuits: 1. Thermistors 2. Strain gauges 3. Humidity sensor 4. Noise level measurement 5. Photoelectric counters 6. Photoelectric control	Develop quality as well as quantity of work.
Connect and analyze with proper test equipment the following timing circuits: 1. Time-delay relay 2. S.C.R. timer 3. Capacity-actuate relay	Timing circuits: 1. Relays 2. Time constants 3. Time-delay relays 4. Capacity-actuated relays 5. S.C.R. timers	Use isolation transformer when working on AC-DC circuits.
Connect and analyze with proper test equipment the following switching and pulse circuits: 1. Transistor 2. Wave shaping 3. Schmitt trigger 4. Pulse generator 5. Pulse frequency divider	Switching and pulse circuits: 1. Transistor switching characteristics a. Common emitter b. Common base c. Common collector 2. Pulse generation 3. Pulse frequency division 4. Wave shaping 5. Schmitt trigger	Use proper and safe work habits.

INTRODUCTION TO INDUSTRIAL ELECTRONICS

IMPLEMENTATION SUGGESTIONS

Laboratory Manual Experiments

Science Electronics, Inc. *Experimental Electronics.* Nos. 44-50.

Gerrish. *Learning Experiences in Transistors and Semiconductors.* Nos. 21-33.

Frost. *Applied Electronics.* Nos. 1-20 and 26-40.

Films

Digital Computer Fundamentals: Introduction. Hickok Teaching Systems, Inc.

Computer Logic. Hickok Teaching Systems, Inc.

Logic Element Circuits. Hickok Teaching Systems, Inc.

INSTRUCTOR'S NOTES

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INTRODUCTION TO INDUSTRIAL ELECTRONICS—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Connect and analyze with proper test equipment the following computer circuits: 1. Diode logic gates 2. Transistor logic gates 3. Multivibrator	Computers: 1. Input a. Cards b. Tape c. Disk 2. Control a. Add b. Subtract 3. Arithmetic a. Diode logic gates b. Transistor logic gates c. Multivibrators 4. Storage a. Drums b. Memory cores 5. Output a. Printer b. Magnetic tape c. Cards d. Punch tape	Develop an appreciation for the work of an industrial technician.

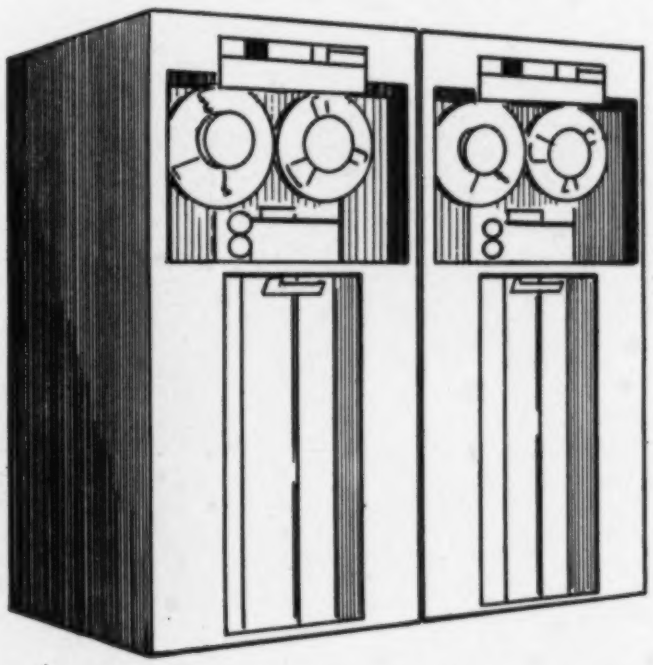

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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Textbooks

Bartee, Thomas C. *Digital Computer Fundamentals.* 2nd ed. McGraw-Hill, 1966. $6.95; answers, 35¢ (621.3819)

Basic Electricity/Electronics. 5 vols. Howard W. Sams, 1964. $24.95 a set (621.381)

Buban, Peter, and Marshall L. Schmitt. *Understanding Electricity and Electronics.* 2nd ed. McGraw-Hill, 1969. $6.96 (621.381)

Gerrish, Howard H. *Electricity and Electronics.* Goodheart-Willcox, 1968. $5.75 (621.381)

Grob, Bernard, and Milton S. Kiver. *Applications of Electronics.* 2nd ed. McGraw-Hill, 1966. $7.95 (621.381)

Grob, Bernard. *Basic Electronics.* 2nd ed. McGraw-Hill, 1965. $10.50 (621.381)

Grob, Bernard. *Basic Television.* 3rd ed. McGraw-Hill, 1964. $8.00 (621.388)

Kiver, Milton S. *Transistors: In Radio, Television and Electronics.* 3rd ed. McGraw-Hill, 1962. $6.50; lab. manual, $2.95 (621.381)

Marcus, Abraham. *Basic Electricity.* 2nd ed. Prentice-Hall, 1964. $7.96 (621.3)

Marcus, Abraham. *Basic Electronics.* Prentice-Hall, 1963. $7.96 (621.381)

Marcus, Abraham and William. *Elements of Radio.* 5th ed. Prentice-Hall, 1965. $8.04; workbook, $1.84 (621.384)

Mileaf, Harry, ed. *Electronics.* Hayden, 1967. 7 vols., paper, $20.95; 1 vol. ed., $14.95 (621.381)

New York Institute of Technology. *A Programmed Course in Basic Transistors.* McGraw-Hill, 1964. $5.95 (621.381)

Laboratory Manuals

Buban, Peter, and Marshall L. Schmitt. *Understanding Electricity and Electronics.* McGraw-Hill, 1968. $1.32 (621.381)

Fischer, William K. *Investigating Electricity.* 1966. $2.50 (621.3) Available from Buck Engineering Company, P.O. Box 686, Farmingdale, New York 11735.

Frost, John S. *Applied Electronics.* 1967. $4.75 (621.381) Available from Buck Engineering Company, P.O. Box 686, Farmingdale, New York 11735.

Gerrish, Howard H. *Learning Experiences in Electricity.* 2nd ed. 1967. $3.50 (621.3) Available from Buck Engineering Company, P.O. Box 686, Farmingdale, New York 11735.

Gerrish, Howard H. *Learning Experiences in Electronics.* 1964. $3.50 (621.381) Available from Buck Engineering Company, P.O. Box 686, Farmingdale, New York 11735.

Gerrish, Howard H. *Learning Experiences in Transistors and Semi-conductors.* 1965. $3.50 (621.381) Available from Buck Engineering Company, P.O. Box 686, Farmingdale, New York 11735.

Science Electronics, Inc. *Experimental Electricity: A Laboratory Manual* by Lyle Rahn and Emil V. Magnuson. McGraw-Hill, 1969. $3.15 (621.3)

Science Electronics, Inc. *Experimental Electronics: A Laboratory Manual* by Lyle Rahn and others. McGraw-Hill. In preparation. $3.15. (621.381)

Zbar, Paul B. *Basic Electricity.* 3rd ed. McGraw-Hill, 1966. $3.95 (621.3)

Zbar, Paul B. *Basic Electronics.* 3rd ed. McGraw-Hill, 1968. $3.95 (621.381)

Zbar, Paul B., and Sid Schildkraut. *Basic Radio and Radio-Receiver Servicing.* 2nd ed. McGraw-Hill, 1959. $2.50 (621.384)

Zbar, Paul B., and Sid Schildkraut. *Basic Television and Television-Receiver Servicing.* McGraw-Hill, 1958. $4.50 (621.388)

Zbar, Paul B. *Industrial Electronics.* McGraw-Hill, 1960. $5.00 (621.381)

3543

Sources for Audio-Visual Materials

Bureau of Mines
United States Department of Interior
Motion Pictures
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue
Chicago, Illinois 60611
or
Mr. Charles Fehr
Encyclopaedia Britannica Educational Corporation
13257 Humboldt Avenue South
Burnsville, Minnesota 55378

Hickok Teaching Systems, Inc.
Wheeling Avenue
Woburn, Massachusetts 01801
or
Mr. Allen Mowbray
Hickok Teaching Systems, Inc.
8041 Quincy
Spring Lake Park, Minnesota 55432

Lab-Volt Division
Buck Engineering Company
P.O. Box 686
Farmingdale, New York 11735

Modern Talking Picture Service
1114 Nicollet Avenue
Minneapolis, Minnesota 55403

Northwestern Bell Telephone Company
Public Relations Department
Film Booking—Room 1335
224 South 5th Street
Minneapolis, Minnesota 55402

Science Electronics, Inc.
1085 Commonwealth Avenue
Boston, Massachusetts 02215

Tektronix, Inc.
Film Library
Delivery Station 50/420
P.O. Box 500
Beaverton, Oregon 97005

University of Illinois
Visual Aids Service
704 South 6th
Champaign, Illinois 61822

University of Indiana
Audio-Visual Center
Bloomington, Indiana 47401

University of Minnesota
Audio-Visual Extension Service
General Extension Division
2037 University Avenue S.E.
Minneapolis, Minnesota 55455

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MECHANICAL POWER TECHNOLOGY

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INTRODUCTION

Since the beginning of time, man has struggled to conquer and control his environment. This conquest has been most facilitated by harnessing the various power sources in the natural environment. Today, the construction of powered implements is so great that an exhaustive list would be pages long. The manufacture and service of these labor-saving devices has become an important part in our economy and, in one way or another, affects almost every industry in existence. For example, the largest and most influential industry is probably that of the automobile, a powered implement. Because of the far-reaching economic and industrial connections and the commercialization of power utilization, it seems essential that the American youth should be acquainted with the development, construction, design, and maintenance of the products which use or produce power.

This resource guide on mechanical power contains sixteen units or divisions. The first unit is a developmental or historical approach to the coverage of power in general. It is designed for use mainly as a junior high course or, in brevity, as an introductory unit in an automobile, small engine, or fluid power course. The internal combustion engine and the transmission of its power are the main concern in most of the units.

Because a course of study is usually dictated by the availability of space and equipment, there has been no attempt to divide the material into teaching units. Rather, common content divisions which may or may not be teachable in a given situation have been used. It is hoped that, on the basis of time, space, and equipment, an instructor can utilize portions of any or all of the units in meeting his unique teaching objectives. The unit on small gas engines shows such an approach in that portions of several of the other units have been utilized. Other courses could be organized around an automobile or truck engine, an entire automobile, or any separate systems such as the drive train or brake system. Much of the activity in a power shop is similar to that of the service trades. Many operations are somewhat routine and teaching is best expedited through teacher demonstrations and pupil practice.

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HISTORY AND DEVELOPMENT OF POWER

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
List the methods by which energy is derived from the sun.	The sun is the origin of most energy sources.	Realize why primitive man often worshipped the sun.
	Man's first energy source was his own muscle power.	
Identify the classes of levers.	The utilization and adaptation of the simple machines: 1. Lever 2. Wheel and axle 3. Pulley 4. Inclined plane 5. Wedge 6. Screw	Appreciate early civilization's struggle to control the environment.
Solve problems of mechanical advantage.	The physical principles of simple machines. The relationships between work, energy, and power.	Realize the improvements available to man through the use of mechanical advantage application.
Identify animals used as energy sources rather than as a source of food.	The domestication of animals for their muscle power.	
Determine horsepower requirements to move objects or rotate a shaft.	The origin, meaning, and methods of measuring horsepower: 1. Physical definition 2. Taxable 3. Brake	Realize the misconceptions often associated with the term "horsepower."
Describe the physical principles involved in sailing.	The methods of utilizing the wind as a power source.	Appreciate man's first use of nonmuscular energy.
Demonstrate how pitch affects power and speed.	The principle of pitch.	
Identify types of water wheels and water turbines.	The utilization of water as a power source.	Appreciate the importance of contemporary hydroelectric power generation.

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HISTORY AND DEVELOPMENT OF POWER

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Compile lists of direct and indirect products of the sun's energy.	
Construct various simple machines and measure or calculate the mechanical advantages with spring scales.	
Research a simple machine and identify its applications in contemporary mechanisms.	
Compile a list of the simple machine applications in a modern complex device such as a typewriter.	
Have a group discussion on the necessity of mechanical advantage in contemporary technology.	
Report on the unusual animals used for power in foreign countries or within our nation's history.	
Construct a Prony brake. Measure horsepower by use of a Prony brake. Measure horsepower by use of a spring scale.	
Construct sail boats or windwheels.	
Research or report on the windmill's impact on the development of the Western United States.	
Measure the speed of a fan at various blade pitches.	
Construct model water wheels or water turbines and measure their power.	

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HISTORY AND DEVELOPMENT OF POWER—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Solve problems of heat and the expansion of gases.	The principles involved in utilizing steam as an energy source.	Realize the potential danger in steam pressure.
Sketch the relationships between valves and piston engine.	The operation of a steam piston engine.	Appreciate the impact of steam power on industrialization.
Calculate the efficiency of a power source.	The sources of power loss in steam engines.	Realize need for more efficient sources of energy.
Compare the disadvantages and advantages of steam piston engine and steam turbines.	The operation of a steam turbine.	Realize need for more efficient power source.
	The utilization of steam turbines in nuclear power plants.	Respect the potential speed of a turbine.
Sketch the four cycles of a four-stroke cycle engine.	The operation of a four-stroke cycle engine.	
List the advantages of internal combustion engines.		
List the applications of internal combustion engines.	The basic necessities of internal combustion: 1. Carburetion 2. Compression 3. Ignition	Recognize the vast areas of application and the versatility of the internal combustion engine.
	The common fuels and lubricants used in internal combustion engines.	Appreciate the adverse effects of friction by using proper lubricants.
List the regulations for handling fuel.	The power potential of fuels.	Always handle fuel with care.
Identify natural resources which have been depleted as power sources.	The limited supply of petroleum and its products.	Realize the present drain on the natural petroleum resources and the limitations of future use.

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HISTORY AND DEVELOPMENT OF POWER—continued

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Demonstrate and measure the expansion of water when heated and vaporized.	
Explode a container under controlled conditions.	
Report on the impact of railroad steam engines on civilization.	
Visit an old locomotive or a modern steam generation plant.	
Measure directly the horsepower and efficiency of a model steam engine.	
Compare the stress and friction efficiency of a steam piston engine and a steam turbine engine.	
Construct or demonstrate a model of Hero's aeolipile.	
Demonstrate four-stroke cycle theory with cutaway engine.	
Report on the history of the automobile.	
Students determine displacement increase by reboring a typical engine.	
Trace the petroleum refining process from well to service station.	
Ignite fuel in tube which is open on one end, demonstrating the power effect of fuel.	
Research past and present natural resources.	

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HISTORY AND DEVELOPMENT OF POWER—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Calculate compression ratios and piston displacements.	The relation between displacement compression and horsepower.	
Recognize the physical differences in two- and four-stroke cycle engines.	The operation of a two-stroke cycle engine.	Respect the heat produced in an air-cooled engine.
List the advantages of a diesel engine.	The operation of a diesel engine: 1. Two-stroke cycle 2. Four-stroke cycle	Realize the heat and pressure developed in a diesel engine.
Enumerate the engineering problems presently thwarting gas turbine production and utilization.	The operation of a gas turbine.	Appreciate the potential impact on the auto industry of a major change in power source.
Compare the jet engine with the piston engine.	The operation of a jet engine.	
Solve problems of force and reaction.	The basic principles of rocketry.	Realize the potential of space exploration through rocket travel.

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HISTORY AND DEVELOPMENT OF POWER—continued

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Compare actual physical weights of identical horsepower two- and four-stroke cycle engines.	
Measure the external temperature of an operating engine.	
Demonstrate how heat is derived through pressure to cause an explosion. Research or report on the applications of diesel engines.	
Present recent articles on gas turbine experimentations and use.	
Compare the various methods of thrust.	
Report on the use of the jet airplane for travel and freight transportation.	
Follow current events in rocket development and the space program.	

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TOOLS, EQUIPMENT, AND ATTACHMENTS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify thread and bolt sizes.	The various fastening devices and their relation to material strength, harness, and application.	Use tools safely and carefully.
Select and use proper hand tools.	Hand tool construction.	Recognize quality tools.
Look up manufacturers' torque specifications.	Torque as related to threaded devices.	Properly torque all threaded devices.
Use threading equipment and repair faulty threads.	The function of threading equipment and thread repair systems.	Appreciate the need to avoid stud breakage.
Measure accurately with such instruments as the micrometer, dial indicator, or feeler gauge.	Decimal and fractional measuring systems.	Recognize the need for accuracy in repair.
Solder, braze, and weld various metals.	Methods of bonding and fusional attachment as related to various metals.	Realize the advantages in joining metals through a heat process.
Use and care of cutting tools.	Cutting tools: 1. Drills 2. Saw 3. File 4. Chisel 5. Reamers 6. Hones	Respect sharp edges of tools.

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TOOLS, EQUIPMENT, AND ATTACHMENTS

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Display fasteners and illustrate the thread systems. Demonstrate the shear strength of various bolt designs.	
Demonstrate use, care, and nomenclature of common hand tools.	
Have student drill and tap a piece of scrap aluminum and also properly torque a stud in the aluminum. Later have student determine stripping torque. Have student thread a rod.	
Demonstrate proper method of using taps and dies.	
Overhead transparencies, filmstrips, and programed instructions are available on use and care of micrometer. Student should practice measurement on actual spare engine components.	
Utilize machine shop facilities and instruments demonstrating the various methods of heat attachment.	
Student should experience use of each cutting tool.	

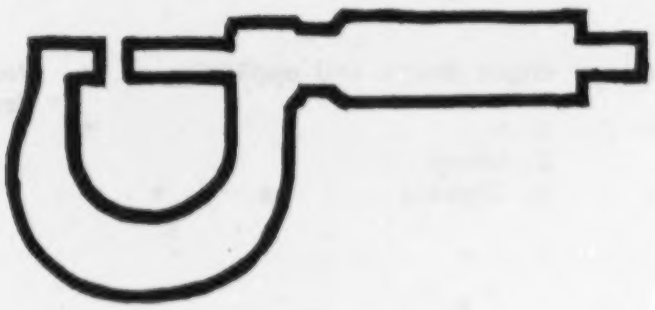

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INTERNAL COMBUSTION ENGINE

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
List implements powered by internal combustion engines, such as: 1. Automobiles 2. Trucks 3. Airplanes 4. Lawn mowers 5. Motorboats	The adapability, versatility, and mobility of internal combustion engines as compared to other power sources.	Appreciate the social and economic influence on our society.
Recognize various alloys and base metals.	The material construction of engine components.	
Compare spark and compression ignition systems.	The transfer of heat energy to motion through compression and combustion.	Appreciate the heat buildup through compression.
Recognize the basic components of a four-cycle engine, such as: 1. Block and cylinder 2. Piston and rings 3. Connecting rod 4. Crankshaft 5. Valves and camshaft	Four-stroke cycle theory: 1. Intake 2. Compression 3. Power 4. Exhaust	Realize the complexity in a modern high-speed engine.
Compare valve train efficiency in various engines.	Valve arrangements: 1. I head 2. L head 3. F head 4. T head	Appreciate the need for precision of the parts of an engine.
Recognize the physical differences in two- and four-cycle engines.	Two-stroke cycle theory: 1. Reed valves 2. Rotary valves	
Recognize the physical differences in cylinder arrangements.	Engine design and applications: 1. In-line 2. V 3. Rotary 4. Opposed	Realize the purposes in various engine designs.

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INTERNAL COMBUSTION ENGINE

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Compile lists of devices powered by internal combustion engines. Research other power sources used on mobile units and compare advantages and disadvantages.	
Display sample alloys and base metals. Experiment with the testing of hardness and wear qualities.	
Explode fuel through compression in controlled cylinder using various fuels, or check burning temperature of various fuels.	
Use cutaway engine and individual parts showing entire mechanical process; identify and relate each part to the other. Also note power flow and expanding gas.	
Examine engines and identify valve arrangement from external clues.	
Compare physical weights, acceleration, horsepower, and r.p.m. output of two- and four-cycle engines.	
Determine the space requirements and reasons for various engine applications.	

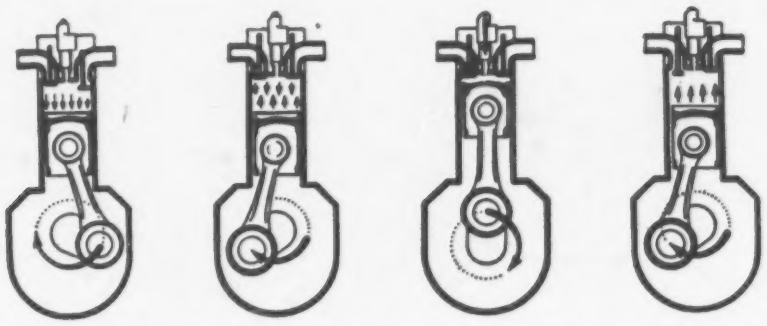

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COOLING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
List types of cooling systems: 1. Air 2. Liquid 3. Oil	Heat transfer and losses: 1. Convection 2. Conduction 3. Radiation	Realize relationship between engine operating temperature and cooling system capacity.
Trace airflow and clean passage on an air-cooled engine.	Air movement and cooling fins in air system.	Respect hot engine components.
Change and check coolant in liquid system.	Antifreeze and other coolant systems.	Use antifreeze and temperature controls in cold weather.
Check operation of a thermostat.	Function of a thermostat.	Run engines at appropriate temperature.
Check a pressure cap.	Pressure systems.	Allow cooling system to cool before removing cap.
Replace a water pump.	Water pumps.	
Reverse flush a radiator.	Formation of rust and sludge.	Use anticorrosive solutions in cooling systems.
Pressure test a liquid system for internal and external leaks.	Heat circulation.	Use only low pressure to find leaks in cooling system.
Change cooling system hoses.	Coolant hose and clamp installation.	
Recognize faulty fan belt and change belt.	Belt tension and causes of belt failure.	Keep hands and clothes away from running belts.

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COOLING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Experiment with the cooling of metal by various methods and determine efficiency. Display components damaged by excessive heat.	
Check engine temperature at various points with heat indicators.	
Weigh water and antifreeze solutions to display the testing system. Demonstrate hydrometer.	
Observe opening and closing of thermostat in heated water.	
Boil water at various pressures to determine boiling temperature.	
Allow water to stand in a metal container for a period of time and examine sediment formation and oxidation.	
Observe the circulation of liquid in glass tubes as hot water seeks a higher level.	
Demonstrate pressure methods of locating cooling system leaks.	

3559

LUBRICATION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Differentiate between the wear and load qualities of various metals.	Friction and wear.	Become aware of heat buildup from friction.
List various petroleum products.	Crude oil products such as: 1. Gasoline 2. Kerosene 3. Fuel oils 4. Motor oils	
Select proper oil for an engine by determining its use and requirements.	The viscosity of oil. The Society of Automotive Engineers (S.A.E.) system of identification which includes Motor Light (M.L.), Motor Moderate (M.M.), and Motor Severe (M.S.).	Use manufacturer's recommended or better oil in personal engines.
Change crankcase oil.	The purpose of oil additives.	Check oil level before starting any engine.
Change oil filter.	Oil filter systems: 1. Full-flow 2. By-pass	
List oil contaminates.	Oil contamination and sludge formation.	Relate engine life to crankcase contamination.
Check oil pressure.	Types of lubricant systems: 1. Pressure 2. Splash 3. Fuel mixture 4. Combination	Recognize advantages of different systems.
Change a positive ventilation crankcase (P.V.C.) valve.	Crankcase ventilation.	
Purge an oil line.	Oil lines and galleries.	
Check oil pump for wear.	Types of oil pumps: 1. Gear 2. Rotor 3. Piston or plunger 4. Vane	
Lubricate automobile chassis.	Bearing and antifriction device construction.	Regularly lubricate all equipment.
Service bearings. Diagnose bearing failure.		

3560

LUBRICATION

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Experiment with heat transfer on different metals with torch and temperature devices. Observe the effects of friction on various metals and various surfaces.	
Trace the refining process. Visit a refinery if possible.	
Check viscosity by timing oil flow through a controlled orifice.	
Test oil for temperature at breakdown of different grades. Boil away and examine residue of several brands of oil.	
Compare internal components of different oil filters.	
Check oil pressure at various points on an operating engine. Compare pressures of different pump types.	
Run test engine with sealed crankcase and observe results. Compare exhaust emission with various systems of crankcase ventilation. Trace oil systems through various engine blocks.	
Diagnose worn pumps.	
Display worn bearings, especially ones burned from lack of grease or oil.	

3561

FUEL

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Select proper fuel base for engine requirements and applications.	Gasoline and diesel fuel: 1. Octane rating 2. Volatility	Do not use open fire around explosive fuel.
	Condensation in storage tanks.	Use deicing additive in cold weather.
Repair a fuel tank.	Methods of removal and repair.	Observe safety precautions when handling fuel tanks.
Recognize fuel systems: 1. Gravity 2. Siphon 3. Pressure 4. Diaphragm	Methods of fuel movement—the advantages and disadvantages.	
Change a fuel filter.	Fuel filtration.	Store fuel in clean containers.
Check fuel pump: 1. Pressure 2. Vacuum 3. Capacity	Mechanical fuel pump operation.	
Determine the fuel delivery needs of an engine.	Vacuum pump operation.	
	Fuel pressure regulators.	
	Electric fuel pumps.	
Clean an air cleaner.	Air filtration: 1. Oil bath 2. Dry element 3. Oil-wetted element	Realize the need for clean air and the adverse effects of the content of impure air.
Replace muffler, tail exhaust pipe, and manifold.	Exhaust systems: 1. Pipe 2. Muffler 3. Resonative 4. Manifold	Recognize the lethal danger in exhaust gases.
Check exhaust emission for hydrocarbon content.	Exhaust emission control devices.	

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FUEL

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Check flash point of different types and grades of fuel.	
Condense vapor in glass bottle by changing temperature of outside.	
Explode a fuel container under controlled conditions.	
Research characteristics, disadvantages, and advantages of each system.	
Check sedimentation and contamination in raw fuel.	
Disassemble and reassemble a variety of fuel pumps tracing the fuel flow. Diagnose pump problems in malfunctioning pumps.	
Check vacuum variation at manifold and at windshield wiper on engine equipped with double action pump under various engine speed and load conditions.	
Filtrate ordinary room air through filter paper, demonstrating constant existence of foreign material.	
Research current developments in exhaust emission control. Compare methods of control.	

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CARBURETION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify pressure areas in a venturi.	The venturi principle.	
	Carburetor fundamentals: 1. Atomization 2. Distribution 3. Metering	
Trace the circuits in a carburetor, recognizing worn or broken parts.	The circuits, functions, and adjustments of a carburetor: 1. Float 2. High speed 3. Idle 4. Low speed 5. Acceleration 6. Power 7. Choke	Check carburetor manual for determining adjustments and circuits.
Adjust an automatic choke.	Choking and priming methods.	
Clean and adjust a carburetor.		Avoid contact with carburetor cleaning solutions; realize importance of following manufacturers' specifications.
Free a heat riser.	Manifold heating: 1. Exhaust 2. Water	Realize effects of preheating on engine performance.
Adjust a carburetor on an operating engine.	Air-fuel ratio requirements in relation to engine load and speed.	Avoid overtightening adjustment needles.
Adjust the load r.p.m. of operating engine.	Function of a governor: 1. Air vent 2. Centrifugal 3. Electronic	Run engine at recommended r.p.m.
Relate engine performance to carburetion.	Exhaust emissions relation to carburetion.	

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CARBURETION

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Show liquid movement by air pressure with soda straws, perfume atomizer, or fly sprayer.	
Trace the circuitry through various carburetors while disassembling, reassembling, and making all necessary adjustments.	
Faulty carburetors are often available through distributors. An ordinary carburetor on which each student can practice expedites learning and maintains interest.	
Compare engine performance with cold and warm manifolds; also check exhaust emission.	
Check engine's performance on dynamometer with different loads while making carburetor adjustments.	
Plot the throttle opening or air flow of governed engine as load is varied.	
Diagnose engine malfunction with "bugged" carburetor.	

3565

ELECTRICITY AND ELECTRICAL EQUIPMENT

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Determine current flow.	Magnetism and atomic structure.	
Calculate voltage drops in a circuit.	Ohm's Law.	
Test a lead-acid storage battery. Charge a battery.	Lead-acid storage cell chemical action.	Use caution when handling sulfuric acid.
	Specific gravity.	Avoid sparks or fire around a charging battery.
Check and service generator fields, commutators, brushes, and bearings.	Generator function and construction: 1. A circuit 2. B circuit	Motorize generator after service.
Adjust current, voltage, and cut out on regulator.	Generator regulation.	Realize the need for precision in adjustment.
Check the diodes and the field, stator, and regulator.	An alternator: 1. Y 2. △	
Check fields, armature connection, and brushes. Repair as necessary.	A starter motor.	
	Ring gear.	
Replace the starter drives.	Starter drives: 1. Bendix 2. Overrunning	
Adjust head lamps.	Electrical equipment such as: 1. Horn 2. Lights 3. Motors 4. Relays 5. Solenoids	Utilize good connections and avoid unnecessary resistance in electrical equipment.
	Wiring systems: 1. One wire 2. Two wire	

3566

ELECTRICITY AND ELECTRICAL EQUIPMENT

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
See electricity guide for theoretical aspects of electricity.	
Measure voltage drops and calculate resistance in various parts of electrical system.	
Cut old battery apart, showing internal construction. Weigh acid from charged and uncharged battery to demonstrate testing principle. Test capacity of different amp-hour-rated batteries with carbon pile and voltmeter.	
Construct model generator. Have students check actual generators with known problems, turn and undercut commutators, and replace brushes.	
Check gear ratios between ring gears and starter drives on various models.	
Display types of drives.	
Model can be made which includes all of the wiring in an automobile providing circuit study and diagnosis for student.	

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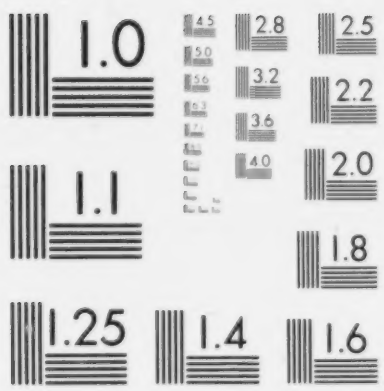

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SPARK IGNITION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Test an ignition coil.	Ignition coils.	Avoid secondary shocks.
Adjust or replace points.	Contact points.	
Check spring tension.	Dwell angle and cam rotation.	
Check spark advance.	A distributor.	
Time an engine.	Spark advance system: 1. Centrifugal 2. Vacuum	Set timing to recommended degree.
Install ignition wire in proper order.	Firing order.	
Check secondary leakage.	Resistance wire.	
Clean spark plugs.	Spark plugs: 1. Heat range 2. Thread size and reach 3. Resistance	Remove all abrasive material from plugs before reinstallation.
Diagnose combustion chamber condition through spark plug condition.	Spark plug polarity.	Avoid touching hot spark plugs.
Check ignition system voltage drops.	Bypass resistors.	
Adjust armature air gap.	Magneto ignition.	Use care in handling flywheels with magnets.
	Transistor ignition.	

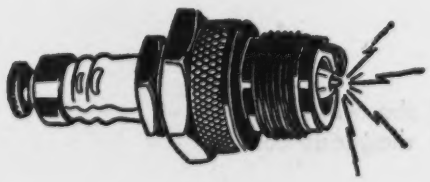

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SPARK IGNITION

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Construct coils with nail, fine wire, and storage battery.	
Construct ignition system from basic parts.	
Observe voltage buildup in condenser with an ohmmeter.	
Demonstrate distribution on ignition simulator.	
Check engine performance with various timing. Display piston burned from early timing.	
Check service manuals for various firing orders and placements of cylinders.	
Experiment with effect of ignition on radio and TV.	
Trace heat transfer from center electrode of plug to engine cooling system.	
Demonstrate polarity with lead pencil or voltmeter.	
Display spark plugs from engines with varied combustion chamber conditions.	
Check and compare secondary voltage with and without bypass resistors.	
Compare voltage outputs of various magneto and battery systems at different speeds.	
Compare transistor voltage to magneto and battery systems.	

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VALVES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Remove valves and seats. Replace valve seats.	Valves and seat function and construction.	Appreciate need for good combustion chamber seal.
	Valve cooling.	
Check spring tension.	Valve springs.	
Check stem clearance and concentricity.	Valve guides and stem seals.	Realize the need for precision in valve repair.
Replace valve guides.		
Ream rocker arms.	Rocker arms and shafts.	
Adjust valve clearance.	Solid tappets and push rods.	
Test hydraulic lifters.	Hydraulic lifters.	Appreciate the speed of valve operation.
	Valve rotators.	
Check alignment and lobe wear. Replace bearings.	Camshaft.	
Change camshaft gears and chain.	Camshaft drives: 1. Gear 2. Chain	
Align camshaft with crankshaft.	Valve timing.	Use care in handling fiber and aluminum gears.
Check and adjust reed valves.	Reed valves.	
	Rotary valves.	
Check cylinder compression.	The causes and effects of valve failure.	Realize the limitations of compression.
Check valves with cylinder leakage test.	Relationship between compression leakage and engine performance.	

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VALVES

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Collect and display burnt valves, showing various failures.	
Display oil burning engine with good compression. Show function of oil control rings by pulling oil through guides.	
Measure valve clearance on cold and hot engines, comparing differences.	
Trace oil flow in valve mechanisms.	
Observe engine performance with loose and tight valves.	
Compare engine performance with valve timing off "one tooth."	
Do comparative tests on engines with various valve problems to determine cause-effect relationship.	

OVERHAUL

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Expand pistons.	Design, construction, and function of pistons.	Mark connecting rods and pistons during disassembly.
Regroove pistons.	Function and construction of rings: 1. Compression 2. Oil control 3. Expanders	
Fit piston pins.	Wrist pin construction, attachment, and bearing methods.	Appreciate the stress placed on engine components.
Ridge, ream, hone, or rebore cylinder.	Blocks and cylinder walls.	
Check for cracks. Weld if necessary.		
Align rods and pistons.	Function and construction of connecting rods.	
Check bearing wear and clearance.	Function and construction of bearings: 1. Connecting rod a. Solid b. Insert c. Roller d. Ball 2. Main bearings a. Insert b. Solid	Realize the need for accurate measurement and proper fit of all components.
Diagnose bearing failure.	Causes of bearing failure.	
Check bearing surfaces, balance, and run out.	Crankshaft.	
	Crankshaft seals.	
	Flywheel.	
	Vibration damper.	
Replace head gasket.	Cylinder head.	Use proper sequence and torque when tightening cylinder heads.

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OVERHAUL

IMPLEMENTATION SUGGESTIONS

The overhaul of the internal components in an internal combustion engine is best facilitated through actual performance of the operations. The use of actual engines which need repair is greatly preferred to pseudo-operations or new or display engines. The engines to be worked on may be those of the student or those often available through local distribution or even junk yards, depending on the type included in the course. In addition to an explanation of the reason for the operation, all operations should be demonstrated to the class.

INSTRUCTOR'S NOTES

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FRICTION DEVICES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Replace a clutch disc and a pressure plate.	A clutch disc.	Realize heat buildup and wear in a friction device.
	Pressure plates: 1. Coil springs 2. Diaphragm	
Adjust pedal. Change throwout bearing.	Clutch release mechanism.	
	Backing plate attachment springs and anchorage.	Maintain properly adjusted brakes in personal automobile.
Turn drum surfaces.	Brake drums.	Avoid cutting drums beyond safety limit.
Reline brake shoes. Arc shoes.	Converted brake shoes and linings.	
	Braking ratio.	
Adjust brakes.	Disc brakes.	
	Emergency brakes.	

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FRICTION DEVICES

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Construct a friction drive device and measure wear and heat quantities of various materials. Calculate frictional pressures necessary to drive specific load without slippage.	
Check temperature of operating brake.	
Determine braking ratio of various automobiles.	

3575

DIRECT POWER TRANSFER

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Types of transmissions: 1. Rotary 2. Linear	Realize the need to transfer power from source to implement.
Calculate mechanical advantages.	Mechanical advantages: 1. Torque 2. Speed 3. Power 4. Efficiency	
Check shaft balance.	Shaft drive.	
Pack universal joints.	Universal joints.	
Replace belts.	Belts and pulley: 1. Flat 2. "V" 3. Notched or tooth	Avoid loose clothing around belts and pulleys.
Adjust chain drive tension.	Chain and sprocket.	
Check gear lash.	Gear drives: 1. Spur 2. Helical 3. Bevel 4. Herringbone 5. Internal and external	
Adjust shift linkage.	Shifting mechanisms: 1. Direct engagement 2. Constant mechanism	
	Synchromesh mechanisms.	
Calculate drive speeds through various planetary configurations.	Planetary drives: 1. Overdrive 2. Automatic transmission	Appreciate the complexity in a transmission device.
	Sprag clutches.	

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DIRECT POWER TRANSFER

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Examine and list transmission methods used on contemporary devices.	
Compute the mechanical advantage of a simple machine constructed by the student or in a typical automobile drive train.	
Demonstrate balance and imbalance through the use of tire balance; relate to shafts and rotary mechanisms.	
Display damaged and worn belts.	
Old transmission and overdrive can be obtained from scrap yard for student work or for display.	

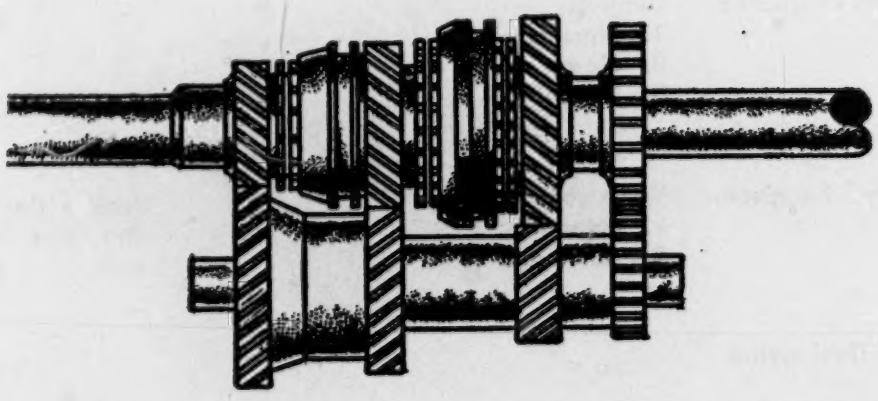

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FLUID POWER TRANSFER

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Recognize the symbols and nomenclature of fluid power. Solve such problems as fluid flow and expansion pressure.	Principles of fluids: 1. Pascal's Law 2. Conversation energy 3. Bernoulli's Principles	
Check viscosity at ambient temperature. Select proper fluid for application.	Fluids: 1. Types 2. Viscosity 3. Storage 4. Filtration 5. Incompressibility Fluid couplings and torque converters.	
Check pressure and volume of pump at various r.p.m.	Fluid pumps: 1. Piston 2. Vane 3. Gear 4. Centrifugal	Realize the danger in high pressure due to explosion.
Measure efficiency of pumps.	Pump ratings: 1. Pressure 2. Capacity	
Compare power loss between motor and pump.	Rotary motors: 1. Piston 2. Valve 3. Gear Rotary motor control.	
Repair leaks in cylinder.	Liner pistons and cylinders.	
Identify valve requirements in specific system.	Controls: 1. Pressure 2. Flow 3. Direction	
Select valve control needed for given application.	Valve controls: 1. Manual 2. Automatic	Realize the use of various actuators and how energy is transmitted in each.
Design and connect up a fluid system to perform a specific job.		

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FLUID POWER TRANSFER

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Most pieces of apparatus for demonstrating basic laws of fluids are available in high school physics and chemistry labs.	
Check viscosity by using container with fixed orifice; time flow with a stopwatch.	
Cut away an old converter available at a junk yard.	
Build small power unit with engine and pump so that experiments can be run.	
Cylinder and valves are often available through government surplus. Also, old power steering units make excellent test units.	
Present student with work problem and have him design hydraulic apparatus to perform job.	

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SMALL GAS ENGINES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Become familiar with equipment driven by small engines and manufacturers of such equipment, including: 1. Lawn mowers 2. Snowblowers 3. Chain saws 4. Motorboats 5. Snowmobiles		Appreciate the small engine influence on society.
Select and use proper hand tools.	The need for varied tools on different fastener applications.	Use tools safely and carefully.
	Torque requirements.	Properly torque all threaded devices.
Measure accurately with micrometer.	Decimal and fractional measuring systems.	
Recognize the various metal alloys used in small engine construction.	The causes of friction and wear.	
Mix two-cycle fuel. Change crankcase oil.	Fuel and lubricants: 1. Octane rating 2. Fuel storage 3. Oil viscosity 4. Oil classification	Use care in handling explosive liquids. Clean up any spilled oil which may cause slipping.
Check lubrication system.	Lubricating systems: 1. Pressure 2. Splash 3. Fuel mixture	Reasons for assuring adequate lubrication before starting an engine.
Clean cooling fins, cowling, and passages. Flush a cooling system.	Cooling systems: 1. Air 2. Water	Respect the danger of being burned on an operating engine.
Recognize the external difference in two- and four-stroke cycle engines.	Basic four-stroke cycle and two-stroke cycle theory.	
Recognize fuel system: 1. Gravity 2. Siphon 3. Pump 4. Diaphragm		

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SMALL GAS ENGINES

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Demonstrate use and care of common hand tools. Indicate appropriate nomenclature.	
Have student drill and tap a piece of scrap aluminum, then torque a stud in the aluminum. Allow student to strip bolt out, demonstrating the need for accurate torqueing.	
Use overhead projector or filmstrip to show micrometer measuring system. Practice on miscellaneous engine parts and use available programed learning materials.	
Display such things as scored pistons and burnt bearings. Experiment with heat transfer of various metals by using torch and heat indicators. Cut apart such pieces as salvaged cylinders, pistons, and rods in order to show design and metals used.	
Trace the petroleum industry from well to service station.	
Demonstrate check-off procedure before starting any engine. Engine should have fuel and lubrication and should be securely mounted.	
Measure engine temperature at various points with heat indicators.	
Cutaway or model engines with moving parts allow good demonstrations of reciprocating cycles.	
Students research characteristics and advantages of various systems.	

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SMALL GAS ENGINES—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify pressure areas of a carburetor.	The venturi principles.	
Clean and adjust a carburetor. Recognize worn or damaged parts in carburetor.	The circuits of a carburetor: 1. Float 2. High speed 3. Idle 4. Choke	Use care in handling the carburetor cleaning solutions and the air pressure.
Clean an air cleaner. Adjust carburetor on operating engine.	Abrasive effect of dust particles. Air-gas ratio requirements as related to engine load and speed.	
Diagnose carburetor malfunction in engine's performance.	Relationship between carburetion and performance.	
Adjust governed speed and idle speed with tachometer.	Governor speed control: 1. Air vane 2. Centrifugal	
Trace current flow in magneto coil.	Basic electricity.	
Check a coil and condenser.	Condenser action.	
Adjust armature air gap.		
Adjust points and set timing.	Breaker points and timing.	Observe manufacturer's recommendation of proper timing.
Measure secondary voltage.		
Clean and adjust spark plugs.	The function of a spark plug.	
Analyze combustion chamber by observing spark plug condition.		Use only correct heat range plugs.

3582

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Demonstrate atomization with perfume atomizer, hand sprayer, or soda straws and water.	
With dismantled carburetor, have student trace fuel flow through circuits and make internal adjustments.	
Filter air through cleaning element to show dirt collection. Operate an engine and with the use of dynamometer, if available, change the fuel-air ratio while recording power change.	
Demonstrate faulty circuits with malfunctioning carburetor on engine connected to dynamometer.	
Demonstrate engine speed control with tachometer and varied load.	
Demonstrate magnetic lines of force, electron flow, and induction.	
Measure secondary voltage with varied armature air gap.	
Students experiment with (or teacher demonstrates) engine performance with various engine timings.	
Plot the firing voltage of plugs in various conditions with constant pressure on plug tester.	

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SMALL GAS ENGINES—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Repair a cylinder: 1. Ridge ream 2. Deglaze 3. Rebore	Causes of cylinder wear and taper: 1. Heat 2. Grit from air 3. Lack of lubrication	
Determine piston and ring condition; replace if necessary.	The function of pistons and rings.	Use extreme care when removing or replacing rings.
Replace a piston pin.	Function of a piston pin.	
Measure connecting-rod bearing clearance.	Connecting-rod bearing system: 1. Integral 2. Insert 3. Needle	Use care in the measurement and handling of all internal parts.
Remove flywheel. Check crankshaft end-play with dial indicator.	Function of a crankshaft.	
Determine main bearing clearance; replace main bearings and reline bore.	Function of main bearing: 1. Integral 2. Insert 3. Needle 4. Ball 5. Sleeve	
Check camshaft bearings and gears. Check cam lobes.		
Repair valves: 1. Grind valve 2. Grind seat 3. Rebush or replace guide Adjust valve clearance.	The function of proper valves.	
Adjust or replace reed valves.	The function of reed valves.	
Replace the common seals and gaskets.	The purpose of seals and gaskets.	
Prepare an engine for storage.	Engine storage requirements: 1. Summer 2. Winter	Carefully prepare personal engine for season change.

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
To facilitate the experiences with internal components, an engine should be disassembled and reassembled. Students will usually have old engines available to work on; actual repairs facilitate the learning of many of the operations that are not practical on demonstration engines. Often small engine distributors will contribute warranty engines to a school. This will allow the student to observe malfunction and perform repair operation. Student sketch of components before the disassembling will expedite proper replacement. Along with the various repair demonstrations, filmstrips and charts on operations are available from most manufacturers.	
Collect several bad valves of known malfunction. Label for students' identification of valve problems.	
Display various reed plate and box designs.	
Review manufacturer's recommendations on storage.	

3585

ROCKETRY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The history of aerospace technology.	The contributions of pioneers in the development of rocketry. An interest in the aerospace program.
	The process of space vehicle development.	Knowledge of the various technologies involved in the aerospace program. Knowledge of the vast occupational opportunities which exist in aerospace.
	The science of aerodynamics.	The evolution of aerodynamics. How the science of aerodynamics contributes to aerospace technology.
	The function of guidance and control in rocketry.	The relationship between the function of guidance and control in aerospace and in aeronautics.
To develop the ability to test model rocket engines to determine parameters such as total impulse so they may be related to the rocket's propulsion ability. Compute problems coping with gravity (mass and weight).	Propulsion systems used in aerospace technology.	To gain insight into remote electrical ignition, staging, cluster firing, and safety as related to the launching of a rocket. Laws of force and action-reaction.
Mathematics as applied to rocketry.	Tracking of rockets.	Use of mathematics. Use of photography.
Design and construct streamers and parachutes.	Recovery of rockets.	Importance of recovery. Problems involved in recovery.
Use of drafting techniques. Use of construction techniques.	Structural design of rockets. Functioning of components.	The forces of aerodynamics. The intricate problems of design. The practicality of design. Cost problems. Safety procedures.

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ROCKETRY

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Students write a report on the contributions made by pioneers. Students collect pictures depicting applications of aerospace technology.	
Students write a report on occupational opportunity. Students prepare charts and diagrams of space vehicle development.	
Lecture with visuals. Students sketch ideas involved in aerodynamics.	
Discuss guidance and control.	
Discuss aerial photography, test stations, and firing of rockets. Graph rocket flights and distance/velocity/acceleration/time relationships. Discuss types of propulsion systems. Use scale models. Discuss trajectory. Discuss weather conditions. Compute momentum, thrust, and velocity.	
Discuss the use of single-station and two-station tracking systems.	
Discuss the different designs employed in recovery.	
Students will design and construct a rocket, manufacturing as many parts as possible. Students will fire the rocket, observing trajectory, performance, and recovery.	

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Sources for Instructional Materials

American Brakeblok Division
Abex Corporation
P.O. Box 21
Birmingham, Michigan 48012

American Petroleum Institute
1271 Avenue of the Americas
New York, New York 10020

Automobile Manufacturers Association
320 New Center Building
7430 2nd Boulevard
Detroit, Michigan 48202

Briggs and Stratton Corporation
West Center at 13th
Milwaukee, Wisconsin 53206

Brodhead Garrett Company
4560 East 71st Street
Cleveland, Ohio 44105

Centrui Engineering
Box 1988
Phoenix, Arizona 85001

Champion Spark Plug Company
P.O. Box 910
Toledo, Ohio 43601

Clinton Engines Corporation
Maquoketa, Iowa 52060

Delco-Remy Division
General Motors Corporation
Anderson, Indiana 46014

Estes Industries, Inc.
Box 227
Penrose, Colorado 81240

Fel-Pro, Inc.
7450 North McCormick Boulevard
Skokie, Illinois 60076

Fluid Power Society
P.O. Box 49
Thiensville, Wisconsin 53092

Ford Motor Company
American Road
Dearborn, Michigan 48127

General Motors Corporation
General Motors Building
Detroit, Michigan 48202

Johnson Motors Division
Outboard Marine Corporation
1284 Pershig Road
Waukegan, Illinois 60085

Marquette Corporation
3800 North Dunlap
St. Paul, Minnesota 55112

Minnesota Mining and Manufacturing Company
Printed Products Division
3M Center
Building 235 - D142
St. Paul, Minnesota 55101

National Aeronautics and Space Administration
Washington, D. C. 20546

National Aerospace Education Council
1025 Connecticut Avenue N.E.
Washington, D.C. 20036

Outboard Boating Club of America
307 North Michigan Avenue
Chicago, Illinois 60601

Perfect Circle Corporation
Hagerstown, Indiana 47346

Rocket Development Corporation
Route 3
Seymour, Indiana 47274

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FLUID POWER TECHNOLOGY

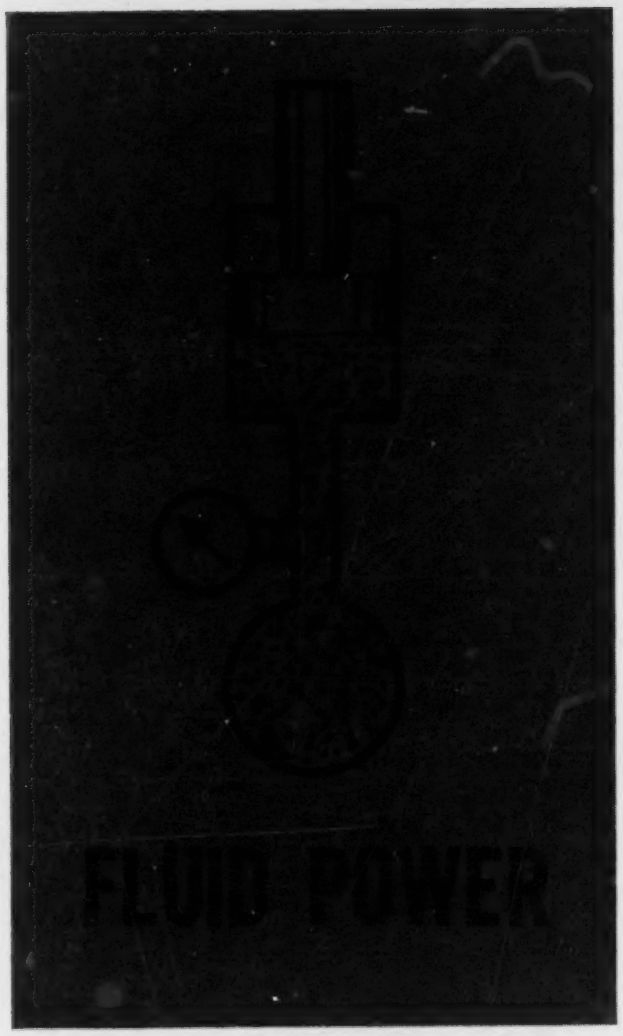

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INTRODUCTION

Fluid power provides man with a dynamic extension of his own physical power. It is a system of transporting, controlling, and storing power by means of pressurized liquids or gases. The system is based on a group of physical laws governing the effects of pressurized liquids. The application of fluid power has in recent years drastically altered the concepts of materials handling and machine control, especially in the areas of aerospace, agriculture, and construction.

The study of fluid power involves history, power input, controls, conductors, applications, testing, and service. Equipment need not be elaborate or expensive. Most shops contain sufficient equipment for practical applications. Fluid power can be correlated with other subject areas such as drafting, machine shop, electricity, or physics. Many books and publications are available to the student and teacher. Examples of fluid power applications are readily accessible for study.

Student activity is important for stimulating interest and knowledge. Student activities could include disassembly and assembly of equipment, circuit construction, hydraulic control applications, experimentation, machine tool cutaways, and group projects. In a technical industrial world which relies heavily on the applications of fluid power, every opportunity to study this technical aspect should be offered. The student should view fluid power in the relationship of design, manufacture, application, and service.

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BASICS OF FLUID POWER

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Definition of fluid power: 1. Hydraulics 2. Pneumatics 3. Fluidics	The student will know the difference between the three types of fluid power.
Write a short paragraph about a number of the scientists and inventors.		The fluid power field of industry is not a new field but one that has recently made its impact in our industries.
Gather pictures that emphasize the use of fluid power applications.	Future potential of fluid power.	Have an awareness of the future of the fluid power industries.
	Applications and limitations: 1. Industrial a. Production machines b. Material handling c. Construction and earth moving d. Agriculture 2. Aerospace a. Missiles and rockets b. Aircraft	The many applications of fluid power today.
Investigate such items as jacks, hoists, and presses. Become familiar with the basic laws, theorems, and principles of hydraulics.	Fundamentals of fluid power hydraulics: 1. Fluids at rest 2. Fluids in motion 3. Pascal's Law 4. Bournelli's Law 5. Pressure 6. Force 7. Work 8. Power	A better knowledge of the basic formulas for hydraulics which include electric horsepower, torque, speed, displacement, volume, force, work, and velocity.
	Mobile applications: 1. Dump trucks (braking, steering, lifting) 2. Forklifts (pushing, pulling, lifting) 3. Bulldozers (steering, lifting, pushing) 4. Cranes (lifting) 5. Back hoe (pumping, pulling, pushing) 6. Farm tractors (lifting, pushing, pumping) 7. Front-end loaders (lifting, pushing)	The many and varied uses of power.
	Industrial applications: 1. Presses (pushing) 2. Machine tools (pumping, motoring, pushing, pulling) 3. Transfer machines 4. Rolling mills (pumping, motoring, pressing, tensioning) 5. Extrusion presses 6. Vibrators (pushing, pulling, rotation)	

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BASICS OF FLUID POWER

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Have reference books available in the industrial arts library or in the main library within the school.	
Subscribe to related magazines such as *Hydraulics and Pneumatics* for good, practical applications.	*Hydraulics and Pneumatics* Magazine. Published monthly. $12.00 per year. Available from Industrial Publishing Company, 812 Huron Road, Cleveland, Ohio 44115.
Have basic formula sheets made up in quantity for distribution to students. Hydraulic calculators are available from companies, in some cases at no charge.	
Provide hydraulic symbol sheets for circuit design. Be certain that both the Joint Industry Conference (J.I.C.) and the American Standards Association (A.S.A.) symbols are provided.	
Have basic formula sheets available for each student.	
Become familiar with as many local application examples of hydraulics as possible. A field trip will be very valuable in getting practical applications presented to the students.	
Discuss the importance fluid power plays in the operation of tools, machines, and various pieces of equipment. These applications are just some of the many ways in which hydraulics can be used and students should be able to add others to the list.	
Make a list of the applications of hydraulics the students have at home, on the farm, and in their immediate area.	

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BASICS OF FLUID POWER—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Marine applications: 1. Rudder pull motor (rotation) 2. Anchor hoist (motoring) 3. Cargo handling equipment (pushing, pulling) 4. Elevators (pushing, pulling, rotation, motoring, cushioning)	
	Aerospace applications: 1. Landing gear (pushing, pulling, shock) 2. Rudder controls (pushing, pulling) 3. Elevators and trim tabs (pushing, pulling) 4. Bomb bay controls (pushing, pulling) 5. Standby power supply (motoring, pumping) 6. Missile guidance system (motoring, pushing, pulling) 7. Missile launching equipment (pumping, motoring, pushing, pulling) 8. Missile fuel transfer (pumping, motoring)	
Become familiar with J.I.C. specifications and also A.S.A. specifications. This primarily involves circuit symbols which students should learn as early as possible for help in constructing basic circuitry. Later students will be able to develop more difficult circuits after gaining more experience.	Reservoir type circuits: 1. Integral 2. Dual purpose 3. Separate Reservoir design: 1. Volume 2. Location 3. Screens and filters 4. Size 5. Heat 6. Mounting	
Calculate a practical set of dimensions for various reservoir capacities.	Maintenance of hydraulic fluid type circuits: 1. Oil petroleum base 2. Fire resistant 3. Glycol 4. Phosphate esthers 5. Water and oil emulsion	Know the nature of fluids and the advantages and disadvantages of the various fluids. Also know characteristics of the oils. Safe handling precautions.
Draw basic circuits from problem sheets presented by the instructor. These will be basic circuits written in paragraph form from which the students will develop graphic circuits using symbols recognized by the J.I.C. and A.S.A. organizations.	Chemical and physical characteristics: 1. Viscosity 2. Pourpoint 3. Flashpoint 4. Demulsibility 5. Stability 6. Rust inhibitors	

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
A handy pocket guide that gives the new A.S.A. standard fluid power symbols is provided by the Parker Hannifin Corporation.	Parker Hannifin Corporation, 500 South Wolf Road, Des Plaines, Illinois 60016
When involving the students in circuit design problems, it is a good practice to have the students work in a drafting room setting if possible. Be certain to have an adequate number of circuit problems available for students to work. A good source for prospective problems is the Bellows-Valvair Company. They have a *Field Engineers' Hydraulic Circuit Selector Handbook* that is very helpful.	*Field Engineers' Hydraulic Circuit Selector Handbook*. Rev. ed. 1965. Available from Bellows-Valvair Company, Division of International Basic Economy Corporation, 200 West Exchange Street, Akron, Ohio 44309.

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BASICS OF FLUID POWER—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Know how to buy and properly prescribe oils for a particular system. Service filters and strainers. Name and explain the basic concepts of hydraulic filtration. Know the proper filter locations within a fluid circuit. Give the advantages and disadvantages of the locations. List the possible sources of hydraulic system contaminants.	Fluid cleaning devices: 1. Intake screen 2. Magnetic plug 3. Filters a. Full flow b. Bypass c. Screen d. Fuller's earth e. Paper f. Fabrics Filter selection: 1. Rating a. Micron size b. Gallons per minute 2. Maintenance 3. Compatability 4. Location	Know the importance of proper filtration within a hydraulic system.
Identify the types of pumps and know the various characteristics of each. Have the ability to use graphic symbols for pumps in circuit design. Be able to identify some of the common problems encountered with hydraulic pumps within various systems. Disassemble and assemble the various pumps.	Pump classification: 1. Constant displacement 2. Variable displacement Pump types: 1. Centrifugal 2. Gear 3. Vane a. Balanced b. Unbalanced 4. Piston a. Radial b. Axial 5. Series 6. Pressure compensated 7. Parallel	The care and maintenance of hydraulic pumps. A pump is like a heart; without it, the system will not function.
Disassemble and assemble hydraulic cylinders. Use the proper symbols when diagraming actuators within a circuit. Properly mount the various types of cylinders. Change seals in cylinders. Calculate actuator force. Calculate cylinder ratings and sizes to develop a given force.	Actuators: 1. Piston cylinder a. Single acting b. Double acting c. Fixed rod end d. Tandem 2. Telescoping 3. Mounting	The many applications of actuators within a system. The many types of actuators available from suppliers.

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IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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BASICS OF FLUID POWER—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Calculate horsepower in hydraulic motors.	Motors: 1. Gear a. External b. Internal 2. Vane a. Balanced b. Unbalanced 3. Piston a. Radial b. Axial	Tremendous weight to power ratio of hydraulic motors. (A 20-horsepower motor weighs scarcely 5 pounds.) This is of great importance to our aerospace applications.
Research critical factors limiting the applications of each sealing material.	Seals and packing: 1. Types a. Tee b. Cup c. Flange d. U e. O-ring f. Special g. Wipers h. End seals i. Squeeze 2. Materials a. Elastomers b. Metallic c. Leather d. Fibrous	The tremendous pressures seals can withstand if properly installed.
Cut and thread standard pipe. Flare, bend, and connect tubing. Figure out correct length of hose. Attach permanent couplings to hose. Attach reusable couplings. Build a simple manifold from aluminum bar stock. Use quarter-inch national pipe tap.	Conductors: 1. Standard pipe a. Wall thickness b. Thread standard 2. Tubing a. Seamless b. Welded c. Sizes d. Wall thickness e. Plastic 3. Hose a. Temperature rating b. Pressure rating c. Braided wrap d. Spiral wrap e. Covers f. Sizes 4. Manifolds a. Cast passages b. Drilled passages	The many ways possible to plumb in fluid power components. Many conductors are applicable to definite system design. The problem is to select the best one.
Disassemble and assemble hydraulic valves. Make and examine some cutaway valves. Know the correct symbols for the var-	Valves: 1. Function a. Routing b. Directional control c. Protection d. Timing e. Volume control	How spool design can change the operation and direction in a directional valve.

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IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
ious valves used in a hydraulic circuit.	f. Flow control g. Pressure control h. Pressure reducing i. Check valve j. Unloading	
The center configurations in three-way valves and how the spools operate.	2. Methods of control a. Manual b. Mechanical c. Hydraulic d. Pneumatics e. Electrical solenoid	The importance of control in automation operations. The many methods of controlling.
	Directional control valve: 1. Characteristics a. Open center b. Closed center c. Tandem center d. Partially open e. Spring centered f. Normally open g. Hydraulically or pneumatically centered h. Internally drained i. Externally drained j. Directly operated k. Remotely operated 2. Types a. Check b. Pilot operated c. Two-way d. Three-way e. Four-way f. Five-way g. Six-way	
	Accessories: 1. Shock absorbers 2. Accumulators 3. Gauges 4. Heat exchangers 5. Intensifiers 6. Manifolds 7. Shaft couplings	

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IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

PNEUMATICS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Develop group discussions concerning the development of pneumatics. Class reports.	Historical development. Reasons for use: 1. Advantages 2. Limitations Application: 1. Power a. Industrial b. Mobile c. Marine d. Aerospace 2. Control a. Logic b. Digital c. Analog 3. Volume flow a. Material handling b. Processing	How important pneumatics is to our modern day production in industry, transportation, packaging, aerospace, and control.

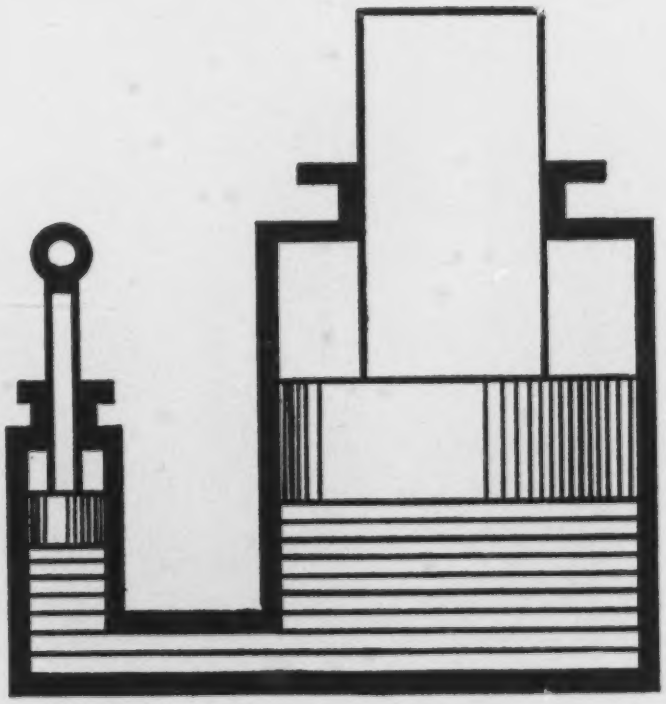

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PNEUMATICS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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GAS LAWS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Experiments: 1. Inflating balloon 2. Water venturi	Pascal's Law.	The contributions these men have made in the fields of science and industry.
Heat gallon can, seal and cool.	Charles's Law.	
Work basic problems concerning the basic laws.	Boyle's Law.	
	Perfect Gas Law.	
	Dalton's Law.	
	Avogadro's Law.	
	Bernoulli's Principle.	
	Compression: 1. Adiabatic 2. Isothermal 3. Polytropic 4. Multistage 5. Intercooling 6. Efficiencies a. Volumetric b. Thermal c. Mechanical 7. Rating	

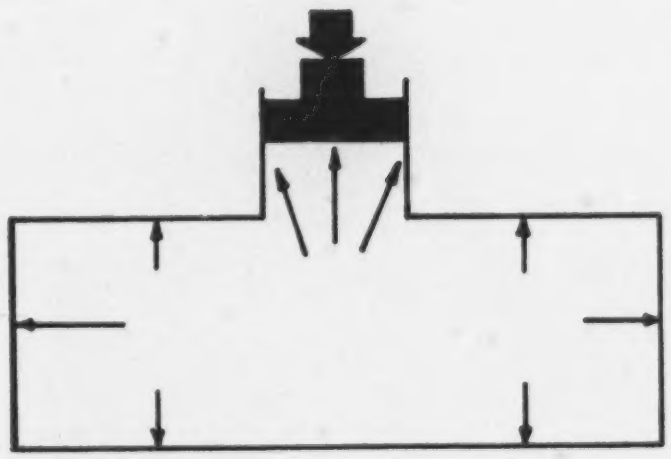

GAS LAWS

IMPLEMENTATION SUGGESTIONS **INSTRUCTOR'S NOTES**

PUMPS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Calculate cubic feet per minute (c.f.m.).	Positive displacement compressors: 1. Reciprocating 2. Piston 3. Diaphragm 4. Nonlubricated 5. Capacities, pressures 6. Speeds, drives 7. Applications	
Report horsepower (hp.).		
Calculate efficiencies such as volumetric, adiabatic, isothermal, and overall.		
Disassemble and assemble pneumatic pumps.	Rotary: 1. Vane 2. Lobe 3. Liquid piston 4. Capacities, pressures 5. Speeds, drives 6. Applications	
	Control: 1. Stop and start 2. Unloading	
	Lubrication: 1. Types 2. Characteristics	
	Cooling: 1. Water 2. Air	

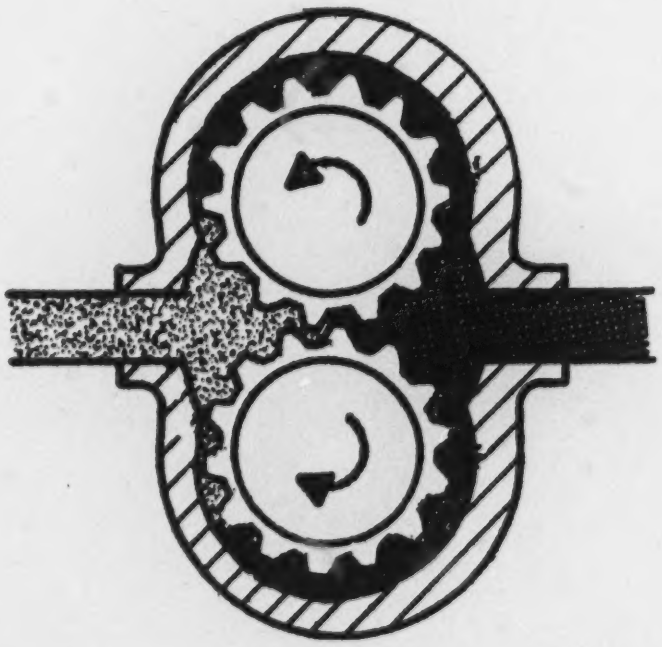

PUMPS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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AIR TREATMENT AT COMPRESSOR

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Intake filtration: 1. Wet a. Oil bath b. Oil soaked 2. Dry a. Centrifugal b. Paper c. Mesh d. Magnetic	
Calculate size of after-cooler.	3. Aftercooling a. Shell and tube b. Tube and fin c. Refrigerated 4. Filtration a. Centrifugal b. Desiccant	

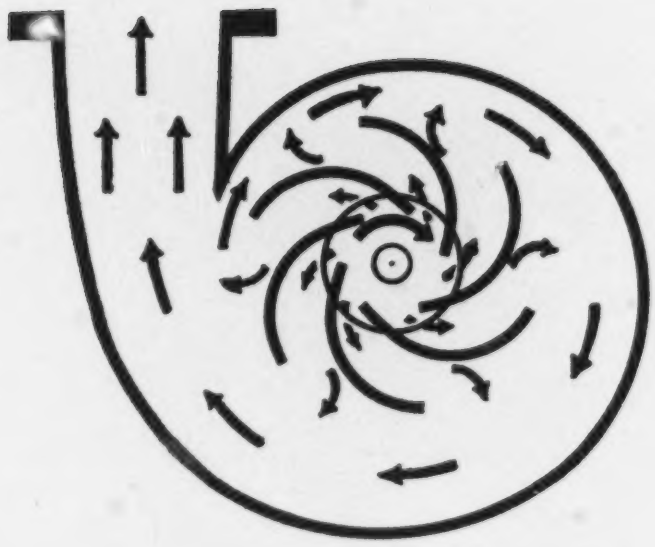

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AIR TREATMENT AT COMPRESSOR

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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RECEIVERS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Calculate receiver sizes.	Function: 1. Storage 2. Pulsation dumping Sizing.	
Draw distribution system example. Run flow versus pressure drop tests. Disassemble and assemble couplings. Construct pipe, tube, and hose installations.	Distributing systems: 1. Flow-pressure drop 2. Installation a. Sizing b. Loops c. Branches d. Pitch e. Drops and legs 3. Materials a. Pipe b. Tube and hose c. Fittings d. Couplings	

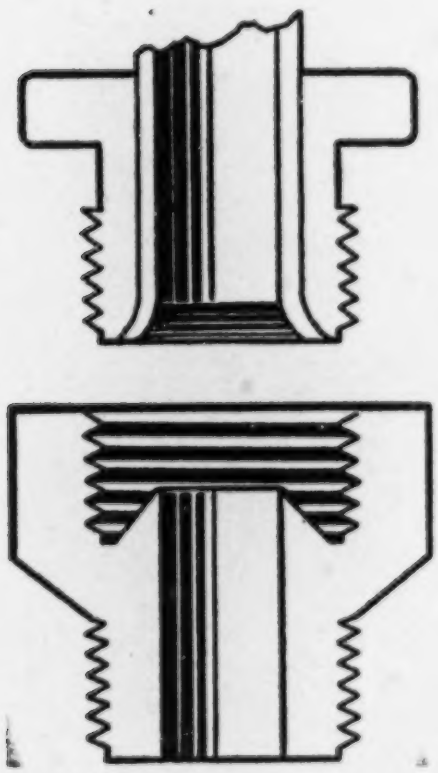

RECEIVERS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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AIR PREPARATION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Disassemble and assemble filters. Flow test filters. Determine water removal efficiency. Determine water passage point.	Filters: 1. Purpose 2. Types a. Centrifugal b. Desiccant c. Porous cartridge d. Mesh e. Sintered metal f. Ribbon 3. Selecting and rating 4. Dumping a. Manual b. Automatic 5. Servicing a. Plastic bowls	Provide cutaways for students to see how filters are constructed to enable better filtration in pneumatic systems. This would also include lubricators.
Disassemble and assemble lubricators. Test for pressure drop and oil feed characteristics.	Lubricators: 1. Drip type — oil fog a. Siphon action b. Flow compensation c. Advantages and limitations 2. Wick type a. Shaded b. Flooded c. Advantages and limitations 3. Mist type a. Adjustable and automatic b. Advantages and limitations 4. Oil selection factor	

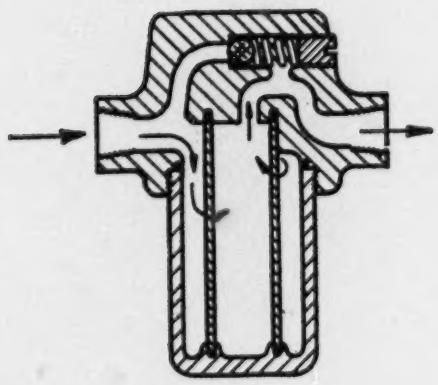

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AIR PREPARATION

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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VALVES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Disassemble and assemble valves. Determine flow paths. Set up tests to determine operating characteristics, flow, pressure drop, and vacuum.	Basic types: 1. Poppet 2. Slide 3. Spool	Valves are the main controlling factor in a pneumatic system. Air must be properly conditioned to assure trouble-free operation.
Determine flow and regulating characteristics of regulator. Observe the operating and relieving characteristics of regulators and the effect of change in primary pressure.	Regulating valves: 1. Purpose 2. Types a. Single state b. Multiple state 3. Characteristics a. Regulating b. Flow	
Build one- and two-valve circuits to learn the action of valves. Test electromagnets by using maximum force at various voltages. Disassemble and assemble electromagnets. Design and build simple circuits to perform each logic function. Set up test to show effect of flow control, check, quick exhaust, and relief valves. Build simple nontiedown circuits. Disassemble and assemble safety valves.	Directional controls: 1. American Standards Association (A.S.A.) symbols and functions 2. Operators a. Hand, cam, foot b. Air c. Electric d. Logic functions e. Accessory valves f. Safety valves	Language and operation relations to electrical, electronic, and computer circuits and symbols.

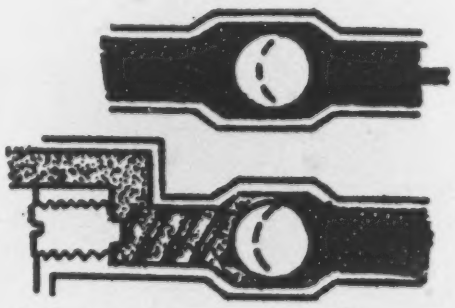

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VALVES

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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ACTUATORS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Disassemble and assemble actuators.	Definition.	
Determine force and speed characteristics of operators in conjunction with valves.	Purpose.	
	Linear: 1. Piston 2. Telescopic 3. Positional 4. Diaphragm 5. Bellows	
	Rotary: 1. Vane 2. Piston a. Radial b. Axial c. Helical d. Rack or chain 3. Lobed rotor 4. Turbine	

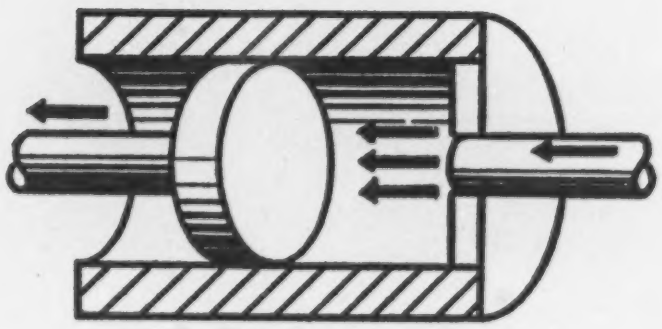

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ACTUATORS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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AIR-OIL SYSTEMS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Compare air-oil actions with those for straight air.	For control: 1. Purpose 2. Advantages and limitations 3. Tandem cylinder 4. Parallel cylinder 5. Dash pot 6. Air-oil tank	
Disassemble and assemble a booster.		
Design and build a simple booster circuit with valves.		
Design and build simple air-oil system for control.	For pressure increase: 1. Purpose 2. Advantages and limitations 3. Tandem cylinder 4. Single pressure booster 5. Dual pressure booster 6. Reciprocating booster	

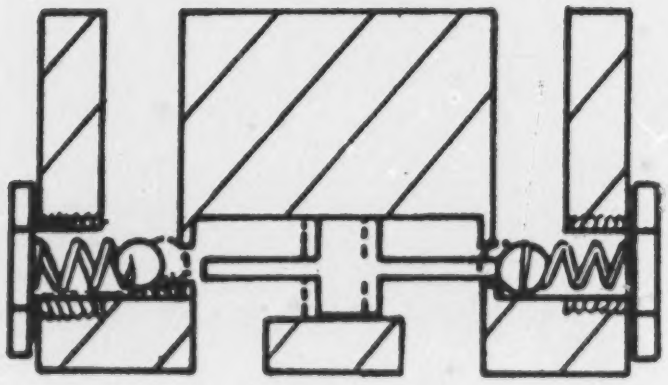

AIR-OIL SYSTEMS

IMPLEMENTATION SUGGESTIONS **INSTRUCTOR'S NOTES**

SEALS AND PACKINGS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Understand various seals as used in devices.	History and purpose. Types: 1. Lip 2. Compression Materials: 1. Leather 2. Metal 3. Plastics and elastomers 4. Fibrous Conditions: 1. Pressure 2. Fluid 3. Heat 4. Dynamic and static	

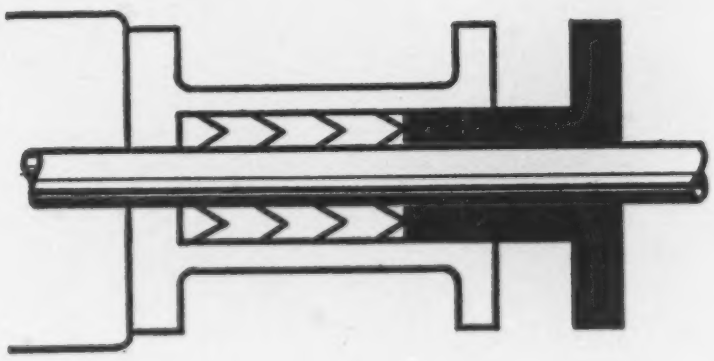

SEALS AND PACKINGS

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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ACCESSORIES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Test noise levels with and without mufflers.	Silencers and mufflers.	
Test setup to calibrate and understand equipment's use in running flow, response, and operating characteristic tests.	Pressure gauges.	
	Vacuum gauges.	
	Flow meters.	
	Oscillascope.	
	Recording oscillograph.	
	Pressure transducer.	
	Manometer.	
	Temperature gauges.	
	Voltmeter.	
	Wattmeter.	
	Ohmmeter.	

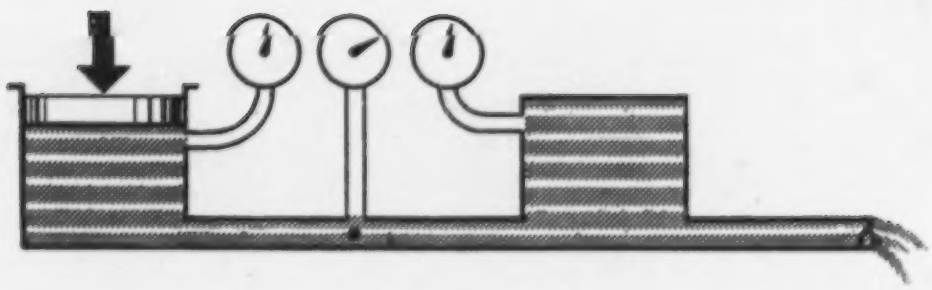

ACCESSORIES

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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CIRCUIT DESIGN

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Design and build circuits. Combine simple circuits into more complex circuits.	Sequence operations: 1. Electrical control 2. Air control 3. Combination Automatic and manual cycle. Combination of logic functions, safety functions, and power functions (both linear and rotary).	

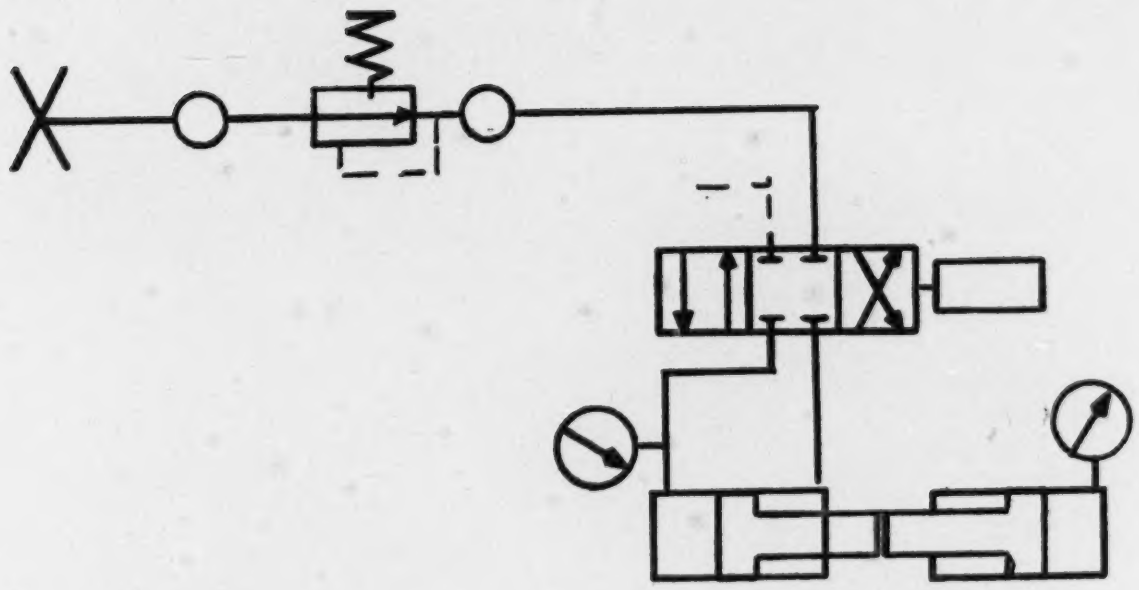

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CIRCUIT DESIGN

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

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VT 012 371
Materials Technology. Resource Guide for Effective Instruction in Industrial Arts. Curriculum Bulletin No. 13C.

Minnesota State Dept. of Education, St. Paul.
MF AVAILABLE IN VT-ERIC SET.
Documents Section, Minnesota State Dept. of Education, Room 140, Centennial Building, St. Paul, Minnesota 55101.
PUB DATE - 69 125p.

DESCRIPTORS - *CURRICULUM GUIDES; TEACHING METHODS; EDUCATIONAL INNOVATION; *INDUSTRIAL ARTS TEACHERS; *INDUSTRIAL ARTS; RESOURCE GUIDES; *PLASTICS; *METALS; WOODWORKING; AFFECTIVE OBJECTIVES; COGNITIVE OBJECTIVES; PSYCHOMOTOR OBJECTIVES

ABSTRACT - Prepared for industrial arts teachers, this curriculum guide has been organized for efficient utilization of several newer methodological approaches to teaching. The order in which material is presented places the psychomotor, cognitive, and effective domains of learning on a continuum with implementation procedures. Three sections, woods, metals, and plastics technology, list: (1) Skills Students Will Be Able to Perform, (2) Concepts Students Will Understand, (3) Appreciations Students Will Develop, and (4) Implementation Suggestions. Sources of resource materials are provided, and related documents are available as VT 012 370 and VT 012 372, also in this issue. (JS)

VT 012 371

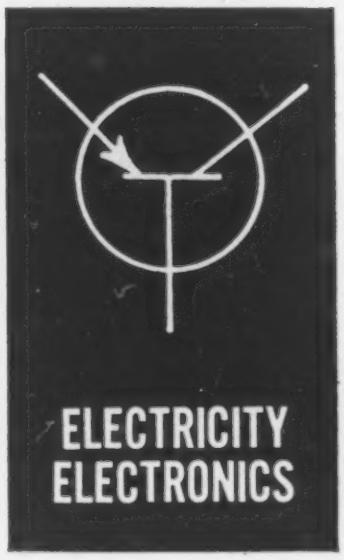

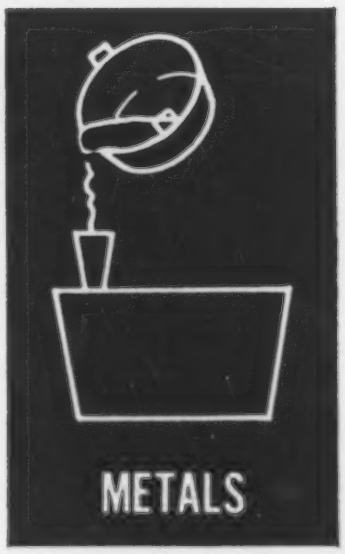

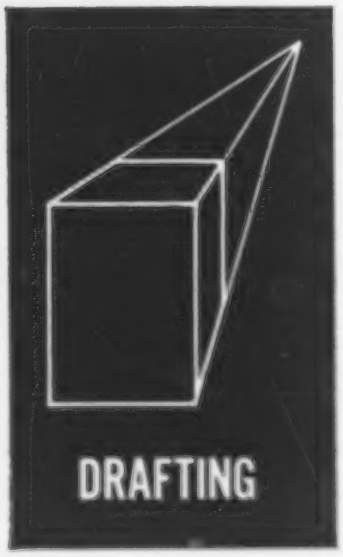

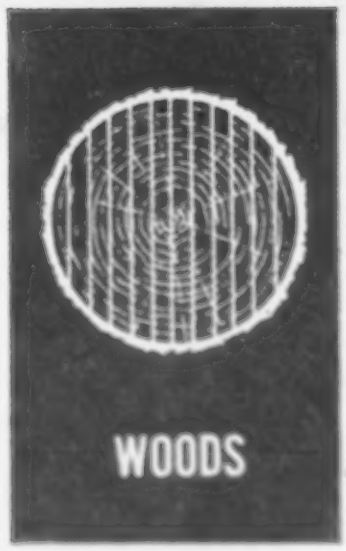

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Resource Guide for Effective Instruction in Industrial Arts

Materials Technology

State of Minnesota
Department of Education
St. Paul

Curriculum Bulletin No. 18C
Code VIII-A-C-8th

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RESOURCE GUIDE FOR EFFECTIVE INSTRUCTION IN INDUSTRIAL ARTS

MATERIALS TECHNOLOGY

CURRICULUM BULLETIN NO. 13C

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FOREWORD

Industrial arts students live in a dynamic, ever-changing society. Preparations for their future place multitudinous demands upon education. The numerous changes occurring in our accelerating technology levy demands upon industrial arts teachers. It is simply not enough to train the students to live in a changing world; it is also necessary to transmit to the student a sense of values and the worth of participation in the technological process which is such a vital part of our society. Industrial arts, as an integral part of education, must provide opportunities for individual fulfillment, individual achievement, and individual freedom.

The success of the industrial arts program in providing these opportunities depends upon several factors, of which the course content and the approaches to teaching are vital aspects. Two main purposes of this guide are, therefore, to offer newer content and to suggest several newer approaches to teaching.

Assistant Commissioner of Education,
Division of Instruction

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ACKNOWLEDGMENT

Grateful appreciation is extended to Mr. Harold E. PaDelford for his help in coordinating materials for the resource guides on "Visual Communication Technology," "Mechanical and Electrical Technology," and "Materials Technology."

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John Mitchell .....Formerly Instructor, Upsala Public Schools

Sterling Peterson .....Consultant, Minneapolis Public Schools

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Carol Stark, Editor

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INDUSTRIAL ARTS CURRICULUM DEVELOPMENT IN MINNESOTA

The State Department of Education has maintained a continuing effort to keep teachers and administrators informed of phenomenal technological and educational advances. The most recent revision of Curriculum Bulletin No. 13, *A Guide for Instruction in Industrial Arts,* was made in 1962.

In the spring of 1967, an effort was initiated to bring industrial arts teachers the latest methods of instruction. Industrial arts education has been under constant evaluation and it was the intent of the steering committee appointed at the time to enlarge upon and bring up to date the content of Curriculum Bulletin No. 13. The committee chose the content, instructional design, and methods used in this guide. Writers were engaged to specifically challenge industrial arts teachers to gain knowledge of and to use the newer approaches to instruction.

The guide has been divided into three issues. These issues are (1) "Visual Communication Technology" with units in drafting and graphic arts, (2) "Mechanical and Electrical Technology" with units in electricity, electronics, and power, and (3) "Materials Technology" with units in woods, metals, and plastics.

PURPOSE AND VALUE OF THIS GUIDE

This guide has been organized for efficient utilization of several newer methodological approaches to teaching. The primary purpose of the guide is to so arrange the course content that the instructor may more easily adapt his teaching to these new approaches. The order in which material is presented places the psychomotor, cognitive, and affective domains of learning on a continuum with implementation procedures. The psychomotor skills (column one) that students should be able to perform include operations, jobs, problems, and activities. Cognitive understandings (column two) include basic principles, concepts, generalizations, and guidance information. Affective values (column three) involve awareness, organization, attitudes, and appreciation. Implementation suggestions (column four) cover teaching methods and techniques, resources, and expedients. Column four provides the cohesive force for columns one, two, and three. Instructor's notes (column five) provides a place for the instructor to keep his plans and thoughts regarding the units.

This guide is not intended to be a "cook-book" approach. It is intended to serve as a guide and resource for effective teaching. The needs of each particular teaching situation should determine the material that will be used.

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METHODOLOGICAL APPROACHES TO TEACHING INDUSTRIAL ARTS

Methodology has sustained the teaching of industrial arts as a subject in general education with several approaches carrying the burden of instruction. However, industry and technology have undergone vast changes in recent years. In an attempt to interpret industry more realistically, several new approaches have been promulgated. Emphasis has been placed on industrial and technological functions and practices. In order to make learning more meaningful, the committee wishes to encourage the use of up-to-date methods of instruction. Complete materials are not available on all approaches, but information is available from the American Industrial Arts Association, the American Vocational Association, and from current publications. Several methodological approaches, each with a short explanation, are presented in the following list.

Mass Production. This is a group undertaking with the intent of understanding industry through the production of a product. Mass production would encompass personnel organization, purchasing, production processes, accounting, and sales. This usually involves the entire class and can be used at any grade level and subject area.

Anthropological Approach. The anthropological approach involves the historical relationships of tools, processes, and products. It can be used as an introduction to a unit of study or as the unit of study. It gives an insight into the massive technologies of the modern industrial complex.

Construction Industry. This approach is a group undertaking to discover the problems in the design and construction of a project. This method would encompass personnel organization, material testing, fastening, and material processing. Students can be grouped into any size of unit according to the complexity of the project.

Unit Method. The unit method employs a limited set of educational experiences. Emphasis is placed on individual achievement through the student's own initiative. Emphasis is also placed on vicarious learning — a sharing of experiences with other students through reports, demonstrations, and other methods of communication. The unit method allows the student to be creative and unique.

Line Production. The line production technique usually consists of a short production run of a product. The production line, jigs and fixtures, and product are set up with student activity. It is usually a short unit used to teach one aspect of mass production.

Individual Project. The individual project emphasizes the engineering approach and craftsmanship. Experiences are not usually shared with other students. The individual project offers the student an opportunity to see through to completion something of his own making.

Individual Study. Some scheduling systems permit an individual approach to study. Open laboratories, libraries, and other media enable the student to have freedom in his pursuit of knowledge.

Conceptual Approach. To gain an understanding of the technology in industry, concepts are taught with each concept enforcing the next one. This approach relies heavily on the cognitive behavioral patterns. Concepts learned are usually reinforced with some type of followup activity.

Research and Experimentation. The research and experimentation approach enables the student to discover and develop technological advances. The process is much used in industry. Materials testing and new product development are techniques used in the schools. The students usually share their experiences with classmates. Access to source materials is a necessity.

Services. The service industry is large and growing. Students gain an understanding of problems involved in the maintaining and repairing of all industrial products. With the increase of mechanized products in the home and on the farm, every individual needs an understanding of the service industry.

Interdepartmental Approach. Involvement of two or more laboratory activities can be used to advantage in enhancing motivation and improving learning situations. This approach enables students to study and construct a more complex problem or project.

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MATERIALS TECHNOLOGY

The materials in this guide have been divided into the three areas of woods, metals, and plastics technology. Iver Johnson, Associate Professor at Mankato State College, prepared the section on woods technology. The section on metals technology was written by Daniel Beal, Instructor, Roseville Public Schools. Plastics technology was prepared by Dr. Harlan Scherer, Professor at Bemidji State College. The three areas have been grouped in this guide because of similarity and for convenience.

This guide has been arranged so that the instructor, in planning for the teaching of industrial arts, can draw objectives from the first three columns. These objectives can then be achieved by using the suggestions in column four. Some of the implementation suggestions will be considered as startling and provocative procedures. This was intended as the steering committee sought procedures that were forceful, useful, and stimulating. It was further intended that this guide serve as an aid to improve the methodology and content of industrial arts. Methodology has, through the years, sustained industrial arts. Innovations in both content and methodology are offered.

No definite order has been established for the presentation of material. It is more important that each instructor select the particular material which is appropriate for a given teaching situation. The instructor is encouraged to use as much of the appropriate material as possible. Material sufficient for several years of work has been provided. It is hoped that this guide will help the instructor to teach more effectively.

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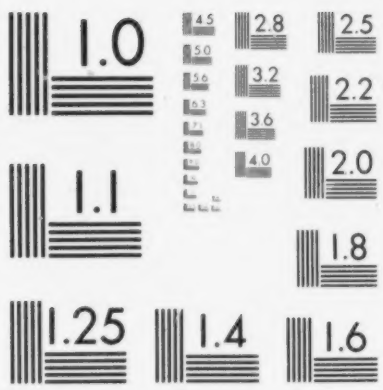

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WOODS TECHNOLOGY

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INTRODUCTION

The need for providing students with tangible and meaningful information concerning woods technology is apparent. A program dealing with the technology of wood, issued as a challenge and of vital interest to the individual, is necessary. Woods technology topics worthy of exploration are the main concern in this resource guide.

Vast strides and improved technology in recent years have provided a good deal of new and vital information in such areas as lamination, veneering, adhesives, and finishing. Developments such as infra-red, laser, and electronic gluing should have meaning for the student. It is important that teachers convey this type of information to students. Conservation, a topic which too often is given little more than lip service, needs new emphasis. Innovations in construction, residential or otherwise, continually develop due to the ever-increasing demands of modern society. Students should be aware of what is happening in the field of construction. It is true that most teachers have had little formal course work in this area; however, if teachers teach only that which they have been taught, they are outdated before they start. The woods industry today is faced with modernization and automation. The teacher must relate these changes to those who will be directly or indirectly involved at some not-too-distant date.

The success of the woods technology program could well depend upon the teacher's ability to attract students with experiences in the basic sciences. The chemical industry today is growing at a rate three times the average of all other industry. It has been reliably estimated that sixty percent of the harvested tree is subject to chemical processing. Through chemistry, wood has been combined with such materials as glass, plastics, and metals.

It is the teacher's responsibility to make a concerted effort to train students in the method of inquiry in order that they may become accustomed to using the tools of knowledge and that they may come to realize today's facts are not ultimate truths. Without question, today's technology is tomorrow's history.

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WOODS AND WOOD TECHNOLOGY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify and compare different species of wood for beauty, usefulness, and consumer application. Make an intelligent choice according to the variety of woods available.	The physical structure of a tree. How a tree grows. The botanical division of woods. Structure, identification, and common species of softwoods (conifers). Structure, identification, and common species of hardwood (deciduous). The nature of grain in wood (open and closed).	An appreciation for the beauty inherent in the grain, color, and texture of various kinds of woods.
	Past and present technology concerning lumbering. Lumber production: 1. Past 2. Industrial applications today 3. Automation Utilization to include plain and quarter sawing techniques. Effect of moisture in lumber: 1. Relationship to value 2. Detrimental possibilities 3. Air-dried lumber and allowable moisture 4. Kiln-dried lumber and allowable moisture 5. Lumber storage procedures	An awareness of the technical advances in lumbering and the effect of these advances on the forest. A basic knowledge of lumbering and lumber production as related to research of forest use and the application to community and industrial relationships.
Use proper terminology in reference to lumber. Select materials intelligently.	Lumber terminology and abbreviations. Defects and surface characteristics of lumber. Boards, planks, and timbers. Common softwood grades: 1. Criteria for grading 2. Consumer recommendations Common hardwood grades: 1. Criteria for grading 2. Consumer recommendations	A basic concept concerning differences in lumber and why costs can vary so greatly.
Compute board feet. Prepare an order for lumber indicating proper material specifications.	Computations of board feet and definition of same. Measurement of lumber. Sale of hardwoods. Sale of softwoods. Considerations when ordering lumber, such as: 1. Quantity 2. Size 3. Grade 4. Species 5. Product seasoning 6. Surface 7. Rule	

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WOODS AND WOOD TECHNOLOGY

IMPLEMENTATION SUGGESTIONS

Introduce forestry in the industrial arts curriculum.

Microscopic comparisons.

Use research and experimentation approach related to the study and understanding of wood. Note such things as effects of temperature, moisture, and species.

Wood sample board complete with comparative technical information on reverse of each sample.

Wood samples in milled state, samples in bark state, and samples of leaf and needle structure.

Class development of a scale model lumber mill. Extent of this project limited only by time and imagination. Students do research and reports relevant to problem.

Samples of plain and quartered wood.

Experiment with wet thin samples to show comparative stability.

Experiment with weight samples prior to and after drying in an oven to determine moisture content.

Class tour of papermill or lumbermill.

Demonstration of the porous nature of woods by ability to absorb stains.

Display a variety of graded lumber samples to compare grades, defects, and surface differences.

Field trip to a lumber company.

Bulletin board of abbreviations and lumber terminology.

Variety of ungraded samples for student grading activity.

Have a local lumber company manager or purchasing agent discuss the role of the lumber company in relation to the community and the consumer.

Set up sales desk where pupils prepare specification sheets; other students can fill the order.

Problem involving board foot computation.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Edgar. *Fundamentals of Manufacturing Processes and Materials.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Fryklund and LaBerge. *General Shop Woodworking.*

Gerbracht and Robinson. *Understanding America's Industries.*

Gilbert. *Children Study American Industry.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Lindberg. *Processes and Materials of Manufacture.*

Olson. *Industrial Arts and Technology.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Instructional Materials

American Forest Products Industries, Inc.
American Institute of Timber Construction
American Paper and Pulp Association
American Plywood Association
Appalachian Hardwood Manufacturers, Inc.
British Columbia Lumber Manufacturers Association
California Redwood Association
Fine Hardwoods Association
Forest Products Laboratory
Forest Products Promotion Council
Hardwood Plywood Manufacturers Association
Insulation Board Institute
Maple Flooring Manufacturers Association
National Forest Products Association
National Hardwood Lumber Association
National Particleboard Association
Paxton Equipment and Supply
Society of American Foresters
Southern Hardwood Lumber Manufacturers Association
Southern Pine Association
Western Wood Products Association
Weyerhauser Company

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WOODS AND WOOD TECHNOLOGY—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Conserve our natural and human resources.	Conservation: 1. Philosophy and practices in modern forestry 2. Aesthetic elements 3. Recreational considerations	An awareness of the agencies of government that manage our forests and range lands. An awareness of the need for all persons to be concerned with our natural and human resources.
Make proper inquiries concerning the various fields affiliated with woods and wood technology.	Occupation opportunities such as: 1. Research and development 2. Production 3. Sales 4. Wood technology 5. Wood utilization 6. Product engineering 7. Merchandising 8. Construction 9. Packaging 10. Furniture 11. Manufacturing 12. Paper and pulp technology 13. Forestry	A more tangible look at occupations. The ability to make occupational comparisons and to direct energies concerning future employment possibilities.
Identify a variety of wood products. Select and specify wood products for a variety of applications. Experiment with materials and make comparative evaluations.	Related wood utilization consisting of the use of 60% of the harvested tree in chemical applications such as distilling, extraction, finishing, gluing, drying, plasticizing, preserving, dissolving, and fireproofing. The variety of wood products available, including particleboard, hardboard, impregnated wood, paper laminations, insulation, plastic laminates, and many building applications.	A favorable attitude toward the role that wood assumes in the lives of all persons. An awareness of the need for educational activity in sciences and mathematics relative to better and more complete utilization of wood. Research and exploration techniques.
Recognize the major classifications of plywood. Purchase plywood according to the situation dictated by intended use. Effectively conceal edge grain in plywood, using a variety of tools and treatment techniques.	Differences in classification as related to interior, exterior, and marine grades of plywood. Knowledge of fabrication techniques relating to plywood core, lumber core, and particle core and the relationship of each to adhesives used in manufacture. Comparative factors involved in plywood pricing. Surface characteristics of plywood showing rotary, flat, and quarter sliced veneers. How hardwood and softwood plywoods are graded, showing criteria and use factors.	An awareness of the amount of available information on plywood that can be helpful to the prudent consumer. An awareness of the aesthetic and emotional reactions that a selection of plywood samples can produce. Acute awareness of material differentiation. Confidence in ability to select and work with plywood. Avocational interests.
Specify plywood.	How plywood is manufactured. Specifications relative to consumer purchasing and use. Plywood fabrication techniques to include edge treatment.	

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Have conservation officer discuss conservation practices today, also history and responsibilities of the conservation department.	
Discussion of occupations by qualified person or persons. Student reports concerning relevant occupations.	
This is an ideal education situation for research, experimentation, and product development problems. Use of team teaching which utilizes science personnel and facilities if available. Bulletin board showing a variety of products resulting from wood chemistry. Experiment with polyethylene-gylcol treatment of wood.	
Field trip to a source containing a variety of sheet size display sheets of beautiful and lesser species of woods. Broad selection of plywood samples. Bulletin board showing plywood construction. Discuss design criteria for using plywood. Comparative experiments with samples of differing plywoods. Discuss plywood use in the home.	

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DESIGN AND PRODUCT DEVELOPMENT

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Relationship of design to craftsmanship.	An appreciation of the need for skill and craftsmanship in following designs.
Develop planning and organizational proficiency.	The design analysis method of problem solving: 1. Statement of problem 2. Analysis and research 3. Possible solutions 4. Experimentation 5. Final solution	An awareness of the need for careful and directed activity in design problems. Use of design as a means of communication with other humans.
Develop material selection proficiency. Develop tool and machine selection proficiency.	Basic concepts relating to functional, material, and visual consideration concerning product design.	Value of foresight in the use of woods and related materials.
Develop a degree of design proficiency.	Design techniques to include partial, redesign, and total design.	A basic understanding of the role of the designer. Self-understandings. Self-criticisms (positive).
Apply the golden mean rectangle to problem situations.	Use of the golden mean rectangle.	An awareness of how the golden mean rectangle has been applied in daily life.
Apply design elements to the partial or total development of a product.	The relationship of balance, proportion, harmony, texture, and form to the product involved.	An appreciation for the beauty which design can bring into our daily lives.
	Occupations concerned with designing in the woods industry.	Awareness of occupational opportunities in design.

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DESIGN AND PRODUCT DEVELOPMENT

IMPLEMENTATION SUGGESTIONS

Class analysis of variety of products concerning design.

Individual students redesign a consumer product.

Small group development of a teacher assigned problem.

Total group development of a given problem situation.

Small group interaction to problems dealing with partial design and redesign techniques.

Individual problem situations based upon the design analysis method.

Class discussion concerning design of the past, also student reports dealing with a similar topic.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Capron. *Wood Laminating.*

Dunning and Robin. *Home Planning and Architectural Drawing.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Goodban and Hayslett. *Architectural Drawing and Planning.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Hepler and Wallach. *Architecture: Drafting and Design.*

Hornung. *Architectural Drafting.*

Lindbeck. *Design Textbook.*

Olson. *Industrial Arts and Technology.*

Olson. *Woods and Woodworking for Industrial Arts.*

Spence. *Architecture: Design, Engineering, Drawing.*

Townsend and Dalzell. *How To Plan a House.*

Wagner. *Modern Woodworking.*

Instructional Materials

American Forest Products Industries, Inc.

American Plywood Association

Fine Hardwoods Association

Forest Products Laboratory

Hardwood Plywood Manufacturers Association

National Forest Products Association

Paxton Equipment and Supply

Rez Wood-Tones, Inc.

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PLANS, PROCEDURES, MATERIALS, AND SPECIFICATIONS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Apply drafting and design techniques and applications. Develop plans.	The concept of planning.	An appreciation of the importance of having completely developed a working drawing.
Write specifications.	How to write product specifications.	
Read and interpret plans.	The nature of plans and blueprints.	
Develop ability to relate a variety of factors into one composite plan. Solve problems as the need dictates.	The need to coordinate kind of wood, design, basic tool and machine processes, and safety into the development of a workable plan of procedure for a given problem.	The overall perspective of what can be involved in planning for the construction of a usable object.
Develop a materials list.	A materials listing.	
Determine product cost.	Cost analysis and estimating factors.	Consumer appreciation of material values.
Innovate, invent, and design jigs and fixtures.	Mass production planning: 1. Jigs and fixtures 2. Quantity purchasing 3. Job analysis 4. Product development 5. Manufacture	Appreciation for orderly procedures in industry. Awareness of the scope of industrial readiness to produce a product.
	The planning of a product.	Foresight in the operations concerned with production of a product.

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PLANS, PROCEDURES, MATERIALS, AND SPECIFICATIONS

IMPLEMENTATION SUGGESTIONS

General class discussion of planning considerations.

Problem solving pertaining to individual or group product problems.

Individually developed plan of procedure for assigned problem.

Individual or group development of materials listing and cost estimation for assigned problems.

Individuals develop plans, plan of procedure, materials list, and cost estimate for a given project.

Set up a corporation to sell stocks and to design, manufacture, advertise, and retail a mass-produced group product or products.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Douglass. *Woodworking with Machines.*

Edgar. *Fundamentals of Manufacturing Processes and Materials.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Fryklund and LaBerge. *General Shop Woodworking.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Lindberg. *Processes and Materials of Manufacture.*

Madden. *Woodworking for Industrial Arts.*

Olson. *Woods and Woodworking for Industrial Arts.*

Wagner. *Modern Woodworking.*

Wagner. *Woodworking.*

Instructional Materials

American Plywood Association

Forest Products Laboratory

Hardwood Plywood Manufacturers Association

National Particleboard Association

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ADHESIVES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The history and development of adhesives.	The roles adhesives play in our daily living.
	The composition of adhesives.	Consumer awareness.
Perform adhesion tests. Use proper terminology.	The nature of adhesion and the terminology pertaining to adhesion.	A tangible awareness of the relationship of adhesion to adherend.
Prepare a variety of adhesives for use.	The classification and use of adhesives, both natural and synthetic.	An interest in the many different adhesives available to the consumer.
Make an intelligent consumer purchase regarding adhesives.	Selection criteria for acquisition of the proper adhesive for a given problem including cost factors.	Confidence in ability to make decisions concerning desirability of a variety of adhesives available for a given situation.
	Joint design for adhesive applications.	Awareness of the vast number of possibilities of joint structure available to the craftsman.
	Bonding applications which include plywood, laminated timbers, panels, metals to wood, plastics to wood, and electronic.	Knowledge concerning scope of applications for adhesives.
Transfer knowledge of industrial processes for own purposes.	Industrial processes using adhesives.	Awareness of adhesives industry.
Apply the mechanics of adhesion to a variety of materials.	The nature of recent developments in the adhesives industry and insight into the need for new adhesives for new technology.	Awareness of high frequency gluing, adhesive tape, plastic laminates, and other recent adhesive applications.

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ADHESIVES

IMPLEMENTATION SUGGESTIONS

Wide range of adhesive samples available to students.

Small group problems dealing with discovery of adhesive characteristics, using a wide variety of materials.

Individual research concerning one or more adhesives.

Utilize both science and industrial arts facilities.

Field trip to any local merchant who manufactures or displays a variety of adhesives.

Have representative from local construction industry discuss how adhesives are used in building industry.

Student reports on adhesives.

Discuss the comparative strengths of adhesives, using a variety of materials.

INSTRUCTOR'S NOTES

Reference Books

Ansley. *Manufacturing Methods and Processes.*

Capron. *Wood Laminating.*

Dahl and Wilson. *Cabinetmaking and Millwork: Tools, Materials, Layout, Construction.*

Edgar. *Fundamentals of Manufacturing Processes and Materials.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Fryklund and LaBerge. *General Shop Woodworking.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Lindberg. *Processes and Materials of Manufacture.*

Olson. *Industrial Arts and Technology.*

Olson. *Woods and Woodworking for Industrial Arts.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Instructional Materials

American Institute of Timber Construction

Borden Chemical Company

California Redwood Association

Forest Products Laboratory

Franklin Glue Company

National Particleboard Association

United States Plywood Corporation

Western Wood Products Association

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ABRASIVES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The nature and composition of abrasives.	Appreciation for the many products provided for consumer use.
Use comparative testing procedures and evaluation of same.	The types of abrasives in use today, both natural and artificial.	Awareness that abrasives are not just "sandpaper," but a product of research and technology.
	The basic manufacturing techniques used in creating electric furnace abrasives. Knowledge concerning modern abrasive technology.	An interest in the abrasives industry.
	How industry produces abrasives for industrial and consumer use.	Industrial awareness.
Select abrasives intelligently.	Technical information about abrasives, including: 1. Grading grains 2. Grit size 3. Types of backings 4. Adhesives used 5. Flexural nature 6. Grain spacing 7. Wet application 8. Color codes	Intelligent consumer selection and use of abrasives.
Write specifications for abrasives desired.	Specifications concerning abrasives.	Awareness of product differences.
	Why one abrasive will cost more than another.	Consumer awareness of cost factors.
Prepare a wood surface for finishing purposes.	The forms abrasives are manufactured in for given production problems.	
Employ proper sanding techniques. Select suitable sanding devices or machine for problem at hand.	Proper application of a selected abrasive to a given problem or project.	Confidence in ability to approach abrasive phase of a problem.
Properly apply abrasive theory to a given problem.	The theory of abrasive action.	

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ABRASIVES

IMPLEMENTATION SUGGESTIONS

Bulletin board display on the manufacture, uses, and types of abrasives.

Students experiment to check cutting characteristics of the many abrasives available. Use a variety of substances, including wet-use abrasives.

Show variety of samples and applications.

Transparencies to show industrial manufacture of abrasive products.

Field trip to manufacturer of abrasive products.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Delta Power Tool Division. *Getting the Most Out of Your Abrasive Tools.*

Delta Power Tool Division. *Practical Finishing Methods.*

Edgar. *Fundamentals of Manufacturing Processes and Materials.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Fryklund and LaBerge. *General Shop Woodworking.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Holtrop and Hjorth. *Modern Machine Woodworking.*

Lindberg. *Processes and Materials of Manufacture.*

Newell. *Coloring, Finishing, and Painting Wood.*

Olson. *Industrial Arts and Technology.*

Olson. *Woods and Woodworking for Industrial Arts.*

Soderberg. *Finishing Materials and Methods.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Wagner. *Woodworking.*

Instructional Materials

Behr-Manning Company

Carborundum Company

Clover Manufacturing Company

Forest Products Laboratory

General Finishes Sales and Services Company

McCloskey Varnish Company

Merit Abrasive Products, Inc.

National Paint, Varnish, and Lacquer Association

Wilson-Imperial Company

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HARDWARE AND FASTENERS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	How industry produces the vast variety of hardware products, including: nails, tacks, staples, screws, hollow wall fasteners, joint fasteners, t-nuts, hanger bolts, repair plates, and cabinet hardware.	An appreciation for industrial technology related to the manufacture of hardware. An interest in manufacturing. An awareness of hardware products available to the consumer.
Develop tool and machine proficiency. Utilize application techniques and tricks.	Procedures for the application of hardware. The function of tools and machines related to the application of hardware.	Hardware selection criteria. Awareness of tools and machines used by the trades and industry to fabricate a variety of products. Awareness of problems involved in the selection and application of a given piece of hardware for a given problem.
	Safe working procedures. The scope of hardware products available to the consumer.	Desirable safety practices. The initiative to challenge a problem situation.
Write specifications relative to hardware.	Hardware specification, including size, type, style, design, finish, and materials.	Further awareness of the need for more than surface knowledge concerning consumer products.
Determine costs.	Cost factors related to hardware manufacture and sale.	Purchasing awareness.
	The nature of occupations related to hardware.	Awareness of occupational preparation, activity, and responsibility.

HARDWARE AND FASTENERS

IMPLEMENTATION SUGGESTIONS

Display of hardware samples.

Students experiment to compare characteristics of a variety of fasteners.

Show application to student designed project or problem.

Individual and/or group reports concerning hardware areas such as history, applications, new products, and occupations.

Library literature available concerning occupations.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Douglass. *Woodworking with Machines.*

Edgar. *Fundamentals of Manufacturing Processes and Materials.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Fryklund and LaBerge. *General Shop Woodworking.*

Gerbracht and Robinson. *Understanding America's Industries.*

Gilbert. *Children Study American Industry.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Lindberg. *Processes and Materials of Manufacture.*

Olson. *Industrial Arts and Technology.*

Olson. *Woods and Woodworking for Industrial Arts.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Wagner. *Woodworking.*

Instructional Materials

Brodhead-Garrett Company

California Redwood Association

G. P. Derickson Company

Forest Products Laboratory

Irwin Auger Bit Company

Midwest Shop Supplies

Minnesota Woodworkers Supply Company

Paxton Equipment and Supply

Satterlee Company

Stanley Tools

Upholstery Supply Company

JOINERY AND ASSEMBLY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Construction principles related to fabrication of woodworking products.	An ability to choose wisely facets of fabrication relevant to the problem situation.
Acquire tool and machine skills and knowledge.	Joint design and strengthening devices.	Awareness of joinery possibilities.
Apply practical knowledge to situations involving clamping devices, joint construction, adhesive preparation, and laminate application.	Factors related to the selection, application, and curing of adhesives. The nature of clamping devices and their proper selection and application.	An awareness of the need for planning and order in the fabrication of a product.
	Industrial joinery, bonding, and lamination practices, including electronic and blanket curing of adhesive.	A working interest in industry as pertaining to an individual or group problem situation.
Properly care for, clean, and maintain tools and devices related to joinery and assembly activities.	Materials, tools, and technology for lamination, bending, and veneering.	An awareness of the design possibilities that lamination, bending, and veneering can lend to a product.
	The nature and function of plastic laminates.	An awareness of the role that plastic laminates have in our way of living.
Design forms for lamination problem.	Nature of jigs and fixtures for lamination problems.	Need for creative thought and expression. Safety awareness.

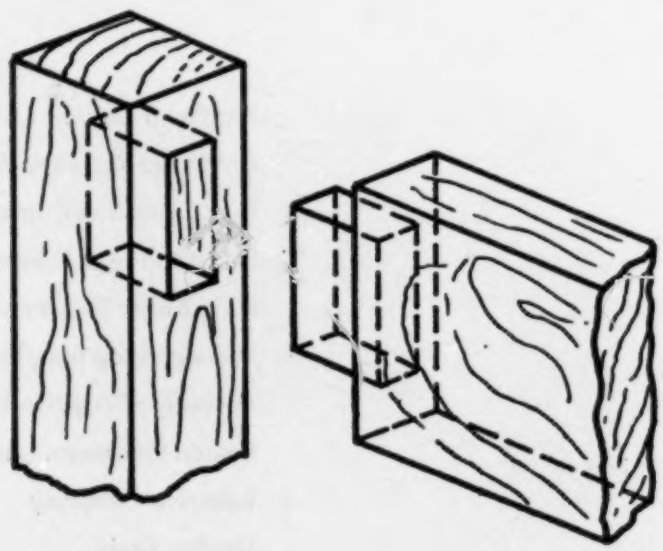

JOINERY AND ASSEMBLY

IMPLEMENTATION SUGGESTIONS

Demonstrations dealing with joint construction, lamination, bending, veneering, and plastic laminate application.

Exhibits and/or samples of joints, lamination, bending, veneering, and plastic laminates.

Discuss and demonstrate clamping and bending devices.

Research and experimentation dealing with laminates, adhesives, jigs, and fixtures.

Construction of jigs and fixtures.

Video tape replay of difficult joinery principle (dovetailing).

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Capron. *Wood Laminating.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Lindberg. *Processes and Materials of Manufacture.*

Olson. *Industrial Arts and Technology.*

Olson. *Woods and Woodworking for Industrial Arts.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Wagner. *Woodworking.*

Instructional Materials

American Institute of Timber Construction

California Redwood Association

Albert Constantive and Son, Inc.

Craftsman Wood Service Company

G. P. Derickson Company

Franklin Glue Company

Industrial Lumber and Plywood

Minnesota Woodworkers Supply Company

National Particleboard Association

Frank Paxton Lumber Company

Youngblood Lumber Company

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HAND AND PORTABLE TOOLS AND MACHINES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Historical development of tools and machines and their contribution to our present society.	Appreciation for the design and function of present day industrial apparatus.
	The physical and mechanical nature of hand, portable, and machine tools.	An awareness of possibilities and knowledge that tools can provide in a problem-solving situation.
Demonstrate a degree of proficiency in the use of tools and machines, including: 1. Setup procedures 2. Maintenance 3. Safe operational practices 4. Lubrication practices 5. Sharpening 6. Adjustment 7. Product fabrication 8. Tool and accessory identification 9. Inspection	The function and operation of tools and machines, including: 1. Drive mechanisms 2. Accessories 3. Cutting sequence 4. Jigs and fixtures 5. Safety consciousness 6. Theory of cutting tools 7. Measurement and inspection devices	Self-discipline. Initiative. Cooperative attitudes. Safe attitudes and practices. Interest in achievement. Awareness of the need for orderly performance. Awareness of the need for proper drawing and design in product to be built. Knowledge of operation of tools and machines. Avocational interests.
	Industrial practices and procedures, both historical and contemporary.	Interest in industry. Production techniques.
Specify correctly a desired tool or tools. Select, care for, and use tools and machines wisely.	Criteria for selection and purchase of tools and machines for personal use.	An appreciation and respect for high quality tools properly maintained.

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HAND AND PORTABLE TOOLS AND MACHINES—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP

HAND AND PORTABLE TOOLS AND MACHINES—continued

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Reference Books — continued

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Wagner. *Woodworking.*

Instructional Materials

American Plywood Association

Black and Decker Manufacturing Company

Brodhead-Garrett Company

G. P. Derickson Company

"Dowl-It" Company

Forest Products Laboratory

Gizco

Greenlee Tool Company

Irwin Auger Bit Company

Midwest Shop Supplies

Millers Falls Company

Minnesota Woodworkers Supply Company

Nelson and Jacobson, Inc.

Nicholson File Company

Northfield Foundry and Machine Company

Oliver Machinery Company

Parks Woodworking Machine Company

Paxton Equipment and Supply

Peerless Saw Company

G. C. Peterson Machinery Company

Fayette R. Plumb Company

H. K. Porter Company, Inc.

Powermatic, Inc.

Rockwell Manufacturing Company

Satterlee Company

Simonds Saw and Steel Company

Stanley Tools

Upholstery Supply Company

J. D. Wallace

Wilson-Imperial Company

FURNITURE AND CABINETMAKING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	History and development of furniture and cabinetmaking.	An appreciation for the value placed on antique furniture.
Identify a variety of period styles of furniture.	Historical periods and furniture styles.	Awareness of the many talented artists and craftsmen responsible for beautiful furniture of the past. An appreciation for the craftsmanship of the past and the continuing need for craftsmanship today.
Plan and design a product for actual construction.	Principles of selecting and designing furniture and cabinets.	Design and planning appreciations.
Discuss facets of furniture and cabinets with trade craftsmen.	Furniture and cabinetmaking terminology.	An ability to relate or communicate with people in furniture and cabinetmaking roles.
Identify, select, and use woods, materials, tools, and machines in project construction.	Woods, materials, tools, and machines used in fabrication of furniture and cabinets.	An ability to intelligently determine which product, tool, or machine best fits a specific need.
Engage in actual construction of a project using one or more types of furniture or cabinet construction.	Types of furniture and cabinet construction.	Ability to select the process that best fits the job to be done. Knowledge of furniture construction. Initiative and resourcefulness in meeting practical situations.
Totally fabricate an article employing any or all of specific cabinet and furniture details mentioned.	Specific details of furniture and cabinet construction including panel construction, layout, standard sizes, edge treatment of plywood, fastening tops, leg and shelf installation, drawer construction and guiding, doors and application, hardware and trim, and built-in detailing.	Self-discipline. Cooperative attitudes. Safe practices. An interest in achievement. Avocational interests.
More wisely determine occupation of interest.	The nature of occupations engaged in the furniture and cabinetmaking trades.	Awareness of occupational opportunities.
Adapt industrial techniques to school shop applications.	Industrial processes and equipment in use today.	An interest in industry and industrial processes and materials.

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FURNITURE AND CABINETMAKING

IMPLEMENTATION SUGGESTIONS

Bulletin board depicting historical development of furniture and cabinetmaking and/or bulletin board dealing with furniture styles.

Student development of a booklet classifying furniture styles and facets of each style.

Implement design analysis method.

Individual students develop and construct a major piece of furniture or cabinetry, employing as many experiences as possible.

Class can mass-produce a less-complex piece of furniture.

Display samples of furniture and cabinet construction.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Capron. *Wood Laminating.*

Cunningham. *Woodshop Tool Maintenance.*

Dahl and Wilson. *Cabinetmaking and Millwork: Tools, Materials, Layout, Construction.*

Delta Power Tool Division. *Getting the Most Out of Your Abrasive Tools.*

Delta Power Tool Division. *Getting the Most Out of Your Band Saw and Scroll Saw.*

Delta Power Tool Division. *Getting the Most Out of Your Circular Saw and Jointer.*

Delta Power Tool Division. *Getting the Most Out of Your Drill Press.*

Delta Power Tool Division. *Getting the Most Out of Your Lathe.*

Delta Power Tool Division. *Getting the Most Out of Your Radial Saw.*

Delta Power Tool Division. *Getting the Most Out of Your Shaper.*

Delta Power Tool Division. *Practical Finishing Methods.*

Dewalt Editorial Board. *Newest Ways to Expert Woodworking.*

Douglass. *Woodworking with Machines.*

Edgar. *Fundamentals of Manufacturing Processes and Materials.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Fryklund and LaBerge. *General Shop Woodworking.*

Gerbracht and Robinson. *Understanding America's Industries.*

Gilbert. *Children Study American Industry.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Holtrop and Hjorth. *Modern Machine Woodworking.*

Lindbeck. *Design Textbook.*

Lindberg. *Processes and Materials of Manufacture.*

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FURNITURE AND CABINETMAKING—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP

IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Reference Books — continued

Madden. *Woodworking for Industrial Arts.*

Olson. *Industrial Arts and Technology.*

Olson. *Woods and Woodworking for Industrial Arts.*

Soderberg. *Finishing Materials and Methods.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Wagner. *Woodworking.*

Instructional Materials

American Forest Products Industries, Inc.

American Plywood Association

Appalachian Hardwood Manufacturers, Inc.

Brodhead-Garrett Company

Albert Constantive and Son, Inc.

Craftsman Wood Service Company

G. P. Derickson Company

Fine Hardwoods Association

T. A. Foley Lumber Company, Inc.

Forest Products Laboratory

Hardwood Plywood Manufacturers Association

Industrial Lumber and Plywood

Midwest Shop Supplies

Minnesota Woodworkers Supply Company

National Paint, Varnish, and Lacquer Association

National Particleboard Association

Paxton Equipment and Supply

Frank Paxton Lumber Company

Stanley Tools

Upholstery Supply Company

Youngblood Lumber Company

UPHOLSTERY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Recognize and classify varying pieces of furniture.	Upholstery classifications and construction principles to include pad seat, tight spring seat, and over-stuffed applications.	An appreciation for the comparative features of differing construction relative to cost and quality.
Identify and classify tools and materials.	The nature of upholstery tools, materials, and frames.	Concepts concerning the intelligent use of tools and materials.
Discuss upholstery, using trade terminology.	Upholstery terminology.	
Perform tasks relative to reupholstery work. Build upholstered furniture.	Upholstery techniques and procedures.	Skills. An interest in the upholstery industry. Cooperative attitude. Safe practices. An interest in achievement. Awareness of the need for careful, organized planning.
	The history and manufacture of upholstery materials.	An appreciation for the value placed on antique furniture.
Repair furniture. Restyle furniture. Make slipcovers.	Concepts and applications for repairing, restyling, and slipcovers.	Construction and value of some older furniture. Cost comparisons related to new furniture versus repair of old.
Use modern approaches, tools, and materials in upholstery work.	The nature of modern materials and methods used in upholstery.	An awareness of new materials, tools, fabrics, and methods used in the fabrication of furniture today.

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UPHOLSTERY

IMPLEMENTATION SUGGESTIONS

Students study styles and construction of upholstered furniture.

Mockup showing construction features.

Display of upholstery tools and materials.

Bulletin board relating terminology to use or function.

Students build small upholstered item, using pad seat construction.

Students plan and build larger upholstered item, using advanced upholstery techniques and modern materials.

Field trip to industry where upholstered furniture is made.

Students repair, restyle, slipcover, or reupholster a piece of furniture.

Class mass-produces some small upholstery item.

Upholstery materials sample kits.

INSTRUCTOR'S NOTES

Reference Books

Bast. *Essentials of Modern Upholstery.*

Bergen. *All About Upholstering.*

Feirer. *Industrial Arts Woodworking.*

Fryklund and LaBerge. *General Shop Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Olson. *Woods and Woodworking for Industrial Arts.*

Tierney. *Modern Upholstering Methods.*

Wagner. *Modern Woodworking.*

Instructional Materials

Albert Constantive and Son, Inc.

"Dowl-It" Company

Forest Products Laboratory

Minnesota Woodworkers Supply Company

National Association of Furniture Manufacturers

National Paint, Varnish, and Lacquer Association

Upholstery Supply Company

Wilson-Imperial Company

PATTERNMAKING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The theory of the foundry and how patternmaking is basic to the foundry process. Patternmaking and mold building as related to other industrial functions.	An awareness of the relationship of one industrial area (wood) to another (such as metals or plastics).
Discuss foundry and patternmaking.	Patternmaking terminology.	
Identify and use patternmaking tools and equipment.	Tools, materials, equipment, and supplies used in patternmaking.	Awareness of new tools, equipment, and materials designed for use in a specific area of industry.
Design, plan, and construct patterns and molds for use in related areas.	Procedure used in the fabrication of patterns.	Craftsmanship. Another facet of industry. Safety habits and attitudes. Awareness of patternmaking procedures.
	Patternmaking as an occupation.	An appreciation for patternmaking as an occupation.

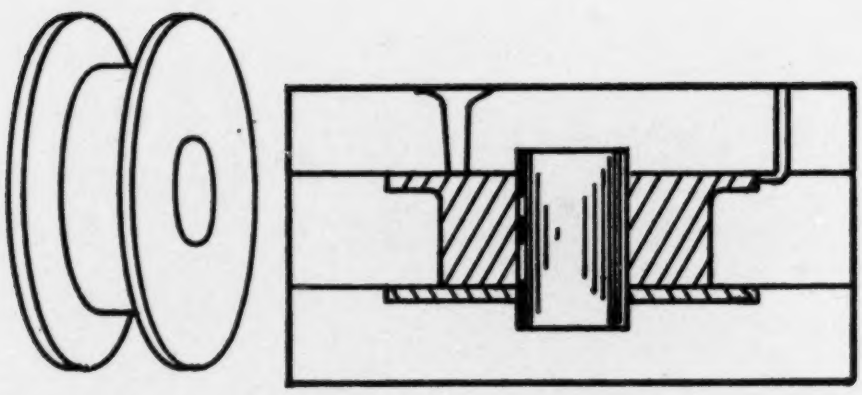

PATTERNMAKING

IMPLEMENTATION SUGGESTIONS

Bulletin board display of foundry-patternmaking relationship.

Sample patterns showing all patternmaking techniques.

Students build patterns and molds for later use in foundry and plastics applications.

Display of tools, materials, and equipment used in patternmaking.

Video tape interview with a patternmaker.

Transparencies of patternmaking processes.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Feirer. *Woodworking for Industry.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Lindberg. *Processes and Materials of Manufacture.*

Olson. *Industrial Arts and Technology.*

Smith. *Patternmaking and Founding.*

Wagner. *Modern Woodworking.*

Instructional Materials

Albert Constantive and Son, Inc.

Craftsman Wood Service Company

Educational Lumber Company, Inc.

T. A. Foley Lumber Company, Inc.

Forest Products Laboratory

Industrial Lumber and Plywood

Midwest Shop Supplies

Minnesota Woodworkers Supply Company

Frank Mittermeier, Inc.

Frank Paxton Lumber Company

G. C. Peterson Machinery Company

Satterlee Company

Upholstery Supply Company

Youngblood Lumber Company

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RESIDENTIAL CONSTRUCTION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Select a vacant lot in the city suitable for residential development.	Considerations relevant to acquisition of property: 1. Neighborhood transportation such as city bus 2. Proximity to schools, churches, and stores	Need for proper evaluation of all factors prior to purchase of property. Comparative cost factors concerning pricing of residential property.
Examine and compare different soils for home and garden applications.	Soil conditions.	Basis for comparison with other lesser or better soil conditions.
	Adjacent property value.	
	Zoning restriction: 1. Residential 2. Commercial 3. Industrial	Familiarity with the variety of zoning situations present in total city development.
	Traffic considerations relevant to property.	
Demonstrate a degree of skill in the use of the transit. Develop a plot plan showing contour factors.	Lot shapes and such factors as elevations and angles.	Need and appreciation of accuracy in determining elevations for later cost factors.
Work with budgets, styles, and tangible functional aspects of home selection.	Considerations relevant to residential design, including budget, style, and function.	A basis for future considerations involved in the actual acquisition of a home.
	Home financing.	Knowledge of a variety of fiscal factors to be considered in the selection and purchase of a home.
	The role of the lawyer and the need for legal advice when considering building a home.	An awareness of legal factors relevant tc acquisition of property and letting of bids.
	Basic legal terms related to acquisition and sale of property.	Familiarity with terminology concerning building restrictions, easements, deeds, title, search and opinions, warranty and quit claim deeds, liens, and surveys.
Work with building plans.	Building plans and specifications.	Interpretation of a set of architectural drawings, details, and specifications.
Draw up basic specifications for bidding purposes.	Procedures used to acquire competitive bids for total construction of a residence.	An awareness of the many different vocations responsible for the total development of a house.

RESIDENTIAL CONSTRUCTION

IMPLEMENTATION SUGGESTIONS

Students are to select a vacant lot in the city and totally research the given piece of property.

Students do soil tests in cooperation with science or agriculture departments.

Consult city zoning ordinances and regulations.

Group discussion pertinent to property involved.

Group work with transit to determine property contours.

Individual and group problems dealing with budget, styling, and functional aspects of planning.

Discussion with real estate agent, banker, or other loan agent relevant to mortgage factors.

Talk by lawyer on pertinent factors such as deeds, title opinions, and easements.

Problems in reading and interpreting house plans and details. Talk by architect on pertinent factors.

Review and evaluate bid specification forms.

Students draw up specifications and bid forms.

Group analysis of student designed specifications and bids.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Dahl and Wilson. *Cabinetmaking and Millwork: Tools, Materials, Layout, Construction.*

Dunning and Robin. *Home Planning and Architectural Drawing.*

Durbahn. *Fundamentals of Carpentry: Volume I, Tools—Materials—Practice.*

Durbahn. *Fundamentals of Carpentry: Volume II, Practical Construction.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Woodworking for Industry.*

Goodban and Hayslett. *Architectural Drawing and Planning.*

Groneman and Glazener. *Technical Woodworking.*

Hepler and Wallach. *Architecture: Drafting and Design.*

Hornung. *Architectural Drafting.*

Mix and Circu. *Practical Carpentry.*

Muller. *Architectural Drawing and Light Construction.*

Spence. *Architecture: Design, Engineering, Drawing.*

Townsend and Dalzell. *How To Plan a House.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

U.S. Department of Agriculture. *Wood Frame House Construction.*

Wagner. *Modern Woodworking.*

Instructional Materials

American Forest Products Industries, Inc.

American Plywood Association

American Wood Preservers Institute

Appalachian Hardwood Manufacturers, Inc.

Architectural Woodwork Institute

Brewster, Inc.

California Redwood Association

G. P. Derickson Company

Fine Hardwoods Association

Forest Products Laboratory

Forest Products Promotion Council

Hardwood Plywood Manufacturers Association

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RESIDENTIAL CONSTRUCTION—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Interpret plans relevant to electrical heating, cooling, and plumbing symbols.	The nature of electrical, plumbing, heating, and cooling systems.	Cooperative attitudes between building trades. Awareness of the work and planning required of the different building trades.
Use the transit. Set grade stakes. Determine building elevation with respect to adjacent buildings and surrounding terrain.	How a building is located on a given piece of property. The procedures used to stake out for excavation.	A real interest in building layout. Planning proficiency as the need for orderly performance is justified. Cooperative attitudes. Understandings of the problems involved when locating a building.
Process building components to scale. Utilize shop machines and tools.	Terminology, materials, and procedures used or related to the fabrication or placing of footings and foundation walls.	Knowledge of masonry and related materials used in basement construction.
Develop a degree of proficiency in the use and care of tools relevant to construction.	Tools for the construction industries—their functions, applications, utilization, and safety.	An awareness of the vast variety of general- and special-purpose tools and machines used by modern day craftsmen.
Identify and specify lumber for building purposes.	Lumber used for construction.	Awareness that a variety of approaches is available to the builder, depending on design and function.
Effectively discuss the development of a home in terms of the tradesman.	Terminology for the total residential development.	Vocabulary proficiency relative to building terminology and construction.
Select type of construction suitable to individual problem.	Differing types of construction, including: 1. Platform frame construction 2. Ballroom frame construction 3. Plank and beam construction	Awareness that a variety of approaches is available to the builder, depending on design and function. Understandings of the variety of building materials available.
Frame a house, developing a degree of skill in the use of all tools and machines related to the fabrication of a project of this scope. Read, interpret, and use building plans. Specify building materials for given building problems.	Floor framing, including: 1. Sill on foundation wall 2. Sill on piers 3. Beams and girders 4. Selection and placing of joists 5. Bridging 6. Framing opening in the floor 7. Notching and boring joists 8. Support for partitions 9. Floor overhang 10. Sub-flooring	Consumer awareness of construction materials to include comparative knowledge relating to cost, use, effectiveness, and suitability. An active interest in the construction industry and in the methods and procedures used in this industry. An awareness of and an appreciation for quality in craftsmanship.
	Exterior wall framing, including: 1. Stud selection, size and spacing 2. Framing openings 3. Header criteria 4. Gable and walls 5. Wall sheathing 6. Building paper or barrier	Self-reliance, self-discipline, and resourcefulness in problem situations. A new insight into the necessity for cooperative habits and attitudes required in group undertakings.

IMPLEMENTATION SUGGESTIONS

Electricians, plumbers, and climate-control persons discuss occupations and their individual role in residential construction.

Class field trips to home under construction.

Video tapes made on site, including interview, observations, or demonstrations of processes.

Students and instructor combine efforts in actually staking out a building on a vacant lot near school. (It is assumed that permission for use will be obtained.) Mathematics or agriculture instructor could serve as resource person dealing with basics of survey techniques.

For a group project, students start construction of a home to scale 1½″=1′0″. Layout of foundation on a sheet of plywood. Basement development optional.

Samples of various species and grades, complete with cost information.

Field trip to local lumber supplier.

Use of transparencies showing building components and component relationship.

Use of scale models to show components.

Use scale cutaway model to show construction principles.

Students can attempt different types of construction.

Field trip to homes under construction.

As suggested previously, a scale model home (scale 1½″= 1′ 0″) is thought to be an effective learning device. Many of the materials used by the carpenter can be simulated in the school shop. A mass production approach using jigs and fixtures will stimulate group activity and individual responsibility. Students can be challenged to design and develop solutions to a number of construction problems as the need dictates.

Individuals and small groups may choose to develop alternate methods for fabrication such as hip roof vs. gable, post and beam vs. platform, varied types of stair construction, varied exterior finishes, window styles, and roof materials.

INSTRUCTOR'S NOTES

Instructional Materials — Continued

Industrial Lumber and Plywood

Insulation Board Institute

McCloskey Varnish Company

Maple Flooring Manufacturers Association

National Forest Products Association

National Hardwood Lumber Association

National Oak Flooring Manufacturers Association

National Paint, Varnish, and Lacquer Association

National Particleboard Association

National Sash and Door Jobbers Association

National Woodwork Manufacturers Association

Frank Paxton Lumber Company

Philippine Mahogany Association, Inc.

Ponderosa Pine Woodwork

Red Cedar Shingle and Handsplit Shake Bureau

Rez Wood-Tones, Inc.

Simpson Timber Company

Southern Hardwood Lumber Manufacturers Association

Southern Pine Association

U.S. Government Printing Office

United States Plywood Corporation

Western Wood Products Association

Weyerhauser Company

RESIDENTIAL CONSTRUCTION—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Interior wall framing, including: 1. Bearing partitions 2. Nonbearing partitions 3. Openings for doors and built-ins 4. Backing 5. Stairways	Safety consciousness. An interest in personal and group achievement. Performance proficiency. Skills.
	Ceiling and roof framing, including: 1. Terminology 2. Types of roofs 3. Use of the framing square 4. Rafter layout 5. Ventilation 6. Collar beams 7. Trussed rafters 8. Flat roofs 9. Roof sheathing	
	Exterior finishing materials and application: 1. Window selection and placement 2. Door selection and placement 3. Siding and related materials 4. Cornice construction and materials 5. Roofing materials and application	
	Comparative information relating to insulation — installation, effectiveness, and types available.	
	The function of a vapor barrier.	
	Interior finishing materials: 1. Drywall 2. Plaster 3. Paneling 4. Masonry applications 5. Plastics and glass 6. Trim and moldings 7. Wood flooring materials 8. Masonry flooring materials 9. Resilient flooring materials 10. Plastic laminates	
	The basics of concrete slab construction with consideration for: 1. Independent slabs and walls 2. Vapor barriers and insulation 3. Heating and plumbing 4. Floor construction	

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Field trips to construction sites in varying stages of completion.	
Class discussion with tradesmen.	
Instructor-developed transparencies for presentation on rafter framing.	
Bulletin boards on rafters, building components, and window and door styles.	

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RESIDENTIAL CONSTRUCTION—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Develop jigs and fixtures for prefab construction.	The prefabricated home: 1. History 2. 20th century prefab 3. Unicom construction	
	The basics of modular design and the advantages and disadvantages.	Understandings related to the manufacture and flexibility of modular design and construction.
	Current innovative thoughts and procedures related to construction industry.	Awareness of the need for continued educational activity as relates to individual success.

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Students can prefabricate components to be used with scale model house.	
Student experimentation with techniques used in modular construction.	
Teacher should always be aware of new developments in the field. It is desirable for teacher to have name on industry mailing list.	

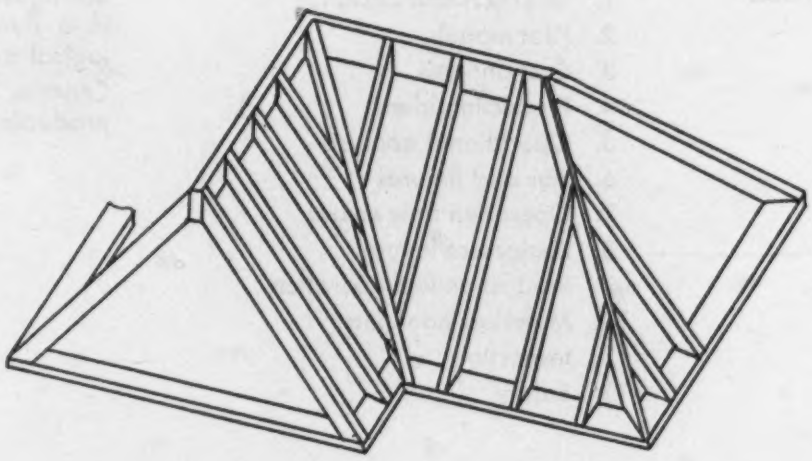

INDUSTRIAL PRODUCTION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Develop basic skills in the use of tools, machines, and materials.	Mass production concepts, including: 1. Historical development 2. Major facets 3. Advantages 4. Disadvantages 5. Terminology	An ability to interpret industrial materials. An awareness of methods of production.
Apply knowledge learned from association with materials, processes, and products of industry.	Corporation structure dealing with: 1. Corporation formation 2. Corporation operation 3. Business organization 4. Departmental breakdown a. Board b. Sales c. Accounting d. Production e. Research and development f. Advertising g. Legal-stock sale	Consideration for industrial life and the role of industry in our society. Problem-solving abilities through activities relating to the utilization of materials and processes of industry.
Make intelligent decisions concerning mass-produced consumer goods.	How a product is produced, including: 1. Selection and design 2. Pilot models 3. Cost analysis 4. Production ideas 5. Operational analysis 6. Jigs and fixtures 7. Operation flow charts 8. Equipment layout 9. Production line operation 10. Materials handling 11. Inspection 12. Safety The sale and distribution of a product. Profit and loss considerations: 1. Preferred stock 2. Common stock	Recognition of and adaption to the demands of living and contributing in a dynamic industrial and technological society. Concern for and awareness of safe production practices.

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INDUSTRIAL PRODUCTION

IMPLEMENTATION SUGGESTIONS

Class members form a corporation.

Students produce and merchandise a product or products. Corporation structure suggests a team teaching approach which includes:

1. Economics — corporation structure
2. Business education — accounting
3. Math — computation of costs and dividends
4. Science — physics' principles in design of jigs, fixtures, and product
5. English — minutes of meetings, prospectus, articles and reports, and advertising

Samples of consumer products.

Individual development of models and mockups.

Fabrication of jigs and fixtures.

Display stock certificates.

Field trip to industry.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Ansley. *Manufacturing Methods and Processes.*

Edgar. *Fundamentals of Manufacturing Processes and Materials.*

Feirer. *Cabinetmaking.*

Feirer. *Woodworking for Industry.*

Gerbracht and Robinson. *Understanding America's Industries.*

Gilbert. *Children Study American Industry.*

Lindberg. *Processes and Materials of Manufacture.*

Olson. *Industrial Arts and Technology.*

Wagner. *Modern Woodworking.*

Instructional Materials

Ford Motor Company

General Motors Corporation

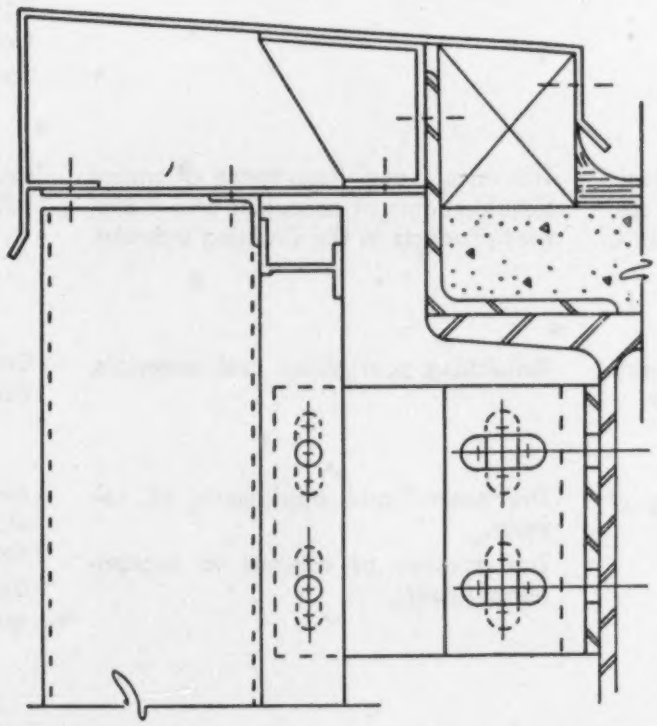

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WOOD FINISHING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The nature of wood finishing tools and materials.	Awareness of materials available for finishing purposes.
	The historical development of wood finishing materials and finishes.	An appreciation for and an awareness of the vast amount of technology involved in modern day materials.
Transfer knowledge of industrial processes to solution of a given problem. Use proper terminology.	Industrial finishing applications such as industrial spraying, roller coating, curtain coating, flow coating and dipping, tumbling, force drying (infrared), and conveyor techniques.	An interest in industrial finishing procedures. Occupational awareness. An awareness of possibilities for individual problem solving. Safety awareness.
Select, prepare for, and apply a variety of finishing materials. Write specifications for a variety of finishing materials. Select proper device for material application using brush, rag, roller, spray, and industrial pr dures.	Working characteristics and application of finishing materials such as stains, bleaches, sealers, fillers, glaze and shading elements, paints, enamels, varnishes, oils, waxes, and lacquers.	Self-reliance and confidence. An interest in achievements. An awareness of the need for organized, complete, and efficient performance of a given finishing problem. A knowledge of finishing materials and techniques. Finishing skills.
Maintain and care for finishing equipment and materials.	Importance of proper maintenance related to the finishing process.	An awareness of the necessity for proper maintenance and care of equipment and supplies. Cooperative attitudes. Safety awareness.
Experiment with a variety of products to test for things such as hardness, abrasion resistance, and moisture resistance.	The nature and importance of recent developments of consumer and industrial products in the finishing industry.	Knowledge of current product availability.
Apply knowledge obtained from personal problems.	Refinishing procedures and materials.	Confidence in ability to challenge difficult problems.
Select and carefully use a variety of volatile materials.	The nature and application of solvents. The dangers of solvents to occupational health.	Awareness of the need for a variety of solvents in wood finishing operations. Desirable habits and attitudes with respect to health and safety.

WOOD FINISHING

IMPLEMENTATION SUGGESTIONS

Samples of finishing materials.

Bulletin board relating finishes to solvent selection.

Variety of wood samples indicating a variety of finish applications for each species of wood.

Group and individual research and exploration concerning the characteristics of a variety of finishes.

Student application of finish to a project of own choosing.

Field trip to any industry using a variety of industrial finishing techniques.

Student writes procedures for proper application of finish to project.

Local painter can discuss construction finishing materials and techniques with class.

Video tape interviews and/or industrial techniques for presentation to class.

INSTRUCTOR'S NOTES

Reference Books

A.C.I.A.T.E. *Evaluation Guidelines for Contemporary Industrial Arts Programs.*

Delta Power Tool Division. *Practical Finishing Methods.*

Feirer. *Advanced Woodwork and Furniture Making.*

Feirer. *Cabinetmaking.*

Feirer. *Industrial Arts Woodworking.*

Feirer. *Woodworking for Industry.*

Fryklund and LaBerge. *General Shop Woodworking.*

Groneman. *General Woodworking.*

Groneman and Glazener. *Technical Woodworking.*

Hammond and others. *Woodworking Technology.*

Newell. *Coloring, Finishing, and Painting Wood.*

Olson. *Industrial Arts and Technology.*

Olson. *Woods and Woodworking for Industrial Arts.*

Soderberg. *Finishing Materials and Methods.*

U.S. Department of Agriculture. *Wood Handbook No. 72.*

Wagner. *Modern Woodworking.*

Wagner. *Woodworking.*

Instructional Materials

American Plywood Association
Brodhead-Garrett Company
California Redwood Association
Champion Pneumatic Machinery Company, Inc.
DeVilbiss Company
Forest Products Laboratory
General Finishes Sales and Services Company
P. R. L. Hardenbergh
McCloskey Varnish Company
Midwest Shop Supplies
Minwax Company, Inc.
National Paint, Varnish, and Lacquer Association
Paxton Equipment and Supply
G. C. Peterson Machinery Company
Pines International Chemical Company, Inc.
Rez Wood-Tones, Inc.
Torit Corporation
United States Plywood Corporation
Upholstery Supply Company
Wilson-Imperial Company

3680

REFERENCES

Reference Books

American Council on Industrial Arts Teacher Education. *Evaluation Guidelines for Contemporary Industrial Arts Programs.* 16th Yearbook. McKnight, 1967. $4.95 (373.2)

Ansley, Arthur C. *Manufacturing Methods and Processes.* Rev. ed. Chilton, 1968. $12.50 (671)

Bast, Herbert. *Essentials of Modern Upholstery.* Bruce Wis., 1963. $4.50 (684.3)

Bergen, John. *All About Upholstering.* Hawthorn, 1962. $5.50 (684.3)

Capron, J. Hugh. *Wood Laminating.* McKnight, 1962. $4.40 (694.6)

Cunningham, Beryl M. *Woodshop Tool Maintenance.* Bennett Co., 1956. $6.80 (621.9)

Dahl, Alf, and D. Wilson. *Cabinetmaking and Millwork: Tools, Materials, Layout, Construction.* 2nd ed. American Technical Society, 1956. $7.15 (684.1)

Delta Power Tool Division. *Getting the Most Out of Your Abrasive Tools.* $2.00 (621.9) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Delta Power Tool Division. *Getting the Most Out of Your Band Saw and Scroll Saw.* $2.00 (621.9) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Delta Power Tool Division. *Getting the Most Out of Your Circular Saw and Jointer.* $2.00 (621.9) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Delta Power Tool Division. *Getting the Most Out of Your Drill Press.* $2.00 (621.9) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Delta Power Tool Division. *Getting the Most Out of Your Lathe.* $2.00 (621.9) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Delta Power Tool Division. *Getting the Most Out of Your Radial Saw.* $2.00 (621.9) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Delta Power Tool Division. *Getting the Most of Your Shaper.* $2.00 (621.9) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Delta Power Tool Division. *Practical Finishing Methods.* $2.00 (694.6) Available from Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh, Pennsylvania 15208.

Dewalt Editorial Board. *Newest Ways to Expert Woodworking.* 1965. $3.95 (684.08) Available from Black and Decker Manufacturing Company, School Sales Department N-039S, Towson, Maryland 21204.

Douglass, J. H. *Woodworking with Machines.* McKnight, 1960. $4.80 (671)

Dunning, W. J., and L. P. Robin. *Home Planning and Architectural Drawing.* Wiley, 1966. $4.95 (690)

Durbahn, Walter E. *Fundamentals of Carpentry: Volume I, Tools—Materials—Practice.* 4th ed. American Technical Society, 1961. $6.00 (694)

Durbahn, Walter E. *Fundamentals of Carpentry: Volume II, Practical Construction.* 3rd ed. American Technical Society, 1956. $6.50 (694)

Edgar, Carroll. *Fundamentals of Manufacturing Processes and Materials.* Addison-Wesley, 1965. $10.50 (670)

Federal Housing Administration, Housing and Home Finance Agency. *Minimum Property Standards for One and Two Living Units.* Available from Federal Housing Administration, Housing and Home Finance Agency, Washington, D.C. 20411.

Feirer, John L. *Advanced Woodwork and Furniture Making.* Bennett, 1963. $5.28 (684.08)

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Feirer, John L. *Cabinetmaking*. Bennett, 1967. $13.28 (684.08)

Feirer, John L. *Industrial Arts Woodworking*. Bennett, 1965. $5.60 (684.08)

Feirer, John L. *Woodworking for Industry*. Bennett, 1963. $7.88 (684.08)

Fryklund, Vern C., and Armand J. LaBerge. *General Shop Woodworking*. McKnight, 1965. $5.60 (684.08)

Gerbracht, Carl, and Frank E. Robinson. *Understanding America's Industries*. McKnight, 1962. $5.60 (601)

Gilbert, Harold G. *Children Study American Industry*. Wm. C. Brown, 1966. Paper, $3.95 (601)

Goodban, William T., and Jack J. Hayslett. *Architectural Drawing and Planning*. McGraw-Hill, 1965. $6.50 (744.4)

Groneman, Chris H. *General Woodworking*. 4th ed. McGraw-Hill, 1968. $5.80 (684.08)

Groneman, Chris H., and Everett R. Glazener. *Technical Woodworking*. McGraw-Hill, 1966. $6.96 (684.08)

Hammond, James J., and others. *Woodworking Technology*. Rev. ed. McKnight, 1961. $7.20; study guide, $2.20 (684.08)

Hepler, Donald E., and P. I. Wallach. *Architecture: Drafting and Design*. McGraw-Hill, 1965. $6.40 (744.4)

Holtrop, William F., and Herman Hjorth. *Modern Machine Woodworking*. Bruce Wis., 1960. $5.00 (684.08)

Hornung, William J. *Architectural Drafting*. 4th ed. Prentice-Hall, 1966. $9.12 (744.4)

Lindbeck, John R. *Design Textbook*. McKnight, 1963. $5.60 (745.2)

Lindberg, Roy A. *Processes and Materials of Manufacture*. Allyn and Bacon, 1964. $15.95; text. ed., $11.95 (670)

Madden, Ira C. *Woodworking for Industrial Arts*. Goodheart-Willcox, 1962. $4.00 (684.08)

Mix, Floyd M., and Ernest H. Circu. *Practical Carpentry*. Goodheart-Willcox, 1963. $5.00 (694)

Muller, Edward J. *Architectural Drawing and Light Construction*. Prentice-Hall, 1967. $10.95 (744.4)

Newell, Adnah C. *Coloring, Finishing, and Painting Wood*. Bennett, 1961. $7.48 (698.1)

Olson, Delmar W. *Industrial Arts and Technology*. Prentice-Hall, 1963. $7.95 (601)

Olson, Delmar W. *Woods and Woodworking for Industrial Arts*. 2nd ed. Prentice-Hall, 1964. $6.48 (684.08)

Smith, Robert E. *Machine Woodworking*. McKnight, 1958. $4.60 (684.08)

Smith, Robert E. *Patternmaking and Founding*. McKnight, 1959. Paper, $2.00 (671)

Soderberg, George A. *Finishing Materials and Methods*. McKnight, 1959. $5.60 (684.1)

Spence, William P. *Architecture: Design, Engineering, Drawing*. McKnight, 1967. $9.80 (744.4)

Tierney, William F. *Modern Upholstering Methods*. McKnight, 1965. $6.40 (684.1)

Townsend, Gilbert, and Ralph J. Dalzell. *How To Plan a House*. 3rd ed. American Technical Society, 1958. $7.65 (690.8)

U.S. Department of Agriculture, Forest Products Laboratory. *Wood Handbook No. 72*. No. A1.76:72. 1955. $2.25 Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

U.S. Department of Agriculture, Forest Service. *Wood Frame House Construction*. No. A1.76:73. 1955. 65¢ Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Wagner, Willis H. *Modern Woodworking*. Goodheart-Willcox, 1967. $6.96 (684.08)

Wagner, Willis H. *Woodworking*. Goodheart-Willcox, 1964. $2.35 (684.08)

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Sources for Instructional Materials

Adjustable Clamp Company
"The Clamp Folks"
417 North Ashland Drive
Chicago, Illinois 60622
catalog

American Forest Products Industries, Inc.
1816 N Street N.W.
Washington, D.C. 20036
pamphlets, wall charts, teacher's manual, films

American Institute of Timber Construction
1787 K Street N.W.
Washington, D.C. 20036
pamphlets

American Ladder Institute
Tower Suite
666 Lake Shore Drive
Chicago, Illinois 60611
pamphlets

American Paper and Pulp Association
122 East 42nd Street
New York, New York 10017
pamphlets, wall charts, films

American Paper Institute
260 Madison Avenue
New York, New York 10016
pamphlets, wall charts, films

American Plywood Association
Information Services Division
1119 A Street
Tacoma, Washington 98401
pamphlets, films

American Wood Preservers Institute
2600 Virginia Avenue N.W.
Washington, D.C. 20037
pamphlets

Anderson Corporation
Bayport, Minnesota 55003
pamphlets

Appalachian Hardwood Manufacturers, Inc.
414 Walnut Street
Cincinnati, Ohio 45202
pamphlets

Architectural Woodwork Institute
1808 West End Building
Nashville, Tennessee 37203
pamphlets

Behr-Manning Company
Department 1220
10th Avenue and 27th Street
Watervliet, New York 12189
pamphlets, films

Black and Decker Manufacturing Company
East Pennsylvania Avenue
Towson, Maryland 21204
pamphlets, books

Borden Chemical Company
Division of the Borden Company
350 Madison Avenue
New York, New York 10017
pamphlets

Brewster, Inc.
Old Lyme, Connecticut 06371
pamphlets

British Columbia Lumber Manufacturers Association
1477 West Pender Street
Vancouver 5, British Columbia, Canada
pamphlets

Brodhead-Garrett Company
4560 East 71th Street
Cleveland, Ohio 44105
catalog

California Redwood Association
617 Montgomery Street
San Francisco, California 94111
pamphlets, films

Carborundum Company
2475 Walden Avenue
Buffalo, New York 14225
pamphlets, sandpaper samples, charts

Champion Pneumatic Machinery Company, Inc.
825 North Pleasant Street
Princeton, Illinois 61356
pamphlets

Clover Manufacturing Company
P.O. Box 228
Norwalk, Connecticut 06852
pamphlets

Columbian Vise and Manufacturing Company
9021 Bessemer Avenue
Cleveland, Ohio 44104
pamphlets, catalog

Albert Constantive and Son, Inc.
2050 Eastchester Road
Bronx, New York 10461
catalog

Conwed Corporation
2200 Highcrest Road
St. Paul, Minnesota 55113
pamphlets

Craftsman Wood Service Company
2727 South Mary Street
Chicago, Illinois 60608
catalog

G. P. Derickson Company
1100 Linden Avenue
Minneapolis, Minnesota 55403
catalog

DeVilbiss Company
268 Phillips Avenue
Toledo, Ohio 43601
pamphlets, films

3683

"Dowl-It" Company
515 North Hanover Street
Hastings, Michigan 49058
pamphlets

Educational Lumber Company, Inc.
P.O. Box 5373
Asheville, North Carolina 28803
catalog

Fine Hardwoods Association
666 Lake Shore Drive
Chicago, Illinois 60611
pamphlets

T. A. Foley Lumber Company, Inc.
P.O. Box 336
Paris, Illinois 61944
catalog

Ford Motor Company
American Road
Dearborn, Michigan 48127
pamphlets

Forest Products Laboratory
P.O. Box 5130
Madison, Wisconsin 53705
pamphlets, books, films

Forest Products Promotion Council
Wood Promotional Materials
5454 Wisconsin Avenue
Chevy Chase, Maryland 20015
pamphlets

Franklin Glue Company
Industrial Adhesives
2020 Bruck Street
Columbus, Ohio 43207
pamphlets, manuals

H. B. Fuller Company
2267 Como Avenue
St. Paul, Minnesota 55108
pamphlets

General Finishes Sales and Services Company
1580 South 81st Street
Milwaukee, Wisconsin 53214
pamphlets, manual

General Motors Corporation
General Motors Building
Detroit, Michigan 48202
pamphlets

Georgia-Pacific Corporation
3101 Hennepin Avenue East
Minneapolis, Minnesota 55413
pamphlets

Gilbert and Miller, Inc.
404 4th Avenue
New York, New York 10016
catalog

Gizco
P.O. Box 1103
Perry Annex
Whittier, California 90605
pamphlets

Greenlee Tool Company
Division of Greenlee Brothers and Company
2136 12th Street
Rockford, Illinois 60010
pamphlets, catalogs, handbook

P. R. L. Hardenbergh
8th and Wacouta Street
St. Paul, Minnesota 55101
catalog

Hardwood Plywood Manufacturers Association
P.O. Box 6246
Arlington, Virginia 22206
pamphlets, films

Industrial Lumber and Plywood
4100 Washington Avenue North
Minneapolis, Minnesota 55412
pamphlets, catalog

Insulation Board Institute
111 West Washington Street
Chicago, Illinois 60602
pamphlets, films

Irwin Auger Bit Company
Wilmington, Ohio 45177
pamphlets

McCloskey Varnish Company
7600 State Road
Philadelphia, Pennsylvania 19136
pamphlets

Maple Flooring Manufacturers Association
424 Washington Avenue
Oshkosh, Wisconsin 54901
pamphlets

Merit Abrasive Products, Inc.
5515 West 104th Street
Los Angeles, California 90009
catalog

Midwest Shop Supplies
521 5th Street
Sioux City, Iowa 51101
catalog

Millers Falls Company
Greenfield, Massachusetts 01301
catalog

Minnesota Mining and Manufacturing Company
Printed Products Division
3M Center
Building 235 — D142
St. Paul, Minnesota 55101
pamphlets, reference manual

3684

Minnesota Paints, Inc.
1101 South 3rd Street
Minneapolis, Minnesota 55415
pamphlets

Minnesota Woodworkers Supply Company
925 Winnetka Avenue North
Minneapolis, Minnesota 55427
catalog

Minwax Company, Inc.
72 Oak Street
Delawanna, New Jersey 07014
pamphlets

Frank Mittermeier, Inc.
3577 East Tremont Avenue
New York, New York 10465
catalog

National Association of Furniture Manufacturers
666 Lake Shore Drive
Chicago, Illinois 60611
pamphlets

National Forest Products Association
1619 Massachusetts Avenue N.W.
Washington, D.C. 20036
pamphlets, manual

National Hardwood Lumber Association
59 East Van Buren Street
Chicago, Illinois 60605
pamphlets

National Oak Flooring Manufacturers Association
814 Sterick Building
8 North 3rd Street
Memphis, Tennessee 38103
pamphlets, manual

National Paint, Varnish, and Lacquer Association
1500 Rhode Island Avenue N.W.
Washington, D.C. 20005
pamphlets

National Particleboard Association
711 14th Street N.W.
Washington, D.C. 20005
pamphlets, manual

National Sash and Door Jobbers Association
20 North Wacker Drive
Chicago, Illinois 60606
pamphlets

National Woodwork Manufacturers Association
400 West Madison Street
Chicago, Illinois 60606
pamphlets

Nelson and Jacobson, Inc.
3546-48 North Clark Street
Chicago, Illinois 60657
pamphlets

Nicholson File Company
Providence, Rhode Island 02904
pamphlets

Northfield Foundry and Machine Company
Northfield, Minnesota 55057
catalog

Northwest Paper Company
Subsidiary of Potlatch Forests, Inc.
Foshay Tower
Minneapolis, Minnesota 55402
pamphlets

Ohio Blow Pipe Company
1727 Doan Avenue
Cleveland, Ohio 44112
pamphlets

Oliver Machinery Company
450 6th Street N.W.
Grand Rapids, Michigan 49502
pamphlets

Parks Woodworking Machine Company
1546 Knowlton Street
Cincinnati, Ohio 45223
pamphlets

Paxton Equipment and Supply
7401 South Pulaski Road
Chicago, Illinois 60629
pamphlets, catalog

Frank Paxton Lumber Company
P.O. Box 683
Des Moines, Iowa 50303
catalog

Peerless Saw Company
571 South 3rd Street
Columbus, Ohio 43215
pamphlets, catalog

G. C. Peterson Machinery Company
117 Washington Avenue North
Minneapolis, Minnesota 55401
catalog

Philippine Mahogany Association, Inc.
P.O. Box 279
South Pasadena, California 91030
pamphlets

Pines International Chemical Company, Inc.
3140 South Canal Street
Chicago, Illinois 60616
catalog

Fayette R. Plumb Company
4837 James Street
Philadelphia, Pennsylvania 19137
catalog

Ponderosa Pine Woodwork
39 South LaSalle Street
Chicago, Illinois 60603
pamphlets

H. K. Porter Company, Inc.
Hardware and Industrial Products Division
Porter Building
Pittsburgh, Pennsylvania 15219
manual

3685

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Powermatic, Inc.
Route 3
McMinnville, Tennessee 37111
catalog, manuals

Proto Tool Company
2202 Santa Fe Avenue
Los Angeles, California 90054
catalog

Red Cedar Shingle and Handsplit Shake Bureau
5510 White Building
Seattle, Washington 98101
pamphlets

Rez Wood-Tones, Inc.
P.O. Box 142
Springdale, Pennsylvania 15144
pamphlets

Rockwell Manufacturing Company
Delta Power Tool Division
Rockwell Building
400 North Lexington Avenue
Pittsburgh, Pennsylvania 15208
pamphlets, charts, books, films, tape cartridges

Rutland Tool and Supply Company, Inc.
5th and Washington
Montebello, California 90640
catalog

Satterlee Company
2200 East Franklin Avenue
Minneapolis, Minnesota 55404
catalog

Sellstrom Manufacturing Company
Highway 53 at U.S. 14
Palatine, Illinois 60067
pamphlets, catalog

Simonds Saw and Steel Company
470 Main Street
Fitchburg, Massachusetts 01420
pamphlets, catalog, films

Simpson Timber Company
2604 East Devon Avenue
Des Plaines, Illinois 60018
pamphlets

Society of American Foresters
1010 16th Street N.W.
Washington, D.C. 20036
pamphlets

Southern Hardwood Lumber Manufacturers Association
805 Sterick Building
8 North 3rd Street
Memphis, Tennessee 38103
pamphlets

Southern Pine Association
P.O. Box 52468
New Orleans, Louisiana 70150
pamphlets, films

L. Stahl Manufacturers
3166 Wadsworth
Saginaw, Michigan 48601
pamphlets

Stanley Tools
Division of Stanley Works
600 Myrtle Street
New Britain, Connecticut 06050
pamphlets, wall charts, catalogs

Superior Fibre Products, Inc.
North 5th and Bayfront
Superior, Wisconsin 55802
pamphlets

George S. Thompson Corporation
727 South 9th Avenue
City of Industry, California 91747
pamphlets

Timesavers Sanders, Inc.
5270 Hanson Court
Minneapolis, Minnesota 55422
pamphlets

Torit Corporation
1133 Rankin Street
St. Paul, Minnesota 55116
pamphlets

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
For outline of available material, request Price List No. 72 (Homes and Construction) or Price List No. 43 (Forestry).

United States Plywood Corporation
2305 Superior Avenue
Kalamazoo, Michigan 49003
pamphlets

Upholstery Supply Company
12530 West Burleigh Road
Brookfield, Wisconsin 53005
catalog

J. D. Wallace
Division of the Union Tool Corporation
800 North Detroit Street
Warsaw, Indiana 46580
pamphlets

Western Wood Products Association
700 Yeon Building
Portland, Oregon 97204
pamphlets, manual, charts

Wetzler Clamp Company, Inc.
4315 11th Street
Long Island, New York 11101
pamphlets

Weyerhauser Company
Tacoma Building
Tacoma, Washington 98402
pamphlets

3686

Wilson-Imperial Company
115 Chestnut Street
Newark, New Jersey 07105
pamphlets

Wilton Tool
Division of Wilton Corporation
9525 Irving Park Road
Schiller Park, Illinois 60176
catalog

Wood Conversion Company
First National Bank Building
St. Paul, Minnesota 55101
pamphlets

Youngblood Lumber Company
1335 Central Avenue
Minneapolis, Minnesota 55413
catalog

Sources for Films

American Forest Products Industries, Inc.
1816 N Street N.W.
Washington, D.C. 20036
From Trees to Lumber
From Trees to Paper
It's a Tree Country

American Paper and Pulp Association
122 East 42nd Street
New York, New York 10017
Your Career in the Paper Industry

American Plywood Association
1119 A Street
Tacoma, Washington 98401
Design vs. Nature's Violence
Miracle in Wood

Thomas J. Barbre Productions, Inc.
Library Division
2130 South Bellaire Street
Denver, Colorado 80222
More Profits for Builders

Bay State Film Productions, Inc.
Box 129
Springfield, Massachusetts 01001
Tomorrow's Abrasive Tools Today

Behr-Manning Company
Sales Promotion Department
10th Avenue and 27th Street
Watervliet, New York 12189
Mechanized Woodsanding

Bemis Brothers Bag Company
604 South 4th Street
Minneapolis, Minnesota 55415
50,000 Windows

Bird and Son, Inc.
East Walpole, Massachusetts 02032
Bird Building Materials

Bowaters Southern Paper Corporation
Calhoun, Tennessee 37309
In Black and White
Harvest of the Forest

Brett-Guard Corporation
162 Woodbine
Englewood, New Jersey 07621
New Approach to Saw Guarding Safety

E. L. Bruce Company, Inc.
Ad Department
Box 397
Memphis, Tennessee 38101
Floors with a Future

California Redwood Association
617 Montgomery Street
San Francisco, California 94111
Architecture West
The Climate of Architecture
The Forever Living Forests
The Japanese Carpenter
The New Architecture

Chicago Tribune
Motion Picture Bureau
33 West Madison Street
Chicago, Illinois 60602
Trees to Tribunes

Consulate General of Canada
Film Library
310 South Michigan Avenue
Chicago, Illinois 60604
The Charging Forest
The Colour of Life

Consulate General of Japan
Ideal Pictures, Inc.
417 North State Street
Chicago, Illinois 60610
The Architecture of Japan

Coronet Films
65 East South Water Street
Chicago, Illinois 60601
Paper and Pulp Making
Paper Making

Daily Tribune
P.O. Box 311
Royal Oak, Michigan 48068
Out of the Woods

DeVilbiss Company
300 Phillips Avenue
Toledo, Ohio 43601
Airless Spray — A Modern Application Method
An Up-To-Date Appraisal of Conventional and Hot Spray Painting Methods
Glass Fibre Spray-Up Method
Making the Most of the Spray Painting Method

3687

Dow Chemical Company
Audio Visual Center
Film Library
Abbott Road Building
Midland, Michigan 48640
Treat Wood Right

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue
Chicago, Illinois 60611
Paper

Region Nine Forest Service Headquarters
710 North 6th Street
Milwaukee, Wisconsin 53203
A Piece of Wood

General Motors Corporation
Public Relations Staff
Film Library
General Motors Building
Detroit, Michigan 48202
ABC of Hand Tools

P. H. Glatfelter Company
Spring Grove, Pennsylvania 17362
The Power of Paper

Hammermill Paper Company
1442 East Lake Road
Erie, Pennsylvania 16512
Great White Trackway

Huych Felt Company
Rensselaer, New York 12144
Paper: Pacemaker of Progress
Paper's Magic Carpet

Idaho Department of Commerce and Development
Film Library — Room 108
State Capitol Building
Boise, Idaho 83702
An Idaho Sawmill
Idaho Saw Timber
Potlatch Story

Insulation Board Institute
111 West Washington Street
Chicago, Illinois 60602
Big Noise About the Quiet House
This — Above All

International Harvester Company
180 North Michigan Avenue
Chicago, Illinois 60601
Packaged Power for Pulpwood Production

International Paper Company
220 East 42nd Street
New York, New York 10017
Paper in the Making

Jam Handy Organization
Film Distribution Department
2821 East Grand Boulevard
Detroit, Michigan 48211
American Look

E. D. Jones Corporation
Pittsfield, Massachusetts 01201
Papermaking in China

Maynard Research Council, Inc.
718 Wallace Avenue
Pittsburgh, Pennsylvania 15212
Materials Handling Methods
Profit Through Industrial Design

McGraw-Hill Book Company, Inc.
330 West 42nd Street
New York, New York 10036
Paper in the Round

McMillan, Bloedel and Powell River, Ltd.
1199 West Pender Street
Vancouver 1, British Columbia, Canada
Powell River Story

Modern Talking Picture Service
1212 Avenue of the Americas
New York, New York 10036
Patterns of Time — The Hardwood Story

Modern Talking Picture Service
9129 Lyndale Avenue South
Minneapolis, Minnesota 55420
Time of Change
Windowalls from the Friendly Valley

National Film Board of Canada
680 5th Avenue
New York, New York 10019
Log Drive

National Lumber Manufacturers Association
7710 Computer Avenue
Minneapolis, Minnesota 55424
Comparative Fire Test on Timber and Steel Beams
Unicom Method of House Construction

Norton Company
Advertising Department
50 New Bond Street
Worcester, Massachusetts 01606
Old as the Hills

Osmose Wood Preserving Company of America, Inc.
980 Elliott Street
Buffalo, New York 14209
The Wonder Wood

Peninsular Paper Company
Ypsilanti, Michigan 48197
The Color Mill

Princeton Television Center, Inc.
Distribution Department
Princeton, New Jersey 08540
Journey of a Tree

Rockwell Manufacturing Company
Delta Power Tool Division
400 North Lexington Avenue
Pittsburgh, Pennsylvania 15208
Rockwell-Delta Uniplane

3688

Simonds Saw and Steel Company
3323 West Addison Street
Chicago, Illinois 60618
Machine Knives and Industry

Southern Pine Association
Box 52468
New Orleans, Louisiana 70150
New Dimensions of Design

Southern Pulpwood Conservation Association
Film Service Laboratories, Inc.
Jefferson Road
Athens, Georgia 30601
Birth of a Southern Pine

L. S. Starrett Company
Educational Division
121 Crescent Street
Athal, Massachusetts 01331
The Tools and Rules of Precision Measuring

Extension Department
State University College of Forestry
Syracuse University
Syracuse, New York 13210
From Wood Fibers to Paper

U.S. Industries, Inc.
Production Machine Division
Advertising Department
6499 West 65th Street
Chicago, Illinois 60638
Modular Automation

U.S. Plywood Corporation
Sales Promotion Department
777 3rd Avenue
New York, New York 10017
The Algoma Story
Feel the Difference
The Story of the Weldwood House
Wood Wonders with Weldwood

University of Idaho
Audio Visual Center
Moscow, Idaho 83843
An American Sawmill
Sawtimber

Vermiculite Institute
208 LaSalle Street
Chicago, Illinois 60604
It's All in the Wall
Savings in the Attic

Weyerhauser Company
Tacoma Building
Tacoma, Washington 98402
Tomorrow's Trees

3689

METALS TECHNOLOGY

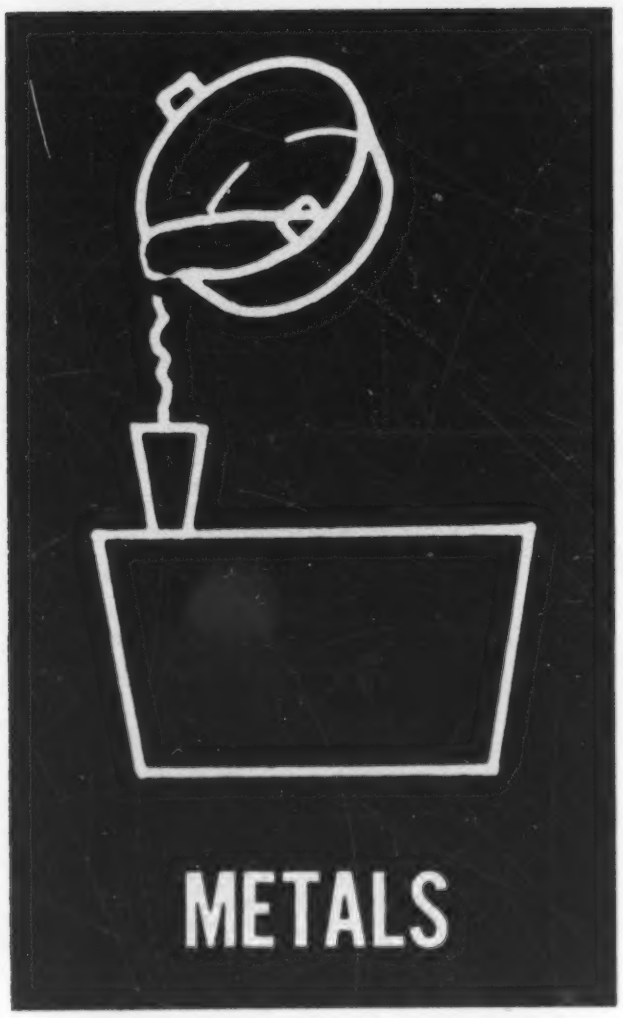

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INTRODUCTION

The study of the metals industry provides an ideal setting for several of the newer methodological approaches such as problem solving, research and experimentation, and creativity-design. This resource guide has been formulated toward a student-oriented process in teaching. Typical in this approach are the following steps:

1. Teacher presents the stated problem for design.

2. Student designs project within the framework of the stated problem.

3. Teacher demonstrates possible stock, machines, and hand tools available for project construction.

4. Teacher presents several methods of fabrication and finishing.

5. Student experiments with various possibilities and is guided in research methods.

6. Student selects from total possibilities in planning his project and construction procedures.

Group work may be introduced in any or all of the steps listed. The student-oriented approach may be directed to all levels of student activity. Teachers are encouraged to plan and utilize new procedures in this approach which keeps in mind the fact that students learn according to what they conceive as meeting their goals.

3692

METALS IDENTIFICATION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Students may experiment with metals, answering questions on provided research sheet.	Basic differences such as degree of hardness, color, and aesthetic appeal of the metals.	A motivating interest in metal characteristics.
Identify metals by shape, chemical classification, method of forming, and size.	Some of the identifying characteristics of metals as they are classified.	An appreciation of the great number of types of metals available.
Evaluate the need for using different metals in different situations, such as nonferrous for outdoor furniture or ferrous for tools.	The broad use of metals in industrial society.	An interest in the many possibilities for adapting metals to common use.
Match lists of projects and metals with explanations for choice.	The need for correlating metal to individual projects.	An insight into the selection of stock for individual characteristics.

3693

METALS IDENTIFICATION

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Present class with samples of the metal varieties available to them. Encourage examination. (It is advisable at this point to introduce a checksheet of characteristics to watch for in metals.)	
Explain the need for classifying metals. Have students suggest reasons.	
Discuss industrial applications by having students make suggestions. Groups may compete by listing metal products used in the house.	
Review the correlation of metal types to products. Have students use the list of metal products and match each product to a possible metal, giving an explanation of the reasons for use.	

3694

COST AND PRICE COMPUTATIONS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Correctly fill out checks and maintain accurate bookkeeping.	The basic principles of finance and record keeping.	A motivating interest in the economic aspects of class materials.
Suggest ways in which product cost can be ascertained by including such factors as materials, labors, and average market.	The breakdown of product cost according to marketing and manufacturing investments.	Recognition of the need for an accurate procedure in cost evaluation.
Follow mathematical procedures for figuring cost of project; then fill out check for cost.	The application of arithmetical calculations in an actual selling-buying context.	An attitude of careful figuring in mathematical computations.

3695

COST AND PRICE COMPUTATIONS

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Present each student with a duplicated sheet of simulated checks with a claimed account of approximately ten dollars and describe the use of checks.	
Have students make an estimated bid on a small, class-constructed project and fill out a check for same. Discuss the wide variation of estimates and the need for better accuracy.	
Instruct students in price-cost calculations (square and lineal footage multiplied by price and number of pieces).	

3696

SHEET METAL FASTENING METHODS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Research in historical methods.	Historical development of fabrication procedures. The basic methods of joining sheet metal.	An apprecation of man's innovation in fabrication.
Participate in group discussion of desired qualities in joining sheet metal.	Basic procedures in joining.	Understanding of the concepts of design as applied to joining sheet stock.
	Industrial methods of joining stock.	A knowledge of the demands of production upon joining techniques.
Design and operate testing facilities. Make a strength-comparative study presentation.	Relation of the following: 1. Kind and size of rivets to strength 2. Variation of time to pressure on spot welding 3. Design of seams to strength and ability to hold liquids	Pride in one's own testing procedures. An awareness of direct procedures necessary for presentation of factual material.
Apply knowledge gained to the needs in construction procedures for individual projects.	The basic principles of sheet metal fabrication.	An application of orderly procedures in selection of construction steps.

3697

SHEET METAL FASTENING METHODS

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Introduce the problem. Students offer possible methods for joining of sheet stock. Trace the history of fastening from hand rivets to pop rivets and from soldering to spot welding. (Soldering will require a separate lesson.)	
Present examples of common types of demonstrations. Discuss use in relation to design, strength, and degree of difficulty. Students may discuss qualities they feel are pleasing in design of joining methods.	
Show film on modern industrial fabrication. (Range of films available varies from bridge riveting to automobile spot welding.)	
Lead discussion on possible testing procedures for experimenting in areas of fabrication strength. (Students may design and build their own testing facilities.)	
Guide students in selection of method best suited to their project design.	

3698

ARC WELDING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The concept of current passing through the resistance of air to form an arc.	A motivating interest in the basis for arc welding.
Sketch a basic schematic of an arc welding process.	The use of metal to be welded as positive and negative terminals through which current will pass.	An insight into basic electric welding concepts.
Name and describe parts and functions of welder.	The use of proper equipment such as helmets, glasses, and shields.	A respect for the safety procedures necessary.
Demonstrate in a "dry run" the ability to correctly set up welder.	Proper arc welding procedure and the method's potential for project fabrication.	Application of scientific developments in the welding field.
Make a horizontal bead.	Heat dispersion on nonferrous stock.	Difficulties encountered by the introduction of "exotic" metals. (This includes contamination, heat, and finishing.)
	Welding with a permanent electrode (TIG).	
	Protecting the weld from atmospheric contamination (TIG and MIG) by use of inert gas.	

3699

ARC WELDING

IMPLEMENTATION SUGGESTIONS

Demonstrate an arc by sparking hot wires from a 6- or 12-volt supply. Encourage discussion as to what is occurring.

Discuss the heat generated by the resistance and have students suggest methods of using it for joining metals.

Introduce a filmstrip or sketch of the arc welder and its necessary components, emphasizing safety precautions.

Discuss basic procedure, electrode size, amperage settings, slant of rod, zig-zag method, and arc distance.

Have individual demonstrations and guidance on procedure.

Present information on gas-shielded (MIG), tungsten inert-gas (TIG), and electron beam (EB) welding.

INSTRUCTOR'S NOTES

Reference Books

Walker, John R. *Modern Metalworking*. Goodheart-Willcox, 1965. $6.96 (671)

Giachino, J. W., and others. *Welding Skills and Practices*. 3rd ed. American Technical Society, 1967. $5.50; study guide, $1.50 (671)

3700

GAS WELDING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The need for close observation during demonstrations.	A stimulating interest in observing correct set-up steps in welding.
	The dangers involved in not following correct welding procedure.	A safety-conscious attitude toward welding.
Follow a step-by-step process in setting up the gas welder.	A knowledge of the welder parts and functions of them.	
Demonstrate ability to turn on, adjust, light the torch, and turn off the unit while naming each part and explaining procedure.		An enlarged vocabulary and an interest in the functions of each component.

3701

GAS WELDING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Motivate class interest through use of demonstration. Class should be instructed to watch carefully in order to write a step-by-step procedure from observations.	
Have class compare their lists of welding procedure. Stress the need for exact steps in setup.	
Demonstrate once more, having students list correct steps as they are being performed. Specify accuracy in naming of parts and purpose of each.	
Evaluate each student's setup ability individually.	

3702

HAND TOOLS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Match names and tools that are familiar.	That new experiences will be based upon the foundation already possessed.	A stimulating interest in the tools that will be used.
Correctly list and name all of the tools needed.	A basic knowledge of the use of tools.	
Students apply their knowledge of tools to actual operations.		An attitude of respect for tools and their functions.
Clean and preserve tools in the correct manner.	The correlation between accuracy and well-cared-for tools.	A proper regard for conscientious tool use.

3703

HAND TOOLS

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Evaluate students' experiences with hand tools by having a paper test with pictures of tools that are to be matched with their names. Allow space for a description of each tool's use.	
Students will check their own results during demonstration of use of each hand tool. Notes should be taken on functions.	
Have students make suggestions as to which tool they would use on various operations of their projects.	
Discuss care and safe use of tools.	

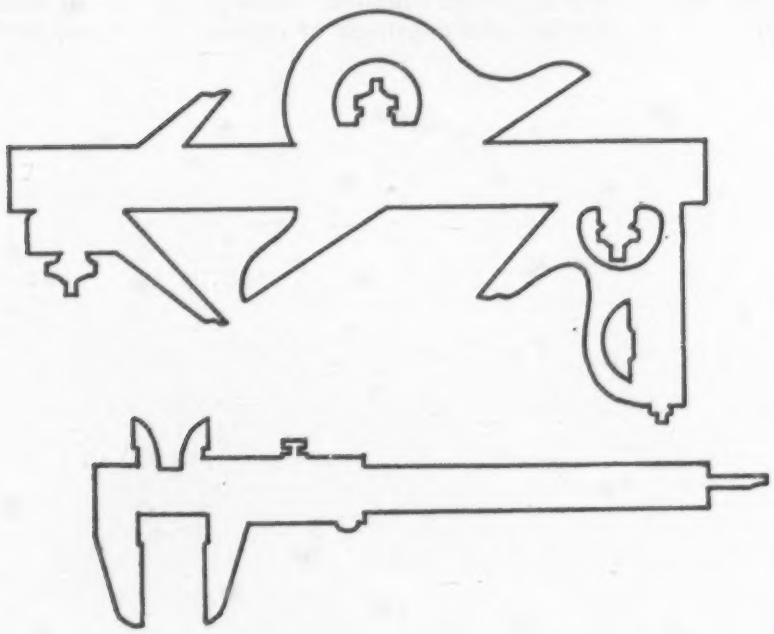

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HAND-OPERATED MACHINES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Perceive and name many of the machine operations by listing them after examining projects.	Some of the many machine operations available.	A motivating appreciation of the time- and labor-saving devices designed in industrial society.
	The basic machine differences by name and operations.	An insight into the many potential operations from which a project may be chosen.
Know the machines by name and function.	The correlation of machine possibilities to project needs.	A stimulated interest in machine operation by comparison of lists of possible machine operations.
Analyze and suggest safety rules for each machine.	Potentially hazardous aspects of each machine.	A respect for the correct and safe operational procedures of machines.
Do correct machine operations. Perform with care and accuracy.	The correlation between machine operation and exactness of layout.	A knowledgeable basis for expanding project designs.

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3705

HAND-OPERATED MACHINES

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Allow students to examine several class-made projects. Discuss the various operations required for construction.	
Tour the shop, naming and discussing briefly each machine available for students' use.	
Have students compare and match lists of operation to machines that will be used.	
Demonstrate each machine, asking for student suggestions on safety rules.	
Allow students to follow (in groups or individually) the list of correlated operations and machines on small assigned projects or scrap pieces in order to become familiar with them.	

3706

THREADING WITH TAPS AND DIES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Organize thoughts to solve a relatively new problem.	That many of the accepted machined parts can be constructed through the use of hand tools.	A motivating interest in handmade threads.
Recognize and label thread sizes.	The size by diameter and threads per inch.	Appreciation of the need for separation of threads by classification.
Correctly choose and apply the threading tools needed for projects.	The hard and brittle characteristics of the threading tools.	An attitude of careful work habits while making threads.

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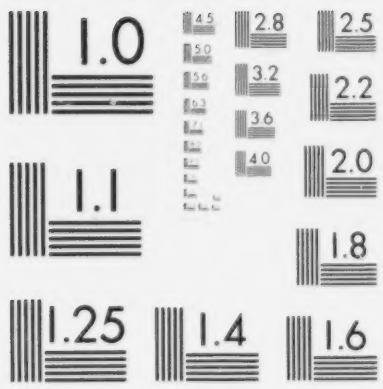

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

THREADING WITH TAPS AND DIES

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Have a large picture of a bolt and nut on the chalkboard or overhead projector and ask students to write briefly their ideas on how these could be made in the shop.	
Discuss with students their suggestions on how to tell one threaded bolt or nut from another.	
Demonstrate the cutting of threads with taps and dies. Emphasize the need for lubrication and freeing of the chip.	
Evaluate students' progress through individual demonstrations.	

C3708

MACHINING OF METAL

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Solve problems. (Student designs tool which will perform the described function.)	Basic principles of design.	Self - reliance, resourcefulness, and imagination.
Learn basic research by experimenting with metal capabilities.	Basic properties of metal. Adapting metal to project needs. Differences in chemical types of metals.	Appreciation of experimentation and research.
	Operations and possibilities of machines.	An understanding of the usefulness of machines in industrial society. Machine safety features.
Do necessary measurements. Do research on types of measuring such as metric, miscroscopic, and light.	Various measuring devices.	Appreciation of accuracy.
Apply previously learned concepts to plan and pattern.	Concepts of drafting, layout, and procedure.	Value of organizing work.
Apply basic skills in the use of machines.	The potentials of the machine.	An active interest in the industry that uses this machine.

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MACHINING OF METAL

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Describe the design problem. (Example: A center punch could be described as a tool which will guide the point of a drill bit.)	
Present and discuss metals that can be machined.	
Give demonstration of a machine's possibilities. (Transparencies, films, texts, and machines can be used.)	
Discussion of measuring devices such as micrometers and calipers.	
Provide guidance for individual students.	

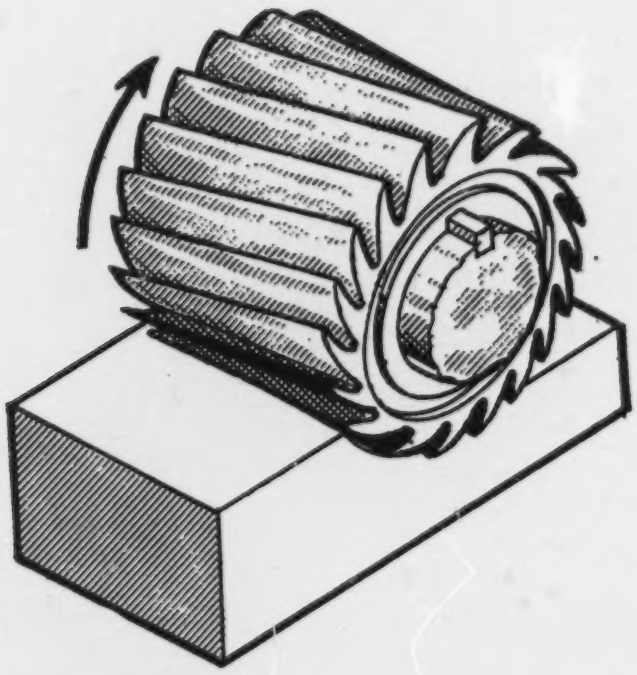

3710

MASS PRODUCTION TECHNIQUES

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Join in class discussion by suggesting methods of improving goods production.	The historical trend of goods production from cottage industry to contemporary methods.	An appreciation of the basic procedures followed in mass goods production.
Design and construct project along class-decided specifications.	The slower "cottage industry" approach to production.	An overview of all the necessary operations of the product to be mass produced.
Plan a flow chart of materials for individual projects with personal assignments to typical job operations.	Use of flow charts and personal assignments in industry.	Appreciation for orderly procedures in industrial production.
Do basic research into areas correlated with the functions of industry.	The complicated facets of production and marketing of goods as the economic basis of our industrial society.	An appreciation for the procedures necessary in production and marketing.

3711

MASS PRODUCTION TECHNIQUES

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Guide students in discussion of suggestions for producing products efficiently. Speed, accuracy, and exchange of duplicate parts would be analyzed.	
Class may decide upon product to be manufactured or choose and change a developed idea.	
Form mock companies with members selected on basis of sociogram. Three companies of approximately eight members each will facilitate competition for speed, accuracy, and other contemporary concepts of marketing and production.	
Guide students in research in the areas of patents, advertising, cybernetics, marketing, and industrial financing.	

3712

HOT METAL FOUNDRY—CASTING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	The progression of metal from the molten stage to the useful end product.	Recognition that castings are fundamental to our economy.
	Importance of the foundry industry.	Size of the industry (over 5,000 foundries located throughout North America).
Temper sand by mixing, testing for crumbling.	Types of sand used.	Importance of safety precautions in relation to properly tempered sand.
Know the various steps in preparation for actual casting.	Tools and procedures for molding.	Proper procedures result in holding to close specifications.
Know the various steps for casting: 1. Melting, checking of temperature, and skimming 2. Skimming of oxides from the top of the melt 3. Pouring a steady stream to prevent flow lines in the casting 4. Cleaning and cutting of sprue and risers 5. Sanding and finishing of casting	Oxidation and reduction gases in relation to the melting points of metals: Metals — F Degrees Solder ..... 400 Pewter ..... 429 Tin ..... 449 Babbitt ..... 462 Lead ..... 621 Zinc ..... 787 Aluminum 1218	Accuracy needed in melt conditions for various metals. The best pouring temperature is usually the lowest that the casting metal can be poured without encountering a mis-run. (Heavy castings should be poured colder than thin, light-walled castings.)
	Negative results occurring because of dross and gas absorption.	Necessity of preventing dross, air, or gas while casting.

3713

HOT METAL FOUNDRY—CASTING

IMPLEMENTATION SUGGESTIONS

In order to emphasize the importance of casting, ask students to name one thing that is not a casting or does not have casting directly responsible for its manufacture.

Casting steps:

1. Tempering sand
2. Molding procedure, using parting board, drag, pattern, parting dust, riddle, ram, strike off bar, cope, sprue and riser pins, molding spoon, vent pin, and finishing trowel
3. Melting of metal and pouring
   a. It is important that any scrap metal used be clean, dry, and grease-free.
   b. Follow furnace instruction for pre-heating before charging. (Usually 10 to 15 minutes.)
   c. Hold crucible close while pouring to maintain a full sprue.

Safety notes:

1. Clothing
   a. Face shield
   b. Wrist-tight asbestos or leather gloves
   c. Heavy apron
   d. Leggings
2. Wash thoroughly after foundry work.
3. Separate foundry area from rest of shop.
4. Keep floor area clean.
5. Have fire extinguisher handy.
6. Flammables and water should be kept out of area.
7. Do not pour on a wooden floor.
8. Check moisture content of sand before pouring.
9. Use extreme caution while removing castings from flasks.
10. Provide adequate ventilation.

INSTRUCTOR'S NOTES

Audio-Visual Materials

American Foundrymen's Society
Golf and Wolf Roads
Des Plaines, Illinois 60016

Malleable Founders' Society
781 Union Commerce Building
925 Euclid Avenue
Cleveland, Ohio 44115
This Moving World

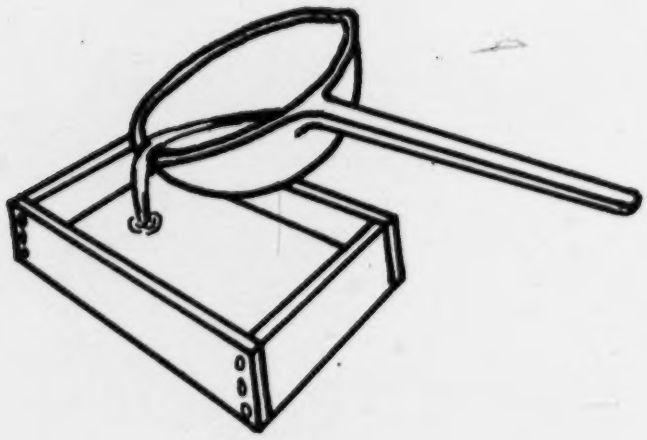

3714

OCCUPATIONS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Demonstrate interview abilities.	Vocational training required.	Early interest in vocations.
Apply understanding of hiring procedures, application techniques, and hierarchical structures within business.	Potential of self for future advancement.	Working conditions such as hazards, special tools, environment, lighting, and air conditioning.
	Wages and salaries.	
Use the school facilities for information on work and occupations.	Special skills or attitudes needed: a. Semiskilled b. Skilled c. Technical d. Professional	Recognition of the relationship of the world of work to society.
	Apprenticeship.	Appreciation of advanced training.

3714 A 88

OCCUPATIONS

IMPLEMENTATION SUGGESTIONS

Cooperate with the guidance department. Suggest class visitation by counselor, parents, and potential employers.

Use recorded interviews on employment such a *A Man's Work*.

Use role-playing for interview techniques.

Discussion Questions

I. What is the world of work? How can you find out about it?

A. Available information

1. *Dictionary of Occupational Titles*
2. *Occupational Outlook Handbook*
3. Occupational files

B. Part-time jobs

C. Personal interviews

1. What purpose do they serve?
2. How are such interviews planned?
3. What questions would you ask?

II. What do you need to know about yourself?

A. Abilities, interests, and special skills

1. Means of measuring
   a. Differential Aptitude Test
   b. Kuder Preference Test
   c. General Aptitude Test Battery
   d. Minnesota Scholastic Aptitude Test
   e. American College Testing
   f. Scholastic Achievement Test
2. Uses of scores

B. Relationship between your record in school and the world of work

1. Grades
2. Attendance
3. Citizenship
4. Extra activities
5. Test results

INSTRUCTOR'S NOTES

Instructional Materials

A Man's Work. 50 records. 100 recorded on-the-scene interviews with men talking about their jobs as they work. Jobs were selected to present a balanced appeal to the average non-college bound male youth. Categories: office and sales occupations; consumer occupations; production occupations; structural occupations; miscellaneous occupations. McGraw-Hill Book Company, 330 West 42nd Street, New York, New York 10036. $258.50

Reference Books

Labor Department, Employment Security Bureau. *Dictionary of Occupational Titles*. Vol. 1, Definitions of Titles. Vol. 2, Occupational Classification and Industry Index. 3rd ed. U.S. Government Printing Office, 1965. Vol. 1, $5.00; Vol. 2, $4.25 (331.703)

Labor Department, Labor Standards Bureau. *Occupational Outlook Handbook*. Published biennially. U.S. Government Printing Office. Paper, $4.25 (371.42)

3714B

REFERENCES

Sources for Audio-Visual Materials

Association Films, Inc.
561 Hillgrove Avenue
La Grange, Illinois 60525
The Challenge
Color and Texture in All Finishes
Following It All of the Way
The Nature of Glass

Elliott Film Company
1114 Nicollet Avenue
Minneapolis, Minnesota 55403
The Common Denominator
Die Casting
Forging in Closed Oils
From Mountains to Microns
The Hough Story
Metallurgy Plus
One Hoe for Kalaboe
Ore from Venezuela
Portrait in Plasters
Precision Tool Making and Machinery
Profile in Steel
The Right Hand of Plenty
This Is Fiberglas
This Is Steel
Wolfsburg
Zinc Controls Corrosion

Ford Motor Company
American Road
Dearborn, Michigan 48127
The Rouge
The World of Henry Ford

General Motors Corporation
Film Library
General Motors Building
Detroit, Michigan 48202
ABC of Hand Tools
ABC of Internal Combustion
ABC of the Automobile Engine
The Miniature Sphere

Graphic Services
Bureau of Mines
4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213
Aluminum, Metal of Many Faces
Asbestos, A Matter of Time
Cast Iron — The Biography of a Metal
Copper, The Oldest Modern Metal
The Drama of Steel
How to Form Aluminum
How to Machine Aluminum
Rubber from Oil
The Oxyacetylene Flame, Master of Metals
A Story of Arc Welding
A Story of Gasoline
A Story of Lead
The Story of Lubricating Oil
The Story of the Modern Storage Battery
This Is Aluminum
Zinc, Its Mining, Milling and Smelting

Swedish Film Center
1780 Broadway
New York, New York 10019
The Bridge

U. S. Steel Corporation
Chicago Film Center
208 South LaSalle Street
Chicago, Illinois 60604
Making, Shaping and Treating Steel
Modern Steel Making
New Neighbor
Research in Steel
Rhapsody of Steel

3715

PLASTICS TECHNOLOGY

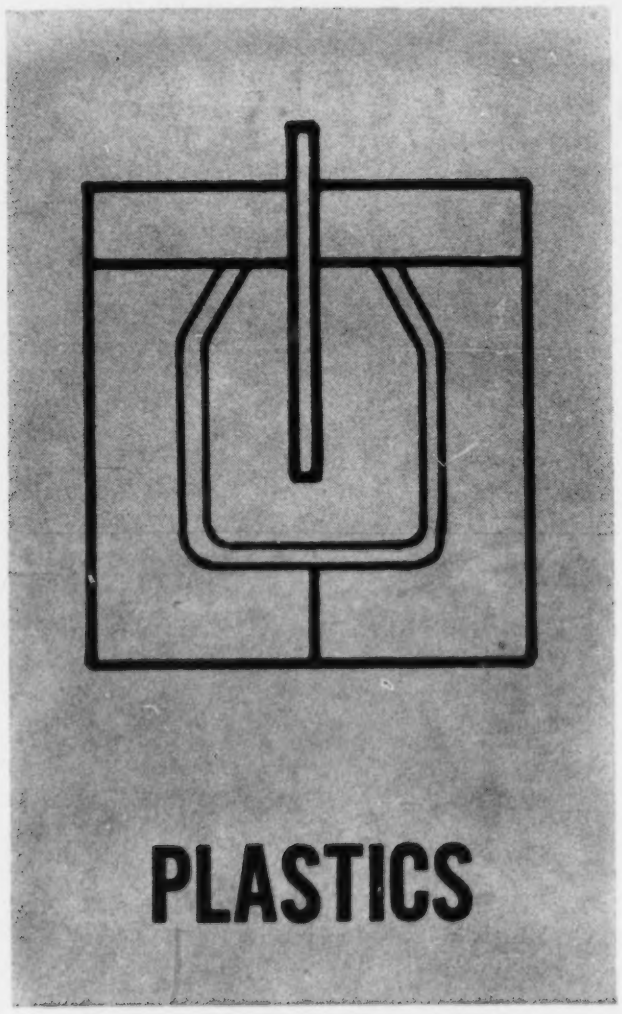

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INTRODUCTION

Modern man lives in a world of plastics, a state of affairs brought about by a materials revolution unprecedented in history. In a little less than forty years, the use of plastics in the United States has increased over a thousandfold. This spectacularly steep curve promises to continue far into the foreseeable future as improved plastics take over more and more of the roles previously assigned to heavier and harder-to-work materials. The size and future potential of this industry dictates representation in the curriculum of any industrial arts program that is based on industry. There can be little doubt that plastics is here to stay and will continue to expand its frontiers into the future.

In using this resource guide on plastics, it is desirable that the teacher select experiences that will be appropriate for the age level and background of the students. No attempt has been made to "pick out" a prescribed set of experiences for a given grade level or to designate a certain period of time for the activity. A wide span of activities and problems are presented to enable the instructor to select those which best meet the needs of the students.

It is strongly recommended that a variety of activities be included in the course of study with emphasis upon the industrial nature of the activity. It is not intended that this curriculum resource material be the "last word" in the field of plastics; rather, it should function as a base upon which the instructor may build.

An essential reference that should be secured for greater implementation of this resource guide is the *Plastics Education Guide* which is available for $2.50 from the Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017. This book contains valuable information concerning equipment, additional references, and films available for the plastics area.

3718

CASTING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Cast various plastic materials.	Properties of various plastic casting materials.	Awareness of the variety of resins available and appreciation of their properties.
Design with casting plastics.	Principles of color and coordination.	Appreciation of color mixing.
Embed or encase with plastic materials.	Effects of various embedding resins on other materials.	Safety attitudes in working with plastic resins.
Construct simple molds for casting embedments.	Various methods of containing plastic resins.	Interest in the recreational possibilities of casting resins.
Cast with elastomers.	Types and characteristics of elastomers.	Awareness of the industrial applications of elastomers.

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3719

CASTING

IMPLEMENTATION SUGGESTIONS

Cast titles.

Embed various materials.

Pot electrical components.

Cast various elastomers in molds.

Fabricate casting molds and clay molds.

Fabricate casting resins by using dish, tin, clay, or cup molds.

Have a class discussion of casting applications for potting electrical components.

Use cast decorative objects for an introduction.

Design a giveaway item that can be produced by mass production procedures.

INSTRUCTOR'S NOTES

Reference Books

Cherry. *General Plastics.*
Swanson. *Plastics Technology: Basic Materials and Processes.*
Gick. *Clear Cast.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*

Instructional Materials

American Handicrafts Company
Industrial Arts Supply Mail Order Company

Audio-Visual Materials

Who in the World Is Swedlow? Film. Swedlow, Inc.
Horizons Unlimited. Film. Epoxylite Corporation.

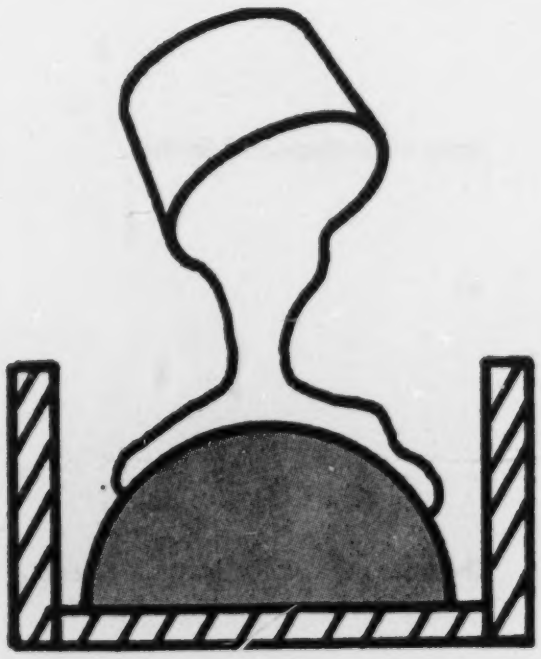

13720

FABRICATION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Sawing, cutting, and shearing.	Methods of shaping and fabricating plastics.	Relationships of plastic fabrication processes to similar processes used for other materials.
Drilling and machining.		Awareness of the fabrication processes used by the plastic industries.
Brake forming, milling, and tapping.		
Blanking and punching.		Discrimination in selection of surface textures.
Sanding, ashing, and polishing.	Methods of polishing. Methods of surface preparation.	Perception in selecting plastic coatings and finishes.
Antistatic coating.	Types of coatings and finishes.	
Foil stamping.		Safe attitudes when handling finishes and solvents.
Finishing and decorating.	Characteristics of finishes and solvents.	

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FABRICATION

IMPLEMENTATION SUGGESTIONS

Apply various fabrication techniques as needed in other areas of plastic processing to complete the product.

Attempt different methods of decorating or finishing plastic products.

Experiment with various surface textures on plastic materials.

Compare in-mold decoration processes with post-mold decoration processes.

INSTRUCTOR'S NOTES

Reference Books

Swanson. *Plastics Technology: Basic Materials and Processes.*
Cherry. *General Plastics.*
DuBois and John. *Plastics.*

Instructional Materials

Society of the Plastics Industry, Inc.
Dow Chemical Company

Audio-Visual Materials

Industrial Processes and Products. Film. Stout State University.
Introduction to Plastics. Filmstrip. KitCo.

3722

REINFORCED PLASTICS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Open-mold processes: 1. Hand lay up 2. Spray up	Nature and structure of reinforced plastics.	Consideration for the interests and needs of others.
Filament winding. Encapsulation. Bag molding.	Types of resins, catalysts, and promoters. Types of reinforcing materials and fillers.	An appreciation of the materials used for reinforced plastics.
Closed-mold processes: 1. Matched die 2 Premix molding	Molding principles and processes.	An awareness of the reinforced plastics industry and its place in general industry.
Injection molding. Continuous lamination.	Necessity of safe procedures for handling and working with reinforced plastic materials.	Safe practices in working with reinforced plastic materials.
Finishing methods: 1. Fastening 2. Bonding 3. Surfacing	Basic design considerations and rules that apply to reinforced plastic structures.	An awareness and appreciation of the vast design potential of reinforced plastic materials.
Test reinforced plastic materials: 1. Resin and glass content 2. Tensile strength 3. Hardness 4. Impact strength	Testing procedures and properties of reinforced plastics.	An awareness of the limitations and expectations of reinforced plastic materials.

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REINFORCED PLASTICS

IMPLEMENTATION SUGGESTIONS

Hand lay up such articles as clipboards, lamp panels, placemats, and trays.

Construct jigs and fixtures for production line work in other areas.

Construct molds for other plastic materials.

Make up a process chart on the production of fiberglass.

Experiment with filament winding.

Close mold with reinforced plastic materials.

Make up test samples using various methods of processing reinforced plastics. Evaluate properties of each sample.

Make up a strength chart on reinforced plastics with various resin-to-glass ratios.

Determine resin and glass content of a small reinforced plastics layup.

Compare impact strength of reinforced plastics with other materials.

Visit a local reinforced plastics industry.

Spray up molds and products with reinforced plastic materials.

INSTRUCTOR'S NOTES

Reference Books

Cherry. *General Plastics.*
Steele. *Fiberglass: Procedures and Processes.*
Swanson. *Plastics Technology: Basic Materials and Processes.*
Society of the Plastics Industry, Inc. *Handbook of Reinforced Plastics of the Society of Plastics Industry.*

Instructional Materials

Society of the Plastics Industry, Inc.
Owens-Corning Fiberglas Corporation
Reinhold Publishing Corporation
McGraw-Hill Book Company
Koppers Company
Pittsburgh Plate Glass Industries
United Merchants and Manufacturers, Inc.
Interchem Corporation

Audio-Visual Materials

This Is Fiberglass. Film. Elliott Film Company.
World of Molded Fiberglass. Film. Molded Fiber Glass Boat Company.
Futures Unlimited. Film. Rohm and Hass Company.
Fabulous Filon. Film. Filon Corporation.
Filament Winding. Film. Ciba Chemical and Dye Company.
Designing with Reinforced Plastics. Filmstrip. Society of the Plastics Industry, Inc.

3724

INJECTION MOLDING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Injection molding with thermoset plastics.	Injection molds for thermoplastics. Product design for injection molding.	An understanding of an industrial method of molding thermoplastics.
Proper handling of molding materials and scrap.	Design capabilities of injection molding. Injection molding materials.	Relationships between heat, pressure, and time and the resultant effect on injection molding.
Injection mold construction.	Types of injection molds.	
Troubleshooting injection molders.	Principles of injection molding.	Basic proficiency in injection molding.
	Safety procedures to be observed when injection molding.	Attitude of safe work performance when injection molding.

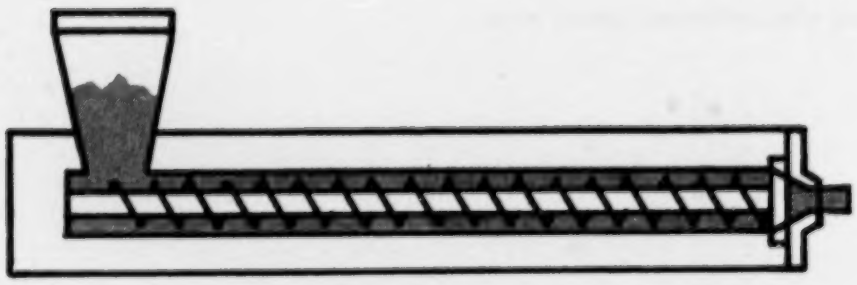

3725

THERMOFORMING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Drape forming.	Types of thermoforming equipment.	An awareness of the thermoforming methods of packaging and fabrication.
Vacuum forming.	Design factors for thermoforming.	An appreciation of the industrial uses of thermoforming.
Free forming.	Thermoforming techniques.	Proficiency in basic thermoforming processes.
Blow forming.		Discrimination in the selection of thermoformed products.
Troubleshooting thermoforming processes.	Properties of materials for thermoforming. Mold design for thermoforming.	Safe working habits while thermoforming.
Thermoforming mold construction.	Types of thermoforming molds.	

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THERMOFORMING

IMPLEMENTATION SUGGESTIONS

Drape form a wall plaque.

Construct a drape-forming mold.

Vacuum form a tackle box.

Experiment with heating methods and devices.

Experiment with various vacuums and pressures.

Experiment with the deep-draw process.

Construct a trimming jig for a vacuum or drape-formed article.

Construct textured molds for forming.

Compare thermoforming with other molding processes.

INSTRUCTOR'S NOTES

Reference Books

Swanson. *Plastics Technology: Basic Materials and Processes.*
Cherry. *General Plastics.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*

Instructional Materials

Comet Industries
Monsanto Company
Dow Chemical Company
General Tire and Rubber Company
Celanese Plastics Company
Mobay Chemical Company

Audio-Visual Materials

The Case of the Fantastic Plastic. Film. Uniroyal, Inc.

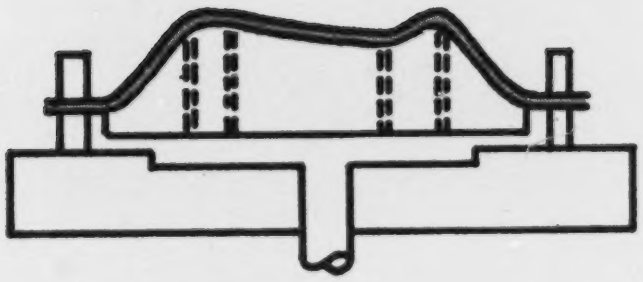

3728

THERMOFUSION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Fluidized-bed coating.	Types of materials used for fluidized-bed coating.	Appreciation of the fluidized-bed coating process.
Rotational molding.	Rotational molding process variables. Principles of rotational molding. Advantages of rotational molding.	Concept of rotational molding and appreciation of industrial applications.
Powder molding.	Industrial methods of processing powdered polyethylene and vinyl dispersions. Designing for powder molding. Factors involved in powder coating with various types of plastics.	Appreciation of industrial methods for processing plastic powder.
Mold plastisols and organisols.	Methods of molding plastisols and organisols. Formulations of plastisols and organisols.	Discrimination in the selection of plastisol and organisol products.
Construct rotational mold.	Design consideration for rotational molds.	Insight into rotational molding design.
Plastisol mold construction.		Basic thermofusion molding skills.

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THERMOFUSION

IMPLEMENTATION SUGGESTIONS

Coat a product using the fluidized-bed coating process.

Rotational mold a plastic product.

Experiment with the design of a rotational molder.

Powder mold a funnel.

Make up a chart on different powder molding processes.

Slush mold an article.

Construct a rotational mold.

Compare costs and mold construction of rotational molding with injection molding.

Test various plastic powders for fluidized-bed coating or rotational molding.

INSTRUCTOR'S NOTES

Reference Books

Cherry. *General Plastics.*
Swanson. *Plastics Technology: Basic Materials and Processes.*
DuBois and John. *Plastics.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*

Instructional Materials

U.S. Industrial Chemicals Company
Chemical Products Corporation
Union Carbide
Phillips Petroleum Company
General Tire and Rubber Company

Audio-Visual Materials

Butyrate Peelable Plastic Packaging. Film. Eastman Chemical Products, Inc.
Of Men and Molecules. Film. B. F. Goodrich Company.

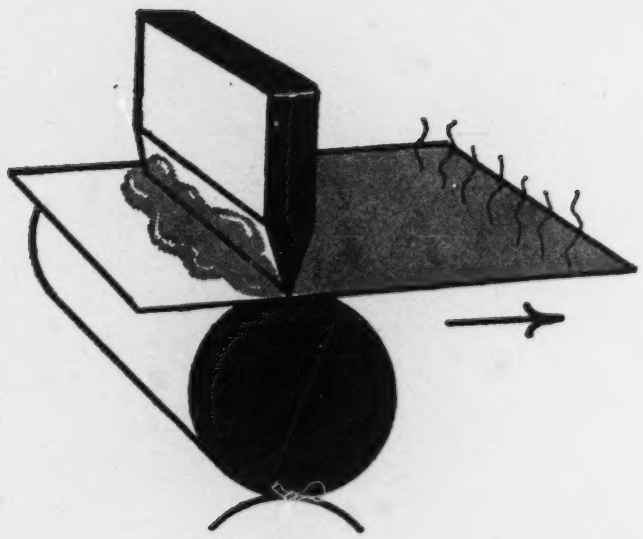

3730

EXTRUSION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Sheet extrusion.	Basic parts and functions of the extruder. Basic processing functions of the extruder.	Appreciation of the industrial methods of plastic extrusion and blow molding.
Extrusion coating.	Essential instruments that control the melt of the extruder.	
Tubular film extrusion.	Auxiliary equipment and accessories used with the extruder.	Insight into extrusion potential through the uses of auxiliary equipment.
Pipe extrusion.	Economic consideration in extruding.	
Maintenance of extrusion and blow molding equipment.	Basic safety rules for extrusion and blow molding.	Safe habits when working with extrusion and blow molding equipment.
Blow molding.	Blow molding methods. Structure of the blowing mold. Blow molding techniques. Characteristics of blow molded products.	Insight into the industrial and consumer applications of extrusions and blow molding.

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EXTRUSION

IMPLEMENTATION SUGGESTIONS

Blow mold an article.

Construct blow mold.

Compare extrusion with injection molding techniques.

Form a parison with an injection molder and blow to shape.

Examine various products made by blow molding.

Compare blow molding, extrusion molding, and injection molding and show how each can be identified.

Extrude various plastic shapes for further product use.

Examine and compare various films made by extrusion.

INSTRUCTOR'S NOTES

Reference Books

Jones and Mullen. *Blow Molding.*
Swanson. *Plastics Technology: Basic Materials and Processes.*
Griff. *Plastics Extrusion Technology.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*
DuBois and Pribble. *Plastic Mold Engineering.*

Instructional Materials

Anchor Plastics
Prodex Corporation
U.S. Industrial Chemicals Company
Celanese Plastics Company

Audio-Visual Materials

Construction and Operation of Plastics Screw Extruders. Film. Waldron-Hartig Company.
Reciprocating Screw Blow Molder. Film. Pennsalt Chemicals Corporation.
What Kind of Pipe Should I Buy? Film. Allied Chemical Corporation.
Extrusion Studies with Transparent Barrels and Dies. Film. E. I. duPont de Nemours and Company, Inc.
Rotablow — Fully Automatic Rotary Blow Molding Machine. Film. Strong Plastics, Inc.

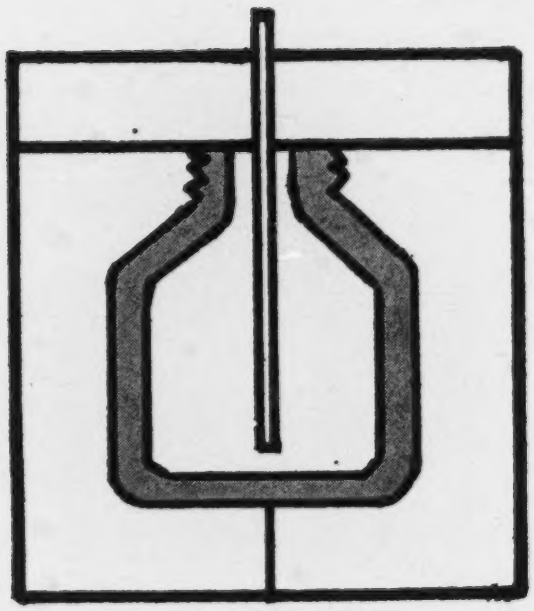

3732

COMPRESSION MOLDING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Compression-mold thermosets.	Types of machines and equipment for compression molding. Types of molding compounds.	A knowledge of the history and importance of compression molding.
Transfer molding.	Advantages of the transfer molding process.	An acquaintance with the materials and equipment used in compression and transfer molding.
Design a compression-molded product.	Characteristics of thermosetting molding compounds.	Relationships of transfer molding to compression and injection molding.
Test compression moldings.	Mechanical and physical properties of molding compounds.	Appreciation of the design limitations and design possibilities of compression and transfer molding methods and materials.
Construct a compression mold.		An acquaintance with the products and occupational opportunities pertaining to this phase of the plastic industry.
	Types of compression molds.	Basic mold construction skills.

3733

COMPRESSION MOLDING

IMPLEMENTATION SUGGESTIONS

Make a case for a miniature checker board.

Test various plastic materials using different times, pressures, and temperatures.

Make a simple mold for compression molding.

Transfer mold an article.

Compare transfer and compression molding.

Mold impregnated reinforced plastic materials.

INSTRUCTOR'S NOTES

Reference Books

Swanson. *Plastics Technology: Basic Materials and Processes.*
Society of the Plastics Industry, Inc. *Compression and Transfer Molding.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*
DuBois and Pribble. *Plastic Mold Engineering.*

Instructional Materials

Allied Chemical
Dake Corporation
Reinhold Publishing Corporation

Audio-Visual Materials

Molding Phenolics. Film. Union Carbide Corporation.
Design of Molded Phenolics. Film. Union Carbide Corporation.

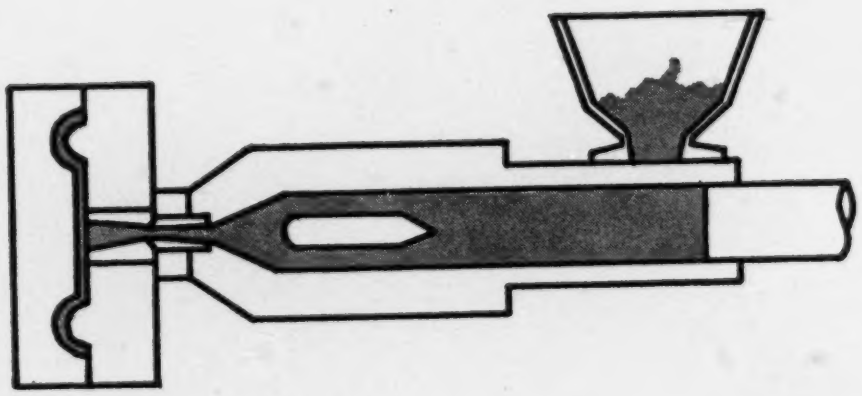

3734

FOAMS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Mold resin foaming systems.	Types of resin foaming systems.	Competency in molding with plastic foams.
Mold pellet foaming systems.	Methods of molding pellet foams.	Awareness of the future potential of foam plastic.
Mold syntac foaming systems.	Techniques of processing syntac foams.	Interest in the plastic foam industry.
Design with plastic foam materials.	Materials used for molding plastic foams.	Insight into the many applications of foam products in industry and in the home.
Safely handle foam materials.	Proper procedures for handling foaming systems.	Safety habits when processing plastic foams.
	Theory of plastic foams. Properties of plastic foams.	

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FOAMS

IMPLEMENTATION SUGGESTIONS

Examine a number of foam articles to determine the type of foam and how it was molded.

Display of various foam products.

Experiment with foam density and related factors.

Mold articles with pellet foam systems.

Foam an article with urethane foam.

Use a syntac foam system to form a backing for a mold.

INSTRUCTOR'S NOTES

Reference Books

Swanson. *Plastics Technology: Basic Materials and Processes.*
DuBois and Pribble. *Plastic Mold Engineering.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*
Ferrigno. *Rigid Plastics Foams.*

Instructional Materials

Dow Chemical Company
Nopco Chemical Company
Koppers Company
Allied Chemical
Reinhold Publishing Corporation

Audio-Visual Materials

Born of Foam. Film. Sinclair-Koppers Company.
Packaging with Dylite. Film. Koppers Company.
Dabco One-Shot Urethane Catalyst. Film. Houdry Process and Chemical Company.
Facts About Foam. Film. Dow Chemical Company.
Focus on Foam. Film. Dow Chemical Company.
High and Dry. Film. Dow Chemical Company.
Lifetime Protection. Film. Dow Chemical Company.

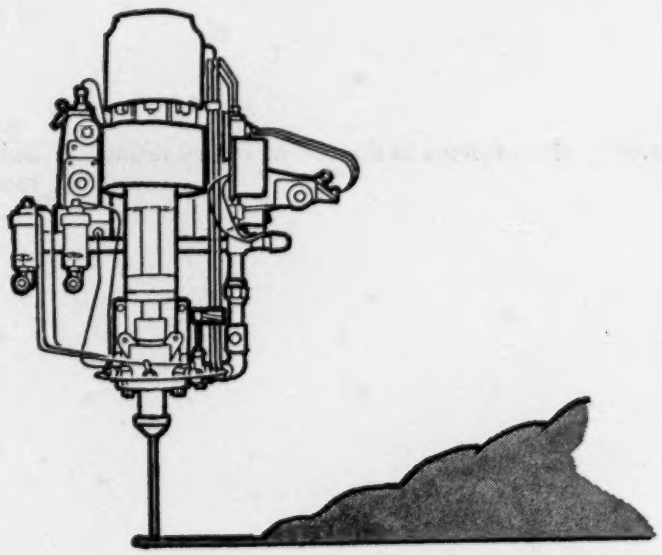

3736

TOOLING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Plaster mold construction.	Types and properties of plaster for mold construction.	Competency in plaster molding.
Design mold and mold clamping devices.		Judgment in mold design.
Laminate plastic tools.	Plastic tooling materials. Reinforcements for tooling plastic.	Concept of plastic tooling and its value in industry.
Mass and surface cast tools.	Major categories and basic techniques of plastic tooling methods.	
Spline master model construction.	Model- and mold-making materials.	Interest in the plastic tooling industry.
Repair plastic tools.	Tooling resins and their properties, characteristics, and uses.	
Die construction with pattern wax.	Plastic applications in the foundry.	Appreciation of industrial applications of plastic tooling.
Spray epoxy materials and metal fibers.	Precautions in the use of epoxy resins.	Safety attitudes when working with tooling materials.

TOOLING

IMPLEMENTATION SUGGESTIONS

Discussion of advantages of plastic tooling.

Group design of plastic tools.

Fabricate molds for injection molding, vacuum forming, or compression molding.

Resurface damaged molds.

Construct mockups and models of plaster.

Fabricate original models and patterns.

INSTRUCTOR'S NOTES

Reference Books

Swanson. *Plastics Technology: Basic Materials and Processes.*
Riley. *Plastics Tooling.*
Ren Plastics, Inc. *The Techniques of Using Epoxy Plastic Tooling Materials.*
Rezolin, Inc. *Manual of Plastic Tooling Material.*
United States Gypsum Company. *Product Information: Data, Applications, and Use.*

Audio-Visual Materials

Industrial Tooling with Gypsum Cements and Epoxy Resins. Film. United States Gypsum Company.
Plastic Tooling and Pattern Making. Film. United States Gypsum Company.
Nothing to Chance. Film. Ren Plastics, Inc.

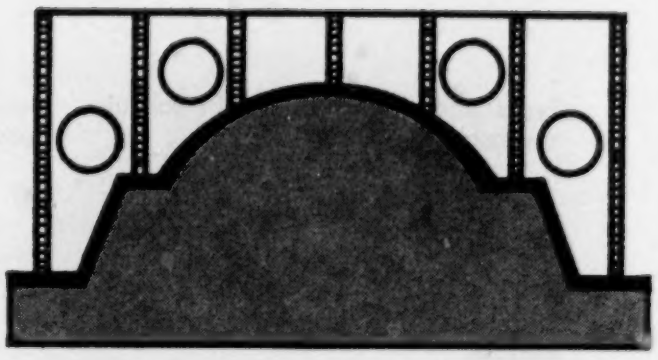

3738

FASTENING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Cohesive bonding: 1. Hot gas welding 2. Hot blade welding	Types of welding processes. Safety factors for plastic welding.	Proficiency in basic plastic welding procedures.
Solvent cement.	Methods of bonding plastics. Types of plastic solvents.	
Ultrasonic welding. High-frequency welding.	Factors influencing the choice of welds used in manufacturing.	Awareness of the need for safety procedures when joining and fastening plastics.
Heat sealing.	Industrial uses of heat sealing.	Appreciation of industrial processes for joining and fastening plastics.
Adhesive bonding: 1. Bonding with epoxies 2. Contact cementing	Types and characteristics of plastics used for adhesives.	Some competency in the selection of a means of joining and fastening plastic materials.
Mechanical linkage: 1. Mechanical fastening 2. Swaging	Types and characteristics of mechanical fasteners.	Judgment in the selection and use of mechanical fasteners.
Press fitting. Shrink fitting.	Techniques for fastening metals to plastics.	

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FASTENING

IMPLEMENTATION SUGGESTIONS

Student experimentation with various welding processes.

Repair or construct using welding techniques.

Construct a plastic clothes bag.

Heat seal picture or card between two sheets of plastic.

Make a display board of mechanical fasteners used with plastic materials.

INSTRUCTOR'S NOTES

Reference Books

Swanson. *Plastics Technology: Basic Materials and Processes.*
Cherry. *General Plastics.*
Kaminsky and Williams. *Welding and Fabricating Thermoplastic Material.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*

Instructional Materials

Branson Sonic Power Company

Audio-Visual Materials

Silent Sound. Film. Branson Sonic Power Company.

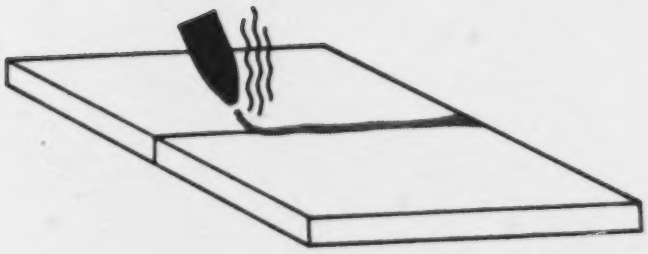

3740

DESIGNING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Select proper materials.	Properties and characteristics of plastic materials.	Awareness of material properties and their effect upon product design.
Select proper molding process.	Location of parting lines, knockout pins, and undercuts.	Insight into relationships between product design and molding processes.
Consider environmental problems.	Environmental conditions and their effects on plastics.	Foresight in the use of plastic products and materials.
Select tolerances on molded articles.	Shrinkage and standards for tolerances on molded articles. Warpage, draft, taper, and wall thickness for plastic moldings. Fillets, radii, ribs, and bosses for plastic.	Proficiency in designing plastic products.
Mix and match color for plastic materials.	Theory of color and color systems.	Discrimination in the selection of plastic products.

3741

DESIGNING

IMPLEMENTATION SUGGESTIONS

Redesign a plastic article already on the market, using a different production process than that for the original.

Design a plastic giveaway item for the school and compare production costs using several production techniques.

Compare plastic property materials with regard to such qualities as heat resistance, weatherability, and strength.

Design a portable fishing tackle box that will be made as a production line item in the class.

Design a simple holder for napkins that can be mass-produced.

Design a paperweight for mass production that could be used as a souvenir for advertising the school's industrial arts program.

INSTRUCTOR'S NOTES

Reference Books

DuBois and John. *Plastics.*
DuBois and Pribble. *Plastic Mold Engineering.*
Swanson. *Plastics Technology: Basic Materials and Processes.*
Cherry. *General Plastics.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*

Instructional Materials

B. F. Goodrich Chemical Company
Milwaukee Chair Company
Rohn and Hass Company
Ferro Corporation
American Insulator Corporation
Shell Chemical Company

Audio-Visual Materials

Color Magic. Film. Interchemical Corporation.
This Is Micarta. Film. Westinghouse Electric Corporation.
The Shape of Plastics. Film. Society of the Plastics Industry, Inc.
The Magic Molecule. Film. Society of the Plastics Industry, Inc.

3742

TESTING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Analytical tests.	Identification of plastic materials.	Insight into plastics identification.
Mechanical tests: 1. Hardness 2. Tensile 3. Flexural 4. Impact	Types of mechanical tests applicable to plastics.	Inquisitiveness concerning the performance properties of plastics.
Thermal tests: 1. Softening point 2. Deflection temperature 3. Flow rate 4. Flammability	Meaning and interpretation of test data. Methods of testing plastic materials.	Relationships between the structure of plastic materials and test performances.
Performance tests: 1. Weathering 2. Fading 3. Stress 4. Water absorption	Properties of different plastic materials.	Awareness of the industrial applications of materials testings.
Electrical tests.	Importance of testing plastic materials.	Appreciation of the need for standards.

3743

TESTING

IMPLEMENTATION SUGGESTIONS

Discuss the necessity of testing materials.

Apply tests to plastic materials.

Students devise simple methods of making testing devices for plastic.

Test and compare various materials.

Identify unknown samples of plastic.

INSTRUCTOR'S NOTES

Reference Books

Celanese Plastics Company. *Standard Tests on Plastics.*
American Society for Testing and Materials. *Plastic — Methods of Testing.*
Society of the Plastics Industry, Inc. *Plastics Engineering Handbook.*
Swanson. *Plastics Technology: Basic Materials and Processes.*

Audio-Visual Materials

What Kind of Pipe Should I Buy? Film. Allied Chemical Corporation.
Form and Formula. Film. Society of the Plastics Industry, Inc.
Ciba Epoxy Resins in Filament Winding. Film. Ciba Chemical and Dye Company.

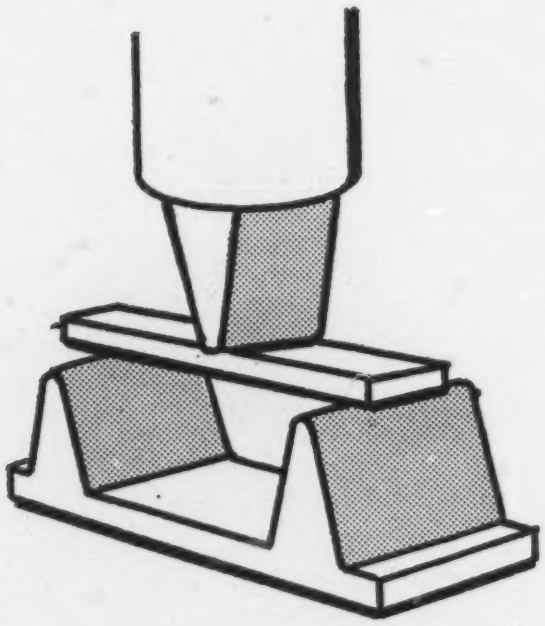

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STRUCTURE

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Solution polymerization with polyethylene.	Basic materials and elements that make up plastics.	Awareness of the effect chemical structure has upon the physical properties of plastics.
Formation of nylon.	Plastics classification.	
Cellulose acetate cast film.	Structure of matter.	Insight into the relationships of materials structure.
Formation of polyesters.	Methods of manufacturing plastic materials.	Appreciation of the importance that research and development have in the plastics industry.
	Chemical structure of plastics.	Appreciation of the raw material producers of plastics and their relationship to the plastic industry.

3744

STRUCTURE

IMPLEMENTATION SUGGESTIONS

Experiment with melting temperatures of various plastics.

Compare chemical resistance of various plastics.

Chemically make polyethylene.

Make a polyester resin.

Determine the effects of various fillers in plastic resins.

Experiment with copolymerization of plastics.

Make a plastic by condensation.

INSTRUCTOR'S NOTES

Reference Books

Swanson. *Plastics Technology: Basic Materials and Processes.*

Instructional Materials

Reinhold Publishing Corporation
Society of the Plastics Industry, Inc.
Bakelite Company
International Plastics Industry Consultants, Inc.

Audio-Visual Materials

The Composition and Properties of Plastics. Film. Society of the Plastics Industry, Inc.
Inside Polypropylene — Its Crystallization and Fabrication. Film. Dow Chemical Company.
Of Men and Molecules. Film. B. F. Goodrich Company.
A New World of Chemistry. Film. Reichhold Chemicals, Inc.
Physical Chemistry of Polymers. Film. Northwestern Bell Telephone Company.
Refinery at Work. Film. Enjay Chemical Company.

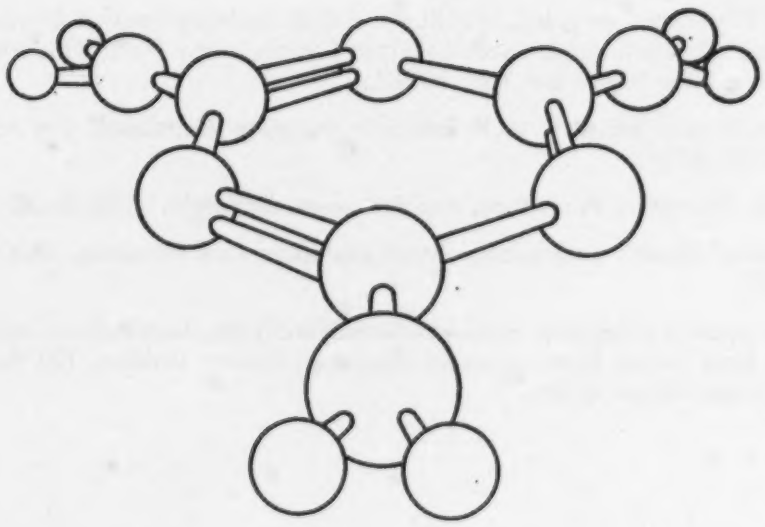

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American Society for Testing and Materials. *Plastics — General Methods of Testing*. Part 27 of the Book of A.S.T.M. Standards. Published annually. $16.00 (668) Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

Celanese Plastics Company. *Standard Tests on Plastics*. 4th ed. 1967. (668) Available from Celanese Plastics Company, Division of Celanese Corporation, 6050 West Touhy Avenue, Chicago, Illinois 60648.

Cherry, Raymond. *General Plastics*. McKnight, 1964. $6.00 (668)

DuBois, J. H., and W. I. Pribble. *Plastic Mold Engineering*. Rev. ed. Reinhold, 1965. $19.50 (668)

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Ferrigno, L. *Rigid Plastics Foams*. Rev. ed. Reinhold, 1967. $14.00 (668)

Gick, Jim. *Clear Cast*. $1.50 (668) Available from American Handicrafts Company, 1109 Nicollet Avenue, Minneapolis, Minnesota 55403.

Griff, Allen. *Plastics Extrusion Technology*. 2nd ed. Reinhold, 1967. $15.00 (668)

Jones, David A., and Thomas W. Mullen. *Blow Molding*. Reinhold, 1961. $6.50 (668)

Kaminsky, Stanley J., and John A. Williams. *Welding and Fabricating Thermoplastic Materials*. 1964. $5.95 (668) Available from Kamweld Products Company, Inc., 742 Providence Highway, P.O. Box 91, Norwood, Massachusetts 02062.

Ren Plastics, Inc. *The Techniques of Using Epoxy Plastic Tooling Materials*. (668) Available from Ren Plastics, Inc., 5656 South Cedar Street, Lansing, Michigan 48909.

Rezolin, Inc. *Rezoline Catalog of Resin Compounds*. (668) Available from Rezolin, Inc., 35640 South Gratiot Avenue, Mount Clemens, Michigan 48043.

Riley, Malcolm W. *Plastics Tooling*. 2nd ed. Reinhold, 1961. $9.50 (668)

Society of the Plastics Industry, Inc. *Compression and Transfer Molding*. Training booklet. Single copy free; 2-50 copies, 50¢ each. (668) Available from Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017.

Society of the Plastics Industry, Inc. *Handbook of Reinforced Plastics of the Society of Plastics Industry*. Reinhold, 1964. $25.00 (668)

Society of the Plastics Industry, Inc. *Injection Molding*. Training booklet. Single copy free; 2-50 copies, 50¢ each. (668) Available from Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017.

Society of the Plastics Industry, Inc. *Plastics Engineering Handbook*. 3rd ed. Reinhold, 1960. $17.50 (668)

Steele, Gerald. *Fiberglass: Procedures and Processes*. McKnight, 1962. $4.40 (666)

Swanson, Robert. *Plastics Technology: Basic Materials and Processes*. McKnight, 1965. $7.00 (668)

United States Gypsum Company. *Product Information: Data, Applications, and Use*. (668) Available from United States Gypsum Company, Plastics Division, 101 South Wacker Drive, Chicago, Illinois 60606.

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Sources for Instructional Materials

Allied Chemical
Plastics Division
P.O. Box 365
Morristown, New Jersey 07960

American Handicrafts Company
1109 Nicollet Avenue
Minneapolis, Minnesota 55403

American Insulator Corporation
1930 Main Street
New Freedom, Pennsylvania 17349

Anchor Plastics
3636 36th Street
Long Island City, New York 11106

Bakelite Company
Division of Union Carbide Corporation
270 Park Avenue
New York, New York 10017

Branson Sonic Power Company
Eagle Road
Danbury, Connecticut 06810

Celanese Plastics Company
744 Broad Street
Newark, New Jersey 07102

Chemical Products Corporation
King Philip Road
East Providence, Rhode Island 02914

Comet Industries
1320 North York Road
Bensenville, Illinois 60106

Dake Corporation
390 Robbins Road
Grand Haven, Michigan 49417

Dow Chemical Company
Plastics Department
Abbott Road
Midland, Michigan 48640

Ferro Corporation
Color Division
4150 East 56th Street
Cleveland, Ohio 44105

General Tire and Rubber Company
Chemical Plastics Division
70 Garden Street
Lawrence, Massachusetts 01841

B. F. Goodrich Chemical Company
3135 Euclid Avenue
Cleveland, Ohio 44115

Industrial Arts Supply Mail Order Company
1408 West Lake Street
Minneapolis, Minnesota 55408

Interchem Corporation
Finishes Division
1255 Broad Street
Clifton, New Jersey 07013

International Plastics Industry Consultants, Inc.
P.O. Box 1324
Long Island City, New York 11101

Koppers Company
Marketing Department
Koppers Building
436 7th Avenue
Pittsburgh, Pennsylvania 15219

McGraw-Hill Book Company
330 West 42nd Street
New York, New York 10036

Milwaukee Chair Company
3022 West Center Street
Milwaukee, Wisconsin 53245

Mobay Chemical Company
Penn Lincoln Parkway West
Pittsburgh, Pennsylvania 15205

Monsanto Company
Plastic Products and Resins Divisions
800 North Lindbergh Boulevard
St. Louis, Missouri 63166

Nopco Chemical Company
175 Schuyler Avenue
North Arlington, New Jersey 07032

Owens-Corning Fiberglas Corporation
5217 Wayzata Boulevard
Minneapolis, Minnesota 55416

Phillips Petroleum Company
Plastics Division
Bartlesville, Oklahoma 74003

Pittsburgh Plate Glass Industries
Fiber Glass Division
1 Gateway Center
Pittsburgh, Pennsylvania 15222

Prodex Corporation
Division of Koehring Company
King George Post Road
Fords, New Jersey 08863

Reinhold Publishing Corporation
430 Park Avenue
New York, New York 10022

Rohm and Hass Company
Plastics Department
Independence Mall West
Philadelphia, Pennsylvania 19105

Shell Chemical Company
Plastics and Resins Division
6054 West Touhy Avenue
Chicago, Illinois 60648

Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

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Union Carbide
4815 West 77th Street
Minneapolis, Minnesota 55424

United Merchants and Manufacturers, Inc.
1407 Broadway
New York, New York 10018

U.S. Industrial Chemicals Company
3701 Wayzata Boulevard
Minneapolis, Minnesota 55416

Sources for Audio-Visual Materials

Allied Chemical Corporation
Plastics Division
40 Rector Street
New York, New York 10006

Branson Sonic Power Company
Division of Branson Instruments, Inc.
Miry Brook Road
Danbury, Connecticut 06910

Celanese Plastics Company
744 Broad Street
Newark, New Jersey 07102

Ciba Chemical and Dye Company
Route 208
Fair Lawn, New Jersey 07410

Dow Chemical Company
Visual Aids Department
Midland, Michigan 48640

E. I. duPont de Nemours and Company, Inc.
Motion Picture Section
Advertising Department
1007 Market Street
Wilmington, Delaware 19898

Eastman Chemical Products, Inc.
Chemicals Division
260 Madison Avenue
New York, New York 10016

Elliott Film Company
1114 Nicollet Avenue
Minneapolis, Minnesota 55403

Enjay Chemical Company
Division of Humble Oil and Refining Company
Headquarters Film Library
P.O. Box 2180
Houston, Texas 77001

Epoxylite Corporation
1428 North Tyler Avenue
South El Monte, California 91733

Filon Corporation
Advertising Department
12333 South Van Ness Avenue
Hawthorne, California 90250

General Electric Company
Chemical Materials Department
1 Plastics Avenue
Pittsfield, Massachusetts 01201

B. F. Goodrich Company
Public Relations Department
Akron, Ohio 44318

Houdry Process and Chemical Company
Urethane Chemicals Department
1528 Walnut Street
Philadelphia, Pennsylvania 19102

Interchemical Corporation
Public Relations and Promotion Department
67 West 44th Street
New York, New York 10036

KitCo
6405 East Kellogg
Wichita, Kansas 67207

Koppers Company
Plastics Division
Koppers Building
436 7th Avenue
Pittsburgh, Pennsylvania 15219

Marbon Chemical Company
Division of Borg-Warner Corporation
P.O. Box 68
Washington, West Virginia 26181

Mobay Chemical Company
Penn Lincoln Parkway West
Pittsburgh, Pennsylvania 15205

Molded Fiber Glass Boat Company
Division of Molded Fiber Glass Body Company
55 4th Avenue
Union City, Pennsylvania 16438

Northwestern Bell Telephone Company
Public Relations Department
Film Booking — Room 1335
224 South 5th Street
Minneapolis, Minnesota 55402

Pennsalt Chemicals Corporation
E. J. Stokes Division
Book Department
3 Penn Center
Philadelphia, Pennsylvania 19102

Reichhold Chemical, Inc.
Advertising Department
525 North Broadway
White Plains, New York 10602

Ren Plastics, Inc.
5656 South Cedar Street
Lansing, Michigan 48910

Rohm and Hass Company
Independence Mall West
Philadelphia, Pennsylvania 19105

3749

Sinclair-Koppers Company
Koppers Building
436 7th Avenue
Pittsburgh, Pennsylvania 15219

Society of the Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

Stout State University
Audio-Visual Department
Menomonie, Wisconsin 54751

Strong Plastics, Inc.
1821 West 60th Street
Los Angeles, California 90047

Swedlow, Inc.
6986 Bandini Boulevard
Los Angeles, California 90022

Union Carbide Corporation
Plastics Division
Advertising Department
270 Park Avenue
New York, New York 10017

Uniroyal, Inc.
Director of Public Relations
1230 Avenue of the Americas
New York, New York 10020

United States Gypsum Company
101 South Wacker Drive
Chicago, Illinois 60606

Waldron-Hartig Company
Division of Midland-Ross Corporation
Sales Department
1137 Globe Avenue
Mountainside, New Jersey 07092

Westinghouse Electric Corporation
Micarta Division
Hampton, South Carolina 29924

3750

VT 012 372
Visual Communication Technology. Resource Guide for Effective Instruction in Industrial Arts.

Minnesota State Dept. of Education, St. Paul.
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Curr-Bull-13A
Documents Section, Minnesota State Dept. of Education, Room 140, Centennial Building, St. Paul, Minn. 55101.
PUB DATE - 70 82p.

DESCRIPTORS - *CURRICULUM GUIDES; TEACHING METHODS; EDUCATIONAL INNOVATION; *INDUSTRIAL ARTS TEACHERS; *INDUSTRIAL ARTS; RESOURCE GUIDES; *DRAFTING; *GRAPHIC ARTS; AFFECTIVE OBJECTIVES; COGNITIVE OBJECTIVES; PSYCHOMOTOR OBJECTIVES

ABSTRACT - Prepared for industrial arts teachers, this curriculum guide has been organized for efficient utilization of several newer methodological approaches to teaching. The order in which material is presented places the psychomotor, cognitive, and affective domains of learning on a continuum with implementation procedures. Two sections, drafting and graphic arts technology, list: (1) Skills Students Will Be Able to Perform, (2) Concepts Students Will Understand, (3) Appreciations Students Will Develop, and (4) Implementation Suggestions. Sources of resource materials are provided and related documents are available as VT 012 370 and VT 012 371, also in this issue. (JS)

VT 012 372

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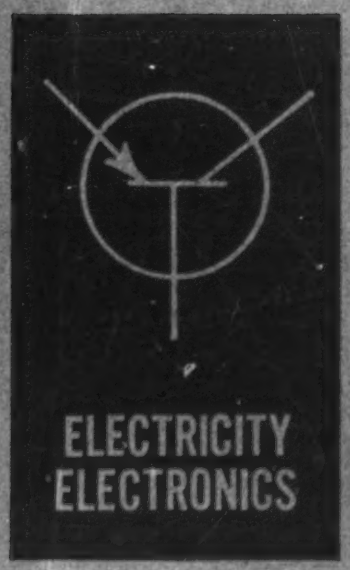

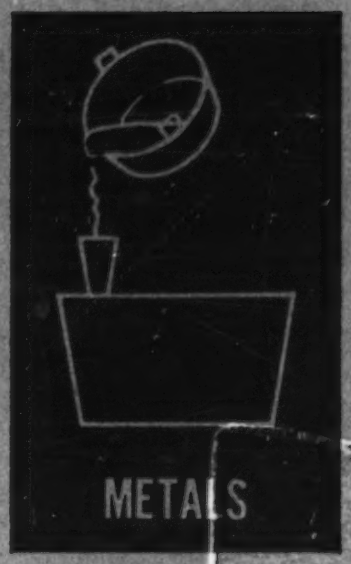

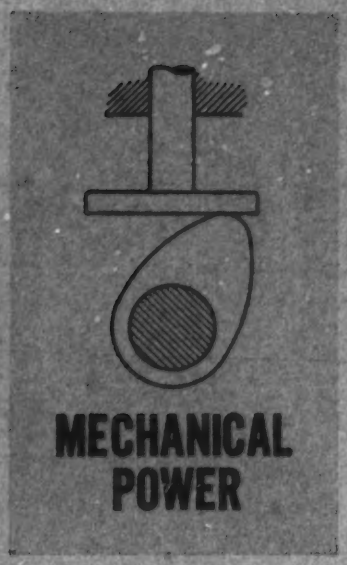

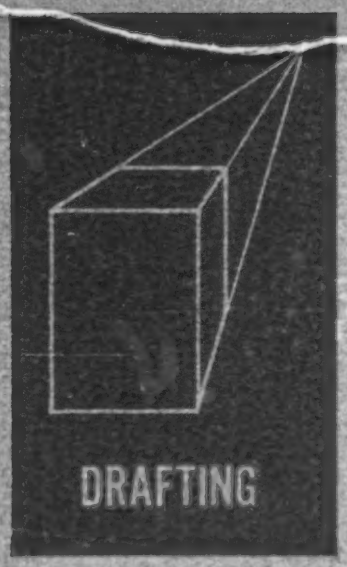

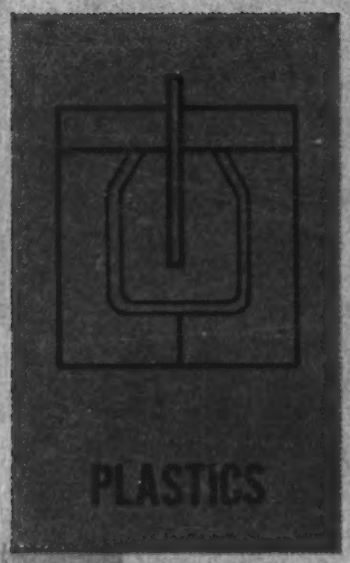

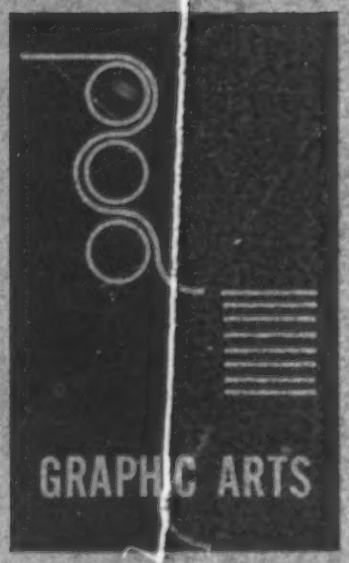

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Resource Guide
for
Effective Instruction
in
Industrial Arts

Visual Communication Technology

State of Minnesota
Department of Education
St. Paul

Curriculum Bulletin No. 13A
Code VIII-A-C-26

VT012372

3752

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RESOURCE GUIDE FOR EFFECTIVE INSTRUCTION IN INDUSTRIAL ARTS

VISUAL COMMUNICATION TECHNOLOGY

CURRICULUM BULLETIN NO. 13A

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FOREWORD

Industrial arts students live in a dynamic, ever-changing society. Preparations for their future place multitudinous demands upon education. The numerous changes occurring in our accelerating technology levy demands upon industrial arts teachers. It is simply not enough to train the students to live in a changing world; it is also necessary to transmit to the student a sense of values and the worth of participation in the technological process which is such a vital part of our society. Industrial arts, as an integral part of education, must provide opportunities for individual fulfillment, individual achievement, and individual freedom.

The success of the industrial arts program in providing these opportunities depends upon several factors, of which the course content and the approaches to teaching are vital aspects. Two main purposes of this guide are, therefore, to offer newer content and to suggest several newer approaches to teaching.

Assistant Commissioner of Education,
Division of Instruction

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ACKNOWLEDGMENT

Grateful appreciation is extended to Mr. Harold E. PaDelford for his help in coordinating materials for the resource guides on "Visual Communication Technology," "Mechanical and Electrical Technology," and "Materials Technology."

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Sterling Peterson ..... Consultant, Minneapolis Public Schools

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INDUSTRIAL ARTS CURRICULUM DEVELOPMENT IN MINNESOTA

The State Department of Education has maintained a continuing effort to keep teachers and administrators informed of phenomenal technological and educational advances. The most recent revision of Curriculum Bulletin No. 13, *A Guide for Instruction in Industrial Arts,* was made in 1962.

In the spring of 1967, an effort was initiated to bring industrial arts teachers the latest methods of instruction. Industrial arts education has been under constant evaluation and it was the intent of the steering committee appointed at that time to enlarge upon and bring up to date the content of Curriculum Bulletin No. 13. The committee chose the content, instructional design, and methods used in this guide. Writers were engaged to specifically challenge industrial arts teachers to gain knowledge of and to use the newer approaches to instruction.

The guide has been divided into three issues. These issues are (1) "Visual Communication Technology" with units in drafting and graphic arts, (2) "Mechanical and Electrical Technology" with units in electricity, electronics, and power, and (3) "Materials Technology" with units in woods, metals, and plastics.

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PURPOSE AND VALUE OF THIS GUIDE

This guide has been organized for efficient utilization of several newer methodological approaches to teaching. The primary purpose of the guide is to so arrange the course content that the instructor may more easily adapt his teaching to these new approaches. The order in which material is presented places the psychomotor, cognitive, and affective domains of learning on a continuum with implementation procedures. The psychomotor skills (column one) that students should be able to perform include operations, jobs, problems, and activities. Cognitive understandings (column two) include basic principles, concepts, generalizations, and guidance information. Affective values (column three) involve awareness, organization, attitudes, and appreciation. Implementation suggestions (column four) cover teaching methods and techniques, resources, and expedients. Column four provides the cohesive force for columns one, two, and three. Instructor's notes (column five) provides a place for the instructor to keep his plans and thoughts regarding the units.

This guide is not intended to be a "cook-book" approach. It is intended to serve as a guide and resource for effective teaching. The needs of each particular teaching situation should determine the material that will be used.

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METHODOLOGICAL APPROACHES TO TEACHING INDUSTRIAL ARTS

Methodology has sustained the teaching of industrial arts as a subject in general education with several approaches carrying the burden of instruction. However, industry and technology have undergone vast changes in recent years. In an attempt to interpret industry more realistically, several new approaches have been promulgated. Emphasis has been placed on industrial and technological functions and practices. In order to make learning more meaningful, the committee wishes to encourage the use of up-to-date methods of instruction. Complete materials are not available on all approaches, but information is available from the American Industrial Arts Association, the American Vocational Association, and from current publications. Several methodological approaches, each with a short explanation, are presented in the following list.

Mass Production. This is a group undertaking with the intent of understanding industry through the production of a product. Mass production would encompass personnel organization, purchasing, production processes, accounting, and sales. This usually involves the entire class and can be used at any grade level and subject area.

Anthropological Approach. The anthropological approach involves the historical relationships of tools, processes, and products. It can be used as an introduction to a unit of study or as the unit of study. It gives an insight into the massive technologies of the modern industrial complex.

Construction Industry. This approach is a group undertaking to discover the problems in the design and construction of a project. This method would encompass personnel organization, material testing, fastening, and material processing. Students can be grouped into any size of unit according to the complexity of the project.

Unit Method. The unit method employs a limited set of educational experiences. Emphasis is placed on individual achievement through the student's own initiative. Emphasis is also placed on vicarious learning — a sharing of experiences with other students through reports, demonstrations, and other methods of communiation. The unit method allows the student to be creative and unique.

Line Production. The line production technique usually consists of a short production run of a product. The production line, jigs and fixtures, and product are set up with student activity. It is usually a short unit used to teach one aspect of mass production.

Individual Project. The individual project emphasizes the engineering approach and craftsmanship. Experiences are not usually shared with other students. The individual project offers the student an opportunity to see through to completion something of his own making.

Individual Study. Some scheduling systems permit an individual approach to study. Open laboratories, libraries, and other media enable the student to have freedom in his pursuit of knowledge.

Conceptual Approach. To gain an understanding of the technology in industry, concepts are taught with each concept enforcing the next one. This approach relies heavily on the cognitive behavioral patterns. Concepts learned are usually reinforced with some type of followup activity.

Research and Experimentation. The research and experimentation approach enables the student to discover and develop technological advances. The process is much used in industry. Materials testing and new product development are techniques used in the schools. The students usually share their experiences with classmates. Access to source materials is a necessity.

Services. The service industry is large and growing. Students gain an understanding of problems involved in the maintaining and repairing of all industrial products. With the increase of mechanized products in the home and on the farm, every individual needs an understanding of the service industry.

Interdepartmental Approach. Involvement of two or more laboratory activities can be used to advantage in enhancing motivation and improving learning situations. This approach enables students to study and construct a more complex problem or project.

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VISUAL COMMUNICATION TECHNOLOGY

The materials in this guide have been divided into the two areas of drafting and graphic arts technology. The section on drafting technology was written by Thomas Kitto, Instructor, Minneapolis Public Schools. Will Wachtler, Instructor, South St. Paul Public Schools, prepared the section on graphic arts technology. These two areas have been grouped in this guide because of similarity and for convenience.

This guide has been arranged so that the instructor, in planning for the teaching of industrial arts, can draw objectives from the first three columns. These objectives can then be achieved by using the suggestions in column four. Some of the implementation suggestions will be considered as startling and provocative procedures. This was intended as the steering committee sought procedures that were forceful, useful, and stimulating. It was further intended that this guide serve as an aid to improve the methodology and content of industrial arts. Methodology has, through the years, sustained industrial arts. Innovations in both content and methodology are offered.

No definite order has been established for the presentation of material. It is more important that each instructor select the particular material which is appropriate for a given teaching situation. The instructor is encouraged to use as much of the appropriate material as possible. Material sufficient for several years of work has been provided. It is hoped that this guide will help the instructor to teach more effectively.

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DRAFTING TECHNOLOGY

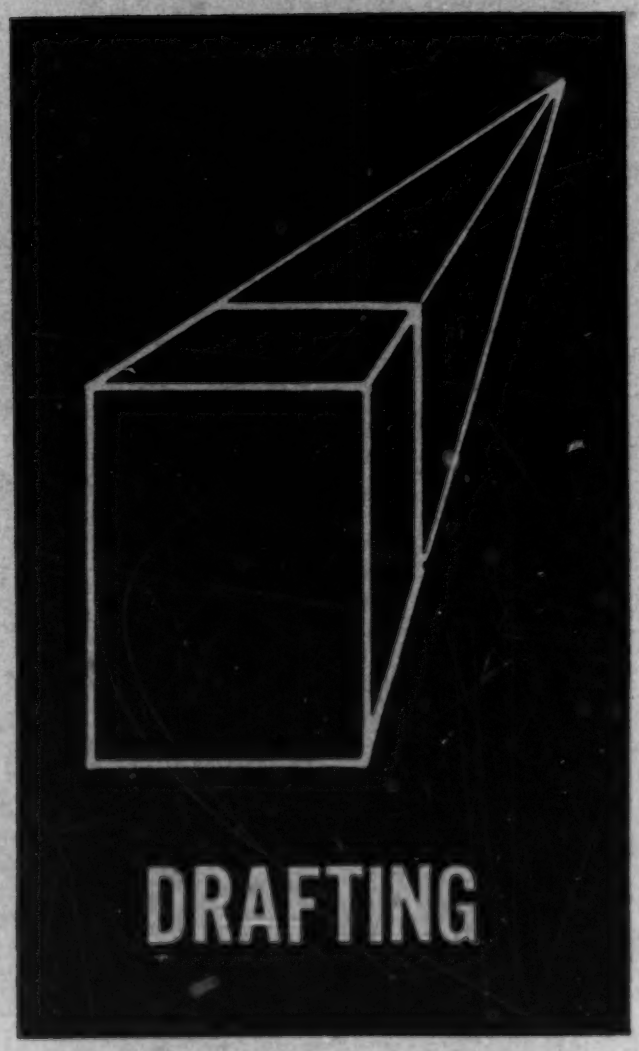

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INTRODUCTION

Drafting has long been considered an integral part of the industrial arts curriculum. Although maintaining an identity of its own, drafting utilizes content materials from each of the other industrial areas. Drafting's main function is to give graphic representation to materials, parts, and assemblies ranging from nuts and bolts to completed buildings. An understanding of symbols and schematics is vital in electronics, fluid power, and architecture.

This resource guide was developed to help the teacher organize both the content and the methodology of drafting. The guide is not to be considered a complete course of study in itself. Some junior high school and senior high school courses may utilize only portions of a unit or some whole courses may be built around a single suggested unit. The teacher is encouraged to select that material which is appropriate for the individual classroom needs.

When properly presented through problems and applications, drafting becomes both dynamic and relevant to the student. It should be noted that drafting is needed by designers, manufacturers, consumers, and service personnel.

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LETTERING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Form single stroke gothic letters.	The strokes and proportion of gothic letters and numerals. Lettering styles.	The habits of forming letters carefully.
Compose letters into words and sentences.	Spacing requirements and rules for compositions.	An appreciation of good, legible lettering.
Letter with an acceptable degree of speed and quality.	Lettering techniques which influence speed. The influence of pencil grade and drawing surface on speed and quality of lettering. The influence of reproducibility on lettering lineweight and size of letters.	An awareness of the need for continued practice to increase speed and accuracy. A habit of practicing lettering in short, frequent sessions.
Letter using ink. (This is included largely as an avocational skill. See "implementation" column for practical use of this skill.)	The importance of strokes in ink lettering. The applications of ink lettering.	An acceptance of ink lettering as a skill of diminishing industrial importance.
Letter using templates and mechanical devices.	The variety and application of mechanical devices for lettering. Related lettering procedures such as typing and computerized lettering.	An appreciation of mechanical lettering devices as useful aids when precise lettering is required.

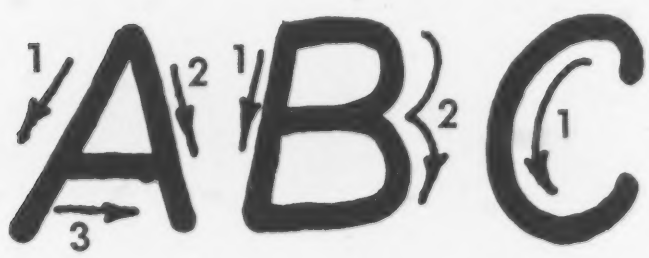

PART 3765

LETTERING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Have students form each letter on a worksheet as it is demonstrated on the overhead projector or board.	
Have students practice composition as it is demonstrated.	
Provide samples of good lettering by students and from industry on bulletin board.	
Evaluate lettering thoroughly on prepared form.	
Require one or two lettering plates at this time and one each week until student becomes proficient. Time is saved if these are prepared by the teacher or are commercially available practice exercises. Letter for 5 to 10 minutes at start of each class and encourage periodic practice outside of class.	
Demonstrate ink lettering on the overhead projector using matte film. Have students letter a cover page for a drawing storage *notebook*. This cover will protect drawings throughout the year. Notebook provides effective opportunity to discuss drawing value and engineering costs.	
Mechanical lettering is not an essential skill, so it can be used as an enrichment item for faster students, or included later in the course at appropriate points such as on electronic drafting.	

3766

SKETCHING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Sketch vertical, horizontal, and oblique lines.	Which hand positions are best suited for drawing these straight lines. That straight lines should be drawn by watching the destination, not the pencil point.	An appreciation of these basic strokes as fundamental building blocks for all sketching.
Sketch circles and arcs.	The construction steps necessary for making well-proportioned circles and arcs.	An awareness that curve construction is a basic skill for all sketching.
Sketch simple two-dimensional forms in proportion.	The principle of proportion in sketching.	Good habits relative to using essential construction steps in making presentable sketches.
Sketch with an acceptable degree of speed and quality in each area studied throughout the course. (See "implementation" column.)	The influence of pencil grade and drawing medium on lineweight and speed.	A desire for further experience with this useful drawing form. An acceptance of sketching as a useful avocational skill as well as an industrial procedure.

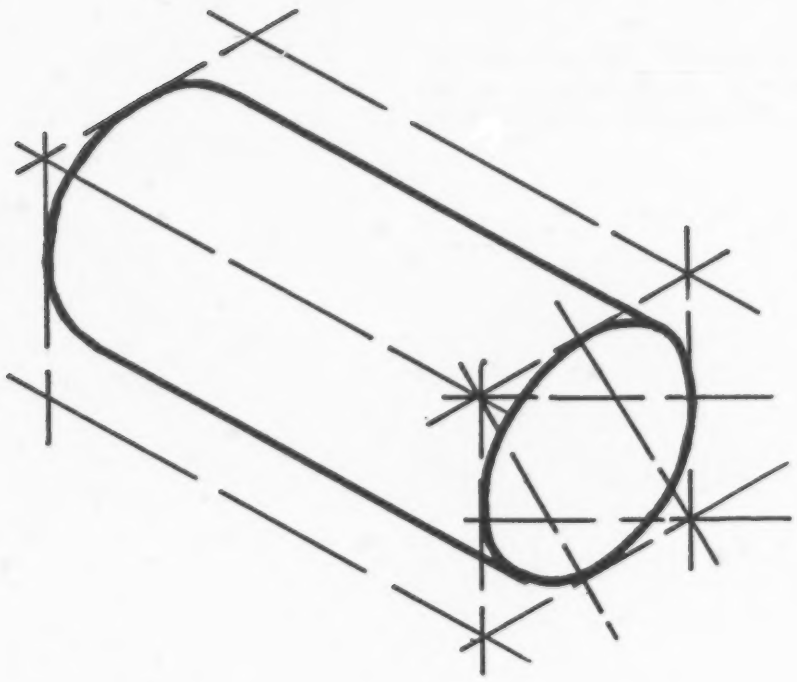

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SKETCHING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Present the drawing of these lines, using the overhead projector, and follow up with skill demonstrations to small groups.	
Demonstrate the techniques of sketching to small groups with emphasis on hand positions, lineweight, construction procedures, and neatness.	
Have students sketch several problems which encourage constructing and proportioning the sketch.	
It is not possible to achieve complete sketching proficiency at this time. However, sketching should be utilized in the development of each succeeding unit so this goal can be accomplished. Such areas as orthographic projection, dimensioning, sectioning, and pictorial drawing can all employ sketching to good advantage. Using sketching throughout the course develops the student's ability with this skill and increases the number of experiences which can be included in a given time spent on each unit.	
Encourage further interest in sketching by displaying a bulletin board showing examples of student and industrial sketches. The latter can be procured by contacting local industries.	

3768

GEOMETRIC CONSTRUCTION AND INSTRUMENT USAGE

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Draw horizontal, vertical, and oblique lines with a drafting machine. "Direct draw" lines to scale and finished lineweight using a drafting machine.	The function and advantages of the drafting machine. The concept of drawing lines directly to finished lineweight (direct drawing) whenever possible.	The attitude that "direct drawing" with a drafting machine is a time-saving procedure worth exploring throughout the course.
Draw horizontal, vertical, and oblique lines with a T-square or parallel rule and related tools. Draw lines to scale length.	How basic drafting tools can be used to draw horizontal, vertical, and oblique lines. What pencil weight and drawing paper options are available. The procedures necessary to center a drawing. Scale measurement.	Good work habits and a constructive attitude toward drawing neatness and accuracy.
Draw arcs and circles.	Relationship of radius and diameter. The function of center lines.	
Make basic straight line constructions such as bisecting a line or dividing a line into a given number of parts.	The variety of geometric constructions utilized in drafting. The interrelationships of these construction procedures.	An appreciation of the application of geometric construction in technical drawing.
Construct arcs tangent to straight lines and/or other arcs. Construct basic geometric forms such as the triangles, hexagon, octagon, and pentagon. Construct more complex geometric configurations such as the ellipse and helix.	Plane geometry fundamentals and terms. The utilization of instruments in technical drawing. Which geometric shapes are most commonly used. The terminology associated with geometric forms. The application of these geometric constructions in technical drawing.	A realization of the importance of correct procedures and sequential relationships in geometric construction. The habit of employing these constructions to solve drafting problems. An increased awareness of the role of instruments in drafting.

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GEOMETRIC CONSTRUCTION AND INSTRUMENT USAGE

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
NOTE: Is is important not to extend this unit beyond the point necessary for understanding the structure and pattern of geometric construction and instrument usage at this time. *Students will better appreciate the usefulness of what they have learned if the constructions or procedures are presented at a point in the course when they will be promptly used in a practical application.* Therefore, practice with as many as possible of these skills should be deferred until a more appropriate time.	
Demonstrate basic skills to small groups.	
Use a job sheet to determine a student's ability to measure accurately.	
Have students make a simple, straight line drawing to acquaint them with basic tools.	
Display a bulletin board showing alphabet of lines and drawing using these lines.	
Have several students stand around a drawing table and draw circles with a compass as the skill is demonstrated. Student may leave when he has shown that he can perform the skill. Have students make a drawing involving arcs and circles.	
Display a bulletin board showing the uses of these constructions in industry.	
Have each student perform the constructions on a worksheet as they are demonstrated.	
Have students make drawings using some of these constructions.	
Select problems throughout the course which use these constructions.	

3770

ORTHOGRAPHIC PROJECTION AND BASIC DIMENSIONING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Sketch two- and three-view orthographic drawings.	The concept of othographic projection. View positions and alternate positions. Sketch proportion and view alignment. View selection and front view determination.	An appreciation of the role of orthographic projection in industry. The ability to discern the best view relationships for representing an object.
Make simple orthographic drawings mechanically. Project a side view using a 45° line. "Direct draw" views on a drafting machine.	The alphabet of lines. How to position views on a drawing. How to achieve lineweight distinction.	An appreciation of line configuration and weight.
Sketch and *dimension* orthographic drawings.	The concept of size description. The significance of size and location dimensions. Basic dimensioning rules for dimension selection and placement. How to measure objects to be drawn using only basic measuring tools.	An awareness of the need for careful dimension selection. An awareness of the role which size description plays in technical drawing.

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ORTHOGRAPHIC PROJECTION AND BASIC DIMENSIONING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Job sheets or workbooks for missing line or missing view completion are desirable, if they are available.	
Sketch orthographic views from pictorial representations of objects.	
Have students sketch simple machine parts or prepared "blocks." (Provide a large selection of these parts or blocks as the choice of an interesting item may motivate student.)	
Encourage some sketching outside of class.	
Show film on orthographic projection.	
A plexiglass "projection box" with hinged sides can be used for demonstrations to large groups and for individual problems by drawing views on it with water-soluble pens.	
A comprehensive selection of overhead projection transparencies is available on this topic.	
Simple two- or three-view drawings are enough to introduce the basic ideas of mechanical orthographic drawing. Extensive treatment can follow when size description is added.	
Have students make several drawings which are representative of a variety of dimensioning problems and which utilize some geometric constructions in order to add significance to that unit.	
Demonstrate drafting skills and techniques thoroughly to small groups of students.	
Present a bulletin board showing industrial drawings of simple parts.	

3772

SECTIONING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Sketch problems using the following types of sectional views: 1. Full section 2. Half section 3. Off-set section 4. Broken out section 5. Aligned section 6. Revolved section 7. Removed section Dimension sectional views. Identify cutting plane and sectional view.	The concept of sectioning. How sectioned areas are indicated by section lining. Conventional practices in sectioning related to drawing of such things as ribs, webs, and unsymmetrical views. The principles for dimensioning a sectional view.	Insight about the use of sectioning to show internal detail. An appreciation of the use of conventional symbols to save time or increase clarity.
Make mechanical drawings using the preceding section views.	The alphabet of lines (continued). The order of penciling lines (continued).	
Make a mechanical assembly drawing with a sectional view showing adjacent parts and miscellaneous hardware.	The section lining of adjacent parts. Conventional treatment of such items as shafts, bolts, and keys in section. That code section lining exists but is no longer very widely utilized in machine drawings.	An increased appreciation of the abstraction of sectioning which allows many variations in order to increase clarity.

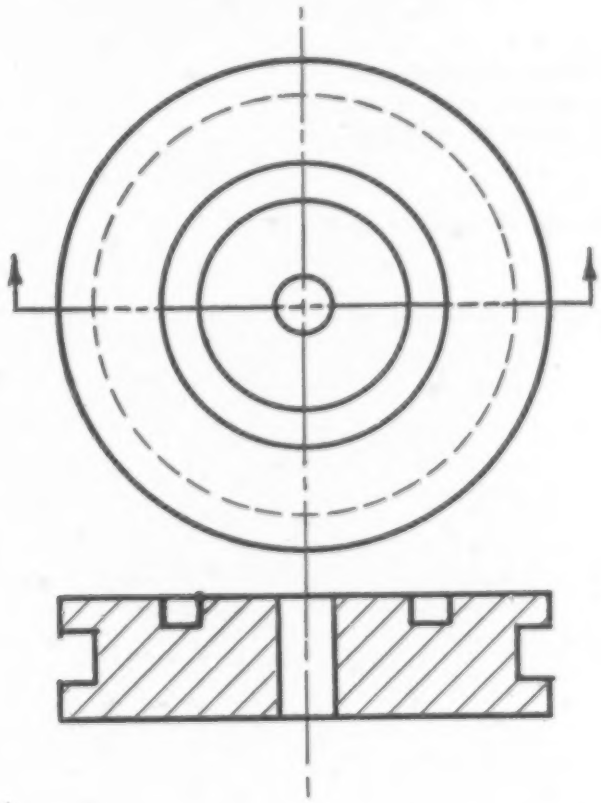

3773

SECTIONING

IMPLEMENTATION SUGGESTIONS

Assign enough sketches to insure coverage of the various types of sections. These should be "finished" sketches. Less precise sketches, which plan required mechanical drawings, may also be requested.

Films on sectioning are available; although, as of this writing, they may be better for review than for original presentation.

Saw open a large casting or small gas engine to demonstrate sectioning. (The latter can show how such things as screws and shafts are not sectioned.) Outstanding overhead projection transparencies are available on this topic.

The structure and concept of sectioning can be developed by sketching, so it is not necessary to draw all of these sectional views mechanically at this time. Some may be incorporated later in the course in such units as "advanced dimensioning" or "the industrial methods."

A bulletin board showing industrial prints with sectional views emphasizes their importance.

Present this topic, but incorporate it in later units such as "fasteners" (using a prepared assembly drawing with the fasteners missing) or "industrial methods" on an assembly drawing.

The small gas engine previously mentioned demonstrates this well. It also makes a good measuring and drawing problem for advanced students.

INSTRUCTOR'S NOTES

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FASTENERS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Draw a semiconventional representation of an American standard screw thread.	The historical development of fasteners. The theory of the screw thread: 1. Inclined plane 2. Helix Screw thread terms. The function of the various thread forms. The relationship of screw size and pitch. The relationship of pitch and lead. Screw thread callouts and their interpretation.	A perception of the historical significance of fasteners. An appreciation of the utility and adaptability of threaded fasteners.
Draw conventional thread symbols mechanically. Sketch and dimension typical threaded parts using conventional symbols.	Conventional thread symbols.	An appreciation of the timesaving advantages of using conventional symbols.
Sketch and identify a variety of fasteners including head and point variations. Draw a hex head bolt and nut mechanically. Draw semiconventional threads having an uneven number of threads per inch. Draw machine and cap screws mechanically, some with templates. Draw assorted other threaded fasteners mechanically, showing them in appropriate applications.	The categorizations of threaded fasteners. The function and application of various threaded fasteners. The necessary geometric constructions to draw fastener heads and uneven thread pitches. How sizes of fasteners can be found in tables in reference books.	An awareness of the tremendous variety of threaded fasteners. A desire to select fasteners carefully to suit the required application. An appreciation of the useful purpose served by tables which provide sizes for common fasteners.
Sketch and draw mechanically a variety of non-threaded fasteners such as keys, pins, rivets, and springs.	The categorization of nonthreaded fasteners. The function and application of nonthreaded fasteners. Semiconventional and conventional spring symbols.	An awareness of the tremendous variety of nonthreaded fasteners. A desire to select fasteners carefully to suit the required application. An appreciation of the useful purpose served by tables which provide sizes for common fasteners.

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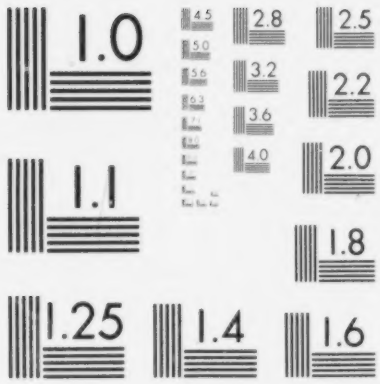

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

FASTENERS

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Demonstrate the theory of threaded fasteners on the overhead projector. Excellent transparencies are commercially available.	
Have students make a mechanical drawing of a threaded fastener using semiconventional thread symbol.	
Assign sketches which require that threads be drawn on parts indicative of the utilization of a particular thread form. (Example: Sketch vise screw showing square thread.)	
Have students draw these symbols on exercise sheets or draw parts other than "common fasteners" which will be studied later.	
Sketch machine parts, adding thread symbols and dimensions.	
Demonstrate fastener categories, using the overhead projector. Transparencies are available and actual screw profiles exemplifying categories or head and point variations can be projected.	
Provide an ample assortment of fasteners for students to see. These can be organized into teaching aids as a student assignment.	
Give skill demonstrations on the geometric constructions necessary and the use of templates.	
A slide series of fasteners in use can be made by photographing pictures in trade journals. A call to an available engineering office will usually provide an ample supply of journals. (The opaque projector can be used if camera isn't available.)	
An assembly drawing with voids at points where fasteners are to be drawn emphasizes application. Students can trace the assembly and add fasteners.	
A slide series on nonthreaded fasteners is effective.	
A collection of machine parts with fasteners in place emphasizes application.	

3776

SHOP PROCESSES AND ADVANCED DIMENSIONING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Convert common fractions to decimals and vice versa. Study a drawing and determine the tolerance on each dimension.	The evolution of dimensioning from common fractions, through decimals, to a prediction for the future. The concept of tolerance: 1. Bilateral tolerances 2. Unilateral 3. Limit dimensions How tolerances are expressed. The significance of assigning both general and specific tolerances. General tolerances: 1. Assigned by note 2. Common fractions and decimals mixed (fractions for rough process, decimals for machining) 3. Varied decimal positions a. one place (0.0) rough process b. two place (0.00) rough machine c. three place (0.000) finish machine Specific tolerances: 1. Supersedes general tolerance note 2. Examples a. Bilateral 1.500 ± .001 or 1.500 + .002 — .003 b. Unilateral 1.500 + .001 — .000 c. Limit 1.500 1.501	An appreciation of the concept of limiting permissible error by specifying tolerance limits.
Identify rough forming processes. Identify finished machining operations. Determine how part features could be machined. Determine the degree of precision to which a part feature can be fabricated or machined. Measure machine parts, using precision tools. Dimension parts made by various rough processes. Dimension features machined by various methods.	The shop processes used in rough forming parts: 1. Process characteristics 2. Process degree of precision 3. Relative cost of process The machining processes used to finish parts: 1. Machine functions and characteristics 2. Machine limitations or degree of precision 3. Relative cost of machine operations Precision measurement and inspection procedures for checking accuracy of shop processes.	An appreciation of the diversity of rough processes and machine functions available for part fabrication. An awareness of the draftsman's role in production control through tolerance assignment. The habit of determining sizes accurately when measuring parts to be drawn. An appreciation of the exactness of modern machined tools.

3777

SHOP PROCESSES AND ADVANCED DIMENSIONING

IMPLEMENTATION SUGGESTIONS

The lectures on this concept should be replete with examples and illustrations of tolerance utilization in industry. The overhead projector works well to implement presentation of these lectures.

Present an ample assortment of fabricated parts to provide examples of how tolerances control production. Student participation should be provided for through job sheets or workbooks requiring the location, interpretation, and specification of tolerance callouts.

Slide series of processes and machines are very helpful in presenting this unit. These can be photos of actual machines or copies of pictures cut from trade journals. (These may also be shown in an opaque projector.)

Films from industry are valuable for this unit.

Have students indicate on job sheets what operations could be used to machine specific features.

Have students accurately measure machined parts and dimension them including probable tolerances.

INSTRUCTOR'S NOTES

NOTE: With a basic understanding of the tolerance concept and an introduction to the fundamental processes of the shop, the student is now ready to comprehend some of the more complex aspects of tolerancing.

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SHOP PROCESSES AND ADVANCED DIMENSIONING—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Determine tolerances and assign them to dimensions.	The effects of tolerance buildup.	An appreciation of the timesaving tables with which a draftsman works.
Calculate the basic sizes, allowance, and tolerances for mating cylindrical parts.	Base line dimensioning.	The habit of assigning tolerances which guarantee part function without unnecessarily raising cost.
	Why positional tolerances are more difficult to maintain than size or form tolerances.	An appreciation of the exactness of modern machine tools.
	Basic-hole and basic-shaft systems of tolerances for mating cylindrical parts.	
	Classes of fit.	
	Process principle vs. function principle of dimension selection and toleranc-ing.	
	Tolerance effect on part interchange-ability.	
	Industrial terminology related to tol-erance size. (Example: "plus or minus a tenth" means ±.0001.)	
Compose and assign feature control symbols.	The concepts and symbols connected with tolerancing form.	An appreciation of form and position tolerancing as a technique useful mainly for large production applica-tions.
Assign modifiers, such as M which means maximum material condition, to control symbols.	Composite form tolerances such as are used in cylindrical and runout measurement.	An awareness of the possible money-saving benefits of this tolerancing system.
Determine and identify datums and relate them to each other.	The concepts of "regardless of feature size" and "maximum material condi-tion."	An appreciation of this system as a supplement to convention dimension-ing.
Relate features and surfaces to datums.	The principles governing the selection of datums.	
Assign true position tolerances.	The concept of "true position" toler-ancing.	
	The compatibility of true position and conventional tolerancing.	
	Why "functional gaging" procedures are used to inspect true position tol-erances.	

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IMPLEMENTATION SUGGESTIONS

INSTRUCTOR'S NOTES

Students will dimension and tolerance a small assortment of interrelated parts. Discuss function of parts and assign tolerances to guarantee part interchangeability. This basic problem may be further studied by utilizing the "form and position tolerancing" mentioned later.

These sketches may be employed as a foundation for the mechanical drawings required in the next unit.

Job sheets are useful for teaching this unit. One sheet for each phase of form and position tolerancing provides an exposure to each idea.

A problem such as the one previously described should be used so that the student has an opportunity to control tolerances which relate to one another. These sketches can then be used for the next unit.

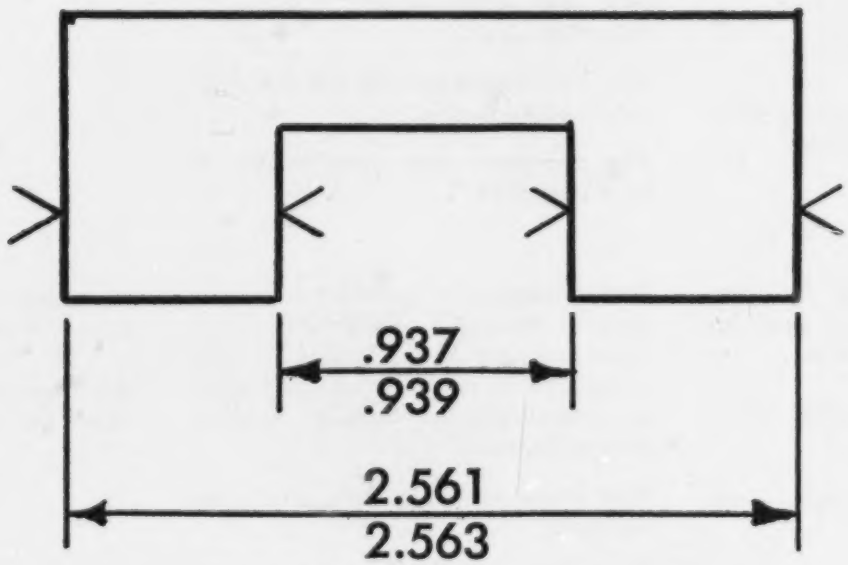

3780

INDUSTRIAL METHOD

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Make detail drawings of machine parts to commercial drafting standards. Make a general assembly drawing. Complete a title block. Make as many as possible of the other drawings specified at the right.	The characteristics and function of the various types of drawings used in industry to control production, including: 1. Design sketch 2. Layout (design assembly) 3. Detail drawings 4. General assembly drawing 5. Working assembly drawing 6. Flow charts 7. Specification control drawing The contents and importance of a drawing title block: 1. Part numbers (importance, sequence) 2. Scale 3. Material 4. Drawing title 5. Signatures 6. Finish The function of engineering in the production sequence. The employment opportunities, job characteristics, and earning potential possible in drafting and engineering.	An appreciation of the manner in which different kinds of drawings used in industry have characteristics and functions which meet specific needs. An awareness of the importance of engineering records such as the drawing title strip. A desire to determine for oneself whether or not drafting or engineering would make a suitable career.
Locate and interpret descriptions of engineering materials and finishes in reference books such as *Machinery's Handbook* by E. Oberg and F. D. Jones. Select materials to suit part requirements. Select finishing materials and/or processing to suit part requirements. Select heat treatments, if any, necessary to meet part requirements.	The characteristics and composition of common engineering materials. The necessity for corrosion control and the materials and/or processes available to accomplish this. How and when to use engineering reference books. How heat treatment changes the characteristics of metals. The processes and terminology of heat treatment.	A habit of using reference books to guide engineering decisions. A feeling of responsibility for part control beyond its size and shape description.
Determine and specify dimensions and tolerances which guarantee part interchangeability and function. Compose and position notes on a drawing. Determine and specify surface quality requirements.	The concepts and procedures for size control through tolerancing. (This understanding should have been well developed in previous units and given an opportunity for thorough application at this time.) How notes control certain production functions. The application and positioning of both general and specific notes. How surface quality is controlled by microinch specifications.	An awareness of tolerance important to a higher degree of sophistication. An appreciation of the function which notes perform on a drawing.

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INDUSTRIAL METHOD

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Illustrate the "industrial method" through a lecture replete with examples of how an industrial problem could be solved. An overhead transparency with a flow diagram showing how an idea passes through engineering would provide structure for this lecture. Examples of the types of drawings employed at each phase of engineering could then be shown.	
A guest lecturer could be utilized to present employment possibilities, job characteristics, and earning potential for draftsmen and engineers.	
Select a drawing problem which includes several detail drawings such as a sub-assembly drawing and a general assembly drawing. Faster students might also draw a specification control drawing, an installation drawing, or drawings in any other category which would be useful for solving the problem selected.	
Discuss part requirements and how to use reference books. Have students determine materials, finish, and/or heat treatment, as required.	Oberg, Erik, and F. D. Jones. *Machinery's Handbook*. 18th ed. Industrial Press, 1968. $16.00; text ed., $13.00; Use of Handbooks, Tables, Formulas, $3.00
A variety of notes can be used on the drawings included in this set. Most assemblies of parts involve many surface quality requirements. This set of drawings should provide for several surface quality callouts.	
This set of drawings should provide ample opportunity for tolerance determination and tolerance buildup analysis.	

3782

AUXILIARY VIEWS AND REVOLUTIONS

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Draw or sketch primary auxiliary views. Complete principal views from auxiliary views. Develop an inclined curved surface in a principal view. Dimension an auxiliary view drawing.	How auxiliary views are used to show true size and shape of inclined surfaces. The selection and positioning of reference planes for symmetrical and unsymmetrical auxiliary views. The relationship of the various auxiliary surfaces to the principal surfaces: 1. Elevation auxiliary surface (top auxiliary) 2. Right or left auxiliary surface (front auxiliary) 3. Front or rear auxiliary surface (side auxiliary) The procedure for developing curved surfaces which do not present their true shape in a principal view. Rules for dimensioning auxiliary views.	An appreciation of auxiliary views as useful additions to the techniques available for graphic problem solving. An awareness of the need to describe all surfaces in their "characteristic" shape.
Draw a secondary auxiliary view. Transfer a curve from a secondary auxiliary view to a principal view.	That secondary auxiliary views are used to draw true size and shape surfaces not perpendicular to any of the principal planes or projection. How secondary auxiliary surfaces are projected: 1. Rotation planes 2. Development of view The method used for transferring curves from a secondary auxiliary view to a principal view.	
Draw a revolution about one axis. Draw a revolution about two axes.	The selection of a rotation axis or axes for revolution of a view or a part of a view. The development of succeeding views by projection.	An appreciation of the value of "revolutions" in determining otherwise obscure true lengths and surface configurations of inclines.
Develop true length of inclined lines and true size and shape of inclined surfaces.	How true lengths of inclined lines can be found by revolution. How true sizes and shape of inclined surfaces can be determined through revolutions.	

3783

AUXILIARY VIEWS AND REVOLUTIONS

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
A film on auxiliary views is an excellent device for teaching this difficult concept.	
A "projection box" with an auxiliary surface is also useful.	
Excellent transparencies on this topic are available for the overhead projector.	
A bulletin board with industrial drawings which include auxiliary views can provide motivation for learning this concept.	
It can be expedient to dimension these auxiliaries with a dimensioning system which has not been studied elsewhere, such as "speed dimensioning, limit dimensions, or metric dimensioning."	
Transparencies for overhead projection are available on this topic.	
Sheet metal drafting can be used to provide a meaningful application of the revolution technique.	
This difficult concept has limited usefulness for the average student and can be utilized as an enrichment topic for faster students.	

3784

PICTORIAL DRAWING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Sketch objects in oblique. Make mechanical drawings in oblique, including cavalier and cabinet drawing. Dimension oblique drawings.	Oblique drawings: 1. Axes 2. Part orientation 3. Circle and arc treatment 4. Procedure for drawing 5. Dimensioning 6. Cavalier drawing 7. Cabinet drawing 8. Sketching procedure	An appreciation of oblique drawing as a simple, approximate form of pictorial drawing.
Sketch objects in axonometric, mostly isometric. Make axonometric mechanical drawings (isometric, dimetric, and trimetric). Draw a 4-point approximate ellipse. Construct an ellipse. Draw an ellipse using a template. Dimension an axonometric drawing.	Axonometric drawings: 1. Relationships of the three categories included — isometric, dimetric, and trimetric drawings 2. Axes for each category 3. Circle and arc treatment a. Template applications b. Approximate ellipses c. Plotted ellipses 4. Procedure for drawing 5. Dimensioning 6. Sectioning 7. Sketching procedure	An awareness of the variations in axonometric positions and the flexibility of this drawing form because of this. An appreciation of the timesaving advantage of templates.
Sketch objects in parallel and angular perspective. Make mechanical drawings of objects in parallel and angular perspective. Develop circles and arcs in parallel perspective. Develop an ellipse in angular perspective.	Perspective drawings: 1. Principles of perspective concept 2. Terms used in perspective drawing 3. Parallel perspective (one point) a. Drawing procedures b. Determination of variables c. Circle treatment 4. Angular perspective (two point) a. Drawing procedures b. Determination of variables c. Circle treatment 5. Sketching procedures	An appreciation of perspective drawing as a form useful in representing large objects as they would appear to the eye.
Pencil shade a pictorial drawing. Air brush shade a pictorial drawing. Make an exploded pictorial drawing.	Shading: 1. Pencil 2. Air brush Exploded view drawings.	A basis for comparison of the pictorial drawing forms studied.
Select the pictorial drawing form best suited for solving a particular problem.	The advantages, limitations, and applications of each of these pictorial drawing forms.	The habit of selecting the pictorial form best suited to solve a drawing need.

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PICTORIAL DRAWING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Demonstrate oblique drawings, using the overhead projector or blackboard.	
Start students sketching simple objects and build up to a "term sketch" of some household or industrial item suitable for oblique representation.	
Assign some mechanical oblique drawings.	
Excellent transparencies of this topic are commercially available.	
Have students sketch a series of objects from simple blocks to a "term sketch." Begin with a grid, but do some sketches without it. It works well to have students make the first sketch on grid paper while the instructor sketches it on the same grid placed on an overhead projector.	
Assign mostly isometric drawings, using dimetric and trimetric for faster students or advanced classes.	
Have students sketch a series of objects.	
Students usually enjoy measuring and drawing objects from the room, such as their desk or a blueprint machine.	
Demonstrate pencil shading and air brush shading to small groups.	
Air brush work can be used as enrichment for faster students.	
Shade objects previously drawn in this unit.	
Have students make an exploded drawing.	
Develop a worksheet of objects to be drawn pictorially and have students indicate the best pictorial form for each instance.	

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ELECTRONIC DRAFTING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify electronic symbols. Describe the function of each electronic component studied. Draw electronic component symbols without templates. Draw electrical component symbols using templates.	The function and identification symbols of basic electronic components. That there are typical patterns for placing these components in a circuit. That templates are readily available for making electronic drawings.	An appreciation of the role of symbolism in electronic drafting. An awareness of how electronic circuits can be reduced to individual component functions by groups of components.
Draw a wiring diagram. Draw a block diagram. Draw a logic diagram. Draw a schematic diagram.	The variety of electronic drawings in use and the application of each: 1. Wiring diagrams 2. Block diagrams 3. Logic diagrams 4. Schematic diagrams a. Tube circuits b. Transistor circuits Layout procedures for the preceding drawing forms: 1. Spacing requirements 2. Standards governing electronic drawings 3. Construction steps Drawing procedures for the preceding drawings: 1. Lineweights 2. Template applications 3. Mechanical lettering applications 4. Inking procedures	An appreciation of the need for drawings to control and record the planning, production, and assembly of electronic devices. The habit of making electronic drawings neat and well-proportioned. An awareness of the role of national standardization organizations in electronic drawing.
Lay out component positions on a printed circuit board. Tape a printed circuit board.	The function of printed circuits in electronics. Layout procedures for printed circuit artwork: 1. Spacing requirements 2. Taping procedures 3. Computerized board layouts The types of circuit boards: 1. Single side 2. Two side 3. Laminated How printed circuits are made. Computerized board layout.	An appreciation of the simplicity of printed circuit boards as compared to hand-wired assemblies. The habit of laying out printed circuit boards carefully and accurately.
Make the drawing for an integrated circuit.	What integrated circuits are and how they are made. What drawings are required to make an integrated circuit.	An appreciation of the potential applications of integrated circuits.

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ELECTRONIC DRAFTING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Develop job sheets for component identification and for adding symbols to voids in schematic diagram.	
Demonstrate how to draw component symbols with and without templates.	
Provide charts with actual components shown next to their symbols.	
There are a variety of wiring diagrams in use today. Select a common form to draw, but point out how it resembles other forms available.	
Block diagrams are very simple and can be used as exercises for inking lines or mechanical lettering.	
Logic diagrams provide an opportunity to inject some computer study into the course.	
Have students make a mechanical schematic from a complete sketch.	
Have students revise a schematic which is crowded or poorly arranged.	
Have faster students ink a schematic.	
A field trip to an electronics firm gives meaning to these drawings.	
Position components on a printed circuit board and have students interconnect them according to a schematic provided.	
Have students position components and tape a printed circuit board from a schematic or logic diagram. This is more meaningful if it is a schematic previously drawn.	
Demonstrate board taping to small groups.	
Take a field trip to a printed circuit manufacturing company.	
Provide samples of printed circuit boards for students to study.	

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PROCESSES FOR CREATIVITY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Solve problems independent of direct teacher control.	The problem solving method. Design steps. The use of library resources.	Resourcefulness in solving problems independently. An appreciation of the usefulness of a step-by-step procedure for solving problems. An appreciation of the value of a library as a source of reference material.
Design a product and make the necessary drawings to control its production. Create tooling to implement production of the designed product. Develop process sheets and flow charts to route production through the shop. Create inspection tools. Make and record revisions on a drawing. Organize a company to promote the manufacture of the designed product.	The types of drawings used to control production. Engineering records, other than drawings, which control production. How tooling can be used to expedite production and improve interchangeability of parts. Inspection tools and procedures. Mass production techniques. How a company is formed and operated. The role of capital in our economy.	An appreciation of industry. An increased awareness of economics in industry.
Design a piece of tooling.	The fundamentals of tool design. The procedural steps in drawing a tool. (Problem solving as related to tool design.) How to locate and select steels and standard parts from suppliers' catalogs.	A desire to participate in creative functions of industry. An appreciation of how large problems can be solved by working with one small portion at a time.
Modify an existing product or design a new product.	The steps employed in product design (problem solving as related to product design). The fundamentals of aesthetic design. Material characteristics. Fabrication processes.	An appreciation of the complexity of product design. A desire to participate in the creative functions of industry. An appreciation of the desirability of studying related subjects such as math, science, and other industrial education courses.

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PROCESSES FOR CREATIVITY

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
The fields of engineering and drafting are too diverse to make it possible to include all of them in the drafting curriculum. Such topics as topographic drafting, aeronautical drafting, road and bridge drafting, product design, and patent drafting are samples of the fields which are available. This unit works exceptionally well with advanced or enriched classes.	
This unit is ideal for team teaching with some other shops. Design and draw up the product in drafting; have another shop build it.	
Films on mass production techniques are readily available from industry.	
A variety of guest speakers on related topics can be used at this time. (Labor unions, management, engineering, and economics are some of the topics on which speakers could be invited to talk.)	
Demonstrate tool design principles such as locating and clamping.	
Have design drawings and actual tools or pictures of tools available for study by students. (Contacting local industries can usually provide drawings and obsolete tooling; otherwise industry may allow you to photograph tooling which they must retain.)	
Have catalogs on steel and tooling components available.	
Use many films. They are available on such topics as aesthetic design, industrial designing, a variety of materials, industrial processes, and creativity.	
There are many ways to approach this problem such as: 1. Present a product to the class which has not been well designed; have them improve it. 2. Present a problem to the class and have them design a product to solve it. 3. Let each student determine his own product to design.	
Students can be grouped into teams with the better individuals designing and others detailing.	

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ARCHITECTURAL DRAWING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Identify those occupations which need to read and interpret architectural plans.	How tradesmen, contractors, estimators, and inspectors use architectural plans in their work.	An appreciation of a set of architectural drawings as a thorough plan for constructing a building.
Identify architectural periods.	What kinds of information are included in a complete set of house plans. What factors influence various architectural periods.	An appreciation of period styles of architecture.
Plan rooms individually. Assemble plans of each room into a floor plan arrangement. Make a finished sketch of the floor plan, including furniture. Determine room sizes and overall dimensions for house.	The function, characteristics, orientation, and size of each room in a contemporary home. Room organization by areas: 1. Living 2. Service 3. Sleeping Traffic patterns. Sketching procedures and techniques.	An appreciation of the desirability of developing a floor plan to suit the needs of a particular family. A desire to employ contemporary design principles in room planning.
Read and interpret a plot plan drawing. Position the house design on a lot. Position such details as walks, driveway, and utilities. Redesign lot contour if necessary to suit design.	Location plan functions: 1. Plot plans 2. Landscape plans 3. Survey plans Location plan symbols. Dimensioning procedures. Rudiments of surveying. House orientation relative to sun. Local property values. Local building ordinances dealing with structure orientation.	An appreciation of the aesthetics of matching an architectural design to the property characteristics. A desire to consider all factors before determining house orientation. An appreciation of the factors influencing property values.
Draw and dimension a floor plan.	Architectural lineweights. Floor plan symbols. Architectural scales. Architectural lettering. Floor plan drawing sequence. Floor plan dimensioning.	An appreciation of scale drawing. An appreciation of architectural symbolism.

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ARCHITECTURAL DRAWING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Use a movie or a slide series showing how various occupations use information included in a set of plans.	
Have sets of building plans available for students to study.	
Show slide series of architectural periods.	
Discuss traffic patterns as well as function and characteristics of the various rooms. Slides or magazine pictures (shown on opaque projector) can stimulate student's creativity in room planning.	
Provide furniture "cut-outs" and grid paper for room layout.	
Cut out room designs and assemble into floor plan best suited to room designs.	
Introduce students briefly to those factors in house construction (such as load-bearing walls or trusses) which may influence design.	
Students can finalize plan with a sketch of entire plan with furniture positioned.	
Provide students with a plot plan of an interesting piece of property. (Local architects can provide one.) Have students position house to take advantage of property assets.	
Remind students to consider the effects of such things as contour and orientation on basic elevation design.	
Have students make a completed drawing of their plot plan.	
A field trip to an interesting building site can arouse imagination.	
Use a slide series of some houses which blend well into their surroundings and some which don't.	
Arrange for a landscape architect to talk to the group.	
Students who have trouble drawing an entire floor plan may draw one room at a time and later incorporate them into a complete plan.	
Provide students with sets of local architectural plans to study.	

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ARCHITECTURAL DRAWING—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Determine fundamental elevation best suited to floor plan design. Determine roof type best suited to evaluation design. Locate openings on elevation and blend into design effect. Develop elevation emphasis with color and material accents. Draw various elevations mechanically.	The fundamental elevation shapes such as one story, split level, and bilevel. The basic roof types such as shed, flat, hip, and gable. The characteristics of materials which emphasize elevation. How consistent horizontal or vertical emphasis lines are created. The effects on balance of mass, light, shade, and landscape.	An imaginative approach to solving elevation design problems. A desire to experiment with different solutions to an elevation design.
Identify building materials and their symbols. Draw a transverse section showing necessary dimensions and sizes of structural members.	The characteristics and applications of common building materials. Foundation types. Residential skeleton framing. Cornice variations. Nonstandard construction: 1. Post and beam framing 2. Steel framing 3. Thin shell concrete construction Structural ties (sheathing and bracing). Protective coverings (siding and roofing).	An appreciation of house construction methods and material applications. An awareness of the influence of construction requirements on design.
Draw standard details: 1. Kitchen 2. Bathroom 3. Stairs 4. Windows 5. Fireplace	How kitchen cabinets are constructed. Standard sizes for detailed items such as cabinets, windows, and doors. Template applications in detailing. Bathroom accessories. Stair construction. Window construction. Fireplace construction.	The habit of planning thoroughly by detailing all areas not completely described in the floor plan or section. The habit of using templates whenever possible.

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
A series of slides showing houses which are well designed and which are poorly designed.	
Excellent transparencies are available on elevation design.	
Discussion of builders' brochures which are projected with the opaque projector. Pictures from magazines can be used in the same way.	
Provide samples of building materials to show students.	
A slide series of houses in various stages of construction helps students understand the fundamentals of house construction.	
Have students build a model house using scale components.	
Have students locate items (such as appliances, windows, and bathroom fixtures) detailed in suppliers' catalogs or Sweet's catalogs.	*Architectural Catalog File: A Classified Collection of Manufacturers' Catalogs.* 10 to 15 volumes in a set. Available from Sweet's Catalog Service, F. W. Dodge Company, Division of McGraw-Hill, 330 West 42nd Street, New York, New York 10036.
Use templates and drawing underlays as much as possible.	
A trip to a cabinet shop or school woodworking shop helps students understand cabinet construction.	

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ARCHITECTURAL DRAWING—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Develop a door and window schedule. Develop a materials schedule. Develop the necessary specifications.	How to specify windows and doors on a schedule. How a schedule can be used to control material specification in room finishing. Building codes. Function or specifications. What is included under specifications.	An appreciation of how schedules are used to insure that finishing is completed as planned. An appreciation of how specifications are used to control construction requirements.
Design, draw, and render an exterior perspective of a house. Make a model of the house designed.	Steps in making a perspective drawing. Rendering principles and techniques. Model building procedures.	A desire to see one's design in a three-dimensional state, either as a model or a pictorial drawing.

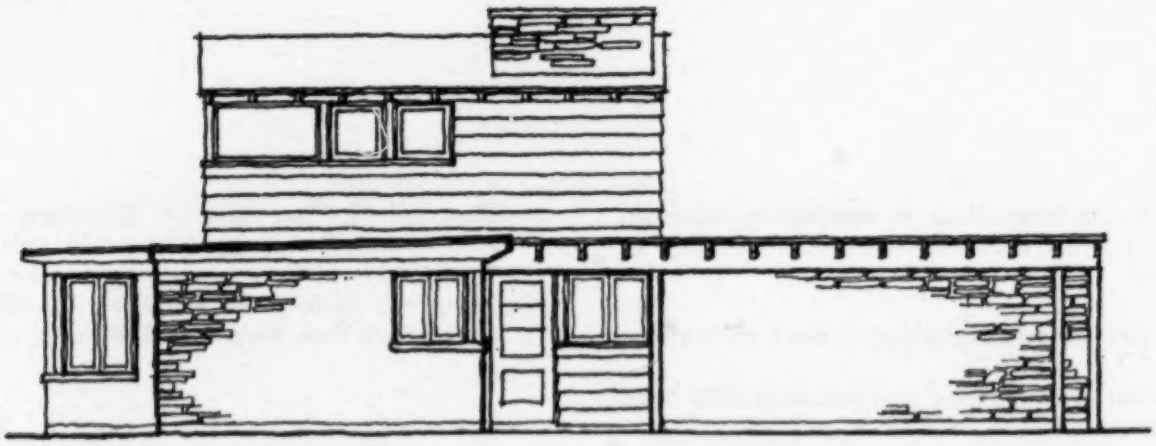

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GRAPHIC ARTS TECHNOLOGY

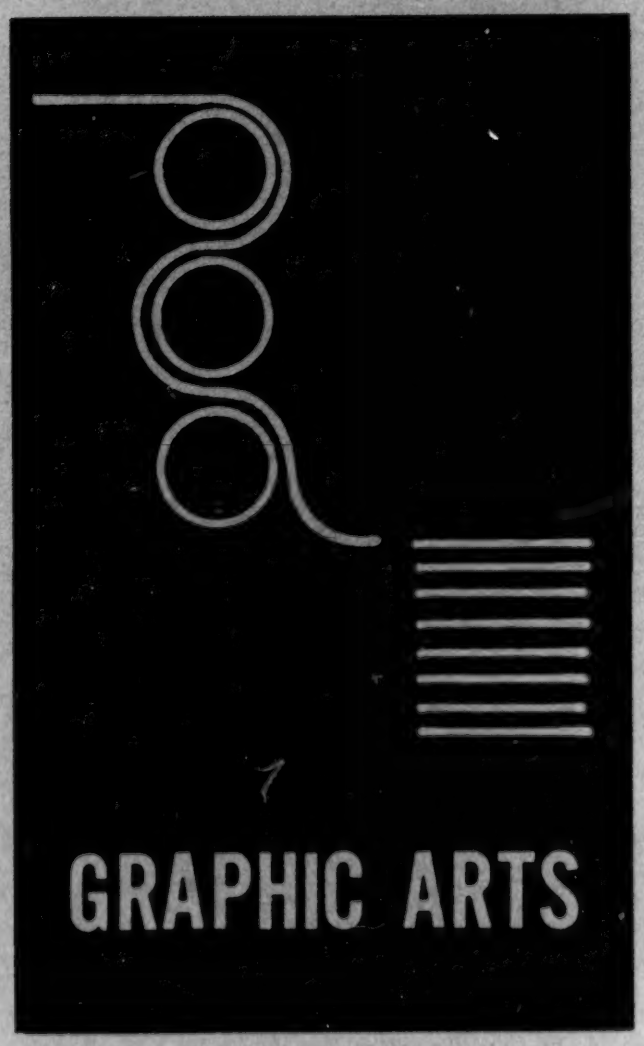

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INTRODUCTION

Graphic arts technology has extended from hand set printing to processes which include photography, static electricity, and the computer. Minnesota has become a leading center of the graphics industry. Because of the impact that graphic arts has on the life of the individual, every student should be encouraged to participate in at least one course.

This resource guide presents some of the processes used in the graphics industry. Certain innovative procedures to be used in presenting the material to the students are also included. Because of the ever-changing nature of graphic arts, each individual unit must be considered as a starting point for ideas. The teacher is encouraged to select as much material as possible from this guide and to enlarge the unit to meet the needs of students in their particular classroom situation.

Creative activity by the student is to be encouraged and emphasized. Situations can be developed in which creativity enhances student interest and activity. Equipment and supplies need not be expensive or elaborate. It is important both that the student experience the processes involved in graphic arts and that the student know the impact of graphic arts on modern society.

BASIC COMPOSITION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Illustrate parts of type.		Appreciation for standards in type sizes.
Understand and use printer's measurement.	Units of measurement for graphic arts.	Awareness of measurement other than metric or linear.
Handle spacing material.	Ratio of spacing material, smallest to largest.	Ease in justification.
Use California job case.	Functional layout of type case.	Proficiency.
Practice typesetting.	Necessity of reading lines in stick before final justification to avoid errors.	Checking techniques.
Typesetting.	Direction and markup have to be followed exactly for perfect copy.	Work procedures.
Justification.	Spacing is based on a percentage system on the em space. Proper justification can avoid "rivers of white."	Spacing and justifying techniques.
Composition using spacing rules.	Excellent typography is based upon the effective use of space.	Appreciation for the effective use of white space.
Proofing.	Need for type on its feet. Excess ink will cause smudging. Reproduction proofs should just have a slight amount of impression. Dried ink on type will cause imperfect proofing.	Appreciation for clean proofs.

BASIC COMPOSITION

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Sketch, freehand, a piece of type. While drawing freehand, hand out 72-point piece of type. Use the relationship of parts to the parts of the human body. For testing, provide outline of type (just the corners) and have students fill it in.	
Measure type, rules, and slugs. Provide worksheet on such problems as changing picas to points and inches to picas.	
Illustrate the proportional idea of spaces. Combinations can produce larger or smaller spaces as the case may be. Set row of each size of space in composing stick, nicks up.	
Provide blank outlines of California job case. Place the symbols of the lower alphabet in their proper compartments. Caps are in order except J and U. Define ligatures. Aid learning by nonsense sentences such as "Be careful driving elephants into small Ford garages" and "Let me now help out your punctuation with commas."	
Set up a practice typesetting sheet of approximately 10 lines. Lines should include various spaces, centering left and right, quotation marks, and caps. Justify lines.	
Set three complete names and addresses—one centered, one flush left, and one flush right. Place large quads on the outside with the 4 or 5 em spaces near the letters. Demonstrate setting up, stone and galley proofing, and distribution.	
Demonstrate justification by changing spacing to larger or smaller sizes. The line has been justified when it will stand alone in composing stick. Emphasize that all lines should be about the same degree of tightness.	
Review spacing rules concerning sentences, between word spacing, and paragraph indentation. Show "rivers of white" sample of poor spacing. Close spacing is better than wide-open spacing. Letter spacing is used on some occasions to aid in justification.	
Demonstrate correct proofing. Stress that washing solvents have to meet the fire department's approval.	

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BASIC COMPOSITION—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Proofreading.	Need for printer's shorthand. Symbols are almost universal in use. Final OK from customer is usually necessary.	Speed and accuracy.
Mitering.	Mitering produces corners that are well joined and show no breaks. Some rules and borders require premeasuring so one will not miter on a center of a design.	Precision measurement.
Simple composition using markup.	Markup will give all the details necessary to produce correct composition. Design usually follows a pattern such as formal, informal, or modern. Using more than two type families causes poor typography.	Appreciation for good type design.
Multiple justification.	Multiple justification cuts composition time. Corrections usually require rejustification except for numbers. Accurately cut slugs are needed when doing this.	Appreciation for labor-saving techniques.
Type classification.	Type identification is usually based upon the shape of the letter. Type faces are generally divided into six major classifications.	Recognition ability for various types.

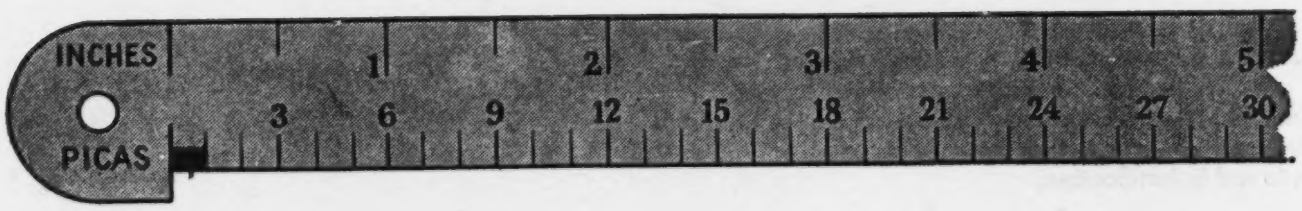

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Discuss and illustrate proofreader's marks. Use on all corrections. Test memory by sight as well as meaning.	
Demonstrate mitering machine; use slow even strokes against the rules or borders. Space out with solid material when possible. Corners fit better when rules are cut one-half point larger.	
Specify a small name card or business card. Use cut when possible and appropriate. Produce six thumbnail sketches of job before starting final one. Instructor and student pick out the best one. Go over type sizes and width measurements and the reasons for them. Have samples of past work produced. Break form for color if desired.	
Design a job that has two or more alignments in single line. Numbers and headings work well. Use local election results by wards or county results by townships or cities. Can also use the names and legislative districts of state representatives or senators.	
Illustrate parts of the face which usually aid in identification, such as serifs, full body strokes, and shape. Use several pages of magazines to identify the six classes of type.	

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BASIC DESIGN

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Lay out dummy booklet.	Basic design follows rules and patterns.	
Modern layout.	Concept of white space. Modern design contains contrast but with simplicity.	Aesthetic appeal.
Formal and informal layouts.	Major differences between both styles. Shape of design helps to create style.	Recognition ability.
	Unity and proportion complement each other in good design. Contrast is an effective method of obtaining pleasing design.	Awareness of golden proportion.
Add subtle effects to printed piece.	Rules, borders, or decoration add dignity to a printed piece if used adroitly.	
Select type faces.	End use of job is the major factor in determining type selection. Each type has its own personality.	Appreciation for good type styling selection.
Do a pasteup from a dummy copy.	Dummies serve as guidelines for finished work. Pasteup serves as copy ready for camera. Correct alignment of all parts of ad is essential; one crooked line will spoil entire job.	"Eye" for alignment.

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BASIC DESIGN

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Produce 16-page dummy book from 25 x 38 sheet of book paper. Use contrasting construction paper to represent illustrations and another color to represent block of type. Strive for effective use of white space and formal, informal, and modern design.	
Have samples of modern layout. Show effective use of bleed cuts and unusual size-space relationships.	
Produce simple ads using both formal and informal design. Use the same copy for both; compare. Illustrate the use of lines which are horizontal, vertical, off center, split, cut in, and unjustified.	
Show samples of printing which is out of proportion or uses too much reverse plate. All display is no display. Mixture of too many faces is difficult to read.	
Illustrate and display what borders can do for a job. Borders that are too heavy will outdraw copy. Get sample from weekly newspaper.	
Distribute type catalogs and have students select type for a relatively large job. Pick out headings, body copy, or lead-in lines. Go over selections. Show markup techniques.	
Paste up on hard-surfaced stock so the fibers do not lift off with the adhesive in case some copy must be lifted. Mark all guide lines. Put some copy in using a French curve or circles.	

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PLATEN PRESSWORK

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Historical background of letterpress printing equipment.	Appreciation for technical progress.
Practice feeding by hand.	Function and operational capacity of platen presses.	Safety feeding habits.
Imposition.	Proper lockup procedures. Use of sinkers to avoid workups. Dummies aid in placing the forms in the proper sequence.	
Change packing.	Different jobs require different packing according to length of run and stock printed. Cutting corners on tympan sheet will aid in drawing it up tight.	Judgment for selecting proper packing.
Ink press.	Split ink disc aids in even distribution of ink. To avoid buckling in ink fountain, start settings from center.	Correct procedures.
Placing form and obtaining position.	Necessity of checking form for lift before removing from stone. Bottom guides are best set one-fourth of way from end of stock.	Appreciation for proper lockup.
Set and seal pins.	Pins should only go through tympan sheet. Excess sealing wax causes inability to move sliding tongue.	
Placing of grippers and fingers.	Fingers and grippers aid in stripping the stock from the form. Their use increases the safety factor.	Caution when using press aids.
Makeready.	Proper makeready is indicated by smooth, even impression on reverse of sheet. Excess impression wears out the type. Sometimes it is necessary to build up behind the type form.	Appreciation of a proper makeready job.
Feeding printing stock.	Each kind and finish of stock will feed differently. Small lifts will help to avoid offsetting. Sandpaper placed on operator's fingers reduces the chances of smudging with fingers.	Sense of "feel" for a variety of stocks.

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PLATEN PRESSWORK

IMPLEMENTATION SUGGESTIONS

Using overhead projector, show illustrations of old type presses, platen as well as rotary and mechanically fed presses.

Individual instruction on feeding. Emphasize that misregistered sheets or sheets that have fallen from pins are NOT to be retrieved.

Demonstrate two types of lockup—chaser and furniture. Point out sections that usually cause binding and spring. Practice elementary lockup with old cut first rather than with type.

Show why anchor sheet has to be held securely to hold makeready sheet. Filler sheets should be cut smaller than platen size. Use just a few fill sheets, more can be added later as impression requires.

Demonstrate inking the disc. Start with a small amount of ink as it is easier to add more.

Mark off paper for width of form and fold to balance the side margins. Estimate top and bottom margins. Mark lines with pencil on tympan.

Start pins one-fourth inch below the line to have pins snug when in proper position. Seal pins with sealing wax.

Show visually the alignment of grippers placed to miss the form. Tighten nuts securely as vibration may loosen them. Because grippers close before the platen does, remove hand quickly.

Show stab marks in tympan while sheet is resting on its three guides. Use enough pressure to mark anchor sheet only and not through to metal platen. Draw makeready patches on reverse side of sheet. Build up with proper weight of stock; paste in open areas only if possible.

Give individual attention during the running of the first few live jobs. Emphasize safety factors. Stress quality on later jobs.

INSTRUCTOR'S NOTES

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PLATEN PRESSWORK—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Mechanical feeding of printing stock.	Feeding setting must be accurate to feed properly. Thickness of stock requires changing of pile high gauge. Doubles can be avoided by using a low pile and ample air separation.	Appreciation for fine adjustments on feeding mechanisms.
Proper hand washup.	Proper care during washup will result in a longer life for press rollers. Ends of rollers are the most important parts to clean as dried ink buildup rapidly appears here. Place solvent on cleaning rag to avoid "drippings" on the inner parts of the press. Power must be off during cleaning for safety. Solvents used must meet fire department's approval.	Cleanliness during cleaning operations.

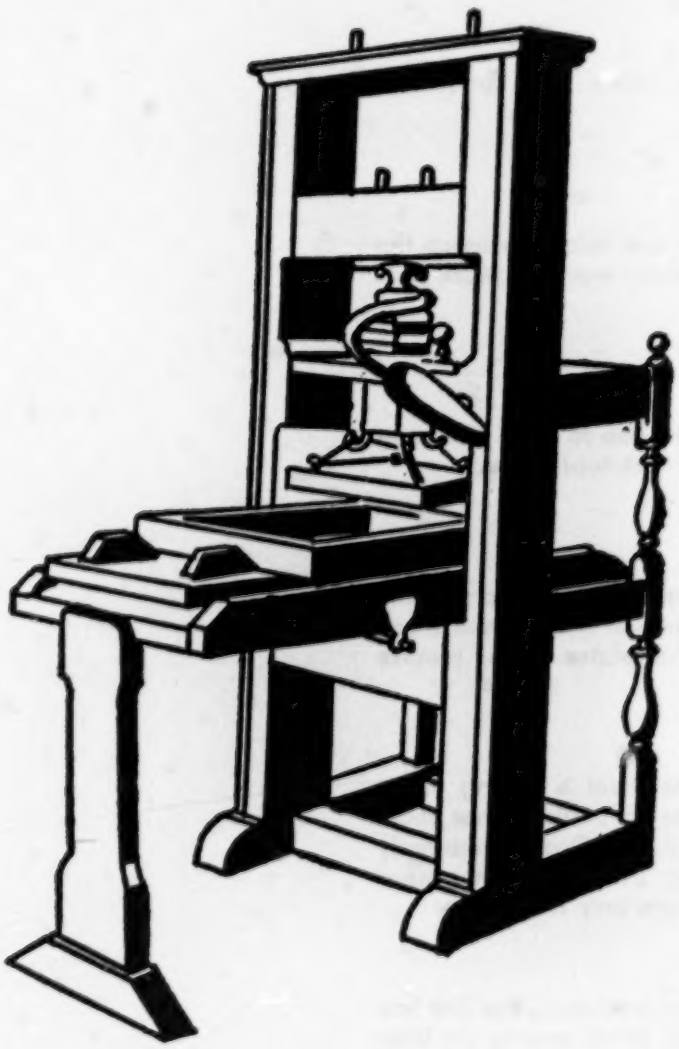

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Feed through several lifts of various types of stock with the use of a form. Watch for doubles.	
Demonstrate proper hand washup. Use semiclean and semidirty rags to get most of the ink off. Finish up with a small new rag for final touchup. Fold rags so palm of hand does not get full of ink; refold rag so dirty spot is inside. Pour solvent on rags only, not directly on press rollers. Show proper storage of rags and reason for it. Limitations to amount of solvent kept in shop are determined by fire department regulations or suggestions.	

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PAPER AND INK

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Historical development of the process of papermaking.	Appreciation for advancement of techniques in papermaking.
	Difference between offset and letterpress printing inks.	Selectivity.
Test for grain direction. Test humidity.	Fibers determine quality and use of paper. Folding qualities of sheet should be noted. Also note reaction of humidity on stock.	Test techniques.
	Grain direction creates bindery problems mainly because of bulk at seam.	
	Use of various types of paper. Final use often determines the type of paper used.	
Paper calculations.	Mathematical formula is used.	Accuracy.
Cost procedures.	Pricing. Packaging from mill in standard lots. Value of standard size and weight.	Purchasing requirements.
	Purpose of watermarks and laid paper; how they are made. Subtle watermarks add dignity.	
Simple design.	Simplicity is effective design.	
Production of sample paper book.	Paper classifications.	
Mixing and matching of inks.	Ink colors do not act the same as the light spectrum. Need for different ink for color harmony.	

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PAPER AND INK

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Schedule report or early paper manufacturing. Group students in pairs to work on separate periods, such as 1850 to 1900, European or American.	Contact any large paper company's public relations department about the possibility of obtaining a brochure on their papermaking process. Arrange a field trip if possible.
Absorb ink into sized and unsized paper stock. Use several varieties of ink and colors. Note rate of drying.	
Draw fibers to illustrate how they appear under a microscope. Compare bond, book, kraft, or other types of paper.	
Fold various types of paper to determine grain direction.	
Show samples of different methods of printing on many grades and weights of paper. Stress finish.	
Stress calculating and cutting to avoid waste.	
Price a complete job. Give formula to get weight of number of sheets. Stress suppliers' breaking point on cost of materials.	
Collect samples of various watermarks.	
Have students create and sketch a watermark of their own design.	
Divide booklet into major paper classifications such as book, bond, cover, and specialty. State standard size, weight, color, and finish. Test with open book test and from sample book; later test just by sight and feel alone.	
Produce color wheel; provide blank outline form. Show colors made from mixing two secondary colors. Students should learn dimensions of color—hue, value, and chroma—and also know about modern matching of ink by light reflection.	

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PAPER AND INK—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Process color work.	Importance of dot structure. Ink density. Alignment.	Press cleanliness.
	Need for proper sequence.	Plate-marking techniques.
Handle ink correctly.	Oxidation, penetration.	Ink-saving techniques.
Add ink additives on proper occasions.	Need for ink adjustments. Specially compounded inks are sometimes needed.	
Overprinting and underprinting.	Transparent and opaque inks. Gold and silver inks have unique structure. Covering power of inks.	Creative effects by the use of various inks.

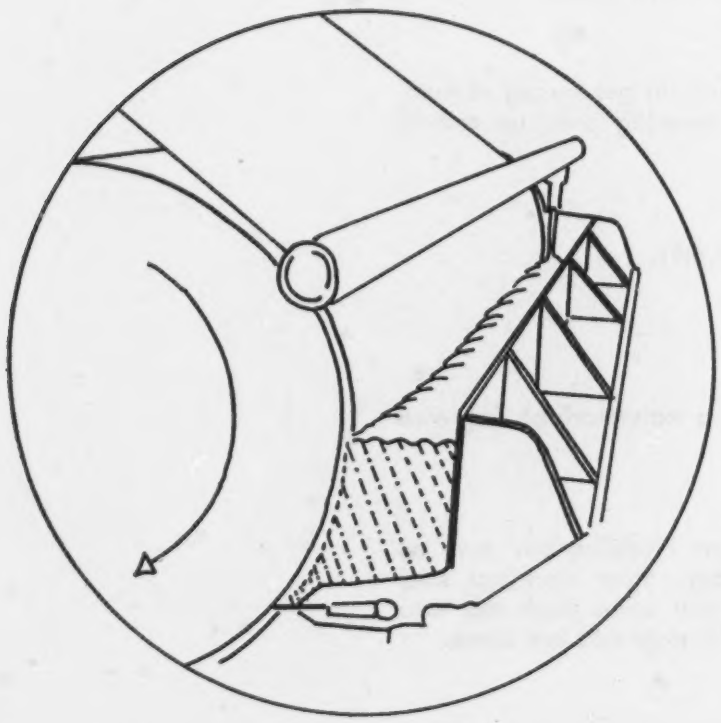

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Produce a process color job. Watch density of ink on first two colors. Press has to be absolutely clean. Wash for color at least once.	
Run colors in the wrong sequence or two of the process colors for the wrong plate.	
Show proper skimming of ink can.	
Purposely add extra amount of modifiers at end of run to show dramatic effect of their overuse.	
Show correct mixing of gold and silver ink. Show samples of same that were not mixed properly. Give reason for the ink not being premixed.	

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BINDERY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Stock estimating.	Cost and time factors in estimating. Allowances for machine preparation. Breaking point in purchasing stock. Obtaining the greatest number out.	Habits of accuracy.
Simple embossing.	Male and female dies and their relationship. Blank embossing adds effective design. Much pressure is required which may break the fibers.	
Perforating and slitting.	Necessity of solid base to obtain sharp separations. Hand operation more difficult as well as dangerous. Grippers and fingers are usually necessary during operation.	Safety habits with grippers and fingers.
Drilling and punching.	Sharp tools are a necessity. Most machines can be set up for step and repeat work with adjustable guides. Accurate stock positioning is necessary.	
Die cutting.	Metal sheet under tympan will save platen and produce better work. Great amount of pressure is needed to go through certain types of stock.	Safety habits with production techniques.
Stitching.	Types of adjustments necessary to change from saddle to side stitch. Cutters on machine must be sharp so wire will be driven through stock. Heavier stock requires a stronger wire.	Fastening techniques.
Collating.	Hand collating is costly. Stock can be obtained that is already in sequence. Money can be saved by farming out to those that have the proper equipment.	

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BINDERY

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Estimate several sample jobs. Include an extra amount for spoilage. Figure the breaking point on paper purchase. Each operation will require extra sheets to get machine in proper operation.	
Set up embossing dies, male and female. Check alignments. Do not leave press lock on impression. Look up press recommendation on how to handle this properly.	
Explain the various uses of type high, over type high, and under type high perforating rules. Place thin metal strip under packing to aid in making perfect separations. Teeth are numbered in units per inch. Rules are made from carbon steel.	
Set up card that has several sizes of holes spaced at a predetermined distance. Demonstrate hand sharpening of drills. Avoid undue stress on paper stock.	
Place thin metal sheet under packing when die cutting in order to produce sharper cuts. Nick rule with screwdriver so stock will remain on sheet while in press; press out later.	
Produce booklet with side and saddle stitching. Make sure stitches are not in trim line. Stitches should just about touch when bent over. Booklet could be preprinted with copy so one can check such things as folds.	
Collate several forms in sequence. Have sheets numbered and in different colors. Can use expandable rack or show position on gathering table for best results.	

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PHOTOGRAPHY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Construct pinhole camera.	History and evolution of photographic instruments.	Appreciation for technical progress.
Handle film correctly.	Sloppy habits cause additional problems later on.	Patience.
Check camera f-stops and lens.	Need for accurate records of settings.	Test techniques.
Develop negative and print black and white photograph.	Kinds and types of developers. Depth of field. Focal length. Understand use of a variety of light meters, American Standards Association (A.S.A.) ratings, and exposure value scales.	Self-reliance. Habits of cleanliness. Correct work procedures.
		Sense of appreciation for quality photography. Knowledge of the great photographic masters.
Flash photography.	Kinds of flashes and reflectors. Advantages and disadvantages of each. Electronic and bulb type. Recharging procedures.	Caution when using bulbs.
Enlarge photographs.	Relationship between light and distance. Use of test strip. Need for different kinds of papers, weights, and finishes. Polycontrast.	Caution when working with chemicals. Resourcefulness.
Take abstract or free form photographs.	Necessity of accurate focusing. Use of cable release.	Creativity.
Time exposure photography.	Why distance from light source is important. Wide angle lenses for certain types of photography.	A sense of eye appeal in photographic composition.
Still life photography.	Klevin degrees and types of lenses for variety of work. Need for different kinds of film. Role of shadows in design. Bounce techniques.	Display and set up techniques. Photographic imagination.
Available light photography.	Changing A.S.A. ratings via different developing with Aquafine or Dinafine.	Unusual camera techniques.

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PHOTOGRAPHY

IMPLEMENTATION SUGGESTIONS

Diagram parts of camera or construct simple pinhole camera.

"Dry run" the feeding of film in camera and developing canisters. Load in daylight and in total darkness. Repeat until done effectively.

Show the interrelationship of the f-stop and time. Suggest use of tripod to be able to test slower speeds without camera movement. Record exposure for each picture. Use same copy for all photographs. Develop and check with magnifying glass.

Detail first camera assignment. Stress design. Suggested subjects include people at work, kids at play, contrasting shadows, architecture details, buildings of unusual design, or churches.

Review the works of some great photographers.

Show samples of the various types of flash. Demonstrate electronic flash.

Form pendulum with pen light on string in darkroom. Change pattern by placing tension on string.

Take a night photo with tripod. Suggest public buildings, churches, traffic patterns, airports, or homes. Parts of buildings can be subjects also.

Use two to five lights with reflectors, diffusion panels, and bounce techniques. Photograph products such as glassware, clothing, or other unique items. Two or three students can work on job together.

Take classroom pictures or pictures of people at work. Open up lens to short depth of field. Need higher speed to avoid "human wiggle."

INSTRUCTOR'S NOTES

Many free technical aids for instructors and students are available. Ask to be placed on the mailing list of:

Eastman Kodak Company
School and Youth Services Department
343 State Street
Rochester, New York 14650

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PHOTOGRAPHY—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Color photography and developing.	Nature of reversal film. Color harmony. Proper background.	Accurate temperature control. Design arrangements.
Presentation mounting.	Pleasing mounting adds to finished product.	Informal design in mounting.

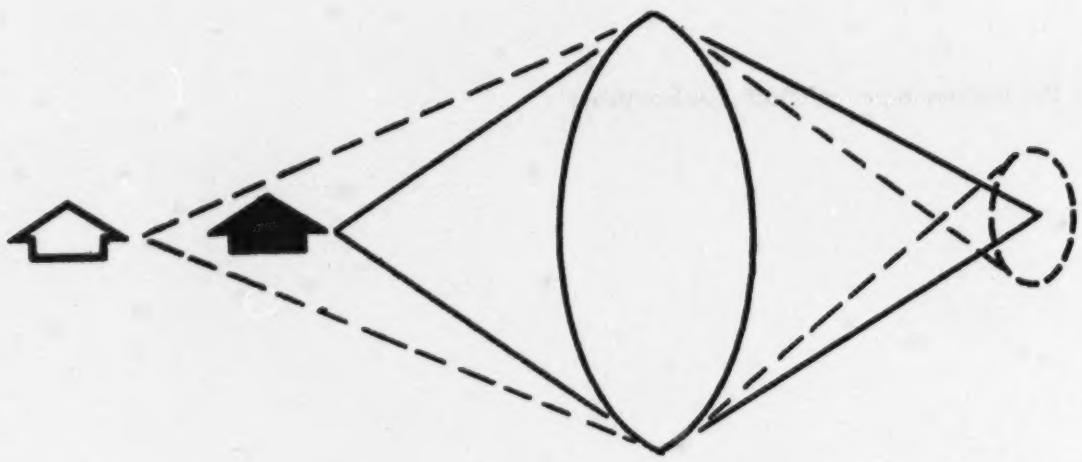

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Choose colorful subjects such as flowers, lake scenes, sunrise and sunset, neon sign at night, abstracts, or double exposure.	
Practice design with colored pieces of paper for mounting on white sheets for proper positioning. Stress unusual arrangements; anyone can do formal arrangements. Can use small cards that are proportional in size.	

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PHOTOLITHOGRAPHY

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Historical evolution of photomechanical method of reproduction.	Appreciation for rapid progress in this field.
Draw image on direct image master.	Transfer process. Ink and water balance. Need for replacing direct image type of drawing.	Drawing technique.
Copy preparation. Cold type pasteup with wax and rubber cement.	Various adhesives used in copy preparation.	Pasteup techniques.
Pull reproduction proofs.	Need for sharpest copy with no fuzziness.	Critical "eye."
Accurate positioning.	Guide lines and gutter marks. Use of blue lines.	
	Effective use of white space.	Sense of balance and harmony.
Guide lines for multiple copy.	Step and repeat copy.	Accuracy.
Use preprinted rules, borders, artwork.	Art services and cold type aids increase productivity as well as increase effective design.	Type style.
	Clean copy for photography lessens the chance for pin-holes.	Habits of cleanliness.
Shoot offset test copy.	Action of light on silver bromide. Emulsion and base side.	Camera test. Range of camera limitation.
Shoot regular copy.	Chemical action during developing. Time relationships and f-stops.	Darkroom procedures.
Enlarge and reduce copy.	Reduction and enlarging scales. Use of ground glass to check image.	Proportion and estimation techniques.
Halftone photography.	Magenta screen. Dot structure and highlights. Flash and bump step.	Precision camera technique.

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PHOTOLITHOGRAPHY

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Show original litho stone. Emphasize its limitation because of size and weight.	Clipper Arts Service Dynamic Graphics, Inc. 6707 North Sheridan Road Peoria, Illinois 61614
Draw simple image using litho crayon. Copy drawings if necessary.	
Paste up dummy ads using several types of adhesive.	
Pull repro from letterpress job. Check impression.	
Practice rearranging copy before pasting up.	
Demonstrate cleaning lens with tissue. Use old lens; show what not to do. Brush off excess rubber cement or wax from copy.	
Show sample of copy shot clean and then shot when the copy was not properly handled.	
Paste up all kinds of copy—typewritten, light and dark reproductions, and printed copy. Shade off at 5-second intervals.	
Shoot copy. Handle film on corners. Stress consistency of procedures.	
Assign jobs that have to be reduced to a certain percentage.	
Use photograph that student has printed. Glossy print is required. Figure range of density from darkest part to highlights.	

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PHOTOLITHOGRAPHY—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Separate copy.	Filters will only let certain colors through.	
Shoot autoscreen film.	Dot structure preprinted in film. Partial development and then still development.	Tray developing techniques.
Strip and opaque.	Emulsion side important. Preruled masking sheets reduce positioning time.	Taping and opaquing procedures.
Two or more colors from single negative.	Simple techniques can produce separate plates for various colors.	Plate covering and opaquing procedures.
Produce presensitized plate.	Kinds of coatings on plate. Perfect contact needed during exposure. Newton rings appear. Moisture on fingers will cause breakdown of diazo layer.	
Plates with platemaker's guide.	Guide use to obtain accuracy. Method of quality control. Guide checks the sharpness of the camera.	Quality control standards.
Develop plate.	Separate chemicals are needed to do different steps in developing. Desensitize both sides if using a two-sided plate as this will avoid lacquer pick-up.	Hand motion during developing.
	Overdeveloping and plugging. Image can be removed and done over.	Plate-saving techniques.
Gum plate.	Protection of nonimage area most important. Gum binding on press is caused by not wiping the plate down properly. Water is only product that will remove gum.	Proper gumming procedures.
	Other types of plates are deep grained, subtractive, and wipe on.	

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IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Separate copy using filters. Also separate by using two negatives and opaque or cover with goldenrod.	
Demonstrate practice shot. Accurate time for development is a necessity.	
Strip on unruled and ruled masking sheets. Show where tape is placed to the best advantage, butting techniques, and paste in of halftones.	
Cut out part of the masking sheet to get one color. Small items can be opaqued and then removed for another shot. Save cutouts of masking sheet so they will drop in place.	
Demonstrate correct hand motion for plate developing. Water may be added during development to avoid plugging or a dry surface. Developing requires even pressure on developing pad.	
Place platemaker's guide in gripper area. Develop to manufacturer's recommendation. Give guide area some type of development. Varying power supply will cause overexposure or underexposure.	
Demonstrate proper motion of developing a plate. Use flat surface near water supply. Large clipboard works well for holding the plate.	
Remove image with acetate; start over.	
Place light coating of gum on plate. Rub down with an almost dry cheesecloth which will remove gum from image area and still protect the nonimage area.	
Discuss the other types of plates available such as additive types and subtractive types.	

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OFFSET PRESSWORK

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Historical aspect of offset printing machines.	
Clean and oil press.	Dirt and grime act as an abrasive against moving parts. Manufacturer's recommendation on oiling must be followed.	Appreciation for clean, well-running equipment.
	Offset transfer principles using one, two, or three cylinders.	
Install offset plate.	Different types of fastening plates. Necessity of even tension on plate. Front and tail clamp will have different locking devices because of direction of cylinder.	
Ink press and set dampening unit.	Ink spoilage can be reduced by evenly removing ink from the entire surface of the can. Emulsification caused when water (fountain solution) mixes with ink. Excessive pressure on dampening rollers causes plate wear and scumming problems.	Sense of "feel" for settings.
Positioning job on stock.	Presses provide adjustment controls that will take care of slight miscalculations on stripping table. Adjustment controls have to be tight and firm because if they loosen during run it will cause a misregister.	
Maintain quality run.	Proper ink and fountain solution balance control affects quality. PH factor in fountain must be checked. Constant sheet inspection is necessary during run for high quality work.	Visual quality control.
Change for process color or light bright colors.	More than one washup is sometimes necessary to obtain true color. Process color inks require an even layer of ink; too much will cause a muddy print.	Color changeover techniques.
Wash press.	Unremoved dried ink will glaze. Wash blanket with water to remove particles of gum and rewash with proper solvent. Dampening rollers should be cleaned with detergent to remove particles of ink. Gum metal rollers to avoid oxidation if press is to set over a long period of time.	Proper attitude towards cleaning press.

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OFFSET PRESSWORK

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Present background material on presses. Show photographs of some early model presses. Note change from stone to metal plates.	*How To Be a Smooth Operator.* Filmstrip and booklets. Available from Minnesota Mining and Manufacturing Company, Printing Products Division, 3M Center, Building 235 — D142, St. Paul, Minnesota 55101.
Show oiling chart for individual press. Demonstrate oiling and wiping down press.	
Draw direct image with only one transfer to show that one more transfer is needed to get the right reading image. Follow a few sheets through the press while turning the flywheel by hand to watch the cycle.	
Show the various types of clamps such as pin bar, slotted, and straight cut. Demonstrate on press.	
Demonstrate how improper feeder settings will cause trouble. Observe results of settings that are too tight or too loose. Increase and decrease suction and blast, showing action of paper stock. Feed sheet by hand, showing movement of side guide and gripper action.	
Check position against copy position by folding or by cutting apart with paper cutter. Demonstrate mechanism that raises or lowers copy by moving cylinder. It is sometimes necessary to cock plate in order to obtain exact position, especially on process color work.	
Demonstrate on press things to watch for in checking quality printing. These include even ink coverage and density. Soften ink if halftones keep filling. Remove stock in small lifts to avoid offsetting, especially on coated stock.	
Run a few copies off on just the first washup and then compare copies printed after the second washup. Post copies of process jobs that were produced with inks too strong or just one color too light.	
Demonstrate proper procedure for washup. Show what happens when excessive cleaning fluid is used. (It drips to various parts of the machine and causes stock to get dirty on its way through press.) If machine has washup feature, pick up spots it missed by hand, with power off. Store rags in proper closed metal container. Glaze can be removed with lye or special glaze removing solvent. Show that a glazed roller loses its affinity for ink.	

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SCREEN PRINTING

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	History and development of process screen printing.	
	Four areas of printing—relief, intaglio, planograph, and screen.	
Select material for screen.	Cotton, linen, nylon, organdy, copper, brass, and stainless steel can be adapted well to certain situations. However, silk is usually used in industrial arts. Numbers 10, 12, 14, or 16 are suitable for most work.	Variety of screens aids in creativity.
Change screen.	Proper tacking or stapling is necessary for quality results. Woof and warp should be at right angles on frame.	Perfectly stretched screen.
Select screen ink.	Particles of all the different kinds of ink must pass through screen without causing difficulty or without plugging.	Proper consistency of ink according to the mesh of the screen and the material upon which it is used.
	Drying is a four-part process — oxidation, evaporation, polymerization, and fusion.	Adequate space for drying. Appreciation for well-designed racks.
Register form.	Distance of screen to base will approximate thickness of object being screened.	Accuracy.
Color registration.	Register marks are placed on bleed portion for additional colors. Semi-transparent inks can be overprinted to produce various shades. Opaque inks can cover hairline registration separations. Pins have to be set accurately and securely to maintain registration.	Importance of perfect alignment.
Knife-cut film.	Shellac and lacquer types of films have different properties. Care must be used on corners. A hard, smooth surface should be placed on the underside when cutting.	Knife handling.

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SCREEN PRINTING

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Report on early beginnings of screen printing; assign small groups to present the subject orally or by discussion.	
Note in detail the characteristics of screen printing. Observe ink patterns and density of ink with a magnifying glass.	
Inspect samples of material printed by a variety of screens. Objects can be brought from home too. Cosmetic and soft drink bottles are usually screened. Look for registration point of container.	
Demonstrate the placing of the screen.	
Display work with ink too thin or too thick and with ink that has been stretched too much or doctored with the wrong extenders or varnish.	
Set up test of ink, comparing drying times of the various types. Add driers and record time. Control drying temperatures if possible.	
Demonstrate the setting of guides. Show the relationship of the different guides (tape, adjustable, V-groove, and commercial) to the type of material that is used.	
Assign simple design problem.	

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SCREEN PRINTING—continued

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
Process of adhering and removing film.	Different adhesives or solvents used in the process. Combustibility of lacquer and many other solvents.	Safety in the use of solvents.
Block out plates.	Lacquer, water, and oil resists are used to block out plates. The kind of resist used depends upon type of ink used and length of run.	Proper selection of material.
Screening on decals.	Special stock with decal backing permits transfer of design to other surfaces.	Suitability of other surfaces for decals.
Special effects in screening.	Flocking adds a distinctive effect on screen work. Glue sizing used as base; flocking is done by hand or air gun. Test amount of glue and flocking it will hold.	Place for prerun testing.

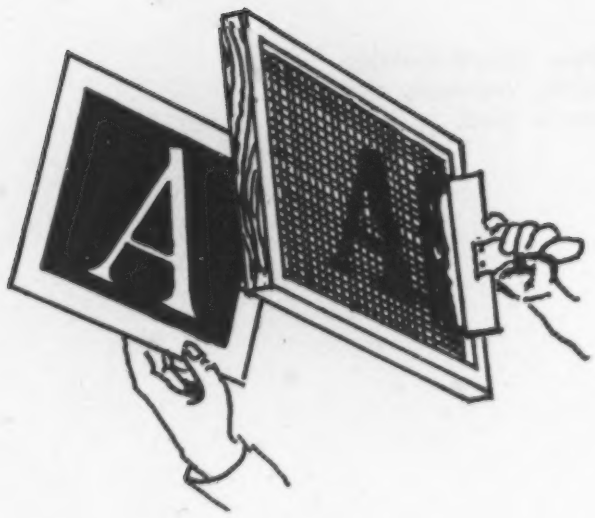

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SCREEN PRINTING—continued

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Demonstrate placing of screen, checking edges carefully. Block out areas with blocking materials; two thin coats are best.	
Improper storage of used cleaning rags can cause fire hazard. Use closed metal containers for storage. Empty frequently. Work in well-ventilated place with no flames nearby.	
Run school seal in various sizes and transfer onto finished projects.	
Demonstrate the simplicity of flocking. Combine colors for effect.	

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CAREER INFORMATION

SKILLS STUDENTS WILL BE ABLE TO PERFORM	CONCEPTS STUDENTS WILL UNDERSTAND	APPRECIATIONS STUDENTS WILL DEVELOP
	Nature of apprenticeship, its historical development. Present rules and regulations. State supervision of apprenticeship.	Appreciation for a time-tested method of instruction.
Fill out a legal contract.	Nature of contract between two or more parties enforced by law. Minor co-signed by parent.	Legal awareness.
Correctly fill out application forms.	Necessity of complete and accurate information.	Awareness of industrial personnel practices.
Interview.	Importance of personal interview. Necessity of presenting good grooming. Reasons for being asked certain types of questions.	Interview knowledge.
	School test results providing norm group and percentile ranking. Some industries depend upon these a great deal; others depend on successful past working experiences.	Appreciation for testing procedures and interpretation.
Obtain career and school information.	A wide variety of information is needed before a final decision can be made on further schooling. Financial considerations for schooling.	Inquiring techniques.
	School and industry recruitment personnel can provide the latest up-to-date information.	
	Location of job opportunities. Additional schooling may be needed. Financial aids usually can be arranged. Scholarships based upon need and ability.	Post-school awareness.

CAREER INFORMATION

IMPLEMENTATION SUGGESTIONS	INSTRUCTOR'S NOTES
Obtain several copies of apprenticeship contracts from the State Apprenticeship Bureau. Get one for each major graphic arts area.	
Reproduce several types of contracts. Fill out forms and review.	
Reproduce application form from a printing firm. Fill out in detail with proper references and personal section. Stress importance of obtaining permission to use certain names and information. Accurate dates are very important.	
Set up interview situation and prepare a list of questions usually asked. Stress importance of followup conversation or letter, information on resume, and answering "help wanted" ads.	
Review test given to students during school. Review other personality tests such as inventory tests, achievement scholastic ability tests, industrial personnel tests, MMPI, and graphic arts tests.	
Assign people to get information on a wide variety of schools such as colleges, private vocational schools, area vocational schools, and trade schools. Suggest resource people that one can contact for information.	
Participate in Career Days. Arrange for visiting personnel from industry or trade association.	
Have counseling information available to students in shop rather than just in counselor's office. Many excellent brochures are provided by graphic arts trade associations. Excellent sources of information are the *Dictionary of Occupational Titles* and the Marine, Army, and Navy career guides.	U.S. Employment Services. *Dictionary of Occupational Titles*. 3rd ed. U.S. Department of Labor, Manpower Administration, Bureau of Employment Security, 1965. Vol. 1, $5.00; Vol. 2, $4.25 Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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REFERENCES

Sources for Instructional Material

Eastman Kodak Company
Audio Visual Service
343 State Street
Rochester, New York 14650

Graphic Arts Technical Foundation
4615 Forbes Avenue
Pittsburgh, Pennsylvania 15213

International Graphic Arts Education Association
Box 3409
Rochester, New York 14614

International Typographic Composition Association
2233 Wisconsin Avenue N.W.
Washington, D.C. 20007

International Typographical Union
Box 2341
Colorado Springs, Colorado 80901

Minnesota Mining and Manufacturing Company
Printed Products Division
3M Center
Building 235 — D142
St. Paul, Minnesota 55101

Printing Industry of America
20 Chevy Chase Circle N.W.
Washington, D.C. 20015

Printing Industry of the Twin Cities
2583 University Avenue
St. Paul, Minnesota 55114

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Sources for Films

Bailey Films
6509 DeLongpre Avenue
Hollywood, California 90028
Learning To Set Type
Putting a Job on a Platen Press

Contemporary Films
267 West 25th Street
New York, New York 10001
Litho
Love of Books

Encyclopaedia Britannica Educational Corporation
425 North Michigan Avenue
Chicago, Illinois 60611
or
Encyclopaedia Britannica Educational Corporation
c/o Mr. Charles Fehr
13257 Humboldt Avenue South
Burnsville, Minnesota 55378
Printing Through the Ages

Matt Farrell Productions
213 East 38th Street
New York, New York 10016
Basic Reproductions Processes in the Graphic Arts

University of Minnesota
Department of Audio-Visual Extension
2037 University Avenue S.E.
Minneapolis, Minnesota 55455
Printing: Platen Press Makeready

University of Southern California
Department of Cinema
Los Angeles, California 90007
Manuscripts
Paper
Papyrus
Printing

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ABSTRACT - Developed by the Bureau of Secondary Curriculum Development, New York State Department of Education, from the suggested services listed in "Automotive Service Occupations" for automotive electric systems, this teaching guide may be used for secondary education classes or for preparing entry workers or adults already working as automotive mechanics. Units, arranged by content outline and teaching approaches, include: (1) Introduction, (2) Fundamentals of Automotive Electricity, (3) Automotive Storage Batteries, (4) Charging Systems, (5) Starting Systems, (6) Ignition Systems, and (7) Lighting and Electrical Accessories. Each unit contains objectives, review questions, textbook references, films, filmstrips, transparencies, and a summary of key points. A comprehensive objective final examination, glossary, bibliography, and directory for resource materials are appended. (FM)

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Automotive Industries Occupations

AN INSTRUCTOR'S GUIDE FOR A PROGRAM IN

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Automotive Industries Occupations

AN INSTRUCTOR'S GUIDE FOR A PROGRAM IN

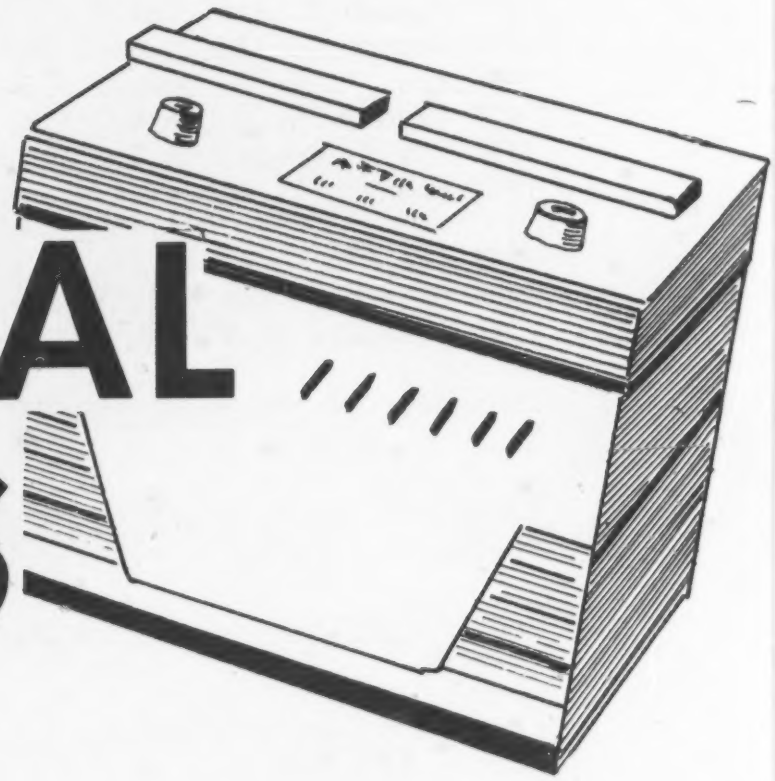

ELECTRICAL SERVICES

TRADE AND TECHNICAL EDUCATION

3836

THE UNIVERSITY OF THE STATE OF NEW YORK / THE STATE EDUCATION DEPARTMENT
BUREAU OF CONTINUING EDUCATION CURRICULUM DEVELOPMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT / ALBANY, NEW YORK 12224

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Foreword

Electrical Services was developed from the suggested services for the basic automotive electrical systems as listed in the *Automotive Service Occupations*. The content may be used in secondary schools and adult programs to assist in preparing individuals who wish to enter the automotive field or to upgrade personnel already working as automotive mechanics. Greater employment opportunities and a higher income potential are possible for those who are willing to become knowledgeable in this specialized field.

Appreciation is expressed to Thomas Onderdonk, auto mechanics instructor at the Washington-Warren-Hamilton County B.O.C.E.S. Occupational Center at Argyle, for his efforts in developing the instructional materials. Assistance relating to content was provided by Edward Shattuck, Associate in the Bureau of Trade and Technical Education. The project was coordinated and the manuscript edited and prepared for publication by Nelson S. Maurer, Associate in the Bureau of Continuing Education Curriculum Development.

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Bureau of Secondary
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Curriculum Development Center

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Message to the Instructor

Electrical Services is designed to prepare trainees for employment in a specialized area of automotive service. The units are planned to be presented in numerical order but the sequence may be altered with the exception of the unit on fundamentals.

Plan each lesson carefully before presenting it to the class. It will be necessary to consider classwork, discussion, demonstrations, and review. The left-hand column of each unit contains suggested topics. The right-hand column gives related information and teaching techniques, methods, and tips which should help to achieve a more effective presentation. Also, this column shows page references for selected textbooks for which the complete citations and symbols are given on page 98. Give a summary of the key points discussed at the conclusion of each unit. A suggested final examination is provided at the end of this guide. The questions are derived from the basic material and are in the form of completion and multiple choice.

Use the chalkboard, overhead projector, charts, diagrams, and other visual aids to clarify the material being presented. A list of suggested aids appears at the end of each unit. Excellent instructional materials are available from various automobile and automotive equipment manufacturers but order these materials well in advance of the scheduled lesson. Specific materials might be located in *Automotive Instructional Material* published by the Automotive Service Industry Association. Many teaching aids may be fabricated from samples or discarded equipment.

New instructional aids are constantly being made available to instructors. Current releases of audiovisual aids are usually listed in issues of such publications as the *American Vocational Journal*, *Industrial Arts and Vocational Education*, and *School Shop*. New information relating to the automotive industry is available from general trade magazines as well as publications distributed by specific manufacturers.

As experience is gained with this guide, it is hoped that suggestions will be sent to the Bureau for consideration in subsequent revisions.

BERTON P. PLUMMER, *Chief*
Bureau of Trade and Technical Education

JOHN E. WHITCRAFT, *Director*
Division of Occupational Education

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Introduction

OBJECTIVES

- To understand the course requirements
- To understand the content that will be covered in the course

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Importance	There is an acute shortage of all types of competent auto mechanics but an even greater shortage exists in the areas of electrical diagnosis and service. The purposes of the course are: • To provide training in the field of automotive electricity for apprentices and vocational students • To permit individuals who are working as auto mechanics to expand their knowledge in the area of automotive electricity
II. Course Requirements	
A. Textbook	*If a textbook is to be used, give its name, price, and source. Arrange for a group order.*†
B. Notebook	*Indicate that a looseleaf notebook is necessary for keeping class notes, job information, booklets, and materials distributed during the course.*
C. Prerequisites	It would be advantageous for trainees to be knowledgeable in the following areas: • Basic mathematics • Science • Principles of operation of the internal combustion engine • Shop safety

†Textbook citations given at the end of each unit.

Introduction

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
III. General Safety	*Discuss the procedures for extinguishing small fires involving:* • *Liquids* • *Wiring* • *Upholstery*
A. Protective clothing	*State the school policy relative to coveralls or shop coats and, if required, suggest that trainees furnish their own protective clothing. Mention possible storage space for clothes, if any exists.*
B. Safety glasses	*Indicate the school policy relative to the wearing of approved safety glasses.* *Arrange for a group purchase of approved safety glasses for those who wish to have their own glasses.*
IV. Overview of Course	*Discuss the general subject matter that is to be covered in each unit of the course. Also, indicate such items as the length of each session, number of sessions, procedures to be followed in class, and what is expected of each class member.* *Indicate that a final examination will be given at the end of the course to point out any weak areas.* *Note that following the test there will be time for reviewing the examination and any other questions related to the course.*

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Fundamentals of Automotive Electricity

OBJECTIVE

- To understand the fundamentals of electricity as they apply to the automotive field

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Structure of Matter	All matter is composed of atoms. Each atom consists of protons, electrons, and neutrons. *(Ref. A, pp. 2-4; Ref. E, pp. 303-304)* *Explain the atomic structure of matter. Include such items as:* • *Protons* • *Electrons* • *Neutrons* The outermost electrons of many atoms are loosely held and are easily influenced by outside forces. *Demonstrate with a simple electroscope how some outer electrons of one substance may be transferred to another substance. (Ref. A, pp. 4-5; Ref. E, p. 303)*
A. Law of electrostatics	Objects that have like charges repel each other, and objects that have unlike charges attract each other. *Demonstrate with a simple electroscope that like charges repel and unlike charges attract. (Ref. C, pp. 8-9)* *Use films, film loops, and transparencies to assist in developing the topic of electrostatics. See Instructional Materials at the end of the unit.*
B. Electrification	Electrification occurs through the transfer of electrons.

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain negative and positive electrification as an excess or a deficiency of electrons.
C. Movement of electrons	Free electrons tend to move away from each other as a result of a repulsive force. If a path is provided, electrons will move from an area of many electrons (negative) to an area of few electrons (positive). *(Ref. A, p. 6)*
	Explain the flow of current as the movement of electrons along a conductor. (Ref. C, pp. 10-11)
	Explain the meaning of direct and alternating current. (Ref. C, p. 20)
	Use films, filmstrips, film loops, and transparencies to assist in developing the topic of the electron theory. See Instructional Materials at the end of the unit.
1. Voltage	The more electrons there are at a terminal, the higher is the repulsive force or pressure between the electrons.
	Explain that voltage is the pressure of electrons, and show how this pressure is measured with a voltmeter. (Ref. A, pp. 15-16; Ref. C, p. 20)
2. Amperage	The more electrons there are moving along a material, the greater is the flow of current. *(Ref. A, p. 16; Ref. C, p. 20)*
	Explain that amperage is the amount of electrons flowing in a conductor, and show how this quantity is measured with an ammeter. (Ref. A, p. 16; Ref. C, p. 20)
3. Resistance	There is a force restricting the movement of electrons through a material.
	Explain that resistance is the force which restricts the movement of electrons through a conductor. Show how this restricting force is measured by an ohmmeter. (Ref. A, pp. 16-17; Ref. C, p. 21)

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain how the resistance of a conductor is affected by its: • *Composition* • *Diameter* • *Length* • *Temperature* Resistance in a circuit reduces the voltage and is called voltage drop. This voltage drop reduces the flow of current. *Explain the causes of voltage drop. Include such items as:* • *Excessively small conductors* • *Bad connections* • *Defective contact points* • *Broken strands in a multistrand wire* *(Ref. C, pp. 26-27)* *Use films, filmstrips, and transparencies to assist in developing the topic of electric current. See Instructional Materials at the end of the unit.*
4. Ohm's law	The voltage, amperage, and resistance in a circuit have a definite relationship to each other. This relationship is known as Ohm's law. *Explain that Ohm's law is expressed as a mathematical formula as follows:* *E (volts) = I (amperes) x R (ohms) or* $R = \frac{E}{I}$ *or* $I = \frac{E}{R}$ *(Ref. A, pp. 20-22; Ref. C, pp. 22-23; Ref. E, p. 305)*

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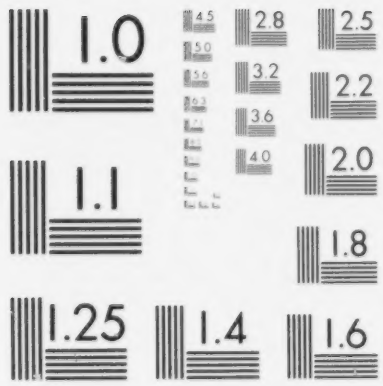

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Solve on the chalkboard several problems involving Ohm's law.
	Use the memory device below to help solve Ohm's law problems. Cover the unknown quantity and the remaining letters give the correct equation.

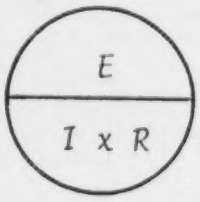

	Use films, filmstrips, film loops, and transparencies to assist in developing the topic of Ohm's law. See Instructional Materials at the end of the unit.
D. Conductors	A good conductor is a material that contains a large number of free electrons and the motion of these electrons within the substance is relatively unimpeded. *(Ref. C, pp. 11-13; Ref. E, p. 304)*
	Discuss the properties, uses, and examples of conductors.
E. Insulators	A good insulator is a material that has few free electrons and the motion of these electrons within the substance is greatly hampered. *(Ref. C, pp. 13-15)*
	Discuss the properties, uses, and examples of insulators.
	Use films, filmstrips, film loops, transparencies, and samples to assist in developing the topic of conductors and insulators. See Instructional Materials at the end of the unit.
F. Semiconductors	A semiconductor is a material that under certain conditions acts as a conductor and under other conditions acts as a nonconductor.
	Discuss the properties, uses, and examples of semiconductors.

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
G. Capacitors	A capacitor is a device that stores an electrostatic charge. *Discuss the factors that affect the charge a capacitor can hold. Include such items as:* • *Area of the plates* • *Distance between plates* • *Nature of the insulating material separating the plates*
II. Magnetism	All objects are composed of molecules and in iron and steel these molecules are actually small magnets. *Explain the theory of magnetism. (Ref. A, pp. 6-7; Ref. B, pp. 362-365)*
A. Characteristics of magnets	*Discuss the characteristics of magnets. Indicate that all magnets:* • *Have a north seeking pole (N pole) and a south seeking pole (S pole)* • *Have lines of force* • *Attract ferrous materials* *Demonstrate the effects of the lines of force around a magnet. (Ref. B, p. 363)*
B. Types of magnets	There are two types of magnets: • Permanent • Temporary
1. Permanent	After being magnetized, the molecules of certain metals maintain their arrangement for a considerable length of time. Such metals are called permanent magnets. *(Ref. A, pp. 8-9)* *Discuss the properties and uses of permanent magnets.*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
2. Temporary	After being magnetized, the molecules of some metals maintain their arrangement for only a relatively short time. Such metals are called temporary magnets. *Discuss the properties and uses of temporary magnets.*
C. Law of magnetism	The law of magnetism states that like poles repel and unlike poles attract. *Demonstrate the law of magnetism. (Ref. A, pp. 9-10; Ref. C, pp. 29-33)* *Use films, filmstrips, film loops, and transparencies to assist in developing the topic of magnetism. See Instructional Materials at the end of the unit.*
III. Electromagnetism	A flow of electrons always produces magnetism or lines of force. Magnetism produced by an electric current is called electromagnetism. *Show the effects of a magnetic field around a conductor carrying direct current.*
A. Characteristics	As long as there is a flow of current through the conductor, the magnetism produced has the same characteristics as that produced by a permanent magnet.
B. Electromagnets	An electromagnet is a coil of wire wound around a soft iron core. As long as this device is energized with electricity, it exhibits the same properties as a permanent magnet. *(Ref. C, pp. 33-34)*
1. Strength	*Discuss the factors that affect the strength of an electromagnet. Include such items as:* • *Amount of current flowing in wire* • *Size of core* • *Kind of core* • *Number of turns of wire*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
2. Uses	Electromagnets are used in many automotive electrical devices. *Discuss such automotive electrical devices that utilize electromagnets as:* • *Relays* • *Circuit breakers* • *Horn circuits* • *Voltage controls* • *Current limiters* • *Solenoids* *(Ref. A, pp. 266-271; Ref. C, pp. 480-485)* *Explain the operation of an electromagnet by using a buzzer, a horn relay, or a cutout relay. (Ref. E, pp. 344-345, 438)* *Use films, filmstrips, film loops, and transparencies to assist in developing the topic of electromagnetism. See Instructional Materials at the end of the unit.*
IV. Circuits	*Explain the parts of a simple electrical circuit. Include such items as:* • *Source of current* • *Conductor* • *Control device* • *Load or energy dissipater* *Draw on the chalkboard a simple circuit composed of a battery, switch, and a lamp. Explain that the current needs a path from the source to the device and back to the source, and that the control device is usually located between the source of current and the load.*
A. Terms	*Explain and give examples of the following common electrical terms:* • *Common ground*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Short* • *Open* *(Ref. B, pp. 374-377)*
B. Types	There are three general types of electrical circuits: • Series • Parallel • Series-parallel *(Ref. A, pp. 23-28; Ref. B, p. 356; Ref. E, pp. 305-306)*
1. Series	A series circuit is arranged so that all of the current must pass through all of the electrical devices. *(Ref. A, pp. 22-25; Ref. C, pp. 24-25)* *Draw on the chalkboard several lamps connected in series, and point out the flow of current through the circuit.*
2. Parallel	A parallel circuit is arranged so that the current divides and flows through several branches. *(Ref. A, pp. 22-25; Ref. C, pp. 24-25)* *Draw on the chalkboard several lamps connected in parallel, and point out the flow of current through the circuit.*
3. Series-parallel	A series-parallel circuit is arranged so that some devices are connected in parallel and other devices are connected in series. *(Ref. A, pp. 23-25)* *Draw on the chalkboard several lamps connected in parallel, and have each lamp connected in series to its respective switch. Point out the flow of current through the several parts of the circuit.* *Use filmstrips, film loops, and transparencies to assist in developing the topic of electric circuits. See Instructional Materials at the end of the unit.*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
V. Switches	A switch is a device that opens and closes an electrical circuit. In the automotive field, switches are usually located between the source of current and the device. Switches may be operated manually or electromagnetically. *(Ref. A, pp. 259-266; Ref. C, pp. 478-485)*
A. Manually operated	*Display and explain the functions and operation of such manually operated switches as:* • *Push-pull* • *Rotary* • *Vacuum* • *Fuse* • *Circuit breaker* *(Ref. B, pp. 578-588; Ref. D, p. 431; Ref. E, p. 433)*
B. Electromagnetically operated	*Display and explain the functions and operation of such electromagnetically operated switches as:* • *Relay* • *Solenoid* *(Ref. A, pp. 13-14, 268-271; Ref. B, pp. 577-578; Ref. E, pp. 312, 352-431)* *Use films, filmstrips, film loops, and transparencies to assist in developing the topic of switches. See Instructional Materials at the end of the unit.*
VI. Meters	Meters are useful in diagnosing troubles. With proper instruments, it is possible to determine the source of the trouble and to make the required adjustments.
A. Voltmeter	Most voltmeters used in the automotive industry consist of a permanent magnet, a movable coil, and a pointer which moves across a calibrated scale.

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Voltmeters are always connected in parallel in the circuit. *(Ref. E, pp. 473-474)*
	Explain the operation and uses of the voltmeter.
B. Ammeters	Most ammeters used in the automotive industry are similar in design to the voltmeter.
	Ammeters are always connected in series in the circuit.
	Explain the operation and uses of the ammeter.
C. Ohmmeter	The ohmmeter is similar in design to the voltmeter and also has a calibrated resistance, a variable resistance, and a self-contained battery.
	Before using the ohmmeter, adjust the indicating needle to the zero mark. When measuring the resistance of a circuit or a device, the source of current of the circuit or device must first be disconnected. Also, the ohmmeter may be used to test the continuity of a circuit or device.
	Explain the operation and uses of the ohmmeter.
	Prepare an electrical circuit consisting of various devices connected in parallel and each device drawing a different amount of current. Demonstrate how to determine the voltage of the circuit, the amperage of the circuit, the amperage of each device, and the resistance of each device.
	Demonstrate how to use the ohmmeter to test the continuity of a device or circuit.
	Use filmstrips, film loops, and transparencies to assist in developing the topic of meters. See Instructional Materials at the end of the unit.
	Have trainees connect and read meters until they acquire the proficiency necessary for an entry mechanic. Include such meters as: • *Voltmeter* • *Ammeter* • *Ohmmeter*

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QUESTIONS FOR REVIEW

1. Explain the general structure of the atom.
2. Explain the nature of an electric current.
3. What makes a substance an insulator?
4. Explain the law of magnetism.
5. What is the difference between a temporary and permanent magnet?
6. What is voltage and how is it measured?
7. What is resistance and how is it measured?
8. Explain the differences between a series and a parallel circuit.
9. What is an open circuit?
10. What are the advantages of an electrical circuit having a common ground?
11. What is a short circuit and why is it harmful?
12. Describe an electromagnet and give examples of its use.
13. Explain the operation and uses of the solenoid.
14. Explain the operation and uses of the relay.
15. Explain how to connect an ammeter in a circuit.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Barr, R. R. & Flocco, T. D. *The automobile electrical system;* 2d ed. Philadelphia, Pa. Chilton Book Co. 1968.

(B) Blanchard, H. F. & Ritchen, Ralph. *Auto engines and electrical systems;* 4th ed. New York, N.Y. Motor. 1967.

(C) Crouse, W. H. *Automotive electrical equipment;* 6th ed. New York, N.Y. Webster Division, McGraw-Hill Book Co. 1966.

(E) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Automotive Electric Association. *Electrical systems manual.* Detroit, Mich. The Association.

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Fundamentals of Automotive Electricity

C. E. Niehoff and Co. *Principles of automotive tune-up.* Chicago, Ill. The Corporation.

Chrysler Corp. *Electrical fundamentals.* Detroit, Mich. The Corporation.

Ford Motor Co. *Basic automotive electricity.* Dearborn, Mich. The Corporation.

General Motors Corp., Delco-Remy Division. *Fundamentals of electricity and magnetism; section A (manual and charts).* Anderson, Ind. The Division. 1967.

_____ *Fundamentals of semiconductors; section J (manual and charts).* Anderson, Ind. The Division. 1965.

FILMS

Electromagnetic induction. Coronet. 1963. 14 min. sound. color. Rent - State University of New York at Albany; Syracuse University Film Library.

Electrostatic charges and forces. Coronet. 1963. 14 min. sound. color. Rent - Syracuse University Film Library.

Fundamentals of electricity. Sterling Educational Films. 1967. 13 min. sound. color. Purchase - Sterling Educational Films.

Magnetism. Encyclopaedia Britannica Educational Corp. 1957. 16 min. sound. black and white. Rent - State University of New York at Albany, Syracuse University Film Library.

Magnetism. Sterling Educational Films. 1967. 13 min. sound. color. Purchase - Sterling Educational Films.

Magnetism and electricity. McGraw-Hill Films. 1965. 17 min. sound. color. Rent - Syracuse University Film Library.

Measurement of electricity. Coronet. 1949. 11 min. sound. black and white. Rent - Syracuse University Film Library.

Ohm's law. Coronet. 1955. 6 min. sound. color. Rent - Syracuse University Film Library.

Pressure and current. Sterling Educational Films. 1967. 13 min. sound. color. Purchase - Sterling Educational Films.

FILMSTRIPS

Automotive mechanic series; set 1. McGraw-Hill Films. 1952. silent. black and white. Purchase - McGraw-Hill Films.
Applications of electromagnetism - 45 frames
Electric current measurement - 33 frames

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Automotive mechanic series; set 1. (continued). McGraw-Hill Films. 1952. silent. black and white. Purchase - McGraw-Hill Films.
Electric current principles - 35 frames
Principles of electromagnetism - 31 frames
Switches, relays, and lights - 19 frames

Modern physics series; set 3. McGraw-Hill Films. silent. color. Purchase - McGraw-Hill Films.
What is magnetism - 51 frames

FILM LOOPS

Amperes and volts. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

The complete circuit. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Circuit concepts. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Electricity and magnetism. Universal Education and Visual Arts. 2 min. sound. color. Purchase - Universal Education and Visual Arts.

Electromagnet, solenoid. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Electromagnets. Universal Education and Visual Arts. 2 min. sound. color. Purchase - Universal Education and Visual Arts.

Electrons, protons. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Electroscope. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Like and unlike charges. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Magnetic field, lines of force. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

North and south poles. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Permanent magnets. Universal Education and Visual Arts. 2 min. sound. color. Purchase - Universal Education and Visual Arts.

Primary-secondary cells. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Properties of magnets. Universal Education and Visual Arts. 2 min. sound. color. Purchase - Universal Education and Visual Arts.

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Fundamentals of Automotive Electricity

Series-parallel. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Static electricity. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

Switches. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

What is electricity. Sterling Educational Films. 2 min. sound. color. Purchase - Sterling Educational Films.

TRANSPARENCIES

Atomic theory. United Transparencies, Inc. Nine transparencies. color. Purchase - United Transparencies, Inc.

Basic construction of dc meter. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Basic dc circuits. United Transparencies, Inc. Six transparencies. color. Purchase - United Transparencies, Inc.

The effect of a coil on an induced current. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Electrical charges. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Electrical meters and resistance. 3M Co. Purchase - 3M Co.

Electrical systems. DCA Educational Products, Inc. 13 transparencies. color. Purchase - DCA Educational Products, Inc.

Electricity and semiconductors. 3M Co. Purchase - 3M Co.

Electromagnetism. United Transparencies, Inc. Six transparencies. color. Purchase - United Transparencies, Inc.

Electron current. United Transparencies, Inc. Nine transparencies. color. Purchase - United Transparencies, Inc.

Electron theory. United Transparencies, Inc. 12 transparencies. color. Purchase - United Transparencies, Inc.

Magnetic field about a current loop. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

The magnetic field encircling a current. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Magnetism. United Transparencies, Inc. 10 transparencies. color. Purchase - United Transparencies, Inc.

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Magnetism and atom structure. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Magnetism and electromagnetism. 3M Co. Purchase - 3M Co.

Ohm's law. DCA Educational Products, Inc. Two transparencies. Purchase - DCA Educational Products, Inc.

Ohm's law. United Transparencies, Inc. Five transparencies. color. Purchase - United Transparencies, Inc.

Pith ball experiment. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Static electricity. United Transparencies, Inc. Seven transparencies. color. Purchase - United Transparencies, Inc.

Temporary charge by induction. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

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Automotive Storage Batteries

OBJECTIVES

- To understand the operation of the lead-acid storage battery
- To be able to test and service lead-acid storage batteries

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. General Information	
A. Function	A storage battery of a vehicle supplies current for the starting motor and ignition during cranking and for lights, radio, heater, and other accessories when the generator is unable to supply enough power. Also, the battery stabilizes voltage in the electrical system. *(Ref. A, pp. 51-52)*
B. Chemical action	The storage battery is an electrochemical device for changing chemical energy into electrical energy. The battery stores chemical energy not electricity. The chemical action is reversible so the charge of a battery may be restored. *(Ref. A, pp. 56-58; Ref. E, p. 443)* *Explain the chemical action of a lead-acid storage battery by using films, filmstrips, film loops, transparencies, and charts. See Instructional Materials at the end of the unit.*
C. Types	There are two types of storage batteries: • Wet charged • Dry charged
1. Wet charged	The wet charged battery is shipped from the factory with a full supply of electrolyte in each cell and is ready for service.
2. Dry charged	The dry charged battery is shipped from the factory without electrolyte and completely dry. The battery is placed into service by adding electrolyte to the cells.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
II. Construction	
A. Plates	The basic unit of a battery consists of grids or plates filled with active materials. *(Ref. A, pp. 52-56; Ref. C, pp. 44-49; Ref. E, pp. 440-443)*
B. Separators	Plates are kept from touching each other by separators which are sheets of porous, non-conducting material.
C. Elements	The negative and positive plates and the separators form an element.
D. Case	The case of the battery is made of hard rubber with partitions. Each element is placed into a partition and connected in series with the other elements.
E. Covers	Covers are placed over cells and sealed. One-piece covers are used on 12-volt batteries to prevent leaking of current to ground.
F. Vent cap	Each cell cover has a vent cap which permits the electrolyte to be checked, water added, and gas to escape.
G. Electrolyte	The electrolyte in a lead-acid storage battery is a fairly concentrated solution of sulfuric acid and water having a specific gravity of 1.290 at 80° F.
H. Forming charge	The plates are activated by a forming charge which changes the lead oxide paste to lead peroxide in the positive plates and to lead in the negative plates.
	Explain the construction of a lead-acid storage battery by using films, filmstrips, transparencies, and charts. See Instructional Materials at the end of the unit.
III. Output	
A. Voltage	Each cell of a lead-acid storage battery develops two volts regardless of the number or size of plates.
	A six-volt battery requires three cells to be connected in series and a 12-volt battery requires six cells to be connected in series.

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
B. Current	The amount of current produced by a lead-acid battery is determined by the area and weight of the active materials in the plates and the amount of sulfuric acid in the electrolyte. *(Ref. B, pp. 589-590; Ref. E, p. 444)*
IV. Battery Rating	Batteries are rated by performance standards established by the Society of Automotive Engineers (S.A.E.). Comparasions may be made only in accordance with S.A.E. standards. *(Ref. A, pp. 58-59; Ref. E, pp. 444-445)*
A. S.A.E. 20-hour rate at 80° F.	The 20-hour rating indicates the battery's ability to deliver current continuously over a 20-hour period and is expressed in ampere hours. The rating measures the amount of working material in a battery and indicates the lighting and accessory load capacity. *(Ref. C, pp. 55-56)*
B. S.A.E. 300 amperes at 0° F.	The 300-ampere rating indicates the battery's ability to deliver current at low temperature. The rating is expressed in minutes and measures the battery's cranking load capacity. *(Ref. C, p. 56)* *Explain how to select a battery using the S.A.E. ratings.*
V. Battery Tests	
A. Hydrometer test	A hydrometer measures the specific gravity of the electrolyte in a cell. This indicates the amount of unused sulfuric acid that remains in the electrolyte and is a convenient indication of the approximate capacity still available. *Demonstrate the procedures for testing a battery with a hydrometer. Include such items as:* • *Checking level of electrolyte* • *Drawing electrolyte into barrel* • *Reading scale* • *Correcting for temperature* *(Ref. A, pp. 59-61; Ref. C, pp. 62-65; Ref. E, pp. 442-446)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Discuss the effects of temperature on hydrometer readings.
	Review the various specific gravities for a cell in different stages of charge with the electrolyte at 80° F.
B. Light-load test	The voltage of a cell varies slightly with the specific gravity of the electrolyte. Only use voltmeters that are very accurate and have an expanded scale. (*Ref. C, pp. 61-62; Ref. D, p. 22-6*)
	Demonstrate the procedures for testing a battery under a light load by the use of a voltmeter. Include such items as: • *Examining battery for physical damage or neglect* • *Adjusting level of electrolyte* • *Placing load on battery* • *Observing correct polarity* • *Reading and interpreting test* (*Ref. A, pp. 63-65*)
C. High-discharge test	The high-discharge test measures voltage while the battery is being discharged at a high rate. (*Ref. A, p. 66; Ref. C, pp. 66-68; Ref. D, pp. 22-5—22-6*)
	Demonstrate the procedures for testing a battery using the high-discharge test. Include such items as: • *Examining battery for obvious defects* • *Checking temperature of electrolyte* • *Adjusting level of electrolyte* • *Determining state of charge* • *Using variable resistor as a load* • *Reading and interpreting test*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
D. Cadmium test	The cadmium test is used to determine the voltage of individual cells of batteries with one-piece hard covers. *(Ref. A, pp. 69-71; Ref. E, p. 446)* *Demonstrate the procedures for testing a battery using a cadmium tester (if available). Include such topics as:* • *Adjusting level of electrolyte* • *Removing surface charge* • *Reading and interpreting test*
VI. Battery Charging	A battery is discharged when most of the available materials in the positive and negative plates have reacted with the electrolyte. The charge of a battery may be restored because the chemical action is reversible. *Review the chemical action of a battery during recharging. (Ref. A, pp. 56-58; Ref. E, p. 443)* A battery may be recharged by being connected to a source of direct current. Two commonly used methods of recharging batteries are: • Slow-charge or constant-current • Fast-charge or constant-potential *Explain the procedures for preparing a battery for charging. Include such items as:* • *Cleaning case and terminals* • *Adjusting level of electrolyte* • *Following manufacturer's specifications relative to vent caps* • *Connecting charger leads to battery*
A. Safety precautions	The sulfuric acid in the electrolyte of a battery is very corrosive and will react with most substances.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Hydrogen and oxygen are produced during the charging process. An explosive mixture may accumulate and be ignited by a spark or flame.
	Discuss the safety precautions that need to be observed during the charging of a battery.
B. Slow charge	The slow-charge method uses a low, steady charging rate. (*Ref. A, pp. 75-76; Ref. C, pp. 93-94; Ref. E, pp. 447-448; Ref. D, pp. 22-6—22-7*)
	Trickle chargers are used to keep freshly charged batteries ready for use.
	Demonstrate the procedures for giving a battery a slow charge. Include such items as:
	• *Advantages of the method*
	• *Proper charging rate*
	• *Safe temperature for electrolyte*
	• *Condition of cells at end of charge*
	• *Effects of overcharging*
C. Fast charge	The fast-charge method uses a high charging rate for a short time. A fast charge should be followed with a slow charge for a few hours. (*Ref. A, pp. 73-75; Ref. C, pp. 94-96; Ref. D, p. 22-7; Ref. E, pp. 448-449*)
	Demonstrate the procedures for giving a battery a fast charge. Include such items as:
	• *Advantages and disadvantages of method*
	• *Safe temperature for electrolyte*
	• *Condition of cells at start of charge*
	• *Color of electrolyte during charging*
	• *Level of electrolyte during charging*
	• *Duration of fast charge based on specific gravity of electrolyte*
	• *Necessity of disconnecting cables when battery is left in vehicle*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
VII. Battery Service	
A. Inspecting	Periodic inspection and care of a battery will extend its useful life appreciably. *Demonstrate the procedures for making a periodic battery inspection. Include such items as:* • *Condition of cables and connections* • *Accumulation of dirt and corrosion* • *Defects in case and cover* • *Loose clamps* • *Level of electrolyte* *(Ref. A, pp. 77-80)*
B. Adding water	The level of the electrolyte must be kept above the tops of the separators. Add distilled water or clean tapwater that is low in mineral content. Excessive water requirements might indicate a malfunction in the charging system of the vehicle. *(Ref. C, pp. 75-76)* *Demonstrate the procedures for adding water to a battery to bring the electrolyte to the proper level. (Ref. D. pp. 22-1—22-2)*
C. Cleaning top and cables	Dirt and grime collect on top of a battery which may permit the battery to discharge slowly to ground. Battery cables, clamps, and terminals accumulate corrosion which may cause poor contact with a loss of voltage. *(Ref. C, pp. 77-80)* *Demonstrate the procedures for cleaning the battery top and cables and for protecting the terminals from corrosion.* Battery cables must carry high amperage with a minimum loss of voltage so cables should be at least No. 6 gage for 12-volt systems and at least No. 1 gage for 6-volt systems. *(Ref. B, pp. 385-388)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Demonstrate the procedures for checking and replacing battery cables.
D. Removing and replacing	Note the locations of the positive and negative terminals so the new battery may be placed in the correct position. *Demonstrate the procedures for removing and replacing a battery. Include such items as:* • *Using a case-type battery carrier* • *Cleaning battery holder* • *Checking condition of battery holder* • *Connecting cables and checking polarity* • *Protecting terminals from corrosion* • *Tightening holddown clamps* *(Ref. C, pp. 90-92; Ref. D, pp. 22-9—22-10)*
E. Activating a dry charge battery	A dry charge battery is activated for service by adding electrolyte to each cell. Safety glasses must be worn when pouring the electrolyte into the battery. *Demonstrate the procedures for activating a dry charge battery. Include such items as:* • *Opening electrolyte container* • *Adding electrolyte* • *Adjusting level of electrolyte* • *Testing charge of battery* • *Giving battery a quick charge* • *Disposing of electrolyte container* *(Ref. A, pp. 80-82; Ref. C, pp. 98-100; Ref. D, p. 22-8; Ref. E, pp. 444-450)*
F. Causes of failure	*Discuss the factors affecting battery life. Include such items as:* • *Low level of electrolyte*

6. What is the function of the plate separators?

7. What are the factors that determine battery capacity?

8. What precaution must be taken of a very weak battery in the wintertime?

9. What precautions must be taken when giving a battery a fast charge?

10. State five causes for a battery to rundown.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Barr, R. R. & Flocco, T. D. *The automobile electrical system;* 2d ed. Philadelphia, Pa. Chilton Book Co. 1968.

(B) Blanchard, H. F. & Ritchen, Ralph. *Auto engines and electrical systems;* 4th ed. New York, N.Y. Motor. 1967.

(C) Crouse, W. H. *Automotive electrical equipment;* 6th ed. New York, N.Y. Webster Division, McGraw-Hill Book Co. 1966.

(D) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(E) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Association of American Battery Manufacturers. *Battery service manual.* East Orange, N.J. The Association. 1967.

Atlas Supply Co. *Basic tune-up training.* Springfield, N.J. The Corporation. 1969.

_____ *Service guide; tires and batteries.* Springfield, N.J. The Corporation. 1968.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation. 1969.

ESB Brands, Inc. *Facts about storage batteries.* Cleveland, Ohio. The Corporation. 1965.

General Motors Corp., Delco-Remy Division. *The d.c. charging circuit.* Anderson, Ind. The Division. 1967.

_____ *Periodic maintenance and circuit checks.* Anderson, Ind. The Division. 1964.

_____ *Storage batteries; section B (manual and charts).* Anderson, Ind. The Division. 1967.

Automotive Storage Batteries

FILMSTRIPS

Automotive mechanic series; set 1. McGraw-Hill Films. 1952. silent. black and white. Purchase - McGraw-Hill Films.
Storage battery operation - 48 frames
Storage battery principles - 35 frames

FILM LOOPS

Battery service. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

TRANSPARENCIES

The electrical system. 13 transparencies. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

The lead-acid secondary battery. United Transparencies, Inc. Seven transparencies. color. Purchase - United Transparencies, Inc.

CHARTS

How a storage battery works. ESB Brands, Inc. color. Free - ESB Brands, Inc.

Parts and assembly of a lead-type storage battery. ESB Brands, Inc. color. Free - ESB Brands, Inc.

Charging Systems

OBJECTIVE

- To be able to diagnose and correct malfunctions in generators, alternators, and regulators

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Function	A generator is a device that converts mechanical energy into electrical energy. *Discuss the functions of the generator including:* • *Charging the battery* • *Supplying current for ignition, instruments, lights, and other electrical units* *(Ref. C, p. 197)*
II. Principle of Operation	Voltage is generated in a coil as it moves through a magnetic field. This effect is called electromagnetic induction. Voltage is also induced if the magnetic field moves and the coil of wire remaines stationary. *(Ref. A, pp. 311-314; Ref. C, pp. 198-204; Ref. E. pp. 316-320)* *Demonstrate the principle of electromagnetic induction by using a:* • *Coil of wire* • *Horseshoe magnet* • *Galvanometer* *(Ref. C, pp. 197-198)* *Use films, filmstrips, transparencies, and charts to assist in developing the topic of electromagnetic induction. See Instructional Materials at the end of the unit.*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
III. Direct Current Generator	The direct current generator produces current that flows in one direction. In automotive direct current generators, the conductor moves and the magnetic field remains stationary. *Use filmstrips, film loops, transparencies, charts, and the actual devices to assist in developing the topic of direct current generators. See Instructional Materials at the end of the unit.*
A. Armature	The armature contains many coils of wire and each coil is connected to a commutator segment. The whole assembly rotates in a magnetic field.
B. Brushes	Brushes contact the commutator segments and carry off the current induced in the coils.
C. Field coils	The field coils produce the magnetic field. The coils are held in place by pole shoes.
D. Frame	The frame holds the component parts of the generator in proper alinement and provides a means of mounting the generator to the frame of the automobile.
E. Drive	Most automotive generators are driven by the engine fan belt. A small fan on the drive end of the shaft provides ventilation which increases the amount of current a generator may produce.
F. Types	The fields of direct current generators are grounded through the regulator (standard duty) or the generator (heavy duty). *Explain the two basic types of direct current generators and show how to identify each. (Ref. D, pp. 22-12—22-13; Ref. E, pp. 330 331)* *Disassemble an automotive direct current generator and discuss the functions of the various parts. (Ref. A, pp. 314-324; Ref. B, pp. 465-467, 471; Ref. E, pp. 335-336)*
G. Inspection	Direct current generators should be inspected every 10,000 miles. *(Ref. A, p. 323; Ref. C, pp. 350-354)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Demonstrate the procedures for inspecting a direct current generator on the car and for adjusting or replacing defective parts. Include such items as: • *Cables, wires, and connections* • *Clamps, and holding devices* • *Belt and drive pulley* • *Commutator and brushes* • *Brush spring tension* • *Commutator riser bars* • *Lubrication (if needed)*
H. Malfunctions	*Discuss the reasons why a direct current generator fails to produce its rated output. Include such items as:* • *Loose or worn drive belt* • *Dirty commutator* • *Loose wires or high resistance* • *Shorted field coils* • *Defective armature* • *Defective cutout contacts* *Show the procedures for protecting the regulator while testing the generator.* *Demonstrate the procedures for testing and correcting both types of direct current generators for:* • *No output* • *Low or unsteady output* • *High output* • *Excessive resistance* • *Grounded field*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Open or short circuits* • *Noisy operation* *(Ref. C, pp. 338-345; Ref. D, pp. 22-10—22-14; Ref. E, pp. 330-334)*
I. Removal and disassembly	*Demonstrate the procedures for removing a direct current generator from a vehicle. (Ref. B, p. 469; Ref. C, pp. 358-359)* *Show the procedures for disassembling and inspecting a direct current generator. Include such items as:* • *Dowel pins or alinement marks* • *Brushes* • *Armature* • *Wiring and insulation* • *Bearings* • *Field coils* *(Ref. A, pp. 322-324; Ref. C, pp. 359-362; Ref. D, pp. 22-14—22-15; Ref. E, pp. 335-336)*
J. Service	Parts of a direct current generator that might need service include: • Armature • Bearings • Brushes • Field coils
1. Armature	Inspect the armature for both mechanical and electrical defects. *Demonstrate the procedures for testing an armature for shorts, opens, or grounds. (Ref. A, pp. 324-327; Ref. C, p. 363; Ref. D, pp. 22-15—22-17; Ref. E, p. 334)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Show the procedures for turning down a commutator on a lathe and undercutting the mica. (Ref. A, pp. 327-328; Ref. D, p. 22-18; Ref. E, p. 336)
2. Bearings	*Demonstrate the procedures for checking, cleaning, and replacing bearings. (Ref. A, p. 333; Ref. C, pp. 363-364; Ref. D, p. 22-18)*
3. Brushes	*Demonstrate the procedures for checking the brush spring tension. (Ref. C, p. 364)*
	New brushes should be sanded to conform to the curvature of the commutator. *(Ref. C, pp. 371-373)*
	Show the procedures for testing, removing, and replacing brushes. (Ref. A, pp. 331-333; Ref. B, pp. 469-472; Ref. D, pp. 22-19—22-20)
4. Field coils	Field coils should be replaced when tests indicate a ground, short, open, or the insulation appears charred. *(Ref. C, p. 363)*
	Demonstrate the procedures for testing, removing, and replacing field coils. (Ref. A, pp. 328-331)
K. Reassembly	*Demonstrate the procedures for reassembling a generator. (Ref. A, pp. 333-334; Ref. C, p. 362; Ref. D, p. 22-20)*
	After servicing, check the output of a direct current generator to see that it is within the manufacturer's specifications.
	Demonstrate the procedures for testing a direct current generator by using a special test bench. (Ref. A, pp. 334-337; Ref. D, pp. 22-20—22-21; Ref. E, p. 336)
L. Reinstallation	After a generator has been repaired and reinstalled, it needs to be polarized relative to the battery circuit.
	Demonstrate the procedures for reinstalling and polarizing both types of direct current generators. (Ref. C, pp. 373-374; Ref. D, pp. 22-21—22-22; Ref. E, p. 336)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
IV. Alternators	Alternators produce alternating current which is changed to direct current for use by the various automotive electrical units. *(Ref. A, pp. 339-340)* *Use filmstrips, film loops, transparencies, charts, and the actual devices to assist in developing the topic of alternators. See Instructional Materials at the end of the unit.*
A. Rotor	Alternating current generators have a moving magnetic field and the unit is called a rotor.
B. Stator	The conductors remain stationary and the unit is called a stator.
C. Sliprings and brushes	The current induced in the stator is collected by brushes in contact with slip-rings.
D. Diodes	Most alternators have built-in diode rectifers. A diode permits current to flow only in one direction. *(Ref. A, pp. 340-342)*
E. Drive	Alternators are usually driven by the engine fan belt. *Disassemble an alternator and discuss the functions of the various parts. (Ref. E, p. 358)*
F. Inspection	Alternators should be inspected about every 5,000 miles. *Demonstrate the procedures for inspecting an alternator on the car and for adjusting or replacing defective parts. Include such items as:* • *Cables, wires, and connections* • *Brushes and sliprings* • *Bearings* • *Belt and drive pulleys* • *Clamp, nuts, and screws* *(Ref. A, pp. 345-350; Ref. D, pp. 22-22—22-23; Ref. E, pp. 336-339)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
G. Tests	*Discuss procedures to avoid when testing an alternator. Include such items as:* • *Reversing the polarity* • *Grounding the system* • *Operating with an open circuit* • *Polarizing the alternator* *(Ref. D, pp. 22-22—22-23)* *Demonstrate the procedures for testing and correcting several common types of alternators for:* • *Low output* • *Overcharging* • *No output* • *High resistance in circuit* *(Ref. A, pp. 350-351; Ref. D, pp. 22-23—22-24; Ref. E, pp. 337-339)*
H. Removal and disassembly	*Demonstrate the procedures for removing an alternator from a vehicle. (Ref. D, p. 339)* *Demonstrate the procedures for disassembling and inspecting the common types of alternators. (Ref. A, pp. 351-352; Ref. B, pp. 493-498; Ref. C, pp. 364-371)*
I. Service	Parts of an alternator that might need service include: • Diodes • Rotor • Stator • Sliprings • Bearings *(Ref. C, p. 371)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
1. Diodes	*Demonstrate the procedures for testing, removing, and replacing diodes. (Ref. A, pp. 353-360; Ref. D, pp. 22-24—22-26; Ref. E, p. 340)*
2. Rotor	*Show how to test a rotor for open and shorts. (Ref. D, pp. 22-26—22-27; Ref. E, p. 339)*
3. Stator	*Demonstrate the procedures for testing a stator for an open circuit and continuity. (Ref. D, pp. 22-27—22-28; Ref. E, p. 339)*
4. Sliprings	*Show the methods of servicing rough or out-of-roung sliprings. (Ref. A, pp. 360-362; Ref. C, p. 371; Ref. D, p. 22-27)*
5. Brushes	*Show the methods of servicing brushes. (Ref. D, p. 22-26)*
6. Bearings	*Review the procedures for checking bearings for wear. (Ref. C, pp. 363-364)*
J. Reassembly	*Demonstrate the procedures for reassembling the common types of alternators. (Ref. A, pp. 363-429; Ref. C, pp. 364-371; Ref. D, pp. 22-28—22-29; Ref. E, p. 341)*
K. Reinstallation	*Demonstrate the procedures for reinstalling the common types of alternators.*
V. Regulators	A regulator is an electromagnetic device which controls the generator output and protects the battery, generator, and other units in the system from high voltage and current. *(Ref. A, pp. 435-437; Ref. B, pp. 476-477; Ref. C, pp. 226-229; 235-244; Ref. E, pp. 343-344)* *Explain how the regulator controls the voltage and current output of a direct current generator.* *Use filmstrips, transparencies, charts, and the actual devices to assist in the developing of the topic of regulators. See Instructional Materials at the end of the unit.*
A. Regulators for direct current generators	The units in a regulator for a direct current generator include: • Cutout relay

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Voltage regulator • Current regulator
1. Cutout relay	The cutout relay prevents the battery from discharging through the generator when the engine is stopped or running at a slow speed. *Explain the operation of the cutout relay. (Ref. A, pp. 437-439; Ref. B, 477-478; Ref. E, p. 344)*
2. Voltage regulator	The voltage regulator prevents the voltage from exceeding a predetermined value and also maintains a constant voltage in the system. *(Ref. A, pp. 439-440)* *Explain the operation of the voltage regulator. (Ref. B, pp. 478-479; Ref. D, p. 345)*
3. Current regulator	The current regulator prevents the current from exceeding a predetermined value. *Explain the operation of the current regulator. (Ref. A, pp. 441-443; Ref. B, p. 478; Ref. D, p. 345)*
4. Polarity	Regulators are designed for specific systems and polarity. *Explain the reasons for using a regulator with the same polarity as the system. (Ref. A, p. 452; Ref. E, 34[illegible])*
5. Variations	*Explain the different variations of the standard regulator such as:* • *Double-contact* • *Combined* • *Heavy-duty* • *Transistorized* *(Ref. C, pp. 239-244; Ref. D, pp. 22-29—22-30)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
6. Service	Many regulator troubles may be corrected just by cleaning the points of the voltage and current regulators. Manufacturer's instructions and specifications should be followed for all regulator adjustments. *Demonstrate the procedures for cleaning regulator contact points. (Ref. D, pp. 22-31—22-32; Ref. E, pp. 348-349)*
a. Preliminary checks	*Explain the precautions that must be followed when making generator-regulator checks. (Ref. B, pp. 480-481; Ref. C, pp. 279-281)* *Demonstrate the procedures for making preliminary generator-regulator checks for such conditions as:* • *Charged battery and a high charging rate* • *Discharged battery and a low charging rate* • *Noisy generator operation* • *High resistance in charging circuit* *(Ref. A, pp. 443-457; Ref. C, pp. 263-276)*
b. Cutout relay	Disconnect the battery when adjusting the air-gap and point opening to prevent damage to the unit by the accidental closing of the contact points. *Demonstrate the procedures for checking and adjusting the cutout relay of commonly used regulators including:* • *Amature airgap* • *Point gap* • *Voltage required to close contacts* *(Ref. B, pp. 481-489; Ref. C, pp. 281-305; Ref. D, pp. 22-32—22-33; Ref. E, pp. 346-363)*
c. Voltage regulator	*Explain how the operation of the voltage regulator is affected by the following malfunctions:* • *Oxidized points*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Broken points* • *Broken or open resistor* • *Excessive spring tension* • *Insufficient spring tension* • *Incorrect armature airgap* *Demonstrate the procedures for checking and adjusting the voltage setting of commonly used regulators including:* • *Instrument connections* • *Airgap* • *Spring tension* *(Ref. B, pp. 481-489; Ref. C, pp. 281-305; Ref. D, pp. 22-34—22-36; Ref. E, pp. 346-363)*
d. Current regulator	*Explain how the operation of the current regulator is affected by the following malfunctions:* • *Oxidized points* • *Broken points* • *Broken or open resistor* • *Excessive spring tension* • *Insufficient spring tension* • *Insufficient armature airgap* *Demonstrate the procedure for checking and adjusting the current settings of commonly used regulators including:* • *Instrument connections* • *Airgap* • *Spring tension* *(Ref. A, pp. 453-479; Ref. B, pp. 481-489; Ref. C, pp. 281-305; Ref. D, pp. 22-36—22-37; Ref. E, pp. 346-363)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
B. Regulators for alternators	The regulator limits the voltage output. The diodes eliminate the cutout relay and the design of the alternator eliminates the current regulator. *(Ref. B, pp. 492-498; Ref. C, pp. 244-259)*
1. Types	*Display and explain the operation of the following types of regulators:* • *Single-unit* • *Two-unit* • *Three-unit.* Some regulators use transistors, diodes, resistors, and capacitors to control the field current and keep the voltage output at a safe level. *Explain the precautions that need to be followed when transistorized regulators are used.* *Use transparencies, charts, and the actual devices to assist in developing the topic of types of regulators for alternators. See Instructional Materials at the end of the unit.*
2. Service	*Demonstrate the procedures for checking and adjusting the settings of the commonly used regulators for alternators. (Ref. A, pp. 479-507; Ref. C, pp. 305-325; Ref. D, pp. 22-37—22-41; Ref. E, pp. 360-368)*
VI. Charge Indicator	The charge indicator shows whether the battery is being charged or discharged. An ammeter or an indicator light is used to indicate this action. *(Ref. B, pp. 614-615; Ref. C, pp. 217-218)*
A. Ammeter	An ammeter is used on vehicles equipped with direct current generators.
1. Operation	*Explain the functions and operation of an ammeter used as a charge indicator by using transparencies, charts, and the actual device. (Ref. A, pp. 289-290)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
2. Service	*Demonstrate the procedures for checking and correcting malfunctions relating to an ammeter and its associated circuits. (Ref. B, pp. 614-615)* *Demonstrate the procedures for removing and replacing an ammeter.*
B. Indicator light	An indicator light is used in place of an ammeter on vehicles that use either a generator or an alternator. *(Ref. A, pp. 290-291; Ref. B, pp. 615-616)*
1. Operation	*Explain the functions and operation of an indicator light when used with:* • *A direct current generator* • *An alternator*
2. Service	*Demonstrate the procedures for checking and correcting malfunctions relating to an indicator light and its associated circuits. (Ref. C, pp. 311-312; Ref. D, p. 22-41)* *Demonstrate the procedures for removing and replacing an indicator light.* *Have trainees service the charging systems of shop engines and live cars. Trainees should develop enough proficiency to be able to enter the field of automotive electricity. Include such jobs as:* • *Inspecting and correcting malfunctions of generators and alternators* • *Disassembling, servicing, and reassembling of generators and alternators* • *Testing and correcting malfunctions of regulators* • *Testing and correcting malfunctions of charge indicators*

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Charging Systems

QUESTIONS FOR REVIEW

1. Why is it necessary to control the output of the generator or alternator?
2. Explain the function of the cutout control.
3. Explain the function of the voltage limiter control.
4. Explain the function of the current limiter control.
5. How does alternating current differ from direct current?
6. How is direct current removed from the armature of a d-c generator?
7. How is current removed from the armature of an alternator?
8. What part in an alternator is used to change the output to direct current?
9. Explain how to check and adjust the drive belt tension.
10. Explain how to check brush spring tension.
11. Explain how to polarize a generator with a "B" type circuit. Explain how to polarize a generator with a "A" type circuit.
12. Explain how to test diodes.
13. What is the function of the field relay on an alternator?
14. What is the maximum voltage recommended for a 12-volt system when making charging system tests?
15. Name at least five safety precautions to observe while testing a charging system.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Barr, R. R. & Flocco, T. D. *The automobile electrical system;* 2d ed. Philadelphia, Pa. Chilton Book Co. 1968.

(B) Blanchard, H. F. & Ritchen, Ralph. *Auto engines and electrical systems;* 4th ed. New York, N.Y. Motor. 1967.

(C) Crouse, W. H. *Automotive electrical equipment;* 6th ed. New York, N.Y. Webster Division, McGraw-Hill Book Co. 1966.

(D) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(E) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox., Inc. 1968.

Automotive Electric Association. *Electrical systems manual.* Detroit, Mich. The Association.

_____ *Standard duty alternator manual.* Detroit, Mich. The Association.

_____ *Tune-up manual.* Detroit, Mich. The Association.

C. E. Niehoff and Co. *Principles of automotive tune-up.* Chicago, Ill. The Corporation.

Chrysler Corp. *Basic principles of the alternator charging system.* Detroit, Mich. The Corporation. 1966.

General Motors Corp., Delco-Remy Division. *The d.c. charging circuit.* Anderson, Ind. The Division. 1967.

_____ *The Delctron generator charging circuit.* Anderson, Ind. The Division. 1966.

_____ *Double contact regulators; section R (manual and charts).* Anderson, Ind. The Division. 1966.

_____ *Fundamentals of Delctron generators; section K (manual and charts).* Anderson, Ind. The Division. 1966.

_____ *Generators; section E (manual and charts).* Anderson, Ind. The Division. 1958.

_____ *Periodic maintenance and circuit checks.* Anderson, Ind. The Division. 1964.

_____ *Standard duty generator regulators; section F (manual and charts).* Anderson, Ind. The Division. 1962.

_____ *Transistor regulators; section L (manual and charts).* Anderson, Ind. The Division. 1966.

FILMSTRIPS

Automotive mechanic series; set 2. McGraw-Hill Films. 1952. silent. color. Purchase - McGraw-Hill Films.
Generator-output regulators - 54 frames
Generators - 30 frames

Inside the alternator. C. E. Niehoff and Co. 40 min. sound. black and white. Purchase - C. E. Niehoff and Co.

FILM LOOPS

Alternator testing procedures; part I and II. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

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Charging Systems

Cutting a generator armature. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Replacing generator brushes. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Testing generator output. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

TRANSPARENCIES

Auto testing - charging system. 3M Co. Purchase - 3M Co.

Electrical system. DCA Educational Products, Inc. 13 transparencies. color. Purchase - DCA Educational Products, Inc.

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Starting Systems

OBJECTIVE

- To be able to diagnose and correct malfunctions in starting motors and starting motor controls

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Function	The starting motor is a direct current motor that is capable of delivering high power for a short time. *Explain the functions of the starting motor.*
II. Principles of Operation	The starting motor is a device that changes electrical energy into mechanical energy. *(Ref. A, pp. 529-531, 533-535)* *Explain and demonstrate the principles of an electric motor by using a single wire loop suspended in the field of a horseshoe magnet. (Ref. C, pp. 110-113, 115-117)* *Explain the functions and operation of the following component parts of an electric motor:* • *Armature* • *Brushes* • *Field coils* • *Bearings* *(Ref. A, pp. 535-538; Ref. B, pp. 549-551; Ref. C, pp. 117-119; Ref. E, pp. 371-374)* *Use filmstrips, transparencies, charts, and the actual device to assist in developing the topic of electric motor operation. See Instructional Materials at the end of the unit.*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the operation of and uses for a: • *Series-wound electric motor* • *Compound-wound electric motor* *Explain the various internal connections used for starting motors including:* • *Four-poles, two-field coils* • *Four-poles, four-field coils* • *Six-poles, six-field coils* *(Ref. C, pp. 117-119; Ref. E, pp. 374-375)*
III. Starting Motor Controls	Starting motors draw several hundred amperes during cranking which requires special switches to handle this amount of current.
A. Manual switch	*Explain the functions and operation of a manually operated starting motor switch. (Ref. C, pp. 134-135)*
B. Solenoid switch	The solenoid switch completes the battery circuit to the starting motor by the use of electromagnetism. *Explain the functions and operation of the solenoid switch used on starting motors including:* • *Pull-in winding* • *Hold-in winding* • *Vacuum switch* • *Relay* • *Related electrical circuits* *Use filmstrips, transparencies, charts, and the actual devices to assist in developing the topic of starter motor controls. See Instructional Materials at the end of the unit. (Ref. A, pp. 551-554; Ref. C, pp. 135-142; Ref. E, pp. 380-381)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
C. Neutral safety switch	The neutral safety switch prevents starting the engine while the transmission lever is in a position that would transmit power to the drive shaft. (*Ref. E, p. 382*) *Explain the functions and operation of the neutral safety switch.*
IV. Starter Drives	*Explain the functions of starter drives.* (*Ref. A, pp. 538-539; Ref. B, pp. 546-547, 551; Ref. C, pp. 119-121*)
A. Bendix drive	The Bendix drive provides an automatic means for meshing and demeshing the drive pinion with the flywheel ring gear. (*Ref. A, pp. 539-541; Ref. B, pp. 551-552; Ref. C, pp. 121-123; Ref. E, p. 375*) *Explain the functions and operation of the Bendix drive by using filmstrips, transparencies, charts, and the actual device. See Instructional Materials at the end of the unit.* *Explain the operation of several variations of the Bendix drive including:* • *"Folo-thru"* • *Friction-clutch* • *Barrel* • *Compression-spring* • *Rubber-compression* • *Spring-loaded friction-clutch* (*Ref. A, pp. 541-545; Ref. C, pp. 123-126; Ref. E, pp. 375-376*)
B. Overrunning clutch	The overrunning clutch transmits torque to the flywheel ring gear and allows the drive pinion to turn faster than the armature shaft after the engine has started. (*Ref. A, pp. 545-548; Ref. B, p. 548; Ref. C, pp. 126-130; Ref. E, pp. 378-379*) *Explain the functions and operation of the overrunning clutch by using filmstrips,*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	transparencies, charts, and the actual device. See Instructional Materials at the end of the unit.
C. Dyer drive	The Dyer drive gives positive meshing of the drive pinion and flywheel ring gear before the starting motor shaft starts turning. *(Ref. A, pp. 548-550; Ref. C, pp. 131-133)*
	Explain the functions and operation of the Dyer drive by using filmstrips, transparencies, charts, and the actual device. See Instructional Materials at the end of the unit.
V. Starting Motor Service	
A. Safety precautions	*Discuss the safety precautions that must be followed when servicing starting motors. Include such items as:* • *Putting transmission into neutral* • *Setting of parking brakes* • *Disconnecting and plugging parking brake vacuum line* • *Grounding of secondary lead* • *Operating starting motor for less than 30 seconds*
B. Inspection	The starting motor needs to be inspected at regular intervals. *(Ref. A, pp. 555-560; Ref. C, pp. 160-162)*
	Demonstrate the procedures for inspecting a starting motor.
	Show how to connect and use an auxiliary starting switch.
	Demonstrate the procedures for locating and correcting such starting motor malfunctions as: • *Starting motor inoperative* • *Starting motor cranks engine slowly*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Starting motor runs but drive pinion does not engage* • *Solenoid plunger chatters* • *Solenoid inoperative* • *Drive pinion does not disengage* *(Ref. A, pp. 562-563, 603-605; Ref. C, pp. 147-157; Ref. E, pp. 382-383)*
C. Oncar tests	Oncar tests indicate the necessity of removing the starter for further service. *(Ref. A, pp. 560-561, 564-567; Ref. B, pp. 552-553; Ref. D, pp. 22-42—22-43; Ref. E, pp. 383-384)* *Demonstrate the procedures for making oncar tests to determine:* • *Excessive resistance in the starting circuit* • *Amperage draw of starting motor* • *Actual readings compared with manufacturer's specifications*
D. Removal	*Demonstrate the procedures for disconnecting and removing a starting motor from the vehicle.*
E. Overhaul	The various component parts of the starting motor should be inspected mechanically and also electrically when appropriate.
1. Disassembly	*Demonstrate the procedures for disassembling a starting motor. (Ref. A, pp. 569-603; Ref. B, pp. 554-570; Ref. D, p. 22-45)*
2. Drives	*Demonstrate the procedures for disassembling and servicing the various types of starting motor drives. (Ref. B, pp. 570-573; Ref. C, pp. 171-183)*
3. Armature	*Demonstrate the procedures for testing and servicing an armature for:* • *Grounds*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Opens* • *Shorts* *(Ref. C. pp. 184-188; Ref. D, pp. 22-45—22-46)* *Demonstrate the method of turning a commutator and undercutting the mica. (Ref. C, pp. 188-189; Ref. D, p. 22-46)*
4. Brushes	*Demonstrate the procedures for inspecting, servicing, and replacing brushes. (Ref. C, p. 175; Ref. D, p. 22-47)*
5. Field coils	*Demonstrate the procedures for testing and servicing field coils for:* • *Grounds* • *Opens* • *Shorts* *(Ref. C, p. 190; Ref. D, pp. 22-46—22-47; Ref. E, pp. 384-385)* *Demonstrate the procedures for removing, servicing, and replacing field coils. (Ref. C, pp. 190-191; Ref. D, pp. 22-46—22-47)*
6. Bearings	*Demonstrate the procedures for inspecting and replacing bearings. (Ref. C, p. 189)*
7. Reassembly	*Demonstrate the procedures for reassembling the various types of starting motors and their drive mechanisms. (Ref. A, pp. 569-603; Ref. B, pp. 556-570; Ref. D, pp. 22-47—22-48)*
8. Tests	*Show the procedures to make the following starting motor tests:* • *No-load* • *Stall* *(Ref. A, pp. 567-569; Ref. B, p. 573; Ref. C, pp. 162-170; Ref. D, pp. 22-43—22-45; Ref. E, p. 384)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
9. Solenoid	*Demonstrate the procedure for testing a solenoid including:* • *Plunger operation* • *Pull-in winding* • *Hold-in winding* • *Current draw* *Demonstrate the procedure for disassembling and servicing a solenoid including:* • *Plunger* • *Contact plate* • *Terminals* • *Return spring* *Show how to reassemble and reinstall a solenoid.*
10. Relay	*Demonstrate the procedures for testing and/or replacing a relay.*
F. Replacement	*Demonstrate the procedures for replacing and connecting a starting motor.* *Show how to test the operation of a starting motor on a:* • *Cold engine* • *Hot engine* *Have trainees service the starting motors and controls of shop engines and live cars. Trainees should develop enough proficiency to be able to enter the field of automotive electricity. Include such jobs as:* • *Inspecting and correcting malfunctions of starting motors and their controls* • *Disassembling, servicing, and reassembling of starting motors and their drives* • *Inspecting and correcting malfunctions of starting motor solenoids*

Starting Systems

QUESTIONS FOR REVIEW

1. State the function of the neutral safety switch.
2. Explain the function of the manifold vacuum switch.
3. Explain how to check the starting motor current draw.
4. Show how to check the resistance between the battery ground and the starting motor.
5. Explain the meaning of "hold-in winding" and "pull-in winding" and explain the functions of each winding.
6. Explain how to turndown a commutator and undercut the mica.
7. Tell how to remove and replace field windings.
8. Explain the operation of the "folo-thru" type of Bendix drive.
9. What is the difference between a solenoid and a relay?
10. What causes the overrunning-clutch type of drive to mesh with the flywheel?

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Barr, R. R. & Flocco, T. D. *The automobile electrical system;* 2d ed. Philadelphia, Pa. Chilton Book Co. 1968.

(B) Blanchard, H. F. & Ritchen, Ralph. *Auto engines and electrical systems;* 4th ed. New York, N.Y. Motor. 1967.

(C) Crouse, W. H. *Automotive electrical equipment;* 6th ed. New York, N.Y. Webster Division, McGraw-Hill Book Co. 1966.

(D) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(E) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Automotive Electric Association. *Electrical systems manual.* Detroit, Mich. The Association.

_____ *Tune-up manual.* Detroit, Mich. The Association.

C. E. Niehoff and Co. *Principles of automotive tune-up.* Chicago, Ill. The Corporation.

General Motors Corp., Delco-Remy Division. *Cranking circuit.* Anderson, Ind. The Division. 1966.

_____ *Cranking motors and series-parallel switches; section C (manual and charts).* Anderson, Ind. The Division.

_____ *Periodic maintenance and circuit checks.* Anderson, Ind. The Division.

FILMSTRIPS

Automotive mechanic series; set 2. McGraw-Hill Films. 1952. silent color. Purchase - McGraw-Hill Films.
Starting system controls - 27 frames
Starting system drives - 29 frames
Starting system principles - 29 frames

FILM LOOPS

Battery-starter charge-volt test. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Battery-starter load test. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Starter current-draw test. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

TRANSPARENCIES

Auto testing - starting systems. 3M Co. Purchase - 3M Co.

Electrical system. DCA Educational Products, Inc. 13 transparencies. color. Purchase - DCA Educational Products, Inc.

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Ignition Systems

OBJECTIVE

- To be able to diagnose and correct malfunctions in the component parts of the ignition system

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Function	The ignition system of an internal combustion engine provides the high-voltage surge to the spark plug at the correct time to ignite the air-fuel mixture in the cylinder. *(Ref. A, pp. 106-107; Ref. B, p. 398; Ref. C, pp. 397-398; Ref. E, pp. 387-389)* *Explain the functions of the component parts of the ignition system including:* • *Battery or generator* • *Switch* • *Coil and resistor* • *Distributor — points, advance mechanism, condenser, and rotor* • *Spark plugs* • *Primary and secondary wires* *Use films, filmstrips, transparencies, and charts to assist in developing the topic of the ignition system. See Instructional Materials at the end of the unit.*
II. Battery	The battery is the fundamental source of power for the primary circuit of the ignition system. *Explain the functions of the battery as a part of the ignition system.*
III. Spark Plug	The spark plug conducts the secondary voltage into the combustion chamber and provides the airgap which creates the spark. *(Ref. A, p. 225; Ref. B, pp. 403-404; Ref. C, pp. 413-414; Ref. E, p. 405)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the functions and operation of the various parts of the spark plug. Use films, filmstrips, transparencies, charts, and the actual device to assist in developing the topic of spark plugs. See Instructional Materials at the end of the unit.
	Explain how to use specification charts to select the correct spark plug for a specific engine.
A. Sizes	The size of a spark plug is controlled by the dimensional requirements of the specific cylinder head into which the plug is installed.
	Explain the reasons for different sizes of spark plugs.
B. Heat range	A spark plug has to operate hot enough to burn off the deposits of combustion and at the same time avoid becoming a source of preignition. *(Ref. A, pp. 226-229)*
	Explain the operation and uses of the different spark plug heat ranges.
	Display and explain the effects of using spark plugs with different heat ranges under such operating conditions as: • *Normal* • *Too cold* • *Too hot* *(Ref. B, pp. 425-426; Ref. C, pp. 453-454; Ref. E, pp. 405-407)*
C. Airgap	The airgap of a spark plug causes the secondary voltage to release its energy in the form of a spark.
	Explain the importance of having the spark plug airgap adjusted according to the manufacturer's specifications. (Ref. E, pp. 408-409)
D. Polarity	The high-tension current for the spark plugs should have a negative polarity. *(Ref. A, p. 231)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the advantages of a negative polarity for the high-tension current.
	Demonstrate the procedures for testing and correcting the polarity of the high-tension current. (Ref. A, pp. 232-233)
E. Fouling	Products of combustion may accumulate on the end of a spark plug and cause it to become inoperative.
	Display spark plugs with different types of fouling and explain the methods of correcting such fouling as: • *Carbon* • *Lead* • *Oil* *(Ref. B, p. 426; Ref. C, p. 455; Ref. D, pp. 21-23—21-26; Ref. E, p. 408)*
IV. Secondary Wires	The secondary wires connect the distributor cap with the coil and spark plugs.
	Explain the construction and uses of high-tension cables. (Ref. C, pp. 413-414)
	Explain the precautions to take when removing high-tension cables from spark plug terminals.
V. Ignition Coil	The ignition coil steps-up the primary voltage from the battery or generator to approximately 20,000 volts.
	Explain the construction and operation of the ignition coil including the resistor. Use filmstrips, transparencies, charts, and a cutaway model to assist in developing the topic of the ignition coil. See Instructional Materials at the end of the unit. (Ref. A, pp. 107-110; Ref. B, pp. 399-402; Ref. C, pp. 405-413; Ref. E, pp. 389-390)
VI. Ignition Distributor	The ignition distributor makes and breaks the primary ignition circuit and distributes the secondary voltage to the proper spark plug at the correct time. *(Ref. A, pp. 113-116; Ref. B, pp. 405-414; Ref. C, pp. 398-405; Ref. E, p. 392)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the functions of a distributor.
A. Contact points	The contact points open and close the primary circuit.
	Explain the function and operation of the ignition contact points.
1. Condenser	The condenser reduces arcing at the contact points.
	Explain the construction and operation of a condenser. (Ref. A, pp. 110-113; Ref. B, pp. 402-403; Ref. C, pp. 409-410; Ref. E, pp. 390-391)
2. Cam angle	The cam angle is the number of degrees through which the distributor cam rotates while the contact points are closed.
	Explain the importance of setting the cam angle according to the manufacturer's specifications. (Ref. E,pp. 394-395)
	Show the procedures for checking and setting the cam angle.
B. Ignition timing	The spark occurs in the combustion chamber at a specific time during compression stroke.
	Explain ignition timing and the effects of the spark occuring:
	• *Early*
	• *Late*
	(Ref. A, pp. 142-146; Ref. B, p. 447; Ref. C, pp. 438-441; Ref. D, pp. 21-21—21-22; Ref. E, pp. 401-402)
	Explain the reasons for adjusting the ignition timing to compensate for:
	• *Driving conditions*
	• *Octane rating of fuel used*
	• *Engine carbon deposits*
	• *Altered compression ratio*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Demonstrate the procedures and safety precautions for checking and correcting the timing of an engine with a stroboscopic timing light.
C. Advance mechanisms	The time the spark occurs varies according to engine load and speed. *(Ref. B, pp. 414-415; Ref. E, p. 394)* *Explain the reasons for varying the time at which the spark occurs.* Methods used to change the time of the spark include: • Centrifugal force • Vacuum *Use films, filmstrips, film loops, transparencies, charts, and the actual devices to assist in developing the topic of advance mechanisms. See Instructional Materials at the end of the unit.*
1. Centrifugal advance	The centrifugal advance uses the force developed by the rotating shaft to change the time the points open. *(Ref. A, pp. 117-120; Ref. B, pp. 415-416; Ref. C, pp. 415-416; Ref. E, pp. 392-393)* *Explain the functions and operation of the centrifugal advance mechanism.*
2. Vacuum advance	The vacuum advance uses the vacuum developed in the intake manifold to change the time the points open. *(Ref. A, pp. 122-124; Ref. B, pp. 416-418; Ref. C, pp. 416-418; Ref. E, pp. 393-394)* *Explain the functions and operation of the vacuum advance mechanism.*
3. Combined advance	Part-throttle operation requires more advance than is possible from centrifugal force alone. *(Ref. A, pp. 120-122; Ref. C, pp. 418-423)* *Explain the functions and operation of the combined centrifugal and vacuum advance mechanism.*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
D. Distributor cap and rotor	*Explain the functions and operation of the distributor cap and rotor. (Ref. E, p. 392)*
VII. Transistorized Ignition Systems	Transistorized ignition allows a small current to flow across the contact points and a high current to flow in the primary windings of the coil. *Discuss the advantages of using transistors in the ignition system. (Ref. B, pp. 456-461; Ref. E, pp. 419-420)* Transistors interrupt the primary circuit. Methods of controlling transistors include: • Contact points • Magnetic impulse
A. Contact points	*Explain the functions and operation of a transistorized ignition system controlled by contact points. (Ref. C, pp. 403-404; Ref. E, pp. 420-421)*
B. Magnetic impulse	*Explain the operation of a transistorized ignition system controlled by magnetic impulses. (Ref. C, pp. 400-403; Ref. E, pp. 421-422)*

VIII. Service	*Explain how failures of the ignition system may be related to:*
	
	• *Loss of energy in the primary circuit caused by:*
	  • *High resistance*
	  • *Defective transistor*
	  • *Defective condenser*
	  • *Improper point setting*
	  • *Discharged battery*
	  • *Grounded circuit*
	
	• *Loss of energy in the secondary circuit caused by:*
	  • *Defective wires*
	  • *Fouled spark plugs*
	  • *High-tension leaks*
	  • *Defective connections*
	
	• *Improper timing:*
	  • *Wrong setting*
	  • *Worn distributor shaft*
	  • *Defective advance mechanism*

Ignition Systems

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
A. Battery	The battery must be fully charged and posts, cables, and terminals clean and in good condition. *Review the procedures for checking and servicing a battery.*
B. Ignition switch	*Demonstrate the procedures for checking, removing, and installing an ignition switch. (Ref. D, p. 21-23)*
C. Primary wires	*Show the procedures for checking and correcting primary wires for:* • *Cracks* • *Corrosion* • *High resistance* *(Ref. D, pp. 21-1—21-3)*
D. Ignition coil	*Demonstrate the procedures for checking and correcting an ignition coil for:* • *Shorts* • *Grounds* • *Opens* • *Continuity* • *Polarity* • *Insulation breakdowns* • *Poor connections* • *Corrosion* • *Flashover* *(Ref. A, pp. 129-130; Ref. B, pp. 420-424; Ref. C, pp. 430-432; Ref. D, pp. 21-4—21-6)* *Show how to remove and replace an ignition coil.* *Show how to test and service the resistor in the ignition coil circuit.*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
E. Secondary wires	*Demonstrate the procedures for checking and correcting secondary wires for:* • *Breaks* • *Poor connections* • *Cracks* *(Ref. C, pp. 465-466; Ref. D, p. 21-7)* *Show how to arrange secondary wires to prevent crossfiring and damage from hot manifolds. (Ref. A, pp. 241-242; Ref. D, pp. 21-7—21-8)*
F. Distributor	*Demonstrate the procedures for checking and adjusting the distributor on the car including:* • *Cap* • *Advance mechanisms* • *Cam angle* • *Rotor* • *Contact points* • *Wires and connections* • *Condenser* *(Ref. A, pp. 130-135; Ref. C, pp. 458-465)* *Demonstrate the procedures for removing a distributor from a vehicle.* *Demonstrate the procedures and precautions to take for disassembling, cleaning, servicing, reassembling, and adjusting the commonly used distributors including:* • *Contact points* • *Advance mechanisms* • *Cam* • *Bearings* • *Shaft*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	(Ref. A, pp. 136-142, 146-161, 197-225; Ref. B, pp. 429-454; Ref. C, pp. 467-472; Ref. D, pp. 21-10—21-19; Ref. E, p. 394)
	Demonstrate the procedures for checking and adjusting a distributor on a test machine. (Ref. A, pp. 135-136; Ref. C, pp. 432-438)
	Demonstrate the procedures of reinstalling and adjusting a distributor on a vehicle. (Ref. C, pp. 472-474; Ref. D, pp. 21-19—21-22)
G. Spark plugs	*Explain that spark plug service depends on:* • *Engine design* • *Vehicle use* • *Type of fuel used* • *Remaining useful plug life*
	Demonstrate the procedures for removing and replacing spark plugs. (Ref. A, p. 239; Ref. D, p. 21-23; Ref. E, p. 410)
	Demonstrate the procedures for checking, cleaning, and adjusting spark plugs. (Ref. A, pp. 237-239; Ref. B, pp. 427-429; Ref. C, pp. 466-467; Ref. D, pp. 21-27—21-29; Ref. E, pp. 409-411)
	Review spark plug fouling and demonstrate the methods for correcting such fouling. (Ref. D, pp. 21-23—21-27)
H. Transistorized ignition	*Demonstrate the procedures and precautions for testing, servicing, and replacing component parts of a transistorized ignition system. (Ref. A, pp. 161-197)*
I. Test instruments	*Demonstrate the procedures for connecting and using instruments to check the condition, operation, and adjustment of the ignition system. Include such test instruments as:* • *Coil tester* • *Condenser tester* • *Dwell meter*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Oscilloscope* • *Tachometer* • *Vacuum gauge* *(Ref. A, pp. 129-142; Ref. C, pp. 430-441; Ref. D, pp. 21-30—21-32)*

J. Troubleshooting	*Develop with the trainees a troubleshooting chart of ignition problems and solutions including such situations as:*
	
	• *Engine cranks but does not start*
	• *Engine runs but misses in one cylinder*
	• *Engine runs but misses in different cylinders*
	• *Engine lacks power*
	• *Engine backfires*
	• *Engine pings*
	• *Advance mechanisms wear rapidly*
	• *Contact points become pitted*
	• *Contact points become oxidized*
	• *Defective spark plugs*
	
	(Ref. A, pp. 242-248; Ref. B, pp. 418-420; Ref. C, pp. 444-456)
	
	Have trainees service the ignition systems of shop engines and live cars. Trainees should develop enough proficiency to be able to enter the field of automotive electricity. Include such jobs as:
	
	• *Servicing:*
	  • *Ignition coils*
	  • *Distributors*
	  • *Spark plugs*
	  • *Transistorized ignition systems*

Ignition Systems

CONTENT OUTLINE

UNDERSTANDINGS AND TEACHING APPROACHES

- *Conducting tests using:*
  - *Coil tester*
  - *Condenser tester*
  - *Dwell meter*
  - *Oscilloscope*
  - *Tachometer*
  - *Vacuum gauge*

QUESTIONS FOR REVIEW

1. Explain spark plug heat range.
2. What is meant by spark plug reach?
3. How many windings are contained in an ignition coil?
4. What is cam angle?
5. What is the speed relationship of the distributor shaft to the camshaft and to the crankshaft?
6. Explain how to check the distributor contact point spring tension.
7. Why is a feeler gauge not recommended for checking the spacing of worn contact points?
8. Explain the function of a condenser, and list the procedures for testing a condenser.
9. Why should the headlights be turned on when adjusting idle speeds on alternator equipped vehicles?
10. What is the purpose of the resistor-type spark plug?

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Barr, R. R. & Flocco, T. D. *The automobile electrical system;* 2d ed. Philadelphia, Pa. Chilton Book Co. 1968.

(B) Blanchard, H. F. & Ritchen, Ralph. *Auto engines and electrical systems;* 4th ed. New York, N.Y. Motor. 1967.

(C) Crouse, W. H. *Automotive electrical equipment;* 6th ed. New York, N.Y. Webster Division, McGraw-Hill Book Co. 1966.

(D) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(E) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Automotive Electric Association. *Transistor ignition systems*. Detroit, Mich. The Association.

_____ *Tune-up manual*. Detroit, Mich. The Association.

Atlas Supply Co. *Basic tune-up training*. Springfield, N.J. The Corporation. 1969.

C. E. Niehoff and Co. *Principles of automotive tune-up*. Chicago, Ill. The Corporation.

Champion Spark Plug Co. *Automotive service manual*. Toledo, Ohio. The Corporation. 1969.

_____ *Facts about spark plugs and engines*. Toledo, Ohio. The Corporation.

_____ *Teachers kit*. Toledo, Ohio. The Corporation. 1969.

Chek-Chart Corp. *Car service*. Chicago, Ill. The Corporation. 1969.

General Motors Corp., AC Spark Plug Division. *Spark plug service manual*. Flint, Mich. The Division.

_____ Delco-Remy Division. *Ignition circuit*. Anderson, Ind. The Division. 1965.

_____ *The ignition circuit; section D (manual and charts)*. Anderson, Ind. The Division. 1958.

_____ *Periodic maintenance and circuit checks*. Anderson, Ind. The Division. 1964.

FILMS

A spark in time on the firing line. Champion Spark Plug Co. 22 min. sound. color. Free - Modern Talking Picture Service.

The spark of power. Champion Spark Plug Co. 1965. 14 min. sound. color. Free - Modern Talking Picture Service.

FILMSTRIPS

Automotive mechanic series; set 2. McGraw-Hill Films. 1952. silent. color. Purchase - McGraw-Hill Films.
Ignition distributor - 49 frames
Ignition system - 38 frames

FILM LOOPS

Adjusting the distributor cam angle. Modern Talking Picture Service. Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

3905

Ignition Systems

Installing spark plug wire terminals. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Replacing ignition points. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Spark plug service. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Timing an engine. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

TRANSPARENCIES

Auto testing - Ignition system. 3M Co. Purchase - 3M Co.

Auto testing - Spark and ignition. 3M Co. Purchase - 3M Co.

Electrical system. DCA Educational Products, Inc. 13 transparencies. color. Purchase - DCA Educational Products, Inc.

Electrical system. Universal Education and Visual Arts. color. seven transparencies. Purchase - Universal Education and Visual Arts.

CHARTS

Ignition systems. General Motors Corp. Free - General Motors Corp.

3906

Lighting and Electrical Accessories

OBJECTIVE

- To be able to diagnose and correct malfunctions in the lighting systems and electrical accessories

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Wire	*Display and discuss the types and kinds of wires and cables used in automotive circuits. Include such items as:* • *Wire sizes* • *Resistance* • *Capacity* • *Insulation* *(Ref. B, pp. 385-387, 394-396; Ref. D, pp. 6-1—6-6; Ref. E, pp. 433-435)* *Demonstrate the use of a wire gauge and show how to select the required wire based on the expected load and distance from the power source.*
A. Connecting devices	A junction block serves as a common connection point for a number of wires. A terminal block serves as a supply of current for several circuits. *Display the various types of connecting devices and explain their use and how they are attached. (Ref. D, pp. 6-6—6-8)* *Demonstrate the procedures for installing and connecting wires. (Ref. D, pp. 6-9—6-10)*
B. Printed circuits	Printed circuits use conductor strips fastened to a nonconducting base. *Display and explain the functions of printed circuits.*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Demonstrate the procedures for making wire connections on printed circuits.
C. Electrical circuits	*Discuss the uses of the following as they relate to automotive electrical circuits:* • *Color-coded wire* • *Common ground* • *Parallel connections* • *Series connections*
1. Wiring diagram	A wiring diagram shows all the devices, connections, switches, and fuses of an electrical circuit. *(Ref. A, p. 98; Ref. B, pp. 374-381; Ref. D, p. 6-4)* *Show how to use a wiring diagram to trace a circuit and demonstrate the procedures for checking the continuity of a circuit. (Ref. D, p. 6-11)*
2. Voltage drop	The total voltage drop in any circuit is equal to the source voltage. *Explain how each unit in a circuit consumes some of the voltage and the total of these voltage drops is equal to the voltage at the source. (Ref. A, pp. 43-44)* *Demonstrate the procedures for measuring the voltage drop across several common automotive devices. (Ref. A, pp. 46-47; Ref. B, pp. 383-386, 393)* A higher than normal voltage drop indicates an excessive amount of resistance in the circuit. *(Ref. C, pp. 26-27)* *Demonstrate the procedures for measuring the voltage drop in an automotive circuit. (Ref. A, pp. 44-49)*
II. Lights	
A. Headlights	*Discuss the different types of headlights commonly used on vehicles. (Ref. A, pp. 85-87; Ref. C, pp. 494-496)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the wiring diagram of a headlight circuit.
	Explain the functions and operation of the door mechanisms used for hidden headlights. (Ref. E, p. 430)
	Use transparencies, charts, and the actual devices to assist in developing the topic of automotive lighting. See Instructional Materials at the end of the unit.
1. Headlight relay	*Explain the functions and operation of a headlight relay. (Ref. A, pp. 270-271; Ref. E, pp. 431-432)*
	Demonstrate the procedures for removing and replacing a headlight relay.
2. Circuit breaker	*Explain the functions and operation of a circuit breaker. (Ref. A, pp. 265-268; Ref. C, pp. 479-480)*
	Demonstrate the procedures for removing and replacing a circuit breaker.
3. Switches	
a. Main	*Explain the functions and operation of the main lighting switch. (Ref. A, p. 259; Ref. E, p. 433)*
	Demonstrate the procedures for removing and replacing a main lighting switch.
b. Dimming	*Explain the functions and operation of the headlight dimming switch. (Ref. A, pp. 259-260; Ref. E, p. 429)*
	Demonstrate the procedures for removing and replacing a headlight dimming switch.
4. Aiming	*Demonstrate the procedures for aiming headlights including hidden headlights. (Ref. A, pp. 88-94; Ref. C, pp. 496-498; Ref. E, pp. 428-430)*
	Review the New York State inspection requirements for headlights.

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
5. Automatic dimming	*Explain the functions and operation of the automatic headlight dimming device.*
	Demonstrate the procedures for removing, replacing, and adjusting the automatic headlight dimming device. (Ref. C, pp. 504-506)
6. Service	The headlight circuit needs to be inspected periodically for loose and corroded connections.
	Develop with the trainees troubleshooting procedures for malfunctions related to headlights. (Ref. A, p. 95)
	Demonstrate the procedures for checking and correcting the headlight circuit for resistance. (Ref. A, pp. 44-45; Ref. E, pp. 430-431)
	Demonstrate the procedures for removing and replacing a sealed-beam headlight. (Ref. E, p. 427)
	Demonstrate the procedures for replacing and adjusting a hidden headlight door mechansim.
B. Parking lights	*Explain the wiring diagram of the parking lights circuit.*
	Explain the methods used to protect the parking lights circuit from overloads.
	Explain the double-contact bulbs and show how to test the filaments.
	Demonstrate the procedure for replacing a bulb.
C. Taillights and license-plate light	*Explain the wiring diagram of the taillight and license-plate light circuits.*
	Demonstrate the procedures for testing the taillights and license-plate light circuits and for removing and replacing defective units.
D. Stoplights	*Explain the wiring diagram of the stoplight circuit and show how the turn signal system is tied into the stoplight system. (Ref. A, p. 97)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the functions and operation of the stoplight switch. (Ref. A, pp. 261-262; Ref. D, p. 29-24; Ref. E, p. 433)
	Demonstrate the procedures for testing the stoplight circuit and for removing and replacing defective parts.
	Explain the functions and sizes of automotive fuses. (Ref. A, pp. 265-266)
	Explain the methods used to protect the stoplight circuit from overloads.
E. Signal lights	*Explain the wiring diagram of the signal light circuit and the operation of the:* • *No-turn position* • *Left-turn position* • *Right-turn position* • *Four-way emergency position*
	Explain the procedures for testing the signal light system and for removing and replacing defective parts.
	Explain the methods used to protect the signal light circuit from overloads.
1. Switch	*Explain the functions and operation of the turn signal switch.*
	Demonstrate the procedures for adjusting, removing, and replacing a turn signal switch. (Ref. A, pp. 97-98, 262-265; Ref. C, p. 503; Ref. E, p. 433)
2. Flasher	*Explain the functions and operation of the flasher unit.*
	Demonstrate the procedures for testing, removing, and replacing a flasher unit. (Ref. A, p. 265)
3. Four-way switch	*Explain the operation of the four-way emergency switch, and show how it is tested, removed, and replaced. (Ref. A, p. 265)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Demonstrate the procedures for installing an emergency flasher unit on vehicles not originally equipped.
F. Marker lights	*Demonstrate the procedures for testing the marker light circuit and for removing and replacing defective units.*
G. Backup lights	*Explain the wiring diagram of the backup light circuit.*
	Explain the functions and operation of the backup light switch. (Ref. A, p. 262)
	Demonstrate the procedures for testing the backup light circuit, and for removing and replacing defective units.
	Demonstrate the procedures for installing backup lights on vehicles not originally equipped.
H. Dome lights	*Explain the wiring diagram of the dome light circuit.*
	Explain the functions and operation of the dome light switch.
	Demonstrate the procedures for testing the dome light circuit, and for removing and replacing defective units.
III. Horns	Most vehicle horns consist of a diaphragm which is vibrated by an electromagnet. (Ref. A, pp. 291-292)
	Use transparencies, charts, and the actual devices to assist in developing the topic of automotive horns. See Instructional Materials at the end of the unit.
	Explain the wiring diagram of the horn circuit.
	Explain the functions and operation of the horn and horn relay. (Ref. A, pp. 268-270, 292-296; Ref. C, pp. 379-382, 480-481; Ref. E, pp. 436-437, 438)
	Demonstrate the procedures for testing, adjusting, removing, and replacing a horn and horn relay.

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain the functions and operation of the horn switch.
	Demonstrate the procedures for testing, removing, and replacing a horn switch.
IV. Windshield Wipers	Windshield wiper motors are generally shunt- or compound-wound motors and either single or two-speed. *(Ref. A, pp. 296-297; Ref. C, pp. 500-501)*
	Use transparencies, charts, and the actual devices to assist in developing the topic of windshield wipers. See Instructional Materials at the end of the unit.
	Explain the electrical circuit of a windshield wiper unit.
	Explain the functions and operation of a two-speed windshield wiper motor. (Ref. A, pp. 299-302; Ref. E, pp. 465-467)
A. Service	*Demonstrate the procedures for adjusting a two-speed windshield wiper motor. Include such items as:* • *Transmission and link assembly* • *Parking switch*
	Demonstrate the procedures for removing, repairing, and replacing a windshield wiper motor and transmission and link assembly. (Ref. A, p. 297)
	Show the procedures for removing, adjusting, and replacing the windshield wiper switch including washer button. (Ref. A, pp. 297-299)
	Explain the different types of wiper blade action.
	Demonstrate the procedures for removing, replacing, and adjusting wiper blades. (Ref. A, p. 297)
	Develop with the trainees troubleshooting procedures for windshield wipers including condition, cause, and correction. (Ref. E, p. 467)

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
B. Windshield washers	*Explain the operation of different types of windshield washer pumps. (Ref. E, pp. 469-471)* *Demonstrate the procedures for removing, cleaning, and replacing a windshield washer assembly.*
V. Powered Accessories	*Explain the various types of electric motors and controls used to power accessories such as:* • *Seats* • *Windows* • *Antennas* *Explain the wiring diagrams of several powered accessories indicating switches, relays, and solenoids.* *Demonstrate the procedures for removing, replacing, and adjusting the electric motors and control units for several different powered accessories.*
VI. Speed Control	*Explain the functions and operation of different types of speed control devices. (Ref. E, pp. 458-463)* *Demonstrate the procedures for testing and adjusting the component parts of a speed control system.* *Demonstrate the procedures for removing and replacing defective parts of a speed control system.*
VII. Radios	Radio service is a specialized business but there are several checks and adjustments that an electrical serviceman can make that might restore the radio to operating condition. *(Ref. A, pp. 302-308; Ref. C, pp. 501-502)* *Demonstrate the procedures for:* • *Replacing a radio fuse* • *Checking, adjusting, and replacing a vibrator*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Locating the source of radio interference* • *Checking the antenna circuit*
VIII. Electric Clocks	Clock repair should be done by an authorized clock serviceman but the electrical serviceman could check the fuse. *Demonstrate the procedures for checking and replacing a clock fuse.* *Have trainees service the component parts of the automobile lighting system and electrical accessories. Trainees should develop enough proficiency to be able to enter the field of automotive electricity. Include such jobs as servicing:* • *Headlights and switches* • *Taillights* • *Stoplights* • *Signal lights* • *Backup lights* • *Dome lights* • *Horns* • *Windshield wipers* • *Powered seats, and windows* • *Speed control devices*

QUESTIONS FOR REVIEW

1. Explain the function of a voltmeter and give two examples of its use.
2. What is a rheostat? Indicate where a rheostat is used in the automotive electrical system.
3. Explain the operation of a relay and give two examples where relays are used in the automotive electrical system.
4. Explain how to adjust the vehicle's headlights.
5. Explain why heavy wire is used in some circuits while others use very light wire.

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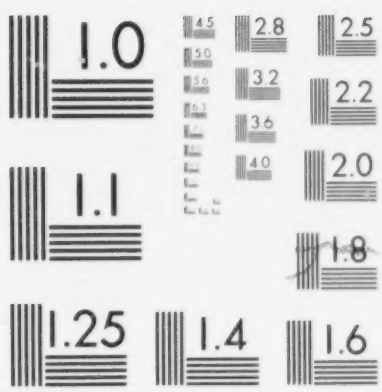

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Lighting and Electrical Accessories

6. Explain the operation of the manually operated headlight beam control.

7. What is voltage drop and how is it determined?

8. Explain how to test a double-contact stop-taillight bulb.

9. Explain the function and operation of the flasher unit.

10. Explain operation of the stoplight switch and tell how to test it.

11. What is the purpose of the thermostatic circuit breaker?

12. What could be the results of installing a fuse with too large an amperage capacity?

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Barr, R. R. & Flocco, T. D. *The automobile electrical system;* 2d ed. Philadelphia, Pa. Chilton Book Co. 1968.

(B) Blanchard, H. G. & Ritchen, Ralph. *Auto engines and electrical systems;* 4th ed. New York, N.Y. Motor. 1967.

(C) Crouse, W. H. *Automotive electrical equipment;* 6th ed. New York, N.Y. Webster Division, McGraw-Hill Book Co. 1966.

(D) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(E) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

REFERENCE BOOKS

Chek-Chart Corporation. *Car service.* Chicago, Ill. The Corporation. 1969.

FILMSTRIPS

Automotive mechanic series; set 1. McGraw-Hill Films. 1952. silent. black and white. Purchase - McGraw-Hill Films.
Gauges and wiring - 36 frames.
Switches, relays, and lights - 19 frames.

FILM LOOPS

Headlight intensity and replacement. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Testing headlight aim. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

3916

Final Examination

Final Examination Part I — Fill-In Statements

Directions: For each statement, write the item or phrase that, when inserted in the blank, will correctly complete the statement.

1. Automotive electrical circuits use, as the return path, the COMMON GROUND.
2. An electromagnet with a movable soft iron core is called a SOLENOID.
3. The quantity of electrons flowing in a circuit is called AMPERAGE.
4. Batteries hooked in SERIES will produce the same voltage as one battery.
5. The voltage of a wet cell is 2 VOLTS.
6. A magnet made of soft steel is called a TEMPORARY magnet.
7. When a storage battery stands in a discharged condition, the plates become SULFATED.
8. Material that opposes the flow of electrons is called an INSULATOR.
9. Unlike poles ATTRACT each other.
10. A generator containing sliprings produces ALTERNATING CURRENT.
11. If the resistance in an electrical circuit is increased without changing the voltage, the amount of current flow is DECREASED.
12. A device that has the ability to store electrical energy is called a CONDENSER.
13. A magnet made of hard steel is called a PERMANENT magnet.
14. The number of degrees that the contact points are closed is referred to as DWELL.
15. The amount of plate surface exposed to chemical action determines the capacity of the battery which is expressed in AMPERE-HOURS.
16. Like poles REPEL each other.
17. Regulation or control of the generator output is accomplished by controlling the strength of the generator FIELD.
18. When the generator output voltage exceeds the battery voltage, the circuit between the generator and the battery is closed by the CUTOUT RELAY.

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Final Examination

19. Mechanical energy is converted into electrical energy by a GENERATOR.

20. A device in the ignition primary circuit which prevents arcing at the points is called a CONDENSER.

21. The mixture of sulfuric acid and water used in automotive storage batteries is called ELECTROLYTE.

22. An instrument used to measure the specific gravity of a liquid is called a HYDROMETER.

23. The ignition distributor is driven by the engine CAMSHAFT and rotates at ONE-HALF engine speed.

24. The device that advances the ignition timing as engine speed increases is called CENTRIFUGAL advance.

25. The distributor advance mechanism that changes engine timing in relation to throttle pressure is regulated by the engine VACUUM.

26. To check an armature for a short circuit, use a GROWLER.

27. To check an armature for a grounded circuit, use a TEST LAMP.

28. As the engine speed increases the coil output voltage will DECREASE.

29. The device that conducts the ignition current from the distributor cap center terminal to the secondary spark plug wire is called the ROTOR.

30. In an eight-cylinder engine, the breaker points will open and close 16 times for each four revolutions of the crankshaft.

31. The two circuits of the ignition system are the PRIMARY and SECONDARY.

32. The ignition points are in the PRIMARY circuit.

33. The electrical sending unit in the gas tank has a VARIABLE resistance.

34. A spark plug's designed operating temperature is referred to as its HEAT RANGE.

35. Voltage jumping over the outside of a spark plug insulator is called FLASHOVER.

36. The instrument for testing resistance between the battery ground and starting motor is called a VOLTMETER.

37. Incorrect battery polarity may damage the DIODES of an alternator.

38. Two causes of detonation are, low OCTANE fuel and too advanced ignition TIMING.

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39. The headlights should be turned on when adjusting idle speeds on vehicles equipped with ALTERNATORS.

40. The presence of black carbon deposits on spark plug electrodes indicates OIL FOULING.

Final Examination Part II — Multiple Choice

Directions: For each statement, place an X in the space to the left of the choice that most accurately completes the statement.

1. The difference in electrical pressure between two posts of a battery is called

   ____ (a) resistance
   ____ (b) amperes
   __X__ (c) volts
   ____ (d) ohms

2. A circuit in which all of the current passes through all of the devices is called

   ____ (a) an open circuit
   __X__ (b) a series circuit
   ____ (c) a short circuit
   ____ (d) a parallel circuit

3. A circuit which has several branches for the current to pass is called a

   ____ (a) combined circuit
   ____ (b) multiple circuit
   __X__ (c) parallel circuit
   ____ (d) series circuit

4. Two six-volt batteries connected in parallel will produce

   __X__ (a) 6 volts
   ____ (b) 12 volts
   ____ (c) 18 volts
   ____ (d) 24 volts

5. Two 12-volt batteries connected in series will produce

   ____ (a) 6 volts
   ____ (b) 12 volts
   ____ (c) 18 volts
   __X__ (d) 24 volts

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6. When the number of turns of wire are doubled in the primary coil of a transformer, the voltage produced by the secondary will

_____ (a) decrease
_____ (b) remain the same
__X__ (c) double
_____ (d) increase to 20,000 volts

7. As the temperature of copper wire increases, its resistance

_____ (a) is absorbed by the insulation
_____ (b) remains the same
__X__ (c) increases
_____ (d) decreases

8. A circuit breaker sometimes takes the place of a

_____ (a) solenoid
__X__ (b) fuse
_____ (c) relay
_____ (d) mechanical starter switch

9. Ohm's law states that the resistance of a circuit can be calculated by

__X__ (a) dividing the voltage by the amperes
_____ (b) dividing the amperes by the voltage
_____ (c) multiplying the ampers times the voltage
_____ (d) dividing the wattage by the amperage

10. The specific gravity of a fully charged battery is

_____ (a) 11.70
_____ (b) 12.75
_____ (c) 1.120
__X__ (d) 1.275

11. High voltage from poor battery connections may cause

_____ (a) instruments to read incorrectly
_____ (b) radio supression
_____ (c) fuses to blow
__X__ (d) headlamps to burn out

12. The unit that stabilizes the operating voltage of the generator is called a

_____ (a) current limitor
__X__ (b) voltage regulator
_____ (c) voltage amplifier
_____ (d) solenoid

13. The ground polarity of all American made passenger cars is

_____ (a) internal
_____ (b) either negative or positive
_____ (c) positive
__X__ (d) negative

14. The starting motor brushes contact the

__X__ (a) commutator
_____ (b) field coils
_____ (c) pole shoes
_____ (d) drive housing

15. The secondary voltage is produced in the

_____ (a) condenser
__X__ (b) coil
_____ (c) battery
_____ (d) distributor

16. Excessively advanced ignition timing may cause

_____ (a) burned contact points
_____ (b) crossfiring
__X__ (c) detonation
_____ (d) decreased coil voltage

17. A rich carburetor mixture may cause spark plugs to

_____ (a) run too hot
_____ (b) become sooty
__X__ (c) become oil fouled
_____ (d) operate at the wrong heat range

18. When adjusting a spark plug gap always bend the

__X__ (a) side electrode
_____ (b) center electrode
_____ (c) terminal tower
_____ (d) insulator

19. The cam angle is the number of degrees that the cam rotates while the contact points are

_____ (a) closing
_____ (b) opening
_____ (c) opened
__X__ (d) closed

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20. If the engine turns over at normal speed, but will not start, the trouble probably is in the

    _____ (a) battery
    __X__ (b) ignition system
    _____ (c) generator
    _____ (d) solenoid

21. When combustion occurrs in the cylinder before ignition, it is called

    __X__ (a) preignition
    _____ (b) detonation
    _____ (c) inductance
    _____ (d) pinging

22. The instrument that measures the current flow is called a (an)

    _____ (a) rheostat
    _____ (b) ohmmeter
    __X__ (c) ammeter
    _____ (d) voltmeter

23. The device in an alternator that allows current to flow only in one direction is called a

    _____ (a) slipring
    __X__ (b) diode
    _____ (c) commutator
    _____ (d) field coil

24. If the starting motor will not operate but the headlights stay bright, the trouble may be in the

    _____ (a) secondary circuit
    __X__ (b) neutral safety switch
    _____ (c) distributor contact points
    _____ (d) voltage regulator

25. At wide open throttle position, the distributor vacuum advance will be

    __X__ (a) 2 minimum
    _____ (b) 2 maximum
    _____ (c) 20° advanced
    _____ (d) 20° retarded

26. If the starting motor will not operate and the headlights go out, check the

    _____ (a) voltage regulator
    __X__ (b) battery terminal connections
    _____ (c) headlight connections
    _____ (d) current at the generator

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27. Reversing the polarity of the coil may

____ (a) have no effect on performance
____ (b) cause contact points to burn
__X__ (c) decrease the ignition secondary output voltage
____ (d) shorten the life of the condenser

28. The unit designed to present a picture of the ignition is called

__X__ (a) an oscilloscope
____ (b) a photoelectric cell
____ (c) a high-speed lens
____ (d) a stroboscope

29. When a battery remains discharged for some time,the plates become

____ (a) cycled
____ (b) undercharged
____ (c) overcharged
__X__ (d) sulfated

30. When using a fast charger,it is important to avoid

____ (a) low specific gravity readings
____ (b) tapering off the charge
__X__ (c) high battery temperatures
____ (d) self-discharge

31. If a battery requires water every few days,it is an indication of

____ (a) extreme hot weather operation
__X__ (b) overcharging
____ (c) overload
____ (d) sulfation

32. Solder being thrown out of the generator commutator usually indicates

____ (a) the generator is being driven too fast
____ (b) too much load on the electrical system
__X__ (c) the generator is exceeding its rated output
____ (d) the battery has become sulfated

33. The unit in the regulator designed to prevent the generator from exceeding its rated amperage output is called a

____ (a) cutout
__X__ (b) current limiter
____ (c) voltage limiter
____ (d) stabilizing unit

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34. A commonly used starter drive is a

_____ (a) constant mesh drive
_____ (b) magnetic drive
_____ (c) vacuum drive
__X__ (d) Bendix drive

35. The starter solenoid is used to

__X__ (a) engage the starter drive with the flywheel ring gear
_____ (b) close the neutral safety switch
_____ (c) drive the engine flywheel
_____ (d) disconnect the battery circuit when the engine is being cranked

36. The magnetism that remains in the generator's pole shoes when the generator is not operating is called

_____ (a) reverse current
_____ (b) electromagnetism
_____ (c) magnetic potential
__X__ (d) residual magnetism

37. Rapid flashing of a directional light indicator lamp on one side and normal flashing on the other side indicates

_____ (a) an overloaded circuit
_____ (b) a defective flasher unit
_____ (c) both bulbs burned out
__X__ (d) one bulb burned out

38. The diodes in an alternator are sometimes mounted in heat sinks which

__X__ (a) absorb and transfer heat
_____ (b) prevent reverse current
_____ (c) cool the alternator
_____ (d) change the polarity

39. For a 12-volt system a suitable wire size to use to connect the horns to the horn relay would be a

_____ (a) 24 gauge
_____ (b) 48 gauge
__X__ (c) 12 gauge
_____ (d) 2 gauge

40. In a 12-volt system, the voltage to the starting motor during cranking should be no less than

_____ (a) 4.5 volts
_____ (b) 13.2 volts
_____ (c) 12.0 volts
__X__ (d) 9.0 volts

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Using Audiovisual Materials

Audiovisual materials are both a tool for teaching and an avenue for learning. While no particular amount of time is recommended for using audiovisual materials, it is suggested that they be used with a variety of learning activities and that the instructor not devote an entire class session to the use of such materials.

Audiovisual materials lend themselves well to bring about a high level of involvement. When working with adults, it is well to remember that much can be learned from each other. It is with the idea of getting people involved and having them make contributions, that these comments are made.

The following suggestions may assist the instructor as he prepares an overall plan for the use of audiovisual materials. The ideas presented should allow for a comprehensive coverage of the content and the efficient use of class time. Steps to consider include:

- Plan the presentation (organization and methods)
- Prepare the equipment and materials
- Orient the class (background material)
- Present the lesson
- Summarize concepts and understandings
- Evaluate knowledges acquired
- Followup with opportunities to explore new knowledges
- Return the equipment and materials

Plan the Presentation (Organization and Methods)

Always preview any audiovisual material to become familiar with its content and to see that it correlates with the lesson. Adult students dislike "time fillers" and inappropriate presentations. While previewing, prepare comments which might answer such questions as:

- What is being illustrated?
- Why is the presented material important?
- What are the important terms and understandings being presented?
- What are some appropriate topics which could be used to stimulate class discussions?

Prepare the Equipment and Materials

Request the required equipment several days ahead of time from the director of adult education or person in charge of audiovisual equipment. Then see that it is delivered prior to the starting of the class. Before the class begins, practice using the equipment to become acquainted with its operation. Arrange the room so that everyone can see and is comfortable. Have a screen ready and place it so that the least amount of outside light

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is reflected onto it. The wall may be used, but a screen is much more desirable. The larger the room and the larger the audience, the larger the screen that is needed. Be sure there is a table for the projector, an electrical outlet, an extension cord (the cord with the projector is usually short), and a spare projector lamp available in case the one in use fails.

If the class is held during the day, be sure the room can be darkened and ventilated. Check to see if the lights can be turned off without shutting off the power to the projector. At the conclusion of the presentation, allow the fan on the machine to cool the equipment for a few minutes before completely shutting off the power to the projector.

Orient the Class (Background Material)

Explain to the class what they will see. Discuss the more important terms used and indicate the main points to be presented.

Present the Lesson

Have the film threaded and the projector ready for use. Stop the film or filmstrip for discussion as the need arises during the showing instead of waiting until the presentation has been completed. A filmstrip offers flexibility for it may be used as a whole or as a part whichever is appropriate to the lesson. It may also be stopped at any frame for discussion or questions. At the end of the showing give your comments and encourage discussion and questions from the trainees.

Summarize Concepts and Understandings

Itemize the important learnings on the chalkboard as they are contributed by the class. Allow time for the trainees to raise other questions which may lead to a more complete understanding. Encourage trainees to keep some kind of notation for future review.

Evaluate Knowledges Acquired

Prepare a list of questions which might assist trainees to evaluate how well they have learned the important points of the lesson. One approach might be for the instructor to present the question and pause for a few moments to allow the trainees to form their answers before responding. Interest could be generated by asking the trainees to keep track of the number of their correct answers.

Followup with Opportunities to Explore New Knowledges

Introduce a few new topics for discussion which will motivate the trainees to project their understandings.

Return the Equipment and Materials

After the class is over make arrangements to return the equipment and school-owned audiovisual materials. For an item ordered from an out-of-school source, complete the required attendance report, prepare the material for mailing, and leave it so that it may be returned promptly.

Preparing and Using Transparencies

Materials for use on the overhead projector may be prepared by hand, the heat-transfer process, and the color-lift process. Each method is described briefly for those who might wish to make their own original transparencies.

General Suggestions

- Select only content that is appropriate for an overhead transparency.
- Keep content of transparency simple.
- Organize the content of the transparency carefully.
- Use multiple overlays (one transparency over another) for the development of a concept or to show steps.
- Keep master and overlays in register with crosshair registration marks in opposite corners.
- Use color to make the transparency attractive but only enough color for emphasis. Color-toned sheets or colored ink may be used to identify parts of a drawing or picture.
- Plan transparency for horizontal projection.
- Use letters and symbols that are at least $\frac{1}{4}$-inch high. Use a lettering guide or dry-transfer letters and symbols to produce attractive titles or labels.
- Leave a $\frac{3}{4}$-inch clear margin on all sides of the transparency.
- Use a pointer to identify a specific part and then remove it quickly or lay pointer on transparency for a hand-held pointer cannot be kept steady, and therefore, becomes distracting.
- Use a sliding or hinged mask to control the rate of disclosure when more than one step is included on a transparency.

Handmade Process

Produces a simple and inexpensive transparency.

Materials Needed

Plastic sheet or roll - clear or frosted

Markers - grease pencil or pen
Ink - transparent or india

Suggested Procedures

- Mark directly on the plastic sheet. This may be done in front of the class as the lesson is being given or may be prepared ahead of time.

- Remove materials placed on a handmade transparency with a sponge or cloth moistened with water or a special cleaning fluid. Then the transparency is ready to be used again.

Heat-Transfer Process

Produces a transparency from almost any original that is flexible and no thicker than a sheet of paper.

Materials Needed

Plastic sheets
Item to be copied
Copying machine

Suggested Procedures

- Material to be copied can be opaque or transluscent but should have a carbon-type ink base *(black)*.

- Follow the directions for the specific copying machine and use the recommended type of plastic sheets.

Color-Lift Process — Drymount Press

Produces a transparency by transferring the ink of a printed picture to a sheet of transparent film. Only material printed on a clay-based paper may be used.

Materials Needed

Special film
Detergent
Flat tray
Drymount press
Pressure boards
Item to be transferred

Suggested Procedures

- Select and test the picture to be lifted. Wet the fingertip and rub over an unprinted portion of the page. Clay-based papers will leave a white residue on fingertip.

- Dry the picture for 5 seconds in a drymount press set at 270° F.
- Put the picture on the coated side of the special film and place between pressure boards. Heat resulting sandwich for 2-3 minutes in a drymount press set for 270° F.
- Place picture and film in lukewarm water containing a liquid detergent. Soak for 2 minutes or until the paper pulls easily from the acetate.
- Wash clay coating from picture and dry film carefully.
- Spray ink surface with clear lacquer spray. Allow spray to dry then mount transparency.

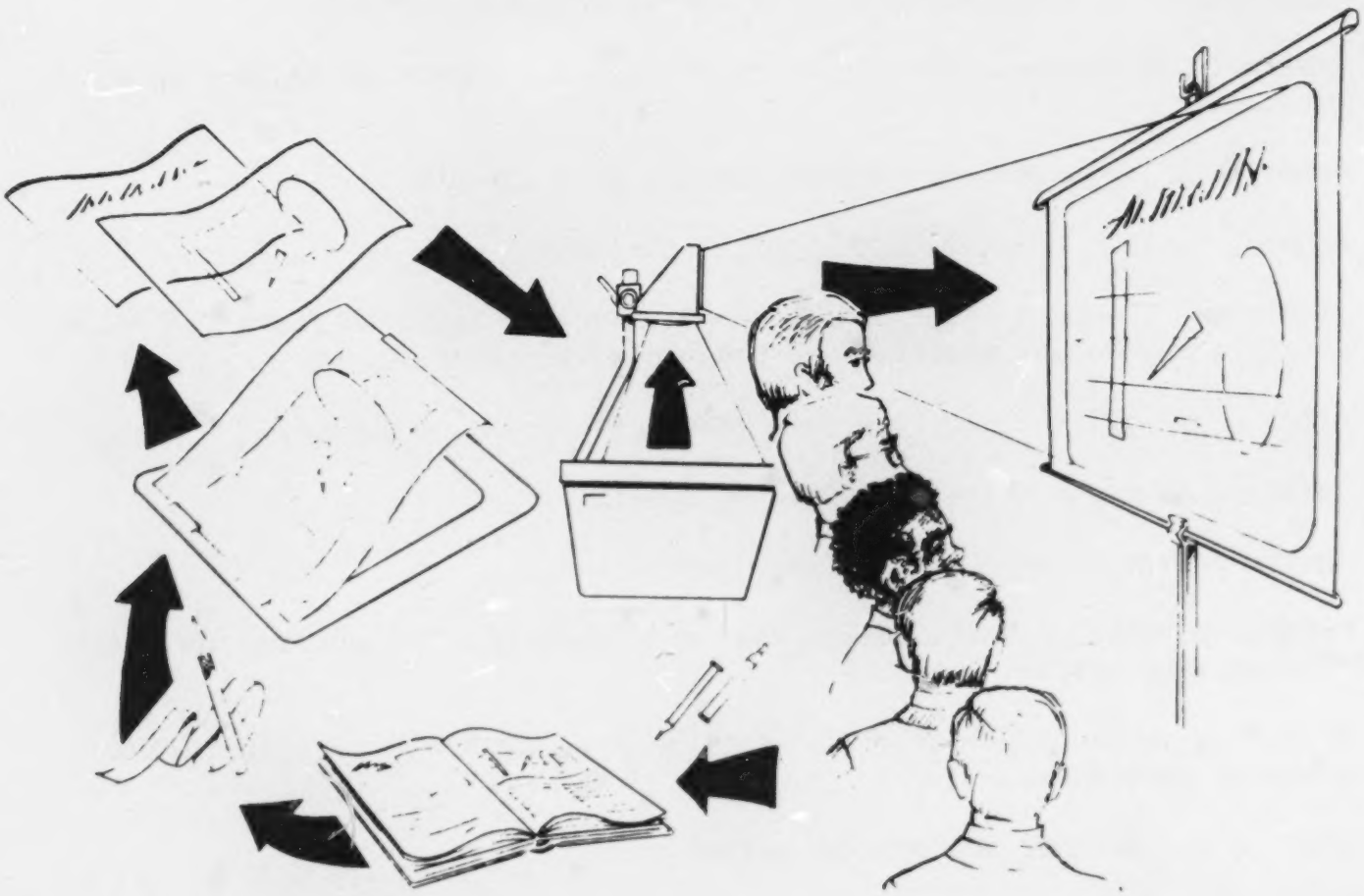

PREPARING AND USING TRANSPARENCIES

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Glossary

a.c.: Alternating current; current that changes its direction of flow at regular intervals.

Active material: Lead paste used in the plates of storage batteries.

Advance unit: A device which moves the ignition timing ahead either mechanically or by vacuum.

Alternator: A generator that produces alternating current.

Ammeter: An electric meter used to measure the amount of amperes in a circuit.

Amperage: The amount of current flowing in a circuit.

Ampere: A unit of flow of electrical current.

Armature: The part mechanically moved through a magnetic field to produce current or moved by magnetism to produce rotation or torque.

Atom: The smallest particle into which matter can be divided.

Battery: A group of cells connected together.

Bendix drive: A type of starting motor drive.

Breaker points: Contact points that open and close the primary circuit of the ignition system.

Brush: A conducting unit which rests on the commutator or slipring of a motor or generator.

Cam: A device that controls or alters motion.

Cam angle: The number of degrees that the distributor shaft rotates during the time the contact points are closed.

Capacitor: A device that has the ability to absorb and retain surges of electricity.

Carbon pile: Carbon disks which decrease in resistance as they are compressed.

Cell: Two different metals suspended in an electrolyte and used to produce an electric current.

Cell connector: A lead strap used to connect the posts of adjoining cells of a storage battery.

Charging rate: Number of amperes being produced to either recharge or hold a battery in a state of charge.

Circuit: The path of an electric current.

Circuit breaker: A device that opens or closes an electrical circuit under specific conditions.

Commutation: The changing of alternating current induced in the armature windings to direct current by means of the brushes and a commutator.

Commutator: A device which forms the connection between the armature windings of a motor or generator and the brushes.

Condenser: A device that has the ability to absorb and retain surges of electricity.

Conductor: A material that will carry current.

Constant current charging: A method of charging storage batteries in which the amperage of the charging current is maintained at a constant rate.

Constant potential charging: A method of charging storage batteries in which the voltage of the charging current is maintained at a constant rate.

Contact points: Two points that complete a circuit when pressed together.

Current: The flow of electrons.

Current regulator: A device which prevents the generator from producing current in excess of its rated capacity.

Cutout relay: The unit which opens and closes the circuit between the generator and battery.

d.c.: Direct current; current that flows in one direction.

Diode: A device which allows current to flow in one direction only.

Distributor: The device that times and distributes the high-tension spark to the spark plug at the proper time.

Dry charge battery: A battery with plates charged but lacking an electrolyte.

Dwell: The numbered degrees that the distributor shaft rotates during the time the contact points are closed.

Electrolyte: A liquid of a mixture of sulfuric acid and water used in a lead-acid storage battery.

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Electromagnet: A coil of wire wound around an iron core which produces magnetism when energized with current.

Electron: A negatively charged particle that makes up part of the atom.

Field: An area filled with a magnetic force.

Field coil: The windings in a generator or motor that produce the magnetic field when current passes through them.

Filament: A fine wire used in a light bulb that heats to incandescence when current passes through it.

Flywheel ring gear: The gear on the outer edge of the flywheel.

Fuse: A protective device designed to open an electrical circuit when the circuit exceeds a specified amount.

Generator: A device for converting mechanical energy into electrical energy.

Grid: A lead screen containing the active battery material.

Growler: An instrument used in testing an armature.

Heat sink: A device usually used to protect diodes from absorbing an excessive amount of heat.

High tension: High voltage produced by the ignition coil.

Hydrometer: A device used to measure the specific gravity of a liquid.

Ignition coil: A step-up transformer that increases the low primary voltage to high secondary voltage.

Insulator: A material that will not conduct an electrical current.

Junction block: A common connection point for a number of wires.

Lines of force: Electrical energy surrounding permanent magnets and current-bearing conductors.

Magnetic field: The area encompassed by magnetic force.

Mica: An insulating material.

Motor: A device that changes electrical energy into mechanical energy.

Neutron: A neutral charged particle that is part of the atom.

Nonconductor: A material that will not conduct an electrical current.

Nucleus: The center portion of the atom.

Ohm: A unit of electrical resistance.

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Ohmmeter: An instrument used to measure resistance in a circuit.

Open circuit: A break or interruption in the normal current path.

Oscilloscope: A testing device which uses a cathode-ray tube to reproduce the spark action of the ignition system.

Overrunning clutch: A type of starter drive which drives in one direction and freewheels in the opposite direction.

Parallel circuit: A circuit so connected as to allow all of its electrical units to function independently of each other.

Plate: A thin section in a battery which carries the active material.

Polarity: The state of a device with reference to the positive or negative terminals of the battery.

Polarization: The process of correcting the direction of current flow in a field coil of a generator to insure that the generated current will flow in the normal direction.

Pole shoe: A metal piece holding the field coil of a motor or generator.

Primary circuit: The low voltage part of the ignition system.

Primary winding: The winding in an ignition coil that carries the battery current and forms the magnetic field.

Printed circuit: An electrical circuit which uses lines printed on a panel as conductors.

Proton: A positive charged particle in the nucleus of an atom.

Rectifier: A device designed to change alternating current to direct current.

Regulator: A device used to control the output of a generator.

Relay: A switch operated by magnetism.

Resistance: The opposition to the flow of electric current.

Resistor: A device placed in a circuit to decrease the voltage or flow of current.

Rotor: The rotating field coil in an alternator; the rotating switch in the distributor that carries the high-tension current from the central terminal to the individual outlets.

Secondary circuit: The high-voltage part of the ignition system.

Secondary windings: The winding in an ignition coil in which the high-tension current is induced.

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Self-discharge: The action within a battery which causes it to discharge even though it is not supplying current.

Segments: The individual bars of a commutator.

Semiconductor: A material which acts as a conductor under some conditions and as an insulator under other conditions.

Separators: Sheets inserted between the positive and negative plates of a lead-acid battery.

Series circuit: A circuit so connected as to allow all the current to pass through all of the units. Failure of any one unit results in failure of all of the units in a series circuit.

Series-parallel circuit: A circuit so connected as to allow all the current to pass through certain units and permit other units to function independently of each other.

Short circuit: A circuit that is completed in such a way that the current bypasses part or all of the normal circuit.

Shunt: A parallel connection of a circuit.

Shunt wound: The field windings connected in parallel with the armature.

Slipring: The rotating connection between the armature and brush of an alternating current generator.

Solenoid: A coil of wire with a movable iron core which centers itself when the coil is energized.

Solid state: An electrical device which operates without mechanical function.

Specific gravity: The weight of an electrolyte relative to the weight of pure water.

Static electricity: A charge of electricity induced by friction.

Storage battery: A device with a reversible action that changes chemical energy into electrical energy.

Stroboscope: A device providing intermittent illumination of a moving object which gives the object the illusion of standing still.

Sulfation: The formation of lead sulfate on storage battery plates.

Tachometer: An instrument for measuring the number of revolutions of a device in a unit of time.

Terminal block: A source of current for several circuits.

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Transformer: A device used to increase or decrease voltage.

Transistor: A semiconductor which can be used as an amplifer or switch.

Volt: A unit of electrical pressure.

Voltage drop: The reduction of voltage across a resistance.

Voltage regulator: An electrical device for controlling or regulating the voltage output of a generator.

Voltmeter: An instrument used to measure the voltage of a given circuit.

Watt: A unit of electrical power.

Wiring diagram: A drawing showing electrical units and the connections necessary for them to function.

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Ohm's law. United Transparencies, Inc. Five transparencies. color. Purchase - United Transparencies, Inc.

Pith ball experiment. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Static electricity. United Transparencies, Inc. Seven transparencies. color. Purchase - United Transparencies, Inc.

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Temporary charge by induction. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

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How a storage battery works. ESB Brands, Inc. color. Free - ESB Brands, Inc.

Ignition system. General Motors Corp. Free - General Motors Corp.

Parts and assembly of a lead-type storage battery. ESB Brands, Inc. color. Free - ESB Brands, Inc.

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ABSTRACT - Prepared by the Ohio State Council of Retail Merchants, this pamphlet presents brief resumes on 45 different careers in retailing, grouped under nine major areas in the field. Areas covered are: (1) managerial and supervisory, (2) professional, including such careers as accountants, electronic data processing, decorators, various types of salesmen, watch repairmen, and printers, (3) advertising, including copywriters, artists, photographers, public relations, and protection, (4) display, including designers, graphic artists, fashion stylists, window trimmers, and painters, (5) office and clerical, such as auditors, secretaries, and business machines operators, (6) skilled craftsmen, including television and radio repairmen, appliance repairmen, furniture finishers, and tailors, (7) technicians, such as nurses, cash register repairmen, and draftsmen, (8) semi-skilled craftsmen, such as auto repairmen, truck drivers, seamstresses, cooks, and pressers, and (9) labor, including stockmen and warehousemen. Brief resumes provide information on duties, responsibilities, educational or training requirements, outlook for the future, and probable salary ranges for each occupation. (AW)

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A MESSAGE TO FUTURE RETAILERS

Retailing, or "the store," is so much a part of our daily lives that most people don't give it a second thought.

Yet retailing is by far the biggest single industry in the United States and there are unlimited opportunities for capable men and women considering a retailing career.

Retailing is the indispensable link between manufacturers and customers. And, for many people, the concept of retailing stops right there—buying and selling. True, buyers buy from manufacturers and sales people sell to customers. This is a very significant and exciting part of retailing, but it is only half the story. More than 50 per cent of the people in retailing are behind the scenes in sales supporting jobs.

For example, retailers have business offices. They need secretaries, file clerks, typists, business machine operators. They need financial experts. They need programmers and systems designers for electronic data processing.

Retailers have advertising and display offices. They need copywriters, artists, carpenters, photographers, production people.

Retailers have employment offices. They need interviewers, counsellors, industrial relations experts.

Retailers have restaurants. They need cooks, waitresses, bakers.

Retailers service products. They need radio and television repairmen, major appliance repairmen.

In fact, there are very few occupations that aren't part of the retail industry.

That's why this booklet. We want you to know about retailing. It is a vital, exciting and growing business. This is an invitation to take a look at us. Perhaps you'll join us.

Harold Friedlander

President, Ohio State Council
of Retail Merchants

BUYING AND SELLING EXECUTIVES *Many people, performing many different jobs, are needed to keep the wheels of a retail store spinning. But at the core of the entire operation is the selling floor. What happens there means the difference between success and failure.*

The responsibility for much of the key work is in the hands of the buyers, department managers and assistant department managers.

When the average shopper sees something she likes, she probably will buy it. It's not that simple for the professional buyer.

The buyer must know what the store's customers will like, what they need, what they can afford and what they will buy. She must know what is too extreme for her store's customers and what is not fashionable enough. She must keep up with the latest styles and be able to judge whether or not her customers are ready for them.

To find the right merchand[illegible]yer goes into the "market," the factories and showrooms in the garment centers of the nation and even in foreign countries. The buyer must also be sure that what she buys in the market will sell at a profit for her store.

The department manager is in charge of the day-to-day operations of his particular area. He must run the merchandising and customer service activities in a way that will insure efficient and economical operations, promote good customer relations and achieve the volume of sales expected from his department. He works with the buyer and the sales force.

The assistant department manager aids both the buyer and the department manager in carrying out the goals of the department.

All three jobs require merchandising skill, an ability to innovate, enthusiasm for the job and the merchandise, a knowledge of the fundamentals of mathematics and, above all, common sense and the ability to get along with people.

Persons who eventually become buyers, department managers and assistant [illegible]ent managers are

MANAGER - SUPERVISER

trained for these jobs in the individual retail stores. But a trainee needs a solid educational background—either four years of college or two years of post-high school education with some actual retail experience, such as working as a sales clerk. Some two-year college graduates are accepted in the store training programs.

Almost any college degree is acceptable for a trainee, although human relations and marketing courses are of great assistance.

Trainees work approximately 40 hours a week. Of course, with moves into executive positions, such as managers or buyers, persons may have to work additional hours. This is especially true during peak periods such as Christmas and Easter. Obviously, a store must cater to the shopping hours demanded by the public.

There is money to be made in retailing. A survey of 7,000 executives in 20 major department and specialty stores indicated that more than 50 per cent of those persons in executive positions earn over $6,500 a year. Moving up the executive ladder, the survey showed that some 850 top personnel had earnings of between $10,000 and $100,000 annually.

One of the advantages in the expanding retail industry is the declining influence of geographical location on an individual's future progress. With branch and suburban stores springing up all over, most areas of the state, particularly in Northern Ohio, offer excellent opportunities for those who wish to enter a career in retailing.

careers in retailing

PROFESSIONAL

ACCOUNTANT *The accountant has two major functions. He prepares financial records of all kinds and he interprets them. Both duties are often done with the aid of a computer.*

The prime requisite for an accountant is an ability to work with figures. He must have specialized professional training, either in college or in a post-high school accounting school.

Depending upon the education background and aptitude, the beginning accountant can earn anywhere from $6,000 to $9,000 a year. Senior accountants can average $15,000 a year.

ELECTRONIC DATA PROCESSING *Retail stores are not strangers to the world of electronics and data processing. Computers perform a variety of jobs. Stores need people to run the equipment, to program it and to design and analyze systems.*

The equipment operator runs the machines, putting the proper tapes on the proper computers, following

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specific instructions and paying careful attention to the commands of the equipment. The job takes discipline and attentiveness. Most training is on the job and a good equipment operator can earn from $120 to $150 a week. A high school diploma is preferred.

The programmer creates the numerical instructions that tell the computer what to do. He gets the information from the system and translates it into program language. There is a critical shortage of programmers. Training can be obtained in special schools. There also are college courses in programming which are more sophisticated. Earnings average from $8,000 to $12,000 a year.

As the title suggests, the person in systems design and analysis creates the systems which the programmer feeds into the computer. They may be financial systems, record systems, merchandise information systems or any number of different systems.

Even though he doesn't program computers himself, he needs a knowledge of programming. The systems designer most generally is a college graduate. He may major in any field, but the main prerequisite is analytical ability. Salaries range from $12,000 to $18,000 a year.

INTERIOR DECORATOR *The interior decorator gives professional assistance to customers in furnishing their homes, offices or other business establishments. The decorator must know about all types of merchandise—china, fabrics, wallpaper, rugs, furniture—and be familiar with the manufacturers from which the best merchandise can be obtained. The decorator must be able to make estimates, draw layouts and devise color schemes.*

Educational background should include training in drawing, wood grains, furniture periods, fabric design, antiques and color harmony.

Most decorators work on straight commission or on a basic "draw" plus commission. The potential earnings and the outlook for the future are excellent.

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FURNISHINGS SALESMEN *Major purchases, such as furniture, appliances, carpeting and sewing machines are not idly made. The customer often relies on the expertise of the salesman to explain the difference between various brands and models and which product will best meet the family's needs.*

The salesman must know good selling techniques and when and how to close a sale. He must keep pace with the changes in models and colors. The goal is to create interest in the product for sale immediately or at a future time.

The educational requirements usually are a high school diploma plus on-the-job training. Many salesmen of the "big ticket" items work on commission. The better the salesman, the better his earnings.

READY-TO-WEAR SALESMAN *The person who enters a retail career as a ready-to-wear or apparel salesman has two avenues to travel. He can gain experience to become a well-paid professional salesman or use it as a foundation to move up to executive jobs.*

There is no formal training for salesmanship. The mechanics—writing sales slips, using the cash register, etc.—are learned on the job. But the salesman must bring to the job enthusiasm, alertness, a desire to help the customer and an ability to inspire confidence.

The good ready-to-wear salesman knows his merchandise, knows fashion trends and knows how to meet the needs of his customers.

Earnings vary, depending upon the background and potential of the person. For example, someone just out of school might start at the minimum wage or a little above it. A college graduate who majored in retailing might earn from $7,000 to $9,000 a year and quickly move into an executive position.

WATCH REPAIRMAN *The watch repairman must be able to disassemble and fix an assortment of time pieces. His educational background should include at least three years of apprenticeship under a qualified*

PROFESSIONAL

watchmaker or completion of an accredited school program.

The repairman must have good eyesight and good muscular coordination. Earnings are flexible, but on the average he can expect to earn $125 a week. Opportunities are excellent and training as a watchmaker is beneficial to persons interested in moving on to electronic instrument work.

PRINTER *Many large retail stores find it practical to operate their own print shops to produce such things as sale notices, flyers on special merchandise or various pamphlets.*

The printer must know how to run a press and all related printing equipment such as the cutter, folder, puncher and plate maker. He also should know about the various types of paper.

Educational background should include the technical training needed to operate the equipment. Salaries vary with individu

careers in retailing

ADVERTISING

COPYWRITER *Advertising copy, in a sense, is a letter to the customer. It tells him what's new or whether something special is going on at the store.*

Unlike writing a letter home, where there is natural interest in your activities, in advertising the copywriter must create the interest.

The copywriter is responsible for the words that appear in a newspaper advertisement. He must understand why the store bought the merchandise and tell the customer what benefit the merchandise will have for her. And, he must tell his story briefly.

The writer must know store policy and keep up with government regulations on merchandise.

The copywriter needs a college education. A major in journalism or English is desirable. Any retail experience is an advantage, but actual training is on the job.

Starting salaries depend upon background and potential. Earnings are good.

The copywriter's future is unlimited. He can step

ADVERTISING

up to such positions as copychief, ad manager, publicity director or branch off into public relations, radio and TV.

LAYOUT ARTIST *Without pictures or other artwork, advertisements might need 1,000 words to tell their story. Art is indispensible.*

The layout artist is responsible for the blueprint of the ad. He must develop and maintain the store look. He must know how to make an ad say "this is quality" or "this is for young people" by capturing a spirit, rather than using words.

Art school training with work in layout and typography is the best educational background. But it takes experience.

The professional layout artist earns good money. But while getting experience, it is often necessary to work for moderate wages and climb up. The larger retail stores offer the most opportunity.

The key to excellence is the ability to be cre[illegible]es in relat[illegible] art fields. within the framework of a store's policy.

There is opportunity for advancement—to art supervisor, art director, ad manager or publicity director.

ARTIST *Filling in the blueprint of the layout artist is the "finished artist" who is responsible for the illustrations that appear in a newspaper ad.*

The artist must understand the merchandise being sold to put emphasis on the product. A good artist keeps up with trends. He must use the newest hair styles, skirt lengths and accessories. If the store has a certain fashion image, he must be sure that image is part of his product.

Top notch artists can command excellent salaries. The beginner may start as a paste-up artist, a junior artist or in a related position.

Art school is essential, as is as much training and experience as possible. Most artists never stop learning, trying new techniques and equipment or taking

The artist with supervisory inclinations can move on to art supervisor, art director, ad manager or publicity director.

PHOTOGRAPHER *If you want to "tell it like it is," nothing does the job better than a photograph. And photography is becoming more important in retail advertising. It is realistic and can give a store or area of merchandise a distinctive look.*

The advertising photographer must be able to take good pictures and do darkroom work. He must understand merchandise to put emphasis on the product rather than the model.

Schools of photography provide an advantage for the beginner, but many photographers have started in art and added photography experience.

The beginner might start with darkroom work and then be trained on the camera. Photographers earn good salaries and there are opportunities to move into other areas of advertising or into executive positions.

RETOUCHER *With photography in use, advertising departments need photo retouchers. A good retoucher is a skilled person who understands art and the engraving process. He must be able to highlight the selling points of merchandise to the best advantage.*

The retoucher also is responsible for pasting down and sizing special type. He also may do hand lettering.

Art school education is important, as well as training in the mechanics of engraving and typography.

The job often becomes a stepping stone for persons to move into finished art, layout or even photography.

PRODUCTION *There is so much that goes into advertising that it needs a control center. That is the production department.*

The production department is where scheduling originates, copies of layouts are made, art assignments are designated and art checked out. It is where copy is put through to the newspaper or printer. It is where proofs come in and go back for final release.

careers in retailing

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Production is a career in itself. Yet, the production department is where many persons start advertising careers since it provides an opportunity to learn the store, its policies, all facets of the department and the work pace. It also gives advertising executives a chance to find out about a beginner's potential.

Wages in production are moderate to start, but advancement can be fast.

ADVERTISING BUSINESS *Since retail advertising is a daily function, it is often realistic for stores to have their own advertising business offices.*

Within this office, advertising costs are figured, billings are made, individual departments are charged back for their advertising and estimates are made for new budgets and future planning.

Business administration in college or business school is the best educational background, although a combination of business and advertising courses may be desirable.

The pay can be good, depending upon the type of work, and there is opportunity for advancement.

RADIO-TELEVISION *There was a time when the retailer who thought of broadcast advertising was considered foolish. But with technological advances, particularly color television, retailers learned they could effectively advertise their products in the broadcast media.*

Yet the potential has only been scratched. Radio and television advertising is a wide open field. Many stores use advertising agencies to create commercials, but more stores are bringing the operation into their own departments. And even when agencies are used, the stores need persons to help sell, coordinate, schedule and work with the agency.

College or technical school training in broadcasting is the best educational background. A great advantage is experience with a radio or TV station. The field is mushrooming and the future is unlimited.

careers in retailing

DISPLAY

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In a simpler world, it was assumed that if you built a better mousetrap, the world would beat a path to your door. But today, the sale of that mousetrap would depend in large part on how it was presented to the public.

One of the fastest growing areas in retailing is "display." It is the art of creating a setting for merchandise, much as a set designer creates a background for the action of a play. Displays are presented in store windows and within departments, the latter called "interior" displays.

The display department includes designers, artists, copywriters, fashion stylists and craftsmen such as carpenters, plastic fabricators and painters. In addition there are window and interior trimmers who are responsible for actual installation of the displays.

Generally, the most helpful academic training for display jobs are vocational or artistic courses. But more important is the desire to be creative and an interest, if not actual experience, in the artful use of materials, colors, composition, lighting and space.

Art training can be valuable, although graphic art is just one part of display. Also of some help is fashion design, interior decoration, industrial design, mechanical drawing or drafting. But none is an end in itself.

Salaries vary according to training, experience and responsibility. An inexperienced trainee might start at the legal minimum wage, but could work up to an annual salary of $8,000 or more. Salaries for qualified specialists and executives run into five figures.

Working hours vary with the duties. But most displays are installed early in the day, before heavy store traffic.

Future opportunities are unlimited since display is becoming a greater part of store planning and merchandising.

Some of the specific jobs in display include:

DESIGNER *The designer is, in a sense, the architect of a window or interior display. He creates the*

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concept from which the display craftsmen work. Many stores, however, do not have specific designers, feeling that design enters into every area of display. The concept may be determined by a supervisor and carried out, with innovations, by the display team.

GRAPHIC ARTISTS *In the area of graphic arts are the people who do silk screening, drafting, signs and the like. The silk screen operator cuts black and white or multicolor designs photographically, using the silk screen process. He does design, layout, mixing of inks and other processes to produce ornamental signs. The draftsman does layouts for temporary special shops, seasonal atmosphere, fixture design and other so-called "board" work. The sign machine operator runs various lettering machines and makes up signs for display and selling departments. He also may do some hand work such as painting borders or other simple embellishments.*

COPYWRITER *The copywriter writes the copy that appears on signs. He also proofreads and edits all sign copy. The prime requisite is an ability to use the fewest words to label a display or to provide pertinent information.*

FASHION STYLIST AND HOME FURNISHINGS COORDINATOR *The fashion stylist is responsible for selecting and coordinating all of the fashion merchandise that appears in windows and interior displays. The stylist also may advise selling departments on fashion coordination. The home furnishings coordinator is in charge of selecting merchandise and coordinating home furnishings windows and interior setups. He also may supervise custom sewing required for such displays.*

CARPENTER AND PLASTICS FABRICATOR *The carpenter, working with wood and metal, and the plastics fabricator, working with plastics, construct properties, backgrounds and "gimmicks" for window and interior*

DISPLAY

displays. Each should be familiar with construction materials and techniques within the specific field.

PAINTER *Painters use spray paints to color properties. They also may repaint previously used backgrounds and props for new displays. Painters must be able to match color cards and be able to use the numerous antiquing and ornamental techniques.*

WINDOW AND INTERIOR TRIMMERS *The window trimmer sets up window and showcase displays to accent the selling points of merchandise and attract customers. He arranges backgrounds, places merchandise on mannequins and adjusts lighting to highlight the merchandise. He works with the carpenters, sign writers, stylists and artists. The interior trimmer arranges formal displays inside the store. In a large store he may be assigned to a specific area.*

MERCHANDISE RETURNER *The "returner" is responsible for returning merchandise used in window and interior displays to the department from which it was borrowed. He must make sure the merchandise is returned in top condition. He also serves as a liaison man and goodwill emissary between display and the selling departments.*

OFFICE & CLERICAL

AUDITOR *The auditor watches over a store's finances as though they were his own.*

As his title suggests, the auditor "audits" or examines business procedures to review the effectiveness and efficiency of the operations and records. He also makes sure that all transactions are properly recorded and comply with federal and state laws.

The auditor is expected to dig out weak business procedures and recommend improvements to management. He prepares reports from which top level management makes policy decisions.

The auditor must have a strong interest in math and be able to write accurate, concise reports.

His educational background should include a college degree in accounting as well as on-the-job training. He can expect to earn from $7,000 to $15,000 a year.

There are great opportunities for advancement because of the increasing need for expense control and the expanding number of laws requiring compliance.

COMPTOMETER OPERATOR *No longer do people peer over ledgers working with figures. Machines do most of the work and the need is for people to run the machines. One of the most useful business machines is the comptometer, which aids in mathematical processes.*

The comptometer operator does bookkeeping, computes reports and checks and sums up mathematical reports. The job may also involve working on store inventory, payroll, saleschecks and profit and loss statements.

Several business schools offer comptometer training, usually in a six weeks course. Starting salaries for persons without experience run about $75 a week. Comptometer operators are in great demand.

CLERK-TYPIST *The clerk-typist in a retail company performs a variety of jobs using the typewriter—typing reports, bills, shipping forms, invoices and other items. She also may do some filing and*

other general office duties.

The clerk-typist must be strong in English and math. At least two years of typing in school or on the job is required. In addition, the clerk-typist should have some training in clerical skills.

Starting salary is about $65 a week. The big advantage for the clerk-typist is the training for future higher paying jobs. The work requires a high degree of skill and provides a variety of interesting duties.

STENOGRAPHER *A stenographer is a highly skilled person with the ability to take dictation in shorthand at a speed of 100 to 120 words a minute and transcribe from her own shorthand or from a dictating machine.*

She must have typing proficiency, clerical aptitude and be strong in spelling and grammar. Her educational background should include business school or high school training in shorthand, typing and clerical skills.

Starting salary is usually $75 for a 40-hour week. The job offers a variety of duties and opportunity to develop office skills.

SECRETARY *The secretary's main purpose is to relieve the executive of various duties to let him get on with the big business.*

She takes dictation, makes appointments for her boss (and reminds him to keep them), arranges travel schedules, handles mail, keeps track of records and receives persons calling to see her boss.

The job requires typing and shorthand skills, an ability to meet the public and work independently.

Graduates of business college are preferred. Beginners earn about $90 a week, but have the opportunity to advance into jobs as secretaries to top management and earn as much as $200 a week.

MAJOR APPLIANCE REPAIRMAN *On that inevitable day when the washing machine won't wash or the refrigerator won't refrigerate, the housewife would forego mink for the repairman who could get her household functioning again.*

Americans are buying more major appliances and the need for good appliance repairmen is critical.

Persons with a curiosity about how things work can expand that interest into a full time, high-paying profession.

The job entails an ability to locate trouble in laundry, refrigeration, air conditioning, cooking and dishwashing equipment and repair it. The repairman must understand electricity and how to install outlets and wiring. He must be able to follow schematic diagrams and understand printed and hand wired circuitry. He must know how to measure voltage and install equipment using natural and bottled gas.

It doesn't hurt to know a little about handling people. Most major repairs are done in the owner's home and he or she is sometimes upset because the appliance is not working.

An electronics course is the foundation of the repairman's education. Then there's on-the-job training and manufacturer training. Most manufacturers of major home appliances have training schools for which the employer pays the fee.

Salaries are good. The apprentice rate is about $2.50 an hour with a top scale of $4 an hour. There is variety in the appliance repairman's work and in the people he meets.

TV-RADIO REPAIRMAN *Behind the television screen is a mass of circuits, transistors, capacitors, condensers and a score of other components of the electronic world.*

It is a job that entails the ability to repair, service and adjust television sets, radio and phonographic equipment.

The best qualified repairman needs the equivalent

SKILLED CRAFTSMAN

of a full electronics course plus on-the-job training. Many employers feel the best trained persons are those who have received electronics training in the military.

Salaries for apprentices are $2 an hour with a top rate of $3.50 and going up.

The radio-TV repairman needs a basic knowledge of electrical current and supply, must know printed and hand wired circuitry and how to read schematic diagrams. He must also understand transistors, vacuum tubes and other component parts as well as the fundamentals of TV picture tubes and the various guns that produce the TV image.

He also must know about high voltage, radiation and magnetism and should have a basic knowledge of how signals are transmitted and received.

Also part of the job is the ability to handle the customer, especially the one who's fuming because he missed his favorite program.

Future needs for radio-TV repairmen will continue to be critical. It is a job that provides continuing employment. Employers supply the working tools and in most cases pay for instruction to keep up with new developments and model changes.

FURNITURE FINISHER *A lot of people like to spend their spare time hunting old furniture and refinishing it. For the amateur, it's an interesting hobby. But for the pro, it is a creative, well-paying vocation.*

The expert furniture finisher can repair and refinish all types of furniture. He can restore it to new-like condition.

The professional finisher must know about wood and wood grains, steel, plastics and glass. He must understand his materials—paints, varnishes, thinners, rubbing compounds, glues and the like. He also must know hand and power tools. All are provided by the employer.

The furniture finisher should be a qualified carpenter and know the fundamentals of the cabinet

maker. The educational requirement is that of a well-trained carpenter. He should have a full course in the materials of his trade. Added to that will be on-the-job and factory training.

Starting pay scale is about $2.50 an hour with a top rate of $4.00 per hour.

Because of the shortage of professional finishers, trained persons can be assured of continuous employment. The job provides a great variety of work, regular hours and personal satisfaction.

The professional finisher should also be customer minded since many times the work is done in the customer's home.

FITTER-TAILOR *People come in all shapes. Clothes do not. So clothing and department stores need experts who can make the garment fit the customer. And it involves a lot more than hemming dresses or cuffing slacks.*

The fitter or tailor must know how to take measurements and make any number of alterations. He must keep up with fashion and the tastes of all age groups and know how to fit persons of all ages.

The tailor is qualified to custom make a garment and knows about materials, both natural and man-made. He knows about different machines and other tailoring equipment. And he also knows about costs. Obviously customers are not willing to pay for alterations that double the cost of the purchase.

Current earnings for fitters and tailors start at about $2.50 an hour with a top scale of $4 an hour. The normal work schedule is 40 hours in a five-day week.

Practically all training and education is gained on the job, which tends to create a critical shortage in this skill.

careers in retailing

TECHNICIANS

REGISTERED NURSE *Thousands of employes and customers are in a large retail store every week. Where there are people, there are bound to be accidents, sudden illness and other emergency situations.*

Most stores have a registered nurse on their staffs to give treatment or first aid to employes or customers who become ill or injured on store premises. The nurse also administers minor treatment and preventative medicine to safeguard the health of store employes.

In addition, she fills out insurance reports and keeps records of all persons treated. The nurse usually maintains a daily log of employes she sees and transfers the entries to the employes' medical records.

She also makes periodic reports to management on the number of employes and customers treated. As part of the job, the nurse administers various insurance plans for the store, such as workman's compensation, public liability and property damage.

The store nurse must be a graduate of an accredited

school of nursing. She also must have a thorough knowledge of store procedures and policies.

CASH REGISTER REPAIRMAN *The major machine in any retail store is the cash register. Many of the larger department stores hire their own cash register repairman who keeps the registers in good working order.*

The repairman fixes the registers when something goes wrong and makes periodic inspections and overhauls. He also may make minor repairs to typewriters and adding machines.

The repairman should have mechanical ability. He must then be thoroughly trained with registers and be able to dismantle a machine and reassemble it. He also must be able to make some repairs right in the department without removing the machine to the shop.

The cash register repairman usually works a 40-hour week and earns an average salary of $7,500 a year.

DRAFTSMAN *Retailing is a people-to-people business. But the people deal with each other in buildings, on sales floors and across counters.*

The draftsman is involved with the physical aspects of the store. It is his job to make working drawings for a project or prepare sketches for displays, changes in departmental layout or store fixtures.

Taking sketches or instructions from supervisory personnel, the draftsman prepares preliminary drawings of site plans, sales floor plans or any proposed change in the building structure. He also copies the plans and drawings prepared by an architect or engineer. He makes detailed drawings of building revisions such as plumbing, piping or electrical fixtures.

The draftsman must be a high school graduate or have vocational school training. He must have a knowledge of plane and solid geometry, trigonometry and the ability to read blueprints. Above all, he must be accurate and have artistic ability.

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careers in retailing

SEMI-SKILLED CRAFTSMAN

AUTO MECHANIC *Many young men enjoy tinkering with automobiles. Just some professional training stands between tinkering and well-paying jobs as auto mechanics.*

The professional auto mechanic needs a basic knowledge of all makes and model cars, both American and foreign. That means knowing everything from air conditioners to windshield wipers.

The auto mechanic must know how to give a fast and accurate diagnosis of the problem and he must know his tools and how to use them.

Most employers prefer the auto mechanic to have a high school education, but aptitude and common sense are the primary requisites.

Training is available at numerous schools, including those run by manufacturers, private trade schools and tax-supported vocational and technical schools.

Because of the growing number of cars and their complexity, many shops are specialized and have specialized areas within them. Just as doctors special-

ize in a particular area of medicine, today's auto mechanic can specialize in the area of his greatest interest.

Earnings for the professional auto mechanic range from $7,000 to $12,000 a year.

The potential is unlimited, considering the growing number of cars and trucks that are on the roads.

BAKER AND CANDY MAKER *During the pre-dawn hours, before many customers even think of taking a shopping trip, bakers and candy makers are preparing those irresistable products that line the shelves of baked goods and candy departments.*

Bakers and candy makers work according to recipes. But there is room for individual initiative since they can suggest variations to be tested. They work hard and fast in the early morning hours to get their foods ready by the time the store opens.

Training may be gained on the job or in trade school courses. Both the baker and candy maker should be able to direct the work of helpers. The baker earns an average of $115 a week. The average weekly salary for a candy maker is $90.

One problem in the future is the possibility that increasing mechanization could eliminate some of the individual skill now required in the profession.

TRUCK DRIVER *The ring on the cash register is not always the signal of a completed sale. Quite often the retail store is responsible for delivering the merchandise to the customer's home.*

Many retail stores maintain their own delivery operations and hire their own truck drivers.

The truck driver for a large retail outlet will cover a specific route between the store and customers' homes. His job, perhaps with a helper, is to load the merchandise, deliver it and unload it.

Stores want their drivers to be in good health, neat and well-groomed.

Truck drivers need chauffeurs' licenses and knowl-

SEMI-SKILLED CRAFTSMAN

edge of vehicle and traffic ordinances.

The truck driver usually works a 40-hour week and overtime when necessary. The average salary for a regular week is $140. In addition to good pay, the job has a particular advantage for men who prefer outside work. The outlook for the future is good.

PRESSER *Clothing shipped from manufacturers to retail stores often must be pressed before it can be placed on the rack for sale.*

To do this job, stores must have pressers to operate pressing machines and hand irons. In some cases, the presser also must do spotting and minor cleaning.

The job calls for specific skills that are gained in on-the-job training. The presser usually earns about $80 for a 40-hour work week. Employment is steady and the need for pressers will continue in the future.

SEAMSTRESS *Many times just a little alteration will make the difference between a garment that looks well on a customer and one that he or she is reluctant to buy.*

On hand to make the small alterations are seamstresses. The seamstress performs simple alterations to both men's and women's clothing. She also may make adjustments on draperies and slipcovers that have been custom made. In her work, the seamstress must know how to hand stitch and use a sewing machine.

Stores provide on-the-job training for seamstresses. The average salary is $70 for a 40-hour week. Since alterations and custom work are always in demand, the future outlook for seamstresses is very good.

CARPET HELPER *Some jobs provide good pay for the work and also the opportunity to become "top dog" on the job. Such is the case with the carpet helper.*

The helper learns his trade by assisting the "master." He learns how to install carpet and how to use the tools of his trade, both hand and power. As a helper,

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he can earn an average of $140 a week and there is often overtime.

The job involves a lot of heavy work. And since much of the work is done in the customer's home, traveling also is involved. The carpet helper has the opportunity to become a master in the trade. The outlook for the profession is good.

COOK *Some time ago, retail stores realized their customers were walking off the premises when they got hungry. So the larger stores decided to open their own restaurants and they went into food service operations.*

The job of the cook is to prepare large batches of food according to prescribed recipes. The cook works behind the scenes. Although not a difficult job, the work is heavy and hot.

Most cooks are trained on the job. The average salary is $80 for a 40-hour week. The outlook is for steady employment.

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LABOR

WAREHOUSEMAN *It is impossible for many stores to keep all the merchandise they need within the retail building. They must have warehouses and warehousemen whose job is stock maintenance.*

The warehouseman has several duties. He puts stock away after it has been received at the dock, matches tickets to the merchandise, pulls items for delivery and for "will call" customers, puts returned merchandise back into stock, operates a tow motor and performs housekeeping duties in his area.

The warehouseman usually works his way up from lower level stock jobs. Salaries average from $2.25 to $2.50 an hour. There is always the opportunity to advance into other warehouse positions such as receiving, shipping and delivery.

STOCKMAN *People who walk into a retail store expect to find merchandise on the shelves and racks. Someone has to get it there.*

The stockman pulls merchandise from his assigned stock area and delivers it to the selling departments. He also places returned merchandise in the stock area and performs housekeeping duties in his area. He also may assist in stock counts on the selling floor and help salespeople arrange merchandise on shelves and racks.

Although little experience is required for the job, most employers require a high school diploma. The work schedule is usually a 40-hour week and salaries range from $1.70 to $2 an hour.

Stockmen must be physically able to be on their feet for long periods of time and be able to handle heavy items.

Working conditions are generally good and persons doing well as stockmen are often promoted to higher rated jobs within the store.

Additional copies of Careers in Retailing may be obtained from the Ohio State Council of Retail Merchants, 71 E. State St., Columbus, Ohio 43215. Telephone: (614) 221-7833.

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ABSTRACT - Prepared by the Bureau of Continuing Education and Secondary Curriculum Development of the New York State Education Department, this curriculum guide is for instructor use in teaching tuneup services in the high school or adult education programs. Units are: (1) Introduction, (2) Engine Service, (3) Ignition System Service, (4) Fuel System Service, (5) Battery and Charging System Service, (6) Starting System Service, and (7) Cooling System Service. Each unit consists of objectives, content outline, questions for review, and an instructional materials list. A final examination, suggestions for using audiovisual materials, a glossary, a directory of related companies, and a bibliography are included. (GEB)

VT 012 392

Automotive Industries Occupations

ED0 56238

AN INSTRUCTOR'S GUIDE FOR A PROGRAM IN

TUNEUP SERVICES

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TRADE AND TECHNICAL EDUCATION

VT012392

THE UNIVERSITY OF THE STATE OF NEW YORK / THE STATE EDUCATION DEPARTMENT
BUREAU OF CONTINUING EDUCATION CURRICULUM DEVELOPMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT / ALBANY, NEW YORK 12224

1970

Automotive Industries Occupations

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BUREAU OF SECONDARY CURRICULUM DEVELOPMENT / ALBANY, NEW YORK 12224

1970

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Foreword

Tuneup Services was developed to provide information and training about locating and correcting troubles occurring in the engine and related component parts. The various systems are analyzed and procedures are suggested to promote a more efficient diagnosis through the utilization of various test instruments and up-to-date troubleshooting methods. The course content may be used in secondary schools and adult programs to assist in preparing individuals who wish to enter this specialized area or to upgrade personnel already working as automobile mechanics.

Appreciation is expressed to Thomas Onderdonk, auto mechanics instructor at the Washington-Warren-Hamilton County B.O.C.E.S. Occupational Center at Argyle, for his efforts in developing the instructional materials. Assistance relating to content was provided by Edward Shattuck, Associate in the Bureau of Trade and Technical Education. The project was coordinated and the manuscript edited and prepared for publication by Nelson S. Maurer, Associate in the Bureau of Continuing Education Curriculum Development.

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Message to the Instructor

Tuneup Services is designed to present an understanding of the major systems of an automobile that affect its performance and economical operation. This guide follows a more conventional approach to tuneup procedures by giving attention to all of the items that are normally involved. The sequence of instructional units may be altered to accommodate the needs and backgrounds of the trainees; also, the availability of tools and equipment may necessitate adaptations in the use of the materials.

Plan each lesson carefully before presenting it to the class. It will be necessary to consider classwork, discussion, demonstrations, and review. The left-hand column of each unit contains suggested topics. The right-hand column gives related information and teaching techniques, methods, and tips which should help to achieve a more effective presentation. Also, this column shows page references for selected textbooks for which the complete citations and symbols are given on page 68. Give a summary of the key points discussed at the conclusion of each unit. A suggested final examination is provided at the end of this guide. The questions are derived from the basic material and are in the form of completion and multiple choice.

Use the chalkboard, overhead projector, charts, diagrams, and other visual aids to clarify the material being presented. A list of suggested aids appears at the end of each unit. Excellent instructional materials are available from various automobile and automotive equipment manufacturers, but order these materials well in advance of the scheduled lesson. Specific materials might be located in *Automotive Instructional Material,* published by the Automotive Service Industry Association. Many teaching aids may be fabricated from samples or discarded equipment.

New instructional aids are constantly being made available to instructors. Current releases of audiovisual aids are usually listed in issues of such publications as the *American Vocational Journal, Industrial Arts and Vocational Education,* and *School Shop.* New information relating to the automotive industry is available from general trade magazines, as well as publications distributed by specific manufacturers.

As experience is gained with this guide, it is hoped that suggestions will be sent to the Bureau for consideration in subsequent revisions.

BERTON P. PLUMMER, *Chief*
Bureau of Trade and Technical Education

JOHN E. WHITCRAFT, *Director*
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Introduction

OBJECTIVES

- To understand the content to be covered in the course
- To be able to conduct a customer interview that will assist in determining possible sources of engine trouble
- To be able to conduct a road test to verify the customer's complaints and to locate other engine troubles

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Importance	Automobile owners are becoming more and more interested in maintaining their cars in a "like new" operating condition. Also, the public concern about air pollution has emphasized the importance of keeping automobile engines properly adjusted. As a result, the field of tuneup has expanded rapidly in the last few years, and this has increased the demand for trained personnel. The purposes of the course are: • To permit individuals who are working as automotive mechanics to increase their knowledges and skills in the field of automotive tuneup • To provide training in the field of automotive tuneup for apprentices and vocational students
II. Course Requirements	
A. Textbook	*If a textbook is to be used, give its name, price, and source. Arrange for a group order.*†
B. Notebook	*Indicate that a looseleaf notebook is necessary for keeping class notes, job information, booklets, and materials distributed during the course.*

†Textbook citations given at the end of each unit.

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Introduction

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
C. Prerequisites	It is important that trainees be knowledgeable in the fundamentals of the following areas: • Internal combustion engine • Automotive electricity • Fuel system • Ignition system • Starting system • Charging system
III. General Safety	*Discuss the procedures for extinguishing small fires involving:* • *Liquids* • *Wiring* • *Upholstery*
A. Protective clothing	*State the school policy relative to coveralls or shop coats, and if required, suggest that trainees furnish their own protective clothing. Mention possible storage space for clothes, if any exists.*
B. Safety glasses	*Indicate the school policy relative to wearing of approved safety glasses.* *Arrange a group order for those who wish to purchase safety glasses.*
IV. Overview of Course	*Discuss the general subject matter that is to be covered in each unit of the course. Also, indicate such items as the length of each session, number of sessions, procedures to be followed in class, and what is expected of each class member.* *Adjust the course content to meet the needs of the trainees and availability of equipment.* *Indicate that a final examination will be given at the end of the course to point out any weak areas.*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Note that following the test there will be time for reviewing the examination and for any other questions related to the course.
V. The Tuneup Process	Tuneup is the process of making the necessary adjustments to bring an engine as near to its original operating condition as possible. Fine adjustment can be made only with accurate instruments and on engines that have no major defects. *Explain the process of tuneup. Include such items as:* • *Locating malfunctions* • *Determining the cause of the malfunctions* • *Correcting the malfunctions as well as the cause* *Discuss the advantages for both the customer and mechanic of performing a complete vehicle tuneup.*
VI. Preliminary Procedures	
A. Customer interview	A customer interview will yield clues as to the type and source of the engine trouble. *Develop with the trainees a questionnaire that will help to gather all the important information from the customer. Consider such items as:* • *Nature of complaint* • *Duration* • *Frequency of trouble* • *Speed at which trouble occurs* • *Unusual sounds* • *Engine temperature* • *Weather conditions*

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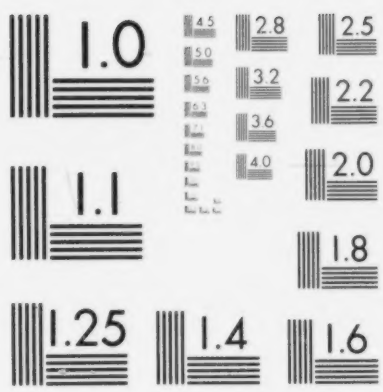

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Introduction

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Changes from normal conditions* • *Recent repairs or new work* • *Mileage since last change of spark plugs and contact points* *(Ref. B, p. 23-2)* *Have trainees role play several interview situations involving a mechanic and customer. Have trainees evaluate the information gathered during each interview and suggest ways to improve communications.*
B. Road test	Road-test the car prior to performing any service to verify the customer's comments and to have firsthand information regarding the condition of the automobile. *Discuss the precautions to take before making the road test. Include such items as:* • *Protecting the seat with a seat cover* • *Having clean hands and feet* • *Removing sharp tools from pockets* • *Having permission to operate the vehicle* • *Selecting the area for the test* • *Obeying all traffic laws* • *Caring for vehicle until it is delivered to the customer* *Discuss the conditions that should be noted during the road test. Relate these conditions to specific malfunctions that will have to be checked during the tuneup. Include such items as:* • *Starting characteristics* • *Accelerating and decelerating patterns* • *Operating conditions at low, medium, and high speeds*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Stalling conditions* • *Amount and color of exhaust smoke* • *Odd engine noises* • *Cooling system performance* • *Charging system operation* *Develop with trainees a checklist of items that could be used during the road test to assist a mechanic to gather important information. Use the above list as a guide.*
C. Work precautions	*Discuss the precautions necessary to take prior and during the tuneup process. Include such items as:* • *Providing for proper ventilation and exhaust removal* • *Bringing engine to operating temperature* • *Protecting fenders with fender covers* • *Protecting the seat with a seat cover* • *Removing sharp tools from pockets before entering a vehicle* *Have trainees road test vehicles. Trainees should develop enough proficiency to be able to identify possible troubles in the:* • *Ignition system* • *Carburetor and fuel systems* • *Engine* • *Charging system* • *Cooling system*

Engine Service

OBJECTIVES

- To be able to make and interpret an engine compression test, a cylinder leakage test, and a vacuum test
- To be able to adjust valve clearance
- To be able to clean and gap spark plugs

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Condition of Engine	The engine must be in a basically satisfactory condition before starting the tuneup service. *Review the symptoms of engine troubles. Include such items as:* • *Excessive oil consumption* • *Smoky exhaust* • *Power loss* • *Certain engine noises* • *Poor acceleration* • *Low fuel mileage* • *Engine misses* *(Ref. D, pp. 85-86)*
II. Compression Test	A compression test determines the mechanical condition of the cylinders and valves. *(Ref. A, pp. 124-126; Ref. B, pp. 23-3—23-4; Ref. C, pp. 189-190; Ref. D, pp. 78-80)* *Explain how engine performance and compression are influenced by:* • *Worn valve guides* • *Burned valves* • *Improper valve adjustment*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Worn or dirty hydraulic valve lifters* • *Worn timing gears or chain* • *Worn piston rings* • *Scored cylinders* • *Excessive crankcase pressure* • *Excessive oil consumption*
	Display and explain the operation of the common types of compression gauges.
	To conduct a compression test, the engine must be at normal operating temperature and supplied with the proper grade of oil, spark plugs removed, and choke and throttle valves wide open.
	Explain the safety precautions to take when making a compression test.
	Demonstrate the procedures for removing secondary wires from spark plugs.
	Demonstrate the procedures for removing spark plugs from an engine. (Ref. B, p. 21-23)
	Demonstrate the procedures for making and interpreting a compression test. Caution against prolonged cranking of the engine to prevent possible damage to the starting motor. (Ref. A, pp. 341-347; Ref. B, pp. 23-3—23-4; Ref. C, pp. 159-190)
	Demonstrate the procedures for determining the cause of low compression readings.
	Compression test readings should be compared with the manufacturer's specifications; and if there is a wide variation among cylinders, there is little value to continue with the tuneup procedure.
III. Cylinder Leakage Test	A cylinder leakage test supplements the information obtained from the compression test.

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Explain how a cylinder leakage test may indicate that leaks are occurring: • *At the valves* • *At the piston rings* • *Between cylinders* • *Between cylinders and cooling system* *Display and explain the operation of the common types of cylinder leakage testers.* *Demonstrate the procedures for making and interpreting a cylinder leakage test. (Ref. B, pp. 23-4—23-5; Ref. D, p. 80)*
IV. Engine Vacuum Test	A vacuum test provides information about the internal parts of an engine. *(Ref. A, pp. 347-349; Ref. B, pp. 23-5—23-7; Ref. C, pp. 190-191; Ref. D, pp. 80-81)* *Explain how a vacuum test may indicate:* • *Incorrect carburetor adjustments* • *Ignition defects* • *Timing defects* • *Cylinder leakage* • *Valve system leakage* *Display and explain the operation of the common types of vacuum gauges.* *Demonstrate the procedures for making and interpreting a vacuum test. Emphasize that the action of the needle is more important than its location on the dial. (Ref. A, pp. 347-349; Ref. B, pp. 23-5—23-7)*
V. Valve Service	*Review the functions and operation of the valves. (Ref. A, pp. 113-123; Ref. C, pp. 73-79; Ref. D, pp. 47-49)* *Review the methods used to lubricate the valve mechanism.*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Discuss ways that faulty valve operation may affect engine performance. Include such items as: • *Loss of power* • *Rough idle* • *Engine miss* • *Poor starting* • *Engine backfire* • *Excessive fuel consumption* • *Noisy engine* *Show the procedures for using an engine stethoscope to isolate a noisy valve or valve lifter.* (Ref. C, p. 184; Ref. D, pp. 126-127) *Show the procedures and precautions for removing valve covers.* *Demonstrate the procedures for inspecting valve assemblies for lubrication, wear, and defective parts.* *Demonstrate the methods of adjusting mechanically operated valves on "L" and "I" head engines.* (Ref. B, pp. 13-36—13-37; Ref. D, pp. 51-53) *Review the functions and operation of hydraulic valve lifters.* (Ref. C, p. 78; Ref. D, p. 53) *Demonstrate the procedures for adjusting hydraulic valve lifters.* (Ref. B, pp. 13-34—13-36; Ref. D, p. 421) *Show the methods of installing valve covers.* *Use film loops, transparencies, and charts to assist in developing the topic of valve service. See Instructional Materials at the end of the unit.*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
VI. Spark Plug Service	*Review the functions and operation of spark plugs. (Ref. A, pp. 217-221; Ref. C, pp. 405-409; Ref. D, pp. 285-291)* *Review the procedures for removing spark plugs from an engine.* *Display and discuss the causes and corrections for the following spark plug problems:* • *Flashover* • *Cracked insulator* • *Fouling* • *Reversed coil polarity* • *Improper gap* • *Normal wear* • *Improper heat range* *(Ref. B, pp. 21-23—21-27; Ref. D, pp. 304-309)* *Review the importance of the following relative to spark plugs:* • *Thread size* • *Thread reach* • *Heat range* • *Manufacturer's recommendations* *Demonstrate the procedures for installing spark plugs and replacing the secondary wires. (Ref. B, p. 21-29; Ref. D, pp. 288-289)* *Use films, transparencies, and charts to assist in developing the topic of spark plug service. See Instructional Materials at the end of the unit.*
VII. Preliminary Checks	*Explain the necessity of performing the following checks and services early in the tuneup procedure:* • *Clean or replace air cleaner*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Check all drive belts for condition and tension* • *Check operation of manifold heat control valve* • *Clean or replace PCV valve* • *Check terminals for corrosion and specific gravity of battery* • *Check level of oil and all coolants* • *Tighten all battery, starter, generator or alternator, regulator, and coil connections* • *Tighten all manifold, carburetor, fuel pump, and vacuum connections* *Have trainees perform engine service on shop engines and live cars until they acquire the proficiency necessary for an entry tuneup mechanic. Include such jobs as:* • *Conducting diagnostic tests for compression, cylinder leakage, and vacuum* • *Adjusting valve clearance* • *Cleaning and gapping or replacing spark plugs*

QUESTIONS FOR REVIEW

1. What is a flashover, and how do spark plug manufacturers guard against it?
2. How can an indication of incorrect coil polarity be detected by visual spark plug inspection?
3. Explain the meaning and cause of "crossfire."
4. Explain the methods of testing engine compression.
5. Explain how the use of oil in the cylinders during compression tests can help isolate the cause of a cylinder having a low compression reading.
6. What usually would be wrong if two adjacent cylinders were found with low compression readings?

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Engine Service

7. Explain the method of testing for cylinder leakage.

8. What condition would be indicated when air is escaping from the tail-pipe during leakage tests?

9. What effect would a worn timing chain have on engine compression?

10. What would the presence of black carbon deposits on spark plugs indicate?

11. What effect would a spark plug that is too hot for the application have on engine performance?

12. Explain the effects of preignition and its relationship to spark plug heat range.

13. Does the fuel octane rating have any relationship to detonation?

14. What effect would a collapsed hydraulic valve lifter have on engine operation?

15. What effect will worn valve guides have on engine performance?

16. Explain how the valve train is lubricated?

INSTRUCTIONAL MATERIALS

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McNeil Corp., Lincoln St. Louis Division. *Professional tune-up procedure*. The Division.

FILMS

The spark of power. Champion Spark Plug Co. 14 min. sound. color. Free - Modern Talking Picture Service.

FILM LOOPS

Engine trouble shooting. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Installing spark plug wire terminals. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Spark plug service. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

TRANSPARENCIES

Spark plugs. Universal Education and Visual Arts. Purchase - Universal Education and Visual Arts.

Ignition System Service

OBJECTIVES

- To be able to test and adjust to manufacturer's specifications a distributor
- To be able to remove, overhaul, and replace a distributor
- To be able to test and replace an ignition coil
- To be able to diagnose ignition system problems with an oscilloscope

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Distributor Service	The distributor performs both electrical and mechanical functions, and thus, requires service in both areas. *Review the functions and operation of a distributor. Include such items as:* • *Control of the primary circuit by the contact points* • *Regulation of the contact points to meet varying engine conditions* • *Distribution of the high-voltage surge to the spark plugs* *(Ref. A, pp. 177-199; Ref. C, p. 392; Ref. D, pp. 255-263)* *Demonstrate the procedures to determine that the coil is delivering a spark to the distributor. (Ref. D, pp. 297-298)*
A. Distributor cap	*Demonstrate the procedures for removing and checking a distributor cap for:* • *Cracks* • *Corrosion* • *Broken tower terminals*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Burned electrodes* • *Oil and dirt deposits* • *Worn carbon brush* *(Ref. A, pp. 208-209; Ref. B, pp. 21-10—21-11; Ref. D, p. 295)*
B. Contact points	*Demonstrate the procedures for checking and correcting the contact points for:* • *Misalinement* • *Improper breaker arm spring tension.* • *Pits* • *Worn rubbing block* • *Oxidization* • *Corrosion* • *Oil and dirt deposits* *(Ref. A, pp. 187-197; Ref. B, pp. 21-11—21-14; Ref. D, pp. 264-267, 300-303)* *Demonstrate the procedures for removing, installing, and adjusting contact points and dual points to manufacturer's specifications. (Ref. B, pp. 21-15—21-16; Ref. D, pp. 303-304)*
C. Condenser	*Review the functions and operation of the condenser, causes for malfunctions, and methods of correcting the malfunctions. (Ref. A, pp. 204-208; Ref. D, pp. 249-252; 298-299)* *Demonstrate the procedures for testing a condenser for:* • *Resistance* • *Capacity* • *Leakage* *Demonstrate the procedures for removing and replacing a condenser. (Ref. B, p. 21-14)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
D. Primary wires	*Demonstrate the procedures for testing, removing, and replacing primary wires.*
E. Advance mechanism	*Demonstrate the procedures for checking and correcting the operation of the centrifugal and vacuum advance mechanisms. (Ref. A, pp. 179-185; Ref. B, pp. 21-16—21-18; Ref. D, pp. 299-300)*
F. Rotor	*Demonstrate the procedures for checking and correcting the rotor for:* • *Corrosion* • *Broken positioning lug* • *Pitted contact points* • *Broken contact spring* *(Ref. A, pp. 209-214; Ref. B, p. 21-11)* *Demonstrate the procedures for removing and installing a rotor.*
G. Tests	*Demonstrate the procedures for removing a distributor from a vehicle, and indicate the importance of:* • *Marking firing position of number one cylinder* • *Being careful of oil pump drive mechanism* • *Not rotating engine with distributor removed* *Explain the functions and operation of various distributor testing machines. (Ref. D, pp. 133-136)* *Demonstrate the procedures for testing a distributor for:* • *Cam angle* • *Contact point alinement* • *Mechanical advance* • *Vacuum advance*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• Condenser capacity • Breaker arm spring tension • Bearing and shaft clearances
H. Overhaul and adjustment	Demonstrate the procedures and use of special tools for cleaning, replacing, and adjusting to manufacturer's specifications the component parts of several types of distributors, including: • Centrifugal advance • Vacuum advance • Contact points and cam angle • Bearings and shaft • Lubrication (Ref. B, pp. 21-18—21-19; Ref. C, pp. 395-404; Ref. D, pp. 299-304)
I. Installation	Demonstrate the procedures for installing a distributor in a vehicle, and indicate the importance of: • Locating firing position of number one cylinder • Caring for oil pump drive mechanism • Seating in block • Checking cam angle • Arranging secondary wires to prevent cross-firing. (Ref. B, pp. 21-19—21-21) Show the procedures for testing carbon-type secondary wires with: • High-reading voltmeter • Ohmmeter (Ref. D, p. 296)

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
J. Ignition timing	The exact setting for ignition timing is specified by the manufacturer. *Explain why manufacturer's specifications for ignition timing may have to be altered slightly to compensate for:* • *Fuel octane ratings* • *Carbon deposits* • *High elevation operation* • *Owner's driving habits* *Explain the operation of a stroboscopic timing light. (Ref. A, pp. 351-352)* *Demonstrate the procedures for timing the ignition to manufacturer's specifications with various types of timing lights. Emphasize safety precautions relative to:* • *Hot manifolds* • *Rotating fan and belts* • *Applying the parking brakes* • *Disconnecting the vacuum advance lines* *(Ref. A, pp. 352-358; Ref. B, pp. 21-21—21-22; Ref. C, pp. 401-402; Ref. D, pp. 263-264)* *Demonstrate the procedures for connecting a tachometer and adjusting the engine r.p.m. to manufacturer's specifications. (Ref. A, p. 359; Ref. C, pp. 474-475; Ref. D, pp. 109-110)* *Explain how changes in the cam angle will affect the ignition timing.* *Demonstrate the procedures for checking the operation of the advance mechanisms with the distributor on the car. (Ref. B, pp. 21-17—21-18)*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
II. Transistorized Ignition Service	The use of transistors in the ignition system permits: • Higher coil output to engine • Longer contact point life • Wider spark plug gap. (Ref. A, pp. 227-229) *Review the basic types and functions of transistorized ignition systems commonly used on vehicles. Use manufacturers' charts, transparencies, and the actual devices to assist in developing the topic of transistorized ignition systems. (Ref. C, pp. 419-422; Ref. D, pp. 269-276)* *Discuss the precautions necessary to take when servicing a transistorized ignition system. Include such items as:* • *Checking high-tension wires* • *Disconnecting coil primary wire* • *Using approved types of condensers* • *Following manufacturer's directions for connecting test instruments* (Ref. B, p. 21-32) *Demonstrate the procedures for testing, removing, and installing:* • *Transistors* • *Pickup coils* • *Ballast resistors*
III. Coil Service	*Review the functions and operation of several types of coils commonly used on vehicles. Include such items as:* • *Primary and secondary windings* • *Magnetic induction*

3998

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Insulating materials* • *Capacity* • *Frequency of operation* • *Polarity* *Use the actual devices or manufacturers' manuals to assist in developing the topic of ignition coils. (Ref. A, pp. 40-42, 164-177; Ref. D, pp. 246-249)* An ignition coil needs to be at operating temperature when tested. *Demonstrate the procedures for testing a coil for:* • *Primary circuit resistance* • *Secondary circuit resistance* • *Primary current draw* • *Secondary current draw* • *Available voltage* • *System polarity* *(Ref. B, pp. 21-4—21-7; Ref. D, pp. 297-298)* *Demonstrate the procedures for removing and installing a coil.* *Explain the functions and operation of the ballast resistor used in the primary circuit by using the actual device. (Ref. A, pp. 172-173; Ref. D, p. 252)* *Demonstrate the procedures for checking a ballast resistor. (Ref. B, pp. 21-3—21-4)* *Explain the methods used to offset the normal voltage drop to the coil during the time the starting motor is operating. (Ref. D, p. 252)* *Demonstrate the methods of testing the voltage of the coil during the time the starting motor is operating.*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
IV. Oscilloscope Applications	The use of the oscilloscope assists in the testing of the entire ignition system and makes possible the obtaining of more information about what is happening in the system than any other test instrument.
A. Types	*Discuss various types of oscilloscopes, and by using manufacturers' manuals, show the different methods used to display patterns. (Ref. D, pp. 150-156)*
B. Patterns	*Explain the difference between:* • *Primary patterns* • *Secondary patterns* *(Ref. D, pp. 141-143)* *Use transparencies or distribute copies of a basic oscilloscope pattern and point out the following:* • *Spark zone* • *Coil-condenser zone* • *Dwell zone* *(Ref. C, pp. 476-477)*
1. Spark zone	*Explain the normal pattern in the spark zone, including:* • *Firing line* • *Coil polarity* • *Spark line* • *Available voltage* *(Ref. A, pp. 376-377; Ref. C, p. 147)*
2. Coil-condenser zone	*Discuss the normal pattern in the coil-condenser zone which shows the coil energy dissipating itself. (Ref. A, p. 377; Ref. D, p. 148)*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
3. Dwell zone	*Explain the normal pattern in the dwell zone, including the:* • *Point closing signal* • *Point opening signal* • *Degrees of dwell* *(Ref. A, pp. 371-378; Ref. D, pp. 148-149)*
4. Trace presentations	*Discuss the following types of trace presentations:* • *Parade sweep* • *Raster sweep* *(Ref. D, pp. 144-146)*
C. Pattern analysis	Pattern irregularities provide clues as to the parts of the ignition system that are faulty. *Explain the necessity of considering the following when making a pattern analysis:* • *Pattern normal or irregular for all cylinders* • *Pattern irregularity occurring in all or only a few cylinders* • *Pattern irregularity occurring in what zone*
1. Spark zone	*Show and explain the causes and effects of pattern irregularities in the spark zone, including:* • *Spark plug gap* • *Shorted plug* • *Crossfiring* • *Resistance in high-tension conductors* • *High-tension leakage* • *Defective distributor rotor* • *Low primary voltage* *(Ref. D, p. 147)*

0004 4004

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Use transparencies, charts, or manufacturers' manuals to show pattern irregularities.
2. Coil-condenser zone	*Show and explain the causes and effects of pattern irregularities in the coil-condenser zone, including:* • *Defective coil* • *Defective condenser* • *Low primary voltage* • *Open in high-tension circuit* • *Shorted plugs* • *Defective contact points* • *Incorrect dwell angle* *(Ref. D, p. 148)* *Use transparencies, charts, or manufacturers' manuals to show pattern irregularities.*
3. Dwell zone	*Show and explain the causes and effects of pattern irregularities in the dwell zone, including:* • *Dwell angle* • *Worn distributor shaft* • *Worn distributor cam* • *Reverse polarity in high-tension circuit* *(Ref. D, p. 149)* *Have trainees perform service on the ignition systems of shop engines and live cars. Trainees should develop enough proficiency to be able to enter the field of automotive tuneup. Include such jobs as:* • *Making distributor checks on the car* • *Adjusting distributor contact points and ignition timing on the car*

4002

19. What is a parade pattern?

20. Explain what condition would be indicated by a reversed secondary firing line.

21. How would a high resistance spark plug wire be indicated in the secondary pattern?

22. What procedure is used to test the maximum available secondary voltage?

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Richard, R. K. *Auto engine tune-up.* Indianapolis, Ind. Howard W. Sams & Co., Inc. 1966.

(B) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(C) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia.* Homewood, Ill. Goodheart-Willcox Co.,Inc. 1968.

(D) Wetzel, G. F. *Automotive diagnosis and tune-up.* Bloomington, Ill. McKnight & McKnight Publishing Co. 1969.

REFERENCE BOOKS

Atlas Supply Co. *Basic tune-up training.* Springfield, N.J. The Corporation. 1969.

Automotive Electric Association. *Tune-up manual.* Detroit, Mich. The Association.

C. E. Niehoff and Co. *Principles of automotive tune-up.* Chicago, Ill. The Corporation.

_____ *Tune-up chart.* Chicago, Ill. The Corporation. 1970.

Champion Spark Plug Co. *Engine tune-up chart.* Toledo, Ohio. The Corporation. 1970.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation. 1969.

_____ *Tune-up service.* Chicago, Ill. The Corporation. 1969.

General Motors Corp., AC Spark Plug Division. *Engine tune-up.* Flint, Mich. The Division. 1970.

_____ *Quality tune-up guidebook.* Flint, Mich. The Division. 1969.

_____ Delco-Remy Division. *Ignition circuit.* Anderson, Ind. The Division. 1965.

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Ignition System Service

General Motors Corp., Delco-Remy Division. *The ignition circuit.* Anderson, Ind. The Division. 1958.

_____ *Periodic maintenance and circuit checks.* Anderson, Ind. The Division. 1964.

_____ *Service tips.* Anderson, Ind. The Division.

McNeil Corp., Lincoln St. Louis Division. *Professional tune-up procedure.* The Division.

Snap-on Tools Corp. *Primary tach-dwell meter.* Kenosha, Wis. The Corporation. 1968.

Sorensen Manufacturing Co., Inc. *Tune-up chart.* Glasgow, Ky. The Corporation. 1970.

Sun Electric Corp. *Specification service.* Chicago, Ill. The Corporation. 1970.

FILM LOOPS

Adjust the breaker points. Carousel Films, Inc. 6½ min. sound. color. Purchase - Carousel Films.

Adjusting the distributor cam angle. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Replacing ignition points. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Timing an engine. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Valve timing the 4-cycle engine. Carousel Films, Inc. 8 min. sound. color. Purchase - Carousel Films.

TRANSPARENCIES

Auto testing - ignition system. 3M Co. Purchase - 3M Co.

Auto testing - spark and ignition. 3M Co. Purchase - 3M Co.

Electrical system. DCA Educational Products, Inc. 13 transparencies. color. Purchase - DCA Educational Products, Inc.

Ignition coil and condenser. Universal Education and Visual Arts. Purchase - Universal Education and Visual Arts.

Ignition system. Universal Education and Visual Arts. Purchase - Universal Education and Visual Arts.

4003

Fuel System Service

OBJECTIVES

- To be able to adjust commonly used carburetors so they perform according to manufacturers' specifications
- To be able to remove, disassemble, clean, and reassemble commonly used carburetors
- To be able to service air cleaners, fuel pumps, and fuel filters
- To be able to diagnose and correct malfunctions in positive crankcase ventilation systems and exhaust emission control systems

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Carburetor Service	*Review the functions of the basic carburetor circuits, including:* • *Choke* • *Idle* • *Main* • *Float* • *Acceleration* • *Power* *(Ref. A, pp. 105-107; Ref. C, pp. 207-216; Ref. D, pp. 318-329)* *Discuss the effects of basic carburetor circuits on:* • *Starting* • *Accelerating* • *Economy* • *Idling* • *Cruising speed*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Discuss the common types and makes of carburetors commonly used on vehicles. Use charts, transparencies, manufacturers' manuals, and the actual devices to assist in developing the topic of carburetor types. (Ref. C, pp. 216-220; Ref. D, pp. 329-350)
A. Air-fuel ratio	*Discuss air-fuel ratio for:* • *Normal conditions* • *Quick acceleration* • *Idle speeds* • *Cold engine* The air-fuel ratio is measured by an exhaust-gas analyzer. The engine must be at operating temperature, compression satisfactory, and the ignition and exhaust systems in good condition. *Explain the functions and operation of an exhaust-gas analyzer. (Ref. C, pp. 247-248)* *Demonstrate the use of an exhaust-gas analyzer to detect such defects as:* • *High float level* • *Low float level* • *Plugged jets* • *Restricted air cleaner* • *Leaking intake manifolds and gaskets* • *Plugged air bleeds* • *Defective acceleration pump* • *Incorrect jets*
B. Oncar adjustments	Some carburetor adjustments may be made on the car. *Demonstrate the procedures for making the following carburetor adjustments on the car:*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Slow idle* • *Fast idle* • *Idle mixture* • *Automatic choke* • *Float level* • *Antistall dashpot* • *Accelerator pump* *(Ref. B, pp. 20-15—20-28; Ref. C, pp. 227-231, 245-247; Ref. D, pp. 354-360)*
C. Removal and disassembly	*Demonstrate the procedures for removing a carburetor from a vehicle.* *Show the procedures for disassembling and cleaning a carburetor.* *Emphasize safety precautions, such as:* • *Effects of carburetor cleaners on skin and clothing* • *Effects of using compressed air on reversed passages.* *(Ref. B, pp. 20-28—20-29)*
D. Reassembly	*Demonstrate the procedures for reassembling a carburetor and making the following adjustments:* • *Float level* • *Float alinement* • *Bowl vent* • *Choke rod* • *Automatic choke* • *Unloader* • *Metering rod*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Pump travel* • *Fast idle*
E. Installation	*Demonstrate the procedures for installing a carburetor on a vehicle. (Ref. B, pp. 20-29—20-30)*
F. Final adjustments	*Discuss the reasons for turning on the headlights and the air-conditioning unit when making idle adjustments on vehicles equipped with an alternator.* *Explain why the vacuum lines for the parking brake release devices need to be disconnected and plugged when making carburetor adjustments.* *Show how to make the following carburetor adjustments on the vehicle after the engine is at operating temperature:* • *Throttle linkage* • *Fast idle* • *Slow idle* • *Idle mixture* • *Antistall dashpot* *Discuss the effects of air entering the intake system through:* • *Defective vacuum pump* • *Vacuum operated transmission shift device* • *Faulty power brake diaphragm* *Demonstrate the procedures for using a vacuum gauge to determine:* • *Carburetor adjustment* • *Intake system leaks* • *Exhaust system restrictions*

4007

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
II. Air Cleaner Service	*Review the types and functions of air cleaners commonly used on vehicles. (Ref. A, p. 152; Ref. C, pp. 241-243; Ref. D, pp. 351-352)*
	Demonstrate the procedures for cleaning an air cleaner. (Ref. B, pp. 20-30—20-32)
III. Fuel Pump Service	*Review the types and functions of fuel pumps commonly used on vehicles. (Ref. C, pp. 255-259; Ref. D, pp. 314-320)*
A. Tests	*Demonstrate the procedures for testing a fuel pump for:* • *Pressure* • *Vacuum* • *Volume* • *Leaks* *(Ref. A, pp. 154-155, 300-302; Ref. B, pp. 20-3—20-7; Ref. D, pp. 352-353)*
B. Removal and replacement	*Demonstrate the procedures for removing and replacing a fuel pump.*
C. Repair	*Show the methods of servicing and repairing a fuel pump. (Ref. B, pp. 20-7—20-12; Ref. D, pp. 352-353)*
D. Vapor lock	*Review the causes and effects of vapor lock. (Ref. B, p. 20-15)*
E. Combination fuel and vacuum pump	*Explain the functions and operation of a combination fuel and vacuum pump by using charts, transparencies, manufacturers' manuals, and the actual device. (Ref. A, pp. 153-154; Ref. C, p. 256; Ref. D, pp. 315-316)* *Show how to test a combination fuel and vacuum pump for:* • *Low vacuum assist* • *Air leaks in intake system* • *Oil leaks in intake system*

4008

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Noisy operation*
	(Ref. B, pp. 20-6—20-7; Ref. D, pp. 353-354)
	Demonstrate the procedures for removing and replacing a combination fuel and vacuum pump.
IV. Fuel Line Service	*Demonstrate the procedures for cleaning fuel lines and checking the operation of the:*
	• *Vent pipe*
	• *Filler pipe*
	• *Vented gasoline tank cap*
	(Ref. B, p. 20-3; Ref. D, pp. 360-421)
V. Fuel Filter Service	*Discuss the various types of fuel filters commonly used on vehicles. (Ref. C, pp. 264-265)*
	Demonstrate the procedures for removing, cleaning, and replacing a fuel filter. (Ref. B, pp. 20-13—20-15; Ref. D, pp. 422-423)
VI. Manifold Service	*Review the functions and operations of the manifold heat control valve. (Ref. B, pp. 20-29—20-30; Ref. C, pp. 237-239; Ref. D, pp. 360-361)*
	Demonstrate the procedures for freeing an inoperative manifold heat control valve.
	Show the manufacturer's sequence procedures for tightening manifold bolts.
VII. Positive Crankcase Ventilation Systems	*Review the functions and operation of various PCV systems commonly used on vehicles. (Ref. A, pp. 285-290; Ref. B, pp. 17-11—17-13, 33-7—33-8; Ref. C, pp. 293-294; Ref. D, pp. 74-75, 443-446)*
	Demonstrate the procedures for testing, removing, cleaning, and replacing various PCV assemblies. (Ref. B, pp. 17-13—17-14; Ref. D, pp. 75-76)

4009

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
VIII. Exhaust Emission Control System	*Review the functions and operation of the various exhaust emission control systems, including:* • *Air injection-air pump* • *Ignition-induction* • *Improved combustion* • *Controlled combustion* *Use manufacturers' charts and manuals and the actual devices to assist in developing the topic of exhaust emission control systems. (Ref. A, pp. 291-295; Ref. B, pp. 33-8—33-12; Ref. C, pp. 295-301; Ref. D, pp. 446-457)* *Demonstrate the manufacturers' recommended procedures for removing, inspecting, and overhauling the various exhaust emission control systems commonly used on vehicles.* *Have trainees perform service to the fuel systems of shop engines and live cars until they acquire the proficiency necessary for an entry tuneup mechanic. Include such jobs as cleaning and adjusting:* • *Carburetors* • *Fuel pump, lines, and filters* • *Positive crankcase ventilation systems* • *Exhaust emission control systems*

QUESTIONS FOR REVIEW

1. Name the major parts and functions of the carburetor choke circuit.
2. What are the functions of the power circuit?
3. What controls the operation of the power circuit?
4. What are the functions of the accelerator circuit?
5. What controls the operation of the accelerator circuit?

Fuel System Service

6. Explain the purpose of the choke unloader, and tell how to adjust it.

7. What are the purposes of the fast-idle device, and what controls its operation?

8. Why should alternator equipped vehicles have their lights turned on while making carburetor idle adjustments?

9. Explain the use of a vacuum gauge for making carburetor idle adjustments.

10. What fuel pump test is recommended in addition to pressure and vacuum tests?

11. What is the purpose of the exhaust manifold heat control valve?

12. Explain the functions of the positive crankcase ventilation system, and describe recommended service procedures.

13. Explain the functions of the exhaust emission control system, and describe recommended service procedures.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Richard, R. K. *Auto engine tune-up.* Indianapolis, Ind. Howard W. Sams & Co., Inc. 1966.

(B) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

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(D) Wetzel, G. F. *Automotive diagnosis and tune-up.* Bloomington, Ill. McKnight & McKnight Publishing Co. 1969.

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Atlas Supply Co. *Basic tune-up training.* Springfield, N.J. The Corporation. 1969.

Automotive Electric Association. *Tune-up manual.* Detroit, Mich. The Association.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation. 1969.

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_____ *Fuel pump shop manual.* Flint, Mich. The Division. 1966.

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_____ *Quality tune-up guidebook*. Flint, Mich. The Division. 1969.

_____ Rochester Products Division. *Adjustment manual*. Rochester, N.Y. The Division. 1969.

_____ *Instructor's guide and filmstrip kit*. Rochester, N.Y. The Division. 1964.

McNeil Corp., Lincoln St. Louis Division. *Professional tune-up procedure*. The Division.

Snap-on Tools Corp. *Exhaust-gas analyzer*. Kenosha, Wis. The Corporation. 1968.

FILM LOOPS

The carburetor. Carousel Films, Inc. 7½ min. sound. color. Purchase-Carousel Films, Inc.

Carburetor idle adjustment. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Testing a fuel pump. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

TRANSPARENCIES

Auto testing - fuel system, tuning. 3M Co. Purchase - 3M Co.

Emission control systems. DCA Educational Products, Inc. Six transparencies. color. Purchase - DCA Educational Products, Inc.

Fuel system. DCA Educational Products, Inc. Six transparencies. color. Purchase - DCA Educational Products, Inc.

Fuel system. Universal Education and Visual Arts. Five transparencies. color. Purchase - Universal Education and Visual Arts.

4012

Battery and Charging System Service

OBJECTIVES

- To be able to clean, test, and charge a battery
- To be able to check the output of a vehicle's charging system
- To be able to test and replace diodes
- To be able to check and adjust regulators

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Battery Service	The battery plays an important role in the operation of the automotive electrical system. The battery must be fully charged in order that it may function properly. *Review the functions and operation of the storage battery. (Ref. C, pp. 440-444; Ref. D, pp. 159-165)* *Review the safety precautions relative to:* • *Harmful effects of battery electrolyte* • *Use of an acid neutralizer* • *Battery filling procedures* *(Ref. B, p. 22-1)*
A. Visual inspection	*Show how to inspect and correct such battery defects as:* • *Corrosion of terminals and cables* • *Cracks in top and sides of case* • *Loose holddown clamps and supports* • *Low level of electrolyte* *(Ref. B, pp. 22-1—22-2; Ref. D, pp. 179-181)*

4013

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
B. Tests	The battery must first be tested and brought up to full charge before conducting tests on component parts of the charging system. *Demonstrate the procedures for testing a battery with a hydrometer and explain:* • *Temperature compensation* • *Float readings* *(Ref. B, pp. 22-3—22-4; Ref. D, pp. 164-167)* *Demonstrate the procedures for testing with meters for:* • *Individual cell voltage* • *Total battery voltage (capacity)* • *Light load* • *Electrical leaks in system* *(Ref. A, pp. 314-318; Ref. B, pp. 22-4—22-6; Ref. D, pp. 176-177)*
C. Charging	When a battery is undercharged or overcharged, the cause must be determined and corrected. *Explain the procedures for charging a battery using the:* • *Fast-charge method* • *Slow-charge method* *(Ref. B, pp. 22-6—22-7; Ref. D, pp. 174-176)* *Emphasize the importance of polarity, and explain how an alternator may be damaged by connecting a battery improperly. (Ref. B, p. 22-9)* *Review the effects of overcharging a battery. Include such topics as:* • *Damaged cases* • *Warped plates*

4014

4015

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Loss of water*
	(Ref. D. pp. 178-179)
D. Replacement	*Demonstrate the procedures for removing and installing a battery in a vehicle. (Ref. B, pp. 22-9—22-10)*
II. Charging System Service	The charging system is directly responsible for the proper operation of the other electrical systems of the vehicle and must be checked during an engine tuneup.
	Review the functions and operation of a:
	• *Generator*
	• *Alternator*
	• *Regulator*
	(Ref. C, pp. 316-319, 323-327, 343-368; Ref. D, pp. 187-194, 199-200,213-220)
	Explain that problems in the charging system may be indicated by:
	• *Short headlight life*
	• *Frequent addition of battery water*
	• *Undercharged battery*
	• *Charge indicator showing discharge when engine is running at a fast idle or key in off position*
	• *High charging rate with a charged battery*
	• *Low charging rate with an undercharged battery*
	(Ref. B, p. 22-11; Ref. D, pp. 228-229)
	Explain the initial checks that should be made of the generating system, including:
	• *Condition and tension of the drive belt*
	• *Condition of wires and connections*

4015

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	(Ref. A, pp. 258-259; Ref. B, p. 22-12)
	Demonstrate the procedures for checking the wiring of the charging system. (Ref. D, pp. 222-223)
A. Output	*Demonstrate the procedures for determining if the output of the generator or alternator is being maintained in accordance with manufacturer's specifications.* (Ref. B, pp. 22-13—22-24; Ref. D, pp. 229-233)
	Demonstrate the procedures for removing and replacing a generator or an alternator.
B. Diodes	Faulty diodes are frequently the cause of alternator problems.
	Demonstrate the procedures for checking and replacing the diodes of an alternator. (Ref. B, pp. 22-24—22-25; Ref. D, pp. 218-219)
C. Regulator	*Show the procedures for connecting test equipment to check and adjust to manufacturer's specifications the following components of a regulator:* • *Cutout* • *Current limiter* • *Voltage control* • *Field relay* • *Circuit resistance* (Ref. A, pp. 84-94; Ref. B, pp. 22-12—22-13, 22-29—22-41; Ref. D, pp. 227-228, 233-242)
	Emphasize the safety precautions relative to: • *Polarity of the system* • *Meter clips* • *Rotating fans, belts, and pulleys*
	Demonstrate the procedures for removing and replacing a regulator.

4016

Battery and Charging System Service

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	Have trainees perform battery and charging system service on shop engines and live cars. The trainees should develop skills proficient enough for entry into the field of automotive tuneup. Include such jobs as: • *Cleaning, testing, and charging batteries* • *Checking output of charging system* • *Checking and adjusting regulators to manufacturer's specifications*

QUESTIONS FOR REVIEW

1. Explain the method of testing individual cell voltage on a battery that has sealed cell connectors.
2. What is the specific gravity of a fully charged lead-acid battery?
3. Describe the method of making temperature compensations when testing batteries that are hotter or colder than normal.
4. What units in the alternator may be damaged as a result of incorrect polarity?
5. Should acid be added to a cell that has a lower specific gravity reading than the others in the battery?
6. Explain the method of load testing a battery.
7. At what voltage is a cell considered to be discharged?
8. Explain how to distinguish between the positive and negative post of a battery.
9. Explain how to make a quick check of the charging system to determine if the system voltage is being limited properly.
10. What are the basic differences in the two types of regulators that control generators and alternators?
11. Why is it so important to observe polarity when testing or charging batteries on alternator equipped vehicles?
12. What is the purpose of the generator-regulator "cutout" unit, and how is it tested?
13. What is the function of the current limiter, and how is it tested?
14. What is the function of the field relay on an alternator equipped system?

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15. Explain the effect of excessive system voltage on resistors, coils, and contact points.

16. Name several safety precautions to observe when testing the charging system.

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(A) Richard, R. K. *Auto engine tune-up*. Indianapolis, Ind. Howard W. Sams & Co., Inc. 1966.

(B) Stockel, M. W. *Auto service and repair*. Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(C) Toboldt, W. K. & Johnson, Larry. *Motor service's automotive encyclopedia*. Homewood, Ill. Goodheart-Willcox Co., Inc. 1968.

(D) Wetzel, G. F. *Automotive diagnosis and tune-up*. Bloomington, Ill. McKnight & McKnight Publishing Co. 1969.

REFERENCE BOOKS

Atlas Supply Co. *Basic tune-up training*. Springfield, N.J. The Corporation. 1969.

_____ *Service guide, tires, and batteries*. Springfield, N.J. The Corporation. 1968.

Automotive Electric Association. *Tune-up manual*. Detroit, Mich. The Association.

C. E. Niehoff and Co. *Principles of automotive tune-up*. Chicago, Ill. The Corporation.

_____ *Tune-up chart*. Chicago, Ill. The Corporation. 1970.

Chek-Chart Corp. *Car service*. Chicago, Ill. The Corporation. 1969.

_____ *Tune-up service*. Chicago, Ill. The Corporation. 1969.

General Motors Corp., AC Spark Plug Division. *Quality tune-up guidebook*. Flint, Mich. The Division. 1969.

_____ Delco-Remy Division. *D.C. charging circuit*. Anderson, Ind. The Division. 1967.

_____ *Delcotron generator charging circuit*. Anderson, Ind. The Division. 1966.

_____ *Periodic maintenance and circuit checks*. Anderson, Ind. The Division. 1964.

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Battery and Charging System Service

_____ *Service tips.* Anderson, Ind. The Division. 1961.

Snap-on Tools Corp. *Heavy duty A.V.R. tester.* Kenosha, Wis. The Corporation. 1967.

FILM LOOPS

Alternators testing procedures, part I. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Alternators testing procedures, part II. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products. Inc.

Battery service. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Battery-starter charge-volts test. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Battery-starter load test. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

Replacing generator brushes. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Testing generator output. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

TRANSPARENCIES

Auto testing - charging system. 3M Co. Purchase - 3M Co.

Electrical system. DCA Educational Products, Inc. 13 transparencies. color. Purchase - DCA Educational Products, Inc.

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Starting System Service

OBJECTIVES

- To be able to check and correct the wiring of the starting system for loose connections
- To be able to test a starting motor for high resistance, current draw, and engine cranking speed

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Component Parts	*Review the functions and operations of the following starting system component parts:* • *Ignition switch* • *Neutral safety switch* • *Ignition bypass* • *Relay* • *Solenoid* • *Starter drives* *Use transparencies, charts, and manufacturers' manuals to assist in developing the topic of starting system component parts.*
II. Tests	Poor starting motor performance is frequently the result of a discharged battery or poor cable connections. *Explain the precautions to take when making starting motor tests. Include such items as:* • *Operating and cooling time for starting motor* • *Disconnecting high-tension coil lead* • *Placing transmission in neutral or park* • *Applying parking brakes*

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Plugging parking brake vacuum release lines* • *Following manufacturer's recommendations* *Demonstrate the procedures for visually checking the starting system circuits for:* • *Broken wires* • *Loose connections* • *Damaged insulation* Dependable starting can be achieved only when adequate cranking speeds are produced. *Show the methods of checking the starting system for:* • *High resistance* • *Current draw as compared to manufacturer's specifications* • *Engine cranking speed* (Ref. B, pp. 22-42—22-43, 22-50—22-51; Ref. D, pp. 372-374) *Demonstrate the procedures for testing and correcting the operation of the neutral safety switch.* *Demonstrate the procedures for removing and installing a starting motor.* *Have trainees perform service to the starting system on shop engines and live cars. Trainees should develop enough proficiency to be able to enter the field of automotive tuneup. Include such jobs as:* • *Inspecting for loose and broken wires and poor connections* • *Testing for high resistance, current draw, and engine cranking speed*

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QUESTIONS FOR REVIEW

1. Explain the method of testing for starting motor current draw.

2. Explain the method of checking the resistance between the battery ground and the starting motor.

3. Explain the function of the neutral safety switch and the method of testing its operation.

4. Why should the ignition coil secondary lead be grounded to the engine during starting system tests?

5. How should a starting motor solenoid control circuit be tested for resistance?

6. What defective condition would cause a solenoid plunger to chatter?

7. Explain why a poor connection at one of the battery terminals may cause the headlights to go out when the starting motor is energized.

INSTRUCTIONAL MATERIALS

(B) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(D) Wetzel, G. F. *Automotive diagnosis and tune-up.* Bloomington, Ill. McKnight & McKnight Publishing Co. 1969.

REFERENCE BOOKS

Atlas Supply Co. *Basic tune-up training.* Springfield, N.J. The Corporation. 1969.

Automotive Electric Association. *Tune-up manual.* Detroit, Mich. The Association.

C. E. Niehoff and Co. *Principles of automotive tune-up.* Chicago, Ill. The Corporation.

_____ *Tune-up chart.* Chicago, Ill. The Corporation. 1970.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation.

_____ *Tune-up service manual.* Chicago, Ill. The Corporation.

General Motors Corp., Delco-Remy Division. *Cranking circuit.* Anderson, Ind. The Division. 1966.

_____ *Periodic maintenance and circuit checks.* Anderson, Ind. The Division. 1964.

Starting System Service

Snap-on Tools Corp. *Heavy duty A.V.R. tester.* Kenosha, Wis. The Corporation. 1967.

FILM LOOPS

Starter current draw test. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

TRANSPARENCIES

Auto testing - starting system. 3M Co. Purchase - 3M Co.

Electrical system. DCA Educational Products, Inc. 13 transparencies. Purchase - DCA Educational Products, Inc.

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Cooling System Service

OBJECTIVES

- To be able to check a cooling system for leaks
- To be able to clean and protect a cooling system from rust
- To be able to check, test, and replace a thermostat

CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
I. Importance	*Review the functions and operation of the cooling system. (Ref. D, pp. 89-90)*
	Discuss the effects of insufficient heat dissipation. Include such items as:
	• *Loss of coolant*
	• *Reduction of cooling airstream*
	• *Loss of radiation surface*
	• *Inadequate heat transfer*
	Discuss the effects of excessive heat production. Include such items as:
	• *Retarded ignition timing*
	• *Incomplete combustion*
	• *Inadequate lubrication*
	• *Loading of engine*
	(Ref. D, p. 96)
	Discuss engine "hot spots" and their effects on spark plug and valve operating temperatures.
II. Inspection	*Demonstrate the procedures for inspecting:*
	• *Hoses and connections*
	• *Liquid level and conditions*

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CONTENT OUTLINE	UNDERSTANDINGS AND TEACHING APPROACHES
	• *Fan belt condition and tension* • *Water pump* *(Ref. B, pp. 19-7—19-10, 19-14; Ref. D, pp. 90-91)*
	Demonstrate the procedures for cleaning and protecting the cooling system from rust. (Ref. B, pp. 19-3—19-5)
III. Tests	*Demonstrate the procedures for pressure testing the cooling system. (Ref. B, pp. 19-5—19-6; Ref. D, pp. 94-95)*
	Show the procedures for checking the operation of the radiator cap pressure valve spring and seal. (Ref. B, pp. 19-6—19-7; Ref. D, pp. 95-96)
	Demonstrate the procedures for removing, testing, and replacing a cooling system thermostat. (Ref. B, pp. 19-11—19-12; Ref. D, pp. 93-94)
	Have trainees perform service to the cooling system on shop engines and live cars. Trainees should develop enough proficiency to be able to enter the field of automotive tuneup. Include such jobs as: • *Inspecting cooling system for leaks* • *Inspecting fan belts for condition and tension* • *Cleaning a cooling system* • *Checking and replacing a cooling system thermostat*

QUESTIONS FOR REVIEW

1. How should an engine cooling system be pressure checked to detect leaks?
2. How can a radiator cap be tested to determine pressure rating and efficiency?
3. Explain the methods of adjusting fan and generator belts.

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4. Explain how to determine if an engine is operating at the proper temperature.

5. What condition would indicate a leak between a cylinder and the cooling system?

6. What condition would indicate a leak between the lubrication system and the cooling system?

INSTRUCTIONAL MATERIALS

TEXTBOOKS

(B) Stockel, M. W. *Auto service and repair.* Homewood, Ill. Goodheart-Willcox Co., Inc. 1969.

(D) Wetzel, G. F. *Automotive diagnosis and tune-up.* Bloomington, Ill. McKnight & McKnight Publishing Co. 1969.

REFERENCE BOOKS

Automotive Electric Association. *Tune-up manual.* Detroit, Mich. The Association.

Chek-Chart Corp. *Car service.* Chicago, Ill. The Corporation. 1969.

FILM LOOPS

Pressure testing the cooling system. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Replacing a thermostat. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Servicing the radiator pressure cap. Modern Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Testing a thermostat. Modern Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

TRANSPARENCIES

The cooling system. Universal Education and Visual Arts. Five transparencies. color. Purchase - Universal Education and Visual Arts.

Cooling system thermostat and pressure cap. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Fan belt adjustment. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Final Examination

Final Examination Part I — Multiple Choice

Directions: For each statement, place an X in the space to the left of the choice that most accurately completes the statement.

1. The specific gravity of a fully charged wet cell should be approximately

   _____ (a) 12.75
   _____ (b) 1125
   __X__ (c) 1.275
   _____ (d) 1.350

2. The device used for translating electrolyte readings to battery capacity is called

   _____ (a) cadium tipped cell tester
   __X__ (b) hydrometer
   _____ (c) voltmeter
   _____ (d) ammeter

3. Before making a load test, the specific gravity of the battery must be at least

   __X__ (a) 1.220
   _____ (b) 1.275
   _____ (c) 12.75
   _____ (d) 1.350

4. During a starter draw test on a 12-volt system, the voltage should not drop below

   _____ (a) 8.0 volts
   _____ (b) 6.0 volts
   __X__ (c) 9.0 volts
   _____ (d) 12 volts

5. The solenoid is part of the

   _____ (a) generator-regulator circuit
   _____ (b) ignition system
   _____ (c) fuel system
   __X__ (d) starting motor control circuit

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6. A spark plug's operating temperature design is called

_____ (a) reach
__X__ (b) heat range
_____ (c) insulation
_____ (d) electrode temperature

7. A resistor-type spark plug is designed for

_____ (a) increased voltage
_____ (b) improved cold weather starting
_____ (c) use with premium fuels
__X__ (d) radio supression

8. Engines with considerable valve overlap and high-lift cams tend to give a

_____ (a) higher and steadier vacuum reading
_____ (b) lower vacuum reading
_____ (c) higher compression reading
__X__ (d) lower and more erratic vacuum reading

9. An excessive spark plug gap can contribute to

_____ (a) rough engine idle
__X__ (b) rough high-speed operation
_____ (c) oil fouling
_____ (d) overheating of the spark plug

10. A dark sooty deposit on a spark plug indicates

_____ (a) oil fouling
__X__ (b) rich carburetor mixture
_____ (c) preignition
_____ (d) too cold for the application

11. A high-speed skip may be caused by

__X__ (a) weak breaker point spring tension
_____ (b) insufficient vacuum advance
_____ (c) use of high octane fuel
_____ (d) plugged idle tube in the carburetor

12. A hesitation on acceleration may be caused by

_____ (a) radio supression
_____ (b) dual advance distributor
__X__ (c) inoperative carburetor pump system
_____ (d) improperly adjusted cutout

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13. Condensers should be tested for

_____ (a) rated output
__X__ (b) capacity, leakage, and resistance
_____ (c) ohms, volts, and amperage
_____ (d) flashover

14. The neutral safety switch is located in the

_____ (a) battery to ground circuit
_____ (b) ignition secondary circuit
__X__ (c) starting circuit
_____ (d) starter solenoid

15. A ballast resistor will

__X__ (a) lower the primary system voltage
_____ (b) increase the primary system voltage
_____ (c) lower the charging system voltage
_____ (d) increase the dwell readings

16. When using a dwell meter to checkout a transistorized ignition system, the leads should be connected to the

_____ (a) ground and coil primary
__X__ (b) tach block
_____ (c) coil primary
_____ (d) heat sink unit

17. Breaker point spring tension should be read

_____ (a) before installing the point set
_____ (b) with rubbing block on the high point of the cam
__X__ (c) when the gauge is just pulling the points open
_____ (d) at 1000 engine r.p.m.

18. Breaker point misalinement should be corrected by

__X__ (a) bending the stationary point bracket
_____ (b) bending the breaker arm
_____ (c) replacing the pivot
_____ (d) discarding the breaker points

19. If the breaker point gap is increased, the dwell will

__X__ (a) be decreased
_____ (b) be increased
_____ (c) not change
_____ (d) be reversed

20. When new distributor contact points are installed, they should be set to

_____ (a) the high specified dwell setting
__X__ (b) the low specified dwell setting
_____ (c) the mid range of the specified dwell setting
_____ (d) at 0°

Final Examination Part II — Fill-In Statements

Directions: For each statement, write the item or phrase that, when inserted in the blank, will correctly complete the statement.

1. The presence of black carbon deposits on spark plugs indicates OIL FOULING.

2. Spark plugs too hot for the application may cause PREIGNITION.

3. A grayish tan color on spark plug insulators indicates NORMAL operating conditions.

4. Voltage jumping over the outside of a spark plug insulator is called FLASHOVER.

5. When combustion chamber temperatures are high enough to ignite the fuel charge before the spark occurs, it is termed PREIGNITION.

6. The instrument for testing resistance between the battery ground and the starting motor is called a VOLTMETER.

7. The instrument for testing the amount of current flowing in a circuit is called an AMMETER.

8. Air emitting from the tailpipe while making a cylinder leakage test indicates a BURNED OR STICKING INTAKE VALVE.

9. Reversed battery polarity may cause damage to an alternator's DIODES.

10. Detonation is usually caused from TOO ADVANCED TIMING or LOW GRADE FUEL.

11. The device used in many distributors to shift the position of the breaker plate to produce a change in the timing of the spark in relation to throttle pressure is actuated by INTAKE MANIFOLD VACUUM.

12. The number of degrees that the contact points remain closed is referred to as DWELL.

13. The carburetor idle mixture is made richer by screwing the mixture screw OUT.

Final Examination

14. The device in the cooling system that increases the boiling point of the coolant is called the PRESSURE CAP.

15. During starting system tests, the ignition secondary should be GROUNDED.

16. Precautions should be observed when using a dwell-tach meter on the breakerless transistor ignition system to prevent damage to the AMPLIFIER UNIT.

17. The antistall device used on most cars equipped with automatic transmissions is called a DASHPOT.

18. Electrical transfer from one secondary lead to another close by is called CROSSFIRING.

19. On most engines the carburetor to distributor vacuum line should be disconnected while setting INITIAL TIMING.

20. The headlights should be turned on while adjusting idle speed on vehicles equipped with ALTERNATORS.

21. The rotor delivers SECONDARY voltage to each spark plug.

22. The vacuum advance mechanism varies the SPARK according to intake manifold vacuum.

23. The carburetor consists of SIX basic circuits.

24. Engines operated at continual high speeds require a COLDER THAN NORMAL spark plug.

25. A low reading on a vacuum gauge may indicate LATE ignition timing or intake manifold air leaks.

26. A floating vacuum gauge needle at idle speed may indicate the carburetor is adjusted TOO RICH OR TOO LEAN.

27. A normal vacuum reading should be between 16 AND 21 inches on the average engine.

28. Idle speed should be set BEFORE initial timing.

29. A low compression reading with two adjacent cylinders would indicate A BLOWN HEAD GASKET.

30. Current produced by an alternator is rectified by the use of DIODES.

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Using Audiovisual Materials

Audiovisual materials are both a tool for teaching and an avenue for learning. While no particular amount of time is recommended for using audiovisual materials, it is suggested that they be used with a variety of learning activities and that the instructor not devote an entire class session to the use of such materials.

Audiovisual materials lend themselves well to bring about a high level of involvement. When working with adults, it is well to remember that much can be learned from each other. It is with the idea of getting people involved and having them make contributions that these comments are made.

The following suggestions may assist the instructor as he prepares an overall plan for the use of audiovisual materials. The ideas presented should allow for a comprehensive coverage of the content and the efficient use of class time. Steps to consider are:

- Plan the presentation (organization and methods)
- Prepare the equipment and materials
- Orient the class (background material)
- Present the lesson
- Summarize concepts and understandings
- Evaluate knowledges acquired
- Followup with opportunities to explore new knowledges
- Return the equipment and materials

Plan the Presentation (Organization and Methods)

Always preview any audiovisual material to become familiar with its content and to see that it correlates with the lesson. Adult students dislike "time fillers" and inappropriate presentations. While previewing, prepare comments which might answer such questions as:

- What is being illustrated?
- Why is the presented material important?
- What are the important terms and understandings being presented?
- What are some appropriate topics which could be used to stimulate class discussions?

Prepare the Equipment and Materials

Request the required equipment several days ahead of time from the director of adult education or person in charge of audiovisual equipment. Then,see that it is delivered prior to the starting of the class. Before the class begins, practice using the equipment to become acquainted with its operation. Arrange the room so that everyone can see and is comfortable. Have a screen ready and place it so that the least amount of outside light

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is reflected onto it. The wall may be used, but a screen is much more desirable. The larger the room and the larger the audience, the larger the screen that is needed. Be sure there is a table for the projector, an electrical outlet, an extension cord (the cord with the projector is usually short), and a spare projector lamp available in case the one in use fails.

If the class is held during the day, be sure the room can be darkened and ventilated. Check to see if the lights can be turned off without shutting off the power to the projector. At the conclusion of the presentation, allow the fan on the machine to cool the equipment for a few minutes before completely shutting off the power to the projector.

Orient the Class (Background Material)

Explain to the class what they will see. Discuss the more important terms used, and indicate the main points to be presented.

Present the Lesson

Have the film threaded and the projector ready for use. Stop the film or filmstrip for discussion as the need arises during the showing instead of waiting until the presentation has been completed. A filmstrip offers flexibility, for it may be used as a whole or as a part, whichever is appropriate to the lesson. It may also be stopped at any frame for discussion or questions. At the end of the showing, give your comments and encourage discussion and questions from the trainees.

Summarize Concepts and Understandings

Itemize the important learnings on the chalkboard as they are contributed by the class. Allow time for the trainees to raise other questions which may lead to a more complete understanding. Encourage trainees to keep some kind of notation for future review.

Evaluate Knowledges Acquired

Prepare a list of questions which might assist trainees to evaluate how well they have learned the important points of the lesson. One approach might be for the instructor to present the question and pause for a few moments to allow the trainees to form their answers before responding. Interest could be generated by asking the trainees to keep track of the number of their correct answers.

Followup with Opportunities to Explore New Knowledges

Introduce a few new topics for discussion which will motivate the trainees to project their understandings.

Return the Equipment and Materials

After the class is over, make arrangements to return the equipment and school-owned audiovisual materials. For an item ordered from an out-of-school source, complete the required attendance report, prepare the material for mailing, and leave it so that it may be returned promptly.

Preparing and Using Transparencies

Materials for use on the overhead projector may be prepared by hand, the heat-transfer process, and the color-lift process. Each method is described briefly for those who might wish to make their own original transparencies.

General Suggestions

- Select only content that is appropriate for an overhead transparency.
- Keep content of transparency simple.
- Organize the content of the transparency carefully.
- Use multiple overlays (one transparency over another) for the development of a concept or to show steps.
- Keep master and overlays in register with crosshair registration marks in opposite corners.
- Use color to make the transparency attractive but only enough color for emphasis. Color-toned sheets or colored ink may be used to identify parts of a drawing or picture.
- Plan transparency for horizontal projection.
- Use letters and symbols that are at least $\frac{1}{4}$-inch high. Use a lettering guide or dry-transfer letters and symbols to produce attractive titles or labels.
- Leave a $\frac{3}{4}$- inch clear margin on all sides of the transparency.
- Use a pointer to identify a specific part and then remove it quickly or lay pointer on transparency, for a hand-held pointer cannot be kept steady, and therefore, becomes distracting.
- Use a sliding or hinged mask to control the rate of disclosure when more than one step is included on a transparency.

Handmade Process

Produces a simple and inexpensive transparency.

Materials Needed

Plastic sheet or roll - clear or frosted

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Markers - grease pencil or pen
Ink - transparent or india

Suggested Procedures

- Mark directly on the plastic sheet. This may be done in front of the class as the lesson is being given or may be prepared ahead of time.

- Remove materials placed on a handmade transparency with a sponge or cloth moistened with water or a special cleaning fluid. Then the transparency is ready to be used again.

Heat-Transfer Process

Produces a transparency from almost any original that is flexible and no thicker than a sheet of paper.

Materials Needed

Plastic sheets
Item to be copied
Copying machine

Suggested Procedures

- Material to be copied can be opaque or translucent but should have a carbon-type ink base *(black)*.

- Follow the directions for the specific copying machine, and use the recommended type of plastic sheets.

Color-Lift Process — Drymount Press

Produces a transparency by transferring the ink of a printed picture to a sheet of transparent film. Only material printed on a clay-based paper may be used.

Materials Needed

Special film
Detergent
Flat tray
Drymount press
Pressure boards
Item to be transferred

Suggested Procedures

- Select and test the picture to be lifted. Wet the fingertip and rub over an unprinted portion of the page. Clay-based papers will leave a white residue on fingertip.

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- Dry the picture for 5 seconds in a drymount press set at 270° F.
- Put the picture on the coated side of the special film and place between pressure boards. Heat resulting sandwich for 2-3 minutes in a drymount press set for 270° F.
- Place picture and film in lukewarm water containing a liquid detergent. Soak for 2 minutes or until the paper pulls easily from the acetate.
- Wash clay coating from picture, and dry film carefully.
- Spray ink surface with clear lacquer spray. Allow spray to dry; then mount transparency.

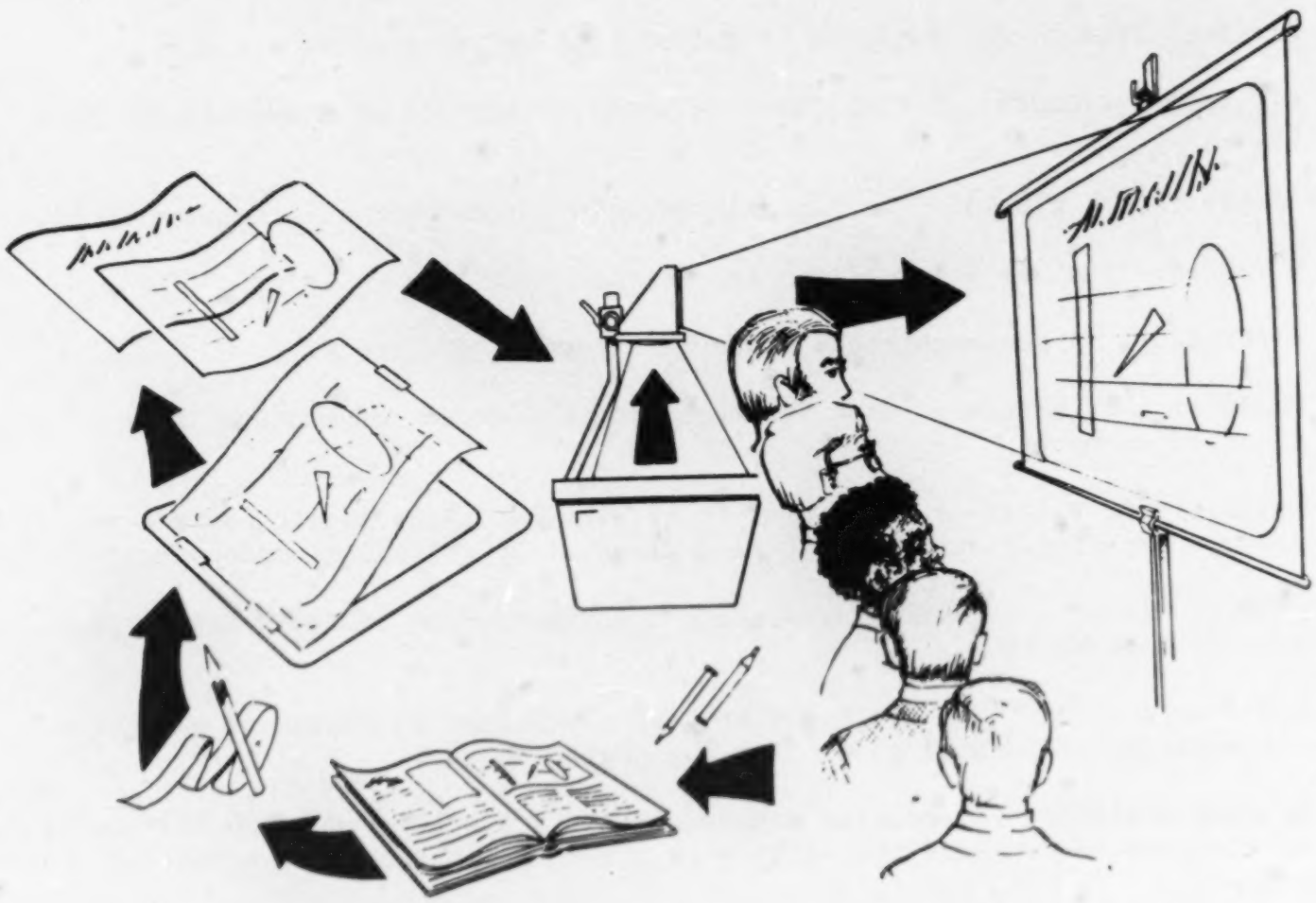

PREPARING AND USING TRANSPARENCIES

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Glossary

Accelerator pump: A small pump in the carburetor that sprays additional gasoline into the airstream during acceleration.

Advance: The spark set so it occurs at an earlier time in the cycle of engine operation.

Advance unit: A device which moves the ignition timing ahead either mechanically or by vacuum.

Air-fuel ratio: The ratio by weight of the fuel as compared to air.

Airgap (regulator): The distance between the contact armature and the iron core.

Airgap (spark plugs): The distance between the center and side electrodes.

Air horn: The air inlet of the carburetor.

Alternator: A generator that produces alternating current.

Ammeter: An instrument used for measuring the amount of amperes in an electric current.

Antibackfire valve: A valve used in an air-injection reaction system to prevent backfiring during the period immediately following sudden deceleration.

Antipercolator: A device for venting the vapors from the main discharge tube of a carburetor.

Antismog device: A special part or system designed to reduce or eliminate the emission of harmful gases from the engine exhaust.

Ballast resistor: A resistor constructed of a special type wire that tends to increase or decrease the voltage in direct proportion to the heat of the wire.

Bendix drive: A gear mounted on a screw shaft attached to the starting motor armature which automatically engages and disengages the starting motor.

Blowby: A leakage or loss of pressure.

Bounce (contact points): Contact points that open and close when they should be closed.

Bounce (engine valves): A valve not held tightly to its seat.

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Breaker arm: The movable part of the contact points in an ignition distributor.

Breaker cam: A multilobed cam rotating in the ignition distributor which interrupts the primary circuit.

Breaker points: Two separable points which interrupt the primary circuit of the ignition system.

Cam angle (distributor): The number of degrees that the distributor shaft rotates during the time the contact points are closed.

Capacitor: A device that has the ability to absorb and store a surge of electrical current.

Centrifugal advance (distributor): A unit designed to advance or retard the ignition timing by using centripetal force.

Centripetal force: The force that deflects a body from its linear path and compels it to move along a curve.

Check valve: A valve that opens to permit the passage of fluid or air in one direction and closes to prevent passage in the opposite direction.

Choke: A butterfly valve located in the carburetor that is used to enrich the mixture for starting a cold engine.

Choke stove: A heating compartment in or on the exhaust manifold from which hot air is drawn to the automatic choke device.

Coil (ignition): A device used to step-up battery voltage.

Compression gauge: A gauge used to test the compression in the cylinders.

Condenser: A device that has the ability to absorb and store a surge of electrical current.

Contact points: Two points that complete a circuit when pressed together.

Current regulator: A device which prevents the generator from producing current in excess of its rated capacity.

Cutout relay (regulator): A device to connect or disconnect the generator from the battery circuit.

Dashpot: A device consisting of a piston and a cylinder used to slow down or delay the operation of some other part.

Detonation: An engine sound indicating that the fuel is burning too rapidly in the cylinder.

Diagnosis: The use of instruments to determine the cause of malfunctions of parts or systems of a vehicle.

Diode: An electronic device that permits current to flow through it in only one direction.

Distributor: A device that interrupts the primary circuit and distributes the secondary current to the spark plugs as required.

Downdraft carburetor: A carburetor in which the air passes downward through the carburetor into the intake manifold.

Dual breaker points (ignition): A distributor using two sets of breaker points to increase the cam angle.

Dwell (distributor): The number of degrees that the distributor shaft rotates during the time the contact points are closed.

Economizer valve: A device installed in a carburetor to control the amount of fuel used under certain conditions.

Electrode (spark plug): The center rod that passes through the insulator and the rod that is attached to the shell of the spark plug.

Electrolyte: A solution of sulfuric acid and water used in the storage battery.

Exhaust-gas analyzer: An instrument used to determine the efficiency with which an engine burns fuel.

Flat spot: A spot during an acceleration period where the engine seems to hesitate for a second before beginning to pull again.

Float bowl: A part of the carburetor that acts as a reservoir for the gasoline.

Float level: A predetermined height of fuel in the carburetor float bowl.

Flooding: A condition where the fuel mixture is overly rich or an excessive amount has reached the cylinders.

Fuel pump: A vacuum device used to draw gasoline from the tank and force it into the carburetor.

Gassing: Small bubbles of gas rising to the top of the electrolyte during battery charging.

Generator: A device for converting mechanical energy into electrical energy.

Heat range (spark plugs): The operating temperature of a given style of spark plug.

Heat sink: A device usually used to protect diodes from excessive heat.

High tension (ignition): The secondary or high-voltage electrical current.

Hot spot: Local areas in the cooling system which have attained above average temperatures.

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Hydrometer: An instrument used to measure the specific gravity of a liquid.

Idle valve: A device used to control the amount of fuel mixture reaching the cylinders during idling.

Ignition coil: A step-up transformer that increases the low primary voltage to high secondary voltage.

Ignition distributor: A device that interrupts the primary circuit and distributes the secondary current to the spark plugs as required.

Ignition system: A method of igniting the fuel in the cylinders.

Intake manifold: The housing used to conduct the air-fuel mixture from the carburetor to the engine cylinders.

Knocking (fuel): An engine sound indicating that the fuel is burning too rapidly in the cylinder.

Manifold heat control valve: A valve in the exhaust manifold that deflects a certain amount of hot gas around the base of the carburetor to aid in warmup.

Metering rod: A movable rod used to vary the opening in a carburetor jet.

Misfire: The fuel charge in one or more engine cylinders which fails to ignite at the proper time.

Muffler: A chamber attached to the exhaust pipe which allows the exhaust gases to cool and reduces the noise of combustion.

Octane rating: A rating that indicates a specific gasoline's ability to resist detonation.

Ohmmeter: An instrument used to measure resistance in a circuit.

Open circuit: A break or opening in the normal current path.

Oscilloscope: An electrical testing device which reproduces the spark action of the ignition system.

Pinging: A metallic rattling sound produced by the engine during heavy acceleration when the ignition timing is too far advanced for the grade of fuel being used.

Positive crankcase ventilation (PCV): A system which prevents crankcase vapors from being discharged directly into the atmosphere.

Preignition: The fuel burning in a cylinder before the spark occurs.

Primary circuit (ignition): The low-voltage part of the ignition system.

Primary winding (coil): The winding in the ignition coil that carries the battery current.

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Primary wires: The wires which carry the low voltage of the ignition system.

Regulator: A device used to control the output of a generator.

Relay: A switch operated by magnetism.

Retard: The spark set so it occurs at a later time in cycle of engine operation.

Rotor (distributor): A rotating switch in the distributor which conducts the secondary voltage from the central terminal to one of the outer terminals.

Secondary circuit: The high-voltage part of the ignition system.

Secondary windings: The winding in an ignition coil in which the high-tension current is induced.

Secondary wires: The wires from the coil to the distributor tower and from the tower to the spark plugs that carry the high voltage of the ignition system.

Short circuit: A circuit that is completed in such a way that the current bypasses part or all of the normal circuit.

Solenoid: A coil of wire with a movable iron core which centers itself when the coil is energized.

Spark: An electric current with enough pressure to jump through the air from one conductor to another.

Spark gap: The space between electrodes of a spark plug through which the spark jumps.

Spark knock: A metallic rattling sound produced by the engine during heavy acceleration when the ignition timing is too far advanced for the grade of fuel being used.

Spark plug: A device that conducts the high-tension current into the combustion chamber of an engine and provides the airgap for the spark.

Stroboscope: A device providing intermittent illumination of a moving object which gives the object the illusion of standing still.

Sulphated: The condition of the plates of a battery that is allowed to remain in a discharged condition for some length of time.

Tachometer: An instrument for measuring the number of revolutions of a device in a unit of time.

Thermostat: A heat controlled valve used in the cooling system of the engine to regulate the flow of water between the cylinder block and the radiator.

Throttle valve: A valve in the carburetor which controls the amount of fuel mixture reaching the cylinders.

Timing light: A stroboscopic unit that is connected to the secondary circuit to produce flashes of light in unison with the firing of a specific spark plug.

Timing marks (ignition): Marks on the vibration damper that are used to synchronize the ignition system so that the spark plugs fire at the precise time.

Transistorized ignition: A form of ignition that utilizes transistors and a special coil.

Troubleshooting: A process of diagnosing the source of trouble by observation and tests.

Tuneup: A process of making accurate and careful adjustments to obtain the utmost in engine performance.

Updraft carburetor: A carburetor in which the air passes upward through the carburetor into the intake manifold.

Vacuum advance (distributor): A device designed to change the ignition timing through the action of the engine intake vacuum.

Vacuum gauge: An instrument designed to measure the amount of vacuum existing in a chamber.

Vapor lock: The boiling or vaporizing of the fuel in the fuel line which interferes with the movement of the fuel to the carburetor.

Venturi: A tube so tapered as to form a constricted area which causes the pressure to decrease as the velocity of the liquids or gases flowing through it increases.

Voltage regulator: An electrical device used to control the voltage output of a generator.

Voltmeter: An instrument used to measure the voltage in an electrical circuit.

Wiring diagram: A detailed drawing showing all electrical units and the connections necessary for them to function.

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Directory

AC Spark Plug Division
General Motors Corp.
Flint, Mich. 48556

American Vocational Journal
American Vocational Association, Inc.
1510 H St. NW.
Washington, D.C. 20005

Atlas Supply Co.
Diamond Rd.
Springfield, N.J. 07081

Automotive Electric Association
16223 Meyers Rd.
Detroit, Mich. 48235

Automotive Service Industry Assoc.
230 North Michigan Ave.
Chicago, Ill. 60601

C. E. Niehoff and Co.
4925 Lawrence Ave.
Chicago, Ill. 60630

Carousel Films, Inc.
1501 Broadway
New York, N.Y. 10036

Champion Spark Plug Co.
P.O. Box 910
Toledo, Ohio 43601

Chek-Chart Corp.
222 West Adams St.
Chicago, Ill. 60606

Chilton Book Co.
401 Walnut St.
Philadelphia, Pa. 19106

DCA Educational Products, Inc.
4865 Stenton Ave.
Philadelphia, Pa. 19144

Delco-Remy Division
General Motors Corp.
Anderson, Ind. 46011

Goodheart-Willcox Co., Inc.
18250 Harwood Ave.
Homewood, Ill. 60430

Howard W. Sams and Co., Inc.
4300 West 62nd St.
Indianapolis, Ind. 46268

Industrial Arts and Vocational Education
P.O. Box 1616
Riverside, N.J. 08075

Lincoln St. Louis Division
McNeil Corp.
4010 Goodfellow Blvd.
St. Louis, Mo. 63120

McKnight and McKnight Publishing Co.
Bloomington, Ill. 61701

Modern Talking Picture Service
Modern Learning Aids Division
1212 Avenue of the Americas
New York, N.Y. 10036

Motor Book Division
Hearst Magazines
250 West 55th St.
New York, N.Y. 10019

Rochester Products Division
General Motors Corp.
Rochester, N.Y. 14603

School Shop
Prakken Publications
416 Longshore Dr.
Ann Arbor, Mich. 48107

Snap-On Tools Corp.
Kenosha, Wis. 53140

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Sorenson Manufacturing Co., Inc.
Glasgow, Ky. 42141

Sun Electric Corp.
6323 Avondale Ave.
Chicago, Ill. 60631

Universal Education and Visual Arts
221 Park Avenue, South
New York, N.Y. 10003

Visual Products Division
3M Co.
3M Center
St. Paul, Minn. 55101

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The spark of power. Champion Spark Plug Co. 14 min. sound. color. Free - Modern Talking Picture Service.

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Adjust the breaker points. Carousel Films, Inc. 6½ min. sound. color. Purchase - Carousel Films.

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Battery-starter load test. DCA Educational Products, Inc. sound. color. Purchase - DCA Educational Products, Inc.

The carburetor. Carousel Films, Inc. 7½ min. sound. color. Purchase - Carousel Films, Inc.

Carburetor idle adjustment. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Engine trouble shooting. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Installing spark plug wire terminals. Modern Talking Picture Service, Modern Learning Aids Division. 4 min. sound. color. Purchase - Modern Learning Aids.

Pressure testing the cooling system. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Replacing a thermostat. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Replacing generator brushes. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

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Replacing ignition points. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Servicing the automatic choke. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

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Testing generator output. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

Testing a thermostat. Modern Talking Picture Service, Modern Learning Aids. 4 min. sound. color. Purchase - Modern Learning Aids.

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Electrical system. DCA Educational Products, Inc. 13 transparencies. color. Purchase - DCA Educational Products, Inc.

4048

Emission control systems. DCA Educational Products, Inc. Six transparencies. color. Purchase - DCA Educational Products, Inc.

Fan belt adjustment. DCA Educational Products, Inc. Purchase - DCA Educational Products, Inc.

Fuel system. DCA Educational Products, Inc. Six transparencies. color. Purchase - DCA Educational Products, Inc.

Fuel system. Universal Education and Visual Arts. Five transparencies. color. Purchase - Universal Education and Visual Arts.

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Ignition system. Universal Education and Visual Arts. Purchase - Universal Education and Visual Arts.

Spark plugs. Universal Education and Visual Arts. Purchase - Universal Education and Visual Arts.

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VT 012 458
Phipps, Lloyd J., And Others
Citizens' Advisory Councils in Education.
Course of Study.

Illinois Univ., Urbana-Champaign. Burban
Educational Development Lab.
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Burban Educational Development Laboratory,
357 Education Building,University of
Illinois, Urbana, Illinois 61801 ($1.50).
PUB DATE - 70 279p.

DESCRIPTORS - *VOCATIONAL EDUCATION;
*ADVISORY COMMITTEES; *COURSE CONTENT;
*TEACHING GUIDES; *CITIZEN PARTICIPATION;
RESOURCE MATERIALS; COURSE OBJECTIVES;
INSTRUCTIONAL AIDS; COURSE ORGANIZATION

ABSTRACT - This course of study has been designed to promote the use of citizens' advisory councils at local educational levels and to improve both the quality and quantity of citizen participation in these educational programs. Designed for use in educational and non-educational settings, this course of study will assist the teacher in determining what is to be taught as well as presenting ideas as to teaching and evaluating techniques, audio-visual aids, and recommended resources. The material has been arranged into teaching units on: (1) The Nature of Citizens' Advisory Councils, (2) Formation Procedures, (3) Internal Operations, (4) Activities and Operations, and (5) Special Citizens' Advisory Councils. Provided for each unit are objectives, suggested teaching techniques, a teaching outline, and resource materials. (Author/JS)

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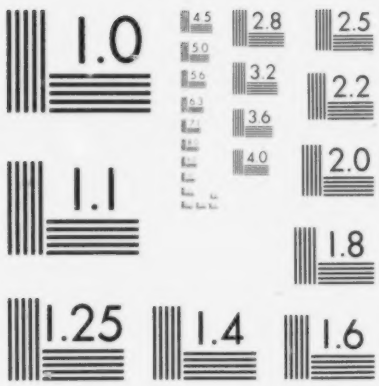

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C1

Course of Study

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Produced by

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University of Illinois
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VT012458

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PREFACE

This publication is one of a series of source units for a course of study designed to assist in the improvement of the quality of citizen's participation in local advisory councils or committees. This course of study has been designed to promote the use of Citizens' Advisory Councils at local educational levels and to improve both the quality and quantity of citizen participation in these councils, as well as in local educational programs. The design allows the course to be used in educational and non-educational settings with equal effectiveness.

This course of study will assist an instructor in determining what is to be taught, as well as presenting ideas as to teaching and evaluating techniques, audio-visual aids, and recommend resources within selected bibliography. Recommended resources have been selected as to their accountability, completeness, conciseness, readability and availability. All efforts have been made to include the cost and complete address of each source.

REDL Staff

TABLE OF CONTENTS FOR THE COMPLETE COURSE OF STUDY:

Course of Study: Citizens' Advisory Councils

Units:

1. Nature of Citizens' Advisory Councils

   Concerns:

   A. History and Philosophy

   B. Organizational Structure and Authority

   C. Functions of a Citizens' Advisory Councils

2. Formation Procedures

   A. Use of Consultants

   B. Selection Committees

   C. Charters, Philosophies, and Constitutions

3. Internal Operations

   A. Mechanics of Meetings

   B. Use of Sub-Committees

   C. Group Dynamics

   D. Leadership Development

   E. Induction of New Members

4. Activities and Operations

   A. Conducting Surveys

   B. Development of Objectives and policies

   C. Evaluation Techniques

5. Special Citizens' Advisory Councils

   A. Problems and Practices of Ad Hoc Committees

   B. Problems and Practices of Vocational-Occupational Committees.

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 1-A

Formation Procedures - History and Philosophy

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Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Nature of Citizens' Advisory Councils (1)

Concerns: History and Philosophy (A)

Objectives: After instruction, the student:

1. Recognizes or recalls reasons for and against citizen involvement in education.
2. Identifies current educational and societal conditions conducive to the increased use of Citizens' Advisory Councils.
3. Recognizes gains and effects received from Citizens' Advisory Councils usage.
4. Judges the effectiveness of the use of Citizens' Advisory Councils in involving citizens.
5. Describes federal and state opinions regarding the use of Citizens' Advisory Councils.

Possible Teaching Techniques:

1. Have students read the Recommended Resource before the class meeting. Fostered and encouraged class discussion on suggested questions below and on questions generated within the group.
2. Invite a local school board member, administrator or citizens' advisory council member to talk to and discuss key questions with the students.
3. Conduct a problem solving session via the following steps: Students should be encouraged to: (1) brainstorm possible school problems, (2) brainstorm possible solutions, (3) collect pertinent data, (4) select best possible solution, (5) anticipate effectiveness of solution, and (6) identify methods a Citizens Advisory Council could use in determining and attempting to solve similar school problems.

Suggested Audio-Visual Aids:

1. A chalkboard or overhead projector should be used during brainstorming sessions to record all responses from the group. Similar aids should be used during class discussions and during resource person's interaction with class.

Anticipated Problems and Concerns	Guides to Solutions & Sample Teaching Techniques
1. What is a Citizens' Advisory Council?	A Citizens' advisory council is a group of lay citizens from the community selected from a school's service area. The council is structured with suitable officers and a yearly program of activities to assist and advise the school board, the school administration and staff in formulating and conducting desired educational programs. Suggested technique: (A) Have the students read pages 12-15 of the Recommended Resource - THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION. (B) On the chalkboard, record the major parts of a Citizens' Advisory Council generated from a class discussion of the definition. These contributions will constitute a composite composed of each individual student's experience with Citizens Advisory Councils.

1. (Continued)	(C) Solicit the remarks of the school board member, administrator, or Citizens' Advisory Council member invited to the meeting as a resource person. Their remarks should be intimately included in a final definition formulated.
2. What are some reasons for developing and using Citizens' Advisory Councils?	(A) To involve lay citizens in education. (B) To facilitate communications between the board and the taxpayers. (C) To provide a true cross section of the community thereby serving as a reliable source of public opinion. (D) To assist the board and administration through special studies. (E) To provide a means of reconciling conflicting views. (F) To provide a training ground for prospective board members. (G) (H) (Note: Additional reasons generated by the class members and appearing to have the general concensus of the class should be included.)

2. (Continued)	<u>Suggested Techniques</u>: (A) Have the students read pages 5-12 of the Recommended Resource - THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION. (B) Conduct a brainstorming session to encourage student involvement. The session should assist in identifying positive reasons for Citizens' Advisory Council usage. Encourage a "rapid fire" type of response from the students for a short period (usually 2 to 3 minutes) of time. All answers should be listed on the chalk board as rapidly as possible. (C) Solicit positive reasons for developing and using Citizens' Advisory Councils from the resource people in attendance.
3. Why is citizen involvememt desirable in education today?	As population, individual specialization, and educational complexity have increased, a gap has formed and widened between the individual taxpayers and those bodies charged with the responsibilities of the local schools. This gap has also formed between schools and the parents of [illegible]ld children in attendance. In an attempt to bridge this communications and understanding gap, lay citizen involvement in local educational efforts is to be encouraged. One of the best involvement techniques available to date is a Citizens' Advisory Council.

3. (Continued)	Suggested Techniques: (A) Have students read the Preface and pages 8-10 of THE HOW OF SUCCESSFUL CITIZENS' ADVISORY COMMITTEE OPERATION. (B) Have students read Appendix I - RURBAN EDUCATIONAL DEVELOPMENT AND THE WORK OF CITIZENS' ADVISORY COMMITTEES. (C) Initiate and encourage class discussion of pros and cons of citizen involvement in education today. A chalkboard may be used to record elicited student responses. (D) Invite additional discussion and input from the resource people in attendance. Their responses should also be recorded on the chalkboard. (E) From the recorded responses, develop a satisfactory answer to the suggested question.
4. What are some tangible results of Citizens' Advisory Councils?	The major contribution that can be made by Citizens' Advisory Councils is their assistance and advice in formulating school policy. When policy is formed with the assistance of a local Citizens'Advisory Council, the local educational program can be considered even more of a combined community effort due to the increased number of citizens involved in the policy development.

4. (Continued)

Several studies have been designed, conducted and reported by Citizens' Advisory Councils. Examples of study topics include projected enrollment trends, projected financial conditions, determination of special needs within the service area, and occupational training program demand and interest within the community.

Suggested Techniques:

(A) Have students read pages 5, 6, and 7 of Appendix II, THE IMPACT OF CITIZENS' COMMITTEES ON THE EDUCATIONAL PROGRAM.

(B) Have students read pages 23 and 24 of CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION.

(C) Show slide set entitled HOW CITIZENS' ADVISORY COUNCILS AID BOARD OF EDUCATION. This slide and audio tape program is available from REDL. The address for REDL is located on the front cover of this teaching unit.

(D) Have a member of a local Citizens' Advisory Council make a presentation to the class informing the class of some positive results of the local Citizens' Advisory Council's work.

4. (Continued)	(E) Initiate and encourage a class discussion on the question. All positive results reviewed and developed by the class members should be recorded on a chalk board. (F) From the chalk board recordings, separate satisfactory reasons from unsatisfactory reasons, thus evolving a suitable final answer.
5. What are the state and federal activities and proclamations in regards to Advisory Councils?	The Vocational Education Act of 1963 and the Vocational Amendments of 1968 both called for the organization of and guidelines for use of national and state advisory councils for developing and evaluating programs of vocational education. As a result, in May, 1969. 37 of the 55 states and U.S. possessions submitting plans for vocational education stipulated the use of local Citizens' Advisory Councils for occupational education. Fifteen such plans recommended local usage of Citizens' Advisory Councils. Only three of the 55 made no mention of such local councils. Commissioner Howe of the U.S. Office of Education has welcomed and encouraged a responsible interest in schools by laymen who hold no official position except that of citizen.

5. (Continued)

Similarly, Illinois State Superintendent of Public Instruction has encouraged the formation and use of Citizens' Advisory Councils indicating that such councils play an important role in working with boards of education throughout the state to help boards resolve problems affecting the operation and growth of schools in Illinois.

Suggested Techniques:

(A) Have students read that part (Title I; Part A; Sec. 104) of the VOCATIONAL EDUCATION AMENDMENTS OF 1968 pertaining to national and state advisory councils.

(B) Have students read pages 109-113 of EDUCATION FOR EMPLOYMENT. (Note: As this will be one of the few references to this publication, the instructor may which to reproduce the pages indicated and supply each student with a copy for individual use.)

(C) Have students review pages 47-49 of the Recommended Reference - THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION.

(D) Review with the students the statements made by Commissioner Howe of the U.S. Office of Education and Mr. Ray Page, Illinois

5. (Continued)

Superintendent of Public Instruction made available in the slide-audio tape presentation entitled, HOW CITIZENS' ADVISORY COUNCILS AID BOARDS OF EDUCATION.

(E) Initiate and propagate a class discussion of the information read and reviewed. From this discussion, evolve a suitable answer.

(F) Have students read page 1 of ADVISORY COMMITTEES - ORGANIZATION AND USE IN VOCATIONAL AND TECHNICAL EDUCATION.

Suggested Evaluation Techniques:

(1) Develop, administer and evaluate an essay test to determine attitudes of students.

(2) Observe changes in student behavior during discussion sessions with various resource persons.

(3) Request and subjectively evaluate student's written self-evaluations as to changes in behavior as reflected from the objectives.

Recommended Resource:

American Vocational Association, The Advisory Committee and Vocational Education Washington, D.C., 1969, pp. 5-15 (Source: Publication Sales; American Vocational Association; 1510 H. St., N.W.; Washington, D.C.; Price: $1.25).

References and Sources:

Evans, Rupert N., Mangum, Garth L., and Pragan, Otto. Education For Employment: the background and potential for the 1968 vocational education amendments, Washington, D.C., 1969, pp. 39-40, 69-71, 109-113; and 118-119. (Source: Publications Office; Institute of Labor and Industrial Relations; P.O. Box 1567; Ann Arbor, Michigan; 48106. Price: $2.50).

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, 1963, pp. 23-24. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois 61801; Price: 50¢).

Illinois State Board of Vocational Education and Rehabilitation, Advisory Committees - Organization and Use in Vocational and Technical Education, Springfield, 1968, pp. 1-2. (Source: Illinois State Board of Vocational Education and Rehabilitation; 405 Centennial Bldg., Springfield, Illinois, 62706, Price: free).

Lloyd, Robert C. "The Impacts of Citizens Committees on the Educational Program," excerpts from a speech given to the National School Public Relations Association Annual Seminar, Boston, Mass., July 6, 1965. (See Appendix II).

Phipps, Lloyd J. and Knell, Kenneth, The How of Successful Citizen Advisory Committee Operation, University of Illinois, Urbana, 1968, Preface and pp. 8-10; (Source: 357 Education Bldg., University of Illinois, Urbana, Illinois, 61801; Price: 75¢).

Phipps, Lloyd J., "Rurban Educational Development and the Work of Citizens' Advisory Committees," address given to a conference on Improving the Effectiveness of Citizens' Advisory Committees, University of Illinois, Urbana, Illinois, Sept. 26, 1968. (See Appendix I).

U.S. Congress, Vocational Education Amendments of 1968, H.R. 18366, 90th Congress, 1968, Title I - Part A - Sec. 104.

APPENDIX I

RURBAN EDUCATIONAL DEVELOPMENT AND THE WORK OF CITIZENS' ADVISORY COMMITTEES*

Lloyd J. Phipps
Director, REDL
University of Illinois

I think I should explain to you first what we mean by Rurban. As you have already surmised, it is a coined word. We had a person call us yesterday and tell us we had no right to do such a thing. The word was not in Webster's dictionary. But I think it expresses very aptly what we have in mind. Rurban is not rural, it is not urban. We mean, by a rurban area, an area that is composed of the open countryside, small towns, and small cities, if you want to call them small. The sociologists think of 200,000 people as being a small city as opposed to the metropolitan areas surrounded by their suburban areas. This is what we might mean by rurban. We are interested in educational developments in these rurban areas.

Some of you, I know, are from the metropolitan areas. Do not tune me out immediately, because what we have to say about rurban educational development also applies to you. You are concerned, or should be concerned, about educational development in rurban areas. Let me give you some information about the situation. At one time and for considerable periods of time in this country, economists and others believed that the answer to the problems of rural areas was to export the surplus population to the metropolitan areas. The economic policies that we have followed in this country have forced the people from our rurban areas. The concomitant result has been a blighting effect on the towns and small cities in rurban aresa.

The outmigration from rurban areas to metropolitan areas has also increased to intolerable levels the problems of these metropolitan areas. Air pollution, water pollution, transportation problems, race problems, ghettos and poverty enclaves resulting from the continuing growth of metropolitan areas are a blight on society and cannot be tolerated in the twentieth century and in an affluent society.

I would like to give you some figures on what the situation is. At the present time, 78 percent of the population in the United States live on one to two percent of the land area. The outmigration from rurban areas, and I mean not just rural areas but from small cities and small towns, is approximately one million people a year. This has been happening for some time. In the 1940's and 1950's approximately twenty million people outmigrated from these areas to the metropolitan areas. If this present trend continues for a few more years, in excess of 90 percent of the population will be crowded onto two to three percent of the geographical area of this country, with the rurban areas being relative vacuums in respect to population. Rurban areas cannot remain viable with this continuing outmigration of their best talent, and the metropolitan areas cannot effectively absorb all persons being forced upon them. Instead of accepting the notion that rural outmigration is inevitable, or even admirable, the idea is arising that the megapolis may not be the answer to all social, economic and political problems in the United States.

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* Address given at a conference, "Improving the Effectiveness of Citizens' Advisory Committees," University of Illinois.

There are some very definite counter proposals that have been advocated recently. One of the proposals is that this country needs to do something to stem the flow from rurban areas to metropolitan areas. Some people are suggesting that we instigate a reverse flow. Considerable sentiment is developing for a national decentralization of business and industry to rurban areas as a means of making these areas more economically viable as places to live and to work, and as a means of solving pollution problems, transportation problems, ghetto problems and poverty problems that have developed to intolerable levels in metropolitan areas. We are seeing more and more articles in the press, if you have been tuned in on this sort of literature, regarding the outmigration problem of rurban areas. There was a national conference on December 11 and 12, 1967 in Washington D. C. which was called by seven cabinet members to discuss and to make definite plans regarding what to do about this problem. The people that are doing rurban planning are beginning to say that the cities cannot solve their problems by themselves. They are saying that we must have rurban development.

Recently, I attended a meeting in Stillwater, Oklahoma, called by Senator Harris. It was a congressional hearing type of meeting. Over 700 people were there from all over the United States, and the hearing was all about the problem of rural to urban migration. They were making some definite plans as to what we can do as a country to utilize the entire country and get a balance, a proper balance, between the rurban areas and the urban areas, metropolitan areas. They were not talking about rural areas, they were talking about rurban areas. They were talking about functional economic areas composed of several counties with small cities, as the central hubs of these rurban areas.

Is it possible to make rurban areas viable again? Some Gallup polls and other types of surveys show that all the people do not want to live in metropolitan areas. About 50 percent of the people would like to live in rurban areas, not necessarily rural areas, but rurban areas. These people have been pushed into metropolitan areas; they have not been pulled there. The population and industries are no longer tied to certain geographical areas. We have the transportation and the power of communication required for locating industry anywhere in this country.

What are some of the ways to implement rurban development? One way is to increase job opportunities in rurban areas. We have an act before Congress at the present time, the Harris-Pierson Act called the Rural Job Opportunities Act, which is designed to increase job opportunities in rurban areas. Another suggestion is the decentralization of industry. Industries are already doing this. IBM has moved out of New York City. Some people are talking about tax incentives to encourage the decentralization of industry. An important way is the development of service jobs in rurban areas. In many rurban areas the recycling of monies within the areas would create more jobs and be of more benefit to the area than the bringing of additional branch factories into the area.

Often in rurban areas maximum benefits from payrolls are not realized because the workers often spend their monies for services outside the area instead of within the area. If an area has good jobs for 1,000 persons in primary businesses and industries, it should be able, by providing adequate services in the area to maximize the recycling of this payroll, to provide good jobs for 9,000 persons. Often, however, these areas have jobs for only 2,000 to 3,000 persons because service businesses and industries have not been developed adequately so that the people will spend their money within the area. In my opinion, our educational systems in rurban areas must accept part, but not all, of the blame for the failure of rurban areas to provide adequate service jobs.

We have consciously or unconsciously promoted educational programs in our schools in rurban areas that have forced the young people and the adults in these areas to leave, instead of preparing them so that they could make a living in the area if they did not want to leave. Our educational programs, in most rurban areas, have systematically promoted the draining away from these areas of the most intelligent and the most talented young adults they produce.

For the young people and adults in rurban areas who are not interested in preparing to leave their home areas or are not capable of handling the courses provided, which are designed in many cases to produce outmigration, we have provided something which we have labeled the general education curriculum which really prepares for nothing. These young adults, after they have completed the schooling available to them, are forced, in most instances, to leave their home areas because of the lack of job opportunities. They drift into metropolitan areas and because they are products of the general education curriculum, they often add to the misery of the cities and usually end up on welfare in the poverty enclaves found in the inner cities.

Education is not the total answer to rurban development, but it is an essential component. Rurban development cannot succeed without adequate educational development in rurban areas. Instead of providing only educational programs in rurban areas designed to prepare young people and the adults for export, why not assist these areas and assist the rurban renaissance by preparing them for the job opportunities that will be available to them in developing and developed rurban areas?

Most rurban areas have permitted or have driven away the industries and the jobs that logically belong in these areas. They have driven them away because they have focused the attention of young people and adults in their areas on the occupations that existed in metropolitan areas. They have failed to focus attention on the job opportunities and potential job opportunities in rurban areas. Further, the educational programs provided have not prepared the young people to work in the industries and jobs that logically belong in rurban areas. The least that could be done would be to provide concurrent work-education programs in local businesses and industries.

Let me give you an example of how industries have been driven from rurban areas. In many agricultural areas in Illinois, the industries associated with production agriculture or farming have been forced to discontinue their businesses or move to metropolitan areas because they could not obtain qualified employees. Not all, but part, of the blame for this situation must be placed on the educational programs provided in rurban areas. Fortunately, we are beginning to rectify our mistakes. Mattoon High School, for example, now has an agricultural occupations program to prepare boys and girls for employment in the agricultural-oriented businesses and industries that should logically serve the rich farming area surrounding Mattoon. Further, Lake Land College at Mattoon now has an agricultural occupations program to prepare at the technical level for employment in nonfarm agriculturally oriented businesses that must be maintained in the rurban areas of Mattoon if this area is to survive as a functional economic area, a viable area that will hold and attract good citizens.

Rurban areas may be able to take giant steps forward by focusing less of their attention on attracting branch factories to their areas and by focusing more of their attention on developing their own industries. Look at some of the rurban areas in Minnesota, for example. There is one area of Minnesota that you all know for its mental health facilities. About 45 percent of the jobs in a 40-mile radius are provided by this mental health industry. It is a home-grown industry.

What has our Rurban Educational Development Laboratory to do with the Illinois Citizens' Education Council? It is our belief that there is a "ground-swell" movement in our country to make rurban areas more viable as places in which to live and work. This "ground-swell" is inevitable as a means of relieving the pressure on metropolitan areas. Rurban development efforts cannot succeed, however, unless they are accompanied or preceded by the correct educational development. It is also our belief that adequate educational development is dependent on the effective work of the Illinois Citizens' Educational Council and the work of local citizens' committees.

We, therefore, believe that a fruitful way of promoting rurban educational development is to promote the effective use and operation of citizens' advisory committees.

We encourage citizens' advisory committees to consider such questions as the following:

1. What educational development is needed to prepare young people and adults for job opportunities in developing rurban areas?

2. How can concurrent work-education programs be implemented?

3. How can the attention of young people and adults be focused on rurban job opportunities as well as metropolitan job opportunities?

4. What educational developments are needed to prepare young people and adults for occupations that logically belong in rurban areas, such as rural recreation occupations and nonfarm agriculturally oriented occupations?

5. What educational developments are needed to prepare people for service occupations that must be provided if a rurban area is to become and remain viable?

6. What educational developments are needed to prepare residents to accept a rurban renaissance? Most people resist change. Rurban renewal on a functional economic area basis will create vast changes and will be resisted by many residents. Educational programs at the adult level and at other levels will be needed that will assist residents in rurban areas to adjust successfully to changes that will occur. And I am firmly convinced that these changes will occur. The problems in metropolitan areas are going to force them to occur. Metropolitan areas cannot solve their problems without a rurban renaissance.

We want to work with you in your public schools, with your citizens' committes, on problems such as these six that I have just mentioned. We hope that you will want to work on educational problem areas such as these.

Excerpts from a Speech: THE IMPACT OF CITIZENS COMMITTEES ON THE EDUCATIONAL PROGRAM

Dr. Robert C. Lloyd
Tuesday, July 6, 1965
National School Public Relations Association Annual Seminar, July 4-8, 1965
Boston, Massachusetts

I appreciate and welcome this opportunity to talk with you about the Baltimore Citizens School Advisory Committee project. This project was a unique and exciting demonstration of private citizens' involvement in public schools. It has been difficult to select points from so much that could be said. I trust my selections will be of interest to you as I look back over two years of work.

First, I will describe briefly the organization and operation of the Citizens Committee. Second, I will highlight quickly some of the basic principles that governed the project and which gave maximum assurance of a successful project. Third, I will mention some important cautions. Fourth, I will share with you what I believe were some of the important values and benefits.

To understand what happened with the Citizens Committee in Baltimore, you need to have some information about the Baltimore city schools. As the sixth largest city in the nation with a population of about 950,000, the public schools enroll 190,000 students in day school programs operating from some 200 schools. Of a total school staff of 11,000 persons, 8,000 are educational staff members and around 3,000 are classified staff. In addition to a 1965 operating budget of about $74.5 million, we plan to spend nearly $17 million in 1965 for construction of new schools. The nine-member school board, appointed by the Mayor with confirmation by the City Council, is fiscally dependent and has no taxing authority.

The Organization and Operation of the Citizens Committee

Following many months of discussion and study, the Board of School Commissioners established the Citizens Committee in late October, 1962, to engage in a two-year study of public education in Baltimore city. Twenty-five citizens from a list of over 700 names were appointed and held their first meeting in November, 1962. With citizens and staff participation, the school board had developed a set of bylaws and an administrative code that were transmitted to the committee. These two documents served to clarify purposes, objectives, operating procedures, and relationships.

In brief, the objectives of the Citizens Committee were as follows:

1. To survey the school needs and to study educational opportunities and services.

2. To contribute to the public understanding of the fundamental issues in education.

3. To examine what good schools are and what good schools can do for the community.

4. To stimulate creative thinking.

5. To identify ways of utilizing the community's resources in developing the best possible educational program.

6. To recommend improvements needed in the decade ahead (1965-1975).

The committee was organized into five citywide study committees: Organization and Administration; Personnel and Staffing; Instruction and Guidance; School Plant Facilities; School-Community Relations.

To accomplish its objectives, the original 25 members appointed by the board, realized from the start that additional volunteers in quantity would have to be secured. At the peak point of operation, at least 1,500 persons had some part through service on over 50 committees and submommittees. More than 450 meetings were held during the two-year period. The general committee of 25 and the steering committee members met some 70 times. At least 20,000 man hours, as a conservative estimate, were volunteered by citizens, all of whom served without compensation and with some personal financial cost to themselves.

The final report contains 303 specific recommendations, some of which have several parts. Presented in three volumes with a total of 530 pages, the report approximates 315,000 words. To honor requests for copies and to assist the school staff in its analysis of the report, an abridgement was prepared. It contains all of the recommendations but does not have the explanations, tables, and certain other supportive information. In addition to rather wide community and national circulation, copies of the abridgement were distributed to all educational staff members in the Baltimore city school system.

Also, to provide a general, abbreviated summary of the project, we produced a synopsis which does not contain the specific recommendations themselves but gives an overall picture of the project and the work of the Citizens Committee.

Basic Principles

A number of basic principles were understood by the Citizens Committee members at the outset of the project. Other principles emerged as the project progressed. In my judgment, the apparent success of the project can be directly traced to these principles. I have not attempted to rank them in any priority scheme.

1. The committee understood its function in relation to the school board, to the staff of the schools, and to the community. This function was advisory. The committee knew that the school board retained responsibility for all policy decisions.

2. The committee constantly communicated in writing with the president of the school board and the superintendent so that these two individuals were kept fully abreast of the progress and problems. In addition, verbal and written reports were presented to the staff as deemed desirable and necessary. The committee realized the importance of communications with particular reference to informing the staff about the work being done. The committee published five issues of its own newsletter which reached a distribution of about 1,500 copies per issue.

3. The administrative code developed by the school board was extremely important in explaining the relationships between the Board, the staff, and the citizens. Also, the bylaws outlining operating procedures greatly aided the committee in promptly moving into the complex task of studying the public school system. Of interest to you is the fact that the bylaws were amended several times by the committee appropriate to their plans and needs. These two documents served an essential purpose in stating for all to know the objectives, policies, and relationships of the Citizens Committee.

4. Once appointed by the school board, the committee enjoyed complete freedom to carry out the project. At no time did the Superintendent or the Board restrict the operation of the Committee, or interfere with its work. Thus, from the outset, there existed a general feeling of mutual trust and confidence.

5. All members of the Citizens Committee were free to talk about the work of the committee by common agreement, but only the chairman could speak for the committee.

6. Every effort was made to involve all interested persons. A variety of techniques were used to invite and encourage participation. A significant membership stipulation was that persons participated as individuals, not as representatives of any group, organization, or institution. Any person could participate who either lived or worked in the city. Some of the individuals who participated included members and former members of the city council, judges, state legislators, former teachers, former school board members, persons working in other city agencies and bureaus, and individuals from a large variety of occupations. Housewives constituted a major portion of the membership. It should be stressed that all persons served as individuals.

7. The committee enjoyed excellent cooperation from the staff. Any initial concerns and apprehensions that staff members may have felt, quite rapidly evaporated. This can be traced primarily, though not exclusively, to the intelligent, sensitive, and sincere manner of the citizens as they made contact with hundreds of staff members at all levels and in all programs. Every school was visited at least once, some several times.

8. The committee tried always to focus its attention on the primary objective--better education. It avoided carefully getting into personalities, making snap judgments, and, all in all, it sought to shelve pet notions in the face of the facts of the matter.

9. The committee began its work with a belief that the public schools in the city were fairly good. They were genuinely convinced, however, that the schools were not good enough. Their report contains recommendations for improvement.

10. For the most part, the committee was a fact-finding committee. It is true that a few members, at times, saw their function as fault-finding.

11. The committee adopted a timetable and was able to adhere to the schedule. Furthermore, the committee had the freedom and responsibility to set its own priorities as to what to study, how to study, and how to report the studies. All areas of the school system were not examined and the committee not only states this forthrightly, but also urges the school board to have these areas examined sometime in the future. Great care was taken to study in depth rather than superficially.

12. The plans of the committee included careful consideration of the nature and style of the final report. What would it be like? What would it contain? The committee also presented to the board its thoughts concerning distribution, realizing that its task was discharged at the moment the report was presented to the board. It nonetheless had strong and definite feelings about wide circulation of the report.

13. For the most part, the committee started with the idea that they first needed an education about public education in Baltimore. Most of the first year was devoted to orientation and information-seeking activities before any particular consideration was given to developing recommendations.

14. In my judgment, one of the most important operating procedures called for review by and clearance from the steering committee of research projects and study procedures.

15. Committee members were given opportunities for full discussion of all business items. Indeed, an atmosphere of permissiveness prevailed in keeping with the desires of the chairman and most of the committee members. While some time may have been lost, in a sense most agreed, in looking back, that this policy was sound.

16. The committee carefully and judiciously guarded against interrupting or corrupting the ongoing school system. The committee understood that the education program must proceed normally even though members of the committee for many months were visiting schools and offices.

17. The committee searched for the good as well as the deficiencies. The good things were applauded and expansion recommended. Deficiencies were forthrightly identified and corrections recommended.

18. A definite review and screening procedure was established for the consideration of each recommendation. After a recommendation had been adopted by a subcommittee, it then had to meet the rigorous testing of the citywide study committee, the steering committee, and ultimately the general committee of 25. At least 40 recommendations were rejected somewhere along the way. Others were combined where obvious duplication occurred. In some cases, recommendations went through six revisions before being approved by the general committee.

19. Provisions were made for minority reports. The handling of minority reports either from individuals or from groups resulted in the formulation of a clear policy.

20. All educational staff members were given an opportunity to participate in plans for establishing the Citizens Committee. This opportunity for participation undoubtedly led to the splendid cooperative assistance provided the citizens by the staff. As mentioned before, definite steps were taken during the two-year project to inform the staff about the work of the committee.

21. The committee was given status and respect. Special stationery was designed and provided. Office space was furnished. Staff was assigned. Requests of all types were promptly handled. Special identification cards were given to members for presentation during school visits.

22. Accurate records were maintained portraying all committee and subcommittee deliberations and decisions. The superintendent approved the use of 16 outstanding school vice-principals for service as permanent recorders to the five major study committees. Not only did these staff members serve well, but they also gained much from their contacts with the citizens.

Other principles could be cited, to be sure. In this listing, I have endeavored to highlight those which seem to me to be the more important guidelines. As a matter of fact, during the project, I was accused of a kind of pre-occupation with machinery and with ground rules. I suppose I would have to plead guilty and yet, as citizens look back over the two years of extremely hard work, they now advise me of the necessity of these ground rules and of this machinery.

Some Important Cautions

There are a number of important cautions that need to be squarely faced by those having responsibility for the operation of a citizens committee. I doubt that any of the ones mentioned below are new to you. Nor have I attempted to put them in any particular order of importance. School staff members and citizens must clearly understand some of the difficulties and hazards so that they are better prepared to meet the difficulties and avoid the hazards insofar as possible. Let me make clear that some of these cautions about people are aimed at a very small portion of people among the many hundreds, even thousands, who were involved in the Baltimore city project.

1. Some citizens may emerge from a citizens committee study as new-found experts who have most, if not all, of the answers. Some few will not have truly learned of the incredible complexity of running a large school system.

2. There will be factions and special interest groups. Disgruntled minorities with their pet theories will be abundantly evident.

3. Some few may even see themselves as the spokesmen for the schools acting as a "super" school board.

4. There will be the initial eager beavers who all too soon are identified as free-loaders and deadwood.

5. Some of those with the big names and the established reputations are not necessarily the real workers.

6. A citizens committee project is work--very hard work.

7. Committees and subcommittees should be as representative as possible. Special efforts should be taken to involve persons from business and industry.

8. Consultants should be carefully selected and their involvement clearly defined.

9. In addition to obtaining facts, citizens need interpretation of facts. You all know the saying, "Don't confuse me with facts. My mind is made up." A few, unfortunately, have this attitude.

10. Recommendations developed by citizens must be based on identified needs following study and investigation and analysis.

11. Citizens need to understand and believe that their relationship to the school board is as an ally, not as a threat. Overall goals and objectives of the two groups are in fact identical as all seek to improve the program of public education.

12. The committee should focus on both present and future needs. Citizens' dreams of public education, as expressedin their recommendations, should be sensibly and realistically based. But there must be some dreams.

13. Committees must regularly consider their own staff needs in relation to the conduct of the citizens' study. Such staffing requirements may be for professional personnel, clerical staff, consultants, and many other phases of human energy and talent that will be required.

14. The committee should develop policies and plans for involving and working with representatives of the public media. This is true at the beginning of the project, even before it officially starts, and throughout the project.

15. Citizens, as is probably true of people generally, need to scrupulously guard against the tendency to overgeneralize and to oversimplify.

16. Above all, members and officers should make certain all along the way that they stick to the objectives and purposes established. The tendency to stray and meander is real, but usually distracting.

17. Lastly, the Committee should be ever mindful of cost implications of suggested improvements. No sound recommendation should be withheld simply because of cost, however.

Values and Benefits

In their report, the Citizens Committee noted what they called products of the process. Indeed, many benefits and values derived simply because there was a committee. Other good things have happened in the short space of time since the report was presented to the school board. Numerous benefits are yet to be realized but are assured as the school board acts on the citizens' recommendations. Let me share with you some of the values and dividends for public education in Baltimore ~~city~~.

The most important product was the process itself of citizens and staff members meeting together, talking, and confronting the educational issues in today's world. Questions were posed for which there were no immediate answers and yet answers were found. Information was requested where research was required and was conducted. Horizons were widened. Understandings were improved. Sights were more sharply focused. The educative process was at work.

Many tangible benefits resulted.

.1. Publications were produced ahead of schedule for use by the Committee. Reports were prepared that were useful both to the staff and to the citizens.

2. The maintenance and operation of buildings were improved.

3. Changes were made in the deployment of personnel.

4. Research activities were expanded and improved.

5. Some changes have been made in a few curricular programs. Other changes have been made in concepts of curriculum development and planning.

6. Closer liaison with colleges and universities, other city agencies, civic and professional groups, and PTAs can be observed.

7. Plans are being reviewed for continuing and extending the use of citizens.

8. A new set of promotional policies has been adopted and the staff appointed to administer these policies.

9. A staff committee is currently working on a long-needed handbook for per diem substitute teachers.

10. Many staff committees are busily engaged examining the report for ideas that may be recommended for adoption.

11. The project led to improved relations with the public media and the public generally.

12. Study of the report by other groups and committees within the city and around the nation surely places additional value on the project and the report.

13. Staff morale has been improved because of the project and more particularly because of the work currently underway wherein all staff members have the opportunity to convey reactions to the recommendations.

14. Materials were accumulated from around the nation by the committee which have been made available to the staff.

15. The committee itself conducted research which has been of value to the staff.

16. The project brought into the schools many citizens who had never before been involved in or particularly concerned about the public school program.

17. Not bound by tradition or custom, citizens explored new areas, proposed new and different procedures, and brought creative thinking to the operation of the public schools.

Finally, it is hoped and anticipated that the impact of the study will be substantial and far-reaching, serving as a blueprint for public education in Baltimore in the decade ahead.

Much remains to be done since there are many recommendations and since the staff must study carefully the effect of any recommendation on the efficiency and effectiveness of the educational system. A complex task faces the administrative staff and the school board in preparing a follow-up report on the actions to be taken for each of the several hundred recommendations.

Summary

The Citizens Committee project, in the final analysis, provided an opportunity for schools and citizens to explore what the community wants and expects the public schools to accomplish. Hopefully, community support for better education has been stimulated and strengthened. The schools have had an unprecedented and unparalleled opportunity to inform the people about the needs, programs, achievements, and problems of the public schools.

Citizens not only examined what good education can do, but they also examined the consequences of not providing good education. The project demonstrated that public education is public business. Our conviction that informed citizens will support improved education has been supported, at least partially, for much remains to be done.

The public schools are really the public's schools.

They will be as good or as poor as the public demands, expects, and supports.

The project seems to have demonstrated, also, through the thoughts and expressions of citizens, that human progress and educational quality are inseparable.

The pursuit of human excellence remains the most important task we face and the successful accomplishment of this task is directly related to our ability to provide excellence in education. Many Baltimore citizens do not talk now about the public schools or your public schools.

Rather, they use the term our public schools.

The committee sought to reaffirm the principle that education is a partnership between schools and the community. As the superintendent commented upon the Citizens Committee report, "The report represents the conscience of the community."

EAS 161

9-29-65

Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 1-B

Nature of a Citizens' Advisory Councils - Organizational Structure & Authority

Produced by the

Rurban Education Development Laboratory

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Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Nature of Citizens' Advisory Councils (1)

Concern: Organizational Structure and Authority (B)

Objectives: After instruction, the student:

1. Recognizes or recalls the roles of the federal government, U.S. Office of Education, State Department of Education, local school board, local school administration, and Citizens' Advisory Council in public education.
2. Generates or recalls the interrelationship as to authority and responsibility between each of the above bodies.
3. Recognizes or recalls the typical organizational structure of most Citizens' Advisory Councils.
4. Recognizes or recalls the officers considered necessary in a Citizens' Advisory Council, their roles, and the organizational structure of most Citizens' Advisory Councils.
5. Recognizes or recalls the responsibilities of each of the above officers.

Suggested Teaching Techniques:

1. At the beginning of the class session, have each student attempt to generate and write down the answers to the suggested anticipated problems and concerns that follow. Through study of the Recommended Reference and class discussion, develop satisfactory answers.
2. Invite a member of the school board, a school administrator, a local Citizens' Advisory Council member, or the local Superintendent of the local educational service region to talk to and discuss with the students, the suggested anticipated problems and concerns that follow. These resource people may wish to speak individually or as a panel.

3. Divide the class into four equal groups to represent the school board, state department of Education, school administration, and Citizens' Advisory Council. These groups through role playing could attempt to clarify the inter-relationships and lines of authority commonly occuring among these educational bodies. Periodically, the groups roles could be alternated allowing each student to serve at least once in each position.
4. Have the class generate specific school problems of various kinds. Then, through group interaction, attempt to identify a specific problem with the correct body responsible and in authority for that problem.

Suggested Audio-Visual Aids:

1. Develop a graph or transparency and a duplicated handout of the flow chart of the lines of educational responsibility and authority shown in Appendix I.
2. A chalk board or overhead projector should be utilized during class discussions to illustrate verbal concept generations from the class.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
1. What are the bodies of authority and responsibility in the nation's public education system.	A. Federal Government B. Department of Health, Education, & Welfare. C. U.S. Office of Education D. National Advisory Council E. State Department of Education F. State Advisory Council G. Local Board of Education H. Local School Administration I. Local Citizens' Advisory Council J. (Note: Other bodies may be included if desired).

1. (Continued)	<u>Suggested Techniques</u>: A. At the beginning of the study period, ask the students to write down plausible answers to the anticipated problem. B. Have students study pages 11-12 of THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION. C. Solicit the reactions of the resource person or persons in attendance to the question.
2. What is the role and responsibility of each of the bodies or levels listed in Anticipated Problem and Concern #1.	A. Federal Government; Dept. of Health, Education and Welfare; U.S. Office of Education - Roles and responsibilities of national priority determination and advisement. (Select composite ideas of the class.) B. National Advisory Council - (Bring out aspects of identifying the national manpower needs and the responsibility for public education.) C. State Department of Education - Legal authority and responsibility for public education. D. State Advisory Council - Similar to National Advisory Council except for individual states. E. Local Board of Education - Legal arm of the state department having legal authority and responsibility for the local district. F. Local School Administration - Implimentation of local policy decisions.

2. (Continued)

G. Local Citizens' Advisory Council - Advises the local board of education, administration, and staff on policy decisions.

H.

Suggested Techniques:

A. Have students read pages 18-25 in the Recommended Resource: INDUSTRY AND COMMUNITY LEADERS IN EDUCATION.

B. Have students review pages 9-15 of THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION.

C. Solicit answers from visiting resource people regarding the determination of their roles and responsibilities. Example: "Mr. Administrator - what do you see as your role and responsibilities in education?"

D. Duplicate the flow chart in Appendix I. Distribute to class for discussion.

E. As mentioned in Suggested Teaching Technique #3, divide the class into four equal parts. Have each group select the level they wish to represent, i.e., state education department, local school board, local school administration, or citizens' advisory council. Select some fictitious problems such as bussing or sex education to demonstrate the lines of authority and responsibility. Change the

2. (Continued)

groups' identity periodically throughout the session so that each group plays all of the roles at some time during the session.

F. Record all perceived lines of authority and responsibility on the chalk board for later use.

G. As mentioned in Suggested Teaching Technique #4, have the individual class members select specific educational problems. Then through class discussion, attempt to determine who would be responsible for each problem.

H. From all previous class input, develop satisfactory answers and alternatives for the question under consideration.

3. How does a Citizens' Advisory Council fit into a local school structure?

A. A local Citizens' Advisory Council is usually organized by the local school board to advise the school board, school administration, and staff. Questions from school administration and staff are usually channeled through the board. The Citizens' Advisory Council has no authority except through the board.

Suggested Techniques:

A. Solicit the comments of the resource people in attendance concerning the role and responsibilities of a Citizens' Advisory Council.

B. Prepare an overhead transparency of the flow chart in Appendix I.

3. (Continued)	C. Discuss with the students and have the students review the flow chart presented in Appendix I. D. Develop suitable answers and alternatives to the question under consideration
4. What officers are necessary for an effective Citizens' Advisory Council?	President, Vice President, and Secretary. A Treasurer is not completely necessary as a Citizens' Advisory Council does not usually handle money. <u>Suggested Techniques</u>: A. Have students read part of page 17 in CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. B. From the students' experiences, solicit and develop a suitable answer for the question under consideration.
5. What is the typical organizational structure within a Citizens' Advisory Council?	Typically, the organizational structure is kept to a minimum in an attempt to avoid structured meetings. Meetings where individual interest and dialogue are spontaneous are desired. The skeleton executive committee shown in Question #4 is considered a minimum for effective and efficient council meeting operation. <u>Suggested Techniques</u>: A. Have an officer of a local Citizens' Advisory Council serve as a resource person. Solicit his comments as to the organizational structure. Record his responses on a chalk board.

5. (Continued)	B. Solicit student input as to organizational structure as seen from their experiences. C. Develop a suitable answer from the input received.
6. How should sub-committees and special study groups be incorporated into a Citizens' Advisory Council organizational structure?	Sub-committees and special study groups may be organized by the Citizens' Advisory Council. Such groups should report to and be responsible to the parent Citizens' Advisory Council. <u>Suggested Techniques</u>: A. Have students review the flow chart in Appendix I. B. Solicit the input from Citizens' Advisory Council members serving as resource people. C. Record all pertinent information on a chalk board. D. Develop a suitable answer for the question under consideration.

<u>Suggested Evaluation Techniques</u>:

1. Develop, administer, and evaluate an essay test based on key questions. Evaluation may be greatly enhanced by comparing the test with the answers generated by the class members at the beginning of the class session.
2. Attempt to observe and evaluate the changes in individual attitudes as students change roles in Suggested Teaching Technique #3.
3. Ask each student for a written self-evaluation of his or her learned behavior in the reflection of the objectives.

Recommended Resource:

Burt, Samuel M., Industry and Community Leaders in Education, Kalamazoo, 1969, pp. 18-25. (Source: W.E. Upjohn Institute; 300 South Westnedge Avenue; Kalamazoo, Michigan; 49007; Price 50¢).

References and Sources:

American Vocational Association, The Advisory Committee and Vocational Education Washington, D.C., 1969, pp. 11-12. (Source: Publication Sales, American Vocational Association; 1510 H. Street, N.W.; Washington, D.C.; Price: $1.25).

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, 1963, p. 17. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois 61801; Price: 50¢).

APPENDIX I

FOR DISCUSSION PURPOSES ONLY

PROPOSED FLOW CHART OF COMMUNICATIONS & AUTHORITY

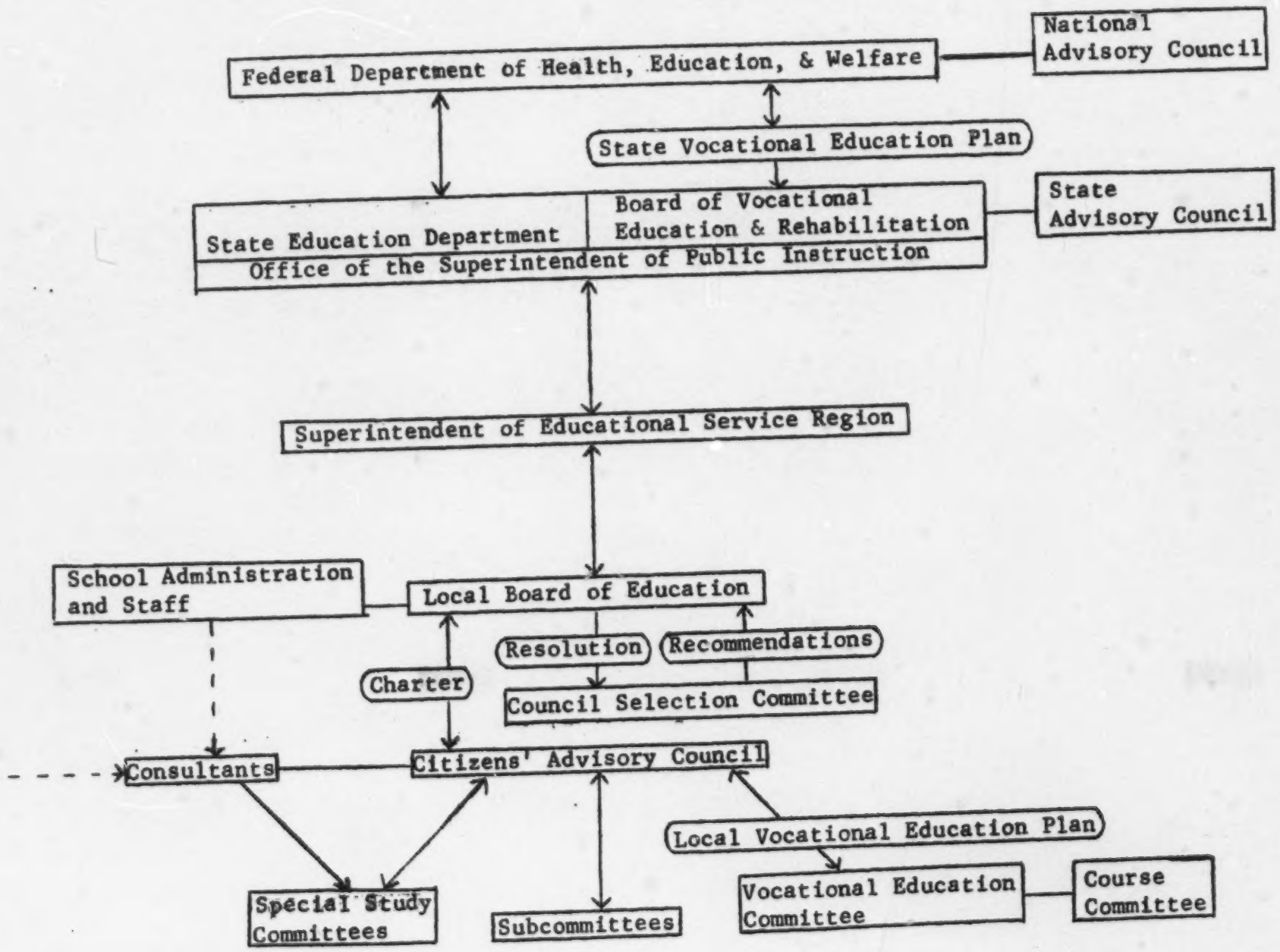

4089

Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit I-C

Nature of Citizens' Advisory Councils--
Functions of Citizens' Advisory Councils

Produced by the

Rurban Education Development Laboratory

Dr. Lloyd J. Phipps, Director
357 Education Building
University of Illinois
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Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit. Nature of Citizens' Advisory Councils (1)

Concern. Functions of Citizens' Advisory Councils (C)

Objectives. After instruction, each class member:

1. Generates functions and activities of Citizens' Advisory Councils generally considered advantageous to the total local educational effort.

2. Recognizes or recalls functions and activities generally considered improper or dangerous to the well being of the school as a whole.

3. Judges the relative value of questionable activities and functions.

Possible teaching techniques

1. Foster and encourage class discussion and generation of reasons why some activities may be injurious to the school followed by generation of criteria for determining the relative value of various activities.

2. Have each student generate a list of proper and improper functions. This list should also include reasons why each function is improper or proper and how the differentiations were made.

3. Divide the class into equal halves to brainstorm activities and reasons why each is proper or improper.

4. Invite a board member, school administrator and Citizens' Advisory Council member to discuss their experiences with the students in regards to successful and unsuccessful activities of Citizens' Advisory Councils.

Suggested Audio-visual aids

1. The slide set and audiotape presentation entitled "Proper Functions of a Citizens' Advisory Council" available free from REDL. This audio visual should prove effective as an instruction and motivational device. (The address for obtaining the slides is shown on the front cover of this unit.)

2. Expose the class members to the material in Appendix I and II. This may be accomplished through reproduction, opaque projection, or overhead projection of the material.

3. A chalkboard should be utilized during brainstorning and class discussion sessions to record response from class member and resource persons.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
1. What are some proper functions of Citizens' Advisory Councils?	<u>Suggested solutions</u> A. Policy development, interpretation, execution, and publicity. B. Clientele determination of the school. C. Determination of the public purposes of the school. D. Development and execution of evaluation arrangements. E. Make recommendations regarding the operation of the school. F. Provide services for parents and others. G. H. I. (Note: Additional responses should be solicited from the class members.) <u>Suggested techniques</u> A. Have class members prepare a list of possible proper functions of a Citizens' Advisory Council. The list should be developed from the class member's own experiences and comprehension of possible functions and activities. B. Have class members view the slide-audio tape entitled "Proper Functions of Citizens' Advisory Councils." C. Have class members read pages 19-22 of the recommended resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. D. Have class members read pages 17-22 of THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION.

1. (Continued)	E. Have class members read Appendix E3 of THE HOW OF SUCCESSFUL CITIZEN ADVISORY COMMITTEE OPERATION. F. Have students read the information included in Appendix I. G. From the above resources, solicit and extract a satisfactory answer from the class members.
2. What are some improper functions of Citizens' Advisory Councils, and why are they considered improper?	<u>Suggested solutions</u> A. Involvement in political concerns. B. Activities termed as pressure groups. C. Independent reporting to the public. D. Involvement in the teaching of specific courses. E. Involvement in individual personnel matters. F. Nonschool activities. G. Fund raising. H. I. J. (Note: Additional responses should be solicited from the class members.) These activities are improper as they tend to cause dissention between different parts of the school. Furthermore, such activities may tend to undermine the authority of the school board. This board is and must remain the final legal authority in the conduction of the school program.

2. (Continued)

Suggested techniques

A. Have class members prepare a list of possible improper functions of a Citizens' Advisory Council. (Note: This activity could be combined with the similar activity under Anticipated Problem and Concern number 1 above.)

B. Have class members read pages 22-23 of the recommended resource CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION.

C. Review with the class members the slide and audiotape set viewed under Anticipated Concern number 1.

D. Have students read the information included in Appendix I.

E. Solicit and encourage contributions by the resource persons in attendance as to their observations about the problem and concern under question. Record ideas on the chalk board.

F. From the above discussion have the class members develop a suitable answer for the question.

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3. How may the activities listed in Problem number 2 above be injurious to the local educational effort?

Suggested solutions. The improper functions listed:

A. May extend the efforts of the Citizens' Advisory Council so broadly that effective results may not be obtainable.

B. May produce a credibility gap between the Citizens' Advisory Council and the public.

C. May cause the community to divide itself as to its moral and financial support of the school.

D. May produce trouble within other community organizations due to duplication of effort and action.

3. (Continued)

E. May cause strife and friction between the administration and teaching faculty.

F. May cause trouble between the school board and the school administration.

G. May cause trouble between the school administration and the nonacademic school personnel.

H.

I.

J.

(Additional injuries may be brought out by class members during discussions.)

<u>Suggested techniques</u>

A. Solicit and encourage the presentation of ideas and opinions by resource people in attendance. Record these ideas on a chalk board for later reference.

B. Have class members review the information included in Appendix I.

C. Conduct a role playing session. Divide the class into groups to represent the school board, school administration, academic faculty, nonacademic staff, a school board member, a school principal, a teacher, a janitor, a Citizens' Advisory Council member, a parent, and a taxpayer. With these roles assigned, select one of the improper activities listed under Problem number 2 and have each actor discuss the activity from his point of view. Have the class members change roles with each new improper function to be discussed.

D. From the above information, have the class members develop a suitable answer for the question.

4. What measures can be taken to attempt to avoid unsuitable and improper activities by a Citizens' Advisory Council?

Suggested solutions

A. The Citizens' Advisory Council should be established under a charter with rules of operation clearly defined.

B. The Citizens' Advisory Council should be responsible to one group only, i.e., the local school board. Citizens' Advisory Councils which must respond to the school board and the school administration or some other group becomes divided in its allegiance and efforts.

C. Effective Citizens' Advisory Council leadership needs to be developed to guide and assist in selecting suitable and proper activities.

D. Establishment and use of effective communications lines between the Citizens' Advisory Council, local school board, and, local administration.

E. The lines of communication and authority between the Citizens' Advisory Council and the school administration should be clearly defined.

F. A member of the school board should be assigned the responsibility of sitting in on and communicating with the Citizens' Advisory Council.

G. A member of the Citizens' Advisory Council should be assigned the responsibility of sitting in on and communicating with the school board.

H.

I.

J.

(Note: Additional measures should be included as they are developed by the class members.)

4. (Continued)	Suggested techniques A. Conduct a brainstorming session to find all possible answers to the anticipated question. The instructor should lead the group in a rapid-fire session of two or three minutes where all answers are considered correct. Incorrect answers can be deleted during subsequent class discussions. B. Have class members read the information in Appendix II. C. Have class members review the information in Appendix I. D. Solicit and encourage the inclusion of information, ideas, and opinions of the resource people in attendance. E. From the above information, have the class members develop a suitable answer for the question.

Suggested evaluation techniques

1. Subjectively evaluate the written work done by the class members to Possible Teaching Techniqued Number Two.

2. Have each student self evaluate his accomplishments during the class period in terms of the stated objectives. The evaluation (6) should be written allowing the teacher to evaluate subjectively his personal efforts and techniques.

3. Upon invitation, observe the class member in his role as the member of an actual Citizens' Advisory Council in an attempt to determine the class and learning effect on his behavior.

Recommended resource

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, Urbana, Illinois, 1963, pp. 19-23 (Source: Rurban Educational Development Laboratory; 357 Education Building, Urbana, Illinois 61801; Price 50¢).

References and sources

American Vocational Association, The Advisory Committee and Vocational Education, Washington, D.C., 1969, pp. 17-22 (Source: Publication Sales; American Vocational Association; 1510 H Street, N.W.; Washington, D.C. 20005; Price $1.25).

Guiding Principles of Effective Citizens' Committees for the Public Schools, New York State Citizens' Committee for the Public Schools, Inc., 2 West 45th Street; New York 36, New York.

Illinois State Board of Vocational Education and Rehabilitation, Advisory Committees--Organization and Use in Vocational and Technical Education, Springfield, 1968, pp. 1-2 (Source: Illinois State Board of Vocational Education and Rehabilitation; 405 Centennial Building; Springfield, Illinois 62706; Price: free).

Phipps, Lloyd J. and Knell, Kenneth, The How of Successful Citizen Advisory Committees Operation, University of Illinois, Urbana, 1968, Appendix E3. (Source: Rurban Educational Development Laboratory; 357 Education Building; University of Illinois; Urbana, Illinois 61801; Price 75¢).

Sixteen Do's and Don'ts for Citizen School Groups. New York State Citizens' Committee for the Public Schools, Inc. 2 West 45th Street; New York 36, New York.

APPENDIX I

From: The New York State Citizens' Committee for the Public Schools, Inc.
2 West 45th Street, New York 36, N.Y.

SIXTEEN DO'S AND DON'TS FOR CITIZEN SCHOOL GROUPS
(Based on the experience of 85 towns and cities)

DO	DON'T
Expect the job of organizing a study group to take time. More time spent in the beginning will mean less time wasted in the end. Give the project a chance to grow. Give leadership a chance to emerge.	Be in a hurry or rush others into accepting responsibility before they have a chance to find out how much is involved.
DO	**DON'T**
Start with temporary officers--maybe as temporary as for just one meeting; perhaps a host and/or hostess, instead of a chairman. Take turns keeping notes for the first few meetings. Provide ample opportunity for expression of all views.	Try to elect a slate of permanent officers at the first meeting, or try to choose subjects for study before you know what subjects interest the whole town most.
DO	**DON'T**
Give the Board of Education, Superintendent of Schools, and other school personnel opportunity at the outset to suggest how you can be most helpful and to join in your activities. If their cooperation is not immediately forthcoming, keep trying. Be sure they receive notices of all meeting dates. Remember that independence doesn't rule out interdependence.	Fail continuously to seek cooperation from school authorities. Don't forget that cooperation does not mean domination.
DO	**DON'T**
Seek out for commendation areas in which your schools are setting an example for others, as well as areas in which there is room for improvement. Be a fact-finding group, not a fault-finding group.	Carp, criticize irresponsibly, or involve personalities.

DO	DON'T
Make membership represent your town, community and education interests, business, labor, churches, organizations, youth, racial and national backgrounds, and all geographic areas. Keep meetings open to interested groups and persons. Build a cross-section membership big enough to do the job you outline for yourselves.	Try to do a board job with only a few chosen members.
DO	DON'T
"Include the opposition in." Invite those who disagree with you to participate in the group. Try to get them to accept responsibility in the group.	Be afraid of opposition or avoid those who disagree with you.
DO	DON'T
Clearly define the purpose, policy, and scope of your group after the first few meetings. This can be amended later, if the interests of the group broaden.	Tackle the job until you have all agreed on precisely what the job is.
DO	DON'T
Choose your subjects for study with reference to the preferences of the entire membership of the group, plus town opinion as sampled by the membership.	Have subjects for study chosen by a small committee and foisted onto the rest of the group.
DO	DON'T
Determine the number of officers needed, the number of sub-committees, etc., with reference to the scope of the job you carve out, in all its aspects.	Hold committee elections in a vacuum or emphasize <u>machinery</u> above <u>subject matter</u>.

DO	DON'T
Elect a responsible steering committee that will coordinate and stimulate the work of all subcommittees, and will authorize, with reference to the whole group, the work of each subcommittee.	Let subcommittees go off on individual tangents which may duplicate the work of other subcommittees.
DO	**DON'T**
Make liberal use of "live" resources in seeking answers to study-group questions. Consult town and school officials, industry, labor, health and housing authorities, architects, etc.	Rely on printed statistics to provide all the answers.
DO	**DON'T**
Keep the whole town continuously up-to-date on the methods, findings, activities of the group as you progress. Report to the press. Send speakers to meetings. Hold open forums.	Wait until your study is complete to let others know what you are doing.
DO	**DON'T**
Be sure final recommendations are based on a factual foundation and represent the views of the entire group in relation to the town. Include study of financial resources which can be tapped to support your recommendations.	Make "wishful" recommendations, which are not related to available sources of income, or to the needs of the town.
DO	**DON'T**
Officially share final recommendations with school authorities before releasing them generally.	Release final recommendations before school authorities have officially examined them.
DO	**DON'T**
Develop dramatic means of presenting your final recommendations to the entire town. Plan definite avenues of action leading to adoption of recommendations.	File your recommendations and forget about them.
DO	**DON'T**
Consider ways in which a school community council can be of permanent service to the town.	Consider your job as finished when you have completed your first full study.

APPENDIX II

GUIDING PRINCIPLES OF EFFECTIVE CITIZENS' COMMITTEES FOR THE PUBLIC SCHOOLS

Be representative of the whole community.

Keep well informed (the process of gathering, digesting and passing on information is all important).

Earn confidence of the community through tangible achievement and services.

Strengthen the work of parent-teacher and other school-minded groups through teamwork, close liaison and by not duplicating efforts.

Work cooperatively with the School Board and School Administration but keep independence of thought and action.

Remember the citizens' committee studies, interprets and recommends, but that policy decisions rest with the Board of Education.

Source: New York State Citizens Committee for the Public Schools
2 West 45th Street
New York 36, New York
Oxford 7-7420

Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 2-A

Formation Procedures--Use of Consultants

Produced by the

Rurban Education Development Laboratory

Dr. Lloyd J. Phipps, Director
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Staff Assistants

Richard Hofstrand W. Edward Shipley

Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit. Formation Procedures (2)

Concern. Use of Consultants (A)

Objectives. After instruction, the student:

1. Describes the services of a consultant.
2. Elicits reasons as to the value of consultants and their services.
3. Identifies a consultant's role and techniques.
4. Generates sources of consultants.
5. Recognizes occasions when a consultant's services are desirable.

Possible teaching techniques

1. Produce a role-playing experience where part of the class members act as consultants with the remainder of the class serving as Citizens' Advisory Council members. Activities and techniques should be acted out.
2. Have a professional consultant and a lay consultant talk to and discuss techniques, activities, and recommendations as to possible problem areas with the class members.
3. Foster and encourage group discussion on the value and activities of consultants.
4. Develop and conduct a debate between panels of students taking opposing sides as to the value of consultants.

Suggested audio-visual aids

1. Utilize chalk board in developing source of consultants for your geographic area.
2. Duplicate and disseminate concise information as to techniques and possible problem areas for consultants.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
1. What is a consultant and what are the characteristics of a suitable consultant?	<u>Suggested solutions</u> A consultant is an adviser or technical specialist whose expertise is needed to insure success of a program to be undertaken and to provide advice as to alternative procedures and their relative values. A suitable consultant should be an expert in the field and on the problem. He should be knowledgeable in the techniques of consultation and be able to allow sufficient time to your case to bring the solution to fruition. <u>Suggested techniques</u> A. Have class members read page 27 of ORGANIZATION AND EFFECTIVE USE OF ADVISORY COMMITTEES. B. Have class members read pages 9-12 of COLLEGE-COMMUNITY CONSULTATION. C. Solicit and encourage remarks concerning the anticipated problem by the professional or lay consultant in attendance as a resource person. D. Foster and expand a class discussion of the definition of a consultant. E. From the above information have the class members develop a suitable answer for the question.
2. What can a Citizens' Advisory Council do to in insure efficient and effective use of a consultant's time?	<u>Suggested solutions</u> A. Make sure you are ready for the consultant. Analyze your problem thoroughly and have resource materials determined and at hand. B. Provide ample time for the consultant's observation of your community before asking him about far-reaching questions and decisions.

2. (Continued)

C. Supply the consultant with any and all information possible about your problem well in advance of his visit or visits.

D. Inform the consultant as to what you want the consultant to do. (For a listing of the different ways a consultant may be utilized, refer to anticipated concern number 3 of this Source Teaching Unit.)

E. Inform the consultant as to how he or she is to relate to the problem. Will his time be spent with large groups, small groups, individuals, or other structural bodies?

F. Provide for several visits from the consultant. "Run in" and "run out" meetings are cheaper, but the soundness and effectiveness of subsequent decisions may be inferior.

G. Don't ask the consultant to give you a speech. Speeches usually do not relate directly to your problems, and speeches seldom result in positive actions.

H.

I.

(Additional items may be added.)

<u>Suggested techniques</u>

A. Conduct a role-playing situation where approximately half of the class members will serve individually as consultants. Have the other half of the class serve as a Citizens' Advisory Council. Have the mock Citizens' Advisory Council generate a possible need together with background information. Have the mock consultants come individually to assist the mock Citizens' Advisory Council.

B. Solicit and encourage the remarks of the resource person in attendance.

2. (Continued)	His or her involvement during the role-playing situation should also be encouraged. He may wish to act as a mock consultant. C. From the above information have the class member develop a suitable answer to the question.
3. What are the different ways that a consultant may be utilized?	<u>Suggested solutions</u> A. The consultant may analyze the problem for you and advise you as to what to do about the problem. B. The consultant may sit down with you and help you analyze the problems and help you determine alternative solutions for your selection. C. The consultant may supply you with technical knowledge and evidence to assist in selection and implementation of your selection solution alternative. D. The consultant may supply several alternative solutions for your selection and implementation. E. F. <u>Suggested technique</u> A. Continue the role-playing situation developed in anticipated problem number 2. Direct the roles to attempt to generate differing methods whereby consultants may be utilized. B. Have the professional or lay consultant in attendance talk formally with the class in regards to his or her methods of consulting. C. From the above information have the class members develop a suitable answer to the question.

4. What arrangement should be made for "permanent" consultants?	<u>Suggested solutions</u> "Permanent" consultants should be those who are ex officio members of the Citizens' Advisory Council, and who advise when called upon or upon observing a questionable activity. "Permanent" consultants should be part of every special study group to assist in clarifying terminology and to effective actions taken by the group. Examples of "permanent" consultants include school board members, school administration members, instructional faculty members, and educational service region personnel. <u>Suggested techniques</u> A. Have the class members read page of the recommended resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. B. Solicit and encourage the remarks by the resource person in attendance. C. From the above information have the class members develop a suitable and satisfactory answer to the question.
5. Who may serve as a Citizens' Advisory Council consultant?	<u>Suggested solution</u> Anyone whose services and expertise are needed by a Citizens' Advisory Council may serve as a consultant. Often times, effective lay consultants may be obtained from neighboring Citizens' Advisory Councils. Such people are usually well aware of such situations and have spent considerable time working on the specific problem. School personnel may also serve as temporary or permanent consultants. Several state institutions of higher learning foster and encourage their staff to serve in such consultation services.

5. (Continued)	<u>Suggested techniques</u> A. Have students review page 11 of the recommended resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. B. Foster and encourage the class members to enter into a discussion of how different people within a community could serve as consultants for differing problems. C. From the above information, have the class members develop a suitable answer for the question.
6. What are some potential sources of consultants?	<u>Suggested solutions</u> A. Local school. B. Local Community. C. Neighboring Citizens' Advisory Councils. D. Neighboring Communities. E. Area Vocational Center. F. Local Educational Service Region Office. G. Local Community Colleges. H. Other State Institutions. I. Office of the Superintendent of Public Instruction. J. K. L. (Other satisfactory answers may be added.) <u>Suggested techniques</u> A. Have students read page 28 in THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION.

6. (Continued)	B. Conduct a brainstorming session where class members may generate and subsequently evaluate various sources of consultants. C. Solicit and encourage the comments of the resource person in attendance. D. From the information generated above, have the class member develop a suitable answer for the question.
7. What about consultant's fees?	<u>Suggested solutions</u> Consultant's fees may vary from several hundred dollars to no charge whatsoever depending on the size and extensiveness of the problem. Local consultants such as school personnel are usually paid for by the school system. Consultants from the community and neighboring communities may charge for the expenses incurred in doing the consultation. Many institutions of higher learning have schedules for their faculty members. Charges to be made for the consultation service should be clearly stated and agreed upon before the actual consultation work begins. <u>Suggested techniques</u> A. Have students read the information presented in Appendix I. B. Request the remarks of the resource person in attendance. C. Have each class member contact a potential consultant or consultant firm to report their charges to the class as a whole. D. From the above information, have the students develop a suitable answer to the question.

<u>Suggested evaluation techniques</u>

1. Prepare, administer, and evaluate an objective examination based on the anticipated problems.

2. Observe and subjectively evaluate changes in student attitudes during the class session.

3. Request students' self-evaluation of their changes in attitude toward the value and use of consultants.

Recommended resource

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, 1963, p. 11. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois 61801; Price: 50¢).

References

American Vocational Association, The Advisory Committee and Vocational Education, Washington, D. C., 1969, p. 28. (Source: Publication Sales; American Vocational Association; 1510 H. Street, N.W.; Washington, D. C.; Price: $1.25).

King, Sam W., Organization and Effective Use of Advisory Committees. Washington, D. C.; U. S. Government Printing Office, U. S. Department of Health, Education and Welfare, Vocational Division Bulletin No. 288, 1968, p. 27.

Williams, Glenn D., "Guidelines for the Consultant," College-Community Consultation. Edited by Roger W. Axford. Dekalb: Enlightenment Press, Northern Illinois University, 1967, pp. 9-12.

APPENDIX I

PROPOSED POLICY

Remuneration for Consultative Services

The following statement is designed to outline in greater detail specific aspects of the noncredit policy dealing with consultative services.

Released time

The services of university staff members may be made available to area schools on a released time basis if departmental schedules permit. The local school system is expected to defray necessary travel and lodging expenses under this arrangement.

Extra pay

If no qualified staff member is available on a released time basis, the consultative service may be provided on an extra pay basis at the option of the school system making the request.

The school system, or other employing party, will enter into a contract with the university for the provision of the requested consultative service.

University staff members serving as consultants may be reimbursed in accordance with the following schedule:

¼ day or less	$15.00
½ day	25.00
3/4 day	40.00
over 3/4 day	50.00

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Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 2-B

Formation Procedures - Selection Committees

Produced by the

Rurban Educational Development Laboratory

Dr. Lloyd J. Phipps - Director
357 Education Building
University of Illinois
Urbana, Illinois 61801

Staff Assistants:

Richard Hofstrand W.E. Shipley

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Formation procedures (2)

Concern: Selection committees (B)

Objectives: After instruction, the student:

1. Identifies the functions of a selection committee member.
2. Identifies the steps in the selection and recruitment process.
3. Distinguishes the lines of authority and responsibility.

Possible Teaching Techniques:

1. Have an experienced local selection committee member or board of education member meet with, talk about, and discuss the concept of selection committees with the class. A local school administrator could be contacted to aid in identifying such a resource person.
2. Conduct a role playing situation where class members are assigned to roles as school board members, selection committee members, and Citizens' Advisory Council candidates. The role playing should include the entire process from selection committee appointment to Citizens' Advisory Council member determination.
3. Foster and encourage class discussion of the Anticipated Problems.
4. Have each student prepare a directive to establish and instruct a selection committee.
5. Have each student develop a list of organizations and bodies within the communities. Examples include: Churches - Jewish, Catholic, Mormon, Methodist, and others; vocational areas - production agriculture, retail, manufacturing, and others; Fraternal organizations; and others.

6. Have each student outline a procedure for contacting Citizens' Advisory Committee member candidates.
7. Have each student develop an appointment letter for contacting successful candidates.
8. Have the class observe a selection committee meeting to observe activities and observations.
9. Have the class, as a whole, act as a selection committee culminating in a codified list of potential candidates.

Suggested audio-visual aids:

A chalk board should be used to list the important points from the resource people and class discussions.

Anticipated Problems and Concerns	Guides to Solutions & Sample Teaching Techniques
1. What is and what are the functions of a selection committee?	A selection committee is a relatively small group of conscientious citizens who are asked, by the school board or other sponsoring agency, to select nominations for possible Citizens' Advisory Council members. The selection committees have 2 basic functions. They are to: (1) secure nominations for membership in the local Citizens' Advisory Council. (2) screen nominees to produce the kind of committee designated by the sponsoring agency.

1. (Continued)	Suggested Techniques: (A) Have class members read pages 11 and 12 in the Recommended Resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. (B) Request comments on the Anticipated Problem from the resource person in attendance. This resource person may be from a selection committee, board of education, or other agency. (C) Foster and encourage a class discussion of the above information to develop a suitable answer to the question.
2. How should citizens' Advisory Committee candidates be selected?	The selection committee may be charged with the responsibility of selecting candidates that will produce a "representative" council. The selection committee needs to create a list of possible candidates. These possible candidates should be contacted personally by a member of the selection committee to determine if the individual is willing to serve. Having determined a list of legitimate candidates, the selection committee must screen and select individuals which will produce a balanced or representative council.

2. (Continued)	<u>Suggested Techniques</u>: (A) Have the class members read pages 12-16 of the Recommended Resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. (B) The material in Appendices I, II, & III should be presented for the student's use. This presentation may be made through duplication or projection of the material. (C) Have the class members read pages 13-17 in ORGANIZATION AND EFFECTIVE USE OF ADVISORY COMMITTEES. (D) Have the class members read pages 24-30 in THE ADVISORY COMMITTEE AND VOCATIONAL EDUCATION. (E) From the above information, have the class develop a satisfactory answer to the question.
3. What is meant by "representative" membership?	"Representative" membership is that membership which represents or attempts to represent the whole community. Every community has many different dimensions. These dimensions include ages, locales, occupations, industries, fraternal groups, religious groups, and many others. The selection committee should attempt

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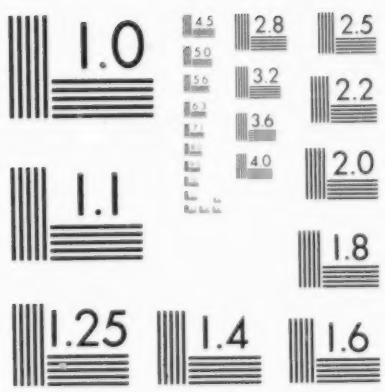

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

3. (Continued).	to include a cross section of the community to insure representiveness. Representation should also include those who are unfavorable to the existing school program. Suggested Techniques: (A) Have students read pages 11 & 15 of the Recommended Resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. (B) Conduct a brainstorming session to identify the many various dimensions and facets of a local community. Spontaneous student involvement for a very short period of time will facilitate the session's success. All responses by the group should be recorded on the chalk board for later use. (C) From the above information, have the class members develop a satisfactory answer for the question.
4. How large should a Citizens' Advisory Council be?	The answer to the question is usually determined by a balance between (1) sufficient number to make the Citizens' Advisory Council representative, yet (2) small enough to facilitate effective council meetings. Citizens' Advisory Councils that are too large will sometimes become bogged down due to the sheer number of participants.

4. (Continued)

Several other criteria may be used also. Some consultants recommend the selection of between 12-15 members. This does not mean, however, that 15 citizens is the limit to be involved in the actions of a Citizens' Advisory Council. Many more citizens may be involved in sub-committees and special study committees. The total goal of involved citizens may be expressed as one percent of the eligible voting citizens in the community.

(A) Have the class members review pages 11-16 of the Recommended Reference entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION.

(B) Have the class members read pages 23-24 in ORGANIZATION AND EFFECTIVE USE OF ADVISORY COMMITTEES.

(C) Solicit the comments and remarks of the resource person in attendance as to the question under consideration.

(D) From the above information, have the class members develop a satisfactory answer for the question.

5. How and to whom should a selection committee announce its results?	The selection committee should prepare several listings of proposed Citizens' Advisory Council memberships. Each individual listing should be representative of the community, and should be able to serve as a Citizens' Advisory Council member. The selection committee should present these listings to the sponsoring agency (usually the board of education). The sponsoring agency must then select one of the lists to serve as the Citizens' Advisory Council. The sponsoring agency should not select individual members from the different lists as this will void the efforts to insure representativeness by the selection committee. <u>Suggested Techniques</u>: (A) Solicit and encourage the comments and remarks by the resource person in attendance, Comments should be in regard to the question under sonsideration. (B) Through the efforts of the resource person and a class discussion, a satisfactory answer should be developed for the question.

6. How should prospective and successful candidates be contacted and announced?	After the nominations have expressed their willingness to serve on the Citizens' Advisory Council, the successful candidates must be contacted. The most effective way of contacting is through a formal letter from the selection committee acting on behalf of the school board. <u>Suggested Techniques</u>: (A) Before class starts, have each class member prepare a letter that could be used to inform a successful candidate of his or her membership. These letters may be discussed in detail during the ensuing class session. (B) Have students read the information presented in Appendices I, II and III of this unit. (C) Have the students study the proposed letter as shown on page 13 of ADVISORY COMMITTEES FOR HOME ECONOMICS. (D) Have the students read the pamphlet entitled THE VOLUNTEER IN VOCATIONAL EDUCATION.

6. (Continued)	(E) From the above information, have the students prepare several examples of satisfactory letters to announce successful membership.
7. Should a selection committee be temporary or continuous?	Selection committees should generally be considered to be a continuous committee. Although their functions are cyclic, they must be available to suggest replacement members for those leaving the Citizens' Advisory Council. Furthermore, the selection committee should be responsible to the school board for the evaluation of the selection process undertaken. <u>Suggested Techniques</u>: (A) Have students review pages 9-16 of the Recommended Resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. (B) Develop two panels of students. Have one panel serve to encourage the use of temporary selection committees. The other panel should serve to encourage the use of continuous selection committees. The advantages and disadvantages of each type should be listed on a chalk board as they are brought out by the two panels.

7. (Continued)	(C) From the evaluation of those factors listed on the chalk board from the above techniques, have the students develop a satisfactory answer to the question.

Suggested Evaluation Techniques, the instructor may:

1. Subjectively observe the written assignments produced by class members.
2. Observe class members' functioning within the mock selection committee exercise.
3. Request written self-evaluation from each student as to his or her accomplishments within the class.

Recommended Resource:

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, Urbana; 1963, pp. 9-16. (Source: REDL; 357 Education Building, University of Illinois, Urbana, Illinois; 61801. Price 50¢).

References and Sources:

_____, Advisory Committees for Home Economics, Terre Haute, Indiana: Vocational Instructional Materials Laboratory, 1969, p. 13. (Source: Vocational Instructional Materials Laboratory; Department of Vocational/Technical Education; Indiana State University; Terre Haute, Indiana; 47801. Price - unspecified).

American Vocational Association, The Advisory Committee and Vocational Education, Washington, D.C., 1969, pp. 24-30. (Source: Publication Sales; American Vocational Assn.; 1510 H. St., N.W.; Washington, D.C. 20005; Price $1.25).

Burt, Samuel M. The Volunteer in Vocational Education, 1969, pp. 13-17. (Source: W.E. Upjohn Institute for Employment Research; 300 South Westnedge Ave.; Kalamazoo, Michigan; 49007. Price - 35¢).

Illinois State Board of Vocational Education and Rehabilitation, Advisory Committees - Organization and Use in Vocational and Technical Education, Springfield, 1968, pp. 3,4, & 7. (Source: Illinois State Board of Voc. Educ. & Rehabilitation; 405 Centennial Building; Springfield, Illinois, 62706; Price: Free).

King, Sam W. Organization and Effective Use of Advisory Committees. Washington, D.C.; U.S. Department of Health, Education and Welfare, 1968, pp. 13-17.

Phipps, Lloyd J. and Knell, Kenneth, The How of Successful Citizen Advisory Committee Operation, University of Illinois, Urbana, 1968, A Appendix Ex 1-2, Appendix F 1-3, and Appendix H. (Source: REDL - see address on cover; Price: 75¢).

_____, Some Ideas about Recruiting (no date), Citizens Committee for the Public Schools. (Source: See Appendix II or contact Citizens Committee.)

_____, The Care and Treatment of Volunteers, (no date), Citizens Committee for the Public Schools. (Source: See Appendix III or contact Citizens Committee for the Public Schools, Inc.; 2 West 45th Street; Room 1201; New York 36, New York; Cost: unknown).

_____, Why A Citizens' Committee Must be Representative, 1962, Citizens Committee for the Public Schools. (Source: See Appendix I or contact Citizens Committee for the Public Schools, Inc.; 2 West 45th Street; Room 1201; New York 36, New York; Cost: Unknown).

APPENDIX I

WHY A CITIZENS' COMMITTEE MUST BE REPRESENTATIVE

Because:

Good Leadership

- Dies off
- Is siphoned off by other organizations
- Loses interest when it's not stimulated by other points of view
- Becomes sterile when it spends too much time talking to itself even about matters of vital concern
- Stops learning because everything is already "decided"

The Community

- Respects the attitudes of its natural leadership groups and wants their point of view on record
- Changes constantly so that new natural groupings and new leaders are developed
- Has all the natural frailities of any group of human beings and is suspicious of eggheads, low brows, extremists, middle of the roaders, fence sitters and banner wavers

The Citizen

- Wants to be able to identify with someone in the group
- Wants a chance to have his ideas explored
- Wants opportunity to work on something interesting to him
- Resents being told but wants a chance at doing some telling himself

The Board of Education

- Is elected to represent all of the people in the school district and can't listen only to the views of a few people or minority
- Labels as "radical" ideas presented by narrow-based groups with an axe to grind
- Resents being accused of knuckling under to pressure groups
- Suspects the validity of studies made by homogeneous groups representing one point of view even when they are demonstrably good studies
- Is reluctant to use an idea unless it can be shown to have widespread community support
- Can't rely on expanding relationships with a group whose leadership may be subject to the ills outlined above
- The Board wants continuing interest, help, awareness, reliable channels through which to communicate and to hear

The Administration

- With its first responsibility to the Board of Education and the children of the district is subject to the same hesitations as the boards of education, suffers more of a setback when supposedly representative groups lead planning astray

REPRESENTATIVENESS doesn't necessarily mean large numbers -- the quality is important too. Does your committee represent not only the geographic, ethnic, religious, socio-economic patterns but the talents, ideas, skills and abilities inherent in your community? Does your committee need new light on old problems? Get the points of view of those opposed: They'll make you think, realign your ideas, marshall your facts, seek further data to refute charges, express yourself clearly in words that convey your meaning to everyone, not just to the initiated.

Source: New York State Citizens Committee for the Public Schools, Inc., 2 West 45th Street, Room 1201, New York 36, New York.

APPENDIX II

SOME IDEAS ABOUT RECRUITING

There is no substitute for face to face communications

So when you go to see him:

Arm yourself with a clear idea of your program and purposes and go with a specific job in mind.

Have conviction about the citizens committee purpose, program and process and convey your conviction to the prospective member.

Take with you any written material you have, but don't rely on the printed word to sell the idea.

Talk about the job, let your prospect catch fire from your enthusiasm.

Be honest about the amount of time and work the job entails. (Too often we snare the half-willing, too-busy person by saying "There's really nothing to it," when we expect a lot of time and talent and effort.)

Be honest about the kind and quality of help the citizens committee can provide to do the job. If special resources are needed, be specific about materials and personnel.

Don't promise the unattainable. (People like Dr. Conant seldom have time to work with a local citizens' committee studying local transportation problems.)

YOUR REPRESENTATIVE MEMBERSHIP

A major job of citizens' committees working for and with their public schools is getting and keeping active members who represent the total community. As in all voluntary agencies, the job may be not where to get them, but how to keep them.

How long a volunteer stays with you and how effective he is depends in large measure not only on his personal interest in better schools but on the way he is recruited and oriented to the program and the way of working of your citizens' committee.

Source: New York State Citizens Committee for the Public Schools, Inc., 2 West 45th Street; Room 1201, New York 36, New York.

APPENDIX III

THE CARE AND TREATMENT OF VOLUNTEERS

Once you have him, treat him well and he'll be a source of inspiration and joy forever.

A FEW SUGGESTIONS

Keep an up to date membership file. Cards are easy to work with, but a loose leaf notebook will do as well, if you allow a full page for each member. Head the page with the name, address and telephone number.

Jot down the member's talents, abilities and his IDEAS for future work

Make a note of other affiliations, service clubs, business, social agencies, etc., and note the times when these call upon all of his spare time and energy.

Record items about his family: does his wife (or her husband) want to work with him, does he have school age children, and if so, what ages.

Remember his special educational interests -- the committee may decide to look into a related subject at some future date.

If he says NO to a job, respect his decision and write it down. He may very well say YES to something else.

A few techniques:

Keep in touch

Find out how he's doing without "checking up on him"

Offer help, ideas, encouragement

Report to him about other activities of the committee

Listen when he tells you something

Act on his suggestions and let him know what has been done about them and the results of his idea

Communication is a two way street. Listening is as large a part as talking.

Remembering and understanding are part of listening.

Source: New York State Citizens Committee for the Public Schools, Inc., 2 West 45th Street, Room 1201, New York, New York.

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 2-C

Formation Procedures - Charters, Philosophies & Constitutions

Produced by the

Rurban Education Development Laboratory

Dr. Lloyd J. Phipps - Director
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Urbana, Illinois 61801

Staff Assistants:

Richard Hofstrand W. E. Shipley

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Formation procedures (2)

Concern: Charters, philosophies, and constitutions (C)

Objectives: After instruction, the class member:

1. Recognizes or generates the purpose(s) for a charter, philosophy and constitution.
2. Recognizes or generates the major parts of a charter, philosophy, and constitution.
3. Recognizes or generates the inclusions generally considered important in the above documents.

Possible Teaching Techniques:

1. Have each class member prepare a mock sample of each document.
2. Have the class members critique the sample documents prepared by other class members.
3. Provide several samples of charters, philososphies, and constitutions for individual perusal.
4. Encourage and foster group discussion of the Anticipated Problems.
5. Have a local senator or representative talk to and discuss with the class members the importance and major aspects of charters, philosophies and constitutions.
6. Have a local Citizens' Advisory Council member or school board member talk to and discuss their experiences in preparation and use of such documents with the class members.

Suggested Audio-Visual Aids:

1. Duplicate and distribute sample copies of charters, philosophies, and constitutions. Samples are shown in the Appendices.
2. Render documents useful for use with an overhead, opaque, or 35mm. projector.

Anticipated Problems and Concerns	Guides to Solutions and Sa ple Teaching Techniques
1. What is a charter or resolution, and why is it important in the effective use of a Citizens' Advisory Council?	Suggested Solutions: A charter or resolution is a document drafted by the sponsoring agency of a Citizens' Advisory Council to authorize the formation and operation of a Citizens' Advisory Council. A Charter or resolution is important as it authorizes the existence and operation of the Citizens' Advisory Council. Suggested Techniques: (A) Have the class members read pages 24-29 of the Recommended Resource entitled CITIZENS PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. (B) Have the class members look through the information included in Appendices I, II, and III. (C) Solicit and encourage discussion of the question by the resource per[illegible] in attendance.

1. (Continued)	(D) From the above information, have the class members develop a satisfactory answer for the question.
2. Who should prepare and what should be included in a charter or resolution?	<u>Suggested Solution</u>: A charter or resolution should be prepared by the sponsoring agency. This is usually the board of education. Others, such as the administration, may prepare the document for the boards ratification. A Charter or resolution should contain: A, The name of the organization or body who is authorizing the Citizens' advisory Council formation. B. Proposed purposes for formation of a Citizens' Advisory Council. C. Proposed activities and operational guidelines for a Citizens' Advisory Council. D. Authorization and appointment of a selection committee. E.Guidelines and membership directives for the selection committee's use. F. Proposed organizational and operational structure for the Citizens' Advisory Council. G. H.

2. (Continued)	I. J. (Other satisfactory items may be added as they are brought out in class discussion.) Suggested Techniques: (A) Have each class member prepare a list o of items that should be included in a charter. (B) Have each class member prepare a mock charter. (C) Have the class members review pages 24-29 of the Recommended Resource entitled CITIZEN PARTICIPATION IN LOCAL POLICY MAKING FOR PUBLIC EDUCATION. (D) Have the class members review the information given in Appendices I, II, and III. (E) From the above information, have the class members prepare a satisfactory answer for the question.
3. What is a philosophy of Education, and why is one important to the development and operation of an educational program?	Suggested Solution: A philosophy of education is a statement of the educational beliefs and value decisions of a school board, Citizens' Advisory Council, or other body.

3. (Continued)	A philosophy is important as it makes public the overall educational beliefs and attitudes of the educational body. From the determination of the philosophy, subsequent decisions concerning the educational program may be made which will reflect the community's value structure and system. Suggested Techniques: (A) Have the class members prepare a philosophy for their own individual lives. (B) Have the class members individually prepare mock philosophies of education. (C) Solicit and encourage the verbal involvement of the resource person in attendance. (D) From the above information, have the class members develop a satisfactory answer for the problem.
4. What is a constitution and by-laws, and why are they important to the operation of a Citizens' Advisory Council?	Suggested Solution: A constitution and by-laws set out the organization, rationale, and operation procedures for an organization. A constitution usually closely follows the contents of a charter and philosophy.

5. What should a constitution and bylaws contain, and who should prepare these documents?

Suggested Solution:

Preparation of the constitution and bylaws usually is a joint effort between the Citizzens' Advisory Council and the school board. A constitution and bylaws should contain:

A. Definition of the organization.

B. Definition of those involved in the organization.

C. Expressed purposes for the organization.

D. Organizational structure

E. Administrative structure.

F. Operational guidelines.

G. Meeting mechanics guidelines and rules.

H.

I.

J.

(Additional satisfactory answers may be added as identified.)

Suggested Techniques:

(A) Have each class member prepare a listing of what a constitution and bylaws should contain.

(B) Have each class member prepare a mock constitution and bylaws.

5. (Continued)	(C) Have each class member obtain a constitution and bylaws from an organization. These samples may be brought into class and discussed as to their format application for Citizens' Advisory Council. (D) From the above information, have the class members as a whole, prepare a constitution and bylaws for a local Citizens' Advisory Council.

Suggested Evaluation Techniques:

1. Collect and subjectively evaluate the mock documents prepared by the class members.
2. Develop, administer and evaluate an objective test on the material covered.
3. Request a written self-evaluation by each student based on the course objectives and anticipated problems.

Recommended Resources:

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, Urbana, 1963, pp. 24-31. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois, 61801; Price 50¢)

References and Sources:

King, Sam W. Organization and Effective Use of Advisory Committees. Washington, D.C.: U.S. Government Printing Office, 1969, Vocational Division Bulletin #288, pp. 27-8, 32-3.

Phipps, Lloyd J. Handbook on Agricultural Education in Public Schools. Danville, Illinois: Interstate Publishers, 1965, pp. 52-6, (Cost - $9.75).

Phipps, Lloyd J. and Knell, Kenneth, The How of Successful Citizens' Advisory Committee Operation, University of Illinois, Urbana, 1968, Appendix F, p.2 and Appendix I, p. 1-3. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois, 61801; Price 756).

APPENDIX I

W H Y A CONTINUING CITIZENS' COMMITTEE:

Advisory committees considering the question of becoming permanent citizens' committees may find the report of the Yorktown Heights, New york, Citizens' Advisory Committee useful. The NYSCCPS realizes that no one kind of organization suits all communities, but reproduces this report for your consideration in studying this problem.

As requested by the Committee, an Ad Hoc committee was formed to consider the advisability of establishing a permanent Citizens' Advisory Committee on Education in Central School District #2, Yorktown, New York. After due consideration of the question, the Committee reached the following conclusions:

1. The Citizens' Advisory Committee for the new High School shall recommend that the Board of Education approve the formation of a permanent Citizens' Advisory Committee on Education.

2. The purpose of this Committee shall be to further the cause of education in the district by assisting the Board and the administrators in arriving at the best possible solution to our educational problems.

3. Membership on this Committee shall be open to all adults in District #2 on an individual basis.

4. This Committee shall make every effort to insure that its membership be truly representative of the entire District.

5. A Committee of this type would offer the following advantages:

   A. It facilitates communication between the board and the taxpayers.

   B. If properly organized, it can be a true cross section of the community and thus be a reliable source of "public opinion."

   C. It provides the board and administrators with access to special talents for studies and investigations, which if conducted by board members would be extremely burdensome and time consuming.

   D. It provides a means of reconciling conflicting views.

   E. It provides a training ground for prospective board members.

Source: NEW YORK STATE CITIZENS' COMMITTEE FOR THE PUBLIC SCHOOLS, INC.
2 West 45th Street, New York 36, New York.

APPENDIX II

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SAMPLE CHARTER FOR A CITIZENS'ADVISORY COMMITTEE

I.
NAME

The Committee will be called the Citizens' Advisory Committee of _____ School.

II.
PURPOSES

The Committee is constituted to:

A. Assist the Board of Education in developing broad educational policy for the school system.
B. Work with the employees of the school system, with the Superintendent's approval, in ways agreeable to all concerned, in planning and conducting the program of the school system.
C. Facilitate communication and cooperation between the school system and the citizens, organizations, and institutions of the District.

III.
NATURE OF POLICY AND POLICY DEVELOPMENT

A. Policy is officially enacted by the Board of Education. The Board cannot legally surrender its responsibilities for the enactment and execution of school policies. In addition to enacting and executing its own policies, it must execute the laws of the State of Illinois that apply in the District. It abdicates none of its authority in creating a citizens' advisory committee.

B. Policy development is understood to be the process whereby policy is prepared for enactment by the Board of Education. Suggestions for school policy may come from any source. The Citizens' Advisory Committee may originate policy proposals and may review proposals from other sources.

C. School policy is understood to comprise the answers to the questions about the purposes and the management of the school system which only the citizens of the District or their authorized representatives can answer. These questions are of the following types:

1. How is the process of policy development to be organized and conducted?
2. Who are the clientele of the school system and how, in general, is each element in the clientele to be served?
3. For what purposes is the public conducting the school system?

4. How are the people of the District to determine whether these purposes are being accomplished?
5. What ways and means must the people of the District provide if the public purposes of the school system are to be accomplished?

   a. How is the program of the school system to be planned?
   b. How are adequate professional and non-professional staffs to be provided, retained, and improved?
   c. How is the school system to be organized and administered?
   d. What funds are required and how are they to be raised?
   e. What facilities (buildings, equipment, library, teaching aids) are to be provided?

IV.
TENURE AND FIELD OF THE COMMITTEE

A. The Citizens' Advisory Committee and any committees affiliated with it will continue as school sponsored committees until the committee is dissolved by a majority vote of the members of the Board of Education. The Board reserves the right to reorganize the Committee if it judges that its functions would be better performed if a different organization were provided.

B. The Committee will concern itself only with matters directly related to the school system.

C. The Committee will promote in the District the adoption of its proposed policy and plans for the school system only with specific authorization by the Board of Education.

V.
MEMBERSHIP

A. The Committee will include approximately 30 members.

B. The original members of the Committee will be those who have served in 1955 as members of an advisory committee.

C. Persons to fill vacancies in committee memberships which may occur during 19___ and 19___ will be recommended to the Board by the Selection Committee.

D. The original members of the Committee will serve for one year, after which they will determine by lot equal numbers of the members who will serve for one, two, or three additional years. New members with three-year terms will begin to replace the original members at the beginning of the third year the Committee is in operation.

E. Beginning in 19___, and each third year thereafter, the Board will name a selection committee to serve for three years in recommending to the Board persons to replace the members who terms will expire and others who may be required to fill vacancies in the membership.

F. Appointments to the Committee will be made by the Board of Education but no one will be appointed who has not been nominated by aelection committee. Resignations of members of the Committee will be received by the Board.

G. A representative of the Board of Education, the Superintendent, and a representative of the teachers chosen by them will meet regularly with the Committee without voting privileges. The Board member and the teacher representative will be chosen annually, but neither shall serve for more than three consecutive years.

VI
SELECTION COMMITTEE

A. Each selection committee will include approximately 15 members, who are highly respected in the District, and who represent as well as possible all elements in the District.

B. In preparing a slate of new members to be presented to the Board, a selection committee will:

1. Consult with a large and representative part of the citizens of the District by whatever means it may devise to secure their suggestions for membership in the Committee.

2. Screen the names suggested by representative citizens and add other names if desired.

3. Recommend to the Board prospective members of the Citizens' Advisory Committee who are:

   a. Capable of and like to be interested in the work the Committee will do -
   b. Able to work cooperatively and constructively with others; their fellow members, the Board of Education, the staff of the school system, and their fellow citizens who are not officially connected with the schools -
   c. Representative of the people of the District in such respects as geographic location, sex, age, schooling, occupation, race, nationality background, membership in the organizations and institutions of the District.

(The Advisory Committee should include parents and non-parents, persons favorable to and critical of current school policies, large and small taxpayers, new and old residents of the District. In all of these respects, and in others that a selection committee may think important, the numbers included in the Citizens' Advisory Committee should correspond to the number of their kind in the District. No one is to be included because he is an officer or a professional executive of an organization or institution. None is to be considered the representative or spokesman of any organization, institution, faction or element in the District.)

C. In recommending persons to fill vacancies in the Citizens' Advisory Committee, a selection committee will consider the personnel of the entire committee and will seek to choose replacements who will help in maintaining the representative character of the Committee.

D. Members of a selection committee may be recommended as members of the Citizens' Advisory Committee.

E. A selection committee will recommend to the Board one person for membership in the Citizens' Advisory Committee for each position to be filled. It will prepare for its own uses a list of alternates who may be recommended to the Board if nominations by the selection committee are not approved by the Board or if those chosen do not accept membership.

F. Appointments to fill vacancies on the selection committees will be made by the Board of Education.

VII
ADVISORY COMMITTEE PROCEDURES

A. The Citizens' Advisory Committee is to organize itself in its own way, determine the frequency and nature of its meetings, choose its officers, provide for sub-committees and affiliated committees, and decide upon the problems it will study and the activities in which it will engage within the field indicated by this Charter.

B. The Committee is expected to add affiliated committees and to involve in its work many more citizens than are included in the central committee. Affiliated committees may be named to deal with the problems of the District, the attendance areas, the high school departments, and the Division of Adult Education.

C. In performing its duties, the Committee is expected to conduct careful fact-finding studies and to use consultants (who are approved by the Superintendent) from the school staff, the District, and sources outside the District.

D. The school system will provide for the Committee assistance by its professional and non-professional staffs, mimeographing and printing services, consultant service, publications, and other aids to the work of the Committee to the extent that resources permit without damage to the current school program. The Committee is asked to submit to the board in October of each year an estimate of its requirements of funds and personal services for consideration in planning the budget for the ensuing year.

E. The Board of Education and the Citizens' Advisory Committee may originate policy proposals jointly or individually. The Board may seek advice from the Citizens' Advisory Committee concerning policy that has originated with either the Board or the Citizens' Advisory Committee.

F. Special, joint meetings of the Board and the Committee will be held when these meetings are desired by both groups.

G. Minutes of the meetings of the Citizens' Advisory Committee, any sub-committee or special reports shall be available to each member of the Committee and to each of the Committee's regular consultants, and to the Board of Education, upon request. Minutes of sub-committee meetings do not need general distribution to all committees but sub-committees should report to the Committee of the Whole once every two months either by oral or written report, and these reports should be incorporated into the minutes of the Citizens' Advisory Committee.

H. Minutes of the meetings of the Board of Education are available to any citizen of the District in the office of the Board of Education.

I. The Committee may may initiate studies of special interest to a majority of the group as well as study and recommend problems suggested by the Board of Education.

J. The Committee may recommend policy for the school personnel, but it is never to consider the emplyment, promotion, transfer, dismissal, or salary of an individual employee.

K. All reports and recommendations of affiliated committees will be cleared by the central committee before they are submitted to the Board of Education or publiciz ed in the District.

L. It being understood that all formal publicity regarding the Committee and its work will be released by the Superintendent.

M. The Committee, as such, will never recommend or endorse candidates for the Board of Education.

N. The members of the Committee are expected to interest in and inform about the work of the schools the individuals and organizations with whom they normally have contacts and to receive from them suggestions for the improvement of the schools. They may properly seek counsel from ot others in the District regarding proposals before the Committee, though the Committee as a whole and its affiliated committees will promote in the district no proposals for policy changes without authorization by the board of Education.

O. The Board of Education may request the services of the Committee in publicizing in the District policy proposals to which the Committee and the Board have agreed.

P. The Board of Education may submit for community consideration policy proposals which have originated in the Committee.

APPENDIX III

Citizens Advisory Committee

CHARTER

The following policies are proposed for adoption by a board of education in creating a district-wide citizens' committee with affiliated committees. A different set of policies would be required if only special committees reporting to a board of education were used.

1. Purpose. The purpose of a citizens' committee is to improve the education of the children, youth, and adults and thereby to develop more useful citizens and to enrich the lives of the people.

2. Ways in Which the Committee is Expected to Contribute to This Purpose.

   a) To study the problems of public education in the district which are properly the concern of the layman, rather than of professional people, and to report the findings of studies to the appropriate persons or groups within the school system.

   b) To advise the Board of Education in developing and revising official policies for the district.

   c) To counsel and work with the employees of the Board of Education in whatever ways are mutually satisfactory to the Committee and to the employees and in keeping with the provisions of this charter in planning and conducting educational programs under Board of Education policies.

   d) To promote two-way communication between the public and the officials and employees of the school district.

   e) To facilitate co-operation in educational affairs between the schools and the organizations and institutions of the district, to extend the use of community resources by the schools, and to increase the proper use of the schools, their staffs, and their facilities by the people of the district.

3. The Legal Status of the Board of Education. The Board of Education is the legally constituted authority over the public schools of the district. It cannot legally surrender any of its powers and responsibilities. It abdicates none of its authority in creating a citizens' committee.

4. Tenure of the Committee. The Citizens' Committee herein created and any committees affiliated with it shall continue as school sponsored bodies until the Committee is dissolved by a mutual agreement of the board of education and the committee.

5. Field of the Committee. Since the public schools exist only for public education, the Committee will concern itself only with the education of the public through the public schools and with matters directly related to it. The Committee and its affiliated committees are primarily study and planning committees, advisory to the Board and its employees. They will promote their ideas and plans in the school and community in conjunction with the Board of Education.

6. Affiliated Committees. The Committee is authorized and encouraged to create affiliated committees as needed for:

   a) Attendance areas within the district.

   b) Important and continuing interests of the schools, such as citizenship education, vocational education, efficiency, finance, and teacher welfare.

   c) Special problems of a temporary nature, such as constructing buildings, adapting to special measures for national security, or planning a system of pupil transporation, etc.

   All committees created by the Citizens' Committee shall be and remain affiliated with the Citizens' Committee. Each affiliated committee shall be given by the Citizens' Committee a definitely prescribed field within the total field of the Citizens' Committee in which it is to operate. Affiliated committees may be created to serve for a definite period or to continue indefinitely with rotation of memberships. Affiliated committees may or may not include members of the Citizens' Committee. The Superintendent of Schools, or his representative, or a member of the Board shall be available as a consultant, with each affiliated committee. Administrators, teachers, non-academic employees, and students, as well as laymen, may be members of affiliated committees. It will usually be advisable to include more laymen than others. The members of some affiliated committees may be chosen primarily because of their expertness in a particular field, rather than because they are representative of the citizens of the district.

7. Membership in the Committee.

   a) The Committee shall include 55 members. Any number of persons may be included in committees constituted by the Citizens' Committee.

   b) The original members of the Citizens' Committee shall be recommended to the Board of Education by a selection committee, named by the Board.

   c) The Selection Committee shall include no fewer than seven members. More than one-half of the members of the Selection Committee shall be citizens who are not associated with the schools as members or employees of the Board of Education. The Selection Committee shall include a member of the Board of Education, the Superintendent of Schools, and one or more other school employees, chosen by the employees they represent.

d) In preparing a slate of members of the Citizens' Committee to present to the Board of Education, the Selection Committee shall:

1) Consult with a large and representative part of the citizens of the district by whatever means it may devise to secure their suggestions of persons to be considered for membership in the Citizens' Committee.

2) Screen the names suggested by representative citizens, taking into account:

(a) the general ability of the persons suggested and the keenness and clarity of their thinking
(b) the respect in which they are held by their fellow citizens
(c) their ability to work constructively with others
(d) their insight into and interest in public education, and
(e) other items considered by the Selection Committee to be important.

e) The total group selected shall be as representative as possible of all of the citizens of the district in such respects as:

1) Geographical distribution within the district
2) Sex
3) Age
4) Years of schooling
5) Occupation
6) Race and nationality backgrounds
7) Social class
8) Political, religious, and social affiliations
9) Membership in organizations

f) It shall include:

1) Parents and non-parents
2) Persons favorable to and critical of current school policies
3) Large and small taxpapers
4) Owners and non-owners of homes, farms, and businesses
5) Old and new residents of the district.

g) In all of these respects and in others that the Selection Committee may consider important, the number recommended for the Citizens' Committee shall be roughly relative to the number of their kind in the district.

h) No person recommended for membership in the Citizens' Committee is to be considered the representative or spokesman of any particular organization, faction, or element in the district. Individuals are to be recommended, each of whom has contacts with a variety of organizations, factions, and elements so that, taken

together, the members of the Committee have means of first-hand communication with all of them. No one is to be recommended because he is an officer or a professional executive of any organization or institution. In general, persons of this type will not be recommended unless they are known for their broad interests in the community and are regarded primarily as citizens rather than representatives of agencies.

i) Members of the Selection Committee may be recommended to be members of the Citizens' Committee.

j) The Selection Committee shall recommend to the Board of Education the exact number of persons to be included in the Citizens' Committee. The Board retains the privilege of asking for additional names if those first submitted are not wholly satisfactory.

8. Terms. The terms of the original members of the Citizens' Committee shall be for one year. At the end of the first year, equal numbers of the members will draw lots for terms of one, two, and three years in order to provide a systematic rotation of members. New members with three-year terms will replace the original members, beginning in the third year. A member will not be eligible for reappointment until one year after his term has expired.

9. Replacement of Members and Unexpired Terms. When members of the Citizens' Committee are to be chosen to replace those whose terms have expired, or when vacancies occur, the chair shall appoint a nominating committee of 5, which shall include a member of the Board of Education, to make recommendations to the Citizens' Committee for the filling of such vacancies.

10. Consultants. There shall sit regularly with the Citizens' Committee as consutants a representative of the Board of Education, chosen annually by the Board; the Superintendent of Schools; a teacher or principls chosen annually by the teachers and principals in the system; and a representative of the non-academic employees in the system, chosen annually by these employees.

11. Relationships of the Citizens Committee

a) To the Board of Education

1) The Board of Education may submit to the Citizens' Committee proposals regarding school policies to which the Committee is expected to react in oral or written reports to the Board

2) The Citizens' Committee may make policy recommendations to the Board of Education and will be apprised of the Board's reactions to these recommendations

3) Special joint meetings of the Board and the Citizens' Committee shall be held when these meetings are desired by both groups

4) Minutes of the meetings of the Citizens' Committee will be sent to each member of the Board of Education.

5) The Board of Education, the Citizens' Committee, and its affiliated committees will not engage in public controversies.

b) To employees of the Board of Education.

1) The Citizens' Committee or any of its affiliated committees may seek information and counsel from any employee of the Board of Education on matters clearly related to the problems on which these committees are working.

2) Any employee may, with the approval of the administrators under whom he works, including the superintendent of schools, request the assistance of the Citizens' Committee or an affiliated committee regarding any phase of his work.

3) Requests for affiliated committees for particular attendance areas or special fields or work may be initiated by indivdual employees or groups of employees and will be considered by the Citizens' Committee if approved by the administrative officer for the attendance area or field and by the Superintendent of Schools.

4) The Citizens' Committee and its affiliated committees may properly recommend regarding school policies for employee welfare, but they are never to consider the employment, promotion, transfer, dismissal, or salary of an individual employee.

5) In asking employees for data regarding the schools, account is to be taken of the time required to assemble these data and the other duties of these employees.

c) To the public

1) The Citizens' Committee is encouraged to promote the interest and participation in the schools of individuals not members of its network of committees and of organizations in the district. The committees herein provided are not to be regarded as substitutes for other forms of public participation in school affairs, but as means of providing a minimum of systematic, representative, and responsible public participation.

2) Each committee member is expected to do what he can to learn the ideas and attitudes about the schools of his associates in the district and to pass on to these associated information about the schools.

3) Publicity regarding the Citizens' Committee and its affiliated committees, dispensed through the press, and radio, printed and mimeographed statements, and other formal means of communicating with the public shall be arranged in conjunction with the Board of Education or its executive officer, the Superintendent of Schools.

4) The Board of Education may request the Citizens' Committee to designate individual members or groups of members to assist in publicizing and promoting in the district policies and proposals which have the joint approval of the Committee and the Board.

5) Recommendations of the Citizens' Committee may be released by the Board for public discussion either before or after action has been taken on them by the Board.

12. Organization of the Citizens' Committee.

a) The Citizens' Committee is to organize itself in its own way, determine the frequency of its meetings, conduct these meetings as desired, and work upon the problems it considers significant.

b) If the Committee desires, an executive secretary of the Committee, chosen by the Committee from the school staff, will be provided and will be given time for his work in this capacity, the amount of time to be agreed upon by the Committee and the school authorities.

c) The Committee is asked to submit annually for consideration as a part of the school budget, an estimate of its clerical expenses for the year.

d) At the end of each year of the life of the Committee, this charter shall be reviewed by the Committee and by the Board. Changes in it may be made by majority vote of the members of the Board. Recommendations of changes may originate in the Committee or in the Board. The Committee will be consulted regarding any proposed changes originating in the Board.

APPENDIX IV

CITIZENS' LAY ADVISORY COMMITTEE

OPERATING RULES

The following operating rules are proposed for adoption by the Citizens' Committee:

1. Officers and Committees

a) The officers shall be a chairman, a vice chairman, and a secretary, elected by the members of the Committee for one-year terms. These officers shall together constitute the Executive Committee

b) Committees for special purposes will be authorized by the Citizens' Committee as needed; will have their work outlined by the Citizens' Committee; and will report to the Citizens' Committee

1) Methods and Procedures concerning the Operation of Affiliated Committees of the Citizens' Advisory Committee

(a) Purpose: The purpose of creating special projects committees is to encourage a detailed study of a particular problem to assist the Lay Advisory Committee and the Board of Education in improving education throughout the school district.

(b) The legal status of the Board of Education: The Board of Education is the legally constituted authority over the public schools of the district. It cannot legally surrender any of its powers and responsibilities. It relinquishes none of its authority in creating a citizens' committee, or any of its affiliated or special projects committees.

(c) Tenure: Special Projects Committees will be terminated when the Lay Advisory Committee has accepted or rejected its findings, and/or it has been released by the Lay Advisory Committee.

(d) The field of the committee shall be limited to the subject assigned by the Lay Advisory Committee.

(e) Membership: Any number as named by the Lay Advisory Committee and who shall be residents of the school district shall make up the membership -- Lay citizens, school employees, and students may serve as members.

(f) Consultants: There shall sit regularly with the Special Projects Committee as a consultant, a representative of the Lay Advisory Committee, and the Superintendent of Schools or his representative. Also, specially qualified people such as employees of the school system and people of special competence both within and from outside the district may be called in for consultation.

(g) The Special Projects Committees shall meet with the Lay Advisory Committee for its initial meeting to learn of the scope of its problem and in the final meeting to explain the results of its written report.

(h) It shall be the province of Special Projects Committees not only to be fact finding bodies, but shall also offer any recommendations it deems proper to the Lay Advisory Committee.

(i) Each Special Projects Committee shall appoint its own chairman, and a secretary to keep minutes of its proceedings.

(j) The Special Projects Committees will not engage in public controversies, nor release any of their findings other than to the Lay Committee.

2. Meetings

a) Regular meetings of the Citizens' Committee will be held on the third Thursday of each month at the various schools from 7:30 to 9:30 p.m. Special meetings may be held or regular meetings may be cancelled by the Executive Committee or by vote of two-thirds of those present at a regular meeting

b) Discussion aimed at arriving at a consensus of the members shall be the prevailing procedure in the meetings. Parliamentary procedures will be used when it is the judgment of the group that a decision should be recorded or transmitted

c) Meeting of the Committee and its affiliated committees are open to non-members by invitation of these committees

d) The Executive Committee has the responsibility of submitting to the Citizens' Committee proposals for meeting agenda for as many meetings in advance as it can feasibly plan. After the first year, an annual program shall be recommended by the Executive Committee and revised and approved by the Citizens' Committee

e) The regular meeting in June of each year shall be devoted to an evaluation of the work of the Citizens' Committee and its affiliated committees and to planning the work of these committees for the coming year. Time will be allowed during meetings for meeting-by-meeting evaluations

f) Minutes of each meeting will be sent by the Secretary to each committee member

3. Loss of Membership in the Committee

Members of the Committee who fail to attend three consecutive meetings without reasons satisfactory to the Committee shall lose their memberships in the Committee

4. Limitation of Committee Activities

The Committee and its affiliated committees will never recommend individuals or slates of candidates for the Board of Education

5. Responsibilities of Committee Members

a) Each member of the Citizens' Committee and its affiliated committees is expected to attend meetings regularly, to participate in committee discussions, and to serve on sub-committees

b) Each member of a committee is expected to study carefully any problem before the committee before committing himself to a final conclusion about it

c) Members of a committee will extend to fellow members the courtesy they themselves will expect of not reporting outside of committee meetings opinions expressed and stands taken by individual committee members

d) The authority of the Citizens' Committee, or an affiliated committee, to study and advise about school matters belongs to the group as a whole. No individual member of a committee has any rights or privileges that he does not possess as a citizen of the district. As a member of a committee, he will exercise his rights as a citizen with unusual discretion lest there be confusion as to whether he is asserting himself as a citizen or as a member of a committee

6. Use of Consultants

The Committee recognizes the need of professional knowledge and assistance and will make extensive use of consultants from within and without the staff of the local schools

7. Change of Rules

It will require a two-thirds vote of those members present of the Committee to change the rules at a regular meeting. Notice must be given one regular meeting in advance before a rule or rules may be changed.

APPENDIX V

Board of Education Policies

Advisory Committee

1. The advisory committee shall exist only by authorization by the Board of Education of Community Unit School District, and the Board of Education reserves the right to dissolve the committee at anytime.

2. The advisory committee shall act in an advisory capacity to the Board of Education, Superintendent of Schools, and the Principal of the High School relative to such problems as curriculum development, course of study, adult education and state and national trends in education.

3. The advisory committee shall denote its time to the whole Community Unit School District and not limit its activities to any one area unless given special authorization by the Board of Education.

4. Membership:

   A. The total membership shall number 15.
   B. The Board of Education shall appoint one of its members for a one-year term
   C. Fourteen members shall be appointed by the Board of Education selected from the area served by Community Unit School District.

5. Term of office:

   A. The term of office shall be for a two-year period except the member appointed from the Board of Education who shall serve for a one-year term.
   B. Seven members shall carry over each year and seven new members shall be appointed each year by the Board of Education upon recommendations submitted by the Superintendent of District, Principal of the High School, and members of the existing advisory committee.
   C. The term of office shall start March 1.

6. After completing his two-year term on the committee, one year must lapse before he may be reappointed to the advisory committee, except the Board Member who may succeed himself year after year, if appointed by the Board of Education.

7. In case of vacancies, a new member shall be appointed to complete the term of office as set down in Article 5, Section B.

8. The officers of the advisory committee shall consist of chairman, vice chairman, and recording secretary.

9. The chairman and vice chairman shall be elected by a majority vote of the total membership at the first meeting after March 1.

10. The recording secretary shall be the Superintendent or Principal who shall act only in an ex-officio capacity.

11. The chairman shall have the following duties:

    A. Preside at all meetings of the advisory committee.
    B. Appoint all necessary committees.

12. The vice-chairman shall have the following duties:

    A. Preside in the absence of the chairman and assume the responsibility of the chairman.

13. The duties of the secretary shall be as follows:

    A. Keep a record of all business transacted at the advisory committee meetings.
    B. Keep attendance record of the members present at committee meetings.

14. All members completing a full term of office shall be awarded a certificate of appreciation by the Board of Education of Community Unit School District.

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 3-A

Internal Operation of Council--Mechanics of Meetings

Produced by the

Rurban Educational Development Laboratory

Dr. Lloyd J. Phipps, Director
357 Education Building
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Urbana, Illinois 61801

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Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Internal operation of council (3)

Concern: Mechanics of meetings (A)

Objectives: To develop within citizens the ability to:

1. Identify the different types of meeting and the factors pertaining to each particular meeting.
2. Select and integrate relevant material in preparation of an agenda.
3. Recall or recognize lines of authority.
4. Plan a meeting using the proper procedures in preparing an agenda.

Suggested teaching techniques:

1. Conduct a discussion and review of the responsibilities of each officer in the Citizens' Advisory Council.
2. Make a list of possible topics for the agenda. Divide class into three groups. Have each group plan a meeting then defend it before the class as a group.
3. List a group of possible agenda items, determine which items are not important and why.
4. Use "brainstorm" procedures as a way of getting new ideas for an agenda.
5. Have students take turns conducting a mock meeting in the class.

Suggested audio-visual aids:

1. Use the chalkboard to list the items involved in an agenda.
2. The overhead projector is very useful as a flexible means of writing down the items to be included on the agenda.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
1. What are the different types of Citizens' Advisory Committee meetings?	All members of the advisory council should attend the general advisory meetings. All other meetings will be attended by subcommittee members. <u>Suggested techniques</u>: A. Through class discussion generate a list of meetings that will involve the lay Citizens' Advisory Committee. B. Using the above list discuss who should be in attendance and how many people should be involved. C. Conduct a class discussion on advantages and disadvantages of the number of people at a particular meeting. D.
2. What is an agenda and how is it used?	An agenda is a valuable tool for any meeting. It is a written procedure to follow in conducting the meeting. The agenda, if used properly, will give each member of the committee a responsibility, not only to look for important topics to present in the meeting, but also to make preparations for a successful meeting.

2. (Continued)	<u>Suggested techniques</u>: A. Discuss with the class the pros and cons of an agenda. B. Write the name of a meeting down and propose an agenda that could be used for that meeting. C. Discuss pitfalls of certain agenda items to prevent radical ideas from developing. D.
3. What is the proper order of business when conducting a public meeting?	The following is a proposed order of business and may vary from one area to another or for different meetings. 1. Call to order and roll call. 2. Minutes of previous meeting. 3. Orders of the day or the agenda. 4. Report of program of work. 5. Special features. (Speakers, music, etc.) 6. Unfinished business. 7. Committee reports. 8. New business. 9. Adjournment. 10. Entertainment, recreation, refreshments.

3. (Continued)	Suggested techniques: A. Provide each member of the class with a copy of Roberts Rules of Order. Have members skim through the booklet and then generate a list similar to the one above. B. Have class carry on a discussion of proper and improper procedures in conducting a public meeting. C. Invite an F.F.A. group to give a demonstration of their meeting and note the formality. D.
4. What is the role of the chairman?	The chairman of a meeting must be a successful leader. His function is to run a progressive, decision-making program. Suggested techniques: A. Conduct a class discussion on the role of the chairman and indicate specific areas of involvement. (See Appendix I.) B. Have the class generate topics for committees, select a chairman and role play the responsibility within the committee of the chairman.

4. (Continued)	C. Use role playing before the entire class and have selected class members chair different types of meetings. D. Assign Appendix I as a reading assignment and then discuss how to be a better meeting chairman with the class. E. F.
5. Other areas requiring information.	Organizing a meeting is more than an agenda and officers. The following questions must be answered before a meeting can be held: 1. Purpose for the meeting. 2. Time of meeting. 3. Place of the meeting. 4. Those to be involved in the meeting. 5. Social aspects. <u>Suggested techniques</u>: A. Conduct a class discussion, relative to the above five factors, and determine how to implement them. B. Have members of the class give prepared reports dealing with each area requiring information.

5. (Continued)	C. Invite a resource person to the class to speak on the topic of "Success through Meeting Mechanics." D. E.

Suggested evaluation techniques:

1. Observe changes in student behavior as the program develops.
2. Check student's written work to see if it fulfills objectives.
3. Conduct an oral evaluation as to relevance of material.
4. Ask students to write a self-evaluation.

Recommended resources:

Vocational Division Bulletin No. 288, Trade and Industrial Education Series No. 71, Organization and Effective Use of Advisory Committees, U. S. Department of Health, Education, and Welfare, 1968, pp. 40-54.

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, 1963, pp. 16-19. (Source: REDL--Address on unit cover, price 50¢.)

Phipps, Lloyd J. and Kenneth Knell, The How of Successful Citizen Advisory Committee Operation, University of Illinois, Urbana, 1968, pp. 10-11. Source: Address on cover, price 75¢.)

Phipps, Lloyd J., Handbook on Agricultural Education in Public Schools. Danville, Illinois, 1965, pp. 57-60, 300-314. (Source: Interstate Printers and Publishers, Inc., Danville, Illinois.)

Vixman, Rachel, Roberts Rules of Order, New York, N.Y., 1967. (Source: Paperback, Pyramid Publications, Inc., 444 Madison Avenue, New York, N.Y., price 75¢.)

Henderson, Melvin and Herbert J. Rucker, A Guide to Parliamentary Practices, Danville, Illinois. (Source: Interstate Printers and Publishers, Inc., Danville, Illinois, price 20¢.)

Maines, Marianne, Advisory Committees for Home Economics, Terre Haute, Indiana, Vocational Instructional Materials Laboratory, 1969, pp. 10-11. (Source: Vocational Instructional Materials Laboratory, Department of Vocational and Technical Education, Indiana State University, Terre Haute, Indiana 47801, price--unspecified.)

APPENDIX I

HOW to be a better Meeting Chairman

■ The chairman of a meeting is its heart and will. His function or object is to run a progressive operation and to the extent that his group discusses what they are supposed to do and to the extent that decisions are made and projects and deadlines are assigned to individuals and teams. The chairman must be a successful leader.

It has been found that a maximum number of seven people can work together productively at a meeting.

Major Stumbling Blocks of Group Meetings:

1. Small meetings are usually very casual and, due to their nature, only a vague notion about the objectives of the meeting are recognized by the participants.
2. The chairman must provide precise knowledge of what he expects. Otherwise, the other members can easily become confused.
3. Creativity is a vital component of group meetings.
4. Oftentimes a high level of antagonism toward ideas exists at such meetings.

Responsibilities of the Chairman:

1. It must be the responsibility of the chairman to work hard to get good suggestions from his committee.
2. Observations indicate that very few chairmen are able to recognize and sort out helpful responses. The chairman usually does not realize that his role includes being a careful, judicious listener.
3. Oftentimes the leader does not appreciate the possibilities of his role. The chairman often has a general role – namely, to get things done. But the result is the old-fashioned waste of talent – both of his own and his group – by not allowing for proper discussion.
4. Group meetings are often sabotaged by the familiar symptoms of boredom, impatience, hostility and rivalry. These create negativity.

Stating the Problem:

1. A chairman should keep notes that all can see. Large pads usually are better than blackboards.
2. Write brief statements of the problems facing the group. These need not be in detail.
3. The chairman should ask experts as to their reactions to these problems.
4. The chairman should have each participant air his own views. There should be a free-wheeling discussion.

Rules for Chairmanship:

1. The chances for a successful meeting are reduced if the group has no recognized leader.
2. Conditions most likely to disrupt include: negative reaction to new ideas, rigidity of thinking, confusion and rivalry.
3. A meeting must have individual personalities and styles if it is to generate constructive thoughts.
4. Though the chairman has responsibilities to conduct the meeting, he should avoid ideas detrimental to the creative thinking of others.

Leadership principles:

1. Never compete with group members. You do not want to lose any ideas that might be useful.
2. Specific times should be set aside when the chairman should contribute his ideas.
3. Listen to group members. Permit the speaker to paint any picture he wishes. The importance of listening cannot be overemphasized.
4. The chairman should establish his intent. His job is to understand what is in the minds of others and help these thoughts come out.
5. Don't permit anyone to be on the defensive. Keep your fingers on the psychological pulse of each member. If one group member disagrees with another in his view point, accept both ideas as being potentially useful. Record both thoughts as both may be useful later on.
6. Avoid pinning down an individual. Never try to put a person on the defensive.
7. Use every member of the group. Learn to control the member who has a tendency to dominate the meeting.
8. When you take over leadership, give it your best. Don't be reluctant to show enthusiasm for what you believe to be the answer to any problem.
9. Keep the meeting moving at a fast pace. Don't spend too much time on any one step. Watch for boredom and counteract it by going on to other subjects.
10. Keep the members informed about where they are and what is expected of them.
11. Do not manipulate the group.
12. Work hard at the technique of chairmanship. The chairman, even though he can be replaced with another person to serve in that capacity, has the primary responsibility to keep the group alert and aggressive to the problems under discussion.

HANDY CHECKLIST OF SOME PROGRAM METHODS

METHOD	CHIEF CHARACTERISTIC	PATTERN OF PARTICIPATION	SPECIAL USEFULNESS	LIMITATIONS
Lecture, film, reading, recitals, etc.	Information-giving.	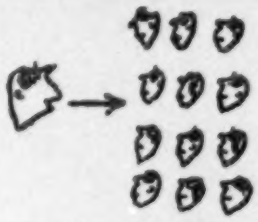	Systematic presentation of knowledge.	Little opportunity for audience to participate.
Forum	Information giving followed by questions for clarification.	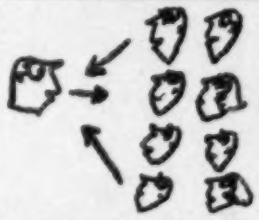	Audience can obtain the specific information it wants on particular aspects of the subject.	Formality; lack of freedom to interchange ideas.
Symposium panel or debate	Presentation of different points of view.	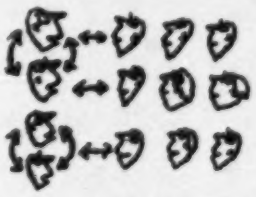	Different points of view spotlight issues, approaches, angles; stimulate analysis.	Can get off the beam; personality of speakers may overshadow content; vocal speaker or questioner can monopolize program.
Discussion	High degree of group participation.	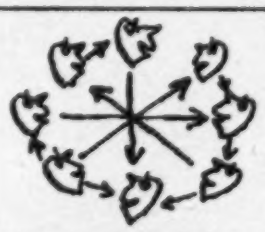	Pooling of ideas, experience, and knowledge; arriving at group decisions.	Practical with only a limited number of people.
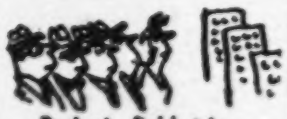 Project, field trip, exhibits, etc.	Investigation of a problem cooperatively.	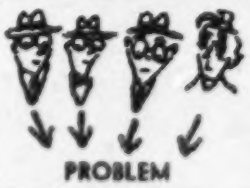	Gives first-hand experience.	Requires extra time and energy for planning.
Buzz groups	100% participation by large audiences through small clusters of participants.		Makes individual discussion, pooling of ideas, possible in large groups. Develops leadership skill in members.	Contributions are not likely to be very deep or well organized.
Group interview	Spontaneous giving of opinions and facts by experts in response to questions.		Brings knowledge from a number of sources to bear on one problem.	Becomes disorganized without careful planning of material to be covered.

APPENDIX II

COMMITTEE ON SCHOOL BOARDS, PRINCIPLES FOR CAUCUS PROCEDURE

As Suggested by
Edward Mowbray Tuttle
in
School Board Leadership in America

(Danville, Illinois: Interstate Printers and Publishers, 1958) P. 26

1. The caucus body shall be so broadly representative of the school district as to deserve the confidence and support of the entire community.
2. The caucus body shall be completely independent of any other civil, political or community organization.
3. Members of the caucus body, whatever the basis of their selection, shall serve in their individual capacities, dedicated to the best interests of the district as a whole.
4. Membership of the caucus body shall be on a rotating basis with one-third of one-half carryover of old members into each succeeding period of operation.
5. The period of service of a particular caucus body shall extend from one school board election (or appointment) through the next with a sufficient number of meetings to accomplish the following things:
   a. Organize the caucus body with a chairman, secretary, committees, etc;
   b. Carry on a campaign to secure from citizens generally suggestions of qualified candidates for board service;
   c. Secure complete data on each potential candidate and go through a process of screening;
   d. Interview and secure consent from candidates finally chosen by the caucus;

e. Present the names of candidates to the proper appointment or election authorities;

f. Publicize the caucus selections to the district with supporting data, and urge widespread and active community backing for the candidates;

g. And finally, arrange for the proper selection of new members of the caucus body for the next period.[1]

Heugh, in an article in The Nations Schools, sets forth criteria to be used in selecting candidates for boards of education in accordance with the tenets of the democratic philosophy:

1. The selection process should provide means for each group which has a clearly identifiable set of interests to voice those interests and to make known its needs....

2. The selection process should promote the cooperative functioning of the various community groups to the end that agreement upon policies and general methods may be achieved....

3. The selection process should be free from partisan control, whether of the political, socioeconomic, religious or so-called 'patriotic' nature....

4. The selection process should be open to public evaluation.

   a. All meetings having to do with the organization process and the actual selection itself should be open to the public.

   b. There should be thorough coverage through the local press of all such meetings.

   c. A clear statement of the policies and purposes of any select committee or group should be given wide public circulation.

1/Edward Mowbray Tuttle, op. cit., pp. 126-127.

5. The selection process should be rooted in the people's experiences. Only when people have the security of starting from a base with which they are familiar can they successfully plan for improvement.
6. The selection process should provide some means or basis for the public's evaluation of the candidates....
7. The selection process should be an integral part of the total effort at overall community planning....
8. The selection process should be flexible in structure providing for orderly change either to meet new conditions or in response to criticism arising from public evaluation.
9. The selection process should further adhere to the principle that candidates chosen according to the foregoing criteria are selected on the basis of individual merit and not primarily because they represent any special interest or group.[2/]

Concerning the last criteria, Heugh says, "Selection on any other basis than that each individual member is the representative of all the people is likely to lead to a detrimental emphasis upon the interests of constituent groups, whether they be geographical, economic, social, political or religious."

2/William C. Heugh, "How to Get a Good School-Board," Nations Schools, 40:26-7, N47.

APPENDIX III

Suggested Panel Procedures

We have received a number of "tips" regarding group discussion procedures. Most of these have come from people who have participated in previous meetings. They make good sense to us, so we are passing them along for whatever value they have to you. It is our sincere hope you will enjoy the session and that a fruitful and effective discussion will ensue.

The role of the chairman

As chairman, you have an important job. Good judgment will dictate your actions. Regardless of how carefully the program has been planned, feel free to change it when the situation justifies.

The successful chairman does not make a speech. He is measured more by his expeditious brevity and his giving the speakers a chance to present their message to the audience. Likewise, he is judged by his skill in protecting the audience from overzealous speakers as well as his ability to make everyone feel they have had an opportunity to join in the discussion.

Introductions, while brief, should be sufficient to impress upon the audience the fact that the speaker is familiar with the subject and well qualified to discuss the topic under consideration.

A general knowledge of the topic is helpful to a chairman. If practical, plans should be discussed with the speakers prior to the panel session with each person being informed regarding the length of time he will be allotted for speaking. Time limits should be established and followed to insure each speaker an opportunity to make his presentation in addition to providing time for general discussion.

The open discussion period is an essential part of the program. One of the most difficult jobs, particularly for a chairman with little

experience, is to wait a sufficient length of time for the first question from the audience. It may seem slow in coming but do not rush in with your own questions. OFTEN THE PAINFUL PROCESS OF WAITING FOR THE FIRST QUESTION IS NECESSARY.

The role of the speakers

The job of the speakers is to state issues sharply and concisely, not to exhaust the subject--and the audience along with it. Principal issues and facts should be set forth as provocatively as possible. Presentations should be planned so they will touch upon the important points in the allocated time. Details may very well be reserved for the open discussion period following the planned presentations.

Conducting the meeting

Plan to arrive at the meeting place in time to see that everything is in readiness for the session.

Participants should be seated facing the audience.

The session ought to start promptly even though the audience may be slow in gathering.

Open the meeting by stating the discussion topic and making any brief comments you may consider appropriate. Explain the plan of action, requesting that the audience refrain from asking questions and commenting until all speakers have had an opportunity to make their presentations. Briefly introduce the panel members, including information about their background and interests in the subject area.

Call on the first speaker. Following his presentation, thank him, call on the next, etc., until each person has spoken. Approximately one-half of the session time should be divided among the speakers, allowing equal time to each. Chairmen are urged to make every effort to see that speakers stay within their allotted time.

Each panelist ought to have an opportunity to speak before the meeting is opened to general discussion for the remainder of the session.

Open the meeting to questions and comments from the audience. Suggest the panel members have a question or comment ready to toss in if the discussion falters. Questions may be directed to a specific member of the panel or to the panel in general. Sometimes it is advisable for the chairman to repeat the questions or comments for everyone's benefit. Do not let one or two individuals monopolize the discussion when others are seeking recognition. Try to achieve as wide participation as possible.

Maintain an informal atmosphere that encourages free and easy discussion.

Closing the meeting

Plan to close on time and do so. Warn the group a few minutes before closing time, reserving the remaining time for summarizations or last-minute questions. In closing, thank the speakers and the audience for their participation.

APPENDIX IV

Jersey Community School Unit No. 100
School Board--Joint Meeting--Citizens' Consulting Committee
March 31, 1970--7:30 to 9:30 p.m.
West Elementary School
Jerseyville, Illinois

Agenda

1. Introductions and roll call. 10 minutes.
2. Statement of purpose. 5 minutes.
3. Discussion groups. 30 minutes.
4. Reflections and interpretation. 30 minutes.
5. What should be the relationship or role of the Citizens' Consulting Committee to the school board? 45 minutes.

Adjournment

CITIZENS' CONSULTING COMMITTEE

Agenda

February 24, 1970, 7:30 p.m.

1. Roll call.

2. Acceptance of minutes of meeting on January 27, 1970.

3. Future meetings.

   Tuesday, March 31.

   Tuesday, April 28; may this be changed to April 21?

   Tuesday, May 26; may this be changed to May 19?

   Tuesday, June 23.

4. Tour of new high school facilities.

5. Old business.

   5.1. Administration report.

   5.2. School board report.

   5.3. Faculty representative report.

   5.4. Miscellaneous.

6. New business. Work/study groups on the following questions taken from Citizen Participation in Local Policy Making for Public Education by Herbert M. Hamlin, College of Education, University of Illinois.

   1. How is public policy for the school system to be developed, interpreted, executed, and publicized?

   2. Who are to be served by the public schools? How? How much? When? Where?

   3. What public purposes are to be served by the public schools?

   4. How is the public to decide whether its purposes are being realized?

   5. What provisions will the public make for organization, administration, program planning, staff, bonds, and facilities, so that its purpose can be realized?

Reports or Summaries

Assignment. Write down some initial thoughts in trying to develop an adequate statement of a philosophy of education. Here are some ideas to wrestle with as you think.

"What is implied by having a democratic viewpoint? What emphasis should be given to the dignity and worth of the individual human personality? How much really should we imply by our belief in the intelligence and rational capacity of man? What do we mean to imply when we talk about freedom with responsibility?"
...from Youth Education, American Association for Supervision and Curriculum Development.

"Philosophy is concerned with man and with society--not primarily individual instances of specific men or specific societies..., Philosophy is concerned with truth...interlocking facts brought together into some sort of comprehensive whole that we can call knowledge. Philosophy is concerned with what makes things good or evil, ugly or beautiful, right or wrong, valuable or worthless."
...from Philosophy for American Education, Kenneth H. Hansen, p. 3.

Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 3-B

Internal Operations - Use of Sub-Committees

Produced by the

Rurban Education Development Laboratory

Dr. Lloyd J. Phipps, Director
357 Education Building
University of Illinois
Urbana, Illinois 61801

Staff Assistants

Richard Hofstrand W. Edward Shipley

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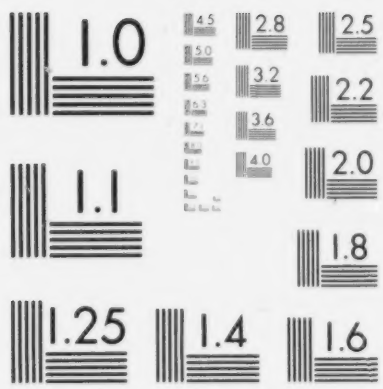

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Internal operations (3)

Concern: Use of sub-committees (B)

Objectives: After instruction, the student is able to:

1. Generate a list of functions and activities considered proper for advisory subcommittees.
2. Identify and recall the kind and size of sub-committees to be used.
3. Demonstrate correct democratic processes.
4. Assume responsibility for effective operation of a sub-committee.

Possible Teaching Techniques:

1. Have class suggest areas needing study or review. Then have students select the topic they desire to expand and set a time limit for collection of information and presentation to the class. Hand in written objectives or goals for their topic.
2. Conduct class discussion on lists of questions using illustrations to help answer these questions.
3. Assign three to four people from the class to come to the class prepared to demonstrate how to work in a sub-committee.
4. Assign a member of the class to research the topic of sub-committees and conduct a lecture-discussion approach to the problem with the class members.

Suggested Audio-Visual Aids:

1. A chalkboard may be used to list areas of concern of the committees.
2. An overhead projector may be used if a chalkboard is not available.

Anticipated Problems and Concerns	Guides to solutions and sample teaching technique
1. What is a subcommittee or a special committee and how is it organized?	A subcommittee is a group of individuals selected from the central advisory committee and elsewhere to study a specific problem area. While the basic practices of subcommittees are the same, various schools have tailored the approach to solving problems with subcommittees to fit their needs Suggested techniques A. Have class review the format of methods and procedures concerning the operation of affiliated committees; Hamlin, pages 30-31. Before initiating a subcommittee this format should be filled. B. Using the discussion approach, suggest a specific problem area and then break the area down to fit the format for subcommittees. C.

Anticipated Problems and Concerns	Guides to solutions and sample teaching technique
2. What is the relationship and duties of a subcommittee?	Each subcommittee should be independent of other subcommittees. All correlary work should be done on the central advisory committee level. <u>Suggested techniques</u>: A. Have class generate a list of duties for a particular area. B. Divide the class into groups and have each person respond, by writing down how they would carry out the particular duty they were assigned. C.
3. How should the subcommittee report to the general committee?	A progress report should be prepared for the central advisory committee meeting and presented to keep the central committee informed. When all the data has been collected and the subcommittee has fulfilled its duties, a written report should be presented to the central advisory committee.

Anticipated Problems and Concerns	Guides to solutions and sample teaching technique
3. (Continued)	Suggested techniques: A. With the aid of the class, develop a format for subcommittee reports. B. Obtain several subcommittee reports and evaluate in the classroom or in small groups. C. Invite a resource person to class to discuss the role of the consultant and the subcommittee. D.

Possible Evaluation Ideas:

1. Divide into committees, all having the sampe topic, and have class members research a topic and submit a written proposal.
2. Observation of the changes in class attitudes during the class sessions.

Recommended resource

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, 1963, pp. 30-31. (Source: REDL, 357 Education Bldg., University of Illinois, Urbana, Ill. 61801; Price: 50¢).

Phipps, Lloyd J. and Knell, Kennth, The How of Successful Citizen Advisory Committee Operation, University of Illinois, Urbana, Ill., 1968. (Source: 357 Education Bldg., University of Illinois, Urbana, Ill., 61801; Price 75¢).

Phipps, Lloyd J. Handbook on Agricultural Education in Public Schools. Danville, Ill., 1965, pp. 54-55. (Source: Interstate Printers and Publishers, Inc., Danville, Ill. 61882).

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 3-C

Internal Operations of Council--Group Dynamics

Produced by the

Rurban Educational Development Laboratory

Dr. Lloyd J. Phipps, Director
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University of Illinois
Urbana, Illinois 61801

Staff Assistants:

Richard Hofstrand W. Edward Shipley

Teaching Source Unit

CITIZENS' ADVISORY COUNCIL IN EDUCATION

Unit. Internal Operation of Council (3)

Concern. Group Dynamics (C)

Objectives. After instruction, the student is able to:

1. Identify and recall practices and procedures used in group dynamics.
2. Demonstrate correct usage of group dynamics.
3. Assume responsibility for the effective functioning of a working group.
4. Identify the purposes of different group dynamic methods.

Suggested Teaching Techniques

1. Have class demonstrations for each identified area of group dynamics.
2. Have individual reports on various group techniques.
3. Have the class attend civic functions using various group techniques. Have the class discuss the process and the effectiveness of the group dynamics.
4. Invite a resource person to discuss the use of group dynamic methods.

Suggested Audio-Visual Aids

1. The overhead projector and acetate sheets could be used very effectively for showing animated interaction of a group.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. What is a definition of group dynamics?	Group dynamics is a process of learning. The process uses the meeting as a vehicle. The different types of meetings are as follows:

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. (Continued)	1. Convention. When local unit representatives gather upon call of the parent organization to talk about problems of common concern, the meeting is designated as a convention. 2. Conference. A conference usually carries with it descriptive adjectives which identify it; for instance, family life conference, career conference, soils conference, etc. The adjective used tells the public what the conference theme is to be. This term should not be confused with a conference of two people regarding some problem as for instance, a teacher-pupil conference. 3. Institute. If a group of people come together for a series of meetings of one or more days duration where instruction and information are given in a specific field, the meeting is often designated as an institute. 4. Workshops. A workshop is a relatively new term used to identify a meeting of people who have assembled where facilities are available for them to go to work.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. (Continued)	5. Seminar. The term seminar is most commonly used around an institution of higher learning and normally presupposes that those participating bring with them much experience and training in the area under consideration. 6. Formal Classes. Formal classes are directed by experts or committees in charge who move the group in the direction they believe it should go. Informal techniques may be employed in the course of the activities. 7. Informal Discussion. Informal discussion has as its keynote, participation. It is hoped that everyone will take part. Meetings are often initiated and conducted on an informal discussion basis. 8. Short Course. If the meeting procedure is more systematic than a conference but less extended and formalized than credit courses offered by colleges, the meeting might be characterized as a short course. 9. Lecture Series. Quite often outside speakers, or perhaps only one speaker, is called upon to deliver a series of addresses.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. (Continued)	These may extend over several days or may be intermittent as, for instance, one day per week or month. These types of meetings can be best designated as lecture series. <u>Suggested Techniques</u> A. Have individual members give oral reports on the different types of meetings. B. Divide class into small groups and discuss the different types of meetings. C. Conduct a class discussion of the different areas after reading associated materials relative to the different types of meetings.
2. What different group dynamic techniques may be employed in a meeting?	In outlining meeting procedures, effort should be made to include the more important techniques which might be employed. A list of techniques are: 1. Formal or stage presentations. All communication is in one direction, from stage to audience. a. Lecture or speech b. Symposium c. Panel discussion d. Colloquy

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
2. (Continued)	2. Discussion techniques a. Open discussion b. Co-leaders in group discussion c. Buzz sessions d. "Phillips 66" technique e. Leadership team (1) discussion leader (2) process observer (3) recorder (4) resource person f. Listening teams g. Role playing h. Dramatic skit i. Brainstorming j. Lecture forum k. Symposium l. Panel forum 3. Demonstration and Laboratory a. Method demonstration b. Result demonstration c. Laboratory procedure 4. Field trips and tours 5. Audio visuals 6. Written communication <u>Suggested Techniques</u> A. Divide the class into groups and use each of the techniques outlined. B. Have class read Appendix 1 and Appendix II. After reading, use discussion approach to gain an understanding.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
2. (Continued)	C. Have members of the class give individual reports to help clarify the meaning of the technique. D. Have class use a written evaluation of the class to see how many techniques that have been used they can identify. E.
3. How is the problem-solving process related to group dynamics?	Group dynamic techniques are employed in situations where a problem-solving process is used. <u>Suggested Techniques</u> A. Use the case approach to determine when and what techniques to use. Present a situation and determine the problem areas. Select a technique or techniques that will best solve the situation. B. Have class generate a list of techniques and suggest when to use the technique. C. Have groups within the class role play different techniques and then have the class determine the technique and the success of the group in using it. D.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
4. What are the advantages of various group dynamic techniques?	Inasmuch as group dynamic techniques involve nearly every aspect of learning and education in some way, it is important to recognize their advantages. The following is a partial list of advantages: 1. Method of relaying information 2. Method of problem solving 3. Uses resources at hand for a meeting 4. Determines meeting procedures 5. Provides a realistic way to approach a situation. 6. Method of getting input from all members. 7. Utilizes all types of people and personalities. 8. 9. <u>Suggested Techniques</u> A. Have class discuss and then generate a list of advantages to group dynamics. B. Conduct a class discussion on the pros and cons of group dynamics. C. Invite a resource person to class to speak on the topic of group dynamics. D.

Suggested Evaluation Techniques

1. Have class use a written identification of different dynamic techniques.
2. Use the class as the evaluators of techniques that have been used in previous classes.
3. Observe the students in a role-playing situation to determine the effectiveness of the teaching unit.
4. Observe the changes in student behavior as a result of the identification of techniques.

Recommended Resources

Morgan, Barton and Glenn E. Holmes, Clarence E. Bundy, Methods in Adult Education, Ames, Iowa, 1960, pp. 56-140. (Source: The Interstate Printers and Publishers, Inc., Danville, Illinois.)

Phipps, Lloyd J. Handbook on Agricultural Education in Public Schools, Urbana, Illinois, 1965. (Source: The Interstate Printers and Publishers, Inc., Danville, Illinois.)

Totten, W. Fred and Frank J. Manley, The Community School, Galien, Michigan, 1969, pp. 140-143. (Source: Allied Education Council, Galien, Michigan 49113.)

APPENDIX I

Some Methods and Tools for Increasing Interest, Participation, and Teaching Effectiveness

William W. Reeder
Department of Rural Sociology
Cornell University

How to Use the Small Group Discussion Method

What is it? Small group discussion is a method for breaking a large group down into small subgroups for greater participation. Its primary purpose is to increase interest, participation, and teaching effectiveness.

Other names. The small group discussion has been called by several other names: Discussion 66, the buzz session and the committee system.

An old method in a new situation. There is nothing new about the small group discussion method. It is one of the oldest in man's experience. It happens at the end of almost every interesting meeting. Folks just naturally gather in groups of three, four, or five to talk among themselves; if a group gets too large it soon subdivides. This old natural method has just been brought into captivity for effective use in classrooms and groups.

What are the advantages of the "small group discussion"?

1. It is a very satisfying method from the point of view of students or group members.
2. It draws everyone into participation into a situation where they feel free and comfortable in taking part.
3. It provides interstimulation which increases the flow of ideas in a setting in which ideas can be challenged and freely batted back and forth without embarrassment to anyone.
4. It places responsibility on every individual to think about the problem and to make a contribution of its solution.

5. The students or members of the group work the answers out for themselves and they are more meaningful than ideas which they are simply told about by someone else.
6. The small group discussion is a big time-saver. It provides a rapid technique for pooling ideas or experiences on a problem, or for bringing out questions and problems of group members. If there are three or four problems to be discussed, the group can be split into parts so that discussion is going on on all questions at the same time. As each team reports on its question, the entire class or group can make additions which they feel should be made.
7. The method increases group unity. Everyone shares in the product and becomes more attached to what is going on.
8. It gives the members of the class or group experience in tackling problems as a member of a team and of expressing themselves in the same kinds of situations as they will work in as citizens in a democracy.
9. As the group gets experiences and sees how much it is able to accomplish, the members develop confidence in their own ability to handle problems and in the democratic process as an effective means of solving problems and getting things done.

Essential steps in organizing the group for the small group discussion. The content of the discussion and the length of the discussion will vary widely according to the purposes of the group but the method of organizing the group for the discussion is pretty much the same in most cases.

1. Orient the group. Tell them briefly what you are planning to do and how you are planning to do it so everyone will know what is going to happen. Here is a sample introduction indicating the kind of information they will want to know about.

"Our topic for discussion tonight is 'How to get participation in the group'. In order that everyone may get in the discussion we have decided to use Small Group Discussion method which is both productive and enjoyable. Here is how it goes:

"First we divide up into groups of four to six--not more than six. We can do this by having the odd rows turn their chairs around so the odd rows are facing the even rows. Then count from the aisle and every three chairs makes a committee of six. As soon as you are in your committee of six introduce yourselves by name and home towns, then select a chairman and a recorder. It is the job of the chairman to see that everyone gets a chance to get his ideas in and the job of the recorder to write down the ideas of the group and to be prepared to report back after the discussion.

"We have two questions so we will divide up; the people on the right side of the room can discuss this question, 'What are the reasons that some people do not participate in meetings?' The people on the left side of the room can discuss this question, 'Why is it that some people do participate in meetings?' We will have 12 minutes to discuss this topic after which we will call on the recorders to report for their groups. I will give each group a card to write on, and I will write the two questions on the board so everyone can see them. Are there any questions? In case there are some questions when we get started, just raise your hand and I will come to you."

Such an introduction lets everyone know what is happening so they will know what to expect and can prepare for it. Sometimes in a large group of 400 and up, written instructions for the odd and even rows helps in this orientation process. If written instructions are used, the leader should go over them with the group.

2. Divide the large group into subgroups. This can be done in several ways depending on the room and the group.
   a. The method of having the odd rows turn around to face the even rows works well in large meetings. If the seats are stationary, the persons on the odd rows can just turn around in their seats.
   b. In smaller groups, you can demonstrate with five people sitting together and have the rest follow your example.
   c. You can have them count off and have the ones form a group, the twos a group, etc. This is effective in some kinds of meetings because it splits up little friendship cliques and helps people to get acquainted and get a greater exchange of ideas.
3. The size of the group. The size of the subgroups depends upon the topic to be discussed. If it is a topic requiring considerable thought, five or six persons provide more thought stimulation and make the members feel easier as one does not feel as pressed to come up with an idea. Where the topic is one where everyone is likely to have several ideas, three- or four-person groups give more opportunity to participate and are more satisfying. Six is about maximum size for best results. By experimenting with larger numbers you will notice that you begin to get individuals who are left out of the participation when the group is seven or more.
4. Length of time for discussion in the small groups. The length of time for discussion will vary with the topic. It should be long enough so that each group has had a chance to get down several ideas but not long enough to exhaust the topic.

5. Consolidating the findings--reporting back to the large group. There are three or four ways of consolidating the findings and reporting back. The size of the group and the purpose are the main factors which determine the method selected.

   a. In raising questions for discussion following a talk you can move from group to group asking each for their best question and allowing time for answers after each question. In using this method it is well to call for questions from different parts of the room. The discussion period is usually not long enough to cover all of the questions and the group will feel better if you do not concentrate on one particular part of the room in calling for questions.

   b. If the group is fairly small, you can have the spokesman from each group present the report for his group. This works best where the group is working out answers to a question or problem. In such a group the repetition of answers adds emphasis and usually does not detract.

   c. In some cases such as in a problem census, program planning, or where a problem calls for a large number of answers, it works well to have a blackboard and have a recorder list all the questions or answers on the board. In this case it is usually best to get all the points down before discussing any of them.

   One method of avoiding repetition and still giving recognition to all the groups is to take a quick vote of the number of groups who had the same question or answer while the recorder is writing down

the statement. This also gives some indication of the relative importance of each.

d. Where the group is large, over 100, it is sometimes advantageous to send the recorders of each subgroup into an adjoining room to consolidate the answers while the group goes ahead with other matters. It is well to have someone prepared to lead out in the consolidation and to have one of the recorders report the findings back to the group.

e. Occasionally it may fit the purposes of the group best to collect the reports from the various groups, have a committee consolidate them, and report the findings at the next meeting. In most cases, however, the purposes will best be served by getting a report back during the same meeting.

6. Discussion following report. The reports are a consolidation of the suggestions of the small groups and does not represent agreement of the group. Some discussion is usually appropriate. The length of such a discussion will depend again upon the topic and purpose. Following the small group discussion, the members are more free to discuss them than they would otherwise be in the large group.

7. Calling the attention of the group to its accomplishments. Frequently the group becomes lost in the process of participation and it is not aware of how much it has accomplished unless it is called to its attention. Such questions as: "How do you feel about the amount we have accomplished today?" "How do you feel about the quality of the ideas that have been presented?" "Do you think we have gotten more or less than a speaker could have given us?" All serve to make the group aware of its own

Almost always it is combined with the large group discussion which is used in reporting back and in the discussion following the report of the small groups.

10. How to teach the small group discussion to a class or group which has not used it before. Select an interesting topic, a problem which you know the class will be interested in and will have ideas about. Select one you have tried before and found it to be successful. Give the class one or two experiences using the method under your direction. After two or three times they will know how to do it themselves with the help of a few instructions. Do not tell them about it--SHOW THEM HOW TO DO IT.

The Large Group Discussion

What is it? The large group discussion is the most common type known to most of us. A large group discussion occurs whenever a total group of seven or more persons carry on a discussion as one unit.

Size. Theoretically the number could vary from seven to a thousand or more ; however, in practice discussion tends to break down a question-and-answer session in groups of 40 or 50.

Where it fits

1. Threshing over ideas as a total group following a small group discussion.
2. Groups under 50 in which the members are well acquainted and are used to discussing can use it fairly well following a talk, a panel, a film, or a symposium.
3. Groups from 7 to 25 can use it fairly well in exploring an idea though it is more productive to combine it with the small group discussion.

The Advantages and Disadvantages of the Large Group Discussion

Advantages

1. Gets more member involvement than the speaker-audience techniques though not as much as the small group discussion or the dramatic techniques.
2. Keeps the group together, everyone knows what is happening.
3. Gives the total group a chance to check on any particular idea which may be presented.

Disadvantages

1. Less productive of ideas than the small group method.
2. Moves slowly and is likely to get side tracked.
3. Frequently a few talkers dominate the meeting.
4. The larger the group the fewer there are who feel free to speak up.
5. As the size of the group increases, member involvement decreases.

Some Suggestions for Leading Large Group Discussions

1. Choose a topic in which the group is interested. A discussion technique may create some interest but for the most part it simply facilitates it.
2. If possible have the group sitting in a circle, square, or diamond shape, facing each other so they can see each other's face and can talk to each other.
3. If the group is small enough so they can see you and hear you easily, sit down in the circle just like any other member with persons on either side. This creates informality and helps the group to take more responsibility upon itself.
4. Encourage people to speak loudly enough so they can be heard. In large groups of row seats or chairs it sometimes is necessary for the leader to repeat the statement.

5. When questions are directed to you as a group leader, bounce them back to the group for an answer rather than answering them yourself. If anyone in the group knows the answer,it is usually better to come from them than from you. This avoids leader domination, maintains member involvement and interest and keeps the discussion from disintegrating into a question-and-answer session. Hold your own comment back until others have expressed their ideas.
6. Use a minimum of formality; the smaller groups will need almost none. The best amount is that amount which makes for greatest productiveness. Too much kills interest and wastes time. Too little in a large meeting may let it get out of hand and thereby waste time.
7. Encourage group members to talk to the group and direct their questions to the group.
8. Summarize at the end. Either a leader summary or a group summary will clinch important points, organize the ideas in their thinking, and enable them to see how much they have accomplished. It is often well to call attention to this last point as groups are seldom conscious of their own productivity.

The Opposing Panel

The opposing panel was developed to meet a particular type of situation which is rather common in classes and groups. There are many important topics which have been talked about, written about, and discussed and yet about which there are still many questions and misconceptions. If you have further talks, or general discussion, most of the time is spent in hashing over that which is already known. When group members see the topic listed they say to themselves, "No, not that again." The opposing panel was developed to meet this kind of a situation to avoid rehashing that which is already known, to get at the unknowns, and to secure interest and involvement.

How you do it

1. Divide your group in half; designating the one-half as the "question raisers" and the other half as the "question answerers."
2. Divide each half into small groups of four to six as in the small group discussion.
3. Announcing the topic, assign the "question raisers" the job of getting down some good questions, the kind which they have wondered about or which they have heard others asking about. Next assign the "question answerers" the job of anticipating the kind of questions which might come up and being ready to answer them.
4. Group yourself as one of the "question answerers," which will enable you to make your contribution as one of the group.
5. Allow 15 to 20 minutes for preparation.
6. Call on one of the subgroups of "question raisers" to ask their best question letting the "question answerers" provide the answers. You, as one of this group, can add anything you wish after others have had a chance.
7. The question raisers may not be satisfied with the answers you give and may wish to add something to the answer themselves. Letting them do so usually adds to their interest and to the completeness of the answer.
8. Call on another subgroup of question raisers for their best question and repeat the same process as tested above as long as your time permits.
9. Take a few minutes at the end for a leader summary or a group summary calling attention to high points, group interest, and group productiveness.

What are the Advantages of the Method?

1. It avoids the known overworked material and removes immediately the unknowns and the unclear items.
2. It introduces a friendly competitive element between the question raisers and the question answerers.
3. It creates a situation in which everyone has to think about the question.
4. It introduces an element of suspense.
5. Participation in the small groups provides for fellowship and social wants thus creating general satisfaction.
6. Experience indicates that both groups go through the same process in the preparation period. They think of both the question and the possible answers.
7. The learning which takes place in the small groups as they discuss possible questions and answers is as valuable as any other part.
8. It creates interest and gets total participation and involvement.
9. It keeps the attention of the group members on the questions and their answers.

Question-and-Answer Techniques

In many classes or meetings a portion of the time is designated for discussion. What usually occurs, however, can better be described as a question-and-answer session. There are four common ways which this may take place.

1. The leader may introduce the questions and call upon the group for answers.
2. The leader may draw questions from the groups and he or some resource person answers them.
3. The leader may draw questions from the group then turn the question back to the group for an answer. In this case a resource person usually makes his contribution as a member of the group.

4. The leader raises some questions which he answers himself or calls upon some resource person to answer.

All of these techniques have their particular uses. A few generalizations may serve as a guide in choosing which one to use.

1. Questions stimulate thought no matter who asks them.
2. People like to ask and answer questions if the situation is made comfortable for them.
3. In trying to get at the questions which are in the minds of the group members it is usually safer to ask for them than to guess at them.
4. Do not underestimate the resources within the group itself. The combined knowledge and experience of the group members are frequently greater than that of the leader or resource person. In such cases your best service is to enable them to pool and share their knowledge quickly and efficiently.
5. On new material or technical matters with which the group has had no knowledge or experience, a resource person is essential.

Suggestions on techniques of getting the group to raise questions.

1. The small group discussion method (Discussion 66) is probably the most productive technique we have for raising questions and gets greatest involvement.
2. An alternate method which works well and gives variety is to give the members of the group a one- or two-minute period to jot down the questions they would like to ask. This concentrates attention on questions for one or two minutes thus producing better questions. Likewise a person gets his own questions clearly in mind and is less likely to forget them as he gets involved in the discussion.
3. Reminding group members to make note of questions when they think of them will help. It is easy to forget the questions that come to your mind when you are trying to keep up with a speaker or a discussion.

Suggestions on pooling the knowledge and experience of a group in answering questions in a short period of time.

1. Here again the small group discussion method is usually the most productive.
2. If you have several questions, divide them among the subgroups with provisions for the total group to make additions following the report of each subgroup.
3. If the group is very large and the time very short, you may find it works best to send the subgroup recorders to another room to consolidate the findings and repeat back later in the program. In this, someone who has had experience should be assigned to help them in consolidating their material.
4. In some instances you may have a blackboard which can be used.
   a. Two recorders each taking every other answer will pool the ideas on the board very quickly.
   b. If the small groups have two or more questions to answer, it can choose a recorder for each question and as each question is finished the recorder for that question can leave the group long enough to list his group's ideas on the board. The group continues on with the remaining questions.

The Lecture

The lecture, the most widely used technique for teaching in American schools needs little introduction. Its characteristic is that one person, the leader or teacher, does the talking and the class or group becomes an audience. It has several advantages and disadvantages.

Some of its advantages

1. It enables a person to present his ideas to a large number of people.
2. It makes possible a systematic presentation of ideas.
3. It enables a person to put out a great deal of information.
4. It enables a large number of persons to take advantage of the unique knowledge or experience of one individual at the same time.
5. It is fairly effective in dispensing information.

Some of its disadvantages

1. The members of the group retain only a small portion of the information which is put out.
2. There are few good lecturers who can hold interest and attention and teach effectively at the same time.
3. The group member does not necessarily become involved and the situation does not require him to think.
4. In keeping up with the flow of ideas the group member quickly forgets what has gone before. It is not uncommon for a person coming out of a lecture not to be able to recall the main points though he is likely to have an impression as to whether it was good or poor.
5. While the lecture is useful in presenting facts and information it has less value in developing skills, attitudes, and the kind of an understanding which is necessary to put the knowledge and facts to work in a concrete situation.

The lecture has several uses by itself and in combination with other techniques. Frequently, we use it in situations where other techniques would be more productive. The caution here is: get acquainted with other techniques; then use the lecture where it fits best.

The Symposium

The symposium consists of two or more brief talks presenting different phases of the same general topic. It is usually followed by a discussion or question period.

Advantages over lecture

1. It introduces a wider variety of experience and knowledge of the subject.
2. It creates some suspense as the audience wonders what the next person is going to say. This is particularly true if the subject is controversial.
3. The change of voices and breaking up of the time span helps to hold attention and interest.
4. In general, a symposium gets greater involvement on the part of the audience than does a lecture.

Some disadvantages of the symposium

1. Usually it is a less systematic presentation.
2. It may not cover as much ground.

The discussion period which usually follows may employ either the small or large group discussion.

Different types

1. Usually the symposium speakers are selected because of their knowledge of the subject.
2. One variation from this which works well in some situations is to divide the group into subgroups as in the small group discussion; assign the subgroups different phases of the general topic; after 10 or 15 minutes discussion in the subgroups, organize a symposium composed of the chairmen of the subgroups. After their presentation the meeting is opened up for questions and discussion from the floor.

3. Another variation is to have each symposium member give a brief presentation. Then have the group become a panel to discuss some of the live issues among themselves before drawing the total group into the situation.
4. There are two main types of presentation depending upon the nature of the topic:
   a. The symposium members may briefly present answers or opinions on the topic or question.
   b. The members may spend their time raising questions and problems which provoke interest, leaving the answers to the discussion period which follows.

The Panel

The panel, sometimes called the "round-table discussion," is usually composed of four to six persons. The members of the panel carry on a discussion of the topic among themselves, and the audience "listens in" on the discussion.

Sometimes the procedure is formal, with the speakers getting permission from the leader, or moderator, when they wish to talk. At other times it is very informal; the panel leader simply states the questions, and the members pick it up from there.

The panel question. Needless to say, the more interesting the topic the better.

The panel members. The membership of the panel may differ somewhat, depending on the question. There are three or four possible choices, any of which can be successful.

1. You may have a panel of experts.
2. You may have a panel of persons who are known to represent different positions or points of view in relation to the question. They may be experts on the topic, but they do not need to be.

3. You may have a panel representing different ages or different occupations without knowing what their point of view might be.
4. The panel may be composed of members of your own group drawn more or less at random.

Some suggestions for using the panel

1. Seat the panel members in a V-shape with the leader, or moderator, at the point of the V. They can see each other, and the audience can see them.
2. If the panel members do not know each other well, a folded card with the person's name on both sides placed on the table in front of him or her will enable both those across and those alongside to refer to the person by name. Print the name large enough so it will be easy to see.
3. The leader has five or six jobs which he must be prepared to do:
   a. Introduce the panel members.
   b. Introduce the topic.
   c. Be prepared to raise some provocative questions which would lead the panel to explore the various aspects of the topic.
   d. Keep the panel on the subject and help it move to a new question when the main points have been brought out on the one being discussed.
   e. Be prepared to lead the audience in a discussion or a question-and-answer period following the panel presentation.
   f. Be prepared to summarize or lead the panel in a summary at the end.

The advantages of the panel

1. There is always an element of suspense as to what is going to happen next.
2. Questions and answers are likely to be raised in the way that the audience thinks of them.
3. Fast moving questions and answers create interest and participant involvement.

4. A panel under a skillful leader can cover a large amount of ground.
5. Of the speaker-audience techniques the panel is perhaps the most dependable in creating interest and general audience satisfaction. Careful planning will help to assure its success.

The Forum

Like the symposium the forum is a speaker-audience technique in which there are two or more speakers who present talks on the same subject. The primary characteristic of the forum, however, is that the subject is controversial, and the speakers present the opposing sides of the question.

Each speaker presents his case to the audience for its consideration. They do not spend their time trying to tear each other's case down as in a debate. The forum is usually followed by a question-and-answer period in which the members of the audience direct their questions to the particular speaker concerned.

Advantages of the forum

1. It is an excellent way to present the various sides of a controversial issue.
2. It can fill an important role in democratic public life in presenting the various sides of a question together and leaving the listeners to make up their minds. Lecturers, or newspapers and magazines, are prone to present and argue only that side of the case which they are individually supporting.
3. In the forum the nature of the topic being controversial is usually interesting to the audience who came to hear it.
4. Like the symposium, the change of speakers and voice, tends to break up the period and to make it appear short.

Some disadvantages

1. The speakers may not spend their time on the issues which are of most concern to the audience.
2. As in the lecture, success is largely dependent upon the ability of the speakers.
3. Since the forum is basically a lecture by two or more persons, it suffers from most of the same weaknesses as the lecture.

APPENDIX II

Source: Methods of Adult Education

Barton Morgan
Glenn E. Holmes
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Special Discussion Techniques

A number of techniques have been devised to stimulate participation and improve the effectiveness of group discussion. Some educators have labeled these activities as "group discussion primers. Others refer to them as "group dynamics techniques." Each device has been developed for a specific type of discussion situation. Discussion leaders who are familiar with these methods can greatly improve the effectiveness of the discussions by analyzing the situation and using effectively the supplemental method or methods best adapted to the situation.

Some of the methods aid in systematizing the discussion. Others tend to increase participation. The aim in using some of the methods is to add variety, to create suspense, or to pep up the discussion. A number of supplemental methods are described in the following paragraphs.

Co-Leaders in Group Discussion

The Great Books Foundation has popularized the use of two chairmen in group discussion and the system is used today in many discussion groups. The success of its use is dependent largely upon the qualifications of the two leaders and their abilities to assume their particular responsibilities.

There are several advantages of the co-leader plan. Leadership is important in obtaining participation in discussion. The use of two leaders speeds up the discussion and facilitates thorough coverage of the subject. Either leader may ask questions. The questions asked by one may assist in leading the discussion in the direction of the goals that have been set. One chairman may act as a check on the other to see that no important information is left out. While one leader may lead the discussion the other may be role playing

The co-leaders help each other when discussion drags. Two persons can think better than one, and two persons can do a better job of analyzing the reactions of the participants than can one person.

Usually when two leaders are used they sit together at one end of the table, if the group is seated at a table, or they sit together on one side of a circle, if the group is so situated. The two persons should share equally the responsibilities of the chairman. It is important that the two persons be able leaders and similar in ability and action. Two poorly trained leaders will not take the place of one capable leader. Special precaution should be taken to make certain that neither of the co-chairmen dominates the discussion.

The co-leader system works best in groups of less than twenty-five or thirty persons. It is not effective with larger groups.

Huddle Groups

It is difficult to get participation in discussion when large groups are involved unless the groups are for a time subdivided into smaller groups. This can be done quite easily.

When a basketball team goes into a huddle on the basketball floor they talk over their offense and defense and agree on a plan of action. The group is small. The five persons are close together and all can participate in the discussion. When a football team goes into a huddle, the quarterback does most of the talking. The group of eleven players is too large for all members to participate.

People normally form groups. Most informal discussion in the hotel lobby or after meetings is done by persons in small groups. A group of five is a normal conversation group. Physically and psychologically members in a group of five are close together.

The most common practice in using the huddle system is for the chairman to introduce the problem or issue, clarify it if necessary, and then motivate the group to want to do something about it. When they are properly motivated, he asks them to get their heads together

in huddle groups of five persons and talk over the problem. He suggests that one person be selected in each group to serve as leader and that they come up in ten to twenty minutes, depending upon the question under consideration, with the decision of the group concerning the answer to the problem.

During the huddle period the members of the group exchange experiences, share ideas, test possible solutions and finally agree on a possible solution.

When the allotted time has been used, or when it appears that there has been thorough discussion of the problem by all huddle groups, the chairman reconvenes the original group and asks the spokesman of each group to make a brief report. He or an appointed secretary summarizes the separate reports on a chalk board.

As the brief reports are made, the chairman may encourage questions from members of other groups, or he may hold up the questioning period until all huddle groups have reported.

When all groups have reported it is usually possible for the chairman to lead the discussion group in summarizing the principles that have been enumerated and in working out a plan of action. If additional information is needed, the chairman may provide it, or a study committee may be set up.

Buzz Groups

The buzz group technique is quite similar to the huddle method in that it is a device used to divide larger discussion groups into smaller groups. Two variations in the technique are used by educators and sociologists.

The most commonly used version of the technique involves dividing the original group to make up buzz groups of 12 to 15 persons.

The chairman usually introduces and clarifies the issue or problem to be discussed and motivates the group to the place that they want to discuss it. He can at this stage divide the large

group into buzz groups and assign each group a specific phase or sub-problem for discussion, or he can assign the same problem to all groups.

The method provides an excellent means of starting a meeting and getting the members of the group acquainted with each other. A chairman and secretary may be appointed in advance or selected by each group. The chairman makes certain that the members of the group become acquainted with each other. He leads the discussion and strives to get all members to participate. It is his responsibility to get the group to consider all facts and phases of the problem and to come to a decision as to the solution to the problem or issue.

The secretary makes note of the contributions made by the various members of the group and prepares a summary which is presented to the group as a whole when the buzz group discussion period has terminated. Usually the buzz sessions will require from 10 to 20 minutes depending upon the topic under consideration.

When the discussion leader reconvenes the group, he normally calls for reports from the secretaries of the various buzz groups before opening the meeting for general discussion and the raising of questions.

The use of buzz groups requires more complete change of seating arrangement than does the use of huddle groups. Each buzz group should be seated in a circle.

The second adaptation of the buzz group method involves the formation of two- or three-person discussion groups rather than groups of 10 to 15 persons. The groups may be formed without movement of people. Since only two or three persons participate in each group, there is little need for formality. One person in each group reports for the group. The method guarantees participation of all members of the group. Usually less time is allowed in using this version of buzz group method since fewer persons are involved.

Normally buzz groups of 10 to 15 persons are used when the original group numbers 40 or more people. With 30 or fewer people, small buzz groups may be used.

Phillips 66 Technique

The "Discussion 66" technique developed by J. Donald Phillips is a variation of the huddle system and is applicable to innumerable group situations in which democratic participation is desired. It may be used with small groups of 10 to 20 persons or with large groups of several hundred persons.

In using this system the large group is asked to form into smaller groups of six persons with as little movement of chairs as possible. If seats are not moveable as in an auditorium or classroom, groups of six persons can easily be formed by having the three in the front row turn and talk with the three persons directly behind them. By starting at one side of the room it is easy to divide the entire group into discussion committees in a few seconds. When persons are seated at tables, the groups may be formed by starting at one end of each table and having the first three persons on one side form a group with the three persons on the opposite side of the table.

It may be desirable when physical arrangements permit to split the group by use of another method. By estimating the total number in attendance by six, it is possible to determine the number of small groups that will be needed. The group then can be asked to count off by the number of sub-groups needed and a different area of the room can be assigned to the ones, twos, threes, etc. This process breaks up cliques, family groups and other groups which are seated together.

Each committee or sub-group is then encouraged to take a minute or two to get acquainted and to select a chairman and a secretary, as is done in using the huddle or buzz system. At the end of the "getting acquainted" and organization period, a clear and concise statement of the problem or issue for discussion should be so worded as to encourage specific single-statement answers.

The time limit for discussion is then started. "You will have just six minutes to come to an agreement as to the best answer to the problem. I will warn you when you have only one minute left." The chairman of each committee then attempts to get the viewpoint of each member of his group and they try to come to an agreement as to the best answer.

The overall discussion leader moves quietly from group to group during the discussion period and when necessary raises questions to stimulate or bring the discussion back to the subject under consideration. He leaves the group immediately, however, so that the members of the group do not direct their answers to him.

When each person in the group has expressed his opinion on the problem and it has been recorded by the secretary, the group selects the best one or two answers for the committee report.

At the end of six minutes the overall chairman reconvenes the group and calls for reports from the secretaries of the committees if there are ten or fewer groups. It is usually best to have each secretary report but one idea or answer the first time around. When all groups have responded, the chairman then can start around again, or call for volunteers. At this time questions may be raised or contributions may be presented by members of the total group.

An alternate plan may be followed in getting the reports from the committee secretaries. The secretaries may be asked to come to the front of the room, or to the stage, and participate as members of a panel.

In large groups it may be necessary to have the secretaries meet in another place where the opinions and solutions are further screened before a presentation is made to the entire audience.

The Phillips 66 technique is designed to obtain a quick mass of ideas, suggestions, attitudes or recommendations. It may serve as an interest approach when opening a meeting. It is not intended to be the meeting in its entirety. It is used to supplement other group discussion techniques.

Discussion Guides

There are two types of discussion guides. One involves people, the others deal with prepared outlines, questions or statements. Either type of guide may be used effectively in facilitating proper direction in discussion.

Persons

Individuals may serve as discussion guides. They are carefully selected because of their interest and knowledge of the subject as well as for their ability to influence people. They are usually assigned a specific responsibility in the development of the discussion. They may prepare for their assignment by reading about the subject, or they may obtain information from other persons. Each guide is given his cue in the progress of the discussion. As many as three or four individuals may serve as guides in one discussion meeting. Each guide has a specific contribution to make. The chairman or discussion leader determines not only the contribution to be made by each guide, but also the most appropriate time for him to make it.

It is important in using this system to make certain that the members of the group do not detect that the persons are serving as guides. Any artificiality detected by the group will hinder spontaneity of discussion. It is good practice for the chairman to provide ample opportunity for everyone to get into the discussion between and following the contributions of the guides.

Outlines

Some discussion leaders prepare and have duplicated an outline of the important items to be discussed. These outlines may be mailed or handed to the members of the group in advance of the meeting or may be distributed to them at the start of the discussion period. They are very effective both in stimulating discussion and in giving it the proper direction.

Leadership Team

The discussion leader is quite largely responsible for the success or failure of group discussion. As a result various devices and helps have been developed to assist him. Some of the devices that have been discussed in previous paragraphs involve the assistance of people, others involve only the use of materials.

The use of a leadership team of four persons has been found to be much more effective in group discussion than the use of one discussion leader alone. Four persons can do more things in group discussion than can one person, especially if they are trained for their specific responsibilities. A leadership team usually consists of (1) a discussion leader, (2) a process observer, (3) a recorder, and (4) one or more resource persons. The responsibilities of these persons as members of a leadership team are described in the following paragraphs.

It is not always necessary or possible to use a leadership team of four persons. The team may be composed of two persons, a discussion leader and a resource person, a discussion leader and a recorder or a discussion leader and a group observer. A three-man team may comprise a discussion leader and two assistants. A discussion leader aided by a recorder and resource person is an example of an effective three-man leadership team.

Discussion leader

The discussion leader serves as a member of the leadership team in much the same manner as he does when he has no assistants with the exception that he now has one or more persons to assist him. His responsibilities are shared. He can give full attention to his leadership responsibilities. The observer, reporter and resource person or persons assume specific functions normally assumed by the discussion leader. The leader's task then is eased providing he uses effectively the other members of the leadership team.

The discussion leader starts the meeting, or discussion, when the leadership team is used in much the same manner as when no

assistants are used. He, however, usually in the early stages of the meeting, introduces the process observer and recorder and explains their functions. He may introduce the resource person or persons at this time or he may defer the introduction until the discussion has progressed to the stage that their assistance is needed

As the discussion progresses the leader calls upon the process observer from time to time to report on the direction that the discussion is moving and the progress which is being made to reach the goals desired by the group.

The discussion leader relies upon the recorder for a careful record of the points or suggestions that have been expressed. He assists the recorder in getting summarizing statements from members of the group for the record. The leader may call upon the recorder from time to time to review the points which have been discussed. He may encourage the recorder to enter the discussion at will.

The effectiveness of the use of resource persons is quite largely in the hands of the discussion leader. It is his responsibility to see that they are carefully chosen and are involved at the most opportune time. It is his job, too, to see that they do not monopolize the discussion.

The discussion leader summarizes the meeting. He will, in doing so, call upon both the observer and recorder for their summaries He may call upon the resource persons, also, to ascertain if the conclusions drawn meet with their approval.

Process observer

The function of the process observer is to watch the group during the discussion and then report back to the group, from time to time, his ideas about what happened during the discussion. The process observer is primarily interested in the behavior and participation of the group. He usually does not participate in the discussion of subject matter. To become involved in what is being said will prevent him from giving full attention to how it is being said, and its relation to the goals that have been agreed upon. The process observer must be objective at all times, yet must not lose the feeling of membership in the group.

The observer may provide to the group several different kinds of information that will be helpful to it in improving its efficiency. A group may secure information about itself through the observer in getting answers to the following questions:

1. Have we agreed upon the goal to be reached?
2. Has the discussion been beamed at the goal or have we wandered off the course?
3. How far has the discussion progressed?
   Has the problem been diagnosed?
   Have the contributing factors been presented?
   Have we discussed all of the possible solutions?
   Are we ready to make a final decision?
4. Has the discussion been moving along satisfactorily or have we bogged down?
5. Are all members of our group participating satisfactorily?
   Have some members dominated in the discussion?
   Have we heard from only a part of our group?
6. Has the group matured to the place that all members are working together as a team?

The process observer may report and make suggestions to the group from time to time without being called upon to do so by the discussion leader, or he may wait for instructions from him. The report is informally made and should be brief. The observer may present data which he has tabulated, his observations, or expressions of his feelings. The members of the group may accept or reject the interpretations of the process observer. An effective observer, however, usually presents in his reports information that aids the discussion leader and the group in reaching the goals that they are striving to reach.

Recorder

The recorder serves as the secretary of the group. It is his responsibility to keep a record of the issues and questions that are discussed, the decisions that are reached, and the proportion of the group that seem to be in agreement.

The recorder, like the process observer, may ask questions or participate in the discussion at will, or he may wait for instructions from the discussion leader. Usually the members of the leadership team meet in advance of the meeting to agree upon procedures to be followed and responsibilities to be assumed by each member of the team.

The recorder normally reports to the group once or twice during the meeting, depending upon the length of meeting, and then summarizes the meeting at the close. He compares his notes on the discussion with the leader's recollections at the close of the meeting. He then edits or revises his notes and prepares a clearly written summary of the discussion.

Resource person or persons

Discussions sometimes bog down because no member of the group has the answers to some of the questions under consideration. A group can discuss as long as they have related information. There are times, however, when it is necessary to introduce information not available from the regular members of the group. The responsibility of providing this information is delegated to the resource person or persons when a leadership team is used.

Persons are usually selected as resource persons because of their knowledge of the subject, or their experiences in the field. They are usually persons who command respect. Often they are local persons. In some cases they are technically trained individuals who are considered specialists. Two or more resource persons may function in a discussion as members of a leadership team in much the same manner as do individuals participating in a symposium. The resource persons participate in the discussion informally. They do not make speeches.

The discussion leader may instruct the resource persons to participate in the discussion as they see fit with no introduction by the leader. In some cases the resource persons are instructed

to refrain from participation until called upon by the leader. The discussion leader should analyze carefully the probable needs of the resource persons and instruct them so that their contributions will be most effective.

Resource persons who leave the impression that they are authorities on the subject may discourage discussion. A good resource person does have the answers, but he presents them in a humble and informal manner. He encourages individuals to question him and perhaps to disagree with him.

In most cases resource persons are introduced at the start of the discussion and questions are directed to them as the needs arise. Most discussion leaders assume that there is no need to direct questions to resource persons as long as members of the group are able to provide correct answers. When incorrect answers or no answers come from the group, it is time to draw on the knowledge and experience of the resource persons.

Listening Team

There are two common uses of listening teams in group discussion. The teams may be designated listeners to take notes and question a formal lecturer or symposium participants, or they may listen,evaluate and question a group participating in informal discussion.

Each member of a good listening team keeps a record of the most important ideas presented by the speaker or speakers. He identifies the issues, the questions, problems and opinions developed by the participants.

The use made of the listening team varies with the type of meeting and the method of presentation. In group discussion, the team is usually called upon to summarize what has been said and to point out problems and concepts which are significant to the group, The team may be called upon periodically during the discussion, or may be called upon only at the close of the discussion.

A listening team may be used to summarize the important problems or concepts presented by a speaker, a panel or by a symposium. The team may make a summary at the close of the presentation, or it may question the speaker or participants before summarizing the salient points or problems which have been presented.

Listening team members must be carefully selected. It is important that they be persons who are well informed concerning the subject under consideration, yet persons who have no biases or axes to grind. They must be alert and sharp to interpret the sense of the presentation or discussion.

Normally listening team members do not enter the discussion unless the chairman calls upon them. Under some circumstances, however, the team members do participate from time to time as members of the group. They may assist the discussion leader in starting the discussion and in helping the group in deciding clearly the objectives or purposes the group wishes to accomplish.

The number of persons serving as members of a listening team varies. Most teams involve two or three persons. As many as five or six persons may be used, however, when a large group is involved and formal methods are used in presenting the subject.

Role Playing

Role playing is a comparatively new tool in adult education yet children have role-played for centuries. Probably one of the first uses of the role-playing technique in adult education was made by psychiatrists in the early 1900's to help patients recover their mental health. The process became known as a psychodrama.

The main emphasis in psychodrama is the problem or problems of a specific individual. The roles assumed by the individual are of a private nature. They should be attempted only under the guidance of a trained therapist.

The terms sociodrama and role playing are often used synonymously. A sociodrama deals with the interactions of people with other individuals or groups. Two or more persons are involved and they execute roles which deal with a problem common to the majority of the members of the group. The audience helps to interpret the roles.

Role playing defined

Role playing is the spontaneous acting out of a situation or an incident by selected members of a group to portray a human relationship problem which is common to members of the group. Roles are usually assigned to various members of the group who act out the problem situation. In most cases no script is used, however, considerable briefing and planning may precede the role-playing scene.

The usual procedure in role playing is for two to five members of the group to reproduce a situation which the group wants to study by acting out a brief scene as it would happen in real life. The other members of the group observe the performance.

The role playing scene usually lasts no longer than ten minutes. The discussion leader or the role players themselves cut the scene at the point where enough action has occurred to provide a basis for discussion. Group discussion then follows.

Advantages of role playing

Role playing has many advantages in group discussion. The most important of them are:

1. The method is new and novel.

2. It provides for more active participation by group members than do many of the discussion techniques.

3. It can bring before the group examples of human behavior and human relations which cannot easily be presented by use of traditional methods.

4. It introduces the situation to both actors and observers with a dramatic impact.

5. The group is drawn from a purely intellectual experience into an emotional experience.

6. It can arouse interest in a problem.

7. It can help to clarify a problem.

8. It provides a means of presenting to the group several possible solutions to the problem.

Dangers in role playing

Role playing is not a gadget or technique to use for fun or entertainment alone. Nor should it be used just to stimulate interest and discussion. It is a useful method when it is used thoughtfully and appropriately. A number of difficulties may be encountered when the method is used improperly.

1. Role playing is not always an appropriate method. The use of role playing can be worse than a waste of time when the situation is not suited to the use of the technique.

2. Role playing takes time. It should not be tried unless there is sufficient time for the dramatic skit and adequate group discussion following the skit. A speaker, a role-playing demonstration and a discussion in one meeting is too much.

3. Role playing can be very ineffective when it is considered as an end rather than a method of reaching a desired goal.

4. An effective role-playing scene is usually short. The method becomes ineffective if used too long. The scene must be cut at the proper time.

5. Sometimes the role play is above or below the level of understanding and maturity of the group.

6. Groups should not attempt to deal with problems that are not their own or at their level.

7. Role playing can be ineffective or even worse when incapable persons are assigned to play the various roles. The method can be no better than the persons assuming the various roles.

8. Role playing is ineffective when there is only one answer to the problem.

9. It is dangerous to use the role-playing technique when it may embarrass or "put on the spot" some member or members of the group.

The role-playing process

The success of the role-playing process is quite dependent upon the resourcefulness of the director, and his ability to help the actors to be spontaneous in assuming their respective roles. The director may be the president of the organization, the chairman of the meeting, or a member of the group who is familiar with the role-playing process.

Role playing as an educational process involves a series of steps. The director must understand each of these steps and acquaint the members of the group with them. The acting out of roles actually represents but one of the steps. The other steps prepare the participants and observers for the action, or helps them interpret it.

The steps usually associated with the role-playing process are:

1. Defining the problem.
2. Establishing a situation.
3. Casting of characters.
4. Briefing of participants.

5. Acting out of roles.
6. Cutting.
7. Discussion and analysis of the action.

Defining the problem. Participation of the group in the selection and defining of the problem is desirable. The problem should be significant and close to the people playing the roles as well as to the observers. The problem must be valid and clear. It must be sufficiently simple in order for the participants to discuss it rationally. Care should be taken to avoid problems which would uncover deep-seated issues which would distract from the purposes of the role-playing process. The observers as well as the actors must understand the problem thoroughly.

Brainstorming

A relatively new term which has been introduced in adult education methods is brainstorming. Brainstorming is a form of creative thinking in which judicial reasoning gives way to creative initiative. Participants are encouraged to list for a period of time all the ideas that come to their minds regarding some problem and are asked not to judge these ideas during the brainstorming session. Judgment of the ideas will come at a later period in which all contributions will be sorted, evaluated and perhaps later adopted.

Ideation or imagineering are two terms often used to describe brainstorming. Everyone is encouraged to "free wheel" in his imagination and to curb his thinking in no way by questioning the practicality of what he and others are suggesting as solutions to a problem. Quality of suggestions steps aside for quantity of suggestions. Freedom of expression is the rule and it is hoped that participants will feel free to combine or modify ideas contribut by others in the brainstorming session.

Brainstorming can be used in new inexperienced groups but is most effective if preceded by orientation ahead of time. Recently tl

author assisted in a brainstorming session of a small group of school superintendents in which they were asked to offer suggestions on "What I would do back home in school administration if I only dared." This was a situation in which it was hoped a long list of ideas would be presented with evaluation of the ideas to come later. The brainstorming as a technique was quite well accepted but it was impossible to get the participants to divorce themselves from practicality. "Yes, but" was in evidence as a response to almost every idea. Creativity was curbed by an evident urgency to "Let's keep our feet on the ground and not go off the deep end into the impossible." No doubt this same group of highly intelligent people could be oriented to brainstorm most effectively after some explanation and training in the technique.

Specifically, brainstorming should develop creativity. Some of our most important decisions in business and industry, as well as in the fields of literature and music, have grown out of someone's brainstorming. It should be noted that the value of brainstorming is just as important, or perhaps more so, as engaged in by individual as it is when used in groups. Those who are fortified with a whole list of creative ideas are better equipped to solve old problems. Their own mental blocks tend to be overcome as they sidestep old habits and past experiences and push into the field of creativity. Business and industry have found that, by developing brainstormers among their employees, long lists of creative ideas have been built, communication between employers and employees has been improved, morale and better understandings have been assured.

There are many ways of organizing brainstorming groups. It must be remembered that the process of brainstorming is a most important experience for the individual, perhaps more important than the end results or final action growing out of the brainstorming experience. The ground rules should be thoroughly understood by the participants. The following points should be observed:

1. Judgment of ideas must be deferred to a later time.

2. Each person should be encouraged to "free wheel" even though his ideas may be wild. Ideas can be tamed down much easier than they can be thought up in the first place.

3. "Hitchhiking" and/or riding "piggyback" on other's ideas should be encouraged, especially if the new slant on the original idea adds to creativity of the group thought process.

4. Positive, dynamic ideas only should be accepted. "Yes, but it won't work" thoughts are ruled out entirely.

5. Perhaps less than 10 percent of the ideas will probably be usable in the final analysis so this means quantity of ideas must be stressed.

6. Brainstorming is most effective in a relatively small group of people, perhaps not more than 12 to 15.

7. A time limit of not more than about one hour is most effective for groups. Mental fatigue, ridiculous responses and uneasiness on the part of participants because of an urgency to get things done, all tend to set in if brainstorm is prolonged indefinitely. Many participants will go home still engaging in brainstorming individually, all of which is very good.

8. The leader of the session should see to it that:
   a. The group members fully understand the brainstorming process.
   b. Likewise, they fully understand what the problem is that the brainstorming will revolve around.
   c. Negative or "killer phrases" be kept to a minimum.

d. Intermittent ideas be thrown in to trigger thinking so as to avoid pauses in discussion.

e. He as a leader stays in the background as much as possible.

f. The recorder is keeping a record of all ideas so that sorting and sifting can be done in the subsequent evaluation.

g. Both the immediate opening remarks and those given in the closing few minutes be carefully recorded. Authorities do not agree completely as to what intervals of time are best for the production of ideas to be most fruitful; some say at the beginning, others believe after the leader has suggested there are only so many minutes left for the discussion.

9. If possible, one might wish to contact the discussion members a day or two later to see if any other ideas have come to their minds.

10. In sifting and evaluating the ideas, those which are unusable should be eliminated, but only after an attempt has been made to identify those which can be used immediately and those which need further study.

Some of the limitations to brainstorming are that:

1. The process is time consuming, particularly where less than 10 percent of the ideas are ultimately usable.

2. Like any discussion group, the productivity to the brainstorming session is dependent upon the abilities and quality of orientation of the participants.

3. Its ultimate value might come more in what it does to participants rather than in what productivity occurs immediately in the brainstorming session, and this value cannot be measured with any degree of accuracy.

Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 3-D

Internal Operations - Leadership Development

Produced by the

Rurban Educational Development Laboratory

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University of Illinois
Urbana, Illinois 61801

Staff Assistants:

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Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Internal Operations (3)

Concern: Leadership Development (D)

Objectives: After instruction, the student is able to:

1. Recognize the different types of leadership.
2. Identifies or recalls methods or procedures used in leadership.
3. Assume responsibility for effective functioning of work groups.
4. Demonstrate self-reliance when working with a group.
5. Demonstrate the ability to listen and correlate instead of dominate.

Suggested Teaching Techniques:

1. Have class members identify the different roles that leaders may take in the community.
2. Use a consultant, as a resource person, to discuss the importance of community leadership.
3. Use a resource person to distinguish the requirement of different community leaders.
4. Determine a process for identifying community leaders.
5. Establish a leadership situation and decide the best type of leaders wanted and how to deal with undesirables.

Suggested audio-visual Aids:

1. A film strip on community leadership would be a good introduction to this unit.
2. The chalkboard and overhead projector will be useful in programming in areas for discussion.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. What are the three types of leaders?	Leaders seemingly are all of the same type. On an analysis of the characteristics of each the following emerge: 1. Position leader. This individual is the leader because of his social, religious, cultural, or political position. 2. Emerging leader. This individual comes from within the group to meet the problem and when the problem is met, the individual goes back into the group. 3. Manipulative leader. This individual is often dictatorial and uses diverse ways to get a job done. This individual often uses people indiscriminatly. <u>Suggested Techniques</u> A. Ask class members to identify the three types of leaders or more listed above. B. Conduct a class discussion to review and determine the characteristics of the different types of leaders.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. (Continued)	C. Carry on a role play situation and have class identify the type of leader. D. Write actual leader situations, present them to the class and have class identify the leader type.
2. What kind of leadership is within a group?	Every individual in a group is a leader in some way. The contribution of each person can be a form of leadership. The following list is part of those who make up leadership. 1. Group leader is the person to take charge of or to open and close the meeting. 2. Content leader is a resource person who gives answers to questions that fall in his particular range of knowledge. 3. Negative leader is the person who is always against what is brought up or suggested. Often this person is negative just to be opposite the majority.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
2. (Continued)	4. Question leader is always asking questions. He often will have no answer but phrases new questions for every answer. He stimulates deeper thinking on other unthought of areas. 5. Idea leader is the person with a "brainstorm" mind. No particular questions or solutions but a wealth of ideas. 6. Apathy leader takes it all in as a topic is discussed. Votes with the majority but doesn't do a thing about it. This person has the idea that everything will work out in time. <u>Suggested Techniques</u>: A. Have the class generate a list of the different types of leaders within a group. B. Have the class identify the characteristics of each type of leader in the above list and add any they think of. C. Conduct a panel discussion and identify the different people who use each leadership role.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
2. (Continued)	D. Have a small group conduct a committee meeting while the class observes. E.
3. Where is the power structure in the community?	The power structure in any community generally does not lie with the group leader. The group leader conducts the program but individuals who control votes, money or people compose the power structure. Often the power structure is an unknown to the public and could be the barber of the group leader or the head janitor in the school. In other situations it could be the priest or minister where there is a dominant church in the area. Civic organizations to which the businessmen belong often end up as the power structure and hold business men's cooperation as the stakes to get community leaders to do what they desire. <u>Suggested Techniques</u>: A. Conduct a discussion of power structure and identify if possible some of the situations listed abo

Anticipated Problems and Concerns	Guides to Solutions and Sample Teching Techniques
3. (Continued)	B. Invite a resource person to discuss power structure and how to utilize it in your organization. C. Discuss the effects of a power structure on a school system and what its effect will be on education. D.
4. How do you develop leaders?	Since leadership is action-oriented, development of leaders is by doing. Unless an individual has an opportunity to either lead or role play, he will not be as effective a leader as he would have been with the chance to lead. <u>Suggested Techniques</u>: A. Divide the class into groups, assign a topic and watch the leadership develop. Do not tell the group to pick a leader but let the leader emerge according to the group. B. Divide the class into groups, assign a leader and watch the leader handle the situation. Give the leader a topic outline and ask him to get the outline duplicated by the group without showing the group the outline.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
4. (Continued)	C.
5. What are some tec.. techniques and skills of leaders?	1. Never compete with group members. 2. Specific time for the leaders remarks should be set aside. 3. Listen to group members. 4. The leader should establish his intent. 5. Don't permit anyone to be on the defensive. 6. Avoid pinning down an individual. 7. Use every member of the group. 8. When you are the leader, give it your best. 9. Keep the meeting moving at a fast pace. 10. Keep members informed about where they are and what is expected of them. 11. Do not manipulate the group. 12. Work hard at the technique of leadership. <u>Suggested Techniques</u>: A. Through class discussion generate the above list.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
5. (Continued)	B. Divide into groups and discuss different principles of leadership and how to apply them. C. D.

Suggested Evaluation Techniques

1. Use the class as the evaluator of how a leader handled the problem and his committee.
2. Observe students in a role-playing situation to determine the effectiveness of the teaching unit.
3. Observe personal interaction within the class for cues of leadership techniques.

Recommended Resources

Morgan, Barton, Holmes and Bandy, Methods in Adult Education, Iowa State University, Ames, Iowa, 1963, pp. 81-93. (Source: The Interstate Printers and Publishers, Inc., Danville, Ill. 61832).

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Phipps, Lloyd J. and Knell, Kenneth, The How of Successful Citizen Advisory Committee Operation, University of Illinois, Urbana, 1968 pp. 14-17. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois 75¢).

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Speech by Mrs. Shulman
given on
February 14, 1963

As Mr. Shrader told you, I am a school board member, and I find that members of citizens committees and members of boards of education have much in common. Perhaps our greatest difference is that boards of education are action groups. We have certain responsibilities and we must take action in order to carry them out. Citizens committees are advisory groups. You make studies and recommend to the board certain action to be taken, but you never act--in that sense. However, I think our similarities are the most important. Certainly, members of citizens committees and members of boards of education should be vitally interested in the education of all children. We should serve with an open mind and a broad outlook. Members of both groups must be willing to read and listen in order to understand school matters, and all of us must wholeheartedly want excellence in education.

Persons chosen as members of citizens committees have a unique opportunity to learn and to serve. Most of us come to citizens committees, and to school boards, with very definite opinions of how schools should be run and what they should accomplish, and although we may remain opinionated as long as we serve, our opinions become educated.

I have found it to be a stimulating and challenging experience to view the many facets of education from both sides of the table and as one does this one becomes more and more aware of what administrators and boards of education are trying to accomplish. A board of education is made up of seven lay citizens; a good working citizens committee usually has 12 to 15 members. Add to that 50 or 75 people who might temporarily be working on sub-committees, depending on how large a project the committee has undertaken. When you have that many people learning and understanding the workings of a school system, this knowledge is transmitted throughout the community, and this, to my mind, is the finest contribution a citizens committee can make.

Lay Citizens Advisory committees bring together the various viewpoints that exist in a school district. Boards of education and citizens committees are not always in agreement, but this is why boards need citizens committees. For instance, a larger representation of the community might point out to the board that its educational goals are not the same as the community's. Together the two groups can determine that "what" and the "why."

What are some of the ground rules? As I see it, a new board member and a member of a citizens committee need some of

the same guidelines to become contributing and valuable members. Some of these guides that I present to you are mine; some, and I am pleased to quote them, are Sarah Lory's, a member of the Fairfax County School Board of Fairfax, Virginia.

1. Go slow in the beginning--especially if you think that you are serving to "reform" the school system. The chances are you will feel differently about a lot of things six months after you are on the committee.

2. Make a real effort to be informed. To be informed will require time, effort, and a compelling interest on your part. And along with this, do not hesitate to ask questions. Seek information from the administrative staff, the supervising staff, the board, the teachers. And at your meetings, feel free to ask anything you want to know about your school district. Some members sit back, afraid to ask about the very thing that has been perplexing them for fear the superintendent or the board representative might take offense. This is not the case. If a board and its superintendent want a citizens committee, they want your understanding and they welcome your questions.

3. Do not become discouraged if you cannot see any immediate results. The progress of a citizens committee is slow, especially at first. You need to get your feet on the ground--there is so much to learn. Some of you don't even know the purpose of a citizens committee when you are invited to serve on it. But all the while that you are adapting to your new role, you are learning, and as you learn you discuss these things with others--at the barber shop, the beauty parlor, at a coffee break or the luncheon table; over the backyard fence or at get-togethers in your homes, and without even being aware of it, you are accomplishing something great--UNDERSTANDING!

4. And finally, accept your job as a member of a citizens committee as one of responsible leadership in the community. As you broaden your knowledge and your viewpoint you can help clear away doubts, misconceptions, and misunderstandings. Like the valuable board member, you can help formulate public opinion and thereby create an active, intelligent and strong public support for the schools. Throughout the state there are committees with such success stories. This is what we all want--the public's understanding and support of the public schools.

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 3-E

Internal Operations - Induction of New Members

Produced by the

Rurban Educational Development Laboratory

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Staff Assistants:

W. Edward Shipley Richard Hofstrand

Resource Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Internal Operations (3)

Concerns: Induction of New Members (E)

Objectives: After instruction, the student is able to:

1. Recognize and recall the purpose of Citizens' Advisory Councils.
2. Identify principles of good public relations.
3. Identify factors that influence the way to inform public.
4. Recall and recognize the essential function of the member within the committee.

Suggested Teaching Techniques:

1. Have a member of the class give a short discussion on purpose and function of Advisory Committees.
2. Invite a resource person to speak on the different principles or parts of public relations.
3. List different types of news or information media and discuss how to give information to each.
4. Divide class into three small groups and have an induction - identification situation for discussing areas and problems that are involved in Citizens' Advisory Councils.
5. Put a topic on the board with a few facts - have class complete the composition.

Suggested Audio-Visual Aids:

1. Newspaper articles, cuts, radio announcements, tickertape - show how its put together and the key words.
2. Get a Dale Carnegie tape for listening pleasure.

Anticipated problems and Concerns	Guide to Solutions and Sample Teaching Techniques
1. What is the responsibility of the school board to the new members of the citizens' committee?	1. Mail a letter of invitation to membership with a copy of the board's resolution of the committee and a copy of the procedures in organizing and conducting the committee. 2. It is helpful for two representatives of the board to call on each new member to urge his acceptance and to answer any questions. 3. A prospective member should be given to understand that he is joining a particular committee that has: a. certain responsibilities b. certain modes of operation c. specific relationships d. certain restrictions upon its prerogatives e. advisory status only f. no action orientation. 4. They may accept or reject knowing what they are accepting or rejecting.

Anticipated problems and Concerns	Guide to Solutions and Sample Teaching Techniques
1. (Continued)	<u>Suggested Techniques</u> A. Have students read Hamlin, pages 16 and 17 and then respond in open class discussion. B. Through class discussion generate a list of desirable school board new member induction techniques. C. Have students write down their interpretation of their selection for the citizens' council. Divide into small groups and discuss. D.
2. What should be the agenda for the first meeting of the year when new members are present?	The agenda projectively should include: 1. A short talk by the board president or his representative. 2. A short talk by the superintendent. 3. A short talk by someone from outside the committee who has had experience with citizens' groups. 4. An overview discussion of the purposes of the citizens' advisory council.

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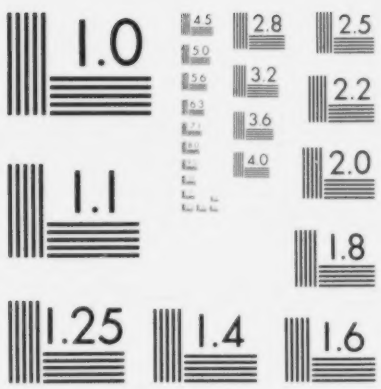

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Anticipated problems and Concerns	Guide to Solutions and Sample Teaching Techniques
2. (Continued)	5. A summary of what was accomplished in the past year. 6. A review of the new years' projected program. <u>Suggested Techniques</u>: A. Compare and discuss opening meetings and the briefings some individuals received as inductees. B. Develop an agenda or a criteria for the first meeting. This could be similar to the one provided or one which the class feels would be the most successful. C.
3. What is the function and relationship of new members to other members of the committee?	When the induction process of new members is followed as has been described and the individual accepts the responsibility of serving as a member, he has indicated his readiness to work. The nominee should not accept the request if they do not have the time or do not have sufficient desire to do a good job. The work of citizen advisory is not without its rewards, but dedication to the cause is required.

Anticipated problems and Concerns	Guide to Solutions and Sample Teaching Techniques
3. (Continued)	<u>Suggested Techniques</u>: A. Have class members respond in writing what they think the relationship between old and new members should be. B. Conduct a class discussion on the topic of new and continuing members with associated responsibilities of each. C. Have class members suggest ways of getting to know each other because in a lot of cases the new members will not know the continuing members and vise-versa. D.
4. What are some principles of good public relations?	Principles of good public relations are: 1. Keep the public informed. 2. Keep the committee informed about public attitudes. 3. Evaluate past work and ask questions such as: a. How well did our message reach the citizens of this area? b. How well did we get our message across?

Anticipated problems and Concerns	Guide to Solutions and Sample Teaching Techniques
4. (Continued)	c. How well did we get the reaction of groups to our report? <u>Suggested Techniques</u>: A. Conduct class discussion on principles of good public relations. B. Have a volunteer panel discuss the pros and cons of public relations and its effect on the public school. C. Invite a resource person to discuss with the class the topic of public relations. D. E.
5. Who should inform the public and what are some ways of informing the public?	Informing the public is a major problem in any area or field. The citizens' advisory committee of its own volition should not inform the public. Any information for the public is sent to the appropriate representative of the school board with a request for publicity. The school board either sends out the publicity or authorizes the advisory council to take care of publicity. Until

Anticipated problems and Concerns	Guide to Solutions and Sample Teaching Techniques
5. (Continued)	information is published or authorization is given, the advisory council does not use the publicity media. Ways to inform the public are diverse. The following is only a brief list: 1. By word of mouth 2. Newspapers 3. Radio 4. Television 5. Organizations 6. Public speakers 7. Publications 8. Circulars 9. Pictures 10. Films <u>Suggested Techniques</u>: A. Conduct a class discussion relative to publicity and the advisory council. B. Invite a publicity consultant to class to discuss effective ways and means.

Anticipated problems and Concerns	Guide to Solutions and Sample Teaching Techniques
5. (Continued)	C. Have a subcommittee or a small group of classmembers present a demonstration and samples of publicity. D.
6. What is the purpose of a public relations subcommittee?	The purpose of the subcommittee is threefold: 1. To collect all the facts, figures, and important news items concerning what the survey subcommittees are doing and trying to do, and to get information to all the people in the community. 2. To provide and promote ways and means by which the general public can present ideas and opinions to the advisory committee. 3. To facilitate communications among advisory members themselves. <u>Suggested Techniques</u>: A. Discuss in class the feasibility of a public relations committee. B. In small groups formulate policy and procedures for the public relations committee. C.

Suggested Evaluation Techniques:

1. Evaluate written material to determine further approach to a specified topic.
2. Conduct an in-class survey to determine the value of different publicity media.
3. Observe the effects of negativism in relationship to publicity.
4. Write a list of things you would like to know if you were a new member then ask - do I have answers to all of these?
5. Review the interpretations of what others have written.

Recommended Sources:

Sumption, Merle R., How to Conduct a Citizens' School Survey. New York, 1952, pp. 182-187. (Source: Prentice-Hall, Inc., 70 Fifth Avenue, New Yor, New York).

Phipps, Lloyd J., Handbook on Agricultural Education in Public Schools. University of Illinois, Urbana, Illinois, 1965, pp. 54-60, 79-85. (Source: The Interstate Printers and Publishers, Inc., Danville, Illinois 61832).

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, 1963, pp. 16-17. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois 61801; Price: 50¢).

Phipps, Lloyd J. and Kenneth Knell, The How of Successful Citizen Advisory Committee Operation, University of Illinois, Urbana, Illinois, 1968, pp. 15-17 and Appendix I. (Source: REDL - address on cover, Price 75¢).

TEACHING SOURCE UNIT

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 4-A

Activities and Operation--Conducting Surveys

Produced by the

Rurban Education Development Laboratory

Dr. Lloyd J. Phipps, Director
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University of Illinois
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Richard Hofstrand W. Edward Shipley

Resource Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit. Activities and operation (4)

Concern. Conducting surveys (A)

Objectives. After instruction, the student:

1. Identifies the different types of surveys that can be administered.
2. Recalls and recognizes advantages and disadvantages of surveying.
3. Identifies instruments used in surveying.
4. Identifies factors that will influence the kind and the length of a particular survey.

Suggested Teaching Techniques

1. Using the overhead projector, with the help of the class, design a survey to fit a special need.
2. Have students generate a list of survey items, write them on the chalkboard, and discuss the advantages and disadvantages of each.
3. Have students generate a list of survey items individually and then divide into small groups to discuss and formulate the best survey items. Each group leader will present their formulation to the class for further discussion.
4. Invite a special consultant to speak to the class, on surveys and surveying.

Suggested Audio-Visual Aids

1. The chalkboard should be utilized to itemize the generated survey topics as they are presented by the class.
2. The overhead projector with acetate sheets could be used very effectively to project prepared survey forms for all the class to see at one time.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. What is a survey and what are its purposes?	A survey is a means of collecting data. There are many techniques in the use of surveys that make them more valid, more reliable, and easier to use. Suggested Techniques A. Ask the class to respond to the question, "What is a survey?" List the ideas put forth by the class on the blackboard. B. With the ideas listed on the blackboard either hand out a mimeo sheet or use an acetate sheet on the overhead projector, to give some examples of good survey forms. C. From the examples, give the class a chance to determine the best parts of the survey and why.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
	D. Discuss in class the relationship between a purpose or need and a survey instrument.
2. What is a sample?	Sampling, instead of surveying the whole population, decreases the work involved but does not reduce the reliability of a survey if certain precautions are taken to ensure that the sample is representative of the community. Use surveying when absolute numbers must be used for an answer. <u>Suggested techniques</u> A. On the chalkboard, draw an illustration of a sample and describe the characteristics of such a process. B. Have a member of the class describe samples or sampling.
3. What areas or groups are representative of our community?	1. Geographical distribution 2. Age 3. Type of business 4. Owners or tenants 5. Religion 6. Nationality 7. Education or profession

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
	8. Sex 9. Ethnic group 10. <u>Suggested Techniques</u> A. Ask class members to generate a list similar to the one provided above. B. Conduct a class discussion concerning problems of representation with these groups or areas. C. Generate a list of ways to achieve representation within the community. D. Invite a resource person or consultant to speak on involvement of factions and dissidents within the community.
4. What are the advantages and disadvantages of surveying?	A. Advantages: 1. Gives exact information 2. Establishes present situation 3. Feels the pulse of the public 4. B. Disadvantages: 1. Very time consuming for a large population 2. Requires a large number of people to conduct

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
	3. Doesn't always give the exact information required. 4. Can be subject to interpretation. <u>Suggested Techniques</u> A. The class may generate a bit of survey items. B. Conduct a discussion as to what information is required and how best to collect it by using the survey. C.
5. What are the different types of surveys?	The three types of surveys are 1. Projective survey 2. Present or existing condition survey 3. Evaluative or follow-up survey
6. What kind of surveys are there and how often should they be conducted?	Some different kinds of surveys are 1. Projected enrollment 2. Current enrollment 3. Bussing needs 4. Occupational needs 5. Occupational desires of employers 6. Occupational desires of students 7. Evaluative as to job, salary 8. Safety

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
	<u>Suggested Techniques</u> Questions 4-6 tie very closely together A. Using the generated survey items, discuss the best possible times for conducting each survey. B. Determine who establishes need for a specific survey by reviewing policy. C. Structure a survey within the group outlining process and procedures to be used. D. <u>Suggested Evaluation Techniques</u> 1. Subjectively evaluate the written work of the class member. 2. Use the class as the evaluator of individual group presentation of their best survey items. 3. Observe student in a role-playing situation to determine the effectiveness of the teaching unit.

<u>Recommended Teacher Resources</u>

Phipps, Lloyd J. and Kenneth Knell, <u>The How of Successful Citizen Advisory Committee Operation</u>, University of Illinois, Urbana, 1968, Appendix B and D. (Source: REDL, 357 Education Bldg., University of Illinois, Urbana, Illinois 61801; Price 75¢).

References and Sources (In addition to above).

Phipps, Lloyd J., Handbook on Agricultural Education in Public Schools. Danville, Illinois: The Interstate Publishers, Inc., 1965, pp. 92-94.

American Vocational Association, The Advisory Committee and Vocational Education, Washington, D. C., 1969, pp. 18-19. (Source: Publication Sales; American Vocational Association; 1510 H. Street, N. W.; Washington, D. C.; Price: $1.25).

Illinois State Office of the Superintendent of Public Instruction, Evaluation, Supervision, and Recognition of Schools, Circular Series A,No. 160, Springfield, Illinois, 1964, p. 52. (Source: The Office of the Superintendent of Public Instruction, Springfield, Illinois).

Oxford, Roger W., College-Community Consultation, DeKalb, Illinois, 60115, 1867, pp. 26-31. (Source: Northern Illinois University, Division of Adult Education, DeKalb, Illinois).

Totten, W. Fred and Frank J. Manley, The Community School, Galien, Michigan, 1969, pp. 196-209. (Source: Allied Education Council, Galien, Michigan 49113).

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TEACHING SOURCE UNIT

CITIZENS ADVISORY COUNCILS IN EDUCATION

Unit 4-B

Activities and Operation--Development of Objectives and Policies

Produced by the

Rurban Education Development Laboratory

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Resource Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit. Activities and Operations (4)

Concern. Development of Objectives and Policies (B)

Objectives. To develop within citizens the ability to:

1. Identify and recall the steps in policy making.
2. Distinguish concepts, principles, and generalization in policies.
3. Identify consequences of no policy.
4. Apply policy concepts, principles, and generalizations to new situations.
5. Distinguish between policies and objectives.
6. Identify objectives for use by Citizens' Advisory Councils.
7. Recognize objectives in relation to policy in public education.

Suggested Teaching Techniques

1. By invitation have a superintendent of schools come into the class and present some policies of the secondary school system. Discuss these to get understanding as to what a policy consists of.
2. Have each class member write policy or policies about a particular topic. Present these policies to the class for review and evaluation.
3. Divide class into small groups and generate ideas that could formulate policy.
4. Divide class into two groups--generate policy items and then assign one side pro and one side con and debate the policy implication and involvement.
5. Collect a series of policies that are already in effect and review the ramifications and conditions.

Suggested Audio-Visual Aids

1. An opaque projector could be used to show class difference policies without having a copy for each student.
2. The chalkboard can be used to list class-generated items.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
1. Policy making	The American system places the responsibility for public policy upon the citizens of the country. Relevant questions are: A. What are policies? B. Who makes policies? C. What are the steps in policy making? <u>Suggested Techniques</u> A. Have class members read pages 3-9 in <u>Citizens Participation in Local Policy Making for Public Education</u>. B. Collect policy statements from different schools, civic groups, businesses, etc., for review. C. Evaluate the different policy in an effort to pick out bias and determine who developed the policy. D. Request the class to generate a list of steps in policy making comparable to those provided in Citizens Participation in Local Policy Making for Public Education. E. Have class members generate general topics to write policy for. Divide class into small groups and have each group select a chairman and a secretary.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
	The group develops the most important policies for the topic selected by the group. After 20 minutes each group will present topic and policies to class for evaluation. F.
2. What is an objective and how is it related to policy?	An objective is a determination of what accomplishment is desired. An objective is often referred to as a goal. Policy, rules, and regulations are the vehicle to achieve objectives. Objectives and policy facilitate philosophy. <u>Suggested Techniques</u> A. Have class generate a list of topics or areas for achievement. B. Have each student write objectives to a selected topic. C. Divide class into small groups and compare objectives. Carry out evaluation in the small groups. D. Conduct a class discussion on the relationship of objectives to policy and rules. E.

Anticipated Problems and Concerns	Guides to Solutions and Sample Teaching Techniques
3. How are Citizens' Advisory Committees involved in developing objectives and in policy making.	The process of education changes slightly from time to time and to keep education viable it is necessary to evaluate education. As a result of this evaluation suggested objectives and associated policies must be changed. Suggested Techniques A. Have class evaluate policies and objectives to determine the relevance for today. B. Have the class generate other areas that objectives or policies could be initiated that are not currently involved and then write on an individual basis their contributions.

Suggested Evaluation Techniques

1. Subjective observation of written assignments by class members.
2. Observe individual students as they respond to a situation.
3. Self-evaluation of students.

Recommended Sources

Phipps, Lloyd J., Handbook on Agricultural Education in Public Schools, Danville, Illinois: The Interstate Publishers, Inc., 1965, pp. 60-65.

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, Urbana: 1963, pp. 3-9. (Source: REDL, 357 Education Building, University of Illinois, Urbana, Illinois 61801. Price, 50¢.)

References and Sources

Ahman, Stanley J. and Marvin D. Glock, Evaluating Pupil Growth, Boston, Massachusetts: Allyn and Bacon, Inc., 150 Tremont Street, 1963, pp. 7-72. Price, $6.00.

National Citizens Commission for the Public Schools, How Can We Conduct a Winning Campaign? New York, New York 10036: 1955, Work Guide No. 3C, pp. 23-24. (Source: National Citizens Commission for Public Schools, 2 West 45th Street, New York, New York 10036.)

Wright, Elmer, Sample Policy Statements, University of Illinois, Urbana, Illinois, 1970.

Phipps, Lloyd J. and Kenneth Knell, The How of Successful Citizens Advisory Committee Operation, University of Illinois, Urbana, Illinois, 1968, Appendix E. (Source: 357 Education Building, University of Illinois, Urbana, Illinois 61801. Price, 75¢.)

The Policy-Making Process

A satisfactory arrangement for policy making in a school district would have the following minimal provisions:

1. A board of education that understands its responsibility for policy making, knows the laws and regulations of its state within it can function, knows the arrangements for policy which are needed, and will provide them.
2. A widely spread understanding that policy proposals from any source will be welcomed, heard, and considered by the board.
3. Administrators who understand their responsibility for proposing policy and who have the courage and vision to provide leadership in policy revision.
4. Organization of the professional and nonprofessional staffs of the school system for proper participation in policy development.
5. A system of citizens committees to propose and review policies.
6. Consultants from within and without the district who can help to guide the policy-making process and supply needed information.

Four Steps in Policy Development

1. Codify existing written policy. Reduce to writing unwritten policy that is currently operative and include it in an organized policy statement.
2. Provide the best possible answers to the five basic policy questions.
3. Compare these answers with those the school system has been giving and with those other school systems have given.
4. Devise a new statement of policy, try it out, and revise it as revision is needed.

Basic Policy Decisions

1. How is public policy for the school system to be developed, interpreted, executed, and publicized?
2. Who are to be served by the public schools? How? How much? When? Where?
3. What public purposes are to be served by the public schools?
4. How is the public to decide whether its purposes are being realized?
5. What provisions will the public make for organization, administration, program planning, staff, funds, and facilities, so that its purposes can be realized?

APPENDIX II

Same Policy Statements

Elmer Wright, Jr.

Legal authority

Reimbursement of classes for Public Aid Recipients participating in the Adult Basic Education program and the General Education Development program shall be for the entire cost of such instruction.

Tuition charges

Tuition charges and reimbursement shall not exceed the total cost of the adult education program. The interpretation of cost of the program is that total costs shall include such items as instruction, supervision, guidance and counseling, facilities, equipment, and other items directly attributable to the operation of the adult program.

Units of credit

A unit of credit in an adult high school shall be awarded for knowledge, skill, or competency equal to that normally required to earn credit in an equivalent course in a regular accredited secondary school.

Credit and residence requirements for graduation

Graduation requirements in a north-central association adult high school shall be the same as set forth in criterions II 2.70 (criterion ICA of present criteria), except that no adult student may be graduated until a minimum of four semester credits have been earned in residence at the adult high school.

Professional staff

The regulations and requirements concerning professional staff shall be the same as set forth in criterion III (criterion IV of the present criteria) except that for noncredit courses the qualification of teachers shall be the subject to the discretion of the local governing board.

Adult basic education program

Scope of program. The Superintendent of Public Instruction shall designate programs of instruction designed to eliminate the inability for adults to read and write English and to substantially raise the general educational level of such adults with a view of making them less likely to become dependent on others, to improve their ability to benefit from occupational and homemaking training, and to otherwise increase their opportunities for more productive and profitable employment, making them better able to meet their adult responsibilities.

Teacher certification

Teacher in an adult education program must hold a valid teaching certificate issued by the State Teachers Certification Board. All teachers of adults not certified and holding a standard certificate may be issued a general certificate as authorized under Sections 21-11 of the School Code of Illinois.

Counseling and library services

Adult high schools shall provide counseling services adequate to the effective formulation of realistic individual programs of study. Library facilities and privileges shall be made available to students and to adult high schools.

APPENDIX III

Decision Making in the School Districts

H. M. Hamlin, Teacher Education, University of Illinois

There are important decisions about agricultural education in the school districts of Illinois that should be faced and not dodged or postponed. Some of the more urgent decisions are the following:

How will decisions be made? Who will share in making them? How will they share?

Will the state and national funds available for vocational education in agriculture be used for all of the purposes for which they may be used?

Will local funds be provided for those types of agricultural education which are not financed in part by state and national funds?

Is agricultural education to be considered a function of a school system or is it to be left to a department of agriculture in a high school?

What counseling about agricultural opportunities and agricultural education will be provided?

What agricultural education will be provided in the elementary school, the junior high school, the senior high school, and the adult division?

What agricultural education will be provided for groups presently unserved?

How will the needs for agricultural education of all of the people of the district be studied?

How will the program in agricultural education be evaluated and improved?

How will the time of the teachers of agriculture be used?

Is an area posthigh school institution needed? What provisions for agricultural education would be made in such an institution?

The Decision-Making Process

The basic decisions about agricultural education must be made officially by the board of education, but they must be understood and supported by the people of the district and the school staff. Boards will make better decisions and receive more support for them if administrators, teaching staffs, and citizens share in arriving at them. The requirements for making good decisions are the following:

A board of education that recognizes the importance of agricultural education and gives attention to it.

An administrator who provides leadership in developing policies and programs that provide adequately for agricultural education.

A teaching staff aware of the contributions agricultural education may make to the total school program, who are consulted when decisions about agricultural education are made, and who integrate agricultural materials appropriately into their own teaching specialties.

Teachers of agriculture who see their field broadly, report regularly to the decision makers regarding it, have constructive ideas for improving it, and are able to get cooperation in putting these ideas into effect.

A system of citizens committees advisory to the board of education including a continuing committee for agricultural education.

Receptivity to suggestions for the improvement of agricultural education from any responsible source in or out of the school district.

Unifying Decisions in Written School Policy

Each basic decision regarding agricultural education is related to every other decision about agricultural education and to the basic decisions about the school system as a whole. The separate decisions that are made must be consistent.

The best approach to decision making in agricultural education is through the development of organized, written policy for the school system. If general school policy is well conceived, few special policies for agricultural education will be needed.

The alternatives to general school policy, properly made are:

Choas

or

Decisions made, one at a time, by a board of education when the need for them is acute. Many of these decisions will be short sighted. Some decisions are likely to be in conflict with other decisions. There are sure to be large gaps in policy.

or

Decision making by administrators and individual staff members when decisions are required. This arrangement transfers policy making from lay citizens to professional educators. The decisions made are almost sure to be short-range, inconsistent decisions. They may not receive board approval if a board decides to act regarding them.

or

Decisions backed only by minority groups in the school or the community.

Well-conceived school policy, developed and supported by those who are to be affected by it, or their representatives, provides a charter for a school system under which agricultural education can be developed over a period of years without fear of whimsical reversals. Anything less is dangerous to all concerned.

Staff and Citizen Participation in Decision Making

All members of the staffs of Illinois school systems should realize the critical importance of agriculture to all of us. They are most likely to gain insights regarding agriculture and agricultural education if they share in developing policies and programs for agricultural education. In small schools the entire staff may participate; in larger systems much of the work must be done in committees.

It should not be assumed that a program of agricultural education for a school system is to be carried out by the teachers of agriculture alone. Most or all of the teachers should participate appropriately. Agriculture is related to the other school subjects; it is a subject which integrates and applies subject matter from many fields. Close cooperation between those who teach agriculture and those who teach the related subjects is imperative.

Administrators, supervisors, and counselors have important parts in developing a schoolwide program of agricultural education. All should share in decisions about it.

A continuing, schoolwide system of citizens committees is needed in every Illinois school district. A representative committee will include some citizens with agricultural interests. An affiliated committee for agricultural education is also needed, which will need help from time to time from special task forces.

The entire public should be represented in a committee or committees for agricultural education if the needs of all are to be considered. A general committee for agricultural education may have subcommittees for vocational and nonvocational education in agriculture. It is unlikely that a committee of farmers will show much interest in providing agricultural education as a part of the general education of nonfarmers.

In Conclusion

Agriculture is the economic base of hundreds of Illinois communities and it is important to every community in the state. It is likely that, after adequate consideration, any Illinois community would decide to expand its program in agricultural education, not to curtail or eliminate it.

Although some of the funds for public school education in agriculture come from state and national sources, they are only a small part of the funds needed for an adequate program and the controls which accompany them are minimal. Agricultural education in the school districts is not suffering from outside control but from failure on the part of the local people to make thoughtfully and promptly the decisions necessary if it is to be as effective as it should be.

If agricultural education is to be used effectively to improve the agriculture of a school district, a much larger part of the funds for agricultural education must be used for the education of those beyond high school age.

Agricultural education should be provided throughout a school system. In one Illinois system 22 or 23 teachers were found to be teaching something about agriculture. A large part of the students in any school system need to be counseled about opportunities and requirements in agricultural occupations.

Agriculture is far broader than farming. The fate of agricultural education in a school system should not be determined by number of percentage of farmers in its community.

The efficient and productive agriculture we now have did not arise by chance. Agricultural education in the public schools has had a critical part in its development. It must be continued, improved, extended, and adapted to change if our present abundance is to continue. If agricultural education is neglected, the effects will become apparent and repercussions from the public may be expected.

Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 4-C

Activities and Operations--Evaluation Techniques

Produced by the

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Source Teaching Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Activities and operations (4)

Concern: Evaluation techniques (C)

Objectives: After instruction, the student is able to:

1. Identify the steps in an evaluation process for public education.
2. Recall and recognize the advantages and disadvantages of evaluation techniques.
3. Recognize correct evaluative procedures for public education.
4. Judge the adequacy with which conclusions are supported by data in situations.

Suggested teaching techniques

1. Prepare some sample evaluations, hand these out to class and then conduct class discussion on the sample evaluations.
2. Have the class generate a list of several topics relevant to public education and have each class member select one and expand or develop an evaluation for that topic.
3. Divide the class into small groups, select a topic from a student-generated list and develop an evaluation.
4. Conduct a class discussion and write up a list of major points to include when developing an evaluation.
5. Invite a resource person to describe an evaluation and discuss the different aspects with the class.

Suggested audio-visual aids

1. Using the opaque projector, show the center pages of So You Want to Evaluate Your School ; an ICEC publication.

2. Use an overhead projection to present transparencies of sample evaluation. Use a grease pencil to add or delete sections.

3. Use the chalk board. Put the evaluation on the chalk board and have individuals be responsible for correcting certain areas.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
1. What do you evaluate?	An evaluation is a measurement to determine value or effectiveness to a specific situation. This evaluation may be broad and general or it may be detailed and specific. <u>Suggested techniques</u> A. Conduct a class discussion of what an evaluation actually is. B. Have the class generate a list of areas that evaluations could be used. C. Present and study different evaluations to see if the evaluation was valid or relevant. D. Invite a resource person to class to discuss an evaluation they were involved in that would benefit the class. E.
2. What should be expected from an evaluation?	An evaluation determines the level or point on a standard scale, a school or facility is functioning. By utilizing the evaluation information it will be possible to realign or

2. (Continued)-	set new goals to achieve the level of quality or competence desired. <u>Suggested techniques</u> A. Using a selection of objectives and policies already being used, review an evaluation that was completed in relation to these objectives and policies. Discuss with the class whether or not the evaluation is valid or determines relevant information. If the evaluation shows that the objectives are not being met then the class could suggest a number of ways to realign and correct the situation. B. Using sample evaluations, divide into small groups and discuss the different evaluations and the implications of each. C.
3. What are the steps in conducting an evaluation and how often should evaluations be conducted?	The steps in an evaluation may vary slightly but generally should fit the following format: A. Obtain consent of the board. B. Determine the goals and expectations of the school. C. Submit the tentative list to the professional staff for comment and suggestions. D. Submit the list of goals to the board of education for endorsement.

3. (Continued)

E. Determine circumstances under which the evaluation will be made.

F. Determine the instrument of evaluation.

G. Decide who is to conduct the evaluation.

H. Make the evaluation and collect the data.

I. Analyze the data.

J. Make out a written report.

K. Give data, analysis and report to the school board.

The process of evaluation is a continuous one. When a need for an evaluation is determined and the board of education agrees, then, an evaluation should be made.

Suggested techniques

A. After carrying out a discussion on the possible steps of an evaluation, generate a list similar to the one provided.

B. Use the small group's approach to get the information or steps in an evaluation.

C. Invite a resource person to come and discuss with the class the best techniques for conducting an evaluation.

D. Determine an area of evaluation and let the class members design an instrument for the evaluation.

E. Conduct a class discussion and utilize the individual information to put together a good, all inclusive instrument.

F.

4. What are some criteria for evaluations?	This topic basically will be covered in determining steps in the evaluation. If they are not covered, introduce the following ideas and information: <u>Suggested techniques</u> A. Use one example of an evaluation and have class members look for: 1. Personal bias by the designer or designers of the evaluation instrument. 2. Political implications. 3. Prejudice of any type. B. Discuss with the class if the evaluation: 1. Finds out the strengths and weaknesses of the program. 2. Evaluates the effectiveness of the program. 3. Determines ways and means of improving the program. C.
5. Can citizens do a good job of evaluating schools?	Yes, they can if they judge <u>results</u> not educational procedures and practices. Citizens should be interested in results. How to get the desired results is for the professional people to figure out. <u>Suggested techniques</u> A. Have the class review different evaluation forms to see if the evaluation is on results or procedures.

5. (Continued)	B. Review with the class the purpose of citizens' advisory committees. C. Discuss with the class the role of the citizens' advisory committees in relationship to the board of education. D.

Possible evaluation ideas

1. Subjective observation of written assignments.
2. Observation of class reaction and response to key points.

Recommended resources

Hamlin, Herbert M., Citizen Participation in Local Policy Making for Public Education, University of Illinois, 1963, pp. 31-35. (Source: REDL, 357 Education Building, Urbana, Illinois 61801; price, 50¢.)

ICEC, So You Want to Evaluate Your School, University of Illinois. (Source: REDL, 357 Education Building, Urbana, Illinois 61801.)

King, Sam W., Organization and Effective Use of Advisory Committees, Washington, D.C.: U.S. Government Printing Office, U.S. Department of Health, Education and Welfare, Vocational Division Bulletin No. 238, 1968, p. 27.

Phipps, Lloyd J., Handbook on Agricultural Education in Public Schools, Danville, Illinois: The Interstate Printers and Publishers, Inc., 1965, pp. 86-98. (Source: The Interstate Printers and Publishers, Inc., Danville, Illinois 61883.)

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Page, Ray, Evaluation, Supervision, and Recognition of Schools, Springfield, Illinois, 1964, Circular Series A, No. 160. (Source: The Office of the Superintendent of Public Instruction, Springfield, Illinois.)

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Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 5-A

Special Citizens' Advisory Councils--Problems of Ad Hoc Committees and Recommended Operational Procedures

Produced by the

Rurban Educational Development Laboratory

Dr. Lloyd J. Phipps, Director
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University of Illinois, Urbana-Champaign
Urbana, Illinois 61801

Staff Assistants

Richard Hofstrand W. E. Shipley

TEACHING SOURCE UNIT

Citizens' Advisory Councils in Education

Unit. Special Citizens' Advisory Councils (5)

Concern. Problems of Ad Hoc Committees and recommended operational procedures (A)

Objectives. After instruction the student should be able to:

1. Identify the need for ad hoc committees.
2. Identify the advantages and disadvantages of ad hoc committees.
3. Identify and recall operating procedures of ad hoc committees.

Possible teaching techniques

1. Have a consultant discuss techniques, activities, and recommendations for use in ad hoc committee programming.
2. Develop an ad hoc committee situation and discuss in the class the function and operating procedures.

Anticipated problems and concerns	Guides to solutions and sample teaching technique
1. What is an ad hoc committee?	An ad hoc committee is a specialized committee that deals with a particular problem area. The ad hoc committee may supplement the general continuous committee or work independently of the general committee under the direction of the Board of Education. Suggested techniques A. Through class discussion determine problem areas that could more easily be handled on an ad hoc basis. For example:

Anticipated problems and concerns	Guides to solutions and sample teaching technique
	1. Special events 2. Parent and teacher relationships 3. Curriculum planning 4. Building utilization B. After generating a list of ad hoc special areas, discuss the "how" and "why" aspects of the special problems to determine proper use of ad hoc committees. C. Have class read pages 5-8 in <u>Organization and Effective Use of Advisory Committees</u>. Discuss the relationship between the types of committees, their purposes and specific functions. D.
2. What are the operating procedures of an ad hoc committee:	The operating procedures are A. Make a detailed study of the problem. B. Determine the best plan of action to take within the community. C. Determine the opposition to the problem. D. Recommend procedure to handle opposition. E. Solicit the assistance of the power structure.

Anticipated problems and concerns	Guides to solutions and sample teaching technique
	1. Lawyers 2. Local newspapers 3. Mayor, etc. <u>Suggested techniques</u>: A. Divide the class into small groups and have each group apply the operating procedures to a problem area of their choice. B. Announce a problem to the class, then have small groups attempt to solve the problem. Have each group select and use one of the preceding five operating procedures. Each group should present alternate ways of handling the situation. C. Compare the solutions suggested by the class and evaluate each solution. D.
3. What are other functions of an ad hoc committee?	Other areas which might be referred to ad hoc committees are A. Bond issues. B. Site selection for schools. C. Revision of total curriculum. D. Establishment of internal school boundaries.

Anticipated problems and concerns	Guides to solutions and sample teaching technique
	<u>Suggested techniques</u> A. Obtain copies of different plans used to solve the various problems frequently encountered by ad hoc committees. Discuss in class. B. Divide the class into small groups, such as would be used for an ad hoc committee, and assign a specific problem for each committee to solve. C.
4. What are the advantages and disadvantages of an ad hoc committee?	Advantages of ad hoc committees 1. The committee studies and reviews only one problem and then is released. 2. Committee members may be specialists or consultants that normally would not be involved in a continuing committee. 3. The committee may utilize people who would not serve on an ongoing committee. 4. Disadvantages 1. Necessary to select new members for each problem. 2. Each new committee must be educated and oriented.

Anticipated problems and concerns	Guides to solutions and sample teaching technique
	3. Since committee is of a temporary nature, members may not become as deeply involved in school community relations as they would on a continuing basis.

Suggested evaluation techniques, the instructor may:

1. Observe the ideas generated by the class members.
2. Observe class members' functioning in an ad hoc committee exercise.
3. Request written self-evaluation from each student as to his or her accomplishments within the class.

Recommended resources

King, Sam W., Organization and Effective Use of Advisory Committees, Washington, D.C.: U.S. Government Printing Office, U.S. Department of Health, Education, and Welfare, Vocational Division Bulletin No. 288, 1968, pp. 5-8.

American Vocational Association, The Advisory Committee and Vocational Education, Washington, D.C., 1969, pp. 18-19. (Source: Publication Sales, American Vocational Association, 1510 H. Street, N.W., Washington, D.C.; price: $1.25.)

State of Illinois Board of Vocational Education and Rehabilitation, Advisory Committees Organization and Use in Vocational and Technical Education, Springfield, Illinois, 1970, pp. 2-3. (Source: Division of Vocational and Technical Education, 405 Centennial Building, Springfield, Illinois, 62706.)

Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit 5-B

Special Citizens' Advisory Councils--
Problems and Practices of Vocational-Occupational Committees

Produced by the

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Teaching Source Unit

CITIZENS' ADVISORY COUNCILS IN EDUCATION

Unit: Special citizens' advisory councils (5)

Concerns: Problems and practices of vocational or occupational committees (B)

Objectives: After instruction, the student will be able to:

1. Recognize problems of the vocational or occupational committees.
2. Judge the effectiveness of using vocational or occupational councils.
3. Interpret federal and state laws regarding the use of citizen committees for vocational or occupational programs.

Possible teaching techniques

1. Have students read the laws and regulations dealing directly with technical and vocational education.
2. Through class discussion determine problems and practices of vocational-occupational programs of the different geographical areas represented by the class.
3. Invite a representative of either a junior college, university or the State Department of Vocational and Technical Education to discuss problems and practices of vocational or occupational committees.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
1. Where do vocational-occupational councils fit into the flow chart on Citizens' Advisory Committee structure? (See Unit 1-B, Appendix I.)	Place the flow chart from Unit 1-B on an opaque projector and use for discussion purposes so that the class may understand the flow of communications and authority. Suggested techniques A. In class discussion, follow the arrows in the flow chart to indicate communications and [illegible]ty.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
1. (Continued)	B. After following the lines of communications and authority, discuss the relationship of the different organizations on the flow chart. C. Without using the proposed flow chart, have students divide into three groups and develop a flow chart showing communications and authority. D. When the three groups have completed their flow charts, utilize the class to help develop a flow chart on the blackboard using the information generated by the groups. E.
2. What areas are involved in vocational or occupational councils?	The following vocational areas should have representation on the vocational advisory council. A. Administration and Supervision of Vocational and Technical Education B. Adult Education C. Agricultural Education D. Business Education E. Engineering Technology

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
2. (Continued)	F. Health Occupations G. Home Economics Education H. Industrial Education I. Public Service Education J. Supportive Services for Vocational and Technical Education <u>Suggested techniques</u> A. Have students study pages 4-17 of <u>Organization and Effective Use of Advisory Committees</u>. B. Through class discussion, have the class generate a list of areas that could be involved in vocational or occupational councils. Compare the generated list with references listed in the literature. C.
3. What is the actual relationship between the general advisory committee and the vocational or occupational committees?	The relationship between the general advisory committee and the vocational occupational committee is based on determined needs. The general committee is responsible for the operation of the different subcommittees. The vocational or occupational committee is responsible

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
3. (Continued)	to the vocational education committee. In turn it is recommended that the vocational education committee work through the general advisory committee with the local board of education. <u>Suggested techniques</u> A. Review the flow chart that the students helped develop. B. Solicit a resource person to attend class and discuss the relationship of the general committee and the vocational or occupational committee with the class. C. Have class review pages 55-60 of <u>Organization and Effective Use of Advisory Committees</u>. D. Conduct class discussion relative to the question under consideration. E.
4. What does the federal law say concerning advisory councils in vocational education?	Public Law 90-576 90th Congress, H. R. 18366, approved October 16, 1968. H9374 National and State Advisory Councils. Quote "Sec. 104 .(a)(1) There is hereby created a National Advisory Council on Vocational Education...."

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
(4) Continued)	"(5) (6) (1) Any State which desires to receive a grant under this title for any fiscal year shall establish a State Advisory Council,...." end quote. The State of Illinois does not stipulate use of local advisory committees for vocational education but does recommend their use. To receive funds under Title I Public Law 89-10 found in the U.S. Office of Education Bulletin 46, it is necessary to have a representative advisory council of those people to be served. <u>Suggested techniques</u> A. Obtain copies of Federal and State Bills referring to advisory councils and hand out to class members for their review. B. Invite a resource person from the State Department to discuss vocational education laws and bills. C. Solicit a consultant from one of the universities to discuss vocational and technical programs.

Anticipated problems and concerns	Guides to solutions and sample teaching techniques
4. (Continued)	D. Using a panel discussion, review the different phases of citizen advisory involvement in vocational and technical education bills and programs. E.

Suggested evaluation techniques

1. Observe class members' reaction to the problems and practices of vocational or occupational committees.
2. Request students' self-evaluation of their change in attitude toward vocational and technical education.

Recommended resources

American Vocational Association, Inc., Vocational Advisory Committees. Washington, D.C., pp. 1-20. (Source: American Vocational Association, Inc., 1010 Vermont Avenue, N.W., Washington 5, D.C.)

Illinois State Board of Vocational Education and Rehabilitation, Advisory Committees, Springfield, Illinois, 1970, pp. 1-10. (Source: Illinois State Board of Vocational Education and Rehabilitation, 405 Centennial Building, Springfield, Illinois 62706, Price: Free.)

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APPENDIX I

Checklist of Activities and Services Provided by Local Industry-Education Advisory Committees[1/]

Student recruitment, selection, and placement

1. Encouraging young people (and parents) to consider vocational and technical education and training through visits to "feeder schools," speeches to civic clubs, career day meetings, etc.
2. Assisting in the screening of students applying for admission to the courses.
3. Participating in the development of aptitude tests for selection of students.
4. Providing information concerning desirable aptitudes, education, and experience background which applicants for entry level jobs should have so that educators may properly plan their student recruitment, as well as educational and training programs.
5. Arranging plant or field trip visits for students and counselors.
6. Providing vocational guidance literature to teachers, counselors, and students.
7. Assisting and participating in surveys of local industry manpower needs.
8. Assisting in the development of aptitude tests, achievement tests, and certification and licensing tests concerned with initial employment of school graduates.
9. Placing students in part-time work during school year or summer vacations.
10. Placing school graduates in jobs.

Instructional program

1. Assisting in the preparation and review of budget requests for laboratory and shop equipment and supplies.

1/ Samuel M. Burt, Industry and Vocational-Technical Education (New York: McGraw-Hill Book Company, 1967), Chapter 3.

2. Evaluating physical conditions, adequacy of equipment, and layout of laboratory or shop.
3. Assisting in the development and review of course content to assure its currency in meeting the changing skill and knowledge needs of the industry.
4. Obtaining needed school equipment and supplies on loan, as gifts, or at special prices.
5. Assisting in the establishment of standards of proficiency to be met by students.
6. Assisting in the development of school policy concerning the kinds and volume of production work or "live jobs" to be produced by students so that this work will be of instructional value in the educational program.
7. Establishing and maintaining a library of visual aids, magazines, and books concerning industry.
8. Assisting in the development of special educational and training programs conducted with funds made available by the Manpower Development and Training Act, the Economic Opportunity Act, etc.
9. Assisting in the development of evening school skill improvement and technical courses for employed plant personnel.
10. Assisting in the development of apprenticeship and on-the-job training related courses.
11. Arranging plant or field trip visits for teachers.
12. Providing sample kits of raw materials, finished products, charts, posters, etc., for exhibit and instructional purposes in classrooms and shops.
13. Assisting in the establishment of student fees and charges for courses and programs.

Teacher assistance

1. Providing funds to assist local teachers to attend regional and national meetings of industry and teacher organizations.
2. Arranging meetings of teachers to establish cooperative relationships between the schools and industry.
3. Arranging summer employment for teachers.
4. Assisting in the establishment of teacher qualification requirements.
5. Conducting clinics and in-service and out-service training programs for teachers.
6. Arranging for substitute or resource instructors from industry to assist regular teachers.
7. Subsidizing teacher salaries in such unusual cases as may be necessary to obtain qualified instructors.
8. Paying industry organization membership dues for teachers.
9. Providing awards and prizes to outstanding teachers.

Student recognition

1. Providing scholarships and other financial assistance for outstanding graduates who wish to continue their education and training.
2. Providing prizes to outstanding students.

Public relations

1. Providing speakers to address trade and civic groups concerning the industry's education and training program in the school.
2. Providing news stories concerning school programs to magazines published for specific industry groups.
3. Providing news stories concerning school programs to local news media.

4. Attending meetings in support of vocational and technical education which may be called by local and state school officials, boards, and legislative groups.
5. Participating in radio and television programs designed to "sell" vocational and technical education to the public.
6. Contributing funds to advertise specific school occupational education and training programs.
7. Advising employees and their families concerning school programs by posting the information on bulletin boards, news stories in company publications, and enclosures in pay envelopes.

VT 012 510
Williams, David L., Ed.; Ammadi, Ali M., Ed.
Moving Products into Agricultural Firms.
Seven Teaching Source Units for Agricultural Occupations Other than Farming.

Illinois Univ., Urbana. Div. of Agricultural Education.
MF AVAILABLE IN VT-ERIC SET.
Agricultural Education Division, University of Illinois, Urbana, Illinois 61801 ($.50, limited supply).
PUB DATE - Apr70 119p.

DESCRIPTORS - *AGRICULTURAL EDUCATION; *CURRICULUM GUIDES; *OFF FARM AGRICULTURAL OCCUPATIONS; *UNIT PLAN; *MANAGEMENT; INSTRUCTIONAL MATERIALS; PURCHASING; AGRICULTURAL SUPPLIES; BIBLIOGRAPHIC CITATIONS; INSTRUCTIONAL AIDS

ABSTRACT - Focusing upon the knowledges and skills needed by employees in moving the product from supplier to the agricultural firm, this teaching source unit was developed by high school and junior college agriculture teachers in a course at the University of Illinois. The materials are divided into seven teaching source units containing 34 problem areas. Units are: (1) Understanding the Purchasing Function of an Agricultural Firm, (2) Determining the Kind, Quantity, and Quality of Products to Buy, (3) Identifying Potential Suppliers, (4) Understanding Methods Used by an Agricultural Firm in Making Buying Contracts, (5) Identifying Methods of Transporting and Routing Products, (6) Understanding Procedures for Receiving Products, and (7) Identifying Ways of Measuring and Reporting Purchasing Performance. Each problem area includes anticipated problems, questions and concerns, suggested teacher and class activities, and a listing of various teaching aids. A selected bibliography is appended. (GB)

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MOVING PRODUCTS INTO AGRICULTURAL FIRMS

Seven Teaching Source Units for Agricultural Occupations Other Than Farming

Division of Agricultural Education
College of Education
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

VT012510

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MOVING PRODUCTS INTO AGRICULTURAL FIRMS

Seven Teaching Source Units for
Agricultural Occupations
Other Than Farming

Edited by:

David L. Williams and Ali M. Ammadi

April 1970

Agricultural Education Division
Department of Vocational and Technical Education
College of Education
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

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FOREWORD

This publication includes teaching source units which resulted from the efforts of a group of hard-working teachers enrolled in a course (VOTEC 459) offered by the University of Illinois, Agricultural Education Division, during the summer of 1969. The course was the second of a three-part summer program designed to give high school and junior college teachers of agriculture firsthand experience in the nonfarm business sector of agriculture. In addition, the participants spent time in the classroom analyzing the experiences in terms of implications for teaching agricultural occupations. Experiences and selected references served as a basis for the development of teaching plans that may be useful in secondary or postsecondary programs of vocational education in agriculture.

The title of this publication, Moving Products Into Agricultural Firms, served as the theme for the course. The following teaching source units focus upon the knowledges and skills needed by employees in moving the product from the supplier to the agricultural firm. The materials developed by the teachers enrolled in the course were divided into seven teaching source units containing 34 problem areas. Each problem area includes anticipated problems, questions and concerns, and some suggested teacher and class activities. Professor David L. Williams and Mr. Ali Ammadi, instructors for the course, edited the materials and arranged the problem areas and units in an order which teachers may find useful.

David L. Williams

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Problem Area 5 Identifying the Characteristics and Functions of the Buyer of an Agricultural Firm

References and Instructional Aids for the Unit

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References and Instructional Aids for the Unit

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References and Instructional Aids for the Unit

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Problem Area 6 Using Computers in Making Buying Decisions in an Agricultural Firm

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References and Instructional Aids for the Unit

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Problem Area 5 Handling and Storage of Products Received in an Agricultural Firm

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Selected Bibliography

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Unit I. Understanding the Purchasing Function of an Agricultural Firm

Problem Area 1: Understanding the Importance of the Purchasing Function to an Agricultural Firm

Problem Area 2: Determining the Structural Organization of the Purchasing Function of an Agricultural Firm

Problem Area 3: Understanding the Various Segments of the Purchasing Function of an Agricultural Firm

Problem Area 4: Understanding the Purchasing Responsibilities of Employees of an Agricultural Firm

Problem Area 5: Identifying the Characteristics and Functions of the Buyer of an Agricultural Firm

References and Instructional Aids for the Unit

PROBLEM AREA. Understanding the importance of the purchasing function to an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the meaning of the purchasing function and its objectives related to an agricultural firm.

2. Appreciate the success of the agricultural firm resulting from proper purchasing operations.

3. Understand how the purchasing function may vary among different types of agricultural firms.

STUDENT MOTIVATION.

1. What is the largest single cost involved in most agricultural firms?

2. How does the purchasing in a farm business differ from that in an agricultural firm?

3. How can the purchasing function affect the operation of an agricultural firm?

SPECIAL ARRANGEMENTS. Secure samples of management training materials used by agricultural firms in recruiting new employees.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students list major purchasing functions of an assigned firm in the area.

2. Ask students to record recent problems encountered due to improper purchasing procedures.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What do we mean by the term "purchasing"?	1. State that purchasing consists of buying materials of appropriate quality in the right quantity at the proper time at the best price from the best source of supply for resale to the customers. 2. Discuss and develop a definition of the term "purchasing" as it applies to the agricultural firm. 3. References: 1, 2.
2. What are the objectives of the purchasing function in an agricultural firm?	1. Discuss the objectives as follows: a. to maintain a constant supply of goods for resale by the firm. b. to maintain a sufficient supply of goods with a minimum investment in inventory. c. to minimize loss to the firm through duplication, waste and obsolescence of goods. d. to maintain appropriate quality standards. e. to purchase goods at the lowest possible cost consistent with the quality and service required. f. to contribute to the competitive position of the firm through proper purchasing. 2. Have students compile a list of objectives of purchasing. 3. References: 1, 2.
3. What are some of the desirable outcomes resulting from proper purchasing by the agricultural firm?	1. Give examples of ways proper purchasing affects the firm. State the following examples: a. gain in customer demand and more customer satisfaction. b. increased profit to the firm through good management dicisions. 2. Use on-job experiences and discuss new purchasing suggestions which may benefit the firm. 3. References: 1, 2, 12.
4. How could the type of an agricultural firm dictate its purchasing functions?	1. Discuss a situation where an agricultural firm might be involved in proprietorship or partnership.

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Problems and Concerns	Guides to solutions and examples of teaching techniques
	2. Analyze the situation of a member company in a cooperative or a corporation-owned retail store.
	3. Have students report individual experiences in various types of agricultural firms and illustrate variations in the purchasing functions.
	4. References: 2, 11.

PROBLEM AREA. Determining the structural organization of the purchasing function of an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the overall structural organization of an agricultural firm.

2. Understand the detailed structural organization regarding the purchasing function.

3. Understand the relationship of the worker to those in charge of purchasing.

4. Recognize that different organizational patterns exist.

STUDENT MOTIVATION.

1. Give the example of the boss cow and the "social order" in a herd. Does such a situation or order of authority exist in an agricultural firm? Is this a structured order of authority or does it just happen?

2. Using a transparency on overhead projector show the structure of a military unit or of a college or school. Can a similar structure be drawn for an agricultural business? Would the organizational structure be the same for all businesses? Should they be the same?

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students map the structural organization of a business or the agricultural business in which they work.

2. Have students map the structural organization regarding the purchasing function.

3. For a given business, have students trace the procedure from the time the need for a product is recognized until the merchandise is placed in the stockroom or displayed for sale.

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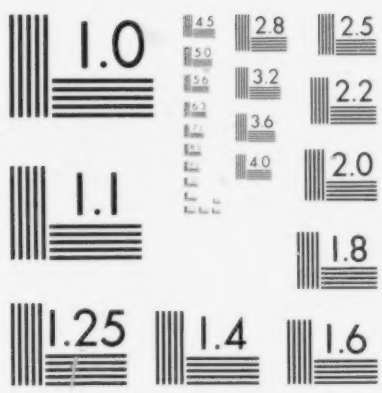

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What kinds or patterns of structural organizations exist in agricultural firms?	1. Have two or more students draw on the chalkboard the organizational pattern of the firm(s) where they work. 2. Identify each pattern with one or more of the following: a. line and staff pattern. b. functional pattern. c. line or military pattern. 3. References: 1, 5, transparencies.
2. Why is it essential that an employee understand the structural organization of his firm?	1. Discuss experiences students have had where an employee did not understand the firms organization. 2. Identify situations encountered by students in their work that required a knowledge of the structural organization of the firm. 3. References: 3, 12.
3. What is the structural organization for purchasing products for resale in the firm where you work?	1. Using the organizational charts drawn by students, identify positions in the firm responsible for purchasing. 2. List on the chalkboard why it is significant for an employee to understand who is in charge of purchasing. 3. References: 6, 7.

PROBLEM AREA. Understanding the various segments of the purchasing function of an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the significant segments of the purchasing function.

2. Understand that the purchasing function includes more than buying.

3. Understand how various activities within the firm are related to the purchasing function.

STUDENT MOTIVATION. Some of you have purchased major items, such as a car. At the time of purchase, you recognized that there was more to purchasing than telling the salesman, "I'll take it." What are some of the problems or concerns you may have had at time of purchase? Were you, in fact, a purchasing agent? Would a purchasing agent in a business have concerns similar to the ones you experienced?

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have student spend some time in the purchasing department to observe and record the activities.

2. Have student help in the receiving of material into a firm to observe or participate in the receiving, inspection and warehousing that is involved and how it relates to purchasing.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are the major segments of the purchasing function of an agricultural firm?	1. List and discuss the three major segments of the purchasing function. Identify activities included in each: a. buying. (1) preferred quality. (2) right quantity. (3) desirable price. b. distribution. (1) to proper place. (2) at given time. (3) by best method. c. disposal of excess. (1) to other contracts. (2) to other facilities. (3) to salvage. (4) return to supplier. 2. References: 12, 2, 11.
2. Why is purchasing a service function to the agricultural firm?	1. Identify through class discussion, situations where purchasing may be considered a service to the firm. These may include: a. reduced cost to firm. b. improved service to other departments. c. uniformity of policy and practice. d. improved continuity of operation. e. saving of valuable time of personnel not specialized in purchasing. f. application of uniform knowledge and skills to common problems throughout the organization. 2. References: 1, 7.
3. What problems might arise if distribution and disposal of excess is not considered by those doing the purchasing?	1. Have students discuss with management personnel in the agricultural firm where employed, the problems encountered in distributing and disposal of excess products. Identify personnel in the firm who handle these problems; are they also responsible for purchasing?

PROBLEM AREA. Understanding the purchasing responsibilities of employees of an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the duties and responsibilities of personnel involved in the purchasing function in an agricultural firm.

2. Understand the knowledges and skills required to perform an efficient job of purchasing products for an agricultural firm.

3. Recognize the advantages of consolidating purchasing in an agricultural firm.

STUDENT MOTIVATION.

1. Using the organizational chart of the agricultural firm prepared by each student, review the reasons why the firm has prepared such a chart. (Emphasize the need for division of responsibility.)

2. Ask students how they would like to become an employee in a firm in which no one would know his duties and responsibilities.

3. Discuss some of the problems which might arise in a firm which had no one responsible for purchasing goods.

SPECIAL ARRANGEMENTS.

1. Arrange with the owner, manager or an employee of an agricultural firm to discuss with the class the responsibilities for purchasing which are assigned to various members of the firm.

2. Have several members of the class report on the purchasing duties and responsibilities which they have experienced in an assigned agricultural firm.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Through discussion with members of an agricultural firm, compile a list of the duties and responsibilities for purchasing which exist in the firm.

2. In the same firm, indicate how each of these duties and responsibilities are assigned among members of the firm.

3. During the supervised experience program, compile a list of the knowledges and skills required to perform the purchasing function in the firm.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are the duties and responsibilities of personnel for purchasing in an agricultural firm?	1. Identify and list on the chalkboard the duties and responsibilities. These may include: a. deciding what and how much to purchase. b. identifying a source of supply. c. negotiating price and completing payment. d. making purchase orders. e. checking, storing and handling goods received. 2. References: 1, 2, 12.
2. What knowledges and skills are required to do a good job of purchasing for an agricultural firm?	1. Discuss the knowledges and skills required to perform the duties listed in problem one. These may include: a. knowledge of the kinds and amounts of goods demanded by the customers of the firm. b. knowledge of when customers will purchase goods. c. knowledge of the available sources of supply for desired goods. d. knowledge of new products being developed. e. ability to complete purchase orders and make payments. f. ability to keep accurate records of goods ordered, received and sold. 2. References: 1, 2.
3. What are the advantages of having one individual or department responsible for all purchasing for the agricultural firm?	1. Discuss the improvements that may result from consolidated purchasing. Advantages may include: a. better control--one set of records for all purchases. b. relieves other members of the firm of additional responsibility and thus allows them to do their primary job more efficiently. c. encourages the development of specialized knowledges and skills which may improve job of purchasing. 2. References: 2, 11.

PROBLEM AREA. Identifying the characteristics and functions of the buyer of an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Recognize and identify the desirable competencies that a good buyer should have.

2. Identify the etiquettes observed in buying agricultural products.

3. Decide what preparations and guidelines are needed for a successful career in buying.

STUDENT MOTIVATION.

1. Divide your class into two groups, then, ask students to assume that the school agricultural club is planning for a large party. What would be the desirable qualities you would like the person in charge of purchasing to possess. List these responses on a transparent sheet. Project the list on a screen and compare responses.

2. Show a set of slides of the major buying operations that take place in an agricultural firm.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Ask students to identify and list the name and titles of individuals responsible for purchasing in the agricultural firm where they are employed.

2. List the duties and activities of the individual(s) responsible for buying the main line products of the agricultural firm.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are the functions of a purchasing agent?	1. Discuss the functions as follows: a. to purchase items for resale or use in company. b. to select source of supplies. c. to determine specifications d. to price items. e. to check items received. f. to determine means of shipment. g. to receive items into the firm. h. to identify products needed by customers. 2. References: 10, pp. 27-32; 1, pp. 24-26.
2. What are the special skills needed by a good buyer?	1. Ask students to discuss buying skills they have observed during their training program. 2. List other abilities as follows: a. be able to remember details. b. be able to write good reports. c. be flexible. d. be able to analyze readily. e. be able to choose wisely. f. have factual knowledge of quality. g. know principles of mathematics. h. possess good human relations. 3. References: 10, pp. 32-44; 9, p. 53.
3. What are the etiquettes followed in buying?	1. Ask students to state the rules they feel a good buyer should follow. Write their ideas on the chalkboard. 2. List some "do's" as follows: a. be loyal, act in good faith and in best interest of your employer. b. exercise reasonable care, diligence and skill. c. follow all instructions and policies and delegate authority when necessary. d. turn over all concessions received to their employers. e. keep accurate records and render an accounting of all their business transactions. 3. List some "don'ts" as follows: a. ask for unreasonable concessions. b. pass mistakes on to the customers. c. cancel orders unfairly. d. accept personal favors from sellers.

Problems and concerns	Guides to solutions and examples of teaching techniques
4. What experiences are necessary for a buyer?	1. List necessary experiences as follows: a. have experience in retail selling. b. have experience in wholesale and retail marketing. 2. Assign readings on: a. functions of buying. b. customer demands and human relations in buying. 3. References: 10, pp. 44-48.
5. What are the keys to a successful career in buying?	1. List key characteristics as follows: a. be able to make sound decisions. b. be able to accept responsibility. c. be able to keep up-to-date. d. be able to maintain good relations. e. be able to make and keep good and accurate records. 2. References: 4, ch. 8, 10, 18.

REFERENCES AND INSTRUCTIONAL AIDS FOR UNIT I

A. BOOKS

1. Heinritz, Purchasing Principles and Applications, Second Edition.

2. Hodges, H. G., Procurement--The Modern Science of Purchasing.

3. Kelley and Lawyer, How to Operate a Small Business.

4. McMillian, A. I., The Art of Purchasing.

5. McNaughton, Business Organization.

6. Ohio State University, Center for Research and Development, Organizations and Functions of Agricultural Businesses, Module 5.

7. Phillips, Managing for Greater Returns in Grain, Feed, etc.

8. Smith, A. E., New Techniques for Creative Purchasing.

9. Smith, Wilson, and others, The Farm Supply Industry, special report No. 15, Agricultural Extension Service, University of Minnesota.

10. Wingate, Buying for Retail Stores, Third Edition.

11. Wingate, J. W. and Friedlander, The Management of Retail Buying.

12. Zemansky, S. D., "The Purchasing Job: Dimensions and Trends," American Management Association.

B. TEACHING AIDS

1. Slides of buying operations necessary in agricultural firms.

2. Transparencies for overhead projector:

   a. organizational structure of a military unit.
   b. organizational structure of the junior college.
   c. line or military pattern of structure.
   d. line and staff pattern of structure.
   e. functional pattern of structure.
   f. pattern of organization of a given structure within the purchasing function.

Unit II. Determining the Kind, Quantity, and Quality of Products an Agricultural Firm Should Buy

Problem Area 1: Determining the Kinds of Products the Agricultural Firm Should Purchase

Problem Area 2: Determining the Proper Quantity of a Product for Purchasing

Problem Area 3: Determining the Quality of Product Which an Agricultural Firm Should Purchase

Problem Area 4: Determining the Proper Time for Purchasing Additional Products for the Agricultural Firm

Problem Area 5: Understanding the Consequences of Miscalculations in Purchasing Products for an Agricultural Firm

Problem Area 6: Determining the Procedures for Receiving Products into the Agricultural Firm

Problem Area 7: Discovering the Importance of Standards and Specifications in Buying

References and Instructional Aids for the Unit

PROBLEM AREA. Determining the kinds of products the agricultural firm should purchase.

OBJECTIVES. To develop in each student the ability to:

1. Identify factors that should be considered in buying new types of products for an agricultural firm.

2. Understand two major lines of products in an agricultural firm.

3. Become familiar with some management skills in buying for an agricultural firm.

STUDENT MOTIVATION.

1. Have each student list ten products he would expect to find in a particular type of business. Compile the lists on the chalkboard.

2. Ask questions as follows:

   a. Why did we expect to find these particular products in the business?
   b. Could the business be successful carrying only these products?

3. Have a wholesaler describe how he goes about convincing a businessman to market a new product.

SPECIAL ARRANGEMENTS. Secure empty containers or representatives of products that a particular agricultural firm would stock and make a shelf display of the items for the classroom.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS. Ask students to survey the business where they are employed and identify a new product that they feel should be carried by the firm. Have students give reasons for their choice.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What factors determine types of products bought for an agricultural firm?	1. List the important elements of concern to customers as follows: a. price. b. quality. c. need. d. personal taste. 2. List other relevant information about the customers that the firm could utilize in serving them as follows: a. spending habits. b. financial status. c. education. d. interests. 3. Have each student interview at least two persons and develop a list of products that should be offered by a particular store in addition to the ideas already given by the class. 4. References: 3, 5, 14, and purchasing guides from commercial companies.
2. What are "short-line" and "main-line" products and how are they related?	1. Join with the class and select a business that carries hog, cattle, sheep, and pet feeds as main-line products. Develop a list of complimentary short-line products. Give examples as follows: a. livestock feeding equipment. b. health aid supplies. c. all types of pet supplies. 2. Discuss the relation between the two types of products and the importance of providing a complete line for the customer to choose from. 3. Ask each student to survey the main-line and short-line products offered in his place of employment and discuss findings with the employer. 4. References: 14 and purchasing guides from commercial companies.
3. How could one determine the availability of a new product?	1. Discuss how availability can be determined. Note the followings: a. catalogs in place of business. b. traveling salesman. c. trade news. d. trade advertising.

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Problems and concerns	Guides to solutions and examples of teaching techniques
	2. Ask each student to assume a new product and suggest ways to determine its availability.
4. What factors should be considered before acquiring new products?	1. Draw from the class points to be considered. List the points which should include the following: a. technical servicing. b. warehouse space. c. shelf space. d. short shelf life. e. special temperature and humidity needs. 2. Be aware that if a new product is added, its special needs also must be met. 3. References: 1, 9, 14.
5. How can we find out if a new product is profitable?	1. Stress the fact that agricultural firms are profit oriented and cannot continue without it. 2. Invite a businessman to speak to the class about determining how a product can be profitable. Have him go through an example item, give dealer cost, overhead cost and retail price and calculate the margin of profit and determine if it would be a good product to handle. 3. Draw from the class why an item may be offered for reasons other than profit. State reasons as follows: a. customer convenience. b. loss leader items. c. close out items. d. sale items. 4. References: 1, 5, 13, 14.

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PROBLEM AREA. Determining the proper quantity of a product for purchasing.

OBJECTIVES. To develop in each student the ability to:

1. Understand the major techniques in determining sales potential for a product in an agricultural firm.

2. Understand the relationships between customer demands and the amount of products purchased by an agricultural firm.

3. Detect the time when an adequate stock of products should be kept in an agricultural firm.

STUDENT MOTIVATION.

1. Illustrate the case of a person who is a tire dealer and has supplied all the tire needs for the customers' farm or business during the past five years and expects to continue meeting their tire needs in the future.

2. Ask questions as follows:

   a. How does the tire dealer know how many tires he will sell?
   b. Should he expect to stock these tires all at one time?

SPECIAL ARRANGEMENTS: From the shelf display developed in problem area one, select both a seasonal and nonseasonal product and determine the quantity that should be ordered for a years supply.

DIRECTED, STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students secure the sales records of a selected item for the past three years. Have students plot the past records on a graph and project sales for two years in the future.

2. Ask students to study the business where employed and determine the method of keeping sales records.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are major methods used to determine sales potentials for a product?	1. Determine with the class some techniques used to figure potential sales.. State examples as follows: a. customer surveys. b. past sales records. c. condition of the local economy. d. buying guides offered by the parent companies. 2. Emphasize the importance of utilizing past sales records. 3. References: 3, 9, 10, 14.
2. What factors should be considered in making special orders for a product?	1. Have a salesman discuss with the class the ordering policies of his company. Examine the factors as follows: a. time from ordering to delivery. b. added expense to handle special orders. c. method of transporting product to the agricultural firm. 2. Ask students to look up information concerning ordering in the wholesale catalogs available in their agricultural firms.
3. What factors should be considered in keeping extra stock of products in the firm?	1. Emphasize the need for adequate space. 2. Consider other elements as follows: a. size of the product. b. amount which must be taken at one time--i.e. minimum order. c. opportunity cost of using space for a certain product. 3. References: 1. 4. Explain the turnover rate by stating that the rate of stock turnover is an index of the velocity with which products move into or out of a store. Note that the turnover rate may be computed on a unit or a dollar basis. Give examples as follows: a. Rate of stock turnover = $\frac{\text{Number of units sold}}{\text{Average unit stock}}$ If a business sold 120 gallons of fly spray in a given year and the average stock was 30, then a rate of turnover for the spray would be 120 divided by 30 or four times turnover.

Problems and concerns	Guides to solutions and examples of teaching techniques
	b. Rate of stock turnover = $\frac{\text{Cost of goods sold}}{\text{Average cost of goods on hand}}$ If the cost of goods sold for the year is $60,000 and the average inventory at cost is $20,000, then the rate of stock turnover is $60,000 divided by $20,000 or three turns. 5. Ask students to discuss with employers the turnover rate of some fast moving items and some slow moving items and report back to class. 6. References: 1, 5. 7. Find out what effects do seasonal needs have on the quantity of a product ordered? a. Attempt to identify with the students the seasonal and nonseasonal products found in the business. b. Bring out in discussion that on a seasonal item such as seed corn the entire year's supply must be ordered ahead and be on hand when planting time arrives or lost sales will result. c. Discuss a nonseasonal item such as dog food which can be ordered periodically and in smaller quantities because demand will be fairly even throughout the year. 3. References: 1, 3, 14.

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PROBLEM AREA. Determining the quality of product which an agricultural firm should purchase.

OBJECTIVES. To develop in each student the ability to:

1. Identify quality differences in like products available to an agricultural firm.

2. Understand factors influencing the quality of supplies or services an agricultural firm will provide.

3. Understand how to determine the value of products carried by an agricultural firm.

STUDENT MOTIVATION.

1. Secure a wide variety of a particular item, such as a small adjustable wrench, and by using buying price, selling price, and quality show relationship between price, profit, and quality.

2. Distribute the above items to the students and encourage them to discuss good points of the wrench as well as the weaknesses of a competitor's wrench.

3. Ask questions:

   a. What is meant by quality?
   b. What is meant by tests of value?

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Choose a particular item sold by agricultural firm and compare it's value with a similar item available for sale from several sources.

2. Make a list of merchandise which is returned to the agricultural firm by customers as unsatisfactory and record reason(s) for it being so judged.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is the range of quality of product available for an agricultural firm?	1. Consider the following points in a discussion of the range of quality: a. range may be from the best materials and workmanship to serviceable and low price. b. price and quality usually go together. c. Reference: 13.
2. What quality of product should a particular agricultural firm carry?	1. Consider how the following influence the quality of product carried: a. nature of merchandise lines carried. b. characteristics of trading area. c. community need. d. competition. e. personal capabilities of the merchant. f. capital resources. 2. References: 13, 14.
3. What are some tests of value of product?	1. As per reference 15: a. is its cost proportionate to its usefulness? b. does it need all of its features? c. is there anything better for its intended use? d. do material costs, reasonable labor costs, overhead, and profit add up to its total cost? e. will another dependable supplier provide it for less? f. is anyone buying it for less?

PROBLEM AREA. Determining the proper time for purchasing additional products for the agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand and appreciate the importance of timeliness in ordering and delivery of products for the agricultural firm.

2. Plan the demand of an agricultural firm's products based upon seasonality.

STUDENT MOTIVATION.

1. Have the class identify the seasons of high demands for an agricultural firm's major products, e.g. farm machinery, fertilizers, herbicides.

2. Have a representative of a local agricultural firm discuss with the class his yearly calendar of ordering and delivery of products to the agricultural firm.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Select a main-line product and develop a yearly calendar showing the following:

   a. seasonal demand.
   b. ordering time.
   c. delivery time.
   d. when product is on inventory.

2. Develop a list which explains possible ordering policies for preseason ordering, in-season ordering, and out-of-season ordering.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. How may a particular season of the year influence the demand for a particular product?	1. List the following examples: a. nature of the product, corn herbicides in spring; tractors prior to spring work. b. type of enterprise, livestock farmer would have a wider demand period compared to a grain farmer. 2. Select a product for study and identify the demand period for that product. 3. Draw a yearly calendar showing when the product should be on inventory at the agricultural firm. 4. Become familiar with supplier's policies for returning products not sold when in season. 5. Have a local, successful, agricultural firm manager discuss these and other topics in class or on a field trip to the agricultural firm.
2. What are the reasons for or advantages of following ordering schedules?	1. State that manufacturers may have different policies. 2. Give an example product such as a combine (if one company requests orders for next year's combines during October-November, it is felt that at this time the salesmen and dealers are then familiar with and can best estimate next year's demand based upon anticipated demand for new sales and sales during the current harvest season. By December this company can start production based upon current orders for next year's product). 3. List advantages of preseason ordering as opposed to in-season ordering--discounts, freight costs, timely delivery, etc.
3. What factors may govern the need for an "early order" for a product?	1. Give examples as follows: a. the product itself and its availability (supply and speed of delivery) will determine when the order should be placed. b. companies policies. c. a combine must be ordered well ahead of a bag of fertilizer to be on hand when the season starts. 2. State that expensive products will be less apt to be on hand year around. Smaller items may be carried year around on a display shelf.

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PROBLEM AREA. Understanding the consequences of miscalculations in purchasing products for an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the probable result of not having merchandise which customers of an agricultural firm desire.

2. Understand policies of suppliers relative to the return of slow moving merchandise.

3. Understand how employees can assist in determining the quantity of products to be purchased.

STUDENT MOTIVATION.

1. Have class members role play a situation in which a customer requests merchandise which is much used but the agricultural firm cannot supply at the present time.

2. Have a parts manager explain to the class the policy of a supplier relative to return of merchandise.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Study "Parts Return List" or a similar booklet to become familiar with the policy of a supplier relative to returnable merchandise from agricultural firm.

2. Assist other employees in preparing for shipment the merchandise which the agricultural firm may return to its supplier.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What factors determine the quantity of merchandise which the agricultural firm may have on hand?	1. Identify and discuss factors influencing quantity of a product that would be maintained in the firm. The discussion should include: a. availability of storage. b. availability of capital. c. availability of labor. d. obsolescence of product. 2. References: 3, 6.
2. What products may the firm return to the supplier?	1. Have students secure and bring to class a "Parts Return List" from the business where they are employed. 2. Discuss the reasons why a supplier may or may not allow a firm to return merchandise. 3. Identify how a "Parts Return List" may be used in purchasing.
3. What can employees of a firm do to help in the procurement of the right amount of merchandise?	1. Have a student describe how a "want list" may be used in purchasing. 2. Discuss how employees can assist in anticipating needs of customers. 3. References: 4, 14.

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PROBLEM AREA. Determining the procedures for receiving products into the agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the importance of processing newly arrived products into the firm properly.

2. Be familiar with the record keeping functions and checking procedures appropriate to each product upon arrival at the agricultural firm.

3. Understand the routing of purchase orders, shipping statements, and invoices when used to process products into the firm--correct, incorrect, and partially correct shipments.

4. Be familiar with procedures followed in moving products to appropriate locations in the firm after checking has been accomplished.

STUDENT MOTIVATION.

1. Discuss with the class--What is receiving; where does it start and stop?

2. Have class members move a small agricultural product through the receiving stages. List from class discussion the reasons for properly checking products into the agricultural firm.

3. From class discussion, outline the steps involved in moving the product into the agricultural firm.

SPECIAL ARRANGEMENTS. Secure a small agricultural product for class members to use in class discussion. Obtain purchasing orders and invoices needed for checking.

DIRECTED, STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Ask students to develop a list of the receiving procedures used by an agricultural firm.

2. Assign each student to select a main-line product and move it through the receiving stages.

3. Ask each student to draw an outline of storage and selling areas specifying products in each area. Determine who is responsible for receiving.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. Where are newly arrived products delivered at the firm?	1. State that it may differ according to the size or kind of product delivered. 2. Make a map of the facilities identifying all points of delivery and other areas of the firm.
2. Why should newly arrived products be accurately checked?	1. Discuss the need for maintaining a record of products entering or leaving the firm. 2. State reasons as follows: a. accurate inventories. b. paying suppliers. c. saving money and time.
3. What inspection and record keeping functions should be performed before putting an item into the firm's inventory?	1. Inspect the delivered product in comparison to the ordered product as to: a. number--shortage, overage. b. damage or condition. c. kind. d. quality. e. size. f. color. g. material. 2. Unveil the total picture of receiving products which includes the following activities: a. taking possession of delivered goods. b. checking condition. c. preparing records of incoming goods. d. checking contents against invoices and buying orders. e. marking goods. f. moving to storage or point of sale. 3. Emphasize that the record keeping function of receiving involves recording or substantiating the following: a. number of packages or units received. b. vendor's name. c. method of shipment and shipping firm. d. facts about receipt of goods. 4. State that a discrepancy report should be filed immediately with the supplier to prevent mistakes in payment, or to speed up reshipment

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Problems and concerns	Guides to solutions and examples of teaching techniques
4. Who is usually in charge of receiving at an agricultural firm?	1. Explain that it depends on the firm. For example, some firms have a receiving clerk(s) who handles all receipts of goods; other firms will have persons designated for receiving in their departments.
5. What should be done with damaged or incorrect shipments?	1. Make sure that students understand that any damage, shortage, or overage should be identified before signing a freight receipt. 2. Emphasize the fact that one should carefully read the invoice before signing the release.
6. Where does the product go after it is officially received by the firm?	1. State the two main areas as follows: a. storage. b. selling area. 2. Ask the students to become familiar with these areas in the firms where they work.

PROBLEM AREA. Discovering the importance of standards and specifications in buying.

OBJECTIVES. To develop in each student the ability to:

1. Understand the nature of standards and specifications and the reasons for their use.

2. Illustrate the importance of standards and specifications in buying.

3. Develop a working knowledge of how standards and specifications are successfully used.

STUDENT MOTIVATION.

1. Show the class a Mepp (or any other type of quality fishing lure) and a poor quality imitation. Pass the lures around and have the students carefully examine them. Ask the students to evaluate the two lures that are quite similar in respect to appearance.

2. Tell a "Fish Story" and relate the importance of specs and standards to the comparison made.

SPECIAL ARRANGEMENTS.

1. Have a resource person who is actively using or enforcing standards discuss with the class the importance of standards to his business.

2. Have students survey a business of their choice and identify the enforcing agencies of standard and specifications for that business.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have employer provide the student with a simple buying experience. (Emphasize selection of a product or item that has specs or standards.)

2. Have the student relate the procedure he followed to purchase the item in a discussion group.

3. Have students list all of the items they come in contact with that are in some way controlled by standards and specifications for a 30-minute period during a routine day.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is a purchase specification?	1. Define by saying that it describes the quality that is expected to be found in the article under consideration. 2. Reference: 8, p. 72.
2. What is the main reason for using purchase specs?	1. State that it can help one find the supply that gives greatest satisfaction. 2. Reference: 8, pp. 72-73.
3. What are the sources of specs?	1. Give examples as follows: a. federal agencies. b. standards associations. c. engineer and technical associations. d. A.S.T.M. and within the firm. 2. Reference: 8, Chapter 11.
4. Why do certain retailers set their own specifications?	1. List reasons as follows: a. there may not be supplies with merchandise that "measures up." b. inspection is easier. c. brand names are no longer the only guide to quality. d. assure more uniform quality. e. product can be easily measured against claims. f. consumers want to know more about quality. g. allows consumer to compare price and quality. 2. Reference: 12, Chapter 8.
5. How could specs facilitate better communications with customers?	1. Explain by giving the following: a. providing a common understanding between intermediates such as agents, jobbers, etc. b. reducing disputes. 2. Reference: 8, p. 72.
6. What are some examples of purchasing methods based on specs?	1. List methods as follows: a. quality. b. brand or trade names. c. use of blue prints. d. chemical or physical characteristics. e. material and methods of production. f. discription of purpose or use. g. standard specs. h. by sample. 2. Reference: 4, Chapter 3.

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Problems and concerns	Guides to solutions and examples of teaching techniques
7. How could an employee of an agricultural firm use one of these specifications?	1. Give an example of blue prints which offer a purchase plan that fixes dimensional measurements. 2. Reference: 4, p. 35.
8. What is a standard?	1. Explain that a standard is the result of general acceptance of a specification. 2. Reference: 4, Chapter 4.
9. What is meant by "Standard Products"?	1. State that products are often stock items ensuing immediate inspection and prompt delivery--usually cheaper. 2. Reference: 4.
10. How could one establish a set of standards for a product if none existed?	1. Hire an outside testing bureau. 2. Reference: 13, Chapter 10.
11. What do testing bureaus do?	1. Give following functions: a. set standards and specs. b. aid buyer in comparing competitive offerings. c. test goods under "normal" conditions. d. conduct innovative research. e. check claims. f. cooperate with complaint departments on claims.
12. Are standards and/or specifications related to profitable buying?	1. Moderate a panel discussion. Choose five for affirmative and five for negative. Highlight both advantages and disadvantages. 2. References: 12, pp. 191-200, 302-303, 458-459, 476-477. 8, pp. 68-69, 74, 198-199, 357. 4, pp. 33-37, 45, 52-53, 308-309, 215. 13, pp. 218, 273-276, 289-290.
13. What are the characteristics of a spec sheet?	1. Show samples if available. 2. Reference: transparencies.
14. How could one convert to specification buying?	1. Give steps as follows: a. develop specifications. b. buy in volume. c. use brand names [illegible] customer security is a consideration. d. establish standards and test if feasible.

A. BOOKS

1. Davidson and Doody, Retailing Management.

2. Davidson and Brown, Retail Management Second Edition.

3. Heinritz, S. F., Purchasing Principles and Applications.

4. Hodges, Henry G., Procurement--The Modern Science of Purchasing.

5. Lasser, How to Run a Small Business.

6. Lewis, Howard T., Procurement--Principles and Cases.

7. Lewis and England, Procurement--Principles and Cases.

8. McMillan, A. L., The Art of Purchasing, 1959.

9. Shilt and Wilson, Business Principles and Management.

10. Tonne, Simon, and McGill, Business Principles, Organization, and Management.

11. Weyant, Hoover, and McClay, An Introduction to Agricultural Business and Industry.

12. Wingate, J. W., Buying for Retail Stores, 1953.

13. Wingate and Friedlander, The Management of Retail Buying.

14. Wingate and Weiner, Retail Merchandising.

15. Zemansky, S. D., The Purchasing Job.

B. TEACHING AIDS

1. Slide series on the various standardizing agencies.

2. Film loop on "ABC's of Buying with Specifications and Standards."

3. Resource men from agriculture businesses.

4. Transparencies from reference 12, pp. 92-95.

5. Purchasing guides from commercial companies.

Unit III. Identifying Potential Suppliers to an Agricultural Firm

Problem Area 1: Recognizing How Products Sold by an Agricultural Firm Affects the Choice of a Supplier

Problem Area 2: Recognizing How the Retailing Aids Offered by Agricultural Suppliers Affect the Choice of a Vendor

Problem Area 3: Understanding How Credit and Discount Policies of Suppliers Affect the Choice of Vendors for an Agricultural Firm

Problem Area 4: Determining How Advertising and Promotional Programs Influence Choice of the Supplier

Problem Area 5: Selecting Suppliers for an Agricultural Firm through Affiliation

Problem Area 6: Determining the Status of the Suppliers of an Agricultural Firm in Terms of Their Business Service

References and Instructional Aids for the Unit

PROBLEM AREA. Recognizing how products sold by an agricultural firm affect the choice of a supplier.

OBJECTIVES. To develop in each student the ability to:

1. Understand how a firm selects a supplier on the basis of the products it sells.

2. Understand how policies of the supplier may influence a firm's selection of a vendor.

3. Identify sources of information for establishing a list of related suppliers.

STUDENT MOTIVATION. Have the students in the class quickly establish a list of firms in the area that sell fertilizers, for example, or any other agricultural product that would have a large number of dealers in the area and ask students which one they would choose if they were farmers. Ask students to justify their choice.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students develop a list of suppliers available to the firm where they are employed.

2. Have students determine, through a discussion with employee(s) of the firm, the quality of merchandise sold by the suppliers listed in number one above as high, medium or low.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. How may the quality of product desired by customers influence the selection of a supplier for an agricultural firm?	1. Emphasize that merchandise may vary greatly in quality, and that customer demand for quality may also vary. 2. Discuss the following in relation to choice of a supplier: a. customers' desire for high quality merchandise that offers long service. b. customers' willingness to sacrifice quality for a reduced price. 3. Have students present their lists of suppliers as described in "structured activities" one and two. (Emphasize that the selected supplier must offer the quality of product desired by the firm's customers.) 4. References: 7b, supplier catalogs and periodic publications of the industry.
2. How may trends in agricultural industry influence selection of the supplier of a firm?	1. Discuss how the management personnel of an agricultural firm must be alert to recognize new trends of the industry. 2. Discuss how innovations in agricultural may influence choice of a supplier. Give the following examples: a. minimum tillage. (Only suppliers whose products fit into this trend should be considered.) b. riding mowers. (Suppliers that handle only push mowers should be reconsidered.) 3. Have the students consider other possible trends in agriculture that would relate to the firm where they are employed and identify types of products that should not be handled or ones that are quickly being replaced. 4. References: 7b, 8.
3. Why is it significant to select a supplier that offers merchandise that has distinct features from its competitors?	1. Discuss the importance of product differenciation using the following lead questions: a. What problems could be created by competitors advertising when the product you sell is very similar to competitors' products?

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Problems and concerns	Guides to solutions and examples of teaching techniques
	b. What advantages could be gained from competitors advertising? c. What problems could be created by complaints of the competitors' products? 2. Have each student select one brand of an agricultural product and present to the class its distinct features. 3. References: 7b, 8.
4. How may the method of packaging a product influence selection of a supplier?	1. Have selected students bring to class a packaged product and through class discussion, analyze the package according to the following: a. package protects product while in transit. b. package prevents pilferage and shopper damage while product is on the counter. c. package lends itself to ease of handling both in storage and on the shelf. d. package provides for efficient storage of product. e. package enhances merchandising of product. f. package includes an informative label. g. package provides convenience to the customer. 2. References: 7b, 8.
5. How may product-demand variations influence the choice of a supplier for an agricultural firm?	1. Write the following three categories of goods on the chalkboard and ask the students to provide examples of agricultural products that could be classified under each. a. high fashion goods--goods that come quickly and are replaced quickly. b. seasonally used goods--goods that are sold and used during a limited time of the year. c. staple goods--goods that are sold, stocked and used the year around. 2. Relate that vendors can be classified into five categories according to the rate of developing and handling of new products.

Problems and concerns	Guides to solutions and examples of teaching techniques
	a. Innovators. Suppliers that lead the industry in research and development of new products. b. Early adopters. Suppliers that wait to see if the product is going to be successful before they start handling it but are still well ahead of the industry. c. Early majority. Suppliers that handle a product after it is well established. d. Late majority. Suppliers that start handling a product when competition is the greatest and profits are low. e. Laggards. Suppliers that are last to develop and handle a new product. 3. Have the class identify the type of vendor they would like to have for each of the three types of goods outlined above.
6. How may the policies of an agricultural firm limit its choice of vendors?	Discuss the implications of the following policies on supplier choice: a. buy in large quantity and store. b. buy in small quantity and limit storage. c. produce own products under its own label. d. buy products with its own label from a manufacture. e. handle nationally sold brands and not a private brand.
7. How may a supplier's policies concerning its product influence a firm's selection of a vendor?	1. Have class members identify how each of the following policies may influence choice of a supplier: a. supplier endorses "fair trade laws" to establish the retail price. b. supplier limits output and will not sell all of its output to one firm. c. supplier directs merchandising of its products. 2. References: 7b, 8.

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Problems and concerns	Guides to solutions and examples of teaching techniques
8. What are sources of information that a firm may use in establishing a list of possible suppliers?	1. Discuss how the following may be used to identify possible suppliers: a. past experience and records. b. suppliers' salesmen and representatives. c. shopping at a competitor's store. d. visiting market centers. e. advertising in periodic publications. f. trade shows. g. trade directories of suppliers. 2. Have the students bring to class examples of sources of information that could be used by the firm to identify possible suppliers. 3. Have each student bring to class the list of characteristics the firm looks for in a supplier in relation to the products it sells. 4. References: 7b, 8, trade directories of suppliers and firms, periodic publications and catalogs of the industry.

PROBLEM AREA. Recognizing how the retailing aids offered by agricultural suppliers affect the choice of a vendor.

OBJECTIVES. To develop in each student the ability to:

1. Identify the retailing aids provided by a vendor.

2. Evaluate the retailing aids offered by a vendor.

3. Select the retailing aids that may increase the sales of an agricultural product.

STUDENT MOTIVATION. Have students enumerate the selling aids that caused them to buy a specific product. Ask students which aids they believe might cause their parents to buy. Compare what causes students versus adults to buy. Relate these to agricultural products.

SPECIAL ARRANGEMENTS.

1. Secure and show a film from a main line product supplier explaining the advantages of its franchise.

2. Plan with a supplier representative to discuss with the class retailing aids offered by his company.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students discuss with management of an agricultural firm and report back to class the value of retailing aids offered by suppliers.

2. Encourage students to ask a vendor's representative to state advantages of retailing aids to a firm provided by his company.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are some ways to evaluate the value of retailing aids offered by suppliers?	1. Have students list five sales made with the help of a selling aid while they were on the job. Consider aids used in each sale and relate to the success or failure of the business. 2. Have manager of an agriculture firm explain how selling aids provided by suppliers help his business. 3. References: 7b, selling aids from suppliers.
2. How do managers of agricultural firms recognize helpful aids of potential suppliers?	1. Discuss how the manager of a firm may use the following to identify helpful retailing aids:' a. guidance from managers of similar agricultural firms. b. observing activities of competitors handling similar products. 2. Assign each student to list five helpful retailing aids he would look for in choosing a new supplier. 3. Use as basis for class discussion "Structured Activities" number one and two.
3. How can vendor representatives aid the manager of an agricultural firm choose a supplier?	1. Discuss the value of the following: a. explaining the policies of the company. b. conducting tours so manager can see retailing aids in action. 2. Have an agricultural supplier's representative explain to the class how retailing aids help sell products. 3. Use teaching aids: a, b, c, d, e, f.

PROBLEM AREA. Understanding how credit and discount policies of suppliers affect the choice of vendors for an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Recognize credit and discount policies available through a supplier.

2. Determine which credit and discount policies are beneficial to an agricultural firm.

3. Use the credit and discount policies effectively.

4. Determine the monetary value derived from the use of credit and discount.

STUDENT MOTIVATION. Have students relate credit and discount policies they have experienced in buying personal items (car, machinery, etc.), and how their buying decisions were influenced by them.

SPECIAL ARRANGEMENTS.

1. Invite a supplier to the class to discuss credit and discount policies.

2. Develop a "bar" graph to illustrate the cost of items with and without credit and discounts.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students discuss the importance of credit and discount policies of a supplier with the manager of the firm where they work.

2. Have a team of students make a board display of the various credit and discount policies of suppliers, illustrating monetary value to the retailing firm.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What credit and discount policies are offered by suppliers of agricultural products?	1. Reference: "Structured Activity" number one. 2. List and discuss policies identified by students. Policies should include: a. floor plan required. b. cash discount. c. volume discount. d. wholesale price. e. carrying charges. 3. References: 1, 5.
2. Why should an agricultural firm use credit and discounts offered by suppliers?	1. Have students identify the affects of using credit and discounts in relation to the following: a. competition. b. greater profits. c. lower prices to consumers. d. greater service. e. new equipment. f. volume sales. 2. References: 1, 2.
3. When can an agricultural firm use credit and discounts effectively in buying?	1. Identify qualifications necessary for a firm to receive credit and discounts offered by a supplier. 2. List commitments required to receive credit and discounts. 3. Discuss penalities and restrictions. 4. References: 5, 7b.
4. How may use of credit and discounts affect the profit of an agricultural firm?	Set up hypothetical buying problems to illustrate the potential results of the following: a. using discounts. b. using credit. c. limited capital versus credit.

PROBLEM AREA. Determining how advertising and promotional programs influence choice of the supplier.

OBJECTIVES. To develop in each student the ability to:

1. Identify good promotional and advertising techniques.

2. Allow the agricultural firm to take advantage of supplier promotion.

3. Help the agricultural firm to increase profits through promotion and advertising offered by the supplier.

4. Realize if a supplier is meeting the product promotional needs of the firm.

STUDENT MOTIVATION.

1. Have students list important sales techniques.

2. Ask students what kinds of promotion is used by different suppliers in their areas.

3. Have students compile materials from each firm and supplier(s) selected.

SPECIAL ARRANGEMENTS.

1. Arrange for a field trip to observe advertising and promotional techniques used.

2. Prepare a list of suppliers with good techniques or programs in advertising and promotion.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students list methods which an agricultural firm follows in order to determine whether advertising is profitable or not.

2. Divide the class into equal groups and allow each to display an exhibit showing promotional techniques and schedules for coverage.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are some techniques used in advertising?	1. State elements that get the attention of the clientele as follows: a. color. b. pictures. c. size and type of the advertisement. d. position of the advertisement. e. local correlation. 2. Use a local resource person to tell of ways of getting attention used in his firm. 3. Take the class on a field trip and observe promotional techniques used by the supplier.
2. How does a firm make arrangements with a supplier to advertise and promote a product?	Explain the following points. a. check on availability of aids. b. determine if the cost is fair. c. determine who furnishes the personnel. d. determine the role of supplier in the choice of advertisement. e. calculate cost of materials. f. make provisions for signing contracts.
3. What factors influence use of advertisement and promotion?	1. Relate sales volume to the amount of money that could be spent on advertising. 2. Consider number of people served by the firm. 3. Find out how much money the supplier will provide for advertisement.
4. What are some strategies in marketing?	1. Have students become familiar with elements that affect the marketing process. Discuss the following: a. personal selling versus advertising. b. customer buying decisions: need, thing, source, price, and time.

Problems and concerns	Guides to solutions and examples of teaching techniques
	c. steps in the sale--AIDA Formula, (attention, interest, desire, and action).
5. What does the supplier consider a continuous process in advertising?	State procedures involved in continuous selling. Explain the following: a. group selling (advertising for desires of masses). b. imitation. c. association. d. suggestion. e. intellectual appeal. f. campaign strategy.
6. How can a firm determine if its advertising is returning money?	Ask a local supplier of an agricultural firm to come and disucss the following items with the class: a. percent of gross sales normally spent on advertising. b. increases in sales due to advertising. c. the best time to advertise.
7. How can you determine if the supplier program is meeting your needs?	1. Note that promotional techniques should increase profit through the following factors: a. increased interest. b. increased sales. c. product enthusiasm. 2. Assign students to devise a promotional technique and illustrate its usefulness. 3. Divide the class into groups and have each group select a supplier of importance or interest. Suggest: fertilizer, farm management, pesticides, or petroleum supplies. 4. Ask each group to determine the sales technique used to promote additional sales. 5. Make a list of promotional techniques used by the supplier. Identify which of the following techniques were used:

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Problems and concerns	Guides to solutions and examples of teaching techniques
	a. national advertising. b. seasonal promotion. c. personalizing advertisement. d. local relativeness. e. identifying with success. f. pictorials.

PROBLEM AREA. Selecting suppliers for an agricultural firm through affiliation.

OBJECTIVES. To develop in each student the ability to:

1. Understand the various types of affiliation.
2. Appreciate the complexity of business ties.
3. Develop a working knowledge of the importance of affiliation to the final selection of a supplier.

STUDENT MOTIVATION.

1. Select four students to play the various roles of:
   a. President of a large machinery company.
   b. Local dealer.
   c. High pressure Brand X salesman.
   d. Customer wanting to buy an oil filter.
2. Assume that the customer is interested in getting the most for his money. Have each of the students act out their roles as though their jobs depended on it.

SPECIAL ARRANGEMENTS.

1. Visit a small local business and a nationally affiliated business. (Example: Local feed store and F.S.)
   a. Encourage students to observe where they get their supplies.
   b. Discuss the affiliations of the two firms.
2. Have students research affiliations of some of the major industries, particularly the agriculture industries.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students identify types of affiliations at their placement station(s).
2. Have students identify the classification of the affiliation. (Example: vertical integration, conglomerate, etc.)
3. Have students identify some affiliation possibilities of the businesses where they are employed.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. Why do companies integrate?	1. State possible outcomes as increased earning or capturing a competitive advantage. 2. Reference: 4, Ch. 12.
2. What is a conglomerate?	1. Explain that the means of diversification through horizontal integration is generally called a conglomerate. 2. Reference: 4, pp. 96-98.
3. What is vertical integration?	1. State that the assumption of processes related to the marketing of a product or good is referred to as integration. (e.g., A supermarket raising its own broilers.) 2. Reference: 4, Ch. 12.
4. What types of affiliations affect the selection of a supplier?	1. List major types as follows: a. holesaling by voluntary groups to meet competition of chains by independents. b. reciprocal buying--"Scratch my back, I'll scratch yours." c. preferred resources--pricing and purchase agreements on large volumes. d. franchise or agency--gives more through identification of interest with the vendor. e. commercial bribery--the acceptance of gifts, money, subsidy, etc. f. market agreements, unions, cooperatives. 2. References: 3, pp. 49-261; 6, pp. 83, 215; 4, Ch. 12.
5. Can a company be affiliated in several ways?	1. Use chart and/or resource man to discuss ties of a business. 2. Reference: organizational charts, resource persons from agricultural firms, and film loops.
6. How does affiliation effect competition?	1. Discuss how affiliation may reduce competition. 2. Reference: 4.
7. How does affiliation influence diversification and intensification?	1. Generate discussion and identify ways affiliation may influence diversification and intensification. Factors considered should include:

Problems and concerns	Guides to solutions and examples of teaching techniques
	a. competition. b. profitability. 2. Reference: 3.
8. How does affiliation affect the final selection of a supplier?	1. State that affiliation generally dictates selection of a supplier. 2. Relate that normal competition is frequently interrupted by affiliation. 3. Have students identify and relate the affiliations that the firms where they work have with major suppliers.

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PROBLEM AREA. Determining the status of the suppliers of an agricultural firm in terms of their business services.

OBJECTIVES. To develop in each student the ability to:

1. Examine the status of the firms' place in the market area.

2. Determine if the present suppliers are meeting the objectives of the agricultural firm.

STUDENT MOTIVATION. Ask students to give reasons why a customer of an agricultural firm might switch to a new vendor.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students identify an agricultural firm which lost some of its customers to a nearby competitor and suggest possible causes.

2. Determine, through a discussion with the manager of the firm, a product that was once an important line in the firm, and why it was cut back or discontinued, and what effect if any this had on the supplier.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What factors influence the reconsideration of the products carried by an agricultural firm?	1. State factors as follows: a. customers' taste. b. customers' mobility. c. replacement of old products by new ones. d. shift in types of product carried by the firm. 2. Have students prepare examples of products that have been either dropped from the line or have lost their importance. Discuss possible causes for the outcome. 3. References: 7a, 8.
2. What factors influence the reconsideration of the suppliers in relation to the products handled?	1. Emphasize that the quality of the product under consideration may change as a result of one or more of the following: a. management becomes poor. b. lack of quality control. c. management decision to change the quality because of more profit. 2. State other reasons as follows: a. competition. b. customer demands. c. cease in production of products. 3. References: 7a, 8.
3. What factors influence the reconsideration of suppliers of an agricultural firm in relation to the policies of that supplier?	1. Discuss the following reasons that may influence policies of a supplier: a. change in management personnel. b. change in financial condition. c. competition. d. new legislation.

Problems and concerns	Guides to solutions and examples of teaching techniques
	2. Have students discuss and analyze policy changes resulting from the following elements. a. advertising. b. credits made available to the firms where the students are receiving supervised experience. 3. References: 2, 7a, 8.

REFERENCES AND INSTRUCTIONAL AIDS FOR THE UNIT

A. Books.

1. Fuller, R. G., Alfred Mannebach, and Edwin Vernon, Moving Products from an Agricultural Firm to the Customer.

2. Heinritz, S. F., Purchasing Principles and Application.

3. Hodges, Procurement, the Modern Science of Purchasing, 1961.

4. National Commission of Food Marketing, Food from the Farmer to the Consumer, June, 1966.

5. Wilson, L. L., Farm and Power Equipment Retailers Handbook.

6. Wingate, Buying for Retail Selling.

7. Wingate, Friedlander, The Management of Retail Buying, New Jersey: Prentice Hall, 1963, (a) pp. 179-192, (b) pp. 221-222.

8. Wingate, Wiener, Retail Merchandising, pp. 215-276.

B. Teaching Aids.

1. International Harverster, F. E. Sales Development Program.

2. Moving products from an agricultural firm to the customer.

   a. Wall charts.
   b. Bulletin board.
   c. Slides.
   d. Film
   e. Advertising and promotion kits.
   f. Organizational chart if an affiliated firm.

3. Periodic publications of the industry.

4. Resource men from agriculture business.

5. Selling aids from a supplier in class.

   a. Product manuals.
   b. Films.
   c. Credit applications.
   d. Employee training programs.
   e. Advertising material.
   f. Product literature.
   g. Supplier catalogs.

Unit IV. Understanding the Methods Used by an Agricultural Firm in Making Buying Contracts

Problem Area 1--Understanding How to Use Purchasing Orders Effectively in an Agricultural Firm

Problem Area 2--Understanding the Role of Price in the Purchasing Function of an Agricultural Firm

Problem Area 3--Considering the Importance of Transporting Agricultural Products When Making Buying Agreements

Problem Area 4--Understanding the Legal Aspects of Procuring Commodities for Agricultural Firms

Problem Area 5--Choosing the Method of Payment When Making Buying Agreements for an Agricultural Firm

Problem Area 6--Using Computers in Making Buying Decisions in an Agricultural Firm

References and Instructional Aids for the Unit

PROBLEM AREA. Understanding how to use purchasing orders effectively in an agricultural firm

OBJECTIVES. To develop in each student the ability to:

1. Realize the importance of accuracy in ordering supplies.

2. Fill out a purchase order correctly.

3. Understand the purchasing responsibilities of various personnel in an agricultural firm.

STUDENT MOTIVATION. Have students write down the items they would want on a new car and then exchange papers and let another student determine from this list if he could properly fill the order.

SPECIAL ARRANGEMENTS.

1. Secure enough copies of a common purchase order so that each class member will have one for classroom use.

2. Prepare a visual for the overhead projector that will show a properly completed purchase order.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students assist another employee in the firm prepare a purchase order.

2. Have students discuss the purchase contract on the back of a purchase order with the managers of the firm where they work.

3. Have students observe how their places of business determine when purchase orders have been filled.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is a purchase order?	1. Have several students give their definition of a "purchase order." 2. Prepare a visual in advance and explain to the class that a purchase order is an agreement that a firm makes with a vender to supply a specific product. 3. Reference: 5, p. 268.
2. What are the major parts of a purchase order and the information contained in each part?	1. Have students relate the types of information required on a purchase order. Make a list on the chalkboard. The list should include the following: a. Name and address of both buyer and seller. b. Department for which goods are purchased. c. Date of order. d. Quantity. e. Description of goods. f. Unit cost. g. Extension. h. Total cost of order. i. Credit terms. j. Discounts. k. Transportation instructions. l. Delivery date. m. Signatures. n. Special terms and agreements 2. Using a visual prepared in advance, explain that a standard order commonly has seven zones or parts as follows: a. Zone 1, special instructions. b. Zone 2, name, address, etc., of buyer. c. Zone 3, name and address of seller or vendor. d. Zone 4, shipping instructions. e. Zone 5, terms or conditions of sale. f. Zone 6, listing of materials ordered, number, description, size, unit price. g. Zone 7, signature of buyer. 3. Reference: 5, p. 271.
3. What is the proper way to fill out a purchase order?	1. Supply each student with a copy of a purchase order. Give the students a problem consisting of items to be purchased and other necessary information and have them fill out the order. 2. Use the overhead projector to show a properly completed form and have students make necessary corrections on their copies.

Problems and concerns	Guides to solutions and examples of teaching techniques
	3. Have each student identify the person who would receive each copy in the firm where employed. Distribution may be as follows: a. Vendor, original copy. b. Purchasing office file. c. Requisitioning department. d. Receiving deportment. e. Inspection department. 4. Reference: 5, pp. 268-271.
4. What are some of the terms and conditions of a purchase contract?	1. Discuss the terms and conditions of contracts experienced by students in the class. The following items should be included in the discussion: a. Quality of product. b. Discount on prompt payment. c. Drafts--not allowed. d. Cartage--no charge allowed by buyer unless otherwise agreed. e. Taxes--usually payed by seller. f. Tools--statement concerning special tools used. g. Shipment--must be made within time specified. h. Patents--seller shall hold purchaser from liability of any nature or kind for or on account of the use or sale of any patented invention. i. Price--agreement as to price to be paid or last quoted or paid if not stated. j. Compliance--this order is placed by the purchaser with the understanding, and in accepting the seller agrees, that no federal statute has been violated in the manufacture or sale of the items covered in this order. 2. Reference: 4, pp. 352-356.
5. How may an order which has been submitted to a vendor be changed?	1. Have students obtain a copy of a change order form from the business where they work. 2. Discuss the procedure for making a change in an order. Emphasize the following steps: a. Restate original order. b. Give the desired order. c. Negotiate change order with vendor. d. Inform various departments within the firm of the change. 3. Reference: 4, pp. 359-361.

Problems and concerns	Guides to solutions and examples of teaching techniques
6. Who has the power to purchase merchandise within a company?	1. Have students determine the items purchased by the various personnel within their businesses and have them find out who had to give approval for purchase of items. 2. Relate that an authorized person should sign all purchase orders and include the following: a. Printed name of the company. b. Personal signature. c. Printed title of the signer. 3. References: 4, p. 358; 14, pp. 258-260.
7. Why should a copy of all purchase orders be kept on file?	1. Discuss the importance of keeping orders on file until filled and payment has been made. 2. Reference: 4, p. 358.

PROBLEM AREA. Understanding the role of price in the purchasing function of an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the importance of prices in buying transactions.
2. Understand the basis for negotiating prices.
3. Understand the economic principles affecting prices.
4. Evaluate different types of discounts offered by suppliers.

STUDENT MOTIVATION. As an advance assignment, have the students price a specific item at several different local firms. As this problem area is introduced, discuss the reasons for differences in the prices. Have students tell where they would purchase the item and why.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Arrange for students to observe a negotiating session between the employer and one of his suppliers. Follow up in class by having students report on what happened during the discussion.
2. Have students critically evaluate two suppliers of similar products. Outline the advantages and disadvantages of purchasing the products from each supplier.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. Why is pricing an important part of the purchasing function?	1. Have each student select an item that is available at the student's business and at several other businesses in the area. Have the student obtain retail prices of the item from several of the businesses and report his finding to the class. a. Discuss why these prices differ. b. Discuss how much savings would be made by "shopping around." c. Discuss possible reasons for not selecting the lowest priced item. 2. Have students discuss with the employers of the business where they work the importance of pricing in purchasing. 3. Develop a definition for the following terms and relate each to price: a. Quoted price. b. Discounts. c. Transportation allowance. 4. References: 2, chs. 15, 16; 4, chs. 1, 17.
2. When may bargaining be effective in reducing the price paid for a product?	1. Have students relate examples of bargaining they have observed in the businesses where they are employed. 2. Discuss how the following may influence the price paid by a firm for a product: a. Buying in quantities. b. Paying cash. c. Ordering during "off season." d. Negotiating for job lots, or "distress" merchandise. e. Purchasing manufacturer's clearance of broken lines, sizes, colors, or styles. f. Providing savings to manufacturer in production, delivery, or selling. 3. Discuss the ethical procedures to be followed in price negotiations. 4. References: 13, Chs. 1-3 and 9-13.

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Problems and concerns	Guides to solutions and examples of teaching techniques
3. How can a buyer for an agricultural firm determine what is a "fair price" for a product?	1. Discuss the implications of the following techniques used in determining price of an item: a. Guessing prices. b. Memorizing prices of similar products. c. Building up prices. 2. Reference: 15, Chs. 6-10.
4. What are the different types of discounts available from agricultural suppliers?	1. Assign a member of the class to lead a discussion on each of the following types of discount. Each student should use examples, preferably from his own place of employment. a. Quantity discount. b. Seasonal discount. c. Trade discount. d. Chain discount. e. Cash discount. f. Retail discount 2. References: 5, 15, Chs. 6-10.
5. What economic principles may affect the price an agricultural firm pays for a product?	1. Explain the following principles and have students cite examples of how each may affect the firm where they work: a. Purchasing cycle. b. Supply and demand. c. Competitive buying. d. Price controls. 2. References: 2, 4, Chs. 1, 17.
6. What are some special buying arrangements that may affect prices?	1. Explain in class the following buying procedures: a. Preferred selling space. b. Free display material. c. Demonstrators. d. Unit packing. e. Guarantees against price decline. f. Merchandise deals. 2. Have students check with employer to see if they use any special buying arrangements. 3. References: 13, Chs. 1-3 and 9-13; 15, Chs. 6-10.

PROBLEM AREA. Considering the importance of transporting agricultural products when making buying agreements.

OBJECTIVES. To develop in each student the ability to:

1. Cut transportation costs when ordering agricultural supplies.

2. Realize the importance of transportation to an agricultural firm.

3. Select the proper transportation method for a given product.

4. Be familiar with the terms used in the delivery of products.

STUDENT MOTIVATION.

1. Select a product such as a bag of feed or hog feeder and ask students how it got from the manufacturer to their farms. Discuss the channels of transportation.

2. Have students estimate the transportation costs of some common items and relate this to the price a company charges for transporting the items.

SPECIAL ARRANGEMENTS.

1. Secure copies of freight guides for use in the class.

2. Duplicate copies of "Methods of Transporting Goods" and "Common Transportation Terms" for distribution to students.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students determine the per unit transportation cost of two major products handled by the firm where they work.

2. Have students determine if merchandise is shipped to the businesses C.O.D., C.A.F., or C.I.F.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. Why should the management of a business firm be concerned with delivery methods when buying products?	1. Have students determine the transportation cost of a major item sold by the business where they work. 2. Explain that transportation expense constitutes a major part of the total retail cost of a product. 3. Reference: 11, p. 167.
2. What are some of the common methods of transporting agricultural products from the supplier to the retail firm?	1. List on the chalkboard transportation methods observed by students in the firms where they are employed. 2. Discuss advantages and disadvantages of each of the following methods of transporting goods: (See chart at end of this problem area.) a. Parcel post. b. Express or rail. c. Truck. d. Airplane. e. Boat. f. Pipeline. 3. Reference: 11, p. 175.
3. What factors should be considered in choosing a method of transporting agricultural products from the supplier to the retail firm?	1. Discuss how each of the following may influence the choice of a method of transporting goods: a. Cost. b. Speed. c. Dependability. d. Convenience in pick up and delivery. e. Packing requirements. f. Speed required in loading and unloading. g. Size of shipment. 2. Have students identify the main factor to be considered in shipping the following items: a. Ton of feed. b. Combine. c. Repair parts for tractor at planting time. d. Soil testing supplies. e. Repair parts for English made tractor. 3. Reference: 11, p. 176.

Problems and concerns	Guides to solutions and examples of teaching techniques
4. How can freight rates for an agricultural product be estimated prior to shipment?	1. Provide a freight guide and have students calculate the transportation costs of various items. Compare the costs of different methods of transportation. 2. Reference: 11.
5. What shipping arrangements must be made by the buyer after merchandise is purchased?	1. Identify decisions that the buyer of a product must make in regard to transportation. The following should be included: a. Who is to pay for the cost of transportation? b. Who is to own the goods and be responsible for them during shipment? c. What will be the method of shipment? d. How will goods be packed? e. How will transfer of title be handled? 2. Review the terms commonly used in shipping goods. (See terms and definitions at end of this problem area.) 3. Reference: 11, p. 177.
6. What are the differences between a straight bill of lading and an order bill of lading?	1. Explain that when payment for the goods is not involved, either because they have been prepaid or purchased on long-term credit, a straight bill of lading is used. This directs the transportation company to deliver the goods only to the consignee and no one else, for the bill is nonnegotiable. An order bill of lading is negotiable, for it directs the shipping company to deliver the goods to the consignee, or anyone the latter may designate, who presents the original bill to the freight agent at destination, properly endorsed just as a check might be endorsed. 2. Show the class examples of the different kinds of bills of lading. 3. Reference: 11, p. 177.

Methods of Transporting Goods

	Truck	Railroad	Airplane
Rates	Lowest rates on short haul	Lowest on long haul	Highest rates
Speed	Faster for short distance than railroad	Faster for long haul than truck	Fastest of all for long distance
Schedule	No regular schedule but handles emergency or rush hour shipments	Definite regularly scheduled	Frequent service, but dependent on weather
Service	Door to door and flexible	Rail service to factory dock	Usually far from commercial centers
Packing	Packing and crating costs reduced	Requires packing but carload lost move without changing cars	Less expense in packing, but must be removed from plane before delivery
Expense	Less handling, therefore less loss or damage	Better terminal facilities, cars need not be unloaded at once	Quick deliveries, cuts down on inventory and warehouse costs

Common Transportation Terms

1. Consignee. Receiver of goods.

2. Consignor. Shipper of goods.

3. F.O.B. shipping point. The shipper assumes the responsibility for the goods until they reach the carrier's shipping point. At this point the title passes to the buyer and he pays the rest of the charges.

4. F.O.B. city of destination. The shipper pays all transportation charges to the city in which the buyer is located. The buyer pays the cartage from the carrier's freight station to his store.

5. F.O.B. store. The shipper pays all transportation charges. Title passes when the shipment arrives at the buyer's place of business.

6. C.A.F. The quoted purchase price includes the cost of the merchandise and the freight to the destination.

7. C.I.F. The quoted price includes the merchandise cost, insurance covering the shipment en route as well as the freight charges.

8. C.O.D. The shipping company collects the cost of merchandise for the shipper as well as the delivery charges from the buyer.

9. Demurrage. When a consignee takes more than his designated time to get a car unloaded, he is charged a small fee called demurrage.

PROBLEM AREA. Understanding the legal aspects of procuring commodities for agricultural firms.

OBJECTIVES. To develop in each student the ability to:

1. Understand the characteristics and procedures of legal contracts.

2. Appreciate the ethical procedures of procurement.

3. Understand the implications of purchasing contracts which may be of interest to an agricultural firm.

STUDENT MOTIVATION. Read a brief case history involving a purchase contract dispute (such as the many cited in reference 9 or one selected from a local, current newspaper). Try to get students to see how this kind of problem can affect them or the agricultural business where they are gaining experience.

SPECIAL ARRANGEMENTS.

1. Save current newspaper reports which could serve as points of discussion for the class.

2. Arrange for an agricultural businessman to come and talk to the class.

DIRECTED, STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have students secure copies of buying contracts used by the agricultural firmswhere employed, become familiar with and be able to explain the statements included and their implications.

2. Have students become familiar with the legal responsibilities of both buyers and sellers by interviewing at least two people involved with these two aspects of the business.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are the characteristics of a legal contract?	1. Explain that a contract comes into existence when two or more parties make an agreement that is enforceable at law. 2. State elements of a legal contract as follows: a. Parties must be competent--know what they are doing, of proper age, and mentally capable. b. Mutual agreement--agreement on the rights and obligations of each party. c. Subject matter must be legal--agreed upon activity must not violate any existing laws. d. Considerations must be given--each party must promise either to give up something of value which he has a legal right to keep, or take on an obligation he is not legally required to assume. e. The contract must be in the proper form--it must be in writing and in a form prescribed by law.
2. What is considered ethical practices in buying?	1. Explain that merchandise could be returned if damaged, faculty, not according to specifications, or not delivered on the time agreed upon. 2. Emphasize that a contract cannot ethically be changed due to change of price or style. 3. Reference: 4, pp. 289-290.
3. What are the types of contracts?	1. List the types on the chalkboard as follows: a. Oral. b. Written. 2. Discuss aspects of written contracts as follows: a. No more valid than oral unless a written contract is required by law. b. Preferred if the transaction is important or complicated. c. Ensures greater certainty and reduces future misunderstanding.

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Problems and concerns	Guides to solutions and examples of teaching techniques
4. What are some common terminologies associated with contracts?	1. Write the following terms on chalkboard and explain each. a. Express. The terms of agreement should be explicitly stated and agreed upon by both parties. b. Implied. Terms must be inferred from: (1) The acts or conduct of the parties. (2) The customs of a particular business. (3) Conditions or circumstances rather than from oral or written words. c. Executed. A contact becomes executed when both parties have complied with all the terms of the agreement and nothing remains to be done. d. Executory. The terms of the agreement that are to be put into effect. e. Formal. A written contract under seal. f. Simple. All other contracts not written under seal.
5. What can an agricultural firm expect from vendor warranties?	1. Give following conditions related to warranties: a. Warranties can be enforced in court if sufficiently specific. b. Implied warranties enforceable in some instances. Examples: (1) Articles sold for food are to be fit for human consumption. (2) An article sold as designed for a certain purpose--an electric heater must actually heat; how much or how long are not guaranteed. 2. Refer to elements that constitute fraud and deceit. 3. Reference: 5.
6. When does title to merchandise pass from seller to buyer?	1. State situations as follows: a. F.O.B. vendors place of business. Title passes to buyer as soon as vendor turns merchandise over to the carrier. b. F.O.B. buyers place of business. Title passes when buyer receives merchandise. 2. Clarify the position of the carrier involved in these two situations in case of damage in shipment.

PROBLEM AREA. Choosing the method of payment when making buying agreements for an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Realize the importance of the method of payment in business contracts.

2. Identify various payment procedures.

3. Make sound purchasing decisions for optimum profits.

STUDENT MOTIVATION. Illustrate an example to the class where a firm may increase its profit by choosing an appropriate method of payment.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS. Ask each student to discuss with the vendor representative of the firm where he is employed and determine why discounts are or are not given to the customers.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. Why are methods of payment important?	1. Discuss the following factors related to payments: a. Available capital. b. Turnover rate of the product. c. Size of the firm.
2. What are the major types of payment agreements?	1. List the major types of payment on the chalkboard. Discuss the terms associated with each. a. Cash discounts. (1) Net ten days. Ten days from date of invoice. (2) E.O.M. Net due at "end of month." (3) Net 30-60 extra. Called "extra dating" payment due 30 days after an extra 60 days has expired. (4) C.O.D. Collect on delivery. (5) R.O.G. Terms of dating begin on date of "receipt of goods" by the buyer. (6) ½/10, n/30. Buyer may take a one-half percent cash discount if paid in 10 days or the net is due in 30 days. (7) E.O.E. or E.O.E. (errors and omissions excepted). If seller's bookkeeper made an error, the correct amount is nevertheless due. b. Trade discounts. Deductions from the list price before an invoice is written. (1) These are allowed as quantity discounts or to adjust prices shown in infrequently published catalogs. (a) Noncumulative. (b) Patronage or cumulative. c. Chain discounts. Two or more trade discounts. For example: a 10% + 5% - $100 purchase less 10% = $90, less 5% = $85.50. d. Advanced dating. Terms of payment figured from an advanced dating (Example: January 1 invoice, March 1 dating). Season dating is a common form, determined by the date of opening of seasonal sales (Example: Christmas toys shipped in July; terms 2/10/30, December 1 or two percent discount if paid in 10 days or the net is due in 30 days).

Problems and concerns	Guides to solutions and examples of teaching techniques
	e. Anticipation. An allowance of an additional cash discount if the bill is paid prior to the expiration date of the cash discount period. (1) Typical allowance is at the rate of six percent per annum. (2) "2/10-60 days extra"--$500 invoice, dated September 1, payment made September 10 or 60 days ahead of due date-- Invoice $500.00 Less two percent 10.00 $490.00 Less one percent (i.e., one-sixth of six percent) 4.90 Net amount $485.10
3. How could the management of an agricultural firm choose a method of payment that would optimize profit?	1. Have students illustrate some example problems of the savings that a firm could realize by taking advantage of discounts or other terms. 2. Discuss the advantages of delayed payment. a. In a firm where capital is tight--using money for other purposes until payment is due on longer terms. b. Delaying payment until some or all of merchandise is sold--particularly seasonal items.
4. What are the legal limitations to the amount of discounting given by a vendor?	1. Review the following aspects of Robinson-Patman Act. a. A quantity discount must not exceed the seller's savings in production and distribution costs made possible by the quantity involved. b. Few firms really know their cost-quantity relationships. c. The seller is expected to be able to offer factual evidence to justify discount allowances. d. Promotional allowances also governed by this act--such as allowances for local advertising or for preferred window space. (Example: This act prohibits any payment to a customer, in consideration for any services, unless such payment is made available on proportionally equal terms to all customers competing in the distribution of such products.)

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PROBLEM AREA. Using computers in making buying decisions in an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand how computers may be used for purchasing in agricultural firms.
2. Realize the values and limitations of using computers in an agricultural firm.
3. Identify general steps followed in purchasing when using a computer.
4. Identify possible sources of computer services.

STUDENT MOTIVATION. Take the class on a field trip to an agricultural firm without a computer and have the person responsible for purchasing explain the purchasing procedures as to the following: staff involved, time involved, cost of an order, forms to be completed, etc. Follow this with a field trip to a firm that uses a computer in purchasing. Have the person responsible for purchasing explain the purchasing procedures as to the following: staff involved, time involved, cost of an order, forms to be completed, etc. Be sure to indicate the shortcuts that a computer can complete and the information that it can provide to the firm from memory. Encourage students to ask questions.

SPECIAL ARRANGEMENTS.

1. Survey the agricultural firms in your community and determine if they use computers in any way in their purchasing procedures. Identify the companies that use computers or have a computer in their facilities.
2. Prepare for a field trip to an agricultural firm in advance and discuss the points that should be covered as indicated under the motivation area above.
3. Select and order in advance 16 mm films that may be used as an instructional aid.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Ask students to collect and understand the use of all forms used for purchasing in their agricultural firm. Identify the ones used on a computer.
2. Ask students to identify the individuals responsible for operating the computer and determine their functions and importance to the firm.

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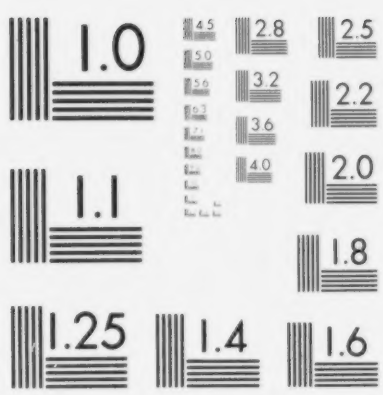

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Problems and concerns	Guides to solutions and examples of teaching techniques
1. How can computers be utilized in purchasing activities?	1. List following functions on the chalkboard: a. Determining requisition needs. b. Preparing orders. c. Giving daily follow-up reports. d. Writing invoice checks. e. Determining accounts payable. f. Analyzing and evaluating purchasing functions of the firm. 2. Show a 16mm film on electronic processing (EDP) in purchasing. 3. Reference: 10, p. 56.
2. What are the main advantages of using a computer in purchasing activities in an agricultural firm?	1. Refer to the firm visited during the field trip and review the highlights. 2. List the following advantages on the chalkboard and have students understand them clearly. a. Develops efficiency to the purchasing functions of an agricultural firm. b. Reduces labor requirements. c. Reduces paper work. d. Could improve communications within the firm. e. Brings unwritten policies together to help the firm determine good purchasing policy. f. May find the answers for many purchasing decisions. Note: The person in charge of computer section should have adequate skills necessary for making optimum use of the computer in the firm. 3. References: 6, pp. 17-20; 10, pp. 55-61.
3. What are the limitations for using computers in purchasing activities in an agricultural firm?	1. Discuss the field trip and write students' responses on the chalkboard. 2. List the limiting factors on the chalkboard as follows: a. Lack of trained personnel in the firm. b. Costs of computers or their services. c. Volume of the jobs, i.e., too small. d. The nature of purchasing processes of some firms does not permit a favorable computer application. 3 Reference: 6, pp. 20-23.

Problems and concerns	Guides to solutions and examples of teaching techniques
4. What are the basic steps followed in a computerized purchasing operation?	1. List the following steps on a transparent sheet and project on the screen: a. Preparing and proofreading the requisition--give special attention to the code numbers. b. Checking the requisition and selecting potential vendors. c. Selecting the lowest and most responsible supplier. d. Printing copies of purchase orders. e. Sending the purchase orders to proper department. f. Determining accounts payable and putting them on the tape for the later recalls. g. Receiving shipments, processing invoices through computer, and rendering of payments. 2. Reference: 10, pp. 86-87.
5. What are some possible sources where computer services can be obtained?	1. Discuss the following sources in the class. a. Private companies. b. Banks. c. Parent companies. 2. Identify location of computers in the community.

REFERENCES AND INSTRUCTIONAL AIDS FOR THE UNIT

A. BOOKS.

1. Brown, Paul L. and William B. Davidson, Retailing Principles and Practices.
2. Davidson, William and P. C. Brown, Retailing Management.
3. Hailes and Hubbard, Small Business Management II.
4. Heinritz, S. F., Purchasing Principles and Applications.
5. Hodges, H. G., Procurement--The Modern Science of Purchasing.
6. Kollios, A. E. and J. Stengel, Purchasing and EDP.
7. Phillips, Richard, Managing for Greater Returns in Grain, Feed, and Other Retail Businesses Serving Agriculture.
8. Richert, Meyer and Haines, Retailing Principles and Practices.
9. Rosenberg, Robert R. and Floyd L. Crank, Essentials of Business Law.
10. Smith, New Techniques for Creative Purchasing.
11. Tonne, Sidney, Simon, and McGill, Business Principles, Organization and Management.
12. Wilson, Leonard L., Farm and Power Equipment Retailer's Handbook.
13. Wingate, J. W. and J. S. Friedlander, The Management of Retail Buying.
14. Wingate and Sampson, Retail Merchandising.
15. Wingate, J. W. and J. D. Weiner, Retail Merchandising.

B. TEACHING AIDS.

1. Films available on electronic data processing (EDP).
2. Freight cost guides.
3. Purchase order samples
4. Railway Freight Classification Manual.
5. Railway Freight Date Book.
6. Sample "Bill of Lading."
7. Sample Purchase Orders.
8. Wholesale catalogues.

Unit V. Identifying Methods of Transporting and Routing Products to an Agricultural Firm

Problem Area 1--Selecting a Carrier to Transport Agricultural Products

Problem Area 2--Providing Shipping Instructions When Ordering Agricultural Products

Problem Area 3--Expediting and Tracing Delivery of Agricultural Products

References and Instructions Aids for the Unit

PROBLEM AREA. Selecting a carrier to transport agricultural products.

OBJECTIVES. To develop in each student the ability to:

1. Recognize ways to cut transportation costs when ordering agricultural products.

2. Realize how business relationships affect the selection of carriers.

3. Become acquainted with innovations in transportation in order to make sound judgments in carrier selection.

STUDENT MOTIVATION.

1. Select a product that could be brought to the firm by several carriers. Discuss channels of transportation.

2. Have students estimate the transportation costs of several agricultural products.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have each student identify how affiliation influences the selection of carriers in the firm where he works.

2. Have each student develop a list of advantages and disadvantages of using common carriers and in-firm transportation.

3. Have each student identify new or emerging methods of transporting products used by the firm where he is employed.

Problems and Concerns	Guides to Solutions and Examples of Teaching Techniques
1. What factors influence the selection of a carrier for agricultural products?	1. Refer back to Unit IV, problem area 3, for a brief review of influencing factors. 2. List major factors on the chalkboard.
2. How can affiliations between the firm and supplier affect the choice of the carrier?	1. Identify and discuss affiliations that may dictate choice of carriers. 2. References: 6, 7, 8.
3. How can exchange agreements between firms affect the carrier selection?	1. Have students relate their experiences with exchange of products between firms. 2. Analyze how an arrangement may bind a firm to a particular carrier.
4. What are the advantages and disadvantages of providing in-firm carriers?	1. Develop a table on the chalkboard with the class on pros and cons of in-firm carriers. 2. Have students relate ideas gained from structured activity No. 2.
5. Why may it be advantageous to ship a product through several carriers?	1. Identify and discuss situations where more than one carrier may be desirable. 2. References: 6, 7.
6. What legal regulations may influence the selection of the carrier?	1. Discuss I.C.C. (Interstate Commerce Commission) regulations. 2. List legal authorities or agencies governing carriers in the state.
7. How will new developments in transportation affect the selection of the carrier?	1. Have students report the experiences gained by completing structured activity No. 3. 2. Discuss how time and demand factors relate to emerging carriers.

PROBLEM AREA. Providing shipping instructions when ordering agricultural products.

OBJECTIVES. To develop in each student the ability to:

1. Minimize transportation costs when ordering products.
2. Provide adequate shipping instructions when ordering products.
3. Recognize informations that must be included in ordering instructions.
4. Understand the potential use of computers in making shipping decisions.

STUDENT MOTIVATION.

1. Show a film on transporting products to the firm describing the importance of shipping instructions.
2. Discuss and analyze a case problem where inadequate shipping instructions resulted in a financial loss to the firm.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Ask each student to discuss with the manager of his firm the problems resulting from inadequate shipping instructions. Make a list of suggestions that could have prevented such incidents.
2. Have the students secure and bring to class purchase orders used by firms where they are employed.

Problems and Concerns	Guides to Solutions and Examples to Teaching Techniques
1. What information must be provided for shipping instructions?	1. Use the purchase orders secured by the students and develop a list of items necessary for complete shipping instructions. 2. References: 3, 5, 6.
2. How does the nature of a product influence the shipping instructions provided for the supplier?	1. Discuss how specific products (tractor, fertilizer, chemicals, seed, flowers, etc.) may require special shipping instructions. 2. Consider situations involving crating, insulating, moisture proofing, cooling, etc. 3. Identify situations where special shipping instructions may assist the supplier in providing better service to the firm.
3. How may computers be used in providing information for shipping instructions?	1. Show a film that describes the potential use of computers. 2. Arrange a field trip to a business that uses a computer. 3. References: 5.

PROBLEM AREA. Expediting and tracing delivery of agricultural products.

OBJECTIVES. To develop in each student the ability to:

1. Expedite delivery of products from the supplier to the local firm.
2. Trace a delivery.
3. Understand the duties of the traffic manager of a firm.
4. Recognize and understand common shipping terms.

STUDENT MOTIVATION.

1. Using a purchase order, illustrate how a simple mistake may slow delivery of a product. Have students relate experiences of mistakes in ordering.
2. Have the students give examples of when they think each type of carrier should be used to expedite a delivery. Have them give their reasons. Make a list of these reasons and compare this list with what they give after covering this problem area.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have the students assist in preparing purchasing orders for the firm where they are employed. Encourage students to observe shipping instructions provided with the order.
2. Have each student assist other personnel in the firm complete tracer request forms.

Problems and Concerns	Guides to Solutions and Examples of Teaching Techniques
1. What factors must be considered to expedite delivery of products from the supplier to the firm?	1. Have students define what expediting a delivery means. 2. Discuss factors that should be considered when determining the best possible method of transporting a product. Include the following: a. cost of transportation b. urgency of need c. speed of transportation d. nature of product e. carefulness in handling f. convenience in pick up and delivery g. insurance 3. Use a purchase order and review information required on the form discussing how accuracy and completeness are related to expediency of delivery. 4. References: 1, 2, 4, 7.
2. Why may it be necessary to trace a delivery?	1. Discuss what tracing a delivery means. 2. List and explain possible reasons for tracing a delivery. 3. References: 1, 2, 4.
3. What are the duties of a traffic manager in an agricultural firm?	1. List the duties on the chalkboard which should include the following: a. routing of products b. auditing deliveries and freight tickets c. tracing shipments d. handling claims e. calculating shipping costs 2. References: 1, 2, 6.
4. What are some of the common terms used in shipping agricultural products?	1. Divide the class into committees and have each committee discuss assigned terms. Include the following: a. various methods of shipment (parcel post, air express, etc.) b. freight bills c. landing costs d. purchase order 2. References: 1, 2.

REFERENCES AND INSTRUCTIONAL AIDS FOR THE UNIT:

1. Aljian, Purchasing Handbook, Second Edition.

2. Heinritz, Purchasing Principles and Applications.

3. McMillan, The Art of Purchasing.

4. Davidson and Brown, Retailing Management

5. Smith, A. E., New Techniques for Creative Purchasing.

6. Shilt, B. A. and W. H. Wilson, Business Principles and Management.

7. Tonne, Simon, and McGill, Business Principles, Organization, and Management.

8. Wingate, J. W. and Friedlander, The Management of Retail Buying.

UNIT VI. UNDERSTANDING PROCEDURES FOR RECEIVING PRODUCTS INTO AN AGRICULTURAL FIRM

Problem Area 1 Understanding the Personnel Organization of the Receiving Function of an Agricultural Firm

Problem Area 2 Planning the Delivery Dock for an Efficient Product Flow Within an Agricultural Firm

Problem Area 3 Understanding the Procedures for Checking Products Received By an Agricultural Firm

Problem Area 4 Marking and Pricing Goods Received in an Agricultural Firm

Problem Area 5 Handling and Storage of Products Received in an Agricultural Firm

References and Instructional Aids for the Unit

PROBLEM AREA: Understanding the personnel organization of the receiving function of an agricultural firm.

OBJECTIVES: To develop in each student the ability to:

1. Identify the chain of authority during the product-receiving function in an agricultural firm.

2. Understand the chain of command in the receiving department of an agricultural firm.

3. Determine the competencies required for the position desired in the receiving department of the firm.

4. Recognize the possibility of improving the personnel organization of the receiving function in the firm.

STUDENT MOTIVATION:

1. Have a resource man discuss with the class various structural organizations used in his agricultural business with emphasis on the receiving function.

2. Ask the class to discuss the following questions:

   a. What department of an agricultural business would you as a young employee like to work in? (Justify the answer.)
   b. If you were working in the receiving department, what would be your responsibilities?

3. Discuss how local businesses vary in their receiving departments. Present and discuss the following questions.

   a. Why does the variation exist?
   b. Which organization would be most efficient?
   c. Which organization would be the easiest to work in as a young person starting to work?

SPECIAL ARRANGEMENTS: Arrange to have at least two managers of different agricultural businesses to discuss their receiving departments with the class.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS:

1. Ask students to list the positions and names of the employees that are involved in the receiving department at the agricultural business where they are gaining experience.

2. Draw a line chart of a typical business personnel organization and discuss how the department employees coordinate their activities.

3. Describe completely what procedure is followed in the receiving department to affirm an order delivery.

4. Explain how the receiving functions differ with respect to different products handled in a firm.

Problems and concerns	Guides to solutions and examples of teachinn techniques
1. Why is it important that all employees understand the chain of authority?	1. Show a film describing how business personnel are organized. (Most product companies furnish films.) 2. Have the class list the advantages and disadvantages of chain of commands that they are familiar with in receiving departments. 3. Ask students how misunderstandings in chain of commands may affect personnel relationships. 4. Suggest alternatives if a key employee is absent (e.g., on vacation)? 5. References: 9, literature describing business personnel organizations, manager of a local agricultural firm and personnel of a receiving department.
2. How do unlike chain of commands affect the efficiencies of product flow in a firm?	1. Have students form committees of similar businesses and proceed as follows: a. become familiar with the chain of commands that exist in the committee. b. select businesses that will cooperate and from efficiency charts of the commands. c. compare charts. 2. References: 3, literature describing business personnel organization.
3. What are the sequential procedures followed to affirm a product received in the agricultural business?	1. Show to the class sample forms used in the receiving department. a. explain why different forms are used. b. read to the class the main items printed on these forms. 2. List the main steps involved to affirm that various products have been received in a firm. 3. References: 6, manager of a local agricultural firm and personnel of a receiving department, invoice sheets, freight vouchers, requisition forms.

Problems and concerns	Guides to solutions and examples of teaching techniques
4. What are the responsibilities of each employee in various receiving departments?	1. Have the class list several employees' positions and their responsibilities and authorities. 2. Select a committee of four employees to discuss their positions with the class. 3. References: 5, 7, manager of a local agricultural firm and personnel of receiving department.
5. What competencies should one possess in order to qualify for employment in the receiving department of an agricultural firm?	1. Have a class discussion leading to general agreement on answers to the following questions. a. What courses or subjects are needed? b. What courses or subjects should be added to the curriculum? c. What is the effectiveness of a student-work program in preparing for such jobs? 2. References: literature describing business personnel organizations.
6. How could one improve the personnel organization of the receiving department in a given agricultural business?	1. Emphasize the importance of creative thinking. 2. Suggest the following questions: a. What are the advantages and disadvantages of the present receiving department? b. What positions could be changed and why? c. What problems can one expect with the personnel organization that is suggested? 3. References: 1, 6, 9, literature describing business personnel organization.

PROBLEM AREA: Planning the delivery dock for an efficient product flow within an agricultural firm.

OBJECTIVES: To develop in each student the ability to:

1. Recognize the importance of and the need for having one delivery area.

2. Identify factors that determine the efficient use of a delivery dock.

3. Suggest methods of improving the existing delivery system within an agricultural firm.

STUDENT MOTIVATION: Present to students slides of agricultural firms showing receiving, handling, and merchandising phases of various products. Emphasize the importance of good management practices in handling such products.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS:

1. Have each student list methods of receiving agricultural products into his firm.

2. Ask students to list advantages and disadvantages of product movement in the agricultural firm where employed.

3. Have students determine the means of handling the products of a given firm as compared to the products of other agriculture firms in the area.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. Why should there be one delivery point?	1. List on the chalkboard students' reasons for having a delivery dock in an agricultural firm. 2. Have students determine alternative methods of handling incoming products. 3. Identify methods of saving labor by having one delivery dock.
2. What are the characteristics of an efficient receiving dock?	1. Direct class discussion on the following questions. a. Where should the receiving are be located? b. What factors influence the location of the receiving dock? c. Why must some products be delivered at different locations (e.g., tractors, fertilizer). d. What factors determine the size of the receiving area? e. How can labor be minimized at the receiving dock?
3. How could the present delivery system in an agricultural firm be improved?	1. Have students identify common methods of handling merchandise. 2. Have students compare each of the handling methods as to cost, speed, maintenance, and ease of operation. 3. Have students survey their placement firms to check amount of physical handling compared to mechanical movement. 4. Show pictures, charts, or slides of an outdated delivery system of a firm and ask class to suggest how it could be improved.

PROBLEM AREA: Understanding the procedures for checking products received by an agricultural firm.

OBJECTIVES: To develop in each student the ability to:

1. Understand the checking procedure of goods received in a firm.

2. Recognize common checking methods used by agricultural firms.

3. Know major attributions of faulty shipments.

STUDENT MOTIVATION: Discuss with students the problems that may arise in checking a load just received in an agricultural firm. List the suggested problems on chalkboard and discuss the importance of the task.

SPECIAL ARRANGEMENTS:

1. Arrange for a field trip to an agricultural firm during the processes of receiving a load of goods in the firm.

2. Bring to class samples of damaged goods resulted from faulty shipments.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS:

1. Ask students to discuss with personnel in their firms and report the checking methods followed.

2. Have students report what is done with products that are not properly shipped to their firms.

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Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are the common checking techniques applied in an agricultural firm?	1. Discuss techniques as follows: a. matching purchase order against the invoice b. opening the goods containers. c. removing and sorting merchandise. d. checking the quantity of goods received against the invoice. e. inspecting goods for quality. 2. Have each student discuss with personnel of his firm the method of checking followed.
2. What are the main methods of checking quality?	1. List the following three main methods of checking on the chalkboard. a. direct check--check with use of invoice. b. blind check--check without invoice and then match for accuracy. c. bulk check--check without breaking the container. 2. Have students discuss advantages and disadvantages of each method in small groups and report the summaries to the class. 3. References: 6, 10
3. Who should be responsible for making quality check on products received?	1. Emphasize that a trained person in the field should check expensive items and spot check other items--this should be done to make sure the customer is getting the kind of items he demands for the price he pays. 2. Have students discuss with checking personnel in the firm and find out what it takes to be a quality checker. Have them report the information back to the class. 3. References: 2, 6, 10.
4. How are dummy invoices used in checking products received by a firm?	1. Bring several invoice samples to class and have each student fill one out for a container of goods received at school. 2. References: 2, 6.

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Problems and concerns	Guides to solutions and examples of teaching techniques
5. What are the main characteristics of faulty shipments?	1. List attributes on the chalkboard as follows: a. breakage--broken items. b. damage--rough handling or tear. c. shortage--lack of some goods. d. overage--too many items. e. substitution--wrong items. 2. Bring samples of goods and their invoices to class and ask students to identify the defects. 3. References: 4, 10.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is meant by preretailing?	1. Discuss advantages and disadvantages of preretailing in class. 2. References: 10, pp. 264-270.
2. What are the various kinds of price tickets?	1. Have students bring items from their places of work to the class and through role-playing techniques price and mark each product. 2. Illustrate the following examples: a. fifty pounds seed corn--string ticket $12.95. b. 1010 garden tractor--handwritten ticket $1,020. c. five gallons red barn paint gummed label $22.42. d. juniper shrub--pin ticket $15.20.
3. What methods are used in working out cost codes?	1. Have a personnel manager of a firm visit the class and explain some cost-code methods. 2. Explain methods of coding, as follows: a. word phase--money talks, 0123456789 b. symbols-- 1 | 2 | 3 4 | 5 | 6 7 | 8 | 9 c. add, subtract, multiply, or divide each digit price 10.50 x 3 31.50 3. References: 2, 3, 4, 6.
4. Why should coded dates be used when merchandise is received?	1. List the following advantages on the chalkboard. a. seasonal items. b. deteriation of items. c. slow selling items easily detected. 2. References: 2, 4, 10.
5. What are the advantages and disadvantages of machine marking?	1. Ask students to identify marking methods used in their firms and mention their advantages and disadvantages. 2. References: 2, 4, 10.

Problems and concerns	Guides to solutions and examples of teaching techniques
6. What items require bulk marking, nonmarking, or premarking?	1. List names of some items on a transparent sheet and project on the screen. Ask students to suggest the appropriate type of marking for each item. 2. References: 2, pp. 494-517.

PROBLEM AREA. Handling and storage of products received in an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Recognize how product characteristics affect their handling methods.

2. Determine various means of handling a product in an agricultural firm.

3. Understand the economical and efficiency factors involved in various handling and storage procedures.

4. Realize how proper handling and storage will affect the product quality and indirectly the net return of a business.

STUDENT MOTIVATION.

1. Show a 16 mm film that describes general handling and storage methods in agricultural firms.

2. Show slides or a super 8 movie (film loop) describing local procedures for handling and storing agriculture products.

SPECIAL ARRANGEMENTS.

1. Arrange for a field trip to visit local agricultural firms to identify handling and storage procedures.

2. Plan to take pictures of various handling and storing procedures used in a local agricultural firm.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Ask students to list the ways in which the products are handled within the agricultural firm where they are gaining experience.

2. Have students list the various storage facilities used in the agricultural firm where they are gaining experience.

3. Ask students to select a specific agricultural product and suggest a storage area and handling method for it in a designated firm. (Include arrangement, efficiency factors, costs, sizes, etc.)

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What products are handled within the agricultural firm?	1. Have the students list the main and short line products handled in the agricultural firm, where employed. 2. Have the students start their collection of product information, handling and storage procedures. 3. References: 10, product information literature, resource persons, agricultural business firms.
2. What are the means used to handle the products in the agricultural firm?	1. Have the students develop a line chart indicating the various ways a specific product is handled in the firm from receiving to delivery to the customers. 2. References: 2, 9, agricultural firms blueprints.
3. What determines the handling procedure of products in an agricultural firm?	1. Have the students list the various forms of products handled within the firm. 2. Ask students to estimate the time needed for unloading and moving the products from storage to the customer. 3. Have a manager discuss with the class the reasons for using his present handling equipment. 4. References: 6, time and efficiency charts, resource person.
4. What are the mechanical efficiencies of the present handling methods?	1. Have students compare their estimated times (above) with suggested handling rates. 2. Ask students suggest equipment maintenance needed to improve handling efficiencies (provide operator manuals). 3. Ask students to suggest equipment that would facilitate higher labor efficiency. 4. References: 1, 9, time and efficiency charts.
5. How can the cost of present handling methods in a firm be determined?	1. Have the students price the handling methods. List sources of information as follows: a. manager b. equipment manuals c. employees d. salesmen

Problems and concerns	Guides to solutions and examples of teaching techniques
	2. Have students compare handling costs between different manufactures of the same equipment.
	3. Have students compare leasing costs to buying costs.
	4. References: Product information literature, resource persons from agricultural firms.
6. In what form are agricultural products usually stored and what types of storage facilities are required?	1. Have students list the various types of storage facilities used in an agricultural firm. Ask them to include the form of the product(s) stored in each facility.
	2. Show a set of slides or film to describe the major facilities in an agricultural firm.
	3. Ask students to collect the following information about the agricultural firms where they are gaining experiences. a. when and how much products are ordered? b. how much time is required for transportation of products? c. how long is the expected storage time for the product?
	4. References: 9, 10, product information literature, resource men from agricultural businesses, agricultural business films.
7. How could the present handling and storage procedures be redesigned to improve product flow efficiencies?	1. Have the students list the advantages and disadvantages of the handling equipment and storage facilities before and after they have worked in the firm.
	2. Use blueprints of present facilities and equipment to suggest a new handling and storage system.
	3. Have the students draw new storage facilities within the present firm and relocate and replace handling equipment within the firm.
	4. Have students develop a cost sheet of the new replacements and determine how this will affect the net return of the business.
	5. References: 4, 6, agricultural firm blueprints, time and efficiency charts, product information literature.

REFERENCES AND INSTRUCTIONAL AIDS FOR THE UNIT

A. BOOKS

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2. Davidson and Brown, Retailing Management.
3. Hailes and Hubbard, Small Business Management.
4. Kelly and Brisco, Retailing.
5. Newton, Ray, and Green, How to Improve Your Personality.
6. Richert, Meyers, Haines, Retailing Principles and Practices.
7. Sheira, Adams, Wright, and Rice, Personality and Human Relations.
8. Shilt and Wilson, Business Principles and Management.
9. Wingate and Friedlander, The Management of Retail Buying.
10. Wingate and Weiner, Retail Merchandizing.

B. TEACHING AIDS

1. Agricultural business films, slides or film loops.
2. Agricultural firms blueprints (storage facilities and handling equipment locations, etc.).
3. Farm Service Feed Manuals.
4. Informative literature describing business personnel organizations.
5. Invoice sheets, freight vouchers, requisition forms, etc.
6. Product information literature.
7. Resource men from receiving departments of agricultural firms.
8. Time and efficiency charts.

Unit VII. Identifying Ways of Measuring and Reporting Purchasing Performance in an Agricultural Firm

Problem Area 1 Preparing Purchase Reports for the Management of Agricultural Firms

Problem Area 2 Measuring the Performance of the Purchasing Department of an Agricultural Firm

References and Instructional Aids for the Unit

PROBLEM AREA. Preparing purchase reports for the management of agricultural firms.

OBJECTIVES. To develop in each student the ability to:

1. Understand the function of reports.

2. Understand the basic principles of reports.

3. Prepare various types of reports.

STUDENT MOTIVATION. Top management must have reports from all departments to have the necessary information for planning, organizing and controlling operations. People in these key executive positions are constantly looking for men who can be moved up through the ranks. Therefore, if you are a member of a purchasing department and are doing a good job of economically obtaining needed material and can do a good job of reporting savings etc., the boss will soon notice you and then you are well on your way up the ladder of success. Ask each student why he would want to be kept informed if he were a top executive.

SPECIAL ARRANGEMENTS.

1. Prepare a role-playing situation where one would be a purchasing agent and the other a new vendor. Have the agent send a report to management telling about the change in vendors, giving reason for the change, such as better service or a better price compared to previous vendor.

2. Prepare transparencies of various types of reports to be used in class discussion and work.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS.

1. Have each student determine what types of reports are used in the business where he works.

2. Have each student observe how purchase reports are prepared in his business.

3. Have students prepare a purchasing report to be given to head of purchasing department for correction or comments.

Problems and Concerns	Guides to Solutions and Examples of Teaching Techniques
1. What is the purpose or function of a report?	1. Using a visual, show the class a sample copy of a purchase report. 2. Have students determine how similar reports may be helpful to the management of a firm. 3. Discuss the differences between reports and records. 4. References: 2, 4, 6.
2. What are the basic types of purchase reports?	1. Discuss the two basic types--periodic and current reports. 2. Have students identify situations where a "report of proved savings" would be used. 3. Reference: 6.
3. What are the basic principles covered in reports?	1. Have students analyze a sample report in terms of the following principles common in reports: a. selection b. comparison c. interpretation d. summary 2. References: 2, 4.
4. What is the procedure followed in preparing a purchase report for management?	1. Have students report information obtained through completion of structured activity No. 1. 2. Have students prepare reports following the procedure outlined in special arrangement No. 1.

PROBLEM AREA. Measuring the performance of the purchasing department of an agricultural firm.

OBJECTIVES. To develop in each student the ability to:

1. Understand the importance of evaluating the performance of the purchasing phase of a business.

2. Understand the procedure followed in making a performance evaluation.

STUDENT MOTIVATION: Name a local retail agricultural business in the community and identify the different products handled by the business. Then present the student with the task of trying to buy the products to be sold in the store and; how they would determine if they were buying as profitable as possible.

STRUCTURED ACTIVITIES FOR SUPERVISED EXPERIENCE PROGRAMS. Have students interview the head of the purchasing department where they work and determine if there is a specific way which the firm follows in order to determine the effectiveness of its purchasing functions.

Problems and Concerns	Guides to Solutions and Examples of Teaching Techniques
1. Why should the purchasing performances be evaluated?	1. Discuss with the students so they will be familiar with: a. cost of buying in relation to rest of business expenses. b. need of most efficient method of procurement. c. need to improve operations. d. need for evaluation 2. Have a procurement manager discuss buying responsibilities with the class. 3. Have a local business owner discuss efficient buying with the class. 4. References: 1, 3, 7.
2. How should the evaluation of the buying department be conducted?	1. Discuss the procedure using the following lead questions. a. Why is this department so hard to analyze? b. Is there more than one method of determining the effectiveness of the department? c. Who should make the evaluation of the department? d. How often should a survey be made? e. Why must a plan be used for evaluation? f. What should be included in the plan? g. What are the drawbacks to each method used? 2. Determine how each of the following can be used to measure performance: a. outside consulting firm b. special staff c. head of department
3. What information is required for an effective preformance evaluation of the purchasing department?	1. Have students analyze how each of the following influences performance of the purchasing department: a. division of responsibility b. policies regarding quantity c. policies regarding quality d. policies regarding price e. regulations on terms and conditions 2. References: 1, 3, 7.

Problems and Concerns	Guides to Solutions and Examples of Teaching Techniques
4. How should the results of an evaluation be analyzed?	1. Discuss using the following lead questions: a. Why is a comparison necessary for analysis? b. What is the cost of the purchasing function? (May range from two to five percent of total cost.) c. How well does the department follow its guidelines? d. Are there any deviations to the basic policies of the department? e. Is the department doing all of its purchasing functions? f. Is there always a continuous and effective supply of materials? g. Is there a continuous turnover of stock and never a time of "stock-out?" 2. Have students report on structured activities No. 1 and No. 2.

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ABSTRACT - Focusing on the knowledges and skills needed by employees in handling products and personnel in nonfarm agricultural firms, this teaching unit was developed by agriculture teachers and the Agricultural Education Division, University of Illinois. The materials are divided into three teaching source units containing 15 problem areas. Divisions are: (1) Understanding the Management of Personnel in an Agricultural Firm, (2) Understanding the Financial Operation, and (3) Understanding the Practices Followed in Storing and Inventorying Products. Each problem area includes teacher objectives, references, anticipated problems and concerns of students, and suggested class and individual student activities. (GB)

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HANDLING PRODUCTS AND PERSONNEL IN AGRICULTURAL FIRMS

Teaching Source Units for Agricultural Occupations Other Than Farming

Agricultural Education Division
Vocational and Technical Education Department
College of Education
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

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HANDLING PRODUCTS AND PERSONNEL IN AGRICULTURAL FIRMS

Teaching Source Units for Agricultural
Occupations Other Than Farming

Edited by:

David L. Williams

October 1970

Division of Agricultural Education
Department of Vocational and Technical Education
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Urbana, Illinois 61801

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FOREWORD

During the summer of 1970 the Agricultural Education Division, University of Illinois, Urbana-Champaign campus, offered the third of a three-part summer program designed to give teachers of agriculture firsthand experience in agricultural occupations other than farming. In addition to gaining experience in a nonfarm agricultural business, the teachers spent time in the classroom intellectualizing their knowledge and experiences in terms of implications for teaching agricultural occupations.

The following teaching source units represent the efforts of the teachers enrolled in the course. The teaching units focus on the knowledges and skills needed by employees in handling products and personnel in nonfarm agricultural firms. The materials are divided into three teaching source units containing 15 problem areas. Each problem area includes teacher objectives, anticipated problems and concerns of students, suggested class and individual student activities, and references. Professor David L. Williams, instructor for the course, edited the materials and arranged the problem areas and units in an order which teachers may find useful.

David L. Williams

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UNIT I. UNDERSTANDING THE MANAGEMENT OF PERSONNEL IN AN AGRICULTURAL FIRM

Problem areas included in this unit are:

1. Applying for and Securing a Job in an Agricultural Firm

2. Working and Advancing in an Agricultural Firm

3. Developing Desirable Employer-Employee Relations in an Agricultural Firm

4. Getting Along with Fellow Workers in an Agricultural Firm

5. Determining the Employee Compensation, Incentives and Benefits Offered by an Agricultural Firm

6. Understanding How Labor Laws and Unions Affect Agricultural Firms

References and Instructional Aids for Unit I.

Problem area. Applying for and Securing a Job in an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of how employees are selected for positions in agricultural firms.
2. Understanding of the procedure followed in applying for and securing a job.
3. Ability to interview for and secure a job.

Student motivation

1. Have you ever applied for a job? Did you get the job? Why or why not?
2. Draw comparisons in the way class members applied for jobs.
3. Discuss why it is important to know how to get a job.

Structured activities for supervised experience programs

1. Invite an employer to visit the class and discuss what he looks for in a perspective employee.
2. Have each student find an advertisement describing a job they would like to apply for. Each student should develop a personal data sheet, write a letter of application, complete an application form and interview for a job.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What does an employer look for in a prospective employee?	1. Have an employer discuss with the class what he looks for in a perspective employee. 2. Reference: 25
2. What does a job applicant need to know about the potential employer and his business?	1. Have an employer give his ideas on what a job applicant should know about his business. 2. Reference: 26
3. How can a person find what jobs are available?	1. Discuss sources of information (see attachment, "Hints in Securing a Job). 2. References: 6, 14, 15, 25
4. How does an individual decide what kind of job to apply for?	1. Discuss how to pick the right job by first evaluating your a. mental ability. b. interests. c. physical characteristics. d. social characteristics. e. emotional characteristics. f. motives and goals.

Problems and concerns	Guides to solutions and examples of teaching techniques
	2. Have each student evaluate occupations of his choice on the basis of a. nature of work. b. personality requirements. c. educational requirements. d. training requirements. e. ways to enter the field. f. working conditions. g. where jobs are located. h. trends in employment. i. degree of competition. j. seasonal variations. k. opportunities for advancement or transfer. l. beginning wage. m. average wage.
	3. References: 6, 9, 14, 15, 16, 25
5. How should a person apply for a job?	1. Have each student make up a personal data sheet and a letter of application and complete an application form for a specific job.
	2. Discuss correct form for a personal data sheet and letter of application (see attachments, "Hints in Securing a Job," and "Writing an Application Letter").
	3. References: 7, 14, 15, 25
6. How should a person prepare for a job interview?	1. Review all steps preceding the actual job interview (see attachments).
	2. Conduct mock interviews in class.
	3. References: 6, 25
7. What can a person do to make the interview successful?	1. Develop a checklist of items that are necessary if an interview is going to be successful (see attachment, "Hints in Securing a Job").
	2. Interview for a position at a cooperating training center.
	3. References: 6, 14, 15, 25
8. How should a person follow up an interview to increase his chances of getting a job?	1. Discuss the procedure for following up an interview.
	2. References: 6, 14, 25

WRITING AN APPLICATION LETTER

I. Opening paragraph

A. Create a desire for the applicant's services.
B. Request consideration as an applicant.
C. Explain source of information concerning job opening.

II. Education

A. Avoid dull recitation of subjects taken in school.
B Present the facts in such a way the employer will know you are qualified for the job.
C. Stress subjects that qualify you for the position.
D. Mention awards, honors, good health, and attendance record.
E. Include any specialized knowledge or training you may have that others probably would not have.
F. Include any extracurricular activities and offices held.

III. Experience

A. If you have had no prior experience (paid) of any kind, do not mention or stress this point. Rather, emphasize your scholastic record if it is good or your grades in your area of specialization, if good. If your record is not good, stress your outside activities.
B. Include paid work experience which does not have any connection with the type of work for which you are applying, either in letter or data sheet.
C. Discuss most recent experience first, especially if it is in the same area as the job for which you are applying.

IV. References

A. Always ask permission before using a name as a reference.
B. List names and addresses (include complete information) of three persons, none of whom are relatives, who can give realistic information about your character and working ability. Give complete names and titles of references.

V. Closing paragraph

A. Purpose of application letter is to stimulate action.
B. Write this paragraph in such a way it will be easy for the businessman to make an interview appointment.
C. Include telephone number where you can be reached easily.

HINTS 1. SECURING A JOB

I. Elements to consider in looking for the right job

A. Know something about the firm before applying.
B. Will it offer stable employment?
C. Will it offer advancement possibilities?
D. Will the type of work be compatible with your own likes and dislikes, temperament, and aptitudes?
E. Can you work under supervision?

II. Sources of information concerning employment opportunities

A. Friends or relatives.
B. Inquiry letters.
C. Employment agencies.
D. Want ads in local papers.
E. Civil Service.

III. Job hunting by mail

A. Fifteen fundamentals to follow when writing a letter of application:

1. Use paper and envelopes that are standard; never use personal stationery.
2. Use conventional letter setup.
3. Do not try to be different, coy, or cute.
4. Express confidence in yourself without being untruthful or boastful.
5. Make your letter as easy as possible to read.
6. Use plain English, no slang, correct grammar, and spelling.
7. Open with explanation as to why you are writing.
8. Do not ask for any kind of job that is available.
9. Show an interest only in the type of work for which you are qualified.
10. The second and third paragraphs should explain how your education and experience qualify you for the position for which you are applying.
11. Refer to people who are qualified to be your references and indicate you have their permission.
12. Ask for interview in the closing paragraph.
13. Type your name in the closing lines and sign it legibly.
14. Make sure your letter is perfect in its appearance--no smudges or smeary erasures, strikeovers, good balance, etc.
15. Proof read your letter carefully to see there are no errors of any kind in typing, grammar, spelling, or general setup.

IV. Two kinds of application letters

A. General--written when uncertain whether there is a vacancy in a certain company.
B. Specific--used to apply for a specific job opening.

V. The personal data sheet

A. The listing of personal qualities, education, skills, experience, and references in tabulated form.

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B. Parts to be included:

1. Personal description and data.
2. Education record.
3. Experience.
4. References (with permission).

VI. <u>The application form</u>

A. The printed form which the employer asks prospective employees to fill out to give him a picture of their personal, educational, and experience background.
B. Important factors to consider when filling out the employment form:

1. Neat handwriting, including figures.
2. Read form carefully first so you can follow instructions exactly.
3. Bring your own pen.
4. In the experience section, list most recent experience first.

VII. <u>The interview</u>

A. Arrange for interview at time which will permit you to change to appropriate clothing.
B. First impressions are very important.
C. Arrive at least a few minutes early.
D. Give impression of maturity.
E. Wear dress appropriate for job and for appearing in an employment office.
F. Make sure you are personally clean in every respect.
G. Watch your manners in every respect, even in matters you consider not very important. Put yourbest food forward.

1. Do not chew gum.
2. Do not come into the interview smoking a cigarette.
3. Walk briskly, give an alert impression.
4. Avoid bored manner.
5. Do not sprawl in chair.
6. See that your voice is not harsh and unpleasant.
7. If the interviewer offers his hand, shake it firmly.
8. Look employer straight in the eye.
9. Let interviewer do most of the talking.
10. Do not interrupt the employer or interviewer.
11. Try to learn something about the company before you go to the interview.
12. Be truthful about your present employment. Specify you will need to give your employer at least two weeks' notice if you leave his company for this new job.
13. Do not bring up salary until the interviewer mentions it--if asked what you want in the way of salary, ask for the regular starting pay for new employees of your background--or mention your present salary.
14. Be seated only after interviewer asks you to sit down.
15. Return to the employment office or call interviewer later to see if an opening has arisen for which you are qualified--just because the jobs were all filled before you applied does not mean there will never be any others.

Problem area. Working and Advancing in an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the knowledges and skills required to work and advance in an agricultural business.
2. Understanding of the relationship of the worker to the management.
3. Understanding of the etiquetts in working with other people.
4. Understanding of the major techniques used in determining advancements and promotions.
5. Understanding of how the firm can increase profits through improved productivity.

Student motivation

1. Have the class divide into small discussion groups, and then list some of the things that they hope to own in the future, such as a new car, nice home, a farm, etc. Then lead a discussion on how much some of these items will cost, and how they will need to increase the amount that they are making in order to have the things they want, and be able to raise a family, etc.
2. Ask students if the wages that they would receive when starting at a particular job would be enough to provide the things they would like to have in a few years.

Structured activities for supervised experience programs

1. Have students list some of the characteristics, traits, and reasons why they feel that some of the people in the most advanced positions of the firm where they are working were able to obtain their positions.
2. Have each student discuss working and advancing with the personnel manager in the firm where he is employed.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. How can an employee get started off right in a new job?	1. Through a class discussion, develop a list of possible problems that might be encountered at a new job, then discuss how to solve the problems. 2. List some "do's." 3. List some "don'ts." 4. References: 3, 12, 17, 23

Problems and concerns	Guides to solutions and examples of teaching techniques
2. What adjustments may a new employee have to make?	1. Have the students report on individual adjustments they had to make when they started a new job. 2. Relate the adjustments that students have to make after summer vacation or when first starting high school to the types of adjustments that they will have to make on a new job. 3. References: 3, 12, 17, 20
3. How can a new employee learn more about his job?	1. Lead a discussion on facts that should be known in advance about a job. Relate this to the subject matter that they are having in class. 2. Ask this question of the personnel manager the day that he comes to the class. 3. Assign students to work in pairs, and actually research an agricultural firm in the area as it relates to this question. 4. References: 3, 20, 23
4. What does an employer expect of a beginning employee?	1. Have the students develop a list of characteristics and responsibilities that they would expect if they had someone working for them. 2. Discuss this list on the day that the personnel manager visits the school. 3. References: 3, 23, 24
5. What is the basis used for the promotion of employees?	1. Analyze and compare at least two different actual systems used by firms in the area. 2. References: 3, 20, 23, 24
6. What in-service training will be available and helpful to a new employee?	1. Through a discussion, identify as many of the in-service training programs that are available to anyone in the community. 2. Identify some of the in-service training programs that are offered or available once a person begins working in a particular firm. 3. References: 3, 12, 20, 23, 24

Problems and concerns	Guides to solutions and examples of teaching techniques
7. How are pay increases determined for employees?	1. Analyze and compare at least two actual systems used by firms in the area. 2. References: 3, 20
8. How can an employee help his firm increase its profits?	1. Discuss the importance of productivity to the ability that an employer has to pay or increase the wages of his employees. 2. Conduct an actual "work-time" study with students doing some job in the shop. 3. References: 3, 20, 23, 24

Problem area. Developing Desirable Employer-Employee Relations in an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the concept of personnel management.
2. Ability to adjust to a working situation.
3. Ability to get along with the employer.
4. Understanding regarding social and personality development on the job.

Student motivation

1. Ask students what characteristics they would look for if they were employing someone to work for them.
2. Discuss the aspects of changing from a type of work such as farming where one works with things to a kind of occupation where one works with people.

Structured activities for supervised experience programs

1. Have students observe employees in the business and develop a list of characteristics of the employee who has been in the firm the longest.
2. Develop a list of things they like about their supervisor or employer.
3. Have students discuss with the manager of the firm some of the characteristics he likes to see in an employee.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is meant by employer-employee relationship?	1. Have students discuss this relationship. Point out the differences and similarities among employer-employee, teacher-pupil, and father-son relationships. 2. Explain why there must be different levels of supervision and structural organization of a business. 3. Reference: 5
2. What does my employer expect of an employee?	1. Discuss the following desirable traits of employees: a. Regular attendance. b. Adherence to business rules and policies. c. Respect for authority. d. Personal authority. e. Personal characteristics. f. Growth in performance of job. 2. References: 4, 26

Problems and concerns	Guides to solutions and examples of teaching techniques
3. How does an employer select employees for his business?	1. Discuss the steps employers go through in selecting an employee. A procedure followed by some businesses is as follows: a. Determine job specifications. b. Check present personnel records to see if desired employee can be found among present employees. c. Check applications on file. d. Advertise for employees through newspaper, employment agencies and present workers. e. Interview applicants. f. May test specific applicant for special knowledge and skill. g. Give applicant a physical. h. Investigate references given by applicant. i. Applicant may be sent to head of department where he is to work. j. When applicant is hired, his records are prepared for personnel department. 2. Reference: 22
4. How could an employer introduce an employee to a new job?	1. An employee can become an asset to a company much quicker if he understands the company and his duties. a. Give employee information about company. b. Give employee manual on company policies and regulations. c. Inform employee about lunchrooms, clothes and lockers, etc. d. Introduce him to department supervisor. e. Be sure he has complete knowledge of conditions of employment. f. Give him an understanding of importance of safety rules. 2. References: 11, 22
5. How can an employee benefit most from supervision on the job?	1. Discuss the role of the supervisor. a. Supervisors are chosen by the management because: (1) they know the jobs of the people. (2) they know the policies of the store. (3) they can teach the jobs they supervise. b. Supervisors are hired to help the employee improve himself and the business.

Problems and concerns	Guides to solutions and examples of teaching techniques
	2. Discuss foundations for good relations with supervisors. a. Be sold on aim and purpose of business. b. Make good use of constructive criticism. c. Be loyal to supervisors. d. Carry out assigned responsibilities. e. Contribute new ideas. 3. Reference: 4
6. How can a new employee encourage good employer-employee relations?	1. Discuss basic human motives as they affect employer-employee relations. a. Treat people as individuals. b. Do not pass the buck. c. Be loyal to others. d. Seek raises and promotions on merit. e. Help build department and store morale. 2. Explain that an employee has an important human relations role in his business and discuss a. how to do job carefully. b. how to help others when needed. c. how to keep busy doing constructive work. d. how to present your ideas. e. how to make good instead of poor excuses. f. how to gain self-confidence. 3. Reference: 4
7. What are the major responsibilities of the employer?	1. Discuss the total operation of a business and how each employee is a part of the total picture. 2. The employer is to provide a. space and equipment. b. training. c. working conditions. d. financial benefits. 3. The employer is responsible for the safety of the workers. Safety is divided into parts. a: Engineering (1) Plant layout. (2) Plant inspection. (3) Cleanliness and order. (4) Maintenance.

Problems and concerns	Guides to solutions and examples of teaching techniques
	b. Educational (1) Initiate safety programs. (2) Secure interest and cooperation of workers. 4. Discuss that an employee can encourage safety by a. being a good example. b. emphasizing importance of safety to new employees. c. making certain tools are in good repair. d. being alert for and correct unsafe practices. e. looking for and reporting any need for safety devices and guards. f. learning first aid and be prepared to assist when needed. 5. Reference: 11

Problem area. Getting Along with Fellow Workers in an Agricultural Firm

Teacher objectives. The objectives for the instructor of students in this area of study are to develop:

1. Understanding of the importance of developing good working relations with co-workers.
2. Understanding of how to get along with fellow workers in an agricultural firm.
3. Understanding of yourself as a fellow worker or employer might see you.

Student motivation

1. What do you look for when you select a friend?
2. What traits do you find undesirable in some of your school mates?
3. How do you think these traits compare with what fellow workers would think of you?
4. Discuss the comparisons and then work into the problems one might have in a business.

Structured activities for supervised experience programs

1. Prepare a list of points to consider in discussing the question: "What constitutes a full days work for a full days pay?"
2. Observe carefully fellow employees as they work together. Report briefly on a situation showing how a co-worker either used or misused one or more of the fundamentals of good human relations.
3. Make a list of the things the best liked co-worker in your business does to cause him or her to be well liked by the fellow workers.
4. Rate yourself on the ways you have used to get along with your fellow workers.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are some traits which help an employee to be accepted by co-workers?	1. Discuss the following and how they may help people to be accepted as a co-worker: a. Learn the line of authority. b. Be friendly. c. Accept and carry out responsibilities. d. Ask for help when it is needed. e. Show you are willing to learn. f. Compliment fellow workers. g. Learn the names of fellow workers. h. Learn the duties of fellow workers. 2. Reference: 4

Problems and concerns	Guides to solutions and examples of teaching techniques
2. How may an employee discourage the formation of cliques in a business?	1. Discuss the following: a. Do a good job at every task. b. Do not instigate or listen to gossip. c. Compliment fellow workers rather than run down fellow workers to others. d. Do not mix shop talk and social life. e. Do not gripe to anyone who will listen. f. Do not limit favors only to certain people. 2. Reference: 4
3. How may an employee gain and maintain the respect and confidence of co-workers?	1. Discuss the following in relation to maintaining good relationships with fellow workers: a. Treat people as individuals--people differ in their attitudes, abilities and backgrounds. They also face different problems at home and at work. Recognize differences in individuals and treat them accordingly. b. Recognize that human behavior is unpredictable--people's moods vary because they face different problems. They worry about money, children or health. Thus, a co-worker may have to be treated differently depending how he feels on a given day. c. Do not pass the buck--blaming someone else and shifting responsibility to a co-worker is called passing the buck. Using excuses to cover up one's own unsatisfactory performance results in poor relations with fellow workers. d. Be loyal to others--the person who is a loyal friend keeps confidences and respects his promises. He is dependable. e. Help build moral--take a full share of the load. Giving a "little extra" helps build group spirit in a business. 2. Reference: 21
4. What are some traits that may be helpful in developing desirable relationships among workers?	1. Explain that workers develop good relationships with others by possessing and using the following traits: a. Enthusiasm. b. Honesty and dependability. c. Initiative. d. Sense of humor.

Problems and concerns	Guides to solutions and examples of teaching techniques
	e. Loyalty. f. Industriousness. g. Tact and courtesy. h. Friendliness. i. Sense of fair play. j. Cooperativeness. 2. Some undesirable traits of employees include a. "using" other people. b. running down other people. c. taking credit for ideas or achievements of others. d. gossip. e. being indifferent to suggestions and criticisms. f. "acting" superior. 3. Reference: 4
5. How may a person examine his own personal qualities?	1. Discuss how one may analyze his personal qualities and how improvements can be made. 2. References: 4, 14

Problem area. Determining the Employee Compensation, Incentives, and Benefits Offered by an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the difference between compensation, incentives, and benefits.
2. Ability to evaluate and compare the compensation, incentives, and benefits offered by one employer to those of another.
3. Understanding of the basis on which compensation, incentives, and benefits are made.

Student motivation

1. Ask students if they would like to pay someone even if that person did not perform any work or service, etc., for them. Then discuss how wages must have some relation to productivity and/or responsibility.
2. Discuss the total expense that could be involved if one became sick or injured, and missed work for a week or more, and did not have any health insurance or sick leave benefits.

Structured activities for supervised experience programs

1. Ask students to study Employees' Handbook which the firm has where they work to become familiar with the firm's policy on wages, incentives, and benefits.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. How may a person compare compensation, incentives, and benefits offered by potential employers?	1. Discuss the relative merit of incentives and benefits as compared to the flat wage received. 2. As a class, total up the "real" wage received by adding up the value of the "hidden" wage to the value of the actual wage received, and compare for different firms. 3. References: 3, 17, 20, 23
2. What is meant by compensation?	1. Ask what it means to the students to get paid when they work. 2. Discuss why an employer is able to pay an employee a particular wage. 3. References: 3, 20, 23, 24

Problems and concerns	Guides to solutions and examples of teaching techniques
3. What is meant by incentives?	1. Define incentive. 2. Ask if any students have ever received a gift from their parents or someone else for reaching a particular goal or standard such as to make the honor roll at school, then relate this to an incentive. 3. References: 3, 20, 23
4. What is meant by fringe benefit?	1. Define fringe benefit. 2. Lead a discussion to point out that benefits are usually given to all employees, but incentives are only received by those that reach a higher than average standard. 3. References: 3, 23, 24
5. How often are compensation and benefits reviewed and revised by a firm?	1. Discuss the various policies used in the firms in which the students are working. 2. Ask the students if they think their employers evaluates their work each day. 3. References: 20, 23, 24
6. How does an employer establish the wage or compensation for various jobs within the firm?	1. Ask students how they would decide how much a farm is worth per acre. Center the discussion on the basis of productivity. Relate this to the value of an individual in a firm. 2. References: 3, 20, 23

Problem area. Understanding How Labor Laws and Labor Unions Affect Agricultural Firms

Teacher objectives. The objectives for the instruction in this area of study are to develop:

1. Understanding of the labor laws that affect young workers.
2. Understanding of the role of labor unions.
3. Understanding of the worker's responsibilities to the union and the benefits he can derive from the union.

Student motivation

1. Are there any labor laws that affect you as a worker?
2. Why do you think these labor laws were passed?
3. What do labor unions have to do with labor laws?

Structured activities for supervised experience programs

1. Ask students to discuss with their employers how child labor laws have affected them.
2. Develop a list of questions about the provisions of the Fair Labor Standards Act and have students answer them by visiting with their employers.
3. Have business agent of local labor union visit class to discuss union operation and answer questions about union goals and methods.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What are the purposes of child labor laws?	1. Discuss early problems of labor. 2. References: 2, 8
2. What are the principal provisions of the Fair Labor Standards Act?	1. Discuss the following: a. What businesses are subject to the Fair Labor Standards Act. b. What is meant by over-time pay. c. What is a legal work week. d. What workers are exempt from the act. e. What age group is affected by child labor laws. f. What is the minimum wage for workers covered by the act. g. What is meant by a hazardous occupation for minors? h. Under what conditions may a student-learner work in a hazardous occupation.

Problems and concerns	Guides to solutions and examples of teaching techniques
	i. What is an age certificate and under what circumstances do employers file them. j. What is a work permit. k. How and at what age can one obtain a work permit.
	2. References: 1, 13, 19
3. What other laws affect young workers?	1. Discuss laws affecting all employees... minimum wage, overtime, etc.
	2. References: 1, 19
4. In what ways are the lives of all of us affected by labor unions?	1. Discuss strikes, national economy, etc.
	2. Reference: 10
5. Why did unions develop?	1. Discuss early conditions of labor.
	2. Reference: 10
6. What are the goals of unions?	1. Have business agent of local union discuss goals and answer questions.
	2. Reference: 10
7. What methods do unions use to reach their goals?	1. Discuss different types of strikes and collective bargaining.
	2. Reference: 10
8. What are the principal achievements of unions and what can be expected in the future?	1. Have a business agent of local union discuss what labor unions have accomplished in the past and where they are headed and answer questions of students.
	2. Reference: 10

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UNIT II. UNDERSTANDING THE FINANCIAL OPERATION OF AN AGRICULTURAL FIRM

Problem areas included in this unit are:

1. Determining the Types of Organizational Structure Used to Finance an Agricultural Firm

2. Understanding and Using Credit Instruments in an Agricultural Firm

3. Understanding the Customer Credit Policies of an Agricultural Firm

4. Understanding the Procedures Used to Collect Bills by an Agricultural Firm

5. Understanding the Role of Insurance in an Agricultural Firm

References and Instructional Aids for Unit II.

Problem area. Determining the Types of Organizational Structure Used to Finance an Agricultural Firm.

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of how a firm acquires funds to start and finance an operation.
2. Understanding of the different types of financial organization of businesses.
3. Understanding of the importance of a sound financial structure to a business.

Student motivation. Select a successful firm in the community and discuss its mode of financial operation. Discuss a short-lived firm and why it may have failed.

Structured activities for supervised experience programs

1. Have each student identify owners or controlling officers of the firm in which he works.
2. Ask student to determine original cost of ownership of a firm and present cost of ownership.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is an organizational structure?	1. Draw a schematic on the chalkboard showing a. Boss. (1) Owner. (2) Stockholder. b. Foreman. c. Worker. 2. Reference 10.
2. What are the common types of organizational structures?	1. Use a transparency to show the ways of doing business a. Sole ownership. b. Partnerships. c. Cooperatives. d. Corporations. 2. Explain how ownership is attained in a cooperative and corporation. a. Briefly explain how cooperative shares are purchased.

Problems and concerns	Guides to solutions and examples of teaching techniques
	b. Explain the difference between common and preferred stock. c. Explain how corporations are financed using a Wall Street Journal as a reference.
	3. Explain the owner's function and method following in making business decisions.
	4. Reference 6.
3. How do structures of businesses differ?	1. List the four common ways of doing business on the chalkboard.
	a. Outline the structural organization of each showing: (1) Owner--stockholder. (2) Officers. (3) Managers. (4) Workers in firm.
	b. Discuss officers required and qualifications for holding office. c. Explain tax laws related to each type of firm.
	2. Discuss the legal features of each type of ownership.
	3. References 6 and 10.
4. How may finances be attained to expand a business?	1. Discuss the use of mortgages, expanding partnerships, issuing additional stocks, and undivided profits and dividends.
	2. Discuss securing outside sources of capital for financing the business.
	3. Reference 9.

Problem area. Understanding and Using Credit Instruments in an Agricultural Firm.

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of how credit may be obtained by a firm.
2. Ability to differentiate between different forms of credit.
3. Ability to properly fill out credit instruments.
4. Understanding of the different types of credit used by a firm.

Student motivation

1. Ask students to explain how credit cards may be used in buying articles.
2. Ask students to identify other ways a person may obtain goods from a firm without a direct cash transaction.
3. Discuss why credit is used in today's business.

Structured activities for supervised experience programs

1. Have students fill out a credit card application.
2. Assign each student to report back to class the types of credit and credit instruments used in the firm in which he works.
3. Develop a list of businesses in the community which extend credit. List those that do not extend credit.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is credit?	1. Define in terms of a "promise to pay."
2. What are some of the common terms associated with credit?	1. Equity. A share or participation in property value.
	2. Capital. Principal available for investment, in accounting, margin of assets over liabilities.
	3. Chattel mortgage. A document by which the owner of goods transfers title to a mortgage.
	4. Commercial paper. Notes, drafts, checks, and certificates of credit or deposite as used in business.
	5. Credit instrument. Any document that identifies a credit obligation.

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Problems and concerns	Guides to solutions and examples of teaching techniques
	6. Promissory note. A written promise by the maker of a note to pay on demand or at a definite time a stated sum of money.
	7. Financial statement (net worth). A paper listing all the assets and liabilities of an individual.
	8. Lien. A right or claim against specific pieces of property.
	9. Open account. Short-term credit used in normal purchasing activity--the charge account.
	10. References 6 and 12.
3. What are the legal aspects related to extending credit?	1. Review "truth in lending" laws. Discuss the following: a. Lending charges and rates. b. Lien on property sold. c. Letter stating lien or waiver d. Discounting open accounts
	2. Discuss the method of recording or identifying mortgages in a county.
4. How are interest rates figured?	1. Discuss how interest rates are calculated as follows: $i = \frac{2mD}{P(n + 1)}$ i--annual rate of charge m--the number of payments in one year D--interest charge in dollars P--principal or cash advanced n--total number of payments
	2. Provide an amortized note and have students figure the interest rate.
	3. Explain: a. Discount loans. b. Add-on loans.
	4. Reference 2.

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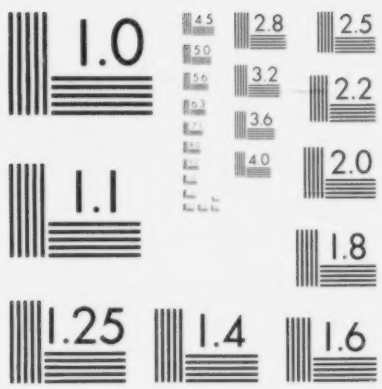

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Problems and concerns	Guides to solutions and examples of teaching techniques
5. Where may credit be obtained?	1. Discuss the following sources of credit: a. Local business-customer credit. (1) Open account or credit card account. (2) Chattel mortgage through parent company. b. Banks--Explain how legal limit affects borrower and how a bank may use a correspondent bank. (1) National bank. Limited to loan of ten percent of the bank capital stock and unimpaired surplus to one individual. (2) State banks. Limitations to borrower vary from state to state. c. Federal agencies. (1) Bank of Cooperatives. (2) Farmers Home Administration (FHA). (3) Federal Land Bank. (4) Production Credit Association (PCA). d. Others: individuals, loan companies, insurance companies, savings and loans, etc.
6. What information is required to properly fill out a credit instrument?	1. Show film, "Back of Every Promise." 2. Discuss the items found in a legal contract. 3. Discuss the following items to be placed on a credit instrument. a. Date of note. b. Amount of note. c. Signatures. d. Repayment clause or schedule. e. Interest rate. f. Deferred payment and repayment privileges. 4. Provide each student with a note and have them fill it out. 5. References 6 and 12.

Problem area. Understanding the Customer Credit Policies of an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the credit policy of a firm that affects customers.

2. Understanding of how a customer credit rating is determined.

3. Understanding how credit is used to increase sales.

Student motivation. Discuss the use of credit for purchasing a product or service and its advantages and disadvantages to a business. Ask students how they would determine the credit rating of a fellow student.

Structured activities for supervised experience programs

1. Have each student fill out a net worth statement.

2. Divide the class into groups and have them prepare a bulletin board of bankruptcy cases and other articles dealing with credit.

3. Have each student study how a selected business determines the credit rating of a customer.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What factors are considered in determining credit risk?	1. Discuss the 4 C's of credit. a. Character of borrower. b. Capacity of borrower to repay. c. Capital of borrower. d. Economic conditions. 2. Character + Capacity + Capital + or - Economic Condition = Credit Risk. 3. Reference 2.
2. What procedure is used to determine a customers credit rating?	1. Discuss how the following may be used in determining a credit rating. a. Individual's bank. b. Local or area credit bureau. c. County court house. d. Other companies where a person was a credit customer. e. Individual's credit references. 2. Have individuals file a net worth statement. 3. References 2, 3, and 5.

Problems and concerns	Guides to solutions and examples of teaching techniques
3. How may the credit policies of a company affect its business?	1. Discuss how credit policies may affect the following: a. Margin of profit in sales. (1) The greater the margin of profit, the greater the risk that may be assumed. (2) Keen competition may force a more liberal credit policy. b. Business decisions. (1) Elastic credit policy strives for a quick turnover. (2) Credit policy and marketing policy must be coordinated. 2. Reference 2.

Problem area. Understanding the Procedures Used to Collect Bills by an Agricultural Firm.

Objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the procedures used in bill collection.
2. Understanding of the different methods of bill collection used by agricultural firms.
3. Understanding of the legal aids related to bill collection that are available to a business.

Student motivation

1. Bring in several types of bill collection letters and discuss them in class. Have students express their opinions on the effectiveness of each letter.
2. Encourage students to identify other types of bill collection tools.

Structured activities for supervised experience program

1. Have each student develop a procedure that may be used by a firm to collect a bill.
2. Have each student discuss the procedure he develops with an official in the business where he works. Have students report findings to the class.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What collection tools may be used by agricultural firms.	1. Have the students relate the type of tools used in collection. Make a list on the chalkboard. The list should include the following: a. Collection letter. b. Note. c. Collection by draft. d. Use of the telephone. e. Use of telegram. f. Personal collection. g. Salesman collection. h. Collection agency. i. Local attorney. 2. Discuss how each of these tools could be used in collection. 3. Reference 2.

Problems and concerns	Guides to solutions and examples of teaching techniques
2. What is a desirable collection procedure that may be used effectively by an agricultural firm?	1. Discuss the characteristics of the customers of a business and their reactions to the collection methods outlined above. 2. Have each student develop a tool that may be used for the collection of a bill. 3. Discuss the advantages and disadvantages of each method. 4. Reference 2.
3. What legal aids may be employed to collect debts.	1. Have a local attorney visit the class to discuss what legal procedures are usually followed in collecting a debt. 2. Discuss how the use of legal procedures in bill collection may affect the business of a firm.
4. How does a business handle insolvent accounts?	1. Discuss the causes of insolvent accounts. 2. Discuss the possibility of extension for debtors to keep them from bankruptcy. 3. Reference 2.

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Problem area. Understanding the Role of Insurance in an Agricultural Firm.

Objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the types of insurance available to an agricultural firm.
2. Ability to recognize the liability of a particular business.
3. Understanding of the contents and terms of company insurance policies.
4. Understanding of the decision that must be made to determine what kind and how much insurance a company should carry.

Student motivation

1. Have each student list at least 20 items that could be covered by insurance.
2. Would it be wise for a business to carry insurance for each item identified? Why? Or why not?

Structured activities for supervised experience programs. Ask each student to survey the business where he is employed or would like to be employed and identify one type of insurance policy that the business carries. Have students discuss policies in class.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is insurance? What does it do, and how are premiums rates figured?	1. Show slidefilm on insurance to students. 2. Define insurance as a contract to shift risk. 3. Discuss how premiums are related to risk. 4. Reference 7.
2. What insurance coverage is available to businesses?	1. Discuss the different risks that a business has. 2. Identify the risks that can be covered with insurance. 3. References 7 and 11.
3. How much insurance does a business need?	1. Have the class select a particular business and determine the amount of insurance needed for a certain area. 2. Discuss the factors that might be considered, such as: a. Activities. What products are made or sold? Service offered? How are products shipped?

Problems and concerns	Guides to solutions and examples of teaching techniques
	b. Financial affairs. Amount of the total assets? Amount of fixed and nonfixed costs and expenses? c. Facilities. What facilities are used--buildings, machinery? Where are they located? What are they worth? d. Staff. How many people are employed? What are their duties? Do they use their car in the business? Do they handle money?
	3. Reference 11.
4. Which company should the agribusiness firm place its insurance with?	1. List the major type of insurance companies on the overhead projector.
	2. Divide the class into small groups and have each group determine the advantages and disadvantages of a type of insurance company.
	3. Reference 11.
5. What is the insurance company's obligation to the business?	1. Have students relate experiences regarding insurance settlements. Explore what was expected in relation to what was received.
	2. Reference 11.
6. What factors should be considered when selecting a specific insurance company?	1. Discuss factors and list them on the chalkboard. Some of these factors might be as follows: a. Rate of adjustment of a claim. b. Specific coverage wanted. c. Premiums. d. Wording of the policy. e. History of the insurance company.
	3. Reference 11.

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UNIT III: UNDERSTANDING THE PRACTICES FOLLOWED IN STORING AND INVENTORYING PRODUCTS IN AN AGRICULTURAL FIRM

Problem areas included in this unit are:

1. Understanding the System Used to Control or Maintain the Inventory of an Agricultural Firm

2. Planning the Storage Arrangement of Products in an Agricultural Firm

3. Maintaining the Quality of Products Stored in an Agricultural Firm

4. Using and Maintaining Storage Equipment in an Agricultural Firm

References and Instructional Aids for Unit III.

Problem area. Understanding the System Used to Control or Maintain the Inventory of an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the system used by agricultural firms to insure that a proper supply of goods is on hand.

2. Understanding of the vital part each employee plays in the successful functioning of the control system.

Student motivation

1. Whose responsibility is it to insure a proper supply of goods for the firm?

2. Is the system used by all businesses very similar or does each type of business have its own unique system?

3. How does improper functioning of the control system affect the agricultural firm?

Structured activities for supervised experience programs

1. Have students describe the system used to control supplies which is in operation at an assigned agricultural firm.

2. Have a visit with the manager of a firm to identify the consequences of improper control of supplies.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What do we mean by stock control or stock maintenance?	1. State that stock control or stock maintenance is the availability of the materials which are needed for proper functioning of the agricultural firm. 2. Discuss the importance of being able to get the needed materials in a very short time. 3. References: 3, 4
2. How does each employee serve in the efficient functioning of the stock control system?	1. Use on-job experiences and discuss the part which each employee plays in the following: a. storing materials. b. keeping record of materials used. c. keeping record of goods sold. d. preserving the quality of materials on hand. e. keeping record of goods received.

Problems and concerns	Guides to solutions and examples of teaching techniques
3. How can a new employee most quickly become a good stock keeper?	1. Have students list certain materials and supplies on hand at their cooperating business. 2. Have the students draw storage plan showing where each item is stored. 3. Have each student bring to class examples of forms used to assist in the control or maintenance of inventory of goods. 4. Reference: 5
4. Of what importance is the cost of storage and handling to the agricultural firm?	1. Have students prepare estimates of the cost to the firm for storage and handling of materials. 2. Reference: 5

Problem area. Planning the Storage Arrangement of Products in an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the need for efficient storage arrangement of products in a business.

2. Ability to calculate costs of alternative methods of storing products.

3. Understanding of the safety precautions necessary in handling and storing certain agricultural products.

Student motivation

1. Have students make an arrangement of small shelf items to illustrate arrangement principles, advertisement effects, etc.

2. After completing this unit ask students to make improvements in their display.

Structured activities for supervised experience programs. Have each student select a product in his cooperating business and outline methods for improving the arrangement of that product to provide for more economical movement of the product.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. Why should a firm have a planned arrangement for storage of products on hand?	1. Explain that products need to be segregated by type and quality in order to avoid errors when selling to customers, to make up shipments of specific type and quality, to take advantages of prices for various types and qualities of products, etc. 2. Discuss how proper storage arrangement affects the movement of products, advertisement, safety, etc. 3. Have a food store owner visit the class to explain the arrangement of food items in a grocery store. 4. Reference: 5
2. How can goods be arranged "displayed" to their best advantage?	1. Have each student secure an item with advertising material from an agricultural firm and discuss them in class to determine what makes a desirable display. 2. From the above procedure select a different item to display and have the class as a unit be responsible for making a "counter display" of the item. 3. Reference: 2

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Problems and concerns	Guides to solutions and examples of teaching techniques
3. What safety precautions should be used when storing certain chemicals, petroleum, etc.?	1. Discuss the items that require safety precautions, then list the safety precautions needed with each item. 2. Reference: 2
4. How may the cost of storage of a product be lower by altering the storage arrangement?	1. Have students determine the costs of storage for items such as feed (bulk vs. sacks), new machinery (outdoors vs. pole buildings), etc. 2. Have each student make suggestions for rearrangement of products in the firm where he works that would lower the storage cost. 3. References: 2, 5

Problem area. Maintaining the Quality of Products Stored in an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the storage requirements for special products.
2. Understanding of the handling techniques required to maintain product quality.
3. Ability to calculate the shrinkage of agricultural products.

Student motivation. Show students some samples of deteriorated items (feed, chemicals, grain, etc.). Ask students to identify cause of deterioration and the estimated economic loss.

Structured activities for supervised experience programs

1. Help students list various products handled by the firm where they work that require special storage conditions.
2. Have students identify problems of quality maintenance and shrinkage in the firm where they work. Have students suggest ways to improve the situations.

Problem and concerns	Guides to solutions and examples of teaching techniques
1. What products are stored by agricultural firms?	1. Have students list the major and minor products handled by agricultural firms.
	2. Discuss why products must be stored by a firm.
2. What special storage requirements are needed for various products?	1. Help students formulate a list of various products that require special storage arrangements to maintain product quality.
	2. Assign a product to each student and have them report to the class the storage requirements for his product.
	3. Reference: 5
3. What agricultural products are subject to shrinkage?	1. List the possible rates for shrinkage for the common agricultural products that are subject to shrinkage.
	2. Discuss how these shrinkage losses can be reduced or eliminated.
	3. Reference: 5

Problem and concerns	Guides to solutions and examples of teaching techniques
4. What handling procedures are used to maintain quality of agricultural products?	1. Visit and observe an agricultural firm that does use several procedures in handling for maintaining product quality. (Also note other problems connected with product quality.) 2. Discuss handling procedures that may be used and how they help maintain product quality. 3. References: 1, 4, 5

Problem area. Using and Maintaining Storage Equipment in an Agricultural Firm

Teacher objectives. The objectives for the instruction of students in this area of study are to develop:

1. Understanding of the proper use of equipment utilized in handling agricultural products.
2. Ability to properly maintain the equipment used in handling agricultural products.

Student motivation

1. Show film on handling agricultural products with modern equipment.
2. Arrange for a field trip to a firm to observe equipment used in moving and storing agricultural products.

Structured activities for supervised experience programs

1. Have students list the various types of equipment used at their training station. Have students review operator's manual for the equipment.
2. Have each student prepare a years service schedule for one piece of equipment used in the firm where employed.

Problems and concerns	Guides to solutions and examples of teaching techniques
1. What is the safe and proper way to use material handling and storing equipment?	1. Have each student give a report on how to use one piece of equipment which is used to handle agricultural products. 2. Discuss how to secure and use operator's manuals for equipment. 3. Explain that operator's manual and service manuals can be secured by contacting the manufacturer through a dealer.
2. Why is proper maintenance of material handling and storing equipment of importance to the firm?	1. Discuss the relative time required to handle and store products using different types of equipment. 2. Discuss how the condition of the equipment influences handling efficiency and safety of operation.
3. What is good maintenance of handling equipment?	1. Explain that properly maintained equipment is available and safe to use.

Problems and concerns	Guide to solutions and examples of teaching techniques
	2. Emphasize that the operator's manual is the best guide to good maintenance.
	3. Use operator's manuals to help students read and understand operating and maintenance instructions.
4. What part does proper product handling play in the reputation of the firm?	1. Have students identify successful agricultural firms in the community and relate reputation of the firms to efficiency of handling products.
	2. References: 1, 4

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ABSTRACT - Intended for extension agents and other agricultural persons, this manual on plant growth of cereal crops was prepared by staff members of North Dakota State University. Sections are: (1) Cereal Crop Development, (2) Specific Crop Production Items, (3) Individual Crops, (4) Supplemental Information, and (5) Glossary. Numerous illustrations are presented for explanations. (GB)

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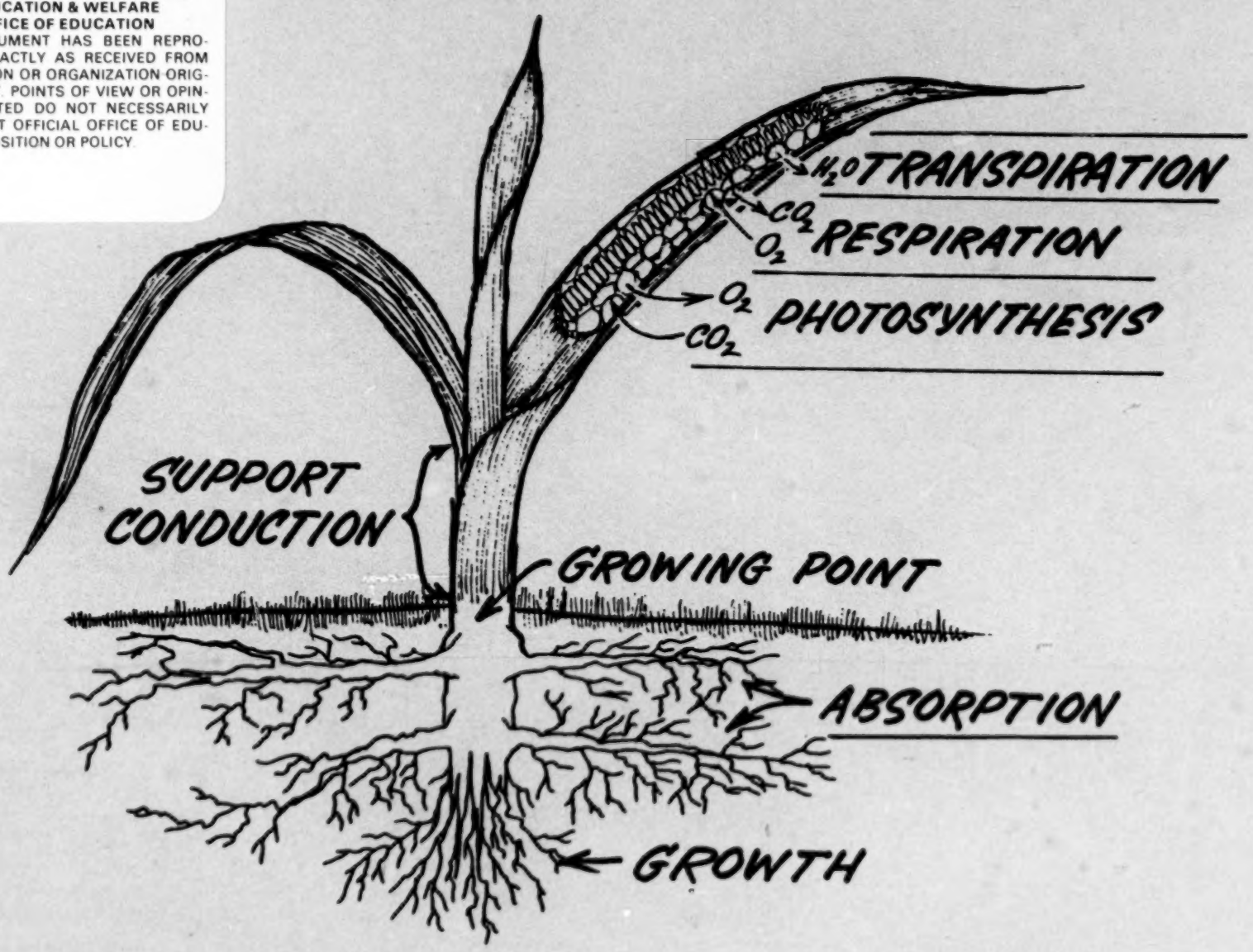

Diagram showing important structures and functions of a cereal plant.

FOR USE OF COUNTY EXTENSION AGENTS AND OTHERS IN THE FURTHERANCE OF MORE PROFITABLE FARM MANAGEMENT

VT012537

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Section A—CEREAL CROP DEVELOPMENT

I. INTRODUCTION

Cereal crops include wheat, barley, oats, rye, corn, rice, grain sorghum and proso millets. These are all grasses grown for their edible seeds. Cereals have the "bunch" habit of growth. This growth habit results from the development of basal buds on the main stem which produce branches or shoots called tillers. These tillers may repeat the process and the bunch habit of growth is built up.

Small grains include wheat, barley, oats, rye and rice.

II. THE PLANT CELL

All living plant parts are made up of cells. Plant cells are of many different sizes and shapes and are specialized in their functions. A group of cells are known as **tissue**, a group of tissues become an **organ** and a group of organs function as a **plant.**

Plant cells have the following basic structure.

Figure 1—PLANT CELL STRUCTURE

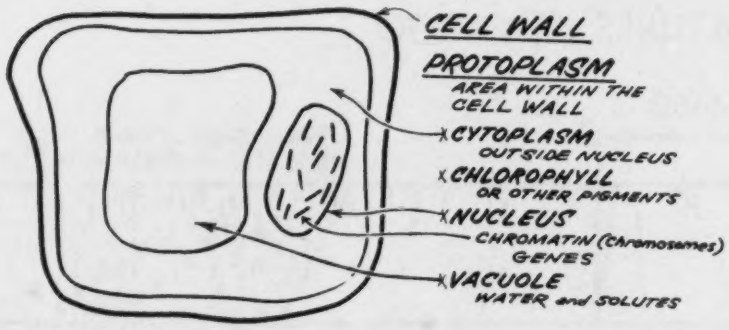

Each cell consists of a mass of **protoplasm,** which is the living matter of the plant, confined by the **cell wall.** Protoplasm is a fluid substance varying in density, and chemical analysis shows it to be principally protein. The protoplasm contains special structures, each having definite functions as follows:

The **Nucleus** is located inside the cell and is enclosed in a membrane. Within this membrane is the nuclear sap consisting of water and dissolved substances. **Chromatin,** also found in the nucleus, is a granular substance which gathers into thread-like masses, breaking up into segments called **chromosomes** when cell division is about to take place. For each type of plant the chromatin gathers into a definite number of chromosomes. The inheritance of the plant is determined by **genes** carried within the chromosomes.

Cytoplasm is the protoplasm outside the nuclear membrane. It has dense bodies of protein called **plastids.** These plastids often carry pigments which give the plant or a part of the plant characteristic colors. The green pigments are **chlorophyll** but there may be many other colors such as are found in flowers, leaves, stems or roots of some plants. Starch grains, oil drops, and other food substances also are found in the cytoplasm.

Vacuoles are found within the cytoplasm and may occupy 90 per cent of the mature cell volume. Their major component is water which contains dissolved salts, acids, pigments or other products of cell metabolism.

Plant growth occurs by cell division and cell enlargement. The area where growth is active is known as **meristematic** tissue. Cell division is called **mitosis** and is the basis for all plant growth.

III. THE SEED (CARYOPSIS)

The essential parts of cereal seeds are:

1. **Pericarp** — the protective covering surrounding the endosperm and germ.
2. **Germ** or embryo—the young dormant plant.
3. **Endosperm**—stored food.
   a. Aleurone—outer layer of cells which may contain pigments.

See Figure 2 — "A Kernel of Wheat"

In cereals the endosperm is mostly starch, while the embryo (germ) is high in protein, oil and minerals.

Figure 2—A KERNEL OF WHEAT

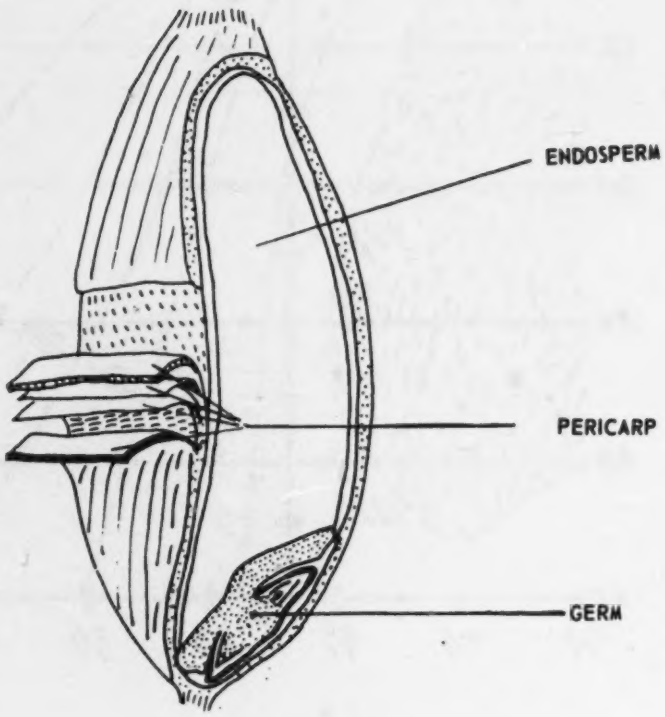

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IV. GERMINATION

Seeds placed in soil germinate if sufficient **water** and **oxygen** are present, and if **temperatures** are suitable. In the germination process, the embryo, which was dormant in the dry seed, resumes growth.

Several factors influence germination:

1. **Water** absorption is the first step in germination. Since water comes from the soil, the seed must be in close contact with moist soil particles to absorb water. A well prepared, firm seedbed conserves soil moisture. Placing seed in moist soil is necessary for good germination.

   Water absorption by seed also is influenced by concentration of chemicals (principally salts) in the soil solution. If the salt concentration is too high, the seed cannot absorb enough water for normal germination. This is why "fertilizer burn" occurs if high concentrations of fertilizer are placed close to the seed. Seed also may fail to germinate in highly saline soils.
2. **Oxygen**—must be present in adequate quantities for respiration to provide energy. It may be limiting in water-logged soils, which slow down or prevent germination.
3. **Temperature**—seeds will not germinate if the temperature is too low. Various kinds of seeds will germinate at different soil temperatures. See Table 1.

Table 1. SOIL TEMPERATURES FOR GERMINATION

Crop	Degrees Fahrenheit Minimum or Threshold	Optimum Range
Wheat	34 to 36	59 to 65
Barley	34 to 36	59 to 65
Oats	34 to 36	59 to 68
Rye	34 to 36	59 to 65
Corn	48 to 50	80 to 90
Sorghum	48 to 50	80 to 90

Millet (assumed to be like corn and sorghum)

Source: Idaho Agricultural Science

These differences in temperature requirements for germination help explain why some crops can be sown earlier in the spring than others. The danger of frost after growth begins also is a factor to consider in deciding when to seed, since some crop seedlings are more frost-tolerant than others.

Soil temperatures depend on depth and time of year. Figure 3, shows soil temperature isotherms at Fargo. This chart shows soil temperatures at various depths throughout the year.

4. **Light**—cereal seeds will germinate either in light or darkness, but other seeds such as bluegrass germinate faster in light.
5. **Seed Viability**—the embyro (germ) must be alive if the seed is to germinate. The viability of seeds can be determined by a germination test. Some live

Figure 3–SOIL TEMPERATURES AT FARGO

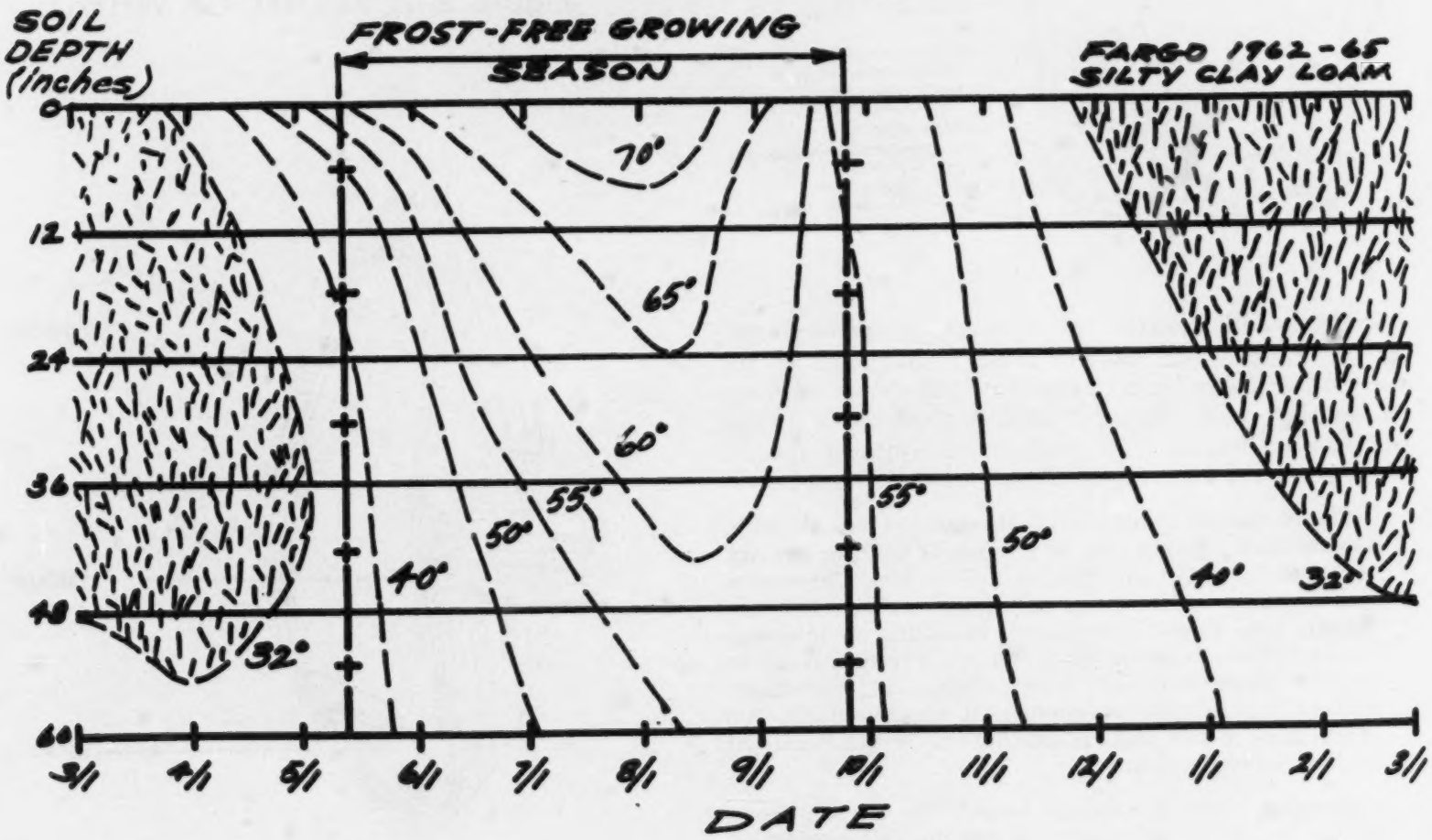

Source: Soils Department NDSU.

seeds are more vigorous than others and will germinate faster and produce more robust seedlings.

6. **Seed Size**—the larger the seed, the more food and energy it can provide to the young seedling. Several experiments have shown that larger seeds germinate faster and produce more vigorous seedlings than do smaller seeds. Large seeds will emerge from greater depths than small seeds. Early seedling vigor and rapid growth provides better crop competition against weeds and seedling diseases. Removing small kernels in seed cleaning is desirable. See Figure 4.
7. **Breaks** in the seed coat (pericarp) may decrease germination in cereals. Broken seeds often have low viability. Injury to the embyro usually is the most serious. Broken seeds often show more mold growth than do whole seeds. Seed treatment protects against mold and fungus growth on the seed surface.
8. **Immature seeds** are attacked more easily by mold growth than mature seeds. Because of less food reserve in the endosperm they also produce smaller sprouts. Good quality seed comes from well matured plants.
9. **Microorganisms**—many kinds of fungi and bacteria in the soil can attack seeds and cause them to rot. Seed treatment protects the seed and seedling against soil borne disease infection.
10. **Diseased seed**—some seed borne diseases cause small, shrunken kernels that should be removed in seed cleaning. Other seed borne diseases such as loose smut and viruses do not affect germination.
11. **Dormancy**—seeds of some cereals may be dormant when newly harvested. They need a storage period for conditioning before they can germinate. Dormancy in wheat, barley and oats often disappears in 20 to 30 days after harvest but may persist for 60 days in wheat. Durum wheat tends to have a longer dormancy than Hard Red Spring wheat. A higher per cent of dormancy also has been observed in wheat harvested before it is mature. Freshly harvested oats and barley kept at a temperature of 36° F. in a relatively high humidity will stay dormant for three years. Dormancy is less common in corn and sorghum than in oats and barley. Varieties of the different cereals differ in dormancy. Temporary dormancy of cereal grains is desirable where prolonged moist weather conditions occur at harvest. There is no dormancy problem in rye or winter wheat. Newly harvested seed can be sown the same fall.

V. EMBRYO STRUCTURE AND GROWTH

The embryo is composed of several distinct parts each having a separate function in the developing

Figure 4—EFFECT OF HARD RED SPRING WHEAT SEED SIZE ON SEEDLING WEIGHT

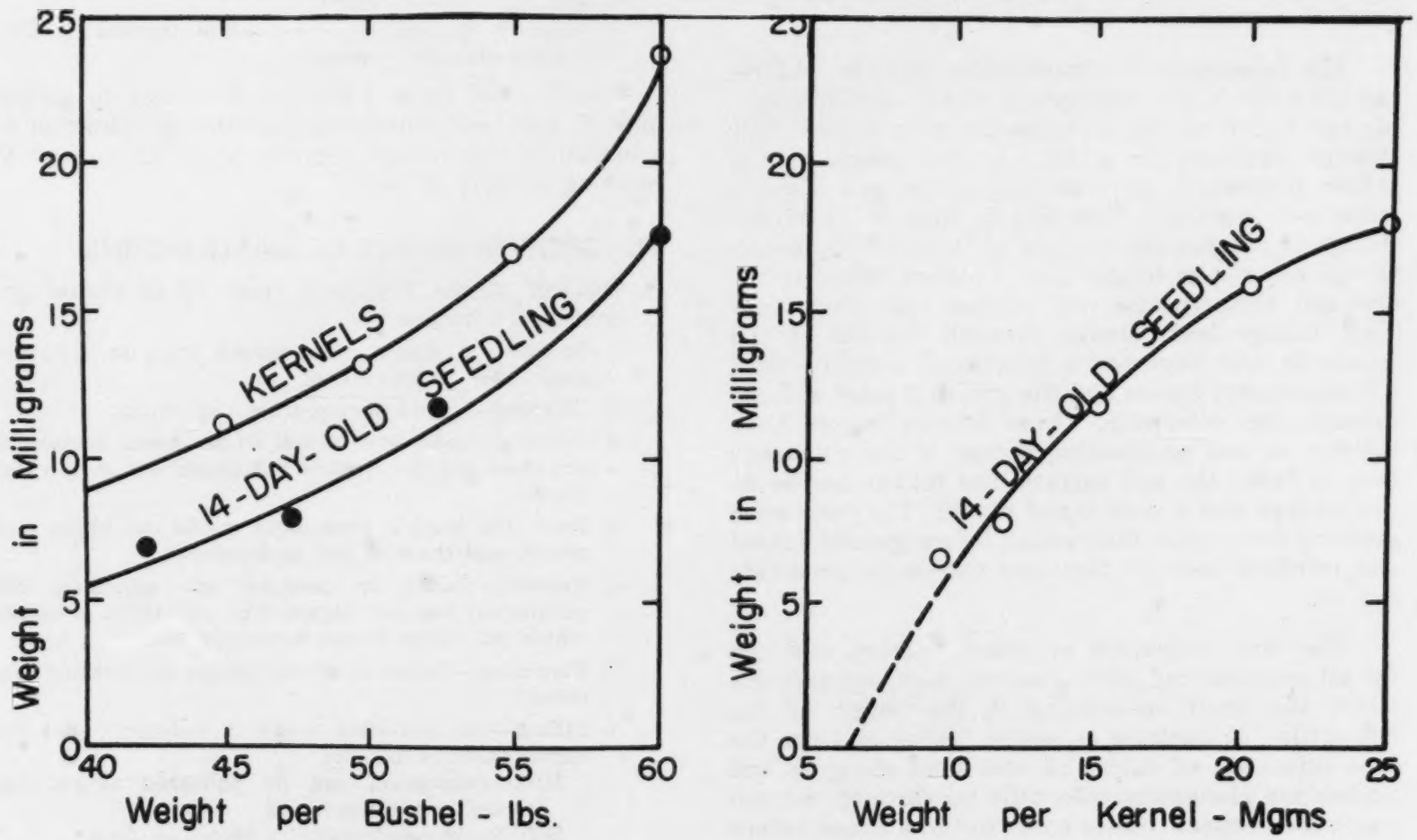

Source: Cereal Crops by Leonard and Martin.

plant. A plant is composed of several major parts which have an exact organization in relation to one another. The plant axis is divided into the ascending portion called the stem and into the descending portion called the root. The area within the embryo where the stem meets the root is called the first node.

The most obvious structure in the embryo is the **scutellum** which is really the first leaf of the plant and is attached to the first node. See Figure 5 page 9. This modified (first) leaf is involved in the digestion and transport of food from the endosperm into the developing embryo and never emerges above the soil surface. The next leaf is called the **coleoptile.** It is really the second leaf and is attached to the second node. This leaf is very important to the emergence of the seedling plant as it has a very sharp point and is well adapted for soil penetration. The third leaf is attached to the third node and is the first foliage leaf. It emerges through the coleoptile, becomes green in color, and is the first leaf to carry on photosynthesis.

The terminal bud, known as the growing point, is surrounded and protected by the leaves during embryo growth and seedling emergence. The growing point is the origin of all new growth in the cereal plant and will ultimately terminate in the head or the tassel in corn. Loss of this structure through frost, disease, or insect damage causes irreparable harm to normal growth and development.

The **coleoptile,** the **internodes,** and the **radicle** are involved in the emergence of the seedling during and following the germination process. The first embryo structure to enlarge is the radicle which grows downward, provides anchorage and absorbs water and nutrients. See Fig 5, page 9. Next the coleoptile reaches the surface of the soil, but usually will become no longer than 3 inches. When it has emerged through the soil surface, the third leaf (first foliage leaf) breaks through the tip of the coleoptile and becomes a functional seedling leaf. All subsequent leaves and the growing point emerge through the coleoptile. These foliage leaves have little or no soil penetrating power. If the coleoptile fails to reach the soil surface, the foliage leaves do not emerge and a poor stand results. They continue growing for a while but remain below ground folded and crinkled because they are unable to penetrate the soil.

The first internode of wheat, barley and rye for all practical purposes does not elongate and this limits the depth of seeding to the length of the coleoptile. In contrast to wheat, barley and rye the first internode of corn and oats does elongate and pushes the elongating coleoptile up through the soil much like a spear. Hence corn, and to a lesser extent oats, can emerge from greater depths than other cereals.

VI. RESPIRATION

Respiration, transpiration, photosynthesis and **reproduction** are four of the major life processes of a plant. Respiration, which is at a very low level in viable seed, increases rapidly during the early stages of germination and continues throughout the life of the plant, providing a source of energy for all growth processes.

Seedling plant growth begins in the embryo (germ) as food is transported from the endosperm to the embryo cells during the process of germination.

As the seed absorbs water the starch, which is the stored food in the endosperm, is broken down into sugars which are simpler chemical compounds. This conversion of starch into sugars is brought about by the action of chemicals called **enzymes,** contained in the seed embryo. Enzymes influence chemical changes without being changed themselves.

The sugars are further broken down into very simple chemicals (carbon dioxide and water) by a process called **respiration.** This breakdown of sugars releases **energy** which is used by the germinating seedling for its life processes.

The breakdown of starch (respiration) which provides energy is shown by steps below:

(1) starch $\xrightarrow{\text{(enzyme)}}$ sugar

(2) sugar + oxygen $\longrightarrow$ H_2O (water) + CO_2 (carbon dioxide) + **energy**

Seeds need large amounts of energy to germinate. It has been estimated that the germination of a bushel of wheat seed requires as much energy as plowing an acre of land.

VII. GROWTH STAGES OF SMALL GRAINS

A. Growth stages, Figure 6, page 10 of plants are commonly known as:

1. Seedling—a young plant grown from seed to the stage when tillers emerge.
2. Tillering—shoots arising from the crown.
3. Jointing—nodes can be felt in the lower portion of the stem but the head is not prominent in the leaf sheath.
4. Boot—the head is prominent inside the upper leaf sheath and the flag leaf is developed.
5. Heading—spikes or panicles are emerging but pollination has not begun. The exception is barley which pollinates before emerging from the boot.
6. Flowering—florets open and pollen is shedding (anthesis).
7. Filling—the fertilized ovary is enlarging and the kernel assumes full size.
   - Milk—endosperm can be squeezed from the kernel as a white liquid.
   - Soft dough—endosperm is becoming firm.
   - Hard dough—endosperm is firm and the kernel changing color.

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Figure 5 **WHEAT EMBRYO**

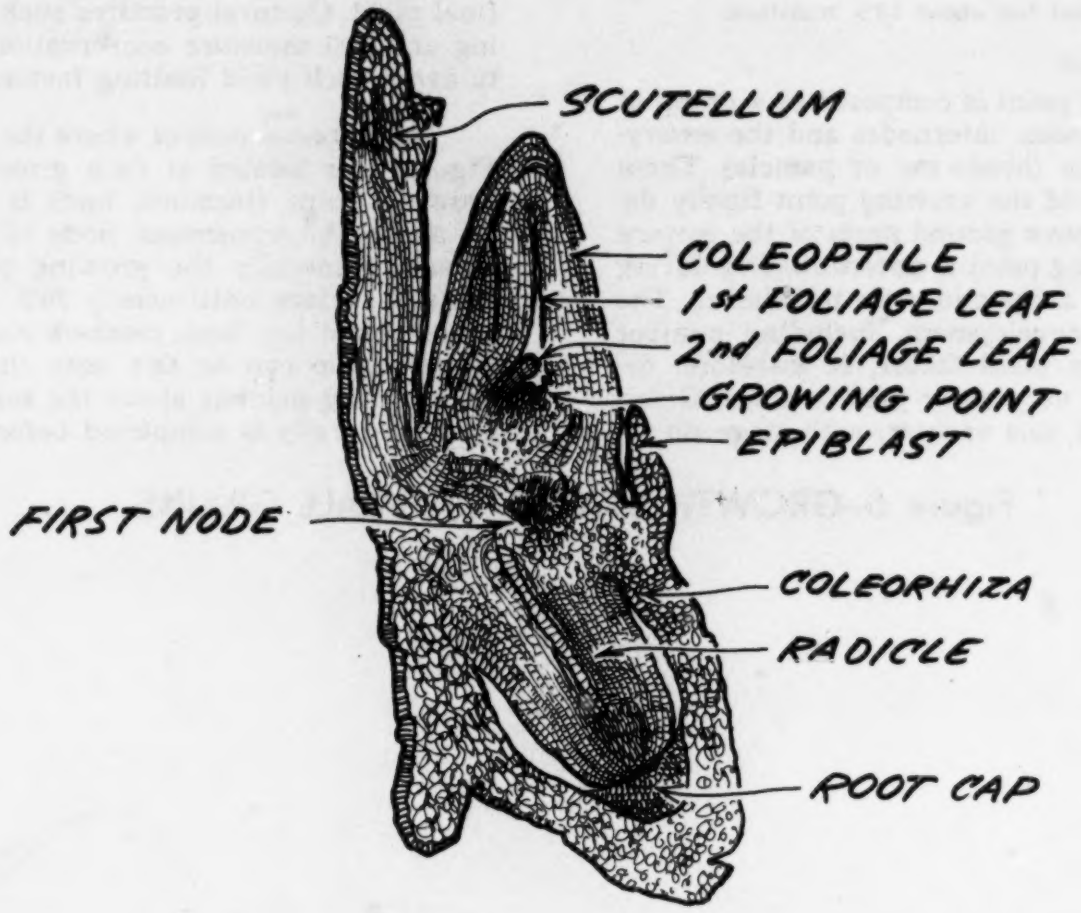

STAGES OF WHEAT GERMINATION

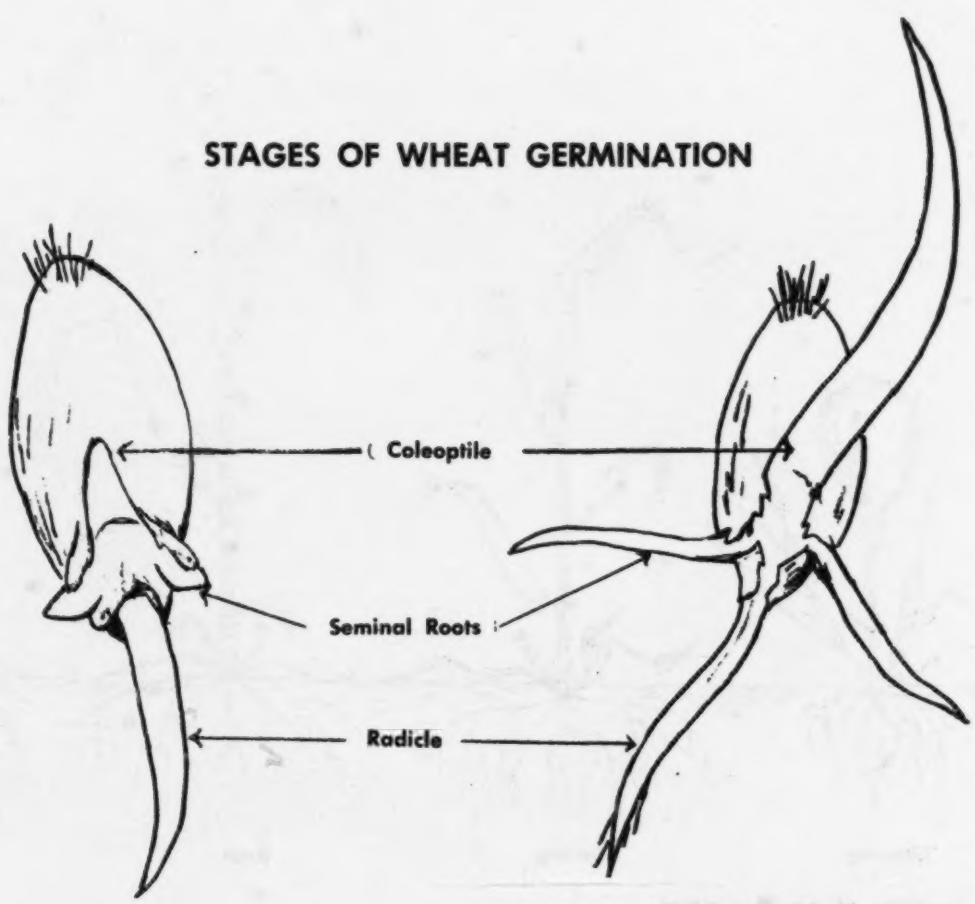

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8. Mature seed—kernel is firm and contains 35% or less moisture.
9. Fully ripe—kernel has about 13% moisture.

B. The growing point

The growing point is composed of a group of closely packed nodes, internodes and the embryonic inflorescence (head, ear or panicle). These component parts of the growing point finally develop into the above ground parts of the mature plant. The growing point is differentiating during the late seedling stage and prior to tillering. The potential plant development, including number of spikelets as a yield factor, is therefore, determined at this very early growth stage. Growing conditions at this early growth stage do influence final crop yield. For example, early season drougth or high temperatures may limit the final yield. Cultural practices such as early seeding and soil moisture conservation usually help to avoid such yield limiting factors.

Make special note of where the growing point Figure 6, is located at each growth stage. The growing point (terminal bud) is **always** located above the uppermost node of each stem in cereals. Generally the growing point is **below** the soil surface until nearly 30% of the mature plant height has been reached. As soon as node (joint) tissue can be felt near the soil surface, the growing point is above the soil surface. Tillering generally is completed before the growing

Figure 6—GROWTH STAGES OF SMALL GRAINS

Arrow shows location of growing point

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point is above ground. This delayed emergence of the terminal bud is a valuable protective mechanism and should be considered when investigating frost, wind or hail damage. Cereals will survive extensive damage to the leaves and crown if the terminal bud is not killed. Maturity, however, is delayed following extensive loss of early foliage leaves.

VIII. PLANT PARTS AND THEIR FUNCTION

A. **Roots**—anchor the plant and absorb water and plant nutrients from the soil. There are two main types of cereal roots, **seminal** (primary) and **crown** (secondary). A third type called **brace** roots may develop above ground in corn.

See Figure 7, page 12.

Seminal roots—develop first. They originate from the embyro when the seed germinates, growing downward from the lower end of the embyro. The radicle develops first, followed by three, five or seven additional seminal roots. Sorghum and millet produce only a single branched seminal root.
Seminal roots sometimes erroneously are called "temporary roots," the belief being that they function only in early stages of growth. Seminal roots may function until the plant matures. In corn they penetrate to a depth of five to six feet, but frequently they die soon after the crown roots are formed. In a well tillered wheat plant they may serve as the chief support of the main stem of the plant.
Crown roots—develop after the seedling emerges. They originate from stem tissue (adventitious) and develop after the young plant unfolds a few leaves. They arise from basal stem nodes which remain underground and develop into an elaborate root system. Crown roots usually develop about one inch below the soil surface even though the seed was planted deeper. Internodes below the crown elongate, bringing it up near the soil surface.
Brace roots—may arise in whorls from nodes above the soil surface in corn and sorghum. When entering the soil they function as ordinary roots.

The number of crown roots may vary but they usually form definite whorls. They tend to grow horizontally before turning abruptly downward. Each whorl of roots tends to have a wider, horizontal spread than the preceding one. Each new tiller gives rise to additional crown roots. A well tillered plant, therefore, develops a large crown root system.

a. Root structure:

Stele—central part of root containing specialized cells and tissue (xylem) for the upward translocation of water and dissolved nutrients and (phloem) for downward translocation of food.
Cortex—surrounds the stele and is composed of cells (parenchyma) capable of transport or storage of carbohydrates.

Epidermis—the outer covering of the root including root hairs.

Root hair—a "work horse" simply an enlarged epidermal cell in close contact with the soil particles, soil water and soluble ions. Root hairs have a life span of only a few hours but new ones are formed continuously during active plant growth.

b. Root growth: See figure 8 page 13.

Growth in a root is due to cell division and enlargement at the **tip** of the root. Roots do **not** "search" for water or nutrients, they only "intercept" water and nutrients present in the pore space of the soil with which they happen to come in contact. There is some movement of water and nutrients in the soil and therefore movement towards the root.

With ample space, the roots of a single plant may have a total horizontal spread of four feet in wheat, eight feet in corn and twelve feet in sorghum. Roots of small grains, corn and sorghum normally penetrate downward three to six feet but most of the weight is in the upper 6 to 12 inches of soil.
Some cereal roots may elongate as much as a half-inch or more a day; seminal roots of winter wheat may grow at that rate for 70 days. Corn roots may grow from 2 to 2½ inches a day for three or four weeks. The mature root system of a corn plant may occupy 200 cubic feet of soil.

Roots of cereal plants do not extend into waterlogged soil. A moist topsoil with cold or dry subsoil in the early stage of plant growth promotes a shallow root habit that may cause the plant to suffer in later drouth. Roots penetrate dry soil only slightly beyond available moisture supplies. They do not "search" for water or nutrients. This is why a firm seedbed without air pockets or thick layers of dry straw is desirable.

Soil temperature affects root development of a growing crop. During the growing season temperatures near the soil surface are considerably higher than temperatures at lower soil depths. The optimum soil temperature for root development of spring sown small grains is reported to be in the range of 68-72° F. Optimum soil temperatures for corn and sorghum are 70-75° F. Studies of soil temperatures at the Fargo Experiment Station (Figure 3, page 6) show that these optimum soil temperatures are not reached in the surface soil until the middle of June. If the 60° isotherm is the temperature at which root growth of spring sown small grain crops is slowed considerably, roots may not extend much beyond the 2½-3 foot depth in soil by the time the plant has completed growth.

Since the soil temperatures in the lower depths are sub-optimum for root development, the small grain crop with a rather shallow root system may suffer from drouth during the drier part of the growing season (July and August). Soil water available to the crop is, therefore, limited to that in the top three feet. During periods of high temperature or drying winds, crops may suffer from drouth even though there is good subsoil moisture at the 4 to 5 foot level.

c. Absorption by roots:

Plants absorb water and mineral nutrients through the root hairs. The roots absorb water and nutrient ions by osmosis. The semipermeable mem-

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Figure 7—ROOT SYSTEM

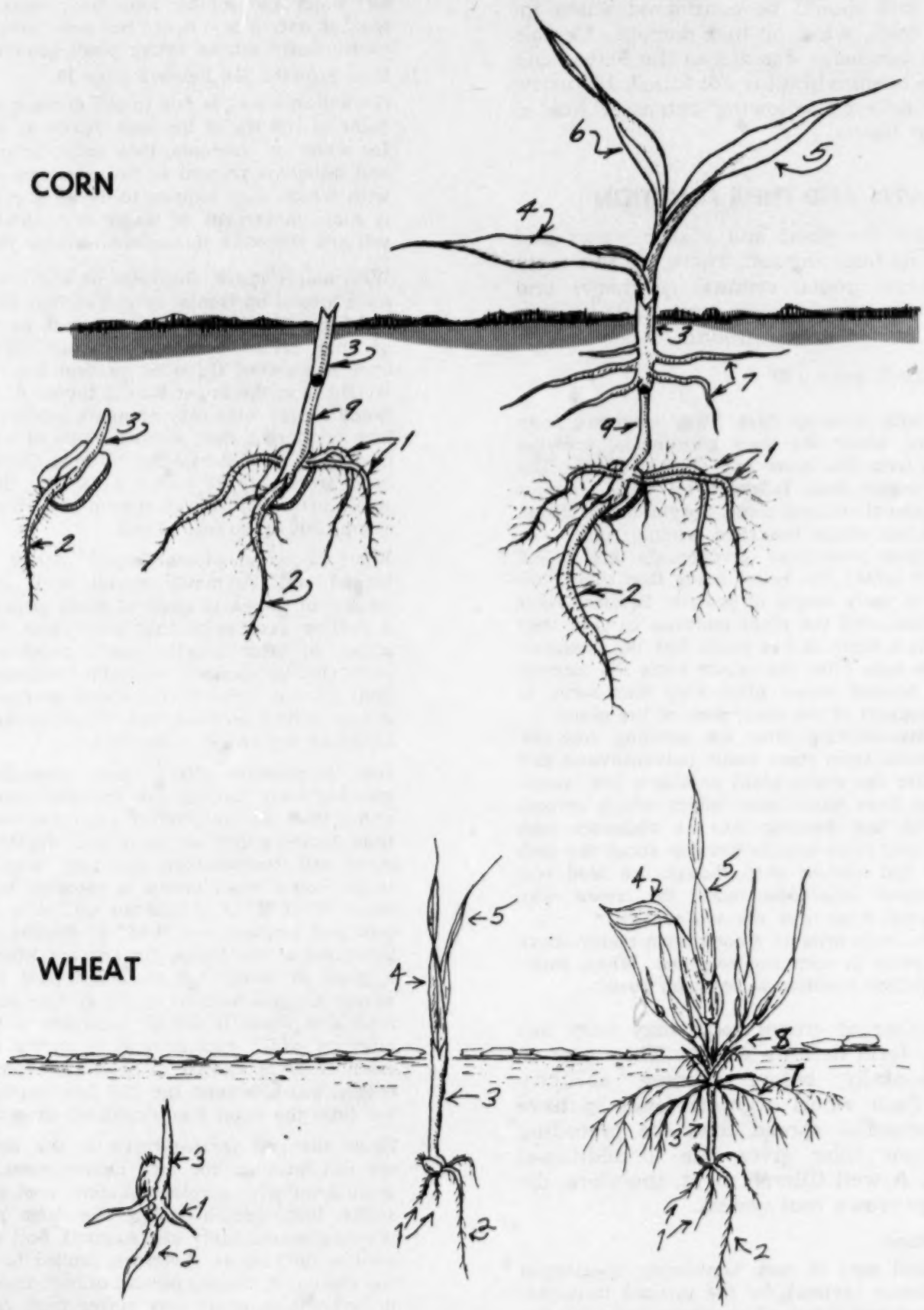

LEGEND:

1. Other Seminal Roots
2. Radicle
3. Coleoptile
4. 1st Foliage Leaf
5. 2nd Foliage Leaf
6. 3rd Foliage Leaf
7. Crown Roots
8. Tiller Branch
9. First Internode

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Figure 8—ROOT GROWTH

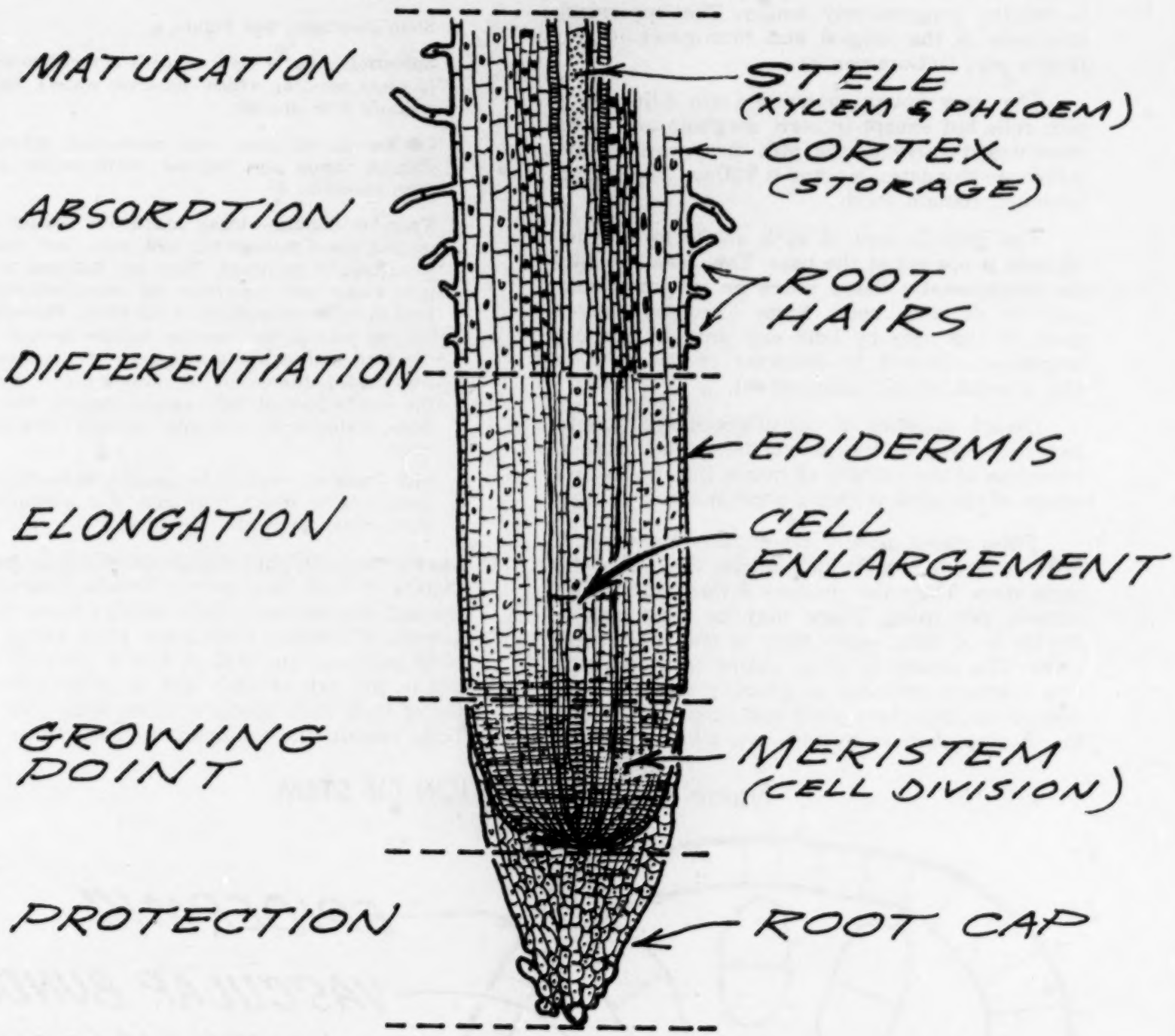

brane of the cell wall is the selective tissue that restricts the free entry or exit of nutrient ions. Water, however, moves freely through this membrane independent of nutrient ion exchange.

The more a plant needs **water** the more rapidly it absorbs available soil water. Water taken up in excess of the ability of the plant to transpire water vapor through the stomata is forced out through pores in the leaf. Wilting occurs when transpiration (water loss) of the plant exceeds water uptake. Wilting may be only temporary if it results from hot, dry winds, or it may be permanent if due to a prolonged drouth or saline soil condition. Temporary wilting is not considered injurious to vegetative crop growth but usually reduces yield and delays maturity.

Nutrients are absorbed as **ions** into root hair cells in response to the metabolic needs of the plant. For instance, potassium nitrate (KNO_3) dissolves and becomes dissociated into K+ (positive) and NO_3— (negative) ions. These ions are transported through the semipermeable membrane independent of water uptake. Thus it is possible for mineral nutrients to be absorbed even when the plant is not actively taking up water. Mineral nutrients may be concentrated in the cell sap at concentrations far above that in the external soil solution.

B. **Stems** (culms) hold the leaves up to sunlight and air. Cereals have a single main culm and tillers each divided into a series of **nodes** (joints) and **internodes.** At first the internodes are very short but later each elongates, the length depending upon

its position and the species. The basal stem internodes are short while the upper internodes tend to become progressively longer. The uppermost internode is the longest and terminates in the flower part (inflorescence).

The very young internodes are filled with pith cells but except in corn, sorghum and solid stem wheat varieties the pith disappears as the internode elongates, leaving it hollow. The nodes, however, remain solid.

The growth area of each above ground internode is always at the base. This area contains the meristematic tissue made up of young and actively dividing cells. Stem elongation takes place in this area by both cell division and enlargement. Growth in diameter of the stem is also a result of cell enlargement.

Dwarf varieties of cereal crops are due to less elongation of the internodes, rather than a reduction of the number of nodes, internodes and leaves of the stem within a given maturity range.

Tiller stems usually are slightly shorter and produce shorter spikes or panicles than does the main stem. They also produce fewer and smaller kernels per spike. There may be more sterile florets in a tiller spike than in the main stem spike. The ability of small grains to produce or lose tillers in response to growing season conditions is an important yield and crop quality factor. A crop such as hybrid corn which does not tiller must be planted thicker to increase stand per acre.

a. Stem structure: See Figure 9.

Epidermis—single layer of cells covered with cutin (a waxy covering which conserves water). The stem contains few stomata.

Cortex—parenchyma cells containing chloroplasts. Fibrous tissue plus tubular configuration provide stem strength.

Vascular bundles—these conductive tissues extend up and down through the root, stem, leaf and other structures of the plant. They are designed to transport water, raw materials and manufactured plant food to different sections of the plant. **Phloem** is the outside part of the vascular bundle through which the food materials manufactured in the leaves are transported downward to storage areas. **Xylem** is the inside part of the vascular bundle that transports water and nutrients upward through the plant.

Pith—may or may not be present. Solid stems may contribute to insect resistance. For example, solid stem wheat for sawfly resistance.

C. **Leaves** carry on photosynthesis, which is the manfacture of food from raw materials secured from the soil and air using light energy from the sun. Leaves of cereals arise from stem nodes. Each node produces one leaf. A bud is generally present in the axil of each leaf. In small grains the lower buds may produce tillers while the upper buds remain undeveloped. In corn these upper

Figure 9—CROSS SECTION OF STEM

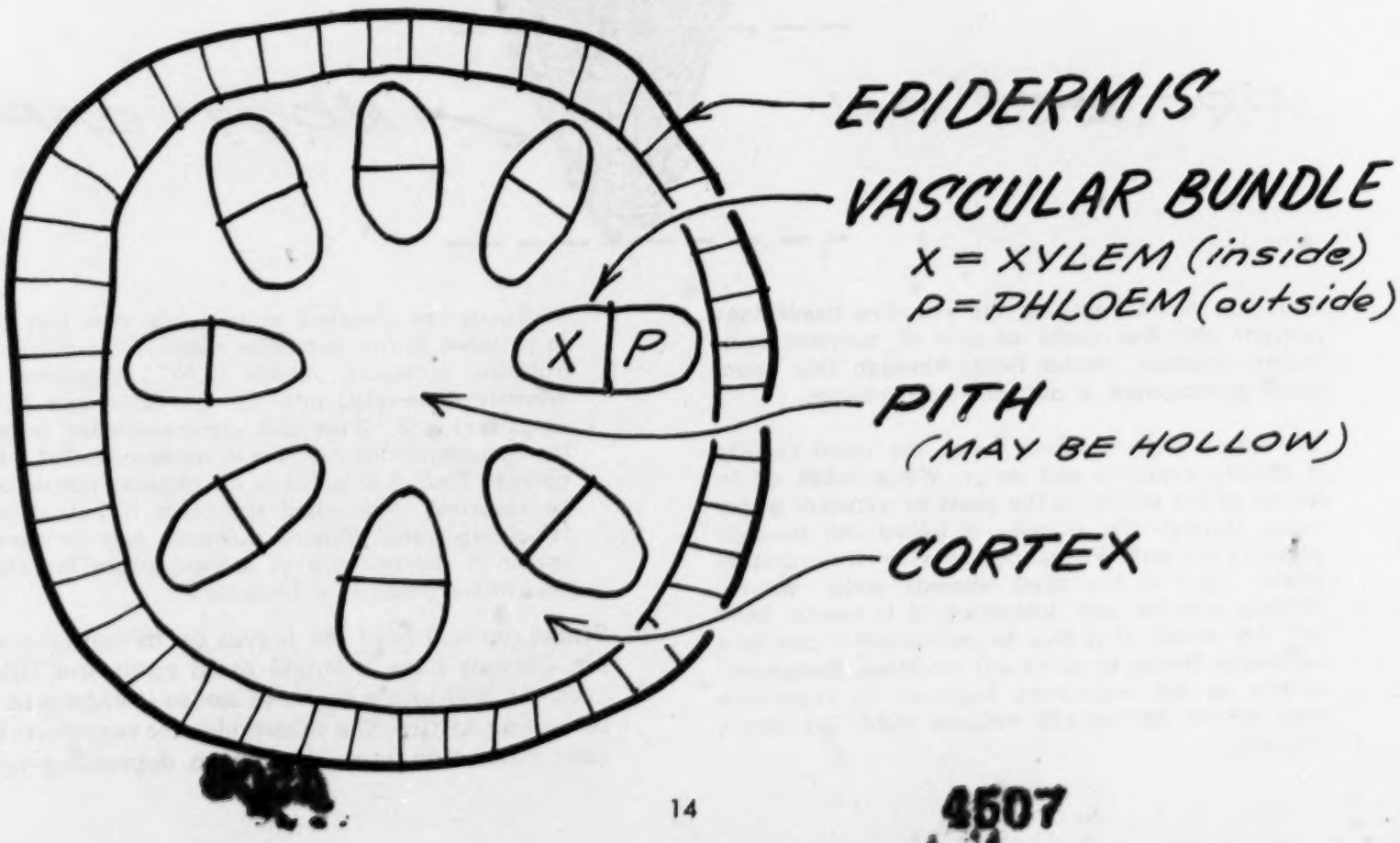

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buds develop into ear shoots. Leaves are arranged in rows on opposite sides of the stem.

The foliage leaf is in two parts, the **sheath** which is wrapped around the stem and the **blade.** Thickened tissue at the junction of the sheath and blade is known as the **collar.** At the base of this junction but on the inner margin of the sheath there occurs a thin membrane outgrowth known as the **ligule.** The ligule is generally regarded as a protective structure preventing rain, dust, insects, etc., from entering and accumulating within the sheath. At the base of the leaf blade there may be appendages called **auricles** which may vary in length and may be partly wrapped around the stem. The shape and size of the ligule and the auricle are often of value in crop identification. See Figure 10, page 16.

The **flag leaf** is the uppermost foliage leaf on small grains. The lower plant leaves die first due to shading, drouth, disease or normal maturity. The flag leaf is the last to remain green and accounts for about 80 per cent of the filling of the grain crop.

a. Leaf structure: See Figure 11, page 16.

Cuticle—is composed of cutin which covers the epidermis and prevents excessive water loss.

Epidermis—a single cell layer containing **many** stomata, especially the underside.

Parenchyma—specialized cells containing chloroplasts separated by extensive air spaces.

Veins—contain the xylem and phloem through which raw materials (water and solutes) are supplied and the products of photosynthesis are translocated.

Stomata—openings in the epidermis with guard cells which control air exchange rate and transpiration in response to light, water uptake and photosynthesis activity.

IX. TRANSPIRATION

Transpiration is the evaporation of water from within the aerial parts of plants, especially the leaves. Often over 99 per cent of the water absorbed by plants is transpired, but a plant is unable to grow unless it has sufficient water. Most of the water that evaporates from the leaves passes out into the air through the stomata, but a small amount of water vapor diffuses through the epidermal cell layers. Liquid water changes to vapor in the transpiration process.

Light, temperature, humidity, wind velocity and soil moisture conditions influence the rate of transpiration in plants. The stomata open in response to light, therefore transpiration is greater in the day time than at night. High temperatures, low humidity and wind movement increase transpiration. When soil water is readily absorbed, the transpiration rate is higher than when soil water is limited and absorbed with difficulty. Cereal plant modifications that reduce excessive evaporation are decreased leaf surfaces, thickened cuticle, and waxy bloom on the cuticle of leaves and stems. A waxy bloom is conspicuous on sorghum, wheat and barley.

The ratio of the total water absorbed to the total amount of dry matter produced by the plant is termed the "water requirement" or "transpiration ratio". It is usually expressed as the number of pounds of water required to produce one pound of dry matter. The mean water requirements of cereals investigated at Akron, Colorado were as follows: oats 635, barley 521, wheat 505, corn 372, millet 287, and sorghum 271 per pound of dry matter. All of these water requirements were based upon the total dry matter in the plants above. The water requirement is not necessarily a measure of the drouth resistance of a crop.

A more practical measure of the water requirement for crops is "consumptive use" which includes evaporation from the soil surface as well as transpiration through the plant. This is frequently referred to as "evapotranspiration". The "drouth resistance" of crops depends on (1) drouth evasion, i.e., ability to complete maturity before soil moisture is depleted, e.g., early maturing small grains. (2) drouth tolerance, i.e., the ability of a plant to go dormant during a drouth and to recover later when soil moisture becomes available, e.g., sorghum. (3) ability of a plant to adjust its growth and development to the available moisture supply, i.e., initiation or loss of tillers and the loss of lower leaves when moisture is limiting, e.g., small grains.

X. PHOTOSYNTHESIS

The manufacture of food substances from carbon dioxide, water and nutrient elements in the presence of light and cholorophyll in living green plant tissue is photosynthesis. The green plant differs from most organisms since it has the ability to reduce atmospheric carbon dioxide to carbohydrate via radiant energy and chlorophyll.

When light of appropriate wave lengths is absorbed by chlorophyll, carbon dioxide and water are converted to sugar and oxygen is realeased. The process is exactly the reverse of that accomplished by respiration. Using the formula $[CH_2O]$ to designate the basic unit of a carbohydrate molecule (six of these would produce $C_6H_{12}O_6$, or glucose), then the empirical equation may be written as:

$$\underset{\textit{carbon dioxide}}{CO_2} + \underset{\textit{water}}{H_2O} \xrightarrow[\textit{(chlorophyll)}]{\text{Light}} [CH_2O] + \underset{\textit{oxygen}}{O_2}$$

This equation gives the impression that the oxygen is coming from the CO_2 molecule. Scientists used radioactive isotopes to prove that the oxygen

Figure 10—EXTERNAL LEAF STRUCTURE

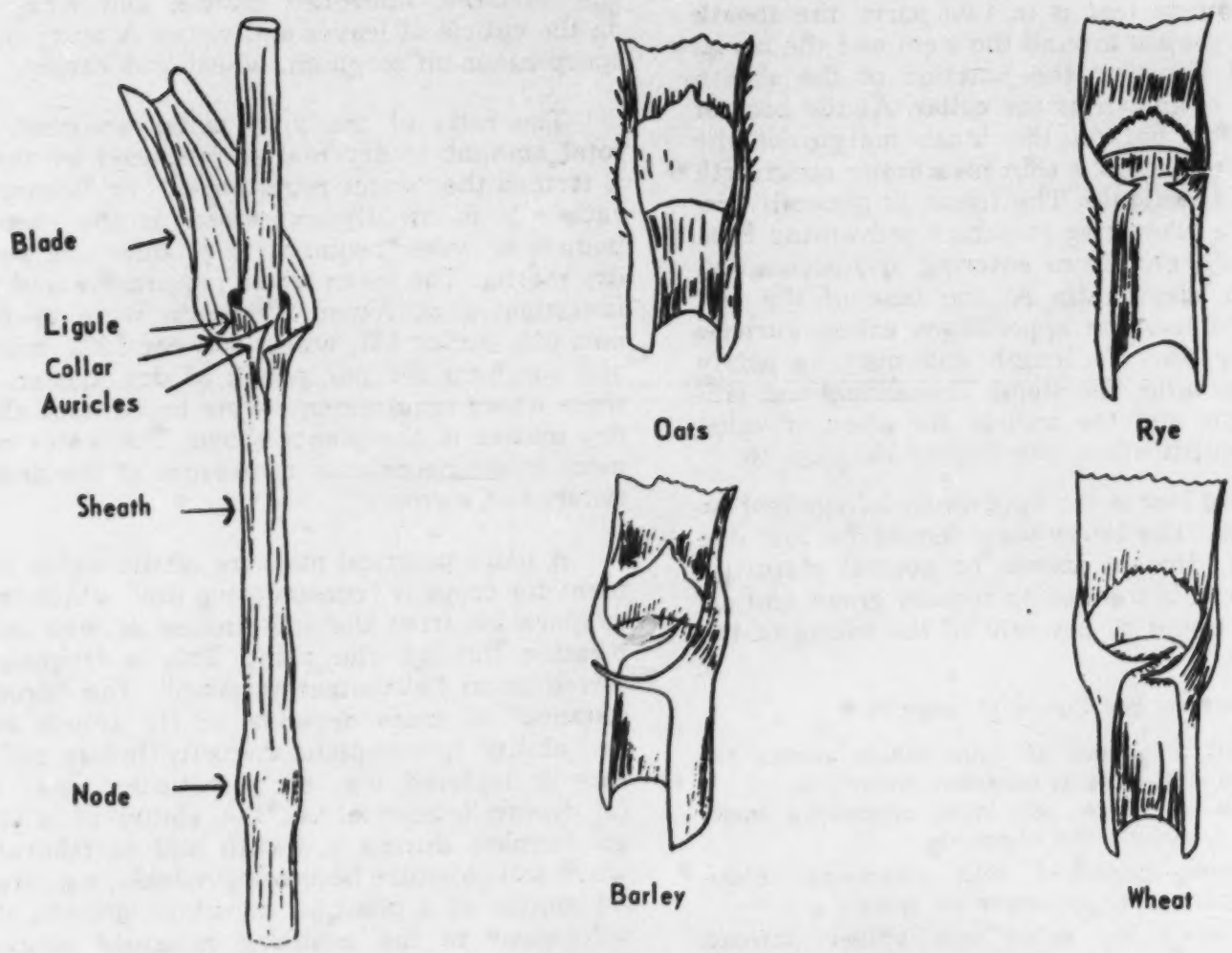

Figure 11—INTERNAL LEAF STRUCTURE

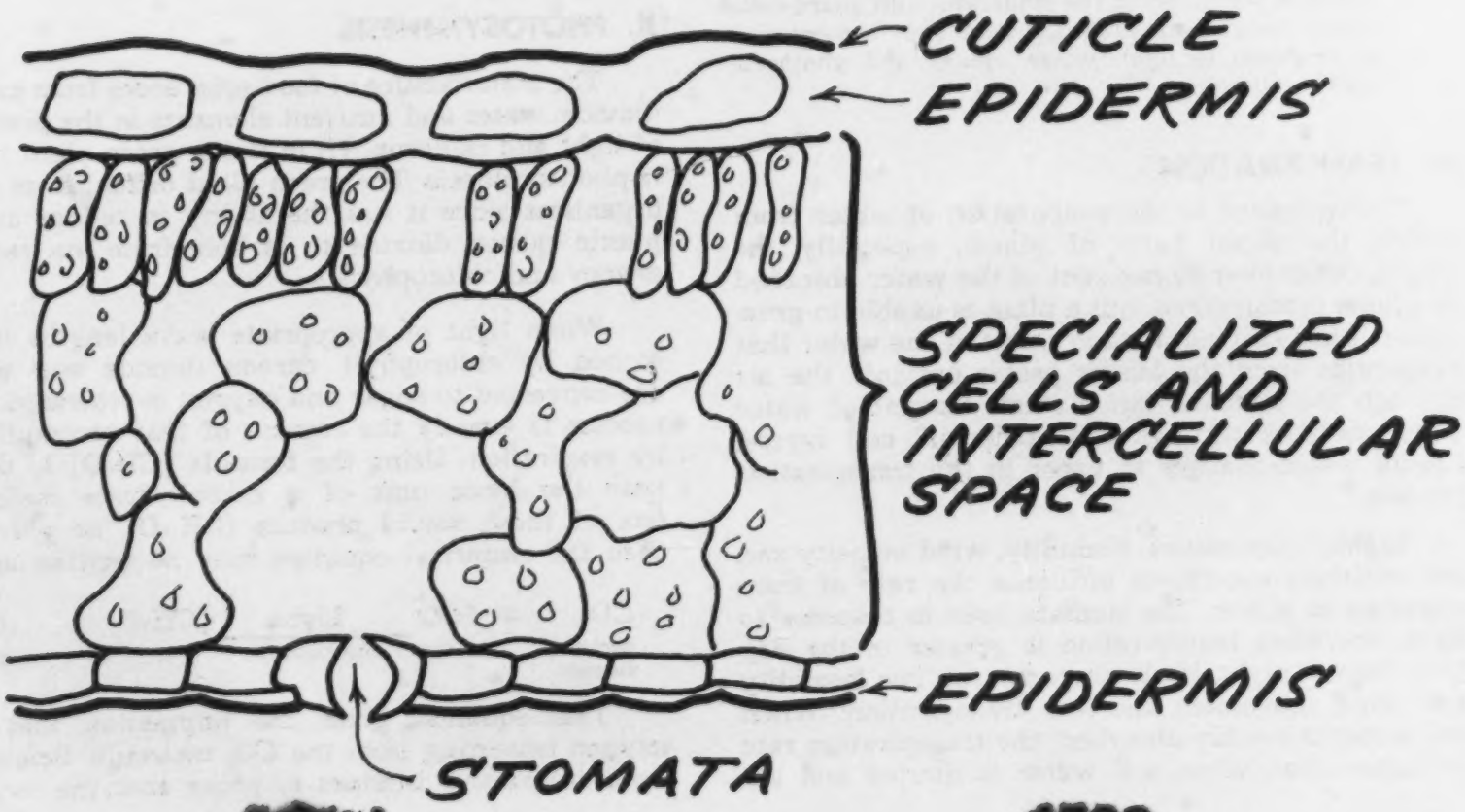

really came from the splitting of the water molecule by light in the presence of chlorophyll. This is the key to the entire process of photosynthesis for it represents a point at which light energy does chemical work. Since two atoms of oxygen (O_2) are produced in the above equation, and each water molecule (H_2O) contains only one atom of oxygen, at least two water molecules must enter into the reaction. Hence:

$$CO_2 + 2H_2O \xrightarrow[\text{(chlorophyll)}]{\text{Light}} [CH_2O] + O_2 + H_2O$$

Figure 12–PHOTOSYNTHESIS

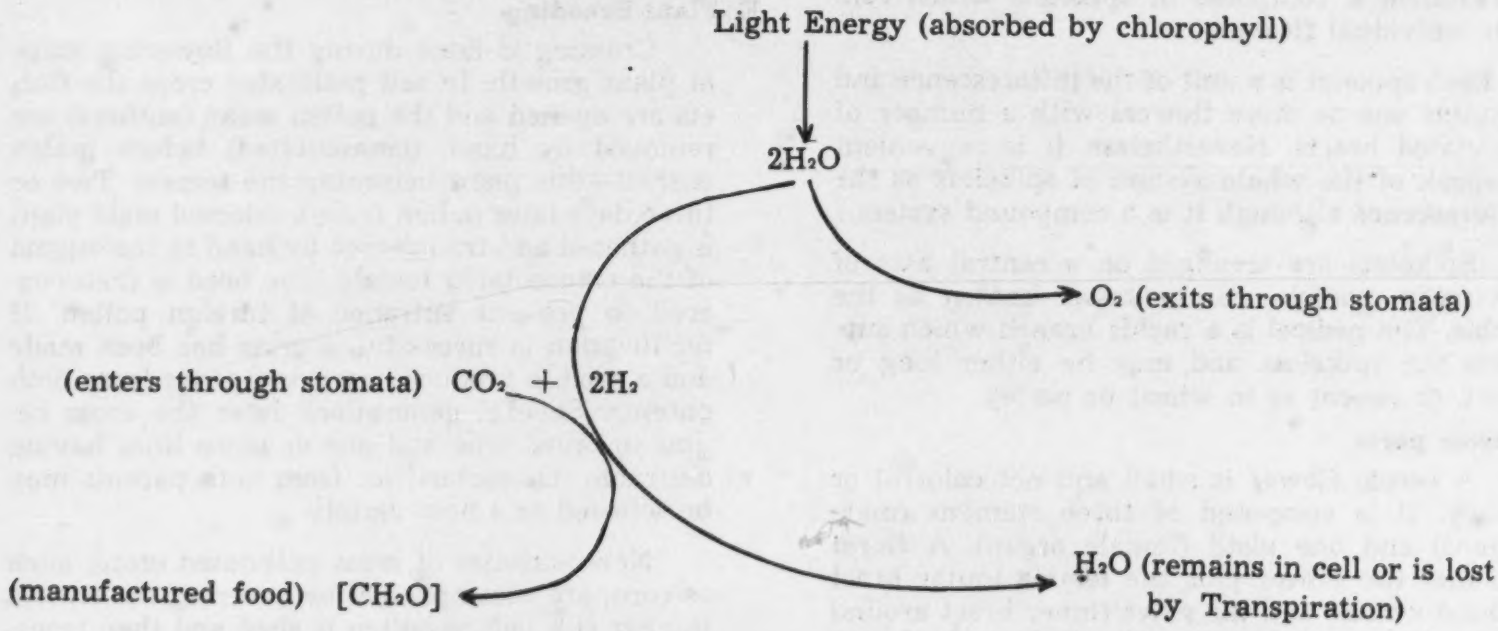

The completed balanced equation for photosynthesisis:

$$\underset{\text{carbon dioxide}}{6CO_2} + \underset{\text{water}}{12H_2O} \xrightarrow[\text{(chlorophyll)}]{\text{Light}} \underset{\text{sugar}}{C_6H_{12}O_6} + \underset{\text{water}}{6H_2O} + \underset{\text{oxygen}}{6O_2}$$

The CO_2 enters the plant through the stomata in the leaf surface. The plant gives up water vapor during transpiration in exchange for fresh dry air containing CO_2. Air contains only 300 ppm carbon dioxide. Hence, in a rapidly growing field with adequate light, CO_2 may become a limiting factor in photosynthesis. The leaf is an ideal photosynthetic factory since it is well supplied with loosely packed cells containing chlorophyll, and veins which provide water and minerals via the xylem and remove sugar via the phloem. The veins branch so profusely that no leaf cell is more than 1 or 2 cells away from a vein.

The stomata are key structures in the plant's control over water loss and the entrance of CO_2. They open in response to light and adequate water supplies and close in dark or drouth. Stomatal closure effectively reduces photosynthesis by impeding the intake of carbon dioxide. Once the CO_2 molecule has entered through the stomatal barrier, it moves into an air chamber with connecting air passages to all parts of the leaf. When CO_2 reaches the wet surface of a cell, it dissolves in the water and becomes available for photosynthesis.

The oxygen released during photosynthesis is liberated to the atmosphere through the stomata. Closure of the stomata also will prevent this gaseous exchange and the oxygen probably would be reabsorbed in respiration, which produces CO_2 that could in turn be used in photosynthesis. Photosynthesis can proceed at 10 to 20 times the maximum rate of respiration but is limited to approximate equalibrium with respiration with stomatal closure. Hence, under stomatal closure the plant is maintained, but doesn't grow.

The water required for photosynthesis is absorbed into the roots and transported via the xylem tissue in the veins to a green cell. Once in the leaf tissue the water moves from cell to cell on diffusion gradients and most is lost by transpiration.

The sugar produced by photosynthesis accumulates rapidly in the green cells and is translocated to other parts mainly as sugar. Most of the sugar is then converted to starch and proteins and deposited in storage tissues of the plant. The stem, roots and seed generally serve as the storage tissues. This stored plant food is available for future plant growth or reproduction by release of energy through the process of respiration.

XI. REPRODUCTION

A. **Inflorescence.** See Figure 13, page 19.

Seed is produced on a spike (wheat, barley and rye), a panicle (oats, sorghum, rice and grain millet), and on a compound spike called an ear (corn). In small grains the entire seed head is known as the inflorescence. In corn the comparable in florescence is the ear. In cereals the inflorescence is composed of spikelets which contain individual flowers.

Each spikelet is a unit of the inflorescence and contains one or more flowers with a number of associated bracts. Nevertheless, it is convenient to speak of the whole system of spikelets as the inflorescence although it is a compound system.

Spikelets are arranged on a central axis of the spike, panicle, ear or tassel known as the **rachis.** The **pedicel** is a rachis branch which supports the spikelets and may be either long or short, or absent as in wheat or barley.

B. **Flower parts**

A cereal **flower** is small and not colorful or showy. It is composed of three stamens (male organs) and one pistil (female organ). A **floret** includes the flower plus the **lemma** (outer bract around kernel) and the **palea** (inner bract around seed). In awned varieties the lemma tip is extended as an **awn.**

C. **Pollination**

Naturally self-pollinated cereals (wheat, oats and barley) are more than 96% self-pollinated, the amount being dependent upon variety and environment. Pollination takes place before the floret opens and before the anthers emerge.

Often cross pollinated cereals include sorghum and the foxtail and proso millets. In these crops the majority of flowers are normally self-pollinated but several are cross pollinated by pollen from another flower either on the same plant or from another plant. Cross pollination among the cereals is done mostly by airborne pollen. Sorghum s are usually 90 to 95 per cent self-pollinated.

Naturally cross-pollinated cereals include corn and rye. Cross-pollination is essential to seed production in rye because many flowers are self sterile. Corn produces male flowers in the tassel and female flowers on the ear, allowing considable natural crossing.

D. **Fertilization**

The fusion of the pollen sperm with the egg cell in the ovary is called fertilization. After a viable pollen grain falls on the stigma it germinates and grows down the style and enters the ovary. There the male sex cells unite with the egg nuclei to produce a new seed.

Pollen grains are sensitive to high temperature. In self-pollinated crops high temperature may sterilize pollen grains within the floret, resulting in no seed set. Pollen grains also are sensitive to desiccation and therefore hot, dry winds during pollination may cause a poor seed set especially in cross pollinated crops. Drouth or mechanical injury also can sterilize pollen and result in poor seed set.

E. **Plant Breeding**

Crossing is done during the flowering stage of plant growth. In self pollinated crops the florets are opened and the pollen sacks (anthers) are removed by hand, (emasculated) before pollen is shed—this plant becoming the female. Two or three days later pollen from a selected male plant is gathered and transferred by hand to the stigma of the emasculated female. The head is then covered to prevent entrance of foreign pollen. If fertilization is successful, a cross has been made and a seed is produced carrying genes from both parents. Several generations later the cross begins to breed true and one or more lines having desirable characteristics from both parents may be selected as a new variety.

New varieties of cross pollinated crops, such as corn, are accomplished by covering the emerging ear silk before pollen is shed and then transferring pollen by hand from a selected male parent.

Commercial hybrids are produced by first crossing the female with a plant that will make it male sterile (no viable pollen). Planting this male sterile female next to a normal flowering plant with bred-in male restorer induces natural cross pollination and the hybrid seed is harvested from the female rows only. Corn hybrids sometimes are produced by detasseling the female rows before they shed pollen.

XII. THE FUNCTIONING PLANT SYSTEM SUMMARIZED. See Figure 14, page 20

The plant is a coordinated system which is compsed of cells organized into tissues, tissues into organs, and finally the organs functioning as a whole plant. The ultimate objective of all plant growth is reproduction of the species. The various plant organs function in relation to one another.

Four basic plant functions resulting in reproduction are:

Respiration is a continuing process which is required in all living plants. Periods of very slow respiration are called dormancy. A stored seed, for example, is dormant. Seed germination is the resumption of rapid metabolic activity which converts stored organic food to simpler compounds, thereby releasing energy. This process continues throughout the life of the plant. This

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Figure 13—STRUCTURE OF FLORET AND SPIKELET

Spikelet

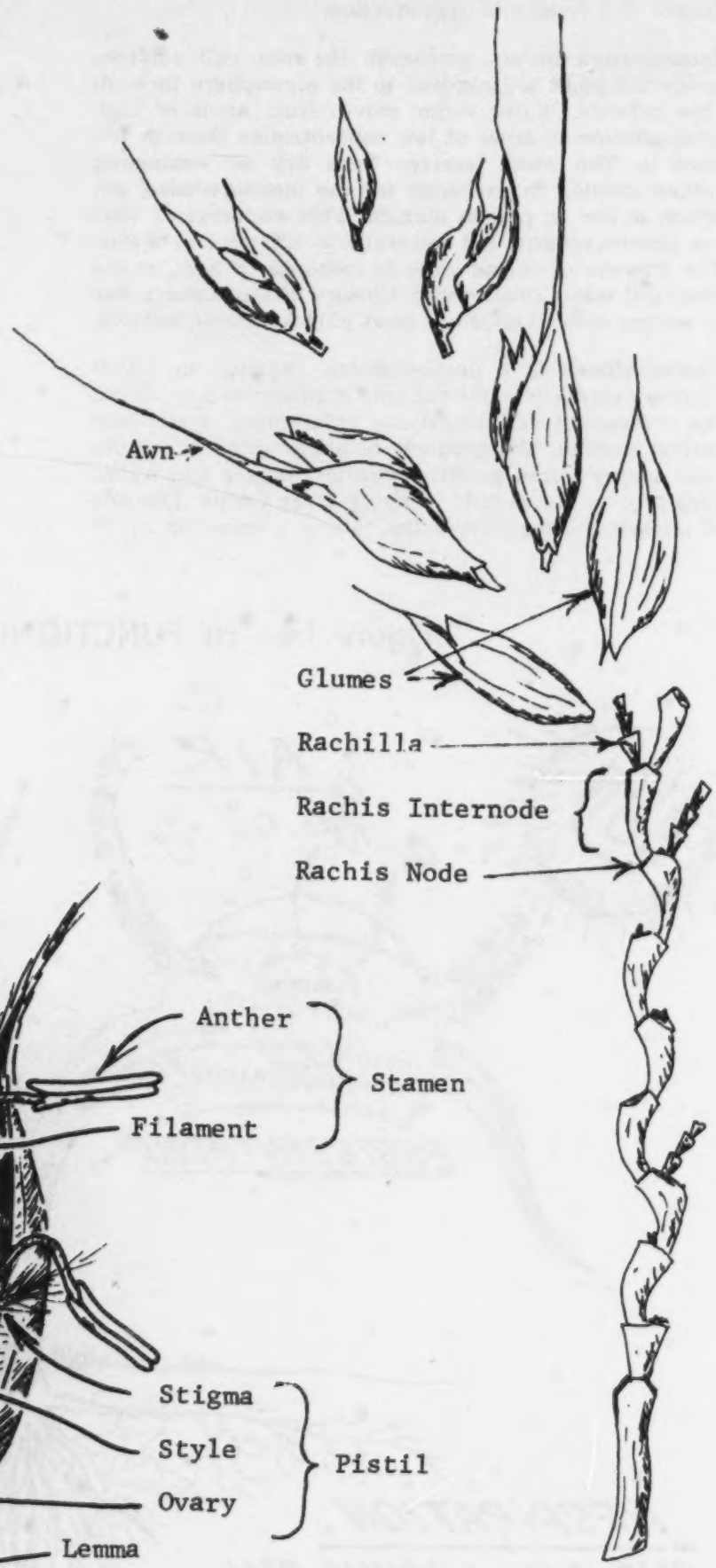

Rachis

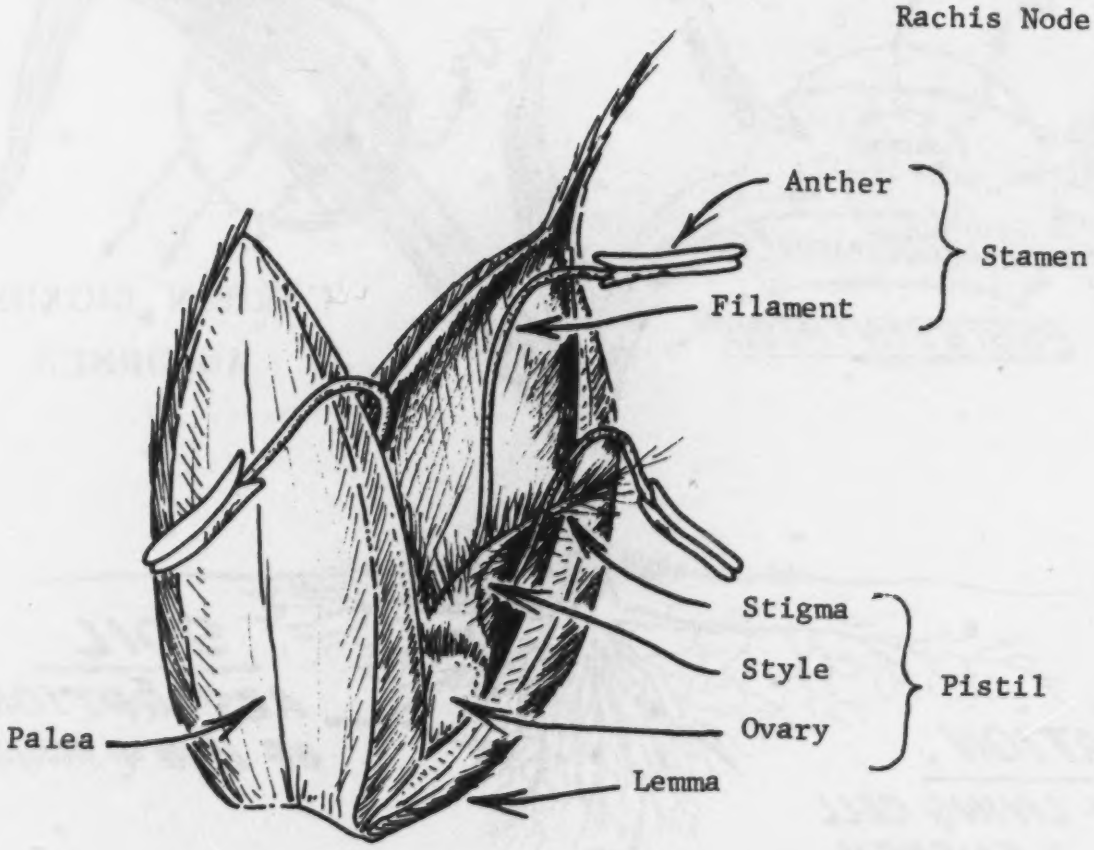

Floret

energy is chemical in nature and is used throughout the plant, particularly in the meristems, in nutrient uptake and finally in reproduction.

Transpiration occurs whenever the wet cell surfaces inside the plant are exposed to the atmosphere through the stomata. Water vapor moves from areas of high concentration to areas of low concentration through the stomata. The plant receives fresh dry air containing carbon dioxide in exchange for the moisture-laden air, which is low in carbon dioxide. This exchange is vital to photosynthesis, but generally is wasteful of water. The stomata open and close in response to light or the plant-soil water relationship. Closure of the stomata due to wilting effectively stops most photosynthetic activity.

Photosynthesis is a photo-chemical reaction in which light energy is transformed into chemical energy within the chloroplast cell containing chlorophyll, water and carbon dioxide. The products of photosynthetic activity are energy stored as carbohydrates, oxygen and water. This process occurs only in living green plants. The rate of photosynthesis exceeds the rate of respiration by 10 to 20 times and results in a net dry weight gain of the plant. Every cell, tissue and organ in the plant is directly related to the photosynthetic activity including manufacture, transportation or storage.

Absorption involves the very specialized root hair cells and the cytoplasmic semi-permeable membrance inside the root hairs. The rapid absorption of water and certain nutrient ions is important to proper plant growth and development. Water moves freely into or out of the root hairs in response to solution concentration gradients from regions of high water concentration to regions of low water concentration. Nutrients are absorbed as ions. The plant is selective in nutrient ion uptake and must expend energy in the uptake and transport of these nutrient ions. It can take up ions without absorbing water. Absorption involves both underground and above ground plant parts. The chlorophyll in green plant cells absorbs light rays from the sun, supplying the energy needed for photosynthesis. Carbon dioxide (CO_2) an essential element in photosynthesis, is taken in through the stomata as a gas and is absorbed by wet cell surfaces within the leaf.

Figure 14—THE FUNCTIONING PLANT SYSTEM

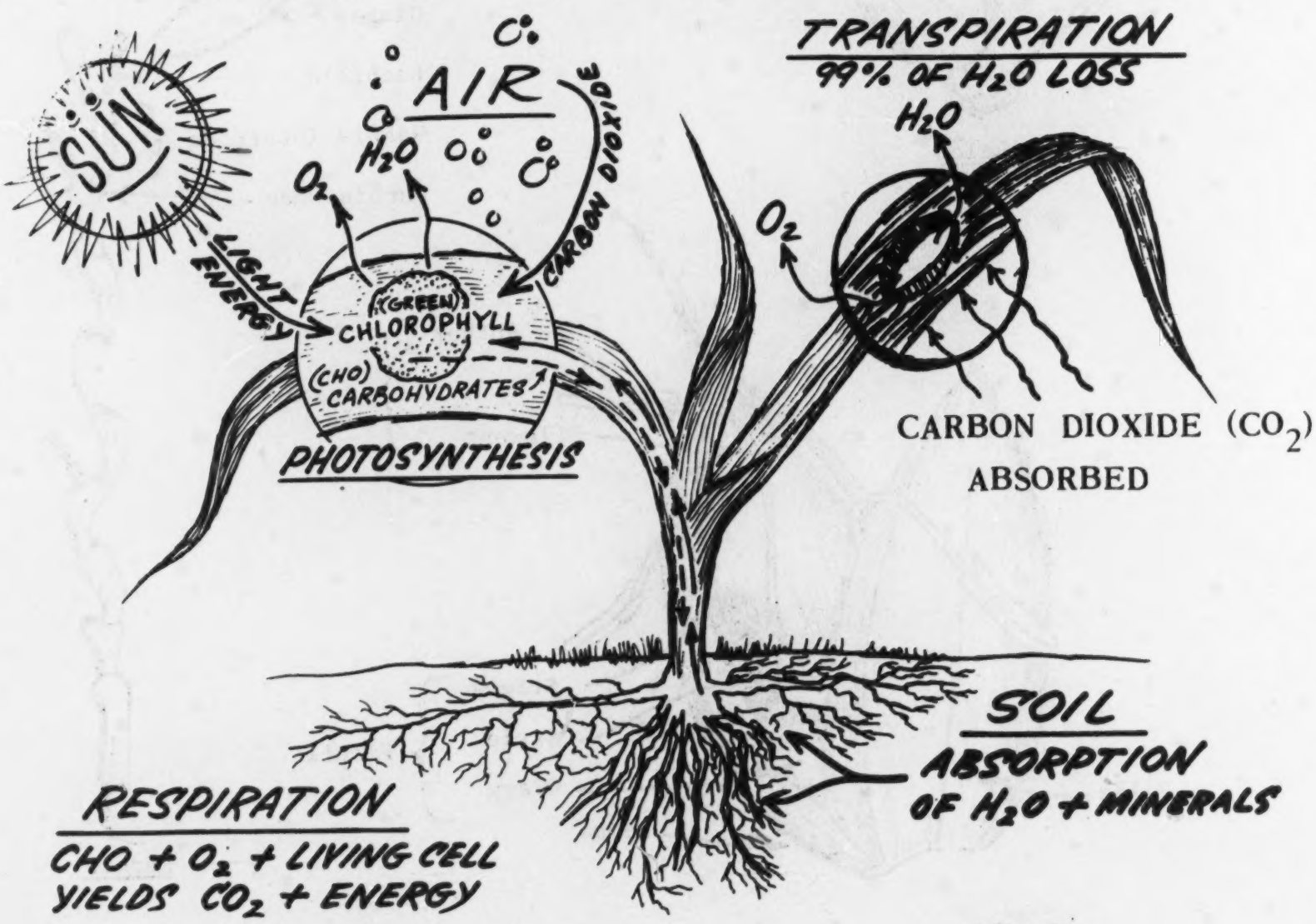

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Section B–SPECIFIC CROP PRODUCTION ITEMS

Growth processes in cereals—the length of the vegetative period of any cereal is determined largely by the temperature, photoperiod, plant nutrition growth hormones, and genetic factors that affect reactions to these conditions. Each cereal species has an approximate minimum, optimum, and maximum temperature at which growth occurs, although varieties within a species may differ. When the average temperature is 18°F below the optimum, the time required to grow a crop to maturity is approximately doubled. Temperature largely determines the length of time a cereal plant takes to reach flowering and to mature after the floral structure has been formed.

The **long day** cereals—wheat, oats, barley and rye —flower earlier when nights are short and days long. The **short day** cereals—corn, sorghum, rice and millet —flower earlier when the nights are long and days short.

A soil rich in nitrogen will keep down the carbon nitrogen ratio (normally 10 or 11 to 1) and delay flowering in the **nitro-negative cereals**—wheat, barley, oats and rye. Excessive nitrogen prolongs vegetative growth in these crops. The **nitro-positive** cereals—corn, sorghum, rice and millets—flower earlier in a soil well supplied with nitrogen unless it is very excessive. Ample phosphorus and potassium often promote earlier flowering. Moisture shortage may cause small grain plants to flower abnormally early, often observed in a dry season, but a moisture deficiency may simply force sorghum plants into dormancy until soil moisture becomes available.

The cereals may be grouped on the basis of certain botanical characteristics as follows:

a. Cool season, long day, nitro-negative, winter or spring habit plants; wheat, oats, barley and rye.
b. Warm season, short day, nitro-positive, spring habit plants; rice, corn, sorghum and millets.

High temperatures reduce small grain yields. High temperatures during the growing season influence final yield, as is well illustrated in Figure 15. This chart shows the relationship of the number of days temperatures reached 90°F. or above during June and July at the four main weather stations and the final state average yield of wheat in North Dakota. Ninety degree temperatures or perhaps a few degrees lower reduce final wheat yields even under favorable soil moisture conditions.

Small grain seedlings may sometimes show sun scald resulting from high soil line temperatures on bright sunny spring days. A light colored line appears across the leaves. This burn occurred when that part of the seedling was at the soil line. This may delay

Figure 15–EFFECT OF 90° F. DAYS ON SPRING WHEAT YIELDS 1958-1965

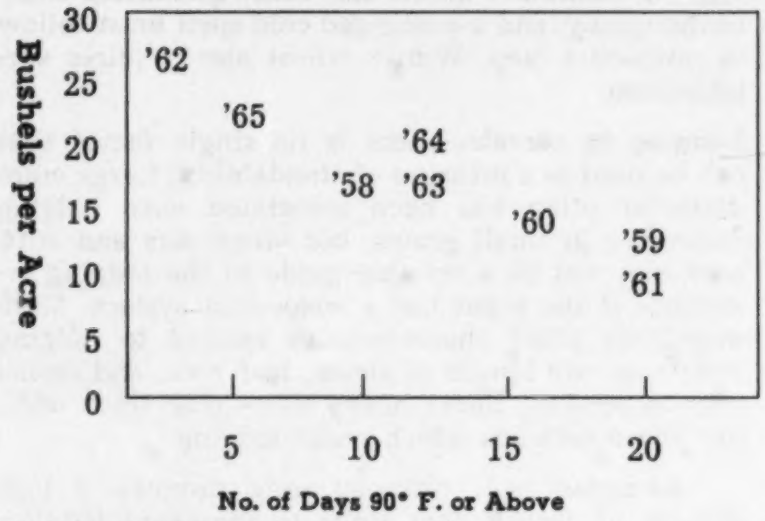

Source: Federal Crop Reporting Service

maturity slightly but has not injured the growing point.

Growing days required—the number of growing days required to reach maturity by each kind of spring sown cereal crop grown in North Dakota will vary depending on (1) variety, (2) date of seeding, (3) temperature, (4) moisture and (5) fertility conditions. High temperatures and drouth tend to force early heading. Drouth may be only severe enough to cause a plant to slow its normal rate of development. Ample rain following such a drouth stress period may hasten heading or maturity. Seeding too late may force the crop into the short days and cooler temperatures of early fall, thus delaying maturity of day length sensitive crops. The following table gives the approximate number of growing days for each crop.

Table 2. APPROXIMATE NUMBER GROWING DAYS FOR NORTH DAKOTA SPRING SOWN CEREAL CROPS

	Emergence to Heading Days	Heading to Ripe Days	Total Emergence to Ripe Days
Barley	38 - 46	32 - 38	70 - 74
Oats	36 - 46	38 - 43	75 - 86
HRS Wheat	42 - 49	35 - 42	83 - 88
Durum Wheat	45 - 52	38 - 42	84 - 94
Millet	30 - 35	30 - 35	60 - 70
Corn	50 - 60	50 - 64	90 -120

Source: N. Dak. Experiment Station. Unpublished Agronomy Dept. Field Notes.

Winter hardiness of fall sown crops—Rye is the most winter hardy crop, followed in order by winter wheat, winter barley and winter oats.

Vernalization changes a plant from winter to spring habit of growth. Winter rye sown in the spring fails to produce heads unless the sprouting seed or the

young plant is subjected to freezing or near freezing temperatures for a two or three week period. Rye may sprout in the fall but not emerge until spring and produce a satisfactory crop. Rye which fails to germinate in the fall must germinate early in the spring, and a prolonged cold spell must follow to produce a crop. Winter wheat also requires vernalization.

Lodging in cereals—there is no single factor that can be used as a measure of standability. Large culm diameter often has been associated with lodging resistance in small grains, but straw size and stiffness may not be a reliable guide to the lodging resistance if the plant has a weak root system. More important plant characteristics related to lodging resistance are length of straw, leaf area, and resistance to bending. Short, heavy stems with thick walls are characteristics which resist lodging.

Abundant soil nitrogen may produce a lush growth of cereals that leads to increased lodging. Lodging usually has been decreased in small grains by applications of phosphorus and potash on deficient soils because these nutrients promote root development. Thick stands keep much of the sunlight from reaching the base of the stems and shade causes the cell walls of the stems to be thin and weak.

When a cereal stem lodges before maturity it usually straightens up. The nodes contain a gravity sensitive hormone which induces cell growth on the lower side, causing the plant to become erect again.

The chief external factors responsible for lodging are:

1. Shading—causing weak straw.
2. Unbalanced nutrition—heavy applications of nitrogen and excess of water may stimulate lodging. Lack of potassium induces weakness in the mechanical tissues.
3. Temperature—warm temperatures can promote lush weak vegetative growth.
4. Disease—several fungus diseases may directly induce stem weakness.

Tillering—varieties of small grain vary in their tendency to tiller. The extent of tillering for any one variety is influenced by environmental factors such as **moisture, soil fertility, temperature** and **sunlight.** Seeding too thick, using small seed and seeding too deep will decrease the amount of tillering. Barley tends to tiller the most, followed by hard red spring wheat, durum wheat and oats in that order.

Leaf stages—counting leaf stages in small grains is important in determining safe crop stages for herbicidal applications. The leaf number refers only to those leaves which are fully expanded and those on the main shoot. It does not refer to tillers or leaves on tillers. A leaf is considered fully expanded when the tip of the next leaf is just visible. See figure 16.

Figure 16—FOLIAGE LEAF AND BOOT STAGES

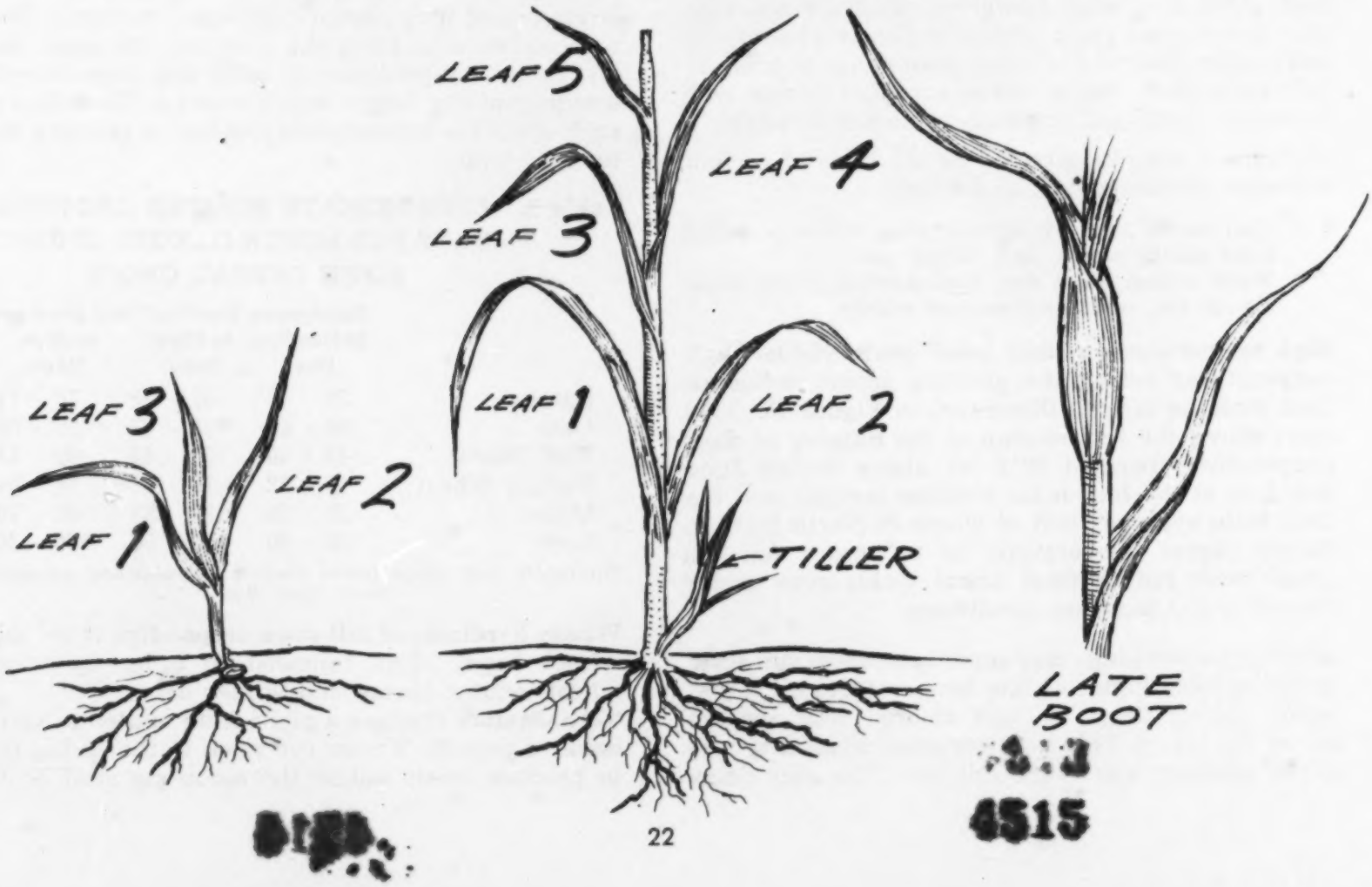

Salt tolerance—decreasing order of cereal crop salt tolerance from most to least tolerant.

Barley
Rye
Oats
Wheat (HRS)
Wheat (Durum)
Sorghum
Corn-poor
Flax

Roots of cereal plants will not grow into waterlogged soils. Adequate soil moisture near the surface in the early stages of crop growth promotes a shallow root system. The crop may suffer later from drouth even though subsoil moisture seems adequate.

Plant roots will not extend through a dry soil zone to reach moisture that may be available in deeper subsoil. Roots don't "search out" moisture or nutrients. They only intercept those with which they come in contact. There is some movement of soil moisture and nutrient ions towards actively absorbing root parts.

Ratio of grain to straw—the ratio will vary with such factors as variety, rate of planting and productivity of soil. As a rule of thumb, however, the following ratios prevail.

Barley,	1 pound of grain to	1	of straw;	1 T straw	= 41.7 bu.
Wheat,	1 pound of grain to	1½	of straw;	1 T straw	= 33.3 bu.
Oats,	1 pound of grain to	2	of straw;	1 T straw	= 62.5 bu.
Rye,	1 pound of grain to	2	of straw;	1 T straw	= 35.7 bu.
Corn,	1 pound of grain to	1	of stover;	1 T stover	= 35.7 bu.

Amount of N, P_2O_5 and K_2O used. Wheat, oats, barley and flax requirements are calculated from data in N. Dak. Agr. Exp. Sta. Bulletin 378 and corn is estimated from several other sources. These figures give a good indication of the nutrients required for the indicated levels of production under North Dakota conditions.

Table 3. MAJOR NUTRIENT USAGE

Crop		Yield	N	Pounds P_2O_5	K_2O
Wheat	(grain)	20 bu.	36	11	7
	(straw)	1800 lbs.	13	3	41
Oats	(grain)	40 bu.	33	10	6
	(straw)	2560 lbs.	22	6	82
Barley	(grain)	30 bu.	35	12	10
	(straw)	1440 lbs.	15	5	44
Flax	(grain)	10 bu.	25	6	5
	(straw)	1120 lbs.	10	3	23
Corn	(grain)	50 bu.	46	18	12
	(stover)	2800 lbs.	27	8	35

Fertilized Wheat Uses Moisture Efficiently—crops produced under adequate fertility levels make more efficient use of available moisture stored in the soil and received through the growing season. Fertilizer application at recommended levels is, therefore, beneficial even in dry years. Table 4 shows a summary of many trials conducted on wheat by the Soils Department at NDSU.

Table 4 EFFECT OF MOISTURE SUPPLY ON WHEAT YIELDS IN NORTH DAKOTA UNDER INADEQUATE AND ADEQUATE SOIL FERTILITY LEVELS.

Moisture supply* Range	Average	Unfertilized Yield Range	Average	Fertilized Yield Range	Average
inches		pounds per acre			
5.6- 7.3	6.4	618-1,254	936	822-1,926	1,272
7.9- 8.8	8.4	246-1,608	1,050	366-1,956	1,290
9.0- 9.9	9.5	858-2,100	1,242	1,140-3,018	1,776
10.1-10.9	10.5	588-2,346	1,356	1,020-2,802	1,776
11.3-12.5	12.0	600-2,352	1,518	894-2,946	2,106
12.6-13.5	12.9	414-2,106	1,602	792-2,856	2,136
13.7-14.8	14.1	732-2,814	1,728	954-3,402	2,340
15.0-16.2	15.8	690-3,006	1,782	1,188-3,276	2,346
16.5-17.8	17.1	498-2,340	1,590	1,668-3,282	2,202
18.7-22.9	20.1	1,158-2,922	1,746	1,902-3,510	2,448

*Sum of growing season precipitation and stored available soil water at seeding to 4 feet or to a zone of dry soil occurring within the 4-foot depth.

Source: Crops and Soils Magazine, April-May, 1967.

The yield triangle—total yield per acre is the combined effect of (1) weight per kernel (2) number of kernels per head and (3) number of heads per acre as represented in Figure 17. Any crop production factor which limits the maximum contribution of any one or more of the yield triangle sides results in decreased yield.

Figure 17—THE YIELD TRIANGLE

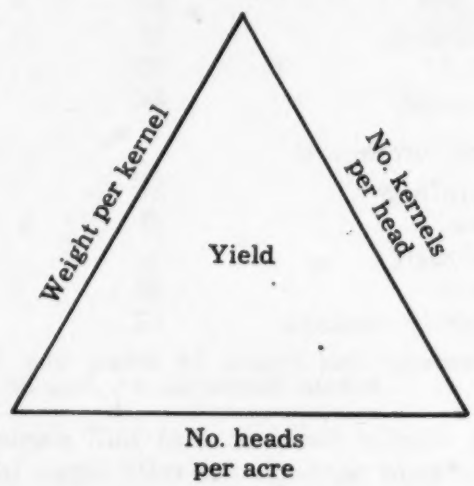

Each crop variety has a genetically determined yield potential; environment determines how closely actual yield approaches genetic potential. It is fairly certain that full yield potential is never achieved, because at some time during the growing season one or more of the environment factors are limiting.

Normal Germination Standards

Table 5 MINIMUM GERMINATION STANDARDS FOR GOOD SEED

HRS wheat	90%	Oats	90%
Durum wheat	85%	Rye	80%
Barley	90%	Corn	90%

Hail damage—effects of defoliation on cereals during active growth reduces the photosynthetic area of the plants and may result in serious yield reduction.

The effect on yield depends largely on the stage of plant development at the time of injury. Experiments with corn have shown that the most serious yield injury results when defoliation occurs at the flowering stage. Earlier defoliation causes less serious yield injury.

Leaf removal was inflicted on oats, barley and wheat in Iowa at weekly intervals from the seedling stage to the hard dough stage of the grain. Cutting off all leaves above the growing point reduced yields about in proportion to the percentage of leaf area removed at each weekly interval. Other experiments have shown that removal of leaf blades also reduces the protein content of grain.

Four trials at the Fargo Station have shown that spring wheat which was beaten fairly severely by hand to simulate hail damage at various stages of growth showed losses as listed in Table 6.

Table 6. YIELD LOSSES FROM SIMULATED HAIL DAMAGE TO SPRING WHEAT AT FARGO

	Per cent Yield Loss	Days Delayed in Maturity
Check—no treatment	0	0
Plants beaten at:		
4 leaf	36	9
jointing	55	12
boot	65	12
headed	84	11
All stems broken at:		
jointing	30	8
boot	41	6
headed	38	4
milk	40	4
nearly mature	12	3

Source: Simulated Hail Injury To Wheat and Flax, North Dakota Report No. 12, July 1964.

These results indicate that hail damage occurring in the boot through the milk stage is the most severe. There was no rain following these treatments such as normally accompanies a hail storm. When estimating field hail loss apply the per cent yield loss from Table 6 only to the percentage of damaged stems in the field.

Recovery may seem to be terrific but final yield is often disappointing because delay in maturity makes the crop more subject to disease, late season drouth and sometimes frost injury.

Fall Frost—early fall frost easily injures **corn** leaves, stopping or restricting photosynthesis. When severe enough it also stops further kernel development, resulting in serious grain yield loss. Table 7 shows effect on germination of fall frost of varying degrees at different corn moisture levels. When germination is injured it can be assumed that further kernel development is stopped.

Table 7. FREEZING TEMPERATURE AND MOISTURE CONTENT AS THEY AFFECT GERMINATION OF MATURING CORN.

Temperature ranges (Degrees F.) Exposure 24 hours. Per cent germination

Per cent moisture in corn kernels	0° - -5°	8° - 4°	16° - 12°	24° - 20°	32° - 28°
10 - 15	97	100			
15 - 20	63	98	100	100	
20 - 25	0	47	88	96	100
25 - 30	0	7	34	77	85
30 - 35	0	0	12	67	75
35 - 40	0	0	0	13	71
40 - 45	0	0	0	12	69
50 - 55	0	0	0	6	33
55 - 60	0	—	0	0	31
60 - 65	0	—	—	0	0

Source: Agronomy, Principles and Practices. — Graber and Ahlgren.

The effect of fall frost on **wheat** is dependent on (1) stage of plant maturity (2) degrees of frost and (3) length of the frost period. Canadian data indicates that a light frost of 28°F. lasting 4 hours and occurring prior to the dough stage will severely injure both germination and yield. Such a frost may wrinkle the bran coat but have no effect on germination and little or no effect on yield when occurring at or after the dough stage. In general, the earlier the stage of crop maturity the easier frost damage affects both yield and germination. During late maturity stages even severe frost may not affect yield or germination but can affect market quality. A light frost of 28° to 30°F. may cause sterility in wheat that has just headed or is about to head.

Table 8. BUSHEL WEIGHT, PER CENT GERMINATION AND SOIL EMERGENCE OF THATCHER WHEAT.

Frost Damage[1] Type of	Test Wt. Lbs./Bu.	Germination Per cent	Emergence Per cent
A	60.0	95.0	87.5
B	57.5	88.0	78.5
C	53.0	74.0	68.5
D	42.5	48.0	27.0

[1] Type A — Sound seeds showing no frost damage.
Type B — Bran coat frost damage only.
Type C — Deep seated frost damage. Kernels with or without slight shriveling and usually dark in color.
Type D — Shriveled and shrunken kernels. Bushel weight low.

Source: The effect of Frost on Germination and the Vitality of Seedlings from Frosted Wheat. Bulletin No. 128 University of Saskatchewan, Sask., Canada.

Effect of Weed Competition on Crop Yield—Numerous studies have shown that weed competition during early stages of crop growth lowers yields more than weeds starting and growing during the later stages of crop growth. Weeds compete for soil moisture, soil nutrients and light. Even though both soil moisture and nutrients seem to be available in amounts greater than crop needs, the crop yield is still reduced.

Competition studies show that at five days after

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emergence the root system of small grains is larger than the root system of common annual weeds, including wild oats, germinating at the same time. At 21 days after emergence, however, the root system of weeds is considerably larger than those of the cereals. This is apparently true of corn and other cereals as well. Weeds, therefore, have the advantage quite early in the growing season unless they are controlled by selective chemicals, tillage or crop competition.

Table 9 shows the advantage of early mustard control with 2,4-D in wheat.

Table 9 EARLY WEED CONTROL PAYS

Crop Stage	Days After Emergence	Yield Per Acre
Check — weed free	—	42 bu.
No weed control	Not sprayed	18 bu.
4th leaf stage	19	40 bu.
6th leaf stage	29	39 bu.
Shot blade (early boot)	35	18 bu.

Source: 1955 Proceedings Western Canada Weed Control Conference.

Crop management practices that promote good stands of strong, vigorous, fast growing crop seedlings and that get them started ahead of weeds make the crop more competitive and a better "weed fighter." Selective weed control chemicals, to be most effective, should be applied at an early stage of crop growth to remove the weed competition as early as possible.

Plant diseases—A plant disease is a plant growth abnormality caused by living parasites such as bacteria, fungi and viruses. Understanding each disease, how it develops and the damage it does to the plant is necessary as a basis for control.

Types of disease causing organisms and their behavior are:

Bacteria are single celled and reproduce by budding; that is, one cell gives rise to another until colonies develop which are held together by a gelatinous matrix. Infection is spread from one plant to another by splashing rain water, insects, plants touching and other mechanical means. An example is black chaff of wheat (not false black chaff, which is inherited).

Fungi or molds are made up of many cells and grow in thread-like strands. Movement from plant to plant during the fungus growth stage is very limited. Movement from plant to plant or area to area is accomplished by wind carried spores (seeds) of the fungus. A good example is stem rust of wheat.

Viruses are restricted in their growth to the protoplasm of living plant cells. They have no mobility at all except by being carried in the plant sap. They must be moved from plant to plant by insects, plant to plant contact in the field or by man himself. An example is barley stripe mosaic of barley.

A crop plant is susceptible to disease during various stages of growth depending on the life cycle of the disease. Seeds can be attacked by fungi or bacteria present on or in the seed or present in the soil in which they are sown. The young seedling can be attacked by soil borne fungi or bacteria. Some of these diseases can be controlled by fungicide seed treatments.

When leaves are exposed to the air, plants are subject to spore producing fungi such as leaf and stem rust or viruses carried by insects. During flowering the plant is subject to spore producing fungi, such as loose smut, which is carried within the kernel and can be detected only by an embryo test.

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Section C – INDIVIDUAL CROPS

This section is not intended to be a complete discussion for each individual crop. When studying individual crops, make frequent reference to the corresponding discussions in Section A and B of this manual.

I. Wheat

Wheat is a cool season crop. It requires a longer growing period and a somewhat higher minimum heat requirement than other small grains.

Optimum preharvest mean temperature for wheat appears to be approximately 60° to 70° F. whereas the annual growing season temperature should be about 12° to 16° F. lower. Annual as well as preharvest daily mean temperatures significantly above 65° F. appear to be associated with low wheat yields. Warm temperatures during the late seedling and tillering stage of wheat may retard heading. Daily maximum temperatures above 90° F. during the three or four weeks after flowering may ripen the grain prematurely. See Figure 15 page 21. Above average temperatures are beneficial at the time of sowing, detrimental during the tillering, flowering and early dough stages and beneficial during ripening.

Germination—as water enters, the seed swells and increases in weight by about 60 per cent. The optimum temperature for germination is about 64° F. The minimum is about 34° F. Much above the optimum causes irregular germination. In soil, under favorable conditions, germination begins in 4 to 5 days. There may be variety differences in speed of germination.

Seedling—when the seedling reaches the soil surface, the kernel is rapidly becoming a mere sack containing diffusable food substances. The coleoptile has grown upward and its tip projects above the soil surface. Seminal roots are developing at this stage. The first foliage leaves appear through the coleoptile and normally are rolled clockwise.

The appearance of seedling leaves is due primarily to the growth of the third internode which brings the **growing point** near the soil surface. The buds on the fourth and fifth nodes which have been developing gradually now swell. The internodes remain very short. This whole area constitutes the crown, which is located just below the soil surface. Adventitious roots and tillers develop from the crown nodes.

Roots—Wheat roots are of two major kinds, seminal and crown.

Seminal roots arise from the embryo. The primary seminal root is the radicle. From the side a pair of lateral roots develop and a second pair may emerge later just above the first pair. Finally, one, two or even three roots, not pre-formed in the embryo, may be produced below the coleoptile. This gives a maximum total of 5 to 6 seminal roots. For a short distance just behind the tip, the root surface bears many delicate root hairs. When the root is from 4 to 6 inches long, many fine lateral branch roots develop. Seminal roots of wheat remain functional throughout the life of the plant, providing nourishment, especially to the main culm.

Crown roots—develop from the nodes of the main axis and from tillers below the soil surface. The first of these roots to form is a pair which grows out from the first tillering node of the main axis, one to the right and one to the left of the first lateral bud. At the second tillering node a similar pair arise, succeeded higher up, where the internodes begin to lengthen, by a whorl of 4 to 6 roots, more or less symmetrically arranged.

Crown roots are larger and thicker than seminal roots. They are at first unbranched and covered almost throughout their length with root hairs. Later numerous lateral branch roots appear. As these develop the older roots become thinner and brown in color and the root hairs disappear except towards the tip.

The first tendency of the crown roots is to spread laterally, the angle depending in part on the variety and on soil conditions. Thereafter they grow downward, branch prefusely and develop a dense mass of roots. Each tiller develops crown roots. A single wheat plant can, therefore, produce a large number of roots. Collectively, these are the **Crown** root system.

The mature system has a depth of 3½ to 4 feet and a maximum depth of 5 to 7 feet. Sixty per cent or more of the whole root system is in the top 12 inches of soil. Winter wheats in general are deeper rooted than spring wheats.

Stems—once at ground level, the stem remains comparatively short for some time, later elongating to full height of the wheat crop. The elongation occurs in the growing region at the base of each internode. The lowest internode elongates first, followed by the others in succession. The number of nodes ranges from 5 to 7. Each node is solid. The internodes generally are hollow but in certain varieties they are solid. The internodes become progressively longer from the bottom to the top of the plant. A crop may, therefore, be short at heading time but tall enough when mature to facilitate harvesting. The lower internodes, and parts of the top internodes, are entirely covered by leaf sheaths.

Tillering—tillers develop from the buds in the axils of the basal stem nodes. In grain sown at a normal depth it is usually the second and third nodes which produce tillers followed by the fourth and fifth nodes. In deeper sown

grain (3 inches and over), the second and third nodes generally remain dormant, with the first tiller arising from the fourth node. Hence sowing too deep tends to reduce the amount of tillering.

Several other factors influence tillering: (1) varietal characteristics (2) thin seeding promotes tillering while thick seeding reduces it; (3) plants from large seeds tend to tiller more than those from small seeds; (4) tillering tends to increase with good fertility; (5) adequate soil moisture and cool early season soil and air temperatures favor tillering.

Leaves—the normal wheat leaf is divided into two main parts, the sheath and the blade, which are separated by the collar.

The **sheath** arises at the node and encircles the stem. The lower three to five millimeters of the sheath is considerably thickened. It is this thickening of the sheath which helps make the node appear thickened. Near the base the sheath is entire (like a cylinder), higher up it is split. It is generally thicker than the blade, with thin transparent margins. In the young plant the sheaths are very short, although the corresponding blades may have reached several inches in length. With the elongation of the internodes, the sheaths rapidly elongate. The junction of the sheath and the blade is the **collar**. The **ligule** is colorless. Its free margin is irregularly cut, and fringed with minute hairs.

Auricles clasp the stem closely. Their size varies with the variety. They are pale green or pinkish in color. Their margins and tips usually are fringed with long hairs.

Inflorescence—the inflorescence of wheat is a **spike** with two rows of spikelets and a single terminal **spikelet.** The initial inflorescence can be seen in the late seedling stage, but the head does not emerge from the enveloping leaf sheaths until some 6 to 7 weeks later.

The main axis (rachis) of the spike consists of a number of short internodes. Each internode is narrow at the base and broad at the top; one side is somewhat convex, and the other side flattened or concave. The position of the concave side alternates so that the rachis has a zigzag appearance. The base of each spikelet is arranged alternately on the rachis. The inside of the spikelet is next to the concave surface of the axis. The length of the rachis internodes varies with variety and species. In some types the internodes are very short, producing a dense head whose spikelets project at a fairly wide angle; in others the internodes are long, producing a long lax head with spikelets pressed against the rachis. Length of head is therefore not necesarily related to number of spikelets or yield.

The common wheat rachis is tough and does not break even when threshed. In certain types of wheat, for example spelt, the rachis is brittle and when threshed the grains remain within the glumes.

The wheat spikelet consists of a short jointed axis, the rachilla, which carries a variable number of alternately placed solitary flowers (florets). There are two glumes at the base of each spikelet. They appear to be opposite one another, but actually one is slightly above the other. The typical glume is somewhat boat-shaped, divided by the mid-rib which divides the glume into unequal parts, the outer being the broadest. The tip of the glume may be broad with a blunt extension of the mid-rib, or narrow with an acute point. The number of florets in a spikelet varies. The lower two florets usually are fertile; the upper and especially the terminal are sterile. As a rule, two grains mature, but three grains may form and very exceptionally four, depending on growing conditions. Thus, we say the heads are filling four rows, six rows or eight rows.

The lemma which encloses the kernel is more or less boat-shaped with several ribs but no distinct keel. The upper margin ends in a point or awn. If the point does not exceed one centimeter, the wheat is said to be beardless; if it exceeds one centimeter, the wheat is said to be awned or bearded. When present, the awn is tapering and somewhat four sided with upward pointing barbs attached along the corners.
Flower opening and pollination—the floret opens a few days after heading. The first head to flower is that of the primary stem, followed by those of the tillers in order of origin. The first spikelet of the head to flower is situated about one third of the way down from the top. Flowering then proceeds upward and downward from this point. In each spikelet the basal floret opens first and the others in succession upward.

The pollen sacs begin to dehisce (shed pollen) as soon as the filaments begin to lengthen within the floret. Much pollen is, therefore, shed before the floret opens and self-pollination normally results. Cross-pollination can occur only if the pollen shed within the flower is sterile.

The time required for a wheat floret to open fully averages three minutes and 36 seconds. Approximately 86 per cent of the florets open in daylight. Florets open over a temperature range of 56° to 78° F. Flowering usually stops in florets below 56° F., although pollen may be discharged from the anthers of previously opened florets down to 52° F. Under ordinary conditions the wheat head completes flowering within two to three days after the first anthers appear. Under certain conditions, such as drouth or high temperatures, some of the

lower as well as the top spikelets of the head may fail to set seed.

Function of awns—the presence of awns on the the florets of wheat has tended to result in the production of heavier kernels. In semi-arid regions awned wheats have rather consistently out yielded awnless types, but usually there has been little or no yield superiority of awn types over awnless types under humid or cool irrigated conditions. Awned heads transpire more than do awnless heads, but the water lost through the awns account for no more than one to five per cent of the total transpiration of the plant. Awns carry on photosynthesis. Under drouth conditions the awns may continue photosynthesis even after the flag leaf dries up. Under some circumstances the contribution of the awns to the total kernel dry matter may comprise as much as 12 per cent. The tips of awned spikes dry less rapidly under hot dry conditions because of the shading or other effects of the awns.

Harvesting—the translocation of material from the straw to the kernels ceases when the moisture content of the kernel drops below 40 per cent. Since field ripening and drying are not uniform some increase in dry matter of the grain continues until the average moisture content drops to 30 to 35 per cent. Wheat that stood in the field for two weeks after it was fully ripe in Nebraska suffered an average loss of 3 to 5 per cent from shattering. The alternate wetting and drying from exposure to rain and dew during this period caused the kernel seed coat to wrinkle after swelling and drying. This lowered the test weight of the grain two pounds per bushel.

Nutrition of wheat plant—nutrients absorbed by the wheat plant include nitrogen, phosphorus, potassium, calcium, chlorine, silicon, sulfur and small amounts of numerous other elements. Most of the mineral matter except nitrogen is absorbed before or by the time the wheat plant blooms, but transfer to the kernel may proceed until about a week before harvest.

The wheat plant absorbs much of its **nitrogen**, usually in the nitrate form, by the time it blooms, but absorption continues until the crop is nearly mature. The whole plant attains a maximum quantity of nitrogen three weeks before harvest. In Kansas winter wheat the amount of nitrogen in the stems and leaves reached its peak at about the time of heading but it decreased in these parts until harvest. Nitrogen began to increase in the heads about the time it started to decrease in the stems and leaves. The amount in the kernel increased from the beginning of its formation until maturity. There are no differences in total nitrogen content of the vegatative parts of high and low protein wheats prior to heading but thereafter nitrogen increases more rapidly in the heads of a high protein variety. The absorption of nitrogen by wheat plants on low nitrogen soils in North Dakota decreased rapidly after they had reached the heading stage, but continued on high nitrogen soils.

Phosphorus is important in the nutrition of the wheat plant even though the total amount in the vegetative parts never reaches one per cent on a dry matter basis. In a phosphorus deficient solution wheat plants develop fewer and smaller kernels and plant respiration is limited.

Potassium is essential to the nutrition of the wheat plant, particularly during the active formation of carbohydrates. In winter wheat in Kansas the postassium absorbed by March 15 did not exceed 12 per cent of the maximum total. The absorption of potassium markedly increases as soon as rapid growth begins in the spring and the plant attains its maximum quantity 7 weeks before harvest. A marked loss in potassium has been observed during the final 6 weeks before ripening of the grain as this element is leached from dry leaves.

Most of the nitrogen and minerals required for the developing kernels have accumulated within the stems and leaves of the plant by flowering time. The following figures indicate the approximate percentage of the nitrogen and minerals taken up by the plant which ultimately go into the grain: nitrogen, 70; phosphoric acid, 75; magnesium, 60; potassium, 30; iron, 20; calcium, 10; sodium, 10; silica a trace and other minor elements even less.

With few exceptions the total dry weight of the wheat plant increases until harvest. The maximum rate of increase occurs between the jointing and blooming stages. The heads of wheat at maturity constitute from 25 to 40 per cent of the total dry weight of the plants. After blooming the dry matter generally decreases in the stems and leaves but increases in the heads.

II. Barley

Germination—Most of the water required for germination enters the seed through the base of the kernel, which is known to possess a semi-permeable membrane.

Seedling—the radicle is visible within 24 to 30 hours after germination begins. It is followed by 5 to 8 other roots which, together with the radicle, form the seminal root system. The coleptile becomes apparent somewhat later, delayed because it does not break through the lemma but forces its way upward beneath it and thus is first seen at the tip of the kernel. The appearance of the coleoptile above ground is mainly due to the elongation of the coleoptile. The length of the coleoptile depends on the depth of seeding. Once above the soil surface the coleoptile tip stops growing, opens and the first foliage appears, followed rapidly by the second and third.

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The young leaves of the seedlings are smooth; the yellowish green color is conspicuous and the auricles prominent and clasping. Before development of the first tiller, crown roots appear from a thickening node near the ground surface. This is the start of the crown.

Roots—the radicle, which is the first seminal root, grows downward and may penetrate to a depth of 5 to 6 feet. It is branched throughout.

Other **seminal** roots tend to spread horizontally and later slope downward. They ultimately reach a length of two to 16 inches and a depth which varies from two to 12 inches. They also are branched throughout. Seminal roots remain active throughout the growing season.

Crown roots originate from nodes near the soil surface. They are first noticed just before tillering. Many of these roots are at first short, unbranched and comparatively thick. They are white in color and have root hairs throughout their length. A few of the crown roots penetrate deeply, reaching a depth of some 4 to 5 feet and at times exceeding the depth reached by the seminal roots. The remainder either spread horizontally or grow downward at an angle. They fill the upper layers of soil with a dense mass of roots. On the whole, the root habit is very similar to that of spring wheat and oats.

Differentiation into a shallow growing upper region and a more deeply penetrating lower region if often marked. Soil moisture and fertility influence the development. In heavy soils and under drouth conditions, the roots may be very shallow and widely spreading.

Stem—the stem has 5 to 8 nodes and internodes. Elongation of the stem occurs in the growing region at the base of each internode. The last internode terminates in the spike.

Tillers—develop in the same manner as wheat, but usually are greater in number.

Leaves—the foliage leaves resemble the leaves of the wheat plant but vary in number, color, length and width. The ligule is well developed and the auricles are clasping and more conspicuous than in any other cereal.

Inflorescence—the inflorescence is a cylindrical spike with alternating spikelets, strongly compressed on a zigzag rachis. At each joint of the rachis there are 3 spikelets, each one containing a floret. In 6 row barley all three spikelets are fertile and develop kernels. The center floret produces a straight kernel while the two outside florets produce slightly twisted kernels. In two row barley only the central spikelet contains a fertile floret. Side spikelets are sterile. Six-row varieties usually have 25 to 60 kernels, while 2 row varieties have 15 to 30 kernels per spike.

Development of the kernel—pollination of the floret is normally completed before the head emerges from the boot. After fertilization the endosperm commences to develop and is followed almost immediately by the embryo. The outside layer of endosperm cells is called the **aluerone.** This aluerone layer may contain a colored pigment, such as in blue barley. The lemma and palea (hull) in barley adhere to the outer epidermis of the pericarp due to the secretion of a sticky substance apparently secreted by the pericarp, which, as the grain dries out, more or less glues them to the pericarp. The hull usually accounts for about 15 per cent of the kernel weight, although it may vary up to 25 per cent or more depending on variety and kernel plumpness.

After pollination, increase in kernel length is very rapid and is completed in about 7 days. Thereafter the lateral (side to side) diameter increases and continues until about the 15th day. On the other hand, the growth of the dorsiventral (front to back) diameter is slower and its growth is maintained until near maturity. This is why thin barley nearly always has good length. The secretion of the substance which causes the lemma and palea to adhere to the kernel occurs about the 9th or 10th day after pollination. About the 15th or 16th day the kernel begins to toughen and the lemma begins to lose color on the back side. This stage also approximately ends the period of most rapid increase in dry matter and ash. The per cent of water in the kernel falls almost uniformly from about 80 per cent to about 40 per cent at the rate of 1 to 2 per cent a day, depending on climate.

Mature grain—the hulless kernel of barley is similar to that of wheat but both ends are pointed. The complete barley kernel, however, includes the lemma, palea and rachilla. The kernels in two-row barley are symetrically developed and broadest near the middle. The center kernels of six row barley are symmetrical and generally broadest above the middle; the side kernels, however, are not symmetrical and are slightly twisted. The rachilla is a continuation of the axis of the spikelet and adheres to the threshed kernel. It lies within the kernel crease and may have either short or long hairs, a character often used in variety indentification.

III. **Oats**

Germination—in germinating cereals the first node stays right at the germ portion of the seed and actually divides the embryo into the radicle and the stem. In oats elongation of the first internode carries the elongating coleoptile upward. The coleoptile originates at the second node. The first foliage leaf originates at the third node. The fourth node then becomes the crown

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node. This is different than in wheat and barley and is similar to corn. The second internode is short, and therefore the second and third nodes remain close together.

Roots—increase in proportion to variety maturity. Late season varieties tend to have a deeper root system than early maturing varieties. Oat roots are small, numerous, fibrous and densely covered with fine root hairs.

Seminal roots—the first primary root is the radicle and is the first part of the seedling to appear at germination. Later a pair of lateral seminal roots develop almost simultaneously, followed by another pair. This gives a possible total of five seminal roots although the number tends to vary.

The radicle tends to grow almost straight downward. The other seminal roots grow downward at an angle varying up to 45°. All are unbranched and covered by root hairs throughout their length. Later some of these roots reach a depth of 3 to 4 feet and are branched throughout. At maturity they are still active.

Crown roots—the first crown roots develop at the fourth node near ground level just before tillers begin to develop and may become very numerous. They tend to grow horizontally but ultimately curve downwards, reaching depths varying from 1 to 5 feet. Thus, the general habit of the oat is to establish a well developed root system in the first foot of soil by extending laterally for a foot or more.

Stem—the oats stem has 4 to 8 internodes and is generally thicker and softer than wheat. The leaf sheath of certain varieties is somewhat hairy at or below the nodes. Oats hay is of better quality than hay made from other small grains. **Tillers** develop as in wheat but are fewer in number. Oats retain greater ability to tiller late than other small grains. A field of oats may therefore green up and sometimes even head after harvest, especially when drouth forces early maturity and rains follow.

Leaf—the leaf sheath closely envelopes the main stem and is united at the base. The ligule is well developed, oval in shape, and ends in a number of fine teeth. There are no auricles. There are variety differences in the leaf blade. The color ranges from a dark green to a light green. In some varieties the blades are long and narrow, tapering to an acute tip; in others they are shorter and broader, narrowing somewhat suddenly at the tip. Fine hairs often are present on the back and on the margins and this characteristic especially, when studied in younger plants, is so constant that it may be used to differentiate certain varieties.

Inflorescence—the flowering head of oats is called a panicle. The main axis is either erect or pendulous, terminating in a spikelet. Along the main axis are four to nine nodes (average 5 to 6) and at each node main lateral branches delevop on alternate sides.

Each main lateral is again branched, the lowest being the most profusely branched. The nodes towards the top of the panicle have fewer and fewer branches, and the top lateral generally is unbranched. There is a tendency for the lower branches to be so crowded together that certain of the lower nodes on the main axis may appear to be carrying not one main lateral branch but a whorl of laterals of various size. Each lateral branch ends in a slender pedicel terminated by a spikelet. In certain varieties the pedicel is one sided because the lateral branches all converge to one side.

Spikelets—the spikelet consists of from two to seven florets enclosed in a pair of bracts called glumes. The average number of florets is three. The basal floret plus one (occasionally two) may be fertile and develop a kernel. Generally the upper florets are sterile.

When an awn is present on oat kernels, it arises from the back of the lemma and is an extension of the midrib. In wild oats an awn is found in all kernels of the spikelet, is strongly developed and twisted below the knee (bend). A few cultivated varieties also have awns but in the majority of these the awn is found on the basal kernel only and is usually small, curved or straight and not twisted. In cultivated types the awn expression may vary. The awn may serve as an organ of transpiration. There is no doubt, however, that it is of importance in wild oats, serving to transport and to bury the the kernel in the soil to promote germination.

Pollination—blooming begins at the top of the panicle and progresses downward, lasting 3 or 4 up to 8 days. In any one spikelet the lower floret opens first, followed by the second and third. All panicles of a single plant usually complete blooming in about 10 days, but plants with many late tillers may bloom for a month when the weather is cool. Oats usually bloom when the temperature starts to drop in the afternoon but may bloom in the forenoon if the temperature drops.

Oats is naturally self pollinated. Cross-pollination can occur, but much less frequently than in wheat. The most frequent percentage is considerably below one per cent. Pollen grains that fall on the stigma germinate quickly and the pollen tube reaches the egg nucleus within 30 minutes. Florets close within an hour after pollination.

Mature grain—except in hull-less oats the lemma and the palea tightly enclose the kernel. The lemma and the palea together form the

"hull". The hull-less kernel, called the "groat", makes up 65 to 75 per cent of the whole kernel. The groat is covered with moderately long, fine, silky hairs.

The basal kernel of a spikelet is the largest; it has a higher percentage of hull than the upper kernels; it may be awned; its base is blunt and has a short rachilla which varies in length, shape and hairiness in the different varieties. The second kernel, if formed, is smaller, has a lower per cent of hull, no awn. a pointed base and may have a rachilla. If a third grain is formed, it resembles the second but is smaller.

So called "double" or "bosom" kernels occasionally may be found. They are so called because the second kernel is wholly or partly enclosed within the lemma of the first kernel. The double grain condition is an abnormality due to incomplete floral development and is more frequently found in certain varieties than in others.

Double kernels as described above are different than two complete normal kernels which remain attached to the same rachilla.

"Fatuoids" or false wild oats, occasionally appear in some cultivated varieties and resemble the common wild oat. A tendency for occurrance of fatuoids in a variety is generally included in the official varietal description.

IV. RYE

There are two types of rye. Fall rye, a winter type sown in the fall, and spring rye, sown in the spring.

Germination begins at a temperature as low as 33° F., but the optimum temperature ranges from 55 to 65° F. Northern rye varieties often cease germination above 85° F. Rye usually germinates after it has absorbed water equal to about 56 per cent of the kernel weight.

Roots—seminal roots are few in number, the radicle and usually only three other seminal roots. They are followed by the crown roots in whorls from the basal nodes. All are functional throughout the life of the plant and a few may penetrate to considerable depths. Rye roots usually spread 6 to 10 inches at a working depth of about 4 feet and a maximum penetration of 5 to 6 feet. Environmental conditions influence the habit of root development. Compared with the other small grain cereals, rye roots are in general more profusely branched, especially near the soil surface.

Stems—the stems are erect and slender, tougher and longer than those of wheat. A purplish pigmentation is common.

Leaves—the sheaths are smooth and tight; the ligules are very short and rounded but may be absent in certain spring ryes; the auricles, when present, are white and narrow, tending to wither early. Most leaves and stems have a waxy covering.

Inflorescence—the inflorescence is a long uniform spike. The rachis is generally tough, with 20 to 30 joints which are somewhat irregular in outline and densely hairy on the edges. Each joint bears a fertile spikelet but there is no terminal spikelet. The number of spikelets averages about 37.

Spikelet—each spikelet has two narrow pointed glumes. There are normally three florets, the two lower fertile and the third sterile. The lemma of each fertile floret is broad and keeled with long hairs on the keel, especially the upper third. It terminates in a medium long awn.

Flower opening and pollination—the first florets to open are those about one third below the top of the spike, anthesis preceeding thereafter both upward and downward. Flowering is said to commence between 5 and 6 a.m. and to continue throughout the morning until 9 to 10 a.m. Thereafter flowering is at a minimum until the evening, when it tends to rise again. The opening of each floret is rapid and, if pollination takes place immediately, the floret may close again within 30 minutes. Winter rye requires vernalization, i.e., exposure to cool temperatures of about 35° F. to induce flowering.

Rye is crossed-pollinated—96 to 99 per cent of the individual flowers of rye are self-sterile. Cross pollination is accomplished largely by wind borne pollen. Insects are not important pollen carriers in rye.

Mature grain—the ripe kernel is threshed free from the lemma and palea. It is longer, more slender, more sharply keeled, more pointed at the base and darker in color than wheat. The kernels also are less uniform in shape, size and color.

Temperature and growth—fall rye makes faster growth under cool temperatures of both fall and spring than winter wheat.

Under normal conditions, winter rye tillers mainly in the fall. Appreciable growth ceases in the fall when mean temperatures drop below 40° F and begins again in the spring when temperatures rise above 40° F.

V. MILLETS

The term "millet" is applied to a number of warm weather annual grasses used both as forage and cereal crops.

Foxtail Millets

Roots—there are three seminal roots. The crown roots are numerous, thin and wiry, developing from the lower nodes near ground level. All roots appear to function throughout the life of the plant but they are shallow and the plant is subject to drouth injury. The crop may escape drouth injury due entirely to its short growing season.

Stems—the stems are erect, slender, leafy and hollow except at the nodes, which are solid and somewhat swollen below. The internodes are short at the base of the stem, becoming longer in the middle region and again shorter above. The last internode, which ends in a spike-like compressed panicle, is the longest. **Tillers** develop from the buds of the basal nodes.

Leaves—the leaf sheafs are in most cases longer than the internodes. The ligule is short, thick, and has fringed edges, but auricles are lacking. The blades are long, broad and tapered gradually to an acute point; the upper surfaces are smooth and the lower are ridged, with a prominent midrib. Leaves extend well toward the top of the stem.

Inflorescence—the inflorescence is a dense, cylindrical, bristly panicle.

Spikelets and florets—there are 1 to 3 bristles at the base of each spikelet. These bristles are about twice the length of the spikelet, which gives the whole spike a bristly appearance. Self-pollination is the rule, though some cross-pollination occurs. The first florets may open when three fourths of the panicle has emerged from the sheath. Flowering proceeds from the top downward. A large head may require 8 to 16 days to complete flowering. Flowering is hastened by high temperatures and low humidity. Most of the flowers open from 8 a.m. to 10 a.m.

Mature grain—the lemma and palea firmly enclose the mature kernel. The color may vary from yellow, pale straw, orange, red, pink, brown or black.

Proso Millet (variations from Foxtail)

Stems—proso millet stems are stout and erect but the lower part may tend to lie on the ground, erecting itself at the lower nodes. Stems are hairy.

Leaves—are covered with hair. The leaf sheath is open and extends well up the stem.

Inflorescence—the proso inflorescence is an open panicle similar to oats. The panicle base is more or less enclosed in the sheath and is usually nodding and rather compact. The numerous branches are rough and bear spikelets near the tips.

Mature grain—when threshed, most of the seed remains enclosed in the hull (lemma and palea). The hulls are of various shades and colors, including white, cream, yellow, red, brown, gray and black. The seed coat of all varieties, however, is a creamy white.

VI. CORN

Corn is an annual cereal known only as a cultivated crop and almost certainly of Central and South American origin.

Germination—some authors state that corn germinates in from ten to twenty days at 43.7° F.; in from five to ten days between 48.6° - 58.5° F. The optimum temperature is given as 86° F.

Water appears to penetrate with equal rapidity over the whole surface of the kernel during germination. There is no evidence of a localized semi-permeable membrane as in barley. About 40 per cent of water by weight is required for germination.

The groove above the embryo widens as the cells become turgid. The coleorhiza enlarges and in some twenty hours breaks the pericarp and protrudes beyond the kernel surface. The radicle at the same time swells, and bursts through the coleorhiza a few hours later. When the radicle is about two centimeters long, the first internode elongates and pushes the coleoptile through the pericarp. At the same time the seminal roots begin to develop. In the very early stages of germination the embryo appears to be largely dependent on its own food reserves and not upon those of the endosperm. The endosperm dissolves much slower than in wheat.

Seedling—when the coleoptile appears above ground, the seedling normally possesses four seminal roots, one primary, which is the radicle, and three lateral. Additional laterals may form later.

The elongating first internode is largely responsible for the appearance of the coleoptile above the soil surface. The length of the first internode depends upon the depth of planting. At normal planting depths of 2 to 3 inches, it is about twice the length of the coleoptile. When planted deeper the first internode increases in length until the node from which the coleoptile grows is within about 2 inches of the soil surface.

This elongation of the first internode occurs to some extent in oats, sorghum and millet, but not in other small grains. It is one reason that corn can be planted deeper than small grains and still emerge. When the tip of the coleoptile is past the ground level, it splits into two lobes and the first of the foliage leaf emerges through

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this split, followed rapidly by the second, third and fourth leaves. Meantime, the node which gave rise to the first true leaf begins to thicken and in a short time the first crown roots emerge, usually in a whorl of four. The later formed crown roots develop from the nodes above.

Roots—the roots are fibrous and of three types.

Seminal roots—the primary seminal root is the radicle. It appears early and, after growing to a considerable length, branches. The seminal roots are typically three in number. Some workers have found the number of seminal roots to vary from 3 to 10.

Crown roots—develop from the nodes near the ground level. They form about an inch below the soil surface no matter how deep the planting. Crown roots develop in whorls from several nodes crowded together at the base of the stem, forming the crown. The early formed crown roots (in plants up to 5 weeks old) may number 10 to 15. They grow almost parallel to the soil surface or at a slight downward angle and are confined almost entirely to the surface foot of the soil. They vary in length from 1 to 2.6 feet and are branched profusely. In older plants the above roots and certain newer ones from the same nodes spread laterally for a distance of 2 to 4 feet and then turn sharply downward. They penetrate the soil from 1.5 to 4.6 feet. All roots, especially those near the surface, are much branched. The color is either brown or white, depending on the age. The more vertically growing and in general the later formed roots may number 20 to 35. They grow straight downward or outward for about 2 feet. Others are much longer and may reach a depth of 7 feet or more. All are profusely branched. In general, corn appears to have a lateral spread of 3½ feet and a penetration of from 5 to a maximum of 8 feet.

Brace or prop roots—at the time of rapid elongation of the stem, several of the nodes just above the ground level may send out whorls of branch or prop roots. These roots are thicker than normal roots and often deeply pigmented. Most of the brace roots enter the soil and function as other roots.

Stems—have easily recognized nodes and internodes. The lower internodes are short and thick, the upper ones become gradually longer and thinner. The result is a stem tapering gradually upward to the tassel. Both nodes and internodes are solid. On the side next to the leaf the stems are furrowed, the position of the furrow alternating at each node. The last node ends in the tassel.

Tillers and branches—a branch bud is present in the axil of every corn leaf. The lower buds may develop into tillers (suckers) while the buds in the larger foliage leaves produce ears. Present day hybrids are non-suckering. The remaining branch buds generally form very small ear shoots which do not develop.

Leaves—foliage leaves arise from nodes, which vary in number from 8 to 20 depending on relative maturity of the plant. They are arranged alternately and each possesses the four parts - sheath, blade, ligule and collar.

The sheath is attached to the node and encircles most of the internode. The sheath wraps around the stem, with the left margin over the right on one side of the stalk and in the opposite direction on the other side. The sheath structure is somewhat similar to the blade. It has fewer stomata, less photosynthetic tissue, but contains considerable stalk supporting tissue.

The blade is continuous with the sheath. It is thin, flat, almost ribbon-like, with an acute tip. Along the edges and at the base it may form a number of folds or wrinkles. A firm midrib, yellowish in color, traverses the entire length. The leaf area of a corn plant is extensive. It has been estimated that the upper leaf surface area of a one acre corn field may exceed 4 acres.

The ligule is nearly one half inch long, colorless, and closely surrounds the stem.

Inflorescence—the stamens and pistils are borne on the same plant. The staminate flowers are borne terminally on the tassel and the pistillate flowers on the ear.

The **tassel** is a terminal panicle which has a variable number of spirally arranged lateral branches. On the central axis the spikelets are arranged in rows, varying in number from 4 to 11. Each row consists of a pair of spikelets, one above the other. On the lateral branches the spikelets, also in pairs, are reduced to two rows.

The shank, husk and ear are produced on a short lateral branch which develops from a bud on the stem node and emerges from within the sheath of one of the larger foliage leaves. Sometimes two, very rarely 3, ear buds may develop into ears. The development succession is then from the top down.

The structure of the **ear shank** is somewhat similar to the main stem. All its internodes are very short, but the nodes just below the ear are the shortest. The leaves arising from these nodes constitute the husk which overlaps and protects the terminal ear.

The **husk** is composed of modified leaves. The sheath in each case is well developed but the blade is reduced, becoming more and more so on the inner husks. A ligule is visible on the outer husks but is a mere trace or absent on the inner husks.

The **ear** is a modified spike and consists of a thickened central axis called the cob, bearing a series of paired spikelets in longitudinal rows. Since each row of paired spikelets develops two kernels (one from each spikelet) the regular occurrence of an even number of kernel rows is inevitable.

Flower opening and pollination—on the tassel the first flowers to open are those of the older spikelets near the tip of the central axis. Thereafter blooming spreads upward and downward,

reaching the tip of the tassel long before it reaches the base. A tassel continues to produce pollen for several days, depending on the variety, the relative development of the tassel and weather conditions. Under favorable conditions pollen discharge commences at sunrise and is more or less complete by noon. Dry bright weather favors the shedding of the pollen; cold weather delays it.

Insects frequently visit the flowers of corn but as agents of pollination they are almost negligible. Wind and gravity are the key distribution agents.

From the corn tassel, the pollen showers down on a calm day over an area with a radius of some three to four feet. In a high wind the pollen may be carried several hundred feet. Thus isolation is necessary to prevent cross pollination in pure seed production of open pollinated varieties. Controlled cross pollination, however, is necessary for hybrid corn production.

The oldest spikelets on the ear are those at the base; the youngest at the tip. The silks of the older spikelets begin to elongate as much as seven days before the silks toward the tip. These older silks have to travel a much greater distance and this reduces silk emergence from the ear to from two to five days. A silk is receptive to pollen whenever it emerges. It remains receptive for nearly fourteen days, and during that period it may continue to elongate until pollinated. As the silks do not emerge simultaneously, but in succession over a period of from two to five days, if follows that the pollination of every silk on an ear takes place over a period of several days. An average plant produces about 25,000 pollen grains for each silk. Usually a corn field will shed pollen over a two week period, thus assuring good pollination under most field conditions.

Mature grain—the corn kernel is a caryopsis with a thick pericarp enclosing a single seed. The mature kernels vary in shape due to variety and position on the ear. The tip end of the kernel may readily be broken off, exposing a small pigmented spot. The embryo is visible beneath a shallow groove on the side of the kernel facing the ear tip. The soft area just above the embryo is a convenient place to visually check kernel maturity. Milkiness or firmness of the endosperm indicates degree of maturity.

Growing temperature—corn is a warm weather plant that requires high temperatures day and night during the growing season. The crop is seldom grown for grain where the mean summer temperature is less than 66° F or where the average night temperature for the three summer months falls below 55° F.

Plants are quite susceptible to injury from high temperatures at the tasseling stage. Pollen may not be produced or may dry up before pollination takes place, resulting in poor kernel set.

Corn plants can be injured by freezing temperatures any time during the growing season. Generally corn is able to recover from freezes that occur before the plants are six inches tall. Frosts early in the fall before the grain is mature kill the leaf tissue and reduce both yield and quality.

VII. SORGHUMS

The discussion of sorghums will be divided into two groups: (1) grain sorghums and (2) grass sorghums.

Grain Sorghums

Roots—at germination a single primary seminal root, the radicle, is produced which grows almost vertically downward and produces numerous lateral branches throughout its length. No additional seminal roots are produced.

The crown roots develop in succession from the basal nodes situated just below or at ground level. Their directional growth is very similar to corn roots. The root system is very abundant, as plants with 6 to 8 leaves may have a lateral spread of 3 feet. Later the roots may have working depths of 3 to 4 feet and maximum depths of 4½ to 6 feet. They are more fibrous than roots of corn and, according to one authority, develop more than twice as many laterals at any stage of their development. This would mean that the root system of the sorghum plant is about twice as extensive as the root system of a corn plant.

The profuse branching and wide distribution of the root system is one of the main reasons why the sorghums are so drouth resistant. Other factors of importance are: (1) the plant grows slowly until the root system is well established; (2) the plants have approximately half the leaf area of corn; (3) the lower transpiration rate reduces water demand; (4) the plant can remain dormant during a prolonged drouth period and resume its development following rainfall.

It is well known that sorghums influence the yield of succeeding crops. This was formerly attributed only to the depletion of soil water and available nutrients by the extensive root system and late summer growth. This depression also is due to the rapid buildup of microorganisms that feed on the high sugar content of sorghum stubble and roots. These organisms

require large amounts of soil nutrients, especially nitrogen which is "tied up" temporarily but becomes available later in the season as the microorganism population declines.

Stems—the stems are erect, solid and slightly furrowed on alternating sides. The nodes are somewhat thickened, the internodes are short at the base, becoming longer toward the top; those of the middle region are nearly equal in length but the terminal internode which ends in the head, is the longest of all.

The buds at ground level may develop as tillers, the number depending partly on the variety and partly on environmental conditions. Up to 15 tillers may develop on certain varieties. These tillers are, in the majority of cases, shorter than the main stalk; they all develop heads which are smaller and mature later than the main stalk. Above ground there is a bud at each node except the terminal node. After the main stem has headed and often not until its seeds are half ripe the uppermost bud may elongate to form a true lateral branch which may develop a late maturing head.

Leaves—the foliage leaves vary somewhat in different varieties. The sheaths are long, in most cases exceeding the length of the internodes but considerable variation is found in different varieties. The ligule is short, membranous and fringed. The leaf blades are very similar to corn. They are, however, more erect and the midrib is more prominent and the edges are smooth. The total leaf area of sorghum is less than of corn.

Flower opening and pollination—the first flowers to open are those near the top of the main stalk. Thereafter, flowering proceeds downward. The whole process of flower opening is within minutes of its inception. Flowering usually takes place between midnight and early morning. The total duration of flowering on the panicle usually is from 6 to 9 days. Self pollination does occur and pollination between flowers on the same panicle is very frequent. Cross pollination also occurs readily.

Grass Sorghums

The term "Grass Sorghums" was first used by Piper to include the grass-like sorghums which are annual in habit, the most important of these being sudangrass. The name sudangrass was given to **Sorghum vulgare sudanense** when it was introduced to the USA from Africa.

Germination—sudangrass germinates over a wide range of temperatures, but best at 86° F.

Roots—the root system is similar to that of the other sorghums.

Stems—the stems are slender, solid and slightly furrowed on one side, the position of the furrow alternating at each node. Buds develop at all the nodes, those at the base develop as suckers, a few of those above as lateral branches.

Leaves—are 6 to 24 inches long by ½ to ¾ inches wide. The sheath overlaps strongly at the base, but in the lower leaves is open nearly the full length of the internode. The blades have a distinct midrib. The ligule is long.

Inflorescence—the inflorescence is an open panicle, erect, 6 to 14 inches long, and up to 10 inches wide at the base. Spikelets appear in pairs, one above the other.

Mature grain—the kernels vary from light reddish-brown, with occasional light color or almost white. In outline they are more or less elliptical, flattened on one side, slightly convex on the other.

VIII. FLAX

Although flax is not a grass and not a cereal, it is sometimes included in the small grain group because of its general production characteristics. In discussing or writing about crops, we should be careful to say "small grains and flax" or "cereals and flax" if flax is included in the discussion..

North Dakota produces seed flax harvested for seed, as distinguished from fiber flax harvested for fiber.

Seeds—flaxseed is a true seed because the pericarp is a part of the boll and is removed in threshing. The embryo is surrounded by a thin layer of endosperm. Cotyledons make up a large portion of the seed and are the first leaves to emerge above ground as the seed germinates. Seeds start germination as low as 38-40° F. Seeds have a smooth, shiny surface resulting from a mucilaginous seed coat covering. One bushel (56 pounds) of flaxseed produces about 19 pounds of linseed oil. The oil percentage usually is lower when drouth occurs within 30 days after blossoming and to the extent that it results in shriveled seed. Differences in seed size, shape and color are important characteristics in distinguishing varieties.

Roots—flax has a single taproot with numerous branches. The root system is relatively short, so that flax is largely dependent on moisture in the surface 2 feet of soil.

Branching habit—the flax plant has a distinct main stem but branches freely from the crown near ground level when grown in thin stands. Such basal branching is partly or entirely suppressed in thick stands. The upper part of the

stem branches freely, with each branch terminating in a flower bud or boll.

Growing point—the growing point is exposed at the tip of each stem. Damage to the growing point of very small flax seedlings can kill the plant. When damage occurs after a few true leaves have emerged, buds in the main leaf axils will develop new stems but crop maturity is delayed.

Stems—three principal tissue areas are recognized in the stems - pith, wood and bark. The **bark** contains the compartively long flax fiber cells that constitute the linen fibers. The **woody** cylinder surrounded by the fiber bundles gives the flax stem its strength and resistance to lodging. Flax in the green boll stage is the most susceptible to lodging. The **pith** disintegrates as flax matures and the stem becomes hollow.

Leaves—stalks, (petioles) are nearly absent; leaves are linear and may be erect or spreading. They have three veins, with the mid-vein prominent. The leaves are arranged spirally around the stem except at the base of the stem, where they are opposite.

Flowers and bolls—the flax flower has 5 petals which vary in size, color and shape, depending on variety. The petal color may be blue, pale blue, white or pale pink. Petal colors may be a lighter shade of color under drouthy conditions. The flowers open at sunrise on clear warm days, the petals falling before noon. Flowering is indeterminate and continues until growth is stopped.

The boll is 5 celled, each cell containing 2 seeds. When completely filled, the boll contains 10 seeds. The bolls of our varieties are semi-dehiscent but rarely dehisce (shatter).

Growing conditions—flax requires moderate to cool temperatures during the growing season. Drouth and high temperatures (about 90° F.) during and following the flowering stage reduce the yield, the seed size, oil content and oil quality. This is why the oil content and quality of northern grown flaxseed is generally higher than when grown further south.

Frost damage—flax just emerging is easily killed by frost. Flax in the seedling stage with several true leaves may not be damaged even when temperatures are as low as 18° F. but a light freeze of 30° F. may cause injury in the blossom or green boll stage. Between these stages, plants generally are not injured even at temperatures of 15° F.

Salt tolerance—flax is less tolerant to alkali or high saline soils than corn.

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Section E. GLOSSARY

Anther—A structure at the tip of a stamen in which the pollen grains are produced.

Anthesis—The period during which the floret is open and the anthers are extended from the glumes.

Auricles—Ear-shaped appendages at the base of leaf blades.

Awn—The beard or bristle extending from the tip or back of the lemma.

Axil—The angle between the leaf and stem or between a branch or pedicel and its main stem.

Axis—The main stem of a flower or panicle.

Blade—The part of the leaf above the sheath.

Boll—The sperical fruit of flax.

Boot—The top leaf sheath.

Boot Stage—The growth stage at which inflorescence expands the boot.

Brace Root—A root that originates above ground and functions to brace and nourish the corn plant.

Branch—A lateral stem.

Bristle—A short, stiff hair.

Bud—Specialized cell tissue from which a new plant part can develop.

Carbohydrates—The chief constituents of plants including sugars, starches and cellulose containing carbon, hydrogen and oxygen in which the ratio of hydrogen molecules to oxygen molecules is 2 to 1.

Caryopsis—The kernel (fruit) of a cereal without the lemma and palea.

Cell—The basic unit of structure in plants.

Chloroplast—A structure within a cell, usually green in color due to the presence of chlorophyll, within which photosynthesis takes place.

Chlorophyll—The green coloring matter of plant cells which takes part in the process of photosynthesis.

Chromosome—A structure within the nucleus of the cell on which the genes are situated.

Coleoptile—A sheath covering the first leaves of a cereal seedling as it emerges from the soil.

Coleorhiza—A sheath covering the radicle.

Collar—The thickened area at the junction of the sheath and blade.

Cutin—A waxy substance covering the leaves and stems of most plants forming the cuticle.

Crown—The base of the stem where adventitious roots arise.

Culm—The stem, including nodes and internodes.

Cuticle—The outer corky or waxy covering of the plant.

Dehiscence—The opening of florets and emergence of anthers.

Dormant—Being in a state of reduced activity in which neither cell division nor growth takes place and in which metabolic activities like respiration are reduced to a minimal rate.

Egg—The female reproductive cell.

Embryo—The undeveloped plant within a seed (germ).

Endosperm—The interior food storage area of a kernel.

Enzyme—An organic catalyst.

Epidermis—A protective tissue on the outer surface of leaves, young roots, stems and all plant parts.

Food—The product of photosynthesis which is stored or used in respiration as a source of energy.

Floret—The flower plus the lemma and palea.

Flower—The reproductive structure of a floret, not including the lemma and palea.

Gene—A physiological unit carried on chromosomes within the nucleus of each cell, which determines hereditable characteristics of the plant.

Groat—An oat kernel with the hull removed (caryopsis).

Hull—The lemma and palea covering the caryopsis such as in barley and oats.

Husk—The leaves on an ear of corn.

Hybrid—The offspring of two parents unlike in one or more hereditable characters.

Imperfect—Flower lacking either stamens or pistils.

Inflorescence—A group of spikelets forming the flowering part of plants.

Internode—The part of a stem or a branch between two nodes.

Ion—An electrically charged particle formed from an atom or group of atoms which has either gained or lost one or more electrons.

Joint—A node.

Kernel—The seed of a cereal.

Leaf—The lateral branch of a stem.

Lemma—The outer (lower) bract of a floret.

Ligule—A membranous projection at the top of the inner side of a leaf sheath.

Lodicule—The organs at the base of the ovary of a cereal floret that swell and force the lemma and palea open during anthesis.

Meiosis—The division of the sexual cells in which the number of chromosomes is halved.

Meristematic—Young plant tissue capable of rapid cell division.

Metabolism—The life processes of plants.

Mitosis—Cell division in which one cell gives rise to two cells, both of them genetically identical to the cell which produced them.

Node—The joint of a stem where a leaf is attached.

Nucleus—The heredity determining part of a cell containing the chromosomes and genes.

Nutrient—A chemical element taken into a plant that is essential to its growth, development or reproduction.

Ovary—Basal portion of a pistil in which the embryo or seed develops.

Palea—The inner (upper) bract of a floret lying next to the caryopsis.

Parenchyma—Soft tissue having cells with thin walls and relatively large cytoplasm usually adapted for food storage.

Perfect Flowers—Flowers containing both stamens and pistils.

Pericarp—The outer covering of a kernel.

Phloem—The part of a vascular bundle through which food materials manufactured in the leaves are transported.

Photosynthesis—A process by which carbon dioxide and water are converted to food and oxygen in the presence of chlorophyll, utilizing the energy of light.

Pistil—The female structure of a flower, consisting of the ovary, style and stigma.

Pith—Parenchyma tissue in the center of a stem.

Pollen—The male germ cells produced in the anthers.

Pollination—The transfer of pollen from the anther to the stigma.

Primary Roots—The seminal root system.

Protoplasm—The contents of a living cell.

Protoplast—Living part of a cell; everything inside the cell wall.

Rachilla—The axis of a spikelet.

Rachis—The axis of a spike.

Radicle—The embryonic root of a germinating seed.

Respiration—A process constantly going on in every living cell by which food is broken down into carbon dioxide and water with a release of useable energy.

Root—The below ground part of the plant which lacks nodes.

Root Cap—A mass of cells protecting the tip of a root.

Root Hair—A single-celled protrusion of an epidermal cell of a young root.

Sclerenchyma—A cell, with a thick, usually lignified cell wall or a tissue composed principally of such cells for example the xylem or cork.

Scutellum—A shield-shaped organ surrounding the embryo.

Seed—A dormant embryo enclosed in a seed coat with the endosperm containing food reserves necessary for its germination.

Seedling—The early growth stage of a plant.

Seminal Roots—Roots developing below the first node of the embryo.

Sheath—The lower part of the leaf that encloses the stem.

Spike—An unbranched inflorescence in which the spikelets are attached directly to the rachis.

Spikelet—The unit of inflorescence consisting of two glumes and one or more florets.

Stamen—The pollen bearing organ of a flower.

Sterile—Incapable of sexual reproduction.

Stoma—An opening in the epidermis for the passage of gases and water vapor.

Stomata—Plural for stoma.

Style—The slender part of the pistil supporting the stigma.

Tiller—An erect shoot arising from buds in the crown.

Tissue—A structural unit of the plant made up of cells which together perform a specific function.

Translocation—Movement of food, water and nutrients from one part of the plant to another.

Transpiration—The loss of water through plant tissue, primarily the open stomata.

Variety—A population of plants having many characteristics in common; a variety may be a pure line or a mixture of pure lines.

Vernalize—To make spring-like in growth habit; thus, a process by which the seeds of winter annuals can be made to behave like spring sown annuals.

Viable—Having life; viable seed is thus live seed.

Xylem—A complex tissue in the vascular bundle of roots, stems, leaves and other plant parts through which water and minerals are transported from the soil to positions of use.

Yield—The net photosynthetic production of a crop, especially the portion harvested and used by man.

NOTE: The office dictionary or Agronomy and Botany textbooks are good sources for information on additional plant terms you may encounter.

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ABSTRACT - Prepared by the Home Economics Instructional Materials Center at Texas Tech University, this 2-part curriculum bulletin is designed for a 1-semester consumer education course at the 11th and 12th grade levels. Sections are: (1) Allocation of resources, (2) Consumer Buying, (3) Consumer Citizenship, and (4) Consumer and the Economy. Behavioral objectives, suggested learning experiences, key points, and references for students and teacher accompany the units of each section. Part Two, which is closely interrelated and supplementary to Part One, is available as VT 012 578, also in this issue. (SB)

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CONSUMER EDUCATION

PART ONE

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DESCRIPTION OF
HOME ECONOMICS INSTRUCTIONAL MATERIALS CENTER

The Home Economics Instructional Materials Center was established September 1, 1967, as a continuing project. It is a cooperative project between the Division of Homemaking Education, Texas Education Agency, and the College of Home Economics, Home Economics Education Department, Texas Tech University at Lubbock, Texas. The instructional materials which are being developed at the Center are intended to assist teachers and coordinators in promoting and teaching home economics gainful employment programs or consumer education.

To provide a background of information for the establishment of the Home Economics Instructional Materials Center, a Planning Grant Project was approved by the Texas Education Agency for February 1 through August 31, 1967. The major purposes of the Planning Grant Project were (1) to assemble and catalog an occupational reference library, (2) to develop procedural steps for preparation of instructional materials, and (3) to illustrate the first sequence of these steps, that is, to develop job analyses and to list competencies needed for employability of students.

The present major objectives of the Home Economics Instructional Materials Center are (1) to develop instructional materials designed for use by students enrolled in cooperative part-time training programs and in pre-employment laboratory training programs in preparation for employment in occupations requiring home economics knowledge and skills, (2) to develop materials in consumer education, and (3) later to develop materials designed for use in home and community service programs.

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FOREWORD

The emphasis placed on consumer education by Part F of the Vocational Education Amendments of 1968 prompted the development of the two bulletins in Consumer Education, Parts One and Two, for use in teaching high school students.

Because of the increasing complexity of the marketplace, it is imperative that home economists evaluate their past efforts in teaching in this area, update their teaching materials and emphases, and develop a philosophy of teaching Consumer Education based on decision-making and the management process. These are the beliefs which guided the development of the curriculum materials presented in Parts One and Two in the Consumer Education series.

Facts concerning best buys soon become obsolete due to rapid technological developments and consequent changes in goods and services available. For this reason, little emphasis has been given to buymanship in the bulletins; instead, the major emphasis has been on decision-making as individuals and families use it in the management process. Consumer education taught from this point of view will remain timely. Such teaching will enable students to identify and analyze their values, needs, wants, resources, and goals and consequently will enable them to make rational decisions regarding the myriad of choices that confront them in the market place, regardless of the technological changes which may occur. It is hoped that this kind of consumer education will contribute to family stability and happiness as students establish homes and begin the family life cycle.

The Consumer Education Bulletins are designed for a one-semester course for both boys and girls at the 11th and 12th grade levels. The comprehensive coverage of the consumer education topic necessitated the presentation of the contents in two bulletins--Parts One and Two. The introductory pages are repeated in each bulletin as are the Tables of Contents.

Both Parts One and Two contain four sections: Allocation of Resources, Consumer Buying, Consumer Citizenship, and the Consumer in the Economy.

In Part One the sections follow this format: Behavioral Objectives, Suggested Learning Experiences, Key Points, and References for both students and teacher. Part Two contains a wide variety of related teaching-learning materials for both students and teacher. Among these are directions for making transparencies, instant slides, bulletin boards, posters, and other visuals; suggestions for using simulation games, case studies, skits, stories, etc; illustrations of programmed instruction, objective tests, crossword puzzles, and cartoons. These may be used in carrying out one or more of the suggested learning experiences in Part One.

Both Part One and Part Two are closely interrelated and supplement each other to provide students and teacher with the potential of achieving the behavioral objectives identified in Part One. Directions for using materials in Part Two are given in the Suggested Learning Experiences in

Part One. References in Part One to the accompanying teaching-learning materials in Part Two are clearly identified.

The learning experiences are written from the student's point of view for both boys and girls. Many learning experiences are included. The teacher is not expected to use all the suggested experiences given in these bulletins in one semester. She may adapt, supplement, and/or expand the suggestions included in view of the specific needs, interests, abilities, and backgrounds of her students. The wide variety of experiences included should enable the teacher to select and assign those teaching-learning experiences that will help her students reach the objectives important to them. Many of the experiences may be used as means of evaluating the progress of students.

"NOTES TO TEACHER" are inserted occasionally throughout the lists of learning experiences. These notes usually give specific suggestions and/or references to material in Part Two.

Key points or summary statements of desired learnings follow each learning experience section. Student references and teacher references are included. Materials suggested in the teacher references give a broader, deeper coverage of the topic under discussion than do the student references and should be helpful to the teacher for background information. The numerous student references given enable the teacher to be selective in choosing those appropriate and available for her students.

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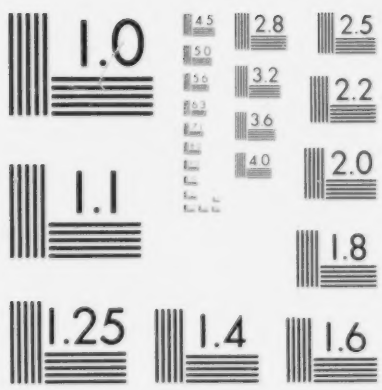

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INTRODUCTION

Note to Teacher: If students are included in the planning of this course, or unit, in consumer education, they are more likely to become actively involved in the course and find it meaningful to their lives.

A number of techniques may be used to gain from students the competencies they feel they need to be able to function effectively in the market place. One way this can be done is to ask students to respond to a Consumer Interest Inventory. You might want to ask students to work in buzz groups to list topics of interest in consumer education. Another possibility would be to read a story or describe a situation in which a bewildered and confused consumer made poor choices in the market place and use this as a basis for listing competencies needed by the consumer. Included on pages xiv and xv is an example of a Consumer Interest Inventory. Directions for administering this inventory follow.

> Directions: Listed on the inventory are some topics which are a part of the area of consumer education. In the column labeled "HAVE STUDIED," write "X" below "Yes" beside each topic you have studied in school, church, or club; mark "X" below "No" if you have never studied this topic. In the column labeled "IMPORTANCE OF INCLUDING IN THIS COURSE" indicate with an "X" the importance of including each topic in this course or unit on consumer education. For example, if you feel that "Values" are a "Very important" topic to include, place "X" under "Very Important" beside the word "Values;" if you feel they are "Of Some Importance," place "X" under this column.
>
> Note: Even though you checked that you have studied a topic, you may feel that it is important to include it. If, however, you feel that you have a good understanding of the topic, you may feel that it is of little importance. Likewise, a topic you have never studied may or may not be of importance to you for this course. Mark the inventory as accurately as you can. Do not skip any items.

CONSUMER INTEREST INVENTORY

HAVE STUDIED			IMPORTANCE OF INCLUDING IN THIS COURSE			
YES	NO	TOPICS	Very Important	Important	Of Some Importance	Of Little Importance
		1. Values				
		2. Goals				
		3. Standards				
		4. Needs and Wants				
		5. Resources				
		6. Family Life Cycle				
		7. Decision-Making Process				
		8. Management Process				
		9. Reasons Why People Buy				
		10. Effects of Advertising on the Consumer				
		11. Protection of the Consumer by Private and Government Agencies				
		12. Banking Services				
		13. Consumer Credit				
		14. Planned Spending (Budgeting)				

HAVE STUDIED			IMPORTANCE OF INCLUDING IN THIS COURSE			
YES	NO	TOPICS	Very Important	Important	Of Some Importance	Of Little Importance
		15. Taxes				
		16. Savings				
		17. Investments				
		18. Selecting Housing and Furnishings				
		19. Insurance				
		20. Social Security				
		21. Current Consumer Issues				
		22. Shopping Skills and Techniques				
		23. Buying Guides				
		24. Sources of Product Information				
		25. Selecting Food				
		26. Selecting Clothing				
		27. Selecting a Car				
		28. Consumers in the Economy				
		29. Consumer Responsibilities				

PART ONE

SECTION ONE: ALLOCATION OF RESOURCES

SECTION ONE: ALLOCATION OF RESOURCES

UNIT I: Management, What It Is

BEHAVIORAL OBJECTIVES

Be able to (1) define management
(2) explain the over-all purpose of management
(3) identify the factors involved in management

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 81-82 in Your Family and Its Money by Thal and Holcombe, pp. 14-20 in Management for Better Living by Starr, or pp. 10-12 in Managing Livingtime by Raines to see what management is, why management is important, and the process involved in management.

2. Discuss such questions as: What is the meaning of management? Why is management important to our lives today? What is the process involved in management? When should the management process be used?

3. View a transparency on what home management is (see Part Two, p. 3). Notice the relationship between family resources and achievement of goals. Discuss.

KEY POINTS

Management is largely a mental process which is made up of many decisions directed toward a certain goal or goals.

Management consists of three parts: planning, controlling, and evaluating.

The ability to manage can be learned.

Management needs to become a vital part of our everyday lives.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT II: Values, Goals, and Standards

BEHAVIORAL OBJECTIVES

Be able to (1) distinguish between values, goals, and standards and determine their relationship to each other
(2) identify individual differences in values, goals, and standards
(3) realize that people who have different values, goals, and standards may have conflicts in relating to each other
(4) clarify your values, goals, and standards

SUGGESTED LEARNING EXPERIENCES

1. Write on a sheet of paper what you think of when the word "value" is mentioned. Share your idea with the rest of the class. Do you all have the same idea of what "value" means?

2. Read pp. 17-19 in Your Family and Its Money by Thal and Holcombe; pp. 4-5 in Money Management; Your Shopping Dollar, a pamphlet from Household Finance Corporation; or pp. 116-118 in Relationships: A Study in Human Behavior by Westlake to clarify what values are and how values affect the way money is spent.

3. Decide on the values you think the teen-age puppets have by just looking at the couples. (The puppets are from the J.C. Penney, Inc. materials in either "How to Furnish a First Home" or "Financing a New Partnership" kit.) Then listen to the description of their values. Are your ideas the same? Can you sometimes tell by looking at a person what some of his values are? Explain.

4. List several of your values. Ask your mother and father to list their values. Compare your list with that of your parents. Are they they same? different? Which values are the same? different? Why? Would you be able to rank your values in order of their importance? Why is this difficult to do? Are these the same values that were important to you three years ago?

5. Take the Forced Choice Value Test (see Part Two, p. 4). Tabulate the results. Then take another value test, if possible, such as the one in the Michigan State Extension Bulletin, No. E 648; Allport, Vernon,

Lindzey's, Study of Values, 3rd edition; or ask your guidance counselor for another value test. Are the results similar? If not, why do you think there is a difference? Do you agree with the findings? Why or why not? Compare these test results with the list made by you and your parents. Are the results consistent?

6. Participate in a discussion on such questions as: Where do we secure our values? Why do we need to recognize our values? Can values be changed? Should people impose their values on others? Explain. What do you think are the major American values? How do values relate to our life styles?

7. Fill in the Values Questionnaire (see Part Two, p. 10) to help you recognize how values influence behavior. Discuss with your classmates how they answered some of the questions.

8. View the instant slides on Directing Your Dollars adapted from the Institute of Life Insurance (see Part Two, p. 13) to identify ways in which the use of money reflects one's values. Discuss. [NOTE TO TEACHER: Instructions and materials for preparing these instant slides are found on p. 12 in Part Two.]

9. Select a book or magazine article about a famous person who has impressed you, or read about values in another culture in a book such as Fifth Chinese Daughter by Jade Snow Wong or The Diary of a Young Girl by Anne Frank. Ask your librarian to help you select a book or article for this assignment. Write a paper on the values you feel that person held and the sources of his or her values. How do values relate to his or her life style? Justify your reasoning.

10. Watch a current movie, TV show, or play and examine it for values. Write a short paper on the values held by one of the characters.

11. Read pp. 26-31 in Management for Better Living by Starr, pp. 19-21 in Your Family and Its Money by Thal and Holcombe, or pp. 6-9 in the booklet, A Date with Your Future by the Institute of Life Insurance to see how goals are related to values. Notice the difference between short-term and long-term goals. Discuss.

12. Look up the word "goals" in the dictionary and compare this definition with the definitions secured from the readings. Discuss.

13. Look at a flannel board (see Part Two, p. 22) that shows how values influence goals. Participate in a discussion on how values are related to both short-term and long-term goals. What are some of the factors that must be considered in establishing goals?

14. Work in small groups and, from the list of items below, decide which would be short-term goals and which would be long-term goals.

A new dress for the Jr.-Sr. Prom
A new car
A tape deck for my room
A record album
A c[illegible] education
A vacation home at the lake

Cowboy boots
A position on the "A" team in basketball
Passing grades on semester exams
A good job

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Listen to all groups report their decisions concerning short- and long-term goals. Do all groups agree? Why or why not?

15. Use the format of the flannel board and identify a value that is important to you. Develop long-term and short-term goals you want to reach because of that value.

16. List some short-term goals and some long-term goals that are very important to you. Try to arrange them in the order of their importance to you. Ask your family to list their short-term and long-term goals. Compare their listing with yours.

17. Keep a record of your money expenditures for a period of about two weeks. Study your record in terms of your values and goals. How did the results relate to your values and goals? Do you present spending habits appear to help or hinder you in reaching your goals? What changes would you make?

18. Read the stories, (see Part Two, pp. 23 and 27) I Am A Lazy Housekeeper and My Family Loves It by Jean H. Maysilles and I've Found a Schedule That Really Works by Norma Duerst, to see what their values and goals are. Do you agree with their philosophies? Why or why not?

19. Read the book, Mama's Bank Account by Kathryn McLean to determine the values that this family holds. Were they forced upon them? What were the goals of this family?

20. Fill in the chart on p. 10 in the booklet, A Date with Your Future, to help you clarify your own goals.

21. Take the case study of Mrs. Esther Strom (see Part Two, p. 36) and analyze it for the values she holds. What is her goal? Choose another of the case studies given in the article, Poverty, U.S.A. (see Part Two, p. 31), and analyze it for values and goals.

22. Read pp. 371-378 in Management for You by Fitzsimmons and White or pp. 60-62 in Your Family and Its Money by Thal and Holcombe to understand what is meant by standard of living and level of living.

23. Discuss such questions as: What factors influence our standard of living? What is the difference between level of living and standard of living? What is the relationship between standards and standard of living? How do certain standards originate? What standards are traditional in your community? What is meant by living on one standard of living but dreaming on a mental standard of living? How can flexibility in standards help a family adapt to changing circumstances?

24. Look at the puppets again from the J.C. Penney's kit on How to Furnish a First Home or Financing a New Partnership to see what conflicts existed between their standard of living and their level of living. What suggestions for solving their problems do you have?

25. Look at a bulletin board to see the relationship of values, goals, and standards (see Part Two, p. 37). Discuss how these three factors influence our standard of living.

26. Fill in the chart (see Part Two, p. 39) to see if you can distinguish between values, goals, and standards. Compare and discuss. What accounts for differences of opinion?

27. Read the first part of the article, How Do Those Joneses Do It? (see Part Two, p. 40). What appear to be the goals of each of the five families described on p. 42 in this article? What values do these goals reflect? Since all five families have a similar standard of living, how do you account for the differences in their values and goals? Why did each family seem dissatisfied with its own way of life? [NOTE TO TEACHER: Give students the first three pages of the article to read and discuss, then give them the last three pages, as indicated below.]

    Tell which of these statements you think is true and justify your reasoning. (a) If each family had managed its income better, they could have had most of the benefits they envied the other families for having. (b) Most families have to establish spending priorities and purchase goods and services that give them the most satisfaction, realizing that some things must be given up.

    Finish reading the article when your teacher gives you the rest of it.

    Were you surprised at the facts behind the scenes? What had you expected?

KEY POINTS

A value is always important to the person who holds it; it is desirable and satisfying; it has the ability to develop in a self-creative way; and it tends to endure.[1]

The rank order of an individual's or family's values may vary in different situations.[3]

Values serve as guides for developing goals.[3]

Families holding similar values may seek different goals.[3]

The extent to which goals are realistic is affected by the assessment of resource potential.[3]

Standard of living is the term used to indicate the level at which families aspire to live as represented by the quality and kinds of consumer goods they seek to enjoy.[2]

Level of living indicates the level at which families actually do live, based on the amount of money they have to spend.[2]

Flexibility in standards influences adaptibility to changing circumstances.[3]

Clarity of values, goals, and standards is affected by experience in management.[3]

Management by individuals and families reflects differences in values, goals, and standards.[3]

Some of the most influential and compelling values are held unconsciously.[3]

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT III: Needs and Wants and Family Life Cycle

BEHAVIORAL OBJECTIVES

Be able to (1) identify some of the needs common to most families
(2) comprehend the different stages of the family life cycle and the characteristics of each stage
(3) become aware of and examine differing wants and needs of the family throughout the family life cycle
(4) examine the differences in individual wants and needs
(5) interpret your wants and needs

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 17-19 in Managing Livingtime by Raines, pp. 31-41 in Your Family and Its Money by Thal and Holcombe, or pp. 2-11 in Relationships: A Study in Human Behavior by Westlake to clarify the difference between wants and needs, and to see how people meet their needs. Discuss.

2. View the filmstrip Umpteen Ways of Shopping from the J.C. Penney's kit on Decision Making for Consumers to see how external forces contribute to family's wants and needs. Discuss.

3. Watch a flannel board presentation on Maslow's Hierarchy of Needs to see the basic needs of people. [NOTE TO TEACHER: See Part Two, p. 46 to help with the presentation.] Find realistic examples to illustrate the various needs. Discuss these needs.

4. Discuss in small groups such questions as: What is the relationship between one's values and the ways in which his needs and wants are met? What major needs do people have? What are the needs that must be considered in planning the expenditure of money? Do all families have the same needs? What are some of the reasons for differences in individuals' wants and needs? How do social group pressures affect needs and wants? What are some of the wants and needs of teen-agers today?

5. Participate in a role-playing situation showing how different cultures influence individual and family needs and wants. Discuss backgrounds, traditions, and goals of individuals in each role-playing situation. Discuss such questions as: What is the result when individual and family needs and/or wants differ? How does your family influence your wants and/or needs?

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6. Make two columns on your paper, one for needs and one for wants. Write items such as the following in the appropriate column: food, wig, housing, radio, stereo, car. Add to this list some items you need and want. Do the items in your columns agree with those of the rest of the class? Why or why not?

7. View the filmstrip, Our Role as Consumers, by the Institute of Life Insurance to gain a better understanding of wants and needs in relation to our role as consumers and to examine the external forces that contribute to needs and wants. Discuss the questions in the filmstrip.

8. Read pp. 2-8 in Housing and Home Management by Lewis, Burns, and Segner; pp. 10-16 in Your Family and Its Money by Thal and Holcombe; pp. 387-409 in Living in Families by Smart and Smart; or pp. 3-25 in Family Development by Duvall to become acquainted with the various stages of the family life cycle and the characteristics of each stage.

9. Watch a flannel board presentation on the various stages of the life cycle to see what proportion of time is spent in each of the stages. Discuss. [NOTE TO TEACHER: See p. 13 in Family Living by Duvall for an example of the various stages in the family life cycle.]

10. Read The Family Life Cycle of Ted and Norma by Dr. David Fulcomer (see Part Two, p. 49) to aid in thinking through the different stages of the family life cycle and the characteristics of each of the stages.

11. Work in small groups to analyze the characteristics of one of the stages of the family life cycle. Share your findings with the rest of the class by using the circle graph from the flannel board presentation of the family life cycle and other illustrative materials, such as transparencies, pictures, charts, slides, or filmstrips, to help make your report interesting. Be sure to include goals you think are important at that particular stage and discuss how changing roles influence these goals. Tell how the goals are interwoven and why they are important at each stage of the life cycle. [NOTE TO TEACHER: Students might enjoy making their own filmstrips as part of this project. A kit for making filmstrips is available from Hudson Photographic Industries, Inc., Irvington-on-Hudson, New York 10533. Filmstrips are made on "U" Film, which is a tough plastic film with a blank surface that can be written or typed upon, erased and reused, in color or black and white. It is made to the exact size of standard filmstrip (35mm.).]

12. Listen to a symposium composed of people or couples at different stages in the life cycle. Describe some of the problems and needs they have encountered at the different stages. Discuss such questions as: At what stage in the life cycle does the homemaker have the most time? the least time? When does she probably have the most energy? the least energy? When does she probably have the most money? the least money? Is it possible for families to be in several stages at the same time? If so, explain. Is the life cycle the same for all families? Explain your answer. How can families provide for their own welfare in each stage? How does society help families provide for their needs and wants?

13. Find pictures in a magazine or book showing as many stages of the family life cycle as possible and discuss how each stage affects wants and needs.

14. Find and bring to class a picture, poem, cartoon, or song to show how people meet their needs or satisfy their wants. Be prepared to share your example with the rest of the class. Discuss.

15. Use the hypothetical situations (see Part Two, p. 59) to clarify wants vs. needs.

KEY POINTS

All people have the same basic needs.

Families' wants and needs change as the family life cycle changes.

Individuals in a family may have different wants and needs.

Different factors influence a person's wants and needs.

Individuals and families have the responsibility to provide for their own welfare beyond the basic expectations of, and protection provided by society.[1]

Value systems are developed as a person's needs are met, as he thinks about and reacts to his experiences, and as he adjusts to change.[1]

The family life cycle is a way of looking at most families' needs and wants as they journey from one stage to another.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT IV: Resources

BEHAVIORAL OBJECTIVES

Be able to (1) recognize human and material resources
(2) suggest ways of adding resources or combining resources to reach goals
(3) show how resources can be used in a given situation
(4) identify and relate available resources to individual and family needs
(5) explain factors that affect and change the availability of resources
(6) recognize the relationship between one's values, goals, and standards and his use of resources

SUGGESTED LEARNING EXPERIENCES

1. Write what comes to your mind when the word "resources" is mentioned. See what the other class members think. Look at your definition again after you have done the reading on resources. If necessary, change your original definition.

2. Read pp. 26-31 in Management for Better Living by Starr, pp. 347-367 in Management for You by Fitzsimmons and White, or Chapter 4 in Your Family and Its Money by Thal and Holcombe to secure a better understanding of resources. Discuss such questions as: What resources are available to everyone? Which ones are limited? How can people increase their resources?

3. View the 3M transparencies (Home Economics 25G, 25H, or see Part Two, p. 63) to help you identify some of your own human and material resources.

4. Make a list of all the resources you can think of that are available to you. Tabulate your list with the rest of the class. Does your list include resources other than time, energy, and money? Look at the list and divide the resources into human and material categories.

5. Read the article, Toward Self-Actualization: Managing Resources (see Part Two, p. 65), to see how human resources should be managed and not manipulated in order for a person to develop toward self-actualization.

16. Read the articles, Resources--What Do We Mean? and Managing Resources to Achieve Goals (see Part Two, p. 89 and 93), to see what resources mean and how people manage resources in order to achieve goals. Discuss these two articles.

17. Take some of the resources such as time, energy, knowledge, health, community facilities, and skills, and relate these to the family life cycle. Some questions might be: When does the homemaker have the most time? least time? When does the homemaker probably have the most energy? least energy? How can knowledge help a family save money? Discuss other resources, also.

18. Discuss questions in regard to resources, such as: Where can a family go for help when their home is destroyed by a tornado? Where can an older single person secure additional resources? What resources are available to a husband who is unemployed? What help is available to a family who has a handicapped child?

19. Write a paper describing a situation in which you have used resources to good advantage. Describe a situation where you feel you did not make wise use of your resources. Be sure to justify your conclusions.

20. Read the case situation, Help (see Part Two, p. 98), and answer the questions at the end of the story. This should help you apply the information on resources. Save this story to use again in the decision-making process. Also keep your answers to the questions so you will not have to do them again.

21. Unscramble the following terms and put them in the right category of human or material resources: knowledge, time, interest, food, money, skills, health, shelter, community facilities, services, transportation, private facilities. Be sure to add a few of your own.

22. Take the case stories of Joseph Crowley and Esther Strom (see Part Two, pp. 34 and 36) and list the resources these persons have available. What additional resources might be available to them?

23. Fill in the chart, My Resources (see Part Two, p. 100), to help you assess the resources you have available, or use the chart on p. 11 of the booklet, A Date with Your Future.

KEY POINTS

The perception of available resources may enhance or limit the management potential of individuals and families.[1]

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The assessment of a resource in terms of other resources or managerial activities clarifies its contribution to management.[1]

The availability and/or scarcity of resources affect the range of choices.[1]

Different forms or combinations of resources may yield similar satisfactions.[1]

The cost of using resources for any purpose is that which must be given up because of such use.[1]

The optimal use of resources varies with differences in families and situations.[1]

The changes in the circumstances accompanying family life stages influence the availability of resources and the demands made upon them.[1]

Families differ in resources available to meet economic needs and risks.[1]

Both human and material resources can be used to meet individual and family goals.

Resources available to individuals and families are limited and vary with changing situations and stages in the family life cycle.

Efficient use of all available human resources may reduce the cost of material resources.

Different resources or combinations of resources can be used to reach the same goal.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT V: Decision-Making Process

BEHAVIORAL OBJECTIVES

Be able to (1) define the term "decision"
(2) identify the factors involved in making a decision
(3) identify the steps in the decision-making process
(4) apply the decision-making process

SUGGESTED LEARNING EXPERIENCES

1. Take the pre-test on decision-making to see how much you know concerning this process (see Part Two, p. 101).

2. Make a list of some of the decisions you or your family face to identify problems to which you can apply the decision-making process. Do not sign your name to the paper. [NOTE TO TEACHER: Use this list to help plan realistic problems for the class to solve.]

3. Read pp. 10-14 in Management for Better Living by Starr; pp. 163-167 in Living in Families by Smart and Smart; pp. 16-19 in Managing Livingtime by Raines; or pp. 84-101 in Your Family and Its Money by Thal and Holcombe to find out what a decision is, the characteristics of a decision, and the factors involved in making a decision.

4. Work in small buzz groups and discuss questions as: What is a decision? What are the characteristics of decisions? What factors are involved in making a decision? When is a decision not a decision?

5. Make a bulletin board to show how the various factors influence decisions. Discuss these factors.

6. Think of a decision you made today and identify the factors that influenced your decision. Share with each other the decisions you made. Discuss these questions: How did you arrive at these decisions? Were they based on past experience, chance, habit, emotion, snap judgment, or some other factor? Give at least one example of a decision you have made that was based on each of these influences: habit, emotion, past experience, and snap judgment. Classify the decisions of your classmates according to these categories.

7. Read Chapter 5 in Your Family and Its Money by Thal and Holcombe; pp. 10-12, 34-40 in Management for Better Living by Starr; or pp. 16-22 in Managing Livingtime by Raines, to see what is involved in making a decision and the steps involved in making a decision. Discuss.

8. View the transparency on the decision-making process from the J.C. Penney kit, Decision Making for Consumers, to clarify the steps in decision-making in your mind. [NOTE TO TEACHER: If this kit is not available, use the diagram of the decision-making process in Part Two, p. 102.]

9. Follow the steps in decision-making as you and your teacher analyze Ann Marie's selection of a hairpiece from the J.C. Penney kit, Decision Making for Consumers. Discuss and clarify each step of the decision-making process.

10. Analyze Henry Buys a Hotrod, as a class, to gain further experience in using the decision-making process. Use the steps in the decision-making process (see Part Two, p. 104).

11. Read the situation, Mrs. Howe Goes to the Circus (see Part Two, p. 106). Use the steps in decision-making to help Mrs. Howe solve her problem. Follow the questions given with the story to guide your thinking.

12. Make a bulletin board to review the steps in making decisions (see Part Two, p. 107).

13. Work in small groups and use the decision-making process to solve a problem given to you by your teacher. [NOTE TO TEACHER: Use some of the decisions students listed in the second learning experience.] If necessary, refer to the bulletin board showing the steps in making decisions. Report to the class how you solved the problem. See if the class agrees with the way you solved the problem.

14. Review the decision you made in the previous situation and analyze the decision in relation to such questions as: To what degree was the decision rational? emotional? based on habit or past experience? To what extent was examination of alternatives necessary? Why? What factors were most influential in the final decision? In what ways is the decision flexible? inflexible? How did clarification of values influence choice of goals? When more than one person is involved in a decision, what complexities arise?

15. Participate in the academic game, Life Career, by Western Publishing Company to practice making decisions. [NOTE TO TEACHER: This game takes from one to six hours to play.]

16. Listen to a student give a review of the book, Cheaper by the Dozen, by Gilbreth and Carey to see how this family made decisions. Be sure to look for types of decisions, simple or complex; and goals, long- or short-term; factors that influenced the decisions; and evidences of the decision-making process in action. Discuss.

17. Play the game, Decision-Making, to see if you understand the terminology used in decision-making (see Part Two, p. 109).

18. See the filmstrip, Marriage and Money, by the Institute of Life Insurance. Write a paper or discuss the following questions:
    a. If I were the couple, I would _____.
    b. The reason I would make this decision is _____.
    Show how you used the decision-making process to arrive at your answer.

    Analyze the filmstrip you just viewed to identify some of the advantages of using the decision-making process. List and discuss the advantages.

    How did your plan differ from your classmates' plans?

19. Take the post-test on decision-making (see Part Two, p. 101) to see if you can apply the decision-making process to one of your problems or a problem given to you by your teacher.

20. Review the story called Help. Answer the following questions about it:
    a. What is Judy's problem?
    b. What goals does she want to reach?
    c. What values does Judy seem to hold?
    d. To help her plan a solution to her problem, consider the alternatives listed below.

    ALTERNATIVE 1. Take Sally in her own (Judy's) car to the doctor. Call the child's parents and tell them about the accident and ask them to meet her at the doctor's office to pick up their little girl.

    ALTERNATIVE 2. Call a cab for Sally. Help her get on her way to the doctor's office. Arrange for a neighbor to keep the child.

    ALTERNATIVE 3. Call her date and ask him if they could possibly arrive late at the Fireman's Ball, explaining the emergency that has arisen--then--take Sally to the hospital and the child to another baby-sitter.

    Answer these questions about each alternative:
    1. What would be the results or outcome of following this alternative?
    2. Would she reach her goal?
    3. What resources would she have to use? Does she have enough of each of these resources to pursue this alternative? Would the outcome be worth the resource cost?
    4. If she chooses to do this, what can she fix for supper?
    5. How might her feelings, values, and previous experiences influence her decision?
    6. What steps still would need to be taken (or decisions made)?

    e. Which one do you think she should choose and why?

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f. Do you think she would be willing to live with the consequences of this decision? Explain.

21. Read the book, The Story of the Trapp Family Singers, by Maria Augusta Trapp. Use the Case Analysis on Decision-Making (see Part Two, p. 112) and analyze the story according to the outline.

KEY POINTS

Decision-making reflects varying degrees of rationality.[1]

Decisions are affected by the interaction of factors which influence managerial behavior.[1]

Rational decisions represent choices resulting from logical analyses of the elements of situations.[1]

The decisions of individuals and families reflect differences in the perception of goals and goal achievements.[1]

Satisfactory decisions may involve family members in different ways at different times.[1]

Disadvantages as well as advantages are usually inherent in the alternatives involved in a decision or choice.[1]

Risk and uncertainty in decision-making vary with people and situations.[1]

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT VI: Management Process

BEHAVIORAL OBJECTIVES

Be able to (1) identify reasons management is important in our lives
(2) apply the management process

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 14-19 in Management for Better Living by Starr or pp. 74-82 in Your Family and Its Money by Thal and Holcombe to understand the steps in the management process. Discuss these steps.

2. View the 3M transparencies, No. 25, The Rational Decision-Making Process, to review the management process. [NOTE TO TEACHER: Transparencies A-M cover the planning phase of the management process; N-O, the controlling phase; and P-T, the evaluating phase.]

3. Develop a bulletin board or visual aid showing the elements and steps involved in the management process (see Part Two, p. 114). Use this visual as a guide to help you analyze examples of the management process in action and to help you apply this process to a problem you will be given later.

4. Read the story, "Getting Dad Back into the Family" in Management in Families, Decision-Making from Michigan State University, Cooperative Extension Service. Identify elements in the story related to planning, controlling, and evaluating. Discuss these question as you analyze the story:

   A. Planning: What was the problem this family faced? What was their central goal? What does this reveal about the values they hold? What resources did this family have in abundance? What resources were limited? What were their greatest resource expenditures? Could they afford this? What was the original big decision made during the planning stage?

   B. Controlling: What were some of the little decisions made during the controlling stage that contributed to the success of the big decision and the family's reaching its goals? What were some of the circumstances this family could not control?

C. Evaluating: As you evaluate this family's solution to their problem, do you think you would have been as pleased with it as they were? Why? Discuss alternative solutions that might suit other families better. What would be the possible outcome of each alternative? What resources would be required to carry it out?

5. Work in small groups to apply the management process to the problems of the couple in the filmstrip, Marriage and Money, from the Institute of Life Insurance. Use questions similar to the ones in the preceding experience to guide your thinking. Discuss your proposed plans with the class.

6. Read the situation, Honeymoon or House (see Part Two, p. 116), and apply the management process to this situation.

7. Play the game, Management Roulette (see Part Two, p. 118), to review management terminology.

8. Fill in the crossword puzzle on Management Mix on p. 27 of the December, 1969 issue of What's New in Home Economics to review management terminology or, as a class project, build a crossword puzzle.

KEY POINTS

Decision-making reflects varying degrees of rationality.[1]

Decisions are affected by the interaction of factors which influence managerial behavior.[1]

Rational decisions represent choices resulting from logical analyses of the elements of situations.[1]

The decisions of individuals and families reflect differences in the perception of goals and goal achievements.[1]

Satisfactory decisions may involve family members in different ways at different times.[1]

Disadvantages as well as advantages are usually inherent in the alternatives involved in a decision or choice.[1]

Risk and uncertainty in decision-making vary with people and situations.[1]

Organization is the way in which individuals and families carry out activities.[1]

The organization of different individuals and families differs in aim and effect.[1]

Plans may incorporate more than one decision.[1]

The implementation of plans may involve reappraisal and adjustment of procedures and coordinating activities.[1]

Individuals and families may facilitate management through creating routine procedures and coordinating activities.[1]

The ways in which plans are communicated may affect their implementation.[1]

Effective organization is related to optimal use of resources.[1]

Anticipated outcomes and incentives energize organizational processes.[1]

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT VII: Budget or Spending Plan

BEHAVIORAL OBJECTIVES

Be able to (1) comprehend the importance of setting up some type of spending plan
(2) examine various types of budgets
(3) select a personal budget plan that is suitable
(4) apply the management process to setting up a budget

SUGGESTED LEARNING EXPERIENCES

1. Write the first word that comes to your mind when the following terms are called out: bargain, rent, utilities, flexibility, planned spending, charge account, donations, insurance, savings, fixed income, emergencies, budget. Put a star by each word that has an unpleasant association for you. Compare your ideas with those of the other members of the class. With which words did you have an unpleasant association? Why?

2. Ask for a volunteer to put all the money he has with him on the desk, tell when he will secure more money, and identify the expenditures he has to make with this amount of money and tell how he will allocate this money. Discuss such questions as: Does your family budget? Do you budget? How does it work for your family? For you? How does your family reach long-term goals? Is your plan written? How often do you examine it for adjustments? Do you use the envelope system?

3. Conduct a survey to determine the various ways students in your school obtain money and the frequency with which they receive it (see Part Two, p. 120). Ask such questions as: Do you earn your money; receive allowances, doles, or gifts; or receive money in a combination of these ways? Do you receive your money on a weekly, monthly, or irregular basis? What are the major items for which your money is spent?

4. Keep a record of all your income for the next two weeks, indicating sources from which it is received. Also keep a record of all expenditures. You will use this information later in this unit to analyze your spending habits.

5. View the Visual Master TM 10--Basic Budgeting--from Coed to introduce general principles of money management and budgeting as they apply to teen-agers. Discuss.

6. Review the story of Mama's Bank Account by Kathryn McLean. When Papa brought home his week's earnings, what did Mama do? When all the money had been accounted for and put into the various piles, what did Mama do and say? Do you think she budgeted? Did she have short and long-term goals? Was her budget successful in relation to her family's needs?

7. Read the "Thought of the Day" on the bulletin board. Discuss what this means in relation to budgeting. [NOTE TO TEACHER: Be sure to put up a new quotation concerning budgeting each day while studying this concept and use it as a basis for discussion. See the Sears booklet, A Department Store in the Classroom, or ask your librarian to help you find quotations if others are not available.]

8. Take the $25.00 in play money given to you by your teacher and list ways in which you would spend it. Does your spending reflect your values and goals? Do not sign your name to the paper. Hand in your paper to the teacher, who will shuffle them and distribute them. Evaluate the anonymous paper you got for the values and goals reflected by the items purchased. Discuss.

9. Listen to a resource person from a bank speak on budgeting. Ask him to discuss the influence budgeting has on the standard of living in the community. Discuss his ideas.

10. View the film, Budgeting, from Bailey Films to see the need for planned spending, how easy it is to buy more than we can afford, and how you can plan a budget to suit individual needs and situations. Discuss.

11. Read pp. 368-413 in Management for You by Fitzsimmons and White; pp. 66-82 and 102-120 in Your Family and Its Money by Thal and Holcombe; or pp. 162-164 in Consumers All (USDA yearbook) to learn about the various parts of a budget and some factors to consider when setting up a budget.

12. Discuss such questions as: Why do we need to plan our spending? What are the advantages and disadvantages of a spending plan? What are the steps in planning a budget? What are the differences and similarities between a family budget and the government's budget? What does the government do when it is short of funds? Can individuals do the same? Why or why not?

13. View a bulletin board or transparency summarizing the advantages of planned spending (see Part Two, p. 121). Hold a "Quaker Meeting" and view this presentation silently for the assigned time period (not more than five minutes). Use this five minutes to think about and explore the ideas presented. Write down every example you can think of that illustrates one of the points made. At the end of the meditation period, share your thoughts with classmates. You may comment on another's statement if you repeat what he said, to his satisfaction, before proceeding.

14. Make a list of all the categories a family must consider when building a spending plan. Are there items that you had not considered before? Take a look at the various categories and see how these might change in

relation to the family life cycle. Discuss. Which items are fixed expenses? flexible expenses?

15. View the cartoon (see Part Two, p. 123) and discuss the questions that go with it to help you recognize the ways individuals live with money.

    Role play the situations described in question 4 accompanying the cartoon to show how people use money in different ways. Discuss the situations. Can you think of other ways people live with money? Which way do you use?

16. Read the article, "One Family's Spending: The First Ten Years," from Changing Times, The Kiplinger Magazine, January, 1970, pp. 25-30. Discuss this article in terms of the family's values, goals, and standards. How did they use their resources to meet their goals? Did they involve the management process? If so, illustrate the steps showing that they used the management process. Would you be able to copy their spending plan? Explain.

17. Look in textbooks and pamphlets to find a variety of forms and guides to be used in setting up a budget. Compare these forms. What are the items that need to be included in a budget? What are some guides that would work for you in setting up a budget?

18. Devise a form that you believe would meet your needs and goals. [NOTE TO TEACHER: Students will use the form they devise later on in the unit. One example is included in Part Two on p. 124.]

19. Find out what salaries are paid for the different jobs available to people in your community. Share your findings. Plan a budget for one of the situations listed below or another one of your choice: Young married couple with one attending college, young married couple with small child and the wife trying to finish high school, single person living in an apartment trying to meet car payments. Use findings obtained above as income to budget.

20. Listen to case studies to see the problems families face in planning their budgets. Situations can be obtained about the first or second Sunday each month in the New York Times on the 100 neediest cases in New York City or in local newspapers prior to the Good Fellow Fund Drive in Texas. Discuss.

21. Interview a case worker or someone who works with various families in your community. Find out what is being done to help families live within their income. Report your findings to the class.

22. Read the article, My Husband and I Never Argue About Money (see Part Two, p. 125). How did this couple handle their budget or spending plan? Was it successful for them? Discuss tensions that may develop when there is no spending plan.

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23. View the film, The Owl Who Gave a Hoot, from the Office of Economic Opportunity to see how foolish everyone was who did not budget his money. Notice the names given to the various people in the film. Also listen carefully to the words of the song. Discuss such questions as: Why were the Pigeons unwise in what they purchased? Why were they named Pigeons? Who were the Owls? Why were they named Owls? How were the Owls "smart buyers"?

24. Read the article "Impulse Buying--Does it Exist?" on page 16 in the Penney's Forum, Fall/Winter, 1968, to see what constitutes impulse buying.

25. Write on a slip of paper what "impulse" buying you participated in this past week or month. Take one item and evaluate it in terms of your values and goals. Would you purchase it again? Why or why not?

26. List a purchase from which you received so much satisfaction that you felt you had gotten more than your money's worth. What enhanced its value to you? Had you earned the money for it? planned to buy it and wanted it for a long time?

27. Listen to a panel discussion on "Money Is a Concern of the Whole Family" to see that a family needs to be involved in planned spending. Include a mother, father, and children. [NOTE TO TEACHER: At least one child should be a teen-ager. Ask each member to discuss purchases that he has made recently or wishes to make. Ask other family members to tell why or how these purchases affect them individually and the family as a unit. Discuss ideas presented.]

28. Visit with homemakers or other students in the school to see how they satisfy their needs and wants and still live within their budgets. Are all family members involved in planning? Discuss your findings.

29. Divide into small groups and develop some guidelines on "How to Be a Careful Shopper and Not Waste Money." Share your ideas with the rest of the class.

30. Read the booklet, A Guide to Budgeting for Young Couples, from U.S. Department of Agriculture or Money and Your Marriage by National Consumer Finance Association and write a short paper on "Two Can Live as Cheaply as One" or "Two Cannot Live as Cheaply as One." Justify your reasoning.

31. Use the information you have accumulated about your own spending habits and plan a budget that you might be able to live with. Work out your spending plan by applying the management principles to it. Use the form that you developed earlier in the unit.

32. Take another resource besides money, such as energy, and study using it "wisely." An example might be: washing windows by using several different items or methods for cleaning them. Your plan might include trying ammonia and water, window cleaner, vinegar and water, or newspapers. Which method gave you the most satisfaction and the results you wanted? Why?

33. Play the bulletin board game from the J.C. Penney Consumer Education materials, Financing a New Partnership, to gain some experience in analyzing individuals' values and goals as reflected in their financial planning and in the way they handle unexpected financial situations. [NOTE TO TEACHER: This could be a class activity to help prepare students for a similar individual experience.]

34. Make a spending plan for the couple described in the situation, The Morris's Spending Plan, (see Part Two, p. 128) to gain further experience in financial planning based on values, goals, and resources.

35. Apply what you have learned in this unit by solving the financial problems of the couple described in the story, Steve and Kathy (see Part Two, p. 129).

KEY POINTS

Plans may incorporate more than one decision.[1]

Organization is the way in which individuals and families carry out activities.[1]

The organization of different individuals and families differs in aim and effect.[1]

The implementation of plans may involve reappraisal and adjustment of procedures to meet changing conditions.[1]

Effective organization is related to optimal use of resources.[1]

Anticipated outcomes and incentives energize organizational processes.[1]

Management by individuals and families reflect differences in values, goals, and standards.[1]

The perception of available resources may enhance or limit the management potential of individuals and families.[1]

A financial plan is a necessary tool in managing money.[2]

The four parts of a financial plan are related.[2]

A successful financial plan fits the specific needs of the family.[2]

A successful plan is based on realistic facts and figures.[2]

Good consumer habits help make a budget work.[2]

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[1]Taken from Concepts and Generalizations: Their Place in High School Home Economics Curriculum Development. Washington, D.C.: American Home Economics Association, 1967.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT VIII: Savings and Investments

BEHAVIORAL OBJECTIVES

Be able to (1) recognize the importance of savings in relation to life style
(2) recognize the importance of saving even small amounts systematically
(3) identify the distinguishing features of savings and investments available from different institutions
(4) clarify personal philosophy regarding savings

SUGGESTED LEARNING EXPERIENCES

1. Look at the flip chart and read the various quotations on savings. Discuss what these mean to you. [NOTE TO TEACHER: Ask your librarian to help you find famous quotations on savings if others are not available.]

2. Brainstorm about various ways of saving to see the many different ways of saving. List all ideas on the board.

3. Read pp. 208-218 in Your Family and Its Money by Thal and Holcombe; pp. 234-237 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks; pp. 249-256 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 10-13 in the pamphlet; or pp. 76-89 in Consumer Economics by Wilhelms, Heimerl, and Jelley to find out the reasons for savings and the different ways of saving.

4. Discuss what savings mean to you. Make a list of all the assets you feel you possess (see Part Two, p. 134).

5. Examine the suggestions listed on the board in terms of the following questions: Which are "regular" savings? Which are investments? Which are determined and carried out by the individual? by his job? by laws? Are some expenditures actually ways of saving? Which ones?

6. Discuss such questions as: What do you save? What are the reasons for saving? What can you save other than money? Where do people put their savings? Who are the savers? Why do you need to set goals for saving? How does your family save? What are some of the factors that affect saving?

7. Write a paper on "Why do people save?" "What do you save?" and "Why do you save?" to see if you understand the philosophy for saving. Is your method of saving haphazard or systematic?

8. View the cartoon (see Part Two, p. 135) to identify some of the money-saving habits of people.

9. Review the story, Mama's Bank Account, by Kathryn McLean to see how Mama saved for her family. Was it haphazardly or systematically? Read the story, The Money Tree (see Part Two, p. 136), and compare the two methods of saving. Did they use the cookie jar method of saving? Why or why not? Discuss the questions at the end of the story.

10. Discuss ways that you could involve the whole student body in developing a regular habit of saving by participating in a savings program. Talk with school administrators to see about putting the program into action.

11. Listen to a symposium composed of representatives from a bank, a savings and loan association, a mutual savings bank, and a credit union explaining their savings programs. Discuss.

12. Make a chart showing the various places where you can save money, the rate of return, stability of value, safety of value, and the advantages and disadvantages of each of the different types of savings. Add any other factors you want to learn concerning savings. Discuss the chart after it has been completed and compare the distinguishing features of each type of savings.

13. Listen to a speaker from a credit union answer the following questions: What is a credit union? How does it operate? Who manages the credit union? How is it chartered? What are some of the "extras" they can do for their members?

14. Take a field trip to a bank and/or savings and loan company to find out about their savings program and the advantages and disadvantages of the various programs.

15. Find some references in the library on the Christmas Club savings, or interview a bank officer to find out about their purpose and how they operate. Discuss such questions as: Do banks pay interest on these savings? What is the difference between the old "cookie jar" way of saving and the Christmas Club? Why are Christmas Club saving accounts sometimes referred to as a "hole in the saving sock"? Who is really being helped? Discuss.

16. Read pp. 219-225 in Your Family and Its Money by Thal and Holcombe; pp. 77-87 in Managing Livingtime by Raines; pp. 92-104 in Consumer Economics by Wilhelms, Heimerl, and Jelley; pp. 256-271 in The Consumer and His Dollars by Schoenfeld and Natella; or pp. 253-258 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks to find out about investments and the ways people may invest their money for future goals.

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17. Discuss such questions as: What is the difference between savings and investments? What is the difference between investing and speculating? What is the difference between stocks and bonds? What is a mutual fund? Should you buy a mutual fund? What are risky investments?

18. Listen to a review of a book, How to Buy Stocks, by Louis Engle to give you a better insight into the world of investing. Discuss.

19. Listen to a superintendent or business manager explain how your school was financed. Ask him to discuss such questions as: When and why were the bonds issued? What is the rate of interest on them? Where did the money come from?

20. Inquire about municipal bonds from the city manager or mayor. Do they have some relation to the school bonds? If so, what is it? Discuss.

21. Discuss the two old sayings, "Don't put all your eggs in one basket" and "Before you invest, investigate." How do these apply to one's decisions about saving and investing money?

22. Work in small groups to devise some guidelines on "How to Be a Careful Investor." Discuss with classmates and compile a composite list.

    Build a hierarchy of savings and investment possibilities based upon your readings and discussions.

23. Listen to a broker discuss your list of guidelines and the heirarchy you developed. Ask if he agrees with your list or would offer other guides to help one be a careful investor. Ask if he agrees with your ranking of savings and investment possibilities. If he does not, what changes would he make? Ask other questions to clarify any points you do not understand concerning investments.

24. Calculate the dividends or benefits of a regular savings program and/or investment in a stock for a period of time.

25. Take one of the different ways of savings and investigate it further by the use of reference material and resource people. Report your findings to the class by the use of illustrative material.

26. Find articles in periodicals on either savings or investments. Write a short review of each article. Have a sharing session in which articles are passed around for all classmates to read.

27. Read this situation and discuss the questions: Johnny Thomas has accumulated $2,700 during the three years he has worked since finishing high school. He has no immediate need for the money and forsees no need for it until sometime in the future after he is married. Johnny has no marriage plans at the present time. The $2,700 is now in his checking account.

a. Should he have all of this money in his checking account? Why or why not?
b. Discuss three places where he could keep his money. What are the advantages of each?

28. Use the case study of Steve and Kathy (see Part Two, p. 129) and analyze their situation in terms of savings. Suggest alternate savings plans and the advantages and disadvantages of each. Decide on a final plan and tell the basis on which the decision was made. Determine what savings goals Kathy and Steve might hold at each stage of the family life cycle. How could they achieve these goals?

KEY POINTS

A regular habit of savings is one of the best ways to build a savings fund.

A savings plan helps an individual or family develop financial security.

Values and goals will influence the type of savings plan an individual or family will select.

Saving is assigning present income to future use.

The choice of a savings program will differ with individuals or situations.

Savings and investments may take many forms.

There is a certain amount of risk and uncertainty in investing money.

The wise saver and investor will secure information before putting his money into any form of savings and investments.

A savings and/or investment program needs to be evaluated periodically to see if it is meeting goals.

Money is only one resource that can be invested.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT IX: Credit

BEHAVIORAL OBJECTIVES

Be able to (1) recognize the role of credit in helping individuals and families maintain a satisfying life style
(2) identify the sources of credit available for different purposes
(3) describe the type(s) of credit available from different sources and the advantages and disadvantages of each
(4) identify factors which influence the cost of credit
(5) recognize the precautions one can observe to protect himself from deceitful practices and unwise use of credit
(6) exercise judgment in the selection of a source and type of credit for a given situation

SUGGESTED LEARNING EXPERIENCES

1. Take the pre-test on credit terms to see how many of the terms you can identify. Also answer the other questions on parts II and III of the pre-test about your feelings and those of your parents and friends concerning credit (see Part Two, p. 139).

2. Find as many advertisements as you can on credit and bring them to class to see how widely advertised credit is. Plan a bulletin board display of them. Are you surprised at the quantity? Why? Are you familiar with any of these advertisements?

3. Role play some television commercials advertising credit. Analyze these commercials. To what emotions and concerns of people do they appeal? Give examples. In your opinion, how strong is the influence of advertising on the individual's selection of a source of credit? Do the advertisements give sufficient information on which to make rational decisions? What other information is needed?

4. Read Chapter 7 in Your Family and Its Money by Thal and Holcombe, Chapter 10 in How to Live Better and Spend 20% Less by Dowd, Chapter 9 in The Consumer and His Dollars by Schoenfeld and Natella, or Chapter 10 in Consumer Economic Problems by Wilson and Eyster to find out what consumer credit is, why families use credit, types or kinds of credit available, and places where one can go to borrow money.

5. Develop a definition of credit from references and previous experiences. Explain what credit means to individuals, families, businesses, and society.

6. Discuss such questions as: What is credit? What are some examples of using credit wisely? Misusing credit? Do all families have or use some kind of credit? If so, what kind? How do people use credit? Do you feel that credit is responsible for our high standard of living? Explain. How does the family life cycle relate to the use of credit?

7. View the film, Consumer Education: Retail Credit Buying, from Bailey Films, to identify some of the problems involved in using credit. Discuss these questions: (1) How are the problems these two girls faced typical of situations in which you might become involved? (2) How could you use retail credit to good advantage, yet avoid getting into such difficulties as these girls experienced? (3) What is the significance of a credit rating?

8. Work in small groups and list the advantages and disadvantages of credit. Report your ideas back to the class. Can you add other ideas to the list?

9. Find out how widespread the use of credit is at the present time. Ask your librarian to help you find this information or find a magazine or newspaper article that discusses the current use of credit. Report your findings to the class.

10. Discuss such questions as: What is the basis of credit? What is a credit rating? What factors affect your credit rating? Discuss what the 5C's or 6C's of credit buying are and see what these things mean in relation to your credit rating. [NOTE TO TEACHER: Some references refer to 3C's others to 5 or 6C's.]

11. Make a chart with the 5C's or 6C's of credit and put down adjectives that you think would fit under each of the 6C's. The 6C's are: character, capital, conditions, collateral, capacity, and common sense. An example of an adjective would be responsible. Under which of the 6C's would this fit?

12. Visit the credit bureau or listen to a representative from the local credit bureau explain the procedures used to judge an individual's credit rating and the way businesses use this service. Ask how you might establish a good credit rating. Discuss such questions as: What is a credit bureau? Why is it needed? Who belongs to the bureau? What services does it provide? What are its purposes?

13. View the filmstrip, Credit Sources, from Visual Education Consultants to identify sources and the criteria each source requires for granting credit. Fill in the chart and answer these questions to summarize information: What determines the availability of credit? What factors affect the cost of a loan? (see Part Two, pp.140 and 144) Discuss with classmates.

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14. Participate in "Swing Around" the class to see the different items you have acquired through the use of credit. Group the items under the type of credit used. Be sure to include mortgages, telephone service, gas and water among the items named.

15. Examine the yellow pages in the telephone book to determine the types and numbers of lending agencies in your community. Some examples are: banks, credit unions, small loan or consumer finance companies, life insurance companies, pawnbrokers, savings and loan companies. Discuss.

16. Compile a list of all the different agencies that are in the business of loaning money. Investigate the advantages and disadvantages of each kind cf loan organization and make reports to the class. Discuss.

17. Work in pairs on a consumer credit project. Investigate one place that loans money to people and fill in the information on the form, Use This Chart to Compare Credit Costs (see Part Two, p. 145). Complete your chart when the other members of the class report on the agency that they went to visit. Which one would you select if you had to borrow money? Why?

18. Examine several loan application blanks used by various lending agencies to see what type of questions are asked on the forms. Why do they need to ask such questions? Discuss.

19. Present or read the skit, The Cashless, Checkless Society of the Future (see Part Two, p. 146), to find out what is meant by a "checkless" society. Discuss.

20. Interview attorneys, credit department managers, and loan agents to determine what happens when an individual or family cannot meet its credit obligations. Find out what help is available in your community when a family is in financial crisis and what the position of a minor is in relation to credit contacts. Ask if they think we will soon be a "checkless" society. Report findings to class.

21. Listen to some case studies of consumers who over-extended their use of credit. Discuss possible ways of helping them out of this financial crisis. An example of such an article would be "We Went Bankrupt--On the Installment Plan" by Helen Arnold on pp. 30-35 of the January, 1961 Reader's Digest.

22. Find articles in the newspapers concerning personal bankruptcies to become aware of the increase in the filing of bankruptcy among individuals. What is the law in Texas on filing bankruptcy? Discuss this in relation to the number of families filing today compared to the number filing thirty years ago.

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23. Visit a pawn shop and have the manager explain how his business operates and who uses his business. Ask an attorney what the state regulations are on pawn shop operations. Share this information with the rest of the class. Discuss.

24. Listen to a speaker from a credit union explain how it is organized and how it operates. Discuss.

25. Discuss such questions as: What is the statutory maximum small loan rate in Texas? Why are interest rates from small loan companies higher than those of some other kind of lending agency? If you were a lender, what questions would you ask a person before you loaned him money? What can a consumer do for his own protection when borrowing money? Should you co-sign another person's note? Why? Why are low-income families sometimes forced to obtain credit from illegal lenders? Where can you borrow with collateral? Without collateral? What are some gimmicks to watch for when borrowing money?

26. Read the play, The Signature, by Betty K. Gipson (see Part Two, p. 148) to determine some of the factors one should consider before signing a contract. What conclusions would you draw regarding the value of one's signature on a contract? The reliability of a salesman's promise? What is the significance of a contract? What information should Mrs. Bates have acquired before she purchased the sewing machine? What two resources did she find from which she could receive aid for this financial legal problem? What similar resources do you have in your community? [NOTE TO TEACHER: You may wish to expand this activity by discussing the questions and information at the end of the story.]

27. Interview an attorney to see if there are any illegal lenders in your community. If so, what is being done to eliminate them? What makes their operations illegal? Report findings to class.

28. Write a brief description of the different types of lending agencies in your community. If you had to borrow $200.00, which one would you select? Explain.

29. Read "Credit as a Resource" from Penney's Forum (see Part Two, p. 156) to gain an understanding of the uniform consumer credit code. Discuss article.

30. View the filmstrip, Truth in Lending, by the Federal Reserve Bank to identify federal efforts to protect the consumer. Discuss.

31. Role play a situation showing a father who has just opened the monthly bill from the department store. He is disturbed by his wife and daughter's purchases. Listen to all three present their viewpoints. Discuss the validity of their viewpoints. [NOTE TO TEACHER: Use this to introduce a study of the specific types of credit arrangements.]

32. Read pp. 157-161 in Consumers All by United States Department of Agriculture to identify some of the characteristics of installment credit. Discuss.

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33. View the filmstrip, The Installment Contract, by Visual Education Consultants to identify precautions one should observe before signing such a contract. Work in small groups to make "caution signs" which you think a prospective installment buyer should observe. Make "go" signs indicating the circumstances under which installment credit might be used. Share with class members.

34. View the film, Consumer Education: Installment Buying, from Bailey Films to examine the factors which affect the cost of installment credit. Discuss: How do the following affect credit costs? (a) high-risk loans, (b) length of loan period and (c) rate of interest. Give an illustration to demonstrate your points. What is sliding-scale interest? add-on interest? When and by what kinds of agency might each of these be used? Show how each of these kinds of interest is computed.

35. View the filmstrip, Charge It, Please, by Visual Education Consultants to identify the different types of charge accounts and the costs and distinguishing features of each type. Answer the following questions: (1) In what ways are charge accounts different from installment buying? (2) What are the types of charge account credit available? (3) What factors influence the cost of charge account credit?

36. Visit several stores to find out what types of credit they use. Contrast a regular charge account and a revolving account; and contrast a revolving account and the installment plan. List the advantages and disadvantages of each type. Discuss such questions as: What is cycle billing? Why have some stores adopted this? What factors determine one's ability to get a charge account? What is a credit card? What are the types of credit cards available? What are the advantages and disadvantages of using credit cards? What are some points to remember when using credit cards?

37. Read the article in the May, 1970 issue of the McCall's magazine, "Hazards of Unsolicited Credit Cards" by Betty Furness, to see the problems involved in unsolicited credit cards. Discuss this article and what can be done about the situation. Plan to take some action as a class to help eliminate this problem, such as writing to your senator.

38. Discuss such questions as: Do you know of anyone who has lost a credit card? If so, what happened? What should one do if he loses a credit card?

39. Work in small groups to investigate the cost of using the different types of charge account credit. As the basis for your investigations select one item that all groups agree to use. Determine the distinguishing features of the type of account you investigate. Let group A investigate the cost of an item if purchased on an open 30-day

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account; group II, a revolving charge account; group III, the 90-day account (a variation of the 30-day account); and group IV, a credit card account.

Compare costs and determine which type of credit would cost the least for this item. Under what circumstances would you use each of the other types of credit?

40. Work in small groups and develop a questionnaire that could be used in your school to find out how the student body feels about credit. Some of the questions on the questionnaire might be: Should you pay cash for everything? Why or why not? Is it cheaper to pay cash? Explain.

41. View the filmstrip, Credit Concepts, by Visual Education Consultants to help you summarize this unit on credit.

42. Work in small groups to write guidelines for the wise use of credit. Develop an appropriate title for your paper. Present your guidelines to the class in an interesting way.

43. Write your personal philosophy regarding the use of credit or write a paper to clarify your own feelings about credit. Compare these feelings with the ones you listed at the beginning of the study on credit. How have they changed?

44. Listen to excerpts from the book, Buy Now, Pay Later, by Black to find out about some of the different forms of consumer credit and some of its abuses on the unsuspecting public. Discuss. Find out whether the use of teen-age credit has increased since the book was written.

45. Listen to the words from the song, "Dollar Down, and a Dollar a Week," to identify what the song is telling us about credit. What do the words tell us as consumers?

46. Use the decision-making process to solve the case study of Steve and Kathy (see Part Two, p. 129 and 159). [NOTE TO TEACHER: The purpose of this activity is to give students an opportunity to apply previous learnings and make judgments regarding the use of credit.]

47. Shop for an item you feel you must have. What would the cost of the item be if you paid cash for it? If you purchased it by the use of credit? Which method would you select to use to pay for the article? Explain.

48. Find an article in one of the current periodicals concerning credit. Write a review of the article to show that you know where to secure recent information on credit. Be sure to list the periodical and the date.

49. Play the academic game, Consumer, by Western Publishing Company to gain experience in coping with the problems and economics of installment buying. [NOTE TO TEACHER: This game requires 11 to 34 players and requires 1-1/2 to 2-1/2 hours playing time. It can be played for two or three days if you have conventional scheduling or it could be played

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without interruption if you have modular scheduling. It also could be used with Future Homemakers or in summer homemaking.]

50. Play the game, Baseball, to summarize the unit on credit (see Part Two, p. 160).

KEY POINTS

Credit can be used to help individuals and families maintain a satisfying life style.

Credit is available from a variety of sources for a variety of purposes.

Each source of credit may offer several types of credit arrangements.

Each source and type of credit offers some advantages and some disadvantages.

The cost of credit depends on a combination of factors.

Individuals and families should select credit wisely to avoid deceitful lending practices or overextending their ability to repay.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT X: Insurance

BEHAVIORAL OBJECTIVES

Be able to (1) recognize the necessity for life and health insurance
(2) explain the different types of life insurance policies
(3) explain the different kinds of health insurance policies
(4) apply insurance information to some family situations

SUGGESTED LEARNING EXPERIENCES

1. Take the pre-test on insurance (see Part Two, p. 161) to determine your understanding of life and health insurance.

2. Read the story, Life Is a Risky Business, (see Part Two, p. 164) to identify some of the dangers involved in the story and then analyze the kinds of insurance needed by the people on Sycamore Street.

3. Read pp. 23-26 in A Date with Your Future by the Institute of Life Insurance; pp. 225-231 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 193-200 in Your Family and Its Money by Thal and Holcombe; pp. 29-34 in Personal Money Management by American Bankers Association; pp. 23-28 in Money and Your Marriage by National Consumer Finance Association; pp. 205-214 in How to Live Better and Spend 20% Less by Dowd; or pp. 3-9 and 13-23 in Policies for Protection by the Institute of Life Insurance to see the purpose of life insurance, the time to purchase life insurance, the amount to buy, and the characteristics of the different types of life insurance. Discuss.

4. Look in the yellow pages of the telephone book to see how many insurance firms are listed. How many different types of insurance are represented? Discuss.

5. Interview your parents or adult friends and find out how many different kinds or types of insurance they have. Share this information with the rest of the class. Identify the different kinds of insurance the class found.

6. Discuss such questions as: What are the major hazards a family faces? How can insurance help provide security to families? What are the psychological advantages of having adequate life and health insurance? How can insurance provide security upon the death or disability of the family's breadwinner?

7. Examine sample copies of life insurance application forms. Discuss the types of information needed on the forms. What minimum health requirements must be met? Why is it important to give accurate information on the form? Are life insurance contracts legal documents? Read the story, $100,000 or Nothing (see Part Two, p. 165) to realize what can happen when one fails to give accurate insurance information. Do the role playing situation suggested at the end of the story. Discuss the points made at the end of the story.

8. Work in small groups to analyze one of the types of life insurance. Be sure to identify the purpose of that particular type and the advantages and disadvantages. Compare costs and length and type of coverage. Report your findings to the rest of the class with the use of illustrative materials. As the reports are given, prepare a chart showing the major features of the various forms of life insurance. Use the following form as a suggestion to help you.

   TYPES ADVANTAGES DISADVANTAGES WHO SHOULD BUY THIS TYPE?

9. Listen to an insurance agent explain what he feels is the minimum amount of insurance a person needs to carry in the various stages of the family life cycle. Ask him to answer some of the following questions: Who needs life insurance? Should the mother carry life insurance? Should children in the family have life insurance coverage? What are the advantages in adult life of having had insurance coverage as a child? How should life insurance premiums be paid? Do you feel families carry enough insurance? Do people buy insurance for investments? If so, is it a wise practice? Discuss.

10. Examine some sample life insurance policies to become aware of what is included in the various policies. Jot down any questions you might have to ask the insurance agent to clarify points you don't understand.

11. Listen to another insurance agent explain the basic types of life insurance as well as the procedure for converting from one policy to another type of policy. Also ask him to answer questions such as: What are the advantages of group life insurance to the employee? To the employer? Would a person need to buy additional insurance if he is already covered by a group policy? Why? Why is it important to select an insurance agent with care?

12. Work in small groups to develop some guidelines that would help an inexperienced shopper select insurance wisely. Let an insurance agent check over your guidelines.

13. View the filmstrip, Dollars for Security, by Institute of Life Insurance to find out what insurance can do for you. Discuss questions asked on filmstrip.

14. Consult with your parents on the different types of life insurance they have. Do you feel it is adequate? Why? What changes would you make?

15. Discuss such questions as: How can consumers be protected from "fly by night" insurance companies? What are the basic regulations in Texas concerning insurance? What kind of protection do consumers have against fraudulent insurance?

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16. View the filmstrip, Consumers in Action, by Institute of Life Insurance to evaluate their goals in relation to the future. What place did insurance play in their decision making? What other factors influenced their decision? What changes may this couple decide to make in their present insurance program? What factors will influence these decisions?

17. Find out if your school has accident insurance. If so, ask the principal or proper authority to come in and discuss why he feels students should carry this type of insurance. Find out also how many claims have been made by students in your school.

18. Read pp. 10-23 in Policies for Protection by the Institute of Life Insurance and pp. 185-192 in Your Family and Its Money by Thal and Holcombe to determine the major reasons for health insurance, the different kinds of organizations which provide health insurance, the different kinds of health insurance policies which are available, and the factors which contribute to the cost of health insurance. Discuss these factors.

19. View the instant slides on Dollars for Health adapted from the Institute of Life Insurance (see Part Two, p. 167) to determine some of the benefits individuals and families derive from health insurance. Discuss. [NOTE TO TEACHER: Instructions and materials for preparing these instant slides are found on p. 12 in Part Two.]

20. Obtain sample accident and health insurance policies to see the various types of coverage. What is meant by a deductible clause? Discuss.

21. Listen to an insurance agent discuss the variations among health insurance policies. Formulate a list of questions on health insurance and give them to him so he can answer your individual questions.

22. Discuss such questions as: What are the advantages of health insurance? Why is it important? What are the different types of health insurance policies? How does each type fit into an individual's needs?

23. Find some interesting facts concerning health and life insurance and develop a bulletin board. Ask your librarian to help you find some statistics on insurance.

24. Review the filmstrip, Marriage and Money, by Institute of Life Insurance to determine the kinds of insurance the couple might need. Use the management process to arrive at your decision for this couple.

25. Recommend the type of life insurance policy you think is appropriate for the individuals described in the situations on p. 27 in Policies for Protection. Give reasons for your recommendations.

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26. Answer the questions on "What Have We Learned?" (see Part Two, p. 176) from Policies for Protection to evaluate what you have learned about life and health insurance.

27. Complete the crossword puzzle (see Part Two, p. 179) from Policies for Protection to review terminology you have used during this unit.

28. Review the story, Steve and Kathy (see Part Two, p. 129). Analyze their needs, resources, and goals, and plan a suitable life and health insurance program for them for their first year of marriage. How will their insurance needs change during the various stages of the family life cycle?

29. Work in small groups to analyze the needs, resources, and goals of the four couples described in Financing a New Partnership. Recommend suitable life and health insurance policies for the couple you were assigned. Give reasons for your recommendations and report all this information to your classmates. You may wish to role play a transaction with one of the couples, do a bulletin board or instant slide presentation, or use some other media to make your report interesting.

30. Continue working in small groups to develop questions on insurance for the game, Jeopardy (see Part Two, p. 181). Play this game with your classmates. This should help you review and summarize what you have learned.

KEY POINTS

There are several types of life insurance and health insurance.

The consumer needs to adapt his insurance coverage to his income and needs.

The security derived from life insurance appears to be a value of the American people.

Personal insurance reduces economic risk and increases family security (actual and psychological) by protecting against possible financial loss.

Insurance can be an investment as well as a protection.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT XI: Social Security

BEHAVIORAL OBJECTIVES

Be able to (1) describe the social security program and the benefits that are derived from the program
(2) recognize the need for keeping up-to-date on social security information and benefits
(3) identify the times when it is necessary or desirable to consult the social security office

SUGGESTED LEARNING EXPERIENCES

1. Find out how many classmates have a social security card. Discuss what this card means to them. Report your findings to the class.

2. Read pp. 200-207 in Your Family and Its Money by Thal and Holcombe; pp. 289-304 in Consumer Economics by Wilhelms, Heimerl, and Jelley; pp. 563-580 in Consumer Economic Problems by Wilson and Eyster; or pp. 330-335 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks to find out the major provisions of the federal Social Security Act.

3. Read the two pamphlets secured from your local social security office called Social Security Information for Young Families and Social Security in Your Financial Planning to see what is included in the Act, who is included in the Act, and how social security claims are figured.

4. Listen to a sociologist or a social studies teacher discuss the background of the Social Security Act, why the Act was passed and amended, the philosophy upon which it is based, the constitutional grounds for such legislation, and varying public opinions concerning it.

5. Discuss such questions as: What is social security? Why was the federal social security program developed? What are the major provisions of the federal Social Security Act and how do they affect us as individuals? Why do we need financial protection against risks of unemployment, old age, disability, and accidents? What are the benefits derived from social security? Who pays for these benefits? What is the relationship of the federal government to the social security program? Who qualifies for social security? When does a person need to consult the local social security office?

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6. See the film, The Social Security Story, from your local social security office. Discuss the following questions based on information from the film: What happens to the reports of earnings employers send in? How are earnings records kept? What should you do when you lose your social security card? Why do you need to contact the social security office every three years?

7. Listen to a resource person from a local social security office explain the factors that people need to understand about social security, the benefits received from the program, when they should consult the office, and how to figure social security claims.

8. Interview grandparents or older people to find out if they are familiar with the benefits they can receive from social security. Also discuss such factors as: Do they feel that the benefits are adequate for them? If not, why not? Report your findings to the class.

9. Complete the following open-ended statements to assess your understanding of social security.

   1. The basic idea of social security is _____.

   2. A person needs to keep up with changes in social security because _____.

   3. You need a social security card if _____.

   4. Social security benefits are paid for a. _____, b. _____, c. _____.

   5. Three rules for keeping social security records are 1. _____, 2. _____, 3. _____.

KEY POINTS

The changes in the circumstances accompanying family life stages influence the availability of resources and the demands made upon them.[1]

The family economy affects and is affected by the larger economy.[1]

Social security benefits are divided into three broad categories: the unemployment insurance program; the old-age, survivors, and disability insurance program; and the medicare program.

It is important to maintain reliable social security records including your card and account number, earnings credited to you, and documents that prove marriage and date of birth of family members.

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[1]Taken from Concepts and Generalizations: Their Place in High School Home Economics Curriculum Development. Washington, D.C.: American Home Economics Association, 1967.

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SECTION ONE: ALLOCATION OF RESOURCES

UNIT XII: Taxes

BEHAVIORAL OBJECTIVES

Be able to (1) examine the effect of taxes on the family income
(2) identify benefits derived from taxes
(3) recognize the various types of income tax forms and the financial records necessary for completing them
(4) accept willingly your future responsibility for paying taxes

SUGGESTED LEARNING EXPERIENCES

1. Take a pre-test to determine your Tax I.Q. (see Part Two, p. 183).

2. Read pp. 275-288 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 378-405 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks; or pp. 424-448 in Consumer Economics by Wilhelms, Heimerl, and Jelley to identify who pays for goods and services provided by the government and to become familiar with the different types of taxes.

3. Discuss benefits citizens receive as a result of taxes, such as recreational facilities, parks, library, protection, highways, and educational materials.

4. Look at the various forms that are used to calculate federal income tax and county and local taxes to become familiar with information that is on the various forms. Discuss what items are included.

5. Discuss ways of securing and recording the necessary information for tax forms and develop a form that would be suitable for you. Why is it important to keep accurate information?

6. Discuss what is meant by the statement made by Oliver Wendell Holmes, "I like to pay taxes. With them I buy civilization."

7. Discuss questions such as: Who pays for parks? Who pays for streets and roads?...repairing them? Who pays the salaries of policemen?... firemen?...city librarians?

8. Listen to a resource person, such as the county clerk, explain the local or county tax levy and the way in which taxes are collected. Discuss his talk.

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9. Work in small groups and complete a list of ways in which our financial resources are shared with others. Classify according to voluntary and compulsory categories and indicate which ones are local, county, state, and federal. Discuss the listing. Do you all agree?

10. Listen to a person from the Department of Internal Revenue discuss factors you need to follow when filling out a form. Work with him on completing a form.

11. Find a cartoon, editorial, or quotation concerning taxes. Write a short paper on what this means to you as a person.

12. Listen to a senator explain the uses made of the federal income tax collected or write to one for this information. Discuss.

13. Interview the principal, superintendent, or business manager to find out if your school receives any financial aid as a result of taxes besides the amount of school tax paid in your community. Find out how taxes pay for school supplies, buses, food, salary, and building upkeep. What is the cost per pupil? Discuss this cost in terms of financing your education. Could you afford to pay this cost each year?

14. Work in a small group and see if you can find the distribution of the tax dollar on the local, state, and federal level. Ask your librarian to help you find this information. Report your findings to the class in an interesting way.

15. Compile a list of ideas showing different ways consumers can help reduce taxes. Include such ideas as the prevention of littering, vandalism in schools, and vandalism in public buildings. Make posters to convey these ideas to the rest of the student body and your community.

16. Interview adults who are paying taxes and ask them for their opinion concerning the local and state taxes. Report findings to the class. Do you think these adults were aware of the benefits they receive from the tax dollar? Explain.

17. View an exhibit to see the various types of forms used for tax purposes. Examples of these forms would be appraisers' schedules, income tax blanks, and city and county tax notices. Examine them.

18. Make a list of the kinds of protection against hazards we receive as a result of taxes. For example: crime, pollution of air and water, contagious diseases, and unsafe food.

19. Write a paper showing different ways the government, through the use of taxes, provides financial assistance to individuals, families, business enterprises, and international agencies.

20. Write a short paper explaining why people should accept willingly the responsibility for paying taxes.

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KEY POINTS

Tax funds help to secure for the citizens certain benefits in the form of property for public use, welfare services, and protection. These benefits can be provided more economically through the use of tax funds than from individual sources.

Accurate records are necessary for some aspects of family finance. The accuracy and completeness of these records is the responsibility of the person filing the return and paying the tax.

Resentment toward taxes may stem from failure to understand the tax structure and the benefits derived from taxes.

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PART ONE

SECTION TWO: CONSUMER BUYING

SECTION TWO: CONSUMER BUYING

UNIT I: Factors Influencing Consumer Purchasing

BEHAVIORAL OBJECTIVES

Be able to (1) recognize factors which affect the attainment of goods and services
(2) relate these factors to the judgments individuals make in selecting goods and services
(3) identify individual pressures which influence buying decisions
(4) recognize and appraise pressures which businesses exert on consumer purchasing decisions
(5) evaluate relevant factors, formulate judgments, and establish priorities in the purchase of goods and services

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 28-37 in Managing Livingtime by Raines to determine factors which affect one's attainment of goods and services. Discuss.

2. Role play a situation in which a mother, father, and children have widely differing opinions on plans to make a major purchase. For help in structuring the situations, refer to But Couldn't We Buy This Car? (see Part Two, p. 225). Discuss the effects of factors such as the following on each member's choice of a car: amount of money available, standard of living each aspires to maintain, personal preferences and satisfactions sought, personal resources (e.g., physical and mental abilities, judgment, age, sex). Analyze the influence of these factors on the selection of a car if your family were buying another car--if your grandparents were buying another car.

3. View the 3M Transparencies 29, E, I, J, and K, Consumers: Who? Why? How? to stimulate discussion of economic, psychological, and sociological pressures which influence buying decisions.

4. Read pp. 44-53 and 159-166 in Consumer Economics by Wilhelms, Heimerl, and Jelley and pp. 81-85 and 106-119 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks to learn about motivations which affect buying. Discuss.

5. Work in small groups, with each group member listing five purchases that he or his family members have made recently. Analyze the motivations

these purchases and classify purchases under these types of motivations:[1]

1. Physical well-being
   a. appetite
   b. comfort and rest
   c. exercise
   d. self-preservation
2. Creativity
3. Recognition
4. Knowledge
5. Beauty and fashion
6. Recreation
7. Financial gain

Discuss each group's analysis of purchases. Discuss such questions as: What other factors influenced the purchase of these five items? Which purchases were planned--which impulsive? Did you plan to buy some item(s) and then change your mine? What prompted decisions not to buy or impulses to buy? With which purchases have you been most satisfied--dissatisfied? Why? Draw conclusions regarding types of business pressures which influence purchases.

6. Go through the self-instructional program, Advertising...Friend or Foe, to learn about advertising appeals, forms of advertising, consumer protection agencies, and consumer responsibilities for truthful advertising. Take the post-test and then discuss the questions.

7. View 3M Transparency 29-N from Consumer: Who? Why? How? as a basis for discussion of these advertising techniques: conformity, imitation, association, suggestion, intellectual appeal, and snob appeal.

8. Bring to class copies of two or three advertisements that make you want to buy what is advertised. Analyze the advertising techniques used in each. Compare and evaluate the claims made in the advertisements, and rate the ads as (1) excellent and probably valid, (2) mediocre, or (3) fantastic and unrealistic.

9. Observe and note the types of things advertised on TV at different times of the day and the types of commercials which accompany certain shows (e.g., cereals with children's programs). What advertising techniques are most frequently used? Which advertisements are realistic? Which ones are most fantastic? Discuss.

10. Collect examples of promotional devices that stimulate consumers to buy and list others that you have seen. Analyze the basis of their appeal. Discuss advantages and disadvantages of such devices as prizes, premiums, trading stamps, coupons, contests, discounts, special introductory offers, sales (one-cent, anniversary, inventory) price reductions, referral sales, special displays, unusual packaging and labeling, free merchandise, and others you have experienced.

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[1]Taken from Consumer Education. Albany, New York: The University of the State of New York, The State Education Department, Bureau of Secondary Curriculum Development, 1967. p. 6.

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11. Present the skit, Americans Spend Money on the Word "Free" (see Part Two, p. 261), as a basis for discussion of gimmicks used by merchants to encourage people to buy.

12. Write a short paper titled "Money to Burn" in which you describe a most unsatisfactory or useless item bought on impulse or as a "bargain." Discuss the factors which motivated the purchase of this item.

13. React to the following situations to become familiar with the idea of opportunity costs.

    A. Think of the last major item your family bought. Write at least three other ways this money might have been spent. What influenced your decision to spend the money as you did?

    B. Write at least four things you would like to buy that cost about $5. Realizing that only one item can be purchased, which one would you probably choose? What is meant by opportunity costs? What factors would influence you to give up the other four?

KEY POINTS

Goods and services attained by individuals and families are affected by values, amount of money available, price of merchandise, standard of living, personal preferences, satisfactions sought, and personal resources.

Individual differences in the factors which influence one's attainment of goods and services are related to the judgments consumers exercise in their selection of goods and services.

Most people hold in common certain sociological and psychological motivations which influence their purchasing decisions. Producers recognize and appeal to these motivations.

The wide variations in goods and services bought and in buying habits reflect individual and family differences within this motivational framework.

Knowledge of advertising techniques may help the consumer to become a more discriminating buyer and enable him to make educated choices.

Promotional devices may be misleading, but if the consumer evaluates them carefully, he may make some excellent buys.

The decisions to buy one item may involve not only the dollar cost of that item but also foregoing the purchase of other items the consumer wants or needs.

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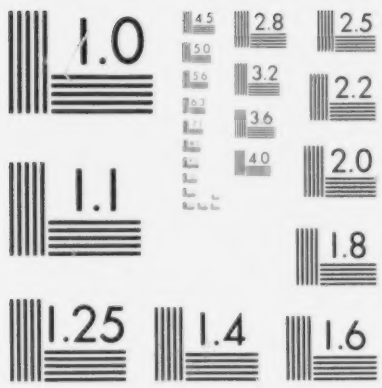

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SECTION TWO: CONSUMER BUYING

UNIT II: Principles of Consumer Purchasing

BEHAVIORAL OBJECTIVES

Be able to (1) recognize the advantages and disadvantages of shopping different types of facilities
(2) recognize the relationship between customer services and prices of merchandise
(3) establish priorities for spending based on what you already have and your long range goals
(4) compare and evaluate product information from a variety of sources
(5) establish criteria for selection of purchases
(6) acquire knowledge of appropriate use and care of products purchased
(7) investigate alternatives you may pursue when a product does not meet expectations
(8) apply guides which lead to more effective purchasing when making personal purchases
(9) test a product by adapting procedures used by testing organizations

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 22-25 in Your Shopping Dollar by Household Finance Corporation for a discussion of the different types of shopping facilities. Classify shopping facilities in your community as:

   Retail stores--department, specialty, variety, discount

   Non-store retailers--door-to-door salesmen, mail order services, vending machines

   Cooperatives

2. Listen to a representative of a consumer cooperative explain the operation of co-ops. Discuss.

3. View the transparencies (see Part Two, p. 185), and discuss types of shopping facilities and services each may offer that would appeal to consumers. Include such items as physical plant facilities, credit for customers, approval privileges, consultation services, installation service and repair, and trade insurance.

4. Work in small groups and visit the various kinds of shopping facilities. To secure information quickly and concisely, use the check sheet, Services of Shopping Facilities (see Part Two, p. 189). Select three items that each of these facilities might stock and secure prices on them as you obtain the other information. Report findings to class and discuss advantages and disadvantages of each type of shopping facility visited. Compare costs of the three items which were priced. Draw conclusions regarding the cost and quality of consumer services available in the different types of shopping facilities.

5. Interview and evaluate the spending habits and shopping ability of three adults. Use the questionnaire and opinionnaire on p. 16 in A Department Store in the Classroom by Sears, Roebuck and Company. Discuss responses.

6. Read pp. 150-168 in Consumer Economics by Wilhelms, Heimerl, and Jelley to find out what factors contribute to effective planning and selection of purchases. Solve some of the consumer problems and projects at the end of the chapter. Discuss.

7. View the transparency (see Part Two, p. 97) to outline guides for effective shopping. Relate the guides listed below to the decision-making process:

   a. Take an inventory of what you have.
   b. Look ahead to what you hope to achieve.
   c. Establish priorities.
   d. Make a plan for purchase of your top priority. (Guides 1-4 were covered in Part II, Allocation of Resources.)
   e. Locate, study, compare, and evaluate information from varied sources relevant to the product you wish to purchase. Include reports from consumer sponsored agencies, catalogs, exhibits, periodicals, government publications, salesmen, manufacturers' pamphlets and brochures, consumers' opinions, labels, seals, tags, instruction booklets, guarantees, and warranties.
   f. Establish criteria for selection.
   g. Acquire knowledge of appropriate use and care of purchase.
   h. Investigate alternatives one may pursue when product does not meet expectations.

8. Read pp. 234-237 in Consumer Economics by Wilhelms, Heimerl, and Jelley; pp. 41-50 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 399-401 in Consumer Economic Problems by Wilson and Eyster; or pp. 85-88 in Legal Protection for the Consumer by Crown to learn about the following consumer-sponsored agencies: Consumers' Research, Inc., Consumers Union of United States, Inc., American Council on Consumer Interests, Consumer Cooperatives, and Cooperative League of the U.S.A. (Also see Part Two, p. 190.)

9. Discuss these questions: What services are provided by each of these agencies? What publications do they prepare? What information is included in the publications? Is advertising used in the publications? Why or why not? How do manufacturers feel about Consumers' Research, Inc. and Consumers Union? How can their attitudes be explained? Which type of information would you consider most reliable: a product

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evaluation published by Consumers Union, a test report issued by a manufacturer, or a testimonial given by a satisfied customer? Explain.

10. Work in interest groups and select a product to test, adapting the procedures used by the Consumers Union. For example: girls might develop a score sheet to rate cosmetics, hand lotions, or similar items they already have. Boys could rate shaving lotions, food items, or similar products. Share results with class. Discuss.

11. Select a product in which you are interested and find out what Consumer Reports and the Consumer Bulletin have indicated about these items. Which brand and model would you select if you were going to buy the product? Give reasons for your selection.

12. Discuss the topic, "Resolved: Ratings from consumer-sponsored testing organizations are reliable," to clarify views on these agencies.

13. Read: "Nice People to Do Business With," Consumer Report, June, 1967, pp. 332-333, to find out what companies look into consumer complaints for the customer. Discuss.

14. Read pp. 401-402 in Consumer Economic Problems by Wilson and Eyster or pp. 55-56 in The Consumer and His Dollars by Schoenfeld and Natella for information about services provided by professional organizations. Discuss.

15. Volunteer to interview businessmen who belong to these organizations (see Part Two, p. 192):
American Bar Association
American Retail Grocers Association
National Furniture Merchants Association
National Farm Federation
AFL-CIO
Ask them what kinds of information these organizations have provided for consumers. Report your findings to the class.

16. Invite members of professional organizations to discuss with the class the contributions their organizations have made to consumer welfare and their reasons for making these contributions. Ask them to discuss reasons their professions deal with issues of concern to the consumer. Discuss their presentation.

17. Discuss such questions as: What are the advantages of mail-order shopping? What are some of the disadvantages of mail-order shopping? How do catalog prices compare with those in the store? Why? Does this indicate it is more economical to shop by catalog? In what way could checking information in catalogs before going shopping in other types of retail outlets be helpful? What procedures must be followed for returning items purchased from a catalog?

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18. Bring articles to class that were purchased through a mail-order catalog or contact a mail-order store and borrow items that are described in the catalog. Compare the actual items with the descriptions in the catalog and evaluate the adequacy and accuracy of the description.

19. Select an item in which you have an interest and compare descriptions of different levels of quality of the same item. What makes the difference in the prices? In other words, what determines quality? Does the information given in the descriptions adequately explain the price differences?

20. Look for information on wear, care, and use of items in catalog descriptions. How does the amount of information compare with what the customer would like to find in a place of business? Fill out an order blank for several articles in the catalog to find out what information must be included.

21. Discuss types of information that can be obtained from exhibits and/or exhibitions at trade fairs, home shows, conventions, or other gatherings where there are displays of merchandise.

22. Plan a visit to a home show or trade fair or exhibit of some kind during the semester. Discuss the type of information gained from exhibits of this sort and advantages of obtaining product information from this source.

23. Work in small groups and examine publications such as the following to find out what kind of product information they give. How reliable is it? On what do they base their information? Discuss reasons popular magazines carry articles which give consumer information. (What's New in Home Economics, Forecast, Co-ed, Seventeen, Good Housekeeping, Parents' Magazine, Changing Times, Redbook, newspapers, and publications from Sears and Penney's)

24. Write to the Superintendent of Documents, Government Printing Office, Washington, D.C. and ask for their publication list in an area of interest to your class; or visit your local extension office and ask about the publications they have available. Examine these publications and discuss the variety of information provided.

25. Discuss such questions as: How much information are salesmen usually able to give about their products? How reliable is information given by sales personnel? What kind of training programs do stores provide for their sales employees? What is the purpose of the training programs? What responsibility is left to the consumer?

26. Read or adapt for a skit presentation the story, Julie Meets a Salesman (see Part Two, p. 193) and discuss the way in which Julie handled the situation as well as the techniques used by the salesman.

27. Role play situations in which a sales person is trying to sell a product. Evaluate the information given by the sales person and the decision made by the customer.

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28. Keep a record of the information given by sales personnel when you shop during the next week. Report findings to the class and discuss accuracy and adequacy of the information given.

29. Interview at least two sales people, asking them to complete these open-ended statements: a. I wish I could refuse to wait on customers who... b. It is a pleasure to wait on customers who...

30. Discuss such questions as: How can information from other consumers be used? What factors need to be considered when asking others for advice? Under what circumstances would you follow the advice given by other consumers?

31. Go through the self-instructional program, The Great Label Question from Home Economics Instructional Materials Center to find out what information is provided on labels, the difference between voluntary and mandatory labeling, and the consumer's responsibility for improving labeling practices. Take the post-test to evaluate what you learned from the program.

32. Read pp. 202-223 in Consumer Economics by Wilhelms, et al. to learn about the value of labels, requirements and standards for labeling of processed foods, grade labeling, acts affecting labeling of textiles and clothing products, and reliability of labels. Discuss.

33. Read the pamphlet, Look for That Label, U.S. Government Printing Office, and discuss the laws which regulate the information to be included on labels on furs and fabrics.

34. Bring to class labels from clothing, food items, furniture, appliances, cosmetics, drugs, and medicines. Work in small groups, with each group examining one type of label, such as clothing or foods. Use the check sheet (see Part Two, p. 195) to compare the information given on the various labels. Report findings to the class, including answers to the following questions:

    What information is found on all the labels?
    What additional information tends to be found on labels?
    Which labels would be most helpful to consumers? Least helpful? Why?
    What information on the label would help the owner of the product in the use and/or care of the product?
    Of what value is the information on the labels?

35. Read pp. 402-405 in Consumer Economic Problems by Wilson and Eyster; pp. 227-234 in Consumer Economics by Wilhelms, Heimerl, and Jelley; or pp. 50-54 in The Consumer and His Dollars by Schoenfeld and Natella for information on some of the associations and organizations which have developed seals, certifications, grade marks, and ratings.

36. Select a private business or industrial organization (see Part Two, p. 196) and find out its functions and purposes. Present the information in a "question interview" television program or prepare an idea for a transparency which would illustrate the products covered by the agency and the seal used, if there is one. Discuss the information presented.

37. Bring in labels or products which carry the seals used by the organizations and agencies discussed in class. Discuss the product on which it was used, the standards which had to be met by the product, and the meaning of the seal or label.

38. List the products advertised in a magazine and indicate whether there is any seal, label, certified test, or testimonial to indicate the standard of quality of the product. Compare lists and discuss.

39. Write to Parents' Magazine, Good Housekeeping, and McCall's magazines and to some of the other private agencies for information about their testing procedures and the standards they set for evaluating products. Report findings to the class.

40. Invite a representative from the Better Business Bureau to talk with the class about their services and their suggestions about evaluating the various testing and certification programs. Discuss.

41. Show the film, The Better Business Bureau, which can be borrowed from your nearest Bureau to see the services provided by the Bureau and become aware of examples of fraudulent schemes. Discuss.

42. Discuss such questions as: Why do you think some manufacturers organize an association and use a seal to indicate that products of the association members meet certain requirements? Why do companies like Burlington, DuPont, Sears Roebuck, and J.C. Penney operate quality control laboratories? What contributions have testing and rating agencies made to consumer welfare? How reliable are certification seals and ratings as buying guides? What factors should be considered when rating the values of magazine endorsements?

43. Read pp. 90-101 in The Consumer and His Dollars by Schoenfeld and Natella to give you some help in establishing criteria for selection of a product. Discuss the "Seven-Way Test of Buymanship" and the factors to consider regarding off-season purchases, bargains, and sales included in this chapter.

44. View filmstrip, Consumers in the Market Place, from the Institute of Life Insurance to review decision-making and to introduce comparative shopping. View a display of pictures of three different items (e.g., a garment, an appliance, and a car). Work in one of three groups and establish general criteria for the selection of any one of these items. Apply these criteria to the selection of the other two items until they are general enough to guide the selection of almost any product. Pool ideas. Include criteria related to durability of materials and workmanship, satisfactions received from ownership, availability and reliability of service, and appropriateness for intended use. Discuss.

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45. Collect a variety of guarantees and warranties. Work in small groups to analyze and evaluate the guarantees and warranties. Use the following questions as guides for evaluation:

    a. What part(s) of the product is(are) guaranteed or under warranty?
    b. What is not covered by the guarantee?
    c. What is the purchaser's responsibility to make and keep the guarantee valid?
    d. Under what circumstances will it become invalid?
    e. For how long is the guarantee effective?
    f. Will the guarantee refund money or replace product in case of defects or failures?

    Classify guarantees as valuable or of little value. Discuss findings with class. Give reasons for your evaluations of the guarantees and warranties.

46. Write a guarantee which is of value and one of little value for some product(s) of your choice. Share with class members. Choose the ones which would be of value to consumers and discuss limitations of the other ones.

47. Examine use and care manuals for appliances in the homemaking department. Work in small groups to read manuals and role play the following situations:
    a. A young couple planning to buy this appliance asks a sales person to explain how it works, the care it requires, and what special features it has.
    b. A homemaker has just purchased this appliance and the company's home economist has come to her home to demonstrate use, care, and special features of the appliance.
    c. A very dissatisfied customer comes to the dealer's office to wage a complaint about an appliance that does not work properly. An investigation proves that the customer has not read or followed the manufacturer's instruction booklet.

    Discuss kinds of information included in instruction booklets and the importance of reading this information in order to get the best use of the product.

48. Plan a bulletin board display emphasizing importance of reading manufacturers' pamphlets and brochures.

49. Ask a serviceman to discuss the importance of appropriate use and care of appliances and how to avoid unnecessary service calls. Encourage serviceman to give examples to illustrate his points. Discuss his comments.

50. Work in small groups and look for information about procedures for minimizing service and repair costs. Report findings to class.

51. Read and discuss pp. 375-377 in Consumer Economics by Wilhelms, Heimerl, and Jelley to identify alternatives the consumer may pursue when a product does not meet expectations.

52. Listen to a panel of three or four sales managers or persons in charge of investigating customer complaints of defective merchandise discuss their stores' policies and problems in making good the warranties and guarantees on merchandise sold. Discuss the information they present.

53. Write a paragraph on the consumer's rights and responsibilities regarding merchandise that does not meet expectations.

54. Select one item for purchase. Work individually or in small groups to acquire information from as many of the sources studied as possible about three or four brands and at least two different qualities of this product. Record information and its source. Include information regarding use and care of product and alternatives one may pursue if product does not meet specifications. Establish criteria for selection of this product. Report experiences and findings to class.

55. List major purchases you will probably make during the next year. Choose one of these anticipated purchases and develop a spending plan for it, using the decision-making process. [NOTE TO TEACHER: This activity could be used for a home experience.]

KEY POINTS

The efficient shopper needs to familiarize himself with the advantages and disadvantages of the various shopping facilities available and the services each offers.

Services and conveniences available to the consumer may increase the cost of merchandise.

Use of decision-making process when planning purchases may help one to acquire more of the things he needs and to receive greater satisfaction from his purchases.

Planned spending is usually more effective when one establishes priorities based on what he already has and his long range goals.

The consumer who studies, compares, and evaluates the information available from a variety of sources is better prepared to make intelligent, satisfying purchasing decisions.

Knowing appropriate use and care of products purchased and applying that knowledge may help the consumer receive maximum satisfaction from his purchase and may help him avoid costly or embarrassing service calls.

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The consumer has certain rights and responsibilities regarding merchandise he has purchased that does not meet expectations. In each instance, there are certain alternatives he may pursue.

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SECTION TWO: CONSUMER BUYING

UNIT III: Buying Services

BEHAVIORAL OBJECTIVES

Be able to (1) appraise the variety of choices within each service area and select those that best meet personal needs
(2) recognize some of the rights and responsibilities of the buyer and the seller in the purchase and execution of a service
(3) recognize the relationship between these two factors: (a) the quality of a service and the efficiency with which it is performed and (b) the degree of understanding that is reached between buyer and seller regarding what each expects of the other

SUGGESTED LEARNING EXPERIENCES

1. Make a list of all the services you and your family have purchased during the past six months. Compile findings under the headings suggested below to determine in what areas services have been most frequently needed.

   Personal services (dry cleaners, beauty shops, laundries, barber shops)
   Professional services (doctors, lawyers, dentists, accountants)
   Household help (yard care, household help, child care)
   Repair services (appliances, equipment, cars, TV sets, record players)
   Financial services (banking, credit, insurance, and investments)

2. Study p. 13 in Your Shopping Dollar by Household Finance Corporation to become familiar with guides for selecting services. Discuss these guides.

3. Role play the following situations in order to explore what the buyer and seller of a service expect of each other. [NOTE TO TEACHER: Further role play situations for selecting financial services and personal services may be developed if desired.]

   The hiring of a person for household help, baby sitting, or yard care (Household help)
   The making of an agreement between a parent and an orthodontist to begin the process of having a child's teeth straightened. (Professional services)

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Taking a television set into a shop to have it repaired and adjusted. (Repair services)

Discuss the role play situations and compile general guides one would consider in selecting services in each of the areas discussed. Include these points:

Cost of service, when and how they will be paid.
Exactly what you will receive for your money.
An understanding of the terms of any paper you sign.
Hours the service is available.
How complaints are handled and adjustments made.
How to evaluate the reliability, competence, training, licensing, and honesty of the service person.
What the seller of the service expects from you, the buyer.

4. Invite a representative from each service area, if possible, to participate in a panel discussion of the guides compiled for selecting services. Ask panel members to discuss points made under each guide and to suggest ways whereby the consumer could help the service person render his best and most efficient service.

5. List one service with which you or your family are sufficiently pleased to use repeatedly when this service is needed. Describe this service in terms of the guides one should consider when selecting a service. Form groups according to the types of services represented. Within each group, compare your choices. Analyze reasons for different choices. Discuss with all class members. Draw conclusions regarding the wide variety of choices available within each service area and the influence of individual differences on making choices.

6. Work in groups to describe an unpleasant and unsatisfactory situation involving the use of a service. Each group may present its situation to the class in whatever way it chooses. Possible techniques are:

   (1) Role play the situation, asking the rest of the class to identify with the buyer or the seller; then reverse roles in order to view the other side.
   (2) Write and present a simple skit.
   (3) Conduct an informal debate.
   (4) Find or draw a cartoon depicting a dissatisfied consumer and a harassed service person.

Analyze each situation to determine what went wrong and how it could have been prevented or improved.

KEY POINTS

Consumer services may be classified under these headings: professional, personal, household help, repair, and financial.

The wide variety of choices within each service area affords the consumer an opportunity to be discriminating in selecting those best suited to his needs.

Both the buyer and seller of a service have certain rights and responsibilities in the purchase and execution of a service.

The quality of a service and the efficiency with which it is performed may be influenced by the degree of understanding that is reached between buyer and seller regarding what each expects of the other.

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SECTION TWO: CONSUMER BUYING

UNIT IV: Housing and Home Furnishings

BEHAVIORAL OBJECTIVES

Be able to (1) recognize factors influencing housing and home furnishings choices
(2) examine and appraise the types of housing available
(3) identify reliable sources of housing information
(4) examine current developments in housing
(5) investigate possible methods of financing a home
(6) form judgments in selecting appropraite housing and home furnishings in a given situation
(7) consider criteria for selecting a home and recognize factors that may alter these criteria
(8) recognize personal responsibilities related to renting or owning some form of housing

SUGGESTED LEARNING EXPERIENCES

1. View the filmstrips, Homes Are for People, by J.C. Penney Company to see the psychological and sociological needs a home can fulfill. Discuss other ways that you have observed homes fulfilling these needs. Consider how these factors influence housing choices.

2. Read and discuss pp. 143-148 in Your Family and Its Money by Thal and Holcombe; pp. 4-7 in Your Housing Dollar from Household Finance Corporation; pp. 369-373 in Thresholds to Adult Living by Craig; pp. 159-166 in Managing Livingtime by Raines; or pp. 195-222 in The Consumer and His Dollars by Schoenfeld and Natella to identify other factors that influence housing choices. Discuss these factors: (1) style of life, including amount and stability of income and other available resources, standard of living, and family mobility; (2) values, goals, needs, and wants; and (3) family life cycle.

3. Think of the different homes in which you have lived. Write a paper telling what you really liked about each home and what you disliked most. Also discuss the factors which influenced your family to make each housing choice. What future housing goals does your family have? What factors are responsible for their working to reach these goals? Compare your responses with those of other class members. Identify factors that many of you hold in common. These shared factors will

probably include:
(1) human factors--style of life, values, goals, and needs; stage of family life cycle; skills, abilities, and other human resources.
(2) environmental factors--amount and stability of income; family mobility, safety, culture, social, technological, physical, and governmental influences.

4. Write a paragraph discussing this apparent paradox: Though similar factors influence the housing choices of most people, the housing choices they make vary greatly. This will help you clarify the influence of values on housing choices.

5. Identify your personal values in choosing a home. Take one of these values tests: Your Values in Choosing a Home by Cutler (see Part Two, p. 199) or Housing and Personal Values Test by Beyer (see Part Two, p. 209), and tabulate your score. Discuss. [NOTE TO TEACHER: Use Values in Housing (see Part Two, p. 212) as a guide for planning this discussion.]

6. View the floor plans from Houses Are for People by The Center for Urban Development to identify major values reflected in each home. Choose the house you like best. Is your choice consistent with your scores on the values test? What values would be important to the people who choose the other houses? Analyze the relationship between the values people hold and the housing choices they make. For what stage(s) in the family life cycle would each house be suitable? Which of the plans are adaptable to the changing housing needs inherent in the family life cycle?

7. Work in small groups to collect three or four pictures of houses and floor plans that appeal to you strongly. Analyze your pictures to decide what values have been given major emphasis. Also identify the stage(s) in the family life cycle for which each house would be approriate; give reasons for your opinion. Use the "Swing Around" technique to let each group present its favorite house plan for the other class members to analyze and identify the values emphasized. What other human factors have been considered in each house design? What environmental factors have received special consideration?

8. Find pictures of houses and house plans that illustrate Cutler's or Beyer's list of values. Then find pictures of families or individuals who you think would value each house highly enough to choose it for their home. Give reasons for the "matches" you make. Be sure to consider the stage(s) in the family life cycle for which each house would be suitable. Discuss the appeal of environmental factors and any other human factors incorporated in these house designs.

9. Read and discuss one or more of the following references to determine the types of housing available along with the advantages, disadvantages, and costs of each: pp. 10-17 in Your Housing Dollar from Money Management Institute of Household Finance Corporation; pp. 318-325 in Consumer Economics by Wilhelms, Heimerl, and Jelley; or pp. 148-153 in Your Family and Its Money by Thal and Holcombe. [NOTE TO TEACHER: The types of housing discussed are: single family residences; apartments, cooperatives, and condominiums; and mobile homes.]

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10. Study the classified ads to secure the information outlined below. [NOTE TO TEACHER: If you do not live in a city or large town where a variety of housing is available, buy newspapers from other cities for this activity.]

    1. Find the cost of renting three furnished apartments that you would consider desirable for yourself and a roommate, if the description in the ad is accurate. What services and restrictions are listed? What features appeal to you and make you consider these apartments good choices? Which bills, if any, are paid? Find the same information about three unfurnished apartments that sound attractive to you.

    2. Find the cost per month of water, electricity, gas, sewage, and garbage disposal for at least two couples whose rent does not include these costs. Share with class members and find the average cost of these services. Compare the costs of renting an apartment with bills paid and renting one for which you pay your own bills.

11. List the most essential items of equipment and furnishings you would have to have to live in an unfurnished apartment. How would the cost of these items affect the total cost involved in renting an unfurnished apartment?

12. Go in small groups or as a class on a field trip to visit several of the apartments you chose on the basis of the advertised descriptions. Ask a manager of one or more of the apartments to show you a copy of the lease you would have to sign if you rented one of the apartments. Discuss these questions when you return to class: How accurate were the descriptions in the newspapers? Did you discover any desirable features about the apartments that were not mentioned in the ad? Any undesirable features? What are the obligations of the tenant and the landlord? [NOTE TO TEACHER: If you cannot interview an apartment manager, secure a copy of a lease and study it to determine the rights and responsibilities of the renter and the owner. See the example in Consumer Economics by Wilhelms, Heimerl, and Jelley, pp. 334-335. Also refer to pp. 12 and 13 in Your Housing Dollar by Household Finance Corporation for points to check in the lease agreement.]

13. Study the classified ads to secure information on homes for sale and homes for rent. On the basis of descriptions given, choose four homes for sale that especially appeal to you. List this information about each home: price and terms for financing, house size, and special features. List the same information about four homes for rent. Discuss and compare findings.

    Visit several of the homes for sale and for rent that sounded desirable from the advertised descriptions. Try to visit homes of different price levels. Use the check sheet on pp. 20 and 21 in Your Housing

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Dollar from Household Finance Corporation to evaluate both types of housing. Take notes on the following features: privacy, accessibility to facilities and services you consider desirable, character and appearance of the community and neighborhood, and other significant features. Discuss check sheet evaluations and written observations when you return to class and compare the rental properties with those for sale. List advantages and disadvantages of each.

Develop a three-column chart for comparing the costs of renting with the costs of buying. In column one, list these expenses: rent, mortgage payments including principal and interest; taxes (if not included in mortgage payment); insurance (if not included in mortgage payment); utilities (list those not included in rent)--electricity, gas, water; repairs; maintenance; services--garbage disposal, parking, yard care and others; other costs. What economic advantages and disadvantages does this chart reveal for renting? For buying? [NOTE TO TEACHER: If making a number of field trips is difficult (or impossible) in your school situation, one field trip--well planned, directed, and evaluated--could serve as an excellent guide in helping students establish criteria for evaluating housing. The other field trips suggested might evolve into home experiences for individuals or small groups who could report their findings to the class.]

14. Visit a mobile home agency and tour mobile homes of different sizes. Find the costs involved in buying and living in a mobile home (trailer park rental, utilities, operating costs of vehicle to tow trailer). Report to class. [NOTE TO TEACHER: If there is no mobile home agency in your town, ask if you may visit some of the mobile homes in a nearby trailer park. Interview occupants and ask them to list advantages, disadvantages, and problems unique to this kind of housing.]

15. Visit a cooperative, condominium, town house, or other type of housing somewhat different from the other types of housing visited to become acquainted with innovations in housing. List desirable and undesirable features of these types of housing. [NOTE TO TEACHER: Visit some of the different types of housing listed in the preceding experiences - when realtors or builders hold "Open House." Secure the information indicated in the preceding activities.]

16. Listen to a review of the book, The Crack in the Picture Window, by John Keats to gain an insight into the problems of suburbia. Discuss.

17. Read the descriptions of the couples in the J.C. Penney material How To Furnish a First Home or Financing a New Partnership. Do the following:
    1. Compare the human and the environmental factors that would influence the housing decisions of these couples.
    2. Use the decision-making process and prescribe for each couple the requirements each should seek for their first home. Consider their short-term and long-term goals, their resources, the alternatives from which they could choose, and possible outcomes of each alternative (suggest at least two for each couple). Recommend a specific housing choice for each couple. You may refer to the housing you selected from the classified ads or from one of the field trips. Give reasons for your recommendations.

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3. Trace the housing needs and decisions of any one of the couples through the various stages of the family life cycle. Recommend decisions you think they should make during each stage.

18. Read and discuss the information presented in the extension bulletin B-1034, Know Your Home Financing, from Texas A & M; pp. 153-165 in Your Family and Its Money by Thal and Holcombe; pp. 344-354 in Consumer Economics by Wilhelm, Heimerl, and Jelley; or How to Finance Your Home by Sidney Margolius to identify factors involved in home financing. As you read, keep a list of terms, with simple definitions, that are new to you. Share with other class members and make a composite list of terms you should know which are related to home financing.

19. Listen to a banker, FHA representative, and a savings and loan association representative discuss types of loans available, sources of loans, the amount one can borrow from each source, down payment requirements, interest rates, and length of loans and special features or characteristics of each type of loan. Explain these terms: prepayment privilege, open-end mortgage, package mortgage, and insured loans. [NOTE TO TEACHER: Develop a visual aid, such as a transparency in chart form, showing current figures for interest rates, terms (length) of loan, and sum of the monthly payments necessary to pay off an amortized mortgage for a given amount. This will enable students to see more clearly what credit actually costs. See p. 162 in Your Family and Its Money by Thal and Holcombe or pp. 30 and 31 in Your Housing Dollar by Household Finance Corporation.]

20. Interview a building contractor, realtor, and architect to determine the services they can perform for the prospective buyer, the cost of these services, and recommendations they would make to help a buyer control costs. Discuss.

21. Listen to an attorney speak on the legal aspects of buying or building a home. Ask him to analyze and explain a mortgage agreement, contract of purchase, title protection, deed, and other papers and legal procedures the buyer must cope with in making property transactions. Discuss.

22. Secure bulletins on selecting and financing a home from your local extension agent or other governmental agencies in your community. Arrange a display of these materials. Work in small groups to select one or more of these materials and prepare a report for presentation to the class on the topic discussed.

23. View filmstrip, Patterns for Protection, from the Insurance Information Institute to acquire the following information: definitions of standards, requirements for protection, factors influencing the cost of insurance rates, and types of liability insurance available. [NOTE TO TEACHER: You may wish to use the related leaflet, Insurance for the

Home, from the Insurance Information Institute which summarizes the filmstrip.]

24. Work in small groups to plan the home furnishings and equipment needs of one of the couples described in How to Furnish a First Home or Financing a New Partnership. Consider the values, goals, needs, and resources of each couple and list items you think they would choose. Establish criteria for the selection of these items. [NOTE TO TEACHER: It is assumed that there will be students in your class who have studied selection of home furnishings and equipment. If so, you may wish to include one or more of these students in each group with those who have not studied this material. If your students have not studied selection of furnishings and equipment, you may wish to spend a limited amount of time to teach them the facts that will enable them to make intelligent selections.] Take your list and find prices for each item. Establish priorities. Which items should be bought first? Within a short period of time? Within a year or two? As the couples progress through the various stages of the family life cycle, how will their furnishings and equipment needs change? What factors, other than the family life cycle, may influence these changes? Present your plans to the class in an interesting way. Role play a planning session between one of the couples, develop a flip chart, use cartoons to make some of your points (and illustrate some of their conflicts), or choose some other interesting means of presentation. Justify your selections by indicating how they will support the life style your couple has chosen.

25. Ask an insurance agent to visit your class and answer any questions you may have about property insurance. Ask him to compare the costs of the different kinds of coverage. Discuss.

26. Conduct a "housing search" by clipping over a two week period of time the articles from newspapers and magazines which tell about current developments in housing for special groups, e.g., low-income families, the disadvantaged, the aging and other groups. Share these with class members on the day assigned. Distinguish between governmental and non-governmental agencies sponsoring the development. [NOTE TO TEACHER: Secure current copies of Newsweek, U.S. News and World Report, McCall's, Changing Times, American Home, Better Homes and Gardens, and similar sources available to you for students to use in the "housing search."]

27. Fill in the crossword puzzle (see Part Two, p. 218) to help you review terminology related to selecting and financing a home.

28. Read the situation called Housing Decisions (see Part Two, p. 222). Use the decision-making process to help the couple described make their first major housing decision as well as some of the decisions they will face at other stages in the family life cycle. Use the questions given with the story to guide your thinking.

29. Complete these open-ended statements to help you clarify your own thinking regarding what is important to you in housing.

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From all the different types of housing I've seen and read about, the type that appeals to me most is _____ because _____.

It would be important to me for a house to have these features: _____ _____ because (Give a reason for wanting each feature you listed.) _____.

My desire to have such features in my home indicates that these values are very important to me: (List values.) _____.

Features I would try to avoid, that might even make me reject certain kinds of housing, are _____ because _____.

In summary, this is what I want my home and my home life to be like: _____.

Some of the circumstances that would cause me to alter my present housing values are _____.

30. Develop a bulletin board display of pictures and articles to show current technological trends in housing. [NOTE TO TEACHER: Be sure to include articles about housing for persons with special needs.]

KEY POINTS

The interaction of many factors influences one's criteria for selecting housing and home furnishings. These criteria may change with changing circumstances.

Although similar factors affect the housing choices of most people, the choices they make vary greatly.

Each type of housing has its own advantages and disadvantages.

A critical appraisal of the different types of housing available may help one establish personal criteria for the selection of housing.

Reliable information regarding the legal aspects and financial obligations involved in housing selections should be acquired before contracts are signed.

Both governmental and private agencies are currently working to assist certain groups of people in meeting their housing needs.

Pamphlets

Insurance for the Home. New York, New York: Insurance Information Institute, 110 William Street, 10038.

Margolius, Sidney. How to Finance Your Home. Public Affairs Pamphlet No. 360, New York, New York: Public Affairs Pamphlets, 381 Park Avenue, South, 10016.

Russell, Laura J. and Jenkins, Jack. Know Your Home Financing. Bulletin 1034. College Station, Texas: Texas A & M University, Texas Agricultural Extension Service.

Your Housing Dollar. Chicago, Illinois: Household Finance Corporation, Money Management Institute, 1966.

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Troelstrup, Arch W. The Consumer in American Society. New York, New York: McGraw-Hill Book Company, 1970. Chapter 10.

Pamphlets

Financing a New Partnership. New York, New York: J.C. Penney Company, Educational and Consumer Relations, 1301 Avenue of the Americas, 10019.

Furnishing a First Home. New York, New York: J.C. Penney Company, Educational and Consumer Relations, 1301 Avenue of the Americas, 10019.

Houses Are for People. Ithica, New York: The Center for Urban Development Research, 109 West Sibley Hall, Cornell University, 14850. Attention: Joyce Breese.

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"A Better House for Your Money," Better Homes and Gardens. Vol. 47, No. 9, September, 1969. (Special building issue)

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Homes Are for People. Parts I and II. New York, New York: J.C. Penney Company, Inc., Educational and Consumer Relations, 1301 Avenue of the A[redacted] 10019.

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SECTION TWO: CONSUMER BUYING

UNIT V: Buying and Maintaining Automotive Products and Services

BEHAVIORAL OBJECTIVES

Be able to (1) identify reasons for the need for personal transportation
(2) compare factors involved in buying a new car, used car, or motorcycle, or leasing a car
(3) recognize the risks involved in owning and operating a car or motorcycle
(4) explain the state automotive insurance regulations
(5) identify principal types of automotive insurance and compare costs involved
(6) plan an automotive budget

SUGGESTED LEARNING EXPERIENCES

1. List reasons why you feel you need and/or want an automobile to determine whether your reasons are needs or just wants. Discuss.

2. Find articles in current periodicals on the problems of getting to and from work. Share ideas and discuss such questions as: What can be done to ease the traffic problem during the rush hours? Are there others forms of transportation for getting to work besides a car?

3. Read pp. 168-177 in Your Family and Its Money by Thal and Holcombe; pp. 125-138 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 173-174 in Consumers All by U.S. Department of Agriculture; or pp. 3-20 in Your Automobile Dollar by Household Finance Corporation for information on costs of operating a car. Discuss such questions as: What are some of the main factors to consider when buying a car? What are some guides for selecting a type of engine? What are the advantages and disadvantages of optionals? How do they affect the price? When is the best time to buy a car? Why is the dealer important? What does the warranty mean? Of what value is it? What can you find out about used cars from on-the-lot-driving and shop tests? Role play the situation, But Couldn't We Buy This Car? (see Part Two, p. 225), and answer the questions which follow.

4. Take a field trip to a car lot that has new and used cars. Find out what information you need to know as prospective buyers and ask the salesman to give his interpretation of the buyer's responsibilities. Discuss.

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5. Work in a group and make a poster on "Tips for Used Car Buyers." Place this poster in a place where the rest of the student body can read it.

6. Work in groups and study what it would cost in terms of transportation to buy a new car, a used car, and a motorcycle or to lease a car. Be sure to include such factors as: purchase cost (down payments, availability of financing, interest rates); taxes; optionals; maintenance; safety ratings; operation cost; license; and trade-in value. Report findings to class. Compare and evaluate results. Then formulate a check list for purchasing a new car, a used car, and a motorcycle or leasing a car to help you in the selection of one.

   Ask the various dealers to examine your check list to see if they agree with the items. Share check list with the rest of the class.

7. Read pp. 69-86 in How to Live Better and Spend 20% Less by Dowd, or pp. 168-183 in Your Family and Its Money by Thal and Holcombe to gain an insight into buying a new or used car. Discuss.

8. Participate in a "fishbowl" discussion on buying a new or used car or leasing a car to help you understand factors you need to consider when securing a car. [NOTE TO TEACHER: Three resource people need to be invited to participate in the discussion. A student acts as a moderator and is seated along with the three resource people. Three empty chairs are placed opposite the moderator and resource people and are occupied by class members who want to ask questions of the guests.]

9. Work in groups and secure additional information on whether it would be cheaper to buy a car or to lease one. Share findings and discuss.

10. Listen to a symposium composed of a banker, car dealer, and a representative from a small loan company to find out the costs of buying a car on credit. Ask them how they finance a car and whether it is cheaper to pay cash for a new car.

11. Complete the following open-ended statement: "If I had to buy a car on time, I would _____."

12. Select a car advertised in the classified ad section of a newspaper. Describe the procedures you would go through before deciding if this was the car you wanted.

13. Read pp. 178-183 in Your Family and Its Money by Thal and Holcombe to secure information on the different kinds of automobile insurance. Discuss.

14. Read the Texas Drivers Handbook to become familiar with the insurance laws and regulations in Texas. Discuss.

15. View the filmstrip, Automobile Insurance, by the Insurance Information Institute to secure information on bodily injury coverages, property damage coverages, and how the cost of automobile insurance is determined. Discuss.

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16. Listen to a car insurance salesman to find out what he thinks is the necessary and adequate coverage for an automobile. Discuss.

17. Obtain copies of automobile insurance policies from several insurance companies. Examine and evaluate to see which offers the best protection.

18. Look at your automobile insurance policy to see if you feel you have adequate insurance. If not, what changes would you make? Give reasons for your decisions about the coverage you selected.

19. Write to AAA or other automobile associations to find out current information on driving costs or find articles that discuss transportation costs. Discuss findings.

20. Prepare a budget for automobile costs, using your personal or family car. Keep an actual record of costs for one month. Evaluate budget in relation to actual expenses.

21. Work in groups and use the formula (see Part Two, p. 224) to figure out what it costs to operate an automobile. Share findings.

KEY POINTS

The automobile is a major purchase.

The cost of operating a car needs to be considered in setting up a budget.

There are many factors to consider before selecting a car.

A person needs to investigate lenders before financing a car.

Automobile insurance is a form of protection.

Insurance is an essential part of a person's financial program.

A plan for financial protection through insurance provides security for an individual or family.

Individuals and families have the responsibility to provide for their own welfare beyond the basic expectations of, and protection provided by society.[1]

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[1]Taken from Concepts and Generalizations: Their Place in High School Home Economics Curriculum Development. Washington, D.C.: American Home Economics Association, 1967. p. 29.

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Money Management--Your Automobile Dollar. Chicago, Illinois: Money Management Institute, Household Finance Corporation, 1963.

Texas Drivers Handbook. Austin, Texas: Texas Department of Public Safety, Box 4087, North Austin Station.

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SECTION TWO: CONSUMER BUYING

UNIT VI: Food

BEHAVIORAL OBJECTIVES

Be able to (1) relate food to cultural and socio-economic influences and psychological satisfactions
(2) give reasons for the increasing cost of foods
(3) recognize factors influencing family food costs
(4) identify the advantages of making a shopping plan
(5) recognize the need for flexible planning
(6) identify methods that are used to encourage shoppers to do impulse buying
(7) relate use of resources for meeting family food needs to values, goals, standards, and available resources
(8) become aware of and recognize the widespread use of food additives

SUGGESTED LEARNING EXPERIENCES

1. Find out what changes have occurred in the food habits of individuals during the past 20 years. Consider such factors as the change from rural to urban living, increased education of the homemaker, and availability of fresh fruits and vegetables. Share your findings with the rest of the class. Summarize factors that influence food choices today.

2. Pick one cultural group and find information on the eating habits and patterns of that particular group. Relate these habits and patterns to the values, goals, standards, and resources of that cultural group. Discuss.

3. Read Chapter 1, 2, and 3 in People, Food, and Science by Cote to see how man has always had to secure food for survival, the influences on food in the United States, and the nutritional problems around the world. Discuss such questions as: What is food for? Why is food important? Why are food habits difficult to change? What are some of the factors that influence a person's food habits? What does food mean to you? Why are America's teen-agers so poorly fed? What can be done to help this age group improve their eating habits? What are some ways in which food money is being wasted?

4. Listen to your teacher discuss the social and psychological factors of food from an anthropologist's point of view. What are some factors that influence our food habits? Which of these factors affect your food habits?

5. Read Chapter 22 in People, Food, and Science by Cote to see how the food industry has changed. Discuss such questions as: How has the food market changed? What are some factors that have caused food costs to rise at a rapid rate the past ten years? What are some of the predictions concerning supermarkets in the future? What has the consumer done to change the food market?

6. Read Chapter 23 in People, Food, and Science by Cote on making decisions in the market. Discuss such questions as: What factors determine how much you spend in the market on food? What are the different types of stores available for buying food? What factors will need to be considered when selecting the store(s) in which you plan to shop? What are the advantages of making and following a shopping list? disadvantages?

7. Discuss the various stages in the life cycle in relationship to food selection and preparation. Discuss such questions as: What resources are available to each stage? When does the homemaker have the most time to prepare food? least amount of time for food preparation? most energy? least energy? How do food needs change during the family life cycle? What factors affect the choices of resources to use at the various stages?

8. Find a picture of a food item that is consumed by teen-agers. Bring it to class. Analyze it for such things as: the amount of money spent in relationship to food value and the reasons for buying the item. See what food items the other members of your class brought.

9. Read the article, "Twenty Ways to Save Money in the Supermarket," by Robert O'Brien in the May, 1970, issue of The Reader's Digest found on pp. 68-70. Do you agree with the suggestions? Can you think of others?

10. Review the article "The Truth That Saves Money in the Supermarket," by Vivian Cadden in the July, 1970 issue of Redbook Magazine to see what her philosophy is on saving money in the supermarket. Do you agree with it? Explain.

11. Divide into three groups to compare ways of planning and shopping for family meals. Each group will shop for food for three days' meals for a family of four. All meals must meet the Basic Four requirements. Assume that you have such staple items as flour, sugar, shortening, and spices. Groups I and II plan menus for the three days and make a shopping list of all items needed before you go to the grocery store. Group III will do no pre-planning. When you go to the grocery store, Group I, follow your list precisely; Group II, make substitutions that you consider wise or desirable; Group III, structure your meals as you shop.

    Compare cost of meals, time required for shopping, appetite appeal of meals, and problems encountered in relation to the type of shopping you did. Draw conclusions regarding the advantages and disadvantages of

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each type of planning. Under what circumstances might each type be used to good advantage? Discuss findings.

12. Listen to a panel discussion composed of three homemakers discuss what proportion of the family income is spent on food, ways to cut the food budget, unwise or impulsive practices they participate in, and ideas on how to make the best use of what they buy after the food has been purchased. Discuss their ideas.

13. Work in pairs and with the permission of the manager of a local grocery store to see if you can observe the different shoppers in his store. Watch for people making "impulse" purchases. Discuss findings.

14. Identify some store practices that managers use to encourage impulse buying. Some examples are: free samples, grouping of items, special displays. Go to several grocery stores and notice how the manager has arranged displays to encourage people to do "impulse" buying. Report your findings to the class and discuss. Compare prices of items in special displays with identical items on the shelves. Are they the same? If not, which is higher?

15. Ask your mother what items she has purchased on "impulse" buying. Ask her to evaluate her purchase as to whether or not she would buy it again. What foods have you purchased on the "spur of the moment"? Was it a "wise" buy? Why or why not?

16. Collect ads of different food sales. Analyze the reason for the promotion of the food. Discuss such questions: Is this a good buy? Is it a "leader"? Is it a seasonal item?

17. Bring to class the food advertisements from the weekly newspaper to see how ads can be used in planning. Take the grocery list of 25 items that your teacher developed and work in teams to shop for the listed items from the advertisements. Give this information: store, advertised price, brand, and size. The team that completes its list first and with the least amount of money is the winner. Discuss results.

18. Interview a grocer to find out how many different items he has stocked in his store. Find out why he has stocked these items and on what basis he makes a selection. Report your findings to the class. Discuss such questions as: Why is it difficult for the grocer to stock certain items in the store? Does the consumer have any influence on the availability of products on the market? What can the consumer do to increase his influence?

19. Go to a grocery store and find the many different forms in which you can purchase such items as potatoes, apples, bread. Be sure to secure the form, the name given to it if it is prepared, net weight, and cost.

Report your findings to the class. Are you surprised at what you found? In what types of situations would you use the various forms of the foods? How would you justify use of the more expensive items?

20. Take one item such as biscuits and do a comparative study to compare resources required to prepare different forms of a food (see Part Two, p. 226). What are your conclusions? Are convenience foods a wise buy? Explain your answer.

21. Role play or read the story of The Cost of Home Cooking by Mary Lumsden (see Part Two, p. 227) to see what factors besides money need to be considered in planning. Discuss.

22. Examine several cookbooks, such as Joy of Cooking by Rombauer, to see the emphasis that is placed on food selection and preparation. Notice how some of the recipes are written and the reasons for writing the cookbook.

23. Look at the cartoon on additives (see Part Two, p. 229) to become aware of the use of food additives. Discuss the questions.

24. Listen to students give short reports on the history of food additives and on current legislation on food additives. Discuss. [NOTE TO TEACHER: You may wish to adapt this entire section on food to your individual situation. Some students may have had a wide variety of learning experiences in food management; other students may have done very little in this area.]

KEY POINTS

The primary satisfactions provided by eating include the relatively immediate sensory and psychological effects it produces and the psychological meanings it has acquired.[1]

Food habits of individuals change as a result of indirect influences such as changes in supply resulting from advances in production, technology, and distribution; economic resources; and the educational, social, and cultural environment.[1]

Technological growth and current sociological trends promote developments in food processing, acceptance of a variety of food forms, and changes in patterns of consumption.[1]

As more services are built into foods, the control of industry over the kinds and quality of food increases while that of the home decreases.[1]

Family food costs will vary with the size and composition of the family, the value placed on food, and the resources available.[1]

Rational choice becomes more difficult as the number of food products and ways of merchandising them increase.[1]

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Use of resources for household food production is influenced by the values (nutritive and non-nutritive) placed on food, the kind and quality of resources available, and the personal satisfaction derived from producing food.[1]

When there is evidence that the addition of a particular nutrient or other additives to a food serves a useful purpose, the government defines and regulates such additions.[1]

The resources available for meeting personal and family food needs include personal capacities, available goods and services, and purchasing power.[1]

The choice of which resource to use in providing food for the family depends upon the quality of each resource available, the cost of the alternatives and their effectiveness in producing the desired result, and the ability of the user to employ the resources for the purpose desired.[1]

Discrimination is required in the selection of foods that contribute a balance of nutrients to the daily diet and at the same time fulfill such non-nutritive requirements for daily meals as are involved in meeting food budgets, family traditions, and individual preferences.[1]

Consumers' choices are a determinant of marketing practices, prices, and qualities of foods in the market.[1]

Informed consumers making rational and discriminating choices in the purchase of food can influence the functioning of the market to serve consumer interests and to improve the effective use of resources.[1]

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[1]Taken from Concepts and Generalizations: Their Place in High School Home Economics Curriculum Development. Washington, D.C.: American Home Economics Association, 1967. pp. 31-37.

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SECTION TWO: CONSUMER BUYING

UNIT VII: Clothing

BEHAVIORAL OBJECTIVES

Be able to (1) perceive the socio-psychological aspects of clothing selection
(2) examine individual differences in values, goals, and available resources as related to clothing selection
(3) recognize clothing needs at the various stages of the life cycle
(4) apply the decision-making process to the selection of clothing

SUGGESTED LEARNING EXPERIENCES

1. Write your response to the picture (see Part Two, p. 230) to see what your response would be if everyone dressed alike in a uniform. Share your response with others in the class. Discuss.

2. Discuss such questions as: Why do we wear clothing? Is this the same reason people in other cultures wear clothing? Why do you select your own clothing? Is it difficult to select clothing for someone else? Why?

3. View the filmstrip, The Psychological Importance of Clothing, by J.C. Penney Company to see the relation of social and psychological factors to clothing. Discuss such questions as: Why do we need to express our individuality in our clothing? What do we communicate through clothing? How is clothing used to help make adjustments from one role to another? How is clothing used as a means of satisfying basic needs? How does clothing give a clue to one's personality? Why is it important for a person to clarify his values and goals? Relate these factors to clothing selection. When have you formed an opinion of another person by his dress? Explain.

4. View the cartoons (see Part Two, p. 232) to recognize individual differences in clothing values. Discuss the questions.

5. Find a cartoon, editorial, or quotation that illustrates factors such as values and roles as they relate to clothing. Write a short paper interpreting what the author is communicating. Share your findings with the rest of the class. Do they agree with your interpretation?

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6. Look at several teen-age magazines, such as Seventeen, Coed, or Ingenue, to see what proportion of the magazine is related to clothing. What do they do to appeal to teen-ager's values and goals? What are some of the values and goals that influence the clothing selection of women and/or men?

7. Read "The Apricot Dress" in the April, 1970 issue of the Coed Magazine and identify Barbie's values and the ways in which these were related to her goals. What basic needs were met? Did she use the management process in selecting the apricot dress? Explain your answer.

8. Look at several examples of clothing in magazines. What does the clothing communicate to you about this person? Share your ideas with the rest of the class. Discuss.

9. Find an illustration in which the clothing seems important and write a short paper to explain what you think this person is communicating to you by his dress. Explain your answer.

10. Review the stages of the family life cycle and discuss clothing needs and/or wants at the various stages. Discuss such questions as: When is there the most demand on the clothing budget? least demand? What can families do to ease the clothing budget when the greatest demands are being made on it? How do clothing wants and needs change during the different stages?

11. Write a paper on how you extend your clothing dollar. Include ideas on how you can make your clothes last longer.

12. Bring a clothing advertisement and label to class. Identify the appeal in the ad. What information is given in the ad? What information is included on the label? What additional information would you need to secure before purchasing the article?

13. Discuss such questions as: How does fashion relate to clothing selection? What factors does one need to consider before selecting clothing? Why do people sew today? Is it for the same reasons as 25 years ago? What determines the amount of clothing we need? What are the factors that influence your own clothing choices? By what criteria do you make your clothing selections? What influences the standards that are acceptable to you in clothing?

14. Use the story, Jane Decides, by Maurietta Cusey (see Part Two, p. 234) to see how she arrived at a decision. Discuss the questions at the end of the story.

15. Work in small groups with a situation in which a family lost all of their clothing in a tornado. Plan what a teen-ager would need to purchase for herself. Her proportion of money to spend is $75.00. Itemize how she plans to spend the money. Share your plan with the rest of the class.

16. Read pp. 28-59 in You Are a Consumer of Clothing by Garrett and Metzen. Discuss such questions as: What resources do you have available for meeting your clothing needs and wants? Which resources do you use most often? Why? What effect does this have on resources available to the

rest of your family? Have your resources for meeting clothing needs changed any in the last two years? If so, how?

17. Describe an article of clothing you would like to purchase. Explain ways in which this garment reflects your values and goals. What do you think it will communicate to others about you? Which of your values and attitudes toward clothing are influenced by your parents? Your friends?

18. Suppose you have $15.00 to spend on clothing. Apply the decision-making process (see Part Two, p. 107) as you plan the way in which you would spend this money. Do you usually make clothing decisions in this way? Why or why not? How might use of this process increase the satisfaction you receive from your clothing dollar?

19. Read the situation, Alice Selects a Coat, (see Part Two, p. 236) and use the decision-making process as you help her select a coat.

KEY POINTS

Clothing is a means of communicating one's role.[1]

An individual may be more readily accepted in a particular role if he conforms to the group's clothing expectations for that role.[1]

Clothing may help the individual to make adjustments when changing from one role to another and to attain success in that role.[1]

Clothing may be used as a means of satisfying basic needs when these needs are not met in other ways.[1]

Clothing reflects an individual's self-concept.[1]

Clothing is a cue to personality; it conveys an impression of what the individual is, does, and believes.[1]

An individual uses clothing as a cue in forming impressions of others.
- a. Impressions made by appearance and dress have greater impact in limited contact situations.
- b. In order to create desired impressions through dress, the individual needs to be aware of the meaning dress communicates to others.[1]

The factors involved in making clothing decisions include the individual's resources, needs and desires, family composition, and stage in the life cycle,

and on the mobility of people, climatic conditions, social environment, and stage in the fashion cycle.[1]

The choices made in the acquisition and use of clothing are influenced by the individual's value patterns and the relative importance of his various clothing goals.[1]

The resources available for meeting clothing needs include available goods and services, purchasing power, personal information, ability, time, and energy.[1]

The availability and use of resources for achieving clothing goals are related to the allocation of resources to other individual and family goals.[1]

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[1]Taken from Concepts and Generalizations: Their Place in High School Home Economics Curriculum Development. Washington, D.C.: American Home Economics Association, 1967. pp. 39, 42, 43.

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PART ONE

SECTION THREE: CONSUMER CITIZENSHIP

SECTION THREE: CONSUMER CITIZENSHIP

UNIT I: Government Protection of the Consumer

BEHAVIORIAL OBJECTIVES

Be able to (1) differentiate between the services provided by the various federal government agencies which protect and/or aid the consumer
(2) compare the services provided by federal, state, and local government agencies in a particular community
(3) collect and analyze newspaper and news magazine articles about the activities of the various government agencies
(4) recognize the relationship between government services and consumer cooperation
(5) inform others of services provided by government agencies

SUGGESTED LEARNING EXPERIENCES

1. Take pre-test on abbreviations of Federal agencies (see Part Two, p. 239) to see how many agencies you can identify.

2. Read pp. 41-49 in The Consuming Public by McClellan; pp. 398-411 in Consumer Economics by Wilhelms, Heimerl, and Jelley; pp. 15-35 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 406-421 in Consumer Economic Problems by Wilson and Eyster; pp. 20-78 in Legal Protection for the Consumer by Crown; or the pamphlet, Guide to Federal Consumer Services.

3. Work in pairs to investigate government agencies (see Part Two, p. 240) their backgrounds, reasons for formation, aims, functions, responsibilities and publications. Present information learned via skits, posters, or transparencies, and radio or TV interviews. As information is presented, fill out summary sheet (see Part Two, p. 241).

4. Go to hardware store, drugstore, or the appliance section of a department store and list ten items that are sold under the provisions of the fair-trade laws. Make another list of ten items that are not sold under the provisions of the fair-trade laws. List selling prices for each item. Next go to another store similar to the first one and list prices they charge for the same items. Compare lists and explain similarities and differences in prices.

5. Answer the following questions: Which federal agency is responsible for each of the following activities or commodities? (a) meat or poultry sold in interstate commerce (b) counterfeit money (c) gas used for heating or cooking (d) unfair competition (e) impure cosmetics (f) use of mails for the promotion of lotteries (g) illegal issuing of stocks and bonds.

6. Discuss such questions as: What federal agencies operate in your community? In what ways do they protect the consumer? Would this service be supplied by anyone else if it were not by the Federal Government? What might be the result if this service were not supplied?

7. Listen to representatives of federal agencies in your community discuss the services available through their agencies. Discuss.

8. Watch for and clip newspaper or news magazine articles for one week about the activities of the various government agencies. Discuss articles and analyze ways in which these activities affect the consumer.

9. Volunteer to study two of the recent News Summary reports of the Federal Trade Commission. Report to the class on the nature of the FTC activities as seen through these reports. [NOTE TO TEACHER: News Summary may be obtained from the Federal Trade Commission, Washington, D.C. 20580.]

10. Write to the Special Assistant for Consumer Affairs (White House, Washington, D.C.) and ask what your class might do to strengthen the position of the consumer. Report to class.

11. Write a letter to your state legislator to find out what state agencies offer services or enforce laws that protect the consumer, such as those affecting foods and drugs, labeling, advertising, frauds, public utility services, small loans and credit, and sanitation practices. Report to class.

12. Interview or listen to a local government official to find out what services are provided locally. Discuss.

13. Prepare a chart to show the relationship among services offered by federal, state, and local agencies. Share the chart with the rest of the class.

14. Visit a local grocer and find out what inspections are made on food before he gets it and what inspections are made in his store. Discuss.

15. View the filmstrip, Inspection for Your Protection, by the U.S. Department of Agriculture to find out about inspection practices.

16. Work in committees to investigate standards or grades for such items as tires, beef, poultry and eggs, butter, margarine, jams and jellies, carpeting, fuel oils and gasoline. Interview respective merchants to find information and/or find out where you can get the information. Present your findings to class.

17. Check the court docket in your community to see if any cases involving consumer problems are being tried. Plan to attend court during these sessions, if possible. Report to class.

18. Invite a local lawyer or judge to discuss his experiences with cases involving consumer problems. Discuss the information presented.

19. Listen to a panel consisting of a housewife, student, businessman, and representative from a government agency discuss such questions as: Do you believe business gains or loses as a result of government regulation? What consumer protection should be provided by the government and what responsibilities should be assumed by the consumer? Why is it necessary to have state legislation in addition to federal legislation for consumer protection?

20. List things you did during the first two hours after you woke up which were affected by government services or read Consumer Information (see Part Two, p. 243). Examples might include:

    listened to radio (regulated by Federal Communications Commission)
    heard the weather forecast (courtesy of Weather Bureau)
    shaved or sprayed with aerosol bomb (regulated by federal agencies)
    dressed (measurements of clothes determined by Bureau of Standards, and fiber content policed by Federal Trade Commission)
    used make-up (checked by Food and Drug Administration)
    ate breakfast (bacon, ham, eggs, and milk checked or regulated by agencies; labeling information on cereal box regulated by Fair Packaging and Labeling Act)
    rode a bus (safety standards and rates regulated by Interstate Commerce Commission)
    used electricity or gas (rates controlled by Federal Power Commission)
    heard an advertisement (regulated by Federal Trade Commission)

21. Discuss need for consumer protection by government agencies. Point out problems involved in enforcing the laws, the necessity of consumer cooperation, and the action consumers should take when they believe laws have been violated.

22. Volunteer to read The Jungle by Upton Sinclair and report on the effect it had on government protection.

23. Volunteer to give a report on the "Muckrakers" and their contribution to the emphasis on the need for reform and government action.

24. Place a question box in the classroom and bring questions from parents and friends about protection given to the consumer. Draw questions and find the answer. Share with class.

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25. Plan a "newspaper" or some other type of communication which would include information on the many agencies and services provided for and available to the consumer. Assume roles of a reporter, layout man, and cartoonist. Distribute the end product to students, parents, or other groups you think would be interested in receiving the information.

26. Discuss the possibility of setting up an agency for other students that would provide information on services available to them as consumers.

KEY POINTS

Consumers are provided informative and protective services by government agencies at the local, state, and federal levels.

The federal government helps to assure better products at reasonable prices by promoting free and fair competition among business firms and among individuals.

Government agencies protect the consumer by insuring the purity, potency, and truthful and informative labeling of drugs and cosmetics and by regulating food additives and labeling practices for certain types of foods.

There are many resource agencies to which consumers may turn when they suspect unfair or illegal practices.

Cooperation and public interest are necessary for the enforcement of laws which protect the consumer.

Pressure by consumers can eventually bring about legislation to change marketing practices.

Some states have fewer agencies which work to protect the consumer than others.

The closest contact the consumer has with government agencies is at the local level.

The powers of the local government are generally derived from the state.

In most situations, the consumer will appeal to local agencies for aid or protection.

Consumer protection by government agencies is necessary because the variety of goods and services now available prevent the consumer from being knowledgeable about all of them.

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Troelstrup, Arch W. The Consumer in American Society. 4th edition. New York, New York: McGraw-Hill Book Company, 1970. Chapters 17 and 18.

Visual

Inspection for Your Protection. Washington, D.C.: U.S. Department of Agriculture. (Order from: No. C-157, Photo Lab, Inc., 2825 Georgia Avenue, N.W., Washington, D.C. 20011. $8.50.)

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SECTION THREE: CONSUMER CITIZENSHIP

UNIT II: Government Legislation

BEHAVIORIAL OBJECTIVES

Be able to (1) relate provisions of federal legislation to the acts which protect the consumer
(2) contact federal and state legislators to determine pending laws related to consumer protection
(3) analyze provisions of "Fair Packaging and Labeling Act" and "Truth-in-Lending Act" to determine protection provided by them
(4) discuss fair-trade laws from the viewpoint of the consumer, retail merchant, and manufacturer
(5) state position in regard to government regulation of consumer affairs
(6) investigate local ordinances which protect the consumer

SUGGESTED LEARNING EXPERIENCES

1. View the transparencies (see Part Two, p. 245) and discuss the main points of the laws dealing with consumer protection. Use handout sheets (see Part Two, p. 250). Discuss such questions as: During which period was the most done for the consumer? Why do you think this happened? What do you predict for the next ten-year period?

2. From the laws previously presented, select one in which you are particularly interested and write your Congressman for more information.

3. Select a law and use a poster to interpret it to other consumers. Display these in your school, in local stores, or other places in your community. Report comments made by those reading the posters.

4. Write your Congressman in Washington, D.C. and your state congressman to request information about recent and pending legislation related to consumer protection. Report reply.

5. Read pp. 49-53 in The Consuming Public by McClellan, about the "Fair Packaging and Labeling Act." Discuss how this act affects shopping for food and household supplies. [NOTE TO TEACHER: This reference points out the limitations, as well as the strengths, of the Act.]

6. Volunteer to read pp. 53-61 in The Consuming Public by McClellan, and the booklet, What You Ought to Know About Truth in Lending, Consumer Credit Cost Disclosure from Federal Reserve System to secure information on the truth-in-lending bill. Report to the class giving background, reasons for the bill, and the strengths and weaknesses of the bill. Discuss.

7. Bring copies of statements from revolving charge accounts, time payment contracts, or installment contracts. Evaluate the information using the Yardstick for Comparison (see Part Two, p. 254). Discuss such questions as: What does the information mean to us? How do we use the information? Is there other information we need to know?

8. Read pp. 415 in Consumer Economic Problems by Wilson and Eyster or interview consumers, retail merchants, and manufacturers. Assume the roles of consumer, retail merchants, and manufacturers and discuss the arguments for and against the fair-trade laws.

9. Read pp. 61-77 in The Consuming Public by McClellan or other available sources to find out about federal control of deceptive advertising. Discuss the scope of federal activity in relation to the control of deceptive advertising.

10. Work in buzz groups and discuss pros and cons of government regulation in regard to consumer interests and protection. In what areas does the government need to act as referee? Who best speaks for the consumer--government, congress, consumer groups, market researchers, manufacturers, or Cabinet officers? What is the consumer's role? the role of business? What limitations are there to government protections? [NOTE TO TEACHER: Refer to pp. 36-41 and 91-114 in The Consuming Public by McClellan for discussion of these issues.]

11. Write a statement of your beliefs about government regulation of consumer affairs to clarify your understanding concerning government regulation.

12. Volunteer to read and clip newspaper and magazine articles about legislation related to consumer protection. Start a class file of such articles. Show ones of particular interest to class, using opaque projector. Discuss with class the implications of the news.

13. Role play the situation in which a new consumer law is put through channels to become familiar with the process. One group could serve as representatives, one as senators, and one as committee members. Introduce bill, debate, vote, and obtain President's signature.

14. View the slides, The Law Behind the Label, by Food and Drug Administration to see services provided by the Food and Drug Administration. Discuss.

15. See the film, A Reason for Confidence, by Association Films to find out how the Food and Drug Act assures consumers of safeguards surrounding foods and drugs. Discuss.

16. Work in committees to investigate state laws and local ordinances in your area. Some possible measures taken by state and local governments are listed on p. 392 in Consumer Economics by Wilhelms, Heimerl, and Jelley. Report to class.

KEY POINTS

Individuals and families, as consumers, are protected by federal, state, and local laws.

Knowledge of laws which protect the consumer enables him to be a more responsible consumer citizen.

There is considerable debate over fair-trade laws in our economic system.

As the marketing system becomes more complicated and impersonal, the need for government protection increases.

Laws are continuously being made to uphold consumer rights.

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Pamphlet

What You Ought to Know About Truth in Lending: Consumer Credit Cost Disclosure. Washington, D.C.: Board of Governors of the Federal Reserve System, 1969.

TEACHER:

Visuals

The Law Behind the Label. Washington, D.C.: Food and Drug Administration.

A Reason for Confidence. Ridgefield, New Jersey: Association Films, 600 Grand Avenue.

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SECTION THREE: CONSUMER CITIZENSHIP

UNIT III: Fraud, Deception, and Quackery

BEHAVIORIAL OBJECTIVES

Be able to (1) analyze various types of offers and recognize examples of fraud, deception, and quackery
(2) recommend action to take in response to fraudulent or deceptive practices
(3) conduct a survey to determine types of frauds and schemes in area
(4) plan a way to share information gained in this study with others
(5) analyze own reaction to certain types of "gimmicks"
(6) prepare a guide for protecting yourself from fraudulent schemes

SUGGESTED LEARNING EXPERIENCES

1. View the transparencies (see Part Two, p. 255) for an introduction to types of fraudulent and deceptive practices. Discuss.

2. Present skits (see Part Two, p. 259) to become familiar with fraudulent schemes. Discuss questions such as: What schemes were shown in these skits? What approach did the salesmen use? How do you think you would have reacted?

3. Use the "In-Basket, Out-Basket" technique to solve the problems presented by your teacher. Read each of the situations described on the "In" sheet and decide what you would do. Write your decision on the "Out" sheet and go on to the next situation. As a class, review all responses in the "Out" basket and discuss differences in the decisions which were made. [NOTE TO TEACHER: See Part Two, p. for examples. Design additional ones or collect real examples using legal and illegal situations.]

4. Select one of the following schemes which you would like to investigate. Read the following references and work in pairs to plan a presentation on the scheme selected.

Schemes

Door-to-door salesman
Unordered merchandise
Telephone solicitations
Accepting C.O.D.'s for neighbors
Photography schemes
Charity gyps
Homework schemes
Packaging deceptions
Health quackery
Mail fraud
Magazine subscriptions
Home improvement swindles
Bait advertising
Referral racket
Debt consolidation schemes
Business opportunity schemes
Wholesale prices, sales, "free" items, contests
Others

References

Schoenfeld and Natella. The Consumer and His Dollars. pp. 291-309.
Furness. Beware of Consumer Pitfalls. pp. 3-11.
National Research Bureau. How to Beat Cheats and Frauds. pp. 3-31.
Seaver. Fads, Myths, Quacks--and Your Health. pp. 1-28.
Better Business Bureau. Facts You Should Know About Schemes. pp. 2-16.
Better Business Bureau. Consumer Information Series--Homework Schemes.
Better Business Bureau. Consumer Information Series--Unordered Merchandise.
Better Business Bureau. Consumer Information Series--Mail Order Profit Mirages.
Better Business Bureau. Consumer Information Series--Fulfillment Complaints.
Better Business Bureau. Consumer Information Series--Bait Advertising.
Chief Postal Inspector, U.S. Post Office Department. How the Postal Inspection Service Protects You Against Mail Fraud.

4. Prepare an interview schedule as a class project and make a survey of parents and classmates to determine types of frauds and schemes they have seen and/or experienced. As the results of the survey are tabulated, discuss reasons these schemes were successful.

5. View the film, Too Good to Be True, to see the examples of bait advertising portrayed. Discuss. [NOTE TO TEACHER: This film may be obtained from your nearest Better Business Bureau.]

6. Bring any articles you might have which give examples of mail fraud, misleading advertisements, phony contests, and whatever else you can find. Discuss the appeal made by these gimmicks.

7. Discuss aids the consumer can obtain in cases of possible fraud, deception, or misleading advertising. Listen to representatives from the Better Business Bureau, Chamber of Commerce, Legal Aid Society, and/or Post Office and discuss action consumers can and should take.

8. Read Fight Back! The Ungentle Art of Self Defense by Federal Trade Commission and discuss action which can be taken by the consumer before and/or after being gypped.

9. Set up a situation in which someone has been the object of a fraudulent scheme. Write a letter of complaint to the proper agency. Document the facts (who, when, where, what), decide to whom the complaint goes, and state action you wish taken.

8. Clip and bring to class advertising you believe is misleading. Look for those which offer "wholesale" prices. In committees, compare the "wholesale" prices with those for the same item at other stores. Report findings.

9. Listen to a representative of the Food and Drug Administration discuss health quackery. Discuss.

10. Role play a situation in which a piece of unsatisfactory merchandise is returned to the retailer. Discuss the situation.

11. Plan a program dealing with fraudulent practices which could be presented at a school assembly, PTA meeting, FHA meeting, or some community function to acquaint citizens with these practices. You may want to use some of the ideas you prepared for previous class presentations.

12. Work in buzz groups and discuss your reaction to trading stamps, premiums, coupons, prizes, and contests. What effect do these have on your buying practices? Explain.

13. Prepare, as a class, a guide for protecting oneself from fraudulent schemes and plan some way to share this guide with others.

14. Select advertisements from newspapers and magazines or various types of offers received in the mail and analyze them to determine which ones seem legitimate and which ones seem questionable.

KEY POINTS

There are a number of types of fraudulent and deceptive schemes used by unscrupulous salesmen and businessmen.

The consumer is less likely to be influenced by fraudulent or deceptive schemes and health quackery if he is aware of the approaches used in the promotion of these.

The consumer who takes time to shop for what he wants and who can judge quantity and quality accurately is less likely to be cheated than the uninformed consumer.

When fraud or deception is suspected, the consumer should report it to the proper authorities.

Although the consumer is given some protection by laws and government agencies, it is the responsibility of the consumer to be alert to questionable schemes.

Fraudulent schemes succeed because they are aimed at such human goals as the desire to make money, remain young, stay healthy, or get a "good deal."

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Pamphlets

Bait Advertising. New York, New York: National Better Business Bureau. (Consumer Information Series No. 6 of 6)

Facts You Should Know About Schemes. New York, New York: Better Business Bureau, Educational Division, 1964.

Fight Back! The Ungentle Art of Self-Defense. Washington, D.C.: Government Printing Office, Federal Trade Commission, 1969.

Fulfillment Complaints. New York, New York: National Better Business Bureau, Inc. (Consumer Information Series No. 5 of 6)

Furness, Betty. Beware of Consumer Pitfalls. Burlington, Iowa: National Research Bureau, Inc.

Homework Schemes. New York, New York: National Better Business Bureau, (Consumer Information Series No. 1 of 6)

How the Postal Inspection Service Protects You Against Mail Fraud. Washington, D.C.: Chief Postal Inspector, U.S. Post Office Department.

How to Beat Cheats and Frauds. Burlington, Iowa: National Research Bureau, Inc.

Mail Order Profit Mirages. New York, New York: National Better Business Bureau, Inc. (Consumer Information Series, No. 3 of 6)

Seaver, Jacqueline. Fads, Myths, Quacks--And Your Health. New York, New York: Public Affairs Pamphlets, 1968.

Unordered Merchandise. New York, New York: National Better Business Bureau, Inc. (Consumer Information Series, No. 2 of 6)

TEACHER:

Visual

Too Good to Be True. New York, New York: Better Business Bureau, Inc.

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SECTION THREE: CONSUMER CITIZENSHIP

UNIT IV: Rights and Responsibilities

BEHAVIORAL OBJECTIVES

Be able to (1) give illustrations of each of the rights of consumers in our society
(2) plan ways to protect your rights as a consumer
(3) recognize responsibilities of the consumer
(4) analyze yourself in terms of acceptance of consumer responsibilities
(5) recognize relationships between rights and responsibilities of consumer
(6) dramatize situations in which consumer responsibilities are being met
(7) willingly practice ethical responsibilities of consumers

SUGGESTED LEARNING EXPERIENCES

1. View the visual (see Part Two, p. 266) and discuss the rights of consumers as outlined by President Kennedy in 1962. Work in buzz groups with each group taking one right. What does this right mean to you? What are some examples of ways in which we use these rights?

2. Interview a foreign student and/or someone who has lived in another country to determine consumer rights in other countries. If possible, tape record the interview. Discuss.

3. Discuss ways in which consumers' rights are protected in the United States. Are there differences in other societies in the rights of consumers? For example, do people in other countries have as much right to choose and to be heard as American consumers?

   Clip magazine and newspaper articles which deal with consumer rights and indicate, in a sentence or paragraph, with which right the article deals.

4. Read pp. 335-344 in The Consumer and His Dollars by Schoenfeld and Natella to see the responsibilities consumers have in contrast to their rights and the relationship between these responsibilities and consumer education. Discuss.

5. View transparencies (see Part Two, p. 268) and answer discussion questions dealing with responsibilities of the consumer.

6. Select a consumer responsibility and plan a display illustrating your concept of that responsibility. You may prefer to investigate in depth one of the responsibilities and report your findings to class. For example, you might investigate the use of natural resources which are limited.

7. Develop a rating scale for measuring the extent to which you assume your responsibilities as a consumer. Use three columns and describe what the expert, average, and uninformed consumer would do. For example:

Expert	Average	Uninformed
Reads labels carefully and knows what to expect of products	Glances at labels	Completely ignores labels

8. Dramatize situations such as the following, to see how consumers should assume their responsibilities:

   Deal only with reliable businesses
   Report unlawful practices to proper authorities
   Read labels and directions
   Evaluate carefully printed consumer aid materials

9. Identify ways in which consumers can assume responsibility for legislation affecting the consumer, for unfair business practices, and for customer services provided by business. Discuss.

10. Discuss some of the ethical responsibilities of consumers. What effects do shop-lifting, unnecessary return of goods due to careless buying, and refunds or exchanges for products abused by the consumer, have on business? How can the public be informed of the way in which their consumer practices increase the cost of goods and services? Plan a project for informing the public of their responsibilities. Use such media as newspaper articles, radio and TV "spot" announcements, and posters.

11. Volunteer to read one of the following books or other similar books to become familiar with consumer problems in our society. Report to the class.

    The Spenders by Steuart Henderson Britt
    The Tastemakers by Russell Lynes
    The Hidden Persuaders by Vance Packard
    The Waste Makers by Vance Packard
    The Status Seekers by Vance Packard
    The Naked Society by Vance Packard

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12. Complete the following statements to summarize what you have learned about consumer rights and responsibilities:

    My rights as a consumer are:
    My responsibilities as a consumer are:

13. Rotate the responsibility of writing a newspaper column each week for several weeks on "Consumer Citizenship," to stimulate interest in consumer's rights and responsibilities. Publish the column in school or local newspapers.

KEY POINTS

Consumers have both rights and responsibilities within our economic system.

Rights of consumers include the right: to be informed, to choose, to safety, and to be heard.

Rights of consumers in the United States are more varied than those of consumers in some societies.

Consumer education helps citizens to assume their responsibilities as consumers.

Our personal consumer power and economic system can be protected and improved only if consumers assume their responsibilities for being better consumer-citizens.

Individuals and families can promote their economic welfare by using their consumer rights as citizens in the market place.

Consumers have certain ethical responsibilities as they function in the business world.

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Lynes, Russell. The Tastemakers. New York, New York: Harper and Row Publishers, Inc., 1954.

Packard, Vance. The Hidden Persuaders. New York, New York: David McKay Company, Inc., 1957.

Packard, Vance. The Naked Society. New York, New York: David McKay Company, Inc., 1964.

Packard, Vance. The Status Seekers: An Exploration of Class Behavior in American and the Hidden Barriers That Affect You, Your Community, Your Future. New York, New York: David McKay Company, Inc., 1960.

Packard, Vance. The Waste Makers. New York, New York: David McKay Company, Inc., 1961.

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PART ONE

SECTION FOUR: THE CONSUMER AND THE ECONOMY

SECTION FOUR: THE CONSUMER AND THE ECONOMY

UNIT I: The Consumer in the United States

BEHAVIORIAL OBJECTIVES

Be able to (1) recognize the role of the consumer in the economy
(2) explain how the level of living changes at various stages of the family life cycle
(3) identify ways in which teens contribute to the national economy
(4) understand the motivations which stimulate consumers to purchase
(5) analyze influences on consumer choices

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 47-65 in Your Family and Its Money by Thal and Holcombe, pp. 28-44 in Consumer Economics by Wilhelms, Heimerl, and Jelley; pp. 18-58 in Economics for Our Times by Smith; or pp. 72-88 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks to gain an understanding of the role of the family in the functioning of the economy.

   Discuss questions such as: What is a level of living? How does your level of living compare with that of your parents? your grandparents? How does the level of living change during the various stages of the family life cycle? What are some of the problems facing consumers today? How and why is the family essential to our economy?

2. Find current articles in magazines such as Changing Times, U.S. News and World Report, Business Week, Time, or Newsweek which are concerned with the national economy to become aware of current economic problems. Report on one article and share with class.

3. View the filmstrip, The Role of Consumers, by Joint Council on Economic Education to understand the importance and present status of consumers. Discuss questions such as: How important is the consumer in today's economy? What is the consumer's status compared to that of business? Government? What is the role of an intelligent consumer citizen? [NOTE TO TEACHER: The booklet accompanying the filmstrip gives additional suggestions for discussion questions and student activities.]

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4. Read Youth's Place in the Economic Cycle (see Part Two, p. 279). Discuss such questions as: How many members of the class have a regular income? How is this income distributed? What kind of buying practices do you use? Do you exercise your responsibility as a consumer? In what ways?

5. View the filmstrip, Exploited Generation by Guidance Associates to understand teen-age spending. Discuss such questions as: How do the teen-ager's spending habits affect the economy? From what sources does the teen-ager receive the money he has to spend in the market place? What do merchants do to encourage teen-agers to spend their money? How are teen-agers' needs and wants satisfied? What are some creative things that could be done in high schools to help teen-agers understand their shopping habits? How do teen-agers determine what kinds of goods are to be produced and in what quantity? How will the teen-agers' buying habits of today influence the economy 10-15 years from now?

6. Discuss such questions as: Do you feel that most advertising is informative? Why? How do you react to most advertising claims? Do you feel that advertising influences your purchases to a great extent? Give examples.

7. Take an ad and work in buzz groups to discuss such questions as: What kind of information do you as a consumer want in this ad? How should this information be made available to the consumer? How can we educate consumers to be more informed about this product? What are you as a consumer going to do about it?

8. Take turns imitating advertising slogans from TV and radio to determine the effect each one has on you. Discuss.

9. View the filmstrip series, Consumer Education Series, by Institute of Life Insurance to understand the influences consumers have on production of goods and services. Discuss questions posed in the filmstrip as you progress through the filmstrips. [NOTE TO TEACHER: See filmstrip guide for possible questions.]

10. Discuss the following questions to understand the influences consumers have on production of goods and services. What is the greatest single influence on consumer choice-making? What other factors influence consumer choice-making? Explain.

11. Write a paper answering the following questions to understand the problems consumers face in a changing society. In what ways are students an important economic force? What problems do students face as consumers? parents face as consumers? What can be done to eliminate these problems?

KEY POINTS

The family has changed from a productive unit to a consuming unit and is dependent upon national conditions for economic well being.

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Consumers' needs and wants are satisfied by economic goods and services.

Consumers have a part in determining what kinds of goods are to be produced and in what quantities.

The family is essential to the functioning of the economy.

The family's level of living is affected by its stage in the family life cycle.

Teen-age spending plays an important role in the national economy.

Because teens are big spenders today, and will spend even more tomorrow as heads of families, it is essential that they recognize their role in the economy.

Consumer choices in the market place are influenced by a number of factors.

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SECTION FOUR: THE CONSUMER AND THE ECONOMY

UNIT II: The Economic System

BEHAVIORAL OBJECTIVES

Be able to (1) explain how the economic system operates
(2) recognize the dependence of consumers upon business to satisfy economic needs and wants
(3) familiarize yourself with the economic principles essential to a citizen for effective participation in our economic system

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 21-39 and 57-71 in Applied Economics by Kennedy, Olsen, and Dodd; pp. 1-14 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 4-16 and 452-463 in Consumer Economics by Wilhelms, Heimerl, and Jelley; pp. 1-61, 143-156, 215-275 in Consumer Economics by Wilson and Eyster; pp. 58-160, 338-374 in Economics for Our Times by Smith; or pp. 26-62 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks to understand how the economic system operates. Discuss.

2. Review the filmstrips II and III of The Role of Consumers by Joint Council on Economic Education to recognize the dependence of consumers upon business conditions. Discuss such questions as: What is a free enterprise system? What is inflation? What is deflation? Recession? In what ways does government help individuals to consume more wisely? How are changes in the economy measured?

3. Listen to an economist or other qualified person discuss "The Economic System in the United States," as an introduction to basic economic principles. Participate in a class discussion of the points made in the presentation.

4. Listen to a symposium in which a banker, an attorney, a savings and loan director, and a financial management expert explain the problems of our changing economy. Discuss the issues brought up by the panel.

5. Read The Mystery of Economic Growth by Federal Reserve Bank of Philadelphia, The Spark of Economic Growth by National Research Bureau, Profits and the American Economy by United States Department of

Commerce, or Understanding and Using Economics by Better Homes and Gardens Reader Service to gain a better understanding of our economy. Report findings to class.

6. Write a paper or present an oral report to the class on the role of the family in the economic system.

7. Prepare a circle graph that shows the Gross National Product for the past year to become aware of the distribution of consumer income in the economy. Data for the chart may be secured through a public library or a school library.

8. Scan newspapers and magazines to become aware of consumer economic issues affecting consumers. Report to the class on one article of particular interest to you.

9. Read pp. 340-348 in Economics for Our Times by Smith; pp. 229-241 in Applied Economics by Kennedy, Olsen, and Dodd; pp. 255-264 in Consumer Economic Problems by Wilson and Eyster; or pp. 17-37 in The Consumer and His Dollars by Schoenfeld and Natella to understand the role of government control in our economy.

10. List examples of government control at the federal, state, and local levels that affect the marketing of certain goods to become aware of types of government control. Why are these controls necessary? How do they protect the consumer?

11. Write a paper explaining ways in which the federal government controls or regulates the stability of our economy. Give your reactions to these controls.

12. Identify the goods and services sold by a food market, car dealer, and a laundry service and then write answers to the following questions: Which of the goods and services could you have provided yourself? Which goods and services could you not provide for yourself? Why are we not entirely self-sufficient?

KEY POINTS

Our economy is not stable, but fluctuates according to the influence of many complex factors.

The economic activities of government are protection, service, regulation of private economic activities, and promoting economic stability and growth.

Modern production, characterized by specialization, standardized products, and mass production, increases the consumer's dependence on business for satisfying his economic needs and wants.

A capitalistic economic system is one in which private individuals own the capital and enjoy free enterprise in its use.

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SECTION FOUR: THE CONSUMER AND THE ECONOMY

UNIT III: Sources and Functions of Money

BEHAVIORIAL OBJECTIVES

Be able to (1) recongize the function of money in our economy
(2) recognize the relationship between the supply of money in the economy and the prices of goods and services
(3) describe the circular flow of money in the economy

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 149-167 in Applied Economics by Kennedy, Olsen, and Dodd; pp. 181-199 in Consumer Economic Problems by Wilson and Eyster; pp. 228-237, 284-296 in Economics for Our Times by Smith; or pp. 62-72 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks; Money and Economic Balance by Federal Reserve Bank of New York; Money and You by The American Bankers Association; or Money: Master or Servant? by Joint Council on Economic Education to recognize the function of money in the economy.

2. Read Two Sides of Money (see Part Two, p. 283) and What Is Money? (see Part Two, p. 287) to gain an overall view of the functions of money. Discuss such questions as: What is money? What are the functions of money? What is the relationship between government and money? What is the relationship between production and consumption? What is the role of money in this process? What are the eight basic functions of a business? Give examples of how each of these operates in business and in the family. What are some differences between social business situations and family business situations? What mediums of exchange have been used in the history of money? What mediums of exchange are used today? What qualities must a satisfactory money possess?

3. Work in groups and prepare a bulletin board or chart to illustrate the development of money in the United States. Discuss.

4. Write a paper on "An Unusual Form of Money" or "How Money Has Changed Through the Years" to become aware of the history of money. Check with your librarian for sources of information.

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5. Discuss the circular flow of money in order to better understand the relationship between money and the business cycle. [NOTE TO TEACHER: Use transparency The Circular Flow of Money (see Part Two, p. 288).]

6. Read pp. 38, 42, 44, 278, 315 in Economics for Our Times by Smith; pp. 8-12 in The Consumer and His Dollars by Schoenfeld and Natella; pp. 64-66 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks; or pp. 113-121 in Consumer Economic Problems by Wilson and Eyster to understand the difference between money and real income.

7. Write a paper comparing money income and real income to clarify their similarities and differences.

KEY POINTS

The value of money depends upon the total quantity of money in the economic system and the stability and growth factors.

The value of money is measured by what it will buy.

Money income represents the purchasing power of consumers and the national economy.

Money is a serviceable means to an end of producing and distributing economic goods and services.

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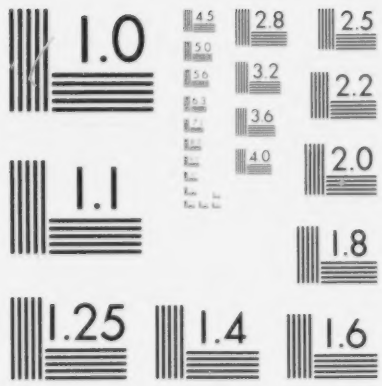

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SECTION FOUR: THE CONSUMER AND THE ECONOMY

UNIT IV: The Market System

BEHAVIORAL OBJECTIVES

Be able to (1) define terms related to the market system
(2) identify the steps in the marketing process
(3) identify and explain the functions of types of markets

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 78-84 in Applied Economics by Kennedy, Olsen, and Dodd; pp. 16-28 in Consumer Problems by Wilhelms, Heimerl, and Jelley; pp. 61-79, 101-125 in Consumer Economic Problems by Wilson and Eyster; or pp. 17-26, 43-52 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks to gain an overall understanding of the market system.

   Discuss such questions as: What is marketing? What are the functions of marketing? How are consumer goods marketed? How much does marketing cost? How do convenience goods affect prices in the market? What determines the size of a market? What are some types of markets? What middlemen are involved in our market system? How does marketing contribute to our standard of living?

2. Read pp. 32-45 in Economics for Our Times by Smith, pp. 3-4 in The Consumer and His Dollars by Schoenfeld and Natella; or pp. 80-85 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks.

   Devise a list of factors which influence consumers in the choice of a market.

3. Prepare a chart or bulletin board showing the characteristics of the marketing system to illustrate the relationship between functions of the marketing system in the economy.

4. Listen to a local merchant speak on his role in the marketing process. Discuss such questions as: At what level of the marketing system does this business operate? How is this business related to the total economy?

5. Work the crossword puzzle (see Part Two, p. 290) on marketing terms to check your understanding of marketing terminology.

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7. Report on one step in the marketing process to understand the functions of each stage in the marketing process. [NOTE TO TEACHER: Steps which students might select are: determining and developing products to be marketed; assembling raw materials; transporting goods; processing or manufacturing; standardizing, sorting, and grading of products; packaging and labeling; storing; conducting research; gathering, assembling, and using information about economic and market conditions and trends; financing and risk taking; determining prices; selling; communicating with different elements of market system.]

KEY POINTS

Price is determined by the balancing of supply and demand.

Marketing helps families achieve a high level of economic living.

In our economy, the role of government is to regulate and promote business for the benefit of the public.

Each step in the marketing process has a unique function and affects production and distribution of products.

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SECTION FOUR: THE CONSUMER AND THE ECONOMY

UNIT V: Banks and Banking Services

BEHAVIORIAL OBJECTIVES

Be able to (1) identify the functions and services of the three different kinds of financial institutions: savings banks, commercial banks, and savings and loan associations
(2) list the advantages of using bank services
(3) reconcile a bank statement

SUGGESTED LEARNING EXPERIENCES

1. Read pp. 182-222, 234-253 in General Business for Everyday Living by Price, Musselman, Hall, and Weeks; pp. 248-274 in Economics for Our Times by Smith; pp. 208-245 in Your Family and Its Money by Thal and Holcombe; pp. 76-92, 364-371 in Consumer Economics by Wilhelms, Heimerl, and Jelley; or pp. 199-215, 317-343 in Consumer Economic Problems by Wilson and Eyster to gain an understanding of banks and banking services.

   Discuss such questions as: What is the role of savings and loan associations in our economy? Is this the only type of savings institution? What are others? How does the role of the commercial bank compare to the role of the savings and loan association?

2. Find out the different types of banks in your community and the functions of each of the banks. Report findings to the class.

3. View the filmstrip Money and Banking by Association Films, as an introduction to banking services. Discuss such questions as: What is the role of commercial banking as part of the enterprise system? What service do banks perform? What types of deposits are made at banks? What is the process for handling checks in a bank? What types of loans are made at banks?

4. Read Money and Banking in Our Everyday Living, How Banks Help, or Using Bank Services from the American Banking Association or The Story of Checks from the Federal Reserve Bank of New York to see the relationship between banking and the economy.

   Discuss such questions as: What is the role of banks in our economy?

What are the different kinds of banks and bank services? How do the different banks serve the consumer? Why are banks important to our economy?

5. Take a field trip to a bank and have the banker explain how the bank operates to become aware of the operation of the bank. Discuss.

6. Prepare a bulletin board illustrating functions of a bank to clarify banking operations.

7. View the filmstrip from the kit, Paying By Check, by American Bankers Association, as an introduction to checking account services. Discuss.

8. Take a field trip to your bank and obtain forms frequently used by depositors. Ask about the requirements for opening a checking account and the regulations for operating a checking account.

   Discuss such questions as: How do I open a checking account? A savings account? Why should I open a checking account? Why can't I just save my money at home? What are the benefits of bank services?

9. Do a field study by going to visit one or more banks in your community to find out what services they have to offer the depositors. For example, you might want to find out such things as building facilities, convenience, service, and free and educational materials.

10. Read Protect Your Checking Account (see Part Two, p. 293) to become aware of the importance of check writing procedures. Discuss.

11. Reconcile a bank statement with a check book record to develop skill in caring for a personal checking account.

12. Listen to a banker explain how a savings and loan association operates. Participate in a discussion of ideas brought out by the speaker.

13. Play the Money Game (see Part Two, p. 295) to check your knowledge of banks and bank services.

14. Play Economic Jeopardy (see Part Two, p. 303) to check your understanding of the consumer in the economy.

KEY POINTS

Banks facilitate the exchange of money in the economy.

Checks are used in place of cash for safety and convenience.

Banks loan and invest the savings of individuals and/or groups to benefit the entire economy.

Banks deal in money lending services for a profit.

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The status of the economy and accompanying government regulations determine a bank's willingness to lend money.

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Consumer Education, Part Two.

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DESCRIPTORS - *CONSUMER EDUCATION; *TEACHING GUIDES; *HOME ECONOMICS EDUCATION; GRADE 11; GRADE 12; INSTRUCTIONAL MATERIALS; *INSTRUCTIONAL AIDS; TEACHING TECHNIQUES; AUDIOVISUAL AIDS; SIMULATION; EDUCATIONAL GAMES; TRANSPARENCIES; LEARNING ACTIVITIES

ABSTRACT - This curriculum bulletin, which is designed for a 1-semester consumer education course at the 11th and 12th grade levels, is closely interrelated and supplementary to Part One. It contains a wide variety of related teaching-learning materials for students and teachers, including: (1) directions for making transparencies, instant slides, bulletin boards, posters, and other visuals, (2) suggestions for using simulation games, case studies, skits, and stories, and (3) illustrations of programmed instruction, objective tests, crossword puzzles, and cartoons. These may be used in carrying out one or more of the suggested learning experiences in Part One, available as VT 012 577, also in this issue. (SB)

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consumer education

part two

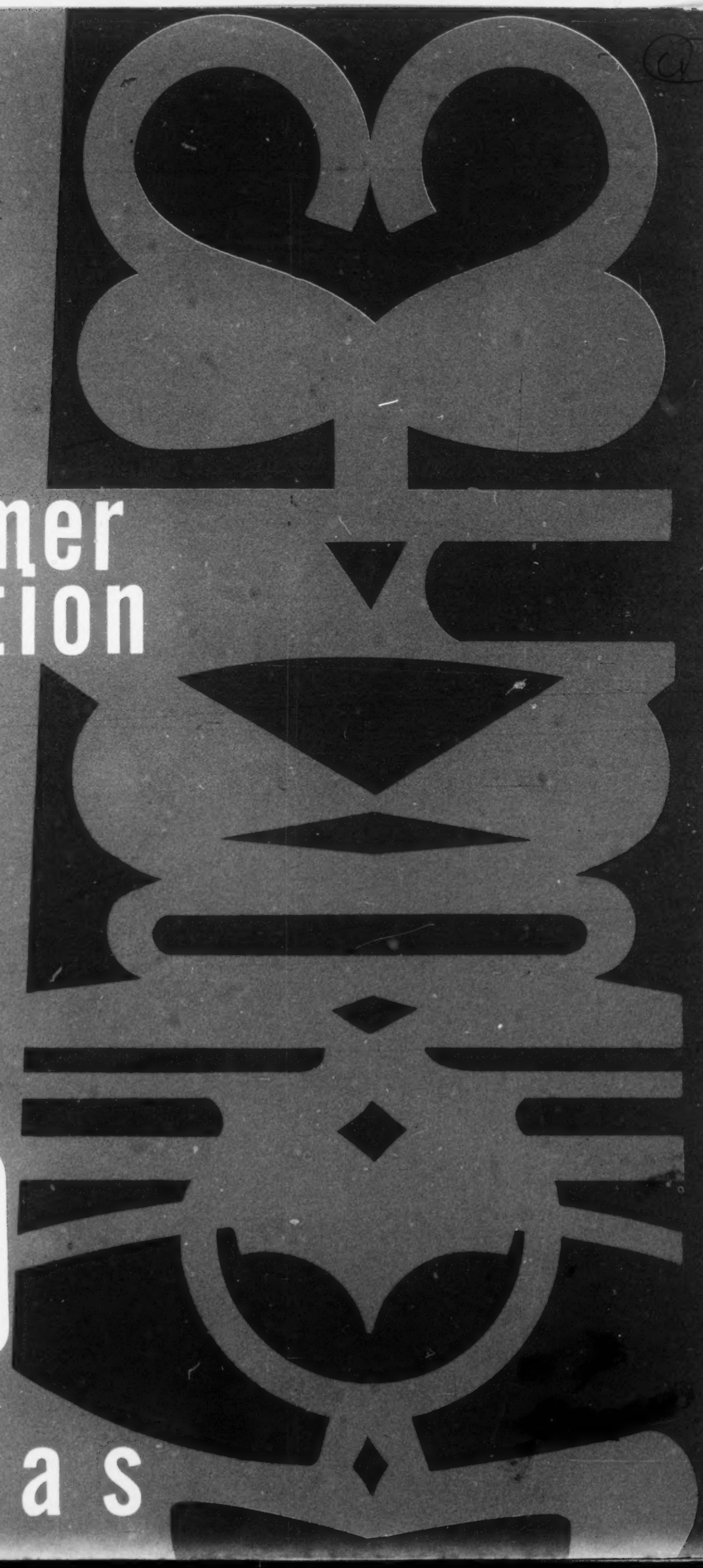

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CONSUMER EDUCATION

PART TWO

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DESCRIPTION OF
HOME ECONOMICS INSTRUCTIONAL MATERIALS CENTER

The Home Economics Instructional Materials Center was established September 1, 1967, as a continuing project. It is a cooperative project between the Division of Homemaking Education, Texas Education Agency, and the College of Home Economics, Home Economics Education Department, Texas Tech University at Lubbock, Texas. The instructional materials which are being developed at the Center are intended to assist teachers and coordinators in promoting and teaching home economics gainful employment programs or consumer education.

To provide a background of information for the establishment of the Home Economics Instructional Materials Center, a Planning Grant Project was approved by the Texas Education Agency for February 1 through August 31, 1967. The major purposes of the Planning Grant Project were (1) to assemble and catalog an occupational reference library, (2) to develop procedural steps for preparation of instructional materials, and (3) to illustrate the first sequence of these steps, that is, to develop job analyses and to list competencies needed for employability of students.

The present major objectives of the Home Economics Instructional Materials Center are (1) to develop instructional materials designed for use by students enrolled in cooperative part-time training programs and in pre-employment laboratory training programs in preparation for employment in occupations requiring home economics knowledge and skills, (2) to develop materials in consumer education, and (3) later to develop materials designed for use in home and community service programs.

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Miss Barbara Clawson, Director of the Center from 1968-1970, and Mrs. Thelma Whigham, Assistant Director of the Center from 1967-1970.

Dr. Camille G. Bell, Chairman, Department of Home Economicd Education, and Dr. Willa Vaughn Tinsley, Dean, College of Home Economics, Texas Tech University, who continue to serve in an advisory capacity.

Linda Glosson, Acting Director
Home Economics Instructional
Materials Center

Betty Robinson, Assistant Director
Home Economics Instructional
Materials Center

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FOREWORD

The emphasis placed on consumer education by Part F of the Vocational Education Amendments of 1968 prompted the development of the two bulletins in Consumer Education, Parts One and Two, for use in teaching high school students.

Because of the increasing complexity of the marketplace, it is imperative that home economists evaluate their past efforts in teaching in this area, update their teaching materials and emphases, and develop a philosophy of teaching Consumer Education based on decision-making and the management process. These are the beliefs which guided the development of the curriculum materials presented in Parts One and Two in the Consumer Education series.

Facts concerning best buys soon become obsolete due to rapid technological developments and consequent changes in goods and services available. For this reason, little emphasis has been given to buymanship in the bulletins; instead, the major emphasis has been on decision-making as individuals and families use it in the management process. Consumer education taught from this point of view will remain timely. Such teaching will enable students to identify and analyze their values, needs, wants, resources, and goals and consequently will enable them to make rational decisions regarding the myriad of choices that confront them in the market place, regardless of the technological changes which may occur. It is hoped that this kind of consumer education will contribute to family stability and happiness as students establish homes and begin the family life cycle.

The Consumer Education Bulletins are designed for a one-semester course for both boys and girls at the 11th and 12th grade levels. The comprehensive coverage of the consumer education topic necessitated the presentation of the contents in two bulletins--Parts One and Two. The introductory pages are repeated in each bulletin as are the Tables of Contents.

Both Parts One and Two contain four sections: Allocation of Resources, Consumer Buying, Consumer Citizenship, and the Consumer in the Economy.

In Part One the sections follow this format: Behavioral Objectives, Suggested Learning Experiences, Key Points, and References for both students and teacher. Part Two contains a wide variety of related teaching-learning materials for both students and teacher. Among these are directions for making transparencies, instant slides, bulletin boards, posters, and other visuals; suggestions for using simulation games, case studies, skits, stories, etc; illustrations of programmed instruction, objective tests, crossword puzzles, and cartoons. These may be used in carrying out one or more of the suggested learning experiences in Part One.

Both Part One and Part Two are closely interrelated and supplement each other to provide students and teacher with the potential of achieving the behavioral objectives identified in Part One. Directions for using materials in Part Two are given in the Suggested Learning Experiences in

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Part One. References in Part One to the accompanying teaching-learning materials in Part Two are clearly identified.

The learning experiences are written from the student's point of view for both boys and girls. Many learning experiences are included. The teacher is not expected to use all the suggested experiences given in these bulletins in one semester. She may adapt, supplement, and/or expand the suggestions included in view of the specific needs, interests, abilities, and backgrounds of her students. The wide variety of experiences included should enable the teacher to select and assign those teaching-learning experiences that will help her students reach the objectives important to them. Many of the experiences may be used as means of evaluating the progress of students.

"NOTES TO TEACHER" are inserted occasionally throughout the lists of learning experiences. These notes usually give specific suggestions and/or references to material in Part Two.

Key points or summary statements of desired learnings follow each learning experience section. Student references and teacher references are included. Materials suggested in the teacher references give a broader, deeper coverage of the topic under discussion than do the student references and should be helpful to the teacher for background information. The numerous student references given enable the teacher to be selective in choosing those appropriate and available for her students.

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PART TWO

SECTION ONE: ALLOCATION OF RESOURCES

SECTION ONE: ALLOCATION OF RESOURCES
UNIT I: Management, What It Is
I-1. Management Is a Mental Process

(See Suggested Learning Experience No. 3, p. 3 in Part One)

Numerous transparency masters are included throughout the units in Part Two for the teacher's convenience. Using transparency masters can save hours of work in producing visuals and provide professional results at low cost. Transparencies should be helpful in explaining an idea in simple terms, in showing relationships between ideas, and in holding class attention while points on the transparency are discussed.

Directions for Using Transparency Masters:

1. Remove the Transparency Master from the book.
2. You will need a sheet of heat-transfer (transparency) film for each transparency to be made.
3. Run the transparency master and film through any transparency-making heat-transfer machine following directions for using the machine. Most heat-transfer machines operate in the same general way:
   a. Place master, face up, on flat surface.
   b. Place heat-transfer film on the master. (Film is usually notch-coded to indicate the side which goes against the master.)
   c. Adjust heat control setting to proper position.
   d. Feed master and film into machine.
4. Mount the transparency in a cardboard frame, if desired.
5. Add color, if desired. Adding color adds to the cost and time required for making the transparency. Colored overhead pencils, felt-tipped or nylon-tipped markers and pens can be used to add brilliant color to your visual. Diazo can be used. Tinted acetate will provide basic colors for materials copied. Colored adhesive film may also be used.

Additional Uses for Ideas Depicted on Transparency Masters:

1. Remove Transparency Master from book and project using an opaque projector.
2. Use the idea shown on the Transparency Master to aid in developing a poster or bulletin board.
3. Duplicate the Transparency Master for use as a handout.

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Through Which One

plans | controls | evaluates

The Use Of FAMILY RESOURCES

SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-1. Forced Choice Values Test[1]

(See Suggested Learning Experience No. 5, p. 5 in Part One)

Directions: Circle the number opposite the one statement in each pair which most appeals to you. You must choose one number in each pair of items.

1--to be reasonably sure about the future for myself and my family.
12--to do things well.

3--to have people think well of me.
5--to have as much freedom as possible to do things I want to do.

11--to have as many good things as possible.
12--to do things well.

6--to do new and different things often.
11--to have as many good things as possible.

7--to have friends.
10--to have things neat, orderly, and organized.

6--to do new and different things often.
8--to create an atmosphere that makes for satisfying family living.

3--to have people think well of me.
9--to do what is right according to my beliefs.

8--to create an atmosphere that makes for satisfying family living.
10--to have things neat, orderly, and organized.

4--to do things for my family and others.
11--to have as many good things as possible.

10--to have things neat, orderly, and organized.
12--to do things well.

2--to have influence with people.
11--to have as many good things as possible.

4--to do things for my family and others.
10--to have things neat, orderly, and organized.

---

[1]Reprinted by permission from Teaching Topics from Institute of Life Insurance and Health Insurance Institute, Vol. 19, No. 2, Spring, 1970, pp. 7-8, 11. Adapted by Teaching Topics from a test developed by Mrs. Doris Dyer for use in a M.A. thesis, Department of Home Management and Child Development, Michigan State University, East Lansing, Michigan, 1962.

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2--to have influence with people.
12--to do things well.

4--to do things for my family and others.
12--to do things well.

4--to do things for my family and others.
7--to have friends.

5--to have as much freedom as possible to do things I want to do.
8--to create an atmosphere that makes for satisfying family living.

2--to have influence with people.
3--to have people think well of me.

7--to have friends.
8--to create an atmosphere that makes for satisfying family living.

5--to have as much freedom as possible to do things I want to do.
12--to do things well.

3--to have people think well of me.
11--to have as many good things as possible.

6--to do new and different things often.
12--to do things well.

9--to do what is right according to my beliefs.
12--to do things well.

1--to be reasonably sure about the future for myself and my family.
10--to have things neat, orderly, and organized.

3--to have people think well of me.
8--to create an atmosphere that makes for satisfying family living.

5--to have as much freedom as possible to do things I want to do.
6--to do new and different things often.

6--to do new and different things often.
10--to have things neat, orderly, and organized.

1--to be reasonably sure about the future for myself and my family.
5--to have as much freedom as possible to do things I want to do.

3--to have people think well of me.
6--to do new and different things often.

5--to have as much freedom as possible to do things I want to do.
7--to have friends.

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10--to have things neat, orderly, and organized.
11--to have as many good things as possible.

2--to have influence with people.
4--to do things for my family and others.

8--to create an atmosphere that makes for satisfying family living.
9--to do what is right according to my beliefs.

8--to create an atmosphere that makes for satisfying family living.
12--to do things well.

4--to do things for my family and others.
5--to have as much freedom as possible to do things I want to do.

9--to do what is right according to my beliefs.
11--to have as many good things as possible.

1--to be reasonably sure about the future for myself and my family.
2--to have influence with people.

9--to do what is right according to my beliefs.
10--to have things neat, orderly, and organized.

6--to do new and different things often.
7--to have friends.

4--to do things for my family and others.
6--to do new and different things often.

2--to have influence with people.
5--to have as much freedom as possible to do things I want to do.

4--to do things for my family and others.
8--to create an atmosphere that makes for satisfying family living.

2--to have influence with people.
9--to do what is right according to my beliefs.

1--to be reasonably sure about the future for myself and my family.
8--to create an atmosphere that makes for satisfying family living.

5--to have as much freedom as possible to do things I want to do.
10--to have things neat, orderly, and organized.

7--to have friends.
9--to do what is right according to my beliefs.

1--to be reasonably sure about the future for myself and my family.
11--to have as many good things as possible.

3--to have people think well of me.
10--to have things neat, orderly, and organized.

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2--to have influence with people.
8--to create an atmosphere that makes for satisfying family living.

3--to have people think well of me.
4--to do things for my family and others.

2--to have influence with people.
6--to do new and different things often.

2--to have influence with people.
10--to have things neat, orderly, and organized.

6--to do new and different things often.
9--to do what is right according to my beliefs.

1--to be reasonably sure about the future for myself and my family.
6--to do new and different things often.

3--to have people think well of me.
7--to have friends.

7--to have friends.
11--to have as many good things as possible.

2--to have influence with people.
7--to have friends.

4--to do things for my family and others.
9--to do what is right according to my beliefs.

5--to have as much freedom as possible to do things I want to do.
11--to have as many good things as possible.

1--to be reasonably sure about the future for myself and my family.
4--to do things for my family and others.

1--to be reasonably sure about the future for myself and my family.
7--to have friends.

3--to have people think well of me.
12--to do things well.

1--to be reasonably sure about the future for myself and my family.
3--to have people think well of me.

5--to have as much freedom as possible to do things I want to do.
9--to do what is right according to my beliefs.

1--to be reasonably sure about the future for myself and my family.
9--to do what is right according to my beliefs.

7--to have friends.
12--to do things well.

Directions follow for scoring the FORCED CHOICE VALUES TEST. Read the directions and score your responses.

DIRECTIONS FOR SCORING FORCED CHOICE VALUES TEST

1. Count the number of times you circled number 1 on the Values Test and insert the number counted in the blank to the left of statement number 1 below. Do this for each of the items through number 12.

2. Rank the items in the column to the right by assigning number one to the item that you circled the most times, number two to the item circled the second highest number of times, etc. In case of a tie give the items all the same rank, but allow a full number count for each item. For example, if there is a tie on number 3, assign two number threes, which take up the three and four spots, making five the next rank.

3. When you have completed ranking, you may look at the key to the left of the ranking and determine the highest to lowest values. Example: If #10 is ranked 1, that means your highest value is "orderliness."

   Be sure to check with your teacher if you have any questions on scoring or ranking.

No. of times circled	Key		Rank
_____	Security	1. To be reasonably sure about the future for myself and my family.	_____
_____	Influence	2. To have influence with people.	_____
_____	Recognition	3. To have people think well of me.	_____
_____	Helpfulness	4. To do things for my family and others.	_____
_____	Freedom	5. To have as much freedom as possible to do the things I want to do.	_____
_____	New Experience	6. To do new and different things often.	_____
_____	Friend-liness	7. To have friends.	_____

(Concluded on next page)

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No. of times circled	Key			Rank
_____	Family Life	8.	To create an atmosphere that makes for satisfying family living.	_____
_____	Religion	9.	To do what is right according to my beliefs.	_____
_____	Order-liness	10.	To have things neat, orderly, and organized.	_____
_____	Wealth	11.	To have as many good things as possible.	_____
_____	Workman-ship	12.	To do things well.	_____

SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-2. Values Questionnaire[1]

(See Suggested Learning Experience No. 7, p. 6 in Part One)

Values are those things which are very important to us. It's fun to think and talk about values because there are no right or wrong answers regarding them. At any given time some things will be much more important to you than others. Later, when the situation changes, you may value other things more highly.

1. If you had some free time, which of these things would you do?

   _____watch TV

   _____go riding around

   _____read a book

   _____go to a ball game

   _____do a chore you had been putting off

2. If you were given $50, would you...

   _____save it?

   _____buy records, gadgets for a car or a room?

   _____spend it for clothes?

   _____buy gifts with at least part of it?

   _____or _____?

3. A girl has just enough time to dress and get to a party. Suddenly, after she is dressed, she discovers a rip in her dress. If she takes time to change, she will be late.

   If she changes her dress, what value is influencing her behavior?

   If she does not change her dress, what value is influencing her behavior?

4. If students placed a high value on popularity, name some things they would insist on doing.

---

[1]Adapted from Training Home Economics Program Assistants to Work with Low Income Families. Bulletin PA 681, United States Department of Agriculture, Federal Extension Service. p. 41.

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5. If students placed a high value on cleanliness, name some things they would insist on doing.

6. If students placed a high value on order in their surroundings, name some things they would insist on doing.

7. If students placed a high value on beauty, name some things they might try to do in their rooms.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-3. Making Instant Slides

(See Suggested Learning Experience No. 8, p. 6 in Part One)

Several suggestions have been made in this publication for using instant slides. These are a slide series that the teacher herself can do quickly.

These slides can be used in any 2" x 2" slide projector and cost less than $1 for twenty. The inside area of a 2" x 2" slide may differ. The instant slide area is 127 (1 7/16" square, the largest available). Also remember that most filmstrip projectors have a slide attachment.

Directions for Making Instant Slides[1]:

(1) Run the master sheet through a transparency-making machine as for transparencies.

(2) Cut each frame on the outside lines.

(3) Put each section in a #127 slide holder.

(4) Seal with a hot iron. Professional slide sealers are available, or the teacher may borrow a Se Lin Iron from the library.

(5) Add color if desired. Colored overhead pens will do small areas quickly and efficiently. Diazo can be used. Tinted Acetate will provide basic colors for materials copied. Colored adhesive film may be used to cover the entire slide. Adding color adds to the cost and time expenditures.

The script to read with the instant slides follows the pages of slide masters.

---

[1]The idea for making instant slides was developed by Jeff Miller, Media Specialist, John H. Glenn Junior High School, San Angelo, Texas.

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ALICE DOWNS continued

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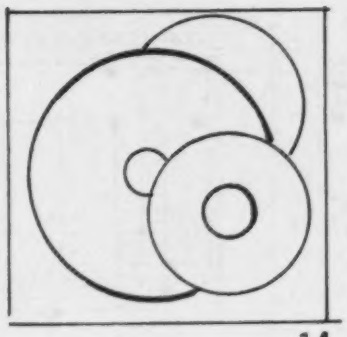

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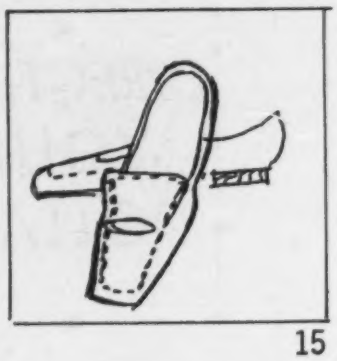

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JOHN M. BRANDT

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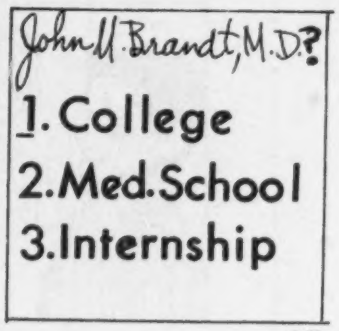

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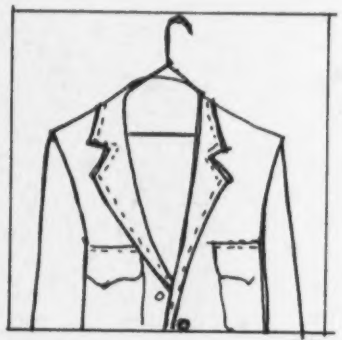

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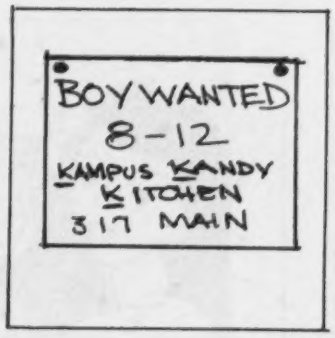

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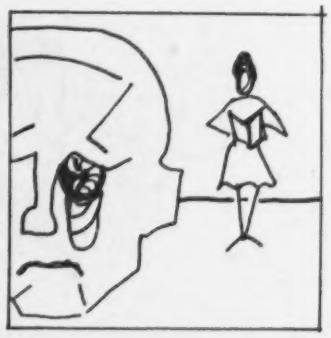

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BABS BLOCK

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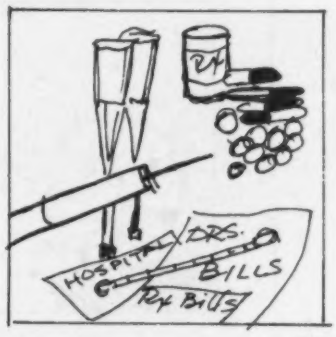

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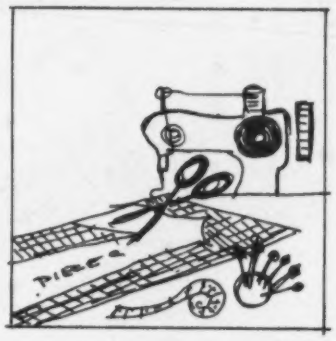

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Directing
YOUR
$ $ $ $

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-4. Directing Your Dollars (Script)

(See Suggested Learning Experience No. 8, p. 6 in Part One)

1. Directing Your Dollars

Presented by
The Educational Division: Institute of Life Insurance

Developed with the cooperation of
Miss Amanda Ebersole
Former Head, Home Economics Education Division
Drexel Institute of Technology
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Former Itinerant Teacher Trainer, Home Economics
Ohio State Department of Education
Dr. William Smith
Professor of Family Relationships
Pennsylvania State University
Miss Grace Woodward
Supervisor of Homemaking
Springfield Township School District
Chestnut Hill, Pennsylvania

Few of us ever have enough money. Instead, we must constantly plan how best to spend each dollar. This is often difficult because the choices are seldom clear cut. To direct our dollars wisely we must know what we want from life--in other words, we must define our personal values. For example...

...To choose between spending for an expensive date or saving for college, we must first decide whether immediate satisfactions are more important than future goals.

What's right for one person is not necessarily right for another. It depends on the individual's values. What are your values? Perhaps these slides will help you clarify them.

2. Today is something special at Jackson High...

3. ...The Big Dance has just been announced; and that's the high point of the social year.

4. It's an event that many have looked forward to for a long time. They're happy it's here.

5. That group at the table seems even happier than most, and for good reason. Their dates are set and everything looks simply great.

6. But is everything as great as it seems? Not quite. Take Alice Downs, over at the right.

7. Behind Alice's pretty smile, there's a pretty grim girl. Let's see what's on her mind.

8. Alice's problem is money--or rather, the lack of it. She needs $35 for a prom dress. She has exactly $2.83 and a bus token.

9. Alice's dad gives her $6.50 a week, plus $200 a year for big expenditures, such as dresses, a coat, and the class trip.

10. In Account with Alice Downs

Date	Withdrawal	Deposit	Balance	Account No.	Tran.
1 Jun 2		$200.00	$200.00		ANE
	**$27.00		*** 173.00		NE
	** 33.00		*** 140.00		NE
	** 75.00		*** 65.00		NE
	** 15.00		*** 50.00		NE
	** 30.00		*** 20.00		NE
	** 20.00		*** 00.00		NE

With so many things happening in her senior year, she finds that, by prom time, none of her $200 is left. Her bank balance is zero.

11. Some months ago, she realized she could buy a prom dress only if she saved money from her allowance. What went wrong?

12. First, she had to pay for necessities. It cost her $1.00 a week for bus fare, plus another $3.00 for lunches and school supplies.

13. Then there were things like cosmetics--which are practically necessities, don't you think?

14. And how was she to know there would be so many wonderful hit records this year?

15. As a member of her gang in good standing, she naturally had to have that wiglet. This year, it was a <u>must</u>. But absolutely!

16. So it went, until she ended up with the $35 question: "How will I get the dress I need for the senior dance?"

17. She could, of course, wear her two-year-old party dress. But she's worn it too often. And it looks so unsophisticated.

18. What about Dad? "I'd <u>like</u> to help; but I just gave $25 to your brother, Bob, to get parts for <u>his</u> hot rod. I can't spare another cent."

19. "That kid brother!" Alice mutters to herself. "Always making things miserable for me..."

20. Bob hasn't yet spent the $25; so Alice tries, very sweetly, to talk him out of it.

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21. Surprisingly, Bob agrees. He'll put off his purchases for two months, provided Alice pays him back by then from her allowance.

22. "That means," Bob says firmly, "no new records, no extra clothing, no nothing."

23. "And, oh yes, I'll expect you to take my place mowing the lawn the next three Saturdays so I can play ball with the league team."

24. "So that's it," says Alice angrily. "I should have known it wasn't generosity--and those are the days I'm to play tennis, too."

    And off she went, wondering how she'd find a way out of her fix.

    How does Alice's predicament reveal her sense of values? What do you think is her best way out? How do your answers reflect the values you hold? Decide how Alice might have avoided such a situation. Later on, prepare a budget based on Alice's income, and on <u>your</u> values!

25. Now let's return to the group and see what's behind Jack Brandt, the boy in the sweater.

26. Jack's mind is on the problems of becoming a doctor.

27. Medicine takes a lot of time, study, and money. Jack's folks have made it clear that part of the financial burden is his.

28. By working Saturdays and summers and by conserving his allowance, Jack has been able to save several hundred dollars.

29. Jack is reluctant to part with his savings. However, he <u>can</u> see drawing from his bank for prom tickets and flowers for his date.

30. He can also see the sense in a new suit, since he'll be able to use it at college.

31. But he's not happy about the gang's proposal to go to a night club after the dance.

32. Jack thinks night clubbing is too expensive. Anyway, he feels it's more fun gathering at someone's home.

33. Say, why <u>not</u> have a home party after the prom? The boys could chip in for refreshments.

    But Jack leaves without making the suggestion. He thinks he'd be called a cheap skate.

Jack could pay for the date by working afternoons for a week or so, in addition to Saturdays.

34. But track practice is in the afternoon. Taking a job would mean quitting the team, and the team needs him.

35. Jack considers a job that requires late hours.

36. But he knows that without a good night's sleep, he falls apart. What to do?

    What do you suggest for Jack? What appears to be one of Jack's dominant values? Do you think he is a cheap skate? How might Jack be hiding his real motives when he thinks (a) the team needs him; (b) he prefers home affairs to night clubs?

37. Now, let's watch Babs Block, who's at the far end. Incidentally, she's engaged to Joe Rand, sitting opposite her.

38. Like the others, Babs' problem is also spelled M-O-N-E-Y.

39. There is little spare cash at the Blocks'. Most of the family's modest income goes for doctor bills for a sick sister.

40. The Blocks haven't much money; but they do have the pleasure of working together closely.

    The whole family has been saving to help Babs. Jointly, they have accumulated $20.

    But $20 isn't enough for the good dress and accessories that Babs needs. And she hasn't anything else remotely suitable.

41. Babs can sew beautifully. But she feels her friends would secretly look down on a "home made" prom dress.

42. "You're imagining things," Mother says. "If you make your own dress, it will be the prettiest there." But Babs isn't convinced.

43. There are still several weeks before the prom. Perhaps if she'd do without lunches...

44. Or maybe she should look for a cheaper dress--though she knows this doesn't pay in the long run.

45. She can't get a job because she's needed at home. Oh well, maybe she won't go to the prom. She'll save the money for her wedding.

46. Later she suggests to Joe, as cheerfully as she can, that they stay at home.

47. "On the other hand, the prom might be the most important dance we'll ever attend. What do you think, Joe?"

What should Babs do? How does your answer reflect the values you hold? Is Babs right in thinking others would look down on a "home made" dress? Discuss the worn yet durable statement that "money isn't everything." Illustrate by considering Babs' relations with her family.

48. You've just seen the money management problems of three typical young people. Have their problems helped you to understand yours?

Once you've decided on the values you want, use them as a guide whenever you're faced with Directing Your Dollars.

The End
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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-5. Bill's Values and Goals

(See Suggested Learning Experience No. 13, p. 6 in Part One)

VALUES	SHORT TERM GOALS	LONG TERM GOALS
Service	Graduate from high school with good academic record	Become a lawyer in order to be of service to people
Knowledge	Save money from part-time job for college	

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-6. I Am a Lazy Housekeeper and My Family Loves It[1]
by Jean H. Maysilles

(See Suggested Learning Experience No. 18, p. 7 in Part One)

Sixteen years ago, when I was married at the tender age of 20, I settled down to keep house like everyone else I knew. My methods were patterned after my mother's and my mother-in-law's--daily dusting, mopping, wiping; weekly scrubbing, polishing and waxing; and the all-out semi-annual house-cleaning, when every piece of ceiling, wall, floor, furniture, cloth, china, glass, and silver was either scrubbed, waxed, cleaned, polished, vacuumed, or washed. By this method I not only devoted two thirds of my life to my housekeeping, but gained myself the reputation of being an "excellent little housekeeper."

How long my health and disposition would have stood up under this strain I don't know, and fortunately never had to find out because about this time I made a very interesting discovery. One day shortly after the birth of my first child, Cindy, when the duties of a good housekeeper and mother were weighing a mite heavily on my frail shoulders, I visited my mother-in-law unexpectedly. She immediately began to apologize about the condition of her house, explaining that she had been ill for two days and hadn't been able to do a thing. As I looked around, her house seemed the same to me as always, except that the flowers on the dining table needed to be changed and there was a pile of old newspapers beside a chair. It took me about two minutes to realize a basic truth--other people don't see your home in the same light that you do. Most people who come to your home are interested in you and your family, and as long as the general view is pleasant they don't know, or care, whether or not you've run the vacuum that day or polished your furniture that week.

With this fact in mind I began to change my housekeeping tactics. Over the past 13 years I have developed a method of housekeeping that seems to please everyone, including me, and that, though it is not entirely a "no-work" way, grows more painless every year.

I was not able to throw off my bad habits of good housekeeping overnight, of course, but within a few months after my delightful discovery I had worked out a beautiful plan. I arose with my husband at 7 o'clock, saw him off to work, tore through our apartment in a whirlwind pickup-dust-over program and relaxed with a second cup of coffee and the morning paper before the baby even woke. During her morning nap I attended to whatever other housekeeping I had to do. And I had already begun to cut corners. Did the kitchen floor really have to be scrubbed today or could

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I wipe up those spots and make it do until Saturday? Did the windows really need to be washed this afternoon? Why not just fold those pajamas instead of ironing them?

A little disguise that I discovered then and have since developed into a full-fledged hobby was flower arranging. Most people are so dazzled by lovely arrangements of flowers that they are not likely to notice a little bit of dust in the corner of the living room or the tarnished silver in the cupboard.

With a few adaptions in my schedule, I was able to continue at the same happy pace even when two years later I had a baby boy, and we moved from our three-room apartment to a seven-room house. In fact, within a year or two I had improved my status. As the children outgrew morning naps I was able to convince them that dusting was fun. Even at three years of age Tim had developed the old competitive spirit and took pride in occasionally having his bedroom judged neater than his big sister's.

When my second little girl, Molly, was born I almost gave up and decided that with three children aged five years, three, and one, I could no longer escape the drudgery of a routine. But after a few hesitations, a few fumbles, and a few weeks of utter chaos, we developed quite a comfortable program.

First of all, we declared that no one was to leave his bedroom in the morning until Mommy came up to dress the baby. This provided my husband and me with time for a pleasant and unharried breakfast. It also provided the two older children with the opportunity to show Mommy just how well they could dress themselves and make their beds. Sometimes this was not at all well, but at least they tried, and they seem to enjoy the responsibility. Usually with a few well-placed strokes on a wrinkled bedspread, the tying of a knotted shoelace or the straightening of a hair part, all was well.

The only hard and fast rule I ever found necessary consisted of just three words--"Put it back." With three children we had the inevitable mountain of toys, thanks to doting grandparents. With some tears, much repeating of "Put it back" and occasional paddling of small rears, all three children came to understand that they were free to drag out even the most mess-making toy, provided they put it back before dragging out the next one or running outdoors to help Mommy plant flowers. We provided a roomy toy chest for each child--which added nothing to the decor of the dining room but served admirably as the place to "put it back." I'll admit these toy boxes became "somewhat cluttered" at times; sometimes, if the children dug deep enough, they found a toy that hadn't been seen for months or even a lollipop that hadn't been quite finished yesterday. Thank goodness, each box had a sturdy lid so that to the casual observer they presented a tidy appearance, even though it was deceptive.

You are thinking that this is all very well, but what about washing and ironing, changing bed linens, scrubbing the bathroom, and running the sweeper? Remember, I told you my method was not one without work. So on two miserable mornings a week I had to work like a demon. On whatever morning seemed best, while the children played in their rooms upstairs

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(and/or occasionally interrupted me), I would scrub and clean and wax and polish the downstairs, and by afternoon I would be ready to collapse. After lunch, while the children took their naps, I would go to bed for two hours.

The upstairs would get the same treatment on Saturday mornings, when Daddy was able to take over playtime downstairs.

A year and a half ago my second son and fourth child, Andy, was born and we moved into an eight-room house. But by this time the older children were growing up, and my method of housekeeping took great forward strides. Let me give you an example of how the day goes in the household of a bad housekeeper with four children.

Simple arithmetic tells you that with four children there are likely to be five unmade beds every morning. These, if all of them were made by Mother, would consume the better part of an hour with the hanging up of pajamas, picking up of dirty clothes, and scrambling under the beds for slippers and last night's book. So, thinking only of the fine character this will develop in my children, I have trained them to make their beds, hang up or put away their clothing or toys and generally leave their rooms in an orderly condition. While this is being done I'm preparing breakfast, and incidentally, this is one area where I don't spare the work--perhaps because I enjoy cooking and it does not seem like work.

Within three quarters of an hour after rising, everyone but the baby and I has left the house for school or work. In 15 minutes I've washed the dishes, dusted any obvious dust, straightened pillows and picked up in our room. Now it's time to dress and feed Andy, who at 20 months seems to approve wholeheartedly of our design for living. If Mommy will play horsie and "Where's the baby?" for a while and then indulge him in an uproarious bath, he is quite content to spend two hours each morning and each afternoon in his crib (he hates his playpen). He sits in there and mumbles to himself in a language only he can understand, then chuckles at his own jokes or jumps up and down with great abandon. Sometimes he even goes to sleep.

Andy's obliging ways leave me plenty of time for myself, except on the one day a week when I go through my old Demon Housewife routine. With the older children in school I have been able to consolidate my former two frantic mornings into one frantic day. I tear through the house from top to bottom, cleaning everything in sight. When four o'clock rolls around I'm literally half dead. But--and this is the good part of that day--that is the night Dad has his special togetherness with the kids. At five-thirty they all pile into the car, drop the baby off with my mother and go out for hamburgers or what-have-you at a local diner. As soon as they leave I quickly eat a bowl of canned soup and go to bed, where I sleep or read for two leisurely hours. When my family returns I'm once again fit to live with.

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As for washing and ironing, I put a load of clothes in the washer every day before I do the breakfast dishes. With that wonderful convenience, a dryer, I take about 15 minutes to fold most of the clothing and save the few things that have to be ironed. I iron for about two hours one night a week while we watch television. It is a practically painless chore.

Having read this far, I'm quite sure you have arrived at the conclusion that here is undoubtedly a very lazy woman. Well, you are right; I am lazy, and you might even say selfish, except that my children and husband would disagree with you wholeheartedly. They like me to be happy; they like to know that I'm not too busy to play a new game, discuss the unfairness of the sixth-grade arithmetic assignment, examine a bird's nest; or too tired to be an interesting and loving wife. They like the fact that I have time to read profusely on all subjects and to pursue my hobby of growing and arranging flowers--a hobby which has grown more dazzling year by year.

I'm generally considered a good housekeeper, a wonderful mother, and "how she ever gets time to do all that gardening" is a "miracle." Frankly, I love to hear these opinions expressed, and have never before gone into the details of how I accomplished this so-called "miracle."

But as you can see, it's all done with smudgy mirrors!

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-7. I've Found a Schedule That Really Works[1]
by Norma Duerst

(See Suggested Learning Experience No. 18, p. 7 in Part One)

I wonder how many mothers have felt at times that the job of managing a home while bringing up small children is a chaotic, never-never job--never ending, never satisfying, never really well done.

It was not until my third child was born that I began to feel that way. When my husband Gene and I were married, seven years ago, I gave up my secretarial position and we moved to a small Wisconsin town, where my husband had accepted a job teaching social studies and physical education at the local grade school. We bought a small, two-bedroom house overlooking a lake just outside of town, and I slipped fairly easily into the role of housewife. I had time to read, to sew, to make friends and visit with them, and to be cheerful and relaxed for my husband when he came home at night. When our first child, Kim Susan was born and three years later our second child, Paul, my daily routine was somewhat disrupted, to be sure, but I still managed to run the house and have time for myself and my family. So when I became pregnant for the third time, I paid little attention to friends who told me: "Two isn't bad, but wait till you have three! You won't have time for anything." I paid little attention, but as soon as Peter Eric made his appearance I discovered that they were right!

Suddenly I just couldn't seem to cope with the everyday demands of the children and the house. Toys began to clutter up the living room; beds began to go unmade. Dust gathered on the television set and dishes collected in the sink. Although Gene always helped with the children--bathing them in the evening and taking them from underfoot whenever he could--my housework just overwhelmed me. And unlike some women, I couldn't be philosophical about the disorder that surrounded me; it depressed me terribly.

It took one exceptionally hectic day to make me see what was wrong. On this particular day I had worked constantly--making beds, wiping noses, picking up toys, fixing lunch, changing diapers, picking up toys, settling arguments. I had managed to find just enough time to be impatient with the children. When shortly before lunch Kim had taken out her dolls and dishes to play, I had snapped, "Don't mess now--pick up your things!" When Paul's attention had wandered from his blocks to his trucks I had frantically scooped up the blocks and put them away.

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At 4:30 in the afternoon I sat down for the first time since breakfast, and suddenly I realized that although I had worked steadily from seven o'clock on, I hadn't accomplished a thing. The living room was a mess, in spite of the fact that I had picked it up at least three times. There were unwashed bottles in the kitchen sink. The pie I had planned to bake for Gene was unmade. I was still dressed in the Bermuda shorts and limp blouse that I had thrown on that morning.

It just didn't make sense. I was wearing myself out and accomplishing nothing. Wasn't there some way to have a reasonable smooth-running and calm household? Couldn't I have a dusted, clean living room and still have time to do my nails? Wasn't there some way of getting the washing and ironing done that would leave time for me to play with Kim and Paul? Did I really have to choose to cuddle and rock my darling baby?

The next day I timed myself to see how long my household jobs really took. I found, to my surprise, that I needed just 20 minutes to vacuum my living room and hall and that dusting the living room took a mere 9 minutes. Bed-making--17 minutes for three beds and the crib. The breakfast dishes could be washed, dried and put away in 14 minutes. These figures, of course, didn't include time out for wiping noses, distributing cookies or zipping up fly fronts for a little boy who can't quite manipulate the zipper. Nevertheless, I came to the conslusion that even with untimed interruptions, housework <u>could</u> and <u>should</u> get done in less time and in a more orderly manner.

What was using up my precious time? One thing, I now realized, was my habit of picking up the toys a dozen times a day. Another was spending too much time in the morning on my second cup of coffee (which usually stretched to three or four). Another was long visits on the telephone. One of my biggest time wasters was hopping from one job to the next. I'd make Kim's bed and then, instead of completing the room, I'd go and throw some things into the washer. Or I'd clear the breakfast table, and instead of doing the dishes then and finishing in the kitchen, I'd shift to the beds or pick up clothes.

Finally I worked out a schedule. I know that some girls hate the idea of a schedule, but I've found it has worked wonders for me. Let me say, however, that mine is not an extremely rigid one. Instead, it is a workable, changeable routine that allows me time for myself, my children, and my husband.

First, I get up earlier in the morning. Peter usually wakes at 6, and rather than snuggle back into bed as I used to do after giving him his bottle, I stay up. I spend this quiet time, from about 6:30 until 7, in showering, getting dressed, putting on make-up and doing exercises (trying to reduce that after-baby roll around my middle).

Gene gets up at 7, and while he's showering and shaving I make our bed, put away pajamas and robes and pick up in our room. Then I make breakfast and have time--usually--to scan the paper and drink my juice before my two little Indians are up and at 'em for the day.

While Paul and Kim are drinking their juice, if all seems calm, I go to their rooms and make beds and pick up there. Before I changed my routine,

Kim and Paul often would be walking around until 10:30 or 11 in their pajamas and robes before I got around to dressing them for the day. Now I've made a rule: Neither of them can watch "Captain Kangaroo" until they are dressed. As a result, they dress eagerly so that they can watch their favorite program.

By 8:30 or 9 I have my beds made, my children dressed and myself neatly dressed and ready to begin the rest of my work for that day. If I can't get around to dusting the bedrooms that particular day or vacuuming the living room, at least things are neat and uncluttered. It's surprising how clean a home looks if it is just picked up and straightened. No one will ever notice whether the windows have tiny finger smudges, if the pillows are on the couch and the papers and toys off the floor. And if the beds are made and pajamas put away, nobody will notice whether the rugs have been shaken and the floor dust-mopped that morning. Don't misunderstand me--these jobs get done too; but sometimes, with the countless "unscheduled" interruptions, it's hard to accomplish everything in one day.

My weekly schedule I follow quite closely. Monday I do my entire washing and steam-iron part of it from the dryer. I prefer this way to my former method of washing a load or two of clothes every day. True, Mondays are busy, but then I'm done with my laundry for an entire week. This does not include, of course, the baby wash, which I do every day after the baby has his bath.

Tuesday I finish my ironing. Wednesday and Thursday are relatively "free," except for the daily cleaning and any odd job that may need doing. Friday I do a thorough cleaning, which includes scrubbing and waxing the kitchen and bathroom, washing windows, wiping out my refrigerator, and so on.

Before going to bed each night I pick up all newspapers, books, and glasses in the living room and plump the pillows on the couch. I stack any stray dishes in the sink so my kitchen won't be messy in the morning. I also put all the toys away. What takes me ten minutes to do at night would take me three times as long with the children underfoot in the morning.

One thing I have learned to live with is a certain amount of clutter in the living room. Our house is small, and Kim and Paul invariably make the living room their playroom. However, instead of picking up toys a dozen times a day and frustrating both myself and the children, I wait now until naptime and then all three of us make a "game" of it. In all honesty, sometimes it takes quite a little cajoling to get the children interested in this particular game. Then in the evening, at 4:45, "Bozo the Clown" comes on, and the children must pick up all their toys again before they can watch the program. In this way the house is all picked up when Gene comes home at 5:30.

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It seemed that the odd jobs around my home were always so hard to squeeze in--things like sewing a button on a coat, straightening out drawers, washing the light fixtures, mending socks, shampooing the furniture or cleaning the oven. I'm a great one for making notes anyway, so I started jotting down all these little extra jobs that weren't getting done. Every day I try to cross one of these jobs off my list. Surprisingly enough, sometimes thinking about a job takes longer than doing it. It gives me a sense of accomplishment, too, to cross them off one by one.

And some short cuts I've discovered have helped me immensely. One thing I do now while I'm preparing dinner is to clean my silverware drawer or scrub the baby's high chair or polish my silver. It's surprising how much can be squeezed in between peeling the potatoes and tossing the salad.

I must admit that even with a schedule and good intentions, a certain number of days are bound to be far from calm and serene. There will always be days, no matter how well planned, when things will all go wrong--when the oatmeal boils over on my clean stove or Paul scribbles with crayons on my floor or the baby is unusually fussy.

However, I've found that with my new system I can find time for myself--to sew a new dress, fix my hair or read a book, visit with friends and entertain occasionally. I've found time to enjoy my children, more time for playing with them, reading to them, appreciating them. I've found time to be pleasant and attractive for my husband, to have appetizing meals for him and still maintain a reasonably calm and clean home.

I've found time for the most important things--my husband, my children, me.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-8. Poverty, U.S.A.[1]

(See Suggested Learning Experience No. 21, p. 7 in Part One)

The impoverished are people, too. And here are a representative eight, chosen from many others interviewed by Newsweek throughout the country and keyed on a map of the U.S. They are at once typical of their plight and individual in their response.

Some have always been poverty-stricken, some only recently; some are not there yet, though headed in that direction. Significantly perhaps, none has ever been wealthy, nor even prosperous. And none is an "operator," able or even willing to exploit all the relief and charity possibilities open to him. Finally, nearly all have pressing health problems, and nearly all, somehow, have hope.

ALICE AND HOWARD NEIPERT

The living room of the Neipert apartment in Portland, Maine, is small and warm and filled with accumulated bric-a-brac of a 50-year marriage. Alice Neipert, a neat, buxom woman with a drawn face, sits quietly in a rocker near the window. She has crippling arthritis. Her husband, Howard, a benign 78-year-old, canes about the house. He has osteomyelitis.

Eight years ago Howard retired with $6,000 in savings and the intention of working at his old job as a shoe salesman three days a week and thus earning $1,200 a year. Within six months, however, he had become too sick to work. All the savings went for medical bills. "That was money we were going to have fun with," Mrs. Neipert says mildly. "We had a few little trips planned, maybe one to Florida."

Now they live on social security--$141 a month.

They eat sparingly, but "well enough," they both say, spending $10 to $15 a week on food and carefully balancing their diets. Mrs. Neipert can't walk very much, but she cleans the three-room apartment every day, does all her own laundry, ironing, and cooking. Howard vacuums, and they have a relay from closet to table for setting the table.

The Neiperts own a TV set, acquired before his retirement. (They think programs are going downhill fast.) Recently they have acquired a toaster

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and some blankets with grocery-store stamps saved over the years. They also have a phone--"the last thing I'd give up," says Mrs. Neipert. "Our son calls from South Portland every night."

Doctor bills and medicine costs menace their future. "Still, we don't owe one nickel, and we have a lot of wonderful friends," says Howard Neipert. "I'm not able to work, so we just have to get along, or else!"

The couple also retains a few "luxuries"--the morning newspaper (Pa'd just be lost without his paper"), and now and then a present. "Last week," says Howard, with a devilish glint, "I brought my wife a pint of sherbert."

MRS. PAULINE VELIZ

A family under siege, Pauline Veliz and her six children huddle in their four-room railroad flat in New York's Spanish Harlem and shut out the world. Their enemy is the fanged street below, which extends into the tenement, up the clammy, urinous stairways, past the occasional dozing junky who sometimes grabs for the children.

And there is a second enemy, sickness, the classic foe of the poor: 10-year-old Rosalinda has asthma. "They tell me she shouldn't climb stairs," says her mother bitterly. Five-year-old Bertile has a rheumatic heart. Antonio, 11, once spent over a year in a convalescent home in Connecticut. "All that time," says Mrs. Veliz, "I never saw my son. Finally I told the welfare people, 'You give me visiting money, or else I'll use the rent money.'" Welfare refused. Mrs. Veliz defied them, went to see her son, and got away with it: "I'm not afraid of welfare anymore. They can't throw you out unless you have a man around. I don't have one and I don't want one. I don't want any more children."

A round vivid woman of 38, Pauline Veliz was born in the U.S. of Puerto Rican parentage. She mentions the two husbands in her life, both now disappeared. Her children are entirely supported by welfare--$133 every two weeks. They attend parochial schools; Pauline accompanies them in the morning, picks them up in the afternoon, and they return via Girl Scout meetings and the like, to the dingy, spotless apartment.

It is not an easy place to keep clean. Periodically the rats appear and must be driven out, their holes boarded up. A month ago a large chunk of kitchen ceiling fell to the floor. There is a puppy. "The children need entertainment," Pauline explains. "They don't have many toys." In the living room bookcase is The Golden Home and High School Encyclopedia, bought on time years ago.

The Veliz children seem frightened, slow, not up to their vital mother. She caresses them often. They run up frequently to touch her hair, hold her hand. "I try to keep them happy," she says, "and safe. These days, there's no safety in the streets."

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CALUDIE MAE LOWE

Every morning a timid, round-eyed Negro mother named Caludie Mae Lowe sweeps the clay front yard of her two-room home in Taliaferro County, Georgia. It is the country way to show a family is living in a house that otherwise appears uninhabitable.

Claudie Mae's two rooms are teeming with humanity. She has eight children, only three of school age, only one now in school. (The others have dropped out, she explains, "till we kin git 'em up some clothes.") She has a husband named Tobe, patient, stocky, middle-aged, "a sawmill man" jobless since last fall after eighteen years with one company, three years with another. Sawmilling is fading out in Central Georgia, so Tobe farmed for a while, "goin' halfs" on 40 acres of cotton with a white man who put up the land, equipment, and $50 a month "run money" for groceries. Since harvest time, however, he has had no work.

Somehow the ten Lowes sleep and "set around" in one room. It is darkish from boarded-up windows, and full of beds and boxes and has an old easy chair with makeshift board seat. The flowered wallpaper has been torn and shredded by children up to a height of four feet. Above are decorations, large advertisements of Stokely's Beans and Van Camp's Pork and Beans.

In the kitchen are several battered electrical appliances, though the electricity was turned off months ago. Last week, the oven of the broken down stove contained a hunk of white fatback, the size of a man's hand and some grits. Claudie Mae was making the family staple--hoe cake. "Ain't got no milk," she said with a bewildered little giggle. "You spose to use milk; I uses water."

As she told of her last visit to the doctor, Claudie Mae's giggle was like that of a sad child. "He say I got dis here thing. Say I got to have my womb took out."

Tobe still hopes to be a sawmill man again, still applies for every opening he hears of. "When de wages went up, de mills just shet down," he says. "This week I been to these heyar planing mills, where dey puttin' up a new mill, and de man say 'I ain't goin' to keep all the hands I got 'cause now they's machines doin' what hands used to do.'"

The rent for Tobe's house is $7 a month, but his landlord, a sympathetic Negro who lives in a more substantial house up the road, is not pressing for his money. "I just don't see how families live like that," he says.

The landlord also lets the Lowe children fetch pails of water from his house. Tobe's well is muddy and unsatisfactory. On days when Claudie Mae is boiling clothes, the children bring the water to the big black pot in the Lowes' front yard. But lately the pot is seldom used; the children have nothing to wear while their clothes are being washed.

Now and then Tobe considers moving his family to the city, but he believes it is not for the likes of him and Claudie Mae. "Hit's right smart fast in town," he says. "Reckon maybe hit's too fast."

THOMAS RAY SPRAY

A glum, pudgy 21-year-old, Thomas Ray Spray already has the mark of the loser upon him. He finished the eleventh grade in a special class at North High School in Des Moines, but the school felt he had gone as far as he could. He wasn't permitted to enter the twelfth grade and get his diploma.

Tom Spray still feels the shock of being given a 1-Y (limited trainability) classification by the Army. "I'd looked forward to going in," he says. "I figured it would be my chance to learn a skill or something. No reason why I couldn't either. I can read well enough to learn a lot of things." Tom lives with his divorced mother and 15-year-old sister in a dingy two-bedroom apartment with cracked walls, chipped paint, and an atmosphere of near-hopelessness. He has worked two and a half months in the past year--mixing fruit cakes in a bakery for the Christmas trade. The rest of the time he has been looking for another job--or else slouching unhappily before the TV set in the living room.

His small, harassed mother supports the family on her $32.50-a-week take-home pay as a pie maker. "Sometimes I just feel like giving up," she says. "Why can't the boy get a job? Why didn't they let him finish school? Why did the Army reject him? Nobody ever tells us. It's not his fault. He tries."

His ambition is to get back into bakery work. "There's a future in that, and it's the only thing I know anything about. I might even get myself classified as a skilled worker on my past experience."

But nothing has turned up lately in bakeries or anywhere else. Tom visits the Iowa Employment Service offices twice a week. "All they ever say," he sighs, "is they ain't got nothing. Leave your application, and we'll be calling you, they say, but nobody ever calls."

JOSEPH CROWLEY

Three years ago Joseph Crowley and his family were moving up in the world. He was a warehouse leader, making $2.49 an hour, at the Essex Wire Corp. in Detroit. He'd moved to a two-story brick and shingle house, bought a new TV set and a new turquoise davenport. Then he was laid off.

Crowley hasn't found a steady job since. Now the family income ($243 a month) comes from neat, little Dolores Crowley, 33, who housekeeps at the rectory next door. When she's at work, Joe cooks for the five children. "Sometimes I get way down in the dumps," he says. "Then I do something extra, like maybe wash down the bathroom walls."

The Crowleys are still eating reasonably well, and the children (3 to 13 years old) are neatly dressed, but there are health problems. Both adult

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Crowleys need dentures, and the children have cavities. Because they can't pay their family dentist, the Crowleys have not visited him lately. "Two or three years ago," Dolores says, "the doctor told me to have a hysterectomy, or at least a checkup every six months. But it would cost $12.50, and more for blood tests, and I haven't been for a year."

The Crowleys are not on welfare. "I was raised on it," says Mrs. Crowley. "I don't want it for my children. Anyway, this is the hand God dealt us and we have to play it."

And Joseph Crowley pulls his 3-year-old son on his knee and says: "If I'd just gone through high school and had a trade, things would be different."

SLIM LEMERT

Sodden, hopeless, living on 10-cent wine and self-disgust, Slim Lemert is on the bottom of any man's pile. He is 37, a former mechanic, divorced, with three children he never sees. Now he is a Main Street wino in Los Angeles.

He has one remaining point of pride. "I've given up a long time ago," he says, "but I've never had to go to no mission. One thing I won't do is become a mission stiff."

Last week Slim had on the same blue jeans he has worn for three years. He hadn't washed in over a week. He hadn't eaten since yesterday, when he'd managed to get down a bowl of beans.

Now and then Slim Lemert works, but he is choosy: "I could make three or four bucks passing out handbills--but you got to walk your feet off twelve hours a day. I'm not about to wear out my shoes for some rich man."

There have always been Slim Lemerts in the world--in good times and bad. They are a part of poverty's landscape; they belong in the land of the poor. Many don't even consider liquor their major problem. "As long as there's a celler," Slim says, "there's going to be a rat in it. I'm the rat, I guess."

Lemert nurses his wine slowly at first, sipping half the glass meditatively, then suddenly gulps the rest all at once. "I'll tell you something very funny," he says. "I hate wine. I almost puke every time I drink it. But if I didn't stay drunk, the chances are I'd kill myself."

JOHN AND CLARA KESTER

People in Adair County in the Ozark foothills of Oklahoma respect John Albert Kester. He is a homeowner, a member of the local school board; for the past ten years he has held the same full-time job.

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He makes $48 a week.

"Handyman's wages," he says, "top pay for farmers, but it's not enough." And an apologetic smile creases the 43-year-old face that looks a dozen years older. Last week, John's wife, Clara, wearing a faded shirt, men's work pants, and shapeless brogans, talked about feeding her seven children: "They get dry beans cooked with grease, 'taters, and when the cow's giving, most of 'em drink milk three times a day. And every month we get the government 'commodities'--about a week's worth of butter, two weeks' of flour, and such like."

The Kesters live on 25 mortgaged acres in a tar-paper "brick" four-room house jammed with castoff furniture. Worn linoleum covers the living-room floor and a bare lightbulb glares over an old TV set and a stove smelling of burning oak.

Now and then the family considers leaving the area. "Sometimes, I get plumb mad because I don't have some of the things I'd like," says Clara, "but mostly I don't think about it." Then she looks about and smiles softly. "We do like it around here. It's the prettiest country in the spring you ever did see."

MRS. ESTHER STROM

Proudly the old woman lifted a bottle of $3.75 cologne from the bureau of her 9 by 10-foot hotel room. "I would rather miss a meal than be without my perfume," she said. "I am still a lady."

Esther Strom is small and plump and 68. She lives on $118.50 a month from social security and her late husband's World War I pension. Her room in the tired old Hotel Tynan half a block off Market Street in San Francisco is $35. She spends $2 a day on food, and for entertainment has the public library.

Esther Strom emigrated from Finland in 1928 as the wife of an American seaman, who disappeared for long periods. "You know how men of the sea are. From the first I was on my own." She became a cook in many of the wealthy homes around Nob Hill. "I'd cook now, if I had the chance. But of course I haven't--not with these hands." Esther's hands are crippled with arthritis.

For a few years, in the '30's, she was a writer. A Finnish publisher brought out two of her books on early Finnish settlements in America. She has also experienced her share of life: "I was a woman who loved wine and song and the men. But now there doesn't seem to be anything left..."

And sitting in her tiny room, she listens to the sounds of traffic and runs her fingers over the worn cloth of her skirt and looks at a picture of herself as a young woman. "Those were the days," she whispers, "when I was alive."

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-9. Relationship of Values, Goals, and Standards

(See Suggested Learning Experience, No. 25, p. 8 in Part One)

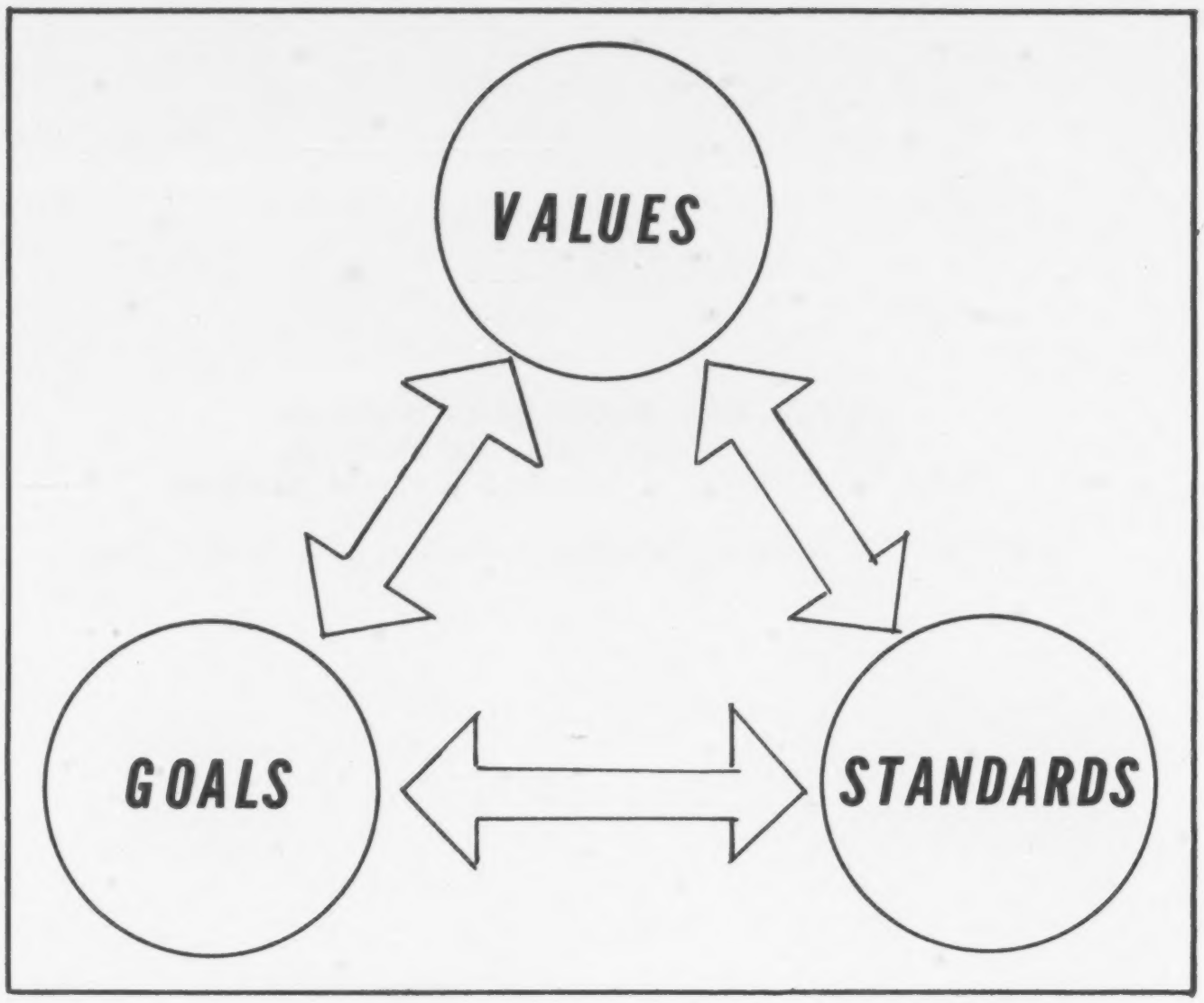

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-10. Value, Goal, or Standard?[1]

(See Suggested Learning Experience No. 26, p. 8 in Part One)

DIRECTIONS: Take each phrase or word and place it in the proper column.

Words and phrases to be used	Values	Goals	Standards
Beauty			
Physical Health			
Privacy			
Freedom			
Mature love			
Mental health			
Knowledge			
Security			
Wholesome home life			
To be popular			
Make your own decisions			
To earn my own money			
To own my own car			
Postpone a necessary trip to the dentist for new clothes			
Must be consistent with our goals and values			
Keeping up with the Joneses			
The way in which you expect or are expected to live			
Two-income families			
Installment buying			

[1]Developed by Mrs. Beverly Fern Alexander, Home Economics Teacher-Coordinator, Big Spring, Texas.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT II: Values, Goals, and Standards
II-11. How Do Those Joneses Do It?[1]

(See Suggested Learning Experience No. 27, p. 8 in Part One)

If others seem to manage better than you can, remember--every family is different and the differences seldom show.

Nearly everyone knows how much his neighbor makes, approximately. Although folks don't go around reporting their incomes out loud, money still has its ways of sounding off. It talks, as they say, and you don't need especially sharp ears to hear its message.

Take your neighbor Jim Jones. Nice fellow, Jim. Good neighbor. Your two families enjoy a casual, easy, back-fence relationship. Yet you're quite capable of discussing the Joneses' financial affairs--in the privacy of the kitchen, with the kids out of earshot and the dishwasher going.

A husband might speculate: "Oh, I don't know, but Jim must make around $15,000." Or $10,000. Or $20,000. Whatever the going rate may be on your block for gross annual incomes of envied neighbors.

A wife puts her comments differently: "They've had three new cars since we got the Edsel.... They plan to send Martha to camp this summer--for two whole months!.... They're ripping out every last bit and doing it all over in avocado.... Some mob scene they had last night. It must have been 3:30 or 4 before those patio lights went off."

A certain brittleness underneath suggests: "How come we can't do all those nice things they do?"

Sex and Your Neighbor's Income

Interest in how much others make and how they spend it seems to be universal. Both men and women crave details on this topic, and whether the information offered is real or imagined, observed or merely sensed, both sexes perk up and pay attention.

But the sexes react to the data differently, especially when the neighborhood financial news has a sting to it. Suppose that Neighbor Jim, so like you in so many respects that you consider yourselves equals, turns out to be sustaining a higher level of material well-being at his house than you've managed to achieve at yours. How do male and female respond?

A man can take this punch and roll with it. It smarts, of course. He thinks of all his efforts and good intentions and wonders, edgily, just what ol' Jim ever did to deserve topping him this way. But a man is likely to be rueful rather than jealous, to feel chagrin rather than indignation.

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[1]Reprinted by permission from Changing Times, the Kiplinger Magazine (April, 1968 issue). Copyright 1968 by The Kiplinger Washington Editors, Inc., 1729 H Street, N.W., Washington, D.C. 20006.

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Superior character? Not really. The fact is, a man doesn't prove himself here on Willow Street. He makes his mark or misses it downtown on Main Street, on the job.

To be sure, he thinks a lot about "being able to do for Jane and the kids, really take care of them," and this goal provides much of his motivation. But in a man's world there is no such thing as being a success on Willow Street and a flop downtown. If his career is successful, he won't rate himself a failure just because his neighbor has a classier car.

With a woman, it's not quite the same. She too can tolerate differences in material matters, but they must be sufficiently remote. How people live in the country club district a mile down the road doesn't bother her. Neither does she feel measured or challenged by families in the lower-priced neighborhood a mile up the road in the opposite direction.

What does get to her are the disparities she discerns right in her own neighborhood, on Willow Street. There she is among families who she assumes, probably rightly, are neither much more nor much less affluent than hers. Each breadwinner probably brings home about what hers does, give or take a little. In age, education, circumstances, even in aspirations, everyone on Willow Street is pretty much alike.

So Willow Street is a wife's real world. And what does she find there? Where all reason and justice lead her to approximate equality, she observes inequality everywhere. Almost every home offers its little evidence of a comfort or an abundance that is absent from hers. Each reminds her of some pinching little economy, postponed pleasure, makeshift expedient. She fumes, not because she can't manage beautifully with what she has--she is in fact, more than willing to do so--but because "it's all so unfair!"

If you live in a highly diversified neighborhood where high-income people rub shoulders and share interests with those of more modest means, there may be less of this green-eyed concern about the Joneses. But most people don't live in such places. They tend to get sorted out by age, family size, and income into neighborhoods of look-alikes.

And then, being merely human with human doubts, everyone is quick to take note when a similarly situated neighbor gets dissimilar results for his money.

A Columbia University sociologist, Herbert J. Gans, recently published a study of a community that symbolizes the big-scale, middle-income, homogenized suburb: the New Jersey Levittown, outside Philadelphia. Gans himself lived there for two years. In The Levittowners he reports that problems and worries were general. About 60% of the people interviewed confessed to problems, 93% admitted worries. Since having problems carries some stigma, Gans thinks that the percentage of worriers probably is a better indicator of the prevalence of anxiety. Low-status people reported

more problems than higher-status people, but worriers were everywhere.

No doubt you can guess the main cause of concern. "The principal irritant was family finances," Gans found. And apparently you can't get away from money problems simply by having more money. "Obviously,...low-income people (earning under $6,500) worried most over finances, but high-income ones (earning over $9,000) reported financial problems as often as the rest--they just did not worry so much about them."

And money problems, as ever, led to other problems, particularly marital ones. "It's money that causes all the other problems," one wife explained. "When my husband and I quarrel, it's because of not being able to do things and have things."

Facts Behind the Scenes

A decade ago, Changing Times took a look at another superfically homogeneous suburban community for the express purpose of discovering what kinds of family financial activity provoked envious comment and what facts lay behind the talk.

This community--we called it Oakmill Valley Estates--was no Levittown. It was much smaller, a bit higher-priced, and populated by junior executives and young professionals who earned a bit more than the Levittown norm. This investigation was not conducted on the Gans pattern, either. It was a journalistic, impressionistic inquiry rather than a sociological, statistical one. Out of it came reports on five families whose fiscal behavior in one way or another tended to disturb the neighborly peace.

--Family #1 always seemed to have money left over, a condition rare elsewhere in the vicinity. The source of the surplus was a mystery. But the fact of its existence was not; for the head of the household had a lively oftexpressed interest in investments and was capable of dropping such depth charges as, "I don't have a dime's worth of oil stock right now."

--Family #2 were the lively ones, always on the go--theater, night spots, the best restaurants, football games, weekend trips, frequent vacation trips.

--Family #3 were outstanding in only one way, but a way that bespoke an opulence that had wives reeling for blocks around. Imagine, a maid five days a week! How on earth did they manage it?

--Family #4 won attention not for anything it did but for what it possessed, mainly an elegant car--this year's, every year--and a houseful of furniture that looked just like the pictures in House Beautiful.

--Family #5's conspicuous distinction was owning a summer home at the seashore. The minute school closed in the spring, the wife and kids vanished until Labor Day. The husband joined them every weekend.

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How did these families come by their exceptional arrangements? Had they found some magic? Did they simply manage better, more expertly? Or did each hold some secret his neighbors had yet to unlock?

Through circumspect inquiry we learned that there were indeed some special reasons behind these special circumstances. And while the inside stories were in a sense secret, they were scarcely miraculous or arcane. On the contrary, they were prosaic, disillusioning and even anticlimactic.

Once inside, the facts were these:

--The secret of the family that had the inexplicable surplus available for saving simply was split-level economics. They earned at one income level and lived at a slightly lower one. Result: surplus. Their economies were not drastic ones but little ones, spread widely and evenly so that they never pinched and didn't show to onlookers. Because the family had been living this way for some years, they were beginning to enjoy the fruits of their prudence. Their investments' earnings were paying for occasional small splurges, the kind that other families had to carve out of their regular budgets.

--The facts behind the family whose endless round of entertainment caused such consternation proved to be equally mundane. He had a good sales job. Most things the family did had business connections for him, thus bringing his generous expense account into play. Others in the community had various fringe benefits from their jobs, too; this family just happened to have unusual ones about which they were unusually close-mouthed.

--There was sad irony in the story of the family with the full-time maid. Instead of being better off than most, they were below par for the community. And they had a bigger family, a bigger house, a bigger mortgage, and bigger monthly payments. They had to economize heavily in ways no neighbor needed to, on clothes and food and recreation. And that full-time maid didn't figure in their budget at all. A concerned in-law paid for her, in full, an arrangement that began "just to help out temporarily" when the youngest boy was born. That was six years earlier.

--The family with elegant car and elegant furniture had nothing special at all to reveal. They just preferred to use their money for car payments and furniture rather than for fancy food or lots of clothes or away-from-home entertainment. So cars and furniture are what they spent it for.

--As for the family with the seaside summer home, their affluence traced back to financial help from well-heeled relatives and inheritances that had come to them at the time they bought in Oakmill Valley Estates. That financial leg-up enabled them to pay mostly cash, so they had a very small mortgage. They could budget a darned sight more for recreation than any other family in the community--and a darned sight less for mortgage payments.

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Are Some Envies Eternal?

Now ten years have passed. Have things changed in the meantime? Not long ago Changing Times returned to Oakmill Valley Estates, just to see.

Yes, there have been changes, for one thing, everybody calls the place plain Oakmill Valley now, "estate" having come to seem a vulgar pretension to apply to a third of an acre. All incomes have gone up, mostly in step with each other and, happily, a step ahead of prices in general. Now two cars per family are customary, with enough instances of three to suggest a trend. The families that once scrimped for clothes dryers now have them. They also have air-conditioning and now scrimp to see kids through good colleges.

There have been changes in the cast of characters, of course, and there has been one fundamental change in the script. Ten years ago, the community consisted solely of young families with small children. By this time, there has been an infusion of older families, those whose children have left home for college or to strike out on their own. Some of yesterday's young families remain in residence, now playing character roles as "older families." And the vanguard of a brand-new generation has entered, heralding another round of young families just starting out. This generation gap produces a new Jones-type problem that could not have existed in Oakmill Valley a decade ago. The box on the following page explains.

On the whole, there seems to be less anxiety about money now than there was ten years ago. Perhaps the general rise in personal incomes is responsible, although, as Gans remarked of Levittown, those with more money are as prone to money problems as the rest but just don't worry about it as much.

Yet the old nagging wonder at how the man next door manages better living per dollar still persists. Similarly, there seems to be no change in the explanations for the disparities that provoke envy. Today's Joneses, like yesterday's, appear to owe the little material successes that set them apart from their neighbors to such humdrum, practical factors as these:

Earlier savings. Having a pile on tap at a propitious moment helps a lot. It can eliminate long-running drains on current income and thus be the equivalent of extra income for years.

Money-managing skill. Income can be wasted. Some of the most-envied families may be wasting theirs. Those with the will to make deliberate spending choices, to keep records and to stick by their financial decisions eventually wind up ahead of those who manage largely by whim.

Hidden help. Extremely common, usually unacknowledged, immensely useful. Whether it comes as one big bundle, occasional boosts or regular, continuing subsidy, it substitutes for cash and/or savings.

Job-related benefits. These take many forms. All share two cha cteristics: low visibility and high income equivalence.

Options. Life offers alternatives. Whatever the Joneses have that you covet--be it boats, bonds or beagles--may be theirs by choice alone. If you want boats or bonds or beagles badly enough to assign them your top financial priority, you can have 'em--instead of something else, naturally.

Cues from the Joneses

One could draw a couple of lessons from the Joneses and their neighbors. They go like this:

--Never conclude that because someone else affords something, you should be able to afford it, too.

--Never conclude that because some people spend in ways that you cannot, you aren't managing right.

Maybe you aren't managing right. But did it ever hit you that maybe the Joneses aren't, either? All you know for sure, remember, is that you and the Joneses manage differently. The judgments on what's right and wrong--for you--remain in your hands, exclusively. Make them. Leave the Joneses out of it.

THE JONESES & THE GENERATION GAP

Another reason why people over 50 and those under 30 don't quite connect is that the over-50's were traumatized by growing up during the 1930's Great Depression.

In those days, Chicago was bankrupt, families lived on day-old bread at 3-1/2 cents a loaf, zoo animals were shot to save money for relief, the family dole in New York was $2.39 a week (only half the needy could get it) and one-fourth of the whole state of Mississippi was sold off in a single day's foreclosure actions.

Witnessing such events marks a person with what a book written two years ago by Caroline Bird called The Invisible Scar. It leaves an over-50 wary about his money.

Now pension plans, social security and amortized mortgages give us built-in savings. We get to enjoy our savings in our own lifetimes, too. And credit is a workaday tool instead of a desperate last resort.

So today's young people confidently expect and get all kinds of things before they earn them--car, house, baby, every convenience, every appliance. And they have a good time while their scarred elders marvel and cluck in alarm over these cock-sure kids, a baffling new breed of Joneses.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT III: Needs, Wants and Family Life Cycle
III-1. What Is Self-Actualization[1]

(See Suggested Learning Experience No. 3, p. 13 in Part One)

Self-actualization is defined as one of the basic human needs--it is the need to become the most effective person a human being is capable of becoming with the potentialities he has. It is more easily explained through an understanding of its relationship to other human needs.

All human behavior is motivated by a desire for satisfaction of several different kinds of needs. These needs have been classified by Maslow and ranked in order of most demanding (physiological) to the highest and ultimate need, which is for self-actualization.

HIERARCHY OF NEEDS (3)

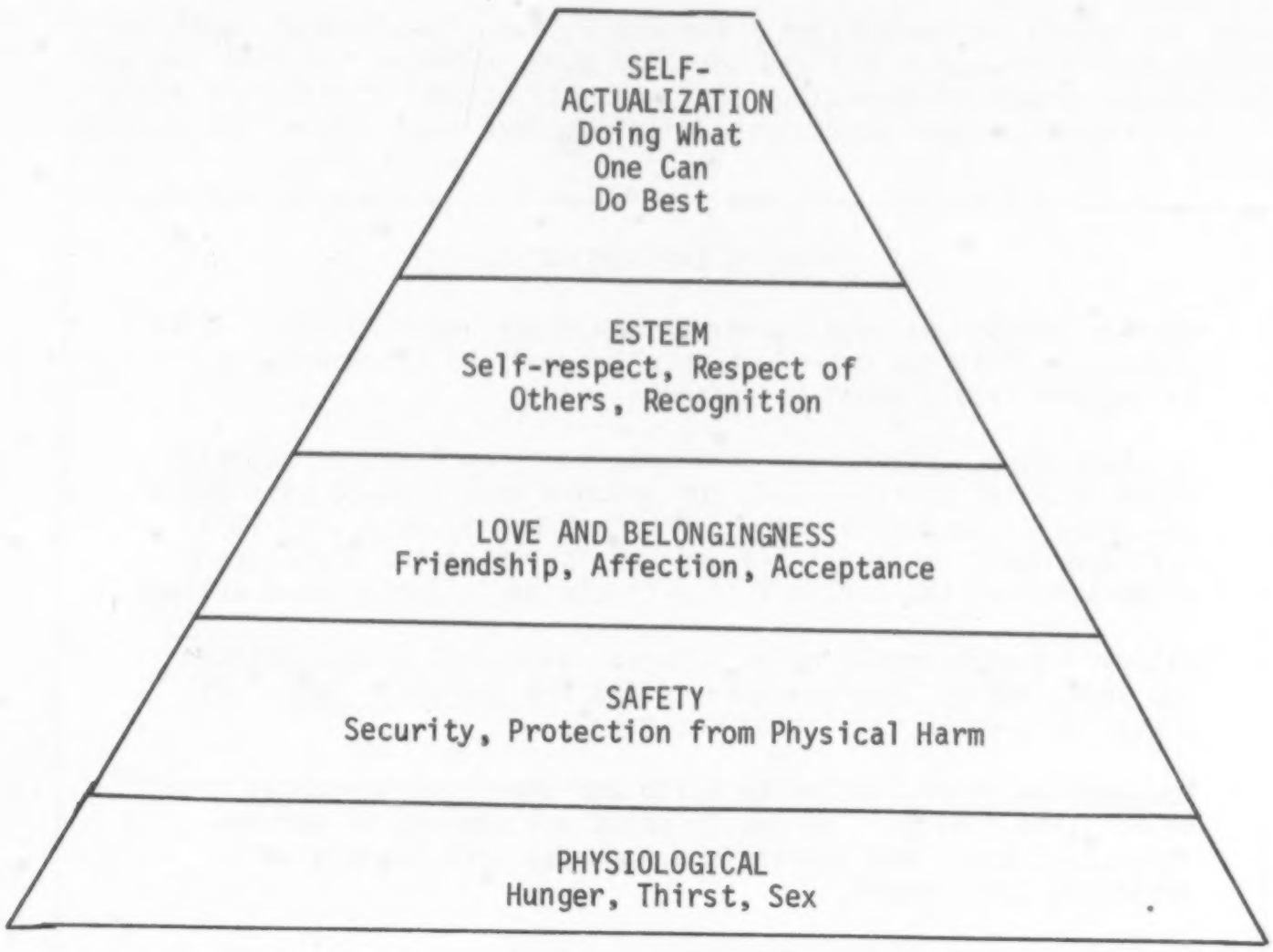

[1]Reprinted by permission from Penney's Forum. New York, New York: J.C. Penney Company, Inc. Fall/Winter, 1969. p. 4.

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Once the lower needs are fulfilled, to some degree, then the next level begins to emerge. As stated by Maslow, "gratification of one basic need opens consciousness to domination by another 'higher' need." (2)

But, usually all the various levels of needs exist to some extent most of the time. That is to say, that hunger does not have to be fully satisfied in order for a desire for safety, love, esteem and self-actualization to be present also. Each individual interprets his needs and the strength of these needs according to his own culture, tastes, values, attitude about self, feelings, family, job and money. (4)

In describing self-actualization in relation to the other basic needs Maslow states--

"Even if all these needs...(the lower level needs)...are satisfied, we may still often (if not always) expect that a new discontent and restlessness will soon develop, unless the individual is doing what he is fitted for. A musician must make music, an artist must paint, a poet must write, if he is to be ultimately at peace with himself. What a man can be, he must be. This need we may call self-actualization." (1)

"...the human being has within him a pressure (among other pressures) toward unity of personality, toward spontaneous expressiveness, toward full individuality and identity, toward seeing the truth rather than being blind, toward being creative, toward being good, and a lot else. That is, the human being is so constricted that he presses toward fuller and fuller being and this means pressing toward what most people would call good values, toward serenity, kindness, courage, knowledge, honesty, love, unselfishness, and goodness." (2)

If an individual is not doing what he can do best or using his capabilities to achieve a feeling of self-fulfillment, he will feel restless and discontent. As educators, our responsibility is to help each individual understand himself and his potentialities and to help him grow and develop to his fullest potential.

In order for an individual to keep striving toward the ultimate in his development, there has to be growth and a feeling of accomplishment so that he knows he is achieving. "Achieving basic-need gratifications gives us many peak-experiences, each of which are absolute delights, perfect in themselves, and needing no more than themselves to validate life." (2) These experiences give reinforcement and keep the individual striving forward.

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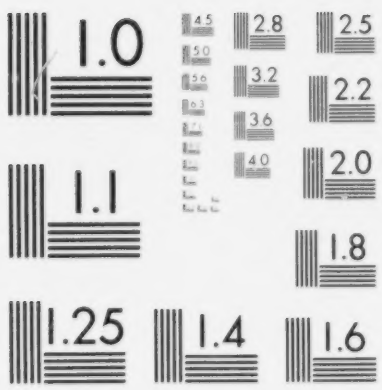

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SECTION ONE: ALLOCATION OF RESOURCES
UNIT III: Needs and Wants and Family Life Cycle
III-2. The Family Life Cycle of Ted and Norma[1]
by Dr. David Fulcomer

(See Suggested Learning Experience No. 10, p. 14 in Part One)

Although this case study is dated in the sense that it is written about a couple who were known by the author in the early fifties, it provides a realistic view of the couple's progress through the family life cycle. It depicts Ted and Norma as husband wife, father and mother, father-in-law and mother-in-law, grandfather and grandmother. The first part of the case study is based on information from Dr. Fulcomer's files regarding an actual couple. The last part is his projection of events that might have occurred in the couple's lives after he knew them.

Ted and Norma were married within two months after he got back from overseas after World War II. They had been engaged since one month before he went overseas, the year before.

He was an attractive fellow, not handsome, but with a happy, active personality in a 5'10" frame which was definitely masculine. In college he was well liked by most students and faculty. He made slightly better than average grades and played basketball.

Norma had a way of arranging her 5'5" in a neat, clean fashion. She had her share of dates in college. Though she would never have won a beauty contest, she made the most of what she had, and that was quite a bit. Almost everyone liked her. She was a good singer and made a "B" plus average. Also, she was very active in other college activities.

They wanted to marry before he went overseas, but both sets of parents had advised waiting. Both felt a loyalty to their families; and, besides, it seemed to be pretty good advice. So they waited, neither ever dating during this period of engagement.

Norma remained at home with her parents and younger sister. Both she and Ted graduated from the same college the year he joined the Air Force. She took a job teaching in a music studio in her home town, and within a year she had made quite a reputation for herself. She decided to open her own studio in the same town and did so just a few months before Ted returned from overseas.

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[1]Permission for use granted by Dr. David M. Fulcomer, Director of the Family Studies Center, Temple Buell College, Denver, Colorado.

Ted did well in the Air Force. He went over as a second lieutenant and came home a major.

ESTABLISHMENT STATE

And so they were married! It wasn't a tremendous "social splash" but even a simple church wedding takes a lot of planning and energy, they discovered. It was in her church. Both were Protestant--he a Baptist and she a Presbyterian. Their home towns (both cities of less than 25,000) were about 70 miles apart.

Wedding plans went fairly smoothly. Norma knew what she wanted and stuck to it pretty well. She and her mother clashed over the flower arrangement in the church and the list of guests at the reception, but Norma finally won out. By the morning of the wedding, everything was all set and the wedding went off as scheduled, with the exception of a few minor details. Both groom and bride's father remained in the background most of the time, except for a small stag party the night before the wedding, when both men, ordinarily very careful about limiting their consumption of liquor, had a bit too much. Both felt the effects the next day.

The reception was a huge success. It was nearly 6 p.m. before the bride and groom got away from the reception and eluded three carloads of well-wishers. The clock had struck eight before they finally got to the hotel in the large city where they were to spend their one-week honeymoon. But they were very happy and very much thrilled with each other.

They enjoyed each other in every way during that week. It did seem to Norma that Ted was awfully abrupt about this sex business. (They had refrained from heavy petting and sexual intercourse before marriage, despite strong temptations.) He didn't seem his usual think-of-Norma-first self here. Also, she was surprised to find that he was a lot more careless about throwing his clothes around and leaving the bathroom in a mess than she had expected. But this didn't bother her very much; after all, she could soon change that, and he didn't mean anything by it! Ted found Norma to be everything he had expected; he had absolutely no complaints.

Next, back to his home town, a one-room apartment three blocks from his parents' home, and his job as a post office employee. He liked the work, the fellows there and the various activities of the work group, such as playing on the softball team in the city league. They kidded each other a lot, and had a lot in common, and had a happy time in general. Ted's salary wasn't too high and he knew he would never get rich in the post office, but he figured it would always give them a sufficient income. Other things in life are a lot more important than money!

Norma had closed her music studio two weeks before their wedding. She spoke of opening one when they got settled, but Ted wouldn't hear of it. By golly, he wanted to support his own wife, besides they agreed that they wanted a couple of kids! And you can't be a good mother and work, too. Oh, if she wanted a few pupils, that would be all right, but none of this full-time work stuff for her. Norma tried to argue with him, but she felt that she could enjoy a life with Ted and without work, so she didn't argue too long about the matter.

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Those early months of marriage went along pretty well. They had lots of good times together. It wasn't long before Norma had a few close girl friends. They were married, too; and sometimes the couples would go out together to shows, games, and picnics. Norma liked a good softball game and often went to see the post office team play. But, sometimes, this got to be too much of a good thing, with two or three evenings a week taken up by softball. In the fall and winter it was bowling.

She wasn't aware of it at first, but she had begun to resent the time some of Ted's friends and activities took away from them as a couple. A few of his close friends were "crude," even though they meant well. Even their language was hard to take sometimes, what with the poor grammar and frequent swear words. But she loved Ted, and she guessed his friends were just a part of him.

Ted agreed to let her take on an increasing number of music students. Expenses were more than he had figured. She was a good manager, he knew, but why did she have to buy such expensive priced stuff, like the new Kimball piano, for instance? True, she had saved up over $400.00 before they were married and used that as the down payment, but the monthly payments really placed a strain on his monthly check. They had a big argument about it several months after they were married--really got sore at each other. She cried and he felt like a fool. But she was her old self the next day, so he forgot the incident.

In the more personal side of their lives, neither had any big complaints. Norma did feel that Ted had a lot to learn about the psychology of women, but they never talked about sex in any thorough way, and she didn't quite know how to begin. So she didn't.

She did wish that they lived farther from his folks. At first it didn't bother her, but after a month or two, she found herself resenting suggestions that his mother made. When she said something to Ted, he would just laugh at her and tell her she was imagining things. True, his mother wasn't the dominating type, but Norma hated the subtle little ways she made hints about the room arrangement, the cooking, etc.

EXPECTANT AND CHILDBEARING STAGE

Then it happened! Norma discovered she was pregnant just at the end of their first year of marriage. Gosh, they had wanted to wait about two years, until they had saved some money and collected a few more pieces of furniture. Ted seemed very happy about it from the start and said that it is good to have your children while you are young. Norma wasn't so sure. She had been planning on approaching Ted with the idea of opening a music studio. Now that was all washed up.

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Ted's mother insisted on a certain doctor, and Norma wanted another. At first Ted sided with his mother, but when he saw that this was upsetting Norma, he took her side and they chose the doctor she wanted.

Everything was so new and strange to Norma. None of her girl friends were pregnant. She had confidence in her doctor and followed his advice to the letter. He gave her a booklet to read about pregnancy and some rules to follow.

Ted didn't pay much attention to her pregnancy, Norma felt. About all he seemed to consider was how it would affect their sex life. He believed women were made to have children and should be able to do it without much trouble--his father had often voiced this opinion. Ted really felt uncomfortable about his ignorance of what pregnancy means to a couple, but he kept this to himself! If anything, he spent more time with his own friends. It got so bad that Norma finally "told him off." He apologized and did spend more time with her for a few weeks.

Norma felt pretty good most of the time--in fact, she was surprised. She did have trouble with coffee (one of her great favorites) and a few other types of food, but she never got awfully sick. During the last two months she felt awfully awkward and lazy, and it embarrassed her to go out in public. When she began to "show," Ted seemed even more embarrassed than she. So she kept pretty much at home. It really made her angry sometimes to see Ted having such a good time--his life seemed little changed. Only a few times did she mention her feelings to Ted, mostly it was a matter of inner resentment. The only thing he seemed to be concerned about when she gave up her music pupils the last month was the reduced income--or so it seemed to her.

Jimmy was born almost two weeks before he was expected! Before she went to the hospital, Norma was afraid, but she didn't let anyone know about it. Ted seemed to have little knowledge and understanding of what it was all about, but when she began labor pains and they had to rush to the hospital, he was really scared. She had a kind of a "rough" time, too; she was in labor for twenty-four hours.

But once Jimmy was born and found to be a fine, healthy 7 lb. 8 oz. young man, Ted was all smiles and thoroughly enjoyed the cigar-passing and the usual jokes by his men friends. Three days later Ted took Jimmy and Norma home. Both excitement and bewilderment reigned the first few days. Norma was glad to have the help of Ted's mother. Then her mother came for two weeks. Finally things settled down to a routine. They were both so proud of Jimmy--and themselves.

But there were troubles, too. Ted wanted to keep up with his social and recreational life. Norma thought he should be home more. Look at the changes she had to make. Ted was really good to her, but he seemed to have little insight into how life was different now. When Jimmy was born, Norma was 24 and Ted 25.

Jimmy was a healthy boy, but it seemed to Ted that the bills for drugs and baby supplies were awfully high. He found it necessary to go more easy on the money he spent, and he didn't like that particularly, especially when

Norma would bring up the subject. Furthermore, he resented her harping on his staying home. Good Lord, a baby shouldn't make that much difference!

Norma met a few young mothers in church and got very friendly with them. They loved to talk about their babies--and did. Ted enjoyed so much of this talk, and then, enough was enough! He missed going out to dances and parties, as they used to do. He was proud of Jimmy and liked to show him off, but how he hated the diapers, the crying and the getting up at night. Norma expected him to take his turn at these things. Well, he guessed he should, but he didn't like it!

Then when she started taking some music students again, she expected him to take care of Jimmy more. That really hurt--but they needed the extra income so he didn't complain, at least not to Norma.

Her mother came up more often now, and that wasn't good. She helped with Jimmy, but she had too many suggestions and was in their way too much, according to Ted. Norma agreed, but she said that it would be hard to get along otherwise. And when the two mothers got together, then Ted, Norma, and Jimmy hardly had a life of their own!

Things went along pretty well, but Ted and Norma seemed to have more difficulties than formerly. Each realized it, but they seldom talked with one another about it; in fact, they never did talk it over freely. Ted began to see the "ball and chain" aspect of marriage, so he thought. Norma began to wonder about Ted, her music career, and their marriage. And they had their share of difficulties about his going out, their expenditures, and their relatives.

Then it happened again! Jimmy wasn't two years old when Norma got pregnant. This certainly wasn't planned. Both Ted and Norma were really unhappy when they found out; each tried to cover up this feeling.

PRESCHOOL STAGE

Pregnancy was more understandable this time, but it wasn't any easier to take. She hated to give up her music income, she thought Ted should really become "somebody" now, and he disagreed; if they thought money was scarce before, it really was now.

Tommy was a healthy 8 lb. 2 oz. baby. They were really happy about his birth when it actually came. They were grateful for the many enjoyments that went with it. It was nice to have a brother for Jimmy, who was just over two and a half years of age when Tommy was born.

Hospital insurance paid for most of the hospital bill, but not for the doctor. They had to arrange to pay that bill by the month. Norma wanted to pick up her music pupils as soon as possible, but Ted objected strenuously.

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He began to feel the pressure of getting a raise or in some way increasing the income. After all, he was almost 28 now. He was beginning to feel older than some of the fellows at the post office. Funny, he hadn't felt that way before.

The next four years were full of contrasts for Ted and Norma, fun and problems, happiness and worries. Gee, there wasn't anything like a nice family. But, gosh, you really have to pay for it, too. In addition to the extra work two young boys made, Norma felt she should get as many music students as possible. Also, she sewed more and did all the washing herself. She bought fewer clothes for herself. Sometimes she resented this need to pinch and save, but this feeling never stayed with her long.

Ted gradually began to get used to being around home much of his spare time. He took pride in being a good baby-sitter, but sometimes there was too much of it. He did enjoy playing with the boys and making things for them. They were awfully cute and full of fun. He liked to take them out where other people could see them and would know they were his.

The parents kept healthy, but it seemed that one of the boys always had a cold or something worse. Lots of money went to the druggist and the doctor. And sleep--gosh, sometimes they were up two and three times a night. They seemed tired so much of the time; no wonder they were so "rough" on each other sometimes.

Church began to be more important to them again. They hadn't been too active or regular when they were first married. After all, though, the children should be reared properly. Besides, when you begin to feel more settled yourself, you can see the importance of religion. So they gradually became more interested and more active. In fact, they were fast becoming one of the most faithful and active young couples in the First Baptist Church.

Money was really short during these years. Norma did what she could with teaching voice, but they both agreed that her main job was with the children. They both thought it strange that at a time when they had the worst money problems they seemed to have fewer of the other troubles. True, Norma was unhappy at times at not using her abilities to produce much needed income. Besides, she missed the work and contacts of a full-time music teacher.

When Jimmy was four, Ted changed from the post office employment to work with an insurance firm. He could see that the post office had no future. Besides, his new boss thought he was a fine prospect as an insurance salesman. And he did well at it too,--right from the start he had more income than he had earned at the post office.

Norma often worried about how to rear the children. There were so many articles. She tried to read as many as possible and to follow them. Actually, she sometimes felt that she and Ted were awfully poor parents. They lost their tempers so often at each other and at the children. Ted didn't worry so much about this. He believed more in the good "old-fashioned" way of handling kids, anyway. They had some bad arguments over this. Usually Norma won out.

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SCHOOL AGE STAGE

Sometimes they yearned for the peace and freedom of the days when they were alone together. Life at home was so hectic so much of the time. Both of them were proud to see Jimmy enter first grade. But they certainly were not prepared for the differences school and growing up would bring to their living. Jimmy did well in school and seemed to get more and more involved with activities that took him away from home. Cub Scouts and then Boy Scouts, junior band and then the town band--and so it went. Tommy was a real live wire. In school, he made things really hum. His grades were not as good as Jimmy's but he had even more friends. Often Ted and Norma asked him why he couldn't do as well as Jimmy, but it seemed to do no good.

While the boys were in the grades, Ted improved his income considerably. Norma could work almost full time at her music again, too. So they could afford such things as a new car, new household appliances, and even the Country Club. Money wasn't such a problem anymore, though they still had to watch it carefully.

TEEN-AGE STAGE

By the time Jimmy started his eighth grade, his father was an officer in the church, was very active in the Chamber of Commerce and Rotary Club, and had begun to push out a bit at the waist line. After all, he was now approaching forty. Gosh, but what a thought! He laughed about it, but it bothered him some, too. Now he watched the softball games. And he had to admit that Jimmy could outlast him in most athletic activities. He hated to think of growing old, gosh, he felt as young as ever. But he was mighty proud of being able to branch out successfully with his own insurance business.

Norma was happy through these years. Ted was a wonderful husband, even if she did get awfully angry at him sometimes. She guessed she wasn't perfect either! She worked hard at keeping her school-girl figure, but admitted that all she could do was keep things under control. Her hair was beginning to turn gray, and that was hard to take, even if Ted said it made her more beautiful.

She had plenty to do, she found, with Jimmy beginning high school, her music pupils, her church responsibilities and trying to keep tab on the family. In fact, very soon she and Ted--mostly Ted--decided that she should drop her music teaching completely.

Oh! Those high school days. Ted and Norma had never seen anything like it--and never wanted to again. Once Tommy got that far along, too, home was a rat race. It seemed that they had hardly an evening a month when all of them were home. Ted had business, or church, or club, or lodge, or something else. Or Norma had recitals, or bridge club, or PTA, and the boys--well,

they got home to eat plenty at each meal, but otherwise were busy elsewhere. Now and then one of them would hang around long enough to see a television program.

And girls! Norma hadn't known up to this time that her own gender could be such a problem to a family with only sons. Jimmy started dating steadily when he was a sophomore and went through a whole series of "loves," each one very serious. Tommy poked fun at such goings-on (which only infuriated Jimmy and was the basis of many fights and squabbles) until he was a freshman; then he, too, had his string of females. But Tommy didn't get too serious with any of them. He changed girls at frequent intervals and seemed to enjoy it.

All through these high school years there seemed to be turmoil and commotion in the household. Arguments over which one of the four could have the car, who could use the bathroom first, whose interests got priority over the others--these were very common. Life was full of excitement about dates, games, elections, contests, and parties.

Norma tried hard to keep some kind of order. She pleaded for evenings with the family all together and alone. But the three men seemed to let life carry them along at its furious clip, and Norma could do little about it.

Things died down a little when Jimmy went off to college. (Norma was 42, and Ted 43--they could hardly believe it. Nor could they easily grasp the thought that they now had a son going to college, and another well along in high school.) Tommy was so active and noisy that Jimmy's absence wasn't too much of a catastrophe as far as family activity--or the lack of it--was concerned. Home didn't change too much.

But when Tommy left, it was as if the cyclone which hit the home had suddenly left, and now a deadness prevailed everywhere! It hit Ted hard, as he admitted, but for Norma it was awful. Now she was sorry that she had given up her work with music.

She became depressed at times. Unfortunately, she began going through the menopause shortly after Tommy left for his freshman year at college. She didn't suffer much physically, but all of a sudden she felt old and useless. Maybe she was only 45, but the best of life seemed to have gone. She tried to busy herself with church work, club, and other activities. They all helped. But she now found that PTA, in which she had been very active, had much less interest for her. In fact, she wondered if she should belong, now that her boys were out of school.

She thought of teaching music again, but Ted said that it would be a reflection on his ability to support her and the boys. Finally, she compromised by taking over the directorship of the church choir. This helped a lot.

In the meantime, Ted was really busy with his work. He won an award from his insurance company for the biggest percentage increase of the year in the entire state. He was mighty proud of that and wasted no chance to let people know about it. He knew Norma was having a tough time and that he ought to spend more time with her, but he just had to keep active in his

expanding business and the things related to it, such as Rotary, lodge, church, club, and special events like conventions.

Norma resented his concentration on work and neglect of her, but she said nothing to Ted. Church activities and club did bring them together at times. And besides, she was gradually beginning to feel better about things. By the time Tommy was in his sophomore year at college, she was pretty much her old cheery self. But even then, a lump often came to her throat at the stillness and neatness of her home and at the many hours which were empty unless she made special plans to occupy them with some activity.

We shall now look in the 70's to anticipate what this decade may hold for Ted and Norma.

Jimmy had always planned to come back to the insurance business with his dad. So, when he graduated from college, he and his father were both very happy about the new partnership. Within a year, Jimmy married his college sweetheart, Nancy, whose home was a farm about 400 miles away. These two had their first child, Joanne, three years later.

Ted was now 51 and Norma 50. As Ted said, "Gosh, we're still young and here we are--grandparents." The thought made him happy, and it also made him sad. He felt quite mixed up at times. But he was so very busy that he did not have much time to fret about such things. Norma was very happy at having this new interest--a real, live, dear, sweet, little human being. She had always wanted a girl of her own. She made it a point not to interfere with Jimmy and Nancy as they reared their little Joanne, but she found it hard to practice this resolve.

She worried quite a bit about the kind of mother-in-law she was being. If only a grandmother could enjoy her children and in-laws and their babies without having to worry all the time about what other people would say! Ted was very happy about being a grandfather. He was proud of his ability to bring up a family and furnish them with all their needs, including a good business which his grandchildren could have some day. He didn't want his sons or their children to work like he did.

Tommy, meanwhile, had finished college with a fair average and had gone to South America to work for an oil company. He wrote that he liked it but he didn't write often. Norma worried about him and wished that he would keep in closer touch with home. After three years in South America, he returned to the U.S.A. where he settled down in New York with his oil company and married a girl his folks had not met until a week before the wedding.

By this time the first grandchild was almost three years old. Jimmy and Nancy seemed to be happy. Norma, however, found this to be not the happiest time of her life, but she kept busy and was reasonably satisfied. Ted was going "great guns" as he termed it.

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A year later something new was added! Ted had a fairly severe heart attack and the doctor told him that unless he became inactive in the business, he probably would have only a few years to live; if he were careful, he might easily live another twenty or thirty. At this time, Ted was 55 and Norma 54.

In his usual abrupt and decisive way, Ted agreed and immediately set to work turning the business over to Jimmy. He spent several weeks going over everything with Jimmy. Then he and Norma took a vacation trip which lasted over a month. If they were reasonably careful, he told Norma, his insurance and the business would give them a pretty good income the remainder of their lives.

When they returned, Ted began to drop into the office in the mornings. He became very restless. At first he tried to putter around the yard and garden at home, and to otherwise occupy himself, but he made little progress. As he himself said, "Damned if I realized how everything would hit me all at once."

Norma was concerned because he was so irritable and nervous. He even lost his good appetite. They were really quite unhappy at home. Ted spent a lot of time with the grandchildren. He tried so many other things. Finally, he told Jimmy that he would just have to work most of the day.

This was arranged, much against the advice of Norma, Jimmy, and the doctor. Things went well for over two years. Ted was happy again; he and Norma were quite happy with each other; everything was rosy. Then came in the second heart attack. That finished work for Ted.

Now Ted and Norma are 57 and 56 respectively. They are settling down to a more quiet life but still struggling at the thought of being labeled "old." They have much time together, and enjoy most of it. Ted, however, is still very restless and dissatisfied. Norma worries over his health, both physical and mental; but she thinks he is getting better, at least in the way he feels about things.

What does the future hold for Ted and Norma and family? The old saying still is true: "Only time will tell."

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT III: Needs and Wants and Family Life Cycle
III-3. Wants Vs. Needs[1]

(See Suggested Learning Experience No. 15, p. 15 in Part One)

EDITOR'S NOTE: These pages have been planned as an individual learning experience to stimulate thought about using money as a resource.

Have you ever stopped to ask yourself why you buy what you buy, how you decide what you need? Have you consciously thought about money as a means to an end, a resource to satisfy wants and needs?

Using the hypothetical situations described below, test yourself to see which of the items pictured on pp. 61-62 you would select. Pretend that you are in a store, make your selection and then ask yourself why you made the choice you did. If you do not select one of the items on these pages, then think of something you would buy, given the particular situation.

1) You are shopping on a Saturday afternoon with a friend. You do not have any purchases in mind, but the two of you are wandering through stores. Do you see any items you might buy?
2) You have gone shopping to purchase a new outfit to wear to a sports event. You have something at home to wear in case you cannot find anything. What would you purchase?
3) Someone has just given you $100 as a gift. Which of these items would you buy? If you do not see anything here you would select, what would you like to buy with the money?
4) You have received $20 back on your income tax. What would you purchase? What would you like if you have more money?

Now ask yourself:

Why did you make the choice you did?
Is the item selected filling a need? If so, what need? If not, why did you select it?
Can you distinguish whether it was a want or a need? How would you define a need? A want?
Would you use the item to reach some goal?
Will the desire for this item be fulfilled by its purchase or will the desire recur at a future date?
How did you decide which of these items to purchase? Was it done by a conscious decision-making process, or did unconscious forces affect you? Will acquiring this item lead to the desire for other things.

According to Maslow, all human beings have basic needs which motivate behavior. These are:
The need for food, clothing, shelter.

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[1]Reprinted by permission from Penney's Forum. New York, New York: J.C. Penney Company, Inc. Fall/Winter, 1969. pp. 14-15.

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The need for safety and security.
The need for love and belongingness.
The need for self-respect and self-esteem.
The need for self-actualization.

The basic needs which we have can be limited to the necessities of life. Wants are unlimited, and economics is based on the belief that they are insatiable over a long period of time. Wants sometimes are categorized as all the items which we have been accustomed to having in our lives, as well as all things desired. Most of what we want is a want, and not a need. Wants are physical (sound, sight, healthfulness), psychological (creativity, gregariousness), and social (approval of a group).

All human beings have wants and needs in common. How individuals interpret and fulfill them depends upon many variables:
*Climate *Age *Sex *Stage of family life cycle *Resources available for food, clothing, shelter, etc. *Income *Occupation *Cultural background *Group *Values *Goals *Customs, etc.

Although we are not consciously aware of it, conscious consideration of any items to fulfill wants or needs involves a mental process of decision-making. The steps involved are:

*Recognizing the problem *Analyzing the problem *Seeking available alternatives *Considering each alternative *Making a decision and acting upon it.

Decisions may also be influenced by unconscious forces (desire for security, self-esteem, status, social approval, or to create a personal image), by advertising or by habit. The reason we tell ourselves--why we make a decision--may not be the real motive--we may rationalize (see article on "Impulse Buying" Forum, Fall/Winter, 1968).

SUMMARY

Perhaps one way to better manage resources is to understand oneself, one's needs and wants and how they influence decisions. Understanding and making conscious decisions may help to utilize resources more wisely and to make them go further.

It is oftentimes said that it is difficult to distinguish wants from needs--sometimes they overlap. Making a definite distinction between the two is not absolutely necessary for every purchase. But, if each individual were to take time to think through what he wants and clarify in his own mind why he wants these things, he might acquire a more accurate picture of his values, goals, and motives.

During the next few weeks, make a conscious effort to analyze those decisions you make about what you buy, as well as those decisions you make about what you don't buy. Ask yourself, are you becoming more aware of money as a resource--are you thinking about this resource as a means toward helping you achieve self-actualization?

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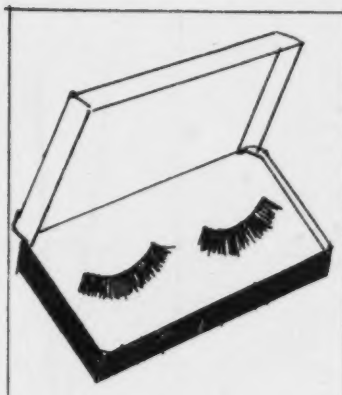

Eyelashes About
$1.50

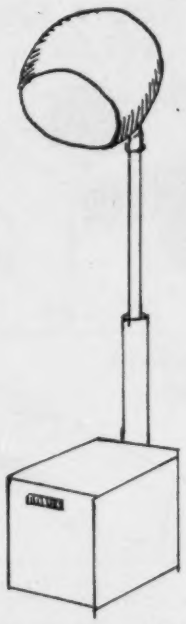

High Intensity
Lamp About $13.00

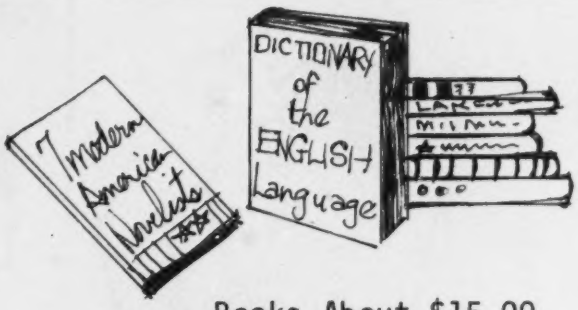

Books About $15.00

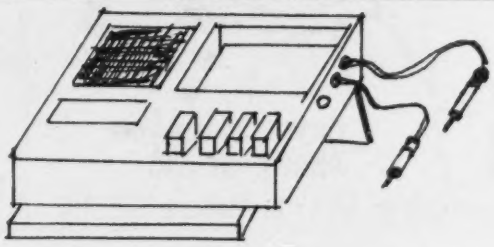

Cassette Tape Recorder About $40.00

Wants Vs. Needs

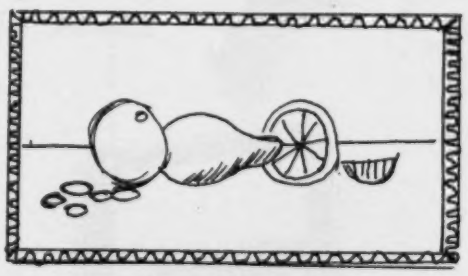

Painting, Original Oil
About $18.00

Panty Hose
About $2.00

Ladies Taffeta Wind-
breaker About $18.00

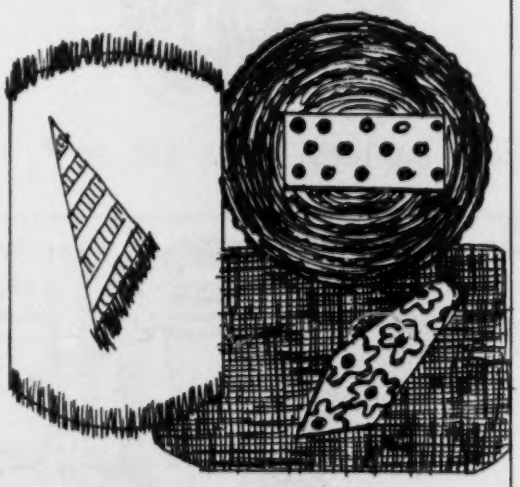

Place Mats About $1.25
4 Cotton Napkins About $2.50

Ladies Watch
About $25.00

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Polariod Camera About $25.00
Ladies Sandals About $9.00
Rayon Blouse About $6.00
Corduory Skirt About $6.00
Records About $2.00
Music for the Young
Socks About $1.00
Fishing Rod About $9.00
Sleeping Bag About $13.00
Winter Coat
About $45.00
Hair Curlers About $30.00
Blender 12 speeds
Candy Various Prices
About $45.00

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-1. Types of Resources

(See Suggested Learning Experience No. 3, p. 17 in Part One)

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TYPES OF RESOURCES

HUMAN

Attitudes

Knowledge

Abilities and Skills

NON-HUMAN

Time

Money

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[1]Vocational Education Media Center, Clemson University and Office of Vocational Education, State Department of Education, Columbia, S.C.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-2. Toward Self-Actualization: Managing Resources[1]

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(See Suggested Learning Experience No. 5, p. 17 in Part One)

"How should I manage my money?" "How can energy be managed to prevent fatigue?"--These and other similar questions may seem to be pertinent to problems today and are frequently asked and contemplated. However, it might be advisable to reconsider whether these are really the most relevant approaches to problems facing individuals and families today. Should the focus be on techniques of managing specific resources or on management of all resources according to the type of problem faced? That this is more than a semantical difference becomes apparent when results or potential results of these two approaches are compared. It must be remembered that research in this area is relatively sparse, and therefore the conclusions must be viewed as tentative hypotheses. However, evidence, even though sparse, is beginning to suggest implications of special interest in family living.

Our society has reached a point where sufficient material resources are available to satisfy basic physiological, and possibly the security, needs of all. It is obvious that this has not occurred, but the cause is distribution rather than resource scarcity. This potential should free people from an overriding concern with the range of problems focusing on satisfaction of these lower basic needs. Other types of needs emerge and our primary concern shifts to the satisfaction of these needs. Higher need satisfaction, including need for love and belonging, for self-esteem, and finally for self-actualization, is likely to lead to many problems of different types than those stemming from lower need predominance.

These problems are more apt to be social in nature. They focus on value selection and change, general goals or patterns of life, integration of different individual roles and integration of unique individuals within a working group. Human resources take on special importance. Even material resource use may take a somewhat different approach. Efficiency and specialization, which are somewhat relevant in technical decisions where accomplishment of a clearly specified task is paramount, are no longer of primary value.

Social problems can be approached in a manner similar to that used in solving technical problems, and this frequently is done. This can mean

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that resources are manipulated, rather than managed. Manipulation refers to the control of resources in order to serve one's own purposes. If we consider this in terms of material resources the results may not be too alarming, though in some situations, they may be questionable. However, in terms of human resources, the question of manipulation rather than management, takes on great importance. This is especially true if we are concerned with self-actualization, which is the realization by an individual of his own highest capacities. If human resources in any group are manipulated rather than managed, it is difficult to see how any need for self-actualization can even emerge; the environment becomes one which discourages the search for one's own identity.

It should be stressed that manipulation of human resources is not necessarily an indication of lack of concern for others; it is more apt to stem from a lack of awareness of the real problems which exist and the magnitude of their importance. In families, value and role problems calling for social decisions may be approached through technical means. Family members are manipulated or controlled as material resources toward efficient achievement of goals, already selected or dictated, either by another family member or an outside group or institution. This is frequently done with the best of intentions, but is a tragic example of an efficient decision-making technique applied to the wrong type of problem.

Recent studies of students by Keniston give some indication of possible results of these differing methods of working with human resources. In families of alienated students (those who had chosen to drop out of society, such as the hippies), domination by an overcontrolling mother prevailed. The mother-child relationship is characterized by maternal control and intrusiveness and children join the mother in an alliance which depreciates the father. These students who appear to be pushed in a certain direction tend, not only to reject parental values, but generally see individual life as purposeless. In families of committed students (those working toward change or reform, such as some student activists), family life was unusually equalitarian, permissive, democratic and highly individualized. Free dialogue and discussion of all feelings was actively supported and children were encouraged to make up their own minds and to stand firm against group pressures. The mother was a highly individuating force, who pushed the children to independence and autonomy.

On the basis of limited evidence, these two groups seem to provide a timely contrast between the possible results of manipulation of human resources and failure to deal with social decision on one hand, and the management of human resources and active involvement with social decision on the other hand.

If management has as its end goal the encouragement of self-actualization, then everyday use of resources must focus on the setting of an environment which will encourage the emergence and satisfaction of this need. This, of course, means that basic physiological needs, needs for security, love and self-esteem must first be satisfied to some degree. Satisfaction of these needs requires the awareness of different types of problems and the use of resources in a way relevant to those problems. It requires the ability to be other-concerned rather than other-directed. It requires the ability to manage human resources by creating an environment in which each individual

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is encouraged to seek out and justify his own values and to discover his own highest capabilities, rather than to work to achieve a goal which has been pre-set for him; this is the route to self-actualization.

Finally any discussion of managing resources in order to encourage self-actualization must consider, at least briefly, the self-actualizing person himself. Studies, especially by Maslow and Rogers, indicate the characteristics prevalent in a self-actualizing individual. He is not the well-rounded person who is well-adjusted to his society. He is not the "all-around good-guy" who wins popularity contests. He may even be considered eccentric or radical. Rogers points out that this is not a life for the faint-hearted, because it involves the courage to be and to become committed and involved fully in the stream of life. Life will be enriching, exciting, challenging and meaningful, but it will not be easy or simple.

In a society when so many advances have allowed us to concentrate on the individual, we should be free to emphasize the humanness of man ("humanistic management," as identified by Fromm). The logical place to start is the family, where major decision--social decision--should be solved by social approaches, and not be ignored or approached technically, and where human resources used in these decisions should be managed and not manipulated.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-3. Circle Graph on Time Use[1]

(See Suggested Learning Experience No. 13, p. 18 in Part One)

According to a recent report, by the age of seventy the ordinary person has spent his time as illustrated below.

NUMBER OF YEARS	DEGREES
20 years of sleeping	103
20 years working	103
7 years in sports	36
5 years in shaving and dressing	25
7 years at the movies, theater, and other amusements	36
1 year on phone	5
2 1/2 years eating and sitting at table	13
2 1/2 years smoking and chewing gum	13
3 years waiting for one thing or another	16
2 years playing cards and games	10
	360

[1]Adapted from Tips and Topics in Home Economics. Lubbock, Texas: College of Home Economics, Texas Tech University. Spring, 1961. Vol. 1, No. 2.

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* Most of the family's money goes to food and incidentals (non-food items).
* There is no record of recent purchases.
* Basic problem is lack of money by the end of the month. Has to cut short the clothing expenses in order to have enough money left for emergencies.
* All purchases made by cash.
* No savings plan established at this time.
* No insurance plans.
* Medical and dental expenses paid by welfare.
* Emergency fund available through welfare if need arises.
* Food stamp program is U.S. Department of Agriculture program administered by Welfare Department. Allotted amount can be used only for food.

DICK HARRISON

Dick Harrison (17 years old). Indianapolis, Indiana.

Present Status: Senior in high school.

Family: Two brothers, father and mother at home.

Employment: Works twelve hours a week, as stock boy in a drugstore. In the summer he works at the same drugstore and paints with an uncle.

Income: $25 per week during school year, $55 per week in summer.

Information from Interview:

* Dick pays for his lunches, clothes, books, dates and records with money he earns.
* He does not receive an allowance--parents occasionally buy clothes for him, but do not have him on a clothing budget.
* Uses the family car. Father pays for maintenance and insurance. Sometimes Dick pays for gas--about $2 per week.
* Figures he sometimes spends $30 per week on clothes. Usually spends $5 on records, $8 on dates and entertainment per week.
* His biggest problem in relation to money is that he can never seem to keep enough cash on hand.
* If he needs more money he draws it out of his bank account or borrows from parents or older brother.
* Does not have charge accounts. Would possibly like one but is afraid that he might overspend the account.
* Does not spend much time shopping--likes to shop for sweaters, slacks, shoes. Mainly, shops alone and is not influenced by anyone in his shopping.
* Interests are jazz music, reading, girls (occasionally), people in general. (Is president of his Family Living Class.)
* Future plans--to attend Purdue in fall. Is saving some for education--feels he should be able to help himself to some extent.
* Has life insurance which his parents pay for.
* When asked if he is consulted in the family's financial planning, he said: "Yes, they ask how I feel."
* Feels young people are wise in handling money in most cases.

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THE AUSTINS

Fred and Brenda Austin (52 and 47 years old). Town in Wisconsin.

Children: Two boys, ages 15 and 13.

Employment: Husband works as a lab technician for a paper company. Wife has worked part-time as a waitress. (She is overweight, and it is believed that this is one of the reasons for her leaving work. Women do not usually work outside the home in this town unless they are head of the household.)

Background: Live in an industrial city of 10,500 people. He is of German background; she is Dutch. Both have high school diplomas. He was born and raised in this town; she was brought up five miles away. He works in the same mill his father worked in, but has a different job.

Income: Around $8,000 before taxes.

Weekly expenses:

Housing	$50.00	(Will soon own home)
Household Operation	10.00	
Food	25.00	
Clothing	6.00	
Car	7.00	(Purchased new car last year; traded in old one. He gets ride to work to avoid taking car. Money includes gas plus money for rides.)
Entertainment	2.00	
Insurance	2.25	(Mill carries term insurance based on $1,000 of earnings)
Medical	1.00	(Covered with mill's health insurance)
Savings	0.00	(Have funds in paper-mill savings plan)
Other	0.00	

Information from Interview:

* They feel most of their money goes for food and taxes.
* Most recent purchases (outside regular purchases) were the car and camping equipment. (Wife stated that they often rent a cabin in the summer, but she spends more time cleaning than enjoying vacation.)
* They do not anticipate any unusual purchase over the next few months.
* Problem with money is that they don't feel they have enough. If they had more they would spend it and live better.
* Mr. Austin pays the bills and does much of the buying.
* They use both cash and charge to purchase items. Will use charge when it is for appliances.

* Have no savings or investment plan.
* Future plans are education of their sons.
* Health is important to them.
* Oldest boy has a paper route. Money he earns is his to use, but he must save.
* They often go out on Friday nights for fish plates, or visit relatives for a change of pace.
* Mr. Austin is somewhat jealous of a younger brother who got an education and is teaching.

MARY GALLAGHER

Mary Gallagher (25 years old). Denver, Colorado.

Employment: Teaches English in a secondary school. Has been teaching here two years. Before coming to Denver she taught in Chicago for two years.

Background: Mary grew up around Chicago but went to college in Colorado. Decided to leave the Chicago area after two years of teaching and join friends in Colorado. Her father is an industrial worker--he is from Ireland. Mother works in local retail store--grew up in Chicago. Parents did not want Mary to leave home, but she felt it would be more fun in Colorado--plus she likes to ski.

Income: Around $8,200 before taxes. Take-home pay $6,233.

Monthly Expenses:

Housing	$120	(Shares new apartment with another girl--rent includes utilities)
Food	80	(Eats out a couple of times a week)
Clothing	100	(Varies, but this is average for dress, slacks, shoes)
Car or Transportation	50	(Auto expenses--gas--insurance)
Entertainment	50	(Approximately)
Insurance	10	
Medical	5	
Savings	0	
Household Help	20	
Drycleaning & Laundry	12	
Other	20	(Sends to younger sister who is in college)

Information from Interview:

* Feels most of her money goes for clothes and food.
* Has charges at local department stores. Felt she wanted to buy nice gifts for her family this past Christmas, and is paying off a $150 bill in one store on a monthly basis.
* Wants to buy a $400 stereo for the apartment in next few months. Not sure how she will buy it. Parents never used credit--always cash. She's worried and feels she should pay off her other bills first.
* Problem she has with money is that she feels she lives from paycheck to paycheck. Is paid twice a month--first check goes for rent and bills; second check to enjoy.

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* Does not have a savings plan--keeps saying she will start the next month.
* Skis in the winter and shares a ski house with friends. Pays $120 for the season plus $6 per weekend for food. Has her own equipment and spends $100 for season tow ticket.
* Has a very small life insurance policy.
* Family is important to her. Is helping a sister who is in college. Also, having fun is important to her.
* In future--would like to be married soon. Dating a young engineer now, but not sure if they will marry. She may go to graduate school.
* Flies home twice a year. Parents came to visit her last summer so will fly home only once this year.

THE LOPEZES

Raul and Rosa Lopez (31 and 25 years old). New York City.

Children: Four (2 girls, ages 11 and 3; 2 boys, 10 and 9).

Employment: He works in a venetian blind manufacturing plant and earns $65 a week (take-home pay). She is a homemaker and is attending school two nights a week to get her high school diploma and to study English. She works three hours every morning as a translator and assistant in a welfare program.

Background: Mr. Lopez came from Puerto Rico when he was 13; she was younger. They met in New York and were married when she was 13. His family is still in Puerto Rico--father owns land and has given each son a plot. Raul would like to return to Puerto Rico--feels his parents have a more comfortable life than he does. She wants to remain in New York--feels that things are not as good in Puerto Rico and that there is nothing to do. Her mother lives in New York and does not want to go back to Puerto Rico.

Income: $260 per month take-home pay. $73 per month supplementary welfare.

Monthly Expenses:

Housing	$57.50	(4-room apartment in city housing project)
Household Operation	8.20	(Gas and electricity)
Food	65-68.00	
Clothing		Varies ($28 per month on shoes for children)
Transportation	8.00	(Husband's carfare)
Entertainment	0.00	(Church socials, which do not cost anything)
Medical	5.00	($10 visit at local clinic)
Savings	0.00	

Other..... 3.00 (TV repair occasionally approximately $32 per year)

Information from Interview:

* Rosa's hobby is knitting; buys yarn at $1.20 per skein regularly. Paid $6 for yarn for skirt and blouse.
* Feel that most of their money goes for food and clothing. Besides regular purchases, last year they bought a second-hand dining room set and washing machine. They were purchased with cash from someone who was moving. They plan to buy paint for the apartment ($30) and fabric for curtains ($15) over the next few months.
* Do not feel they need to rationalize any spending--all purchases fill real and specific needs.
* Purchases for house or selves are paid with cash. Furniture was bought two years ago on credit from a dealer in the neighborhood.
* Saving is done by keeping any money which is extra and hiding it at home.
* Have no insurance.
* Future plans are to see children through school. Hope children will go to college, but children feel they should work when they graduate to help out at home.
* Important to them that their children get along in school.
* Rosa hopes that husband's income will increase as he is at job longer (at present job 1 1/2 years). If income is increased, hope for an easier time managing money.
* Boys belong to Kadets (2 uniforms each, at $17 each). Feel it teaches them about America, discipline, neatness, drilling. Group of boys 8-14 meet two nights a week.
* When Rosa was asked amount spent on clothing, she gave a detailed list of all family clothes.

THE SMITHS

Bill and Barbara Smith (50 and 45 years old), New York City.

Children: Three (2 boys 13, 6; girl 11).

Employment: He is a Science Editor of a national publication; she is a dress designer. Both enjoy their jobs very much. Neither is interested in retirement, and they want to be able to work beyond 65--both have confidence in their abilities to continue earning indefinitely.

Background: Couple has been married 23 years. Husband feels his parents were "completely irresponsible" about money, and feels his attitudes are influenced by this. Wife states that her ideas about earning power and money that are important come from feelings of the"pinch" during the depression. Both went to college in New York. From 1945-1956 they lived in Europe where he was a free-lance writer; she worked in couturier houses as a designer. Feel they had their free time then; do not want free time at retirement age.

Monthly Expenses:

Housing.....$240 (8-room apartment)

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Household Operation.....	30	(Phone, gas, electricity)
Food.....	240	(Including household supplies)
Clothing.....		(No budget--purchased as needed)
Car/Transportation.....	110	($50 car rental, $12.50 weekly for fare and $10.00 extra for weekends and getting around in city)
Entertainment.....	40	
Insurance.....	6	(Comprehensive household $73 per year)
Medical.....	125	($1500 per year)
Savings.....		Vary
Vacation Home.....	22	(Maintenance fee--$265 per year)
Household Help.....	124	

Information from Interview:

* Feel most of their money goes for rent and food.
* Recent purchases made were a vacation house and furniture, and a $200 tuition down-payment for daughter for private school.
* Anticipate buying $300 more in furniture for country home.
* Felt they had "unchecked leaks" in money management, so hired an accountant to review income, living expenses, etc.; realized they were expecting to do too much with amount of money they had.
* Bill feels he needs to rationalize some of the impulse buying he does; recently purchased a $75 drawing without a second thought.
* Have savings plan for taxes and schooling.
* Bill not currently carrying life insurance; changed job, and policy being reassessed.
* Future plans: To continue in careers, be prepared financially to help children in their growth (private school if necessary, camp if thought beneficial, etc.).
* Growth of family members as individuals in a mutually beneficial unit is important to them.
* If had more money, would travel.
* No planned program for children's education; parents will assist to a certain extent; children will be able to contribute; state schools considered a good idea. Can't worry about college now because have expense of private schools--will wait and see what happens.
* Outstanding debt--owe dentist $1000. Not too concerned--will pay as they feel they can.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-5. Self-Actualization Through Management of Resources[1]

(See Suggested Learning Experience No. 15, p. 18 in Part One)

EDITOR'S NOTE: We held another of our Forum's Forums to discuss in depth the theme of the issue--"Self-Actualization Through Management of Resources." Each of the "Forum" members represented a different point of view and is a specialist in one of the many areas which are all a part of management of resources and the development of the individual.

The "Forum" was conducted differently this time. We used the case studies (found on the preceding pages) as a starting point for our discussion. The morning session of our "Forum" was very philosophical and inspirational. In the afternoon, we selected three of the case studies and reviewed them for indications of family values, goals, and management.

Dr. Beatrice Paolucci, Professor, Family and Child Sciences at Michigan State University, served as moderator.

Some points which came out of the morning discussion were:

* Consumers need more information about what motivates their buying, as well as what are the actual costs.
* Many people today have only day-to-day goals; they are not future oriented and do not look any further than a short time span from the present. Spending is often done day-to-day, without knowing where it is leading.
* Cultural differences must be understood when evaluating a spending plan. Any part of a culture which adds meaning and value to the lives of the individuals within that culture is significant. (An example cited was that for some low income families being buried in splendor is very important; therefore, insurance is maintained for burial purposes.)
* We need to assist people with an understanding of the overall value system in the larger society. The individual has a right to differ in his values--striving for something which is real for him. When people find that consequences differ, their values will change.
* At one time, people found their identity through their work. Young people today do not feel that it is all important to produce. They want to perform in different ways--such as production of an atmosphere where creativity can take place and competent individuals can develop.
* An understanding of the self is basic to achieving self-actualization.
* To achieve self-actualization, the individual has to maintain himself physiologically and psychologically. As educators, we are obliged to start with people where they are at the nutrition level if need be. Any of the aspects of maintaining and developing the individual can be taught through means which would be appropriate for a particular culture.

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* People should have a knowledge of values, but they also need to know what their physiological and psychological needs are.
* Self-actualization is the ultimate that an individual can reach within a society.
* What is a human being? What kind of society can we make, given the environment now present?
* Space is important in the development of personality.
* There is a need for standards to measure aspects of human development. We have established standards in certain areas: nutrition (caloric intake, protein, etc.), sanitation, clothing (through research on space-suits we have more information on maintaining body temperature, ability to move, etc.), space (amount of space required for growth), etc. But, we need more information and standards to help measure whether or not people are achieving goals in line with particular cultures.
* The use of money is reflective of what is important to people at a given point in their lives.
* Some people think of money as a goal--not a resource. Or they may consider money their only resource and believe that it can do everything for them. The concept of money needs to be re-evaluated; money should be a helper to achieve a goal--not an end in itself.
* Mass media help to make consumers aware of the many alternatives available to them as well as to create needs. People need to learn to discriminate about the information they get in light of their own values and goals.
* At the poverty level, time and energy are spent keeping alive. For the large number of people in the United States who have been freed from just surviving, the inner resources have not developed to any kind of full potential.
* People are managing well if they are achieving satisfaction and meeting their own goals.
* Teaching should be viewed as a reciprocal relationship. Teaching is not an input procedure--the teacher is learning also. There is a difference between teaching and allowing learning to take place.

Some evaluations and questions which arose during the discussion of the case studies were:

THE JONES FAMILY

* Basic to any use of resources is an understanding of one's basic philosophy of life.
* Free medical care is a community resource.
* It is felt that the money is probably not balancing out because of the condition of the mother.
* There are omissions in terms of basic expenditures--no mention of cleaning or school supplies. Since the woman is on welfare she may not have told some of her expenditures to the caseworker.
* The amount of money this woman receives could be re-evaluated. What foods could be purchased for the $76 a month for this family of 6? Are there community resources to supplement this? How can a family be taught to use creatively $5 a month for entertainment?

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* When expenditures are recalled, certain spending is remembered--but is it a true picture?
* Is the mother hampering her children? Chances are the 11 year old assumes much of the responsibility for the other children when the mother is ill. Human resources are sometimes removed in an urban society; in families of previous generations, an aunt or grandmother would probably have been present to help the mother.
* The society decides upon the amount of money a family will receive from welfare. What does this tell us about the values of the society?
* Any management problem should be approached from--what is available (human, spiritual, medical, community resources, etc.) or what could be available?
* This woman has aspirations to help herself. She is using a community resource (the Work Incentive Program) in order to train to be a clerk-typist.

THE LOPEZ FAMILY
* It is difficult to tell from this case study if money is being used as a tool to buy intangibles--such as love and revenge.
* In the Pureto Rican family it is very important to both marriage partners that the male dominate. The balance of their relationship may be thrown off--she is going to school and also wants to remain the the United States. What is this doing to the balance of power in this family?

THE AUSTIN FAMILY
* One of their future goals is the education of their children, but they have no savings plan.
* The exploration of whether there will be a difference in housing costs when they own their own home would make an interesting project.
* Health is also important to this family but they do not spend much money on food. It may be that the foods they eat are not expensive. Does this have anything to do with their background?
* There is no mention of how they paid for the car.
* The area where a family lives influences costs.
* There are forces working against the middle income family--they may not be able to take advantage of community housing.
* What are the constraints upon a family because of income, position, locale, etc.?
* What kinds of planning does it take to operate on a weekly, semi-weekly, monthly or seasonal basis?

GENERAL THOUGHTS
* All the cases have similar spending--spend for basics. What are the common problems they have?
* Would people be more likely to self-actualize if society provided a basic income to low income families?
* In order to analyze the cases and possible alternatives these families may have, the values, goals and resources of each family have to be uncovered.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-6. An Economist and Anthropologist Comment on Use of Resources[1]

(See Suggested Learning Experience No. 15, p. 18 in Part One)

EDITOR'S NOTE: We were interested in what families did not include, as much as in what they did include. In fact we asked Dr. Gordon Bivens, an economist from the University of Missouri, and Dr. Ethel Alpenfels, an anthropologist of New York University, if they would comment on these case studies. We think you will find their discussion interesting and "food for thought" for what areas of financial planning might need to be strengthened in teaching the management of resources.

DR. GORDON E. BIVENS, PROFESSOR OF FAMILY ECONOMICS
UNIVERSITY OF MISSOURI

PLANNED SPENDING OR A "HAPPENING"?

One gets the feeling that in these cases there is little actual planning of spending...that it somehow just happens. If so, and if this implies that the families aren't really thinking through their spending on the basis of underlying goals and values, then a real challenge exists--that of helping them to help themselves advance toward goal achievement by taking hold of their spending and using it as a tool to achieve their goals. In other words, to look upon spending as something that, within limits at least, can be tamed, controlled and disciplined to serve their larger purposes in life. But, on to some of the specifics...

THE FAMILIES AND FOOD, CLOTHING AND HOUSING...

Despite several families feeling that most of their money went for food and clothing, clothing expenditures for the families ranked third, fourth or fifth in their spending rather than first or second. Blowing up the importance of clothing expenditures may be due to some of these purchases involving relatively large outlays, forgetting that such expenditures may be infrequent. Food for families, on the other hand, did rank either as their largest or second largest expenditure.

It is curious that the families did not sense how large a chunk housing took, especially if household operation is included. Even though these case families apparently did not recognize it, housing ranks as their first or second largest expenditure; this was true even for the single girl!

In addition, household operation (utilities, cleaning supplies, probably telephone in some cases and related expenditures) ranked as the third- or fourth-ranking expenditure. This insensitivity to housing expenditures may

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be due to lack of awareness or to a feeling of complacency that "Oh, well, what can I do about it anyway?" But, it seems it is an area of spending on which attention could well be focused.

THE SINGLE INDIVIDUALS AND CLOTHING...

The single individuals' spending for clothing was relatively large, as one might expect. And it may point out an interest area on which to "hang" one's teaching, extending out from there to other areas. Also, it may be that the clothing area is one in which increased planning and understanding might result in just as great pleasure resulting from decreased expenditures for clothing, leaving more money for other things.

WHEELS NO BIG DEAL??...

For the case study families, expenditures for transportation were either relatively unimportant in their way of life, or they were underreporting how much they spent for transportation. In no case were they reporting more than about 6 per cent for transportation; but even at the time of the U.S. survey of 1961, transportation expenditures were about 15 per cent of the total. For the individuals (Mary Gallagher and Dick Harrison), transportation was relatively more important.

WHOOPS! WHAT HAPPENED?...

In no case did the families and individuals in these case studies report spending for personal care--barber shops, beauticians, etc. Could this be because of their feeling that these might be considered as frivolous? Or, is it just that they aren't aware of such expenditures? For urban families any single consumers in 1961 (the last nationwide consumer expenditure survey), 3 per cent of all expenditures for for these purposes.

Although some of the cases reported recreation and related expenditures, others did not. And, even when reported it seems possible that the amount may be low. In 1961, recreation spending made up about 4 per cent of total expenditures for U.S. urban families and single consumers. That represented $218, or about $4 a week. The Austins reported $2 per week, the Lopezes nothing. The Smiths reported $10 per week, but that probably represents no more than 2 per cent of their total spending. As would be expected, the single individuals had a larger amount going for recreation.

Reading materials (even newspapers) and other educational expenditures (such as school-related expenses, including school lunches and supplies) generally were not reported by the families. Each of these areas was about 1 per cent of total spending in the 1961 survey. It may be that these case study families actually are that much different; or it may be that they simply are overlooking such expenditures.

AND, NO CHRISTMAS, BIRTHDAYS, OR OTHER OCCASIONS?

Giving to church and charities as well as to individuals (family and friends) was not reported in any of the cases except Mary Gallagher's help to her sister. This omission seems strange since, in 1961, nearly $300 was used for this purpose for all urban families and single consumers. Of course, gifts and contributions aren't usually considered expenditures as such, like food, clothing, and other current consumption spending, but neither is insurance, and some of these case families did report that.

Some other expenditure areas which often are omitted or underreported include: professional and occupational expenses (dues, etc.), hobby-related expenditures, home furnishings (even for replacement, let alone additional), payments on autos and household appliances.

CREDIT FREE?

In those cases where credit was being used, it appears that the families were not considering a separate expenditure for the amount paid for the use of the credit--this may suggest an area needing to be brought to their attention.

OVERALL...

These cases probably are not terribly different from many families and single individuals, although no claim is made for their representativeness. It would appear that one way to help these case families and individuals help themselves would be to make them more aware of how they currently are spending. Further, to consider whether, in fact, their pattern of spending is justified (in light of their goals and values), or if they might want to reassess it and adjust their spending...using less here, more there...to conform more nearly to a clarified picture of what is truly important to them. Naturally, many might decide that their current spending allocations actually are in line with their goal rankings; but, if that isn't the case, helping them to recognize it and do something about it would be rendering a real service.

DR. ETHEL J. ALPENFELS, PROFESSOR OF ANTHROPOLOGY
NEW YORK UNIVERSITY

(Dr. Alpenfels reviewed the three case studies discussed by the "Forum," pages 73, 69, and 71--The Lopez, Jones and Austin families.)

SPENDING PATTERN SEEMS TYPICAL

These families seem in certain ways to be fairly representative of families in similar economic circumstances. The large amount spent for food is to be expected in families with several small children.

These three case studies show a constant struggle for survival with chronic shortages of cash, absence of savings and low wages, reinforced by a strong feeling of helplessness and a constant hope that things will "get better" when the husband earns more money, or when there is more money available.

CULTURAL DIFFERENCES

The Lopez family, however, does not seem to be representative of Puerto Rican families living in New York City. This may be due to the fact that both husband and wife have been in the states since pre-adolescence. In some ways, however, Mrs. Lopez' night school attendence, her careful records of money spent on clothing (she listed all items of family clothing in her interview), and both parents' concern about school and free education, are usual among Puerto Ricans, especially Puerto Rican women.

Her husband's wish to return to the island and an almost martyr complex on Mrs. Lopez' part, is often found among Puerto Rican migrants. Mr. Lopez is looking at a dream, which is probably not realistic, and is remembering his childhood better than it was.

On the other hand, the Austins in Wisconsin do not seem to be comparable with the other families. They live in a small town and seem to be living close to a subsistence level, because they choose to do so in order to finish paying for their home. In this locale, owning a home is important, followed by car ownership for transportation to relatives' homes, church and school affairs. Such communities are now building community colleges, and whether this is true or not, the Austins expect their sons to save money or to work their way through college. They are fairly representative of mid-western families in this respect. The status symbol of owning a home will continue to drain the family budget until the Austins own it, and, until then, other items of expenditure will suffer.

CULTURE OF POVERTY

The Jones family (Washington, D.C.), perhaps more than any of the others, displays a strong feeling of dependence as well as helplessness in handling expenditures. This is representative of what anthropologists call the "culture of poverty." The high rent and excessive expense for utilities is often found in slum areas. These expenditures seem out of proportion to the amount spent on food and clothing. This they share with other low income families. In this family, the cultural profile, including even the therapy treatment of the mother, may be found in any large city. Abandonment of mother and children, a mother-centered family, unemployment and undoubtedly secondhand clothing and furniture are accompanied by a chronic shortage of cash. It does not seem possible that the mother can feed a family of five small children on $76 in food stamps, and it is not surprising that she makes no attempt to keep records, to plan or to consider goals for the future. She is lucky to survive in the present.

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SOME GENERALIZATIONS

Except for the Austins in Wisoncsin, the families seem to be alienated and marginal to any national institutions except that of public assistance. They did not mention having money in the bank, and there was no mention of the community. They all indicate political apathy and mistrust of the government (high taxes quoted by the Austins).

They seem to be making little attempt to plan for their future, either in their homes or their communities. They are not future-oriented.

The families seem to share the widespread value in our country--that of concern for material things. For example: the careful record of money spent for clothing kept by Mrs. Lopez, the remarks about the home by the Austins, the feeling that they spent most of their money on clothing. All of these indicate a concern with "outward respectability." Far less attention is paid to the inner person, the education, the personality and the dignity of the individual.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-7. Analysis of Case Study Families[1]

(See Suggested Learning Experience No. 15, p. 18 in Part One)

The following learning experiences are suggestions for using the case studies (pages 69-75), the discussion from the "Forum" (pages 76-79) and the reviews of the economist and anthropologist (pages 80-84). There are numerous ways of using this material to encourage individual or group analysis of the families and their money management, resources, values, etc. The article on pages 89-92 gives a review of background information on resources.

The following chart may be used to compile information drawn from the case studies. The learning experiences outlined on page 86 are suggestions for applying this information.

	What values, goals, aspirations seem apparent?	What conflicts seem to be present?	What information has been left out that you would like to know?	What resources are they using?
The Austins				
The Joneses				
The Lopezes				
The Smiths				
Dick Harrison				
Mary Gallagher				

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-8. Understand Self-Actualization[1]

(See Suggested Learning Experience No. 15, p. 18 in Part One)

* What did these families overlook (or not think about) when they reported their spending plan? Why do you think they omitted these things?

* What additional resources could each of these families use which they do not seem to be taking advantage of at this time?

* How does your evaluation of each family compare with those reviewed by the "Forum" members?

* Dr. Alpenfels (anthropologist) and Dr. Bivens (economist) considered the case studies from their viewpoints. Using one of the families and considering their money management, resources, self-actualization and needs and goals, show how the two points of view can be applied to give a better understanding of this family. What other points of view might also be brought to bear? Are there any statements with which you disagree?

* Based on the facts presented in the case studies, write a descriptive story of one of the families or one of the single persons. If a classmate writes up the same family, compare your story to his. How are your personal values, opinions and background reflected in this exercise? [To the teacher: If you have participated in any sensitivity training, you are probably aware that this technique is used to demonstrate that people impose their own values and past experience to make judgments on a situation.]

Management of resources should be flexible to withstand emergencies that may occur unexpectedly. If you were these families, how would you manage your resources under the following situations:

The Austin home burns, not completely, but with extensive damage to the kitchen and living room.

How can they manage their resources to cope with this emergency until the rooms are repaired? What adjustments will need to be made in their spending? What resources, other than money, will they need to consider using?

Mrs. Jones' welfare payments are re-evaluated and she will receive $30 more per month.

How do you think she will use this additional money? How would you advise her to utilize this increased resource?

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[1]Reprinted by permission from Penney's Forum. New York, New York: J.C. Penney Company, Inc. Fall/Winter, 1969. p. 13.

Mr. Lopez has decided that it would be better for his family to return to Puerto Rico. He will use the land his father gave him to farm.

How will the family react? Do you agree that his decision is the best way for his family to manage its resources?

Dick Harrison's father has lost his job. Dick has made plans to attend college in the fall but does not have the tuition money.

Do you think he can still manage to reach his goal? How?

Bill Smith impulsively buys another painting ($150 this time). Part of this money was to have gone for furniture for their summer home.

What will be Barbara's reaction? (How about role playing this one?)

Mary Gallagher decides to marry the engineer she's been dating. She would like a big wedding (her parents can give her $500 toward it). She would still like to buy the $400 stereo and extensive trousseau.

If you were Mary, what factors would you think through? Can she manage her resources to achieve her goals? What resources and how? Will she need to re-evaluate her goals?

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-9. Using Resources to Achieve Goals & Self-Actualization[1]

(See Suggested Learning Experience No. 7, p. 10 in Part One)

The following is a suggested learning experience to help students identify resources and select goals which will lead a hypothetical young person to self-actualization. The drawings at the bottom of the page are ideas for presenting this information on the bulletin board.

1) Ask a few students to write a story about a young person, mentioning resources, goals, background, etc.

2) Then ask these students to present their story to the class--if there are any questions about this hypothetical person, the class can ask the authors. From this story, the class can then analyze the goals, resources, and what this person wants to become.

3) The following may be placed on the bulletin board:

* A picture of the hypothetical person.
* The goals this person wants to reach (e.g., to be a football coach, to be a husband and father, to be a member of the Town Council, etc.).
* The number of sub-goals needed to achieve each of these goals (e.g., for the football coach it may be--being on the high school football team, furthering his education, etc.).
* Resources needed to achieve each of these sub-goals and the final goal could be listed next to the sub-goals or discussed.
* Alternate routes to achieving the goals could be evaluated considering the resources this person has (e.g., considering his resources, could this person by-pass the second sub-goal and go right to the goal of being a coach; could he by-pass all 3 sub-goals? How?).
* The number of goals and sub-goals and the routes will vary depending upon the individual.

USING WHAT I HAVE TO BECOME ALL THAT I CAN BECOME

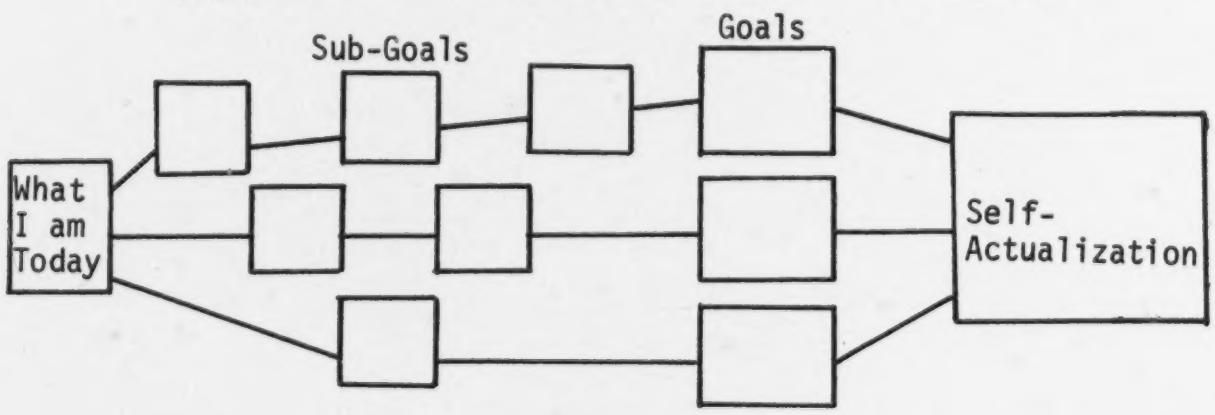

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-10. Resources--What Do We Mean?[1]

Helen D. Turner, Acting Director, Division of Home Economics
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(See Suggested Learning Experience No. 16, p. 19 in Part One)

"Something that lies ready for use or can be drawn upon in an emergency." (Webster New World Dictionary) But for what use? The purpose or need determines the kind of and extent of the resources available. Roughly, resources are tangible like money, property, tools, facilities or intangible like knowledge, skills, information, services.

To accomplish a particular purpose may require the use of both tangible and intangible resources.

MONEY

Suppose you need a new dress and the one you want costs $75. If you have $75 in your purse, the transaction is simple. The resource is money. But suppose you don't have enough cash--do you have a bank account on which you can write a check? Again a simple transaction; a check is used in lieu of money. Your bank account is your resource.

Still want that dress? You may have no checking account and no money but you do have a job with future earnings. Your future earnings become your resource for obtaining the dress if you decide to open a charge account with the store and pay for the dress later. "Credit" is your resource. You can wear that dress before it's paid for, drive a new car, buy a house, make investments that will help you "make millions." Credit must be recognized as one of the very important resources available to individuals, families and businesses.

Money, a bank account or credit then are financial resources for acquiring that $75 dress. However, if none are available to you, there are alternate resources that would help you acquire a new dress. Can you sew well enough to construct a comparable garment?

KNOWLEDGE AND SKILLS

Knowledge, skills and abilities are often overlooked when listing personal or family resources. What should be included are those resources which you or other family members can acquire as well as those skills already mastered.

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If you can paint a house, put a new washer in the bathroom faucet, replace the spark plugs in your car, fill out an income tax form, write a book, paint a landscape, you may find that these skills and abilities are your most important resources. They may be substituted for money in acquiring needs or wants, or they may be the means by which money is obtained.

The use of skills as an alternative resource for acquiring goods or services for which money is usually required hinges on the amount of time and energy one possesses. Both are considered by management experts to be somewhat interchangeable with money.

TIME

Time is a limited resource and the only one which is equally and universally available to all. The decisions one makes as to how it will be spent will determine how far it will go. If you choose to make that new dress rather than spending $75 for it, and you have the skill to do a creditable job, the next question you must ask yourself is, "Do I have enough uncommitted time to accomplish the task?" If not, what adjustments can be made--what can I give up--temporarily or permanently to free time--could someone else take over part of my responsibilities? In this case you are drawing on someone else's time resource to supplement your own. Most of us are guilty of wasting this resource in small amounts, and we constantly complain of not "having time" to read, to write friends, to take part in community activity, etc. A friend of mine never wastes minutes--the brief waits for a friend to appear, a meeting to begin or her turn at the hairdresser are used to dash off brief notes to friends all over the world. She doesn't bother with long letters but keeps close contact with frequent short communication.

ENERGY

Energy as a resource is a variable--available to all but in differing amounts. Some seem endowed with greater amounts of energy than are others. Illness, loss of sleep, emotional crises and depression among other things can temporarily reduce one's natural store of energy. Age and chronic illness permanently reduce it. The amount of energy one has (or thinks he has) has a direct effect on his use of time. A person with a lot of energy accomplishes more in a given period of time. He works faster, can continue longer without rest and moves quickly from one task to another.

Both time and energy are involved in most decisions about use of money. Also, judicious use of time and energy may determine how much money we have.

COMMUNITY RESOURCES

A discussion of what is meant by resources can't overlook the community in which we live. Depending on its size, the resources upon which we can draw are almost unlimited. Some we must pay for--thus using one resource to acquire another. Some are "free" in that there is no direct dollar cost; for these we share in the tax dollars which pay the cost. Some of these resources may be used instead of personal time and energy such as laundries, drycleaners, car washes and restaurants.

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Others provide education--knowledge and skills for children and adults--these include public schools, community colleges, vocational schools, universities, public libraries, trade schools, Cooperative Extension Service.

Community resources important to all are the health services and facilities available--doctors and dentists, hospitals, clinics, public health services.

Museums, art galleries, concerts and theaters are resources which provide both entertainment and cultural experiences.

Police and fire departments and city sanitation departments are invaluable resources for our health and safety.

We use public transportation (buses, airlines, railroads, taxis) with no real thought of its value as a resource. It "lies ready to use when needed"--for business, pleasure or in an emergency.

Or consider the magnificent resource of the whole system of modern highways on which we operate our private automobiles to get us from place to place. Over them goods are carried in trucks to fill stores and markets. Of course you and I pay for highways with our tax dollars but how would you like to build your own or drive over the paths made by earlier travelers?

If it's entertainment or recreation you want, consider the many parks, playgrounds, tennis courts, swimming pools, spots for fishing, camping, hiking, picnicking that are reasonably accessable to most of us.

Commercially provided are sporting events, bowling alleys, golf courses, movie theaters, live theaters and a myriad of other recreational opportunities.

NATURAL RESOURCES

Then there is that whole area of "natural resources" upon which we draw as a nation. Some are held in common by all of us in that they are government-owned; others are individually owned and exploited, often with government control. The land which grows the food we eat, the forests, the lakes and streams, the oil and minerals underground, the wild birds and animals that help provide the balance of nature as well as a continual source of pleasure are invaluable to us all.

The present programs to clean up and to prevent future pollution of air, water and land are an example of how important these natural resources are to us and to generations to follow. One has only to drive out on a Sunday afternoon to observe the appalling litter that is fast obliterating the beauty of the landscape and filling brooks and streams.

MISCELLANEOUS

How does the above begin to cover all resources? Not covered are assets

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such as life insurance, property, savings accounts and investments. The brightness of a midsummer day, the beauty of a spring morning, the quiet of a pine forest and the joy of a mountain stream probably don't count on an economist's list of resources, but I can't leave them off. They go along with friendship and the love and confidence of family.

And finally resources include the inner strengths in each of us--courage that forces men to move forward in spite of danger, perseverance, emotional stability in a crisis, kindness, courtesy and respect. Some are inherited--basic intelligence and aptitudes are examples. Others such as our values, attitudes and motivations are a part of our environment. Intangible as they are, those resources within us probably determine how much we acquire and how we use all other resources available.

We feel rich indeed when we list personal or family resources in terms of the above definition.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-11. Managing Resources to Achieve Goals[1]

Dr. Helen M. Thal, Assistant Director
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(See Suggested Learning Experience No. 16, p. 19 in Part One)

Any reader of Peanuts knows Charlie Brown, and has observed him in his role as manager. His anguish and frustrations are only too familiar as he sends his baseball team out to the diamond. His goal is clearly defined and absolute--to win--even once. He has identified his resources, that motley band of players including reluctant Snoopy in the outfield, crabby Lucy as shortstop, and Linus, Peppermint Patty and Schroeder completing the lineup. Charlie Brown, on the pitcher's mound, starts each game with his plans, organization and strategy well in mind, only to be thwarted by the ineptness of the outfielder or the clumsiness of the shortstop. The result is another no-hit game. Always it is Charlie Brown who must bear the shame and humiliation. He would be the first to agree that managing resources to achieve a goal is no ordinary run-of-the-mill chore; it's hard work, takes brains and there is no end to the unexpected events that can happen. It was ever thus for managers.

Three singularly important concepts are involved here, and each is sufficiently complex in and of itself: management, resources, and goals. Management, of course, implies the presence of the other two, so that actually we are talking about the function of management. If no goals are present, or if no resources exist, no management is called for.

It would appear, therefore, that management is the concept about which we are presently concerned. If that be so, we are further concerned with decision-making and resource allocation, both significant components of management.

Because management takes place only after goals have been identified (or problems defined), the first set of decisions relates to the goals themselves. To know what it is we are aiming for, and to have these objectives well in mind, gives purpose and meaning to everything else we do toward their accomplishment. This is no mean trick, because most individuals and families have multiple goals, and even when given an order or priority, we find often that goals are in conflict with needs or with immediate wants or emergencies. Unlike Charlie Brown, whose goals are so sharply identified, so clean in their simplicity, so uncomplicated and without intervening con-

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[1]Reprinted by permission from Penney's Forum. New York, New York: J.C. Penney Company, Inc. Fall/Winter, 1969. pp. 18-19.

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flicting goals, most of us engaged in goal achievement meet our first frustration at this point of decision-making: deciding which goals come first--or to put it another way--categorizing our wants and making some compromises.

There would be no need for this kind of mental exercise if our resources were unlimited. Here is the point at which Charlie Brown is undone. His resources are limited in every way you might measure them: he doesn't have enough members on the team; none of them are notably skilled in the art of baseball; their interest and enthusiasm for the game leave something to be desired. No matter how Charlie Brown shifts his players around (allocates his resources), there just are not enough there to win the game.

It seems less than fair to mark Charlie Brown down for poor management. He uses what he has to try to get what he wants, but what he has just isn't enough. Is it possible that his goal is unrealistic? With his available resources, would he do better to turn to basketball or hockey? At least he would have enough players to complete a team.

Goal achievement, then, begins with identification of goals that are realistic and with a realistic determination of the available resources. One of the causes among real life people for failure in management is our tendency to be over ambitious in our goals. You may have experienced this yourself at one time or another; you set out to save a given amount in a specified period of time, only to discover that you can't do it because there are too many other demands on your income; demands that you had failed to consider initially.

Skillful goal setters and achievers have learned from experience how to identify their objectives, and have given themselves a series of sub-goals that eventually contribute to final accomplishment of the major goal. The intervening successes in achieving the sub-goals lend impetus and encouragement. Any small victory is a reward.

Management begins with decisions related to one's goals. Next, the manager considers his resources and another series of decisions must be made. One thing we learn very quickly as far as resources are concerned is that they are limited. There never is enough time; or the skills needed to do a job are inadequate; or all the equipment to facilitate the job is not available or not in working order, or not adequate for the task at hand; or funds are short. Now the manager really knows what it is to be frustrated. This may be the very point at which he throws in the towel and gives up, or turns for help to a credit agency, if it's a money matter, or to a community agency that can provide the means to help him over the hump.

Knowing how to utilize these limited resources to best advantage takes practice. Doesn't everything? It also takes patience. And it demands one's attention and honest appraisal. To overestimate (over-measure) the available resources, or to add another set of demands to an already overburdened resource inventory, will lead to nothing. But it is a trap we have all fallen into at one time or another. We overestimate the time available or understimate the time needed to do the task; we make a financial commitment at a time when our income is already overtaxed.

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That resources are interchangeable is one characteristic that can help us enormously as we make decisions about their use or allocation. It is possible to use one's skill or the special talents of other family members to redecorate the living room, thus saving some money. If, however, time is at a premium or skills are limited, then money is used to secure skills and services of somebody else. That money can be replaced by using other resources to accomplish other tasks. Too often in a prosperous society we assume that money will do everything and, consequently, we get out of the habit of putting other resources to work.

Because money is so often the resource we think of first, and because so many family and individual goals are dependent on income, it deserves special attention.

Managing money begins with knowing what our funds must do. It's a matter of goals again. Right away we recognize that a certain amount of money is necessary to meet the needs of day-to-day living. Food, clothing and shelter must be provided. We might classify medical and dental care in this set of needs, and the costs involved in operating the household. But what may be a need for one household may be a want for another, so further classification infringes upon family goals and values. Beyond the specific needs, however, are the special wants that exist. Some of these are short-range--a vacation, or a record album, or a guitar or a car. By careful planning these wants can be realized within the foreseeable future.

Another set of wants also exists in family life. These wants may not be realized for many years--owning a home, sending children to college, owning a vacation home, creating a retirement income. Even if these wants, which may become needs at a later time, are designated for the future, the money manager must consider them and make provision for them years in advance.

In making that provision, he is committing a portion of today's income for use at a much later time. At the same time, he may be committing future income to meet the needs that exist at the present. For example, any purchase of goods on a credit plan is a commitment to use income not yet earned. The purchase of a car might involve monthly payments for the next 24 months, which means 24 payments of a fixed amount out of income yet to be earned. Any time that such commitments are made, the family or individual will have just that much less per month for other things.

In setting goals, whether short or long range, the manager or management team must understand that it is not simply the use of this week's income that is being planned, but that the anticipated earnings of a lifetime are involved. The style and quality of life are at stake. Goal setting, when viewed in this way, is a rather sobering piece of family business, for decisions are made as to what you want to achieve, what you want to become and what you want for the other family members.

Once goals have been determined, and these will be multiple, the process of handling the money can be fairly simple. Well, maybe not so simple at first, but in time and with practice it does become easier. It's a skill that can be learned, a fact which should give us some comfort and reasurance.

* Know exactly how much money you have to work with each week or each month. Just exactly what is your take-home pay? What other money comes into the family coffers--rents, interest, payments to other family members, etc.?

* Know your fixed obligations that must be paid on a regular basis. These will include your rent or mortgage payments, any installment loan payments, insurance premiums, pledges or commitments to a church or charitable organization, taxes--in short, any and all payments you make on a regular basis and in a fixed amount. Your commitments to future goals will demand regular set-asides, and these should be included as a fixed expense; otherwise you may never have the satisfaction of achievement.

* Know your flexible expenses. Here you become concerned with the day-to-day living costs that are yours to control. Your food and clothing bills are flexible in that you can set your own limits according to your own standards and your family needs; such operating costs as the telephone bill is manageable, personal allowances for family members, household operating costs, personal upkeep--all of these, while important, are controllable.

* Know that emergencies are a fact of life. So be prepared. An emergency fund saves the family budget. This will be the fund you draw on when the hot water heater bursts, or the garage door is blown off in a blizzard or when some other minor disaster or momentous event occurs. It is helpful to look on this not as a disaster fund, but as an opportunity fund, providing the cash to take advantage of a particularly attractive sale, or to permit participation in an event that contributes to professional growth and development.

These are the four elements that make up the money management plan that will lead eventually to goal achievement. Each of these is related, one to the other. When one element of the plan is changed, the change is reflected throughout the plan. Consider, for example, what will obviously happen if an additional fixed obligation is assumed: corners will have to be cut in other areas. Or if income is increased, it will be reflected throughout the plan, or vice-versa.

The serious money manager, intent on achieving a series of goals, acquires four skills that improve her operating plan and hasten the achievement of goals.

* Skill in the market place. Careful buying habits, comparison shopping, buying what is needed, avoiding impulse purchasing as much as possible, knowing where to go for what in order to secure value for your dollars--all these add up to money saved.

* Skill in thrift. It's almost an old-fashioned notion--thrift. But when considered as a part of the money management plan, it extends the dollar value of one's income. Actually, thrift is a form of conservation. It is the conserving of one's goods, which means caring for them, getting as much

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use out of them as possible so as to avoid replacement frequently. It also means a systematic plan for saving money. The key to any savings plan is its regularity, not the amount. No matter how modest the set-aside is in amount, if tended to each week or each month, the rate of growth will be astonishing.

* Skill in using consumer credit. With prevalence of credit cards and with the countless opportunities available for buying now and paying later, it is not surprising that families or individuals find themselves in trouble. It is such a tempting way to get what you want when you want it. As every school boy knows (or we hope he knows!), consumer credit is not a free commodity. When the time comes to use it, therefore, it is well to know (a) that the purpose of using it is worth the added cost; (b) that the credit agency of your choice offers the most favorable rate; (c) that you are ready and willing to commit yourself to an extended time period during which payments will have to be made.

* Skill in using financial institutions. What institutions offer you the most favorable interest rates on your savings? Which kind of checking account is most advantageous for you? Which lending institution offers the least expensive loan plans? What life and health insurance plans are most suitable for your needs? What institution in your community can provide you with the most favorable mortgage plan? Where should you turn for help in planning an investment program? The answers to these questions lend support and help to the management of financial resources.

Knowing the four elements of a management plan, and acquiring the special skills as suggested here, are the principles that will bring about satisfaction and lead to goals that are important to the family. But one further understanding will be of special help if acquired early in the game. Know yourself and your family. Although money is an inanimate commodity, it is tied to the intimate on-going activities of the family. In managing it, you soon realize you are managing other human beings, including yourself.

To secure the most utility and satisfaction from your dollars, therefore, you must be honest in your own self-analysis and understanding. We each have our whims, our weaknesses, our self-interests and our tendencies for self-indulgence. On the other hand, we each have our strengths. We can look ahead and see where we are going; we are confident about our futures; we are capable of self-direction; we are concerned about others; we want to contribute to a better community. All of these aspects of our individual personalities are reflected in the management of our financial resources.

Charlie Brown, manager, experiences little satisfaction as a result of his efforts. His gain has been his insight into the frailties of the human race, and his philosophical understanding of his own financial practices: "Happiness is thirty-five cents for the movie, fifteen cents for popcorn and a nickel for a candy bar."

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-12. Help!![1]
(Case Situation)

(See Suggested Learning Experience No. 20, p. 19 in Part One)

Judy, a busy career girl, dashed home from the office at five o'clock Friday afternoon. It was a hot, stickly day; and her numerous appointments left not a moment to spare. Judy was tired and exhausted. In fact, she had barely had time to swallow her scanty lunch of vegetable soup and a glass of milk.

"What I need," Judy thought to herself, "is a good, hearty, nutritious dinner to boost me on the way, but I've accepted a date at seven o'clock for the Firemen's Ball and I must shower and freshen up. I know we won't be eating out this evening, either."

After rummaging around in the kitchen, Judy found she had these foods on hand:

In the Refrigerator	In the Cupboard
Meats and meat substitutes:	Flour
Chuck roast	Sugar
Ground beef	Spices
Eggs	Spaghetti
Chicken	Macaroni
Dairy products:	Wheaties
Milk	Coffee and tea
Cheese	Rice
Butter	Bread
Fresh fruits and vegetables:	Canned peas
Apples	Canned pork and beans
Peaches	Canned chicken noodle soup
Carrots	Canned fruit cocktail
Lettuce	Box of Jello
Tomatoes	Instant vanilla pudding
Green beans	Chocolate cake mix

"How I will ever manage and still have my apartment in order by the time Jack arrives leaves me in a real quandry," sighed Judy with a questioning look in her eyes.

What Now?

Judy's neighbor, Sally, was taking care of a five-year-old niece on the evening of the Fireman's Ball. Her neice was an active little girl who loved to play with dolls--walking dolls, talking dolls, girl dolls, boy

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[1]Reprinted by permission from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Division of Home Economics Education, University of Illinois, Vol. XI, No. 6, Spring, 1967-68. pp. 429-430.

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dolls, dolls whose eyes opened and closed, dolls that said "Ma Ma," old dolls, new dolls--just any kind of dolls, so Sally decided to get one of her dolls out of the storage closet.

Just as she was reaching her favorite old Raggedy Ann doll from the very top shelf, the chair on which she was perched slipped from under her. Sally tumbled to the floor and broke her ankle. At least, it sure felt that way. Immediately, she limped to Judy's apartment and frantically knocked on the door.

"Oh, Judy," she said when Judy answered. "I just fell and I know I broke my ankle. No one is home except my niece, and I must see a doctor. Could you possibly take me?"

It was already 5:15 and Judy knew she had to be ready to go out by seven. She had just taken her shower, slipped into her lounge clothes, and was ready to start dinner--but Sally was in distress and needed help immediately. All the physicians would have gone home for dinner, and the nearest hospital was three miles from the apartment. It would take at least an hour to get there and back during the rush hour. And Sally's niece--her parents lived eight or ten miles away.

"Oh, what shall I do; oh, what shall I do?" thought Judy.

DIRECTIONS: Think about what you would do, if you were Judy, to adjust to this emergency.

Write a detailed time plan--beginning at 5:00 p.m. and ending at 7:00 p.m. of what you would do, if you were Judy. Before beginning the plan, answer the following questions:

1. What is/are Judy's specific goal/s for this time period?

2. What, according to this description, does Judy seem to value?

3. What resources does she have available to her?

4. What might she fix to eat?

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IV: Resources
IV-13. My Resources

(See Suggested Learning Experience No. 23, p. 19 in Part One)

DIRECTIONS: Under each main topic list the resources you feel you have available at the present time. Circle the ones you would like to obtain or make better use of in the near future.

MONEY:

TIME:

ENERGY:

KNOWLEDGE:

ATTITUDES:

TALENTS AND INTERESTS:

THOUGHTS AND FEELINGS:

ABILITIES:

PAST EXPERIENCES:

COMMUNITY FACILITIES:

PRIVATE FACILITIES:

SKILLS:

AVAILABLE GOODS AND SERVICES:

INSURANCE:

OTHERS:

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT V: Decision-Making Process
V-1. Pre-Test and Post-Test on Decision-Making

(See Suggested Learning Experience No. 1, p. 23 in Part One)

DIRECTIONS: List below one of the most recent decisions you had to make. Use the form below to describe the decision you made.

1. The problem I faced was:

2. Several alternatives I could have chosen were:

3. The consequences of each alternative might have been:

4. The alternative I selected was:

   The reason I selected it was:

5. I was willing to accept the consequences of my decision because:

6. The resources I used in making the decision were:

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT V: Decision-Making Process
V-2. Diagram of Decision-Making Process

(See Suggested Learning Experience No. 8, p. 24 in Part One)

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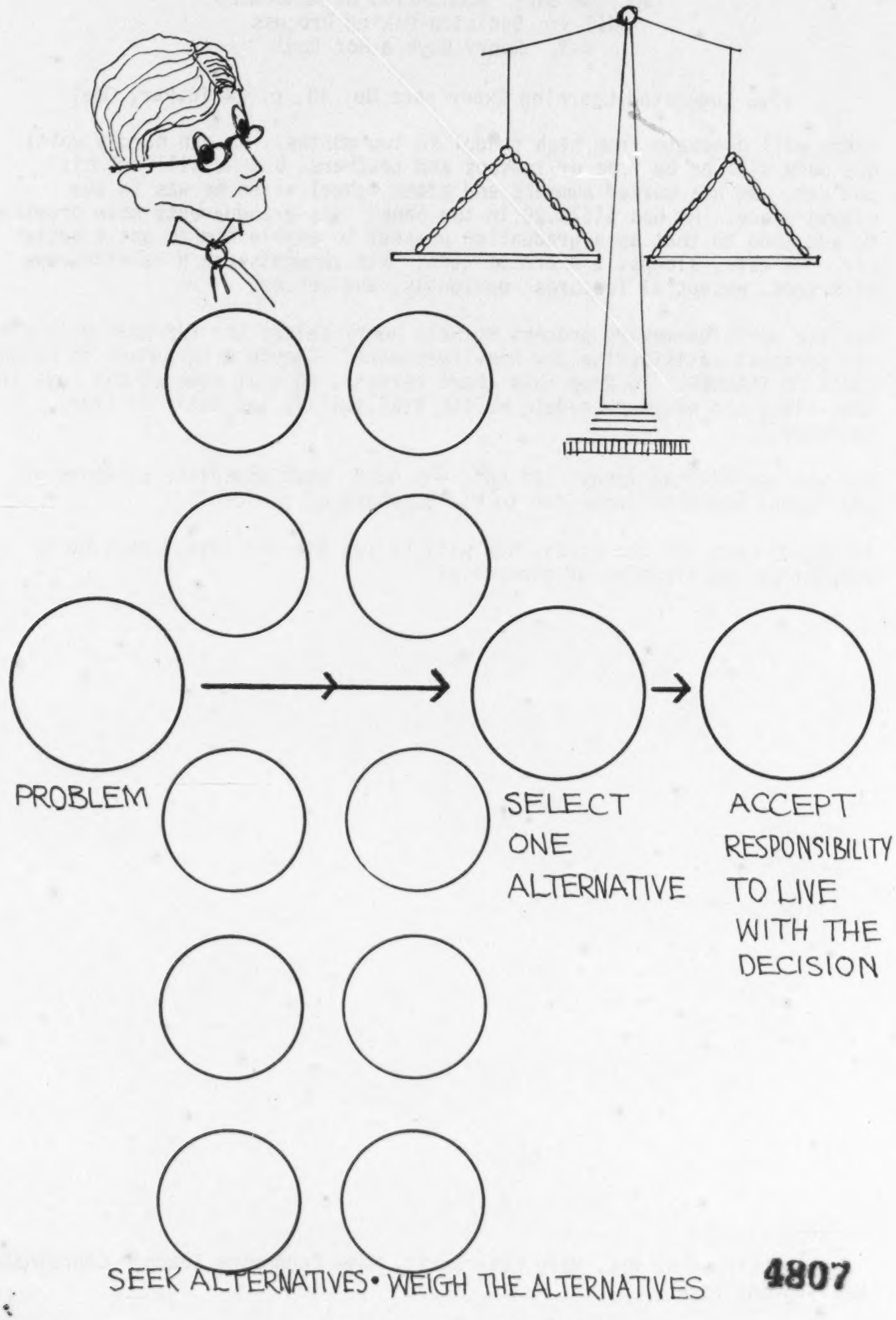
PROBLEM
SELECT ONE ALTERNATIVE
ACCEPT RESPONSIBILITY TO LIVE WITH THE DECISION
SEEK ALTERNATIVES • WEIGH THE ALTERNATIVES

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT V: Decision-Making Process
V-3. Henry Buys a Hot Rod[1]

(See Suggested Learning Experience No. 10, p. 24 in Part One)

Henry will graduate from high school in two months. He can hardly wait! Not only will he be free of lessons and teachers, but he will own his own car. He has worked summers and after school since he was in the eighth grade. He has $1573.29 in the bank. His grandparents have promised to add $500 to that as a graduation present to enable him to get a better car. He eats, sleeps, and dreams cars. His thoughts are a kaleidoscope of brands, essential features, optionals, and prices.

Use the decision-making process to help Henry select the car that will give him greatest satisfaction for his investment. Complete the chart on p.105. [NOTE TO TEACHER: To keep this chart current, consult some of the boys in your class who keep up-to-date on the availability and costs of items included.]

Did you use all the money? If not, why not? What immediate expenses do you expect Henry to incur due to his purchase of the car?

If you did use all the money, how will he pay all the costs involved in completing the transfer of ownership?

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[1] Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

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HENRY'S HOT ROD[1]

Henry's Problem:	Brands and Varieties Available	Products That Satisfy His Needs	Evaluation by Standards	Decision
Which car to buy	(list at least five)	Brands		
Resources:	Price Range	Price		
$2273.29	$2000-$2200 (for used cars, three or four years old)			
	Essential Features	Essential Features		
	Standard transmission 4 speed Disc brakes Heavy duty suspension Posi-traction			
	Optional Features	Optionals		
	Floor Shift $75 Mags $150 Racing Tires $200 Tape Deck $75 Hood Scoops $25 Air Foil or Spoiler $25			

[1]Adapted from Decision Making for Consumers. New York, New York: J. C. Penney Company, Inc.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT V: Decision-Making Process
V-4. Mrs. Howe Goes to the Circus[1]

(See Suggested Learning Experience No. 11, p. 24 in Part One)

Mrs. Howe is a homemaker with two daughters, 8-year old Amy and 12-year old Sue, who want to to to a town 40 miles away on Saturday afternoon to a circus. The afternoon performance begins at 3:30. Mrs. Howe is expecting guests on Sunday. She must do the following household tasks before she can take the girls to the circus:

wash and dry two loads of clothes
vacuum all the floors
dust the furniture
mop the kitchen and bathroom
change linens on two beds
prepare lunch
prepare at least part of the food for Sunday dinner
leave something started for supper
burn the trash
sweep the back porch
clean the lavatories in the bathroom

Mrs. Howe has these major appliances: washer, dryer, vacuum cleaner, electric range with automatic controls, refrigerator, and dishwasher.

Using the decision-making process, follow the outline below to help Mrs. Howe reach her goals.

A. State her central goal.

State her satellite goals.

B. What are her resources in addition to the appliances listed?

C. What are her limitations?

D. Outline a work plan for her, listing tasks in the order that you think would make most efficient use of her time, energy and other resources.

In this outline indicate (1) the jobs that can be dovetailed, (2) jobs that each of the girls could do, and (3) specific menus you would prepare for lunch, supper, and the company dinner. List Mrs. Howe's tasks and those of each girl separately.

E. How did your plan differ from those of your classmates? How would you explain these differences?

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[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT V: Decision-Making Process
V-5. Bulletin Board on Decision-Making

(See Suggested Learning Experience No. 12, p. 24 in Part One)

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STEPS TO DECISION MAKING

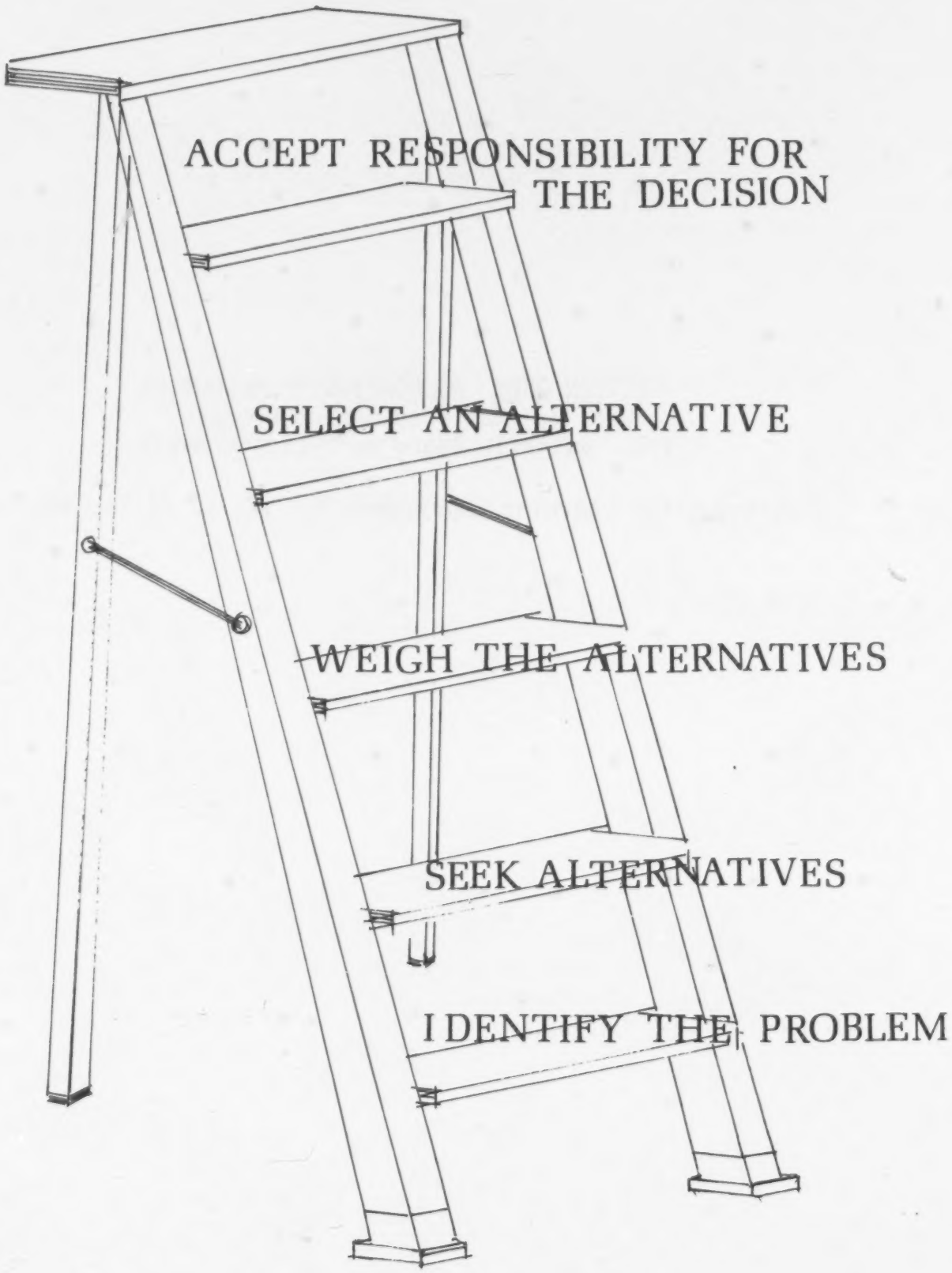

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT V: Decision-Making Process
V-6. Game of Decision-Making[1]

(See Suggested Learning Experience No. 17, p. 24 in Part One)

Select a word or phrase from the list and write one of these in each of the 20 squares of your Decision-Making Game (see example on p. 111). As the teacher gives definitions of the terms, put a dried bean in the square where you have written the term associated with that definition. When a straight line of beans is formed in any direction, call out, "Decision-Making Process." The square which says, "Decision-Making Process" is a free square on all cards.

1. Orderliness
2. Religious faith
3. Standards of living
4. Level of living
5. Short-term goals
6. Long-term goals
7. Security
8. Transportation
9. Education
10. Recreation
11. Retirement
12. Skill
13. Knowledge
14. Interest
15. Attitude
16. Time
17. Resources
18. Family life
19. Beauty
20. Power
21. Truth
22. Purity
23. Goodness
24. Heritage
25. Goals
26. Values
27. Thrift
28. Money
29. Mental health
30. Physical health
31. Equality
32. Freedom
33. Family life cycle
34. Prestige
35. Economy
36. Environment
37. Leisure
38. Aesthetics
39. Beginning family
40. Expanding family
41. Contracting family
42. Old-age family

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[1]Developed by Mrs. Beverly Fern Alexander, Home Economics Teacher-Coordinator, Big Spring, Texas.

STUDENT GAME SHEET FORM

		Decision-Making Process	

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Leisure	Standards of Living	Freedom	Short-term Goals	Family Life Cycle
Aesthetics	Interests	Goals	Knowledge	Money
Skill	Prestige	DECISION-MAKING PROCESS	Beginning Family	Equality
Mental Health	Aesthetics	Economy	Environment	Heritage

EXAMPLE OF STUDENT GAME SHEET

SECTION ONE: ALLOCATION OF RESOURCES
UNIT V: Decision-Making Process
V-7. Case Analysis on Decision-Making[1]

(See Suggested Learning Experience No. 21, p. 26 in Part One)

OBJECTIVE: Analyze decisions and make rational decisions concerning real-life situations.

The Story of the Trapp Family Singers. Maria Augusta Trapp.

I. A. Describe the interrelatedness of values, goals, and standards.
   B. Explain the role of values in determining personal and family behavior.
   C. Identify basic values held by the Trapp Family Singers.
   D. In what way did the values you cited affect the goals and standards of the Trapps?
   E. Give examples of major goals held by the Trapp family and indicate the values from which they stemmed.
   F. Provide examples of values that were in conflict.

II. A. Explain how standards are determined.
   B. Provide one example from Maria's experiences illustrating how environment and economic conditions influenced her standards.

III. A. Classify Maria's resources into human and material categories.
   B. Select a major goal of Maria's and analyze according to:
      (1) What human resources were available to help accomplish this goal?
      (2) What human resources were available but not used?
      (3) Why do you perceive that these resources were not used?
   C. Using the same goal as above, answer the following questions:
      (1) What material resources did the goal require?
      (2) Were there any material resources that were not used?
      (3) Why do you think these resources were not used?
      (4) Give three examples of how Maria substituted human resources for her lack of material resources.
      (5) Suggest possible ways that Maria might have expanded her resources.

IV. A. Explain the following statement and cite examples from Trapp Family Singers illustrating it: "A value is always important to the person who holds it; it is desirable and satisfying; it has the ability to develop a self-creative way; and it tends to

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[1]Adapted from case study developed by Mrs. Kyle Jane Coulter, Department of Home and Family Life, Texas Tech University, Lubbock, Texas, in cooperation with Dr. Camille Bell, Chairman, Home Economics Education, Texas Tech University, Lubbock, Texas.

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endure. It is a concept of the desirable, explicit or implicit, which governs our choice of methods, modes, or goals of action."[2]

B. Identify three major decisions made by Maria.

C. Provide examples of several minor decisions which stemmed from one of the major decisions you cited.

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[2]Gross, Irma H. and Crandall, Elizabeth Walbert. Management for Modern Families. 2nd edition. New York, New York: Appleton-Century-Crofts. Division of Meredith Publishing Company, 1963. p. 22.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VI: Management Process
VI-1. Steps in Management Process

(See Suggested Learning Experience No. 3, p. 29 in Part One)

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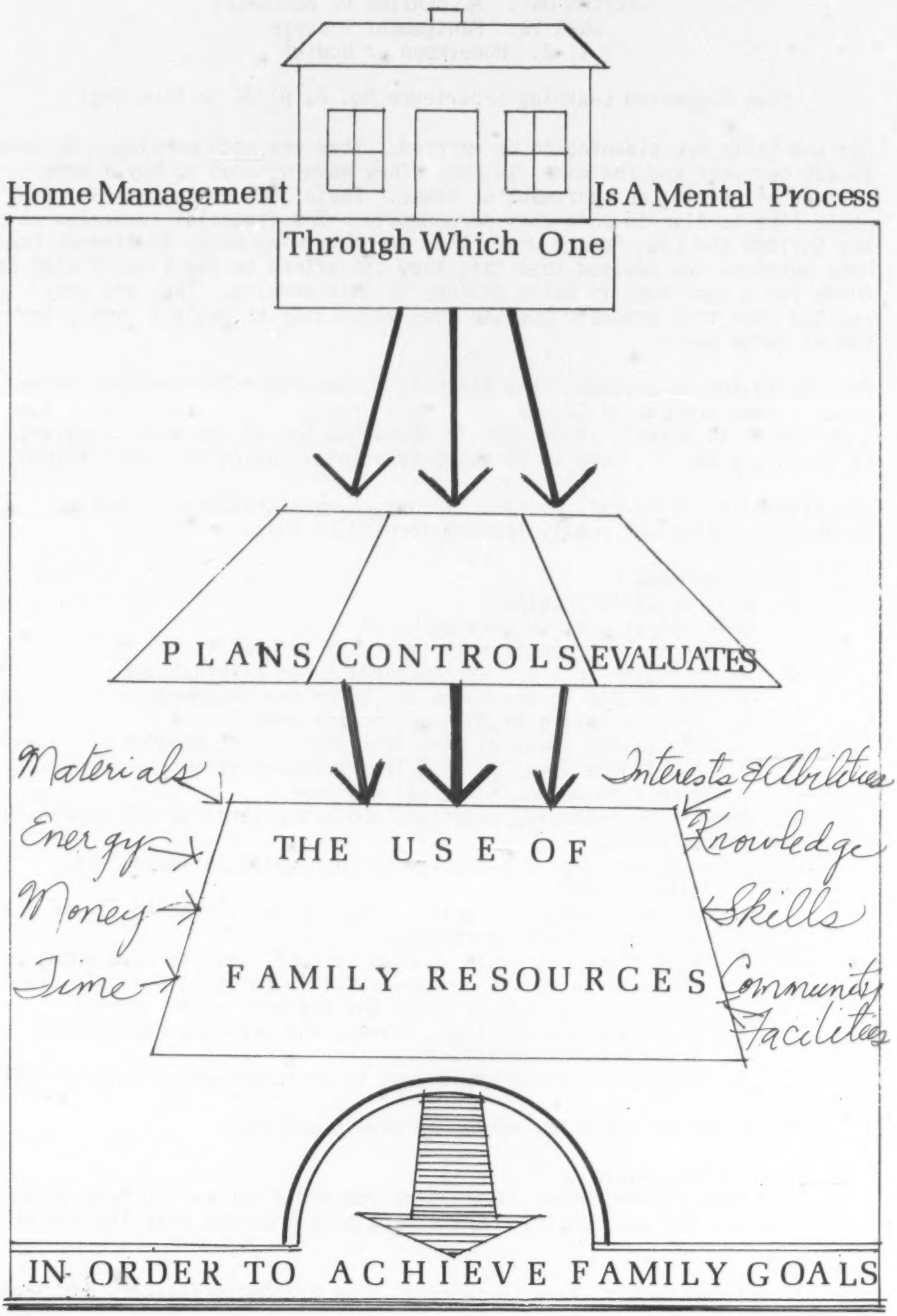
Home Management Is A Mental Process
Through Which One
PLANS CONTROLS EVALUATES
Materials
Energy
Money
Time
THE USE OF
FAMILY RESOURCES
Interests & Abilities
Knowledge
Skills
Community Facilities
IN ORDER TO ACHIEVE FAMILY GOALS

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VI: Management Process
VI-2. Honeymoon or House[1]

(See Suggested Learning Experience No. 6, p. 30 in Part One)

Jim and Sally are planning to be married. They are both working. He makes $6,000 per year and she makes $4,800. They have decided to buy a home instead of renting an apartment or house. Their jobs are secure and they would like to live in this city permanently. The financial counselor at the Savings and Loan Agency where they are borrowing money to finance their home purchase has advised them that they can afford to pay $110 or $120 per month for a home even if Sally decides to quit working. They are very excited over this prospect because they would like to begin a family in two or three years.

Jim has $3,000 in savings. The financial counselor tells him that if he makes a down payment of $2,000, he should arrange to pay the balance over a period of 30 years. If Jim should decide to pay $3,000 down, however, he could pay for his home in 25 years at a total saving of almost $8,000.

Jim planned to spend part of this savings on an extravagant Caribbean honeymoon. Sally was really looking forward to this.

I. Planning Phase
   A. What is Jim's problem?
   B. What values does he seem to hold?
   C. What goal is probably most important to him?
   D. As he begins to plan, he considers these alternatives:
      1. Pay $2,000 on the house and go on the honeymoon.
      2. Pay the entire $3,000 down on the house.
      3. Pay $2,500 down; go on a less extravagant honeymoon.
      4. Pay $2,000 down; go on a less extravagant honeymoon and buy some furnishings for their new home.
   E. Answer the following questions about any three of the foregoing alternatives.
      1. What would be the results or outcome of following this alternative?
      2. Would he reach his goal? (The one you stated in C)--if not, what goal would he reach?
      3. What resources would he have to use? Does he have enough of these resources to be successful in carrying out this plan? Would the outcome be worth the resource cost? Why?
      4. How might his feelings, values, and previous experiences influence his decision?
      5. What other steps would need to be taken--or decisions made?

   Which one do you think he should choose and why?

II. Controlling Phase
   You have decided which alternative you would choose and have given reasons for your choice. Anticipate some problems that Jim and Sally

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[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

may yet face before their marriage, and arrive at the small decisions you think they should make to cope with these problems and still reach their goals. You might suggest some other expenditures they may wish to make to help them reach appropriate decisions regarding these expenditures. One of them may require medical care, or some other emergency may arise that they had not anticipated. Suggest the controlling decisions you think they should make in each instance.

III. Evaluating Phase

Assume that they have carried out the decisions they made. Do you think their resources were used effectively?--with satisfaction? How have the decisions that were made and carried out in this plan affected future decisions or created additional decisions? Do you think they would be satisfied with the consequences of the decisions made in this situation? Why?

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VI: Management Process
VI-3. Management Roulette[1]

(See Suggested Learning Experience No. 7, p. 30 in Part One)

PLAYERS NEEDED:

Four students play individually at each table. A dealer is chosen in each group. The teacher is final judge of any answer about which there is a question.

MATERIALS NEEDED:

Thirty-two cards (about 3 x 5) for each group of four players with one management term written on each card.

OBJECT OF THE GAME:

The object of the game is to score as near 88 points as possible when completing two hands of Management Roulette.

PREPARATION FOR GAME:

1. The thirty-two cards are divided into two equal stacks called Group I and Group II as illustrated on p. 119.
2. Note that one term in each group is repeated; for example, in Group I the term "Consumer" is used twice.
3. Each group also contains a series of three related management terms; for example, Group I contains three terms related to decision-making. Mark each of these three cards "Series Card."

RULES FOR GAME:

1. Two hands are played in each game. The first hand is played using cards from Group I; the second hand is played using cards from Group II.
2. For the first hand, deal each player four cards from Group I.
3. Each player looks at the cards in his hand.
4. Players should use some means of determining which player goes first. All play moves to the left or counterclockwise around the table.
5. After looking at the four cards, each player in turn will place a card from his hand on the table in front of him, face up, as he does one of the following:
   a. Defines a management term on his card (5 points)
   b. Gives the antonym of the term on the card if this term has appeared in this game before (10 points)
   c. Defines a term which is the first part of a series listed on the card (5 points)
   d. Defines a term which is the second part of a series (10 points)
   e. Defines a term which is the third part of a series (20 points)

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[1] Developed by Mrs. Luanna Price, Graduate Research Assistant, College of Home Economics, Texas Tech University, Lubbock, Texas

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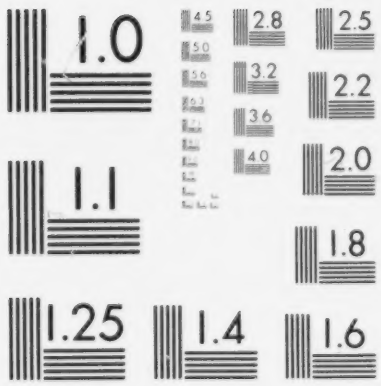

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

6. If the player gives the incorrect answer, he forfeits the card to the player on his left. The forfeited card is then placed face down on the table until all other cards have been played.
7. Play continues until all cards in players' hands have been played or forfeited.
8. Each player in turn then has one chance to correctly define or give the antonym of the forfeited cards in his stack (1 point for each correct definition or antonym).
9. Each card is now discarded, whether or not the term is correctly defined.
10. Play continues until all cards are played.
11. The second hand is played using cards in Group II.

SCORING SYSTEM FOR GAME:

5 points for correctly defining a management term
10 points for correctly defining the antonym of a term
10 points for correctly defining the second term in a series
20 points for correctly defining the third term in a series
1 point for each correct definition or antonym of forfeited card (series cards also worth only 1 point now)

MANAGEMENT TERMS FOR CARDS

Group I	Group II
Series Card: Decision-Making: Planning	Series Card: Types of Credit: Installment Buying
Series Card: Decision-Making: Controlling	Series Card: Types of Credit: Charge Accounts
Series Card: Decision-Making: Evaluating	Series Card: Types of Credit: Credit Cards
Level of Living	Decision-Making
Management	Needs
Goals	Wants
Consumer	Evaluate
Alternatives	Resources
Choose	Impulse Buying
Consumer	Income
Short-term Goals	Money Management
Plan	Long-term Goals
Human Resources	Income
Non-human Resources	Standard of Living
Standard	Budget
Fraud	Values

4824

4823

SECTION ONE: ALLOCATION OF RESOURCES
UNIT VII: Budget or Spending Plan
VII-1. You and Your Money

(See Suggested Learning Experience No. 3, p. 33 in Part One)

Please fill in each of the following blanks which describes you.

(DO NOT SIGN YOUR NAME.)

1. Where do you get the money you have to spend:
   a. Earn it....._____
   b. Allowance from parents....._____
   c. Receive doles....._____
   d. Other....._____

2. How do you buy:
   a. Cash....._____
   b. Lay-a-way....._____
   c. Credit (charge account)....._____

3. For what things do you use the money you have to spend:
   a. Clothing....._____
   b. Food....._____
   c. Recreation....._____
   d. Car Expense....._____
   e. Gifts....._____
   f. School Expenses....._____
   g. Donations....._____
   h. Savings....._____
   i. Other....._____

4. Who helps decide how you use the money you have to spend:
   a. Parents....._____
   b. Friends....._____
   c. Decide Alone....._____
   d. Books, Magazines, etc....._____
   e. Other....._____

5. Do you make a plan for spending.....Yes_____ No_____

6. Do you keep a record of your spending.....Yes_____ No_____

7. Amount of money you have to spend per week/month....._____
   Specify which it is.

8. What is your biggest problem in relation to money?

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VII: Budget or Spending Plan
VII-2. Advantages of Planned Spending

(See Suggested Learning Experience No. 13, p. 34 in Part One)

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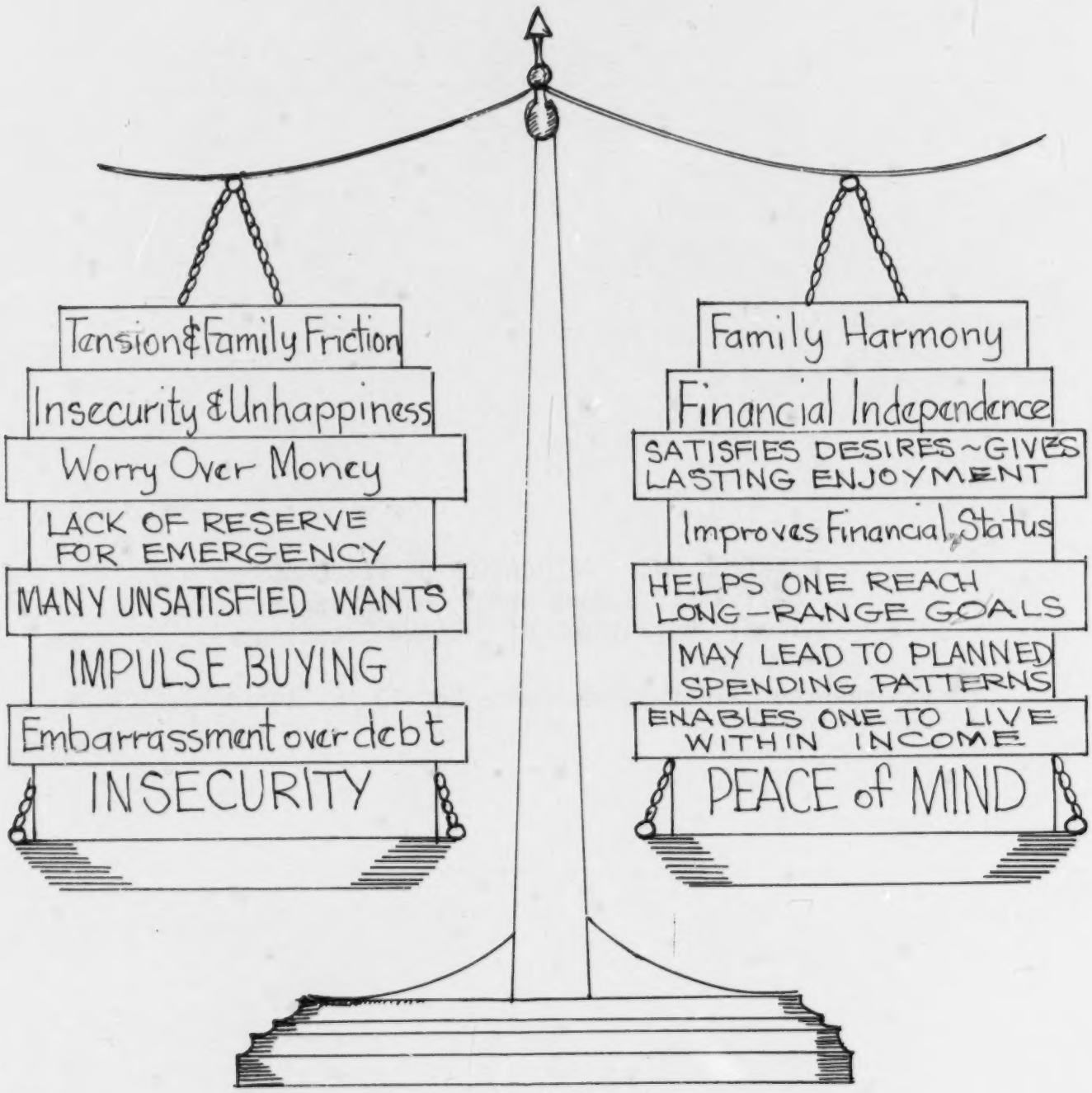

Weigh the Advantages of Planned Spending

4826

SECTION ONE: ALLOCATION OF RESOURCES
UNIT VII: Budget or Spending Plan
VII-3. The Way Individuals Live With Money

(See Suggested Learning Experience No. 15, p. 35 in Part One)

"I started on a shoestring—just when loafers and sandals came into style."

OBJECTIVE: To recognize the ways individuals live with money.

1. What goals do you think the speaker has set? Are they short-term or long-term goals?

2. What values do you think he holds?

3. What categories are probably included in his spending plan?

4. Dr. Helen Thal in Your Family and Its Money, pp. 66-70, mentions four ways that people live with money: (1) living from day to day, (2) living from pay check to pay check, (3) always in the "red," and (4) living creatively. In which of these ways do you think the speaker lives? Why?

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[1]Courtesy Publishers-Hall Syndicate, New York, New York.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VII: Budget or Spending Plan
VII-4. Form for Spending Plan

(See Suggested Learning Experience No. 18, p. 35 in Part One)

HOUSING

Rent.....
Furniture and equipment..
Utilities.....
Other.....

GROCERIES

Food.....
Household supplies.....
Other.....

TRANSPORTATION

Car payments.....
Car insurance.....
Gasoline and upkeep.....

CLOTHING

Purchasing new clothing..
Cleaning.....
Laundry.....
Repair.....
Other.....

HEALTH

Insurance.....
Doctor.....
Medicine.....
Other.....

GIFTS

Church and charity.....
Family and friends.....

RECREATION AND ENTERTAINMENT

LIFE INSURANCE.....

PERSONAL

Grooming services.....
Grooming supplies.....
Pocket change.....

EDUCATION

School expenses.....
Newspapers, books, and magazines.....
Travel.....

SAVINGS.....

Total expenditures.....

Total income.....

Write a paragraph explaining why you chose to spend the money the way you did.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VII: Budget or Spending Plan
VII-5. My Husband and I Never Argue About Money[1]
"What, never? Well, hardly ever."
by Joyce Kissock Lubold

(See Suggested Learning Experience No. 22, p. 35 in Part One)

My husband and I decided early in the game that it is simply ridiculous for any mature couple to argue about money. "Either we've got it or we haven't," my husband pointed out. "That's right, dear," I said, admiring my bridegroom's clear thinking. "There really isn't any reason for the subject to come up."

And yet we found quite soon the subject did come up, and once up was very hard to get down again. I might mention at breakfast that Aunt Clara's birthday was arriving soon and that we should send her something nice considering all she had done for us. My husband would agree, adding that we didn't have to get her a diamond brooch, for heaven's sake. I would answer with sudden passion that I couldn't understand why he didn't like Aunt Clara, and...well, the point is that we both got off the subject.

We continued, nevertheless, in our determination not to argue about money. If a conversation drifted toward what we could not afford, we just stopped talking. We uncovered a number of things we could talk about, however. The Abominable Snowman, for instance. Or the development of design in the pottery of the Navaho Indians. Meanwhile, my husband bought the things he thought we needed, I bought the things I thought we needed, and we were happy as clams.

But over the years, in our Eden, a little seed of trouble began to grow. What happened increasingly was--we ran out of money. Neither of us, it seemed, could walk around with cash in our pockets. It was like an allergy--we couldn't stand the feel of it next to our skin. My own particular temptation was the toy store. Let me take $10 to buy sneakers for the children, and a kind of madness for new pickup trucks for my three youngsters comes over me. My husband fights his losing battles in the hardware store. He is not physically able to walk past a new yard tool, for example.

We decided that since we couldn't carry money without spending it, we wouldn't carry money at all. We opened charge accounts all around town. We charged the groceries, and the newspaper; we charged at the shoe store. My husband had a long talk with our baby-sitter, who seemed dazed at the idea but agreed to let us run a monthly account.

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[1]Reprinted by permission from Joyce Kissock Lubold and Reader's Digest, August, 1962. pp. 58-60. Condensed by Reader's Digest from The Rotarian.

All through that happy cash-free month we warned each other about the Bill-Paying to come. The big evening arrived. At the dinner table, our eight-year-old said matter-of-factly, "Guess I'll study at Billy's tonight. You'll probably be fighting."

My husband and I looked at each other. "But you know Daddy and I never argue about money," I said.

"Yeah," he said kindly, "but I bet you will tonight. I better go over to Billy's."

"You stay here, son," my husband said sharply.

That night we paid the bills in almost total silence. Which wasn't easy. Because there were an awful lot of bills. I couldn't believe that a family of five had consumed this much in four weeks. My husband, breathing heavily, was apparently making the same discovery. I found an unexpected charge for lawn clippers that filled me with unreasoning rage. He choked back an exclamation of distress as he corrected a few really minor mistakes I had made in calculation. With tight smiles we stamped the envelopes, putting aside those which could not be mailed until another paycheck, and shut the desk.

"Well," my husband said, "the kids can't say we argued." His voice was taut.

"Just let them try," I said. So was mine.

We were miserable. We had spent too much, and we both knew it. In the days that followed we became more miserable still; our unnatural restraint made small angers work within our souls until they had to come out. Within a week I mentioned the lawn clippers disparagingly at least four times. My husband, meanwhile, found ways to turn innocent family conversations into little lectures on the Need for Economy.

That month trudged wearily on until he announced one morning at breakfast, "We'll pay the bills again tonight." Then he added to our son, with labored jocularity, "No need for you to leave, your mother and I won't argue."

The boy went on eating his cereal. "Maybe it'd be better if you did argue when you pay the bills," he said at last. "Instead of all the rest of the time."

Well, when a truly loving and open-minded couple hear a great truth, they recognize it. My husband and I looked at each other, and he said joyfully, "Boy, you go over to Billy's right after supper."

That evening we argued--about anything and everything. He brought up for scorn the wooden train I had bought for the baby who couldn't even push himself around yet. I referred to the bag of fertilizer that was so rich it burned the grass. He made a witty remark on the green shoes that didn't go with anything until I bought a dress that matched them. I let my voice get high and shrill. We pounded the table. We waved our arms. We stalked around the room, gesticulating. We had a grand time.

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And when the last bill was paid, our voices quiet with fatigue, we walked into the kitchen for a cup of coffee. There was a kind of battlefield camaraderie.

My husband stretched luxuriously and grinned. "Boy, that sure cleared the air," he said. "You wait till next month, though. I know what we can afford to spend on the yard now, and I'm not going to spend a cent more. You won't have a chance to yell about anything."

"Neither will you, smart boy," I said. "I'm going to watch it like a hawk this month."

And then we looked at each other in astonishment. We'd stumbled on the answer to the whole thing!

And that's the way it has worked out for us. We've stuck to our basic rules: Don't talk about money. Don't argue about money. Don't carry it around. And schedule one rousing money fight every once in a while, just to clear the air.

This last rule has been hard to keep. The first few cleared the air so well that we don't really have enough to argue about any more.

So we made up one final rule: "Remember always that marriage is more important than money." And this last rule is one that all husbands and wives should keep.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VII: Budget or Spending Plan
VII-6. The Morris's Spending Plan[1]

(See Suggested Learning Experience No. 34, p. 37 in Part One)

The take-home pay per month for Joe and Jean Morris is $483.50. The per cent of the income spent for various items may be different from the average percentage families spend because their children are young--six months and two years of age. Joe and Jean keep meat in the freezer as well as some garden produce from her parent's farm. The children's grandparents give them many items of clothing, consequently the family clothing costs are a little lower than average. They own one car.

Joe and Jean are high school graduates. She is a homemaker and he has just completed an auto-technical school. Both are 22. They have had a better start than many couples because her parents raise the meat and produce which Jean preserves for later use. Occasionally the Morrises use a charge account, but these occasions are infrequent. They have a regular savings plan.

Make a proposed spending plan for this couple. Apply the information you have studied.

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[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VII: Budgets or Spending Plans
VII-7. Steve and Kathy[1]

(See Suggested Learning Experience No. 35, p. 37 in Part One)

Introduction: The following situation has been devised to give students some practical experience in developing a spending plan and in coping with some of the unexpected expenditures all families face. This experience may help them to see that no degree of planning takes care of all contingencies for all time--that planning must be flexible.

Directions: Use the "in-basket, out-basket" technique to present the material to the students. Give them the story plus Problem I when you introduce the experience. At an assigned time interval, ask students to put Problem I responses in the "in-basket" and take Problem II from the "out-basket." You may wish to assign time limits for each problem, but some students may want to work at a faster pace than others so that your "in-" and "out-baskets" stay in constant use. You may wish to amplify the situations given, asking students to establish criteria for the selection of the items mentioned or to find the actual costs of these items in your locale.

The Story: Graduation night, June 1967, and Steve Parks wasn't graduating. Finishing school had not seemed very important until this year when he had made six credits! No one could believe that he would ever pass six subjects in one year! But somehow that just did not make up for the past three years of goofing off. He still lacked two credits for earning that diploma.

Steve stayed home from graduation exercises; he did not want to be around all his friends who were so excited about getting out of school. He might go out to the river for the all night party later, but for now he wanted to be alone. He knew he would not go back to school next fall. He would be nineteen in October. His parents were disappointed, but that was nothing new. He thought of all the times they had been disappointed before. How many times had he racked up the family car racing with his friends? He did not know how often the principal had called his mother in for a conference about his traunncy or misconduct, but he knew it was often.

Despite all this, his dad had financed a good used car for him just two weeks ago. Mr. Parks had said to him, "Son, this is as far as I'll go. It's yours if you earn the money to pay for it. Even if you wreck it, you have to pay for the car." For the first time in a long time, Steve knew his dad really meant what he said.

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[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

Summer dragged by interminably. Many of Steve's friends had gone to summer school or to a bigger town to work. Steve had a lot of time to think. His mother mailed in an application for correspondence courses for him to finish school. She looked so hopeful when the books and first lessons arrived that Steve could not let her down. He worked just enough to pass. Then he began to date Kathy Martin. Why had he not ever noticed her before? She was only one grade behind him and one of the cutest girls in school. She would be a senior this fall. There was no doubt about her graduating; she was an honor student.

Steve and Kathy were going steady by the end of September. She was so sweet and stupid in a funny way, especially for a girl who could be so smart. She did not nag or push or try to change anything about him. She helped him with the correspondence lessons, and now he had to finish them because it was important to her. She liked his car and helped him wash and wax and polish it as often as he did these things. He had not missed a payment on it, and he had a little money in the bank. Kathy made him feel great.

Just before Thanksgiving he asked her to marry him. He gave her a ring that cost $350. He paid $25 down on it.

Mr. and Mrs. Martin were incredulous when Steve and Kathy came to talk to them about being married, but Mr. and Mrs. Parks were not surprised. Kathy was supposed to go to college. This had been planned for years. Ultimately, the Martins gave in and agreed to a June wedding. In December, relatives of both families who lived far away wrote of their plans to come for visits during the holidays. "The perfect time for our wedding," begged Steve and Kathy, "when everybody can be here." The wedding was planned. On December 22, at 8:00 p.m. in the First Presbyterian Church, Steve and Kathy were married.

Kathy planned to stay in school while Steve continued working for his father. He was earning $250 a month which had been enough for a $55 car payment, gasoline, and dates. Now he had a $30 ring payment and household expenses. They were able to find a tiny, but clean, three-room house which they rented for $35 per month on the condition that they repaint and repair all the interior with materials furnished by the landlord. They did this and it was fun working on "their" house together. The Martins and Parkses helped them get enough furniture, of the attic variety, to start keeping house.

Steve and Kathy were determined to make things work out well. They were very happy together, and they wanted to disprove everyone's dire predictions that they would never make it. Steve worked 15 miles from home, so Kathy had to fix him a sack lunch. She rode to school with a friend who lived three houses down. She took her lunch, too. She looked forward to Saturday mornings when she could sleep late. It was very difficult to get up at 6:15 a.m. in order to fix Steve's breakfast and lunch and get him off to work by 7:00 a.m. Kathy was a very good cook. She had cooked supper almost every week night for the past two years because her mother did not get off work until 5:30. The evening and a good meal together was the best time of their day.

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Steve's grandmother had given them a used television set for a wedding gift. His uncle had rented a meat locker for them and bought a quarter of beef to go in it. Kathy's grandmother had already bought her a portable sewing machine for a combined graduation-Christmas gift. Her parents paid all the utility deposits to help them get started.

Even with all this help, Steve and Kathy realized that they must plan very carefully in order to live on what Steve earned. They allowed $70 a month for groceries, $20 for gasoline (since Steve had to drive to work), $11 for utilities, and $8 for recreation. Steve and Kathy felt it was very important that they get out with their friends at least once a week. This left $21 to take care of all other expenses.

Problem I

A. Analyze their spending plan. Answer the following questions to guide your thinking. What are their long-term goals? their short-term goals? What resources do they have that will help them reach these goals? What values are reflected by the goals they wish to reach and the way they use their resources? In your opinion, is their planning practical and workable?

   As they implement their plans, what suggestions would you make to help them control their spending plan and live within the limits they have set?

   As they live with this spending plan and evaluate it during the next few months, what changes do you think they will wish to make? Why?

B. In January, Kathy became pregnant. By the end of February, she was so badly nauseated, their secret was out, and Kathy had to drop out of school. The $21 left for miscellaneous expenses would not cover everything. Steve worked frantically to finish the correspondence courses so he could get a better job. By June 15 the last lesson had been returned and he passed the tests. July 1, Steve and Kathy moved to a larger town where he took a job paying $350 per month. This was not very much money, but he could advance to $500 per month in five years if he did well. He and Kathy decided this was their best opportunity.

Problem II

Make a spending plan for them based on this new salary. Consider how their needs, resources, and goals will be changing during this beginning stage of the family life cycle. Do you think there will be any shifting in the values that are most important to them? If so, what changes would you expect?

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They found a nice little house for $65 per month. They also made payments of $25 per month toward the baby's birth since they did not have hospitalization insurance early enough to cover the baby's birth. Some of their friends thought it was foolish of them to take it out now, but they did so anyway.

Problem III

Everything went along smoothly until the middle of September when Steve had to buy two new tires. How will this extra expense affect their spending plan? Evaluate the status of their budget and work out some way whereby he can pay for these tires.

Problem IV

On October 26, Mary Jane Parks was born. She was a beautiful black-haired, 8-pound bundle of energy, but she was rather expensive. Steve and Kathy had already paid $100 which covered her prenatal care, but they still owed $200 for hospital and doctor expenses. Re-evaluate their spending plan and see if you can figure out any way whereby they can pay this debt within the next year. If the doctor and hospital allow them to make monthly payments, how much can they afford to pay each month? If all expenses have to be paid immediately, where can they go for help? List at least three sources. Give the terms each source would require. Which one would you choose? Why?

Problem V

At Christmas, Mr. and Mrs. Martin and Mr. and Mrs. Parks decided to give Steve and Kathy cash. They thought their children needed new clothes and a little "fling" of some kind. If you were Steve and Kathy, how would you spend the $200 gift? Why would you spend it for this? What values would this reflect?

Problem VI

In February, Steve had the flu. Medicine and doctor bills came to $45, but he got a $50 per month raise. What changes would you make in their spending plan? Why?

Problem VII

Steve and Kathy were very happy and extremely proud of Mary Jane, who was a very good baby. Kathy had a difficult time doing the laundry, however; since Steve had the car at work all day, she had to go to the laundromat in the evenings. Kathy disliked this because evenings were the only time the three of them could be together. In April, Steve bought a good used washer for $135. In your previous planning, had you saved enough money for him to pay for this? If not, how can he finance the washer? Revise the spending plan to accommodate the washer.

Problem VIII

In November, Kathy became pregnant again. This time only the prenatal care would have to be worked into the spending plan because their hospitalization

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policy had been in effect over a year. Steve was doing well and received another $50 raise the first of December. Kathy was very proud of him. They both agreed that their little house was going to be too small for two children. Mary Jane needed a yard to play in, too. They went house hunting, and once again evaluated their spending plan and adjusted it to meet the anticipated changes in their style of life. What revisions do you think they had to make?

Evaluation:

You have been involved in applying the management process to a real-life situation. You have used the steps of planning, controlling, and evaluating to meet the changing needs of a young family. At each step you used the decision-making process of facing the problem; considering values, goals, resources, and needs; examining alternative actions and outcomes; and selecting a course of action. In each instance would you have been willing to live with the consequences of your chosen course of action? Discuss.

Explain the following statements: Management is a way of life. Management must be flexible.

Can you think of any other summary statements you could make about management or the decision-making process?

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VIII: Savings and Investments
VIII-1. Assets

(See Suggested Learning Experience No. 4, p. 41 in Part One)

1. Discuss what savings means to you.

2. Make a list of all the assets you feel you possess.

Life Insurance	$_____
Automobile	$_____
Bank Account	$_____
Savings Account	$_____
Stocks, Bonds	$_____
Others	$_____
	$_____
	$_____
	$_____
	$_____
Total Value	$_____

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VIII: Savings and Investments
VIII-2. Savings Habits

(See Suggested Learning Experience No. 8, p. 42 in Part One)

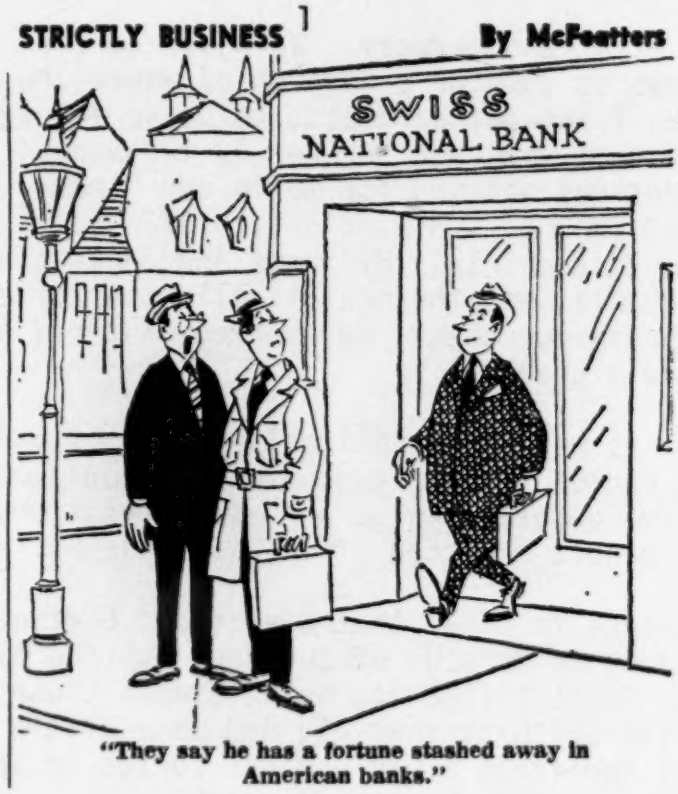

"They say he has a fortune stashed away in American banks."

OBJECTIVE: To recognize some of the idiosyncrasies people reveal in their money saving habits.

1. What practice of the very wealthy is being lampooned by this cartoon?

2. Where are some of the most ridiculous places you have ever put your money for safekeeping? Why did you put it there?

3. What stories have you heard other people tell about this same thing? What reasons did they give for putting their money in the place they chose?

4. Explain this statement: Money just saved may be money lost.

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[1]Courtesy Publishers-Hall Syndicate, New York, New York.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT VIII: Savings and Investments
VIII-3. The Money Tree

(See Suggested Learning Experience No. 9, p. 42 in Part One)

It was the first cool, crisp Saturday of fall. I lay with eyes closed in my favorite lounge chair under the tree beside my kitchen window and savored the "feel" of the day. Summer days skittered through my mind, and I was glad they were only memories. Beneath me lay buried the fruits of an arduous summer's work.

It all began on our first anniversary. We moved to the "north" place about thirty miles from home to combine a section of wheat and plow the wheat ground. What a lark, I thought at first, to be so far away from parents and in-laws, alone with my husband for nearly two weeks! Little did I realize the accommodations waiting for me in our "Second Honeymoon Haven." My kitchen was a shed room 6' x 8' and only 6 1/2' tall. My husband is 6' tall. He almost had to crawl in. My range and cooktop were a two-burner hot plate with a portable, non-thermostatically controlled, tin oven; my refrigerator, a 75 pound ice chest; our bedroom a tent; and our bathroom... 640 acres of land and a creek.

We were just as poor as we were estatically happy. I had just graduated from college with a degree in home economics. I could cook a holiday dinner for thirty-five people, manage a house without any effort or do any of the other things people expected of me, but this was something else!

Our first neighbors came to visit that evening at bedtime. I turned the covers back, and there, on my side of the bed, lay the biggest centipede I ever hope to see. Scott killed it, but I didn't close my eyes all night long. I was sure that anything that big had many little friends or relatives. That was the first of an endless series of spiders, scorpions, snakes and even crickets that chirped all night.

Days were much better. The only major annoyance was that all my "kitchen" windows (one) and doors (one) had to be closed when I cooked, to keep the excellent cross ventilation from blowing out the burners. This was my first opportunity to show off my cooking skills to Scott; we had shared a kitchen with his parents (their own!) for the past year. I made cakes, yeast rolls, homemade ice cream and every other good thing I could think of. Miraculously, by praying and keeping the door shut, everything turned out perfectly.

The two weeks were over so soon, I almost regretted their passing. We returned at least twice during the summer to plow the ground again. I felt like the only things I lacked being the original pioneer woman were the long dress, sunbonnet and brogan shoes.

One memorable pioneer-type misadventure I can never forget! We awoke one morning about 3:30 to the sound of rain falling, soft and gentle. The world smelled so sweet and fresh as the newly plowed ground became wet.

We feel asleep again with great contentment, knowing that morning would

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bring a lazy, peaceful day. About 4:00 a.m. I felt a small drip and moved over a little. Scott had felt the same thing on his side, and he had moved over a little, too. We got up and moved the bed. The rain became a downpour, and we discovered we were under a true sieve! That tent leaked from every thread. We dressed and drove into town arriving at my mother's door about 4:45 a.m. If we had not been so wet and miserable, I think she would have disowned me.

We thought we were really wealthy when the wheat money came in, and Scott was paid for the plowing. We paid our car off, bought a range and refrigerator and had $800 left. At the end of May, I had signed a contract to teach school. No young couple, married just one year, had ever been so lucky!

What should we do with the $800? I wanted to put it in the bank, but Scott said, "No. The temptation to check on it will be too great." His father suggested that we put it in a savings account, but Scott vetoed that, too. We already knew what we were going to spend the money for. We were going to build a room onto our house so there would be space enough for a family after I taught a couple of years. Finally, it was decided. We would bury the money under the tree by our kitchen window! We wrapped the roll of bills carefully in layers of foil, put this in a plastic bag, sealed it in a clean pint jar, and buried it under that tree. We called the tree our money tree--a private joke that sent us into hysterics when mentioned in front of our friends.

One day I lay over the exact spot where our treasure was buried. I felt secure and happy just thinking about what it would provide for us. I dreamed of that new room and the child who would occupy it, and I squeezed back tears of happiness, thinking God for His blessings.

My prayers took a slightly different turn the next fall when we started building our room and decided we would now dig up the money and pay cash for our project. Scott dug in the exact spot where we had buried it--he thought--but no money. He dug a little deeper, then to this side and then to that side. At first it was funny, but after two whole hours had passed, I could hardly keep the tears back. We just knew someone had seen us hide the money and had stolen it while we were away from home. Scott finally plowed around that tree with the chisel plow, and the jar was uncovered, still sealed, with money intact. Again I thanked God for blessing two very foolish young people.

We have never had another money tree.

SUGGESTED QUESTIONS

Was Scott's reasoning sound in the way he chose to safeguard his money? Give reasons for your answer.

Do you know of other people who have chosen to save their money in an unconventional manner? Give examples.

Compare what Scott's total savings would have been in one year's time if he had (a) put the $800 in the bank, (b) put it in a savings account at the current interest rate compounded annually, or (c) put it in a savings and loan account at the current interest rate compounded quarterly.

If you were Scott, where would you have put your money? Why?

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-2. How to Shop for Credit[1]

(See Suggested Learning Experience No. 13, p. 48 in Part One)

Credit is available from many sources and in a variety of forms. To make the best use of this resource, the consumer will have to be willing to shop, compare, ask intelligent questions, evaluate and finally use credit with discretion.

To use credit wisely it is important to understand the many different forms of credit available.

WHAT KINDS OF CREDIT ARE THERE?

There are basically three kinds of credit--service, sales and cash credit.

Service Credit--this form of credit is often not thought about as a kind of credit, but the use of electricity, telephone, gas, etc. consumed one month and paid for at the end of that month is credit which the utility companies extend to consumers for the use of their product.

Sales Credit--this form of credit, offered by retail stores, appliance dealers, etc. and often called retail credit, has many forms:

(1) Regular or Thrity Day Charge Account--goods purchased during one month are itemized and billed at the end of the month (with cycle billing the billing period will fall at different times during the month, depending upon the last name or account number).

Payment is due upon receipt or 10 to 15 days after the bill is received; there is no service charge if bills are paid within the time allotted.

(2) Ninety Day Account--is a variation of the regular charge. When a high priced item is purchased (e.g., furniture), a plan may be worked out so that the consumer can pay for the item in 90 days (3 equal monthly payments), and there is usually no service charge.

(3) Option or Revolving Account--with this type of account the consumer pays either the whole balance at the end of the month or a stated portion of the balance (the minimum amount stated must be paid). There is usually no service charge on items paid for the month following the month they were charged. If only a portion of the balance is paid, the following month a service charge is calculated as a per cent of the unpaid balance.

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[1]Reprinted by permission from Penney's Forum. New York, New York: J.C. Penney Company, Inc. Fall/Winter, 1969. p. 20.

(4) Retail Bank Card--a bank or institution arranges with several retail stores to have one charge card which can be used in any one of the participating stores. The consumer is billed by the bank or institution on a revolving account with a 30 day option.

(5) Installment Sales--used for the purchase of big items (car, furniture, etc.), this type of credit requires a written contract with service charges and a payment schedule for each item bought. Title to the goods usually remains with the dealer or finance company until final payment is made.

Cash Loans--may be categorized by method of payment:

Term or Single Payment--repayment and interest on the loan are due in one lump sum, 30, 60, 90, or 120 days from the date of securing the loan.

Installment Loan--periodic payments (usually monthly) of principal and interest on the loan can be made over a 3 to 36 month period.

Checking Account with Overdraft--consumer arranges a credit limit with a bank, $300, $500...up to $5,000 which is available to be drawn against and allows the consumer to write a check for money he does not actually have on deposit. As the consumer draws from the overdraft part of this account, his checking account is credited with enough money to cover the overdraft. This money is then treated in a manner similar to a bank loan, and the consumer is billed for the overdraft (separate from his checking account). Repayment is made monthly according to the original agreement established with the bank.

The interest rate paid on any of these cash loans will depend upon existing laws, the institution extending the loan and whether or not security was pledged.

WHERE DOES ONE GO FOR CREDIT?

Sales Credit is available through retail stores and other dealers (auto, appliance, etc.).

Cash loans are available from:
Banks--most commercial bank loans are for 3 years or less; collateral may be required.

Savings and Loan Associations and Building and Loan Associations--are similar to commercial banks but are usually used for mortgages.

Consumer Finance Companies--personal finance or small loan companies usually deal in small or modest-size loans.

Savings Bank Passbook Loans--the passbook is retained as a security on a loan; the bank still pays interest on the balance in the savings account.

Credit Unions--these consumer cooperative lending agencies are available to benefit their members.

Life Insurance Policies--Money can be borrowed on the cash values of certain policies.

Pawnbroker--a pawnbroker gives a consumer money and a ticket for an item of value; the ticket can be redeemed within a certain period of time by repaying the same amount of money as originally obtained.

WHAT DOES CREDIT COST?

As of July 1, 1969, credit costs legally must be stated in dollar amounts and annual percentage rates which may be used by the consumer for comparative shopping.

WHAT ABOUT CONTRACTS?

For any kind of installment credit or cash loans a contract must be drawn up and signed. The consumer should read this contract carefully and be sure that all information about the sale is stated and that all blank spaces are filled in. Information needed is:

- Description of item being sold
- Cash price
- Credit service charge (in dollars and annual percentage rates)
- Other charges, if any (insurance and excise tax, etc.)
- Total credit for down payment, trade in, etc.
- Description of any security taken
- Amount of each payment--when and where?
- Penalty for nonpayment

The consumer should not sign any contract he does not understand--and should not be embarrassed to ask more questions.

WHAT QUESTIONS SHOULD THE CONSUMER ASK?

The consumer may want to ask himself some questions about his credit transaction:

- What is his current level of debt?
- Does he have a cash reserve in case there is an emergency?
- Has he done some comparative shopping to be sure he's aware of the credit cost he's paying?
- Has he asked questions about credit?
- What is the best form of credit for each individual situation?
- What are all the commitments in the contract?
- Would it be better to use savings for this item?
- How much can be paid from his income each month and still have enough money for emergencies and daily living?

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The consumer should ask questions of the person extending credit (some of these pertain to sales credit, others to cash loans):

Would there be a difference in price if he paid now in cash or paid a larger down payment?
How will the service charges vary for different periods of time--paying off in six months as opposed to one year?
Are there additional charges? If so, what are they and why must they be paid?

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-3. Criteria for Granting a Loan

(See Suggested Learning Experience No. 13, p. 48 in Part One)

Credit Source	Term of Loan (Check one)			Credit Rating Check Required (Check)	Security Required (List)	Purpose for Loan (List)	Size of Loan (List)	Criteria Unique to Lending Source (List)
	Short	Long	Flexible					
Bank								
Credit Union								
Savings and Loan Association								
Insurance								
Consumer Finance Company								
Retail Store								

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-4. Use This Chart to Compare Credit Costs[1]

(See Suggested Learning Experience No. 17, p. 49 in Part One)

Name of lender	Number of payments	Size of payments	Other charges	Total amount to be reapid	Amount of loan	Dollar cost of credit	True annual interest rate
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		
	x	+	=	-	=		

[1]Reprinted from Consumer Credit. Cooperative Extension Service, College of Agriculture, The University of Connecticut, Storrs, Connecticut, p. 23.

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SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-5. Cashless, Checkless Society of the Future[1]

(See Suggested Learning Experience No. 19, p. 49 in Part One)

Hugo: A typical high school graduate
Mother: Hugo's mother

(Hugo comes in humming "Can't Buy Me Love." Stops, looks down at ring, then at bill and back and forth. Finally he slinks over to the computer and slips in the bill, pensively. The computer lights up, makes noises, and in general goes wild. The numbers go up on the computer. Mother comes running in.)

Mom: What's happening? (Boy frantically trying to fix the computer. Somehow he makes it stop. Mother gasps as she sees the ring.) Hugo, what is this about?

Hugo: (Slowly putting out ring) It's for Hermine.

Mom: The one you've known for three weeks? (Hugo nods head happily) Where...the...money? How much?

Hugo: Oh, a mere $350. It's all right Mom, I charged it on our credit card. There it was--"instant cash" (snaps fingers). I couldn't resist. The jeweler said he was going to give me this special deal. It seems as if the ring was just returned by this guy who got turned down and they hadn't even had time to put it back in the display case. So, it was selling for cut rate, and since I was the first to come in, he'd let me have a chance to get it before anyone else.

Mom: Hugo, that instant cash is actually a loan from the bank...a loan that has to be paid back at an interest rate of 1-1/2% per month--18% per year. Not to mention the service charges. (Hugo beginning to look sick. Mom looks at ring closely.) And Hugo, are you sure this ring is genuine?

Hugo: Well, it...<u>looks</u> real.

Mom: If it isn't, the bank won't recognize any disputes we have about it with the jeweler. Didn't you know that? (Turns around to the computer.) Hugo, you've exceeded your credit limit!!

Hugo: Won't the bank cover it?

Mom: If the credit limit is ever exceeded, all we own becomes payable on demand. (Both look shocked. Hold heads in hands.) (Phone rings.)

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[1]Developed by students of Mrs. Albie Rasmussen, Department of Family Economics, Justin Hall, Kansas State University, Manhattan, Kansas 66502.

Hugo: (Answers phone, pause) Yes...yes...yes...yes...(hangs up) Mom... she accepted...she accepted!

Mom: Who? What?

Hugo: The guy's girl who originally bought the ring. And the guy, he wants this ring back--sentimental value or something, I guess.

Mom: (Now also getting excited) So the jewelers will take the ring back?

Hugo: Yes! And the jeweler said he'd give me a real good deal on another ring for all my trouble.

Mom: Hugo!

Hugo: Relax, Mom. I was lucky this time and I'm not going to be trying this again until I've looked at this credit card business and shopped around for the best deal in a ring. (Walks out saying) I wonder if she'll settle for my class ring temporarily.

(Mother smiles and shakes her head.)

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-6. The Signature[1]
by Betty K. Gipson

(See Suggested Learning Experience No. 26, p. 50 in Part One)

This play involves the purchase of a sewing maching. From it you will learn the value of your signature, the significance of a contract, and the importance of seeking information before making a large purchase. In addition, you will learn about the existence of two resources in your community which can aid the family with financial legal problems.

THE CHARACTERS:

Mrs. Helen Bates	Sewing machine salesman
Mary Bates, daughter, age 15	Manager, sewing machine company
Mrs. Vera Wise, a neighbor	

(Mrs. Bates is sitting at the kitchen table drinking a cup of coffee and looking at the ads in the morning paper, and her daughter, Mary, is washing the breakfast dishes.)

MRS. BATES: Mary, stop washing the dishes and come here. There's an ad in the morning paper for a sewing machine for only $75. Have you heard of a Dynamic sewing machine?

MARY: No. We don't have that kind at school.

MRS. BATES: We could use a sewing machine, but I don't know anything about a Dynamic sewing machine.

MARY: My home ec. teacher says you shouldn't buy anthing from a company that you're unfamiliar with. She says you should look up the information on brand names when you're not sure of quality. You're supposed to look it up in some book.

MRS. BATES: What's the name of the book?

MARY: Gosh, I don't remember. IT REALLY DOESN'T MATTER.

MRS. BATES: Well, I'm going to call the company and ask them to send out a salesman. After all, I'm certain that the newspapers wouldn't let a dishonest company place an ad in the paper. Mary, I'm going next door to use the phone.

(It is the next morning. Mrs. Wise, the neighbor, Mrs. Bates, and Mary are talking to the salesman from the Dynamic Sewing Machine Company. The salesman has just finished a demonstration of the machine and is showing them a picture of a zigzag sewing machine in a desk cabinet.)

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[1]Reprinted from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Division of Home Economics Education, University of Illinois, Vol. XII, No. 3, Winter, 1968-69. pp. 148-155.

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MRS. BATES: This machine certainly seems to be a good buy for $75. I've seen similar zigzag machines in local department stores for three times that price. But Mary says they don't have any Dynamic machines in her sewing class at school and that her teacher never heard of this company.

SALESMAN: Really? I'm surprised! THIS IS A NATIONALLY ADVERTISED MACHINE. IT'S ADVERTISED IN ALL THE LEADING MAGAZINES. I can see you know a real value when you see one. It's a real pleasure talking to such a smart homemaker. A smart homemaker like you could really save money making the children's clothing and making things to make the apartment attractive. So, your daughter takes home economics. This sewing machine would really help improve her grades. What kind of grades do you make, Mary?

MARY: They could be better, but I sometimes make a good grade.

SALESMAN: Just as I thought. With a machine you could improve and maybe even begin to sew for others and make a little spending money for yourself. How does that sound to you?

MARY: Swell! I can always use more spending money. Not to mention better grades. Mother, wouldn't the desk cabinet look pretty in my room?

MRS. BATES: Yes, it would. What do you think, Vera?

MRS. WISE: Well, it certainly is a lovely machine. But how can you possible sell it for $75? I just don't know...

SALESMAN: LOW OVERHEAD AND VOLUME SALES. But, to get back to you, Mrs. Bates. I have to hurry; I have another appointment.

MRS. BATES: I'd sure like to have the machine, but I'll have to talk it over with my husband tonight. Can you come back tomorrow?

SALESMAN: I'm sorry, Mrs. Bates, but we only have a few of this model for sale and I couldn't promise to have one left to sell tomorrow. I have several other calls to make this morning, and if I sell out, then you will be out of luck. I'm afraid you'll have to make up your mind now.

MRS. WISE: Helen, I wouldn't let him rush me into anything. Talk to Fred tonight, and let Mary find out more about the machine from the library.

MARY: (Who fears she won't get the machine if her mother waits to talk to her father) Mother, I'm sure this is a good machine. It sews as well as any machine I've ever used. Besides, I need a sewing machine.

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MRS. BATES: Well, I don't know, Mary.

SALESMAN: You and your daughter have been so nice to me, Mrs. Bates, I sure hate to see you lose out on this bargain. Wait! I just had an idea about how you can save the machine until tomorrow and still have a chance to talk to your husband. IT WON'T COST YOU ANYTHING. To have us hold a machine for you, all you have to do is sign this contract and give me a $25 deposit. Then, if your husband doesn't like the machine, we'll tear up the contract, refund your deposit, and pick up the machine. YOU HAVE NOTHING TO LOSE. You know there are plenty of other ladies in this building who would like to own this machine. Also, if you sign now and save the company the added expense of sending another salesman back, we'll give you a $12 buttonhole attachment. Think of the money you can earn making buttonholes for the neighbors. Your husband will certainly be proud of you.

MRS. BATES: Mary, what do you think? I really hate to lose out on such a bargain.

MARY: Mother, I CAN'T SEE WHAT HARM CAN BE DONE IN MERELY SIGNING A CONTRACT. After all, he says he'll tear it up if you aren't satisfied. I know that buttonhole attachments are expensive. That would mean you're getting the machine for $63. And you said it was a bargain at $75. I DON'T SEE HOW YOU CAN AFFORD TO SAY NO. Besides, the machine would look nice in my bedroom.

MRS. BATES: Well, if you think so, Mary. I'll sign.

MRS. WISE: Helen, I don't think you should sign until you know more about the company and talk to Fred first.

MRS. BATES: Didn't you hear the salesman say that this was a nationally advertised company? He wouldn't mislead me about something like that. (Mrs. Bates signs the contract.)

(Several days later Mrs. Bates' sewing machine is delivered. Much to her surprise and disappointment the machine is not like the one the salesman demonstrated. The machine is in a portable case and does not do a zigzag stitch. She calls Mary and Mrs. Wise to come and see the machine.)

MRS. BATES: This isn't the machine I ordered. The delivery man left this payment book showing I owe 12 monthly payments of $8 each. My goodness, that's $96 more. The company must have made a mistake. I've seen machines like this in stores for $35 to $40.

MRS. WISE: This certainly isn't the machine the salesman showed you. I thought the machine he showed you was too nice to sell for $75. You should have checked on the company.

MRS. BATES: I don't need advice now.

MARY: Mother, what are we going to do?

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MRS. BATES: I'm going to call the company. I'm sure they delivered the wrong machine.

(Mrs. Bates calls the company.)

MRS. BATES: Is this the Dynamic Company? I'm Mrs. Bates. Your company delivered the wrong machine to me this morning. They delivered a portable, plain-stitch machine, instead of a zigzag, desk-cabinet machine. I ordered the $75 model. They left a cheaper model. Also, the payment book shows me owing you a balance of $96. The machine only cost $75, and I already paid $25. How can I owe you $96 more?

MANAGER: Mrs. Bates, that $75 was the cash price of the sewing machine. What you are paying is the time or installment price, and it comes to a total of $121. It was all on the paper you signed. If you ordered a $75 machine, then you ordered our cheaper model portable. The model you described is our deluxe model which we sell for $350. Now if you aren't satisfied with the cheaper model, we would be happy to send out our deluxe model. Of course, if you just want a cabinet, we have them for $100 to $250. Just let me know what we can do to satisfy you.

MRS. BATES: Well, I guess you'd better come and pick up your machine. My husband wasn't too happy about my buying the machine in the first place, and I know we can't afford to spend any more on a machine now. So come and pick the machine up and refund my deposit. The salesman said you would tear up the contract if I changed my mind.

MANAGER: I can't believe our salesman told you that. He didn't have authority to make such an agreement with anyone. You will either have to live up to your contract or I'll have to turn this matter over to our lawyer.

MRS. BATES: YOU CAN'T DO THAT!

MANAGER: I'm sorry, Mrs. Bates. We not only can but we will if you make it necessary. When you sign a contract, you make yourself legally responsible to the conditions set up in the contract. Nowhere in our contract did we agree to refund your money or agree to allow you to return the machine. We can't be held responsible for any verbal conditions or promises made by our salesman.

(Mrs. Bates hangs up and returns to Mary and Mrs. Wise.)

MRS. WISE: Well, Helen, what did he say?

MRS. BATES: He said he had not made a mistake, and that he'd sue me if I

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didn't pay for the machine. I guess there is nothing I can do. I'm just stuck with the machine.

MRS. WISE: I know what I'd do. I'd call the Better Business Bureau. They might be able to help you.

(Mrs. Bates calls the Better Business Bureau and tells them what has happened. The Better Business Bureau tells Mrs. Bates they have had similar complaints about this company, and had she called prior to her purchase they could have been of help to her. They would have warned her of the bad reputation of this company and told her of the things the Dynamic Company had done to other homemakers. They advise that it would do no good for them to follow through on her complaint because they had been unable to help in prior cases. They suggest she contact a lawyer. Mrs. Bates has returned to the kitchen where Mary and Mrs. Wise are sitting.)

MRS. BATES: I called the Better Business Bureau and they said it was too late for them to be of any help. They said I should see a lawyer. But I can't afford a lawyer. Besides, I'm afraid of lawyers. Lawyers scare me like doctors. Lawyers are for criminals. I'm no criminal...I'm just not going to pay them one cent. I'LL SHOW THEM! It's better to lose $25 than lose $96. I'll just not tell your father anything.

MRS. WISE: Helen, I really think you should see a lawyer. I don't think that the Dynamic Company is just going to let you stop paying them. I've heard that the legal aid office will help people with their problems if they can't afford a lawyer. Why don't you go see them?

MRS. BATES: No! I've made up my mind. I'm just not going to pay them anything, and I'm not going to worry Fred about all this. I'll show them.

(Several months have gone by and Mrs. Bates has continued to refuse to seek legal advice or pay for the sewing machine. She has received several bills and notices from the Dynamic Company, and has just thrown them away. On this day a notice of suit was delivered from the court, addressed to her and her husband. The notice advised that they were being sued for the unpaid balance on the sewing machine, costs of court, interest on the installments, and attorneys' fees. The notice advised that they had five days to comply with these demands or file an answer setting up any defenses.)

(The scene is Mrs. Bates' kitchen. She and Mrs. Wise are talking.)

MRS. WISE: Helen, Mary asked me to come over right away. She said you were upset. What's wrong?

MRS. BATES: A man just delivered this court notice. What in the world am I going to do?

MRS. WISE: Is it about the sewing machine?

MRS. BATES: Yes. I should have listened to you and seen a lawyer. Do you think it's too late, now?

MRS. WISE: I don't know, but if I were you, I'd go find out.

(Mrs. Bates went to the legal aid office. The attorney reviewed her financial situation and determined she was entitled to legal aid services. The attorney contacted the attorney for the Dynamic Company and advised of his intention to defend their suit, alleging fraud. The Dynamic Company, fearing the adverse publicity of a court hearing, dismissed the suit and refunded Mrs. Bates' money.)

SUGGESTED QUESTIONS

FUNCTION OF QUESTIONS:	QUESTIONS
To assist student in identifying with the Bates family	1. Does this seem to be a true story?
	2. Which character do you like best?
To clarify values and goals	3. What do you think Mrs. Bates' goals were?
	4. At what time in the story did you understand the goals of Mrs. Bates, Mary, and Mrs. Wise?
To identify legal problems	5. What do you consider to be the real legal problem caused by the purchase of the sewing machine?
To identify the cause of the problem	6. What actually caused the problem?
	7. What advice can you give Mrs. Bates about the use of her signature?
To determine the effect of the problem	8. How might this problem affect the family?
	9. What might have happened if Mrs. Bates had not gone to a lawyer?
To develop the ability to analyze the problem	10. Now that you have studied the problems which can result from the unwise use of one's signature, what advice would you give people who are about to make a purchase involving the signing of a contract?

To increase knowledge of the use of community resources	11. What community resources could Mrs. Bates have used which might have prevented this problem?
	12. How many community resources can you name and locate which are available to a family in need?
To develop economic efficiency	13. If Mrs. Bates really needed a machine, how could she have managed to make the purchase on her family income? Did she use the best method available to her?
	14. Do you think Mary was of any help to her mother when she needed advice?
	15. What do you think Mary could have done to help her mother avoid this problem?
To develop a sense of security in regard to use of law	16. Do you think it was fair for Mary's mother to have to get a lawyer? Why?

CONCEPTS AND GENERALIZATIONS

A. The signature:

1. A lack of knowledge concerning the value of one's signature and the responsibilities associated with the signing of one's signature may result in serious problems for the individual and his family.

2. When you place your signature on a contract or agreement, it means that you accept the conditions set forth in the contract and are therefore legally responsible for the contents included in the contract.

3. Seeking advice before making a major purchase or signing any agreements may help avoid problems associated with the signing of contracts.

B. Contracts:

1. A contract is an agreement between two or more persons, and holds the parties responsible for those terms included in the agreement.

2. A knowledge of the mechanics of signing a contract can lead to a more intelligent approach to management of family affairs.

3. An awareness of the risks involved in making purchases from companies with which one is unfamiliar can help prevent problems. There are added risks involved in signing contracts with such companies.

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4. Familiarity with the contents of a contract and the reputation of the person or company involved aids one in deciding whether to sign a contract.

5. There are agencies in the community such as the Better Business Bureau and the Legal Aid Society which can advise one concerning contracts.

6. A person who is contracting is bound only by what is actually written in the contract, unless fraud is involved. He is not held responsible for any oral agreements made at the time the contract is signed.

C. Resources:

1. There are many agencies and resources in the community to advise and help a family with its problems, and to aid in decision-making.

2. For those families which lack sufficient financial means, there are usually community agencies such as a legal aid office which offer their services without charge.

D. Consumer guides:

1. If in doubt concerning the reputation of a company, community agencies, such as the Better Business Bureau, can provide helpful information.

2. Having all the facts that pertain to a given situation will help one in making a more intelligent decision.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-7. Credit As a Resource--
Understanding the Uniform Consumer Credit Code[1]

(See Suggested Learning Experience No. 29, p. 50 in Part One)

EDITOR'S NOTE:

Currently, there has been so much talk about credit legislation to protect consumers, that we asked a credit expert to explain the latest proposed legislation in terms of what it will mean to consumers.

At the present time, consumer credit is treated under a vast number of laws which vary in each state. In our fast-moving and mobile economy, there have been attempts in the past few years to help the consumer and businessman alike with more uniform regulations in the area of credit. For the consumer, who is moving from state to state more often, uniformity in regulations would mean that once the regulations were understood in one state, they would be consistent wherever the consumer went. For the businessman, who is using computers in all aspects of his work, uniformity would eliminate the multiplicity of forms and procedures which are required since rates and laws vary from state to state.

The federal legislation which has passed last year and which will become effective July 1, 1969, is the Truth-in-Lending Act. One of the requirements under this act is that consumers will be given the price of credit in dollars as well as in annual percentage rate. It is felt that by comparing annual percentages, shopping for credit will be easier for the consumer. This bill will help to clarify many areas of credit sales and loans (i.e., regulate credit advertising, restrict amount of garnishment of wages, etc.), but there are still regulations which vary from state to state that the law may not cover.

In the last few years, pressure for consumer protection legislation has raised its head. In fact, it was primarily through the work of the Truth-in-Lending hearings that the existence of credit abuses came to light, and spotlighted to legislators the need for remedial legislation.

For the past six years a group of lawyers, judges, economists and law professors, with advice from consumer-oriented and industry-oriented people, have been working to draft a new credit law, designed to bring all consumer credit transactions (either credit sales or cash loans) under one comprehensive code. This project of credit legislation is known as the Uniform Consumer Credit Code (referred to as the "Code"). This proposed law, in order to go into effect in any state, will need to be passed by that individual state.

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[1]Reprinted by permission from Penney's Forum. New York, New York: J.C. Penney Company, Inc. Fall/Winter, 1969. p. 21.

At the present time there is a hodgepodge of existing state service charge and interest rate ceilings. (The Federal legislation requires the statement of rate but has not established ceilings.) The existing state rates vary depending on the creditor, the debtor and the nature of the transaction, i.e., credit sales of autos, personal loans, F.H.A. loans, revolving store charge accounts, etc. Under the "Code" these would be replaced by a single set of maximum rate ceilings covering all consumer credit transactions along with a full disclosure of service charges (dollar amount and annual per cent).

If enacted in any state, the "Code" would replace numerous overlapping and conflicting laws and regulations that now govern individual credit transactions. State Legislatures will be taking a good look at the "Code" this year, and for some years to come. The Federal Act specifies that if a state passes a law which requires similar disclosures, the state law will apply and the control of credit will move from federal to the state governments. (As a project, students may want to investigate whether or not the "Code" is being considered in your state--is it being considered as it was originally proposed or have there been amendments added?)

Consumer protection provisions in this proposed credit code follow.

Features and what they mean to the consumer:

Home Solicitation Sales:
Consumer has a three day "cooling off" period to cancel any high-pressure sales made in the home. Seller may charge a cancellation fee of 5% of the cash price, but not exceeding the amount of cash down payment.

Referral Sales Eliminated:
This provision eliminates the practice in which the buyer is encouraged to purchase merchandise (sometimes of questionable quality) on the assumption that he will be able to avoid paying by merely supplying the seller with the names of friends or relatives who may be called on by the seller.

Prohibition of Garnishments Prior to Judgment:
Eliminates practice in which an unsuspecting buyer signs a paper, in advance, giving the seller or lender the right to go to the buyer's employer and make deductions from his pay (garnishment), without obtaining a judgment from the courts. Under the "Code" the seller must get court permission to take wages.

Garnishment Limitation:
Assures the consumer (debtor) a minimum wage which will remain free of garnishment. Employers are also prohibited from discharging employees because of garnishments.

Use of Negotiable Instruments:
Imposes much greater responsibility upon financial institutions engaged in buying consumer sales contracts from appliance dealers, motor vehicle

dealers and other sellers of consumer and agricultural goods. (Financial institutions purchase the contract from the dealer and then usually send a booklet of payment statements to the buyer; the buyer then deals with the financial institution.) Under the "Code" the consumer can bring charges against the finance company or the original dealer if he feels he has a case (i.e., faulty merchandise).

Balloon Payments:
Sometimes a note or sales contract is set up so that there are smaller payments each month until the last payment ($20 per month and then $50 for the last payment). If the consumer is not in a position to pay the larger final payment he might be unable to refinance the final large payment (balloon) at reasonable finance charges. The "Code" will permit him to refinance at terms no less favorable than those in the original contract.

Cross-Collateral Limitations:
Limits the extent to which a seller can repossess any property not related to the specific sale. If a consumer has purchased a TV and had $50 or more to pay on it when he buys a refrigerator from the same dealer, a new contract is written for the refrigerator. The next $50 paid goes toward the TV and if the payments can not be met on the refrigerator the dealer cannot take title of the TV. That contract is closed.

Deficiency Judgments:
If a TV is bought for $500 and is repossessed after $100 worth of payments have been made, the dealer can require that the original buyer pay the difference between the resale price (e.g., $200) and the amount paid so far when repossessed (e.g., $500 - $100 = $400, resale $200; therefore there is a $200 deficiency). Under the "Code" dealers cannot seek a court order for deficiency of money owed if the original selling price was less than $1,000.

Other References:

Changing Times, March 1969, pp. 39-41.
Consumer Reports, March 1968, pp. 121-125.
A Summary of the Uniform Consumer Credit Code, National Conference of Commissioners, 1155 East 60th Street, Chicago, Illinois 60637.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-8. Steve and Kathy--Their Use of Credit

(See Suggested Learning Experience No. 46, p. 52 in Part One)

You may wish to review the story of Steve and Kathy on p. as you prepare to solve this problem.

Steve and Kathy are faced with a major decision. Their 1965 Impala is in need of repairs that may cost as much as $500. They can't decide if it would be wiser to have the repairs made or to buy a better car.

Use the decision-making process to help them decide what to do.

Consider their goals, values, resources, and style of life. Consider the alternatives and possible outcomes of each alternative. Choose the alternative that seems best to you and tell why this seems like a good idea.

Put your plan into action. For either alternative, give this information: amount of money needed, sources you would contact for a loan, terms you could get, security required, repayment schedule you think they could handle, precautions you would observe, and any other information you consider important in this transaction.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT IX: Credit
IX-9. Credit Baseball[1]

(See Suggested Learning Experience No. 50, p. 53 in Part One)

Preparation

Write a question suitable for a review of the credit unit on the front of each note card given to you. On the back of the card, write the answer to your question and a reference that would substantiate your answer. Use one card for each question and answer. Put all the cards together.

Set up a baseball diamond with bases at appropriate points in the room, or set it up on a bulletin board. You may wish to cut four construction paper or felt bases and a number of baseballs evenly divided between two colors. Arrange baseballs (separating colors) on each side of the lower edge of the bulletin board.

Directions for Playing

1. Divide into two teams.
2. Draw for the first team up to bat. This team may choose the color of ball it wants and then put one ball on home plate.
3. Send one team member up to bat.
4. The pitcher (teacher or student) draws a question from the box and throws (reads) it to the batter who has a few seconds to answer. The batter may give one answer; only the first answer will be accepted.
5. If the answer is incorrect the batter has made an out, and he sits down. If the answer is correct, the batter moves the ball to first base and returns to his seat.
6. This continues with each right answer moving the ball to the next base until home plate is reached and the team scores.
7. Place balls (the "score") in the upper corner of the bulletin board to keep an accurate tally of scores before you at all times.
8. Each time a right answer is given, leave that card out so that the question will not be repeated during this class period.
9. One strike constitutes an out. If each batter is allowed three strikes, the game moves too slowly. Do, however, allow a team three outs before the next team comes to bat.
10. If a question is answered incorrectly, return the card to the box.
11. Play as many innings as time permits as long as enthusiasm is high and students are learning.

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[1]Adapted from game developed by Connie Evans, Homemaking Teacher, Dalton, Nebraska.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-1. Insurance Pre-Test
Insurance ABC's: Risk-Sharing and Planning[1]

(See Suggested Learning Experience No. 1, p. 55 in Part One)

Do you understand the terms given below?

In the space before each term, place the letter of the statement that best describes the term.

_____1. premium	A. Insurance covering losses from destruction or damage of property and losses resulting from lawsuits.
_____2. insurance	B. The amount paid by a person for insurance coverage.
_____3. economic risk	C. A means of protection against loss by sharing the cost of risks with many people.
_____4. property and liability insurance	D. A happening that may present the possibility of financial loss.
_____5. personal insurance	E. Protection against costs of illness and accident and loss of income because of illness, accident, or death.

Do you face risks?

None of us can escape the possibility of risks in our everyday life. Let us consider how we, individually, may be involved in economic risk--risks that may result in loss of things of value or that may affect our personal health and well-being.

a. Divide a sheet of paper into two parts and then print the following headings:

Risks that I face Ways to avoid or reduce the seriousness of each risk

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[1]Reprinted from Policies for Protection. New York, New York: Institute of Life Insurance, 1969. pp. 5, 29.

b. On the left side of your sheet, list the risks you that might face during a full week, covering time you spend at school, at home, at part-time work, and during your recreational hours.
c. On the right side of your sheet, indicate how you might be able to prevent these risks or reduce the seriousness of their effects. Indicate in each instance if it would be worthwhile to be protected by insurance.

Do you agree or disagree with the following statements?

After each statement, place a check mark in the column you feel is correct.

	Agree	Disagree
1. Insurance is made possible because large numbers of people are willing to share the cost of the same kind of risk.	____	_____
2. Some of our risks are shared by paying taxes for protection that is provided by local fire and police departments.	____	_____
3. Most of us can afford to buy insurance to protect us against every possible loss.	____	_____
4. Well-planned income replacement will provide a family with adequate protection as their needs change.	____	_____
5. Protection against the loss of income because of illness, accident, or death is obtained by purchasing property and casualty insurance.	____	_____
6. It is easier for a person to decide how much life and health insurance he needs than it is for him to determine the amount of auto or fire insurance he should carry.	____	_____
7. If a family is covered by enough insurance, it can prevent or avoid economic risks.	____	_____
8. A man without the responsibility of a wife and family never has to worry about income replacement.	____	_____

INSURANCE ABC'S: RISK SHARING AND PLANNING

Answers to Pre-Test

DIRECTIONS: Check your answers to each of the following questions.

Do you understand the terms given on p. 161? Correct answers are:

1. B
2. C
3. D
4. A
5. E

Do you agree or disagree with the statements on p. 162? Correct answers are:

1. Agree
2. Agree
3. Disagree
4. Agree
5. Disagree
6. Disagree
7. Disagree
8. Agree

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-2. Life Is a Risky Business[1]

(See Suggested Learning Experience No. 2, p. 55 in Part One)

It is a typical spring morning in Centerville. On Sycamore Drive, the sidewalks are strewn with tricycles, scooters, and various other toy vehicles--indicating that this is a street where small children play. Mr. Mowbray, who lives at 416, is mowing his lawn. He has been home from work for a few days because of an accident at work and is just getting back on his feet. On the vacant lot across the street from the Mowbray home, a hotly contested ball game is in progress.

Mrs. Jenkins is burning trash just behind her garage. There was a lot of junk in that garage, and this seemed like a good day to clean it out.

Andy Patterson, 17, is backing the car out of the driveway. It was a great day for Andy when he received his driver's license last month. Right now there are many things on his mind--the play at school in which he is trying out for a part, the chance of getting a summer job at the local drug store, and, most important of all, his plans for buying a car of his own.

Mr. Barton who retired last year after 40 years in the office of the Brick and Tile Company, is resting in his favorite chair on his new screened-in back porch.

Thoughts of danger are far from anyone's mind this bright morning. But even on this pleasant street, dangers and risks of all kinds are lurking.

[NOTE TO TEACHER: At this point the students could have been asked to complete the story. For this teacher's objectives, though, it seemed more effective to lead into a discussion, with such questions as:

1. Can you name some of the dangers?
2. What is meant by a risk?
3. How can risks be shared?

This should make the concept of insurance clearer than it often is to students, and they could proceed to analyze the kinds of insurance needed by the people on Sycamore Street. Perhaps their curiosity would be piqued enough for them to ask questions about costs of insurance and about the policies. If students were asked to make recommendations regarding how various people on the street should react to an insurance salesman's call, they could be led to high levels of cognition.]

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[1]Reprinted from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Division of Home Economics Education, University of Illinois, Vol. XIII, No. 2, November-December, 1969. p. 74.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-3. $100,000 or Nothing--A Story About Life Insurance[1]
by Allan Vogelsang

(See Suggested Learning Experience No. 7, p. 56 in Part One)

"I don't know what to do, Nancy," Lynda complained as she sipped her cup of coffee. "I had this $100,000 life insurance policy on my ex-husband for three years, you know. Well, now that he's dead," she paused and dabbed daintly at her completely dry eyes with a pink tissue, "the insurance company refuses to pay me the money!"

"Gosh, Lyn, how awful for you!" Nancy commiserated, reaching out and squeezing Lynda's hand, sympathetically. "Why won't they pay? Did they say?"

"Oh, they said all right. They gave me a list!"

"A list! Were there that many reasons?" Nancy was incredulous.

"I'll say!" Lynda replied, disgustedly. "They started out by reminding me that I lied to them on the application when I said George had never had a heart attack."

"You didn't."

"Sure I did. How else could I have gotten that much insurance?"

"I often wondered," Nancy admitted. "But you said they sent you a list. What else was on it?"

"Oh, they said something about my not having an 'insurable interest' in dear old George when he died," Lynda replied. "You know. 'Cause we were divorced by that time."

"Is that bad? The insurable interest bit, I mean."

"I guess so. They said I had to have it to collect. But then, that was only part of it. It seems that since Goerge committed suicide, the policy is void anyway--or so they say." Lynda lowered her head dejectedly.

"You poor dear, to have to listen to that from those mean insurance people!" Nancy said, consolingly, while filling Lynda's nearly empty cup with fresh coffee. "Sugar?"

---

[1]Reprinted from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Division of Home Economics Education, University of Illinois, Vol. XIII, No. 2, November-December, 1969. pp. 75-76.

"No, thanks, hon. I like it black. Especially when I'm upset like this." Lynda lifted her cup. Setting the cup back on the coffee table, she continued. "And, as if that weren't bad enough, they found out that George was 45 years old instead of only 35, as I'd told them. According to them, that makes the policy void, too."

"Well," Nancy said, "if I were you, I'd fight them. Go get yourself a good lawyer!"

"Oh, what's the use?" Lynda said in a tired voice. "I forgot to pay the premium on January 25, and George went and killed himself on January 30--the louse! That means, or so the insurance company told me, that the policy wasn't in force at the time of old Georgie's death." She gazed around the room, sadly taking note of all the material wealth which belonged to Nancy rather than to her. Mentally she had already spent about half of the hundred thousand. She said, "Boy, I could almost taste that bundle!" She lifted her cup, which had been refilled again by that excellent hostess, Nancy, and drank.

[NOTE TO TEACHER: The story can be followed by a role playing session between Lynda and her attorney. The attorney could be the teacher, a resource person, or a student who had been primed for the role by previous reading and discussion with appropriate persons.

In the role playing session, Lynda and the class learn the following regarding the insurance company's disclaimer of liability:

1. The fact that Lynda lied about her husband's heart attach would not be relevant after three years because of the "Incontestable Clause."

2. The divorce would not release the company from liability because an insurable interest is not necessary at the death of the person whose life was insured, provided it was present when the policy was first taken out.

3. The sucide clause usually provides that the company will pay for death from this cause after the policy has been in force for two years.

4. The misstatement of George's age only reduces the amount payable to the beneficiary to that which would be payable for the amount of premium paid. It does not void the policy.

5. The fact that George killed himself after the premium was due does not excuse the company from paying, because his death occurred within the thrity-day grace period.

The "attorney" would have real insurance policies to support his statements which would be shown or read to the class. If some companies' policies differ on these points, this would be pointed out. State insurance laws vary. Contact your state insurance commissioner in the capital of your state.]

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-4. Dollars for Health

(See Suggested Learning Experience No. 19, p. 57 in Part One)

IKE BRANDON

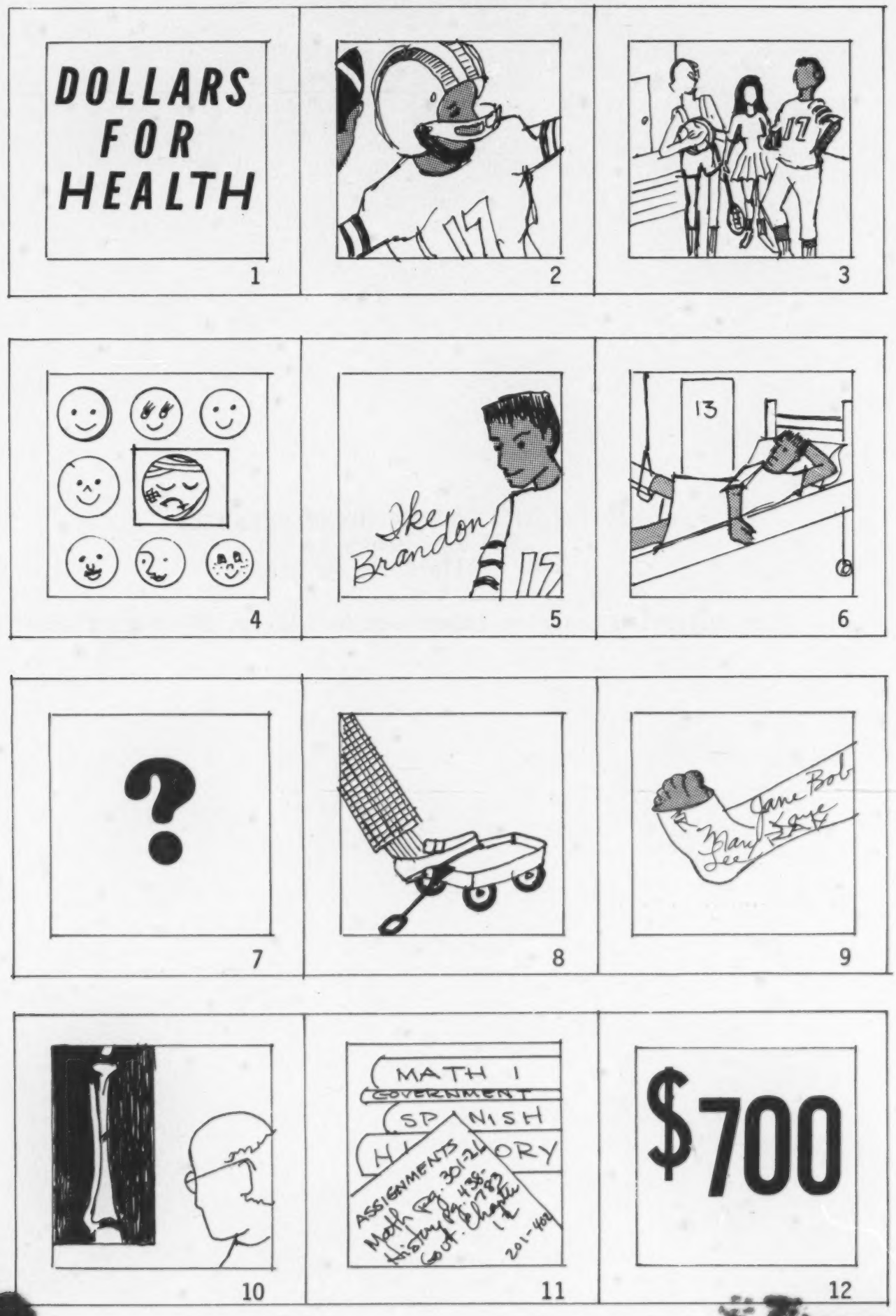
DOLLARS FOR HEALTH
1
2
3
4
Ike Brandon
5
13
6
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8
Jane Bob
Mary Lee
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MATH I
GOVERNMENT
SPANISH
ASSIGNMENTS
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History pg. 438-
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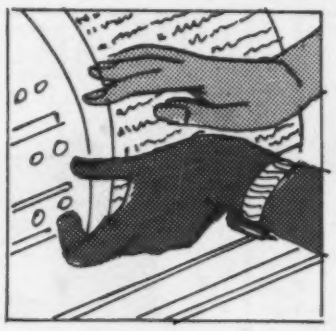

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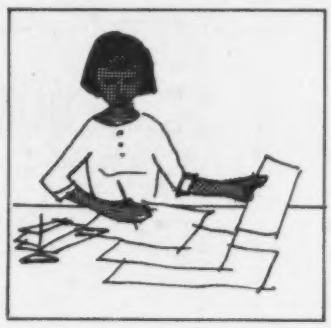

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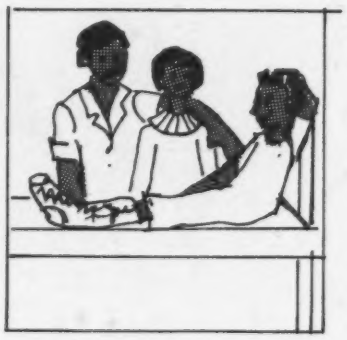

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GINNY TODD

19

20

21

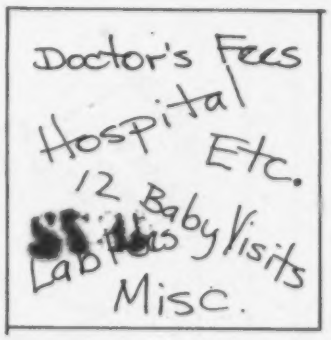

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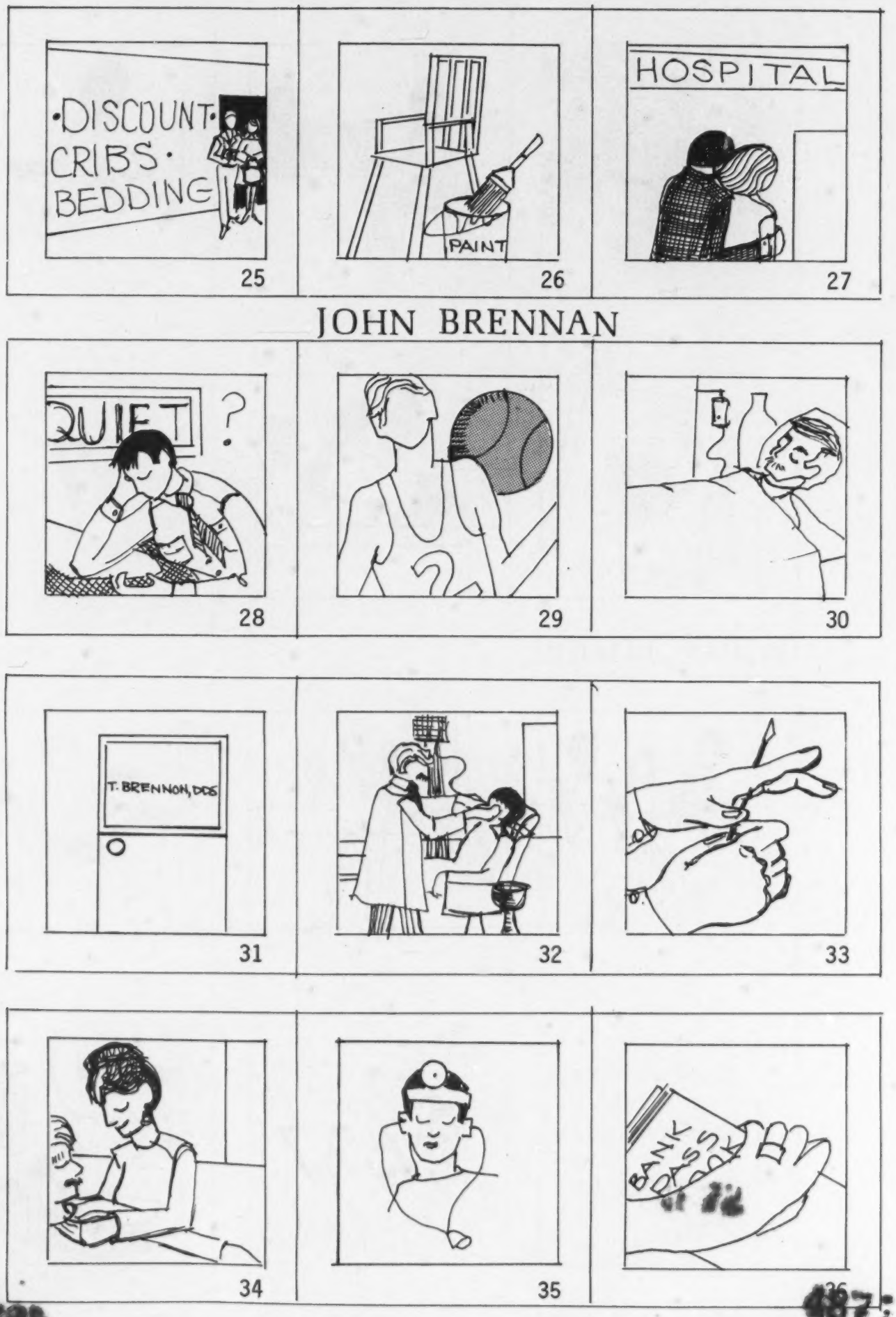
·DISCOUNT·
CRIBS·
BEDDING
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PAINT
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HOSPITAL
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JOHN BRENNAN
QUIET ?
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T. BRENNON, DDS
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BANK BOOK
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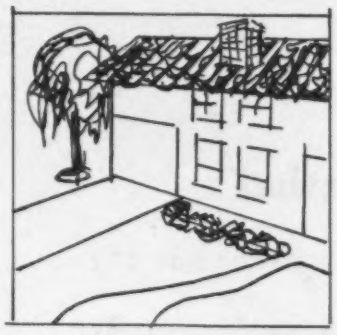

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FOR TYPEWRITER COPY

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-4. Dollars for Health (Script)

1. Dollars for Health

   Presented by the
   Health Insurance Institute

   Developed with the cooperation of:
   Dorothy W. Hamilton
   Chairman, Social Studies Department
   Milford High School
   Milford, Connecticut

   Justine B. O'Reilly
   Supervisor, Home Economics
   Portland Public Schools
   Portland, Oregon

   Enos C. Perry
   Director, Bureau of Business Education
   Board of Education
   Chicago, Illinois

2. We Americans lead active lives.

3. We're probably the healthiest people the world has ever known.

   Nonetheless, loss of health is still an ever-present threat to all of us.

4. This year, for example, nearly one out of eight Americans will be hospitalized.

   Many problems are created by ill health. Perhaps you'll have a better understanding of these problems after viewing episodes in the lives of the three young people we just met.

5. Let's begin with the football player, Ike Brandon. His particular story does not take place on an athletic field.

6. Instead, we find him in a hospital bed. Ike, of all people!

7. Why...this fellow never even got hurt on the football field. "Iron Ike," the school paper calls him.

8. But the wagon his brother left on the back stairs last week proved more dangerous than a guard's tackle...

9. ...and in no time at all, Ike's iron leg became a plaster "autograph album."

10. Unluckily, Ike has a compound fracture. No more football this year. No dancing, or running around with the gang, either.

11. And what about school work? Even with help, he'll have a job keeping up. There's something else, too...

...What would you think a broken leg can cost these days--excluding the valuable, authentic signatures, of course?

12. In Ike's complicated case, these are the costs:

Semi-private room and board	
8 days @ $30.00 per day	$240.00
Operating room	45.00 & up
Anesthesia	15.00 & up
Laboratory	50.00
X-ray examinations	50.00
Plaster and drugs	30.00 (est.)
Emergency room	10.00
Recovery room	10.00
Hospital costs	$450.00
Fee for orthopedic surgeon	250.00 & up
Total cost	$700.00

$700 for a broken leg! Ike's leg can't be made of iron. It must be solid gold. Where will all that money come from?

13. It's Ike's father, a mechanic, who must provide the answer.

To Mr. Brandon, $700 is a large sum, even if he is the best paid man in his shop.

14. Fortunately, the Brandons have insurance protection, even against the cost of broken legs.

15. Therefore, Ike's accident will merely mean a few rearrangements of family plans.

16. This year, for instance, they'll have to skip the vacation trip to grandma's.

17. But no great sacrifices are called for...even to meet medical expenses.

...The money was there when it was needed.

18. What type of insurance do you think Mr. Brandon has which takes care of Ike's leg?...

19. Now let's turn to Ginny Todd. Indirectly, Ginny has been made very much aware of medical costs.

20. Her married sister, Sue, is about to have her first baby.

21. Occasionally Ginny sits in on what Sue's husband, Al, calls "planning sessions."

22. Estimated medical costs of expected baby:

Doctor fees including delivery	$200
Hospital	250-300
12 prenatal check-ups	100
Miscellaneous laboratory fees, etc.	15 and up
Labor-Delivery room	45 and up
Anesthesia	6 and up
Medicine	10-30

23. Ginny never realized how maternity expenses mount up. And that's not all...

24. There are the bassinet, baby clothes, and a hundred other items.

    Of course, there were many months to prepare, so everything has been budgeted in advance.

25. According to the plan, Sue and Al buy the things they need bit by bit.

26. They count on many hand-me-downs, too.

27. Like most young families, Sue and Al must make every penny count. But...they'll have no trouble with hospital expenses...

    ...the hospital plan at Al's office helps take care of these expenses.

28. In what ways has Al provided financially for the birth of their child?

29. And now let's find out about Ted Brennan, the third member of the trio.

30. Ted certainly knows about ill-health, for his father recently had a heart attack.

31. Since his father is a dentist, the disability is especially unfortunate, for a dentist's job is strenuous.

32. It means being on his feet, concentrating intensely, often as much as 10 hours a day.

    Though he gets some assistance, Dr. Brennan does all the important work himself.

33. You might say his business life depends on the skill of his own two hands.

34. But now he must depend on the hands of others, especially those of his wife.

35. He must have complete rest for several months. Even, then, he may not be able to continue being a dentist.

    Today, Dr. Brennan's office is empty. His income has disappeared.

    And his <u>own</u> expenses will be both prolonged and heavy.

36. True, the Brennan bank book shows a sizeable balance.

37. But these savings alone couldn't maintain the Brennans for very long... even at reduced living standards.

38. Could this mean that the Brennans will have to sell their lovely home?

39. These problems are on Dr. Brennan's mind although he knows worry slows recovery.

40. What form of protection might Dr. Brennan have had to free him from financial worries?

41. Now you've seen how sickness and accidents can affect your lives.

    And you should be aware of some of the ways to provide the necessary dollars for health.

42. What types of health insurance policies would have been best in each of the cases in the film?

    Should health insurance be purchased to cover all possible medical expenses? Or should it cover only serious sickness and accidents? What are some of the factors to be considered when deciding?

    What organizations provide protection against the costs of hospital, medical care, and the loss of income?

    Help in answering these questions is available from many sources, including the Health Insurance Institute and the Educational Division, Institute of Life Insurance.

The End
Adpated by the
Home Economics
Instructional Materials Center
Texas Tech University
Lubbock, Texas

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-5. What Have We Learned About Insurance[1]

(See Suggested Learning Experience No. 26, p. 58 in Part One)

Matching Items

Directions: There are four basic types of life insurance policies: (a) term, (b) straight life, (c) limited payment, and (d) endowment. Answer each question below by selecting one of these basic types and writing the letter that precedes your choice in the answer space provided.

_____1. Costs less than the other three types.
_____2. Has a cash value at maturity equal to the amount of insurance purchased.
_____3. Is the most flexible.
_____4. Premiums are payable as long as the insured lives.
_____5. Savings values increase most rapidly.
_____6. Premiums are paid for a stated number of years, after which the policy is paid up for life.
_____7. Has no cash value.
_____8. The cheapest form of permanent insurance.
_____9. Is considered temporary insurance.

Situation Analysis Items

Directions: Each of the four basic types of life insurance policies (term, straight life, limited payment, and endowment) has special features designed to serve specific purposes. For each situation described below, indicate which basic type would be most suitable. Write your choices in the answer spaces provided.

10. A high school student who has no insurance.

_____

11. A policy taken when a child is five years of age to help finance his college education.

_____

12. The head of a family who has borrowed a large sum of money which he is to repay over the next five years.

_____

13. A professional man age 45 whose children are grown and who earns a large income and who is more interested in protection for his wife than in retirement for himself.

_____

[1]Reprinted from Policies for Protection. New York, New York: Institute of Life Insurance. pp. 26-27.

14. A man age 30 who already has $20,000 of straight life and who has just bought a home with a $10,000 mortgage on it.

_____

15. A businessman whose family is grown, who plans to retire in a few years and is largely concerned with building up as much retirement income as possible.

_____

Rating Scale

Directions: Below are several statements pertaining to the various aspects of insurance you have studied. For each statement indicate the degree to which you agree or disagree with it by writing the appropriate letters (SA-A-D-SD) on the short line following the statement. Then using the lines beneath the statement, justify your position, giving reasons to support it.

SA--strongly agree
A--tend to agree
D--tend to disagree
SD--strongly disagree

16. The amount every wage earner should spend for insurance protection is 10 per cent of his income. _____

_____

_____

17. The typical family can wisely buy as much insurance as it can afford. _____

_____

_____

18. The head of a family should buy all types of insurance. _____

_____

_____

19. Everyone should study his economic risks carefully and purchase first the insurance protection he needs most. _____

_____

_____

20. Most persons should buy straight life insurance because it is the cheapest form of permanent protection. _____

_____

_____

21. Young married men should buy limited payment life insurance so they won't have to pay premiums during their retirement years. _____

_____

_____

WHAT HAVE WE LEARNED ABOUT INSURANCE?

Answer Key

DIRECTIONS: Check your answers to each of the items numbered below.

Matching Items (p. 176)

1. A
2. D
3. B
4. B
5. D
6. C
7. A
8. B
9. A

Situation Analysis Items (pp. 176-177)

The answers given here are recommended. Without more information, it is possible to give logical reasons for other answers.

10. Straight life
11. Endowment
12. Term
13. Straight life
14. Term
15. Endowment

Rating Scale

Either "disagree" or "strongly disagree" may be accepted for questions 16, 17, 18, and 21. Questions 19 and 20 may be marked "agree" or "strongly agree."

16. D or SD The amount of insurance purchased depends upon individual and family needs.

17. D or SD Consultation with an insurance agent is strongly recommended.

18. D or SD The types of insurance policies purchased depend upon individual and family needs.

19. A or SA Each family should set its own priorities.

20. A or SA It is difficult to generalize, but this is the "all purpose" type of life insurance.

21. D or SD They may have great need for protection now. The money which they can set aside for premium payments would buy more permanent protection if they purchased straight life instead of limited-payment life.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-6. Crossword Puzzle on Insurance[1]

(See Suggested Learning Experience No. 27, p. 58 in Part One)

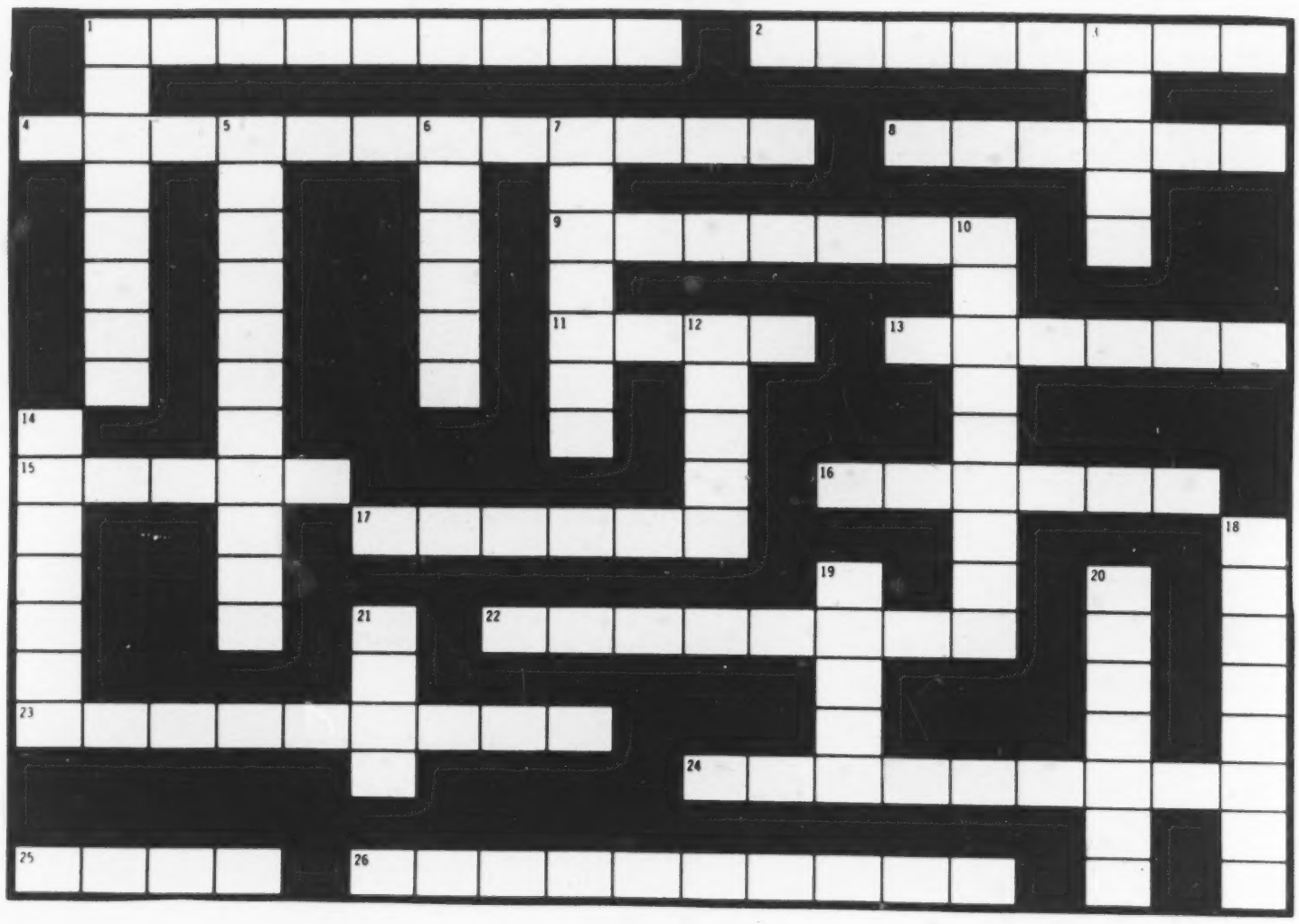

ACROSS

1. Type of life insurance that amounts to an insured savings plan.
2. The least expensive type of permanent protection in life insurance is _____ life.
4. A person who has insurance.
8. Disability insurance pays for loss of _____.

---

[1] Reprinted from Policies for Protection. New York, New York: Institute of Life Insurance. p. 24.

9. Hospital, surgical, and _____ insurance are often called basic health coverage.
11. Type of life insurance policy that protects for a given period of years.
13. A provision that under certain conditions an insurance policy will be kept in full force by the company without the payment of premiums is called a _____ of premium.
15. A family income _____ may be added to a straight life policy.
16. An insurance contract.
17. Life Underwriters Associations are organizations of insurance _____.
22. Having insurance gives one a feeling of _____.
23. Insurance companies help finance home and apartment buildings by investing in _____.
24. A means of sharing risks.
25. A permanent life insurance policy has a _____ value, which the policyholder may borrow against.
26. A double indemnity policy pays double when death results from _____ means.

DOWN

1. Type of risk that may cause financial loss.
3. Type of insurance plan often provided by a wage earner's company.
5. The insurance company puts money to work in _____.
6. The two types of personal insurance are life and _____.
7. The type of insurance premiums are paid for a set number of years but protection lasts for life is called _____ payment.
10. Type of insurance that protects against the claims of other people if the insured person should injure them or damage their property.
12. Charges for insurance are known as premium _____.
14. Amount paid for insurance.
18. Overhead insurance is a type of _____ health insurance.
19. Chance of losing something of value.
20. Surgical _____ insurance is a type of health insurance.
21. All permanent life insurance has _____ values. This means that insurance protection need not be given up to get the use of cash in an emergency.

ANSWERS

ACROSS
1. Endowment
2. Straight
4. Policyholder
8. Income
9. Medical
11. Term
13. Waiver
15. Rider
16. Policy
17. Agents
22. Security
23. Mortgages
24. Insurance
25. Cash
26. Accidental

DOWN
1. Economic
3. Group
5. Investments
6. Health
7. Limited
10. Liability
12. Rates
14. Premium
18. Business
19. Risks
20. Expense
21. Loan

4884

SECTION ONE: ALLOCATION OF RESOURCES
UNIT X: Insurance
X-7. Insurance Jeopardy[1]
Allan Vogelsang
(adapted from TV to teach insurance)

(See Suggested Learning Experience No. 30, p. 58 in Part One)

Preparation required: Construct a large board with hooks on which to hang cards (about 4' x 4'). Cards have a score on one side and a question or an answer on the other. Scores range from 10 to 60 under each category, and questions become more difficult as scores increase. A skillful teacher might construct questions in the six levels of the cognitive domain[2]: repeating knowledge learned, stating knowledge in own words, applying knowledge, analyzing, synthesizing, and evaluating. Several questions at each level under each category will be needed. In this game, the categories of insurance are automobile, home and property, health, and life.

The class may be divided into three (or more) teams and each team member given a noise maker with which to signal his readiness to answer the questions. The members of one team may have whistles, another bells, and the third snappers. In this way, it can easily be determined which team signaled first.

Rules of Play: Some means of determining which team will select the first questions is decided upon, e.g., "Guess a number between 1 and 10," or draw slips of paper marked 1, 2, and 3.

The first team chooses a category and a level, e.g., auto at 10. That card is turned over for all to see (or it is read aloud) and anyone who thinks he can answer the questions (or, in this case, provide the question which fits the given answer) signals with his noisemaker. The first to signal is given a try. If correct, his team scores that amount (in this example, 10); if not, his team has that amount subtracted from its score.

If answer is correct, that team chooses another category and level, e.g., health at 30. If incorrect, other members may signal immediately to have a try.

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[1]Reprinted from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Division of Home Economics Education, University of Illinois, Vol. XIII, No. 2, November-December, 1969. pp. 66-67.

[2]Bloom, Benjamin et al., editors. Taxonomy of Educational Objectives: Cognitive Domain. New York, New York: David McKay Company, Inc., 1956.

Play may continue until all cards are turned over or for a specified time. Team scores determine the winner.

The game may be used for review or evaluation without resources, but if used in the beginning of the insurance study, an assortment of bulletins, books, posters, charts, etc., should be available from which students can discover needed information. Time limits would need to be longer in this circumstance.

SECTION ONE: ALLOCATION OF RESOURCES
UNIT XII: Taxes--I.Q. Pre-Test

(See Suggested Learning Experience No. 1, p. 65 in Part One)

Answer the following questions:

1. Who pays for public services such as the library and park?
2. What are some of the different taxable items you purchase?
3. What benefits and services do the taxes from these items provide you?
4. Who picks up the litter on the highways? Who pays for this service?
5. From where does the money come for those people who receive welfare payments?
6. Who decides what the local school tax will be?
7. What local services are provided as a result of taxes?

PART TWO

SECTION TWO: CONSUMER BUYING

SECTION TWO: CONSUMER BUYING
UNIT II: Principles of Consumer Purchasing
II-1. Retail Stores
II-2. Non-Retail Stores
II-3. Cooperatives

(See Suggested Learning Experience No. 3, p. 75 in Part One)

RETAIL STORES

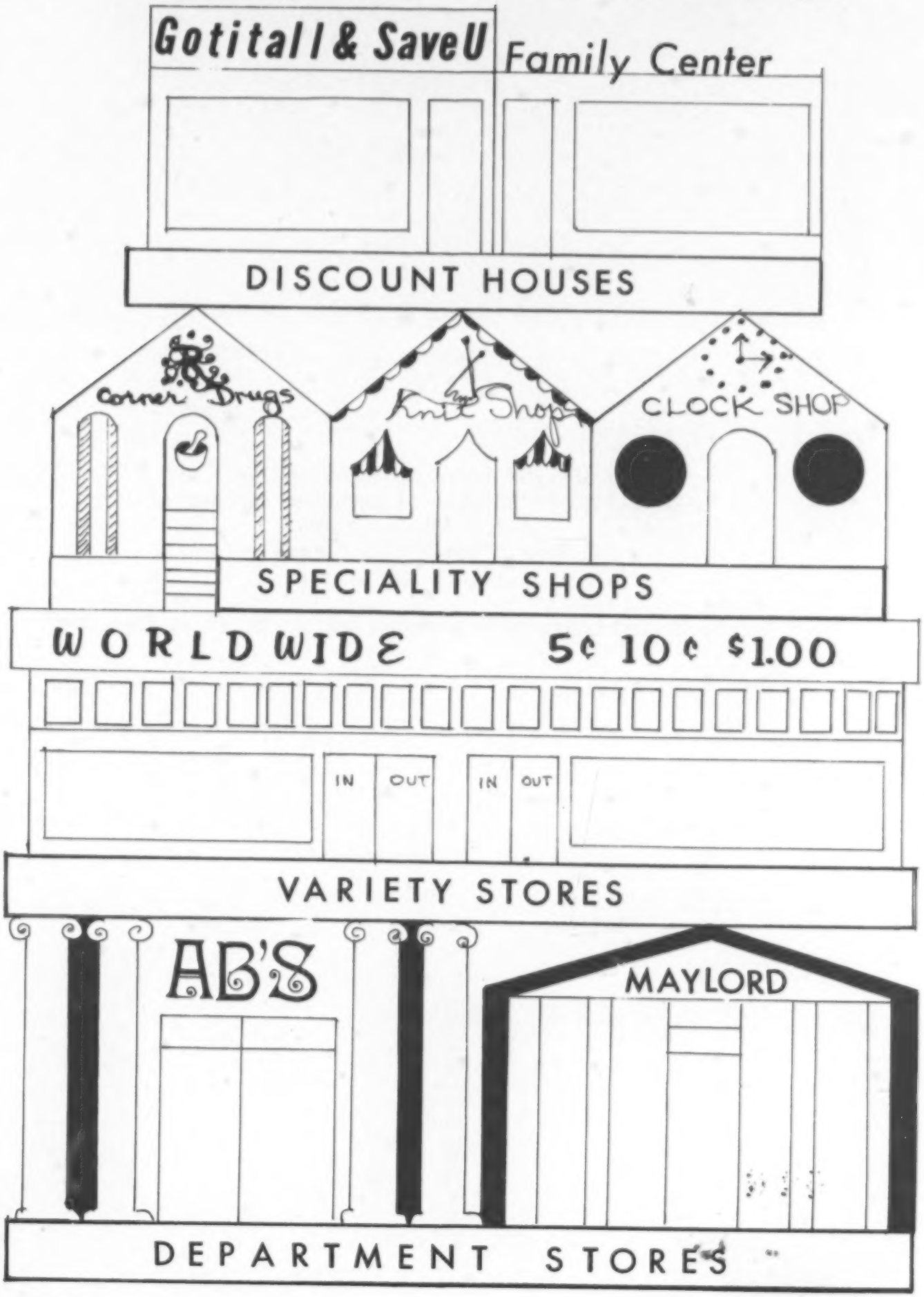

4890

NON-STORE RETAILERS

door-to-door sales

vending machines

mail order

4891

COOPERATIVES

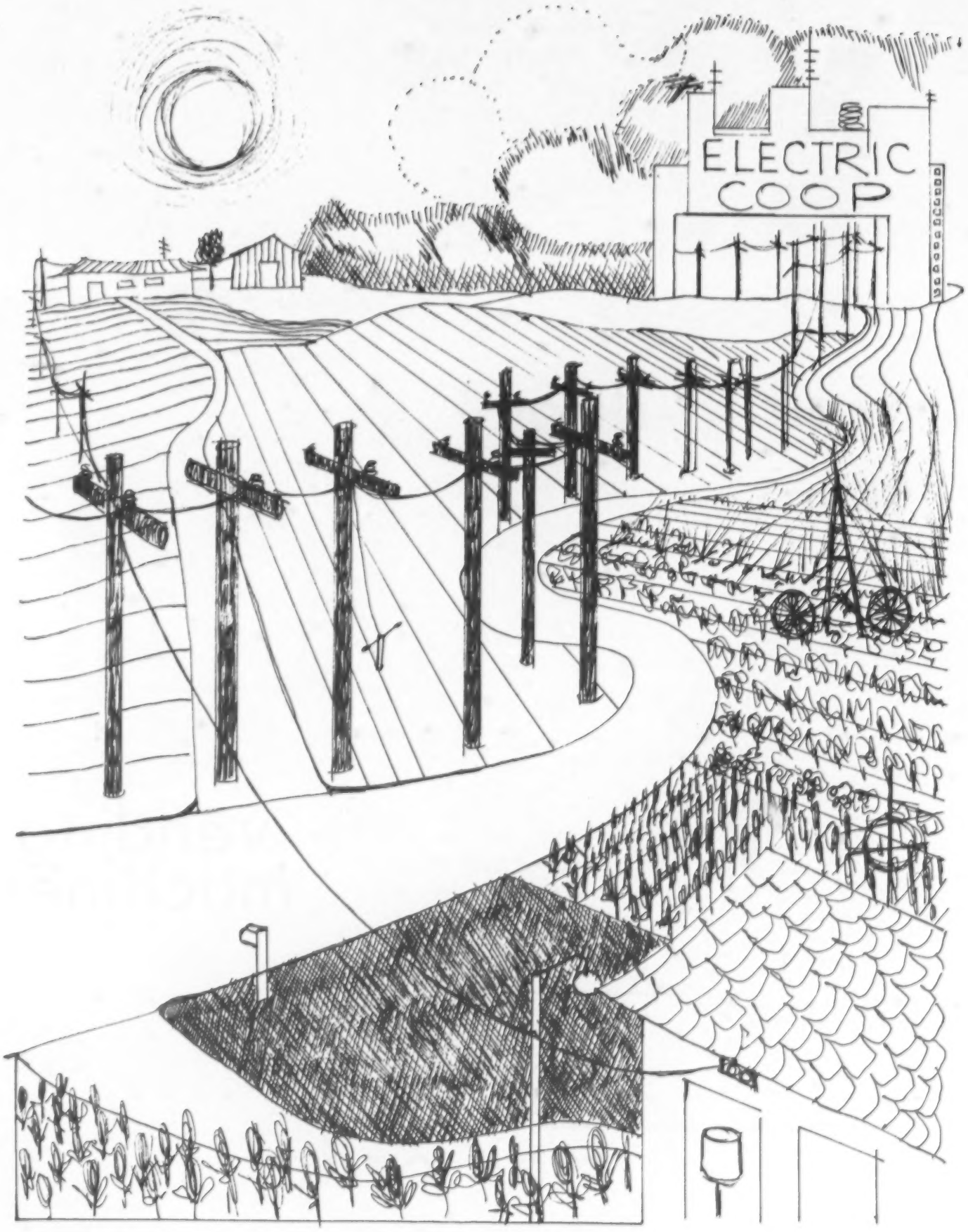

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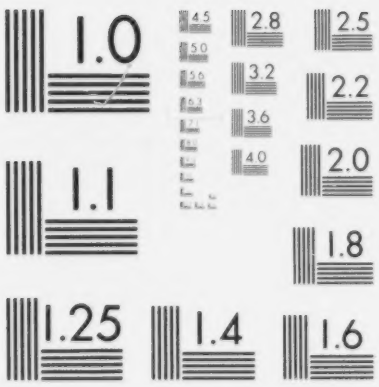

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SECTION TWO: CONSUMER BUYING
UNIT II: Cooperatives
II-4. Services of Shopping Facilities

(See Suggested Learning Experience No. 4, p. 76 in Part One)

Check type of shopping facility visited:

Department store _____
Variety store _____
Door-to-door selling _____
Vending machines _____
Speciality store _____
Discount store _____
Mail-order _____
Cooperative _____

In the blanks at the left, check services offered by the shopping facility you visited. In the space at the right, jot down any pertinent information that would help you report on the services of this facility.

_____ 1. Wide selection of merchandise
_____ 2. Different price levels
_____ 3. Return privileges
_____ 4. Approval privileges
_____ 5. Alterations
_____ 6. Convenient shopping hours
_____ 7. Night shopping
_____ 8. Physical plant--attractive and well kept
_____ 9. Desirable location
_____ 10. Adequate, free parking facilities
_____ 11. Self-service
_____ 12. Well-trained sales people
_____ 13. Sales staff adequate to handle customer load
_____ 14. Evidence of customers receiving personal service
_____ 15. Personal shopping
_____ 16. Decorator or other consulting services
_____ 17. Merchandise attractively displayed
_____ 18. Prices on merchandise clearly marked
_____ 19. Free delivery
_____ 20. Mailing facilities
_____ 21. Adequate opportunity to inspect merchandise
_____ 22. Customer credit (find out types if offered)
_____ 23. Insurance on credit contracts or merchandise
_____ 24. Check cashing privileges
_____ 25. Profit-sharing with customers
_____ 26. Installation service (where applicable)
_____ 27. Repair service (where applicable)
_____ 28. Other cutomer services offered--list below

_____
_____
_____

Cost of three items class chose to compare:
Item 1 _____ Item 2 _____ Item 3 _____

SECTION TWO: CONSUMER BUYING
UNIT II: Cooperatives
II-5. Consumer-Sponsored Services

(See Suggested Learning Experience No. 8, p. 76 in Part One)

1. Consumer's Research, Inc.--outgrowth of what was originally a small club for the study of consumer goods. Now a national organization, nonprofit corporation, with extensive laboratory testing facilities. Subscribers are not members, but purchasers of periodical literature. Large staff of professional research and technical personnel who test and rate the efficiency of consumer products through scientific testing methods; develop testing methods and procedures; advise educators in the economics of consumption; provide consulting services on technical problems for consumers, government agencies, and others; and publish monthly and annual reports (Consumers' Research Bulletin) on products. Products are listed by name as recommended, intermediate, or not recommended and price level is indicated as low or high. (Washington, New Jersey 07882)

2. The American Council on Consumer Interests--nonpartisan, nonprofit organization serving consumers primarily through the publication of a series of booklets dealing with vital issues. Typical titles: Consumers Look at Fair Trade, What You Should Know About the Law of Estates, Consumers Look at Antitrust Laws. Publishes newsletter and Consumer Education Forum, serves as clearinghouse for consumer information materials, and conducts annual conference devoted to consumer problems. (15 Gwynn Hall, University of Missouri, Columbia, Missouri 65201)

3. Consumers Union of United States, Inc.--nonprofit organization. Purposes are (1) to provide consumers with information and assistance on all matters relating to consumer goods and services; (2) to give information and assistance on all matters relating to expenditure of family income; (3) to initiate and to cooperate with individual and group efforts that seek to create and maintain acceptable living standards. A large technical staff is employed in laboratories, and part-time shoppers buy sample products to send to the laboratory for testing. Ratings of products are based on laboratory tests, controlled-use tests, and expert opinion or experience or a combination of these factors. They publish monthly and annual reports on tests of products in Consumer Reports. Brands are grouped as acceptable and not acceptable. (Mount Vernon, New York)

4. Consumer Cooperatives--groups or organizations established to provide goods or services at lowest possible cost without sacrificing quality. They operate for benefit of their members as individual consumers. They subscribe to certain basic principles: (1) membership is open to any person, (2) each member has only one vote regardless of how much he has invested, (3) no profits are permitted, (4) members should obtain the best possible product or service at the most economical price, and (5) maximum information regarding products or services should be given to all members.

5. The Cooperative League of the U.S.A.--a national federation of cooperatives. Their purpose is to promote cooperatives and the benefits of cooperatives and to maintain an effective consumers' lobby in Washington. Consumers' Lobby is published monthly and is available at no charge to

persons who can produce concrete evidence of having communicated with their congressman or senator at least once during a three-month period. It contains reports on impending legislation and advice on steps deemed appropriate on the consumer's part.

6. National Consumers League--is supported by dues and contributions from its members. Its purpose is to promote legislative action in the interest of consumers. It has supported the efforts for pure foods and drugs, drug safety and efficacy, truth-in-lending, truth-in-packaging, and better health insurance. Publications include "Fact Sheets," legislative alerts, and information regarding other consumer protection needs. (Washington, D.C.)

7. Consumer Federation of America--was chartered in 1967 and employs a full-time executive director. Voting members are city, county, regional, state, and national consumer organizations, whereas nonvoting members are state or national consumer-oriented organizations sympathetic to the work of CFA, such as trade unions, state organizations, and national organizations such as the YMCA. It publishes a newsletter, Consumer Action, in which information about pending legislation is described. Another function is to serve as a clearinghouse for an exchange of project information among local, state, and national groups. CFA concentrates on fact-finding and analysis of consumer issues, alerting its member groups, testifying before congressional committees and federal agencies, and providing a voice for all consumers in the nation. (Washington, D.C.)

SECTION TWO: CONSUMER BUYING
UNIT II: Cooperatives
II-6. Professional Organizations

(See Suggested Learning Experience No. 15, p. 77 in Part One)

1. American Home Economics Association--has promoted the education, welfare, and protection of consumers. It supports legislation designed to protect the interests of consumers through (1) establishment of standards of quality and identity; (2) provisions for informative labeling and informative advertising; (3) prohibition of fraudulent practices and sale of harmful goods and services; (4) prohibition of restraints on trade which increases consumer prices. It has published a series of buying guides which are available through Consumer Interests Committee. (1600 20th St., Washington, D.C. 20009)

2. American Medical Association--promotes the improvement of the quality of medical products. Special committees and councils are assigned to test medical products and apparatus. It publishes a monthly periodical--Today's Health, distributes pamphlets, and occasionally sponsors educational radio and television programs. (535 N. Dearborn St., Chicago, Illinois 60610)

3. American Dental Association--protects and informs the public in regard to dental products. The Council on Dental Therapeutics studies products which are claimed to have healing or curative qualities (therapeutic values). After investigation a product may be accepted by the Council, which means it meets certain standards dealing with its composition and the advertising concerned with it. A seal of acceptance may be used by the manufacturer of a product if it has been accepted by the Council, but this does not mean that it is recommended by them. (211 E. Chicago Avenue, Chicago, Illinois 60611)

4. American Association of Nurserymen, Inc.--sets standards for grading nursery stock. (825 Southern Building, Washington, D.C. 20005)

5. National Association of Bedding Manufacturers--recommends standards for mattresses. (724 9th St., N.W., Washington, D.C. 20001)

6. National Home Study Council--provides information on reputable home study courses. (1601 18th St., N.W., Washington, D.C. 20009)

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SECTION TWO: CONSUMER BUYING
UNIT II: Cooperatives
II-7. Julie Meets a Salesman[1]
by Lois Guebert

(See Suggested Learning Experience No. 26, p. 78 in Part One)

Julie Smith came home from work Friday evening with her first $60 paycheck. She couldn't have been happier. She had graduated from high school the Friday before and had begun work as a secretary on Monday. Her boyfriend had given her a diamond for graduation, and they were planning to be married the next summer.

Julie's parents were very proud of her and delighted about the engagement. They had known David, her fiance, for several years. They immediately announced her engagement in the local newspapers. As soon as the announcement appeared in the paper, Julie began to get mail on special offers, bargains, and insurance plans. Since none of this seemed to be interesting reading, she rapidly threw it away.

One Saturday about a month later, when Julie was home alone, the doorbell rang. There stood a very nice looking young man in a dark business suit.

"Hello, are you Julie Smith?" said the man.

"Why, yes. Can I help you?" said Julie, quite surprised that he knew her name.

"I saw in the paper that you will be getting married soon and I have something I'm sure you will be interested in seeing," replied the man. "Have you started on your hope chest yet?"

"Well, just barely," Julie said rather cautiously.

"Do you have a few minutes so that I could show you our special offer?" said the anxious salesman.

"I suppose so," answered Julie, thinking that it wouldn't hurt just to look.

The salesman went to his car and came back with two huge suitcases filled with pots and pans. He then proceeded to explain the advantages of his line of cookware and how a kitchen just wasn't complete without a set, such as he had to offer. He even demonstrated how easy it was to bake a cake in his skillet right on top of the range.

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[1]Reprinted from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Division of Home Economics Education, University of Illinois, Vol. XIII, No. 2, November-December, 1969. pp. 77-78.

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"There are three types of sets from which to choose," he explained. "They begin with the basic set for $150 and the complete set for $300."

"Oh, I can't possibly afford anything like that," said Julie. "I'm trying to save money for our furniture. What would just one small saucepan cost if I bought it alone?"

"Well," he began to stammer a little, "the 2-quart size is $20.00. But don't worry about the money, we'll work out an agreement for payment with you. A down payment of only $10 is all that is necessary. You can pay the rest off in small weekly or monthly payments," he continued. "Your friend, Sally Miller, just purchased this set this morning and I sold three others like it yesterday. Now if you will just fill out this form and decide which set you want, it will be sent to you within a week."

"Now, wait a minute," replied Julie quickly. "I realize that this line is of good quality and may be a good bargain, but I need time to think it over and discuss it with my parents and my finace."

"There's one thing I failed to mention earlier," he said. "If you agree to buy any of these sets today on the first call, you will receive our $30.00 electric fry pan or a four piece starter set of our fine china absolutely free. Now you can't afford to pass that up, can you?"

Julie was really in a state of confusion as to what to do. She had never been faced with a decision such as this before. Much money was involved, and the salesman wasn't giving her any time to think straight. He kept on talking to distract her. However, she did remember her mother always reminding her never to rush into anything unless she was absolutely sure of what she was getting and that it was worth the money. Since she wasn't sure, she told the salesman, convincing as he was, that she wanted to think about it some more and that she would call him if she decided to buy the set.

When he left, Julie looked at the clock. The salesman had spent over an hour trying to sell his product. She smiled and felt proud of herself.

"He didn't talk me into it," she said aloud.

"Into what?" asked her mother, as she walked in the door.

[NOTE TO TEACHER: This story could be followed by a discussion or a role playing session in which the consequences of this decision, and of the alternative decision of buying the cookware, are brought out. The contract Julie refused to sign could be shown. Follow-up activities could include role playing with a vacuum cleaner salesman, a brush salesman, and other door-to-door sales people.]

SECTION TWO: CONSUMER BUYING
UNIT II: Cooperatives
II-8. How Much Do I Tell?

(See Suggested Learning Experience No. 34, p. 79 in Part One)

Information*	Labels 1	2	3	4	5	6	7	8	9	10
1. Name of product										
2. Brand name or trademark										
3. Name & address of manufacturer or distributor										
4. Geographical source										
5. Conditions under which goods are produced										
6. Production or expiration date										
7. Quantity and/or size of product										
8. Form and/or size of product										
9. Composition of product										
10. Construction of product										
11. Grade										
12. Performance in use										
13. Directions for use and care										
14. Safety warnings										
15. Approvals and guarantees										

*Explanations of these categories of information may be found in Your Shopping Dollar. Money Management Institute, Household Finance Corporation, 1966. p. 21.

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CONSUMER TWO: CONSUMER BUYING
UNIT II: Cooperatives
II-9. Private, Business, and Industrial Organizations

(See Suggested Learning Experience No. 36, p. 80 in Part One)

1. Advertising Federation of America--Proposes to explain advertising to the public; to raise continually higher the standards of truth and good taste in advertising; to help make advertising more effective for business and more useful to the public; to help protect advertising against harmful restrictions and possible taxation; and to encourage improvement in education for men and women in or preparing for advertising careers.

2. American Association of Advertising Agencies--Sets advertising standards and hears complaints on objectionable advertising.

3. American Automobile Association--Lists approved establishments in the travel guides it supplies to members. Maintains a staff of field reporters who inspect and report on hotels, motor courts, restaurants, and other establishments that cater to the traveler.

4. American Gas Association--Tests and certifies more than 95 per cent of all gas appliances sold in the United States and Canada. Certifies that the product meets standards of economy, safety, and durability.

5. American Institute of Laundering--Tests fabrics in goods and ready-made garments for shrinkage, colorfastness, crocking, and other laundering properties. Provides labels of approval which manufacturer may attach to garment or cloth which has passed tests of washability. Issues periodic information bulletins to their members on the care and handling of different fabrics and materials. Operates a training school to prepare people for jobs in the laundering field.

6. American Standards Association--Provides a systematic means among its members for development of American standards. Standards of quality as well as of size and type have been developed.

7. Better Business Bureaus--Improves advertising by eliminating misleading advertising and unethical promotional schemes. Investigates unfair competition among distributors and unfair treatment of consumers. Publishes information booklets for consumers.

8. Better Fabrics Testing Bureau--Tests and rates dye and other properties of fabrics. Provides seals of approval for goods which are satisfactory for the purpose intended. (One applies only to color--Color Tested, the other to more general characteristics.)

9. Electrical Testing Laboratories--Tests and inspects electrical equipment and other products. Awards certification by ETL or by a sponsoring industry group to tested items which comply with certain established standards.

10. Good Housekeeping Institute--Studies and tests products discussed or advertised in Good Housekeeping magazine. Product must meet tests for quality and make truthful advertising claims before it is advertised or given the Consumers' Guarantee Seal which promises that Good Housekeeping will replace or refund purchase cost to consumer if the product or performance is defective.

11. National Association of Investment Clubs--Provides guidance for investment clubs; a nonprofit organization.

12. National Association of Real Estate Boards--Sets up a code of ethics for real estate agents. Members usually display their membership certificate and are permitted to use the term "realtor" in their advertising.

13. National Canners Association--Sets up minimum standards for can sizes, fill, quality, and descriptions of canned products. Association members are encouraged to pack their products in accordance with these standards.

14. National Consumer-Retailer Council, Inc.--Promotes adequate standards for consumer goods and encourages informative labeling and advertising; a nonprofit organization of consumer and retail organizations.

15. National Institute of Dry Cleaning--Tests fabrics in goods and ready-made garments for dry cleaning properties. Provides certification of products which meet their standards. Issues periodic information bulletins to their members on the care and handling of different fabrics and materials. Operates a training school to prepare people for jobs in the dry cleaning field.

16. Nationwide Consumer Institute, Inc.--Tests consumer products, many for Parents' Magazine; a private organization. Arranges with impartial consultants and consumer advisors to test products by use.

17. Nationwide Consumer Testing Institute--Offers manufacturers of consumer products a certification program. Provides Institute's Seal of Quality which may be displayed on products that pass laboratory qualification tests.

18. Parents' Magazine, Consumer Service Bureau--Awards seals to advertisers whose products meet specific standards. Commendation Seal--indicates that the product will perform as advertised. "For Use as Directed" Seal--indicates that the results advertised will not occur unless proper directions are followed. The third seal indicates refund or replacement if the product or performance is defective. Advertiser must apply for the seal which is awarded only after the product has received approval of the Bureau.

19. Underwriters' Laboratories, Inc.--Promotes safety in electrical appliances. Provides label of approval for products which have passed certain safety tests. Sponsored by the National Board of Fire Underwriters.

20. United States Testing Company--Tests a wide variety of products for quality, construction, safety, and use.

SECTION TWO: CONSUMER HOUSING
UNIT IV: Housing and Home Furnishings
IV-1. Your Values in Choosing a Home[1]
by Virginia F. Cutler

(See Suggested Learning Experience No. 5, p. 90 in Part One)

What kind of home would you be happiest in? Would you like to know the answer to this question? Then read the directions carefully in the following pages and do exactly what you are asked to do and when you get to page 206 you will have the answer.

First look through the characteristics of homes below and decide which one you would like best to live in a put a 1 on the line opposite your choice. Look through the list again and write 2 by the one place you like next best. Then look for your third choice and write 3, and keep going until you number <u>every</u> place. There should be 10 numbers.

A home should be:

1. Beautiful _____
2. Comfortable _____
3. Convenient _____
4. In a good location _____
5. Planned for good health _____
6. Place where hobbies or other interests can be followed _____
7. Private _____
8. Safe _____
9. Place where you can share activities with family and friends _____
10. Inexpensive _____

Now we shall tell you more about these homes. Read what it says about every place. When you have finished you will have a chance to vote again.

<u>ONE</u>

This is a beautiful home. It has nice colors and good design. It is good to look at both inside and outside, and fits in with the surroundings. You may not have much chance to carry on your hobbies and may not have much privacy but it is very beautiful.

<u>TWO</u>

This is a comfortable home, a place where you can rest and relax and find relief from strain. It won't be too hot or too cold and will have everything arranged to make you comfortable. It may not be very beautiful and might not be economical but you will have real comfort in this home.

---

[1]Reprinted from <u>Personal and Family Values in the Choice of a Home</u>. New York, New York: Cornell University, Agricultural Experiment Station, Bulletin 840, November, 1947. pp. 8-16.

THREE

This home is convenient; it is neat and orderly, with a place for everything. It has many new labor saving devices. Household tasks and chores may easily be done in this place. You may not like the location and you may not have enough privacy but it is convenient.

FOUR

This home is in a perfect location. It is in a neighborhood that you like and is handy to the places that are important to you. It might not be a very comfortable place nor too safely built but the location is just right.

FIVE

This home is built for good health. It is spotlessly clean and it will be easy to keep clean. There is lots of sunshine, light, and fresh air. It may not be in the best location nor an especially good place for inviting your friends, but it will offer much to keep you well.

SIX

In this home you can putter around and do the things you really like to do. You can carry on almost any personal interest or hobby. It might not be very beautiful nor too safely built but things you like to do in your spare time at home can easily be done in this place.

SEVEN

This home will give each member of the family some privacy. You can do the things you want to do without being bothered. You will have some space that will be your very own. It might not be too well planned for health or convenience but you will have some privacy when you want it.

EIGHT

This home is built for safety. You will feel safe from wind and storm. There won't be much chance of the house catching fire and little chance for accidents. It might not be very comfortable nor too well planned for friendship activities, but you will feel safe in this home.

NINE

This is the home where you can bring your friends. It will also be a place where the family can have some good times together. It may not be economical and might not be very convenient, but you will always be able to have social good times with the family or friends.

TEN

This is the home that is not expensive. It won't cost much to operate. It will fit in with your family income. It may not be the best place for inviting your friends nor too well planned for health but it will suit the family income.

Now that you know more about these homes, which three would you like best to live in; and which two would you like the least.

Number _____ is my first choice.
Number _____ is my second choice.
Number _____ is my third choice.
The home I like the least is number ___.
The home I like next least is number ___.

What you have done so far has shown what kind of home you think you would like but you can't be sure until you compare every home with every other home. Now you will have a chance to do just that. If you were shopping for a home, which one in each pair would you like best to live in? Draw a circle around the number of the home you prefer in each pair. It might be difficult to decide, but you should make a choice in each case. Don't miss a single one.

1 - is the beautiful home. It has nice colors and good design. It is good to look at both inside and outside.
10 - is the inexpensive home. It won't cost much to operate and will suit the family income.

---

9 - is the home to bring your friends. You will be able to have many good times here.
6 - is for personal interests or hobbies. You can spend your spare time at home doing almost anything you like to do.

---

2 - is the comfortable home. You will be able to rest and relax and feel at ease.
8 - is the safely built home. There will not be much danger of fire, accidents, or other such troubles.

---

7 - is the home that will give you some privacy. You can do the things you want to do without being bothered.
9 - is the home to bring your friends. You will be able to have many good times here.

---

3 - is the convenient home. It is neat and orderly and has many new labor saving devices.
6 - is for personal interests or hobbies. You can spend your spare time at home doing almost anything you like to do.

---

4 - is the home in the ideal location. It is near to the things that are really important to you.
1 - is the beautiful home. It has nice colors and good design. It is good to look at both inside and outside.

---

6 - is for personal interests or hobbies. You can spend your spare time at home doing almost anything you like to do.
10 - is the inexpensive home. It won't cost much to operate and will suit the family income.

---

5 - is the home built for good health. It is clean, there is lots of sunshine and fresh air.
3 - is the convenient home. It is neat and orderly and has many new labor saving devices.

---

10 - is the inexpensive home. It won't cost much to operate and will suit the family income.
9 - is the home to bring your friends. You will be able to have many good times here.

---

8 - is the safely built home. There will not be much danger of fire, accidents, or other such troubles.
7 - is the home that will give you some privacy. You can do the things you want to do without being bothered.

---

9 - is the home to bring your friends. You will be able to have many good times here.
3 - is the convenient home. It is neat and orderly and has many new labor saving devices.

---

5 - is the home built for good health. It is clean; there is lots of sunshine and fresh air.
2 - is the comfortable home. You will be able to rest and relax and feel at ease.

---

6 - is for personal interests or hobbies. You can spend your spare time at home doing almost anything you like to do.
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---

7 - is the home that will give you some privacy. You can do the things you want to do without being bothered.
2 - is the comfortable home. You will be able to rest and relax and feel at ease.

---

5 - is the home built for good health. It is clean, there is lots of sunshine and fresh air.
8 - is the safely built home. There will not be much danger of fire, accidents, or other such troubles.

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2 - is the comfortable home. You will be able to rest and relax and feel at ease.
10 - is the inexpensive home. It won't cost much to operate and will suit the family income.

---

3 - is the convenient home. It is neat and orderly and has many new labor saving devices.
1 - is the beautiful home. It has nice colors and good design. It is good to look at both inside and outside.

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8 - is the safely built home. There will not be much danger of fire, accidents, or other such troubles.
3 - is the convenient home. It is neat and orderly and has many new labor saving devices.

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7 - is the home that will give you some privacy. You can do the things you want to do without being bothered.
6 - is for personal interests or hobbies. You can spend your spare time at home doing almost anything you like to do.

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5 - is the home build for good health. It is clean; there is lots of sunshine and fresh air.
4 - is the home in the ideal location. It is near to the things that are really important to you.

---

3 - is the convenient home. It is neat and orderly and has many new labor saving devices.
2 - is the comfortable home. You will be able to rest and relax and feel at ease.

---

3 - is the convenient home. It is neat and orderly and has many new labor saving devices.
7 - is the home that will give you some privacy. You can do the things you want to do without being bothered.

Here you will find the answer to the question on page 199.

Look through the choices you have just made. Count all the 1's you have circled and write the total by number 1 in the list below. Then count the 2's circled and continue through the 10 numbers.

TOTAL	TOTAL
_____1 Beauty	_____6 Personal Interests
_____2 Comfort	_____7 Privacy
_____3 Convenience	_____8 Safety
_____4 Good Location	_____9 Friendship Activities
_____5 Health	____10 Economy

Write the words with the highest totals in the blanks below.

The kind of home that will make me the happiest to live in will provide for:
_____, _____, _____, _____, _____
_____.

Now that you know what kind of a home will make you the happiest, the next step is to see how you feel about the home you are living in.

Describe how you feel about your home by putting a cross (X) on each line. For example, if you feel that your home is very beautiful, put a cross [illegible] if you think it isn't at all beautiful, put a cross there; or if

it is some place between these two, put a cross in between, and do the same with each line.

very beautiful	average	not at all beautiful
very comfortable	average	very uncomfortable
very convenient	average	very inconvenient
very good location	average	poor location
well planned for health	average	poorly planned for health
ample privacy	average	no privacy
very safe	average	very unsafe
good for friendship activities	average	not good for friendship activities
very inexpensive	average	very expensive

The last step is for you to tell what these home values mean to you.

If you were asked to give your idea of a beautiful girl, you might say, "my idea of a beautiful girl is one who has red hair and brown eyes, weighs 120 pounds, and is 5 1/2 feet tall."

In the same way think what a beautiful home means to <u>you</u> and tell <u>three definite things</u> about it. Do the same for all sentences below.

1. My idea of a beautiful home is _____
_____

2. My idea of a comfortable home is _____
_____

3. My idea of a convenient home is _____
_____

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4. My idea of a good location is _____
_____

5. My idea of a home planned for good health is _____
_____

6. My idea of a home planned for personal interests is _____
_____

7. My idea of a home that gives privacy is _____
_____

8. My idea of a safe home is _____
_____

9. My idea of a home where I can bring my friends is _____
_____

10. My idea of a home that isn't expensive is _____
_____

If you would like some ideas and suggestions to help you in making your home come nearer to your ideal, circle those numbers above where you want help.

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	Agree	Disagree
12. I think a house should have a place set aside for the sick.	____	_____
13. From the standpoint of accidents, I think the house is a dangerous place.	____	_____
14. I must have a location where nearby houses won't lower the resale value of my property.	____	_____
15. I want a house which I can sell at a profit at any time.	____	_____
16. I would only buy a house that had low maintenance costs.	____	_____
17. I want a house for which I can pay as little as possible.	____	_____
18. I often think owning a house leaves too little money for other things.	____	_____
19. I want a house which enables some to save money by doing my own maintenance and repair work.	____	_____
20. I want a house where I can change furniture around.	____	_____
21. In my house I want complete freedom to do as I please.	____	_____
22. I want a place in my house where I can be free from interruption of family members.	____	_____
23. I want a house located where I can be free from neighbors' interruptions.	____	_____
24. I want a place in my house where others can't interrupt me.	____	_____
25. I must have a house which is pleasant for me to look at.	____	_____
26. Having a garden makes living more beautiful.	____	_____
27. A beautifully decorated house adds much to the joy of living.	____	_____
28. I want a house which I can be proud to have my friends see.	____	_____
29. I want a location where my children's playmates will come from families of the right [illegible]al class.	____	_____

	Agree	Disagree
30. I want a house which will help me in my social contacts.	____	_____
31. I want a house just as nice as my friends' houses.	____	_____
32. I think my house has a lot to do with my friends' opinions of me.	____	_____
33. I want my house to give me a feeling of orderliness.	____	_____
34. I must have a house which gives me a feeling of calmness.	____	_____
35. When I'm upset I want a place in the house where I can be alone.	____	_____
36. I get bored having to stay in the house.	____	_____
37. I want a house where I can have plenty of room for my recreation.	____	_____
38. A house is one place where I like to do things for the fun of it.	____	_____
39. I like to spend my leisure time away from the house.	____	_____
40. I want my recreation to come before the household chores.	____	_____

KEY TO HOUSING AND PERSONAL VALUES TEST ITEMS

Family centerism values are measured by scores on items 1-5.

Equality values are measured by scores on items 6-8.

Physical health values are measured by scores on items 9-13.

Economy values are measured by scores on items 14-19.

Freedom values are measured by scores on items 20-24.

Aesthetics values are measured by scores on items 25-27.

Prestige values are measured by scores on items 28-32.

Mental health values are measured by scores on items 33-40.

SECTION TWO: CONSUMER BUYING
UNIT IV: Housing and Home Furnishings
IV-3. Values in Housing[1]

(See Suggested Learning Experience No. 5, p. 90 in Part One)

"Values" in housing can have one of two meanings--the word can refer to the monetary value of a house--or it can refer to the feelings, attitudes, desires, and tastes of the people involved. Values, in the latter sense, "are determined (by the individual's) cultural background, education, habits, and experiences," according to the Cornell Value Study group. The term "values" is used in housing as it is used in the disciplines of soicology and psychology rather than as used in economics, "because, on the basis of recent research, (values) seem to provide a clue to theory that could result in the design of more satisfactory housing for individual families."

Glenn H. Beyer, reporting on a study of approximately 1700 families in the Buffalo and Triple Cities areas of New York, identified nine values in relation to housing that were used in the study. (Reported in Housing and Personal Values, a publication of Cornell University, Agricultural Experiment Station, Ithaca, N.Y.) These nine values are: equality, family centrism, freedom, aesthetics, economy, leisure, mental health, prestige, physical health.

Beyer, Mackesey, and Montgomery referred to a different listing of values in Houses Are for People (Cornell University, Housing Research Center). In this bulletin the human value groups are more briefly listed as:

"ECONOMY: families who place special emphasis on price."

"FAMILY: families who emphasize the health and well-being of the family."

"PERSONAL: families who emphasize personal enjoyment, self-expression, and aesthetics."

"PRESTIGE: families who emphasize social prestige and a formal social life."

In a much smaller sampling of homemakers in Colorado, still a third listing of values was developed, based on "educational felt needs in Housing and home furnishings" (Colorado State University and Colorado State Board for Vocational Education). Felt needs were expressed in six value categories: safety, beauty, privacy, economy, efficiency, independence.

Still other lists can be used, other values added, or some combined. The exact listing seems to be of relatively little significance in high school teaching of home economics. But what is important is that students are

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[1]Reprinted from Tips and Topics in Home Economics. Lubbock, Texas: College of Home Economics, Texas Tech University. Vol. VII, No. 2, December, 1966. pp. 4-5.

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guided in the development of concepts and generalizations that can guide their housing decisions in relation to values and other factors.

Concept: Human factors influencing the form and use of housing
Generalizations: Housing standards are influenced by incomes, values, attitudes, educational levels, and housing knowledge.
Man consciously or unconsciously expresses his values through housing.
The values of individuals and families, their standards, their ways of living, and their preferences affect the neighborhood environment.

It seems imperative that students be helped to identify their own values, clarify which values are more important to themselves than are others, and how these values influence their family housing and the housing of others. In understanding one's self and one's choices, one can better understand other people and their choices.

Let us look at the nine values identified by Beyer and see what they mean in relation to a family's housing. The description of the value is the explanation given by Beyer (Housing and Personal Values). Most people are oriented toward several of these values, but the nine values he identified fall into two groups:

(1) "Those individuals who are oriented toward family centrism, equality, economy, and physical health are adjusted to the reality of living as a group and are generally less sensitive to the material world."
(2) "Those who are oriented toward freedom, mental health, aesthetics, prestige, and leisure are more individualistic and generally express a high degree of sensitivity to the material world."

Equality

"This value involves rank, rights or privileges. A person having this value is expected to respect the rights of others and to be sensitive to their needs. He will treat others as equal or near equal, and his family relationships will be based on mutual respect. In the family, this includes relationships of husband-wife, parent-child, and children-children, and equality in the treatment of the in-laws." (Beyer) The individual might say:

I want a house where children's needs can be considered before others.

Teachers and students might:

--Examine pictures of, or make visits to homes of varying economic and social levels. Determine whether there is evidence that equality is the value of the family.

--Analyze floor plans to find ways of meeting individual family needs and interests.
--Plan ways that family members can entertain their own friends at home and have a desirable amount of privacy.
--Read short stories to find ways that individual rights are respected in houses of different sizes.

Family Centrism

"Individuals having an orientation toward this value are expected to regard the family as a relatively self-sufficient and tightly knit unit. They will often judge situations to be good or bad, desirable or undesirable in relation to the effect on the family as a whole." (Beyer) The individual might say:

> I want a house with enough room for our parents to feel free to move in...I want a house where family members can spend time together.

Teachers and students might:
--Investigate ways that houses can be arranged so that families have opportunity to share activities, yet have opportunity for privacy.
--Visit homes that are well planned to provide for three or four generations to live in the same house.
--Discuss advantages of selecting multi-purpose furniture, and furnishing multi-purpose rooms.
--Identify ways a house may be changed to meet the needs of different age groups, and different families as they move from one family life stage to another.

Freedom

"It is expected that a person who values freedom places emphasis on being allowed to make as many of his own decisions as possible. He tends to rebel at assignment, regimentation, and other forms of restrictions. He usually wants to pursue interests and activities of his <u>own</u> choosing. Thus, to a considerable extent, he is an individualist and a non-conformist, refuting the authority of custom." (Beyer) The individual might say:

> I want a house where I can change furniture around...In my house I want complete freedom to do as I please.

Teachers and students might:
--Determine the characteristics and the features houses may have if a family values freedom to a great extent.
--Describe features in the homes of their friends that indicate that freedom is a primary value of the family.
--Discuss: If only one family member has this value, how might arrangements in the house be consistent with his value and yet not encroach on other family members' wishes?

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Aesthetics

"A person holding this value is expected to evaluate his environment in terms of its orderliness, harmony, and beauty. He values what he himself sees or experiences, as opposed to what social opinion says he should experience. He usually wants to express his own individuality and his own tastes, and this tends to permit him to be singled out from others as an individual in his own right." (Beyer) The individual might say:

> I must have a house which is pleasant for me to look at...Having a garden makes living more beautiful.

Teachers and students might:
--Take a field trip to see actual houses and analyze the houses and individual rooms for total effect of aesthetic groupings.
--Experiment with furnishings in the living room of the home economics department for most pleasing effects.
--Experiment with changing the entire appearance of a room, merely by use of accessories.
--Collect a group of fabrics (different colors and textures) and discuss what effects they give and where they might be used.
--Arrange with real estate agents to visit vacant apartment buildings and houses. Plan ways that a family who places great value on beauty could change the apartment or house to satisfy this value.

Economy

"Economy is recognized as a value by persons who tend to emphasize the economical uses of goods and services. The worth of one item is usually measured against the worth of another before making a choice, frequently in monetary terms but sometimes in terms of efficiency. Economic pressures are quickly sensed by individuals who hold this value." (Beyer) The individual might say:

> I must have a location where nearby houses won't lower the resale value of my property.

Teachers and students might:
--Collect documents used when purchasing a house: investigation of title, recording of deed, contract, mortgage. Investigate comparative costs of different services concerned with house purchasing.
--Investigate rental costs, with services provided in each case.
--Talk with representatives of utility companies about ways to reduce utility bills.
--Compute and compare interest costs of different loan companies and banks for buying furniture and major appliances "on time."
--Compare costs of living in a mobile house, an apartment, and a house.

Leisure

"A person holding this value tends to place personal enjoyment before work and its reward. Such a person wants more than the average amount of time for recreational activities. Leisure to him is an end in itself...(he) may either pursue recreational activities or simply be passive toward work." (Beyer) The individual might say:

> I want a house where I can have plenty of room for my recreation... A house is one place where I like to do things just for the fun of it.

Teachers and students might:
--Look at pictures of houses (interior and exterior) and suggest inexpensive physical changes that could be made to satisfy a family's value of leisure.
--Plan ways that housework and other work in the home can be simplified to make for more leisure which the family values.
--Role play a situation in which the value of leisure is not met satisfactorily; determine possible effects on family members in other areas of their daily lives.

Mental Health

"The person who values mental health wants peace of mind primarily and will try to achieve this by attempting to control his enviornment, or, if he can not do that, adjusting to it in a way that will tend to reduce frustration, anxiety, and other inner conflicts." (Beyer) The individual might say:

> I want my house to give me a feeling of orderliness...I must have a house which gives me a feeling of calmness. When I'm upset I want a place in the house where I can be alone.

Teachers and students might:
--Search through current "women's magazines" for feature articles describing the home life of well known persons, with pictures of those persons' homes. Is there any evidence that the individual person and his family value mental health? Cite evidences.
--Explore the market for ways to reduce sound levels in houses (such as the use of window fabrics and carpets, special "soundproof" ceiling materials). Try to find the causes of increased sound levels within the house and from outside the house. Show house plans with sleeping areas in the rear away from street sounds.
--Find examples of mobile devices for attaining privacy inside the house, and the use of fencing and landscaping to provide privacy.
--Cite examples of houses that provide for rest by family members (a quiet place for mother to take a nap in the middle of the day).

Prestige

"Individuals holding social prestige as a value generally have a great desire for the attention and respect of their peers. It is important to

them to be represented as the right kind of person. In some instances, they seek distinction in sophisticated and subtle ways and in other instances through extravagant display." (Beyer) The individual might say:

I want a house which I can be proud to have my friends see.

Teachers and students might:
--Distinguish between families who have a high value of beauty, yet because of their income and special family needs, persons of lower income might mistakenly interpret the families' values to be primarily social prestige.
--Show how families of all economic levels may have prestige as a value. Explore ways that this value is expressed.
--Cite examples of houses in the community which reflect prestige as a value; interpret the relationship of this value to other values held to be important.
--Locate examples of houses (pictured in magazines) that show prestige as an apparent value expressed in sophisticated ways; in subtle ways; and through extravagant display.

Physical Health

"A person with this value tends to make his decisions according to what he thinks their effect will be on his physical well-being. He is likely to want to promote, or at least not to impair his physical health. He will be concerned with sunshine, fresh air, diet, physical exercise, and so on, and is likely to avoid situations that might lead to physical fatigue, ill health or accidents." (Beyer) The individual might say:

I want every room in my house to have a good supply of fresh air.

Teachers and students might:
--Inventory their own homes for safety hazards.
--Demonstrate scientific principles involved in accident prevention.
--Read about ways that ventilation affects comfort, efficiency, and relationships. How can construction techniques, placement of house on the building lot and location of trees affect temperature control?
--Explore work habits that will minimize fatigue.
--Observe arrangement of rooms to meet physical needs.
--Read research on the effect that temperature has on employees' productivity, and apply this knowledge to home activities.

SECTION TWO: CONSUMER BUYING
UNIT IV: Housing and Home Furnishings
IV-4. Crossword Puzzle--Housing

(See Suggested Learning Experience No. 27, p. 94 in Part One)

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CROSSWORD PUZZLE--HOUSING

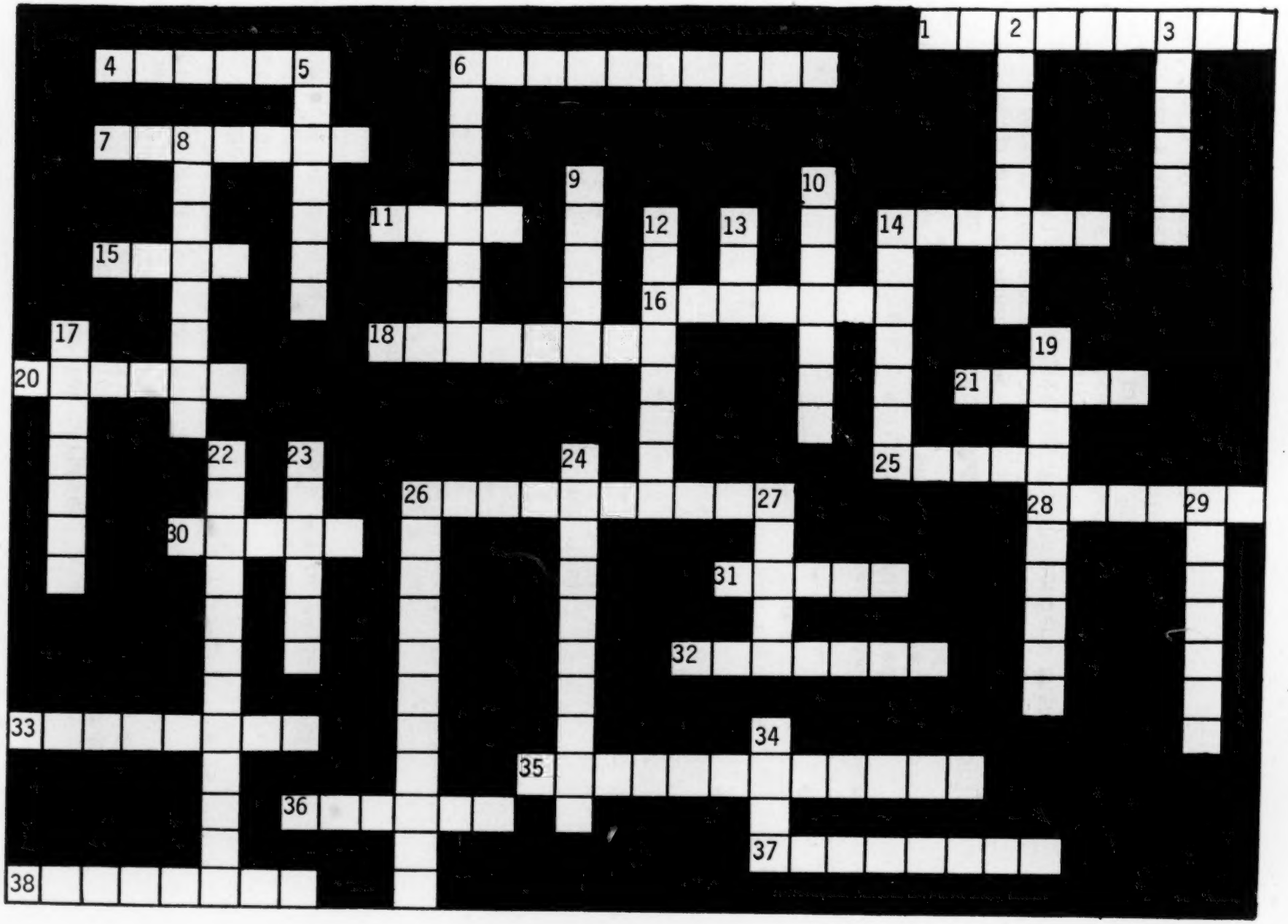

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CROSSWORD PUZZLE--HOUSING[1]

ACROSS

1. A multi-family, rental housing unit
4. A type of moveable home
6. The amount owed on property for tax purposes
7. A value in housing important to individuals who seek independence
11. The part of a property that usually requires time-consuming care from the homeowner
14. The amount your property is worth minus what you owe on it
15. A sum of money borrowed with the agreement to repay according to the terms set by the lender
16. A real estate broker
18. The fee one pays for the use of someone else's money
20. A value in housing which makes individuals desire an aesthetically pleasing environment
21. One who has bought property
25. A legal document attesting to an individual's ownership of property
26. Property of monetary value put up to secure a loan
28. An institution which some families wish to find near the neighborhood where they establish homes
30. Objectives toward which individuals work
31. Funds assessed by local, state and national governments to provide services for the general public
32. One basic physical need of families and individuals
33. A basis of comparison which sets acceptable limits for a desired goal
35. One factor which influences housing choices
36. A value in housing which makes individuals seek facilities for sharing as well as opportunities for privacy when they make housing choices
37. A housing value held by individuals who have a great desire for the attention and respect of others
38. A professional person legally empowered to act for a client

DOWN

2. To estimate the value of property
3. A written agreement put in the care of a third party which does not become effective until certain conditions are fulfilled
5. A housing value important to families who place special emphasis on price
6. The legal description of a property plus its history of ownership
8. A housing value held by individuals who respect the rights of others
9. One of the factors influencing housing choices which is affected by the size of the family, the activities family members engage in and the possessions they have to store
10. Paying for the use of someone else's property
12. A legal agreement which pledges property as security for the payment of a loan and stipulates the procedure which will follow if the borrower fails to repay the loan

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[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

13. A source for mortgage loans involving a small risk for the lending institution (initials--3 letters)
14. A deposit of money made on property you wish to purchase to signify your intent to go through with the deal
17. A housing value which prompts individuals to seek adequate room and facilities for recreation
19. A term applied to the type of savings which equity represents
22. Reducing the principal of a loan by making regular payments on it
23. The important ideals and beliefs of individuals which influence the choices and decisions they make
24. A factor influencing housing choices dependent upon services desired
26. A multi-family housing unit in which apartments can be purchased and maintained by individual owners who also hold a proportionate interest in the common areas of the property
27. A legal document describing the obligations agreed to by a tenant and a landlord
29. A type of mortgage agreement that allows for the borrowing of additional sums under the terms of the original mortgage agreement
34. A type of multi-family dwelling in which apartments may not be purchased outright and in which profits, expenses and risks are shared by the individuals and families who select this type of housing (abbreviation)

ANSWERS TO CROSSWORD PUZZLE

Across

1. apartment
4. mobile
6. assessment
7. freedom
11. yard
14. equity
15. loan
16. realtor
18. interest
20. beauty
21. owner
25. title
26. collateral
28. school
30. goals
31. taxes
32. shelter
33. standard
35. neighborhood
36. family
37. prestige
38. attorney

Down

2. appraise
3. escrow
5. economy
6. abstract
8. equality
9. space
10. renting
12. mortgage
13. FHA
14. earnest
17. leisure
19. investment
22. amortization
23. values
24. facilities
26. condominium
27. lease
29. open end
34. co-op

SECTION ONE: CONSUMER BUYING
UNIT IV: Housing and Home Furnishings
IV-5. Housing Decisions[1]

(See Suggested Learning Experience No. 28, p. 94 in Part One)

David Jackson, a junior accounting major in a state university, is engaged to Jane Bond, a junior primary education major. They plan to be married in June. David earns $200 a month at a part-time job in the business manager's office at the university. He receives $75 a month from an educational insurance policy his family took out on him when he was a child. Jane earns $25 per week working three hours a day and Saturday afternoons in a children's clothing shop. They will attend at least one session of summer school and keep their jobs. Jane's avocational interests are music and art. David's are hunting and gardening. They have a 1966 Ford Mustang, a portable TV, a stereo and a piano.

After graduation David plans to work in Dallas in a large accounting firm that handles the business affairs of a varied clientele including individuals, business firms and estates. David's beginning salary will be $600 a month, and he can expect to be earning $750 to $800 by the end of five years. He plans tc work with this firm for about five years, then he would like to move from the city to a large town and establish his own accounting firm that would eventually include two or three partners. If he does well in private practice, he may eventually earn $15,000 to $18,000 per year. In the beginning, he may expect to earn about $10,000 a year.

Jane will teach for four or five years, then they plan to have a family. She and David want two children. They prefer bringing their children up in a large town instead of the city. They plan to live a rather conservative life--participating in civic, school and church affairs--and doing many things together as a family.

I. A. What is/are David's and Jane's central goal/goals?

B. What are their satellite goals?

C. What resources do they have that will help them reach their goals?

D. Give three examples that indicate they have made some definite plans toward reaching those goals.

II. They will have to make several decisions regarding housing at various stages in their family life cycle. From the choices or situations given below, tell what decision would be appropriate for the stage specified and give reasons for your opinion.

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[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

A. Beginning--establishment phase (immediately after marriage through graduation)
   1. One-bedroom furnished apartment with central heating and air-conditioning. Bills paid; $125 a month.
   2. Two bedroom apartment with range, refrigerator, living room furnished, central heating. $80 per month, no bills paid.
   3. A two bedroom mobile home, two years old, in excellent condition, payments $90 per month, will be paid off in seven years.

B. On the basis of your study of the classified ads, what kind of housing do you suggest they secure in Dallas? Consider (1) What can they afford to spend for housing? (2) Should they rent, buy, or build? Give reasons for your answer. (Be sure to discuss factors that would influence their decision.)

C. Expectant and Childbearing phases
   At this stage of the family cycle David and Jane want to build or buy a home of their own. They have found a very beautiful four-bedroom brick home for $30,000. It is eight years old, in need of some redecorating, and in a neighborhood they like. The grounds are neat and well kept. They can borrow money at 5 3/4% for 30 years. Could they afford this house? Under what circumstances would it not be too great a financial burden to them? What factors should they consider as they try to decide whether it would be better to buy this house or build a new house for the same amount of money? (Show your work. Give reasons to justify your opinions.)

D. Trace the housing needs of this couple through the remaining stages of the family life cycle. What housing decisions lie ahead for them at each stage? Use the steps in decision-making to guide your thinking. Consider their goals, both present and long-term, their resources, the alternatives they have to consider, the possible outcomes of each alternative you suggest and then the decision you would recommend. Justify your reasoning.

SECTION TWO: CONSUMER BUYING

UNIT V: Buying and Maintaining Automotive Products and Services

V-1: Forumla for Cost of Buying a Car

(See Suggested Learning Experience No. 21, p. 101 in Part One)

$$\frac{\text{Total fixed and variable cost}}{\text{annual mileage}} = \text{cost per mile}$$

Problem:

Bill bought a used car for $1400. The total of the three year note at the bank for the car loan was $2000. He budgeted approximately $40 a month for operation expenses. Based on past experiences, he estimated he would drive 50 miles a week. What will be the cost per mile for one year?

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SECTION TWO: CONSUMER BUYING
UNIT V: Buying and Maintaining Automotive Parts and Services
V-2. But Couldn't We Buy This Car?

(See Suggested Learning Experience No. 3, p. 99 in Part One)

The Williams family is considering the purchase of a second car. Mrs. Williams is a private secretary and rides to work with her husband. Her hours are not exactly the same as his, therefore, she could often use her time to a better advantage if she could have her own car.

Keith Williams is 18 years old. He will be allowed to drive the new car to junior college 30 miles away where he will be taking courses three days a week this summer. Although he owns a car (a ten year old model!), he will use the new car for dating.

Mr. Williams, manager of a department store, will use the car occasionally on week-ends for recreational excursions. Each family member has strong preferences regarding the kind of car he thinks should be bought.

DIRECTIONS: Role play this situation. As you do try to answer some of the following questions considering different family members' viewpoints.

What factors should the Williams consider in deciding on a car?
What size car would fit their needs. What options might they consider?
What price range might be suitable? Should they buy the car now or wait? Should they use cash or credit? Will they buy a new or used car?

SECTION TWO: CONSUMER BUYING
UNIT VI: Food
VI-1. Biscuits: To Buy or Make?[1]

(See Suggested Learning Experience No. 20, p. 106 in Part One)

(Sample--could adapt to any product)

I. Score the three types of biscuits you are comparing according to the Betty Crocker score sheet you were given. Call the canned biscuits A, the mix biscuits B, and the biscuits from "scratch" C.

II. Compare preparation time for biscuits

	A	B	C
Time began	_____	_____	_____
Time finished	_____	_____	_____
Elapsed time	_____	_____	_____

III. Compare number of pieces of equipment used in preparation of

A	B	C
_____	_____	_____

IV. Find the cost of each type of biscuit, using one cup flour for basic biscuits and one cup biscuit mix to compare with one can biscuits.

A	B	C
_____	_____	_____

Cost of ingredients:

1 c. flour = 3 1/2¢
1 c. shortening = 13¢
1 c. milk = 7¢
1 c. mix = 8¢

Cost of baking powder and salt is negligible. You might add 1/2¢ to total cost.

CONCLUSIONS:

Best quality biscuit _____
Lease expensive biscuit _____
Circumstances under which each would be a desirable choice (Use your own paper) _____

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[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

SECTION TWO: CONSUMER BUYING
UNIT VI: Food
VI-2. The Cost of Home Cooking[1]
by Mary Lumsden

(See Suggested Learning Experience No. 21, p. 106 in Part One)

Carol and Larry were recently married. Larry works at a local service station and Carol works at a nearby factory.

By the time Carol gets home from work every night she is exhausted. As she enters the house she is usually greeted by the familiar words of her husband, "What's for supper tonight, honey?"

Carol begins at once to prepare her meal by getting out the convenience foods and taking the packaged mixes from the cupboard shelf.

Let's listen to their discussion tonight:

"Carol, I wish you could cook like my mother. She never used any of those mixes. I'll even bet you could save lots of money if you made things yourself instead of using those convenience foods, and you know we need to save all the money that we can."

"So you think that convenience foods are more expensive? While I'm preparing supper why don't you read this pamphlet that I just ordered? See if what it has to say about convenience foods changes your mind."

Larry sits down with the pamphlet and begins to read. "This is interesting. I really hadn't thought of it in this way. I guess we do have to count the cost of your time.

"It says right here that preparation time is less for these convenience foods than those prepared at home. In home prepared foods one must consider the amount of time used in reading directions, peeling, cutting, stirring, measuring, pouring, putting on and removing from the range, and serving and cleaning up.

"Sometimes the food cost of convenience foods is actually less than the cost of the ingredients for home-prepared products because of the efficiency possible in mass production. It says that the average 'convenience food' meal, for four, costs $2.23 and is prepared in 32 min. while the average home-prepared meal costs $2.00 but takes on the average 1 hour and 59 min. to prepare. When you value the time of the homemaker at $1.40 per hour, you are actually saving 38% of the total cost in using prepared foods."

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[1]Reprinted from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Division of Home Economics Education, University of Illinois. Vol. XIII, No. 2. November-December, 1969. pp. 84-85.

"And just think, Larry," says Carol, "if I had to prepare a complete meal after I came home from work, we wouldn't be eating until nine or ten o'clock. How would your stomach like that? If it took me that long to prepare supper I wouldn't have time to do the cleaning, ironing and all of the other things that I have to do tonight. Of course, if you would like, I could send the ironing out and have a cleaning lady come in every day so that I could spend more time preparing your meals."

"No, Carol," says Larry, "I think you're the wise one. I wonder why my mother doesn't use convenience foods."

"I don't know. There's something else you will have to remember, too," says Carol. "I haven't had as much experience in preparing food as your mother. I'm probably saving us lots of indigestion pains by using convenience foods."

They both laugh as they sit down to eat their "convenience meal."

This story could be followed by another one about a couple who loved to cook as a hobby, saved money on food, had dishes they could not have bought and into which they put extra nutritive values, etc.

After students had read both, a discussion could reveal which appealed more and why. Differing viewpoints could be supported and respected. The role of values in decision-making could be pointed out.

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SECTION TWO: CONSUMER BUYING
UNIT VI: Food
VI-3. Cartoon on Food Additives

(See Suggested Learning Experience No. 23, p. 106 in Part One)

"Doris, know what? — This product is composed of nothing EXCEPT additives."

OBJECTIVES: To become aware of the widespread use of food additives.

What are food additives? Why are they used?

Examine packaged food products in the foods lab and make a list of all the food additives they contain. Did you find any product to be free of additives?

Who determines which and how much additive(s) a product can contain?

Do you recall any recent controversy regarding the use of food additives? How was it resolved?

Off the Record by Ed Reed reproduced by permission of the Register and Tribune Syndicate, Des Moines, Iowa.

SECTION TWO: CONSUMER BUYING
UNIT VII: Clothing
VII-1. This Is Our New School Uniform

(See Suggested Learning Experience No. 1, p. 109 in Part One)

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This is Our
NEW SCHOOL
UNIFORM!

SECTION TWO: CONSUMER BUYING
UNIT VII: Clothing
VII-2. Cartoons

(See Suggested Learning Experience No. 4, p. 109 in Part One)

THE BETTER HALF[1] **By Bob Barnes**

"Oh, I'm so glad you like my new hat, dear!"

OBJECTIVE: To recognize individual differences in clothing values

Did you ever buy an article of clothing with which you were greatly pleased, only to find that your family members thought it was a ridiculous or most unsuitable purchase? If so, what was it?

What prompted you to buy it?

Did the family's displeasure spoil the pleasure you expected to find in owning and wearing the article?

Can you recall ridiculous clothing purchases that your family members have made in the past?

How do you account for these conflicting views regarding what is suitable and what is ridiculous?

---

[1]The Better Half by Bob Barnes reproduced by permission of the Register and Tribune Syndicate, Des Moines, Iowa.

FROM NINE TO FIVE [1] **By Jo Fischer**

"Will you please drive slower? I hardly have time to see what's in the store windows!"

OBJECTIVE: To recognize how individual values are reflected in the things that attract one's attention

Study the four people in this picture and tell how you think the three people are reacting to the speaker.

What has probably been the reaction of the two silent passengers and the bus driver as they drove past all the window displays? What has been holding their attention?

If each of these people went into a store to purchase an item of clothing, what values would be most influential in determining his clothing choice? Why do you think so?

With which of the people do you identify most closely? Why?

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[1]Courtesy Publishers-Hall Syndicate, New York, New York.

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SECTION TWO: CONSUMER BUYING
UNIT VII: Clothing
VII-3. Jane Decides[1]
by Maurietta Cusey

(See Suggested Learning Experience No. 14, p. 110 in Part One)

Jane came bursting into the kitchen, executing a jubilant dance around her mother.

"Mother, guess who just called?" Not waiting for an answer the words tumbled forth. "Dan Myers, the dreamiest boy in school and he wants me to go to the Homecoming Dance. He's the answer to every girl's prayer, and he's asked me! Mother, I'll have to have a new dress. I just can't go in that old blue velvet with DAN MYERS! There's the dreamiest dress at the Fashion Nook. It's just the dress to give me a new personality. Mother, may I? Can we possibly--I know we decided the blue velvet would do if I were asked to the Dance. But I didn't dare hope Dan would ask me."

"That's wonderful that such a popular boy asked you to the dance; but surely it doesn't make that much difference in your choice of dress. The blue one is really becoming to you. It's your best color and the style is good, too."

"But Mother, it just isn't Dan's type. Besides all the other girls are planning on new dresses for this special occasion. It only comes once a year. Perhaps I could give up my allowance for several months and maybe a few more baby sitting jobs--"

"Jane, I do realize how important this is to you; but perhaps we can talk it over a bit more. Do you remember our family planning session last week? When we planned our expenditures for this month, there was little left for extras. The new tires for the car, David's dentist bill and your new winter coat are immediate expenses that are imperative. If you gave up your allowance, how would you cover your current expenses--school supplies, lunches, etc.?"

"Maybe I could make my old coat do for another season."

"That will be your decision to make, Jane, if you feel this one time warrants such a sacrifice."

Jane went to her room to think for awhile. She was not very happy to give up either the coat or the dress. After awhile she came back to the kitchen.

"You've made your point, Mother. I would look pretty silly in that old winter coat and an expensive new dress; but thanks for giving me the opportunity of making the decision. I guess it wouldn't be worth being in debt the rest of the year just so I could look glamorous one night. The

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[1]Taken from Illinois Teacher for Contemporary Roles. Urbana, Illinois: Home Economics Education, University of Illinois, Vol. XIII, No. 2, November-December, 1969. pp. 79-81.

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blue velvet it will be, and Dan can take me as I am. Maybe you would help me do a little something to it?"

"Of course. Perhaps a glittery trim at the neck and hemline for a bit more glamour. Time expended in handwork can take the place of money."

"Thanks for the idea. Really, Mother, the blue velvet is more my type, and Dan did ask me the way I am!"

1. How would you rate the communication or understanding between this mother and daughter? Can you think of other ways this mother might have responded? How might this have affected Jane's response?

2. Why were the items listed for purchase more important than the new dress?

3. Pretend Jane had decided to go ahead in purchasing the dress in preference to the needed coat. It is now a month later and the weather is cold. Dan has asked her for another date; this time to go to a play. Can you imagine the possible conversation that might take place between Mother and Jane? (This would be a good situation for role playing.)

4. This story implies the family meets together to go over finances, making plans that involve all. How do you feel about such a family planning session? How could this solve financial problems in a family?

Written assignment:

Make a list of the items you want in the next week. How much money is involved in this? How many of these items will you actually secure? How will you decide which to buy? What do the other members of your family want to buy?

Make a list of items you would like to have in the next three or four months.

Will your immediate day-to-day purchases affect your ability to acquire these items?

SECTION TWO: CONSUMER BUYING
UNIT VII: Clothing
VII-4. Alice Selects a Coat[1]

(See Suggested Learning Experience No. 19, p. 111 in Part One)

Use your own paper in responding to the following items:

I. Alice is shopping for a new coat. She has a dress coat two years old and a corduroy school coat one year old. She is going to college next fall and is trying to select a coat that will fit into her college wardrobe. Coat I is the most flattering to her coloring. Coat II is more versatile. Coat III is an all-weather coat. If she chooses coat one, what values will be most strongly influencing her?

What values (or advantages) will she be giving up if she does not choose coat two?

What values will she be giving up by not choosing coat three?

What disadvantages do you see in her choosing coat one? coat two? coat three?

What coat do you think she should choose and why?

Would this be the same coat you would choose to meet the needs of your own wardrobe? Why? If not, which one would you choose and why?

Interview one of your classmates to determine which of the coats she would choose and why.

How do you account for this difference in choices?

II. Advertising has two purposes: one, to furnish pertinent information to the consumer and the other, to make a psychological appeal that will sell the product. Evaluate the advertisements on display. (Use your own paper.) Put the items of information from each ad under the proper heading.

Important Consumer Information	Psychological Appeal
1.	
2.	
3.	
4.	

[1]Developed by Mrs. Mary Lois Scott, Home Economics Teacher-Coordinator, Wellington, Texas.

Which advertisement do you think gives most adequate consumer information? What other information is needed in each of the three other ads to enable one to make an intelligent decision about buying?

[NOTE TO TEACHER: Display pictures of two currently fashionable coats that a high school senior might choose. Coat I should be glamorous and, perhaps, impractical. Coat II should be a very attractive coat but more versatile than coat I. Coat III is an all-weather coat.]

CASPER 4941

PART TWO

SECTION THREE: CONSUMER CITIZENSHIP

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SECTION THREE: CONSUMER CITIZENSHIP
UNIT I: Government Protection of the Consumer
I-1. Pre-Test on Federal Agencies Abbreviations

(See Suggested Learning Experience No. 1, p. 117 in Part One)

Below is a list of abbreviations commonly used when describing federal agencies related to consumer protection. Next to each abbreviation, write the correct name of the agency.

1. HEW
2. CAB
3. FAA
4. FCC
5. FPC
6. FRB
7. FTC
8. ICC
9. VA
10. CAC
11. USDA
12. FDA

Answers to pre-test abbreviations are listed below:

1. Health, Education, and Welfare
2. Civil Aeronautics Board
3. Federal Aviation Agency
4. Federal Communications Commission
5. Federal Power Commission
6. Federal Reserve Board
7. Federal Trade Commission
8. Interstate Commerce Commission
9. Veterans Administration
10. Consumer Advisory Council
11. United States Department of Agriculture
12. Food and Drug Administration.

SECTION THREE: CONSUMER CITIZENSHIP
UNIT I: Government Protection of the Consumer
I-2. Government Agencies

(See Suggested Learning Experience No. 3, p. 117 in Part One)

Department of Agriculture, USDA (Agriculture Marketing Service, Agricultural Research Service)

Department of Commerce (National Bureau of Standards, Office of Technical Services, Patent Office, Office of Business Economics, Weather Bureau, Bureau of Public Roads)

Department of Health, Education, and Welfare, HEW (Public Health Service, Office of Education, Food and Drug Administration)

Department of the Interior (Bureau of Commercial Fisheries)

Department of Justice

Department of Labor (Bureau of Labor Statistics)

Post Office Department

Treasury Department (Comptroller of the Currency, Coast Guard)

Civil Aeronautics Board, CAB

Federal Aviation Agency, FAA

Federal Communications Commission, FCC

Federal Power Commission, FPC

Federal Reserve Board, FRB

Federal Trade Commission, FTC

Department of Housing and Urban Development, HUD

Interstate Commerce Commission, ICC

Veterans Administration, VA

Consumer Advisory Council, CAC

President's Committee on Consumer Interests

SECTION THREE: CONSUMER CITIZENSHIP
UNIT I: Government Protection of Consumer
I-3. Summary Chart: Governmental Protection for the Consumer

(See Suggested Learning Experience No. 3, p. 117 in Part One)

Agency	What help is given?	Location (Address)
Department of Agriculture, USDA		
Department of Commerce		
Department of Health, Education, and Welfare, HEW		
Department of the Interior		
Department of Justice		
Department of Labor		
Post Office Department		
Treasury Department		
Civil Aeronautics Board, CAB		
Federal Aviation Agency, FAA		
Federal Communications Commission, FCC		
Federal Power Commission, FPC		

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Agency	What help is given?	Location (Address)
Federal Reserve Board, FRB		
Federal Trade Commission, FTC		
Department of Housing and Urban Development, HUD		
Interstate Commerce Commission, ICC		
Veterans Administration, VA		
Consumer Advisory Council, CAC		
President's Committee on Consumer Interests		

SECTION THREE: CONSUMER CITIZENSHIP
UNIT I: Government Protection of Consumer
I-4. Consumer Information[1]

(See Suggested Learning Experience No. 20, p. 119 in Part One)

Here's how one consumer's day might go if he got all the latest news:

Before breakfast, he learns from the FTC that the razor blades he uses, are "not materially superior to stainless steel blades" during the first five shaves despite what the ads say, and whatever corrosion occurred on Brand X blades "had no material effect" on shaving performance.

At breakfast, he hears the same agency question the claims that the Low Calorie Breakfast he is having "is of as much or more nutritional benefit as a breakfast comprised of two fresh eggs, two slices of bacon, two slices of buttered toast and an orange or glass of orange juice." (Incidentally, according to an earlier study at Cornell University, this advertised breakfast might also cost more.)

When he switches to a new brand of instant non-fat dry milk, he learns it has recently been recalled because of salmonella in samples tested by the FDA.

On his way to work in his 1969 coupe, he hears that the National Highway Safety Bureau claims that this model and the 1968 sedan have stearing columns that do not meet Federal safety standards despite the company's certification.

And he learns that his favorite tire company has agreed to recall approximately 43,000 tires because samples failed to pass endurance and strength tests required by the government.

He later is told by the FTC that the claims made for the new "autostabilizer" on his wife's car misrepresented that it is an effective safety device, that it is an anti-skid device that will increase traction, and that it will automatically pull the rear end of a skidding car into line or will help save lives.

Back home, he gets set to apply their usual week-killer on the yard, only to be told by his wife, who heard it from the U.S. Dept. of Agriculture, that the chemical has been banned for such use because it had caused birth defects in mice. (It was not banned, however, on ranges and pastureland.)

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[1]Reprinted by permission from U.S. Consumer. Vol. IV, No. 4, April 27, 1970.

At dinner, he may begin to wonder about the purity of the meat he is eating after hearing about the latest firm fined for shipping uninspected meat across state borders, according to the USDA.

Then, as he prepares to take his daily exercise with his trusty old exercise machine, he sees a story in the paper from the FDA saying it has "serious potential for damage to the heart and other vital body organs." Good night!

SECTION THREE: CONSUMER CITIZENSHIP
UNIT II: Government Legislation
II-1. Transparencies on Government Legislation

(See Suggested Learning Experience No. 1, p. 123 in Part One)

How will knowing about
what is going here

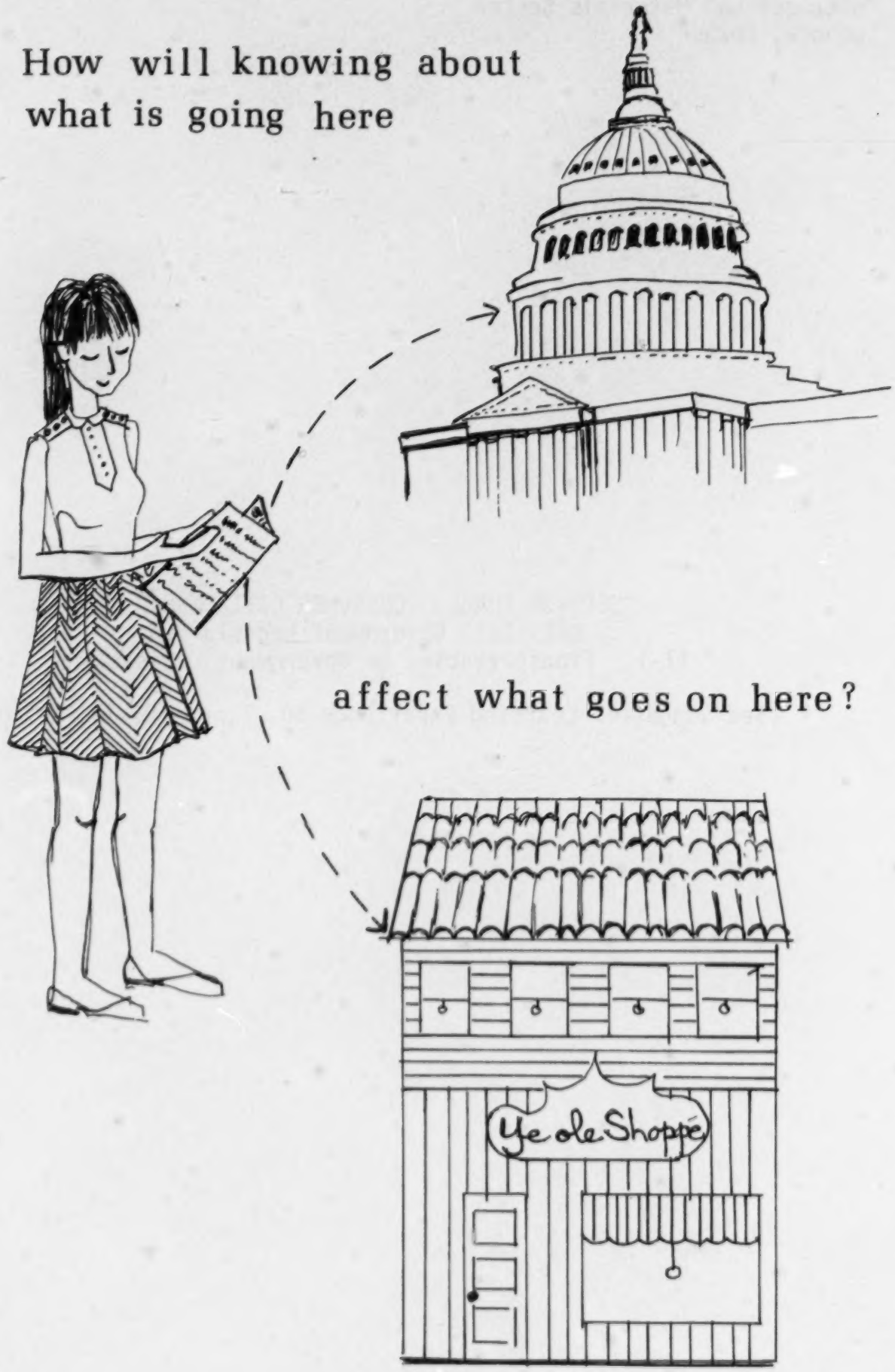

affect what goes on here?

4950

What's Been Happening HERE?

SHERMAN Anti-trust Act 1890

Clayton Act 1914

Wheeler Lea Act 1938

MILLER TYPINGS ACT 1937

MEAT-INSPECTION ACT 1906

Robinson Patman Act 1936

Federal FOOD & DRUG Act 1938

Securities & Exchange Act 1934

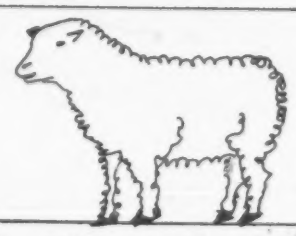

WOOL PRODUCT LABELING ACT 1939

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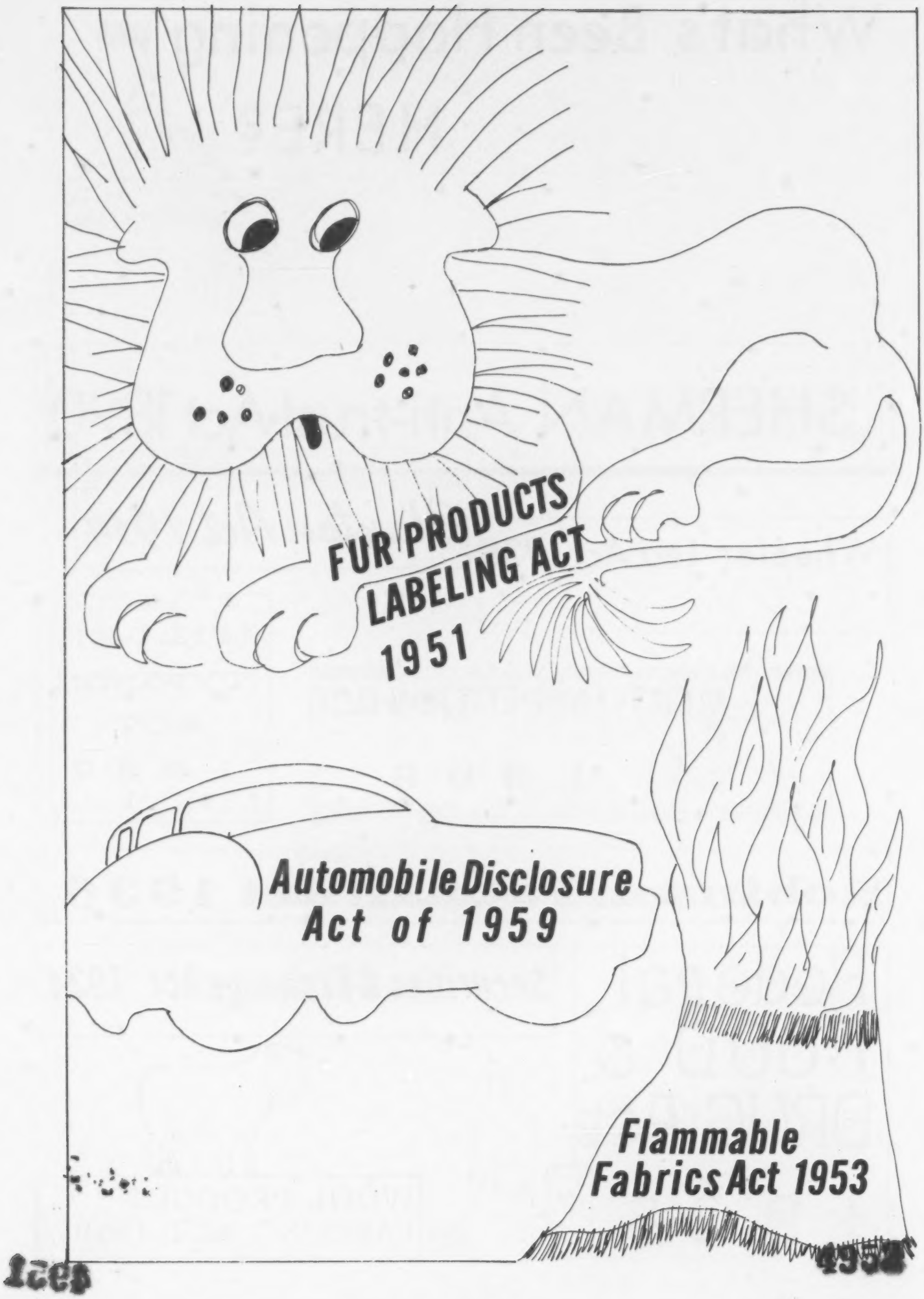
FUR PRODUCTS
LABELING ACT
1951
Automobile Disclosure
Act of 1959
Flammable
Fabrics Act 1953

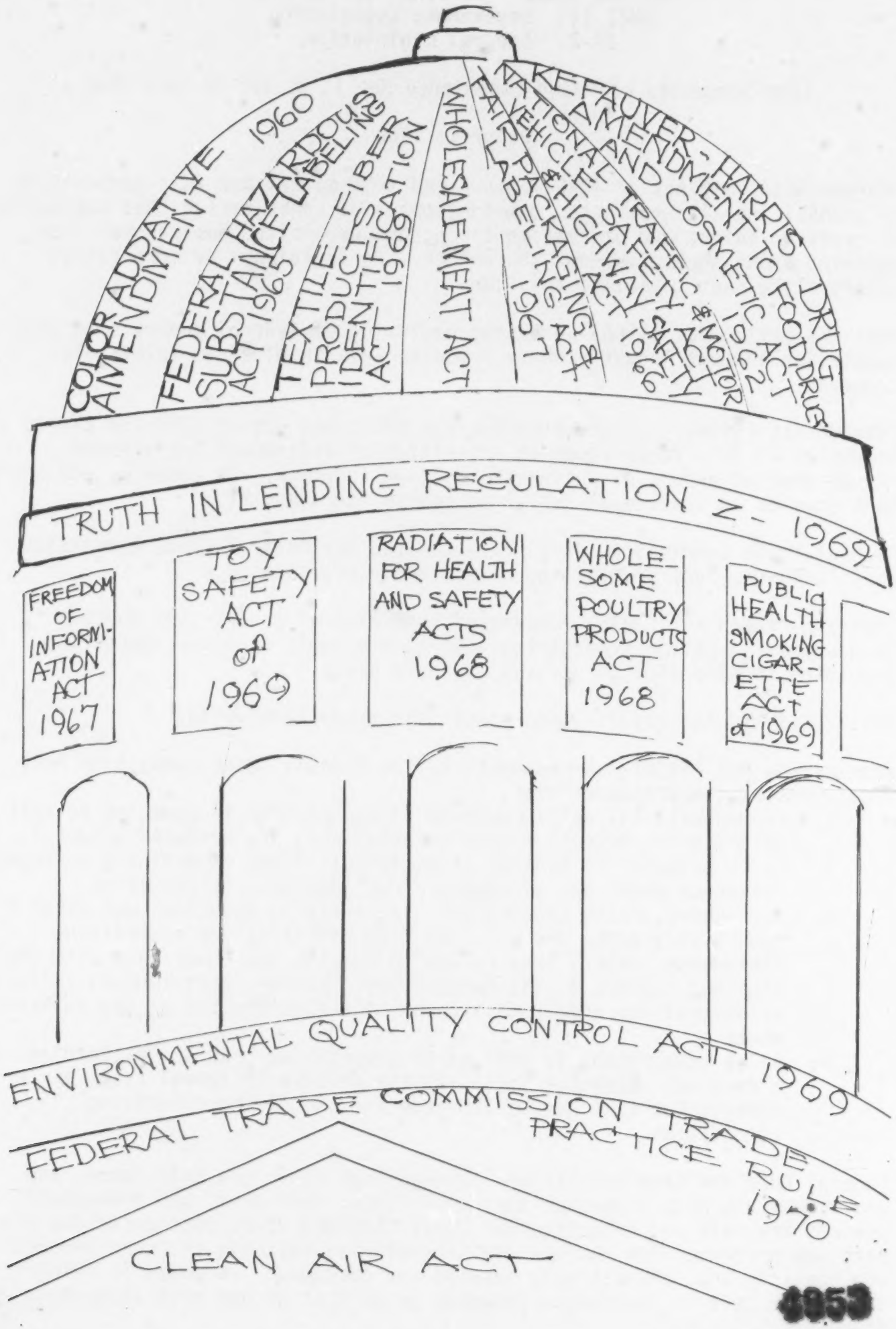
COLOR ADDATIVE AMENDMENT 1960
FEDERAL HAZARDOUS SUBSTANCE ACT 1965
TEXTILE PRODUCTS IDENTIFICATION ACT 1969
WHOLESALE MEAT ACT
FAIR PACKAGING & LABELING ACT 1967
NATIONAL VEHICLE & HIGHWAY SAFETY ACT 1966
TRAFFIC & MOTOR SAFETY ACT
KEFAUVER-HARRIS AMENDMENT TO FOOD DRUG AND COSMETIC ACT 1962
TRUTH IN LENDING REGULATION Z - 1969
FREEDOM OF INFORMATION ACT 1967
TOY SAFETY ACT of 1969
RADIATION FOR HEALTH AND SAFETY ACTS 1968
WHOLESOME POULTRY PRODUCTS ACT 1968
PUBLIC HEALTH SMOKING CIGARETTE ACT of 1969
ENVIRONMENTAL QUALITY CONTROL ACT 1969
FEDERAL TRADE COMMISSION TRADE PRACTICE RULE 1970
CLEAN AIR ACT

SECTION THREE: CONSUMER CITIZENSHIP
UNIT II: Government Legislation
II-2. Federal Legislation

(See Suggested Learning Experience No. 1, p. 123 in Part One)

Prior to 1950

Sherman Antitrust Act of 1890--encouraged free market and fair competition by prohibiting all contracts, combinations, and conspiracies that monopolize or restrain interstate or foreign trade; and prohibited businessmen from agreeing among themselves not to compete. An individual or corporation acting alone cannot violate this law.

Meat Inspection Act (1906)--provided beginning of federal supervision and regulation in meat industry where products were involved in interstate commerce.

Clayton Act (1914)--supplemented Sherman Antitrust Act of 1890 and closed loopholes in it. It is aimed at activities of individual businessmen rather than at groups of businessmen acting together. It condemns any action that enables an individual seller to monopolize a market.

Federal Trade Commission Act (1914)--created the Federal Trade Commission which enforces laws prohibiting unfair trade practices.

Robinson-Patman Act (1936)--prevented restraint of trade. One purpose is to prevent the seller from giving unusual discounts to one customer and requiring someone else to pay the standard price.

Miller-Tydings Act (1937)--made state fair-trade laws valid.

Wheeler-Lea Act (1938)--an amendment to the Federal Trade Commission Act. Provisions of the amendment are:

1. In general, all unfair methods of competition in commerce as well as unfair or deceptive acts or practices, are declared unlawful.
2. It is unlawful to publish or distribute false advertising in order to induce purchases of foods, drugs, devices, or cosmetics.
3. Publishers, radio broadcasters, advertising agencies, and other advertising media are relieved from liability for advertising statements, unless they refuse to furnish the Commission with the name and address of the manufacturer, packer, distributor, seller, or advertising agency that causes the distribution of the advertisements.
4. False advertising is defined as advertising that is "misleading in a material respect," including the failure to reveal facts as to consequence that may result from the use of the advertised commodities.

Federal Food and Drug Act (1938)--insured that foods are safe, pure, and wholesome; and made under sanitary conditions; that drugs and therapeutic devices are safe and effective for their intended uses; that cosmetics are safe and prepared from appropriate ingredients; that all of these products are honestly and informatively labeled and packaged. It makes it illegal to [illegible] or sell in interstate commerce goods that do not meet acceptable standards.

Securities and Exchange Act (1934)--provides Federal Reserve Board with power to limit amount of credit one can obtain for purpose of purchasing stocks on registered security exchanges.

Wool Products Labeling Act (1939)--classified wool product as any product made wholly or in part of new, unused wool, reprocessed wool, or reused wool. Label must indicate class of wool used, percentage of fibers that are actual wool, and whether it is loaded or weighted in any way. The name of the manufacturer, distributor, or retailer must be on the label.

1950-1959

Fur Products Labeling Act (1951)--required that each product made of fur must be identified with a stamp, tag, or label giving specific information as to kind, name, and grade of fur.

Flammable Fabrics Act (1953)--prohibits manufacture and/or sale of any article of wearing apparel that does not meet Commercial Standard for Flammability of Clothing Textiles prepared by Commercial Standards Division of Department of Commerce. It is enforced by the Federal Trade Commission.

Automobile Disclosure Act of 1959--prevented misrepresentation by dealers of the value of the cars they sell and the trade-in allowances they give.

1960-1970

Color Additive Amendment (1960)--required retesting of all colors previously listed for certification.

Federal Hazardous Substances Labeling Act (1960)--required warning labels and other consumer-protection information to appear on any household product such as foods, drugs, and cosmetics that is toxic, corrosive, or flammable or that is an irritant or a strong sensitizer, or that generates dangerous pressure through decomposition, heat, or other means.

Textile Fiber Products Identification Act (1960)--protected consumers by requiring that textile fiber products bear labels identifying each fiber by the name for it that was approved by the Federal Trade Commission. The percentage of the fiber, by weight, in the piece of textile fabric must be given.

Kefauver-Harris Drug Amendments to Food, Drug, and Cosmetic Act (1962)--broadened scope of Food and Drug Administration's work and provided additional protection for consumers. It required drug makers to show by substantial evidence that any new drug is effective as well as safe.

National Traffic and Motor Vehicle Safety Act and Highway Safety Act (1966)--insured that all new cars manufactured after January 1, 1968, would conform

to Federal motor vehicle safety regulations and sets national standards of tests and regulations for drivers.

Fair Packaging and Labeling Act (1967)--enabled Food and Drug Administration to regulate packaging and labeling to prevent deception. It required clear indication of weight or volume; amount in each serving; standards for descriptions; and ingredients in amounts of proportions.

Wholesome Meat Act (1967)--extended the provisions of the 1906 Act so that all meat, not just that covered in interstate commerce, would be inspected by either the Federal government or an adequate state program.

Freedom of Information Act (1967)--opened all federal information not violating national security or trade secrets to the public.

Wholesome Poultry Products Act (1968)--updated the 1957 Poultry Products Inspection Act and provided for the inspection of all poultry and poultry products under a national uniform standard for wholesomeness.

Radiation for Health and Safety Act (1968)--dealt with radiation output of color television and electronic ovens. The act set standards for television. Department of Health, Education, and Welfare is to carry out research to determine what the biological effects of radiation are, at what levels they are dangerous, and to set regulatory standards.

Toy Safety Act of 1969--amended the Federal Hazardous Substances Act to protect children from toys which are hazardous due to the presence of electrical, mechanical, or thermal hazards, and for other purposes.

Public Health Smoking Cigarette Act of 1969--extended public health protection with respect to cigarette smoking.

Environmental Quality Control Act (1969)--established Environmental Quality Council. It is presided over by President of United States or the Vice President in his absence and is composed of the Vice President, and Secrtaries of the following departments: Agriculture; Commerce; Health, Education, and Welfare; Housing and Urban Development; Interior; Transportation; others as need is seen.

Functions:

1. Advise President on environmental quality matters
2. Recommend measures to ensure that programs dealing with development and conservation of natural resources take into account environmental effects
3. Review adequacy of systems for monitaring and predicting environmental changes
4. Foster cooperation between federal, state, and local governments and private organizations in environmental programs
5. Seek advancement of scientific knowledge to prevent the endangering of man's health and well-being
6. Stimulate public and private programs and activities to protect against pollution

Clean Air Act (1969)--made provision for fuel and vehicle research to eliminate air pollution.

Truth-in-Lending, Regulation Z (1969)--required that the cost of credit be made available in writing to the borrower and/or customer so he will know how much he is paying for credit and its relative cost in percentage terms.

Federal Trade Commission Trade Practice Rule (1970)--baned the unsolicited mailing of credit cards and suggests that unsolicited ones be mailed to the Federal Trade Commission, Washington, D.C. 20580, with a letter explaining how the cards were received and that they were not asked for or accepted.

SECTION THREE: CONSUMER CITIZENSHIP
UNIT II: Government Legislation
II-3. Yardstick for Comparison

(See Suggested Learning Experience No. 7, p. 124 in Part One)

Truth-in-Lending Law requires:

Revolving accounts to include the following information:

- Balance outstanding at beginning of the billing period
- Amount and date of each credit extension during the billing periods--and a brief description of any purchase
- Amount credited to the account during the billing period--for payments, returns, exchanges
- Dollar amount of finance charge
- Periodic rate used to figure charges
- Annual percentage rate charge
- Balance on which charges are computed
- Closing date
- Date for paying without incurring additional credit charges

Time Payment or installment contracts to state:

- Name and address of buyer and seller
- Description of the purchase
- Cash price
- Down payment or trade-in allowance, if any
- Unpaid balance
- Itemized list of charges not included in finance charge
- Total amount financed
- Finance charge in dollar amount
- Annual percentage rate
- Date on which charges begin to accrue
- Number, amount, and due dates of payments
- Total payments
- Amount and explanation of penalities for late payment
- Description of security interest held by the creditor, if any

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SECTION THREE: CONSUMER CITIZENSHIP
UNIT III: Fraud, Deception, and Quackery
III-1. Figured for Fraud
III-2. Destined to Deception
III-3. Cues to Quackery

(See Suggested Learning Experience No. 1, p. 127 in Part One)

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FIGURED FOR FRAUD

Door-to-door Salesmen
What's his lead? What promises does he make? What's the price? the quality? Check his address. READ BEFORE YOU SIGN!

Mail Fraud
Who's it from? What must I do? How much will it cost? How good is it?

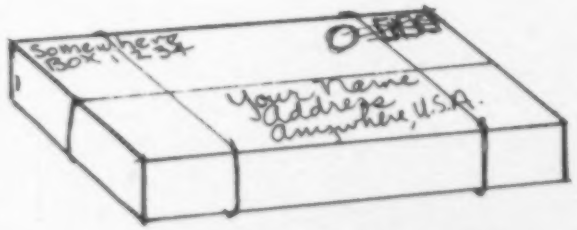

Unordered Merchandise
Did someone in your family order it? You don't have to pay for it or return it, if you don't use it.

Subscriptions
What's the catch? How much will it cost in all? REMEMBER--FEW THINGS ARE REALLY FREE!

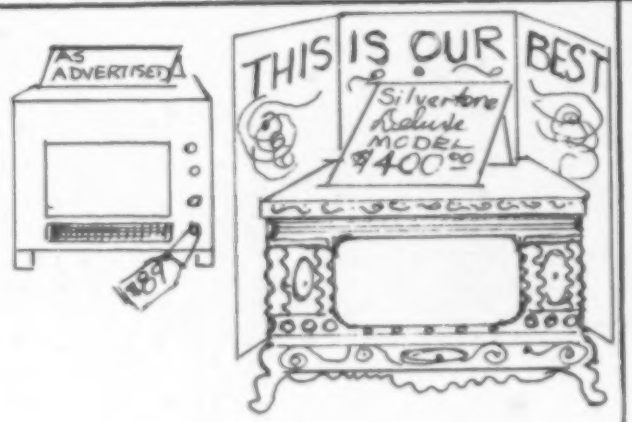

Bait and Switch
Is merchandise really for sale? Does salesman try to show you something higher priced or critize the sale item?

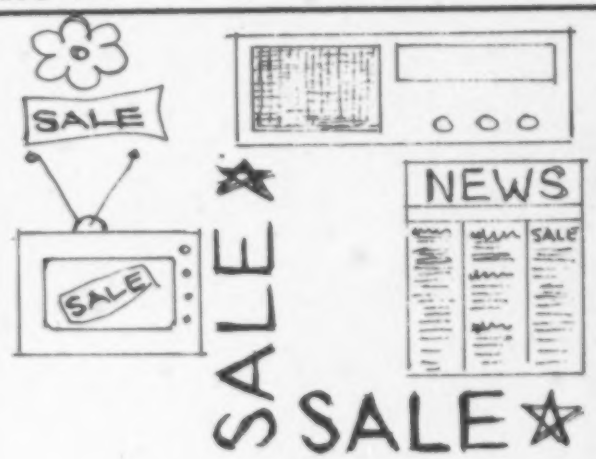

Sale
Is it really a sale? How do prices compare with those in other stores? What about quality?

4960

DESTINED TO DECEPTION

Referral Plans
Are you promised a discount if friends whose names you give buy?

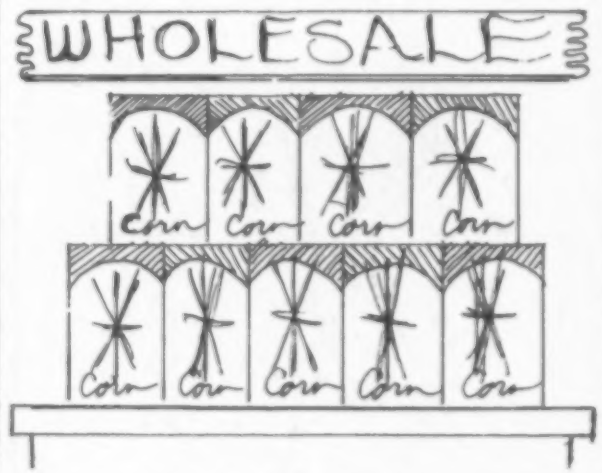

Wholesale Prices
If the seller is a retailer, he can't sell wholesale.

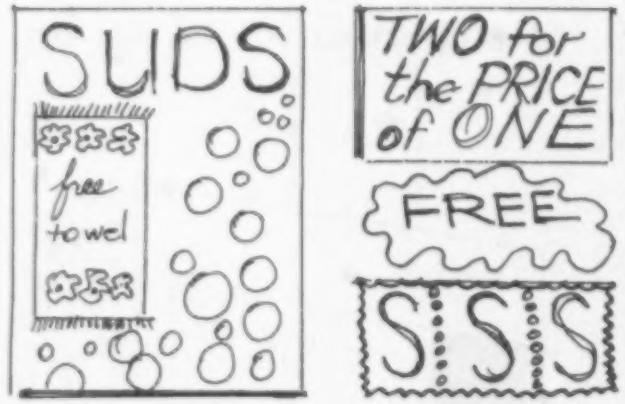

Free
Remember--few things are really "free."

Contests
Who were the winners? Do you have to buy something in order to get your prize?

Home Improvement Racket
Are you promised free stamps, payment for using your home for advertising purposes? Does the repairman use the scare approach? READ BEFORE YOU SIGN!

BEWARE OF THESE

CUES TO QUACKERY

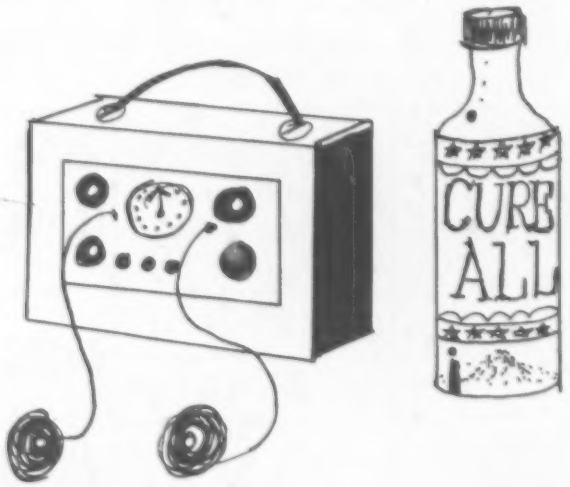

Does he use a special machine or "secret remedy"?

Does he claim that the medical profession is against him?

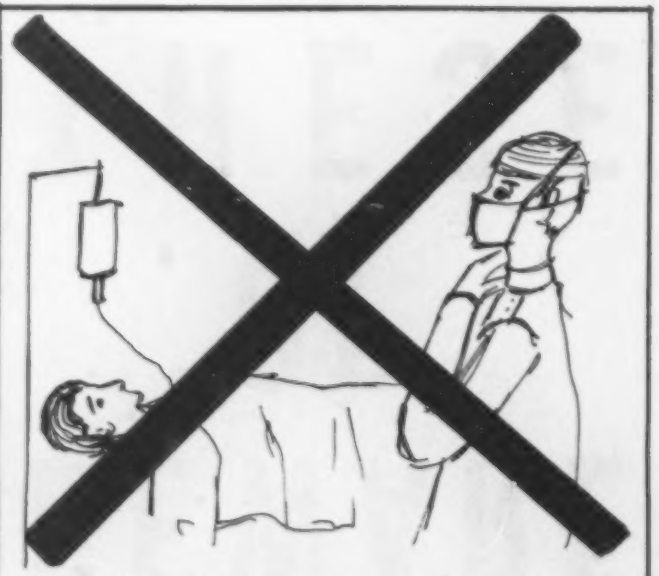

Does he say surgery and X-rays and drugs are bad?

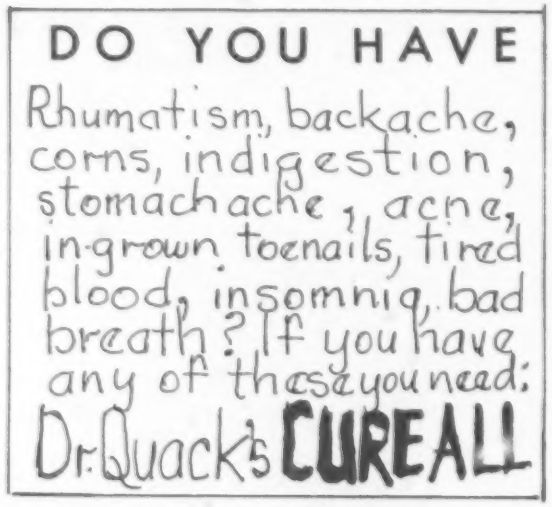

How did you hear about the remedy or the doctor? REAL DOCTORS DO NOT ADVERTISE!

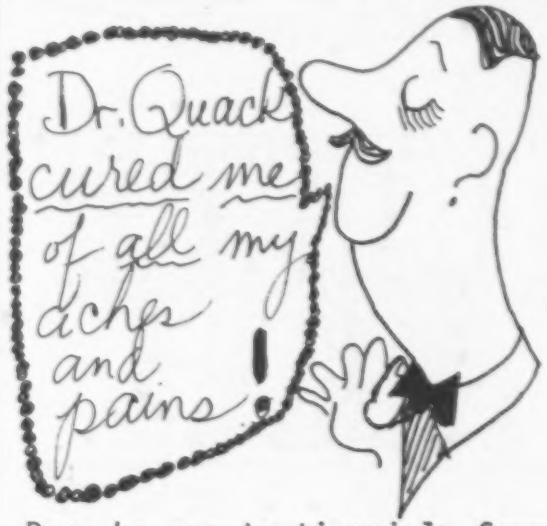

Does he use testimonials from "cured" patients?

Can you buy the remedy through the mail?

1962
258
1962

73 OF 327

ED

056 238

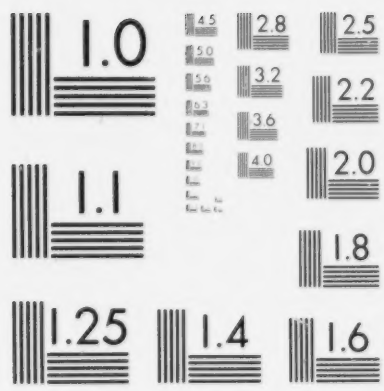

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SECTION THREE: CONSUMER CITIZENSHIP
UNIT III: Fraud, Deception, and Quackery
III-4. The High-Pressure Salesman[1]

(See Suggested Learning Experience No. 2, p. 127 in Part One)

Sally Jones: A typical high school graduate

Mr. Joe Blowhard: A high-pressure salesman

Mr. Blowhard: Hello, sucker, or-er, I mean Miss Jones, Congratulations. I heard you're graduating from high school soon. I'm Joe Blowhard of the Fly-by-Night Pot and Pan Company. I'm sure you've heard of our reputable, honorable company, haven't you? Oh, of course you have.

Sally: Well...er...yes...(Joe interrupts)

Mr. Blowhard: Wonderful! Our company has a special bargain for graduating seniors. You ask why we offer you such a good deal? Well, we feel that you graduates deserve a little something extra.

Sally: That's nice--what are you?.....(interrupted)

Mr. Blowhard: Well, we're offering some beautiful cookware at a very low cost. I'm sure you'll want to plan to purchase some of these for that hope chest that I'm sure a pretty girl like you has already started.

Sally: But I don't have a hope chest --

Mr. Blowhard: I was just coming to that. For a limited time only we are offering a free hope chest with the purchase of our cookware. You may ask--How can we afford to do this? Well, we feel high school seniors deserve a reward for their great accomplishment.

Sally: Oh, that's grand--what do I have to.....

Mr. Blowhard: We're offering style 6, 11, and 14 at a low $39.95 and style 14 is our saucepan set for only $3.98 down. Monthly payments are easy--just $2.50 a month--less than 10 cents a day.

Sally: When will I get my new hope chest?

---

[1]Developed by students of Mrs. Albie Rasmussen, Department of Family Economics, Kansas State University, Manhattan, Kansas.

Mr. Blowhard: It will be delivered with the first shipment. Due to our great response, it will probably be a month or so before delivery, but I'm sure your wait will be worth your while. Now, if you'll just sign here. (Sally signs) Thank you very much and I'm sure you'll be pleased.

Mr. Blowhard: (smiling, smirk) Goodbye, Miss Jones.

Sally: Goodbye, Mr. Blowhard, and thank you again.

(Sally is smiling and happy. Then suddenly she stops to think.)

Sally: How much does the whole set cost?
How can I get in touch with him? I didn't check his I.D.
Do I actually need this cookware?
Can I afford it now?
Can I stop the payments?
I wonder what the hope chest is like.

SECTION THREE: CONSUMER CITIZENSHIP
UNIT III: Fraud, Deception, and Quackery
III-5. Americans Spend Money on the Word "Free"[1]

(See Suggested Learning Experience No. 2, p. 127 in Part One)

Setting: Store counter

High school girl: (Runs in breathlessly) Is this where I pick up my free cologne?

Sales clerk: Yes, you get this exquisite cologne imported directly from Paris.

Girl: Gosh! That's an awfully small bottle.

Clerk: You know the old saying: The best things come in small packages.

Girl: What does it smell like? Sexy, I hope!

Clerk: (opens bottle and waves it in front of girl's nose) Heavenly, absolutely heavenly.

Girl: Oh! I can hardly wait to put some on.

Clerk: (businesslike) Now! What color makeup mirror would you prefer?

Girl: (surprised) Makeup mirror? What do you mean?

Clerk: The cologne is free with this lovely mirror which we are offering--today only--at an amazingly low price of $34.95.

Girl: $34.95? You've got to be kidding! I thought the cologne was free!

Clerk: It is free when you buy this lovely makeup mirror. It's a real bargain at $34.95! We have just a few left.

Girl: Well, I don't know.....

Clerk: A lovely young lady like you can't afford to be without this mirror that ordinarily sells for $49.95.

Girl: Really?

---

[1]Developed by students of Mrs. Albie Rasmussen, Department of Family Economics, Kansas State University, Manhattan, Kansas.

Clerk: That's a saving of $15 on the mirror. And the cologne sells at $20 an ounce. Now just sit down and let me show you the colors which we carry.

Girl: Well...I don't know..I really do like it though. (Sits down and starts looking at mirror.)

Clerk: Look! I'm not really a sales clerk at all. I'm one of the students in Family Economics. We want to demonstrate one of the many examples of advertising which tricks the consumer into thinking he's getting something for nothing.

Girl: (angry--jumps up) There ought to be a law against it!

Clerk: We do have the recently enacted Buyers Protection Act to protect consumers against frauds, but consumers have to help themselves by not believing deceptive advertising such as this which sounds as if you are getting something for nothing.

Girl: (hanging her head) I feel so foolish.

Clerk: You aren't the first consumer to bite on a "come-on" scheme like this. Americans spend millions of dollars on the word "free." (points to posters)

Girl: What a gyp! I came clear up here and what did I get--nothing!

Clerk: You got something better than a tiny bottle of cologne! You got a tip on how to be a better consumer. (hands girl a card) We hope the scented Family Econocard will remind you that a consumer must expect to pay a fair price for merchandise.

Girl: (reading on back of card) This is a real groovy motto. (reads back of card) The best protection against deception and fraud is an alert consumer.

Clerk: (to crowd) Thank you for coming to visit the Family Economics Department, and remember (points to sign and reads) Americans spend millions of dollars on the word "free."

-End-

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SECTION THREE: CONSUMER CITIZENSHIP
UNIT III: Fraud, Deception, and Quackery
III-6. Fasten Your Seat Belts But Hang Onto Your Money[1]

(See Suggested Learning Experience No. 2, p. 127 in Part One)

(Relax, enjoy yourself, ad lib.)

Salesman: Good morning lovely lady! I'm Mr. Blowhard from the Fly by Night Airline School.

Sally: But I've already planned on going to another airline school.

Salesman: I'm glad to hear of your interest in airline training. Now, our school will assure free placement service in a major airline. All of our graduates have been placed "somewhere." (gets out a contract and pen and places it in front of Sally)

Sally: I am going to attend the school sponsored by the airline which hires me.

Salesman: Of course, but a background in our school will give you poise, sophistication, and charm so essential to gracious living.

Sally: Uh huh? And what's this going to cost?

Salesman: First let me explain that our instructors have been selected from top echelon executives.

Sally: What's it going to cost?

Salesman: Only $350 for eight weeks!

Sally: How about living costs?

Salesman: The school maintains facilities at the Hilton Plaza at a slight nominal cost to the students.

Sally: But my Aunt Sally who flies for the airline which sponsors the school I plan to attend says the airline trains their own employees.

Salesman: (Chidingly) Now, you don't look like the kind of a girl who plods along in her old maid aunt's footsteps.

Sally: But my airline will pay me a salary while I'm being trained.

---

[1]Developed by students of Mrs. Albie Rasmussen, Department of Family Economics, Kansas State University, Manhattan, Kansas.

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Salesman: Think how much more you could get if you were trained by Fly by Night's top executives!

Sally: How much more!! That's just it!! You can't really promise me anything.

Salesman: Our school guarantees to place all their qualified graduates.

Sally: (In a huff) Well, I probably wouldn't qualify! And by the way my Aunt Sally is not an old maid. She's really cool! She's wised me up on Fly By Night Airline School. (Walks off indignantly)

Salesman: (Stands alone) That Sally's one girl who is too smart to fall for my line. Most girls fall for these way out promises. They end up spending good money without checking into the false promises. They sign a contract without reading and they're sorry later. They haven't been warned to

Fasten the seat belt
But hang onto your money!

SECTION THREE: CONSUMER CITIZENSHIP
UNIT III: Fraud, Deception, and Quackery
III-7. "In" Basket--"Out" Basket Situations

(See Suggested Learning Experience No. 3, p. 127 in Part One)

"In" Basket

Directions: Draw one of the situations from the "in" basket. Read the situation, then decide what you would do as a consumer. Use whatever resources you need to arrive at a solution.

Situations:
(1) A new "doctor" moves into your community. He advertises in the paper that he can cure all without surgery or X-rays.
(2) A local retail merchant puts an ad in the paper inviting consumers to come in and buy diamond watches at wholesale prices.
(3) Through the mail you have received a letter soliciting money to support a local training center for handicapped children. You are asked to pledge a monthly amount or to make one donation.
(4) You have received an unordered package through the mail. It contains greeting cards to sell.

"Out" Basket

Solutions: Write your decision for each situation on an "out" sheet and place in the "out" basket. Later share the solutions to each problem with classmates.

SECTION THREE: CONSUMER CITIZENSHIP
UNIT IV: Rights and Responsibilities
IV-1. Basic Consumer Rights

(See Suggested Learning Experience No. 1, p. 133 in Part One)

BASIC CONSUMER RIGHTS

THE RIGHT TO BE INFORMED

THE RIGHT TO SAFETY

THE RIGHT TO CHOOSE

THE RIGHT TO BE HEARD

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SECTION THREE: CONSUMER CITIZENSHIP
UNIT IV: Rights and Responsibilities
IV-2. Consumer Responsibilities

(See Suggested Learning Experience No. 5, p. 134 in Part One)

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TO BE INFORMED

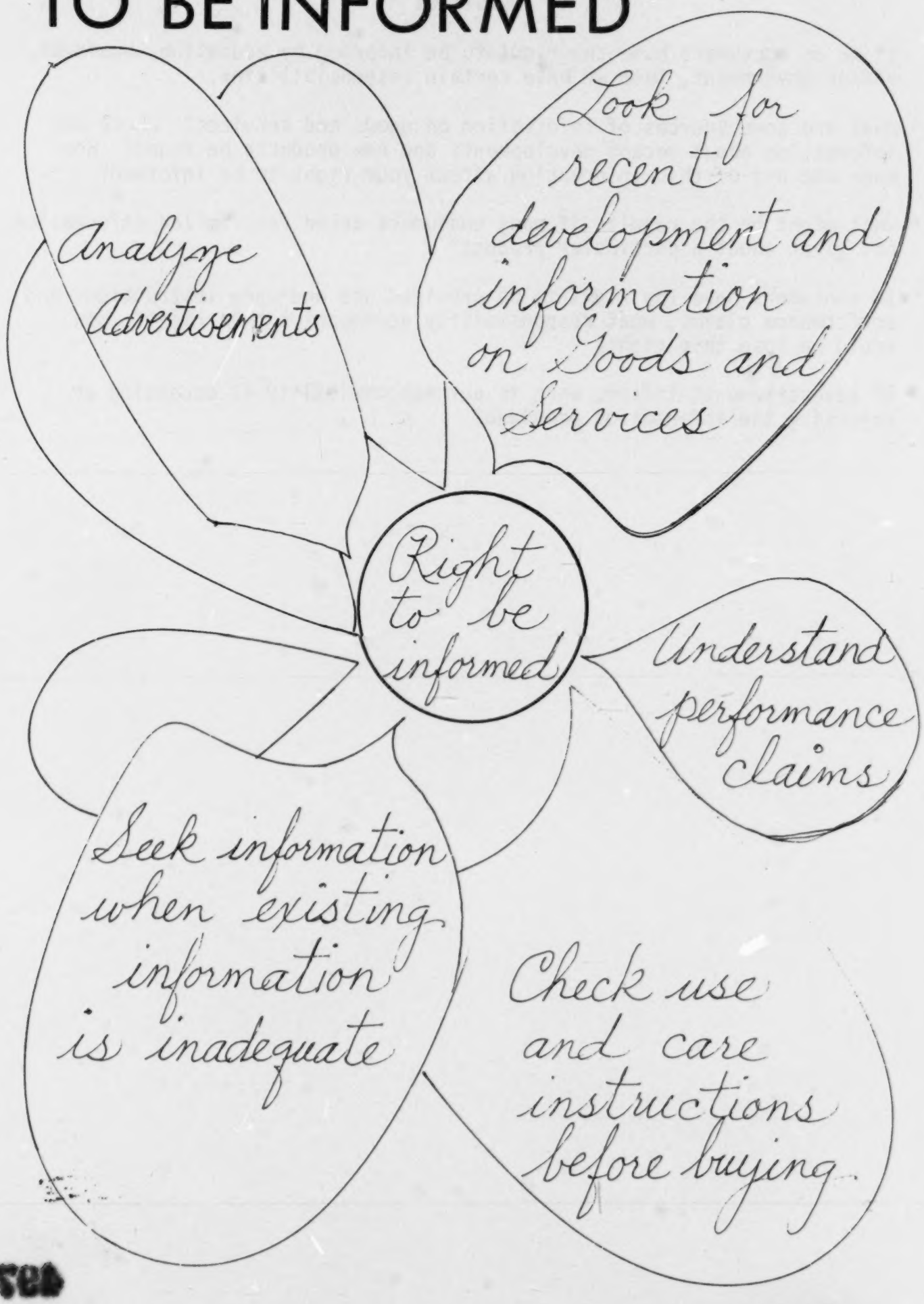

TO BE INFORMED
Questions

If we as consumers have the right to be informed by education, business, and/or government, then we have certain responsibilities.

* What are some sources of information on goods and services? Where can information about recent developments and new products be found? How does the use of this information affect your right to be informed?

* What might be the results if many consumers asked for similar information not given about a particular product?

* If consumers have the right to be provided use and care instructions and performance claims, what responsibility accompanies this right? How could we lose this right?

* If advertisements inform, what is our responsibility in accepting or rejecting the information provided?

TO SAFETY

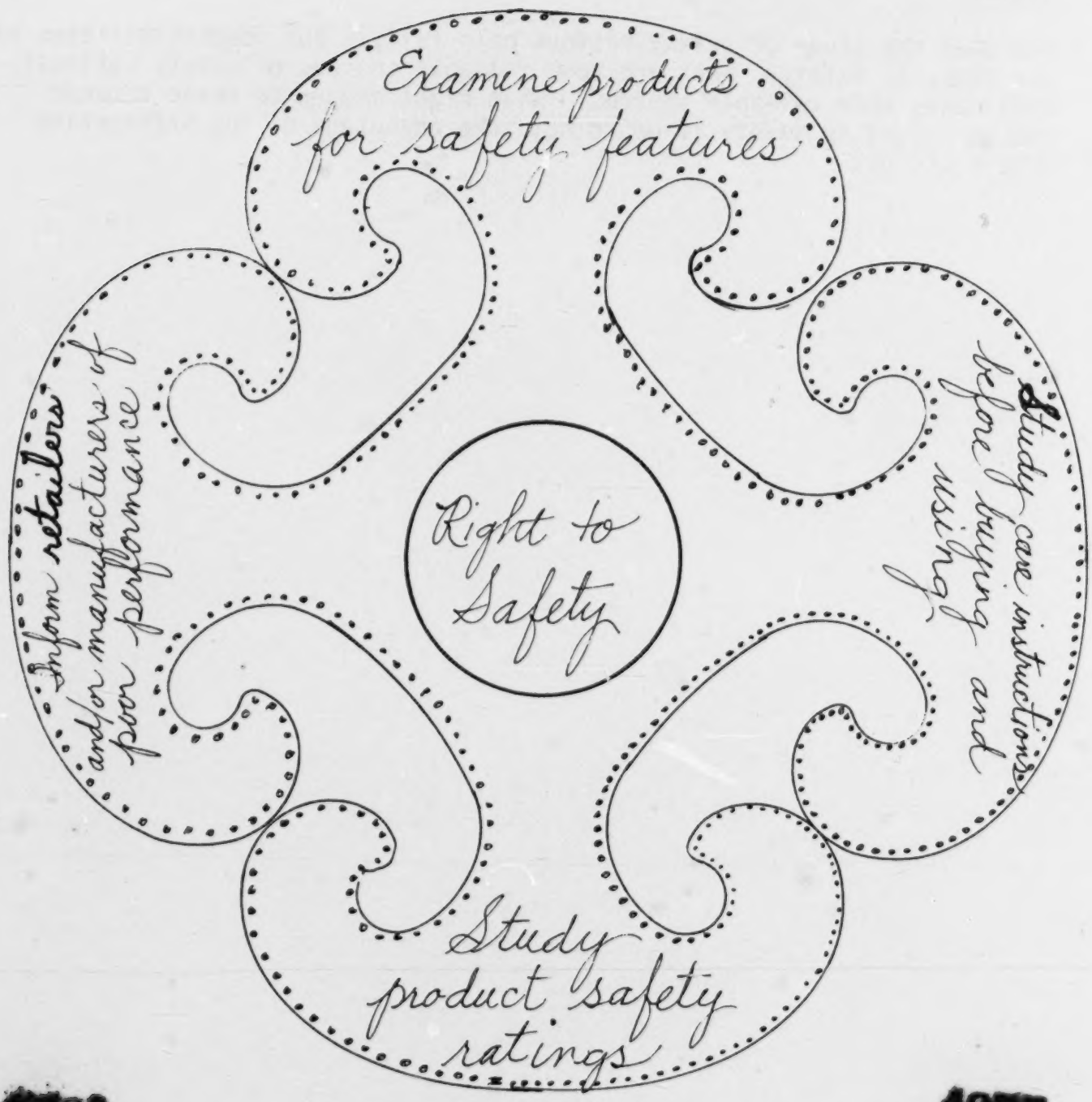
Examine products for safety features
Study care instructions before buying and using
Right to Safety
Inform retailers and/or manufacturers of poor performance
Study product safety ratings

TO SAFETY
Questions

If we as consumers have the right to be protected from the sale of goods and services that endanger our lives or safety, then we have certain responsibilities.

* How will we know if a product is safe? How do we influence the right to safety when we purchase goods without examining them first for safety features?

* What kind of information are we responsible for obtaining before purchasing goods or services?

* What should you do if the performance of goods or results of service are not safe? How would our right to safety be influenced if no one reported faults?

* How does the study of safety ratings help fulfill our responsibilities to our right to safety? What are some reliable sources of safety ratings? What makes them reliable sources? What might happen to these sources and our right to safety if we do not take advantage of the information offered to us?

TO CHOOSE

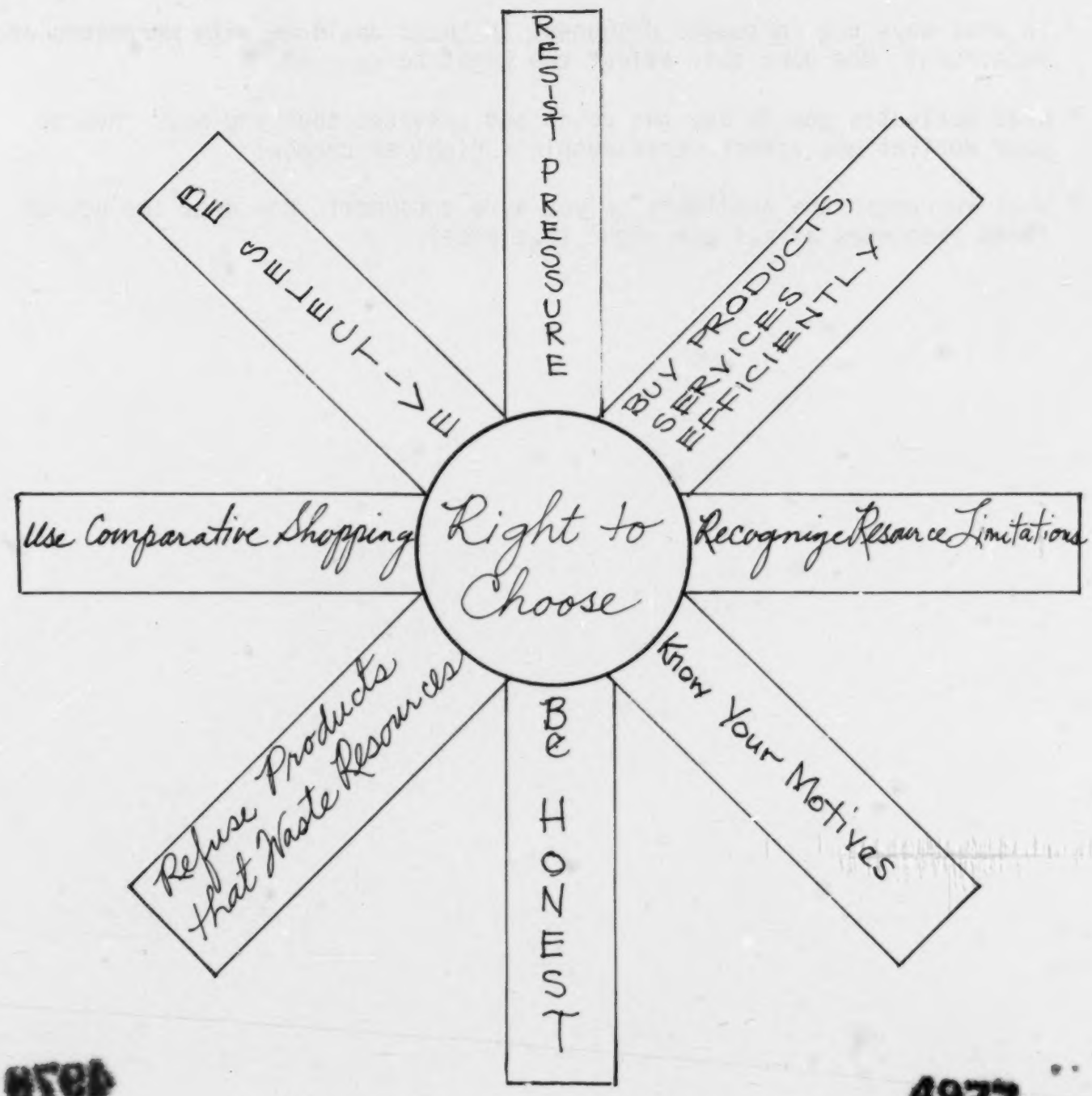

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TO CHOOSE
Questions

If we as consumers have the right to choose goods and services at fair and competitive prices, then we have certain responsibilities.

* What are some pressures that we should assume responsibility for resisting?

* How does buying from habit limit our ability to be selective? How does the responsibility to do comparative shopping affect the right to choose?

* How can one determine whether or not products or services are produced efficiently? What relationship is there between efficient production and fair and competitive prices?

* What are some products that represent a needless waste of limited natural resources? of human resources?

* In what ways are consumers dishonest in their dealings with merchants and repairmen? How does this affect the right to choose?

* What motivates you to buy the goods and services that you buy? How do your motivations affect other people's right to choose?

* What resources are available to you as a consumer? How does the use of these resources affect our right to choose?

TO BE HEARD

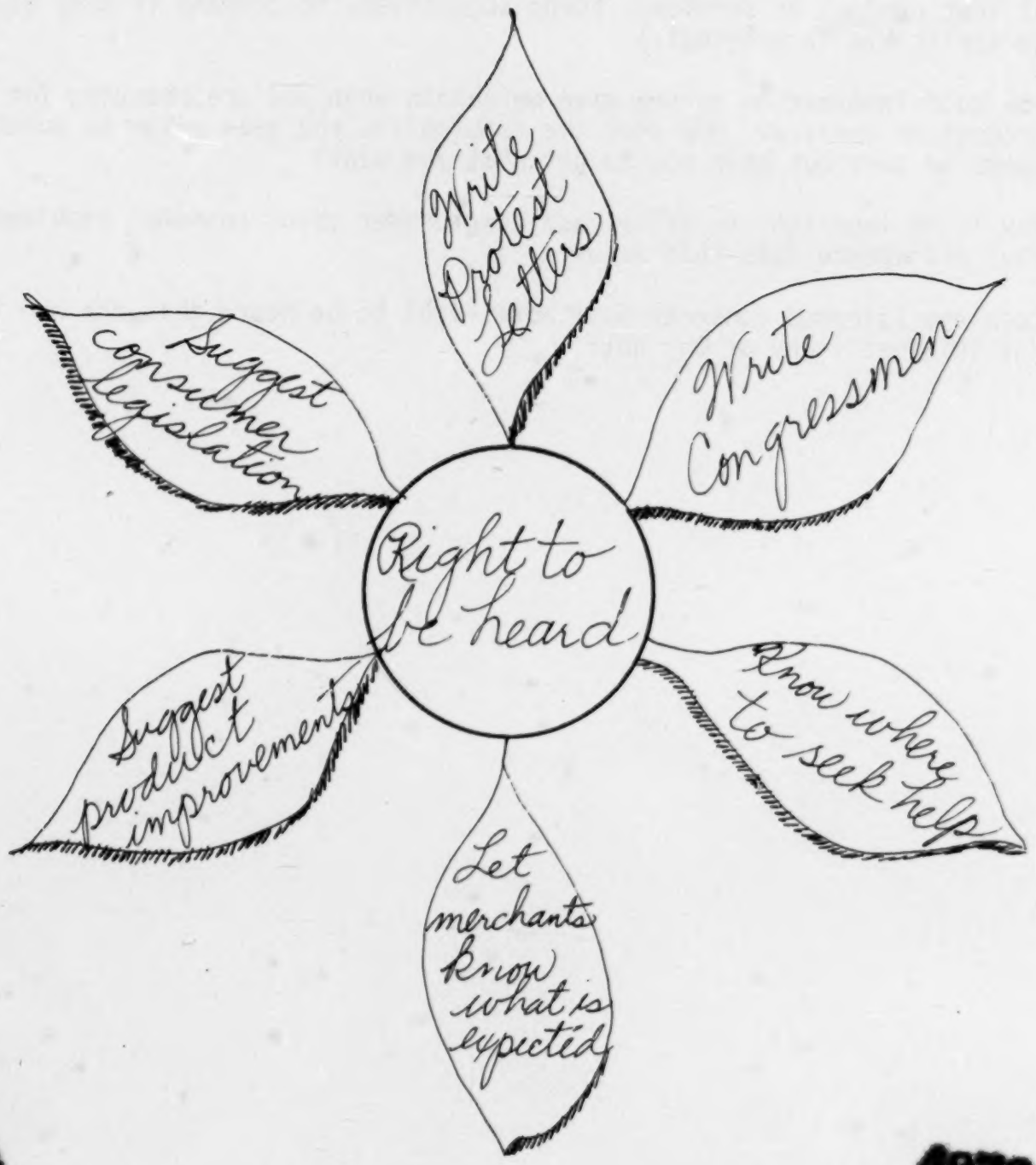
Right to be heard
Write Protest Letters
Write Congressmen
Know where to seek help
Let merchants know what is expected
Suggest product improvements
Suggest consumer legislation

TO BE HEARD
Questions

If we as consumers have the right to be heard, then we have the responsibility to keep channels of communications open between ourselves, business, and government.

* What should we do if we note irresponsible industries, merchants, and/or repairmen? How does the writing of protest letters help fulfill our responsibility to our right to be heard?

* Why is it our responsibility to know where to go for help? What do many consumers tend to do because they do not know where to go for help? How do their actions affect our right to be heard?

* One of our responsibilities is to suggest product improvements. Let's select a product or service and think of some suggestions for improvements of that product or service. (Send suggestions to company if they seem to be applicable or original.)

* How much information do you give merchants when you are shopping for a product or service? How does the information you give prior to purchasing goods or services help you to get what you want?

* Why is it important to write your congressmen about consumer problems? What difference does this make?

* Does the informed consumer have more right to be heard than one who is not informed? Why or why not?

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HOW ARE YOU GOING TO DO IT?

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PART TWO

SECTION FOUR: CONSUMER AND THE ECONOMY

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When there are many products, there has to be a place for the consumer to go to buy them. Here is where the retailer plays a role in the economy. He acts as a purchasing agent for the consumer. He buys from the manufacturer (directly or indirectly) and sells to the consumer. The consumer indicates which products will continue to be sold in the stores, and which will be dropped, by the "vote" he casts with each purchase.

The retailer, in turn, represents the voice of the consumer back to the manufacturer in terms of satisfaction or dissatisfaction.

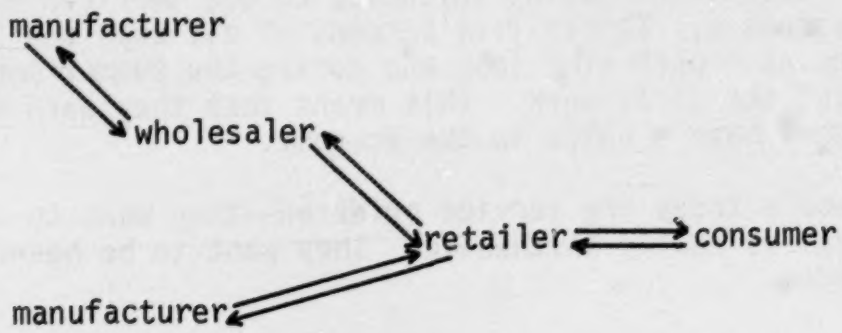

Two terms used in discussing the economy of the country are:

GROSS NATIONAL PRODUCT (GNP)--this represents the total national production of goods and services at market prices--the dollar value of all goods and services produced in a year. In 1966 the figure was $759 billion--on 1975 it is predicted to be $1 trillion.

DISTRIBUTION OF
PERSONAL CONSUMPTION EXPENDITURES

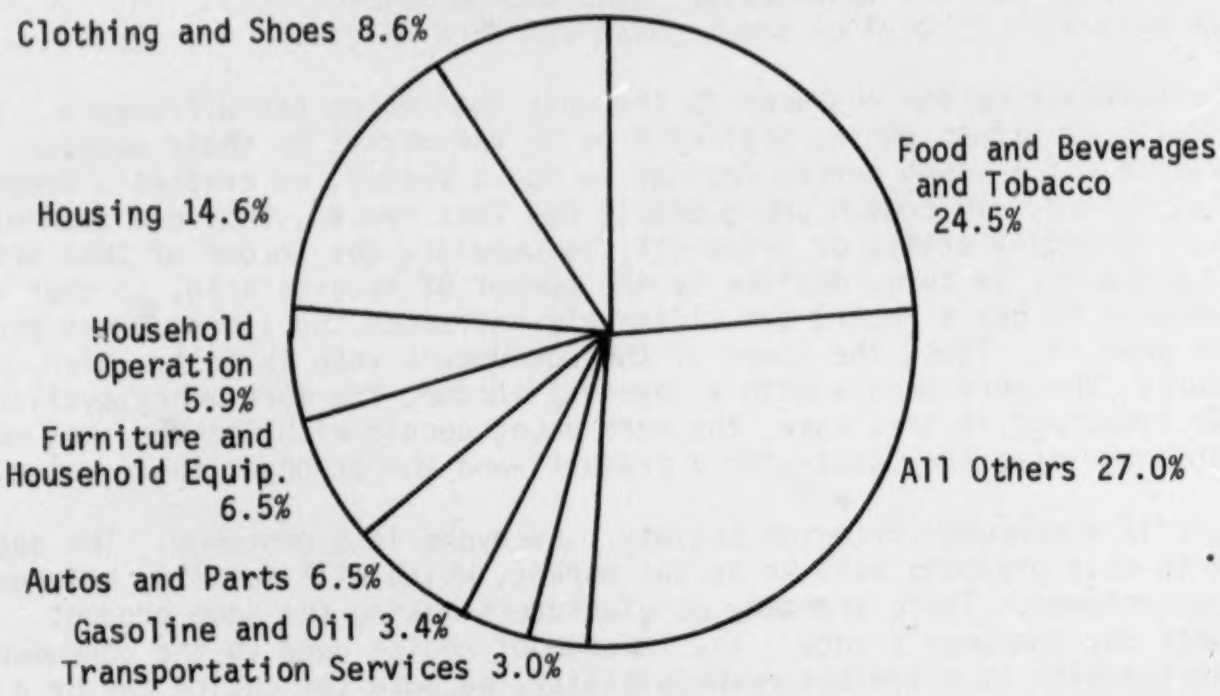

Total consumption expenditures in 1966--
$465 billion

PERSONAL INCOME--income received by individuals from all sources.

This personal income is used for spending for--
Services
Durable goods
Nondurable goods
Personal savings
Taxes

DISTRIBUTION OF THE
PERSONAL INCOME DOLLAR

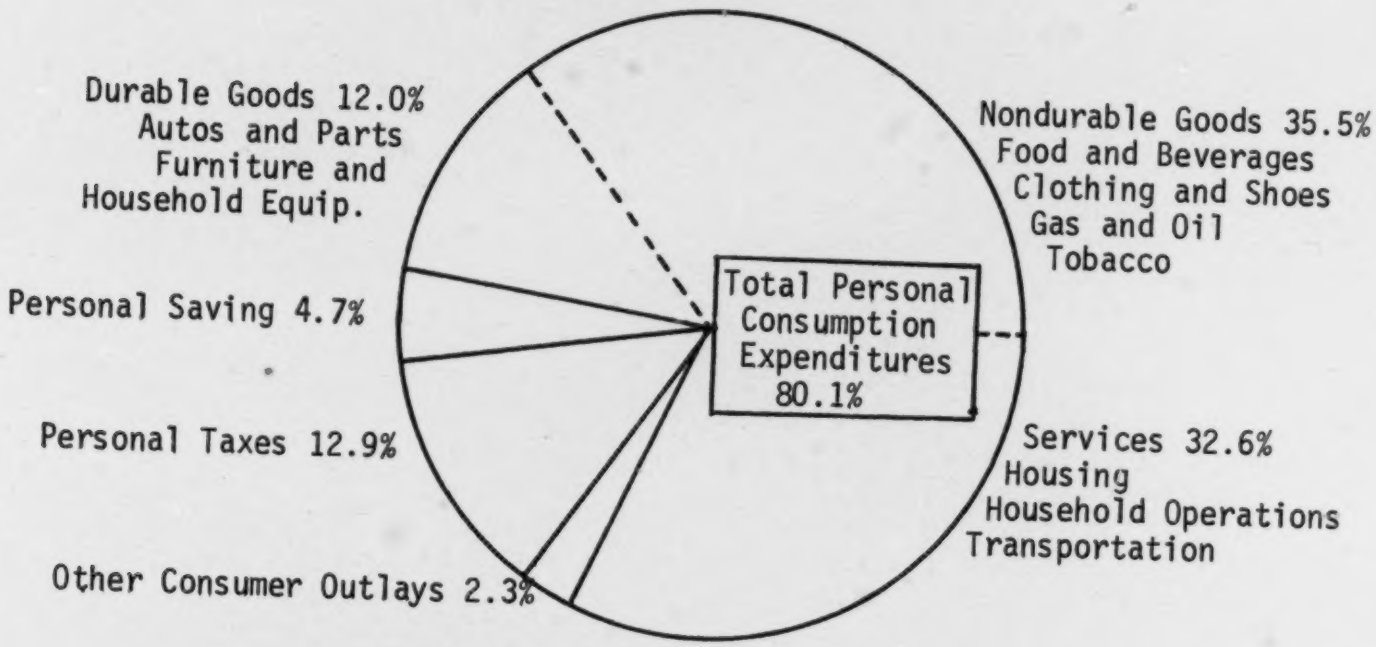

Total personal income in 1966--$580 billion

In our society--which is free and competitive, there are many responsibilities for the individual and for business to keep goods and services flowing.

Businesses have a responsibility to the consumer and the community.

(1) Supply the consumer with products and services that meet standards for satisfactory performance.
(2) Relay messages from the consumer to the manufacturer.
(3) Supply the consumer with information about products.
(4) And in the community he fulfills responsibility by donating to funds and charities, paying taxes, and providing jobs.

The consumer also has responsibilities. He has more freedom in our society to decide how he will spend his money than under any system--and this brings a great responsibility.

(1) He should stay informed of new products on the market
(2) Comparative shop
(3) Investigate credit
(4) Check labels and service offered
(5) And have a spending plan

Youth has an opportunity to exercixe the responsibility and independence he desires as he plays his role in the economic cycle. The responsibility of education is to help him understand this cycle and his place in it.

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SECTION FOUR: CONSUMER AND THE ECONOMY
UNIT III: Sources and Functions of Money
III-1. Two Sides of Money

(See Suggested Learning Experience No. 2, p. 149 in Part One)

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TWO SIDES OF MONEY[1]

People in Jobs

Earning

The history of the world is the record of a man in quest of his daily bread and butter.

--H.W. Van Loon
The Story of Mankind

As each person earns and spends, he satisfies his own individual needs and wants.

Collectively, through earning and spending, people promote the economic development, growth, and well-being of their nation.

People in the Marketplace

Spending

[1]Developed by Gerald A. Porter, University of Oklahoma, Norman, Oklahoma.

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FUNCTIONS OF MONEY

1. to serve as a means of payment.
2. to expedite the use of credit.
3. to serve as a standard, a guide to the measurement of the value of goods and services.
4. to serve as a storehouse of the value of goods and services produced.

PRODUCTION

Physical Resources

Land

Machines

Human Resources

Labor

Capital

DISTRIBUTION

Money constitutes a medium of communication as it facilitates the kinds distribution required to get products and services to the consumer in complex economic circumstances.

Money, like language a store of word and experience, acts also as a translator and as a transmitter. As the written word has advanced the separation of social functions, money has moved away from its original role as a store of work. It has separated itself from the commodity form and has become a vital specialist agent of exchange and a significant translator of human values.

CONSUMPTION

Kinds of Purchasing Power

Cash

Demand Deposits (checkbook money)

Credit

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THE CONTENT OF MONEY MANAGEMENT

How Business Operates

SOCIAL BUSINESS SITUATIONS

1. Nature

   Business

   Government

   Education

   Religion

   Philanthropic

   Etc.--all others

2. Form

   Proprietorship

   Partnership

   Corporation

   Cooperative

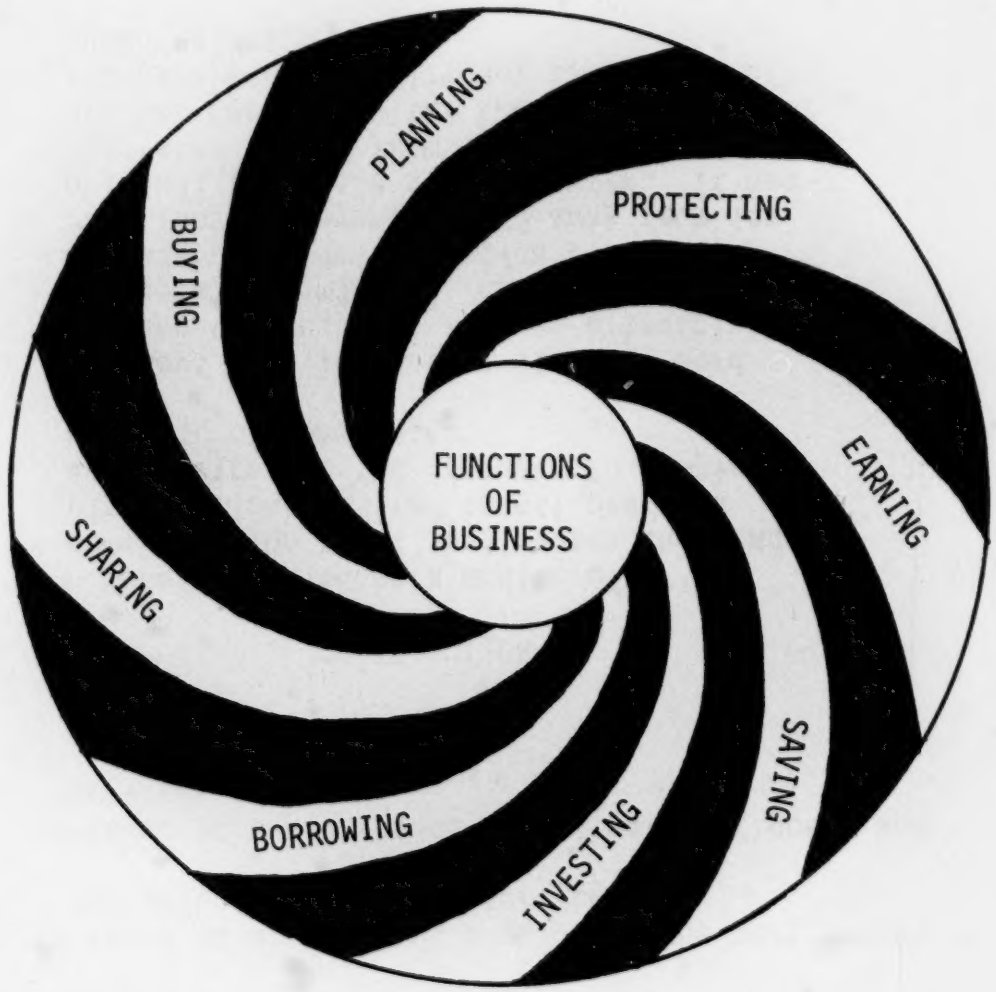

FAMILY BUSINESS SITUATIONS

1. Children
2. Teen-agers
3. Young Adults
4. Middle Aged
5. Aged

The fundamental principles and basic functions of business are the same in a profit-making enterprise as they are in a family wage-earning situation. A family experiences the same kinds of financial successes and failures as does any business firm. The business firm or the family unit should practice good money management in terms of each of the major elements indicated above.

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SECTION FOUR: CONSUMER AND THE ECONOMY
UNIT III: Sources and Functions of Money
III-2. What Is Money?[1]

(See Suggested Learning Experience No. 2, p. 149 in Part One)

Over the long span of human history, money has assumed many forms and shapes. Different societies, at different times, have been willing to exchange goods or services for:

Seashells	Bricks	Beaver pelts
Whale's teeth	Coconuts	Blankets
Boar's tusks	Cocoa beans	Bronze axes
Stones	Iron rings	Wheels
Feathers	Salt	

In some of the South Pacific islands, great stone wheels served as money. Someone has said that those were the days when the men handled all the money. It took muscle to move a huge stone wheel.

In ancient Greece oxen were money; one ox was the basic money unit. When the Greeks introduced coins of gold and silver, this unit remained the basis for metal money, with each of the various coins worth different fractions of an ox.

In ancient Rome different things circulated as money. When the emperors were firmly established, they issued coins of gold and silver, and, throughout the Empire, their subjects used them. In addition, the Romans used pieces of bronze and copper that were not made into coins; Roman merchants had to weigh and test each piece every time they made a sale or purchase. In the early days of the Empire, however, Ceasar paid the legionnaires in cakes of salt, not metal, and the Roman emperors did this again, in the later days of the Empire, when they began to run out of metal. This custom may be the origin of the saying that a person is - or is not - "worth his salt."

The point is this: Any number of different materials - including paper I O U's - may serve as money. How money functions, and what money represents, are the important aspects of money. What material the money is made of is not an important aspect at all. In any society, people may use as money anything they wish, provided that they agree with other people throughout the society that the material they are using has the same meaning for all of them.

The question, "What is money?" can be answered briefly: MONEY IS ANYTHING THAT PEOPLE WILL ACCEPT IN EXCHANGE FOR GOODS OR SERVICES, IN THE BELIEF THAT THEY MAY IN TURN EXCHANGE IT, NOW OR LATER, FOR OTHER GOODS OR SERVICES.

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[1]Reprinted from Primer on Money. Washington, D.C.: U.S. Government Printing Office. Bulletin No. 34-710.

see

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SECTION FOUR: CONSUMER AND THE ECONOMY
UNIT III: Sources and Functions of Money
III-3. Circular Flow of Money

(See Suggested Learning Experience No. 5, p. 150 in Part One)

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CIRCULAR FLOW OF MONEY IN THE ECONOMY

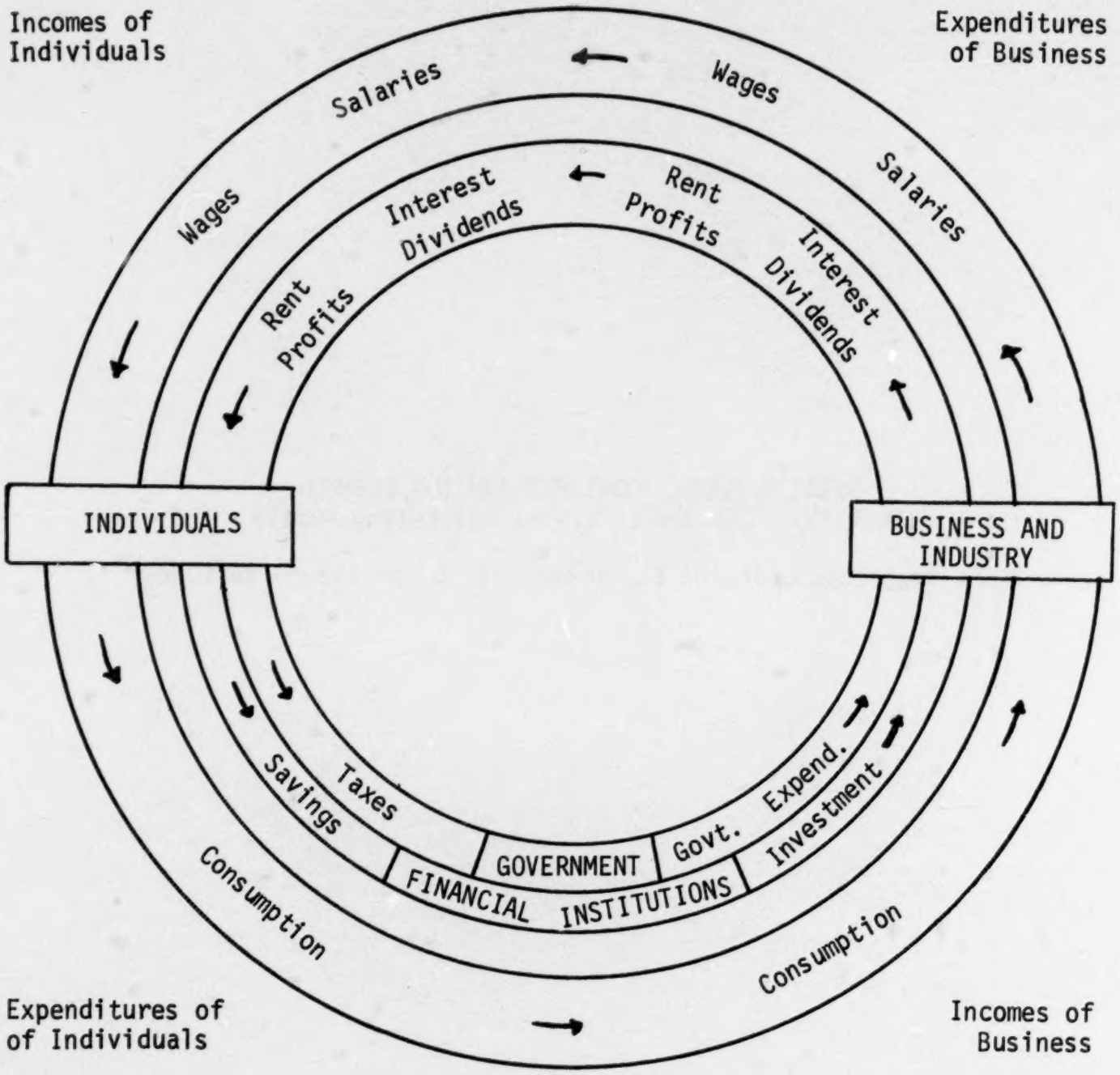

SECTION FOUR: CONSUMER AND THE ECONOMY
UNIT IV: The Market System--Marketing Puzzle

(See Suggested Learning Experience No. 5, p. 153 in Part One)

Home Economics
Instructional Materials Center
Lubbock, Texas

MARKETING PUZZLE

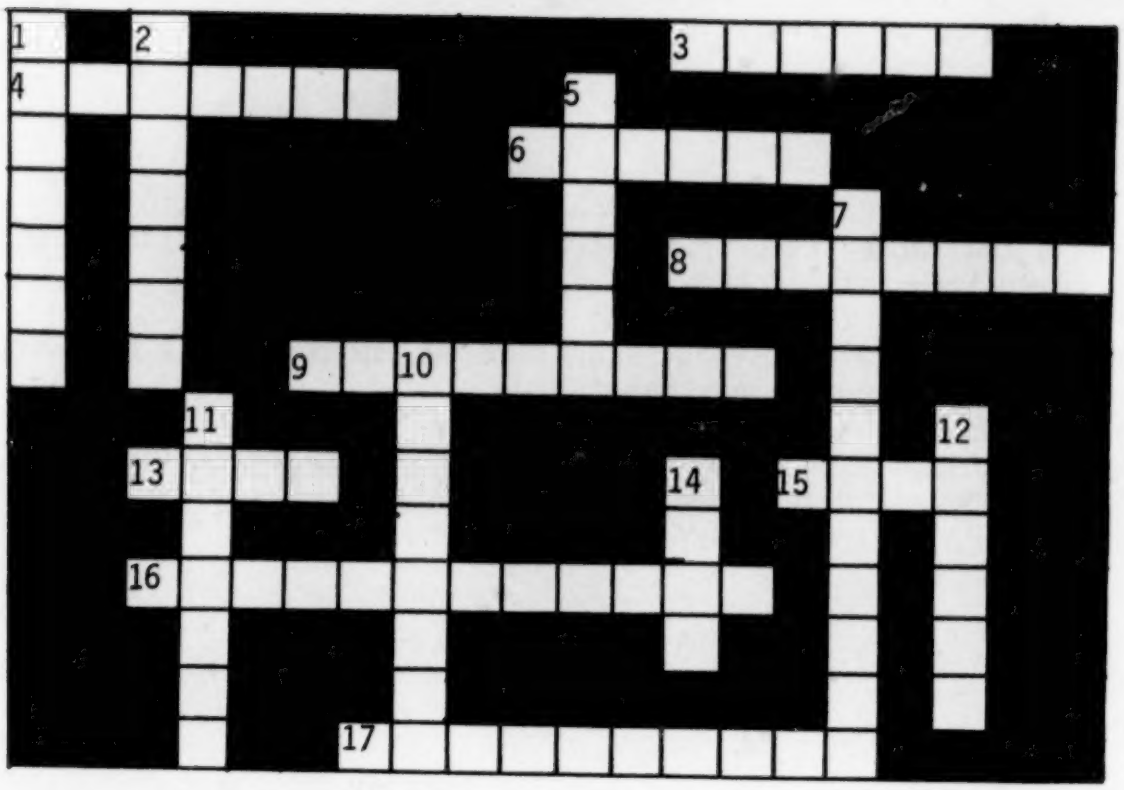

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MARKETING PUZZLE

ACROSS

3. The quantity of goods offered for sale
4. The quality of goods that enables it to satisfy a want
6. The person who brings prospective buyers and sellers together
8. Control over the supply of goods or services that makes it possible to control prices and prevent competition
9. Sale and distribution of goods
13. Production of large quantities of goods is referred to as _____ production
15. A system in which individuals and businesses are free to make their own choices is called the _____ enterprise system
16. Process of dividing or spreading goods over a wide area
17. The creation of utility in goods or services

DOWN

1. A sum of money paid by government to encourage production
2. When a few large producers control most of the production of an item or commodity, this is known as _____ competition
5. The price minus the cost is the _____
7. An association of individuals created by law to conduct business under a charter granted by government
10. The person who sells to consumers
11. Various things used in the production of goods and services
12. Market price is determined by the supply and _____
14. Any material things or services that people desire

ANSWERS TO CROSSWORD PUZZLE

ACROSS

3. supply
4. utility
6. broker
8. monopoly
9. marketing
13. mass
15. free
16. distribution
17. production

DOWN

1. subsidy
2. limited
5. profit
7. corporation
10. retailer
11. capital
12. demand
14. goods

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SECTION FOUR: CONSUMER AND THE ECONOMY
UNIT V: Banks and Banking Services
V-1. Protect Your Checking Account

(See Suggested Learning Experience No. 10, p. 158 in Part One)

Individuals lose billions of dollars to forgers. Careful check-writing habits may protect you from forgers.

Your signature is the key to your banking account. Once your checking account signature becomes available, so do your finances. Use a clear-cut legible signature when signing checks. Plain, easy-to-read signatures are more difficult to forge than flourished illegible handwriting.

Your signature can be easily obtained, so use a different signature for banking than you do for other types of correspondence and business. If you normally sign your name, Jane Jacobs, sign your checks Jane C. Jacobs.

If you have imprinted checks, have them read J.C. Jacobs, but sign them Jane C. Jacobs. The forger will likely assume that your check imprint is the same as your signature and will forge incorrectly. Your bank should catch the inconsistency and return the check stamped "irregular signature."

When checks are to be mailed, cover your signature by folding either the check or another piece of paper on it. Lock up cancelled checks so your signature is hidden.

Print, do not write, the amount on the dollar line. Printed block style letters are the most difficult to alter. In the example, you can see that "two" was changed to "five."

In making out checks, try to use a fountain pen. Do not sign your checks with a lead or dry indelible pencil or a ballpoint pen. Do not sign your checks in your check book since the signature will imprint on the next check.

When writing a check, keep your bank balance stub covered. Do not tempt a potential forger.

Abbreviations are easy to alter. It is best to write out fully all names and companies.

Extend each entry to full width allotted. If necessary, draw a line or use dashes to completely fill the space. Additions or alterations can be placed in empty spaces.

The check artist has devised skillful ways of forging checks. Your caution with your checks and your signature will keep his hand out of your bank account.

January 1 19 70

YOUR NAME
YOUR ADDRESS
YOUR CITY, U.S.A. 00000

1st

PAY TO THE ORDER OF Jane Jacobs $200.00

TWO HUNDRED no/100 DOLLARS

FIRST NATIONAL BANK
ANYTOWN, U.S.A.

John Harrison

':1133...047/'.: "145 345 5"'

January 1 19 70

YOUR NAME
YOUR ADDRESS
YOUR CITY, U.S.A. 00000

1st

PAY TO THE ORDER OF Jane Jacobs $200.00

Two Hundred no/100 DOLLARS

FIRST NATIONAL BANK
ANYTOWN, U.S.A.

John Harrison

':1133...047/".: "145 345 5"'

January 1 19 70

YOUR NAME
YOUR ADDRESS
YOUR CITY, U.S.A. 00000

1st

PAY TO THE ORDER OF Jane Jacobs $500.00

Five Hundred no/100 DOLLARS

FIRST NATIONAL BANK
ANYTOWN, U.S.A.

John Harrison

":1133...047/".: "145 345 5"'

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SECTION FOUR: CONSUMER AND THE ECONOMY
UNIT V: Banks and Banking Services
V-2. Money Game[1]

(See Suggested Learning Experience No. 13, p. 158 in Part One)

Supplies Needed:

Slips of paper containing row letter terms and definitions (see list of terms and definitions on p. 296)

Container for slips

Master card for each game

Playing cards (1 for each player)

Dried beans

Persons Needed

Caller

Assistant to check master card

Players (any number)

Directions for Playing

1. The Money Game is played like Bingo.
2. The object of the Money Game is to spell money vertically, horizontally, or diagonally.
3. Each player receives a playing card. (Six sample playing cards are shown on pp. 300-302.)
4. Dried beans may be used to indicate terms on the card which have been used.
5. The center square on each card, labeled "MONEY" is a "free" space.
6. The caller will draw a slip from the container, read the row letter, then the definition of the term (see p. 296).
7. The assistant takes the slip from the caller and checks each term as it is used on the master card (see p. 299).
8. If a player thinks his playing card has the term which goes with the definition called, he places a bean on the square containing that term.
9. When a player has filled a complete row (vertically, horizontally, or diagonally) he calls "MONEY."
10. The caller stops the game and checks the player's card with the master card.
11. If the player's card checks with the master card, he becomes caller and a new game is begun. If the player's card fails to check with the master card, the game continues until another player calls "MONEY."

---

[1]Developed by Anne C. Cleveland, Homemaking Teacher, Glens Falls High School, Glens Falls, New York.

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List of Terms and Definitions

ROW M

ANSWER:	CALLER READS:
Advertising	Use of media to promote sales
Media	Modern means of mass communication
Health	State of well-being
Profit	Gain or benefit
Loss	Lack of profit--no gain
Shelter	Home or housing
Transportation	Means of locomotion - carfare--auto--bus
Mortgage	Pledge of property to gain credit
Value	Worth of idea or property
Travel	Trip or journey away from home
Liabilities	Expenses & debts of a person

ROW O

ANSWER:	CALLER READS:
Disability	Illness or accident making one unable to work
Unemployment	Out of work
Consumer	One who buys or uses goods & services
Seller	One who offers goods for sale
Credit	Confidence in a person and/or ability to pay one's debts
Net pay	Amount of actual cash a worker receives after deductions
Insurance	Contract to pay a person in case of loss by fire, etc.
Deductions	Amount of money withheld from paycheck for taxes, etc.
F.I.C.A.	Federal Insurance Contribution Act

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Income	Amount of money earned
Resources	All assets of an individual
Savings & Loan Association	A bank that saves and lends money, usually for purchasing of property

ROW N

ANSWER:	CALLER READS:
Buyer	One who purchases an item
Goals	An end that one tries to reach
Recreation	Play, amusement, entertainment
Luxuries	Anything contributing to enjoyment but not a necessity
Contributions	Money given to a fund for special person or purpose
Community	Group of people living in same place
Taxes	Compulsory payments to government on income and property
Federal	United States government
State	The state in which you live
Local	The city or county in which you live
Assets	All of the property and income owned by a person

ROW E

ANSWER:	CALLER READS:
Savings	Amount set aside and not spent--amount in bank account
Corporation	A group of people organized to run a business
Stock	Shares bought in a company
Annuity	Investment that pays fixed yearly payment
Operating Expenses	Cost of running a home or business

Charity	Giving help to those in need
Retail	Sale of goods directly to consumer in small amounts
Wholesale	Sale of goods in large quantity to retailer
Interest	Money paid for use of another's money
Installment	Amount of money due regularly on a time purchase or loan
Loan	Money borrowed
Savings bank	An institution primarily for saving of money

ROW Y

ANSWER:	CALLER READS:
Fraud	Dishonest or deceitful means of doing business
Allowance	Amount of money given regularly to a person for needs
Budget	A plan for managing money
Rent	Set amount due regularly for use of property
Fixed expenses	Amount of money needed for regular expenses
Emergency fund	Amount set aside for unexpected expenses
Wages	Amount paid for labor
Down payment	First payment on an article bought on credit
Service charge	Amount of money paid for credit on time purchase
Pension	Amount paid to retired worker if a person has contributed or his company has contributed to an income retirement fund
Social Security	Federal Old Age Insurance Plan
Investment	Purchase of property, stocks or bonds in the hope of increasing value of money

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Master Card

M	O	N	E	Y
Advertising	Disability	Buyer	Savings	Fraud
Media	Unemployment	Goals	Corporation	Allowance
Health	Consumer	Recreation	Stock	Budget
Profit	Seller	Luxuries	Annuity	Rent
Loss	Credit	Necessities	Operating Expenses	Fixed Expenses
Shelter	Net Pay	Contributions	Charity	Emergency Fund
Transpor-tation	Insurance	Community	Retail	Wages
Mortgage	Deductions	Taxes	Wholesale	Down Payment
Value	FICA	Federal	Interest	Service Charge
Travel	Income	State	Installment	Pension
Liabilities	Resources	Local	Loan	Social Security
	Savings & Loan Assoc.	Assets	Savings Bank	Investment

Sample Playing Cards

M	O	N	E	Y
Travel	Consumer	Community	Operating Expenses	Fixed Expenses
Liabilities	Income	Local	Stock	Investment
Loss	Seller	MONEY	Annuity	Rent
Media	Buyer	Federal	Savings	Budget
Shelter	Disability	State	Charity	Allowance

M	O	N	E	Y
Liabilities	Resources	Federal	Loan	Social Security
Loss	Savings & Loan Assoc.	State	Savings Bank	Investment
Travel	FICA	MONEY	Savings	Wages
Advertising	Deductions	Local	Charity	Allowance
Media	Consumer	Assets	Retail	Budget

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M	O	N	E	Y
Advertising	Disability	Buyer	Savings	Fraud
Media	Unemployment	Goals	Corporation	Allowance
Health	Consumer	MONEY	Stock	Budget
Profit	Seller	Recreation	Annuity	Rent
Loss	Credit	Luxuries	Operating Expenses	Fixed Expenses

M	O	N	E	Y
Value	Credit	Assets	Retail	Budget
Travel	FICA	Recreation	Savings Bank	Service Charge
Profit	Net Pay	MONEY	Operating Expenses	Allowance
Mortgage	Consumer	Taxes	Corporation	Down Payment
Health	Income	Buyer	Loan	Fraud

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M	O	N	E	Y
Profit	Insurance	Luxuries	Installment	Pension
Health	Deductions	Necessities	Savings	Fraud
Shelter	Resources	MONEY	Charity	Wages
Transpor-tation	Income	Contributions	Wholesale	Emergency Fund
Advertising	Unemployment	Goals	Interest	Social Security

M	O	N	E	Y
Shelter	Net Pay	Necessities	Charity	Emergency Fund
Transpor-tation	Insurance	Contributions	Retail	Wages
Mortgage	Deductions	MONEY	Wholesale	Down Payment
Value	FICA	Community	Interest	Service Charge
Travel	Income	Taxes	Installment	Pension

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SECTION FOUR: CONSUMER AND THE ECONOMY
UNIT V: Banks and Banking Services
V-3. Economic Jeopardy

(See Suggested Learning Experience No. 14, p. 158)

Preparation: Construct a large board with hooks on which to hang cards or use bulletin board tacks to hold cards (about 4" x 4"). Cards have a score on one side and either a question or an answer on the other side. Scores range from 10 to 60 under each category. Difficulty increases as scores increase. The following categories are used for Economic Jeopardy: Economics, Money, Marketing, and Banking. [NOTE TO TEACHER: Assign points to the questions according to the ability of students. Some cards on the board may contain a question--players give an answer in response. Some cards may contain an answer--players respond by giving the question. Sample questions and answers for each category are given on pp. 304-306.]

Divide into teams. Give each team member some type of noise maker for signaling his readiness to answer.

Rules of Play:

1. Employ some means of determining which team will select the first question.
2. The first team chooses a category and a level, e.g., Money for 40 points.
3. The card is turned over for all to read (may be read aloud) and any player who thinks he can answer the question signals using his noise maker.
4. If the player answers correctly, his team scores the value of that card. If he answers incorrectly, his team forfeits the value of the card and the other team is given the opportunity to answer the question.
5. Each time a team answers incorrectly, it forfeits the value of the card.
6. Play continues until all cards are turned over.
7. The team which has scored the most points at the end of the game wins.

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CATEGORY: MONEY

Questions

1. What is money?
2. What is inflation?
3. What is bartering?
4. What can be used for commodity money?
5. What is real income?
6. What is price?
7. What is currency?
8. What is sound money?
9. What is a general decrease in prices?
10. What is money made by a person other than the Federal Government?

Answers

1. Anything accepted in payment for goods or services
2. A general increase in prices
3. Trading goods for goods
4. Tobacco leaves, furs, beads, cigarettes
5. The purchasing power of income or wages
6. The value of anything expressed in money terms
7. The coins and paper bills used as a means of payment
8. Money with fairly stable purchasing power
9. Deflation
10. Counterfeit

CATEGORY: BANKING

Questions

1. Who is someone who puts money in a bank?
2. What is a service charge?
3. What is a blank endorsement?
4. Who is the payee?
5. What is clearing?
6. What is a cashier's check?
7. What is investing?
8. What are dividends?
9. What are fixed-dollar investments?
10. What is the amount of money that has been invested?

Answers

1. A depositor
2. A fee paid for checking account service
3. An endorsement that permits a check to be cashed by anyone
4. The person to whom a check is written
5. The process of collecting payment for checks

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6. A check that a bank draws on its own funds
7. Putting savings to work earning income
8. A savings and loan association's payment to its savers
9. Investments that do not increase or decrease in dollar value
10. The principal

CATEGORY: ECONOMICS

Questions

1. What is the gross national product?
2. What are the factors of production?
3. What is production?
4. What is free enterprise?
5. What is profit?
6. What is mass production?
7. What is subsidy?
8. What is utility?
9. What is consumption?
10. What is capital?

Answers

1. The total amount that a nation produces during any year
2. Natural resources, labor, and capital
3. The principal function of business
4. A system in which individuals and business enterprises are allowed to make their own choices
5. The difference between what a business earns and the operating costs
6. Goods produced in large quantities
7. A government's financial assistance in private enterprises
8. Production which involves creating value
9. The act of using goods and services to satisfy needs and wants
10. Buildings and equipment used by workers to produce goods

CATEGORY: MARKETING

Questions

1. What are the functions of marketing?
2. What is the process of moving goods from producers to consumers?
3. What is a cooperative?
4. What is a monopoly?
5. What is merchandising?
6. What is a retail market?

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7. What is a business unit owned by the government?
8. Who is a wholesaler?
9. What is an individual proprietorship?
10. What is one step in the marketing process?

Answers

1. Tasks performed in the process of moving goods from the original producer to the point of final sale
2. Marketing
3. An enterprise owned by its customers
4. The ability to control the supply and price of goods or services
5. Process of filling demands for products
6. Final outlet in the distributing system
7. Government enterprise
8. A merchant who buys in large quantities for the purpose of selling smaller quantities of goods
9. An unincorporated business owned by one individual
10. Transportation

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ABSTRACT - Developed during a University of Maryland School of Nursing project, reviewed by 10 practical nursing educators, and field tested in four schools, this program guide contains suggestions for planning a course to prepare licensed practical nurses for charge nurse responsibilities in nursing homes, extended care, and related facilities. Part I describes planning, implementing, and evaluating activities, including the role of the teacher and resource committee, scope of the program, funding, criteria for trainee selection, facilities requirements, brief description of the curriculum and standards, policies, and expectations. Part II contains materials and resources to be used in conducting the course, including guidelines and criteria for continuing education programs, charge nurse functions, sample application and evaluation forms, directory of publishers in the health care field, a bibliography, and guidelines to assess nurse manpower and health care facilities. The guide is designed to be used with the student text, which is available as VT 012 605 also in this issue. (SB)

VT 012 604

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THE LICENSED PRACTICAL NURSE AS CHARGE NURSE

INSTRUCTOR'S GUIDE

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THE LICENSED PRACTICAL NURSE AS CHARGE NURSE:

Instructor's Guide

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PREFACE

CONTINUING EDUCATION

Practical nursing education is conditioned greatly by the changing and expanding complexity of health care. No program of basic preparation, whatever its type or quality, could possibly encompass all a practical nurse needs to maintain currency and relevancy to the developments in health care.

Education of practical nurses must be a continuing process. Acceptance of this fact imposes obligations upon individual practical nurses, their employers, the health professions, and practical nursing educators. The National Licensed Practical Nurses Educational Foundation, Inc., the nursing education and research arm of the National Federation of Licensed Practical Nurses - NFLPN, has defined continuing education for practical nurses as follows:

> Continuing education includes those organized educational experiences which are planned to help practical nurses achieve more productive and satisfying fulfillment of their roles as health workers. Such fulfillment should be of mutual benefit to both the practical nurse and to society, but should not be limited to preparing the practical nurse to meet the unique service needs of a single agency. Improved patient care is the primary goal of all continuing education of the LPN/LVN.

The contract between the Federation and the United States Public Health Service to develop materials to help with the preparation of LPN charge nurses for nursing homes, extended care, and related facilities is an example of a continuing education program for LPNs. Part II of the Guide contains the Federation's statements on "Continuing Education" and "Criteria for Continuing Education of the LPN/LVN," and "Ten Propositions Basic to Vocational Development."

THE PROJECT

Since the passage of PUblic Law 89-97, Title XVIII "Medicare" and Title XIX "Medicaid," and the subsequent conditions of participation and policy regulations, there has been considerable interest in the licensed practical nurse who works as a charge nurse in nursing homes, extended care, and related facilities.

In June, 1967 the Public Health Service awarded a grant to the University of Maryland School of Nursing to study the problem of preparing the LPN for these responsibilities. Project activities included review of the literature; survey of the functions of the charge nurse in an ECF; design, test, and evaluation of the curriculum; and the development of an Instructor's Guide. Mrs. Dorothy Justice, Assistant Professor and Chairman of the Practical Nurse Program at the University of Maryland School of Nursing, served as project director. The Instructor's Guide, Fundamentals of Nursing Management Skills for Licensed Practical Nurses Who Serve As Assistants to Registered Nurses in Extended Care Facilities was prepared by Linda A. Tarr, R.N., M.S.

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In June, 1969 the National Licensed Practical Nurses Education Foundation, Inc. received a contract from the Public Health Service to test, review, and revise the Instructor's Guide and to develop a textbook for use by LPN trainees. Major project activities included (1) review and testing of materials, and (2) revision and preparation of the publications.

A ten-member team of instructors from practical nurse education programs critiqued Guide materials prior to curriculum field test and following preparation of the Guide and Text drafts. Four schools used Guide materials to plan, conduct, and evaluate a continuing education program: "Preparation of LIcensed Practical Nurses for Charge Nurse Responsibilities in Nursing Homes, Extended Care, and Related Facilities:

Midwest City Public Schools
Midwest City, Oklahoma

Mount Sinai Hospital School of Practical Nursing
Miami Beach, Florida

New Orleans Public Schools
New Orleans, Lousiana

Southern Illinois University
Division of Technical and Adult Education
Carbondale, Illinois

Constant in each program were common objectives and quality of teaching faculty; hours of instruction and course format varied. The course was offered as a 10-day work conference at Southern Illinois University. Classes were three mornings a week for four weeks at Midwest City. The New Orleans program utilized Saturday mornings for 11 weeks with an intensive period of clinical application for five consecutive days the seventh week. The Mount Sinai program held some 30 classes Tuesday and Thursdays from 2 to 4 P.M. In most settings, trainees returned to their places of employment for applied clinical practice. Plans for coordination and supervision of trainees varied. In one program all trainees utilized a common agency for experience. Participating faculty included:

Mrs. Ruth Killough and Mrs. Sandy Mitchell
Midwest City Public Schools

Mrs. Carmen Ross and Mrs. Alice Gutterman
Mount Sinai Hospital School of Practical Nursing

Dr. Edwina Frank and Mrs. Anna Goldman
New Orleans Public Schools

Mrs. Beatrice Chiodini
Southern Illinois University

Nelly B. Oles of Community Health Service of the U. S. Public Health Service was Project Officer; Teresa M. Crowley, Executive Director of NLPNEF, served as Project Coordinator. Sandra Rasmussen directed the project and prepared the Instructor's Guide and Trainee Text.

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INTRODUCTION

This Guide contains suggestions to help you plan, implement, and evaluate a course to prepare licensed practical nurses for charge nurse responsibilities in nursing homes, extended care, and related facilities.

The suggestions are intended to help you develop a course similar in content and quality to other programs throughout the country, yet flexible and particular to the needs of your immediate community.

Part I of the Guide describes activities necessary for planning, implementation, and evaluation of the LPN charge nurse course. A complete sample course including objectives and activities is included.

In Part II of the publication you will find materials and resources that might prove useful as you set up and conduct the course.

This Guide and the suggestions contained herein are specific for use with the book The LPN Charge Nurse: Trainee Text and Study Guide.

The author acknowledges the assistance of Federation staff, faculty review team, participating instructors, and many others whose efforts and encouragement helped make this publication possible.

Sandra Rasmussen

Part I

PLANNING, IMPLEMENTATION, AND EVALUATION ACTIVITIES

THE IDEA

A variety of factors prompt communities to begin a LPN charge nurse course. Local, regional, or State Public Health Officials may initiate the idea as they try to implement Medicare and Medicaid health programs. Nursing home directors, often through their associations, may request such a course. The licensed practical nurse association or vocational-technical educators responsible for continuing education may suggest the idea. Or a group of citizens concerned about long-term care and specifically the area's needs for nursing home personnel may organize into a committee and make their wants known.

THE TEACHER

Usually one person, most frequently a practical nurse educator, assumes major responsibility for coordinating the planning, implementation, and evaluation of the course. The teacher should be a registered professional nurse with experience and interest in long-term care and practical nurse education. Qualifications for employment should be similar to requirements for employment in the agency sponsoring the course. The teacher must hold a current license as a registered nurse.

A well prepared teacher is one of the most important factors for program success. The quality of the program is to a great extent dependent upon the teacher and her abilitis. Part II of the Guide contains a statement describing "Characteristics of Teachers in the Health Care Field."

TASK FORCE OR RESOURCE COMMITTEE

Once initial interest in the development of a LPN charge nurse course is apparent, an advisory committee should be convened. The "advisory" committee should be a working committee, and a more appropriate name might be Task Force or Resource Committee. Individuals involved in comprehensive health planning and/or regional medical programs, as well as any existing group or committee working with or interested in long-term care and practical nurse education should be involved. Duplication of effort must be avoided. Key representatives on the Resource Committee should be:

- Public Health officials responsible for Medicare/Medicaid Programs
- vocational-technical educators
- administrators and directors of nursing from nursing homes, extended care, and related facilities
- licensed practical nurses

The committee should be broad in membership yet small enough to work together. If possible it should include citizens: influential community leaders, the consumer of long-term care health services, and people from various health associations and community groups.

The task force should identify its purpose and major functions. In most cases it will function in a liaison capacity between the program and the community. It plays a key role in effective public relations. The task force should be active through all major program

phases: planning, implementation, and evaluation. For example, it may survey local health care institutions to determine the actual need for LPN charge nurses. It may assist with curriculum development; it may prove instrumental in locating cooperating clinical agencies. The task force may assist with follow-up studies of trainees. It plays an important role in on-going evaluation of the program and participates in planning necessary changes.

STANDARDS, POLICIES, AND EXPECTATIONS

Licensing and accreditation standards relative to the LPN as charge nurse in hospitals, nursing homes, extended care, and related facilities must be reviewed. The teacher should study Chapter 4 "Settings for Long-term Care" from The LPN Charge Nurse: Trainee Text and Study Guide thoroughly. She must obtain and read rules and policies governing licensing of institutions as well as the conditions of participation in Medicare and Medicaid programs. Public health personnel can be of great assistance to the teacher in explaining and interpreting standards.

The teacher must acquaint herself with policies operative in institutions in immediate area. She must become familiar with expectations nurses themselves, both the registered nurse and the licensed practical nurse, have regarding their role as charge nurse in long-term care institutions.

SCOPE OF THE PROGRAM

The teacher and task force must outline the scope of the program, that is, a clear understanding of what the program is and what the program is not. Perhaps it is most useful to circulate as a fact sheet the Statement of Functions of the LPN Charge Nurse (see Part II) explaining that these functions constitute program objectives, goals, and expected behavioral competencies.

It is wise to anticipate some of the questions that will be asked. Licensed practical nurses often ask, "will this course remove a waiver?" "Is this a medication course?" Administrators may ask, " will this help my institution qualify for Medicare/ Medicaid participation?"

A clear, emphatic description of the scope of the program is necessary for effective planning and implementation. Other programs and courses can be established to meet additional service and educational needs.

THE NEED

The teacher and/or task force should document the actual need for LPN charge nurses in the area before the program is planned and implemented. Public health personnel, State employment services, as well as health care institutions in area may help supply this information. Both short-term and long-term needs should be identified. Part II contains a form "Guidelines to Assess Nurse Manpower Supply and Demand" that should prove helpful.

THE TRAINEES

The licensed practical nurse association can prove helpful in contacting its membership to determine interest among LPNs in such a course. The nursing home association or administrators of nursing homes and similar institutions directly, can supply similar information about prospective trainees.

Criteria for acceptance of applicants for the course must be established. LPNs most likely to benefit from the program should be accepted first:

1. The LPN who is a graduate of a State-approved School of Practical Nursing, who is a charge nurse at present.

2. The LPN who is a graduate of a State-approved School of Practical Nursing, who is planning to be a charge nurse in the near future.

3. The waivered LPN who is a charge nurse at present.

4. The waivered LPN who is planning to be a charge nurse in the near future.

Part II of the Guide contains several sample letters and forms the teacher might find useful in her contacts with administrators to explain the program and obtain trainees:

- "Application
- "Endorsement"
- "Evaluation: The LPN Charge Nurse"
- "Agreement"

It is extremely important that administrators and directors of nursing have and understand the Statement of Functions of the LPN Charge Nurse.

FUNDING

The actual sponsorship of the LPN charge nurse course will vary from State to State, community to community. It is highly desirable that vocational-technical education acknowledge continuing education as a priority and undertake the responsibility for such a course. In some cases funds may come from comprehensive health planning and/or regional medical programs. A special grant may be obtained. Funding and sponsorship may come from local and/or State health associations, especially the nursing home associations or licensed practical nurse association. Monies might be securred directly from public health.

Initial funding and plans for additional courses must be worked through before program planning begins. If funds are available for a single program only, the program should be designated as a demonstration or experimental course.

Depending upon the arrangements that can be made for use of existing classroom and clinical facilities, major program costs will be for personnel: the teacher and secretarial assistance. Office and classroom supplies, communication expenses (mailings and telephone charges) are other specific program expenses.

FACILITIES

Both classroom and clinical facilities are required to implement the LPN charge nurse program. The education focus of the course will be enhanced if some of the program is offered in a "school" setting. Course schedules (late afternoon, evenings, or Saturdays) may permit utilization of existing classrooms. If the course is viewed as an integral part of the educational program, the teacher and trainees should have welcome access to existing classrooms and laboratories, the library, cafeteria, as well as audio-visual equipment and materials.

There is a tendency among health care facilities to offer their agencies for clinical experience rather than conduct an educational program of their own. Clinical experience is a necessary dimension of the course. Part II of the Guide contains "Guidelines to Assess Health Care Facilities and Services." This should help the teacher survey and select suitable clinical facilities.

Specific program needs include a conference room for discussion/conversational teacher-trainee learning. The teacher should have an office or office space that includes a telephone and typewriter; her contacts with the community are many. Secretarial assistance and duplication services should be convenient.

EDUCATIONAL RESOURCES

Each trainee should purchase the book The LPN Charge Nurse: Trainee Text and Study Guide. The teacher may recommend the purchase of two additional books by the trainees or, if budget permits, make these books available for use in the library:

> Nursing Care Planning by Dolores E. Little and Doris L. Carnevali. Philadelphia, Lippincott, 1969.
>
> A Handbook for Head Nurses by Doris A. Geitgey. Philadelphia, Davis, 1961.

Both of the above books are available in paperback; the Geitgey book will be in a second edition shortly.

Three films are recommended for use:

> "Mrs. Reynolds Needs a Nurse"
>
> "The Eye of the Beholder"
>
> "The Inner Man Steps Out"

These may be available free from your State Department of Health. Other sources of free or rental films include:

American Journal of Nursing, Educational Services Division
10 Columbus Circle
New York, New York 10019

Abraham Krasker Memorial Film Library
Boston University, School of Education
765 Commonwealth Avenue
Boston, Massachusetts 02215

Additional educational resources for both teacher and trainee use are suggested in Part III of the Trainee Text and in Part II of this Guide. A "Directory of Major Publishers in the Health Care Field" is included in Part II.

EVALUATION

Course evaluation begins with program planning. Evaluation must be on-going and periodic. It should be an accepted and shared responsibility among the teacher, the trainees, and the employer.

The employer and the trainees should complete the form, "Evaluation: The LPN Charge Nurse" at the beginning of the course. The teacher, the trainees, and the employer should again complete the form at the completion of the course, and if possible at three and six month intervals thereafter. A "Trainee Evaluation of Course" is found in Part II.

Evaluation information is needed to plan necessary changes or improvements in the course. Frequently the sponsor wants to know "if anything happened" because of the course.

Evaluation will be one of many ways to document to the employer, the trainees, and the teacher the value of the program and to what extent course objectives were met.

If possible, the teacher should request the terminal and the three and six month evaluations from the trainees and employers in person. If this proves difficult, a friendly explanatory letter and copy of the form should be mailed. At all times the importance and necessity of the evaluation should be stressed.

CURRICULUM

The curriculum has eleven major units. These correspond directly with the chapters in the book The LPN Charge Nurse: Trainee Text and Study Guide.

INTRODUCTION

THE LICENSED PRACTICAL NURSE

MEDICARE AND MEDICAID

PATIENTS ARE PEOPLE

SETTINGS FOR LONG-TERM CARE

INTRODUCTION - The LPN Charge Nurse

PLANNING PATIENT CARE

COORDINATING STAFF ACTIVITIES

IMPLEMENTING PATIENT CARE

EVALUATING PATIENT CARE

CONCLUSION

OBJECTIVES (Goals; Expected Behavioral Competencies) and ACTIVITIES (Teaching, Learning, Evaluation Activities) have been identified for each unit.

As indicated in the Preface, course hours and format varied from program to program. The initial University of Maryland course was 84 hours and most of the curriculum field test projects were similar. The "shortest" course was 60 hours, the ten-day work conference. Course time includes both classroom and clinical experiences.

Self-motivation and self-direction on the part of the trainees is crucial for program success. Trainees are expected to read, study, and complete the Text and Study Guide. Trainees are involved directly in the classroom learning process and in planning their clinical experiences.

The teacher may or may not be able to guide application of learnings in the clinical area. This in large part will depend on location of trainees and cooperating agencies. Because the trainee is preparing for a leadership role in which evaluation is a key dimension, self-evaluation of clinical application by the trainee herself is sound. When this can be combined by teacher evaluation, the activity proves more worthwhile.

Part II of the Guide contains several forms that might help the teacher as she plans, implements, and evaluates the curriculum: "Who is My Trainee?" "Charge Nurse Functions - a test," "Evaluation: The LPN Charge Nurse," "Role Playing Situations," and "Trainee Evaluation of Course."

The following pages contain a "sample course." The teacher is encouraged to adapt and change the format and organization in whatever ways necessary to meet specific objectives for the LPN charge nurse course in her community.

OBJECTIVES (Goals; Expected Behavioral Competencies)	ACTIVITIES (Teaching, Learning, Evaluation Activities)
INTRODUCTION	
- understands course objectives and activities	Trainee: - introduce self - describe work setting, kinds of patients, and present responsibilities - discuss course expectations - take "test" Charge Nurse Functions - complete form Evaluation: The LPN Charge Nurse - discuss anything of importance Teacher: - introduce self - describe course objectives and activities - give "test" and self-evaluation (see Part II) - answer questions about course - assign Chapter 1 "The Licensed Practical Nurse" from The LPN Charge Nurse: Trainee Text and Study Guide
THE LICENSED PRACTICAL NURSE	
- develops a working definition of nursing - understands the functions and qualifications of the LPN	Trainee: - discuss facts and feelings about nursing - review functions and qualifications of the LPN

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OBJECTIVES	ACTIVITIES
- understands the unique contribution the LPN is making to long-term patient care	- view film "Mrs. Reynolds Needs a Nurse" and discuss - discuss contribution LPN is making to long-term patient care - share learnings from Study Guide Teacher: - guide discussion as necessary - assign Chapter 2 "Medicare and Medicaid" from The LPN Charge Nurse: Trainee Text and Study Guide
MEDICARE AND MEDICAID - understands purpose of Medicare and Medicaid programs - understands the similarities and differences in the Medicare and Medicaid programs - explains the Medicare and Medicaid programs to others	Trainee: - discuss purpose of Medicare and Medicaid programs - discuss similarities and differences in Medicare and Medicaid programs - question teacher and/or resource people about programs - role play situations suggested in Study Guide Teacher: - guide discussion as necessary - obtain resource people involved directly with Medicare and Medicaid programs to explain programs - assign Chapter 3 "Patients are People" from The LPN Charge Nurse: Trainee Text and Study Guide

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OBJECTIVES	ACTIVITIES
PATIENTS ARE PEOPLE - understands that patients are people - understands the characteristics, needs, and role of the LPN relative to older people - understands the characteristics, needs, and role of the LPN relative to children and adults with chronic conditions	Trainee: - visit with older adults - note characteristics of older adults - discuss needs of older adults - discuss role of the LPN in caring for older adult patients - visit with individual with long-term illness - note characteristics of individual with long-term illness - discuss needs of children and adults with chronic conditions - discuss role of LPN in caring for individuals with chronic conditions - share learnings from Study Guide Teacher: - guide discussion as necessary - invite an older man and woman, and a child and/or adult with a chronic illness to class (guests may or may not be "patients;" an informal session with refreshments is suggested) - assign Chapter 4 "Settings for Long-term Care" from The LPN Charge Nurse: Trainee Text and Study Guide

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OBJECTIVES	ACTIVITIES
SETTINGS FOR LONG-TERM CARE	
- understands the concept progressive patient care - knows the kind of patient that should receive care in a hospital - knows the kind of patient that should receive care in an extended care facility - knows the kind of patient that should receive care in an intermediate care facility - knows the kind of patient that should receive care in a nursing home	Trainee: - question panel of nurses about institutions and patients - discuss similarities and differences in institutions and patients - discuss the role of the LPN in each institutional setting - share learnings from Study Guide Teacher: - guide discussion as necessary - organize a panel of four RNs, one each from a hospital, ECF, intermediate care facility, and nursing home to discuss the institution and patients - assign Chapter 5 "Introduction" to Part II in The LPN Charge Nurse: Trainee Text and Study Guide - ask trainees to bring job description of charge nurse to class
INTRODUCTION - The LPN as Charge Nurse	
- understands the need for LPNs as charge nurses in settings for long-term care - understands the functions of LPN charge nurses	Trainee: - discuss each job function: what does it mean? why is it important? - compare jobs functions from various institutions - review self-evaluation form completed first day of class - share learnings from Study Guide

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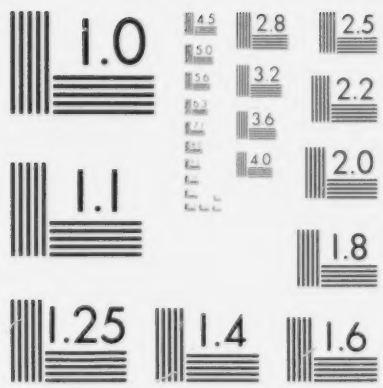

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OBJECTIVES	ACTIVITIES
	Teacher:
	- guide discussion as necessary
	- assign Chapter 6 "Planning Patient Care" from The LPN Charge Nurse: Trainee Text and Study Guide
	- suggest Chapters 1-5 from Nursing Care Planning and Chapter 1 from A Handbook for Head Nurses
PLANNING PATIENT CARE	
- demonstrates awareness of the comprehensive nature of long-term care	Trainee:
- understands the condition, needs, and therapeutic goals of each patient	- discuss each function in detail
	- view film "The Eye of the Beholder" and discuss
- receives and interprets verbal and written reports about patient care	- shares learnings from Study Guide
	- discuss suggested readings
- makes nursing rounds to observe and determine patient needs	- plan clinical experiences for each function
- assists the physician with examinations and treatments	- apply learnings in clinical area; evaluate performance
- discusses patient care goals with physician, nursing supervisor, and staff	Teacher:
	- guide discussion as necessary
- develops nursing care plans for individual patients	- help plan clinical experiences for each function
	- guide application of learnings in clinical area; evaluate performance
	- assign Chapter 7 "Coordinating Staff Activities" from The LPN Charge Nurse: Trainee Text and Study Guide
	- suggest Chapters 9, 10, 11 from Nursing Care Planning and Chapters 10 and 13 from A Handbook for Head Nurses

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OBJECTIVES	ACTIVITIES
COORDINATING STAFF ACTIVITIES	
- exhibits an understanding of basic human behavior - demonstrates fundamental leadership techniques - uses management principles and procedures - communicates verbally and non-verbally; listens, speaks, reads, writes, gestures effectively - motivates staff to give skilled nursing care to all patients	Trainee: - discuss each function in detail - view the film "The Inner Man Steps Out" and discuss - discuss learnings from Study Guide, especially goal-setting exercise - discuss suggested readings - plan clinical experiences for each function - apply learnings in clinical area; evaluate performance Teacher: - guide discussion as necessary - assist as necessary with goal-setting exercise - help plan clinical experiences for each function - guide application of learnings in clinical area; evaluate performance - assign Chapter 8 "Implenting Patient Care" from The LPN Charge Nurse: Trainee Text and Study Guide - suggest Chapters 6 and 8 from Nursing Care Planning and Chapters 2 - 9 from A Handbook for Head Nurses - ask trainees to bring chart forms, report forms, requisitions, as well as stated policies, procedures, and routines

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OBJECTIVES	ACTIVITIES
IMPLEMENTING PATIENT CARE	
- develops plans to meet on-going needs of all patients	Trainee:
- develops plans for common types of emergency situations	- discuss each function in detail
- assigns personnel in terms of patient needs and staff proficiencies	- study materials brought to class (chart and report forms, procedures and routines)
- helps staff care for patients with special needs, the patient with mental illness, the dying patient	- role play the situation between Yvonne Foley, LPN charge nurse and Helen Phillips, nurses' aide
- coordinates work with that of other departments such as dietary, housekeeping, physical and occupational therapy, social service	- tape record a team conference or tour of duty report you lead or give; study the recording; bring to class if possible
- seeks guidance and assistance when problems are beyond scope	- share learnings from Study Guide
- prepares and gives verbal and written reports about patients: conferences, nurses' notes, tour of duty and special reports	- discuss suggested readings
	- plan clinical experiences for each function
	- apply learnings in clinical area; evaluate performance
	Teacher:
	- guide discussion as necessary
	- evaluate usefulness of forms and procedures brought to class with trainees
	- plan role playing situation (See Part II for materials)
	- analyze tape recordings with trainees
	- help plan clinical experiences for each function
	- guide application of learnings in clinical area; evaluate performance

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OBJECTIVES	ACTIVITIES
	- assign Chapter 9 "Evaluating Patient Care" from The LPN Charge Nurse: Trainee Text and Study Guide - suggest Chapters 7 and 12 from Nursing Care Planning and Chapters 11, 12, and 14 - 17 from A Handbook for Head Nurses
EVALUATING PATIENT CARE	
- applies basic principles of evaluation - makes nursing rounds to observe and assess patient care and needs - assesses patient care given by staff and guides appropriate changes - appraises self-performance and plans improvement	Trainee: - discuss each function in detail - share learnings from Study Guide - discuss suggested readings - plan clinical experiences for each function - apply learnings in clinical area; evaluate performance Teacher: - guide discussion as necessary - help plan clinical experiences for each function - guide application of learnings in clinical area; evaluate performance
CONCLUSION	
- evaluates course objectives and activities	Trainee: - take "test" Charge Nurse Functions - complete form Evaluation: The LPN Charge Nurse - complete form Trainee Evaluation of Course - discuss expectations from course

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OBJECTIVES	ACTIVITIES
	- discuss course objectives and activities
	- discuss anything of importance and interest
	<u>Teacher</u>:
	- give "test," self-evaluation, and course evaluation forms (see Part II)
	- discuss expectations from course with trainees
	- discuss course objectives and activities with trainees
	- discuss anything of importance and interest

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Part II

MATERIALS AND RESOURCES

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CONTINUING EDUCATION

Continuing Education includes those organized educational experiences which are planned to help practical nurses achieve more productive and satisfying fulfillment of their roles as health workers. Such fulfillment should be of mutual benefit to both the practical nurse and to society, but should not be limited to preparing the practical nurse to meet the unique service needs of a single agency.

Guidelines for Continuing Education Programs

1. Every constituent State or local division or unit should have an education committee, and a budget allotment with which to carry out the function of the committee.

2. Exploration of the resources of a State or area is an essential step in locating cooperative help for planning and carrying out a continuing education program. Look to the allied health organizations, the nursing home association, regional medical groups, the State vocational education department, junior/community colleges and nursing organizations for assistance.

3. Leadership for educational programs should be selected from the best qualified, highly competent persons available.

4. The purpose of an educational program should be defined and the objectives stated clearly.

5. The curriculum for a continuing education program should meet the learning needs of the participants, build upon basic preparation, incorporate contemporary curriculum theory and be reviewed periodically.

6. Facilities for continuing education programs may require creative exploration. Hiring expensive rooms is not necessary. The possibilities of using adult education centers, vocational schools, junior/community colleges, Savings and Loan Association meeting rooms or those in health care agencies, clubs, community centers and parish houses should be investigated. Any one of them in a community may have meeting-room space available without a charge or for a modest fee.

7. Education Methods - Few continuing education programs are educationally effective if the instruction is limited to reading a paper or giving a lecture. A variety of participative methods and new educational media should be utilized in the program.

8. The title of a program should be selected with care. A sub-title may identify further its contents.

9. Advance information should be sent to participants which will prepare them for involvement in the content of any program and will insure accurate expectations.

10. Evaluation - Plans for evaluation of the program should be made to determine whether or not objectives have been met. Participant evaluation should be solicited at the close and desirable, some time after the program. Suggestions for improvement should be encouraged.

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CRITERIA FOR CONTINUING EDUCATION OF THE LPN/LVN

Continuing Education includes those organized educational experiences which are planned to help practical nurses achieve more productive and satisfying fulfillment of their roles as health workers. Improved patient care is the primary goal of all continuing education of the LPN/LVN.

I. TO REMOVE A WAIVER

1. A program in each State providing opportunity for removal of the waiver administered by an educational institution with the approval of the State board of nurse examiners and the cooperation of LPN associations.

2. Consideration and evaluation of the competence gained by work experience and continued learning of the LPN in meeting requirements of the program.

3. Provision of counseling services as an integral part of the program.

4. No limitations on age for admission to the program.

5. Provision of financial assistance when required.

II. TO IMPROVE PRACTICE

1. Varied opportunities for continuing education geographically and financially accessible to all LPNs.

2. Wide dissemination of information about learning opportunities in the areas.

3. Cooperative efforts of educational institutions, division, State and national nursing and health organizations, and health care agencies in development of programs.

4. Motivation of LPN/LVNs towards continuing education.

III. TO CHANGE A CAREER GOAL

1. Admission to higher education institutions available to all LPN/LVNs for systematic study.

2. Guidance in planning a change in career goal provided by educational institutions.

3. Consideration and evaluation of the competence and knowledge gained through work and life experience in meeting the requirements of the program.

4. Provision of financial assistance where required.

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TEN PROPOSITIONS BASIC TO VOCATIONAL DEVELOPMENT

1. People differ in their abilities, interests, and personalities.

2. They are qualified, by virtue of these characteristics, each for a number of occupations.

3. Each of these occupations requires a characteristic pattern of abilities, interests, and personality traits, with tolerances wide enough, however, to allow both some variety of occupations for each individual and some variety of individuals in each occupation.

4. Vocational preferences and competencies, the situations in which people live and work, and hence their self concepts, change with time and experience (although self concepts are generally fairly stable from late adolescence until late maturity), making choice and adjustment a continuous process.

5. This process may be summed up in a series of life stages characterized as those of growth, exploration, establishment, maintenance, and decline, and these stages may in turn be subdivided into (a) the fantasy, tentative, and realistic phases of the exploratory stage, and (b) the trial and stable phases of the establishment stage.

6. The nature of the career pattern (that is, the occupational level attained and the sequence, frequency, and duration of trial and stable jobs) is determined by the individual's parental socio-economic level, mental ability, and personality characteristics, and by the opportunities to which he is exposed.

7. Development through the life stages can be guided, partly by facilitating the process of maturation of abilities and interests and partly by aiding in reality testing and in the development of the self concept.

8. The process of vocational development is essentially that of developing and implementing a self concept; it is a compromise process in which the self concept is a product of the interaction of inherited aptitudes, neural and endocrine make-up, opportunity to play various roles, and evaluations of the extent to which the results of role playing meet with the approval of superiors and fellows.

9. The process of compromise between individual and social factors, between self concept and reality, is one of role playing, whether the role is played in fantasy, in the counseling interview, or in real life activities such as school classes, clubs, part-time work, and entry jobs.

10. Work satisfactions and life satisfactions depend upon the extent to which the individual finds adequate outlets for his abilities, interests, personality traits, and values; they depend upon his establishment in a type of work, a work situation, and a way of life in which he can play the kind of role which his growth and exploratory experiences have led him to consider congenial and appropriate.

From Vocational Development: A Framework for Research by Donald E. Super and others. New York, Teachers College Columbia University, 1957.

CHARACTERISTICS OF TEACHERS IN THE HEALTH CARE FIELD

Enthusiastic interest in learning and in contributing to knowledge of health care and of teaching.

A high level of knowledge and competence in the area of teaching within the health care field and interest in maintaining such.

A broad liberal education background on which to draw for personal and professional growth and development.

Knowledge and comprehension of teaching role and relationships in the institutional setting and a willingness to participate in the activities required by the role.

Ability to participate in defining new teaching roles demanded by changing goals of education and society in health care and education.

Ability to evaluate and apply knowledge of current health programs, problems and trends to the prediction of probable trends in medical practice, health care, and education in the health professions and occupations.

Ability to utilize knowledge of historical, philosophical, social, political, and economic concepts and trends in the functioning as a faculty member.

Enthusiasm for sharing knowledge in ways which stimulate others to pursue knowledge and skills.

Ability to synthesize knowledge of the learner and the theories of learning and instruction for organization and presentation of content and experiences.

Ability to involve the learner in developing effective ways of learning and continuing to learn.

Ability to relate to students and colleagues in education and health care services.

Skill, understanding and insight into dynamics of human behavior with the ability to initiate, maintain, and terminate relationships.

Understanding of the growth process in students; ability to guide students through learning to examine and/or re-examine values.

THE LICENSED PRACTICAL NURSE AS CHARGE NURSE

A Statement of Functions

The qualified licensed practical nurse who functions as charge nurse on certain tours of duty in nursing homes, extended care, and related facilities performs the following functions:

1. PLANS PATIENT CARE

- demonstrates awareness of the comprehensive nature of long-term care
- understands the condition, needs, and therapeutic goals of each patient
- receives and interprets verbal and written reports about patient care
- makes nursing rounds to observe and determine patient needs
- assists the physician with examinations and treatments
- discusses patient care goals with physician, nursing supervisor, and staff
- develops nursing care plans for individual patients.

2. COORDINATES STAFF ACTIVITIES

- exhibits an understanding of basic human behavior
- demonstrates fundamental leadership techniques
- uses management principles and procedures
- communicates verbally and non-verbally; listens, speaks, reads, writes, gestures effectively
- motivates staff to give skilled nursing care to all patients.

3. IMPLEMENTS PATIENT CARE

- develops plans to meet on-going needs of all patients
- develops plans for common types of emergency situations
- assigns personnel in terms of patient needs and staff proficiencies
- helps staff care for patients with special needs, the patient with mental illness, the dying patient
- coordinates work with that of other departments such as dietary, housekeeping, physical and occupational therapy, social service
- seeks guidance and assistance when problems are beyond scope
- prepares and gives verbal and written reports about patients: conferences, nurses' notes, tour of duty and special reports.

4. EVALUATES PATIENT CARE

- applies basic principles of evaluation
- makes nursing rounds to observe and assess patient care and needs
- assesses patient care plans and modifies as necessary
- assesses patient care given by staff and guides appropriate changes
- appraises self-performance and plans improvement.

GUIDELINES TO ASSESS NURSE MANPOWER SUPPLY AND DEMAND

1. Staff (each facility and total)

   Registered Nurses: number and kind

   Licensed Practical Nurses: number and kind

   Aide/Assistants: number and kind

2. Inactive nurses in area

   Registered Nurses: number and kind

   Licensed Practical Nurses: number and kind

   Aide/Assistants: number and kind

3. Unfilled budgeted positions (each facility and total)

   Registered Nurses: number and kind

   Licensed Practical Nurses: number and kind

   Aide/Assistants: number and kind

4. Turnover (each facility and total)

   Registered Nurses: number and kind

   Licensed Practical Nurses: number and kind

   Aide/Assistants: number and kind

5. What competitive factors affect nurse manpower supply?

6. What is the mobility of nurse manpower in and out of the area?

7. What nurse manpower needs will result fron new or planned health facilities?

8. What are the budgeted nurse manpower positions for new facilities (each facility and total)?

   Registered Nurses: number and kind

   Licensed Practical Nurses: number and kind

   Aide/Assistants: number and kind

October 1, 1970

William Lamont, Administrator
Franklin Hospital Skilled Care Unit, E.C.F.
201 Bailey Lane
Benton, Illinois 62812

Dear Mr. Lamont:

Southern Illinois University, Division of Technical and Adult Education, is presenting a ten-day work conference entitled: Preparation of Licensed Practical Nurses for Charge Nurse Responsibilities in Nursing Homes, Extended Care, and Related Facilities. Please refer to the enclosures for more details.

The need for such a course has been called to our attention; therefore, we anticipate cooperation from the institutions in this locality.

We are interested to know approximately how many LPNs you employ as charge nurses. Also, how many of your personnel would you be willing to send, to participate in this course? Please reply promptly so that you can be sent application blanks and other forms for these people.

Please note that a registration fee of $10.00 (ten dollars) has been requested from each participant. We have particular reasons for requiring this: (1) to "guarantee" registration and participation, (2) to "psychologically" convince the participants of the worth of the course, and (3) to allow purchase of trainee supplies. Therefore, if in your generosity, you would desire to pay the fee, we recommend that you forestall this until after the trainee has successfully completed the course.

Replies are to be sent to:

Mrs. Beatrice Chiodini, R.N.
Practical Nursing
Vocational Technical Institute
Southern Illinois University
Carbondale, Illinois 62901

Sincerely,

Beatrice D. Chiodini, R.N.
Instructor

BDC:hh

Enclosures

October 10, 1970

William Lamont, Administrator
Franklin Hospital Skilled Care Unit, E.C.F.
201 Bailey Lane
Benton, Illinois 62812

Dear Mr. Lamont:

Thank you for your interest in our work conference, "Preparation of Licensed Practical Nurses for Charge Nurse Responsibilities in Nursing Homes, Extended Care, and Related Facilities." I am happy to clarify the requirements.

We plan to accept LPNs most likely to benefit from this program; so, in considering applicants, we will evaluate them in this order:

1. The LPN who is a graduate of a State-approved School of Practical Nursing, who is a charge nurse at present.

2. The LPN who is a graduate of a State-approved School of Practical Nursing, who is planning to be a charge nurse in the near future.

3. The waivered LPN who is a charge nurse at present.

4. The waivered LPN who is planning to be a charge nurse in the near future.

Should any further clarification be needed, please do not hesitate to contact me.

Sincerely,

Beatrice D. Chiodini, R.N.
Instructor

BDC:hh

October 15, 1970

William Lamont, Administrator
Franklin Hospital Skilled Care Unit, E.C.F.
201 Bailey Lane
Benton, Illinois 62812

Dear Mr. Lamont,

We are pleased that you are interested in our course for LPN charge nurses. Also, we are happy to know that your Director of Nursing and your LPNs are interested.

I am enclosing three (e) each of the following forms: "Application," "Endorsement," and "Evaluation: The LPN Charge Nurse." Please return these to me as soon as possible, so that I can advise you about their acceptance.

Sincerely,

Beatrice D. Chiodini, R.N.
Instructor

BDC:hh

Enclosures

October 20, 1970

William Lamont, Administrator
Franklin Hospital Skilled Care Unit, E.C.F.
201 Bailey Lane
Benton, Illinois 62812

Dear Mr. Lamont,

We are pleased to inform you that three licensed practical nurses from your institution have been selected as trainees for the LPN charge nurse course.

We believe this kind of a continuing education program is a shared responsibility between the sponsoring school and the employing institution. Therefore, would you study and sign the enclosed "Agreement."

Thank you for your interest and cooperation.

Sincerely,

Beatrice D. Chiodini, R.N.
Instructor

BDC:hh

Cnslosure

APPLICATION

LPN Charge Nurse Course

Name: _____ Telephone: _____

Address: _____

Education & Licensure:

Circle highest year completed: 8, 9, 10, 11, 12 College: 1, 2, 3, 4

School of Practical Nursing: _____

Address: _____

Year Graduated: _____ Current License Number in State: _____

What other educational activities or classes have you taken to upgrade your nursing performance? _____

_____

Employment: (give most recent employment first)

Institutions (Name & Address)	Title or Position	How Long? (Dates)

How many years of geriatric or long-term care nursing experience do you have? _____

Health History:

Height: _____ Weight: _____

Past illnesses or injuries: _____

_____

Present health problems: _____

_____

What medications are you taking currently? _____

How many days of work did you miss because of illness last year? _____

Interest:

Why do you want to take this course?

2020 5049

_____ Date

_____ Signature of Applicant

ENDORSEMENT

LPN Charge Nurse Course

_____ has applied for admission to the LPN Charge Nurse Course.

1. How long have you known this LPN?

2. In what capacity?

3. Please describe her nursing performance?

4. What leadership potential does this LPN have?

5. Why do you recommend this LPN for the course?

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Date:_____

Name:_____

Present Position:_____

EVALUATION: THE LPN CHARGE NURSE

Name of LPN Charge Nurse_____Date_____

Directions:

1. Read each criterion (job function).
2. Recall a specific behavior as an example of the function.
3. Using the behavior example, evaluate the performance of the LPN charge nurse as unsatisfactory, satisfactory, good or out-standing.
4. Guide action (changes, improvements).

Definitions:

UNSATISFACTORY: performance below licensing and accreditation standards, ward and institution policies, and LPN and supervisor expectations; change or improvement required.

SATISFACTORY: performance meets licensing and accreditation standards, ward and institution policies, and LPN and supervisor expectations; change or improvement necessary.

GOOD: performance above licensing and accreditation standards, ward and institution policies, and LPN and supervisor expectations; change or improvement suggested.

OUT-STANDING: performance above and beyond licensing and accreditation standards, ward and institution policies, and LPN and supervisor expectations; no change or improvement suggested; work to maintain high quality performance.

CRITERIA	EVALUATION			
	Unsatisfactory	Satisfactory	Good	Out-standing
1. PLANS PATIENT CARE				
- demonstrates awareness of the comprehensive nature of long-term care				
- understands the condition, needs, and therapeutic goals of each patient				
- receives and interprets verbal and written reports about patient care				
- makes nursing rounds to observe and determine patient needs				
- assists the physician with examinations and treatments				
- discusses patient care goals with physician, nursing supervisor, and staff				
- develops nursing care plans for individual patients				
2. COORDINATES STAFF ACTIVITIES				
- exhibits an understanding of basic human behavior				
- demonstrates fundamental leadership techniques				
- uses management principles and procedures				
- communicates verbally and non-verbally; listens, speaks, reads, writes, gestures effectively				
- motivates staff to give skilled nursing care to all patients				

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AGREEMENT

_____ (sponsoring school)

and

_____ (employing institution)

The _____ agrees to release _____ _____, LPN from her regular duties to attend all scheduled classes and clinical instruction for the LPN charge nurse course. The course will be offered the following time and place: _____ _____

The employing institution agrees to provide opportunities, under the supervision of the Director of Nurses, for the above named LPN, to utilize learnings obtained through the course.

_____ agrees to provide the Administrator and Director of Nurses, or her designate, with background materials about the course.

Signed:

Date _____ _____
Administrator, Employing Institution

Date _____ _____
Director of Nurses, Employing Institution

Date _____ _____
Teacher, LPN Charge Nurse Course

GUIDELINES TO ASSESS HEALTH CARE FACILITIES AND SERVICES

1. Select a variety of facilities to assess.

2. Identify facility

   - Name
   - Address
   - Telephone
   - Contact person

3. Ascertain control

   - Public
   - Voluntary non-profit
   - Profit-making

4. Verify licensure, accreditation, or approval

5. Identify services offered

6. Ascertain patient characteristics

   - Number
   - Age
   - Sex
   - Type of care
   - Place of residence
   - Pay status

7. Examine facility

   - Patient care or services provided
   - Equipment and supplies
   - Instructional facilities
   - Eating facilities
   - Records
   - Accessibility, transportation, and parking
   - Personnel

8. Determine educational orientation

   - Use of facility by students (professional, technical, vocational)

     .. Kind of students
     .. Number
     .. Extent of facility use (space and duration)

   - Special research programs

- Inservice education program

  .. Initial orientation
  .. Continuing education

- General attitude toward:

  .. Education
  .. Patients
  .. LPNs

9. Determine understanding and acceptance of program by:

   - Administration/management
   - Key personnel, for example, directors, managers, and supervisors
   - LPNs

10. Enter into appropriate written agreements

    - State the purpose of the agreement
    - Identify special responsibility of the facility
    - Identify special responsibility of the program
    - Identify mutual responsibilities for LPN Charge Nurse Program and trainees
    - State effective dates and renewal conditions of agreement
    - Indicate arrangement for cooperative planning by facility and program
    - Include specific facility and program provisions for the following:
      .. formal responsibility for educational program
      .. extent of use of facility by program
      .. handling of disciplinary problems
      .. procedure for clearing assignment of trainees to facility
      .. extent to which facility provides resource persons for program
      .. health procedures to be followed for trainees
      .. emergency care for teachers and trainees while in facility
      .. class, conference room space, office space for teachers
      .. locker room facilities, eat facilities, parking
      .. extent of compliance of trainees and teachers with facility rules, regulations
      .. legal protection for trainees and teachers while in agency.

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TRAINEE EVALUATION OF COURSE

1. What did you find most useful about the course?

2. What did you find least useful about the course?

3. What did you enjoy most about the course?

4. What did you enjoy least about the course?

5. What changes would you suggest for the next course?

6. What improvements would you suggest for the next course?

7. Please offer specific comments and suggestions about the classroom learnings:

8. Please offer specific comments and suggestions about the clinical learnings:

9. Please offer specific comments and suggestions about educational resources: personnel, materials, and media.

10. Additional comments and suggestions.

WHO IS MY TRAINEE?

INDIVIDUAL DIFFERENCES

Why should I be concerned with individual differences?

In what ways might I use my knowledge of trainee individual differences?

How will individual trainee differences influence achievement?

In what ways might I use knowledge of developmental tasks of different age groups to assist trainee learning?

TRAINEE CHARACTERISTICS

Who is my trainee?

What do I need to know about her/him before I can plan or guide learning experiences?

What will I do with what I learn about her/him?

- Age
- Educational background
- Former/present employment
- Career goal
- Family status
- Maintenance/financial resources and needs
- Personal and character references
- Health status
- Academic potential (test scores)
- Level of maturity
- Concept of role of LPN charge nurse
- Motivation or reason for becoming a LPN; reason for entering the LPN charge nurse program

2023

CHARGE NURSE FUNCTIONS

Directions: Circle the letter of the best answer.

1. The major function of the charge nurse in the nursing home is to

   a. see that the work is done.
   b. supervise the aides.
   c. see that necessary supplies are available.
   d. see that patients receive good nursing care.

2. The charge nurse on evenings seldom has enough linen. She should

   a. make joint plans with the day charge nurse for linen use.
   b. hide extra linen on good days so she will have enough later.
   c. complain to the Director of Nursing Service.
   d. request the administration to purchase more linen.

3. The charge nurse on day duty notes that two of her aides are taking longer and longer breaks. She should

   a. ask why they are not working well.
   b. ask them to report to the charge nurse every time they leave the floor.
   c. make a note about it and report to the Director.
   d. plan to work with them to see why they have so much time.

4. The family reports that grandpa will not eat. The charge nurse says to the patient

   a. Why won't you eat?
   b. Was there something about your meal that you didn't like?
   c. You have upset your family by not eating.
   d. The doctor says you must eat to keep your strength up.

5. The charge nurse overhears two aides talking. One says, "There goes 202's light again. What does she want now!" The nurse should

   a. go and check the patient.
   b. ask the aide what the problem is.
   c. disconnect the buzzer light.
   d. correct the aide for not calling the patient by name.

6. The charge nurse notices that the number of disposable pads used goes up and up. She should

   a. ask the aides why so many are being used.
   b. tell the aides not to use so many pads.
   c. determine why so many patients are incontinent.
   d. have the aides sign out for each pad.

7. The night charge nurse finds that a patient must be changed again just as her shift is ending. She should

   a. tell the day charge nurse what happened.
   b. ask the aide to do it as a favor to her.
   c. ask the day charge nurse for an aide to help the night aide.
   d. find out why the bed was not changed earlier.

8. The evening charge nurse comes on duty after two days off. The day nurse tells her that everyone is the same and gets ready to go. The evening nurse should

   a. read the report book before the day nurse goes.
   b. ask the day nurse to go over the Kardex with her.
   c. tell the day nurse that you will get the report from the book and nurses' notes.
   d. ask the day nurse what is new since the evening nurse was last there.

9. Mrs. Green is a newly employed aide who has been assigned to the unit. Which is the best description of what the beginning aide can do? She can

   a. do simple nursing measures.
   b. do those things which an ordinary person could do at home.
   c. function as an assistant to the nurse.
   d. perform the duties assigned by the charge nurse.

10. What do people want <u>most</u> from their jobs? They want

   a. appreciation for their efforts.
   b. a good amount of money.
   c. a chance to do a good job.
   d. new and different experiences.

11. What is the best solution to the problem presented by this patient? "Why don't you ever remember that I want my newspaper before I get up in the morning?"

   a. don't worry about it - a nursing home is not the place for maid service.
   b. tape a note to the bed stating "give newspaper early in morning."
   c. use nursing care plan to notify staff.
   d. ask night nurse to get a paper for him at 6 A.M.

12. How can you find out if the aides are giving good emotional support to the patient?

   a. observe the behavior of patients.
   b. observe the patients and aides together.
   c. ask the patients if they are happy.
   d. ask the aides if they are providing emotional support.

13. The aide states that her patient is so deaf that he can't communicate. The nurse gives this advice: try to

   a. speak louder.
   b. stand right in front of him.
   c. speak right into his ear.
   d. ask family if the patient has a hearing aid.

14. What statement about leaders is true?

   a. "Leaders are born, not made."
   b. "Everyone is a leader at times."
   c. "Leaders should not issue flat orders."
   d. "A good leader is a friend to all under her."

15. The charge nurse tells an aide, "Get Mr. Pitts up." Later she finds him in bed. The charge nurse should ask

    a. Mr. Pitts, "Did the aide get you up?"
    b. the aide, "Why didn't you get Mr. Pitts up?"
    c. the aide, "Has Mr. Pitts been up yet?"
    d. Mr. Pitts' roommate, "Did the aide get Mr. Pitts up?"

16. The best definition of Extended Care Facility is a government certified nursing home

    a. which provides skilled nursing care and specialized services.
    b. where skilled nursing care is provided.
    c. for Medicare patients.
    d. specializing in chronic diseases.

17. The charge nurse makes rounds on all the sick patients. How should she note the information she observes?

    a. take the Nursing Notes with her.
    b. make notes to use later.
    c. make a mental note to remember what she finds.
    d. take the Kardex with her.

18. Mrs. Thompson is awake night after night crying for her daughter. The night charge nurse should

    a. get another repeat sedation order.
    b. ask the day staff to keep her up during the day.
    c. get permission for the daughter to stay all night.
    d. ask her supervisor to help solve the problem.

19. The relief charge nurse is assigned to pass medications on the "senile" floor. The patients do not wear armbands. How can the nurse be sure that medications are given to the right patients?

    a. ask each patient his name before giving the medication.
    b. ask an aide who knows the patients to give the medications the charge nurse pours.
    c. put all patients to bed and take a floor plan with her.
    d. ask an aide who knows the patients to accompany her on medication rounds.

20. The nursing home inaugurates an unpopular policy. In announcing it to her staff the charge nurse should

    a. let the staff know that that is the rule and it is the charge nurse's job to enforce it.
    b. suggest that the staff take up their grievances with the administration.
    c. show that she is aware of the policy's unpopularity but suggest a trial period.
    d. make it clear that she disapproves of the ruling and won't really enforce it.

21. A person who requires "bed and board" should receive institutional care in a/an

    a. hospital.
    b. extended [illegible]cility.
    c. intermediate care facility.
    d. nursing home.

Directions: Answer the next few questions as if you were the charge nurse. Use a few words; it is not necessary to use complete sentences.

22. What is an Extended Care Facility?

23. The charge nurse notices bath towels and sheets missing from unit linen inventory. What should she do?

24. What do people want most from their jobs?

25. Mrs. Stone is blind. How should the charge nurse tell a high school student to feed her?

26. Mrs. Allport likes to eat two soft-boiled eggs for lunch but she only gets them when you are on duty. What can you as charge nurse do about this?

27. A fire breaks out in a wastebasket in a patient's room. What should the charge nurse do?

28. The aides are complaining that they have too many baths to do every morning. The office cannot assign any more aides to the unit. How can the charge nurse best solve the problem?

29. As charge nurse, you must assign some extra work to one of two aides. One aide is a personal friend of yours. How should the assignment be made?

30. Mr. Wong who speaks only Chinese has just been admitted. How can the charge nurse and staff communicate with him?

31. Mrs. Jackson is 83 and has moderage congestive heart failure. The doctor calls and asks how she is doing. What should the charge nurse check to determine the patient's condition?

ROLE FOR YVONNE FOLEY, LPN CHARGE NURSE

Maryland Nursing Home is a fifty-bed Extended Care Facility located in a town of about 25,000 people. It has a transfer agreement with City General Hospital.

The majority of the patients are admitted from the hospital rather than from home. The institution has been open for three years and many of the patients have been here for that period of time. Many of the patients have more than one chronic condition such as congestive heart failure, arthritis, arteriosclerosis; some have terminal cancer. In addition many have disabilities which add to their daily living problems such as senility, cataracts, deafness, and incontinence.

Many facilities and specialists are available at this ECF including a physical therapy department, an occupational therapy department, visiting specialists such as a social worker, dentist, podiatrist, an active volunteer group and visiting clergy.

The nursing staff is very interested in their patients and they are working together to improve patient care.

The scene today takes place on the 3-11 shift on Wing B. You are Yvonne Foley, the LPN charge nurse, and you are about to make patient care assignments. You try to assign personnel in terms of patient needs and staff proficiencies.

Alan Weaver is a 74-year old retired railroad employee in room 12. His conditioned has worsened during the day. Mr. Weaver has terminal carcinoma of the liver. Shortly after 1 P.M. he slipped into a deep sleep, his pulse rate increased from 74 to 98, and his blood pressure dropped from 120/90 to 90/70. The doctor has seen Mr. Weaver and believes death is pending.

Helen Phillips is your most experienced, dependable nurses' aide. She joined the staff two years ago. Before this she worked as a nurses' aide for 10 years in an outlying rural hospital. She is 43 years old; her husband manages a local filling station. They have five children: a married daughter with two children, a son in the Navy, a son in his second year in college, and a girl and boy in high school.

Mrs. Phillips attended a vocational education class on long-term care in preparation for employment at Maryland Home. She is a skilled, personable employee and you intend to recommend her for the LPN training program.

You have ample staff to meet the needs of the entire ward. Because Mrs. Phillips is the most qualified aide for the task, you assign her to stay with Mr. Weaver for the entire tour of duty. You review his condition with her, his needs, and her functions. This is an important nursing assignment.

ROLE FOR HELEN PHILLIPS, NURSES' AIDE

Maryland Nursing Home is a fifty-bed Extended Care Facility located in a town of about 25,000 people. It has a transfer agreement with City General Hospital.

The majority of the patients are admitted from the hospital rather than from home. The institution has been open for three years and many of the patients have been here for that period of time. Many of the patients have more than one chronic condition such as congestive heart failure, arthritis, arteriosclerosis; some have terminal cancer. In addition many have disabilities which add to their daily living problems such as senility, cataracts, deafness, and incontinence.

Many facilities and specialists are available at this ECF including a physical therapy department, an occupational therapy department, visiting specialists such as a social worker, dentist, podiatrist, an active volunteer group and visiting clergy.

The nursing staff is very interested in their patients and they are working together to improve patient care.

The scene today takes place on the 3-11 shift on Wing B. Yvonne Foley, the LPN charge nurse, is about to make patient care assignments. You are Helen Phillips, a nurses' aide. You joined the staff two years ago. Before this you worked as a nurses' aide for 10 years in an outlying rural hospital. You are 43 years old; your husband manages a local filling station. You have five children: a married daughter with two children, a son in the Navy, a son in his second year in college, and a girl and boy in high school.

You attended a vocational education class on long-term care in preparation for employment at Maryland Home. You like your work very much and pride yourself on being considered one of the most experienced, dependable aides.

You know that work with long-term care and geriatric patients means caring for patients with terminal illness. You have cared for dying patients before as an aide in the general hospital and here at the home, but you have never been alone with a person who died and you are afraid of this situation. You are ashamed of this fear and have never mentioned it to your charge nurse or the other aides. At times the fear has proved awkward, but so far you have always managed to have another aide or nurse with you when you cared for a dying person or for the body after death.

You are anxious to get ahead on the job; Maryland Home will sponsor several aides for LPN training and you want to be selected. You have managed to hide this fear of being alone with a dying person from your charge nurse and you hope she never finds out because it might jeopardize your reputation as an out-standing aide and hurt your chances of her recommendation for LPN training. Abnormal fears aren't things that people understand and you might be considered neurotic.

If the charge nurse should ask you to be alone with a dying person, give excuses, try to get out of it. But do not tell her about your fear unless she asks you - and then wait 30 seconds before you answer. If she insists, you will refuse and quit your job.

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ABSTRACT - Developed during a University of Maryland School of Nursing project, reviewed by 10 practical nurse educators, and field tested in four schools, this trainee text contains information designed to prepare students for charge nurse responsibilities in nursing homes, extended care, and related facilities. Part I, The Licensed Practical Nurse (LPN) and Long-Term Care, contains background information about: (1) The LPN Today, (2) Medicare and Medicaid, (3) Patients, and (4) Settings for Long-Term Care. Part II, The LPN as a Charge Nurse, discusses the nurse's role in these chapters: (1) Introduction, (2) Planning Patient Care, (3) Coordinating Staff Activities, (4) Implementing Patient Care, and (5) Evaluating Patient Care. Part III, Educational Resources, lists related books, articles, and audiovisual aids. Each illustrated chapter contains two sections, one offering basic information about the topic and the other study activities. The instructor's manual is available as VT 012 604 also in this issue. (SB)

VT 012 605

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LICENSED PRACTICAL NURSE

CHANGE NURSE

TRAINEE TEST

AND

STUDY GUIDE

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THE LICENSED PRACTICAL NURSE AS CHARGE NURSE:

Trainee Text and Study Guide

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PREFACE

CONTINUING EDUCATION

Practical nursing education is conditioned greatly by the changing and expanding complexity of health care. No program of basic preparation, whatever its type or quality, could possibly encompass all a practical nurse needs to maintain currency and relevancy to the developments in health care.

Education for practical nurses must be a continuing process. Acceptance of this fact imposes obligations upon individual practical nurses, their employers, the health professions, and practical nursing educators. Practical nurses must continue to increase and enrich their competencies by whatever means are most appropriate.

The National Licensed Practical Nurses Educational Foundation, Inc., the nursing education and research arm of the National Federation of Licensed Practical Nurses, defines continuing education as follows:

> Continuing education includes those organized educational experiences which are planned to help practical nurses achieve more productive and satisfying fulfillment of their roles as health workers. Such fulfillment should be of mutual benefit to both the practical nurse and society, but should not be limited to preparing the practical nurse to meet the unique service needs of a single agency. Improved patient care is the primary goal of all continuing education of the LPN/LVN.

This text is a result of a continuing education project between the Foundation and the U. S. Public Health Service.

THE PROJECT

Since the passage of Public Law 89-97, Title XVII "Medicare" and Title XIX "Medicaid," and the subsequent conditions of participation and policy regulations, there has been considerable interest in the licensed practical nurse who works as a charge nurse in nursing homes, extended care, and related facilities.

In June, 1967 the Public Health Service awarded a grant to the University of Maryland School of Nursing to study the problem of preparing the LPN for these responsibilities. Project activities included review of the literature; survey of the functions of the charge nurse in an ECF; design, test, and evaluation of the curriculum; and the development of an Instructor's Guide. Mrs. Dorothy Justice, Assistant Professor and Chairman of the Practical Nurse Program at the University of Maryland School of Nursing, served as project director. The Instructor's Guide, Fundamentals of Nursing Management Skills for Licensed Practical Nurses Who Serve As Assistants to Registered Nurses in Extended Care Facilities was prepared by Linda A. Tarr, R.N., M

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In June, 1969 the National Licensed Practical Nurses Education Foundation, Inc. received a contract from the Public Health Service to test, review, and revise the Instructor's Guide and to develop a textbook for use by LPN trainees. Major project activities included (1) review and testing of materials, and (2) revision and preparation of the publications.

A ten-member team of instructors from practical nurse education programs critiqued Guide materials prior to curriculum field test and following preparation of the Guide and Text drafts. Four schools used Guide materials to plan, conduct, and evaluate a continuing education program: "Preparation of Licensed Practical Nurses for Charge Nurse Responsibilities in Nursing Homes, Extended Care, and Related Facilities:

Midwest City Public Schools
Midwest City, Oklahoma

Mount Sinai Hospital School of Practical Nursing
Miami Beach, Florida

New Orleans Public Schools
New Orleans, Lousiana

Southern Illinois University
Division of Technical and Adult Education
Carbondale, Illinois

Constant in each program were common objectives and quality of teaching faculty; hours of instruction and course format varied. Participating faculty included:

Mrs. Ruth Killough and Mrs. Sandy Mitchell
Midwest City Public Schools

Mrs. Carmen Ross and Mrs. Alice Gutterman
Mount Sinai Hospital School of Practical Nursing

Dr. Edwina Frank and Mrs. Anna Goldman
New Orleans Public Schools

Mrs. Beatrice Chiodini
Southern Illinois University

Nelly B. Oles of Community Health Service of the U. S. Public Health Service was Project Officer; Teresa M. Crowley, Executive Director of NLPNEF, served as Project Coordinator. Sandra Rasmussen directed the project and prepared the Instructor's Guide and Trainee Text.

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INTRODUCTION

This book is for you to read, study, and enjoy. It contains information, study activities, and a listing of educational resources that should help you prepare for charge nurse responsibilities in nursing homes, extended care, and related facilities.

Each chapter of the book has two sections. The first section offers basic information about the topic. The second section is a study and work section. In most cases this text will be used in conjunction with a continuing education course to prepare LPNs for charge nurse roles. However, the book is valuable by itself as a text and study guide.

Part I contains background information about the LPN and long-term care. This may be a review for you if you have been employed for some time in a long-term care setting. It may offer new and current information about (1) The LPN Today, (2) Medicare and Medicaid, (3) Patients, and (4) Settings for Long-term Care.

Part II introduces you to the LPN charge role. Chapter 5 contains a Statement of Functions for the LPN Charge Nurse. Subsequent chapters describe in detail each function: (6) Planning Patient Care, (7) Coordinating Staff Activities, (8) Implementing Patient Care, and (9) Evaluating Patient Care.

A listing of related books and articles will be found in Part III. Audio-visual materials that might prove useful to you and your staff for inservice education programs have been included.

Many LPN-patient photos supplement the printed material. Photo credits go to Donald Bulucos of Chicago, Joel M. Snyder of Chicago, and the Holy Ghost Hospital of Cambridge, Massachusetts.

The author acknowledges Mrs. Etta B. Schmidt, Executive Director of the National Federation of Licensed Practical Nurses, and many others for their assistance and encouragement throughout this project.

Sandra Rasmussen

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Part I

THE LICENSED PRACTICAL NURSE AND LONG-TERM CARE

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Chapter 1

THE LICENSED PRACTICAL NURSE

NURSING

Every individual must satisfy certain basic human needs to live, to maintain health, and to affirm his being. The acting, thinking, feeling, relating, believing individual is the healthy person.

Nursing is the act of assisting a healthy, handicapped, ill, or dying person to meet his basic needs for life, health, and being. A nurse is a man or woman who is willing and able to provide a direct health service of helping to people.

Nurses help people in the home, at school, at work, and throughout the community plan, promote, and maintain health. Sometimes illness interferes with a person's ability to care for himself; nurses care for sick people at home and in a variety of institutions such as hospitals, nursing homes, extended care facilities, physicians' offices, and clinics.

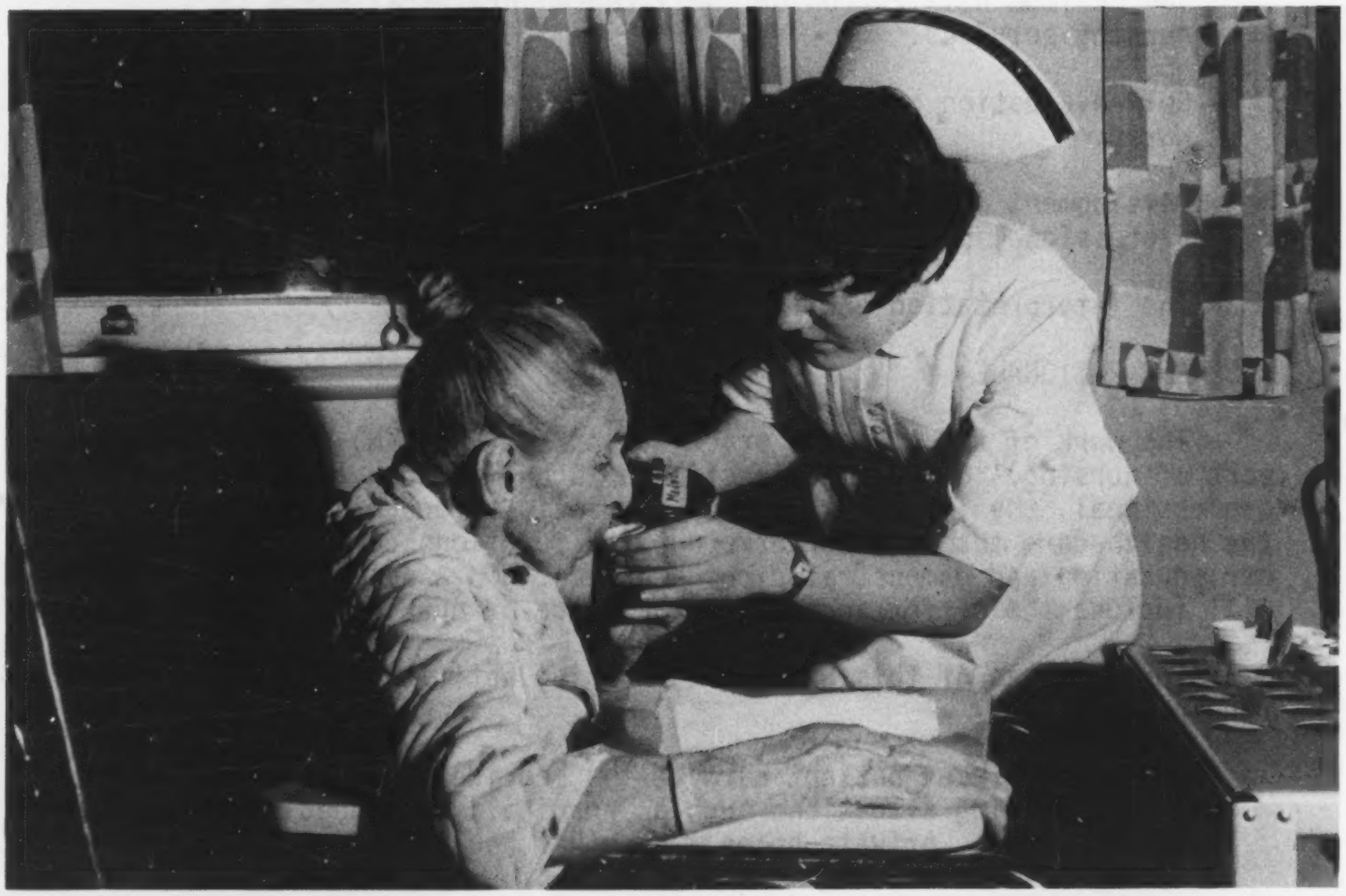

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Figure 1-1. Nursing.

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FUNCTIONS AND QUALIFICATIONS OF THE LPN

The following Statement of Functions and Qualifications of the Licensed Practical Nurse was prepared and approved by the Executive Board of the National Federation of Licensed Practical Nurses in June 1970. The National Federation of Licensed Practical Nurses is the membership organization for licensed practical/vocational nurses and is the recognized policy-making body for LPN/LVNs.

The Statement reflects the expanding role of the LPN in today's health care system. It provides flexibility in the functions of the LPN who has obtained additional knowledge and skills through continuing education and nursing experience. The Statement will serve as a guide for nursing service directors for maximum utilization of LPNs and for nurse educators for the development of curriculum in schools of practical nursing as well as the design of continuing education programs for the LPN.

PURPOSE

The identification of the role of the Licensed Practical Nurse[1] which is intended to serve as a guide to:

- The maximum utilization of the licensed practical nurse in nursing services.
- Self-evaluation of nursing practice by the licensed practical nurse.
- Development and evaluation of educational standards for the professional preparation of the licensed practical nurse, and
- The interpretation of licensing legislation.

ROLE AND RATIONALE

The work of the licensed practical nurse (LPN/LVN) is an integral part of nursing. Under the direction of a qualified autonomous health professional, the licensed practical nurse is a recognized member of the health-care team and performs nursing functions commensurate with her education and demonstrated competencies. On a selective basis, this will include the performance of a wide range of nursing activities.

For purposes of this Statement, nursing activities encompass situations ranging from:

- providing direct patient care at the bedside in relatively stable nursing situations such as hospitals, extended care units, nursing homes, private homes, and other health care facilities and agencies.

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[1] The title LPN is the same as LVN in California and Texas.

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- to performing nursing functions in semi-complex situations, such as hospital nursing service units, recovery rooms and labor rooms;

- to more complex situations, such as hospital nursing service units, intensive or coronary care units and emergency rooms;

- to the promotion of personal and community health--an important function of all well prepared members of the health-care team;

- to promoting and carrying out preventive measures in community health facilities such as well-baby clinics, out-patient clinics and services.

In semi-complex and complex nursing situations a greater depth of knowledge and a higher level of judgment is required of the LPN; and a closer working relationship with, and the greater the degree of direction by, the autonomous health professional.

The determination of the capabilities of the LPN in complex nursing situations should be arrived at through:

- an evaluation of the nursing needs of the patient;

- a realistic appraisal of the elements within the situation (e.g. the complexity of scientific principles underlying the functions and techniques to be carried out);

- the ability of the LPN to perform in the situation based on his knowledge, skills and previous experience;

- the amount and character of the direction needed by, and available to the LPN, in the performance of the functions and procedures.

EDUCATION

The LPN should be qualified for nursing practice through:

1. Preparation in a formal educational program in practical nursing approved by the appropriate nursing authority in a State.

2. Initial orientation within the employing institution.

3. Inservice and continuing education for all nursing practitioners to maintain competencies; and, for those who qualify, to gain additional competencies which will enable them to broaden their scope of nursing practice within the employing agency by the performance of specialized activities.

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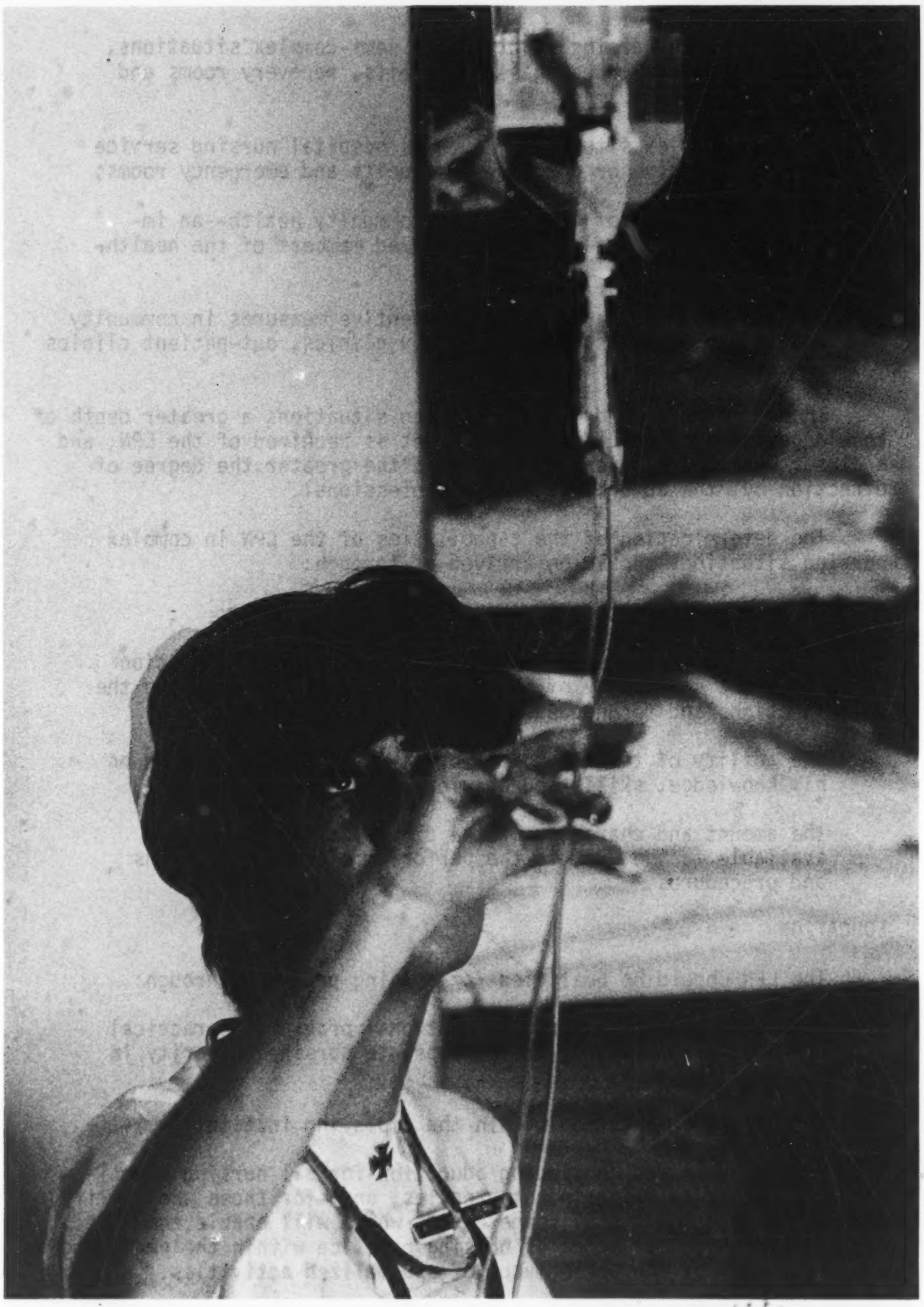

Figure 1-2. The expanding role of the LPN in today's health care system.

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LEGAL STATUS

1. The LPN must be currently licensed to practice practical nursing according to State law, and

2. Must perform within the limits of preparation and experience.

PERSONAL QUALIFICATIONS

1. Recognizes and has a commitment to meet the ethical, moral and legal obligations of the practice of practical nursing.

2. Maintains and promotes good health practices.

3. Actively promotes and participates in nursing organizations, inservice education programs, workshops, institutes and other educational and community activities.

FUNCTIONS

The LPN is prepared to function as a member of the health-care team by exercising sound nursing judgment based on preparation, knowledge, skills, understandings and past experiences in nursing situations.

The LPN participates in the planning, implementation and evaluation of nursing care in all settings where nursing takes place. The following illustrate the types of activities performed:

1. Direct Patient Care

(in hospitals, extended care units, nursing homes, private homes and other related health facilities)

a. Provides for the emotional and physical comfort and safety of patients through:

(1) The understanding of human relationships between and among patients, families and other health-care personnel.

(2) Participation in the development, revision, and implementation of policies and procedures designed to insure comfort and safety of patients and other health-care personnel.

(3) Assisting the patient with activities of daily living and encouraging appropriate self-care.

(4) Recognizing and understanding the effects of social and economic problems upon patients.

(5) Protecting patients from behavior that would damage their self-esteem or relationship with families, other patients, or persons.

(6) Recognizing and understanding cultural backgrounds and spiritual needs, respecting and religious beliefs of individual patients.

(7) Considering needs of the patient for an attractive, comfortable and safe environment.

b. Observes, records and reports to the appropriate persons:

(1) General and specific physical and mental conditions of patients, and signs and symptoms which may be indicative of change.

(2) Stresses in human relationships between patients, patients' families, visitors and health care personnel.

c. Performs more specialized nursing functions for which the LPN is prepared, such as:

(1) Administration of medications and therapeutic treatments prescribed for the patient.

(2) Preparation and care of patients receiving specialized treatments.

(3) Carrying out first aid, emergency and disaster measures.

d. Assists with rehabilitation of patients, according to the patient care plan, through:

(1) Knowledge and application of the principles of prevention of deformities, (e.g. the normal range of motion exercises, body mechanics and body alignments).

(2) Encouragement of patients to help themselves within their own capabilities.

(3) Awareness of and encouraging the fulfillment of the special aptitudes and interests of patients.

(4) Utilizing community resources and facilities for continuing patient care.

2. Patient Care Management

The licensed practical nurse, with additional preparation in specialized areas and under direction of autonomous health professionals is qualified to:

a. Supervise other nursing and health-related personnel.

b. Coordinate and make assignments of other nursing and health-related personnel and patients.

c. Serve as team leader.

d. Serve as charge nurse.

3. Community Health

The licensed practical nurse contributes to community health through nursing activities performed outside patient-care institutions, e.g. visiting nurse associations, well-child and other public health clinics, and industrial nursing units.

4. Individual Citizens of the Community

The licensed practical nurse participates in activities which promote the community's attitudes and welfare in health care. As a private citizen, the LPN,

a. Utilizes community resources to promote a better understanding of the health services among the general public, and

b. Promotes and participates in community health projects and other health oriented activities.

THE LPN AND LONG-TERM CARE

Licensed practical nurses are prepared to nurse patients effectively in nursing homes, extended care, and related facilities. LPNs qualify through education and experience to meet the needs of long-term care patients: the majority of stated functions of the LPN relate to direct patient care.

EDUCATION

Learning to meet the nursing needs of older persons and individuals who need long-term care is an integral part of the curriculum of most State-approved schools of practical nursing. All practical nursing students study Medical Nursing and care for a variety of patients with long-term care conditions.

In addition to Medical Nursing, most LPN students study Geriatric Nursing. The Geriatric Nursing Course typically includes learnings about (1) physical, mental, emotional, social, and spiritual characteristics of older adults, (2) the aging process, and (3) conditions of illness of older persons. Most of these students have nursing experience with older persons in general hospitals; approximately one-half of the practical nursing programs in the country provide opportunity for student learning in nursing homes and extended care facilities.

An increasing number of practical nursing schools are including a unit on long-term care in their curricula. Topics for study emphasize chronic disease, the characteristics and needs of patients with long-term illnesses, and patient rehabilitation.

Figure 1-3. Most students have nursing experience with older persons.

ROLE AND FUNCTIONS

A re-examination of the Statement of Functions and Qualifications of the Licensed Practical Nurse documents the competencies of the LPN for care of the long-term patient. The first nursing activity states:

> providing direct patient care at the bedside in relatively stable nursing situations such as hospitals, extended care units, nursing homes, private homes, and other health care facilities and agencies;

The Statement describes the major activity of the LPN as direct patient care. The LPN

- provides for the emotional and physical comfort and safety of patients;
- observes, records and reports to the appropriate persons;
- performs specialized nursing functions;
- assists with rehabilitation of patients, according to the patient care plan.

The second function explained in the Statement is patient care management. By role and functions, the LPN is qualified to work competently with long-term care patients.

Figure [illegible] The major activity of the LPN is direct patient care.

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EXPERIENCE

Figure 1-5. A significant number of LPNs are working in nursing homes, extended care, and related facilities.

The 1969 Facts About Nursing reports:

(1) LPNs in Nongovernmental Nursing Homes & Related Facilities

(April 1968)

23,532 full-time 11,291 part-time

(2) Nonsupervisory RNs in Nongovernmental Nursing Homes & Related Facilities

(April 1968)

13,123 full-time 14,949 part-time

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The hospital is the largest employer of LPNs; approximately two-thirds of all employed LPNs work in hospitals. Some 14% of employed LPNs are private duty nurses; 13% of employed LPNs work in nursing homes and related facilities. This last figure compares with some 4% staff or general duty RNs. Only 2% of all employed staff or general duty RNs are full-time employees in nursing homes and related facilities; 9% LPNs are full-time.

A significant number of licensed practical nurses are working in nursing homes, extended care, and related facilities, and the number is increasing annually.

STUDY ACTIVITIES

NURSING

1. What is nursing? Write your own definition of nursing.

2. Who is a nurse? Describe yourself as a nurse.

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3. What do nurses do? Describe the general functions of nurses. What do you do as a nurse?

4. Read the following 1887 job description of a bedside nurse. Compare the description with the general functions of nurses today.

1887 Job Description

In addition to caring for your 50 patients, each bedside nurse will follow these regulations: 1. Daily sweep and mop the floors of your ward, dust the patient's furniture and window sills. 2. Maintain an even temperature in your ward by bringing in a scuttle of coal for the day's business. 3. Light is important to observe the patient's condition. Therefore, each day fill kerosene lamps, clean chimneys, and trim wicks. Wash the windows once a week. 4. The nurse's notes are important in aiding your physician's work. Make your pens carefully, you may whittle nibs to your individual taste. 5. Each nurse on day duty will report every day at 7 A.M. and leave at 8 P.M., except on the Sabbath on which day she will be off from 12 noon to 2 P.M. 6. Graduate nurses in good standing with the director of nurses will be given an evening off each week for courting purposes, or two evenings a week if you go regularly to church. 7. Each nurse should lay aside from each pay day a goodly sum of her earnings for her benefits during her declining years, so that she will not become a burden. For example, if you earn $30 a month you should set aside $15. 8. Any nurse who smokes, uses liquor in any form, gets her hair done at a beauty shop or frequents dance halls will give the director of nurses good reason to suspect her worth, intentions and integrity. 9. The nurse who performs her labors, serves her patients and doctors faithfully and without fault for a period of five years will be given an increase by the hospital administration of five cents a day.

(From "Bright Corridors," a publication of Cleveland Lutheran Hospital)

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FUNCTIONS AND QUALIFICATIONS OF THE LPN

1. What is the general value of a Statement of Functions and Qualifications of the Licensed Practical Nurse?

2. "The work of the licensed practical nurse is an integral part of nursing." What does this mean? Why is it important?

3. Describe the range of nursing activities of licensed practical nurses.

4. In a complex nursing situation, the LPN may work closely with an autonomous health professional. In these situations, how are the capabilities of the LPN determined?

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5. How did you become an LPN? (If you completed a formal education program in practical nursing, describe the program briefly.)

6. What additional learnings have you acquired through (a) orientation to the job, (b) inservice programs, and (c) continuing education?

7. In what State (s) do you hold a current license?

8. What legal responsibilities do you have as an LPN?

9. The LPN "recognizes and has a commitment to meet the ethical, moral and legal obligations of the practice of practical nursing." What does this mean? Why is it important?

10. The LPN "maintains and promotes good health practices." What does this mean? Why is it important?

11. The LPN "actively promotes and participates in nursing organizations, inservice education programs, workshops, institutes and other educational and community activities." What does this mean? Why is it important?

12. Describe a patient situation in which the major function of the LPN is direct patient care.

13. Describe a patient situation in which the major function of the LPN is patient care management.

14. Describe a patient situation in which the major function of the LPN is community health.

15. What special functions does the LPN citizen have in the community?

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16. Describe a "typical" tour of duty for yourself.

17. Using the functions described in the Statement, compare and contrast your "functions" with stated functions.

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THE LPN AND LONG-TERM CARE

1. Support or document the statement: licensed practical nurses are prepared to nurse patients effectively in nursing homes, extended care, and related facilities.

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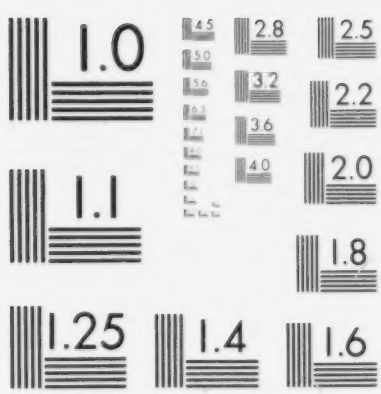

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Chapter 2

MEDICARE AND MEDICAID

In 1965 Congress added to the Social Security program begun in 1935 two significant amendments on health care and services. One, Title XVIII, established MEDICARE - a Federal program of hospital and medical insurance for nearly all people 65 and over. The other, Title XIX, established MEDICAID - a Federal-State program to help provide medical services for the needy and the medically indigent.

The following remarks were made by President Johnson upon signing the Social Security Amendments of 1965 in Independence, Missouri, July 30, 1965:

> It was a generation ago that Harry Truman said, "Millions of our citizens do not now have a full measure of opportunity to achieve and to enjoy good health. Millions do not now have protection or security against the economic effects of sickness. And the time has now arrived for action to help them attain that opportunity and to help them get that protection.
>
> . . . today, . . . we are taking such action 20 years later. . . . The need for this action is plain . . .
>
> There are more than 18 million Americans over the age of 65. Most of them are threatened by illness and medical expenses that they cannot afford . . .
>
> This insurance will help pay for care in hospitals, in skilled nursing homes, or in the home. And under a separate plan it will meet the fees of the doctors . . .
>
> No longer will older Americans be denied the healing miracle of modern medicine. No longer will illness crush and destroy the savings that they have so carefully put away over a lifetime so that they might enjoy dignity in their later years. No longer will young families see their own incomes, and their own hopes eaten away simply because they are carrying out their deep moral obligations to their parents, and to their uncles, and their aunts.

In the Federal Government both programs are administered by the Department of Health, Education, and Welfare. The Social Security Administration directs Medicare; Social and Rehabilitation Service directs Medicaid.

Both Medicare and Medicaid help pay medical bills. Both are part of the Social Security act. They work together but they are not the same.

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Figure 2-1. MEDICARE - a Federal program of hospital and medical insurance for nearly all people 65 and over.

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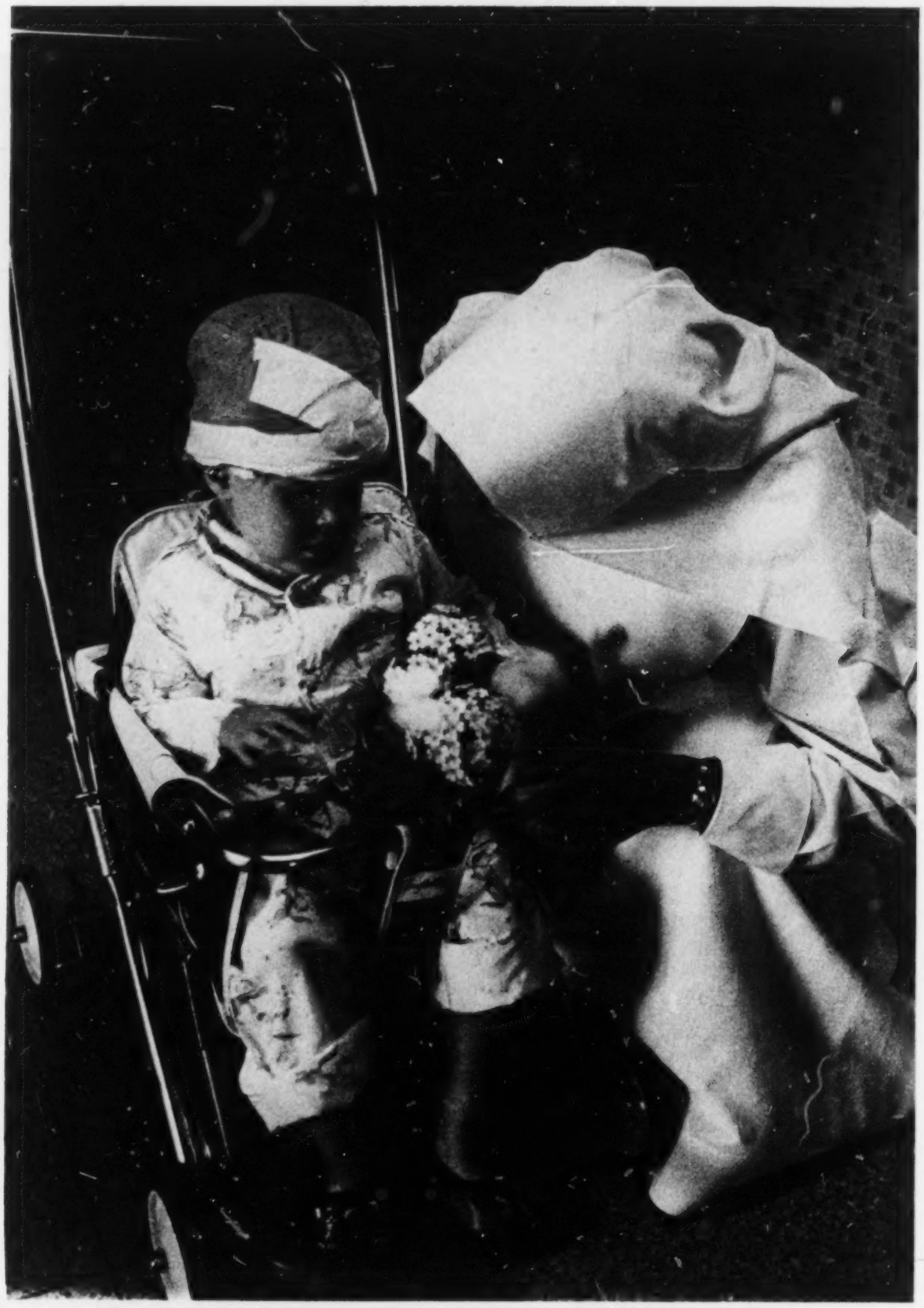

Figure 2-2. MEDICAID - a Federal-State assistance program to help provide medical services for needy and low-income people.

Both Medicare and Medicaid insist on high standards, support expansion of facilities, encourage innovation in medical care delivery and require review of care. Medicaid requires that medical services be available everywhere in a State. It is also beginning a program to train and employ neighborhood people as community health workers.

Together Medicare and Medicaid are significant programs striving to benefit everybody by improving the quality, the quantity, the efficiency, the distribution, and the effectiveness of medical services in the United States.

Both Medicare and Medicaid must be operated in compliance with Title VI of the Civil Rights Act of 1964 which prohibits discrimination:

> No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefit of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.

The following comparison may help you identify similarities and differences between the two programs:

	MEDICARE	MEDICAID
(1)	- is for people 65 or older. - almost everybody 65 or older rich or poor can have Medicare. - some people 65 or older can have both Medicare and Medicaid.	- is for <u>certain kinds</u> of needy and low-income people: .. the aged .. the blind .. the disabled .. members of families with dependent children .. some other children. - some States also include (at State expense (other needy and low-income people.
(2)	- is an <u>insurance</u> program. - money from trust funds pays medical bills for <u>insured</u> people.	- is an <u>assistance</u> program. - money from Federal, State, and local taxes pays medical bills for <u>eligible</u> people.
(3)	- is a <u>Federal</u> program. - Medicare is the same all over the United States.	- is a <u>Federal-State</u> partnership. - States design their own Medicaid programs with Federal guidelines. - Medicaid varies from State to State.
(4)	- Medicare is everywhere in the United States.	- Medicaid will probably be everywhere in the United States by 1970. - Medicaid is now in most States, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands.

	MEDICARE	MEDICAID
(5)	- Medicare Hospital Insurance provides basic protection against costs of .. inpatient hospital care .. post-hospital extended care .. post-hospital home health care.	- Medicaid pays for at least these five services: .. inpatient hospital care .. outpatient hospital services .. other laboratory and X-ray services .. skilled nursing home services .. physicians' services.
	- Medicare Medical Insurance provides supplemental protection against costs of physicians' services, medical services and supplies, home health care services, outpatient hospital services and therapy, and other services.	- in many States Medicaid pays for such additional services as dental care, prescribed drugs, home health care, eye glasses, clinic services, and other diagnostic, screening, preventive, and rehabilitative services.
(6)	- Medicare pays most but not all hospital and medical costs for people who are insured.	- Medicaid can pay what Medicare does not pay for people who are eligible for both programs.
	- Hospital Insurance pays inpatient hospital bills except for the first $52 in benefit period.	- Medicaid can pay the $52 Medicare does not pay in each benefit period for eligible people.
	- Medical Insurance pays $4 out of $5 (80%) of reasonable medical costs <u>except</u> for the first $50 in each calendar year.	- Medicaid can pay the first $50 per year of medical care costs and can pay what Medicare does not pay of the remaining reasonable charges for eligible people.
	- insured people pay $5.80 a month for Medical Insurance (rates differ slightly depending on time of enrollment; premium rates are reviewed annually).	- Medicaid can pay the $5.80 a month for eligible people.
(7)	- Medicare Hospital Insurance is financed by a separate payroll contribution.	- Medicaid is financed by Federal and State governments.
	- Medicare Medical Insurance is financed by monthly premiums. The Federal Government pays half and the insured person pays half.	- The Federal Government contributes from 50% (to the richest States) to 83% (to the State with the lowest per-capita income) of medical care costs for needy and low-income people who are aged, blind, disabled, or members of families with dependent children.
		- States pay the remainder, usually with help from local governments.

STUDY ACTIVITIES

The Senior Citizens Club of Jeffersonville has invited several health practitioners to participate in a panel discussion of Medicare: Dr. Joseph McCartney, a local physician; Mrs. Ruth Ziegler, RN, Director of Nursing at Lake Valley Memorial Hospital; Mrs. Ida Mae Washington, LPN Charge Nurse, and Miss Ellen Higgins, LPN Charge Nurse at Elk Manor Nursing Home and Extended Care Facility.

Mrs. Ziegler described the Hospital Insurance part of Medicare briefly:

> Your hospital insurance helps pay for medically necessary services provided by health facilities participating in Medicare when you are a bed patient in a hospital. And if you need further care after a hospital stay, payments are made when you are a bed patient in an extended care facility or a patient at home receiving services from a home health agency. The services hospital insurance helps pay for are called covered services. Your hospital insurance covers almost all of the services you would ordinarily receive as a bed patient in a participating hospital or extended care facility or as a patient at home receiving services from a participating home health agency. Your hospital insurance will also, in some cases, help pay for care in certain hospitals that do not participate in Medicare. When you receive covered services from a participating hospital, extended care facility, or home health agency, you do not need to make any claim for your hospital insurance benefits. These institutions or agencies make the claims and receive the Medicare payment. They have agreed to charge you only for services which are not covered by Medicare. You will always receive a notice from the Social Security Administration when a payment has been made on your behalf.

The men and women senior citizens asked the following general questions of the panel; try to answer them in an accurate, explanatory way.

1. How is the hospital insurance part of Medicare financed?

2. How often can I use my hospital insurance?

3. Can I renew my hospital insurance?

4. How do I keep a record of how much insurance, how many "days" or "visits" I have used?

5. What does hospital insurance pay for when I am a hospital bed patient?

6. How does a person get admitted to an extended care facility?

7. What benefits am I entitled to in an extended care facility?

8. How does a person qualify for home health benefits?

9. What home health benefits can a Medicare patient receive?

Dr. McCartney described the Medical Insurance part of Medicare briefly:

> Your medical insurance helps pay for doctors' services, outpatient hospital services, medical services and supplies, home health services, outpatient physical therapy, and other health care services. The kinds of services medical insurance can help pay for are called covered services. For each calendar year, medical insurance does not pay any of the first $50 of reasonable charges for covered services. Reasonable charges are determined by the Medicare carriers - the organizations selected in each State by the Social Security Administration to handle medical insurance claims - and take into account the customary charges of your doctor as well as the charges made by other doctors in your locality for similar services. After Medicare records show that your bills for covered services are over $50 for a calendar year, medical insurance will pay 80% of the reasonable charges for covered services for the rest of the year. (There are a few exceptions to this rule.) Be sure to send in a claim as soon as your bills reach $50 so the Medicare records will show the first $50 as well as the rest of your bills.

The group asked the following questions of the panel about Medical Insurance; try to answer them in an accurate, explanatory way.

1. What are some of the doctor bills medical insurance helps pay?

2. What kinds of dental services will medical insurance cover?

3. When I am a patient in a hospital, what kinds of laboratory and X-ray services are paid for by medical insurance?

4. Will medical insurance pay for ambulance services?

5. What kinds of outpatient hospital services does medical insurance help pay for?

6. Would you explain the home health benefits that are covered by medical insurance?

7. What are some of the different medical services and supplies that are paid for by medical insurance?

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8. How does a person make a claim for medical insurance?

The local district of the State Association of Licensed Practical Nurses has invited a representative of the State office of Social and Rehabilitation Service to discuss the Medical Assistance (Medicaid) Program. Try to find answers to some of the following general questions.

1. Just what is Medical Assistance (Medicaid)?

2. Who administers the Medicaid program?

3. What kinds of people in this State can benefit from the Medicaid Program?

4. Who is eligible for Medicaid?

5. What kinds of medical care and services are covered by the Medicaid Program?

6. How do hospitals and nursing homes meet institutional requirements to participate in Medicaid?

7. How is payment for Medicaid care and services handled?

8. Are any social services available under Medicaid?

9. Can a person qualify for both Medicare and Medicaid? Please explain.

Chapter 3

PATIENTS ARE PEOPLE

It is important to remind yourself again and again that patients are people. Each patient is a multi-dimensional person. At the same time he or she may be a worker, a mate, a parent, a homemaker; your patient may be a son or daughter, citizen, friend, organization member, religious affiliate, and user of leisure time.

Your patients require skilled long-term care because of chronic disease or disabilities, or because of dependencies associated with aging. We all have different concepts of health, illness, life and death, and each patient's reaction to illness and his subsequent need for care is conditioned greatly by his individual and cultural perceptions of life and death.

Many patients requiring long-term care experience intense feelings of guilt and disappointment. "How can my family afford to keep me in this nursing home; it would be better if I died." "What good am I to my wife and boys; I am only half a man, I have no legs." Occasionally patients obtain secondary gains, such as absence from work, because of a long-term illness.

Patients are people - very special, complex people.

OLDER PEOPLE

Many of your patients are older adults and you already know a great deal about older people and their characteristics. The following review may prove helpful.

PHYSICAL CHARACTERISTICS

- loses speed and flexibility in movement
- performs simple, repetitive tasks best
- more susceptible to respiratory infections
- circulatory diseases more common
- less able to maintain normal body temperature
- sensory processes decline
- male sex drive decreases
- hypertrophy of prostate gland

MENTAL CHARACTERISTICS

- poorer short-term memory
- rate of learning declines but not necessarily the capacity to learn

EMOTIONAL CHARACTERISTICS

- possibility of shelved obsolescence or life of esteem and achievement
- timid, uncertain, easily discouraged, sensitive, suspicious
- kind, gracious, gentle, loving, wise, and possesses the inner security and peace which youth cannot achieve

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Despite these many physical impairments and the fact that at times the older adult may be confused, he is still capable and able to assist with his personal care and with many of the activities of daily living.

Institutionalization may be a new and strange experience for the older adult and he may be afraid. Institutionalization for many adults is not voluntary. If the older adult can help make plans for his health care he seems to adjust to the situation better.

CHILDREN AND ADULTS WITH CHRONIC CONDITIONS

Today a great number of children, youth and young adults have chronic diseases and disabilities and need long-term care. Deaths from communicable disease are fewer in the United States than 60 years ago. Improved diagnostic practice makes it possible to identify and detect chronic disease (pathological processes) in children, youth, and adults earlier than in former years.

Many long-term care patients are accident victims. Accidents are a leading cause of disability in the United States among children and young adults. Thousands of disabled veterans from former and present wards need skilled long-term care and rehabilitation.

Heart disease and cancer affect people throughout the age span and cause many chronic conditions and disabilities.

For these reasons the number of persons with chronic disabilities is increasing. However, new treatment modalities, progressive health legislation, and a concern on the part of the health profession for long-term care patients makes rehabilitation a possibility and reality for many persons with chronic conditions.

STUDY ACTIVITIES

1. Please ask and answer the question "who am I?" twenty times.

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2. Think of a specific patient: an older adult, a child or adult with a long-term illness. Ask and answer the question "who is my patient?" twenty times.

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3. Each patient is a multi-dimensional person. What does this mean?

4. Describe a "typical" older adult. Mention physical, mental, emotional, social, and spiritual characteristics.

5. Why is aging so often associated with illness?

6. Explain the following statement: The older adult is a difficult patient; the older adult is a challenging patient.

7. Why does an <u>increasing</u> number of children, youth and young adults need long-term care?

Chapter 4

SETTINGS FOR LONG-TERM CARE

"The right person, in the right place, at the right time, with the right service, at the right cost," is basic to the concept of progressive patient care and the idea of comprehensive health planning. Patients who require skilled long-term care because of chronic disease or disabilities, or because of dependencies associated with aging receive care in a variety of settings: hospitals, extended care facilities, nursing homes, residential facilities, and at home.

The LPN charge nurse may function in several different institutional settings: hospitals, extended care facilities, intermediate care facilities, and nursing homes.

HOSPITALS

The daily census of most general hospitals reveals a large number of medical (long-term) patients as well as a significant number of patients over the age of 65. Today hospitals participate and provide services in the Health Insurance for the Aged Program (Medicare) and the Medical Assistance Program (Medicaid). Conditions of Participation have been established and procedures to determine eligibility stated. Specific conditions of participation have been developed for the following hospital functions and situations:

- Compliance with State and Local Laws
- Governing Body
- Physical Environment
- Medical Staff
- Nursing Department
- Dietary Department
- Medical Record Department
- Pharmacy or Drug Room
- Laboratories
- Radiology Department
- Medical Library
- Complementary Departments
- Outpatient Department
- Emergency Service or Department
- Social Work Department
- Utilization Review Plan

The conditions of participation for the nursing department are included for study. Because so many nursing responsibilities entail cooperation and collaboration with other hospital departments, it is suggested that the LPN obtain and read the entire Conditions of Participation; Hospitals.

405.1024 Condition of Participation - Nursing Department
The hospital has an organized nursing department. A licensed registered professional nurse is on duty at all times and professional nursing service is available for all patients at all times.

(a) Standard; Organization. - There is a well-organized departmental plan of administrative authority with delineation of responsibilities and duties of each category of nursing personnel. The factor explaining the standard is as follows: The delineation of responsibilities and duties for each category of the nursing staff may be in the form of a written job description for each category.

(b) Standard; Licensed Registered Professional Nurse. - There is an adequate number of licensed registered professional nurses to meet the following minimum staff requirements: Director of the department; Assistants to the director for evening and night services; Supervisory and staff personnel for each department or nursing unit to insure the immediate availability of a registered professional nurse for bedside care of any patient when needed; and registered professional nurse on duty at all times and available for all patients on a 24-hour basis. The factors explaining the standard are as follows: (1) The staffing pattern insures the availability of registered professional nursing care for all patients on a 24-hour basis every day. (2) If a licensed practical nurse or nursing aide is on duty during the evening andnight hours in a ward with patients who do not generally need skilled nursing care, there is a registered professional nurse supervisor who makes frequent rounds and is immediately available to give skilled nursing care when needed. She is free to render bedside care and is not occupied in the operating room, delivery room, or emergency room for long periods of time. (3) The ratio of registered professional nurses to patients together with the ratio of registered professional nurses to other nursing personnel is adequate to provide proper supervision of patient care and staff performance, taking into consideration the characteristics of the patient load. (4) A registered professional nurse assigns the nursing care of each patient to other nursing personnel in accordance with the patient's needs and the preparation and competence of the nursing staff available.

(c) Standard; Other Nursing Personnel. - There are other nursing personnel in sufficient numbers to provide nursing care not requiring the service of a registered professional nurse. The training and supervision of these personnel are continually planned and carried out to enable them to perform effectively the duties which are assigned to them.

(d) Standard; Non-floor Services. - There are adequate nursing personnel for the surgical suite, clinics, and other services of the hospital in keeping with their size and degree of activity. The factors explaining the standard are as follows: (1) A registered professional nurse is in charge of the operating rooms. (2) Surgical technicians and licensed practical nurses may be permitted to serve as "scrub nurses" under the direct supervision of a registered professional nurse; they are not permitted to function as circulating nurses in the operating rooms.

(e) Standard; Qualifications. - Individuals selected for the nursing staff are qualified by education, experience, and demonstrated ability for the positions to which they are appointed. The factors explaining the standard are as follows: (1) The director of nursing makes decisions relative to the selection and promotion of nursing personnel based on their qualifications and capabilities and recommends the termination of employment when this is necessary. (2) The educational and experiental qualifications of the director of nursing, her assistants, and supervisors are commensurate with the size and complexity of the hospital. (3) The functions and qualifications of nursing personnel are clearly defined in relation to the duties and responsibilities delegated to them. (4) There is a procedure to insure that hospital nursing personnel, for whom licensure is required, do have valid and current licensure. (5) Personnel records including application forms and verification of credentials are on file. (6) New employees are oriented to the hospital nursing service, and their jobs.

(f) Standard; Working Relationships. - There are well established working relationships with other services of the hospital, both administrative and professional. The factors explaining the standard are as follows: (1) Registered professional nurses confer with the physicians relative to patient care. (2) Interdepartmental policies affecting nursing service and nursing care to patients are made jointly with the director of nursing. (3) There are established procedures for scheduling laboratory and X-ray examinations, for ordering, securing, and maintaining supplies and equipment needed for patient care, for ordering diets, etc.

(g) Standard; Evaluation and Review of Nursing Care. - There is constant review and evaluation of the nursing care provided for patients and there are written nursing care procedures and written nursing care plans for patients. The factors explaining the standard are as follows: (1) Nursing care policies and procedures are written and consistent with generally accepted practice and are reviewed and revised as necessary to keep pace with best practice and new knowledge. (2) A registered professional nurse plans, supervises, and evaluates the nursing care for each patient. (3) Nursing care plans are kept current daily. Plans indicate nursing care needed, how it is to be

accomplished, and methods, and approaches and modifications necessary to insure best results for the patient. (4) Nursing notes are informative and descriptive of the nursing care given and include information and observations of significance so that they contribute to the continuity of patient care. (5) Only (i) a licensed physician or a registered professional nurse or (ii) a licensed practical nurse, a student nurse in an approved school of nursing, or a psychiatric technician, when these classes of personnel are under the direct supervision of a registered professional nurse, is permitted to administer medications, and in all instances, in accordance with the Nurse Practice Act of the State. (6) All medical orders are in writing and signed by the physician. Telephone orders are used sparingly, are given only to the registered professional nurse, and are signed or initialed by the physician as soon as possible. (7) Blood transfusions and intravenous medications are administered in accordance with State law. If administered by registered professional nurses, they are administered only by those who have been specially trained for this duty. (8) There is an effective hospital procedure for reporting transfusion reactions and adverse drug reactions.

(h) Standard; Staff Meetings. - Meetings of the registered professional nursing staff are held at least monthly to discuss patient care, nursing service problems, and administrative policies. The pattern for meetings may be by clinical departments, by categories of the staff, or by the staff as a whole. Minutes of all meetings are kept. The factors explaining the standard are as follows: (1) Minutes reflect the purpose of the staff meetings; e.g., review and evaluation of nursing care, ways of improving nursing service, discussion of nursing care plans for individual patients, consideration of specific nursing techniques and procedures, establishment and/or interpretation of nursing department policies, interpretation of administrative and medical staff policies, reports of meetings, etc. (2) Minutes are available to staff members either individually or are maintained in a central place.

EXTENDED CARE FACILITIES

Sometimes a patient no longer needs the intensive care which hospitals provide, but still needs full-time skilled nursing care and other health services which cannot be furnished in his home. In these cases, the doctor may transfer the patient from the hospital to an extended care facility. This is a specially qualified facility which is staffed and equipped to furnish full-time skilled nursing care and many important related health services. An extended care facility may be an institution or a distinct part of an institution which qualifies to participate in the health insurance program for the aged. All extended care facilities must have transfer agreements with one or more hospitals.

The extended care benefit provided by the health insurance program for the aged is intended to be a benefit for those persons who, though they no longer require the level of intensive care ordinarily furnished in a general hospital, continue to need for medical reasons a level of care entailing medically supervised skilled nursing and related services

on a continuing basis in an institutional setting. The extended care benefit covers not only postacute hospitalization where the individual is convalescing or being rehabilitated but also those types of cases where the patient may continue to be severely ill and indeed have little or no prospect of recovery. A physician certifies that the extended care facility services are required because the patient needs "skilled nursing care on a continuing basis" for any of the conditions for which he had just been previously hospitalized. Thus, a terminal cancer patient who may receive only palliative treatment but whose condition requires skilled nursing services available at all times would qualify for extended care benefits. The underlying purpose of the extended care benefit is to encourage the most effective and economical utilization of available medical care resources and facilities. Since it will be necessary for many aged patients who are hospitalized for intensive treatment of an acute phase of illness to undergo a period of medically supervised convalescence or care in a facility which is staffed and equipped to provide skilled nursing and other restorative services, the extended care benefit was provided to enable physicians to transfer patients to such facilities rather than allowing patients to continue unnecessarily to occupy high-cost hospital beds.

Accordingly, an extended care facility, whether it is a distinct part of an institution or a separate institution, is a facility which provides a level of care distinguishable from the level of intensive care ordinarily furnished by a general hospital. This level of care is reflected in the conditions of participation. While the conditions call for a wide range of specialized medical services and the employment by the facility in adequate numbers of a variety of paramedical and skilled nursing personnel, the emphasis is on the provision of skilled nursing and related care rather than the type of care and treatment required in the acute phase of an illness. Similarly, although the legislative language concerning rehabilitation services is the same with respect to hospitals and extended care facilities, the general concept of an extended care facility is that of an intermediate institution which provides post-hospital, subacute services. Hence, a rehabilitation hospital would be equipped and staffed to diagnose and evaluate the patient's disability and to initiate a rehabilitation regime. A rehabilitation extended care facility, on the other hand, would be staffed and equipped to continue and modify such a regime during the patient's convalescence.

In general, a hospital is designed to initiate care, including diagnosis and treatment. The extended care facility is designed to continue care, with appropriate modifications as the patient's condition changes.

Specific conditions of participation have been developed for the following extended care facility functions and situations:

- Compliance with State and Local Laws
- Administrative Management
- Patient Care Policies
- Physician Services
- Nursing Services
- Dietary Services
- Restorative Services

- Pharmaceutical Services
- Diagnostic Services
- Dental Services
- Social Services
- Patient Activities
- Clinical Records
- Transfer Agreement
- Physical Environment
- Housekeeping Services
- Disaster Plan
- Utilization Review Plan

The following overview explains these conditions of participation in a little more detail. An extended care facility is engaged primarily in providing to inpatients (1) skilled nursing care and related services for patients who require medical or nursing care, or (2) rehabilitation services for the rehabilitation of injured, disabled, or sick persons. The facility must have policies which are developed and reviewed by a group of professional personnel, including one or more physicians and one or more registered professional nurses; policies relate to skilled nursing care and other medical services provided by the facility. An extended care facility or ECF, must have a physician, a registered professional nurse, or a medical staff responsible for the execution of such policies. The health care of every patient must be under the supervision of a physician and a physician must be available to furnish necessary medical care in case of an emergency. An ECF must maintain clinical records on all patients.

An extended care facility must provide 24-hour nursing service which is sufficient to meet nursing needs in accordance with the policies developed; at least one registered professional nurse must be employed full time. The ECF must provide appropriate methods and procedures for the dispensing and administering of drugs and biologicals. It must have in effect a utilization review plan. Other conditions relating to the health and safety of patients who receive services in an extended care facility may be required by State, local, and Federal officials as deemed necessary.

The conditions of participation - nursing services are included for study. Because so many charge nurse responsibilities require cooperation and collaboration with all departments, it is suggested that the LPN obtain and read the entire booklet Conditions of Participation; Extended Care Facilities.

> 405.1124 Condition of Participation - Nursing Services. - The extended care facility provides 24-hour nursing service which is sufficient to meet the nursing needs of all patients. There is at least one registered professional nurse employed full time and responsible for the total nursing service. There is a registered professional nurse or licensed practical nurse who is a graduate of a State approved school of practical nursing in charge of nursing activities during each tour of duty. The terms "licensed practical nurse (s)" and "practical nursing" as used in this section are synonymous with "licensed vocational nurse (s)" and "vocational nursing."

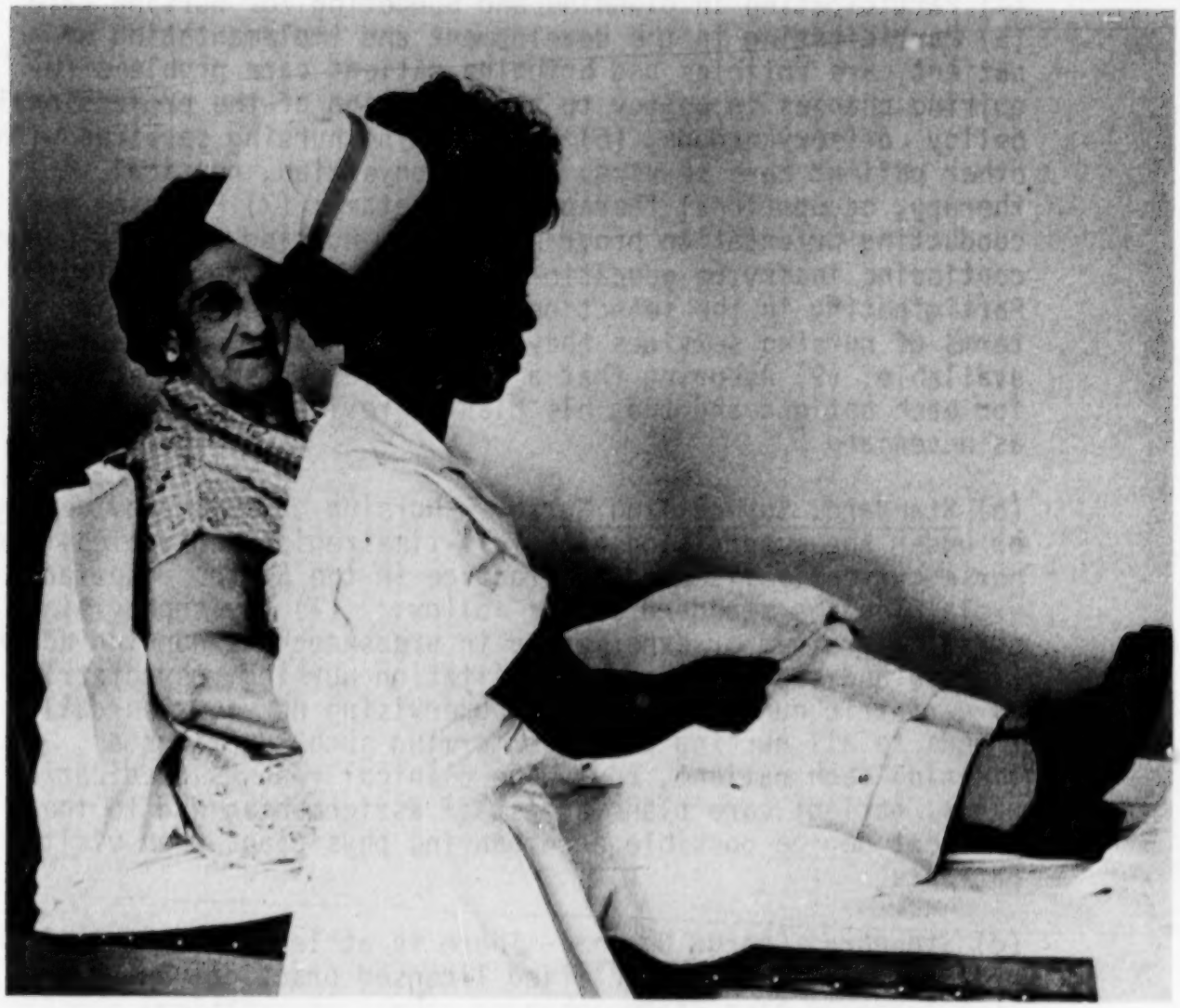

Figure 4-2. Patient care in an extended care facility.

(a) Standard; Full-time Nurse. - There is at least one registered professional nurse employed full time. If there is only one registered professional nurse, she serves as director of the nursing service, works full time during the day, and devotes full time to the nursing service of the facility. If the director of nursing has administrative responsibility for the facility, she has a professional nurse assistant so that there is the equivalent of a full-time director of nursing service. The director of nursing service is trained or experienced in areas such as nursing service administration, rehabilitation nursing, psychiatric or geriatric nursing.

(b) Standard; Director of Nursing Service. - The director of the nursing service is responsible for: (1) Developing and/or maintaining nursing service objectives, standards or nursing practice, nursing procedure manuals, and written job descriptions for each level of nursing personnel; (2) Recommending to the administrator the number and levels of nursing personnel to be employed, participating in their recruitment and selection,

and recommending termination of employment when necessary; (3) Assigning and supervising all levels of nursing personnel; (4) Participating in planning and budgeting for nursing care; (5) Participating in the development and implementation of patient care policies and bringing patient care problems requiring changes in policy to the attention of the professional policy advisory groups; (6) Coordinating nursing services with other patient care services such as physician, physical therapy, occupational therapy, and dietary; (7) Planning and conducting orientation programs for new nursing personnel, and continuing inservice education for all nursing personnel; (8) Participating in the selection of prospective patients in terms of nursing services they need and nursing competencies available; (9) Assuring that a nursing care plan is established for each patient and that his plan is reviewed and modified as necessary.

(c) Standard; Supervising Nurse. - Nursing care is provided by or under the supervision of a full-time registered professional nurse currently licensed to practice in the State. The factors explaining the standard are as follows: (1) The supervising nurse is trained or experienced in areas such as nursing administration and supervision, rehabilitation nursing, psychiatric or geriatric nursing. (2) The supervising nurse makes daily rounds to all nursing units performing such functions as visiting each patient, reviewing clinical records, medication cards, patient care plans and staff assignments, and to the greatest degree possible accompanying physicians when visiting patients.

(d) Standard; Charge Nurse. - There is at least one registered professional nurse or qualified licensed practical nurse who is a graduate of a State approved school of practical nursing on duty at all times and in charge of the nursing activities during each tour of duty. The factors explaining the standard are as follows: (1) A State-approved school of practical nursing is one whose standards of education meet those set by the appropriate State nurse licensing authority. (2) Some State laws laws grant practical nurse licensure (nonwaivered) to certain individuals who have an educational background considered to be equivalent to graduation from a State-approved school of practical nursing. Such licensure determination is made by the appropriate State nurse licensing authority on the basis of evaluation of the individual's educational achievements, as well as on successful completion of the appropriate State licensing examination. Licensure under such conditions may be accepted as meeting the requirement of graduation from a State-approved school of practical nursing. (3) It is desirable that the nurse in charge of each tour of duty be trained or experienced in areas such as nursing administration and supervision, rehabilitation nursing, psychiatric or geriatric nursing. (4) The charge nurse has the ability to recognize significant changes in the condition of patients and to take necessary action. (5) The charge nurse is responsible for the total nursing care of patients during her tour of duty.

(e) Standard; 24-hour Nursing Service. - There is 24-hour nursing service with a sufficient number of nursing personnel on duty at all times to meet the total needs of patients. The factors explaining the standard are as follows: (1) Nursing personnel include registered professional nurses, licensed practical nurses, aides and orderlies. (2) The amount of nursing time available for patient care is exclusive of nonnursing duties. (3) Sufficient nursing time is available to assure that each patient: (i) Receives treatments, medications and diet as prescribed; (ii) Receives proper care to prevent decubiti and is kept comfortable, clean, and well-groomed; (iii) Is protected from accident and injury by the adoption of indicated safety measures; (iv) Is treated with kindness and respect. (4) Licensed practical nurses, nurses' aides and orderlies are assigned duties consistent with their training and experience.

(f) Standard; Restorative Nursing Care. - There is an active program of restorative nursing care directed toward assisting each patient to achieve and maintain his highest level of self care and independence The factors explaining the standard are as follows: (1) Restorative nursing care initiated in the hospital is continued immediately upon admission to the extended care facility. (2) Nursing personnel are taught restorative nursing measures and practice them in their daily care of patients. These measures include: (i) Maintaining good body alignment and proper positioning of bedfast patients; (ii) Encouraging and assisting bedfast patients to change positions at least every 2 hours day and night to stimulate circulation, and prevent decubiti and deformities; (iii) Making every effort to keep patients active and out of bed for reasonable periods of time, except when contraindicated by physicians' orders, and encouraging patients to achieve independence in activities of daily living by teaching self care, transfer and ambulation activities; (iv) Assisting patients to adjust to their disabilities, to use their prosthetic devices, and to redirect their interests if necessary; (v) Assisting patients to carry out prescribed physical therapy exercises between visits of the physical therapist. (3) Consultation and instruction in restorative nursing available from State or local agencies are utilized.

(g) Standard; Dietary Supervision. - Nursing personnel are aware of the dietary needs and food and fluid intake of patients. The factors explaining the standard are as follows: (1) Nursing personnel observe that patients are served diets as prescribed. (2) Patients needing help in eating are assigned promptly upon receipt of meals. (3) Adaptive self-help devices are provided to contribute to the patient's independence in eating. (4) Food and fluid intake of patients is observed and deviations from normal are reported to the charge nurse. Persistent unresolved problems are reported to the physician.

(h) Standard; Nursing Care Plan. - There is a written nursing care plan for each patient based on the nature of illness, treatment prescribed, long- and short-term goals and other pertinent information. The factors explaining the standard are as follows: (1) The nursing care plan is a personalized daily plan for individual patients. It indicates what nursing care is needed, how it can best be accomplished for each patient, how the patient likes things done, what methods and approaches are most successful, and what modifications are necessary to insure best results. (2) Nursing care plans are available for use by all nursing personnel. (3) Nursing care plans are reviewed and revised as needed. (4) Relevant nursing information from the nursing care plan is included with other medical information when patients are transferred.

(i) Standard; Inservice Education Program. - There is a continuing inservice educational program in effect for all nursing personnel in addition to a thorough job orientation for new personnel. Skill training for nonprofessional nursing personnel begins during the orientation period. The factors explaining the standard are as follows: (1) Planned inservice programs are conducted at regular intervals for all nursing personnel. (2) All patient care personnel are instructed and supervised in the care of emotionally disturbed and confused patients, and are helped to understand the social aspects of patient care. (3) Skill training includes demonstration, practice, and supervision of simple nursing procedures applicable in the individual facility. It also includes simple restorative nursing procedures. (4) Orientation of new personnel includes a review of the procedures to be followed in emergencies. (5) Opportunities are provided for nursing personnel to attend training courses in restorative nursing and other educational programs related to the care of long-term patients.

INTERMEDIATE CARE FACILITIES

Many people, because of their physical or mental limitations or both, require living accommodations and care, which as a practical matter, can be made available to them only through institutional facilities. These people do not have an illness, disease, injury, or condition that requires the degree of care and treatment which a hospital or skilled nursing home provides. An intermediate care facility is an institution or a distinct part of an institution which is licensed under State law to provide its residents with such a defined range and level of care and services on a regular basis. Many State plans include benefits in the form of institutional services in intermediate care facilities.

The following pages describe the minimum range or level of care and services suitable to the needs of individuals in intermediate care facilities.

(i) Admission, transfer, and discharge of residents. The admission, transfer, and discharge of residents of the facility are conducted in accordance with written policies of the institution that include at least the following provisions. (a) Only those persons are accepted into the facility whose needs can be met within the accommodations and services the facility provides; (b) As changes occur in their physical or

mental condition, necessitating service or care not regularly provided by the facility, residents are transferred promptly to hospitals, skilled nursing homes, or other appropriate facilities; (c) The resident, his next of kin, and the responsible agency if any, are consulted in advance of the discharge of any resident, and casework services or other means are utilized to assure that adequate arrangements exist for meeting his needs through other resources.

(ii) Personal care and protective services. The types and amounts of protection and personal service needed by each resident of the facility are a matter of record and are known to all staff members having personal contact with the resident. At least the following services are provided. (a) There is, at all times, a responsible staff member actively on duty in the facility, and immediately accessible to all residents, to whom residents can report injuries, symptoms of illness, or emergencies, and who is immediately responsible for assuring that appropriate action is taken promptly. (b) Assistance is provided, as needed by individual residents, with routine activities of daily living including such services as help in bathing, dressing, grooming, and management of personal affairs such as shopping. (c) Continuous supervision is provided for residents whose mental condition is such that their personal safety requires such supervision.

(iii) Social services. Services to assist residents in dealing with social and related problems are available to all residents through one or more caseworkers on the staff of the facility; and/or, in the case of recipients of assistance, through caseworkers on the staff of the assistance agency; or through other arrangements.

(iv) Activities. Activities are regularly available for all residents, including social and recreational activities involving active participation by the residents, entertainment of appropriate frequency and character, and opportunities for participation in community activities as possible and appropriate.

(v) Food service. At least three meals a day, constituting a nutritionally adequate diet, are served in one or more dining areas separate from sleeping quarters, and tray service is provided for residents temporarily unable to leave their rooms.

(vi) Special diets. If the facility accepts or retains individuals in need of medically prescribed special diets, the menus for such diets are planned by a professionally qualified dietician, or are reviewed and approved by the attending physician, and the facility provides supervision of the preparation and serving of the meals and their acceptance by the resident.

Figure 4-3. Resident care in an intermediate care facility.

(vii) Health services. Whether provided by the facility or from other sources, at least the following services are available to all residents: (a) Immediate supervision of the facility's health services by a registered professional nurse or a licensed practical nurse employed full-time in the facility and on duty during the day shift. In some States there are two or more classifications of intermediate care facilities, and the employment of a nurse is not required of institutions in classifications serving only residents determined by their physicians not to need supervision by a licensed nurse. (b) Continuing supervision by a physician who sees the resident as needed and, in no case, less often than quarterly; (c) Under

direction by the resident's physician and general supervision by the nurse in charge of the facility's health services, guidance and assistance for each resident in carrying out his personal health program to assure that preventive measures, treatments, and medications prescribed by the physician are properly carried out and recorded; (d) Arrangements for services of a physician in the event of an emergency when the resident's own physician cannot be reached; (d) In the presence of minor illness and for temporary periods, bedside care under direction of the resident's physician including nursing service provided by, or supervised by, a registered professional nurse or a licensed practical nurse; (f) An individual health record for each resident including (1) the name, address, and telephone number of his physician; (2) a record of the physician's findings and recommendations in the pre-admission evaluation of the individual's condition and in subsequent reevaluations and all orders and recommendations of the physician for care of the resident; (3) all symptoms and other indications of illness or injury brought to the attention of the staff by the resident or from other sources, including the date, time, and action taken regarding each.

(viii) Living accommodations. Space and furnishings provide each resident clean, comfortable and reasonably private living accommodations with no more than four residents occupying a room, with individual storage facilities for clothing and personal articles, and with lounge, recreation and dining areas provided apart from sleeping quarters.

(ix) Administration and management. The direction and management of the facility are such as to assure that the services required by the residents are so organized and administered that they are, in fact, available to the residents on a regular basis and that this is accomplished efficiently and with consideration for the objective of providing necessary care within a homelike atmosphere. Staff are employed by the facility in sufficient number and competence, as determined by the appropriate State agency, to meet the requirements of the residents.

NURSING HOMES

Almost one million Americans are in 24,000 nursing homes. In recent years an increasing number of people have enterred the "nursing-home-business-for-profit." According to Florence McQuillan, nurse and authority on nursing home administration, a modern nursing home has the following objectives:

1. To provide continuing care for those recovering from surgical or medical disorders.

2. To assist patients in reaching optimal physical and emotional health.

3. To provide for the total needs of patients - physical, emotional, and spiritual.

4. To assist the aging toward an active participation in life.

5. To provide for rehabilitative services when the need exists.

6. To work cooperatively with other community and social agencies.

On the other hand, David Pryor, Congressman from Arkansas, believes a nursing home is "a halfway house somewhere between society and the cemetery." "American nursing homes for the elderly are divided into three general categories: expensive, bad, and terrible."

Who is correct? Perhaps both descriptions are accurate. We know that "less than good conditions" exist in many nursing homes. We know also that high quality care exists in many homes and can and will exist in even more. Most of our discussion will focus on nursing homes providing "skilled nursing care" as defined in the Medicaid provisions.

Just a word or so in general about nursing homes. A nursing home may be a private home, an institution, building, or residence which provides through its ownership or management maintenance, personal care, nursing, to three or more persons. Because of some illness or physical infirmity these people require such care. Nursing home management may be public (Federal, State, county, or community), religious, fraternal, charitable, non-profit, or private (individual or corporate) for profit. A "home for the aged" is similar, yet it provides sheltered care simply because people are older people and unable to maintain an independent way of life except for institutionalization.

States and most large cities have minimum standards, that is, rules and regulations for nursing homes. When a nursing home meets these standards, it is licensed. Standards relate to administration; general policies, medical supervision of patients; nursing; records; medications, treatments, narcotics and dangerous drugs; food service; plant maintenance, housekeeping, and sanitation; water supply and sewage disposal; furnishing, equipment, and supplies; buildings and grounds of the existing home; buildings and grounds of new construction or conversions; fire protection in the existing home; fire protection of new buildings and conversions; additions and alternations; building plans; as well as special standards for infants and children under 18 years of age.

To qualify as a skilled nursing home and receive Medicaid payments, an institution must supply the licensing agency of the State full and complete information as to the identity of each person having an ownership interest of 10% or more in the nursing home. If the nursing home is organized as a corporation or a partnership, officers, directors, and/or partners must be identified.

The nursing home must have and maintain an organized nursing service for its patients, which is under the direction of a professional registered nurse who is employed full-time by the home; other nursing and auxiliary personnel must be sufficient in number to provide adequate and properly supervised nursing services for all patients during all hours of each

Figure 4-4. Patient care in a nursing home.

day and all days of each week. There must be at least one professional registered nurse or licensed practical (or vocational) nurse on duty at all times and in charge of the nursing activities during each tour of duty. The LPN should be a graduate of a State-approved school of practical nursing or be a person who is found by the appropriate State licensing authority on the basis of the individual's education and formal training to have background considered to be equivalent to graduation from a State-approved school of practical nursing.

To qualify as a skilled nursing home, an institution must make satisfactory arrangements for professional planning and supervision of menus and meal service for patients for whom special diets or dietary restrictions are medically prescribed.

The nursing home must have satisfactory policies and procedures relating to the maintenance of medical records on each patient of the nursing home, dispensing and administering of drugs and biologicals, and assuring that each patient is under the care of a physician and that adequate provisions are made for medical attention to any patient during emergencies.

The nursing home must have arrangements with one or more general hospitals under which such hospital or hospitals will provide needed diagnostic and other services to patients of the nursing home. The hospitals agree to accept acutely ill patients from the nursing home who need hospital care.

The qualify as a skilled nursing home, institutions should meet the requisite provisions of the Life Safety Code of the National Fire Protection Association for nursing homes.

STUDY ACTIVITIES

"The right person, in the right place, at the right time, with the right service, at the right cost," is basic to the concept of progressive patient care and the idea of comprehensive health planning.

Complete the following chart by describing the kind of patient that should be in each of the following institutional settings: a hospital, an extended care facility, an intermediate care facility, and a nursing home. Identify major nursing needs of each patient and delineate the role of the LPN in meeting these needs.

When you have finished each chart, compare and contrast (1) patients, (2) patient nursing needs, and (3) the role of the LPN in meeting patient needs in the different institutional settings.

HOSPITAL

Patient Description	Nursing Needs	Role of the LPN

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EXTENDED CARE FACILITY

Patient Description	Nursing Needs	Role of the LPN

INTERMEDIATE CARE FACILITY

Patient Description	Nursing Needs	Role of the LPN

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NURSING HOME

Patient Description	Nursing Needs	Role of the LPN

Part II

THE LICENSED PRACTICAL NURSE AS CHARGE NURSE

Chapter 5

INTRODUCTION

With the advent of Medicare and Medicaid, and the acknowledged shortage of prepared health practitioners in the areas of gerontology and long-term care, the LPN, because of her education, her role and functions, and her experience, emerged as one of the most qualified members of the health team to move into a leadership role in the management of skilled nursing care for patients in nursing homes, extended care and related facilities.

The government publications, Conditions of Participation; Hospitals and Conditions of Participation; Extended Care Facilities (Title XVIII - Medicare), as well as Institutional Services in Intermediate Care Facilities and Standards for Payment for Skilled Nursing Home Care (Title XIX - Medicaid) document well the need and the plan for utilization of the LPN in a patient management role.

> Hospitals: If a licensed practical nurse or nursing aid is on duty during the evening and night in a ward with patients who do not generally need skilled nursing care, there is a registered professional nurse supervisor who makes frequent rounds and is immediately available to give skilled nursing care when needed.
>
> Extended Care Facilities: There is at least one registered professional nurse or qualified licensed practical nurse . . . on duty at all times and in charge of the nursing activities during each tour of duty.
>
> Intermediate Care Facilities: Immediate supervision of the facility's health services is by a registered professional nurse or a licensed practical nurse employed full-time in the facility and on duty during the day shift.[1]
>
> Skilled Nursing Home: There must be at least one professional registered nurse or licensed practical (or vocational) nurse on duty at all times and in charge of the nursing activities during each tour of duty.

Consistent with national health needs and Federal legislation, is the Patient Care Management section of the revised Statement of Functions and Qualifications of the Licensed Practical Nurse.

> The licensed practical nurse, with additional preparation in specialized areas and under direction of autonomous health professionals is qualified to:

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[1] In some States the employment of a nurse is not required if a physician determines the residents do not need supervision by a licensed nurse.

a. Supervise other nursing and health-related personnel.

b. Coordinate and make assignments of other nursing and health-related personnel and patients.

c. Serve as team leader.

d. Serve as charge nurse.

One of the first projects of the National Licensed Practical Nurses Educational Foundation, Inc. (the education and research arm of the National Federation of Licensed Practical Nurses) was the development of Guidelines for Continuing Education Programs for LPNs, and Criteria for Continuing Education of the LPN/LVN. The contract between the

Figure 5-1. The LPN charge nurse.

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Federation and the U. S. Public Health Service which resulted in the publication of this text is another example of LPN readiness and willingness to prepare for key nursing roles in patient care management.

The term charge nurse, as used in this text, means the immediate nursing supervisor, administrator or director of an individual unit or ward. In general, the charge nurse has a dual responsibility: (1) patient care, and (2) staff effectiveness.

The charge nurse is responsible for the nursing care of all patients on her unit for a specific tour of duty. This includes planning, implementation, and evaluation of the nursing care of all patients.

The charge nurse is responsible for staff effectiveness, because in large part, it is through her staff that she nurses her patients. Because she is in a leadership role, she is also responsible for guiding her staff toward personal and group satisfaction and achievement in their work.

Charge nurse functions vary from institution to institution, from unit to unit, and from shift to shift. In general, however, the following list of functions is characteristic and typical of the LPN charge nurse.

THE LICENSED PRACTICAL NURSE AS CHARGE NURSE

A Statement of Functions

The qualified licensed practical nurse who functions as charge nurse on certain tours of duty in nursing homes, extended care, and related facilities performs the following functions:

1. PLANS PATIENT CARE

   - demonstrates awareness of the comprehensive nature of long-term care
   - understands the condition, needs, and therapeutic goals of each patient
   - receives and interprets verbal and written reports about patient care
   - makes nursing rounds to observe and determine patient needs
   - assists the physician with examinations and treatments
   - discusses patient care goals with physician, nursing supervisor, and staff
   - develops nursing care plans for individual patients.

2. COORDINATES STAFF ACTIVITIES

   - exhibits an understanding of basic human behavior
   - demonstrates fundamental leadership techniques
   - uses management principles and procedures
   - communicates verbally and non-verbally: listens, speaks, reads, writes, gestures effectively
   - motivates staff to give skilled nursing care to all patients.

3. IMPLEMENTS PATIENT CARE

- develops plans to meet on-going needs of all patients
- develops plans for common types of emergency situations
- assigns personnel in terms of patient needs and staff proficiencies
- helps staff care for patients with special needs, the patient with mental illness, the dying patient
- coordinates work with that of other departments such as dietary, housekeeping, physical and occupational therapy, social service
- seeks guidance and assistance when problems are beyond scope
- prepared and gives verbal and written reports about patients: conferences, nurses' notes, tour of duty and special reports.

4. EVALUATES PATIENT CARE

- applies basic principles of evaluation
- makes nursing rounds to observe and assess patient care and needs
- assesses patient care plans and modifies as necessary
- assesses patient care given by staff and guides appropriate changes
- appraises self-performance and plans improvement.

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STUDY ACTIVITIES

1. Study the job description for charge nurse at your institution. Compare and contrast the description with The Licensed Practical Nurse as Charge Nurse: A Statement of Functions. What is similar? What is different?

   Similarities:

   Differences:

Chapter 6

PLANNING PATIENT CARE

The LPN charge nurse plans patient care for a specific tour of duty. To do this, she:

- demonstrates awareness of the comprehensive nature of long-term care
- understands the condition, needs, and therapeutic goals of each patient
- receives and interprets verbal and written reports about patient care
- makes nursing rounds to observe and determine patient needs
- assists the physician with examinations and treatments
- discusses patient care goals with physician, nursing supervisor, and staff
- develops nursing care plans for individual patients.

DEMONSTRATES AWARENESS OF THE COMPREHENSIVE NATURE OF LONG-TERM CARE

In the United States today, nursing homes, extended care, and related facilities assume a major responsibility for giving skilled long-term care. The nursing needs of your patients have many dimensions: physical, mental, emotional, social, and spiritual. It is necessary to meet these comprehensive patient needs on a planned, on-going basis over a long (extended) period of time, perhaps for the entire life of the person. It is equally important to encourage patient independence and prevent dependency.

UNDERSTANDS THE CONDITION, NEEDS, AND THERAPEUTIC GOALS OF EACH PATIENT

Patients are people ane each patient is an individual. A disease, disability, or dependency is specific for a person. All people have similar basic human needs. The degree of wellness or illness determines greatly how each need can be met and to what extent nursing is necessary to help the patient meet his needs. The physician works closely with the charge nurse and other members of the health team to establish a therapeutic goal for each patient and plan care. A goal may be curative, rehabilitative, or palliative.

RECEIVES AND INTERPRETS VERBAL AND WRITTEN REPORTS ABOUT PATIENT CARE

Verbal and written reports about patients between personnel on different tours of duty promote continuity of patient care. The charge nurse obtains a complete report on the condition of each patient from the nurse she is relieving. She discusses special conditions and needs such as abnormal vital signs, pain, changes in general condition. The charge nurse makes special note of patients receiving inhalation therapy, patients with indwelling catheters, patients receiving parenteral fluids. Treatments, medications, and specific plans for the day are discussed. Anything unusual in terms of physical environment of the ward, personnel changes for the tour of duty, or special events for the institution are reviewed.

MAKES NURSING ROUNDS TO OBSERVE AND DETERMINE PATIENT NEEDS

The LPN charge nurse, as well as team leaders and nursing supervisors, make "rounds" on patients. Nursing rounds are made at the change of shifts, with physicians, with students and staff, during visiting hours, and whenever patient needs necessitate a visit by the charge nurse.

Nursing rounds at the beginning of a tour of duty is an organized way for the charge nurse to observe patients and determine needs. The LPN charge nurse should observe each patient in an organized manner; a planned "general to specific, head to toe" observation plan is recommended:

- Make general observation
- Note and feel skin
- Note head: eyes, nose, ears, hair, scalp, beard, lips, gums, teeth, tongue, breath
- Talk with patient; listen
- Check chest: abdomen, back genitals
- Have patient move; lift covers
- Examine extremities
- Discuss appetite, activity, elimination
- Discuss desires, likes, dislikes, complaints
- Note mental/emotional condition, reaction to institutionalization, treatments, nursing care.

Nursing rounds permit the charge nurse opportunity to secure and give information to patients and staff. Often she interprets policies pertinent to patient care and institution management while on rounds. Observation of nursing ethics in principle and practice is possible through nursing rounds. Rounds offer an opportunity for guidance, teaching, and on-the-spot teaching between the charge nurse and staff; personnel development on the job is enhanced through rounds. Orientation to the job, follow-up learning, and staff development continue with the help of the charge nurse as she makes rounds. Establishing rapport, good will, and personal interest in the job of the staff is often accomplished as the charge nurse makes rounds and talks with staff and their patients. A sense of togetherness is fostered when the charge nurse is "with" her staff and patients at the bedside.

Through rounds the charge nurse can assess the physical environment of her unit, as well as the availability, use, and maintenance of supplies and equipment. She can elicit and discuss suggestions for improving working conditions. Patient care and the multiple factors in the environment that affect care are observed.

Nursing rounds are very important for the development of good public relations with the patient, his family, and visitors. The opportunity to meet and talk with people about health, health care, and a particular patient and his needs is possible when the charge nurse makes rounds. Often the charge nurse uses rounds as a way to discuss referral plans with the patient, his family, and the physician.

ASSISTS THE PHYSICIAN WITH EXAMINATIONS AND TREATMENTS

The physician assumes responsibility for initial examination and diagnosis; he prescribes treatment. The effective charge nurse shares observations of the patient with the physician; she interprets and explains treatment measures to the patient and his family. In most cases the charge nurse knows the patient best and she should try in every way possible to assist the physician as they plan patient care together.

DISCUSS PATIENT CARE GOALS WITH PHYSICIAN, NURSING SUPERVISOR, AND STAFF

Communication with the physician, nursing supervisor and staff about patients, their problems, needs, as well as therapeutic goals and approaches, promotes quality patient care. Patient care is planned and implemented by a team of people. The charge nurse evaluates the patient's condition, his needs and therapeutic goal. She finds out what the physician is trying to accomplish in his care of the patient. She asks the nursing supervisor for guidance about nursing care; she involves allied health personnel in planning care: the dietician, the physical and occupational therapists, the clergy, the social worker, and the administrator.

DEVELOPS NURSING CARE PLANS FOR INDIVIDUAL PATIENTS

A nursing care plan is an organized program to provide individualized nursing care based upon the medical therapeutic plan and nursing assessment of patient needs, goals, and approaches. According to Little and Carnevali[1] the rationale for care plans is as follows:

- Nursing care plans are needed to individualize care
- Nursing care plans help in setting priorities
- Nursing care plans help in systematic communication
- Planning is essential to continuity of nursing care
- Planning is needed to coordinate care
- Nursing care plans assist in the evaluation of care
- Nursing care plans contribute to staff development.

Dolores E. Little and Doris L. Carnevali, both professors at the University of Washington and experienced nurses in planning nursing care write:

> The current concept of planning patient care hinges on the belief in the individuality of each patient, hence the need for systematic tailoring of his nursing care to his specific requirements. This planned individualization is carried out in the ordered diagnostic studies, the physicians' therapeutic plan of care, and in the general aspects of nursing activities. It can be done consistently and methodically through the use of written care plans. The written statements of patient problems, goals, and nursing approaches offer a common basis of information to all who

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[1] Every LPN charge nurse should purchase, read, and study the book Nursing Care Planning by Dolores E. Little and Doris L. Carnevali, a 1969 Lippincott of Philadelphia publication.

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read them or who give an oral report from them. In this way nursing care plans contribute to continuity of care - the even progression of care during the stages of illness. They also contribute to, and are influenced by, efforts in coordinating tests, therapy and other non-nursing aspects of care. Plans and progress reports make possible more accurate assessment of nursing care and also contribute to staff development in areas of both knowledge and skill.

In any work setting, the responsibility for creating nursing care plans rests with the nurses who direct or give patient care. There may be total or selective coverage of the patient population in the use of written care plans.

The climate of experimentation, of tentativeness, of alternate solutions, of changing perspectives on problems and priorities, tends to foster a flexible, creative, challenging, patient-centered work milieu; one well suited to the constancy of change in the individual patient and the total patient population.[1]

There are certain common steps and components in the process of planning care, whether it be thought through in a moment at the patient's bedside or carefully drafted in advance. According to Little and Carnevali the basic steps in the process are:

1. Identifying the patient factors that will influence nursing care.

2. Ruling in or ruling out problems and setting current priorities of attention and care.

3. Stating the nursing care problems[2] that have been given current priority of attention.

   a. Setting of the desired patient goals or objectives in the problem area.

   b. Prescribing the nursing actions to be undertaken that will assist the patient in achieving his goal.

   c. Determining what cues will enable the nurse to assess the patient response and the effectiveness of the nursing actions.

4. Revising any or all components of the nursing care plan as necessary in terms of patient response or changes in his situation.[3]

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[1] Little and Carnevali, Nursing Care Planning, p. 16.

[2] A nursing care problem is a situation in which the patient requires or would benefit from the assistance of the nurse in attaining the desired goal or solution.

[illegible] p. 47.

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The nursing history is the first component in planning a patient's nursing care. It is a necessary part of both continuity and individualization. If one considers that continuity must begin with the patient in his home environment and continue throughout the illness experience, then it becomes obvious that the gap between non-patient and patient status, or between home and institution, must be bridged smoothly. The nursing history may make this possible.

The history is the cord of individualization also. It provides the data from the patient to show where discrepancies exist between his previous patterns and those which may be expected of him in his patient role. It also gives beginning data on cues to patient response. The information obtained in this initial contact forms the basis for immediate priority setting and statement of current and potential problems of concern as well as selection and modification of nursing approaches that meet his needs, values and desires.

The exact content areas of the nursing history should prove useful in terms of economy of time and appropriateness to patient care in particular institutional settings. To obtain information that is not used in planning patient care is not justified.

The exact format of a nursing care plan will vary from institution to institution. In most cases the plan will be an integral part of the Kardex. If an institution does not have a particular form for a nursing care plan, several variations are suggested; divide a card in half and lable the two sides as follows:

(1) GOALS	APPROACHES
or	
(2) PROBLEMS	APPROACHES
or	
(3) GOALS	ACTIONS

The following sample plan will give an idea of content for a nursing care plan for a long-term care patient.

GOAL	ACTION
1. Encourage further independence and responsibility for self.	a. Accept offers of help from patient or request his help, especially on his good mood days.
	b. Praise his efforts to keep his room neat and his help to others as well as himself.

2. Encourage interest in repair of prothesis

   a. Help him to consider situations where being able to walk with prothesis would simplify his life and make it more pleasant.

   b. Ask if he wishes to set aside any of his pay for prosthesis repair.

3. Continue to assist patient in becoming oriented to time and place.

   a. Identify care setting and time when it can be introduced without threatening him or making him seem in error.

Figure 6-1. Planning patient care.

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STUDY ACTIVITIES

1. Obtain a nursing care history on one of your patients. Use the following form or any modification of the form that seems appropriate.

NURSING CARE HISTORY

Patient's Name_____ Diagnosis_____

Admitting Date_____ Date of History_____

History obtained by_____

General Information

I. Previous nursing home and/or hospital experience. Yes___ No___

Date of last nursing home/hospital experience_____

II. Previous experience in this nursing home. Yes___ No___

Date_____ Diagnosis_____

III. Kinds of activities carried out by nurses that were helpful.

IV. Kinds of activities carried out by nurses that bothered you.

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II. Fluid Habits:

A. Fluid preferences

B. Fluid dislikes

III. Sleep Habits:

A. Usual bedtime?_____

B. Usual number of hours of sleep_____

C. Get up at night_____

D. Nap habits

Time

E. Number of pillows desired?_____

F. Number of blankets desired?_____

G. Windows open?_____Curtains drawn?_____

H. If unable to sleep at home, what things do you do that help you fall asleep?

IV. General Hygiene:

A. Bathing preference: Usual Time

Tub_____ _____

Shower_____ _____

B. Care of teeth:

Type: Usual Time of Cleaning

Natural_____ _____

Dentures_____ _____

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V. Visitor and family contact during hospitalization. Yes___ No___

Desire for any restriction of visits. Yes___ No___

If restriction, please indicate desires.

VI. Goal expectations from nursing home experience.

Habits of Daily Living

I. Food Habits:

A. Meal patterns:

	Time	Usual Foods
Breakfast		
Lunch		
Dinner		
Snacks		

B. Food dislikes

C. Food allergies

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V. Elimination:

A. Usual bowel habits:

Frequency_____ Time_____

B. Bowel irregularities:

Constipation? Yes___ No___

C. Bladder irregularities:

Yes___ No___

Other Specific Information

Any Specific Questions You Wish to Ask Me?

Observations Made During History Taking:

3. Use the nursing care history and make out a nursing care plan. If possible obtain several other nursing care histories and make out additional nursing care plans. In addition to the history, use personal knowledge of the patients and information available from the charts; try to involve other staff in the activity.

GOAL ACTION

GOAL ACTION

GOAL ACTION

GOAL ACTION

2. Every individual must satisfy certain basic human needs to live, to maintain health, and to affirm his being. These needs relate to the following:

- Environment
- Social class
- The family
- Marriage
- Religion
- Vocational development
- Recreation
- Love
- Sex
- Water
- Food
- Elimination
- Personal cleanliness
- Clothing
- Activity
- Rest and sleep
- Oxygen

Nursing is the act of assisting a healthy, handicapped, ill or dying person to meet his basic needs for life, health, and being. Use the information you have obtained from the nursing care history and complete the following NEED/ACTION PLAN. Basic needs and concept statements explaining the needs are listed on the left-hand side of the page. On the right-hand side, indicate the approach or action you as a nurse would take to help the patient meet this particular need.

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PATIENT NEED	NURSING ACTION
Environment	
- The total well-being of an individual is influenced by his surroundings (environment). - Surroundings, belongings, possessions, and valuables are necessary, accepted, and cherished parts of a person's life. - A healthful environment is pleasant, comfortable, safe, and convenient. - The readiness of a person to return to the community and the process of recovery is influenced directly by environment.	
Social class	
- Income, occupation, education, and ethnic status are some of the indeces of social class. - An individual's behavior in part reflects his social class and style of life.	
The family	
- The immediate family includes the father, mother, and children. - The extended family includes such relatives as grandparents, uncles, aunts, and cousins. - There are many significant people in the life of a patient: neighbor, minister, sweatheart. - The need for long-term care by any member of the immediate or extended family affects family roles, relationships, responsibilities, and economics. - Readiness to return to the family is conditioned by behavior and characteristics of the specific family constellation.	

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PATIENT NEED	NURSING ACTION
Marriage	
- Most adults of all societies are married. - People may live together in other arrangements than licensed marriage. - Divorce is recognized, although with degrees of disapproval, in nearly every world society. - Feelings of frustration, loneliness, bereavement, and desertion may arise when a husband and wife are separated because of a long-term illness.	
Religion	
- Most people believe in something spiritual or sacred. - Long-term disease or disability may be a contributing factor to some people "becoming more religious" and influence others to "forsake" or question former beliefs and practices.	
Vocational Development	
- Problems might arise when youth and young adults interrupt education and career development because of long-term disability. - Vocational rehabilitation is necessary for many people with chronic disabilities. - Money is required in an industrial society to purchase the necessities and luxuries for healthful living. - Most people work to earn money. - Personal satisfaction and achievement are possible through work. - The desire for economic security is normal for an individual and family.	

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PATIENT NEED	NURSING ACTION
- Most persons who need long-term care have inadequate financial resources to pay for necessary care. - Stopping work because of a disability or because of retirement may have both psychological and economic crisis consequences for an individual and his family.	
<u>Recreation</u>	
- Play and recreation are important for personal health of people of all ages. - Creative use of leisure time contributes to positive feelings of identity and worth. - Play and recreation are socially acceptable outlets for pent-up energy. - People, well or ill, need to have fun, relax, socialize with other people, and "take one's mind off troubles."	
<u>Love</u>	
- People need love. - An individual needs to love, to cherish, and to aid others. - An individual needs to be beloved, cherished, and aided by others. - Some people are unable or unwilling to love and receive love. - Some people are unable to express hostility openly and state that they "hate." - People may face difficulties and stresses because of separation from loved ones because of long-term illness.	

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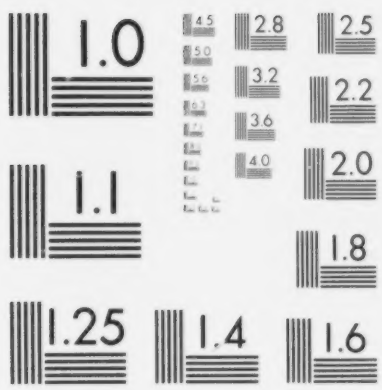

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PATIENT NEED	NURSING ACTION
Sex	
- Sex is an aspect of psychic energy present and manifested by a person throughout human life. - A sexual relationship is a dynamic and creative phase of living. - Men and women can live without sexual experiences, but their lives will lack much warmth and richness of living closely associated with love. - A long-term disease or disability may bring a person problems and stress and the feeling of being unfulfilled sexually. - People have individual rights in choosing sexual modalities.	
Water	
- Water is necessary for human life. - Fluids and water from foods supply the body with water necessary for bodily processes. - Daily fluid intake balances daily fluid output.	
Food	
- Food is necessary for life. - Carbohydrates, fats, proteins, vitamins, minerals, and water are vital nutrients. - The body needs food for energy, to build and repair tissues, and to regulate many bodily processes. - The Basic Four is a daily food plan to assure necessary amounts of food nutrients. - People have individual differences and food patterns because of cultural, religious, and traditional reasons. - Over or undereating may have nutritional and psychological significance.	

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PATIENT NEED	NURSING ACTION
<u>Elimination</u> - Elimination is necessary for life. - Urine is the waste eliminated by the urinary system; feces is the waste material eliminated by the gastrointestinal tract. - Psychological feelings of guilt and dependency may arise when the patient needs assistance with elimination.	
<u>Personal cleanliness</u> - All body surfaces harbor microorganisms and cleanliness is basic to healthful living. - People have different concepts or levels of cleanliness.	
<u>Clothing</u> - Clothing is an accepted necessity for healthful living. - People have varying ideas about nudity and modesty. - Clothing helps regulate body temperature. - Clothing is one component of good grooming.	
<u>Activity</u> - Activity is characteristic of life. - Activity depends upon proper functioning of bones and muscles and the coordination of the nervous and encodrine systems. - Rehabilitation means the restoration of the patient to his maximum physical, social, and economic capacity. - Rehabilitation begins at the <u>onset</u> of any illness or disorder. - Disability or disuse phenomena may be caused by inactivity or activity in a faulty position, or because of weakness or pain.	

PATIENT NEED	NURSING ACTION
<u>Rest and sleep</u>	
- Rest and sleep are necessary to replenish energy. - People can rest without sleeping. - Older persons do not need extensive sleep. - Sleep may be a symptom of withdrawl.	
<u>Oxygen</u>	
- Oxygen is necessary for human life. - Breathing (normal pulmonary ventilation) provides adequate oxygen for body use. - Air pollution contributes to chronic lung disease.	

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Chapter 7

COORDINATING STAFF ACTIVITIES

The LPN charge nurse coordinates staff activities for a specific tour of duty. To do this, she:

- exhibits an understanding of basic human behavior
- demonstrates fundamental leadership techniques
- uses management principles and procedures
- communicates verbally and non-verbally: listens, speaks, reads, writes, gestures effectively
- motivates staff to give skilled nursing care to all patients.

EXHIBITS AN UNDERSTANDING OF BASIC HUMAN BEHAVIOR

The whole person, including his physical, mental, emotional, social, and spiritual characteristics and needs, constitutes the realm of human behavior. Basic human behavior reflects an interaction of both hereditary and environmental influences. Hereditary factors refer to those physical and psychical (mental) traits transmitted from parents to child; they are genetically determined. Environment is the aggregate of external emotional, social and spiritual factors affecting the person.

People behave in consistent predictable ways; they also behave in unique different ways. People behave in both similar and different ways. Personality is the sum total of what is most typical and deeply characteristic about a person. Within each society there are ranges in physical and sensory characteristics, in intelligence and educational achievement, in behavior and social relationships. It is important to remember that most people behave in ways which make sense to them. A person's view of himself, his self-concept, influences greatly what he does. His previous experiences (be they good or bad) influence his perception of any new situation and this in turn influences his behavior. Behavior is influenced to a great extent by a person's basic needs and the manner and degree to which they are met.

DEMONSTRATES FUNDAMENTAL LEADERSHIP TECHNIQUES

Leadership techniques include the ability to involve people in a common effort toward a specific goal. It is fairly well accepted today that leaders are not born, nor do they possess specific personality traits. But what a leader does and how he does it are very important, that is, his leadership behavior. Many studies have examined the results of autocratic, democratic, and laissez faire styles of leadership. There is much current interest in leader and group situations in terms of achievement, affiliation, and power motivation.

In general, if you want to be an effective leader you will be flexible rather than rigid. You can choose from a range or combination of leader styles (autocratic, democratic, or laissez faire), as well as a variety of leader behaviors (tell, persuade, consult, join, or delegate). A good leader is aware of her own characteristics, needs and problems. She

also knows the characteristics, needs, and problems of her staff and unit. The leader should assess the many dimensions of the situation and then choose the appropriate style of leadership behavior. The LPN charge nurse may tell staff what they are to do. You might try to persuade staff to accept a decision you have made. Another time you may elect to consult with staff about a decision. You might join staff as "just another member" to work on a problem and reach a decision together. You might delegate a problem to staff for solution; you would define the problem and boundaries within which the problem must be solved and indicate your agreement to support the solution. Study the following examples:

TELL — Helen, would you take Mrs. Hines in 234 off the bed pan. Mary, her aid, cut her finger and is having it dressed.

PERSUADE — Fluid intake on too many of our patients is low. Please try to offer fluids at least once each hour for each patient.

CONSULT — Ethel, do you think Mr. Hargraves and Mr. Palmer would be compatible roommates?

JOIN — Let's decide together the kind of staff party we want.

DELEGATE — We want to show our appreciation to Gertrude. Her husband is being transferred and she will leave us in two weeks. Usually we spend between $5.00 and $8.00 on a gift or little party. Would you three ladies plan something appropriate?

As an effective leader, you must be honest in dealing with your staff; let them know how much influence they have and how you will use your authority. Sometimes in an attempt to be democratic or fair, it may be tempting to avoid responsibility by involving others in decision-making in which the responsibility is clearly that of yours. Do not try to avoid responsibility by the simple expedient of involving others in a decision. Allow staff to participate in decision-making whenever it is feasible; but make necessary decisions yourself when the situation requires this.

By virtue of your position as charge nurse, you are an authority figure. You are responsible for the total nursing care of every patient on the unit for a particular tour of duty. Tasks number in the hundreds. A wise leader will keep in mind both the immediate problems and tasks as well as the long-range patient care goals and unit objectives. Whatever your individual style of leadership or the particular behavior you select, person-centered leadership as over against task-centered leadership usually proves most effective for everyone involved.

USES MANAGEMENT PRINCIPLES AND PROCEDURES

Patient care is a group effort the the LPN charge nurse is the leader of the group. The effective charge nurse will implement a variety of management principles and procedures. Management principles and procedures include the ability to plan, coordinate, guide, and evaluate the activities of others.

The effective charge nurse will view her unit as an organism not a machine. The unit is a living, flexible, changing, complex network of relationships among people who are trying to achieve individual and group goals. The wise charge nurse involves staff in as many decision-making situations as possible especially decisions which they will implement. She strives to establish mutual confidence as the basis for cooperation rather than an authoritarian-obedience basis. Whenever possible the charge nurse relates to staff in a face-to-face manner. Person-centered leadership as over against task-centered leadership is more effective in meeting personal and group goals.

A good charge nurse strives to establish a two-way flow of communication; "feedback" opportunities should be many. The nurse works with her staff to develop unit objectives and individual nursing care plans so that patient care standards can be relevant to staff tasks. The charge nurse develops a collaborative relationship with supervisors, peers, and subordinates.

As a leader the charge nurse tries to increase her own awareness of personal behavior and its effect on others. She examines her own attitudes and assumptions as they affect job performance and relationships. She strives ever to increase her knowledge of staff as individuals, a group, and a unit. She tries to increase her skill in diagnosing human situations, that is, just what is going on. She tries to increase her own understanding and skill relative to change and the process of change. She strives to create a unit in which individuals may obtain optimum personal and work satisfaction and unit objectives may be achieved:

The effective charge nurse tries to maintain face-to-face work groups at all levels. She involves people together to solve problems and face issues. She is aware of individual, group and unit needs. She works to establish and maintain a supportive communications climate. Whenever possible staff are involved in decision-making that affects group norms and goals. The charge nurse fosters individual initiative through group cohesion. She is flexible in establishing group goals and procedures.

COMMUNICATES VERBALLY AND NON-VERBALLY

Good communication means that persons concerned with communication understand what each is trying to communicate. It in no way guarantees that people will do what we want them to do, believe what we want them to believe. We can understand perfectly well the position of another person and still refuse to do what the communication attempts to get us to do. What you mean to say, what you actually say, and what the other person hears may differ. In general, however, realistic understanding and effective increase where there is clear communication.

Communication is the way one person conveys, imparts, or shares feelings, acts, and thoughts with another person. Communication is a fusion of impressions and expressions. An impression is what the person takes in. Listening and reading may be considered the intake or impressions. An expression is what the person gives out. Acting, speaking, and writing are output or expressions.

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The LPN charge nurse communicates with the patient, his family and visitors. She may ascertain an important subjective symptom, reassure a crying child, teach an older gentleman how to clean his dentures properly, chat about the mid-east crisis, or listen while a lady prays.

Because patient care is shared by many people round-the-clock, communication between the LPN charge nurse and other members of the health team is vital. She must be able to follow and implement written and oral directions from the physician. Through "report," "rounds," team conferences and patient care assignments she communicates with the nursing staff. The patient's medical record is an example of a very important written form of communication. The ability of the LPN charge nurse to report and record in an accurate and meaningful manner is an important function.

Communication with the patient and about the patient is one of the most necessary aspects of modern health care.

LISTENING

Purposeful, interpretive "hearing" is listening. Listening conveys feelings, facts, and thoughts from one person to another. Hearing is mere recognition of sounds; listening is reaction to and interpretation of significant sounds. A person learns to listen, but he also listens to learn. Listening therefore is active, not passive. It is purposeful and very basic for learning. A person listens to acquire information and to see the relationships among ideas. Listening brings pure auditory pleasure; it lets one appreciate the moods, the meanings, the humor, and the pathos of another individual. Never be too busy or too lazy to listen properly. A patient may confide in the housekeeper simply because she took the time to listen to him attentively. Suggestions for effective listening include the following:

1. Listen for a purpose.
2. Be attentive and courteous:
   - look at the speaker
   - give the speaker your attention
   - respect the speaker's opinions.
3. Think critically while listening:
   - recall
   - analyze
   - comment
   - question.
4. Appreciate and enjoy what you hear.
5. Discriminate fact from fancy; recognize "propaganda."
6. Evaluate the worth of what was said.

READING

Recognition, comprehension, and interpretation of written symbols are reading. Reading conveys feelings, facts, and thoughts from one person to another. Reading is a necessary communication medium for the LPN charge nurse. Written orders and directives about the patient must be read with interest, perveived accurately, understood correctly, and

interpreted therapeutically. Through the printed word, the nurse as well as the patient gains pleasure and emotional satisfaction as they learn more about the physical world, other lands and cultures. Through reading a person gains further understanding of self and is able to extend and develop special interests. Suggestions for effective reading include the following:

1. Identify the purpose of written communication.
2. Perceive and study the words.
3. Understand and comprehend phrases, sentences, ideas, and the theme.
4. Interpret the meaning of written communication:
   - recognize relationships of purpose, ideas, and viewpoint
   - recognize emotions, motive, mood, and tone
   - develop a sensory image
   - relate to personal experience
   - make judgments and draw conclusions.

ACTING

Communicating by gestures, facial expression, and touch is acting. Acting conveys feelings and emotions from one person to another. The newborn infant communicates as he reacts with his whole body. He cries to express discomforts and demands, and he quiets down from fussing when his needs are met. Reflex activity is acting or communication. Overt and covert gestures are ways children and adults communicate. Facial expression, with or without language, is a powerful mode of communication. Touching is communicating. Recently, many articles and books have appeared about body language. Suggestions for effective "acting" include the following:

1. Gesture in a free, natural manner.
2. Parallel conversation with appropriate facial expression.
3. Handle the patient in a gentle, confident manner.

SPEAKING

A system of vocal symbols or sounds is speaking. Speaking conveys feelings, facts, and thoughts from one person to another. Language is a system of vocal symbols or sounds. A meaning exists for each sound or combination of sounds in a particular language. Language is a means of communication, a source of pleasure, and an outlet for emotions. The infant makes a few throaty sounds; he learns to babble, coo, gurgle, chortle, and eventually to speak. Speech is very important in the total development of the child. The ability to make friends, to acquire a sense of security, and to instill self-respect and mutual respect is, to a considerable extent, dependent upon a child's ability to speak easily and well. Language is important in maintaining good mental health in the adult. Speaking is a key communication medium. The saying "It's not so much what you say but how you said it," is very true. Practice the following variations in voice flexibility with the single word "Oh."

Say	with	to express
Oh-h-h-h	rising inflection	surprise or excitement
Oh-h-h-h	falling inflection	disappointment
Oh-h-h-h	no inflection	boredom

Study the following examples of variation in voice stress:

DID Mr. Harris refuse his shower?
(Meaning - I am surprised that he refused.)

Did MR. HARRIS refuse his shower?
(Meaning - Are you sure it was Mr. Harris?)

Did Mr. Harris REFUSE his shower?
(Meaning - Are you sure he refused? Perhaps he misunderstood.)

Did Mr. Harris refuse his SHOWER?
(Meaning - Are you sure it was his shower he refused?)

Conversing, discussing, interviewing, and reporting are the forms of speaking most frequently practiced by the LPN charge nurse with the patient and staff. Friendly, spontaneous expression is conversation; the charge nurse visits with the patient about his grandchildren. In a discussion, remarks center around a topic, and all contributing comments bear upon the subject; the charge nurse shares observations about the patient at the 10:30 A.M. team conference. When the charge nurse admits a new patient to the unit, she asks certain preplanned questions, she listens attentively; this is a form of interview. Giving information in an accurate, brief, clear manner is reporting; the LPN charge nurse reports to the nursing supervisor that George Armstrong, Bed 2, Room 364 has a blood pressure of 80/40 at 2:00 P.M.; bleeding from the rectal area is increasing. Effective oral communication - conversing, discussion, interviewing, and reporting - is a requisite for the LPN charge nurse. Suggestions for good speaking include the following:

1. Converse and discuss in a spontaneous, firendly, poised, self-confident manner.
2. Practice social courtesies when speaking:
   - listen attentively to others
   - wait until another has finished before beginning to speak
   - refrain from conversing when someone is talking to a group
   - respect private conversations of others.
3. Interview in a planned, orderly, sequential manner.
4. Report information in an accurate, brief, clear manner: who, what, when, where, why.
5. Enunciate clearly and pronounce words correctly:
   - use speech organs properly - lips, teeth, tongue, jaw, nose, roof of mouth, and larynx - to produce clear sounds
   - maintain good posture, deep breathing, and slow steady exhalation
   - learn standard acceptable English
   - produce vowel and consonant sounds properly and clearly
   - practice acceptable pronunciation of words; use a dictionary
   - recognize differences in volume
   - achieve vocal flexibility through variations in stress, pitch, inflection, and rate.

WRITING

Formation and placement of word symbols on paper constitute writing. Writing conveys feelings, facts, and thoughts from one person to another. Writing is a necessary communication medium for the LPN charge nurse. The

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patient's medical record or chart is a written, legal record of the history and progress of the patient. The medical record is utilized by the institution for therapeutic, education, research, and administrative purposes. The LPN charge nurse communicates to others through various tour of duty and special written reports. Observing precedes all recording, and reporting frequently accompanies it. Written communication must be accurate, brief, and clear. Accuracy means factual evidence, understanding, and interpretation of observations. Brevity means presentation of essential ideas only and omission of unnecessary details, using as few words as possible. Clarity means presentation of all important ideas in a complete, sequential, legible manner. Many institutions request that nurses print. All entries on the medical record and written reports should be in ink; erasing is not permitted. Letters should be consistent in size, slant, spacing, and formation. The LPN charge nurse signs for each entry, her name and title. Suggestions for effective writing include the following:

1. Understand the function of words and phrases.
2. Identify subject and predicate of simple sentences.
3. Recognize and compose declarative, interrogative, imperative, and exclamatory sentences.
4. Spell words correctly - both ordinary words and medical terms.
5. Capitalize and punctuate correctly.
6. Print or write legibly.
7. Strive continuously to improve content and mechanics of written communication.

MOTIVATES STAFF TO GIVE SKILLED NURSING CARE TO ALL PATIENTS

The LPN charge nurse is responsible for staff effectiveness, because in large part, it is through her staff that she nurses her patients. Because she is in a leadership role, she is also responsible for guiding her staff toward personal and group satisfaction and achievement in their work.

First, the LPN charge nurse motivates her staff to give skilled nursing care to all patients through example. She is a good nurse. Second, she communicates to her staff the belief that skilled nursing care makes a difference - a difference for the patient and his family, a difference for the individual staff member, as well as a difference for the unit and total institution. Third, the LPN charge nurse "helps staff help themselves" establish and meet patient care and job satisfaction goals.

STUDY ACTIVITIES

1. Describe your own personality.

2. Describe the personality of a "subordinate," for example, a nurses' aide.

3. Describe the personality of a "superior," for example, the director of nursing or the administrator.

4. Describe a ward situation in which you would TELL a nurses' aide what to do. Why did you choose this kind of leadership behavior?

5. Describe a ward situation in which you would PERSUADE a nurses' aide to accept a decision you have already made. Why did you choose this kind of leadership behavior?

6. Describe a ward situation in which you would CONSULT with a nurses' aide about a problem. Why did you choose this kind of leadership behavior?

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7. Describe a ward situation in which you would JOIN your staff and work on a problem and reach a solution together. Why did you choose this kind of leadership behavior?

8. Describe a patient care situation in which you would DELEGATE a responsibility to a nurses' aide. Why did you choose this kind of leadership behavior?

9. In what ways do you communicate <u>most</u> effectively? Why?

10. In what ways do you communicate <u>least</u> effectively? Why? How can you change this?

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11. The LPN charge nurse motivates staff to give skilled nursing care to all patients. Try out the following goal setting exercise on yourself and adapt it for use with staff.

    a. Identify patient care and/or job satisfaction goals that are important to you. Describe as clearly as possible (3) three patient care and/or job satisfaction goals that are meaningful to you and give the dates when you expect to reach them. These goals may be nursing, career, personal, ward, or institution goals. Don't just dream them up. They should be real goals or ambitions that you have.

    (i) My first goal is

    I intend to reach it by

    (ii) My second goal is

    I intend to reach it by

    (iii) My third goal is

    I intend to reach it by

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b. Team up with a colleague and discuss the goals you have set. Ask and answer the following questions.

(i) The Need: How important is this goal to you? What will it mean in your life?

(ii) Activity: What things are you presently doing to achieve this goal? What things are you planning to do in the near future to achieve it, i.e. three to six months?

(iii) Anticipation of Success: How confident are you of reaching this goal? Why? What will you do after you have achieved it?

(iv) Anticipation of Failure: What are the possibilities of your failing to reach this goal? If you do fail, what will you do next?

(v) Personal Blocks: What hang-ups in your own personality or "self" could keep you from reaching your goal. How do you plan to overcome them?

(vi) Environmental Blocks: What situations or circumstances exist in the "world" (the ward and the institution) that could hinder you in reaching these goals? How do you plan to overcome them?

(vii) Help: What other people (in the ward or institution) or or things will you use to help you achieve your goals? How will you use them?

c. Restate your first goal.

(i) My first goal is

I intend to reach it by

d. Plan the action steps to achieve this goal. These steps should should be specific steps that you actually intend to take. For each action step, you should include how it will be measured, a date on which you will review your progress, and the final accompoishment date. (See next page.)

PLANNING ACTION STEPS TO REACH FIRST GOAL

Action Steps To Be Taken	How I Will Measure My Progress	Specific Dates For Progress Review	Specific Accomplishment Dates

e. List what you believe are personal strengths that could help you reach your first goal.

Personal Strength	How I Can Use This Strength To Reach My Goal
1.	
2.	
3.	
4.	
5.	

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g. List environmental or world obstacles (the ward or institution) that might keep you from reaching your first goal. (For example, staff turnover is high; employees seem concerned with salary only.)

World Obstacle	What I Can Do About It (Do I Need Help?)
1.	
2.	
3.	
4.	
5.	

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h. Review your goal-setting achievement plan individually or with a colleague. Ask and answer the following questions.

(i) Is the goal specific, measurable, and time-phased?

(ii) Is the goal realistic and attainable, or am I just doing some wishful thinking? What results do I expect?

(iii) Is the action plan too general? How will it be tested?

(iv) Are the dates realistic for the goal and action steps?

(v) Are there any strengths that I have not planned to use for attaining this goal?

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(vi) Are there any obstacles or blocks which I have not anticipated?

(vii) When is the first progress review? How will information be gathered for this review?

(viii) Will I be able to take the action steps?

(ix) Do I really want to?

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Chapter 8

IMPLEMENTING PATIENT CARE

The LPN charge nurse implements patient care for a specific tour of duty. To do this, she:

- develops plans to meet on-going needs of all patients
- develops plans for common types of emergency situations
- assigns personnel in terms of patient needs and staff proficiencies
- helps staff care for patients with special needs, the patient with mental illness, the dying patient
- coordinates work with that of other departments such as dietary, housekeeping, physical and occupational therapy, social service
- seeks guidance and assistance when problems are beyond scope
- prepares and gives verbal and written reports about patients: conferences, nurses' notes, tour of duty and special reports.

DEVELOPS PLANS TO MEET ON-GOING NEEDS OF ALL PATIENTS

A plan is an organized way to try to do something well. For example, ward plans or routines are guides to help staff give the best nursing care possible in the existing facilities with the present personnel.

Every health care institution has policies and procedures that govern and guide its operation. Every ward has a policy manual and/or nursing procedure book. These are plans to help meet the on-going needs of all patients in the most effective, efficient way. These policies or procedures relate to patient care in general as well as such events as admission, transfer, discharge, and death. Policies guide relationships with physicians, the laboratory, the kitchen, social service, the maintenance department, the laundry, the pharmacy, and administration.

The LPN charge nurse utilizes plans or routine ways of doing things when she requisitions a diet, orders drugs, or requests laboratory work. Routine plans are helpful in ordering linen and maintaining necessary equipment and supplies. Tour of duty reports, the narcotic record, interdepartment and interagency correspondence are examples of plans or routines. Plans are used to work out weekly staff assignments, vacation time, coffee breaks and meal time. Plans and routines have been developed for emergency situations. The patient's medical record is a planned or routine way to record observations in an efficient, meaningful way.

Plans and routines are most useful when they are developed by the people or groups who will implement them. Plans are less effective when they are superimposed down on a group from administration. Every plan or routine should be clear in terms of goal (purpose) and approach (action). Plans and routines should be reviewed periodically to assure currency. Written plans and routines facilitate accessibility by the entire staff at all times. Misunderstandings and misinterpretations of intentions are fewer when plans are written.

DEVELOPS PLANS FOR COMMON TYPES OF EMERGENCY SITUATIONS

Emergency or disaster situations may occur on an individual or mass basis. Shock, hemorrhage, or acute respiratory distress are individual emergency situations requiring immediate lifesaving measures. Fires, explosions, storms, earthquakes, as well as thermonuclear attacks, are mass disaster situations. In general, all patients are in dependent situations - dependent on staff for assistance. Plans for common individual and mass emergency situations are required for licensure of any institution for patient care. For example, Conditions of Participation; Extended Care Facilities requires the following:

> 405.1136 Condition of Participation - Disaster Plan. - The extended care facility has a written procedures to be followed in case of fire or other disaster.
>
> (a) Standard; Disaster Plan. - The facility has a written procedures to be followed in case of fire, explosion or other emergency. It specifies persons to be notified, locations of alarm signals and fire extinguishers, evacuation routes, procedures for evacuating helpless patients, frequency of fire drills, and assignment of specific tasks and responsibilities to personnel of each shift.
>
> (b) The factors explaining the standard are as follows: (1) The plan is developed with the assistance of qualified fire and safety experts. (2) All personnel are trained to perform assigned tasks. (3) Simulated drills testing the effectiveness of the plan are conducted on each shift at least three times a year. (4) The plan is posted throughout the facility.

The Red Cross First Aid Course or the Medical Self-help Course is included in the curricula of some practical/vocational nursing programs. First Aid is the immediate and temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained; it may save the life of the individual, or a group of people; it fosters safety consciousness. Medical Self-help is a program to prepare a person to maintain health and alleviate suffering during any period of disaster when professional care and normal services might not be available. If you did not receive either course as a student, please enroll in a class as a post-graduate. You might suggest that such a class become an inservice activity at the institution for other nurses and aides. A local vocational school or college might offer the course as part of its continuing education or adult education program if it knows the need exists.

The LPN charge nurse constantly reminds her staff of the accident-prone nature of older people and persons who are handicapped. Preventing an accident or emergency is always best. The charge nurse practices safety consciousness in terms of ward environment; she notes spilled water, side rails that are down, litter. She assumes responsibility for a safe and confortable environment for patients and staff; this includes general cleanliness, lighting, storage, noise air control, odor, and insects.

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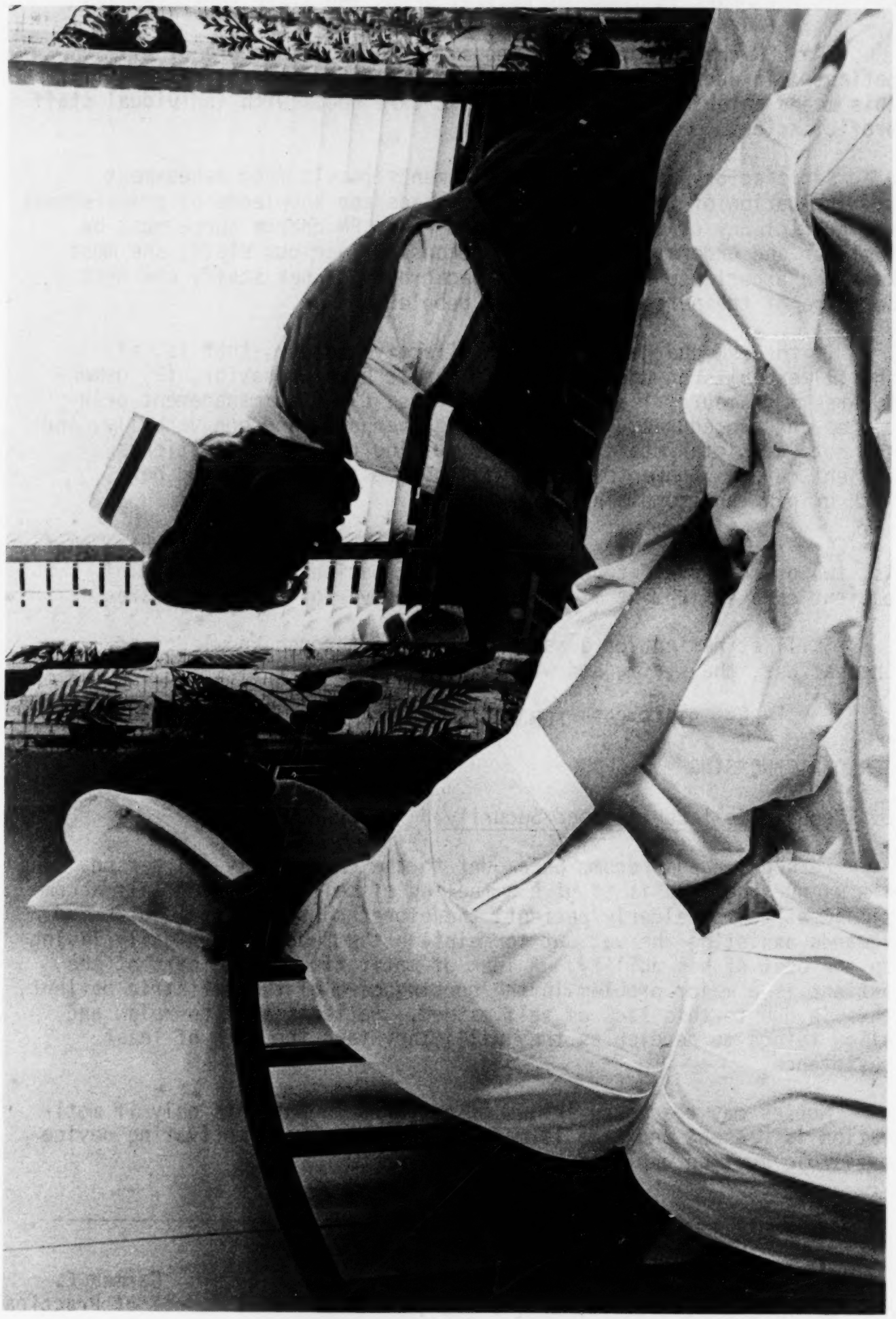

Figure 8-1. Implementing patient care.

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ASSIGNS PERSONNEL IN TERMS OF PATIENT NEEDS AND STAFF PROFICIENCIES

The LPN charge nurse is responsible for nursing care of all patients; in addition, she coordinates the activities of all staff. This means matching individual patient care needs with individual staff proficiencies.

Satisfactory patient care assignments result from assessment and evaluation of individual patient needs and knowledge of preparedness and proficiency of each staff member. The LPN charge nurse must be familiar and understand job descriptions for various staff; she must know the experience and education background of her staff; she must be aware of the personality of her people.

If the LPN charge nurse is an effective leader, that is, if she (1) exhibits an understanding of basic human behavior, (2) demonstrates fundamental leadership techniques, (3) uses management principles and procedures, (4) communicates verbally and non-verbally, and (5) motivates staff to give skilled nursing care to all patients, patient care assignments rarely will be questioned. Behind her back griping and complaints will be few.

Sometimes the charge nurse may utilize multiple assignments, that is, two or more staff to care for certain patients. This kind of patient care assignment might prove effective for difficult cares.

Skill at patient care assignment comes through knowledge of the patient, the staff, and with experience.

HELPS STAFF CARE FOR PATIENTS WITH SPECIAL NEEDS

GERIATRIC NURSING[1]

I. Adequate Self-Concept and Security:

Personal needs become paramount to the chronically ill person. The aim of nursing care is to give a feeling of self esteem and self accomplishment to the elderly patient, therefore, nursing care is directed towards assisting the patient to maintain the functions of daily living to the best of his ability. A lack of motivation on the part of the patient is a major problem in the nursing care of the geriatric patient, this is due to this lack of self esteem. Patients tend to relax and allow things to develop as they will; they take the path of least residtance.

Nurses may teach new skills or patterns to patients only if motivation is present and time is made available. Every motivating device available must be employed.

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[1] This section, Geriatric Nursing, was prepared by Mrs. Carmen F. Ross, R.N., M.A., Director of the Mount Sinai Hospital School of Practical Nursing in Miami Beach, Florida. The LPN charge nurse curriculum was field tested at this school; Mrs. Ross served as project director and main instructor.

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1. Praise and recognition
2. Keep material in the context of the familiar as much as possible, relate new learning to old
3. Provide time, never appear to push
4. Help the learner to understand the task
5. Keep the stimulus and response together when demonstrating or explaining.

The nurse must consider the loss of speed and the need for motivation. The greatest difficulty comes in attempting to organize old familiar material in new and strange ways. Memory deteriorates and new material is readily lost while old material is retained. The patient develops rigidity of thinking and follows patterns even if he knows they are not working. This major difficulty in altering patterns results in failure of logical thinking. The individual retreats into extraneous discussion when faced with difficult problems.

The current level of functioning is relative to the original peak of earlier functioning. If familiar tasks are maintained and exercised, these skills will remain - hence the emphasis upon activities of daily living. The greater his ability to care for himself the greater the self esteem of the elderly patient.

Problems in motivation arise because the elderly person has lived longer and has some actual loss of capacity to function, and also because he has lost many of his peer group and persons who were important and close to him, they are no longer living or within close contact go give meaning to his life. At times he does not always accept his differences from other age groups.

There is a general slowing down of responses based on slowness of decision as to how to respond, especially in complex and unfamiliar tasks. The stimuli come too rapidly or in irregular fashion, with a result of jerky, piecemeal performance, due to an overlap of activity with the previous response. The nurse should try to structure the situation for the older adult so his central nervous system will have time to make the appropriate response. Instructions should be presented slowly, using rhythmic stimuli - avoiding hurried, confused or emotion-laden orders.

To maintain feelings of self worth, call the patient by his or her preferred name rather than "Grandma," etc. Give explanations to patients. Avoid opportunity for your patient to make mistakes, anticipate his needs, thereby preventing him from constantly asking for service which tends to increasingly point up his limitations. Recognize that creativity and productiveness are still the right of old age - provide opportunity for the elderly to be engaged in growing things and creative experiences.

II. Stress and Adjustment:

Adjustment is related to earlier behavior. Stress is associated with a loss of life enjoyment, loss of feelings of self confidence and usefulness, a general loss of zest and a loss of resiliency. Stress of any kind yields increased anxiety, recovery is usually slower. Anxiety is demonstrated by the magnifying of normal aches and pains producing a hypochrondriasis with

excessive attention to digestive and eliminative functioning and exaggerated reports of sleeplessness. Psychiatry offers an approach to stress in the elderly by focusing upon recognition of the patient's patterns of dealing with stress - determined by his constitutional makeup, his temperament, biologic hereditary makeup, organic assets and deficits, his environment, emotional motivation and dynamics.

While youth is normally optimistic and looks forward, age recognizes failings and tends to look backward. All patients regress during periods of stress or illness, elderly patients more so. The nurse's role in anxiety is to:

1. Focus the energy from anxiety into useful channels of activity and purpose to alleviate stress
2. To identify the cause of externally produced anxiety and lessen these if possible
3. To recognize clues to the patient's buildup of anxiety and his patterns of response
4. Supply thereness of the nurse in period of extreme panic and stress
5. Supply focus of disturbing hostility.

It becomes increasingly difficult to adjust to the lack of emotional resources. The tranquilizing drugs are useful as a supportive measure to control anger, frustration and upheaval. It is helpful to a patient's security if he can remain in familiar surroundings. Drugs are not a cure, but a supportive measure. In unfamiliar surroundings a patient is often deserted by those meaningful to him and feels surrounded by disinterested strangers.

Needs as seen by the elderly patient include:

1. Good health - a chance for a variety of experiences
2. Place to live and enough money to live comfortably
3. Recognition by others - a chance for participation with others.

III. Activities of Daily Living

In the very elderly and incapacitated patient it is extremely difficult sometimes to find ways of maintaining hope and purpose in the patient's life. But without hope and purpose one only exists, he does not truly live. In our efforts to help such patients we must avoid the extremes of doing too much and of doing too little. A variety of interests and projects that occupy the hands or the minds can be offered, but the nurse's activities should be aimed at motivating the patient toward appropriate activities of daily living and self-care.

A. Maintenance of Motor Skills:

Before any maintenance regime can be instigated, the nurse must first evaluate the patient's condition and identify the physical limitations if there are any. The extent to which any individual can perform day-to-day actions (ADL) is a good indication of his capacities. This should include the walking and non-walking activities such as, being able to sit alone in bed, roll from side to side, and the daily routines such as feeding himself, brushing teeth, combing hair, etc.

If this evaluation of the patient is to be of value, it must occur during each contact with the patient, not just during the initial nursing care given. The nurse must prevent further physical limitations, while attempting to correct those already present. Daily observation is the key here. This is a nursing responsibility to be sure that the auxilliary personnel know what they are doing and what factors must be included in their daily patient observations.

Protective positions to help keep the bed patient in good alignment:

Unless medical orders specify the restriction of motion of certain body areas, bed patients can be prevented from developing physical limitations by a variety of positions.

The protective back-lying (supine) position:

In the back-lying position, the two areas of the body that need particular attention are the feet and the neck. The greatest danger to the feet occurs when they are not held in the dorsal flexion position. The toes drop downward, the feet are in plantar flexion. If this occurs for extended periods of time, the complication of drop foot occurs. During the time the patient is in bed, pillows are always used to support the head. Caution should be used here to prevent flexion of the cervical spine. Both thorax and neck must be supported as well.

Suggested Action	Complications to be Prevented
- Provide a firm supportive mattress	- Exaggerated curvatures of the spine and flexion of the hips
- Use a bed board if necessary	
- Place pillow under upper shoulder, the neck and the head so that the head and neck are held in the correct position	- Flexion contractures of the neck
- Place pillows or arm supports under the forearms so that the upper arms are alongside the body and the forearms are pronated slightly	- Internal rotation of the shoulder and extension of the elbows
- Make hand rolls or use small towels for hands to grasp. If paralyzed, use thumb guides to hold the thumbs in adducted position	- Extension of the fingers and abduction of the thumbs (claw-hand deformation)
- Place sand bags along the hips and upper thighs	- External rotation of the femur
- Place small soft roll on sponge rubber under the knee, sufficient to fill the popliteal space but not to create pressure, and not to exceed 5 degree flexion	- Hypertension of the knees
- Use a foot block or make an improvised firm foot support to hold the feet in dorsal flexion	- Plantar flexion

The protective side-lying position:

This is a welcome relief from prolonged periods of lying on the back. Turning to the side rests certain muscle groups and brings others into use.

Suggested Action	Complications to be Prevented
- Place a pillow under the head and the neck	- Lateral flexion of the neck
- Place a pillow under the upper arm	- Inward rotation of the arm and interference with respiration
- Provide a hand roll for the fingers and thumbs	- Extension of the fingers and abduction of the thumbs
- Use one or two pillows as needed to support the leg from groin to the foot	- Internal rotation and adduction of the femur

The protective face-lying (supine) position:

Lying on the abdomen, face down, can be a valuable and relaxing position if the patient is comfortable in this position and enjoys it. The feet are the only area of real concern. Unless supported or allowed to go over the end of the mattress, they are forced into plantar flexion and the legs rotate inward or outward.

Suggested Action	Complications to be Prevented
- Move patient down in bed so that his feet are over the mattress; or support his lower legs on a pillow just high enough to keep the toes from touching the bed	- Plantar flexion
- Place sponge rubber pads under shoulders	- Forward hunching of the shoulders
- Place small pillow under the head	- Flexion of the cervical spine
- Place a small pillow or some other suitable support under the patient between the end of the rib cage and the upper abdomen if this facilitates breathing and there is a definite space there	- Hyper-extension of the spine; impaired respiration

Protective exercises for the bed patient:

When routine activity is omitted for several days or longer, it is more difficult for the muscles to resume their former task. Therefore efforts to assist patients to maintain good muscle tone must begin with the first day of confinement to bed. This must be continued on a regular daily basis. Maximum range of motion must be included:

Trunk:	Hyper-extension Flexion Extension	Head:	Flexion Extension Hyper-extension
Legs:	Outward rotation Inward rotation	Feet:	Dorsal flexion Plantar flexion

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Arms: Flexion
Extension
Hyper-extension
Adduction
Abduction

These exercises must be done regularly to prevent the formation of contractures.

Getting the patient out of bed:

Remember that there is a loss of back strength in your older patients. Hand strength is retained, so let the patient help you assist him. Give your directions clearly and slowly, allowing the patient to respond to one direction at a time. See that his clothing is comfortable yet without dangling belts or strings that will catch on the furniture. The patient's shoes and slippers must provide the needed support without being heavy or cumbersome.

Sleep patterns:

Older patients usually change their sleeping habits. They must avoid fatigue and find the need for more frequent rest periods during the day. They are easily distracted by noise or bright lights, and they sleep intermittently throughout the night. If this is not too distressing to the patient, don't worry about it. The patient's not sleeping seems to distress the nurse more than it does the patient.

B. Nutrition and Oral Hygiene:

Nutrition is more than diet. Proper nutrition includes not only ingestion of adequate and balanced quantities of all necessary nutritive elements but also digestion of foods, their absorption, transport to the tissues and utilization by the cells. Impairment of cellular nutrition may result from any one or more of several factors:

1. inadequate nutritional supply (such as dietary deficiencies, digestive failure, oxygen lack due to anemia)
2. inefficient distribution (circulatory impairments)
3. ineffective utilization of food elements (hypoinsulinism, asphyxia, enzyme deficiencies)
4. accumulation of injurious metabolic debris (such as azotemia, uric acid deposition)

The rate of metabolism diminishes in man with the process of aging. This therefore affects nutrition in several ways. There must be a reduction in caloric requirements and in some cases eating habits must be altered. Habits are probably one of the greatest obstacles in the path toward obtaining an optimum diet by the majority of persons. Habits of eating play a most significant role in nutritional problems. Habits may last longer than life itself, for they may be transmitted from one generation to the next. The longer habits have been indulged in, the more rigidly they become fixed.

Water: The total intake of beverage fluids should be such that the 24-hour urinary volume is a minimum of 1500 ml. In hot weather this may mean fluid intake of 3 Liters or more, but in ordinary cool weather, with moderate activity, an intake of 2 Liters is optimal. In the older person it may be desirable to space the fluid intake. Small amounts at relatively frequent intervals rather than large quantities at one time. Water is vital, not only for urinary excretion but to avoid constipation and assist the weakened digestive process.

Calcium: With advancing age it becomes more difficult to maintain a positive calcium balance. Loss of calcium from bone leads to osteoporosis and serious fragility responsible for fractures, therefore the dietary calcium requirements of older persons will be much higher.

Protein: The elderly are prone to suffer from protein starvation more than other forms of deficiency. Insufficient protein is a significant factor in the pathogenesis of tissue wastage, anemia, bone atrophy and edema. Mild deficiencies may be manifested primarily by a sense of habitual fatigue. Unfortunately, the majority of older persons dislike or resent the precription of milk. Milk is not only a valuable source of protein but a major source of calcium. Skim milk may be preferable to whole milk if one wants to avoid the increased fat intake. Other significant sources of protein are cheese and lean meats. The requirements of the older person are similar to those of a younger person, 1 Gram of protein per Kilogram of body weight per day.

Care of the Mouth and Teeth: General good health is as essential as cleanliness for maintaining a healthy mouth and teeth. Frequent cleansing of the mouth and the teeth aids in reducing dental caries.

Toothbrushing: It has been shown that bacteria in the mouth react with food particles to form an acid which predisposes to dental caries. Therefore, frequent cleansing of the teeth and mouth is a requisite for maintaining a healthy mouth and teeth. After using the toothbrush, the mouth should be rinsed thoroughly with clear water. Mouth washes may be used but never in lieu of the toothbrush. The toothbrush must be small enough to reach all teeth. If food is wedged between the teeth, dental floss may be used, provided care is taken so as not to injure the gums.

Dentures: The removable type are removed and cleaned with a brush, after each meal. Denture brushes are helpful but not necessary if only a regular brush is available. Some dentists recommend that removable dentures remain in place except for cleaning. If the patient has been instructed to remove his dentures while sleeping, a disposable denture cup is convenient and easy to use. Keeping dentures out for long periods permits the gum lines to change, thus affecting the fit of the dentures.

C. Bathing and Skin Care:

The skin of older patients is thin, delicate and very sensitive to trauma and pressure. The loss of subcutaneous fat leads to wrinkling and sagging, sweat glands atrophy and the general excretory function of the skin is decreased.

Bath: Daily bathing is unnecessary, in fact, may be harmful if too frequent. For the incontinent, a tub bath or thorough cleaning of the

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anterior and posterior pelvic region is sufficient. Use a mild soap and be sure that the skin is rinsed free of soap after cleansing. Avoid alcohol rubs or the use of any scented lotion or cream that may contain alcohol. Bathing should be followed by the application of lanolin or emollient creams which are gently massaged into the skin. Particular attention should be given to bony prominences and weight bearing areas. Powders may be used but sparingly. Avoid application in the body creases, to prevent caking or irritation.

Care of the Nails: Both toe and finger nail care is extremely important. Because of limitation in peripheral circulation, the nails become hard and thick. Before any specific care is given, the feet and the finger nails must be soaked in a mild soap solution to soften and make cutting of the nails and care of the cuticle easier. Nails should be cut straight across and the sharp edges smoothed with an emery board or nail file.

Care of the Hair: The hair becomes thin, dry and lifeless because of the diminished blood supply to the scalp. Daily massage to the scalp followed by brushing with a soft bristled brush will help to maintain the body and texture of the hair. Lanolin cream in small amounts, along with oil treatments preceding shampoo may also be given. Frequent shampoos are to be avoided because of the already decreased supply of natural oils. Attention should be given to the type of shampoo selected. Avoid the use of harsh soaps or shampoos which contain even a minimum amount of alcohol. The hair style should be designed to suit the desires of the patient. A simple style can be both comfortable and attractive. The distribution and quality of hair changes with age. The axillary and pubic areas become fine and scanty while the eyebrows become coarse and bristley. Hair on the face, particularly chin and upper lip area can cause distress. Shaving the area or using a pumice followed by the application of a cream will prevent drying. Plucking hair from the chin may be necessary. Do not pluck hair from a mole or other growth; just cut close to the skin surface as necessary.

D. Bladder and Bowel Control:

Patients tend to worry about bowel function, tending to forget that with less food intake (which is common in elderly patients) and lessened activity there is less bowel function. Regularity of going to the toilet is a helpful stimulus. Mild cathartics are useful. Lack of attention to signals leads to constipation. Attention to diet is necessary.

Frequent micturition - night frequency - is an early sign of kidney function impairment. Retention of urine and mild infection may be due to decreased muscle tone of the bladder. Observe for distention. Most elderly females complain of a troublesome discharge and may have a mild infection. A mild douche may be ordered.

The condition of incontinence causes embarrassment and discomfort to the conscious patient and leads to skin irritation and decubiti ulcers. The causes are: disorders of the central nervous system pathways, loss of conscious control of bladder and bowel, spinal cord damage, loss of

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bladder and bowel reflex action, actual tissue damage of bowel and bladder - sphincters or supportive tissue. Control is based upon normal voluntary and involuntary muscular action coordinated by normal urethra-bladder reflex.

Between voiding the bladder outlet is elevated by contracture of the levator ani muscle in the perineum and the muscular walls of the bladder relax. As the bladder fills with urine the involuntary nerve endings at the trigone are stimulated by the weight of the urine and increased muscle tone of the bladder. The internal sphincter relaxes releasing urine into the posterior urethra. Stimulated by this, the bladder muscles contract preparatory to emptying the bladder. As involuntary stimulus occurs some charges overflow to the pudenal nerve (voluntary nerve from the sacro-spinal cord). This allows the central nervous system to send appropriate stimuli to the levator ani muscle which causes the muscle either to quickly and forcefully pull the outlet higher to prevent overflow or lower to allow outflow. If this mechanism is disturbed, incontinence results.

Frequently indwelling catheters are used to correct incontinence. There are some disadvantaged of the catheters: (1) possibility of infection, (2) loss of bladder muscle power. The catheter should be clamped and opened at intervals of 2 - 4 hours, (3) stones may form due to irritation of a foreign body.

Toilet training of the incontinent adult may be helpful. Observe the patient's normal voiding pattern and adjust accordingly. Watch for frequent small amounts of voiding. This usually indicates that the muscles are not contracting strongly enough to empty the bladder completely and the patient is voiding overflow. This may be due to pressure of a distended bowel. This can be relieved by a flatus tube or enema.

External drainage for male patients should be available. Old age may cause relazation of muscles and consequent incontinence. Most elderly males have hypertrophy of the prostate, making urination difficult. Practice in exercise of muscular control can tend to correct the relazation of the muscles, this is taught - contract abdominal, gluteal and perineal muscles while breathing normally.

E. Visual Care:

Adaptation is decreased and the visual field narrows, speed of focus is decreased. There is a great need for better lighting, light stairs, hallways, night lights at the bedside and in the bathroom areas. There is a need for special care at dusk.

Accumulation of secretions due to lower lid droop, with a decrease in conjunctival secretions which is followed by irritation and tearing occurs. These secretions should be washed from the inner to the outer canthus. Take care not to press upon the eye ball. Most persons over the age of 60 wear glasses at least for reading. Care of glasses is a major problem in nursing homes. Glasses should be clean and available at all times. If they are lost, confusion and the inability to cooperate may result.

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F. Auditory:

There is an increasing incidence of deafness within the sound range of the human voice after the age of 75 (2 men out of 10 and 1 woman out of 10 have noticeable deafness).

The nurse should check to determine if she is being accurately understood. Many patients are unaware of this disability or are unwilling to admit it. Don't rely upon the presence of a hearing aid, it may not be turned on. Any noise or voice not clearly understood is annoying to a deaf person. Speak clearly and slowly in view of the patient (for lip reading).

G. Body Perception:

Some loss of pain sensitivity is present after the age of 50. This may be dangerous as the patient may fail to report injuries that he may have suffered. There is also a loss of the sense of movement of body parts, loss of the sense of balance (due to inner ear changes). Frequent falls occur due to a lack of balance. There is a need for stair and hallway railing, tub and bathroom grips, canes and supports. These self-help devices will aid the patient's self-respect.

H. Anatomical and Physiological Changes:

Slower cell division, healing is slowed, defenses respond to infection more slowly and less effectively, loss of elasticity of connective tissue, decreased speed of response and decreased strength with increased rigidity of body structure such as the rib cage occur. There is a lessened chest expansion which leads to lung congestion. This condition causes problems following anesthesia or during conditions such as pneumonia.

The bone is rarefied, causing easy fractures. Fatty infiltration of cells and loss of elasticity of blood cells cause poor circulation which results in poor adjustment to prolonged changes in position; such as lowering of the head or prolonging standing. The blood collects in the lower extremities and it causes dizziness, fainting and falling. A lack of essential nutrients in the blood is quickly felt. These people do not tolerate a lack of food easily. Any small change in the blood pressure is more significant for the older age group. There is gradual degeneration and atrophy of the nervous system in old age, with impaired sensation. The gag reflex is less acute, causing the patient to be more prone to aspiration.

Diminished chest expansion makes it imperative that oxygen content be normal in the available air supply, fresh air is necessary but one must avoid drafts. Arthritis and fibrositis are aggravated by chills, drafts, dampness and changes in barametric readings. A decrease in adipose tissue and circulation to the small outer arteries makes it difficult to withstand chills. There is lowered skin temperature due to the lessened circulation. Clothing should be adapted to the needs of the patient. The wearing of their own clothes should be encouraged.

I. Reaction to Drugs:

As a rule the elderly patients require smaller dosages of sedatives and larger dosages of stimulants. The intramuscular drugs are slower to react due to the slowed circulation. Culumative effects of the drug may

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occur due to kidney and liver function impairment, which slows excretion of the drug from the body, especially digitalis (causing heart block), bromides, and barbiturates.

There are many satisfactions in store for the nurse who chooses geriatric nursing. All the principles involved in nursing care of the acutely and chronically ill may be needed at various times. She will need to learn well the philosophy and psychology of caring for the chronically ill and aged. She will need experience in a wide variety of nursing skills and will find there is much for her to learn as she works in this particular field of nursing. Many of the points mentioned under rehabilitation and recreation will become more meaningful and useful when applied to patients living in "homes." They will need attention to clothing, meals, recreation, and companionship there as they would in their own homes. Arrangements should be made to assure them some privacy and a homelike atmosphere. Some effort and imagination may be necessary in providing a specific place for each individual to call his own, and into which others may not trespass unless asked. A corner of a ward may be all the patient has but everyone should respect his right to call it his domain and allow him to keep there the few personal belongings he may treasure.

THE PATIENT WITH MENTAL ILLNESS

No illness afflicts the whole person more than mental illness. When a person is unable to cope with the demands of his internal desires, the realities of daily living, and the dictates of his conscience, conflict develops and a mental illness may result. Hereditary factors are responsible for some kinds of mental illness. In most cases, however, factors within the environment cause mental illness. It is most prevalent in highly industrialized nations. There are more people in hospitals with mental illness at any one time, than with all other diseases combined. Many children in the United States are mentally ill and only a very small percentage of these are receiving any kind of psychiatric treatment. Overwork, fatigue, death of a loved one, financial difficulties, home problems, dissatisfaction with work, and a sudden change of living habits, or some romantic difficult may precipitate a mental illness.

Neurosis and psychosis are the two major categories of mental illness. A neurotic reaction is a mental illness in which thinking and judgment are impaired to the degree that the individual tries to resolve the conflict in a manner that handicaps his effectiveness as a normal functioning person; loss of contact with reality is minimal in a neurotic reaction. There are the following types of neurotic reactions:

- Anxiety reaction: anxiety is the prominent feature
- Phobic reaction: pathological fear exists
- Conversion reaction: an unconscious conflict is disguised
- Dissociative reaction: certain functions or parts of the personality are detached
- Obsessive-compulsive reaction: ideas and acts recur despite their irrationality
- Depressive reaction: severe depression exists.

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A psychotic reaction is a mental disturbance in which there is loss of contact with, or serious distortion of, reality. Organic psychoses result from impaired cerebral function. Arteriosclerosis, senility, alcoholism, and neurosyphilis are common causes of organic brain syndrome; infections, toxins, and head trauma may cause organic psychoses. Functional psychoses are psychogenic in origin; that is, there is no defined physical cause, and no apparent structural changes in the brain exist. Schizophrenic reaction includes a group of reactions characterized by apathetic, silly, or unexpected emotional responses. Many types and variations of thinking defects occur. Delusions and hallucinations may be apparent. Paranoia and paranoid reaction are syndromes characterized by overuse of the mechanism of projection. A complex system of delusions exists. Affective reactions are disorders in which there is a disturbance in mood (affect). For example, the person may be depressed or elated (manic). Changes in mood occur without apparent cause and vary in degree and duration from what is considered normal.

Emotional factors are presumed to cause such conditions as peptic ulcer, essential hypertension, bronchial asthma, and ulcerative colitis. These illnesses are called psychosomatic disorders or psycho-physiological reactions.

Personality disorders are characterized by defective behavior patterns. For example, the paranoid personality is undully sensitive and suspicious. The person with an emotionally unstable personality is immature and becomes very excited and ineffective under minimal stress. Individuals with sociopathic personalities exhibit antisocial or asocial behavior. In most of the personality disorders, anxiety is minimal; however, the behavior patterns tend to be chronic.

Anxiety is a state of tension which tries to warn a person of impending danger. Anxiety is very important in the dynamics of normal and abnormal behavior. It may be the driving force behind the successful businessman. Anxiety may cause unreasonable emotional trauma, render the individual ineffective, and reduce him to a dependent state.

Anxiety has both psychic and somatic components. The anxious person perceives discomfort and feels apprehension. The anxious person may have sweating or flushing, rapid respiration, tachycardia, palpation, anorexia, nausea, vomiting, cramps, diarrhea, as well as urgency and frequency.

To deal with anxiety the person enlists certain defenses. Suppression is conscious purposeful forgetting. Repression is purposeful but unconscious forgetting. Regression is returning to a more satisfactory emotional level. Rationalization is ascribing acceptable motives to thoughts or behavior that has other motives. Projectionis attributing one's own thoughts or actions to another person or object. Introjection is turning of unacceptable tendencies against one's self. Compensation is attempting to overcome feelings of inferiority. Reaction formation is manifesting a very unacceptable or dangerous impulse in the exact opposite direction. Sublimation is diverting instinctual drives into socially acceptable behavior. Denial is conscious negating fact or reality. Identification is adopting personality characteristics of another, especially one who is admired. Isolation is separating unacceptable conscious impulses from the rest of mental content and thus rendering them harmless.

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A physician, hopefully a psychiatrist, diagnoses a mental illness following a complete medical and psychiatric examination. A team of people - psychiatrist, psychologist, social worker, occupational therapist, recreational therapist, nurse, and clergy - help the patient with a mental illness recover.

Specific attitude therapy may be prescribed by the psychiatrist. When the staff takes the initiative and approaches the patient, this is an attitude of active friendliness. The patient must take the initiative when relating to the staff in passive friendliness. A matter-of-fact attitude is a neutral approach to the patient. Kind firmness is a positive, coaxing manner with the patient. Work therapy may be prescribed for the patient; a menial monotonous task may satisfy the need for punishment in a depressed person. Planned recreation is therapeutic; playing volleyball allows a patient to express hostility within a group setting in a socially acceptable manner.

The nurse is a key member of the therapeutic team. Observation and communication are two very important nursing (therapeutic) measures. Observation is purposeful, planned, and objective. The nurse observes the patient's general behavior - his appearance, speech, actions and attitudes. She notes his emotion (mood) - is the patient anxious, agitated, elated, or depressed? She is alert to the patient's thought content. An illusion is a misinterpretation of a real, external sensory experience. A delusion is a false belief that is maintained against logical argument and despite objective contradictory evidence; for example, a patient has delusions of grandeur when he imagines that he is the Secretary General of the United Nations and that he is guiding quarreling, disputing nations to world peace. A hallucination is a false sensory perception in the absence of an actual external stimulus. Observations indicative of the patient's insight, intelligence, orientation, and memory are important.

Communication with the mentally ill patient is therapy. To be therapeutic, the nurse accepts the patient as he is. She relates with the patient in a consistent manner and at his level of understanding. Communication that increases anxiety, fosters an intimate nurse-patient friendship, and is judgmental for the patient is untherapeutic.

In addition to observation and communication, the nurse helps the patient meet his basic physical needs for life and health. She sees that his nutrition is adequate. The patient needs exercise, recreation, rest, and sleep. The nurse institutes necessary safety measures to protect the patient from himself, to protect other patients and to protect herself. Special supervision might be needed for the aggressive patient or for the suicidal patient.

Treatment for the patient with mental illness may include establishing a therapeutic environment, psychotherapy, certain somatic techniques, and medications. Psychotherapy refers to regularly scheduled interviews between the patient and the therapist. This may be done on an inpatient or outpatient basis. Talking with the therapist may help the patient. For example, the therapist may help the patient understand his feelings and behavior patterns. He may reassure the mother that hostile feelings toward her three young children are not so abnormal. He may listen while the patient ventilates. This talking-it-out therapy is called catharsis.

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In some cases, the therapist may suggest that the patient modify his environment - for example, that the husband and wife send the children to the grandparents for a month and plan a vacation together. In psychoanalysis the therapist and patient strive to uncover unconscious conflicts and deal with them in such a way that the patient gains insight into his illness and recovers. In group therapy one therapist and several patients talk together. Group therapy is often used in conjunction with individual therapy. In recent years, many new kinds of encounter and sensitivity group sessions have been tried.

Certain somatic techniques are used, to a lesser extent today than in former times, to treat an individual with a mental illness. Electroshock therapy (EST), sometimes referred to as electroconvulsive therapy (ECT), is useful in relieving symptoms of depression. An electric current is passed through electrodes applied to both temporal areas, producing a grand mal seizure. Following 8 to 20 treatments, symptoms improve. The patient is up in 30 minutes. Narcoanalysis with intravenous injections of amobarbital (Sodium Amytal) or thiopental (Sodium Pentothal) makes some patients more accessible to therapy. Hydrotherapy using a cold wet sheet pack, a prolonged continuous bath, or a pool is used in some institutions to manage patients. Insulin coma therapy has been used successfully and produces remissions of symptoms in many cases of withdrawal. Regular insulin is injected, and following 25 or more comas improvement is seen. A skilled team of doctors, nurses, and attendants is necessary to give safe insulin therapy. Psychosurgery may be performed to relieve symptoms when other techniques fail. The association fibers between the frontal lobes and the thalamus are sectioned, presumably detaching the emotional component from the psyche.

Medications are being used with increasing frequency to treat mental illness. Such barbiturates as phenobarbital and pentobarbital (Nembutal) are useful sedative and hypnotic drugs. Chloral hydrate and paraldehyde help delirium. The "tranquilizing" or ataraxic drugs reduce psychic tension without a corresponding sedative or hypnotic effect. The patient thus remains accessible to psychotherapy. Serious toxicity problems accompany prolonged use of many of these drugs. Some of the major tranquilizing drugs in use today include:

- Chlorpromazine (Thorazine)
- Procloperazine (Compazine)
- Promazine (Sparine)
- Perphenazine (Trilafon)
- Thiopropazate (Dartal)
- Promethazine (Phenergan)
- Reserpine (Serpasil)
- Meprobamate (Miltown, Equanil)
- Mephenesin (Tolserol)
- Azacyclonol (Frenquel)
- Hydroxyzine (Atarax)
- Phenagycodol (Ultran)

A wide variety of stimulant and antidepressant drugs are being used to combat mental depression. The effectiveness of these drugs varies greatly from patient to patient. Amphetamine (Benzedrine), dextro-amphetamine (Dexedrine), and methamphetamine (Desoxyn) are used with patients with mild to severe depression. Imipramine (Tofranil), isocarboxazide (Marplan),

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nialamide (Niamid), and phenelzine (Nardil) are used in depressive reactions. When used discriminately drugs are of great value in adjunctive management of many psychogenic disorders. Medications should augment, never replace, a total program of psychotherapy.

THE DYING PATIENT.

All people die. Death is a significant phenomenon in the growth and development process. Death is the cessation of life. Although the life-span increases, the force of mortality remains. The LPN charge nurse working with long-term care patients encounters the dying patient and death frequently. She must help her staff cope with this difficulty in a supportive, positive way. Nursing includes helping a person die in a dignified and meaningful manner.

Death may be sudden. In most cases, however, a variety of changes in body structure and functions are associated with the process of dying. The skin may become pale or mottled. The hands, ears, and nose may be cold. The person may perspire profusely. The body may lose muscle tone; the jaw may sag and the cheeks may become flaccid. The person may breathe through his mouth. Respirations may be rapid and shallow or abnormally slow. Breathing may be noisy and rattling. There seems to be an accumulation of mucus in the respiratory tract. There may be a general slowing of circulation. The person may be unable to swallow; he may be involuntary of stool and incontinent of urine. The person may lose his ability to speak. Hearing usually remains intact. The eyes may look sunken, the lids half-closed, and the eyeballs rolled up. The person may show evidence of anxiety, distress, and restlessness; he may moan.

Death is a significant factor that conditions the thoughts, feelings, and actions of all individuals living in the twentieth century. A great variety of attitudes about death exist.

- Death is mysterious and caused by evil spirits and demons.
- Life is a tedious preparation for the glorious hereafter.
- Death is the end of the good life on earth.
- Death offers the possibility of salvation or new birth.
- Rituals enhance the meaning of death.
- Learning "how to die" is important.
- Dying is an intensely romantic experience.
- Death is the inability of the biological organism to live.

A person develops a concept of death. The young child denies death as a natural and final process. To him, death is like sleep. You are dead, then you are alive again. Death is similar to a journey. You are gone and then you come back again. Consequently, young children may seem to be rather callous toward death. They may express immediate sorrow but soon forget about it. The older child accepts the idea that a particular peson has died. He does not accept death as something that eventually happens to everyone - particularly to him. By the age of nine or ten most children recognize death as inevitable for all persons and as something that can come to them. Most children accept biological death.

Intense feelings are often associated with "dying" for the teen-ager. Popular songs and expressions depict dying as the utmost in romantic self-sacrifice. The adolescent, however, begins to think about death in religious and philosophical terms; he ponders an afterlife. Death is somewhat of a mystery to the adolescent. The young adult affirms life! Death is an unpleasant fact that may end everything. In times of disaster or war, death may be a factual reality for the young adult; he often views death with a sense of hostility. The increasing incidence of illness makes the middle-aged adult more aware of death. His thoughts about death are in part responsible for feelings of depression that characterize this developmental stage. The middle-aged adult often views death with a sense of futility. The older person recognizes the nearness of death. His attitudes toward death parallel his attitudes toward life. The older person who remains future-oriented seems best equipped to die. The older person often shares his feelings and concerns about death with the clergy. Death remains an ever present possibility for the health as well as the long-term ill person in this twentieth-century war-torn, nuclear age.

A PSYCHOLOGY OF GRIEF REACTIONS[1]

Introduction

Little Johnny's pet dog, Rags, was hit by a car three days ago and was "put to sleep" by the veterinarian. For the last two nights Johnny has cried himself to sleep with Mom or Dad sitting by.

In every instance of grief reaction deep emotional feelings dominate. These grieving emotions are caused by the experience of loss. It may be the loss of a loved pet, a parent, or a series of losses.

For Johnny, the natural expression of loss and "licking of the wounds" has begun and will be worked out. For another person the working through of the pain may be delayed, blocked or distorted. These varied reactions produce different appearances for the same experience of loss. We want to explore these very evident grief reactions and also some mild, everyday grief reactions.

Four facts are important in the psychology of grief. First, grieving is a natural life experience. Next, the characteristics and stages of grief reactions can be identified. Third, some kinds of grief reactions call for special attention. Finally, this emotional process can be helped by an alert community and prepared congregation.

Natural Origins of the Grief Reaction

Grief is a deep and moving sense of loss. Grief reaction is a person's response to the loss. The type of grief reaction varies according to the personality of the person, the kind of loss, and the environment and social setting. For example, a flexible personality reacts differently to losses of varying degrees of severity while a less mature personality reacts the same way to all feelings of loss. In addition, the people or circumstances surrounding the grieving person may help or may block the grieving process.

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[1] By Donald W. Manthei, presented to the Adult Forum at Second Church, Newton, Massachusetts, November 9, 1969.

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The grief process is based in personality development. The basic nature of human personality development which provides the foundation for the experience of grief is the twofold process by which we first develop a sense of selfhood apart from other persons and physical objects and then invest ourself in other persons and objects. For example, the infant first gratifies his own needs only to discover as his senses of sight, touch, and smell develop that there is a dimly perceived other person, the mothering person, who is answering his cries and fussing. This is the first awareness of the difference between self and the world. It is a very necessary distinction which continues to develop. The child at age two is still working on this sense of selfhood when he proclaims, "I wanna do it!" "This is mine!" "give it to me!" And in adolescence, as he interacts with persons of uniquely different backgrounds and appearances, he is still refining his selfhood - his identify.

Along the way of development the person is also involved in a second natural process - that of investing himself in things, persons and patterns of behavior that interest him, satisfy his needs and provide him with new hopes or challenges. For example, the infant becomes attached to the bottle or breast, to mother, to a toy or blanket, to father, to pets, to friends and to his house.

But, life brings still another experience - the loss of some of these loved objects, persons and things. The bottle is taken away. A sitter sometimes replaces Mommy. Father goes to work. Pets get lost or die. Friends get interested in other children. The family moves to a new house and neighborhood.

Although we usually think of death as loss which causes grief and mourning, these other losses bring similar reactions. We need to recognize the natural place of investment and loss in the life process. The anxieties of separations and perceived loss arise in many day-to-day events and during a significant period of transition. Often the lonely and depressed college student is one who as a child moved frequently or during a crucial time of peer group adjustment and thus lost the important peer group interaction. College provides a new challenge to reinvest himself, but frightened of yet another loss he is now unable to do so. He needs help in recognizing the opportunity before him and help in removing barriers to using his new chance.

For children, death, family moves, and separations are crucial. In adolescence a previous feeling of loss may be reactivated at a time of transition from high school to college or a job. The drag of the past loss makes the unknown of the future more frightening. For adults accidents, ill health or aging may cause feelings of loss of opportunity, property and abilities.

A grief reaction may be caused by a single significant event, several minor connected events or an unconnected accumulation of losses. A single loss might be the death of a loved one. An example of connected events is the loss of one's health or ability which leads to loss of job and then loss of income and security. A grief reaction may result from unconnected events such as the move of a friend, loss of important sale, and simultaneous accidents which disable one's car, home or a family member.

Description of the Grief Experience

Characteristic signs of grief reactions are feelings of pain, shock, anxiety and anger. In normal grief reactions these are openly felt and expressed: one flinches with pain, stands stunned, wonders what has happened, worries what will be next, and demands: "Why has this happened to me?" "It isn't fair!"

The briefest way we can describe grief is in six common stages.[1] These stages may appear in any sequence. The first four stages appear for several days or even a few weeks. They are related to the painful process of disengaging oneself from the lost person or object.

1. Shock - disbelief, "This is unreal." The state of shock may be for twenty minutes to an hour. Physical signs of shock are deep sighing, choking, dryness in the mouth and throat, sensations of emptiness, lack of power, and chill.

2. Emotional release - crying, moaning, rapid talking, flailing.

3. Isolation - feelings of loneliness, desires for withdrawal, depression. Common behavior involves recurrent complaint of physical symptoms; identifying with the deceased; and idealizing the lost person.

4. Guilt and anger - for example Mrs. A's reaction. Her husband died in heart surgery. Recently they had had a disagreement which she now recalls and feels guilty. "Did that contribute to his heart condition and his death?" she worries. Now people are taking over the funeral arrangements and she strikes out with anger at their "intrusion." Another person in the same situation may react with anger toward the lost person.

The release of feelings - all kinds, are important for letting go of the relationship which death has ended. The last two stages involve reinvestment in life without the loved one.

5. Return to routine - with the necessary changes.

6. Reinvestment - in new relationships and interests; new life with others.

Grief Reactions Requiring Attention

Normal grief work is open and expressed, providing both disengagement and reinvestment. By contrast abnormal grief reactions are defensive and attempt to cover the emtions, pain and sense of loss. The attempts to cover or forget grief seem to arise from fears of our own death which we do not want to face. (Reports from the experiences of the dying person would help our understanding at this point, but that is another topic and an important area for future discussion.)

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[1] Erich Lindemann. "Symptomatology and Management of Acute Grief," The American Journal of Psychiatry. CI (1944), pp. 141-49.

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The common forms of abnormal grief reactions are those that involve delay and distortion. (See the Lindemann article.) In delayed grief there is little or no reaction at the time of loss because it is blocked. Sometimes circumstances prevent the reaction of grief from being expressed. A college girl whose mother lost emotional control at grandmother's funeral found that trying "to help Mother" prevented the student herself from normal release of emotions.

Or a young married man called from a distance to his parent's home to handle father's funeral arrangements rushed to leave work and family. From the time he arrived before the funeral until he left the day after, he was busy with details. Then he rushed back to work and his own family. He had no time or opportunity to react.

Delay of a grief reaction may also be caused by personality factors which block expression. A common example is a stoic silence which denies the pain while professing that the deceased "would want us to be strong" and "to carry on." Such rationalization can thwart a natural emotional release and lead to an otherwise unexplainable physical illness. This delayed grief reaction brings us to the second major group of abnormal grief reactions.

Distorted grief reactions involve over-reaction or under-reaction to loss at the time of the loss or during the next several weeks. Signs of distortion are seen in over-reactions through excessive physical complaints, continued weeping, extreme guilt and hostility. Under-reaction may appear in neglect of self or tasks, loss of feeling and later result in depression.

These conditions call for professional help by the trained clergyman or therapist. The grieving person needs help in searching for the earlier cause of delay or distortion in reaction. Assistance through understanding, clarification and possibly instruction may help to resume the grief work.

Two cautions are relevant to us when we are in the presence of a mourning person. First, too many people who require the mourner's attention and alertness may repress and delay the grieving process. Second, persons may force denial on the mourner or cause distortion in his grief reaction. A young college girl reported her "Frustration" in attempts to "cheer" her boyfirend who had just had his arm permanently crippled in an auto accident. A young minister tried to cheer a young woman whose father had died of cancer at the age of forty-five. His comforting picture was "The joyful Christian funeral" he attended for his own aged grandmother. Both are examples of uninformed "helpers."

Constructive Considerations

We must recognize that the emotions and behavior involved in grief reactions are normal. This knowledge can help us understand what we may already have experienced as well as help us to see the "natural" in what we could wrongly be inclined to see as bizarre and unmentionable.

There are at least three further concerns to consider. Those who grieve need assistance, time for quiet to "lick their wounds," and later opportunity to talk it out. To facilitate these conditions we may offer

various types of support through provision of food services and other necessities, opportunities for reinvestment in new relationships and special care for those with delayed or distorted reactions.

We also need to be concerned for social conditions which create a climate for undue loss - poverty, divorce, the lonely adult, etc.

Finally, we need to become prepared for emergencies and disasters. We have gathered valuable knowledge about the intense care of victims of major disaster. We need to share this knowledge so that "potential" victims can seek and use such care in sudden need. And we need to train more personnel in these skills of intensive care.

The grief process is part of an intense and natural emotional experience. It follows life's natural development: differentiation and investment of ourselves, the experience of loss which requires subsequent reinvestment of self.

Descriptions of the characteristics and stages of grief reactions help us place our reactions and the reaction of others in perspective. Examples of delayed and distorted reactions can alert us. And constructive considerations lead us to issues beyond the individual into the congregation and community.

COORDINATES WORK WITH THAT OF OTHER DEPARTMENTS

The nursing department coordinates patient care, 24-hours per day, seven days a week. The efforts of many other departments within the institution are necessary and important for patient care: dietary, housekeeping, physical and occupational therapy, social service. At one time most of these services were an integral part of nursing. Today the nurse does not actually scrub the floor, but she is concerned that the floor is clean. She may not cook the meal, but she is concerned with diet as well as the attractiveness of the tray and the patient's interest in eating.

Because so many different people, so many different departments, share patient care, coordination of work is necessary. Because nurses are acquainted with so many functions of the other departments and because they care for patients around the clock, patient care coordination has become an important nursing function. With the great increase in allied health personnel at all levels - professional, technical, and aide/assistant - patient care coordination is a very complex task.

Guidelines and policies for inter-department working together must be established and well-understood by the supervisors and directors of the departments involved. It should not be left for a nurses' aide and dietary aide to figure out on the spot the procedure for passing trays. Doris A. Geitgey, professor at the University of Washington and nursing leader, offers some practical suggestions on how to coordinate work with that of other departments in her book, A Handbook for Head Nurses.

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SOME HINTS ON HOW TO IMPROVE RELATIONS WITH OTHER SERVICE DEPARTMENTS

Doctors: How to work with the medical staff.

a. Take the initiative in establishing friendly relations and mutual understandings with the house staff.
   - Welcome the new doctor to your ward.
   - Ask the resident physician and the interne how you can be of most assistance to them and then do your best to follow their requests.
   - Try to meet the idiosyncrasies of the individual physician.
   - Learn the physician's plan for the care of his patients.
   - Encourage mutual planning for patient care.
   - Talk over your ward problems with your physicians.
   - Explain the nursing situation to your doctors; they will be more cooperative if they know about unusual difficulties.
   - Do your part as planned when mutual decisions have been reached.
   - Ask for a conference with your medical staff when important problems arise.
   - Encourage the patient's confidence in his physician.
   - Show your loyalty to your medical staff.
b. Follow the doctors' orders in a meticulous manner.
   - Accept orders cheerfully and without complaints.
   - Don't let orders accumulate; carry them out as quickly as possible.
   - Report to the doctor any inability to carry out his orders, and explain the reasons.
   - Encourage the doctor to write his orders according to hospital policy.
c. Keep the doctor informed on his patient's condition.
   - Notify doctors immediately upon the admission of their patients.
   - Report and read accurately the results of treatments.
   - Report all symptoms and reactions of their patients.
d. Make ward rounds with your doctors.
   - Establish a mutually agreeable time for rounds.
   - Take notes of any significant comments made by the doctors or the patients.
   - Have charts and other needed equipment ready for the doctors' use during rounds.
   - If you are unable to make rounds, assign a member of your staff to attend the doctors.

Laboratory Workers: How to assist personnel employed in diagnostic and clinical facilities.

a. Familiarize yourself with tue functions of laboratory facilities and the ward's relations with them.
b. Prepare the patient correctly for diagnostic procedures.
c. See that the patient arrives at the laboratory at the correct time.
d. Arrange for the return of the patient to your ward when the test is completed.
e. If laboratory work is done on the ward, help the technician as much as possible.
   - Greet the technician in a friendly manner.
   - Locate the patient for him.
   - Be sure that the patient is ready for the test.

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Nutritionists: How to cooperate with the dietary service.

a. Become familiar with the services provided by the dietary division.
b. Prepare the patients for their meals.
c. Request the number and type of diets necessary for your ward, but don't over-order.
d. Have requests in the proper form and on time.
e. Avoid wasting foods.
f. Ask for conferences as necessary to meet special problems.
g. Instruct your personnel in the matter of your patients' dietary requirements.

Social Service Workers: How to work with the medical social service department.

a. Know and inform your staff about the functions of the social service department.
b. Maintain a friendly, cooperative attitude towards the department.
   - Know and use the name of your medical social service worker.
   - Introduce new workers to your personnel.
   - Take new workers on a tour of your ward.
   - Explain any special functions of your ward.
   - Hold frequent, informal conferences with your worker.
   - Arrange for privacy for the worker and patient during interviews.
c. Accept the help which the medical social service worker can give you in understanding your patients.
d. Encourage your patients to talk with the social worker.

Clinic Personnel: How to link the hospital care of the patient with his out-patient care.

a. Inform yourself and your personnel of the responsibilities of the out-patient department.
b. Make out out-patient referral forms according to the policy of your hospital.
c. Prepare your patient for his first clinic visit.
   - Tell him where the clinic is located.
   - Inform him of the date and time of his appointment.
   - If the appointment is made by another division, tell the patient how he will be notified of his appointment.
   - If any charge is made by the out-patient clinic, explain the cost to your patient so he will be prepared to pay the amount if possible.
   - Stress the importance of keeping the appointment.

Engineers: How to correlate your work with that of the maintenance department.

a. Learn what services the maintenance department provides.
b. Report any mechanical difficulty promptly.
c. Inform the engineer of the location of the trouble.
d. Give the engineers a chance to get to your ward; remember that they have many wards to service.
e. Be courteous and considerate; thank the engineer for his help.

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Laundry Workers: How to get along with the linen supply service.

a. Avoid wasting linen.
   - Use linens for their intended purposes (don't use bath towels for polishing shoes; avoid using good linen for cleaning rags; impress upon staff the importance of correct usage of linen supplies).
   - Encourage personnel to use only the necessary amount of linen.
b. Avoid hoarding linen for a "rainy day."
c. Get linen orders in on time and in proper form.
d. Avoid ordering excessive amounts of linen.
e. Gain an awareness of the problems of the laundry department and give due consideration to these problems.
f. Check the linen delivered with the amount ordered.

Druggists: How to stay on good terms with the pharmacy department.

a. Turn in drug orders correctly and at the right time.
b. Avoid ordering large amounts for delivery on the week-end.
c. Order sufficient drugs to meet your ward requirements, but don't overstock.
d. Follow directions of the pharmacy for the care of empty drug and sollution bottles.
e. Eliminate as many "emergency" drug orders as you can.

SEEKS GUIDANCE AND ASSISTANCE WHEN PROBLEMS ARE BEYOND SCOPW

It is imperative that the LPN charge nurse comprehend her functions and qualifications as an LPN and as a charge nurse. The ability and necessity to seek guidance and assistance when problems arise that are beyond her scope are indications of wisdom, maturity, and leadership ability.

The LPN charge nurse is not a lone practitioner; she is an integral part of nursing. According to the Statement of Functions and Qualifications, in semi-complex and complex nursing situations a greater depth of knowledge and a higher level of judgment is required of the LPN; and a closer working relationship with, and the greater the degree of direction by, the autonomous health professional.

In a complex patient care situation, the LPN charge nurse should ask herself the following questions before seeking guidance and assistance:

1. Do the nursing needs of this particular patient indicate assistance from a health professional?

2. What are the components of the patient care situation?

3. Do I have the knowledge, skills and previous experience to handle this patient care situation alone?

4. What kind and how much assistance (direction) do I need? Is it available?

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When a ward situation involving staff becomes complex, the LPN charge nurse should ask herself similar questions before seeking guidance and assistance:

1. Does this particular ward situation indicate assistance from a health professional?

2. What are the components of the ward situation?

3. Do I have the knowledge, skills and previous experience to handle this ward situation alone?

4. What kind and how much assistance (direction) do I need? Is it available?

The capable LPN charge nurse does not bother her superiors with problems that are within her prerogative to solve. In an attempt to avoid looking inadequate, the charge nurse should not avoid seeking professional help. Ask and answer the above questions with a complex patient care or ward situation arises. Seek help from a health professional when the situation truly demands.

PREPARES AND GIVES VERBAL AND WRITTEN REPORTS ABOUT PATIENTS

Verbal and written reports about patients between personnel on different tours of duty promote continuity of patient care. The LPN charge nurse gives a complete report on the condition of each patient to the nurse who will relieve her. She mentions special conditions and needs such as abnormal vital signs, pain, changes in general condition. She mentions any special treatments, medications, or events of the day. She comments on anything unusual in terms of the physical environment of the ward, changes in personnel assignments for the coming tour of duty, and special institution events.

Reports should be useful. It is important that the LPN charge nurse understand the purpose of a report. Frequently, both verbal and written reports become "busy work," and this exercise proves to be a gross misuse of skilled nursing time. A good report should be accurate, concise, useful, and interesting. The LPN charge nurse achieves skill at preparing and giving verbal and written reports through knowledge, practice, and experience.

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STUDY ACTIVITIES

1. Review staff assignments for a particular tour of duty. What is the purpose of the "plan" or assignment routine? Just how were staff assigned?

2. What one ward plan or routine seems to work best? Why?

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3. What one ward plan or routine poses the most problems? Why? How could you help change this situation?

4. Henry Jacobs, an elderly patient in room 303, develops severe respiratory distress. What do you do?

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5. What directions would you give your staff in case of a fire on the ward?

6. What knowledges, skills, and attitudes do you believe are most important in caring for older patients? How do you share these with your staff?

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7. What knowledges, skills, and attitudes do you believe are most important in caring for the patient with mental illness? How do you share these with your staff?

8. What knowledges, skills, and attitudes do you believe are most important in caring for the dying patient? How do you share these with your staff?

9. How can you and your staff help a patient and his family through a grief process?

10. Review patient care assignments for a particular tour of duty. On what basis did you "match" specific patients with certain staff? Did you use multiple assignments? When? How does your plan for patient care assignments reflect both patient needs and staff proficiencies?

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11. What is the most difficult aspect of working with personnel from other departments? Why? How could you help change this situation?

12. What is the most satisfying aspect of working with personnel from other departments? Why?

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13. Describe a ward situation in which you would seek guidance and assistance from the director of nursing.

14. Describe a ward situation in which you would seek guidance and assistance from a physician.

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15. Describe a ward situation in which you would seek guidance and assistance from administration.

16. A new LPN charge nurse questions the time involved in preparing and giving verbal and written reports about patients. "This is important," you state. Explain your statement.

Chapter 9

EVALUATING PATIENT CARE

The LPN charge nurse evaluates patient care for a specific tour of duty. To do this, she:

- applies basic principles of evaluation
- makes nursing rounds to observe and assess patient care and needs
- assesses patient care plans and modifies as necessary
- assesses patient care given by staff and guides appropriate changes
- appraises self-performance and plans improvement.

APPLIES BASIC PRINCIPLES OF EVALUATION

To evaluate something is to assess, measure, or determine its value or worth. A major responsibility of the LPN charge nurse is to evaluate patient care. Unfortunately, evaluation often becomes a time-consuming, meaningless activity. To be useful, evaluation (1) must be done in terms of criteria or standards, (2) it must lead to action, and (3) it should be positive.

Criteria are established and/or accepted standards. For example, you know in an adult the pulse rate varies from 60 to 100 beats per minute; the rhythm is regular; and the intensity is "full." If you count a patient's pulse and note the rate is 120 beats per minute, irregular and weak, this observation has use only when compared to the known standard or criterion for a normal pulse.

Criteria or standards are both external and internal. Most patient observations are compared with established (external) standards of what is normal: normal temperature, normal skin, normal urine, normal behavior, normal blood sugar, etc. Nursing policies and procedures are another example of external standards or guides for performance and evaluation. Internal criteria are personal achievement goals you set for yourself in terms of performance. Setting personal achievement goals is very important in self-development and personal growth.

Second, evaluation should lead to action. For example, the nurse who observed the fast, irregular, weak pulse did something. She acted. Depending on the exact nature of the patient situation, she may have reported the observation, charted it, called the physician, or given the prescribed medication. But, in any case, her evaluation led to action.

Third, evaluation should be positive. It is so easy to say, "don't do this," "this is wrong." People tend to repress negations. The exasperated LPN charge nurse says, "how many times have I told you that is the wrong way to move this patient." Because of this negative evaluation, the aide repressed the comment and continues to move the patient in the wrong way. How much better if the charge nurse had said, "Mary, may I show you a good way to move Mr. Thompson." This interaction is positive. Chances are the aide will correct her performance because the evaluation is positive.

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MAKES NURSING ROUNDS TO OBSERVE AND ASSESS PATIENT CARE AND NEEDS

Nursing rounds at the beginning of a tour of duty is an organized way for the LPN charge nurse to observe patients and determine needs. During the tour of duty and most certainly at the end of the tour, the charge nurse again makes rounds to observe and assess patient care and needs. Evaluation of patient care and needs must be in terms of criteria or standards, it must lead to action, and it should be positive.

The Kardex and nursing care plans (goals and actions) can serve as criteria or standards against which the charge nurse compares patient care observations. The nurse must determine just how she will measure or assess goals and when a goal should be reached. It might prove useful to design a companion part to the nursing care plan to include REVIEW and ACHIEVEMENT. For example,

GOAL ACTION

REVIEW ACHIEVEMENT

These activities may become unconscious and routine for the experienced charge nurse as she makes her rounds.

Evaluation, patient care observations, should lead to action. The charge nurse reports the difficulty her staff had ambulating Mrs. Daniels; she suggests that P.M. staff might try to walk her following her pain medication. The charge nurse reports that Mr. Gray ate most of his noon meal when the tray was left with him for an hour; she obtained this privildge from the kitchen. She suggests that P.M. staff try to let Mr. Gray feed himself slowly over a long period of time. In both these examples, evaluation (patient care observation) led to action and was useful.

In general, a positive, affirmative approach proves more successful than negation. With conscious practice and experience, the LPN charge nurse can learn to communicate observations in a positive manner and her evaluations of patient care will become more useful.

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ASSESSES PATIENT CARE PLANS AND MODIFIES AS NECESSARY

Nursing care plans should be useful. To keep a care plan useful necessitates on-going and periodic evaluation of the plan; revisions may prove necessary because a goal or action was inappropriate or because a goal has been achieved. Little and Carnevali comment about revising nursing care plans as follows:

> All of us like to believe that we do things well. Revision implies that our original work was not good enough. This could, in turn, lead to rejection of the planned care concept, because it gives overt evidence of our lack of perfection. In learning to write nursing care plans, as in learning to walk, our early efforts may tend to be clumsy. The difference is that babies are not deterred by the clumsiness of their first efforts; but adults, including nurses, expect a great deal of themselves; we are chagrined when we do not measure up.
>
> The mental processes and activities involved in planning, giving, and assessing nursing care are infinitely complex. It is reasonable to expect that we will be a long time in achieving a high level of skill in these activities. Physicians who have been prescribing therapy for their entire professional lives continue to encounter patient responses to treatment that vary from their predictions; and they, too, must revise their orders accordingly. So, we nurses also must expect to have both failures and successes. We must study and learn from each of them. When we succeed, we need to know why; when we fail, we also need to know why. Support from clinical research should help us to become increasingly successful in our nursing intervention, just as it has similarly served the medical profession.
>
> Despite knowledge, innovation always involves some risk. When you commit your decisions to writing, as one does in the nursing care plan, you lay your judgments open to the scrutiny of others, and you assume professional responsibility for them. This rather lonely aspect of the nurse's role can be made less threatening if those in authority will acknowledge that there is risk in professional growth and will support - even encourage - their staff to stretch more vigorously so as to achieve their full potential in providing planned nursing care.[1]

ASSESSES PATIENT CARE GIVEN BY STAFF AND GUIDES APPROPRIATE CHANGES

The LPN charge nurse coordinates staff activities; she nurses her patients through her staff and she is responsible for staff guidance and development.

Staff evaluation should be on-going and periodic. If possible, it should be a shared responsibility between the individual staff member and the charge nurse. Both should understand and agree on the purpose and principles of evaluation. The manner of evaluation, the tool or report, should be clear.

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[1] Little and Carnevali, Nursing Care Planning, pp. 166-67.

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Staff evaluation should be in terms of established criteria that are accessible, understood, and used by both staff and the charge nurse. To be useful, the evaluation should be positive and lead to action.

APPRAISES SELF-PERFORMANCE AND PLANS IMPROVEMENT

The LPN charge nurse is a recognized leader. Leadership in nursing necessitates continuing personal and vocational growth and development.

Your work performance will be evaluated by a superior. More important, however, will be the self-evaluation and self-improvement program you plan and institute for yourself. You may choose to increase your ability to lead others. You may try to develop more sureness in yourself - self-confidence. You may try to improve your relations with others. A specific goal may be to gain an understanding of your personnel.

Self-improvement may mean taking advantage of inservice programs at the institution, enrolling in nursing courses at neighborhing colleges, or attending special program meetings of nursing organizations.

Self-improvement also includes ways you strive to be a more effective person on and off duty. Set and strive for personal and vocational goals in terms of self, friends, family, and community.

STUDY ACTIVITIES

1. Evaluation must be in terms of stated criteria or standards. What does this mean? Why is it important?

2. Evaluation should lead to action. What does this mean? Why is it important?

3. Evaluation should be positive. What does this mean? Why is it important?

4. In what ways can you, the LPN charge nurse, make nursing rounds useful?

5. Use the four nursing care plans you developed in chapter 6 and plan a way to assess and modify the plan. Add the following dimensions to each plan: REVIEW and ACHIEVEMENT

REVIEW

ACHIEVEMENT

REVIEW

ACHIEVEMENT

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REVIEW ACHIEVEMENT

REVIEW ACHIEVEMENT

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6. Use the following evaluation format to evaluate (1) a high school student enrolled in a health occupations assistants' program, (2) a nurses' aide who has been employed three months, and (3) yourself, the LPN charge nurse.

   If possible, explain the purpose and principles of evaluation to the high school student and to the nurses' aide and encourage them to participate in a self-evaluation. See if your immediate nursing supervisor will evaluate you. Then, compare and contrast observations in a face-to-face conference. Evaluation is to be useful. To be useful, it must be done in terms of stated criteria or standards, it must lead to action, and it should be positive.

   Directions for use of evaluation format:

   - Read stated criterion/standard (usually a specific job function).
   - Recall a specific behavior as an example of the criterion/standard.
   - Using the behavior example, assess competency in terms of stated criterion.
   - Identify and indicate "strength" or "weakness" in the area.
   - Offer action suggestions for improvement and professional development.

   (Example) LPN charge nurse

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
Complies with ward safety policies.	Am reluctant to prevent staff from smoking in washrooms.	Weakness	Determine reasons for policy and rule; talk with superior if reluctance continues
Continues to improve practitioner abilities	Attended one-day institute on "Meeting the Special Needs of the Ambulatory Patient"	Strength	Keep posted on professional programs and conferences and try to attend

HEALTH OCCUPATIONS ASSISTANT

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
- Escorts patients (especially those in wheelchairs or who have physical disabilities)			
- Feeds patients			
- Makes beds			
- Writes letters and reads to patients			
- Encourages patients in various activities and interests			
- Runs errands			
- Assists patients with personal hygiene			
- Assists with care of patient environment			
- Assists with passing patient nourishments			

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NURSES' AIDE

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
- Bathes, feeds, shaves, and dresses patients			
- Makes beds			
- Takes temperatures, pulse, respiration, and blood pressure			
- Gives enema to selected patients			
- Applies heat and cold locally			
- Collects specimens			
- Tests diabetic urines			
- Weighs, measures, and positions patients			
- Applies simple dressings and ointments			
- Helps patients in and out of bed			

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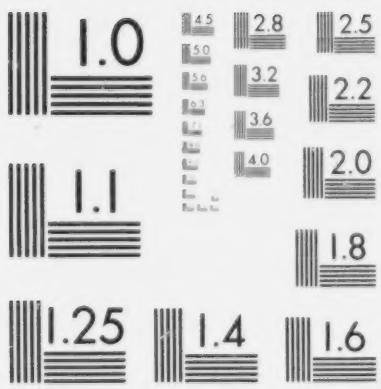

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

NURSES' AIDE - continued

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
- Helps admit, discharge, and transfer patients			
- Escorts patients to meals, activities, and appointments			
- Understands needs of patients who need long-term care			
- Encourages and motivates patients toward meaningful activities			
- Observes and reports changes in patients' condition and behavior			

LPN CHARGE NURSE

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
1. Plans patient care			
- demonstrates awareness of the comprehensive nature of long-term care			
- understands the condition, needs, and therapeutic goals of each patient			
- receives and interprets verbal and written reports about patient care			
- makes nursing rounds to observe and determine patient needs			
- assists the physician with examinations and treatments			
- discusses patient care goals with physician, nursing supervisor, and staff			
- develops nursing care plans for individual patients			

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LPN CHARGE NURSE - continued

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
2. Coordinates staff activities			
- exhibits an understanding of basic human behavior			
- demonstrates fundamental leadership techniques			
- uses management principles and procedures			
- communicates verbally and non-verbally			
- motivates staff to give skilled nursing care to all patients			
3. Implements patient care			
- develops plans to meet on-going needs of all patients			
- develops plans for common types of emergency situations			
- assigns personnel in terms of patient needs and staff proficiencies			

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LPN CHARGE NURSE - continued

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
- helps staff care for patients with special needs			
- coordinates work with that of other departments			
- seeks guidance and assistance when problems are beyond scope			
- prepares and gives verbal and written reports about patients			
4. Evaluates patient care			
- applies basic principles of evaluation			
- makes nursing round to observe and assess patient care and needs			
- assesses patient care plans and modifies as necessary			
- assesses patient care given by staff and guides appropriate changes			

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LPN CHARGE NURSE - continued

Criteria	Behavior Example	Strength/Weakness	Action Suggestion
- appraises self-performance and plans improvement			

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Part III

EDUCATIONAL RESOURCES

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AUDIO-VISUAL MATERIALS

(Note: Production data are included if the resource is more likely to be purchased, for example, a filmstrip or transparency. Descriptions only are included if the resource is more likely to be rented or borrowed and if the sources are varied, for example, a film.)

Aging (1963, black and white, 28 minutes)
Shows two elderly gentlemen playing cards; they reveal their attitudes toward life, loneliness, and the younger generation.

Ambulation Training of the Hemiplegic Patient (8mm sound/color). New York, Modern Talking Picture Service
Shows beginning ambulation training of the hemiplegic patient using a handy standy or a pick-up strap, according to the particular needs of the patient.

Basic Nursing Procedures (16 color filmstrips of approximately 50 frames each, scripts, records). New York, Blakiston-McGraw
Introduces and demonstrates principles and procedures basic for nursing action.

Basic Wheelchair Features and Handling (8 mm color/sound). New York, Modern Talking Picture Service
Describes basic features needed in wheelchair suitable for person who can stand when getting into and out of it.

Bed to Wheelchair Transfer (8 mm color/sound). New York, Modern Talking Picture Service
Shows step-by-step procedure for hemiplegic transfer.

Better Up Than Sorry (color/sound cartoon filmstrip). Hollywood, Harris-Tuchman
Shows good bedrail practice; shows good judgment and encourages consistent bedrail practice among all nursing personnel.

Body Mechanics (8 mm color/sound). New York, Modern Talking Picture Service
Shows "dos" and "don'ts" of lifting techniques; emphasizes proper body mechanics to protect patient and aide.

Chronic Bronchitis and Emphysema (1965, color, 32 minutes)
Explains anatomical and functional abnormalities related to emphysema and bronchitis.

Critical Decades (1965, black and white, 31 minutes)
Shows how the family doctor can foster preventive attitudes in his patients; uses case history of a 66-year old woman with severe heart disease to show problems that arise from lack of medical attention during middle age.

Diabetes and Its Long Range Control (1961, color, 35 minutes)
Emphasizes likelihood of diagnostic and therapeutic management of diabetes: discusses diet, exercise, insulin, and oral drugs.

Diabetes and You (1960, color, 21 minutes)
Discusses symptoms of diabetes and importance of early detection.

Diabetes Unknown (black and white, 25 minutes)
Interviews with a variety of individuals with diabetes show how symptoms and treatment vary from person to person.

Diabetes - What You Don't Know Can Hurt You (1964, color, 27 minutes)
Discusses body processes involved in diabetes, its diagnosis and control.

Emphysema (1962, color, 15 minutes)
Describes emphysema in detail, showing case history of actual patient.

Exercises to Mobilize the Shoulder (8 mm color/sound) New York, Modern Talking Picture Service
Shows exercises to preserve or restore range of motions of shoulder.

Fundamental Nursing Principles (159 transparencies, 90 overlays). Philadelphia, Lippincott.
Introduces principles basic for nursing action.

Fundamental Nursing Series (12 color/sound 8 mm motion picture cartridge film loops, 12 Study Study Manuals, 12 Instructor's Guides). New York, Balkiston-McGraw.
Offers complete "package" to learn basic nursing procedures.

Fundamentals of Nursing (22 color 8 mm film loops with Student Guide and Instructor's Guide). Philadelphia, Lippinsott.
Offers a total learning kit for basic nursing.

Growing Up, Growing Older (1968, color, 9 minutes)
Traces life of one person from infancy to old age.

A Halo For a Cap (color/sound cartoon filmstrip). Hollywood, Harris-Tuchman
Describes "do's" and "don'ts" of auxiliary volunteer.

The Hemiplegic Patient; Bed Positioning of the Acute Patient (8 mm color/sound). New York, Modern Talking Picture Service
Demonstrates muscle testing techniques to evaluate hemiplegic's ability to stand.

The Hemiplegic Patient; Passive Range of Motion (8 mm color/sound). New York, Modern Talking Picture Service

Home Management of Disability of Arthritis (1964, black and white, 30 minutes)
Shows rehabilitation procedures for arthritis and similar diseases.

Homes That Care (1958, black and white, 30 minutes)
Describes nursing homes and homes for the aged; stresses treating patients as individuals.

Independent Ambulation and Elevation Activities of the Hemiplegic Patient (8 mm sound/color). New York, Modern Talking Picture Service
Illustrates proper teaching methods as patient progresses with cane to curb, ramp, and stair climbing.

Medicare and You (color/sound cartoon filmstrip). Hollywood, Harris-Tuchman
Answers essential questions on Medicare - what it is, who gets it, who pays for it, how it works, what it covers.

More Than Food (1965, color, 23 minutes)
Emphasizes scope of importance of food service in nursing homes.

Mrs. Reynolds Needs a Nurse (1963, black and white, 38 minutes)
Urges nurses to meet emotional as well as physical needs of patients; shows positive and negative patient-staff relationships.

Orientation to the Use of Crutches (8 mm sound/color) New York, Modern Talking Picture Service
Shows fitting of underarm crutches, the tripod principle and crutch walking, including stairs.

The Patient and Circulatory Disorders (54 transparencies with 99 overlays, Instructor's Guide). Philadelphia, Lippincott.
Includes learnings about normal anatomy and physiology, special tests and procedures, and the patient and coronary disease.

The Patient and Fluid Balance (64 transparencies with 158 overlays, Instructor's Guide). Philadelphia, Lippincott.
Includes information about the state of equilibrium, disequilibrium, and fluid therapy.

Remotivation: A New Technique for the Psychiatric Aide (1958, black and white, 24 minutes)
Describes the remotivation technique for increasing a patient's meaningful appreciation of his environment and his heightened activity in it.

Still Going Places (1955, black and white, 40 minutes)
Describes active therapy program for older people.

Stroke: Early Restorative Measures in Your Hospital (1962, color, 20 minutes)
Motivates physicians, nurses and hospitals to employ early rehabilitation services for stroke patients.

Stroke Patient Comes Home (1964, series of six films, black and white, each 28 minutes)
Includes information about (1) getting around, (2) learning self-reliance, (3) physical well-being, (4) returning to the community, (5) understanding his illness.

Take 2 and See (color/sound cartoon filmstrip). Hollywood, Harris-Tuchman
Illustrates necessity of correlating patient's name and hospital number with orders.

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Technique for Propelling Standard Wheelchair by Hemiplegic Patient (8 mm color/sound). New York, Modern Talking Picture Service
Demonstrates manner to teach hemiplegic to use a wheelchair.

There is a Way (1960, black and white, 25 minutes)
Demonstrates patient training in bowel and bladder control following a stroke.

Three Grandmothers (1963, black and white, 28 minutes)
Compares and contrasts role of grandmothers in Nigeria, Brazil, and Canada.

TLC- Tend with Legal Care (color/sound cartoon filmstrip). Hollywood Harris-Tuchman
Describes correct charting, safety precautions, handling orders, correct patient identification, unethical criticism.

To Live Till You Die (black and white, 60 minutes)
Contrasts western points of view concerning the aged; examples from Sweden and Italy.

Transferring From Wheelchair to Bed with Maximal Assistance (8 mm sound/color). New York, Modern Talking Picture Service
Shows safest and easiest way to transfer from wheelchair to bed.

Within the Quiet Zone (color/sound cartoon filmstrip). Hollywood, Harris-Tuchman
Explains costs of hospital care in a frank and meaningful manner.

Yellow Leaf (1957, black and white, 27 minutes)
Depicts pressing problem of older people finding satisfactory living arrangements and adjusting to living in a home for the aged.

VT 012 610
Teaching Plans. Preparatory Course for the Barber Trade, Part III.

Connecticut State Dept. of Education, Hartford. Div. of Vocational Education.
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ABSTRACT - Prepared by the Division of Vocational Education of the Connecticut State Department of Education, this teaching guide is the third part of a 4-part series and is for instructor use in presenting the theory and practice of the barbering trade. The contents are divided into six blocks: (1) History of Barbering and Orientation, (2) Instruments and Accessories, (3) Practical Skills, (4) Bacteriology, (5) Systems of the Body, and (6) Chemistry. The lesson plans include the aims, preparation, presentation suggestions, and applications of the various aspects of barbering. Parts I and II are available as VT 012 612, and Part IV is available as VT 012 611, also in this issue. (GEB)

VT 012 610

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Hartford

Instructor's Lesson Plans
for
Theory and Practice

PREPARATORY COURSE FOR THE BARBER TRADE

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Instructor's Lesson Plans

Theory and Practice

Practical and Scientific Barbering

	Unit	Title
Block I	I	HISTORY OF BARBERING
AIMS:	A	To appreciate the past history of barbering.
	B	To understand the changes and progress in barbering.
	C	To understand the present trends in barbering.
PRESENTATION:	A	THEORY, LECTURE METHOD - ORIENTATION 1. Explain the contributions of various races and lands to history of barbering. 2. Explain how primitive man first cut his hair and compare with methods of today. 3. Explain the influence of superstitions. 4. Explain the significance of the beard in early times. 5. Explain the origin of the word "barber". 6. Explain the role of the barber-surgeons during the Middle Ages. 7. Explain the origin of the influence of the Barber Trade Guilds. 8. Explain the importance of changes which have occurred in barbering. 9. Explain the progress of barbering-your state and community. 10. Explain the requirements to practice barbering in your state.
APPLICATION:	A	Study textbook, Lesson I, Pages 8 - 22.
	B	Review Examination Questions.
	C	Glossary Drill - Word Study
TESTS:		Special Test (Instructional material)

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Instructor's Lesson Plans

Theory and Practice

Practical and Scientific Barbering

	Unit	Title
Block I	2	THE NEW BARBER SALESMANSHIP AND ETHICS
AIMS:	A	To understand the requirements of successful salesmanship to the practice of barbering.
	B	To acquire the ability in "The Art of Selling."
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION 1. Explain the importance of salesmanship to the practicing of barbering. 2. Define salesmanship. 3. Explain the ethics and pre-approach involved. 4. Explain the importance of personal appearance and hygiene. 5. Explain the importance of acquiring the knowledge of the profession. a. To make analysis of skin and scalp. b. To be skilled in proper selection of treatment. c. To keep record of treatments. 6. To utilize the knowledge of barber science. 7. Explain the importance of harmony prevailing among business associates.
APPLICATION:	A	Study textbook, Lesson XI, Pages 4 - 6.
	B	Discussion - Question and Answers
TEST:	A	Oral
	B	Performance

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

QUESTIONS

BLOCK I HISTORY OF BARBERING

1. What evidence is available to prove the existence of barbering in ancient times?

2. What is the origin of the word "barber"?

3. What significance was attached to the wearing of beards in ancient times?

4. What recognition did the Greeks and Romans give to barbering?

5. When and how did barbers learn to become surgeons?

6. What were the duties of the barber-surgeon?

7. When and why were the clergy forbidden to practice surgery?

8. How were the barber-surgeons organized in London to protect themselves against practitioners?

9. What conflict existed between the barbers and surgeons, and how was it settled?

10. What is the origin of the barber's pole?

11. When was the first school for barber-surgeons established in France?

12. When was the alliance between surgeons and barbers completely dissolved in England?

13. How long did barber-surgeons practice their profession?

14. Who were responsible for bringing the barber-surgeons to America?

15. What discoveries in the nineteenth and twentieth centuries have contributed to the progress of barbering?

16. How do barber license laws protect both the barber and the public?

17. When and where was the first barber license law passed?

18. When was the barber license law passed in your state?

19. Name the members of your State Board of Barber Examiners.

20. Define the requirements to become a barber in your state?

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

ANSWERS

BLOCK I HISTORY OF BARBERING

1. The earliest records in the form of writings and excavated objects show that barbering was practiced in ancient Egypt and China.

2. The word "Barber" comes from the Latin word "Barba" meaning beard.

3. The custom of wearing beards was a sign of wisdom, strength and manhood and was cherished as being sacred.

4. As early as 400 B.C. in Greece, barbers were a distinct group of artisans. Shaving became a daily procedure in Rome. The common people frequented the barber shops where topics of importance were discussed.

5. In the beginning of the Christian Era, barbers assisted the clergy in the practice of surgery and medicine.

6. Besides doing the regular work of a barber such as shaving, haircutting and hairdressing, the barber-surgeon was permitted to perform surgical operations, do blood-letting and dress wounds.

7. In 1163, Pope Alexander III forbade the clergy to shed blood in surgical operations.

8. The Barbers' Company of London was organized in the thirteenth century to regulate the profession for the benefit of its members. Examinations were given to test the skill of the applicants.

9. Competition and jealousy existed between the Barbers' Guild and the Surgeons' Guild. In 1450, a law was passed uniting the two groups. The law was later enacted, restricted the work of the barber and surgeon to their own fields. In 1745, a bill was passed separating the barbers from the surgeons.

10. A striped pole, having red, white and blue colors, represented the blood, skin and veins involved in blood-letting.

11. In the middle of the thirteenth century, the barber companies of Paris organized the first school of its kind for teaching barbers how to practice surgery.

12. In the year 1745.

13. For over six hundred years.

14. Dutch and Swedish settlers brought with them barber-surgeons to look after the needs of the colonists.

15. The invention of electricity and electrical appliances, better instruments for shaving and cutting hair, and the application of the principles of sanitation and sterilization, have elevated the practice of barbering.

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE:

ANSWERS (Continued)

BLOCK I HISTORY OF BARBERING

16. The passage of barber license laws standardizes the educational requirements for the practice of barbering, thereby eliminating incompetent barbers. As a result, the public is given better service and is protected from the spread of contagious diseases by the enforcement of sanitary and sterilization rules.

17. In 1897, in the State of Minnesota.

18. In 1901.

19.

20. The applicant is above the age of nineteen years, of good moral character, possesses a diploma, certificate or other evidence satisfactory to the Board of Barber Examiner, showing graduation from the eighth grade of grammar school, or its equivalent. The same to be determined by the Board of Barber Examiners. That he is free from any contagious disease.

That he has completed his period of apprenticeship as required by his state license law.

In Connecticut an apprentice starting his apprenticeship must be over the age of sixteen years of age, successfully completed a course of not less than six months of study, both of theory and practice at any barber school or college approved by the Board of Barber Examiners. He will then take an examination for registration as a barber apprentice and continue for not less than two and one-half years as an apprentice under the supervision of a licensed practicing barber in a registered barber shop. During this time he will have to continue his studies on practical and related instruction for a minimum of 144 hours per year as approved by the Connecticut Barbers Joint Apprenticeship Council and the Board of Barbers Examiners.

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SUPPLEMENTAL INSTRUCTION MATERIAL

BARBER TRADE
BLOCK I Unit 2

DON'T SELL BARBERS SHORT

The talkative nature of barbers is an old story. It appears in literature, the drama and on vaudeville stages and in that large body of folklore signed by Anon. In it, barbers are philosophers, teachers, political economists and sometimes they are even humorists. That they are not more often humorists is due to the simple fact that no one particularly likes the thought of a Falstaff laughing merrily as he hones a razor for use on the back of the neck. Barbers, in spoken and written literature, generally are Characters, with the modern implication of that easy word, they are the urban counterparts of the cracker-barrel philosophers. Possibly, in this one solitary instance, art follows life. It may easily be that they are teachers, political economists and sometimes even humorists. What is overlooked, however, is that they also form a continuing potential threat to any existing order. The monarchy survives in Great Britain, as the Presidency does here, only by the sufferance of barbers. They should not be taken lightly.

Perhaps so early on an April morning, this may be taken as the creation of windmills for later tilting. It is not. A barbershop is like a newspaper or the radio, a platform for the exchange of public opinion. If, on a given day, all the barbers in America suddenly denounced, say, equality for women, by nightfall all women probably should be back at their original place of serving the table, not eating at it. If all barbers agreed to sponsor a state of anarchy, within a week there would be no enforced laws worth mentioning. The fact that they do not agree shows no more than the proof of the original point, that barbers are like any other commentators - individualists, not units in a machine.

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DON'T SELL THE BARBER SHORT (Cont'd)

Democracy in its various minor variations must look carefully under the bed when three separate haircuts, given by three separate barbers, yield a single, unchanged, repeated threat of the same doctrine.

Let the power of the barber be not underestimated simply because the present barber prefers to be an agreeable theorist rather than a rabid teacher. Even one barbershop, centrally located and bleakly in earnest, could conceivable change the course of the human race. If all the barbers in a shop at the Pennsylvania Station suddenly decided that anarchy is the only answer, that doctrine immediately would entrain for Pittsburgh, Williamsport, Chicago, and St. Louis. A cell even more powerful than that at a station could be set up at an airport, for the ramifications would be world-wide. As they chat agreeably about the weather, ladies' hats, the price of pork loins and the prospects of the Dodgers, the barbers may not know just what power is theirs for the asking. Perhaps they do know. Perhaps they wish to change in the status quo to be gradual rather than immediate; they may favor the monarchy and the presidency. On thought, this is the most reasonable explanation.

In its barbershop sketches, vaudeville makes of the barber a thing of fun, the butt of jest. This is not too bright any way it is looked upon, and the answer requires only the question as to where is vaudeville now. Vaudeville has had a haircut, not carefully with shears, but with the razor over all. The barber lingers on, while the actors stand before the Palace, sadly remembering barber jokes which no one seems to wish to hear again. This, no doubt, is justice. This, further, is an indication that the barber must not be sold short, at least not while the hair is growing longer every day. Finally, it is an indication that

DON'T SELL THE BARBER SHORT (Cont'd)

the barber is more than he is pictured, even the normal barber, and not only that theoretical one who is interested in anarchy. The barber has been around for a long time, and this afternoon will not be his last working hour. Pay attention to him, not only because he holds the razor.

The thoughts and the conversation of the barber grow and increase through the day, and that is true of any other student and scholar. The The first client in the morning may bring in no more than the weather, but the second will have a street accident and the third a relevant quotation from Schopenhauer. Human-interest stories follow confidential background material, and that in turn follows casual speculation. As he passes along news and comment, the barber is an editor, winnowing out what seems important from what can be regarded as no more than trivial. A good barber, one experienced in his trade, can soothe and reassure, can also teach and reaffirm, and he is one to deserve the complete attention.

This, he is in a position to demand in any case. He can answer lassitude by the only legal form of hair-pulling allowed in this state. Further, a man sitting down is at a disadvantage in any argument with a standing man, especially if the latter holds the razor. Listen to him.

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block II	1	INSTRUMENTS - ACCESSORIES
AIMS:	A	To acquire a trade knowledge of barbering tools and accessories.
	B	To learn how to recognize and care for barbering instruments and accessories.
PREPARATION:		Select and arrange various types of razors, shears, clippers, hones, strops, combs, brushes and latherizers.
PRESENTATION:	A	THEORY LECTURE METHOD 1. Explain why proper implements are necessary for efficient barbering. 2. Name and illustrate the various implements and accessories used in barbering. 3. Explain and illustrate the main parts, types and proper care of razors. 4. Explain and illustrate the main parts, types and care of shears. 5. Explain and illustrate the main parts, types and proper care of clippers. 6. Explain and illustrate the various types of hones and strops. 7. Explain and illustrate the various types of combs, brushes and latherizers. 8. Explain the sanitary requirements in the use of barbering implements and accessories.
APPLICATION:	A	Study textbooks, Lesson I, Pages 24 - 30.
	B	Review with discussion and demonstration.
	C	Review examination questions.
	D	Vocabulary or word study.
TESTS:	A	Examination papers, Lesson I, Chapter I, Pages 2,3.
	B	Manipulation of tools.

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Division of Vocational Education

INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III	1	PRACTICAL SKILLS
AIMS:	A	To understand the basic principles of male haircutting.
	B	To become skilled in the proper use and care of haircutting instrument.
	C	To acquire skill in the cutting and styling of men's hair.
	D	To understand the handling of special problems relating to male haircutting.
PREPARATIONS:	A	Select and arrange necessary supplies - combs, brushes, shears, clippers, etc., for demonstration and practice.
PRESENTATION:	A	THEORY: LECTURE METHOD -- DISCUSSION 1. Explain the importance of the basic principles of male haircutting. 2. Explain the need of studying physiognomy 3. Explain the need of being analytical in contour outline. 4. Give name and description for men's basic haircuts. 5. Give name and description for boy's basic haircuts. 6. Explain the importance of cleanliness in haircutting. 7. Explain the steps and procedure to be followed in giving a haircut. DEMONSTRATION 1. Proper Manipulation and use of haircutting implements a. Show how to hold and use the clipper (hand - electric). b. Show how to hold and use the comb and shears (thinning included). 2. Procedure of Haircutting a. Show how to prepare a patron for a haircut. b. Show how to use the shear and comb (for a natural hairline). c. Show to use clipper on a patron. d. Show how to taper and thin out hair. e. Show how to use the finger and shear work on patron. f. Show how to make the front and side outlines on a patron. g. Show how shave the neck on a patron. h. Show how to finish the haircut.

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Block III	Unit 1	Practical Skills (continued)
	B	Demonstration (continued) 3. Special Problems a. Show how to shape eyebrows. b. Show how to trim or cut hair out of ears. c. Show how to trim a mustache.
APPLICATION:	A	Study textbook - Lesson II, Pages 15 - 22.
	B	Study exhibits - Lesson II, Pages 16, 17,18,19,20,21.
	C	Student Practical Performance
	D	Discussion - Orientation - Visual Aid - Review
	E	Student Practice
TEST:	A	Examination papers - Lesson II, Chapter II, Pages 4,5.
	B	Select questions for T and F master list.
	C	Select questions from M.T. master list.
	D	Oral
	E	Performance

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICAL

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III	2	PRACTICAL SKILLS
AIMS:	A	To understand the basic principles of shaving.
	B	To require the proper technique in face and neck shaving.
	C	To know how to handle the fundamentals and special problems related to good shaving.
PREPARATION:	A	Select and arrange necessary supplies - razors, hones, strops, lather, brushes, towels,etc., for demonstration and practice.
PRESENTATION:	A	THEORY: LECTURE METHOD - DISCUSSION 1. Explain the fundamentals and importance in good shaving. 2. Explain the four most popular positions of holding the razor. 3. Explain and list the necessary steps to prepare the face for shaving. 4. Explain the section of steam towels and lather on the face. 5. Explain the precautions to be observed in shaving the face. 6. Explain the proper method of shaving. Number of steps, etc. 7. Explain the precautions to be observed in shaping the eyebrows and mustaches, the use of styptic powder and removing of blackheads.
	B	DEMONSTRATIONS 1. Honing and Stropping a. Review the use of razor on the hone and strop. 2. Position and strokes of the razor a. Show how to apply and hold the razor in the free hand stroke. b. Show how to apply and hold the razor in the back hand stroke. c. Show how to apply and hold the razor in the reverse free hand stroke. d. Show how to apply and hold the razor in the reverse back hand stroke. 3. Proper Method of Shaving a. Show how to prepare the patron. (1) Arrange chair cloth (2) Recline chair (3) Tuck in towel (4) Hygenic preparation

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Block III	Unit	2 PRACTICAL SKILLS (Continued)
PRESENTATION: (Continued)	B	Demonstrations - (Continued) 3. Proper Method of Shaving (continued) (b) Show how to make and apply lather (c) Show how to heat and apply steam towels (d) Demonstrate how to shave the right and the left side of the face (e) Demonstrate how to shave second time over (f) Demonstrate how to finish shaving the face (g) Demonstrate neck shave 4. SPECIAL PROBLEMS RELATED TO GOOD SHAVING (a) Demonstrate how to shape eyebrows (b) Demonstrate how to shape mustache (c) Demonstrate how to apply styptic powder (d) Demonstrate how to remove blackheads from the face.
APPLICATION:	A	Study textbook - Lesson II, Pages 3 - 14
	B	Student Practical Performance
	C	Discussion - Orientation - Review
	D	Student Practice
TEST:	A	Examination papers - Lesson II, Chapter II, Pages 2, 3
	B	Select questions from T and F master list
	C	Select questions from M.T. master list
	D	Oral
	E	Performance

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III	2	LATHERING TECHNIQUE
AIM:	A	To appreciate the important part lathering has on a good shave.
PREPARATION:		Select and arrange various types of lathering preparations, soap - cream - shaving brush-latherizer.
PRESENTATION:	A	Explain and illustrate various methods of lathering.
	B	Explain the different mixtures of lather
	C	Explain the rotary movement
	D	Explain and illustrate the use of hot towels in lathering.
	E	Explain what effect soap or shaving cream has on beard.
APPLICATION:	A	Study textbook - Lesson I, Page 30 Lesson II, Page 3
	B	Review with discussion.
	C	Student practice.
TEST:	A	Oral
	B	Demonstration by students

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III	3	PRACTICAL SKILLS
AIMS:	A	To know the benefits of proper hair shampooing.
	B	To acquire skill in shampooing the hair.
PREPARATION:	A	Select and arrange necessary supplies - towels, combs, brushes, various kinds of shampoos; etc., for demonstration and practice.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION 1. Explain the importance of shampooing to the practice of barbering. 2. Explain the essential benefits of a scalp manipulation accompanying the hair shampoo. 3. Explain the essential benefits of regular shampoos. 4. Explain the proper procedure of shampooing the hair.
	B	DEMONSTRATION 1. Proper Shampoo Service a. Demonstration how to prepare patron. b. Demonstration how to apply the shampoo and make sufficient lather to cover the scalp. c. Demonstrate manipulation of scalp-rotary movements using finger tips only with normal pressure. d. Demonstrate how to properly rinse the hair (twice). e. Demonstrate how to dry and groom the hair
APPLICATION:	A	Study textbook -- Lesson II, Pages 22, 23. Discussion - Orientation - Review -- Student Practice.
TEST:	A	Oral
	B	Examination papers - Lesson II, Chapter II, Page 5
	C	Performance

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III	4	PRACTICAL MASSAGE
AIMS:	A	To review the principles of anatomy and massage as applied to facial treatments.
	B	To understand the benefits of the plain practical massage.
	C	To acquire skill in giving a practical massage.
PREPARATION:	A	Select and arrange necessary supplies - towels, cleansing cream, vanishing cream, tissue, witch hazel, toilet water, etc., for demonstration and practice.
PRESENTATION:	A	THEORY - LECTURE METHOD - QUESTIONS - ANSWERS METHOD 1. Explain the importance of practical massaging to the practice of barbering. 2. Explain the necessity of being thoroughly familiar with the origin and insertion of the muscles as well as their location. 3. Explain how important it is to also know the location of the nerves, arteries, and the general lymphatic drainage system. 4 Explain and discuss the difference, in giving a strong robust man and a delicate one, a practical massage. 5. Explain and demonstrate the technique of practical massaging involving the muscles of the face and neck. a. Massaging of forehead to remove lines. b. To remove wrinkles at corners of eyes. c. Massaging around eyes. d. To remove wrinkles corner of mouth, chin, etc. e. To improve contour of cheeks. f. To correct flabbiness and double chin. g. To relax the nervous system and restlessness. 6. Explain the sanitary precautions to be observed in giving a practical massage. 7. Explain the physiological effects of movements. 8. Explain what results are obtained by passive movements. 9. Explain the difference between the active and restive movements.

Block III	Unit	4 PRACTICAL MASSAGE (continued)
PRESENTATION (Continued)	B	<u>Demonstrations</u> 1. Movements for practical massage (cleaning or vanishing cream). a. Show how to prepare the patron. b. Show how to apply either cleansing or vanishing cream. c. Show how massage the forehead. d. Show how to massage the regions of the nose and eyes. e. Show how to massage the temples and around the ears. f. Show how to massage the cheeks and chin. g. Show how to massage under the chin and neck. 2. <u>Proper Method to be Applied for Rolling Cream Massage</u> a. Show how to prepare the patron. b. Steam face well with three or four hot towels. c. Apply cold cream, and manipulate thoroughly. d. Apply one or two hot towels to remove excess cream, etc. e. Apply rolling massage cream thinly and spread evenly over face. f. Manipulate the face with rotary and stroking movements with finger tips and continue this operation evenly and with precision all over the face and neck and forehead until cream has been rolled off. g. Apply more cold cream with a few light manipulations, cleanse skin. h. Apply witch hazel steam (plenty of hot towels) i. Apply toilet lotion. j. Dry thoroughly and finish as desired. k. Use dual vibrators if desired.
<u>APPLICATION</u>:	A	Study textbook, Lesson IX, Pages 29 - 39.
	B	Review - Discussion
	C	Student practice of movements.
<u>TEST</u>:	A	Oral
	B	Performance in giving a practical massage.
	C	Thesis on "Benefits of Proper Massaging" (150 words)

CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education

BARBER TRADE

SUPPLEMENTAL INSTRUCTIONAL MATERIAL

	Unit	Title
Block III	4	MASSAGE, GENERAL OR ROLLING CREAM
	1.	Directly after shaving, cleanse face thoroughly with steam towel.
	2.	Apply cleansing cream in abundance. Manipulate well. Apply three (3) steam towels being careful not to remove the cold cream.
	3.	With the cold cream as a base, apply Rolling Cream.
	4.	Apply Witch Hazel Steam (3 steam towels)
	5.	Remove commodones.
	6.	Apply cleansing cream, manipulating well. Apply three (3) steam towels, without removing cream.
	7.	Apply Infra-Red over cream 5-10 minutes or Ultra-Violet Lamp 3-5 minutes. Manipulate under light.
	8.	Remove cream, sponge with cleansing satins.
	9.	Apply powder if necessary.
	10.	(Optional) If powder has been applied, use double vibrator.

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III		PRACTICAL SKILLS
	5	SINGEING
AIM:	A	To understand what value singeing does to hair.
	B	To acquire skill in the art of singeing.
PREPARATION:	A	Select and arrange necessary supplies - wax tapers, comb, match, towel, etc., for demonstration and practice.
PRESENTATION:	A	THEORY — LECTURE METHOD OR QUESTION-ANSWER METHOD 1. Explain the values of singeing. 2. Explain the structure of hair before and after a singe. 3. Explain the necessary precautions required in giving a singe. 4. Explain the difference between singeing a man's hair and a lady's long hair. 5. Explain the procedure of singeing.
	B	DEMONSTRATION 1. Proper Use of Singeing Implements a. Review how to use comb - fingers and wax taper. 2. Procedures in Singeing a. Show how to prepare a patron for hair singeing. b. Demonstrate the procedures in giving a singe. c. Show how to singe a man's hair. d. Show how to singe a woman's hair.
APPLICATION:	A	Study textbook - Lesson II, Page 22.
	B	Study different types of singeing.
	C	Discussion - Orientation by students - Review
	D	Student Practice
TEST:	A	Question and Answer
	B	Oral
	C	Performance

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INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III		PRACTICAL SKILLS
	6	STROPPING AND HONING
AIM:	A	To know the necessary principles of proper stropping and honing.
	B	To acquire the best skill in the sharpening of the razor.
	C	To acquire skill in the precision stroke, use and care of the hone and strop.
PREPARATION:		Pick our and arrange necessary supplies - old razors, hones, strops, soap, lather, etc.
PRESENTATION:	A	THEORY: LECTURE METHOD 1. Explain the important part of honing and stropping required for proper shaving. 2. Explain the distinction between honing and stropping. 3. Explain the requirements of proper honing and stropping. 4. Explain the proper care of a hone and strop. 5. Explain what sanitation means to a hone and strop.
	B	DEMONSTRATIONS 1. Honing a. Preparation of the hone for use. b. Proper procedure to hold the razor. c. Show how to stroke the razor on the hone. d. Demonstrate how to test the razor. e. Demonstrate how to clean a hone. 2. Stropping a. Preparation of the strop for use. b. Demonstrate how to hold and stroke the razor on the strop. c. Show how to clean the strop. d. Show how to test razor after stropping.
APPLICATION:	A	Study textbook, Lesson I, Pages 24 - 26
	B	Review with discussion and orientation.
	C	Review examination questions, Lesson I.
TEST:	A	Examination papers, Lesson I, Chapter I, Pages 3, 4, 5.
	B	Select questions from T and F master list.
	C	Select questions from M. T. master list.
	D	Performance test.

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THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block III		PRACTICAL SKILLS
	7	HAIR TONIC APPLICATION
AIMS:	A	To understand the benefits of hair tonics.
	B	To acquire skill in selection and sale of hair tonics.
	C	To acquire skill in the effective application of hair tonics.
PREPARATION:	A	Select and prepar necessary supplies - different kinds of hair tonics, combs, brushes, towels, etc., for practice and demonstration.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION 1. Explain the importance of hair tonics to the practice of barbering. 2. Explain the benefits of regular hair tonic application. 3. Explain the prime importance of proper approach in the sale of a tonic. 4. Explain how to judge merits of particular tonic. 5. Explain benefits of different types of hair tonics. 6. Explain the results derived from proper manipulation and a scalp steam.
	B	DEMONSTRATION 1. Hair Tonic and Scalp Steam a. Demonstrate how to apply a hair tonic. b. Demonstrate how to manipulate (1) Hand (2) Electric vibrator c. Show how to give a scalp steam (1) Towels (2) Head steamer d. Demonstrate how to dress the hair.
APPLICATION:	A	Study textbook - Lesson II, Pages 25, 26.
	B	Discussion - Orientation - Review - Student Practice.
TEST:	A	Examination papers - Lesson II, Page 6.
	B	Oral
	C	Performance

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	Unit	Title
Block IV		Bacteriology
	1	BACTERIA - HYGIENE -- SANITATION
AIMS:	A	To understand the structure and behavior of bacteria.
	B	To understand the role of bacteria in the cause and spread of disease.
PREPARATION:	A	Prepare outline to show classification of pathogenic and non-pathogenic bacteria.
	B	Prepare slides for "Keystone Overhead Projectors" demonstrating general forms, groups, etc., of bacteria.
PRESENTATION:	A	THEORY - LECTURE METHOD - VISUAL AID - DISCUSSION - QUESTION AND ANSWER METHOD 1. Explain what bacteriology means and from what language it is derived. 2. Explain why bacteriology is an important subject to the barbers. 3. Explain how bacteria was first discovered. a. Jesuit priest (Kircher) b. Leeuenhock - Linnaeus - Plenciz -- Cohen c. Louis Pasteur - Lister - Koch 4. Distinguish between pathogenic and non-pathogenic bacteria, giving examples of each. 5. Describe and illustrate the various forms and shapes of bacteria. 6. State three common diseases caused by bacteria. 7. Explain the conditions favorable to the growth and and multiplication of bacteria. 8. Explain how bacteria may infect our bodies. 9. Explain under what conditions bacteria form spores. 10. Distinguish between local and general infections - giving example of each. 11. Explain how the body fights infection. 12. Explain the dangers of human disease carriers. 13. Explain the chief sources of contagion in the barber shop. 14. Explain how sanitation and sterilization will help combat bacteria in the barber shop.
APPLICATION:	A	Study textbook, Lesson VIII, Pages 3, 6, 9, 12, 13.
	B	Discussion - Orientation -- Review

Block IV	Unit 1	BACTERIOLOGY BACTERIA - HYGIENE - SANITATION (continued)
APPLICATION: (continued)	C	Have students demonstrate and explain slides, etc.
	D	Study summary of bacteria as a cause of disease.
TEST:	A	Oral
	B	Examination papers, Lesson VIII, Chapter XIII, Page 3.
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.
	E	Thesis on summary of bacteria as a cause of disease (200 words)

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	Unit	Title
Block V		BACTERIOLOGY
	1	STERILIZATION
AIMS:	A	To understand the importance of sterilization in the prevention of disease.
	B	To be able to sterilize barber implements, equipment and supplies in an effective, safe manner.
PREPARATION:	A	Select and arrange various equipment and supplies used for the purpose of sterilization, such as cabinet sterilizer, receptacle for boiling water, formalin, shallow tray, bottles, soap, etc.
	B	Select and arrange ultra violet ray (if available).
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION 1. Explain the barber's responsibility regarding sterilization in the barber shop. 2. Explain the four methods of sterilization. a. Moist heat b. Chemical c. Vapor d. Dry heat 3. Explain the five most commonly used disinfectants and germicidal agents. 4. Explain the meaning and application of common sterilization terms. 5. Explain the safety precautions to be observed in the use of sterilization agents. 6. Explain the various strengths and uses of formalin solution. 7. Explain how tools should be sterilized. 8. Explain how other equipment can be dedorized and disinfected. 9. Emphasize the importance of sterilization.
APPLICATION:	A	Study textbook - Lesson VIII, Pages 6-10
	B	Review table on antiseptic values.
	C	Discussion

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Block IV	Unit 1	Sterilization (continued)
TEST:	A	Oral
	B	Examination papers - Lesson VIII, Chapter XIII, Page 3
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.
	E	Student briefly describe the importance of sterilization (oral or 150 words)

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PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block IV		BACTERIOLOGY
	1	HYGIENE (PERSONAL)
AIMS:	A	To understand the basis for personal and public health.
	B	To establish habits and attitudes favorable to good health.
PREPARATION:	A	Prepare outline showing different steps required to maintain a personal hygienic appearanc.
PRESENTATION:	A	THEORY - LECTURE METHOD - VISUAL AID - DISCUSSION 1. Explain one of the outstanding fundamentals for the success of a barber. 2. Explain the value of good health to the barber. 3. Name and illustrate the mental attitudes favorable to good health. 4. Explain methods used to maintain external and internal cleanliness of the body. 5. Explain how to maintain a wholesome atmosphere in the barber shop. 6. Explain the eating and drinking habits conducive to sound health and hygiene. 7. Explain how to maintain good posture while working. 8. Explain the benefits acquired from regular exercise and adequate amount of sleep.
APPLICATION:	A	Study textbook - Lesson VIII, Pages 10-12.
	B	Review - Discussion
TEST:	A	Oral
	B	Select questions from T and F master list.
	C	Grade students for personal cleanliness and clean working habits.

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THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block IV		BACTERIOLOGY
	1	SANITATION
AIMS:	A	To understand the importance of sanitation in the prevention of disease.
	B	To maintain sanitary conditions in the barber shop.
PRESENTATION:	A	Prepare outline on sanitation.
	B	Select necessary equipment, supplies, etc., for demonstration.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION 1. Explain the barber's responsibility regarding sanitation in the barber shop. 2. Explain what methods and processes sanitation deals with. 3. Explain how to maintain a barber shop in a sanitary condition. 4. Explain the sanitary rules to be observed in a barber shop. 5. Explain the proper way to dispose of soiled objects, etc.
APPLICATION:	A	Study textbook - Lesson VIII, Pages 10 - 12.
	B	Review - study bacteriology - sterilization, Lesson VIII, Pages 3 - 13.
TEST:	A	Oral
	B	Select questions from T and F master list.
	C	Select questions from M. T. master list.
	D	Assign monitors to maintain barber school or shop in a sanitary condition.
	E	Have students write thesis on sanitation (200 words)

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PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block IV		BACTERIOLOGY
	1	ANTISEPTIC VALUES
AIMS:	A	To understand the use and value of antiseptics in the practicing of barbering. 1. Antiseptics are for use on human body.
PREPARATION:	A	Select two or three antiseptics which can be used safely on the skin, etc., for demonstration, etc.
PRESENTATION:	A	THEORY - LECTURE METHOD - CHART OR TABLE - DISCUSSION 1. Explain the difference between antiseptics and disinfectants. 2. Explain how important the use of antiseptics is in the barbering profession. 3. Name and explain six antiseptics which can be used on the skin without fear of causing irritation or injury. 4. Explain table on antiseptic values.
APPLICATION:	A	Study textbook, Lesson VIII, page 6.
	B	Review - Discussion
TEST:	A	Oral
	B	Select questions from T and F master list.
	C	Thesis on uses and values of antiseptics (100 words).

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THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block IV	1	FORMULAS - AGENTS
AIMS:	A	To understand the use and application of formulas and agents for external use which can be used in the practicing of barbering.
PREPARATION:	A	Prepare outline of formulas useful to the barber profession.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION 1. Explain the importance of selecting the proper formula for each treatment. 2. Explain how careful study is made on specific cases. a. Formula may be too weak. b. Formula may be too strong. c. May be modified to suit the case. 3. Explain how any reputable druggist can put up preparations required for skin and scalp treatments administered by the professional barber. 4. Explain and demonstrate formula to be used for dandruff. a. Mild cases. b. Severe cases. 5. Explain what formula to use for ordinary scalp stimulation. 6. Explain what formula to use for ordinary shedding hair. 7. Explain what formula to use for Alopecia Areats, Eczema, itching scalp, Impetigo of the scalp, Seborrhea Sicca and Oleosa, scaly conditions of the scalp. 8. Explain formula to be used as skin and scalp food ointment. 9. Explain and discuss agents for external use. a. Alcohol b. Boric acid c. Phenol d. Glycerin e. Sulphur f. Mercury g. Oil of cade

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PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block IV		BACTERIOLOGY
	1	E FORMULAS - AGENTS (cont'd)
APPLICATION:	A	Study textbook, Lesson IX, Pages 15-23.
	B	Student practice in writing formulas.
	C	Student practice in applying formulas.
	D	Review - Discussion
TEST:	A	Oral
	B	Writing formulas
	C	Select questions from T and F master list.

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INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	1	A CELLS - TISSUES - ORGANS
AIMS:	A	To understand the general organization of body. 1. To know the skeletal system.
	B	To understand the vital activities of the cells.
	C	To understand the vital activities of the tissues.
	D	To understand the vital functions of the body. 1. Organs - (Lungs, kidneys, etc.)
PREPARATION:	A	Display wall charts of cells or other body structure.
	B	Illustrate diagram of animal cell (textbook, Lesson III, Page 6.)
PRESENTATION:	A	THEORY - LECTURE METHOD - CHARTS 1. Explain the importance of anatomy and physiology to the practice of barbering. 2. Explain and illustrate the structure of cell a. composition b. activities c. reproduction 3. Describe the important tissues of the body a. composition b. function 4. Describe the important organs of the body a. composition b. functions 5. Describe the important systems of the body a. number b. composition c. functions
APPLICATION:	A	Study textbook - Lesson III, Pages 3 - 6 Discussion - Orientation - Review
	A	Examination papers, Lesson III, Chapter III, Pages 2, 3.
TEST:	B	Oral
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.

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INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	2	SKIN, SCALP AND THE APPENDAGES
		A SKIN
AIMS:	A	To acquire the knowledge of the structure and function of the skin and its various layers.
	B	To acquire the knowledge of the structure and the function of the skin, hair and nails.
PREPARATION:	A	Prepare sectional views of skin.
	B	Prepare diagram or drawing of nail 1. nail body 2. nail bed
	C	Chart
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION -QUESTION AND ANSWER METHOD - VISUAL AID 1. Explain the principal functions of the skin 2. Name and describe the various layers of skin 3. Describe the function of the blood vessels, lymph vessels and papillae of the skin. 4. Name the parts of the body which are hairy and hairless. 5. Explain the production of pigment in the skin 6. Name and locate the skin glands 7. Explain the function of the skin glands, and the facts influencing their activity 8. Name and describe the main parts of the nail 9. Explain the function of the nail matrix a. composition and location b. production 10. Give a summary of the anatomy of the skin.
APPLICATION:	A	Study textbook - Lesson VI, Pages 3 - 8
	B	Discussion - Review - Orientation
TEST:	A	Oral
	B	Examination papers - Lesson VI, Chapter XI, Pages 2 - 3
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.
	E	Thesis on "The Anatomy of the Skin."

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INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	2	STUDY OF SKIN AND ITS APPENDAGES
		B. ANATOMY OF HAIR
AIMS:	A	To understand compositions and functions of hair To acquire the skill to determine the type of scalp treatments to apply to patrons.
PREPARATION:	A	Prepare drawings - supplemental material for discussion.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION - QUESTION AND ANSWER METHOD - VISUAL AID 1. Explain the structure and function of hair. 2. Explain and name the four groups of hair a. size and sex b. color and atmospheric moisture c. growth, shape, etc. 3. Describe the various layers of the hair. 4. Explain the production of pigment in hair. 5. Explain the physiology of the hair. 6. Explain the chemical composition of the hair. 7. Explain the elasticity of the hair. 8. Explain what the sebaceous glands furnish to the hair. 9. Explain how the new hair crowds out the old hair. a. growth of new hair b. papilla c. medulla d. hair e. adipose tissue f. hair muscle g. sebaceous gland h. horny layer 10. Explain what determines the number of hairs on the head. 11. Render a summary of the anatomy of the hair a. hair follicle b. hair
APPLICATION:	A	Study textbook - Lesson VI, Pages 8 - 14
	B	Discussion - Review - Orientation

Block V	Unit 2	ANATOMY OF HAIR (continued)
APPLICATION:	A	Study textbook - Lesson VI, Pages 8 - 14
	B	Discussion - Review - Orientation
TEST:	A	Examination papers, Lesson VI, Chapter XI, Pages 3, 4, 5.
	B	Select questions from T and F master list.
	C	Select questions from M. T. master list.
	D	Thesis on "The Anatomy of Hair"
	E	Oral

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INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	2	STUDY OF THE SKIN AND THE APPENDAGES
		C HAIR AND ITS CARE
AIMS:	A	To understand how to care for hair.
	B	To abilitize as a hair specialist.
	C	To understand the prevention of baldness.
PREPARATION:	A	Read Dr. Herman Goodman's Book "Your Hair."
	B	Display available supplies, etc., for demonstration and orientation.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION 1. Explain the requirements for the proper care of hair. 2. Explain the network of helpers required by the hair to retain its normal health. a. papillae c. oil sac b. follicles d. capillaries e.practitioner 3. Explain the necessity of stimulation - cleanliness and occasional food the hair requires. a. massage b. shampoo c. ointments and tonics 4. Explain how "diet and general health" have a very important part in the life, growth and appearance of the hair. 5. Explain the importance of "Barber Science" in the care of the hair. 6. Explain how the proper knowledge in the "care of the hair" will increase a barber's revenue and also satisfy the patrons. a. Knowledge of barber science. b. Ability to service the hair c. Satisfaction rendered to patrons. 7. Explain what Trichoptilosis is. 8. Explain what is meant by Monilithrix. 9. Explain why today's methods in "hair and its care" are more scientific and effective.

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Block V	Unit 2	C HAIR AND ITS CARE (continued)
APPLICATION:	A	Study textbook - Lesson VII, Pages 3, 4, 5, 6.
	B	Discussion - Review - Orientation
TEST:	A	Oral
	B	Conference led by student
	C	Thesis on "Hair and Its Care" (not less than 200 words)

SUPPLEMENTAL INSTRUCTION MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

FACIAL FOR OILY SKIN AND BLACKHEADS

1. Prepare patron as usual.
2. Cleanse face well with three hot towels (wrung out from castile soap water).
3. Remove blackheads with the comedone extractor, touching or daubing each spot as it is finished with an astringent.
4. Sponge face well with mild antiseptic, dry.
5. Apply astringent cream followed by placing eye pads over patron's eyes, apply high frequency or infra-red for not more than five minutes.
6. Remove excessive cream and follow by moderate massage manipulations.
7. Steam in an astringent solution (witch hazel), followed by two or three cold towels.
8. Dry and finish as patron desires.

"REMARKS"

To be used for an excessively oily condition of the skin.

Also for oily skin containing numerous blackheads.

Treatments should be repeated weekly. In most cases patron should follow diet.

NOTE: Above procedure can be also used for "Milia Facial."

SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

FACIAL FOR ACNE ROSACEA

1. Prepare patron as usual.
2. Cleanse face well with cream, after which it should be gently removed with soft tissues.
3. Bathe face with soda solution.
4. Dry face well and apply astringent cream.
5. Blue light may be used from three to five minutes.
6. Apply warm towel to remove cream.
7. Apply witch hazel, and finish as patron desires.

"REMARKS"

1. This is a difficult case to do much with, other than to give cosmetic relieving treatments.

   a. Patron should consult a physician.
   b. All treatments must be authorized or given under medical supervision.

2. If light is applied, place pads over patron's eyes.

SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

FACIAL FOR ACNE VULGARIS

1. Prepare patron as usual.

2. Apply three or four hot towels and see that face and neck are thoroughly cleansed.
   a. A medicated soap may be used in the hot water from which the towels are wrung.

3. Extract comedones with extractor, evacuating pustules that may be in evidence, make sure to apply a good antiseptic lotion immediately upon removal of the comedones.

4. Dry face well and irradiate with ultra-violet for three to six minutes.

5. Bathe face with a good acne germicidal lotion.

6. Apply acne cream and rub lightly in the skin.

7. Place pads over patron's eyes, apply infra-red lamp from seven to fifteen minutes, time to be lengthened with number of treatments.

8. Remove all traces of cream from face with two or three hot towels.

9. Apply a good cool antiseptic lotion.

10. Apply astringent cream.

11. Apply witch hazel, dry, and finish as desired.

12. Use high frequency from seven to ten minutes.

"REMARKS"

Requires continuous care and treatment. Dieting is necessary.

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

TREATMENT FOR OILY HAIR

1. Prepare patron as for usual shampoo.

2. Give scalp massaging manipulations from three to five minutes.

3. Apply tincture of green soap or tar shampoo.

4. Rinse hair well (twice) and dry.

5. Apply ultra violet lamp all over the head from three to five minutes at a target of about 22 inches.
   a. Operator must be guided by the condition of the scalp as to the proper distance.
   b. If scalp is not sensitive, it is advisable to continue scalp massage manipulations for three to five minutes.

6. Apply antiseptic alcohol tonic or desired tonic.

7. Comb hair to suit.

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

TREATMENT FOR DRY SCALP

1. Prepare patron for usual shampoo.

2. Give scalp manipulations from five to ten minutes, massaging all parts of the scalp thoroughly; use either hand or vibrator.

3. Apply with cotton warm olive or castor oil to scalp, parting hair and working it well into the scalp.

4. Allow oil to remain for a few minutes while you may apply infra lamp on it.

5. Give either a soapless oil shampoo or a special egg shampoo. (Operator should be guided by the condition of the scalp.)
   a. Soapless oil for normal condition.
   b. Special egg for irritated condition.

6. Rinse thoroughly and dry well.

7. Apply infra lamp (red) for five minutes at a target of 16 to 20 inches.

8. Finish operation by dressing hair as desired without the addition of any other elements.

"REMARKS"

If scalp is too dry, operator may between 6th and 7th operation, prior to infra red lamp, apply scalp food ointment and follow with infra red lamp.

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

TREATMENT FOR MALNUTRITION OF THE SCALP

1. Prepare patron for usual shampoo with clean linen.

2. Massage scalp very thoroughly with hand or vibrator for about ten minutes, covering every part and moving every inch of the scalp, using a rotary action in your operation.

3. Shampoo scalp with castile soap or any good shampoo which will not dry the hair.

4. Rinse hair well (twice) of all soap matter and dry.

5. Apply ultra violet lamp for three to five minutes at a target of 24 inches. Iradiation is usually divided into four parts: frontalis, two temporals and occipital, in other words, the temples, the front and back of the head.

6. Apply scalp food ointment, rub well into the scalp.

7. Use infra red light on ointment for a few minutes.

8. Dress hair with comb - use no tonics.

"REMARKS"

A. In all cases of malnutrition, the hair presents a very lifeless and dull appearance. Scalp generally dry and covered with flaky dandruff of a white variety. Scalp is also tight or hard to move.

B. Precautions: Protect eyes of patron with colored goggles.
Moistened pads over the eyes.
Operator must wear goggles also.

C. Give these treatments at least once a week.
In some cases twice a week will be necessary.

SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

GARLIC RUB RECOMMENDED FOR BALDNESS

Men who are worried about falling hair should cut down on their before-dinner Martinis, rub a little garlic on their noggins and exercise regularly.

This part of the advice proffered by Florence M. Doyle, Scalp Specialist.

"Heavy drinking and dietary excesses of almost any kind are apt to cause a person to lose his hair," Miss Doyle said, "A diet deficiency, on the other hand, also may be responsible for such a condition."

She said if a person expected to keep his hair, he must stay in good physical condition.

"This rule is particularly important for men who live sedentary lives," she said. "I find that the less active a person is the more inclined he is to baldness."

Miss Doyle said the condition of the scalp was even more important than that of the body.

"The scalp must be kept clean at all times," she said. "However, it is not wise to wash the hair more than once every two weeks. Water is bad for the hair and scalp. When washing the hair, use a good shampoo and not ordinary face soap."

To keep the scalp from becoming dry, she advocated the use of olive or castor oil.

"In most cases", she continued, "a man's hairline begins to recede because of lack of stimulation at the roots of the hair. To avoid this, the scalp should be vigorously massaged every day. The use of certain

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GARLIC RUB RECOMMENDED FOR BALDNESS (cont'd)

stimulants will help too. One of the best stimulants I know of is garlic. It can be purchased in processed form, completely deodorized."

Miss Doyle said that baldness often was caused by illness, eyestrain, worry, overwork, and hypertension. She said hats, unless they were very tight, did not affect hair growth.

She said baldness is more frequent today than every generation before. It is now common among men in their early 20's, as compared to 30 a generation ago.

Occupation and climate also affect the hairline, she said. She observed that baldness ranked this way among various job holders:

1. Accountants
2. Airplane pilots
3. Musicians
4. Newspapermen
5. Professional athletes.

SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

TREATMENT FOR CHILDREN'S HEAD LICE

In the spring of the year many children come home from school scratching their heads - not from what knowledge they gleaned but from head lice they have picked up. When they scratch, the condition is in an advanced stage. Herman Goodman, M. D., dermatologist, suggests this treatment in his book "Your Hair."

"Successful treatment of the patient with head lice requires that all the living parasites be removed from the head; all visible eggs be destroyed; and reinfestation be avoided. Caps and other articles worn or placed in contact with the scalp must be cleaned."

"Lice are removed by fine combing. (Such a comb is sold at drug stores.) They are destroyed by keeping the hair under a cap moistened with equal parts of delphinium (larkspur) and ether, or kerosene and salad oil. Other formulas include mixture of vinegar and alcohol. It is necessary to remove the nits."

The louse attaches the egg to the hair shaft with a cement-like substance. This substance may be softened by either a solution of alkali, such as sodium bicarbonate or borax, or acid, such as warmed household vinegar."

"Patience is required to clear the lice-ridden scalp. A piece of gauze or linen should be soaked in one of the suggested liquids and carefully and deliberately stroked over separate strands of hair until all the hair has been moistened. Stroke should be in the direction from free end and toward the scalp. This direction is necessary because the eggs are attached to the hairs at an angle. If the rubbing is done from the scalp to the free end of the hair, the eggs will probably be passed over without being loosened. Stroking with the saturated cloth effectively removes the eggs.

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

INTERNATIONAL INDIVIDUALIZED HAIR TREATMENT

The success of the treatment is in the uniformity of service and with professional thoroughness. A general procedure is here given; you may substitute whatever ointment or lotion the case may require, but the general application is the same.

1. Wrap clean hair cloth and necessary clean linen carefully around patron's neck.
2. Comb hair gently and note if any sores are visible on the scalp. Study conditions of the scalp and hair, determine treatment most suitable.
3. Massage scalp thoroughly as may be required until it moves loosely over the skull.
4. Carefully cleanse hair and scalp with required shampoo. Rinse out all soap or other shampoo ingredients.
5. Dry hair well with clean towels or electric dryer.
6. Use ultra violet lamp if required, as also may be expedient in the conditions of the scalp and hair.
7. Use whatever ointment the case may require and apply same with fresh new cotton. Oils may be applied the same way.
8. Give a few light scalp manipulations.
9. Use infra red lamp as required.
10. Cover head with clean towel and allow ointment or oil to remain on for about ten minutes.
11. If necessary, shampoo head for second time and dry well.
12. Take fresh piece of cotton and apply astringent, or other ointment or lotion, parting hair in one or two inch sections until the entire scalp is covered.
13. Gently manipulate scalp, massaging preparation well into scalp.
14. Comb hair as desired, using no brush if possible. If brush is used, see to it that it is perfectly sterilized before and after using.
15. Finish treatment as may be desired, and carefully remove hair cloth and other linens.

5311

SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

HAIR AS RACE CHARACTERISTICS

1. Dr. Blumenbach stated five different races as to their skin color - black, brown, red, yellow and white

2. Dr. Pritchard grouped them in three classes.
   a. Color of hair and skin not sufficient to determine the character of the race.

3. Dr. G. St. Hilaire classifies all the whites, yellow, brown and red races under straight hair (Leiotrichi), and all negroes, (Negritos) Hottentot, and Bushman under the wooly-haired (Ultrichi).

4. Hair may well be described in general terms as coarse, fine,smooth, straight, curly, waved, frizzy, wooly, crimped or tufted.

5. Seborrhea Oleosa, commonly found among Negroes.
   a. Appears on scalp and face.
   b. Secretion of sebaceous glands.
   c. Acne and comedones are often seen.

6. Seborrhea Sicca cheifly attacks the scalp.
   a. Dandruff accumulates.
   b. Skin and hair become dry.

7. Seborrhea is a functional disorder causing the sebaceous glands to an increased or altered secretion.
   a. Natural sebum consists of fat and the breaking down of cellular tissues so necessary for the oiling of the skin.
   b. Either one of the causes gives the two varieties of Seborrhea (oleosh-sicca).

5312

SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK V, UNIT 2

LOCATE SHAVING BRUSHES OF ANTHRAX INFECTED SHIPMENT HEALTH OFFICERS THROUGHOUT STATE SEEKING OTHERS

Anthrax is a severe infectious disease that primarily affects cattle, sheep and other animals. Man may contract the disease by contact with such animals or by handling animal products such as hides, wool and bristles that have come from infected animals.

Recently information was received from the U. S. Public Health Service that shaving brushes of a lot marked "332 Imperial Japan Sterilized" had been found infected with anthrax. The brushes in questions were imported from Japan in October, 1937. While the importer's records did not show that any of them had been sold to wholesalers in Connecticut, the information furnished by the Public Health Service was sent to all health officers in Connecticut by the State Department of Health in a circular letter dated January 30, 1939. On Saturday, February 4, 1939, three brushes "Made in Japan" and bearing the lot number indicated were received in the office of the State Department of Health Officer of Clinton. These brushes were promptly sent to the laboratory for examination for anthrax. From telephone conversation with Doctor Wellman, Health Officer of Clinton, it was learned that the store where the brushes were found had recently changed hands, that the former owner was away and could not be reached at the time in order to ascertain the source of the brushes.

However, since brushes in this infected lot have been found in one Connecticut store, it is possible that they may be found in others. Additional information concerning the matter is contained in a press release sent out for publication January 26, 1939, by the New York City Department of Health after conference with Public Health Service officials which reads in part as follows:

> "Recently a case of anthrax in North Dakota was traced to a Japanese shaving brush. In the study of this case anthrax bacilli was found on a number of similar shaving brushes from the same lot both in the laboratory of the National Institute of Health at Washington and in the laboratory of the New York City Department of Health.
>
> The brushes were imported from Japan in 1937 and distributed from New York, the shipments, so far as the present investigation has gone, being made to points outside of the city. Steps are now being taken by the United States Public Health Service in cooperation with state and local health authorities to recover those still in the hands of wholesale and retail dealers.
>
> "In New York City there have been no cases of anthrax since 1936 and no cases traceable to infected shaving brushes since 1925. Nevertheless, the Department of Health believes it advisable to call attention to this particular lot of Japenese shaving brushes, inasmuch as it is possible that there may be some of these brushes in the hands of dealers or users in New York City.

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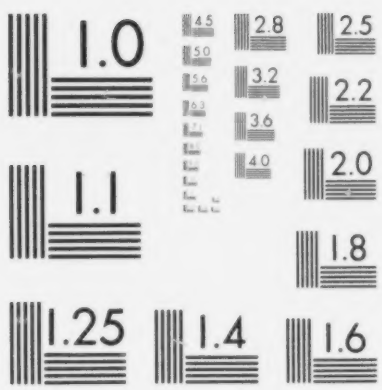

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

BARBER TRADE

BLOCK V, UNIT 2

Anthrax Infected Brushes (continued)

> "The brushes are of a cheap variety - small in size, 4½ inches over all, the handles, 3/4 inch in diameter, painted in two colors. On top they are stamped 'Japan 332', and on the side they bear the words 'Imperial - sterilized', the latter in small letters. The brush is of stiff hair, grayish in color, or mixed black and white."

If any additional brushes bearing the lot number in question are found anywhere in Connecticut, it will be greatly appreciated if notice is sent to the State Department of Health at once. Better still, it would save time and trouble in investigations if the brushes were shipped in and information furnished with reference to their origin. Such information would facilitate further checkup on the distribution of the lot of infected brushes.

Incidentally, the only case of anthrax traced to a shaving brush during recent years in Connecticut occurred in 1932. A man gave his own brush to his son and began using an old brush he had found somewhere and in a few days he came down with anthrax which was fatal. Presumbaly, the old brush was one that was distributed during or shortly after the World War when a number of shaving brushes were found to be infected with anthrax.

CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education

INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	3	STUDY OF THE BONES OF THE HEAD AND FACE
		(OSTEOLOGY)
AIMS:	1	To understand the structure and function of the bones of the head and face.
	2	To become capable of identifying the important bones of the head and face
PREPARATION:	A	Illustrate wall and loose leaf charts showing bones of the head.
PRESENTATION:	A	THEORY - LECTURE METHOD - VISUAL AID - QUESTIONS AND ANSWERS 1. Name and explain the two kinds of bony tissue 2. Explain the importance of the bones of the head and face to the practicing of barber. 3. Explain the structure of bony tissue. 4. Explain how the bone marrow aids in the nutrition of the bone. 5. Explain how the blood supply reaches the bones. 6. Explain the vital functions of bones in body. 7. Explain and illustrate the number and shape of bones found in the body. 8. Name and describe the kind of joints in body. 9. Name and locate the facial bones. 10. Explain the structure and function of the chest cavity.
APPLICATION:	A	Study textbook - Lesson III, Pages 7 - 10
	B	Discussion - Review - Orientation
TEST:	A	Examination papers - Lesson III, Chapter IV, Pages 3, 4
	B	Oral
	C	Select questions from T and F master lists.
	D	Select questions from M.T. master list.

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education

INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	3	THE SKULL
AIM:	1	To understand the structure and function of the bones of the skull
	2	The ability to identify the important bones of the skull.
PREPARATION:	A	Illustrate wall and loose leaf charts showing bones of the skull
PRESENTATION:	A	THEORY - LECTURE METHOD - VISUAL AID - QUESTION AND ANSWERS 1. Describe the shape and function of the skull. 2. Name and locate the cranial bones. 3. Name the number of bones found in the skull. 4. Name the important muscular and nerve attachments of the cranial bones.
APPLICATION:	A	Study textbook - Lesson III, Pages 7 - 10
	B	Discussion - Review - Orientation.
TEST:	A	Oral
	B	Examination papers, Lesson III, Chapter IV, Pages 3, 4
	C	Select questions from T. and F. master list.
	D	Select questions from M.T. master list.

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education

INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	4	STUDY OF MUSCLES OF THE HEAD, FACE AND NECK (MYOLOGY)
		(continued)
PRESENTATION:	A	THEORY - LECTURE METHOD - VISUAL AID - QUESTIONS AND ANSWERS 15. Emphasize the important muscles involved in face and scalp treatments. 16. Emphasize the importance of knowing how to read a table on muscles.
APPLICATION:	A	Study textbook, Lesson III, Pages 11-17
	B	Discussion - Review - Orientation
	C	Demonstration by students on charts and table of muscles.
TEST:	A	Oral
	B	Examination papers, Lesson III, Chapter V, Pages 5, 6
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.
	E	Reading of table and charts (including explanation)

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education

INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	5	STUDY OF NERVES OF HEAD, FACE, NECK (NEUROLOGY)
		A. NERVOUS SYSTEM B. CHART OF NERVES C. TABLE OF NERVES
AIMS:	1	To understand the structure and function of the nervous system.
	2	The ability to identify the important nerves and their branches of the head, face and neck.
	3	To acquire the ability to read and understand table on nerves.
PREPRATION:	A	Display wall and loose-leaf charts showing the nerves of the head, face and neck.
	B	Display table on nerves.
PRESENTATION:	A	THEORY - LECTURE METHOD - VISUAL AID - QUESTIONS AND ANSWERS 1. Name and describe the two divisions of the nervous system. 2. Name and describe important parts of their function. 3. Distinguish between motor and sensory nerves. 4. Explain the effects of nervous action on various body functions. 5. Compare the nervous system with industrial units in a community. 6. Name and locate cranial nerves and their branches. 7. Name the parts of the body supplied by the cranial nerves and their branches. 8. Describe the function of the cranial nerves and their branches. 9. Name and locate other nerves which supply the head, face and neck regions. 10. Emphasize the important nerves involved in face and scalp treatments. 11. Emphasize the importance of knowing how to read a table on nerves. 12. Explain what is meant by nerve fatigue.

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BLOCK V	Unit 5	STUDY OF NERVES OF HEAD, FACE, NECK (Continued)
APPLICATION:	A	Study textbook - Lesson IV, Pages 3-11
	B	Discusstion - Review - Orientation
	C	Demonstration by students on charts and table of nerves.
TEST:	A	Oral
	B	Examination papers - Lesson IV, Chapter VI, Pages 2, 3.
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.
	E	Reading of table and charts (including explanation).

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	6	BLOOD VASCULAR CIRCULATORY SYSTEM (ANGIOLOGY)
		A. VEINS OF HEAD, FACE AND NECK B. ARTERIES C. PRINCIPAL ARTERIES AND VEINS
AIMS:	A	To understand the structure and functions of the blood vascular system.
	B	To understand how the blood and lymph circulate through the body.
	C	To know the blood supply to the face and scalp.
	D	To appreciate how important the knowledge of the blood vascular system is to the average barber.
PREPARATION:	A	Display wall and loose leaf charts of the heart and blood circulation to the head, face and neck.
	B	Procure movie on "The Heart and Circulation", Code #EF-27.
PRESENTATION:	A	THEORY-LECTURE METHOD-VISUAL AID-QUESTION-ANSWER 1. Explain what the blood vascular system consists of. 2. Name and describe the two main branches of the blood vascular system. 3. Give a description of the location and activities of the heart and blood vessels. 4. Distinguish between arteries, veins and capillaries. 5. Explain the vital functions of the blood. a. Weight b. Appearance through microscopic examination. c. Types of corpuscles and their function. 6. Trace the circulation of the blood from and to the heart. 7. Name and locate the main blood vessels found in the head and face. 8. Name the parts of the head and face supplied by these blood vessels. 9. Trace the flow of blood from the head and face to and from the heart. 10. Emphasize the importance of understanding the blood vascular system.

Block V	Unit 6	BLOOD VASCULAR CIRCULATORY SYSTEM (Continued)
APPLICATION:	A	Study textbook - Lesson IV, Pages 13-23
	B	Discussion - Review - Orientation
	C	Demonstration by students on charts on blood circulation to the head, face and neck.
TEST:	A	Oral
	B	Examination papers, Lesson IV, Chapter VII, Pages 3, 4
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.
	E	Reading charts (including explanations).

CONNECTICUT STATE DEPARTMENT OF EDUCATION
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INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	6	B. LYMPHATIC SYSTEM (LYMPH VASCULAR)
AIMS:	A	To understand the structure and functions of the lymphatic system.
	B	To understand important factors of the lymphatic system to the art of barbering.
PREPARATION:	A	Display wall and loose-leaf charts of the lymphatic system.
	B	Prepare diagram to give a complete summarization of the lymphatic system.
PRESENTATION:	A	THEORY - LECTURE METHOD-VISUAL AID-QUESTIONS-ANSWERS 1. Explain what comprises the lymphatic system. 2. Explain what lymph is a. source b. types c. description d. function 3. Explain the importance of the lymphatics to the art of barbering. 4. Explain why the lymphatic system is called the drainage system of the body. 5. Explain the thoracic duct. 6. Explain the right lymphatic duct. 7. Explain the relationship of the lymphatic system to the blood vascular system.
APPLICATION:	A	Study textbook - Lesson V, Pages 3-6
	B	Discussion - Review - Orientation
TEST:	A	Oral
	B	Examination papers, Lesson V, Chapter VIII, Pages 2, 3
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.

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INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	7	DIGESTIVE TRACT (RELATIONSHIP TO BARBERING)
		A.-B. FOOD AND DIGESTIVE TRACT
AIMS:	A	To understand the food requirements of the body.
	B	To understand how the digestive system changes the food we eat. 1. Manner it is absorbed and assimilated by the body.
PREPARATION:	A	Display loose-leaf chart of the alimentary canal.
	B	Procure movie "Digestion of Foods" Code #EF-26.
PRESENTATION:	A	THEORY - LECTURE METHOD - VISUAL AID - DISCUSSION QUESTION AND ANSWER METHOD 1. Explain for what purpose food is taken into the body. 2. Name the chemical elements found in the food substance that maintain that body. 3. Explain the various combinations of these chemicals. a. What they form-what they are called b. Name the substances involved 4. Name the vitamins and their importance in the daily diet. 5. Name and describe the important digestive organs. 6. Explain how the alimentary canal and its appendages function. 7. Explain how the accessory organs function. 8. Explain how poor digestion affects hair and skin.
APPLICATION:	A	Read textbook - Lesson V, Pages 11-17
	B	Discussion - Review - Orientation
TEST:	A	Select questions from T and F master list.
	B	Select questions from M.T. master list.
	C	Examination paper - Lesson V, Chapter X, Pages 4, 5, 6.
	D	Oral

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE
BLOCK V, UNIT 7

NEW MEDICAL INTEREST IN VITAMIN E

Physicians have renewed interest in the elusive vitamin E, and they feel that many of us lack sufficient of the valuable vitamin in our diets.

It is considered that vitamin E plays an important chemical role in aiding the body to take nourishment from all the other vitamins. It has been proven that this vitamin is essential to normal reproduction, normal growth and the proper functioning of the pituitary gland. When young animals are denied vitamin E they get partial paralysis and do not reproduce.

Vitamin E comes from 100 per cent whole grains (which most menus lack), but it may be gotten from other foods such as fresh wheat germ, avacado oil, corn oil, sesame seed oil, soya bean oil, peanut oil, lettuce, tomatoes, carrots, egg yolks and nuts.

As you glance through that list, including whole grains, you undoubtedly are aware that you do not eat many of these foods, at least in any quantity. If that is the case you are perhaps in need of vitamin E and should plan to include one of those foods in your daily diet.

Women depend upon vitamin E for beauty and for your reproduction. The consensus of medical opinion is that if a pregnant mother has sufficient vitamin E there is little danger of a miscarriage or a premature birth. Other ailments such as diabetes and partial paralysis are being treated with concentrated doses of vitamin E.

Whole grains are: cornmeal, steel-cut oatmeal, all-bran, barley,wild rice, wheat germ, whole wheat, corn.

If we are told to eat these foods to keep us normal, healthy and beautiful, why not eat them?

Acne cannot be wished away! It can be overcome.

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INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	8	RESPIRATORY - EXCRETORY - UROGENITAL SYSTEMS
		(RELATIONSHIP TO BARBERING)
AIMS:	A	To understand the structure and functions of the respiratory, excretory and urogenital systems.
	B	To understand why the skin and hair are dependent on the proper functions of the organs comprising the excretory and respiratory systems.
PREPARATION:	A	Prepare brief outline to be used for discussion or conference.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION - CONFERENCE 1. Name and describe the important respiratory organs. 2. Name and describe the important excretory organs. 3. Explain the vital functions performed by these excretory organs. 4. Explain the location and functions of the important glands in the body. 5. Explain the chemical changes continuously taking place in the respiratory and excretory systems. 6. Distinguish between abdominal and costal breathing. 7. Explain the importance of knowing the functions of the respiratory and excretory systems in the art of barbering.
APPLICATION:	A	Study textbook - Lesson V, Pages 7 - 10
	B	Discussion - Review - Orientation - Conference
TEST:	A	Examination papers - Lesson V, Chapter IX, Pages 3, 4.
	B	Oral
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
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THEORY AND PRACTICE

INSTRUCTOR'S LESSON PLANS

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block V		SYSTEMS OF THE BODY
	9	RESPIRATORY - SECRETORY - UROGENITAL SYSTEMS
		B. DISEASES OF THE SEBACEOUS GLANDS
AIMS:	A	To understand the basic knowledge of diseases of the sebaceous glands.
	B	To acquire skill in the cosmetic and barber science treatment of certain diseases of the sebaceous glands, which can be treated in the practice of barbering.
	C	To acquire the skill in the recognition of serious cases, and advise the patron to consult a competent physician for the proper medical care and treatments required.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION

1. Explain why disorders of the sebaceous glands are easily detected by the careful barber science practitioner.
2. Explain the importance of knowing the diseases of the sebaceous glands to the practice of barbering.
3. Explain and define acne.
4. What is meant by commodones.
5. Explain what is meant by Milia.
6. Explain the cause and function of Seborrhea.
7. Explain the type, size, formation and removal of moles.
8. Explain the formation and occurrance of warts.
9. Define and explain "Pigmentation from the Actinic Rays of Light."
   a. Freckles (Lentigo)

Block V	Unit 9	RESPIRATORY-EXCRETORY-UROGENITAL SYSTEM (cont'd)
		DISEASES OF THE SEBACEOUS GLANDS (continued)
		10. Explain dermatitis due to local application of drugs. a. give name and reaction 11. Explain the sanitary precautions to be observed in treating diseases of sebaceous glands 12. Explain the importance of acquiring the ability and skill to recognize, treat certain diseases of the sebaceous glands.
APPLICATION:	A	Study textbook, Lesson IX, Pages 15-23
	B	Review - Discussion - Orientation
	C	Student Practice in detecting different diseases of the sebaceous glands.
TESTS:	A	Oral
	B	Examination papers, Lesson IX, Chapter XIV, Page 4.
	C	Select questions from T and F master list.
	D	Select questions from M.T. master list.
	E	Thesis on "How to Detect Diseases of the Sebaceous Glands", (namely "Acne", 150 words)

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education

INSTRUCTOR'S LESSON PLANS

THEORY AND PRACTICE

PRACTICAL AND SCIENTIFIC BARBERING

	Unit	Title
Block VI	1	CHEMISTRY
AIMS:	A	To understand the properties and uses of common chemical substances and cosmetic ingredients.
	B	To understand the composition and purification of water.
PREPARATION:	A	Display available bottles of chemical substances and cosmetic ingredients.
PRESENTATION:	A	THEORY - LECTURE METHOD - DISCUSSION - QUESTION AND ANSWER METHOD 1. Explain the importance of chemistry to the practice of barbering. 2. Explain properties of solids, liquids, gases. 3. Explain meaning of elements and compounds. 4. Distinguish between acids, bases and salts, giving an example of each. 5. Explain and illustrate the meaning of physical and chemical changes. 6. Distinguish between soft and hard water. 7. Explain the composition and uses of water. 8. Explain the methods used to purify water. 9. Explain the properties and uses of chemicals for facial cosmetics. 10. Explain the properties and uses of chemicals for scalp cosmetics. 11. Explain how to mix a solution. 12. Explain table of measurements and equivalents. 13. Explain the safety precautions to be observed in the use of chemicals in the barber shop.
APPLICATION:	A	Study textbook, Lesson X, Pages 17-21.
	B	Review - Discussion
TEST:	A	Oral.
	B	Examination papers, Lesson X, Chapter XVI, Pages 4, 5.
	C	Select questions from T and F master list.
	C	Select questions from M.T. master list.

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SUPPLEMENTAL INSTRUCTIONAL MATERIAL

BARBER TRADE

BLOCK VI, UNIT 1

FORMULAE TO DESTROY LICE AND NITS

Bichloride	4 grains
Acetic Acid	½ ounce
Water	8 ounces

TREATMENT

1. Prepare patron as for the usual shampoo.
2. Sponge small portion of the hair at a time until entire head has been covered.
3. Prepare carbolic acid solution - 1 in 40 parts of water.
4. Sponge all parts of hair to destroy nits. To neutralize carbolic acid, use alcohol.

"REMARKS"

Another home remedy to destroy parasites is:

1. To brew quassia bark or chips.
2. Use liquid freely over the head.

VT 012 611
Trade Theory Tests. Preparatory Course for the Barber Trade, Part IV.

Connecticut State Dept. of Education, Hartford. Div. of Vocational Education.
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ABSTRACT - Prepared by the Division of Vocational Education of the Connecticut State Department of Education, this document is the fourth in a 4-part series and contains theory tests of the barbering trade. The tests are objective in nature including matching and true-false questions. A bibliography and reference materials are appended. Part I and II are available as VT 012 612, and Part III is available as VT 012 610, also in this issue. (GEB)

VT 012 611

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Hartford

TRADE THEORY TESTS

PREPARATORY COURSE

For The

BARBER TRADE

PART IV

1963

CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Hartford

TRADE THEORY TEST

BLOCK I — BARBER TRADE

HISTORY OF BARBERING

Name_____ Class_____ Date_____

Section A

1. 500 B.C.
2. 1450
3. 1897
4. 1901
5. 303 B.C.
6. Barber Surgeons
7. Macedonian Conquest
8. Classic Times
9. Colonial Days
10. 1887

Section B

1. The first barber's organization in this country was formed in the year . . . . . ( )
2. Barbering became an art in Greece in . . . . . ( )
3. In the era of 300 B.C., barbers were known as . . . . . ( )
4. Barbering was confined most to the negro barbers in . . . . . ( )
5. Barbers were restricted from blood-letting, tooth pulling and cauterizing in . . . . . ( )
6. The barber's reputation for talkativeness dates back to . . . ( )
7. Shaving was little known until the time of . . . . . ( )
8. In Conn., the first barber law was passed in . . . . . ( )
9. Records show that the first barbers were brought from Sicily to Rome in the year . . . . . ( )
10. In the U. S., the first barber law was enacted in . . . . . ( )

CONNECTICUT STATE DEPARTMENT OF EDUCATION
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Hartford

TRADE THEORY TEST

BLOCK I — BARBER TRADE

HISTORY OF BARBERING

Name_____ Class_____ Date_____

1. Egypt and China are the countries which refer to Barbering in their earliest written records . . . . . T F

2. Barbering became an art in Greece in the year 500 B.C. . . T F

3. Barbers were restricted from blood-letting, tooth-pulling cauterizing by an act of Parliament in 1450 . . . . . T F

4. In the U. S., the first barber law was passed in Minnesota, 1897 . . . . . T F

5. In Connecticut, the first barber law was enacted in 1901 . T F

6. The Barber's Company was in existence in London about the middle of the Thirteenth Century . . . . . T F

7. Records show that the first barbers were brought from Sicily to Rome in the year 303 B.C. . . . . T F

8. During that time no barber was allowed to keep more than two apprentices . . . . . T F

9. The barbers were known as barber surgeons in this era . . . T F

10. During that period medical skill was confined to the clergy . . . . . T F

11. In the year 1745, the union of the barber surgeon was dissolved . . . . . T F

12. "Barba" is the Latin pronunciation of beard . . . . . T F

13. In the colonial days in this country barbering was mostly confined to negro barbers . . . . . T F

14. The Journeyman Barbers, Hairdressers and Cosmetologists' International Union of America was the first barber's organization in this country and was formed November 5, 1887 in Buffalo, N. Y. . . . . T F

15. Through the years, barbering has been proved to be a venerable as well as a valuable art . . . . . T F

16. During the 14th Century, efforts were made to establish the name of hairdresser instead of barber . . . . . T F

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TRADE THEORY TEST

BLOCK I, UNIT 2-C BARBER TRADE

BARBER SHOP OPERATION, ETHICS AND SALESMANSHIP

Name_____ Class_____ Date_____

Section A

1. Opportunity
2. Ethics
3. Labor Relations
4. Operation
5. Science
6. Salesmanship
7. Posture
8. Shop
9. Equipment
10. Advertisement

Section B

1. The act of effect and manipulation is called . . . . . ( )
2. The illumination of the . . . . must be a soft, white glareless ray . . . . . ( )
3. A satisfied customer is the best . . . . . ( )
4. Barber Science is the way . . . . yours is the . . . . . ( )
5. The act of selling goods, service and good-will . . . . ( )
6. The science that treats of the principles of human morality and duty is called . . . . . ( )
7. Poise and . . . . . are attractive to the patron . . . . ( )
8. Type of . . . . . and knowledge of usage are primary factors of importance . . . . . ( )
9. Barber . . . . . Service has replaced much of the lost shaving . . . . . ( )
10. . . . . information is a complete necessity in Barber Shop operation . . . . . ( )

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CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Hartford

TRADE THEORY TEST

BLOCK I, UNIT 2-C — BARBER TRADE

BARBER SHOP OPERATION, ETHICS AND SALESMANSHIP

Name_____ Class_____ Date_____

1. Ethics: The science that treats of the principles of human morality and duty . . . . . T F

2. Operation: The act of effect and manipulation . . . . T F

3. Salesmanship: The act of selling goods, service and good will . . . . . T F

4. The kind of work that is performed by the operators and the condition in which the shop is kept after it is installed is the difference between success and failure. T F

5. The chairs and individual bowls must be installed without the appearance of overcrowding . . . . . T F

6. The walls and ceiling must be painted a color that is soothing (a light blue for the walls and cream color for the ceiling) . . . . . T F

7. The floor covering should be a good pattern of linoleum, unless the floor is tile . . . . . T F

8. There should be rubber mats around the chairs . . . . . T F

9. Do not clutter up the walls with pictures or signs . . T F

10. One or two well-placed mirrors on the walls will add to the attraction of the shop . . . . . T F

11. The illumination of the shop must be a soft, white, glareless ray . . . . . T F

12. The customers' waiting chairs should be comfortable; a neat magazine rack containing only a few well-chosen magazines and a cover-top-type ash tray must be grouped together T F

13. A wholesome atmosphere of calmness, pleasantness, extreme cleanliness make up the best form of advertising . . . T F

14. If the barber expects to be a successful salesman, he must have the right mental attitude towards himself so that he can fit his abilities to the opportunities . . . . . T F

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15. The barber must have a thorough knowledge of the treatment he proposes so he can explain in detail the proper shampoo, the medicinal valve of ultra-violet ray, the infra-red and the high frequency, if these are to be used in giving the treatment ..... T F

16. Essentially, the barber is to keep a record of the names and addresses of customers treated, the nature of the treatment, what the treatment was for, the date started and the ultimate results ..... T F

17. A satisfied customer is the best advertisement ..... T F

18. The barbers biggest troubles have always arisen almost entirely from lack of unit and confidence in each other ..... T F

19. The barbers must strive unceasingly and most constructively for the humanization of the profession ..... T F

20. Barber Science service has replaced much of the lost shaves ..... T F

21. Barber Science is the way - yours is the opportunity ..... T F

22. For a successful business and a professional future - STUDY, WORK, SERVE, COOPERATE, ORGANIZE AND EDUCATE ..... T F

TRADE THEORY TEST

Block II

BARBER TRADE

INSTRUMENTS AND ACCESSORIES

Name_____Class_____Date_____

Section A

1. Commodone Extractor	6. Serrated	11. Eighty years
2. Finger-grip	7. Inflammable composition	12. Hair brush
3. Widths	8. Against	13. Gauge
4. Sterilize	9. Strops	14. Poor quality steel
5. Sanitary	10. Gexman	15. Synthetic

Section B

1. As a safety precaution, do not use combs made of ..... ( )
2. A nickle-plated razor is most always one of ..... ( )
3. The use of hair clipper can be dated back ..... ( )
4. Pigskin, horsehide and cowhide are used to make ..... ( )
5. Because it is difficult to sterilize properly ..... is undesirable ..... ( )
6. The third finger is inserted in the .... of the shears ..... ( )
7. In shaving, the edge is pushed toward the point ..... the beard ..... ( )
8. Swaty and Carborundum hones are both ..... ( )
9. The....of the razor are measured by eights and sixteenths of an inch ..... ( )
10. Shears having a.....of 7 inches and a plain edge are preferred to other kinds ..... ( )
11. The.....type shear has no finger brace..... ( )
12. Thinning shears have one or both blades..... ( )
13. A.....is used to remove blackheads ..... ( )
14. To prevent the dulling of sharp instruments, do not.....with boiling water..... ( )
15. Creams and shaving powders are more...to use than the "cake of shaving soap"..... ( )

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TRADE THEORY TEST

Block II

BARBER TRADE

INSTRUMENTS AND ACCESORIES

Name_____Class_____Date_____

1. A nickle-plated razor is most always one of poor quality steel.....T F

2. The hair brush is undesirable because it is difficult to sterliize properly..... T F

3. The science of honing is acquired only by long experience..... T F

4. In shaving, the edge is pushed toward the point against the beard.. T F

5. The third finger is inserted in the finger-grip of the shears..... T F

6. Stropping will smooth the edge after honing..... T F

7. Strops are made only of pigskin and horsehide..... T F

8. A standard set of strops is made up of leather and canvas..... T F

9. Swaty, Belgian and Carborundum are all synthetic hones..... T F

10. The widths of the razor are measured by eights and sixteenths of an inch ... T F

11. Grindings of razors can be termed as hollow grind and wedge..... T F

12. The French type of shear is more acceptable than the German type... T F

13. The German type shear has no finger brace..... T F

14. Shears having a gauge of 7 inches and a plain edge are preferred to other kinds..... T F

15. Hair should always be thinned close to the scalp..... T F

16. Thinning shears have only one blade serrated..... T F

17. Clippers were first used eighty years ago..... T F

18. Motor and magnetic are the most used hand clippers..... T F

19. The size of cutting thickness of the clipper blades are 000 and 1..T F

20. A commodone extractor stops infection of blackheads.....T F

21. The tweezer and needle is used to relieve inflammation.....T F

INSTRUMENTS AND ACCESSORIES (CONT'D)

Block II — BARBER TRADE

22. The hair duster is a most essential implement and absolutely necessary..... T F

23. All hair brushes are made with bristles set in a "curve" for better action on the scalp and hair..... T F

24. All combs are made of non-inflammable rubberized composition..... T F

25. Styptic powder is used for drying the moisture on the neck..... T F

26. Inferior shaving brushes are dangerous to the degree of carrying anthrax infection..... T F

27. Shaving brushes come in several sizes: 2, 3 and 4..... T F

28. Latherizers and atomizers are used to dispense hair tonics..... T F

29. Shaving soap is made of formaldehyde..... T F

30. Creams and shaving powders are more sanitary than the "cake" of shaving soap..... T F

31. To prevent the dulling of sharp instruments, do not sterilize with boiling water..... T F

Block III
Units 1 & 2

Barber Trade

TRADE THEORY TEST

SHAVING AND HAIRCUTTING

Name_____Class_____Date_____

Section A

1. Natural	6. Blade	11. Singeing
2. Halitosis	7. Edge	12. Cloth
3. Tapering	8. Wrist	13. Thinning Shears
4. Hair	9. Epithelium	14. Haircutting
5. Dull	10. Ingrown	15. Lathering

Section B

1. A razor has a perfect....when its teeth are sawlike..... ( )
2. A rotary movement is best in .....the beard..... ( )
3. .....hair is caused by close shaving..... ( )
4. Eliminating any chance of.....is a good hygenic precaution..... ( )
5. Freedom of the .....is paramount in all strokes for good shaving.....( )
6. Dry beard hairs will.....the razor.....( )
7. A close shave removes the .....and furnishes a breeding ground for bacteria.....( )
8. To be an artist in .....the barber must study physiognomy.....( )
9. Concern as to the .....is essential in good haircutting.....( )
10. The still.....of the shears should always ride the comb.....( )
11. The neckshare must always follow the .....hair line.....( )
12. The importance of .....is mainly personal adornment.....( )
13. Burning the hair ends is called.....( )
14. The haircutting....should be wrapped on the outside of the back of barber chair.....( )
15. The use of the .....is not warranted on fine hair.....( )

Block III, Units 1 & 2 BARBER TRADE

SHAVING AND HAIRCUTTING

Name_____Class_____Date_____

1. The width of the razor should be about 5/8 of an inch..... T F

2. Steel razors are more durable than silverplated ones..... T F

3. A razor is never used for thinning or tapering the hair..... T F

4. A razor has a perfect edge when its teeth are very fine..... T F

5. A rotary movement is best in lathering the beard..... T F

6. Before shaving, use hot towels on a sensitive or chapped face..... T F

7. Ingrown hair is caused by close shaving..... T F

8. Eliminating any chance of halitosis, a good hygenic precaution..... T F

9. In shaving, the only strokes used are: 1. The free hand, and 2. back hand..... T F

10. Lather does not necessarily have to be wiped from the blade..... T F

11. Freedom of the wrist is paramount in all strokes for good shaving..... T F

12. Dry beard hairs will dull the razor..... T F

13. A hot towel must contain an abundance of hot water to be applied efficiently..... T F

14. A close shave removes the epithelium and furnishes a breeding ground for bacteria..... T F

15. To be an artist in hair cutting, the barber must study physiognomy..... T F

16. Hair cutting is classified in seven different styles..... T F

17. The basic service rendered in a barber shop is haircutting..... T F

18. Concern as to the tapering is immaterial in good haircutting..... T F

19. The natural hair-line is found on the top of the patron's head..... T F

20. The higher the clipper-work proceeds, the better the haircut will fit the contours of the patron's head..... T F

21. The still blade of the shears should always ride on the bottom of the fine teeth of comb..... T F

SHAVING AND HAIRCUTTING (CONT'D)

22. Clipper-lines and shear-ridges should be noticeable after the haircut is completed.....T F

23. The use of the thinning shears on fine hair is not warranted.....T F

24. The best method of giving a pompadour is to use the clipper exclusively T F

25. The neck shave must follow the natural hair line.....T F

26. The hair part should be diagonal to the ears.....T F

27. The art of hair cutting is not easily acquired.....T F

28. The importance of hair is mainly personal adornment.....T F

29. The haircutting cloth should be wrapped on the outside of the back of the barber chair.....T F

30. More men than women cut their hair.....T F

Block III, Units 3 & 5 TRADE THEORY TEST BARBER TRADE

PRACTICAL SKILLS

SINGEING AND SHAMPOOING

Name_____ Class_____ Date_____

1. Manipulations	6. Dry hair	11. Hot water
2. Hair Dressing	7. Egg	12. Hair
3. Henna Rinse	8. Split Hair	13. Shampooing
4. Swab	9. Boiling	14. Alkaline
5. Tar Shampoo	10. Soft water	15. Lighted Taper

Section B

1.....is given temporary relief by "Charring" the ends.....( )

2. Singeing has no direct value toward the health of the.....( )

3. In singeing, the .....is passed over the protruding hairends.....( )

4. A shampoo used for an oily scalp.....( )

5. Soap will form a lather with.....( )

6. An oily scalp requires a soap which is.....( )

7. Working with the hands .....( )

8. The easiest way to soften water is by.....( )

9. Imparts a slight auburn tinge to the scalp.....( )

10. An aid to apply hot oil to the scalp.....( )

11. An egg shampoo should be used for.....( )

12. Barbers should be well-trained operators in .....service.....( )

13. .....would be a more appropriate use for tonics.....( )

14. Dry.....shampooing is not advisable on black hair.....( )

15. .....must not be used to rinse an egg shampoo.....( )

Block III, Units 3 & 5

TRADE THEORY TEST

PRACTICAL SKILLS

BARBER TRADE

SINGEING AND SHAMPOOING

Name_____Class_____Date_____

1. Singeing cures all hair ailments..... T F

2. In singeing the hair, the lighted taper is passed over the protruding hairends..... T F

3. The tapers used in singeing are made of cotton..... T F

4. The best results in singeing are obtained by first wetting the hair with an alcoholic tonic..... T F

5. Split hair is given temporary relief by "charring" the ends..... T F

6. Singeing has no direct value toward the health of the hair..... T F

7. Monilithrix is a result of singeing..... T F

8. Trichoptilosis is a necessity in order to give a good singe..... T F

9. Shampoos may be given as often as desired without injurious results to the hair..... T F

10. A proper shampoo may be given in three minutes..... T F

11. Excessive pressure and "rubbing" in one spot is essential in giving a good shampoo..... T F

12. Both the hair and scalp should be rinsed well, removing all traces of lather or soap-suds..... T F

13. Egg shampooing is beneficial in mild cases of exzema and psoriasis..... T F

14. Hot water must be used to rinse an egg shampoo..... T F

15. Apply the egg mixture on dry hair only..... T F

16. Therapeutic value of the special egg shampoo is found in the chemicals contained: carbon, nitrate, phosphorus, albumen, sodium chloride, etc; which are nutritive and healing to scalp..... T F

17. When applying hair tonic, the barber should use gentle rotary movements starting over the parietal bones and continuing over the aponeurosis... T F

18. Hair tonics are specifically beneficial for the hair and scalp..... T F

SINGEING AND SHAMPOOING (CONT'D)

19. Hair dressing would be a more appropriate use for tonics ..... T F

20. Some tonics will spoil the appearance of white or grey hair ..... T F

21. Oil shampoos will give the best results for oily scalp conditions .... T F

22. Tar shampoos are most often used for dry, brittle hair ..... T F

23. After the application of an alcoholic tonic, singeing the hair ..... T F

24. Dry egg shampooing is not advisable on black hair, as it shows traces of the egg regardless of excessive brushing ..... T F

25. Barbers should be well-trained operators in shampooing service ..... T F

Block III, Units 3 & 5

TRADE THEORY TEST

PRACTICAL SKILLS

PRACTICAL MASSAGE

BARBER TRADE

Name_____Class_____Date_____

Section A

1. Electrolytic cup
2. Motor points
3. Castile soap
4. Neolithic
5. Dermal
6. Communicable
7. Glandular
8. Blue Light
9. High-frequency
10. Egg shampoo
11. Effleurage
12. Milk and egg
13. Scalp manipulations
14. Pressure
15. Commodones
16. Flexible
17. Acne
18. Mechane Therapy
19. Wrinkles
20. Hair brushing
21. Oil mask
22. Head
23. Steaming
24. Chronic

Section B

1. Steam has the same effect on hair that the.....has..... ( )
2. Do not treat.....cases of psoriasis or exzema..... ( )
3. Never give facial manipulations in an.....facial..... ( )
4. When the skin has been dried by fever, the barber never uses the ( )
5. The procedures of massage include.....petrissage, friction..... ( )
6. Study of.....is essential in beneficial massaging..... ( )
7. Many elementary skin and hair disorders will be eliminated by..... ( )
8. The Clay Pack is used for treatment of..... ( )
9. Hot towels wrung out from.....water are always a good starting procedure in any type of massaging..... ( )

10. For extremely dry skin there is nothing better than an..... ( )

11. If the.....structure is then vibratory movements when applied excessively may cause severe headaches.....( )

12. Excessive skin dryness will aid in causing.....( )

13. In a case of .....congestion, movements must be applied to eliminate the blood from that part.....( )

14. Massage is an ancient practice dating back to the.....period....( )

15. Never use hot water to rinse an.....( )

16. Regular massaging will make a tight scalp or skin.....( )

17. Facial or scalp treatments are not to be given if a .....( )

18. Massage is limited to the.....face and neck.....( )

19. A.....facial is beneficial to an excessively dry skin...( )

20. If speed and.....of massage are increased, the effect is destructive.....( )

TRADE THEORY TEST

Block III, Unit 4 | PRACTICAL MASSAGE | BARBER TRADE

PRACTICAL SKILLS

Name_____Class_____Date_____

1. Facial or scalp treatments are not to be given if a communicable disease is recognized in a patron..... T F

2. Massage is limited to the head, face and neck..... T F

3. Firm kneading and fast tapping movements help to reduce fatty tissue..... T F

4. A facial massage is best given with the cushion tips of the fingers..... T F

5. An astringent lotion is recommended for an excessively dry skin..... T F

6. A Clay Pack is good for all types of skin except a dry skin..... T F

7. A milk and egg facial is beneficial for a sensitive or dry skin..... T F

8. After extracting commodones, do not apply an antiseptic solution to the skin..... T F

9. Regular massaging will make a tight scalp or skin flexible..... T F

10. Massage is an ancient practice dating back to the Neolitic period (10,000 B. C.)..... T F

11. Massaging is a scientific systematic manipulation of the face, neck, and head either by hands, electrical devises or other mechanical applicances for cosmetic purpose or therapeutic benefits..... T F

12. Massaging needs to be applied by a strong hand and for a definite length of time..... T F

13. The barber should be thoroughly familiar with the origin and insertion of the muscles as well as their location to give efficient massaging..... T F

14. The location of the nerves, arteries, and the general lymphatic drainage system is also especially important..... T F

15. In a case of glandular congestion movements must be applied to eliminate the blood from that part..... T F

PRACTICAL SKILLS

Block III, Unit 4 PRACTICAL MASSAGE (CONT'D) BARBER TRADE

16. Judicious manipulation must be applied in the case of anemia, due to the necessity of increasing the flow of blood to the part..... T F

17. Treatments may produce the following physiological effects:— Increase nutrition, decrease waste matter in the part, indirectly increases glandular action, causes muscular changes by relieving tension, relieves fatigue..... T F

18. Facial massages and treatments retard and remove wrinkles..... T F

19. Excessive skin dryness will aid in causing wrinkles..... T F

20. If the dermal structure is thin vibratory movements when applied excessively may cause severe headaches.....T F

21. Bleaching treatments are directly beneficial to the skin.....T F

22. The clay pack is used for treatment of commodones.....T F

23. For extremely dry skin there is nothing better than an oil mask (hot oil facial).....T F

24. Hot towels wrung out from castile soap water are always a good starting procedure in any type of massaging.....T F

25. Great care must be exercised in diagnosing each case to achieve the best results by applying the proper type of massage.....T F

26. The wise practitioner will work co-operatively with the physician.....T F

27. The barber must acquire a complete knowledge of the application of the vibrator and the therapeutic light to obtain successful results.....T F

28. Mechane Therapy together with cosmetics along with intelligent application will eliminate many elementary skin and hair disorder....T F

29. Study of motor points is essential in beneficial massaging.....T F

30. The procedures of massage include effleurage (stroking or rubbing). petrissage (Kneading), Friction (pressure) and tapotment (slapping with fingertips).....T F

31. Never give facial manipulations in an acne facial.....T F

32. If speed and pressure of massage are increased, the effect is destructive..... .....T F

TRADE THEORY TEST

PRACTICAL SKILLS

Block III, Unit 6 HONING & STROPPING BARBER TRADE

Name_____ Class_____ Date_____

Section A

1. Canvas
2. Grit
3. Saw-like
4. Diagonally
5. Tendency
6. Wrist
7. Moistened
8. Science
9. Pressure
10. Teeth

Section B

1. In stropping a razor equalized normal.....is applied on both sides of the razor.....( )
2. The .....of honing is acquired by long experience.....( )
3. A keen edge has a .....to dig in and drag.....( )
4. .....teeth are fine teeth.....( )
5. The .....strop is never used on a freshly honed razor.....( )
6. Proper honing cannot be accomplished if the .....is turned.....( )
7. The .....of a razor point in the opposite direction after honing...( )
8. The thumbnail should be .....with lather for testing the keenness of a razor.....( )
9. Dullness of the razor's edge is the result if.....is not removed from the strop.....( )
10. The Razor must be stroked.....from heel to point.....( )

TRADE THEORY TESTS

PRACTICAL SKILLS

Block III, Unit 6 HONING & STROPPING BARBER TRADE

1. The science of honing is acquired by long experience..... T F

2. The saw-like teeth of a razor point in the opposite direction after honing..... T F

3. The razor must be stroked diagonally accross the hone, from heel to point toward the edge..... T F

4. The wrist does not turn in honing properly..... T F

5. A razor with very fine teeth has a perfect edge..... T F

6. The feeling of a keen edge over the flesh is smooth without the sensation of cutting..... T F

7. A blunt edge has a tendency to dig in and drag..... T F

8. A razor is tested by passing lightly over the moistened thumbnail.... T F

9. A sticky, harsh disagreeable gritty sensation is felt from a rough or overhoned edge..... T F

10. The stroking of the razor blade in stropping is just the reverse of honing..... T F

11. The canvas strop is used on a freshly honed razor..... T F

12. Equalized, normal pressure is applied on both sides of the razor into a keen, cutting edge..... T F

13. The purpose of stropping is to smooth and shape the razor edge into a keen cutting edge.....T F

14. Strops should be kept suspended and rolled..... T F

15. Lather removes accumulated grit from the strop..... T F

TRADE THEORY TESTS

PRACTICAL SKILLS

Block III, Unit 7 HAIR TONICS BARBER TRADE

1. Cosmetics applied to the hair and scalp are called hair tonics..... T F
2. Hair tonics remove dandruff permanently..... T F
3. Hair dressing is the main purpose for the use of tonics..... T F
4. Tonics will grow hair..... T F
5. Alcoholic hair tonics attain the best results..... T F
6. The barber picks the tonic by its color..... T F
7. The method of application of a hair tonic is standard..... T F
8. Tonics which contain oil are of better quality..... T F
9. A scalp steam is necessary with the application of all hair tonics.. T F
10. Information about tonics should be ignored by the barber..... T F
11. For best results, tonic must be applied daily..... T F
12. Tonics serve best after a hair singe..... T F
13. Oil tonics evaporate more readily than alcoholic ones..... T F
14. Tonics are absorbed by both the hair and scalp..... T F
15. Tonics serve as deodorants..... T F

TRADE THEORY TESTS

PRACTICAL SKILLS

Block III, Unit 7 HAIR TONICS BARBER TRADE

Name_____Class _____Date_____

Section A

1. Singe
2. Information
3. Application
4. Cosmetics
5. Absorbed
6. Hair
7. Deodorants
8. Oil
9. Dandruff
10. Evaporate

Section B

1. Application of hair tonic is recommended after a .....( )
2. Advertisements claim tonics remove.....( )
3. A mistaken notion about tonics is that they act as.....( )
4. Hair tonics are classified as .....( )
5. Alcohol will.....quicker than oil.....( )
6. .....on tonics are available from the manufacturers.....( )
7. Dry hair is better serviced by a tonic with an .....base.....( )
8. Constant.....of tonics may be harmfull.....( )
9. .....absorbs tonics because it is porous.....( )
10. The scalp is stimulated by the tonic it.....( )

TRADE THEORY TESTS

Block IV

BARBER TRADE

BACTERIOLOGY

Name_____Class_____date_____

Section A

1.	Staphylococcic	11.	Boils	21.	Spirilla
2.	Chlorophyll	12.	Temperature	22.	Metabolism
3.	Hygiene	13.	Lysol	23.	Putrefaction
4.	Antiseptic	14.	Sterilization	24.	Boric acid
5.	Protoplasm	15.	Formalin	25.	Vapors
6.	Catabolism	16.	Baking soda	26.	Formalin
7.	Spore formers	17.	Bacilli	27.	Germ Extinction
8.	Freezing	18.	Lump alum	28.	Carbolic Acid
9.	Contagion	19.	Disinfectant	29.	Cocci
10.	Fission	20.	Alcohol	30.	Pathogenic

Section B

1. Bacteria which are rod-shaped.....( )
2. Bacteria which grow in bunches.....( )
3. The Gonorrhea bacteria is the.....( )
4. The staphylococcic bacteria produces.....( )
5. Bacteria are devoid of.....( )
6. The Syphilis bacteria is the.....( )
7. .....is the process by which bacteria multiply.....( )
8. When a product is produced that is not useful, the process is...( )
9. Some bacteria known as.....will survive boiling.....( )
10. For each micro--organism there is some one....at which the most rapid growth is possible.....( )
11. Many....bacteria can live and multiply in the blood stream but die if removed.....( )

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BACTERIOLOGY (CONT'D)

Block IV

BARBER TRADE

12. .....is the process of destroying bacteria.....( )

13. Hydrogen peroxide (H_2O_2) is used as an..... ( )

14. .....are used to keep objects sterile.....( )

15. Phenol is also known as.....( )

16. Glycerine added to.....will prevent the rusting of instruments( )

17. 60%.....may be used on the skin as an antiseptic.....( )

18. Adding a small quantity of.....to the water in which instruments are boiled will keep them bright.....( )

19. To insure complete.....articles must be boiled for at least twenty minutes.....( )

20. The science of preserving health is .....( )

21. A 40% solution of formaldehyde gas in water is.....( )

22. The total of all chemical changes which occur in the body is called( )

23. The substance found in living plants and animals is called.....( )

24. .....is represented by a destructive process.....( )

25. An alternative method of sterilization for objects that cannot be boiled.....( )

26. .....is the process of transferring specific diseases from person to person.....( )

27. .....solution cannot be used as a germicide .....( )

28. .....is used in 2% solution as an antiseptic; 10% solution as a disinfectant.....( )

29. .....must not be used as a styptic.....( )

30. .....will not destroy bacteria.....( )

TRADE THEORY TEST

Block IV

BARBER TRADE

BACTERIOLOGY

Name_____ Class_____ Date_____

1. Germs, microbes and bacteria are the same..... T F

2. Bacilli are rod-shaped: Cocci are spherical and Spirilla are spiral bacteria..... T F

3. Non--pathogenic bacteria produce disease..... T F

4. The tuberculosis, typhoid fever, and influenza bacteria are the bacilli..... T F

5. The Gonorrhea bacteria is the cocci..... T F

6. The Syphilis bacteria is the spirilla..... T F

7. All bacteria are harmfull..... T F

8. Freezing will destroy bacteria..... T F

9. The staphylococcic bacteria produces boils and abscesses..... T F

10. Bacteria are found everywhere..... T F

11. Moisture is essential for the growth of bacteria..... T F

12. Infection refers to the entrance of bacteria into the tissues.....T F

13. Bacteria are devoid of chlorophyll.....T F

14. Bacteria may be Parasites (living on living matter) or Saprophytes (living on dead matter).....T F

15. "Fission" is the process by which bacteria mutiply.....T F

16. The process of decomposition of substances by bacteria is known as Fermentation when a useful product is produced.....T F

17. When a product is produced that is not useful, the process is putrefaction.....T F

18. Multiplying once an hour a single bacterium would produce in 24 hours about 17,000,000.....T F

19. Bacteria vary in size, but average about 1/25,000 of an inch in diameter.....T F

20. Some bacteria known as Spore Formers will survive boiling.....T F

21. For each micro--organism there is some one temperature at which the most rapid growth is possible.....T F

BACTERIOLOGY (CONT'D)

Block IV BARBER TRADE

22. Bacteria are not specific in their growth; they do not reproduce only their own kind, always changing their respective characteristics T F

23. The coccic family shows most active motility, especially in fluids....T F

24. Most Germs can be destroyed by heat, sunlight, infra-red and the Ultra-Violet light.....T F

25. Many pathogenic bacteria can live and multiply in the blood stream, but will die if removed.....T F

26. Sterilization is the establishment of conditons favorable to health...T F

27. Hygiene is the process of destroying bacteria.....T F

28. Sanitation is the science of preserving one's individual health and Cleanliness.....T F

29. Formaldehyde gas in water at 40% strength is known as Chlorozol.....T F

30. A deodorant destroys bacteria.....T F

31. An antiseptic is a germicide.....T F

32. A germ is any micro-organism.....T F

33. Lump alum may be used as a styptic.....T F

34. It is dangerous to visit a sick person if there is a quarantine card on the door.....T F

35. Contagious diseases could be controlled if no germs were passed from the sick to the well.....T F

36. A communicable disease is one which cannot be avoided.....T F

37. To be sterilized, water must be heated to 150 degrees Fahrenheit.....T F

38. Hydrogen peroxide (H_2O_2) is used as an antiseptic.....T F

39. Lysol is used in 2% solution as an antiseptic: 10% solution as a disinfectant.....T F

40. Vapors are used to keep objects sterile.....T F

41. An ariticle which cannot withstand heat may be sterilized chemically..T F

42. Boric acid solution is used as a germicide.....T F

43. A disinfectant and a germicide are the same, both being agents which destroys germs.....T F

44. Alcohol is the best antiseptic recommended for barber shop use.....T F

45. Shears and razors may be sterilized by boiling for five minutes.....T F

BACTERIOLOGY (CONT'D)

Block IV — BARBER TRADE

46. Phenol is also known as carbolic acid.....T F

47. Rubber combs and hair brushes are sterilized by boiling.....T F

48. Glycerine added to Formelin will prevent rusting of instruments.....T F

49. An object is sterile when it is free from living organisms.....T F

50. Disinfectants may be used after shaving.....T F

51. Formaldehyde is a germicide.....T F

52. 60% alcohol may be used on the skin as an antiseptic.....T F

53. Adding a small quantity of baking soda to the water in which instruments are boiled, will keep them bright.....T F

54. When using alcohol as a germicide, it should be heated.....T F

55. To insure complete sterilization, articles must be boiled for at least twenty minutes.....T F

56. Chemical sterilization employs heat and boiling water.....T F

57. A barber must have a knowledge of bacteriology to understand the cause, prevention and control of infectious diseases in the barber shop.....T F

58. Infection may be spread by air, dust, flies and insects, person to person, instruments and linens, water and food.....T F

59. Contagion is the process of transferring specific diseases from person to person.....T F

60. Good complexion, fine-texture skin, sparkling eyes and luxuriant hair are signs of good health.....T F

61. Famine, Dryness and unsuitable temperature are unfavorable conditions to pathogenic bacteria.....T F

Block V

TRADE THEORY TEST

BARBER TRADE

SYSTEMS OF THE BODY

Name_____ _____Class_____Date_____

Section A

1. Adrenals	9. Auricle	17. Gland
2. Cecum	10. Pancreatic	18. Oxygen
3. Sudoriferous	11. Larynx	19. Bile
4. Angiology	12. Unit	20. Lungs
5. Urinary	13. Osteology	21. Integumentary
6. Epiglottis	14. Thyroid	22. Abdominal
7. Nerves	15. Costal	23. Mammary
8. Tonsils	16. Chemical	24. Myology

Section B

1. All systems of the body work independently, but are vitally concerned with the .....as a whole.....( )
2. The study of muscles is called.....( )
3. Atria.....and atrium are the same.....( )
4. .....is the term applied to the Vascular or Circulatory system( )
5. The.....glands are situated on either side of the trachea.....( )
6. The spleen is a .....and manufactures white corpuscles.....( )
7. The.....are ductless glands.....( )
8. .....secretion assists in digesting food.....( )
9. The.....are organs of respiration.....( )
10. .....breathing is the process of breathing deeply.....( )
11. Vocal cords are fibrous cords stretched across the.....( )
12. The opening into the trachea is known as the.....( )
13. .....is necessary to life.....( )

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SYSTEMS OF THE BODY (CONT'D)

Block V

BARBER TRADE

14. Digestion is a.....change..... ( )

15. The large intestine includes the.....the colon and the rectum..... ( )

16. .....are lymph glands..... ( )

17. .....glands secrete milk..... ( )

18. Sebaceous and.....glands are internal appendages of the skin ..... ( )

19. Nerve endings belong to the.....system..... ( )

20. The.....and reproductive organs compose the Urogenital system..... ( )

21. The.....is secreted by the liver..... ( )

22. The study of the skeletal system is termed..... ( )

23. .....breathing is the process of breathing lightly..... ( )

24. Neurology is the study of the..... ( )

TRADE THEORY TEST

Block V

BARBER TRADE

SYSTEMS OF THE BODY

Name_____Class_____Date_____

1. Within the skeletal system of the body are found eight more..... T F

2. These systems work independently but are vitally concerned with the unit as a whole..... T F

3. The study of the skeletal system is termed myology..... T F

4. The muscular system is the least important system in body..... T F

5. Muscles are tubular and colored black..... T F

6. This study of muscles is called osteology..... T F

7. The nervous system contains all the higher functions of life, such as: sensations, intelligence and thought..... T F

8. The brain and the spinal cord are the two main centers of this system T F

9. Meurology is also part of this system..... T F

10. All glands of the body belong to the Vascular or Circulatory system T F

11. Atria, auricle and atrium are the same..... T F

12. Aortas and ventricles are the cavities of the heart..... T F

13. Pulmonary arteries and veins transport blood throughout the body..... T F

14. Angiology is the term applied to the Vascular or Circulatory system T F

15. The Thyroid glands are situated on either side of the Trachea..... T F

16. The spleen is a gland and manufactures white corpuscles..... T F

17. The Adrenals are ductless glands..... T F

18. Pancreatic secretion assists in digesting food..... T F

19. Lachrymal and sebaceous glands discharge saliva..... T F

20. The lungs are organs of respiration..... T F

21. Abdominal breathing is the process of breathing deeply..... T F

22. Costal breathing is the process of breathing lightly ..... T F

23. Vocal cords are fibrous cords stretched across the larynx ..... T F

24. A lung is an elongated elastic bag of spongy tissue, divided into lobes ..... T F

25. The opening into the trachea is known as the spiglottis ..... T F

26. Oxygen is necessary to life ..... T F

27. Digestion is a chemical change ..... T F

28. The human body is nourished by food ..... T F

29. The large intestine is five feet long and includes the cecum, the colon and the rectum ..... T F

30. Tonsils are lymph glands ..... T F

31. The urinary and reproductive organs compose the Urogenital System .... T F

32. The liver is not a gland ..... T F

33. Mammary glands secrete milk ..... T F

34. Bile is secreted by the liver ..... T F

35. Skin is an elastic, inflexible, membrane, and is the external covering of the body ..... T F

36. Skin toughens by exposure ..... T F

37. Friction and pressure will increase the thickness of skin ..... T F

38. Color of skin varies with age, sex, race and climate ..... T F

39. Nails and hair are external appendages of the skin ..... T F

40. Sebaceous and sudoriferous glands are internal appendages of the skin ..... T F

41. Nerve endings do not belong to the Integumentary System ..... T F

42. Color of hair is determined by the climate ..... T F

43. Impetigo is the technical name for Freckles ..... T F

44. Dermatology is the study of the skin ..... T F

45. The functions of the skin are absorbing heat and water..... T F

TRADE THEORY TEST

INTEGUMENTARY

Block V, Unit 2 BARBER TRADE

SKIN, SCALP AND THE APPENDAGES

Name_____Class_____Date_____

Section A

1. Papillary
2. Absorption
3. Trichology
4. Anidrosis
5. Eyelash
6. Hygroscopic
7. Bristles
8. Scarf skin
9. Malpigian
10. Textures
11. Epithelial
12. Keratin
13. Sebum
14. Respiration
15. Sebaceous
16. Melanin
17. Corium
18. Hyperidrosis
19. Touch
20. Follicles
21. Blood
22. Arrector
23. Acidic
24. Alkali

Section B

1. .....causes these skin cells to take in some oxygen and to emit some carbon dioxide.....( )

2. .....and soap remove natural oil from the skin.....( )

3. Epidermis, ...and Epithelial tissue are the same.....( )

4. .....layer is the pigment of the skin.....( )

5. The tendency of the skin to take in oily substances and reject watery one.....( )

6. There are no blood vessels in the.....tissue.....( )

7. The.....and the Reticular are the two layers of the Derma.....( )

8. Derma, true skin and.....are the same.....( )

9. There are no more hairs than.....( )

10. The life of an.....is from four to five months.....( )

11. .....is the scientific study of hair.....( )

12 The coarse hair within the ears and nostrils is called

13. .....is the horny substance of which hair is made.....( )

14. The.....muscle of the hair is an involuntary muscle.....( )

15. Hair is.....; not porous in the usual sense.....( )

16. Perspiration is.....( )

17. .....is the term used for the lack of sweating.....( )

18. .....of hair are classified by size.....( )

19. .....is excessive sweating.....( )

20. .....is both the hair and skin pigment.....( )

21. When the .....supply is cut off, the growth of hair stops..( )

22. .....is a semi-liquid substance consisting of oil mixed with water.....( )

23. The skin is the seat of the organ of.....( )

24. The arrector muscle of the hair follicle activates the.....gland..( )

TRADE THEORY TEST

INTEGUMENTARY

Block V, Unit 2 SKIN, SCALP AND THE APPENDAGES BARBER TRADE

Name_____Class_____Date_____

1. Respiration causes the skin cells to take in some oxygen and to emit some carbon dioxide..... T F

2. Skin does not have to be cleansed; it performs this action itself..... T F

3. Alkali and soap removes natural oil from the skin, leaving it dry and rough..... T F

4. Epidermis, scarf skin, epithelial tissue and epithelium are the same.... T F

5. The Mapigian Layer is the pitment layer of the skin..... T F

6. Dermatitis is the second layer of the skin..... T F

7. The skin protects from the invasion of bacteria..... T F

8. The tendency to take in oily substances and reject watery ones is called Absorption..... T F

9. The Epidermis has three layers of fatty tissue..... T F

10. There are no blood vessels in the epithelial tissue..... T F

11. The Papillary and the Reticular are the two layers of the Derma..... T F

12. Skin is 1/2 inch thick..... T F

13. The skin is a good conducter of heat..... T F

14. A person's skin is always darker around the eyes, nipples and armpits T F

15. The aubcutaneous layer of the skin is the true skin..... T F

16. Corium derma and the true skin are the same..... T F

17. Sebum cools the skin..... T F

18. When the blood supply is cut off, the growth of hair stops..... T F

19. There are more hairs than follicles..... T F

20. The life of an eyelash is from four to five months..... T F

21. Sebum is a semi-liquid substance consisting of oil mixed with water, dead epithelial cells, and other waste matters such as fats, fatty acids and salts..... T F

22. Trichology is the scientific study of hair.....T F

23. The root of the hair is the part of the hair that lies within the follicle.....T F

24. The arrector muscle of the hair follicle and application of heat and electrical impulse activates the sebaceous gland.....T F

25. The three layers of the hair are: The cuticle, the derma and the medulla.....T F

26. The coarse hair within the ears and nostrils is called bristles.....T F

27. It takes from 41 to 72 days for the hair to grow from the papilla to the surface of the scalp.....T F

28. The skin is the seat of the organ of touch.....T F

29. Keratin is the horny substance of which hair is made.....T F

30. After a hair has fallen out, a new hair will appear in about ten daysT F

31. Hair has blood vessels.....T F

32. The average life of hair is from two to four years.....T F

33. The arrector muscle of the hair is an involuntary muscle.....T F

34. An old hair is not entirely out of the hair follicle before a new one has begun to form and to grow in its place.....T F

35. Hair is hygroscopic; not porous in the usual sense but it does absorb moisture.....T F

36. Sebaceous glands are sweat glands.....T F

37. Perspiration is acidic.....T F

38. Anidrosis is excessive sweating.....T F

39. Hyperidrosis is the term used for the lack of sweating.....T F

40. When the hair is pulled out by the roots, hair growth is destroyed..T F

41. Textures of hair are classified by size.....T F

42. Melanin is both the hair and skin pigment.....T F

43. The matrix or nail bed is the portion directly beneath the body of the nail and has an abundant supply of blood vessels and nerves.....T F

44. Average nails grow about 1/8 of an inch per month.....T F

45. Nerve endings are exposed through the epidermis.....T F

11. ..... is a water soluble salt consisting of fatty acid in combination with sodium or potassium..... ( )

12. Alcohol, in weak....., is cooling and antiseptic..... ( )

13. An.....solution is one in which the solvent is water..... ( )

14. .....cannot be created or destroyed..... ( )

15. .....is the building up of a compound..... ( )

16. .....chemistry treats of substances derived from the animal and vegetable kingdom..... ( )

17. Boiling means heating to a temperature of 212° ..... ( )

18. Creams are mainly.....of different kinds mixed in different proportions with water..... ( )

19. An.....agent is one which allows oil and water to mix..... ( )

20. Soaps are harmless to the skin if they do not contain free..... ( )

21. Phenol and mercury bichloride are two disinfectants which are..... to metals..... ( )

22. An alkaline solution will turn red.....paper blue..... ( )

23. The temperature of boiling water is 100° ..... ( )

24. .....can be defined as a chemical change taking place when an acid is added to a base of alkali..... ( )

25. About 65% of the.....is composed of water..... ( )

26. Alcohol is obtained by the.....of certain sugars..... ( )

27. Formaldehyde gas is rendered inactive by the addition of..... ( )

28. .....stains are readily removed with alcohol..... ( )

29. Do not use.....soap on the face..... ( )

30. Cocoa butter or.....are ingredients of a superfatted soap..... ( )

TRADE THEORY TEST

Block VI | ELEMENTARY CHEMISTRY | BARBER TRADE

Name_____ Class_____ Date_____

Section A

1.	Pharmacology	11.	Minerals	21.	Concentration
2.	Emulsifying	12.	Organic	22.	Matter
3.	Aqueous	13.	Oil	23.	Composition
4.	Compounds	14.	Neutralization	24.	Naptha
5.	Corrosive	15.	Liquid	25.	Fahrenheit
6.	Fermentation	16.	Lanolin	26.	Ammonia
7.	Physical change	17.	Synthesis	27.	Alkali
8.	Iodine	18.	Human Body	28.	Molecules
9.	Litmus	19.	Soap	29.	Centigrade
10.	Element	20.	Salt	30.	Glycerine

Section B

1. Chemistry is the science that reats of the .....of matter.....( )
2. .....is the science that treats of drugs and their relatives( )
3. There are three state of matter: solid, gas and.....( )
4. An.....is the smallest form in which matter exists.....( )
5. .....is the conbinations of similar atoms.....( )
6. The principal types of.....are: acids, bases and salts.....( )
7. A.....takes place when a substance does not change its atomic structure.....( )
8. A.....takes place when a substance does not change its atomic structure.....( )
9. Soft water contains practically no.....( )
10. .....is a thick, colorless alcohol obtained from the hydrolysis of fixed fats.....( )

TRADE THEORY TEST

Block VI, BARBER TRADE

ELEMENTARY CHEMISTRY

Name_____ Class_____ DATE_____

1. Chemistry is the science that treats of the composition of matter....T F

2. Matter is anything that occupies space and has weight.....T F

3. Energy is the activity, power or force found in matter.....T F

4. Pharmacology is the science that treats of drugs and their relations.T F

5. There are five states of matter, three of them being solid, gas and liquid.....T F

6. An element is the simplest form in which matter exists.....T F

7. An Atom is the smallest particle of an element.....T F

8. Molecules are combinations of similar atoms.....T F

9. Compounds are various molecules existing together in fixed relations..T F

10. The principal types of compounds are: acids, bases and salts.....T F

11. An acid is a compound having electronegative properties and reacts with bases to form salts.....T F

12. A base, better known as an alkali, is a compound having an electrositive reaction. It unites with acids to form salts and with fats to form soap .....T F

13. A salt is a compound usually containing a positive metal atom.....T F

14. A chemical change takes place where a substance does not change its atomic structure.....T F

15. A physical change is one that takes place when a substance is altered in its chemical nature.....T F

16. Hard water, such as rain or distilled water, contains practically no minerals.....T F

17. Soft water contains a small amount of mineral salts.....T F

18. Glycerine is a thick, colorless, syrupy liquid obtained from the (also is an alcohol) hydrolysis (process of decomposition involving the addition of water) of fixed fats.....T F

19. Soap is a water soluble salt consisting of fatty acid in combination with sodium or potassium.....T F

20. Alcohol, in weak concentration, is cooling and antiseptic.....T F

21. An aqueous solution is one in which the solvent is alcohol.....T F

22. A tincture is a solution in which the solvent is water.....T F

23. Matter may be created or destroyed.....T F

24. The Chemical symbol for water is H_2O_2.....T F

25. Synthesis is the building up of a compound.....T F

26. Energy cannot be created or destroyed.....T F

27. Organic chemistry treats with substance found generally in mineral derivation.....T F

28. Inorganic chemistry treats of substances derivedfrom the animal and vegetable kingdom.....T F

29. Boiling means heating to a temperature of 212° Fahrenheit to destroy microbes and drive off gases.....T F

30. Creams are mainly oil of different kinds mixed in different proportions with water.....T F

31. An Emulsifying agent is one which allows oil and water to mix.....T F

32. A water-in-oil (w/o) cream is the most ideal for a cleansing agent because it tends to melt at body temperature and spreads readily over the skin (cold cream).....T F

33. After the cleansing cream is removed, the skin should feel smooth not sticky or greasy, perfectly clean and relaxed.....T F

34. Soaps are harmless to the skin if they do not contain free alkali..T F

35. Vanishing cream is an oil—in—water (o/w) emulsion containing as high as 75% water.....T F

36. Phenol and mercury bichloride are two disinfectants which are corrosive to metals.....T F

37. Formalin, Phenol, mercury bichloride and cresol when used as disinfectants should be labeled POISON.....T F

38. The temperature of boiling water is 100 degrees Centigrade, and 212 degrees Fahrenheit.....T F

39. Neutralization can be defined as a chemical change taking place when an acid is added to a base or alkali..... T F

40. An acid solution will turn blue litmus paper red..... T F

41. An alkaline solution will turn red litmus paper blue..... T F

42. Potassium hydroxide, as a base, is used in the manufacture of soap..T F

43. The addition of a base to an acid results in the formation of water and a salt ..... T F

44. Hard water may be softened by boiling, distillation or adding borax... T F

45. About 65% of the human body is composed of water..... T F

46. Alcohol is obtained by the fermentation of certain sugars..... T F

47. Formaldehyde gas is rendered inactive by the addition of ammonia..... T F

48. Iodine stains are readily removed with alcohol..... T F

49. Emulsions are permanent mixtures of oil and water combined with the aid of gums or soaps..... T F

50. Creams differ from ointments and pastes in the large amount of water they contain..... T F

51. Do not use naptha soap on the face..... T F

52. Lanolin or cocoa butter are ingredients of a superfatted soap..... T F

53. The use of ammoniated mercury as a bleaching agent is harmful to the skin..... T F

54. Benzine and gasoline are used in dry shampoos..... T F

55. Shampoos are dilute solutions of soap in water..... T F

56. Hand lotions are dilute emulsions of steric acid and water..... T F

APPENDIX

A student course, to be effective and to conserve time for both the student and the Instructor, must utilize supplementary aids which contribute to the development of each individual. Accordingly, current materials are grouped in this bibliography as (A) Texts and workbooks required by each student, (B) Reference texts, and handbooks for class use, and (C) manufacturers' and organizations' trade literature.

CHART "A" TEXTS AND WORKBOOKS (One Copy required for each student)

Title	Publisher	Address	Edition Used
Practical and Scientific Barbering	Jouneymen Barbers' Hairdressers and Cosmetologists International Union of America	Indianapolis, Indiana	1947
English in Action Course I	D.C. Heath & Co.	Boston, Mass.	1950
Quiz on Words	American Book Co.	New York, N.Y.	1940
Economics for our Time	McGraw-Hill Book Co., Inc.	New York, N.Y.	1950
Connecticut The State and its Government	Oxford Book Co.	New York, N.Y.	1948

CHART "B" REFERENCE TEXTS (One or more copies required for class use)

Applied Biology	Delmar Publishers	Albany, N.Y.	1950
Applied Chemistry			1950
Bacteriology for Nurses			1950
Once Over Lightly	Charles DeZenler	New York, N.Y.	1939
Your Hair	Milady Publishing Corp.	New York, N.Y.	1946
Practice and Science of Standard Barbering			1950
Modern Textbook of Barbering			1950
Sanitation, Hygiene, Baceriology and Sterilization			1946
Sullivan's Method	Bookhaven Press	Los Angeles, Cal.	1942
Practical Mathematics	McGraw-Hill Book Co., Inc.	New York, N.Y.	1940
Essential Business Mathematics			1947
Advanced Problems in Arithmetic	Newson & Company	New York, N.Y.	1929
Triangle Arithmetic	John C. Winston Co.	Philadelphia, Pa.	1928
Applied Mathematics	D. VanNostrand Co., Inc.	New York, N.Y.	1942
Master Barbers' text	Associated Master Barbers' & Beauticians of America	Chicago, Ill.	1950
Practical Nursing	W.B. Saunders	Philadelphia, Pa.	1949

CHART "C" MANUFACTURERS' AND ORGANIZATIONS TRADE LITERATURE
(Copies needed for class use)
(All titles except those marked x are free for class use)

Title	Publisher	Address	Edition Used
x Today's Health	American Medical Assoc.	Chicago, Ill	Latest
x Barbers Journal	American Hairdresser, Inc.	Easton, Penn.	Latest
x The Master Barber and Beautician Journal	L. E. McLlvain	Chicago, Ill	Latest
x Journeymen Barbers' Journal	Journeymen Barbers' Int. Union	Indianapolis, Ind.	Latest
x Cosmetics and Toiletries	Thomas B. Haire	Ea. Stroudsburg	Latest
Weekly Health Bulletin Monthly Health Bulletin	Connecticut State Department of Health	Hartford, Conn.	Latest
Monthly Bulletin	Conn. State Dept. of Labor	Hartford, Conn.	Latest
Public Act No. 308 (An act concerning Barbers) Regulations concerning Barber Shops & Barber Schools	Connecticut State Board of Barber Examiners	Hartford, Conn.	1949
Standards of Apprenticeship	Conn. State Barbers' Joint Apprenticeship	Waterbury, Conn.	1952
Monthly Bulletin	Conn. Federation of Labor	Bridgeport, Conn.	Latest
Conn. State Register & Manual	Office Sec'y of State	Hartford, Conn.	Latest
Conn. Resources Bulletins No. 1-8	Conn. Development Commission	Hartford, Conn.	Latest
Some Facts (Conn. makes it Better)		Hartford, Conn.	Latest
Catalog (Equipment)	Koch's	Chicago, Ill.	Latest
Catalog (Tools & Equip.)	John Oster Mfg. Co.	Racine, Wis.	Latest
Catalog (Tools)	Pearlduck, Inc.	New York, N. Y.	Latest
Catalog (Supplies)	Stephan's	Worcester, Mass.	Latest
Catalog (Equipment)	Koken Companies, Inc.	St. Louis, Mo.	Latest
Catalog (Supplies & Charts)	Kreml	New Canaan, Conn.	Latest

VT 012 612
Instructor's Manual. Preparatory Course for the Barber Trade, Parts I and II.

Connecticut State Dept. of Education, Hartford. Div. of Vocational Education.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 63 69p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *TEACHING GUIDES; *BARBERS; *MANUALS; VOCATIONAL EDUCATION; ADULT EDUCATION PROGRAMS; *SERVICE OCCUPATIONS; LESSON PLANS; SKILL DEVELOPMENT

ABSTRACT - Prepared by the Division of Vocational Education of the Connecticut State Department of Education, this manual is part of a 3-part series and was assembled for use by instructors in presenting material and motivating students interested in the barber trade. Part I provides the trade and related outlines for the course, including estimated hours of instruction, trade theory and practice, social studies, English, and mathematics, while Part II consists of a weekly schedule for trade and related instruction which correlates the trade theory and related instruction. Each part contains several blocks, and the entire course is arranged for 1,300 hours. Parts III and IV are available as VT 012 610 and VT 012 611, also in this issue. (GEB)

VT 012 612

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DIVISION OF VOCATIONAL EDUCATION

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VT-235-I

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INSTRUCTOR'S MANUAL

PREPARATORY COURSE

For The

BARBER TRADE

CONNECTICUT STATE
DEPARTMENT OF EDUCATION
Hartford, Connecticut
1963

VT012612

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TO THE INSTRUCTOR:

This manual has been assembled for use by instructors in the Barber Trade. The content was prepared after the need for developing highly skilled and efficient practitioners in the Barber Trade was recognized. Students learning the Barber Trade are given actual and pertinent information and instruction governing trade and related subjects.

The Instructor's Manual should aid the instructor in motivating and encouraging the student to grasp every opportunity to gain and expand his knowledge, to develop and improve his skill, and to realize the opportunities that lie ahead in the security of his future life's work. The training creates within the student justified pride in the knowledge acquired.

This manual is divided into four major parts. Part One covers all the trade and related outlines for the course, such as, estimated hours for trade and related instruction, trade theory and practice, social studies, English salesmanship, and mathematics for Barbers.

Part Two consists of a weekly schedule for trade and related instruction whereby trade theory and shop practices, mathematics, social studies, English and Salesmanship are applied and correlated for the Barber Trade.

Part Three deals with the teaching plans for trade theory. It consists of seven blocks of instructional materials built around the textbook, reference texts, illustrations and supplemental material.

The trade theory tests included in Part Four are correlated with the teaching plans in Part Three.

The four parts of the manual are arranged in a natural sequence of teaching-learning difficulty. Use of the manual will improve the effectiveness of instruction to the potential Barber craftsman.

CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Hartford

TRADE AND RELATED OUTLINES

PREPARATORY COURSE

For The

BARBER TRADE

PART I

1963

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CONTENTS

PART I

TRADE AND RELATED OUTLINES

1. Estimated Hours for Trade and Related Instruction - - - - - -
2. Trade Theory and Practical Outlines - - - - - - - - - - - - - -
3. Social Studies -
4. English - Salesmanship -
5. Mathematics for Barbers -

PART II

WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION

1. Trade Theory and Shop -
2. Mathematics -
3. English - Salesmanship -
4. Social Studies -

PART III

TEACHING PLANS

1. Block I - - - History of Barbering - - - - - - - - - - - - -
2. Block II - - - Instruments and Accessories - - - - - - - - - -
3. Block III - - - Practical Skills - - - - - - - - - - - - - - - -
4. Block IV - - - Bacteriology - - - - - - - - - - - - - - - - - -
5. Block V - - - Systems of the Body - - - - - - - - - - - - - -
6. Block VI - - - Chemistry -

PART IV

TRADE THEORY TESTS

1. Block I - - - History of Barbering - - - - - - - - - - - - -
2. Block II - - - Instruments and Accessories - - - - - - - - - -
3. Block III - - - Practical Skills - - - - - - - - - - - - - - - -
4. Block IV - - - Bacteriology - - - - - - - - - - - - - - - - - -
5. Block V - - - Systems of the Body - - - - - - - - - - - - - -
6. Block VI - - - Chemistry -

APPENDIX

Bibliography -

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PREPARATORY COURSE
FOR THE
BARBER TRADE

TRADE AND RELATED INSTRUCTION

1. The instruction identified in this section covers pre-apprenticeship training as required under Public Act #308 (an act concerning Barbers) and is intended to prepare the student for an apprentice license. A majority of the time has been apportioned to practical training for two reasons.

   a. A student must develop basic skills to a considerable extent before he may enter a barber shop as an apprentice and perform work upon regular customers.

   b. The student may have an opportunity to complete technical and related training during his on-the-job training since annual renewal of his apprentice license requires that he attend classes for this type of instruction a minimum of 144 hours each year.

   The course has been set up to include a full year (school) of approximately 1300 hours, 300 hours beyond the minimum required by law, in order that the course may be coordinated with the Vocational Technical School Program.

2. The time allotment shall be for one school year and will provide:

   a. The related technical knowledge of the barber trade.
   b. The basic skills of the trade - to provide sufficient knowledge to continue as a barber apprentice.
   c. General trade information necessary for basic understanding of trade processes.
   d. Trade calculations and mathematics.
   e. Trade hazards and safety.

ONE SCHOOL YEAR

Trade Theory		200 hours
Practical Work		950 hours
General Trade Information		110 hours
Applied Mathematics		40 hours
	Total	1300 hours

3. Experience has shown that one school year is reasonably adequate for basic training in this area.

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PREPARATORY COURSE
FOR THE
BARBER TRADE

TRADE AND RELATED INSTRUCTION

TRADE THEORY	ESTIMATED HOURS
HISTORY OF BARBERING	
1. Orientation	5
2. Scope of Cosmetics	1
3. Ancient Practices	2
4. The New Barber	1
5. What of Tomorrow?	1
6. State Board Requirements for Licenses	2
7. Development of Modern Cosmetology	1
8. Legislation	2
INSTRUMENTS AND ACCESSORIES	5
PRACTICAL SKILLS	
1. Haircutting	5
2. Shaving	5
3. Shampooing	5
4. Massaging	5
5. Singeing	1
6. Honing and Stropping	3
7. Hair Tonic Applications	1
BACTERIOLOGY	10
SYSTEMS OF THE BODY	
1. Cells - Tissues - Organs	10
2. Integumentary (Study of skin and its appendages)	20
3. Skeletal (Study of bones of head, face and neck)	15
4. Muscular (Study of muscles of head, face and neck)	10
5. Nervous (Study of nerves of head, face and neck)	10
6. Circulatory or Vascular (Study of circulation of blood and lymph of head, face and neck)	10
7. Digestive (Relationship to barbering)	10
8. Excretory (Relationship to barbering)	6
9. Respiratory (Relationship to barbering)	6
10. Urogenital (Relationship to barbering)	5
11. Internal Secretions (Relationship to barbering)	8
CHEMISTRY (Contribution to barbering)	15
TRADE HAZARDS AND SAFETY	5
GLOSSARY AND TRADE TERMINOLOGY	10
PREPARATIONS FOR FINAL EXAMINATION	5
Total Trade Theory	200

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TRADE AND RELATED INSTRUCTION (continued)

PRACTICAL WORK		Estimated Hours
USE OF INSTRUMENTS AND ACCESSORIES	150	
CARE OF EQUIPMENT	80	
HAIRCUTTING	290	
SHAVING	250	
SHAMPOOING	50	
MASSAGING	60	
SINGEING	10	
HONING AND STROPPING	30	
HAIR TONIC APPLICATIONS	10	
SANITATION - STERILIZATION - HYGIENE	20	
Total Practical Work		950 hours
GENERAL TRADE INFORMATION		
PROFESSIONAL ETHICS AND RELATED SCIENCES	110	
Total General Trade Information		110 hours
APPLIED MATHEMATICS		
FUNDAMENTAL OPERATIONS	12	
PROBLEMS PERTAINING TO BARBERING	28	
Total Applied Mathematics		40 hours
TOTAL FOR COURSE		1300 hours

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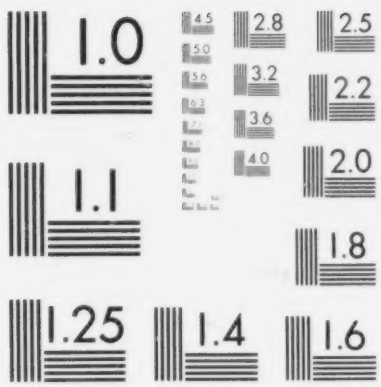

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PREPARATORY COURSE FOR BARBER TRADE
THEORY AND PRACTICE

DATE STARTED_____ NAME_____

DATE COMPLETED_____ INSTRUCTOR_____

Block	Unit	Title	Estimated Hours 1150	Theory 200	Practical 950	Total
I		HISTORY OF BARBERING	15			
	1.	A. Orientation (1) Definition of Barbering (2) Principles and practices of Barbering a. The demand b. The outlook 1. Working conditions 2. Social standing 3. Opportunity to serve 4. Responsibilities 5. Average age of barbers 6. Statistics from the State Board of Barber Examiner's Office 7. Number of idle licenses now otherwise occupied.		5		5
	2.	A. Scope of Cosmetics B. Ancient Practices (1) Chinese civilization		1 2		

(continued)

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Block	Unit	TITLE	Estimated Hours			
				Theory	Practical	Total
I	2.	(2) Egyptian Civilization				
		(3) Grecian Civilization				
		(4) Roman Civilization				
		(5) Western Civilization				
		(6) The Barber - Surgeons				
		C. The New Barber	1			
		(1) The American Barber				
		(2) The Modern Barber Shop				
		(3) Salesmanship and Ethics				
		D. What of Tomorrow?		1		10
		E. State Board's Educational Requirements for Licenses		2		
		F. Development of Modern Cosmetology		1		
		G. Legislation		2		
		(1) The Connecticut Barber Law				
		(2) The Connecticut Regulations				
TEXTBOOK - "Trade Histories"						
TEXTBOOK - "Practical and Scientific Barbering"						
		Public Act #308				
		An Act Concerning Barbers				
		Apprenticeship Standards				
		Supplemental Research Material				

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PREPARATORY COURSE FOR BARBER TRADE
THEORY AND PRACTICE

Block	Unit	TITLE		Estimated Hours Theory	Practical	Total
II		INSTRUMENTS AND ACCESSORIES	5			
		A. Razors (1) Kinds of razors (2) Types of razors (3) Parts of razors (4) Descriptions of razors (5) Razor Grindings (6) Care of razors		.5	28	28.5
		B. Shears (1) Kinds of shears (2) Types of shears (3) Thinning shears (4) Parts of shears (5) Methods of grinding (a) Plain (b) Corrugation (6) Description of shears (7) Care of shears		.5	20	20.5
		C. Clippers (1) Kinds of clippers (2) Types of clippers (3) Parts of clippers (4) Care of clippers		.5	20	20.5
		D. Combs (1) Kinds of combs (2) Types of combs (3) Description of combs (4) Care of combs		.5	2	2.5
		E. Brushes (1) Kinds of brushes (2) Types of brushes (3) Parts of brushes (4) Uses of brushes (5) Care of brushes		.5	2	2.5

(continued)

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Block	Unit	TITLE	Estimated	Theory	Practical	Total
II		INSTRUMENTS AND ACCESSORIES (cont'd)	5			
	1	F. Strops (1) Kinds of strops (2) Parts of strops (3) Methods of stropping (4) How to treat a strop (5) Effect of stropping (6) Care of strops		.5	20	20.5
		G. Hones (1) Kinds of hones (2) Structure of hones (3) Methods of honing (4) How to keep hone clean (5) Effect of honing (6) Care of hones		.5	28	28.5
		H. Comedon Extractor (1) Kinds (2) Types (3) Structure (4) Use of (5) Care of		.3	8	8.3
		I. Tweezer and Needle (1) Kinds (2) Structure (3) Use of (4) Care of		.2	2	2.2
		J. Soaps (1) Kinds (2) Composition (3) Methods of Using (4) Effect of soaps		.5	20	20.5
		K. Barber Shop Equipment		.5	80	85.5

REFERENCES:

"Practical and Scientific Barbering"
"Once Over Lightly"
Supplemental Research Material
"Master Barber"

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
III		PRACTICAL SKILLS	25			
	1.	A. Haircutting (1) Importance of (2) Methods of (3) Shapes of heads (4) Cutting Virgin hair (5) Thinning (6) Tapering (7) Slithering (8) Women's Haircutting (9) Trade terms (10) Current problems		5	290	295
References: "Practical and Scientific Barbering" "Modern Textbook on Barbering" Supplemental Research Material						
	2.	B. Shaving (1) Importance (2) Methods of (3) Beard textures and densities (4) Selecting razor best suited for the beard (5) Lathering techniques (a) Methods of preparing lather (6) Current problems		5	250	255
References: "Practical and Scientific Barbering" "Once Over Lightly" "Master Barber" Supplemental Research Material						
	3.	C. Shampooing (1) Importance (2) Essential requirements (3) Purpose (4) Methods (5) Types (6) Scalp manipulations (7) Desired results (8) Elements of a successful shampoo		5	50	55

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
III		PRACTICAL SKILLS (continued)	25			
	3	C. Shampooing (cont'd) (9) Brushing (10) Current problems				
References: "Practical and Scientific Barbering" "Master Barber" "The Van Dorn System" "The Hair and Scalp" Supplemental Research Material						
	4.	D. Massaging (1) Purpose (2) Essentials (3) Prerequisities for training (4) Methods of (5) Basic Movements (6) Importance of motor points (7) Effects of (8) Mistaken notions about massage (9) Most frequent causes for unsatisfactory results (10) Necessary equipment and materials		5	60	65
References: "Practical and Scientific Barbering" "Master Barber" "Modern Barber" "The Principles and Practices of Beauty Culture" Supplementary Research Material						
	5.	E. Singeing (1) Definition (2) Purpose (3) Methods (4) When to recommend (5) Results (6) Trade terms		1	10	11
References: "Practical and Scientific Barbering" Supplemental Research Material						

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
III		PRACTICAL SKILLS (continued)	25			
	6	F. Honing and Stropping (1) Types of hones and strops (2) Shape of teeth of razor to result with (3) Procedures of testing razor (4) Precision of stroke (5) How to avoid distorting cutting edge of razor (6) Preparation of hone and strop		3	30	33
References: "Practical and Scientific Barbering" "Modern Barber" Supplemental Research Material						
	7.	G. Hair Tonics (1) Types (2) Preparation (3) Application (4) Results		1	10	11
References: "Manufacturer's Information" Supplemental Research Material						

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
IV		BACTERIOLOGY	10			
	1.	(1) Contribution to barbering		1		
		(2) Nature		1		
		(3) Occurrence		1		
		(4) Types of Bacteria		1		
		(5) Transmission of disease, infection, immunity		1		
		(6) Group hygiene		1		
		(a) Sanitation				
		(b) Prophlaxis				
		(c) Methods of sterilization				
		(d) Methods of disinfection				
		(e) Methods of preparations for Barber Shop use				
		(7) Sanitary regulations for barbers and barber shops		1		
		(8) Trade terms		1		
		(9) Easy rules applied in making solution		1		
		(10) Tables of antiseptic values		1		
References:						
		"Applied Bacteriology"				
		Supplemental Research Material				
		"Sullivan Beauty Manual"				
Regulations concerning barber shops and barber schools					20	30

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
V		SYSTEMS OF THE BODY	110			
	1.	A. Cells - Tissues - Organs				
		(1) Life activities of cells		1		
		(2) Parts of cells		1		
		(3) Locations of cells		1		
		(4) Functions of cells		1		
		(5) Types and descriptions of tissues		1.5		
		(6) Functions of tissues		1.5		
		(7) Structure of organs		1.5		
		(8) Functions of organs		1.5		
						10
REFERENCES: "Applied Biology" "Basic Origin of Man" Supplemental Research Material						
	2.	A. Integumentary (Dermatology)				
		(1) The study of the skin		2		
		(a) Divisions of skin				
		(b) Functions of skin				
		(2) Appendages of skin		2		
		(a) Sebaceous glands				
		(b) Sudoriferous glands				
		(c) Hair				
		(c) Nails				
		(e) Nerve endings				
		(3) Diseases of appendage		2		
		(4) Forms of Acne		2		
		(5) Definition of skin disorders		2		
		B. The Study of the Hair				
		(1) Structure of hair		1		
		(2) Forms of hair		.5		
		(3) Functions of hair		1		
		(4) Texture of hair		.5		
		(5) Composition of hair		1		
		(6) Growth of hair		1		
		(7) Superfluous hair		1		
		(8) Disorders and diseases of hair		1		
		(9) Technical terms regarding hair		1		

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
V		SYSTEMS OF THE BODY (continued)	110			
	2.	C. The Hair Follicle				
		(1) Structure		1		
		(2) Health of follicle		1		20
		REFERENCES:				
		Supplemental Research Material				
		"Practical Nursing"				
		"Practical and Scientific Barbering"				
		"Master Barber"				
		"Your Hair"				
	3.	A. Skeletal				
		(1) Structure of bones		2		
		(2) Function of bones		1		
		(3) How joints function		1		
		(4) Composition of bones		1		
		(5) Cartillage and ligaments		1		
		(6) The skull		4		
		(7) Bones of the head, face and neck		4		
		(8) Some bone disturbances		1		15
		REFERENCES:				
		Supplemental Research Material				
		"Practical Nursing"				
		"Practical and Scientific Barbering"				
	4.	A. Muscular (Myology)				
		(1) Structure of muscles		1		
		(2) How muscles work		1		
		(3) Power of muscles		.5		
		(4) Muscle tone		.5		
		(5) Rehabilitation and control		1		
		(6) Distinction between ligaments and tendons		1		
		(7) Origin and insertion of muscles		1		
		(8) Characteristics of muscles		1		
		(9) Varieties of muscular tissue		1		
		(10) Muscles of the head, face and neck		1		
		(11) Chart of muscles		.5		
		(12) A table of muscles		.5		10
		REFERENCES:				
		"Practical and Scientific Barbering"				
		"Practical Nursing"				
		"Modern Barbering"				
		Supplemental Research Material				

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
V		SYSTEMS OF THE BODY (continued)	110			
	5.	A. Nervous (Neurology)				
		(1) Classification of the nervous system		1		
		(2) Kinds of nerves		1		
		(3) Functions of nerves		1		
		(4) The spinal cord		1		
		(5) The brain		1		
		(6) The central nervous system		1		
		(7) The sympathetic nervous system		1		
		(8) Importance of the nervous system to Barbering		1		
		(9) Chart of nerves		1		
		(10) Nerves of the head, face and neck		1		10
REFERENCES: Supplemental Research Material "Practical and Scientific Barbering" "Practical Nursing" "Modern Barbering"						
	6.	A. Circulatory or Vascular System (Angiology)				
		(1) Two systems		1		
		(a) Blood vascular				
		(b) Lymph vascular				
		(2) Functions of blood		1		
		(3) Functions of lymph		1		
		(4) Composition of blood		1		
		(5) The heart		1		
		(6) The systemic circulation		1		
		(7) The pulmonary circulation		1		
		(8) Principal vessels of the head, face and neck		1		
		(9) Schematic drawing of the circulation of blood		1		
		(10) Lymph glands of the head, face and neck		1		10
REFERENCES: Supplemental Research Material "Practical and Scientific Barbering" "Practical Nursing" "Modern Barbering"						

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
V		SYSTEMS OF THE BODY (continued)	110			
	7.	A. Digestive Systems				
		(1) Diagram of digestive tract		1.5		
		(2) Parts of the digestive system		2		
		(3) Relation of food		1		
		(4) Absorbtion		1		
		(5) Alimentary canal		2.5		
		(a) The large intestine				
		(b) The small intestine				
		(6) Food for health		1		
		(7) Relationship to Barbering		1		10
REFERENCES: Supplemental Research Material; "Practical and Scientific Barbering"; "Practical Nursing"; "Modern Barbering"						
	8.	A. Excretory System				
		(1) Importance in Barbering		1		
		(2) Principal organs of excretory system		1		
		(3) Division		1		
		(4) Functions		.5		
		(5) Purpose		.5		
		(6) Disorders and disturbances of		1		
		(7) The "Skin as an Organ of Excretion"		1		6
REFERENCES: Supplemental Research Material; "Practical and Scientific Barbering"; "Practical Nursing"; "Modern Barbering"						
	9.	A. Respiratory System				
		(1) Diagram of the process of respiration		1		
		(2) The skin as an organ of respiration		1		
		(3) Purpose of		1		
		(4) Divisions of		1		
		(5) Functions of		1		
		(6) Disturbances of		1		6
REFERENCES: Supplemental Research Material; "Practical and Scientific Barbering"; "Practical Nursing"; "Modern Barbering"						

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
V		SYSTEMS OF THE BODY (continued)	110			
	10.	A. Urogenital System				
		(1) Divisions of		1.5		
		(a) The urinary system		1		
		(b) Reproductive organs				
		(2) Functions of		1		
		(3) Importance of		1		
		(4) Relationship to barbering		1.5		6
REFERENCES: Supplemental Research Material "Practical and Scientific Barbering" "Practical Nursing" "Modern Barbering"						
	11.	A. Internal Secretions				
		(1) Important organs of secretion		1		
		(2) Ductless gland		1		
		(3) Function of		1		
		(4) Purpose of		1		
		(5) Table of glands		1		
		(6) Manufacture of hormones		1		
		(7) Results of secretions		1		
		(8) Relationship to barbering		1		8
REFERENCES: Supplemental Research Material "Practical and Scientific Barbering" "Practical Nursing" "Modern Barbering"						

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Block	Unit	TITLE	Estimated Hours	Theory	Practical	Total
VI		CHEMISTRY	15			
	1.	A. Chemistry of Cosmetics				
		(1) Definitions of terms		1		
		(2) Classes of preparations		1		
		B. Cosmetics for the Hair				
		(1) Types of		1		
		(2) Purpose of		1		
		(3) Functions of		1		
		(4) Results		1		
		C. Cosmetics for the Skin				
		(1) Types of		1		
		(2) Purpose of		1		
		(3) Functions of		1		
		(4) Dangers of		1		
		(5) Results		1		
		D. Simple Tests		1		
		E. Contribution to Barbering		1		
		F. Need for Scientific Research in Application of Chemical Discoveries in Barbering		2		15
REFERENCES: Supplemental Research Material; "Applied Chemistry"; "Principles and Practices of Beauty Culture"; "Practical and Scientific Barbering"; "The Van Denn System"						
		TRADE HAZARDS AND SAFETY				
		A. First Aid Treatments		5		5
REFERENCES: Supplemental Research Material						
		GLOSSARY:				
REF: Perpetual Building of Glossary by Students				10		10
		PREPARATION FOR FINAL EXAMINATION				
REF: Mock Examination and Revue				5		5

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PREPARATORY COURSE FOR BARBER TRADE

Social Studies

Block	Unit	TITLE	Estimated Hours	Hours Applied	Review-Tests	Total
I		SOCIAL STUDIES	20			
	1.	Economics				
		A. The Citizen's Economic life				
		Human wants and their satisfaction		1	.5	1.5
		How man makes economic progress		1	.5	1.5
		How man uses natural resources		1	.5	1.5
		Management of business		1	.5	1.5
		How buying and selling take place		1	.5	1.5
		How government aids and controls business		1	.5	1.5
		Human relations in business and industry		1	.5	1.5
		B. How Connecticut people make a living		1	.5	1.5
		Industry Major industries - their products, value and use of products, where products go		1	.5	1.5
		The people who run our factories, the functions of labor and management		1.5	.5	2
		Labor organizations		1.5	.5	2
		Agriculture		1.5	.5	2
		Insurance		1.5	.5	2

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Block	Unit	TITLE	Estimated Hours	Hours Applied	Review-Tests	Total
II	2.	GOVERMENT - SOCIAL STUDIES				
		A. Development of Local Government			1	1
		<u>The City Charter</u>				
		Introduction				
		The First Charter				
		Charter began life as a city		1		1
		<u>How Citizens Vote</u>				
		Who can vote				
		Provisions for being voter				
		How to vote				
		The candidates for office				
		Who can be candidate		1		
		How to become a candidate				1
		Methods				
		Provisions for voting				
		<u>Political Parties</u>				
		Party organization				
		The precinct or election district committees		1		1
		The county committees				
		The state committees				
		The national committee				
		Policical conventions				
		Political boss				
		B. Local Government in Connecticut				
		<u>Township</u>				
		Incorporated communities		2	.5	2.5
		Form of government				
		Town meeting				
		Borough				
		<u>City</u>				
		Steps necessary to become city				
		Forms of city government		2	.5	2.5
		Mayor-Council				
		Commmission				
		City Manager - Council				
		<u>The Country</u>				
		Relation of the County to the State, Town and City				
		Form of government -				
		Three county commissioners				
		Other county departments and officers		1	.5	2.5
		County Seat				

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Block	Unit	TITLE	Estimated Hours	Hours Applied	Review-Tests	Total
II	2	GOVERNMENT - SOCIAL STUDIES (cont'd)				
		C. Organization of Connecticut Government			1.5	1.5
		<u>Legislative Department</u>				
		Comparision of the two houses of the General Assembly		1		1
		Making a law				
		Influence of law making				
		The citizens part in this				
		<u>Executive Department</u>				
		Governor, Lieutenant Governor, Secretary of the State, Treasurer, Comptroller, Attorney-General		1		1
		Administrative departments				
		<u>The Judicial Department</u>				
		Need of Courts				
		Kinds of law cases Civil - Criminal			1	
		Connecticut Courts				1
		Connecticut Juries				
		<u>Financial Needs of Connecticut Government</u>				
		Need for money			1	1
		Sources of government revenue				
		Spending public money				
		<u>Attempts at Reorganization of State Government</u>		.5		1
		D. United States Government			1	1
		General purpose and plan of National Government				
		Legislative Department		1		1
		Enforcement of National Laws				
		Judicial Government				
		Financial Needs		1		1
		Federal State Relations				

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PREPARATORY COURSE FOR BARBER TRADE

English - Salesmanship

Block	Unit		Estimated Hours	Hours Applied	Review-Tests	Total
		ENGLISH	30			
I		YOUR LANGUAGE ACTIVITIES				
	1.	Building Paragraphs References - Textbook Pages 94 - 107		1	.5	1.5
	2.	Explaining Reference - Textbook Pages 107 - 130		1	.5	1.5
	3.	Work, Service and Leadership Reference - Textbook Pages 145 - 157		1	.5	1.5
	4.	Writing Business Letters Reference - Textbook Pages 182 - 198		1	.5	1.5
	5.	Thinking, Listening and Discussing Reference - Textbook Pages 182 - 198		1	.5	1.5
	6.	Improving Your Speech Reference - Textbook Pages 229 - 245		1	.5	1.5
	7.	New Words to Use Reference - Textbook Pages 245 - 275		1	.5	1.5
II		HANDBOOK OF GRAMMAR AND USAGE				
	1.	Form of Written Work Reference - Textbook Pages 275 - 281		1	.5	1.5
	2.	Subject, Predicate and Parts of Speech Pages 281 - 313		1	.5	1.5

5401

Block	Unit	ENGLISH (continued)	Estimated Hours		
				Applied	
					Review-Tests
					Total
II		HANDBOOK OF GRAMMAR AND USAGE (cont'd)			
	3.	Punctuating Simple Sentence Reference - Textbook Pages 313 - 328		1	.5	1.5
	4.	Capitalization Reference - Textbook Pages 328 - 337		1	.5	1.5
	5.	Writing Plurals and Possessives of Nouns Reference - Textbook Pages 337 - 346		1	.5	1.5
	6.	Correct Pronouns Reference - Textbook Pages 346 - 365		1	.5	1.5
	7.	Correct Verbs Reference - Textbook Pages 365 - 394		1	.5	1.5
	8.	Correct Adjectives, Adverbs and Prepositions Reference - Textbook Pages 394 - 411		1	.5	1.5
	9.	Compound and Complex Sentences Reference - Textbook Pages 411 - 428		1	.5	1.5
	10.	Sentence Sense Reference - Textbook Pages 428 - 440		1	.5	1.5
	11.	Building Varied, Forceful Sentences Reference - Textbook Pages 440 - 446		1	.5	1.5
	12.	Spelling Reference - Textbook Pages 446 - 456		1	.5	1.5
	13.	Appendix Reference - Textbook Pages 456 - 459		1	.5	1.5

5402

Block	Unit	TITLE	Estimated Hours	Hours Applied	Review-Tests	Total
III		SALESMANSHIP	10			
	1.	Definition - Qualifications - Value - Reference - Textbook Lesson XI - Pages 4 - 6		1.5	.5	2
	2.	Pre-approach and Analysis Reference - Textbook Lesson XI - Pages 4 - 6		1.5	.5	2
	3.	Personal Appearance and Hygiene		1.5	.5	2
	4.	Knowledge of Profession		1.5	.5	2
	5.	Ability to Apply Your Knowledge		1.5	.5	2

5403

CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Hartford

WEEKLY SCHEDULE
For
TRADE AND RELATED INSTRUCTION

PREPARATORY COURSE
For The
BARBER TRADE

PART II

1963

5405

PREPARATORY COURSE

WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION

BARBER TRADE

WEEK I

Related and Technical Instruction	Monday	Tuesday	Wednesday	Thursday	Friday	Reference and Text
	Assignment	Assignment	Assignment	Assignment	Assignment	Instruction Material
TRADE THEORY	Orientation to Barber Trade Definition of Barbering	Barber's License Law Regulations for Conn. State Board of Barber Examination State Board Examination		Apprenticeship Program Barber Science	Review	M Lecture T Once Over Lightly W Public Act #308 T An Act Concerning Barbers F Apprenticeship Standard
MATHEMATICS	Class Oriented On Applied Mathematics					Applied Barber Mathematics
ENGLISH SALESMANSHIP		Study Period or Extra Cur.		English Building Paragraphs		Text
SOCIAL STUDIES A) Economics B) Government			Class Oriented on Economics			Outline on Social Studies
PRACTICAL	Barber Chairs and Fixtures	FAMILIARIZE CLASS Additional Equipment Sinks, Lights, etc.	Supplies Tonics, Creams, Lotions, etc.	Laundry Hair cloths Towels Uniforms	Instruments and Accessories	Barber School Equipment, etc.

5406

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK II

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Introduction and Practices	to Principles of Barbering	Opportunities For and Responsibilities of Barbers	The Demand -The Outlook	Review and Test	M Textbook T Supplemental Material W Lecture T Trade Histories F Oral Prepared by Instructor
MATHEMATICS	Whole Numbers Addition Subtraction Multiplication Division					Applied Barber Mathematics
ENGLISH Salesmanship		Gym		English Explaining		Text Lecture
SOCIAL STUDIES A) Economics B) Government			Class Oriented on Economics			Outline on Social Studies
PRACTICAL	How to clean Barber School	Proper place for Supplies Laundry	FAMILIARIZE CLASS Procedure to Refill or Replace Supplies	Daily Maintenance of Barber School	Check	Barber School Equipment and Supplies

54017

PREPARATORY COURSE — WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION — BARBER TRADE

WEEK III

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Scope of Cosmetics	Ancient Practices of Barbering	The New Barber Educational Requirements Legislation	What of Tomorrow?	Review and Test	M Supplemental Material T Once Over Lightly W Conn. Requirements T Lecture F Prepared Test
MATHEMATICS	Fractions Addition Subtraction					Applied Barber Mathematics
ENGLISH Salesmanship		Study Period or Extra Cur.		Work Service Leadership		Text
SOCIAL STUDIES A) Economics B) Government		Human Wants and Their Satisfaction				Text
PRACTICAL	Sterilization Instruments and Accessories	Hygiene-Sanitation Hands washed Dress and Shoes, Hair Groomed	Demonstration by Instructor Proper and Various Implements and Accessories used in Barbering	How to Prepare Patron	How to Prepare lather-various methods	Tools and Accessories Students Performance Soaps - Shaving Brush - Latherizer, etc.

5408

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK IV

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Instrument & Accessories Razors and Shears	Clippers Combs Brushes	Strops, Hones, Commodone Extractor, Needle, Tweezers, and soap	Barber Shop Equipment	Review	M Textbook T Instructor's Guide W Lecture T Charts - Diagrams F Class Discussion
MATHEMATICS	Fractions Multiplication Division					Applied Barber Mathematics
ENGLISH Salesmanship		Gym		Writing Business Letters		Text - Outline
SOCIAL STUDIES A) Economics B) Government			How man Makes economic progress			Text Some facts Conn. makes it better
PRACTICAL		Start Students in Manipulation Razor	Shear	Comb		Student Razor Shear Comb

5409

PREPARATORY COURSE

WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION

BARBER TRADE

WEEK V

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instruction Material
TRADE THEORY		HAIRCUTTING				
	Methods of Shapes of heads	Thinning Tapering cutting	Slithering- Women's hair cutting	Trade terms Current problems, hair tonics	Review and Test	M Textbook T Your Hair - Dr. Goodman W Instructor's Guide T Modern Barbering F Discussion - Oral test
MATHEMATICS	Review and Test					Applied Barber Mathematics
ENGLISH Salesmanship		Extra Cur. or study period		Thinking Listening Discussion		Text Study Lecture
SOCIAL STUDIES A) Economics B) Government			How man uses natural resources			Text Economics for our times
PRACTICAL		HANDLING OF CLIPPERS				
	Hand	Clippers	Electric		Test Care of equipment and tools	Different types Hand and electric clippers Student's Performance

5410

PREPARATORY COURSE

WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION

BARBER TRADE

WEEK VI

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instruction Material
TRADE THEORY	Shaving Importance of beard textures and densities Method of selecting razor		Lathering techniques	Current problems	Review and Test	M Lecture T Textbook W Illustration - Charts T Instructor's Guide F Discussion - Oral Test
MATHEMATICS	Decimals Addition Subtraction					Applied Barber mathematics
ENGLISH Salesmanship		Gym		Improving your speech		Text Demonstration Lecture
SOCIAL STUDIES A)Economics B)Government			Test or Discussion			Connecticut resources Bulletin Question - Answer
PRACTICAL	Student's Performance of Each Other How to prepare patron for shave	Patron Seated Linen properly arranged	Position of operator at chair	Mixture and application of lather	Application of steam towels	Barber Chairs Linens Lathorizer, etc.

5411

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK VII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
			SHAMPOOING			
TRADE THEORY	Importance of Essential requirements Purpose	Methods Types Desired results	Scalp Manipulations Brushing	Current problem	Review and test	M Textbook T Supplemental Material W Instructor's Guide T Master Barber F Discussion - Prepared Test
MATHEMATICS	Decimals Multiplication Division					Applied Barber mathematics
ENGLISH Salesmanship		Study period or extra cur.		New words to use		Select from word study Text
SOCIAL STUDIES A) Economics B) Government			Management of business			Text Lecture Conn. State Dept. of Labor Bulletins
PRACTICAL		Handling and Manipulation				Razors - Shears Combs Shaving Creams Soaps Brushes Latherizer
	Dummy razor	Shear	Comb	Methods and Techniques		

5412

PREPARATORY COURSE — WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION — BARBER TRADE

WEEK VIII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
	MASSAGING					
TRADE THEORY	Purpose of Essentials for pre-requisities for training	Methods of	Importance of	Most Frequent	Review and Test	M Textbook T Principles and Practices W Supplemental Material T Lecture F Discussion - Oral Test
MATHEMATICS	Percentage Simple percentage					Applied Barber mathematics
ENGLISH Salesmanship		Gym		Review your language activities		Text - Pages 1 - 275 Lectures Discussion Questions and Answers
SOCIAL STUDIES A) Economics B) Government			How buying and selling take place			Text Conn. makes it better
PRACTICAL	Start Students on Honing and Stropping Basic strokes and procedure to hold razor Preparation of Hone and Strop for use					Old razors - hones Stropes Soap Lather, etc.

5413

PREPARATORY COURSE — WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION — BARBER TRADE

WEEK IX

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional
TRADE THEORY	Singeing - Honing - and Stropping Purpose of Methods of Results of	Types of Hones and Strops Procedures of testing razors	Shape of teeth on razor to result with Precision of stroke	Preparation of hone and Strop	Review and Test	M Textbook (P.&S.Bar.) T Instructor's Guide W Illustration T Lecture F Discussion - Prepared Test
MATHEMATICS	Percentage Interest					Applied Barber mathematics
ENGLISH Salesmanship		Study period or extra cur.		Test Block I Unit 1 - 7		Text - Oral
SOCIAL STUDIES A) Economics B) Government			How government aids and controls business			Text Discussion
PRACTICAL	Instructor and Students - Lathering How to clean, hone and strop	Testing razor after honing and stropping	Rotary movement	Use of hot towel	Open Through cleaning of barber school	Alcohol - Soap Hone Strop Towels Latherizer

5414

PREPARATORY COURSE

WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION

BARBER TRADE

WEEK X

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	Reference
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY		BACTERIOLOGY				M Applied Bacteriology T Supplemental Material W Conn. Rules and Regulations T Textbook F Discussion
	Contribution to barbering What is health?	Nature Occurrence Type of bacteria	Transmission of disease Infection and immunity	Hygiene Personal and Group	Sanitation Prophy-laxis	
MATHEMATICS	Percentage Discounts					Applied barber mathematics
ENGLISH Salesmanship		Gym		Handbook of grammar and usage Form of written work		Text
SOCIAL STUDIES A) Economics B) Government			Human relations in business and industry			State Department of Labor bulletins Text
PRACTICAL	Demonstration - Start students shaving each other					
	Proper method of shaving Number of steps, etc.	Using dummy razors -	Free hand stroke	Back hand stroke	Practicing reverse free and back hand stroke	Dummy razors and other necessary supplies required for shaving

5415

PREPARATORY COURSE — WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION — BARBER TRADE

WEEK XI

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	BACETERIOLOGY					
	Sterilization Disinfection	Preparation for barber shops	Trade terms Making solutions	Tables of antiseptic values	Test	M Conn. Rules and regulations T Textbook W Applied Bacteriology T Test Book F Prepared Test
MATHEMATICS	Percentage review					Applied barber mathematics
ENGLISH Salesmanship		Study period or extra curricula		Subject predicate and parts of speech		Text
SOCIAL STUDIES A) Economics B) Government			Review citizen's economic life			Text Connecticut resources Bulletins
PRACTICAL	Continue Students on Shaving Each Other					
	How to shave second time over	Application of creams - hot towels, lotion	Dry face properly and powdering	Neck shave	Use of styptic powder	Creams - Lotions Powder - Linens Razors - Styptics Powder, etc.

54116

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Characteristics of living matter Cellular bases of man	Cells - - Protoplasm and the cell Parts of the cell	- Tissues - - Location of cells Function of cells	- Organs Diagram illustrating relative sizes of brain	Review	M Lecture T Textbook W Applied Biology T Supplemental Material F Discussion
MATHEMATICS	Percentage Tests					Applied barber mathematics
ENGLISH Salesmanship		Gym		Punctuating simple sentence		Text Blackboard
SOCIAL STUDIES A) Economics B) Government			Test			Oral questions on "Some facts"
PRACTICAL	Demonstration of natural hair line by instructor	HAIRCUTTING How to prepare patron for haircut Manipulation of shear and comb			Test Shaving strokes Preparation Finish	Shears - Combs Haircloths - Towels Supplies, etc.

5417

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XIII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Cells - Types of tissues Description of tissues	Tissues - Function of tissues	Organs Structure of organs Functions of organs	Review	Test	M Textbook T Instructor's Guide W Supplemental Material T Applied Biology F Discussion - Oral
MATHEMATICS	Formulas Check Problems					Applied barber mathematics
ENGLISH Salesmanship		Study period or extra cur.		Capitalization		Text
SOCIAL STUDIES A) Economics B) Government			Industry Major products Value, use, etc.			Text Conn. makes it better Conn. resources bulletins
PRACTICAL	Manipulation of shear and comb on one another	Start Students on Haircutting Start on natural hairline, drawing hairline over and around the ear				Shears - Comb, etc

5418

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XIV

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Systems of the Body - Intequmentary (Dermatology)					M Lectures T Supplemental Material W Textbook T Modern Barbering F Discussion
	Study of skin Function of skin	Division of skin	Appendages of skin	Hygiene of skin	Review	
MATHEMATICS	Formulas How to find and use Areas Equations					Applied barber mathematics
ENGLISH Salesmanship		Gym		Writing plurals and possessives of nouns		Text
SOCIAL STUDIES A) Economics B) Government			Industry Manufacturers Function of labor and management			Conn. State Department of Labor bulletins Text Conn. Federation of Labor bulletins
PRACTICAL	Demonstration Taper hair Finger and shear work	Haircutting Have students practice on one another		Demonstration Neck shave Finish hair-cut		Shears - combs, etc.

5419

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XV

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Integumentary System (Dermatology)				Cont.	M Practical Nursing
	Muscles and nerves of the skin	Nutrition of the skin	Forms of acne	The Scalp	Test	T Textbook W Skin and Disease T Lecture F Prepared Test
MATHEMATICS	Formulas: Finding circumference Areas and volume of					Applied barber mathematics
ENGLISH Salesmanship		Extra curricula or study period		Review and discussion		Text Study
SOCIAL STUDIES A) Economics B) Government			Labor Organization			Texts: "Labor in America" Practical and scientific barbering
PRACTICAL	Demonstration How to use hand clippers	Haircutting Have students demonstrate on one another			Demonstration How to use electric clippers	

5420

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XVI

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Integumentary System (Dermatology) cont'd.				Review	M Supplementary Res. Material T Your Hair-Dr. Goodman W Textbook T Modern Barbering F Discussion
	Study of hair	Divisions of hair	Textures and forms of hair	Composition and growth of hair		
MATHEMATICS	Formulas: Circles Cylinders Cones and Spheres					Applied barber mathematics
ENGLISH Salesmanship		Gym		Correct pronouns		Text Master list
SOCIAL STUDIES A) Economics B) Government			Agriculture			Text Conn. Resources bulletin
PRACTICAL	Demonstration Shape eyebrows Trim mustache Trim or cut hair out of ears	HAIRCUTTING AND SHAVING Start students on one patron from other departments every day				Razor - Shears - Combs - Clippers - Supplies - Patrons from other departments

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XVII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Integumentary System (Dermatology) cont'd Disorders and diseases of hair	Technical terms regarding hair	Hair follicle	Review	Test	M Textbook T Supp. Res. Material W Your Hair - Dr. Goodman T Question-Answer F Prepared Test
MATHEMATICS	Formulas: Review of important points					Applied barber mathematics
ENGLISH Salesmanship		Study period or extra cur.		Correct verbs		Text
SOCIAL STUDIES A) Economics B) Government			Insurance			Text Lecture Circulars from Insurance Commissioner's Office
PRACTICAL	HAIRCUTTING AND SHAVING Re-check on daily care of equipment, shop and tools					Pro-rate the increase of patrons according to the progress of the students

e45

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XVIII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	About bones How joints work	SKELETAL SYSTEM (Osteology) The skull	The vertebral column	Bones of the face and neck		M Supp. Res. Material T Textbook W Charts-Illustrations T Discussion F Lecture
MATHEMATICS	Formulas: Some business problems Test					Applied barber mathematics
ENGLISH Salesmanship		Gym		Correct adjectives, adverbs and prepositions		(Discussion) Text
SOCIAL STUDIES A) Economics B) Government			Review how Connecticut people make a living			Discussion - Study Questions and answers
PRACTICAL	HAIRCUTTING AND SHAVING Utilize this week in having the students perform different styles of haircuts					Patrons and Demonstrations by instructor

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XIX

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Skeletal System (Osteology) Continued					M Master Barber T Supplemental Res. Mat. W Textbook T Group Discussion F Oral Test
	Composition of bones	Cartilage and ligaments	Bone diseases	Review	Test	
MATHEMATICS	Measurments and weights Simple measurements, table of equivalents					Applied barber math
ENGLISH Salesmanship		Open		Review		Take from test Oral Special test
SOCIAL STUDIES A) Economics B) Government			Test			Texts - Oral
PRACTICAL	Demonstration Preparation and procedure in giving a singe	HAIRCUTTING	- SINGEING - SHAVING Have students start singeing following each haircut and shave, etc.			Shears - Combs — Razors Clippers -- Towels Wax tapers Match

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PREPARATORY COURSE WEEKLY SCHUDLE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XX

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment	Assignment	Instructional Material
TRADE THEORY	Review-Preparation for Mid-Year Examination				Mid-Year Examination	M Supplemental Res. Mat. T Illustrations W Charts T Discussion - Lectures F Mid-Year Test
MATHEMATICS	Measure-ments and weights Solutions Formalin					Applied Barber math
ENGLISH Salesmanship	Gym			Compound and com-plex sentences		Text
SOCIAL STUDIES A) Economics B) Government			Class oriented on government			Outline on social studies
PRACTICAL	- - - - Demonstration on Shampoo - - - -

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXI

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Characteristics of muscles	MUSCULAR SYSTEM (Myology) Varieties of muscular tissues Origin and insertion of muscles	Tendons Aponeurosis	Types of muscles	Review	M Textbook T Chart W Practical Nursing T Supplemental Res. Mat. F Discussion
MATHEMATICS	Banks and banking					Applied barber math
ENGLISH Salesmanship		Study period or extra cur.		Sentence sense		Text
SOCIAL STUDIES A) Economics B) Government			Development of local government The City Charter			Connecticut The State and its Government Chapter V
PRACTICAL	Haircutting - Shaving - Shampoo - Hair Tonic Continues daily performance Increase patrons as required		Demonstration on Application and manipulation		Mid-Year Test	Daily selection of tools, supplies, etc. Test Actual Performance

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY		MUSCULAR SYSTEM (Myology) cont.				M Modern Barbering T Textbook W Chart and Table of Muscles T Supplemental Res. Mat. F Test - Prepared
	Muscles of head, face and neck	Muscles of the scalp eye and ear	Muscles of mastication, nose and mouth	Chart of muscles A table of muscles	Test	
MATHEMATICS	Bank and banking					Applied barber math
ENGLISH Salesmanship		Gym		Building varied, forceful statements		Text
SOCIAL STUDIES A) Economics B) Government			How citizens vote			Lecture Text: Connecticut Outline Government in Connecticut
PRACTICAL		STERILIZATION				
	Demonstration on sterilization of tools and accessories	Re-check on daily sterilization of tools, etc.		Continue daily work on hair-cutting	Open	Cabinet sterilizer Formalin, Shallow tray Receptacle for boiling water, bottles, soap, etc.

5427

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXIII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	NERVOUS SYSTEM (Neurology)					M Supplemental Res. Mat. T Textbook W Instructor's Guide T Your Hair-Dr. Goodman F Discussed
	Classification of the nervous system	Functions of the nervous system	Kinds of nerves	Chart of nerves	Review	
MATHEMATICS	Banks and banking					Applied barber math
ENGLISH Salesmanship		Study period or extra cur.		Spelling		Text Word study Glossary
SOCIAL STUDIES A) Economics B) Government			Political parties			Chapter 8 Text - Outline Government in Connecticut
PRACTICAL	CONTINUE STUDENTS ON Haircutting - Shaving -- Shampooing Recheck for errors and carelessness				Singeing	Usual materials Required

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXIV

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	NERVOUS SYSTEM					M Illustrations T Discussion W Textbook T Master Barber F T. & F. Test
	The brain	The spinal cord	The central nervous system. The sympathetic system	Importance to barbering	Text	
MATHEMATICS	Review on banks and banking					Applied barber math
ENGLISH Salesmanship		Gym		Appendix		Text
SOCIAL STUDIES A) Economics B) Government			Review and test			Discussion Questions - Answers Text
PRACTICAL	Field day	Demonstration by instructor	MASSAGE Preparation application of cleansing cream, massage cream	Manipulations with rotary movements	Witch hazel steam removal of blackheads	Creams - Lotions Towels, vitrators Rolling Massage Cream

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXV

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	BLOOD CIRCULATORY OR VACULARY SYSTEM (Angiology)				Review	M Textbook T Supp. Res. Mat. W Instructor's Guide T Charts F Lecture
	Two systems Blood Lymph	Functions of of blood and lymph	Composition of blood	Systemic circulation The heart		
MATHEMATICS	Test on banks and banking					Applied barber math
ENGLISH Salesmanship		Study period or extra cur.		Review		Discussion Study Questions - Answers
SOCIAL STUDIES A) Economics B) Government			Local Government in Connecticut Township			Lecture Chart Government in Connecticut
PRACTICAL	Actual performance while students work on patrons	Recheck on professional ethics			Massaging	Patrons and students

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PREPARATORY COURSE — WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION — BARBER TRADE

WEEK XXVI

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	BLOOD CIRCULATORY OR VASCULAR SYSTEM (Angiology)					M Supp. Res. Mat. T Illustrations W Textbook T Discussion F Prepared test
	The pulmonary system	Principle vessels of the head, face and neck	Schematic Drawing of circulation of blood	Lymph glands of the head, face and neck	Test	
MATHEMATICS	Taxation					Applied barber math
ENGLISH Salesmanship		Gym		Test Block II		Take from text
SOCIAL STUDIES A) Economics B) Government			City			Text outline Government in Connecticut
PRACTICAL	HAIRCUTTING - SHAVING - SHAMPOOING - MASSAGING RECHECK on special problems in haircutting and shaving					

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXVII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY		DIGESTIVE SYSTEM				M Illustration T Textbook W Chart T Supp. Res. Material F Inst.'s Guide
	Diagram of the Digestive tract Organs of	Relation of food Absorption	Alimentary canal The intestines	Salivary glands and gastric juice	Review	
MATHEMATICS	Taxation					Applied barber math
ENGLISH Salesmanship		Study period or extra cur.		Salesmanship Class oriented on salesmanship		Outline on salesmanship
SOCIAL STUDIES A) Economics B) Government			The County			Text: Connecticut State Register and Manual
PRACTICAL	TESTS Shampooing		Demonstration How to grind a shear	TESTS Massaging		Actual performance by students

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXVIII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	DIGESTIVE SYSTEM The liver, gall bladder & pancreas	Relationship to barbering	Disturbances of the system	Health habits	Test	M Textbook T Supp. Res. Material W Modern Barbering T Lecture F Prepared Test
MATHEMATICS	Taxation					Applied barber math
ENGLISH Salesmanship		Gym		Definition		Text: Practical and scientific barbering Instructor's illustration
SOCIAL STUDIES A) Economics B) Government		Discussion and review				Survey of Students Local - County - State - Government
	Recheck Singeing	Daily Continuance Haircutting and shaving		Hair tonic Steam towels Manipulations Vibrators		Usual equipment and supplies required

5433

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

XXIX

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Function and purpose	Respiratory System Divisions	Relationship to barbering	The Lungs The Skin	Review	M Textbook T Suppl. Res. Material W Practical Nursing T Instructor's Guide F Discussion
MATHEMATICS	Review on taxation					Applied barber math
ENGLISH Salesmanship		Open		Qualifications		Instructor's Guide Text
SOCIAL STUDIES A) Economics B) Government			Test			Have class submit outline. Oral text Text
PRACTICAL	Increase Patrons if Required by Students HAIRCUTTING - SHAVING - etc. Re-check for General cleaning of school					

5434

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXX

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional
TRADE THEORY	Function and purpose	The Excretory System Organs of	The kidneys	Excretion of water from man	Test	M Textbook T Skin and diseases W Supplemental Res. Mat. T Instructor's Guide F Oral Test
MATHEMATICS	Test on taxation					Applied barber math
ENGLISH Salesmanship		Gym		Value		Lecture Class discussion
SOCIAL STUDIES A) Economics B) Government			Organization of Conn. Gov. Legislature Department			Connecticut - The State and its Government Outline government in Connecticut
PRACTICAL	Demonstration by instructor	LADIES HAIRCUTTING Request patrons from other departments			Continue daily routine of hair-cutting & shaving	Thinning shears - Cutting shear - Comb

5435

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXI

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Urogenital System					M Applied Biology T Suppl. Res. Material W Textbook T Lecture - Discussion F T. & F Test
	Function and purpose	Urinary system	Reproductive organs	Relationship to barbering	Review and test	
MATHEMATICS	Insurance					Applied barber math
ENGLISH Salesmanship		Study period or extra curricula		Pre-approach and analysis		Demonstration Text Instructor's Guide
SOCIAL STUDIES			Executive department			Text Outline Government in Connecticut
PRACTICAL	PERSONAL HYGIENE		FIRST AID TREATMENT			Tincture of iodine Tanic acid jelly Spirit of ammonia Cotton, gauze, scissors, adhesive tape, etc.
	Hands, nails Clean uniform	Hair Groomed Shoes shined Daily shave	Cuts Burns	Falls, Shock	Fainting spells Artificial Respiration	

5436

PREPARATORY COURSE WEEKLY SCHEDULE FOR RELATED AND TRADE INSTRUCTION BARBER TRADE

WEEK XXXII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Systems of Internal Secretions					M Textbook T Applied Biology W Supp. Res. Material T Lecture - Discussion F Prepared Test
	Function, purpose and results of	Ductless glands (endocrine)	Table and diagram of glands	Manufacture of hormones	Review and test	
MATHEMATICS	Insurance					Applied barber math
ENGLISH Salesmanship		Gym		Personal appearance		Text Lecture Health and grooming chart
SOCIAL STUDIES A) Economics B) Government			Judicial Department			Text Government in Connecticut
PRACTICAL	Open	PREPARATION FOR STATE EXAMINATION Haircutting and Shaving				Mock Examination

S4S7

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXIII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	The Special Senses				Review and test	M Supp. Res. Material T Applied Biology W Practical Nursing T Textbook - Lecture F Prepared Test
	Feel	The ear	The eye	Smell		
MATHETICS	Insurance					Applied barber math
ENGLISH Salesmanship		Study period or extra curricula		Hygiene		Texts Instructor's Guide
SOCIAL STUDIES A) Economics B) Government			Financial needs Reorganizational attempts of State Gov.			General Statues Text
PRACTICAL	PREPARATION FOR STATE EXAMINATION Shampooing and Massaging					Mock examination

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXIV

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	CHEMISTRY					M App. Chemistry T Textbook W Supp. Res. Material T Mfg's Catalog F Discussion
	Contributions to barbering	Trade terms Poisons and their antidotes	Preparation 1.Chemistry of 2.Classes of	Cosmetics	Review	
MATHEMATICS	Review on insurance					Applied barber math.
ENGLISH Salesmanship	Gym			Knowledge of profession		Instructor's Guide Text Question and Answer
SOCIAL STUDIES A) Economics B) Government			Review and test			Discussion Outline Government in Connecticut Text Oral
PRACTICAL	PREPARATION FOR STATE EXAMINATION Singeing - Honing - - Stropping					Mock Examination

5439

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXV

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Chemistry				Review	M Suppl. Res. Material T Textbook W Your Hair-Dr. Goodman T Oral Tests F Discussion
	Cosmetics for the skin	Preparations for personal hygiene	Cosmetics for the hair	Simple test		
MATHEMATICS	Test on insurance					Applied barber math
ENGLISH Salesmanship		Study period or extra curriculum		Ability to apply your knowledge		Students application on mock sales talk
SOCIAL STUDIES A) Economics B) Government			U. S. Gov't General purpose and plan of national government			Connecticut State Register and Manual
PRACTICAL	PREPARATION FOR STATE EXAMINATION Hair Tonic Application - Sterilization - Personal Hygiene					Mock examination

5440

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXVI

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Chemistry					M Textbook
	Scientific research	Weights and measures	Vitamins	Review	Test	T Applied Chemistry W Supp. Res. Material T Question -- Answer F Prepared Test
MATHEMATICS	Business forms					Applied barber math
ENGLISH Salesmanship		Gym		Review salesmanship		Text - Study Class discussion Lecture
SOCIAL STUDIES			Legislative Department National laws Judicial Dept Financial needs State relations			Conn. State Register and Manual U. S. Bulletins
PRACTICAL	REVIEW Check and correct faults on practical work					

5441

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXVII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	FIRST AID TREATMENTS Artifical respiration Bleeding	Burns and scalds	Cuts Electric shock	Epileptic fits	Foreign bodies in the eye	M Practical Nursing T First Aid Manual W Supp. Res. Material T Textbook F Lecture
MATHEMATICS	Purchase orders					Applied barber math
ENGLISH Salesmanship			Open	Test Block III		Text Special Test Oral
SOCIAL STUDIES A) Economics B) Government			Review and test U. S. Government			Discussion Oral Written Summary by students Text
PRACTICAL	REVIEW Check and correct faults on practical work					

3442

PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXVIII

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	First Aid Treatments				Discussion after test	M First Aid Material T Practical Nursing W Lecture T Oral - Prep. Tests F Discussion
	Heat exhaustion Nose Bleed	Unconscious-ness	Review - - - -	-Test		
MATHEMATICS	Invoices					Applied barber math
ENGLISH Salesmanship		Gym		Review Block I - II		Study - Text Discussion Question - Answer
SOCIAL STUDIES A) Economics B) Government			Review on economics Governments			Charts - Outline Discussion Question - Answer Lecture
PRACTICAL		Have Student give patron haircut - shave - massage - shampoo - singe Follow this with Honing and Stropping				

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND INSTRUCTION BARBER TRADE

WEEK XXXIX

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	Preparation for final examination by the Board of Barber Examiners					M Textbook T Practical Nursing W Applied Biology and Chemistry T Master Barber F Instructor's Guide
MATHEMATICS	Review of business forms					Applied barber math
ENGLISH Salesmanship		Study period or extra curricula		Test English		Text - Special Test Oral
SOCIAL STUDIES A) Economics B) Government			Test Social studies			Complied by Instructor
PRACTICAL	HAVE ALL STUDENTS TAKE A MOCK EXAMINATION ON PATRON FOR ENTIRE WEEK					

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PREPARATORY COURSE WEEKLY SCHEDULE FOR TRADE AND RELATED INSTRUCTION BARBER TRADE

WEEK XXXX

Related Subjects	Monday	Tuesday	Wednesday	Thursday	Friday	References
	Assignment	Assignment	Assignment	Assignment		Instructional Material
TRADE THEORY	PREPARATION FOR FINAL EXAMINATION BY THE BOARD OF BARBER EXAMINERS					M Supp. Res. Material T Your Hair W Charts - Illustrations T Lecture - Discussion F Tests
MATHEMATICS	Test on business forms					Applied barber math
ENGLISH Salesmanship		Gym		Open		Open
SOCIAL STUDIES A) Economics B) Government			Open			
PRACTICAL	GRADUATION			STATE EXAMINATION		

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VT 012 627
Numerical Control of Machine Tools, Point-to-Point System. A Suggested Guide for a Training Course.

Bureau of Adult, Vocational, and Technical Education (DHEW/OE), Washington, D.C.
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IDENTIFIERS - MDTA PROGRAMS; *MANPOWER DEVELOPMENT AND TRAINING ACT PROGRAMS

ABSTRACT - To assist in organizing and conducting manpower development, training, and retraining programs, this individually authored guide and resource manual provides a course outline for 60 hours of instruction in numerically controlled machine tools programing and operation. Course units are: (1) Introduction to Numerical Control, (2) Blueprint Interpretation, (3) Machining Methodology, (4) Holding Devices, (5) Programing 1 and 2: Two Axis, (6) Tape, (7) Test the Program, (8) Basic Electricity, (9) Hydraulics, (10) Basic Electronics Devices, (11) Control Systems, (12) Auxilliary Functions, (13) Programing 1, 2 and 3: Three Axis, (14) Programing a Slope, (15) Programing an Arc or Circle, (16) Test the Programs, and (17) Computer Assistance. A bibliography and a listing of 21 films are included, and an instructor's lesson plan, floor plans, equipment lists, and teaching tips are appended. (GB)

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VT 012 627

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numerical control of machine tools

point-to-point system

a suggested guide for a training course

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OE–87051

NUMERICAL CONTROL OF MACHINE TOOLS

Point-to-Point System

A Suggested Guide for a Training Course

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
ELLIOT L. RICHARDSON, *Secretary*
OFFICE OF EDUCATION
TERREL H. BELL, *Acting Commissioner*
Bureau of Adult, Vocational, and Technical Education
ARTHUR LEE HARDWICK, *Associate Commissioner*
Manpower Development and Training Program

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FOREWORD

Employment opportunities for trained operators of numerically controlled machine tools are expected to be very favorable in the foreseeable future. The accelerated shift toward automation in manufacturing is expected to raise the employment level in the number of workers operating numerically controlled machine tools. Industries manufacturing short run items are already finding it increasingly difficult to secure trained manpower.

This guide provides a course outline for 60 hours of instruction in numerically controlled machine tools programing and operation. This combination course guide and resource manual should be of assistance in organizing and conducting manpower development, training, and retaining programs.

Equipment for carrying out training programs in this field is expensive; therefore, the assistance of local advisory groups should be sought in selecting items that will best serve local needs. The suggested lists included in the guide covering equipment, supplies, and teaching aids are a helpful starting point in discussions with local representative advisory committees and employers.

This guide was developed under the direction of Norman Mitby, Director, Madison Vocational, Technical, and Adult Schools (Madison, Wisconsin) for the Division of Manpower Development and Training and the Division of Vocational and Technical Education. The course material was prepared by Alun C. Thomas, Assistant Supervisor, School of Vocational Trade and Technical Education, of the Madison School.

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Lockheed-Georgia Co., Marietta, Ga.
Macomb County Community College, Warren, Mich.

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Milwaukee Institute of Technology, Milwaukee, Wis.
Norwalk State Technical Institute, Norwalk, Conn.
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Burgmaster Corp., Gardena, Calif.
The Cincinnati Milling Machine Co., Cincinnati, Ohio
Cleereman Machine Tool Corp., Green Bay Wis.
Coleman Engineering Co., Inc., Santa Ana, Calif.
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General Electric Co., Waynesboro, Va.
George Gorton Machine Co., Racine, Wis.
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Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.
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Lennox Tool & Machine Builders, Lima, Ohio
The Lodge & Shipley Co., Cincinnati, Ohio
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Pratt & Whitney Co., Inc., West Hartford, Conn.
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The Sheffield Corp., Dayton, Ohio
Square D Co., Industrial Control Division, Milwaukee, Wis.
Swift Ohio Corp., Kenton, Ohio
Vacu-Blast Co., Inc., Belmont, Calif.
Wales Strippit Co., Akron, N.Y.
The Warner & Swasey Co., Cleveland, Ohio

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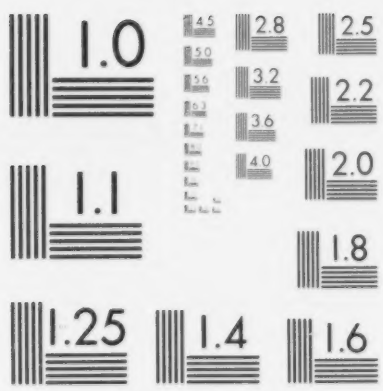

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

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PURPOSE OF THE COURSE GUIDE

This course guide has been prepared to assist in planning and developing a course for training and retraining workers in the machine tool area which pertains to the application of numerical controls—point-to-point positioning. The guide has been organized to suggest the basic principles necessary as a background for selecting the content for a numerical controls course. It will be of use to manpower training directors in industry or school administrators who are interested in offering this course in their communities. Sufficient details have been included to provide assistance for an instructor to develop and operate an efficient manpower development and training program.

In addition to serving as a guide to manual manuscript programing of machine tools, it can also serve as a guide for the training of personnel in such fields as graphic arts, welding, and tube bending, where numerical controls are being applied. The course developed in this guide may be used as a prerequisite to contour programing or continuous path programing. Much of the related material included in this manual has been added specifically for the purpose of encouraging the trainee to progress beyond the entry level.

No attempt has been made to cover the entire series of numerical control systems or procedures. The suggested course outline and the suggested resource materials require adaptation to the specific objectives of the personnel to be trained and the system, or systems, of numerical controls to be used. The selection of topics, the sequence and methods of presentation, the laboratory hardware, and the final planning should be determined by instructional specialists, depending upon the needs and background of the trainee group. Supplementary materials such as textbooks, references, manufacturers' bulletins and manuals, catalogs, and films are listed for the instructor's convenience. The references and films cited at the end of unit outlines are given in greater detail in the bibliography or the list of films near the end of this publication.

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OCCUPATIONAL INFORMATION

*Tape Control Machine Operator (mach. shop) 609.782**

Numerical Control Machine Operator

Sets up and operates magnetic or punched tape controlled machine tools that automatically mill, drill, broach, and ream metal parts. Bolts fixture to machine bed, using wrench. Positions metal stock on fixture according to program directions, using rule and calipers, and secures it, using clamps or bolts. Assembles cutting tools in tool holders and positions tools in machine spindles according to directions, using calipers and hand tools, or inserts cutting tools in specified machine magazines. Places control tape in reading magazine and hooks tape at beginning point over reading mechanism. Turns dial to index cutting tool to specified set point, turns switches to operating position, and starts machine. Changes cutting tools and location of clamps, and repositions metal stock on fixture as directed by program instructions. Observes machine operation and verifies accuracy of machining against blueprints or engineering drawings by measuring cuts with micrometers, dial indicators, and gages. Notifies supervisor of discrepancies. May adjust machine feed and speed and change cutters to machine parts according to specifications when automatic programing is faulty or if machine malfunctions.

*Drill Press Operator, Tape Control (mach. shop) 606.782**

Tape Control Drill Press Operator

Sets up and operates tape controlled, turret type drill press that automatically positions indexing table, selects tool, and drills, reams, and taps metal castings. Installs holding fixture on indexing table of machine and control tape in reader at zero point indicated on process diagram. Locks drilling, reaming, and tapping tools in turret in sequence specified on process sheet. Positions casting in holding fixture and starts machine to perform trial run. Stops machine at each tool and table position during trial run and verifies diameter and depth of cut, using specified fixed gages. Turns screw on turret indexing head to adjust depth of cut. Notifies supervisor when hole diameters do not conform to specifications. Positions new casting in fixture and starts machine which automatically positions indexing table, selects tools, and machines casting through predetermined code punched in control tape. Verifies dimensions of holes, using fixed gages and following diagram of casting.

*Jig Borer, Tape Control (mach. shop) 606.782**

Tape Control Jig Borer

Sets up and operates tape controlled, single spindle jig borer to face, drill, ream, and tap metal castings. Positions holding fixture on indexing table and adjusts clamps of fixture to secure casting in position specified on process sheet. Pushes button to zero indexing table and console at established locating point. Positions control tape in reader at zero point and starts machine which automatically positions indexing table through predetermined code punched in tape. Calculates travel of cutting tool required to touch top of casting and selects precision blocks which equal that distance. Places blocks under dial indicator to set machine for depth of cut. Turns handwheel to lower cutting tool and dial indicator. Stops wheel when needle on dial indicates cutting tool has machined casting to specified depth. Presses buttons to record dimension on console for subsequent automatic machine process and to advance tape. Verifies dimension of holes, using specified gages.

*Multipurpose Machine Operator, Tape Control (mach. shop) 609.782**

Tape Control Multipurpose Machine Operator

Sets up and operates tape controlled machine that reams, mills, taps, drills, and bores metal castings. Fastens casting in holding fixture at position indicated on process sheet, using wrenches. Inserts spec-

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ified preset cutting tools in rotary tool magazine. Positions control tape in machine at zero position indicated on tape. Pushes button to start machine that automatically positions indexing table and toolholder, selects tool, and machines part through predetermined code punched in tape. Stops machine after each machining operation on initial casting and verifies dimensions, using specified fixed gages. Turns screw on boring tool to adjust diameter of cut to size of gage. Notifies supervisor if other machining processes do not conform to specifications. Verifies hole dimensions of all castings processed, using fixed gages and following diagrams of castings. May be designated according to name for machine operated as MILWAUKEE-MATIC operator.

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*Refers to the classification and code of the *Dictionary of Occupational Titles.*

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EMPLOYMENT OPPORTUNITIES

The sales of numerically controlled machine tools doubled between 1963 and 1965. It is estimated that 10,000 numerically controlled machine tools are in operation today. New applications for numerical control (N/C) and other forms of automation are being found constantly. Men must be trained or retrained in order to supply the programers and N/C machine operators required to utilize these machine tools effectively.

As the number of numerically controlled units increases and older conventional machine tools are replaced, the demand for N/C programers and operators continues to rise. With the implementation of the "autofacturing"[1] concept in the future, employment appears even better.

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[1] Morse and Cox. *Numerically Controlled Machine Tools*, p. 16.

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TRAINEE QUALIFICATIONS

The trainee should have a good basic background in machine tool work. More specifically, the background in blueprint interpretation, machining methods, holding procedures, operational sequencing, and mathematical calculations should be of such competence that only a short review will be necessary before starting the programing procedure. If the trainee does not possess this background, separate courses involving considerably more time may be necessary.

It may be desirable to set up specific prerequisites for all trainees, such as a period of machine operation, formal preparation of a machine shop program, or a testing program. An example of a testing program as recommended by one survey was the U. S. Employment Service Specific Aptitude Test Battery B359.

Whatever method or methods are used in the selection of trainees, it is of prime importance that the materials presented be adjusted to the needs of the group and the objectives of the course.

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ORGANIZING AND TEACHING THE COURSE

Teacher Qualifications

A teacher for this course must have a thorough knowledge of the skills involved in machine shop procedures along with experience in the operation and programing of at least one machine. His knowledge should include interpretation of the blueprint of the machined part, metal removal processes, machine(s) functions, nomenclature, and programing procedure.

The instructor should have the ability to work with people, organize instructional materials, present the materials, and evaluate the results.

Since several disciplines are presented, it is quite possible that several persons may be needed to teach this course. In that case, the efforts of all teachers must be coordinated so that the total instruction meets the objectives of the course.

If the person selected for this teaching assignment has had no teaching experience, he should be instructed in the necessary teaching fundamentals, such as lesson planning, teaching methods, and course construction.[2]

Organizing the Instruction

The instruction should be organized to meet the course objectives. If the main objective is to produce a programer for a specific machine tool system, then each lesson should be prepared to meet this objective. Each of the lessons should have objectives and procedures for instruction and evaluation so that the objectives will be attained. The instructor must use instructional materials to motivate the student to realize his maximum potential.

Each lesson is organized so that it integrates with or leads into the next lesson and contributes toward the course objective. The instructor must evaluate each student to insure that the student is progressing toward the course objective(s).

Planning the Lesson

Presentations should be well planned. Identify the topic to be covered and the objectives to be attained.

Identify the lesson by number and sequence. Select a descriptive and understandable title. Set a realistic goal concerning the time necessary to cover the material well. Too little time is frustrating, while too much is boring. The time element is closely associated with the background of the student. The lesson objectives should be stated and interpreted by each student so that they become his objectives. Choose realistic objectives which allow you to see later how successful you were in realizing them.

The equipment and materials necessary for each lesson are selected to attain the objectives. They should be prepared, available, in good working order, and accessible so they blend into a smooth presentation. Delays and insufficient equipment or materials lead to poor rapport with the students.

Teaching aids are simply an extension of the communication process. Visual aids large enough to be visible to all will enhance the instruction. Maximum use should be made of such teaching aids as chalkboard, charts, strip films, films, mockups, cutaways, and an overhead projector in presenting the lesson.

References should be identified, listed, and made available for the student's use. The practice of locating and using ready-reference materials and knowing how to attain references on one's own encourages the student to continue to search and learn outside of a formal class situation. Public libraries, company libraries, periodicals, bulletins, and professional groups all help the student keep abreast of the technology.

Written plans may be brief. The instructor will know the following:

1. The goals or objectives of the lesson—the kind of learning desired
2. The outline and suggested time schedule for the lesson, including:
   a. An interesting approach—a way to introduce the lesson, to capture the interest of the trainees, and to direct their attention

[2] *The Preparation of Occupational Instructors.* Superintendent of Documents, Catalog No. FS 5.280:80042. Washington, D.C.: U. S. Government Printing Office. Price $1.25.

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to the lesson's goals or objectives

b. Activities which involve the trainees in discovering and applying new facts and principles

c. A way to summarize the lesson—to help the trainees arrive at some valid conclusions and/or evaluate the extent to which lesson goals have been achieved.

3. The facts and principles or main ideas to be brought out in the lesson
4. The teaching materials and references to be used

Criteria for Evaluating the Training

The criteria which serve as a guide in determining whether the trainee is ready for employment as a programer or N/C machine tool operator may not be as clearly defined as in some other occupations. Therefore, it is very important that every attempt should be made to properly evaluate the trainee's progress.

The use of various evaluative devices is necessary for the instructor and the trainee to accumulate objective information pertinent to the growth of the trainee. Competencies of the following kinds are important to develop during the training program:

A. Activities showing understanding, knowledge, and skills:
   1. Understands and conforms to directions
   2. Demonstrates ability to work with minimum supervision
   3. Demonstrates ability to develop and follow a work plan or schedule
   4. Demonstrates effective time utilization
   5. Demonstrates knowledge of basic programing procedures
   6. Demonstrates clean, accurate, and orderly work habits

B. Personal qualities:
   1. Courtesy, friendliness, and tact in dealing with supervisors, professional people, and others
   2. Acceptable appearance
   3. Good personal habits in speech, manners, cleanliness, and method of work
   4. Acceptable attitude
   5. Understanding his role and that of others

Appendix "I" contains some suggestions or reminders of teaching tips.

Training Facilities

The facilities for training should be pleasant, with adequate light, training aids, references, and equipment to permit each student to attain his objectives. Consideration should be given to sound, ventilation, external interference, equipment preparation, adequate spacing, seating arrangement, equipment availability, and time of meeting. Suggested floor plans and equipment are shown in the appendix.

Length of Course and Course Units

The course is developed as supplementary work for people who have had a background in machine tool work. Emphasis should be placed on E.I.A. standards. The instruction is confined to one type of machine tool and controls with the two basic formats (tab sequential and word address) for programing. Additional types of machines and controls could be included with additional time, study, and equipment. This course is not designed to train people in computer programing or maintenance of machine tools.

While this course is designed for point-to-point positioning of machine tools, a brief introduction to computer assistance and computer programing is included at the end of the course.

The following course outlines are meant to serve as a suggested guide only. It is of the utmost importance that the course be adjusted to the background of the trainees and the specific objectives to be attained.

Unit		*Class Room Hours*	*Laboratory Hours*
I.	Introduction to Numerical Control (N/C)	2	1
II.	Review of Blueprint Interpretation	1	2
III.	Review of Machining Methodology	2	1
IV.	Holding Devices	2	1
V.	Programing 1—Two Axis	1	2
VI.	Programing 2—Two Axis	1	2
VII.	Tape	2	1
VIII.	Test the Program	1	2
IX.	Review of Basic Electricity	2	1
X.	Review of Hydraulics	2	1
XI.	Review of Basic Electronic Devices	2	1
XII.	Control Systems	2	1
XIII.	Auxiliary Functions	2	1
XIV.	Programing 1—Three Axis	1	2
XV.	Programing 2—Three Axis	1	2
XVI.	Programing 3—Three Axis	0	3
XVII.	Programing a Slope	1	2
XVIII.	Programing an Arc or Circle	1	2
XIX.	Test the Programs	0	3
XX.	Computer Assistance	3	0
		29	31

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Units may be shifted in their order of presentation, deleted completely if they are not necessary, or extended if the need becomes apparent. For a group of experienced machinists, it may be advisable to delete blueprint interpretation or use that block of time to convert a conventional engineering drawing to base line dimensions. Units IX, X, and XI (Review of Basic Electricity, Review of Hydraulics, and Review of Basic Electronic Devices) may be deleted and that block of time used for additional programing or operation. It may be advisable to terminate the course after two-axis programing and make three-axis programing a separate course. The intent of this suggested course and resource materials is to aid in the development of courses to fit needs in training and retraining personnel for numerically controlled jobs.

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COURSE UNITS

I. INTRODUCTION TO NUMERICAL CONTROL (N/C)

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To give a brief overview of the following:

Introduce and define N/C and its terminology
Present the role of N/C in manufacturing
Acquaint the student with the development and potential of N/C.

Materials

Projector, screen, pointer, blackboard, chalk, eraser, *Glossary of Terms,* information sheets, assignment sheets, and film or films

Unit Outline

A. Course orientation
   1. Objectives
   2. Length of course
   3. Schedule
   4. Standards of performance
   5. Physical facilities
   6. Specific regulations or variations

B. Introduction and explanation of N/C
   1. Basic areas of N/C
   2. Advantages and disadvantages of N/C
   3. Comparison of N/C with conventional procedures
   4. Types of controls
      a. Point-to-point
      b. Continuous path
   5. History or development of N/C machine tools

C. Personnel requirements
   1. Methods analysis
   2. Design engineer or designer
   3. Parts programer
   4. Operating personnel
      a. Fixture or holding devices
      b. Tool preparation
         (1) Conventional
         (2) Preset
      c. Loading and removal
   5. Maintenance personnel
      a. Mechanical
      b. Electrical—electronic
      c. Hydraulic—pneumatic

D. Numerical control programing
   1. Blueprint interpretation
      a. Dimensioning systems
         (1) Base line or absolute
         (2) Incremental
         (3) Undimensioned
      b. Design for production
   2. Method of machining
   3. Holding procedure to obtain maximum advantage
   4. Selection of tools
   5. Planning sheet preparation
   6. Coordinates—rectangular
   7. Reference point
   8. Type of system
      a. Fixed sequential
      b. Tab sequential
      c. Word address
      d. Interchangeable—compatible
   9. Manuscript
      a. Main functions
      b. Auxiliary functions
   10. Tape preparation equipment
   11. Tape, cards, etc.
   12. Test and verification
   13. Operation

E. Glossary of terms—E.I.A.–A.I.A. standards
   1. Fundamental terms
   2. Related terms
   3. Term application

F. Summarize major points

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Suggested Activities

(This outline is suggested sequentially.)

Develop the class climate, objectives, and standards
Acquaint students with the physical facilities
Introduce the subject material and issue resource materials
Demonstrate the process if equipment is available or use a film to show the process (laboratory activity)
Answer questions, review information, and summarize the major points
Review standards and make specific assignments

Suggested Assignment

Study resource materials (may be reproduced or modified and used as student handouts).
Study reference materials list and other related references which may become available.
Assign terms to know and understand from the E.I.A. *Glossary.*
Study materials on blueprint interpretation and change incremental dimensions to absolute or base line dimensions.

Texts

Electronic Industries Association. "Glossary of Terms for Numerically Controlled Machines," *and other chapters in Axis and Motion Nomenclature for Numerically Controlled Machines.*

———. *Automation Bulletin No. 3B—Glossary of Terms for Numerically Controlled Machines.*

References

Amber and Amber. *Anatomy of Automation,* pp. 9–175.

Hesse. "How To Get the Most out of N/C," *Production,* pp. 92–95.

Morse and Cox. *Numerically Controlled Machine Tools,* pp. 9–175.

"Numerical Control: The Second Decade," *American Machinist,* pp. N/C 1–48.

Rockenfelder. "N/C Pays Off in Short-Run Production," *Tool & Manufacturing Engineer,* pp. 71–72.

Taylor. "Equipment Justification," *Production.*

U.S. Department of Labor, Bureau of Labor Statistics. *Outlook for Numerical Control of Machine Tools,* pp. 1–55.

Weinstein and Keim. *Fundamentals of Digital Computers,* pp. 5–6.

Wilson. *Numerical Control in Manufacturing,* pp. 1–120.

Films

Changing Months to Minutes. Kearney & Trecker Corp.

From Print to Product. Kearney & Trecker Corp.

Complete information on the references throughout this manual may be found in the bibliography.

Resource Materials for Unit I—Introduction to Numerical Control

Numerical control of machine tools is a technique of automatic operation by means of numerical instructions expressed in code. These instructions or programs are prepared in advance. Recorded on punched cards, magnetic tape, or punched tape, these coded instructions can control the sequence of machining operations, machine positions, spindle speeds and rotational direction, distance and direction of movement of the tool or workpiece, flow of coolant, table indexing, and even the selection of the proper preset cutting tool for each operation. The tapes are placed on a control unit—a system of electronic interpreting devices. When the control unit is activated, it can drive the machine tool through the programed operations and movements without human intervention. The machine operator's role is confined largely to starting, stopping, loading and unloading, and observing the tool. The operator can change instructions after each job by replacing the tape on the control unit with another tape containing a different program.

Relation to Conventional Machine Tools

Numerical control can be best understood by comparison with the two conventional types of control generally used in the operation of machine tools. In general purpose machine tools, the most common type, instructions about table direction, spindle speed, and distance the tool must travel in cutting a particular part are established manually by an operator who rearranges various elements such as cams, bars, sequencing, and cycle timers, according to the needs of a particular job. The machine operator consults blueprints and other data to get his instructions. In the second type, the specialized tool, instructions about sequencing, positioning, and tool travel are built into the machine through mechanical—electrical devices, but these are restricted to a fixed set of operations for mass production of parts of one specific design. This type of control is found in types of specialized automatic machine tools used for making

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long runs of the same item. This second type of control also results in a high degree of automatic operation. Currently, numerical control is being used for on-off switching.

Both conventional systems require considerable time (compared to numerical control, as will be shown later) for setting up the controls and making expensive tooling such as templates, jigs, and fixtures to guide the cutting tool in its operation. In addition, operation of conventional machine tools does not achieve the high degree of coordination and precision inherent in numerically controlled design.

Numerical Control Development

Automation is actually nothing new. It has been with us from the earliest days of civilized man. In later eras, the potter's wheel, the bowstring drill, water wheel, mule-drawn capstan, wood-turning lathe, and steam engine were but a few of the myriad of inventions which advanced the field of manufacturing. As early as 1725, knitting machines in England were controlled with punched cards. The patterns in cloth were woven according to a prepunched set of cards that directed the weaving machine.

The control of sound was perhaps the earliest effort in automatic control. Early in the 16th century, rotating drums with prearranged pins were used to control chimes in the cathedrals of Europe and in some American churches. Music boxes operated by the same method were the vogue shortly thereafter. In 1863, M. Fourneaux patented the first automatic player piano. This used the principle of air passing through a perforated roll of paper, which in turn actuated the piano keys. This method was improved to the point where the roll perforations were able to control tone, sound intensity, and roll speed.

Charles Babbage[3] designed the first digital computer around 1833, but he never completely finished his work and it was not until 1944 that the first accurate and more versatile computer called the Mark I was developed by Howard Aiken and staff, utilizing Babbage's principles. However, this too was a comparatively slow machine without internal storage facilities. It was in 1946 that a fully electronic computer, the ENIAC, was completed. John von Neumann designed a complete stored program digital computer, the EDVAC, which represented a significant advance over the previous models. In 1951, the first mass-produced computers came on the market, and Neumann's principles can be found in use in the computers used today.

Computers were one of the first tools of what might be called the "Second Industrial Revolution." Automatic operation of machine tools that would be controlled by numbers given to the machine led to the term "Numerical Control," that is, "the control of a machine tool by numbers." A more formal definition of N/C, as put forth by E.I.A., is a system in which the direct insertion of programed numerical values, stored on some form of input medium, are automatically read and decoded to cause a corresponding movement of the machine which it is controlling. These developments relieve the employee of tedious and time-consuming problems of computation and direct handling of machine positioning, as well as the associated duties of proper checking of the completed parts.

Research and development on numerical control, which got underway after 1947, was accelerated by the need of the aircraft industry for new machining techniques that could produce the many intricately designed parts of high-speed planes cheaper, faster, and more accurately than was possible with conventional techniques. Advances in communication engineering, servomechanisms, and electronics, perfected during World War II for directing antiaircraft fire, provided the basis for making numerical control technically practicable.

By 1949, the U.S. Air Force became aware that the complex shapes required for modern aircraft and missile manufacture were causing the various manufacturing programs to fall gradually behind their projected schedules. Manual and tracer-controlled machines could not keep up with the demand and at the same time assimilate the many engineering design changes required.

John T. Parsons, an early pioneer in North Carolina, was given a contract by the Air Material Command to "study the design problems involved in making an experimental machine that would produce contoured surfaces from instructions in the form of punched cards" (IBM Standards). He designed and built a bridge-type planer mill that would machine intricate shapes, pockets, radii, etc., to accuracies of .015 inch. It was, however, an open-loop system with no check as to whether the commanded information was adequately and satisfactorily performed. It was soon apparent that a self-checking medium should be incorporated into the basic machine tool. Parsons persuaded the Massachusetts Institute of Technology to participate as a subcon-

[3] Weinstein and Keim. *Fundamentals of Digital Computers*, pp. 5–6.

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tractor to further refine his basic machine and to incorporate checking features inherently in the machine. The contract asked M.I.T. to accomplish the following:

1. Develop a method of "coding" punched tape to reduce the number of tapes required and provide "checking" features to minimize error in the event of equipment failure or malfunction
2. Develop and design electronic equipment to "read" the tape, to convert the instructions to electronic signals, and to use these signals to control mechanical movements of table/or cutter in longitudinal, crosswise, and vertical travel simultaneously
3. Modify an existing tracer controlled mill (Cincinnati Hydro-Tel with tracer control removed) for use with the experimental control systems, to test the system and to point the way for further development and improvement
4. Demonstrate that it would be technically feasible to build and use machine tools employing punched tape control

The initial planning was completed by 1950, and a prototype one–axis system was in operation. This beginning opened the path for rapid advances in this new field, and by 1952 a machine using three axes and establishing the concept of numerical control practicable for industrial use was in operation in the M.I.T. machining laboratory. Refinement of principles and techniques was continued at M.I.T. and also begun by numerous machine tool builders and producers of electronic control and computer equipment. In 1955, the first few commercial models of numerically controlled machine tools were displayed at the National Machine Tool Show and placed in factories for operational use. By 1957, numerically controlled machine tools were installed and used in production in various Air Force contractor plants located across the country, providing an important impetus to industrial application.

Since its commercial introduction, research and development have advanced numerical control significantly. Reliability of control components has been increased, and special systems for a variety of specific machine applications have been devised. A wide range of competing systems featuring varying combinations of electronic, electrical, hydraulic, optical, pneumatic, and mechanical control devices has been made available. The point-to-point controls are usually the least sophisticated; the continuous path system is more complex and requires a far greater input of detailed instructional information than a positioning system. Although direct programing with a desk calculator is also possible for continuous path systems, it would be too time consuming for practical use of the system. Therefore, the use of an electronic computer has become practically indispensable as a computing tool for the programer preparing instructions for machine tools controlled by a continuous path system.

Impact of Numerical Control

The impact of numerical control started slowly but has grown steadily. At first it seemed to be a fad. A few pioneers were experimenting with automatic control systems. Very little attention was paid to the exotic experiments which were being conducted. Even in 1956, curiosity over numerically controlled machine tools was more prevalent than was serious consideration.

When numerical control caught on, it progressed rapidly and interest mushroomed. Two schools of thought emerged. One maintained that a shift of people in jobs, the creation of more jobs, and a better way of life for all would result. The other believed that the industrial revolution was out of control, jobs would be erased much more rapidly than created, and wholesale problems would result for mankind.

One has read and heard much on both sides. It is true that it is necessary to adjust, analyze, prepare, and retain the flexibility and ingenuity so richly inherited. To improve requires a change, but to make a change does not necessitate improvement. It, therefore, behooves each of us to be informed and prepared.

Numerical control is here to stay, if for no other reason than the basic economics of manufacturing. If a competitor can produce more parts with better accuracy at a lower price, he will run you out of business. This is true on the world market and in the smallest of businesses and industries.

Numerical control is only a part of automation, but it is a vital and basic part of our way of work. It has not come to us without some problems, changes, or adjustment anymore than did the industrial revolutions which have preceded the present one.

In October of 1954, *American Machinist* issued a 24–page special report entitled "Numerical Control —What It Means to Metalworking." In summary that report said, "We are on the threshold of an era, perhaps a Second Industrial Revolution, in which manufacturing tools will no longer depend on man's limited dexterity, in which drudgery will be abol-

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ished by automatic controls." On October 26, 1964, Special Report No. 559 entitled, "Numerical Control: The Second Decade," was published. If possible, secure this report and read it in its entirety. In case the report cannot be obtained, the following excerpt is included in this manual.

Special Report[4]

Numerical control has made an indelible mark on metalworking in only a single decade. It is revolutionizing the way of life in plants making metal goods. And it is only the beginning.

It promises to have the same revolutionary effect upon the metalworking industry that the automobile has had on the national economy. Since the horse and buggy were replaced by motor cars, life has not been the same. Life in metalworking already is taking on a new aspect as a result of the introduction of numerical control. It is not in our country alone that this is happening. It is happening in Europe, too. And it is spreading to Japan and Russia and perhaps to other far corners of the metalworking world.

Consider what happened in N/C's first decade. Out of the laboratories of the Massachusetts Institute of Technology came the first N/C unit—a milling machine, which was based on experimental work done earlier outside MIT. Giddings & Lewis then made a major breakthrough with its N/C profile skin miller; and the U.S. Air Force soon thereafter placed orders for N/C skin and spar milling machines.

Burg contributed significantly to the creation of a commercial market for N/C machines as a moderate price when it brought out its Burgmaster N/C turret drilling machine. In these early years, and in the years that followed, General Electric, with its N/C system, played a stellar role in working with various machine tool builders in developing N/C machines.

Only a few N/C machines were on display at the 1955 Machine Tool Show at Chicago, but in the latter half of the 1950's, both machine tool builders and N/C system makers went feverishly to work to develop the new concept. It was heavy stuff, because, as one observer says, "Man suddenly had learned a new way to communicate with machines . . . to tell them his most complex thoughts and have them respond." At the end of 1958, another major breakthrough occurred when Kearney & Trecker introduced the first so-called "machining center"—the Milwaukee-Matic. It was the first product on the commercial market embodying the mill-drill, bore-tap concept.

Big Boost at '60 Show

Then came the 1960 Machine Tool Show at Chicago, where almost 100 N/C machines were exhibited. A year later, *American Machinist* checked on the status of numerical control. It found that the U.S. machine tool industry was offering for sale 156 different N/C machine tools. At the same time, 48 control systems were being manufactured.

[4] "Numerical Control: The Second Decade," *American Machinist,* pp. NC 2–5.

Numerical Control was making impressive gains. It was being talked about, written about, and tried out, but it still had a very high price tag on it. N/C machine tools, in fact, were so experimental and expensive that, with few exceptions, they were bought at first only for defense and related operations, especially in the aerospace industry, with Government support. The major task confronting N/C suppliers was to devise a practical, workable machine that could be priced attractively for commercial customers. It would be a machine that little shops as well as big ones could afford. Pratt & Whitney came up with such a machine—its Tape-O-Matic N/C drilling machine (of which around 1,000 have been sold), and still another breakthrough had taken place. Other low-priced N/C drilling machines were soon put on the market by other builders.

N/C Accelerates

How fast was numerical control catching on? In its Ninth Inventory of Metalworking Equipment in 1963, *American Machinist* found that, out of 7,370 plants from which complete returns were received, 316 said that they had one or more N/C machines. These 316 plants possessed around 800 point-to-point N/C machines and 300 contouring machines. On the basis of the returns, *American Machinist* estimated that some 2,800 N/C machines were in use by U.S. metalworkers.

More recently, the U.S. Commerce Department's Business and Defense Services Administration and the Bureau of the Census have come up with revealing figures. More than $217 million of N/C machine tools (3,583 machines to be exact), were shipped to users between January 1, 1954, and December 31, 1963. The acceleration in demand for N/C machines was best shown by what happened during those years. Of the 3,583 machines delivered to customers, little more than 5 percent were shipped in the 5 years 1954–1958 inclusive, 31 per cent in the 3 years 1959–1961, and a dominant 64 percent in the 2 years 1962 and 1963. Out of the total, 2,478 machines had positioning controls, 441 continuous path controls, and 664 dial or plugboard controls.

The growth of numerically controlled machines has been accelerating rapidly, and as of June 1, 1966, approximately 7,000 numerically controlled machines are operating throughout U.S. industry. Of these, 88 percent are of the point-to-point or positioning variety with about 40 percent going to small shops. Numerical control has gained in popularity to such an extent that by 1970, it is anticipated that approximately 75 percent of the new general purpose machine tools being bought will be numerically controlled. This is not too surprising considering the proven economic advantages of numerical control.

Future Directions of Numerical Control

The significance of numerical control lies in the possibility of its becoming a major means of making more automatic the production of items that are

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manufactured in small quantities rather than on a mass-production basis. Since industrial experts estimate that about three-fourths of all metalworking production consists of items manufactured in quantities of less than 50 pieces, the economic impact of numerically controlled machining could be quite significant. Such jobbing production is common to all sizes of firms, from small machine shops employing only a few persons to the large plants employing thousands of workers. Moreover, even those firms which produce primarily on a mass-production basis have numerious departments engaged in jobbing production.

Current research and development are directed toward making numerical control the most automatic, universal, and flexible system possible. The future may see, for example, more equipment featuring "adaptive control"—a control refinement that combines automatic machining with constant monitoring of the results. This concept permits a continuously automatic adjustment of the machine and programed feeds, speeds, or other instructions to compensate for such uncontrollable factors as vibrations, cutting-tool wear, and temperature changes.

Another increasingly important development is "the machining center," also called multioperation machine, capable of performing a number of operations in machining a whole part under numerical control. A number of machining centers are already on the market and in operation. Such machines are available in various sizes and capabilities. Some machining centers can be complete machine shops in themselves.

Further important advances through the use of the computer are also being made toward simpler, faster, and more automatic preparation of the machine instructions and control tapes that command the machine. Computer-assisted programing consists essentially of a specially devised symbolic language capable of transmitting a brief, simple description of the machining operations and shape of the workpiece to a computer. In turn, the computer calculates and translates these brief directions into the detailed machine instructions and coded language of the control tape. Computerized programing has become essential in the application of the continuous path type of numerical control where manual programing proves too slow, time consuming, and uneconomic. Its use, however, has been extended to the less complex positioning type of numerical control.

The current advanced state of automatic programing has been due in large measure to the continuing efforts of the users and producers of the numerically controlled machine tool and the computer. At the present time, numerous systems are available, including the well-advanced and widely-used Automatically Programmed Tool System (APT), largely developed by the Aerospace Industries Association on the basis of earlier work started at M.I.T. under contract to the U.S. Air Force.

The possibility of extending the principle of numerical control to other types of production machinery is also being tested. Operations most frequently mentioned as already being successfully adapted to this type of control include drafting, assemblying, riveting, welding, inspecting, testing, tube forming, molding, wire wrapping, and steel rolling. In these applications, tapes or cards on which numerical data about the dimensions, sequence, and timing of operations are recorded, are used to control production equipment. Thus, numerical control has far-reaching implications for other operations in metalworking and for other industries.

What Is Programing?

It is a process which begins with a tooling analysis of the part print, and then involves considering the machine tool, fixtures, and cutters. This process includes operational analysis, the cutter path definition, the geometry of the part, the consideration of proper machining practices, the preparation of the program manuscript, the punching and processing of this data, and the final checkout of the completed program.

The term "programing" can have at least two meanings in most industrial organizations today. These would be the programing of computers and the porgraming of numerical control machine tools. The latter is usually known as "part programing"; it encompasses the use of a computer in the process of producing machine tool programs. This is different from the function of the "computer programer," since he is the one who actually creates the computer routines for use by others.

The computer programer seldom uses the routines he creates, just as the machine tool designer seldom operates the machine he designs.

The common concept of part programing deals with the calculations of coordinate points on the part and the transcription of this information to a program sheet or manuscript, from which the control cards or tapes are punched. This is actually only part of the process of programing. Photos 1 to 6 illustrate the programing processes.

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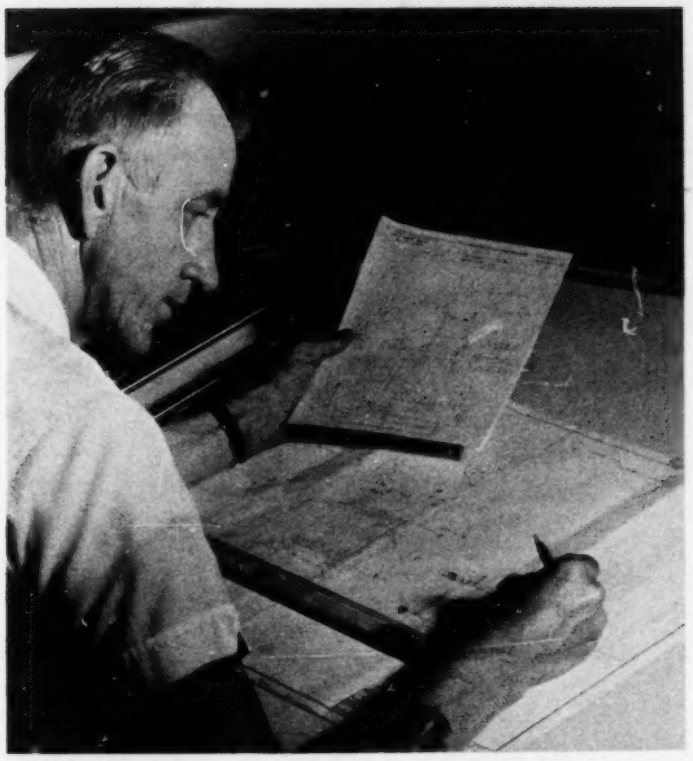

1. Coding the blueprint after receiving the tooling drawing.

The programing process begins with an analysis of the part to be machined. The part programer must first consider the part in relation to the machine tool. Can all operations physically possible be machined on the N/C machine? Are the overall dimensions within the range of the machine tool? Can the required tolerance be held on the machine available? Is the part suitable for numerical control? Can it be defined numerically?

Next, the programer must consider the tooling required to produce the part. He must determine the type of holding device to be used, which often requires a sketch or tool drawing showing the location of the part and the fixture. He must also select the proper type and size of cutters to be used for the job as limited by the geometry of the part, the machine tool, and holding fixture. Standard calculations of RPM and feed rates are used, based on the proper cut speed required by the material, the type and size of cutters, and the limits of the machine tool itself.

After selecting the required tooling, the part programer determines the number of operations re-

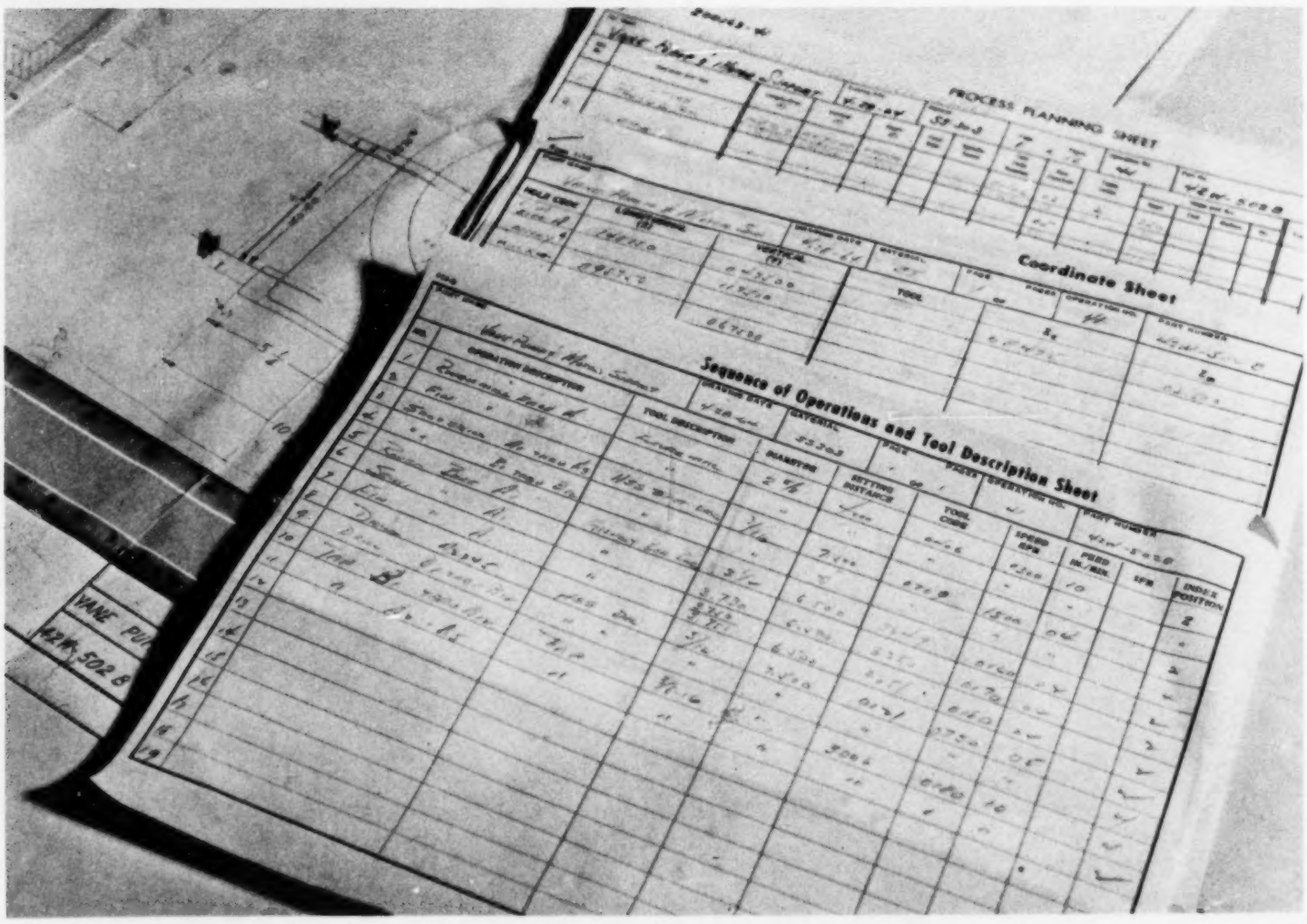

2. Completion of the forms.

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quired and in what sequence they are to be machined. For each operation he determines the direction of cut and selects a convenient starting and unloading point. Often each operation is laid out on a sketch of the part. These sketches serve as a guide to both the part programer and the machine tool operator as they check out the finished program.

Each operation is described in terms of the geometry of the part. This description is usually translated into the language of the control system through the

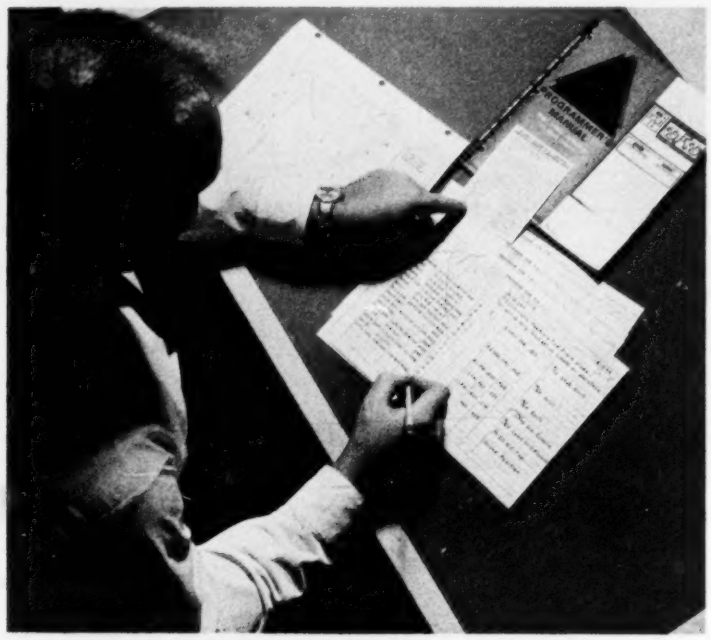

3. Completion of forms for a different machine.

4. Typing the manuscript.

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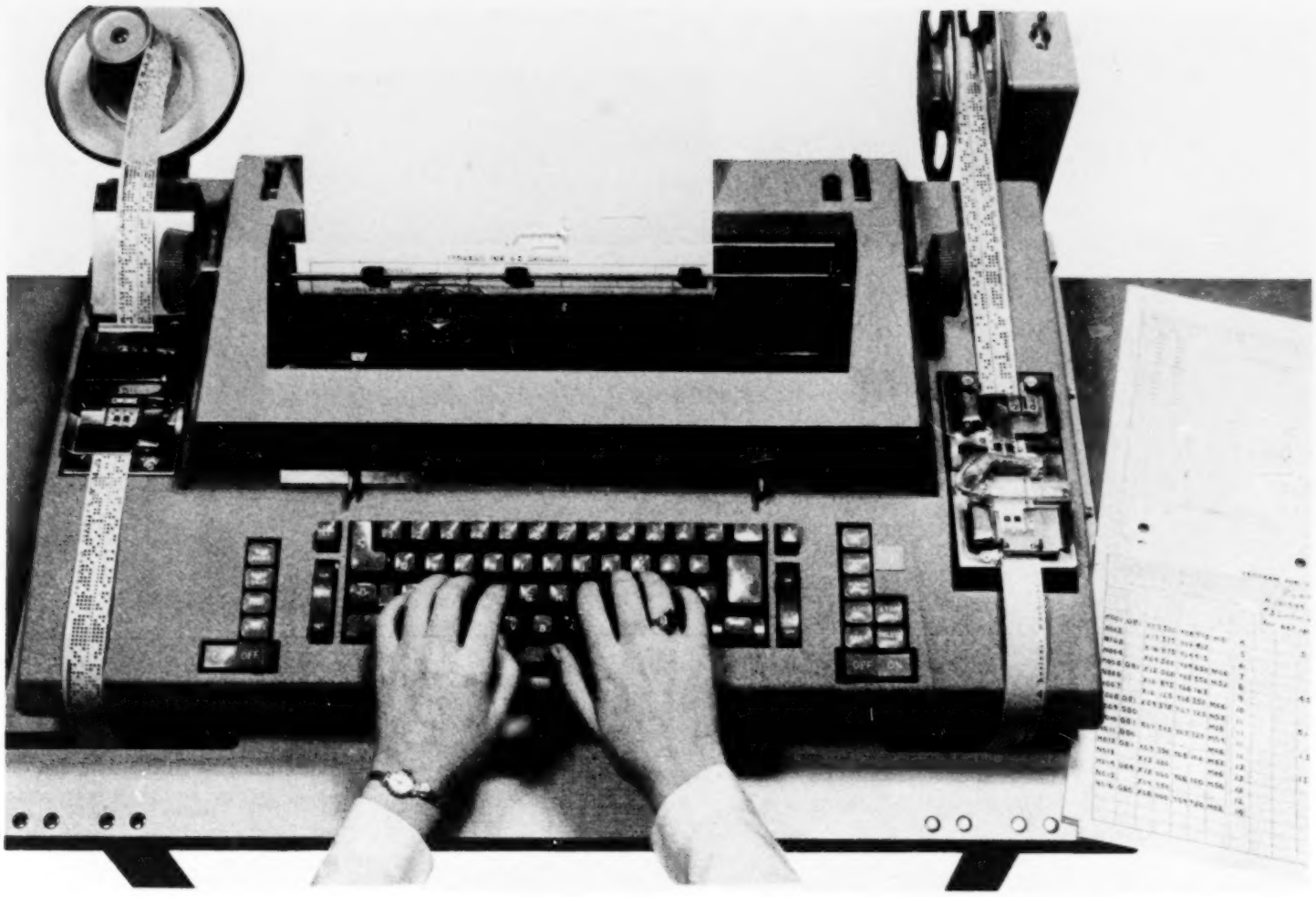

5. Typing in the manuscript for a different machine.

use of computer routines. Occasionally, however, a desk calculator is used for this purpose in programing simple shapes. Once the part programer has described the path he wishes the cutter to follow, he adds the required instructions to control the auxiliary functions of the machine tool. These include such functions as feed rate, tool change, spindle, and coolant. All this information is placed on a program manuscript. What actually goes into these manuscripts will be covered later.

The completed manuscript is then carefully checked, usually by another part programer. He asks such questions as: Has the cutter been turned on and off at the right moment? Do the programed heights clear the clamps? Has the cutter path been defined correctly?

The checked information is next punched into paper cards or tape.

The final step in the part programing process is to check out the program. A visual inspection of the printed manuscript is made to check for obvious errors. Many numerical control users have found that automatic data plotters prove a valuable tool in rough checking the program cutter path. However, the resolution of the data plotter is such that the small errors cannot be found. Some manufacturers use the N/C machine tool and cut the program in soft metal, plastic, wood, or the like. Once a program is checked out by the programer, it is ready for production. The final check is on the actual part. Many programers today are verifying the program tape and using the actual part for proveout by the block stop method.

What Sort of Background Should a Part Programer Have?

This question is always asked by the customer considering numerical control. The required background may best be indicated by examining what the part programer does to produce an N/C program.

First, the part programer must be able to read and understand the engineering blueprint. Furthermore, he will be required to understand the mathematical principles (good basic mathematics, applied geometry, and right angle trigonometry) and apply this

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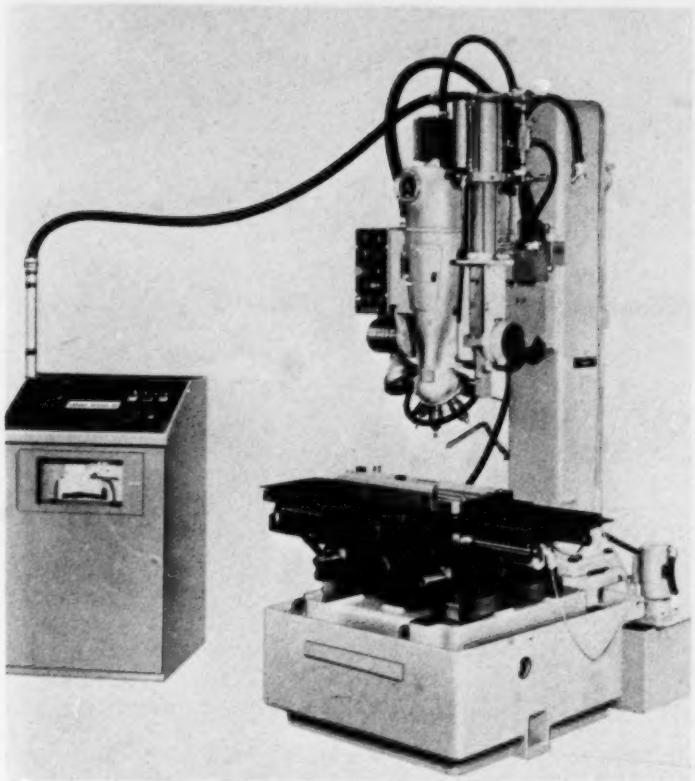

7. Turret drilling machine.

Summary

One needs to be informed of numerical control so that an adjustment can be made to it economically, socially, and technically. This chapter introduces only one of its aspects—numerical control in the technical vein—with a hint toward the economic justification or social implications. Further studies in these areas are encouraged. The bibliography will aid in completing the overview and will introduce completely new concepts; for example, "autofacturing."

In regard to the technical aspects, this course reviews the development of numerical controls and identifies the personnel and processes needed to implement parts programing. There are many systems of controls and many personnel structures to accomplish the necessary tasks of implementing and operating numerically controlled machines. This manual will deal specifically with the common knowledge necessary for systems using discrete positioning, or point-to-point control without the use of a computer. The last chapter will introduce computer assistance.

Photos 7 to 12 illustrate some operations and controls typical of N/C machine tools.

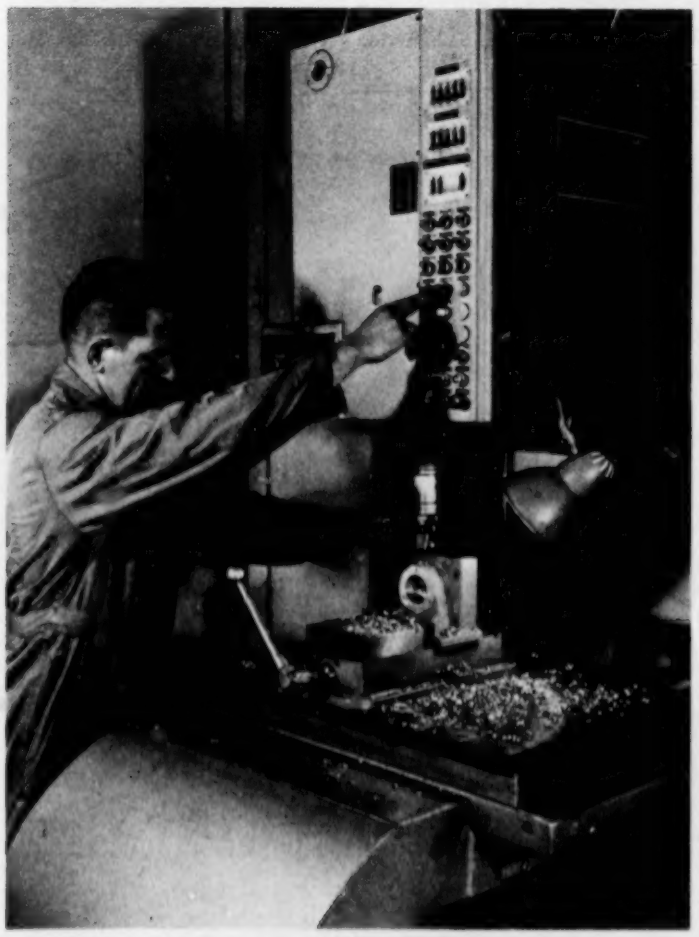

8. Milling operation on a N/C machine.

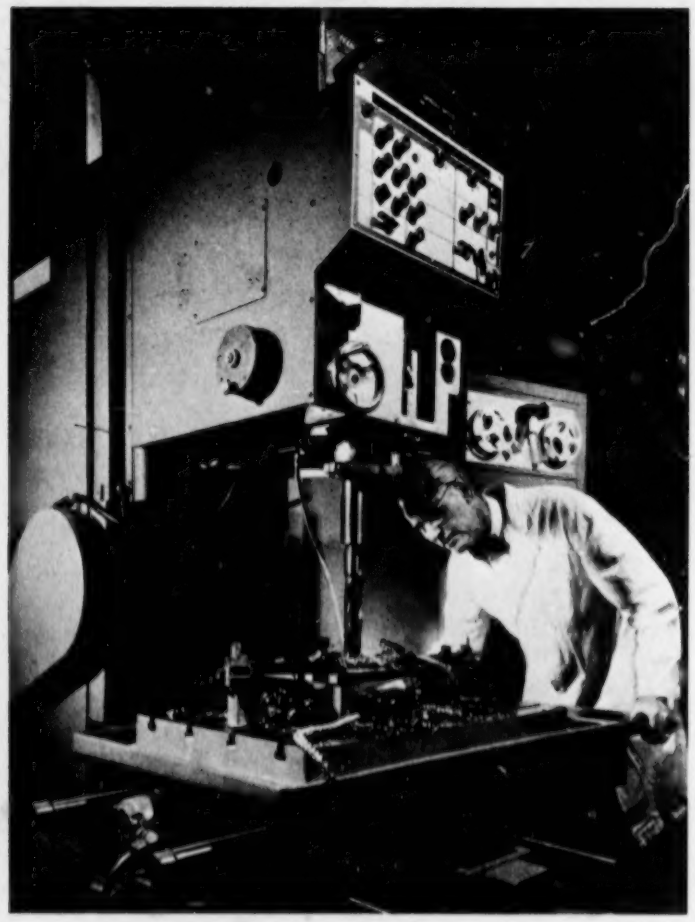

9. N/C drilling machine.

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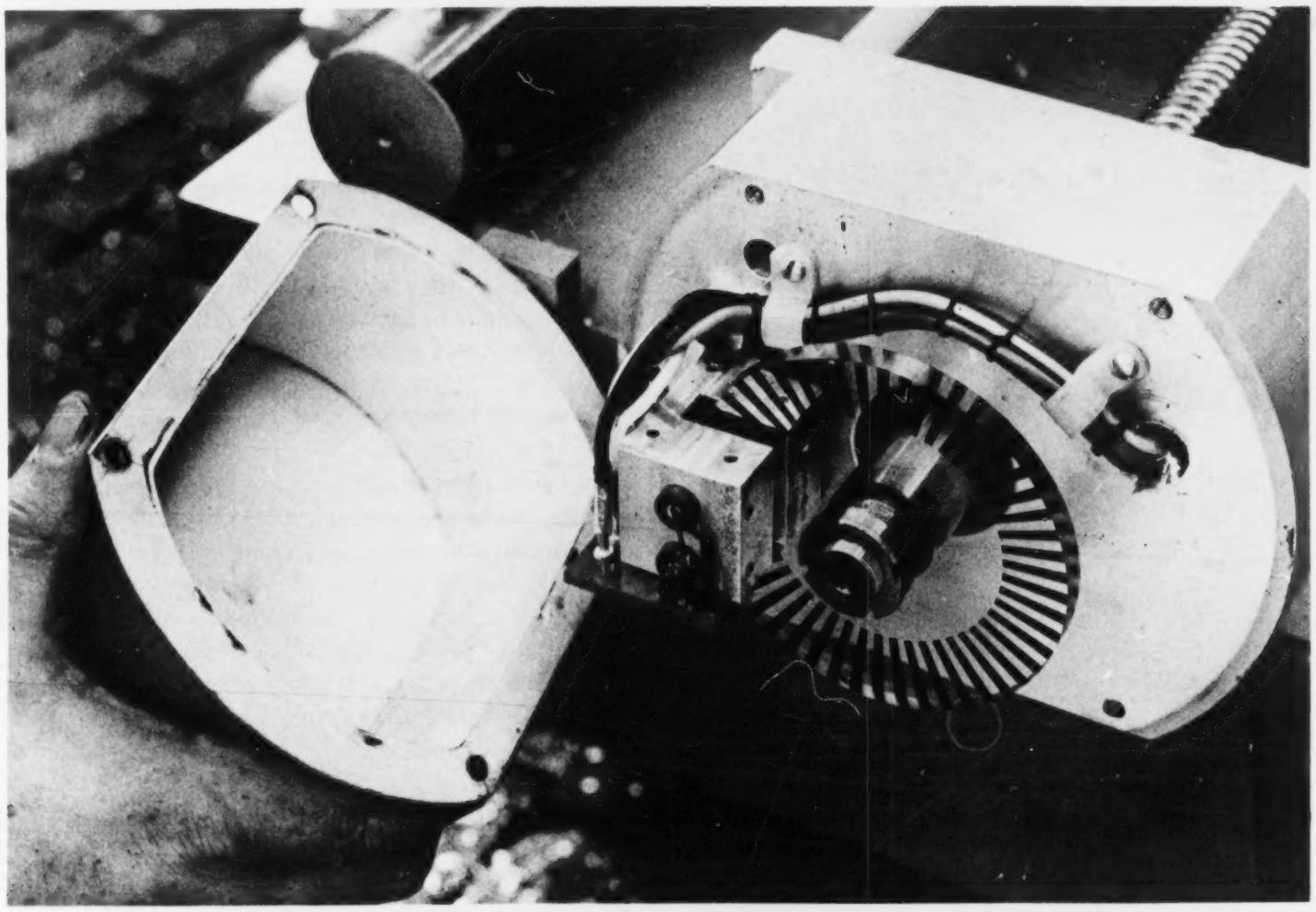

10. The digital system insures positive positioning.

11. Transistorized control for N/C drilling machine.

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12. N/C controlled lathe.

II. REVIEW OF BLUEPRINT INTERPRETATION

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objectives

To acquaint the student with the visualization and interpretation of blueprints
To review base line dimensioning system
To review the selection of machine methodology for part program
To review basic mathematical concepts

Materials

Glossary, blackboard, chalk, eraser, blueprints, information sheets, and assignment sheets

Unit Outline

A. Purpose of blueprints
   1. Basic layout
   2. Orthographic projection
   3. Details and lines
   4. Notes
   5. Dimensions and dimensioning systems
B. Title block
   1. Name of part
   2. Number of piece
   3. Material or materials
   4. Alterations and redesigning
   5. Sealing
C. Bill of material
   1. Number required
   2. Description
   3. Material
   4. Size
   5. Drawing number
D. Visualization
   1. Three-view drawings
   2. Placement of views

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3. Lines (alphabet of)
4. Notes and symbols
   a. Process
   b. Accuracy
   c. Surface
   d. Depth
   e. Location
5. Dimensioning
   a. Reference
   b. Length of distance
   c. Tolerance
   d. Finish
6. Cross section
7. Broken-out sections
8. Enlarged details
9. Picture drawings
10. Assembly drawings
11. Detail drawings

E. Special views and assembly drawings
   1. Section views
   2. Auxiliary views
   3. Assembly drawings

F. Materials
   1. Ferrous—nonferrous
   2. Kinds of steel
   3. Plastics
   4. Materials selection factors
      a. Strength
      b. Stability
      c. Weight
      d. Appearance
      e. Cost
   5. Number classifications
      a. Company
      b. Trade names
      c. S.A.E.—A.I.S.I.—A.S.T.M.

G. Supplementary information

H. Machine tool terminology

Suggested Activities

Complete dimensioning changes, coding, and sequencing on the working blueprint

Study machining methodology, particularly speed and feed for various materials

Continue to work on glossary terms and meaning

References

Ihne and Streeter. *Machine Trades Blueprint Reading*

McCarty. "Automated Programming from Undimensioned Drawings," pp. 65–68.

Nicholson, Jones, and Baughman. *Blueprint Reading.*

Olberg and Jones. *Machinery's Handbook.*

Films

From Print to Product. Kearney & Trecker Corp.

3-Dimensional Drafting. Ridgway's of New York.

Resource Materials for Unit II — Review of Blueprint Interpretation

The cliché, "a picture is worth a thousand words," is indeed an understatement about blueprints and engineering drawings. Blueprints and drawings serve as a vital communication link between the engineer-designer, production planner, machinist, tool and die maker, and programer. Therefore, it is of paramount importance that all concerned with the manufacturing processes have a thorough understanding of engineering drawings, blueprints, and tooling sketches. It would be an insurmountable task to call attention to all of the possible variations from A.S.A. standards (American Standards Association) that may be prevalent in various companies' drawings. Hence, the purpose of this chapter is to familiarize the student with the prevailing standard practices, and hopefully lay the ground work for the adoption of these principles by the companies in this field.

Working Drawings

Working or detailed drawings cover a wide range of drawings primarily concerned with the manufacture of parts. Working drawings contain such detailed information as type of raw material, dimensions necessary for fabrication, finished surfaces, and in some instances, degree of finish, heat treatment required, and chemical finish (i.e., paint, anodize). Assembly drawings, on the other hand, show how various parts are related to the whole. "Pictures" for the "do-it-yourselfer" of knocked-down furniture and children's toys are an example of assembly drawings. Generally speaking there are no dimensions on an assembly drawing, hence fabrication from raw stock to end product is virtually impossible. For purposes of this chapter, discussion will be limited largely to detailed or working drawings.

Working drawings are usually limited to one item per sheet. Suppose there were a drawing of a special type of machine bolt 1½–inches long. Obviously it would seem wasteful to have this as the sole item on a sheet. However, when it comes to referencing various parts for inventory control, the other part or

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READ ALL NOTES. LIMITS ON FRACTIONAL DIMENSIONS ARE PLUS OR MINUS 1/64" UNLESS OTHERWISE SPECIFIED.	SYM. & PC. NO.	PATT. NO. B-15 SOLID	MATERIAL SALGITE	H. T. / R. C. —	SCALE FULL
	PUMP GEAR			Supers'ds / Supers'd by	
	DWG. NO.	ACE MFG. CORP. YOUR TOWN, U.S.A.		Drawn / Traced	Check'd / Appr'd

DRAWN BY
FILE +
APPROVED BY

SCALE: FULL SIZE

MATERIAL: RIGID TYPE 1 PVC PLASTIC
COLOR: GEON #B700A LIGHT GRAY SPECIAL

NOTE — NOMINAL DIMENSION TOLERANCE = 1/64" UNLESS OTHERWISE SPECIFIED

AJAX MACHINE CO., INC. HOMETOWN, U.S.A.	DWG. NO. A—

REQ'D.	PART NO.	DESCRIPTION	MAT'L.	MAT'L. SPEC.	UNIT WT.	NEXT ASSY.	USED ON	NEXT ASSY.	FINAL ASSY.
LIST OF MATERIAL						APPLICATION		QUANTITY REQ'D.	

UNLESS OTHERWISE SPECIFIED	DRAWN	NAME HANDLE FOR AIR RELIEF VALVE	ACME IRON WORKS, INC. OUR CITY, U.S.A.	
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±~	CHECKED			
ABOVE TOLERANCES DO NOT APPLY TO CAST SURFACES	APPROVED			
ALL MACHINED SURFACES 125√		MATERIAL FREE CUTTING BRASS	DWG. NO.	REV.
ALL MACHINED CORNERS AND FILLETS TO BE .020 RADIUS				
REMOVE ALL BURRS AND BREAK ALL SHARP EDGES		SCALE FULL / WT.		

Figure II-1. Sample title blocks.

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parts, if placed on the same sheet, could easily become "lost." Also, when items are long and complicated, several views may be necessary to show the object; if more than one part were placed on a drawing, it would only cause confusion to the person trying to understand the print.

Usually, "company standards" are found along the bottom or in the lower right-hand edge of the print in the title block, depending on the size of the sheet. Figure II–1 shows a few sample title blocks. Note the type of information found in each. The standard dimensional tolerances, surface quality finishes, etc., as are applicable per company, are usually noted. The scale, although indicated on almost all drawings, is not intended to be used for the purpose of producing the part, but rather to tell the reader that the part is drawn either to an enlarged or reduced size. "Scaling" a print to determine dimensions is frowned upon by most production shops.

Orthographic Projection

Orthographic projection is perhaps the most widely used of all methods of representing parts in a drawing. The prefix "ortho" means right angle, and "graphic" refers to picture. Thus, the prints are right angle pictures of parts. The object is viewed perpendicular to the particular surface. Imagine, for example, a cube. If one were to view one surface of this cube at right angles to it, all one could see would be a square. In order to actually "see" only one side of a cube at a time, however, and still retain the true size and shape of it, one's eye would have to be an infinite distance from the surface. Obviously this is not possible in actual practice, so for purposes of blueprints, the principles of orthographic projection are applied. This enables the draftsman to convey a picture of an object without distortion, as one would actually perceive it. It is imperative that one thoroughly understand this concept if one is to interpret correctly any blueprint, especially detailed working drawings.

An integral concept which parallels that of orthographic projection is that of view arrangement. Let us return to the example of the cube. A cube has six separate surfaces. Thus, using orthographic drawing principles, it is possible to have six separate pictures; that is, one picture of each surface. In the majority of cases, only two or three of the six possible views are used. Use of more views is not only repetitious and confusing, but time consuming. After one becomes more familiar with the relationship which must exist between views (due to method of projection), it can be readily seen that to add more views would indeed be redundant.

Figure II–2(A) shows a three-dimensional drawing of a step block. This is the way it would tend to look if the physical part were viewed with the human eye. By contrast, figure II–2(B) shows the same block as an orthographic drawing. This, with the addition of necessary dimensions and notes, would constitute a working drawing. The various surfaces are numbered alike in their respective figures for ease of understanding.

Although many texts on various aspects of blueprint reading go to considerable length concerning the names of various views, it is not necessary here. What is important and should be emphasized again and again is the relationship that exists from view to view of the various surfaces. Note, for instance, that surface 1, 2, 3, 4 in figure II–2(B) shows as a rectangle (plane) in the view to the lower right. The view immediately to the left shows this surface (1, 2, 3, 4) as a line. The view immediately above shows line 1–3 as a point and line 2–4 as a point. It should be pointed out that each view gives but two overall linear dimensions, namely, length and width, or length and height, or width and height. Thus, as was mentioned earlier, at least two orthographic views are usually needed to describe an object so that the basic overall dimensions of length, width, and height are included.

It should be further pointed out that the relative size of the object does not change from view to view. This is an imperative principle of orthographic projection. This not only aids the draftsman in making the drawing, but it is an aid in interpretation. Knowing that all lines, planes, and points must project from view to view is a definite aid when trying to visualize the part, be it simple or complex.

The various views of the part are drawn separated as shown, primarily for ease of dimensioning. *The distance between views in no way affects the principles of projection.* Wide spacing may make it more difficult to follow various points from view to view by eye, but a straight edge will prove to be a definite advantage. The various views are, as was pointed out, two-dimensional pictures of a surface. Each of these transparent surfaces is then cut apart at a strategic place to enable it to be flattened and placed on a sheet of paper. The projection of the various views is shown in figure II–3. If the transparent projection surface were cut along the dashed line and folded along the other edges, the result would be a picture as shown in figure II–2(B). The job of the

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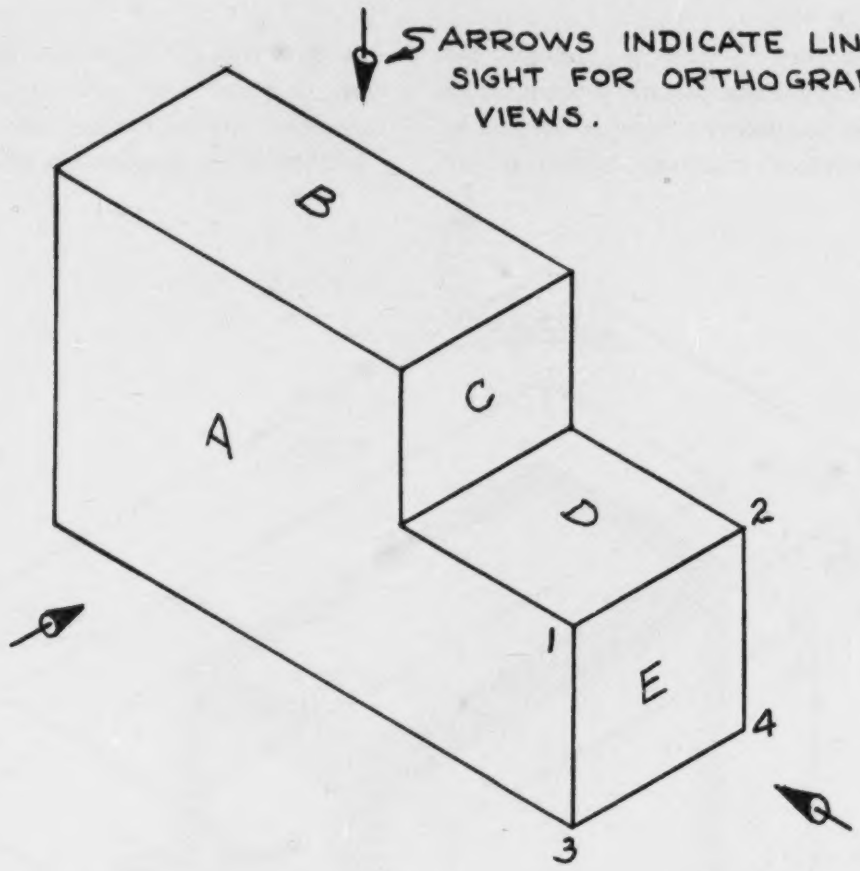

(A) PICTORIAL VIEW OF STEP BLOCK

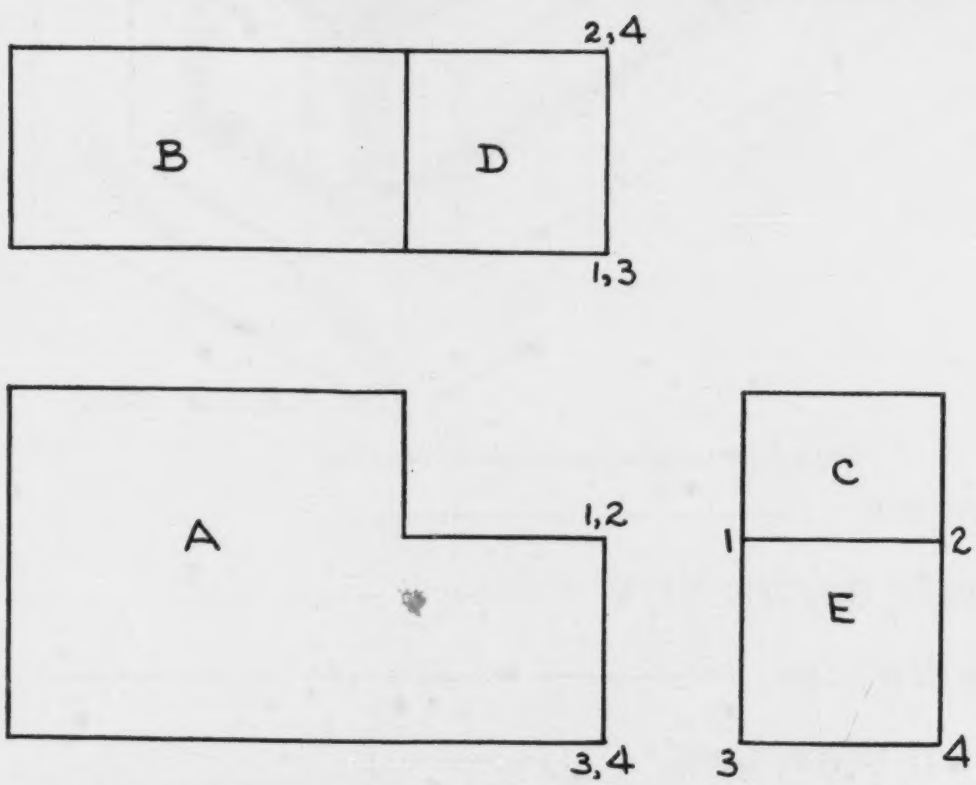

(B) ORTHOGRAPHIC DRAWING OF STEP BLOCK

Figure II-2. Orthographic projection.

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interpreter of this picture is then to "refold" the blueprint into the three-dimensional picture. This requires considerable practice to master. It is suggested that the "apprentice" blueprint reader, as well as the "master" blueprint reader, seek various texts on blueprint reading, or with the aid of an instructor, practice his technique of visualization. A helpful method is to sketch each of the surfaces given, posi-

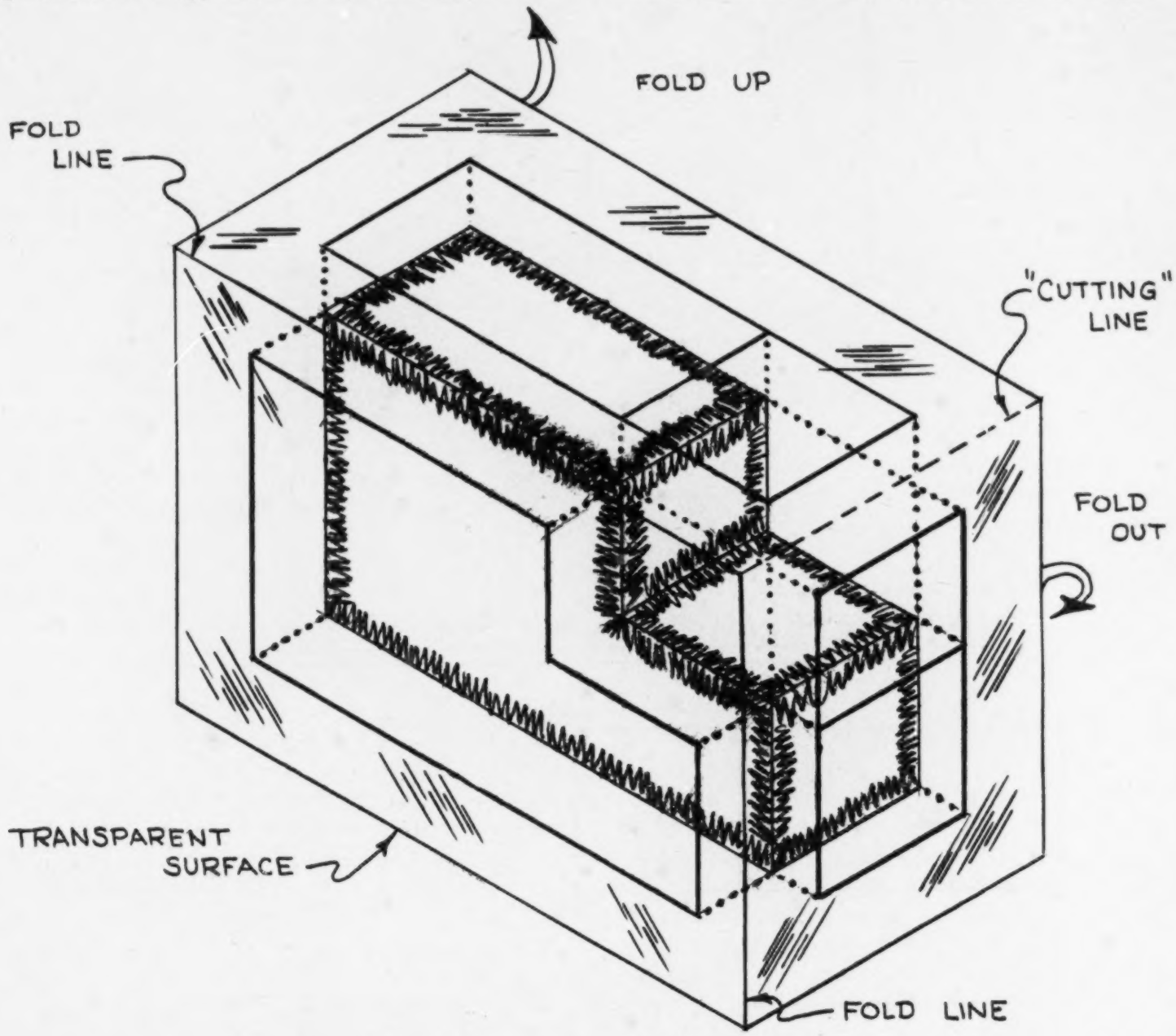

Figure II-3. Transparent projection of step block.

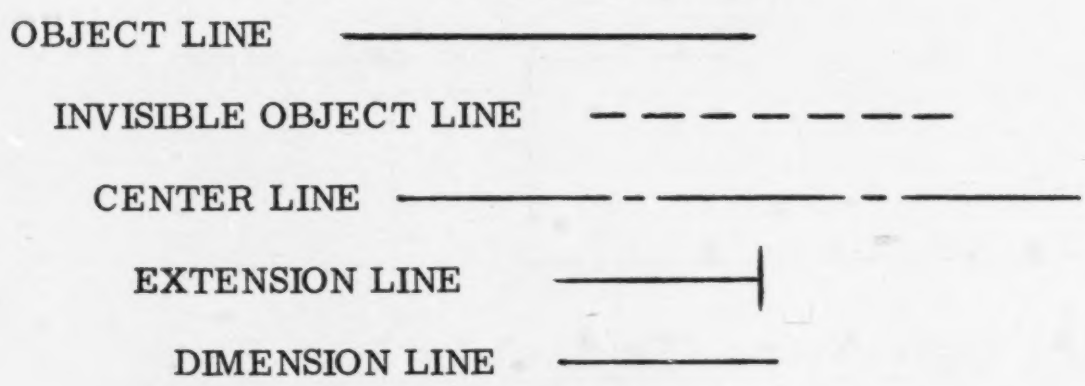

Figure II-4. Alphabet of lines.

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tion as illustrated in figure II–3, and drop lines to intersect, thus forming a pictorial view of the object. For those not skilled in sketching techniques, it is suggested that first sketchings be limited to rectangular objects. Round objects require a slightly different approach.

The Alphabet of Lines

In much the same way, blueprints consist of various interrelated views; each of the views consists of different line types. Some of the lines that make up the alphabet of lines are shown in figure II–4. A complete list can be found in any mechanical drawing text or in Olberg and Jones' *Machinery's Handbook*. Words are formed by combining different letters of the alphabet. Similarly, the draftsman combines different line types to form views that eventually become a blueprint.

Object lines show the *outline* or overall shape of the object. Every edge or surface which is visible from a particular view is represented by an object line.

Invisible object lines, or hidden lines, as they are sometimes called, represent surfaces or edges that are "hidden" from view. It does not necessarily follow that when a hidden line shows in one view and is projected to the next adjacent view, it will become a visible and hence a solid object line. This may be true in some isolated or special cases; however, the student is cautioned against drawing any such generalities or conclusions.

Center lines are used to indicate symmetry of an object or small sections, such as holes, on large objects. The center line is usually indicated by a long and short dash, alternately spaced, but may be shown as simply a fine solid line when representing small holes, radii, etc. The symbol ℄ (meaning center line) might also be noted on either the line type illustrated or the fine solid line. This symbol in no way affects the significance of the line type.

The dimension line is usually a relatively fine solid line, broken to place the dimension (digits indicating size). The arrow heads indicate the termination of the dimension.

Extension lines extend from various places on the object at the exact locations between which the dimension lines are drawn. It should be pointed out that present trends in dimensioning for N/C production are to use but one arrow head and one extension line—the one that is omitted being the one that would return to the zero reference plane.

Dimensions

Thus far the discussion has been limited to the description of the shape of an object. Dimensioning deals with the other major facet of drawings or blueprints; namely, the description of size. For the most part, dimensions are either fractional, decimal, or angular. The majority of prints used primarily in conjunction with N/C machining are of the decimal type. This not only saves time for the programer, but expedites the entire operation. Many companies are in the process of using the decimal system exclusively on new product drawings. These changes are made on existing part drawings by changing all dimensions to decimals. In the majority of industries, it is customary to omit inch marks (″) on all dimensions up to and including 72 inches. For those greater, the distances are usually given in feet (′) and inches (″), with the indicator marks given. To be certain, a check of the title block usually indicates prevailing company standards. The "scale" of the drawing may also indicate probable units of measure of the dimensions.

On all blueprints, either in or near the title block (see figure II–1), a note stating the applicable tolerance for all dimensions is found, unless otherwise specified. Tolerance is the amount of variation permitted in the size of a part or in the location of points or surface. Present-day interchangeable manufacturing makes it possible to make mating parts in widely separated localitites, bring them together, and have all parts fit properly. Without the principle of tolerance, this would not be possible.

Tolerance is sometimes misinterpreted by some production workers who think that they should "set up" to the upper limit (maximum allowable size), and then proceed to make parts. Nothing could be farther from the truth. One should *always* set up to the nominal or stated size of the part. The tolerance has been predetermined to take into consideration such facts as tool wear, machine tool vibration, expansion and contraction of the material due to temperature and humidity changes, etc. Such calculations are the duties and responsibility of the engineer-designer—not the production worker. Some companies have established standard tolerances that apply to dimensions both fractional and/or decimal. If this is the case, these standards should be adhered to unless the blueprint specifies otherwise.

Angles are expressed in one of two ways on a blueprint. First, they can be expressed in terms of degrees (°), which can be further broken down into minutes (′) and seconds (″). Second, an angle can be ex-

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pressed in terms of its rectangular coordinates. This designation may be preferred for use with certain types of N/C machines.

Base line dimensioning has many advantages for N/C programing. Figure V–1 is an example of this form of dimensioning.

Notes and Symbols

Frequently on working drawings it is necessary to convey additional information which cannot be done through the media of views, lines, or dimensions. Such information usually is included in notes or symbols. Information typically included may be: type of finish required, number of pieces required, type and specification of material from which the part is to be made, the diameter, coarseness of threads, and class of fit.

Perhaps the most common and important kinds of supplementary information with which the blueprint reader should be familiar are finish marks, material abbreviations, thread types, and taper designations.

Finish marks are used to indicate surfaces that are to be accurately machined according to precise specifications. Grinding, honing, and lapping are but a few typical finishing operations. Some finish marks in general use today are illustrated in figure II–5. The "f" in figure II–5(A) is perhaps the oldest form of finish mark in use today. The crossbar of the letter is placed so as to intersect the surface to be "finished." An equally "antique" designation is shown at (B), the letter superimposed on the line is used to indicate the method to be used to machine that surface, in this case "G" for "grind." The sharp "V" designations shown at (C) and (D) are somewhat modern versions of the "f." The meaning is virtually the same. Recent developments in technology have made it necessary to define more thoroughly surface quality. The A.S.A. (A.S.A. B461–1955) recommends utilization of a symbol similar to the one shown at (E). Such a symbol makes it possible to designate surface roughness, waviness, and lay. Inasmuch as this symbolism is being more widely used by American industry, it might prove advantageous to the blueprint reader to become familiar with it and its interpretation.

In some instances, finish marks may be absent from the part drawing. The blueprint reader should first check notes on the drawing because it may simply state "FAO," meaning "finish all over." Absence of both finish marks and a note regarding finish would mean the part was to be used as produced, i.e., as a rough casting or forging.

Typical thread representations are shown in figure II–6. For the most part, their use is very limited due to the excessive amount of time required for the draftsman to show the graphic style. Threads are represented the same, regardless of their form and series. Assume, for instance, a 1–8N–2, 1–12N–2, and 1–1GN–2 were to be represented side by side by the conventional form. Depending upon the draftsman and the company standards, all three could be shown the same; if these same threads were represented graphically, the number of threads would have to change for each one. Inasmuch as the threads are made primarily from the information on the note, the number of threads shown, if any, is indeed unimportant.

Regardless of the method of graphic representation for the thread, the thread is specified by means of a standard notation. Such a notation would be:

¾—10 UNC—2A

The ¾ is the nominal diameter of the thread; 10 is the number of threads per linear inch of thread. UNC—Unified National Course—is the unified form, COURSE SERIES. The "2" designates the class of fit. The "A" designates an external thread. An internal thread is designated with a "B". Since there is no further designation, this thread would have a right-hand thread. When a left-hand thread is necessary, it is designated as shown below:

¾—10 UNC—2A *LH*

Tapers may be dimensioned in a number of different ways, each of which has its own advantages and disadvantages. One method is a note depicting a certain number, American Standard Taper. Another method would be to dimension a diameter at one end of the shaft, the length of the tapered portion, and then the included angle of the taper. A third method would be to specify, via notes, that the taper is to be turned to certain company standard gages.

The blueprint reader should familiarize himself with various standard abbreviations used in various notes. Countersink, counterbore, spot face, and diameter are but a few words that are abbreviated—some in different ways—on blueprints. A check with a glossary of machine shop term abbreviations might prove helpful.

Special Views

Thus far we have been concerned solely with orthographic views that basically show the exterior surface of a part or object. In many cases, it is very difficult

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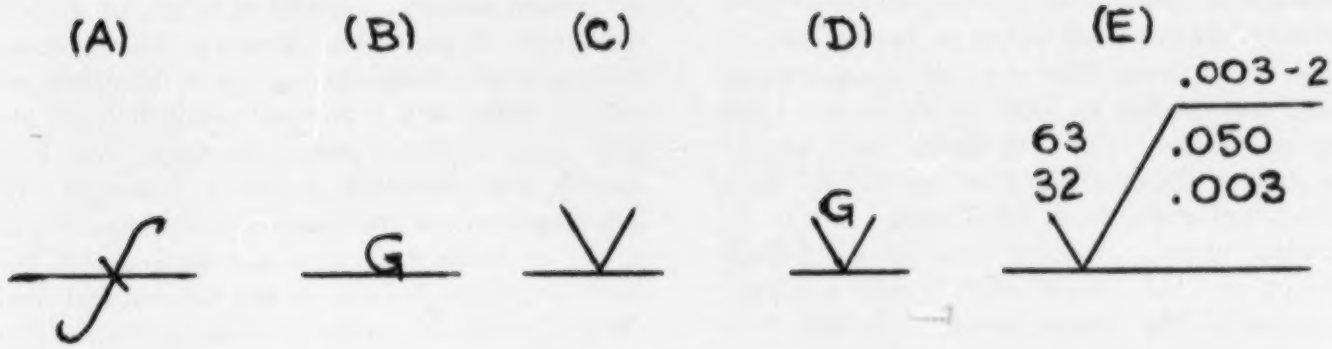

Figure II-5. Finish marks.

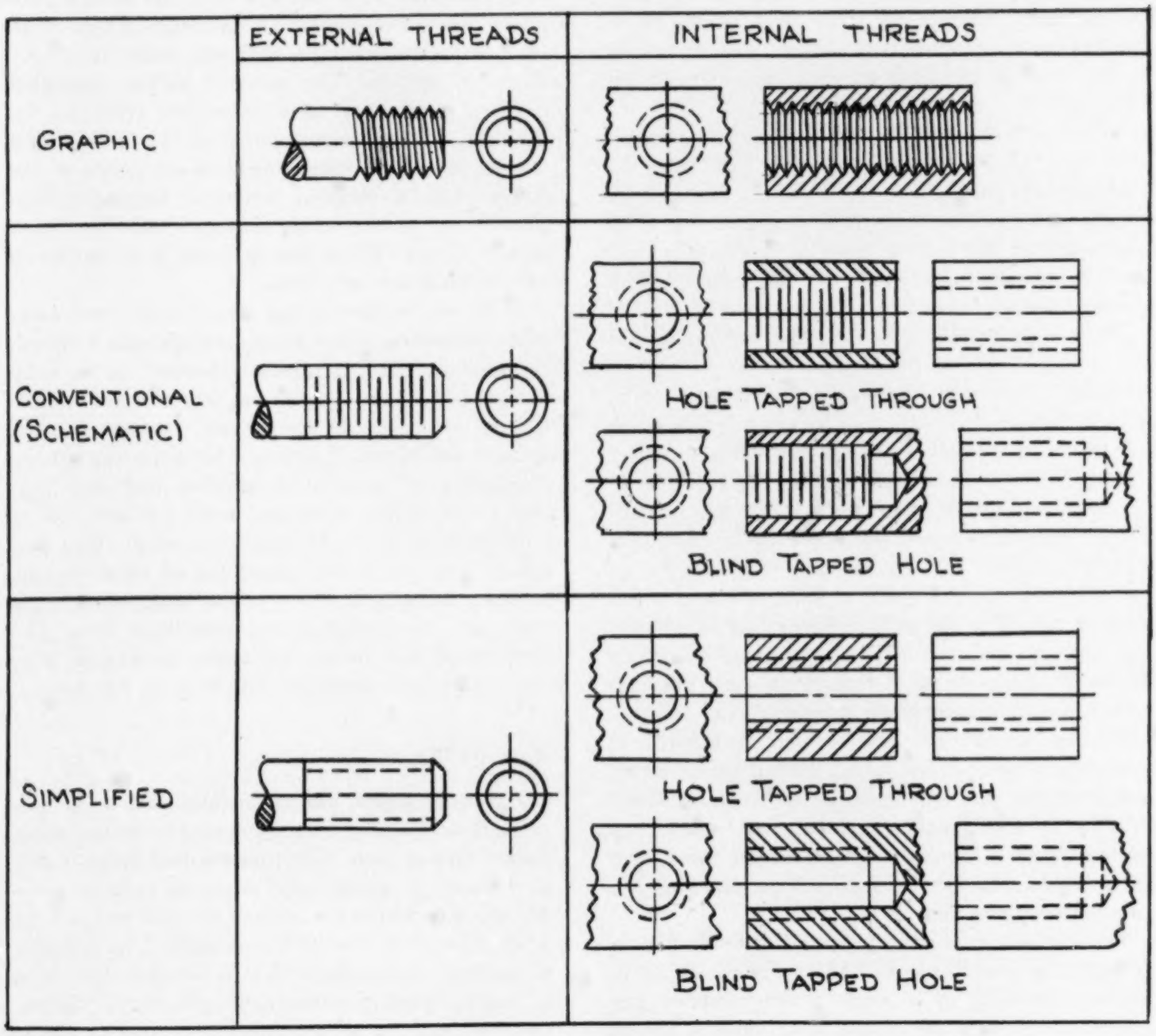

Figure II-6. Thread symbols.

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to illustrate clearly all of the necessary details of parts. As was pointed out earlier, various surfaces that cannot be "seen" when viewing an object from a particular direction are shown as hidden lines or invisible object lines. This type of representation, however, soon begins to have limited usage, while still being effective. Thus, to clarify such interior details and to eliminate the need for hidden lines, the principle of section views is employed.

A cutting plane is *assumed* to be passed through the object, and the "pieces" thus formed are separated, exposing the interior construction. For purposes of the "visualization" process of blueprint interpretation, one part is mentally disregarded.

There are several different types of sectional views, cross sections, or sections; however, they are all based on the same principle and differ only according to the kind of information they convey. A brief description of some of the more common types of sectional views follows.

When the cutting plane is passed entirely through an object, a *full section* is formed. Generally, the cutting plane passes from one extremity of an object to the other. For all practical purposes, let it be assumed that the cutting plane in this case is in a straight unbroken line, much like one would cut an orange or an apple.

With some objects, a full section is desirable but not practical, due to the location of various details. That is, if a straight line cutting plane were to be passed through the part, all important details could not be shown in section. To overcome this, an *offset cutting plane* is used. This cutting plane is "bent" at right angles and made to pass through various inner details that would not otherwise be shown. It should be noted that the graphic representation of an offset section is virtually no different from a full section. A look at the section view of the offset does not indicate points of offset. In order to determine points of offset, one must look to the next adjacent view where the cutting plane shows as a line.

Certain symmetrical objects lend themselves to *half-section views*. That is, the section view portion is identical or uniform in shape to the unsectioned portion. In a half section, approximately one-quater of the object is "removed." Half-section views have the advantage of showing both interior and exterior, side by side, in one view.

Occasionally, it is advantageous for the draftsman to represent a small segment or area of the object in section. Removal of a small section without any special notation in any of the other views is known as a *broken-out section*.

The geometry of the spokes of hand wheels, pulleys, and other similar objects with thin spokes are usually difficult to represent by any of the aforementioned section view methods. Here, *revolved sections* which utilize the concept of a cutting plane cut the spoke at a convenient predetermined place. This "cut" is then rotated, in place, 90°. Consequently, the draftsman is able to make an orthographic picture of the shape of the spoke. Not only is this an invaluable aid in showing a shape otherwise difficult to describe, it also can be dimensioned readily. Parts with taper or changing cross-sectional areas are often more accurately described through the use of repeated, revolved sections.

A *removed section* is nothing more than a section view that has been removed from its normal projected position in the standard arrangement of views. Revolved sections are probably the most "frequently removed" sections. The removed section, regardless of type, is relocated at a convenient place on the drawing. A label corresponding to the label on the cutting plane line relates the removed section to the whole part. A removed section is frequently "exploded" or drawn to an enlarged scale to clarify certain details. When this is done, it is sometimes referred to as a *detail section*.

It should be pointed out that in a sectional view, when the cutting plane passes through solid material, the "cut portion" is usually "shaded." Some companies go to great lengths to depict various materials by changing the spacing and crossing diagonal lines in the section. There is a tendency toward the elimination of material designation and identification in the section views, and using just one type of cross-hatching lines. Normally, diagonal lines are spaced about 1/16–inch apart for all materials, the thinking being that the material designation, type, alloy, etc., is detailed in the title block area. The blueprint reader should thoroughly familiarize himself with existing company standards in this respect.

Auxiliary Views

When the object has an inclined surface or surfaces, these surfaces, when projected by orthographic means, do not show their true size and shape in any of the normal orthographic views. In order to show the true size and shape of such inclined surfaces, an auxiliary view of that surface is made. The principle of making an auxiliary view is virtually the same as that involved in orthographic projection; namely, the observer's line of sight must be perpendicular to the particular surface. The resulting picture is then

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a true size and shape representation. This is of particular importance when dimensioning. After all, the machinist, tool maker, or whoever may be working with the print is most concerned with a true picture so he can get the proper visualization of the finished object. The term "auxiliary," or "helping," implies that when the draftsman makes the view, he is trying to further clarify the total picture of the part. It is not uncommon to find auxiliary views which appear to be "standing alone in space." In other words, the only surface shown is the slanting surface of the orthographic views. The other surfaces are not shown, because they would become distorted in the auxiliary view. Thus, the whole thing becomes a sort of merry-go-round in terms of where does it stop?

Depending on the complexity of the part and its shape, the draftsman might choose to show two orthographic and one auxiliary views instead of the usual three orthographic views. Orthographic, section, and auxiliary views are an integral part of the total picture of blueprints. In order to have near total understanding of the language of blueprints, it is essential that one understand how auxiliary views fit as a further aid in blueprint interpretation.

Pictorial Drawings

Pictorial drawings, such as are shown in figure II–2(A), have limited usage in production or working drawings. Although it might be argued that such methods of representation are much easier to visualize, the vital aspect of dimensioning becomes not only difficult, but at times almost impossible for accurate interpretation. With all due respect to the various mechanical drawing textbooks, a close check on problems that are pictorially represented will reveal several possible interpretations for a given dimension. It almost goes without saying that present day production technology cannot afford such guess work. Even with the widely used orthographic representations just described, there are altogether too many questionable aspects of these prints!

Pictorial drawings, as was mentioned previously, are used quite extensively for certain types of assembly drawings to show how and where various parts are intended to fit with respect to each other. A special type of pictorial representation, namely perspective, is used widely in architectural-building trades work.

For the most part, pictorial drawings, regardless of their special category, differ from orthographic views in that the pictorial views combine two or more surfaces into one picture, whereas the orthographic views show but a single surface per view. Three-dimensional representation is achieved as compared to two-dimensional pictures.

Summary

This brief chapter on blueprint interpretation in no way is intended to be a complete coverage of the subject of blueprints. Neither does it constitute a comprehensive summary of the area. Rather, it is intended to serve as a quick review of the various aspects most likely to be encountered when working with shop drawings. Blueprint interpretation can indeed be a lengthy, thought-provoking subject. The same could be said of most of the individual areas mentioned throughout the chapter. If the various areas mentioned provide food for thought and promote further investigation, this guide's purpose will have been served.

Education is perhaps a shortcut to experience, but certainly no substitute for it. In much the same way, the various ideas presented are of little value or significance without application to existing company standards in daily working situations.

III. REVIEW OF MACHINING METHODOLOGY

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To review the machining principles
To acquaint the student with the selection of speeds, feeds, and rate of machining
To select the sequence of operations
To select holding devices

Materials

Speed and feed charts, chalkboard, chalk eraser, films, reference materials, tool selection form and/or demonstration

Unit Outline

A. Basic machine tools
   1. Drill press
   2. Milling machine

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3. Shaper-planer
4. Lathe
5. Grinder
6. Punching-blanking
7. Forming

B. Machining principles
1. Internal
a. Drilling
b. Reaming
c. Boring
d. Counter functions
(1) Counter boring
(2) Counter sinking
(3) Spot facing
e. Tapping
f. Slotting
g. Punching, piercing, blanking
h. Forming
i. Broaching
2. External
a. Turning
b. Facing
c. Angle turning
d. Form turning
e. Threading
f. Slotting
g. Milling-hobbing
(1) Keyways
(2) Splines
(3) Gears
h. Surfacing
(1) Mill
(2) Shaper-planer
(3) Grinder
i. Forming
3. Speeds and feeds
a. Material machining
b. Cutting material
c. Condition and size of machine
d. Holding device
e. Power source
f. Wet or dry
g. Rigidity of foundation structure
h. Calculation of speeds and feeds
i. Table referencing of speeds and feeds
j. Cutting fluids

C. Holding devices
1. Tool
a. Chucks
b. Sleeves
c. Holders
d. Tapers
2. Work
a. Vises
b. Clamps
c. Jigs and fixtures
d. Magnetic chucking
e. Vacuum chucking

D. Tooling
1. Standard
a. Size
b. Material
(1) High speed
(2) Carbide
(3) Oxide
c. Conditioning
d. Maintenance
2. Preset tooling
a. Methods of presetting
b. Instrumentation used
c. Purpose of preset tooling
d. Function

E. Movement systems
1. Mechanical
2. Pneumatic
3. Hydraulic
4. Electrical
5. Feedback systems
6. Flat surfaces
7. Dovetail-machine slide system
8. Antifriction devices

F. Operational sequencing
1. Mounting
2. Holding (part and tool)
3. Tool selection
4. Referencing
5. Speed and feed selection
6. Inspection
a. Size
b. Shape
c. Finish
d. Position to reference
7. Auxiliary functions

Suggested Activities

Review machining principles by live demonstration or films

Demonstrate the sequencing operation entry on a tool sheet

Demonstrate speed and feed calculations

Introduce holding devices

Assist student in independent work

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Suggested Assignment

Complete the tooling sheet, including speed and feed calculations, from the blueprint of the previous lesson

Study holding devices and coordinate referencing

Continue the study of the glossary of terms

References

Burghardt and others. *Machine Tool Operation,* Part I, pp. 130–161; Part II, pp. 170–210.

Feirer and Tatro. *Machine Tool Metalworking,* pp. 12–96.

Felker. *Machine Shop Terminology,* pp. 62–172, 331–397.

Johnson. *Machine Shop,* pp. 187–217, 253–294.

Jones. *Machine Shop Training Course,* Vol. I, pp. 1–16, 146–156, 190–238; Vol. II, pp. 1–14, 100–135.

Metal Cutting Tools Institute. *Metal Cutting Tool Handbook,* pp. 1–165, 167–254, 293–375, 477–579.

Oldberg and Jones. *Machinery's Handbook.*

U.S. Department of Commerce, National Bureau of Standards, Ordinance Corp. Pamphlet, *Machining Data* (AD 425000).

Films

Manufacturing with Milwaukee-Matic. Kearney & Trecker Corp.

One Hoe for Kalabo. National Machine Tool Builders Association.

Tape-O-Matic. Pratt & Whitney Co.

Resource Materials for Unit III — Review of Machining Methodology

Machine designers spend considerable time and effort in developing a machine tool to do specific functions. Those functions may be drilling, boring, milling, spot welding, template shearing, type setting, or numerous others. Many auxiliary or related functions are also necessary to complete a task. The purpose of this unit is to review the basic principles and apply them to the alterations of numerically controlled machines.

In order to apply these principles to numerically controlled machines, a thorough understanding of the part to be machined and the machine tool capabilities is necessary. The key factors which influence machining methods of conventional or numerically controlled equipment are the selection of the correct machine tool, best holding device, and sequence of operations to produce the part accurately and efficiently.

The history of man's development of machines has been a movement toward more efficient production. The first industrial revolution can be attributed in part to improved machining methods which could hold tolerances that would permit part interchangeability. Many improvements have occurred in the past; however, the rate of improvement as it pertains to accuracy and efficient production seems to be accelerating today.

An example of the accelerated improvement is found in the area of drilling. The purpose is to remove material to produce a hole the size, depth, and position called for on the blueprint or sketch. The machine's structure and capacity determine the size of the piece which could be placed in the machine, the size hole that could be drilled, and the accuracy of the work done. The material being drilled would force a judgment in selecting the style of drill. Wood will have one style, cast iron another, steel another, and plastic still another. Even with one material, the lip clearance, number of flutes, etc., would alter. The depth and size of the hole are major items of consideration.

Not only can drilling be done with a drilling machine, but also with a lathe, a mill, or in a machining center. Whether to drill one hole at a time or use attachments to make many holes at a time must also be decided. The process of gauging many and varied types of drills and drilling machines to

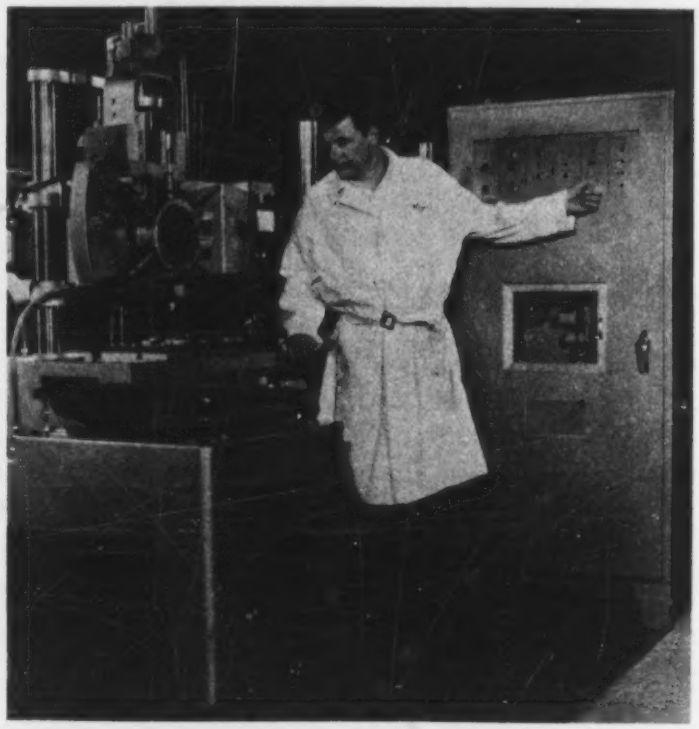

13. Two-axis N/C positioning controls.

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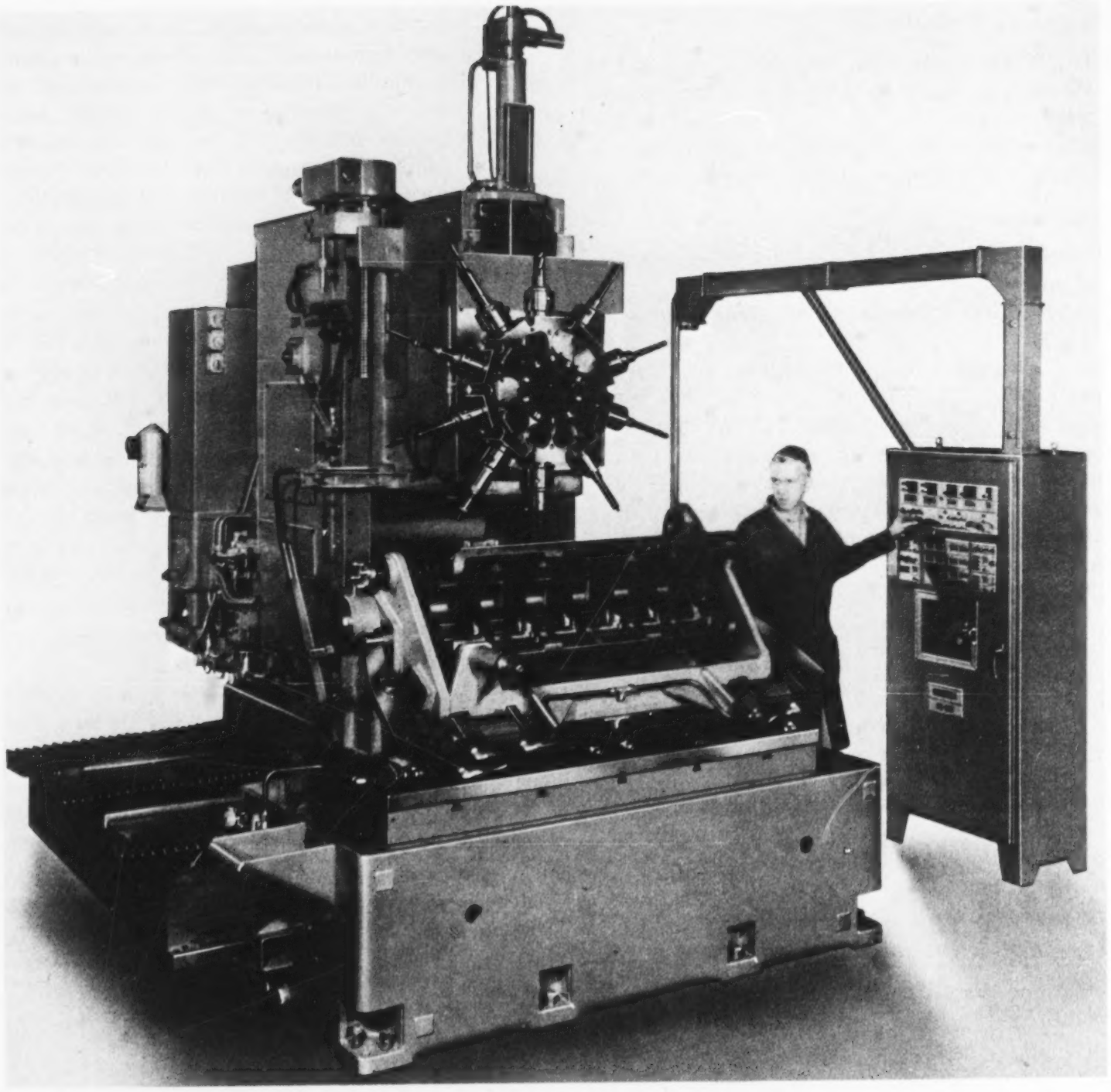

14. A large turret head drill with cradle-type fixtures.

make many holes in one part is possible. Photos 13 to 18 show some of the numerically controlled machine tools with which drilling is accomplished.

The selections of the methods of machining are many and varied. The concept of numerical control or machining centers are other variations that need to be fitted into our manufacturing procedure. Man's knowledge and judgment are teamed together to select the efficient way of producing each part with the facilities available to him.

The lathe principle of turning the piece while holding the tool has gone through much the same transition. The engine lathe with varied sizes and types, the turret lathe, the automatic screw machine, the chuckers, etc., are all variation of the same principle. Photos 19 and 20 illustrate N/C adaptations to the lathe family, or the control console (Photo 18).

Perhaps the engine lathe of the future will have the ways and bed over the top so that the chips and fluid may drop directly into a container. The reduced wear and part removal time, or other advantages, may be obtained by this design change. This is pos-

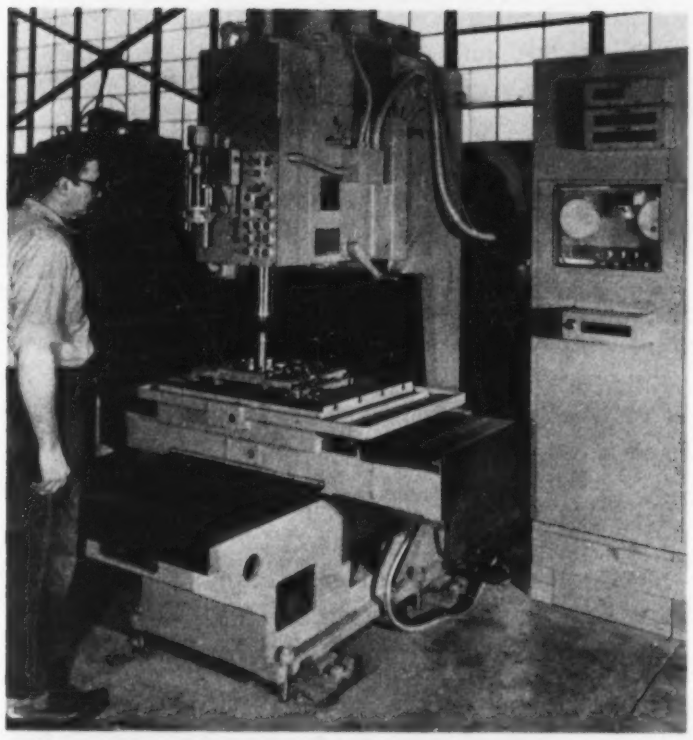

15. Two-axis point-to-point system.

sible when the controls are no longer adjusted to man's physical stature.

Milling, another form of metal removal, entails the following considerations: the various sizes, shapes, and forms as predicted by the shape of the cutter, holding the work, turning the tool, or turning both the work and the tool. The cutting of a keyway, a spline, a gear, a thread, etc., has many factors previously mentioned or implied. The rate of machining, speed, feed, and depth of cut are dependent upon the material being cut, the condition of the machine and cutting tool, the amount of material removed, and the accuracy.

The shaper and planer family finds it somewhat more convenient to marry numerical control for on and off functions and a tracer system for some shape. The basic cutting action—whether a shaper, a planer, a grinder, or a milling head is used—is unique to the material being cut, the rigidity of the cutting action, and the material doing the cutting.

Press operations such as shearing, blanking, and

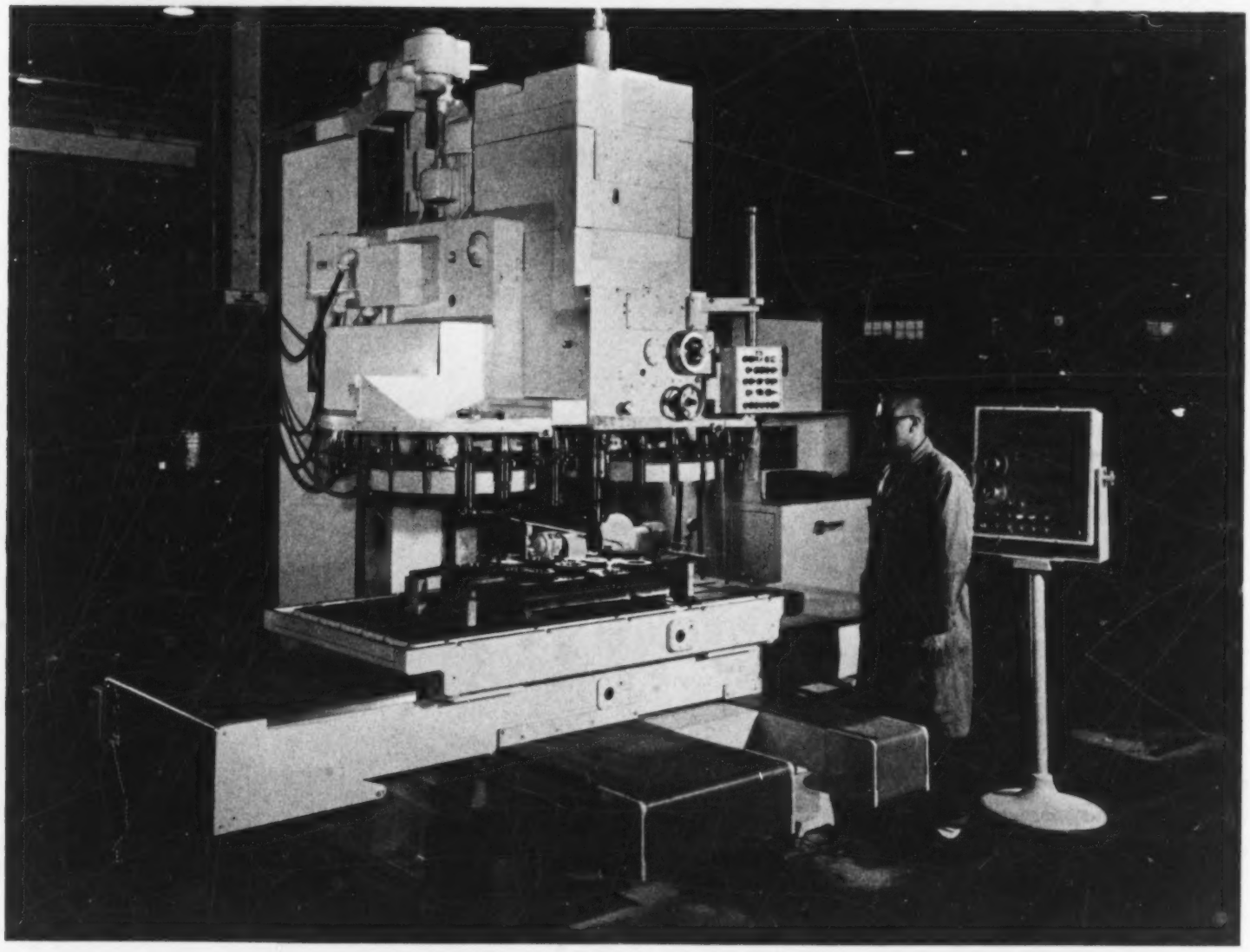

16. Three-axis tool changer-numericenter with tool changer.

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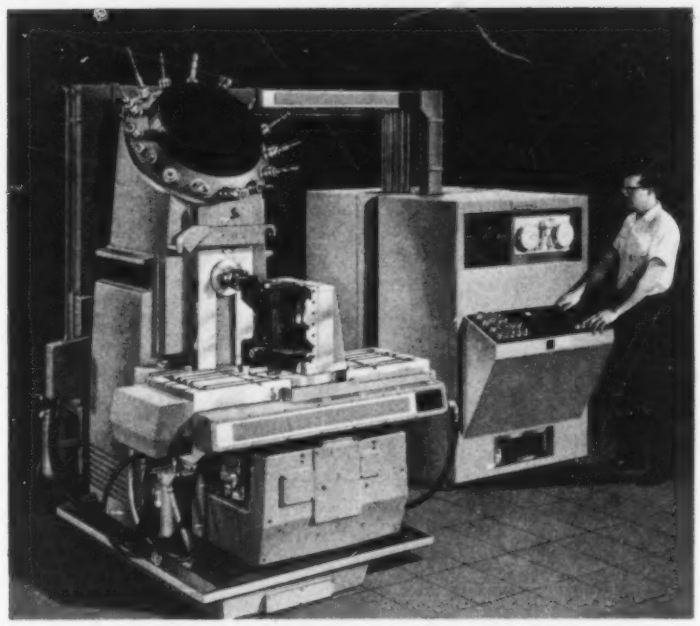

17. Tool changer and turret.

forming using the machining principles of shear, machinability, plasticity, hardenability, deformation, and the many others that occur, are a part of the knowledge necessary to manufacture a part by these processes.

The processes of spot welding, tube bending, type setting, or any other process of manufacturing must be understood before any control system will work very well. Numerical control is a tool; its use may assist greatly or it may hinder. The selection of each component which contributes to the end product is of vital importance. The chain is only as strong as its weakest link.

Speed and Feed

Probably the most critical factors in "part programing" or operating are the selection of speeds and feeds. Their selection is dependent upon the

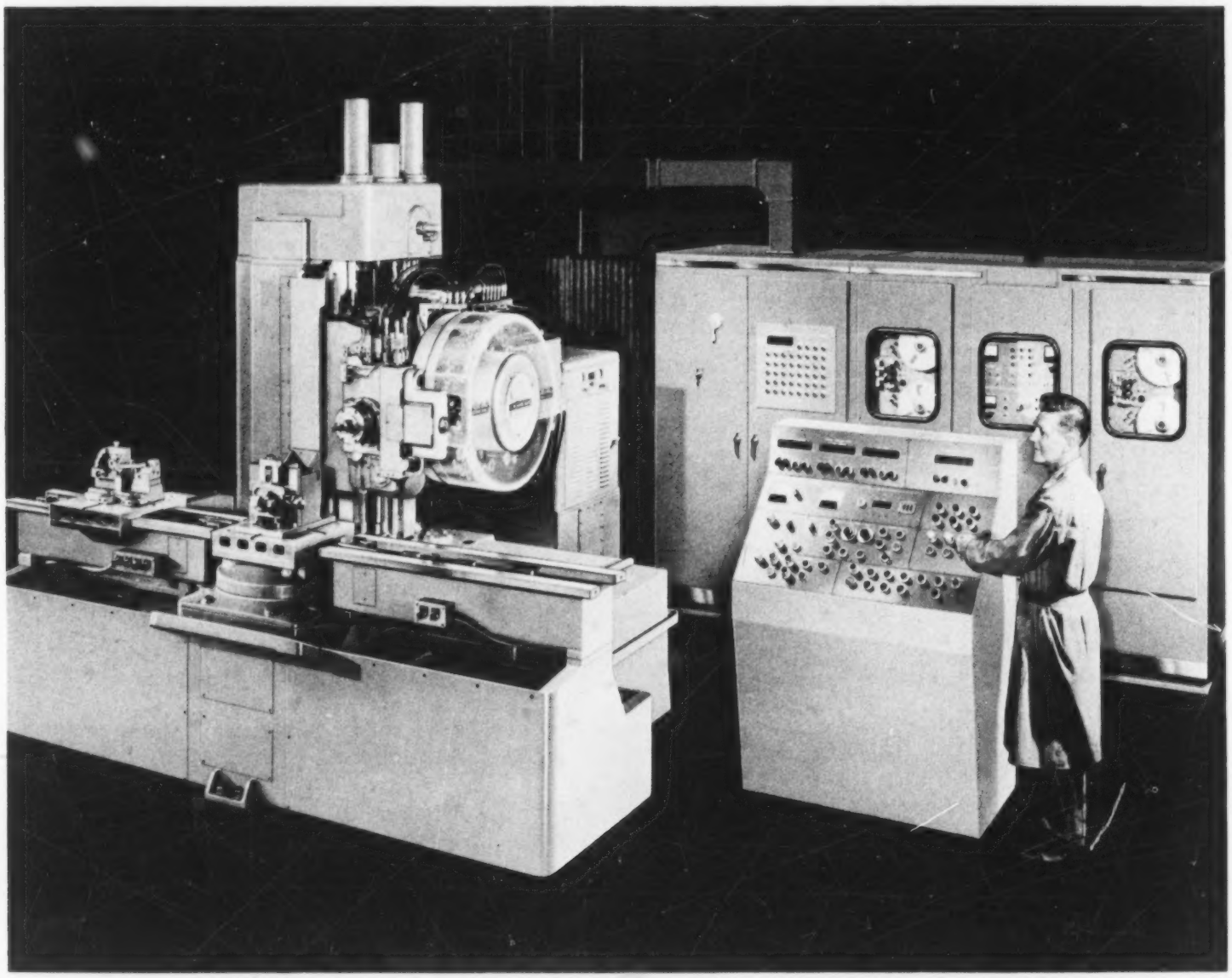

18. Three-axis control, tool selector, indexing (8 position) turntable, and shuttle loading stations.

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19. Inserting the tape in a N/C controlled lathe.

following: (1) tool material (high speed steel, carbide, oxide, etc.); (2) material being cut; (3) depth and width of cut; (4) condition of the machine tool; (5) accuracy and finish desired; (6) holding devices (tool and part); or (7) auxiliary functions (cutting fluid, dry, mist coolant, etc.).

Any good reference book will be a guide in developing the speed and feed or chip load relationship. A general formula for determining speed of rotational tools is RPM: $\frac{4 \times \text{Cutting Speed}}{\text{Diam. of the Piece}}$. This is a simple general formula, and the variables are the cutting speed and diameter. Either tables, such as tables 1, 2, and 3, or experimental research and experience, will assist in determining the RPM (revolutions per minute) and the best surface speed.

The feed rates, spindle speed rates, and chip loads used need to be carefully planned and organized. Most manufacturers have established tables in these areas which have been tested through use. If such

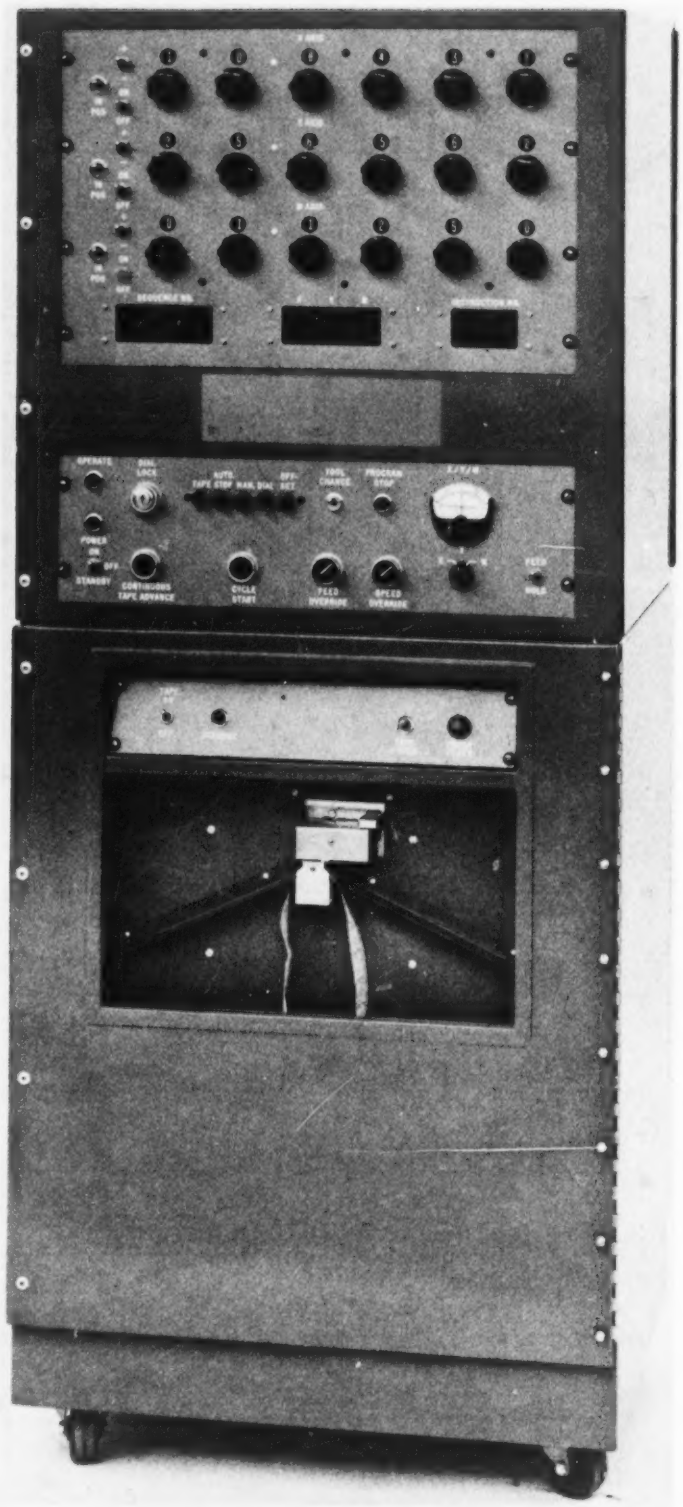

20. Control console with tape reader.

tables are available, refer to them when programing. The publications listed in this unit are excellent general references and the tables are only a few of the ready references available.

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Table 1: Feeds

Drill size, inches	Feed per revolution
1/8 and less	0.001 - 0.002
1/8 to 1/4	0.002 - 0.004
1/4 to 1/2	0.004 - 0.007
1/2 to 1	0.007 - 0.015
1 and larger	0.015 - 0.025

Table 2: Cutting Speeds

Material	High speed steel* Cutting speed in surface feet/min.
Aluminum and alloys	200 - 300
Brass and bronze, soft	100 - 300
Bronze, high tensile	70 - 90
Cast iron, soft	100 - 150
medium	70 - 100
hard	40 - 60
Steel, low carbon	80 - 150
medium carbon	60 - 100
high carbon	50 - 60
alloy	50 - 70

*Carbon drills one-half table speed.

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Table 3: Materials and Cutting Speeds

Material to be milled	High speed steel	Super high speed steel	Stellite	Tantalum carbide	Tungsten carbide
	Cutter speed in feet per minute				
Aluminum	500-1000		800-1500		1000-2000
Brass, soft	70-175		150-200		350-600
hard	65-130		100-160		200-425
very hard	30-50		50-70		125-200
Cast iron, soft	50-80	60-115	90-130		250-325
hard	30-50	40-70	60-90		150-200
chilled		30-50	40-60		100-200
Steel, soft	60-90	70-100		150-250	
medium	50-80	60-90		125-200	
hard	30-50	40-70		100-150	

Information pertaining to the machining processes can be obtained from numerous sources. Many reference books carry information as to chip load, formula calculation, feed rates, spindle speeds, recommended horsepower, etc. The most complete information in one volume may be found in Machining Data[5] used by the Ordinance Corps, U.S. Army.

[5]U.S. Department of Commerce, National Bureau of Standards, Ordinance Corp. Pamphlet, Machining Data (AD 425000), Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 1961.

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IV. HOLDING DEVICES

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To acquaint the student with various methods of holding parts on an N/C machine tool
To acquaint the student with tool holding devices
To select and reference holding devices for parts and tools

Materials

Charts, pictures, models, examples, film and live machine setup (of the machine tools in your shop)

Unit Outline

A. Work holding devices
   1. Referencing plate
   2. Vises
   3. Blocks
   4. Chucks
   5. Jigs or fixtures
   6. Indexing table
   7. Indexing head
   8. Angular
   9. Clamps
B. Methods of holding work
   1. Mechanical
   2. Hydraulic
   3. Pneumatic
   4. Electrical
C. Standard holding accessories
   1. Spacing blocks
   2. Stepping blocks
   3. Reversible chuck jaws
   4. Pneumatic cleaning
D. Referencing to the holding device
   1. Fixed zero controls
   2. Zero shift
   3. Floating zero controls
   4. Symmetrical sides or ends
   5. Indexing
   6. Locating reference
E. Tool holding devices
   1. Adapter
   2. Collets
   3. Chucks
   4. Presetting
   5. Changing tools
   6. Tool changers
   7. Safety features
   8. Referencing to holder
F. Head control systems
   1. Feed systems
      a. Manual
      b. Mechanical
      c. Pneumatic
      d. Hydraulic
      e. Electrical
      f. Tape
   2. Speed ranges
   3. Reversal of spindle
   4. Special features
      a. Pitch screws
      b. Hydro-sensing
      c. Pressure releasing
      d. Turret features
      e. Tool selection
      f. Tool changers
G. Selection of holding devices
   1. Shape of part
   2. Material of part
   3. Processes to machine
   4. Accuracy
   5. Number of operations
   6. Sequencing of tools

Suggested Activities

Demonstrate work holding devices
Demonstrate references to work holding devices and procedures
Demonstrate tool holding devices and the operational procedures
Demonstrate the selection of holding devices for work and tools
Individual student participation

Reference

Manual of the machine tool being used
Sample: Kearney & Trecker Corp. *Fixture Design for Kearney & Trecker Milwaukee-Matic Model II.*

Resource Materials for Unit IV — Holding Devices

(3 hours of instruction)

Holding devices are numerous and varied. Their

basic purpose is to hold securely the work piece in such a manner that the maximum work may be done with speed and accuracy. Machine tool employees are familiar with the conventional holding units such as vises, right angle plates, indexing heads, hold-down bolts, or even jigs and fixtures.

During World War II, a hole to be drilled or a slot to be milled was carefully laid out, scribed, and prick-punched on the scribed perimeter to hold accuracy. The visual inspection of cutting half the prick-punched mark away was assurance that tolerance was held. To drill the hole in this manner consumed enormous quantities of time.

To lay out the piece, to mound and hold the piece without distortion, to get the tool started properly in each new setting took time and effort, to the extent that about 20 percent of the time was used in actual metal removal—low efficiency at best.

Special jigs and fixtures were developed for special long-run jobs. Drill bushings, faster clamping devices, and table repeatability were developed in response to demand. The accuracy of the machine tool improved with major strides; however, a piece or pieces must still be held.

Numerical control machines in general have a repeatability into the fourth place after the decimal. They have a closed loop control system to assure accuracy. They have indexing tables and standard holding fixtures (Photo 21) which assist in the speed and accuracy of producing parts. However, each piece or set of pieces must be considered as to the manner of holding prior to the programing. To determine the potential of the machine, the following factors must be considered: the type of metal removal necessary, the number of sides to be machined, the material to work with, the premachining necessary, or any of the other variables that may be present.

Numerical control machines with mechanical or

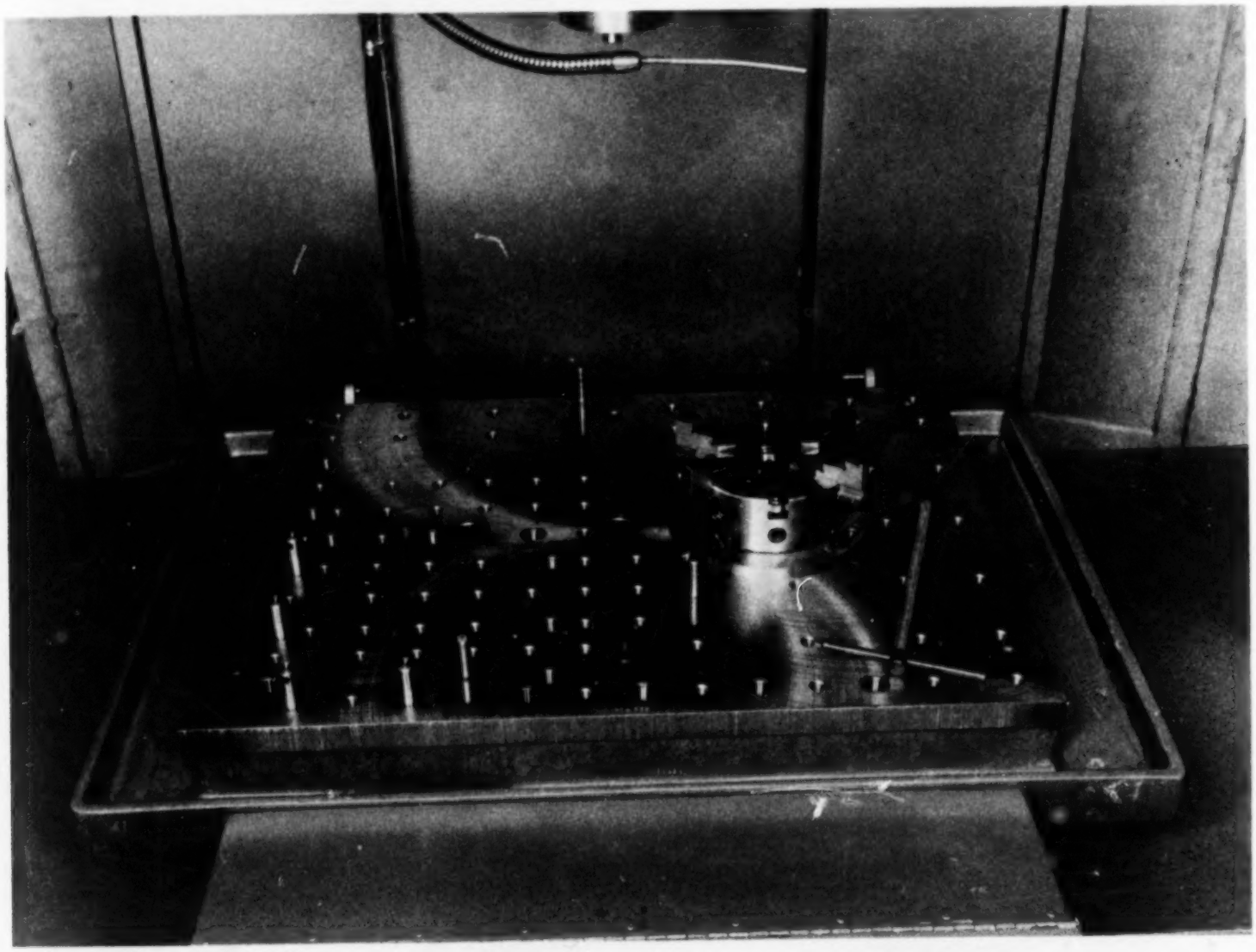

21. Standard holding fixture.

hydraulic movements have the accuracy built in. This is probably the major advantage over retrofitting conventional machine tools to numerical control. The holding units that are used extend the built-in accuracy or deter the complete utilization of the machine.

Nearly all of the numerical control machine manufacturers have incorporated standard holding devices (Photo 19). These holding devices have been developed through periods of testing and experience so that the maximum use may be attained from the machine. This service is extremely valuable in a new installation. Additional service may be requested to assist in developing specific needs that may arise.

Photos 7, 10, 12, 21, and 22 show holding devices. They are located firmly and accurately to be an extension of the table. Each of the locational positions can be easily referenced in x and y on the two-axis movements, as illustrated in figure IV–1. For example, using Photo 21 with a 16″ x 24″ table, travel and use the center large hole as zero reference. The large hole to the left would then be x – 6.0000 and y 0.0000 if the center distance were 6″. The chuck is centered on the large hole to the right, so the center of the chuck would be x + 6.0000 and y 0.0000. In this manner, any standard holding device can be located and referenced easily, quickly, and accurately.

The vise in Photo 10 can be used to reference from

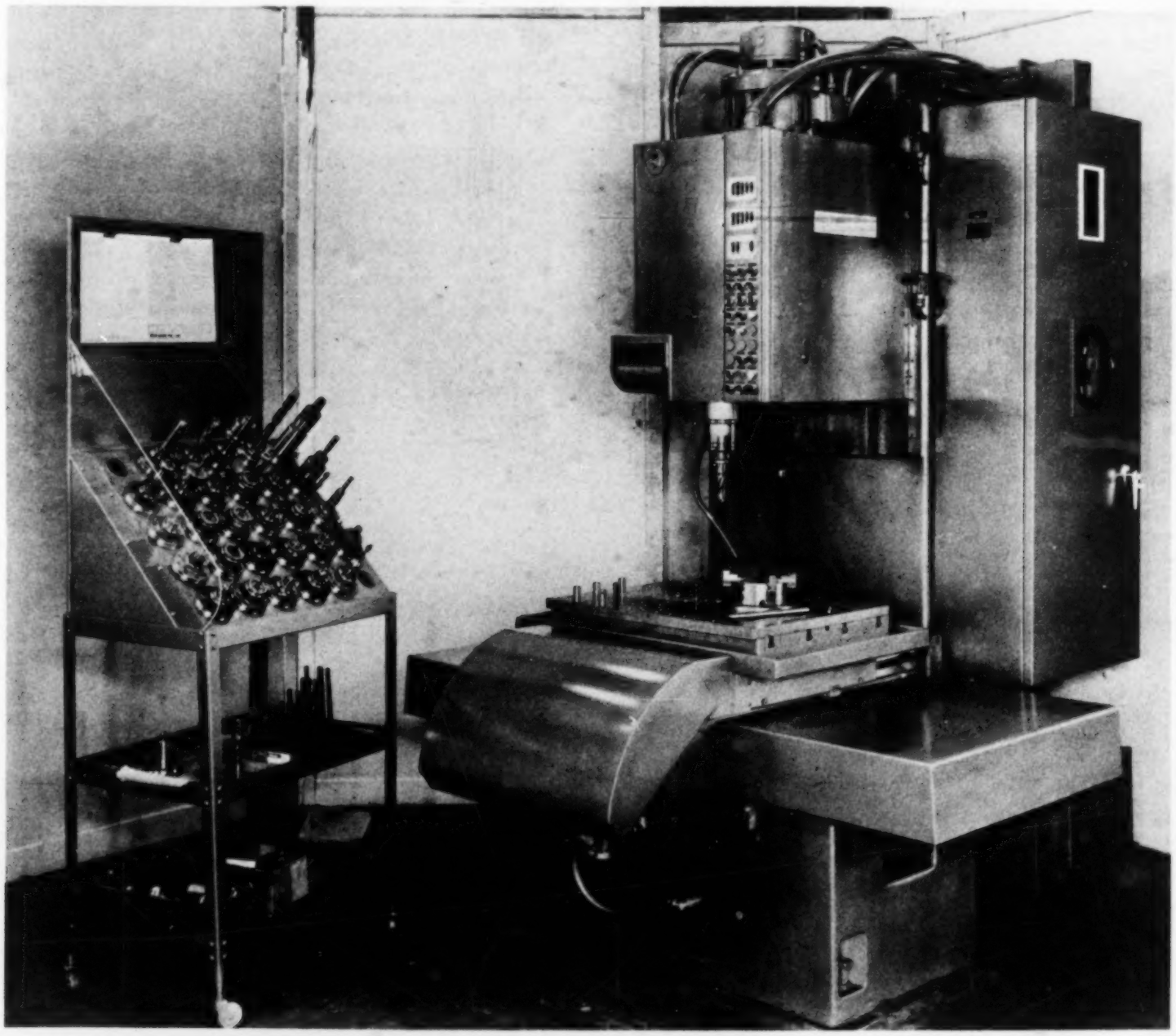

22. Tooling cart and standard holding devices.

5498

the solid jaw, and the height of the piece can be established from the vise base top to the milling cutter. The table can be programed so the next piece can be loaded to either side and then fed under the cutter. Many possibilities are available, depending upon the ingenuity of the programer.

Further use may be made of standard holding devices by additional specific units developed in cooperation with the tooling departments. In many cases, small variations and/or additions increase the use and versatility at very moderate cost. The unique holding devices observed by the author were the result of teamwork between the operator, programer, and tooling design people.

Standard holding devices vary with each machine style. The reciprocating quill in the vertical position, the turret head machines, the horizontal spindle machines, and the indexing tables, all have some advantages or disadvantages. Some are better suited for one type of task than another. The ingenuity of the team can get the maximum benefit for all.

The indexing table with standard or special holding devices has a definite advantage for many types of pieces. The valve body has two flanges to be milled and six holes to be drilled and tapped. The two ends that are identical can be programed exactly the same if the holding device can locate the valve body over the center of the table. The piece may be rough, as the part does not lose its basic reference. In other cases, three, four, or more sides may be processed at one setting with table indexing.

The standard size blocks similar to gage blocks can be used to space finished or semifinished parts with uneven or nonflat holding sides. They may also be used to space out a part to be drilled, tapped, or bored through. Numerous other uses for modular blocks will develop as standard and special-holding methods are used.

Many other standard holding devices may be employed, such as indexing heads (direct or differential, plain or universal, angle plates, vee blocks, clamping devices activated mechanically, pneumatically, or hydraulically), chucks, etc.

Each holding device needs to hold the part accurately and firmly, to be easy and quick to load and unload (even when a shuttle pallet is used), to be adapted to existing devices if possible, and to be developed with the ingenuity, knowledge, and skill of the tool designer, programer, and operator.

Tool Holding Devices

Tool holding devices vary greatly. Straight and tapered shank holders of the fixed and adjustable variety can be found. Conventional tapers, collets, and series of straight holders with various locking devices supply the machine tools with the holding and alinement of the tool.

Many of the numerical control machines use preset tooling. This is especially true for three-axis programed control. Each tool is preset to a specific distance extending beyond the spindle nose. Adjustments within the holder make it possible to use standard tooling with the adjustment available to sharpen and reset the tool. This process assists the programer in setting the spindle traversing and depth coordinates.

The selection of tools has another type of holding device. This process may vary from standard tools in standard holding devices (Photo 22) to special holding devices which select the location (Photos 16, 17, and 18) of the next tool in readiness to make an automatic change. Some of the automatic tool changers call for a sequencing of tools as they are to be used. These tools need to be loaded only in the order of use. Other systems program a socket code. The coded socket rotates under the spindle as soon as the spindle is empty and withdrawn. Others code the tool, so when the tape calls for a tool, it will rotate into position for change. Each system seems to work well on the machines for which it is designed.

In the case of holding devices for work or tools, it is necessary to work with specific systems to understand the process and make adjustments pertaining to the selection. As one proceeds into programing, each of these areas falls into its proper place.

Manuals written specifically for the machine or machines which are used are helpful. An inspection of the hardware is likely to be most valuable in completing one's understanding of holding devices for parts or tools. While inspecting the hardware in these areas, check carefully the activating devices of the head.

Nearly all of the machines in use at present have varied methods for holding and sensing the work to be done. Manual, semiautomatic, fully automatic, or combinations with special features should be noted and evaluated, both for the purchase of the machine tool and its use. Examples of these features might be hydrosensing, cam depth control, or dialed readout on the console. To become familiar with all systems takes considerably more time than is allotted in this lesson.

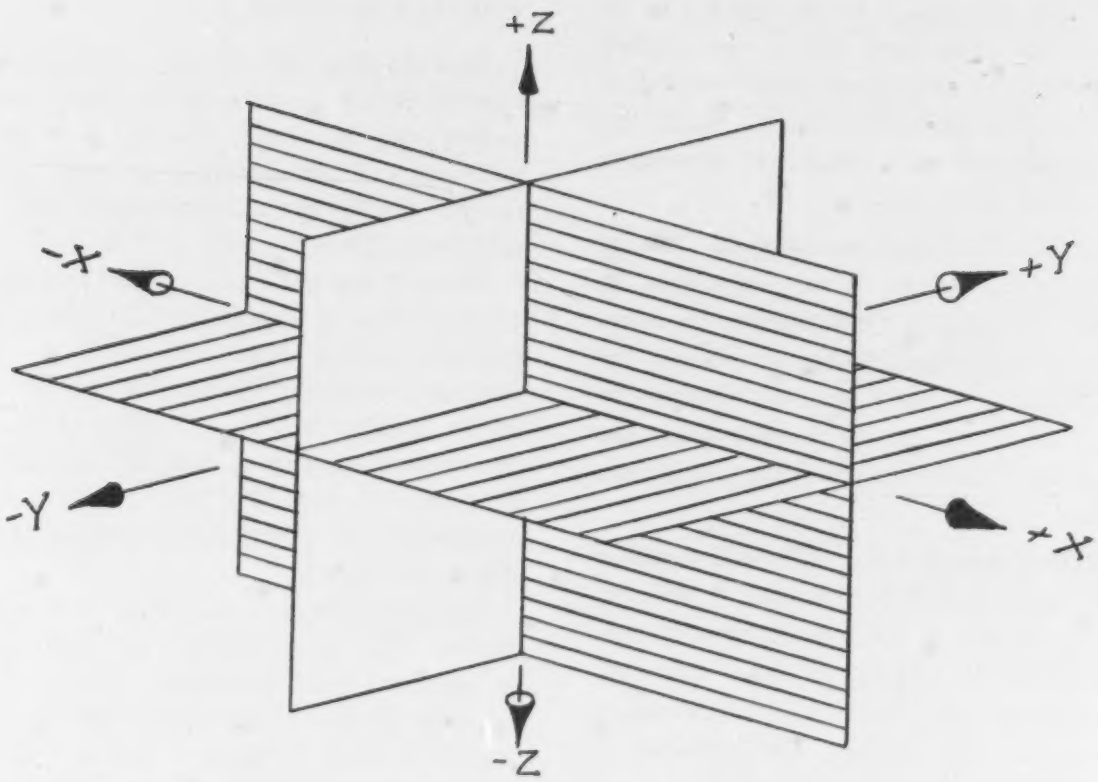

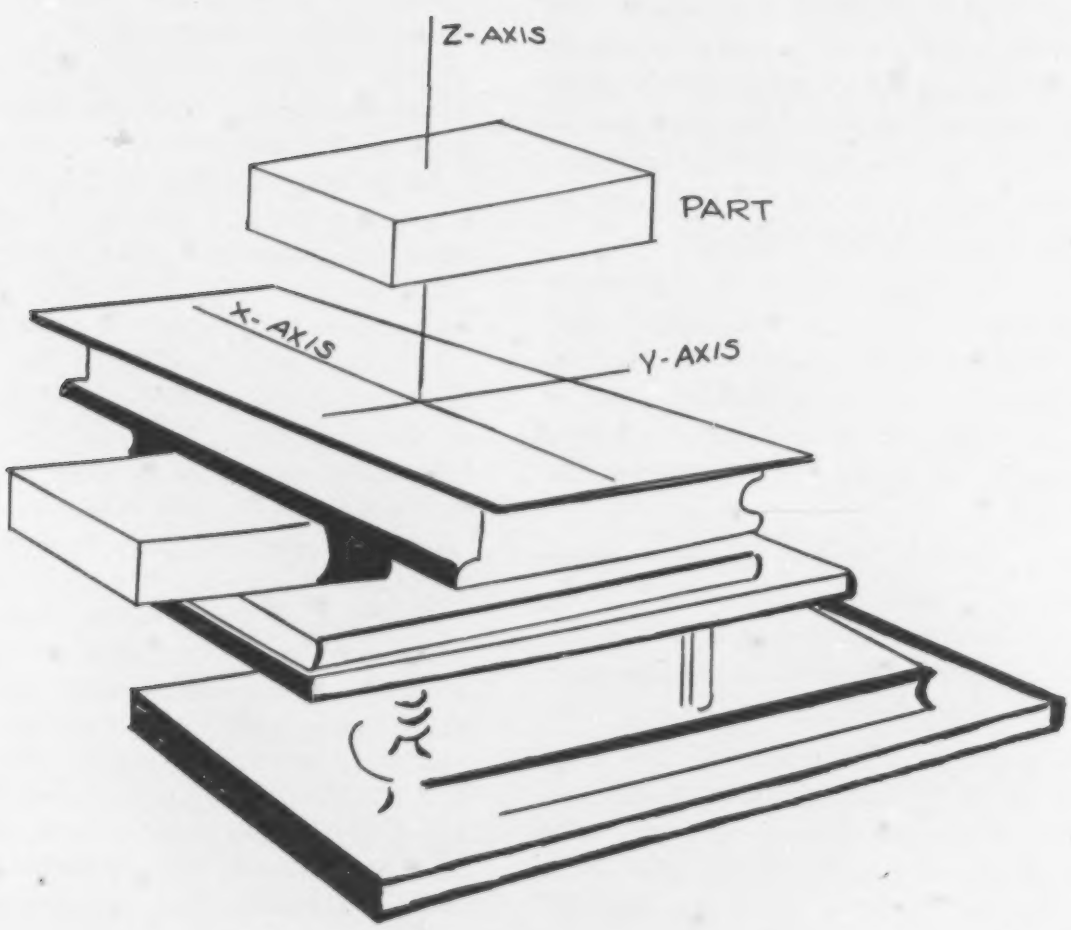

Figure IV-1. Plane relationships to the machine tool.

PROCESS CHART FOR P&W TAPE-O-MATIC

PRATT & WHITNEY, INC.
WEST HARTFORD, CONNECTICUT, U.S.A.

DWG NO. C-10109 OR PART NO. DOO-1212	OPER NO. 4	PART NAME FIGMENT PLATE	PREP BY C. D. S. DATE 2-15-62
			CH'ED BY J. D. DATE 2-18-62
			SHEET 1 OF 2
LATEST DWG CHGE	REMARKS: SET UP AND TOOL REQUIREMENT		DEPT NO.
			TAPE NO.

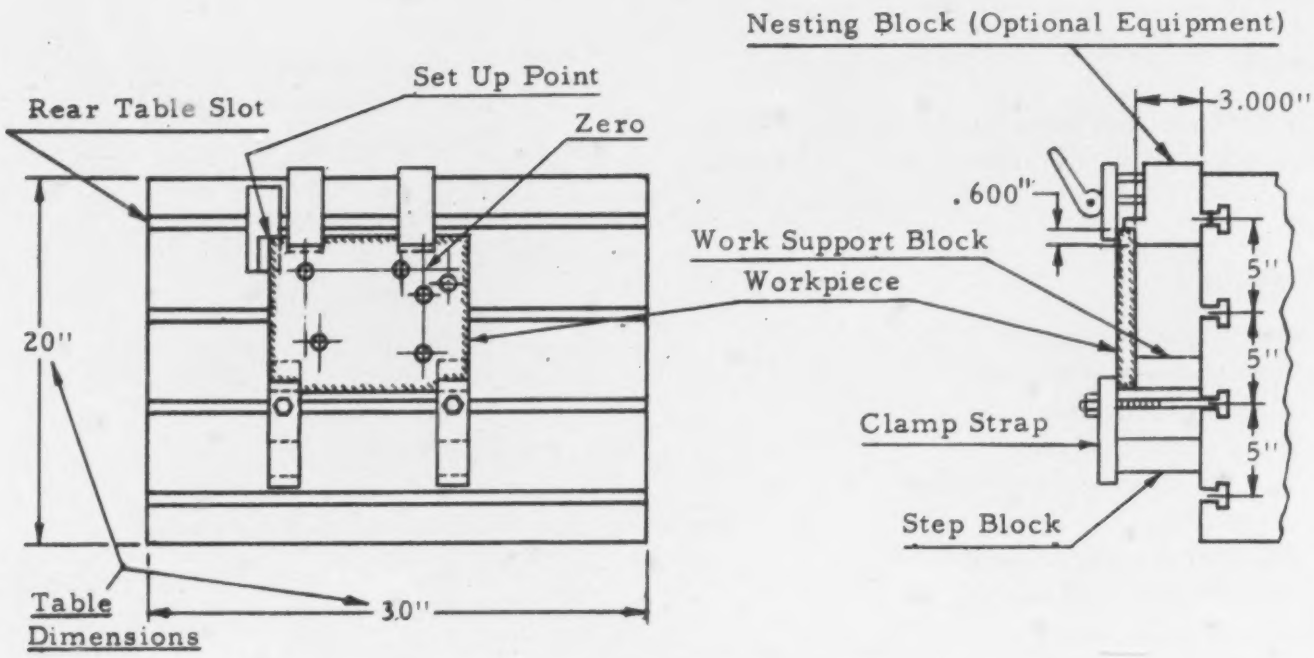

QUAN. REQ.	IDENT.	DESCRIPTION OF TOOL	QUAN. REQ.	IDENT.	DESCRIPTION OF TOOL
1		NESTING BLOCK SET	1		CENTER DRILL 1/4 DIA.
1		ACCUSET & PROVING BAR	1		COMB DRILL & C'BORE
2		CLAMP STRAPS			5/16 DRILL X 19/32 C'BORE
2		"T" BOLTS 1/2-13	1		COMB DRILL & C'BORE
2		"T" NUTS			1/4 DRILL X 15/32 C'BORE
2		WASHERS			
2		NUTS FOR "T" BOLTS			
2		STEP BLOCKS			
2		WORK SUPPORT BLOCKS			
1		WAHLSTROM QUICK-CHANGE			
		DRILL CHUCK M-9412			
1		SAFETY DRILL DRIFT			
1		8" ADJUSTABLE WRENCH			

Figure IV-2. Sample set up and tool requirement sheet.

V. PROGRAMING 1 — TWO AXIS

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objectives

To select and code a series of holes
To establish and position a setup point and reference zero point
To position the coded holes by the Cartesian coordinate system

Materials

Blueprint to code, coordinate sheets, chalkboard, chalk eraser, reference material, specific machine information

Unit Outline

A. Visualization of the project
   1. Interpretation of the print
   2. Coding of the holes
      a. Order or procedure
      b. Operations to complete task
      c. Selection of the path
   3. Establish a reference point
   4. Redimension if necessary
B. Determine holding method
   1. Rigidity
   2. Clear surface of holding hardware
   3. Clear table to drill and tap through piece
   4. Place clamps over parallels
   5. Position on table
C. Procedure to position setup or reference zero
   1. Methods of positioning
      a. Mechanical
      b. Electrical
      c. Hydraulic
      d. Combination
   2. Methods of referencing
      a. Fixed zero
      b. Floating zero
   3. Table movement
   4. Saddle movement
   5. Controls and reset procedure
   6. Translating position to zero reference
D. Cartesian coordinate system
   1. Planes
   2. Axis X and Y explained and identified
   3. Standard system
   4. Positive and negative quantities
   5. Quadrants
   6. Z or third axis
   7. Tabling the coordinates of the coded holes
E. Controls
   1. Table and saddle
      a. Mechanical
      b. Electrical
      c. Hydraulic
      d. Manual
      e. Feedback systems
      f. Rate of movement to position
      g. Guide structure
   2. Head
      a. Parts and names
      b. Mechanical
      c. Hydraulic
      d. Pneumatic
      e. Electrical
      f. Depth controls
      g. Speed selection
      h. Tool changing
F. Retrofitting vs. N/C machine tools
   1. Advantages
   2. Disadvantages

Suggested Activities

Demonstrate the location of reference zero, taking into consideration the machine tool, control system, and holding device
Demonstrate coding the sequence of operation by the Cartesian method
Demonstrate the preparation of the blueprint by dimensioning
Individualized assistance as the student programs

References

Manual of the machine tool to be used
Sample: Pratt & Whitney *Tape-O-Matic Operator's Instructions.*
Blueprint to code

Films

Films of machine tool to be used
Sample: *Tape-O-Matic*. Pratt & Whitney.

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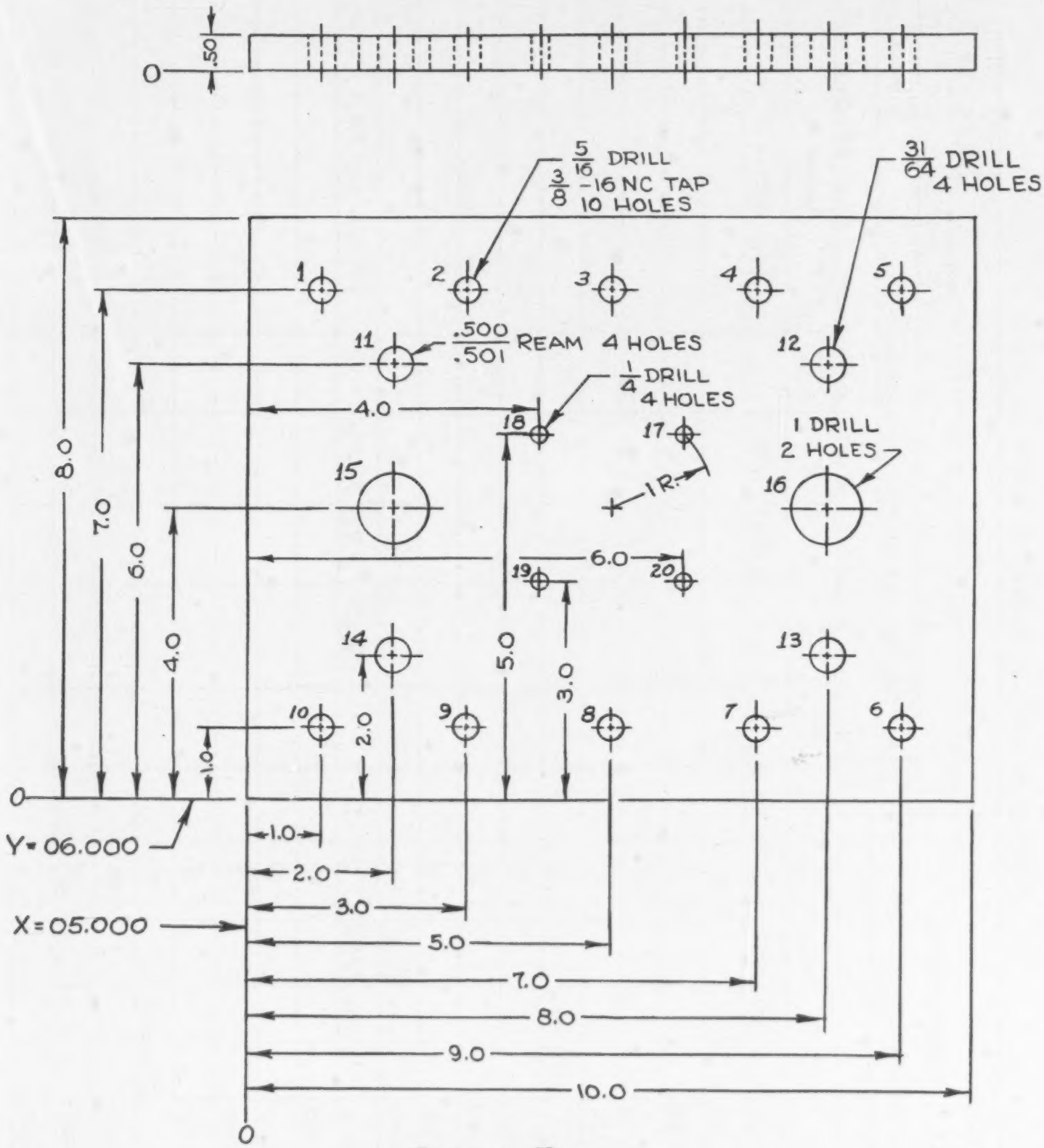

Figure V-1. Sample drawing programing.

PROGRAM FOR ACRAMATIC 220

CINCINNATI
ACRAMATIC POSITIONING
NUMERICAL CONTROL SYSTEM

PART NAME: Cover Plate
PART NO.: Figure V-1
DRAWING NO.:
REVISION:
FIXTURE NO.:
PROGRAMMED BY: L. Bellew
PAGE 1 OF PAGES 2
SET UP AND TOOL INFORMATION: Zero Point X= 05.000 , Y= 06.000
DATE: 7-19-66

Hold in #5 vise with positive stop at end of part

H or N	G	X	Y	M									
SEQ. NO.	PREP. FUNCT.	POSITION	POSITION	MISC. FUNCT.	POS. NO.	TOOL NO.	HEAD POS.	SPINDLE FEED IN./MIN.	SPEED RPM	DEPTH OF CUT	TABLE FEED IN./MIN.	TOOL REMARKS
H001	G81	X06 000	Y13 000	M51	1	1		6.5	1710	THRU		5/16 DRILL
N002		X08 000			2							
N003		X10 000			3							
N004		X12 000			4							
N005		X14 000			5							
N006			Y07 000		6							
N007		X12 000			7							
N008		X10 000			8							
N009		X08 000			9							
N010		X06 000		M06	10							
H011	G84	X06 000	Y07 000	M52	10	2		13.0	230	THRU		3/8-16 NC TAP
N012		X08 000			9							
N013		X10 000			8							
N014		X12 000			7							
N015		X14 000			6							
N016			Y13 000		5							
N017		X12 000			4							
N018		X10 000			3							
N019		X08 000			2							

PROGRAM FOR ACRAMATIC 220

CINCINNATI
ACRAMATIC POSITIONING
NUMERICAL CONTROL SYSTEM

PART NAME	PART NO.	DRAWING NO.	REVISION	FIXTURE NO.	PROGRAMMED BY	PAGE	PAGES
COVER PLATE	FIG V-1				L. BELLEW	2	2

SET UP AND TOOL INFORMATION

DATE

H or N SEQ. NO.	G PREP. FUNCT.	X POSITION	Y POSITION	M MISC. FUNCT.	POS. NO.	TOOL NO.	HEAD POS.	SPINDLE FEED IN./MIN.	SPEED RPM	DEPTH OF CUT	TABLE FEED IN./MIN.	TOOL REMARKS
N020		X06 000		M06	1							
H021	G81	X07 000	Y12 000	M53	11	3		6.0	1070	THRU		31/64 DRILL
N022		X13 000			12							
N023			Y08 000		13							
N024		X07 000		M06	14							
H025	G81	X07 000	Y08 000	M54	14	4		12.0	535	THRU		0.500 - 0.501 REAMER
N026		X13 000			13							
N027			Y12 000		12							
N028		X07 000		M06	11							
H029	G81	X07 000	Y10 000	M55	15	5		6.5	500	THRU		1" DRILL
N030		X13 000		M06	16							
H031	G81	X11 000	Y11 000	M56	17	6		5.5	2140	THRU		1/4" DRILL
N032		X09 000			18							
N033			Y09 000		19							
N034		X11 000		M26	20							
N035	G80	X10 000	Y16 000	M02	21							UNLOAD POSITION

Figure V-2. Sample program for Figure V-1.

THE CINCINNATI MILLING MACHINE CO.
NUMERICAL CONTROL POSITIONING SYSTEM
TOOL DESIGN DEPT.

CHANGE NOTICE	CHG	DRAWN BY	DATE	CHK'D BY	DATE	CHANGE NOTICE	CHG	DRAWN BY	DATE	CHK'D BY	DATE
	X						O				
	O						O				
	O						O				

OPER. NO.
SETTING NO. OF
SHEET OF
LOC/MACH.

NC-

PART NAME

TOOL NO. | TOOL NAME

POS. NO.	X POSITION	Y POSITION
1	06.000	13.000
2	08.000	13.000
3	10.000	13.000
4	12.000	13.000
5	14.000	13.000
6	14.000	07.000
7	12.000	07.000
8	10.000	07.000
9	08.000	07.000
10	06.000	07.000
11	07.000	12.000
12	13.000	12.000
13	13.000	08.000
14	07.000	08.000
15	07.000	10.000
16	13.000	10.000
17	11.000	11.000
18	09.000	11.000
19	09.000	09.000
20	11.000	09.000
21	10.000	16.000

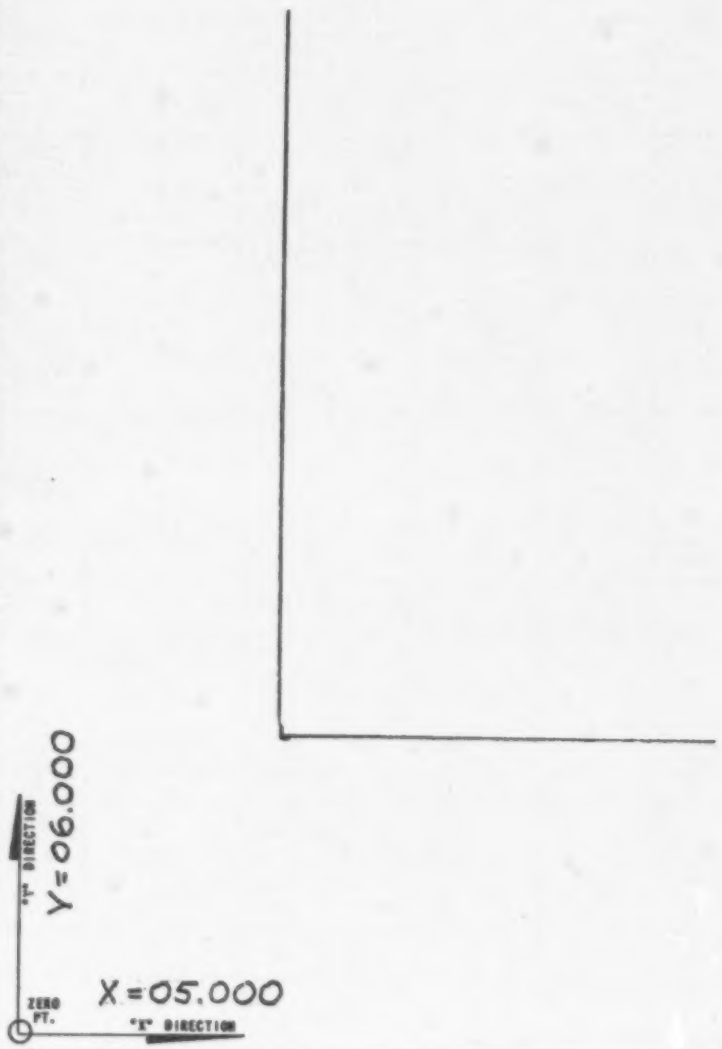

Figure V-3. Sample coordinate sheet for Figure V-1.

VI. PROGRAMING 2 — TWO AXIS

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objectives

To acquaint the student with head functions and operations

To select tools to perform the operations to the accuracy required

To acquaint the student with speeds and feeds

To sequence the operation with the least loss of time

To acquaint the student with the planning and organization needed to complete a manuscript

Materials

Film, chalk, chalkboard, eraser, projector, blueprints, coordinate sheet, tool sheet, manuscript blank, spot or center drill, adapters, drill taps, machine (if possible), machine manual

Unit Outline

A. Drill machine head
   1. Functions
      a. Spindle
         (1) Drive
         (2) Speed range and control
         (3) Rigidity
         (4) Rotation—reversing
         (5) Tool holding devices
      b. Quill
         (1) Conventional mode—mechanical
         (2) Pneumatic motion
         (3) Hydraulic motion
         (4) Feed rate
         (5) Depth stops—mechanical, electrical
         (6) Automatic return
         (7) Floating feed—tapping
         (8) Rapid travel
   2. Positioning
      a. Locking
      b. Raising and lowering
      c. Turrets
      d. Drives
      e. Columns—squareness

B. Tools
   1. Spot or center drills
      a. Cutting edges
      b. Angle of cutting edges
      c. Relief
      d. Feed
      e. Speed
      f. Depth calculations
   2. Drills
      a. Standard drills
         (1) Name and function of parts
         (2) Cutting edges—length of cuting edge, angle of cutting edge, and relief
         (3) Thinning of dead center
         (4) Materials
         (5) Feed rates in inches per minute and thousands per revolution
         (6) Coolants
      b. Special drills
         (1) Sizes
         (2) Flutes
         (3) Combination with other tools
      c. Tape
         (1) Kinds
         (2) Name, parts, and function
         (3) Lead, pitch, and thread shape
         (4) Coolants
         (5) Feed and withdrawal
      d. Reamers
         (1) Kinds
         (2) Name, part, and function
         (3) Types
         (4) Feed rate
         (5) Coolant
      e. Milling
         (1) Kinds
         (2) Feed rates
         (3) Speed rates
         (4) Coolant
      f. Holding devices
         (1) Chucks
         (2) Adapters
         (3) Sleeves
         (4) Special

C. Tool list
   1. Purpose
   2. Selection
   3. Tool description
   4. Speed calculation
   5. Feed calculation
   6. Depth calculation
      a. Approach allowance
      b. Overtravel
      c. Drill point and depth

d. How to determine—measurement references
e. Deep hole procedure
7. Auxiliary functions
a. Coolant
b. Tool removal
c. Preset adapters
d. Tool changing

D. Coordinates
1. Zero shift
2. Sequence reversal
3. Establishing a reference from a hole

E. Manuscript
1. Purpose
2. Entries
3. Checking of the entries
4. Auxiliary functions
5. Introduction to tape

Suggested Activities

Demonstrate the process of entries into a manuscript using the tool and coordinate sheets
Explain the reasons for the order of entry based on the part and the machine used
Individual assistance as the student completes his manuscript

References

Manual of the machine used
Manual of the controls used
Sample program completed

Films

Film of the machine and controls being used
Sample: *Drama in Drilling*. Brown & Sharpe.
Film of other machines

VII. TAPE

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To acquaint the student with the function, process, and equipment to produce a control by punched tape
To acquaint the student with the reaction devices and systems of punched tape control
To assist the student to complete a manuscript and punch the tape
To acquaint the student with the language and use of numerically controlled equipment

Materials

Films, projector, chalkboard, eraser, tape, punched tape, tape punching equipment, tape verifying equipment, tape controlled machine to run through the control, if possible

Unit Outline

A. E.I.A. standard codes
1. Purpose of standards
2. Physical characteristics
a. Width
b. Length
c. Dimensions
d. Purpose
3. Uses
4. How standards are achieved

B. Materials
1. Paper
2. Plastic
3. Laminated
4. Metallic
5. Others

C. Binary code
1. Purpose
2. Procedure
3. Justification
4. Binary-decimal (BCD)

D. Format
1. Point-to-point—continuous path
a. Words
b. Blocks
c. Address
d. Procedure
2. Types
a. Fixed sequential
b. Tab sequential
c. Word address
d. Universal
e. Other
3. Parity check
4. Auxiliary functions

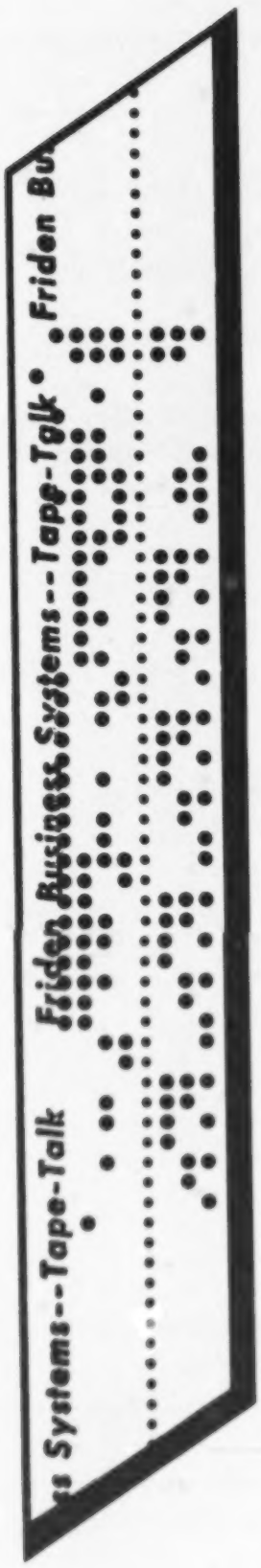

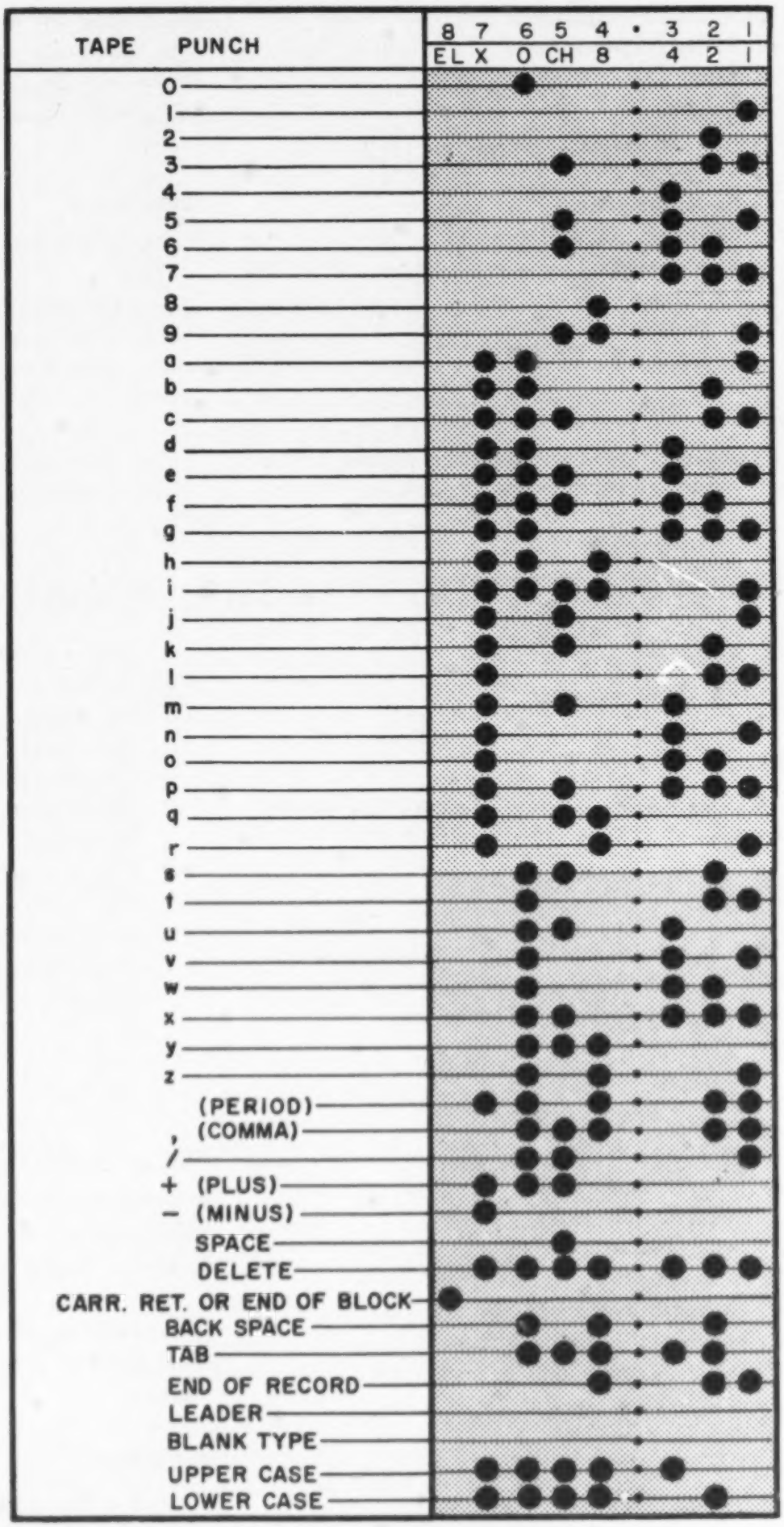

Figure VII-1. E.I.A. Standard coding for 1-inch wide, eight-track tape.

E. Tape punching equipment
   1. Friden Flex-O-Writer
   2. Dura
   3. Others
F. Control and feedback systems
   1. Reader
   2. Servo-mechanisms
   3. Open and closed loop systems
      a. Movement
      b. Purpose
      c. Feedback
      d. Advantages

Suggested Activities

Issue prepared tape and interpret a portion of the manuscript as it appears on the tape

Demonstrate the process of producing the tape from the manuscript

Demonstrate the verification of the tape

Demonstrate the operation in the machine tool to be used

References

Electronic Industries Association. *One-inch Perforated Tape.*

———. *Character Code for Numerical Machine Control Perforated Tape.*

———. *Axis and Motion Nomenclature for Numerically Controlled Machines*

———. *Interchangeable Perforated Tape Variable Block Format for Positioning and Straight Cut Numerically Controlled Machines.*

VIII. TEST THE PROGRAM

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objective

To complete a program, verify the tape, and test the program

Materials

Manuscript, tape, tape punching equipment, tape verifying equipment, printout of tape, a machine to test the tape, and a part to machine

Unit Outline

A. Manuscript
   1. Inspect part
   2. Interpret blueprint
   3. Select machine tool
   4. Select holding device
   5. Code blueprint
   6. Complete tooling selection and calculations
   7. Complete the coordinate sheet
   8. Complete entries onto the manuscript
B. Tape
   1. Punch the tape
   2. Verify the tape
   3. Check printout against manuscript
   4. Make corrections
   5. Recheck the tape
C. Test program
   1. Mount and reference holding device
   2. Select and prepare tools
   3. Mount part
   4. Insert tape
   5. Test program
   6. Inspect part
   7. Run program
D. Evaluate the test
   1. Processes
   2. Cost
   3. Time
   4. Accuracy

Suggested Activities

Review manuscript for completeness and accuracy

Review tape punching and verifying

Individual assistance on completion of tape punching and verifying

Demonstrate the test on the machine tool

Demonstrate a part being run after testing is completed

Reference

Manuals of the equipment being used

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IX. REVIEW OF BASIC ELECTRICITY

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To acquaint the student with a basic concept of electricity and the electron theory

To illustrate to the student how Ohm's Law and Kirchoff's Law are used in relation to a series circuit

To acquaint the student with fundamental motor principles

To explain and illustrate the use of fuses and/or circuit breakers, relays, and limit switches

To familiarize the student with electrical symbols and schematic diagrams used in electrical work

Materials

Information sheets, chalkboard, chalk, eraser and pointer, wire, dry cells, lamps, volt-ohm-ammeter, various resistances, permanent and electro-magnets, iron filings, various types of motors, electrical prints (schematic diagrams), fuses, relays, and limit switches

Unit Outline

A. Introduction to electricity
   1. The electron theory
   2. Factors in electricity—voltage, current, and resistance
   3. Methods of generating voltage—friction, heat, light, Piezo-effect, chemical and mechanical
   4. Ohm's Law
   5. Kirchoff's Law

B. Electrical circuits
   1. Series circuit
      a. Definition
      b. Use of Ohm's Law in solving for circuit values
      c. Kirchoff's Law
      d. Application of measuring instruments
   2. Parallel circuit
      a. Definition
      b. Use of Ohm's Law in solving for circuit values
      c. Kirchoff's Law
      d. Application of measuring instruments
   3. Series-parallel (combination) circuit
      a. Definition
      b. Use of Ohm's Law in solving for circuit values
      c. Kirchoff's Law
      d. Application of measuring instruments

C. Fundamentals of magnetism
   1. Phenomena of permanent magnetism
   2. Law of magnets
   3. Magnetic and nonmagnetic materials
   4. Phenomena of electromagnetism
      a. Structure and operation of electromagnets
      b. Application

D. Motors
   1. Fundamental motor principle
   2. Series, shunt, and compound motors
   3. D.C. and A.C. motors
   4. Motor applications

E. Design and functions of electrical control devices
   1. Fuses and/or circuit breakers
   2. Switches
   3. Relays
   4. Limit switches

F. Electrical symbols and schematics
   1. Match electrical component and symbol of same
   2. Analyze circuit drawings (schematic diagrams)

Suggested Activities

Demonstrate the basic circuits and explain the principles of each

Demonstrate the operation principles of the electrical power system on the machine tool using the manual's schematic diagram as the guide and applying the principles of each component

References

Lister *Electric Circuits and Machines.*

Manual of the machine tool

X. REVIEW OF HYDRAULICS

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To acquaint the student with the principles of a hydraulic system and its component parts

To apply the hydraulic principles to machine tools

To acquaint the student with the advantages of hydraulics

Materials

Hydraulic diagrams, machine tool manual, machine tool circuit diagrams, cutaway models, film, chalkboard and accessories, live demonstration on a machine tool or demonstration unit

Unit Outline

A. Introduction and orientation
   1. History and background
   2. Basic principles and fundamentals of fluids
      a. Density
      b. Specific gravity
      c. Define fluids
   3. Pascal's Law
   4. Boyle's Law
   5. F = P x A

B. Pumps
   1. Types
      a. Gear-type pumps
      b. Vane-type pumps
      c. Piston-type pumps
      d. Centrifugal pumps
   2. Fluid motors
   3. Capacity
   4. Pressure

C. Cylinders
   1. Single acting
   2. Double acting
   3. Capacity
   4. Load

D. Valves
   1. Pressure control valves
      a. Relief valve
      b. Pressure reducing valve
      c. Pressure sequence valve
      d. Unloading valve
      e. Pressure switch
   2. Volume control valve—flow current valve
   3. Direction control valve
      a. Four-way valve
      b. Check valve
   4. Miscellaneous valves
      a. Prefill check valves
      b. Pilot valves

E. Reservoirs
   1. Capacity
   2. Location
   3. General design
   4. Air filters
   5. Accessories

F. Piping
   1. Tubing
      a. Rigid
      b. Flexible
   2. Fittings
      a. Flared tube
      b. Flareless tube
      c. Welded tube
      d. Screwed pipe connectors
   3. Accumulators
      a. Types
      b. Precautions in use

G. Packing
   1. Basic packing types
   2. Materials
   3. Design
   4. Specifications

H. Fluids
   1. Classes
   2. In service
      a. Gravity settling
      b. Centrifuging
      c. Continuous reconditioning
   3. Viscosity and sludge accumulation

I. Application of hydraulics principles
   1. Tracing a flow chart
   2. Setting up a system

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3. Identifying the component parts of a system
4. Uses of hydraulic systems in industry
5. Relationship of electronics, air, and mechanisms to hydraulic systems

Suggested Activities

Demonstrate a typical hydraulic circuit, illustrating each of the major components and the principle upon which it operates

Diagram the circuit of the J.I.C. standard system

Trace a hydraulic circuit on a machine tool from the manual

References

General Motors Institute. *Hydraulic Control of Machine Tools.*

Oster. *Basic Applied Fluid Power.*

Pippenger and Hicks. *Industrial Hydraulics.*

Vickers. *Industrial Hydraulic Manual.*

Manual of machine tool (applicable to hydraulics or pneumatics)

XI. REVIEW OF BASIC ELECTRONIC DEVICES

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To explain and describe an electronic device.

To familiarize the student with the vacuum tubes and solid-state devices used in N/C

To show the advantages in the use of electronic devices in N/C

Materials

Information sheet, vacuum tube and transistor charts, chalkboard, chalk, eraser, pointer, control system schematic of the machine tool controls

Unit Outline

A. History of electronics
   1. The Edison effect
   2. The Fleming valve
   3. DeForest's triode

B. Control features of vacuum tubes
   1. Analysis of rectifying action of diodes and analysis of rectifying circuits
   2. Amplifying action of triodes
      a. Simple linear amplifier
      b. D.C. and A.C. amplifiers
      c. Pulse amplifiers

C. Fundamentals of solid-state devices
   1. Crystalline structure of germanium or silicon
   2. Adding impurities to germanium or silicon to provide proper operation
   3. The solid-state diode
   4. Rectification similar to the vacuum tube diode

D. The transistor
   1. Structure
      a. Emitter
      b. Base
      c. Collector
   2. Similarity to vacuum tube triode
   3. Simple transistor amplifiers
      a. Linear
      b. Pulse
   4. Additional transistor developments
      a. Zener diode
      b. Transistor tetrode
      c. Silicon control rectifier (SCR)
      d. Tunnel diode

E. Control applications of vacuum tubes and transistors in N/C circuits
   1. Need for rectification
   2. Need for amplification
      a. Linear
      b. Pulse
   3. Speed of operation

F. Applications to controls for N/C

Suggested Activities

Demonstrate a complete control system identifying each component, its function, and its operating principle

Trace a series of commands to the machine movement from the schematic diagram

References

Chute. *Electronics in Industry.*

Manual of machine tool controls

XII. CONTROL SYSTEMS

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objective

To acquaint the student with the basic operational principles of various control systems

Materials

Manuals of control systems from several different manfacturers, charts, instruction sheets, and examples of various controls, resource people from control systems should also be utilized

Unit Outline

A. Controls
   1. Kinds and functions
   2. Capability of controls
   3. Axis movement control
   4. Open and/or closed loop
   5. Accuracy of the machine to controls
   6. Advantages and disadvantages of each
B. Methods of input
   1. Manual
   2. Tape
   3. Electrical
   4. Pneumatic
   5. Hydraulic
   6. Mechanical
   7. Combinations
C. Movement systems
   1. Mechanical
   2. Electrical
   3. Hydraulic
   4. Pneumatic
   5. Combinations
D. Feed back controls
   1. Transducers
      a. Linear
      b. Rotary
   2. Optics
   3. Read out systems
   4. Open loop
E. Retrofitting
F. Maintenance

Suggested Activities

Classify the control systems such as a family of controls

Illustrate the capabilities of each system and the principles on which each functions

Demonstrate the various capabilities of a machine tool dependent upon the controls installed for it

Individual assistance

References

Manuals of several different machine tools and the controls which can be used to control them

XIII. AUXILIARY FUNCTIONS

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objective

To acquaint the student with the auxiliary functions and equipment available on N/C machine tools

Materials

Charts, sample programs, auxiliary equipment, diagrams, models, and/or the equipment

Unit Outline

A. Auxiliary equipment
   1. Identify and classify
   2. Built into the machine and controls
   3. Attachments
   4. Operational principles and function
   5. Economic justification
B. Work holding equipment
   1. Referencing plate and attachments
   2. Indexing
   3. Angular
   4. Jigs and fixtures
C. Tool holding devices
   1. Tooling adapters (preset)
   2. Tool changers
      a. Sequencing
      b. Random selection
D. Auxiliary functions
   1. Coolant control
   2. Spindle reversal

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3. Tool selection
4. Tool change
5. Feed and speed change
6. Indexing
7. Others

Suggested Activities

Identify and classify auxiliary functions and equipment

Issue programs and illustrate use of auxiliary functions

Demonstrate the application and principle of auxiliary function

Individual student assistance

References

Manuals of machine tools with various auxiliary functions

XIV. PROGRAMING 1 — THREE AXIS

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objective

To assist the student in programing a three-axis machine tool (development of blueprint coding, sequencing, tool list, and coordinate record)

Materials

Blueprints, sample programs, manuals for machine tools and machine tool control systems, tool sheets, coordinate sheets, and manuscript sheets

Unit Outline

A. Introduction
   1. Identify the part and the operations necessary
   2. Select the machine tool
   3. Identify the control system
   4. Select the holding device
   5. Select the format for the program

B. Blueprint work
   1. Reference the holding device
   2. Dimension the work (base line system)
   3. Code the blueprint
   4. Select the tools
   5. Sequence the operations
   6. Enter the coordinates

C. Format for programs
   1. Tab sequential
   2. Word address
   3. Combination
   4. Fixed sequential
   5. Others

D. Special holding devices
   1. Indexing
   2. Angular
   3. Jigs or fixtures

Suggested Activities

Issue the blueprints, tool sheets, and coordinate sheets

Select the format, machine tool and control system, and review with the class

Demonstrate the basic procedures

Individual assistance

References

Materials from the preceding units

Manual of machine tool

Manual of control system

Completed tool sheets (similar program)

Completed coordinate sheets (similar program)

XV. PROGRAMING 2 — THREE AXIS

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objective

To assist the student in programing a three-axis machine tool (development of a manuscript and transfer to punched tape)

Materials

Sample manuscripts, sample tapes, tape punching equipment, tape verification equipment, manuscript sheets

Unit Outline

A. Material organization
   1. Tool list

2 Coordinates
3. Sequencing
4. Calculation
5. Auxiliary functions
6. Tool coding
7. Others

B. Manuscript
1. Entries onto the manuscript
a. Format
b. Sequencing
c. Accuracy
d. Permissible omissions
e. Longhand entries
f. Typed entries — punch tape
g. Repeat sequences
2. Entries by other methods

C. Verification of the tape
1. Printout—visual check
2. Item by item check
3. Block by block check on the machine tool

Suggested Activities

Demonstrate the process of completing a manuscript

Demonstrate the tape punching process and the verification of the tape

Individual assistance

References

Manuals and papers of the programing process such as:

Cincinnati Milling Machine Co. *Customer Training for Numerical Control.*

Ex-Cell-O Corp. *Guide Book for Numerically Controlled Machine Tools.*

Friden, Inc. *Friden Flexowriter for Numerical Control.*

Kearney & Trecker Corp. *Control Data for 3-Axis Model II.*

Square D Co. *Controlling from Tape.*

XVI. PROGRAMING 3 — THREE AXIS

Training Time

Laboratory, 3 hours

Objective

To assist the student to complete and test his program

Materials

Student's manuscript, tape, a corrected manuscript and tape, and a machine tool and part to test the program

Unit Outline

A. Check material prepared
1. Manuscript
2. Tape
3. Blueprint

B. Test program
1. Load part
2. Load the tape
3. Prepare tooling as needed
4. Energize the machine tool
5. Make the test
6. Evaluate the piece machined

C. Automatic run of a part

Suggested Activities

Demonstrate checking procedures

Demonstrate the testing procedure on the machine tool

Demonstrate automatic cycle

Assist student with his project

References

Master blueprint used

Master preparation sheets

Master manuscript and tape

XVII. PROGRAMING A SLOPE

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objective

To acquaint the student with the principles of programing a slope and assist him in the programing procedures

Materials

Blueprint (slope surface), coordinate sheets, manuscript form, sample program, sample tape, machine tool and part

Unit Outline

A. Control capabilities
   1. Movement in x or y
   2. Movement in x or y simultaneously
   3. Distance movement limitations
   4. Time of movement delay

B. Mathematics review
   1. Trigonometry of right triangle
   2. Chart interpretation
   3. Angle of slope

C. Programing
   1. Determine starting point
   2. Calculate for size of cutter
   3. Determine movement
   4. Calculate and record coordinates
   5. Punch tape
   6. Verify tape
   7. Test program

Suggested Activities

Review the control limitations of the machine tool used

Demonstrate the procedure for calculating the coordinates

Demonstrate the machining of a slope

Individual student assistance

References

Gettelman. "Let's Discuss Numerical Control in Simple Language," *Modern Machine Shop.*

Manual of the machine tool and controls

XVIII. PROGRAMING AN ARC OR CIRCLE

Training Time

Classroom, 1 hour; laboratory, 2 hours

Objectives

To acquaint the student with the principles of programing an arc or circle and assist him in the programing procedures

Materials

Blueprint (arc or circle), coordinate sheets, manuscript form, sample program, sample tape, machine tool and part

Unit Outline

A. Geometry of the arc or circle
   1. Calculate coordinates
   2. Describe arc path
   3. Describe cutter path

B. Procedures of cutting arcs and circles
   1. Tracer
   2. Point-to-point
   3. Continuous path

C. Limitations of point-to-point
   1. Limits of control
   2. Limits of procedure
   3. Limits of describing path
   4. Limits of process

D. Introduction of continuous path
   1. Methods
   2. Equipment
   3. Procedure

Suggested Activities

Demonstrate procedure for selecting and calculating coordinates

Demonstrate programing procedures

Introduce other methods of cutting an arc or circle

Individual student assistance

References

Giddings & Lewis Machine Tool Co. *Bickford Numer-Mite; Programming Instruction Manual.*

Jacobowitz. *Computer Arithmetic.*

Magor. *Contour Tracing in Relation to Numerical Control* (conference paper).

McCarty. *Automated Programming from Undimensioned Drawings* (conference paper).

XIX. TEST THE PROGRAMS

Training Time

Laboratory, 3 hours

Objective

To test the programs developed for cutting slopes and arcs

Materials

Tested programs, tested tapes, reference blueprints, tape punching equipment, tape verifying equipment, machine tool to use for testing and demonstrating, and a part to machine

Unit Outline

A. Verify program
   1. Tool sheet
   2. Coordinate entries
   3. Manuscript
   4. Tape

B. Test programs
   1. Mount part
   2. Select and insert tool
   3. Load tape
   4. Reference tool to part
   5. Test procedure
   6. Inspect part

Suggested Activities

Demonstrate cutting a slope and an arc or circle

Individual student assistance

References

Tested program

Tested tape

Tested part

XX. COMPUTER ASSISTANCE

Training Time

Classroom, 3 hours

Objective

To acquaint the student with computer assistance to programing

Materials

Sample programs, a field trip and/or a demonstration, charts, diagrams, and resource people

Unit Outline

A. Computer
   1. Function
   2. Basic operation
   3. Computer language
   4. Pre and post processors

B. Program preparation
   1. Format
   2. Application
   3. Limitations
   4. Personnel
   5. Economic justification
   6. Systems

C. Computer control

Suggested Activities

Introduce the principles of computer assistance

Demonstrate the programing of a part by computer assistance

Introduce computer programing

References

"Eight-Axis Machining Center for Westinghouse," *Machine and Tool Blue Book.*

Holman, John. "N/C Positioning and the Computer." *Modern Machine Shop.*

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"Low Cost N/C for Small Shops," *Machine and Tool Blue Book.*

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Young. "N/C Turret Lathe and Unique Tooling = Flexible Setups, High Productivity," *Machine and Tool Blue Book.*

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With the change in the technology many new publications are becoming available, and the instructor should search for the latest information.

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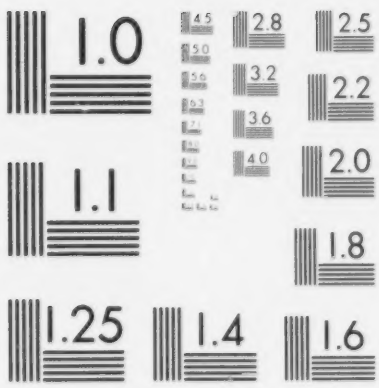

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

FILMS

These films should be booked well in advance. The borrower is obligated to pay the transportation costs.

Breaking the Gaging Bottleneck. 16 mm., sound, 15 min., color. Pratt & Whitney Co., Inc., Advertising Department, Charter Oak Boulevard, West Hartford, Conn. 06090.

Summary: This film describes the Pratt & Whitney Sigmatic Multi-Dimension Gaging Machines and their use in precision gaging applications.

Changing Months to Minutes. 16 mm., sound, 15 min., color. Kearney & Trecker Corp., Advertising Department, 11000 Theodore Trecker Way, Milwaukee, Wis. 53214.

Summary: This film tells the story of Milwaukee-Matic, a single unit, numerically controlled machining center. This unit performs such operations as milling, boring, drilling, and related functions automatically and shuttles workpieces on and off the machining area.

Cutting a Dovetail Taper Slide. 16 mm., sound, 25 min., b & w. Kearney & Trecker Corp., Advertising Department, 11000 Theodore Trecker Way, Milwaukee, Wis. 53214.

Summary: This film shows every step in the process of milling a dovetail taper slide, from the planning of the job, through the layout, to the final checking. Such important details as the various cutters necessary and how to use a rotary table in milling a taper are also covered.

Cutting Edge, The. (1963) 16 mm., sound, 29 min., color. Norton Co., Advertising Department, Worchester, Mass.

Summary: This film demonstrates in detail the procedure in sharpening the four basic types of milling cutters—staggered tooth side milling cutte[illegible], reamers, and inserted blade face mills—that are used in every manufacturing plant or machine shop of any size.

Drama in Drilling. 16 mm., sound, 20 min., b & w. Brown & Sharpe Manufacturing Co., 235 Promenade Street, Providence, R.I. 02900.

Summary: This film presents the Brown & Sharpe turret drilling machine. It demonstrates and explains the principle of work positioning and drilling in connection with the use of this machine.

From Print to Product. 16 mm., sound, 30 min., color. Kearney & Trecker Corp., Advertising Department, 11000 Theodore Trecker Way, Milwaukee, Wis. 53214.

Summary: This film shows the Model D Rotary Head milling machine performing many unusual and intricate operations.

Highway to Production. 16 mm., sound, 30 min., color. The Cincinnati Milling Machine Co., Advertising Department, 4701 Marburg Avenue, Cincinnati, Ohio 45200.

Summary: This film tells the story of the part machine tools have played in man's quest for material comforts, and demonstrates the building of milling machines, from the pouring of the iron to the final inspection.

Kellering. (1959) 16 mm., sound, 22 min., color, Pratt & Whitney Co., Inc., Advertising Department, Charter Oak Boulevard, West Hartford, Conn. 06090.

Summary: This film illustrates and explains how the Pratt & Whitney Keller machine pioneered the art of automatic tracer-controlled milling to reproduce accurately the shape of any two-dimensioning template or three-dimensional full model. It depicts and explains how the Keller machine is engineered and manufactured to produce economically dies, molds, and any

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other work pieces having irregular shapes or complex geometrical curves. (Cleared for TV.)

Little Showoff, The. 16 mm., sound, 20 min., color. Kearney & Trecker Corp., Advertising Department, 11000 Theodore Trecker Way, Milwaukee, Wis. 53214.

Summary: This film tells the story of the TRI-D milling head. It shows how this machine produces many geometric shapes in metal and in a single setup, using only simple arithmetic.

Manufacturing with Milwaukee-Matic (1958) 16 mm., sound, 17 min., b & w. Kearney & Trecker Corp.

Summary: This film covers the complete machining of a part, performing all operation—milling, drilling, boring, and changing tools—automatically. The entire process is commanded by tape control.

New Servo-Controlled Contour-Matic Machine for Increased Profits. (1964) 16 mm., sound, 10 min., color. The DoAll Co., Film Librarian, 254 N. Laurel Ave., Des Plaines, Ill. 60016.

Summary: This film illustrates a revolutionary new control system for power fed Contour-matic Band machines. The new system utilizes a very sensitive servo-valve to maintain constant feed rate for the most efficient machining of all materials. (Not cleared for TV.)

Numerical Control—Solid State. (1961) 16 mm., sound, 10 min., color. UNIVAC Division, Sperry Rand Corp., Graphic Services Department, Sperry Rand Building, New York, N.Y. 10010.

Summary: This film presents a demonstration of automatically controlled machine tools used in the manufacture of metal parts for the aircraft industry. It shows how the Univac Solid State Computer prepares control media for machine tools, making it possible to fabricate highly complex parts faster and more economically than could be done with conventional tooling methods. (Cleared for TV.)

One Hoe for Kalabo. 16 mm., sound, 27 min., color. National Machine Tool Builders Association, 2139 Wisconsin Avenue, Washington, D.C. 20000.

Summary: From U. S. Industrial Plant to African village . . . the story of how machine tools have given dignity and power to human labor and world civili[illegible]

Profit Robbers, The. (1963) 16 mm., sound, 15 min., color. Kearney & Trecker Corp., Advertising Department, 1100 Theodore Trecker Way, Milwaukee, Wis. 53214.

Summary: This film depicts the machining center of the future. It is a numerically controlled, five-axis, milling, drilling, boaring, reaming, and tapping machine tool. Tools are changed automatically, and work-pieces are presented to the horizontal spindles in five planes.

Quality and Cost. 16 mm., sound, 15 min., color. Kearney & Trecker Corp., (see above)

Summary: This film is the story of the ever present problems of manufacturing—quality and cost. It si.ows how to produce quality at minimum cost and deals primarily with the use of special purpose production machine tools.

Researches in High Speed Milling. 16 mm., silent, 20 min., b & w. The Cincinnati Milling Machine Co., Advertising Department, 4701 Marburg Avenue, Cincinnati, Ohio 45200.

Summary: This film presents the story of high speed carbide milling, beginning with a simple exposition of the meaning of positive and negative rake in metal cutting tools, the various angles involved, and the mechanism of chip formation itself. The slow motion scenes are photographed at the rate of 3,000 pictures per second.

Rotomatic Positioning Table. (1962) 16 mm., sound, 18 min., color. LaPointe Machine Tool Co., Educational Department, 34 Tower Street, Hudson, Mass. 01749.

Summary: This film describes the newest LaPointe production, the Rotomatic Positioning Table, and its adaptation to drilling machines and milling machines. This machine is shown with numerical, electro-mechanical, or manual control.

Tape-O-Matic. (1962) 16 mm., sound, 13 min., color. Pratt & Whitney Co., Inc., Advertising Department, Charter Oak Boulevard, West Hartford, Conn. 06090.

Summary: This film shows how numerical control can be used in every machine shop in the country. It tells the complete story of P & W's low cost Tape-O-Matic drilling machine. (Cleared for TV.)

3-Dimensional Drafting. 16 mm., sound, 26 min.,

color. Ridgway's of New York, Inc., 110 West 42nd Street, New York. N.Y. 10010.

Summary: This film presents the interesting features and phases of the "Instru-master" technique of producing three-dimensional, one-view drawings; it shows illustrations and drawings being made and explained.

Tracer Control in Action. (1953) 16 mm., sound, 36 min., color. George Gorton Machine Co., Attention: Miss Marjorie R. Allert, Assistant Advertising Manager, 1321 Racine Street, Racine, Wis.

Summary: This film is a technical exposition of tracer control applications with pantograph machines and die and mold duplicators, including "automated" production applications, photographed under actual shop conditions. It includes material on profiling, profile grinding, and electric arc etching.

Uses and Abuses of Twist Drills. 16 mm., sound, 26 min., b & w. Cleveland Twist Drill Co., Mr. W. E. Wenger, Advertising Manager, P. O. Box 6656, Cleveland, Ohio 44110.

Summary: This film portrays and demonstrates the various types of twist drills. It also shows the applications of these drills and the care that should be given them. (Not cleared for TV.)

Due to the change in the technology many new films are becoming available.

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APPENDIXES

APPENDIX A

INSTRUCTOR'S LESSON PLAN

Related Technical Information

Unit_____
Lesson_____

Subject

Review of Machining Methodology

Objectives

Teaching Aids

Films, feed and speed tables, plan sheet for NC, and mockups

Materials

Blueprint of a part, sample part machined

References

Feirer and Tatro. *Machine Tool Metalworking.*
Metal Cutting Tools Institute. *Metal Cutting Tool Handbook.*
U. S. Department of Commerce. *Machining Data* (AD425000).
Manual of machine tool to be used

I. PREPARATION (of the learner)
- Review metal cutting processes
- Review sequencing of cutting operations
- Calculate feeds and speeds for various machining processes in several materials

II. PRESENTATION (of the information)

Instructional Topics	Things to Remember to Do or Say
Machining principles	Preview films
Metal removal	Call attention to specific machining operations
Feed rate calculation	Sequencing of machining
Speed rate	Rigidity of support
NC machining	Time of process
Programing	Cost of process per part
	Feed rate—dependent on materials, conditions, finish
	Table interpretation for several materials—alloy steel = CRS cast iron aluminum
	Speed rate factors affecting cutting tool material coolant or dry
	Movement system
	Accuracy
	Machining on paper
	Control system flexibility

III. APPLICATION (drills, illustrations, analogies, oral questions or assignments)
- Drilling—calculate feed and speed rate for a 1" H.S.S. drill in cast iron, alloy steel, aluminum.
- Which operation should be done first? Second? How should this part be held?
- What kind of tooling should be used to change rapidly yet hold accuracy?
- When should coolant be used?

IV. TEST (final check on the student's comprehension of material presented)
- How would you sequence the operations of a part (blueprint and/or part available) to get the fastest machine time yet hold the accuracy required? Select the tools and machine. Support the selection of your process with objective criteria.

Suggested Reading for Student:
The Next Lesson Is: Holding Devices

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APPENDIX B

SAMPLE LESSON PLAN FOR UNIT III
REVIEW OF MACHINING METHODOLOGY

Training Time

Classroom, 2 hours; laboratory, 1 hour

Objectives

To review the machining principles
To acquaint the student with the selection of speeds, feeds, and rate of machining
To select the sequence of operations
To select holding devices

Materials

Speed and feed charts, chalkboard, chalk eraser, films, reference materials, tool selection form and/or demonstration

Unit Outline

A. Basic machine tools—Film–*One Hoe for Kalabo*–sound, color, 27 min.
   1. Drill press
   2. Milling machine
   3. Shaper—planer
   4. Lathe
   5. Grinder
   6. Punching—blanking
   7. Forming

B. Machining principles
   1. Internal
      a. Drilling—Film–*Tape-O-Matic*–sound, color, 13 min.
      b. Reaming
      c. Boring
      d. Counter functions
         (1) Counter boring
         (2) Counter sinking
         (3) Spot facing
      e. Tapping
      f. Slotting
      g. Punching, piercing, blanking
      h. Forming
      i. Broaching
   2. External
      a. Turning
      b. Facing
      c. Angle turning
      d. Form turning
      e. Threading
      f. Slotting
      g Milling—hobbing
         (1) Keyways
         (2) Splines
         (3) Gears
      h. Surfacing
         (1) Mill
         (2) Shaper—planer
         (3) Grinder
      i. Forming
   3. Speeds and feeds—Machine Data–By Process (Drilling, Milling, Boring)
      a. Material machining
      b. Cutting material
      c. Condition and size of machine
      d. Holding device
      e. Power source
      f. Wet or dry
      g. Rigidity of foundation structure
      h. Calculation of speeds and feeds
      i. Table referencing of speeds and feeds
      j. Cutting fluids

C. Holding devices
   1. Tool
      a. Chucks
      b. Sleeves
      c. Holders
      d. Tapers
   2. Work
      a. Vises
      b. Clamps
      c. Jigs and fixtures
      d. Magnetic chucking
      e. Vacuum chucking

D. Tooling—*Metal Cutting Handbook*–Drill pp.1-64, Mill pp. 475-658, Reaming pp. 165-256
   1. Standard
      a. Size
      b. Material
         (1) High speed
         (2) Carbide
         (3) Oxide

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c. Conditioning
d. Maintenance

2. Preset tooling—Manual for the machine tools and controls used
   a. Methods of presetting
   b. Instrumentation used
   c. Purpose of preset tooling
   d. Function

E. Movement systems—Manual for the machine tool used
1. Mechanical
2. Pneumatic
3. Hydraulic
4. Electrical
5. Feedback systems
6. Flat surfaces
7. Dovetail—machine slide system
8. Antifriction devices

F. Operational sequencing—Film–*Manufacturing with Milwaukee-Matic*–sound, b & w, 17 min.
1. Mounting
2. Holding (part and tool)
3. Tool selection
4. Referencing
5. Speed and feed selection
6. Inspection
   a. Size
   b. Shape
   c. Finish
   d. Position to reference
7. Auxiliary functions

Suggested Activities

Review machining principles by live demonstration or films

Demonstrate the sequencing operation entry on a tool sheet

Demonstrate speed and feed calculations

Introduce holding devices

Assist student in independent work

Suggested Assignment

Complete the tooling sheet, including speed and feed calculations, from the blueprint of the previous lesson

Study holding devices and coordinate referencing

Continue the study of the glossary of terms

References

Burghardt and others. *Machine Tool Operation,* Part I, pp. 130–161; Part II, pp. 170–210.

Feirer and Tatro. *Machine Tool Metalworking,* pp. 12–96.

Felker. *Machine Shop Technology,* pp. 62–172, 331–397.

Johnson. *Machine Shop,* pp. 187–217, 253–294.

Jones. *Machine Shop Training Course,* Vol. 1, pp. 1–16 ,146–156, 190–238, Vol. 2, pp. 1–14, 100–135.

Metal Cutting Tools Institute. *Metal Cutting Tool Handbook,* pp. 1–165, 167–254, 293–375, 477–579.

Olberg and Jones. *Machinery's Handbook.*

U.S. Department of Commerce. *Machining Data* (AD 425000).

Films

Manufacturing with Milwaukee-Matic. Kearney & Trecker Corp.

One Hoe for Kalabo. National Machine Tool Builders.

Tape-O-Matic. Pratt & Whitney Co.

APPENDIX C

SUGGESTED CLASSROOM FLOOR PLAN

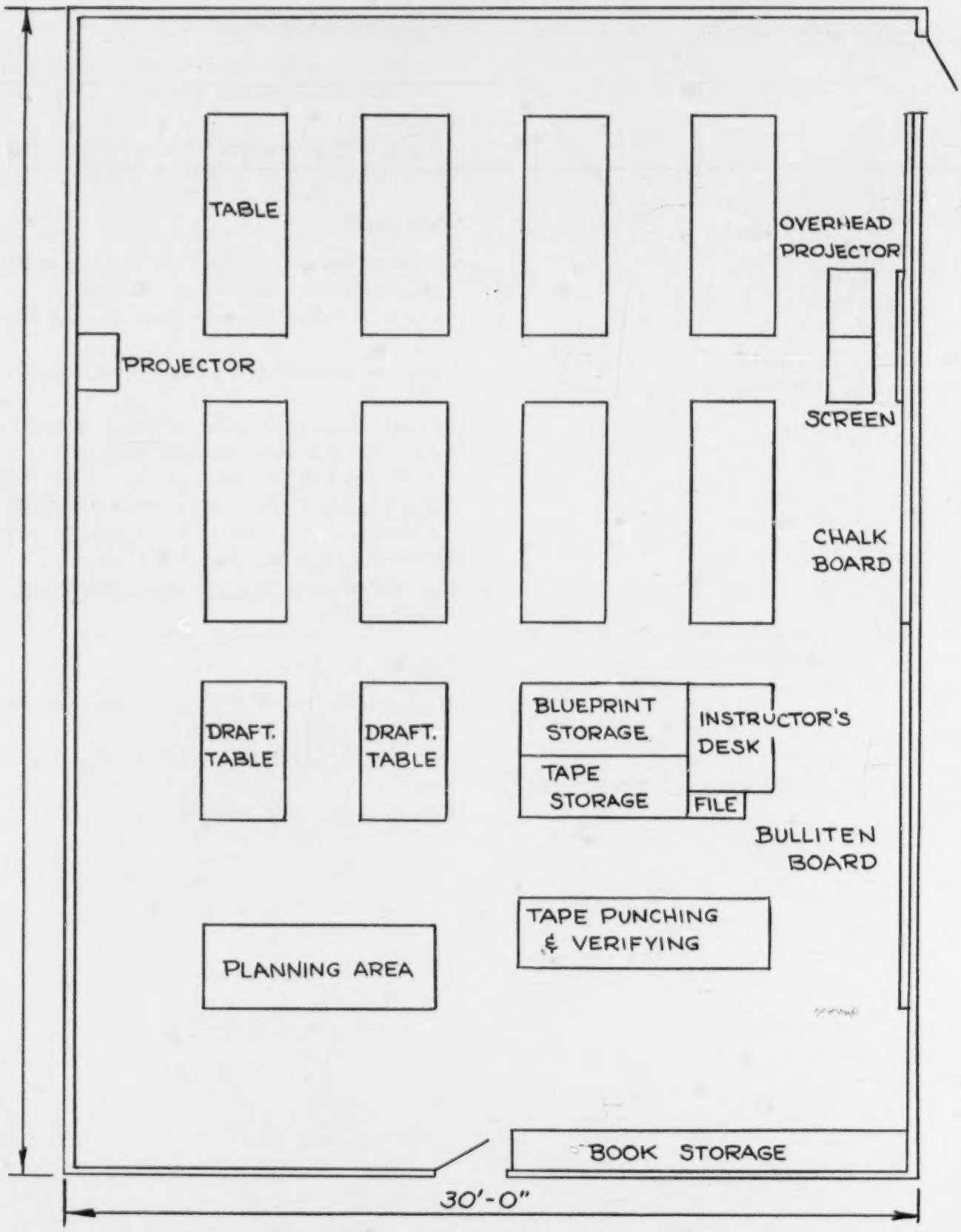

Figure VIII-1. Classroom floor plan.

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APPENDIX D
SUGGESTED LABORATORY FLOOR PLAN

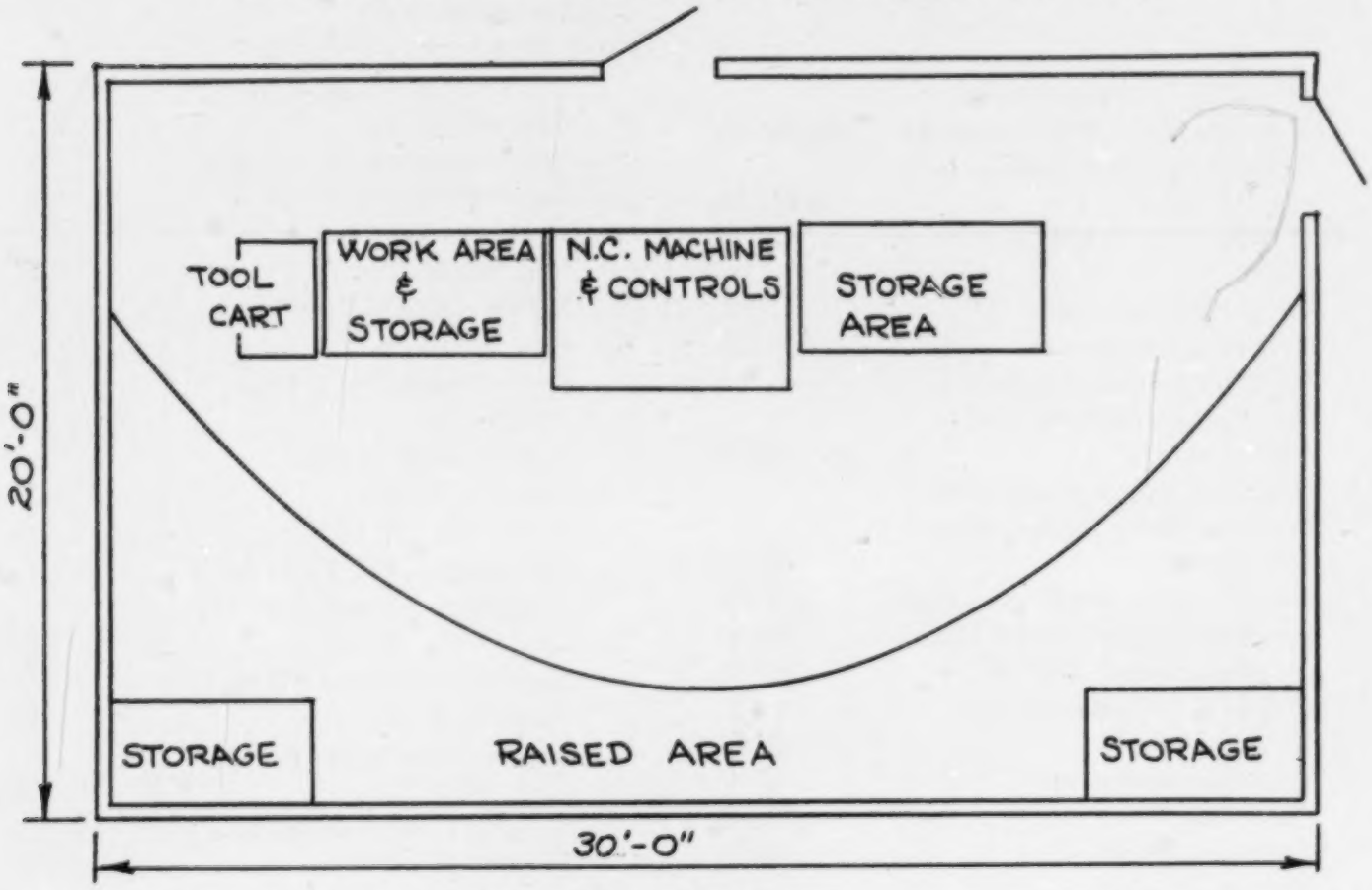

Figure VIII-2. Laboratory floor plan.

APPENDIX E
SUGGESTED LIST OF CLASSROOM EQUIPMENT

Classroom 30′ x 40′		Estimated costs*
8	Tables, 4′ x 8′	$ 800.00
24	Chairs	400.00
2	Drafting tables, 3′ x 5′	300.00
2	Drafting machines, 24″ arms, w/scales	300.00
4	Triangles, 30–60 degrees	8.00
4	Triangles, 45 degrees	8.00
10	Scales, inquiring	15.00
2	Pencil sharpeners	10.00
1	Book storage	100.00
1	Blueprint storage	100.00
1	File	100.00
1	Instructor's desk	120.00
1	Chart stand	10.00
1	16-mm. projector & screen	500.00
1	Overhead projector	250.00
1	Tape punching & verifying equipment	3,600.00
1	Tape storage	100.00
1	Tape splicing equipment	54.00
2	Drafting sets	30.00
1	Planning area table	100.00
1	Blackboard, 20′	200.00
1	Bulletin board, 10′	60.00

*Costs in appendixes E, F, and G were estimated as of 1967.

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APPENDIX F

SUGGESTED LIST OF LABORATORY EQUIPMENT

Laboratory		
20′ x 30′		
1	N/C machine TAPE-O-MATIC	
	Model B, N/C machining center	$20,995.00
	Model B positioning table (without head)	11,950.00
	OPTIONAL FEATURES—MODEL B	
	Three-digit operation Number read-out	995.00
	Depth indicator and mounting Brackets (Standard #4 M. T. drilling spindle)	160.00
	Depth indicator and mounting Brackets (boring and/or milling type spindles)	160.00
	Extra drum for six (6) extra depths	230.00
	Four-inch column riser for Model B	440.00
	Auto-transformer (8KVA)	300.00
	OPTIONAL ACCESSORIES	
	Coolant system	295.00
	Work-illumination light	27.00
	Tool cabinet	275.00
	Tape tumble box	40.00
	Extra reel	25.00
	Book of angular indexing tables	11.00
	Tape roll	44.25
	TAPE-O-MATIC tape processing sheets	2.25
	WORK LOCATING AND CLAMPING DEVICES	
	Accuset zero locator	395.00
	Accuset for special boring spindle	395.00
	Nesting block set	195.00
	Universal 3-jaw chuck	360.00
	Set of blocks and magnets	147.00
	Setup fixtures set	165.00
	TOOL HOLDING DEVICES	
	Quick change chuck, 1/32″–1/2″ Cap. (#3 M. T.)	49.50
	Quick change chuck, 3/8″–3/4″ Cap. (#4 M. T.)	22.30
	Jacobs chuck, 3/16″–3/4″ Cap. (#4 M. T.)	22.30
	Keyless chuck, 1/32″–1/2″ Cap. (#3 M. T.	25.00
	Keyless chuck, 0–5/16″ Cap. (#3 M. T.)	21.90
	Keyless chuck, 1/8″–5/8″ Cap. (#4 M. T.)	29.75
	Quick drift (#4 M.T.)	15.75
	Drill speeder, 6 1/4 : 1 (#4 M. T.)	114.75
	Tapping attachment, #00–#10 Cap. (#4 M. T.)	103.75
	Tapping attachment #4–5/16″ Cap. (#4 M. T.)	168.75
	Tapping attachment #10–5/8″ Cap. (#4 M.T.)	228.75
	Tapping attachment stop post, for MODEL B	40.00
	MAINTENANCE EQUIPMENT AND SPARE PARTS	
	Maintenance kit	495.00
	Proboscope	1,370.00
	Symmetry-quadrature test meter	150.00
2	Tool storages	160.00
2	Holding device storages	160.00
1	Tool setting equipment	300.00
1	Work bench	120.00
1	Tool cart	84.00
	Miscellaneous equipment	1,000.00

APPENDIX G

SUGGESTED LIST OF SUPPLIES

3 rolls	Standard punch tape	$100.00
	Film rental & postage	50.00
	Paper, pencils, erasers, etc.	50.00
	Teaching materials	50.00
	Book & manuals	200.00
	Tools & parts	200.00
	Miscellaneous	300.00

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APPENDIX H

SAMPLE PROGRAMS AND PHOTOS

PROCESS CHART FOR P&W TAPE-O-MATIC

PRATT & WHITNEY CO., INC.
WEST HARTFORD, CONNECTICUT, U.S.A.

DWG. NO. C-10109
PART NO. DOO-1212

OPER. NO. 4

PART NAME FIGMENT PLATE

PREPARED BY C.D.S.
DATE 2-15-62
CH'ED BY J.D.
DATE 2-18-62
SHEET 2 OF 2
DEPT. NO. 69
TAPE NO.

LATEST DWG. CHGE

REMARKS: PROCESSED FOR FLEXOWRITER WHEN A TYPE-OUT OF INSTRUCTIONS IS DESIRED

MISC. FUNC.	SEQ. NO.	TAB OR EOB	+ OR −	"X" COORDINATE	TAB OR EOB	+ OR −	"Y" COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB
		TAB	−	4.500	TAB	+	.875	TAB	SET-UP INFORMATION	EOB
%	001	TAB	−	3.500	TAB		0	TAB	SET DEPTH AND CENTER DRILL	
									SIX HOLES, TWO 5/16 DIA. AND	
									FOUR 1/4 DIA.	EOB
	002	TAB	−	.500	EOB					
	003	TAB	+	.500	TAB	−	.250	EOB		
	004	TAB		0	TAB	−	2.781	EOB		
	005	TAB			TAB	−	4.531	EOB		
	006	TAB	−	3.031	TAB	−	4.000	EOB		
&	007	TAB	+	3.500	TAB	−	3.000	TAB	CHANGE TOOL TO COMB. DRILL AND	
									C'BORE, 19/32 C'BORE X 5/16 DRILL	EOB
	002	TAB	−	.500	TAB		0	TAB	DRILL AND C'BORE 2 HOLES	
									19/32 X 5/16	EOB
	004	TAB		0	TAB	−	2.781	EOB		
&	007	TAB	+	3.500	TAB	−	3.000	TAB	CHANGE TOOL TO COMB. DRILL	
									AND C'BORE, 15/32 C'BORE X 1/4 DRILL	EOB
	001	TAB	−	3.500	TAB		0	TAB	DRILL AND C'BORE 4 HOLES	
									15/32 X 1/4	EOB
	003	TAB	+	.500	TAB	−	.250	EOB		
	005	TAB		0	TAB	−	4.531	EOB		
	006	TAB	−	3.031	TAB	−	4.000	EOB		
/	007	TAB	+	3.500	TAB	−	3.000	TAB	CHANGE TOOL TO CENTER DRILL	
									REMOVE AND REPLACE PART	EOB
				NOTE:						
				ON THE NC 1 FLEXOWRITER THE EIA CODE FOR:						
				& IS USED FOR TOOL CHANGE FOR THE TAPE-O-MATIC						
				% IS USED FOR STOP TAPE REWIND FOR THE TAPE-O-MATIC						
				/ IS USED FOR TAPE REWIND FOR THE TAPE-O-MATIC						
				CARR. RET. IS USED FOR END OF BLOCK (EOB)						
				CAUTION: DO NOT USE LOWER CASE "L" FOR NUMERAL "1"						

Figure VIII-3. Sample process chart for Flexowriter when a type-out of instruction IS desired.

PROCESS CHART FOR P&W TAPE-O-MATIC

PRATT & WHITNEY CO., INC.
WEST HARTFORD, CONNECTICUT, U.S.A.

DWG. NO. C-10109
PART NO. D00-1212

OPER. NO. 4

PART NAME FIGMENT PLATE

PREPARED BY C.D.S.
DATE 2-15-62
CH'ED BY J.D.
DATE 2-18-62
SHEET 2 OF 2
DEPT. NO. 69
TAPE NO. 001

LATEST DWG. CHGE

REMARKS: SAMPLE PROCESS FOR ULTRA-SONIC "TAPE MASTER" TAPE PUNCH

MISC. FUNC.	SEQ. NO.	TAB OR EOB	+ OR −	"X" COORDINATE	TAB OR EOB	+ OR −	"Y" COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB
	000	TAB	−	04.500	TAB	+	00.875	EOB	SET-UP INFORMATION	
RWS	001	TAB	−	03.500	TAB	+	00.000	EOB	SET DEPTH AND CENTER DRILL 6 HOLES	
	002	TAB	−	00.500	TAB	+	00.000	EOB		
	003	TAB	+	00.500	TAB	−	00.250	EOB		
	004	TAB	+	00.000	TAB	−	02.781	EOB		
	005	TAB	+	00.000	TAB	−	04.531	EOB		
	006	TAB	−	03.031	TAB	−	04.000	EOB		
TC	007	TAB	+	03.500	TAB	−	03.000	EOB	CHANGE TOOL TO COMB. DRILL & C'BORE	
	002	TAB	−	00.500	TAB	+	00.000	EOB	DRILL AND C'BORE 2 HOLES 19/32 X 5/16	
	004	TAB	+	00.000	TAB	−	02.781	EOB		
TC	007	TAB	+	03.500	TAB	−	03.000	EOB	CHANGE TOOL TO COMB. DRILL & C'BORE	
	001	TAB	−	03.500	TAB	+	00.000	EOB	DRILL AND C'BORE 4 HOLES 15/32 X 1/4	
	003	TAB	+	00.500	TAB	−	00.250	EOB		
	005	TAB	+	00.000	TAB	−	04.531	EOB		
	006	TAB	−	03.031	TAB	−	04.000	EOB		
TC RW	007	TAB	+	03.500	TAB	−	03.000	EOB	CHANGE TOOL TO CENTER DRILL. UNLOAD AND REPLACE PART.	

NOTE:
RWS IS USED TO INDICATE TAPE REWIND STOP
TC IS USED TO INDICATE TOOL CHANGE.
RW IS USED TO INDICATE TAPE REWIND

Figure VIII-4. Sample process chart for ultra-sonic "Tape Master" tape punch.

5534

PROCESS SHEET FOR P&W TAPE-O-MATIC

PRATT & WHITNEY CO., INC.
WEST HARTFORD, CONNECTICUT, U.S.A.

DWG. NO. C-10109	OPER. NO. 4	PART NAME FIGMENT PLATE	PREPARED BY C.D.S DATE 2-15-62
PART NO. D00-1212			CH'ED BY J.D. DATE 2-18-62
			SHEET 2 OF 2
LATEST DWG. CHGE	REMARKS: PROCESSED FOR SOROBAN TAPE PUNCH, OR THE FLEXOWRITER WHEN A TYPE-OUT OF THE INSTRUCTIONS IS NOT DESIRED		DEPT. NO. 69
			TAPE NO. 001

MISC. FUNC.	SEQ. NO.	TAB OR EOB	+ OR −	"X" COORDINATE	TAB OR EOB	+ OR −	"Y" COORDINATE	TAB OR EOB	INSTRUCTIONS	EOB
		TAB	−	4.500	TAB	+	.875	EOB	SET-UP INFORMATION	
RWS	001	TAB	−	3.500	TAB		0	EOB	SET DEPTH AND CENTER DRILL	
									SIX HOLES, TWO 5/16 DIA. AND	
									FOUR 1/4 DIA.	
	002	TAB	−	.500	EOB					
	003	TAB	+	.500	TAB	−	.250	EOB		
	004	TAB		0	TAB	−	2.781	EOB		
	005	TAB			TAB	−	4.531	EOB		
	006	TAB	−	3.031	TAB	−	4.000	EOB		
TC	007	TAB	+	3.500	TAB	−	3.000	EOB	CHANGE TOOL TO COMB. DRILL AND	
									C'BORE, 19/32 C'BORE X 5/16 DRILL	
	002	TAB	−	.500	TAB		0	EOB	DRILL AND C'BORE 2 HOLES	
									19/32 X 5/16	
	004	TAB		0	TAB	−	2.781	EOB		
TC	007	TAB	+	3.500	TAB	−	3.000	EOB	CHANGE TOOL TO COMB. DRILL	
									AND C'BORE, 15/32 C'BORE X 1/4 DRILL	
	001	TAB	−	3.500	TAB		0	EOB	DRILL AND C'BORE 4 HOLES	
									15/32 X 1/4	
	003	TAB	+	.500	TAB	−	.250	EOB		
	005	TAB		0	TAB	−	4.531	EOB		
	006	TAB	−	3.031	TAB	−	4.000	EOB		
TCRW	007	TAB	+	3.500	TAB	−	3.000	EOB	CHANGE TOOL TO CENTER DRILL	
									REMOVE AND REPLACE PART	
				NOTE:						
				ON THE NC 1 FLEXOWRITER THE EIA CODE FOR:						
				& IS USED FOR TOOL CHANGE FOR THE TAPE-O-MATIC						
				% IS USED FOR STOP TAPE REWIND FOR THE TAPE-O-MATIC						
				/ IS USED FOR TAPE REWIND FOR THE TAPE-O-MATIC						
				CARR. RET IS USED FOR END OF BLOCK						
				CAUTION: DO NOT USE LOWER CASE "L" FOR NUMERAL "1"						

Figure VIII-5. Sample process chart for Soroban tape punch, or the Flexowriter when a type-out of the instruction IS NOT desired.

5535

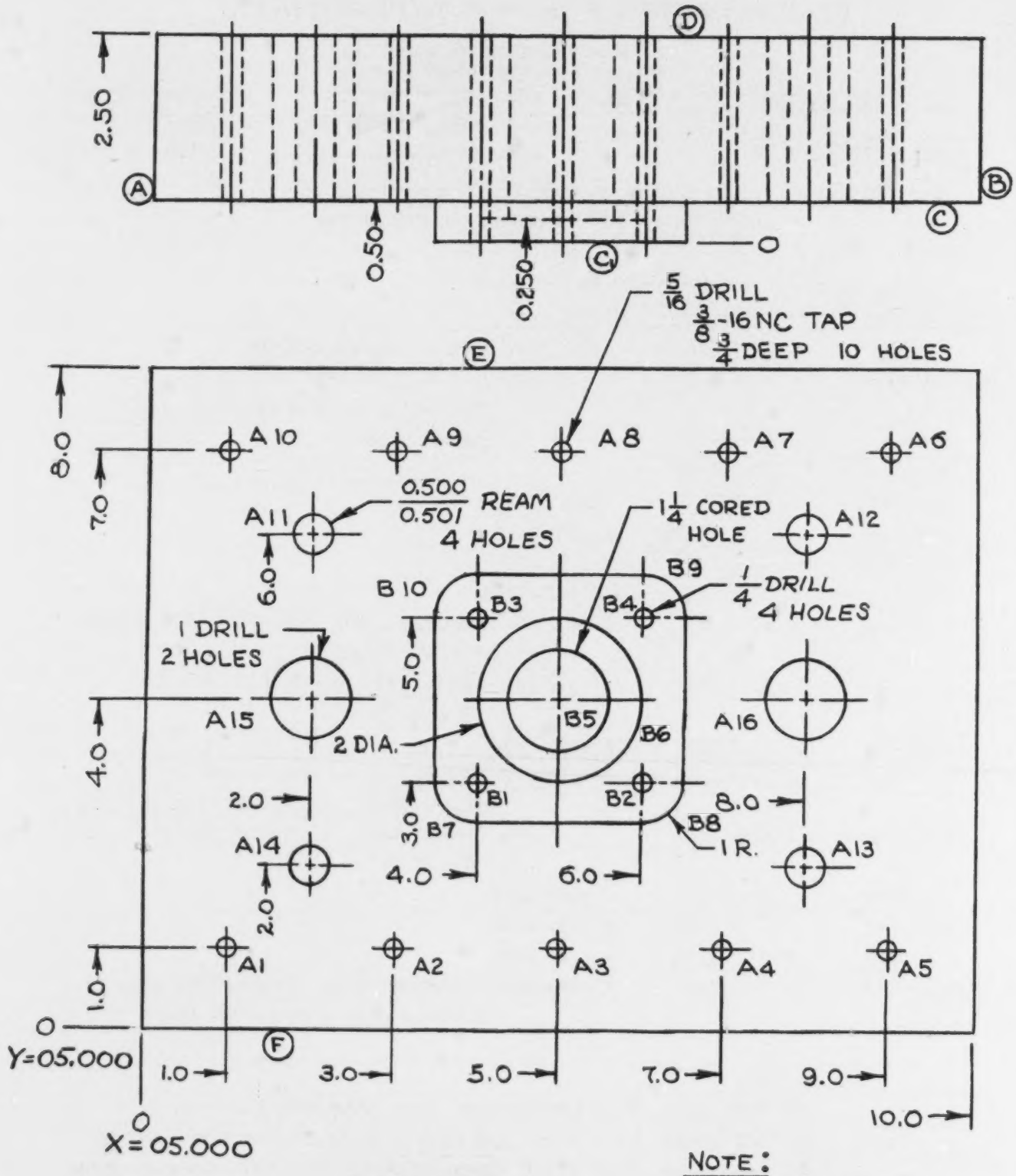

Figure VIII-6. Sample drawing for programing.

CINCINNATI
ACRAMATIC POSITIONING
NUMERICAL CONTROL SYSTEM

PART NAME: MANIFOLD
PART NO.:
DRAWING NO.:
REVISION:
FIXTURE NO.:
PROGRAMMED BY: P. Petrey
PAGE 1 OF PAGES 2
DATE:
SET UP AND TOOL INFORMATION: Zero Point X = 05.000 Y = 05.000

Hold in # 5 vice

H or N SEQ. NO.	G PREP. FUNCT.	X POSITION	Y POSITION	M MISC. FUNCT.	POS. NO.	TOOL NO.	HEAD POS.	SPINDLE FEED IN./MIN.	SPEED RPM	DEPTH OF CUT	TABLE FEED IN./MIN.	TOOL REMARKS
H001	G81	X06 000	Y12 000	M51	1	1		4.0	1220	THRU		5/16 DRILL
N002		X08 000			2							
N003		X10 000			3							
N004		X12 000			4							
N005		X14 000			5							
N006			Y06 000		6							
N007		X12 000			7							
N008		X10 000			8							
N009		X08 000			9							
N010		X06 000		M06	10							
H011	G84	X06 000	Y06 000	M52	10	2		13.0	230	THRU		3/8 - 16 NC TAP
N012		X08 000			9							
N013		X10 000			8							
N014		X12 000			7							
N015		X14 000			6							
N016			Y12 000		5							
N017		X12 000			4							
N018		X10 000			3							
N019		X08 000			2							

Figure VIII-7. Program for Acramatic 220. *(Continued on next page)*

2231

5538

CINCINNATI ACRAMATIC POSITIONING NUMERICAL CONTROL SYSTEM

PART NAME				PART NO.
DRAWING NO.	REVISION	FIXTURE NO.	PROGRAMMED BY	PAGE 2 OF PAGES 2
SET UP AND TOOL INFORMATION				DATE

H or N	G	X		Y		M									
SEQ. NO.	PREP. FUNCT.	POSITION		POSITION		MISC. FUNCT.	POS. NO.	TOOL NO.	HEAD POS.	SPINDLE FEED IN./MIN.	SPEED RPM	DEPTH OF CUT	TABLE FEED IN./MIN.	TOOL REMARKS
N020		X06	000			M06	1							
H021	G81	X07	000	Y11	000	M53	11	3		4.0	710	THRU		31/64 DRILL
N022		X13	000				12							
N023				Y07	000		13							
N024		X07	000			M06	14							
H025	G81	X07	000	Y07	000	M54	14	4		4.0	100	THRU		0.500 - 0.501 REAMER
N026		X13	000				13							
N027				Y11	000		12							
N028		X07	000			M06	11							
H029	G80	X07	000	Y09	000	M55	15	5		4.0	360	THRU		1" DRILL
N030	G81					M26	15							
N031		X13	000			M06	16							
H032	G81	X11	000	Y10	000	M56	17	6		3.5	1530	THRU		1/4 DRILL
N033		X09	000				18							
N034				Y08	000		19							
N035		X11	000			M06	20							
H036	G80	X10	000	Y09	000	M57	21			1.5	600	.250		2" CARBIDE END MILL
N037	G81					M26	21							
N038	G80	X10	000	Y16	000	M02	22							UNLOAD POSITION

Figure VIII-7. Program for Acramatic 220. *(Continued on next page)*

THE CINCINNATI MILLING MACHINE CO.
NUMERICAL CONTROL POSITIONING SYSTEM

TOOL DESIGN DEPT.

CHANGE NOTICE	CHG	DRAWN BY	DATE	CHK'D BY	DATE	CHANGE NOTICE	CHG	DRAWN BY	DATE	CHK'D BY	DATE
	X						O				
	O						O				
	O						O				

OPER. NO.
SETTING NO. OF
SHEET OF
LOC/MACH.

NC-

PART NAME

TOOL NO.	TOOL NAME

POS. NO.	X POSITION	Y POSITION
1	06.000	12.000
2	08.000	12.000
3	10.000	12.000
4	12.000	12.000
5	14.000	12.000
6	14.000	06.000
7	12.000	06.000
8	10.000	06.000
9	08.000	06.000
10	06.000	06.000
11	07.000	11.000
12	13.000	11.000
13	13.000	07.000
14	07.000	07.000
15	07.000	09.000
16	13.000	09.000
17	11.000	10.000
18	09.000	10.000
19	09.000	08.000
20	11.000	08.000
21	10.000	09.000
22	10.000	16.000

JN-44-59

Figure VIII-8. Numerical control positioning system.

0420
5539

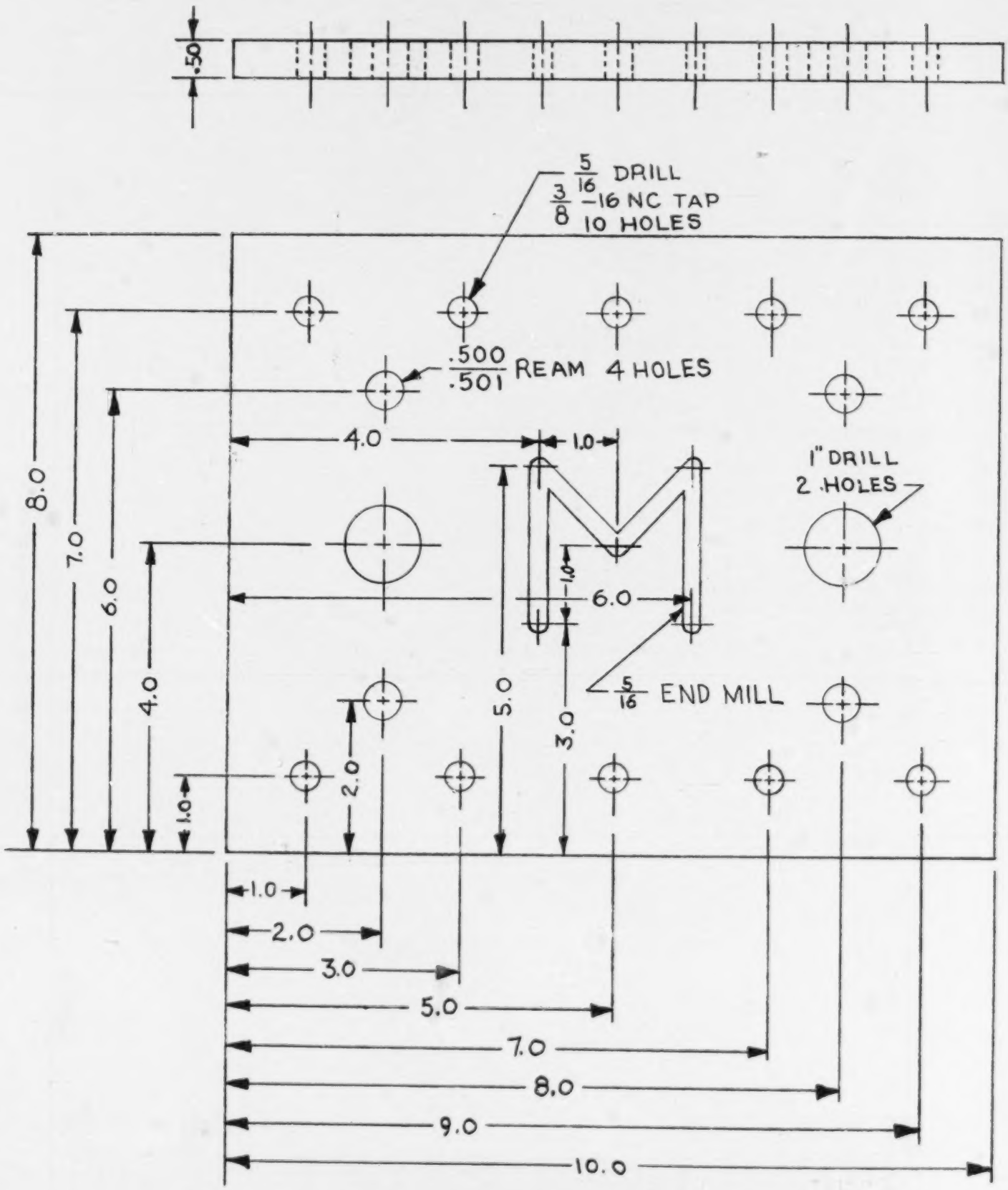

COVER PLATE

MATERIAL: SAE 1018 STEEL

SCALE: 1/2"=1"

Figure VIII-9. Sample drawing for programing.

2233

6540

PROGRAM FOR #3 CINTIMATIC

CINCINNATI
ACRAMATIC POSITIONING
NUMERICAL CONTROL SYSTEM

PART NAME: COVER PLATE
PART NO.: FIG.
DRAWING NO.:
REVISION:
FIXTURE NO.:
PROGRAMMED BY:
PAGE 1 OF 2 PAGES
SET UP AND TOOL INFORMATION: REF. POINT X=05.000 Y=06.000
DATE:

HOLD IN #5 VICE WITH A POSITIVE STOP

H or N SEQ. NO.	G PREP. FUNCT.	X POSITION	Y POSITION	M MISC. FUNCT.	POS. NO.	TOOL NO.	HEAD POS.	SPINDLE FEED IN./MIN.	SPEED RPM	DEPTH OF CUT	TABLE FEED IN./MIN.	TOOL REMARKS
H001	G81	X06.000	Y13.000	M51	1	1		6.5	1710	THRU		5/16 DRILL
N002		X08.000			2							
N003		X10.000			3							
N004		X12.000			4							
N005		X14.000			5							
N006			Y07.000		6							
N007		X12.000			7							
N008		X10.000			8							
N009		X08.000			9							
N010		X06.000		M06	10							
H011	G84	X06.000	Y07.000	M52	10	2		10.0	250	THRU		3/8-16 N.C. TAP
N012		X08.000			9							
N013		X10.000			8							
N014		X12.000			7							
N015		X14.000			6							
N016			Y13.000		5							
N017		X12.000			4							
N018		X10.000			3							
N019		X08.000			2							
N020		X06.000		M06	1							
H021	G81	X07.000	Y12.000	M53	11	3		6.0	1070	THRU		31/64 DRILL
N022		X13.000			12							
N023			Y08.000		13							
N024		X07.000		M06	14							
H025	G81	X07.000	Y08.000	M54	14	4		12.0	500	THRU		.500 - .501 REAMER
N026		X13.000			13							
N027			Y12.000		12							
N028		X07.000		M06	11							
H029	G81	X07.000	Y10.000	M55	15	5		6.5	500	THRU		1" DRILL
N030		X13.000		M06	16							
H031	G80	X09.000	X09.000	M56	17	6		3.0	800	3/16		1/4" END MILL
N032	G79				17							
N033			Y11.000		18							
N034		X10.000	Y10.000		19							
N035		X11.000	Y11.000		20							
N036			Y09.000		21							
N037	G81				21							
N038	G80	X10.000	Y16.000	M02	22							UNLOAD POSITION

Figure VIII-10. Sample program for cover plate.

NUMERICAL CONTROL POSITIONING SYSTEM	CHANGE NOTICE	CNO	DRAWN BY	DATE	CHK'D BY	DATE	CHANGE NOTICE	CNO	DRAWN BY	DATE	CHK'D BY	DATE	OPER. NO.	NC-
TOOL DESIGN DEPT.													SETTING NO. OF SHEET OF LOC/MACH.	PART NAME COVER PLATE

POS. NO.	X POSITION	Y POSITION
1	X06.000	Y13.000
2	X08.000	
3	X10.000	
4	X12.000	
5	X14.000	
6		Y07.000
7	X12.000	
8	X10.000	
9	X08.000	
10	X06.000	
11	X07.000	Y12.000
12	X13.000	
13		Y08.000
14	X07.000	
15		Y10.000
16	X13.000	
17	X09.000	Y09.000
18		Y11.000
19	X10.000	Y10.000
20	X11.000	Y11.000
21		Y09.000
22	X10.000	Y18.000

TOOL NO.	TOOL NAME
1	5/16 DRILL
2	3/8-16NC TAP
3	3/64 DRILL
4	.500/.501 REAM
5	1" DRILL
6	1/4" END MILL

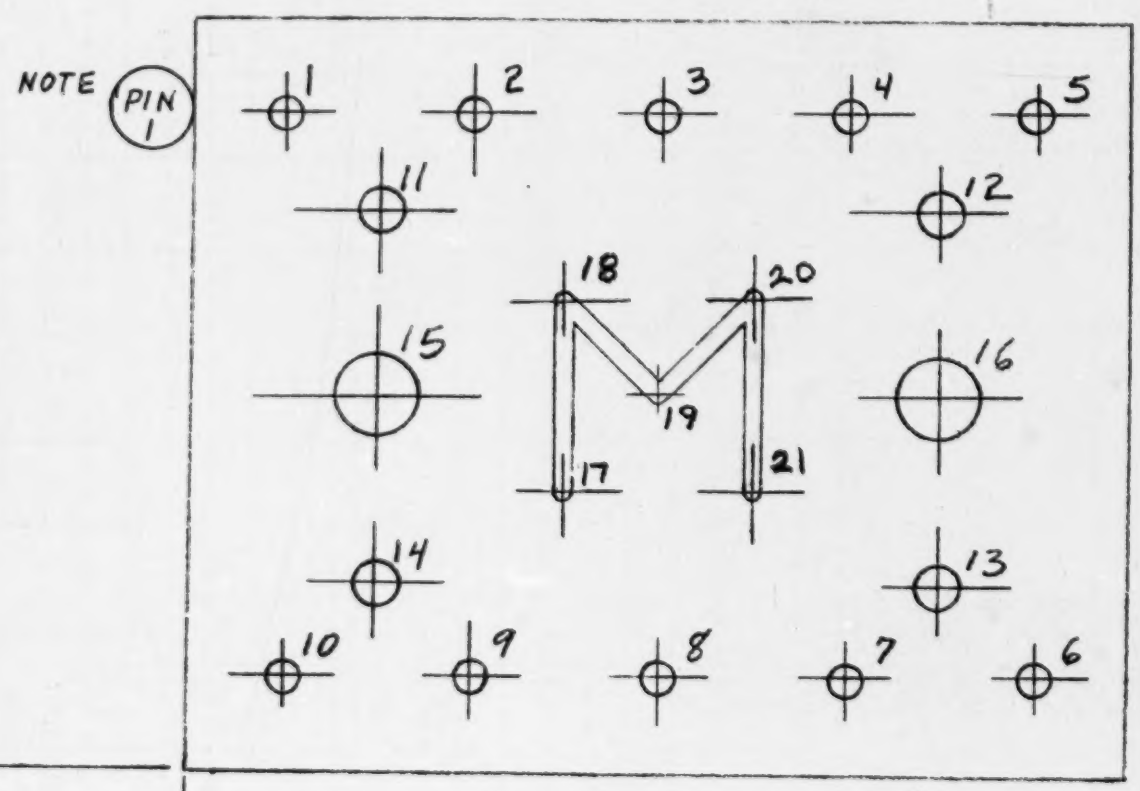

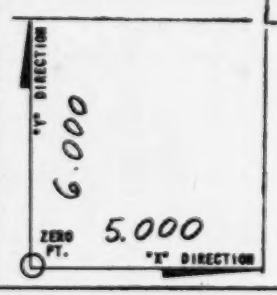

NOTE: PART HELD IN #5 VICE, USING PIN 1 AS STOP

Figure VIII-11. Numerical control positioning system for cover plate.

5542

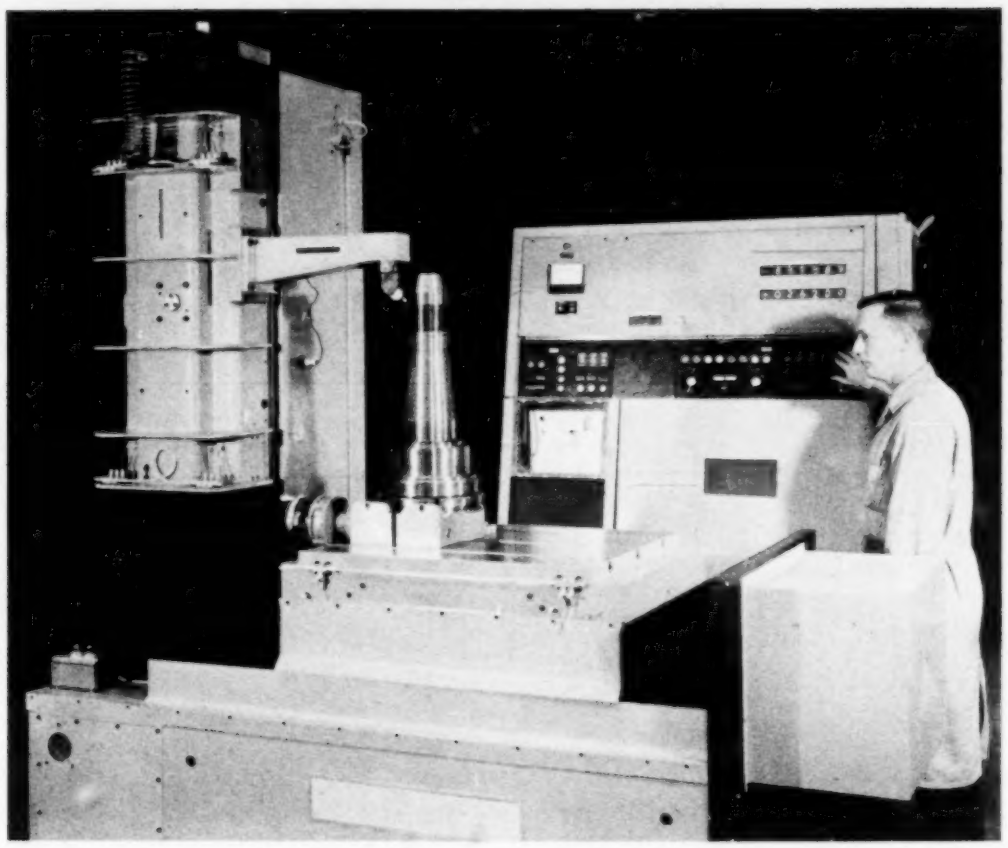

23. Controlled measuring machine.

24. Universal measuring machine.

5543

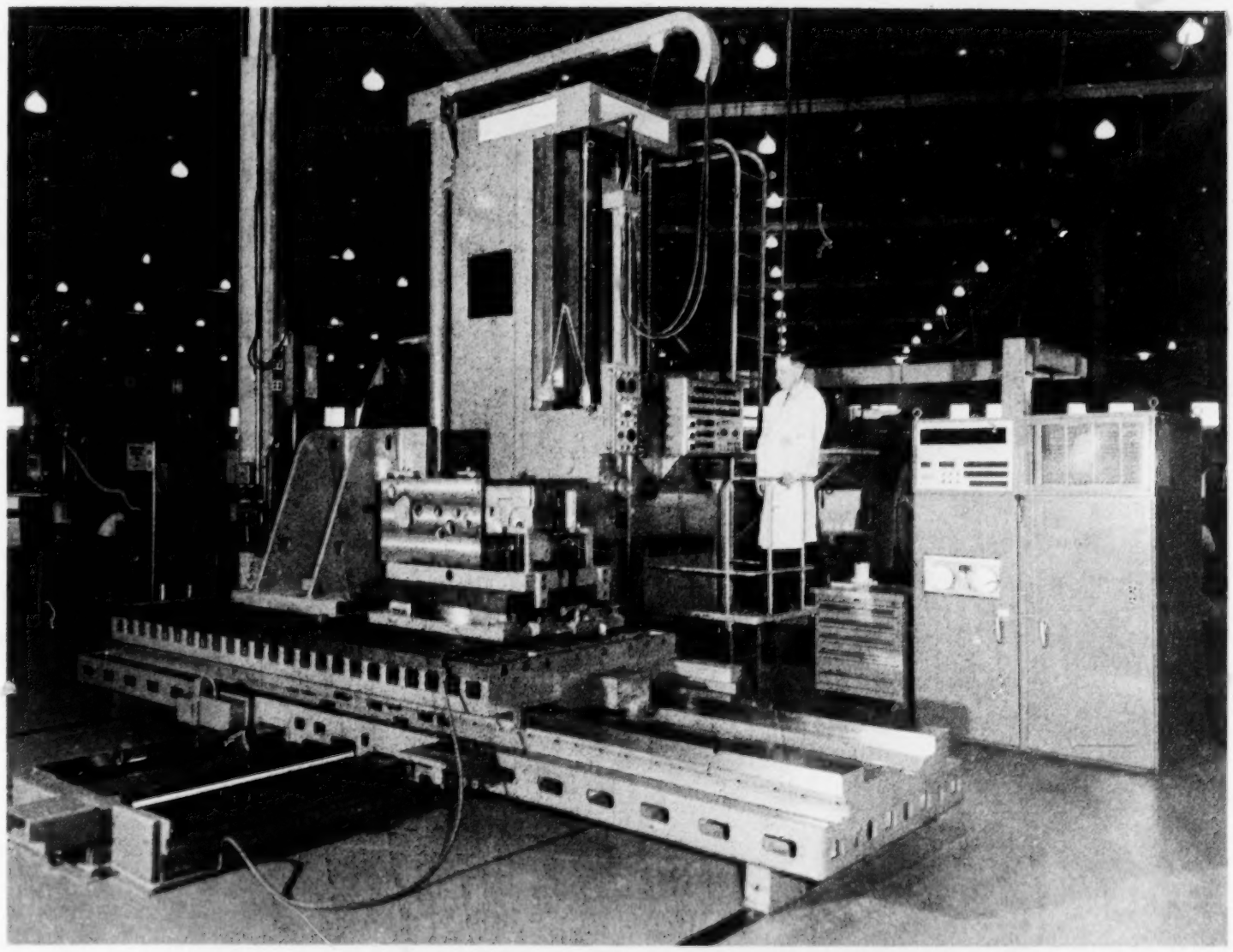

27. Five-axis machine.

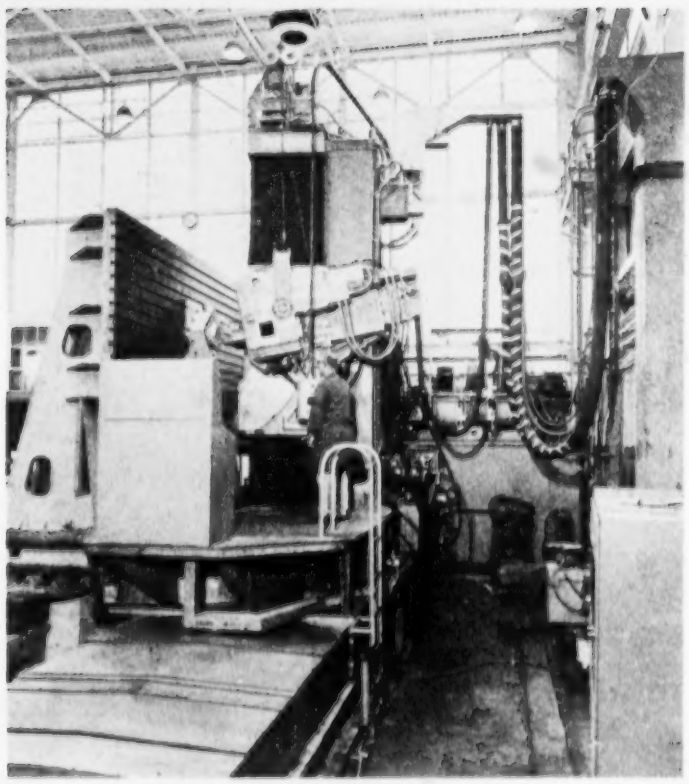

28. A horizontal two-, three-, or four-axis control mill.

5545

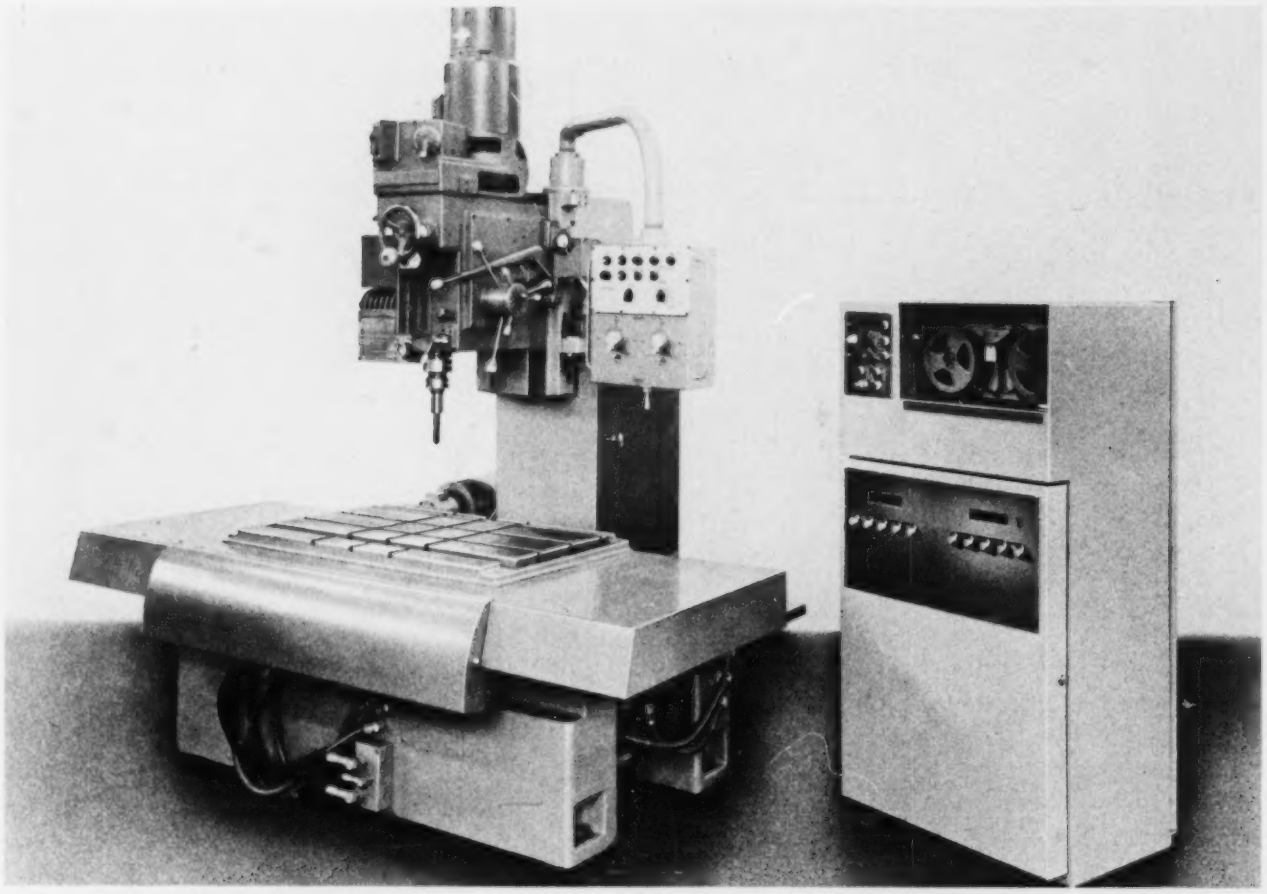

29. Vertical spindle drilling and milling machine.

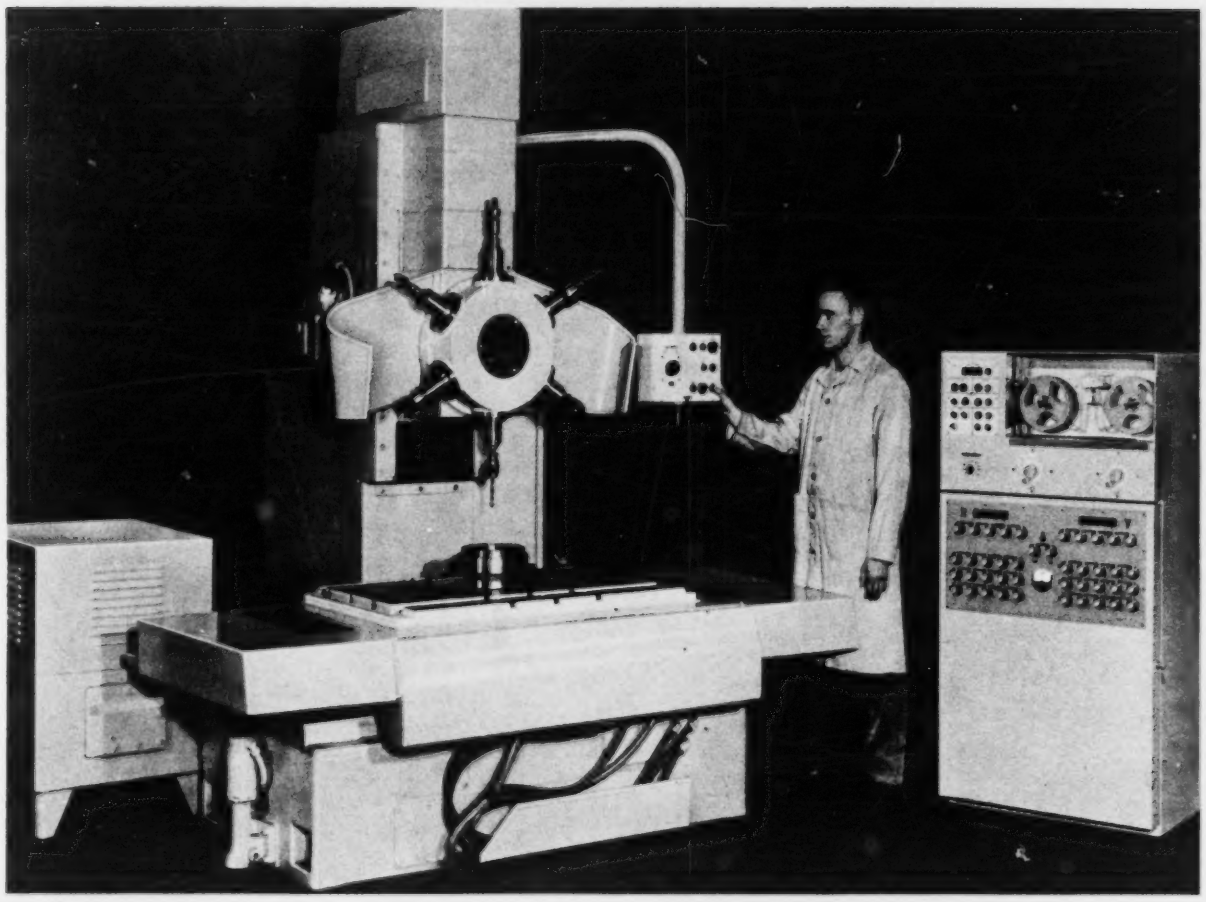

30. Drilling machine turret.

5546

APPENDIX I
TEACHING TIPS

There is no one good, all-purpose teaching technique or procedure. It is necessary to utilize a variety of methods to get across different facts and ideas.

Talking is not teaching.

Listening is not learning.

Class Discussion—Introduce the problem in a stimulating manner, keeping the topic before the group at all times by keeping the comments relevant to the subject. Each member must assume responsibility for an effective discussion. Summarize at the end of each unit to stress the basic or important principles.

Resource Persons—Prepare the class for the topic to be covered. Give the resource person a topic and a length of time to present his topic. Allow time for questions and answers.

The student will learn faster, remember better, and apply the information more fully and skillfully if you keep in mind the following points:

1. If the student can see the target clearly, the potential of hitting it is good. Be sure the learner knows what is expected of him. A systematic, carefully planned course and unit outline, in which the desired goals or purposes are carefully differentiated into information, learning processes, skills, and values is most helpful to learning.

5547

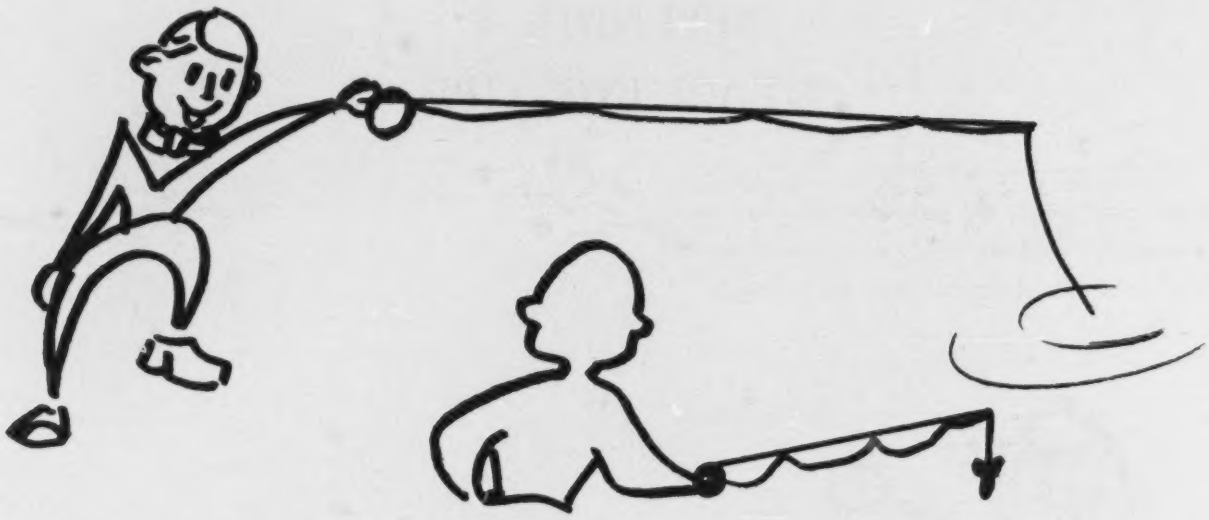

2. We learn when we practice. Effective practice requires a model to be imitated. The student will use his faculties for discovering new facts, for critical thinking, and for discriminating judgments if he sees the instructor doing this. The student should be urged to practice skills in the manner in which he wishes to use them on the job.

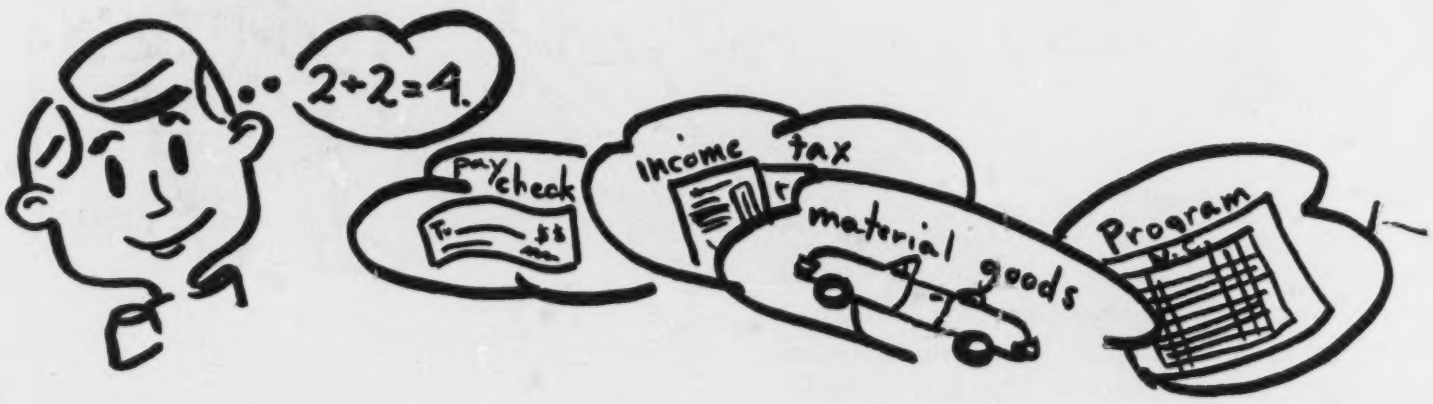

3. Instructors teach for transfer and application. A new principle learned will have many applications and associations if it is within the experience of the student. An ounce of experience is worth a ton of theory, simply because it is only as an experience that a theory or principle has significance.

4. Motivation factors are important to learning. Nothing motivates like success. Rewards are strong motivational factors. Mature students learn to be motivated by both present and remote rewards. Praise is better than scolding.

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5. Learning is increased by knowledge of results. The beginning golfer who got a hole-in-one asked his instructor, "What did I do right?" Do your comments (feedback) lead him on or make him fear the results?

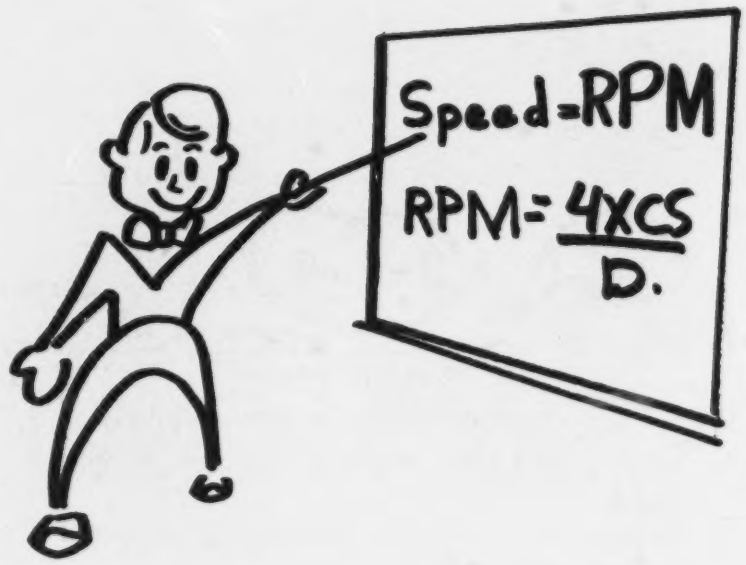

6. We learn best what is meaningful. Our most meaningful experiences are those which help us reach our goals. No occurrence is an event for us unless it has bearing or significance for our purposes.

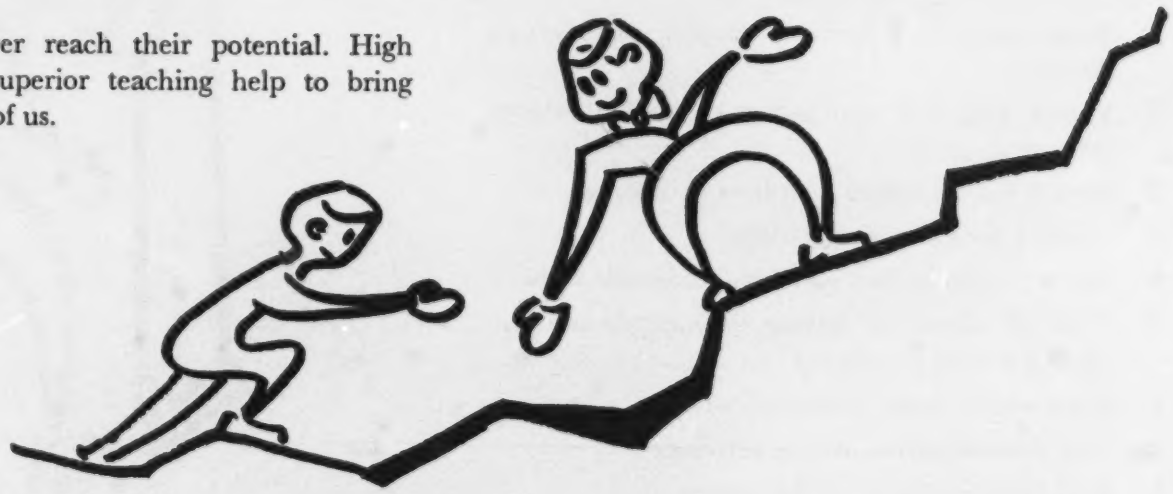

7. Most people never reach their potential. High motivation and superior teaching help to bring out the best in all of us.

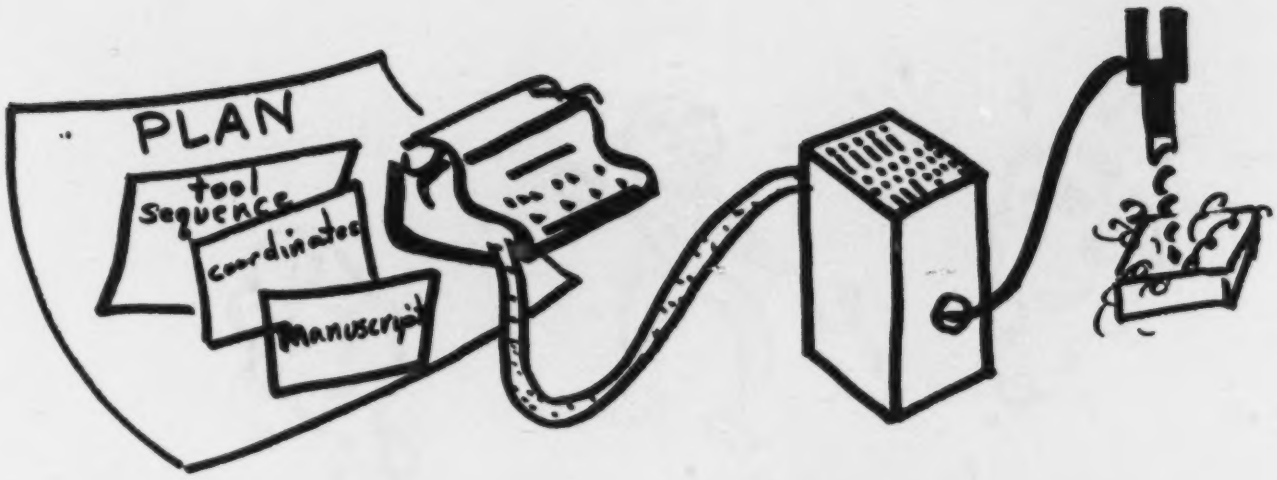

8. Learning is improved when organized for sequential and cumulative effects. Each student must skillfully file his fund of information so that he can quickly put his finger on whatever he needs to know.

Treat your students as you, an adult, wish to be treated.

Characteristics of Students

C Come to class with opinions on various subjects

H Have a remarkable ability to learn things thoroughly

A Appreciate a systematic, business-like procedure in the learning process

R Require subject matter designed to meet their needs

A Acutely desire participation in laboratory work

C Contemplate consideration as adults

T Traditionally have firmly developed aptitudes and attitudes

E Expect practical application of the knowledge they are gaining

R Reveal the richness of their lives to others

I Invite informality and variety

S Seek to upgrade their social and economic status

T Take an interest in having their experiences co-related with new material

I Insist on full use of classroom time

C Crave participation in class activities

S Seek "give and take" in discussions

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ABSTRACT - This teaching guide on animal nutrition was compiled by agriculture education instructors in cooperation with the Department of Agricultural Education at Montana State University. Topics are: (1) Introduction to Animal Nutrition, (2) How Animals Use Their Feed, (3) How Nutrients Are Supplied to Livestock, and (4) Balancing the Ration. The guide is in outline form with objectives for each section. (GB)

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ANIMAL NUTRITION

Teachers Guide

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AGRICULTURAL EDUCATION DEPARTMENT
MONTANA STATE UNIVERSITY, BOZEMAN,

ANIMAL NUTRITION

Teacher's Guide

Compiled by

Agriculture Education Instructors

Summer Session 1970

under the guidance of

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Bozeman, Montana

Animal Nutrition

Teacher's Guide

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INTRODUCTION

Note To Teachers In Planning the Animal Nutrition Unit: Plan Early To:

1. Conduct an animal feeding experiment. A procedure for an experiment which has been conducted with chickens is included on pages 39,40,41 & 42. For additional information, the bulletin "Animal Feeding Demonstrations for the Classroom" may be purchased for 30¢ from the National Dairy Council, 111 Canal Street, Chicago, Illinois 60606.

2. Field trips should be incorporated in conjunction with your animal science class.
   Suggestions:
   - Outstanding feeding operations in the area
   - -- range
   - -- dairy
   - -- poultry
   - Feed mills
   - State programs on feeding such as
   - -- MSU Annual Feeders' Day or
   - -- local meetings with University or company nutritionists

3. Film strips, slides, etc. on nutritional subjects - See Montana Vocational Agricultural Education Course of Study suggested list of references and resources.

4. Examples of different feeds brought to the classroom such as grains, hays, silages, etc. are important visuals.

5. Have local grain, hay, and silage samples sent to MSU for analysis through your county extension office.

ANIMAL NUTRITION

OBJECTIVES -- To provide a basic understanding of animal nutrition with practical application to animal feeding.

I. INTRODUCTION TO ANIMAL NUTRITION

Discoveries in the basic sciences as chemistry, physics physiology, radiation-biology, have increased the knowledge base of applied animal nutrition. For this reason it is vitally important that persons feeding animals keep abreast of up-to-date feeding practices. This is particularly important if today's livestock feeder is to remain competitive.

A. Goals of animal rearing are to assure:

1. Health - Healthy animals are much more economical to raise and are more efficient producers.

2. High production - To economically produce the maximum milk, wool, growth, calf crop, eggs, etc.

3. An adequate income - To provide the necessities and some of the luxuries of life.

4. Satisfaction in work accomplished.

B. Factors of major importance in attaining these goals:

1. Feeding - Supplying the animal with the quality and quantity of all required nutrients in the most satisfactory and economical manner.

2. Breeding - Maintaining a breeding program that will result in the maximum production of top quality produce (milk, meat, wool, eggs, etc.)

3. Control of parasites and diseases - It has been conservatively estimated that these cost American Farmers 2.8 billion dollars annually.

4. Other management practices - Maintaining records, handling and marketing livestock, etc.

C. The nutrition of farm animals is important because of the following:

1. Economy - Feed cost probably represents the largest single expense in animal production.

a. Dairy Cattle - up to 60% of the cost of whole milk is feed costs.

b. Hogs - 80% of the total cost of producing pork.
c. Beef - 80% of the cost (not including purchase price) of finishing cattle.
d. Poultry - 50 to 70% of the total production cost.
e. Sheep -

2. Production Efficiency - A diet deficient in one or more of the essential nutrients can drastically reduce the ability of the animal to use other nutrients. For example, low protein stunted growth (disregarding other nutrients supplied) Optimum production depends upon feeding the animal according to age, purpose, and species requirements.

3. Dietary Health - Good feeding practices can prevent or help prevent many nutritional related diseases such as: bloat, nitrite poisoning, compaction, ketosis, anemia, colic, flourosis, founder, goiter, heaves, rickets, etc. Unsanitary feeding practices also spread diseases.

4. Market for feeds - Feed is sold through animal products.

D. Animals need feed to:

1. Maintain their bodies to perform the work of respiration, digestion, circulation, etc.

2. Replace and repair tissues which are constantly being broken down.

3. Produce meat, milk, eggs, wool, and do work.

4. Promote growth. Maximum feeding during growth does not necessarily give optimum production later in life. For example, beef and dairy heifers fed at 130% recommended feeding levels produced less milk than those given 100% of the standards.

5. Develop the young fetus, produce viable young, and settle upon breeding.

E. Definitions needed to understand nutrition.

Alfalfa Meal - is the product obtained by grinding entire alfalfa hay without the addition of any alfalfa stems, alfalfa straw or foreign material or the removal of any of the leafy portion. Fiber content should not be higher than about 29 to 30%.

Amino Acids - different nitrogenous compounds which are the fundamental structural units of proteins. (The amino acids may be any one of a class of organic compounds containing the amino group ($-NH_2$) and the carboxyl group (-COOH) attached to a carbon skeleton of varying size. A few amino acids (methionine, cystin) also contain sulfur.)

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Calorie - the amount of heat required to raise 1 quart of water 1 degree centigrade.

Carbohydrates - the chief source of energy and heat in the food of animals. This group of substances includes the sugars, starch, cellulose and other compounds. Carbohydrates are composed of three chemical elements - carbon, hydrogen, and oxygen.

Carotenes - yellow-colored substances that animals convert into vitamin A.

Cellulose - cellulose and related compounds make up the cell walls of plants. It is more complex in molecular structure than starch; very insoluble and resistant; it can be digested by animals only through the action of bacteria, as in the rumen of cattle or sheep.

Concentrates - feeds that are low in fiber and high in total digestible nutrients which may be low in protein or rich in protein.

Digestion Coefficient - percent of each nutrient digested in a feed.

Enzymes - organic compounds which bring about changes in other organic compounds without themselves being changed or broken down.

Essential Amino Acid - those amino acids which cannot be synthesized in the body from other substances or which cannot be made in sufficient amounts.

Fats and Oils - are alike in composition and properties. Fats, however, are solid at ordinary temperatures while oils are liquid. Fats furnish 2.25 times as much heat or energy per pound as carbohydrates

Heat Increment - the additional amount of heat which is produced in the body following and because of consumption of food.

Kilocalorie (KCAL) - 1,000 calories. Megacalorie.

Megacalorie (MEGCAL) - 1,000 Kilocalories. The term used most with Net Energy values. One Megcal also is equal to one Therm.

Metabolism - changes which take place in the nutrients after they are absorbed from the digestive tract.

Mineral - inorganic compounds occurring naturally as a product of inorganic processes.

Net-energy value - caloric energy in a feed available for maintenance and production. Determined by subtracting the energy lost in the feces, urine, combustible gases, and heat increment from the gross energy of the feed.

Nitrogen - free extract made up of the more soluble part of the carbohydrates. It includes starch, the sugars, and the more soluble portions of the carbohydrates.

NPN - non-protein nitrogen; compounds such as urea or biuret.

NRC - (National Research Council) periodically a committee on Animal Nutrition reviews research reports and establishes standards for the different species based on recent research. These recommendations are printed, published, and are available for a nominal fee from the National Academy of Sciences, National Research Council, 2101 Constitution Avenue, N.W., Washington, D. C. 20418

Nutritive ration - the ratio, or proportion between the digestible protein and the digestible non-nitrogenous nutrients (including fat multiplied by 2.25)

Nutrient - a food constituent or group of food constituents of the same general chemical composition, that aids in the support of life.

Digestible Nutrient - that portion of a nutrient which may be digested and taken into the body.

Total Digestible Nutrient (TDN) - the sum of all the digestible organic nutrients; protein, fiber, nitrogen-free extract and fat. (X2.25)

Protein - proteins are complex compounds. In plants and animals there are many different proteins which differ from each other in composition. Each molecule of protein is composed of different nitrogenous compounds called amino acids.

Ration - the feed allowed for a given animal during 24 hours, whether it is fed at one time or in portions at different times.

Balanced Ration - a ration which furnishes the several nutrients in such proportion and amount to properly nourish an animal for 24 hours.

Maintenance ration - the amount of food needed to support the animal, when doing no work and yielding no product.

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Starch - composed of many molecules of glucose. Starch is the chief carbohydrate in plants and therefore very important in stock feeding.

Soiling Crops - green forage crops that are cut and fed in fresh condition to stock.

Supplements - a feed or a feed mixture used with another feed to improve the nutritive balance or performance of the total ration.
Supplements can be:
a. fed undiluted as a supplement to other feeds, or
b. offered as free choice with other parts of the ration separately available, or
c. further diluted and mixed to produce a complete feed

Toxicity - an imbalance in the system due to a shortage or over supply of a nutrient, which may be sickening or cause death. Veterinarians qualify the toxicity level by mild or acute.

Therms of net energy - a therm is a unit of measuring heat; it is the amount of heat required to raise the temperature of 1,000 kilograms of water 1 degree centigrade or to raise the temperature of 1,000 lbs. of water about 4 degrees fahrenheit. One therm is equal to 1,000 kilocalories. See MEGCAL.

Vitamin - an organic nutritive required in very minute amounts.

Roughages - feeds that are high in fibers and; therefore, low in total digestible nutrients.

II. HOW ANIMALS USE THEIR FEED

A. General Composition of Body - different species are similar in composition, expressed in a dry, fat free basis but varies on total basis with kind and ages of livestock.

1. Water - content decreases with age (i.e. 95% in embryo - 50 to 60% in mature animals).
   a. The nutritional state of the animal and the fat it has stored accounts for the decrease of water stored in the animal.
   b. Blood plasma contains 90 to 92%, muscles 72 to 78%, bone 45%, and teeth enamel 5% water.

2. Protein - on a fat-free basis, the average body contains 21.6% protein.

3. Ash - on a fat-free basis, the body contains 5.3% ash (mineral matter). The protein and ash content do not vary as much as water and fat. The percentages of the principal mineral constituents of the body are indicated in the following table:

Element	Percentage
Calcium	1.33
Phorsphorous	0.74
Sodium	0.16
Potassium	0.19
Chlorine	0.11
Magnesium	0.041
Sulfur	0.15

4. Carbohydrates make up less than 1% of body at any given time. Carbohydrates are stored in the form of glycogen. Excess carbohydrates are stored as fat.

5. Fats - fats are stored under the skin and around the intestines, kidneys, and other organs. Every cell contains some form of lipids.

B. The relationship of nutrients in the feed to body functions of animals.

1. Six nutrients are considered essential to an animal's growth and development.

   a. Proteins are found in every cell and are the principle constituents other than water for the organs and soft structures of the body such as muscles, tendons, and connective tissues.

b. Carbohydrates are the main source of energy and heat for animals.

c. Fats are used for energy and heat when needed. Fats contain 2.25 times as much energy as carbohydrates. Three fatty acids (arachidonic, linoleie, linolinie) are considered essential.

d. Water - water is the largest single constituent of nearly all living plant or animal tissues, and also performs exceedingly important functions.
   1) Water makes up over 50% of body composition, and many tissues contain 70-90% water. A loss of 10% of body water could cause death.
   2) Water facilitates cell reaction-product of reaction.
   3) Aids in digestion and transfer of metabolic products.
   4) Regulates temperature of animals.
   5) Special body fluids-(Lubricates joints, cussions eye, etc.)
   6) Helps hold body shape.

e. Minerals - minerals though present in most plants in relatively small amounts, are essential for animal growth.
   1) Aside from calcium, the elements occur as fractions of a percent only but are absolutely essential to life.
   2) Calcium is present almost entirely in the bones and teeth as phosphate and hydroxide.
   3) Phosphorous, which combines with calcium to form the skeleton accounts for 80% of the body supply. The remainder is distributed in combination with proteins, fats, and as inorganic salts.
   4) Sulfur occurs throughout the body as part of protein molecules.
   5) Sodium, potassium, and chlorine are present almost entirely as inorganic salts in body fluids.
   6) Magnesium is present in the bones, but is also found distributed throughout the body.
   7) Iron is an essential constituent of the hemoglobin in blood and is also found in body organs and tissues.
   8) Iodine, copper, zinc, manganese, cobalt, selenium, and probably florine and chromium are essential for stuctural or metabolic purposes.
   9) Boran, silicon, bromine, aluminum, nickel, and arsenic occur normally in the body though their exact function is not known.

f. Vitamins regulate body functions.
   1) Keep the mucous membranes healthy.
   2) Prevent respiratory diseases.
   3) Prevent nervous disorders.
   4) [redacted] bone deformity.

[redacted]

5) Prevents reproduction disorders.
6) Helps blood clotting.
7) Prevents muscle disorders.

C. Major plant and animal differences which affect livestock feeding.

1. All animal life depends on plants. Plants contain the same substances as animals but the amounts present are very different.

2. Differences:
   a. Animal cell walls are made of protein whereas plant cell walls are made of cellulose and are more rigid.
   b. Animals store food as fats.
      Plant reserve food as carbohydrates.
   c. Animals utilize plants as food.
      Plants use energy supplied from sun to make its food.
   d. Animals can move to obtain food.
      Plants are rooted (anchored) to one spot.
   e. Animal dry matter is mostly protein.
      Dry matter of plants is mostly carbohydrates.
   f. There is more calcium in an animal.
      Plants are much lower in calcium.

D. Necessary processes required to utilize feeds and thereby sustain life.

1. Digestion and absorption.
   a. Food is broken down into relative simple chemical compounds that are mostly soluble in water and are readily absorbed through the membranes which line the digestive system.
      The digestive system includes the mouth, gullet, stomach, small and large intestines.
   b. Digestion starts in the mouth.
      1) Food is ground (mastication) by the teeth and moistened to be swallowed. A cow may secrete 125# of saliva in 24 hours.
      2) Very little digestion takes place in the mouth as the food is there for such a short time. Carbohydrate digestion may start with saliva enzyme action but the acidity of the stomach (1.5 - 3.0 pH) stops the enzyme action.
   c. Gullet (Esophagus) - Passageway to the stomach or gizzard in a chicken.
   d. Stomach - 2 types (complex and simple)
      1) The simple stomach is found in man, dog, pig, and carnivorous animals.
         (a) Protein digestion starts in the stomach with enzyme action. Broken into polypeptides.
         (b) Hydrochloric acid aids digestion in the stomach.
         (c) Very little carbohydrate or fat digestion takes place in the sto[redacted]

2) The complex (compound) stomach is found in cattle and sheep.
   (a) Ruminants have 4 compartments or stomachs (rumen, reticulum, omasum, and abomasum) which may hold over 250 quarts. In cattle more than 50% of the mature animals digestive tract capacity is in the rumen and reticulum. This area is needed so bacteria and protazoans may break down the cellulose and other complex carbohydrates. Food is regurgitated from the reticulum to be rechewed and reswallowed. The finer particles are constantly being moved on through the 3rd (omasum) and 4th (abomasum) compartments.
   The abomasum has enzymes like those found in the stomach of monogastric animals.
   (b) Proteins are digested and resynthesized by the bacteria in the rumen and passed to the abomasum where they are digested.
   (c) Carbohydrates are broken down by micro-organisms to meet their own needs. During the process volatile fatty acids are produced, absorbed and used as an energy source by the animal.
   (d) The micro-organisms synthesize the B-complex vitamins which can be absorbed and utilized by the animal.
3) Small Intestine.
   (a) The small intestine in cattle is about 160 feet long and 60 feet long in swine. It is lined with villi which protrude from the intestinal wall thereby enlarging the area in which the nutrients come into contact. Most absorption of nutrients occurs in the small intestine.
   (b) Most of the proteins (dietary and microbial), fats, and carbohydrates are broken down by enzymes and absorbed in the small intestine. This is also the site of mineral and vitamin absorption.
   (c) Bile secreted into the small intestine helps break down the dietary fats.
4) Large Intestine - One important function of the large intestine is to absorb water and stop dehydration. Digestion of nutrients continues in the large intestine to a smaller degree.
   (a) That part of the large intestine next to the small intestine called the cecum is greatly enlarged in horses and to some degree in swine. There is bacteria present in the cecum and large intestine of horses to help break down complex carbohydrates which are found in roughages.

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(b) The purpose of the colon is to regulate the passage of the feces which contain undigested food and other body wastes.

E. Transportation of nutrients - arteries take blood from the heart and veins bring it back. At the end of the small arteries are capillaries which connect the arteries to veins. The nutrients pass through the capillary walls to the blood and are carried where needed. Waste products are also passed through the capillaries.

1. Blood - the composition of blood is very important as it is the medium by which nutrients are carried throughout the body and by which metabolic waste products are removed. Blood makes up 5 to 10% of the body weight. Corpuscles make up 35 to 40 percent of the blood. About one-third of the solid matter of the red corpuscles is the iron containing protein hemoglobin which is responsible for transporting oxygen and carbon dioxide. The plasma contains 10% of solids, more than one-half of which is protein. The remainder consists principally of fatty substances, sugar, non-protein nitrogen compounds, and inorganic salts.

2. Lymph is a nearly colorless fluid that bathes the body cells and fills the space in between them. Nutrients and oxygen pass to the cells in lymph and carbon dioxide and waste products are transferred to the veins through the lymph.

3. Glucose is withdrawn from the blood and temporarily stored as glycogen in the liver. (3 to 7% of the liver weight is glycogen). The glycogen is converted to glucose as the body needs it to nourish the various body tissues.

F. Other Process - Hormones control and regulate many of the body functions and are important in metabolism. An example is thyroxine which regulates the rate of metabolism.

III. HOW NUTRIENTS ARE SUPPLIED TO LIVESTOCK

A. Classification of Feeds - When feeds are used to make up diets or feed mixtures they usually have a specific purpose depending upon their chemical make-up. In the NRC classification feeds are divided into eight main groups:

1. Dry forages and roughages.
   Forages or roughages are low in net energy per unit weight, usually because of their high fiber content though sometimes because their water content is high. According to the NRC nomenclature and also according to the Canada Feed Act products that in the dry states contain more than 18 percent crude fiber are classified as forages and roughages. Thus, in addition to forages, such products as oat hulls, alfalfa meal, dried beet pulp, brewers grains (some samples), and rice bran, which are sometimes listed among the concentrates are included in this group. Few roughages contain as much as 1,200 kilocalaries digestable energy per lb. (16 percent TDN), and the average is not far from 1,000 kcal per lb. (50 percent TDN). Examples are:
   - Hay
     - Legume
     - Nonlegume
   - Straw
   - Fodder (aerial pt w ears w husks, or heads)
   - Stover (aerial pt wo ears wo husks, or heads)
   - Other products with more than 18 percent fiber
     - Hulls
     - Shells

2. Pasture, range plants, and forage fed green.
   Included in this group are all feeds not cut and cured. For example: all feeds cut and fed green or feeds cured on the stem, such as dormant range plants. The term "fresh" is a common term used even though the feeds may be dry and weathered when consumed.

3. Silages
   Characteristic examples are:
   - Corn plant (including plant parts and grain)
   - Legume
   - Grass

4. Energy or basal feeds
   Products with less than 20 percent protein and less than 18 percent crude fiber. The term "basal feeds" and "energy feeds" are often used interchangeably.
   Characteristic examples are:
   - Cereal grains
   - Mill by-products
   - Fruits
   - Nuts
   - Roots

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Fruits, nuts, and roots are classed as energy feeds because in making up diets and feed mixtures they are included primarily to supply energy. However, many of the fruits and some roots are excellent sources of vitamins and minerals for humans.

5. Protein supplements
   Products which contain 20 percent or more protein.
   Common sources are:
   - Animal by-products
     - Tankage
   - Marine
     - Fish Meal
   - Avian by-products
     - Feathers, litter, and feces
   - Plant
     - Cotton meal
     - Soybean meal
     - Linseed meal
     - Mustard meal

6. Mineral supplements
   See p.25-27 for explanation and discussion of minerals

7. Vitamin supplements
   See pages 27 - 32 for listing of sources and a discussion of vitamins.

8. Additives are various compounds added to nutrients which do not, of themselves, have nutritional value but may enhance growth, increase rate of gain, increase disease resistance, add coloring to animal products, may increase palatability, etc.
   Examples are:
   - Antibiotics
   - Flavors
   - Hormones
   - Medicants

B. Utilizing pasture and range land effectively for livestock feed.

1. Feeding value of pasture and range grasses.
   See pages 644, 636, 566, and 550 of Morrison's Feeds & Feeding, Ninth Edition.

2. Effect that growth and maturity has on the feeding value of pasture and range grasses.
   - The protein content decreases with maturity.
   - The T.D.N. content decreases with maturity.
   - The lignin content increases with maturity.
   - The vitamin content, particularly pro-vitamin A (carotene), decreases with maturity.
   - The palatability usually decreases with maturity.

In summary, the maturity is the most important factor affecting chemical composition and digestibility of a plant.

3. Economical value of utilizing pasture and range land.
   a. Pasture
      Dairy: High energy concentrates and trace mineral salts in the ration are needed to supplement pasture.
      Beef: Trace mineral salts plus good pasture will usually meet the animal's needs.
      Sheep: Trace mineral salts plus good pasture will usually meet the animal's needs.
      Horses: Possibly need trace mineral salt in addition to pasture.
      Swine: Can use only limited amounts of pasture feed.
      Poultry: Cannot be economically supplied on a commercial basis, but may be met on a common small farm flock for only home use.
   b. Range
      Dairy: Impractical and uneconomical.
      Beef: (a) Usually sufficient except for some minerals to meet the needs of beef cattle if phosphorous and iodized salt supplements are fed free choice.
      (b) Advisable to use a protein supplement on winter range.
      Sheep: Same as beef.
      Horses: Same as beef and sheep.
      Swine: Uneconomical
   c. Cost/pound of different nutrients:
      1) Beef, sheep, and hourses - pasture and range are the most economical sources of feed for these species.
      2) Dairy, swine, poultry - must be supplemented extensively with grain concentrates due to digestive systems and energy requirements for production.

4. Factors which make for efficient utilization of pastures and range land.
   Range and Pasture
   a. Proper Species:
      Preferred species of grasses according to species of livestock.
   b. Fertilization:
      Improves production quantity and quality.
   c. When to graze - Range
      Regulate grazing of range lands by percentage of decreaser and increaser plants.
      Pastures: See figure 1, next page entitled "Pasture Management for Maximum Profit with Proper Capacity/Acre".

FIGURE 1

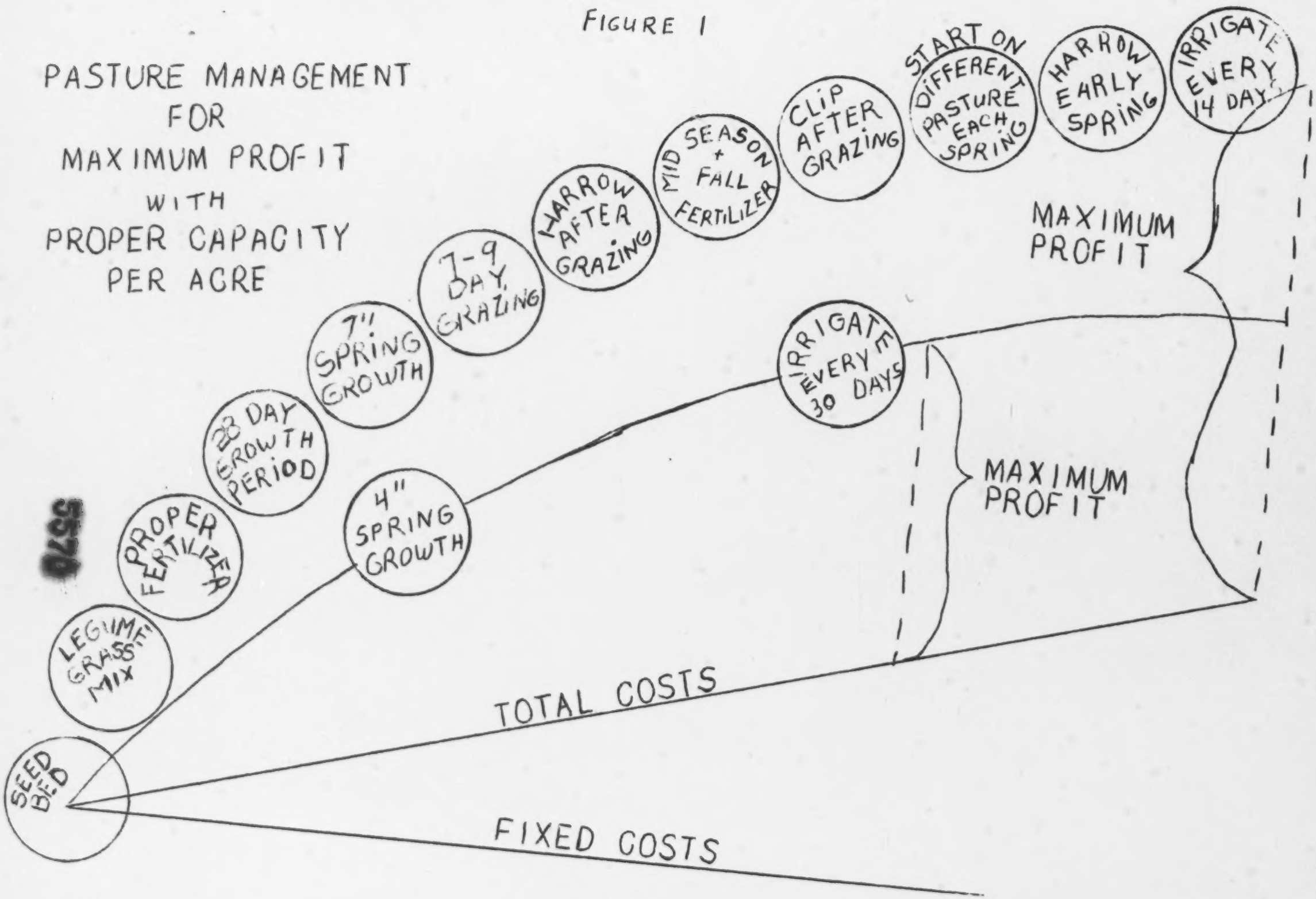

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d. Small Grains may be used as early spring pasture to defer use permenant pastures and range.

e. Management Practices which improve pasture and range utilization are:

Clipping
Weed control
Fertilization
Irrigation

C. Utilizing harvested forages for feeding livestock.

1. Types of forage examples are:

a. Hay - forages cut, cured, and stored for later use by livestock.

1) Legume - alfalfa, clovers, soybeans, sanfoin.
2) Grass - bromegrasses, wheatgrasses, timothy, native grasses.
3) Grass and legume mixes - combinations of the above grasses and legumes.

b. Silage - forage crops cut, chopped green, and stored uncured in a silo to create a desired fermentation.

1) Grasses and small grains.
2) Legumes
3) Corn

c. Soilage - forage crops cut and fed in fresh condition to livestock.

1) Legumes
2) Grasses

d. Others - straw, fodder.

2. The value of forage will depend on the time of cutting, length of curing period, losses due to bleaching and leaching, and method of storage. Except for pasture, harvested forages are the cheapest source of nutrients.

a. Characteristics of legume hay are:

1) Highest yield per acre.
2) Highest in protein.
3) Highest calcium content of all farm grown feed.
4) Lower in phosphorous content than cereal grains but higher than grasses.
5) High in Vitamins A and D.
6) Legumes on the average have a higher TDN and net energy than grass hay. For average figures, see NRC or Morrison's Tables of Feed Composition. For specific examples, contact County Extension Agent for local analysis data.

b. Characteristics of grass hay are:

1) Yield will vary greatly but is lower than legumes in the same area.
2) Protein content of grasses is 50% or lower than legumes.
3) Calcium content is about 1/3 as great as that in legumes.

4) Phosphorous content is slightly lower in grass compared to legumes.
5) Grass hay is slightly lower in carotene, Vit. A, and Vit. D.
6) Lower in TDN (45.7%) and higher in fiber (31%) than legumes.
7) Palatability of grass hay will depend on kind of grass and harvesting methods.

c. Characteristics of silages are:
1) Highly palatable, slightly laxative.
2) Nutrient values of average silages are:
a) Grass - TDN = 15.6%; Fiber = 9.7%; Protein =3.2%
b) Legume - TDN=20%; Fiber=9.8%; Protein=4.1%
c) Corn - usually exceeds other home grown crops TDN production per acre.
d) Immature corn - TDN = 12.9%; Fiber = 5.8%; Protein = 0.9%
e) Carotene is generally higher than sun cured hay of the same crop.
f) Vitamin D is relatively lower in most circumstances.
3) Silage is generally worth more per 100 lbs of dry matter than hay.

d. Characteristics of other roughages such as straw.
1) High in fiber, very low in protein and energy.
2) Low in calcium and phosphorous.
3) Used as bulk in feeding fattening rations.

e. Silage - an acre of land will produce a higher yield of soilage crop than when used for pasture.

3. Factors which affect amount of forage consumed.

a. The species and type of produce desired will affect consumption. Examples are:
1) Beef cattle
a) Fattening - small amount of good quality roughages.
b) Wintering - large amounts of roughages depending on size of cow and weather conditions.
2) Dairy cows - large amounts of good quality roughages can be fed. The total ration should contain at least 40 to 45% roughage on a dry matter basis.
3) Sheep - good quality roughages alone will winter sheep up until 6 weeks before lambing.
4) Hogs - can use little roughage. What is used must be of good quality, preferably legumes.
5) Horses - cheap roughage may be used to winter horses. However, moldy or dusty hay should not be fed. Silage should not be fed to working horses.

b. The palatability of the roughages will affect the amount of roughage consumed by the animal. The

palatability will be determined by stage of maturity, methods of harvesting and handling the feed and the type of forage fed.

c. Frequency of feeding - animals fed less often will tend to consume more roughages per feeding but less total feed.

d. Method of feeding - animals on a self-feeding arrangement will eat more than their basic requirements for minimum maintenance.

e. Amount and kind of grain fed - the more concentrate fed the less roughage will be consumed.

f. Deficient or toxic rations may reduce intake due to poorer digestibility.

g. Environment - hot humid conditions reduce forage intake whereas cool or cold weather increases consumption.

h. Variety of forage fed-feeding a combination of forages may increase total dry matter intake, particularly if the forages are of poor quality.

i. Type of forage - hay vrs. green chop vrs. silage, etc. The type of forage fed should be determined on the basis of economics with considerations given to nutritional limitations. Satisfactory results may be obtained from all-silage, all-hay or combinations for cattle.

j. Physical form of feed - more intake if dense feed is fed. (pellets or cubes).

k. Abnormal fermentation in silages - poor quality silage may occur if silage is put up too dry or too wet. This will cause a decreased appetite for silage.

4. Standards for feeding roughages - generally, feed ruminants all the good quality roughages which they will eat. Given below are some approximate amounts of roughage which different species will eat.

a. Beef cattle
   1) 10#/cwt/day of green growing pasture
   2) 1.5# to 2.0#/cwt/day of hay
   3) 3# silage = 1# hay
   4) Straw can be used for roughage to some extent
   5) Total hay required
      20 - 30 lbs/day for 5 months wintering or 1.5 to 2.25 ton plus pasture or range.

b. Dairy cows
   1) 100 to 150# pasture/day
   2) 1.5 to 2.5# hay/cwt/day
   3) 3# silage = 1# hay
   4) Straw for bedding use only
   5) Total hay required - 20 to 30 lbs/day or 3.5 to 5.5 ton annually if fed year-round.
   6) A cow will consume up to 3.0 lbs. of dry matter per 100 lbs. body weight if the roughage is of good quality. Conversely, only 1.5lbs per 100 lbs. may be consumed if the roughage is very mature or of poor quality.

c. Sheep
   1) 1# range grass per 25# body weight
   2) 2# to 3# hay/cwt/day
   3) 3# silage = 1# hay
   4) Straw is of no value to sheep
   5) 5 to 6 sheep = 1 cow

d. Swine - used successfully as a weight regulatory device with brood sows, or to regulate marketing dates of other hogs.

e. Hay equivalent factors of other feeds.
   1) Definition - pounds of forage required to provide the same amount of dry matter present in 1 lb. of hay at a comparable moisture level. Therefore, the value will vary with moisture content. See table 1 (hay equivalent factors)

5. Economy of roughage - roughage is usually the cheapest source of TDN, Protein, and Energy.

E. Problems which may be encountered in forage feeding:

1. Results of changing forage rations.
   a. Requires time for rumen microflora adoption. Commonly causes stresses to animal which may cause a temporary reduction in production and adversely affect health.
   b. Plan forage program to avoid abrupt changes, particularly when many cows are expected to freshen. About 2-4 weeks are required for rumen adjustment when changes in types of forage are made.

2. Failure to full-feed forage when it is economically justified.
   a. Should feed to the point of moderate refusal by larger cows.
   b. Must feed more concentrates to larger cows if their forage intake is held to the average for the herd or that of milking heifers.
   c. Failure to limit forage intake when justified - sometimes it is more economical to feed a limited forage, high concentrate ration. Examples: fattening steers, high-producing dairy cows.
   d. Poor appetite for forage - may be related to:
      1) Ration imbalance or deficiency
      2) Poor quality roughage
   e. Some disorders are primarily forage related. Examples:
      1) Milk fever - High Ca, low P content in roughages
      2) Grass Tetany
      3) Nitrate Poisoning
      4) Prussic-acid poisoning
      5) Milk-fat depressions - particularly with pelleted rations
      6) Weak or silent heats - insufficient phosphorous
   f. Forage may fail to supply adequate nutrients for animal's production needs.

Table 1

HAY-EQUIVALENT FACTORS FOR COMMONLY USED FORAGES

Moisture %	Usual Examples	Hay-Equivalent Factor
85	Actively-growing forage	6.0
80	Direct-cut hay-crop in horizontal silos	4.5
	Green forage in mid-summer	
85	Direct-cut hay-crop in upright silos	3.6
	Wet or immature corn silage; other annuals	
70	Wilted hay-crop, normal corn silage	3.0
65	Wilted hay-crop, dry corn silage	2.6
60	Haylage	2.3
55	Haylage	2.0
50	Haylage	1.8
45	Haylage	1.6
40	Haylage	1.5
35	Haylage	1.4
30	Haylage	1.3

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F. Utilizing grain for feeding livestock.

1. Economic importance of concentrates usually grain and protein supplements.
   a. Concentrates will be used to bring nutrients in roughage ration to desired level when livestock is being fed for maximum production.
      1) Concentrates may be either low or high in protein.
      2) All common feed grains are concentrates.
      3) Corn is used as a standard when determining the value of grains.
   b. Amount of total ration supplied by concentrates for various species.
      1) Beef--when fattening 90% of total ration can be grains.
         In the breeding herd grain can be substituted for roughage when economical. Calves should be wintered on grain equal to 1% of body weight.
      2) Sheep--grains can be used as a source of energy when needed on range. Fattening lambs should be fed grain at rate of 1½ lb. per day or more.
      3) Swine--fattening rations will be about 95% concentrate and fed up to approximately 4 lbs/cwt of live pig. Brood sows should be limited to the energy needed.
      4) Dairy-grain should be limited to 4-6 lbs per day until 6 months of age, 2 lbs per day from then until 3 months before calving if good roughage is given. Grain should be increased from ½ lbs/cwt to 1 ½ lbs/cwt - from 3 weeks until calving - producing cows will eat up to 2½ lbs/cwt of live body weight but should be fed according to milk production.
      5) Poultry--total ration should not be over 5% fiber. Concentrates will make up about 97% of the ration.
      6) Horses--grain can be fed at the rate of ½ lb/cwt of live body weight. Horses working hard can be fed grain to double this amount.

2. Grains utilized for feeding livestock - The particular grain use will depend upon the home-grown grain available, the cost for buying needed grain and the limitations on feeding that grain. Grains commonly used and their characteristics are:
   a. Corn
      1) Excellent where available, (corn and cob meal are excellent feeds for dairy and beef animals.)
      2) Should be ground or cracked for swine & poultry.

b. Rye
   1) Not generally used in wheat growing areas.
   2) Can be used up to 45% of concentrate for dairy, beef and sheep.
   3) Rye should not be fed to young chicks.
   4) May not be palatable for swine.

c. Barley
   1) Averages 5.4% fiber, TDN higher than oats and less than corn.
   2) Barley can be used as the sole source of grain for dairy cattle.
   3) Beef cattle gain as rapidly on barley alone as on corn alone.
   4) Sheep gain as well on barley as corn but require more feed.
   5) Barley can be fed as the only grain to sheep.
   6) Swine do nearly as well on barley as on corn but require more feed.
   7) Barley is less palatable for poultry and is less valuable than corn. It should be limited to 30% of chick starter and 15% of boiler rations.

d. Wheat
   1) Beef cattle can utilize wheat at the rate of up to 60% of the concentrate ration. Inexperienced feeders should use no more than 30% wheat in the ration.
   2) Wheat is worth more than shelled corn in the ration but may cause bloat if fed alone.
   3) Wheat is equal to ground corn for dairy cows. Soft Pacific Wheat can furnish up to 100% of the grain in the ration.
   4) Wheat is worth more than barley for fattening lambs and need not be ground.
   5) Wheat should be mixed with a bulky feed for horses.
   6) Wheat is preferred over barley for poultry.
   7) Wheat is worth more than corn for swine and need not be ground when self fed.

3. Advantages and limitations of grains for feeding:
   a. High in starch - low or relatively low in fiber, high in TDN and net energy.
   b. Palatability - nearly all grains are palatable to all livestock with the exception of rye.
   c. Minerals - slightly higher than hay in P but low in Ca.
   d. Vitamins - generally low in Vitamins. Corn is the only grain that has an appreciable pro-Vitamin A content. All grains contain an adequate supply of Vitamin E.
   e. Protein and quality of protein is such that some supplementation is generally needed.

f. Because of their limitations, grain alone will not give an adequate supply of nutrients to meet livestock needs. Grains usually need to be supplemented to supply adequate levels of:
   1) Protein (amount and quality)
   2) Minerals
   3) Vitamins
   4) Bulk

4. Criteria used in determining the levels of grain feeding.
   a. Dairy-acording to milk production
   b. Swine
      1) Fattening swine should be full fed on grain concentrates.
      2) Breeding herd should be supplied with enough net energy to supply body and fetal development needs.
   c. Beef
      1) Fattening beef can be full fed on grains.
      2) Breeding herd should have grain or supplements to supply energy and protein if fed low quality hay.
   d. Sheep
      1) Fattening - grain intake should be limited to what they can clean up in 15 minutes twice each day or they can be self-fed a grain ration mixture of 1/3 oats, barley and beet pulp.
      2) Breeding herd - should be fed only to meet the energy needs and nutrient needs not furnished by the forage.
   e. Horses should be fed according to the work they are doing.

C. Supplying protein needs to provide optimum livestock production.

1. Proteins are used by the body in the following ways:
   a. As structural components (80% of the body weight is protein on a dry and fat free basis).
   b. As enzymes
   c. As Hormones
   d. As oxygen carriers in blood
   e. and are associated with genes

2. Effect of protein on feed costs and production.
   a. Expense - there must be a correlation between amounts of protein with relation to production and cost because protein is usually the highest cost feed stuff.
   b. A lack of protein will cause:
      1) Lower production
      2) Lower efficiency
      3) Lack of growth
      4) Kwashiorkor in humans
      5) Poor reproduction

c. Excess protein will cause:
   1) Excess costs
   2) a) animal will not limit amounts of protein intake.
      b) excess protein will be converted and used as an energy source.

3. Importance of protein quality.
   a. Proteins are complex compounds made of 25 or more amino acids.
   b. Ruminants will supply the quality of protein if the quantity is present. This is possible because microbial action will manufacture specific amino acids for use by the animal. However, the proper quantity of protein is very important.
   c. Monogastric (simple stomach) animals cannot make ten of the amino acids and therefore the following are considered the * essential amino acids:
      1) Histidine
      2) Arginine
      3) Valine
      4) Leucine
      5) Isoleucine
      6) Trypotophane
      7) Threonime
      8) Lysine
      9) Methionine
      10) Phenylalanine

   * Key to memorize PHILL MT VAT

   d. Chickens also need glycine in addition to the 10 essentials.
   e. Arginine - not considered essential for maintenance in rats but required for growth.
   f. In swine the following amino acids are not required for maintenance but are required for growth.
      1) Arginine
      2) Histidine
      3) Leucine
   g. Humans - both arginine and histidine are not thought to be required for adult maintenance but probably are necessary for normal growth of children.
   h. High quality - low quality protein.
      1) The quality of the protein would be in reference to the types of amino acid present in relation to the types needed.
      2) In feeding poultry or swine the quality is as important as quantity.
      3) Different feeds (plant and animal sources) may supplement the limiting amino acids of each other and thereby increase the protein quality.

4. Supplying quality protein - a source must have at least 20% protein to be considered a protein supplement.
   a. Home grown feeds often need to be supplemented with a protein supplement in order to provide livestock with adequate protein for optimum production.
   b. From animal sources:
      1) Meat by-products such as meat scraps and tankage are good sources of protein if an economical source is available.
      2) Milk and milk products provide a good source of protein but are usually too expensive for common use by most species.
   c. Plant sources
      1) By products which contain between 20-30% protein.
         a) Gluten feed
         b) Brewers' grain
         c) Malt sprouts
         d) Distillers' grain
      2) Compounds containing 30% and up protein.
         a) Linseed Oil Meal
         b) Cotton Seed Meal
         c) Soybean Oil Meal
         d) Mustard Oil Meal
            Recent research indicates that mustard oil meal is usable in limited amounts up to 20% of protein supplement for beef cattle and sheep.
            Five percent of the feed is probably the upper limits for swine.
   d. Avian as a source of protein.
      1) Poultry feathers have been treated and used to some degree of success as a protein supplement.
   e. Waste products as a source of protein - research is presently being conducted with many waste products to determine the protein feeding value. For example, excretory wastes are currently being investigated.
   f. Marine - Fish Meal
      1) Fish meal may have a high percentage of protein (up to 80%) but may have some limiting factors due to a lack of cystine and methionine. Investigation continues to find the optimum use in many different feeds.
      2) The amount of salt in fish meal may be a limiting factor for use in feed.
   g. Non-protein nitrogen - may be used with ruminants up to certain levels. Common sources are:
      1) Biuret
      2) Diammonium phosphate
      3) Urea
         a) This is an N.P.N. source that is being used most at the present time.

b) Urea furnishes no energy and is not a protein, but is a manufactured nitrogen product that will substitute for protein if properly used and if economically justified.

c) The lack of minerals and energy in N.P.N. requires that the other part of the ration must be higher in these nutrients.

d) Economics - if 7 lbs. of grain plus 1 lb. urea is cheaper than 7 lbs. of soybean oil meal then urea may be used up to the safety limits.

e) Factors to consider in using urea.
   1) Ruminants should be gradually converted to feeds containing urea (2 to 4 weeks).
   2) Mix well - urea must be mixed well with the feed used.
   3) Do not mix with raw soybeans for the soybeans contain urease which will act on the urea to release ammonia.
   4) Do not feed to calves prior to 2-3 months of age.
   5) Do not feed over recommended amount. The recommendation for each class of livestock will vary.

5. Factors determining amounts of protein supplement needed.
   a. Kinds and amounts of feeds fed.
      1. Feeds vary in the amounts of digestible protein.
      2. There are a number of charts which provides the average composition of protein in various feeds.
      3. However, the maturity, condition, and methods of harvesting roughage have a part in the amount of protein supplement needed so an analysis of the feed fed should be made to determine the exact needs.
   b. Species of animal and protein requirements.
      1. Ruminants (cattle and sheep) have little trouble with the quality as long as they have the proper amounts.
      2. Swine and poultry need the proper type as well as the proper amounts.
      3. Amount and type of produce (work, eggs, meat, milk, etc.) will determine quantity and quality needed.
   c. Age - it is very important that young animals have ample amounts of protein of the proper kind for growth.

H. Providing necessary minerals for livestock.

1. Functions of minerals are:
   a. Skeletal and soft tissue formation.

b. As a part of enzyme reactions.
c. As an integral part of some organic compounds, examples are:
Fe - hemoglobin
Co - Vit B_{12}

2. Deficiencies symptoms are:
a. Phosphorous
1) Lack of appetite.
2) Unthrifty appearance.
3) Weak or dead off-spring.
4) Depraved appetite - "pica".
5) Poor breeding efficiency
b. Calcium
1) Low milk production.
2) Bones break easily.
3) Poor bone growth - ricketts.
c. Iodine
1) Weak young.
2) Goiter - usally observed in the young for domestic livestock.
d. Iron
1) Most critical for young swine.
2) Anemia in baby pigs.
e. Cobalt as such is required for ruminants but not for simple stomach animals. Simple stomached animals receive cobalt in vitamin B_{12}. Cobalt supplementation would vary with the region. Montana is not known to be cobalt deficient.
f. Zinc
1) Parakeratosis - in swine.
2) Needs to be supplemented in swine rations.

3. Mineral content of feed.
a. Cereal grains tend to be high in P and low in Ca
b. Calcium is most apt to be deficient in swine.
c. Nonlegume roughages have less calcium than legume.

4. Minerals likely to be deficient under Montana conditions.
a. Salt is the one mineral supplement needed for all species of animals.
b. Calcium is most apt to be deficient in swine and poultry due to low roughage intake.
c. Phosphorour is most apt to be deficient in ruminants because of high amount of roughage and low amount of concentrates fed.
d. Iodine - the Northwest United States including Montana is in an iodine deficient area and therefore the ration needs to be supplemented. Iodine is usually fed free choice as a stabilized, iodized salt.
e. Except for iodine, trace minerals for ruminants in Montana have not shown to be essential.

f. Trace minerals are generally added to all swine and poultry feeds. Zinc in the most critical trace element for the swine ration. Iron is most apt to be deficient in young pigs.

5. Means of supplying essential minerals.
   a. Salt
      1) Feed free choice.
      2) Mix with feed at 1% of ration for dairy cattle.
      3) Mix .5% with grain for swine.
      4) Form in which salt is purchased:
         a) block
         b) loose
         c) rock or lump
      5) Salt is presently being used in beef to limit the amount of feed (such as protein supplement) intake.
   b. Calcium and Phosphorus.
      1) Source
         a) monosodium phosphate
         b) diammonium phosphate
         c) dicalcium phosphate
         d) steamed bone meal
         e) polysodium phosphate
      2) Method of feeding would depend on the form.
         a) free choice
         b) mixed in feed
      3) There must also be a concern for having the calcium and phosphorous in proper ration.
   c. Trace minerals - Iodine is supplemented by the use of iodized salt to ruminants. A trace mineral premix should be used in swine and poultry rations. the premix should contain sufficient amounts of minerals to furnish the levels recommended by the National Research Council.

I. Providing adequate vitamins.

1. Characteristics of vitamins.
   a. Definition - an organic substance which is an essential dietary constituent needed in minute amounts for one or more species.
   b. Some vitamins are metabolic essentials but not dietary essentials because they can be synthesized from food or other metabolic compounds. Example: vitamin C is a dietary essential for man, guinea pigs, and monkeys, but not for domesticated livestock.
   c. The vitamins are often classed as to their solubility
      1) Fat soluble vitamins include A, D, E, and K.
      2) Water soluble vitamins include C and members [illegible]e B complex.

d. The members of the B-complex were first designated by letters but the use of names have become more common for most members. B complex members include:
   1) Thiamine
   2) Riboflavin
   3) Niacin
   4) B_6
   5) Pantothenic acid
   6) Biotin
   7) Choline
   8) Folic acid
   9) B_{12}

e. Vitamins considered likely to be deficient will be discussed in further relation to livestock.

f. Vitamin requirements are stated in forms of units - see table 2.

2. Function, deficiency symptoms and natural sources of vitamins which are frequently added to farm animal rations - see table 3.

3. Supplementing livestock feeds with vitamins.
   a. Dietary needs for vitamins differ widely among species, therefore the amounts given should be based on recent NRC recommendations.
   b. The vitamin needs for swine and poultry may be met by adding to the grain mixture a vitamin premix which meets the minimum NRC recommendations.
   c. Under normal circumstances Vitamin K is a dietary need for poultry only.
   d. The B-complex vitamins are not a dietary need for ruminant animals because of bacterial synthesis in the rumen.
   e. Ruminants on pasture or receiving high quality sun-cured hay will receive adequate amounts of Vitamins A, D, and E. Animals receiving low roughage rations or bleached roughage should have some vitamin A supplementation.

TABLE 2

VITAMIN UNITS

The practice of expressing the strength of a vitamin preparation in "units" is a relic of the days before isolation of the pure chemical substance. Units represent the first approximation attempts at dealing quantitatively with the new factor in question, and were a convenient device to express the activity of a preparation containing an unknown amount of an uncharacterized material. The availability of crystalline vitamins made it possible and desirable to work in terms of milligrams or micrograms of the pure substance.

The accuracy of any assay is enhanced when a standard product is available for comparison. Standard vitamin preparations were first made available by the Permanent Commission on Biological Standardization of the Health Organization of the League of Nations and distributed through National Control Centers to qualified investigators. Its functions have been assumed by the Expert Committee on Biological Standardization of the World Health Organization. These standards are widely used for research and to prepare working standards for use by manufacturers and enforcement agencies. International standards have been established for vitamins A, B_1, C, D, and E. An "International Unit" is, by definition, based on the activity of an International Standard preparation. The United States Pharmacopoeial Convention has been designated as the Control Center for the United States. Its Committee on Reference Standards has extended the work of the original Commission until USP standards for ascorbic acid, calcium pantothenate, choline chloride, nicotinamide, nicotinic acid, pyridoxine hydrochloride, riboflavin, thiamine hydrochloride, eight "essential" amino acids, vitamin A and vitamin D (form for both rat anc chick assay) are now available. (Address USP Reference Standards, 46 Park Ave., New York 16, N.Y.). When an International Standard exists, the USP standard is compared and brought as closely as possible into agreement. Therefore, a "USP unit" is equal to an "International Unit."

The existence of adequate standards has proved a boon, both to research workers and to Federal and state control officials.

Vitamin A

1 I.U.= USP unit=the vitamin A activity of .344 micrograms of crystalline vitamin A acetate, corresponding to .30 micrograms of vitamin A alcohol.

Provitamin A: beta-carotene

1 I.U.=0.6 micrograms of beta-carotene. The International Standard is a solution in vegetable oil, containing 200 I.U. per gram.

Vitamin D

1 I.U.=1USP unit= vitamin D activity of 0.025 micrograms of crystalline vitamin D_3. Products assayed against this new standard (official May 1, 1951) will have only 93.4 per cent of the unitage shown when assayed against the last USP Cod Liver Oil Reference Standard.

An even greater difference is shown when the new USP Standard is used for assay of chicken feeds. Products assayed against the new standard show about 75 per cent of the unitage shown when assayed against the last USP Cod Liver Oil Reference Standard. In order to differentiate between the present A.O.A.C. Chick Unit, the new Unit which is 33 per cent larger, the term "International Chick Unit" has been adopted.

Other vitamin units

The activity of other vitamins is expressed as the weight in milligrams or micrograms of the various chemically pure materials.

One still occasionally encounters values for vitamins other than A and D listed in "units". For reference use, we list these below.

Thiamine: 1 I.U.=the thiamine activity of 3.0 micrograms of crystalline thiamine hydrochloride.

Ascorbic acid: 1 I.U.=the vitamin C activity of .05 mg. of L-ascorbic acid.

Vitamin E: 1 I.U.=the vitamin E activity of 1 milligram of synthetic, racemic alpha-tocopherol acetate.

Table 3

DATA ON VITAMINS

Name	Function; units of potency, etc.	Deficiency Symptoms	Good Natural Sources	Other Sources (synthetic concentrates)
Choline	Essential for building and maintaining cell structure. Essential in fat metabolism	Slow growth Hemorrhagic kidneys	All natural fats contain some choline	Methionine and Cystine to furnish labile Methyl groups
Niacin	Components of two coenzymes which function in biological oxidation reduction systems	Pellagra in man. In swine slow growth, diarrhea, dermatitis, Similar symptoms in chicks	Animal and fish by-products. Distillers grain and yeast.	
Vitamin E	Reproduction in rats. Hatchability in poultry. Normal muscle development in many animals	"Stiff-lamb" disease. Muscle disorders in many types of animals. White muscle disease in calves. Heart muscle injury	Whole cereal grain particularly in the germ. Green forage and other leafy material	Synthetic D, L-Alpha-toxopherol acetate is the international standard
Vitamin K	Blood coagulation	Subcutaneous and intermuscular hemorrhages in poultry. Deficiencies in other species only under special conditions	Green leafy material fresh or dry. Any dietary need may be unimportant in species other than birds because of bacterial synthesis in the G.I. tract.	Menadione

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Table 3, Continued - DATA ON VITAMINS

	Function; units of potency, etc.	Deficiency Symptoms	Good Natural Sources	Other Sources (synthetic concentrates)
Vitamin A (animal form) Carotene (plant form or Pro-Vitamin A)	Stimulates the formation and development of body cells--hence a growth vitamin. Also involved in dim-light vision. 0.6 μg carotene = 1 IU of vitamin A	Retarded growth of young. Interference with reproduction. Impaired night vision.	Leafy forage, fresh or preserved against oxidative loss. Milk or fish fat (variable). Yellow corn	Pure crystalline vitamin A acetate 3,000,000 IU/g. Mixed carotene, 1,000,000 IU/g
Vitamin D (D_2 is plant form; D_3 is animal form)	Facilitates absorption of calcium, hence is related to normal bone formation. Irradiation by direct sun (ultraviolet rays) effectively supplies animals with needed vit. D. Poultry do not utilize D_2 effectively.	Rickets in young; osteomalacia in adults. Swollen and sore joints. Poor reproduction	Sun-cured leafy hay for animals (but not poultry).	Fortified fish oils, irradiated sterols for both poultry and animals. Crystalline D_2 or D_3 40,000,000 IU/g
Riboflavin	Part of an enzyme necessary for the oxidation process in all living cells. It is synthesized by microorganisms in herbivora.	Slow growth, nerve degeneration, diarrhea, (pigs, calves) Curled toe paralysis, low egg production (poultry)	Liquid, condensed or dry milks Dried leafy forages. Distillery solubles. Dried brewers' yeast.	Pure synthetic riboflavin, 400,000 BS units/g 1 g has potency of 100 lb. skim milk powder.

Table 3 - continued - DATA ON VITAMINS

Name	Function; units of potency, etc.	Deficiency Symptoms	Good Natural Sources	Other Sources (synthetic concentrates)
Pantothenic Acid	A part of Coenzyme A, necessary for the utilization of all energy yielding nutrients. Particularly important in Canada, since typical Canadian hog rations are often too low in this vitamin	None in herbivora. Stilted gait in pigs, especially with hind legs (often called goose-steping and confused by some with rheumatism or rickets). Dermatitis around bill and eyes in poultry.	Brewers' yeast. Dry milk or whey. Cane molasses. Alfalfa.	Synthetic calcium pantothenate (92% pantothenic acid).
Vitamin B_{12}	A cobalt-containing substance active in treating pernicious anemia. Probably active part of "the animal protein factor."	Poor growth, poor feathering, poor hatchability. Its use usually increases gains of young by 10-20%.	Feeds of animal or marine origin. Liver meal is especially potent.	Fermentation products and by-products from making antibiotics.

J. Providing water

1. All species of animals need water in varying degrees

2. Functions of water are:
   a. Body thermoregulatory
   b. Dissolving nutrients
   c. Transportation of nutrients and body waste
   d. Digestion
   e. Structure

3. Sources of water:
   a. Drinking water
   b. Metabolic water
   c. Feed-natural water content
   d. Water must be of good quality, clean, and free from excess minerals

4. Amounts needed - all animals should have free choice at all times
   a. Rule of thumb would be 2 3/4 lb. water/lb. of dry matter plus water for production.
   b. Amounts needed vary with amounts lost
      1) Temperature
      2) Production level (milk, eggs, etc.)
      3) Type of feed fed - relates to the percentage of moisture in the feed.
      4) Species - amounts given are approximately daily consumption

Poultry, 100 hens	4 - 6 gallon/day
Ewes	1 - 1 1/2 gallon/day
Sow with litter	5 gallon/day
Beef Cattle	10 gallon/day
Dairy Cattle	
Med Prod (30 lbs milk/day	13.5 gal/day
High Prod (80 lbs milk/day	24 gal/day

K. Utilizing feed additives in feeding livestock

1. Feed additives are materials that are not nutrients (dietary essentials) but are added to the feed for the purpose of increasing feed efficiency, growth rate, health of the animal or level of production. The additives are fed at very low levels.

2. Feed additives include antibiotics, hormonal compounds, coloring materials and flavors.
   Examples;
   Low levels of antibiotics (Aureomycin, streptomycin, etc.) for swine, poultry, calves, lambs.

Stilbestrol fed orally implanted in fattening steers.
Thyroprotein (iodinated casein) fed to lactating dairy cattle - uncertain responses.
Marigold feed is used in poultry rations when a high yellow egg yolk is desired.

3. Any feed additive must be used according to the manufacturer's directions. Higher levels may result in undesirable residues in the marketed product or undesirable side effects in the animal.

IV. BALANCING THE RATION

A. Determining the needs

1. Nutrients are needed for:
   a. Maintenance - those nutrients in quantity which are needed to maintain the animal's physical existance at an even, healthy level.
   b. Production - additional energy and other nutrient requirements beyond the maintenance of the animal's body are required for production of:

      meat eggs
      milk work
      wool
      reproduction of species

      The quantity as well as the type of production must first be considered before one can determine an animal's nutritional needs.

2. Feeding standards established for determining nutrient needs. Different tables are available which state the amounts of nutrients required by farm animals, by species, at various ages and production levels to secure optimum results. Tables indicate requirements for protein, energy (TDN or net energy), vitamins, and minerals. References most commonly used are:
   a. Morrison's Feeding Standards
   b. NRC (National Research Council)

3. Aspects other than nutrient content need to be considered in balancing ration.
   a. The available home grown feeds will affect the ration because they generally are more economical to use. However, they may need to be supplemented with proteins, vitamins, and minerals.
   b. The feeds which need to be bought to balance the ration will be determined by the cost per pound of nutrients of the available feeds.
   c. The limitations of feeds such as palatability and feed intake limitations of animals should be considered.
   d. The comparative feed value of different feeds for different species should be evaluated.

B. Computing the ration

1. Determine the nutrient needs for the particular situation according to feeding standard recommendations (From Morrison or NRC Tables).

2. Determine the nutrient content in feeds to be fed (From Morrison or NRC Tables).

3. Calculate the amount of feed required to meet nutrient needs for the particular situation.

4. See the examples for calculating net energy that follow.

NET ENERGY PROBLEM

Net Energy Required for Maintenance of 500 lb. steer.

NE_m = 4.55 megcal/day (See Table 4)

Net Energey Required for 1.0 lbs. gain/day on a 500 lb. steer.

NE_g = 1.48 megcal/day (See Table 4)

Feeds Used to Balance Ration:

Alfalfa hay 34% fiber

Barley grain

(Amounts furnished by feed. See Table 6)

Feed	(NE_m) megcal/100 lbs.	(NE_g)
Alfalfa hay, 34% fiber	42	8
Barley grain	87	58

	NE_m	NE_g
Animal Need	4.55 megcal/day	1.48 megcal/day
Alfalfa Hay, 34% fiber	42 megcal/100#s	8 megcal/100#s
Barley grain	87 megcal/100#s	58 megcal/100#s
8#s Alfalfa Hay	3.36 megcal.	.64 megcal.
2# Barley grain	1.74 megcal.	1.16 megcal.
Total megcal supplied	5.10 megcal.	1.80 megcal.

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Table 4. Net Energy Requirements for Growing and Finishing Steers

Daily gain	Body weight, lb.							
	400	500	600	700	800	900	1000	1100
lb.	NE_m required, megcal/day							
0	3.85	4.55	5.21	5.85	6.47	7.07	7.65	8.21
	NE_g required, megcal/day							
0.6	0.74	0.87	1.00	1.12	1.24	1.35	1.46	1.57
0.8	0.99	1.17	1.35	1.51	1.67	1.82	1.97	2.12
1.0	1.26	1.48	1.70	1.91	2.11	2.31	2.50	2.68
1.2	1.52	1.80	2.06	2.32	2.56	2.80	3.03	3.25
1.4	1.80	2.12	2.44	2.73	3.02	3.30	3.57	3.84
1.6	2.08	2.45	2.81	3.16	3.49	3.81	4.13	4.43
1.8	2.35	2.79	3.20	3.59	3.97	4.34	4.69	5.04
2.0	2.65	3.13	3.59	4.03	4.46	4.87	5.27	5.66
2.2	2.95	3.48	3.99	4.48	4.96	5.41	5.86	6.29
2.4	3.25	3.84	4.40	4.94	5.46	5.97	6.46	6.94
2.6	3.55	4.20	4.82	5.41	5.98	6.53	7.07	7.59
2.8	3.87	4.57	5.24	5.89	6.50	7.10	7.69	8.26
3.0	4.18	4.95	5.67	6.37	7.04	7.69	8.32	8.94
3.2	4.51	5.33	6.11	6.86	7.58	8.28	8.96	9.63
3.4	4.84	5.72	6.56	7.36	8.14	8.89	9.62	10.33

Table 5. Net Energy Requirements for Growing and Finishing Heifers

Daily gain	Body weight, lb.							
	300	400	500	600	700	800	900	1000
lb.	NE_m required, megcal/day							
0	3.10	3.85	4.55	5.21	5.85	6.47	7.07	7.65
	NE_g required, megcal/day							
0.6	0.65	0.80	0.95	1.09	1.22	1.35	1.47	1.59
0.8	0.88	1.09	1.29	1.48	1.66	1.83	2.00	2.17
1.0	1.12	1.39	1.64	1.88	2.11	2.33	2.55	2.76
1.2	1.37	1.70	2.01	2.30	2.58	2.85	3.12	3.37
1.4	1.62	2.01	2.38	2.73	3.07	3.39	3.70	4.01
1.6	1.89	2.34	2.77	3.18	3.57	3.94	4.31	4.66
1.8	2.16	2.68	3.17	3.64	4.08	4.51	4.93	5.34
2.0	2.45	3.03	3.59	4.11	4.62	5.10	5.57	6.03
2.2	2.74	3.39	4.01	4.60	5.16	5.71	6.23	6.75
2.4	3.03	3.76	4.45	5.10	5.73	6.33	6.91	7.48
2.6	3.34	4.14	4.90	5.62	6.31	6.97	7.61	8.24
2.8	3.66	4.53	5.36	6.15	6.90	7.63	8.33	9.02
3.0	3.98	4.93	5.83	6.69	7.50	8.30	9.07	9.81
3.2	4.31	5.35	6.32	7.25	8.14	8.99	9.83	10.63
3.4	4.65	5.77	6.82	7.82	8.78	9.70	10.60	11.47

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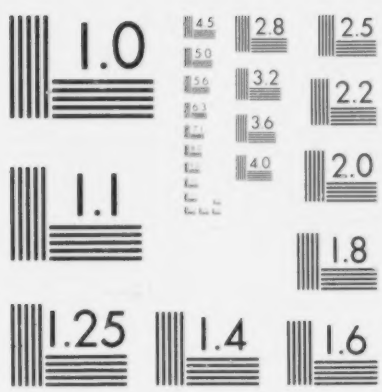

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Table 6. Net Energy Content of Feeds
Expressed on a 90% Dry Matter Basis Unless Otherwise Indicated

Feed	For maintenance (NE_m)	For weight gain, in addition to maintenance (NE_g)
	megcal per 100 lb.	
Dry Roughages		
Alfalfa hay, 21% fiber	59	34
Alfalfa hay, 24% fiber	55	28
Alfalfa hay, 28% fiber	50	20
Alfalfa hay, 34% fiber	42	8
Alfalfa meal, dehy., 17% protein	55	28
Barley hay	50	20
Barley straw	41	6
Bermuda grass hay, common	43	12
Corn cobs, ground	43	12
Corn fodder, well-eared, dry	57	34
Corn stover	50	24
Cottonseed hulls	42	9
Oat hay	47	16
Soybean hay	48	19
Sudangrass hay, average	48	19
Timothy hay, average	48	19
Timothy hay, before bloom	56	32
Timothy hay, late bloom	47	17
Timothy hay, late seed	41	6
Silages (Expressed on a 30% dry matter basis)		
Alfalfa, wilted, good quality	18	9
Corn, dent, well-matured, well-eared	22	13
Sorghum, dual purpose	20	9
Concentrates		
Barley grain	87	58
Barley, light weight	72	48
Beet pulp, molasses, dried	83	55
Brewer's grains, dried	58	35
Coconut meal, solvent	68	45
Corn, dent, No. 2	92	60
Corn and cob meal (ground ear corn)	81	54
Cottonseed meal, 41% solvent	64	41
Fat (98% dry matter)	203	127
Hominy feed, 5% fat	94	61
Linseed meal, solvent	73	49
Milo grain	87	58
Molasses, cane, to 15% (71% dry matter)	65	41
Oat grain	75	51
Soybean meal, exp. or hydr.	84	56
Soybean meal, solvent	78	52
Wheat grain	90	59
Wheat bran	69	46
Wheat mill run	78	44
Whey, dried	84	55
Yeast, Brewer's dried	74	50

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DEMONSTRATING NUTRITIONAL DEFICIENCIES

Richard F. Welton*

In order to make instruction in livestock nutrition more meaningful, a simple experiment was devised for students to demonstrate nutritional deficiencies. All of the equipment, material, and feed are available from local hatcheries, feed dealers, and in the school or home.

This study was run for a period of four weeks, and involved 200 male single combed white leghorn chicks. The chicks were divided into seven groups of 30 birds each; except group seven, which consisted of 20 birds. Each of the seven groups of birds were further divided into pens of 10 each. Four chick diet components were varied in the diets which were fed. The four components were: 1. Ground corn, 2. Soybean oil meal (50% protein), 3. Vitamin premix, and 4. Mineral pre-mix.

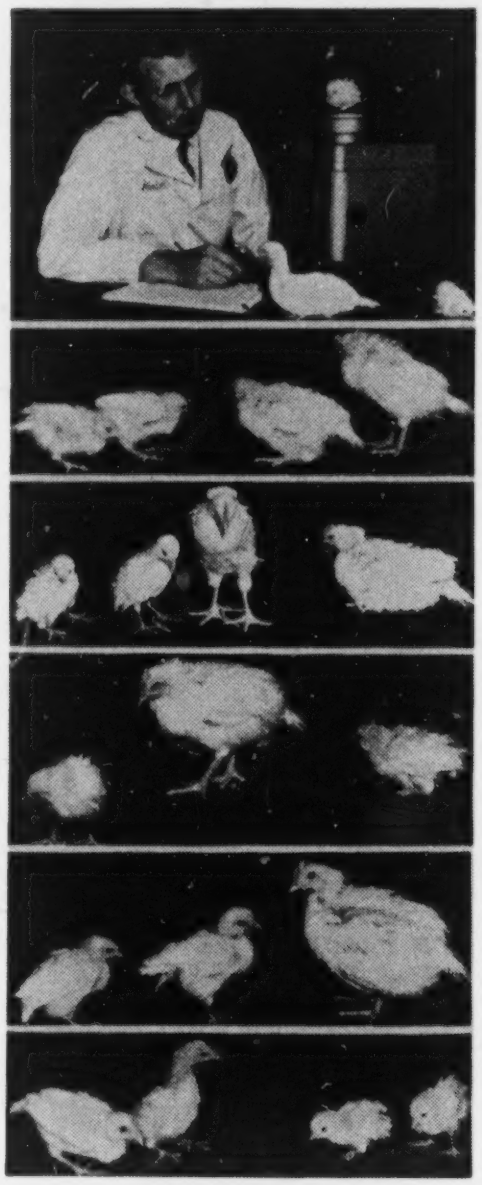

The nutritional requirements for the chicks from birth to eight weeks of age were used to determine the nutritional level of the control diet.

The basis of the vitamin pre-mix was a Ray Ewing Grow-Lay Pre-Mix 2. However, to raise the nutritional level of the ration to minimum requirements as would be needed when feeding only corn, supplemental vitamins were added as shown in Table 1. Finely ground corn was added to bring the total weight of the vitamin pre-mix up to two pounds. These ingredients were mixed together in a feed mixer for 10 minutes.

The mineral pre-mix contained: 1. Eight pounds of Purina Mineral SP-37753, 2. One pound of iodized salt.

The mineral mix was ground to a texture of table salt, and mixed with the iodized salt for 10 minutes.

Seven combinations of the four feed components were selected as the following treatments:

Treatment 1. Corn, soybean meal, vitamin pre-mix and mineral pre-mix (control diet).

Treatment 2. Corn, soybean meal and mineral pre-mix. (vitamin deficient diet).

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Treatment 3. Corn, soybean meal and vitamin pre-mix. (mineral deficient diet).

Treatment 4. Corn, and soybean meal. (vitamin and mineral deficient diet).

Treatment 5. Corn, vitamin pre-mix and mineral pre-mix. (protein deficient diet).

Treatment 6. Corn and mineral pre-mix. (vitamin and protein deficient diet).

Treatment 7. Corn only. (protein, vitamin and mineral deficient diet)

The seven diets are described in Table 1.

Prior to placing the chicks in the battery, the equipment was cleaned thoroughly and the brooder temperature set at approximately 100° F. The temperature was reduced 5-7° each week of the study until room temperature of 70° F was reached.

Table 1. Supplemental Vitamins

Vitamin	Supplied by pre-mix	Supplied in addition to pre-mix	Total
Vitamin A	2000 IU	none	2000 IU
Vitamin D_3	750 IU	none	750 IU
Vitamin B_{12}	1 mg	4 mg	5 mg
Riboflavin	.75 mg	1 mg	1.75 mg
Niacin	25 mg	10 mg	35 mg
Pantothenic Acid	.15 mg	4 mg	.55 mg
Choline	10 mg	400 mg	410 mg

Table 2. Composition of Diets Used in Experiment

Kind and Amount of Feed Used (Pounds)

Corn vs complete diet	Treatment	Corn	Soybean meal	Mineral pre-mix	Vitamin premix	Total
Complete vs vitamin deficient (T2)	1	25.8	12.0	1.8	.4	40
Complete vs mineral deficient (T3)	2	26.2	12.0	1.8	0	40
Complete vs vitamin and mineral deficient (T4)	3	27.6	12.0	0	.4	40
	4	28.0	12.0	0	0	40
	5	37.8	0	1.8	.4	40
	6	38.2	0	1.8	0	40
Corn vs protein deficient (T5)	7	40.0	0	0	0	40
Corn only (on right) vs protein and vitamin deficient (T7 vs T6)	Total	187.5	48	7.2	1.2	280

Results and Discussion: The control treatment provided the best growth (Table 3). During the fourth week, the gain by birds in treatment one was twice that of birds in treatment number two, but treatment two had the highest gain. Therefore, the least of the difficulties was caused by a simple vitamin deficiency in this case. The deficiencies of protein or minerals resulted in a very severe growth restriction. This indicated that minerals and protein were the most limiting factors in this study. It was interesting to note that the corn diet (treatment 7) actually showed a decrease in gain during the second week.

Feed efficiency (table 4) was comparable in treatments one and two. The difference was only 20%. Feed efficiency numbers for treatment four and seven were quite large and meaningless to chart. Treatment six (corn and minerals) was little affected by the absence of vitamins (compared to treatment five and six). Feed efficiency appeared to be primarily a reflection of differences in rate of gain.

Feed consumption was the greatest in the control diet (treatment one) The increase was gradual during the first three weeks of the study when compared to the six other treatments. However, during the fourth week, the feed consumption increased by 225 grams per bird when compared to the next highest intake diet (treatment two), which consumed an average of 55 grams per bird during the week. Again, it was obvious that feed consumption as well as feed efficiency was a function of growth rate. Perhaps the reason for the reduced feed consumption in treatment two during the fourth week could be explained by exhaustion of vitamin supply supplied by the yolk at birth. It was interesting that feed consumption fell off during the second week and never recovered in treatments four, five, six, and seven.

It is important to note the mortality in both the corn treatment and the corn with protein treatment was approximately 90% during the study. Losses in treatment seven were not noticeable until after the second week. The 10% mortality in the control pen occurred during the first week and was unrelated to treatment effect.

Table 3. Effect of Diet on Body Weight Gain

Dietary Deficiency	Ave. Start	Body Wt. (grams) 1st wk	2nd wk	3rd wk	4th wk	Overall avg. gain
1. none	34	72	130	212	309	275
2. vitamin	34	65	94	132	160	126
3. mineral	33	47	58	64	73	40
4. vitamin & mineral	33	45	45	45	46	13
5. protein	32	45	55	69	82	50
6. vitamin & protein	33	49	62	76	94	61
7. protein, vitamin & mineral	32	38	37	37	39	7

Table 4. Effect of Diet on Chick Efficiency

Dietary Deficiency	Feed/Gain 1st wk	2nd wk	3rd wk	4th wk
1. none	2.1	1.9	1.7	1.9
2. vitamin	2.2	2.4	2.4	2.4
3. mineral	3.9	3.8	5.4	4.9
4. Vitamin & mineral	4.6	8.5	9.1	9.6
5. protein	5.0	4.8	4.5	4.6
6. vitamin & protein	4.0	4.0	4.1	4.2
7. protein, vitamin & mineral	10.0	15.0	64.0	50.0

Conclusions:

1. The effect of a balanced ration had a remarkable effect upon the comulative gain of the birds in this study.
2. Unsupplemented ground corn had a very unfavorable effect on gain.
3. The omission of one or any combination of the three feed components, which were varied, markedly affected the cumulative gain of the various treatments.
4. The high protein and mineral ration showed a favorable response to gain. The addition of only protein to the corn diets did not improve rate of gain.
5. Feed efficiency was especially low when vitamins and minerals were omitted from the diet.
6. Birds in this study apparently were unable to utilize unsupplemented corn or corn with protein efficiently.
7. Minerals supplementation relieved death losses more than supplementation with vitamins or protein in this study.
8. This type of study is recommended as an excellent demonstration project for older students.

References:

1. Nutrient Requirements for Chickens, National Research Council, National Academy of Science.
2. Grow-Lay premix 6399, Hoffman-La-Roche Inc.
3. Purina Livestock Mineral SP-3775, Ralston Purina Co.

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ABSTRACT - Prepared by the Office of Vocational Education of the South Carolina State Department of Education in cooperation with the Department of Industrial Education and the Vocational Education Media Center of Clemson University, this curriculum guide is for teacher use in a 2-year high school and area vocational center building construction program. The material is aimed toward the development of basic manipulative skills and knowledge required for entry into the occupation of the student's choice, along with the development of desirable work habits and attitudes. Specific objectives, program description, the duties of a carpenter, and an outline for a 2-year carpentry course are included in this guide. A considerable amount of supplementary instructional material and additional sources of information are appended. Transparencies to accompany this material are available as VT 012 633, also in this issue. (GEB)

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CURRICULUM GUIDE FOR TRADES AND INDUSTRIES BUILDING CONSTRUCTION PROGRAMS

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CURRICULUM GUIDE
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BUILDING CONSTRUCTION PROGRAMS

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PREFACE

Building Construction programs are offered in about 50 high schools and area vocational centers across the state of South Carolina. These programs have been quite successful in preparing young men to enter the carpentry trade as apprentices, and have proven valuable in helping ease the critical shortage of carpenters which exists in many sections of the state. In the past, some of these courses were called Carpentry and some were called Building Construction. Both groups are presently entitled Building Construction.

In order for you as an instructor of one of these programs to be assured that your course is being taught in the most efficient manner, there are several things you must do. These are summarized in seven steps as follows:

1. Analyze the trade and determine what skills and knowledges are required to hold a job in the trade.

2. Establish goals or objectives for students to achieve in the program.

3. Organize course content in such a manner that students have an opportunity to meet the objectives. (Include exercises, projects and other methods to do this).

4. Prepare daily lesson plans and secure the instructional materials needed for teaching the course.

5. Teach the course the most efficient way.

6. Evaluate results of the teaching. This evaluation should be a dual one—evaluation of individual students to determine their achievement in the course and evaluation of the total program to determine how well graduates perform after employment. The evaluation of both the students and the performance of graduates should identify areas of the instructional program which need strengthening.

7. Make needed improvements in the program. These improvements may be eliminating weaknesses identified in evaluating the program (Step 6), the addition of instruction on innovations occurring in the trade, or deletion of obsolete information.

This curriculum guide should aid the instructor in carrying out these seven steps which we feel are essential in offering an effective instructional program.

The curriculum guide committee, which includes carpentry instructors, supervisory personnel, teacher educators and experienced carpenters, has attempted to:

1. Analyze the carpentry trade.
2. Establish objectives for the course.
3. Organize course content.
4. Provide supplementary instructional materials.
5. Give sources of additional information.

This guide was not written to be the text needed to teach a course, but rather to serve as a basic framework upon which you can develop your own instructional program. Modifications of the outline of objectives and course content may be helpful in some localities, since building practices vary in different sections of the state. You should be able to use the curriculum guide as a basis to write your own course of study.

Those who have prepared this guide sincerely hope it will make the job of the teacher easier and improve the overall quality of the programs.

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We wish to acknowledge and express our gratitude to the following people who served on the Building Construction Curriculum Planning Committee and who spent many hours in gathering material for use in this publication:

Mr. W. L. McDuffie, Former Teacher Educator, South Carolina State College, Orangeburg, South Carolina (Presently serving as Principal, Denmark Branch, South Carolina Area Trade Schools).

Mr. Gene McGrew, District 5 Supervisor, Trades and Industries, Box 1486, Florence, South Carolina.

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Mr. Arnold Hansen, Instructor, Pageland High School, Pageland, South Carolina.

Mr. W. T. Whetsell, Instructor, Bonds-Wilson High School, North Charleston, South Carolina.

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GENERAL OBJECTIVES

The Trades and Industries programs should help the student attain:

1. Basic manipulative skills and knowledge required for entry into the occupation of his choice.
2. An understanding of the responsibilities of a citizen of our democracy.
3. A positive, healthy attitude toward work.
4. Desirable work habits.
5. The ability to cooperate with fellow workers, employer, and customers.
6. The ability to accept and adapt to technological changes.
7. An appreciation of quality workmanship.
8. Self-confidence and initiative.
9. Communicative skills—the ability to listen, to understand, and to be understood.
10. Knowledge of the importance of performing jobs in an orderly, organized fashion.
11. A knowledge of the job opportunities to be found in the trade.
12. A knowledge of the best procedures to follow to secure a job.

DESCRIPTION OF PROGRAM

1. *Length*

Building Construction, as well as the other Trades and Industries programs offered in high schools and area vocational centers, is 1,080 hours in duration. Classes are scheduled for three hours per day, five days per week, thirty-six weeks per year for two years; or for two hours per day, five days per week, thirty-six weeks per year for three years. In either case, the total time is 1,080 hours.

Normally, the course is divided into two parts—Building Construction 1, and Building Construction 11, with Building Construction 1 being offered in the eleventh grade and Building Construction 11 in the twelfth grade. However, some schools offer the course three years—in the tenth, eleventh and twelfth grades, and divide the overall course into three parts—Building Construction 1, 11, and 111.

11. *Credit*

Students earn two units of credit for each year of training satisfactorily completed in the program.

111. *Requirements for Admission*

Persons admitted to the program should be in good physical condition, have an interest in construction and enjoy working with their hands. Most schools require that applicants be administered examinations prior to enrollment to determine their interest in and suitability for this type of work. Some schools require applicants to be interviewed by a counselor or instructor prior to admission. Every effort is made to help the student select the trade that best suits his interests and abilities.

SPECIFIC OBJECTIVES OF THE TRADES AND INDUSTRIES BUILDING CONSTRUCTION PROGRAM

Upon completion of the Building Construction Program, the student is expected to:

1. Be able to perform basic manual skills common to the carpentry trade.
2. Be safety conscious and use safe work practices at all times.
3. Be able to correctly use the essential measuring instruments and other tools used in the carpentry trade.
4. Be able to make basic sketches for residences and commercial buildings.
5. Be able to interpret and use blueprints and working drawings.
6. Be able to solve construction problems related to building residences and commercial buildings.
7. Conserve materials and properly care for tools and equipment.
8. Be acquainted with the job opportunities available in the trade.
9. Know proper procedures for presenting complaints related to working conditions, salaries, etc.—to know the importance of following the proper "chain of command" to solve these problems.
10. Understand the wage structure and the factors that effect it.
11. Understand basic factors relating to building cost estimating, cost control, and discounts.
12. Have a general knowledge of the legal liabilities and tax responsibilities of a contractor.

DUTIES OF A CARPENTER

Carpenter (Const.) 860.381. Constructs, erects, installs, and repairs structures and fixtures of wood, plywood, and wall board, using carpenter's handtools and power tools, and conforming to local building codes. Studies blueprints, sketches, or building plans, for information pertaining to type of material required, such as lumber or other materials. Prepares layout, using rule, framing square, and calipers. Marks cutting and assembly lines on materials, using pencil, chalk, and marking gage. Shape materials to prescribed measurements, using saws, chisels, and planes. Assembles cut and shaped materials and fastens them together with nails, dowel pins, or glue. Verifies trueness of structure with plumb box and carpenter's level. Erects framework for structure and lays subflooring. Builds stairs and lays out and installs partitions and cabinet work. Covers subfloor with building paper to keep out moisture and lays hardwood, parquet, and wood-strip block floors by nailing floors to subfloor or cementing them to mastic or asphalt base. Applies shock-absorbing, sound-deadening and decorative paneling to ceilings and walls. Fits and installs prefabricated window frames, doors, doorframes, weather stripping, interior and exterior trim, and finish hardware, such as locks, letter drops and kick plates. Constructs concrete forms and pouring chutes. Erects scaffolding and ladders for assembling structures above ground level. May weld metal parts to steel structural members. When specializing in particular phase of carpentry is designated according to specialty as LAYOUT CARPENTER, PARQUETRY-FLOOR LAYER. When specializing in finish carpentry, such as installing interior and exterior trim, building stairs, and laying hardwood floors, is designated FINISH CARPENTER. When erecting frame buildings and performing general carpentry work in residential construction is designated FRAMING CARPENTER, HOUSE CARPENTER.

From the Dictionary of Occupational Titles

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OUTLINE OF COURSE CONTENT

INTRODUCTION

The following pages contain an outline of the information that the curriculum committee felt should be included in the two-year carpentry course. The outline is divided into two sections, Building Construction 1 and Building Construction 11. The instructor will need to determine which information to cover the first year and which to cover the second year. The manner in which the course is divided will depend upon time limitations and the methods of instruction used. For example, with programs in which students build a house each year, most of the practical exercises contained in the outline can be covered twice in the two years of the course.

Information contained herein is not necessarily in the sequence in which it should be taught. The instructor should teach the material in the order which would be most convenient for him. If lack of time is a problem, less important topics should be deleted from the course. The outline is quite flexible, and instructors should feel free to rearrange the information contained, add to it or delete sections from it as they desire to make it fit their needs.

An orientation section should be included at the beginning of both years, preferably with an emphasis on safety and objectives of the program in the first year, and an emphasis on safety and job opportunities in the second year.

BUILDING CONSTRUCTION 1

1. *Orientation*

New students entering the carpentry course may not be acquainted with the carpentry trade. Therefore, the purpose of orientation is to help the student learn the nature of carpentry work, the objectives of the course and the behavior and quality of work expected of persons taking the course.

A. History of the trade
B. Duties of a carpenter
C. Relationship of carpentry to other trades (see pages 24-25 in Appendix).
D. Employment in the trade
   1. Job opportunities
   2. Apprenticeship programs
   3. Advancement prospects
   4. Outlook for future of trade
   5. Current wage scales and prospects for future
E. Purpose and objectives of the Building Construction course (see page 3).
F. Safety (Recommended teaching unit: Safety Handbook, A Guide for Trade and Industrial Education Programs, 1968, published by Vocational Education Media Center, Clemson University. Copies available to teachers through State Supervisor of Trades and Industries).
   1. General shop safety
   2. Protective clothing and equipment
   3. Handling materials
   4. Injuries resulting from falls and lifting
   5. Importance of good housekeeping
   6. Proper use of tools and equipment
   7. Importance of proper conduct
   8. Importance of being safety conscious

11. *Blueprint Reading and Sketching* (Suggested textbook: Building Trades Blueprint Reading, Delmar Publishers, Albany, New York.)

The purpose of this unit is twofold, first to prepare the student to interpret drawings similar to the ones he will be required to follow in his work, and second to enable the student to become proficient in making simple shop sketches which are used quite frequently in the trade for building garages, home workshops, remodeling old houses, etc.

A. Introduction to blueprint reading
   1. Purpose and use of working drawings
   2. Drawing interpretation
      a. Placement of views
      b. Dimensions
      c. Invisible edges
      d. Circles and arcs
      e. Sectional views
B. Drawing interpretation problems
   1. Construction shack blueprints
   2. Structural members of a frame structure

3. Roof framing members
4. Doors, windows and exterior walls
5. Framing plans and elevations
6. Rough openings, roofs and floor framing
7. Details and sections
8. Piers and floors
9. Windows, lintels and doors
10. Wall plates, roofs and rafters

C. Shop drawings—Students should not be expected to become draftsmen in a Building Construction course, but should become able to make usable shop sketches. The tools and equipment required for teaching this unit will depend upon the depth the instructor plans to go in the subject. The only tools required for simple shop sketches are grid paper and a pencil, but a few additional items such as a drawing board, a T-square, triangles and a French curve could prove useful. Since only shop sketches and not working drawings are to be done, students will not need a set of drawing instruments. However, the instructor could keep a complete set of drawing equipment and instruments in the classroom for his own use, and show students how the various instruments are used in making working drawings.
1. Tools for sketching
2. Sketching straight lines
3. Sketching circles, arcs, irregular shapes
4. Making a working sketch
5. Isometric sketches
6. Sketching angles in isometric
7. Dimensioning an isometric sketch
8. Sketching circles and arcs in isometric
9. Sketching irregular shapes in isometric
10. Reading three-view drawings
11. Symbols for floor plans
12. Laying out simple floor plans

111. *Related Mathematics*

A. Review of basic math—Time required in review will vary from school to school depending upon the background of students entering the program. To determine what information should be covered in review, the instructor should administer some type of test which will identify the math weaknesses of students.
1. Working with whole numbers
   a. Addition
   b. Subtraction
   c. Multiplication
   d. Division
2. Working with fractions
   a. Reading fractions
   b. Addition of fractions
   c. Subtraction of fractions
   d. Multiplication of fractions
   e. Division of fractions
   f. Changing fractions to decimals
3. Reading and using a twelve inch ruler

B. Conversion problems
1. Inches to feet/feet to inches
2. Feet to yards/yards to feet
3. Cubic feet to cubic yards/cubic yards to cubic feet

C. Percentage problems
   1. Computing simple percentage problems
   2. Calculating interest on loans (inform students of types of loans, where available, steps in securing loans, and cautions to observe in borrowing money).
   3. Calculating discounts
   4. Calculating penalties
   5. Calculating profits and losses
   6. Figuring sales tax
D. Record keeping
   1. Importance of good record keeping
   2. Methods of bookkeeping used by carpenters
E. Purchasing Insurance
   1. Importance of insurance
   2. Types
F. Area calculations (Use problems related to carpentry. Example: For calculating the area of a rectangle, have students figure the floor covering requirements for a room with specified dimensions).
   1. Square
   2. Rectangle
   3. Circle
   4. Triangle
G. Measurement
   1. Length measurements
   2. Square measurements
   3. Board foot measurements
   4. Cubic measurements
   5. Weight measurements
H. Ratio and proportion principles
   1. Ratio and proportion
   2. Applications to carpentry
I. Mathematics required for using the framing square
   1. Reading framing square tables
   2. Uses of framing square
   3. Exercises (to be assigned by instructor)

IV. *Hand Tools and Equipment*

A. Squares
   1. Try square
   2. Try and miter
   3. Framing
   4. Combination
   5. Sliding "T" bevel
B. Straight edge
C. Plumb bob
D. Marking tools
   1. Chalk line
   2. Regular pencil
   3. Scratch awl
   4. Scriber
   5. Compass and dividers
   6. Butt guage

I. Portable belt sander
J. Portable finishing sander
K. Portable planer
L. Shaper
M. Bench or pedestal grinder
N. Jointer

VI. *Site Layout and Foundation Construction*

In programs where the class builds a house, first year students should be assigned the less complicated jobs and the more complicated tasks should be assigned to second year students. Although all students probably cannot be involved in doing every task in site layout and foundation, all should become familiar with the steps that are necessary in getting the site cleared and the foundation prepared.

A. Site layout
   1. Selecting location
   2. Clearing
   3. Setting up transit level
   4. Using water level
   5. Locating lot lines
   6. Locating building line
   7. Constructing batter boards
   8. Locating corners of buildings
   9. Testing corners for squareness
   10. Locating offsets, chimneys and piers
   11. Locating line of excavation
   12. Excavating for footing
B. Foundation construction
   1. Building foundation forms
   2. Pouring footing
   3. Pouring foundation walls
   4. Installing drain tile
   5. Locating and installing anchor bolts
   6. Installation of termite shields
   7. Treating foundations for termites

VII. *Floor Framing*

A. Sills
   1. Types—solid, laminated, and "T"
   2. Determining sizes needed
   3. Installing
B. Girders
   1. Types
   2. Determining sizes needed
   3. Installing
C. Ledgers
   1. Purpose
   2. Determining sizes needed
   3. Installing
D. Stirrups
   1. Purpose
   2. Types
   3. Installation

E. Headers
   1. Purpose
   2. Determining sizes needed
   3. Installation
F. Floor joist
   1. Proper spacing
   2. Determining sizes needed
   3. Installation
G. Bridging
   1. Use
   2. Types
   3. Proper spacing
   4. Installation
H. Subflooring
   1. Uses
   2. Materials used
   3. Proper spacing
   4. Installation

VIII. *Wall Framing*

A. Installation of sole plate
B. Studding
   1. Types
   2. Spacing
   3. Installing
C. Framing openings for windows and doors
   1. Determining dimensions of required opening
   2. Procedure for framing openings
   3. Installation of cripple studs
   4. Installation of headers
D. Special posts
   1. Corner
   2. Partition
   3. Window
   4. Door
E. Bracing
   1. Types
   2. Installation
F. Wall plates
   1. Purpose
   2. Installation
G. Wall sheathing
   1. Purpose
   2. Materials used
   3. Diagonal sheathing
   4. Installation
H. Ceiling joists
   1. Purpose
   2. Spacing
   3. Determining size requirements
   4. Framing for openings for chimney, stairways, etc.

IX. *Roof Framing*

A. Types of roofs
   1. Shed
   2. Gable
   3. Gambrel
   4. Hip
   5. Mansard
B. Cutting rafters
   1. Types of rafters
   2. Laying off with framing square
   3. Use of a layout tee
C. Installation of roof framing

X. *Roofing*

A. Sheathing
   1. Types of materials used
   2. Installation
B. Application of roofing felt
   1. Types of roofing felt
   2. Application
C. Flashing
   1. Types of materials used
   2. Installation on eaves and rake
   3. Installation around chimneys, vent pipes, etc.
D. Selecting and installing covering
   1. Types of shingles and other roof covering
   2. Application of roofing material
E. Special roofing problems—covering around dormers, chimneys, skylights, etc.

XI. *Exterior Finishing*

A. Windows and exterior doors
   1. Selecting doors and windows
   2. Installation of frames
   3. Installing doors and windows in frames
B. Wall coverings
   1. Types of materials used
      a. Masonry
      b. Aluminum siding
      c. Clapboard and beveled siding
      d. Novelty siding
      e. Wood shingles
      f. Plywood
   2. Advantages and disadvantages of each
   3. Procedure of applying each
C. Trim work
   1. Trim problems
      a. Molding installation
      b. Porch trim
      c. Cornice trim
      d. Installing louvers and vents
      e. Front entrances

2. Types of materials used
3. Installation
4. Painting

XII. *Insulation*

A. Purposes
   1. Keeping heat in or out
   2. Control condensation
   3. Retard spread of fire
   4. Sound proofing
B. Types
   1. Blanket
   2. Batt
   3. Granulated, cellular and fibrous
   4. Slab or block
C. Insulation value of various insulating materials
D. Determining insulation required
E. Installation of insulation materials
F. Installing storm doors and windows

BUILDING CONSTRUCTION 11

1. *Orientation*

Orientation in Building Construction 11 should consist mainly of a review of the information covered in orientation in Building Construction 1 with emphasis on the following topics:

A. Purpose and objectives of the course (see page 3)
B. Employment picture in the trade
   1. Job opportunities
   2. Apprenticeship programs
   3. Advancement prospects
   4. Outlook for future of trade
   5. Salaries and salary prospects for future
C. Safety (Recommended teaching unit: Safety Handbook, A Guide for Trade and Industrial Education Programs, 1968, published by Vocational Education Media Center, Clemson University. Copies available to teachers through State Supervisor of Trades and Industries).
   1. General shop safety
   2. Protective clothing and equipment
   3. Handling materials
   4. Injuries resulting from falls and lifting
   5. Importance of good housekeeping
   6. Proper use of tools and equipment
   7. Importance of proper conduct
   8. Necessity for being safety conscious at all times.

11. *Blueprint Reading*

The blueprint reading of Building Construction 11 should be a continuation of the information covered in Building Construction 1. In addition to reviewing the blueprint reading and shop drawing discussed in Building Construction 1, the following information should be discussed if time permits.

A. Reading scaled drawings
B. Specifications
C. Dimensions
D. Elevation drawings
E. Wall sections
F. Interpreting elevation drawings (review)
G. The plot plan
H. Foundation drawings
I. Plan symbols and indications
J. Schedules
K. Interpreting basement plans
L. Floor frame plan
M. Interpreting floor plans (review)
N. Roof frame plan
O. Details—cornice
P. Details—walls
Q. Details—windows and doors
R. Details—dormers and louvers

S. Details—stairs
T. Details—fireplace
U. Details—cabinets
V. Interpreting detail drawings (review)
W. Use of quantity and material lists

III. *Related Mathematics*

The use of the mathematics taught in Building Construction 1 will continue in Building Construction 11 as students draw house plans, solve construction problems and estimate costs. In addition to the information taught in Building Construction 1, the information which follows should prove beneficial to persons completing the carpentry program.

A. Record keeping (review)
   1. Importance
   2. Methods of bookkeeping
B. Purchasing insurance (review)
   1. Importance
   2. Types of insurance
   3. Calculating needs
C. Volume calculations
   1. Cubes
   2. Rectangular solids
   3. Cylinders
D. Powers and roots
E. Applied plane trigonometry
   1. Reading angles with protractor
   2. Right triangle
      a. Pythagorean theorem
      b. Exercises in solving for length of unknown side when two sides are known
F. Mathematics required for using the transit (or builder's level if transit isn't available).
   1. Methods and steps of using transit
   2. Exercises in proper use of transit
G. Review of use of framing square
H. Estimating (See pages 32-38 in appendix for sample estimators checklist). Students should be given a set of house plans and a copy of the estimators checklist and be required to find the estimated cost of building a house.
   1. Phase 1 — Preparation, site work, foundation and masonry costs.
   2. Phase 11 — Dry-in stage, mechanics rough-in.
   3. Phase 111 — Finish carpentry, finish work, appliances and sundry costs.
   4. Phase IV — Interior and exterior decoration and final finish work costs.

IV. *Use of Power Tools* (See pages 51-91 in appendix)

A. Review of use of power tools used in Building Construction 1.
   1. Radial arm saw
   2. Table saw
   3. Band saw
   4. Router
   5. Pneumatic hammer
   6. Portable hand drill
   7. Portable circular saw

8. Saber saw
9. Portable belt sander
10. Portable finishing sander
11. Portable planer
12. Shaper
13. Bench or pedestal grinder
14. Jointer

B. Other power tools
1. Jig saw
2. Drill press
3. Disk sander
4. Belt sander
5. Planer

V. *Site Layout and Foundation Construction*

In programs where the class builds a house, students enrolled in Building Construction 11 should be assigned the more complicated steps in site layout and foundation construction. The less complicated tasks should be assigned to first year students. Although all students probably will not be involved in every step in site clearance, layout and foundation construction, all should become familiar with the steps to be followed in completing this phase.

A. Site layout (Review from Building Construction 1)
1. Selecting location
2. Clearing
3. Setting up transit level (assign exercises in using)
4. Using water level
5. Locating lot lines
6. Locating building line
7. Constructing batter boards
8. Locating corners of buildings
9. Testing corners for squareness
10. Locating offsets, chimneys and piers
11. Locating line of excavation

B. Foundation construction (Review)
1. Building foundation forms
2. Pouring footing
3. Pouring foundation walls
4. Installing drain tile
5. Locating and installing anchor bolts
6. Installation of termite shields
7. Treating foundations for termites

VI. *Floor Framing* (Review of information covered in Building Construction 1)

A. Sills
1. Types—solid, laminated and "T"
2. Determining sizes needed
3. Installing

B. Girders
1. Types
2. Determining sizes needed
3. Installing

C. Ledgers
   1. Purpose
   2. Determining sizes needed
   3. Installing
D. Stirrups
   1. Purpose
   2. Types
   3. Installation
E. Headers
   1. Purpose
   2. Determining sizes needed
   3. Installation
F. Floor joists
   1. Proper spacing
   2. Determining sizes needed
   3. Installation
G. Bridging
   1. Use
   2. Types
   3. Proper spacing
   4. Installation
H. Subflooring
   1. Uses
   2. Materials used
   3. Proper spacing
   4. Installation

VII. *Wall Framing* (Review of information covered in Building Construction 1)

A. Installation of sole plate
B. Studding
   1. Types
   2. Spacing
   3. Installing
C. Framing openings for windows and doors
   1. Determining dimensions of required openings
   2. Procedure for framing openings
   3. Installation of cripple studs
   4. Installation of headers
D. Special posts
   1. Corner
   2. Partition
   3. Window
   4. Door
E. Bracing
   1. Types
   2. Installation
F. Wall plates
   1. Purpose
   2. Installation
G. Wall sheathing
   1. Purpose
   2. Materials used
   3. Diagonal sheathing
   4. Installation

H. Ceiling joists
   1. Purpose
   2. Spacing
   3. Determining size requirements
   4. Framing for openings for chimney, stairways, etc.

VIII. *Roof Framing*

A. Types of roofs (Review of information covered in Building Construction 1)
   1. Shed
   2. Gable
   3. Hip
   4. Gambrel
   5. Mansard
B. Roof plans
   1. Location of main framing members (ridge, hips, valleys and jacks)
   2. Dimensions – overall and overhang
   3. Location of intersections
   4. Exercise in drawing roof plans – Supply students with house plans and have each draw a usable plan for framing the roof of the house.
C. Rafters
   1. Types
   2. Laying off with framing square
   3. Use of layout tee
   4. Exercises in rafter cutting – assign students sufficient exercises in laying out and cutting rafters for them to become proficient in these two jobs.
D. Installation of roof framing – If Building Construction 1 and 11 classes are building a house, have second year students be responsible for constructing the roof framing.
E. Special roof framing problems (Review)
   1. Chimney saddles
   2. Bay window roof framing
   3. Truss roof
   4. Dormer roofs

IX. *Roofing* (Review of information covered in Building Construction 1)

A. Sheathing
   1. Types of materials used
   2. Installation
B. Roofing felt
   1. Types
   2. Installation
C. Flashing
   1. Types of materials used
   2. Installation on eaves and rake
   3. Installation around chimneys, vent pipes and similar items.
D. Selecting and installing roofing
   1. Types of shingles and other roof covering
   2. Application of roofing material
E. Special roofing problems – covering around dormers, chimneys, skylights and similar items.

X. *Exterior Finishing* (Review of information covered in Building Construction 1)

A. Windows and exterior doors
   1. Selecting doors and windows
   2. Installation of frames
   3. Installation of doors and windows in frames
B. Wall coverings
   1. Types of materials used
      a. Masonry
      b. Aluminum siding
      c. Clapboard and beveled siding
      d. Novelty siding
      e. Wood shingles
      f. Plywood
   2. Advantages and disadvantages of each
   3. Procedure of applying each
C. Trim work
   1. Trim problems
      a. Molding installation
      b. Porch trim
      c. Cornice trim
      d. Installing louvers and vents
      e. Front entrance trim
   2. Types of materials used
   3. Installation
   4. Painting

XI. *Insulation* (Review of information covered in Building Construction 1)

A. Purposes
   1. Keeping heat in or out
   2. Control condensation
   3. Retard spread of fire
   4. Sound proofing
B. Types
   1. Blanket
   2. Batt
   3. Granulated, cellular and fibrous
C. Insulation values of various insulating materials
D. Determining insulation requirements
E. Installation of insulation materials
F. Installation of storm doors and storm windows

XII. *Interior Finishing*

A. Interior walls
   1. Materials commonly used
   2. Installation of furring strips
   3. Application of materials
B. Ceilings
   1. Materials commonly used
   2. Installation of furring strips
   3. Installation of ceiling material

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C. Installation of door frames
D. Interior trim
   1. Installation of door trim
   2. Installation of window trim
   3. Installation of baseboard
E. Floors—Students should obtain experience in installing the types of flooring materials which are most commonly installed by carpenters. They should also become familiar with the types of materials which are installed by other flooring specialists and know the type of base required for installing these different types of materials (carpet, tile, linoleum, terrazzo).
   1. Types of flooring materials commonly applied by carpenters.
      a. Advantages and disadvantages of different types
      b. Procedure for applying and finishing each type
   2. Types of flooring commonly applied by specialists other than carpenters
      a. Advantages and disadvantages
      b. Type of base needed for each
F. Doors
   1. Types
      a. Style
      b. Materials used to make
   2. Installation of interior doors
   3. Installation of locks
   4. Installation of door stops
G. Cabinets
   1. Custom built on the site by cabinet maker
   2. Installation of factory built cabinets
H. Interior molding
   1. Types
   2. Installation
I. Staircases
   1. Types
   2. Staircase terminology
   3. Planning staircases
      a. Safety considerations
      b. Calculations necessary for staircase layout
   4. Use of framing square in laying out
   5. Construction of staircase
   6. Installation of preconstructed disappearing stairways

XIII. *Recent Advances in Building Construction*

An outline is not included for this section. However, the instructor should be alert to new materials and techniques of building being introduced and keep a file of literature on these for use with this section of the course. Student participation in this section should be encouraged by having them bring to class newspaper and magazine articles, catalog descriptions, and sales literature on any recent advances in the field.

XIV. *Locating and Securing a Job*

A. Finding information on available jobs
B. Considerations to ponder before seeking a job
C. Arranging for the interview
D. Preparing for the job interview
E. Being interviewed

XV. *Human Relations*

A. Importance of being able to get along with other people
B. Problems in interpersonal communications
C. Personal qualities required to be able to get along with other people
D. Understanding one's self
E. Understanding the actions and feelings of other people
F. Best procedures to follow in trying to solve working condition problems

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APPENDIX

RELATIONSHIP OF CARPENTRY TO OTHER TRADES

Carpentry is an ancient craft, yet its role in the building industry is still one of the most important. Carpenters work mainly with wood materials to construct buildings. Although many buildings are presently being constructed of masonry and materials other than wood, the carpenter still plays a major role in laying out for the building and installing doors, windows, etc.

The carpenter does much of the work in constructing a building, but major portions must be performed by other skilled craftsmen. The plumber, the electrician, the brick layer, the tilesetter, the cabinet maker, the sheet metal worker, the air conditioning and heating technician, and the painter are all necessary to complete a residence or other building.

A building contractor (many times a former carpenter) who bears the overall responsibility for the construction job coordinates the work of all the people involved in the project. He "subs" out (subcontracts) the different phases of building to plumbing, heating, electrical and other contractors. He sees to it that they complete the job according to the set of specifications. The completed building will be of better quality if these craftsmen cooperate with each other and carry out the work assigned to each.

All of the subcontractors will not be present at the construction site at all times and probably all would not be there at any one time. The carpenter must reach a certain stage in completion before the plumber can begin, the plumber a certain stage before the tilesetter can begin, and so on down the line. The stages of preparation for each trade to complete before the next one begins is pretty clearly understood by each group, and normally things work out smoothly. But, when one tradesman fails to complete his part of the job, confusion and poor workmanship are the result. Although the sequences in which different tradesmen arrive on the scene to do their work varies to a certain extent (depending upon the type of construction), the general order in which they might work is as follows:

1. Contractor – completes necessary paperwork–planning, estimate of cost, contract, purchase of builder's risk insurance, financial arrangements, etc.

2. Grading contractor – clearing of lot and preliminary grading.

3. Carpenter – layout for foundation (puts up batterboards, lines, etc.)

4. Grading contractor – excavates for foundation.

5. Laborers – digs out for the footings for foundation.

6. Carpenters – pours footings for foundation.

7. Bricklayer – lays block or brick foundation walls and piers.

8. Carpenter – "dries in" house (at a stage where work can be performed inside in rainy weather).

9. Plumber – "roughs in" plumbing (in case of houses built on concrete slabs, the plumber would "rough in" the plumbing before the carpenter).

10. Electrician – "roughs in" electrical system.

11. Heating and air conditioning technician and sheet metal worker – "roughs in" heating system.

12. Bricklayer – completes brickwork (veneers with brick if called for, lays steps, chimneys, fireplaces, etc.).

13. Carpenter – applies exterior siding (if not brick veneered), completes exterior trim and interior trim, applies paneling and sheetrock for interior walls, lays wooden flooring if required, completes formwork for pouring concrete floors for carport, basement, etc.

14. Cabinet maker (or finished carpenter when cabinet maker is not available) – installs cabinets.

15. Tilesetter – completes tilework.

16. Plasterer or dry wall finisher – prepares walls and ceiling for painting.

17. Cement finisher – pours and finishes concrete floors.

18. Plumber – installs plumbing fixtures.

19. Painter – applies paint or wall paper to interior walls, applies paint to exterior trim.

20. Electrician – completes electrical work.

21. Floor finisher – sands and applies finish to wooden floors, lays floor covering where required.

22. Carpet installer – installs carpet where required.

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THE USE OF LIVE PROJECTS

All trade instructors desire to have a quality instructional program. Building Construction instructors are no exception, but many have hindrances preventing them from having a quality program. One of these hindrances is the high cost of building materials which restricts the use of repetitive exercises in which building materials are consumed as a means of instruction. Another is the fact that the program is broader in scope than most other programs and to teach everything that needs to be taught is most difficult. And finally, many carpentry instructors are hampered by their classes being required to perform maintenance activities which have little, if any, instructional value.

One way of overcoming these hindrances is to have the carpentry classes build a house each year. In several programs, in this state, students build houses valued at from $12,000 to $22,500 which the school then sells or rents at the going market value.

By having the class build a house, the high cost of purchasing building materials ceases to be a problem because when the school sells the house it should more than clear the cost of building materials. The problem of teaching everything that needs to be taught in the course is also eliminated, because students can receive instruction and experience in practically every phase of building. The third hindrance, that of performing maintenance work, should be eliminated also, since students will be busy doing worthwhile work and instructors will not need to take on meaningless maintenance activities.

Students are involved in drawing up the house plans, writing up bills for materials, laying out for foundations, constructing the house and working with subcontractors. The "subcontractors" are often Trades and Industries classes in electricity, air conditioning, brick masonry, and painting and decorating. Home economics and family living classes sometimes aid in planning the house and decorating it once it is completed. Horticulture classes could be used to do the landscaping. Through first-hand experience, students learn of the problems encountered in planning, financing, laying out and building a house.

The use of "live" projects in this manner seem to make the instructional program more effective and economical to operate. In spite of this fact, instructors sometimes find it difficult to secure the approval of their school authorities to build houses. Understandably, school administrators and others have been reluctant to approve building a house because of a fear that the school will lose money on such an endeavor. Administrators' resistance should subside if the instructors can show the benefits of having the students build a house and the small danger of losing money on the project. Actually, the risk of losing money is quite small. Perhaps the instructor could take his principal or director to visit a Building Construction Program which uses "live" projects and have the instructor and his school administrators explain the procedures they follow. After seeing such a program in operation and recognizing its benefits, reluctant administrators might desire to see a similar program initiated in their school.

Both instructor and administrators should see to it that the instructional value of such a project does not suffer due to the desire to make a huge profit from the sale of completed houses. The instruction which can be derived should be the primary motive for building. If a house is to be built, then certain guidelines should be observed to prevent financial and other difficulties from arising. A good set of guidelines to follow are on pages 27-30 of this publication. The section is entitled "Policies and Procedures for the Operation of Program of Real Work in All Connecticut Vocational-Technical Schools" and is reprinted in its entirety with permission of the Connecticut Department of Education.

THE CONNECTICUT PLAN FOR CARPENTRY AND MASONRY CLASSES OF VOCATIONAL SCHOOLS TO BUILD RESIDENCES

This section, reprinted by permission of the Connecticut State Department of Education, in addition to giving the procedures to be followed, discusses fully the problems and possible weaknesses involved in doing "live projects" for the public and explains how to overcome them. Instructors considering building houses should study this section and discuss its contents with their administrators and other appropriate school officials before beginning. Instructors should adhere closely to these guidelines and other restrictions imposed by the proper authorities.

"CONNECTICUT STATE DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL EDUCATION
Bureau of Vocational-Technical Schools

Policies and Procedures for the Operation of Program of
'Real Work in All Connecticut Vocational-Technical Schools'

PURPOSE

This section is intended to provide a policy framework within which 'Real Work' experiences as an element of instruction may be organized and maintained to best advantage in the Vocational-Technical Schools.

JUSTIFICATION OF 'REAL WORK' PROGRAM

Justification of school participation in the field of actual commercial work is that such work is necessary for valid and complete training of the student. If a school program aims to provide, as a part of its offerings, reasonably good training in trade judgment and operative skills, actual work under usual conditions is obviously essential. Where such 'real work' experiences are not provided, vitally needed values are lost or at least greatly diminished. The history of apprenticeship, both ancient and modern, points to a continuing recognition that experiences on 'real work' are imperative if good vocational preparation is to result.

DIFFERENCE IN BUSINESS AND SCHOOL OBJECTIVES

There are, however, important differences between the contractor or industrialist engaged in private business and the Vocational-Technical School's total educational program. These differences need to be fully understood by both administrative and instructional staffs otherwise the objectives may become confused and the program correspondingly abortive. Private business is primarily organized for profit and whatever training may be carried on is more or less secondary or incidental. The Vocational-Technical School on the other hand is organized for education and vocational training in proper balance. Its primary business, therefore, is the development of human values.

Obviously, then, the producing of 'commercial jobs' is not the primary function of a Vocational-Technical School and should never become a dominating factor in school outlook or policy. On the other hand, 'real jobs' must be recognized for what they are, important media of training, and not dismissed from mind merely because it can be shown that the school is not expressly engaged in producing articles for sale. In the practical phases of the training there is very evident relationship between the 'quality of the job' and the kind of instruction the student receives.

ASPECTS RELATED TO THE PUBLIC INTEREST

An element which usually needs clarification in the public mind is the somewhat natural assumption that the Vocational-Technical School may be a threat to privately organized business or industry because of the amount of commercial work it may do.

This impression is further magnified if a school, as a general practice, contracts for such work at rates considerably below usual prices. As a rule, however, this feeling grows out of general rather than specific information. An example will perhaps help to clarify the extent in reality of such competition. In a typical school electrical shop, the total amount of work done during a recent year amounted to approximately $3,600.00. This included a wide range of work such as house wiring, motor repairing and a limited amount of industrial electrical installation. In the same area served by this school, there were six contractors in the electrical field. Assuming that each contractor has secured an equal share of this work, it would have amounted to $600.00 each. If those contractors realized a gain of 10% above operating cost their total business profit in each case would have been $60.00 higher for that year if the school had not participated in electrical contracting. Furthermore, it is well to remember that this same school employed in its electrical department two electrical tradesmen who were trained as instructors, one of whom had previously been in business as a contracting electrician. Both of these men, if released from their present work, might well enter the contracting field themselves and thus increase the competition to a much greater extent than that represented by the school's production work needs in this trade. In addition, most of the journeymen employed by these local contractors received their basic training in the electrical trade at the Vocational-Technical School.

RELATION TO COST OF TRAINING

Whether vocational training is provided by private industry and paid for by private funds or carried on under public auspices and paid for by public funds, costs are in both cases evidently necessary. Contractors train apprentices on 'real work'. In doing this, they achieve three general objectives:

a. Provide valid training for the apprentice.
b. Conserve material costs.
c. Promote completion of the job.

It is unlikely that any employer would approve having apprentices trained on exercise work to be scrapped after completion. This would be an expensive and perhaps futile form of apprentice training from the standpoints of materials, time and human values. The Vocational-Technical School is in much the same position so far as its practical training is concerned. The school needs 'real work' to provide valid instruction and when properly selected and organized such work results in:

a. Value for the student in more effective training in less time.
b. Material costs reduction.
c. Work produced which contributes to the public and general welfare.

In both instances time, materials and human values are conserved, the product resulting from the training has a sale value and overall costs to the public are to that extent reduced.

INTERNAL USE OF SCHOOL FACILITIES

Another element which has public implication is the extent to which school facilities may be used in producing goods and rendering services for the benefit of its own employees or students. It is more or less apparent that such practice if uncontrolled will seriously impair training effectiveness and perhaps endanger public confidence as well.

GENERAL PROVISIONS FOR PRODUCTION WORK AUTHORIZATION

All production work as hereinafter described or classified must be properly authorized. Such authorization shall be in accordance with detailed instructions as outlined in Section 11 of this Bulletin or such later revisions of the same as may be established.

Before accepting a production job of more or less detailed character, suitable plans, specifications and details should be on hand—

a. Provided by customer, acceptable to school.
b. Provided by the school, approved and paid for by customer.

following the above practice, job estimating and organization is improved and instruction thereby prompted. If the school develops such plans, the students benefit and the school is also fairly compensated for preparatory engineering essential to completion of the job.

Where a customer agrees to supply materials or fabricated parts for all or any portion of a production job, the conditions of such agreement should be stated on the production order or be included in a signed contract upon which such order is based. Materials when supplied by a customer should meet acceptable standards for the work to be done and to be delivered by the customer or his agent to the site or at the school at time or times as may be required for most effective instructions and progress of the work. As a matter of fair business practice, the school or its agents should not enter into any price arrangements or negotiations having to do with the actual purchasing of such materials for a customer's job. The school, however, may supply a customer with information concerning kinds and quantities of materials needed for a prospective job.

CONTRACT IMPLICATIONS AND RESPONSIBILITIES

It should be kept in mind that all production work when accepted, regardless of size or character, constitutes a contract by the State with a customer. A customer may be any person, partnership, corporation or institution. In this connection, it may be noted that, except for the courtesy discounts recommended, school employees or students having work done by the school are, therefore, to be considered as customers in the usual sense of that term.

Directors are responsible for all production work carried on in the schools under their charge and approval and general supervision of such work shall directly or indirectly include the following on their parts:

Approval

a. Examination and approval of customer's credit.
b. Examination and approval of plans and specifications including licenses and permits.
c. Examination and approval of estimate and prices.
d. Examination and approval of contract forms and procurement of required signatures.
e. Issuance of production order authorizing that the work be started.

Supervision

a. Follow up progress of work by frequent inspections and instructor contract.
b. Keep instructors conscious of need for following plans and specifications meticulously and in case of change, securing the owner's direction in writing for such change, using the prescribed form for this purpose.
c. See that partial payments, if called for, are promptly billed in the manner as prescribed in Section 11 of this Bulletin.
d. See that instructional objectives and effective teaching methods are employed and good public relations maintained.
e. Encourage prompt job completion and require that all production orders be completed in accordance with accounting procedures and turned in to the Central Office for billing without delay.

In like manner, instructors are responsible to the school director for carrying out their responsibilities in accordance with policies and procedures as herein outlined and provided.

CLASSIFICATION OF CHARGES AND DISCOUNTS

General

In order to safeguard values and establish reasonable uniformity, the following provisions and classification of charges shall govern 'production work' commitments in the Vocational-Technical Schools.

The extent of discounts, within the ranges as hereinafter stated, will obviously depend upon the nature of the job and the attendant conditions and circumstances. It is not intended that discounts must apply in all cases and certainly it is not intended that the maximum of the range should become the rule. The actual discounts which will reasonably apply in each case is the responsibility of the school director as a part of required approval of job estimates and production orders.

Production Work for the General Public

Labor charges: Production work price of labor to the general public should be reasonably commensurate with prevailing trade price. Any downward adjustment to meet special school training conditions should not exceed 10 to 25% on labor only. Unless some such special conditions exist which reasonably justify reduced labor prices, the average journeyman rate per hour of the respective trade should prevail.

Material charges: The general public should be charged retail prices for materials used in production work when furnished by the school. The retail price is the price charged to the public and is distinguished from the net price or wholesale price with which the school, industrial plant or contractor is favored. The difference or monetary gain helps to pay for the direct costs of handling materials and the indirect overhead costs of maintaining a business. In trades where the general public can purchase materials at the same price as a contractor or the school, a 10% handling charge should be made if the school is required to furnish the materials.

Direct Sales: Direct sales to the public shall be avoided except in minor cases of accommodation or emergency character or sales of necessary training supplies and tools to students. The school is not, nor should it be, engaged in retail selling to the general public."

"CONNECTICUT STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Bureau of Vocational-Technical Schools

Legal Basis of the 'Industrial Fund'
Connecticut Vocational-Technical Schools

Training on 'real jobs' has long been an established policy of the Connecticut Vocational-Technical Schools, particularly in the operative or skill phases of instruction. In recognition of the proven values of this policy and to properly provide for it, the General Assembly in 1929 enacted legislation establishing an 'Industrial Fund for the State Board of Education.' This law recorded in Chapter 223 of The Public Acts of that year reads as follows:

'SECTION 1. The sum of thirty-five thousand dollars is appropriated to establish an industrial fund for the state board of education in connection with its administration of trade and vocational education. Said board shall use said fund as a revolving fund for the purchase of manufacturing materials and supplies, in the establishment and continuance of such productive work as the trade and vocational schools shall perform in connection with the board's educational program for such schools.

SECTION 2. Claims against the state in behalf of said state board of education shall be paid by order of the comptroller drawn against said fund. The proceeds of all sales resulting from the productive work of the schools shall be paid into the state treasury and credited to said fund.

SECTION 3. At the end of each fiscal period, any balances in excess of thirty-five thousand dollars, as shown by the inventory of manufactured articles, material on hand or in process of being manufactured, bills receivable and cash balance, shall revert to the state treasury.'

Subsequent legislation expanded the original Act to authorize purchase of personal and contractual services and equipment properly chargeable to production contracts and has also increased the amount of the fund from time to time. Section 324b of the 1951 supplement to the General Statutes increased the working capital in the fund to one hundred and twenty thousand dollars."

SAMPLE ESTIMATORS CHECK LIST

The following form is a sample check list which can be used to estimate the cost of building a house. Additional copies for use by students can be made by making a thermofax ditto master and reproducing it on a spirit duplicator.

ESTIMATORS CHECK LIST

AJAX BUILDERS SUPPLIES, INC. ESTIMATE BY _____

JOB NAME _____ DATE ESTIMATE MADE _____

JOB NO. _____ PLAN NO. _____ DATE STARTED _____

LOCATION _____ DATE COMPLETED _____

PHASE 1, PREPARATION, SITE WORK, FOUNDATION, MASONRY

1. Engineering, Estimating Cost, Plans, Survey _____
2. Building permits _____
3. Utility deposits _____
4. Sewer tap _____
5. Water tap _____
6. Site clearance _____
7. Strip and store top soil _____
8. General grading _____
9. Temporary power pole _____
10. Temporary power _____
11. Temporary toilet _____
12. Builder's risk insurance _____
13. Batter boards and layout _____
14. Excavation of footings _____
15. Concrete for footings _____
16. Footing reinforcement _____
17. Cement block for foundations @
    (A) 4x8x16 _____
    (B) 6x8x16 _____
    (C) 8x8x16 _____
    (D) 12x8x16 _____
    (E) Lintel blocks _____
    (F) Cap blocks _____

(G) Pilaster blocks

(H) Dur-o-wall

18. Brick, foundation and veneer
    (A) Face brick
    (B) Common brick
    (C) Fire brick
    (D) Flu liner
    (E) Flu thimble
    (F) Cleanout door
    (G) Damper
    (H) Ash Dump
    (I) Chimney flashing & pitch
    (J) Angle iron for fireplace
    (K) Mantel material
19. Mortar mix
20. Sand
21. Wall ties
22. Screened foundation vents, 8x16 w/closers
23. Anchor bolts & washers
24. L-irons
25. Steel I-Beams
26. Door and window bucks
27. Wall reinforcing
28. Termite shields or chemical treatment
29. Basement sash, steel or aluminum
30. Steel door frames
31. Steel basement posts
32. Backfill allowance
33. Period cleanup

PHASE 2, DRY-IN STAGE, MECHANICS ROUGH-IN

1. Outside sills

2. Inside beams or girders
3. Floor joists plus doubles
4. 2x4 nailers
5. 1x4 bridging
6. 1x6 s4s or ½" 5-ply plywood sub-floor
7. 2x4 sole & plates
8. 2x4 wall purlines
9. 2x4x8 fir studs
10. 2x4x12 wall bracing
11. 2x6 window and door headers
12. 2x6 interior door headers
13. 2x6 ceiling joists
14. 2x6 rafters, king rafters & valley rafters, ridge plate
15. 2x6 partition caps
16, Ceiling joist bridging
17. 4x9 asphalt impregnated fiber board sheathing
18. Roof bracing, collar beams
19. 1x6 T&G roofers or ½" 5-ply plywood roof decking
20. Roof vents
21. 15 # felt
22. Asphalt shingles
23. Foundation, window and door flashing
24. Flash plates
25. Carport and porch plate material
26. Carport ceiling joists, rafters, truss material not included elsewhere
27. Screened porch material
28. Deck material
29. Outdoor cooker material
30. Window units
31. Window screens
32. Window stool
33. Window trim
34. Door trim
35. Window locks
36. Window lifts
37. Door blocking 5/8" 4x8 AD plywood
38. Exterior door frames
39. Exterior doors
40. Exterior locks keyed alike
41. Exterior butts, 4x4

42. Patio door, thermopane or plain
43. Garage door
44. Rough hardware
    (A) 16d cc nails
    (B) 8d cc nails
    (C) roofing nails
    (D) finish nails
    (E) box nails
    (F) floor cletes
    (G) drywall nails
    (H) chaulk
45. Electrical work
46. Plumbing work
47. Heating and/or air conditioning work
48. Temporary heat
49. Period cleanup

PHASE 3, FINISH CARPENTRY, FINISH WORK, APPLIANCES & SUNDRY

1. Exterior wall paneling (boards & battens, aluminum, asbestos, etc.)
2. Boxing – lookouts & ledging
3. Exterior plywood, 3/8 soffit
4. Facier boards
5. Freiz boards
6. Screen wire or soffit vents
7. Crown moulding
8. Shingle moulding
9. Brick moulding
10. Drip cap
11. Carport stripping, facier boards, boxing, crown moulding not listed elsewhere
12. Carport ceiling, ¼" ext. plywood
13. Carport ceiling lattice strip
14. Polyethelene vapor barrier for oak floors
15. Oak flooring
16. 5/8 particle board or plywood underlayment
17. 1x4 # 2 stripping material
18. Sheetrock
19. Water resistant tile backerboard
20. Prefinished paneling
21. Drywall cornerbead
22. Floor insulation
23. Ceiling insulation
24. Exterior & stairwall wall insulation
25. Interior door jambs

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26. Interior doors

27. Door stop material
28. Interior door locks
29. Interior door butts
30. Disappearing stairway unit
31. Interior stairway material

32, Birch, pine or fir baseboard
33. Birch, pine or oak shoemould
34. Interior crown mould
35. Special moulding
36. Cabinets: Kitchen base
Kitchen wall
Bath vanities
Bookcases
Desks
37. Medicine cabinets
38. Vanity mirrors
39. Attic flooring
40. Screen doors
41. Screen door hardware
42. Aluminum Storm Screen Doors
43. Weatherstripping
44. Thresholds
45. Door bumpers, straight & hinged
46. 1x12 closet shelving
47. 3/4" galv. or wood closet rod
48. Carport fill soil & compaction, fine grade
49. Basement fill soil & Compaction, fine grade
50. Patio fill soil & compaction, fine grade
51. Polyethelene slab vapor barrier
52. Reinforcing wire or steel
53. Edge forms
54. Expansion joint
55. Concrete for slabs
56. Concrete finish work
57. Cure & protection
58. Appliances:
(A) Drop-in range, gas or electric
(B) Surface units, gas or electric
(C) Wall Oven, gas or electric
(D) Hood & fan
(E) Roof cap

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(F) Exhaust pipe
(G) Plastic cement
(H) Attic fan
(I) Bath exhaust fan
(J) Dishwasher
(K) Disposal
(L) Washing Machine
(M) Dryer
(N) Rotary antenna system
(O) Intercom system
(P) Food center appliances
(Q) Window air conditioners
(R) Bar-be-cue surface unit
(S) Refrigerator

59. Tub enclosure or rod
60. Shower door or rod
61. Light fixture allowance (including chime equipment)
62. Light bulbs and tubes allowance
63. Gutters & Downspouts
64. Access door material
65. Period cleanup

PHASE 4, INTERIOR, AND EXTERIOR DECORATION, FINAL FINISH WORK

1. Tape & finish sheetrock
   (A) Rolls of tape
   (B) Pounds of gyp cement
2. Plaster
3. Paint interior walls & trim
   Paint thinner
4. Textured ceiling allowance (sand, spray, crowfoot)
5. Wall paper installation
6. Paint windows
7. Clean windows
8. Finish doors (plain & louvered)
9. Paint or stain inside cabinets
10. Stain paneling trim, putty paneling nail holes
11. Sand, fill 2 coats finish OAK floors & stairway finished
12. Carpeting
13. Seamless floor covering
14. Inlaid floor covering
15. Ceramic tile
    (A) On sheetrock

(B) On cement

16. Chrome bath accessories

17. Stone floors or quarry tile
18. Epoxy painted floors
19. Clean-up and wax
20. Period cleanup
21. Caulking compound
22. SWP Undercoater
23. SWP Exterior paint
24. Porch & floor enamel
25. Galvite primer
26. Paint thinner
27. Fence material

28. Stepping stones
29. Cement walkways

30. Splash blocks
31. Storm sewer material
32. Foundation waterproofing
    (A) Cement parget
    (B) Pitch
    (C) Drain tile, gravel fill

33. Carport & porch columns

34. Wrought iron railings
35. Ornamental shutters
36. Clothes line material

37. Cupola
38. Yard rough grading
39. Yard finish grading, seeding
40. Shrubbery
41. Driveway
42. Final cleanup
43. Call back
44. Supervision

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THE IMPORTANCE OF PUBLIC RELATIONS TO THE BUILDING CONSTRUCTION PROGRAM

The carpentry instructor can improve the effectiveness of his program and the other trade programs of the school by doing his share of the public relations work.

For a Building Construction Program to serve the purpose for which it was intended, certain people must know that the program exists and know the service it renders to the community.

First of all, the general public should know the value of the program. After all, the taxpayers are footing the bill for the program and have a right to know how their money is being spent. The public must have confidence in the school and its staff so that it will be willing to give financial and other support. Educators have found over the years that the schools in communities in which people have confidence in their school and its programs (due in part to good public relations) usually get the financial backing and cooperation necessary to offer a high quality educational program. Likewise they have found that schools in communities which do not have the trust and confidence of the people, do not get the support and backing they need. Simply stated, public trust is essential to having a good school.

In addition to the general public being familiar with trade programs, it is important that prospective students (who can profit from the training) be aware of the existence of the program and know how they can benefit by enrolling in it.

Prospective employers of graduates of the program also need to be informed about the program, be involved in planning the curriculum and know how the program can help solve the labor shortages that exist.

Public relations is not a small task, and the instructor should do his part and not leave it as the responsibility of the administration and central office.

Often, school people think of public relations as being the picture stories found in the Sunday newspaper, and far too many, regarding it as such, have used this as their sole means of public relations. Actually, the newspaper article is only one means of public relations (which may not be the best means).

For purposes of our discussion, public relations can be defined as "actions which contribute to mutual understandings and cooperative actions by the many groups involved in the promotion and execution of school programs."

One good means of public relations is to offer the kind of program that will adequately prepare students for employment. If the students in the program and graduates of the program are sold on its value, then the word of mouth advertising they will do will be of more value than the work a hired public relations man could do.

Another group that can help with public relations is a well selected and properly functioning advisory committee. For Building Construction Programs this committee should consist of carpenters, contractors and interested citizens. They should be called on to help plan the curriculum, formulate policies to be followed, and aid in securing employment for graduates of the program. Public relations should not be the major job for the advisory committee, but will result as a by-product of the overall work they do. Members of the advisory committee can help sell the program to other craftsmen in the field. Once these craftsmen are sold on the program, the battle of public relations is half won. The value of a properly functioning advisory committee cannot be overemphasized.

News stories for newspapers and radio and television stations can be useful in keeping the public informed. These news media are usually most appreciative of newsworthy stories furnished to them. Stories can be written by the instructor and submitted to the newspaper, or a reporter can be called on to come to the school to make photographs and write the story.

If the class builds a house, valuable publicity could be obtained when the school disposes of the house, whether this is done by public auction, sealed bids, or by placing it on the market with a definite price. Notices concerning the sale could be put in the newspapers and on

radio and television, with an "open house" being held for the public and prospective buyers to see the product of the students' work.

Instructors and administrators can also speak to civic clubs and other groups about their programs. Color slide sets and films, which are relatively easy to make, can be used to spice up these talks and make the presentation easier to deliver.

The instructor's key role in public relations work is to offer a sound instructional program which is worthy of public notice. He should remain alert to good opportunities for increasing the public's understanding of what he is doing. He should keep his eyes and ears open to public criticism (justified or unjustified) of his program and should correct situations for which criticism is justified. If the criticism was unjustified, then he should find some tactful means for clearing up the misunderstanding which prompted the criticism.

There is a final word of caution on the subject of public relations. The purpose of public relations should be to give all persons a clear and true picture of what is being done in our programs, and not to give a "sugar coated" and false version of what is being done. Information disseminated should always be factual. Although it is important to sell the program to the public, it is equally as important not to try to oversell it. The public is not easily fooled and can see through false information. Many attempts at public relations have failed for this reason.

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Wagner, Willis H. Modern Woodworking—Tools, Materials and Procedures. Homewood, Ill.: Goodheart—Willcox Co., Inc.

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PERIODICALS

American Builder. Simmons-Broadman Publishing Corp., 30 Church Street, New York, N.Y.

Industrial Arts and Vocational Education. 400 Broadway, Milwaukee, Wisconsin 53201.

Power Tool Instructor. Free subscription upon request. Mail request on school letterhead to Editor, Power Tool Instructor, 554 N. Lexington Avenue, Pittsburgh, Pa. 15208.

Practical Building. Cahners Publishing Company, 5 South Wabash Avenue, Chicago, Illinois.

School Shop. 416 Longshore Drive, Ann Arbor, Michigan. Free subscription upon request.

School Shop News. Free subscription upon request from Stanley Tools, New Britain, Connecticut.

PAMPHLETS AND PUBLICATIONS

Pamphlets available from American Plywood Association, 119 A Street, Tacoma, Washington 98401:

"Guide to Plywood Grades"
"Guide to Plywood Properties and Grades"

Catalogs available from Rockwell Manufacturing Company, The Rockwell Building, Pittsburgh, Pa. 15208:

"Portable Power Tools for Home or Professional Use"
"Rockwell Delta Industrial Woodworking and Metalworking"
"Rockwell Delta Power Tools for the Building Trades and Home Shop"
"Rockwell Delta Stationary Home Shop Power Tools"
"Rockwell Machine Tools"
"Rockwell Portable Power Tools for Industry, Construction, and the Building Trades"

Booklets and publications available free upon request from Stanley Tools, Division of the Stanley Works, New Britain, Connecticut:

No. 60 "Hand Tool Catalog"
No. 300 "Power Tool Catalog"
No. T2 "Joy of Accomplishment Folder"
No. T482 "Instruction Sheet: How to Check the Accuracy of a Level"
No. T13 "Boy's Booklet: How to Choose and Use Tools", "Router Bit Selector Chart"
No. T96 "Surform" Folder
No. T43 "Chisel" Folder
No. T122 "Hex-a-matic" Nut Driver
No. T199 "All-n-one" Tool
"Suggested List of Equipment for Junior or Senior High School"
"How to Use the Steel Square"

Pamphlets available from National Forest Products Association, 1619 Massachusetts Avenue, N.W., Washington, D. C. 20036:

"Manual for House Framing" – Wood Construction Data Booklet Number 1.
"Random Length Wood Decking" – Wood Construction Data Booklet Number 2.
"Design of Wood Formwork for Concrete Structures" – Wood Construction Data Booklet Number 3.
"Plank-and-Beam Framing for Residential Buildings" – Wood Construction Data Booklet Number 4.
"Heavy Timber Construction Details" – Wood Construction Data Booklet Number 5.
"Design of Wood Structures for Permanence" – Wood Construction Data Booklet Number 6.
"Insulation of Wood-Frame Structures" – Wood Construction Data Booklet Number 7.
"The Wood Tank" – Wood Construction Data Booklet Number 8.

Manual available from U. S. Expansion Bolt Company, York, Pennsylvania 17405.

FILMSTRIPS

The following filmstrips are available from the Industrial Education Department, Clemson University, Clemson, South Carolina 29631:

C-Kit 2 – Woodworking Tools and Machines

1. Hand Tools – Hammers – Saws – Selecting, carrying and arranging tools at the workbench – safe use of coping saws – handsaws – hammers.

2. Planes – Bits – Knives – Chisels – Screwdrivers – Files – Safe use of smooth, jack, and jointer planes – bits and drills – chisels, gauges and carving tools – knives – selecting and using screwdrivers – safe use of files and wood rasps.

3. Tool Grinder – Introduction to the tool grinder, kinds of tool grinders, names and functions of parts – safe practices for setting up a tool grinder – safe practices for using a tool grinder.

4. Drill Press – Introduction to the drill press, names and functions of parts – safe practices for setting up a drill press – safe practices for using a drill press.

5. Jig Saw – Introduction to the jig saw, names and functions of parts – safe practices for setting up a jig saw – safe practices for jig sawing.

6. Band Saw – Introduction to the band saw, names and functions of parts – safe practices for setting up a band saw – safe practices for band sawing.

7. Disk Sander – Introduction to the disk sander, kinds of disk sanders, names and functions of parts – safe practices for setting up a disk sander – safe practices for disk sanding.

8. Belt Sander – Introduction to the belt sander, names and functions of parts – changing a sander for horizontal operation – safe practices for setting up a belt sander, replacing an abrasive belt – safe practices for belt sanding.

9. Lathe: Parts, Spindle Turning – Introduction to the wood-turning lathe, kinds of wood-turning lathes, names and functions of parts – safe practices for setting up a lathe for spindle turning – safe practices for spindle turning.

10. Lathe: Faceplate Turning – Other Operations – Safe practices for setting up a lathe for faceplate turning – safe practices for faceplate turning – safe practices for sanding and polishing – safe practices for drilling.

11. Planer – Introduction to the planer, names and functions of parts, safe practices for setting up a planer – safe practices for using a planer.

12. Jointer – Introduction to the jointer, names and functions of parts, safe practices for setting up a jointer – safe practices for using a jointer.

13. Circular Saw: Parts – Installing a Blade – Introduction to the circular saw, kinds of circular saws, names and functions of parts – kinds of blades, installing a blade.

14. Circular Saw: Setting Up – Operating – Safe practices for setting up a circular saw – safe practices for using a circular saw.

C-Kit 3 – The Use of Machines in Our Industrial Life

1. The Evolution of Machines
2. Care and Use of the Band Saw
3. Care and Use of the Jig Saw
4. Care and Use of the Drill Press
5. Care and Use of the Shaper
6. Care and Use of the Circular Saw

C-Kit 4 – Woodworking Series – 4 strips

Shows correct usage and effective operation of hand and power tools in producing articles of wood.

Films formerly available from Clemson University are now available from State Department of Education, Audio-Visual Library, 1513 Gervais Street, Columbia, South Carolina 29201. Telephone 758-2687. A list of films currently available will be sent upon request.

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FREE FILMS

From Modern Talking Picture Service, 503 North College St., Charlotte, N. C. 28202:

Patterns of Time—The Hardwood Story, 13½ min. color. Produced by Fine Hardwoods Association and Hardwood Plywood Manufacturer's Assn. Film no. 2760.

From Modern Talking Picture Service, 714 Spring St., N.W., Atlanta, Georgia 30308:

Miracle in Wood, 27 min. color. Produced by American Plywood Association. Film no. 3159.

The Wood that Could, 28 min. color. Discusses applications for laminated timber beams. Produced by American Institute of Timber Construction.

From Audio-Visual Aids Library, 1513 Gervais Street, Columbia, S. C. 29201:

Interior and Exterior Trim. No. C-6, 12 minutes.
Fundamentals of Stair Layout. No. C-7, 11 minutes.

Note: Requests for use of films should be on school letterhead and contain the following information:

1. The title of the film.
2. The date or dates you prefer and alternate dates (order as far in advance as possible).
3. Your name and title.
4. Mailing address.

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SAFETY IN TRADES AND INDUSTRIES
BUILDING CONSTRUCTION PROGRAMS

This section contains information needed to properly instruct students on how to work safely in the Building Construction trades. The accident rate in the trade runs higher than in most. Accidents often result in partial or total disability, sometimes death. Many less serious accidents, such as broken limbs, cuts and bruises are painful and can be expensive by causing the carpenter to be out of work for periods of time ranging from a few days to several months.

The important thing to remember is that costly accidents will not occur if workers are safety conscious and follow recommended safety precautions. The following information should be valuable in aiding students to develop the correct attitudes toward safety and acquaint them with certain safety precautions:

1. Dress sensibly for the job.

   a. Wear eye safety glasses as required by South Carolina law. Sun glasses should not substitute for safety glasses.

   b. Clothing should suit your individual needs and be suitable for the prevailing weather conditions. Avoid loose fitting clothing that would restrict freedom of movement.

   c. Students tend to work harder and safer if they are wearing clothes which they are not afraid to get dirty. Therefore, as students enter the shop each day they should immediately exchange their regular school clothing for coveralls or other accepted working attire. Time should be provided at the end of class for them to wash up and change back into their regular clothing.

   d. Avoid wearing pants or overalls that are too long. Cuffs made by turning up the legs of pants tend to catch heels and cause tripping and falls.

   e. To avoid catching on nails, keep the sleeves of shirts or jackets buttoned.

   f. Keep hair cut short or keep long hair in place with a visor or hair net.

   g. To protect feet from protruding nails, wear shoes with thick sturdy soles.

   h. To protect feet from falling objects, wear safety shoes or boots with steel toe caps.

   i. Wear a hard hat when exposed to overhead work where there is a chance of falling objects.

   j. Remove rings, wristwatches, neckties, neck chains and other jewelry.

2. Use caution in handling materials (approximately 25% of all injuries are a result of moving materials and tools improperly).

   a. Long pieces of material should be carried by two persons.

   b. Use the muscles in your legs and knees to lift heavy objects. Do not use your back muscles! To do so could result in painful back injuries.

   c. Observe caution when carrying planks or other objects across frozen, wet, or otherwise slippery footing.

3. Avoid falls.

   a. Learn to watch your footing, avoid objects that could trip you.

   b. Check scaffolding and temporary walkways before walking on them. Be sure the supports are strong and secure.

   c. Use only ladders which are in good condition and set up properly.

4. Practice good housekeeping.

   a. Materials and equipment should be stacked straight and neat.

   b. Keep aisles and walkways clear of tools, materials and debris.

   c. To prevent fires and reduce hazards which cause accidents, dispose of scraps and rubbish daily.

   d. Whenever you see protruding nails, remove them or bend them down immediately.

   e. When working above other workers, place tools and materials where they will not fall and cause injuries.

5. Properly use tools and equipment. (See pages 52-91 of appendix for specific safety precautions on individual machines.)

   a. Wear eye safety glasses as required by South Carolina law.

   b. Carry tools with sharp edges or points with the cutting edges and points down and away from you.

   c. Never carry awls, chisels and other tools with sharp points or edges in your pockets.

   d. Never use tools with mushroomed ends.

   e. Never use a tool with a loose head or broken handle.

   f. Never attempt to clean or adjust a power machine while it is in motion.

   g. Only the operator should be allowed to start or stop the machine and only the operator should be allowed in the operator's zone while it is in operation.

   h. Machines should not be operated while the instructor is away. Some means should be provided for disconnecting power to prevent machinery from being used while the instructor is gone.

   i. Keep tools sharpened and equipment in 100% working condition.

   j. All power tools should be grounded.

   k. Do not overload lifting equipment.

   l. All machines should be equipped with safety guards and devices.

6. Observe warnings posted at the construction site.

7. Consider the safety of fellow workers at all times.

8. The teacher should be prepared to administer first aid if the need arises (See section on first aid in Safety Handbook, A Guide for Trade and Industrial Education Programs). A well-supplied first aid kit should be kept in the shop or at the job site at all times.

9. Proper conduct is important in preventing unnecessary injuries.

   a. Avoid horseplay.

   b. Avoid running in the shop.

10. Keep your mind on the job. Many accidents occur when the worker is preoccupied with things other than the job at hand. Some causes of inattention could be:

    a. Financial worries.

    b. Daydreaming.

    c. Emotional conflicts.

    d. Distractions – chatting with fellow workers, watching passersby, listening to radio, etc.

    e. Illness.

    f. Some medications.

    g. Feeling of insecurity.

    h. Anger or frustration.

11. Safety equipment which should be in the shop:

    a. CO_2 type fire extinguisher

    b. Well-supplied first aid kit

    c. Approved eye protective devices for each student.

Pages 52-91 give specific safety precautions for each machine. Transparencies with the parts labeled are included. The following machines are covered in this section:

	Page
1. Radial Arm Saw	51
2. Table Saw	53
3. Band Saw	55
4. Jig Saw	57
5. Drill Press	59
6. Disk Sander	61
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16. Bench or Pedestal Grinder	81
17. Pneumatic Hammer	83
18. Shaper	85
19. Portable Planer	87
20. Wood Lathe	89

NOTE: This list is not to be interpreted as the suggested equipment for carpentry programs. Some equipment is listed because it is still in use in many carpentry shops and the writer feels that information should be included for the machines currently being used. Some equipment listed would not be recommended for use in carpentry programs.

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RADIAL ARM SAW

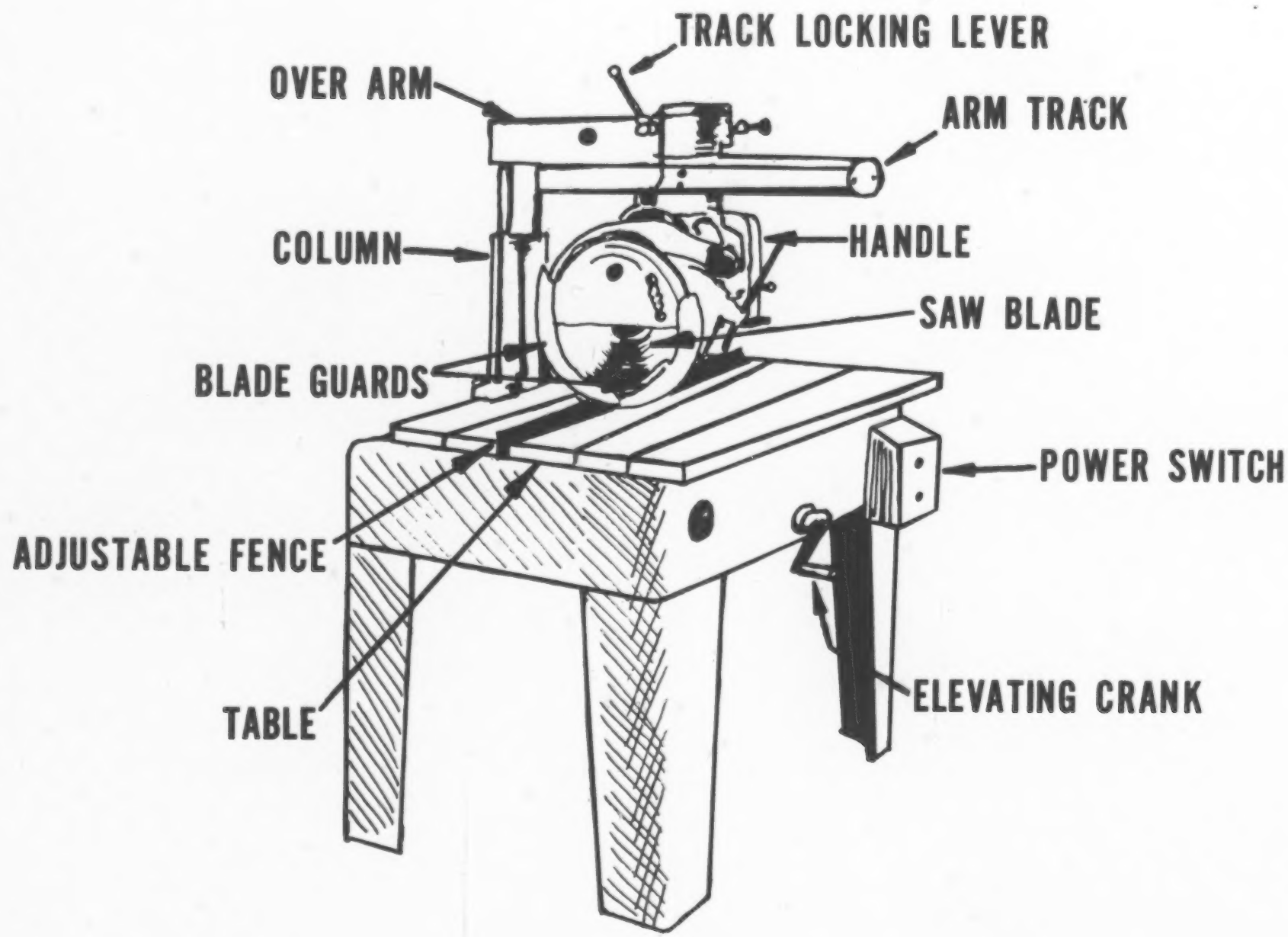

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1. RADIAL ARM SAW

The radial arm saw is used for ripping and crosscutting stock and for bevel, angle cuts and other specialized cuts used in woodworking shops.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the radial arm saw.
3. Never wear loose clothing when operating the radial arm saw.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Do not use the saw when other persons are talking to the operator.
7. Always use anti-kickback device when ripping. Feed only from side opposite anti-kickback.
8. Always use a push stick when ripping narrow pieces of stock.
9. When ripping stock, never place your fingers between the saw and the guide or fence.
10. Set the blade guard so that it just clears the stock being cut.
11. Be sure all levers are locked as required for the operation being performed before the power is turned on.
12. Never rip thin material or material less than 12" in length.
13. Never lower the saw blade so that it will cut into the table top.
14. Inspect all stock for knots, nails and other defects before cutting.
15. Keep hands well away from the blade and do not stand in line with the cut.
16. Hold stock firmly on the table and against the fence when crosscutting stock.
17. When shutting off radial arm saw, never leave until the blade has completely stopped. Never force material against the blade to stop it from turning.

TILTING ARBOR SAW

(TABLE SAW)

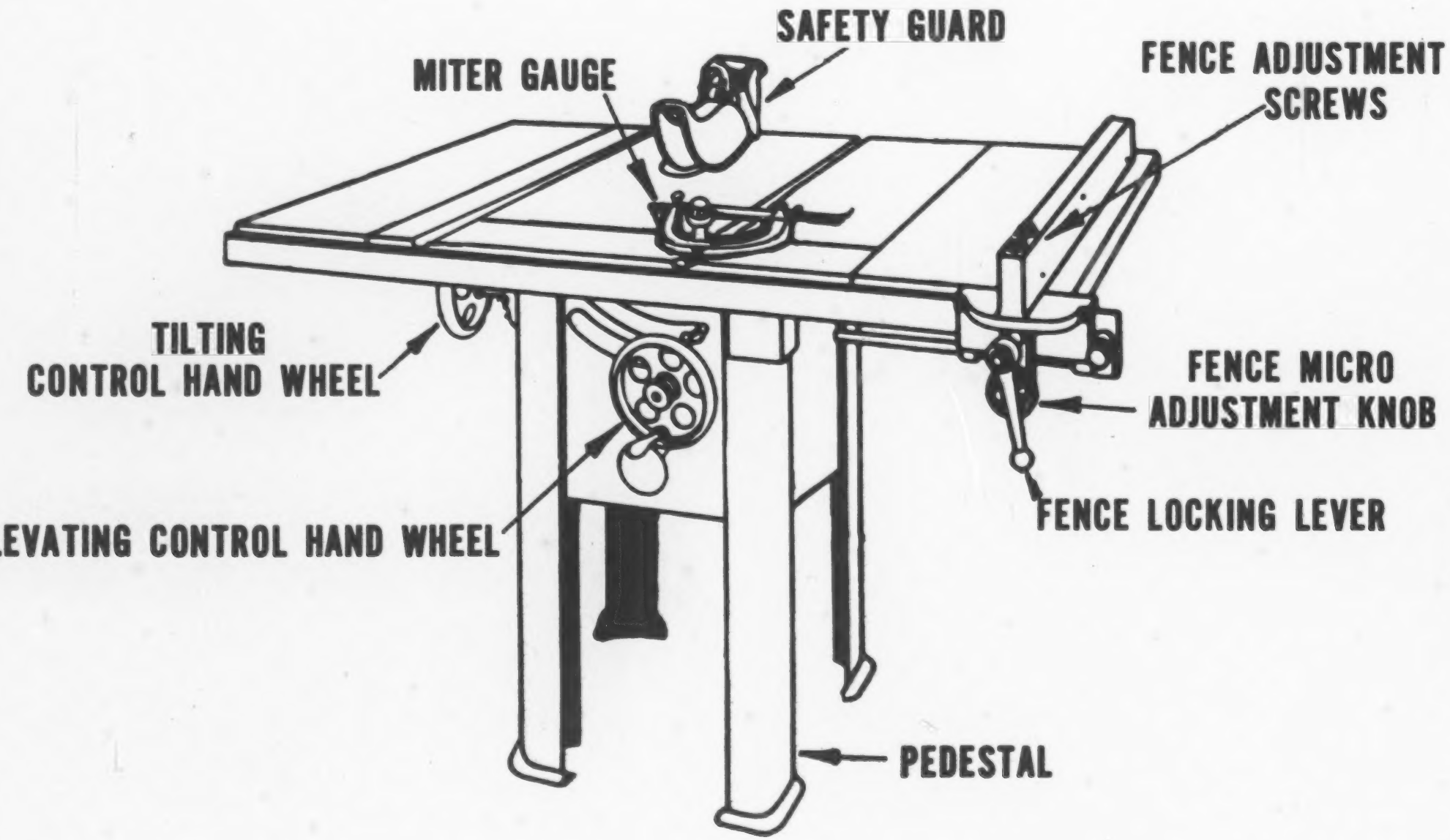

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2. TABLE SAW

The table saw is used for ripping, crosscutting and many other special operations in most woodworking classes.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the table saw.
3. Never wear loose fitting clothing when using the table saw.
4. Keep all guards and safety devices in good working condition and in place.
5. Make all adjustments with the power off.
6. Always use a push stick when ripping narrow stock.
7. Stand to one side and keep area directly behind and in front of the blade clear when the saw is in use.
8. Be sure blade is sharp and properly set. A dull blade will cause kickback.
9. Do not allow saw blade to project more than 1/8" to 1/4" above the stock being cut.
10. Never saw freehand; use the miter gauge or fence depending on cut being made.
11. Always place jointed or straight edge against fence.
12. Do not reach over the saw; use an assistant to help you with long stock.
13. Allow only the operator to feed stock through the saw.
14. Do not operate the saw when other persons in the area are talking to or otherwise disturbing the operator.
15. Keep work area clean and free of obstructions.
16. Always stop the saw and use a brush when cleaning sawdust from the table saw.
17. Remove the rip fence when crosscutting.
18. Never stop the saw blade by forcing a piece of wood against the side of the blade.
19. Provide a means of locking the switch in the off position when the saw is not in use.
20. Shut off machine and do not leave until the blade has completely stopped.

5658

BAND SAW

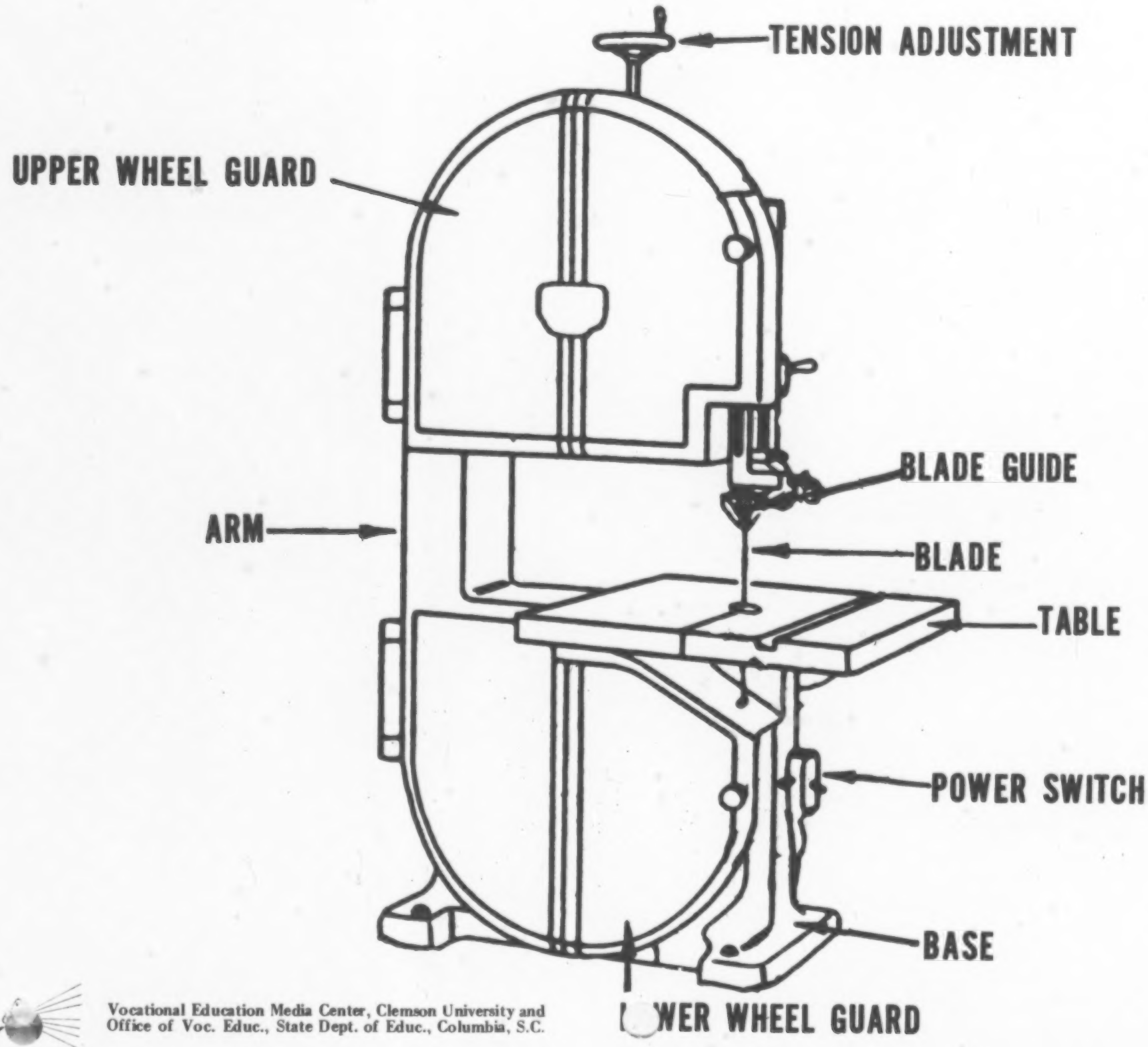

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3. BAND SAW

The band saw is most commonly used for straight and curved cuts in the shop.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the band saw.
3. Never wear loose fitting clothing when using the band saw.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Always use a push stick for close cutting work (keep hands out of the path of the blade).
7. Be sure that both the upper and lower wheel guards are securely closed before starting the band saw.
8. Check blade tension before starting the band saw.
9. Adjust upper blade guard and guide to allow for 1/8" - 1/4" clearance above the work piece.
10. Always check stock for knots, nails, and other defects before beginning your cut.
11. Do not place pressure against the blade or twist the blade by making too sharp a curved cut.
12. Always use a stick to remove blocks or chips near the saw blade.
13. Never back a saw blade out of the saw kerf while the saw is running.
14. Give your undivided attention to your work.
15. Shut off power and wait until saw blade stops before leaving the saw; use the brake if available.

JIG SAW

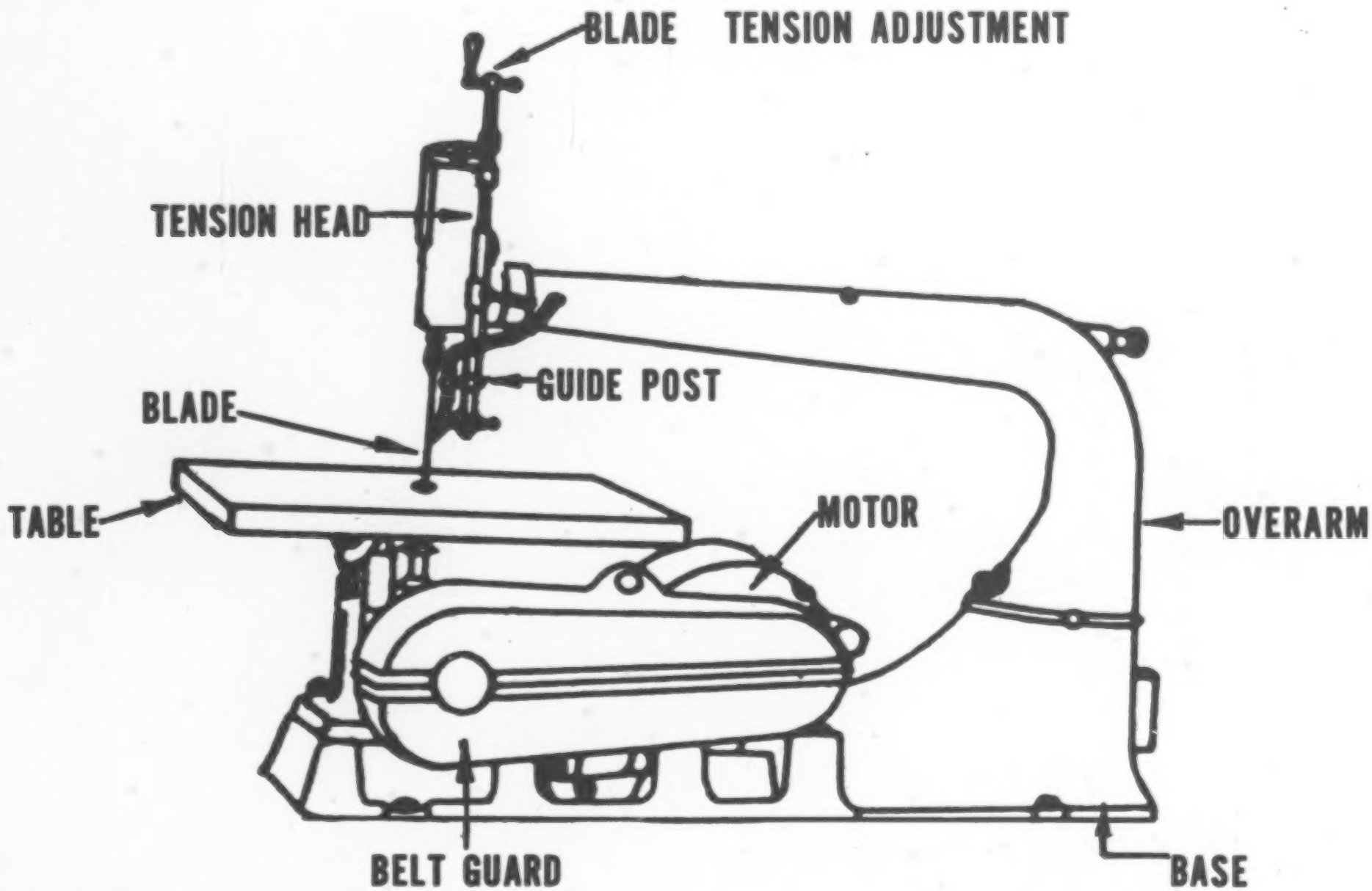

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4. JIG SAW

The jig saw is commonly used for cutting curved outlines; it may also be used for straight cuts where great accuracy is not required.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the jig saw.
3. Never wear loose fitting clothing when using the jig saw.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Always be sure the blade is properly installed with the teeth pointing down.
7. Check the machine by turning it over by hand to see that the blade tension is correct and that the blade clearance is proper.
8. Always keep the hold down adjusted to just clear the work piece so that it will not be raised off the table.
9. Always keep your fingers out of the direct path of the blade cut when feeding work into the jig saw.
10. Never force or crowd the work into the saw blade.
11. Never remove chips or small blocks from the saw table with your hands or fingers.
12. Shut off the power, and do not leave the jig saw until it has completely stopped.

5662

DRILL PRESS

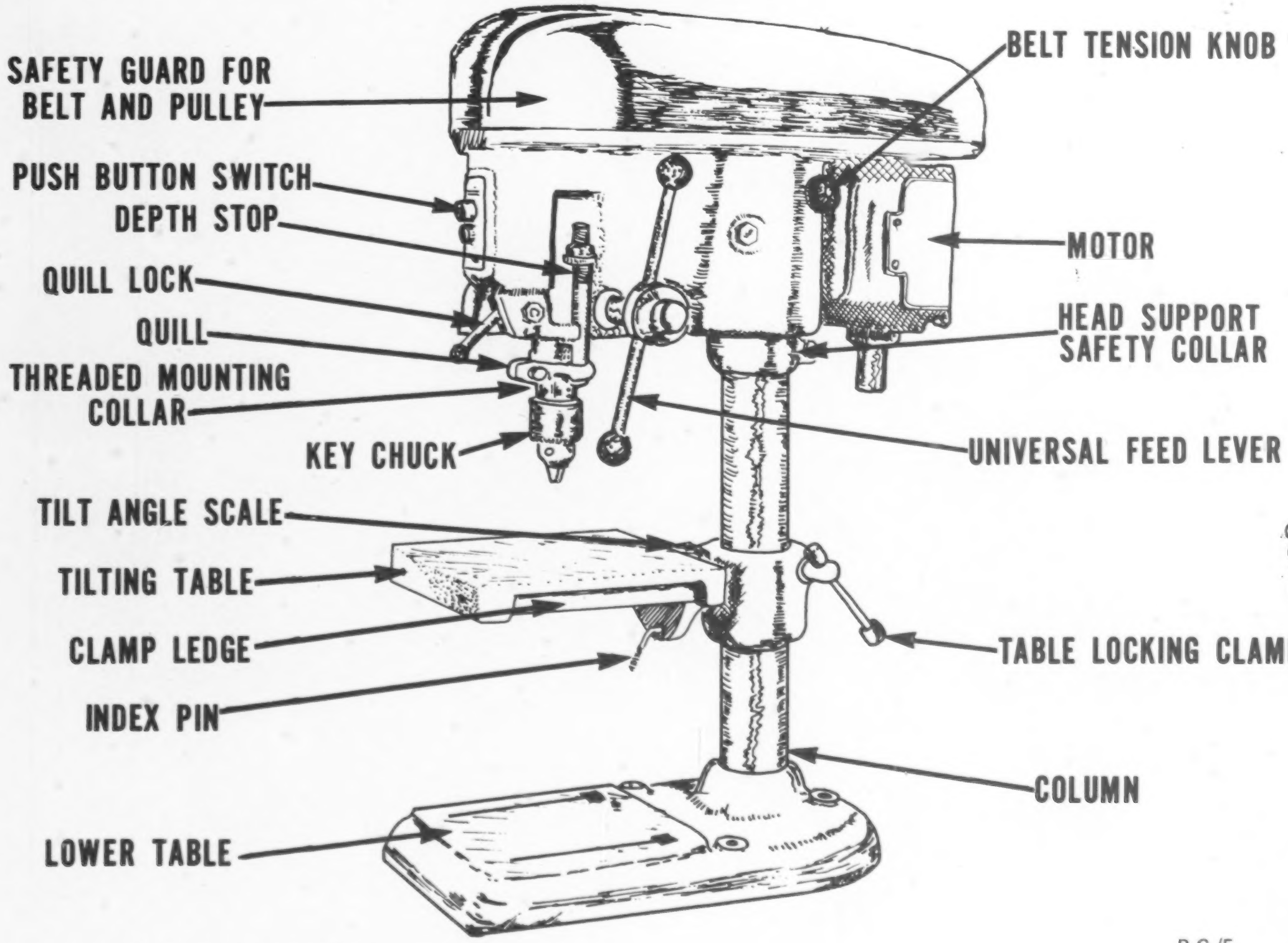

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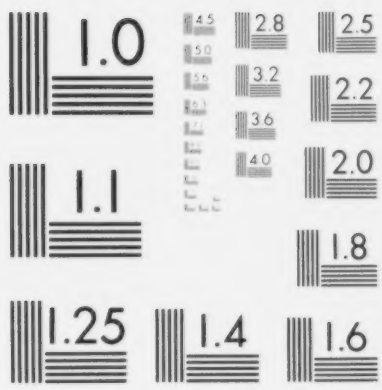

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

5. DRILL PRESS

The drill press is commonly used for boring holes in steel and wood. When working with wood it can also be used for mortising, routing, limited sanding and countersinking.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the drill press.
3. Never wear loose fitting clothing when using the drill press.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Always fasten work piece securely with the proper vise or clamp.
7. Always keep the long end of a work piece to your left if possible.
8. Support the end of a long work piece with a stand.
9. Always adjust the drill speed to suit the material being drilled and the size of the hole being bored.
10. Always remove the chuck key from the chuck after tightening a drill bit and before starting the motor.
11. Always feed the drill bit cautiously into the work piece.
12. Never attempt to stop a revolving work piece in which the drill bit is caught. Stop the drill press and then free the drill bit.
13. Always use cutting oil when drilling steel.
14. Always use sharp drill bits.
15. Always wait until the drill press stops before leaving the machine.

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DISK SANDER

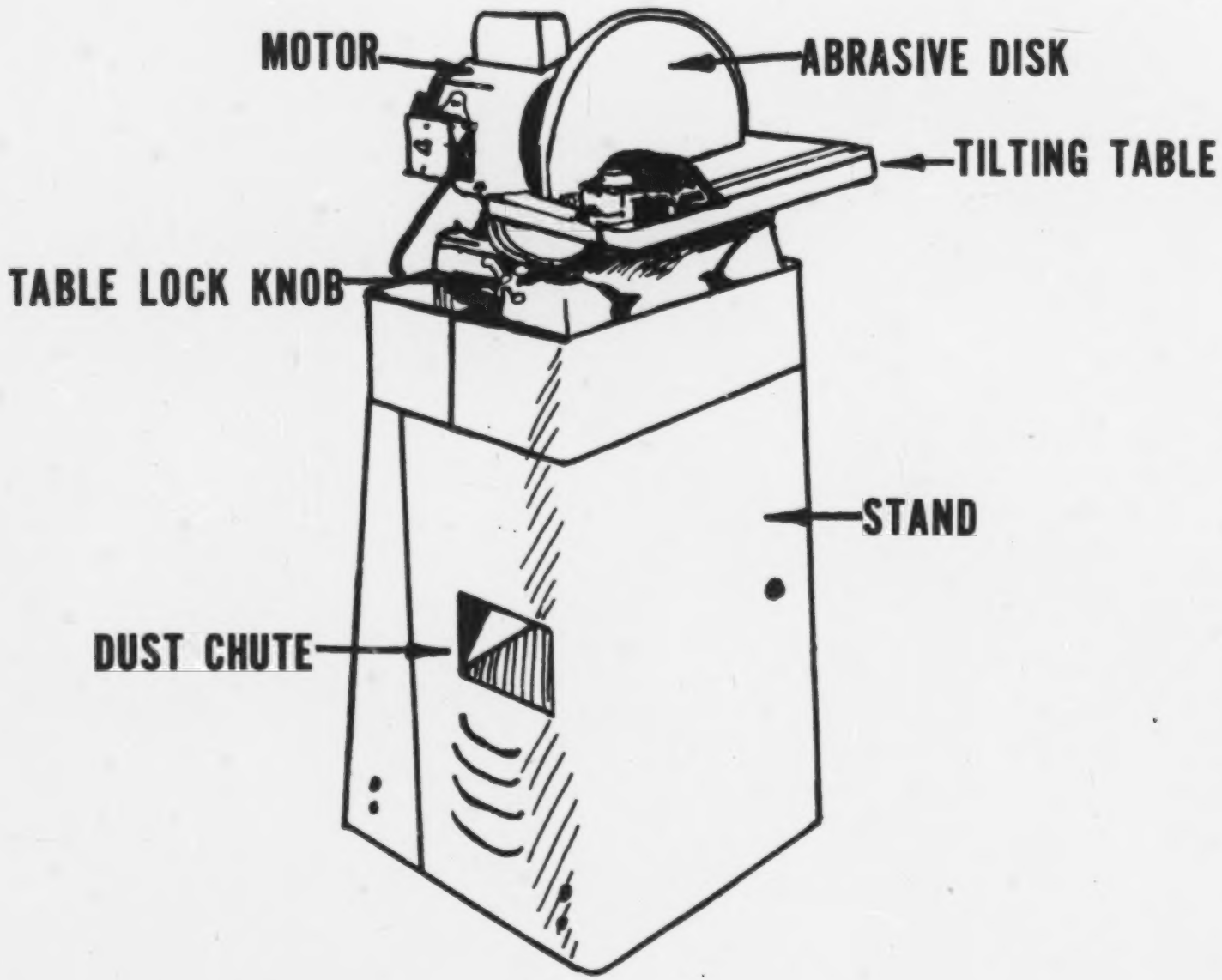

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6. DISK SANDER

The disk sander is commonly used to form and shape parts used in making woodworking projects.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the disk sander.
3. Never wear loose clothing when using the disk sander.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Always check to determine that the abrasive disk is properly mounted; never operate the disk sander if the abrasive paper is loose.
7. Always use the table, fence and other guides to control the position of the work whenever possible.
8. Always use hand-held clamps or a jig to hold small pieces for sanding.
9. Always sand on the side of the disk which is moving down toward the table; move the work along this surface so it will not burn.
10. Never use the sander to form or shape objects where other machines will do a better job.
11. Never sand work that has excess glue or finish on the surface.
12. Never force a piece of wood against the disk to stop it after the power has been shut off.
13. Always keep hands at least 2 inches from the sander disk.
14. Shut off power and wait until the disk stops completely before leaving the area.

BELT SANDER

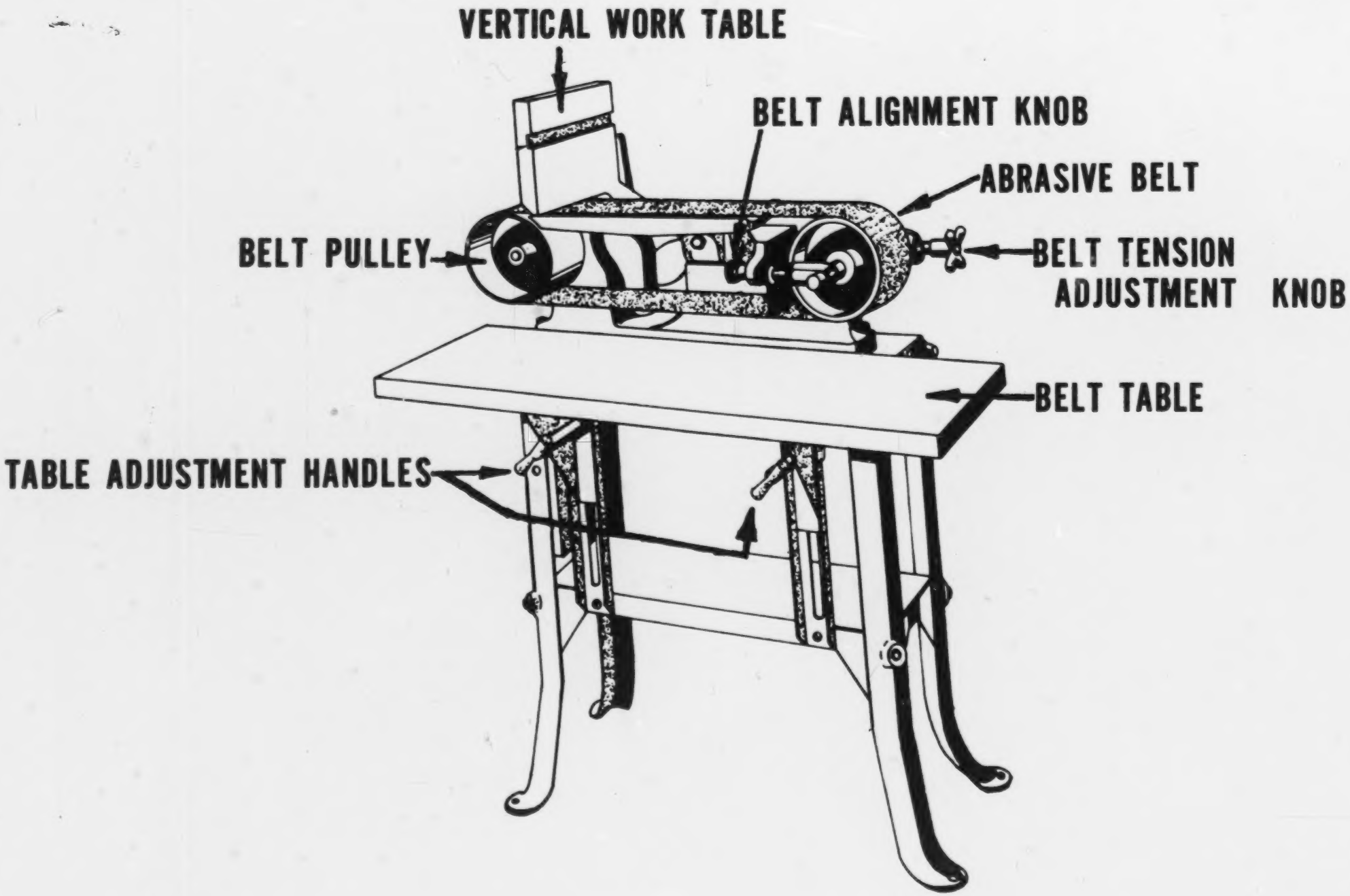

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B.C./7

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7. BELT SANDER

The belt sander is commonly used for sanding flat surfaces, edges, and, in some special cases, the inside curve of a work piece.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the belt sander.
3. Never wear loose fitting clothes when operating the belt sander.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Always be sure the belt is properly mounted; run the sander to make sure the belt tracks properly.
7. Always use the table fence and other guards to control the position of the work whenever possible.
8. Always use a hand clamp or jig to hold small and irregular shaped pieces.
9. Always keep the fingers, if possible, 2 inches away from the abrasive belt.
10. Always support the work against the table when sanding the end grain of narrow pieces.
11. Always use a pad or push block when sanding thin pieces.
12. Never use the sander to form or shape objects where other machines will do the job better.
13. Never sand work that has excess glue or finish on the surface.
14. Never force a piece of wood against the abrasive belt in order to slow it down.
15. Shut off the power, and do not leave the area until the belt sander has come to a complete stop.

JOINTER

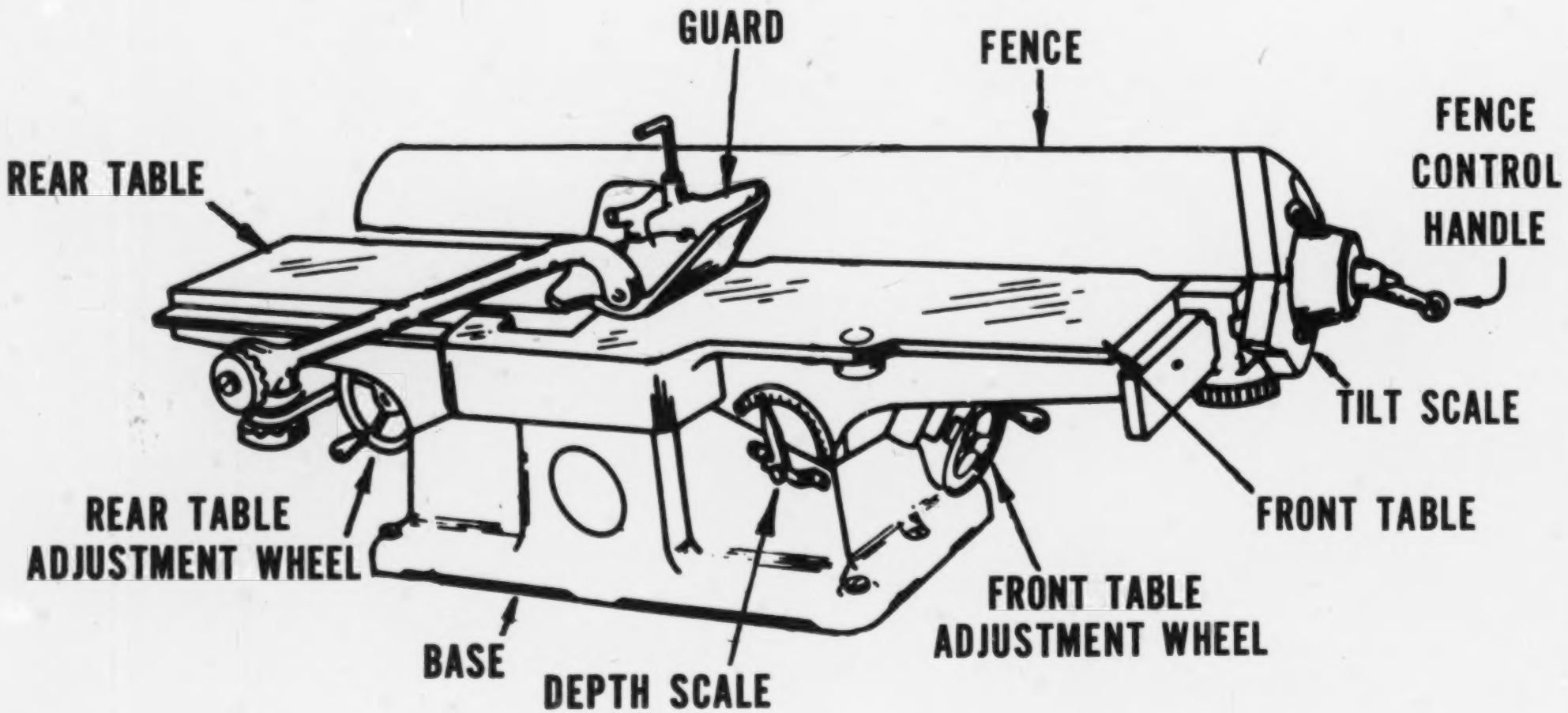

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B.C

8. JOINTER

The jointer is commonly used in most shops where skills in woodworking are taught. A jointer is used for straightening, beveling, tapering and rabbeting the edges of lumber.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the jointer.
3. Never wear loose fitting clothing when using a jointer.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Check all stock for loose knots, nails or other defects before jointing.
7. Use a push stick or hold down block when jointing stock that is too small or short to give a reasonable distance of safety for your hands. Never joint lumber less than 10 inches long.
8. Lock fence in place before beginning jointing operations.
9. Keep hands away from the area immediately above the cutter head.
10. Always joint stock with the grain of the lumber to prevent splintering.
11. Never operate the jointer with fewer knives in the head than it is designed to use.
12. Always hold the edge or side of the stock being jointed tightly against the fence.
13. Shut off the power and do not leave the jointer until it has come to a complete stop.

5670

PLANER

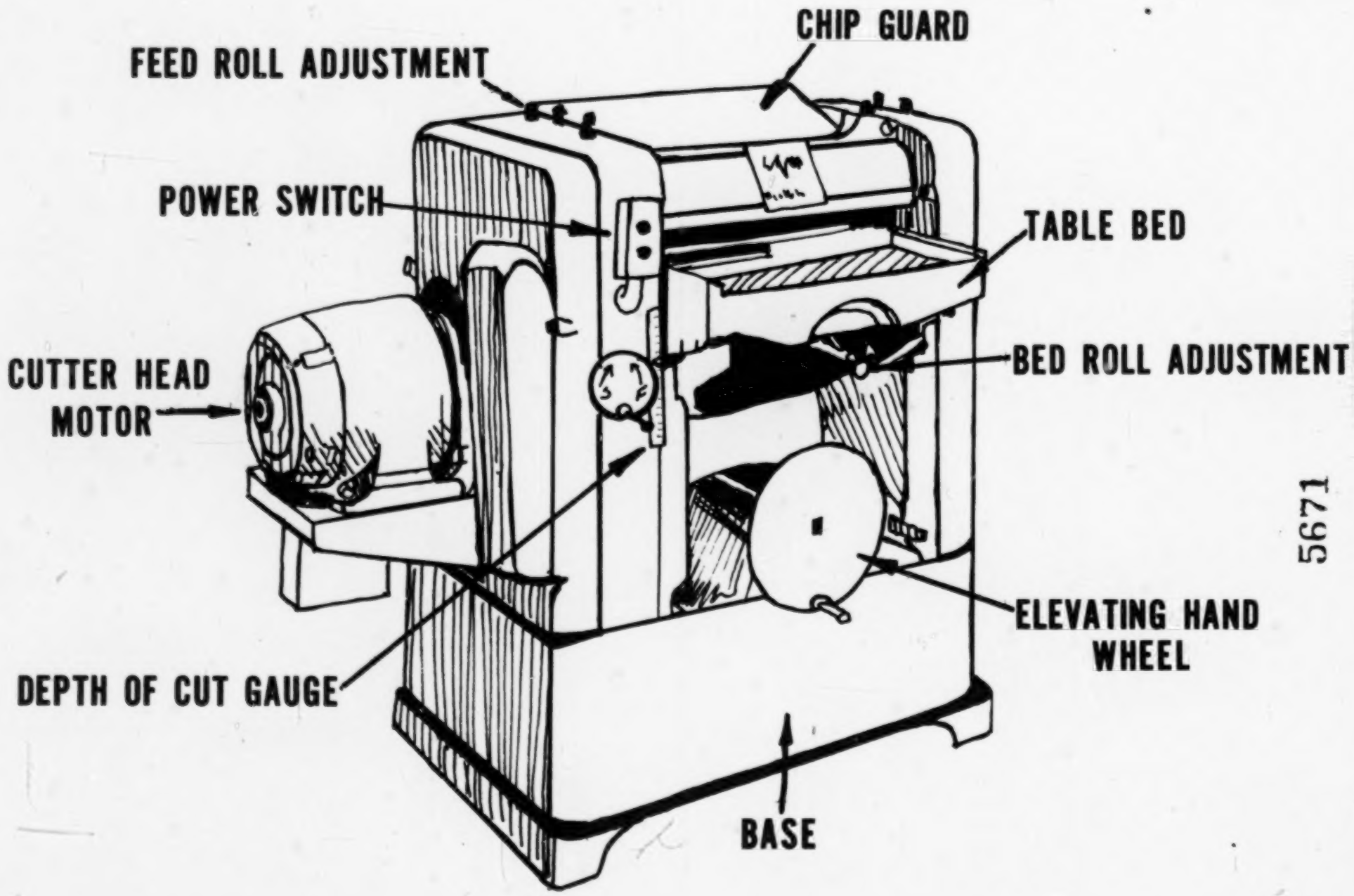

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9. PLANER

The planer is generally used to smooth the rough face of lumber and/or to obtain a desired thickness of stock for a specific use.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the planer.
3. Never wear loose fitting clothing when operating a planer.
4. Keep all guards and safety devices in good working condition and in place.
5. Make all adjustments with the power off.
6. Check all stock for loose knots, nails and other defects before putting it through the planer.
7. Be sure blades are sharp and properly adjusted. Never operate the planer with fewer knives in the cutter head than it is designed to use.
8. Remove shavings only when the power is off, and use a brush for this purpose.
9. Always keep hands away from the material nearing the feed rolls.
10. Never plane stock which is shorter than 1 foot longer than the distance between the feed rolls or less than ¼" thick.
11. Never plane stock of different thicknesses; this can result in kickback.
12. Use gloves when rough stock is being planed.
13. Pass the stock around the planer and not over it when preparing to run it through the second time.
14. Never look directly into the feed roll area during the operation of the machine.
15. Do not overload the machine by taking too deep a cut.
16. When shutting down the planer, do not leave the machine until it has come to a complete stop.

PORTABLE CIRCULAR SAW

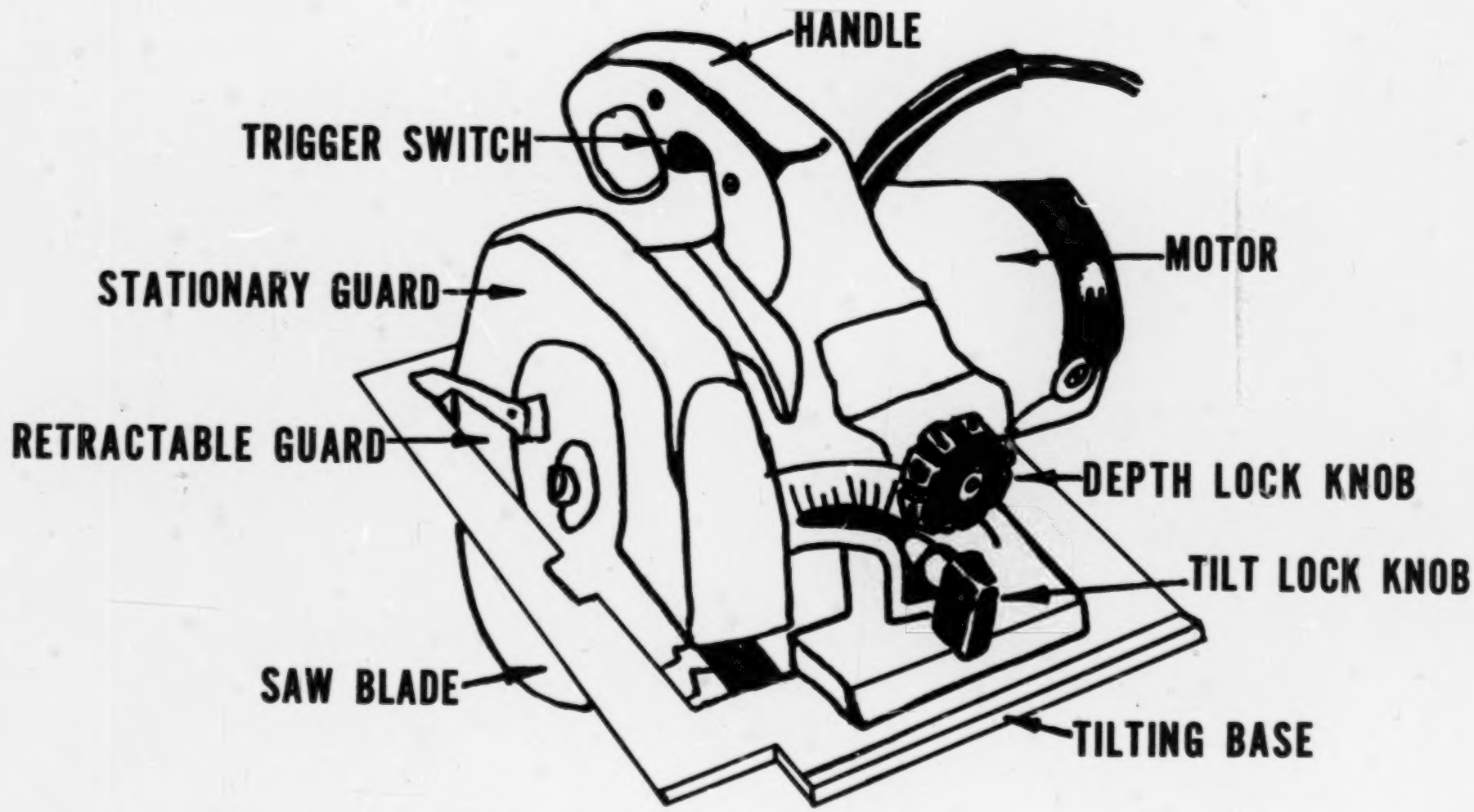

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10. PORTABLE CIRCULAR SAW

The portable circular saw is commonly used for framing and other rough construction work.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the portable circular saw.
3. Never wear loose fitting clothing when operating the portable circular saw.
4. Keep all guards and safety devices in good working order and in place.
5. Always check the power cord for condition, and be sure it is a 3-wire cord and is properly grounded.
6. Make all adjustments and check blade tightness with the power source disconnected.
7. Never stand on a wet surface when operating a portable circular saw.
8. Always be sure the switch is off before connecting to the power source.
9. Always use a sharp blade.
10. Always support the work piece securely with saw horses or other supports; clamp small pieces so they cannot slip or move.
11. Be careful not to cut into the saw horse, work bench or other support with the blade.
12. Always adjust the depth of cut to the thickness of the stock plus 1/8".
13. Always stand to one side of the cutting line during the cut.
14. Always be sure blade is not in contact with the work piece when starting the portable circular saw.
15. Always use both hands to hold and guide the saw through the work piece.
16. When shutting off, wait until the blade stops completely before placing the saw on the table.

PORTABLE SABER SAW

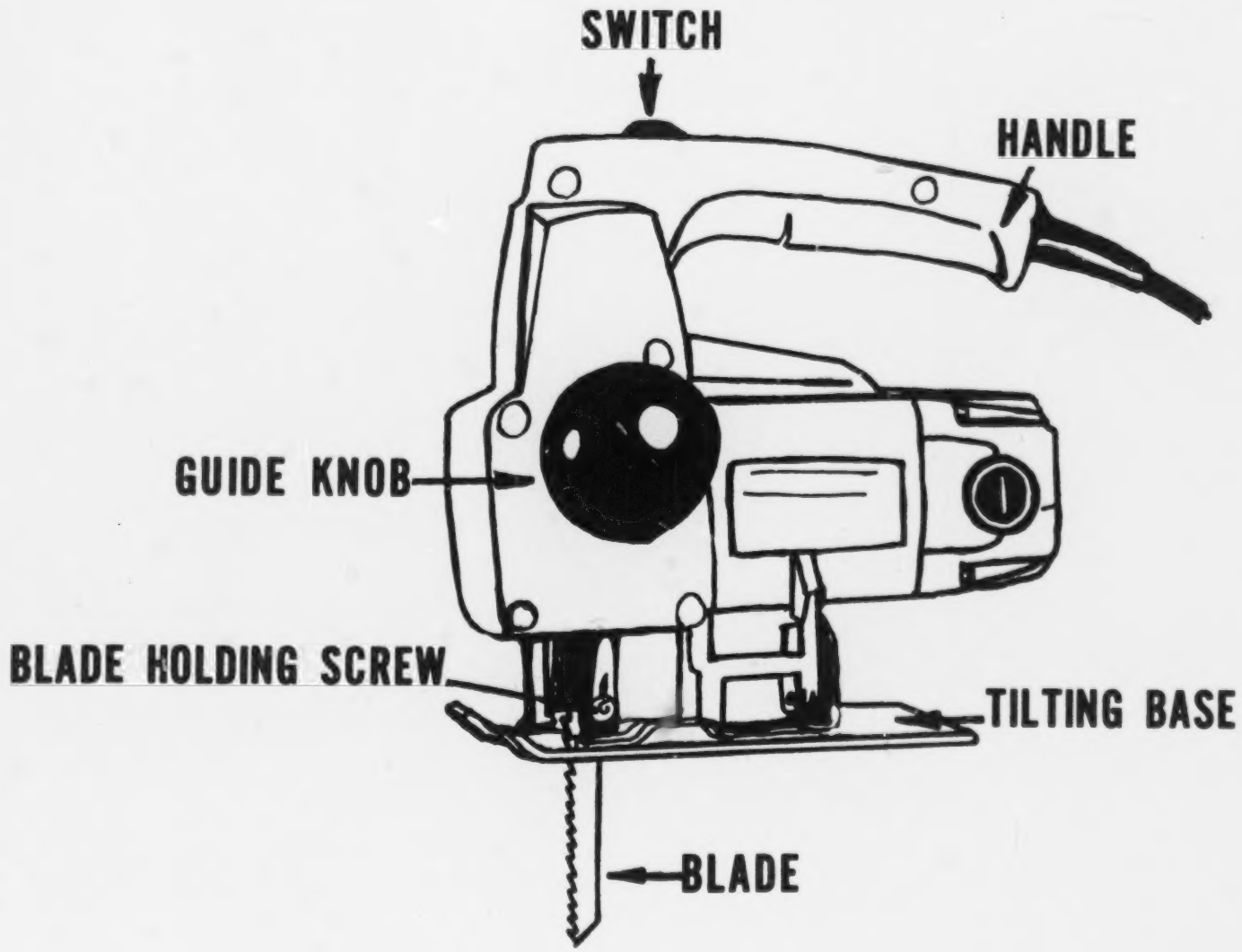

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11. PORTABLE SABER SAW

The saber saw is commonly used for cutting curves and other light work when a jig saw or band saw is not easily accessible or the work piece is too large for the jig or band saw.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the saber saw.
3. Never wear loose clothing when operating the saber saw.
4. Keep all guards and safety devices in good working order and in place.
5. Always check the power cord for condition and be sure it is a 3-wire cord and is properly grounded.
6. Make all adjustments with the power disconnected.
7. Never stand on a wet surface when operating a saber saw.
8. Always be sure the switch is off before connecting to the power source.
9. Always be certain you have the correct blade for the job to be done and the blade is securely fastened in the saw.
10. Always grip the saw firmly with both hands.
11. Always secure the work piece firmly with a vise or clamps as needed.
12. Always be careful not to cut into the bench or other support with the blade.
13. Always place the base of the saw firmly on the work piece before starting the cut.
14. Always start the motor before the blade contacts the work piece.
15. Always maintain a constant cutting pressure; excessive pressure can overload the motor and cause blade breakage.
16. Never make curved cuts so sharp as to jam, twist or otherwise foul the blade.
17. After the cut is completed, shut off the saw and wait until the blade stops completely before setting the saw down.
18. After completing the job, disconnect the saw from the power source and remove the blade.

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PORTABLE BELT SANDER

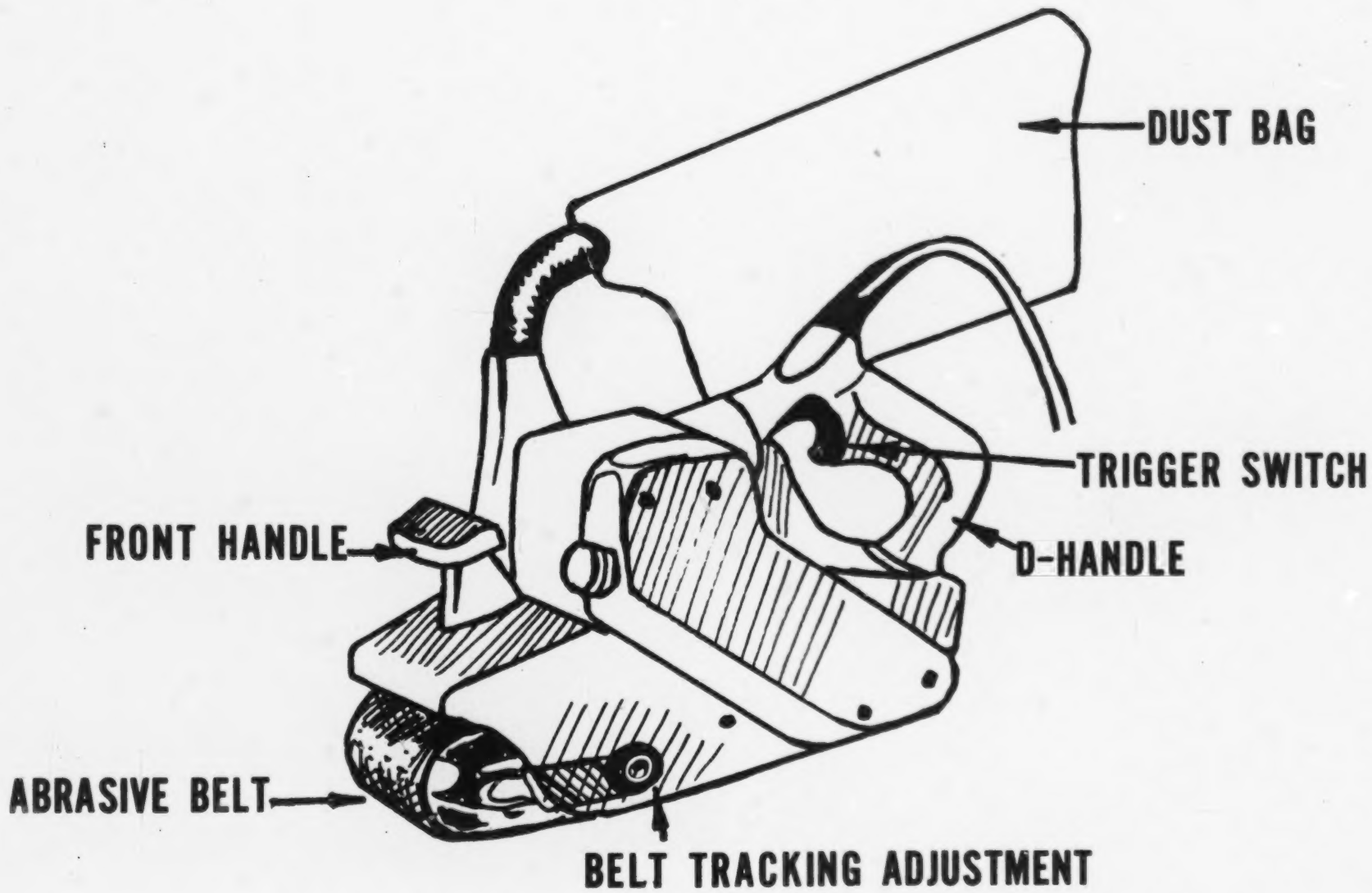

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B.C.

12. PORTABLE BELT SANDER

The portable belt sander is commonly used in shops for sanding flat surfaces for both rough and semi-finish work.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the portable belt sander.
3. Never wear loose fitting clothing when operating the portable belt sander.
4. Keep all guards and safety devices in good working order and in place.
5. The portable belt sander cord should be a 3-wire cord and be properly grounded. Check grounding and condition of the cord before using the portable belt sander.
6. Make all adjustments with the power disconnected.
7. Never stand on a wet surface when operating the portable belt sander.
8. Always be sure the power switch is off before connecting to the power source.
9. Always check the mounting of the belt; run the portable belt sander to make sure the belt tracks properly.
10. Always grasp the portable belt sander firmly in both hands.
11. Never apply excessive pressure to the belt sander; this causes overheating of the motor and loading of the belt.
12. Always secure the work piece firmly so that it will not be thrown backward by the action of the belt.
13. Always wait until the belt stops moving completely before setting the portable belt sander down.

PORTABLE FINISHING SANDER

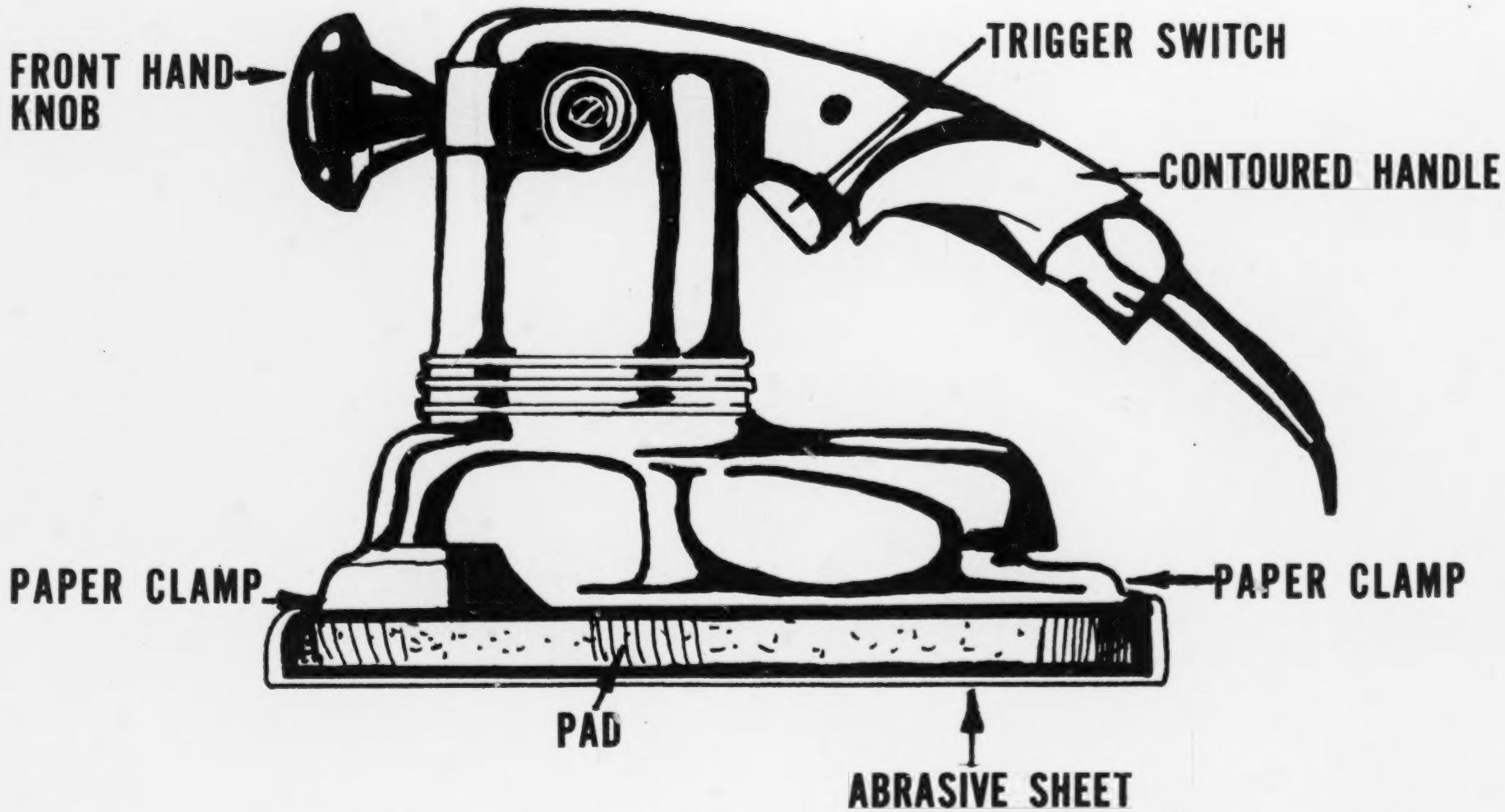

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13. PORTABLE FINISHING SANDER

Finishing sanders are commonly used to complete the final sanding where only a small amount of material needs to be removed. They may also be used for cutting down and rubbing finishing coats.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the finishing sander.
3. Never wear loose clothing when operating the finishing sander.
4. Keep all guards and other safety devices in good working order and in place.
5. Always check the power cord for condition and be sure it is a three wire cord and is properly grounded.
6. Make all adjustments with the power disconnected.
7. Never stand on a wet surface when operating a finishing sander.
8. Always be sure the switch on the finishing sander is off before connecting it to the power source.
9. Always be certain the power source is disconnected before replacing the abrasive pad.
10. Small work pieces must be fastened to the work area before being sanded.
11. Never apply excessive pressure beyond the weight of the sander itself; excessive pressure will cause overheating and reduced efficiency.
12. Always grip the sander firmly to maintain control of it.
13. Always start the sander before it is applied to the work piece.
14. Always remove the sander from the work piece before shutting it off.
15. Always disconnect the sander from the power source when the work is completed.

PORTABLE ROUTER

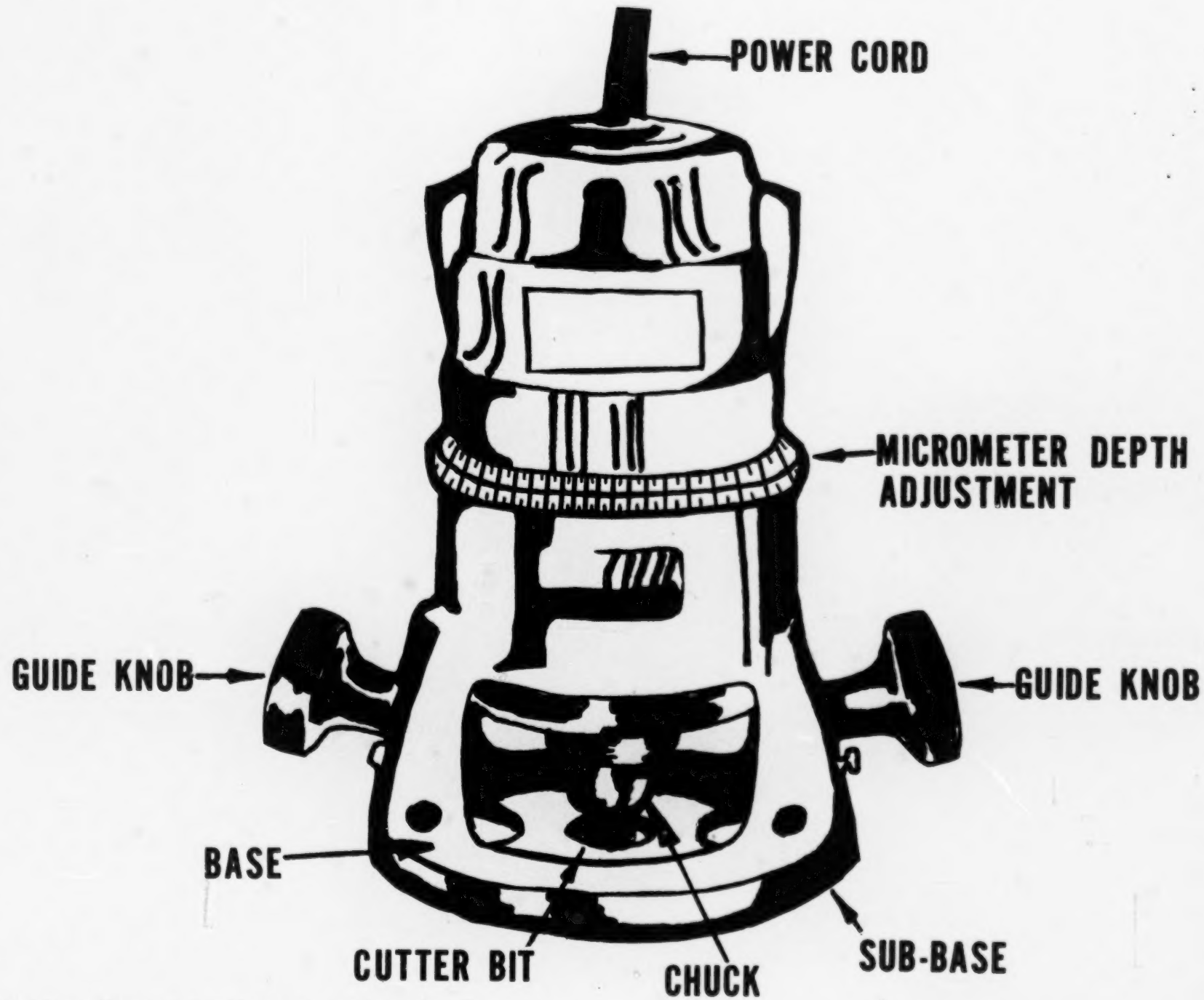

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14. PORTABLE ROUTER

The router is commonly used to cut irregular shapes and form various contours on the edges and surface of wood projects.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the router.
3. Never wear loose clothing when operating the router.
4. Keep all guards and safety devices in good working order and in place.
5. Always check the power cord for condition and be sure it is a 3-wire cord and is properly grounded.
6. Make all adjustments with the power source disconnected.
7. Never stand on a wet surface when operating a router.
8. Always be sure the switch on the router is off before connecting it to the power source.
9. Always disconnect the router from the power source when inserting bits. The bit must be securely inserted in the chuck at least ½" and the base must be tight.
10. Always be certain the work piece is securely fastened and/or clamped so it will not move.
11. Always place the router base on the work piece with the bit clear of the work before starting the router.
12. Always grip the router firmly with both hands.
13. Always feed the router smoothly through cut; don't force the router into the work and overload the motor.
14. When the cut is completed, shut off the motor and don't lift the router from the work piece until the bit has stopped rotating.
15. When the work is completed, disconnect the router from the power source and remove the bit.

PORTABLE ELECTRIC DRILL

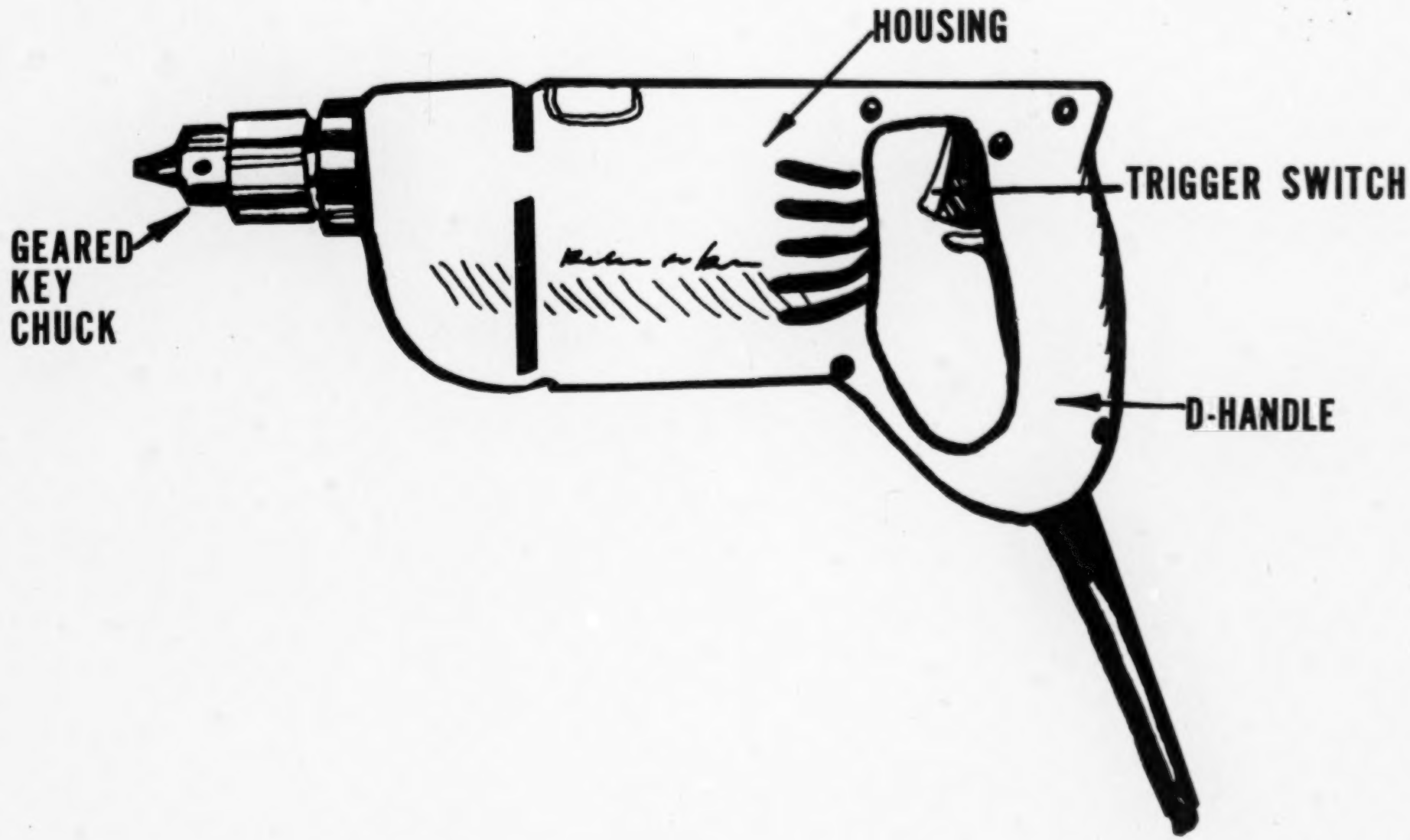

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PEDESTAL GRINDER

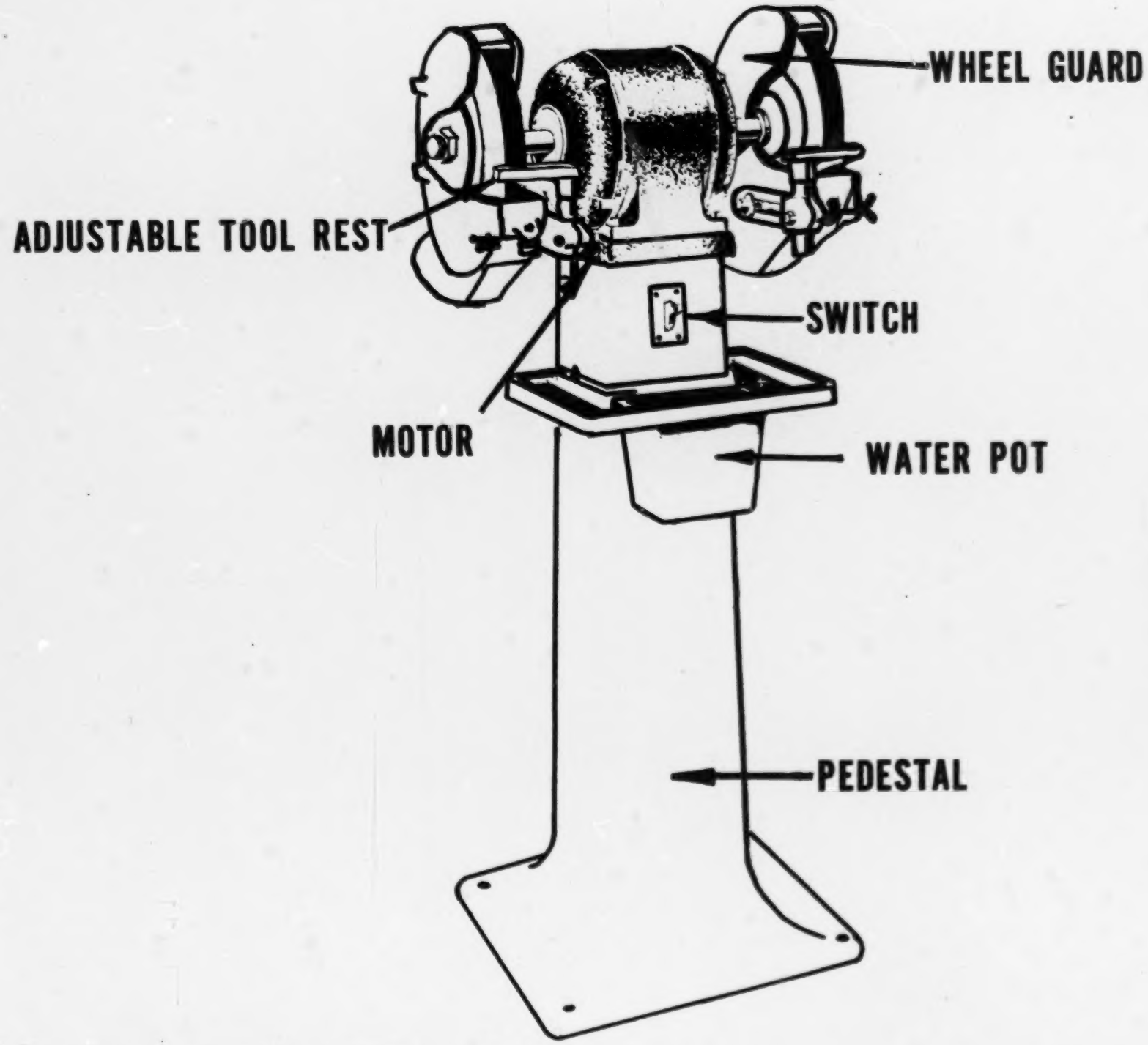

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16. BENCH OR PEDESTAL GRINDER

The bench or pedestal grinder is a tool commonly found in the shop. It is used to sharpen tools, smooth welds, shape tools and other jobs requiring the removal of metal.

SAFETY PRECAUTIONS

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the grinder.
3. Never wear loose clothing when using a grinder.
4. Keep all safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Do not use a grinder unless the plastic shield on the grinder is in place.
7. Keep the tool rest adjusted to within 1/8" of the stone at all times.
8. Always check stone for tightness and for cracks or flaws before using.
9. Keep the guard adjusted as near the wheel as possible.
10. Keep the grinding wheel true by frequent dressing.
11. Never use a grinding wheel after it has been worn to less than one half its original size.
12. Always use the face of the grinding wheel, not the sides, for grinding.
13. Always keep the hands and fingers away from the grinding wheel when it is in use.
14. Always use pliers, vise-grips or other suitable holding devices when grinding small, round or oddly shaped jobs.
15. Never force the job against the grinding wheel. Avoid overloading the grinder.
16. When starting a new wheel, stand back and allow it to run for a few minutes before using it for grinding.
17. Never apply the job to the grinder before it has reached running speed or while it is coasting to a stop.
18. Always keep work piece cool by frequent dipping in cold water.
19. Always stand to one side of the wheel when using the grinder.
20. When shutting off, wait until the grinder completely stops before leaving the area.

PNEUMATIC NAILER

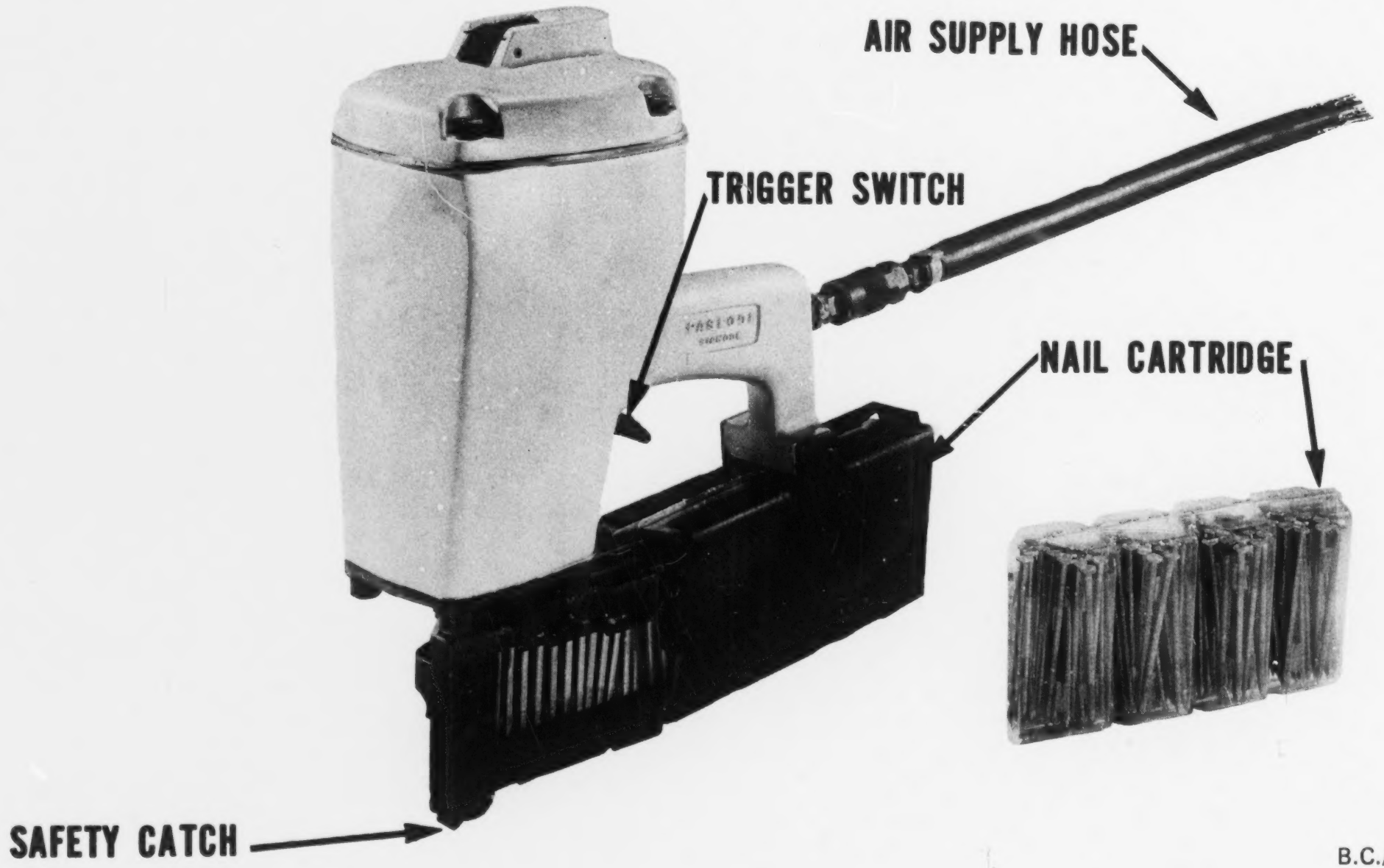

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Courtesy Signode Corporation

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17. AIR POWERED NAILER

The air powered nailer has taken much of the work out of nailing and has greatly increased the amount of work which can be performed by carpenters. Instead of being hammered into place, nails are fired into position by bursts of air. The nails used are similar to regular nails, and although they may be somewhat smaller, they are coated to increase their holding power.

SAFETY PRECAUTIONS

1. Wear approved eye protection.

2. Keep your mind on your work.

3. Know the operating procedures for the equipment before attempting to use it. Learn where the safety features are and how they work.

4. Use the correct type and size of nail for the job. Follow manufacturer's specifications.

5. Use no more air pressure than is recommended by the manufacturer. Normally, pressures should not exceed 90 pounds.

6. Before operating, check the machine to see that all safety features are working properly. Test fire the nailer into a block of wood for this purpose.

7. Never point the nailer in the direction of anyone, and always keep the nose pointed away from your body. Keep the nose pointed in the direction of the work.

8. When using, place the nose of the nailer firmly against the surface to be nailed.

9. Keep free hand away from the spot to be nailed.

10. Disconnect from the air supply when not in use.

SHAPER

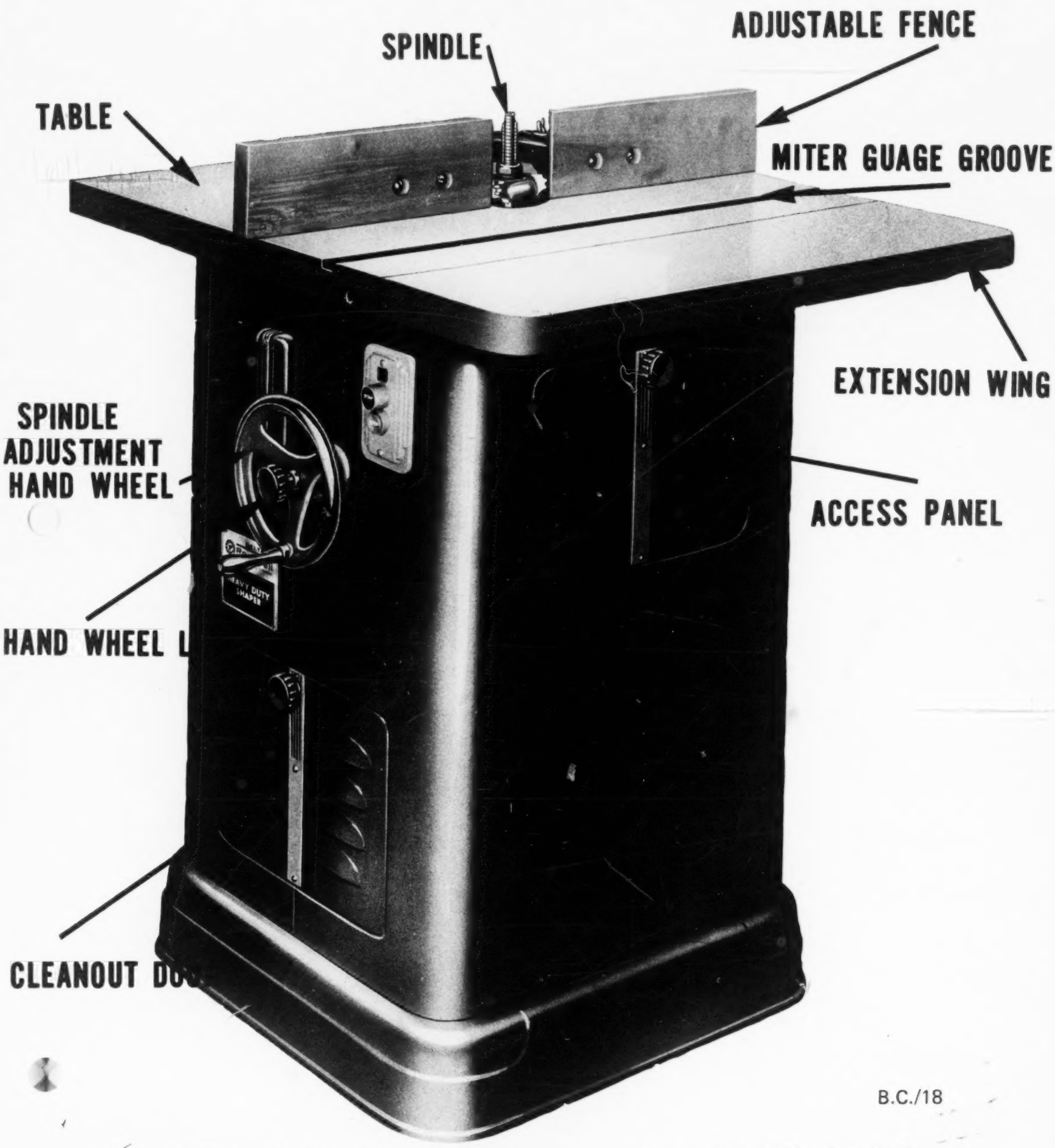

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Courtesy Rockwell Manufacturing Company

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18. SHAPER

The shaper is used by cabinet makers for making various contours and irregular shapes on edges of work. These shapes may be cut for the purpose of making joints or for adding a decorative effect. The shaper utilizes a high speed cutter past which the work is moved. The cutting head can be changed, and various types are available for cutting and making many different shapes.

SAFETY PRECAUTIONS

1. Wear approved eye protection.
2. Always feed stock into cutter.
3. Keep hands away from the cutter.
4. Be sure spindle nut is tight before starting motor.
5. Check all attachments and safety devices.
6. Have your instructor check all setups before starting the machine.
7. Use only new stock that is straight and is free of splits, checks and knots.
8. Make a trial cut on an extra piece of stock having the same thickness as the workpiece.
9. Keep a 4-inch margin of safety when utilizing the fence (or miter guage) and a 6-inch margin when using depth collars. For smaller parts, make a special holder or push board.
10. Only the operator should be in the operating zone and allowed to turn the machine on and off.

PORTABLE POWER PLANER

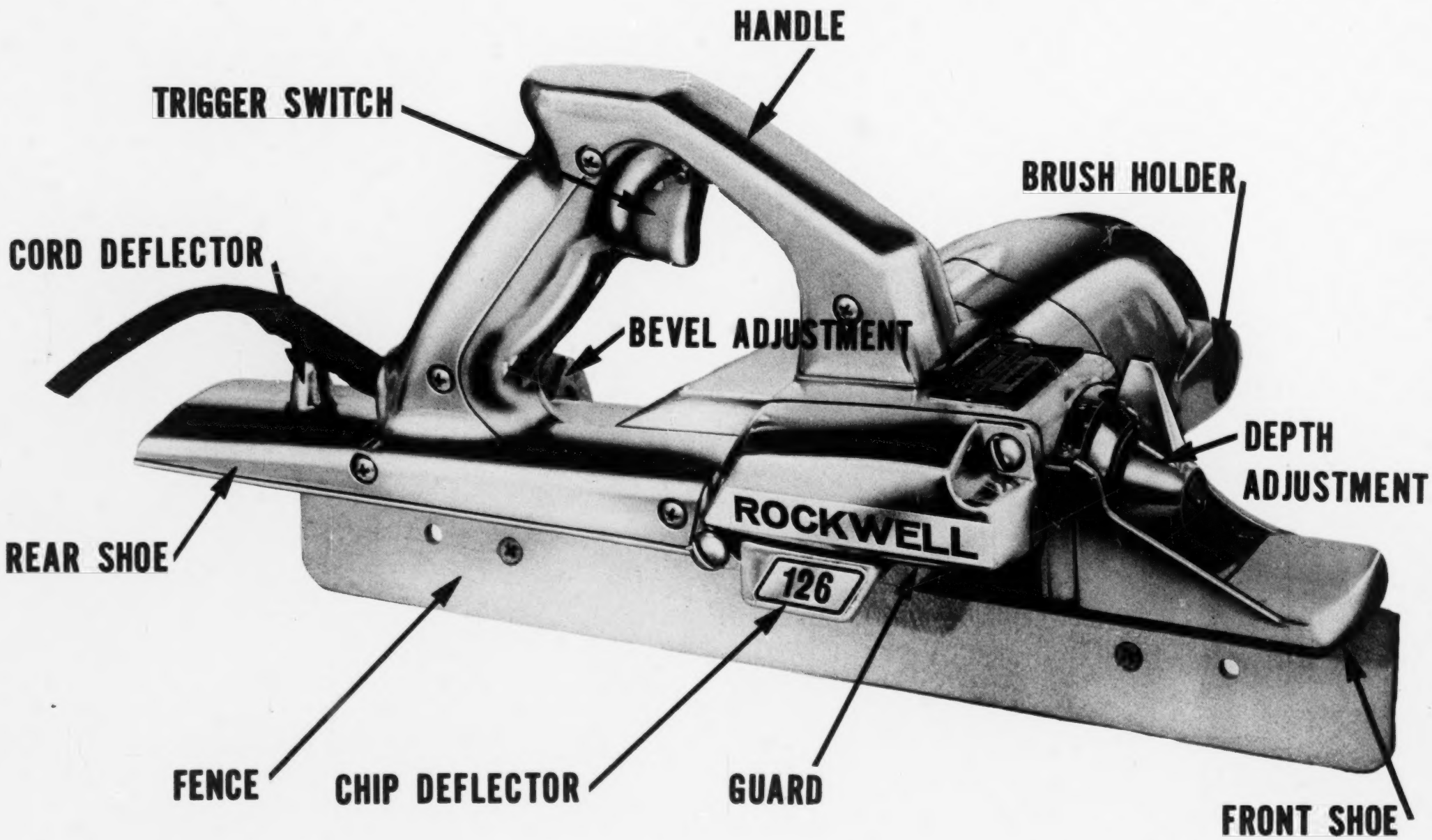

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Courtesy Rockwell Manufacturing Company

19. PORTABLE PLANER

The portable planer has almost replaced the hand plane for planing down the edges of doors and other work. In the power planer are high speed cutting knives which can be raised and lowered to cut the desired thickness.

SAFETY PRECAUTIONS

1. Wear approved eye safety glasses.
2. Remove tie, roll up sleeves and take off rings and wristwatch.
3. Be sure the workpiece is securely clamped and free of nails and obstructions.
4. Turn power off and disconnect plane from the power source before attempting to make adjustments.
5. To start cut, place front shoe on edge of work. Switch on motor and move along the work.
6. Keep your eyes on the work.
7. Do not overload the plane. Keep the cutting pressure even.
8. When the cut is finished, turn off the motor and be sure it has stopped before setting it down.
9. Disconnect plane from power source when not in use.

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WOOD LATHE

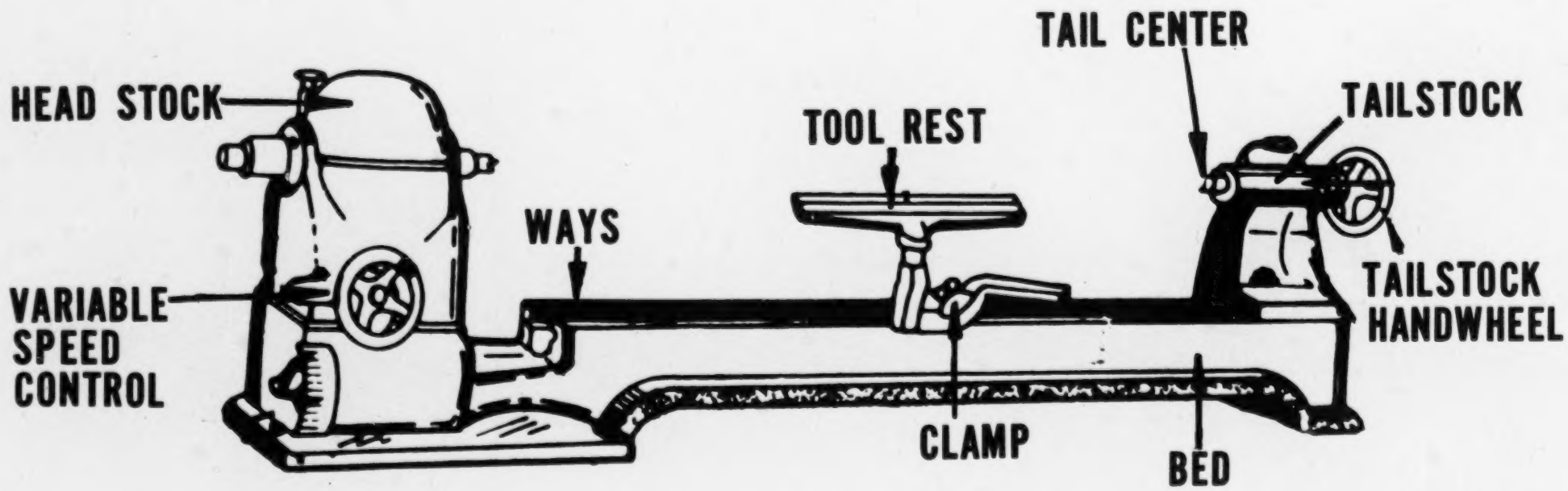

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20. WOOD LATHE

Although the wood lathe is not regarded by all authorities as a machine which should be in the carpentry laboratory, many of them are still in use in such laboratories. In the lathe, a workpiece (usually a rectangular solid in shape) is rotated against a cutting tool and made into a cylinder. The cutting tools (called turning chisels) are manipulated by the operator to form the desired shape. Wood turning, as this operation is called, can be performed in two ways—by spindle turning (with the work mounted between centers), and faceplate turning (with the work mounted on a faceplate).

SAFETY PRECAUTIONS

A. For Spindle Turning (turning between centers)

1. Wear approved eye protection. Remove tie, roll up sleeves and remove watch and rings.
2. When selecting stock, avoid loose knots, checks, crossgrain, improperly glued stock, and splintery stock.
3. Center stock properly.
4. Lock tail stock in position and secure work firmly between centers.
5. Rotate stock by hand to determine clearance of tool rest. Clearance should be between 1/4 inch and 3/8 inch at all times.
6. Do rough turning at a slow speed.
7. Avoid heavy cuts.
8. Keep the turning chisel at proper angle and grip firmly.
9. From time to time, check the dead center for heating, lubrication and adjusting.
10. Keep tools sharp at all times.
11. Do not leave tools on bed of lathe while operating lathe.
12. Remove tool rest before sanding.
13. Only the operator should cut the machine on and off and be in the operator's zone.

B. For Faceplate Turning

1. Wear approved eye protection.
2. Remove tie, roll up sleeves and remove watch and rings.
3. Operate lathe at proper speed—the larger the stock, the lower the speed and the greater the need for accurate balancing.
4. Perform rough turning at a slow speed.

5. Keep tools sharp and properly shaped.

6. Avoid heavy cuts.

7. Care must be taken to avoid getting the chisel caught in work which could cause damage to work, tool, or operator.

8. Hold turning chisel firmly at the proper angle.

9. Keep tool rest at proper height and distance from work.

10. Remove tool before sanding.

11. Do not keep tools on bed of lathe while operating.

12. Screws holding the workpiece should be of a proper size, and screwed in straight, tight, and flush.

VT 012 638
Agriculture Shop Safety; Student Manual.

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ABSTRACT - This student reference manual on agricultural mechanics shop safety was prepared by the South Carolina State Department of Education and the Clemson University Agricultural Education Department. Illustrated topics are: (1) Protective Clothing Equipment, (2) Color Coding for Safety, (3) Fire Safety and Fire Extinguishers, (4) Electrical Safety, (5) Lifting Heavy Weights, (6) First Aid, (7) Hand Tool Safety, and (8) Power Tool Safety. Related documents available in this issue are VT 012 639, Teacher's Guide, and VT 012 637, transparencies. (GB)

VT 012 638

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AGRICULTURE SHOP SAFETY

STUDENT MANUAL

VT012638

STATE DEPARTMENT OF EDUCATION
Office of Vocational Education
Vocational Agricultural Section
Columbia, South Carolina

In Cooperation With

CLEMSON UNIVERSITY
Agricultural Education Department
and
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Clemson, South Carolina

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Frank R. Stover
State Supervisor
Agricultural Education

INTRODUCTION

Safety is a part of our everyday life. We must consider safety in every activity in which we are engaged whether it be at home, in school, or anywhere else. Everyone must be conscious of safety so that possible accidents can be avoided. On the other hand, we must always be prepared to aid someone in the event an accident does occur.

This reference manual is prepared for you to use so that you can learn the safe way to work in the shop now and in your chosen occupation later. First aid is briefly discussed, so you can be prepared to assist yourselves and others in the event an accident does occur.

All sections of this manual should be studied so that you can prepare yourselves to be safe workers, and so you can assist others to become safe workers. Whenever you are not sure of a safety practice, refer to the safety reference manual, the operator's manual, and/or your instructor. Always remember it is best to spend a little more time and be safe than sorry.

Learning to work safely is one of the best lessons you can learn in school.

AGRICULTURAL MECHANICS SHOP SAFETY

Student Reference Manual

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PROTECTIVE CLOTHING AND EQUIPMENT

Protective clothing and equipment will not prevent accidents and injuries; but when properly used, such items may serve to lessen the resulting degree of damage or injury.

A. Eye Protection

The requirements for eye protection and the minimum quality standards of safety glasses are specified by the South Carolina Eye Protection Act. All areas requiring eye protection will be marked by signs, such as "Eye Protection Required Beyond This Point." Your instructor will inform you of the policy of your school on obtaining and using eye protective devices.

Eye protection equipment must be disinfected regularly. This may be accomplished by thorough cleaning with soap and warm water, or by a complete immersion in a "Lysol" solution. Storage cabinets which have ultra-violet lamps that come on when the cabinet doors are closed are used for the purpose of sanitizing safety glasses.

B. Head and Ear Protection

Although head and ear injuries are not very common in school shops, "hard" hats are highly recommended for projects such as building construction, where there is a possibility of being struck by a falling object.

C. Hand, Foot and Leg Protection

The majority of all disabling injuries occur to hands, legs and feet. Finger injuries are the most frequent.

1. Gloves and Hand Leathers. Canvas or heavy cotton work gloves should be worn to provide protection from blisters due to friction. Asbestos gloves should be used when heat is present. Leather gloves which extend well past the wrist are recommended for use in welding. Rubber gloves should be worn when handling acids, solvents and petroleum. When working around machinery, a decision must be made as to whether or not the use of gloves presents a greater hazard if caught in the machinery.

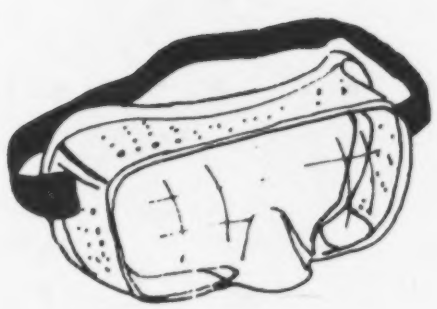

GOGGLE TYPE

SPECTACLE TYPE WITH SIDE SHIELDS

TWO TYPES OF EYE PROTECTIVE EQUIPMENT

2. Foot Protection. Safety shoes with steel toe inserts are used in industry to protect feet from heavy objects dropped or lowered on the feet. Metal inner soles protect feet from the hazards of protruding nails.

3. Leg Protection. Leggings provide protection against sparks, acid and metal splashes.

D. Respiratory Equipment

Filter respirators are available for protection against various types of dust, mists and fumes. Extreme care must be exercised when selecting filters, as a false sense of security can be generated by a filter not appropriate to the hazard present.

A filter may remove dusts and some fumes, but may not be capable of protecting the user from carbon monoxide or carbon tetrachloride fumes at all. (Carbon tetrachloride, formerly used as a cleaning agent and as a filler for fire extinguishers, should never be used for anything! Less toxic agents are available. Carbon tetrachloride is no longer recommended as a cleaning agent.)

E. Body Protection

Shop coats, aprons and coveralls should be used when appropriate in shops and labs. Aprons should be tied securely to prevent getting caught in machinery.

While working in the shop, the clothing you wear is very important in creating a safe atmosphere. Your clothing can very well mean the difference between your being able to work safely and comfortably and not being able to do so.

A student prepared to work safely and comfortably in the shop should:

1. Remove all rings, watches and other jewelry.
2. Roll up or fasten sleeves so they are not loose and flapping.
3. Remove or tuck his tie into his shirt.
4. Put on his safety glasses or other approved eye safety protection devices.
5. Depending on the job to be done, a properly fitted shop coat or coveralls may be worn. These should fit snugly so as not to catch in moving pieces of machinery.

AN INDIVIDUAL PROPERLY DRESSED

AN INDIVIDUAL IMPROPERLY DRESSED

DRESS FOR WORKING IN THE SHOP

COLOR CODING FOR SAFETY

The safety color codes developed by the American Standards Association for industrial use should be used in schools teaching agricultural mechanics. Standard color codes are as follows:

A. RED:

1. identifies Fire Protection equipment.
2. indicates Emergency Stops on equipment.

B. ALERT ORANGE:

designates hazards that might cut, crush or shock.
Examples: switch box interiors, gears and pulleys, cutting edges, presses and transmission cases.

C. HIGH VISIBILITY YELLOW:

1. indicates Caution.
2. designates hazards from stumbling, falling, tripping, bumping or collision.

Examples: aisles, handrails, barricades, protruding parts, stair approaches and floor areas near pits.

D. SAFETY GREEN:

identifies first aid and safety equipment.
Examples: first aid kits, stretchers and personal protective equipment storage.

E. PRECAUTION BLUE:

marks equipment controls as a reminder to use caution.
Example: electrical controls, valves, brakes and on signs indicating that equipment is not to be used.

F. BLACK AND WHITE:

indicates Housekeeping Areas.
Examples: locations of waste containers, stair risers and food dispensing equipment.

FIRE SAFETY AND FIRE EXTINGUISHERS

Knowledge of the classes of fires, and the correct types of extinguishers for a given class of fire is extremely important. Using an incorrect type of extinguisher may only create a greater hazard.

A. Classes of Fires

Class	Flammable Material	Type of Extinguisher To Be Used
A	Wood, Hay, Paper, Textiles	(1) Soda-acid (2) Water pump (3) Water from hose or bucket (4) Smother with blanket
B	Oil, Grease, Gasoline	(1) Pressurized dry chemical (2) Carbon dioxide (CO_2)
C	Live Electrical Equipment	(1) Carbon dioxide (CO_2) (2) Pressurized dry chemical

B. Characteristics of Fire Extinguishers

1. Soda-Acid (Figure 1)–One of the most common types. This extinguisher contains water, soda and a bottle of acid. When turned upside down, the acid mixes with the soda water and generates pressure for the stream. Use on Class A fires only. **Caution**–Once turned upside down, this extinguisher cannot be stopped until it is completely discharged. The solution may cause skin burns and is harmful to fabrics. This extinguisher should be pressure tested and recharged by qualified personnel once a year. Dangerous if used on electrical or oil fires.

2. Water Pump (Figure 2)– The water pump extinguisher is simply a tank with a hose and a hand-operated pump. Use on Class A fires only. Anyone can inspect this extinguisher for correct water level, pump operation and hose condition. Dangerous if used on electrical or oil fires.

3. Pressurized Dry Chemical (Figure 3)–The active ingredient in this extinguisher is ordinary baking soda and is not harmful to humans or fabrics. This type of extinguisher can be used intermittently, if necessary. Use on Class B or C fires only. A pressure gauge indicates the condition of the extinguisher. Use of this extinguisher leaves a residue of baking soda which, in some instances, may be difficult to remove. This extinguisher must be recharged by a qualified person.

4. Carbon Dioxide (CO_2) (Figure 4)–Use on Class B and C fires only. **Caution**–This extinguisher is only effective at close range. Released carbon dioxide gas (which puts out the fires) could injure a person because of the resulting low temperatures (far below 0°). A leaky valve may result in an extinguisher being empty when needed. An experienced serviceman must determine (by weighing) when the extinguisher needs a recharge. Refilling must be done by a qualified person.

5. Carbon Tetrachloride–Phosgene, a dangerous gas, results when the carbon tetrachloride strikes a hot surface.

The various types of extinguishers are recognizable by their shapes. Everyone should make a habit of knowing where fire extinguishers are located in the school or at work. Never allow a soda-acid or water type extinguisher to be placed in a shop area where there is a possibility of electrical or oil fires.

C. Fire Safety Precautions

1. If your clothing should catch on fire, don't panic. Smother the flames by wrapping in a blanket, a coat, or by rolling on the ground.

2. Flammable liquids, such as gasoline and paint thinner, should be kept in approved cabinets or storerooms.

3. Large quantities of flammable liquids should be stored in an area away from the main building.

4. Do not use highly flammable liquids for cleaning purposes.

5. Store flammable liquids only in approved safety containers.

6. Inspect all paint and chemical cabinets periodically for fire hazards.

7. Practice fire prevention in the school shop.

8. Fire extinguishers must be inspected regularly by qualified personnel.

9. Know and practice the proper procedure for evacuating the shop in case of fire or other emergency situations.

TYPES OF FIRE EXTINGUISHERS

TYPES OF EXTINGUISHERS CAN BE RECOGNIZED BY THEIR SHAPES.

FOR CLASS A FIRES (WOOD, HAY, PAPER AND TEXTILES)

1. SODA-ACID—

TO OPERATE:

AIM NOZZLE AT FIRE
TURN EXTINGUISHER UPSIDE DOWN

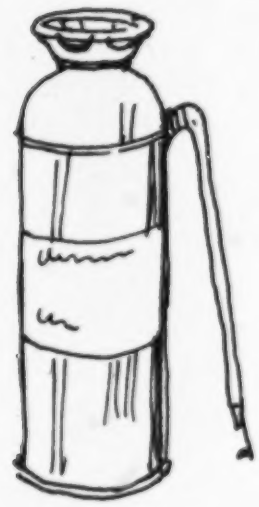

2. WATER PUMP

TO OPERATE:

AIM NOZZLE AT FIRE
OPERATE HAND PUMP

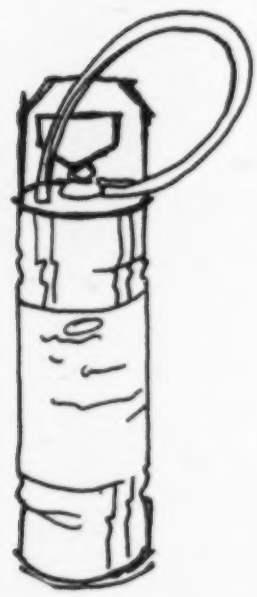

FOR CLASS B AND C FIRES

(OIL, GREASE, GASOLINE, PAINT, ELECTRICAL FIRES)

3. PRESSURIZED DRY CHEMICAL

TO OPERATE:

PULL SAFETY PIN
AIM EXTINGUISHER AT FIRE
SQUEEZE HANDLE

4. CARBON DIOXIDE (CO_2)

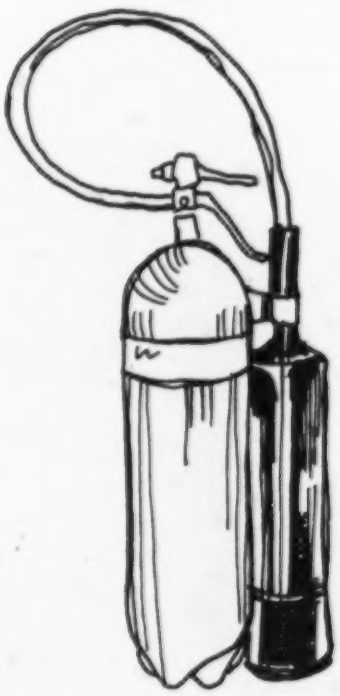

TO OPERATE:

PULL SAFETY PIN
AIM NOZZLE AT FIRE
SQUEEZE HANDLE

ELECTRICAL SAFETY

Electrical equipment is found in every vocational agriculture mechanics shop. Everyone should know the dangers present in electrical equipment and wiring and how to protect themselves and others from injury.

A. General Electrical Safety

1. Always install all electrical wiring in compliance with the National Electrical Code.
2. Never use temporary wiring. All extension cords for tools and appliances should be 3-wire parallel ground with grounding lug plugs.
3. Assume that all electrical equipment and wiring is "alive" and must be treated as such.
4. Remember the importance of safety interlocks and the dangers of by-passing electrical safety devices such as circuit breakers.
5. Never work on electrical equipment alone—always have someone else nearby.
6. While working on electrical equipment, stand on rubber mats or wooden floors.

B. Rescue from Electrical Shock

A person may receive an electric shock by touching a bare wire, an exposed socket or a faulty electrical tool or appliance. Shock hazards also exist inside various types of electronic equipment and around power lines. The possibility of shock is greatly increased if the person is also in contact with a grounded surface or if the floor or his body is wet.

1. If possible, shut off the current quickly.
2. If the current cannot be shut off promptly, attempt to move the victim away from the conductor, using some sort of insulated material.
3. Do not touch the victim until electrical contact is broken. Use a wooden pole, such as a broom handle, to separate the victim and the conductor. A large cloth such as a coat, may also be used.
4. A live conductor may cling to the victim, making it necessary to pull him (or the conductor) quite a distance away.
5. If the victim is not breathing after he has been removed from contact with the conductor, give him artificial respiration.

PROPER REMOVAL OF LIVE ELECTRICAL WIRE

LIFTING HEAVY WEIGHTS

Proper lifting is a skill. Attaining this skill could prevent sprains, back injuries and ruptures. Everyone is prone to demonstrate his strength, not realizing the safe limits of his muscle ability. Unwise muscular activity may cause an injury to your back that will be life long.

To lift an object, place feet eight to twelve inches apart. Keep the feet close to the object that is being lifted; this will keep the back muscles from having to lift all the load. Bend knees outward and keep the object close to the body.

To turn with the lifted object, shift the feet in the direction of travel. Never twist the body.

To place object on floor, reverse the lifting procedure; keep back straight, lower load by bending knees. Be sure supporting blocks are on floor so the fingers will not be mashed or pinched when an object is set down.

PROPER WAY TO LIFT

IMPROPER WAY TO LIFT

LIFTING HEAVY OBJECTS

FIRST AID

First aid is the immediate care given to an injured or sick person until the service of a physician can be obtained.

All students should know the fundamentals of first aid. Your shop should be equipped with a good general first aid kit containing bandages, gauze, cotton, tape, gauze pads, band-aids, eye pads, triangular bandages, tourniquet, ammonia, cotton buds, splints, measuring cups, scissors, tweezers, antiseptic cream and a first aid guide booklet.

The first aid program of the American National Red Cross provides for the training and certification of both instructors and students in first aid procedures. The Red Cross also publishes instructors' and students' handbooks.

A complete coverage of all first aid procedures is not possible in this brief publication. The following summary of recommended first aid procedures covers those situations most likely to be encountered in the agriculture mechanics shop.

A. Shock

Any serious injury may cause shock. Bad burns, loss of blood, cuts and broken bones are often followed by shock.

1. Signs of shock: The victim's skin feels cool and is whiter than usual. Perspiration may appear, especially on the forehead or chin or over the mouth. The victim may vomit.
2. First aid for shock: Always treat for shock when giving first aid. Shock may result in a loss of blood to the brain and may be more serious than the visible injury.
   a. Make the victim lie down so his head is level with, or lower than, the rest of his body.
   b. Cover the victim, placing a blanket beneath him and a coat or blanket over him. However, don't make him sweat.
   c. The patient may drink warm water if an hour or more will pass before the doctor arrives. Don't give water if the person is unconscious or has an injury in the stomach region. Stimulants, such as ammonia, have no value in shock.
   d. Don't disturb the patient unnecessarily. Try to avoid measures that would cause more pain. Don't feed him.

B. Wounds in which Bleeding is not Severe

Do not touch the wound or the skin near it with fingers, clothing or any other object. Do not breathe directly on the wound.

1. Apply a sterile gauze dressing.
2. Apply a bandage over the dressing.
3. Send the victim to a doctor.

Do not apply such things as lard, butter or oils to wounds. Do not put adhesive tape directly on a wound, and do not use cotton as a dressing.

C. First Aid for Serious Bleeding

Serious bleeding requires immediate first aid care for the victim. If someone is available to call the doctor, have him do so while you attempt to stop the bleeding. If there is no one available, attempt to stop the bleeding before you call the doctor. Locate a physician as soon as possible.

In most cases, bleeding can be stopped by applying pressure with a cloth wad placed directly on the wound. Bandage this wad tightly against the wound and do not remove it.

1. Keep the victim quiet.
2. Do not handle him roughly, transport him carelessly or talk to him unnecessarily.
3. Treat him for shock.
4. Do not give him any stimulants.
5. A bleeding limb should be raised slightly above the rest of the body by placing blankets or some other object under the limb.
6. For severe bleeding of the upper or lower extremities, the use of a tourniquet or finger pressure may be helpful.
7. Locate a physician.

D. Wounds that may Result in Tetanus (lockjaw)

Germs which cause tetanus are found around horses, on farms or where land has been fertilized with horse manure. Powder burns, such as those caused by fireworks, may also result in tetanus. Tetanus germs grow best in puncture wounds, such as those caused by nails, sharp sticks, splinters or other sharp objects. Even though the wound might not seem serious it should be treated by a physician, since a tetanus injection might be necessary.

First Aid Procedures:

1. Squeeze wound to encourage bleeding.
2. Apply dressing and bandage.
3. Get the patient to a doctor. A tetanus injection may be necessary.

E. Eye Injuries

Follow these procedures if a small object is on the eye surface:

1. Do not rub the eyes.
2. Do not attempt to remove the object with any sort of instrument.
   a. If you can gently pull the eyelid away from the eye and see the object under the lid, you may be able to remove it by touching it with a corner of a sterile cloth.
   b. If the foreign object has entered the eyeball, do not try to remove it. Place the injured person flat on a stretcher and get a doctor.
3. Send the injured person to the school nurse or to a doctor.

F. Artificial Respiration

The mouth-to-mouth (or mouth-to-nose) method is now believed to be the most practical method for emergency ventilation of a person who has stopped breathing when medical breathing equipment is not available. When a person stops breathing, artificial respiration should be started as soon as possible.

See the instructions for artificial respiration on the following page.

ARTIFICIAL RESPIRATION

MOUTH-TO-MOUTH (MOUTH-TO-NOSE) METHOD

(1) If there is foreign matter visible in the mouth, wipe it out quickly with your fingers or a cloth wrapped around your fingers.

Tilt the head back so the chin is pointing upward.

(2) ⬆ Pull or push ⬇ the jaw into a jutting-out position.

(3)

(4) Open your mouth wide and place it tightly over victim's mouth. At same time pinch victim's nostrils shut.

(5) Or close the nostrils with your cheek.

Or close the victim's mouth and place your mouth over the nose.

(6) Blow into the victim's mouth or nose. If you are not getting air exchange, recheck the head and jaw position (see drawings above at left).

(7) If you still do not get air exchange, quickly turn the victim on his side and administer several sharp blows between the shoulder blades in the hope of dislodging foreign matter.

Resume breathing procedure.

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HAND TOOL SAFETY

GENERAL RECOMMENDATIONS

A. Use the proper tool for the job to be done. Don't hammer with pliers; use the proper size and type hammer for the job. Don't pry with files or screwdrivers; use a pry bar. Use a wrench to tighten or loosen bolts; don't use pliers.

B. Use tools properly; select the size and type tool to fit the job. In doing this you will be able to do better work and to do it more safely.

C. Store tools in their proper and safe place. Put them in tool boxes, trays or hang them up when not in use. Tools improperly stored can cause injury and become damaged.

D. Only use tools that are in good condition. Tools with split handles, worn teeth, loose heads and dull or chipped edges do poor work and are more apt to cause injuries.

CHISELS, COLD

1. Always wear safety glasses.
2. Use the proper size and type chisel for the job to be performed.
3. Keep the cutting edge sharp.
4. Use a hammer of the proper type and size for the chisel being used—the larger the chisel, the heavier the hammer.
5. Hold the chisel properly. Use a fairly loose grip so that if the hammer misses, your hand will slip on the chisel and lessen the effect of the hammer blow on your hand.
6. Don't use a chisel which has become mushroomed on the end from hammer blows. Pieces may fly off and cause injury. Grind off the mushroomed end to a slight taper and flat across.

PROPER WAY TO HOLD CHISEL

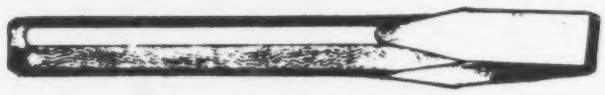

PROPERLY SHAPED CHISEL

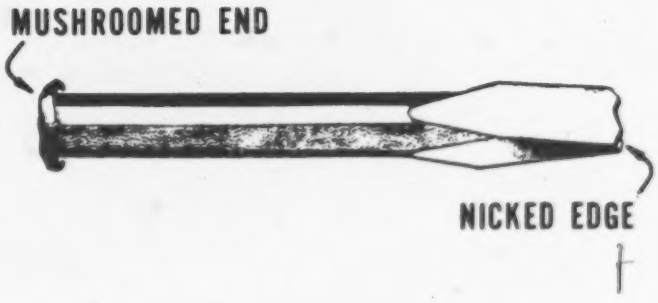

CHISEL NEEDING SHAPING

COLD CHISEL

CHISELS, WOOD

1. Always wear safety glasses.
2. Use proper size and type chisel for the job being performed.
3. Keep your chisels sharp and clean.
4. Never use a chisel as a pry bar or screwdriver.
5. Use the proper hammer for the type of chisel being used—a wooden mallet for a firmer chisel and a steel hammer for a framing chisel.
6. At all times protect the cutting edge when not in use.
7. Never drive a chisel too deep into the work—take lighter cuts.

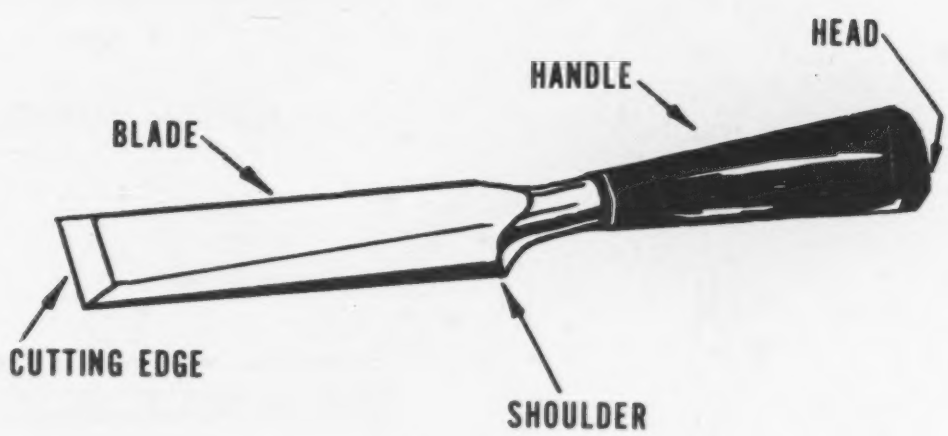

WOOD CHISEL

PUNCHES

1. Always wear safety glasses.

2. Use the proper size and type of punch for the job being done.
   a. Use a starting punch to start a pin out.
   b. Use a pin punch to drive the pin out.

3. Use the correct type and size hammer for the punch being used.

4. Hold the punch properly, the same as you would hold a chisel.

5. Don't use a punch which has become mushroomed; dress the end of the punch the same as you would a cold chisel.

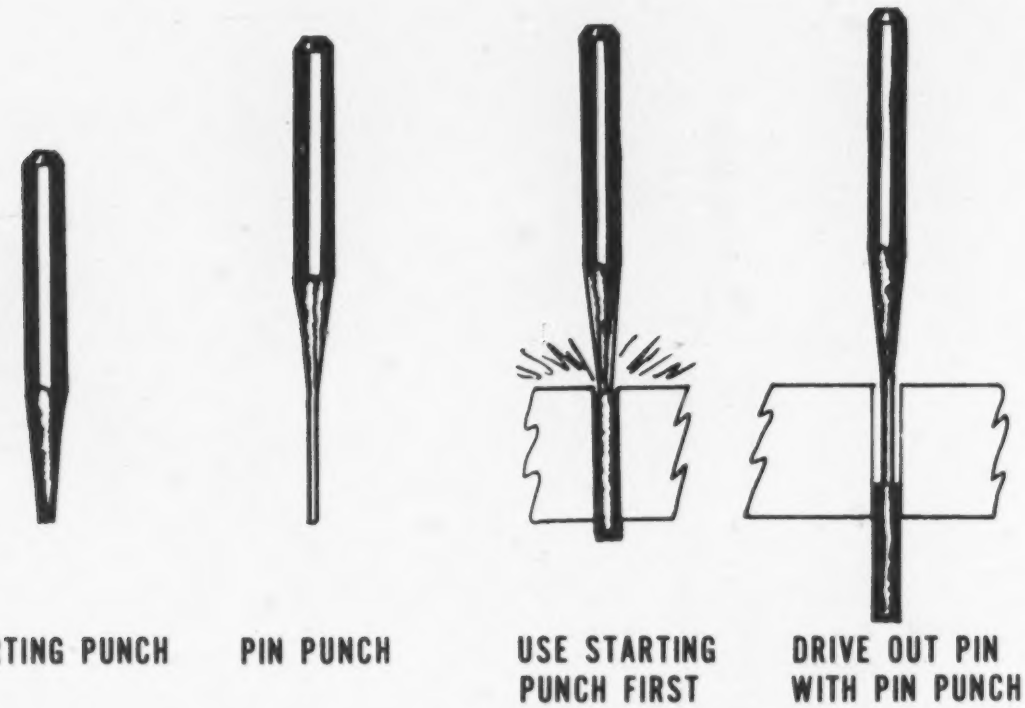

TWO TYPES OF PUNCHES

PROPER USE OF PUNCHES

PUNCHES

FILES

1. Always wear safety glasses.

2. Never use a file without a handle; the tang can cause a serious injury.

3. Files are very hard and brittle. Never use a file as a hammer or a pry. They may break and cause an injury.

4. Use only sufficient pressure to keep the file cutting. Excessive pressure can dull the file and possibly break it. Apply pressure only on the forward stroke.

5. Always clean the file with a file card when the teeth become clogged.

6. Store files where they will not bang together or hit other tools.

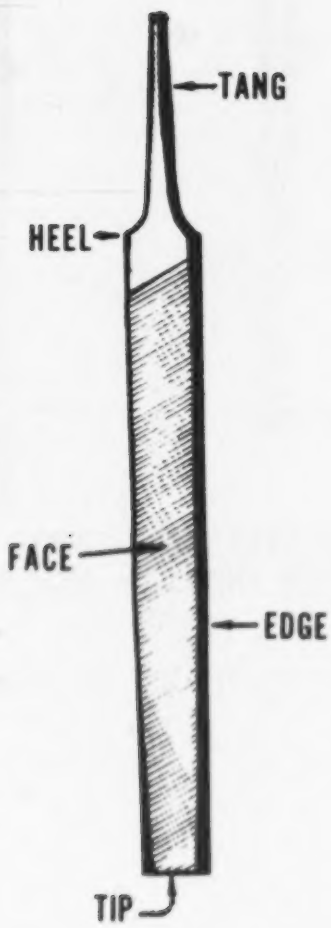

NEVER USE A FILE WITHOUT A HANDLE

FILES

HAMMERS

1. Always wear safety glasses.

2. Never use a hammer with a split or broken handle or a loose head. Be certain the head is tight and properly wedged, if necessary.

3. Always use the proper type and size hammer for the job to be done:
   a. a machine hammer for machine work
   b. a claw hammer for carpentry work
   c. a large hammer for heavy work
   d. a small hammer for light work.

4. Hold the hammer near the butt of the handle, and use a normal swing. Don't choke the hammer handle.

5. When using a hammer on a metal surface, never strike a surface harder than the face of the hammer.

6. Don't use the butt of a hammer handle to drive or bump anything.

7. Never use a hammer handle to pry.

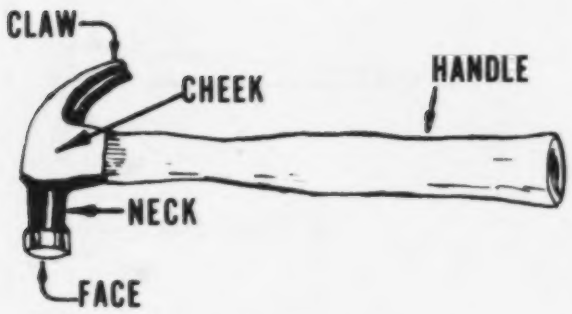

CLAW HAMMER

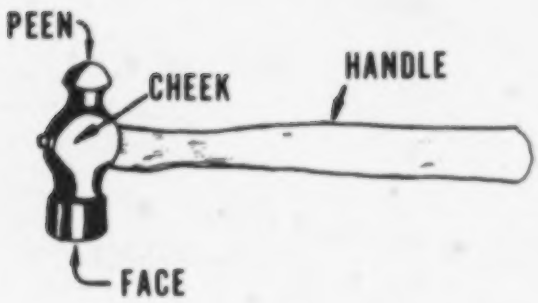

BALL PEEN HAMMER

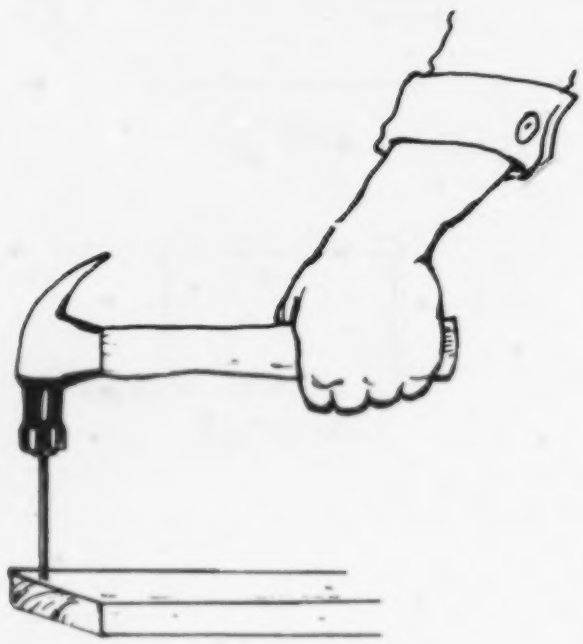

PROPER WAY TO HOLD A HAMMER

HAMMERS

SAWS

1. Always wear safety glasses.

2. Always use the proper type and size saw for the job to be done:
   a. a hack saw to cut metal
   b. a rip saw to saw wood along the grain
   c. a crosscut saw to saw wood across the grain.

3. Always use a sharp saw that has the proper set.

4. Don't force a saw when cutting.

5. When starting a saw cut, use your thumb on the side of the saw above the teeth to guide the blade. Always pull the saw up or toward yourself when starting a cut; if you push the saw, it can jump and cause you to cut yourself. It may also start the cut somewhere other than where you want.

6. Saws kept rust-free and sharp are less likely to jump or bind in the saw kerf. Keep handles tight.

7. Saws should always be hung up when not in use to protect the saw and to prevent injuries.

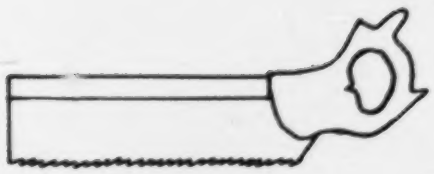

BACK SAW

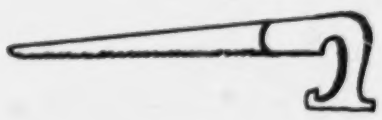

KEYHOLE SAW

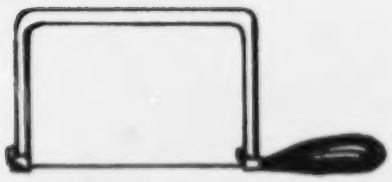

COPING SAW

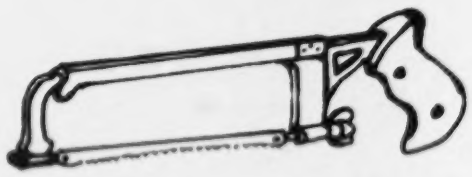

HACKSAW

HANDSAW

SAWS

SCREWDRIVERS

1. Always wear safety glasses.

2. Use the correct type and size screwdriver for the job to be done.

3. Never hammer on a screwdriver handle—this will split the handle and can cause injury. A screwdriver may be tapped to drive the rust from a screw slot.

4. Never use a screwdriver:
   a. to pry.
   b. as a cold chisel.
   c. to check electrical circuits.

5. Keep screwdriver bits properly shaped.

6. Never use a pair of pliers or wrench or other tool to turn a screwdriver.

7. Keep screwdriver shank vertical with the screw head.

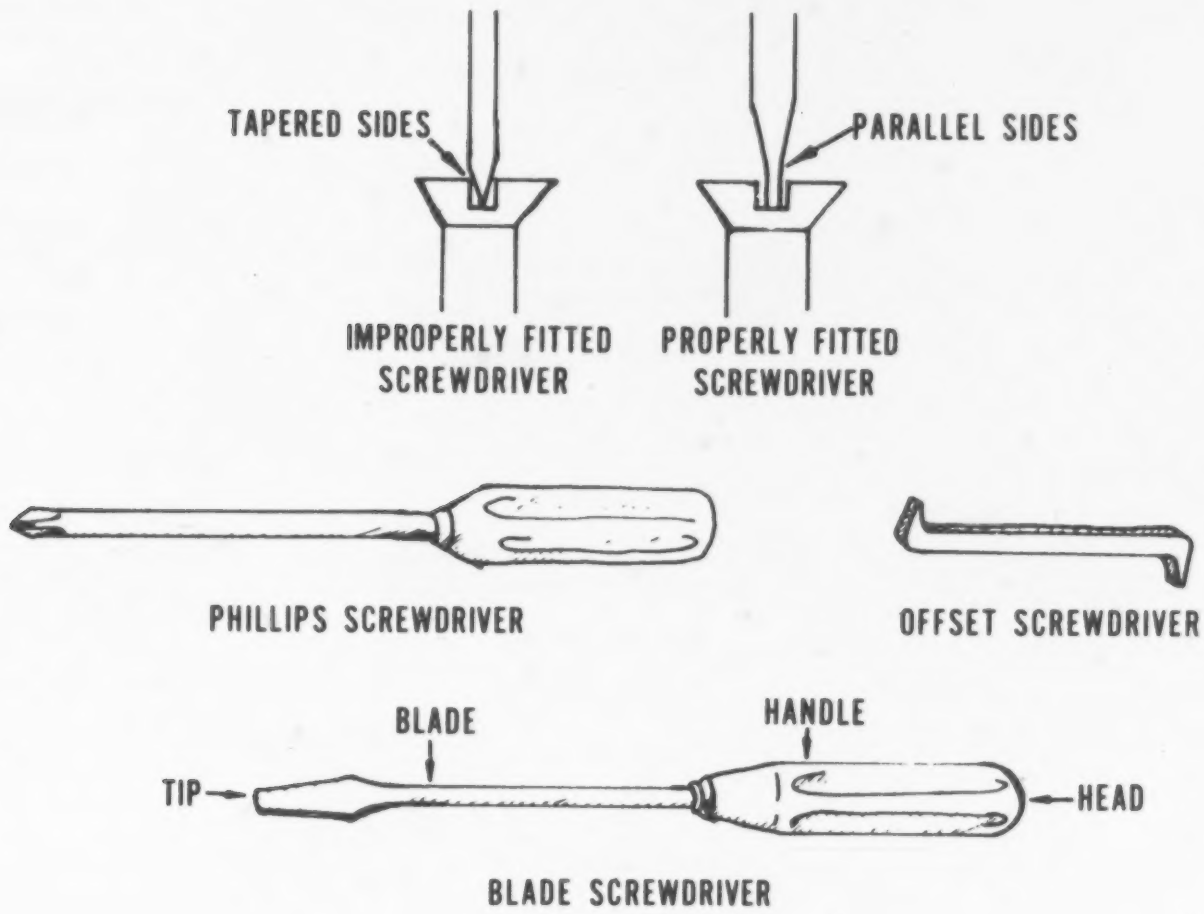

SCREWDRIVERS

WRENCHES

1. Always wear safety glasses.

2. Use the proper type and size wrench for the job to be done.

3. The jaws of the wrench, especially an adjustable wrench, should fit the nut or bolt head snugly.

4. Whenever possible pull on the wrench. To push on a wrench can cause cut, bruised or broken knuckles.

5. Be sure the pressure is applied to the fixed jaw of an adjustable wrench. Use adjustable wrenches only when no other type of wrench will work.

6. Never attempt to put a wrench on moving machinery. Never leave a wrench on machinery after completing your work—it can fly off and cause injury.

ADJUSTABLE WRENCH

RATCHET HANDLE

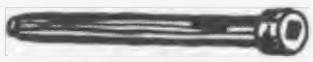

EXTENSION

OPEN END WRENCH

T-HANDLE

BOX END WRENCH

REGULAR SOCKET

DEEP SOCKET

SOCKET WRENCH AND HANDLES

WRENCHES

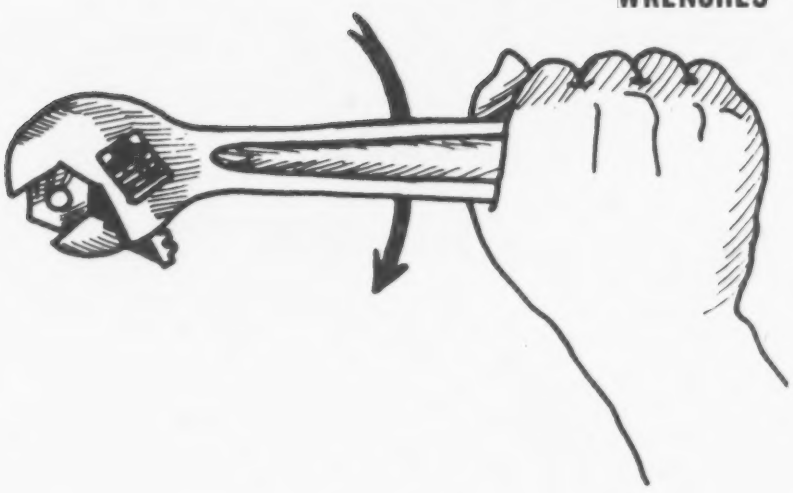

THE PROPER WAY TO USE A WRENCH

HAND PLANES

1. Always wear safety glasses.
2. Be sure to use the proper size and type of hand plane for the job to be done.
3. Always keep the plane irons sharp and in good condition.
4. Clean chips and other waste materials from around the plane iron with a brush or stick; never use the fingers.
5. Lay the plane on the bench on its side to prevent damaging the cutting edge.
6. When putting the plane away, be sure the plane iron is protected from damage and place it so the iron will not cause injury to anyone.
7. Be certain the plane iron is properly adjusted before use.

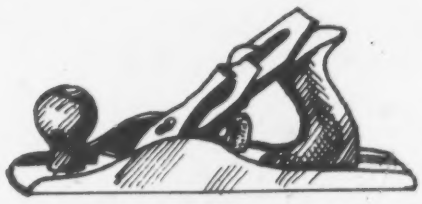

JACK

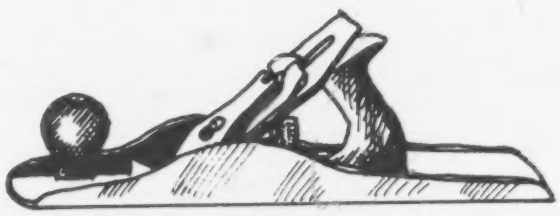

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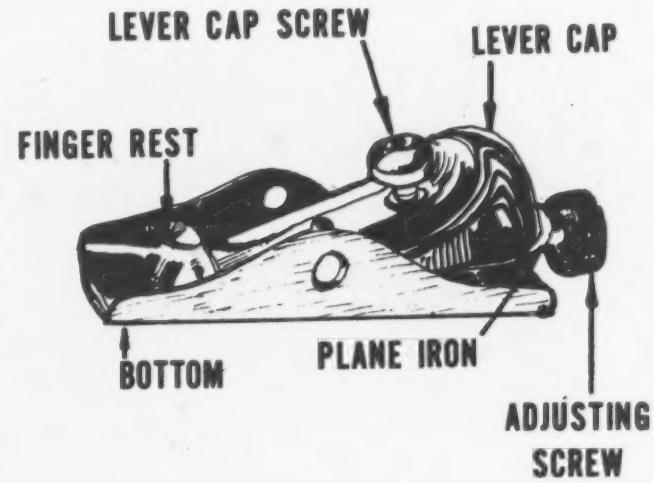

SMOOTH

BLOCK

HAND PLANES

POWER TOOL SAFETY

JOINTER

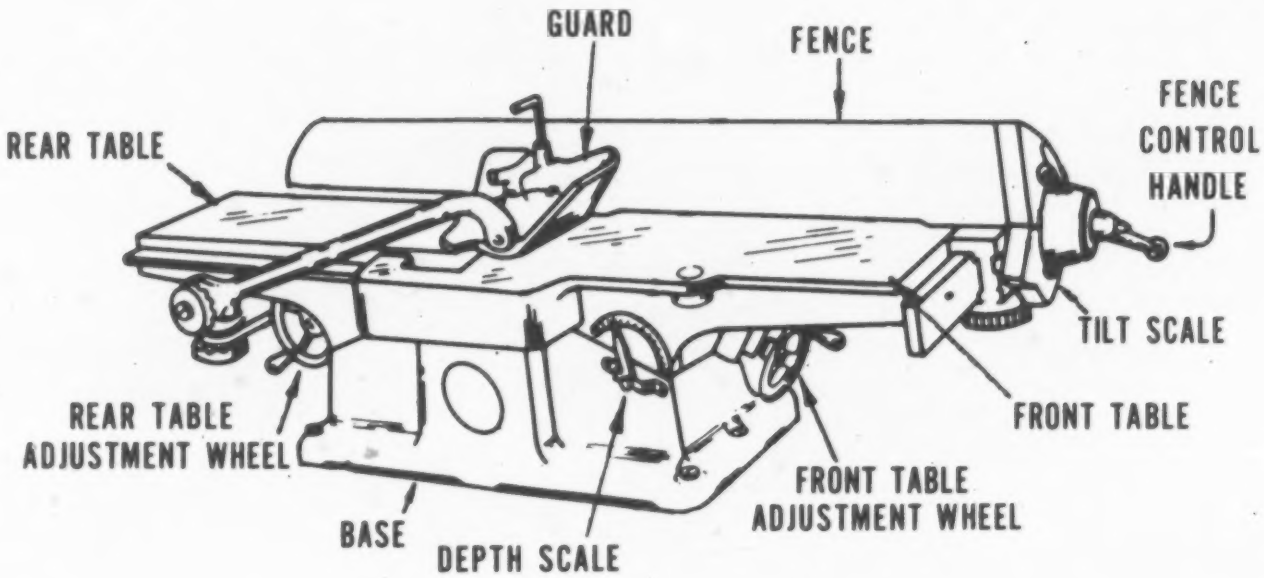

The jointer is commonly used in most shops where skills in woodworking are taught. A jointer is used for straightening, beveling, tapering and rabbeting the edges of lumber.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the jointer.
3. Never wear loose fitting clothing when using a jointer.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Check all stock for loose knots, nails or other defects before jointing.
7. Use a push stick or hold down block when jointing stock that is too small or short to give a reasonable distance of safety for your hands.
8. Lock fence in place before beginning jointing operations.
9. Keep hands away from the area immediately above the cutter head.
10. Always joint stock with the grain of the lumber to prevent splintering.
11. Never operate the jointer with fewer knives in the head than it is designed to use.
12. Hold the edge or side of the stock being jointed tightly against the fence.
13. Shut off the power, and do not leave the jointer until it has come to a complete stop.

PLANER

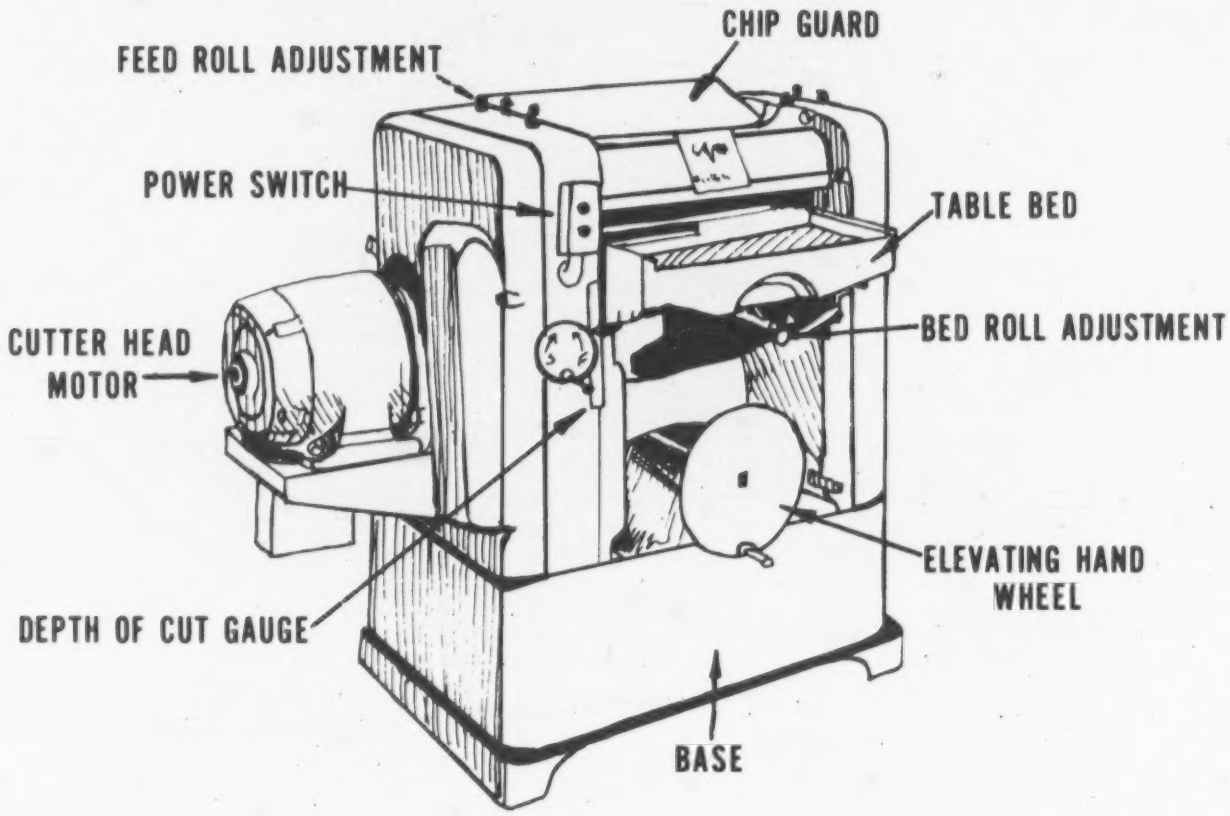

The planer is generally used to smooth the rough face of lumber and/or to obtain a desired thickness of stock for a specific use.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the planer.
3. Never wear loose fitting clothing when operating a planer.
4. Keep all guards and safety devices in good working condition and in place.
5. Make all adjustments with the power off.
6. Check all stock for loose knots, nails and other defects before putting it through the planer.
7. Be sure blades are sharp and properly adjusted. Never operate the planer with fewer knives in the cutter head than it is designed to use.
8. Remove shavings only when the power is off, and use a brush for this purpose.
9. Always keep hands away from the material nearing the feed rolls.
10. Never plane stock which is shorter than 2 feet longer than the distance between the feed rolls or less than 1/4" thick.
11. Never plane stock of different thicknesses; this can result in kickback.
12. Use gloves when rough stock is being planed.
13. Pass the stock around the planer and not over it when preparing to run it through the second time.
14. Never look directly into the feed roll area during the operation of the machine.
15. Do not overload the machine by taking too deep a cut.
16. When shutting down the planer, do not leave the machine until it has come to a complete stop.

TILTING ARBOR SAW

(TABLE SAW)

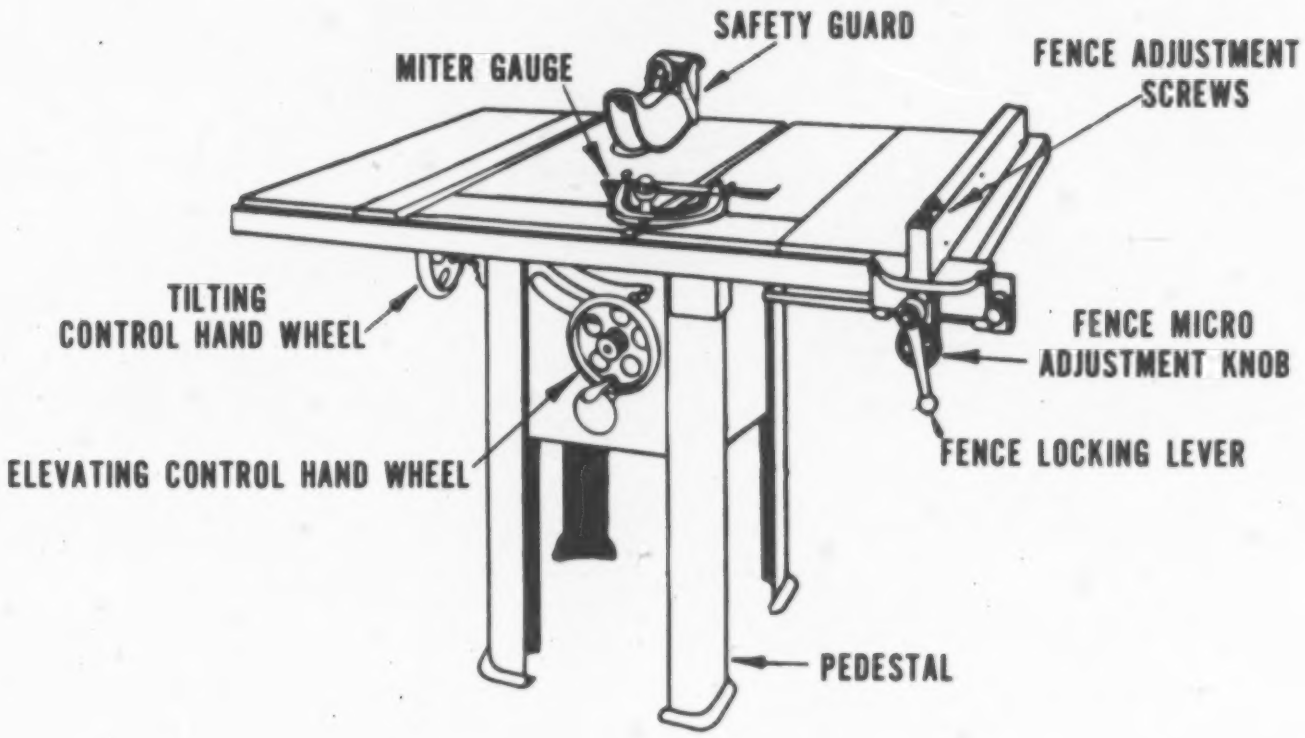

The table saw is used for ripping, cross-cutting and many other special operations in most woodworking classes.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the table saw.
3. Never wear loose fitting clothing when using the table saw.
4. Keep all guards and safety devices in good working condition and in place.
5. Make all adjustments with the power off.
6. Always use a push stick when ripping narrow stock.
7. Stand to one side, and keep area directly behind and in front of the blade clear when the saw is in use.
8. Be sure blade is sharp and properly set. A dull blade will cause kickback.
9. Do not allow saw blade to project more than 1/8" to 1/4" above the stock being cut.
10. Never saw freehand; use the miter gauge or fence depending on cut being made.
11. Always place jointed or straight edge against fence.
12. Do not allow your hand to pass the front edge of the saw table.
13. Do not reach over the saw; use an assistant to help you with long stock.
14. Allow only the operator to feed stock through the saw.
15. Do not operate the saw when other persons in the area are talking or otherwise disturbing the operator.
16. Keep work area clean and free of obstructions.
17. Always stop the saw and use a brush when cleaning sawdust from the table saw.

18. Remove the rip fence when crosscutting.

19. Never stop the saw blade by forcing a piece of wood against the side of the blade.

20. Provide a means of locking the switch in the "off" position when the saw is not in use.

21. Shut off machine and do not leave until the blade has completely stopped.

RADIAL ARM SAW

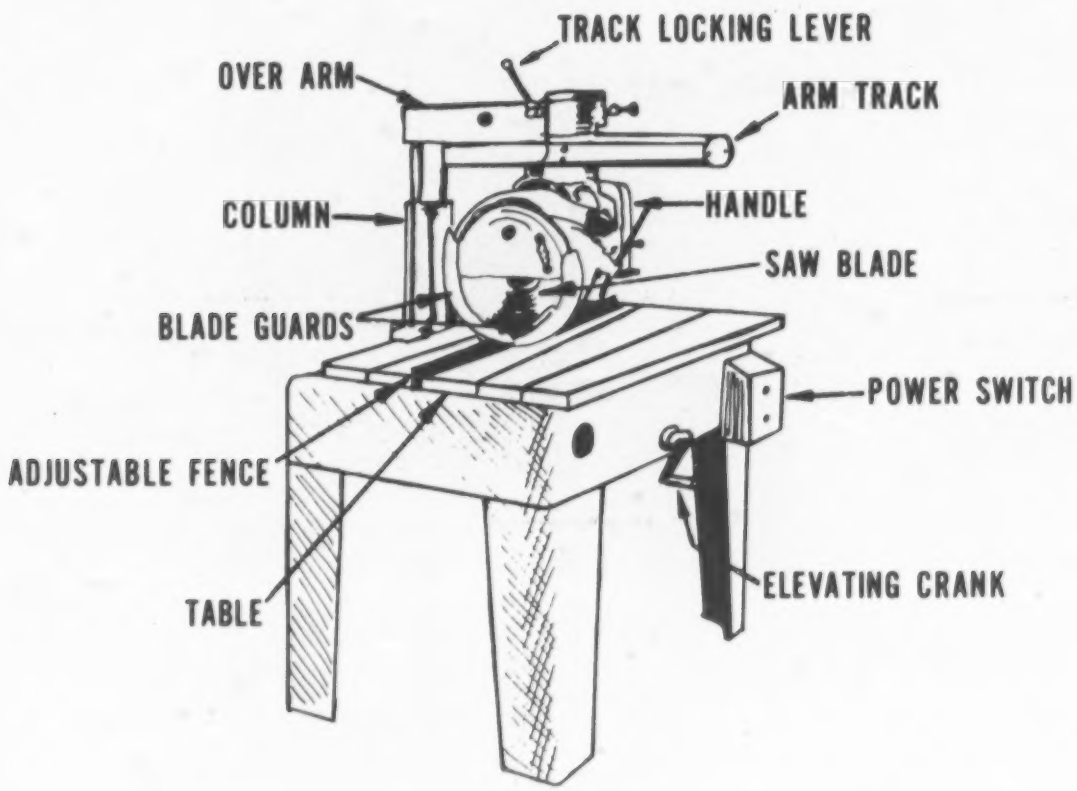

The radial arm saw is used for ripping and crosscutting stock and for bevel, angle cuts and other specialized cuts used in woodworking shops.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the radial arm saw.
3. Never wear loose clothing when operating the radial arm saw.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Do not use the saw when other persons are talking to the operator.
7. Always use the anti-kickback device when ripping. Feed stock only from the side opposite the anti-kickback device.
8. Always use a push stick when ripping narrow pieces of stock.
9. When ripping stock, never place your fingers between the saw and the guide or fence.
10. Set the blade guard so that it just clears the stock being cut.
11. Be sure all levers are locked as required for the operation being performed before the power is turned on.
12. Never rip thin material or material less than 12" in length.
13. Never lower the saw blade so that it will cut into the table top.
14. Inspect all stock for knots, nails and other defects before cutting.
15. Keep hands well away from the blade, and do not stand in line with the cut.
16. Hold stock firmly on the table and against the fence when crosscutting stock.
17. Never force material against the blade to stop it.
18. When shutting off radial arm saw, never leave until the blade has completely stopped.

BAND SAW

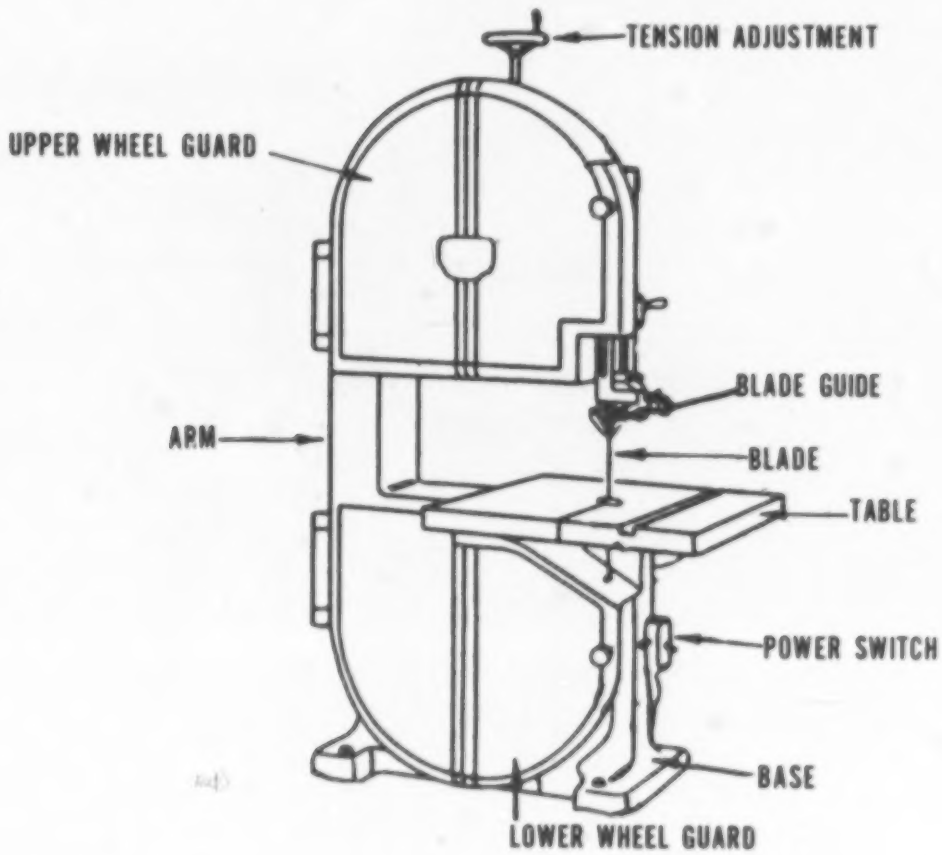

The band saw is most commonly used for curved or circular cuts and straight cuts where great accuracy is not required.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the band saw.
3. Never wear loose fitting clothing when using the band saw.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Check stock for knots, nails and other defects before beginning your cut.
7. Always use a push stick for close cutting work. Keep hands out of the path of the blade.
8. Be sure that both the upper and lower wheel guards are securely closed before starting the band saw.
9. Check blade tension before starting the band saw.
10. Adjust upper blade guard and guide to allow for 1/8" - 1/4" clearance above the work piece.
11. Do not place pressure against the blade or twist the blade by making too sharp a curved cut.
12. Always use a stick to remove blocks or chips near the saw blade.
13. Never back a saw blade out of the saw kerf while the saw is running.
14. Shut off power and wait until saw blade stops before leaving the saw; use the brake, if available.
15. Give your undivided attention to your work.

JIG SAW

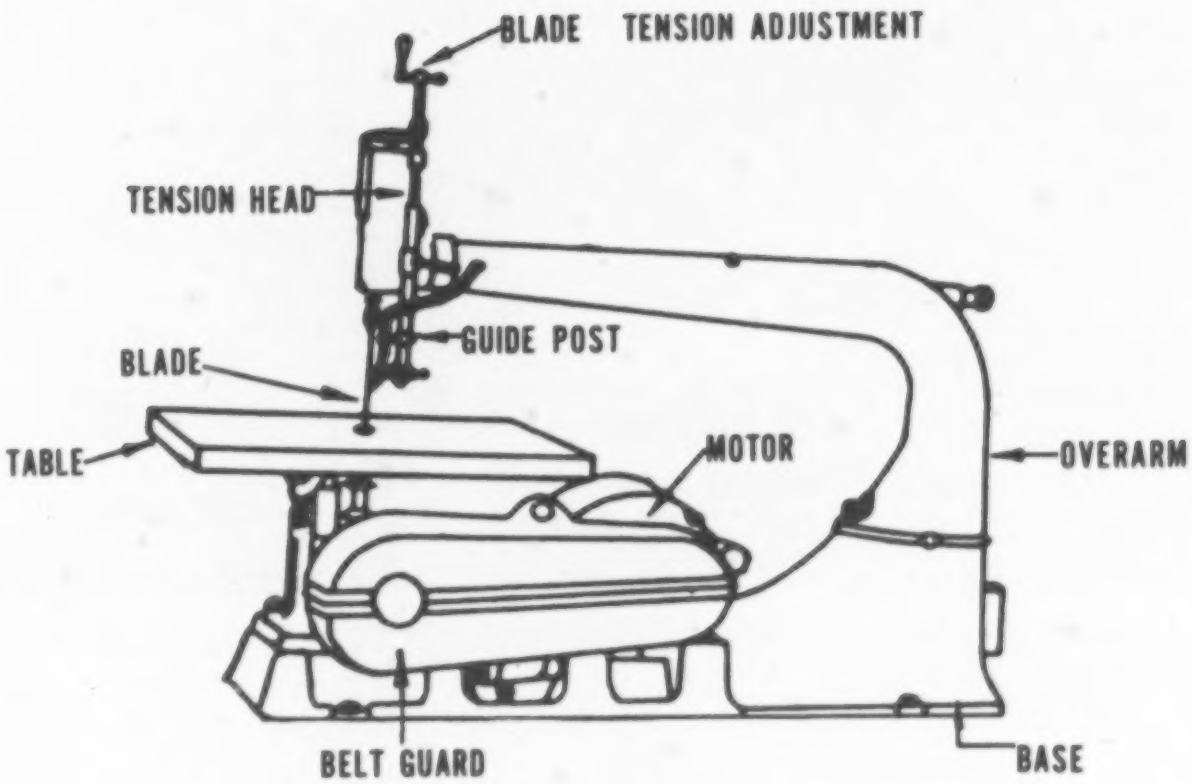

The jig saw is commonly used for cutting curved outlines. It may also be used for straight cuts where great accuracy is not required.

Safety Precautions

1. Wear safety glasses.

2. Obtain your instructor's permission to use the jig saw.

3. Never wear loose fitting clothing when using the jig saw.

4. Keep all guards and safety devices in good working order and in place.

5. Make all adjustments with the power off.

6. Always be sure the blade is properly installed with the teeth pointing down.

7. Check the machine by turning it over by hand to see that the blade tension is correct and that the blade clearance is proper.

8. Always keep the hold down adjusted to just clear the work piece so that the work will not be raised off the table.

9. Always keep your fingers out of the direct path of the blade cut when feeding work into the jig saw.

10. Never force or crowd the work into the saw blade.

11. Never remove chips or small blocks from the saw table with your hands or fingers.

12. Shut off the power, and do not leave the jig saw until it has completely stopped.

DRILL PRESS

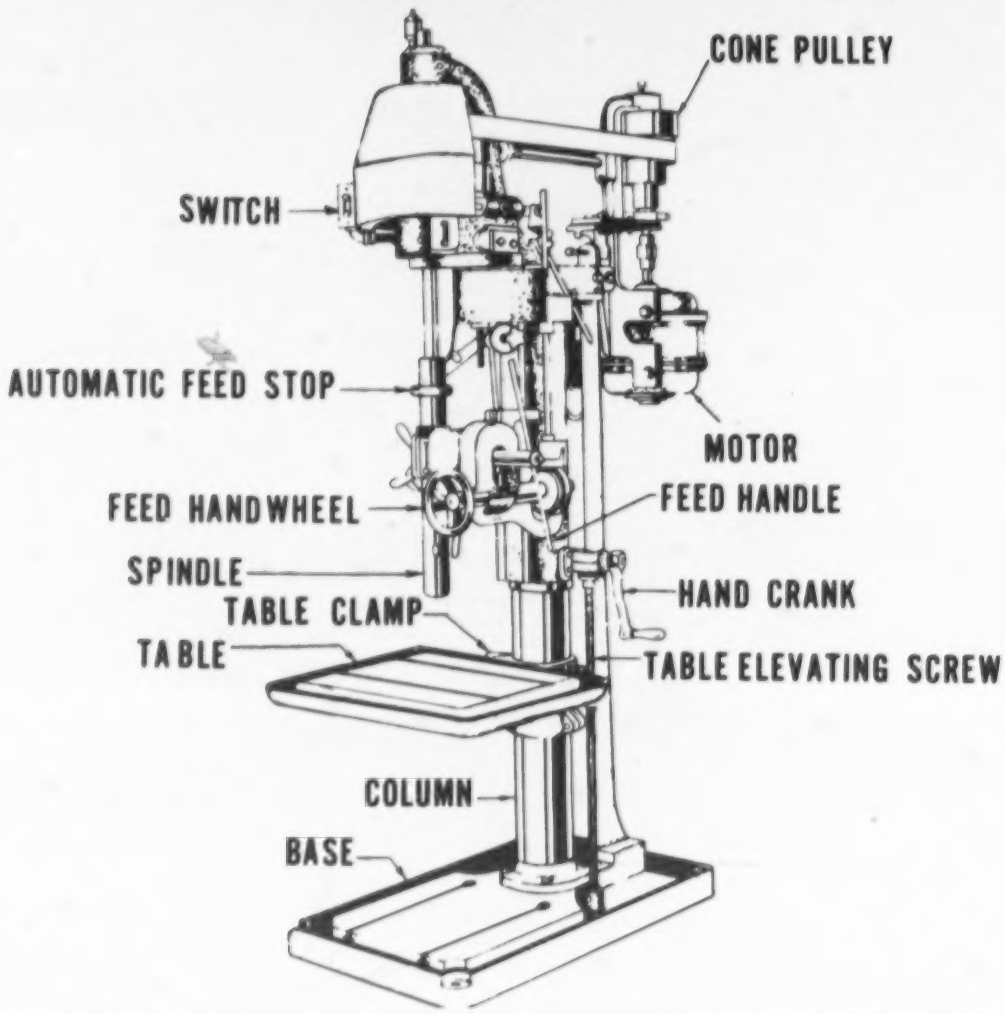

The drill press is commonly used for boring holes in steel and wood. When working with wood, it can also be used for mortising, routing, limited sanding and countersinking.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the drill press.
3. Never wear loose fitting clothing when using the drill press.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Fasten work piece securely with the proper vise or clamp.
7. Always keep the long end of a work piece to your left, if possible, when drilling.
8. Support the end of a long work piece with a stand.
9. Adjust the drill speed to suit the material being drilled and the size of the hole being bored.
10. Always remove the chuck key from the chuck after tightening a drill bit and before starting the motor.
11. Always feed the drill bit cautiously into the work piece.
12. Never attempt to stop a revolving work piece in which the drill bit is caught. Stop the drill press and then free the drill bit.
13. Always use cutting oil when drilling steel.
14. Be certain that the drill bits are sharp before using.
15. Always wait until the drill press stops before leaving the machine.
16. Be sure to remove the drill bit from the chuck when the job is completed.

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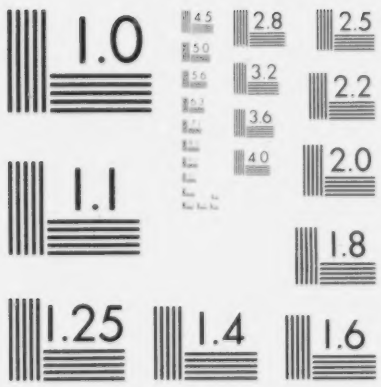

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

DISK SANDER

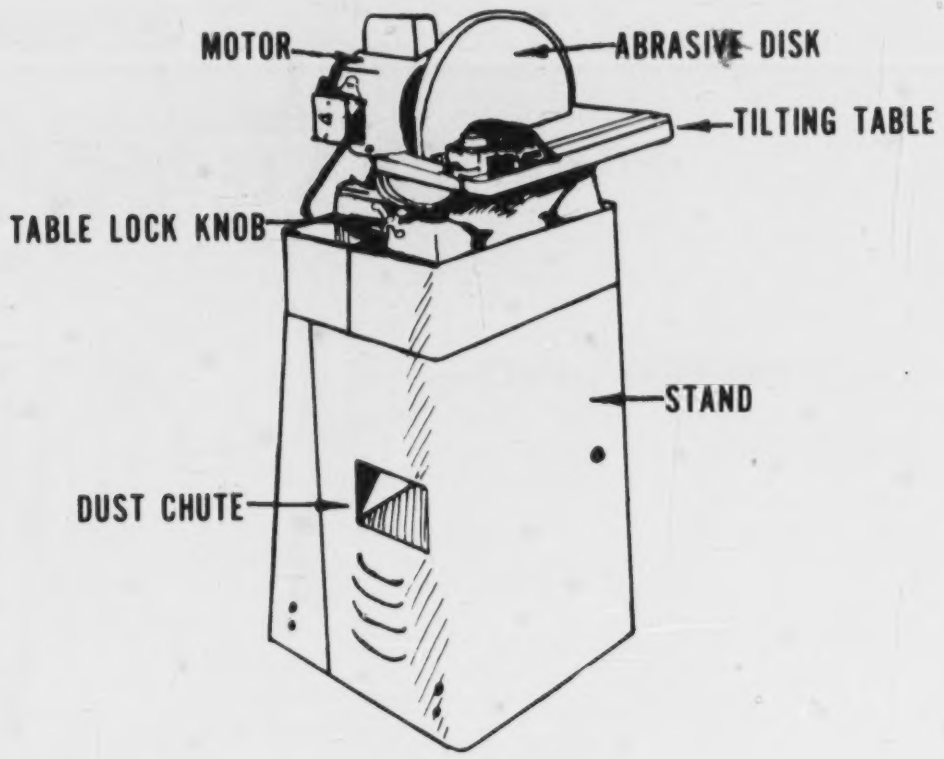

The disk sander is commonly used to form and shape parts used in making woodworking projects.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the disk sander.
3. Never wear loose clothing when using the disk sander.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Check to determine that the abrasive disk is properly mounted. Never operate the disk sander if the abrasive paper is loose.
7. Use the table, fence and other guides to control the position of the work, whenever possible.
8. Always use hand-held clamps or a jig to hold small pieces for sanding.
9. Always sand on the side of the disk which is moving down toward the table. Move the work along this surface so it will not burn.
10. Never use the sander to form or shape objects where other machines will do a better job.
11. Never sand work that has excess glue or finish on the surface.
12. Never force a piece of wood against the sanding disk to stop it after the power has been shut off.
13. Always keep hands at least 2 inches from the sander disk.
14. Shut off power and wait until the sanding disk stops completely before leaving the area.

BELT SANDER

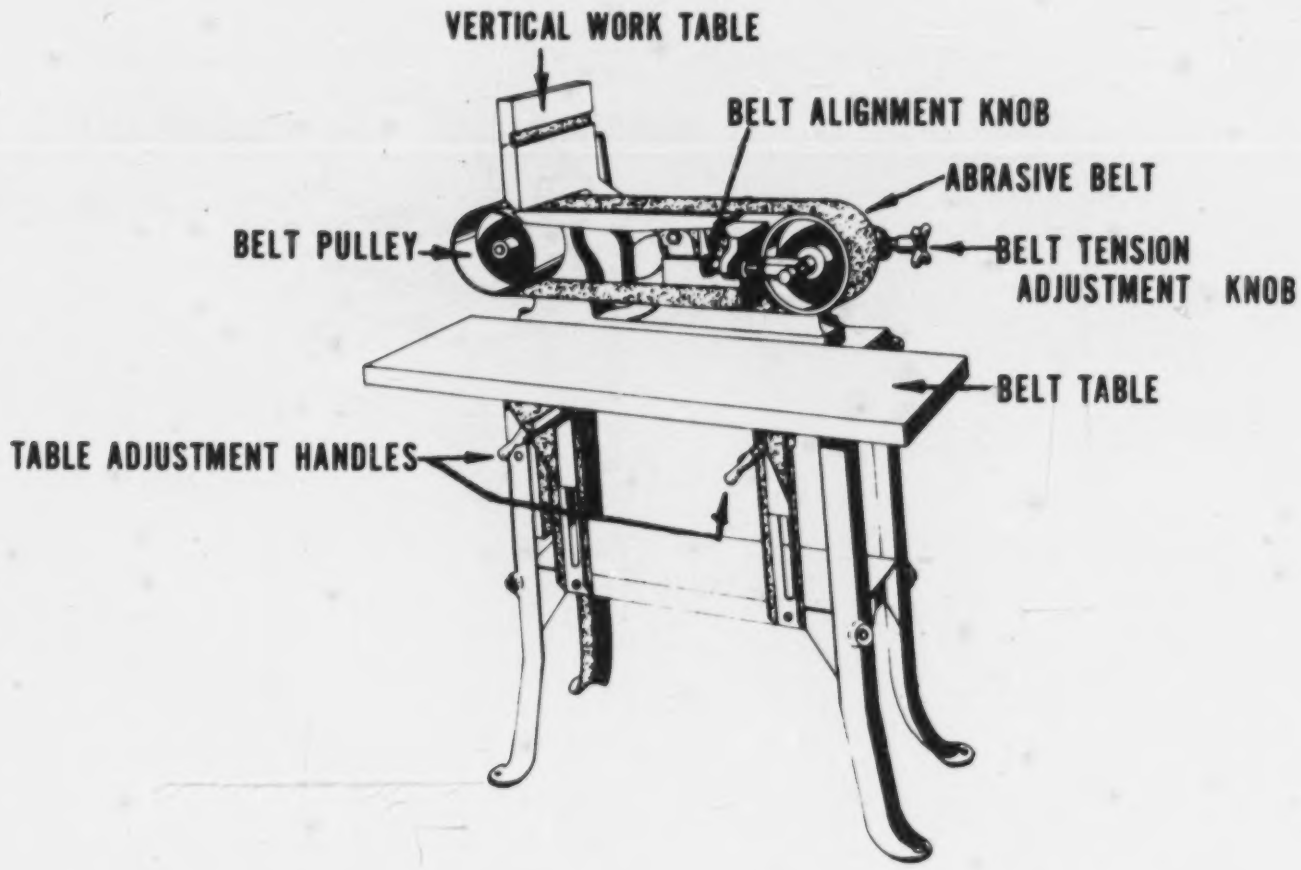

The belt sander is commonly used for sanding flat surfaces, edges and in some special cases, the inside curve of a work piece.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the belt sander.
3. Never wear loose fitting clothing when operating the belt sander.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Run the sander to make sure the belt tracks properly. Always be sure the belt is properly mounted.
7. Always use the table, fence and other guards to control the position of the work, whenever possible.
8. Be sure to use a hand clamp or jig to hold small and irregular shaped pieces.
9. Keep your fingers, if possible, 2 inches away from the abrasive belt.
10. Always support the work against the table when sanding the end grain of narrow pieces.
11. Always use a pad or push block when sanding thin pieces.
12. Never use the sander to form or shape objects where other machines will do the job better.
13. Never sand work that has excess glue or finish on the surface.
14. Never force a piece of wood against the abrasive belt in order to slow it down.
15. Shut off the power, and do not leave the area until the belt sander has come to a complete stop.

WOOD LATHE

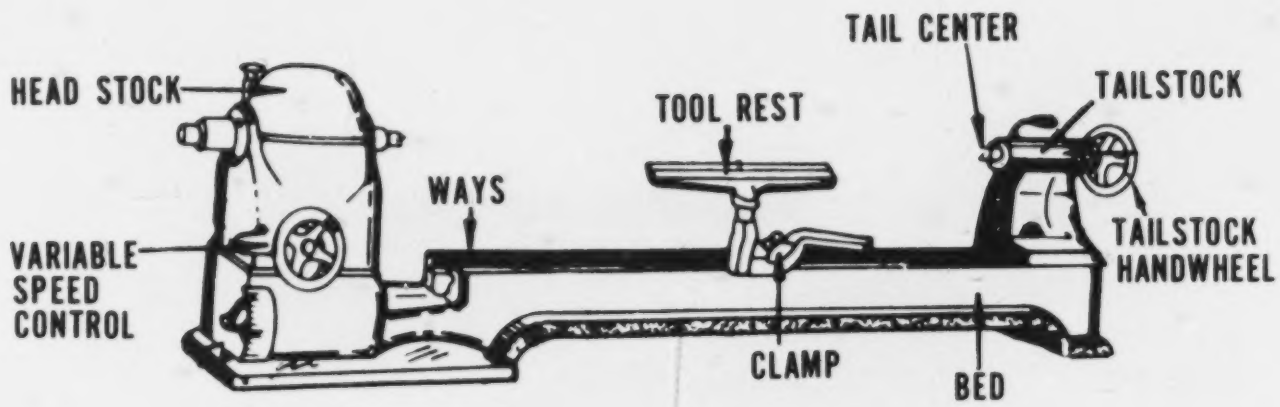

The wood lathe is commonly used in the shop for making cylindrical objects of many shapes to be used in shop projects.

Safety Precautions

1. Always wear safety glasses.

2. Obtain your instructor's permission to use the wood lathe.

3. Never wear loose clothing when using the wood lathe.

4. Keep all safety devices in good working order and in place.

5. Make all adjustments with the power off.

6. Check the stock to be sure it contains no loose knots, insecurely glued joints or checkered ends.

7. Always check stock to make sure it is securely mounted, centers properly imbedded and tail stock firmly clamped in place. Spin the set-up by hand before starting the lathe.

8. Keep the tool rest adjusted close to the stock and slightly above center.

9. Remove the tool rest when it is not in use, such as during sanding or polishing operations.

10. Always stop the lathe to make any and all measurements.

11. Never allow excess chips to gather on the floor, as they present fire and slipping hazards.

12. Always keep your lathe tools sharp.

13. Replace lathe tools in the cabinet when not in use.

14. Always hold the lathe tool in both hands.

15. Stand slightly to one side of the cut being made; and hold the chisel so that, if thrust back suddenly, it will not strike the body.

16. Always have observers stand either in front or at the ends of the lathe and otherwise out of any danger area.

17. Be sure to use the proper tool for the type of cut to be made.

18. When shutting off the lathe, wait until it stops completely before leaving the area.

HORIZONTIAL BAND SAW

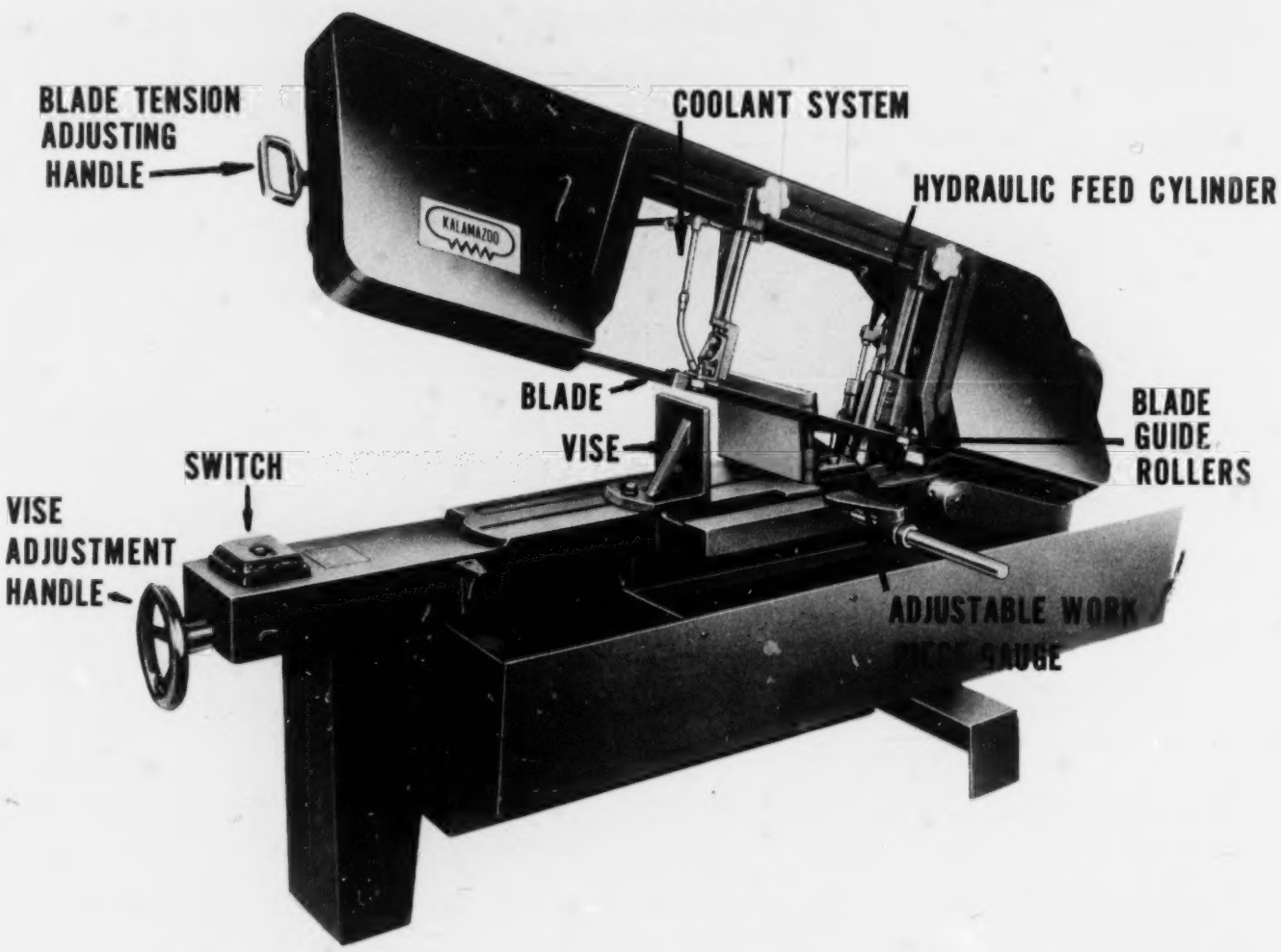

POWER HACKSAW

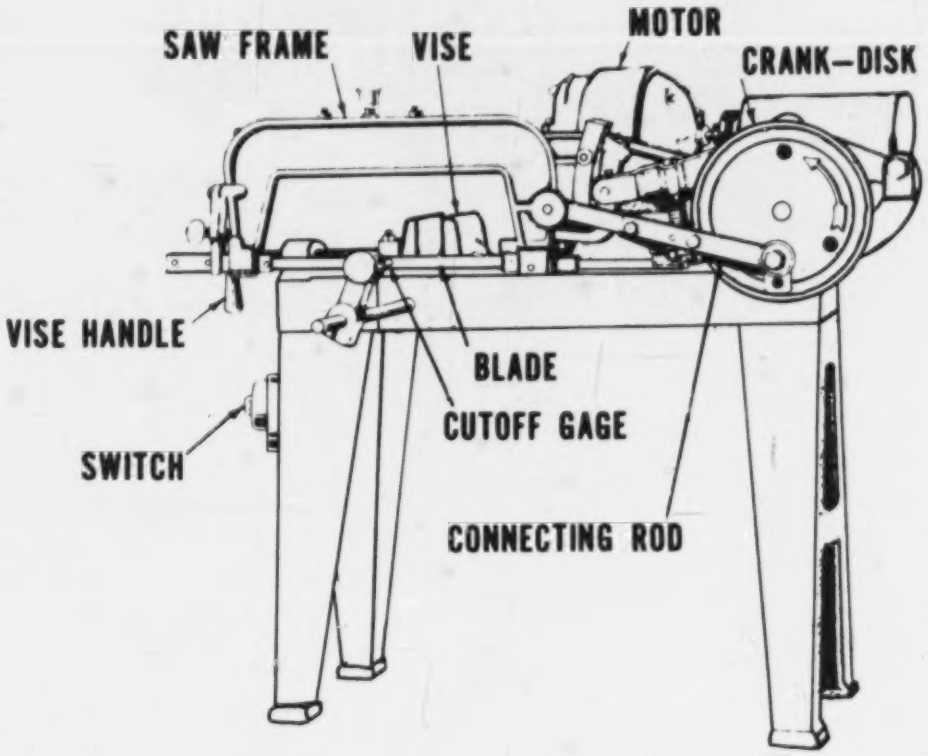

The power hacksaw is used to cut metals which are softer than the hacksaw blade. Power hacksaws can be of two types: the reciprocating hacksaw and the band hacksaw. The uses are similar, and in most cases the safety precautions will be the same.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the power hacksaw.
3. Never wear loose fitting clothing when using a power hacksaw.
4. Keep all guards and safety devices in good working order and in place.
5. Make all adjustments with the power off.
6. Be sure to get help when cutting heavy materials.
7. Keep floor clear of grease, oil and short pieces of metal at all times.
8. Never clean chips from the saw while it is running.
9. Never clean chips from the machine with the hands—use a brush.
10. Handle cut pieces carefully, because they contain burrs which can cause serious cuts until the burrs can be removed.
11. To prevent tooth breakage, the blade should be in motion before it comes in contact with the stock.
12. Never put excessive tension on the blade; too much tension could shatter the blade, causing particles of flying steel.
13. When shutting off the hacksaw, wait until the blade stops completely before leaving the area.

PEDESTAL GRINDER

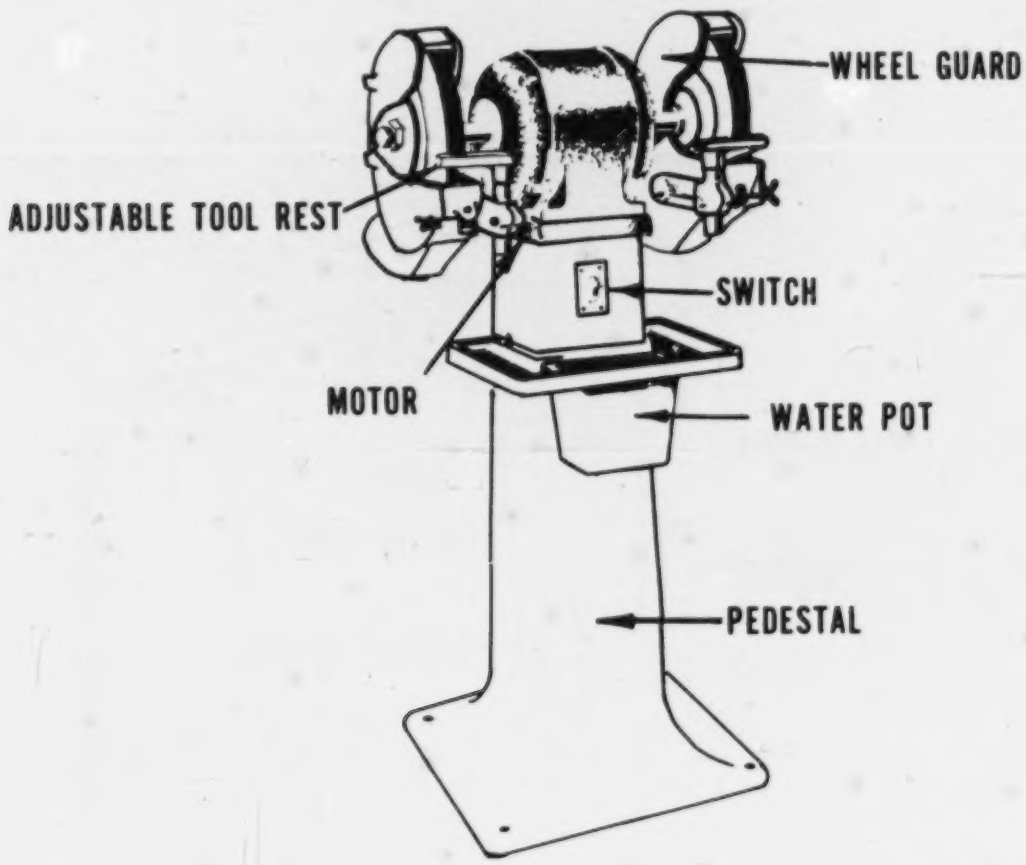

The bench or pedestal grinder is a tool commonly found in the shop; it is used to sharpen tools, smooth welds, shape tools and other jobs requiring the removal of small amounts of metal.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the grinder.
3. Never wear loose clothing when using a grinder.
4. Keep all safety devices and guards in good working order and in place.
5. Make all adjustments with the power off.
6. Do not use a grinder unless the plastic shield on the grinder is in place.
7. Keep the tool rest adjusted to within 1/8" of the stone at all times.
8. Always check stone for tightness and for cracks or flaws before using.
9. Keep the guard adjusted as near the wheel as possible
10. Keep the grinding wheel true by frequent dressing.
11. Never use grinding wheels which have been greatly worn down by use. Never use a wheel after it has been worn to less than one half its original size.
12. Use the face of the grinding wheel, not the sides, for grinding.
13. Never allow the hands and fingers to contact the grinding wheel when it is in motion.
14. Always use pliers, vise-grips or other suitable holding devices when grinding small, round or oddly shaped workpieces.
15. Never force the job against the grinding wheel, and avoid overloading the grinder.
16. When starting a new wheel, stand back and allow it to run for a few minutes before using it for grinding.

17. Never apply the job to the grinder before it has reached running speed or while it is coasting to a stop.

18. Be sure to keep work piece cool by frequent dipping in cold water.

19. Always stand to one side of the wheel when using the grinder.

20. When shutting off, wait until the grinder completely stops before leaving the area.

ENGINE LATHE

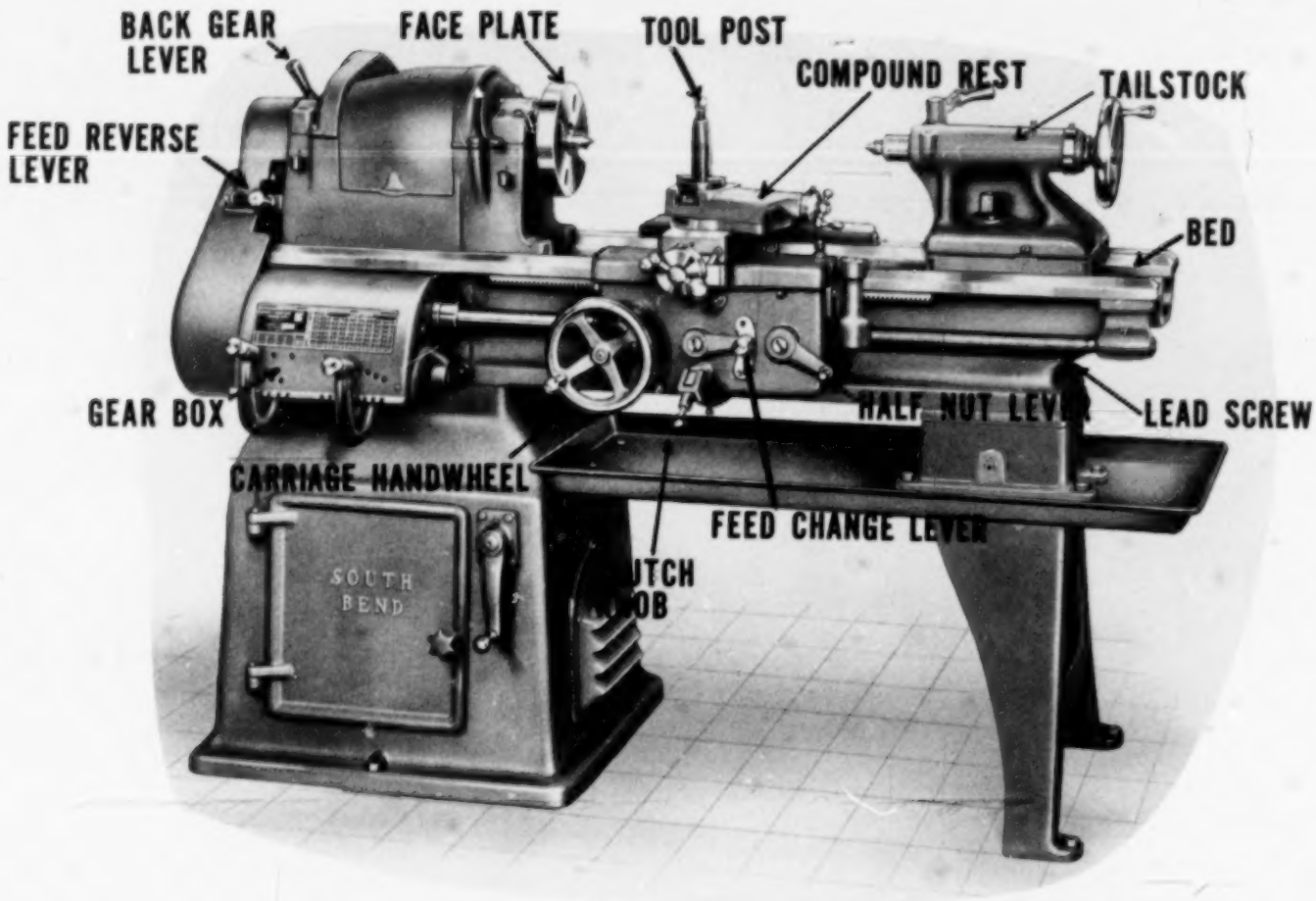

The engine lathe is used in the shop for turning down metal cylinders and to prepare special replacements not available in the area. It can also be used to make parts when machinery is being modified for special purposes.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the engine lathe.
3. Never wear loose clothing when using the engine lathe.
4. Keep all safety devices and guards in good working order and in place.
5. Make all adjustments with the power off.
6. Clamp all work solidly; use the correct tool and work holding device for the job.
7. Keep tools not in use in cabinets and out of the immediate work area. Never place tools on the lathe ways.
8. Be sure to turn the face plate or chuck on by hand.
9. Always turn the set-up-job by hand to be sure clearances are correct before turning on the power.
10. Always stop the machine to make measurements.
11. Always allow the lathe to stop by itself; never attempt to use your hand to help slow it down.
12. Support all work solidly.
13. Always use the hand feed to make all finish cuts near the face plate, chuck or shoulder.
14. Always remove the key from the chuck before starting the lathe.
15. Never use a file without a handle.
16. Never use your hands to remove chips or shavings from the lathe—use a cleaning brush. Stop the lathe before cleaning.
17. Always keep the floor area around the lathe clean and free of oil and metal chips and shavings.

18. When shutting down the lathe, wait until it has completely stopped before leaving the area.

OXYACETYLENE WELDER

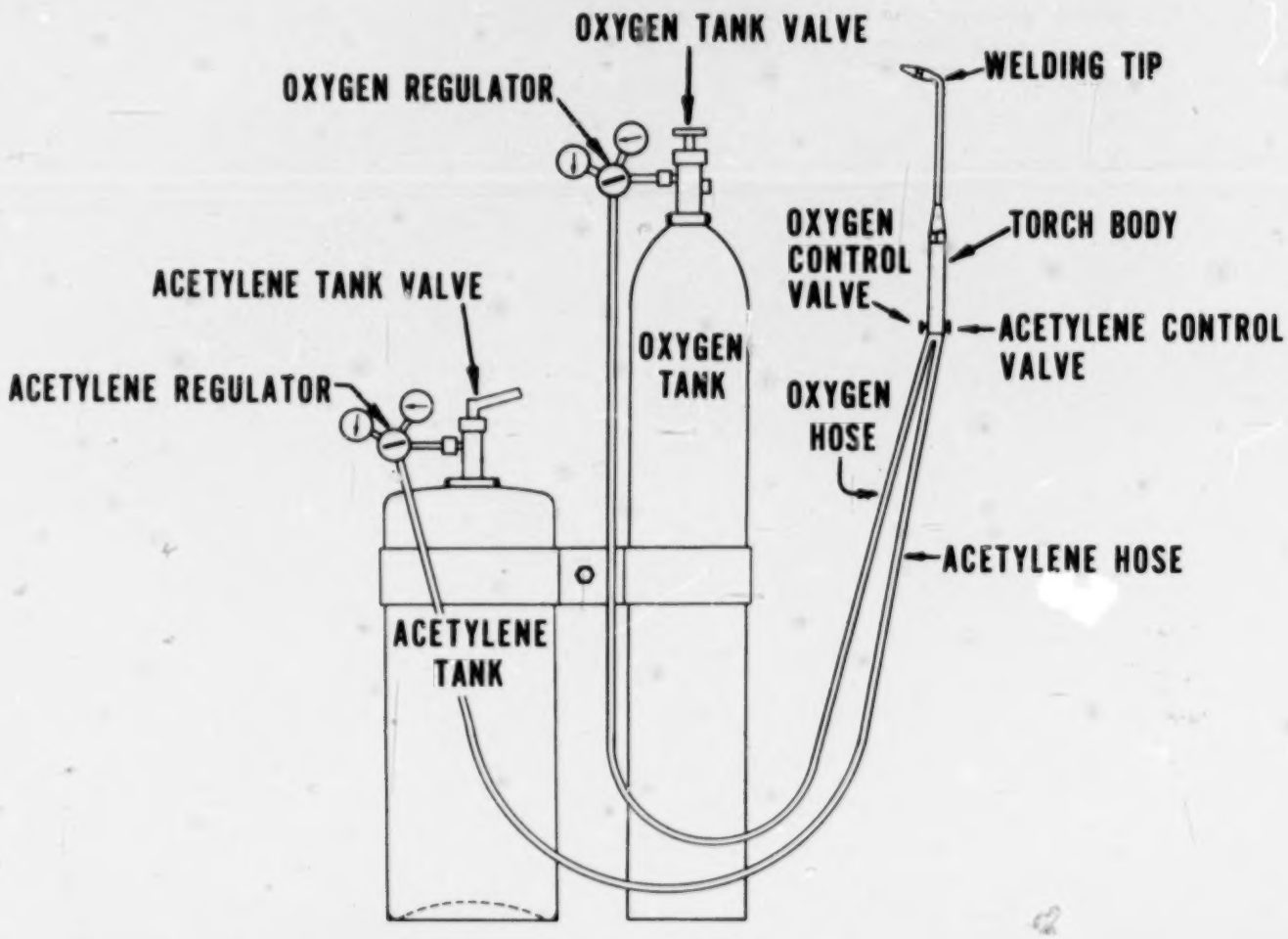

Oxyacetylene welding equipment is commonly used in shops to fuse weld, braze weld, cut steel and provide heat when required for shaping metals.

Safety Precautions

1. Obtain your instructor's permission to use the oxyacetylene welder.

2. Wear gloves and nongreasy clothing without cuffs.

3. Always wear approved welding goggles with a shade 4 or darker colobar lens. Wear safety glasses when welding goggles are not being used—for example, when grinding.

4. Never use oil of any kind on any part of the oxyacetylene welding equipment.

5. Check all connections and hoses daily for leaks. A soap solution works well for this.

6. Use the proper hoses with standard fittings, usually a braded double hose, green for oxygen and red for acetylene.

7. Keep hot metal and flame away from the hose.

8. Never light the torch near flammable material.

9. Always keep the welding tip pointed down and away from yourself to prevent saturating your clothes with gas before lighting.

10. Never open the acetylene tank valve over one full turn so that it can be shut off quickly in case of an emergency.

11. Never drop or subject the gas tanks to rough handling.

12. Be sure to shut off both tanks and bleed lines and gauges when you have finished welding.

13. Never lay a lighted torch down.

14. Always place hot metal in a designated place or scrap barrel to prevent burns.

15. Never put more pressure on the hoses than is required to properly operate the tip being used.

16. Keep the safety caps on tanks not in use, and store unused tanks upright and in an area where flame or excessive heat cannot reach them.

17. Be sure there is adequate ventilation in the welding area. Provide additional ventilation when working on galvanized metals.

18. Always use a flint lighter when lighting the torch.

ELECTRIC ARC WELDER

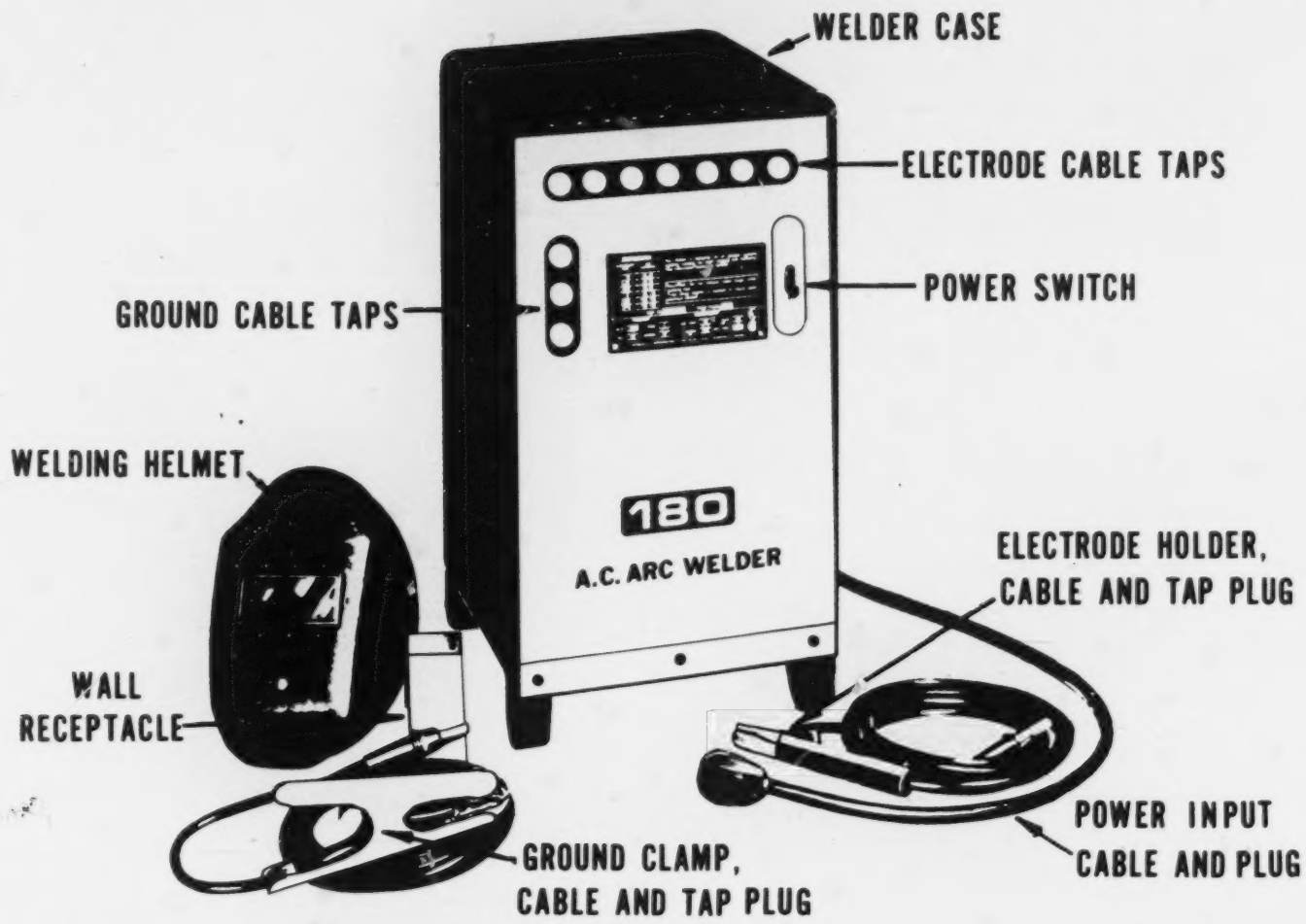

The electric arc welder with its accessories is commonly used in the shop for fusion welding, braze welding, cutting and heating of metals.

Safety Precautions

1. Obtain your instructor's permission to use the electric arc welding equipment.

2. Wear gloves and clothing without cuffs, which cover and protect the entire body, including arms and legs. High top shoes are recommended to prevent slag and sparks from falling onto and burning your feet. A skull cap will protect the head and hair from sparks and slag.

3. Wear a welding helmet with the proper shade lens for the welding job being done.

4. Always make sure the welder is properly grounded before starting it.

5. Check the electrode holder, welding cables and other connections to be certain they are properly insulated.

6. Never weld in an area which is damp or where you are standing in water.

7. Always wear safety glasses or a lift front head shield when chipping or cleaning welds.

8. Never strike an arc until you are sure that all persons in the area are protected from the arc rays.

9. Never look at an arc without a head shield with the proper shade lens in it.

10. Always place electrode stubs in a container when discarding them. If they are thrown on the floor they present a dangerous hazard.

11. Check the area around where you are welding for flammable materials.

12. Be sure to keep the shop well ventilated.

13. Always see your instructor for treatment if you have experienced an arc flash, regardless of how minor you may think it is.

14. Do not allow the welding cable to come in contact with hot metal or sharp edges.

15. Never cool the electrode holder in water.

16. Place all hot metal in the designated area.

17. Always use forced ventilation when working with galvanized iron.

HYDRAULIC ARBOR PRESS

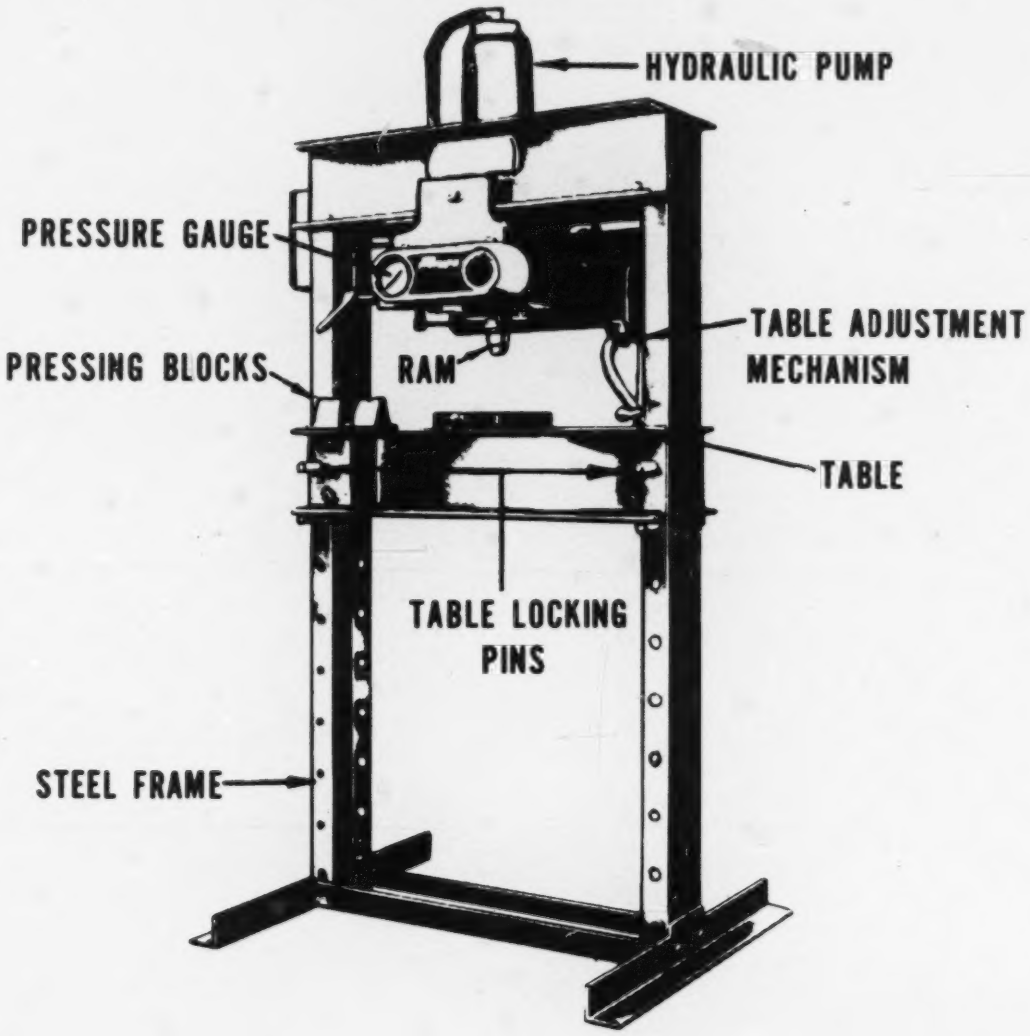

The hydraulic arbor press is commonly used in the shop to shape metals, test welds and to remove or replace bearings, gears and other tight fitting collars on shafts.

Safety Precautions

1. Always wear safety glasses.

2. Obtain your instructor's permission to use the hydraulic arbor press.

3. Never wear loose clothing when operating the hydraulic arbor press.

4. Keep all safety devices in good working order and in place.

5. Make all adjustments before pressure is applied to the work piece.

6. Never attempt to move or hold the work piece after pressure is applied.

7. Be sure no other person is standing in an area where he may be hit by flying metal.

8. Always stand behind the end of the hydraulic arbor press and never in front of the work area, to avoid being hit by flying metals.

9. Be very cautious when pressing strong springs or springy material.

10. When applying pressure to the work piece, stop periodically to inspect the work to be sure everything is all right.

11. Never leave the hydraulic press when you are applying pressure to a work piece. Always relieve the pressure before leaving the work area.

12. Always use sufficient supports, clamps or other devices to adequately hold and support the job being done.

HYDRAULIC JACK

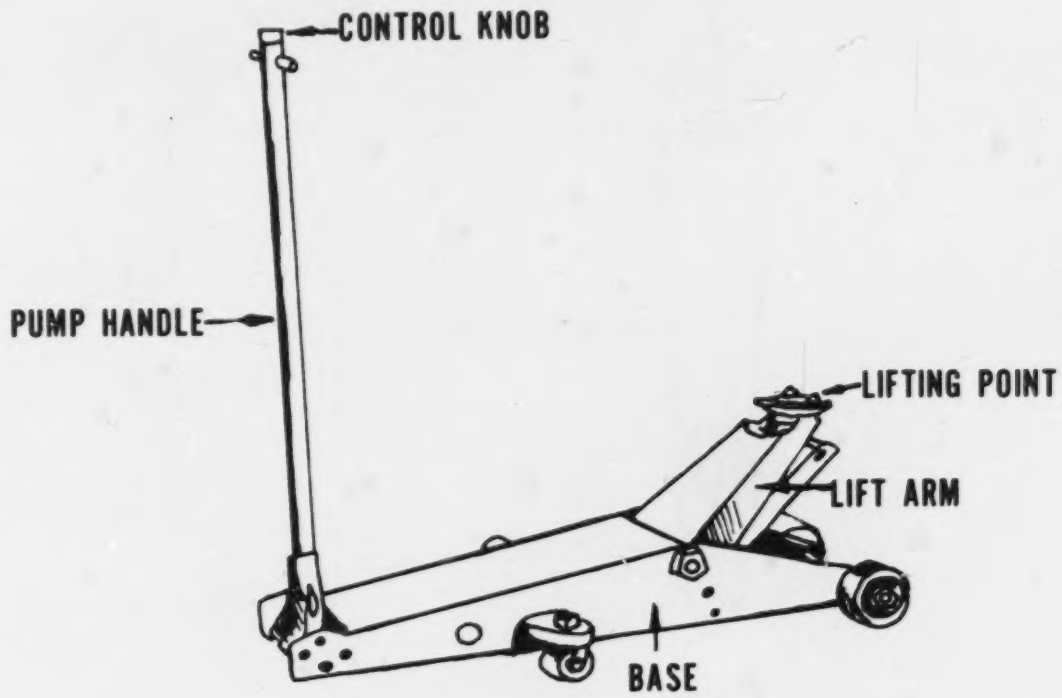

The hydraulic jack is used in shops for many purposes, such as lifting heavy objects, positioning heavy parts and supporting heavy objects.

Safety Precautions

1. Always wear safety glasses.

2. Obtain your instructor's permission to use the jack.

3. Never wear loose clothing when using a jack.

4. Keep all safety devices in good working order and in place.

5. Make all adjustments before applying pressure to the job.

6. Always use a jack capable of supporting the load to be lifted or moved.

7. Use extra footing supports under the jacks where needed.

8. Always check jacks to be sure that neither the jack nor the load will be damaged.

9. When it is necessary to work under the object being held by the jack, always place additional supports under the object, such as supporting blocks or jack stands. Never work under an object supported only by a jack.

10. Never leave an object supported only by a jack; place other supports under it, and identify the object so that others will not be hurt and so that someone else will not try to remove the jack.

CHAIN HOIST

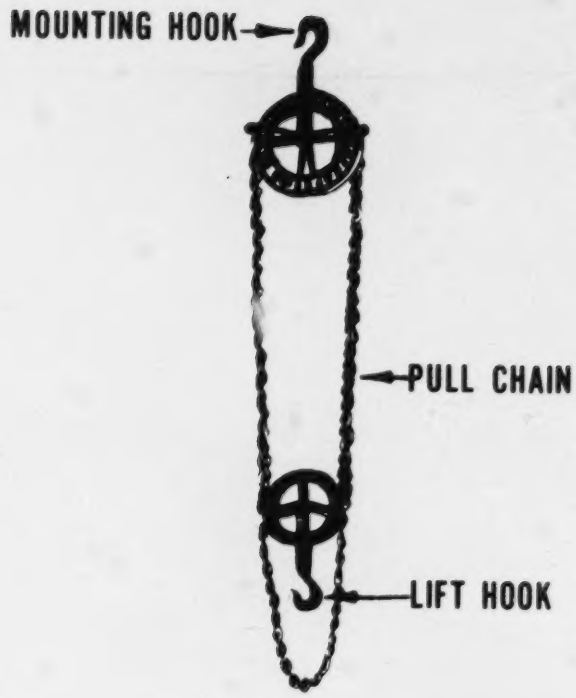

MANUAL

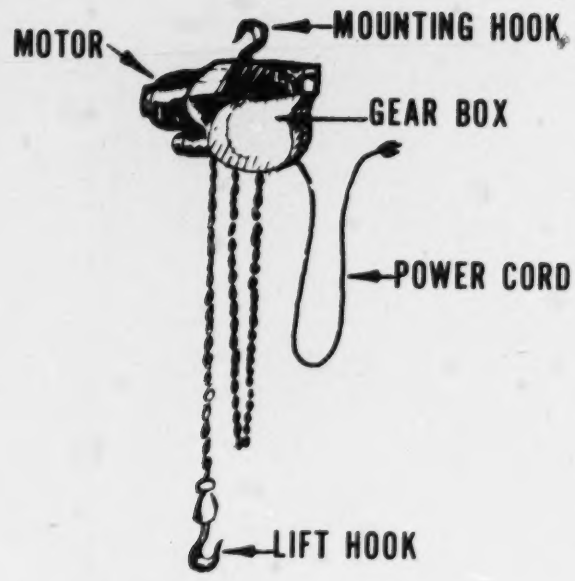

ELECTRIC

The chain hoist is commonly used in the shop for raising heavy objects, shaping metals and pulling bent pieces of equipment into place. It is also used for moving heavy objects and for raising objects higher than jacking allows.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the chain hoist.
3. Never wear loose clothing when using a chain hoist.
4. Keep all safety devices in good working order and in place.
5. Make adjustments and check all connections before raising an object.
6. Never lift an object of greater weight than the capacity of the chain hoist.
7. Be sure the supporting frame or beam is of sufficient capacity to handle the load being raised.
8. Never get under the object being raised.
9. Always use chains, cables or other devices of sufficient capacity to hold the object.
10. Never lift the object higher than is needed to properly perform the job.
11. Always check the chains, cables or other lifting devices as soon as they are carrying the load and before raising the object to the desired height.
12. Never leave a load suspended on the hoist when you must leave the area.

STEAM CLEANER

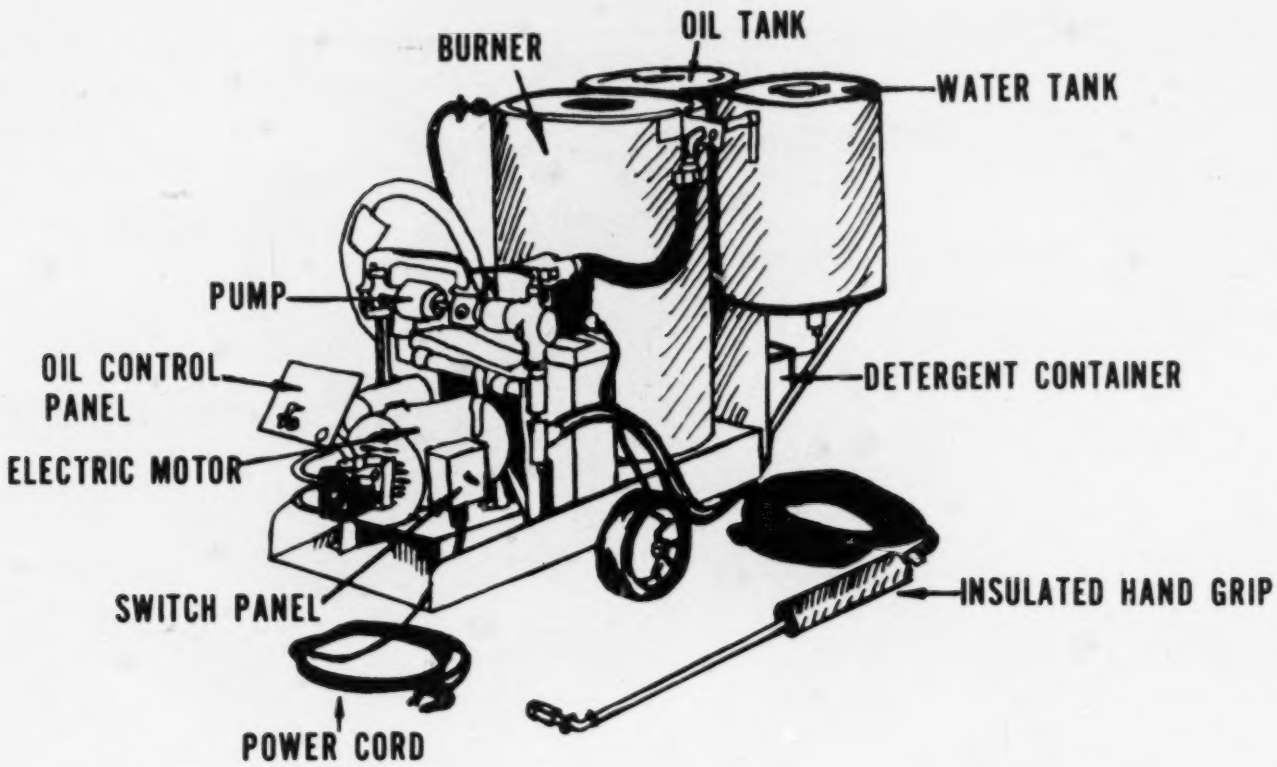

The steam cleaner is commonly used in shops for the purposes of complete cleaning of equipment, for repairs and/or painting and to clean parts for reassembly.

Safety Precautions

1. Always wear safety glasses.

2. Obtain your instructor's permission to use the steam cleaner.

3. Never wear loose clothing when using the steam cleaner.

4. Keep all safety devices in good working order and in place.

5. Make all adjustments with the power off and the burner cool.

6. Always check to be sure there is sufficient water flowing through the steam cleaner before lighting the burner.

7. Always check the electrical connections to be sure they are tight and to be certain they will not become wet or lie in water, as this can cause short circuits and possible serious injury.

8. Always hold the steam cleaner hose by the insulated hand grip, and wear gloves to prevent burns to the hands.

9. Never point the steam cleaner toward other persons.

10. Check the work area to be sure there are no persons in a location where they will be accidentally sprayed.

11. Be sure the safety blow-out plug is pointed toward the floor.

12. Keep a constant check to be sure there is sufficient water in-flow to the steam cleaner to insure safe and proper operation.

13. Never operate the steam cleaner unless water droplets are emitted with the steam.

14. When shutting off the steam cleaner, turn off the burner first and leave water pump running until clear cool water flows from the steam hose, then turn off water. Never leave the steam cleaner until it has been completely shut down.

PORTABLE CIRCULAR SAW

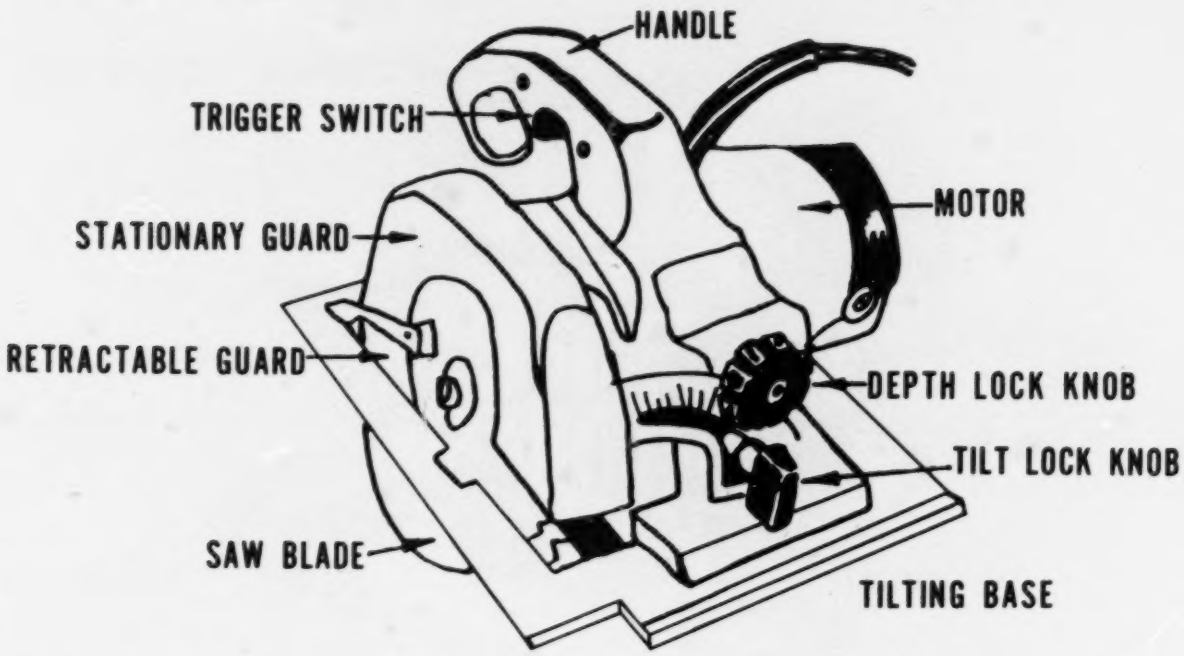

The portable circular saw is commonly used for framing and other rough construction work.

Safety Precautions

1. Always wear safety glasses.

2. Obtain your instructor's permission to use the portable circular saw.

3. Never wear loose fitting clothing when operating the portable circular saw.

4. Keep all guards and safety devices in good working order and in place.

5. Always check the power cord for condition, and be sure the power cord is 3-wire and is properly grounded.

6. Make all adjustments and check blade tightness with the power source disconnected.

7. Never stand on a wet surface when operating a portable circular saw.

8. Always be sure the switch is off before connecting the portable circular saw to the power source.

9. Always use a sharp blade.

10. Support the work piece securely with saw horses or other supports. Clamp small pieces so they cannot slip or move.

11. Be careful not to cut into the saw horse, work bench or other support with the blade.

12. Adjust the depth of cut to the thickness of the stock plus 1/8".

13. Always stand to one side of the cutting line during the cut.

14. Be sure blade is not in contact with the work piece when starting the portable circular saw.

15. Always use both hands to hold and guide the saw through the work piece.

16. When shutting off, wait until the blade stops completely before placing the saw on the table.

PORTABLE SABER SAW

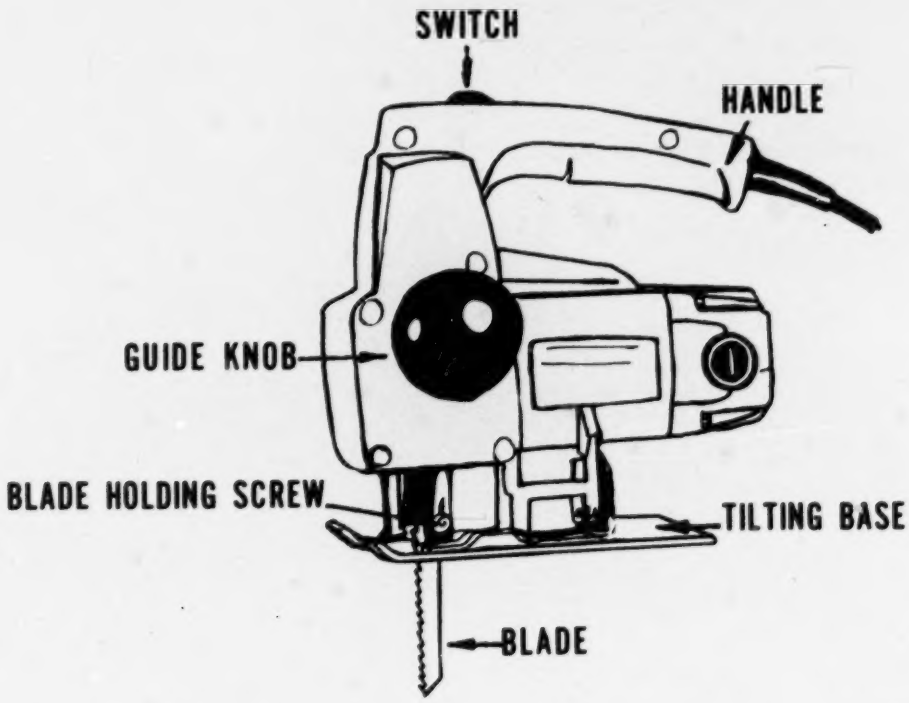

The saber saw is commonly used for cutting curves and other light work when a jig saw or band saw is not easily accessible or the work piece is too large for the jig or band saw.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the saber saw.
3. Never wear loose clothing when operating the saber saw.
4. Keep all guards and safety devices in good working order and in place.
5. Always check the power cord for condition, and be sure the power cord is 3-wire and is properly grounded.
6. Make all adjustments with the power disconnected.
7. Never stand on a wet surface when operating a saber saw.
8. Always be sure the switch is off before connecting the saber saw to the power source.
9. Always be certain you have the correct blade for the job to be done and that the blade is securely fastened in the saw.
10. Grip the saw firmly with both hands.
11. Always secure the work piece firmly with a vise or clamps as needed.
12. Be careful not to cut into the bench or other support with the blade.
13. Always place the base of the saw firmly on the work piece before starting the cut.
14. Start the motor before the blade contacts the work piece.
15. Always maintain a constant cutting pressure. Excessive pressure can overload the motor and cause blade breakage.
16. After the cut is completed, shut off the saw and wait until the blade stops completely before setting the saw down.

17. After completing the job, disconnect the saw from the power source and remove the blade.

18. Never make curved cuts so sharp as to jam, twist or otherwise foul the blade.

PORTABLE FINISHING SANDER

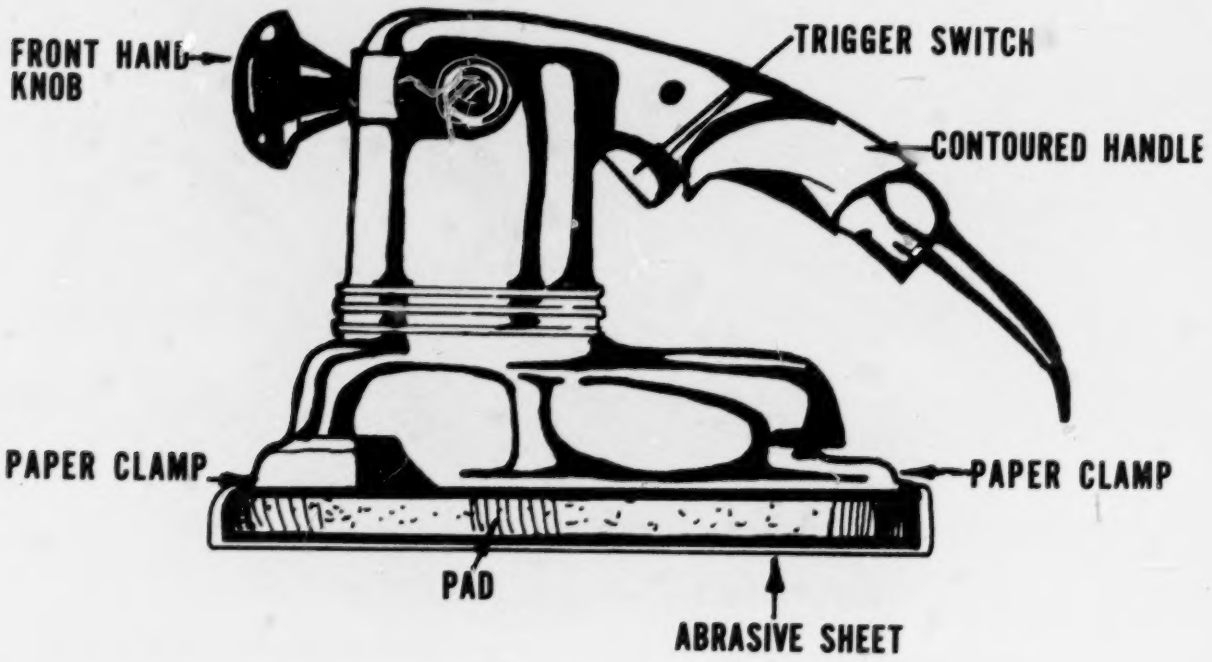

Finishing sanders are commonly used to complete the final sanding where only a small amount of material needs to be removed. They may also be used for cutting down and rubbing finished coats.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the finishing sander.
3. Never wear loose clothing when operating the finishing sander.
4. Keep all guards and other safety devices in good working order and in place.
5. Always check the power cord for condition, and be sure the power cord is 3-wire and is properly grounded.
6. Make all adjustments with the power disconnected.
7. Never stand on a wet surface when operating a finishing sander.
8. Always be sure the switch on the finishing sander is off before connecting it to the power source.
9. Always be certain the power source is disconnected before replacing the abrasive pad.
10. Small work pieces must be fastened to the work area before being sanded.
11. Never apply excessive pressure beyond the weight of the sander itself. Excessive pressure will cause overheating and reduced efficiency.
12. Grip the sander firmly to maintain control of it.
13. Start the sander before it is applied to the work piece.
14. Remove the sander from the work piece before shutting it off.
15. Always disconnect the sander from the power source when the work is completed.

PORTABLE ROUTER

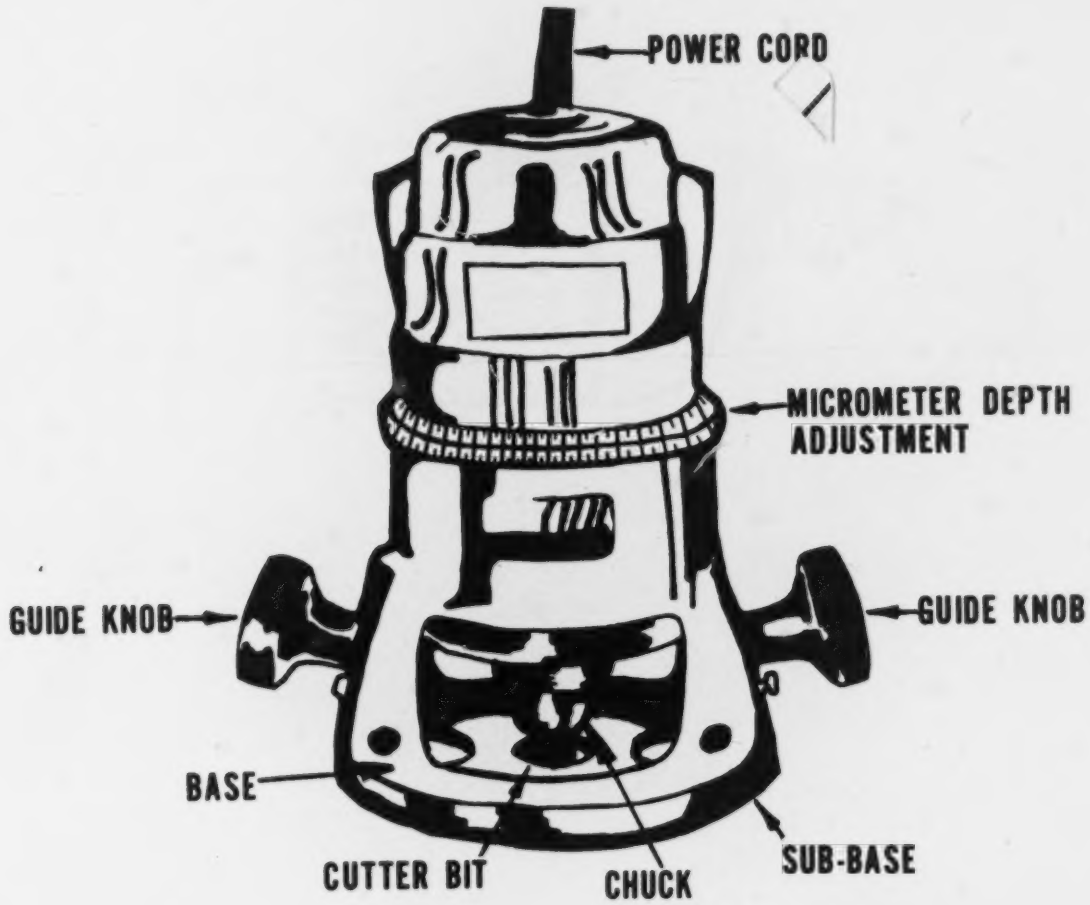

The router is commonly used to cut irregular shapes and form various contours on the edges and surface of wood projects.

Safety Precautions

1. Always wear safety glasses.

2. Obtain your instructor's permission to use the router.

3. Never wear loose clothing when operating the router.

4. Keep all guards and safety devices in good working order and in place.

5. Always check the power cord for condition, and be sure the power cord is 3-wire and is properly grounded.

6. Make all adjustments with the power source disconnected.

7. Never stand on a wet surface when operating a router.

8. Be sure the switch on the router is off before connecting it to the power source.

9. Always disconnect the router from the power source when inserting bits. The bit must be securely inserted in the chuck at least 1/2", and the base must be tight.

10. Always be certain the work piece is securely fastened and/or clamped so it will not move.

11. Place the router base on the work piece with the bit clear of the work before starting the router.

12. Always grip the router firmly with both hands.

13. Feed the router smoothly through cut. Do not force the router into the work and overload the motor.

14. When the cut is completed, shut off the motor. Do not lift the router from the work piece until the bit has stopped rotating.

15. When the work is completed, disconnect the router from the power source and remove the bit.

PORTABLE ELECTRIC DRILL

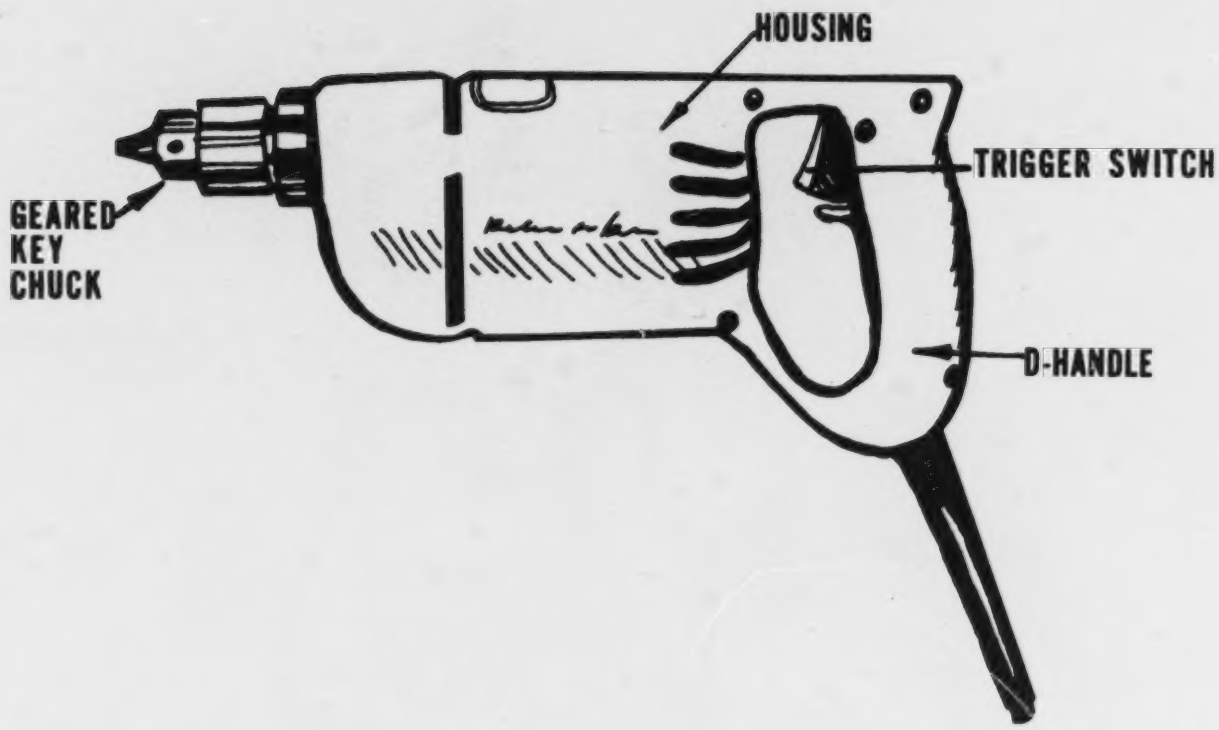

The portable electric drill is commonly used for drilling holes in wood, steel and other materials and for reaming, sanding, grinding, buffing and other jobs where the drill must be brought to the work.

Safety Precautions

1. Always wear safety glasses.

2. Obtain your instructor's permission to use the portable electric drill.

3. Never wear loose fitting clothing when using the portable electric drill.

4. Keep all guards and safety devices in place and in good working order.

5. Always check the power cord for condition, and be sure the power cord is 3-wire and is properly grounded.

6. Make all adjustments with the power disconnected.

7. Never operate an electric drill while standing on any wet surface.

8. Always be sure the switch is off before connecting the portable electric drill to the power source.

9. Seat the bit firmly and all the way in the chuck, and tighten it securely with the chuck key.

10. Always remove the chuck key from the chuck as soon as the bit has been tightened or loosened.

11. Be sure the stock to be drilled is securely fastened.

12. Start the drill and observe the bit to be sure it is properly fastened in the chuck and running true.

13. Always position the drill and bit on the work before starting the drill motor.

14. Hold the drill firmly in both hands to maintain the correct drill angle.

15. Never force the drill into the work. The amount of pressure needed will vary according to the bit size and the type of material being drilled.

16. Always remove the drill bit from the chuck as soon as the work is completed.

17. Never lay the drill down until the motor has completely stopped.

18. Never lock the trigger switch on when holding the drill with the hands and drilling holes.

PORTABLE DISK SANDER, POLISHER AND GRINDER

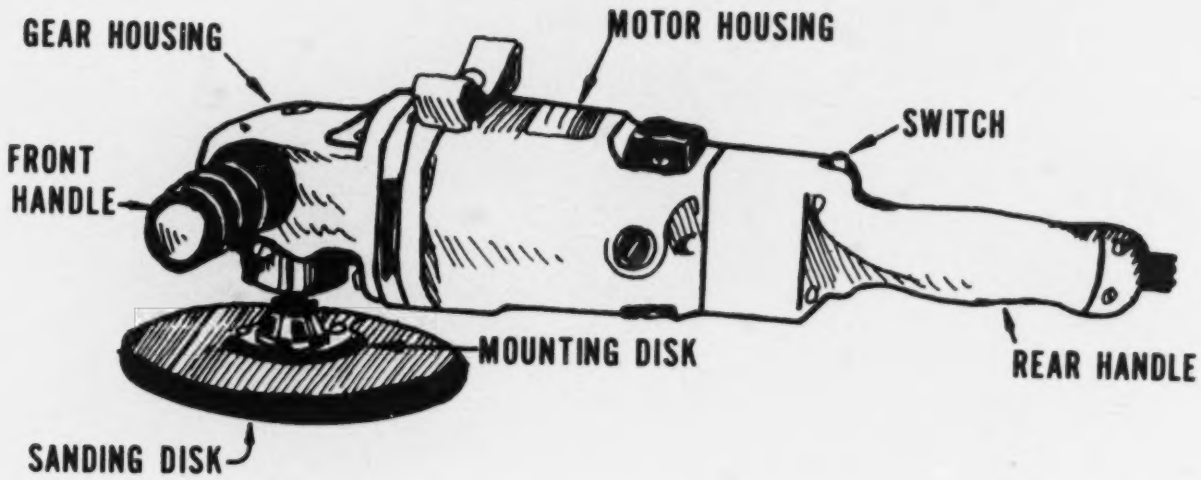

The portable disk sander, polisher and grinder is commonly used in shops for jobs too large to be brought to pedestal- or bench-mounted equipment. Wire wheels are also used on the portable grinder for cleaning and polishing of metals.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the portable grinder.
3. Never wear loose clothing when operating the portable grinder.
4. Keep all guards and safety devices in good working order and in place.
5. Check the cord for condition, and be sure the power cord is 3-wire and is properly grounded.
6. Make all adjustments with the power disconnected.
7. Never stand on a wet surface when using a portable grinder.
8. Be sure the switch is off before connecting to the power source.
9. Make sure the abrasive wheel or abrasive disk or wire wheel is tightened securely.
10. Never force the grinding wheel into the work.
11. Always use an abrasive wheel of the proper type and coarseness for the material being ground.
12. After mounting a new wheel, disk or brush, always allow it to run a few minutes to be certain it is properly mounted.
13. After shutting off the grinder, never stop the wheel by holding it against a work piece.
14. Always be certain the work area is clear so no one will be hit by flying chips or pieces.
15. When shutting off the portable grinder, always wait until the wheel, disk or brush stops rotating before setting the grinder down.
16. It is sometimes advisable to wear gloves, depending on the operation being performed, when using the portable grinder.

17. Always hold the grinder firmly in both hands when operating.

18. Always be certain the work piece is securely fastened before beginning the grinding, polishing or sanding operation.

ELECTRIC IMPACT WRENCH

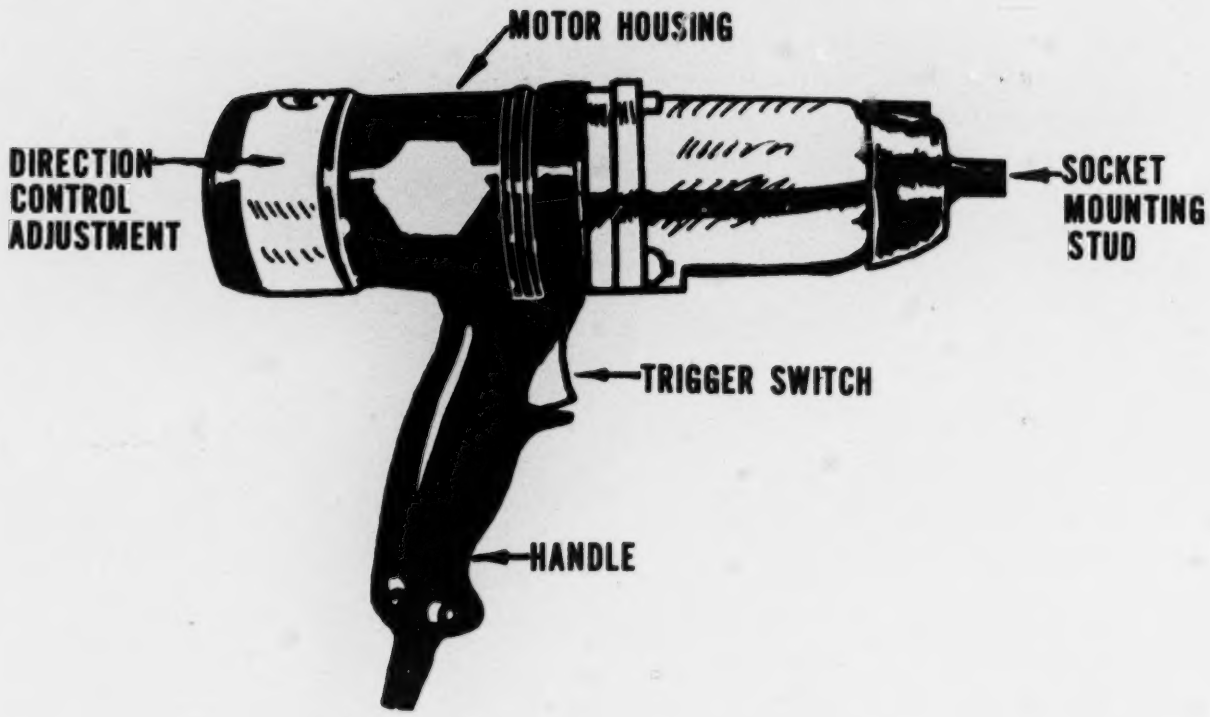

The electric impact wrench is commonly used in mechanics shops for removing or replacing larger sized nuts and bolts. The use of this tool greatly speeds up assembly and disassembly procedures.

Safety Precautions

1. Always wear safety glasses.
2. Obtain your instructor's permission to use the impact wrench.
3. Never wear loose clothing when operating the electric impact wrench.
4. Keep all guards and safety devices in good working order and in place.
5. Always check the power cord for condition, and be sure the power cord is 3-wire and is properly grounded.
6. Make all adjustments with the power disconnected.
7. Never stand on a wet surface when using an electric impact wrench.
8. Be sure the switch is off before connecting the wrench to the power source.
9. Always disconnect the impact wrench before placing a socket on it. Be certain to use only the sockets designed for use with this tool.
10. Be careful to hold the wrench firmly in both hands.
11. Never attempt to apply the socket to a nut or bolt head while the wrench is turning.
12. As soon as the nut or bolt has loosened, shut the wrench motor off.
13. Remove the socket from the wrench when the job is completed.
14. Allow the wrench to stop completely before laying it down.
15. Disconnect the wrench from the power source. Remove the socket and put the tool away when the job is completed.

PORTABLE AIR POWERED TOOLS

Many of the portable tools considered in the previous eight sections are also available with compressed air as the power source. The safety precautions would be generally the same for air powered tools as for the same electric powered tools, except for the items specifically related to electricity. There are, however, a few specific items which should be considered where compressed air is the power source.

Safety Precautions

1. Be certain the compressed air supplied to the tool does not exceed the limits specified by the manufacturer of the tool.

2. Always check the compressed air hose and connections to be certain the hose is in good condition and all connections are tight.

3. Keep the compressed air hose free from kinks and protect it from being pinched or run over.

4. Place the compressed air line so that no one will trip or otherwise become entangled in it.

5. Never allow horse play with compressed air lines.

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ABSTRACT - This teaching guide on agricultural shop safety is one of a 3-part unit for teaching shop and tool safety prepared by the South Carolina State Department of Education and Clemson University Agricultural Education Department. Designed to supplement the student manual, this guide and reference manual contains suggested demonstrations, general safety materials, and safety test questions and answers. Appended are suggested reference books, the South Carolina eye protection law, and a list of available films and filmstrips. Related documents available in this issue are the student manual, VT 012 638, and transparency masters, VT 012 637. (GB)

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AGRICULTURE SHOP SAFETY

TEACHER'S GUIDE

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STATE DEPARTMENT OF EDUCATION
Office of Vocational Education
Vocational Agricultural Section
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In Cooperation With

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Frank R. Stover
State Supervisor
Agricultural Education

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THE SAFETY UNIT

The unit for teaching shop and tool safety is composed of three parts:

1. A student reference manual
2. A teacher guide and reference manual
3. A set of transparencies

The student reference manual is intended for use by the student and contains materials for reading and study. Contained in it are specific safety rules for hand and power tools and specific study materials concerning general shop safety.

The teacher guide and reference manual is designed to supplement the student manual and in certain areas provide information for the teacher only. It contains some suggested demonstrations and other general safety materials for the instructor's information and review in preparation for teaching shop safety.

The transparencies are intended to help the teacher in the classroom presentation of safety instruction.

SUGGESTED TEACHING SEQUENCE

1. Review the material in the teacher guide and reference manual and in the student reference manual before beginning safety instruction with your class. Review the provided transparencies to familiarize yourself with the total teaching unit.

2. Review each tool and demonstrate the safe use of each item of equipment in your shop.

3. If desired, the students can be tested using the suggested test questions and/or the pictures of the various power tools with the labels removed.

INTRODUCTION

A major objective of every instructor must be to prepare his students to work safely in their chosen occupations. Mastery of the skills and knowledge of an occupation are very important, but not any more important than becoming safety-conscious and learning the safe way to do things.

Instruction in safety must be practical—not just preparing students to pass a course or an examination. Safety instruction must develop in the student a safety consciousness, which can be seen as an awareness that serves as a guide for the student's conduct in his life's activities whether they be on the job, in the home or at school. Safety awareness may be thought of and discussed as safety attitudes, and these can be learned in the shop. The results of safety instruction cannot be measured by the number of correctly answered questions on a test, but by the application of correct safety practices in the shop and other evidence of a proper safety awareness. Students must be safety-conscious and alert to dangerous situations. They must know how to prevent accidents, and also be able to apply basic fundamentals of first aid if an accident occurs.

Safety instruction must not be taken lightly. An organized safety unit must be taught early in the school year, preceding any instruction which involves use of tools or equipment that may be hazardous. Correct safety practices and procedures must be followed by the teacher in all activities and at all times, and they must be reviewed as the need arises.

Why teach shop safety? A few of the more important reasons for teaching safety in our agricultural mechanics shops are listed here; you can probably add many more.

The shop is an excellent place to teach a student safety and to help him develop safety consciousness.

A shop provides a good situation for the teacher to demonstrate and practice safe procedures and practices.

The many power tools and equipment used in our shops are dangerous when not used properly.

Improperly used hand tools can cause serious injury.

Many of our shop classes are large, and this situation can cause hazardous working conditions.

Some of the mechanics shops are too small, inadequately equipped and poorly lighted. These conditions demand cautious use of equipment.

And last but not least, anyone can have an accident, and these accidents can vary from very minor to fatal.

Safety instruction includes various practices and activities. These may be considered under two headings: General and Specific.

General Instruction—This might be called "safety management in the shop," and refers to safety policies, housekeeping, student conduct, student dress, fire prevention and control, color coding and zoning, first aid, lifting heavy weights, and electrical safety.

Specific Instruction—This refers to teaching and demonstrating the safe use of hand tools, power tools and equipment.

AGRICULTURAL MECHANICS SHOP SAFETY

Teacher Guide and Reference Manual

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SAFETY RESPONSIBILITIES

1. *The School Administrator*

The administrator's safety responsibilities include:

a. Promotion of a safety-conscious attitude in all phases of his school's operations.

b. Establishing a safety education program in all departments of his school.

c. The maintenance of safe working conditions, the safeguarding of equipment, and the elimination of health hazards in his school.

d. Insuring compliance with all local and state regulations pertaining to safety in school shops and laboratories.

e. Maintaining contact with the local, state and national agencies which provide safety services.

2. *The Teacher*

The local agricultural teacher is entirely responsible for everything that happens or takes place in the shop. He has the same responsibility in all activities related to the instructional program, whether they be at the school or in field work away from the school.

The teacher's basic safety responsibilities include:

a. Maintaining safe working conditions and practices in his class or laboratory.

b. Providing safety education for his students and encouraging student cooperation in all phases of safety.

c. Recommending needed safety improvements to the school's administrator.

d. Following the recommendations of administrators for the promotion of safe practices and safety education.

e. Keeping up to date on the latest safety practices in education and in industry.

f. Setting a good example for his students by personally observing all safety rules and practices.

3. *The Students*

All students have safety responsibilities, including:

a. Rendering the proper attention to safety instruction.

b. Obeying safety rules and observing safety practices at all times—at home, at school and at work.

c. Being watchful of fellow students in order to prevent their injury through unsafe actions.

d. Notifying the teacher of any unsafe conditions observed so that corrective action may be taken.

Safety—A part of the Teaching Program

Teaching safety is probably the most important phase of an instructional program in agricultural mechanics. We, as teachers, should be more interested in the student than in his learning a new skill. For example, sharpening a rotary mower blade is a fairly simple skill or job. However, in removing the blade, grinding and replacing the blade, the student can easily have an accident. The development of the safety attitude in the student during these job activities is of greater value than merely learning how to sharpen the blade.

Learning shop safety (safety attitude, safety consciousness) has several values for the student.

- He learns to properly use hand tools.
- He learns to safely operate dangerous power equipment.
- The safety attitude once learned will be of future benefit in hazardous occupations.
- Through example or demonstration, the student will teach others safety.

Planning and Organizing a Shop Safety Program

Teaching safety in the agricultural mechanics shop evolves around the three well-known decisions the teacher must first make when planning his educational program. These decisions are:

What to teach in the area of shop safety.

How to use the most effective methods of teaching.

When to teach safety.

The primary purpose of this publication is to answer the first two questions—what to teach and how to use the most effective

methods of teaching. Instruction and suggestions by experienced shop teachers are presented on what are considered the major needs or lessons in the farm shop.

Suggestions for methods of teaching these safety lessons are also included. The teacher should remember that telling is not teaching. For example, telling the student that the jointer is a dangerous piece of equipment is only the beginning or the introduction to the lesson. The student must see (by demonstration) that the jointer is a dangerous machine unless safety rules are observed. He must also see and understand that the jointer can be a safe machine if properly operated.

Some teachers may have to learn to be safety-conscious themselves before teaching this attitude to their students. Whether teaching a group or an individual, teachers should follow very closely the best safety practices in their demonstrations at all times. The example of the teacher will greatly influence the attitude of the student.

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TEACHER LIABILITY

This section contains information for the teacher and should not be included as part of the safety instruction program for the students.

1. *Introduction*

Complete coverage of all aspects of teacher liability for student injury is not possible in this brief publication. The infinite number of ways for students to sustain injuries and the varied conditions and situations possible in each case, preclude a quick and easy textbook establishment of responsibility for a given type of injury or circumstance.

This section does describe, in general terms, the liability of teachers for pupil injuries and the elements of proof of negligence which may lead to the liability of a teacher.

In preparation for the performance of his profession, the vocational teacher should familiarize himself with the legal aspects of school accidents and the manner in which he may be held liable.

2. *The School is Immune*

School districts and school boards in South Carolina claim "Common Law," or governmental immunity. Common law immunity, originating in England during the Middle Ages, is based on the principle that "The king can do no wrong." Today, this legal tradition is interpreted to mean a sovereign state can do no wrong and cannot be sued without its own consent. Following this principle, the school district (a division of the government) and the school board (an agency of the state) are immune to tort action. (Tort: "A wrongful act, not including a breach of contract or trust, which results in injury to another's person, property, reputation, or the like, and for which the injured party is entitled to compensation," Random House Dictionary of the English Language, 1966).

While the school district and the school board are immune to suit for damages, the teacher is not. In the case of an accident resulting from negligence, the individual directly responsible (perhaps the teacher) may be held personally liable. The fact that the teacher is employed by a governmental (state) agency does not provide him immunity. In an effort to clarify this point, the office of the Attorney General for South Carolina was contacted. The answer received can best be summed up in this paragraph quoted from the letter received from the Attorney General's office:

"There being no South Carolina Law on the subject, the only advice that can be given is that the teachers try to be as free from negligent conduct as possible. If there is no negligence on the teacher's part, there can be no liability, but if the teacher is negligent, there may be liability. What may constitute negligent conduct of teachers is again unanswerable as we have no cases."

The teacher's actions are governed by the common-law principle that charges every individual to act or use those things under his control to prevent injury to anyone else. A teacher is expected to practice the same degree of care and prudence that any other reasonable person would have practiced in the same or similar situation.

Legally, the teacher's relationship with his students is described by the Latin phrase, "in loco parentis" (in place of the parents). In situations related to the education of his students, society expects the teacher to exercise some of the rights and duties of the parents. The teacher is expected to use reasonable care in the performance of these duties, since students have been entrusted to him.

3. *Types of Accidents*

An accident generally results from an unsafe act or a physical or mechanical hazard. An accident which was unforeseeable, unavoidable and for which no one was to blame is called a "pure accident," and no damages are recoverable. On the other hand, proof of negligence on the part of the person directly responsible for the conditions under which the accident occurred may result in that person having to pay damages.

4. *Negligence*

Negligence, defined as "the failure to exercise due care," is the basic problem in establishing liability.

One may be judged liable if it can be shown that the injuries to another were the direct result of improper actions on the part of the defendant. The teacher cannot be held at fault in cases where his own actions had no reasonable connection with the injury. Conscientious, continuous safety education and safe practices by the teacher, along with student cooperation and participation, are the keys to the avoidance of liability cases.

Specific areas in which the teacher must definitely assume and accept responsibility, thereby reducing the possibility of being negligent, include the following:

a. Supervision—A teacher who leaves a class unsupervised might be judged negligent if a student's injury results from lack of supervision. If called away from the shop, the teacher must stop and lock all power machinery.

b. Machine Guards—The school must provide adequate guards, and the teacher must insure they are used. The teacher allowing the use of unguarded machinery is negligent.

c. Eye Protection—The public schools of South Carolina are required by law to furnish protective eye devices to students and teachers participating in specified vocational and industrial arts laboratories. The teacher is responsible for having his students wear these protective devices.

d. Physical Facilities—The teacher must insure that the working area is safe and that tools and equipment are handled safely. Included in this category are housekeeping and the use of safety clothing.

e. First Aid—Teachers may be negligent in their actions, or failure to act, in the case of an accidental injury. The teacher is expected to do the best he can for the student in case of injury. Teachers should not attempt to go beyond normally accepted first aid procedures. First aid is the care rendered until a physician is obtained. The teacher should have a knowledge of first aid, and first aid equipment should be readily available in the shop. Know your local regulations concerning application of first aid.

f. Permission Slips—Parental releases, or permission slips, may be useful to inform parents of the activities in which their children will participate. These same slips may have a degree of value in causing the students to be more conscious of their actions. The teacher must keep in mind that permission slips do not, in any way, relieve him of his "in loco parentis" responsibility of the teacher for the safety of a student.

g. Liability Insurance—The wise vocational teacher will investigate and select some form of liability insurance, either on an individual or a group basis. Group liability insurance is usually sponsored by educational or professional associations. One example of such coverage is that available to members of the American Vocational Association. Additional information may be obtained from:

American Vocational Association, Inc.
1025 Fifteenth Street, N.W.
Washington, D. C. 20005

5. *Additional Information*

The following publications are highly recommended for additional information on teacher liability:

Kigin, Denis J., Teacher Liability in School-Shop Accidents. Ann Arbor, Michigan: Prakken Publications, Inc., 1963.

Williams, William A., Accident Prevention Manual for Shop Teachers. Chicago: American Technical Society, 1963.

THE PREVENTABLE ACCIDENT

Just what causes an accident? Do all accidents contain some similar factors? If certain factors are present in all accidents, can the elimination of these factors lead to possible prevention of future accidents?

In his book, Industrial Accident Prevention, H. W. Heinrich[1] says that "A preventable accident is one of the five factors in a sequence that results in an injury. The injury is invariably caused by an accident and the accident in turn is always the result of the factor which immediately preceded it. In accident prevention, the bull's eye of the target is in the middle of the sequence—an unsafe act of a person, or a mechanical or physical hazard. The several factors in the accident-occurrence series are given in chronological order in the following list:

"1. Ancestry and social environment
"2. Fault of person
"3. Unsafe act and/or mechanical or physical hazard
"4. The accident
"5. The injury

"The occurrence of a preventable injury is the natural culmination of a series of events or circumstances which invariably occur in a fixed and logical order. One is dependent on the other and one follows because of another, thus making a sequence that may be compared to a row of dominoes placed on end and in such alignment in relation to one another that the fall of the first domino causes the fall of the entire row. An accident is merely one factor in the sequence."

Let's briefly discuss and identify the factors in the accident sequence.

1. Ancestry and Social Environment. We all have probably inherited some personal characteristics that may contribute to an accident. These characteristics might include such things as poor eyesight, bad hearing, or a tendency to be nervous.

Our environment may have caused us to develop habits or behavior patterns that may contribute to accidents. Examples of these might be our tendencies to make and accept dares, show off, and take chances.

We must keep in mind that each of us is a product of our heredity and environment, and that these traits may play a part in an accident.

2. Fault of Person. Personal faults or shortcomings that may contribute to accidents include:

a. A lack of knowledge or skill related to what you are trying to do.

b. Being physically unsuited for the job, such as having poor hearing or vision, being the improper age or height, having allergies, faulty reaction time, and illness or a physical handicap.

c. Improper attitudes, such as willfully disregarding danger, resenting authority, not following instructions properly, being overconfident, getting angry, being over-tired, participating in horseplay, being distracted or hurrying unnecessarily. Personal faults may also result from improper instruction and supervision.

3. Unsafe Act and/or Mechanical or Physical Hazard. An "unsafe act," according to the National Safety Council, is "A violation of a commonly accepted safe practice." Examples of such unsafe acts include:

a. Operating equipment without permission.

b. Operating or working at unsafe speeds (too slow or too fast).

c. Removing or disconnecting safety devices and guards.

d. Using unsafe equipment.

e. Working on moving or dangerous equipment.

f. Horseplay.

g. Failure to use safety clothing or personal protective devices such as respirators, goggles, helmets and gloves.

A mechanical or physical hazard is a condition which could have been guarded, corrected or eliminated. Hazardous conditions are present in machines, vehicles, electrical equipment, hand tools, dusts, radiation, and on working surfaces, such as floors, ramps, roads, shelves and stairs. Specific examples of hazards include unguarded or poorly guarded machinery, insufficient light or ventilation and unsafe clothing.

The combination of an unsafe act and a mechanical or physical hazard results in an accident.

4. The Accident. An accident is an unplanned and uncontrolled event in which an action or reaction of either an object, a person or a substance results in personal injury, or the probability of personal injury. Many accidents

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[1]Herbert W. Heinrich, Industrial Accident Prevention (New York: McGraw-Hill Book Company, 1959), pp. 14-15.

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do not cause injury, but the probability of injury is always present. We don't want to have accidents just so we can see how close we can come to being injured!

5. The Injury. The injury is the damage, hurt or suffering resulting from the accident. Injury may not always be personal, physical pain. Injury can also occur as a loss in pay for being out of work, the loss in damaged equipment or material spoiled, or the loss of time needed to meet a schedule.

Now we have analyzed the accident sequence—

1. Ancestry and social environment
2. Fault of person
3. Unsafe act and/or mechanical or physical hazard
4. The accident
5. The injury

These events occur in a chain reaction—like a row of falling dominoes.

Notice that the removal of the third domino, the unsafe act or hazard, prevents the occurrence of the accident and the injury. The major objectives of safety education are:

1. To teach you to recognize and respect unsafe acts and hazards.
2. To teach you how to avoid injury to yourself and to others by knowing what to do about unsafe acts and hazards.

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DEMONSTRATION FOR THE PREVENTABLE ACCIDENT

1. Prepare five wooden blocks, 1" x 2" x 4". These may be painted black with white spots to resemble dominoes. The edges of the blocks should be labeled as follows:

   a. Ancestry and social environment
   b. Fault of person
   c. Unsafe act
   d. The accident
   e. The injury

2. Prepare a sheet metal frame, U-shaped, about 14 inches long, with slots every 3 inches.

3. Place wood screws in base of edges of previously prepared wooden blocks and leave screw so head is about 1/8 inch from wood.

4. Place blocks in the metal tray so that screw heads are in slots in side of tray. Place them in the order (a) through (e) in 1. above and so the students can read the labels on the edge.

5. Push block (a), Ancestry and social environment, and note how each block causes the next to fall—the accident sequence.

6. Remove block (c), Unsafe act, and push block (a) again and note that if the unsafe act is removed the sequence is broken and the last two remain standing.

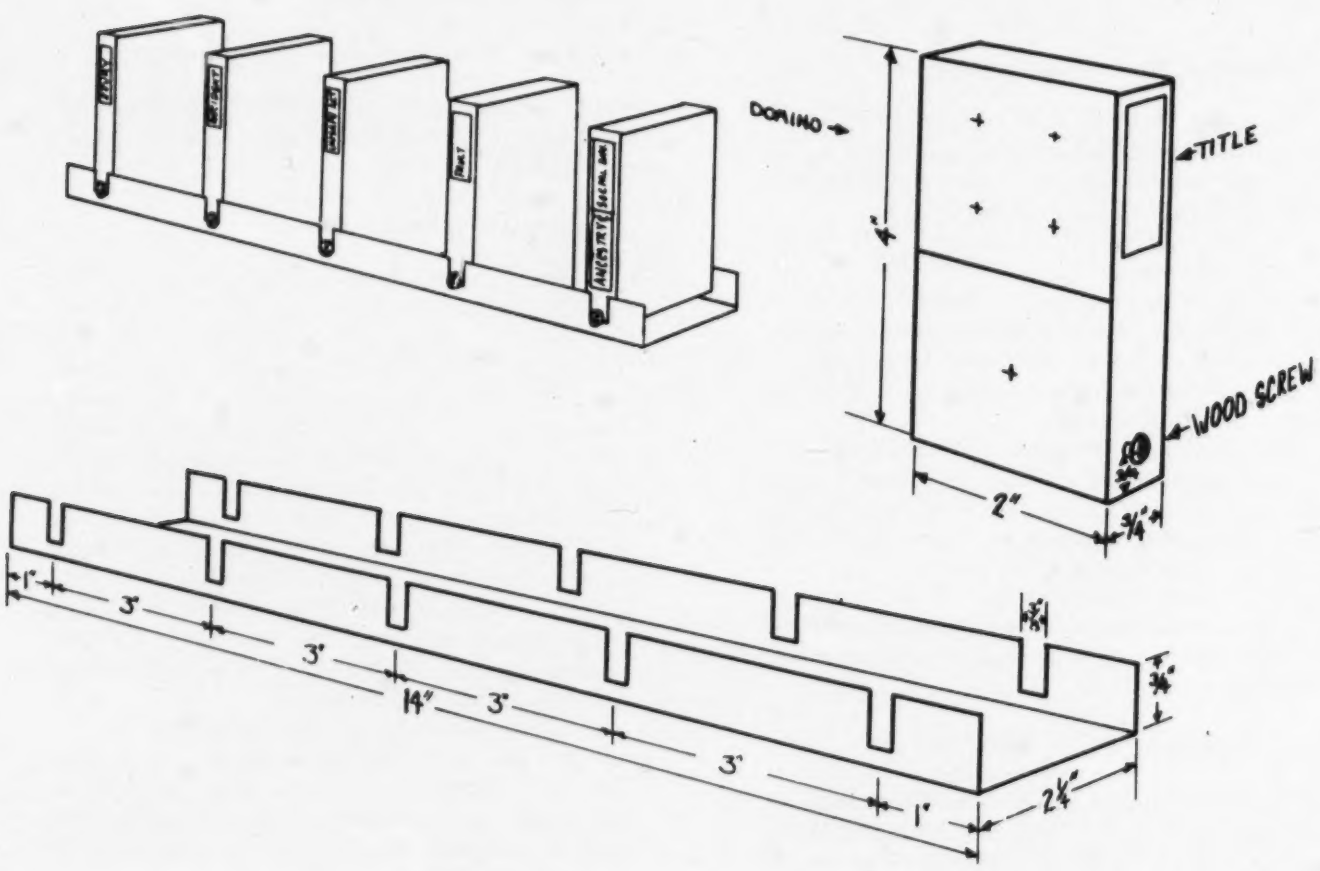

SHOP AND LAB SAFETY

1. *General Recommendations*

   a. Insure that students know fundamentals of first aid and procedures to follow in case of fire.

   b. Promote safety at all times.

   c. Require active student participation in safety activities.

   d. Use color coding on machines and hazard strips on floors. Teach students the meaning and importance of such codes.

2. *Color Coding for Safety*

A summary of the industrial color codes developed by the American Standards Association for industrial use is presented in the student reference manual.

3. *Protective Clothing and Equipment*

Protective clothing and equipment will not prevent accidents and injuries; but when properly used, such items may serve to lessen the resulting degree of damage or injury.

The wise and proper use of protective clothing and equipment by students will be the result of good personal safety habits inspired by the teacher. The student must be taught to prepare himself to enter the school shop or lab safely so that, in future years, he will be a safety-conscious worker.

The teacher might start by "checking" the personal appearance of class members before beginning lab work. This checking should consist of reminding everyone to have his sleeves rolled up, rings and watches placed in pockets, and ties tucked in or removed. As soon as students know the routine, develop class participation through the use of a "safety inspector" or a "buddy system."

a. Eye Protection

The requirements for eye protection and the minimum quality standards of safety glasses are specified by the South Carolina Eye Protection Act, reproduced in its entirety in the Appendix of this publication. Of special importance to administrators and teachers is the requirement to provide visitors to the shop with eye protection. All areas requiring eye protection should be marked by signs, such as "Eye Protection Required Beyond This Point." Mounting the storage rack for both students' and visitors' safety glasses near the shop entrance is recommended.

Eye protection equipment may be disinfected by thorough cleaning with soap and warm water, or by a complete immersion in a "Lysol" solution. Commercially available storage cabinets include one type which has ultraviolet lamps that come on when the cabinet doors are closed, for the purpose of sanitizing safety glasses.

b. Head and Ear Protection

Although head and ear injuries are not very common in school shops, "hard" hats are highly recommended for programs such as building construction, where there is a possibility of being struck by a falling object. Again, providing for the safety and protection of visitors is recommended.

c. Hand, Foot and Leg Protection

The majority of all disabling injuries occur to hands, legs and feet. Finger injuries are the most frequent.

d. Respiratory Equipment

Filter respirators are available for protection against various types of dust, mists and fumes. Extreme care must be exercised when selecting filters, as a false sense of security can be generated by a filter not appropriate to the hazard present. Before selecting filters, carefully evaluate the hazards present, the exposure conditions and the characteristics of available filters. An additional factor will be the need for periodically cleaning and sanitizing the filters. A very important point for the teacher to emphasize is that a filter may remove dusts and some fumes, but may not be capable of protecting the user from carbon monoxide or carbon tetrachloride fumes at all.

(Additional point: Carbon tetrachloride, formerly used as a cleaning agent and as a filler for fire extinguishers, should never be used for anything! Less toxic agents are available. Carbon tetrachloride is no longer recommended as a cleaning agent.)

e. Body Protection

Shop coats, aprons and coveralls should be used as appropriate in shops and labs. Aprons should be tied securely to prevent getting caught in machinery.

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4. *Fire Safety and Fire Extinguishers*

General information concerning fire extinguishers and fire safety is presented in the student reference manual.

5. *Electrical Safety*

Electrical equipment is found in nearly every vocational subject area. Students should be taught the dangers present in electrical equipment and wiring and how to protect themselves and others from injury.

a. General Electrical Safety

(1) Install all electrical wiring in compliance with the National Electrical Code.

(2) Never use temporary wiring. All extension cords for tools and appliances should be 3-wire parallel ground with grounding lug plugs.

(3) Teach students to assume that all electrical equipment and wiring is "alive" and must be treated as such.

(4) Students should be taught the importance of safety interlocks and the dangers of by-passing electrical safety devices, such as circuit breakers.

(5) Never work on electrical equipment alone—always have someone else nearby.

(6) While working on electrical equipment, stand on rubber mats or wooden floors.

b. Rescue from Electrical Shock

A person may receive an electrical shock by touching a bare wire, an exposed socket or a faulty electrical tool or appliance. Shock hazards also exist inside various types of electronic equipment and around power lines. The possibility of shock is greatly increased if the person is also in contact with a grounded surface, or if the floor or his body is wet.

(1) If possible, shut off the current quickly.

(2) If the current cannot be shut off promptly, attempt to move the victim away from the conductor, using some sort of insulated material.

(3) Do not touch the victim until electrical contact is broken. Use a wooden pole, such as a broom handle, to separate the victim and the conductor. A large cloth, such as a coat, may also be used.

(4) A live conductor may cling to the victim, making it necessary to pull him (or the conductor) quite a distance away.

(5) If the victim is not breathing after he has been removed from contact with the conductor, give him artificial respiration.

6. *First Aid*

First aid is the immediate care given to an injured or sick person until the service of a physician can be obtained.

Teachers of vocational subjects should be qualified to administer first aid. The shop should be equipped with a good general first aid kit containing bandages, gauze, cotton, tape, gauze pads, band-aids, eye pads, triangular bandages, tourniquet, ammonia, cotton buds, splints, measuring cups, scissors, tweezers, antiseptic cream and a first aid guide booklet.

The first aid program of the American National Red Cross provides for the training and certification of both instructors and students in first aid procedures. The Red Cross also publishes instructors' and students' handbooks. For additional information on first aid training and certification, contact your local Red Cross chapter.

A complete coverage of all first aid procedures is not possible in this brief publication. A summary of recommended first aid procedures covering those situations most likely to be encountered in the agricultural mechanics shop is included in the student reference manual.

7. *Lifting Heavy Weights*

Proper lifting is a skill. Attaining this skill could prevent sprains, back injuries and ruptures. High school age boys are prone to demonstrate their strength to each other, not realizing the safe limits of their muscle ability. They must have demonstrated to them that unwise muscular activities may cause life-long injury to their backs.

To lift an object, place feet eight to twelve inches apart, keep the feet close to the object that is being lifted—this will keep the back muscles from having to lift all the load. Bend Knees outward and keep the back straight. Lift the object by pushing up with the legs. Keep the object close to the body.

To turn with the object lifted, shift the feet in the direction of travel. Never twist the body.

To place object on floor, reverse the lifting procedure; keep back straight, lower load by bending knees, be sure blocks are on floor so the fingers will not be mashed or pinched.

Demonstration: Why is the back subject to injury? With 10 or 12 one inch square blocks stacked on top of each other, show how little force is needed to push them over. Now place a five pound block of lead on top of the blocks. Relate the blocks to the vertebra of the backbone. Have several sets of blocks so each student may perform the experiment.

The correct lifting procedure: Lift a 15 or 20 pound block of concrete using the correct procedure. Point out to the class the parts of the body doing the work and the position of the vertebra. Provide a light object, such as an empty cardboard carton. Lift this incorrectly, point out the position of the vertebra, and contrast the parts of the body doing the work. (Position for incorrect lifting: legs straight, feet away from object and back arched over the object.)

Have each student lift heavy object correctly several times.

Objects too heavy: Caution students that it is better to ask for help with lifting heavy loads than to risk an injury.

Using a slab of concrete that weighs about 100 pounds, have the student make a reasonable effort to slide it on a concrete floor. Then place several pieces of pipe between the slab and the floor. Now it rolls very easily. Be certain to keep at least two pieces of pipe evenly spaced under the slab at all times. Let each student take his turn.

Objects that are large or bulky but light: Be sure you can see where you are walking when carrying these loads. Even if they are light in weight, you may need help to see ahead. This is especially important when going up or down steps and around cluttered areas.

Demonstrate with a large cardboard container carried by one person, and contrast with two persons carrying the container. Emphasize that sight, not weight, is important here.

Reference: M. O'Brien, Shopwork Teaching Tricks (Interstate Publishers, Danville, Ill., 1956).

8. *Housekeeping in the Shop*

A clean, well-kept shop would involve the following:

- Storing tools in their proper places after use.
- Storing all lumber and other items after use.
- The proper storage of inflammable materials.
- Storing finished and unfinished shop projects.
- Turning off electrical switches and lights after work.
- Removing all waste materials (sawdust, shavings, metals, etc.) daily.
- Sweeping floors after use.
- Cleaning floors of any grease, oil, acid and water.
- Encouraging students and farmers to remove completed projects from shop immediately.
- Seeing that the shop is kept in good working condition at all times. Some materials should be moved immediately rather than waiting until the end of the shop period. Avoid letting the shop become a dumping place for the school.
- Placing scrap stock in properly marked boxes.
- Cleaning equipment and tools after use.
- Cleaning electric lights monthly.
- Washing windows once each month.
- Cleaning shop walls and ceiling once each year.

Suggestions for Teaching:

a. List with class the daily jobs to be done to have a clean and orderly shop.

b. Have class clean and arrange shop as it should be kept in the future.

c. Discuss and decide on tool storage: (1) system used; (2) individual responsibility; (3) reporting defection of tools.

d. Delegate responsibilities by classes.

e. Discuss possibility of using check sheet after shop period.

9. *Shop Safety Policies*

For the shop to be a safe place for work, certain safety policies (rules and regulations) must be followed by all. This includes the

teacher, students and farmers. Reading this list of shop safety policies and posting them on the walls will not result in their being followed. These policies—the purpose, the need and the adoption of such—must be developed with the classes that will use the shop. The students must understand the necessity of having such regulations and be willing to abide by them.

a. Disconnect power equipment when not in use.

b. Safety glasses, goggles or face shields must be used at all times.

c. Shop classes must be supervised at all times.

d. Students must not operate equipment without teacher's permission.

e. Defective and faulty machines and equipment should not be operated; label machines not safe to use.

f. All machines should have proper guards whether in use or not.

g. All machines must be stopped (shut off) before lubricating or adjusting.

h. No one should stand in line with a revolving wheel or tool.

i. No conversation is allowed between machine operator and student.

j. All hand tools must be sharp and in safe condition before use.

k. Each student should be responsible for the proper storage of tools, supplies, etc. that he is using.

l. Any oil or grease on floors must be removed immediately.

m. Power machines should not be used for trivial operations; use hand tools.

n. All welding must be done in booths or behind protective screens.

o. All power machines should be allowed to stop by themselves after electricity is cut off. Stay with the machine until it stops.

p. Never throw a tool or piece of material to anyone.

q. Loose fitting clothing and long neck ties will not be worn in shop. (Encourage the wearing of coveralls.)

r. Files and similar tools should not be used without handles.

s. All students should know how to use fire extinguishers, which should be conveniently located.

t. All lumber should be inspected for loose knots, splits, and nails before running it through machines.

u. Have electrical motors and equipment inspected for wiring, fusing and grounding.

v. Shop must be kept clean and orderly at all times.

w. Safety inspection of shop will be made monthly.

x. Post and observe fire regulations.

y. Gasoline should not be stored in the shop; keep other inflammables in red containers.

Suggestions for Teaching:

(1) Take group or class into the shop.

(2) Develop the need for establishing and abiding by policies.

(3) Have the class gather around a power tool.

(4) Question the class as to needed safety rules for this piece of equipment.

(5) Follow a similar method for developing and adopting the remaining policies.

(6) Type several copies of the adopted policies.

(7) Review the policies with the class.

(8) Observe and check shop activities to see that policies are followed.

POWER TOOLS

TEACHER DEMONSTRATIONS: GENERAL SUGGESTIONS

The demonstrations presented here are suggested as general guide lines for the teacher in presenting demonstrations on the safe use of the various power tools. Specific safety precautions for each tool are presented in the student reference manual. During these demonstrations the teacher should emphasize all safety aspects as they relate to specific pieces of equipment and to general shop work. At all times the teacher should have with him and be familiar with the operator's manual for the specific tool in his shop. The tools vary somewhat from manufacturer to manufacturer, so specific procedural steps may differ from tool to tool. The demonstration should provide the instructor with the opportunity to demonstrate all safety features of and practices to be used with the specific tool.

The instructor must be thoroughly familiar with the specific tool, its features and its safe use. Previous preparation and parctice will make these demonstrations much more meaningful and valuable to the student. The use of student cooperation can sometimes be very helpful in these demonstrations. Students can read specific instructions, answer questions and help hold or support large work pieces where required.

To help the instructor prepare for and give these demonstrations, a few specific suggestions follow:

1. Prepare beforehand; assemble all needed materials, equipment and references. Be sure to practice the entire demonstration before presenting it to the class.

2. Wear safety glasses at all times. This is a state law, so protect yourself. Present a good image by wearing an approved type of eye protective device at all times. Students must be required to wear approved eye protective devices at all times.

3. Dress properly for shop work at all times.

   a. Remove all rings, watches and other jewelry.

   b. Roll up or otherwise fasten sleeves.

   c. Remove or otherwise secure your tie.

   d. As required for the job to be done, wear a properly fitted shop coat or coveralls.

   Present yourself, the instructor, as an example of the proper way to dress and protect yourself when performing work in the agricultural mechanics shop. For further information, refer to the section entitled, "Protective Clothing and Equipment," in the student manual.

4. Situate or locate the class so that all students can observe the demonstration. Be certain that all students are not in a danger area so that if something should happen none of them will be hit by flying objects, either work pieces or broken pieces of material. All students should be properly dressed for shop work with safety glasses and proper clothing.

5. Perform the demonstration.

6. After completing the demonstration, hold a class discussion concerning the proper and safe use of the specific tool under consideration. Question students and otherwise encourage a thorough examination of the procedures just demonstrated. Help students find answers to all of their questions. Finally, if required, repeat the entire demonstration.

7. After the demonstration and discussion, have the students repeat the procedure under your supervision. Watch them carefully and correct any student errors as they occur. After each student or group of students have finished, again hold class discussions or critiques concerning the students' procedures or methods. Assist the students in determining the answers to their questions.

8. A list of questions concerning the safe use of the specific piece of equipment is presented following this section. This can be used for a short quiz on each tool or as a general safety test.

ONE: USING THE JOINTER

Materials:

Jointer in good condition
Safety glasses
1" x 4" x 24" work piece
Operator's manual for jointer
List of safety practices

Procedure:

1. Check the stock for loose knots, nails and other defects.

2. With power off, check jointer blades for sharpness and adjustment according to the operator's manual.

3. Set front table to the desired depth of cut (about 1/8" for rough cut and 1/16" for finish cut).

4. Lock the fence in the desired position. Turn on the switch or power.

5. Place edge of stock on front table, and apply downward and sideward pressure on stock to hold it firmly against table and fence.

6. Start the stock through. Hold it down on the front table until the leading edge has passed the cutter head, then move the left hand beyond the cutter head. Maintain the downward and sideward pressure at all times. Continue feeding the stock, using the right hand.

7. Shut off jointer and wait until cutter head stops.

TWO: USING THE PLANER

Materials:

Planer in good condition
Blade guage and wrenches for knife adjustment
Stock 1" x 6" x 5', several pieces free of defects
Operator's manual for planer
List of safety practices

Procedure:

1. Check stock for loose knots, nails and other defects.

2. With power off, check planer blades for sharpness and proper adjustment according to the operator's manual.

3. Adjust table to proper thickness of stock to be surfaced.

4. Start the planer, begin feeding stock and engage clutch.

5. Use gloves if rough stock is being planed.

6. Let stock go free after the in-feed end has passed the rear table feed rolls.

7. When planing long stock, a roller support should be used to support the stock on the in-feed and out-feed side of the planer. Short stock may be supported by hand.

8. When stock exits from the machine, shut the planer off and wait until the machine stops completely.

THREE: USING THE TABLE SAW

Materials:

Table saw in good condition
Sharp blade properly set
Rule or square
Stock 1" x 12" x 5' (Several pieces)
Push stick
Operator's manual for table saw
List of safety practices

Procedure:

1. Check the stock for knots, nails and other defects.
2. With power off, check blade for sharpness, set and tightness on arbor, using the operator's manual.
3. Adjust blade so that it projects about 1/8"-1/4" above the stock to be cut, and lock the handwheel.
4. Set the rip fence to the desired width, and lock both the front and rear rip fence clamps. Check setting with ruler.
5. Lower the guard and make sure the anti-kickback device is in place.
6. Select jointed or straight edge of stock, and place this edge against the fence.
7. Start the table saw.
8. Feed the stock gently into the saw.
9. Push the stock through completely and allow it to drop, or have an assistant on the opposite side of the saw receive it.
10. Use a push stick to cut narrow stock.
11. Shut off the table saw, and wait until it comes to a complete stop.

FOUR: USING THE RADIAL ARM SAW

Materials:

Radial arm saw in good condition
Sharp blade for saw properly set
1" x 4" x 4' (several pieces)
Operator's manual for the radial arm saw
List of safety practices

Procedure:

1. Check stock for knots, nails, and other defects.
2. With the power off check blade for sharpness, set and tightness according to the operator's manual.
3. Set up radial arm saw for cross-cutting operation; check squareness of blade with fence, using a framing or try square, and check that saw blade will not cut into the table.
4. Start radial arm saw and be sure blade is rotating downward before making cut.
5. Firmly hold the stock against the fence.
6. Stiffen your arm and pull the saw very slowly through the stock.
7. Push saw back and shut it off; do not leave the area until the saw blade has stopped rotating.
8. Set the stop, if there is one on the saw, to prevent the saw from rolling forward or accidently being pulled forward.

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FIVE: USING THE BAND SAW

Materials:

Band saw in good condition
Proper size blade for diameter of circle to be cut
A circle cutting jig if available
1" x 10" x 12" wood or plywood (several pieces)
Operator's manual for the band saw
List of safety practices for the band saw

Procedure:

1. Check the stock for knots, nails and other defects.

2. With the power off check the blade for width, sharpness, set and general condition, and for adjustment according to the operator's manual.

3. Adjust lower blade guard so that it clears the work piece by 1/8"-1/4".

4. If jig is available, set it up for size of circle desired. If no jig is available, mark the circle desired; be sure the minimum radius is not too small for the blade being used.

5. Start the saw; stand directly behind the line of cut, if possible.

6. Feed the work piece slowly through with the right hand, and guide it with the left.

7. Complete the cut, shut off band saw, and wait until the blade stops completely. (Use the brake, if available.)

SIX: USING THE JIG SAW

Materials:

Jig saw in good condition
Proper blade for materials to be cut
Work piece already marked
Operator's manual for the jig saw
List of safety practices

Procedure:

1. Check the stock for knots and other defects.

2. With the power off, check the jig saw for blade tension and clearance; roll over by hand to check all adjustments and clearance.

3. Adjust the hold down so that stock will not be lifted up during the cutting operation.

4. Start the saw and begin feeding the work piece slowly into the saw. Do not force the work piece, and be certain your fingers are not in the direct line of the cut.

5. Complete the cut. Always stress safety.

6. Shut off the saw, and wait until it stops completely.

SEVEN: USING THE DRILL PRESS

Materials:

Drill press in good condition
Correct drill bit for material being drilled
Work piece
Correct vise or clamp for work piece
Operator's manual for the drill press
List of safety precautions

Procedure:

1. With power off, set up drill press for the job to be done. Insert drill bit and tighten with chuck key. Remove chuck key.

2. Adjust drill table to proper height with the drill bit in line with the center hole in the table and set the depth stop.

3. Set work piece under drill bit, and fasten securely with a vise or clamp.

4. Start the drill and cautiously lower the drill bit through the work piece.

5. Raise drill bit slowly from the work piece after the hole has been completed.

6. Shut off drill press and wait until it has completely stopped before leaving the machine.

EIGHT: USING THE DISK SANDER

Materials:

Disk sander in good condition
Abrasive disk of proper coarseness for the job
Work piece to be shaped
Operator's manual for the disk sander
List of safety practices

Procedure:

1. With the power off, check the abrasive disk and the sander for proper adjustment and setup.

2. Set the table up for the job to be done.

3. Start the sander and slowly feed the work into the side of the disk which is rotating downward toward the table. On this surface, move and position the work piece to complete the job selected. Keep fingers at least 2 inches from the disk.

4. After completing the job, shut off the sander and wait until the sander disk stops completely.

NINE: USING THE BELT SANDER

Materials:

Belt sander in good condition
Abrasive belt of correct coarseness for the job
Work piece to be sanded
Pad or push stick
Operator's manual for the belt sander
List of safety practices

Procedure:

1. With the power off, check the abrasive belt and the sander for proper adjustment and setup.

2. Start the sander and watch to make sure the belt tracks properly. Adjust it, if required.

3. Begin sanding the work piece, using the pad or push stick if needed. Always keep hands as far away from the abrasive belt as possible.

4. After completing the sanding job, shut off the sander and wait until the belt stops completely.

TEN: USING THE WOOD LATHE

Materials:

Wood lathe in good condition
Lathe tools in good condition
Properly prepared work piece, marked for centers
Operator's manual for the wood lathe
List of safety practices

Procedure:

1. Check the wood lathe for proper set up and adjustment for the job to be done.

2. Properly center the work piece and firmly secure it in the lathe.

3. Adjust the tool rest so that it clears the side of the work piece by about 1/8", and lock the tool rest support to the lathe bed. Keep the tool rest adjusted so the cutting action is above the center of the work piece. Be sure work piece will clear tool rest. Rotate by hand before starting the lathe.

4. Adjust speed of lathe for size of stock.

5. Select the proper tool for the job.

6. Hold the chisel properly in both hands, standing slightly to one side of the cut; and beginning at left end of work piece, take small cuts.

7. Continue the cutting until stock is the proper or desired size and shape; at all times keep tool rest adjusted to about 1/8" clearance of work piece. Stop the lathe to make all adjustments and measurements.

8. Shut off the lathe and wait until it stops before leaving the area.

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ELEVEN: USING THE POWER HACKSAW

Materials:

Power hacksaw in good condition
Stock to be cut
Operator's manual for the power hacksaw
List of safety practices for the power hacksaw

Procedure:

1. With the power off, check the blade for sharpness, set and tension according to the operator's manual.

2. Secure the stock to be cut in the vise. Be sure stock is properly placed in vise.

3. Start hacksaw and gently lower blade to stock being cut. Set speed of feed for proper speed. This is determined by the hardness of materials being cut.

4. After cut is completed, shut off saw. If it does not have an automatic stop, allow saw to stop completely; then raise blade to highest position before leaving the saw.

TWELVE: USING THE GRINDER

Materials:

A grinder in good condition
Grinding wheel dresser
Wrench to adjust tool rest
Chisel with mushroomed end
Operator's manual for grinder
List of safety practices

Procedure:

1. Check the grinder for proper guard and tool rest adjustment, and check grinding wheel for trueness. Dress, if needed.

2. Start the grinder and allow it to reach operating speed before beginning to grind the chisel.

3. Position the chisel on the tool rest, holding it firmly. Without applying excessive pressure, begin grinding and slowly rotate the chisel until it is properly ground.

4. Remove chisel from grinding wheel. Shut off grinder and wait until the wheel completely stops before leaving the area. Never grind on a wheel coasting to a stop.

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THIRTEEN: USING THE ENGINE LATHE

Materials:

Engine lathe in good condition
Proper tools and holding devices
Work piece
Operator's manual for the engine lathe
List of safety practices

Procedure:

1. Check the lathe for proper adjustment and proper speed for the job to be done.

2. Mark, center punch and drill work piece to be turned.

3. Using the face plate and lathe dog, mount the work piece on the lathe centers. Be sure dog is fastened securely and tail stock is locked in place.

4. Turn set up by hand to be sure it has sufficient clearance and does not bind.

5. Using proper tool and tool holder, set up tool post. Tool should cut on the center line of the stock.

6. Turn on lathe and slowly feed tool into the work until the desired depth of cut is reached, then engage automatic feed. Be certain to stop feed before the tool engages or hits the lathe dog.

7. Back out the cutting tool, shut off the lathe, and wait until it completely stops before leaving the area.

FOURTEEN: USING THE OXYACETYLENE WELDER

Materials:

Oxyacetylene welding equipment in good condition
Welding tip
Welding goggles
Gloves
Flint lighter
Operator's manual for the welding equipment
List of safety practices

Procedure:

1. Wear welding goggles, gloves and be sure clothing is not loose or grease soaked. Present yourself as an example of the proper way to dress when using oxyacetylene welding equipment.

2. Turn on gas, acetylene only one turn, oxygen all the way.

3. Check all hoses and connections for leaks.

4. Adjust oxygen and acetylene regulators to the proper pressure for the tip selected for this demonstration. (See operator's manual.)

5. On the torch, open acetylene valve about 1/8 of a turn. Using the flint lighter with the torch pointed away from your body and not toward anyone, light the torch.

6. Open the acetylene valve until the flame no longer smokes or until the flame almost leaves the tip.

7. Open oxygen valve until a neutral flame is produced.

8. Shut off acetylene valve first, then oxygen valve on the torch.

9. Shut down equipment completely and bleed lines.

FIFTEEN: USING THE ELECTRIC ARC WELDER

Materials:

Electric arc welder in good condition
Electrodes and metal
Head shield for self and class
Proper protective clothing
Operator's manual for welder
List of safety practices

Procedure:

1. Wear head shield with proper shade lens and heavy leather gloves. Be sure clothing completely covers the body. Present yourself as an example of the proper way to dress when using the electric arc welder.

2. Provide all students with face shields with the proper shade lens.

3. Check your welder and accessories to determine that everything is in good working order.

4. Demonstrate the proper way to strike the arc, and run a bead without power to the welder.

5. Turn on welder and have all students cover up with the provided face shields. Now drop your head shield in place and proceed to strike the arc and run the bead.

6. Shut off welder, lift head shield and place the electrode stub in the proper container.

7. Using safety glasses or head shield with flip-up lens, chip the slag from the weld; be certain not to chip toward the student. Students should wear their safety glasses during this operation. Cool the weld or mark it as hot, and place in the proper container or area.

SIXTEEN: USING THE HYDRAULIC PRESS

Materials:

Hydraulic press in good condition
Correct supports, jigs and clamps for job to be done
Work piece
Operator's manual for the hydraulic press
List of safety practices

Procedure:

1. With the pressure relieved, check the hydraulic press for adjustment and proper setup.

2. Adjust the work table to the proper height for the job to be done.

3. Set up the work piece, using sufficient supports or other devices to hold it in a suitable working position.

4. Begin to slowly apply pressure to the work piece.

5. Stop applying pressure periodically, and check to see that all is going right.

6. After work has been completed, slowly release the pressure. Do not leave the press until all the pressure has been relieved.

SEVENTEEN: USING JACKS

Materials:

Jack in good condition
Object to be raised
Jack stands or supporting blocks
Operator's manual for the jack
List of safety practices

Procedure:

1. Check the jack for proper adjustment and setup.

2. Place jack under the lift point of the object, and slowly begin to raise the object.

3. Stop jacking periodically to check that all is going well.

4. When object is raised to the desired position, place the supporting blocks or jack stands so as to allow a person to work safely under the raised object, if necessary.

5. Remove the supporting blocks or jack stands, and slowly lower the object. Remove the jack. Do not leave the object raised.

EIGHTEEN: USING THE CHAIN HOIST

Materials:

Chain hoist in good shape
Chains, cables or other lifting devices
Object to be lifted
Operator's manual for the chain hoist
List of safety practices

Procedure:

1. Check the chain hoist for proper adjustment and operation.

2. Using the necessary chains, cables or lifting devices, properly secure the object to be lifted to the hook on the chain hoist.

3. Begin raising the object slowly. As soon as the load is on the lifting devices and the chain hoist, stop raising the object and check the connections for security.

4. Complete raising the object.

5. Slowly lower the object until all weight is removed from the lifting devices and the chain hoist.

NINETEEN: USING THE STEAM CLEANER

Materials:

Steam cleaner in good working condition
Object to be cleaned (motor, tractor, etc.)
Water and electrical supply, detergent
Heavy gloves
Operator's manual for the steam cleaner
List of safety practices

Procedure:

1. Check the steam cleaner for adjustment, electrical hookup and water inlet hookup and flow. (See owner's manual.)

2. Put in detergent according to the operator's manual.

3. Start water pump and check outflow before starting the burner.

4. Start burner and check for proper operation and steam output. Also check safety blowout plug for security and position.

5. Hold steam hose by the insulated handle in both hands, and clean the object selected for cleaning.

6. After cleaning is completed:

   a. Shut off burner and wait until the water flowing from the steam hose is cool.

   b. Shut off water pump.

   c. Shut off input water.

   d. Shut off electric service to steam cleaner.

TWENTY: USING THE PORTABLE CIRCULAR SAW

Materials:

Portable circular saw in good condition
Sharp properly set blade
Work piece
Operator's manual for the portable circular saw
List of safety practices

Procedure:

1. Fasten and/or support the work piece securely in preparation for the cutting operation.

2. Inspect the power cord for condition and proper grounding.

3. Check the blade for sharpness, set and tightness.

4. Check the blade guards to be sure they are in proper working condition.

5. Set the saw blade to the proper depth of cut, the thickness of the stock, plus 1/8".

6. Check to be sure the switch is off; connect the saw to the power source.

7. Bring the saw blade up to the desired point of the cut, back off so the blade does not touch the wood, and start the saw motor.

8. When the motor reaches operating speed, advance the saw through the work.

9. After completing the cut, release the switch and hold the saw until the blade stops rotating. Then set the saw down.

TWENTY-ONE: USING THE PORTABLE SABER SAW

Materials:

Saber saw in good condition
Saw blade for material to be cut
Tools to put in saw blade
Work piece
Operator's manual for the saber saw
List of safety practices

Procedure:

1. Fasten and/or support the work piece securely for the cutting job to be performed.

2. Inspect the power cord for condition and proper grounding.

3. Insert the blade and tighten securely.

4. Check to be sure the switch is off. Connect the saber saw to the power source.

5. Grasp the saw firmly in both hands and start the motor. Check to be sure the blade is operating correctly and is secure.

6. Line the saw up with the cut to be made. Place base firmly on the work piece, and be sure blade does not contact the work piece. Start the motor and advance the blade into the work piece. Keep pressure enough to keep the blade cutting, but not so much as to overload the motor or break the blade.

7. After completing the cut, stop the motor and wait until the blade stops completely before setting the saw down.

TWENTY-TWO: USING THE PORTABLE BELT SANDER

Materials:

Portable belt sander in good condition
Proper size and grade belt for selected job
Work piece to be sanded
Operator's manual for the portable belt sander
List of safety practices

Procedure:

1. Fasten the work piece firmly in a vise or other jig in preparation for the sanding operation.

2. Inspect the cord for condition and proper grounding.

3. Install the belt, following the operator's manual; and check the belt for proper tracking. Adjust if needed.

4. Check to be sure the switch is off; connect the sander to the power sources.

5. Grasp the portable belt sander firmly in both hands; start the motor, and slowly lower the belt to the work piece; allow the heel to touch first, and level the machine as it moves forward. Sand with the grain, using a slow back and forth movement. Never stop in one place.

6. Lift the sander from the work piece before stopping the motor. Stop the motor.

7. Allow the belt to stop completely before placing the sander on the work bench.

TWENTY-THREE: USING THE PORTABLE FINISHING SANDER

Materials:

Finishing sander in good condition
Proper grade of abrasive paper for job
Work piece
Operator's manual for the finishing sander
List of safety practices

Procedure:

1. Depending on size of work piece, fasten the work piece if needed.

2. Inspect the power cord for condition and proper grounding.

3. Properly place the abrasive paper on the finishing sander.

4. Check to be sure the seitch is off; connect the sander to the power source.

5. Hold the sander firmly above the work piece. Start it and apply it to the work piece.

6. When the job is done, lift the sander from the work piece and shut it off.

7. Disconnect the sander from the power source and set it aside.

TWENTY-FOUR: USING THE PORTABLE ROUTER

Materials:

Router in good condition
Router bit for job selected
Tools needed to put bit in router
Work piece, properly prepared and free of defects
Vise or clamps
Operator's manual for the router
List of safety practices

Procedure:

1. Fasten the work piece securely for the routing job to be performed.

2. Inspect the power cord for condition and proper grounding.

3. Insert the selected router bit and tighten securely.

4. Check to be sure the switch is off; connect the router to the power source.

5. Hold the router firmly in both hands at all times.

6. Place the base of the router on the work piece. Be sure the router bit is not touching, and start the router motor.

7. Move the router smoothly into the cut in the proper direction, counter clockwise usually, being careful not to overload the router motor.

8. After completing the cut, shut off the router. Do not raise the router from the work until the bit stops rotating.

9. Disconnect the router from the power source and remove the bit before setting the router aside.

TWENTY-FIVE: USING THE PORTABLE ELECTRIC DRILL

Materials:

Portable electric drill in good condition
Sharp drill bit
Mild steel, center punched for hole
Vise
Operator's manual for the portable electric drill
List of safety practices

Procedure:

1. Fasten the work piece firmly in the vise in preparation for drilling the hole.

2. Inspect the drill and cord to make sure it is in good condition and properly grounded.

3. Place the drill bit all the way in the chuck, and tighten it securely with the chuck key. Immediately remove the chuck key.

4. Check to be sure the switch is off. Connect the drill to the power source.

5. Start the drill and observe that the drill bit is properly inserted and running true. Stop the drill.

6. Position the drill over the work piece with the bit in the center punch mark and the drill at the correct angle for the hole to be drilled.

7. Hold the drill firmly with both hands. Start the motor and feed the drill bit into the work piece. Apply enough pressure to keep the bit cutting; don't force the drill bit. Ease off the pressure slightly as bit begins to break through; this will prevent burrs and the drill bit should not grab. Do not lock the switch on the drill in the "on" position.

8. Stop the drill and withdraw the drill bit; allow the drill to stop completely; remove the drill bit from the chuck, and remove the chuck key from the chuck. Put the drill bit in its proper location, and lay the drill down.

TWENTY-SIX: USING THE PORTABLE DISK SANDER, POLISHER AND GRINDER

Materials:

Portable grinder in good condition
Abrasive wheel of proper type
Tools necessary to fasten disk and adjust guards
Work piece to be ground
Operator's manual for the portable disk sander
List of safety practices

Procedure:

1. Fasten the work piece securely in preparation for the grinding operation to be performed.

2. Mount the grinding disk properly and securely; inspect the cord for condition and grounding; adjust the guard.

3. Check to be sure the switch is off; connect the grinder to the power source.

4. Start the grinder, and check for disk mounting and general proper operation.

5. Grasp the grinder firmly in both hands; and when the grinder reaches operating speed, begin the grinding operation.

6. Move the grinder slowly over the area to be ground to prevent overheating. Do not apply excessive pressure to the portable grinder in an attempt to speed up the operation.

7. Stop the grinder and wait until the wheel stops rotating completely before placing the portable grinder down.

TWENTY-SEVEN: USING THE PORTABLE ELECTRIC IMPACT WRENCH

Materials:

Electric impact wrench in good condition
Correct size and type of socket
Bolts and nuts to be tightened and loosened on a piece of machinery
Operator's manual for the impact wrench
List of safety practices

Procedure:

1. Inspect the power cord for condition and proper grounding.
2. Firmly place the correct size socket on the wrench for the job to be done.
3. Check to be sure the switch is off; connect the wrench to the power source.
4. Firmly grip the wrench in both hands, and place the socket over the nut or bolt to be tightened or loosened.
5. Remove the wrench from the nut or bolt after the wrench has stopped.
6. Remove the socket; disconnect the wrench from the power source and set aside.

TWENTY-EIGHT: USING PORTABLE AIR POWERED TOOLS

Select an air powered tool and follow the procedure for the comparable electric powered tool. You should emphasize proper use of the selected tool and the specific safety precautions related to the use of compressed air as a power source.

SUGGESTED SAFETY TEST QUESTIONS

Questions in this section are provided for the teacher's use at his discretion. There are general safety questions pertaining to overall shop safety and specific questions concerning each tool covered in the student reference manual.

GENERAL SAFETY

1. The most frequent injuries occur to
   a. head
   b. eyes
   c. legs
   d. fingers

2. A cleaning agent no longer recommended for use in shops is
   a. kerosene
   b. carbon tetrachloride
   c. varosol
   d. all of the above

3. The following items should be removed when working in the shop
   a. rings and watches
   b. ties
   c. loose fitting sweaters
   d. all of the above

4. Fire equipment and emergency stops are identified by which of the following colors?
   a. blue
   b. green
   c. red
   d. yellow

5. First aid equipment is identified by which color?
   a. green
   b. yellow
   c. white
   d. blue

6. A fire containing wood, hay, paper or textiles is what class of fire?
   a. A
   b. B
   c. C
   d. none of the above

7. An electric fire is what class of fire?
   a. A
   b. B
   c. C
   d. none of the above

8. A soda acid fire extinguisher should be used on what class of fire?
   a. A
   b. B & C
   c. A & C
   d. all of the above

9. A carbon dioxide type fire extinguisher can be used on what class(es) of fire(s)?
   a. A & B
   b. A & C
   c. B & C
   d. A, B & C

10. All electrical appliances and extension cords should be
    a. 2 wire cable
    b. 3 wire cable parallel ground
    c. 4 wire cable
    d. any of the above

11. When lifting a weight, a person should
    a. bend over at the waist and pick it up
    b. bend the knees, keeping the back straight and pick it up
    c. either A or B
    d. none of the above

12. Shock can be caused by
    a. bad burns
    b. loss of blood
    c. broken bones
    d. all of the above

JOINTER

1. All adjustments on the jointer should be made
   a. while it is operating
   b. with the power off
   c. while using it
   d. all of the above

2. When using the jointer the hands should be
   a. placed directly over the cutter head
   b. on the rear of the stock behind the cutter head
   c. on top of the stock not hanging over
   d. none of the above

3. All stock should be jointed
   a. across the grain
   b. with the grain
   c. against the grain
   d. any of the above is correct

4. When jointing small or short work pieces
   a. hold them firmly with both hands
   b. remove the guard
   c. use a push stick or hold down block
   d. push it through rapidly

PLANER

1. When planing hard woods
   a. take deeper cuts
   b. take shallower cuts
   c. set up the speed of feed
   d. none of the above

2. Stock of different thicknesses should not be planed together because
   a. they may cause kick back
   b. it is all right, nothing will happen
   c. the machine will stall
   d. none of the above

3. You should never plane material which is thinner than
   a. 3/4"
   b. 1/2"
   c. 1/4"
   d. 1/8"

4. When preparing to run stock through for the second time, the stock should be
   a. passed over the planer
   b. passed around the planer
   c. passed under the planer
   d. any of the above

TABLE SAW

1. Always use a push stick when you are
   a. turning the switch on or off
   b. removing scrap from the saw table
   c. ripping short or narrow work pieces
   d. making adjustments

2. The saw blade should not project more than
   a. 1/4" above the work piece
   b. 1/2" above the work piece
   c. 3/4" above the work piece
   d. none of the above

3. When shutting off the saw, the saw blade
   a. should be stopped by forcing a piece of wood against it
   b. should be allowed to stop by itself
   c. either a or b above
   d. neither a nor b above

4. When ripping, the waste stock should be
   a. next to the ripping fence
   b. on the clear side of the blade
   c. either a or b above
   d. none of the above

RADIAL ARM SAW

1. Never rip material which is less than
   a. 6" long
   b. 12" long
   c. 18" long
   d. 24" long

2. When crosscutting stock, it
   a. should be held firmly against the fence
   b. should not be held firmly against the fence
   c. should be held away from the fence
   d. none of the above

3. When shutting off the radial arm saw
   a. wait until the blade stops before leaving the saw
   b. stop the blade with a piece of wood
   c. continue cutting until the blade stops
   d. none of the above

4. It is advisable to
   a. make adjustments with the saw running
   b. place fingers between the work and the fence
   c. set the saw blade so it will cut the table
   d. use a push stick when ripping narrow work pieces

BAND SAW

1. Adjust the upper blade guide and guard so that it will clear the work piece by
   a. 1/8"-1/4"
   b. 3/8"-1/2"
   c. 5/8"-3/4"
   d. it does not matter how much clearance you allow

2. You may back the saw blade out of the kerf
   a. with the blade running
   b. with the blade stopped
   c. while the blade is coasting to a stop
   d. none of the above

3. To stop the band saw
   a. jam the blade with scrap pieces
   b. pinch the blade in a sharp arc
   c. apply the brake gradually if so equipped
   d. none of the above

4. For close cutting work
   a. use your hands
   b. use a push stick
   c. either a or b above
   d. none of the above

JIG SAW

1. To remove chips and small blocks from the saw table
   a. use your fingers
   b. use a brush
   c. use a rag
   d. none of the above

2. Always adjust the hold down
   a. to the position used by the teacher
   b. up and out of the way
   c. so it just clears your work piece
   d. none of the above

3. A properly installed blade has the teeth pointed
   a. down
   b. up
   c. either up or down

4. When feeding your work piece into the jig saw
   a. feed it slowly and carefully
   b. maintain a firm grip for control
   c. keep your fingers out of the path of the blade
   d. all of the above

DRILL PRESS

1. The long end of a work piece should, whenever possible, be kept
   a. to your left
   b. to your right
   c. either left or right
   d. none of the above

2. After tightening a drill bit in the chuck
   a. remove the chuck key from the chuck
   b. leave the chuck key in the chuck
   c. none of the above

3. A work piece should be
   a. held in the hand
   b. held with pliers
   c. held firmly in a vise or clamp
   d. none of the above

4. When a work piece is caught and revolving with the drill bit
   a. catch it and stop it with your hand
   b. stop the drill and free the work piece
   c. step back; it will fall off eventually
   d. hit it with a hammer to break it loose

DISK SANDER

1. Always sand on the side of the disk which is rotating
   a. downward toward the table
   b. upward away from the table
   c. in the center
   d. any of the above would be correct

2. Hands should always be kept at least
   a. 1/2" from the disk
   b. 1" from the disk
   c. 2" from the disk
   d. 3" from the disk

3. Never use the sander
   a. to form objects which can be done better on other machines
   b. on surfaces with excess glue or finish
   c. if the abrasive disk is loose
   d. all of the above

4. When shutting off the sander
   a. allow the disk to stop before leaving the machine
   b. force a block against the disk to stop it
   c. slow the disk down with the hand
   d. either b or c

BELT SANDER

1. Small and irregular shaped pieces should be
   a. held firmly in the fingers
   b. held with the hand
   c. held in a jig or hand clamp
   d. all of the above

2. When sanding thin work pieces
   a. use a pad or push block
   b. hold firmly with the palm of the hand
   c. remove the table and guard
   d. none of the above

3. When sanding the end grain of wood
   a. hold it loosely away from the table
   b. support it against the table
   c. hold it against the idler pulley
   d. either a, b, or c is correct

4. When starting the belt sander
   a. wait until it reaches its rated speed before using
   b. check to be sure the belt tracks properly
   c. both a and b above
   d. neither a nor b

WOOD LATHE

1. When using lathe tools the operator should
   a. stand slightly to one side
   b. stand directly in line with the tool
   c. remove his safety glasses
   d. stand as far away as possible

2. The tool rest should be adjusted so that all cuts are made
   a. below center
   b. on center
   c. above center
   d. all of the above are correct

3. Lathe speed is dependent on
   a. diameter of stock
   b. length of stock
   c. shape of stock
   d. all of the above

4. When not in use, lathe tools should be
   a. stored in a cabinet
   b. kept in your pocket
   c. laid on the lathe ways
   d. thrown in a drawer

POWER HACKSAW

1. To prevent tooth breakage
   a. set the saw on the work before starting
   b. set the blade in motion before it comes in contact with the work
   c. hold the blade against the work while cutting
   d. none of the above

2. To clean chips from the saw
   a. stop the blade
   b. use your hands
   c. use a brush
   d. a and c above

3. The saw must be stopped before
   a. making adjustments
   b. cleaning up chips
   c. oiling the machine
   d. all of the above

4. The work pieces should
   a. be clamped firmly
   b. be held in the hand
   c. not be supported if very long
   d. all of the above

BENCH OR PEDESTAL GRINDER

1. The tool rest should be adjusted to within
   a. 1/2" of the stone
   b. 1/4" of the stone
   c. 1/8" of the stone
   d. any distance, it is not important

2. A stone should not be used when it has worn down to less than
   a. 1/4 of its original diameter
   b. 1/2 of its original diameter
   c. 3/4 of its original diameter
   d. 1/10 of its original diameter

3. When starting a grinder
   a. apply the work immediately
   b. wait until it reaches operating speed before using
   c. either a or b above
   d. neither a nor b above

4. When grinding small, round or odd shaped jobs
   a. hold them firmly in the fingers
   b. hold them loosely in the fingers
   c. use vise grips or pliers to hold them
   d. none of the above

ENGINE LATHE

1. When shutting off the lathe
   a. allow it to stop by itself
   b. slow it down with your hands
   c. use your cutting tool to slow it down
   d. all of the above

2. When putting a chuck or face plate on the lathe
   a. use the lathe power to put it on
   b. put it on by hand
   c. use wooden blocks to drive it on
   d. none of the above

3. All finish cuts near a shoulder, the face plate or chuck should be made using
   a. the hand feed
   b. the automatic feed
   c. at fast speeds
   d. none of the above

4. It is advisable to
   a. make adjustments while it is running
   b. use a file without a handle
   c. remove shavings and chips with the hand
   d. none of the above

OXYACETYLENE WELDER

1. The hoses for oxyacetylene welding equipment are color coded; the appropriate colors are
   a. red for exygen and green for acetylene
   b. green for oxygen and red for acetylene
   c. red for oxygen and blue for acetylene
   d. blue for oxygen and red for acetylene

2. When lighting the oxyacetylene torch you should use a
   a. match
   b. flint lighter
   c. cigarette lighter
   d. another oxyacetylene torch

3. Oxygen and acetylene tanks should be stored
   a. laying down so they won't fall over
   b. upright with the safety cap on
   c. in the welding area so they are handy
   d. none of the above

4. All hoses and connections should be checked for leaks
   a. daily
   b. weekly
   c. bi-weekly
   d. monthly

ELECTRIC ARC WELDER

1. Which of the following items of clothing are not recommended for wearing when doing electric arc welding?
   a. long sleeved shirt
   b. skull cap
   c. long pants with cuffs
   d. high top shoes

2. Electrode stubs should be discarded
   a. on the floor
   b. in a can
   c. in your pocket
   d. any of the above

3. If you experience an arc flash
   a. wash the eyes with water
   b. close your eyes and rest, then resume work
   c. report this to your instructor
   d. forget about it

4. When chipping slag
   a. wear safety glasses
   b. protect your eyes with your hand
   c. use a lift-front shield
   d. either a or c above

HYDRAULIC PRESS

1. When using the hydraulic press
   a. apply the pressure rapidly
   b. apply the pressure slowly
   c. position your work with pressure applied
   d. all of the above

2. When leaving the work area
   a. leave pressure on the work piece
   b. relieve all pressure
   c. either a or b
   d. none of the above

3. If after you begin to apply pressure the work piece slips or tips
   a. hold it with your hand and continue applying pressure
   b. relieve the pressure and straighten it up
   c. force it back under pressure
   d. none of the above

4. If more pressure is required than the safety valve will allow
   a. by-pass the safety valve
   b. take the safety valve off
   c. replace the safety valve with one of a larger capacity
   d. none of the above

JACKS

1. It is safe to work under an object
   a. supported only by the jack
   b. supported by the jack and jack stands or other supports
   c. either a or b
   d. neither a nor b

2. Always make
   a. sure the jack is capable of supporting the load
   b. sure the jack and the object will not be damaged
   c. adjustments when the load is raised
   d. a and b above

3. You should never
   a. leave a job supported only by a jack
   b. use extra supports to hold job up
   c. place footing supports under the jack
   d. all of the above

CHAIN HOIST

1. When moving an object with the chain hoist
   a. raise it as high as possible before moving
   b. get under it to help hold it up
   c. keep it as close to the floor as possible
   d. swing it because it will move easier

2. When lifting an object
   a. check connections as soon as weight is applied
   b. get under the object
   c. leave it suspended
   d. all of the above

STEAM CLEANER

1. The hose for the steam cleaner
   a. should be held by the insulated grip
   b. can be pointed at other people
   c. can be laid down while you do other work
   d. none of the above

2. When shutting off the steam cleaner
   a. Shut off the water first
   b. shut off the burner first
   c. unplug the electric power first
   d. a, b and c above can be done in any order

3. The safety blow out plug should always be pointed toward the
   a. right
   b. left
   c. floor
   d. ceiling

PORTABLE CIRCULAR SAW

1. The depth of cut should be adjusted to the thickness of the stock plus
   a. 1/16"
   b. 1/8"
   c. 1/4"
   d. 1/2"

2. When starting the saw the blade should
   a. not be in contact with the stock
   b. be in contact with the stock
   c. either a or b, it doesn't matter
   d. none of the above

3. When operating a portable circular saw you should
   a. never stand on a wet surface
   b. guide the saw with both hands
   c. check the power cord for condition and proper grounding
   d. all of the above

4. All adjustments should be made with
   a. the switch off
   b. the switch on
   c. the power source disconnected
   d. none of the above

PORTABLE SABER SAW

1. After the job is completed the saber saw should be
   a. put away with the blade in it
   b. put away with the blade removed
   c. laid off to one side
   d. none of the above

2. When using the saber saw the work pieces should be
   a. held in one hand
   b. secured firmly with vise or clamps
   c. held by another person
   d. all of the above

3. The saw motor should be started
   a. with the blade in contact with the work piece
   b. before the blade contacts the work piece
   c. before the saw is brought to the work piece
   d. none of the above

4. When sawing curved lines, the sharpness of the arc to be cut is limited by
   a. the strength of the operator
   b. the skill of the operator
   c. the width of the blade
   d. the length of the power cord

PORTABLE BELT SANDER

1. Applying excessive pressure to the belt sander can cause
   a. overheating of the motor
   b. loading of the belt
   c. a and b above
   d. none of the above

2. When using the portable belt sander your work piece should be
   a. held in one hand
   b. held in both hands
   c. secured firmly to the work table
   d. none of the above

3. The portable belt sander should be applied to the work
   a. as soon as it is started
   b. after the motor has reached its operating speed
   c. before the motor is started
   d. either a, b or c; it doesn't matter

4. The operator of the portable belt sander should stand
   a. to the right or left of the work piece
   b. directly behind the work piece
   c. either a or b
   d. neither a nor b

PORTABLE FINISHING SANDER

1. When replacing the abrasive pad the
   a. switch should be turned off
   b. power source must be disconnected
   c. either a or b; it doesn't matter
   d. none of the above

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2. When removing the sander from the work piece
   a. the sander motor should be stopped first
   b. the sander should be removed before the motor is stopped
   c. you should apply extra pressure as you shut off the motor
   d. none of the above

3. When using the portable finishing sander, small work pieces should be
   a. fastened securely to the work table
   b. held firmly in the hand
   c. held loosely in the hand
   d. held with pliers

4. When using the portable finishing sander you should
   a. never stand on a wet surface
   b. disconnect the power source before replacing the abrasive pad
   c. make adjustments with the power off
   d. all of the above

PORTABLE ROUTER

1. Before cleaning, oiling or replacing the cutter bit you should
   a. shut the switch off
   b. disconnect the power source
   c. either a or b
   d. neither a nor b

2. When using the portable router the work piece should be
   a. secured firmly in a vise or with clamps
   b. held firmly in one hand
   c. held loosely in one hand
   d. either a, b or c above

3. When finishing a job the router should be
   a. removed from the work piece before it is shut off
   b. shut off and immediately removed from the work piece
   c. shut off and removed from the work when the cutter stops rotating
   d. none of the above

4. The portable router should be held
   a. in the right hand
   b. in the left hand
   c. firmly in both hands
   d. any way you want

PORTABLE ELECTRIC DRILL

1. When using the electric drill you should never
   a. stand on a wet surface
   b. lock the switch in the on position
   c. hold the stock to be drilled in your hand
   d. all of the above

2. After inserting and tightening the drill bit, the chuck key should be
   a. removed from the chuck
   b. left in the chuck
   c. either a or b
   d. neither a nor b

3. When using the portable electric drill the operator should
   a. hold the drill in one hand
   b. steady the work piece with your free hand
   c. hold the drill firmly in both hands
   d. a and b above

4. When the job is completed the operator should
   a. wait until the drill stops before laying down the drill
   b. remove the bit before storing the drill
   c. both a and b
   d. neither a nor b

PORTABLE DISK SANDER, POLISHER AND GRINDER

1. After mounting a new wheel on the tool, the operator should
   a. start the grinder and begin work
   b. start the grinder and run it a few minutes to be sure the wheel is mounted properly
   c. hold the wheel against the work piece and start the grinder
   d. none of the above

2. When shutting off the grinder
   a. wait until the wheel stops before you set it down
   b. hold the wheel against the work piece to slow it down
   c. set the grinder on the edge of a bench so the wheel can run freely
   d. none of the above

3. The operator of a portable grinder should
   a. wear safety glasses
   b. check to see that no one will be hit by chips or sparks
   c. hold the grinder firmly in both hands
   d. all of the above

ELECTRIC IMPACT WRENCH

1. The socket should be applied to the nut or bolt head while it is
   a. rotating
   b. standing still
   c. either a or b
   d. neither a nor b

2. When using an electric impact wrench, the operator should
   a. never stand on a wet surface
   b. allow the wrench to stop before changing sockets
   c. hold the wrench firmly in both hands
   d. all of the above

3. The sockets to be used with the electric impact wrench are
   a. special type for the wrench
   b. regular sockets
   c. either a or b
   d. none of the above

PORTABLE AIR POWERED TOOLS

1. When using portable air powered tools the operator should
   a. be certain the pressure on the line does not exceed the manufacturers' specifications
   b. be certain the air hose is not kinked or in danger of being pinched or run over
   c. the air hose is in good condition and all connections are secure
   d. all of the above

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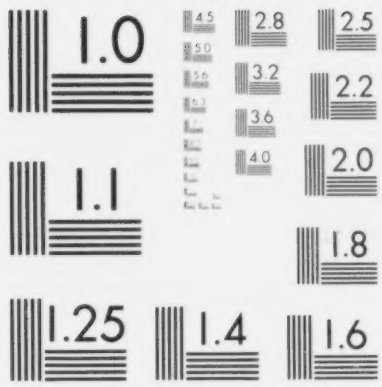

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

ANSWERS TO SAFETY TEST QUESTIONS

GENERAL SAFETY

1. d
2. b
3. d
4. c
5. a
6. a
7. c
8. a
9. c
10. b
11. b
12. d

JOINTER

1. b
2. b
3. b
4. c

PLANER

1. b
2. a
3. c
4. b

TABLE SAW

1. c
2. a
3. b
4. b

RADIAL ARM SAW

1. b
2. a
3. a
4. d

BAND SAW

1. a
2. b
3. c
4. b

JIG SAW

1. b
2. c
3. a
4. d

DRILL PRESS

1. a
2. a
3. c
4. b

DISK SANDER

1. a
2. c
3. d
4. a

BELT SANDER

1. c
2. a
3. b
4. c

WOOD LATHE

1. a
2. c
3. d
4. a

POWER HACKSAW

1. b
2. c
3. d
4. a

BENCH OR PEDESTAL GRINDER

1. c
2. b
3. b
4. c

ENGINE LATHE

1. a
2. b
3. a
4. d

OXYACETYLENE WELDER

1. b
2. b
3. b
4. a

ELECTRIC ARC WELDER

1. c
2. b
3. c
4. d

HYDRAULIC PRESS

1. b
2. b
3. b
4. d

JACKS

1. b
2. d
3. a

CHAIN HOIST

1. c
2. a

STEAM CLEANER

1. a
2. b
3. c

PORTABLE CIRCULAR SAW

1. b
2. a
3. d
4. c

PORTABLE SABER SAW

1. b
2. b
3. b
4. c

PORTABLE BELT SANDER

1. c
2. c
3. b
4. a

PORTABLE FINISHING SANDER

1. b
2. b
3. a
4. d

PORTABLE ROUTER

1. b
2. a
3. c
4. c

PORTABLE ELECTRIC DRILL

1. d
2. a
3. c
4. c

PORTABLE DISK SANDER, POLISHER AND GRINDER

1. b
2. a
3. d

ELECTRIC IMPACT WRENCH

1. b
2. d
3. a

PORTABLE AIR POWERED TOOLS

1. d

APPENDIX

THE SOUTH CAROLINA EYE PROTECTION LAW

The following is a copy of the eye protection law:

(R545, H1314)

An Act To Require The Public Schools Of The State To Supply Plano Protective Eye Devices To Pupils And Teachers Participating In Certain Courses And To Require Pupils And Teachers Desiring Protective-Corrective Eye Devices To Secure Such Devices At Their Own Expense.

Be it enacted by the General Assembly of the State of South Carolina:

Section 1. Every pupil and teacher in any public school participating in any of the following courses:

(a) Vocational or industrial art shops or laboratories involving use of or exposure to:

(1) Hot molten metals
(2) Milling, sawing, turning, shaping, cutting, or stamping of any solid materials
(3) Heat treatment, tempering, or kiln firing of any metal or other materials
(4) Gas or electric arc welding
(5) Repair or servicing of any vehicle
(6) Caustic or explosive materials

(b) Chemical or combined chemical-physical laboratories involving caustic or explosive chemical or hot liquids or solids; is required to wear industrial quality eye protective devices at all times while participating in such courses or laboratories. The trustees of each school district shall purchase and cause such plano protective eye devices to be placed in such public schools for the eye protection of pupils, teachers, and visitors to such classrooms or laboratories.

(c) Any person desiring protective-corrective lenses instead of plano protective devices supplied by the school trustees shall at his own expense procure and equip himself with industrial quality eye protective devices secured from legally authorized dispensers.

The phrase "industrial quality eye protective devices", as used in this section, means devices meeting the standards of the American Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1-1959, promulgated by the American Standards Association, Incorporated.

Section 2. This act shall take effect upon approval by the Governor.

In the Senate House the 4th day of June

In the Year of Our Lord One Thousand Nine Hundred and Sixty-Five.

Edgar A. Brown
President Pro Tempore of the Senate

Solomon Blatt,
Speaker of the House of Representatives.

Approved the 8th day of June, 1965.

Robert E. McNair
Governor.

SUGGESTED REFERENCE BOOKS

Williams, William A., Accident Prevention Manual for Shop Teachers. Chicago: American Technical Society, 1963.

Silvius, G. Harold and Curry, H. Estell, Teaching Successfully in Industrial Education. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1967.

FILMS AVAILABLE

1. Challenge, The (1959) 16 mm. Sound Color 10 min. Concerns prevention of fires. Available from The Travelers Insurance Companies, Travelers Film Library, 52 Prospect Street, Hartford, Connecticut 06115.

2. Days of Our Years (1956) 16 mm. Sound Color 20 min. Emphasizes need for safety on the job. Available from Union Pacific Railroad, Motion Picture Bureau.

3. Don't Drop Your Guard 16 mm. Sound Color 15 min. Shows importance of machine guards. Available from Aetna Life and Casualty Company, Public Relations and Advertising Department Film Library, 151 Farmington Avenue, Hartford, Connecticut.

4. Home Sweet Home (1962) 16 mm. Sound Color 24 min. Emphasizes need for home safety. Available from The Travelers Insurance Companies. (See address above.)

5. Knowing Not Enough (1957) 16 mm. Sound Color 28 min. The title explains itself. You must not only know safety practices, but must follow them. The Travelers Insurance Company. (See address above.)

6. Lifting, Man's Age Old Problems (1964) 16 mm. Sound Color 14 min. Discusses how to avoid back injuries from lifting. Available from Aetna Life and Casualty Company. (See address above.)

7. Safety at Work (1963) 16 mm. Sound Color 18 min. Shows how safety programs can reduce deaths and injuries in industry. Available from Aetna Life and Casualty Company. (See address above.)

8. Safety Makes Sense (1966) 16 mm. Sound Color 20 min. Discusses safety and accident prevention. Clark Equipment Company, Industrial Truck Division, Battle Creek, Michigan 49016.

9. Slips and Falls (1965) 16 mm. Sound Color 10½ min. Compares hazards of steel workers on skyscrapers to hazards of homes, offices and shops. Available from Bell Systems Telephone Office. (Call manager of your local Bell System Business Office.)

Safety Filmstrips available from the Department of Industrial Education, Clemson University, Clemson, South Carolina 29631.

FT-20 – Organization

FT-21 – Machines

FT-22 – Handling

FT-23 – Falls

FT-24 – Factory Safety

FT-25 – A Safe Day

FT-26 – As Others See Us

FT-27 – Paradise Valley

FT-SS5 – Safety for Sale

FT-SS6 – Twenty-Hour Safety Course (9 strips)

FT-SS9 – Rules for Tools

FT-SS10 – Grime Doesn't Pay

FT-SS11 – Open for Infection

FT-SS12 – Women and Machines

FT-SS13 – The Eyes Have It

FT-SS14 – Nothing Upstairs

FT-SS15 – Double Trouble

FT-SS16 – Woven in Safety

FT-S1 – Safe Only in Smart Hands

FT-KIT I – Personal Side of Safety (5 strips)

VT 012 648
Carmody, John F.
Basic Automotive Air Conditioning.

Bergen County Vocational and Technical High School, Hackensack, N.J.
Rutgers, The State Univ., New Brunswick, N.J. Curriculum Lab.
New Jersey State Dept. of Education, Trenton. Div. of Vocational Education
MF AVAILABLE IN VT-ERIC SET.
Vocational-Technical Curriculum Laboratory, Rutgers University, 4103 Building, Kilmer Campus, New Brunswick, New Jersey 08903 ($2.00).
PUB DATE - JAN71 162p.

DESCRIPTORS - *TRADE AND INDUSTRIAL EDUCATION; *STUDY GUIDES; *TECHNICAL EDUCATION; *AUTO MECHANICS; *AIR CONDITIONING; AIR CONDITIONING EQUIPMENT; GLOSSARIES; HAND TOOLS; ILLUSTRATIONS

ABSTRACT - This book, individually authored in cooperation with Rutgers University, presents principles and related theory of an automotive air conditioning system. Intended for teacher and student use in vocational high school programs, the units of instruction include: (1) Basic Principles, (2) Special Tools and Equipment, (3) The Drive Belt, (4) The Electro-Magnetic Clutch, (5) The Compressor, (6) Service Valves, (7) Basic Service Procedures, (8) Compressor Crankshaft Seal Repair Procedures, (9) The Condenser, (10) The Receiver Drier, (11) Thermostatic-Expansion Valve Functions, (12) The Evaporator, (13) The Electrical Control System, (14) Testing, and (15) Tubing. The lessons are presented in outline form with numerous illustrations. A glossary and achievement tests are appended. (GB)

VT 012 648

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STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL EDUCATION

BASIC AUTOMOTIVE AIR CONDITIONING

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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State of New Jersey
Department of Education
Division of Vocational Education

BASIC AUTOMOTIVE AIR CONDITIONING

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Automotive Air Conditioning by
Boyce H. Dwiggins

Heat and Its Workings by
Morton Mott-Smith Ph.D.

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To the Instructor:

CONTENT OF THE BOOK

The book contains units of instruction which:

1. Explain the basic principles and related theory of an automotive air conditioning system.

2. Identify the system components, and explain their operation.

3. Instruct the student - step by step - in repair and service procedures.

ARRANGEMENT

The material is arranged so that a sequential learning process may be established. The order of the units of instruction follows the flow of refrigerant in the system, and the related information precedes each component service procedure. Schematics and charts are used to increase the effectiveness of instruction.

This arrangement should prove helpful in an educational system where the shop instructor also teaches related theory, as he may turn the page and continue with shop operations. In an educational system using separate related classes, the teacher may turn a page and become familiar with the shop procedures the student will follow. Lessons are marked T (theory) and S (shop) for quick identification.

PARTS REQUIRED FOR INSTRUCTION

In order to perform service and repair procedures, it will be necessary for the instructor to furnish system components and spare parts. In some cases defective parts are required, such as a radiator cap or blower motor. The instructor may compile his own list of parts by glancing through the shop assignments at the end of each lesson or procedure.

Automobile Air Conditioning

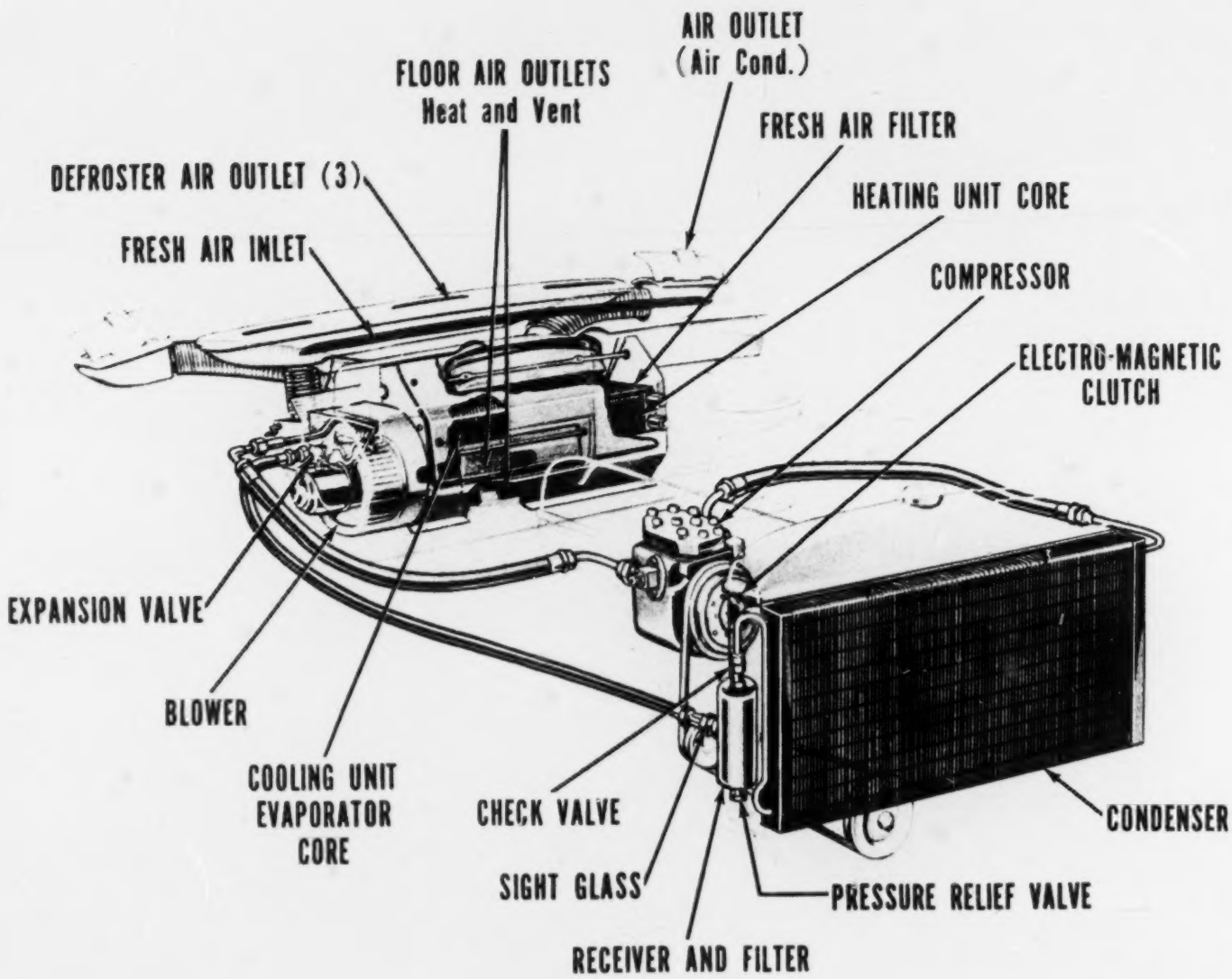

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UNIT I - BASIC PRINCIPLES

Lesson I — The Purpose of Automotive Air Conditioning

Objective: To learn how automotive air conditioning makes us feel more comfortable.

Automotive air conditioning is a process that cleans, cools, and circulates the air. It also reduces the air moisture content (humidity).

Normal body temperature is 98.6F. This temperature is created and maintained by food intake. As food is taken into the body, it is converted into energy. Since the body creates more heat than is needed, heat must constantly be given off. The rate of which heat is given off, is controlled by air temperature, air movement, and humidity.

In helping us control these three factors, automotive air conditioning makes the body feel more comfortable.

Assignment:

1. What does automotive air conditioning do?
2. What is normal body temperature?
3. How is normal body temperature maintained?
4. What factors control body heat dissipation?

UNIT I - BASIC PRINCIPLES

Lesson 2 — Convection

Objective: To learn the principle of convection, and its relation to body comfort.

Heated air expands and becomes less dense than the surrounding air. As air expands, it also rises and as a result cooler air is drawn up from below, replacing the heated air. This cycle is constantly repeated. The cycle is known as convection.

As the flow of air moves more rapidly, heat is dissipated at a faster rate. The body gives up heat through convection, as body heat travels to the surrounding air when the air temperature is less than the body skin temperature.

We have learned that *heat travels to a lower temperature and that warm air rises*. This movement of air cools the body.

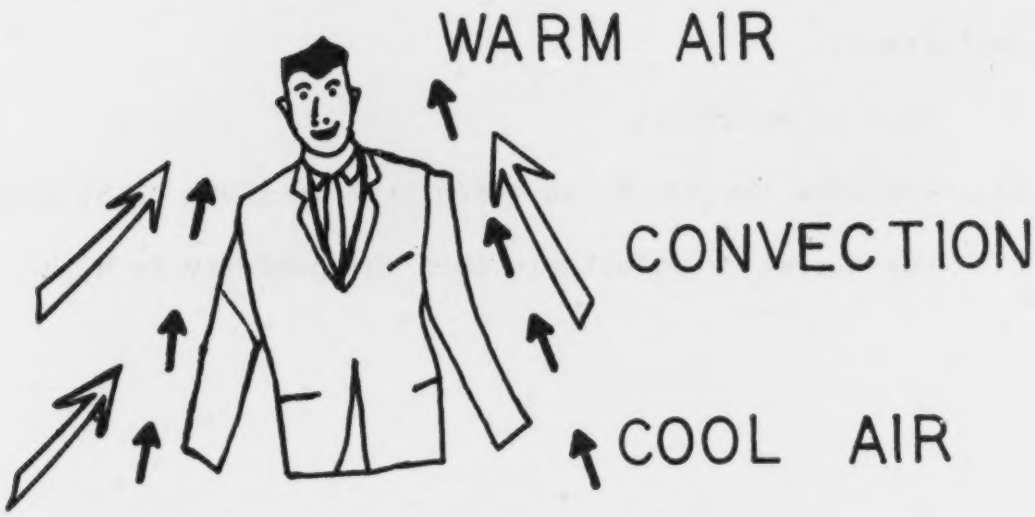

Assignment:

1. Why does heated air expand?
2. Describe the flow of heated air.
3. How does air movement affect convection?
4. How does convection affect the body temperature?

UNIT I - BASIC PRINCIPLES

Lesson 3 — Evaporation

Objective: To learn the principle of evaporation, and its relation to body comfort.

Evaporation is a process in which moisture changes to a vapor. As moisture evaporates from a warm surface, a lot of heat is removed and a cooling effect is produced.

Moisture in the air is measured in terms of humidity. As an example, 50% relative humidity indicates that the air, in a specific location, contains one half the moisture that it is capable of holding, at a given temperature. The comfort range for the human body is approximately 70-80°F at 40-50% relative humidity. The drier the air (low humidity), the more moisture may be absorbed. The opposite is true of high humidity.

The body skin surface is constantly giving up moisture to the surrounding air in the form of perspiration. As this moisture evaporates, heat transfer takes place reducing body temperature.

Assignment:

1. What is humidity?
2. Describe the manner in which heat is given up by evaporation.
3. Why are we uncomfortable when the humidity is high?

UNIT I - BASIC PRINCIPLES

Lesson 4 — The Refrigerant - R12

Objective: To learn the requirements an automotive refrigerant must fulfill, and how R12 meets these requirements.

A refrigerant is needed in an automotive air conditioner to produce cooling. Cooling takes place by removing heat. A refrigerant chosen for this purpose must:

1. Stand high pressure without deteriorating.
2. Be non-inflammable.
3. Have low toxicity.
4. Absorb and convey heat.
5. Be non-corrosive to metals.
6. Be harmless to rubber.
7. Be compatible with petroleum oil.

R12 meets these requirements and is used in nearly all modern cars equipped with air conditioning.

R12 is produced from carbon tetrachloride. It is almost colorless, and has a slightly sweet odor. It is packaged in small cans by the pound, and also available in cylinders of up to 150 pounds.

Assignment:

True or false?

1. R12 cools because it is a "cold" liquid. ( )
2. R12 will not burn. ( )
3. R12 is harmless to the human body. ( )
4. R12 will not rust metal. ( )

UNIT I - BASIC PRINCIPLES

Lesson 5 — The Refrigeration Cycle

Objective: To learn the names of the components in a basic refrigeration cycle, and the refrigerant flow, of an automotive air conditioner.

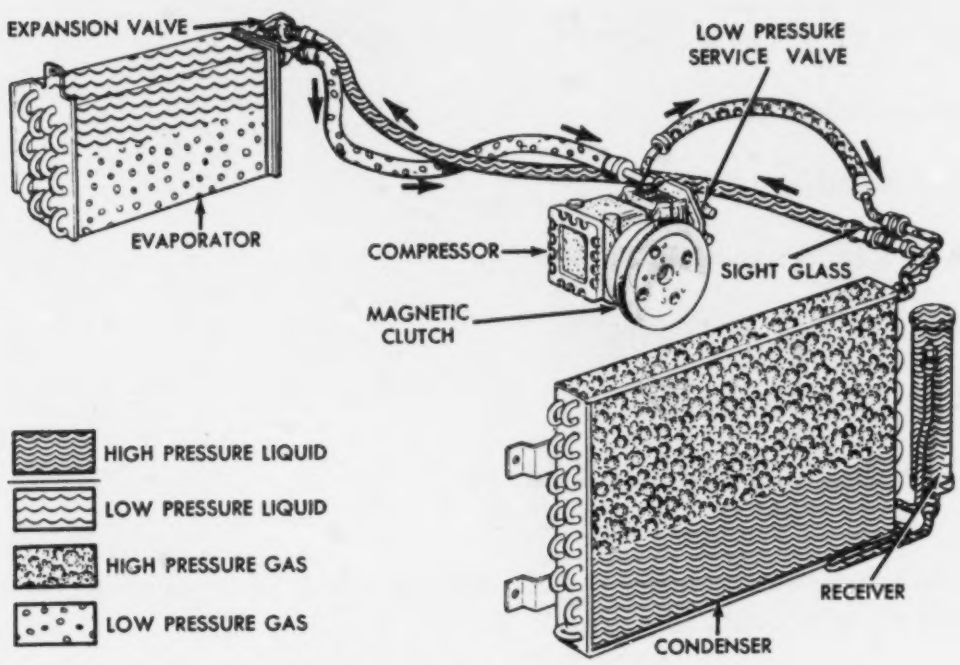

Operation of the compressor draws the heated refrigerant from the evaporator, through the suction line, into the cylinder of the compressor. The compressor pushes the refrigerant, a high pressure gas, to the condensor through the high pressure line. The temperature of the gas entering the condensor is much higher than the air around it and heat is transferred to the outside air which circulates through the condensor fins. As this process takes place, the high pressure gas condenses into a liquid, and is sent to the receiver drier.

The flow of liquid refrigerant is then controlled by the thermostat expansion valve, which meters the proper amount of refrigerant into the evaporator. At the valve exit the pressure is reduced. As the liquid refrigerant absorbs heat, in the evaporator, it boils and changes into a low pressure gas. The gas is then drawn to the compressor, and the cycle begins again.

Assignment:

1. Begin with the compressor, and name the components of a basic automotive air conditioner.

2. Draw a diagram showing the flow of refrigerant.

3. Why does the refrigerant boil when the pressure is reduced?

UNIT I - BASIC PRINCIPLES

Lesson 6 — Safety

Objective: To learn safety procedures pertinent to automotive air conditioning. Care in disconnecting components of the system, and proper work habits.

General: It is recommended that the work habits and safety precautions as listed below be followed when servicing the system. They are listed in a group to avoid needless repetition with each shop procedure.

Always wear safety goggles

1. Before disconnecting any component of the system, the system must *first be discharged.*

2. When discharging the system open the connection, with caution, and *be alert to pressure trapped in the system.*

3. If pressure is present, allow it to *bleed off slowly.* After disconnecting a component, immediately *cap all lines or connections* to prevent the entrance of dirt or moisture.

4. When discharging the system *wrap a clean cloth around the discharge hose.* The precence of oil on the cloth indicates the system is *loosing oil and being discharged too fast.*

5. *Never* discharge the system in a confined area.

6. *Never* discharge the system near an open flame.

7. Where possible, *discharge the system into the building exhaust system.*

8. When charging the system *never invert the refrigerant container.* If a slug of liquid refrigerant enters the compressor, the compressor will be damaged.

9. When charging the system, *never place the container of refrigerant on the car radiator.*

10. When charging the system *do not allow the container of refrigerant to tip over.*

11. When charging the system *proceed slowly and watch system pressures.* If the high gauge exceeds 240 lbs. *stop charging and determine the cause.* System blockage may exist and result in dangerously high pressures.

12. When charging the system on a hot day it may be wise to *place a portable fan in front of the condenser* to simulate ram air-flow.

13. When charging the system add the recommended amount of refrigerant *as specified by the manufacturers. Never guess or overcharge.*

14. When a compressor is removed for repair or replacement, always drain the oil into a graduated container and *record the amount of oil drained.*

15. When adding oil to the compressor, *use the viscosity recommended by the manufacturer.*

16. The use of proper tools is very important. *Work with two or three wrenches* where needed, and "back-up" the line or connection to prevent the line from twisting, kinking, or breaking.

17. *Use flare wrenches* on line nuts and loosen carefully.

18. Tighten all connections to the *specified torque.*

19. *Use a service valve wrench only,* when opening or closing service valves.

20. *Have all required tools ready* before starting to service the system.

21. *Lubricate all threads and fittings with refrigeration oil* when assembling connections.

22. *Lubricate* all O rings and copper gaskets where applicable with *refrigeration oil.*

23. Never bend a flexible hose *less than ten times the diameter of the hose.*

24. Always locate hoses and lines *as far from the exhaust manifolds as possible.*

25. Keep hoses and lines mounted securely *to eliminate vibration.*

Assignment:

Study this lesson and write a 500 word composition about safety.

UNIT II - SPECIAL TOOLS AND EQUIPMENT

Lesson I

Objective: To learn the kind of tools and equipment needed to service an automotive air conditioner.

The tools and equipment shown are recommended by General Motors. They are required in order to properly service factory installations.

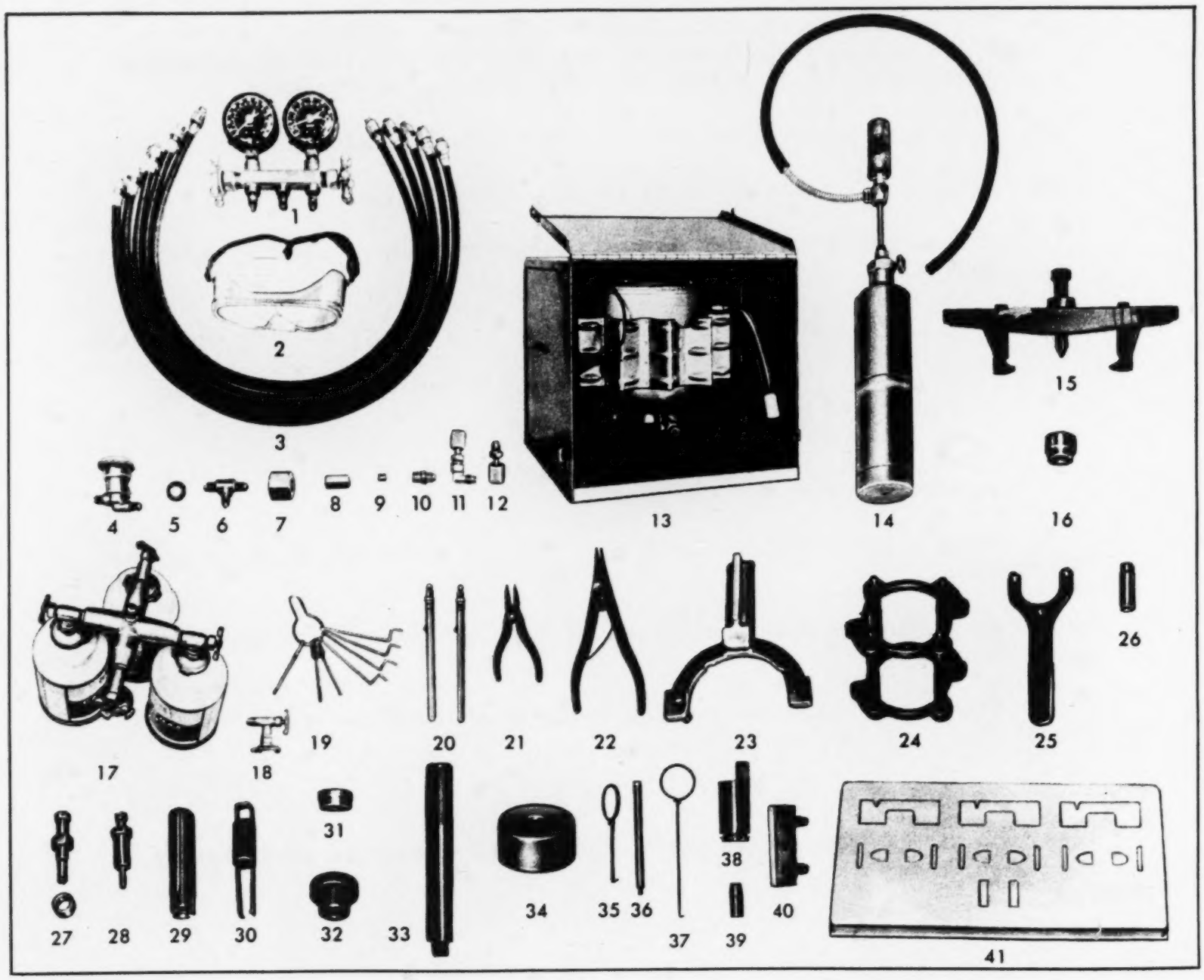

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Air Conditioning Special Tools

1. J-5725-A Gauge Manifold Test Unit
2. J-5453 Goggles
3. J-5418 Gauge Charging Lines (5)
4. J-5462-1 2-Way Valve
5. J-5462-3 Refrigerant Drum Washer
6. J-5462-2 3-Way "T"
7. J-5462-4 Refrigerant Drum Reducer
8. J-5462-7 Female Connection
9. J-5462-8 Ring Seat
10. J-5462-9 Pipe Fitting (1/4" x 1/4")
11. J-9459 90° Gauge Line Adapter
12. J-5420 Gauge Line Adapter
13. J-5428 Vacuum Pump
14. J-6084 Leak Detector
15. J-8433 Puller
16. J-9395 Puller Pilot
17. J-6272 Multi-Opener (4 Can)
18. J-6271 Fitzall Valve (Single Can)
19. J-7151 Non-Magnetic Clutch Shims
20. J-5421 Pocket Thermometers (2)
21. J-5403 #21 Snap Ring Pliers
22. J-6435 #26 Snap Ring Pliers
23. J-9396 Compressor Holding Fixture
24. J-9397 Compressing Fixture
25. J-9403 Clutch Hub Holding Tool
26. J-9399 9/16" Thin Wall Socket
27. J-9401 Hub and Drive Plate Assembly Remover
28. J-9480 Hub and Drive Plate Assembly Installer
29. J-9392 Seal Remover
30. J-9393 Seal Seat Remover
31. J-9398 Pulley Bearing Remover
32. J-9481 Pulley and Bearing Installer
33. J-8092 Handle
34. J-9521 Internal Assembly Support Block
35. J-5139 Oil Pickup Tube Remover
36. J-9432 Needle Bearing Installer
37. J-9553 Seal Seat "O" Ring Remover
38. J-21508 Seal Seat "O" Ring Installer
39. J-21303 Shaft Seal Protector
40. J-9527 Pressure Test Connector
41. J-9402 Parts Tray

In addition, the mechanic will need tools and equipment as listed below:

Ammeter
Tachometer
Test lamp
Jumper leads
Remote control
Pressure tester for radiator caps
Tubing benders
Tubing cutter
Flaring tool kit
Flare wrenches
Mechanic's tool kit
Graduated container (ounces)

UNIT III - THE DRIVE BELT

Lesson I — Function in the System

Objective: To learn the purpose of the drive belt, and the importance of inspection and adjustment.

The drive belt is used to drive the compressor. It is driven by the engine crankshaft, which is connected with an electro-magnetic clutch.

Smaller type compressors usually use an idler pulley for the purpose of adjustment and belt location. Larger compressors have two belts, and adjustment is provided at the compressor mounting plate.

Drive belts should be inspected periodically, and replaced if they show signs of deterioration. Where two belts are used, they should be replaced in pairs, as they are manufactured in matched sets.

Belt adjustment is very important and should be performed with the use of a gauge, as shown in the diagram.

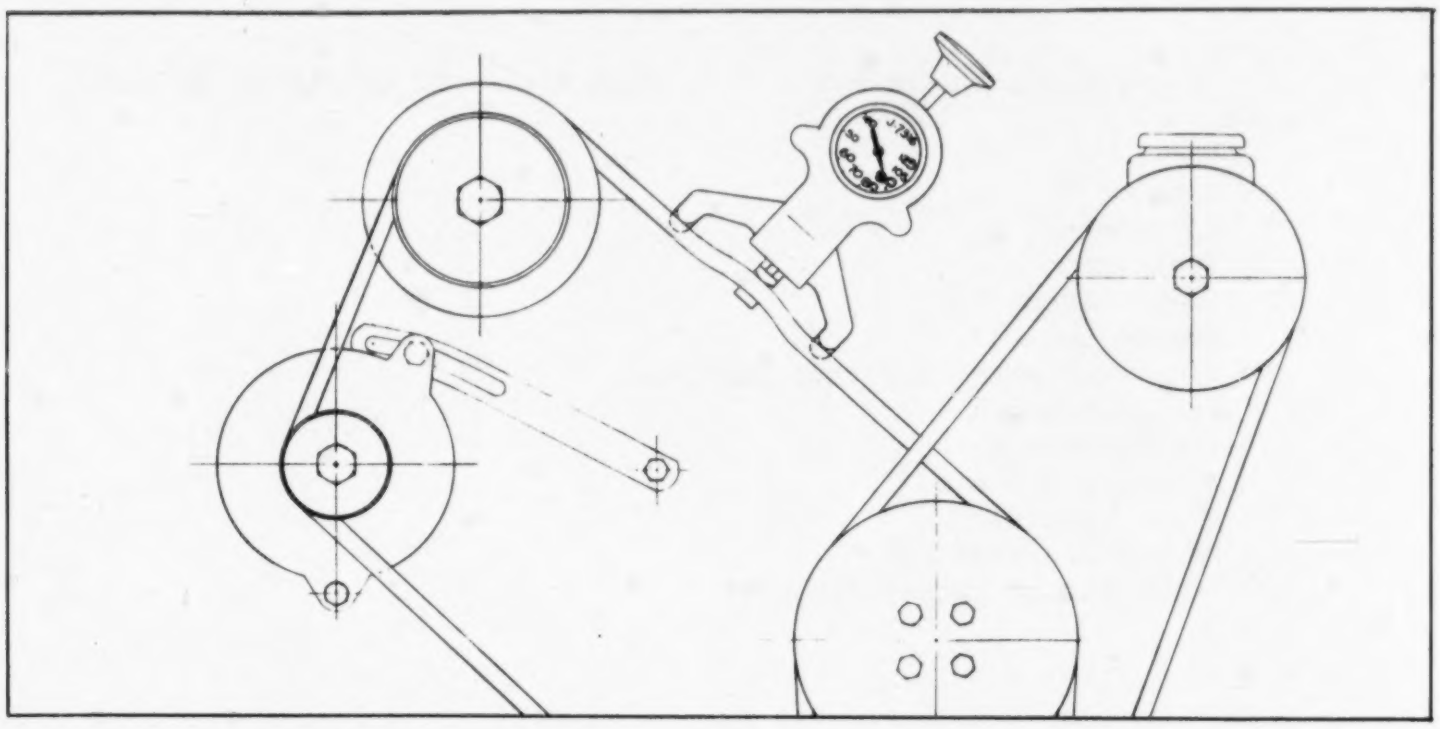

A loose belt will slip and decrease compressor efficiency. A tight belt will overload the clutch and compressor shaft bearings, causing premature bearing failure.

Assignment:

1. Why is an idler pulley used?

2. What would happen if one belt was replaced on a two-belt compressor?

3. How could you inspect the belt thoroughly?

4. What do you think is meant by the statement "decrease compressor efficiency"?

UNIT IV - THE ELECTRO-MAGNETIC CLUTCH

Lesson I — Function in the System

Objective: To learn what the electro-magnetic clutch does, and how it operates.

Nearly all cars equipped with air-conditioning use an electro-magnetic clutch to drive the compressor. The clutch operates by the principle of magnetic attraction.

Basically, the clutch consists of a bearing pressed into a hub, a pulley, a friction disc, and a field coil.

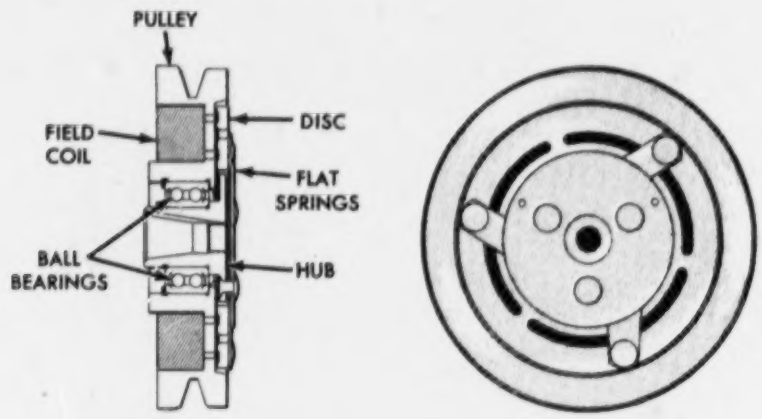

Operation of the clutch is as follows:

Driven by a belt, while the engine is running, the pulley free-wheels and spins on the bearing. When the field coil is energized, magnetic attraction connects the pulley to the friction disc. The clutch then spins as a unit, driving the compressor crankshaft. This action starts the refrigeration cycle.

Assignment:

1. What does the electro-magnetic clutch do?
2. What force engages the electro-magnetic clutch?
3. Under what condition would the electro-magnetic clutch "free-wheel?"
4. How is the field coil energized?

UNIT IV - THE ELECTRO-MAGNETIC CLUTCH

Lesson 2 How to Test the Clutch

Tools needed: Ammeter, remote control, test lamp.

In the event of a complaint of insufficient or no cooling, test the clutch in the following manner:

TEST FOR CURRENT TO THE CLUTCH

1. Disconnect the clutch field lead at the bullet connector. Connect the test lamp to the lead from the control switch and ground the test lamp.

2. Turn the ignition switch and the control switch on. The test lamp should light.

   If the lamp does not light, the trouble lies before the clutch. Check for: blown fuse, defective control switch(es), wiring to the clutch.

TEST CLUTCH FIELD CURRENT DRAW

1. Connect the ammeter in series with the clutch. Connect the negative lead of the ammeter to the clutch field lead. Connect the positive lead of the ammeter to the positive post of the battery. The clutch should engage with a sharp click.

2. The ammeter will indicate the field current draw. Compare the draw to specifications as shown:

Car manufacturer	Field current draw. Amperes at 12 volts.
Ford	2
Chrysler	2.5 to 3.3
General Motors	2.7 to 3.3
American Motors	2.5 to 2.9

An ammeter reading of zero indicates an open field circuit.

A lower ammeter reading indicates resistance in the field circuit.

A higher ammeter reading indicates a shorted field winding.

Assignment:

1. Use the test lamp and make an electrical continuity test to the clutch. Ask your instructor to help you.

2. Connect an ammeter in series to the clutch and record the field current draw.

3. State the reason why a clutch, known to be good, could not function with current supplied to the field.

4. What could cause resistance in the field circuit?

UNIT IV - THE ELECTRO-MAGNETIC CLUTCH

Lesson 3 How to Remove the Clutch

Tools required: Hub and drive plate puller, support bracket, drive plate holding tool, pulley puller, puller pilot, thin wall 9/16" socket, 5/8" National Coarse capscrew, tool kit.

To remove the clutch proceed as follows:

GENERAL MOTORS SIX CYLINDER

Note: It is not necessary to discharge the system or to remove the compressor when performing this service. The compressor is shown off the car for purposes of illustration.

REMOVE HUB AND DRIVE PLATE

1. Place the support bracket in a vise and mount the compressor to the bracket.

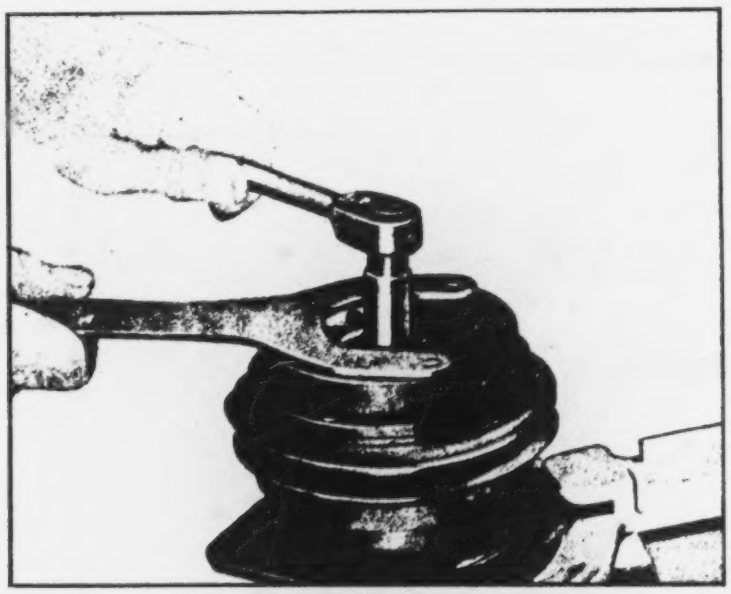

Removing Shaft Locknut

2. Hold the drive plate with the holding tool, as shown, and remove the shaft locknut. Discard the locknut.

3. Install the hub puller and remove the hub and drive-plate assembly.

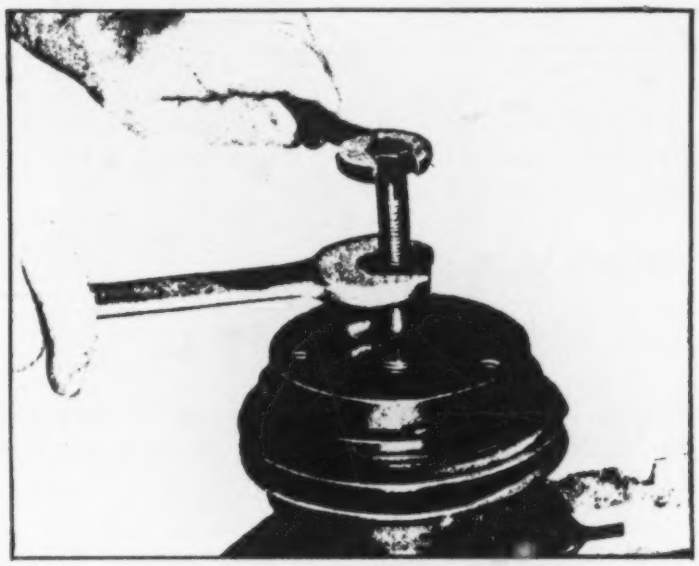

Removing Hub and Drive Plate Assembly

REMOVE THE PULLEY AND BEARING ASSEMBLY

1. Remove the pulley and bearing retaining ring.

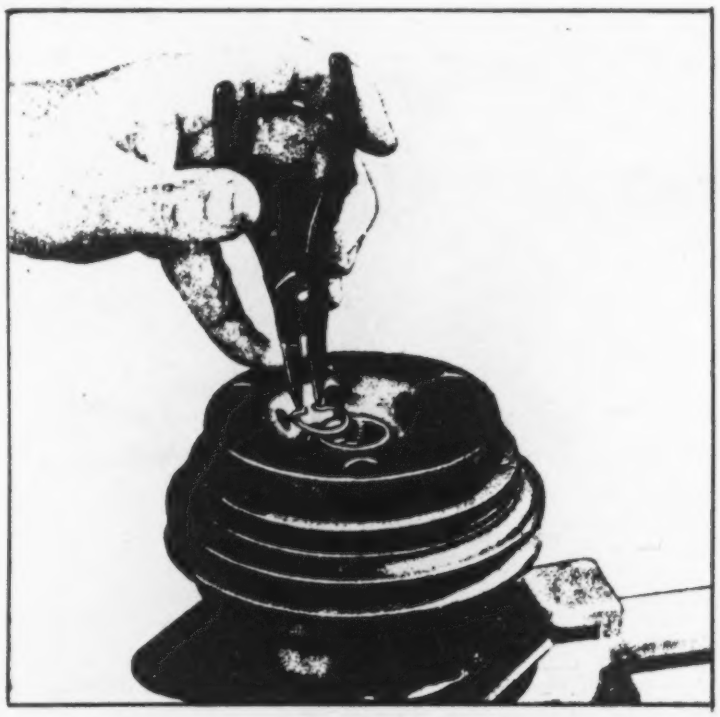

Removing Pulley and Bearing Assembly Retainer Ring

2. Remove the shaft key.

3. Install the puller pilot on the compressor shaft, and use the pulley puller to remove the pulley and bearing assembly.

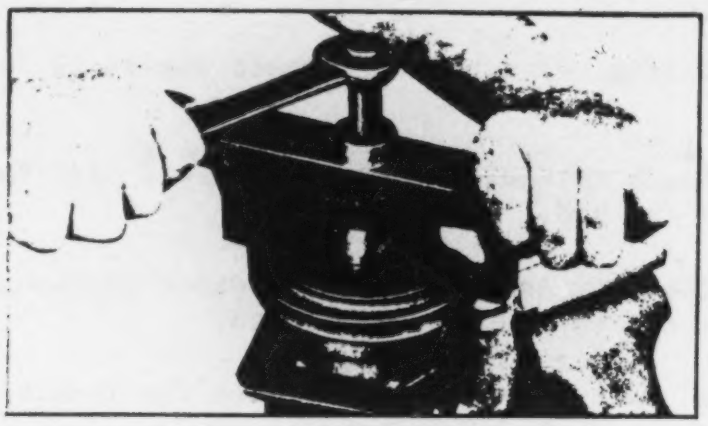

Removing Pulley

REMOVE THE COIL HOUSING

1. Scribe the coil housing to the compressor case to be sure that the terminals will be reassembled in the proper position.

2. Remove the coil housing retainer ring.

Removing Coil Housing Retainer Ring

3. Remove the coil housing assembly.

York and Tecumseh

1. Remove the driving belts and disconnect the field lead at the bullet connector.

2. Remove the clutch retaining bolt and screw a 5/8" National Coarse capscrew into the hub.

3. Tighten the capscrew against the compressor crankshaft. The clutch assembly will loosen and may be removed.

4. Remove four ¼" machine screws and remove the clutch field from the compressor.

Chrysler Corporation

Follow the procedure outlined above with these exceptions:

1. Caution: The hub may be threaded National Coarse or National Fine. Use the proper capscrew or cross threading will result.

2. The clutch field is retained with three ¼" capscrews.

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UNIT IV - THE ELECTRO-MAGNETIC CLUTCH

Lesson 4 How to Install the Clutch

Tools needed: Hub installer, drive plate holding tool, support bracket, tool kit.

To install the clutch:

General Motors six cylinder

INSTALL THE COIL HOUSING

1. Position the coil housing to the compressor case and align the scribe marks.

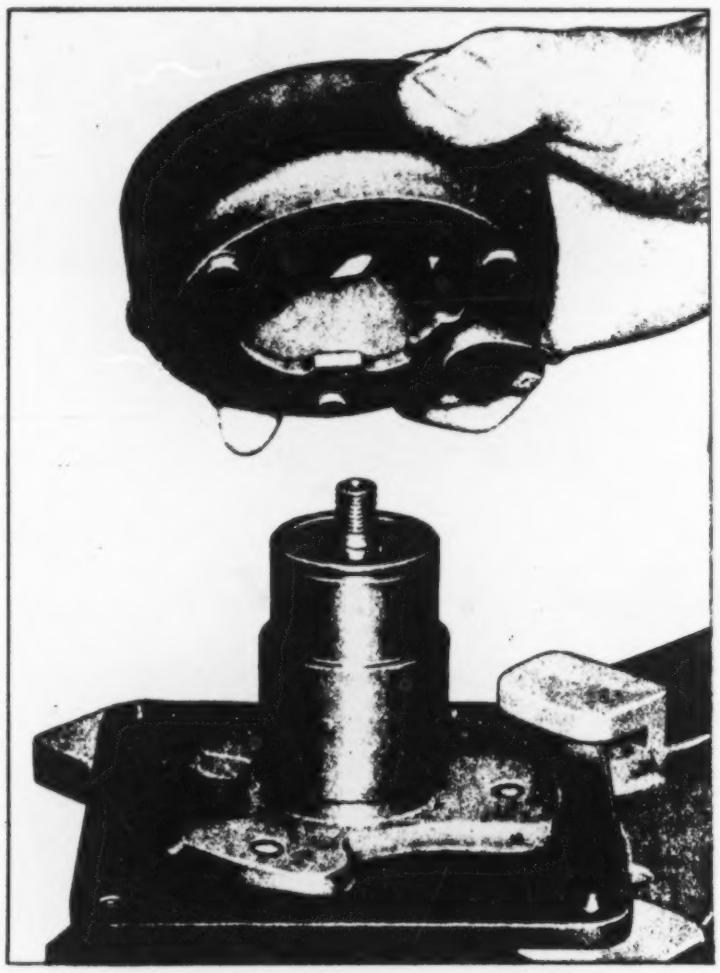

Installing Coil Housing

2. Install the coil housing retainer ring, with the flat side of the ring facing the coil housing.

INSTALL THE PULLEY AND BEARING ASSEMBLY

1. Press the pulley and bearing assembly onto the neck of the compressor. *Check that the pulley will rotate freely.*

2. Install the pulley and bearing retainer ring.

3. Install the shaft key.

   Note: *Align the key with the shaft and allow it to extend 3/16" out of the end of the keyway.*

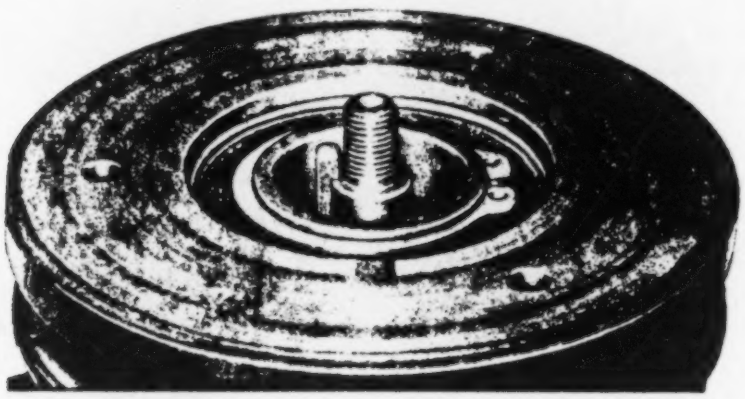

Drive Plate Key Installed in Keyway

INSTALL THE HUB AND DRIVE PLATE

1. Align the hub with the shaft key. Use the hub installer to tighten the assembly on the shaft until there is a 3/32" space between the frictional surfaces of the drive plate and the pulley.

   Note: Hold the hub with the drive plate holding tool and tighten the assembly, slowly and carefully.

Installing Hub and Drive Plate Assembly

2. Install the spacer and retainer ring.

   Note: The convex side of the retainer ring must face the spacer.

3. Install a new locknut and torque it 14-16 ft. lbs.

   Note: The notch on the locknut must face towards the retainer ring.

4. Check the air gap between the frictional surfaces. Gap should be .022 to .057, or 1/32" to 1/16".

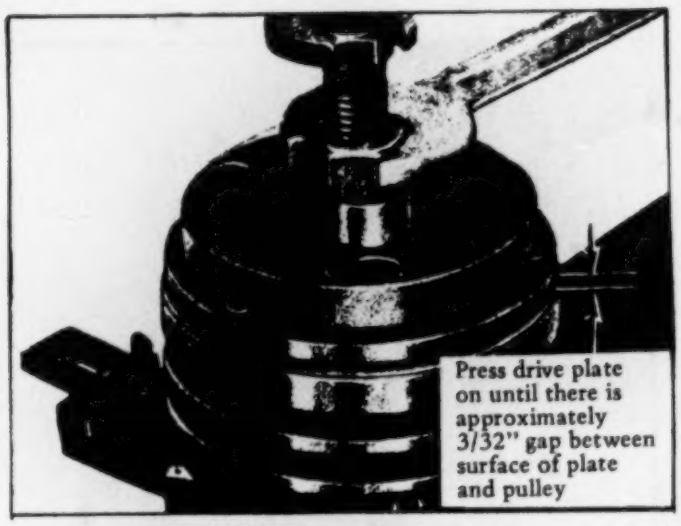

Installing Drive Plate Assembly

Caution: Do not pound or drive the hub and drive plate onto the shaft. Major internal damage to the compressor will result.

York and Tecumsek

INSTALL THE CLUTCH FIELD

1. Attach the clutch field to the compressor with four ¼" machine screws.

   Caution: Tighten the screws uniformly to avoid distorting the assembly. Torque screws 4 to 7 ft. lbs.

INSTALL THE CLUTCH

1. Wipe the compressor shaft clean.

2. Inspect the position of the Woodruff key. The key must be fully seated in the shaft and tightly fit. The key must also be parallel to the taper of the shaft.

3. Assemble the clutch onto the compressor shaft.

   Caution: Be sure the clutch hub keyway is aligned with the Woodruff key.

4. Lock the clutch onto the shaft with a 5/16" capscrew.

   Caution: Do not hammer the clutch onto the shaft as the clutch will be damaged.

5. Spin the clutch to be sure there is no interference with the field.

6. Energize the field wire and check clutch engagement. The clutch should engage and disengage with a sharp click. Connect the field lead at the bullet connector.

Chrysler

Follow the procedure outlined above with the following exceptions:

1. When installing the clutch field, be sure the lead wire points up and is routed between the compressor cylinder head.

2. Tighten the three field mounting screws to 17" lbs.

3. Assemble the clutch to the compressor shaft using a new self-locking bolt. Torque the bolt to 20 ft. lbs.

UNIT IV - THE ELECTRO-MAGNETIC CLUTCH

Lesson 5 — How to Replace the Clutch Bearing (Stationary Field Type)

Tools needed: Arbor or hydraulic press, hub puller, bearing tool adaptor and support plate, tool kit, 5/8" N.C. and N. F. bolts.

Parts needed: Clutch bearing

To replace the clutch bearing, remove the clutch from the compressor crankshaft and proceed as follows:

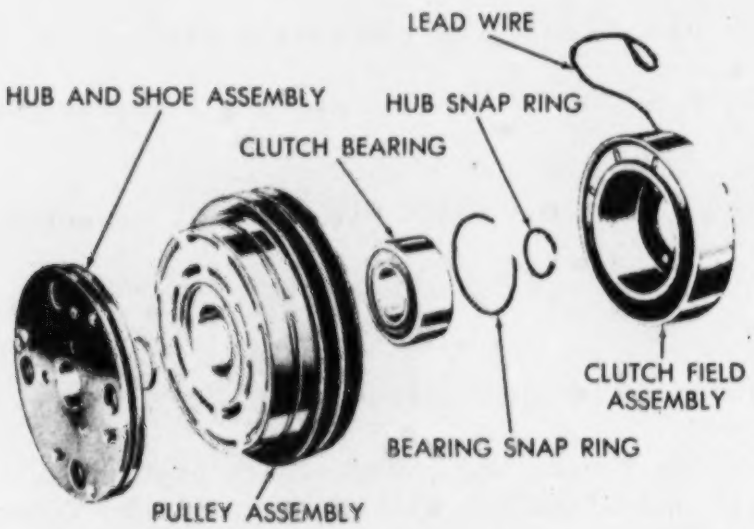

Magnetic Clutch—Stationary Field Type

DISASSEMBLY

1. Remove the small snap ring from the drive hub.

2. Install the hub puller. Tighten the hex head bolt until the drive hub is removed from the bearing.

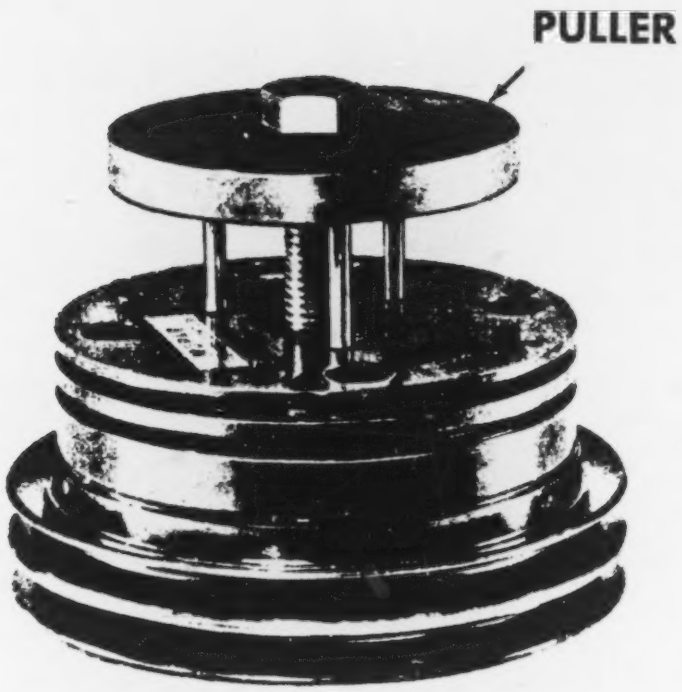

Removing the Hub and Shoe Assembly

3. Remove the bearing snap ring from the pulley assembly.

4. Place the pulley assembly on the press, with the pulley side down, and center the bearing hub on the support plate.

5. Install the bearing adaptor and press the bearing from the pulley assembly.

   Note: Whenever a bearing is pressed from the pulley assembly, a new bearing must be installed. The old bearing cannot be reused.

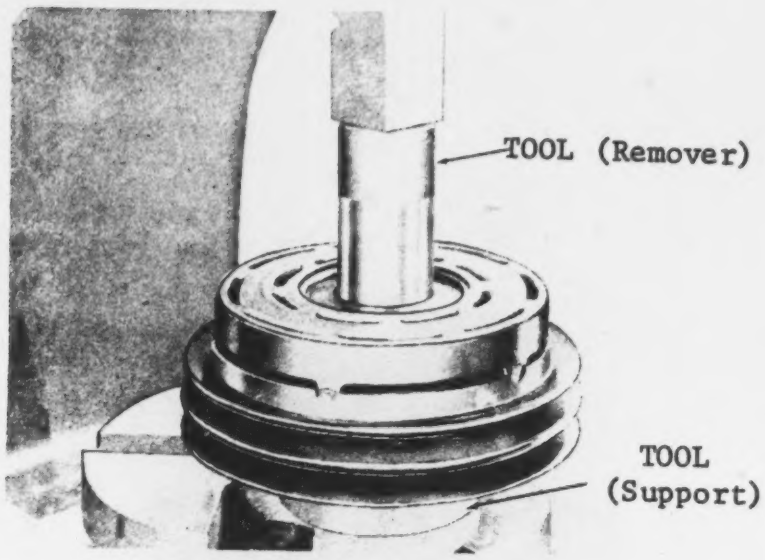

Removing the Bearing from the Pulley Assembly

ASSEMBLY

1. Place the pulley assembly, with the pulley side up, on the press, and insert a new bearing into the bore. Install the bearing adaptor on the bearing and press the bearing into the pulley assembly.

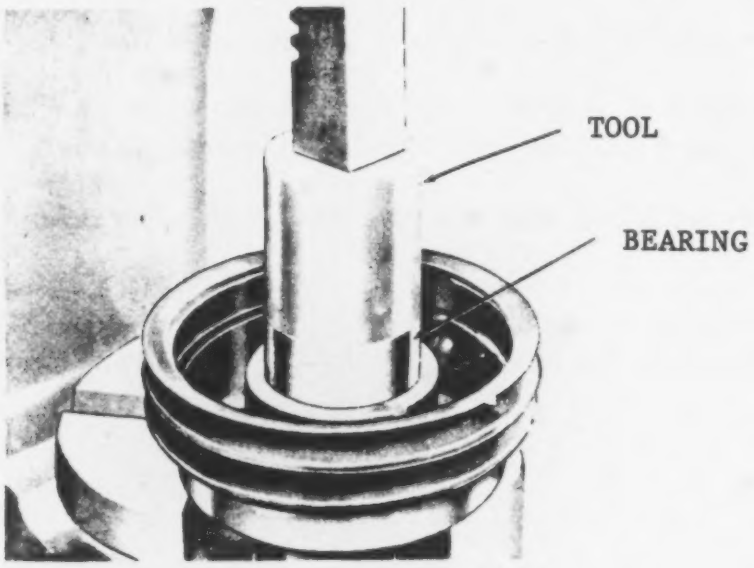

Installing a New Bearing in the Pulley Assembly

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2. Install the pulley assembly on the support plate, with pulley side facing down.

3. Start the drive hub into the inner bearing race and press the hub into position with the press.

4. Install the bearing snap ring and the hub snap ring.

   Install the clutch on the compressor crankshaft, and tighten the clutch with a new bolt.

   Note: The pulley assembly and the hub assembly are matched parts. Do not replace either unit separately.

Assignment:

1. Remove the clutch and disassemble the drive hub.

2. Ask your instructor to watch as you remove the clutch bearing.

3. Name the parts of the clutch.

4. Assemble the clutch and replace it on the compressor.

UNIT V - THE COMPRESSOR

Lesson I — The Function of the Compressor

Objective: To learn why a compressor is used in an automotive air conditioning system, and what it does.

The purpose of the compressor is to pump the refrigerant into the condensor.

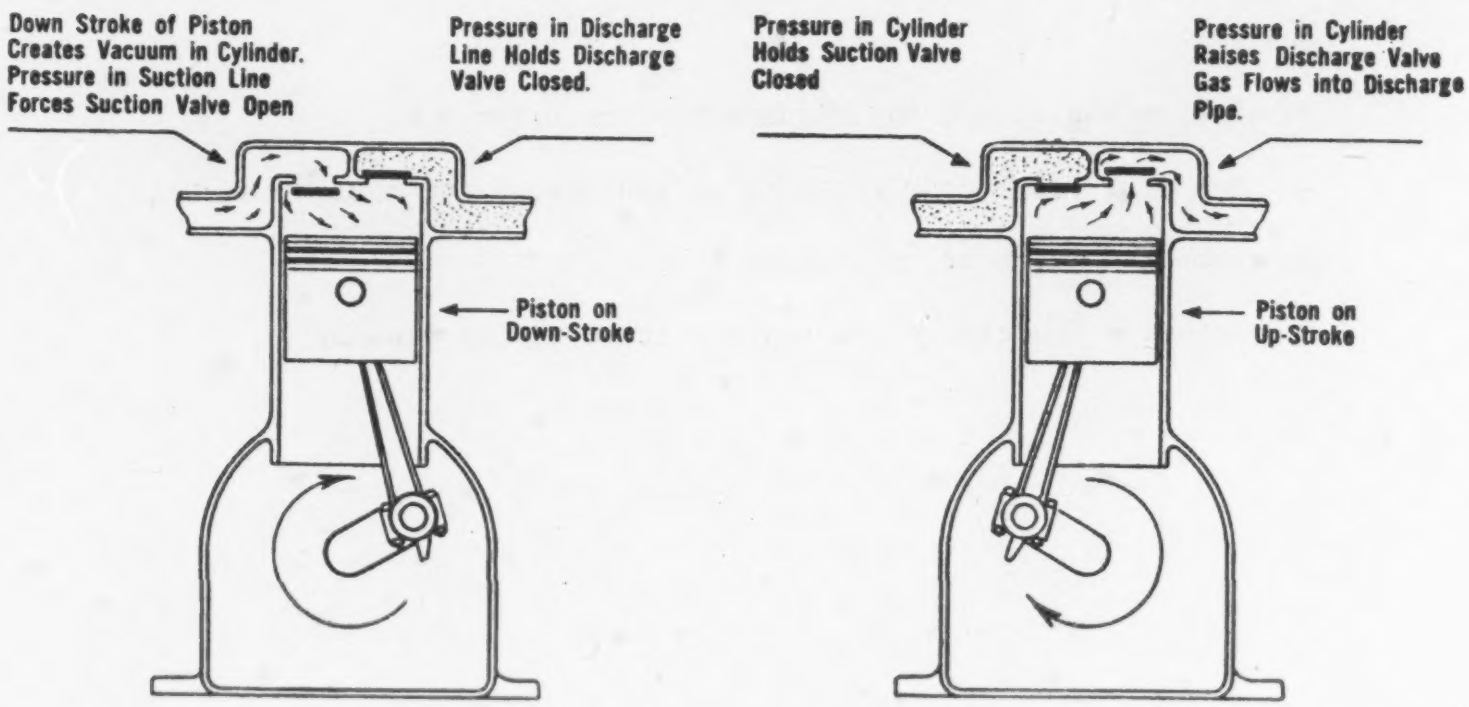

Operating Cycle of Reciprocating Compressor

The refrigerant enters the compressor as a low pressure gas, and leaves the compressor as a high pressure gas.

Each cylinder in the compressor has a suction valve and a discharge valve. As the piston in the cylinder travels downward, a low pressure area is created in the cylinder. Pressure in the suction line opens the suction valve, causing *low pressure gas* to enter the cylinder.

As the piston travels upward, the low pressure gas is compressed to a higher pressure, and temperature. This pressure closes the suction valve and opens the discarge valve causing *high pressure gas* to leave the cylinder.

Assignment:

1. What does a compressor do?

2. What is the state of the refrigerant as it enters the compressor?

3. What is the state of the refrigerant as it leaves the compressor?

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UNIT V - THE COMPRESSOR

Lesson 2 — Types of Compressors

Objective: To learn the types of compressors used in cars equipped with air conditioning, and the names of the principal manufacturers

Nearly all cars equipped with air conditioning use reciprocating compressors. By reciprocating, we mean straight-line-travel. As applied to a compressor, this term refers to the up and down travel of the piston in the cylinder.

The principal manufacturers of compressors are General Motors Corporation; Chyrsler Corporation; York, and Tecumsek Manufacturing Companies. General Motors manufactures five or six cylinder compressors, and the other companies manufacture a two cylinder model.

Typical Two Cylinder "in line" compressor

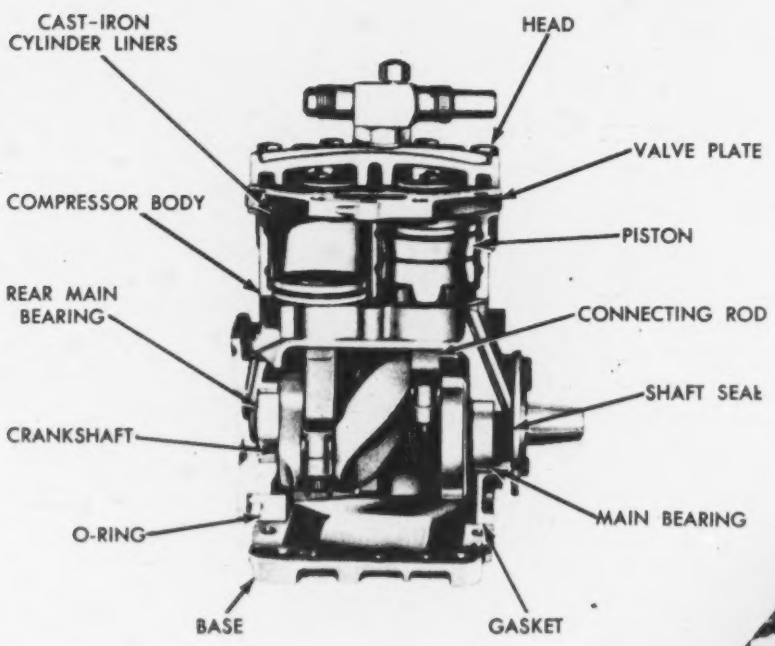

York Manufacturing Co.
Tecumsek Manufacturing Co.

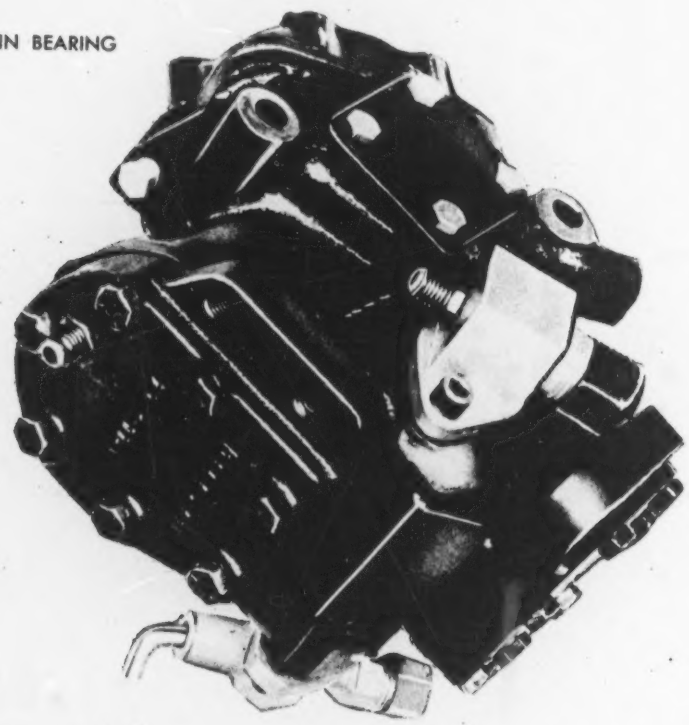

Chrysler Corporation Two Cylinder "V" Type Design

UNIT VI - SERVICE VALVES

Lesson I — Function in the System

Objective: To learn the need for service valves, and types of service valves in an air conditioning system.

All compressors are equipped with service valves. They are needed to perform the following service functions:

1. Discharge
2. Evacuate
3. Charge
4. Test

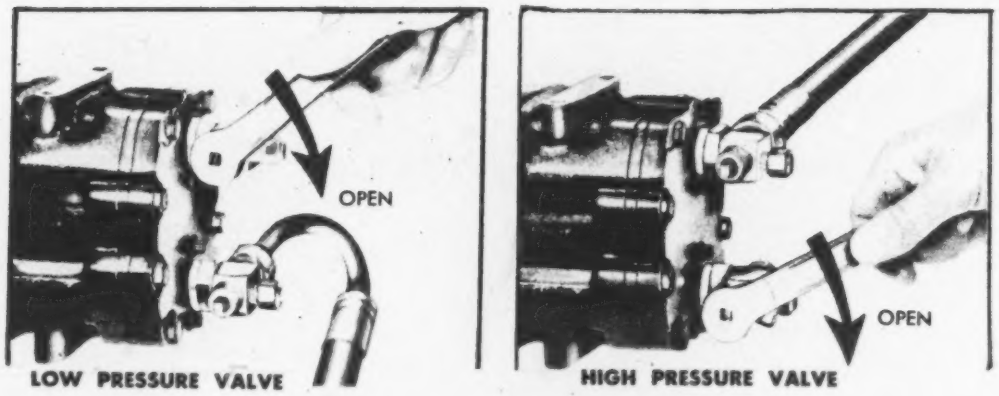

Opening Service Valve and Gauge Ports

The diagram shows service valves connected for charging the system. The compressor is a Chrysler Corporation "V" type design. Notice that Chrysler uses three service valves.

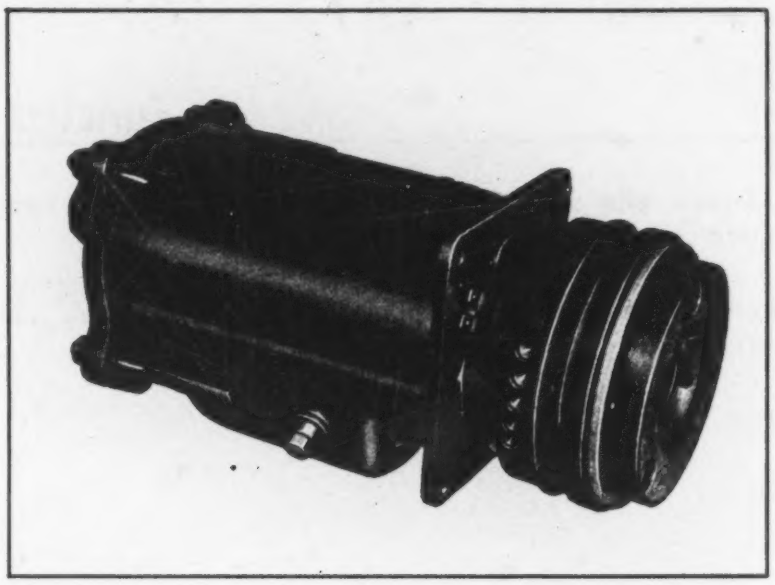

General Motors Corporation Six Cylinder Compressor

Assignment:

1. What does the term reciprocating mean?

2. How many cylinders are there in a York Compressor?

3. What is the difference between an "in line" and a "V" type compressor?

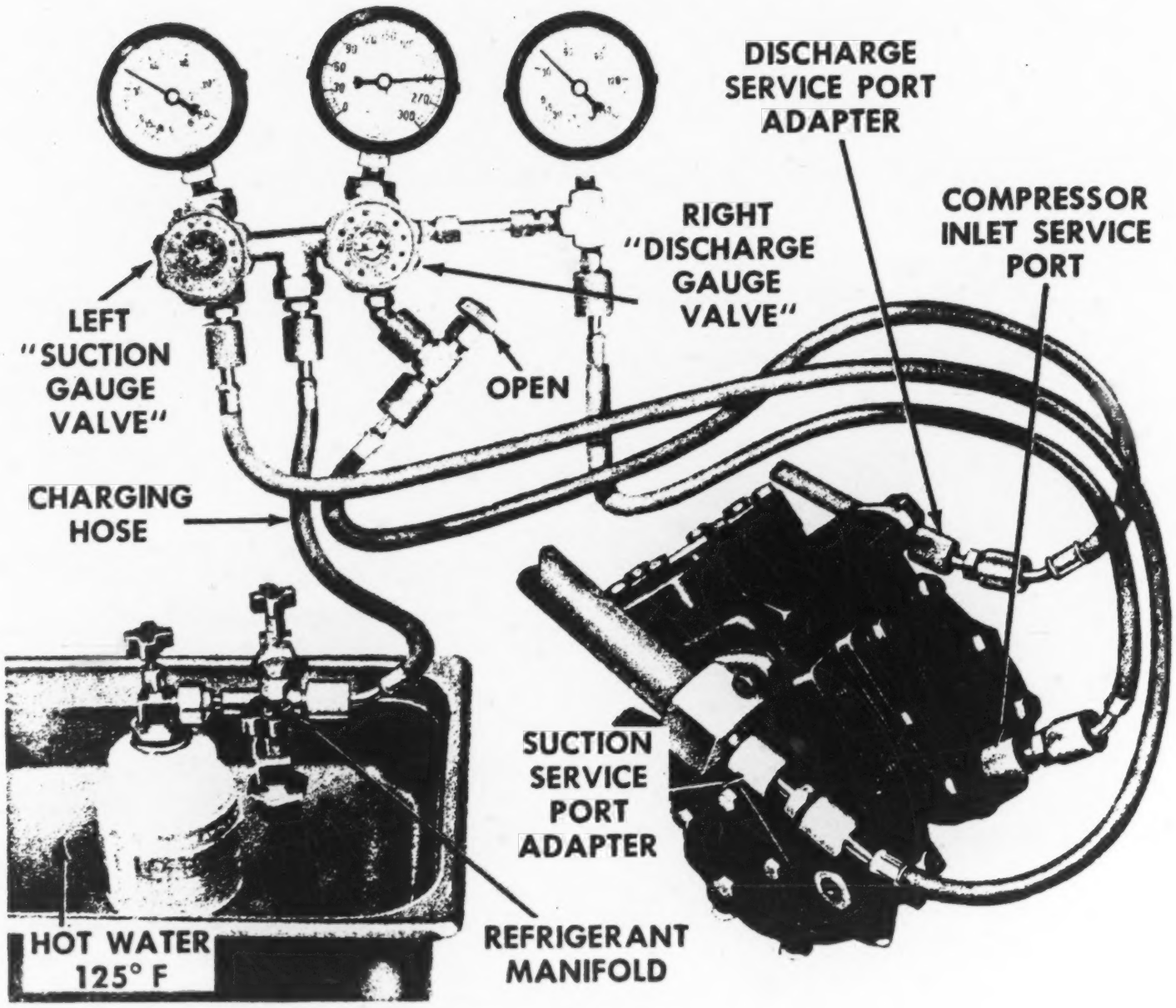

Adding Partial Refrigerant Charge

One valve is mounted at the outlet of the compressor and permits access to the high pressure side of the system. The other valve is mounted at the inlet side and permits access to the low pressure side.

There are two types of service valves; hand shut-off type, and Schrader type. A description of each follows:

HAND SHUT VALVES

This valve is a three position valve. It may be:

1. Front-seated. Refrigerant flow is shut off.

2. Back-seated. Refrigerant flow takes place.

3. Mid-positioned (cracked). In this position refrigerant flow takes

place, and pressure is indicated on the gauge.

Note: In position one and two the gauge part is closed and pressure cannot be indicated on the gauge.

A special wrench is needed to open and close the valve.

Service valve ratchet wrench

Hand shut-off type service valve

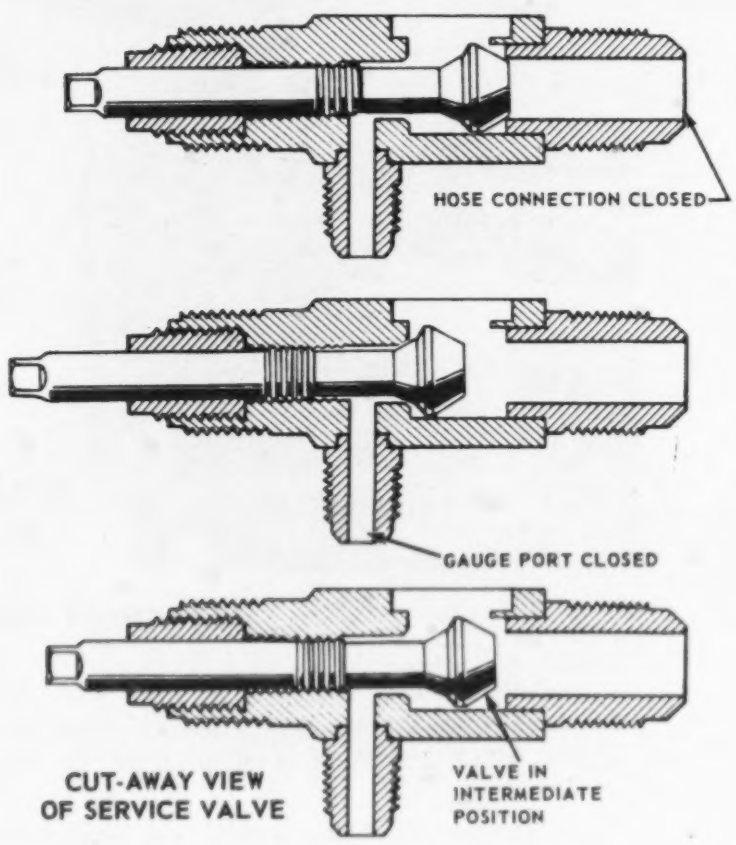

SCHRADER VALVE

This valve is a two-position valve. It may be:

1. Back-seated. This is its normal position; refrigerant flow takes place.

2. Cracked. In this position refrigerant flow takes place, and the gauge port is open. Pressure is indicated on the gauge.

Note: With the Schrader valve, refrigerant flow cannot be shut off.

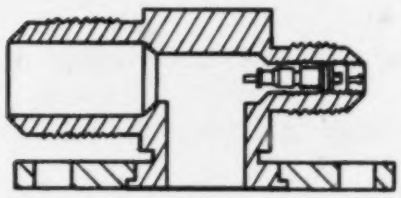

COMPRESSOR VALVE Schrader

The valve contains a stem pin, which when depressed by an adaptor connected to the hose of the manifold gauge set, connects the system to the gauge.

Inserts seal connections

Both types of valves are equipped with protection caps to seal out dirt and moisture.

Assignment:

1. What is the purpose of a service valve?

2. Where are service valves located?

3. Describe the positions of a hand shut-off type service valve, and describe the refrigerant flow for each position.

4. Is there an advantage to the hand shut-off type valve?

5. Is there a disadvantage to the hand shut-off type valve?

6. Describe the positions of a Schrader valve, and refrigerant flow for each position.

7. Is there an advantage to the Schrader type valve?

8. Is there a disadvantage to the Schrader type valve?

UNIT VI - SERVICE VALVES

Lesson 2 — The Gauge Manifold Set

Objective: To learn the need and purpose of the gauge manifold set, and the method of connecting it to the air conditioning system.

A gauge manifold set is needed in order to test, service, or repair an automatic air conditioning system. A description of the gauge manifold set and connection to the system follows:

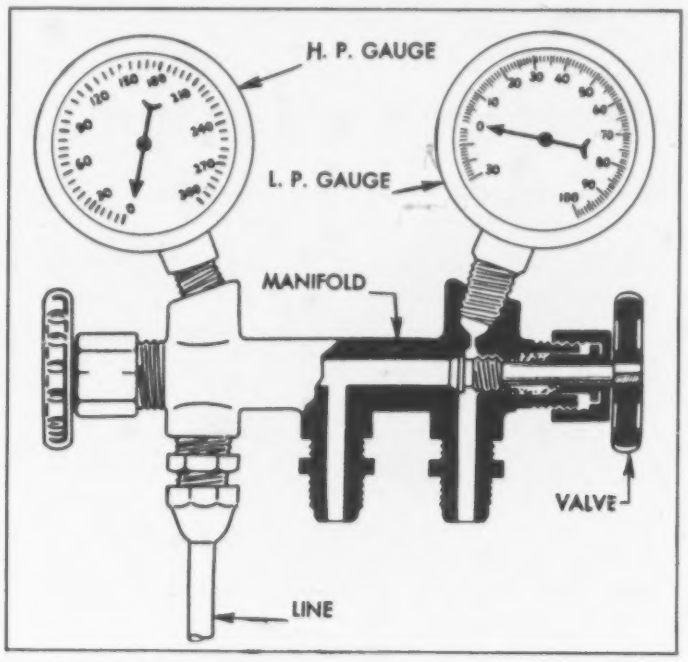

Pressure Gauge Set

THE LOW PRESSURE GAUGE

This gauge is a compound gauge; it will indicate either pressure or vacuum. Pressure readings up to 150 lbs., and vacuum 0 to 30 inches are recorded on the gauge. This gauge is always connected to the suction side of the system, the low pressure side. It may be connected to the suction service valve at the compressor, or to a suction pressure control device in the line before the compressor.

THE HIGH PRESSURE GAUGE

The high pressure gauge indicates pressures up to 500 lbs. and is always connected to the discharge service valve at the compressor. This is the high pressure side of the system.

THE MANIFOLD

The gauge manifold is a mounting fixture. It is equipped with a hand shut-off valve for each gauge. The manifold contains internal passages which are connected to the valves, and also to a common inlet-outlet port. The inlet port is used for purging, evacuating, and charging the system.

The manifold has threaded fittings, to which hoses approximately three feet long are attached. Where the hoses are connected to the service valves, the gauge manifold is said to be "connected into the system."

Assignment:

1. What is the purpose of the gauge manifold?

2. Where would you connect the compound gauge?

3. Where would you connect the high pressure gauge?

4. Connect the gauge manifold to the air conditioning system.

UNIT VI - SERVICE VALVES

Lesson 3 — How to Connect the Gauge Manifold to the Service Valves

Tools needed: Gauge manifold, service valve wrench, tool kit.

To connect the gauge manifold proceed as follows:

HAND SHUT-OFF TYPE

1. Remove the protective caps from the service valves.

   Caution: Remove the caps slowly and be alert to a hissing sound. If the valve is defective refrigerant may escape and could be pressurized. Close gauge manifold valves.

2. Connect the high pressure gauge manifold hose to the discharge service valve of the compressor.

3. Connect the low pressure gauge manifold hose to the suction service valve of the compressor.

   Note: Connect both hoses hand-tight. Service valves are marked "suction" and "discharge."

4. Mid-position both service valves by turning several turns in a clockwise direction.

5. Open the high pressure gauge manifold valve, momentarily, to purge the air from the high pressure hose. Close the valve.

6. Repeat and purge air from the low pressure hose. The gauge manifold set is now connected to the system.

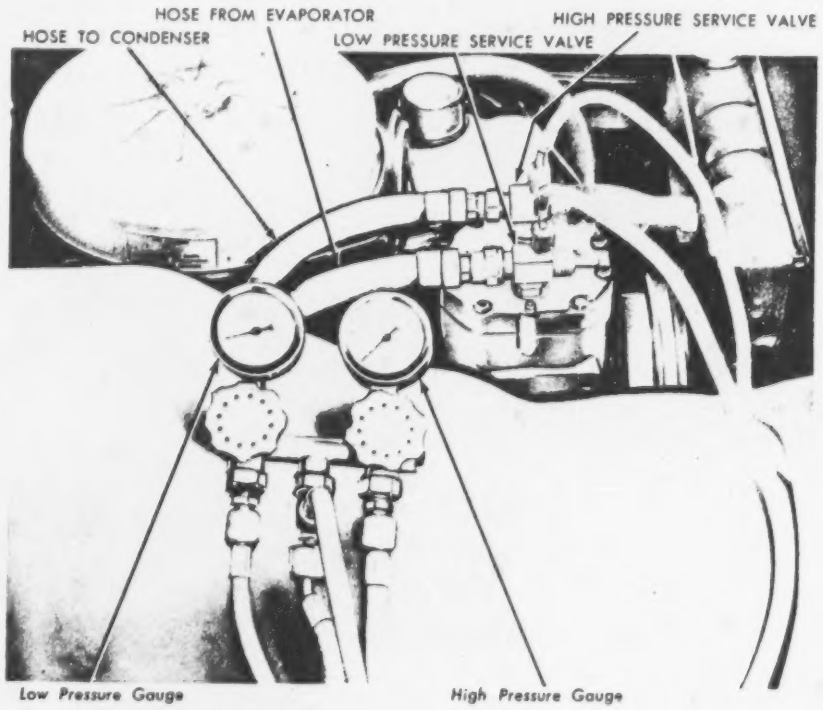

SCHRADER TYPE

1. Remove the protective caps from the service valves.

   Caution: Remove the cap slowly in event the valve is defective.

2. Close the gauge manifold hand valves.

   Note: In order to connect the manifold hoses to the service valves it is necessary to attach an adaptor as shown.

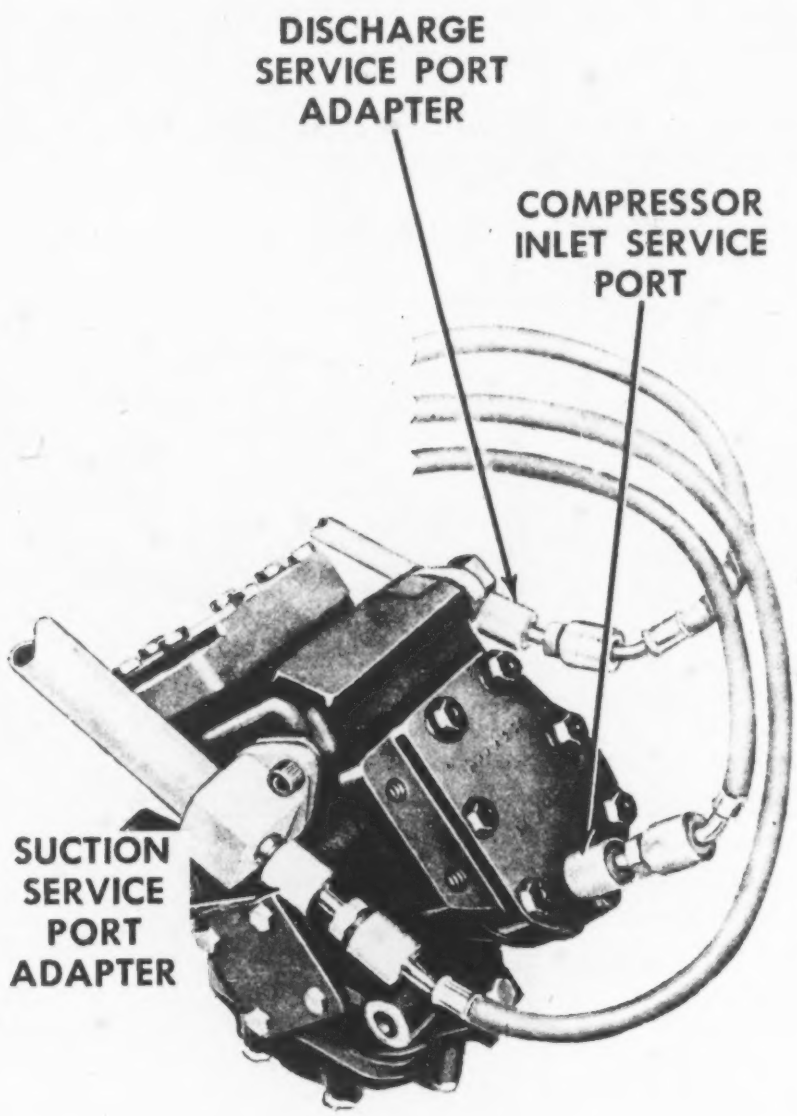

3. Connect the high pressure gauge manifold hose to the discharge service valve of the compressor.

4. Connect the low pressure gauge manifold hose to the suction service valve of the compressor.

   Note: Connect both hoses hand tight.

5. Open the high pressure gauge manifold valve, momentarily, to purge the air from the high pressure hose. Close the valve.

6. Repeat and purge the air from the low pressure hose.

   The gauge manifold is now connected to the system.

Assignment:

1. State two important cautions that must be observed when connecting the gauge manifold.

2. What might happen if air was not purged from the hoses?

3. State the step that must be performed in order to obtain a reading on the gauges when working with hand shut-off type service valves.

4. Connect the gauge manifold hoses to each type of service valve. Use an air gun and blow through the valve. Ask your instructor to explain the circuits.

UNIT VI - SERVICE VALVES

Lesson 4 — How to Connect a One Pound Can of R-12 to the Gauge Manifold

Tools needed: Gauge manifold can tap

Material needed: One pound can of R-12

Note: The one pound can of R-12 has become more popular when charging the system, because its use makes it simpler to calculate exactly how much refrigerant has been added. This eliminates the need for a scale and the weighing of larger containers. Can fixtures are available that connect three or four cans to the charging hose and ease charging.

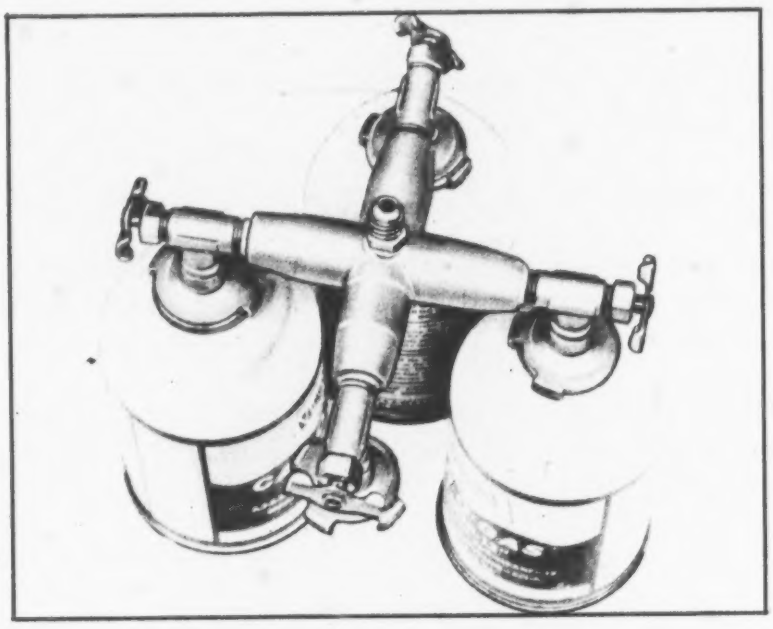

Disposable Cans and Valves

A special valve is required to connect the one pound can to the fixture, or to the center charging hose. This valve is known as a "can tap." To connect a one pound can of R-12 proceed as follows:

CONNECT THE VALVE TO THE ONE POUND CAN

1. Open the valve by turning it to the full counterclockwise position.

2. Connect the valve to the can.

   Caution: Be sure that the valve-to-can gasket is in place, and in good condition.

3. Connect the center charging hose to the valve.

CONNECT CHARGING LINE TO GAUGE MANIFOLD SET AND PIERCE CAN

1. Connect the center charging hose to the gauge manifold. Close both high and low pressure gauge manifold valves.

2. Turn the can tap valve to the full clockwise position. This will pierce the can and close the valve.

PRESSURIZE CHARGING LINE AND PURGE

1. Open the valve at the one pound can by turning to the full counter-clockwise position. The charging line is now pressurized.

2. Momentarily open and close the charging line at the gauge manifold. This will purge air from the charging line.

The one pound can is now connected and prepared for charging.

Assignment:

1. Connect a can tap to a used one pound can of R-12.

2. Practice opening and closing the valve.

3. Why must the gauge manifold valves be closed before opening the can tap valve?

4. Practice purging air from the center charging hose.

UNIT VII - BASIC SERVICE PROCEDURES

The services and procedures contained in this unit of instruction are those services that are most commonly performed. They are included at this point because most of the service procedures described in subsequent units of instruction require their understanding. In this way repetition is avoided.

UNIT VII - BASIC SERVICE PROCEDURES

Lesson I How to Discharge the System

Tools needed: Gauge manifold, service valve wrench, tool kit

Whenever any repair or replacement of components in the system is required, it is necessary to discharge the system. Proceed as follows:

1. Close the gauge manifold hand valves. Connect the gauge manifold to the compressor service valves. If the service valves are the hand shut-off type, turn to the mid-position.

2. Connect the center discharge hose to the manifold outlet. Direct the discharge hose to the building ventilation system or to the atmosphere.

   Caution: Do not discharge refrigerant into a confined area or near an open flame.

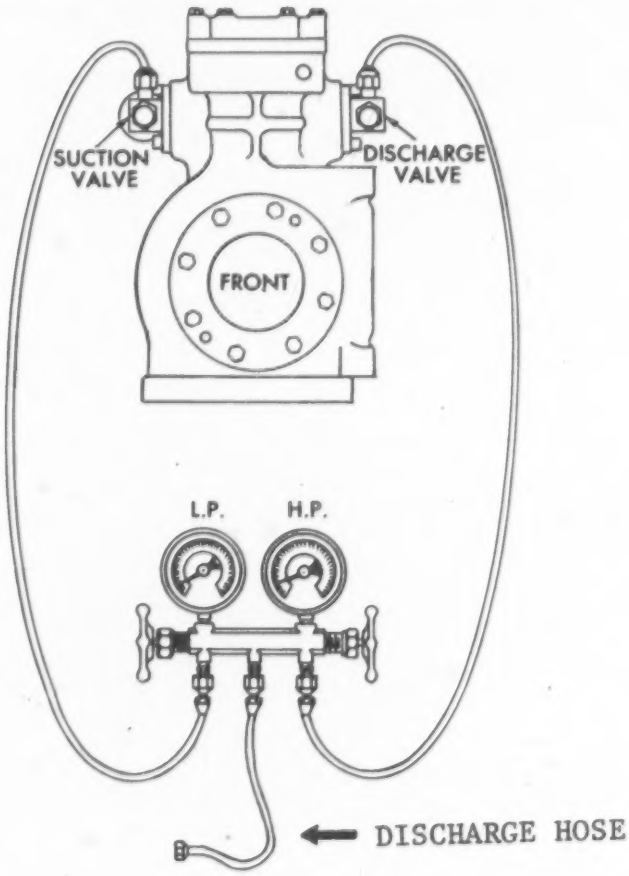

3. Start the engine and adjust the idling to 1500 R.P.M. Adjust the air-condition controls for maximum cooling and operate the system for fifteen minutes.

4. Allow the engine to idle for several minutes and turn the engine off.

5. Slowly open the gauge manifold hand valves and allow the refrigerant to bleed off. Continue bleeding until both gauges read zero.

6. Close the gauge manifold hand valves. Disconnect the gauge manifold from the compressor service valves.

   The system is now discharged and components may be removed or disconnected.

Assignment:

1. Refer to step 1. Why do we close both gauge manifold hand valves?

2. What might happen if we did not close the valves?

3. Why must the bleeding operation be performed slowly?

4. What is the next step to perform when a system component is disconnected?

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 2 System Evacuation

Objective: To learn the reasons why an automotive air conditioning system should be evacuated, and the purpose of a vacuum pump.

Whenever a component of an automotive air conditioning system containing refrigerant is disconnected and opened to the atmosphere, air and moisture will enter the system. It is of the most critical importance that the air and moisture be removed, to permit the system to function efficiently, and to prevent damage.

Note: The need for evacuation has no bearing on the length of time that the system was open.

Air must be removed, as its presence in the system will reduce the condenser's ability to condense the refrigerant gas and supply liquid refrigerant to the receiver drier. Air is a common cause for a loss of cooling efficiency.

Moisture will cause sticking of the thermostat expansion valve and irregular cooling. It will cause sludge which will damage the compressor. Moisture will also cause corrosion of the tubes in the evaporator and the condenser.

Note: Do not add alcohol or methanol to the system to prevent freezing of moisture. If these chemicals are added, the drier section of the receiver drier will release the moisture it has accumulated, and absorb the chemical. This will result in more moisture in the system.

The evacuation of air and moisture is accomplished by the use of a vacuum pump. In order to understand how this is done, it is first necessary to learn the relation of pressure to the boiling point of water.

The boiling point of water at sea level is 212°F. Atmospheric pressure at sea level is 14.7 P.S.I.

If this pressure is increased, the boiling point of water is increased.

If this pressure is lowered, the boiling point of water is lowered.

Vacuum is a term used to describe a pressure that is less than atmospheric pressure. This pressure is measured in inches of mercury, and designated by the symbol H.G. Example: 21^{HG} - or 21 inches of vacuum.

When a vacuum pump is connected to the system, the pressure in the system is lowered, moisture then boils and changes to a vapor which is collected by the vacuum pump.

A vacuum pump should be efficient enough to create at least 28 HG, and more desirable 29 - 30 HG. However, the higher values are possible only at sea level.

Water will boil under a vacuum at the temperature shown:

Vacuum	Degrees Fahrenheit
28. HG	100°
28.50 HG	90°
29. HG	75°
30. HG	- 25°

For each 1000 feet above sea level the specification should be lowered by 1 HG.

Assignment:

1. Would an air conditioning system have to be evacuated if it were open for five seconds?

2. Why does air in the system reduce condensation of the refrigerant gas?

3. Which situation is the most dangerous?

   a. Corrosion of the tubes in the condenser.

   b. Corrosion of the tubes in the evaporator.

4. Why is the boiling point of water highest at sea level?

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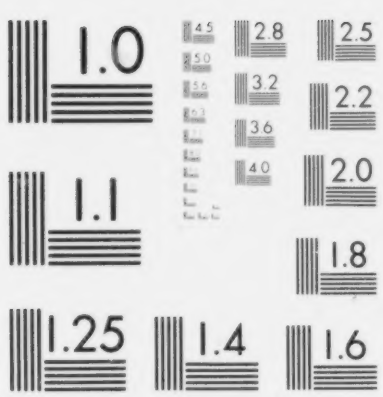

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 3 How to Evacuate the System

Tools needed: Vacuum pump, service valve wrench, gauge manifold, can tap.

Material needed: R-12

To evacuate the system proceed as follows:

CONNECT VACUUM PUMP AND GAUGE MANIFOLD

1. Connect the gauge manifold to compressor service valves.
2. Turn both service valves to the mid-position.
3. Turn both gauge manifold valves to the closed position.
4. Remove the protective caps from the inlet and exhaust parts of the vacuum pump.
5. Connect the center manifold hose to the inlet of the vacuum pump.

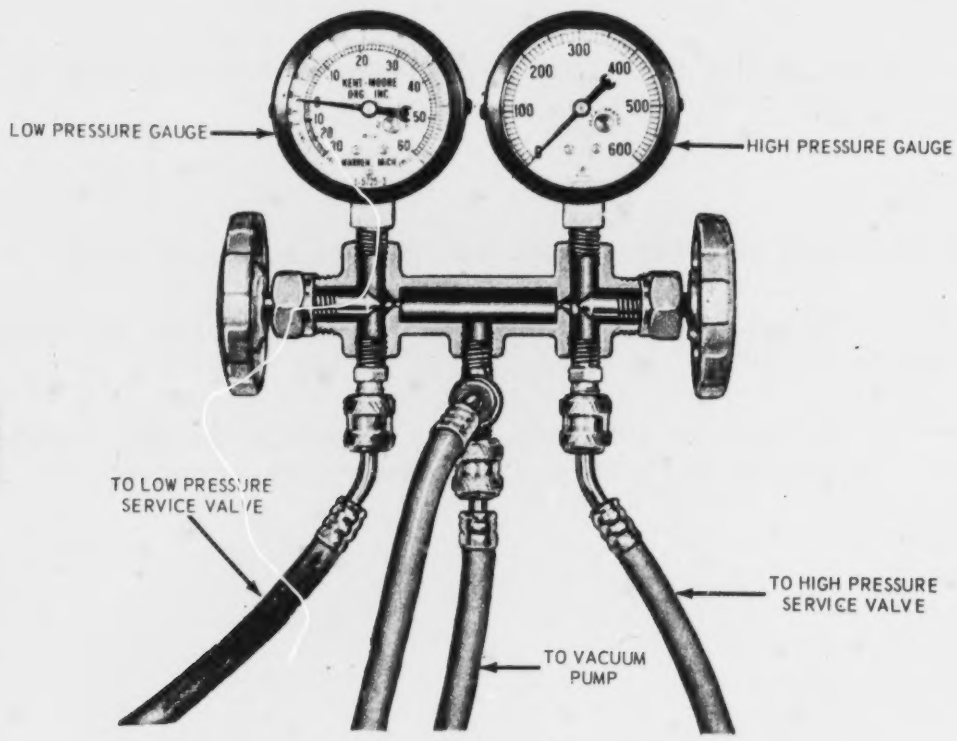

EVACUATE THE SYSTEM

1. Open both gauge manifold valves and start the vacuum pump.

2. Operate the vacuum pump at least thirty minutes. Close both gauge manifold valves and stop the vacuum pump. The low-pressure gauge should indicate at least 28 HG.

3. Disconnect the center manifold hose from the vacuum pump and connect the hose to a 1 lb. can of R-12. Open the valve at the can tap.

4. Momentarily open and close the center manifold hose at the gauge manifold to purge air from the hose.

5. Open the high-pressure-gauge manifold valve and allow the refrigerant to enter the system until a pressure of 5 PSI is indicated on the low-pressure gauge. Close the high-pressure-gauge manifold valve. Close the valve at the refrigerant can tap and disconnect the hose from the can tap.

6. Connect the center manifold hose to the inlet of the vacuum pump and repeat steps 1 and 2.

   Note: This double evacuation is necessary to assure complete removal of air and moisture.

7. Close both service valves at the compressor and gauge manifold valves.

SYSTEM IS NOW EVACUATED AND PREPARED FOR CHARGING

Assignment:

1. Why are both service valves set at the mid-position?

2. What trouble might be indicated if the low-pressure gauge did not indicate 28 HG?

3. Connect the vacuum pump and gauge manifold to the service valves. Your instructor will help you evacuate the system.

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 4 The Propane Gas Leak Detector

Objective: To teach the student the purpose of a leak detector and to describe how a leak detector functions.

The propane leak detector is a propane gas burning torch. It is used to locate refrigerant leaks in an air conditioning system.

The leak detector consists of a propane gas cylinder equipped with a hand shut-off valve, a burner head containing a reactor plate, and a sampling tube.

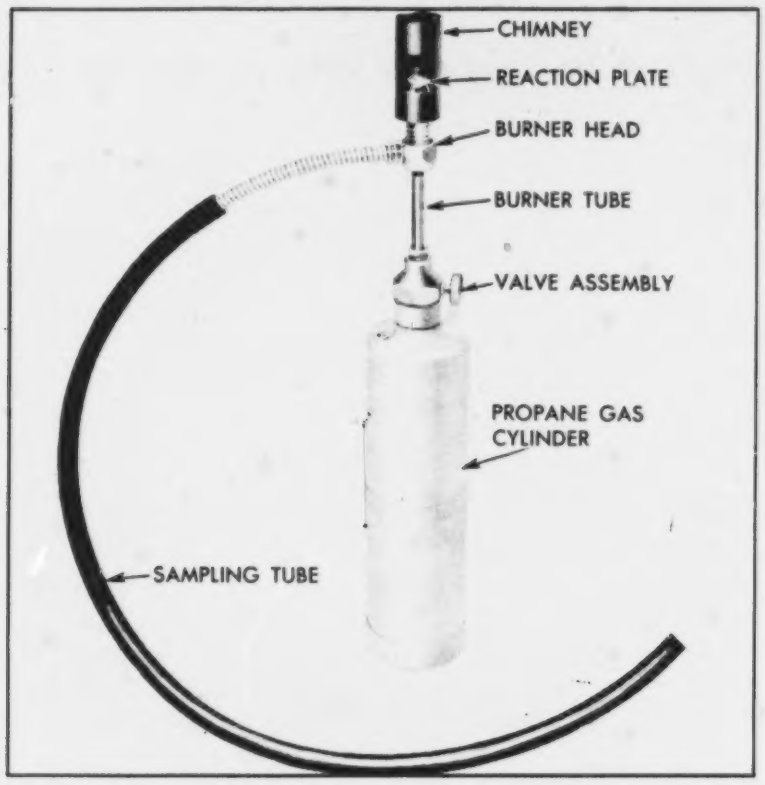

Leak Detector

Refrigerant gas drawn through the search hose will cause the flame in the burner head to vary in color in proportion to the size of the leak. A very small leak will produce a flame color of yellow-green to bright green. A larger leak will produce a brilliant blue flame.

The leak detector requires little service. When the gas cylinder is exhausted, a new cylinder may be screwed on the valve assembly. The plate may be cleaned periodically and is replaceable. It also may be tested for sensitivity. To test the reactor plate, light the torch

and hold the sampling tube under a compressor service valve. Crack the valve open and close it quickly. If the color of the flame does not change, clean or replace the reactor plate.

Assignment:

1. Name the parts of the leak detector.

2. What does the sampling tube do?

3. What color is produced by a large leak?

4. What other method might be used to test the reactor plate?

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 5 — How to Test the System for Leaks

Equipment needed: Leak detector, gauge manifold

Material needed: R-12

Caution: Never use the leak detector where a large concentration of refrigerant vapor is known to exist. When refrigerant vapor is exposed to an open flame, Phosgene, a poisonous gas is formed. This gas should never be inhaled.

Before testing the system for leaks it is necessary to check the system pressure. Proceed as follows:

NORMALIZE SYSTEM AND CHECK PRESSURE

1. Start the engine and run it at a fast idle. Adjust the controls for maximum cooling and operate the system for ten minutes.

2. Install the gauge manifold and determine system pressures.

3. Compare pressures with specifications. If pressures are low add a partial charge.

4. Turn the engine and air conditioner off.

   In event the system was serviced, or a leak repaired, use a portable fan to remove vapors from the engine compartment and dash area.

TEST SYSTEM FOR LEAKS

1. Open the leak detector valve and light the torch. Adjust the valve to obtain a small flame.

   Note: A small flame will detect a small leak, a large flame may not.

2. Allow the torch to burn until the reaction plate becomes red hot. The leak dectector is now ready for use.

3. Test all connections, hoses, compressor seals, and system components by placing the sampling tube on, over, and under the possible leak point.

Note: As R-12 is heavier than air, the escaping vapor may be present at the lowest part of the leak. It is good practice to place the sampling tube under the point being tested for several seconds. In this manner small leaks will not remain undetected.

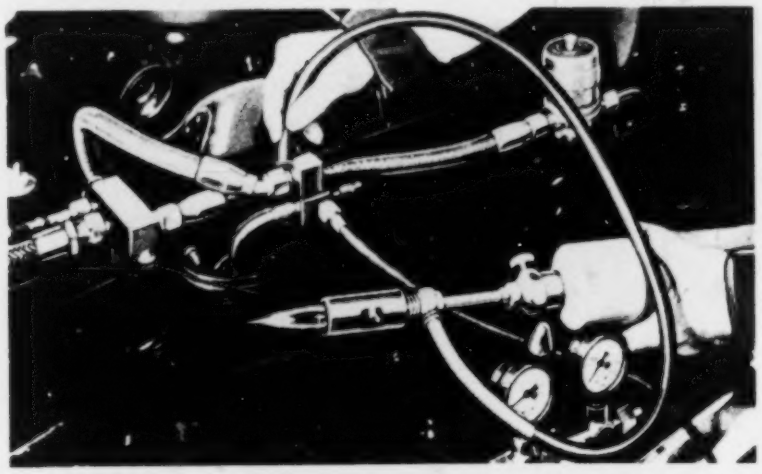

Using Leak Detector

4. Watch the flame and look for a change in color. If the color does not change, the system is tight and no leaks are present. If the color does change, repair the leak and retest.

5. Shut off the leak detector and allow it to cool.

6. Remove the gauge manifold.

Assignment:

1. Light the leak detector and learn how to warm up the reactor plate.

2. Place the sampling tube over a recently discharged can of R-12 and watch the color of the flame change.

3. Why should the sampling tube be placed under the point being tested?

4. What major caution should be observed when using the leak detector?

5. Name several other cautions.

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 6 How to Charge the System

Tools needed: Gauge manifold, service valve wrench, leak detector, tachometer, can tap.

Materials needed: 1 lb. cans of R-12

Note: Before performing this service, evacuate the system, and refer to the manufacturer's specifications to determine system capacity. To charge the system proceed as follows:

INSTALL GAUGE MANIFOLD SET

1. Connect the gauge manifold to the compressor service valves. Close both gauge manifold valves.

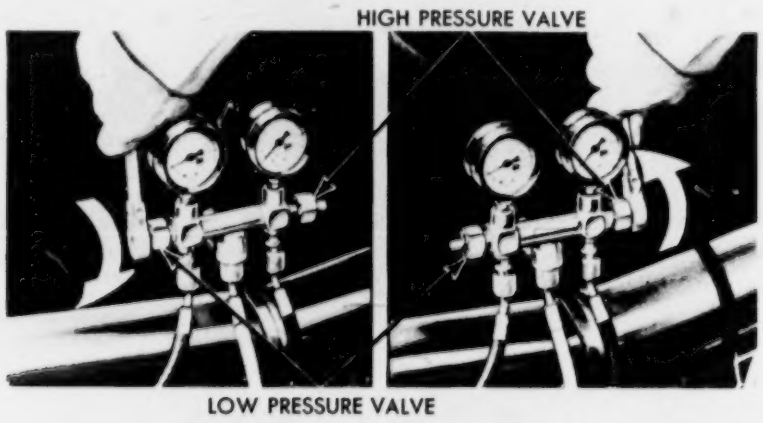

Closing Manifold Valves

2. Turn the compressor service valves to the mid-position.

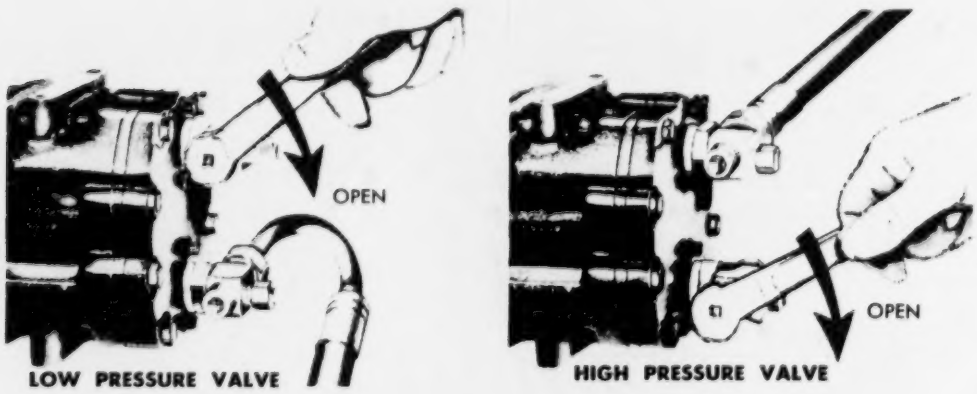

Opening Service Valve Gauge Ports

CONNECT MANIFOLD CENTER HOSE TO REFRIGERANT CAN

1. Close the valve at the can tap - turn counterclockwise to open.

   Attach the can tap to a 1 lb. can of refrigerant.

2. Connect the center hose to the can tap valve.

3. Close the valve at the can tap - turn clockwise. This will pierce the can.

4. Open the valve at the can tap - turn counterclockwise. This will charge the center hose with refrigerant.

5. Momentarily open and close the center hose of gauge manifold. This will purge air from the center hose.

CHARGE THE SYSTEM

Caution: When charging the system keep the can of refrigerant in an upright position. If the can is inverted liquid refrigerant will enter the system and damage the compressor.

1. Start the engine and adjust the idle to 1500 R.P.M. Adjust the air conditioning controls for maximum cooling.

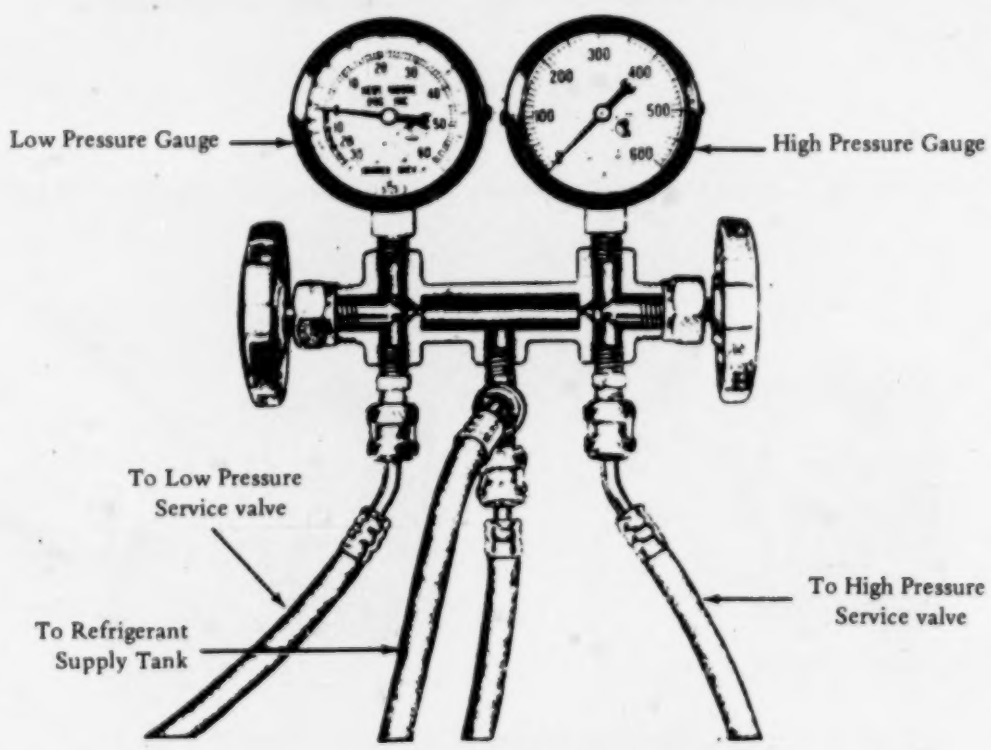

2. Slowly open the low side-gauge manifold valve.

   Refrigerant gas will enter the system.

   Note: Continue charging until the can is empty. In order to determine when the can is empty, observe the frost line on the outside of the can. As refrigerant enters the system, the frost line will move down on the outside of the can.

3. When the can is empty, close the low side-gauge manifold valve. Then slowly loosen the center hose at the gauge manifold set to relieve pressure. Remove the valve at the can tap.

4. Install another 1 lb. can of refrigerant and continue to charge the system, as described, to full capacity.

5. Check the sight glass for bubbles. If bubbles appear, add refrigerant in ¼ lb. increments until the bubbles disappear.

6. Test the system for leaks.

7. Return the engine speed to a normal idle.

REMOVE GAUGE MANIFOLD

1. Back seat both compressor service valves - turn counterclockwise.

2. Remove gauge manifold from the service valves and replace the protective caps.

3. Remove the can tap from the 1 lb. refrigerant can.

Assignment:

1. Connect a 1 lb. can of refrigerant to the center hose.

2. Connect the gauge manifold to the service valves.

   Your instructor will help you charge the system.

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 7 How to Add a Partial Charge

Tools needed: Gauge manifold, service valve wrench, can tap.

Material needed: One pound cans of R-12

To make a partial charge proceed as follows:

CONNECT GAUGE MANIFOLD AND REFRIGERANT TO SYSTEM

1. Connect the gauge manifold to the service valves. Adjust both gauge manifold valves to the closed position by turning them clockwise. Adjust both service valves to the mid-position.

2. Connect a 1 lb. can of R-12 to the center charging hose. Momentarily open and close the center charging hose of gauge manifold to purge the air. Close the can tap valve.

3. Open the low-pressure-gauge manifold valve, turn to the full counterclockwise position.

CHARGE THE SYSTEM

1. Start the engine and adjust the idling to approximately 1500 RPM. Adjust the air conditioning controls for maximum cooling.

2. Open the can tap valve and add refrigerant to the system.

   Note: Add refrigerant in one half pound amounts until the sight glass is clear of bubbles. Then add one half pound more.

   Caution: During charging the high pressure side may build up excessively. Do not allow this pressure to exceed 240 lbs. Stop engine, determine the cause and correct it.

3. Adjust both service valves to the full counterclockwise position. Remove the gauge manifold.

4. Test the system for leaks.

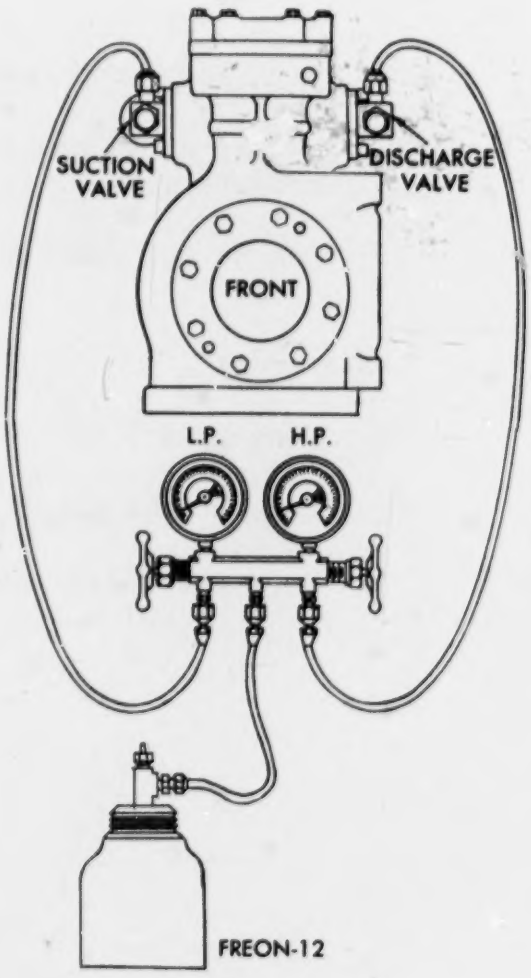

Connections for charging system.

Assignment:

1. Why are the service valves adjusted to the mid-position when charging the system?

2. To what side of the system do we add a partial charge?

3. State a reason why the high side-pressure might exceed 240 lbs.

UNIT VII - BASIC SERVICE PROCEDURE

Lesson 8 How to Isolate the Compressor

Tools needed: Service valve wrench, tachometer, tool kit

When it is necessary to remove a compressor for repair or replacement the compressor may be isolated from the system. The procedure is recommended as the system will remain sealed and the refrigerant charge will not be lost.

Note: This procedure applies only to compressors equipped with hand shut-off valves, and to compressors that are in operating condition.

ISOLATE THE COMPRESSOR

1. Start the engine and adjust the idling to 1,500 RPM. Adjust the air conditioning controls for maximum cooling. Operate the system for fifteen minutes. This procedure will return most of the oil to the compressor.

2. Return the engine speed to a normal idle; turn the engine and air conditioner controls off.

3. Close the high-pressure and low-pressure service valves by turning to the full clockwise position.

4. Loosen the protection cap on the high pressure service valve gauge part.

5. Crack the high-pressure service valve and allow the refrigerant gas to bleed off slowly.

   Caution: Bleed slowly or the compressor oil will also be discharged.

6. Close the high-pressure service valve - turn clockwise.

7. Disconnect the service valves at the compressor. The compressor is now isolated and may be removed.

   Caution: Do not disconnect the hoses at the service valves.

Assignment:

1. Why is it recommended that we operate the system and return the oil to the compressor before the compressor is isolated?

2. Why should the protection cap on the service valve gauge part be loosened slowly?

3. What would happen if a hose was disconnected at the service valve?

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 9 — How to Evacuate the Compressor and Return it to Service

Tools needed: Gauge manifold, service valve wrench, tool kit

Material needed: 1 lb. can of R-12, service valve gaskets or seals

To evacuate the compressor proceed as follows:

PURGE AIR FROM THE COMPRESSOR

1. Connect the service valves at the compressor.

   Note: Always install new gaskets or seals.

2. Open the high-pressure-gauge manifold valve. Close the low-pressure gauge manifold valve.

3. Crack the suction service valve. Refrigerant pressure in the low side of the system will force air out of the compressor through the high-pressure-gauge manifold valve.

4. Purge the air from the compressor for a few seconds. Close the high-pressure-gauge manifold valve.

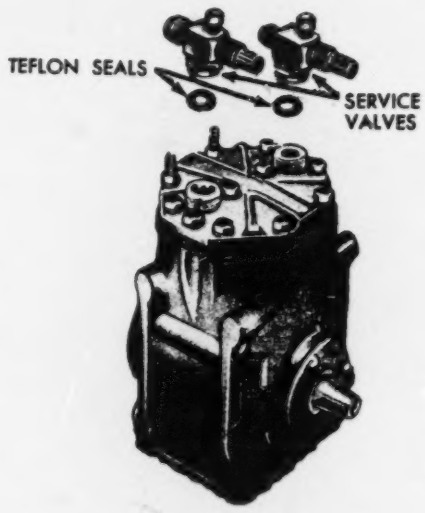

Compressor Service Valves Removed

CHECK SYSTEM CHARGE

1. Mid-position both compressor service valves.

2. Start the engine and operate the system for fifteen minutes.

   Check sight glass for bubbles.

3. Add a partial charge if necessary.

4. Turn both compressor service valves to the full counterclockwise position.

5. Remove the gauge manifold.

6. Test the service valves for leaks.

Assignment:

1. What would happen if a compressor was not evacuated?

2. Would a new compressor have to be evacuated?

3. What procedure would be necessary if a service valve leaked?

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 10 Refrigeration Oil

Objective: To learn the need for refrigeration oil in an automotive air conditioning system, and cautions in its use.

Oil is needed in the compressor to eliminate wear on the cylinder wall, piston, and other moving parts. Oil also lubricates the thermostat expansion valve, and keeps it from sticking. Compressor seals are kept pliable by oil, and this aids in preventing oil leaks.

As a small amount of oil is always present on the cylinder wall, it comes into contact with the refrigerant and circulates in the system. For this reason, refrigeration oil must be highly refined and non-forming.

Rules to remember concerning refrigeration oil are:

1. Never use motor oil, or any other type of oil, as a substitute for refrigeration oil.

2. Always use the viscosity recommended by the compressor manufacturer.

3. Never reuse refrigeration oil.

4. Always keep the oil containers tightly capped to prevent contamination by humidity or foreign substances.

5. Always follow the manufacturers instructions when checking the oil level. Methods of checking the oil level, and adding oil vary, as system and compressor design may dictate.

6. Always replace the access plug as quickly as possible.

The dipstick method of checking oil level is shown.

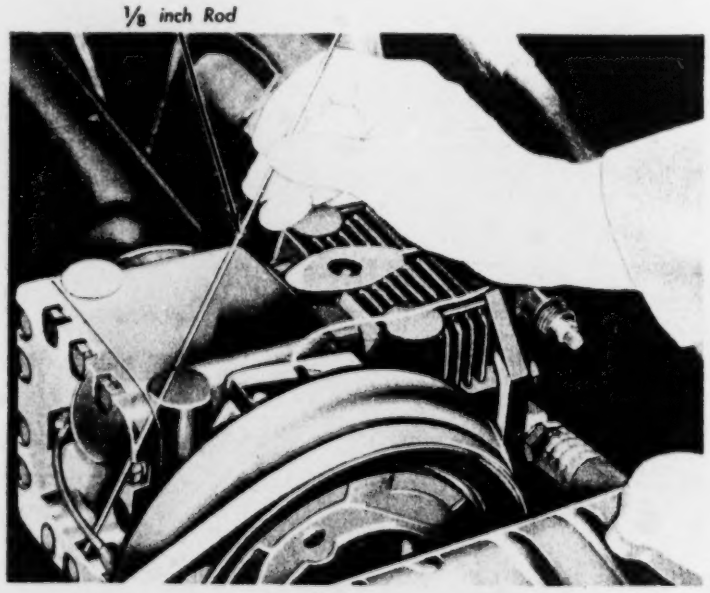

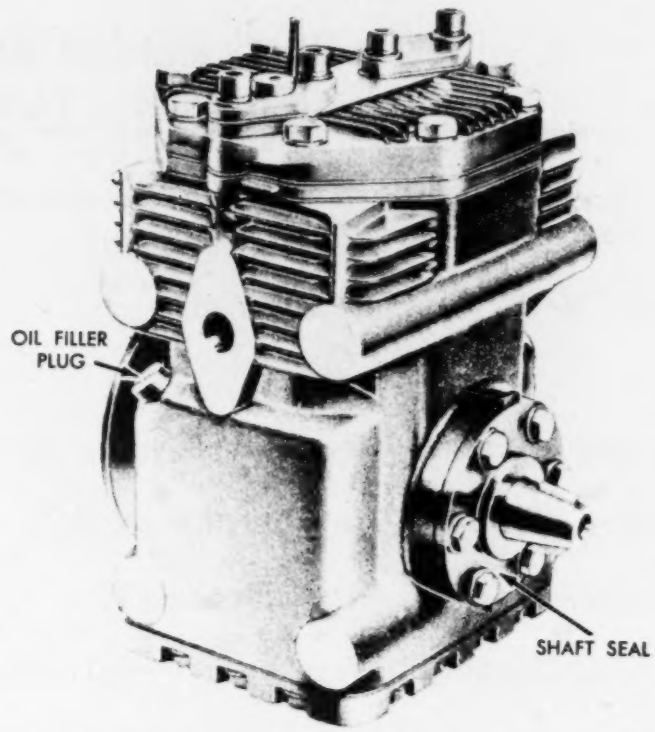

Assignment:

1. What is meant by the term non-foaming?

2. What does "viscosity" mean?

3. Can moisture enter a capped container?

UNIT VII - BASIC SERVICE PROCEDURES

Lesson II How to Check and Add Oil to the Compressor (Chrysler, York, Tecumsek)

Tools needed: Gauge manifold, service valve wrench, tool kit, leak detector, vacuum pump, dipstick.

Material needed: R-12, refrigeration oil

General

The oil level of the compressor should be checked:

1. As a periodic service - every 10,000 miles.
2. Whenever a system component is replaced.
3. Whenever a compressor is serviced or replaced.
4. Whenever the refrigerant charge is lost because of collision damage.

Before checking the oil level, start the engine and operate the air conditioner for fifteen minutes. To check and add oil proceed as follows:

CHRYSLER

1. Discharge the system.
2. Slowly remove the oil plug and insert a dipstick.
3. The oil level should be 2 inches on the dipstick. If oil is needed add oil to the proper level.
4. Evacuate the system.
5. Charge the system.
6. Test the system for leaks.

YORK AND TECUMSEK

Note: This procedure applies to compressors equipped with hand shut-off service valves.

1. Isolate the compressor.
2. Slowly remove the oil plug and insert a dipstick.

Note: These compressors are available in several models. The amount of oil specified varies from six to ten ounces, and will measure 7/8" to 1 3/16" on the dipstick. The compressor model must be identified in order to check the oil.

3. If oil is needed add oil to the proper level. Install the plug.

4. Evacuate the compressor and return it to service.

5. Test the system for leaks.

YORK AND TECUMSEK

Note: This procedure applies to compressors equipped with Schrader service valves.

1. Discharge the system.

2. Check the oil level. Follow the procedure outlined in steps 2 and 3 above.

3. Evacuate the system.

4. Charge the system.

5. Test the system for leaks.

Assignment:

1. Isolate the Tecumsek compressor. Your instructor will teach you how to identify the compressor model and how to check the oil.

UNIT VII - BASIC SERVICE PROCEDURES

Lesson 12 How to Check and Add Oil to the Compressor (General Motors Six Cylinder)

Tools needed: Gauge manifold, vacuum pump, leak detector, container indicating ounces, tool kit, tachometer.

Material needed: R-12, refrigeration oil

Note: It is not recommended that the oil in the compressor be checked as a periodic service because the oil cannot be checked while the compressor is installed on the car. The oil should only be checked when a hose has burst, or a system component is replaced.

To check or add oil to the compressor proceed as follows:

REMOVE COMPRESSOR AND DRAIN THE OIL

1. Start the engine and adjust the speed to 1,200 RPM. Adjust the air conditioning controls for maximum cooling and operate the system for fifteen minutes.

2. Return the engine speed to a normal idle and stop the engine.

3. Discharge the system.

4. Remove the compressor.

5. Remove the drain plug, hold the compressor in a horizontal position over the container and drain the oil.

6. Measure and record the amount of oil drained and discard the oil.

ADD OIL TO THE COMPRESSOR

Note: If the oil drained from the compressor is contaminated or contains water, it will be necessary to replace the receiver drier and flush the system components with liquid refrigerant. Add the full 11 ounce charge to the compressor.

If the oil is not contaminated, proceed as follows:

1. If the amount of oil drained was 4 ounces or more, add the same amount of oil to the compressor.

2. If the amount of oil drained was less than 4 ounces add 6 ounces to the compressor.

UNIT VIII - COMPRESSOR CRANKSHAFT SEAL REPAIR PROCEDURES

Lesson I - How to Replace the General Motors Six Cylinder Compressor Crankshaft Seal

Tools needed: Gauge manifold, hub and drive plate puller, hub and drive plate installer, pulley puller, seal seat remover, shaft seal remover and installer, "O" ring remover, charging line adaptor plate, vacuum pump, can tap, support bracket, tool kit, leak detector.

Material needed: Seal kit, refrigeration oil, R-12

Note: The use of proper tools is essential when performing this compressor service. Do not attempt to reseal the compressor without them.

REMOVE THE COMPRESSOR

1. Discharge the system.

2. Disconnect the driving belts and the hoses at the compressor. Remove the compressor.

3. Remove the clutch.

REMOVE THE CRANKSHAFT SEAL

Caution: Perform the following operations carefully. Do not nick or scratch the shaft or housing.

1. Remove the seal seat retaining ring.

Removing Seal Seat Retaining Snap Ring

2. Install the seal seat remover on the flange of the seal seat and remove the seal seat.

Removing Shaft Seal

3. Install the shaft seal remover and engage the locking tongs of the tool with the tabs of the shaft seal. Remove the shaft seal.

Removing Seal Seat

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4. Engage the "O" ring with the hook of the tool and remove the "O" ring from the housing.

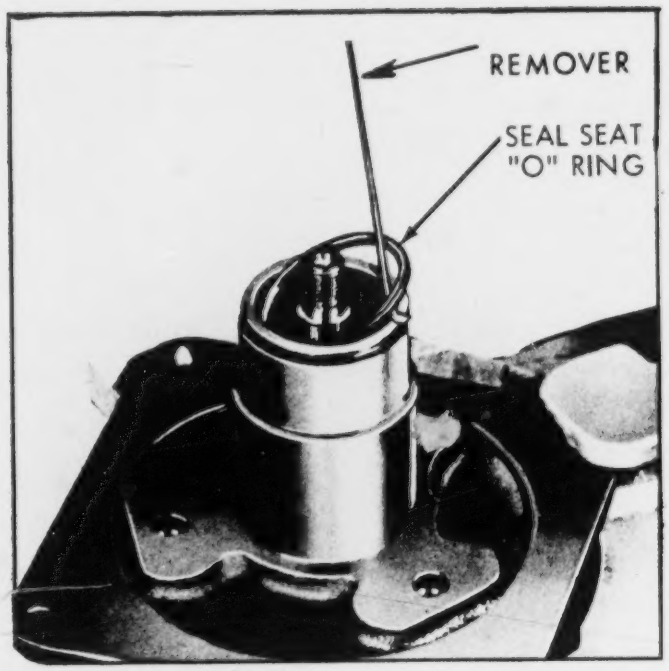

Removing Shaft Seal Seat O-Ring

INSTALL THE SEAL

Note: All seal parts must be kept clean.

1. Clean the housing and shaft with refrigeration oil. Apply refrigeration oil to all seal parts.

2. Place the "O" ring on the shaft seal remover and installer and position the "O" ring in its groove by pressing down on the sleeve of the installer. Turn the tool slowly and remove the tool.

3. Place the shaft seal on the seal installer. Engage the locking tongs as shown and insert the tool and seal over the shaft. Turn the seal and engage the flat on the shaft. Remove the tool.

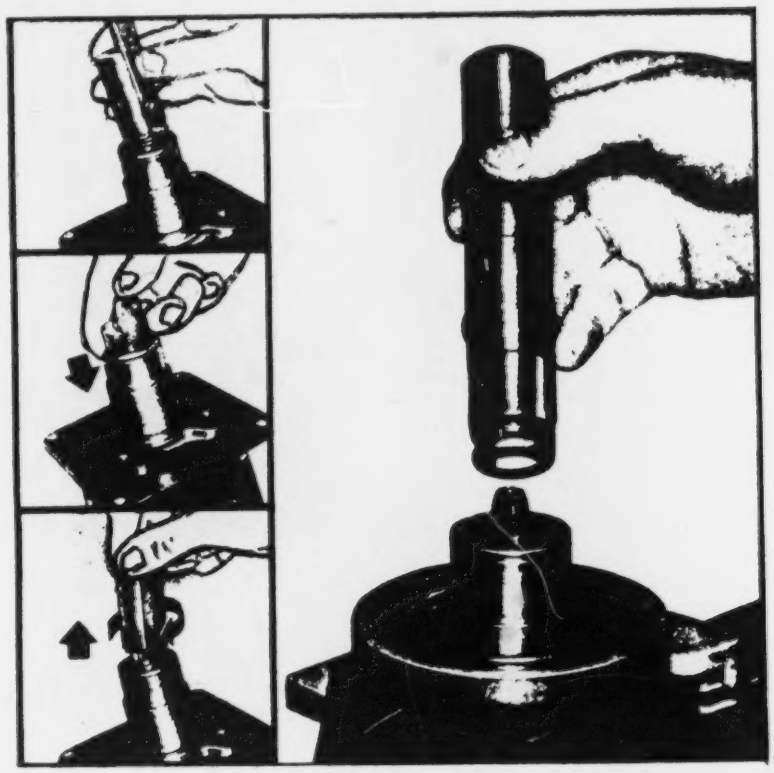

Replacing Seal and "O" Ring

4. Install the seal seat on the seat installer and install the seal seat.

5. Install the seal seat retaining ring.

Note: The flat surface of the retaining ring must face the seal seat.

LEAK TEST THE COMPRESSOR

1. Install the charging adaptor plate to the compressor.

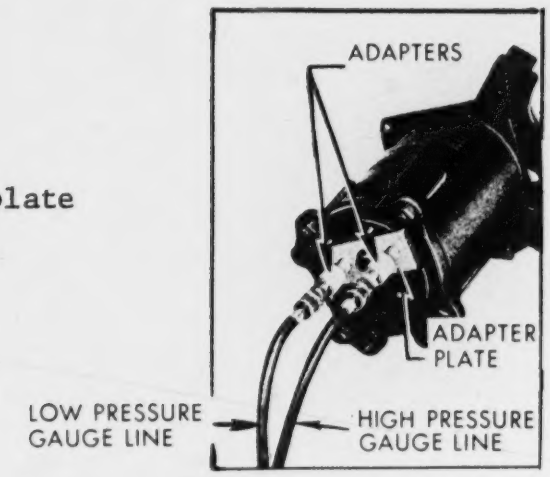

Charging Line Adapter Plate

2. Install the can tap on a 1 lb. can of R-12. Connect center manifold hose to can tap part and to gauge manifold.

3. Connect the gauge manifold to adaptor plate at the compressor.

   Open the valve on the can tap and momentarily loosen the center hose to purge the air from the lines and the compressor.

4. Open the gauge manifold hand valves and pressurize the compressor.

5. Rotate the crankshaft and test the seal and shaft areas for leaks with the leak detector.

6. Close the valve on the can tap. Slowly disconnect the center hose at the gauge manifold and allow the pressure to bleed off.

7. Remove gauge manifold and the adaptor plate.

8. Install the clutch.

INSTALL COMPRESSOR

1. Mount the compressor on the engine and connect the hoses and clutch lead.

2. Adjust the driving belts.

RETURN SYSTEM TO OPERATION

1. Evacuate the system.

2. Charge the system.

3. Test the system for leaks.

UNIT VIII - COMPRESSOR CRANKSHAFT SEAL REPAIR PROCEDURES

Lesson 2 — How to Replace the York and Tecumseh Compressor Crankshaft Seal

Tools needed: Gauge manifold, vacuum pump, leak detector, 5/8" x 2" NC bolt, tool kit, jumper wire.

Material needed: Seal kit, refrigeration oil, R-12

Note: If the compressor is equipped with hand shut-off service valves isolate the compressor. If the compressor is equipped with Schrader type service valves, connect the gauge set and discharge the system.

REMOVE THE COMPRESSOR

1. Disconnect the service valves at the compressor. Remove the driving belts. Disconnect the clutch lead at the bullet connector.

2. Connect a jumper wire from the position terminal of the battery to the clutch field lead and engage the clutch.

3. Remove the clutch hub bolt and install the 5/8" NC bolt in the clutch hub. Tighten the bolt slowly and remove the clutch.

4. Remove the compressor mounting bolts and remove the compressor.

REMOVE THE SEAL

1. Remove the Woodruff key from the crankshaft.

2. Remove the seal plate bolts and carefully pry the plate loose.

   Caution: Do not injure the sealing surfaces or the crankshaft.

3. Remove the carbon ring and the seal assembly.

4. Remove the gasket and clean the crankcase and seal plate mounting surfaces. Clean the crankshaft.

INSTALL THE SEAL - YORK COMPRESSOR

1. Apply refrigeration oil to the new seal and crankshaft.

2. Place the seal on the crankshaft with the carbon ring retainer facing out, and engage the seal drive ring slats with the drive pins on the crankshaft journal.

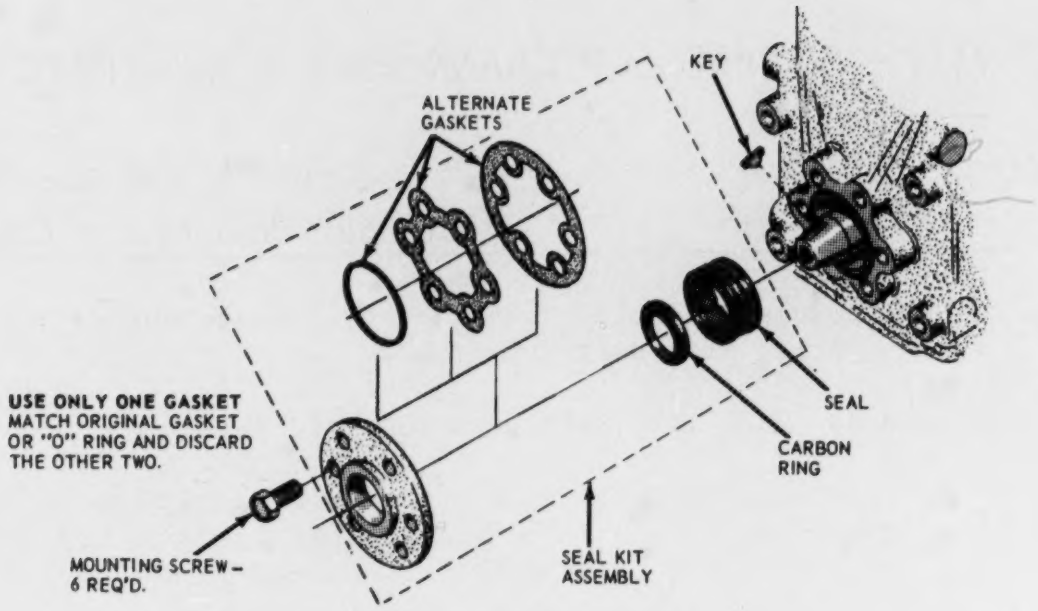

Crankshaft Seal Installation—York Compressor

3. Place the carbon ring on the crankshaft and in the seal ring retainer. The polished surface of the carbon ring must face out.

4. Apply refrigeration oil to the crankcase and seal cover plate and install the gasket on the crankcase.

   Note: Match the gasket from the seal kit with the original gasket. Alternate gaskets are supplied in the seal kit.

5. Install the seal cover plate with the polished side facing in. Install the capscrews and tighten evenly and in a diagonal manner. Torque is 7-13 foot lbs.

INSTALL THE SEAL TECUMSEH COMPRESSOR

1. Apply refrigeration oil to the new seal and crankshaft.

2. Install the seal on the crankshaft with the end that fits the carbon ring facing out.

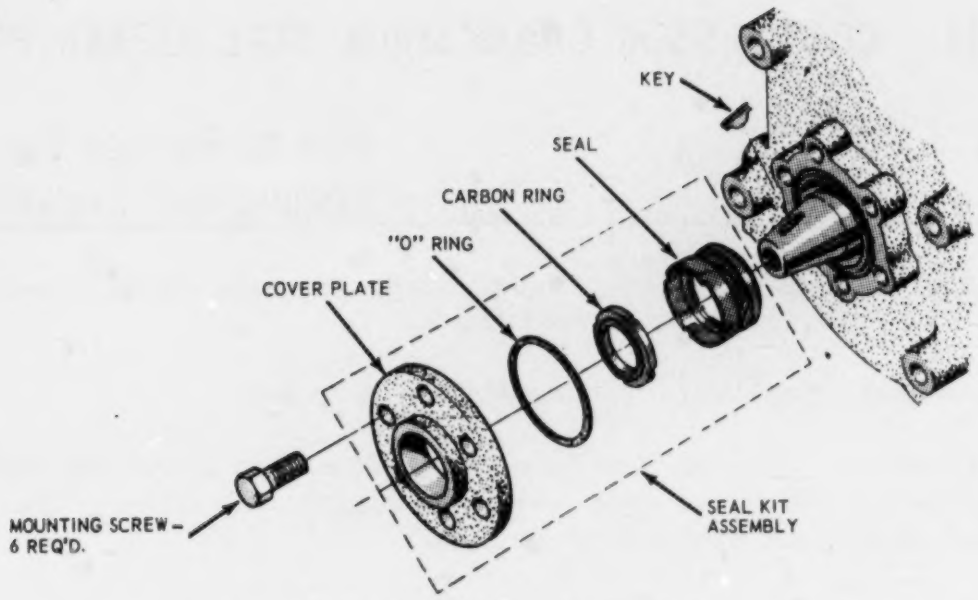

Crankshaft Seal Installation--Tecumseh Compressor

3. Place the carbon ring on the crankshaft with the raised rim of the carbon ring facing outward.

4. Install the "O" ring and seal plate cover on the crankshaft. Align the seal plate cover with the crankcase and install the capscrews.

5. Tighten the capscrews carefully and in a diagonal manner.

   Torque is 6-10 foot lbs.

INSTALL THE COMPRESSOR

1. Install the Woodruff key and align the key in the shaft.

2. Install the clutch and snug the hub bolt.

3. Install the compressor and tighten the mounting bolts.

4. Engage the clutch with a jumper wire and torque the hub bolt 20-30 foot-lbs. Remove the jumper wire and connect the clutch field lead.

5. Install the driving belts and adjust the belts.

6. Connect the service valves to the compressor - use new gaskets or seals.

RETURN COMPRESSOR TO SERVICE

1. If the compressor was isolated, evacuate the compressor and add a partial charge.

2. If the system was discharged, evacuate the system and charge the system.

3. Test the system for leaks.

UNIT VIII - COMPRESSOR CRANKSHAFT SEAL REPAIR PROCEDURES

Lesson 3 — How to Replace the Chrysler Compressor Crankshaft Seal

Tools needed: Gauge manifold, vacuum pump, can tap, leak detector, tool kit, 5/8" NC or NF bolt

Material needed: Seal kit, refrigeration oil, R-12

The Chrysler "V" type compressor crankshaft seal can be replaced without removing the compressor from the engine. Discharge the system, remove the clutch, and proceed as follows:

REMOVE THE SEAL

1. Remove the Woodruff key, and the crankshaft housing seal bolts.

2. Remove the bearing housing from the case. Insert two screwdrivers in the slots provided, and pry the housing from the case.

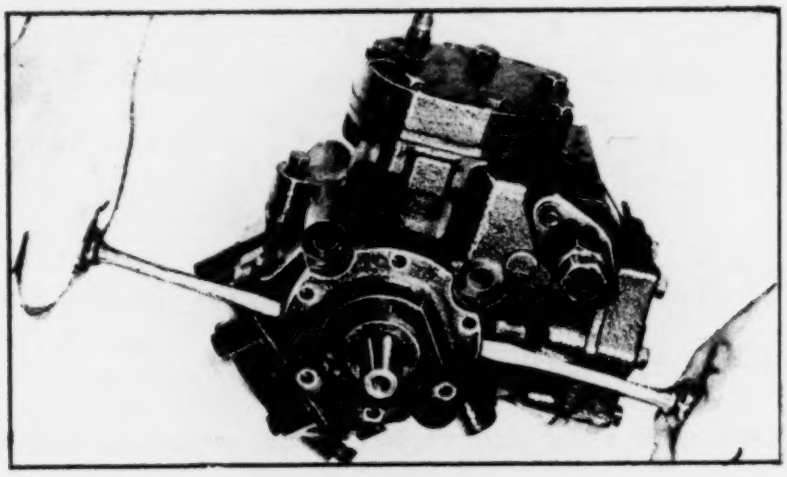

Crankshaft Bearing Housing Removal

3. Remove the crankshaft bearing housing seal face-plate from the bearing housing.

   Note: This is part of the gas seal replacement package and must be replaced when the gas seal is replaced.

4. Remove the gas seal from the crankshaft

INSTALL THE SEAL

Note: The crankshaft gas seal replacement package consists of the crankshaft gas seal assembly and the crankshaft bearing housing seal face plate. Two types of crankshaft seals are supplied for service, as shown. If the replacement package contains the cartridge-type seal, follow the entire installation procedure given below. If the replacement package contains the unitized-type seal, steps 1, 2, and 4 will not apply.

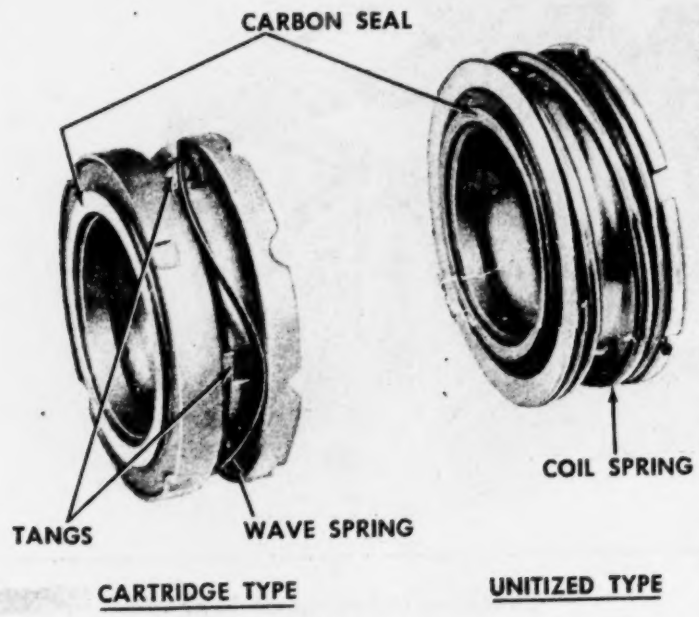

Gas Seal Identification

1. Before installing the cartridge-type gas seal assembly, insert the assembly to make sure that the tangs index the slots of the mating part. This will insure proper spring action. The carbon seal must be assembled, as shown.

2. Hold the seal firmly on the outside edge to prevent it from rotating out of the index slots.

3. Lubricate the crankshaft with refrigerant oil. Slide the seal on the crankshaft with the smooth (carbon seal) surface up, or toward the front of the compressor.

4. When the seal bottoms against the crankshaft bearing, test indexing of tangs again by pressing down with thumbs to see if it has the proper spring action.

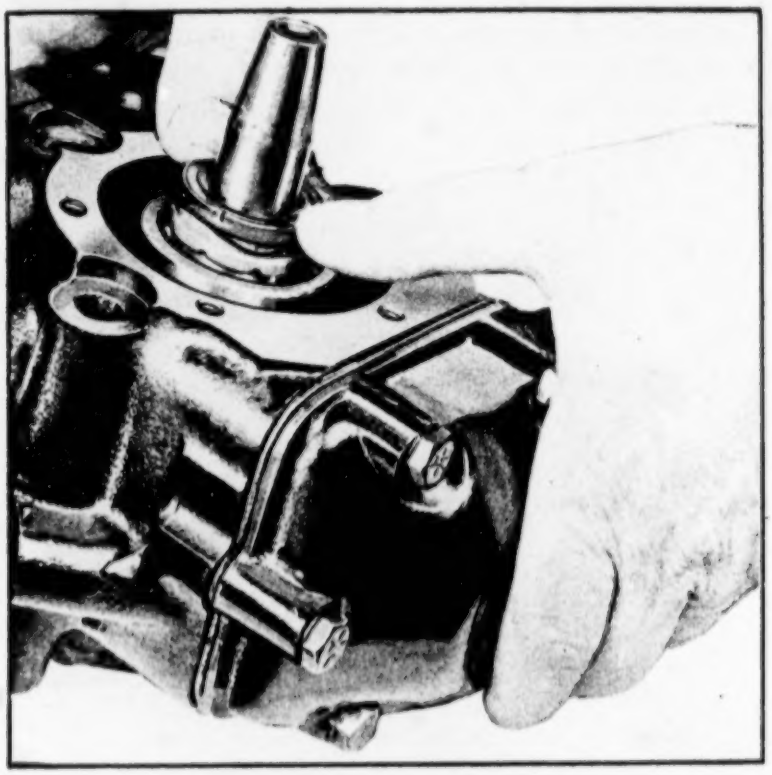

Checking Indexing of Tangs

5. Lubricate and install the crankshaft bearing housing seal face plate with the smooth (micro-finish) side up. Use a sleeve with the minimum inside diameter of 1 3/8 inches to avoid damaging the micro-finish sealing surface of the face plate. Tap sleeve lightly until the seal face plate is fully seated in the housing.

6. Install the bearing housing oil seal, using plenty of refrigerant oil.

7. Install the housing, making sure that it is in proper alignment with the screw holes. The gas seal assembly may be damaged if the bearing housing is rotated after the housing seal contacts the carbon seal.

8. Install bolts and tighten 10 to 13 foot-pounds torque.

RETURN COMPRESSOR TO SERVICE

1. Install the clutch

2. Evacuate the system

3. Charge the system

4. Test the system for leaks

Drawings and part of text courtesy of Chrysler Corporation.

Assignment:

1. Write a composition and state the key points and cautions to remember when performing compressor crankshaft seal repair procedures.

2. Prepare a list of the special tools required and explain their use. Refer to page 10 (Special tools and equipment).

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UNIT IX - THE CONDENSER

Lesson I — The Condenser's Function in the System

Objective: To learn what the condenser does.

The purpose of the condenser is to dissipate heat. For this reason, it is mounted in front of the car radiator.

The condenser is similar in design to a cooling system radiator, but it is engineered to withstand much higher pressure. Heat dissipation is accomplished as air passing through the condenser fins cools the hot refrigerant gas. As the refrigerant gas cools it condenses, and drops to the bottom of the condenser. For this reason the inlet to the condenser is always located at the top.

The refrigerant is then directed to the receiver drier as a high pressure liquid.

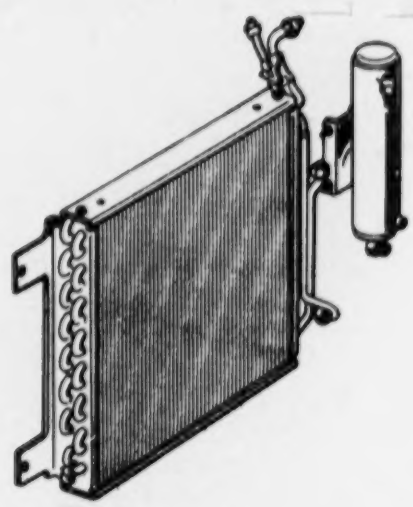

Assignment:

1. What does the condenser do?
2. Why must the condenser inlet be located at the top?
3. What effect do you think the condenser has on the car cooling system?
4. Where is the condenser located?

UNIT IX - THE CONDENSER

Lesson 2 How to Service the Condenser

Tools needed: Condenser comb, air gun, tool kit.

Note: In event a condenser developes a leak, do not attempt to repair it by welding, brazing, or soldering. The condenser must be replaced.

To service a condenser proceed as follows:

1. Tighten the condenser mounting bolts.

2. Clean the condenser with an air gun. Blow out leaves, bugs, and foreign material.

   Note: Bug screens are not recommended as they decrease air flow and reduce cooling efficiency.

3. If the condenser fins are bent, straighten them with the condenser comb.

Caution: This service must be performed carefully. Apply light pressure to the comb as you straighten bent fins. Too much pressure may rupture a condenser tube.

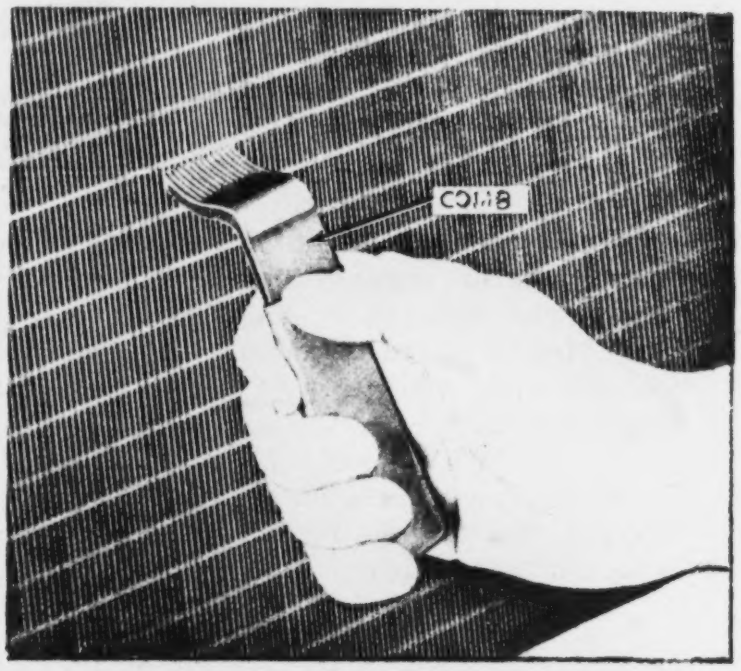

Condenser Comb

Assignment:

1. Why is unrestricted air flow through the condenser important?

2. Practice using the condenser comb.

UNIT X - THE RECEIVER DRIER

Lesson I — The Receiver Drier's Function in the System

Objectives: 1. To learn what the receiver drier does.

2. To learn where the receiver drier is located.

The receiver drier has four functions to perform in an automotive air conditioning system. They are:

1. Storage
2. Moisture absorption
3. Filtration
4. Trouble diagnosis

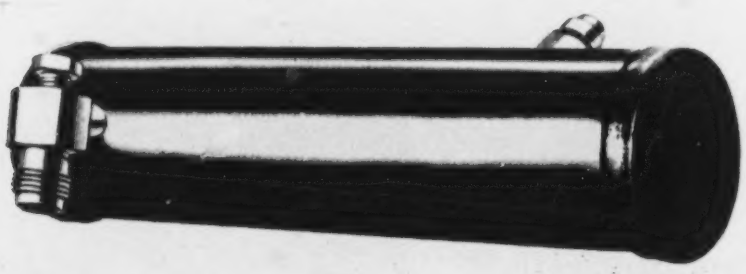

The receiver drier is located at the front of the car radiator, or in the engine compartment as close to the radiator as possible. The reason for this is to keep the unit cool so the refrigerant will remain in a liquid state. Another reason is because water and refrigerant do not mix when the refrigerant is a liquid. This is the best place to extract water.

This location also places the unit before the thermostat expansion valve. The valves function must be performed at the start of the refrigeration cycle.

Assignment:

1. What does a receiver drier do?
2. Give three reasons for its location in the system.

UNIT X - THE RECEIVER DRIER

Lesson 2 — Storage

Objective: To learn the purpose of the receiver section of the receiver drier.

Refrigerant enters the receiver drier as a high pressure liquid, and is stored in the receiver section until it is needed in the evaporator. It is normal however for the liquid refrigerant to contain some gases. For this reason, the receiver drier is constructed with a pickup tube which extends to the bottom of the unit. The liquid refrigerant, being heavier than the gas, drops to the bottom and the gas remains on top. In this way a solid column of liquid refrigerant is insured at the thermostat expansion valve.

The receiver section serves another purpose. Normal refrigerant loss through hose porosity and other minute leaks, is considered to be ½ lb. of refrigerant a year. The receiver section acts as a reservoir for the refrigerant, and makes system efficiency less dependent upon a precise state of charge.

Assignment:

1. If the refrigerant condenses to a liquid in the condenser, why is it normal to have some gases in the receiver?

2. Why is it necessary to have a solid column of liquid refrigerant to the thermostat expansion valve?

3. What is normal leak down?

UNIT X - THE RECEIVER DRIER

Lesson 3 — Moisture Absorption

Objectives: 1. To learn how damaging moisture is to an automotive air conditioner.

2. To learn how the receiver drier absorbs moisture.

Moisture will damage any refrigeration system. At low temperature it may freeze in the thermostat expansion valve and stop the cooling cycle. It also may freeze over the filtering screens and stop filter action. Moisture combined with oil in the compressor will form sludge and damage the compressor by lack of lubrication. When mixed with the refrigerant, moisture produces a highly corrosive acid. This will damage the evaporator, condenser, and compressor.

The receiver drier contains an element that absorbs moisture. The element is known as a dessicant, and usually consists of silica gel. Silica gel separates moisture from the refrigerant, and prevents damage to the components of the refrigeration system.

Because the dessicant is so eager to perform its function and absorb moisture, new receiver driers are capped tightly when stored. When installing a new unit, have all service tools required ready, and keep the unit sealed until connections are made.

Assignment:

1. What might happen if acid produced a hole in the evaporator?

2. What might happen if acid produced a hole in the condenser?

3. What units might be damaged if sludge was formed in the system?

UNIT X - THE RECEIVER DRIER

Lesson 4 — Filtration

Objective: To learn the purpose of a filter

Filters are used to remove particles of foreign material from the refrigerant. Such particles, circulating in the system, could block the thermostat expansion valve or damage the compressor.

In the unit shown, refrigerant flows through a screen, then through the filter, and again through a screen. This location of screens keeps the filter material from separating and circulating through the system.

Where evidence of frosting at the receiver outlet exists, a clogged filter may be suspected. Replace the receiver drier, as the filter cannot be cleaned.

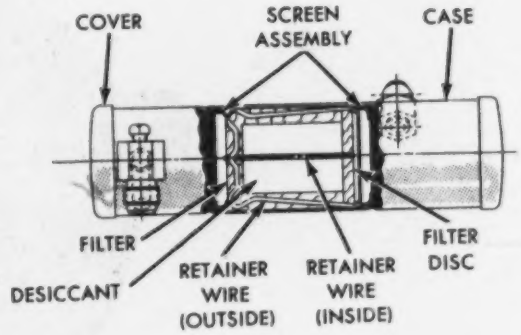

Assignment:

1. How could foreign material enter the system?

2. Why would a clogged filter cause the receiver drier to frost?

UNIT X - THE RECEIVER DRIER

Lesson 5 — Trouble Diagnosis

Objective: To learn the purpose of a liquid sight glass in the receiver drier.

Liquid sight glasses are installed in the liquid line of all refrigeration systems. They are used as a service aid when diagnosing system troubles.

The liquid sight glass is an intergral part of the receiver drier, and it is located in the outlet line, or center of the unit as shown:

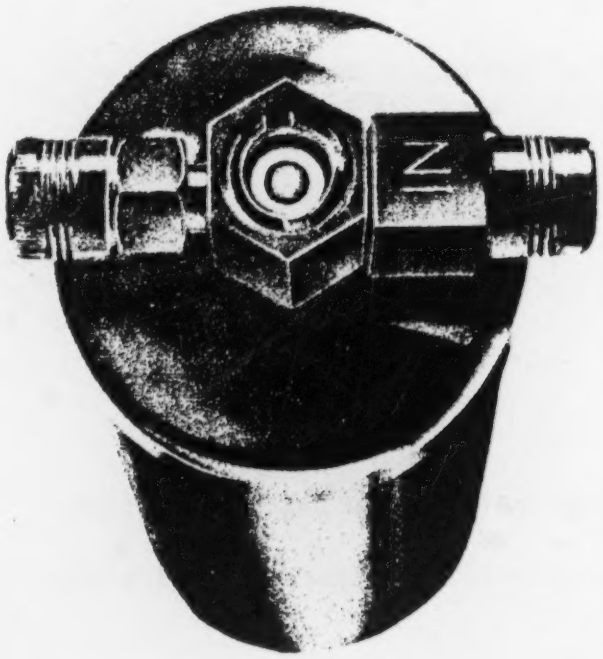

The unit has a protective plug, which when removed, allows us to see into the refrigerant system and determine if it is fully charged. The appearance of foam or bubbles beneath the sight glass, when the temperature of the air surrounding it is above 70°F, informs us that there is a shortage of refrigerant, or air is in the system. However, it is important to remember, that continuous bubbles may appear in a fully charged system, if the temperature of the surrounding air is low.

UNIT X - THE RECEIVER DRIER

Lesson 6 How to Use the Sight Glass

Tools needed: Push button remote control

The sight glass is used to determine if the system contains a full charge of refrigerant. To check the system for state of charge proceed as follows:

1. Start the engine and adjust the idle speed to 1,200 RPM.

2. Adjust the air conditioning controls for maximum cooling, and allow system to operate for fifteen minutes.

3. Remove the protective cap from the sight glass and clean the glass.

4. Observe the sight glass and note which of the following conditions exist:

LIQUID SIGHT GLASS

The presence of foam or bubbles

This indicates a system that is undercharged. Add refrigerant as necessary and check the system for leaks.

The absence of foam or bubbles

This indicates a fully-charged system, or a completely discharged system. To determine which condition exists, proceed as follows:

1. Disconnect the lead wire to the clutch at the bullet connector.

2. Connect the push button remote control from the position terminal of the battery to the clutch field lead.

3. Cycle the clutch off and on with the remote control while the system is operating.

If the system contains refrigerant, foam or bubbles will appear when the clutch is cycled off, and disappear when the clutch is cycled on.

If bubbles or foam do not appear as the clutch is cycled on and off, the system is discharged.

Assignment:

1. Where is the sight glass located?

2. Why can foam or bubbles appear in a fully charged system when the clutch is cycled off?

3. Is the sight glass on the high or low pressure side of the system?

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UNIT X - THE RECEIVER DRIER

Lesson 7 How to Replace the Receiver Drier

Tools needed: Gauge manifold, vacuum pump, tool kit, leak detector

Materials and parts needed: R-12, receiver drier

To replace the receiver drier proceed as follows:

DISCHARGE THE SYSTEM

1. Connect gauge manifold to the compressor service valves.

2. Discharge the system.

REMOVE THE RECEIVER DRIER

1. Disconnect the lines at the inlet and outlet of the receiver drier and cap the lines. Notice the position of the "in" and "out" working.

2. Remove the mounting bolts or brackets and discard the receiver drier.

INSTALL THE RECEIVER DRIER

1. Install the receiver drier in its original position.

   Note: Do not remove the sealing caps until you are ready to connect the lines as the dessicant will immediately begin to absorb moisture.

2. Connect the lines at the inlet and outlet.

   Note: The outlet line from the condenser must be connected to the inlet of the receiver drier.

EVACUATE THE SYSTEM

1. Connect the vacuum pump to the gauge manifold center connection.

2. Operate the vacuum pump for a minimum of thirty minutes.

3. Disconnect the vacuum pump.

CHARGE THE SYSTEM

1. Connect a container of R-12 to gauge manifold center connection.

2. Add the recommended charge and check the sight glass.

3. Test the system for leaks.

4. Remove the gauge manifold.

Assignment:

1. Why should the gauge manifold be connected to the system before it is discharged?

2. What do you think might happen if the lines to the receiver drier were connected wrong?

3. What additional procedure could you follow that would reduce the entrance of moisture into the receiver drier?

UNIT XI - THE THERMOSTATIC-EXPANSION VALVE

Lesson I — The Thermostatic-Expansion Valve's Function in the System

Objective: 1. To learn what the thermostatic-expansion valve does.

2. To learn where it is located in the refrigeration system.

Several methods of supplying the proper amount of liquid refrigerant to the evaporator have been used. The most popular method uses a thermostatic-expansion valve. Briefly stated, the thermostatic-expansion valve meters liquid refrigerant as needed, to the evaporator.

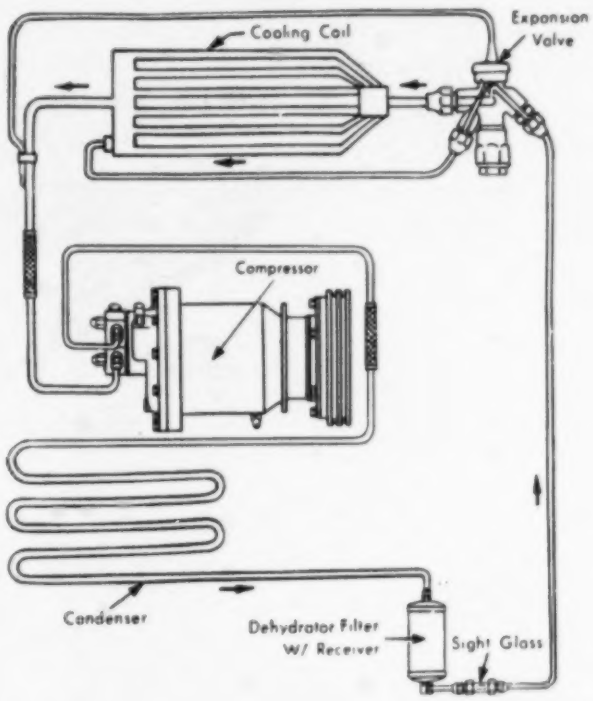

The valve is the dividing point in the refrigeration circuit between high pressure liquid supplied by the receiver drier, and low pressure liquid and gaseous refrigerant in the evaporator.

The valve is designed so that the temperature of the refrigerant at the evaporator outlet must have 4°F of superheat before more liquid refrigerant is permitted to enter the evaporator. By superheat, we mean an increase in temperature of the gaseous refrigerant <u>above</u> the temperature at which the refrigerant vaporized.

The thermostatic-expansion valve is located at the inlet side of the evaporator.

Assignment:

1. What does the thermostatic-expansion valve do?

2. What do we mean by the term "superheat?"

3. Where is the thermostatic-expansion valve located?

4. What is the phase of the refrigerant when it enters the thermostatic-expansion vlave?

UNIT XI - THE THERMOSTATIC-EXPANSION VALVE

Lesson 2 — How the Thermostatic-Expansion Valve Functions

Objectives: 1. To learn how the valve is constructed.

2. To learn how the valve meters and controls the flow of liquid refrigerant into the evaporator.

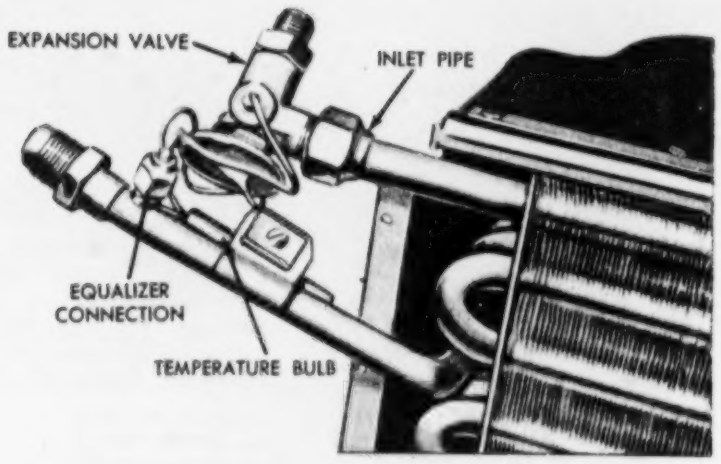

Expansion Valve Connections

The valve consists of the following parts:

Valve body; valve and seat; valve spring; diaphragm; operating pins; inlet screen; capillary tube;and remote bulb.

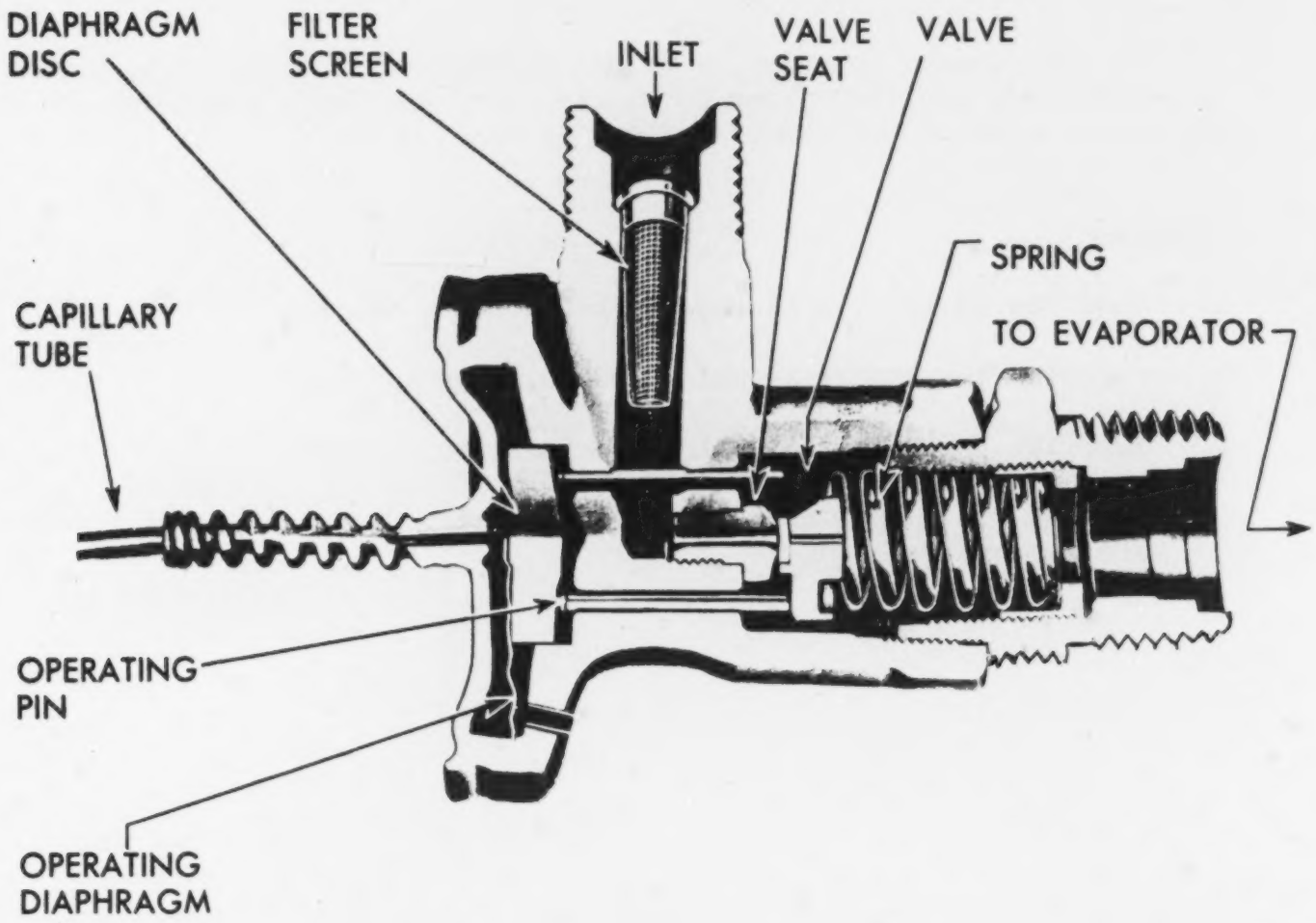

As we learned previously, the valve is located at the inlet side of the evaporator. However, the remote bulb is located at the evaporator outlet pipe. This location of the bulb allows it to communicate the temperature of the refrigerant at that point, through the capillary tube, to the valve body.

The capillary tube and remote bulb is filled with carbon dioxide gas, which exerts a pressure above the diaphragm. The valve is closed by pressure of the spring. When the air conditioning system begins to operate, the compressor draws refrigerant gas from the evaporator, lowering the pressure in the evaporator and under the diaphragm. As the pressure in this area is reduced, the pressure above the diaphragm exerted by the gas in the capillary, overcomes the spring pressure, and forces the diaphragm against the operating pins. This action opens the valve and meters liquid refrigerant into the evaporator starting the cooling cycle.

As the temperature at the outlet pipe of the evaporator cools, gas pressure above the diaphragm and in the capillary decreases, allowing the spring to move the valve toward its seat. This action closes the valve and shuts off the flow of liquid refrigerant.

In this manner the flow of liquid refrigerant into the evaporator is controlled, and the system is cycled "off" and "on", depending on the temperature of the evaporator outlet pipe.

Assignment:

1. Name the parts of a thermostatic-expansion valve.

2. Describe the manner by which the valve is opened.

3. Describe the manner by which the valve is closed.

3. What do you think would happen if the valve stuck open and flooded the evaporator?

UNIT XI - THE THERMOSTATIC-EXPANSION VALVE

Lesson 3 — How to Test the Thermostatic-Expansion Valve

Tools needed: Gauge manifold, vacuum pump, leak detector, can tap, service valve wrench, flare wrenches, tool kit.

Material needed: 1 lb. can of R-12, refrigeration oil, tray of ice.

To test the thermostatic-expansion valve, discharge the system and proceed as follows:

REMOVE THE VALVE

1. Disconnect the liquid line at the valve.

   Note: Use a back-up wrench and hold the valve while using a flare wrench on the liquid line nut.

2. Remove the valve from the evaporator.

   Note: The procedure in removing the valve will vary with the design of the evaporator. Always notice the location of the capillary and remote bulb, and use care when removing it to prevent damage.

TEST THE VALVE

1. Make an adaptor using the necessary fittings and connect the valve inlet to the gauge manifold charging hose.

2. Connect the charging hose to a 1 lb. can of R-12, and open the valve at the can tap ¼ turn. Refrigerant gas should escape from the valve outlet.

   Note: If the refrigerant gas does not escape, the capillary and bulb have lost their charge or the valve diaphragm is defective. Replace the valve.

3. If the gas did escape in step 2, it will now be necessary to determine if the valve will close and shut off refrigerant flow when cold.

4. Place the remote bulb in the tray or container of ice. The valve should close and stop the flow of escaping refrigerant.

   If the refrigerant continues to escape the valve is defective.

If the refrigerant does not escape the valve is good.

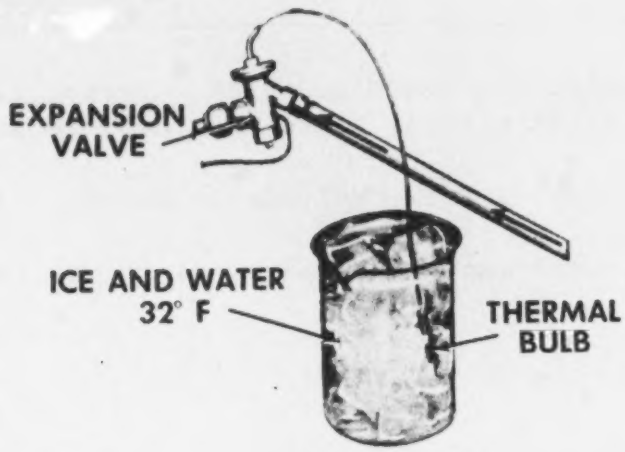

REPLACE THE VALVE

1. Install the valve or a new replacement and connect it to the evaporator. Connect the liquid line. Apply refrigeration oil to all threads.

   Note: Install the remote bulb and the capillary in their original position, and be sure the contacting areas of the evaporator outlet are clean.

RETURN SYSTEM TO SERVICE

1. Evacuate the system

2. Charge the system

3. Test the system for leaks

4. Performance test the system. (Unit XV lessons 1, 2, 3)

Assignment:

1. Remove the thermostatic-expansion valve from the evaporator and test the valve. Follow the procedure described in this lesson.

UNIT XII - THE EVAPORATOR

Lesson I — Function in the System

Objective: To learn how the evaporator cools and dehumidifies the air.

The evaporator core consists of a series of coils in a radiator type container. Its outer shell is made of steel or plastic, and it is located in the dash area.

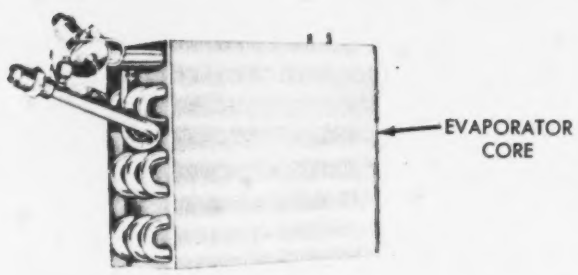

The purpose of the evaporator core is to cool and remove the moisture from the air that is flowing through it, when the air conditioner is operating.

High pressure liquid refrigerant from the thermostatic-expansion valve enters the core. As the pressure in the evaporator is lower, the refrigerant immediately boils. Heat from the core's surface is given up to the vaporizing refrigerant which is cooler than the core. This, in turn, cools the core surface. Air passing through the fins of the evaporator also gives up its heat to the cooler surface of the core and is circulated by blower action in the car.

As the process of heat loss from the air to the evaporator core takes place, moisture in the air condenses on the outside of the core, and drops to a drip-pan at the bottom of the evaporator shell. The water is drained from the drip-pan, by hoses, to the under body of the car.

Assignment:

1. What is the purpose of the evaporator?

2. In what physical phase is the refrigerant as it leaves the evaporator?

3. Why does the air passing through the evaporator give up its heat?

4. Name the principle by which the air is dehumidified.

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UNIT XII - THE EVAPORATOR

Lesson 2 Evaporator Pressure Control Devices

Objective: To learn the types and need for an evaporator pressure control device in an air conditioning system.

In order to regulate the pressure in the evaporator during the refrigeration cycle, a pressure control device is needed. The device is needed to maintain maximum evaporator cooling, and control the formation of ice or frost on the evaporator fins and tubing.

If the pressure in the evaporator exceeds the recommended pressure, cooling efficiency will decrease at the rate of 1°F per pound of pressure.

If the pressure in the evaporator is lowered below the recommended pressure, the evaporator will ice up and restrict the flow of cooling air.

Two pressure control devices are:

1. The evaporator pressure regulator valve (EPR).

This valve is used on Chrysler Corp. cars. It is located in the compressor behind the suction service valve port connection, and is not adjustable.

2. The suction throttling valve (STV).

This valve is used on General Motors cars. It is located in the suction line, and the valve is adjustable.

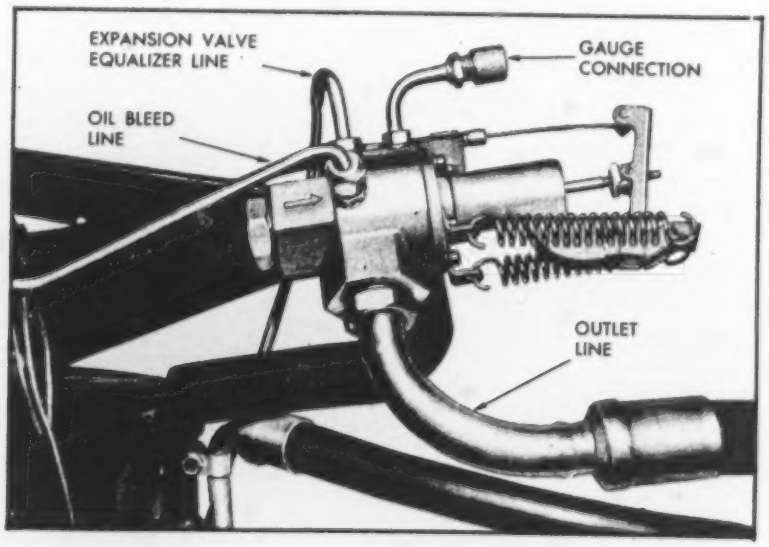

Suction Throttling Valve

Assignment:

1. Describe the purpose of an evaporator pressure control device.
2. What will happen if the pressure in the evaporator is lowered?
3. Where is the E.P.R. located?
4. Where is the S.T.V. located?
5. Which valve is adjustable?

UNIT XII - THE EVAPORATOR

Lesson 3 How to Test and Adjust the S.T.V.

Tools needed: Gauge manifold, vacuum gauge, tool kit, tachometer.

Note: Operation of the S.T.V. is controlled by vacuum or by a Bowden cable. To test and adjust the vacuum controlled type proceed as follows:

TEST THE VALVE

1. Install the gauge manifold. Connect the suction pressure gauge to the connection at the S.T.V. Connect the high-pressure gauge to the compressor discharge valve.

2. Start the engine and adjust the idle speed to 1,000 R.P.M. Adjust the air conditioning controls for maximum cooling and operate the system 15 minutes.

3. Record the pressure as indicated on the suction gauge, and compare this pressure with specifications. Pressure should be approximately 28 P.S.I.

   If the pressure is incorrect, remove the vacuum hose at the S.T.V. and install the vacuum gauge. The gauge should indicate 4-6 inches of vacuum. If this value is not obtained, check the hoses for kinks and leaks and check the vacuum controls. Repair as indicated.

4. Adjust the air conditioner controls to "warmer" and operate the system for 10 minutes. The suction gauge pressure should rise 3 P.S.I.

ADJUST THE S.T.V.

1. If adjustment of the S.T.V. is necessary, loosen the lock nut and rotate the vacuum unit to obtain the desired pressure. Turn the vacuum unit chockwise to raise the pressure, counterclockwise to lower the pressure. Tighten the locknut.

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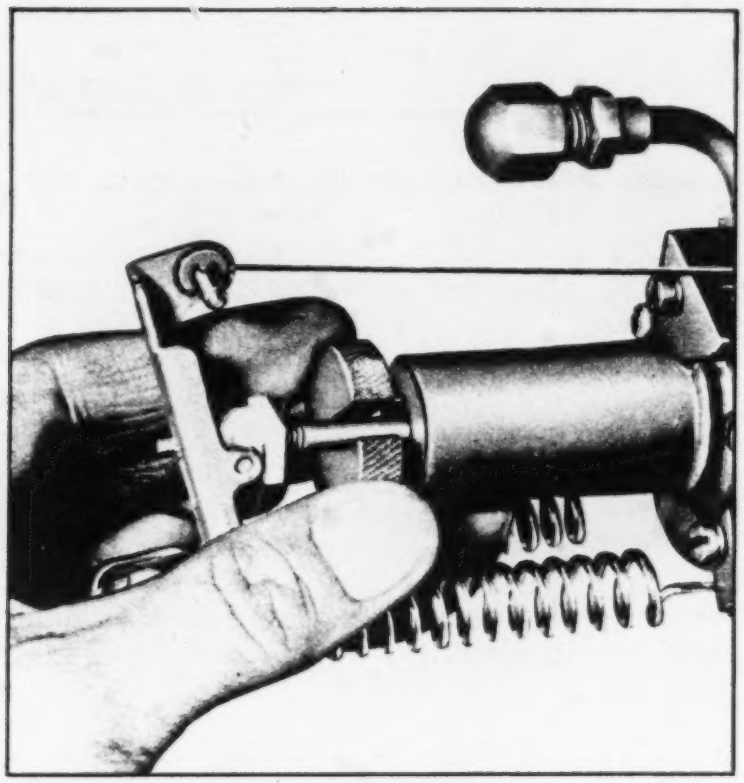

Adjusting Suction Throttling Valve

2. Recheck operation of the S.T.V. To test and adjust the Bowden cable-controlled-type follow the procedure outlined above, but first adjust the Bowden cable.

ADJUST THE BOWDEN CABLE

1. Adjust the temperature control lever to the maximum cold position.

2. Loosen the cable clamp at the S.T.V.

3. Adjust the length of the cable to position the valve lever against its stop in the forward position. Tighten the cable clamp.

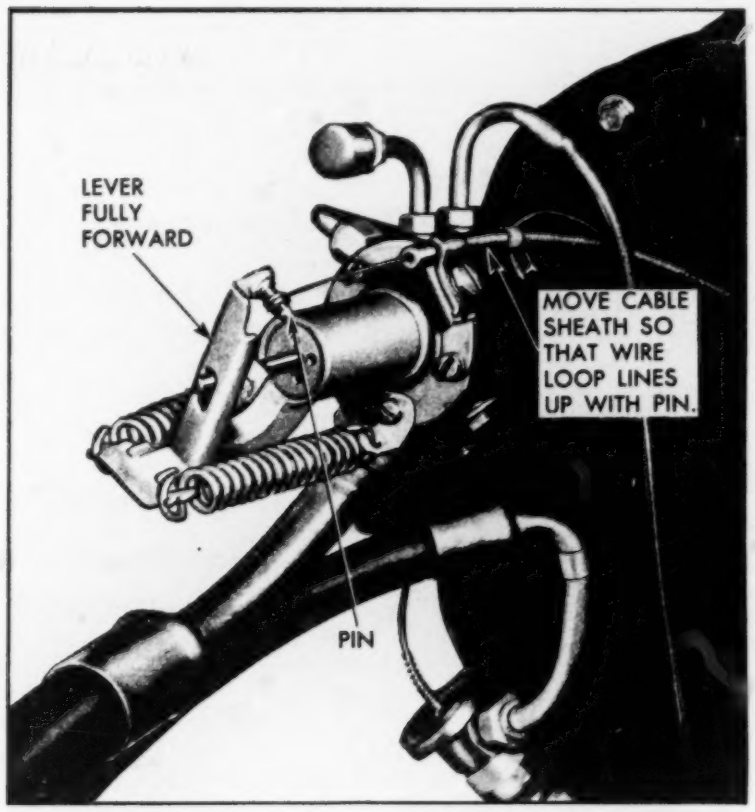

Suction Throttling Valve Cable Adjustment

4. Check the operation of the cable for binding, and be sure the valve lever returns to its stop.

UNIT XII - THE EVAPORATOR

Lesson 4 — How to Test the E.P.R. Valve

Tools needed: Gauge manifold

EPR VALVE TEST CONDITIONS

Normally, this test is performed after completion of the Over-all Performance Test. The gauge manifold will be connected, as shown.

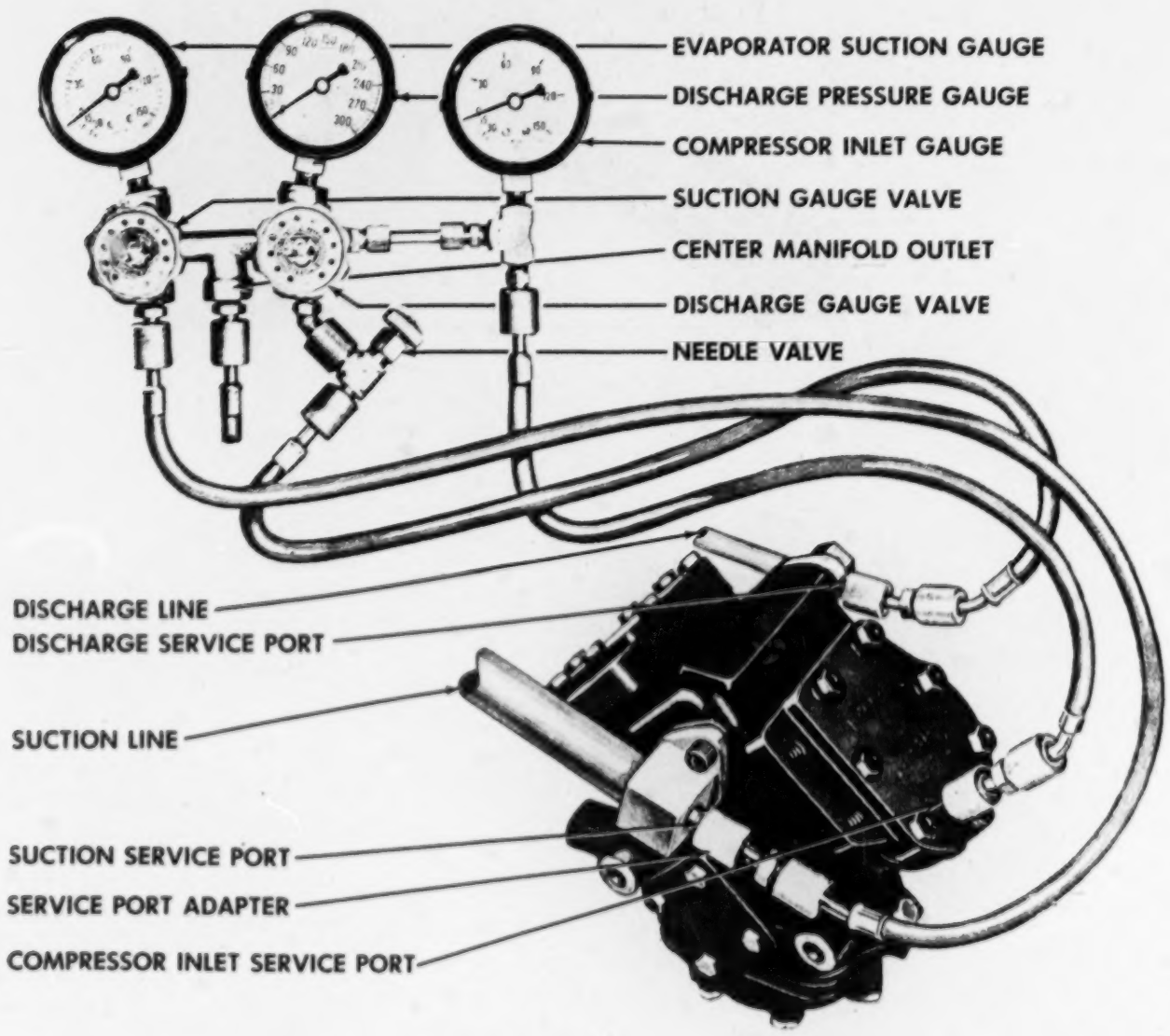

GAUGE MANIFOLD CONNECTIONS (Plymouth)

Adjust the engine speed to 1250 rpm. Close the hood for this test. Open the windows.

Turn the blower switch to position No. 2, push the "Cool" button.

The heat load on the evaporator will soon call for continuous operation of the refrigeration system. The "EPR" valve will open and the pressure at both the suction port and the compressor inlet service port will be about the same. It is normal for the compressor inlet pressure to be slightly lower than the evaporator suction pressure.

Observe the evaporator suction gauge and the compressor inlet gauge. Both should register 26 psi or slightly higher. This shows that the "EPR" valve is open. The next step is to find the minimum evaporator suction pressure maintained in the suction line by the "EPR" valve.

The "EPR" valve action can be speeded by reducing the heat load on the evaporator. This is done by turning the blower switch to position No. 1 ("Low-Speed"), thus reducing the volume of air passing through the evaporator. Immediately the evaporator will start to get colder. It is necessary to watch both suction gauges for the following reactions.

1. Pressure registered at the evaporator suction gauges will become progressively lower.

2. At the same time the compressor inlet gauge will start to fluctuate. This fluctuation is caused by the alternately opening and closing of the "EPR" valve. It indicates that suction pressure is reduced to the point where it just about balances the internal gas pressure in the bellows. The "EPR" valve is actually operating as a modulating valve.

3. When fluctuation at the compressor inlet gauge stops and the pressure registered drops steadily, the "EPR" valve is maintaining minimum suction line pressure. Allow pressure registered at the compressor inlet gauge to drop 15 psi or lower, then read the evaporator suction gauge.

   Note: If, and only if the compressor inlet pressure will not pull down to 15 psi, increase engine speed to approximately 2000 rpm.

4. The suction gauge pressure should be 22 to 26 psi. This shows that the suction pressure held by the "EPR" valve is correct. Again, determine the pressure at which the valve is fully open.

5. Turn the blower switch to position No. 2, push the "Cool" button to increase the heat load on the evaporator. This will increase suction pressure, causing the "EPR" valve to open fully.

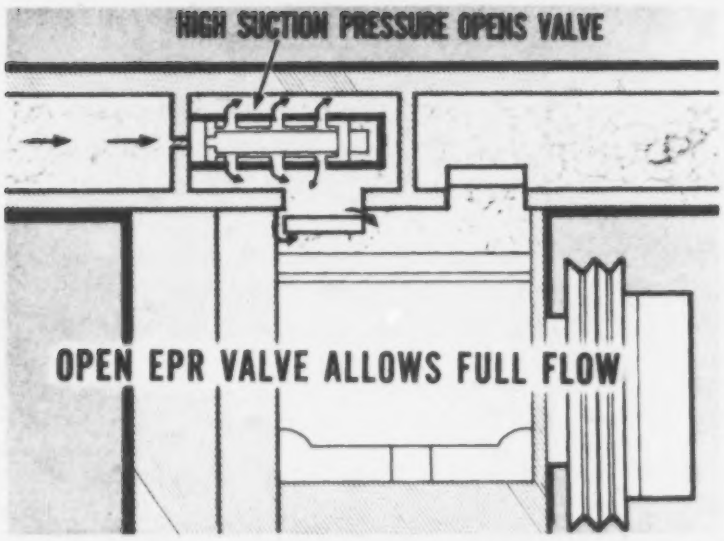

Warm evaporator raises suction pressure

6. Watch both the evaporator suction and the compression inlet pressure gauge. The pressure registered at the compressor inlet gauge will increase quite rapidly. Both suction gauges should again hold at a pressure of 26 psi or slightly higher within a few minutes.

   If the minimum suction pressure registered step 4 above is 22 to 26 psi and the suction pressure registered with the valve fully open step 6 above is 26 psi or slightly higher, the "EPR" valve is working normally. A system which passes both the Over-All Performance Test and the "EPR" Valve Test requires no further tests.

SUCTION PRESSURE ABOVE 26 PSI

If the minimum suction pressure is higher than 26 psi step 4 above, the evaporator will not get as cold as it should for maximum performance. It will be necessary to replace the "EPR" valve. Repeat the "EPR" valve test and the Performance Test.

SUCTION PRESSURE BELOW 22 PSI

If the suction pressure goes below 22 psi step 4 above, the evaporator is too cold. The correction is to replace "EPR" valve and repeat the "ERP" valve test.

Drawings and text courtesy of Chrysler Corporation.

UNIT XIII - THE ELECTRICAL CONTROL SYSTEM

Lesson I — How the Electrical Control System Operates the Air Conditioner

Objectives: 1. To learn the components of the electrical system.
2. To learn the flow action of current in the electrical system.

The electrical control system will vary to a great degree, in order to meet the requirements of various types of air conditioning installations. To gain an understanding of how the system functions, we will consider and trace the basic circuit shown in the diagram.

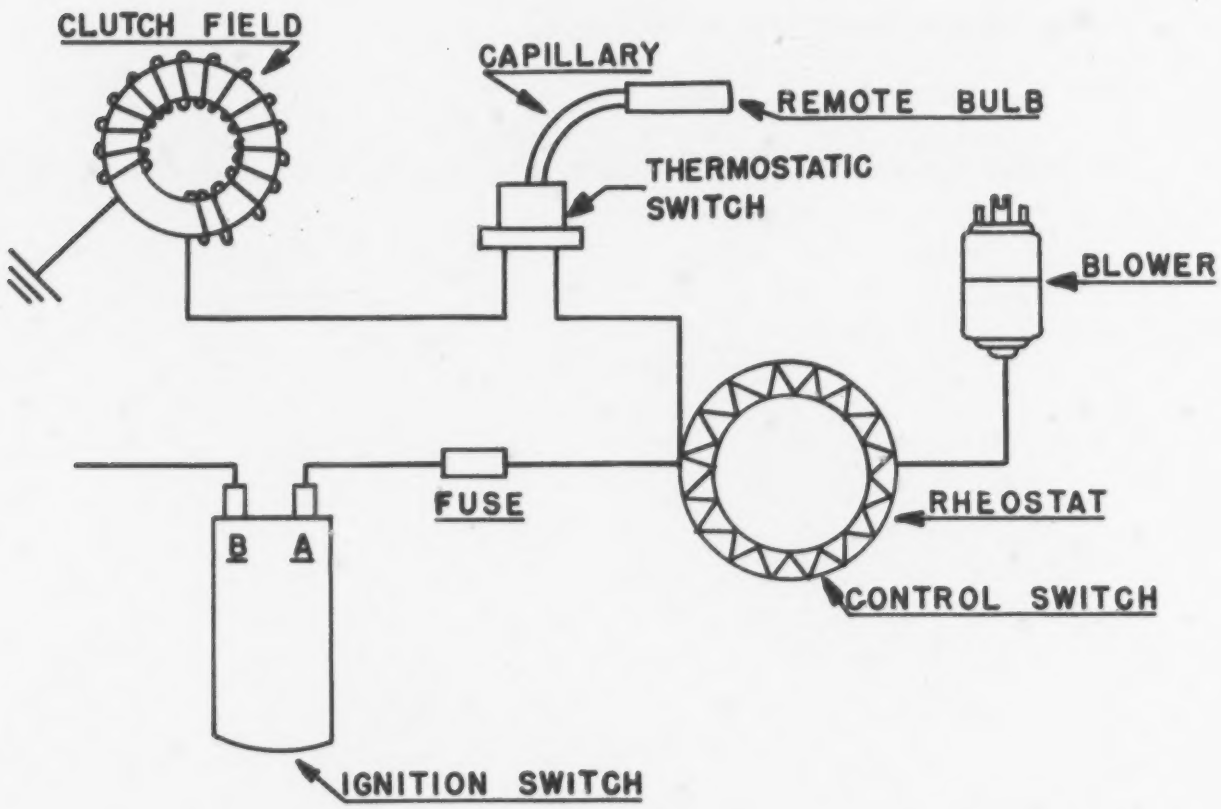

Current flows from the ignition switch accessory terminal through a fuse to the control switch of the air conditioner. When the control switch is turned on, two circuits are energized:

1. Current flows to the blower motor in the evaporator shell. As the control switch is turned clockwise from "on", current flows through more of the rheostat which is a resistance unit and controls blower speed from high to low.

2. Current flows to the contact in the thermostatic switch. If the thermostatic switch remote bulb is warm, the contacts are closed and current then flows to the field windings of the electromagnetic clutch. The clutch will then drive the compressor starting the cooling cycle.

   As the thermostatic remote bulb switch cools, the contacts open, stopping the flow of current to the clutch. This stops compressor operation. The blower will continue to operate, however, and cooling will continue as the clutch is cycled off and on by control of the thermostatic switch.

Assignment:

1. Which switch turns the blower on?

2. What does the rheostat do?

3. Describe the manner in which the current flow to the clutch is stopped.

UNIT XIII - THE ELECTRICAL CONTROL SYSTEM

Lesson 2 — The Thermostatic Switch

Objective: To learn what the thermostatic switch does and how it functions.

The thermostatic switch controls the operation of the compressor by controlling the electro-magnetic clutch.

When the temperature of the evaporator becomes colder than the lower limit for which the switch is set, the switch opens the circuit to the clutch, and stops the operation of the compressor. When the temperature of the evaporator rises to the upper limit at which the switch is set, the switch closes and energizes the clutch. This resumes compressor action, and cooling begins again. The switch works on approximately a 6°F differential. This means the evaporator temperature must warm 6°F for the contacts to close and restart the cycle.

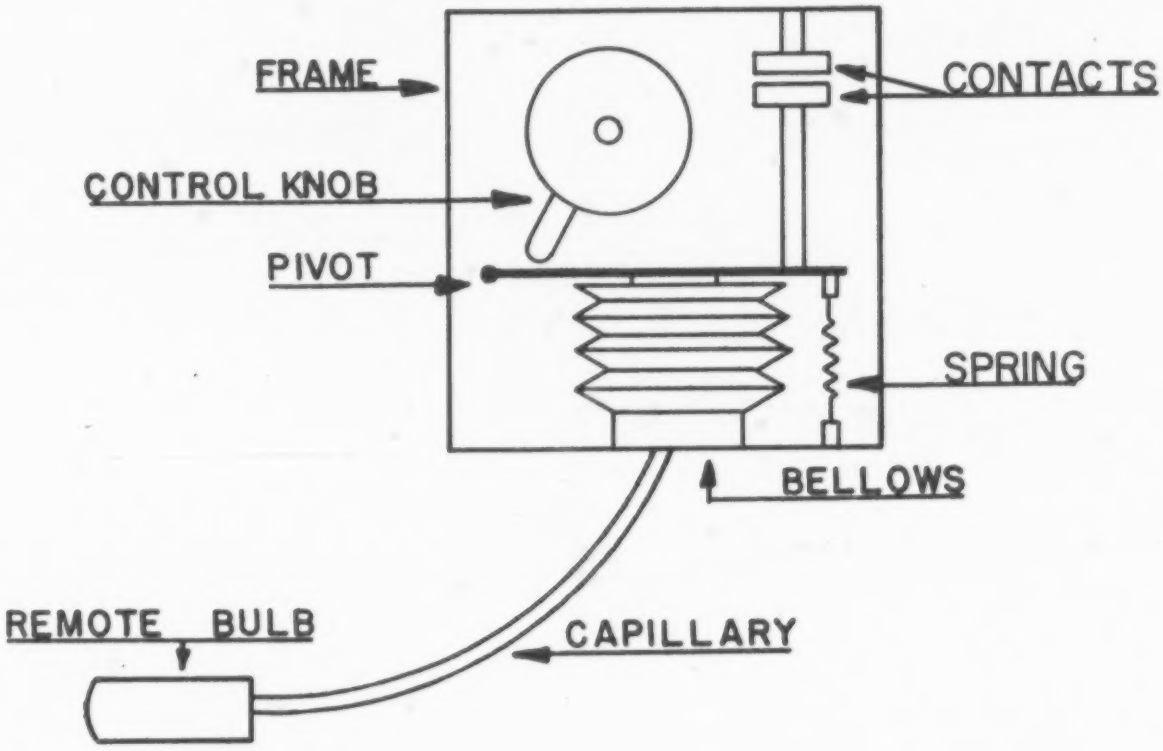

The switch shown in the diagram has a remote bulb connected to a bellows, through a capillary tube. The bellows is connected to a pivot link that has a contact. Another contact is mounted on the frame of the unit. The bulb and capillary are filled with liquid refrigerant. When the refrigerant is warm, it expands and creates a pressure that is transmitted to the bellows. This action moves the pivot link and closes.

the contact points. As the refrigerant cools, it contracts, and the pressure in the bellows is reduced. This action allows a spring which is connected to the pivot link to open the contacts.

Assignment:

1. What material is used to operate the thermostatic switch?

2. Why do the contacts close when they are warm?

3. What does the term "thermal" mean?

4. What circuit is completed when the thermostatic switch contacts are closed?

5. Where is the remote bulb located?

UNIT XIII - THE ELECTRICAL CONTROL SYSTEM

Lesson 3 How to Test the Thermostatic Switch

Tools needed: Ammeter, test lamp, tachometer, thermometer, tool kit.

In the event of a complaint of erratic or no cooling, test the thermostatic switch. The switch may be defective and inoperative, or improperly calibrated. Proceed as follows:

TEST FOR A DEFECTIVE SWITCH

1. Turn the ignition and air conditioner control switch on.

2. Disconnect the clutch field lead at the clutch. Ground the test lamp clip and touch the prod of the test lamp to the lead from the switch. The lamp should light.

3. If the lamp does not light, check the fuse and current supply to the battery terminal of the switch.

4. Ground the test lamp clip and touch the prod of the lamp to the battery side of the switch. If the lamp does not light, trouble lies before the switch.

5. If the lamp did light in step 4, touch the prod of the lamp to the clutch side of switch: If lamp does not light the switch is defective and must be replaced. If lamp does light, check for an open circuit between the switch and the clutch.

IMPROPERLY CALIBRATED

1. Disconnect the clutch field lead at the clutch and connect an ammeter in series.

2. Install the thermometer at the evaporator air discharge.

3. Start the engine and adjust the idle speed to 1,000 rpm. Adjust the air conditioner controls for maximum cooling and operate the system 15 minutes.

4. Note the air discharge temperature and observe the ammeter: The ammeter will indicate clutch current draw as the clutch cycles on and off.

   Air discharge temperature and its relation to cycling of the clutch will vary according to the manufacture. Also, it may be possible to adjust the switch. Refer to the manufacturer's specifications and procedure for adjustment.

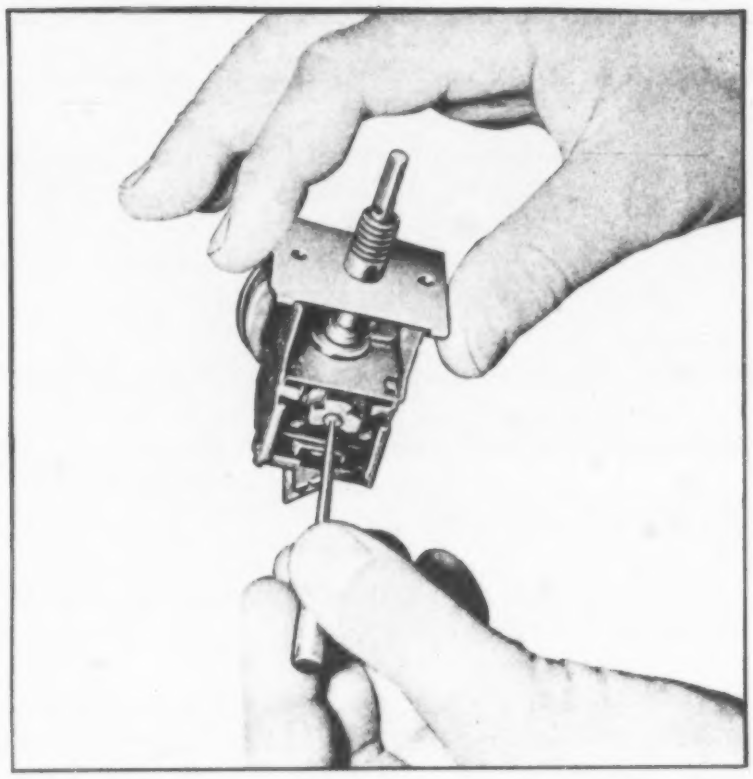

Thermostatic Switch Adjustment

Note: If the clutch does not cycle off when the lower temperature is reached, the contacts are probably fused together. This will cause the evaporator to freeze up. Replace the switch.

Assignment:

1. Use the test lamp and make a continuity test to the clutch. Your instructor will help you.

2. Connect an ammeter in series with the clutch and install a thermometer. Record the temperatures at which the clutch cycles and compare the temperatures to specifications. Report to your instructor.

UNIT XIII - THE ELECTRICAL CONTROL SYSTEM

Lesson 4 How to Test the Blower Motor

Tools needed: Ammeter, test lamp, jumper wire.

If a complaint of low velocity or no air discharge is encountered, test the blower motor. Proceed as follows:

LOOSE MOTOR FAN TEST

1. Turn the control switch on and listen for the sound of the motor. If only a hum can be heard, the fan is loose on the motor shaft.

2. Remove the blower and tighten the set-screw in the motor shaft.

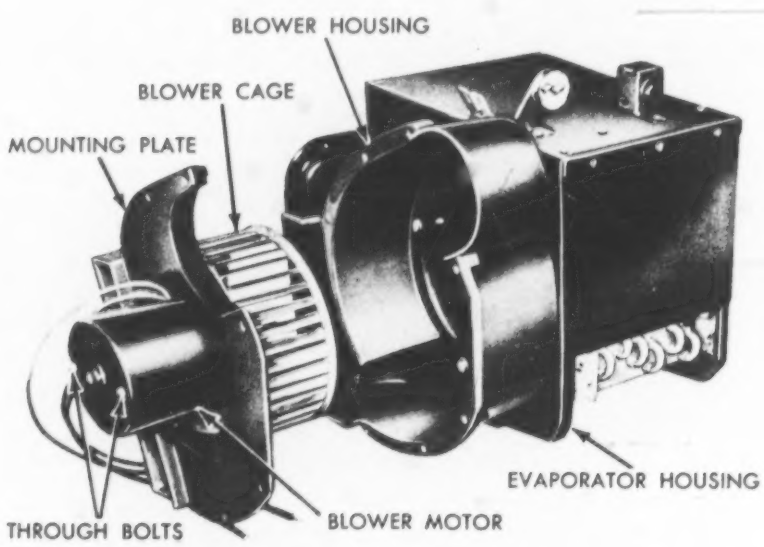

Blower Motor and Evaporator Assembly

MOTOR CURRENT DRAW TEST

This test will determine if the motor is defective.

1. Disconnect the wires to the blower motor at the bullet connector.

   Note: Do not disconnect the ground wire.

2. Connect an ammeter in series with a battery. The blower motor will operate independently of the control switch, and current draw will be indicated on the ammeter.

3. Compare the current draw with specifications, approximately 12 to 16 amperes.

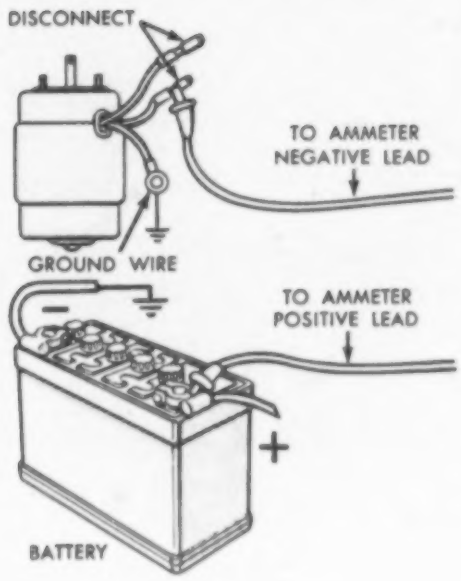

ELECTRICAL CONTINUITY TEST

This test will determine if current is supplied to the motor.

1. Turn the control switch on. Connect the clip of the test lamp to ground. Touch the prod of test lamp to the wires going to the motor. The test lamp should light.

2. If the lamp does not light, the trouble is before the motor. Check for: Blown fuse; defective control switch or wiring.

   Note: Do not overlook the possibility of a defective ground. Check for a loose screw in the ground wire eyelet, or corroded connection.

UNIT XIV - TESTING

Lesson I — Performance Test - (Road Test)

Tools needed: Thermometer

In order to determine if the air conditioning system is functioning efficiently, it may be desirable to drive the car, and check the air discharge temperature.

Note: If the car was parked in the sunshine and interior is very hot, drive car with windows open and allow time for normal cool-down. Proceed as follows:

1. Drive the car at a speed of forty MPH. Adjust the controls for maximum cooling.

2. Close the windows and vents tightly and install the thermometer at the air discharge duct.

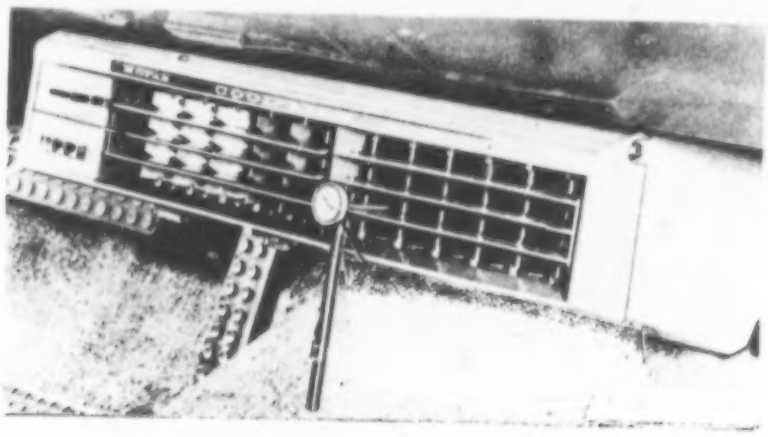

Checking Temperature at Outlet Grille

Use the table as a guide and determine system efficiency.

Temperature outside Degree Farenheit	Relative Humidity	Discharge air Temperature Degree Farenheit
70	50-60	43
	90	45
80	50-60	47
	90	54
90	40-50	53
	60	58
100	25	55
	40	60

UNIT XIV - TESTING

Lesson 2 — How to Test System Pressure (engine off)

Tools needed: Gauge manifold, service valve wrench, tool kit.

In order to determine if the air conditioning system contains a refrigerant charge, the system pressure may be recorded and compared to the chart. This test refers to a vehicle that has been parked and the system not operating. Proceed as follows:

1. Connect gauge manifold to the service valves.

2. Record the pressure readings and compare them to the chart.

PRESSURE-TEMPERATURE RELATIONSHIP OF "FREON-12"

Temp. °F	Pressure	Temp. °F	Pressure	Temp. °F	Pressure	Temp. °F	Pressure
-8	5.4	30	28.5	68	67.5	106	128.1
-6	6.3	32	30.1	70	70.0	108	132.1
-4	7.2	34	32.0	72	73.0	110	136.0
-2	8.2	36	33.4	74	75.5	112	140.1
0	9.2	38	35.2	76	78.3	114	144.2
2	10.2	40	37.0	78	81.1	116	148.4
4	11.3	42	39.0	80	84.1	118	153.0
6	12.3	44	41.0	82	87.0	120	157.1
8	13.5	46	43.0	84	90.1	122	161.5
10	14.6	48	45.0	86	93.2	124	166.1
12	15.9	50	47.0	88	96.4	126	171.0
14	17.1	52	49.0	90	99.6	128	175.4
16	18.4	54	51.0	92	103.0	130	180.2
18	19.7	56	53.0	94	106.3	132	185.1
20	21.0	58	55.4	96	110.0	134	190.1
22	22.4	60	58.0	98	113.3	136	195.2
24	23.9	62	60.0	100	117.0	138	200.3
26	25.4	64	62.5	102	121.0	140	205.5
28	27.0	66	65.0	104	124.0		

If no pressure is indicated on the gauges, the system has developed a leak and is empty. It will then be necessary to:

1. Add a partial charge.

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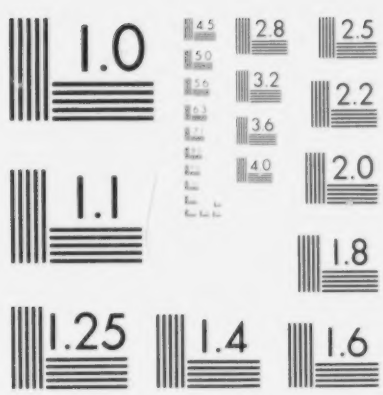

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

2. Test the system for leaks and repair the leaks.

3. Replace the receiver drier.

4. Evacuate the system.

5. Charge the system.

Assignment:

1. What significance does the chart have in relation to safety?

2. Connect the gauge manifold to the compressor service valves and record the pressure.

3. Is the pressure normal? Inform your instructor.

UNIT XIV - TESTING

Lesson 3 — How to Test System Pressure (engine running)

Tools needed: Gauge manifold, service valve wrench.

The pressures existing in the high and low sides of the system, when compared to the manufacturers specifications, indicate whether the system is operating normally. Pressures will vary within a wide range due to variations in humidity and ambient air temperature.

Note: When testing system pressures, always refer to the manufacturer's specifications. Proceed as follows:

1. Connect the gauge manifold to the compressor service valves.

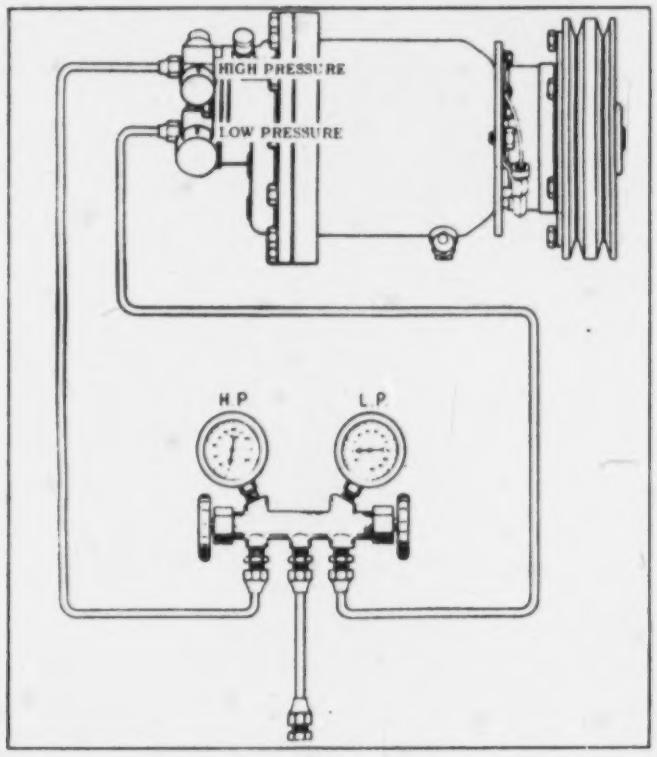

Gauge Connections for Pressure Tests

2. Start the engine and adjust the idle speed to 1500 rpm. Adjust the controls for maximum cooling and operate the system for fifteen minutes.

3. Record the pressure readings and compare them with specifications.

A "normal" pressure recorded on the gauges could be: Low Pressure: 30 PSI. High Pressure: 175 PSI. The important point to remember when testing system pressures is that the high pressure gauge should indicate six or seven times more pressure than the low pressure gauge. The following examples are given as an aid in diagnosing system malfunction.

Low Pressure	High Pressure	
30 PSI	70 PSI	System malfunction
10 PSI	250 PSI	System malfunction
40 PSI	270 PSI	System normal
25 PSI	160 PSI	System normal
18 PSI	85 PSI	System malfunction

Assignment:

1. State two reasons that could cause abnormally high pressure in the high side of the system.

2. State two reasons that could cause abnormally low pressure in the low side of the system.

3. Connect the gauge manifold to the compressor service valves and operate the system. Record the high and low pressures and advise your instructor if the pressures are normal.

UNIT XIV - TESTING

Lesson 4 — Trouble Shooting Guide

When trouble developes in the air conditioning systems, the procedures as listed below for the condition encountered should assist in locating the source of trouble.

Trouble	Procedure
SHORTAGE OR NO AIR DISCHARGE	
1. Discharge temperature high	Check air conditioner controls. Check for air passage restriction.
2. Low fan speed	Check for loose fan on blower motor. Test blower motor.
3. No fan operation	Check fuse to blower motor circuit. Check control switch. Check blower motor ground wire.
NOISE	
1. Scraping noise	Check for loose fan, or reposition fan on motor shaft. Check motor bearings and loose mounting.
2. Rattle and vibration noises	Check for loose air ducts, tubing contacts, loose compressor bolts, loose clutch.
WATER LEAKING INSIDE CAR	Check for evaporator drain tubes disconnected, kinked, or clogged.
FROSTING OR SWEATING OF EVAPORATOR	
1. Controls improperly adjusted	Refer to specifications; check all controls and adjust as required.
2. Shortage of refrigerant	Test system for leaks and repair leak. Charge system.
3. Restricted liquid line	Check line for kinks. Check receiver drier for stoppage.
4. Evaporator pressure control malfunction	Test control, adjust or replace as required.
5. Thermostatic switch malfunction	Test switch, adjust or replace as required.
6. Expansion valve malfunction	Test valve, clean screen, or replace.
7. Clutch does not disengage	Test clutch. Check thermostatic switch for contacts welded closed.
INSUFFICIENT COOLING	
1. System lost refrigerant charge	Locate leak and repair. Process system and check compressor oil level.

2. Clutch malfunction	Test clutch. Check for slipping belts. Check clutch slippage by observing bolt in compressor shaft. Bolt should turn at same speed as pulley.
3. Blower not operating	Check fan and blower motor.
4. Thermostatic switch malfunction	Test thermostatic switch. Check remote bulb for clean contact.
5. Evaporator pressure control malfunction	Test control, adjust or replace as required.
6. Compressor malfunction	Test compressor.
7. Clogged liquid line or receiver drier	Check for stoppage and repair as required.
8. Expansion valve malfunction	Test valve, clean screen or replace.
INTERMITTENT COOLING	
1. Freeze-up in high humidity areas	Raise low limit of STV or thermostatic switch. Replace EPR valve (Chrysler)
2. Expansion valve loss of remote bulb charge	Replace valve.
EVAPORATOR DISCHARGE AIR TOO COLD	Check evaporator pressure control device and thermostatic switch. Replace or adjust as required.
HIGH PRESSURE GAUGE READING EXCESSIVE PRESSURE	
1. Air in system	Test system for leaks, and repair as necessary. Evacuate and charge system.
2. Blocked air circulation through the condenser.	Clean condenser and straighten fins.
3. High engine temperatures	Test radiator cap. Test cooling system for leaks. Test radiator flow. Check engine for cooling system malfunction.
LOW-GAUGE READING ON HIGH SIDE OF SYSTEM	
1. Shortage of refrigerant	Locate leak. Evacuate and charge system.
2. Deflective compressor	Test compressor. Repair or replace.
LOW-GAUGE READING ON LOW SIDE OF SYSTEM	
1. Shortage of refrigerant	Locate leak. Evacuate and charge system.
2. Evaporator pressure control malfunction	Test control, adjust or replace as required.
3. Evaporator coils dirty	Clean coils with cold water.
4. Restriction in liquid line, suction line, or receiver drier.	Check lines for kinks and replace lines that are kinked. Check receiver drier, if clogged it will show frosting.
5. Expansion valve screen clogged.	Clean screen.

UNIT XIV - TESTING

Lesson 5 — How to Test a Radiator Cap

Tools needed: Radiator cap testor
Parts needed: A new radiator cap, a defective radiator cap.

A radiator cap that is defective will permit a loss of radiator coolant. This will result in higher engine operating temperature and reduce the efficiency of the air conditioner. To test the radiator cap proceed as follows:

1. Wet the adaptor and sealing gasket of the cap with water.

2. Install the cap on the adaptor.

   Note: The adaptor is made to accommodate long and short reach caps. The sealing gasket of the cap must contact the inside shoulder of the adaptor.

3. Assemble the adaptor to the pressure tester pump.

4. Stroke the pump plunger and attain a pressure reading on the dial for which the cap is rated. The cap should hold pressure and the dial reading should not fade. If the cap does not hold pressure, it is defective.

Radiator Cap Tester

5. If the cap holds the rated pressure, continue pumping and determine if the cap will relieve a higher pressure. If the cap does not relieve and holds a higher pressure it is defective.

Assignment:

1. State two cautions to remember when assembling the cap to the adaptor.

2. What would the result be to a car cooling system if the cap did not hold the rated pressure?

3. Practice testing a radiator cap. Your instructor will supply a good cap and a defective cap.

UNIT XV - TUBING

Lesson I — How to Cut Tubing

Tools needed: Tubing cutter, flaring tool, air gun
Material needed: 8" of copper tubing

A tubing cutter is used to cut a piece of tubing to the desired length, or to remove a defective flare.

1. The cutter consists of rollers for the tubing to rest on, a cutting wheel, a knob and screw feed, and a reamer for removing burrs. The rollers are made in a manner that permits removing a defective flare without waste of stock.

   By turning the knob clockwise, the cutting wheel is fed to the outside of the tubing under pressure. Rotating the tool around the tubing and tightening the knob results in a square cut.

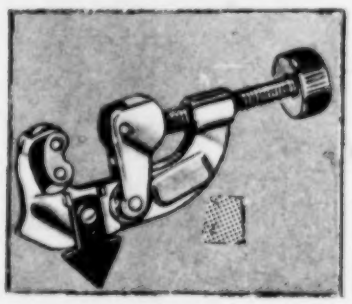

To cut a piece of tubing proceed as follows:

1. Place the tubing cutter on the tubing and position the cutting wheel where the cut is to be made.

2. Tighten the knob until the cutting wheel contacts the tubing as shown:

SCREW THE CUTTING WHEEL LIGHTLY AGAINST THE TUBING

3. Apply pressure a *little at a time* and rotate the tubing cutter around the tubing until the cut is made.

4. Dress the end of the tubing with the flat side of the reamer. Insert the point of the reamer inside the tubing and rotate the reamer lightly in a clockwise manner. This procedure will remove burrs. Blow through the tubing with an air gun.

ROTATE THE CUTTER KEEPING A SLIGHT PRESSURE AGAINST THE CUTTING WHEEL WITH THE SCREW ADJUSTMENT.

Note: When the above procedure is performed to tubing that is part of the system, it will be necessary to disconnect the tubing at the opposite end in order to blow it out.

Assignment:

1. Name the parts of a tubing cutter.

2. What might happen if a tubing line that was part of the system were not blown out?

3. Cut a piece of tubing, dress the burrs, and show it to your instructor.

4. Flare the tubing and remove the flare. Ask your instructor to watch as you do this.

UNIT XV - TUBING

Lesson 2 — How to Bend Tubing

Tools needed: Bending spring
Material needed: 14" of copper tubing

The use of a bending spring makes it possible to bend tubing without collapsing or kinking. There are several types of tubing benders.

1. The spring type. The spring can be of the inside (Figure A), or outside (Figure B) type. Both serve the same purpose and are available in various sizes. The outside type is bell-mouthed on one end to aid installation.

Figure A

Figure B

2. The mechanical bender.

   For sharper bends with larger size tubing a mechanical bender is recommended.

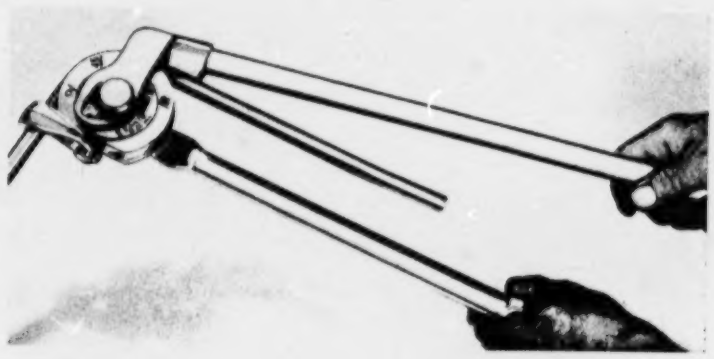

BEND TUBING WITH AN OUTSIDE BENDING SPRING

1. Install the bending spring on the tubing and position it where you want the bend.

2. Grasp the bending spring and hold it with the thumbs extended as shown.

3. Apply pressure, slowly and evenly, bending to the desired shape.

4. Remove the bending spring by turning it in an attempt to unwind the spring. This makes it easier to slip the bending spring off the tubing.

Assignment:

1. Use a bending spring and bend a piece of tubing as shown in step 2. Show it to your instructor.

2. Straighten the tubing and bend it again without the bending spring. Show it to your instructor.

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Lesson 3 — How to Make a Double Flare

Tools needed: Flaring tool kit, tubing cutter
Materials needed: 6" of copper tubing

All tubing used in an air conditioning system with flare type connections must be double-flared. A double-flared connection results in a strong and leak-proof seal, and is recommended wherever a connection is subject to vibration. To make a double-flare, a flaring tool kit is used.

FLARING TOOL KIT

The kit consists of a flaring bar, a yoke and cone, and adaptors for various size tubing.

MAKE A DOUBLE-FLARE

1. Install the compression nut on the tubing. Place the tubing in the flaring bar. Snug the wing-nuts but do not tighten them.

2. Select the adaptor that fits the inside diameter of the tubing.

   Note: The adaptor has two purposes:

   a. To be used as a guide to judge the location of the tubing in the flaring bar.

   b. To compress the tubing and prepare it for the final flare.

3. Place the adaptor next to the tubing, with the stem facing up. Adjust the tubing in the flaring bar so that it is even with the top of the heavy stock of the adaptor. Tighten the wing-nuts securely.

4. Invert the adaptor and place the stem inside the tubing.

5. Place the yoke and cone over the flaring bar and locate the point of the cone in the center of the adaptor.

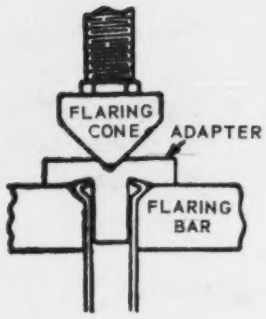

6. Turn the handle slowly and compress the tubing until the adaptor contacts the flaring bar.

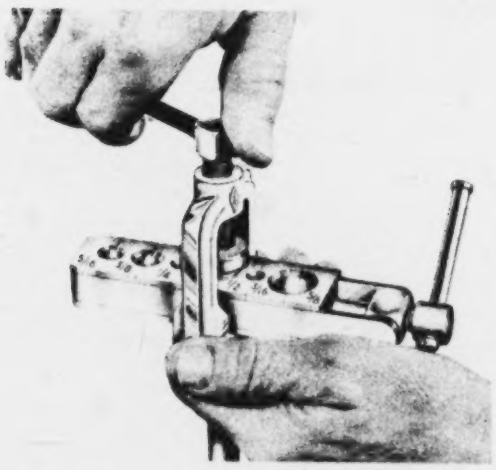

Using a flaring tool on a piece of copper tubing.

7. Remove the yoke and adaptor and inspect the tubing. The tubing should be compressed evenly, ready for the double flare.

8. Place the cone in the center of the tubing and apply a drop of motor oil.

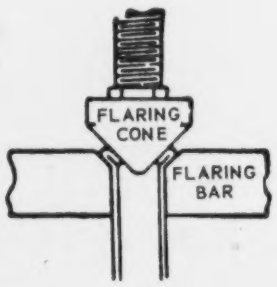

9. Turn the handle of the yoke, slowly, and tighten the cone.

   Note: Do not overtighten or attempt to double-flare in one operation. Back off the cone and inspect the depth of the flare.

10. Proceed and tighten the cone until an even seat of 45° is formed.

11. Inspect the inside and outside of the flare for cracks, and for an even and smooth seat. If the flare is defective, cut it off and make a new double-flare.

Assignment:

1. Name the parts of a flaring tool kit.

2. What is the purpose of the adaptor?

3. Why must the cone be tightened slowly?

4. Make a double-flare and show it to your instructor.

UNIT XV - TUBING

Lesson 4 — How to Repair a Hose

Tools needed: Gauge manifold, tool kit, vacuum pump, leak detector
Material needed: Splicer, two hose clamps, refrigeration oil, R-12

A refrigeration hose that is in good condition, but has been chafed or injured in a small area, may be repaired by installing a hose splicer.

Caution: Do not repair a hose that has dried out, shows sign of cracking, become oil soaked, or has ruptured under pressure.

To install a hose splicer, proceed as follows:

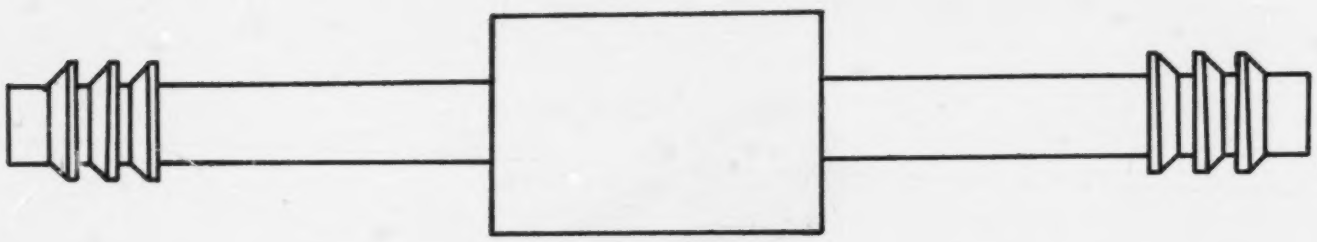

SPLICER

TEST SYSTEM PRESSURE

1. Connect the gauge manifold to the service valves and test the system for pressure. If pressure is present, discharge the system.

PREPARE THE HOSE FOR REPAIR

1. Remove the injured area of the hose by cutting with a single-edged razor blade. Cut the hose square as shown.

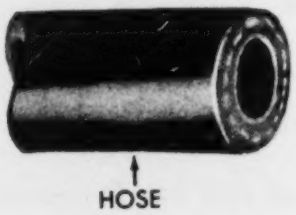

2. Inspect the inside of the hose for the presence of hose material.

Caution: Do not use your finger to clean the inside of the hose. If necessary, disconnect the hose and blow through it with an air gun.

3. Apply refrigeration oil to the inside of the hose.

INSTALL HOSE SPLICER

1. Install the hose clamps on the hose, loosely, and position them out of the way.

2. Apply refrigeration oil to the splicer, and push the splicer into the hose with a twisting motion, until the end of the hose contacts the locating bead.

3. Position the hose clamp over the splicer sealing beads and tighten the clamp.

   Note: The hose clamp tang is used to contact the locating bead, and position the hose clamp as shown.

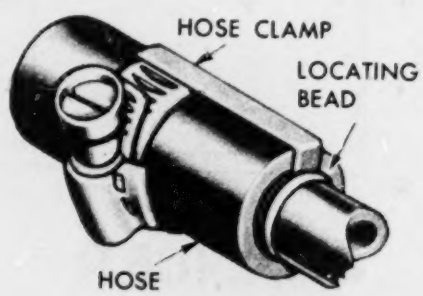

4. Repeat the process and connect the remaining half of the hose.

RETURN SYSTEM TO SERVICE

1. Evacuate the system

2. Charge the system.

3. Test the system for leaks.

Assignment:

1. Why is it necessary to connect the gauge manifold and test the system pressure?

2. Why should you not use your finger to clean the inside of the hose?

3. What is the purpose of the locating bead?

4. Ask your instructor for a hose and splicer. Install the splicer and show it to him.

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UNIT XV - TUBING

Lesson 5 — Periodic Maintenance

It is recommended that periodic maintenance be performed in the spring of each year to insure that the air conditioning system will operate efficiently for summer driving. Proceed as follows:

1. Check all system component mounting bolts for looseness.
2. Check refrigerant hoses for deterioration and tighten the clamps.
3. Check the compressor crankshaft oil seal for leakage.
4. Inspect the compressor driving belts and adjust as needed.
5. Operate the system and check the temperature at the air discharge outlets.
6. Check the temperature at the inlet and outlet of the receiver drier.
7. Check the system for state of charge.
8. Check the system for leaks.
9. Check the vacuum hoses, at the control units, for deterioration.
10. Check the evaporator drip pan hoses for kinks or deterioration.
11. Refer to the manufacturer's specifications to determine if anti-freeze is required in the cooling system. If anti-freeze is needed check the specific gravity of the coolant.
12. Pressure test the radiator cap.
13. Check and clean the condenser.
14. Advise the car owner to operate the system for fifteen minutes in the winter to keep the seals pliable and the expansion valve from sticking.

GLOSSARY

Ambient temperature: The temperature of the air which surrounds an object on all sides.

Ammeter: An electric meter used to measure current. It is calibrated in amperes.

Ampere: A unit of electric current flow.

Atmospheric pressure: Pressure that the gases in the air exert upon the earth, measured in pounds per square inch. At sea level, this pressure is 14.7 psi.

Bellows: A corrugated cylindrical container which moves as pressures change.

Bending spring: A coil spring which is mounted on the inside or outside of tubing. Used to prevent kinks when shaping tubing.

Boiling temperature: The temperature at which a fluid changes from a liquid to a gas.

Bowden Cable: A tube containing a wire, used to control a valve from a remote point.

Calorie: The heat required to raise the temperature of one gram of water one degree centigrade.

Capillary tube: A small diameter tubing used to connect a temperature control bulb to a control mechanism.

Centigrade scale: The temperature scale used in the metric system. On this scale the freezing point of water is 0. The boiling point is 100.

Clutch field: The coils of wire through which the current flows to create the magnetic force that engages the clutch.

Clutch, magnetic: An electro-mechanical device attached to the compressor crankshaft, operated magnetically, which when engaged operates the compressor.

Cold: The absence of heat.

Compound gauge: An instrument used for measuring pressures both above and below atmospheric pressure.

Compression: A term used to denote an increase of pressure on a gas.

Compressor: The pump in a refrigeration system which draws a vacuum or low pressure on the cooling side of the refrigeration cycle, and compresses the gas into the high pressure or condensing side of the refrigeration cycle.

Compressor, reciprocating: A compressor which uses a piston and cylinder mechanism to provide pumping action.

Compressor seal: A leakproof seal located between the crankshaft and compressor body.

Condensate: Fluid which forms on the evaporator coils or fins.

Condense: The changing of a gas or a vapor into a liquid.

Condenser: The part of a refrigeration system which receives hot, high pressure refrigerant gas from the compressor, and cools the refrigerant gas causing it to change into a liquid.

Condenser comb: A comb-like device made of metal or plastic which is used to straighten the fins on condensers and evaporators.

Contaminant: A substance, such as dirt or moisture, foreign to the refrigerant or oil in the system.

Convection: The transfer of heat by means of movement or flow of a liquid or a gas.

Cracking a valve: To open a valve a small amount.

Cut-in: Temperature or pressure valve which closes a control circuit.

Cut-out: Temperature or pressure valve which opens a control circuit.

Cycle: A series of events which repeat in some order.

Cylinder head: The part which encloses the compression end of a cylinder.

Defrost cycle: The time period of a refrigeration cycle in which evaporator frost and ice accumulation is melted.

Dessicant: A substance used to collect and hold moisture.

Dew-point: The temperature at which a vapor - at 100% humidity - begins to condense and changes to a liquid.

Double flare: A tubing end which has been formed into two-wall thickness. A 37 to 45 degree bell-mouth or flare.

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Gauge Manifold set: A tool for testing refrigeration systems. It is composed of gauges, hoses, and a manifold with valves.

Ground wire: An electrical wire used to conduct electricity from an electrical component to ground.

Halide torch: A type of gas-burning torch used to detect refrigerant leaks.

Heat: A form of energy, the addition of which causes substances to rise in temperature.

Heat of Compression: The mechanical energy of pressure transformed into the energy of heat.

Heat transfer: The movement of heat from one body or substance to another. Heat may be transferred by radiation, conduction, convection, or by a combination of these three methods.

Hg (Mercury): A heavy silver-white metallic element; the only metal that is liquid at ordinary room temperature. Symbol, Hg.

High pressure gauge: A part of the gauge manifold set used to indicate pressures in the high side of a refrigeration system.

High side: That part of a refrigeration system which is under condensing or high side pressure.

Humidity: Moisture, dampness.

Hydrometer: An instrument used to measure the specific gravity of a liquid.

Idler: A pulley used on a belt drive to provide the proper belt tension and eliminate belt vibration.

Liquid indicator: A glass window located in the liquid line of a refrigeration system which provides an opening through which the flow of liquid may be observed.

Liquid line: The tube which carries liquid refrigerant from the condenser or liquid receiver to the refrigerant control mechanism.

Low pressure gauge: A part of the gauge manifold set, used to indicate pressures in the low side of a refrigeration system.

Low side: That portion of a refrigeration system which is under the lowest evaporating pressure.

Magnetic field: A space in which magnetic lines of force exist.

Oil, refrigeration: A specially prepared oil completely free of moisture and contaminants. It is designed to mix with the refrigerant and circulate in the system.

Orifice: An accurate size opening for controlling the flow of fluid in a refrigeration system.

Pressure: An energy impact on a unit area; the force or thrust exerted on a surface.

PSI: The symbol used to indicate pressure measured in pounds per square inch.

Pump down: The procedure of using a compressor or a pump to reduce the pressure in a refrigeration system.

Purging: Releasing compressed gas to the atmosphere in order to eliminate contaminants from a refrigeration system.

R-12: Dichlorodifluoromethane - a refrigerant known as Freon 12.

Radiation: The transfer of heat by rays.

Receiver-drier: A cylinder in a refrigeration system used to store liquid refrigerant. The cylinder also contains a dessicant.

Reciprocating: An action in which the motion is back and forth in a straight line.

Refrigerant: The chemical substance used in a refrigeration system which absorbs heat by a change of phase from a liquid to a gas.

Refrigerant charge: The quantity of refrigerant in the system.

Relative humidity: The ratio of the quantity of vapor present in the air, to the greatest amount possible at a given temperature.

Schrader valve: A spring loaded device which permits fluid flow in one direction when a center pin is depressed.

Service valve: A device attached to a refrigeration system which provides an opening for gauges and charging hoses.

Sight glass: A glass window located in a refrigeration system which shares refrigerant, oil, or gas bubbles in the liquid line.

Silica gel: A chemical compound used as a drier.

Specific gravity: The weight of a liquid compared to water which is assigned a value of 1.0.

Squirrel cage: A part of an air blower assembly driven by an electric motor. This design is more compact than a fan and directs air flow more efficiently.

Suction line: A hose or pipe used to carry the refrigerant gas from the evaporator to the compressor.

Superheat: The temperature of a vapor above the boiling temperature of its liquid state.

Teflon: A synthetic rubber material used for sealing; usually formed in O rings.

Temperature: The degree of heat or cold as measured by a thermometer.

Test light: A tool; a lamp provided with leads used to determine if current is flowing in an electrical circuit.

Thermometer: A device or instrument used for measuring temperatures.

Thermostat: A device which is responsive to ambient temperatures.

Torque: A force, usually described as a turning or twisting force.

Torque wrench: A tool; used to measure the amount of torque or pressure applied to a nut or bolt.

Vacuum: A reduction in pressure below atmospheric pressure.

Vacuum gauge: An instrument designed to indicate the value of pressure below atmospheric pressure, existing in a chamber or cylinder.

Vacuum pump: A mechanical device used to create a vacuum. A vacuum pump is needed to rid a refrigeration system of moisture and air.

Vapor: A term used to denote vaporized refrigerant; used instead of the term gas.

Viscosity: A term used to describe the resistance to flow by a liquid.

Voltage: A term used to indicate the electromotive force in an electrical circuit. It is voltage which causes current to flow.

Voltmeter: An instrument used to measure the amount of voltage existing in an electrical circuit.

Woodruff key: A device used to align and hold a pulley on a rotating shaft, usually usually half-moon in shape.

ACHIEVEMENT TEST

Unit I — Basic Principles

1. What does automotive air conditioning do?
2. What is normal body temperature?
3. How is normal body temperature maintained?
4. What is convection?
5. What happens when air is heated?
6. Heat travels to _____heat.
7. What is relative humidity?
8. What is evaporation?
9. How does cooling take place? State the <u>principle</u>.
10. What is the basic purpose of a refrigerant, as used in an automotive air conditioner?
11. Is R-12 flammable?
12. Is R-12 corrosive?
13. Draw a diagram, and show the major components of an automotive air conditioning system, in their proper location.

ACHIEVEMENT TEST

Unit IV — The Electromagnetic Clutch

1. What is the average field current draw of the clutch?

2. Draw a sketch and show how to connect an ammeter when testing the clutch.

3. When removing the General Motors clutch, must the system be discharged?

4. When removing the General Motors clutch, how is the hub and drive plate assembly removed?

5. State the caution to remember when removing the Chrysler clutch.

6. When installing the General Motors clutch coil housing, how can you be sure the housing is aligned properly?

ACHIEVEMENT TEST

Unit VI — Service Valves

1. How is a Schrader valve "cracked"?

2. How do you back seat a Schrader valve?

3. State the caution to remember when connecting the adaptor to a Schrader valve.

4. How many inches of vacuum can be indicated on the compound gauge?

5. How many PSI of pressure can be indicated on the high pressure gauge?

6. How is the center inlet-outlet part of the gauge manifold used?

7. Is a service valve wrench needed when connecting the gauge manifold to a Schrader valve?

8. How is air purged from the gauge manifold and hoses?

9. State the caution to remember when connecting a can tap to a 1 lb. can of R-12.

10. In what direction would you turn the valve on the can tap to pierce a 1 lb. can of R-12?

ACHIEVEMENT TEST

Unit VII — Basic Service Procedures

1. Draw a schematic and indicate the gauge manifold connections to the service valves when discharging the system.

2. Why should the air conditioner be operated at an engine speed of 1500 RPM before discharging the system?

3. Why is it not recommended that alcohol or methanol be added to the system to prevent freezing of moisture?

4. What is meant by the term vacuum?

5. When evacuating the system, state the procedure to follow if a vacuum of 28HG was not reached.

6. How is the reactor plate of the leak detector tested?

7. Why is it important to keep a container of R-12 upright when charging the system?

8. How can you determine that a 1 lb. can of R-12 is empty?

9. How can a compressor equipped with Schrader valves be isolated?

10. When should the oil level in a Chrysler compressor be checked?

11. Why should the oil level in a York compressor be checked after collision damage to the system?

12. How often should the oil be checked in a General Motors six cylinder compressor?

ACHIEVEMENT TEST

Unit X — The Receiver Drier

1. How can liquid refrigerant be "stored" in the receiver drier when it is subjected to high pressure?

2. How can normal leak down be kept at a minimum?

3. Why does silica gel absorb moisture?

4. Describe the procedure to follow if evidence of sludge was found in the compressor.

5. State two methods of checking for a clogged receiver drier.

6. How could bubbles appear in the sight glass when the system is fully charged and the temperature of the surrounding air is below 70°F?

ACHIEVEMENT TEST

Unit XII — The Evaporator

1. State a caution to observe when undercoating a car equipped with an air conditioner.

2. How is operation of the STV controlled?

3. When testing the STV where is the low pressure gauge manifold hose connected?

4. How many inches of vacuum are present in the vacuum hose to the STV?

5. In what direction is the vacuum unit of the STV turned to raise the pressure in the evaporator?

6. How is the STV Bowden control cable adjusted?

7. When testing the ERP valve, how is the heat load on the evaporator reduced?

8. What is the correct suction pressure maintained by the EPR valve?

ACHIEVEMENT TEST

Unit XIII — The Electrical Control System

1. What is a rheostat?

2. Name the two circuits that are energized when the air conditioner control switch is turned on.

3. Why does the blower motor continue to run when the clutch is cycled off?

4. We learned that the thermostatic switch operates on a 6° air temperature differential. Where is this differential?

5. Where is the thermostatic switch capillary located?

6. Describe the testing procedure used to locate a defective thermostatic switch.

7. Draw a schematic and show how you would connect an ammeter in series to the clutch.

8. How do you know when the contacts in the thermostatic switch are fused together?

9. How would you check the blower motor ground?

10. What are the blower motor current-draw specifications?

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ABSTRACT - To provide information on aerospace education and to help the teacher, this curriculum guide for grades K-12 was prepared by the Oklahoma State Department of Education. The guide contains activities keyed to objectives and concepts to be developed, listings, and examples of many current publications and other available resources which are classified by grade level and subject matter area. Appended is a bibliography containing film listings, resource materials, and references. (GB)

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Aerospace Education Curriculum Guide

(K-12)

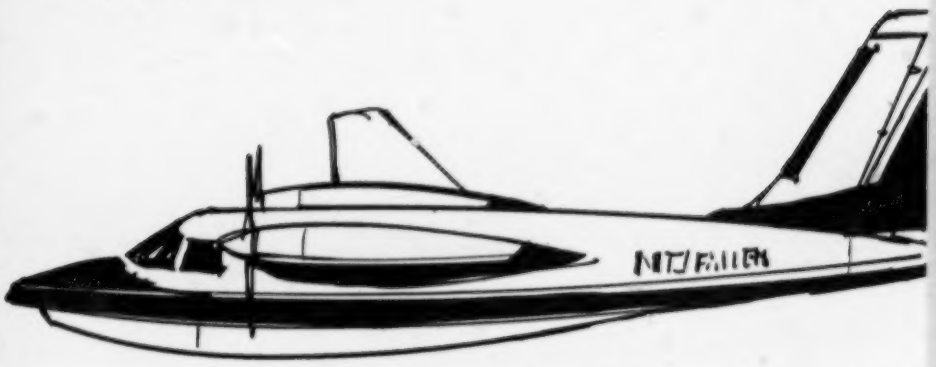

Prepared by the
State Air Education Committee
and the
Members of the Aerospace Education Workshop
and the
Oklahoma Curriculum Improvement Commission

in cooperation with
The Oklahoma Aeronautics Commission

OKLAHOMA STATE DEPARTMENT OF EDUCATION
Scott Tuxhorn, Superintendent
5909 1970

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A Curriculum Guide for Aerospace Education

(K-12)

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State Air Education Committee
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1970

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STATE OF OKLAHOMA
OFFICE OF THE GOVERNOR
OKLAHOMA CITY

DEWEY F. BARTLETT
GOVERNOR

In 1968 the State Air Education Committee, chaired by the State Superintendent of Public Instruction, was appointed to study the Oklahoma educational program in aviation and aerospace. As a result this committee held an Aerospace Education Workshop in the summer of 1969 for the teachers of Oklahoma. The participants of the Aerospace Education Workshop developed this material for the first Aerospace Education Curriculum Guide for grades kindergarten through twelve. Another Aerospace Education Workshop is planned for the summer of 1970 when a further revision of this guide will be made.

The aerospace industry is the third largest and fastest growing industry in Oklahoma. Many of our young people will choose their careers in this dynamic field and, I hope, earn their living in this great state.

This Aerospace Education Curriculum Guide is a step forward for our educators. This material will assist them with their many students who have an interest in this area.

As Governor of Oklahoma, I urge all educators in the State of Oklahoma to include aerospace education at every academic level and in every field of study with the opening of our schools in September, 1970.

We are grateful to the leadership shown by the State Department of Education, the Oklahoma Aeronautics Commission, and to all of those who have made contributions to this booklet.

Dewey F. Bartlett
Governor

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FOREWORD

The special Air Education Committee appointed in 1968 by Governor Dewey F. Bartlett resulted in the Oklahoma Aerospace Education Workshop in the summer of 1969. This guide was prepared by the teachers participating in the workshop, consultants, and other educators and is designed to assist teachers in teaching aerospace education. Its purpose is to assist teachers to incorporate aviation and space matters in their daily teaching so that their students will become more aware of these dynamic industries.

We all recognize there is a growing national interest in capitalizing on the motivation that aviation and aerospace studies provide for students as well as teachers. As one who has participated actively in both aviation and aviation education, I commend the Oklahoma educators at the local and state level for the imagination and initiative in developing this curriculum guide in Aerospace Education.

The State Department of Education gratefully acknowledges the contributions of the State Committee and Subcommittees of the Oklahoma Curriculum Improvement Commission, and especially to the Oklahoma Aeronautics Commission for their support of this project.

The State Department of Education takes pride, in behalf of all those who have had a share in producing it, in offering this guide to the teachers of the State of Oklahoma for reference, and for suggestions on how they may enhance their effectiveness in the fine art of teaching. I am confident that the excellent materials contained in this booklet will be of great value to all schools of the state that seek to use them to suit local needs objectively and professionally.

Scott Tuxhorn
State Superintendent of Public Instruction

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1970

OKLAHOMA AEROSPACE EDUCATION WORKSHOP

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EDUCATION!
SPACE TRAVEL
HISTORY
EXCITEMENT
TRAVEL
WHO, ME FLY?
5915
FAMILY FLYING FUN

TO THE TEACHER:

All of us recognize the great interest that our students have in aviation and space activities. The motivation to learn more in this field, and to feel a part of this exciting activity, is already high among our youth. The purpose of this book is to provide information and to help the teacher who wants to accomplish the goals of education. The teacher wants to insure that the student's learning activities are both effective and efficient. The materials available are of such variety and from such diverse sources that obtaining and evaluating these requires excessive amounts of time and effort for the interested teacher.

This curriculum guide contains listings and examples of the many current publications and other resources available, and has classified them according to subject matter and grade level. The teacher who wants to establish an aerospace oriented course of study will find many examples here of courses that have been developed in recent years and which can be used as models. The teacher who desires to incorporate a unit on aviation or space can find in this guide many illustrations graded for applicability to specific age groups.

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WHAT IS AEROSPACE EDUCATION?

Aerospace education is that branch of general education concerned with communicating knowledge, skills, and attitudes about aerospace activities and the total impact of air and space vehicles upon society. It must be distinguished from those branches of special education known as aeronautical and/or astronautical education which are concerned with training specialized aerospace workers.

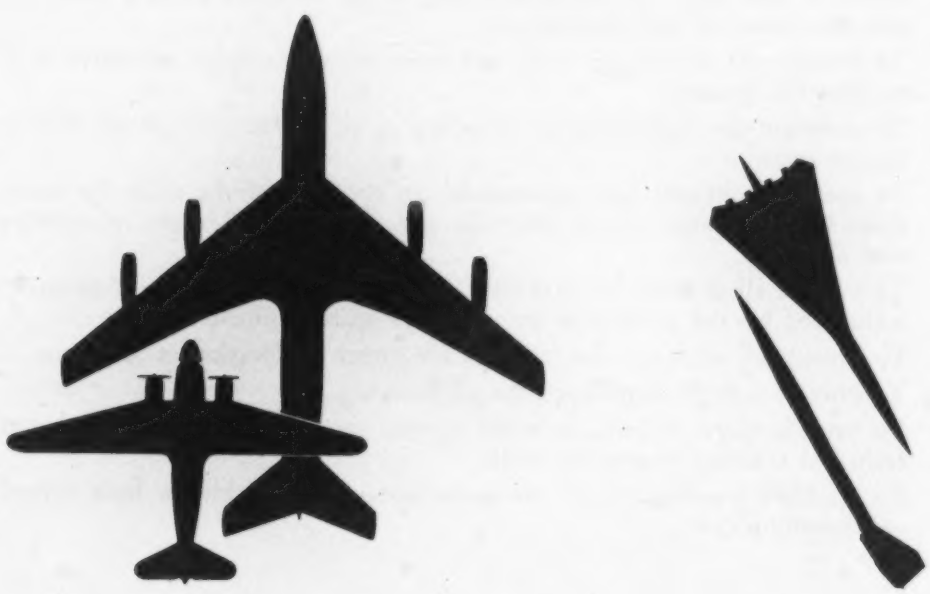

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INTRODUCTION

We feel that the public schools in the State of Oklahoma should make every effort to include aerospace education in every subject.

It is recommended that high schools introduce a separate course in aerospace education in addition to integrating it into all subject matter areas.

PHILOSOPHY

This program should be implemented in such a manner that the teacher has the freedom to utilize that amount of time and content deemed expedient or important in this area.

It is further believed that the teacher should have a pragmatic awareness of the subtle relationships and nuances between aerospace education and the total curriculum.

It is desirable that the program include grades K-12.

Finally, it is recommended that the content utilize all of the materials, aids, and resources as possible.

GENERAL OBJECTIVES

1. To develop an awareness of the needs and implications of aerospace education and its impact on our society.
2. To seek to integrate aerospace education with all classroom activities.
3. To motivate and stimulate pupils' interest in and understanding of the scientific and social advancements being made by mankind as a result of aerospace research and development.
4. To develop the abilities to speak and write about aerospace education in a meaningful manner.
5. To motivate the child's interest in aerospace education through all subject matter areas.
6. To create an interest and appreciation on the part of the child for aerospace literature and related materials, and to assist him in the interpretation of these.
7. To prepare all students so that they may participate in a society strongly influenced by the growth of aviation and space exploration.
8. To furnish all students opportunities for career exploration in aerospace.
9. To provide a flight experience for all students.
10. To provide some students aviation ground school and/or vocational and technical training in aviation skills.
11. To establish a collection of aerospace materials available to both school and community.

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Aerospace Activities

Primary Level

AEROSPACE ACTIVITIES

Primary Level

Content Area

Language Arts

Activities

Experience Chart

1. From class dictation write simple chart stories about the planets.
2. From class dictation write simple chart stories about the satellites.
3. From class dictation write simple chart stories about the solar system.
4. From class dictation write simple chart stories about the moon.
5. From class dictation write simple chart stories about the moon, the solar system, and the stars.
6. From class dictation write simple chart stories about the United States' space program.
7. From class dictation write simple chart stories about airplanes.
8. From class dictation write simple chart stories about a trip on an airplane.
9. From class dictation write simple chart stories about air and gravity.
10. From class dictation write simple chart stories about a trip to the moon.
11. From class dictation write simple chart stories about why I would like to go to the moon.
12. From class dictation write simple chart stories about how I would feel in space.

Written

1. Write stories about the solar system.
2. Write stories of space travel.
3. Write stories of the United States' space program using pictures.
4. Write stories about the lives of the astronauts.
5. Write stories about how an airplane flies.

Dramatic Plays

1. Dramatize the launching of a satellite.
2. Dramatize a trip on an airplane.
3. Dramatize a trip in space.
4. Dramatize the story of a space pilot.
5. Dramatize the life of a space traveler.

Reading

1. Develop a picture dictionary of aerospace vocabulary.

Content Area	Activities
Arithmetic	Number Experiences 1. Compare the size of the planets to the size of known objects. 2. Countdown the launching of a satellite. 3. Compare the size of the planets to the size of the earth.
Music	Rhythm 1. Imitate the feeling of floating in space. 2. Imitate the movements of an airplane with music background. 3. Imitate the different kinds of airplanes with music background.
Social Studies	Social Studies 1. Have children bring pictures in the news about the astronauts.
Science	Science

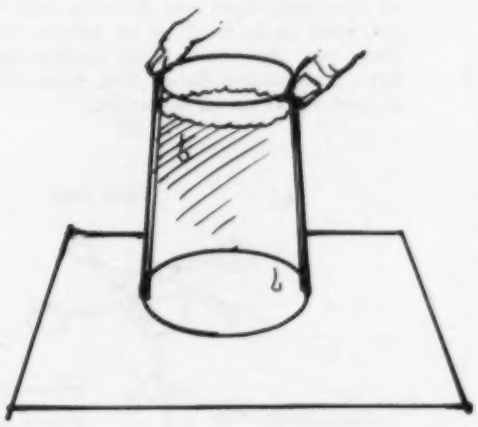

1. Place a hard-boiled egg (shell removed) on top of an empty quart milk bottle. The egg cannot be pushed through the bottle without exerting force. Remove the egg and insert a flaming torch made from a piece of rolled-up paper into the milk bottle. Quickly place the egg back on top of the bottle. Why did this happen?
2. Fill a glass to the top with water. Place a card on the top of the glass larger than the diameter of the glass. Holding the card firmly on the glass, quickly turn the glass over. Remove your hand from the card carefully.
   CAUTION: Perform this experiment over a pail or similar container.
3. Submerge a tumbler and allow it to fill with water. Turn it to an inverted position and lift it straight up until nearly all of the glass is above the water. Tell why H_2O would not run out of the tumbler.
4. Obtain two plumber's force cups and wet the bottom rim of each cup. (Two suction cups of equal size may be used instead.) Press the cups together to expel the air inside the cups. When you try to pull them apart, you may find this to be very difficult. Why?
5. Make a nail hole near the bottom of a small sized tin can. Fill the can with H_2O, hold the palm of the hand tightly over the top of the can, and the water will stop flowing from the hole. Lift the hand and the water will start to flow again. What can account for the stoppage of water?

6. Place a drinking straw in a full bottle of water. Press clay around the neck or close the opening between the straw and the bottle. Hold the clay tightly to the bottle with your fingers and try to drink through the straw.
7. Insert a glass tube into a one-hole stopper. Insert the stopper into a soda pop bottle completely filled with water. Suck on the tube and try to get a drink of water. Loosen the stopper and try again.
8. Show that air pressure on a parachute slows the fall of an object. Make a parachute from a piece of cloth. Drop an article without parachute attached, then with parachute attached.
9. Make model rockets from clay.
10. Grow plants with and without light.
11. Throw ball into air; discuss why it always comes down.
12. Shine flashlight on turning ball to demonstrate night and day.
13. Make parachutes of large handkerchief. Tie object to it. Observe how air slows the fall of object.
14. Make kites and fly them.
15. Keep daily weather chart with comments about "good" flying weather.
16. Fasten inflated balloon to small lightweight toy so that when air is released toy will move forward.
17. The "pop bottle" barometer shown in the diagram will indicate changes in pressure only if it is kept at uniform temperature. If the temperature is allowed to vary, it will operate on the same principle as a thermometer. Discuss the reasons for this.
18. Make a simple anemometer like the one shown in the diagram. Note the behavior of the vanes when the device is held in the wind or in front of an electric fan. Point out that commercial anemometers have a registering device that works like a speedometer on an automobile.

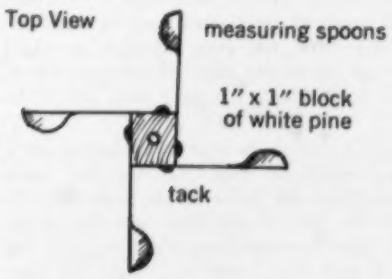

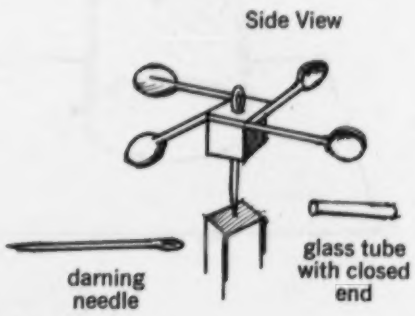

AIM: While continuing the interest in *Man in Space* — being alert to any new developments in the space program, a study of the Nature of the Universe, would be appropriate, beginning with the solar system, then going into the study of related subjects such as geology, weather, biology and botany.

Concepts To Be Developed	Activities	Resources
There are nine planets rotating around the Sun. This is called the Solar System The planets in order are: Mercury Venus Earth Mars Jupiter Saturn Uranus Neptune Pluto	Learn the names and order of the planets, using a nonsense quotation to help: "Many Vicious Elephants Move Jungles Searching Unfriendly Native Parties"	Room Environment: 1. Pictures of the planets showing their order 2. A globe of the Earth 3. A model of the Sun with the Earth rotating around it.
The earliest man was interested in the heavens above. The first tool for observing the stars and planets was a pair of eyes	*Science:* Begin keeping a Moon chart, showing the changes of the Moon	
	Language: Dictionary work— Begin building a working vocabulary on the Solar System. The following words should be defined and added to each child's Space notebook: astronomy comet galaxy gravity light-year lunar orbit meteor meteorite solar universe	

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Concepts To Be Developed	Activities	Resources
	Math:	
The Earth is a ball nearly 8,000 miles across.	Work on comparisons in distance and size, practice reading large numbers and discuss scaled measurement.	
	Science:	
The Sun is 109 times greater than the Earth.	Count out 109 BB's. Draw a straight line across a large sheet of paper. Spread glue on the line. Make sure the BB's touch one another. Draw a large circle around it. Imagine the circle to be the Sun, the BB's to be planets the size of the Earth.	

The planets vary in size. Jupiter is the largest. Pluto, the smallest.

Planet	*Diameter*	*Scale Measurement*
Mercury	3,000	1 inch
Venus	7,600	2 1/2 inches
Earth	7,900	2 3/4 inches
Mars	4,200	1 1/2 inches
Jupiter	87,000	2 feet & 5 inches
Saturn	71,500	2 feet
Uranus	29,500	10 inches
Neptune	27,000	9 inches
Pluto	3,600	1 1/4 inches

Using the scale measurement on page 7 cut pictures of each planet to show comparison in size.

Art:

Sunset Scenes — Cut and paste windmills, birds, planes, etc. from black construction paper. A silhouette effect is achieved by pasting the pictures on white paper, 8" by 12". Blend in sunset colors using colored chalk.

Film: *What Makes Night and Day?* Elementary Science Series, Young American Films, McGraw-Hill, Inc.

Concepts To Be Developed	Activities	Resources
Everything we do takes up space Heat energy from the sun travels through millions of miles of space to get here to warm the Earth. Early man identified outlines of imaginary figures in the sky formed by groups of stars called constellations. The Greeks began charting the stars		Film: *What Is Space?* Prod — EBF Dist — EBEC Encyclopaedia Britannica Films
Early man made guesses about the Universe and was sometimes wrong.	Discuss, on a simple level, the work of Aristotle—how people accepted and believed his ideas regarding an Earth-centered-Universe.	Film: *How Do We Know The Earth's Shape?* Film: *How Do We Know The Earth Moves?* Film: *How Many Stars?* Prod—MIS Dist—MIS Moody Institute of Science Educational Film Division 17000 E. Washington Blvd. Whittier, California 90606
Most of the planets are named for Greek and Roman mythological characters.	Read aloud each day for a determined length of time. Make picture dictionaries for a *Language* assignment. Show the following gods and goddesses: Athens—wisdom Apollo—sun Diana—moon Neptune—sea Mercury—messenger Venus—love Mars—war Jupiter—king of all the gods	*Stories of Gods and Heroes* adapted by Morris Schreiber
Three gods rode in chariots: Apollo's chariot was pulled by horses, Diana's by hounds, and Neptune's drawn by seahorses. The Olympic Games were begun in ancient Greek times.	*Art:* Make cut-outs of these three mythological characters. Paste black construction paper *Language:* Read to the class about the history of the Olympics *P.E.* Work at some track events —50 yard dash, 600 yard walk-run, standing broad jump *Math:* Mark field, using measurement Practice using stop watch	*The First Book of the Olympic Games* By John Walsh Film: *Track and Field* — Narrated by Bob Mathias Prod—UWF Dist—UEVA United World Films

Concepts To Be Developed	Activities	Resources
	Health:	
When an athlete is in training, he eats well and gets plenty of rest and exercise. He doesn't smoke.	The nurse might come in to discuss with class a good health program The children are tested in the "step-up-step-down" test to see if they can qualify for the physical fitness training and testing required by the state	
	Geography:	
Columbus helped to clear up a misconception of long standing. That the Earth was flat	Review the continents and discuss the discovery of North and South America	
Copernicus followed Columbus and set forth the idea of a sun centered universe. His ideas were ridiculed	Discussion	
Galileo was an Italian who accepted Copernicus' ideas about the universe Unlike Aristotle, Galileo accepted as true only what he could prove	Read aloud and discuss the life of Galileo	*Galileo* Author: Gregor A. S. Scribner, 1965. Grades 2-7
	Science:	
	Read about and discuss Galileo's laws of falling objects. Take turns dropping a light and a heavy object simultaneously to determine whether one would fall to the ground first.	
	Social Studies:	
A heavy object and a light object, when dropped at the same time, fall to earth simultaneously. B.C. means Before Christ A.D. means Anno Domimi, in the year of our Lord	Make a timeline to be placed on the bulletin board. Have the children draw pictures and place them at the proper date. Begin with John Glenn's flight and work backwards, adding to it during the year	
Galileo developed the telescope, which paved the way to more accurate study of the universe	Discuss the difference between Galileo's telescope and the telescope at Mount Palomar.	

AEROSPACE ART

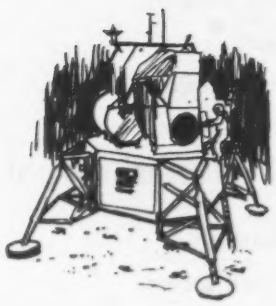

Draw or paint pictures of a space pilot.

Draw or paint pictures of a moon station.

Draw or paint pictures of the "man on the moon" or other figures imagined on the moon.

Draw or paint pictures of a trip to the moon.

Make a glider or airplane out of paper.

Build an airplane out of blocks.

Build an airport with blocks.

Draw or paint different kinds of clouds.

Draw or paint pictures of different kinds of airplanes, then make them into a mural.

Build a space capsule with blocks.

Draw or paint pictures of planets.

Draw a picture of a moon station.

Draw or paint pictures of space adventures.

Draw or paint pictures of rockets.

Make a rocket of cardboard tubes. Make an oatmeal-box capsule for a monkey, using clay and cotton to fit and pad it.

Make clay monkey to fit into the capsule.

Draw or paint pictures of the moon in phases.

Draw or paint pictures of the moon. Show the surface in the detail.

Make a picture book of different kinds of airplanes.

Make silhouettes of common kinds of airplanes. Use them as flashcards.

Have an exhibit of model airplanes.

From sturdy boxes, make an airplane large enough for the children to get into.

Construct a table-model airport.

Draw or paint pictures illustrating the history of ballooning.

Draw or paint pictures of satellites.

Draw or paint pictures of space travel or of what might be seen in space.

Build a table-model rocket base.

Draw or paint moonscapes.

Make imaginary moonscapes using clay.

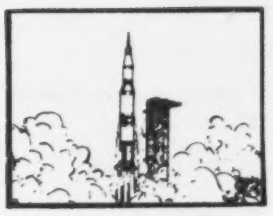

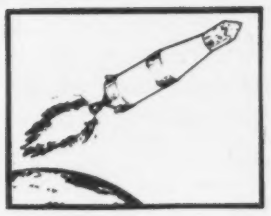

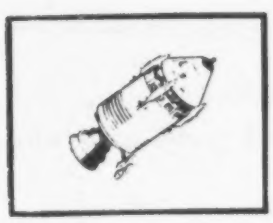

Make gravity pictures with string dipped in tempera paint. Place the paper on the floor and allow the string to fall where the gravity will cause it to fall.

Make a paper-bag space helmet.

Make oatmeal-box oxygen tanks.

Build a table model of a space station.

Construct a large table-model Mercury capsule using chicken wire for framework. Cover it with aluminum foil. If possible make it large enough for a child to get into.

Make a mural of our galaxy in space, showing approximate location of our solar system.

Draw or paint pictures of space vehicles.

Construct dioramas of an airport.

Make balloon models and use as mobiles.

Draw landscapes of the major planets.

Make paper models of satellites. Hang them as mobiles.

Build a table model of Cape Kennedy.

Make imaginary "moonscapes" with clay.

Make a three-dimensional map of the moon.

Make papier-mache models of the planets.

Build a model Nike base.

Make a table-model lunar vehicle.

Make clay models of different kinds of rockets, missiles and satellites.

Make diagrams of rocket and jet motors.

Make a three-dimensional map of the moon.

Prepare a mural of the history of flight.

Make models of historical airplanes.

Dress a doll in a model space suit.

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Aerospace Activities

Secondary Level

HOME ECONOMICS IN AEROSPACE

When man ventures into the hostile environment of space, he must take with him all the things he needs to keep him alive and comfortable: food, clothing, shelter, even the air he breathes and the water he drinks. For protection during space flight, the astronaut must have a spacecraft especially designed to shelter him from the hazards of space. He also requires a spacesuit which can be pressurized to protect him during extravehicular activity or in such cases of spacecraft pressure failure. For body energy, he must have food that is highly nutritious and especially prepared to be handled and eaten during the conditions encountered in space flight.

There are several aspects of space that make sustaining life a more complex process than it is on the surface of Earth. The factors to be considered are vacuum or total absence of air, a lack of atmospheric pressure, a lack of oxygen, weightlessness or zero gravity, ionizing radiation from solar flares which can be more deadly than the radiation of a nuclear bomb, and micrometeoroids that could penetrate the surface of the spacecraft. In addition, there are extremes of heat and cold much greater than those encountered on earth. Temperatures on the surface of the moon vary from a minus 243 degrees F. in the dark areas to plus 212 degrees F. in direct sunlight. This is the type of environment in which man must live and work as part of space exploration.

The environment to which man is normally accustomed is that of earth's gravity and atmospheric pressure. To survive extremes outside of these conditions, an adequate environment must be provided. The spacesuit can provide a suitable environment in addition to that provided by the environmental control system of the spacecraft.

The spacesuit designed for the crews of NASA'S spacecraft, consists of four layers which fit loosely inside one another. The layers are fastened together only around the boots, the zipper, the connections for the oxygen hoses and the medical instrument wires. The garment, complete with helmet and boots, weighs approximately 30 pounds.

The outside layer is made of a high temperature resistant white nylon. Beneath the outer layer is the restraint garment, so called because when the suit is inflated, it keeps the suit from billowing. It is woven of nylon net fabric and designed to allow mobility when inflated. The third layer is treated with rubber to make it almost airtight. The innermost layer is a smooth soft nylon layer designed for comfort.

The spacesuit is designed to provide safe protection against vacuum, heat, and cold. This suit is primarily an intravehicular suit and affords little if any micrometeorid protection. The spacesuit is designed as a backup to function in the event of pressure failure.

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Air inlet and outlet connections are located on the torso of the suit at waist level. A near 100 percent breathable oxygen system is provided to the suit from storage bottles.

Two pockets, one located between each knee and ankle, hold tools for opening food packages during flight and for cutting parachute lines if necessary on landing. Two large shin pockets are provided for flight plan data storage.

Accessories — Gloves are attached to the suit at the wrist with quick disconnect couplings. A small battery pack and two fingertip lights are mounted on each glove. This provides a small light source the astronaut needs when reading spacecraft instruments while on the dark side of the Earth.

The helmet has a built-in drinking port through which the astronaut can insert the nozzle of a "water gun" into his mouth without removing the helmet. The helmet provides visibility, comfort, and windblast protection. The communication system consisting of ear phones and microphones is an integral part of the helmet. Disconnect couplings also attach the helmet to the suit to facilitate removal or donning.

Three Suits for Each Astronaut—Primary crews are provided with three suits. All suits, including the boots, gloves, and helmets, are individually tailored. One suit is for training, a second for the actual mission, and the third is provided as a backup.

Since the water supply on a spacecraft is limited, the manner of shaving, brushing teeth, and bathing must be changed.

A shaver operated by a spring motor, like a windup toy train is used. It has a built-in vacuum cleaner that collects the cut whiskers—which otherwise might float around getting into eyes and noses or fouling instruments because of the weightlessness and zero-gravity atmosphere.

For teeth brushing, they may either use a chewing gum something like one which now advertises its tooth cleaning as well as pleasant taste or a toothpaste which is treated so that it is edible. The astronaut eats the used dentifrice instead of spitting it out.

For "washing up," they'll use a chemically impregnated near-lintless cleaning tissue, to prevent water droplets and lint from fouling the instruments.

Regarding physical activity and sleep, the astronauts have no room to stand up straight or lie out flat for rest. The spacecraft limits their movement because of a need to conserve space. Exercise routines are done by isometrics.

HOME ECONOMICS

OBJECTIVES

1. The student will describe how mans' environmental needs are met in space flight in terms of seven atmospheric conditions (such as: weightlessness, lack of oxygen, etc.); on type of clothing; three personal hygiene and fitness habits (such as: shaving, brushing teeth, and bathing); two sanita-

tion procedures; and three problems encountered in providing an adequate diet (such as weight load on the spacecraft, the weightless condition of space, and low residue for waste disposal).

2. The student will be able to list eight physical changes (such as: cardiovascular, muscular, and skeletal changes due to weightlessness, negative calcium balance, dehydration, negative nitrogen balance, etc.) which could take place in the human body due to living in a spacecraft.
3. The student will explain the main use of a low-residue diet as it relates to waste disposal on a spacecraft; the lowered caloric requirements as affected by physical activity on a space craft; and adequate levels of carbohydrates, fats, protein, vitamins, minerals, and water as a necessity for optimum astronaut nutrition.
4. Given a list of foods, the student will plan a nutritious meal by selecting only those which are low-residue foods.
5. The student will prepare a low-residue meal and evaluate texture, flavor, appearance, juiciness, and acceptance on a nominal scale.
6. The student will describe in detail the one main method of dispensing water on a spacecraft for drinking and food reconstitution.
7. The student will be able to name and describe in general the types of diets under investigation for long duration flights and their feasibility.
8. The student will list eight current techniques of food processing used in the food industry and one example of a food characterized by each technique.
9. The student will name and describe in general how food for the future may be obtained from oceans and lakes and from organic and inorganic substances.

ENERGY REQUIREMENTS FOR VARIOUS ACTIVITIES DURING SPACE FLIGHT

Activity	Time (hour)	Energy Expenditure Rate Cal./Min.	Total Performance Calories
Sleep	7	1.2	504
Quiet sitting or standing	12	1.5	1080
Instrumentation	2	1.8	216
Complex neuromuscular tasks	2	2.6	312
Moderate work	1	7.0	420
			2532

The diet contains about 150 grams of fat, 310 grams of carbohydrate, and 80 grams of protein for a total of 2800 calories. The urine volume on this diet would be about 800 milliliters per day. The fecal losses are minimized by the use of low-residue foods. The diet contains about five per cent crude fiber and results in an average daily output of 80 to 85 grams of feces. Three liters of water per day are included with this diet. Since astronauts are busy and preoccupied, water intake must be programmed into the daily schedule. Salts to provide levels about 10 per cent above earth allowances are added to provide calcium, magnesium, potassium, and sodium. Liberal allowances of ascorbic acid and Vitamin E are included. Other vitamins are provided on the basis of the recommended allowances.

NUTRITIONAL NEEDS ON LONG DURATION FLIGHTS

Environmental conditions in space such as weightlessness, heat and cold, wearing of pressurized suits, inactivity, and cabin temperature may produce more definite changes in nutrient requirements on long duration flights.

On long-term space travel, the effect of prolonged inactivity could cause a negative nitrogen balance. Also, a prolonged constant cabin temperature could lower the basal metabolic rate thus lowering the energy requirements of man.

The sweating process plays an important part in determining energy requirements of men exposed to solar radiation or high temperatures. Considerable nitrogen is lost in sweat. An increase in protein is necessary under conditions that produce a great deal of sweating.

Another change in nutritional needs may be due to the continuous wearing of pressurized suits for extended flight explorations. A diet of precooked freeze-dried foods seems efficient in supplying the necessary nutrient requirements. During periods of inactivity, while wearing the pressure suit, there is no need to increase the nutritional requirements. However, during periods of exercise, both water and energy requirements need to be increased.

The water requirements for long duration space flights are very important. Both caloric requirements and water requirements are strongly affected by physical activity, thermal environment and clothing. As a minimum, two liters of fluid should be provided daily with provision for additional water, if necessary. Of this amount, one to one and one-half liters become urine and one liter becomes water vapor, leaving the lung surfaces and the skin as "insensible" perspiration. If any visible perspiration occurs, the water requirement may rise to many times the basic value. Even if there is no visible perspiration, as in the hot, dry desert, water needs rise sharply with the temperature. Some water is made from food that is eaten. In the metabolism of carbohydrates such as sugar, about one gram of water is formed for every gram of food.

The dietary recommendation of long duration space flights is that the diet be as simple as possible with the maximum use of natural foods. The diet preferred is a liquid formula or one which can be reconstituted to liquid or semi-liquid form. The caloric requirements for a 150 pound man should provide 2700 to 3200 calories per day of which 12.5 per cent are protein, 52.5 to 57.5 per cent carbohydrate, and 30 to 35 per cent fat.

Evolving from this new interest in nutritional needs for space travel has been a new technology entitled Gastronautics. Gastronautics is "a new interdisciplinary technology—astrophysiological dietetics—regulation of diet consistent with the normal functioning of an organism beyond the earth environment."

Packaging of Foods for Flight — Early space feeding was mainly that of serving liquids and semi-solid foods from collapsible squeeze tubes. These tubes were like aluminum toothpaste-type tubes with a nontoxic food grade organic inside coating. These special coating materials were applied to the inner surface of the aluminum tubes to prevent formation of hydrogen gas, which would have resulted from reaction between the metal and the acids in certain foods, such as applesauce. Precision filling and sealing techniques were devised to eliminate any trapped gasses which might expand and rupture the container when the pressure in the spacecraft cabin was reduced. A new gasketing material was developed to increase protection against leakage or spoilage during storage. Special in-the-tube sterilization techniques were also employed to preserve the contents. The average tube of food weighed 5½ ounces, with the aluminum tube accounting for a large proportion of this weight. The weight of the tube in proportion to the weight of the food was considered to be too high, but subsequent development of a lightweight plastic container helped to overcome this problem.

The food in these tubes is transmitted to the mouth of the astronaut by applying pressure to the tube. The food is fed into the mouth through a three and one-half inch polystyrene pontube which screws onto the aluminum tube and cuts open the tube when it is attached. During space flights, when the space suit may not be pressurized, the face plate can be opened to allow the food to be squeezed directly from the tube into the mouth. But if the space suit is pressurized, the pontube must be used and it is inserted into an opening in the face plate of the suit.

For foods which need reconstitution with water, a package was designed with an enclosed aesceptic tube which extends to submit water and through which the food was directly fed into the mouth. This packaging was transparent to enable the astronauts to identify the foods. This laminate was developed to provide adequate heat sealability, very low water vapor permeability to protect foods against moisture pick-up and oxidation, and durable enough to meet the stresses of reconstitution of foods.

The sandwiches, bacon and fruit cake packages were provided with a pull-tab arrangement for dispensing the food. The dispenser for bite-size pieces was made of Plexiglas and contained a pull-tab and a closure flap of polyethylene. The astronauts removed the bite-size pieces by hand and placed them directly in the mouth while the face plate was open. In the early flights, a water-proof polyethylene mitten was worn over the pressure suit gloves for sanitation purposes.

FOOD CONCEPTS FOR LONG DURATION FLIGHTS

Long duration space flights have been considered to be of three months duration or longer. Weight, storage, waste disposal, and water supply will be of prime concern on these flights. In order to minimize storage and weight, several types of diets have been proposed.

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Investigated Diets

Taking an energy pill instead of eating a meal is more like science fiction. Mealtime is an important part of the day for the astronauts in order to avoid monotony. The energy pill concept, not highly favored, would require 90 large size capsules for the protein, minerals, and vitamins and 250 capsules in the form of fat to provide 2200 to 2500 calories per day. The psychological and physiological aspects of consuming such a large number of pills per day almost rules out this concept.

Another proposal is to increase the body weight of the space traveler before flight and he will then utilize this increased fat during space flight. This would be similar to a semi-starvation diet. The psychological aspects of this semi-starvation diet make it nonacceptable.

A third diet concept is the use of liquid formula diets containing chemicals for a well balanced diet. The levels of all nutrients must be adequate if it is to be used as the only food source. This diet provides 20 to 40 calories per fluid ounce. The advantages of this diet are that it would shorten food preparation time and provide sterile food.

Synthetic diets for space programs have also been studied. The chemical diet consists of proportions of L-amino acids, the required water-soluble and fat-soluble vitamins, pertinent salts, glucose and ethyl linoleate as the source of essential fat. Only distilled water may be added to the diet. Studies on this diet have demonstrated that there were no adverse physiological or psychological effects. The physical status and psychological outlook after consumption of the diet was good. Fecal residue was strikingly reduced. The major advantage of this diet is that one cubic foot of the diet will provide a 154 pound astronaut with all the required nutrients and 2830 calories per day for one month. In addition, this synthetic diet is completely water soluble, low in bulk, completely digestible, and has good storage stability.

Each day, an average man requires, in addition to about 2 lb. of oxygen, almost 7 lb. of water, and approximately 2 lb. of food. This is his intake. His output consists of about 2½ lb. of carbon dioxide, almost 8 lb. water, and just a small amount of solids, urea, and minerals. Thus, he consumes the equivalent of his weight in about 15 days. In only 6 months, he takes in about a ton of oxygen, food, and water. On extended missions, it will be prohibitive to carry along all these supplies, and it will be necessary to use some of man's output for developing an input.

Current Innovations with Nutrients

Some unique ideas and innovations with the use of nutrients are being investigated for space flight. Clothing could be made of fibers spun from soy bean, casein, and zien. The United States Department of Agriculture has already developed fibers from egg whites and chicken feathers.

There is a possibility of using edible structures for the design of spacecraft fuel tanks, rocket motors, and lunar rocket launch facilities. Other ideas include the use of transparent sugar castings as a substitute for optical

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glass; glue and adhesives from fish, animal protein or starch; paper from soybeans, egg albumin or starch; and ink from vegetables.

The astronaut of the future who undertakes a space journey lasting from two to four years may receive a complete meal by chewing a concentrate the size of a licorice stick. The meal stick which is being developed will contain all the necessary vitamins, minerals, and calories of a full meal.

Investigation has gone into the synthetic development of high energy metabolites which are compounds having a greater density of calories for a given weight than the usual source of calories. These have been studied to lessen the weight and volume of food. Two compounds that have a caloric content higher than carbohydrate are being tested for consumption by man. These compounds are 2.4 di-methyl hepatanoic acid (2,4-DMHA for short) and 2-3 butanediol and do not exist in nature. They were designed entirely from consideration of biochemical and physiological energy requirements. It has not been advocated that the next astronauts carry a liquid diet of 2,4-DMHA and 1,3-butanediol, even though all kinds of tempting flavors could be added. A great deal more study is needed before it can be fed to humans. This is the first time a nutritional source has been designed that is potentially more efficient than nature. Always before the attempt has been to imitate nature. Because future space travelers will probably live on nutrients recycled from their own body wastes, this type of food may serve as "lifeboat rations." When the space traveler leaves his ship, these nutrients may be just what he needs.

The chemical synthesis of proteinoids from amino acids to go along with the synthetic vitamins is another possible food source. This chemical synthesis must be inexpensive and simple to operate for long duration space flights. These proteinoids have an acceptable taste similar to grilled fish in either the raw or roasted state.

Water that can't leak has been investigated. It's stored like jelly. It turns liquid only when squeezed, and becomes like jelly again when the pressure is relaxed. A substance somewhat like the gelatins used in ice cream which is edible could be put in an astronaut's drinking water or his soup. Since in space there is no gravity, water tends to ball up—form in droplets and this makes it hard for an astronaut to transfer it from one container into another containing dried, powdered food. There is a tendency for the droplets to escape and drift around in the cabin. Subsequently, this new gelled water does not break up into droplets. If some should escape, it becomes a gelatinous mass and simple to recover. It's not likely to float around and short cut the circuitry. When a glass of this water is turned upside down the liquid remains in the open glass. It can be spooned out, or transferred to a plastic squeeze bottle and can even be served cold.

There has been investigation into the development of a building material made from edible contents. This material contains hominy grits, powdered milk, cornstarch, flour, and powdered banana flakes. It is harder than fiberboard and contains 300 to 400 calories per 100 grams. For emergency food, it can be ground or soaked for 24 hours to make a cereal having a banana flavor. When molded in sheets and coated with a removable film laminate this

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edible material can be utilized for structures in space stations such as instrument panels, bunks, clipboards, walls, packaging and compartment dividers.

Many of these new nutrient ideas need much research before they can actually be utilized for space flight.

SUGGESTED ACTIVITIES

1. The student might collect pictures of astronauts' spacesuits and discuss the reason for the types of construction and the fabrics used, as relates to space flight.
2. The students could be divided into groups. Each group plans a meal and presents to the class, through demonstration, what would happen to each type of food if eaten under the conditions which exist in space.
3. The student could develop a written list of physical changes which might take place in the human body due to living in a spacecraft. Class discussion could evolve from these lists.
4. The students could plan two nutritional daily menus. One menu planned for a very active man and requiring a high caloric level. The second menu planned for a little-active astronaut and requiring a low caloric level. A comparison of the two menus could stimulate a discussion on caloric requirements.
5. Utilizing the daily menu planned for the astronaut which contains a low caloric level, the students might evaluate the menu to determine if they had provided adequate proportions of carbohydrates, protein, and fat.
6. From a list of astronaut foods, the students could plan three meals. One meal for a Mercury flight, one for a Gemini flight, and one for an Apollo flight. The three meals might then be evaluated for adequate proportions for the necessary nutrients.
7. Menus for Gemini and Apollo flights could be shown to the students. The students might evaluate the menus to determine whether each food would or would not be acceptable for space flight.
8. A discussion might be stimulated on the reasons for establishing strict weight, volume, packaging, and nutritional requirements for space food.
9. To stimulate discussion of the eating of space foods on a spacecraft, the teacher might puree some food in a blender and seal the pureed food in small plastic bags. The students might clip the corner of the plastic bag and squeeze the food into the mouth as the astronauts would do on flight.
10. A discussion might be developed on how the production of space food has influenced the production of certain consumer foods.
11. The teacher might have the students develop a list containing possible means of obtaining foods for the future, in the event the world food supply would run short. A discussion on foods of the future might evolve from these lists.

VOCABULARY LIST

1. orbit
2. satellite
3. vacuum
4. meteroids
5. probe
6. planet
7. eleptic
8. crater
9. sound barrier
10. payload
11. solar cell
12. fuel cell
13. freez-dehydrated
14. telescope
15. radar
16. telemetry
17. lift-off
18. potable
19. pressure suit
20. posigrade
21. retrograde
22. lunar rover
23. mare
24. solar wind
25. ultra violet
26. ionosphere
27. atmosphere
28. rocket burn
29. orbital period
30. second stage
31. retro rocket
32. heat shield
33. ablation
34. rendezvous
35. docking
36. module
37. spacecraft
38. launch vehicle
39. supersonic
40. hypersonic
41. touchdown
42. computer
43. lunar
44. meteorite
45. atomic power
46. sublimation
47. eclipse
48. aeronautics
49. sonic boom
50. countdown

THE SOCIAL STUDIES AND AEROSPACE

THE SOCIAL IMPACT OF AVIATION UPON SOCIETY

I. Aims and Objectives

This unit is designed to help students:

1. Understand the national and international problems created by aviation.
2. Become aware of the part played by research in aerospace development.
3. Appreciate the services and responsibilities of all phases of domestic, international, and military flying.
4. Realize the growing interdependence of all people through aerospace development and related fields.
5. Appreciate the changes brought about in geographic relationships by the elimination of national boundaries and the changing concepts of time and space.
6. To comprehend more fully the magnitude of occupational opportunities offered by the aviation industry.

II. Outline of Unit Content

This unit is designed to help the student:

1. Understand the national and international problems created by aviation through the study of:
   a. Customs and conditions
   b. Language barriers
   c. Climatic conditions
   d. Geographical relationships
2. Understand the social impact upon the community where research centers are located.
3. Appreciate the services of all phases of air transportation by studying:
   a. Military uses of the airplane
   b. Public uses of the airplane
4. Study the mobility of our society and the psychological and sociological effects of it due to the changing concepts of space and time.
5. Understand the growing interdependence of all peoples through aerospace development and related fields.
   a. Personnel
   b. Education and training
   c. Accounting and finance
   d. Supply management
   e. Data management and processing
   f. Weather
   g. Behavioral science
   h. Maintenance and engineering
   i. Aircraft control
   j. Aerospace medicine and foods

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6. Study the magnitude of occupational opportunities offered by the aviation industry.

III. Suggested Student Activities

1. Make a bulletin board showing job opportunities in aviation.
2. Field trips to a local airport to see what various occupations are employed there.
3. Write to foreign embassies and obtain weather information and terrestrial conditions.
4. Make a map showing locations of various materials used in the construction of aircraft and spacecraft.
5. Make a map showing locations of research centers.
6. Engage the pupils in a Pen Pal Club with students from foreign countries.
7. Keep a notebook on the social, psychological, and physical changes and influences effected upon our society due to the "Space Age."

SOCIAL STUDIES AEROSPACE CURRICULUM DEVELOPMENT

The goal of aerospace education is not to make every student a professional pilot. The primary objective is to help all students understand the economic, social, cultural, and technological implications involved in aerospace—its operation, its problems, and most of all its possibilities. Because aerospace is such a dynamic and growing field, new problems and new areas are constantly arising, making it necessary to make changes. Because it is not static, what may be an adequate answer to any given problem today may not be an adequate answer tomorrow. One of the most important aspects of a student's education, therefore, should be to learn that while the techniques of problem solving may remain the same, no solution can be considered final. This conclusion has been dramatically demonstrated in the Mercury to Apollo missions in reaching the moon.

A study of the impact of aerospace is beneficial whether or not the student continues with any phase of aerospace or ever gets a pilot's license. All students who take a course in chemistry will not become chemists just as all students learning about aerospace will not become astronauts.

Aerospace education has unlimited possibilities and responsibilities to be a part of the fabulous future of the field of flight.

Government Involvement In Aviation

I. Aims and Objectives

The specific aim or objective of this unit is to help the student realize that our air space is our greatest national/natural resource, and as such necessitates government involvement and supervision.

II. Outline of Unit Content

This unit is designed to help the student:

1. Understand why our government is involved in aviation and aerospace.
   a. Military development and security
   b. Space exploration

c. Airport development
d. Airway systems development

2. Understand how our government is involved in aviation and aerospace.
   a. Laws concerning Air and Space
   b. International regulations
   c. Federal regulation of aviation
   d. Economic regulations and aviation
   e. State regulation of aviation
   f. Local regulation of aviation

III. Suggested Pupil Activities

1. Make a pie chart showing % of Military aircraft, General Aviation aircraft, and Commercial aircraft.
2. Prepare a bulletin board illustrating the advances in Military aircraft.
3. Spacemobile visit illustrating aspects of the space program.
4. Invite guest speakers to speak on such subjects as:
   a. Airport management
   b. Air control
   c. Registration of aircraft and pilots
5. Field trips to FAA Academy in Oklahoma City (if location will permit).
6. Trace the development of Federal regulation from the Federal Air Mail Act of 1925 to the present.
7. Study how the FAA investigates aircraft accidents.

AEROSPACE TERMS

Aerodynamics
The science that treats of the motion of air and other gaseous fluids, and of the forces acting on bodies when the bodies move through such fluids, or when such fluids move against or around the bodies.

Air density
The ratio of the mass of air to its volume, expressed as its weight per unit of volume, e.g., 1 kilogram per cubic meter.

Airfoil
A surface which furnishes lift, thrust or control to the vehicle.

Airspeed
The speed of an aircraft in relation to the air through which it is passing.

Airway
An air route along which aids to air navigation, such as beacon lights, radio ranges and direction finding facilities, and landing fields are maintained.

Altimeter
An instrument for indicating the relative altitude of an airplane by measuring atmospheric pressure.

Animometer
A device for measuring the velocity of the wind, in common use at airports.

Apogee
The point in an elliptical orbit around earth which is farthest from earth.

Apollo
United States program with the objective of earth-orbiting a space laboratory, launching astronauts to the vicinity of the moon, and landing a man on the moon, and returning him to earth.

Astro
A prefix meaning "star" or "stars" and, by extension, sometimes used as the equivalent of "celestial," as in astronautics.

Azimuth
The initial angle or direction between true North and a great circle course.

Bernoulli's Principle
As the speed of a confined fluid increases, the fluid pressure decreases.

Bioastronautics
Astronautics considered for its effect upon animal or plant life.

Center of Gravity
The point through which the resultant forces of gravity acts no matter how the body is oriented.

Centrifuge
A large motor-driven apparatus with a long rotating arm at the end of which human and animal subjects or equipment can be revolved at various speeds to simulate very closely the prolonged accelerations encountered in high-performance aircraft, rockets, or manned missiles.

GENERAL SCIENCE AND EARTH SCIENCE IN AEROSPACE

Unit: Aviation

Topics: History of Manned Flight
sample reference—FAA films
History of Aircraft Development
sample reference—Smithsonian Institute booklets
Aircraft Construction
sample reference—Piper Aircraft booklets
Forces Acting on Aircraft in Flight
sample reference—Jeppesen and Company
Function of Aircraft Controls
sample reference—Sanderson Company
Flight Maneuvers
sample reference—FAA films
Atmospheric Characteristics
sample reference—FAA, Weather Bureau
Weather Map Interpretation
sample reference—FAA, Weather Bureau
Radio Communications
sample reference—CAP, FAA

Air Traffic Rules
sample reference—FAA
Aerial Navigation
sample references—FAA, CAP, Sanderson Company

Suggested Activities:

1. Have students bring a collection of aviation magazines.
2. Have students bring newspaper clippings concerning aviation to place on the bulletin board for the aviation unit study.
3. Invite a local airport operator to speak to the class about aviation of the area.
4. Visit the local airport, with assistance of the local airport operator.
5. Visit a nearby FAA Flight Service Station.
6. Have students bring model airplanes for a hanging display during the unit of study.
7. Invite a representative of a model airplane flying club to speak and perhaps give a flying demonstration for the class.
8. Have an in-class contest of paper airplane, kites, glider, rubberband powered planes and gasoline powered planes.

GENERAL SCIENCE AND EARTH SCIENCE

Unit: Space Flight

Topics: History of Rocketry
sample reference—NASA films
Rockets and Newton's Laws
sample reference: Holt Company,—Library of Science
What is a Satellite
sample reference—NASA Films *Publications
Kinds of Satellites
sample reference—NASA Films
The Universe
sample reference—Film "Universe"—NASA
Manned Space Flights
sample reference—NASA Film
Taking Earth's Environment Into Space
sample reference—NASA Films
Space Flights to Other Planets
sample reference—NASA Films

Suggested Activities:

1. As a class project have the students build a mobile of the solar system.
2. As a class project have the students build paper models of spacecrafts.
3. Have the class simulate 1/6 gravity of the moon by suspending 5/6 of the weight by a rope to an overhead support.
4. Have the class build model rockets.
5. Have a model rocket contest by judging both the appearance and altitude of the rocket when it is fired.
6. Have the students build a mock-up space suit.

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7. Have a contest of the student's drawings and models of a proposed vehicle to travel on the moon.
8. Have the class build a model of a space station large enough to house 50 people and show where all the various types of equipment would be located.

AEROSPACE EDUCATION IN THE LIFE SCIENCES

Suggested areas of approach:

I. Environmental Biology

A. Biosphere—general discussion of the film of life
B. Exosphere—general discussion of the film of life
C. Life support systems to be considered in both biosphere and exosphere.
   1. Oxygen content control
   2. Pressure—both normal air pressure and artificial pressure
   3. Thermal control
   4. Water
   5. Food
   6. Waste control
   7. Hygiene
   8. Radiation effects
   9. Protection—radiation, meteorites, etc.
   10. Contamination
D. Implementing support systems in exosphere

II. Physiological Aspects of Aerospace

A. Physical effects: such as
   1. Circulation
   2. Respiration
   3. Pressure
   4. Weightlessness and muscle-tone relationships
   5. Dehydration
   6. Fatigue
   7. Various physical conditions such as hypoxia, hyperventilation, flicker vertigo, coreolis effect, etc.
   8. Visual orientation
   9. Cosmic radiation
   10. Possible meteoroid bombardment
B. Psychological Effects
   1. Requirements and training
   2. Stress
   3. Phobias
   4. Long periods of isolation
   5. Induced hiberation studies
C. Aeromedicine
   1. Experimentation—past and present
   2. Medical technological advances
      a. Cardiovascular monitoring devices

b. Electrostatic cameras for monitoring patients
c. Heart valve improvement
d. Transducer transmitter that relays intestinal data
e. Laser surgery
f. Aids to blind and deaf
g. Walking wheel chair
h. Other bionic devices

D. Health Education
1. Safety
2. Fitness
3. Personal hygiene

E. Effects of biological clocks (interruption of normal cycles)
1. Man
2. Animals
3. Plants

III. Genetic Effects — Mutations
A. Radiation
B. Weightlessness

Suggested Laboratory Exercise:

Procedure:

Select two containers, one of which will easily fit into the other. Affix pointer to the top of the smaller container. Use glue to fasten the stick. Drill a hole in the center of the bottom of the larger container. The diameter of the hole should allow the one-hole stopper to just enter. Adjust the height of the tube to the top of the container.

To Tube A attach a length of rubber tubing and affix the other end of this tube to the center of large container. Tube B should be attached to a piece of tubing which will be pinched shut after potassium hydroxide is added. The jar can be weighted with sand so that it sinks in a pan of water. Ice can be added to the water to produce varying ambient temperatures within the jar.

As the test animal consumes oxygen, the small container will sink in the water of the large container. The change in levels can be observed on the scale. The markings on the scale can be calibrated by introducing known amounts of air into container through the attached hose. Make several calibrations.

Once the scale is calibrated, you are ready to begin experimentation. Place a test animal in the jar. Stopper and attach the rubber hose of Tube A to the center tube of large container. Add saturated potassium hydroxide to fill bend in Tube B. Stuff cotton into the bent end. Close the other end by pinching the rubber tube with a pinch clamp. The potassium hydroxide in the cotton will remove the carbon dioxide exhaled by the animal. Why is this necessary? Record the original level of air in the small container and allow the test animal to remain sealed in the jar. Add ice to the water surrounding the jar and maintain a constant temperature while oxygen consumption is being recorded.

Determine the volume of oxygen consumed per minute for several ambient

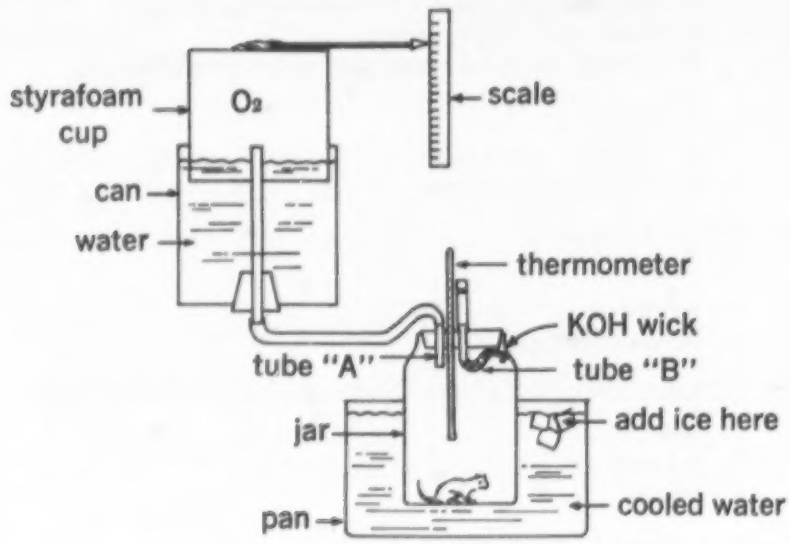

temperatures. This can be calculated from the total oxygen consumed divided by the total time of the experiment.

Example: 30 cc of oxygen in 10 minutes = 3 cc of oxygen consumed per minute.

Determine the minute oxygen consumption rate for 20°, 15°, 10°, 5°, 0° Centrigrade using room temperature as a control. Graph the results.

Discussion:

1. What conclusions can you make about the effect of ambient air temperature on metabolic rate?
2. Which ambient air temperature provided the minimum metabolic rate?
3. What additional factors would have to be considered before this temperature could be used within space suits?

Additional Investigation:

This same apparatus may be used to investigate several space problems. Here are a few problems that are currently being considered by space scientists:

1. To what extent does hypothermia induce drowsiness or sleep?
2. How might the reduced activity associated with hypothermia affect the astronaut's ability to rapidly recover maximum performance efficiency?
3. Could hypothermia provide relief from the psychological and physiological problems associated with long-term confinement and boredom?
4. In what ways could forced astronaut hiberation be beneficial for long space flight?
5. Compare the metabolic effects of hypothermia in homeotherms with poikilotherms as a simulated study of estivation and hibernation.

(This laboratory exercise and many more may be found in the NASA publication *"Space Resources for Teachers—Biology."*)

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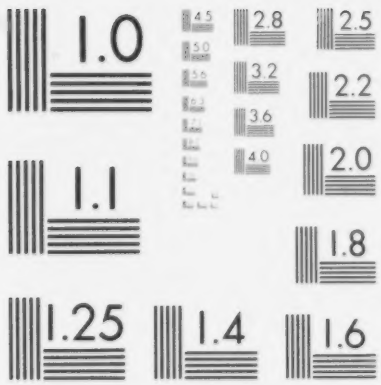

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

INDUSTRIAL ARTS AND SPACE TECHNOLOGY

Industrial arts has been defined as the study of tools, materials, processes, products, occupations, and related problems of America's industrial society. As such the profession of industrial arts teaching necessarily concerns itself with those societal developments which have relevance to its area of study. America's space program is such a development. In the effort to increase mankind's knowledge of the heavens and the earth through the use of manned and unmanned spaceflight, America's space program has developed new tools, new materials, new processes, as well as new jobs, unheard of 10 years ago. It has provided great impetus to accelerating advancements and developments in science and technology, and the resulting changes in patterns for living.

Space is the new frontier of science and technology; and if industrial arts is to give students an insight into American industries, teachers must be more concerned with space age technology. The image of industrial arts will be greatly improved in the eyes of the students, parents, administrators, and the lay public when teachers introduce these changes to shop and classroom teaching.

SPACE AGE APPLICATIONS OF INDUSTRIAL ARTS TECHNOLOGY

Drafting:

Ellipses to show the orbit of a space vehicle, the sun and the planets.
Booster engines and stages.

Assembly: Draw the following:

Saturn V Rocket
Pipe cutting tool
Portable power tool
Chart case

Other areas are:

Electronic drawing
Sheet metal drawing
Pictorial drawing
Architectural drawing
Structural drawing
Plumbing drawing
Charts and drafts

NASA Tech Briefs are available which give detailed information in each of the above areas.

RELATIONSHIP TO INDUSTRIAL ARTS

By this time you have become aware of the magnitude of the aerospace industry; an industry encompassing many people working in many kinds of jobs. This space age industry can be said to be made up of a number of other industrial organizations, as shown in Fig. A. Space vehicles require products made of ceramics, plastic, and metal as well as the power and electronic components. It is evident that industrial arts can make a significant contribu-

tion to understanding the aerospace industry because it, too, is concerned with the same areas, as are shown in Fig. A. Industrial arts students work with the principles and the skills necessary to produce, propel, and control spacecraft. Fig. B shows graphically the kinds of systems present in these crafts and gives further evidence of the many opportunities for industrial arts teachers to help acquaint their students with the products and processes of the space age.

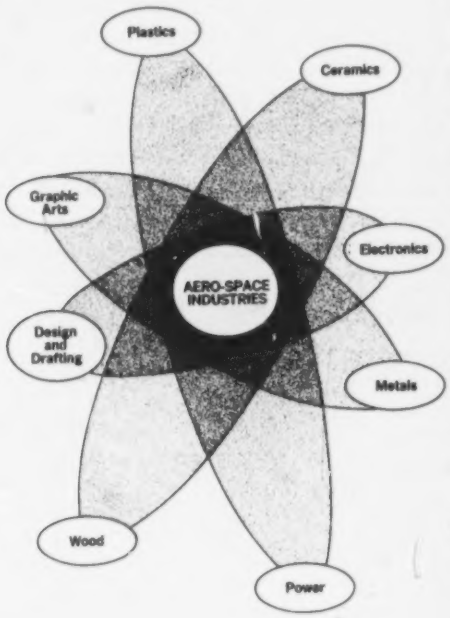

Fig. A

Fig. B

TYPICAL AEROSPACE OCCUPATIONS

aeronautical engineer
aeronautical draftsman
design draftsman
plumbing draftsman
electrical draftsman
mechanical engineer
aircraft designer
machinists
tool and die makers
welders
riveters
heat treaters
jig builders
press and shear operators
model maker
pattern maker
lathe operators
instrument maker
telephone engineer
television repairman
radio electrician
electronic engineer
truck mechanic
diesel mechanic
rocket engine mechanic
photographer
plastics fabricator
ceramics engineer
mock-up builder

A complete coverage of this subject is in the NASA publication "Space Resources for the *High School Industrial Arts.*" "Industrial Arts Resource Units."

PRIVATE PILOT GROUND SCHOOL COURSE

I. Introduction

We feel that the high schools in the state of Oklahoma should make every effort to incorporate aviation and aerospace information into every subject course where it could be inserted by reason of its current interest, its motivating assistance and its logical application in the sequence of study.

In schools which can introduce a separate course in the subject aviation or aerospace, it is recommended that the following be offered in the general education curriculum as an elective, one year (two semester) course.

This course is general and introductory or exploratory, not terminal in nature. No prerequisites are set, but the course is designed for use in grades 10, 11, and 12.

It is further suggested that teacher qualification include some evidence of a *strong* interest in aviation.

II. Objectives

1. To prepare all students so that they may participate in a society strongly influenced by the growth of aviation and space exploration.
2. To introduce the student, through highly motivational subjects of aviation and space, some disciplines of various academic fields. This would include an adequate reading and speaking vocabulary pertinent to aerospace.
3. To furnish all students opportunities for career exploration in aerospace.
4. To provide a flight experience for all students desiring it.
5. To provide some students aviation ground school and/or vocational and technical training in aviation skills.
6. To establish a collection of aerospace materials available to both school and community.

The objectives of this course would be reached by different options in course content. It is recommended that the decision of a specific combination of these options be left to the individual school, dependent upon their facilities.

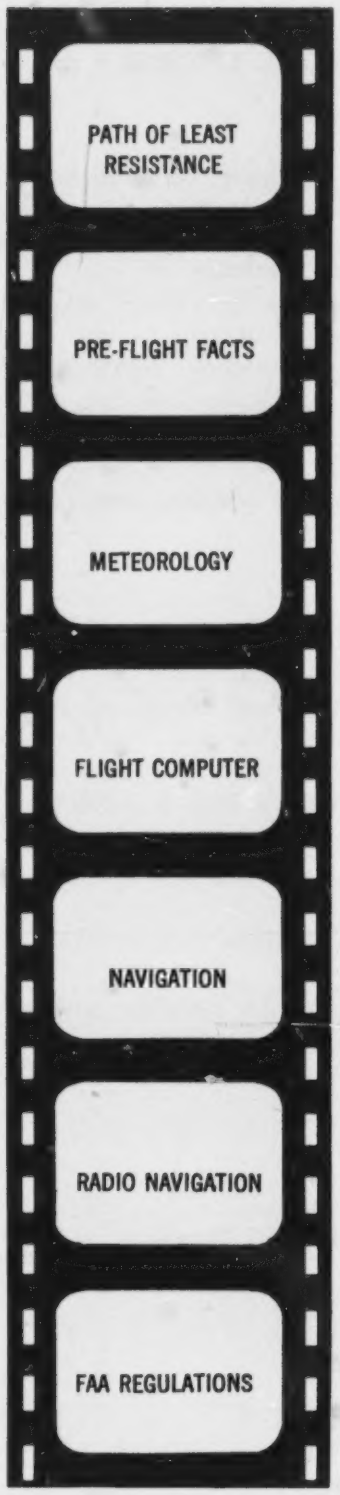

AVIATION EDUCATION

Private

LESSON	*Orientation*
REFERENCES	Sanderson Teacher Education Manual, Flight Instructor's Handbook, Federal Aviation Agency, 1964
OBJECTIVES	Indoctrinate teachers to course methods, teaching techniques, the need for aviation instruction in schools and administrative considerations.
ELEMENTS	Aviation Statistics, Objectives, Organization, Administration, Methodology, Evaluation
SCHEDULE	Lecture :15 minutes Show Sanderson filmstrip, "Path of Least Resistance" :30 minutes Questions :05 minutes
EQUIPMENT	Private Pilot Manual (1) to ea. student DuKane Projector and filmstrip Blackboard TEACHER EDUCATION MANUAL (1) to each student
INSTRUCTOR'S ACTIONS	Orient teachers to Teacher Training Course Show filmstrip Answer questions
STUDENT'S ACTIONS	Register Sign class roster Introductions Ask questions regarding course
EVALUATION	Not required for orientation session

AVIATION EDUCATION

Private

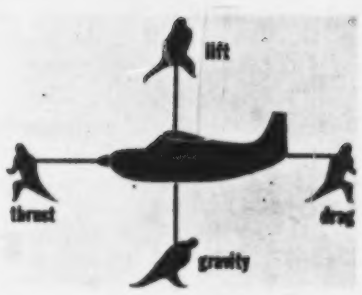

LESSON — *Pre-Flight Facts (Section A)*

REFERENCES — *Private Pilot Manual*, Pre-Flight Facts, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.
Aviation Psychology Manual for Flight Instructors, H. J. Holmes and Thomas Hogan.

OBJECTIVES — Acquaint teachers (students) with aircraft components and the four forces.

ELEMENTS — *Aircraft Components* / *The Four Forces*

Wing	Lift
Power Plant	Gravity
Empennage	Thrust
Landing Gear	Drag
Fuselage	

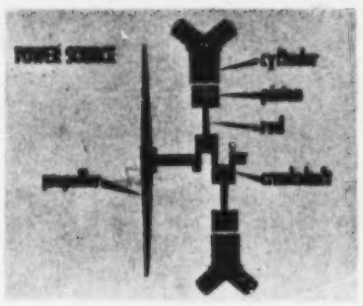

SCHEDULE

Introduction of filmstrip	:10
Pre-Flight Facts, Section A	
Show filmstrip	:40
Question and answer session	:20

EQUIPMENT — DuKane Projector
Sanderson Filmstrip—Pre-Flight Facts Section A
Blackboard for post filmstrip instruction
Model airplane with moveable controls
Suggested Illustrations for overhead projector:

1. Aircraft Components
2. Wing Structure
3. Power Source
4. Four Forces
5. Propeller
6. Airfoil
7. Lift

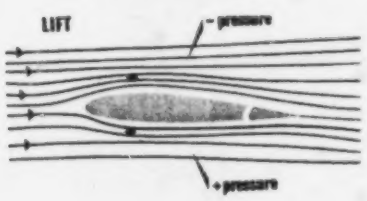

INSTRUCTOR'S ACTIONS — Serve as a discussion leader following the showing of the filmstrip.

Typical questions:

What is the main function of the wing?

What is the role of the wing in producing lift?

Illustrate the four forces acting on an aircraft in flight. (Use blackboard)

What are two ways to recover from a stall condition? (Use model plane to illustrate)

What are the four strokes of the engine power cycle?

What is the purpose of the empennage?

Demonstrate or show how the propeller develops "thrust."

(In addition to the above questions, it is suggested that the teachers use the questions outlined in the Sanderson Programmed Learning System)

STUDENT'S ACTIONS

Discuss objectives and resolve above questions.

Review the major concepts presented in the filmstrip.

Demonstrate as many of the concepts as possible using a blackboard, model, or a visual aid.

EVALUATION

The lesson is complete when the student teachers can explain, illustrate, describe, define, discuss or formulate the ideas presented and communicate their ideas to others.

AVIATION EDUCATION

Private

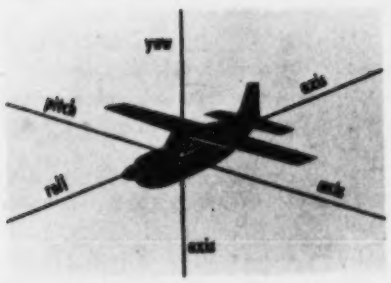

LESSON — *Pre-Flight Facts (Section B)*

REFERENCES — *Private Pilot Manual,* Pre-Flight Facts, Sanderson Films, Inc.—Sec. B *Flight Instructor's Handbook,* Federal Aviation Agency, 1964.

OBJECTIVES — Develop a basic understanding of the three axes: yaw, pitch and roll, along with the aircraft control system, the trim system, vacuum system, and electrical system.

ELEMENTS

The Three Axes
- Yaw Axis
- Pitch Axis
- Roll Axis

Aircraft Controls
- Ailerons
- Rudders
- Elevators
- Stabilators
- Wing Flaps

Trim Systems
- Trim Tab
- Adjustable Stabilizer
- Moveable Tail

Vacuum System

Electrical System

SCHEDULE

Introduction of filmstrip Pre-Flight Facts, Section B	:10
Show filmstrip	:40
Question and answer session	:20

EQUIPMENT

DuKane Projector
Sanderson Filmstrip—Section B
Blackboard
Model Airplane

Suggested illustrations for overhead projector:

1. Three Axes
2. Tail Structure (VS)
3. Horizontal Stabilizer
4. Trim Tab—Stabilator
5. More Down Trim
6. More Up Trim
7. Roll Right Bank
8. Roll Left Bank
9. Vacuum System
10. Venturi
11. Electrical System

INSTRUCTOR'S ACTIONS — Serve as a discussion leader following the showing of the filmstrip.

5953

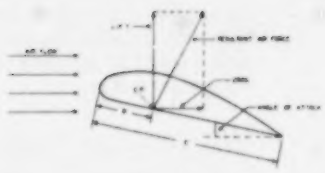

Lift and drag on an airfoil.

Typical questions:

What is the one point in the airplane's attitude, about which it can be balanced perfectly?

Explain the yaw axis and related control surface.

Describe the pitch axis and related control surface.

Illustrate the roll axis and related control surface.

What are the trim systems provided to minimize elevator or stabilator control pressures?

Review the functions of the trim tab, adjustable stabilizer and moveable tail.

Discuss the electrical system. (In addition to the above question, the instructor should use questions outlined in the Sanderson Programmed System)

It is important to learn the relationship of lift to drag in regards to flap settings:

What is the purpose of the wing flaps?

Explain what flap settings are used for take-off and landing.

STUDENT'S ACTIONS

Respond to the above questions correctly; however, if there is some misunderstanding, teacher should be able to resolve points of confusion.

Review material and/or slides which are difficult to understand.

Discuss and review the important points.

EVALUATION

In presenting this unit, the teacher should use the question and answer quiz as much as possible following the showing of the filmstrip. A quiz will check the effectiveness of the lesson, check retention, review the material, build enthusiasm and repeat the important points covered in the filmstrip.

AVIATION EDUCATION

Private

LESSON — *Pre-Flight Facts (Section C)*

REFERENCES — *Private Pilot Manual,* Pre-Flight Facts, Sanderson Films, Inc.—Sec. C. Flight Instructor's Handbook, Federal Aviation Agency, 1964.
Aviation Psychology Manual for Flight Instructors, H. J. Holmes and Thomas Hogan.

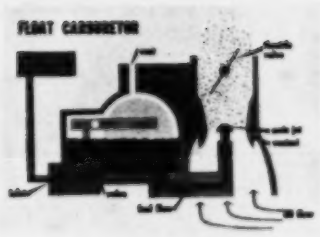

OBJECTIVES — Create an understanding of what the primary function of the fuel system is, how it operates and why there is a need for different types of fuel systems. Acquaint teachers (students) with different types of landing gears and primary function.

ELEMENTS

Fuel System
Gravity Type Fuel System
Fuel Pump Type Fuel System
Fuel Tanks
Fuel Selector Valve
Fuel Strainer
Carburetor
Carburetor Heat System

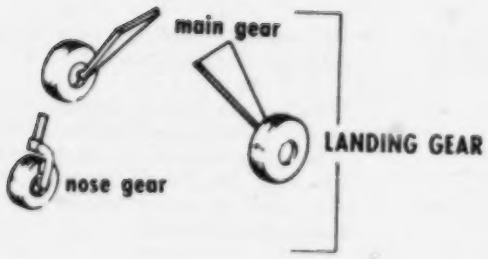

LANDING GEAR
Conventional Landing Gear
Tri-Cycle Landing Gear
Brake System

Pre-Flight Inspection

SCHEDULE

Introduction of filmstrip	:10
Pre-Flight Facts, Section C	
Show filmstrip	:40
Question and answer quiz	:20

EQUIPMENT

DuKane Projector
Sanderson Filmstrip—Section C

Suggested illustrations for overhead projector:

1. Gravity Fuel System
2. Fuel Pump Type Fuel System
3. Carburetor
4. Carburetor ice
5. Carburetor Heat System
6. Brake System

Pre-Flight inspection checklist
Blackboard

5955

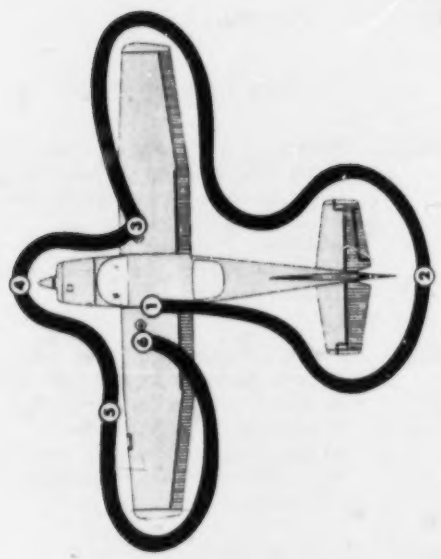

INSTRUCTOR'S ACTIONS

Conduct a question and answer quiz using some of the questions that follow:

What is the primary function of the fuel system?

Name two types of fuel systems.

Where is the fuel strainer located in relation to the fuel system?

Why should not the carburetor heat be used during taxi?

Where is the fuel selector valve located?

Explain the operation of the carburetor.

Name the two basic types of landing gears and the main difference between them.

Discuss the importance of a pre-flight inspection.

STUDENT'S ACTIONS

The students should be able to discuss the above questions.

Write in the correct answers to all of the questions outlined in the Sanderson Programmed Learning System following the Pre-Flight Facts Section. Look up wrong answers in Pre-Flight Facts Manual.

EVALUATION

Oral quizzing of Section A, B, & C. Look up wrong answers in Pre-Flight Facts Manual.

Responses to Sanderson Programmed Learning System.

GRAVITY TYPE FUEL SYSTEM

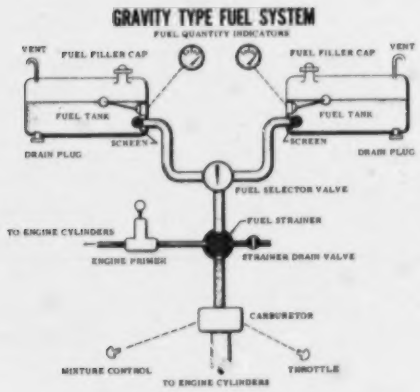

AVIATION EDUCATION

Private

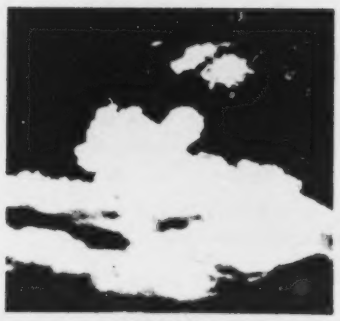

CUMULUS

LESSON — *Meteorology (Section A)*

REFERENCES — Private Pilot Manual, Meteorology, Section A, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Acquaint the teachers (students) with air masses and other weather phenomena.

ELEMENTS — United States Weather Bureau Weather Map
Terminology and Weather
Weather Symbols
Clouds
Atmospheric Pressure
Thunderstorms
Air Masses

CIRRUS

SCHEDULE

Period 1

Introduction of filmstrip Meteorology, Section A	:20
Showing of filmstrip	:40

Period 2

Lecture following filmstrip	:20
Manual repeat of film for question and answer quiz	:40

Period 3

Trip to U.S. Weather Bureau & Airport

EQUIPMENT — DuKane Projector
Blackboard
Actual Weather Maps
The Koch Chart

Suggested Illustrations for overhead projector:

1. Weather Map
2. Speciman (Station Model)
3. Basic Weather Symbols
4. Barometric Pressure in Millibars
5. Thunderstorms
6. High Pressure Area
7. Low Pressure Area
8. Cold Air Profile
9. Warm Front Profile
10. Occluded Front Profile

INSTRUCTOR'S ACTIONS

Arrange for a class tour of the weather bureau and airport if possible. Invite a meteorologist to speak to the class.

Typical questions:

What is the primary function of the weather bureau?

How often during a 24-hour period is weather information plotted on weather maps?

Discuss and explain the various symbols used in the station model.

What are isobars?

Name the two fundamental types of clouds.

Discuss thunderstorms and their stages.

STRATUS

NIMBUS

STUDENT'S ACTIONS

Discuss objectives and resolve questions.

Explain correctly the concepts and ideas presented in this session.

Recognize various frontal conditions and cloud formations.

Compute take-off distance using the Koch Chart.

EVALUATION

Lesson is complete when student can correctly explain each of the key elements listed above.

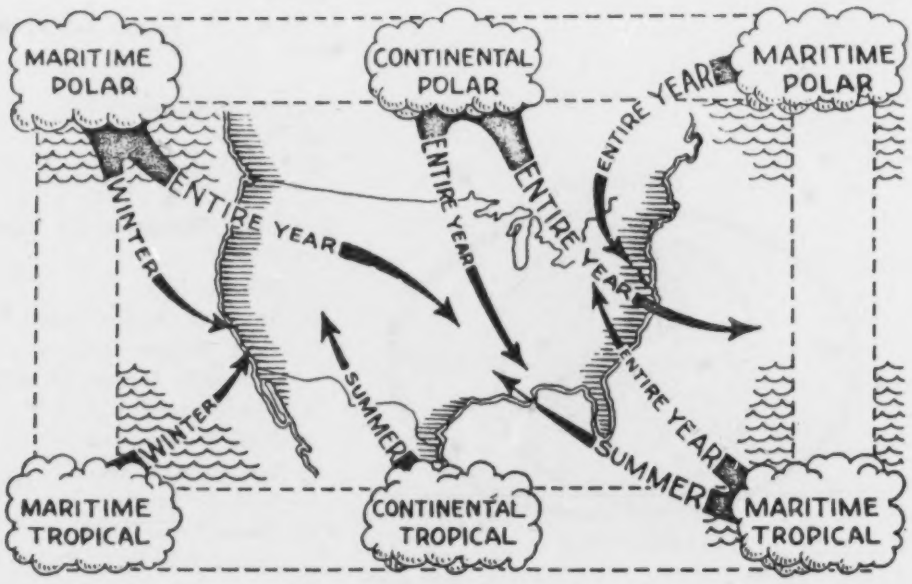

AVIATION EDUCATION

Private

SEQUENCE REPORT PICTURE
Cold Front approaching
MKC 15+ 132/64/58/131 /992
Cold Front passing
MKC M5 2 TRW 962/56/55/3221
G25/946
After cold front passage
MKC M2 12RW 222/5
/42/3615/ 17

CLEAR: SMOOTH AND GLASSY

RIME: ROUGH AND COURSE

FLYING INTO LOW PRESSURE
(Aircraft Low)

FLYING INTO HIGH PRESSURE
(Aircraft High)

LESSON — *Meteorology (Section B)*

REFERENCES — *Private Pilot Manual*, Meteorology, Sec. A & B, Sanderson Films, Inc. *Flight Instructor's Handbook*, Federal Aviation Agency, 1964.

OBJECTIVES — Acquaint the teachers (students) with fog, icing conditions, density altitude, turbulence, frontal icing and weather reports by radio.

ELEMENTS

Fog	Turbulence
Density Altitude	Frontal Icing
Icing Conditions	Weather Reports by radio

SCHEDULE

Period 1

Introduction to filmstrip Meteorology, Section B	:10
Showing of filmstrip	:40

Period 2

Lecture following filmstrip	:10
Manual repeat of film for question and answer quiz	:40

EQUIPMENT

DuKane Projector
Blackboard
Weather Maps (daily fascimile)
Recording of weather reports (local airport)

CLEAR: SMOOTH AND GLASSY

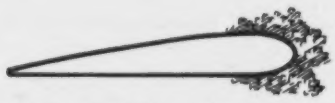

RIME: ROUGH AND COARSE

Suggested illustrations for overhead projector:

1. Density Altitude
2. Scheduled Broadcast Order
3. Sigmets
4. Thermal Effect on Landing
5. Sea Level Takeoff
6. Koch Chart
7. Turbulence in Cumulonimbus Clouds
8. Effect of Ice
9. Vortex Core

Use following from Sec. A., Meteorology:

10. Cold Air Profile
11. Warm Front Profile
12. Occluded Front Profile
13. Barometric Scale
14. Warm Front Icing

INSTRUCTOR'S ACTIONS

Typical questions:

What is meant by density altitude?

How does density altitude apply to the pilot?

Name two kinds of ice and where they will form.

Tell about heavy aircraft turbulence.

Discuss various radio weather reports.

Explain mountain wave.

STUDENT'S ACTIONS

Be able to answer oral questions asked by teachers.

EVALUATION

Paper and pencil test.
Oral examination.

FLYING INTO LOW PRESSURE
(Aircraft Low)

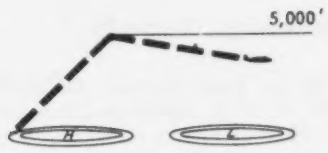

FLYING INTO HIGH PRESSURE
(Aircraft High)

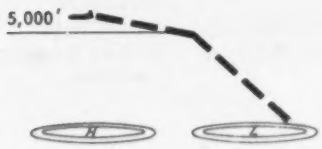

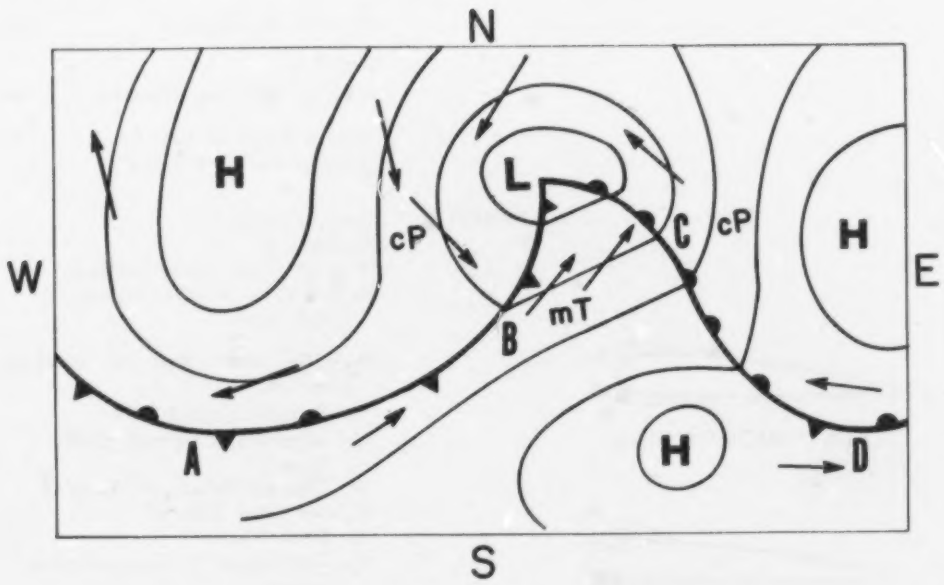

AVIATION EDUCATION

Private

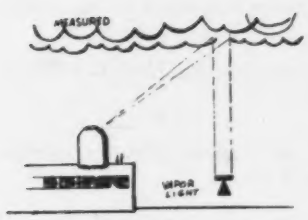

LESSON — *Meteorology (Section C)*

REFERENCES — *Private Pilot Manual,* Meteorology, Section B, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Introduce students to the weather advisory service and special advisories available to pilots.

Acquaint students with sequence reports, winds aloft forecasts, and other types of forecasts.

ELEMENTS — Weather Advisory Service
Sequence Reports
Sky Coverage
Ceiling
Visibility
Present weather conditions
Barometric pressure
Temperature and dewpoint
Wind
Altimeter setting
Pilot reports
The Notam Status Code

Winds Aloft Forecast
Terminal Forecasts

SCHEDULE — *Period 1*

Pre-filmstrip instruction	:20
Sanderson filmstrip Meteorology, Section C	:40

Period 2

Interpretation of Practice Teletype Reports—pages 1-1 to 1-5. Use practice frames, end of Section C filmstrip)	:40
Question and answer session	:20

EQUIPMENT — DuKane Projector
Blackboard
Actual Sequence Reports from local airport-Radio (for listening to "airway" broadcast of weather reports)

Suggested illustrations for overhead projector:

1. Sequence Reports

SEQUENCE REPORTS

029 SA29031200
ROW 70015 072/53/20/3020G29
/986/OCNL BD
ELP 030 091/54/31/3115/993
GDP AMOS /46/28/2519/
991/000/
CNM 015+ ↓074/4X11Q
GT HOT
INK S 015+ 075/47/46/2905/
982/APARANT FROPA
0540C GND FG DSIPTD
RPDLY/ 312 47 24230→INK↘11/
IAN
MAF S —X11/2F 055/58/2908/
979/R10VV1/4 F5

2. Example of Sequence Report
3. Sky Coverage Symbols
4. Letters to indicate how ceiling is measured
5. Letters to indicate obstruction to visibility
6. Wind Direction Symbols
7. Altimeter Converted to Sea Level
8. Practice Winds Aloft Forecast
9. Practice Frames (Use) C-64 and C-65

INSTRUCTOR'S ACTIONS	Lecture on weather advisory service of general nature. Involve the students as much as possible in reading practice teletype reports. Assign each student *one* sequence report.
STUDENT'S ACTIONS	*Make* accurate interpretation of teletype reports of all types Ability to *read* all sky coverage symbols. *Understand* the order of the scheduled weather broadcast.
EVALUATION	Oral reading of sequence report correctly. Check retention of the subject of meteorology by having the students take Sanderson Films, Inc., Programmed Learning System, Meteorology. Oral review of test. Look up wrong answers in manual.

5962

WINDS ALOFT FORECASTS

FD SAT 030550
12Z-24Z TUE

LVL 3000 5000FT 10000FT 15000FT
20000FT 25000FT

SJT 1720 1920+14 2520+06
2330−04 2335−14 2340−25
18Z 3325 2825+15
MRF 2720+05 2630−05
2635−15 2540−25
HOU 1820 1820+15 2012+07
2512−04 2715−15 2720−25
VCT 1720 1820+16 2015+07
2415−14 2625−25
BRO 1625 1818+17 2308+08
2613−12 2722−24
COT 1625 1625+17 2320+08
2520−02 2420−12 2525−25

SKY COVERAGE SYMBOLS
USED ON SEQUENCE REPORTS

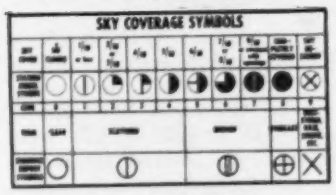

SEGMENTS

FL GSW 031735
1135C-1535C TUE
SIGMET NR 1. AT 1715 C135 RPRTD
MDT—SVR TURBC 290 OVR
AMARILLO.
OVR NWRN TEX AND OKLA PNHDL
ALG AND 50 MIS EITHER SIDE
OF WINK
AMARILLO GUYMON LN LKLY MDT
OR GREATER TURBC 230-350.

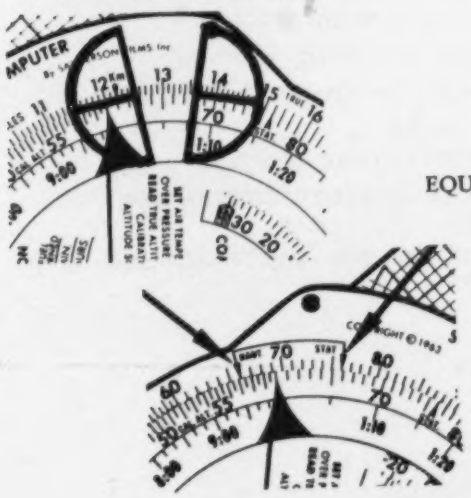

AVIATION EDUCATION

Private

LESSON — *Flight Computer (Section A)*

REFERENCES — *Private Pilot Manual*, Flight Computer, Section A, Sanderson Films, Inc.

Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Use of flight computer in pre-trip planning and to compute in-flight aircraft problems.

Develop greater confidence in flying through a good understanding of the computer.

ELEMENTS — *Flight Computer*
Calculator side
Changing values
Speed index
Multiplication or division index
Time and distance problem
Fuel consumption

SCHEDULE — *Period 1*

Introduction to computer	:10
Showing of filmstrip, Flight Computer, Section A	:40

Period 2

Lecture on computer use	:15
Work Practice Time and Distance Problems, page A-5	

Period 3

Work Practice Fuel Consumption Problems, page A-8, A-9, A-10	:30
Work Review Problems, Page A-10	:15

EQUIPMENT — DuKane Projector
Sanderson Flight Computers (one for each student)
Blackboard

Suggested illustrations for overhead projector:

1. Computer side of Sanderson Flight Computer (Moveable Scales)
2. Problem Logs (Draw on Clear Overhead Transparency)

5963

INSTRUCTOR'S ACTIONS

Lecture on the use of Flight Computer

Provide opportunity for students to solve problems presented in Sanderson Films, Inc., booklet entitled, "Flight Computer."

Assist those students who have difficulty in problem solving.

Review key points brought out in filmstrip.

STUDENT'S ACTIONS

Solve all flight computer problems in manual, Section A, Pages A-5 to A-10.

Develop correct understanding of the basic operation of the flight computer.

Explain what the "A", "B", "C" scales of computer are used for.

EVALUATION

Demonstrate ability to solve all computations presented in Section A with the use of a Sanderson Flight Computer.

Demonstrate the ability to explain the use of a flight computer to others.

PRACTICE PROBLEMS — TRUE HEADING AND GROUND SPEED

1. True course—310°; T. A. S.—120 m.p.h. wind velocity—16 m.p.h.; wind direction—180°; what is the true heading and ground speed?_____
2. True course—178°; T. A. S.—135 m.p.h.; wind velocity—23 m.p.h.; wind direction—45°; what is the true heading and ground speed?_____
3. True course—65°; T. A. S.—155 m.p.h.; wind velocity—20 knots; wind direction—Northwest; what is the true heading and ground speed?_____
4. True course—West; T. A. S.—130 knots; wind velocity—18 knots; wind direction—344°; what is the true heading and ground speed?_____
5. True course—95°; I. A. S.—111 m.p.h.; temperature—+25° C.; altitude—7,500 feet; wind velocity—10 knots; wind direction—360°; what is the true heading and ground speed?_____

COMPUTER SIDE OF SANDERSON FLIGHT COMPUTER

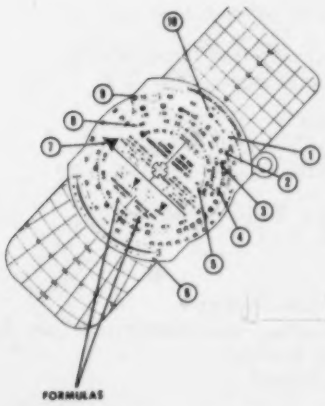

1. "A" SCALE—(Miles, miles per hour, gallons, gallons per hour, true airspeed, and true altitude.)
2. "B" SCALE—(Time in minutes, calibrated altitude, and calibrated airspeed.)
3. "C" SCALE—(Time in hours and minutes)
4. DENSITY ALTITUDE WINDOW
5. PRESSURE ALTITUDE WINDOW
6. TEMPERATURE CONVERSION SCALE
7. SPEED INDEX
8. AIR TEMPERATURE WINDOW
9. NAUTICAL—STATUTE CONVERSION ARROWS
10. UNIT INDEX FOR MULTIPLICATION AND DIVISION

COMPUTER SIDE OF SANDERSON FLIGHT COMPUTER

AVIATION EDUCATION

Private

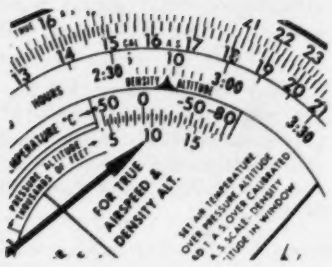

LESSON — *Flight Computer (Section B)*

REFERENCES — *Private Pilot Manual,* Flight Computer, Section B, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Solving of true airspeed problems using the flight computer.

Changing nautical values to statute equivalents with the use of the computer.

Finding answers to multi-part problems.

ELEMENTS — *Flight Computer*

T.A.S.	Statute miles
Nautical values	Multi-part problems

SCHEDULE — *Period 1*

Introduction of filmstrip Flight Computer, Section B	:05
Showing of filmstrip	:40
Period 2	
Lecture on Computer use	:15
Problem solving	:50

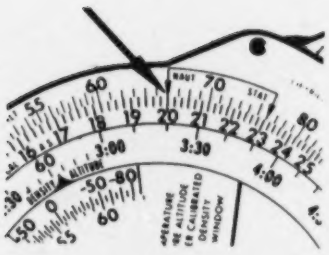

EQUIPMENT — DuKane Projector
Blackboard
Sanderson Flight Computers (one for each student)

Suggested illustrations for overhead projector:

1. Computer Side of Sanderson Flight Computer (Moveable Scales)
2. Problem Logs (Draw on Clear Overhead Transparency)

INSTRUCTOR'S ACTIONS — Introduce students to other uses of flight computer.

Assist students with problem solving.

STUDENT'S ACTIONS — *Know* how to compute T.A.S., conversion of nautical miles to statute and statute to nautical miles.

Explain correct use of the computer

EVALUATION

Require students to answer correctly all practice multi-part problems on page B-5.

Instructor should help answer student questions during problem solving period.

PRACTICE MULTI-PART PROBLEMS

1. Wind—0 m.p.h.; ground speed—120 m.p.h.; distance—320 miles; fuel consumption—9 g.p.h.; how much fuel will be burned?_____

2. Altitude—7,500 feet; I.A.S.—150 m.p.h.; temperature—+15° C.; distance—256 miles; fuel consumption—11.5 g.p.h.; wind 0 m.p.h.; how much fuel will be burned?_____

3. Altitude—9,000 feet; I.A.S.—115 m.p.h.; temperature of—10° C.; distance—335 miles; fuel consumption—8.5 g.p.h.; wind —0 m.p.h.; how much fuel will be burned?_____

4. Ground speed—135 m.p.h.; wind —0 m.p.h.; temperature—+20° C.; altitude—9,000 feet; distance—425 miles; fuel consumption—12 g.p.h.; how much fuel will be burned?_____

5966

STUDENT'S ACTIONS

Find correct answers to practice problems listed in Flight Computer, Section C, Appendix 1, page 1-1 in manual.
Describe the correct use of the computer in solving the various problems.

PROBLEM LOG

tas	dist.	time	gph	fuel
?	455	?	10	?

EVALUATION

Administration of Flight Computer Programmed Learning Tests at the end of the lesson on computers.
Discuss answers to Programmed test questions and look up answers in manual.

WIND SIDE OF SANDERSON FLIGHT COMPUTER

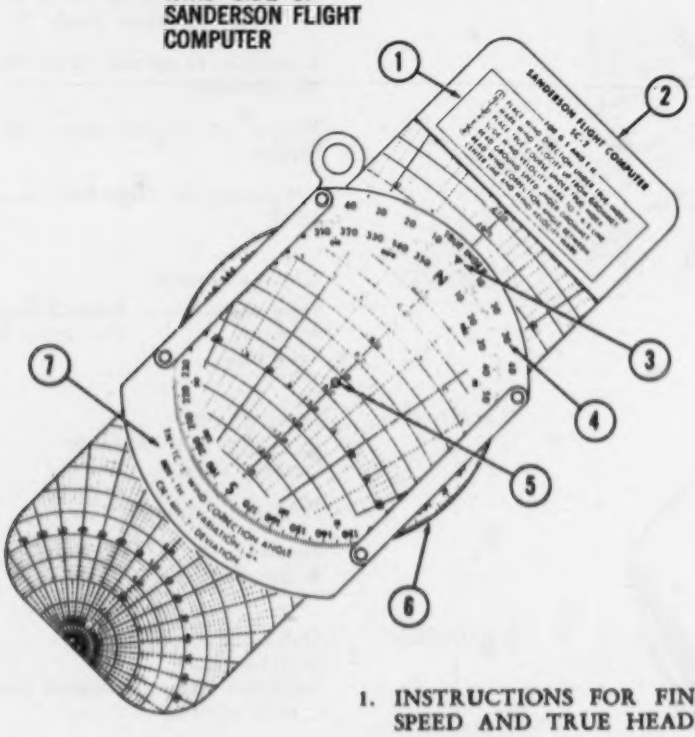

1. INSTRUCTIONS FOR FINDING GROUND SPEED AND TRUE HEADING.
2. SLIDING GRID
3. TRUE INDEX
4. WIND CORRECTION ANGLE SCALE
5. GROMMET
6. AZIMUTH
7. INSTRUCTIONS FOR DETERMINING TRUE HEADING, MAGNETIC HEADING, AND COMPASS HEADING

5968 2

AVIATION EDUCATION

Private

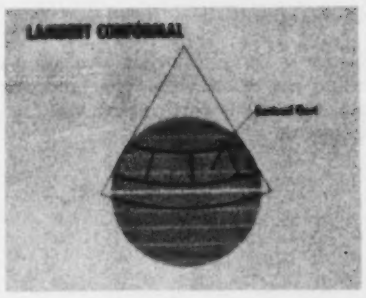

LESSON — *Navigation (Section A)*

REFERENCES — *Private Pilot Manual*, Navigation, Section A, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — To familiarize students with navigation charts.
To know how to select charts, read chart symbols, air traffic control symbols and aeronautical and topographical symbols.

ELEMENTS — WAC Charts
Sectional Charts
Latitude and Longitude Chart Symbols
Radio Facilities

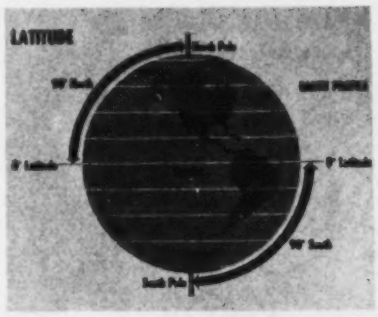

SCHEDULE — *Period 1*

Lecture on introduction to Navigation	:20
Showing of filmstrip, Navigation, Section A	:40
Period 2	
Discussion of filmstrip information	:50

EQUIPMENT — DuKane Projector
WAC Charts
Sectional Aeronautical Charts
Blackboards
Suggested illustrations for overhead projectors:
1. Sectional Chart
2. Longitude
3. Latitude
4. Aeronautical Symbols
5. Topographical Symbols
6. Cruising Altitudes
   Flight Levels

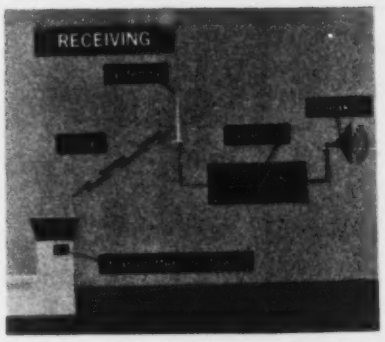

INSTRUCTOR'S ACTIONS — Present a general lecture on Section A of Navigation, using as many charts and other aids as possible.
Develop a list of questions using Sanderson Private Pilot Manual.
Have the students interpret the various chart symbols during the question and answer quiz.

STUDENT'S ACTIONS — Correct *interpretation* of all chart symbols.

5969

Understand the major differences between the WAC Charts and Sectional Charts.

EVALUATION Oral quizzing by instructor.

Lesson is complete when student can retain the information presented during the filmstrip presentation and follow-up discussion.

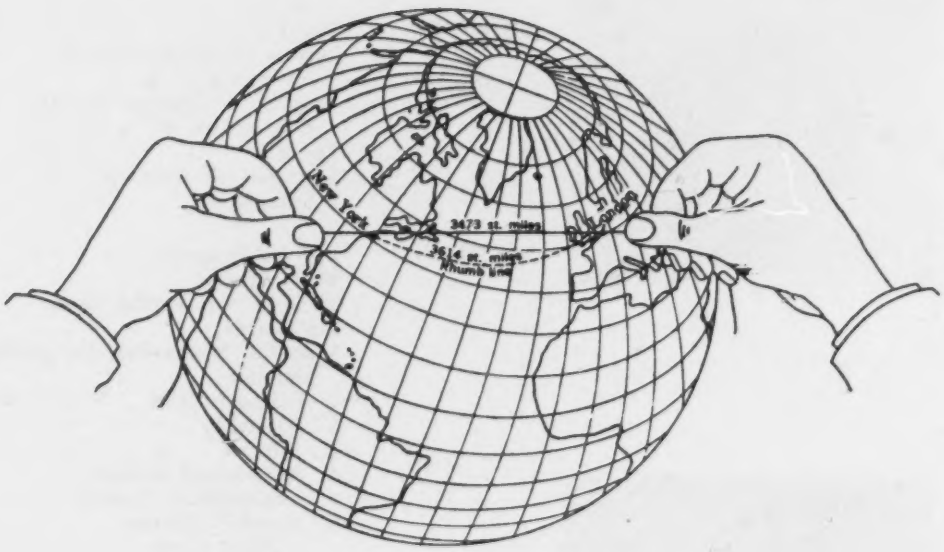

AVIATION EDUCATION

Private

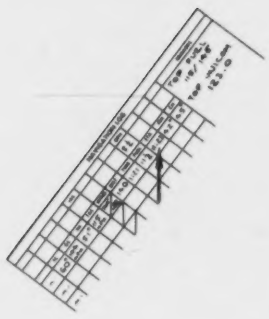

LESSON — *Navigation (Section B)*

REFERENCES — *Private Pilot Manual,* Navigation, Section B, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Students should know how to use all of the flight planning aids.

Knowledge of all of the steps necessary in pre-trip planning such as drawing a course, selecting check points, measuring the true course and other computations.

ELEMENTS — *Navigation Planning Aids*
Flight Computer
Navigation Plotter
Airman's Information Manual

SCHEDULE

Period 1	
Introduction	:10
Showing of filmstrip, Navigation, Section B	:40
Period 2	
Question and answer quiz	:50
Period 3	
Pre-trip planning session	:50

EQUIPMENT — DuKane Projector
Sectional Aeronautical Charts
Navigation plotter for each student
Flight Computers for all students.
Airman's Information Manual

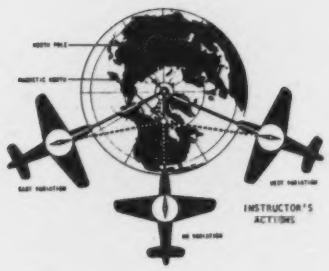

Suggested illustrations for overhead projectors:

1. Pre-Flight
2. Notices to Airmen
3. Airport Directory
4. Airport/Facility Directory
5. Magnetic North Pole
6. East Variation
7. West Variation (Instructors can use clear transparencies for drawing additional items for this section).

INSTRUCTOR'S ACTIONS — Serve as discussion leader following the filmstrip showing.

Assist students in planning a trip using all of the flight planning aid.

5971

Build question and answer session around overhead transparencies.

PRACTICE WINDS ALOFT FORECAST

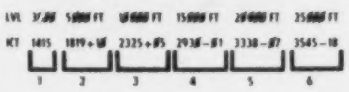

STUDENT'S ACTIONS

Resolve any questions during the session following the showing of the filmstrip.

Plan a trip using all of the flight planning aids. (Omit radio frequencies and airport data.)

EVALUATION

Student demonstrations of ability to plan a trip using flight computer, navigation plotter, Airman's Information Manual and other manuals.

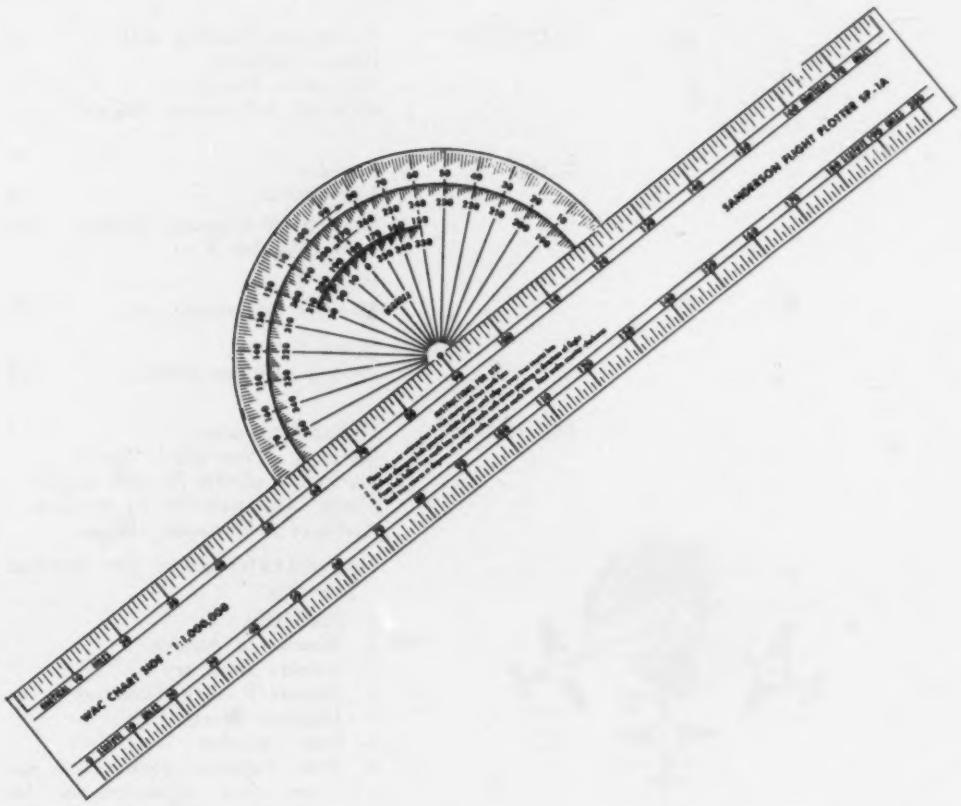

AVIATION EDUCATION

Private

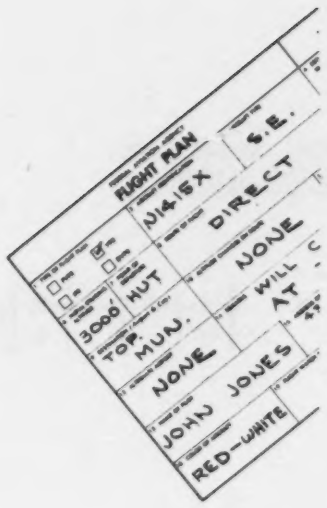

LESSON — *Navigation (Section C)*

REFERENCES — *Private Pilot Manual*, Navigation, Section C, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Knowing how to obtain radio frequencies and other airport data from charts and manuals.
Provide students an actual flight experience with a well-qualified pilot who will show how to plan a flight plan, fly a short cross-country trip, communicate with ground control and tower, compile a flight log and close flight plan upon arrival.

ELEMENTS
- Radio Frequencies and Airport Data
- Flight Plan
- Flying the Trip
- Pre-Takeoff
- Enroute
- Arrival
- After Landing

SCHEDULE

Period 1	
Introducing remarks	:10
Showing of filmstrip Navigation, Section C	:40
Period 2	
Discussion and questions	:50
Periods 3 & 4	
Trip to airport and flight	1:30

EQUIPMENT
- Sectional Charts
- Flight Plan Forms
- Navigation Logs
- Flight Computers
- Navigation Plotters
- Airplanes
- Airman's Information Manual

Suggested illustrations for overhead projector:

1. Teachers can use computer transparency, flight plan forms, navigation logs and plotters, etc.

INSTRUCTOR'S ACTIONS — Conduct question and answer session. Develop questions.

5973

Administer Navigation Programmed Learning System test.

Plan a trip to airport, in addition, arrange for airplanes and pilots to fly a short cross-country trip to a nearby airport.

STUDENT'S ACTIONS

Demonstrate ability to find radio frequency and airport data in Airman's Information Manual and navigation charts.

Fill out flight plan and know how to file it.

Assist pilot with navigation and check points during the trip, also, filing of flight plan.

FINDING GROUND SPEED AND TRUE HEADING

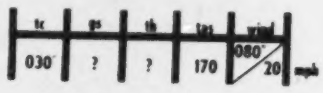

EVALUATION

Determine the amount of the subject retained by the students by administering test on Navigation at the end of Section C.

Evaluate student's ability to use sectional charts, airport data, etc., during actual flight if possible.

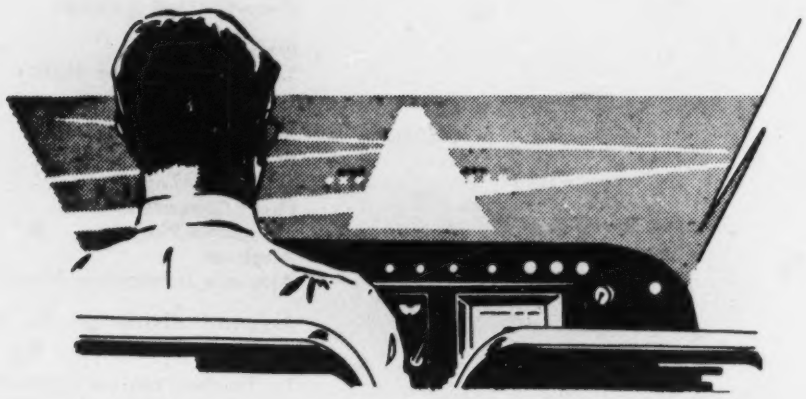

AVIATION EDUCATION

Private

LESSON *Radio Navigation (Section A)*

Private Pilot Manual, Radio Navigation, Section A, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

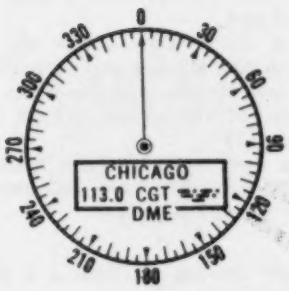

Bearings are magnetic at the station.
DME where shown indicates Distance Measuring Equipment.

Present advantages of the Omni Navigational Aid System.
Ways of determining position using the Omni radio equipment.
Methods of intercepting a radial.

Omni Navigation
Omni signal
Omni equipment
Flying inbound and outbound on a radial
Homing
Position Fixing
Intercepting a radial
Omni disadvantages

Period 1
Introductory remarks :10
Showing of filmstrip :40
Radio Navigation, Section A

Period 2
Questions and answer session :50
(Use pictures in filmstrip for this part.)

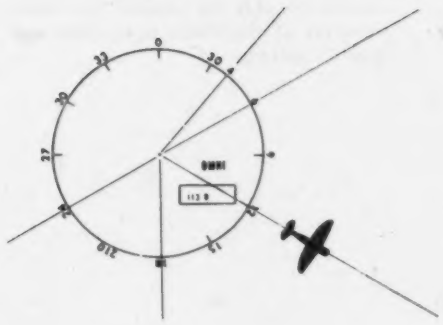

DuKane Projector
Blackboard
Sectional Aeronautical Charts
Table of VHF Reception Distances

Suggested illustrations for overhead projector:

1. Omni Station
2. Basic Indicators
3. Transparency of Omni Station with several radials and a miniature plane developed to be placed on overhead projector for the purpose of testing students. (Use illustrations in text, Pages A-7 and A-12.)

Serve as discussion leader following the showing of the filmstrip.

Demonstrate Omni equipment (Use overhead projector.) Present various

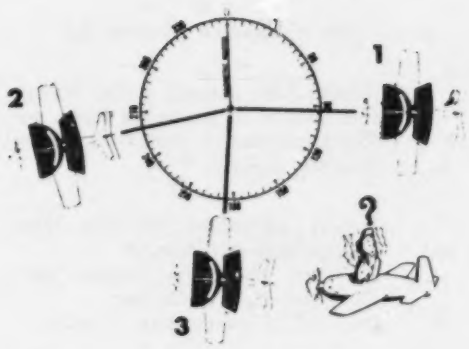

positions of the plane from Omni station and CDI indications.

Typical questions:

How many courses are available to a pilot using the Omni Navigational Aid System?

When the left-right needle is centered while on a course, will the wind drift the plane in either direction?

Are omni bearings true or magnetic bearings?

Where can a pilot obtain the information about a particular Omni Station (such information as the name of the station and its frequency?)

Name two types of Omni Stations.

What are the three basic indicators on the Omni equipment?

STUDENT'S ACTIONS

Explain the use of Omni as a radio navigation aid.

Determine the position of the airplane from the station.

Know how to locate himself when in doubt about his position on a flight.

Student *demonstration* of ability to intercept a radial.

Knowledge of VHF reception distances.

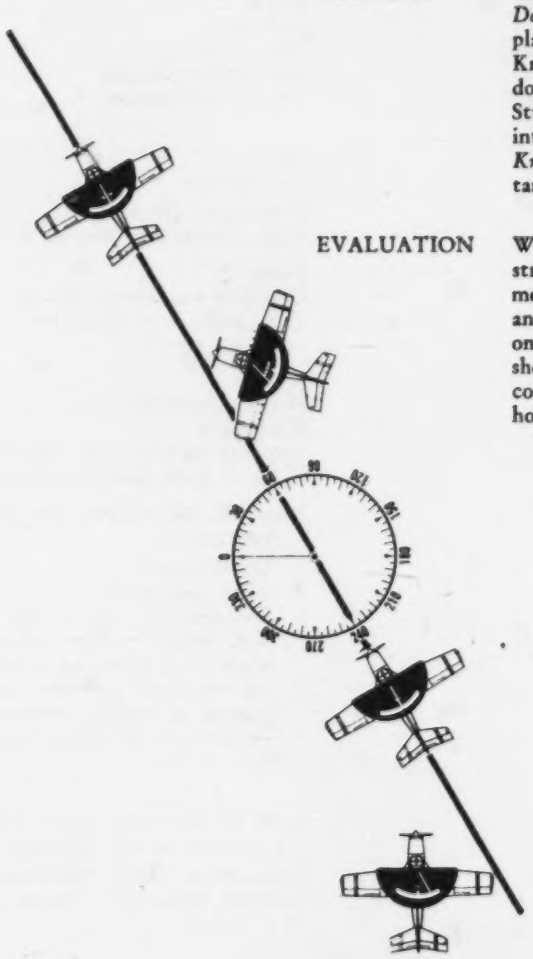

EVALUATION

While presenting this unit, the instructor should use the discussion method to determine the retention and knowledge of the subject matter on the part of the students. Students should be able to explain the basic concepts of the Omni equipment and how it operates.

5976

AVIATION EDUCATION

Private

LESSON

F. A. Regulations (Section A)

***Private Pilot Manual*, F. A. Regulations, Section A, Sanderson Films, Inc. *Flight Instructor's Handbook*, Federal Aviation Agency, 1964.**

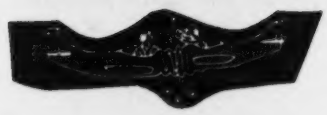

To develop knowledge of Part 61 of the Federal Aviation Regulations, certification of pilots and flight instructors.

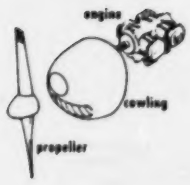

	61.3	Certificates and ratings required
	61.5	Application and issue
	61.7	Temporary certificate
	61.9	Duration of certificates
	61.11	Exchange of certificate
	61.13	Change of name
61.15	61.17	Aircraft ratings
	61.21	Prerequisites for flight test
61.23	61.25	Flight tests
	61.27	Retesting after failure
	61.39	Pilot logbooks
	61.43	Medical certificate
61.61	61.73	Student Pilots
61.81	61.101	Private Pilots

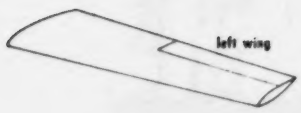

Period 1

Introductory remarks	:10
Show filmstrip	:40

F. A. Regulations, Section A

Period 2

Review session	:50

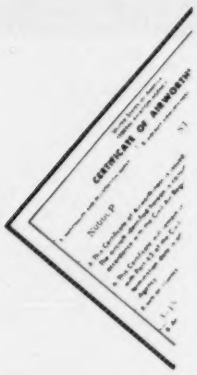

DuKane Projector
Blackboard
Arrange for resource person (FAA representative)

Introduce filmstrip

Conduct question and answer session.

Typical questions:

What is the minimum age at which a student pilot is authorized to pilot an airplane?

What are the requirements for solo flight?

What is the duration of a student pilot certificate?

At what age can a student pilot become eligible for a private pilot certificate?

5977

What class medical certificate is required for a private pilot?
In terms of minimum flight experience requirements for a private certificate, how many hours of dual instruction and solo flight time are required?
Where is acrobatic flight prohibited?
What are the right-of-way rules for an aircraft in distress?
Can a private pilot carry passengers for hire?

AVIATION EDUCATION

Private

LESSON	*F.A. Regulations (Section B)*
REFERENCES	*Private Pilot Manual,* F. A. Regulations, Section B, Sanderson Films, Inc. *Flight Instructor's Handbook,* Federal Aviation Agency, 1964.
OBJECTIVES	Understand definitions listed in Appendix 1 of F. A. Regulations, Section B, Sanderson Films Private Pilot Manual.
	Develop knowledge of all flight rules governing the operation of aircraft within the U. S. (Private pilot) This includes basic VFR minimums.
	Review of rules governing the maintenance of U.S. registered civil aircraft and rules for operating civil aircraft in a defense area, or into, within, or out of the U.S. through air ADIZ.
SCHEDULE	*Period 1*
	Introduction :05
	Showing of filmstrip :40 F. A. Regulations, Section B
	Period 2
	Question and answer session :50
	Period 3
	Examination :50
EQUIPMENT	DuKane Projector Blackboard
INSTRUCTOR'S ACTIONS	Arrange for a representative of the FAA to assist with discussion session. Administer an examination on Sections A & B of the Federal Aviation Regulations. (Instructor can use test questions from the Sanderson Programmed Learning System.)
STUDENT'S ACTIONS	*Read* aloud appropriate sections from F. A. Regulations, Section B. *Participate* in discussion. Demonstrate general knowledge of Federal Aviation Regulations.
EVALUATION	Ability to explain correctly F. A. Regulations to other students. Written examinations, Sections A & B.

5979

Bibliography

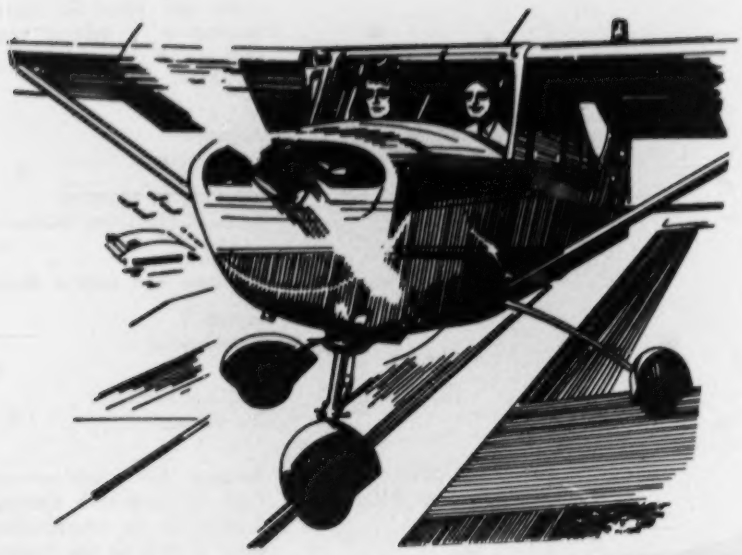

5980

FILMS

Hint: Always order free films on school stationery.

Hint: Always ask for their "Film Catalog."

P — Primary, I — Intermediate, Sd. sound, color, b-w

Britannica Press, 425 North Michigan Avenue, Chicago, Illinois 60611.

"An Airplane Trip by Jet" — 11 min. color, P. I., 1961.
"Sound and How It Travels" — 11 min. b-w P. 1963.

Cenco Educational Films, Chicago, Illinois, 1963.

"The Moon" — 14 min. sd. color. P. I.

Churchill Films, 662 North Robertson Boulevard, Los Angeles, California 90069.

"Airport in the Jet Age" — 11 min. Color. P. I. 1962.

Coronet Films, Chicago, Illinois

"Aristotle and the Scientific Method" — 1959, 13½ min. sd. color. P. I.
"Beyond our Solar System" — sd. 11 min. b-w. P.
"What Do We See in the Sky?"
"Airplane: Principle of Flight"
"How Weather Helps Us"
"How Air Helps Us"
"Billy's Helicopter Ride"

Encyclopaedia Britannica Films, Wilmette, Illinois

"Myth, Superstition and Science" — 1960, 13 min. sd. color, P. I.
"Air and What It Does"
"Airplane Trip by Jet"
"A Space Flight Around the Earth"
"Airplanes: How They Fly"
"What Makes Clouds"
"Whatever the Weather"

FAA Film Library AC-921, P.O. Box 25082, Oklahoma City, Oklahoma 73125.

"The Flight"

Film Associates of California, Los Angeles, California

"Discovering Numerals" — 1964, 9 min. sd. color. P.
"Clouds"
"Snow"

McGraw-Hill Book Company. Text-Film Division, 330 West 42nd St. New York 10036

"Airplanes and How They Fly" — 11 min. b-w.
"Air All Around" — 8 min. b-w
"What Makes Rain"

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National Aeronautics and Space Administration, NASA Central Film Depository,

1411 South Fern Street, Arlington, Virginia 22202.
"Apollo 11" and many others.

Piper Aircraft Corporation, Director of Aviation Education, Lockhaven, Pennsylvania 17745

"Don't Tell my Wife" — 19 min. color, sd.
"Wings to the Bahamas" — 26½ min. color, sd.
"Wings to Alaska" — 26½ min. color, sd.
"The Sky is Yours" — 26½ min. color, sd.
"The Flight of Bluebird II" — 26 min. color, sd.
"This Could Be You" — 27½ min. color, sd.

Shell Oil Company, 450 N. Meridian, Indianapolis, Indiana 46204

"How an Airplane Flies"

Sigma Educational Films, 11717 Ventura Boulevard, Studio City, California 91604

"The Community Airport" — 1966, color, P.

Transportation. Department of Federal Aviation Administration, Film Library, AC-921,

Aeronautical Center, P. O. Box 25082, Oklahoma City, Oklahoma 73125
"Best Investment We Ever Made" — 24 min. color. el A.
"Dulles International — Port of the Future" — 1965, 14 min., color, el.
"Flight" — 28 min. color, P.A., 1962.
"How an Airplane Flies" — 18 min. color. P.A. 1968
"Other Passenger, The" — 30 min. color. P.A. 1965
"Plane is Born, A" — 27 min. color. P.A. 1968
"Sonic Boom and You" — 10 min. color. P.A. 1968
"Traveler Meets Air Traffic Control, A" — 33 min. color. P.A. 1963

United Airlines, 230 W.O.W. Building, 14th and Farnam St., Omaha, Nebraska 68102

"Ready for Flight"
"Stewardess Story"

Walt Disney Films, 800 Sonora Avenue, Glendale, California 91201

"Man in Flight"

RESOURCE MATERIALS

Hint: For best results, order free materials on school stationery

Hint: *Always* ask for their "List of Publications"

Charts and Pictures

Apollo Spacecraft Model Kit #H-1836
Revell, Inc.
4223 Glenco Avenue
Venice, California 90292 ($1.50)

McDonnell Douglas Corporation
Director of Public Relations
3000 Ocean Park Boulevard
Santa Monica, California 90406

Steps to the Moon Kit #9030
Chart 38" x 26"
Hammond, Inc.
Maplewood, New Jersey 07040 ($1.00)

Ask to be put on a mailing list
"NASA Facts" — Film Catalog Free
c/o NASA Central Film Depository
1411 South Fern Street
Arlington, Virginia 22202

"Apollo Saturn Lunar Landing"
Space Division
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Aero Commander
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Suggested Sources of Airplane Photographs (When writing for photos ask for other free materials.)

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Beech Aircraft Corp.
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Seattle, Washington 98124
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Wichita, Kansas 67201

Pamphlets

"Aircraft Profiles"
Suite 310 Shoreham Building
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Washington, D.C. 20005

"The World of Beechcraft"
Beechcraft Aircraft Corp.
Wichita, Kansas 67201

Teacher's Kit Material
Cessna Aircraft Company
Air Age Education Division
Wichita, Kansas 67201

"Lockheed Pathway to the Stars" Free
Corporate Offices
P. O. Box 551
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"Meet the 10 Place Learjet 25"
Lear Jet Industries, Inc.
P. O. Box 1280
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NASA Facts Free

"Journey to the Moon"
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1411 South Fern Street
Arlington, Virginia 22202

Model Aircraft Lab

Civil Air Patrol
National Headquarters
Maxwell AFB, Alabama 36112
(Building and Flying Paper Airplanes)

List of films and other materials on weather
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Weather Bureau Central Region
601 East 12th Street
Kansas City, Missouri 64106

Freedom in Space
Weather Satellites
Radio Corporation of America
Defense Electronics Products
Camden, New Jersey

What's the Weather
Air France
683 Fifth Avenue
New York, New York 10022

The Story of Safety in the Skies
FAA
Distribution Section TAD-484
Washington, D.C. 20553
(Cartoon Booklet — Traffic Control)

How to Introduce the Study of Outer Space in Grades K-6
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Recommended Books on Space Science and Astronomy
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"Air Transportation and World Progress" Free
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Air World Education Free
Trans-World Airlines
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New York, New York 10016

"The Age of Flight"
United Aircraft
East Hartford, Conn. 06108

"The Story of Flight and Air Transportation" Free
United Air Lines
School and College Dept.
P. O. Box 66141
Chicago, Illinois 60666

"Space, the New Frontier"
"Fifty Years of Aeronautical Research"
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

The DC-8 Jet Mainliners — S Study of Important Parts

United Airlines
School and College Service
O'Hara International Airport
P. O. Box 8276
Chicago, Illinois 60666
(Folder illustrates parts of large jet)

Delta Airlines, Inc.
Public Relations Department
Atlanta Airport
Atlanta, Georgia 30320

Historical Airplane Pictures
TRW, Inc.
Corporate Public Relations
23555 Euclid Avenue
Euclid, Ohio 44117

Journey to the Moon NF-40
(Color wallsheet)
NASA Manned Spacecraft Center
Houston, Texas 77058

Moon Exploration
11" x 14" Captioned prints
Communicative Arts
Box 11017
San Diego, California 92111

Map of the Moon
Stafford Industries, Inc.
P.O. Box 702
Devon, Pa. 19333

Pan America's Flying Clipper
Educational Department
Pan American Bldg.
New York, New York

Pathway to the Stars
Lockheed Aircraft Corporation
Box 551
Burbank, California 91503

Space Travel (Chart 54" x 44" color)
(sequence of events that lead man into space)
Denoyer-Geppert Co.
5235 Ravenswood Avenue
Chicago, Illinois 60666

Airworld Education Study Series
Trans World Airlines
605 Third Avenue
New York, New York 10016

Story of Flight and Air Transportation
United Air Lines
School and College Department
Box 66141, Chicago 60666

Trip to the Moon and Return
Chart 23" x 29"
Communicative Arts
Box 11017
San Diego, California 92111

Wall Charts, instrument panel.
aircraft panel
Piper, Aircraft Corporation
Attention: Director, Aviation Ed.
Lockhaven, Pennsylvania 17745
(also motion pictures)

Suggestions for Commemorating Wright Brothers' Day — Free — Elem. Level
National Aerospace Education Council
Room 310, Shoreham Building
806 15th Street, N. W.
Washington, D.C. 20005

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The New Seeing Why, Dowling, Thomas L., et al. Philadelphia: Winston and Co.
The First Book of Airplanes by Jeanne Bendick. New York, Franklin Watts, Inc. 1958.
How and Why Wonder Book of Weather by George Bonsall. Wonder Books, N.Y.
The Big Book of Real Helicopter. New York: Grossett and Dunlap.
Off Into Space by Margaret O. Hyde. New York: American Book Co.
Satellites in Outer Space, Isaac Asimov. New York: Crowell Company, 1958.
The First Book of Space Travel, Jeanne Bendick. Franklin Watts, Inc., 1963 (68). 48 pp.
What Is the Moon Like, Franklin M. Branley. New York: Thomas Y. Crowell, 1961, 48 pp.
Jets of the World, C. B. Colby, New York: McCann, Inc., 1966.
Peter and the Rocket Trip, Hazel W. Carson. Chicago: Beckley-Cardy Company, 1955.
Space for Everyone, Philip S. Egan. Chicago: Rand McNally & Co., 1961.
The Moon for Young Explorers, Carroll Lane Fenton. New York: John Day and Company, 1963, (64 pp.)
You Will Go to the Moon and the Stars, Mae and Ira Freeman. New York: Random House, 1959.
Fly High Fly Low, Mae and Ira Freeman. New York: The Viking Press, 1957.
I Want to be a Pilot, Carla Greene. Chicago: Children's Press, 1957.
The Buttons and the Whirleybird, Edith S. McCall. Chicago: Benefic Press, 1959.
This Is Cape Kennedy, Miroslav Sasek. Dallas: MacMillan, 1964.
Jeepers, There's a Jet, Thelma Shaw. Chicago: Albert Whitman and Co., 1960.
Let's Find Out About the Moon, Martha Shapp. New York: Franklin Watts, 1965, 55 pp.
The Moon Jumpers, Janice Udry. New York: Harper and Brothers, 1957.
A Trip to Grandmother's, Clare Whitbeck, et al. Department of Transportation, Federal Aviation Administration, Washington, D.C. 20590.
Peter and the Moon Trip, Hazel Corson. Pub. by Benefic, 1965.

TEACHER'S BIBLIOGRAPHY

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Von Braun, Wernher, et al., *Project Satellite,* New York: British Book Center, 1958.
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Cox, Donald, *Stations in Space,* Holt, Reinhart and Winston, 1960.
Davy, M. J. B., *Interpretive History of Flight,* London: H.M.S.O., 1948.
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Emme, E. M., *Aeronautics and Astronautics,* 1915-1960, Washington, D.C., NASA, 1961.
Emme, Eugene M., *A History of Space Flight,* Holt Library of Science, Series III, 1965.
Gadland, Kenneth W., *Development of the Guided Missile,* New York: Philosophical Library, 1954.
Gibbs-Smith, C. H., *A History of Flying,* New York: Praeger, 1954.
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Gray, George W., *Frontiers of Flight,* New York: Alfred Knoph, 1948.
Hoyle, Fred, Astronomy: *A History of Man's Investigation of the Universe.*
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Matz, Lloyd, *This is Outer Space,* Archer House, Inc., New York: 1960.
Lewellen, John, *The Story of Flight,* New York: Golden Press, Inc., 1959.
Milbank, J., *The First Century of Flight in America,* Princeton: Princeton University Press, 1943.

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The Planetarium

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Order from:

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Public Affairs Office
NASA Manned Spacecraft Center
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Above-listed books and many others may be obtained from:

National Aerospace Education Council
806 Fifteenth Street, N.W.
Washington, D.C. 20005

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Shrader, W. A., *Fifty Years of Flight*, 1903-1953, Cleveland: Eaton, 1953.

Turnbull, A. D. and C. L. Lord, *History of U. S. Naval Aviation*, New Haven: Yale University Press, 1949.

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Asimov, Isaac, *The Moon*, Follett, 1966.

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Kiefer, Mildred S., *Planet X*, Melmont, 1965.

May, Julian, *Rockets*, Follett, 1967.

Shapp, Martha and Charles, *Let's Find Out About the Moon*, Watts, 1965.

Sonneborn, Ruth A. *The Question and Answer Book of Space*, Random, 1965.

Victor, Edward, *Planes and Rockets*, Follett, 1965.

FAA, Aviation Education
GA-20
Washington, D.C. 20590
(A self-addressed gummed label should accompany each request)

FAA — Publications

a. Demonstration Aids for Aviation Education (For teachers only)
b. "Teaching Guide for an Aerospace Communication Lab" (For teachers only)
c. "Aerospace Units for Elementary Science Classes:—Grades 2 and 3 (For teachers only)
d. "A Flight to Grandmother's"—Scripts and illustrations are taken from filmstrip.

NASA — Publications

The following NASA materials are available through the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402

a. Model Spacecraft Construction
b. Introducing Children to Space — The Lincoln Plan
c. Space Resources for Teachers — Biology
d. The Spaces of Tomorrow
e. What's Up There

All the following materials can be obtained by writing to:
Educational Programs Division, NASA Headquarters, Washington, D.C.

a. Educational Guidance in the Space Age
b. Science Education in the Space Age
c. The Planetarium — an elementary — school teaching resource
d. Space Science
e. Aerospace Curriculum Resource Guide
f. Life Science in a Space Age Setting
g. A Universe to Explore
h. Space Resources for the High School

Encyclopedia

Above and Beyond
New Horizons Publishers
14 volumes plus Teacher's Guide
1968

Exploring Space
World Book Encyclopedia Guide for Teachers
Field Enterprises Education Corporation
Chicago, Illinois

Teaching Aids:

You and Space (Supplementary reader)
Natural Aerospace Educational Council
Room 616, 806-15th Street, N.W.
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VT 012 666
Aiken, William; Omvig, Clayton
Training in Mail Room Occupations--A Means, Not An End.

Kentucky Research Coordinating Unit, Lexington.
Jefferson County Schools, Louisville, Ky.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - ND 150p.

DESCRIPTORS - *BUSINESS EDUCATION; *OFFICE OCCUPATIONS EDUCATION; *TEACHING GUIDES; *OFFICE MACHINES; *SECONDARY EDUCATION; RESOURCE MATERIALS; INSTRUCTIONAL MATERIALS; TEACHING TECHNIQUES; PROGRAM PLANNING; UNITS OF STUDY (SUBJECT FIELDS); RESEARCH COORDINATING UNITS; PILOT PROJECTS; ENTRY WORKERS
IDENTIFIERS - KENTUCKY

ABSTRACT - Based on the results of a high school pilot project, these instructional materials were developed to aid in training mail room employees. Recommended as a twelfth grade course, this guide includes teacher and student information on the: (1) Collator, Jogger, and Electric Stapler, (2) Mail Opener, (3) Folding Machine, (4) Inserting Machine, (5) Keyboard Embossing Machine, (6) Addresser-Printer, (7) Mailing Machine, and (8) Parcel Post Scale and Scales. Also included are nine instructional units covering such topics as the zip code, bulk rate mail, and automation. Additional resource materials for the teacher are appended. A description of the pilot project is included. (JS)

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VT012666

TRAINING IN MAIL ROOM OCCUPATIONS -
A Means, Not An End

BY

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Jefferson County Schools
Louisville, Kentucky

and

Clayton Omvig, Director
Research Coordinating Unit
Department of Vocational Education
College of Education
University of Kentucky
Lexington, Kentucky

What can the vocational department of a school do to meet the special needs of students who are in their senior year and have never been enrolled in, or exposed to, occupational training? Can these non-vocational students, less than a year away from graduation, be helped to receive entry level skill training that will open a door for them in the world of work? Jefferson County Schools, Louisville, Kentucky, in a cooperative project with the Kentucky Research Coordinating Unit for Vocational Education (KRCU), came up with a rather unique, one year training program in mailroom occupations which did much to answer the two aforementioned questions.

In the winter of 1968, the State Bureau of Vocational Education gave encouragement to the local schools of Kentucky to develop new vocational programs with a different approach, a new philosophy, and innovative methods to achieve the established goals of vocational education. Jefferson County was interested in participating and assistance was sought from the Research Coordinating Unit. This assistance took the form of consultation on program planning and supplemental funds needed to initiate the program.

Every comprehensive high school has a large number of seniors who have not been enrolled in any of the established vocational programs and who have no intention of going to college. Jefferson County Schools was no exception. Therefore, the over-riding goal which permeated the entire conceptual view in planning this project was what can be done in one year that will equip these students with: 1) a skill that would open a door in the job market, 2) a better image of themselves, 3) the ability to deal with the mechanics of job application, 4) a knowledge of the many opportunities that

actually exist for employment, and 5) an opportunity to achieve while in school.

The vehicle used to accomplish this goal was a simulated mail room facility not unlike those found in a large business. The greater Louisville area offered numerous opportunities for mailroom occupations, but no training in postal occupations was available to in-school youth. Therefore, this area of training was selected, Other areas of training might have been just as appropriate to the achievement of the program goals, for the main purpose of the project was not solely to train students for mail room occupations, but to implement the idea or philosophy that something could be done in one year for the students we have been missing in the regular vocational programs.

The general purposes of the mail room project were:

1. To teach operating skills on the machines in the laboratory, including the collator, jogger, mail opener, embossor, addresser-printer, folding machine, inserting machine, parcel post scales, other scales, and the mailing machine
2. To relate the machine skills learned to actual business situations
3. To develop within the students an awareness of job opportunities
4. To help students overcome the problems encountered in the transition from high school to work

The Students

The students with whom this project was concerned were those that vocational education had been missing, but the very ones which the Vocational Amendments of 1968 stressed should be served. They were not enrolled in

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vocational education; they were not achieving in their academic subjects, but they were not drop-outs. They were getting by, and that was all. Many were characterized by poor attitudes, poor academic performance and economic and social deprivation. They were twelth graders, almost ready to terminate their high school careers, but with no saleable skills, no intention of going on to college, and no orientation to other forms of post-secondary education. The intention was to develop a program, and later programs, that would equip these students with entry skills, and more important, to change attitudes and change the self-image that these students had developed.

A natural human tendency is to crave and enjoy success experiences. Many students in our nation's schools, such as the students described above have experienced little or no success in their academic courses. The image these students had of themselves was not good, and repeated D and F grades did little to change their self-concept.

Over the two year period during which the program has been operating, sixty students were selected and enrolled from the number which applied. These students were identified by the school's professional counseling staff as being disadvantaged socially, academically, or economically.

The Program

The pilot mail room training program was organized in 1968 as a part of the Division of Business and Office Education and was originally called Postal Occupations. During the summer of 1969, the Supervisor of Business and Office Education and the teacher who had taught the course

refined the curriculum which was developed during the first year and changed the name of the course to Office Services.

The mail room training program was housed in a simulated laboratory setting. Visits were made to large businesses and to the U.S. Postal Department in the Louisville area to ascertain the types of postal equipment which were applicable and arrangement of the equipment in the laboratory.

If properly organized and carried out, simulation can be a very effective technique in occupational training. But, a cooperative program which puts the student into a real job situation is generally preferred by vocational educators. The high school chosen as the pilot school for this new course, Eastern High School, Middletown, Kentucky, had no cooperative program. Therefore, a simulated program was developed. The plan was to combine the best aspects of both simulated and cooperative programs into the course activities. The project went beyond the "make believe" of simulation. The activities carried out in the training facility were not mythical. They were real - as real as any tasks performed in a cooperative program. The only difference was that they were done in the laboratory. Real mailing projects were brought into the school from the business world; this brought added meaning to the simulation. Instead of sending the students to the work, the work was brought to the students. The very heart of the program was in these work projects. The projects were volume mailings from large and small businesses, from universities, alumni associations, charity drives, churches, social and philantrophic organizations, and local schools. One mailing alone contained nearly 100,000 pieces of mail and over

one quarter million pieces of mail were handled during the first year of the program. These projects gave meaning to the skills the students were learning. They learned the value of accuracy and meeting time schedules. There was no room for error when a customer had to be satisfied or if the student's program stood to lose money if envelopes and letters were ruined or if the postage machine was incorrectly operated. These values, as well as the pride of achieving and experiencing success, were not simulation to these students.

The training followed a standard rotation system whereby each student received instruction as to the use, care, safety precautions, and operation of each machine in the laboratory. This instruction preceded the application of skills learned to the actual mailing projects.

The machines in the laboratory were not machines which were familiar to the students. Therefore, a certain amount of curiosity was immediately aroused by the presence of the machines, and the students looked forward to learning how to operate them.

Outlines on the operation of each machine were provided to the students and, because of the small class size (fifteen), the students could stand close to the machines and follow their instruction sheets while the instructor demonstrated machine operation. The students were responsible for knowing the information about each machine and kept notebooks with the various instruction sheets included.

Skill building on the machines closely followed the demonstration, with students being assigned in pairs. One member of the team operated the machine while the other, the assistant, helped the operator with machine set-up. The assistant then observed the operator in action. When the

operator had completed his job, the team changed places and the same process was repeated.

The teacher observed both students and gave credit for each job when completed. The teams then rotated to another machine and did an assigned job at that work station. This procedure was repeated until each student could efficiently operate all the machines in the laboratory and was consciously aware of mail flow activities.

In addition to the skill training component, the program contained an extensive amount of personal and group guidance. The students were taken on field trips to industry; they were provided with occupational information; and representatives from business, industry, and government came to talk to them and to observe them in their work. Attitudes and self-concept were two major problems these students faced, and the teacher had as a major goal the improvement of both.

Outcomes

Some of the project outcomes reported here are based entirely on subjective judgments made by the students, the teacher, and the project director. Other outcomes are concrete and measurable. It was felt that both would be worthy of reporting.

The students enrolled in this pilot program needed a different approach to education and they found it. They expressed excitement about such aspects of the program as:

1. the machines and learning to operate them
2. working on "real" projects from some of the largest businesses in their community

3. learning about opportunities they never dreamed existed, and more important, they began to see themselves as capable of "fitting in"
4. achieving good grades-a first experience for some
5. meeting important people from business, industry, and government who came to talk to them
6. being exposed to the business world through visits
7. having some personal attention and seeing someone concerned about them

Although not the sole purpose of the project, making the students employable at the entry level was a goal of the project. This goal was achieved. Of the sixty students who participated in the project over the two year period, all but five obtained employment in an occupation which was directly or closely related to the instruction. Types of employment included: mail room occupations, secretarial and clerical occupations in which mail handling was among the assigned duties, employment in the U. S. Postal Department, and parcel service occupations. Of the students who did not find gainful employment, marriage and military service accounted for three. Placement was excellent, considering the present unemployment rates for youth.

Attitudinal development and the improvement of the students' self-image were also among the project goals. These two concepts were difficult, if not impossible, to directly measure. But, indicators of success were observable. Considered as indicators were the students' grade point averages and attendance records, eleventh versus twelth grade. Favorable

teacher comments were also subjectively considered.

Although a statistical comparison of significance could not be made, the grade point averages achieved by these students appeared to increase substantially. A true comparison could not be made since the courses taken during the two years were different. As juniors, the average grade point earned by the postal occupations' students was 1.76. As seniors, while enrolled in the postal occupations' course, the average grade point rose to 2.14. Very likely, other factors also contributed to this increase, but the project staff was convinced that much of this increase was due to the student's involvement in the project.

Student attendance was another variable considered in the evaluation of the effectiveness of the course. Analysis of the students' records revealed a substantial drop in absenteeism on the part of the students included in the pilot course. As juniors, the total days of absenteeism for these students was 1078, or an average of 18.6 days per year, per student. As seniors, the total was 595, or 10 days per student. This represented nearly a 50% reduction in absenteeism. Personal comments made by the students may account for part of this decrease. The students indicated, "we like the course," "we like to do the work," "this class means something." They apparently wanted to attend school to take part in the work activities. This conclusion was further founded by analysis of when the students were absent as seniors. Half-day absence was more prevalent, and these half days were missed opposite the half day in which the course was offered.

All-in-all, the project was considered to be a success. After initial financial support from the Research Coordinating Unit, the course has now

been included as a regular part of the school curriculum. It has become self-sustaining, equipment-and postage-wise, through the collection of a small fee for each piece of mail handled. The equipment, after two years of extensive use, is still in perfect condition; the students take pride in the facility. What has been learned in the operation of this pilot project has been incorporated into the planning of other one year courses. This course will probably not be initiated in any other school in Jefferson County, for the intent was not to flood the market with postal employees, but to demonstrate that we can work effectively with seniors whom we previously missed.

Another result of the project was the development of a written curriculum and lesson plans for each unit that was taught in the course. The project was launched with no curriculum or lesson plans, just an idea. Hard work and dedication by a compassionate teacher resulted in ultimate success.

A limited supply of the lesson plans and curriculum materials developed in conjunction with this project are available from the Kentucky Research Coordinating Unit, 152 Taylor Education Building, University of Kentucky, Lexington, Kentucky 40506.

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FOREWORD

The responsibility of any school system is to provide for the educational needs of all children. Many students enrolled in the twelfth grade of the Jefferson County Public Schools will be seeking employment immediately following graduation. The wide use of machines in performing present-day business services has opened a new field to these students. A course designed to familiarize them with the operation of business machines was added to the high school curriculum in 1968.

During the summer of 1969 the Supervisor of Business Education and Distributive Education and a teacher in this field developed Office Services. This publication is intended for use as a guide by teachers of the course dealing with business machines.

The cooperation of the State Department of Education and the Louisville Branch Office of Pitney-Bowes, Inc., has been invaluable in planning the course.

Sincere appreciation is expressed to those who participated in the development of this guide.

Richard VanHoose
Superintendent
Jefferson County Schools

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INTRODUCTION

There are students enrolled in their twelfth year of study in public secondary schools who have given little thought to choosing a vocation, have developed few or no job skills, and have very little motivation to seek additional schooling or training after graduation.

Because of concern for these students, the Supervisor of Business Education in Jefferson County, Kentucky, conceived the idea of developing a program designed to help them and worked out the preliminary details with the Department of Vocational Education in Frankfort, Kentucky.

Eastern High School in Middletown, Kentucky, was chosen for the program which started in the fall of 1968. The class was called Postal Occupations during the first year. The second year the name was changed to Office Services.

A coordinating unit for research at the University of Kentucky provided eleven thousand dollars worth of equipment of a type that is often found in the office services department of a large company or the mailing facility of a business.

Pitney-Bowes is the manufacturer of all the equipment in the laboratory. The following machines are now being used.

Collator	Folding Machine
Jogger	Inserting Machine
Mail Opener	Parcel Post Scales
Embossing Machine	Scales
Addresser-Printer	Mailing Machine

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The manufacturers have smaller and larger machines of each of the model in the laboratory; however, the middle model of each of the machines was selected as the best for learning skills. Films and field trips provide exposure to other models designed to perform the same basic function. This guide will refer to the specific machines used in the laboratory. In the future, it is possible that other machines may be added.

The class meets one hour each school day and one unit of credit is awarded upon completion of the school year. The size of the class is limited to a maximum of fifteen. The students must be approved by a school counselor or a teacher in the business department. Learning and enriching experiences that are of personal value to the student are coordinated with the operation of the machines and the building of skills which comes through the performance of actual jobs for local individuals and businesses.

Evaluation for the six-weeks grading periods is varied according to the jobs and activities carried on in the classroom during that period. This program is designed to help the students find themselves and to have the feeling that it is possible to succeed at something--their success being that they can perform jobs which require repetition and the use of their hands. Consequently, they are not penalized in any way for failure or for a poor background in academic subjects. This one fact, above all others, probably is responsible for the greatest motivation of the students.

Financially the class is self-sustaining. A service charge of one cent per piece of material processed is charged. The money received goes into a fund from which small miscellaneous supplies are purchased and transportation for field

trips provided. The student's Filing Practice Set and book[1] is paid for out of this fund, also. With this fund there will be no need in the future for an initial loan from the school office to put postage in the Mailing Machine.

The second year of this program has now been completed and those familiar with it judge it to be a success. As far as is known there is no other program similar to this one anywhere in the United States.

This guide provides the methods used and units developed for the program.

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[1]Walter L. Blackledge, Ethel H. Blackledge and Helen J. Keily, You and Your Job (Cincinnati, Ohio: South-Western Publishing Company, 1967).

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IMPORTANCE OF JOBS IN THE LABORATORY

Suggested Procedure for Obtaining Jobs

After the students have learned to operate the machines successfully, real jobs from organizations and businesses are needed in order for the students to improve in speed and efficiency and to develop other desirable working traits.

Jobs done in the laboratory should be intermingled with other units presented during the year, according to the judgment of the teacher.

Initiative is important on the part of the teacher. Contacts need to be made inside and outside the school. First, a letter explaining the program and services available could be sent to the individuals who might use the services of the students. Follow-up should then be made with a personal appointment or telephone call. Any questions from the individual could be answered at this time.

It should be made easy for an individual to contact the teacher at school to schedule jobs that they will have at a later date or to inquire about jobs. Individuals should be given the school telephone number so that the teacher may be contacted either during her planning period (give the time) or they may be asked to call at their convenience, and leave their name and telephone number so the teacher may return their call during her planning period. This will be valuable in communication and planning between the teacher and individuals for whom the students do jobs.

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Sources of Jobs

There are sources of jobs in the school and the community. Teachers, counselors, secretaries, and other personnel at the school should be given information concerning jobs which can be performed in the laboratory. The following groups and organizations may provide such jobs.

Parent-Teacher Associations	Book company representatives
YMCA and YWCA	Local businessmen
Alumni Associations	Leaders of civic and charitable organizations

OBJECTIVES

Main Objective

To help students with no previous vocational curriculum experience become aware of job opportunities and to develop some skills to a job-entry level

General Objectives

To teach operating skills on the machines in the laboratory: Collator, Jogger, Mail Opener, Embosser, Addresser-Printer, Folding Machine, Inserting Machine, Parcel Post Scales, other scales, and Mailing Machine

To relate the machine skills learned to actual business situations

To provide enriching learning experiences that will encourage self-improvement

To develop an awareness of job opportunities

To help students with problems which they will encounter in the transition from high school to the first job

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ORIENTATION TO COURSE
(Two Class Periods)

I. Uniqueness of course

A. First in Kentucky

B. Name change from Postal Occupations to Office Services

C. Visitors to classes and laboratory

D. Difference from any course student has taken

E. Materials free to student because of service charge for work done by them in this class

II. Equipment

A. Funded by Research Coordinating Unit from University of Kentucky

B. Value--$11,000

C. Care

1. Dust

2. Keep covers on

3. Turn switches off after use

III. Student attitudes

A. Desire to operate machines efficiently

B. Desire to make self-improvements

C. Desire to learn about job opportunities

D. Willingness to work

IV. Content of course

A. Topics

1. Operation of machines

2. Volume mailings

3. Filing practice set

4. Enrichment units

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B. Procedures

1. Classroom demonstration and practice

2. Guest speakers

3. Films

4. Filmstrips

5. Transparencies

V. Opportunities that could develop from course

A. Discovery of new interests and awareness of new jobs

B. Part-time jobs during school year

C. Jobs during holiday vacations from school

D. Jobs immediately after graduation

VI. Follow-through from course

A. Job applications and interviews

B. Civil Service examinations

C. Job placement

D. Easier transition from high school to job

A question and answer period should be provided with the students being given ample time to ask questions concerning the course, or other related questions.

The machines in the laboratory are not machines which are familiar to the students. Therefore, a certain amount of curiosity is immediately aroused by the presence of the machines. It should be briefly shown what each machine will do without going into any detail about the operation. The students will look forward to learning how to operate the machines.

Machines

Outlines for the instruction on each machine[1] follow the order in which the machines are taught to the students. The students stand near the machine for each demonstration. This is possible because of small classes. Duplicated sheets containing specific information relating to the machine in the laboratory are given to all students with words in all capitals to indicate parts of a machine which the student should be able to identify. Students are responsible for knowing all information on sheets given them and to assemble the sheets in a folder to be checked periodically by the teacher.

Skill building on the machines should follow this procedure. Students are assigned to teams of two. The student operating the machine is called the operator and the other member of the team is the assistant. The assistant helps the operator to get the machine set up for operation and then quietly observes the operator in action. When the operator has completed his job, he changes places with his assistant to help him and observe him.

The teacher observes both students and gives them credit for each job when completed. The teams rotate to another machine and do an assigned job on it until each student can operate all the machines in the laboratory efficiently.

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[1]These outlines are reproduced or adapted with permission. Original material prepared by Pitney-Bowes.

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FLOOR PLAN

OFFICE SERVICES LABORATORY

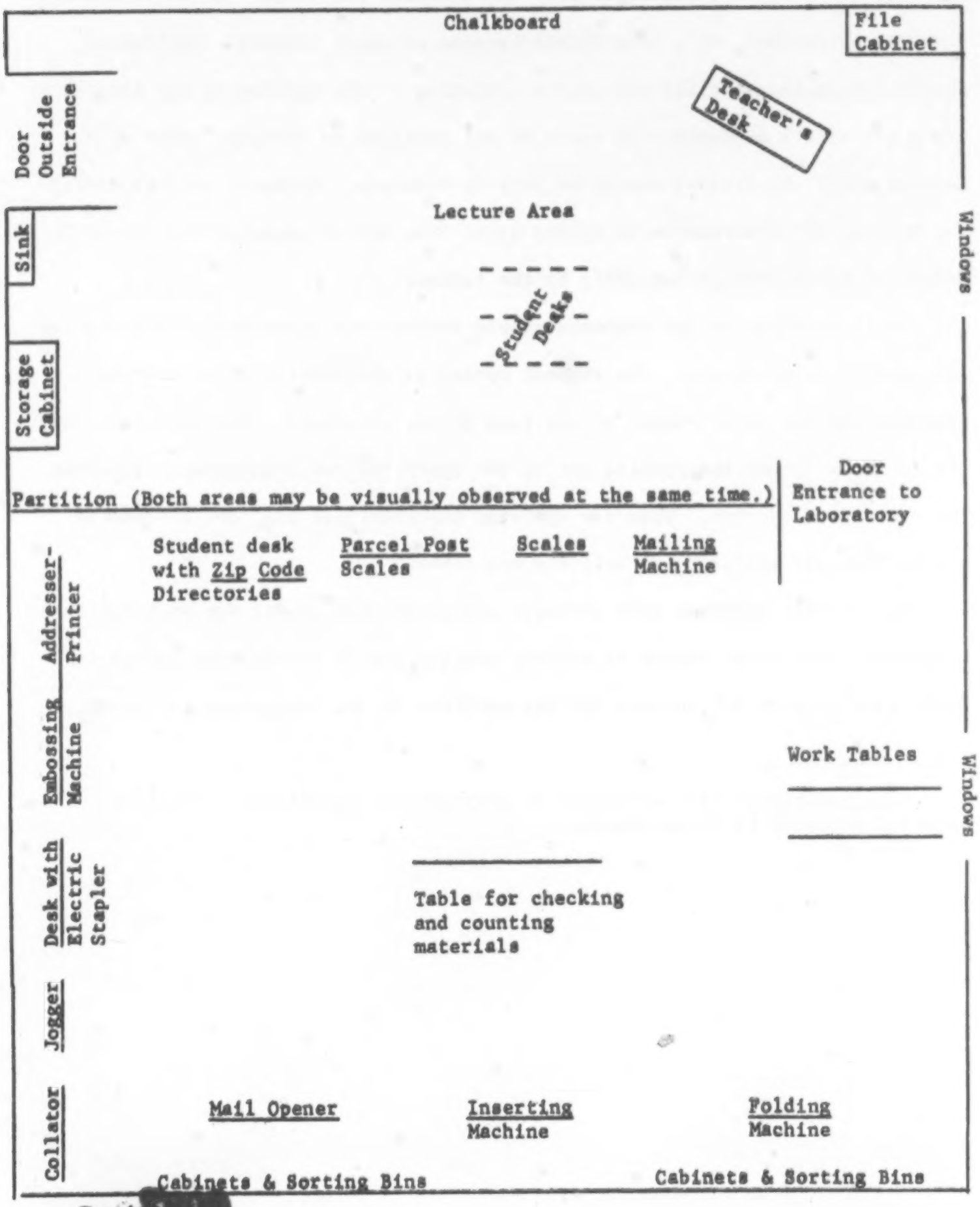

ROTATION PLAN
(Two members per team)

Collator Jogger and Electric Stapler	Mail Opener	Folding Machine	Inserting Machine
Team	Team	Team	Team
A	B	C	D
G	A	B	C
F	G	A	B
E	F	G	A
D	E	F	G
C	D	E	F
B	C	D	E

Keyboard Embossing Machine	Addresser-Printer	Mailing Machines
Team	Team	Team
E	F	G
D	E	F
C	D	E
B	C	D
A	B	C
G	A	B
F	G	A

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COLLATOR-JOGGER

ELECTRIC STAPLER

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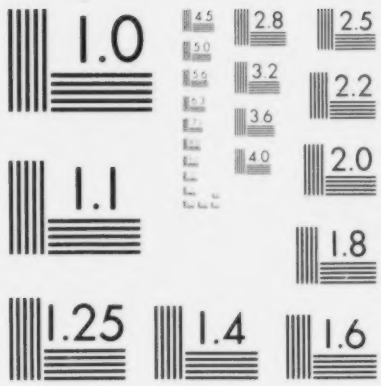

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

COLLATOR, JOGGER, AND ELECTRIC STAPLER

Teacher Material

Description	Pitney-Bowes Model 60R16, 16 stations (or bins), electric semi-automatic, floor model
Use	To assemble booklets or brochures (Up to sixteen pages may be assembled at one time on this model.)
New Term	Aerate--to supply paper with air (This is necessary before putting paper into the Collator.)
Activity	Provide all students with a small stack of paper (approximately 50 sheets) and have them practice aerating (The same paper may be used many times.)

Machine Demonstration

I. Setting up the Collator and Jogger

A. Remove cover and place in a safe place

B. Lift FEED ARMS with FINGER-LIFT CONTROL

C. Load STATIONS--one TRAY at a time

1. Pull out TRAY from operating position
2. Make adjustment for size of paper
3. Check sheet SEPARATORS
4. Aerate paper and place in STATION
5. Return TRAY to operating position
6. Follow the previous five steps for each TRAY used

D. Check FEED ROLLERS in all STATIONS

1. Place rubber part of ROLLER facing down in STATIONS being used
2. Place metal part of ROLLER facing down in STATIONS not being used
3. Lower FEED ROLLERS by FINGER-LIFT CONTROL

E. Check STROKE ADJUSTMENT

F. Set COUNTER on zero

G. Place Jogger a convenient distance to the right

H. Turn MOTOR SWITCHES on to Jogger and Collator

II. Operating the Collator and Jogger

A. Start (A light touch of the FOOT SWITCH activates the FEED ARMS in each STATION which pushes out the top sheet of paper in each STATION being used.)

B. Inspect (Quickly train eyes to scan pages to make sure that no blank or misprinted pages are used.)

C. Grasp (With one motion gather all pages.)

D. Place assembled booklets in Jogger to vibrate the papers and make the pages of each booklet even (Consecutive booklets are placed in opposite directions, giving a criss-cross effect so that the booklets are easy to handle when stapling.)

III. Completing job responsibilities

A. Turn off MOTOR SWITCHES to Collator and Jogger

B. Remove all paper left in STATIONS of Collator

C. Return COUNTER to zero (Always inform teacher of number on COUNTER.)

D. Replace cover on Collator

E. Move booklets from Jogger to table and staple

IV. Stapling--Acco Model AVS Electric Stapler

A. Features

1. May staple up to 120 times per minute

2. Has stapling capacity of 20 sheets of bond paper and 25 sheets of onion skin paper

3. Uses any brand of standard staples

B. Operation

1. Learn correct method of refilling (Always unplug.)

2. Learn to adjust margin

Student Participation

1. Give each student an opportunity to sit down at the machine and collate several booklets for the "feel" of it with the remainder of the class observing (All Stations in the Collator will be filled from the machine demonstration.)

2. Give the students an opportunity to staple several times

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Supplementary Materials

1. Show pictures of other models of Collators and point out some of their features (Example--Rolomatic has 50 stations and collates, counts, stitches, and staggers completely automatically.)

2. Give students duplicated sheets containing specific information about the Collator in the laboratory (They are responsible for learning this information.)

Skill Building

The students should develop the following skills.

1. Be able to identify the parts of the Collator

2. Be able to refill the stapler and use it properly

3. Following the Rotation Plan and team assignment, collate the following

   a. Fifty booklets of 16 pages each
   b. Fifty booklets of 8 pages each
   c. Fifty booklets of 4 pages each

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COLLATOR, JOGGER AND ELECTRIC STAPLER

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description	Pitney-Bowes Model 60R16, 16 stations, semi-automatic, floor model
Use	To assemble booklets or brochures (Sixteen pages may be assembled at one time on this model.)
New Term	Aerate--to supply paper with air (This is necessary before putting paper into the Collator.)

Operating Procedures

I. Setting up the Collator and Jogger

A. Remove cover and place in safe place

B. Lift FEED ARMS with FINGER-LIFT CONTROL

C. Load STATIONS one TRAY at a time

1. Pull out TRAY from operating position

2. Make adjustment for size of paper

3. Check sheet SEPARATORS

4. Aerate paper and place in STATIONS

5. Return TRAY to operating position

6. Repeat the five steps for each TRAY used

D. Check FEED ROLLERS in all STATIONS

1. Place rubber part of roller face down in all STATIONS being used

2. Place metal part of roller face down in all STATIONS not being used

3. Lower FEED ROLLERS by FINGER-LIFT CONTROL

E. Check STROKE ADJUSTMENT

F. Set COUNTER on zero

G. Place Jogger a convenient distance to the right

H. Turn on MOTOR SWITCHES to Jogger and Collator

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II. Operating the Collator and Jogger

A. Start (A light touch of the FOOT SWITCH activates the FEED ARMS which push out the top sheet of paper each STATION being used.)

B. Inspect (Quickly train eyes to scan pages to make sure that no blank or misprinted pages are used.)

C. Grasp (With one motion gather all pages.)

D. Place assembled booklets in Jogger to vibrate the papers and get the pages of each booklet even (Consecutive booklets are placed in opposite directions, giving a criss-crossed effect so that the booklets are easy to handle when stapling.)

III. Completing job responsibilities

A. Turn off MOTOR SWITCHES to Collator and Jogger

B. Remove all paper left in STATIONS of Collator

C. Return COUNTER to zero (Always inform teacher of number on the COUNTER.)

D. Replace cover on machine

E. Move booklets from Jogger to table and staple

IV. Stapling--Acco Model AVS Electric Stapler

A. Features

1. May staple up to 120 times per minute

2. Has stapling capacity of 20 sheets of bond paper or 25 sheets of onion skin paper

3. Uses any brand of standard staples

B. Operation

1. Learn correct method of refilling (Always unplug.)

2. Learn to adjust margins

Skill Building

1. Know the parts of the Collator

2. Know how to refill and use properly

3. Collate (according to Rotation Plan)

a. Fifty booklets of 16 pages each
b. Fifty booklets of 8 pages
c. Fifty booklets of 4 pages

MAIL OPENER

MAIL OPENER

Teacher Material

Description	Pitney-Bowes Model LA; semi-automatic; largest model of three
Use	To open letter mail and stack it efficiently
New Term	Fanning envelopes--exposing them to air Jogging envelopes--giving them a slight shake on the table so that paper clips will not come in contact with the cutting knives
Activity	Provide each student with a small stack of envelopes to fan and jog

Machine Demonstration

I. Setting up the Mail Opener

A. Remove cover and place in a safe place

B. Set TRIM ADJUSTMENT according to the depth of cut desired

C. Adjust STACKER to catch envelopes and CHIP CATCHER to collect chips ejected

D. Fan and jog envelopes

E. Turn on MOTOR SWITCH to machine

II. Operating the Mail Opener

A. Place envelopes on LETTER FEED PLATE

B. Exert gentle downward pressure on right end of stack (Letters will feed from bottom of stack.)

III. Completing job responsibilities

A. Turn off MOTOR SWITCH

B. Remove CHIP CATCHER, place chips in the waste paper basket, and return to proper place

C. Replace cover on machine

D. Remove opened letters from STACKER

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Student Participation

Give each student an opportunity to run his stack of envelopes through the Mail Opener several times to get the "feel" of it. To conserve envelopes, the same ones may be used over until the envelopes are about half their original size.

Supplementary Materials

Show pictures of the other two models of Mail Openers manufactured by Pitney-Bowes (Point out any differences in the picture and the model in the laboratory.)

Share with the students some case studies involving different types of companies and ways in which a Mail Opener is used in their business (Show picture of mail opener used in each case study. Use "10 case studies of Time and Money Savings made possible by Pitney-Bowes mail openers" (Series B) Free from Pitney-Bowes, Inc., Stamford, Connecticut.)

Give students duplicated sheet containing specific information about the Mail Opener (They are responsible for learning this information.)

Skill Building

The students should develop the following skills.

1. Be able to identify the parts

2. Be able to operate the mail opener efficiently (Have student spend a minimum of 15 consecutive minutes operating the mail opener. This is the easiest machine in the laboratory to operate so the student should concentrate on speed along with skill.)

MAIL OPENER

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description	Pitney-Bowes Model LA; semi-automatic; largest model of three
Use	To open letter mail and stack it efficiently
New Terms	Fanning envelopes--exposing them to air
	Jogging envelopes--giving them a slight shake on the table so that paper clips will not come in contact with the cutting knives

Operating Procedures

I. Setting up the Mail Opener

A. Remove cover and place in a safe place

B. Set TRIM ADJUSTMENT according to the depth of the cut desired

C. Adjust STACKER to catch envelopes and CHIP CATCHER to collect ejected chips

D. Fan and jog envelopes

E. Turn on MOTOR SWITCH

II. Operating the Mail Opener

A. Place envelopes on LETTER FEED PLATE

B. Exert gentle downward pressure on right end of stack (Letters will feed from bottom of stack.)

III. Completing job responsibilities

A. Turn off MOTOR SWITCH

B. Remove CHIP CATCHER, place chips in the waste paper basket, and return to proper place

C. Replace cover on machine

D. Remove opened letters from STACKER

Skill Building

1. Be able to identify parts of the Mail Opener

2. Following the Rotation Plan and team assignment, spend a minimum of 15 consecutive minutes efficiently operating the Mail Opener. Concentrate on speed along with skill.

6099

FOLDING MACHINE

FOLDING MACHINE

Teacher Material

Description	Pitney-Bowes Model FH with AUTOMATIC FEED PLATE Range of speed approximately 6,000 8½" x 11" sheets per hour May be attached to Inserter Model 3300
Use	To fold sheets of paper various ways
New Terms	Shingle or shingling--to lay as to overlap (like shingles on the roof of a house) Leading--end of paper going into the Folding Machine first Trailing--end of paper going into the Folding Machine last
Activity	Provide each student with a small stack of paper (approximately 50 sheets) to aerate and then shingle it in preparation for the folding machine. The same paper may be used many times

Machine Demonstration

I. Setting up the Folding Machine

A. Remove cover and place in a safe place

B. Adjust FRONT and REAR PAPER GUIDES

1. Center paper

2. Position the FRONT PAPER GUIDE to correspond with the width of the paper, leaving about the thickness of a dime between the paper and GUIDE. Loosen screw to move GUIDE; tighten screw when the GUIDE is in correct position

3. Position REAR PAPER GUIDE up to the paper, leaving about the thickness of a dime between paper and GUIDE; using the same procedure as above

C. Set the SEPARATOR for thickness

1. Adjust nut under the FEED PLATE as necessary (Loosening the nut lightens the engagement, tightening the nut increases the engagement.)

2. Using one sheet of the paper that is to be folded, set SEPARATOR for the lightest possible pull, not permitting the feeding of doubles

D. Determine the fold settings

1. Set for standard fold on 8½" x 11" paper

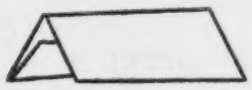

   a. Use red lines on the calibrated charts
   b. Place paper with letterhead <u>trailing</u>

2. Set for accordion fold on 8½" x 11" paper

   a. Use red lines on the calibrated charts
   b. Place paper with letterhead <u>leading</u>

3. Set for single fold

   a. Depress the SINGLE FOLD DEFLECTOR
   b. Set the SECOND FOLD KNOB according to position of the crease

4. Set for double fold

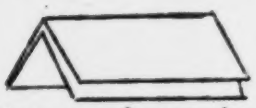

   a. Fold a sample sheet by hand (Make by folding a sheet in half and then folding this in half again.)

   b. Measure the distance from the <u>leading</u> edge of the paper to the first crease using the SCALE on the SINGLE FOLD DEFLECTOR

   c. Set FIRST FOLD KNOB at the corresponding figure

   d. Repeat the procedure measuring from the first crease to the second crease and set the SECOND FOLD KNOB at the corresponding figure

5. Set for other folds

   a. Fold a sheet of paper by hand the way it should look after going through the machine

   b. Measure the distance from the <u>leading</u> edge of the paper to the first crease using the SCALE on the SINGLE FOLD DEFLECTOR

   c. Set FIRST FOLD KNOB at the corresponding figure

   d. Repeat the procedure measuring from the first crease to the second crease and set the SECOND FOLD KNOB at the corresponding figure

E. Check STACKER SPEED LEVER

1. Use upper position for high speed, normal feeding, and extra long paper

2. Use lower position for low speed and for intermittent feeding or small sheets

[redacted]

II. Operating the Folding Machine

A. Aerate and shingle paper

B. Place paper in FEED PLATE with letterhead leading or trailing according to fold being used.

C. Turn MOTOR SWITCH to ON

D. Stack automatically

E. Remove contents of the STACKER at reasonable intervals

F. Follow the above procedures until all material is folded

III. Completing job responsibilities

A. Turn MOTOR SWITCH to OFF

B. Remove <u>all</u> contents from STACKER

C. Replace cover on machine

D. Check all material folded and process according to instructions of the teacher

Student Participation

Let each student run a few pieces of paper through the machine, having each student set the machine for a different fold (Example: first student folds a few papers using the standard fold; the next student sets machine for an accordion fold). Proceed until all the students have had a chance to fold some papers

Supplementary Material

1. Explain to students that this FOLDING MACHINE may be attached to the Inserting Machine (The operator starts with unfolded sheets of paper. They come out of the machine folded and inserted into envelopes.)

2. Give students duplicated sheets containing specific information about the Folding Machine in the laboratory (They are responsible for learning this information.)

Skill Building

The students should develop the following skills.

1. Be able to identify the parts of the Folding Machine

2. Be able to set and operate efficiently the Folding Machine to make a standard fold, accordion fold, single fold, double fold, and other folds

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FOLDING MACHINE

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description — Pitney-Bowes Model FH with AUTOMATIC FEED PLATE
Range of speed--approximately 6,000 8½" x 11" sheets per hour

May be attached to Inserter Model 3300

Use — To fold sheets of paper in various ways

New Terms — Shingle or shingling--to lay so as to overlap (like shingles on the roof of a house)

Leading--end of paper going into the Folding Machine first

Trailing--end of paper going into the Folding Machine last

Operating Procedures

I. Setting up the Folding Machine

A. Remove cover and place in a safe place

B. Adjust FRONT and REAR PAPER GUIDES

1. Center paper

2. Position the FRONT PAPER GUIDE to correspond with the width of the paper, leaving about the thickness of a dime between the paper and the GUIDE (Loosen screw to move GUIDE; tighten screw when GUIDE is in correct position.)

3. Position REAR PAPER GUIDE up to the paper, leaving about the thickness of a dime between paper and GUIDE, using the same procedure as above

C. Set the SEPARATOR for thickness

1. Adjust nut under the FEED PLATE as necessary (Loosening the nut lightens the engagement, tightening the nut increases the engagement.)

2. Using one sheet of the paper that is to be folded, set SEPARATOR for the lightest possible pull, not permitting the feeding of doubles.

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D. Determine the fold settings

1. Set for standard fold on 8½" x 11" paper

   a. Use red lines on the calibrated charts
   b. Place paper with letterhead trailing

2. Set for accordion fold on 8½" x 11" paper

   a. Use red lines on the calibrated charts
   b. Place paper letterhead leading

3. Set for single fold

   a. Depress the SINGLE FOLD DEFLECTOR
   b. Set the SECOND FOLD KNOB according to position of crease

4. Set for double fold

   a. Fold a sample sheet by hand (Made by folding a sheet in half and then folding this in half again.)
   b. Measure the distance from the leading edge of the paper to the first crease using the SCALE on the SINGLE FOLD DEFLECTOR
   c. Set FIRST FOLD KNOB at the corresponding figure
   d. Repeat the procedure measuring from the first crease to the second crease and set the SECOND FOLD KNOB at the corresponding figure

5. Set for other folds

   a. Fold a sheet of paper by hand the way it should look after going through the machine
   b. Measure the distance from the leading edge of the paper to the first crease using the SCALE on the SINGLE FOLD DEFLECTOR
   c. Set FIRST FOLD KNOB at the corresponding figure
   d. Repeat the procedure measuring from the first crease to the second crease and set the SECOND FOLD KNOB at the corresponding figure

E. Check STACKER SPEED LEVER

1. Use upper position for higher speed, normal feeding, and extra long paper

2. Use lower position for low speed and for intermittent feeding or small sheets

II. Operating the Folding Machine

A. Aerate and shingle paper

B. Place paper in the FEED PLATE with letterhead leading or trailing according to the fold being used

C. Turn MOTOR SWITCH to ON

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D. Stack automatically

E. Remove contents of the STACKER at reasonable intervals

F. Follow the above procedures until all material is folded

III. Completing job responsibilities

A. Turn MOTOR SWITCH to OFF

B. Remove <u>all</u> contents from STACKER

C. Replace cover on machine

D. Check all material folded and process according to instructions of the teacher

Additional Information

The Folding Machine in the laboratory may be attached to the Inserting Machine. The Operator begins with unfolded sheets of paper and they come out of the machine folded and inserted into envelopes.

Skill Building

1. Know the parts of the Folding Machine

2. Following the Rotation Plan and team assignment, work at the Folding Machine until efficient in setting up and operating the machine to make the following folds.

   a. Standard
   b. Accordion
   c. Single
   d. Double
   e. Other

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INSERTING MACHINE
INSERTING and FOLDING MACHINE
(Combined)

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INSERTING MACHINE

Teacher Material

Description	Pitney-Bowes Model 3300; most difficult machine in the laboratory to operate (The Folding Machine may be attached to this machine.)
Use	To stuff enclosures automatically, one at a time, into envelopes
New Term	Flapping envelopes--using a small stack of envelopes, inserting one flap under the other and then bending the flaps back
Activity	Provide each student with a small stack of envelopes (approximately 50) to practice flapping them

Machine Demonstration

I. Setting up the Inserting Maching

A. The FEEDER

1. SIDE GUIDES

a. Loosen the two LOCK KNOBS beneath the DECK
b. Place the enclosure between the SIDE GUIDES
c. Tighten the LOCK KNOBS after setting the GUIDES evenly according to the DECK MARKS and leaving the thickness of a dime between the enclosure and the GUIDES

2. SEPARATOR SHIELD

a. Examine the three-fingered STONE and the ADJUSTABLE SHIELD (Amount of STONE exposure should be the thickness of a dime. More STONE exposure is required when the paper is either heavy or rough-surfaced.)
b. Change the amount of STONE exposure by pushing or pulling the SHIELD HANDLE under the FEEDER

3. SEPARATOR GAP

a. Place one of the enclosures underneath the ROLLER up to--but not against--the STOP SWITCH ARM (If necessary, lower the STONE by turning the STONE ADJUSTMENT SCREW to the left.)
b. Turn the POWER and MOTOR SWITCHES to ON (This operates the FEED ROLLER. The POWER SWITCH remains on until job is completed.)
c. Raise the STONE by turning the STONE ADJUSTMENT SCREW clockwise until the ROLLER pulls the enclosure against STOP SWITCH ARM
d. Turn only the MOTOR SWITCH to OFF
e. Leave the enclosure there

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B. RAM PICK-UP STATION

1. SIDE GUIDES

   a. Loosen both LOCK KNOBS on the SIDE GUIDES
   b. Set each SIDE GUIDE so that its DECK MARK is ¼" greater than the SIDE GUIDES on the FEEDER
   c. Tighten both LOCK KNOBS temporarily

2. GATE POSITION

   a. Measure the height of the enclosure
   b. Loosen the GATE KNOB and set its red pointer ¼" greater than the enclosure's height
   c. Tighten the GATE KNOB temporarily
   d. Turn the MOTOR SWITCH to ON
   e. Firmly hold the HANDWHEEL at the left end of the machine and press the FEED SWITCH, releasing the enclosure
   f. Turn only the MOTOR SWITCH OFF when the enclosure has stopped in the RAM PICK-UP STATION
   g. Loosen the GATE KNOB again
   h. Use the GATE KNOB to move the enclosure gently back toward the direction from which it came
   i. Tighten the GATE KNOB firmly as soon as the enclosure stops moving
   j. Turn only the MOTOR SWITCH to ON and OFF to move the enclosure into the STACKER
   k. Return enclosure to FEEDER TRAY

3. GATE TENSION

   a. Turn MOTOR SWITCH to ON
   b. Firmly hold the HANDWHEEL at the left end of the machine and press the FEED SWITCH, releasing the enclosure
   c. Turn the MOTOR SWITCH to OFF when the enclosure has stopped in the RAM PICK-UP STATION (If it slides or twists beyond the GATE, the GATE TENSION should be increased, but if its lead edge is crumpled, GATE TENSION should be lowered. If adjustment is needed, loosen the GATE TENSION ADJUSTING KNOB. Move to the right to increase tension and to the left to lower tension.)
   d. Loosen both SIDE GUIDE KNOBS and move each GUIDE in to the thickness of a dime from each end of the enclosure when the GATE TENSION checks correctly and the enclosure in RAM PICK-UP STATION lies straight
   e. Tighten both SIDE GUIDE KNOBS
   f. Turn the MOTOR SWITCH to ON and OFF to move the enclosure into the STACKER
   g. Return the enclosure to FEEDER TRAY

4. RAM PUSHER

   a. Turn MOTOR SWITCH to ON
   b. Firmly hold the HANDWHEEL at the left end of the machine and press the FEED SWITCH, releasing enclosure
   c. Let the HANDWHEEL slip slowly in your hand (The RAM PUSHER will move the enclosure to your left.)
   d. Turn the MOTOR SWITCH to OFF when the slotted SCREW in the RAM BLADE is to the left of the ENVELOPE LEDGE

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e. Loosen this SCREW with a coin (penny or dime) and use it to position the RAM PUSHER (The RAM PUSHER must touch the enclosure's trail edge and the RAM BLADE tip is ahead of the enclosure by the thickness of a dime.)
f. Tighten the SCREW with a coin
g. Turn the MOTOR SWITCH to ON and OFF to move the enclosure into the STACKER
h. Return enclosure to the FEEDER TRAY

C. ENVELOPE-HOPPER STATION

1. SIDE GUIDE POSTS

a. Turn the SIDE GUIDE POSTS to slide them all the way out to the end of their DECK SLOTS
b. Lay an envelope between the SIDE GUIDE POSTS at equal DECK MARKS
c. Slide the SIDE GUIDE POSTS to within the thickness of a dime at each end of the envelope

2. FLAP GUIDE POSTS

a. Take an envelope and pull the flap out straight
b. Lay the envelope, flap out and throat down, against the LEDGE (Flap crease must be parallel and even with the edge of the LEDGE.)
c. Loosen the FLAP POST KNOBS and center each FLAP GUIDE POST between the tip of the flap and the end of the envelope holding the envelope crease and flap in the position described above
d. Move each FLAP GUIDE POST lightly against the flap, and tighten the FLAP GUIDE KNOBS

3. FENCE

a. Loosen the KNOBS at each end of the FENCE holding the envelope crease and flap in the position described above
b. Move the FENCE to the position where the back edge of the envelope can rest on the FENCE SHELF
c. Make sure the FENCE is close enough to confine the envelope, but not close enough to cause any squeeze (The thickness of a dime should be allowed.)
d. Tighten the KNOBS

D. Test run

1. Use one enclosure and one envelope to check adjustments

2. Turn MOTOR SWITCH to ON

3. Let the enclosure slide down the FEEDER TRAY until it hits the FEED ROLLER

4. Depress the FEED button (The enclosure should be stuffed into the envelope and the envelope dropped into the STACKER.)

5. Turn the MOTOR SWITCH to OFF

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III. Completing job responsibilities

A. Turn the power and motor switches to OFF after the last enclosure is inserted

B. Remove unused envelopes

C. Remove stuffed envelopes

D. Replace cover on machine

E. Check inserted envelopes for accuracy

F. Take envelopes to Mailing Machine if postage is to be applied in the laboratory or count and box according to the instructions of the teacher

Student Participation

1. Give each student an opportunity to run a few enclosures through the machine while it is set up.

2. Have them remove the enclosures from the envelopes for future use.

Skill Building

Each student is to set up machine to insert at least 25 cards into small envelopes and reset machine to insert at least 25 letters into standard size envelopes. These two jobs will require making all the adjustments becuase of the different kinds of materials used. When completed the student is to remove the insertions from the envelopes so they may be used again.

The students should develop the following skills.

1. Be able to identify the parts of the Inserting Machine

2. Be able to set up and operate the Inserting Machine efficiently. (These two activities will require all adjustments to be made and be a good learning experience.)

   a. Insert letters into standard size envelopes
   b. Insert 4" x 6" cards into small envelopes (Remove insertions from the envelopes so they may be used again.)

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INSERTING MACHINE

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description	Pitney-Bowes Model 3300; most difficult machine in the laboratory to operate (The Folding Machine may be attached to this machine.)
Use	To stuff enclosures automatically, one at a time, into envelope
New Term	Flapping envelopes--using a small stack of envelopes inserting one flap under the other and then bending the flaps back

Operating Procedures

I. Setting up the Inserting Machine

A. The FEEDER

1. SIDE GUIDES

a. Loosen the two LOCK KNOBS beneath the DECK
b. Place the enclosure between the SIDE GUIDES
c. Tighten the LOCK KNOBS after setting the GUIDES evenly according to the DECK MARKS and leaving the thickness of a dime between the enclosure and the GUIDES

2. SEPARATOR SHIELD

a. Examine the three-fingered STONE and the ADJUSTABLE SHIELD (Amount of STONE exposure should be the thickness of a dime. More STONE exposure is required when the paper is either heavy or rough-surfaced.)
b. Change the amount of STONE exposure by pushing or pulling the SHIELD HANDLE under the FEEDER

3. SEPARATOR GAP

a. Place one of the enclosures underneath the ROLLER up to--but not against--the STOP SWITCH ARM (If necessary, lower the STONE by turning the STONE ADJUSTMENT SCREW to the left.)
b. Turn the POWER and MOTOR SWITCHES to ON (This operates the FEED ROLLER. The POWER SWITCH remains on until job is completed.)
c. Raise the STONE by turning the STONE ADJUSTMENT SCREW clockwise until the ROLLER pulls the enclosure against STOP SWITCH ARM (At this point, the FEED ROLLER will automatically stop.)
d. Turn only the MOTOR SWITCH to OFF
e. Leave the enclosure there

B. RAM PICK-UP STATION

1. SIDE GUIDES

a. Loosen both LOCK KNOBS on the SIDE GUIDES
b. Set each SIDE GUIDE so that its DECK MARK is ¼" greater than the SIDE GUIDES on the FEEDER
c. Tighten both LOCK KNOBS temporarily

2. GATE POSITION

a. Measure the height of the enclosure
b. Loosen the GATE KNOB and set its red pointer ¼" greater than the enclosure's height
c. Tighten the GATE KNOB temporarily
d. Turn the MOTOR SWITCH to ON
e. Firmly hold the HANDWHEEL at the left end of the machine and press the FEED SWITCH, releasing the enclosure
f. Turn only the MOTOR SWITCH to OFF when the enclosure has stopped in the RAM PICK-UP STATION
g. Loosen the GATE KNOB again
h. Use the GATE KNOB to move the enclosure gently back toward the direction from which it came.
i. Tighten the GATE KNOB firmly as soon as the enclosure stops moving
j. Turn only the MOTOR SWITCH on and off to move the enclosure into the STACKER
k. Return enclosure to FEEDER TRAY

3. GATE TENSION

a. Turn MOTOR SWITCH to ON
b. Firmly hold the HANDWHEEL at the left end of the machine and press the FEED SWITCH, releasing the enclosure
c. Turn the MOTOR SWITCH to OFF when the enclosure has stopped in the RAM PICK-UP STATION (If it slides or twists beyond the GATE, the GATE TENSION should be increased; but if its lead edge is crumpled, GATE TENSION should be lowered. If adjustment is needed, loosen the GATE TENSION ADJUSTING KNOB. Move to the right to increase tension and to the left to lower tension.)
d. Loosen both SIDE GUIDE KNOBS and move each GUIDE in to the thickness of a dime from each end of the enclosure when the GATE TENSION checks correctly and the enclosure in RAM PICK-UP STATION lies straight
e. Tighten both SIDE GUIDE KNOBS
f. Turn the MOTOR SWITCH to on and off to move the enclosure into the STACKER
g. Return the enclosure to FEEDER TRAY

4. RAM PUSHER

a. Turn MOTOR SWITCH to ON
b. Firmly hold the HANDWHEEL at the left end of the machine and press the FEED SWITCH, releasing the enclosure

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c. Let the HANDWHEEL slip slowly in your hand (The RAM PUSHER will move the enclosure to your left.)
d. Turn the MOTOR SWITCH to OFF when the slotted SCREW in the RAM BLADE is to the left of the ENVELOPE LEDGE
e. Loosen this SCREW with a coin (penney or dime) and use it to position the RAM PUSHER (The RAM PUSHER must touch the enclosure's trail edge and the RAM BLADE tip is ahead of the enclosure by the thickness of a dime
f. Tighten the SCREW with the coin
g. Turn the MOTOR SWITCH to ON and OFF to move the enclosure into the STACKER
h. Return enclosure to the FEEDER TRAY

C. ENVELOPE-HOPPER STATION

1. SIDE GUIDE POSTS

a. Turn the SIDE GUIDE POSTS to slide them all the way out to the end of their DECK SLOTS
b. Lay an envelope between the SIDE GUIDE POSTS at equal DECK MARKS
c. Slide the SIDE GUIDE POSTS to within the thickness of a dime at each end of the envelope

2. FLAP GUIDE POSTS

a. Take an envelope and pull the flap out straight
b. Lay the envelope, flap out and throat down, against the LEDGE (Flap crease must be parallel and even with the edge of the LEDGE.)
c. Loosen the FLAP POST KNOBS and center each FLAP GUIDE POST between the tip of the flap and the end of the envelope holding the envelope firmly in this position
d. Move each FLAP GUIDE POST lightly against the flap and tighten the FLAP GUIDE KNOBS

3. FENCE

a. Loosen the KNOBS at each end of the FENCE holding the envelope crease and flap in the position described above
b. Move the FENCE to the position where the back edge of the envelope can rest on the FENCE SHELF
c. Make sure the FENCE is close enough to confine the envelope, but not close enough to cause any squeeze (The thickness of a dime should be allowed.)
d. Tighten the KNOBS

D. Test run

1. Use one enclosure and one envelope to check adjustments

2. Turn MOTOR SWITCH to ON

3. Let the enclosure slide down the FEEDER TRAY until it hits the FEED ROLLER

4. Depress the FEED button (The enclosure should be stuffed into the envelope and the envelope dropped into the STACKER.)

5. Turn the MOTOR SWITCH to OFF

6. Examine the stuffed envelope to see if the enclosure is placed in the envelope correctly and if not, recheck adjustments and do another test run

7. Begin the job if the envelope is stuffed correctly

II. Operating the Inserting Machine

A. Envelopes

1. Flap the envelopes and bend flaps properly

2. Fan the envelopes

3. Place envelopes in the HOPPER throat down with creases aligned to the LEDGE with bottom edge of lowest envelope resting on the FENCE SHELF

4. Keep stack of envelopes in HOPPER at least one inch high

5. Add envelopes carefully so the evenness of the stack will not become distorted

B. Enclosures

1. Fan enclosures

2. Place a stack of enclosures at the top of the FEED TRAY

3. Lean enclosures slightly forward against the fingers of the left hand

4. Tilt the enclosures in the opposite direction on the FEED TRAY with the left hand

5. Let enclosures slide down the FEED TRAY

6. Guide the stack lightly until the top enclosure contacts the FEED ROLLER

7. To add move enclosures, lift the trailing edge of last enclosure of the old stack and let the new ones slide under

C. Continuous operation

1. Turn MOTOR SWITCH to ON

2. Press the FEED button (Continuous, automatic operation should begin.)

3. Add flapped envelopes before the stack drops below one inch high

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4. Add enclosures before stack is used up

5. Remove stuffed envelopes from STACKER at intervals

III. Completing job responsibilities

A. Turn the POWER and MOTOR SWITCHES off after the last enclosure is inserted

B. Remove unused envelopes

C. Remove stuffed envelopes

D. Replace cover on machine

E. Check inserted envelopes for accuracy

F. Take envelopes over to Mailing Machine if postage is to be applied in the laboratory or count and box according to the instructions of the teacher

Skill Building

1. Know the parts of the Inserting Machine

2. Know how to set up and operate efficiently the Inserting Machine following the Rotation Plan and team assignment

3. Do the following jobs

   a. Insert letters into standard size envelopes
   b. Insert 4" x 6" cards into small envelopes
   c. Remove the insertions from the envelopes so that they may be used again

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INSERTING AND FOLDING MACHINES COMBINED

Teacher Material

Description	Pitney-Bowes Inserter 3300 and Folder FH combined
Use	Automatically folds and stuffs enclosures in one continuous operation

Combining the Machines

I. Preparing the Inserting Machine by removing the FEEDER

A. Unplug FEEDER by removing plug from socket

B. Remove FEEDER MOUNTING BRACKET

1. Unscrew thumb screws

2. Push away from control panel until flexible SHAFT is free

II. Preparing the Folding Machine

A. Remove the FEED PLATE, GUIDE SPRINGS and STACKER TRAY

B. Remove the DEFLECTOR CLIPS and position the STACKER LEVER <u>down</u>

III. Combining the Machines

A. Place Folder on top of the sub-base and slide it <u>towards</u> the Inserter <u>between</u> the edges of the sub-base

B. When the Folder is about a finger width from the Inserter, press down on the Folder and continue to slide it towards the Inserter until the Folder is locked in place by the hook on the sub-base

C. Plug the Folder power plug into the Inserter

1. Depress POWER and MOTOR SWITCHES of the Inserter to ON

2. Depress MOTOR SWITCH of the Folder to ON

D. Attach the FEEDER on the Folder in place of the original FEED PLATE

E. Plug FEEDER plug into the receptacle on the CONTROL PANEL

F. Set the Folder for the proper fold size

G. Check the SINGLE FOLD DEFLECTOR to see if it is in the correct position

Class Participation

Give each team the opportunity to combine the Folding and Inserting Machines, following each step while the remainder of the class observes.

Skill Building

Following the Rotation Plan and team assignment the students should be able to set up and operate efficiently the combined machines.

INSERTING AND FOLDING MACHINES COMBINED

Name_____

Student Material
(To be duplicated and given to students)

Team_____

Description Pitney-Bowes Inserter 3300 and Folder FH combined

Use Automatically folds and stuffs enclosures in one continuous operation

Combining the Machines

I. Preparing the Inserting Machine by removing the FEEDER

A. Unplug FEEDER by removing plug from socket

B. Remove FEEDER MOUNTING BRACKET

1. Unscrew thumb screws

2. Push away from control panel until flexible SHAFT is free

II. Preparing the Folding Machine

A. Remove the FEED PLATE, GUIDE SPRINGS, and STACKER TRAY

B. Remove the DEFLECTOR CLIPS and position the STACKER LEVER down

III. Combining the Machines

A. Place Folder on top of the sub-base and slide it towards the Inserter between the edges of the sub-base

B. When the Folder is about a finger width from the Inserter press down on the Folder and continue to slide it towards the Inserter until the Folder is locked in place by the hook on the sub-base

C. Plug the Folder power plug into the Inserter

1. Depress POWER and MOTOR SWITCHES of the Inserter to ON

2. Depress MOTOR SWITCH of the Folder to ON

D. Attach the FEEDER on the Folder in place of the original FEED PLATE

E. Plug FEEDER plug into the receptacle on the CONTROL PANEL

F. Set the Folder for the proper fold size

G. Check the SINGLE FOLD DEFLECTOR to see if it is in the correct position

Skill Building

Know how to set up and operate efficiently the two machines combined

6120

KEYBOARD

EMBOSSING MACHINE

Note: A unit on the Zip Code must precede the teaching of the Embossing Machine.

KEYBOARD EMBOSSING MACHINE

Description	Pitney-Bowes Model 795
Use	Emboss metal PLATES to be used for printing purposes
New Terms	Emboss--raise from a surface
	Blank-out--flatten embossed surface of date PLATE
	Tab--an insert used on data PLATE (various colors available)
	Sight Strip-- special strip of paper which will fit on the back PLATE to provide information (various colors available)

Machine Demonstration

I. Setting up Embossing Machine

A. Remove cover and put in a safe place

B. Using the LINE SPACING KNOB, move the PLATE HOLDER toward you to its forward stop (In this position the LINE INDICATOR will be set at one.)

C. Insert a blank PLATE into the PLATE HOLDER with the reading side up and the straight edge toward the operator

D. Pull the PLATE RELEASE LATCH toward you and, at the same time, depress the forward edge of the PLATE (The PLATE should lock snugly in the PLATE HOLDER.)

E. Observe COLUMN INDICATOR and position CARRIAGE to the desired embossing position (Line 2, column #1)

II. Operating the Embossing Machine

A. Depress KEY to emboss the desired character (As the embossing stroke is completed, CARRIAGE automatically advances one space (column) to right. The next KEY can be depressed only after the previous embossing cycle is completed. When two KEYS are engaged at approximately the same time, a stoppage may occur. When this happens, depress the CLEAR KEY ⊗ to relieve the stoppage and then resume embossing.)

B. Continue embossing until the line is complete and then depress CARRIAGE RETURN KEY ⊕ to reposition the plate to its left margin and to advance plate to the next line (The LINE INDICATOR should now be positioned at 3.)

C. Complete the next line and the embossing on the remainder of the plate in the manner described

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D. Proofread PLATE always (If an error is observed, the incorrect character(s) may be removed by blanking-out.)

1. Visually position the PLATE to proper line and column (The COLUMN INDICATOR should be aligned with the character to be removed.)

2. Depress BLANKING KEY (red) one time to blank out each character to be removed

3. Reemboss by backspacing to space blanked out on the PLATE and operate the machine in the normal manner

4. Emboss a new PLATE if error requires a large area of PLATE to be blanked out

III. Completing job responsibilities

A. Turn MOTOR SWTICH to OFF

B. Remove PLATE

C. Replace cover on machine

Student Participation

Give each student the opportunity to sit down at the Embossing Machine, insert a PLATE, position it, type his own name, and remove the PLATE. The same PLATE may be used for embossing until it is filled.

Supplementary Materials for Data Plates and Student Participation

1. Tabs

a. Show examples
b. Tell why used (Tabs indicate essential information to the businessman. Different colors or tab positions indicate different information.)
c. Have students insert tabs on a plate and remove them
d. Show pictures of different kinds of tabs available

2. Sight strips

a. Show examples
b. Tell why used (Sight-strips identify a plate in the Addresser-Printer. Many times the same material is not sent to all patrons.)
c. Explain how to type

(1) Points going upward
(2) Use variable line spacer
(3) Type first information as on first line of embossed PLATE
(4) Show how to cut sight strip and insert into PLATE
(5) Have students cut and insert a SIGHT STRIP into PLATE

3. Give out duplicated sheets containing specific information about the Embossing Machine in the laboratory (The students are responsible for learning this information.)

Skill Building

The student should develop the following skills.

1. Learn parts of the Embossing Machine

2. Compile five addresses--complete with name, street address, city, state and correct Zip Code

3. Following the Rotation Plan and team assignments, use these addresses to emboss five plates, type SIGHT STRIP for each, and insert into correct PLATE

6124

KEYBOARD EMBOSSING MACHINE

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description	Pitney-Bowes Model 795
Use	Emboss metal PLATES to be used for printing purposes
New Terms	Emboss--raise from a surface
	Blank-out--flatten embossed surface of PLATE
	Tab--an insert used on PLATE (various colors available)
	Sight Strip--special strip of paper which will fit on the back of a PLATE to provide information (various colors available)

Operating Procedures

I. Setting up the Embossing Machine

A. Remove cover and put in a safe place

B. Using the LINE SPACING KNOB, move the PLATE HOLDER toward you to its forward stop (In this position the LINE INDICATOR will be set at one.)

C. Insert a blank PLATE into the PLATE HOLDER with the reading side up and the straight edge toward the operator

D. Pull the PLATE RELEASE LATCH toward you and, at the same time, depress the forward edge of the PLATE (The plate should lock snugly in the PLATE HOLDER.)

E. Observe COLUMN INDICATOR and position CARRIAGE to the desired embossing position (Line 2, column 1)

II. Operating the Embossing Machine

A. Depress KEY to emboss the desired character (As the embossing stroke is completed, CARRIAGE automatically advances one space (column) to right. The next KEY can be depressed only after the previous embossing cycle is completed. When two KEYS are engaged at approximately the same time, a stoppage may occur. When this happens, depress the CLEAR KEY ⊗ to relieve the stoppage and then resume embossing.)

B. Continue embossing until the line is complete and then depress CARRIAGE RETURN KEY ⊖ to reposition the plate to its left margin and to advance plate to the next line (The LINE INDICATOR should be positioned at 3.)

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C. Complete the next line and the embossing on the remainder of the plate in the manner described

D. Proofread PLATE always (If an error is observed, the incorrect character(s) may be removed by blanking out.)

1. Visually position the PLATE to proper line and column (The COLUMN INDICATOR should be aligned with the character to be removed.)

2. Depress BLANKING KEY (red) one time to blank out each character to be removed

3. Reemboss by backspacing to space blanked out on the PLATE and operate the machine in the normal manner

4. Emboss a new PLATE if error requires a large area of PLATE to be blanked out

III. Completing of job responsibilities

A. Turn MOTOR SWITCH to OFF

B. Remove PLATE

C. Replace cover on machine

Skill Building

1. Know parts of Embossing Machine (See Glossary below.)

2. Compile five addresses complete with name, street, address, city, state, and correct zip code

3. Following the Rotation Plan and team assignment use the complete addresses in doing the following

a. Emboss five PLATES, proofread, and make any corrections
b. Type five SIGHT STRIPS correctly and insert in back of PLATE

Glossary

Name	What It Is and What It Does
1. Line Indicator	Identifies the addresser plate line in position to be embossed
2. Line Spacing Knob	Facilitates the manual alignment or setting of the addresser plate in relation to the plate holder scale (Knob may be rotated in either direction until plate positioning is achieved.)
3. Power Control Knob	Switches the machine ON or OFF

4.	Keyboard	The keyboard is almost identical in appearance and function to the keyboard on a standard typewriter
5.	Power ON Indicator	When illuminated, indicates that the power is ON
6.	Column Indicator	Identifies the vertical column on the addresser plate in position to be embossed
7.	Carriage	Houses the plate holder and the mechanism to control both forward/rear and left/right positioning of the addresser plate
8.	Plate Holder	Adjustable device permitting forward and reverse movement of plate for embossing on succeeding lines (Has handle to facilitate release of plate from plate frame.)

9. Model 795/796 Standard Keyboard

   a. The carriage release key moves the carriage toward its left stop position (right-hand margin of addresser plate). When the optional stop-type tabulator is installed, the key can be used to stop the carriage at predetermined positions to speed embossing operations.
   b. The blanking key is used to blank-out (remove) embossed characters from an addresser plate.
   c. The clear key is used to free a stoppage which may be caused when two keys are engaged at the same time. The key can be used for both upper and lower case characters.
   d. The back space key positions the carriage one space (column) to the right.
   e. The shift keys are used when upper case (capital) letters are desired and to select the top character on a key having two symbols, such as the key. The use of the shift key is required to emboss the asterisk.
   f. The space bar positions the carriage one space in direction of embossing.
   g. The shift lock key locks the shift mechanism so that it is not necessary to hold either shift key depressed during long runs of upper case embossing.
   h. The carriage return key returns the carriage to the extreme right stop position (left-hand margin of addresser plate) and automatically advances the addresser plate one line. The key must be held down until <u>after</u> the plate holder has advanced to the next line.

6127

ADDRESSER-PRINTER

ADDRESSER-PRINTER

Teacher Material

Description	Pitney-Bowes Model 730 with push button controls
Use	Prints information from embossed plates

Machine Demonstration

I. Setting up the Addresser-Printer

A. Remove cover and put in a safe place

B. Check REPEATER CONTROL--should be on one (If more than one print per plate is desired, check below for procedures.)

C. Load plates in the PLATE FEED HOPPER

1. Raise type side of plates <u>up</u>

2. Place notched edges of the plates to the rear

3. Place PLATE WEIGHT on top of plates

D. Advance first plate into SIGHT STATION by depressing the SKIP button

E. Locate print position

1. Draw a <u>vertical</u> <u>line</u> on the paper where the <u>left</u> edge of the print should appear

2. Draw a <u>horizontal</u> <u>line</u> where the <u>top</u> of the printing should appear

3. Put the paper in the PRINT STATION against the MAGNETIC FORM GUIDES wherever they happen to be and print one plate by pushing the CONSEC. button.

4. Compare the location of the print to the pencil lines and adjust the MAGNETIC FORM GUIDES accordingly.

5. Print the same plate by pushing the REPEAT button and check to see if the print location is accurate

6. If the print location is correct, begin the job.

7. If print location is still not correct, repeat items 4 and 5 above

II. Operating the Addresser-Printer

A. Put paper in PRINT STATION against MAGNETIC FORM GUIDES and press the REPEAT button to print the first plate

6129

6130

B. Continue printing by selecting the correct button from the PRINT CONTROL PANEL

1. Depress CONSEC. when you see the plate you wish to print in the SIGHT STATION

2. Depress SKIP if you wish to skip over a plate without printing it

3. Depress REPEAT after you have made your first print, if you want to make more than one print (Make as many repeat prints as you need.)

C. Use REPEATER CONTROL for 2, 3, or an infinite number of prints from one plate

1. Load plates as you normally do

2. Set REPEATER CONTROL LEVER to desired setting

a. To print each plate 2 or 3 times

(1) Set REPEATER CONTROL LEVER at position 2 or 3 respectively
(2) Turn REPEATER TIMING KNOB counterclockwise so that the point on the knob matches the white dot on the DECK
(3) Depress SKIP button to advance first place into PRINT STATION
(4) Insert form to be printed into PRINT STATION
(5) Depress CONSEC. button and to get first print of desired number

b. To print each plate 4 or an infinite number of times

(1) Set REPEATER CONTROL LEVER at position 1
(2) Depress SKIP button to advance first plate into PRINT STATION
(3) Set REPEAT CONTROL at ∞
(4) Insert form to be printed into PRINT STATION
(5) Depress CONSEC. button for desired number of repeats

III. Completing of job responsibilities

A. Eject the last plate using the SKIP button

B. Turn MOTOR SWITCH to OFF

C. Unload the PLATE RECEIVER

D. Replace cover on machine

E. Check and proof printed matter

1. Make sure you have correct number of prints per plate

2. Make sure you have all the plates and that they are in the order received from the patron

6130

Student Participation

Give each student an opportunity to address several envelopes to get the "feel" of the machine. Have different sizes of envelopes and paper so the MAGNETIC FORM GUIDES will have to be moved. The remainder of the class will observe.

Supplementary Materials

1. Show students pictures of other Addresser-Printers.

2. Give students duplicated sheets containing specific information about the Addresser-Printer in the laboratory (The students are responsible for learning this information.)

Skill Building

The students should develop the following skills.

1. Be able to identify the parts of the Addresser-Printer

2. Be able to set up and operate the Addresser-Printer efficiently

3. Following the Rotation Plan and team assignment, set the machine and do the following jobs using the five plates you embossed

   a. Address five small envelopes
   b. Address five standard envelopes
   c. Address five invoices for window envelopes

6131

ADDRESSER-PRINTER

Name_____

Team_____

Student Material
(To be duplicated and given to the students)

Description	Pitney-Bowes Model 730 with push button controls
Use	Prints information from embossed plates

Operating Procedures

I. Setting up the Addresser-Printer

A. Remove cover and put in a safe place

B. Check REPEATER CONTROL--should be on one (If more than 1 print per plate is desired, check below for procedures.)

C. Load plates in the PLATE FEED HOPPER

1. Raise type side of plates <u>up</u>

2. Place notched edges of the plates to the rear

3. Place PLATE WEIGHT on top of plates

D. Advance first plate into SIGHT STATION by depressing the SKIP button

E. Locate print position

1. Draw a <u>vertical line</u> on the paper where the <u>left</u> edge of the print should appear

2. Draw a <u>horizontal line</u> where the <u>top</u> of the printing should appear

3. Put the paper in the PRINT STATION against the MAGNETIC FORM GUIDES wherever they happen to be and print one plate by pushing the CONSEC. button

4. Compare the location of the print to the pencil lines and adjust the MAGNETIC FORM GUIDES accordingly

5. Print the same plate by pushing the REPEAT button and check to see if you now have the print location desired

6. If the print location is correct, begin the job

7. If the print location is still not correct, repeat Items 4 and 5 above

II. Operating the Addresser-Printer

A. Put paper in PRINT STATION against MAGNETIC FORM GUIDES and press the REPEAT button to print the first plate

8132

B. Continue printing by selecting the correct button from the PRINT CONTROL PANEL

1. Depress CONSEC. when you see the plate you wish to print in the SIGHT STATION

2. Depress SKIP if you wish to skip over a plate without printing it

3. Depress REPEAT after you have made your first print, if you want to make more than one print (Make as many repeat prints as you need.)

C. Use REPEATER CONTROL for 2, 3, or an infinite number of prints from one plate

1. Load plates as you normally do

2. Set REPEATER CONTROL LEVER to desired setting

a. To print each plate 2 or 3 times

(1) Set REPEATER CONTROL LEVER at position 2 or 3 respectively
(2) Turn REPEATER TIMING KNOB counterclockwise so that the point on the knob matches the white dot on DECK
(3) Depress SKIP button to move plate into SIGHT STATION
(4) Insert form to be printed into PRINT STATION
(5) Depress CONSEC. button to get first print of desired number

b. To print each plate 4 or an infinite number of times

(1) Set REPEATER CONTROL LEVER at position 1
(2) Depress SKIP button to advance first plate into PRINT STATION
(3) Set REPEAT CONTROL at ∞
(4) Insert form to be printed into PRINT STATION
(5) Depress CONSEC. button for desired number of repeats

III. Completing of job responsibilities

A. Eject the last plate using the SKIP button

B. Turn MOTOR SWITCH to OFF

C. Unload the PLATE RECEIVER

D. Replace cover on machine

E. Check and proof printed matter

1. Make sure you have correct number of prints per plate

2. Make sure you have all the plates and that they are in the order received from the patron

Skill Building

1. Know the parts of the Addresser-Printer

2. Know how to set up and operate the Addresser-Printer efficiently

3. Following the Rotation Plan and team assignment set the machine and do the following jobs using the five plates you embossed

[illegible] Address five small envelopes
[illegible] Address five standard envelopes
c. Address five invoices for window envelopes

MAILING MACHINE

6134

MAILING MACHINE

Teacher Material

Description	Pitney-Bowes Model 5600 with Pitney-Bowes Meter 5309 which automatically feeds and prints stamps with a machine feed rate of 170 letters per minute
Use	Seals and stamps envelopes and imprints postage on tape for packages that cannot be run through the machine

Machine Demonstration

I. Setting up the Mailing Machine

A. For printing and sealing

1. Move OPERATING LEVER to Operate

2. Check SEPARATOR and adjust to allow feeding of the bottom letter while holding back the remainder of the stack

3. Set the FRONT GUIDE by placing the leading edge of letter between it and the block on the FENCE at the left of the SEPARATOR

4. Move the LETTER PROP left or right by squeezing together the handle and plate at left of LETTER PROP and sliding it in track (The trailing edge of the bottom letter should be against the center of the supporting surface of the LETTER PROP.)

5. Position the STACKER at the right according to the length of the envelopes (It may be removed for convenience during tape runs.)

6. Set date on METER

   a. Raise the DATER COVER
   b. Move the plastic wheels so that the date to be printed is aligned with the DATE INDEX

7. Turn LETTER FEED SWITCH to ON and check machine adjustments by running a sample envelope through the machine

8. Turn LETTER FEED SWITCH to OFF

9. Use screw driver to remove SAFETY PLATE if date and other adjustments are correct

10. Move SETTING LEVERS at the top of the machine to required amount of postage

11. Look in INDICATOR WINDOW to make sure the machine is set for the correct amount

6135
6136

B. For printing only--Run envelopes the same as for printing and sealing, but with flaps closed

C. For sealing only--Center the OPERATING LEVER between REMOVE and OPERATE and run the machine the same as for printing and sealing

II. Operating the Mailing Machine

A. Fan and jog envelopes and make sure that each flap is extending over that of the preceding envelope

B. Turn the LETTER FEED SWITCH to ON

C. Continue to add to the stack of envelopes while the machine automatically feeds and prints stamps

III. Completing job responsibilities

A. Turn LETTER FEED SWITCH to OFF

B. Return SETTING LEVERS to zero

C. Replace SAFETY PLATE and replace screw with screw driver

D. When the last mail for the day has gone through the machine, record in DAILY RECORD OF METER REGISTER READINGS

1. Record the amount of the ASCENDING REGISTER on the METER in Column A (The Ascending Register is the total of all postage used.)

2. Record the amount of the DESCENDING REGISTER in Column B (The DESCENDING REGISTER shows the balance of postage on hand.)

3. Total Column A and B in Column C. Column C must always agree with the last entry made by the postal employee at the time of the last setting of METER

4. Place OPERATING LEVER to LOCK and lock with key

E. Place cover on machine

F. Check all envelopes to make sure postage is on each

G. Bundle according to instructions using pressure-pensive labels furnished by the Post Office for "Local" and "Out of Town"

IV. Additional Meter Information

A. Specifications

1. Setting capacity--$9999.99

2. Meter Stamp--Minimum 1¢, Maximum $9.99 (Meter automatically ceases to operate when DESCENDING REGISTER is below $2.00)

6136

B. To remove meter

1. Move OPERATING LEVER to REMOVE

2. Lift the METER straight up

C. To install METER

1. Keep OPERATING LEVER at REMOVE

2. Grasp the METER HANDLE and guide the METER to the left rear corner above the METER TABLE

D. To acquire additional postage in METER

1. Remove METER as explained

2. Place METER in carrying CASE

3. Obtain check made out to the Postmaster for the amount of postage desired

4. METER, DAILY RECORD OF METER REGISTER READINGS, and check must be presented to employee at the Post Office

5. Install METER as explained

6. Place OPERATING LEVER to LOCK and lock machine with key

E. For Tape Operation only

1. Position TAPE DEFLECTOR for wet or dry tape

2. Remove SAFETY PLATE

3. Look in INDICATOR WINDOW to make sure you have set the correct amount of postage

4. Depress TAPE TRIP LEVER (The LETTER FEED SWITCH does not have to be on for tape operation.)

5. Show class sample tape with "00" in the amount for postage

V. Postal regulations governing metered mail

A. Bundle 5 or more letter-type pieces of metered mail with the addresses facing in one direction

B. Bundle Special Delivery and Air Mail separately

C. Deliver to the Post Office on the date shown on the meter stamp

613713

Student Participation

1. Give each student the opportunity to run a few envelopes through the Mailing Machine. They will seal and look like the real postage except in the amount space will be "00"

2. Let each student depress the TAPE TRIP LEVER and remove a dry tape for his own

3. Give students duplicated sheets containing specific information about the mailing machine in the laboratory. They are responsible for learning this information

Supplementary Material

1. Show samples of different metered mail--some with advertisements

2. Show where brand initials and meter numbers are on samples

Skill Building

The student should develop the following skills.

1. Be able to identify parts of the Mailing Machine

2. Know how to set up the Mailing Machine for the following operations

   a. Printing and sealing
   b. Printing only
   c. Sealing only
   d. Tape operation

3. Be able to remove and install the METER, and record entries in the DAILY RECORD OF METER REGISTER READINGS

615610

MAILING MACHINE

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description	Pitney-Bowes Model 5600 with Pitney-Bowes Meter 5309 which automatically feeds and prints stamps with a machine feed rate of 170 letters per minute
Use	Seals and stamps envelopes and imprints postage on tape for packages that cannot be run through the machine

Operating Procedures

I. Setting up the Mailing Machine

A. For <u>printing and sealing</u>

1. Move OPERATING LEVER to <u>Operate</u>

2. Check SEPARATOR and adjust to allow feeding of the <u>bottom</u> letter while holding back the remainder of the stack

3. Set the FRONT GUIDE by placing the <u>leading</u> edge of letter between it and the block on the FENCE at the <u>left</u> of the SEPARATOR

4. Move the LETTER PROP left or right by squeezing together the handle and plate at <u>left</u> of LETTER PROP and sliding it in track. (The <u>trailing</u> edge of the <u>bottom</u> letter should be against the center of the supporting surface of the LETTER PROP.)

5. Position the STACKER at the <u>right</u> according to the length of envelopes (It may be removed for convenience during tape runs.)

6. Set date on METER

   a. Raise the DATER COVER
   b. Move the plastic wheels so that the date to be printed is aligned with the DATE INDEX

7. Turn LETTER FEED SWITCH to ON and check machine adjustments by running a sample envelope through the machine

8. Turn LETTER FEED SWITCH to OFF

9. Use screw driver to remove SAFETY PLATE if date and other adjustments are correct

10. Move SETTING LEVERS at the <u>top</u> of the machine to required amount of postage

11. Look in INDICATOR WINDOW to make sure the machine is set for the correct amount

6139 0019

B. For printing only--Run the envelopes the same as for printing and sealing, but with flaps closed

C. For sealing only--Center the OPERATING LEVER between REMOVE and OPERATE and run the machine the same as for printing and sealing

II. Operating the Mailing Machine

A. Fan and jog envelopes and make sure that each flap is extending over that of the preceding envelope

B. Turn the LETTER FEED SWITCH to ON

C. Continue to add to the stack of envelopes while the machine automatically feeds and prints stamps

III. Completing job responsibilities

A. Turn LETTER FEED SWITCH off

B. Return SETTING LEVERS to zero

C. Replace SAFETY PLATE and replace screw with screw driver

D. When the last mail for the day has gone through the machine, record in DAILY RECORD OF METER REGISTER READINGS

1. Record the amount of the ASCENDING REGISTER on the METER in Column A (ASCENDING REGISTER is the total of all postage used.)

2. Record the amount of the DESCENDING REGISTER in Column B (The DESCENDING REGISTER shows the balance of postage on hand.)

3. Total Columns A and B in Column C. Column C must always agree with the last entry made by the postal employee at the time of the last setting of METER

4. Place OPERATING LEVER to LOCK and lock with key

E. Place cover on machine

F. Check all envelopes to make sure postage is on each

G. Bundle according to instructions using pressure sensitive labels marked "Local" and "Out of Town" obtained from the Post Office

IV. Additional METER information

A. Specifications

1. Setting capacity--$9999.99

2. Meter Stamp--Minimum 1¢, Maximum $9.99 (Meter automatically ceases to operate when DESCENDING REGISTER is below $2.00.)

B. To remove METER

1. Move OPERATING LEVER to REMOVE

2. Lift the METER straight up

C. To install METER

1. Keep OPERATING LEVER at REMOVE

2. Grasp the METER HANDLE and guide the METER to the left rear corner above the METER TABLE

D. To acquire additional postage in METER

1. Remove METER as explained

2. Place METER in carrying CASE

3. Obtain check made out to the Postmaster for the amount of postage desired

4. METER, DAILY RECORD OF METER REGISTER READINGS, and check must be presented to employee at the Post Office

5. Install METER as explained

6. Place OPERATING LEVER to LOCK and lock machine with key

E. For TAPE OPERATION only

1. Position TAPE DEFLECTOR for wet or dry tape

2. Remove SAFETY PLATE

3. Select amount of postage

4. Look in INDICATOR WINDOW to make sure you have set the correct amount

5. Depress TAPE TRIP LEVER (The LETTER FEED SWITCH does not have to be on for tape operation.)

V. Postal regulations governing metered mail

A. Bundle 5 or more letter-type pieces of metered mail with the addresses facing in one direction

B. Bundle Special Delivery and Air Mail separately

C. Deliver to the Post Office on the date shown on the meter stamp

6141S&P

Skill Building

1. Know the parts of the Mailing Machine

2. Know how to set up and operate efficiently the Mailing Machine for the following operations

   a. Printing and sealing
   b. Printing only
   c. Sealing only
   d. Tape operation

3. Know how to remove and install the METER, and record entries in the DAILY RECORD OF METER REGISTER READINGS

PARCEL POST SCALE

AND

SCALES

Note: A unit on the classes of mail and services offered by the Post Office must precede the teaching of the two scales in the laboratory.

PARCEL POST SCALE

Teacher Material

Description	Pitney-Bowes Model 3700
Use	To determine the amount of postage for parcels
New Term	Oscillation--the rocking back and forth of a scale drum after a parcel has been placed on the PLATFORM

Machine Demonstration

I. Setting up the Parcel Post Scale

A. Remove cover from machine and place in a safe place

B. Level by manipulating the two ADJUSTABLE FEET in the front of the BASE until the BUBBLE in the BULLS-EYE LEVEL is centralized

II. Operating the Scale

A. Place parcel on the PLATFORM

B. Determine zone

1. Obtain OFFICIAL ZONE CHART from your local Post Office and place on wall or bulletin board by Scales

2. Use the prefix (first three digits) of the Zip Code of the Post Office to which the parcel is addressed and refer to the chart for the zone

3. Depress ZONE SHUTTER of the correct zone (The ZONE SHUTTER will automatically return to closed position when a second shutter is depressed or when the parcel is removed from the PLATFORM.)

C. Determine the amount of postage in two-ounce graduations using STRIP RATE CHART (SURFACE RATE will appear in the white column and AIR PARCEL POST RATE will appear in the blue column.)

D. Go to Mailing Machine, and acquire tape showing correct amount of postage

E. Attach tape to parcel

III. Completing job responsibilities

A. Remove parcel from scales

B. Place cover on scales

6144

Student Participation

1. Let all the students determine an amount of postage while the remainder of the class observes

2. Have several packages wrapped, each weighing a different amount

3. Give each student a different Zip Code for his parcel

4. Have the student refer to the OFFICIAL ZONE CHART, determine the zone, depress the correct ZONE SHUTTER, and tell the amount of postage necessary for SURFACE RATE and AIR PARCEL POST RATE

Supplementary Material

1. Show the students maps that were previously used to determine the zone. Compare the use of the map with the use of the OFFICIAL ZONE CHART which is much easier

2. Give students duplicated sheets containing specific information about the Parcel Post Scales in our laboratory (They are responsible for learning this information.)

Skill Building

Following the Rotation Plan and team assignment, the student is to spend the amount of time necessary to learn how to perform the following correctly.

1. Identify parts of Parcel Post Scales

2. LEVEL Scales

3. Determine zone

4. Determine correct amount of postage for a parcel

8618
0145

PARCEL POST SCALE

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description	Pitney-Bowes Model 3700
Use	To determine the amount of postage for parcels
New Term	Oscillation--the rocking back and forth of a scale drum after a parcel has been placed on the PLATFORM

Operating Procedures

I. Setting up the Parcel Post Scales

A. Remove cover from machine and place in a safe place

B. Level by manipulating the two ADJUSTABLE FEET in the front of the BASE until the BUBBLE in the BULLS-EYE LEVEL is centralized

II. Operating the scales

A. Place parcel on the PLATFORM

B. Determine zone

1. Use OFFICIAL ZONE CHART posted near the Scales

2. Use the PREFIX (first three digits) of the Zip Code of the Post Office to which the parcel is addressed and refer to the chart for the zone

3. Depress ZONE SHUTTER of the correct zone (The ZONE SHUTTER will automatically return to closed position when a second shutter is depressed or when the parcel is removed from the PLATFORM.)

C. Determine the amount of postage, using STRIP RATE CHART in two-ounce graduation (SURFACE RATE will appear in the white column and AIR PARCEL POST RATE will appear in the blue column.)

D. Go to Mailing Machine and acquire tape showing correct amount of postage

E. Attach tape to parcel

III. Completing job responsibilities

A. Remove parcel from PLATFORM

B. Place cover on scales

Skill Building

Following the Rotation Plan and team assignment spend the necessary amount of time to learn how to perform the following correctly.

1. Identify parts of Parcel Post Scales

2. LEVEL Scales

3. Determine zone

4. Determine correct amount of postage for a parcel

SCALES

Teacher Material

Description	Pitney-Bowes Model S-510 with "throw-over poise"
Use	To determine the amount of postage through 10 pounds

Machine Demonstration

I. Setting up the Scale

A. Remove cover and place in a safe place

B. Level by manipulating the ADJUSTABLE FEET in the BASE until the BUBBLE in the BULLS-EYE LEVEL is centralized

II. Operating the Scale

A. Place letter or parcel mail on PLATFORM

B. If the INDICATOR WIRE goes beyond 5 pounds, change the "THROW-OVER POISE" to the 5-10 pound range (Separate sections of the scale CHART apply to each range.)

1. Read in white background from 0-5 pound range

2. Read in green background from 5-10 pound range

C. Determine the class of mail and zone desired

D. Visually follow across the CHART to the INDICATOR WIRE

1. If the INDICATOR WIRE falls on the line, the lower postage rate applies

2. When the INDICATOR WIRE exposes any portion of the line, the next higher rate applies

III. Completing job responsibilities

A. Remove letter or parcel from Scale

B. Replace cover on Scale

Student Participation

Give all the students the opportunity to determine the amount of postage needed for various samples of first, second, and third class mail while the remainder of the class observes

6148

Supplementary Material

Give duplicated sheets containing specific information about the Scales in the laboratory. The students are responsible for learning this information

Skill Building

Following the Rotation Plan and team assignment, the student is to spend the amount of time necessary to perform the following correctly.

1. Identify parts of the Scales

2. LEVEL Scales

3. Determine correct amount of postage for different classes of mail

SCALES

Name_____

Team_____

Student Material
(To be duplicated and given to students)

Description — Pitney-Bowes Model S-510 with "throw-over poise"

Use — To determine the amount of postage on a letter or a parcel through 10 pounds

Operating Procedures

I. Setting up the Scales

A. Remove cover and place in a safe place

B. Level by manipulating the ADJUSTABLE FEET in the BASE until the BUBBLE in the BULLS-EYE LEVEL is centralized

II. Operating the scales

A. Place letter or parcel on PLATFORM

B. If the INDICATOR WIRE goes beyond 5 pounds, change the "THROW-OVER POISE" to the 5-10 pound range (Separate sections of the scale CHART apply to each range.)

1. Read in white background from 0-5 pound range

2. Read in green background from 5-10 pound range

C. Determine the class of mail and zone desired

D. Visually follow across the CHART to the INDICATOR WIRE

1. If the INDICATOR WIRE falls on the line, the lower postage rate applies

2. When the INDICATOR WIRE exposes any portion of the line, the next higher rate applies

III. Completing job responsibilities

A. Remove letter or parcel from Scale

B. Replace cover on Scale

Skill Building

Following the Rotation Plan and team assignment, spend the amount of time necessary to perform the following correctly.

1. Identify parts of the Scales

2. LEVEL Scales

3. Determine correct amount of postage for different classes of mail

6150

INSTRUCTIONAL UNITS

INTRODUCTION TO UNITS

The units that follow were prepared exclusively for the students who are a part of this program and may not be adaptable to other courses.

These units can be alternated during the year with jobs performed in the laboratory and may be used in any order with the exception of the units on Zip Code and Mail Classification. Zip Code should precede presentation of the Embossing Machine and Mail Classification should precede the Scales.

In this program the teacher and schedule <u>must</u> be flexible. In each situation the jobs done for organizations and businesses will vary. Consequently, the teacher may expand or reduce a unit and may find it desirable to change the order of presentation.

Because of the small number of students per class, the teacher will get to know the students well and may discover new needs. Therefore, any unit or units that would be beneficial or enriching to the students in the program at a given time may be added.

Current newspaper or periodical articles that identify with units in this course should be shared with the students. This will not only help them to be better informed, but also, will help them to realize that what they are studying is relevant.

An evaluation of each unit should follow any method the teacher feels would be most indictative of what the students have learned. This will probably vary with the different units.

6152

ZIP CODE

Objectives

To help the students understand the importance of the Zip Code and what it is

To teach the students the correct placement of the state and the Zip Code on the embossed plate

Time Two or three class periods, depending on the amount of drill given on locating Zip Codes

Presentation

Introduce Mr. Zip

Show transparency Mailing TM-1 (Zip stands for Zone Improvement Program which made its public appearance in mid-1963.)

Mention publicity and methods of advertising; show examples of advertising

Evaluate job of publicizing and advertising, since most Americans are now aware of the Zip Code

Discuss objectives for Zip Code

To increase the speed, accuracy and quality of all mail service

To hold down postal operating costs

Show film, "A Straight Line--The Story of the Zip Code."

This is a 25-minute color film which may be obtained from the Post Office Department.

Contact the local postmaster or write to Motion Picture Branch, Room 2507
U. S. Post Office Department
Washington, D. C. 20260

Discuss film

Give definition

Zip Code is a five-digit numeric address symbol that is quickly and easily identifiable by both postal employees and optical scanning equipment. (Use transparency Mailing TM-3)

0	6	9	04
AREA	STATE	CITY	LOCAL ZONE

The first digit identifies one of the 10 general geographic areas around the United States.

The second digit designates a state within the indicated geographic area . . . a portion of a densely populated state . . . or two sparsely populated states.

6158

The third digit pinpoints a large city or a postal sectional center.

The fourth and fifth digits indicate a specific delivery zone--part of a multicoded city or a smaller town.[1]

Explain use of National Zip Code Directory

Have several copies of the National Zip Code Directory in the classroom

Use the National Zip Code Directory and transparencies Mailing TM-8 and Mailing TM-9 to explain how to locate a Zip Code whether in the state list of post offices or in an appendix

Introduce city Zip Code directories

If the area is large enough to have a city Zip Code directory, obtain one from the post office and show the students how to locate a Zip Code in it (Several will be needed in the laboratory for use throughout the year.)

If there is no city directory for the area, obtain one from a city that is near-by so that the students will be familiar with one

Call the local post office to locate the Zip Codes of new streets that are not listed

Give the students a list of addresses and have them locate the correct Zip Code for each (Throughout the year probably some jobs done in the laboratory will require the students to locate Zip Codes.)

Show students how to emboss an address on a metal plate

Single space the address

Begin embossing on line two of the plate

Place the city, state, and Zip Code on the last line of the address

Show transparency with two-letter state abbreviations, Mailing TM-5

Use two-letter state abbreviations, typed in capitals with no period afterwards

Post a copy of the abbreviations by the Embossing Machine for reference (These abbreviations have been approved by the post office to be used with Zip Code. They may be read by the Optical Character Reader.)

Space two times after the state abbreviation and type the Zip Code

After the demonstration of the Embossing Machine, each student will use this information as he embosses plates.

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[1]ZZZZZZZIP Code (Stamford, Conneticut: Pitney-Bowes, Inc., 1966), p. 5.

Resource Material

Current newspaper and periodical articles about Zip Code or Optical Character Reader

United States Post Office Department, "How to Address Mail," Excerpts from Chapter I, Postal Manual, POD Publication 28 (Washington, D. C. 20260: United States Postal Department, July, 1966).

Robinson, Jerry W. "The Marriage of ZIP and OCR," Typewriting News, (Spring, 1969), 3-4.

Transparency Masters 1, 3, 5, 8, and 9 From "Handling the Mail" prepared by Mrs. Mavis Sparks, Instructional Materials Laboratory, University of Kentucky, Lexington.

United States Post Office Department. Mr. Zip. Washington: Government Printing Office, 1968.

ZZZZZZZIP Code. Free brochure. Walnut and Pacific Streets, Stamford, Connecticut 06904: Pitney-Bowes, Inc.

6155

CLASSES OF MAIL, POSTAL SERVICES AND PRIVILEGES

Objectives

To help the students to identify the different classes of mail

To give the students practice in using postal services and privileges

To teach students the proper way of packaging and wrapping

To acquaint the students with the outlook for employment in post office occupations

Time Two or three class periods (will be longer if field trip is taken)

Presentation

Share with the students a brief historical development of postal services (Excellent information may be obtained from most encyclopedias, along with some good illustrations.)

The information and materials which follow were prepared by Mrs. Mavis C. Sparks, Specialist in Business and Office Education, University of Kentucky, in her unit, "Handling the Mail," Office Practices, January, 1968, and is used with her permission.

(Show transparencies while presenting the material prepared by Mrs. Sparks.)

Types of postal services

a. Domestic mail
   - -- Mail within, among, and between the U. S. and its territories and possessions; Army, Air Force and Navy post offices; and the United Nations
   - -- Includes first class and airmail, air parcel post, second class, third class, and parcel post
   - -- Weight limit, 70 pounds
   - -- Minimum size applicable to all classes, 3 by 4½ inches
   - -- Sending facilitated by zip coding (see "Mailing Transparency Masters" Mailing TM-1 and -3
b. Special services
   - -- Protection and individual treatment of pieces of mailing granted special consideration by payment of extra postage
   - -- Include special delivery, special handling, registered mail, certified mail, collect on delivery, and insured mail
c. Foreign mail
   - -- Mail outside the U. S. and its territories and possessions
   - -- Rates on surface mail and airmail to Canada and Mexico same as for domestic mail within U. S.
   - -- Other rates and weights were revised January 7, 1968
d. Other services
   - -- Mailing supplies sold
   - -- Tracing mail
   - -- Recalling mail

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Classes of domestic mail

a. First-class mail (See "Mailing Transparency Master" No. 10.)
   -- Includes
      1) Handwritten or typed letters and photocopies or carbon copies
      2) Bills, checks, punched cards, forms, etc., in partly written form
      3) Typewritten reports and documents
      4) Matter sealed against inspection
      5) Postal cards and post cards (single and double)
      6) Business reply cards and envelopes
      7) Airmail up to 8 oz. (sealed and unsealed)
   -- Will be forwarded or returned at no extra charge
   -- See "Special services" section for service applicable
   -- Rates applicable January 7, 1968 (See "Mailing Transparency Master" No. 10.)
   -- Permits sealing of:
      1) Parcels and envelopes wider than five inches or longer than 11½ inches
      2) Merchandise, books, or catalogs in envelopes smaller than 5 by 11½ inches (if contents are indicated on the outside)
      3) Require additional postage for forwarding
b. Second-class mail
   -- Applies to newspapers and periodicals
   -- Is granted to publishers and news agencies by application, payment of required fees, and compliance with regulations
   -- Rates
      1) Lower than third class and parcel post
      2) Transient rate charged when necessary to forward out of town
      3) Rates applicable January 7, 1968 (See "Mailing Transparency Master" No. 11.)
c. Third-class mail (See "Mailing Transparency Master" No. 12.)
   -- Includes
      1) Circulars and advertisements
      2) Unsealed greeting cards without written-in messages
      3) Books and catalogs having 24 or more pages
      4) Hotel keys and identification devices mailed without cover
      5) Other matter that cannot be classified as first or second class mail that weighs up to 16 oz.
d. Fourth-class mail (parcel post)
   -- Used for sending merchandise, books, printed matter, and all other mailable matter not first, second, or third class that weighs 16 oz. or over
   -- Limits weight and size according to delivery zone
   -- May be sent sealed or unsealed (sealing implies consent to postal inspection)
   -- Requires additional postage to forward; if undeliverable, may be returned to sender for postage due
   -- Rates determined by weight and distance transported; zones and rates applicable January 7, 1968. (See "Mailing Transparency Master" No. 14.)
e. Mixed classes of mail or combination mailing
   -- The practice of sending two classes of mail together as a single mailing so that they will arrive at the same time
   -- Postage paid on the two classes at their respective rates; sending by the lower class method
   -- "First-Class Mail Enclosed" must be typed, written, or stamped below the postage and above the address.
      "Mailing Transparency Master" No. 15.

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Special mailing privileges

a. Controlled circulation
   -- Applies to publications of 24 or more pages, circulated free or mainly free
   -- May not be forwarded, but can be returned to sender when so requested and address is known
   -- Rates
b. Official mail
   -- Allows government offices and personnel to send official mail without placing postage on envelopes or packages
   -- Charges estimated periodically and the Post Office Department reimbursed in a lump sum
   -- Requires stamps for special services, such as special delivery and airmail
c. Free mail
   -- Mail sent without postage by the general public
   -- Includes
      1) Matter for copyright
      2) Census mail, immigration and naturalization service mail, and absentee ballot envelopes from members of the Armed Forces
d. Franked mail
   -- Requires a real or facsimile signature of the sender in place of the stamp and the words PUBLIC DOCUMENT--FREE on the address side
   -- Used by the Vice President, members and members-elect of Congress, Resident Commissioners, and the Secretary of the Senate
   -- Privileges cease shortly after expiration of term of office
e. Penalty mail
   -- Used for official government correspondence
   -- Name comes from the note in stamp position: Penalty for Private Use to Avoid Payment of Postage $300
f. Mail for the blind
   -- Some free; other at nominal rates

Special mailing services (See "Mailing Transparency Master" No. 16.)

a. Special handling
   -- Applies only to parcel post
   -- Provides the most careful handling and transportation available
   -- Does not provide special delivery to the addressee
   -- Fee, in addition to regular postage, varies according to weight; no extra charge for forwarding
b. Special delivery
   -- Gives first-class mail promptness plus immediate delivery from the post office to the addressee
   -- Applies to all classes of mail
   -- Requires repayment of full fee if necessary to forward, unless request is made at time of mailing
c. Registered mail
   -- Applies to all classes
   -- Requires tight sealing by a method other than transparent tape
   -- Provides reimbursement for the full value of the article up to $10,000 if no commercial or other insurance is carried
   -- Moves from post office to post office in a locked pouch and is checked and accounted for at each post office and at delivery

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d. Insured mail
   -- Applies to third and fourth class mail
   -- Reimburses up to $200 if article is lost or stolen
e. Certified mail
   -- Provides the sender with a receipt by which a piece of mail may be traced
   -- May provide restricted delivery and return receipts
      1) Assures delivery to addressee only when mail is registered, certified, or insured for more than $10
      2) Gives legal evidence that the addressee actually received the piece of mail
   -- Gives the letter an appearance of importance and urgency
   -- Provides evidence of mailing
f. Collect on delivery (C.O.D.)
   -- Obtained by paying a fee plus the regular postage
   -- Rate varies with amount to be collected, weight of package, and distance
   -- Maximum amount collectible on one package--$200
   -- Available only on bona fide order or agreements made between the addressee and the mailer
g. Certificate of mailing
   -- Gives proof that the mail was put in the post office

Other services

a. Mailing supplies sold
   -- Stamps
      1) Available in sheet, coil, or booklet form
      2) Can be exchanged at full value when incorrect denomination is purchased or when damaged
   -- Precancelled stamps and envelopes
      1) Save cancelling time at the post office
      2) Can be used only by persons and companies who have been given a permit
      3) Can be used only at post office where purchased
   -- Stamped envelopes and cards
      1) May be purchased individually or in quantity lots
      2) May include return request and return address when ordered in quantity lots
      3) Postal cards available in single or double form (airmail postal cards, single form only)
      4) Exchange on unserviceable and spoiled envelopes and cards given in stamps, stamped envelopes, or postal cards (not cash)
b. Tracing mail
   -- Requires a written request to the post office
   -- Very difficult to trace mail that is not insured, registered, or certified
c. Recalling mail
   -- Requires filing a Senders' Application for Withdrawal of Mail and paying for all expenses incurred: telegrams, phone calls, return postage, etc.
   -- Will notify sender if mail has already been delivered, but will not inform addressee of recall request

Packaging and wrapping (See "Mailing Transparency Masters" Nos. 24 through 27.)

a. Use a container strong enough to retain and protect the contents during the normal course of mailing.
   -- For breakable items: boxes or cartons of fiberboard, kraftboard, chipboard (for small items), fiber mailing tubes with metal ends, metal, and wood
   -- For unbreakable goods not likely to be damaged by the weight of other mail: heavy wrapping paper, burlap or similar cloth
b. Use cushioning materials to protect the items from outside impact and from damaging one another.
   -- Always keep the container full unless the package contains specially designed padding.
   -- Use cellulose materials, cotton, clothing, shredded paper, or tissue paper for packing lighter items.
   -- Cushion heavy articles with excelsior, flexible corrugated fiberboard, or felt.
   -- Do not pack heavy and lightweight items in the same compartment.
   -- Pack heavy items so they will remain in a fixed position.
   -- Cushion fragile articles individually.
c. Use outside wrapping paper at least equal in quality and strength to a grocery bag.
   -- May omit outside paper wrappers if the box used constitutes an adequate shipping container.
   -- Do not use thin paper bags of two or more thicknesses of thin wrapping paper.
d. Fasten or close with strong twine or rope, tape, staples, or glue.
   -- Tape should be durable enough to withstand 60 pounds minimum pressure or should be the reinforced type.
   -- Staples may need to be reinforced by tape, twine, or glue.
   -- Glue should cover at least 50 percent of the area of contact when it is used and should hold firmly.
e. Mark or label packages appropriately.
   -- Mark <u>Fragile</u> when containing articles of delicate nature, such as glass, chinaware, electrical appliances, jewelry, musical instruments and radios.
   -- Mark <u>Perishable</u> when containing products which decay quickly, such as fresh meats, fresh fruits, and vegetables.
   -- Use <u>Rush</u> or <u>Do Not Delay</u> special delivery and special handling packages only.
   -- Use <u>Do Not Blend</u> or <u>Do Not Fold or Crush</u> only when content is fully protected by stiffening material.
   -- Cover or completely mark out old markings or labels when reusing a carton for mailing.
f. Weighing and determining amount of postage (Se "Mailing Transparency Master" No. 28.)
   -- Read postage scales accurately.
   -- Apply appropriate rate and zone chart for class of mail involved.

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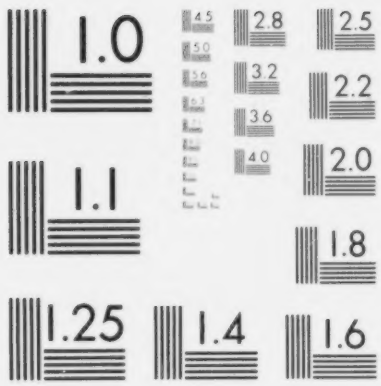

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Supplementary Suggestions

Show films, If the Mail Stopped (28 minutes) and River of Mail (10 minutes), in color, free. Contact your local postmaster or write to
Motion Picture Branch, Room 2507
United States Post Office Department
Washington, D. C. 20260

Have students package and wrap parcels in the laboratory and determine correct amount of postage for each. (Near the holidays perhaps the students could wrap parcels for mailing for teachers and others.)

Take the students on a field trip to the post office. If in an area where there are branch post offices, be sure to go to the main post office on the field trip. It will prove to be more interesting because of the size and volume of mail and the amount and size of machinery.

Discuss jobs related to the post office. Have a copy of the Occupational Outlook Handbook in the classroom. Show the students the section on post office occupations and share with them briefly some of the information. Keep the book where the students may refer to it when they desire. (Occupational Outlook Handbook may be ordered from the Government Printing Office, Washington, D.C. 20402. Separate reprints may be ordered for post office occupations.)

Resource Material

"Post Office," The World Book Encyclopedia, XV, Chicago: Field Enterprises Educational Corporation, 1970, pp. 624-630.

United States Department of Labor. "Employment Outlook for Post Office Occupations," Occupational Outlook Handbook. Washington: Government Printing Office, 1968.

129 Timely Mailing Tips, Free from the local Pitney-Bowes office or Pitney-Bowes, Inc., Walnut and Pacific Streets, Stamford, Conneticut 06904.

Post Office Department Publications
Mail for Servicemen, POD Publication 118, August, 1969
Domestic Postage Rates, Fees and Information, POD Notice 59, July 14, 1969
International Mail, POD Publication 51, May 1, 1967
"How to Pack and Wrap Parcels for Mailing." Excerpts from Chapter 1, Postal Manual. POD Publication 2, November, 1968
"New Domestic Postage Rates and Mail Classification Changes," Reprint from Postal Bulletin No. 20624, dated 12-28-67

6162

BULK RATE MAIL

Objectives

To help the students to understand the meaning of bulk rate mail

To teach the students to sort, bundle, and label bulk rate mail properly

Time One class period (Preferably this would be the day before the students would work on an actual job in the laboratory using this information.)

Presentation

Explain that the bulk rate is applicable to mailings of separately addressed identical pieces in quantities of at least 50 pounds or 200 pieces and that each piece may weigh up to but not including 16 ounces and all pieces in the mailing must be identical in size, weight, and number of enclosures.*

A $30 bulk rate mailing fee is charged for each calendar year.

A permit may be obtained at the post office.

Prepaid postage must be by one of the following:

Permit imprints
Meter stamps
Precanceled stamps
(Show example of each and identify.)

Sort, bundle, and label

Explain the procedure according to the information attached (How to Prepare Second and Third Class Mailings, POD Publication 21, April, 1969, can be obtained from The Louisville Post Office.)

Select suitable envelopes that the students addressed earlier in the year while using the Addresser-Printer (These envelopes may be used to demonstrate the correct procedure.)

Have other materials for the students to use while learning to prepare bulk rate mail

Obtain, if possible, several jobs from organizations and businesses that send out a bulk rate mailing periodically (This will provide use of their acquired knowledge about bulk rate mail throughout the year. Possible sources for jobs are a PTA that sends out newsletters or a civic organization that sends out a bulletin or newsletter.)

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*United States Post Office Information Sheets concerning Bulk Rate Mail follow the unit.

Explain use of form 3602

This form must be prepared in duplicate and presented with the mailing.

A copy should be obtained from the post office and the students shown how it would be filled out according to the envelopes that they have been working with while learning to sort, bundle, and label.

Give information concerning postage of bulk rate mail

Postage must be paid prior to or at the time of the mailing.

Deposits may be made in advance to cover mailings.

Details concerning the specifics of obtaining a permit and the specifications required by the holder of the permit have been omitted. The supervisor or an individual in a higher position would probably be the one to purchase the permit and make sure that the mail met the necessary specifications.[1] However, employees in the mail room would probably have the responsibility of sorting, bundling, and labeling the bulk rate mail.

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[1]United States Post Office Department, "Mailing Permits"--Excerpts from Chapter I, Postal Manual, POD Publication 13 (Washington, D. C. 20260: United States Postal Department, July, 1966.)

UNITED STATE POST OFFICE
Louisville, Kentucky 40201

The bulk rate is applicable to mailings of separately addressed identical pieces in quantities of at least 50 pounds or 200 pieces. Each piece may weigh up to but not including 16 ounces and all pieces in the mailing must be identical in size, weight, and number of enclosures.

A bulk mailing fee of $30 is required for each calendar year.

The rate for circulars, miscellaneous printed matter, and merchandise is 22¢ per pound with a minimum charge of 3.8¢ per piece (2.76 ounces or less). The rate for books and catalogs having 24 or more bound pages (with at least 22 printed) is 16¢ per pound, with a minimum of 3.8¢ per piece (3.8 ounces or less). If your total bulk mailings at all post offices exceed 250,000 pieces in the calendar year (last six months of 1969), the minimum charge per piece is 4¢ (2.90 ounces or less for circs., etc., 4.00 ounces or less for books, etc.).

Postage must be prepaid by one of the following methods:

1. Permit Imprints ($15 application fee required)
2. Meter Stamps ($15 permit may be needed)
3. Precanceled Stamps

A permit to use any of these methods may be obtained in the office of Postal Information, Room 105, Main Post Office.

PERMIT IMPRINTS

Permit Imprints may be made by printing press, handstamp, lithography, mimeograph, multigraph, addressograph, or similar device. They may not be typewritten or handdrawn. The imprint must be legible and must be of a color that contrasts sufficiently with the paper to make the imprint readable.

Bulk Rate
U. S. Postage
PAID
Louisville, Ky.
Permit No. 0

OR

Bulk Rate
U. S. Postage
PAID
Permit No. 0

Postage in full on the entire quantity must be paid prior to or at the time or mailing. Advance deposits to cover a number of mailings may be made at Window No. 18 in the main office lobby, (hours 8:00 AM to 4:30 PM, Monday thru Friday), or check may be mailed to "Postmaster, Louisville, Kentucky 40201". If deposits are made by check a bank guarantee of the account will be required.

The mail must be presented at the Weighing Section, Door No. 1, rear platform, main post office (hours 8:30 AM to 5:00 PM, Saturday, 8:00 AM to noon). Each mailing must be accompanied with a statement, Form 3602, prepared by typewriter, ink, or indelible pencil, bearing hand-written signature in ink or indelible pencil. One receipt may be obtained by presenting a duplicate copy.

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Mail bearing permit imprints must not be sidtributed otherwise than through the mail. It must not be used as enclosures.

WITH METER STAMPS

When postage is paid with meter stamps the words "Bulk Rate" or the abbreviation "Blk. Rt." Must be included. If meter will not print correct amount (such as 3.8¢) then the next lower value which can be recorded by meter (such as 3¢) should be printed together with an inscription showing additional amount paid, as for example, "Add'l .8¢ Pd." The additional amount due under this arrangement must be paid by advance deposit, as is done with permit imprint mail. This means that an imprint type permit (a permit to mail without stamps affixed) must be obtained. In these instances a separate statement of mailing (Form 3602) must be filed (in addition to Form 3602-PC) showing amount of additional postage paid.

When meter stamps are placed directly on the mail, omit the date. If tapes are used the month and year must be shown.

Metered mail partly paid by advance deposit must be mailed at the Weighing Section, Main Post Office. If fully paid with meter stamps it may be mailed at any branch or station of the Louisville post office; each mailing accompanied by a statement of mailing on Form 3602-PC.

WITH PRECANCELED STAMPS

When postage is paid by means of precanceled stamps the identifying words "Bulk Rate" must be printedor handstamped in the upper right corner of the address portion. The stamp should be placed adjacent to this marking, or precanceled stamps may be used to hold together the edges of matter mailed without envelopes.

The mail may be presented at the Weighing Section, Main Post Office, or at any branch or station of the Louisville post office. Each mailing must be accompanied by a statement of mailing on Form 3602-PC.

NONPROFIT ORGANIZATIONS

Authorized nonprofit religious, educational, scientific, philanthropic, agricultural, labor, veteran and fraternal organizations or associations may mail at the special minimum rate 1.6¢

Application (Form 3624) to mail as a nonprofit organization must be approved by the postmaster. Nonprofit organizations mailing at special bulk rates must print the words "Nonprofit Organization" or "Nonprofit Org." as part of or adjacent to the postage.

UNITED STATES POST OFFICE
LOUISVILLE, KENTUCKY 40201

HOW TO PREPARE SECOND-CLASS & THIRD-CLASS BULK RATE MAIL

1. ZIP Code each piece.

2. Face all addresses same way.

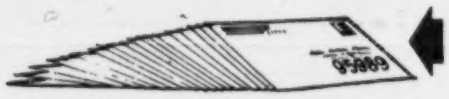

EACH PIECE MUST CARRY ZIP CODE

3. Sort by ZIP Codes.

4. When there are 10 or more pieces (6 or more for second-class) as described below they must be tied together with twine both lengthwise and crosswise.

BUNDLES

3rd CLASS (10 or More Pieces)
2nd CLASS (6 or More Pieces)

5 DIGIT | CITY | SCF (Same First 3 Digits) | STATE | MIXED STATES

BUNDLE AS FOLLOWS:

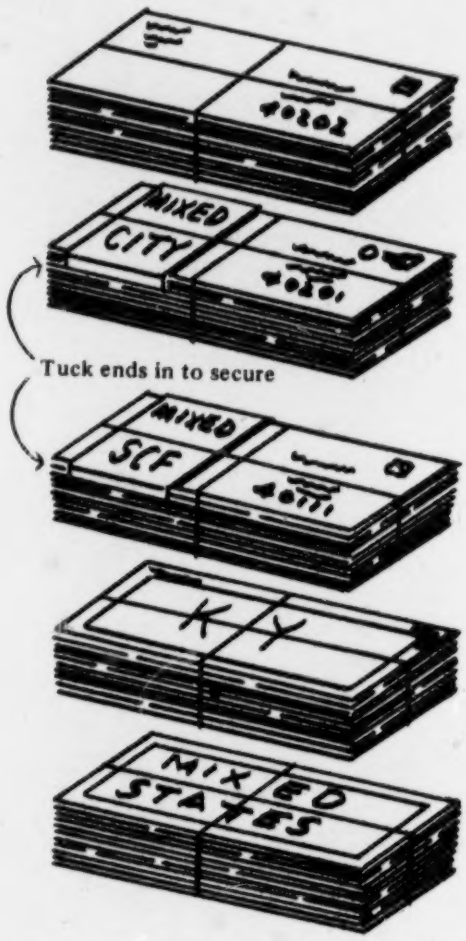

LABEL
Do not label

a. Pieces with same five-digit ZIP Code.

b. Pieces with same first three digits of ZIP Code (multi ZIP Coded cities) — "Mixed City" (Leave top address exposed)

Tuck ends in to secure

c. Pieces with same first three digits of ZIP Code (post offices in same Sectional Center Facility). — "Mixed SCF" (Leave top address exposed)

d. Pieces for same State. — State "(Name)" (Cover address)

e. Pieces remaining. — "Mixed States" (Cover address)

5. When there is a sufficient volume (enough to fill a No. 2 sack 1/3 full) the mail must be sacked and labeled. The weight per sack must not exceed 80 pounds.

SACKS (⅓ SACK OR MORE)

Approx. 1 ft. of mail

5 DIGIT | CITY | SCF | STATE | MIXED STATES

Sample Sack Labels →	Danville KY 40422 Circs Jay Co Louisville KY.	Chicago IL 606 Circs Jay Co Louisville KY	SCF Dayton OH 453 Circs Jay Co Louisville KY	Nashville TN TERM 370 TN Circs Jay Co Louisville KY	DIS Louisville KY 400 Mixed States Circs Jay Co Louisville KY

Letter size mail is labeled "Circs" (Circulars) - Other mail "Ord P" (Ordinary Papers). Sack labels must show the name of the mailer.

Sectional Center Facilities and Multi-Coded cities are listed in the National ZIP Code Directory. Separate lists are available upon request. Further information on any of the above matter may be obtained from the Weighing [illegible] Main Post Office - Phone 582-5526.

Postmaster

UNITED PARCEL SERVICE

Objectives

To develop an awareness of a firm which specializes in the field of small package delivery

To develop an understanding of how UPS operates

To provide information about UPS employment opportunities

Time Three class periods

Presentation

Introduction

Define parcel

Show the class a picture of a parcelman with his vehicle (This may be obtained from the local United Parcel Service office, along with the brochure, "The ABC's of UPS Service.")

Inform students that this company delivers over one million packages a day and ask them to identify this company

Give brief history

1907--a messenger service operating from a basement office with six boys and six bikes was started in Seattle by James E. Casey.

1919--became known as United Parcel Service: United to signify consolidation--Parcel to identify its medium--and Service as a pledge.[1]

Presently offers service to a large portion of the United States

Show the film, "The Parcelman," a 27 minute color film which gives a good overview of the work and organization of UPS (This film may be obtained from the local UPS representative.)

Discuss film

Explain how UPS operates

Note similarities to United States Post Office

Discuss differences from the post office

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[1]Pitney-Bowes UPS Parcel Register System, p. 1.

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Show advantages of UPS

Rates competitive with parcel post rates

Parcelman automatically calls daily to pick up parcels.

Deliveries are made directly to customers.

Handles C.O.D.--cash or check may be requested

Parcelman makes up to three attempts to deliver a package on consecutive delivery days, if necessary, with no extra charge for this service.

Each parcel automatically covered up to $100 for loss or damage at no additional charge with additional coverage for a fee

Shipper may request delivery information.

Compare methods of record-keeping for the shipper (See Transparency UPS-Pickup Record 26411 and 23568.)

By hand

List each individual parcel in the pick-up book including the name, address, and Zip Code of the recipient plus the weight of the parcel

Count the number of packages shipped

Handstamp each parcel

By Parcel Register System

Show the students pictures of UPS Scales and UPS Meters made by Pitney-Bowes (Brochures and pictures of this equipment may be obtained from the local Pitney-Bowes office. Other companies also manufacture UPS Parcel Register Systems. The sale of this equipment is dependent upon the fact that the prospects use the service of another company.)

Make clear that there is no need to list each parcel unless C.O.D. or extra valuation shipment, then use only identifying number

Explain that the machine counts each package automatically and prints a tape for each parcel that shows the shipper number, date, and shipping cost and that there is no need to handstamp

Show students a sample package which has previously been received through UPS and let them examine the tape and the information printed on it

Supplementary Suggestions

Invite a representative from the local United Parcel Service office to come to class and provide answers to questions the students may have about UPS and also, have him explain job opportunities with UPS, qualifications needed, and company benefits

If there is an UPS Operating Center in the area, take the students on a field trip to see it in operation

Resource Material

Pitney-Bowes UPS Parcel Register System, The ABC's of UPS Service.
Contact Mr. William Tinius, Assistant Branch Manager
Pitney-Bowes, Inc.
2804 Crittenden Drive
Louisville, Kentucky 40209

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CIVIL SERVICE

Objectives

To develop an awareness of opportunities for employment by the federal government

To provide an understanding of the procedure for obtaining information concerning the Civil Service examinations

Time Three class periods

Presentation

Introduction to Civil Service

Includes most jobs in state and federal government agencies in the executive branch who are appointed rather than elected

Largest single employer in the United States

Usually covers only those workers included in the Merit System

Selects the best qualified person as demonstrated on a competitive examination

Guarantees an individual that he will keep his job on the basis of good performance instead of allegiance to a political party

Workers in all parts of the United States, territories, possessions, and some other lands hired and assigned by Interagency Board of U. S. Civil Service Examiners

The address and telephone number of the Interagency Board of the Civil Service Commission is listed in the telephone directory under United States Government--Civil Service Commission

Less than 10 employees out of every 100 live in Washington, D. C.

Examinations

Required of applicants

Announced for specific types of positions where there is a need to fill these positions

Sources of information about examinations and announcements

Post Office

Federal Job Information Center

State Employment Services Offices

SF13 6171

Applications available from Interagency Board office in response to call or written request

Notice sent to the applicant by Interagency Board giving the time, place, and date of the examination, some sample questions, and a longer application than the first one--(for those positions requiring a written test)

After first application has been received and processed, examinations according to types of jobs may be written, oral, or a performance test, such as operating a machine, typing, or stenography. (Some examinations do not require a written or performance test. Applicants may be required to show experience or training in a particular field of work or potential to learn or perform in a skill. Some examinations may require only high school graduation in order to qualify.)

Information concerning the jobs, experience or tests required, and how to apply given in examination announcements (Before applying, applicants should read the announcement carefully.)

Examination scores

All applicants notified of their scores by mail

Passing scores

Names of persons who score 70 or better placed on a list of eligibles in order of score, those with highest scores being considered first

Extra points given to veterans; disabled veterans, or their wives; widows of veterans; and dependent mothers of deceased or disabled veterans

Even though one passes, he may reapply at any time while the examination is still open if improvement of score is desired.

One who fails may retake the examination if applications are still being received.

Additional requirements

Minimum age 18, usually, but for most jobs 16 if high school graduate

High school graduate preferred

American citizen

Good physical condition

Must physically be able to perform duties of position

World's largest employer of handicapped people

1718 6172

Benefits

No discrimination against sex, race, or religion

Promotion and transfer privileges

Vacation (earned at the rate of 13 days a year for first 3 years--20 days for next 12 years, and after 15 years 26 days a year)

Paid holidays

Sick leave allowance which can be accumulated without limit until needed (earned at the rate of 13 days a year)

Retirement plan which may be as early as 55 with 30 years of service or as late as 70

Compensation

According to duties and responsibilities under several different pay plans

Extra pay for overtime work

Allowances if the employee must travel or buy uniforms for his job

Supplementary Suggestions

Have students list types of jobs under Civil Service with which they are familiar; add to list as the course progresses

Arrange a display of sample announcements of examinations for several positions, sample applications, and sample examination questions; let the students examine them and ask questions (These samples may be obtained from the nearest Interagency Board office and it is possible to be placed on their mailing list to receive announcements in the future and keep students up-to-date on examinations being given.)

Have books about Civil Service available for the students to examine (Some recommended ones are Intensive Clerical and Civil Service Training by Robert Fisher, South-Western Publishing Company, Cincinnati, 1968; and those printed by the Civil Service Commission. A price list may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402.)

Provide each student with the Civil Service Commission brochure, "Working for the U. S. A." (These may be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.)

Invite a representative of the Interagency Board to come and speak with the classes (This will make federal employment more personal to them.) Have the speaker from the Interagency include information about student summer employment in his presentation; allow time for the students to ask questions

Share with students current periodical or newspaper articles concerning the Civil Service Commission or Interagency Board

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Resource Material

"Civil Service," The World Book Encyclopedia (1970 ed.), XV,469-470.

United States Civil Service Commission. Thinking About Your First Job? Pamphlet 5. Washington, D. C.: U. S. Government Printing Office, 1965.

United States Civil Service Commission. Working for the U. S. A. Pamphlet 4. Washington, D. C.: U. S. Government Printing Office, 1967.

Gregg, John Robert, and others. Applied Secretarial Practice. New York: McGraw-Hill Book Company, 1968. (pp. 153,464)

"Federal Office Assistant Examination: Stenographer, Typist, Clerk and Office Machine Operator--What It Is, and How It Is Given." AN 2400 R3, Washington, D. C.: Superintendent of Documents, U. S. Government Printing Office.

AUTOMATION

Objectives

To develop a basic awareness that automation exists

To help the students understand that our daily lives are influenced by automated equipment

Introduction of unit

Films

This Is Automation is a thirty-minute color film produced by General Electric in which both simple and complex examples of automation range from the manufacture of cookies to the manufacture of cars.

The Information Machine is a ten-minute color film suitable for high school students and gives an amusing account of the development of the computer beginning with primitive man.

Bulletin board

Mount actual punched cards, punched tapes, program sheets, pictures of computers, recent periodical and newspaper articles about automation, and current articles about opportunities for employment in automation

Request the students to bring any current articles on automation that they encounter and add them to the bulletin board

Encourage students to bring items which would be evidence of automation in the community and add them to the bulletin board. (Examples of items would be punched clothing tags, utility bill stubs, receipts with magnetic ink numbers, and other items.)

Terminology

Automation

Define

Develop some understanding of the meaning

Terms used interchangeably with automation

Technology

Mechanization

Electronic

Data processing

0175

History of Computer--a Few Significant Developments

Abacus

Developed by ancient Greeks, Romans, and Chinese

Used as a counting device

Still in use today

Application of punched cards

Developed by Dr. Herman Hollerith in 1880

First used by Census Bureau

Electronic computers

1940--used to solve military problems

Contributed to winning of World War II

Commercial computers

First available in 1951

1952--predicted outcome of presidential election

1954--first computer installed in private industry

1969--now in third generation of computers

A Few Examples of Automation Used by Businesses and Professional People

Banks

Automatic processing of checks

Magnetic ink characters and numbers used to code checks

Magnetic ink characters and numbers used to code deposit slips (Show class actual examples of a check and a deposit slip with magnetic ink characters and numbers)

Processing of loans

Doctors

Automatic answering service

Recording heartbeats

Diagnosis of disease

Medical research

Education

Attendance records

Class scheduling (An explanation may be given of how this and the previous item are done by computer in the Jefferson County School System.)

Budget maintenance

Test scoring

Grade cards

Government

National

Election results

Income tax records

Inventories of defense supplies (Students may add to this list.)

State

State taxes

Processing of car licenses and operating licenses

Local

Tax offices

Post office

City records

Real estate agents

Customer description of house he desires to purchase--price, size, style, basement, and other details

Information matched by computer with houses on the present market having this description

Service companies--billing and address changes

Telephone company

Gas company

Water company

Electric company

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Weather forecaster

Predicting weather conditions

Charting hurricanes

Brochures--Two brochures containing basic information on the computer and data processing are available. Both are approximately twenty pages in length, have clever illustrations, and are written on about a ninth grade level.

"Electronic Data Processing Written for the Layman--What Is Data Processing?" published by National Cash Register

"You and the Computer," a student guide, published by General Electric

Require students to read the brochures

Discuss content of the brochure in class

Conclusion of Unit

Take students to the school office and make arrangements for the secretary to explain in detail how the teletype machine is used to record on tape their attendance records

Evaluate this unit by having the students write several paragraphs giving specific examples of automation as it relates to daily living.

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YOU AND YOUR JOB

General Objectives

To teach methods of finding a job

To teach proper methods of getting the desired job

To teach ways to keep a job

Teacher Information

The book, You and Your Job[1], should be furnished each student. (Funds for these books should be available from service charges collected on jobs done in the laboratory.) The presentation that follows will be suggestions to use with the chapters in the book.

The teacher should keep in mind that:

a. New ways of making things, new things to make, and new patterns of living are continuously causing changes in the kinds of jobs available.
b. An individual is likely to engage in more than one occupation (perhaps several) during his lifetime.
c. Experience carries much less weight now than it did 20 years ago, and education is increasingly becoming more important.
d. An individual may need to be prepared for more than one job.
e. Consideration must be given to changing ideas of the student if his final choice is to be worthwhile.
f. Interest is as decisive as ability in determining career directions and satisfaction.
g. There are many roads to a occupational goal.
h. The student must make his own choice and realize that the decision is his.
i. His choice now may be only tentative. His experiences at this time may not be adequate for him to make any job choice at all. If the student does make a selection at this time, future events may create new interests.[2]

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[1]Walter M. Blackledee and others, You and Your Job (Cincinnati: South-Western Publishing Company, 1967.

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[2]From Mavis C. Sparks unit "Careers in Business and Office Occupation," December, 1967.

Additional Materials and Suggestions for Use with Chapter 1, You and Your Job

Study want ads

Use transparencies, Job Finding TM 3, 4 and 5, and explain the "employment wanted" ad and the kinds of "help wanted" ads shown on the transparencies

Give each student an ad section from the local newspaper and have the students locate an ad of each kind discussed (These ad sections may be saved for later use.)

Employment offices

Give the students the address of the nearest government employment office

Invite a representative of a local commercial employment agency to visit the class (He will be able to share current employment information about the local area and explain the workings of his company. He may challenge the students, and perhaps will encourage them in their endeavors.)

Additional Material and Suggestions for Use with Chapter 2, You and Your Job

Explain the importance of working and the classification of occupations and their interdependence

Distribute copies of excerpt from the unit, "Career in Business and Office Occupations" by Mrs. Mavis C. Sparks, September, 1967 (See Appendix)

If possible, have the following books and brochures in the classroom (Good material for the students to inspect)

The Encyclopedia of Careers & Vocational Guidance
Volume I Planning Your Careers
Volume II Careers & Occupations
William E. Hopke, Editor-in-Chief
Doubleday & Company, Inc., Garden City, N.Y., 1967
in cooperation with J. G. Ferguson Publishing Company, Chicago

Occupational Outlook Handbook, U.S. Department of Labor, Bureau of Labor Statistics, Government Printing Office, Washington, D. C., 1968-1969

Free brochures from General Motors, Public Relations Staff, Detroit, Michigan 48202

Can I Make the Production Team?

Can I Be an Office Worker?

In Planning Your Future, Look First at the Retail Automobile Business

Survey books in the school library that deal with careers, check these books out of the library, and have a display in the classroom

The importance of working[1]

a. By 1975 the U.S. civilian work force will be about 95 million persons working in over 24,000 different occupations.
b. The basic reasons why people must work include providing the necessities--food, clothing, and shelter. Beyond this, people work to provide themselves and their families with the finer things of life.
c. An individual may also work for other reasons unique to himself.

The classification of occupations and their interdependence

a. The major occupational groups into which jobs may be classified[2]
   -- Semiskilled workers (13 million in 1964). Engage in assembling goods in factories; driving trucks, buses, cabs; and operating machinery.
   -- Clerical workers (11 million in 1964). Operate computers and office machines, keep records, and type.
   -- Skilled workers (9 million in 1964). Include carpenters, tool and die makers, instrument makers, all-around machinists, electricians and typesetters.
   -- Professional and technical (8½ million). Include such highly trained personnel as teachers, engineers, physicians, lawyers, and clergymen.
   -- Proprietors and managers (about 7½ million). People who are in business for themselves or manage the operations of commercial, industrial, or public employers.
   -- Service workers. Men and women who maintain law and order, assist profesional nurses in hospitals, give haircuts and beauty treatments, serve food and beverages, and see to it that the public is satisfactorily accommodated in hotels, restaurants, airplanes, ships, and trains.
   -- Sales workers (4½ million). Found in retail stores, wholesale firms, insurance companies, real-estate agencies, and selling wares door to door.
   -- Unskilled workers (3½ million, excluding those in farming and mining). Those who move, life, and carry materials and tools.
   -- Private household workers (5.3 million). Maids, governesses, laundresses, caretakers, butlers.
   -- Farmers and farm managers (2.3 million). Have the help of over 2 million farm laborers and foremen.
b. The places where work is done[3] (Any skill may be sought by a wide variety of employers.)
   -- Manufacturing. New products for industrial and consumer markets and the rapid growth of the defense-space market have spearheaded these industries to employ 17 million, the largest group.
   -- Trade. This major industry group employed 12 million in 1964 in wholesale and retail outlets in large and small cities due to the increasing needs of our urban society.
   -- Government. Employment in government work has grown faster than any other industry. The increases have been greatest in education, health and hospitals, sanitation, and police services. State and local governments account for three-fourths of the employees.

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[1]From Mavis C. Sparks unit "Careers in Business and Office Occupations," December, 1967.

[2]Occupational Outlook Handbook (Washington, D.C.: U.S. Government Printing Office, 1966), pp. 10-11.

[3]Ibid., p. 11.

-- Service and miscellaneous. There have been rapid employment increases in these industries due to rapidly growing needs for maintenance and repairs, domestic service, laundry, hotel service, and other services.
-- Agriculture--Employment has decreased in this industry, which once employed more than half all workers, due to decrease in the number of farms; mechanization; and improved fertilizers, feeds, and pesticides.
-- Transportation and public utilities. A tremendous jump in air and bus travel has offset the declines in the railroad industry. Employment in this industry has dropped 5 percent since 1947.
-- Construction. This industry has an employment increase of 57 percent for the period 1947 to 1964. The nation's growing need for homes, offices, stores, highways, bridges, dams, and other physical facilities brought this about.
-- Finance, insurance, and real estate. Employs 2.9 million.
-- Mining. Employment has fallen off because of labor-saving technological changes and a shift to sources of power other than coal.

Opportunities for work in business[4]

a. Clerical and sales occupations. Those concerned with preparing, transcribing, transferring, systematizing, and preserving written communications and records; collecting accounts; distributing information; and influencing customers in favor of a commodity or service.
   -- Stenography, typing, filing, and related occupations. Concerned with making, classifying, and filing records, including written communications.
      1) Secretaries. Cary out minor administrative and general office duties, in addition to taking and transcribing dictation.
      2) Stenographers. Take shorthand or speedwriting notes by hand or machine and transcribe them.
      3) Typists. Record data by means of a typewriter.
      4) Correspondence clerks. Compose correspondence and related items to obtain or give information.
      5) Personnel clerks. Assist job seekers in filling out application forms; supply information regarding company hiring policies or requirements; investigate applicant's work history to determine suitability for employment; and compile and keep current employment records, such as recruitment, training, promotion, attendance, retirement, and discharge of employees.
      6) File clerks. Classify, sort, and file correspondence, records, and other data.
      7) Duplicating machine operators. Make copies of data by means of machines, such as the Dual-Lith, Multilith, Masterlith, Mimeograph, Dupligraph, Multigraph, Compotype, Graphotype, and Xerox. May duplicate braille printed pages on chemically treated plastic paper.
      8) Miscellaneous office machine operators and stenography, typing, filing, and related occupations.

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[4] Dictionary of Occupational Titles, Volume II (Washington, D.C.: U.S. Government Printing Office, 1965), pp. 5-8, 46-49, 51-65.

-- Computing and account-recording occupations. Concerned with systematizing information about transactions and activities into accounts and quantitative records, and paying and receiving money.

1) Bookkeepers. Compute, classify, and record numerical data to keep sets of financial records complete. Does not include machine operators.
2) Cashiers. Receive and disburse money in establishments other than banks, using adding machines, cash registers, and change makers.
3) Tellers. Disburse and receive money in a bank and record transactions.
4) Automatic data-processing-equipment operators. Those concerned with electronic and electromechanical machines that record, store, process, and transcribe data from punchcards, paper tape, magnetic tape, or other sources; solve mathematical, engineering, or technical problems; keep records; or supply information.
5) Billing machine operators. Operate billing machines with or without computing devices to keep accounts and prepare statements, bills, and invoices.
6) Bookkeeping machine operators. Operate bookkeeping machines to copy and post data, make computations, and/or compile records of transactions.
7) Computing-machine operators. Operate adding or calculating machines to perform arithmetic operations.
8) Account-recording-machine operators. Operate machines to keep quantitative records and accounts.
9) Computing and account-recording occupations, not elsewhere classified.

-- Material and production recording occupations. Concerned with receiving, storing, issuing, shipping, and accounting for stores of material or material in use. Includes assigning locations and space to items, verifying quantity, identification, condition, and value; the physical handling of items, including binning, picking, stacking, and counting; preparing or committing stocks for shipment; inventorying stock; replenishing depleted items; filling orders, issuing tools, equipment, or materials to workers.

1) Production clerks. Route parts for fabricating operations or repairs; schedule work and deliver parts to avoid over-production; compile records and reports on number and types of units produced; and schedule shipment of parts.
2) Shipping and receiving clerks. Assemble, pack, address, stamp, load, and ship merchandise or material; or receive, unpack, verify, and record incoming merchandise or materials.
3) Stock clerks and related occupations. Receive, store, ship, and issue supplies, materials, and equipment in a stockroom or warehouse environment. May take inventories, keep records, and requisition stock.
4) Weighers. Weigh materials or products for the purpose of keeping clerical records.
5) Other

-- Information and message distribution occupations. Concerned with distribution of information and messages by mail, telephone, telegraph, and in person.

1) Messengers, errand boys, and office boys and girls. Run errands; sort and deliver letters, packages, and messages; furnish workers with clerical supplies; and perform similar routine tasks in an office.
2) Mail clerks. Prepare incoming and outgoing mail for distribution. Time stamp, read, and sort incoming mail; and seal and stamp outgoing mail or packages.
3) Post office clerks. Sell postage stamps, postal cards, postal savings certificates, and U.S. Savings Bonds; write money orders; register and insure mail; compute mailing costs; sort outgoing mail; and record daily transactions.
4) Mail carriers. Sort mail and deliver it to private homes and business establishments along an established route.
5) Mail-preparing and mail-handling-machine operators. Operate machines to emboss names, addresses, and other matter on metal plates for use in addressing machines, and similar information on items, such as envelopes, accounting forms, and advertising literature; to address, fold, stuff, seal, and stamp mail; and to address envelopes.
6) Telephone operators. Operate the telephone switchboard to relay incoming and interoffice calls, make connections with outside lines for outgoing calls, establish connections between subscribers, supply information, and calculate long distance charges.
7) Telephone operators. Operate telegraph equipment to transmit and receive signals or messages. Transmit train-delay reports, train orders, etc.
8) Receptionists and information clerks. Answer the telephone and information requests from patrons and inquiries from company employees or from visitors coming into an establishment regarding such matters as activities carried on in an establishment; location of offices and employees within firm, other firms, hotels, stores, and places of interest; and transit service. Keep a record of call callers and nature of their business, make appointments and interview people to secure such information as hospital admittance data.
9) Other occupations in this category.

-- Miscellaneous clerical occupations. Concerned with public contact, such as examining and adjusting claims and records, collecting and tracing accounts, and quoting prices.

1) Collectors. Collect payments on installments or overdue accounts; trace addresses of customers changing residence without notification; and collect money from coin boxes.
2) Adjusters. Investigate and determine the validity of customers' claims or complaints concerning merchandise or service, and arrive at a settlement.
3) Hotel clerks, n.e.c. Register guests, rent rooms, check keys and valuables, distribute mail, and supply information.

4) Direct service clerks, n.e.c. Perform sales service work, involving personal contact with customer, such as furnishing prices on items of merchandise over the telephone; examining returned merchandise to determine if it is represented on sales slip, and crediting customer's account or authorizing cash refund; returning found articles to owners; storing and issuing merchandise to customer on demand.

5) Other miscellaneous occupations in this category.

-- Salesmen of services. Sell real estate, insurance securities, business and financial services, radio and television broadcasting services, hotel services, maintenance and repair services, utilities, and printing and advertising, etc.

-- Salesmen and salespersons of commodities. Sell horticulture and nursery products; agriculture products; foodstuffs, beverages, and tobacco; textiles, textile products, and apparel; leather and leather products; paper and paper products; chemicals and drug preparations; fuel and petroleum products; plastic products; rubber products; stone, clay, and glass products; metal and metal products; house-furnishings; hotel and restaurant equipment and supplies; industrial, construction, mining, and drilling equipment and supplies; farm and garden equipment and supplies, household appliance and electrical machinery, equipment, and supplies.

b. Professional, technical, and managerial occupations (those concerned with the theoretical or practical aspects of such fields of human endeavor as art, science, engineering, education, medicine, law, business relations, and administrative, managerial, and technical work. Most require substantial educational preparation at the university, junior college, or technical level.)

-- Occupations in administrative specializations. Concerned with specialized administrative and managerial functions which are common to many types of organizations. Demand a knowledge of a particular function rather than a knowledge of the operations of an organization. Includes occupations which involve the more routine nonclerical duties or a combination of clerical and administrative work.

1) Accountants and auditors. Examine, analyze, and interpret accounting records for the purpose of giving advice or preparing statements and installing or advising on systems of recording costs or other financial and budgetary data.

2) Budget and management analysis occupations. Study the policies, organizational structures, and administrative practices of such organizations as governmental units, industrial firms, and nonprofit groups; and review periodic budgets submitted by operations personnel. Prepare reports summarizing findings and recommending to line management changes in policy, organization, and administration. Consolidate the budget estimates of several organizational units and prepare a unitary budget itemizing such proposed expenditure as salaries and wages, overhead, and production costs, for consideration and action by upper echelon of management.

3) Purchasing management occupations. Negotiate and contract for the purchase of equipment, products, and supplies for industrial plants, utilities, governmental units, or similar establishments, and purchase merchandise for resale; determine quality to be purchased, costs, delivery dates, contract conditions, sources of supply, and taking inventories.

4) Sales and distribution management occupations. Manage sales and marketing for a manufacturer, retail or wholesale house, jobber, or other establishment. Do market research and analysis; establish and manage a sales organization; and evaluate sales statistics and reports.
5) Advertising management occupations. Influence public consumption or opinion, either as an employee of the organization served or as a member of an agency under contract; manage advertising programs and campaigns; and, in advertising agencies, manage customers' accounts.
6) Public relations management occupations. Promote or create good will for individuals, groups, or organizations by writing or selecting favorable publicity material and releasing it through various communications media, preparing and arranging for displays, making speeches, and performing related publicity efforts.
7) Personnel and training administration occupations. Formulate policies relating to the personnel administration of an organization and conduct programs of recruitment, selection, training, promotion, welfare, safety, compensation, recreation and separation of employees.
8) Inspectors and investigators, managerial and public service. Examine people, animals, plantlife, products, and establishments, in the capacity of city, county, Federal, or private inspector or investigator, for enforcement of health, safety, and other regulatory laws.

-- Other managers and officials.
1) Wholesale and retail trade managers and officials. Concerned with selling merchandise to retailers; to industrial, commercial, institutional or professional users; or to other wholesalers; or acting as agents in buying merchandise for or selling merchandise to such persons or companies.
2) Finance, insurance, and real estate managers and officials. Include managerial occupations concerned with banks and trust companies, credit agencies other than banks, investment companies, brokers and dealers in securities and commodity contracts, and security and commodity exchanges; all types of insurance, and insurance agents and brokers; owners, leasors, leasees, buyers, sellers, agents, and developers of real estate.
3) Service industry managers and officials. Found in hotels and other lodging places; establishments providing personal, business, repair, and amusement services; medical, legal, engineering, and other professional services; nonprofit membership organizations, and other miscellaneous service.
4) Others, agents and appraisers, etc.

-- Occupations in education. Include teaching of commercial subjects at the college, junior college, business school, vocational school, company training school, high school, and junior high school levels, and school administrative positions.

-- Occupations in writing. Opportunities in writing business and financial news for newspapers and magazines, textbooks and related material for schools and colleges, and writing for technical publications within and outside the company.

Clerical occupations predominately held by women[5]

a. With over nine-tenths women
   -- Receptionists
   -- Secretaries
   -- Stenographers
   -- Telephone operators
   -- Typists

Clerical occupations with over four-fifths or more men[6]

a. Agents
b. Baggagemen
c. Collectors, bill and account
d. Dispatchers and starters
e. Express messengers and railway mail clerks
f. Mail carriers
g. Messengers
h. Telegraph messengers

Job families

a. Definition. A group of related occupations having similarities in fundamental work activities; machines used; and experience, training, skills, and personal qualities required of the worker. Varying levels of ability may exist in the jobs which compose the family.
b. Business and office job families
   -- Stenography, typing, filing, and related occupations
   -- Computing and account-recording occupations
   -- Material and production recording occupations
   -- Information and message distribution occupations
   -- Sales
   -- Teaching commercial subjects
   -- Management positions

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[5] Estelle Popham, Opportunities in Office Occupations (New York: Vocational Guidance Manuals, 1964), p. 19.

[6] Ibid., p. 20.

A STUDY OF_____WORK

(MY CHOSEN FIELD OF WORK)

Picture of Person Engaged in

Chosen Occupation

Job Description:

by

_____
Name

_____
Subject

_____
Teacher

_____
School

_____
Address

_____
Date

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WORK

A. Nature of the Work

-- Activities, duties, and responsibilities

-- Machines and tools used, and in what way

-- Special skills used

-- Unusual characteristics of duties

-- Expected changes in the nature of the work due to new machines, products, and processes

B. Place of the Position in the Administrative Structure
(An organization chart may be used here.)

-- Relation to other jobs

-- Relation to the organization as a whole

-- Related positions

C. Status in the World of Work and Employment Outlook

-- History of the occupation

-- Importance of the occupation

-- Importance and relation to society

-- Number of and future need for workers in the U.S., the state, the county

-- Turnover and places where demand for workers in this occupation is greatest

-- Typical place of employment

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D. Personal Requirements for Doing the Work

-- Mental (verbal comprehension, reasoning, number ability, space ability, or mechanical comprehension required)

-- Personality (sociable, energetic, persuasive, careful with details, persistent, etc.)

-- Physical (height, weight, general health status, energy level, personal appearance, posture, voice, and manner of speaking, etc.)

-- Interests (outdoor, mechanical, computational, scientific, persuasive, artistic, literary, musical, social service, clerical)

E. Education and Training Required

-- Kind and level of education necessary (professional, technical, or general; graduate study, college degree, vocational school, high school, grade school; special skills and level of attainment to meet minimum qualifications)

-- In-service training on the job

-- Schools in the area which provide the type of training needed

-- How to gain admission to the type(s) of training needed

-- Limitation on number admitted to special training

-- Length of training in school and on the job

-- Probable cost

F. Methods of Entering the Occupation

-- Certificate, license, or diploma required

-- Types of formal examinations and/or proficiency tests which must be passed (where, when, how, and by whom given)

-- Sources of information concerning openings (special agencies that may assist [illegible]etting a job, etc.)

-- Required memberships in unions and/or professional societies

G. Possible Restrictions on Eligibility (age, sex, height or weight, physical handicaps, personal appearance, other)

H. Working Conditions

-- Hours of work (regular or irregular; overtime)

-- Indoor or outdoor (if outdoor, describe nature)

-- Travel (frequency and distance)

-- Health and accident hazards (noise or quiet; dust, dirt, oil, grease; odors; temperature extremes or sudden changes; dangers)

-- Work pace (busy seasons, constant rush, work against time, work under tension, slow pace and routine work, required output)

-- Changing procedures and creative demands

-- Work with others; alone; in the midst of activity

-- Closeness of supervision and supervisory responsibilities

I. Income, Advancement, and Security

-- Salary (beginning, yearly, monthly; at the end of first year; after five years)

-- Possibilities for promotion (related jobs to which transfer could be made, as a promotion or as a substitute for present job; difference in training or skills required; how to gain entrance)

-- Security offered (probational or tryout period, tenure, seniority, permanency of occupation)

-- Sick leave and vacation policy

-- Retirement (age, types of plans or provisions for, and pay)

-- Special benefits (insurance, hospitalization, company discounts, family recreation areas, etc.)

J. Organizations (Business, Civic, and Professional) to Which One Engaged in This Occupation Can Belong (name, purpose, activities, time and frequency of meetings, local chapter president, dues)

K. Advantages and Disadvantages of the Occupation (not mentioned previously)

L. What I Am Doing to Prepare Myself for This Occupation

M. Why I Think I Will Be Successful in This Occupation

N. Alternate Job Choices

O. Sources of Information Used (Check sources given below. Add extra pages if necessary)

-- Interviews (counselors; school officials; teachers; officers of trade, industrial, professional, and labor organizations; persons working in the occupation)

-- Libraries (college, high school, public, business department)

-- Current magazines

-- School catalogs

-- Material published by the Department of Labor, the state employment service, and/or community organizations

-- Personal visits to offices or plants where acutal work activities were observed

-- Radio and television programs

-- Motion pictures viewed

-- Tryout experiences (part-time or summer work experience)

P. Interview Form for You to Use When Talking with a Person Employed in Your Chosen Occupation

An interview with a _____
(Job title)

_____
Date

Name of Worker_____

Name and Address of Company_____

_____

Duties on the Job: (General and daily, weekly, monthly)

_____ _____

_____ _____

Preparation and Training:

Most helpful school subjects: _____, _____,

_____, _____, _____,

Least helpful school subjects: _____, _____,

_____, _____, _____,

Type of on-the-job training given: _____

_____

_____

Special Requirements:

Personal qualifications needed: _____, _____,

_____, _____, _____,

Physical qualifications needed: _____, _____,

_____, _____, _____,

Employment tests taken: _____, _____

_____, _____, _____,

Advancement opportunities: _____, _____,

_____, _____, _____

Job Details:

Beginning salary _____ Pay periods _____

Working hours_____ Overtime and Saturday work

_____

Availability of jobs_____

Supply of workers available _____

Working conditions _____

_____

Advantages of the job: _____

_____

Disadvantages of the job: _____

_____

Job customs:

Smoking _____ Morale _____ Rest periods ___

Recreation space _____

Coffee hours _____ Sources for snacks _____

_____ Lunch hours _____

Husband and wife employees _____

Dress _____

Sick leave and vacation policy _____

_____

This interview has convinced me that I (would, would not) like to enter this field of work because _____

_____

_____

_____

Suggestions for Use with Chapter 3, You and Your Job

Assemble as many sources of local summer employment as possible and share this information with the students

Have students add sources of local summer employment of which the teacher could have been unaware

Compile a list of sources of summer employment that are out of the local area (Students and teacher should work on this jointly.)

Suggestions for use with Chapter 5, You and Your Job

Have students select an ad from the ad sections available in the classroom (This ad should be about a job that fits in with the occupation that each student has studied. Students should have the teacher's approval of their chosen ad before they proceed.)

After a rough draft of the Letter of Application and Personal Data Sheet has been completed, check it and make any suggestions for improvement

Have students type the Letter of Application and Personal Data Sheet on typing paper as if actually being sent to a company

Additional Materials for Use with Chapter 6, You and Your Job

Obtain as many samples of application blanks as possible

Point out differences in these blanks

Suggestions for Use with Chapter 7, You and Your Job

Invite an individual who interviews employees for his company, professionally, to speak with the classes

Have some students interview each other (This will have to be well planned so that the student playing the role of the interviewer will know about the occupation for which he is interviewing the other student. This could be recorded and played back.)

After the students have written the thank-you letter, have them type the letter correctly, as it would look if they were going to mail it

ED096196

Suggestions for Use with Chapter 8, You and Your Job

Help the students to understand the forms necessary for employment by using transparencies, Job Finding TM 18, 19, 20 and 21 (See Appendix.)

Social Security Card

Employee's Withholding Exemption Certificate and information concerning who qualifies as a dependent

Pay check stub

Obtain the unit, Personal Development and Human Relations, prepared by Mrs. Mavis C. Sparks from the Instructional Materials Laboratory, University of Kentucky, Lexington, Kentucky 40506 (Parts of this unit that will be the most benefical to the students may be used.)

68196197

WHO QUALIFIES AS YOUR DEPENDENTS?

1. Persons who receive more than half of their support from you during the year.

2. Persons who have less than $600 gross income of their own during the year.

3. Persons who are not claimed as exemptions by your husband (wife).

4. Persons who are citizens or residents of the U.S., or are residents of Canada, Mexico, the Republic of Panama or the Canal Zone.

5. Persons who have your home as their principal place of residence and have been members of your household for the entire year.

or

Any person who is related to you as

a. Son, daughter, grandchild, stepson

b. Father, mother, grandparent, stepfather, stepmother, father-in-law, mother-in-law

c. Brother, sister, stepbrother, stepsister, half brother, half sister, brother-in-law, sister-in-law

d. Uncle, aunt, nephew, niece (if related by blood)

Job Finding TM20

0198

ADDITIONAL ACTIVITIES

Speakers and guests from the work world can bring enthusiasm and valuable information to students in the classroom; field trips can provide enriching learning experiences.

Classroom Speakers

Always prepare students before the day that the speaker is to come so that some thought can be given to questions concerning his occupation or company that the students would like to have him answer. Make sure to request each speaker to leave some time after his presentation for a question-answer period or some dialogue between him and the students.

Invite an individual who started to work immediately upon graduation from high school and who has done well in his chosen occupation. Have him share his "success story" with the classes. This will be genuine proof of success and should provide a challenge to the students. Schedule this guest near the beginning of the school year. Later in the year it may be desirable to invite another individual, provided he is another excellent example of success.

Have the School Representative of the local telephone company come to talk with the class about telephone manners and usage. In almost all occupations an individual talks on the telephone to some extent. Ask the School Representative to record the voices of some members of the class and play them back. Discuss their telephone usage. The representative will have special equipment to do this. South Central Bell Telephone Company provides, upon request, a brochure, Lecture-Demonstrations, Booklets, Films, Teaching Aids, and Tours, offering additional services.

The Recruiting Supervisor from the local telephone company will come to inform the students about the kinds of jobs available in the telephone business. Most students will be unaware of all but the most common ones, such as, telephone operator and lineman. Usually this individual does some interviewing for the company and can give excellent suggestions about the necessary qualifications, interviews, and applications.

A personnel manager of any large business or industry in the area can provide the students with information concerning the different kinds of jobs available in his organization, qualifications required for the jobs, and desirable work habits. If more than one large company or industry is in the area, the personnel manager can be scheduled at intervals during the year.

The local Pitney-Bowes office can acquire their latest films on equipment. Invite a representative to show several of these films to the students. These films expose students to newer and larger machines than are in the laboratory. After showing the films, the representative may talk with the students about the kinds of jobs available with Pitney-Bowes, and necessary qualifications and training.

Field Trip

Preparation is also necessary before field trips are taken. The day before the trip, try to generate interest and enthusiasm. Point out to students anything which should be given special attention during the trip. The day after the field trip have a follow-up discussion.

Arrange a field trip to Pitney-Bowes later in the year to see their display of equipment. Employees of Pitney-Bowes will demonstrate the operation of the machines. Students find this informative and interesting.

Supplementary Work

Since the volume of work may not be uniform throughout the year, the teacher may need short-term activities for use when there are no jobs available.

The number and the volume of jobs may vary from year to year. The following short-term activities may be used when time permits.

Interaction Briefs. This is a topic in each issue of Today's Education (National Education Association Journal). Three have been used and were very interesting to the students: "An Experiment in Communication (September, 1969); "An Experiment in Cooperation" (October, 1969); and "Looking at Leadership" (January, 1970). It is likely that in the future additional ones will be printed that will be applicable to any classroom.

Cross Media Kit on Consumer Education. This kit includes a sound filmstrip, Getting Credit; transparency masters; lesson plans; worksheets; and a teacher's manual. It is quite possible that the A-V Librarian has it or may get it from the NEA Publications Division.

Consumer Finance. A teacher's kit which contains all the material needed for a one-week teaching unit on comsumer finance may be ordered from
Educational Services Division
National Consumer Finance Association
1000 Sixteenth Street, N. W.
Washington, D. C. 20036

Filing. This may be developed by the individual teacher or "Gregg Quick Filing Practice Set" may be used.

Caring for Your Money. This unit could include budgeting, process of opening a bank account, proper way to write checks, bank reconciliation and banking services.

Resource Material

Books

Andrews, Margaret E.
About Her, About Him, The Job You Want.
St. Louis: McGraw-Hill Book Company, Inc., 1968.

Units prepared by Mrs. Mavis C. Sparks, Instructional Materials Laboratory, University of Kentucky, Lexington, Kentucky 40506.

Finding and Applying for a Job, May, 1968
Personal Development and Human Relations, March, 1967
Transparency Masters--Finding a Job, May, 1968
Handling the Mail, April, 1968.

Periodicals

Daiger, Richard H. "Instant Replay--A New Technique for Teaching the Job Interview," Business Education Forum, 24 (December, 1969), 3.

Andrews, Margaret. "Job-Readying the Special-Needs Student," Business Education World, Volume 50 (January-February, 1970), 6-7.

Free Brochures

Getting the Right Job--Glidden-Durkee, 900 Union Commerce Building, Cleveland, Ohio 44115.

Helpful Hints for Young Job Seekers--South Central Bell Telephone Company, Employment Office, 521 West Chestnut Street, Louisville, Kentucky 40202

Job Hunting Hints--Louisville Gas and Electric Company, 311 West Chestnut, Louisville, Kentucky 40202

Can I Get the Job?--Public Relations Staff, General Motors, Detroit, Michigan 48202.

Films--a series on jobs, Coronet Films.

Your Job: Finding the Right One
Your Job: Applying For It
Your Job: Fitting In
Your Job: Good Work Habits
Your Job: You and Your Boss
Your Job: Getting Ahead

APPENDICES

TIPS FOR USING THE TRANSPARENCY MASTERS[1]

Making Transparencies from the Masters

To make transparencies from the following pages in only a few seconds, just run the master in contact with a transparency film on top of the master (with the notch in the upper right hand corner) through a dry photo copy machine. Color may be added by using special transparency films, special colored pencils, or special marking pens.

Additional masters may be made by using a typewriter and a Number 2 pencil. Multilith copies and illustrations printed in permanent or carbonbase ink will also copy.

Using the Transparencies Effectively in Classroom Presentations

The transparencies should be used to promote more vivid understanding of the content being presented. They should help clarify points and should be selected carefully so that they will contribute to the smooth flow of instruction rather than being thrown in as a gimmick.

The following suggestions will enable the teacher to gain more satisfactory results from using the transparency as a teaching tool:

1. Use a pointer at the transparency to direct attention to a detail; the pointer will show on the screen.

2. Use a grease pencil or a china-marking pencil to add details or mark points while the transparency is being projected for discussion. The marks may be wiped off later with a soft dry cloth or a piece of paper. (A white grease pencil will not show on the hands or face.)

3. Control the rate of presentation by covering the transparency with a piece of paper and exposing each point of information as you are ready to discuss it. Presenting one line or column at a time is helpful.

4. Use overlays to break complex ideas and present them in the proper order.

5. When writing on transparencies, eliminate glare by using a sheet of paper to cover the transparency below the writing surface. Light around a transparency may also be eliminated by taping paper on the base of the projector (if frames are not used).

6. Insure exact alignment of overlays by placing small crosses on the overlays at the points where they should be matched with the basic transparency to provide a margin against which overlays may rest as a guide to placement.

---

[1]Mavis C. Sparks, "Transparency Masters, Handling the Mail." (Lexington, Kentucky: Instructional Materials Laboratory, Division of Vocational Education, Office of Education, University of Kentucky, April, 1968))

Hi, FOLKS -

I'M MR. ZIP

THE 10 ZIP CODE NATIONAL *

GEOGRAPHICAL AREAS

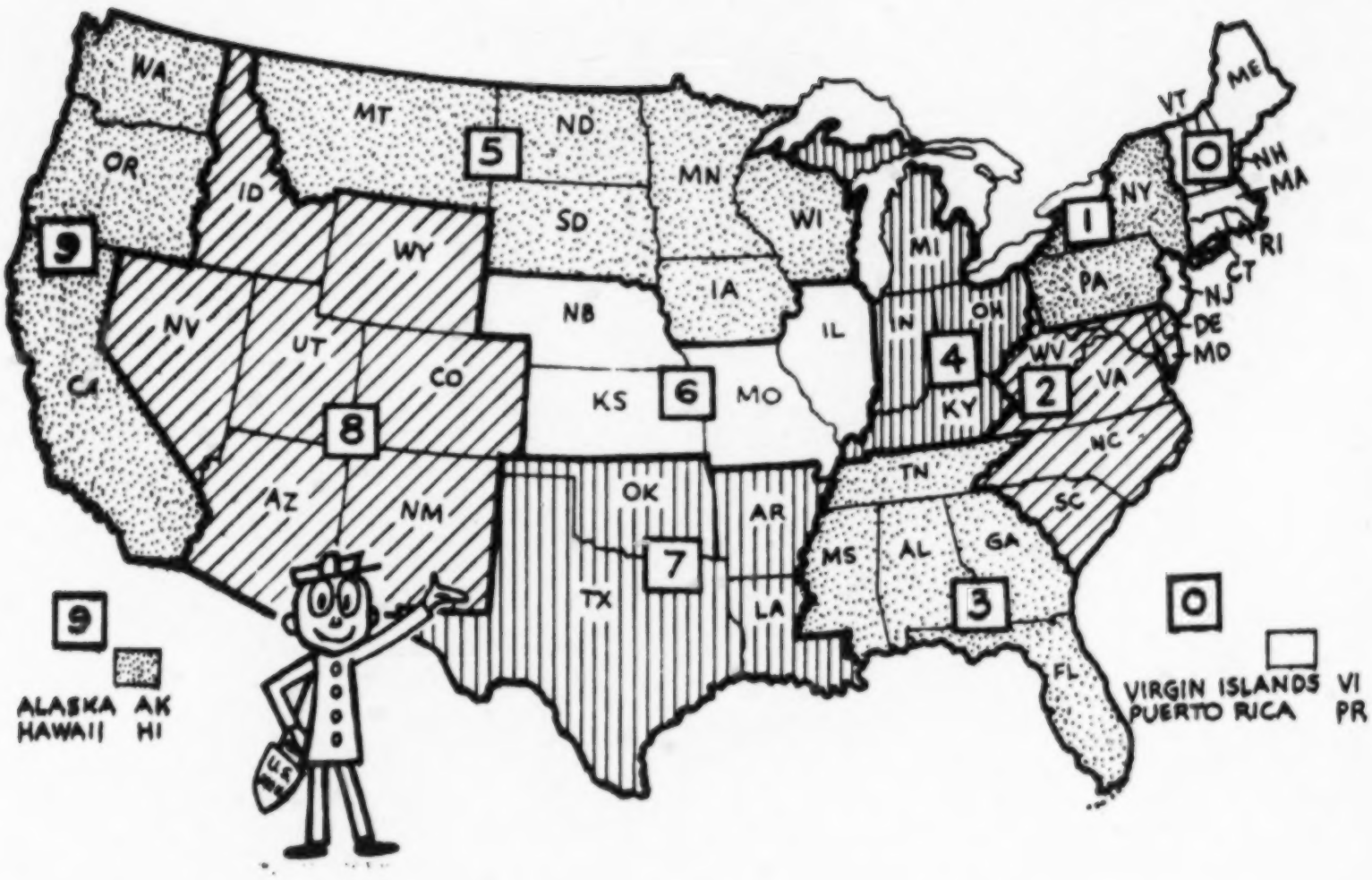

The numbers on the map represent the first number of the zip code and identify the geographical area.

*U. S. Post Office Department, National Zip Code Directory: Washington, D.C.: U. S. Government Printing Office.

ZIP CODE NATIONAL AREAS Mailing TM - 3

T. VANTREESE, INST. MATL. LAB., U.K.

6205

SPECIAL TWO-LETTER STATE ABBREVIATIONS

AUTHORIZED FOR USE WITH ZIP CODE *

Alabama	AL	Montana	MT
Alaska	AK	Nebraska	NB
Arizona	AZ	Nevada	NV
Arkansas	AR	New Hampshire	NH
California	CA	New Jersey	NJ
Colorado	CO	New Mexico	NM
Connecticut	CT	New York	NY
Delaware	DE	North Carolina	NC
District of Columbia	DC	North Dakota	ND
Florida	FL	Ohio	OH
Georgia	GA	Oklahoma	OK
Guam	GU	Oregon	OR
Hawaii	HI	Pennsylvania	PA
Idaho	ID	Puerto Rico	PR
Illinois	IL	Rhode Island	RI
Indiana	IN	South Carolina	SC
Iowa	IA	South Dakota	SD
Kansas	KS	Tennessee	TN
Kentucky	KY	Texas	TX
Louisiana	LA	Utah	UT
Maine	ME	Vermont	VT
Maryland	MD	Virginia	VA
Massachusetts	MA	Virgin Islands	VI
Michigan	MI	Washington	WA
Minnesota	MN	West Virginia	WV
Mississippi	MS	Wisconsin	WI
Missouri	MO	Wyoming	WY

Standardized abbreviations are also provided for post office names with more than 13 characters. A copy may be obtained from your local post office.

*National Zip Code Directory.

LOOKING UP ZIP CODES

(Excerpts from the National Zip Code Directory; smaller city directories may be obtained.)

State List of Post Offices — Kentucky

Post Office	Zip Code
Scranton	40373
Scuddy	41760
Sebastians Branch	41370
Sebree	42455

Appendix — Zip Code 405

Lexington

Post Office Boxes, Stations, Branches

Box Nos.	Stations	
1-2599	Main Office Boxes	01
4001-4499	Gardenside sta.	04
7001-7160	Henry Clay sta.	02

Apartments

Beaumont Cabana	04
Continental	03
Cooperstown	08

Buildings

American Mutual Building 496 Southland Drive	03
Bank of Commerce Bldg. 107 Cheapside	07

Colleges & Universities

Lexington Theological Seminary, 631 S. Limestone	08
Transylvania College 201 West 3rd Street	08
University of Kentucky Limestone & Euclid	06

Hospitals

Cardinal Hill Convalescent Hosp, 1856 Versailles Road	04
Central Baptist Hospital, 1740 S. Limestone	03

Rural Routes

1	03
2	04
3, 4 & 6	05
5 & 7	02

Excerpts from the National Zip Code Directory (contd.)

Named Streets	
Abbott Rd	02
Abelia Lane	04
Aberdeen Dr	03
Adair Rd	02
Adams	08

Numbered Sts., Aves., Etc.	
2nd, E	08
2nd, W	
100-399	07
400-out	08
3rd, E	
100-599	08
600-699	02
700-out*	05

*"out" appearing after a street number means this number and all higher numbers should bear the ZIP Code shown.

FIRST-CLASS MAIL

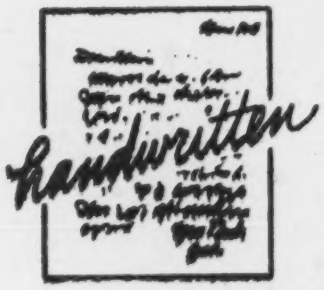

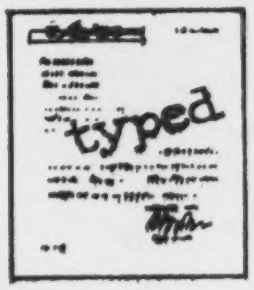

LETTERS

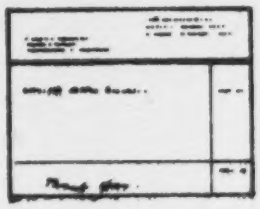

BILL

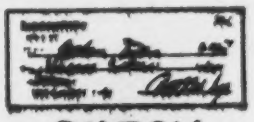

CHECK

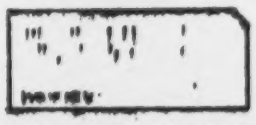

PUNCHED CARD

MATTER IN PARTLY WRITTEN FORM

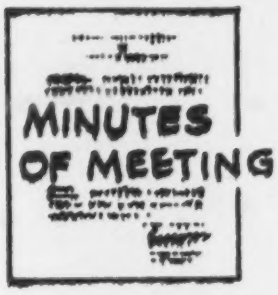

TYPEWRITTEN REPORTS AND DOCUMENTS

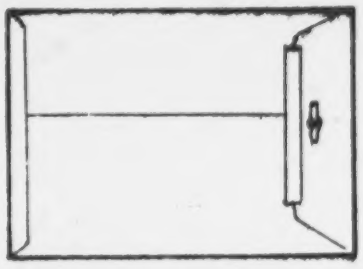

MATTER SEALED AGAINST INSPECTION

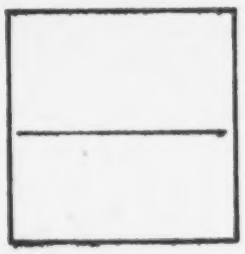

SINGLE And DOUBLE POST And POSTAL CARDS

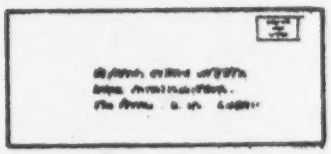

BUSINESS REPLY CARDS AND ENVELOPES

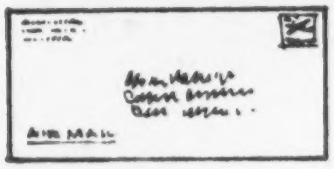

AIR MAIL

6¢ An Ounce; Airmail 10¢ An Ounce
Forwarded or Returned at No Extra Charge

FIRST-CLASS MAIL
T. VANTRESSE, INST. MATL. LAB., U.K.

6209

SECOND-CLASS MAIL

Within county of publication, the rate per pound or fraction of a pound:*

Beginning —		
Jan. 7, 1968	Jan. 1, 1969	Jan. 1, 1970
1.3¢	1.4¢	1.5¢

.24 minimum change per piece

Outside county of publication, the rate per pound or fraction of a pound varies by zone and whether advertising is included.

Special rates may be obtained by religious, educational, scientific, philanthropic, agricultural, labor, veterans, fraternal organizations or associations; rural electric cooperatives; the official highway or development agency of a state; and nonprofit educational radio or television stations.

• Used By Printers and Publishers

A publication must have at least four issues a year to qualify.

*U.S. Post Office Department. Postal Manual. Washington, D.C.: U.S. Government Printing Office. (Post Office Services TL-213, 2-14-68——Issue 1115, p. 132.121).

T. VANTREESE, INST. MATL. LAB., U.K.

6210

THIRD-CLASS MAIL

CIRCULARS & ADVERTISEMENTS

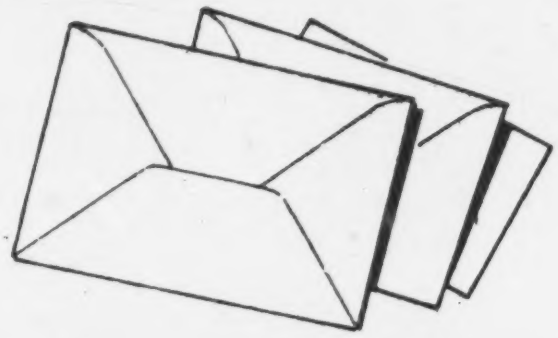

UNSEALED GREETING CARDS

BOOKS & CATALOGS OF 24 OR MORE PAGES

HOTEL KEYS & IDENTIFICATION DEVICES WITHOUT COVER

WEIGHS LESS THAN 16 OZ.; CANNOT BE CLASSIFIED AS FIRST- OR SECOND-CLASS.

Single piece rate -- 6¢ for the first 2 ounces or fraction of 2 ounces plus 2¢ for each additional ounce or fraction of an ounce.

*Bulk rates -- 16¢ per pound or fraction for books and catalogs having 24 or more bound pages with at least 22 copies printed, seeds, cuttings, bulbs, roots, scions, and plants. 4¢ approximate minimum rate per piece

22¢ per pound or fraction for all other matter.

Nonprofit organizations mail for half the regular rate.

*Postal Manual (Post Office Services TL-213, 2-14-68—Issue 1115, p. 134.211).

T. VAN TREESS, INST. MATL. LAB., U.K.

FOURTH-CLASS MAIL

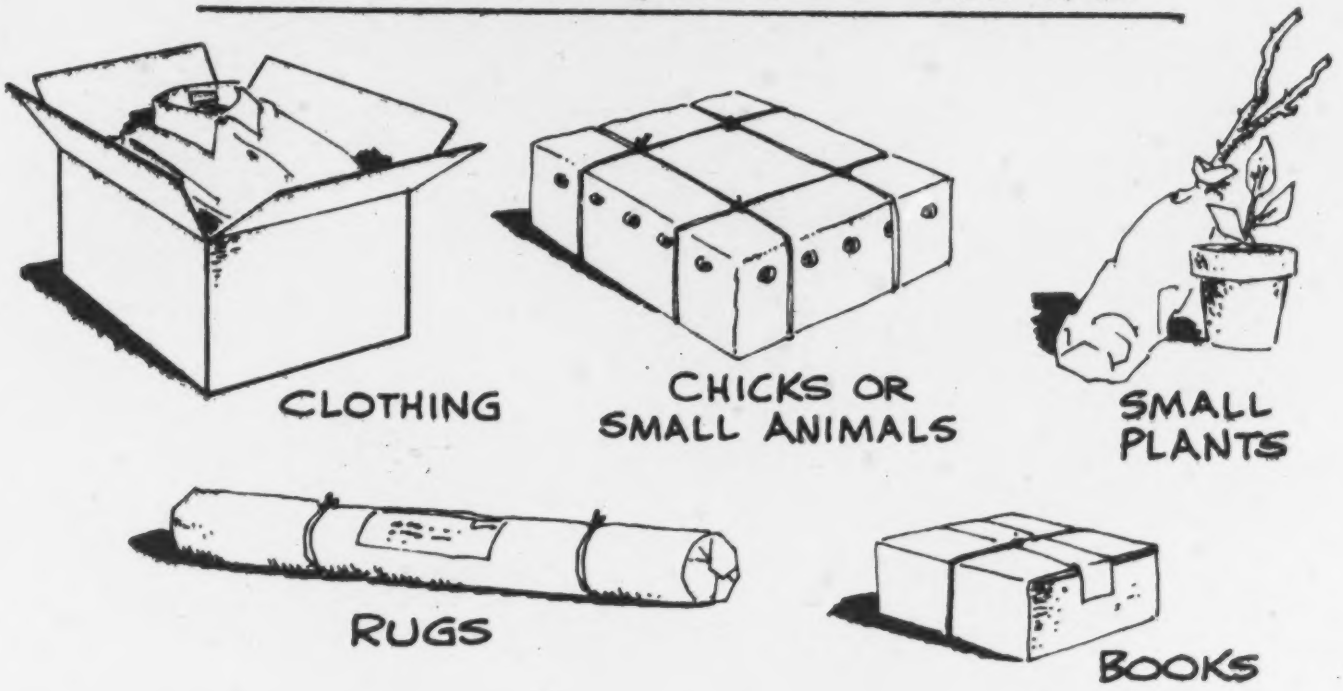

- Includes Merchandise, Books, Printed Matter, and All Other Mailable Matter Not First, Second, or Third Class
- Weighs 16 oz. or Over
- May Be Sent Sealed or Unsealed

- Limits on weight and size determined by classification of post offices sending and receiving and the distance (zone). Maximum weight 70 lbs. and maximum size 100 inches.

FOURTH-CLASS MAIL RATES *

FOURTH-CLASS (PARCEL POST) ZONE RATES

weight 1 pound and not exceeding — pounds	Zones							
	Local	1 and 2	3	4	5	6	7	8
2 - - - - - - -	$ 0.40	$ 0.50	$ 0.50	$ 0.55	$ 0.60	$ 0.70	$ 0.75	$ 0.80
3 - - - - - - -	.40	.55	.60	.65	.75	.85	.95	1.05
4 - - - - - - -	.45	.60	.65	.75	.85	1.00	1.10	1.25
5 - - - - - - -	.45	.65	.70	.80	.95	1.10	1.30	1.45
6 - - - - - - -	.45	.70	.80	.90	1.05	1.25	1.45	1.65
66 - - - - - - -	1.65	3.10	3.80	4.85	6.35	8.00	9.50	11.70
67 - - - - - - -	1.65	3.15	3.85	4.90	6.40	8.10	10.00	11.90
68 - - - - - - -	1.65	3.15	3.90	4.95	6.50	8.25	10.15	12.05
69 - - - - - - -	1.70	3.20	3.95	5.00	6.55	8.35	10.30	12.20
70 - - - - - - -	1.70	3.25	4.00	5.10	6.65	8.45	10.40	12.35

Rates determined by weight and distance to be transported.

Forwarding requires additional postage.

Special rates provided for books, films, music, tests, sound recordings, manuscripts, reference charts, and medical information.

Library rate provided for certain items loaned or exchanged between schools and certain other agencies.

*Postal Manual (Post Office Services Th-198, 1-15-67——Issue 1025, pp. 135-215).

COMBINATION MAILING

Sending Two Classes of Mail Together So That They Will Arrive at The Same Time

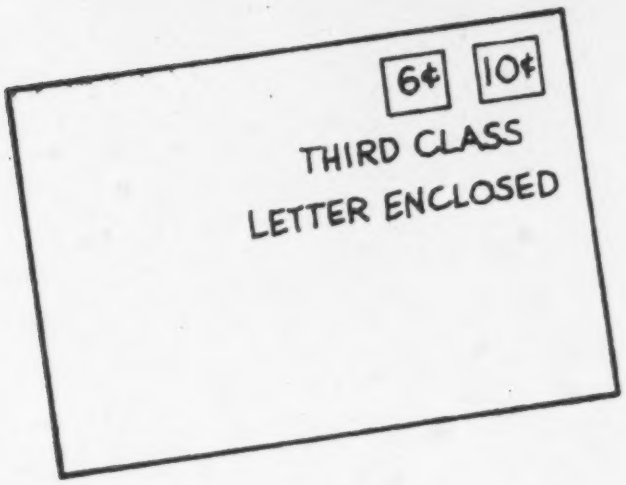

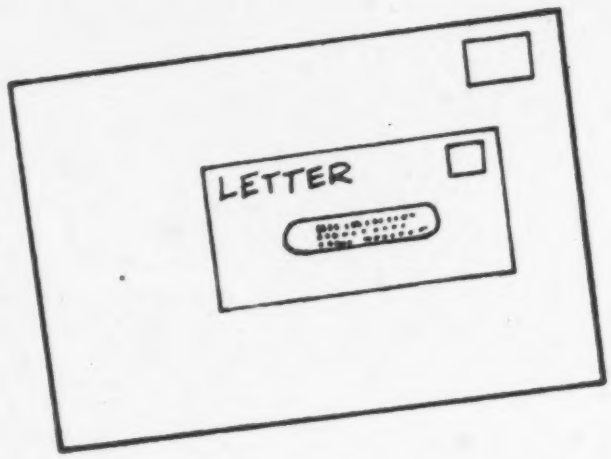

- Requires Postage on Each Class Separately
- Sent by the Lower of the Two Classes
- "First-Class Mail Enclosed" Must Be Typed, Written, or Stamped Below The Postage And Above The Address

T. VANTREESE, INST. MATL. LAB., U.K.

SPECIAL MAILING SERVICES FORMS

No. 222673

RECEIPT FOR CERTIFIED MAIL—30¢

SENT TO

POSTMARK OR DATE

STREET AND NO.

CITY, STATE, AND ZIP CODE

If you want a return receipt, check which
☐ *10¢ shows to whom and when delivered* ☐ *35¢ shows to whom, when, and address where delivered*

If you want delivery only to addressee, check here ☐ *50¢ fee*

FEES ADDITIONAL TO 30¢ FEE

POD Form 3800
July 1963

NO INSURANCE COVERAGE PROVIDED—
NOT FOR INTERNATIONAL MAIL

(See other side)

CERTIFIED MAIL
No. 222673

INSTRUCTIONS TO DELIVERING EMPLOYEE

☐ Show to whom and when delivered ☐ Show to whom, when, and address where delivered ☐ Deliver ONLY to addressee

(Additional charges required for these services)

RECEIPT

Received the numbered article described below.

REGISTERED NO.

CERTIFIED NO.

INSURED NO.

SIGNATURE OR NAME OF ADDRESSEE (*Must always be filled in*)

SIGNATURE OF ADDRESSEE'S AGENT, IF ANY

DATE DELIVERED

SHOW WHERE DELIVERED (*only if requested*)

GPO

RETURN RECEIPT REQUESTED

25¢

CERTIFICATE OF MAILING

5¢

Form 3817
Rev. 8-53

Post Office Department

Received from:

AFFIX STAMP AND POSTMARK

One piece of ordinary mail addressed

to

THIS RECEIPT, WHICH MAY BE USED FOR DOMESTIC AND INTERNATIONAL MAIL, DOES NOT PROVIDE FOR INDEMNIFICATION

POSTMASTER.

GPO 16—69310-1

PRECANCELED MAIL

PIKEVILLE COLLEGE
The Pulse of
EASTERN KENTUCKY'S
FUTURE
Pikeville, Ky. 41501

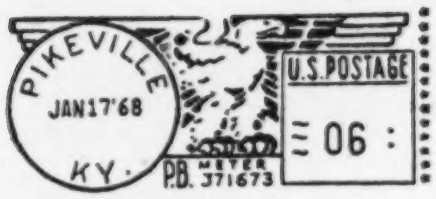

METERED

PRECANCELED STAMP

Takes less processing time in the post office.

Requires special permit to use.

PRECANCELED MAIL

Mailing TM - 23

T. VANTREESE, INST. MATL. LAB., U.K.

6216

PACKAGING

(AS RECOMMENDED BY THE POSTAL MANUAL)

· ODD SHAPED ARTICLES:

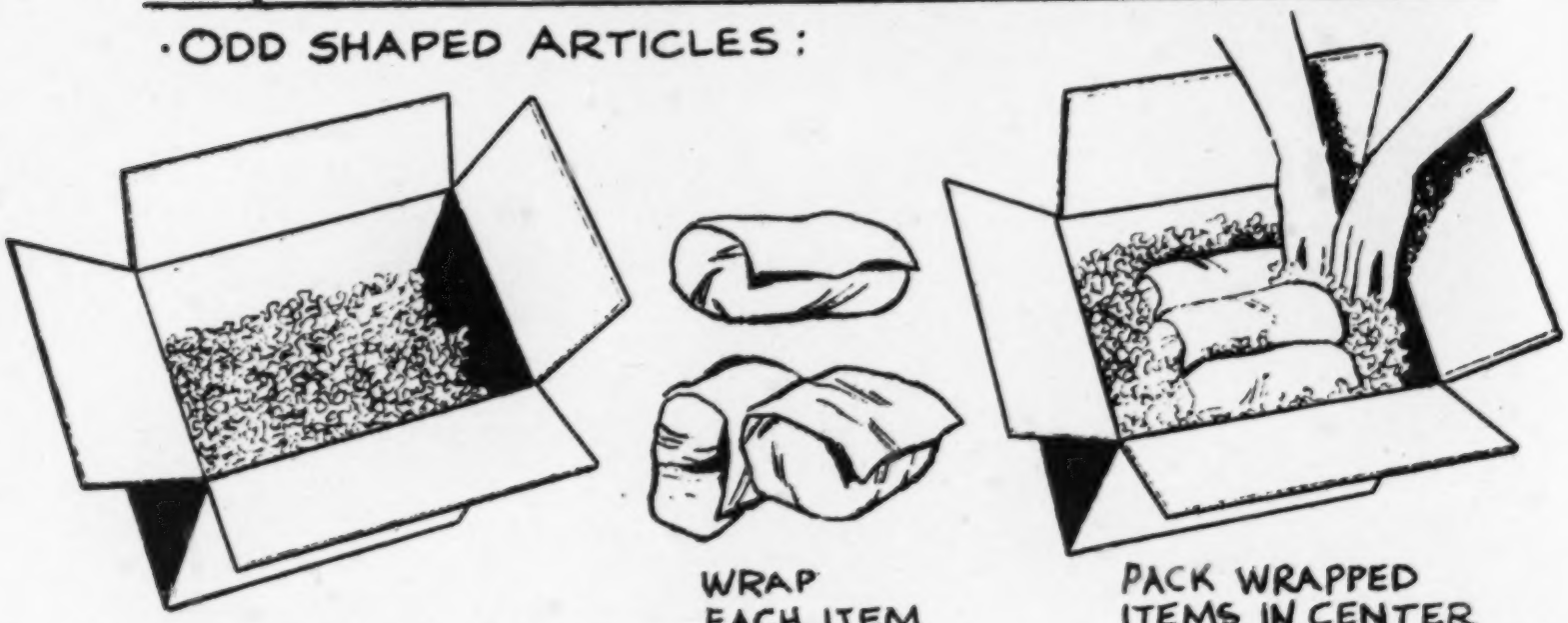

PACK CUSHIONING MATERIAL IN BOTTOM OF CARTON

WRAP EACH ITEM SEPARATELY

PACK WRAPPED ITEMS IN CENTER OF CARTON And PACK MATERIAL AROUND And OVER

· FRAGILE ARTICLES

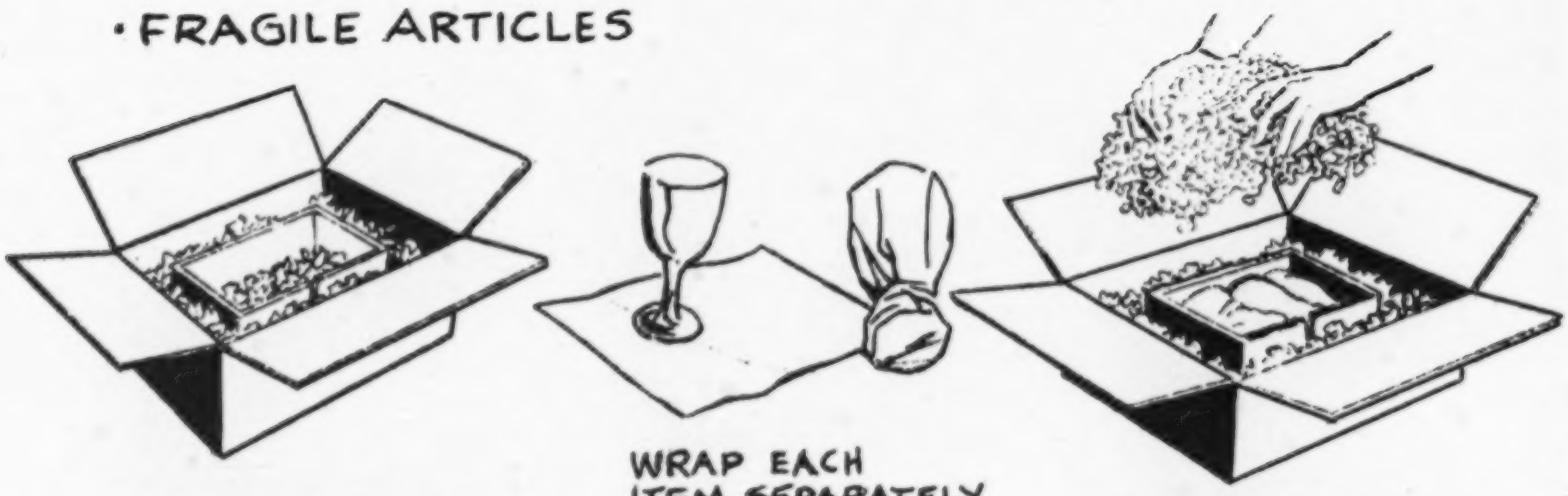

PLACE PACKING MATERIAL IN BOTTOM OF CARTON. PLACE INSERT IN CENTER OF PACKING

WRAP EACH ITEM SEPARATELY

PLACE IN INSERT And COVER WITH PACKING MATERIAL

*Postal Manual (Post Office Services 11-165, 9-6-65—-Issue 890, pp. 121.335 and 121.34).

T. VANTREESE, INST MATL. LAB., U.K.

PACKAGING
(AS RECOMMENDED BY THE POSTAL MANUAL)

FRAMED PICTURES:

(1) FORM ROLLS FROM NEWSPAPER

(2) WRAP SECURELY AROUND FRAME

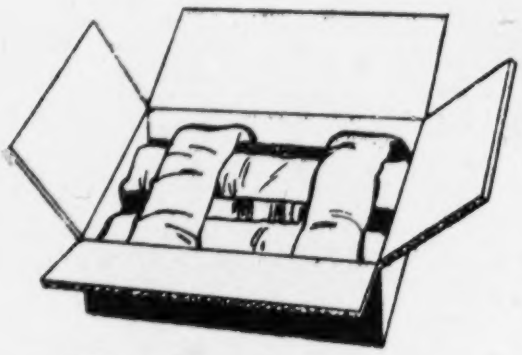

(3) PACK SECURELY IN CARTON

PAMPHLETS, FORMS, PAPERS, ETC.

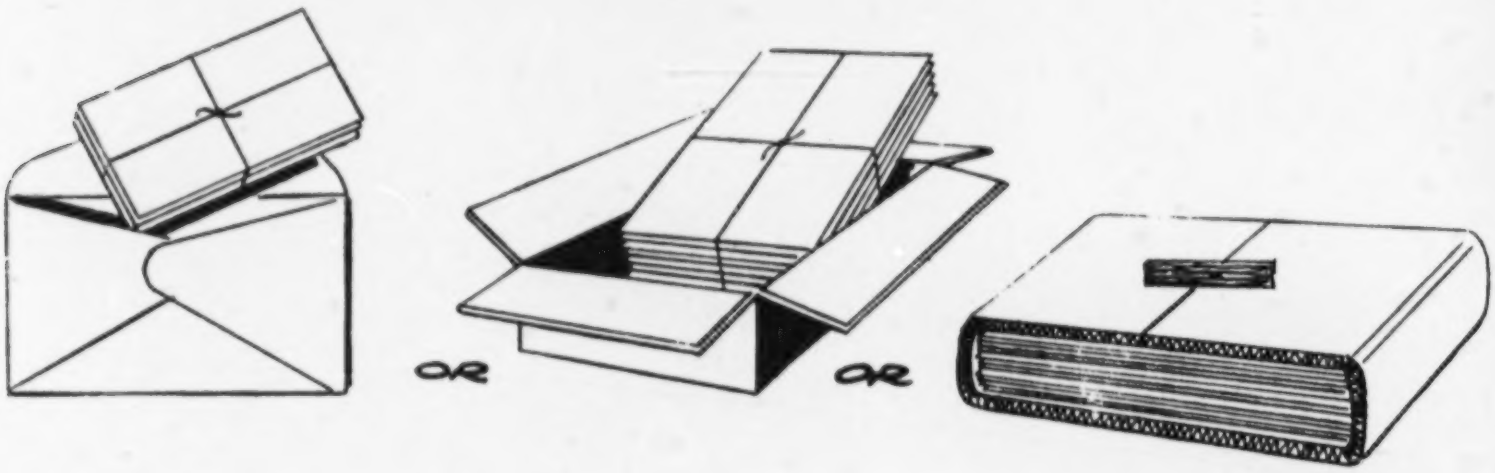

*Postal Manual (Post Office Services TL-165, 9-6-65—Issue 890, pp. 121.35—121.36).

WRAPPING
(AS RECOMMENDED BY THE POSTAL MANUAL)

1 POSITION PARCEL ON HEAVY WRAPPING PAPER

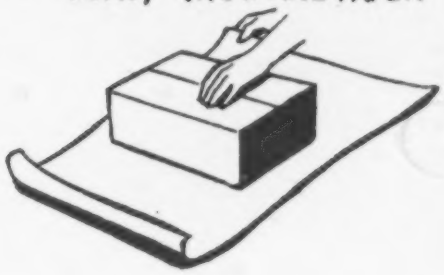

2 WRAP LENGTHWISE (TAPE MAY BE USED TO HOLD PAPER IN POSITION)

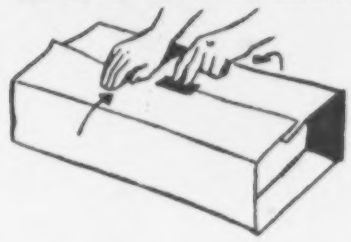

3 TUCK ENDS MAKING NEAT FOLDS AT CORNERS

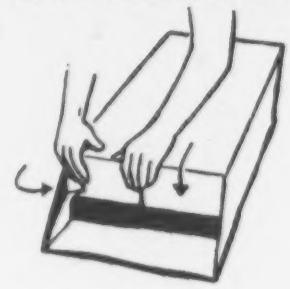

4 FOLD CORNERS (SECURE WITH TAPE IF DESIRED)

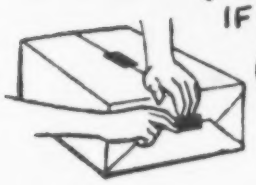

5

6 LOOP STRONG CORD AROUND END OF PARCEL -THEN LENGTHWISE

7 PULL TIGHT AND TIE KNOT

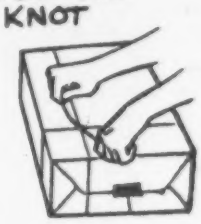

8 REPEAT STEPS 6 AND 7 LOOPING CORD AT EACH INTERSECTION - And TIE KNOT

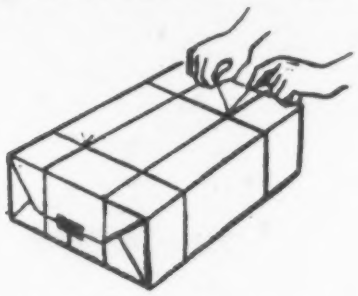

9

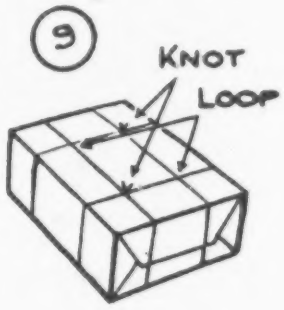

*Postal Manual (Post Office Services TL-165, 9-6-65——Issue 890, p. 121.44).

T. VANTRESSE, INST. MATL. LAB., U.K.

6219

WRAPPING--REINFORCING CLOSURES

(FASTENING DOWN PACKAGE FLAPS WITH TAPE & STAPLES AS RECOMMENDED BY THE POSTAL MANUAL)

- APPLYING ONE-THICKNESS PAPER TAPE:

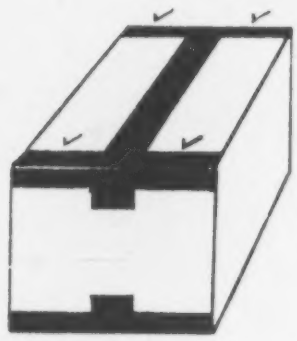

✓ MOST IMPORTANT TO TAPE HERE

- USING REINFORCED PAPER TAPE:

- USING PRESSURE-SENSITIVE FILAMENT TAPE:

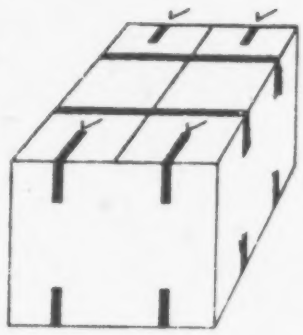

- STAPLING:

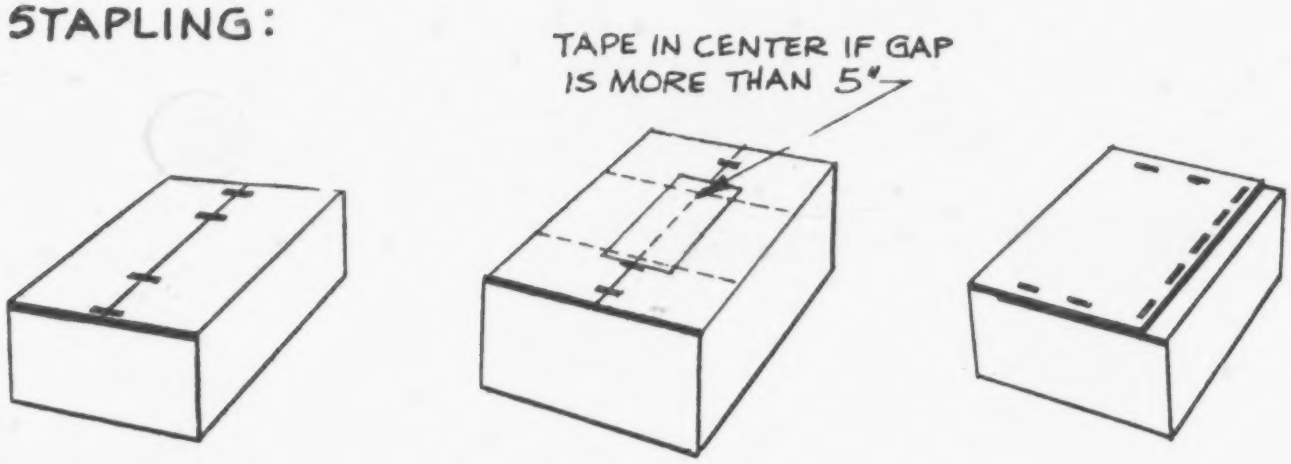

*Postal Manual (Post Office Services TL-165, 9-6-65—Issue 890, pp. 121.53—121.54).

T. VANTREESE, INST. MATL. LAB., U.K.

HOW TO COMPUTE THE SIZE OF A PACKAGE*

1) Measure the longest side to get the length.

2) Measure the distance around at the thickest part to get the girth.

3) Add the length and the girth.

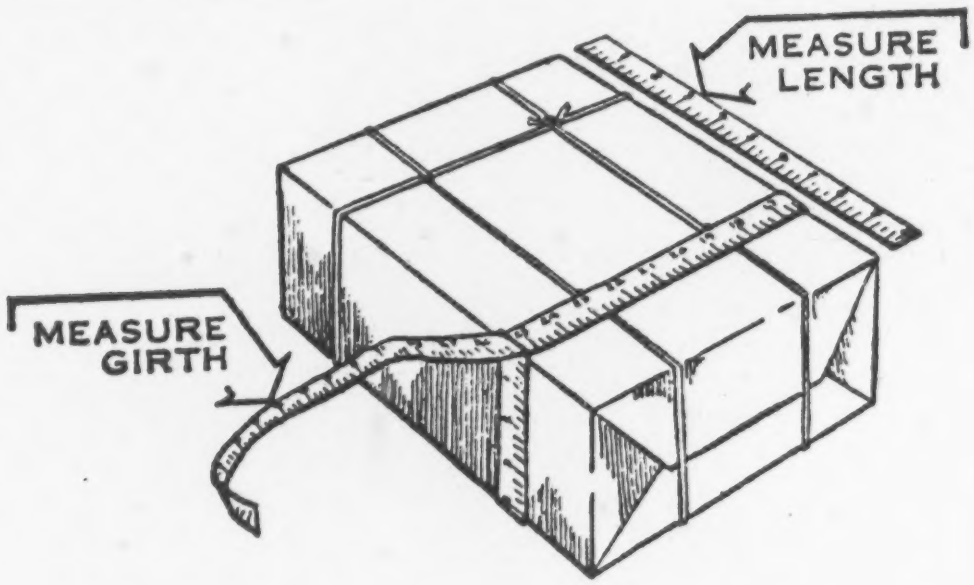

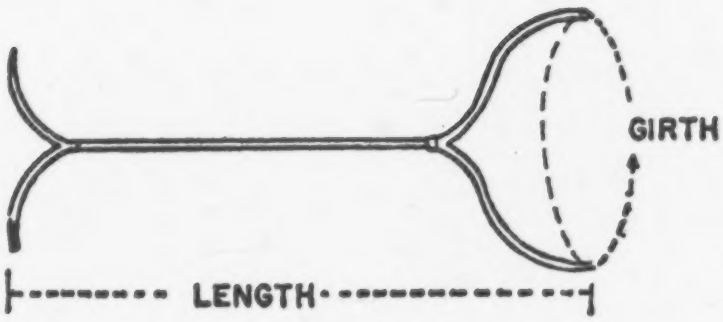

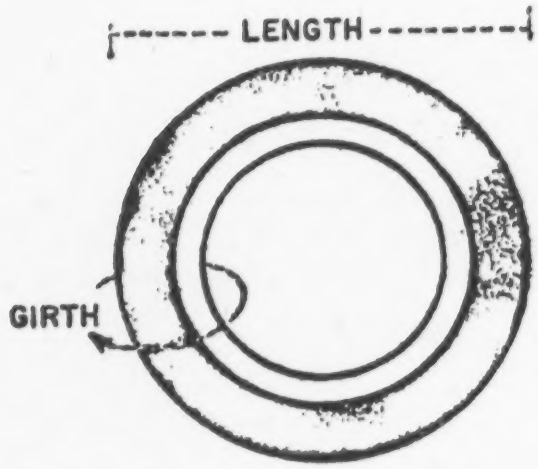

*Postal Manual (Post Office Services TL-208, 9-15-67——Issue 1091, p. 135.32).

ORIGINAL

United Parcel Service
PICKUP RECORD (REGISTER)

DATE / /

RECEIVED FROM: (PLEASE USE STAMP OR PRINT)
NAME Your Company
STREET Main Street
CITY Anytown, U.S.A.

UNLESS A GREATER VALUE IS DECLARED IN WRITING ON THIS RECEIPT, THE SHIPPER HEREBY DECLARES THE RELEASED VALUE OF EACH PACKAGE, OR ARTICLE NOT ENCLOSED IN A PACKAGE, COVERED BY THIS RECEIPT TO BE AS FOLLOWS: $100 FOR EACH PACKAGE OR ARTICLE.

26411

PLEASE MARK ANY SPOILED SHEET "VOID" AND GIVE TO DRIVER

CUSTOMER'S CHECK ACCEPTED AT SENDER'S RISK UNLESS OTHERWISE NOTED ON C.O.D. TAG.

REGISTER READINGS

(1) ASCENDING REGISTER	X	5	3	4	5	6	7	8
(2) DESCENDING REGISTER	X	X	4	5	6	7	8	9
(3) TOTAL READINGS MUST EQUAL TOTAL - LINE 4		5	8	0	2	4	6	7
(4) TOTAL SETTINGS FROM LAST STATEMENT		5	8	0	2	4	6	7

REGISTER TAPE COUNTER		UNUSED REGISTER TAPES
END	05443	NO. 1 CREDIT AMOUNT
START	05432	(ATTACH TO REVERSE SIDE)

C. O. D.'S

SALES MEMO.	AMOUNT	SALES MEMO.	AMOUNT
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	

DECLARED VALUATIONS

SALES MEMO.	DECLARED VALUE
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

SC 1430
2-20-086
APR-8-67
COMMON CARRIER
39131 PB
≈.00

U 1203 PB
10M PADS 1-66

26411 | PICKUP TIME 4:15 | RECEIVED BY | NO. PKGS. 10 | NO. CALLS

United Parcel Service
PICKUP RECORD 23568
MARK ANY SPOILED SHEET "VOID" AND GIVE TO DRIVER.
CUSTOMER'S CHECK ACCEPTED AT SHIPPER'S RISK UNLESS OTHERWISE NOTED ON C.O.D. TAG.
SHIPPER COPY
DATE 4/1/67

RECEIVED FROM (NAME AND ADDRESS): (USE STAMP OR PRINT)
Your Company
123 Main Street
Anytown, U.S.A.

LBS SC 1430 2-20-086
STAMP YOUR UPS SHIPPER NUMBER ABOVE

ENTER EACH PACKAGE ON SEPARATE LINE.
ENTER WEIGHT ACCORDING TO DESTINATION ZONE.
INCREASE FRACTION OF POUND TO NEAT FULL POUND.

SALES MEMO.	NAME	STREET NUMBER	STREET NAME	CITY	STATE		WEIGHT ZONE L	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6	ZONE 7	ZONE 8	C.O.D. AMOUNT OR "CALL"
	Jones Co	3009	3rd Ave S.	Birmingham	Ala.	1				10					
	Smith Co.	2	Charlesgate W.	Boston	Mass.	2					10				
	Doe Co.	1410	L St. N.W.	Washington	D.C.	3				10					
	Sports Center	4701	West Broad	Richmond	Va.	4			10						
	Sales Co.	1109	Summit Ave	Greensboro	N.C.	5		10							
	Jones Co.	1209	Wade St.	Raleigh	N.C.	6		10							
	Smith Co.	201	S. King Rd.	Charlotte	N.C.	7		10							
	Doe Co.	715	Mamaroneck Ave	White Plains	N.Y.	8				10					
	Smith Co.	570	Whalley Ave	New Haven	Conn.	9					10				
	Sports Center	786	Central Ave	Albany	N.Y.	10					10				
						11									
						12									
						13									
						14									
						15									

23568 | PICKUP TIME 4:15 | RECEIVED BY Bill Fisher | NO. PKGS. 10 | NO. CALLS

TOTALS (OFFICE USE ONLY)	PKGS. & CALLS	L	2	3	4	5	6	7	8	C.O.D.'S	MISC.

U 1203
100M
2-66

Unless a greater value is declared in writing on this receipt, the shipper hereby declares the released value of each package, or article not enclosed in a package, covered by this receipt to be as follows: $100 for each package or article.

UPS - PICKUP RECORD 26411 and 23568

6222

THE EMPLOYMENT WANTED AD

5 EMPLOYMENT WANTED
COLLEGE GRADUATE, age 25, presently employed desires career in sales or promotion. Prefer salary plus arrangement. Limited travel. Box 186 Herald-Leader 40507
MATURE man presently employed in local area with experience in sales, sales management and management. Capable of taking full charge if necessary. Wishes to make new connection in this area. Herald-Leader Box 220, 40507

1. STATE QUALIFICATIONS CLEARLY.
2. ASK FOR A SPECIFIC TYPE OF WORK.
3. OMIT NAME, TO KEEP MATTER CONFIDENTIAL.

GENERALLY, HAS MORE VALUE FOR THE EXPERIENCED WORKER.

COST DEPENDS UPON THE NEWSPAPER. (Some newspapers allow high school students to place one ad a year free.)

COST QUOTED BY ONE KENTUCKY PAPER:

15 WORDS OR LESS	$1.80 FOR 1 DAY
(Additional charge for longer ads)	$3.90 FOR 3 DAYS $5.20 FOR 1 WEEK

STUDYING HELP WANTED ADS* 1

EMPLOYMENT AGENCIES

C / M C / M
277-6168 277-6168

C A U T I O N !

Look Out Below

The following jobs listed could mean advancement, job security, better pay, professional growth!

C / M of Lexington
Will accept all
responsibility!

ADMINISTRATIVE

LOAN MANAGER - - - - - - - - - - $6,000
CLAIMS ADJUSTER (degree) - - - $6,800
FIELD REPRESENTATIVE - - - - - $5,200
CLERK - - - - - - - - - - - - - $3,800

DATA PROCESSING

PROGRAMMER (6 mo. exp.) - - - $7,200
OPERATOR (trained) - - - - - - $5,200
TAB OPERATOR - - - - - - - - - - $5,200

MISCELLANEOUS

SHIPPING CLERK - - - - - - - - - $4,500
AGENT (debit) - - - - - - - - - $7,800
INSURANCE - - - - - - - - - - - $8,000

FEMALE

PERSONNEL CLERK - - - - - - - - $3,600
SECRETARY - - - - - - - - - - - $4,000
CLERK TYPIST - - - - - - - - - - $4,000
PAYROLL CLERK - - - - - - - - - $4,000
MEDICAL SECRETARY - - - - - - $3,600
GENERAL OFFICE - - - - - - - - $3,400

C / M

OF LEXINGTON, KY.
366 Waller Ave. 277-6168
"Affiliated Offices Coast to Coast"

General listing by employment agency

CAUTION

NOTICE To Readers!

You are cautioned to make no investment to get a position advertised in the Help Wanted columns of this newspaper. Ads here, or in other classifications which require investments in stocks, samples, merchandise, or cash bond should be investigated thoroughly before money is paid out.

Advertisers requiring a cash investment must so specify in their ad. Kindly report any exception to Classified Advertising Manager. Dial 254-666.

*Ads from The Lexington Leader, March 4, 1968.

STUDYING HELP WANTED ADS* 2

3 MALE HELP WANTED

Reserve Life Ins. Co.

Needs a branch manager for the Lexington area because of expansion. Vested renewals, free group hospitilization insurance. Also salary to those who qualify. Write resume to

RESERVE LIFE, P.O. BOX 1028

Lexington, Ky. 40504

Specific inquiry by a company

4 FEMALE HELP WANTED

PAYROLL BOOKKEEPING -- Salary open to person with experience. 40 hour week. Paid vacation. Good working conditions. Accurate typing a must. Send resume to P.O. Box 5271 Lexington, Ky.

"Blind" placement

INSTRUCTION--SCHOOL

U. S. CIVIL SERVICE TESTS!

Men-women 18 and over. Secure jobs. High starting pay. Short hours. Advancement. Preparatory training as long as required. Thousands of jobs open. Experience usually unnecessary. Grammar school sufficient for many jobs. FREE information on jobs, salaries, requirements. Write TODAY giving name and address. Lincoln Service, Box 497 Herald-Leader, 40507

Job placement offered through enrollment in special course

6225

*Ads from The Lexington Leader, March 4, 1968.

YOUR SOCIAL SECURITY CARD

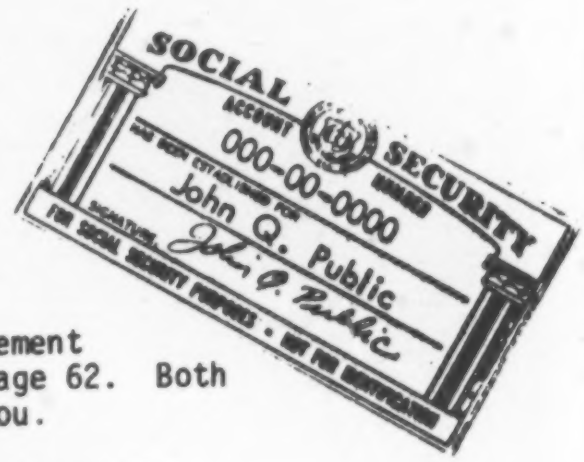

1. You must have one before you start to work.

2. Contributions paid to social security for ten years will provide a monthly retirement check for life to persons retiring at age 62. Both you and your employer contribute for you.

   Disability benefits may be obtained by those who qualify.

3. The number is yours for life and may be used as your identification number for other purposes. Memorize it.

4. An applications form may be obtained from any post office or local social security office.

APPLICATION FOR SOCIAL SECURITY NUMBER
(Or Replacement of Lost Card)

Information Furnished On This Form Is CONFIDENTIAL

DO NOT WRITE IN THE ABOVE SPACE

See Instructions on Back. Print In Black or Dark Blue Ink or Use Typewriter.

1 Print FULL NAME YOU WILL USE IN WORK OR BUSINESS (First Name) (Middle Name or Initial—If none, draw line—) (Last Name)

2 Print FULL NAME GIVEN YOU AT BIRTH

3 PLACE OF BIRTH (City) (County if known) (State)

4 MOTHER'S FULL NAME AT HER BIRTH (Her maiden name)

5 FATHER'S FULL NAME (Regardless of whether living or dead)

6 YOUR DATE OF BIRTH (Month) (Day) (Year)

7 YOUR PRESENT AGE (Age on last birthday)

8 YOUR SEX MALE ☐ FEMALE ☐

9 YOUR COLOR OR RACE WHITE ☐ NEGRO ☐ OTHER ☐

10 HAVE YOU EVER BEFORE APPLIED FOR OR HAD A SOCIAL SECURITY, RAILROAD, OR TAX ACCOUNT NUMBER? NO ☐ DON'T KNOW ☐ YES ☐ (If "Yes" Print STATE in which you applied and DATE you applied and SOCIAL SECURITY NUMBER if known)

11 YOUR MAILING ADDRESS (Number and street) (City) (State) (ZIP Code)

12 TODAY'S DATE

13 Sign YOUR NAME HERE (Do Not Print)

TREASURY DEPARTMENT Internal Revenue Service
Form SS-5

Return completed application to nearest SOCIAL SECURITY ADMINISTRATION DISTRICT OFFICE

FORM W-4 (Rev. Jan. 1967)
U.S. Treasury Department
Internal Revenue Service

EMPLOYEE'S WITHHOLDING EXEMPTION CERTIFICATE

Type or print full name _____ Social Security Number _____

Home address _____ City _____ State _____ ZIP code _____

EMPLOYEE: File this form with your employer. Otherwise, he must withhold U.S. income tax from your wages without exemption.

EMPLOYER: Keep this certificate with your records. If the employee is believed to have claimed too many exemptions, the District Director should be so advised.

HOW TO CLAIM YOUR WITHHOLDING EXEMPTIONS

1. If SINGLE (or if married and wish withholding as single person), write "1." If you claim no exemptions, write "0" . . . _____
2. If MARRIED, one exemption each is allowable for husband and wife if not claimed on another certificate.
   (a) If you claim both of these exemptions, write "2"; (b) If you claim one of these exemptions, write "1"; (c) If you claim neither of these exemptions, write "0" . . . _____
3. Exemptions for age and blindness (applicable only to you and your wife but not to dependents):
   (a) If you or your wife will be 65 years of age or older at the end of the year, and you claim this exemption, write "1"; if both will be 65 or older, and you claim both of these exemptions, write "2" . . . _____
   (b) If you or your wife are blind, and you claim this exemption, write "1"; if both are blind, and you claim both of these exemptions, write "2" . . . _____
4. If you claim exemptions for one or more dependents, write the number of such exemptions. (Do not claim exemption for a dependent unless you are qualified under Instruction 4 on other side.). . . . _____
5. If you claim additional withholding allowances for itemized deductions fill out and attach Schedule A (Form W-4), and enter the number of allowances claimed (if claimed file new Form W-4 each year) . . . _____
6. Add the exemptions and allowances (if any) which you have claimed above and write total . . . [ ]
7. Additional withholding per pay period under agreement with employer. (See Instruction 1.) . . . $

I CERTIFY that the number of withholding exemptions claimed on this certificate does not exceed the number to which I am entitled. 648—10—79061-1

(Date) _____, 19____ (Signed) _____

1. This form helps the employer determine how much Federal income tax to withhold from the employee's wages.

2. Only the correct number of exemptions should be claimed.

3. An employee may claim fewer exemptions than he actually has, but not more. Claiming fewer exemptions results in more tax being deducted from the pay check.

4. A new certificate should be filed when the number of exemptions changes. It <u>must</u> be filed within 10 days when the number <u>decreases</u>.

YOUR PAY CHECK

Typical Check Stub:

Social Security

GROSS EARNINGS	TAX DEDUCTIONS					MILEAGE AND EXPENSE
	FED.INC.	F.I.C.A.	STATE INC.	STATE UCI	CITY INC.	
222.50	24.93	8.07	1.93		3.34	
	OTHER DEDUCTIONS					
GROUP "B"	HOSP.INS.	SAVINGS	LOANS	ADVANCES	CHAR.ORG.	MISCL.
4.00	9.25					.76

NET AMOUNT $*170.22 FOR THE PERIOD ENDING FEB. 15, 1964

114-062 PLEASE DETACH AND RETAIN THIS STATEMENT OF EARNINGS FOR YOUR RECORDS.

IMPORTANT - PLEASE CASH CHECK PROMPTLY

CHECK STUB NOT NEGOTIABLE
800-2 Form 126-Sal. 9-60 Printed in USA

RETAIL CREDIT COMPANY
ATLANTA, GEORGIA

Plan your spending around your net pay not your gross pay.

The pay period where you work may be weekly, every two weeks, or monthly.

Notice the amount deducted and kind of deductions from your salary.

Be familiar with company insurance, loan policy, and savings plan.

VT 012 680
Course Outline for Introduction to the World of Work (Seventh Grade).

Alabama State Dept. of Education, Montgomery. Agricultural Education Service.
MF AVAILABLE IN VT-ERIC SET.
Vocational Agricultural Education, Field Office, 101 Petrie Hall, Auburn, Alabama 36830 (free to State Supervisors and Head Teacher Educators only).
PUB DATE - 70 35p.

DESCRIPTORS - *TEACHING GUIDES; CURRICULUM GUIDES; PREVOCATIONAL EDUCATION; *OCCUPATIONAL INFORMATION; OCCUPATIONAL CHOICE; OCCUPATIONAL ASPIRATION; *COURSE CONTENT; GRADE 7; UNITS OF STUDY (SUBJECT FIELDS); UNIT PLAN; *INDUSTRIAL ARTS
IDENTIFIERS - *OCCUPATIONAL EXPLORATION

ABSTRACT - Prepared by the Alabama State Department of Education, this course outline is designed as an introduction to occupations for seventh grade students. The 26 units, presented for each month of the school year, provide topical outlines and references for (1) job descriptions including opportunities and general skill requirements, (2) some study of life science, and (3) study and practice of simple hand tools and elementary skills with wood, leather, plastic, electricity, and other simple arts and crafts. An introductory section provides a description, purposes, and objectives of the course. A bibliography and a Widening Occupational Roles Kit are included. (FM)

VT 012 680

ED0 56238

Alabama
1970-71

COURSE OUTLINE
FOR
INTRODUCTION TO THE WORLD OF WORK

(SEVENTH GRADE)

"Blessed is the man who has found his work. One monster there is in the world--the idle man."

—CARLYE, FRIENDLY CHAT

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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STATE OF ALABAMA
State Department of Education
Division of Vocational Education
Agricultural Education Service
Montgomery, Alabama

VT012680

6230

91 OF 327

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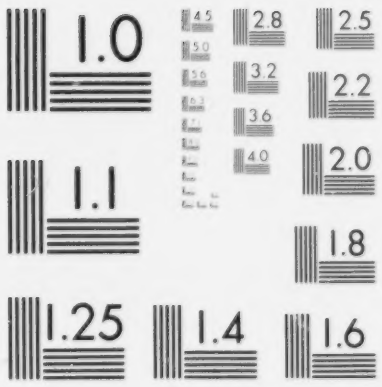

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

INTRODUCTION TO THE WORLD OF WORK
(Seventh Grade)

Description of Course

This course is an introduction to occupations in the world of work. Some study of life science, including the knowledge and skills required of the occupations in the state and the nation, is presented. Simple hand shop tools and elementary basic skills are studied and practiced with wood, leather, plastic, electricity and other simple arts and crafts. This is an exploratory course of occupational job descriptions including opportunities and general skill requirements in the world of work. The quality and richness of this course will depend largely upon the ingenuity and initiative of each teacher.

Purposes of Course

1. Create favorable attitudes to the world of work in relation to the home, community, state, and nation.

    a. Install pride in workmanship
    b. Encourage dignity of work

2. Develop an awareness of students to the world of work in the home, community, state, and nation.

3. Development of simple motor skills.

Objectives of Course

1. To develop pride in workmanship.

2. To develop an appreciation for the dignity of work.

3. To develop a comprehension of occupational classification levels.

4. To develop a comprehension of occupational cluster categories.

5. To develop the ability to evaluate personal assets and liabilities as related to occupational opportunities.

6. To develop the ability of students to realistically select occupational goals from available alternatives.

7. To develop simple motor skills.

    a. To develop the ability of students to associate tools with intended purposes.

    b. To develop a safety attitude.

    c. To develop the ability to follow instructions.

INTRODUCTION TO THE WORLD OF WORK
(Seventh Grade)

SEPTEMBER

Units	References and Teacher Comments
I. Orientation and General Information	
A. Purpose and value of occupations course	
B. Requirements of course	
C. References and supplies needed	
D. Review of course content	
E. Others	
II. The Dignity of a Life of Work	
A. A history of development	
1. Ancient times	
2. Middle ages	
3. Industrial revolution	
B. The responsibilities of the adult in our society	
1. To the family unit	
a. Father	
(1) Physiological needs	
(a) Decision making	
(b) Values, goals and standards	
(c) Emotional needs	
b. Mother	
(1) Physiological needs	
(a) Care for family, food, clothing and shelter	
(b) Assist wage earner	
(c) Family management	
(2) Psychological needs	
(a) Emotional needs	
(b) Social and religious training	
(c) Development of personal values	
2. To the community	
a. Local Community	
(1) Voting	
(2) Obeying laws	
(3) Social activities	

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Introduction to World of Work, (cont'd)
(Seventh Grade)

SEPTEMBER (Cont'd)

Units	References and Teacher Comments
a. Local Community (Cont'd) (4) Neighborhood (5) Church (6) School (7) Local taxes (8) Economic asset--not liability	
3. To His Country	
a. Voting b. Citizenship c. Taxes d. Laws e. National defense f. A productive member of society	
III. Suggested Learning Activities	
1. Invite parents of students to discuss their work and responsibilities to family and community. 2. Invite local law enforcement officer and town officials to discuss civic responsibilities of citizens. 3. Others	
IV. Sketching, Drawing and Planning	
A. Introduction to occupational fields B. Employment opportunities in field of drafting, designing, and engineering	"Exploring the Industries" "General Shop"
1. Importance of occupations 2. Nature of work	"Occupational Outlook Handbook"
a. Engineering b. Designing c. Drafting d. Others	
C. Skills and practice	
1. Sketching lines 2. Using simple drawing 3. Drawing blocks and other objects	

Introduction to World of Work (cont'd)
(Seventh Grade)

SEPTEMBER (Cont'd)

Units	References and Teacher Comments
D. Making a work plan 1. Drawing and sketching a project to be made 2. Amount, kind, and size of material required 3. Tools and equipment needed to do the job 4. Steps to be followed in construction E. Suggested learning activities 1. Students practice drawing and prepare ten or more blocks of various shapes. Over-all sizes should be approximately 2" x 4" x 6". 2. Have each student to sketch free hand as many different views of each block as he can discover. 3. Students complete a number of suggested problems in textbook 4. Make a simple work plan for one of woodworking projects provided in textbook	

Introduction to World of Work (Cont'd)
(Seventh Grade)

OCTOBER

Units	References and Teacher Comments
I. Youth Organizations	
A. Future Farmers of America	
B. Boy Scouts	
C. 4-H Club	
D. Future Homemakers of America	
E. Girl Scouts	
F. Others	
II. Future Farmers of America (FFA)	"Official FFA Manual"
A. History	
B. Value of being an FFA member	
C. Opportunities in FFA	
D. FFA Motto	
E. Symbols of FFA Emblem	
F. Others	
III. Parliamentary Procedure	"Parliamentary Procedure for FFA Chapters"
A. Value of parliamentary procedure	
B. Order of business for a chapter meeting	
C. How business is introduced and conducted.	
D. Others	
IV. Suggested Learning Activities	
1. Invite president or leaders of youth organizations to speak to class.	
2. Get local FFA president to discuss FFA program to class.	
3. Let students practice making motions and voting on motions in parliamentary procedure.	
4. Others	
V. Woodcraft	
A. Job opportunities in the wood industries	"Exploring the Industries"
1. Importance of occupations	"General Shop"
2. Occupations in the wood industries	
3. Nature of work	"Occupational Outlook Handbook"
4. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

OCTOBER (Cont'd)

Units	References and Teacher Comments
B. Tools used in woodcraft occupations	
1. History of hand tools	
2. Identification of simple hand tools	
a. Measuring and marking tools	
b. Planes	
c. Boring tools	
d. Hammers	
e. Chisels	
f. Saws	
g. Others	
3. Use and care of hand tools	
4. Safety practices to follow	
C. Selection of hardware and supplies	
1. Fasteners	
2. Wood screws	
3. Nails, bolts, brads	
4. Glue	
5. Sandpaper	
6. Hinges	
7. Others	
D. Constructing woodcraft projects	
1. Simple work plan	
a. Drawing or sketching of project	
b. Amount, kind, and size of material required	
c. Tools and equipment required to do the work	
d. Steps to be followed in construction	
E. Wood finishing	
1. Sanding and preparing for finish	
2. Selecting and cleaning paint brushes	
3. Applying stains, varnishes, and enamel	
4. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

OCTOBER (Cont'd)

Units	References and Teacher Comments
F. Suggested learning activities	
1. Students build some of the following suggested woodcraft projects. See plans in project book.	
a. Note holder b. Book ends c. Candle holder d. Cutting board e. Tie rack f. Towel rack g. Bird house h. Broom holder i. Seed flat j. Map puzzle k. Letter holder l. Spool holder m. Napkin holder n. Flower pot holder o. Pencil stand	

Introduction to World of Work (Cont'd)
(Seventh Grade)

NOVEMBER

Units	References and Teacher Comments
I. Introduction to the World of Jobs	"Our World of Work"
A. You and the world of work	
1. Why worry about the world of work	
2. Why think about it now	
3. Finding out about the world of work	
B. The people we are	
1. More people	
2. More hands to work	
3. More mouths to feed	
4. Different kinds of people	
5. More older people	
6. More women	
7. People on the move	
8. Why people move	
9. Where people move	
C. Jobs everywhere	"Exploring the World of Jobs"
1. Jobs connected with your life	"Occupational Outlook Handbook"
2. Your need for a job	
3. Looking into a job	
4. How jobs are organized	
5. Professional and related occupations	
6. Clerical and related occupations	
7. Sales occupations	
8. Service occupations	
9. Skilled and other manual occupations	
10. Others	
D. The right job for you	
1. Job limits	
2. Finding the right job	
3. Preparing for a job	
4. Dangerous jobs	
5. Glamorous jobs	
6. Irregular hours	
7. Shift work	
8. Salaries and benefits	
9. Advancements	
10. Your own business	

Introduction to World of Work (Cont'd)
(Seventh Grade)

NOVEMBER (Cont'd)

Units	References and Teacher Comments
II. The Job World	"Occupational Outlook Handbook"
A. Economic and aesthetic rewards of life of work	"Our World of Work"
Each of the occupational classifications listed below should be studied first from the economic standpoint and then approached from the aesthetic point of view.	"WORK"
1. Professional and related occupations	
a. Business administration	
(1) Accountants (2) Advertising workers (3) Marketing research workers (4) Personnel workers (5) Public relations workers	
b. Clergy	
(1) Protestant clergymen (2) Rabbis (3) Roman Catholic priests	
c. Conservation occupations	
(1) Foresters (2) Forestry aids (3) Range-managers	
d. Counseling	
(1) School counselors (2) Rehabilitation counselors (3) Vocational counselors	
e. Engineering	
(1) Aerospace (2) Agricultural (3) Ceramic (4) Chemical (5) Civil (6) Electrical (7) Industrial (8) Mechanical (9) Metallurgical (10) Mining	

Introduction to World of Work (Cont'd)
(Seventh Grade)

NOVEMBER (Cont'd)

Units	References and Teacher Comments
f. Health service occupations	
(1) Chiropractors	
(2) Dental hygenists	
(3) Dental laboratory technicians	
(4) Dentists	
(5) Dietitians	
(6) Hospital administrators	
(7) Licensed practical nurses	
(8) Medical laboratory assistants	
(9) Medical record librarians	
(10) Medical technologists	
(11) Medical X-ray technicians	
(12) Occupational therapists	
(13) Optometrists	
(14) Osteopathic physicians	
(15) Pharmacists	
(16) Physical therapists	
(17) Physicians	
(18) Podiatrists	
(19) Registered professional nurses	
(20) Sanitarians	
(21) Speech pathologists and audiologists	
(22) Veterinarians	
g. Mathematics and related fields	
(1) Mathematicians	
(2) Statisticians	
(3) Actuaries	
h. Natural sciences	
(1) Biological sciences	
(2) Earth sciences	
(a) Geologists	
(b) Geophyscists	
(c) Meteorologists	
(d) Oceanographers	

Introduction to World of Work (Cont'd)
(Seventh Grade)

NOVEMBER (Cont'd)

Units	References and Teacher Comments
i. Physical sciences	
(1) Chemists	
(2) Biochemists	
(3) Physicists	
(4) Astronomers	
j. Performing arts	
(1) Actors and actresses	
(2) Dancers	
(3) Musicians and music teachers	
(4) Singers and singing teachers	
k. Other art related occupations	
(1) Commercial artists	
(2) Industrial designers	
(3) Interior designers and decorators	
B. Suggested Learning Activities	
1. Invite some members of the above professions to discuss their work with the class.	
2. Take class on field trip to visit and observe some of the professional workers.	
3. Have students write job descriptions of different professional occupations.	
4. Others	
III. <u>Electrical Crafts</u>	
A. Employment opportunities in the field	"General Shop"
1. Importance of occupations	"Exploring the Industries"
2. Occupational categories	
3. Nature of work	"Occupational Outlook Handbook"
4. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

NOVEMBER (Cont'd)

Units	References and Teacher Comments
B. Uses of electricity C. Safety D. Common terms in electrical work E. Low voltage circuits 1. Tools and materials 2. Action of a simple bell circuit 3. Series and parallel wiring F. Suggested learning activities 1. Students read a kilowatt-hour meter. 2. Have class work meter problems in textbook. 3. Construct a panel and wire a doorbell to ring from two locations. a. Tools needed: Hammer, screwdriver, needlenose pliers b. Materials needed: 1 doorbell, 1 dry cell, 1 pc. Panel board, 6' #18 bell wire, 2 push buttons, strap staples c. Outline procedures 4. Discuss selected topics at end of chapter in textbook. 5. Invite electrician to speak to class. 6. Field trip to generating plant, building site, or other place to observe workers in field of electricity. 7. Students make some of the following projects. See plans in project book. a. Buzzer or bell b. Test light c. Extension cord d. Lamp e. Electromagnet f. Toy motor 8. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

DECEMBER

Units	References and Teacher Comments
I. Exploring the World of Jobs	
A. Jobs are changing	"Our World of Work"
1. Changes in certain jobs 2. Preparing for job changes 3. Automation 4. Changing times 5. Opportunities for women 6. Changing traditions 7. Changing with the job	"Exploring the World of Jobs" "The Job in Your Future"
B. Making plans	
1. Look at yourself 2. Guiding your job decision 3. The employer's point of view 4. Goals	
II. The Job World (Cont'd)	"Occupational Outlook Handbook"
A. Each of the occupational classifications listed below should be studied first from the economic standpoint and then approached from the aesthetic point of view.	"Our World of Work" "WORK"
1. Professional and related occupations (cont'd)	
a. Social sciences	
(1) Anthropologists (2) Economists (3) Geographers (4) Historians (5) Political scientists (6) Sociologists	
b. Teaching	
(1) Kindergarten and elementary school teachers (2) Secondary school teachers (3) College and university teachers	

Introduction to World of Work (Cont'd)
(Seventh Grade)

DECEMBER (Cont'd)

Units	References and Teacher Comments
c. Technicians	
(1) Engineering and science	
(2) Draftsmen	
d. Writing occupations	
(1) Newspaper reporters	
(2) Technical writers	
e. Other professional and related occupations	
(1) Architects	
(2) College placement officers	
(3) Home economists	
(4) Landscape architects	
(5) Lawyers	
(6) Librarians	
(7) Photographers	
(8) Programers	
(9) Psychologists	
(10) Recreation workers	
(11) Social workers	
(12) Surveyors	
(13) Systems analysts	
(14) Urban planners	
2. Managerial occupations	
a. Industrial traffic managers	
b. Purchasing agents	
3. Clerical and related occupations	
a. Stenographers and secretaries	
b. Typists	
c. Receptionists	
d. Bookkeeping workers	
e. Cashiers	
f. Office machine operators	
g. Electronic computer operating personnel.	
h. Telephone operators	
i. Shipping and receiving clerks	

Introduction to World of Work (Cont'd)
(Seventh Grade)

DECEMBER (Cont'd)

Units	References and Teacher Comments
B. Suggested learning activities 1. Invite people of different occupations studied to discuss their work with the class. 2. Carry class on field trip to visit and observe different type jobs being studied in class. 3. Have students write job descriptions for different occupations . 4. Others	
III. Metalcrafts	
A. Employment opportunities in the field of metalworking 1. Importance of occupations 2. Occupations in metalworking industry 3. Nature of work 4. Others	"Occupational Outlook Handbook" "Exploring the Industries" "General Shop"
B. Common terms in the metalworking industries 1. Rolling 2. Casting 3. Forging 4. Machining 5. Alloy 6. Ferrous metal 7. Nonferrous metal 8. Countersinking 9. Grinding 10. Peening 11. Tap 12. Die 13. Riveting 14. Soldering 15. Annealing 16. Etching 17. Brazing 18. Welding 19. Others	
C. Introduction to skills in metalworking 1. Identification and use of tools and equipment used in this course 2. Bending and fastening small sheet metal projects 3. Soldering	
D. Suggested learning activities 1. Invite sheet metal or machine shop employee to discuss his work with class. 2. Field trip to sheet metal or machine shop to observe machinery and type work done. 3. Students make some of the following projects. See plans in project book. a. Plaque b. Small Scoop c. Cookie cutter d. Coaster e. Ash tray f. Trophy	

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Introduction to World of Work
(Seventh Grade)

JANUARY

Units	References and Teacher Comments
I. The Job World (Cont'd)	"Occupational Outlook Handbook"
A. Each of the occupational classifications listed below should be studied first from the economic standpoint and then approached from the aesthetic point of view.	"Our World of Work" "WORK"
1. Sales occupations	
a. Salesman and saleswomen in retail trade b. Automobile salesman c. Automobile parts countermen d. Automobile service advisors e. Salesmen in wholesale trade f. Manufacturer's salesman g. Insurance agents and brokers h. Real estate salesman and brokers i. Securities salesmen	
2. Service occupations	
a. Private household workers b. FBI special agents c. Firefighters d. Policemen and policewomen e. State police officers f. Cooks and chefs g. Waiters and waitresses h. Hospital attendants i. Barbers j. Cosmetologists k. Others	
B. Suggested learning activities	
1. Invite people of different occupations studied to discuss their work with the class. 2. Carry class on field trip to visit and observe different type jobs being studied in class. 3. Have students write job descriptions for different occupations. 4. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

JANUARY (Cont'd)

Units	References and Teacher Comments
II. Power and Mechanics	
A. Job opportunities in power and mechanics	
1. Importance of occupations 2. Types of maintenance and repair occupations 3. Nature of work 4. Others	"General Shop" "Occupational Outlook Handbook"
B. Introduction to engines	
1. History and development of engines 2. Types of engines 3. Uses of engines 4. Principle of internal-combustion engine 5. Major parts of a one-cylinder engine 6. Others	
C. Suggested learning activities	
1. Students write a report on how gasoline is processed from crude oil 2. Show film "ABC of Internal Combustion," General Motors Corp. 3. Demonstrate the following to students: a. Things to do: Remove spark plug and head assembly, turn engine slowly observing action of valves and pistons, determine stroke, check firing, replace head assembly and spark plug b. Tools needed: Socket wrench set, screwdriver, pliers, spark plug wrence, and tester 4. Invite mechanic to speak to class about his work. 5. Field trip to garage to observe work done. 6. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

FEBRUARY

Units	References and Teacher Comments
I. The Job World (Cont'd) A. Each of the occupational classifications listed below should be studied first from the economic standpoint and then approached from the aesthetic point of view. 1. Skilled and other manual occupations a. Skilled workers b. Semiskilled workers c. Unskilled workers d. Building trades (1) Asbestos and insulating workers (2) Bricklayers (3) Carpenters (4) Cement masons (5) Construction laborers and hod carriers (6) Electricians (construction) (7) Elevator constructors (8) Floor covering installers (9) Glaziers (10) Lathers (11) Marble setters, tile setters, and terrazzo workers (12) Operating engineers (construction machinery operators) (13) Painters and paperhangers (14) Plasterers (15) Plumbers and pipefitters (16) Roofers (17) Sheet-metal workers (18) Stonemasons (19) Structural-, ornamental-, and reinforcing-iron workers, riggers, and machine movers	"Occupational Outlook Handbook" "Our World of Work" "WORK"

Introduction to World of Work (Cont'd)
(Seventh Grade)

FEBRUARY (Cont'd)

Units	References and Teacher Comments
B. Suggested learning activities	
1. Use part of set of 6, 12" LP records "Exploring the World of Work," 555 West 166th St., South Holland, Illinois.	
2. Use "Widening Occupational Roles Kit (WORK)" if available for individual and group study, Science Research Associates, Chicago, Illinois.	
3. Invite different people to discuss their work with the class.	
4. Others	
II. <u>Introduction to Leathercraft</u>	
A. Job opportunities in leathercraft	"General Shop"
1. Importance of occupations	
2. Type of jobs	
3. Nature of work	
4. Others	
B. Kinds of leather	
1. Art and craft leathers	
2. Carving and stamping leathers	
3. Lacing materials	
C. Processing leather	
1. Curing or dressing	
2. Tanning	
3. Finishing	
4.	
D. Transferring a design on leather	
E. Stamping and stipping a design	
F. Carving and cutting leather	
G. Fastening leather	
H. Punching holes and slits for edge lacing	
I. Lacing edges	
J. Suggested learning activities	
1. Have students make list of items they own made of leather	

Introduction to World of Work (Cont'd)
(Seventh Grade)

FEBRUARY (Cont'd)

Units	References and Teacher Comments
J. Suggested learning activities (Cont'd) 2. Visit a leather shop if one is available 3. Let students repair leather items. 4. Obtain leather or leather kits and let students make one of following or other leather projects. a. Book marker b. Comb case c. Key case d. Folding coin purse e. Billfold f. Man's belt g. Woman's belt with plastic buckle h. Knife sheath i. Photograph album	

Introduction to World of Work (Cont'd)
(Seventh Grade)

MARCH (Cont'd)

Units	References and Teacher Comments
d. Mechanics and repairmen (cont'd)	
(10) Industrial machinery repairmen	
(11) Instrement repairmen	
(12) Maintenance electricians	
(13) Millwrights	
(14) Television and radio service technicians	
(15) Truck mechanics and bus mechanics	
(16) Vending machine mechanics	
(17) Watch repairmen	
B. Suggested learning activities	
1. Use part of set of 6, 12" LP records, "Exploring the World of Work," Wilson Corporation, 555 West 166th Street, South Holland, Illinois.	
2. Use "Widening Occupational Roles Kit (WORK)" if available for individual and group study, Science Research Associates, Chicago, Illinois.	
3. Invite counselor to discuss the process of occupational choice.	
4. Others	
II. <u>Introduction to Plastics</u>	
A. Importance of plastic industry	"General Shop"
B. Employment opportunities	
1. Type jobs	
2. Working conditions	
3. Nature of work	
C. Types of plastics	
D. Laying out and transferring patterns	
1. Tool	
2. Laying out and transferring	
E. Sawing plastics	
1. Tools	
2. Sawing	

Introduction to World of Work (Cont'd)
(Seventh Grade)

MARCH (Cont'd)

Units	References and Teacher Comments
II. Introduction to Plastics (Cont'd)	
F. Dressing plastic edges	
1. Tools	
2. Dressing edges	
G. Drilling holes in plastic	
H. Tapping and threading	
I. Surface decorating	
1. Tools	
2. Decorating surfaces	
J. Forming plastics	
K. Carving plastics	
L. Fastening plastics	
1. Tools	
2. Cementing joints	
3. Fastening with screws	
M. Coloring plastics	
1. Types of dyes	
2. Cold method of coloring	
N. Fiber glass	
1. How fiber glass products are made	
2. Products made of fiber glass	
3. Materials needed for fiber glass activity	
a. Forms	
b. Plastic resin and catalyst	
c. Coloring, cleaning materials, and waxes	
O. Suggested learning activities	
1. Have students make a list of plastic articles found in their home.	
2. Field trip to plastic industry if possible.	
3. Carry class to hardware or houseware store and observe articles made of plastic.	

Introduction to World of Work (Cont'd)
(Seventh Grade)

MARCH (Cont'd)

Units	References and Teacher Comments
O. Suggested learning activities (Cont'd) 4. Students make some of the following plastic projects. a. Paper weight b. Letter opener c. Pen set for desk d. Picture frame e. Book ends f. Tubular lamp g. Bud vase h. Earrings i. Jewelry box j. Fiber glass bowl	

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Introduction to World of Work
(Seventh Grade)

APRIL

Units	References and Teacher Comments
I. The Job World (Cont'd)	"Occupational Outlook Handbook"
A. Each of the occupational classifications listed below should be studied first from the economic standpoint and then approached from the aesthetic point of view.	"Our World of Work"
	"WORK"
1. Skilled and other manual occupations (cont'd)	
a. Some other manual occupations	
(1) Assemblers	
(2) Automobile painters	
(3) Automobile trimmers and installation men (upholsterers)	
(4) Blacksmiths	
(5) Boilermaking occupations	
(6) Dispensing opticians and optical mechanics	
(7) Electroplaters	
(8) Furniture upholsterers	
(9) Gasoline service station attendants	
(10) Inspectors (manufacturing)	
(11) Jewelers and jewelry repairmen	
(12) Motion picture projectionists	
(13) Photographic laboratory occupations	
(14) Power truck operators	
(15) Production painters	
(16) Shoe repairmen	
(17) Stationary engineers	
(18) Stationary fireman (boiler)	
(19) Welders and oxygen and arc cutters	
2. Some major industries and their occupations	
a. Manufacturing	
(1) Aircraft, missile, and spacecraft manufacturing	
(2) Aluminum industry	
(3) Apparel industry	
(4) Atomic energy field	
(5) Baking industry	
(6) Electronics manufacturing	

Introduction to World of Work (Cont'd)
(Seventh Grade)

APRIL (Cont'd)

Units	References and Teacher Comments
a. Manufacturing (cont'd)	
(7) Foundries	
(8) Industrial chemical industry	
(9) Iron and steel industry	
(10) Motor vehicle and equipment manufacturing	
(11) Petroleum and natural gas production and processing	
(12) Petroleum refining occupations	
(13) Pulp, paper, and allied products industries	
b. Wholesale and retail trade	
(1) Restaurants	
c. Government	
(1) Civilian employment	
(2) Federal Government	
(3) State and local governments	
(4) Armed Forces	
d. Agriculture	"Handbook of Agricultural Occupations"
(1) Opportunities in area of:	
(a) Agricultural production	
(b) Agricultural supplies	
(c) Agricultural products	
(d) Agricultural resources	
(e) Agricultural mechanics	
(f) Ornamental horticulture	
(g) Forestry	
(h) Professional agriculture	
B. Suggested learning activities	
1. Invite workers in different occupations to discuss their work with class.	
2. Field trip with class to observe different jobs.	
3. Have students write description of different occupations.	
4. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

APRIL (Cont'd)

Units	References and Teacher Comments
II. Elementary Life Science	"Exploring Agriculture"
A. Careers in agriculture	"Handbook of Agricultural Occupations"
1. Importance of agricultural occupations 2. Occupations in agriculture 3. Nature of work 4. Others	"Occupational Outlook Handbook"
B. Nature study and conservation	"Agriculture in Our Lives"
1. Kinds of natural resources 2. The balance in nature 3. Identifying plants and animals 4. Outdoor experiences 5. Others	
C. Elementary plant science	
1. Plants as sources of food 2. Plants as sources of shelter and clothing 3. Industrial uses of plants 4. Seeds and what they do 5. Others	
D. Elementary animal science	
1. Importance of domesticated animals 2. Animals as sources of food 3. Animals as sources of clothing 4. Types of farm animals 5. Others	
E. Mechanized agriculture	
1. History of farm machinery and equipment 2. Tractors 3. Antique and modern tractors 4. New ways to prepare to soil 5. Planting machines 6. Cultivators 7. Milestones in mechanized agriculture	

Introduction to World of Work (Cont'd)
(Seventh Grade)

APRIL (Cont'd)

Units	References and Teacher Comments
F. Suggested learning activities 1. Make individual and class collections of insects, leaves, wood samples, flowering plants, and soil 2. Invite a conservation specialist to discuss what is being done to conserve the natural resources. 3. Make a list of agricultural occupations in community. 4. Discuss questions at the end of chapter in textbook. 5. Have students write a narrative description of the development of mechanized agriculture. 6. Students give reports on care and feeding of animals. 7. Show film "Vocations in Agriculture" Extension Service Film Library, Auburn University. 8. Plant seed in flats to observe germination and growth. 9. Field trip to a farm to observe plants and animals. 10. Invite farmer to speak to class. 11. Hatch chicks in a small incubator. 12. Others	

Introduction to World of Work (Cont'd)
(Seventh Grade)

MAY

Units	References and Teacher Comments
I. The Job World (Cont'd)	
A. Each of the occupational classifications listed below should be studied first from the economic standpoint and then approached from the aesthetic point of view.	"Occupational Outlook Handbook" "Our World of Work" "WORK"
1. Major industries and their occupations (cont'd)	
a. Transportation, communication, and public utilities	
(1) Civil aviation	
(a) Pilots and copilots (b) Flight engineers (c) Stewardesses (d) Aircraft mechanics (e) Airline dispatchers (f) Air traffic controllers (g) Ground radio operators and teletypists (h) Traffic agents and clerks	
(2) Electric power industry	
(a) Powerplant occupations (b) Transmission and distribution occupations (c) Customer service occupations	
(3) Radio and television broadcasting	
(a) Radio and TV announcers (b) Broadcast technicians	
(4) Railroads	
(a) Locomotive engineers (b) Locomotive firemen (helpers) (c) Conductors (d) Brakemen (e) Telegraphers, telephoners, and towermen	

Introduction to World of Work (Cont'd)
(Seventh Grade)

MAY (Cont'd)

Units	References and Teacher Comments
(4) Railroads (cont'd)	
(f) Station agents	
(g) Clerks	
(h) Shop trades	
(i) Signal department workers	
(j) Track workers	
(k) Bridge and building workers	
(5) Telephone industry	
(a) Telephone craftsmen	
1. Central office craftsmen	
2. Central office equipment installers	
3. Linemen and cable splicers	
4. Telephone and PBX installers and repairmen	
(b) Construction	
(c) Finance, insurance, and real estate	
1. Banking	
a. Bank clerks	
b. Tellers	
c. Bank officers	
2. Insurance business	
(d) Mining	
1. Petroleum and natural gas production occupations	
2. Natural gas processing occupations	
(e) Printing (graphic arts)	
1. Composing room occupations	
2. Photoengravers	
3. Electrotypers and sterotypers	

Introduction to World of Work (Cont'd)
(Seventh Grade)

MAY (Cont'd)

Units	References and Teacher Comments
e. Printing (graphic arts) (cont'd)	
4. Printing pressman and assistants 5. Lithographic occupations 6. Bookbinders and related workers	
B. Suggested learning activities	
1. Invite some employees of the above industries to discuss their work with the class. 2. Carry class on field trip to visit and observe some of the workers in industries. 3. Have students write job descriptions of different industrial jobs. 4. Others	
II. <u>Graphic Arts</u>	
A. Introduction to graphic arts	"General Shop"
1. Definition of graphic arts 2. Purpose of graphic arts 3. Importance of graphic arts 4. History of graphic arts 5. Job opportunities in this field 6. Nature of work	
B. Methods of printing	
1. Letterpress 2. Lithography 3. Gravure 4. Screen	
C. Suggested learning activities	
1. Field trip to printing shop to observe type work done. 2. Invite publisher of local paper to discuss type job opportunities in printing industry. 3. Have students make reports on early or ancient printing and paper making. 4. Field trip to paper mill.	

Introduction to World of Work (Cont'd)
(Seventh Grade)

MAY (Cont'd)

Units	References and Teacher Comments
C. Suggested learning activities (cont'd)	
5. Stretch silk or metal screen material over a frame. Let students make screen printing projects by using cut-outs and forcing ink through the cut-outs or through the screen. Suggested projects to make are silhouettes of leaves, animals, letters, faces, etc.	
III. <u>Ceramics</u>	
A. Introduction to ceramics	"General Shop"
1. Definition of ceramics	
2. Job opportunities in this field	
B. The story of ceramic materials	
C. Designing in ceramics	
D. Making a pinch bowl	
E. Building with slabs and making tile	
F. Building with coils	
G. Casting with slip	
H. Decorating the surface	
I. Simple modeling	
J. Glazing the ware	
K. Firing the ware	
L. Making plaster molds	
M. Enameling on metal	
N. Suggested learning activities	
1. Visit a factory, museum, store, or dealer in ceramic materials. Have students make a report on the processes and wares.	
2. Visit a gift shop. Study the ceramic displays.	
3. Visit jewelry stores and gift shops to get ideas about enameled cuff links, pins, earrings, etc. Study sizes, how they are made, and the designs. Let students try to make some of these items.	
4. Others	

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INTRODUCTION TO THE WORLD OF WORK
(Seventh Grade)

References

1. "Occupational Outlook Handbook," U. S. Department of Labor, U. S. Government Printing Office, Washington, D. C., 1968-69. Price: $4.25

2. *"General Shop," Groneman & Feirer, McGraw Hill Book Company, Manchester Road, Manchester, Missouri 63011. Price: $4.65

3. "Exploring the World of Jobs," and "The Job in your Future," Junior Guidance Series Booklets, Science Research Associates, 259 East Erie Street, Chicago, Illinois 60611. Price: 77¢ each

4. "Exploring the Industries," Groneman, Steck-Vaughn, Austin, Texas. Price: $1.08

5. "Jobs in Your Future," Scholastic Magazines and Book Service, 900 Sylvan Avenue, Englewood Cliffs, New Jersey 07632. Price: 75¢

6. "Handbook of Agricultural Occupations," Hoover, The Interstate Printers and Publishers, Danville, Illinois (1969). Price: $5.95

7. **"Exploring Agriculture," Evans and Donahue, Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1963). Price: $5.25

8. "Our World of Work," Guidance Series Booklet, Science Research Associates, 259 East Erie Street, Chicago, Illinois 60611. Price: 75¢

9. "Official FFA Manual," Future Farmer Supply Service, Alexandria, Virginia 22309. Price: See FFA catalog

10. "Parliamentary Procedure for FFA Chapters," Supervision Vocational Agriculture, Field Office, 101 Petrie Hall, Auburn, Alabama 36830. (Free)

11. **"Agriculture In Our Lives," Alfred H. Krebs, The Interstate Printers and Publishers, Danville, Illinois 61832. Price: $5.36

Widening Occupational Roles Kit***

WORK is an occupational study system designed to give students in grades six through nine a chance to broaden their knowledge of the world of work. Source: Science Research Associates, 259 East Erie Street, Chicago, Illinois. Price: $141.75

REFERENCES (Cont'd)

****400 Junior Occupational Briefs
5 Junior Guidance Booklets
35 Student Workbooks
1 Teacher's Manual
5 Color Filmstrips

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*State adopted textbook in Industrial Arts
**State adopted textbook in Vocational Agriculture
***Work would be a valuable addition to the school library or guidance service making it available to all departments.
****Junior Occupational Briefs may be ordered individually or as a complete set. Price: $89.50

VT 012 681
Course Outline for Exploring the World of Work (Eighth Grade).

Alabama State Dept. of Education, Montgomery. Agricultural Education Service.
MF AVAILABLE IN VT-ERIC SET.
Vocational Agricultural Education, Field Office, 101 Petrie Hall, Auburn, Alabama 36830 (available free to State Supervisors and Head Teacher Educators only).
PUB DATE - 70 31p.

DESCRIPTORS - *TEACHING GUIDES; *VOCATIONAL AGRICULTURE; *INDUSTRIAL ARTS; *OCCUPATIONAL INFORMATION; CURRICULUM GUIDES; AGRICULTURAL EDUCATION; COURSE CONTENT; GRADE 8; UNITS OF STUDY (SUBJECT FIELDS); OCCUPATIONAL CHOICE; UNIT PLAN
IDENTIFIERS - *OCCUPATIONAL EXPLORATION

ABSTRACT - This unit outline, which was prepared by the Alabama State Department of Education for eighth grade students, covers the work opportunities and requirements in elementary agribusiness science and industry. The 23 units, presented for each month of the school year, provide for laboratory experiences in occupational arts and crafts, including the identification, use, and care of hand tools, hardware, woods, leather, metals and other materials. Each unit consists of a content outline, suggested activities, and references. Appended are audio-visual aids, a bibliography, and an occupational kit. (FM)

VT 012 681

ED0 56238

Alabama
1970

COURSE OUTLINE
FOR
EXPLORING THE WORLD OF WORK

(EIGHTH GRADE)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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STATE OF ALABAMA
State Department of Education
Division of Vocational Education
Agricultural Education Service
Montgomery, Alabama

VT012681

6266

EXPLORING THE WORLD OF WORK

Purpose of the Course

This is an exploratory course of the work opportunities and requirements in elementary agribusiness science and industry. This course in occupational arts and crafts includes the identification, use and care of hand tools, hardware, woods, leather, metals and other materials. Students are given a general picture of agriculture and industry and receive elementary laboratory experiences in the many areas of the World of Work. The course includes instruction on professional occupations in addition to jobs in agribusiness and basic industry.

Course Objectives

1. To give students a general picture of agriculture and industry and a knowledge of the job opportunities available in these fields.

2. To assist students in gaining some knowledge of the many areas of the world of work.

3. To assist students in developing leadership abilities through FFA activities.

4. To introduce students to simple arts and crafts to assist them in determineing interests and abilities in these areas.

Alabama
1970

COURSE OUTLINE

FOR

EXPLORING THE WORLD OF WORK

(Eighth Grade)

SEPTEMBER

Units	References and Teacher Comments
I. Orientation and General Information	
A. Purpose and value of course	
B. Department policies and goals	
C. References and supplies	
D. Introduction to youth organizations (FFA)	
1. FFA is a definite part of the course. Students should take advantage of the leadership development opportunities this part of the course affords.	
2. Organization	Official FFA Manual "Parliamentary Procedure for FFA Chapters"
a. History	
b. Aims	
c. Purposes	
d. Membership	
e. Degrees	
f. Advantage of membership	
3. Leadership	"Your Opportunities in Vocational Agriculture"
a. How to be a good FFA member	
b. Conducting effective meetings	
c. Parliamentary procedure	
d. Duties and responsibilities of members	
e. Characteristics of leadership	
4. Suggested learning activities	
a. Conduct a tour of facilities	
b. Have students make brief reports on some phase of FFA	
c. Practice opening and closing ceremonies with class	
d. Review contest application forms with students	
e. Invite the FFA president to discuss the work of organization	
f. Others	

Exploring the World of Work, cont'd
(Eighth Grade)

SEPTEMBER cont'd

Units	References and Teacher Comments
II. Our World of Work	
A. Changes in our economy	
1. Better living 2. Automation and shorter work week	
B. Importance of training for a job	
1. Why some jobs pay more 2. Jobs you are interested in	
C. The industrial world	
1. Where the jobs are 2. Kinds of industries in the world of work	
D. The occupational world	"Our World of Work" (Pages 14-48) "Exploring the World of Jobs"
1. Variety of occupations 2. White collar workers 3. Professional occupations 4. Managerial jobs 5. Clerical 6. Sales 7. The craftsman 8. Agricultural occupations 9. Service occupations	
E. Suggested learning activities	
1. Make a list of ten occupations that did not exist in 1900 2. Assign students to study the Industrial Revolution and write narrative description 3. Show filmstrip: "Preparing for Jobs in the 70's", Guidance Associates, Inc. Pleasantville, New York 10570	
F. Others	

Exploring the World of Work, cont'd
(Eighth Grade)

SEPTEMBER cont'd

Units	References and Teacher Comments
III. Jobs in Your Future	
A. Review student's interests and abilities	"Jobs in Your Future" (Pages 6-38)
1. Who are you?	"Occupational Outlook Handbook"
2. What will you be doing ten years from now?	
B. What can you do?	
C. What can you do now?	
1. Three laws about jobs	
2. Why you should stay in school	
3. Education and jobs in your future	
D. Job interest fields	
1. Literary work	
2. Scientific work	
3. Mechanical work	
4. Clerical work	
5. Persuasive work	
6. Outdoor work	
7. Service work	
8. Artistic work	
E. Suggested learning activities	
1. List and discuss occupations under the eight interest fields	
2. Complete exercises in "Jobs in Your Future"	
3. Use "Widening Occupational Roles Kit", if available	
4. Bring local newspaper to class and study advertisements and want-ad section. Observe what job openings are listed. What training, salary and opportunities for promotion would apply to these jobs.	
5. Use flash cards to identify the hand tools that will be used later in the arts and crafts part of this course.	

Exploring the World of Work, cont'd
(Eighth Grade)

SEPTEMBER cont'd

Units	References and Teacher Comments
6. Write a short essay on one of the job interest fields listed in III D above. Comment on "Why I Think I Would Like This Type of Work".	

Exploring the World of Work, cont'd
(Eighth Grade)

OCTOBER

Units	References and Teacher Comments
I. Wood Crafts	
A. Uses of forest products	
B. Trees - description and location	
C. Figuring board measure	
D. Safety	"Exploring the Industries"
E. Measuring and laying out	
F. Gauging width and thickness	
G. Sawing across or with the grain	"General Shop"
H. Assembling and adjusting planes, spoke shaves, and cabinet scrapers	
I. Boring and drilling holes	
J. Fastening with screws	
K. Driving and pulling nails	
L. Cutting and trimming with the chisel	
M. Sharpening tools	
N. Sanding for finishing	
O. Gluing and clamping	
P. Wood finishing	
1. Paint and enamel	
2. Stain	
3. Woodfiller	
4. Shellac	
5. Varnish	
6. Applying a penetrating finish	
7. Rubbing varnish surfaces	
8. Care of brushes	
Q. Suggested learning activities	
1. Figure a bill of materials	
2. Measuring and sawing wood	
3. Use hammer, plane, and chisel	
4. Sand, assemble and finish a wood project in worktext or textbook	
5. Complete exercises in worktext	
6. Examination	
7. Perform the following exercises:	
a. Mix paint ready for use	
b. Prepare a board surface for painting	
c. Apply paint to wood surfaces	
d. Discuss common paint failures	
e. Prepare board and apply varnish finish	

Exploring the World of Work, cont'd
(Eighth Grade)

OCTOBER cont'd

Units	References and Teacher Comments
8. Suggested wood crafts projects for students to construct and carry home: a. Bookends, bookshelves b. Combination nail and tool box c. Flower pot d. Wood miter box e. Magazine rack f. Simple bookcase g. Others	

Exploring the World of Work, cont'd
(Eighth Grade)

NOVEMBER

Units	References and Teacher Comments
I. Surveying Occupational Fields	
A. Dictionary of occupational titles grouping	"Dictionary of Occupational Titles"
1. Professional, technical, and managerial occupations 2. Clerical and sales occupations 3. Service occupations 4. Farming, fishery, forestry, and related occupations 5. Processing occupations 6. Machine trades occupations 7. Bench work occupations 8. Structural work occupations 9. Others	"Exploring the World of Jobs" "The Job in Your Future" "Occupational Outlook Handbook"
B. Categories adopted for introduction to occupations study	
1. Manual and mechanicsl 2. Clerical, sales and service 3. Professional, technical, and managerial 4. Others	
C. Suggested learning activities	
1. List major groupings on chalk board and have class members to list occupations under each major group 2. Select a number of occupations and have students put them into proper categories 3. Develop a list of occupations under each category 4. Invite a resource person from each major group to talk with class 5. Record: "Introducing the World of Work, Part I and Part II", (Wilson Corporation, 555 West 166th Street, South Holland, Illinois 60473) 6. List the major types of occupations that exist in your hometown. Give advantages and disadvantages of each	

Exploring the World of Work, cont'd
(Eighth Grade)

NOVEMBER cont'd

Units	References and Teacher Comments
II. Planning Your Career	
A. Some things we need to know about an occupation	
1. Description of work involved	"The Job in Your Future"
2. Working conditions	
3. Hours of work	
4. Abilities required	"Exploring the World of Jobs"
5. Earnings	
6. Personality required	
7. Education and training required	"Our World of Work"
8. Where education and training can be acquired.	
9. Advantages	
10. Disadvantages	
11. Outlook for future	
12. Advancement possibilities	
13. Demand for workers	
14. Health and safety aspects	
15. Others	
B. Some ways to learn about occupations	
C. Suggested learning activities	
1. Invite the guidance counselor to discuss ways to learn about occupations and school resources	
2. Show film: "The Big Question - Choosing Hour Career", Association Films, Inc., 347 Madison Avenue, New York, N. Y.	
3. "Exploring the World of Work", Set of 6, 12"LP records, Wilson Corp., 555 West 166th Street, South Holland, Illinois 60473	
4. Use "Widening Occupational Roles Kit (WORK)" if available for individual and group study, Science Research Associates, Inc., 259 East Erie St., Chicago, Illinois 60611	
5. Administer "General Interest Survey" Kuder Form E	
6. Visit a few local agribusiness firms and observe what the employees do. What training do you think would be helpful for these employees?	

Exploring the World of Work, cont'd
(Eighth Grade)

NOVEMBER cont'd

Units	References and Teacher Comments
7. Arts and Crafts Exercise	
a. Whipping the end of a rope	"General Shop"
b. Make a crown knot	
c. Make a crown splice	
d. Make an overhand knot	
e. Make a square knot	
f. Make a clove hitch	
g. Make a bowline knot	
h. Make a sheep shank	
i. Make a short splice	
j. Make a long splice	
k. Make an eye splice	

Exploring the World of Work, cont'd
(Eighth Grade)

DECEMBER

Units	References and Teacher Comments
I. Careers in Drafting, Designing, and Engineering	
A. History and trend B. Jobs in drafting, designing, and engineering	"Occupational Outlook Handbook" "Exploring the Industries"
1. Draftsman 2. Technician 3. Artist 4. Design engineer 5. Mechanical engineer 6. Agricultural engineer 7. Civil engineer 8. Others	
C. Working conditions	
1. Type of work 2. Where work is done 3. What workers like about occupation 4. What workers dislike about occupation 5. Advantages of careers in drafting, designing, and engineering 6. Disadvantages	
D. Suggested learning activities	
1. Have students interview a person employed in drafting, designing or engineering 2. Show film "The Draftsman-Surveyor," Modern Talking Pictures Service, Inc., 501 N. College St., Charlotte, N. C. 28202 3. Invite resource person to discuss occupations (Use other teachers when possible) 4. Show film "Engineers in the Making," General Motors Corp., Public Relations Staff, Film Library, General Motors Building, Detroit, Mich. 48202	

Exploring the World of Work, cont'd
(Eighth Grade)

DECEMBER cont'd

Units	References and Teacher Comments
II. Drafting and Planning	"Exploring the Industries"
A. Introduction	
B. Line symbols	
C. Sketching or freehand drawing	"General Shop"
D. Sketching working drawings	
E. Sketching pictoral drawings	
F. Lettering and numbering	
G. Measuring	
H. Planning the procedure of your work	
I. Suggested learning activities	
1. Complete and draw views in worktext	
2. Complete measuring problems in worktext	
3. Practice lettering exercises in worktext	
4. Make a simple work plant for one of wood craft projects provided in worktext and textbook	
5. Examination	
III. Careers in the Woods Industries	
A. History and trend	"Occupational Out look Handbook"
B. Jobs in the woods industries	
1. Machinery operator	"Exploring the Industries"
2. Pulpwood producer	
3. Tree farmer	
4. Grader	
5. Saw operator	
6. Forester	
7. Carpenter and cabinetmaker	
8. Plywood factory worker	
9. Veneer lathe operator	
10. Furniture construction	
11. Wood finisher	
12. Others	
C. Working conditions	
1. Type of work	
2. Where work is done	
3. What workers like about occupation	
4. What workers dislike about occupation	
5. Advantages of career in wood industries	

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Exploring the World of Work, cont'd
(Eighth Grade)

DECEMBER cont'd

Units	References and Teacher Comments
6. Disadvantages of career in wood industries	
D. Suggested learning activities	
1. Invite a forester to discuss occupations in wood industries	
2. Arrange field trip to local woods industry	
3. Use "Widening Occupational Roles Kit" if available	
4. Arts and crafts - leather	
a. Follow exercises in pages 319-345, "General Shop":	"General Shop"
1. Trace designs on leather	
2. Carving leather	
3. Punch holes and lace	
4. Finish leather	
5. Complete small leather project such as belt, billfold or calf halter	

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Exploring the World of Work, cont'd
(Eighth Grade)

JANUARY

Units	References and Teacher Comments
I. Careers in Agribusiness	
A. History and trend	"Handbook of Agricultural Occupations"
B. Jobs in agribusiness	
1. Farmer	
2. Feed salesman	"Occupational Outlook Handbook"
3. Farm machinery dealer	
4. Vo-Ag teacher	
5. Landscape gardner	
6. Agricultural supply salesman	
7. Agricultural engineer	
8. Farm machinery mechanic	
9. Agricultural products buyer	
10. Others	
C. Working conditions	
1. Type of work	
2. Where work is done	
3. What workers like about occupation	
4. What workers dislike about occupation	
5. Advantages of careers in agribusiness	
6. Disadvantages	
7. Others	
D. Suggested learning activities	
1. Discuss section on jobs in agriculture from Occupational Outlook Handbook	
2. Show film "Dynamic Careers Through Agriculture" Vo-Ag Film Library	
3. Show film "A Step Ahead" New Holland Film Library, Memphis, Tennessee	
II. Agribusiness	"Agriculture in Our Lives"
A. Introduction to Agribusiness	"Exploring Agriculture"
1. What is agribusiness	
2. Benefits from studying vocational agriculture	"Suggested Teaching Outline for Life Science and General Shop"
3. Agriculture today	
4. Country living	"Agriculture in Our Lives"

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Exploring the World of Work, cont'd
(Eighth Grade)

JANUARY cont'd

Units	References and Teacher Comments
B. Elementary plant science 1. How plants are useful to man 2. Function of seed in the growing of plants 3. How plants reproduce, pollinate, and fertilize 4. Conditions necessary for plant growth 5. Plant food 6. How plants feed C. Introduction to animal science 1. Breeds of livestock 2. Selection of livestock 3. Feeding animals 4. Livestock breeding 5. Parasites D. Conservation 1. What is conservation 2. Wildlife conservation 3. Conserving water 4. Soil conservation E. Introduction to ornamental horticulture 1. What is ornamental horticulture 2. Care and maintenance of a lawn 3. Fertilizing ornamental plants 4. Pruning ornamentals 5. Transplanting trees and shrubs F. Suggested learning activities 1. Tour one or more farming enterprises in community 2. Conduct field trip of an agribusiness 3. Show filmstrip "Sexual Reproduction in Plants" Modern Talking Pictures 4. Each student plant seeds in a flat 5. Have students plant pine seedlings 6. Visit and FFA member with a club calf	

Exploring the World of Work, cont'd
(Eighth Grade)

FEBRUARY

Units	References and Teacher Comments
I. Careers in the Metal Industries	"Exploring the Industries"
A. History and trend B. Jobs in the mteal industries	"Occupational Outlook Handbook"
1. Foundry man 2. Miner 3. Machinist 4. Engineer 5. Technician 6. Welder 7. Tool maker 8. Diemaker 9. Mechanical operator 10. Sheet metal operator and craftman 11. Inspectors 12. Metalsmith 13. Jewelry worker 14. Metal workers	
C. Working conditions	
1. Type of work 2. Where work is done 3. What workers like about occupation 4. What workers dislike about occupation 5. Advantages of careers in metal working 6. Disadvantages	
D. Suggested learning activities	
1. Demonstrate the welding process to class 2. Students collect want-ads and discuss in class 3. Visit or invite a representative of a local metal industry 4. Use "Widening Occupational Roles Kit" if available	
II. Bench Metals	
A. Introduction	"Exploring the Industries"

Exploring the World of Work, cont'd
(Eighth Grade)

FEBRUARY cont'd

Units	References and Teacher Comments
B. Making of iron and steel	
1. Raw materials used in making iron and steel	"General Shop"
2. Processes in making iron	
3. Processes in making steel	
C. Uses of steel	
D. Safety	
E. Cutting metal	
F. Filing	
G. Drilling	
H. Grinding, polishing, and identifying metals	
1. Parts of the grinder	
2. Use of the grinder	
3. Identifying metals by the type of spark	
4. Grinding metal	
I. Riveting	
J. Threading and tapping	
K. Metal finishing	
L. Suggested learning activities	
1. Order free kit: "How Steel is Made" includes bottled sample of raw materials and color filmstrip, Chicago Film Distribution Center, U. S. Steel Corp., 208 South LaSalle Street, Chicago, Illinois 60690	
2. Students complete problems in work-text	
3. Show film "Precision Tool Making and Machining" Modern Talking Pictures Service	
4. Use hacksaw, cold chisel, file, and center punch	
5. Students do exercises in drilling threading and tapping	
III. <u>Sheet Metal</u>	"Exploring the Industries"
A. Introduction	
B. Measuring and laying out	"General Shop"
C. Cutting	

Exploring the World of Work, cont'd
(Eighth Grade)

FEBRUARY cont'd

Units	References and Teacher Comments
D. Folding and forming E. Common joints 1. Lap seam 2. Folded seam 3. Grooved folded seam 4. Burred edge seam 5. Double seam F. Soldering 1. Definition of soldering 2. Soldering materials 3. Soldering tools 4. Tinning a soldering copper 5. Soldering a joint G. Suggested learning activities 1. Students complete problems in worktext 2. Student complete one of suggested metal projects in worktext 3. Examination 4. Make one of the following items: a. Dustpan b. Feed scoop c. Funnel d. Sugar scoop e. Tool box	

Exploring the World of Work, cont'd
(Eighth Grade)

MARCH

Units	References and Teacher Comments
I. Careers in Electricity	
A. History and trend B. Jobs in electricity and electronics	"Exploring the Industries"
1. Electrical technician 2. Electrical testing specialist 3. Engineers 4. Electronics technician 5. Linesman 6. Electrician 7. Others	"Occupational Outlook Handbook"
C. Working conditions	
1. Type of work 2. Where work is done 3. What workers like about occupation 4. What workers dislike about occupation 5. Advantages of careers in electricity 6. Disadvantages	
D. Suggested learning activities	
1. Show film "Your Future in Electronics" RCA Institute, Inc., 350 W. 4th St., New York, N. Y. 2. Show film "The Electronics Technician" Modern Talking Service, 501 N. College St., Charlotte, N. C. 28202 3. Invite resource person from Ala. Power Co. or Electricial Co-op to discuss electrical occupations 4. Show film "The Electrical Worker" Modern Talking Picture Service 5. Use "Widening Occupational Roles Kit" if available for individual and group study. Science Research associates, Inc.	
II. Electricity	
A. Safety B. Sources of electricity	"Exploring the Industries"

Exploring the World of Work, cont'd
(Eighth Grade)

MARCH cont'd

Units	References and Teacher Comments
1. Dry cell 2. Wet cell 3. Generators	"General Shop"
C. Conductors and insulators	
D. Magnetism in our lives	
1. Permanent magnetism 2. Electromagnetism	
E. Elementary applied electricity	
1. Current 2. Resistance 3. Voltage 4. Series connection 5. Parallel connection 6. Ohm's law	
F. Splices	
1. Western union 2. Tap 3. Pigtail 4. Extension cord	
G. Cord repairs	
1. Underwriter's knot 2. Fastening plug	
H. Soldering	
I. Wiring diamgrams	
J. Electrical maintenance	
K. Fuses	
L. Suggested learning activities	
1. Complete problems in worktext 2. Divide class into groups and construct one of suggested electrical projects in worktext - doorbell, dry cell, buzzer or motor 3. Students practice making splices and cord repair 4. Examination	

Exploring the World of Work, cont'd
(Eighth Grade)

MARCH cont'd

Units	References and Teacher Comments
5. Record wire sizes of different kinds of wire 6. Make a Western Union or end splice 7. Make a knotted tap splice 8. Make a hook on the end of a wire 9. Make an underwriting knot 10. Attach plug and socket to a cord 11. Attach appliance plug to a cord 12. Make an extension cord for home use 13. Assemble lamp project	
III. <u>Careers in Mechanics</u> A. History and trend B. Jobs in mechanics 1. Auto mechanics 2. Small engine mechanic 3. Tractor and machinery mechanic 4. Diesel mechanic 5. Millwright 6. Others C. Working conditions 1. Type of work 2. Where work is done 3. What workers like about occupation 4. What workers dislike about occupation 5. Advantages of careers in mechanics 6. Disadvantages D. Suggested learning activities 1. Show film "The Motor Mechanics" Modern Talking Picture Service 2. Visit or arrange a representative from a vocational school to discuss mechanics occupations 3. Discuss sections on mechanics in "Occupational Outlook Handbook"	"Occupational Outlook Handbook" (Pages 398-431)

Exploring the World of Work, cont'd
(Eighth Grade)

APRIL

Units	References and Teacher Comments
I. Mechanics of Machines	"Power Goes to Work"
A. Types of simple machines	"General Shop"
1. Lever	
2. Pulley	
3. Wheel and axle	
4. Inclined plane	
5. Wedge	
6. Screw	
B. Definition of mechanical advantage	
C. Definition of work	
D. Ways of putting power to work	
E. Tools, wrenches, gauges, and fasteners	
1. Threaded metal fasteners	
2. Tools for assembling	
3. Bolts, nuts, and screws	
4. Hints for using wrenches	
5. Gauges	
F. Suggested learning activities	
1. Show film "ABC's of Hand Tools-Part I and II" (General Motors)	
2. Demonstrate use of simple machine machines	
II. Engines	
A. Steam	"General Shop"
B. Internal - combustion	"Small Engines, Vol. I"
1. How small gasoline engine works	
2. Importance of proper care and operation	
3. Safety in operating power mowers	
4. Selecting power mowers	
5. Servicing small engines (Demonstration by teacher)	
a. Cleaning	
b. Servicing air cleaners	
c. Servicing fuel strainers	

Exploring the World of Work, cont'd
(Eighth Grade)

APRIL cont'd

Units	References and Teacher Comments
d. Lubricanting e. Refueling f. Servicing spark plugs g. Checking and adjusting carburetors	
C. Diesel	
D. Suggested learning activities	"Occupational Outlook Handbook" (Pages 318-362)
1. Show film "Where Mileage Begins" General Motors Corporation	
2. Disassemble a small four-stroke engine (demonstration by teacher)	"Exploring the Industries"
3. Build a model engine (hobby store type)	"General Shop"
4. Service a power mower	
III. <u>Careers in Building Trades</u>	
A. History and trend	
B. Jobs in building trades	
1. Carpenters 2. Painters 3. Plumbers and pipe fitters 4. Bricklayer 5. Electrician 6. Roofer 7. Cement masons 8. Plasterers 9. Others	
C. Working conditions	
1. Type of work 2. Where work is done 3. What workers like about occupation 4. What workers dislike about occupation 5. Advantages of careers in building 6. Disadvantages	
D. Suggested learning activities	
1. Use "Widening Occupations Roles Kit (WORK)" if available for individual and group study, Science Research Associates	

Exploring the World of Work, cont'd
(Eighth Grade)

APRIL cont'd

Units	References and Teacher Comments
2. Show film "Careers in the Building Trades" Coronet Instructional Films 65 East South Water Street, Chicago, Illinois 60601 3. Class visit a construction site and observe workers. Learn order of procedure in constructing a building. 4. Students cut, thread, and assemble pipe (exercise) 5. Students construct concrete stepping blocks 6. Glazing a. Safety in cutting glass b. Demonstrate and have students perform the following operation: 1. Cut a piece of glass 3" x 8" 2. Cut a pane and fit it into a sash about 8" x 10" 3. Install a pane in a sash using glazier points and putty 4. Grind a smooth edge on a piece of glass	

Exploring the World of Work, cont'd
(Eighth Grade)

MAY

Units	References and Teacher Comments
I. Personal Development	"Personal Development for Successful Employment"
A. Developing good health habits	
1. Importance	"Your Opportunities in Vocational Agriculture"
2. Proper eating habits	
3. Proper rest	
4. Exercise	
5. Cleanliness	
B. Selecting and buying clothes	
C. Caring for clothes	
D. Developing desirable social characteristics	
1. Manners	
2. Courtesy	
3. Getting along with people	
E. Improving personal appearance	
F. Respect of law and authority	
G. Suggested learning activities	
1. Role playing:	
a. Manners	
b. Table manners	
c. Courtesy	
d. Personal appearance	
2. Invite a law enforcement authority to discuss respect of law, authority, and property	
3.	
II. Tomorrow's Jobs	"Occupational Outlook Handbook" (Pages 13-27)
A. Our labor force	
B. How most people make their living	
C. Future manpower requirements	
1. In the professions	
2. Clerical occupations	
3. Managerial occupations	
4. Sales occupations	
5. Service occupations	
6. Skilled occupations	
7. Semi-skilled occupations	
8. Others	

Exploring the World of Work, cont'd
(Eighth Grade)

MAY cont'd

Units	References and Teacher Comments
D. Future manpower supply E. Evaluating occupations course and planning ahead F. Suggested learning activities 1. Discuss chapter in "Occupational Outlook Handbook" on Tomorrow's Jobs. 2. Show slide set "Looking Ahead to a Career" Bureau of Labor Statistics, U. S. Department of Labor, 341 Ninth Avenue, New York, New York 10001	

EXPLORING THE WORLD OF WORK

Eighth Grade

References - Occupational Kits - Audio-Visual Aids

References

1. "Occupational Outlook Handbook," U. S. Government Department of Labor, U. S. Government Printing Office, Washington, D. C., 1968. Price: $4.25

2. "Exploring the Industries," Groneman, Steck-Vaughn, Austin, Texas. Price: $1.08

3. "Exploring the World of Jobs" and "The Job in Your Future," Junior Guidance Series Booklets and "Our World of Work," Guidance Series Booklet, Science Research Associates, 259 East Erie Street, Chicago, Illinois 60611. Price: $ .77 and $ .75

4. **"General Shop," Groneman & Feirer, McGraw-Hill Book Co., 330 West 42nd Street, New York New York 10036. Price: $4.65

5. "Jobs in Your Future," Scholastic Magazines and Book Services,. 900 Sylvan Avenue, Englewood Cliffs, New Jersey 07632. Price: $ .75

6. "Handbook of Agricultural Occupations," Hoover, The Interstate Printers and Publishers, Danville, Illinois (1969). Price: $5.95

7. *"Agriculture in Our Lives," Krebs, The Interstate Printers and Publishers, Danville, Illinois (1964). Price: $5.36

8. *"Exploring Agriculture," Evans and Donahue, Prentice-Hall, Englewood Cliffs, New Jersey. Price: $5.25

9. "Occupational Guidance," Chapman, Turner E. Smith & Company, Atlanta, Georgia (1963).

10. "Dictionary of Occupational Titles," U. S. Government Department of Labor, U. S. Printing Office, Washington, D. C. (1965).

11. "Your Opportunities in Vocational Agriculture," Phipps, The Interstate Printers and Publishers, Danville, Illinois. Price: $3.15

12. "Personal Development for Successful Employment," Vo-Ag Series.

13. "Suggested Teaching Outline for Life Science & General Shop," Vo-Ag Series.

14. "Small Engines, Vol. 1," American Association of Agricultural Engineers and Vocational Agriculture, Athens, Georgia. Price: $3.54

15. "Power Goes to Work," General Motors Corporation, Education Division, Detroit, Michigan. Free

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*State adopted textbooks in Vocational Agriculture
**State adopted textbook in Industrial Arts

6294

Exploring the World of Work, cont'd
(Eighth Grade)

Widening Occupational Roles Kit*

WORK is an occupational study system designed to give students in grades six through nine a chance to broaden their knowledge of the world of work. Source: Science Research Associates, 259 East Erie Street, Chicago, Illinois. Price: $141.75

WORK includes:

400 Junior Occupational Briefs
5 Junior Guidance Booklets
35 Student Workbooks
1 Teacher's Manual
5 Color Filmstrips

Audio-Visual Aids

1. Guidance Associates, Inc., Pleasantville, N. Y. 10570. Filmstrip: "Preparing for Jobs in the 70's."

2. Wilson Corporation, 555 West 166th Street, South Holland, Illinois 60473. Records: "Exploring the World of Work," set of six, 12" LP records.

3. Association Films, Inc., 347 Madison Avenue, New York, N. Y. Film: "The Big Question - Choosing Your Career."

4. Modern Talking Pictures Service, Inc., 501 N. College Street, Charlotte, N. C. 28202. Films: "The Draftsman - Surveyor." "Precision Tool Making and Machining," "The Electronics Technician," "The Electrical Worker," "The Motor Mechanic." Filmstrip: "Sexual Reproduction in Plants."

5. General Motors Corporation, Public Relations Staff, Film Library General Motors Building, Detroit, Michigan 48202. "Engineers in the Making," "ABC's of Hand Tools, Part I & II," and "Where Mileage Begins."

6. Coronet Instructional Films, 65 East South Water Street, Chicago Illinois 60601. Film: "Careers in the Building Trades."

7. RCA Institute, Inc., 350 West 4th Street, New York, New York, Film: "Your Future in Electronics."

8. Chicago Film Distribution Center, U. S. Steel Corporation, 208 South LaSalle Street, Chicago, Illinois 60690. Kit: "How Steel is Made." Includes bottled sample of raw materials and color filmstrip. Free

9. Vo-Ag Film Libriary, Auburn University. Film: "Dynamic Careers Through Agriculture."

10. New Holland Film Library, Memphis, Tennessee. Film: "A Step Ahead."

11. Bureau of Labor Statistics, U. S. Department of Labor, 341 - 9th Avenue, New York, N. Y. 10001. Slide Set: "Looking Ahead to a Career."

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*WORK would be a valuable addition to the school library or guidance service making it available to all departments.

**Junior Occupational Briefs can be ordered individually or as a complete set. Price: $89.50

VT 012 682
Course Outline for Vocational Orientation (Ninth Grade).

Alabama State Dept. of Education, Montgomery. Agricultural Education Service.
MF AVAILABLE IN VT-ERIC SET.
Vocational Agricultural Education, Field Office, 101 Petrie Hall, Auburn, Alabama 36830 (available free to State Supervisors and Head Teacher Educators only).
PUB DATE - 69 31p.

DESCRIPTORS - *TEACHING GUIDES; *CURRICULUM GUIDES; *AGRICULTURAL EDUCATION; *INDUSTRIAL ARTS; VOCATIONAL EDUCATION; GRADE 9; COURSE CONTENT; *OCCUPATIONAL INFORMATION; BIBLIOGRAPHIES
IDENTIFIERS - *AGRIBUSINESS

ABSTRACT - Prepared for an orientation of 9th grade students interested in agribusiness, this course outline was developed by the Agriculture Education Service of a State Department of Education. The outline contains units of instruction keyed to each month of the school year, and each unit includes an introduction, reference list, suggested learning activities, and a provision for additional teacher comments. The units are also keyed to occupational objectives in agribusiness and basic trades. (LM)

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VT 012 682

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S-A-M-P-L-E

Alabama
1969

COURSE OUTLINE FOR VOCATIONAL ORIENTATION (Ninth Grade)

OCCUPATIONAL OBJECTIVES
IN AGRIBUSINESS

Agricultural Production
Agricultural Supplies
Agricultural Mechanics
Agricultural Products
Ornamental Horticulture
Agricultural Resources
Forestry
Pre-Professional (Other)

OCCUPATIONAL OBJECTIVES
IN BASIC TRADES

Metal Work
Wood Work
Trowel Trades
Construction
Mechanics
Electricity
Other

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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STATE OF ALABAMA
State Department of Education
Division of Vocational Education
Agricultural Education Service
Montgomery, Alabama

VT012682

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S-A-M-P-L-E

Alabama
1969

COURSE OUTLINE
FOR
VOCATIONAL ORIENTATION
(Ninth Grade)

SEPTEMBER

Units	References and Teacher Comments
I. Orientation & General Information	
A. Introduction to course	
1. Purpose of course 2. Department goals and policies 3. Dues, forms, etc. 4. Setting up student notebook 5. Plans for the year 6. Tour of facilities 7. Others	
B. Supervised work experience program	"Your Opportunities in Vocational Agriculture"
1. Determining the type program 2. Setting individual goals 3. Starting supervised programs 4. Production projects 5. Improvement projects 6. Supplementary practices 7. Financing supervised programs 8. Keeping records 9. Placement for work experience 10. Others	"Supervised Practice Program Record Book" "Suggested Teaching Outline for Life Science & General Shop"

OCCUPATIONAL OBJECTIVES IN AGRIBUSINESS

1. Agricultural Production
2. Agricultural Supplies
3. Agricultural Mechanics
4. Agricultural Products
5. Ornamental Horticulture
6. Agricultural Resources
7. Forestry
8. Pre-Professional (Other)

OCCUPATIONAL OBJECTIVES IN BASIC TRADES

1. Metal Work
2. Wood Work
3. Trowel Trades
4. Construction
5. Mechanics
6. Electricity
7. Other

SEPTEMBER cont'd

Units	References and Teacher Comments
11. Suggested learning activities	
a. Determine whether the following are productive, improvement, or supplementary practices	
(1) Sow and litter (2) Corn (3) Broilers (4) Watermelons (5) Pasture improvement (6) Spraying peach trees (7) Castrating pigs (8) Others	
b. Give students a list of transactions to practice entering in a "dummy" record book	
c. Have students make a list of possible places in community for work experience	
d. Others	
C. Youth Organizations (FFA)	"Official FFA Manual"
1. Organization	"Suggested Teaching Outlines for Life Sciences and General Shop"
a. Histroy b. Aims c. Purposes d. Membership e. Degrees	"Parliamentary Procedure for FFA Chapters"
2. Leadership	"Now You're Talking"
a. Public speaking b. Conducting effective meetings c. Parliamentary procedure d. Duties and responsibilities of members e. Characteristics of leadership	
3. Contests and awards	"Alabama FFA Contests and Awards"
a. Awards program b. Individual and group contests c. Others	
4. Suggested learning activities	
a. Have students make brief reports on some phase of FFA b. Practice opening and closing ceremonies with class c. Review contest application forms with students d. Others	

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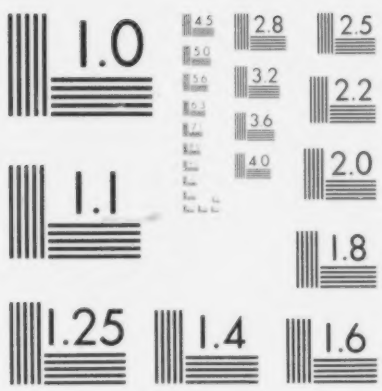

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OCTOBER

Units	References and Teacher Comments
I. Shop Management and Safety	
A. Advantages of shop work B. Arrangement of tools and equipment C. Housekeeping in the shop D. Student behavior in the shop E. Safety precautions F. Safety devices G. Suggested learning activities	"Suggested Teaching Outline for Life Science & General Shop" "General Shop Guide for Vo-Ag Students" "Farm Mechanics Text and Handbook"
1. Students study and complete pages 1-11 in "General Shop Guide for Vo-Ag Students" 2. Demonstrate safety devices 3. Develop housekeeping chart 4. Tour shop with students 5. Others	
II. Introduction to Sketching, Drawing, and Planning	
A. Importance of planning and drawing B. Job opportunities in this field C. Type training required for employment D. Where training may be obtained E. Working conditions and pay expected F. Instructional areas	"General Shop Guide for Vo-Ag Students" "Exploring the Industries" "Farm Mechanics Text and Handbook" "The Farm Shop" "General Shop, 3rd Edition"
1. Drawing equipment 2. Lettering and freehand drawing 3. Determining angles 4. Angle layout 5. Alphabet of lines 6. Placing dimensions 7. Reading the architect's scale 8. Learning to draw to scale 9. Isometric drawing principles	
G. Suggested learning activities	
1. Study and complete pages 83-97 in "General Shop Guide for Vo-Ag Students" 2. Visit an architect's office to observe type work done and equipment used 3. Have students draw a plan for a proposed shop project 4. Others	

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OCTOBER cont'd

Units	References and Teacher Comments
III. Introduction to Mechanics	
A. Job opportunities in mechanics	"Occupational Outlook Handbook"
1. Automobiles 2. Trucks 3. Diesel 4. Tractors 5. Small motors	"Auto Mechanics Fundamentals" (Chapter 7, 22) "Small Engines, Care-Operation-Maintenance and Repair-Vol. I"
B. Description and nature of work C. Working conditions D. Training requirements E. Where training may be obtained F. How to enter and advance G. Instructional area	
1. Engine classification, parts identification	
a. Cycle classification	
(1) Four-stroke cycle (2) Two-stroke cycle	
b. Valve location classification	
(1) L-head (2) F-head (3) I-head (4) T-head	
c. Combustion chamber design d. Cylinder classification	
(1) In-line engine (2) V-type engine (3) Horizontal-opposed engine (4) Slant or inclined	
e. Fuel classification f. Engine mountings	
H. Suggested learning activities	
1. Study and answer questions on page 179, "Auto Mechanics Fundamentals" 2. Perform the following exercises on a small gasoline engine	

OCTOBER cont'd

Units	References and Teacher Comments
a. Identify types of small engines b. Clean small engines c. Service carburetor air cleaner d. Service fuel strainer e. Service crankcase breather f. Lubricate small engine g. Refuel small engine (1) Select the fuel (2) Tools and materials needed (3) Prepare fuel for two-cycle engine (4) Filling the fuel tank (5) Storing fuel h. Service spark plugs (1) Types of spark plugs (2) Importance of proper maintenance (3) Inspecting and servicing spark plugs (4) Installing the spark plug i. Check and adjust carburetor (1) Principles of operation (2) Tools and materials needed (3) Adjust high speed and idle valve j. Check compression k. Starting engines l. Operating engines m. Storing engines	

NOVEMBER

Units	References and Teacher Comments
I. Introduction to Woodworking Industry	
A. History of this industry	"Farm Mechanics Text and Handbook"
B. Opportunities for employment	
C. Chances for promotion	
D. Working conditions	"The Farm Shop"
E. Wages expected	
F. Qualifications and training needed	"General Shop Guide for Vo-Ag Students" (Pages 12-50)
G. How to enter a job in woodworking industry	
H. Identification and use of hand tools used in woodworking industry	"General Shop, 3rd Edition"
1. Marking and measuring tools	
2. Boring and drilling tools	"Tool Study and Identification Kit"
3. Smoothing and cutting tools	
4. Clamping devices	
5. Hammers and wood malls	
6. Saws	
7. Screwdrivers and files	
8. Painting and glazing	
9. Levels	
I. Power tool study	
1. Identification, safe use, and adjustment of power woodworking tools	Note: Students study and complete pages 51-82 in "General Shop Guide for Vo-Ag Students"
a. Circular saw (tilting arbor)	
b. Bandsaw	
c. Jig saw	
d. Drill press	
e. Portable electric drill	
f. Grinder	
g. Disk sander	
h. Portable belt sander	
J. Identification--wood and hardware	Note: Students study and complete pages 98-108 in "General Shop Guide for Vo-Ag Students"
1. Selection and characteristics of wood	
2. Qualities of wood	
3. Joint identification	
4. Size and kind of nails	"Hardware Study and Identification Kit"
5. Size and kind of screws	
6. Identification of common hardware	
7. Others	

NOVEMBER cont'd

Units	References and Teacher Comments
K. Suggested learning activities	
1. Visit a woodworking shop to observe type of work done and tools used	
2. Each student learn to adjust and use hand and power tools	
3. Each student build wood projects such as	
a. Tool box b. Nail box c. Miter box d. Footstool e. Lawn chair f. Gunrack g. Bookcase h. Sawhorse i. Kitchen stool j. Flower box k. Doghouse l. Others	Note: See pages 109-124 in "General Shop Guide for Vo-Ag Students"
4. Others	

DECEMBER

Units	References and Teacher Comments
I. Orientation to Agribusiness	
A. Agribusiness--Our Greatest Business	"Careers in Agribusiness and Industry" (Chapters 1, 2, 3)
1. What is agribusiness	
2. Agribusiness--a two-way street	
3. How big agribusiness is	"Handbook of Agricultural Occupations"
4. Overall view of agribusiness	
5. Agribusiness has a place for you	
6. Kinds of positions	
7. General view of opportunities in agribusiness	
8. What agribusiness graduates do, and whom they work for	
9. Salary you might expect	
10. Type person employers look for in a college graduate	
12. A look at the "merchandise" of agribusiness	
13. Amount farmers buy from agribusiness	
14. Suggested learning activities	
a. Briefly discuss chapters 1, 2, 3 in "Careers in Agribusiness and Industry"	
b. Have students list all agribusiness opportunities in their school area, county, or neighboring counties	
c. Visit an agribusiness establishment (store or farm)	
d. Others	
II. Introduction to Agricultural Production	
A. Opportunities in agricultural production	"An Introduction to Business & Industry"
1. Self-employment as owner or tenant	"Suggested Teaching Outlines for Life Science and General Shop"
2. Paid on-farm employee	
3. Possibilities in livestock production	
a. Scope of operation needed	"Agriculture in Our Lives"
b. Labor and capital needed	
c. Marketing facilities	
4. Possibilities in crop production	"Exploring Agriculture"
a. Scope of operation needed	
b. Labor and capital needed	
c. Marketing facilities	

DECEMBER cont'd

Units	References and Teacher Comments
5. Possibilities in horticulture production a. Scope of operation needed b. Labor and capital required c. Marketing facilities available 6. Other possibilities B. Qualities needed for success in farming 1. Business acumen 2. Practical scientist 3. Laborer 4. Skilled mechanic C. Suggested learning activities 1. Visit local farming operation to observe land, equipment, labor, etc. 2. Invite successful farmer to talk to class 3. Have each student list land, equipment, livestock, buildings, etc., for a proposed farm and make estimate of total cost or investment	

JANUARY

Units	References and Teacher Comments
I. Introduction to Agricultural Production (Cont'd from December)	
A. Principles of crop production	"Agriculture in Our Lives"
1. Principles of plant growth	
a. Seeds and their function b. Plant reproduction, pollination, fertilization c. Germination of seed d. How plants make their food e. Water and its relationship to plant growth f. Temperature and its relationship to plant growth g. Causes of plant diseases h. Families of common plants i. Cultivation practices for various crops j. Suggested learning activities	"Crop Production in the South" "Suggested Teaching Outline for Life Science and General Shop" "1961 Yearbook of Agriculture--Seeds"
(1) Have students make "rag-doll" germination seed test (2) Identify parts of seed (3) Plant seed in window boxes, etc., to observe growth (4) Others	
2. Plant food and fertilizer	"Plant Food & Fertilizers"
a. How plants feed and grow b. Fertilizer elements needed for plant growth c. Effects of fertilizers on the soil d. What the major plant food elements do to a plant e. Trace minerals and their effect on plants and animals f. Mathematical calculations of plant food needs g. Value of soil testing h. Methods of applying fertilizer i. Suggested learning activities	"Agriculture in Our Lives" "Crop Production in the South"
(1) Determine what 8-8-8 represents on fertilizer bag	

JANUARY cont'd

Units	Reference and Teacher Comments
(2) Observe plants that are deficient in different plant foods	
(3) Take soil samples and send to soil testing laboratory	
(4) Visit farm supply store to observe different types of fertilizer available	
(5) Others	
B. Principles of livestock production	"Agriculture in Our Lives"
1. Introduction	
2. Value of farm animals	"Stockman's Handbook"
3. Farm animal classification	
4. Importance of domesticated animals	"Livestock and Poultry Production"
5. Breeds of dairy cattle, beef cattle, hogs, sheep, and poultry	
6. Livestock terms and definitions	"Suggested Teaching Outline for Life Science and General Shop"
7. Animal nutrition	
a. Why good feeding is important	
b. How animals use their feed	
c. Nutrients necessary for proper nourishment	
8. Animal breeding	
a. How animals were domesticated and improved	
b. Crossbreeds	
c. Hybrids	
d. Selection and judging	
e. Gestation periods	
9. Suggested learning activities	
a. Visit local farms to observe different breeds of livestock	
b. Show films and filmstrips on breeds	
c. Have students complete a "livestock term chart"	
d. Others	
II. Leadership (FFA)	
A. Developing public speaking skills	"Now You're Talking"
1. Selecting a topic	
2. Collecting material for speech	
3. Writing the speech	
4. Presenting speech before an audience	
5. Others	

FEBRUARY

Units	References and Teacher Comments
I. Introduction to Construction Industry	
A. Employment opportunities in building trades	"Occupational Outlook Handbook"
1. Asbestos and insulating workers	
2. Bricklayers	
3. Carpenters	
4. Cement masons	
5. Construction laborers and hod carriers	
6. Electricians (construction)	
7. Elevator constructors	
8. Floor covering installers	
9. Glaziers	
10. Lathers	
11. Marble setters, tile setters, and terrazzo workers	
12. Operating engineers (construction machinery operators)	
13. Painters and paperhangers	
14. Plasterers	
15. Plumbers and pipefitters	
16. Roofers	
17. Sheet metal workers	
18. Stonemasons	
19. Structural-, ornamental-, and reinforcing-iron workers, riggers, and machine movers	
B. Qualifications and training needed	
C. Where training may be obtained	
D. Working conditions	
E. How to enter and advance	
F. Waters expected	
G. Instructional units	
1. Figuring bills of materials	"Farm Mechanics Text and Handbook" (Chapter 6)
a. Bill of material	
b. Unit of measure in selling lumber	
c. Board foot and running foot	
d. Method used in writing dimensions	
e. Allowing extra materials for dressed lumber and for waste	
f. Calculating cost of lumber	
g. Shingles, lath, and molding	

FEBRUARY cont'd

Units	References and Teacher Comments
2. Suggested learning activities	
a. Study and answer questions	
b. Have each student classify, select and care for lumber properly	
c. Take field trip to building supply store to observe materials available	
d. Each student figure bill of material for a small shed or building	
e. Others	
II. Introduction to Electrical Industry	
A. Job opportunities in the electrical field	"General Shop Guide for Vo-Ag Students"
1. Electrician	"Occupational Outlook Handbook"
2. Electronics	
3. Radio and TV	
4. Air conditioning and refrigeration	"Farm Mechanics Text and Handbook"
5. Others	
B. Qualifications and training needed for employment	"The Farm Shop"
C. Working conditions	"Wiring Simplified"
D. How to enter and advance	
E. Instructional areas	
1. Electrical theory	
2. Electrical terms	
3. Methods of generating electricity	
4. Conductors of electricity	
5. Wiring materials	
6. Fundamentals of wiring	
7. Identification of tools used in electrical work	
F. Suggested learning activities	
1. Students study and complete pages 135-142 in "General Shop Guide for Vo-Ag Students"	
2. Visit a building project and observe electrical work being done and tools used	
3. Invite electrician to discuss his work with the class	

FEBRUARY cont'd

Units	References and Teacher Comments
G. Exercises for students to perform 1. Measure size of wire with gauge 2. Western Union or end splice 3. Romex cable splice 4. Knotted tap splice 5. Pigtail splice 6. Hook end of wire 7. Underwriter's knot 8. Attach plug and socket to cord 9. Attach appliance plug to cord 10. Attach rigid conduit to box 11. Install switch box in a wall 12. Attach romex cable to switch box 13. Install wall switch to switch box 14. Hook up single-pole switch 15. Hook up a three-way switch 16. Hook up convenience outlet to source of electricity 17. Others	

MARCH

Units	References and Teacher Comments
I. Orientation to Agribusiness (cont'd)	
A. Introduction to Agricultural Supplies Industry	"Careers in Agribusiness and Industry"
1. Who manufactures farm supplies	"An Introduction to Agricultural Business and Industry"
2. Specific career opportunities in the farm supplies industry	
a. Business services	"Handbook of Agricultural Occupations"
b. Supplying petroleum products to farmers	
c. Supplying fertilizer and lime	
d. Careers in agricultural chemicals	
e. Retail supply store opportunities	
3. Qualifications and training needed for employment in farm supply industry	
4. Where can training be obtained	
5. Working conditions in the different jobs	
6. How to enter and advance in a farm supply job	
7. Suggested learning activities	
a. Visit various farm supply businesses to observe operation	
b. Have students write brief description of jobs in farm supply industry	
c. Others	
B. Introduction to Ornamental Horticulture Industry	"Careers in Agribusiness and Industry"
1. Products and services of ornamental horticulture	"Handbook of Agricultural Occupations"
2. Specific positions in ornamental horticulture business	"Ornamental Horticulture for Vo-Ag in Alabama"
3. Preparing for a career in ornamental horticulture	
4. Suggested learning activities	
a. Take field trip to greenhouse or nursery	
b. Make hardwood and softwood cuttings	

MARCH cont'd

Units	References and Teacher Comments
c. Prepare propagation bed d. Students make bark, whip, and cleft grafting e. Others	
C. Introduction to Agricultural Products Industry	"Careers in Agribusiness and Industry"
1. Opportunities in the food industry	"Handbook of Agricultural Occupations"
a. Processing and manufacturing b. Wholesale distribution c. Retailing d. Qualifications and preparations for employment in food industry e. Others	
2. Job opportunities in dairy industry	
a. Dairy processing b. Selling dairy plant equipment c. Selling dairymen's supplies d. Preparing for careers in the dairy industry	
3. Careers in the grain industry	
a. Specific positions in the grain trade b. Qualifications and abilities needed	
4. Careers in the meat and livestock industry	
a. Specific positions in the meat and livestock industry b. Qualifications for careers in the meat and livestock industry	
5. The cotton trade	
a. Work of the cotton trade b. Specific opportunities in the cotton trade c. Desirable qualifications for careers in the cotton trade	
6. Suggested learning activities	
a. Take field trips to different types of processing plants	

MARCH cont'd

Units	References and Teacher Comments
b. Invite manager of processing plant to speak to class c. Show films on processing of agricultural products d. Have students write occupational briefs on description and nature of work, working conditions, and how to enter and advance in the field of agricultural products	
D. Introduction to Agricultural Mechanics Industry	"Careers in Agribusiness and Industry"
1. "Goods" that come from the farm equipment industry 2. Three components of farm equipment industry a. Manufacturers b. Wholesalers or branch houses c. Retail dealers 3. Positions with manufacturers 4. Positions with wholesalers 5. Positions with retail dealers 6. Qualifications and preparation for farm equipment positions 7. Suggested learning activities a. Visit farm equipment establishments to observe type of work done b. Each student to write occupational briefs for farm machinery sales and service occupations giving information or description and nature of work, working conditions, educational and personal qualifications, how to enter and advance c. Identify tools and equipment used by tractor and auto mechanics d. Others	
E. Introduction to Agricultural Resources Industry	"Careers in Agribusiness and Industry"
1. Career opportunities in agricultural resources	"Handbook of Agricultural Occupations"

MARCH cont'd

Units	References and Teacher Comments
a. Soil management and services b. Forestry conservation and services c. Wildlife conservation and utilization d. Recreation areas and services e. Water and air pollution	"Occupational Outlook Handbook"
2. Personal qualifications needed for employment in each of the agricultural resource areas 3. How and where may training be obtained 4. Suggested learning activities	
a. Each student write an occupational brief of different jobs stating working conditions, description, and nature of work, training needed, chances for advancement, etc. b. Make a list of agricultural resource possibilities in the area c. Visit a developed and operating resource enterprise d. Invite trained people or specialists to discuss the different fields in agricultural resource conservation and utilization e. Others	
F. Introduction to Forestry Industry	"Occupational Outlook Handbook"
1. Career opportunities in forestry 2. Where training may be obtained 3. Location of forest industries 4. How to enter a forestry occupation 5. Suggested learning activities	"Careers in Agribusiness and Industry" "Handbook of Agricultural Occupations"
a. Make a list of forestry occupations which serve the community b. Visit forestry industries in the area c. Show films on forestry work d. Identify trees in school area e. Demonstrate how to plant seedlings	"Developing Farm Woodlands in Alabama" "Exploring Agriculture"

MARCH cont'd

Units	References and Teacher Comments
f. Determine type of land suitable for trees g. How to order seedlings h. Demonstrate how to control undesirable species i. Discuss good cutting practices j. Discuss protection from fire	
G. Introduction to Professional Agriculture	"Handbook of Agricultural Occupations"
1. Opportunities in professional agriculture	"Careers in Agribusiness and Industry"
a. Research	"Agriculture in Our Lives"
(1) Conservation (2) Crops and soils (3) Equipment (4) Forestry (5) Livestock (6) Machinery (7) Management (8) Marketing (9) Processing (10) Rural sociology	"Occupational Outlook Handbook" "Exploring Agriculture"
b. Education	
(1) Agricultural extension (2) High schools and colleges (3) Farm organizations (4) Foundations (5) Government agencies (6) High schools (7) Industry (8) International technical aid	
c. Industry	
(1) Equipment (2) Fats and oils (3) Feed (4) Fertilizer (5) Food (6) Forest products (7) Fuel (8) Herbicides (9) Pesticides (10) Machinery	

MARCH cont'd

Units	References and Teacher Comments
d. Business	
(1) Banking	
(2) Credit	
(3) Insurance	
(4) Land appraisal	
(5) Marketing	
(6) Merchandising	
(7) Packaging	
(8) Public utilities	
(9) Transportation	
(10) Sales	
e. Specialized services	
(1) Federal government	
(2) State government	
(3) Private business	
(4) Foreign service	
f. Communications	
(1) Advertising	
(2) Exhibits	
(3) Motion pictures	
(4) Photography	
(5) Publications	
(6) Public relations	
(7) Radio	
(8) Television	
g. Conservation and recreation	
(1) Conservation	
(a) Forest	
(b) Soil	
(c) Water	
(d) Wildlife	
(2) Recreation	
(a) Game preserves	
(b) Golf courses	
(c) Parks	
(d) Playgrounds	

MARCH cont'd

Units	References and Teacher Comments
2. Suggested learning activities	
a. Invite professional agriculture workers to talk to class	
b. Visit office or business of professional agricultural workers	
c. Determine the different professional agricultural jobs and employers in the area	
d. Students write occupational briefs on different occupations giving description and nature of work, working conditions, how to enter and advance, etc.	
e. Others	
II. <u>Leadership (FFA)</u>	
A. Contests and awards	"Alabama FFA Contests and Awards"
1. Preparing for area and district contests in public speaking, land judging, livestock judging, dairy judging, etc.	

APRIL

Units	References and Teacher Comments
I. Introduction to Metal Working Industry	
A. Careers in Metal Industry	"General Shop Guide for Vo-Ag Students"
1. Job opportunities in metal industry	"Farm Mechanics Text and Handbook"
a. Planning, drawing, and designing	
b. Bench metal	"The Farm Shop"
c. Art metalwork	
d. Machine shop	
e. Foundry	
f. Forging and heat treatment	
2. Training and skills needed	
3. Where training may be obtained	
4. Working conditions	
5. Description and nature of work	
6. How to enter and advance	
B. An Introduction to Metals	"General Metalwork"
1. Metals in history	"Occupational Outlook Handbook"
2. Manufacturing iron and steel	
3. Manufacturing copper	
4. Manufacturing aluminum	
5. The products of metal	
6. Safety in the metals shop	
C. Introduction to Sheet Metal	
1. Job opportunities in this trade	
2. Training and skills needed	
3. Where training may be obtained	
4. Working conditions	
5. Description and nature of work	
6. How to enter and advance	
7. Instructions areas	
a. Identify tools used in this trade	
b. Operate a blow torch	
c. Operate an electric soldering copper	
d. Operate a propane torch	
e. Clean and tin a soldering copper	
f. Bending and fastening sheet metal	
g. Repairing sheet metal projects	

APRIL cont'd

Units	References and Teacher Comments
8. Suggested learning activities	
a. Students study and complete pages 143-149 in "General Shop Guide for Vo-Ag Students"	
b. Visit a sheet metal shop and observe work done and tools used	
c. Suggested projects to build	
(1) Feed scoop	
(2) Dust pan	
(3) Metal magazine rack	
(4) Funnel	
(5) Others	
D. Introduction to arc welding	"General Shop Guide for Vo-Ag Students"
1. Job opportunities in this field	
2. Description and nature of work	"Occupational Outlook Handbook"
3. Working conditions	
4. Training and skills needed	
5. Where training may be obtained	"Farm Mechanics Text and Handbook"
6. How to enter and advance	
7. Instructional areas	
a. Safety in using the arc welder	"New Lessons in Arc Welding"
b. Selecting electrodes	
c. Amperage settings	"Metals and How to Weld Them"
d. How to set up a welder for welding	
e. How to strike an arc	
f. How to run a bead	
g. Identification of tools and equipment used in arc welding	
8. Suggested learning activities	
a. Students study and complete pages 150-153 in "General Shop Guide for Vo-Ag Students"	
b. Visit welding shop and observe type work done and equipment used	
c. Exercises for students to do	
(1) Set up arc welder for use	
(2) Strike an arc and run bead	
(3) Construct small projects using welder	
(4) Flat position welds	

APRIL cont'd

Units	References and Teacher Comments
(a) Butt joint (b) Lap joint (c) Tee joint (d) Corner joint	
(5) Others	

MAY

Units	References and Teacher Comments
I. Introduction to Construction Industry (cont'd)	
A. Glazing	"General Shop Guide for Vo-Ag Students"
1. Job opportunities in this field	
2. Qualifications and training needed	"Farm Mechanics Text and Handbook"
3. Working conditions and chance for advancement	
4. How to enter and advance	"The Farm Shop"
5. Instructional areas	"Occupational Outlook Handbook"
a. Kinds of paint	
b. Selecting the type paint to use	
c. Mixing and tinting paints	
d. Preparing surfaces to be painted	
e. Applying paint	
f. Common paint failures	
g. Applying varnishes and stains	
h. Caring for paint brushes	
i. Figuring amount of paint needed	
j. Cutting glass	
k. Installing windowpanes using glazier points and putty	
l. Grinding the edge of a piece of glass smooth	
6. Suggested learning activities	
a. Put a satin finish on piece of wood	
b. Put a blond finish on piece of wood	
c. Apply varnish to surface (open grain wood)	
d. Prepare a board surface for painting	
e. Students study and complete pages 125-134 in "General Shop Guide for Vo-Ag Students"	
f. Field trip to observe paint conditions	
g. Others	
B. Introduction to plumbing	
1. Job opportunities in this field	"General Shop Guide for Vo-Ag Students"
2. Description and nature of work	

MAY cont'd

Units	References and Teacher Comments
3. Working conditions 4. Training and skills needed 5. Where training may be obtained 6. How to enter and advance 7. Identification and use of tools used in this trade 8. Instructional areas a. Identification of pipe fitting b. Measuring pipe c. Cutting and reaming pipe d. Pipe threading e. Assembling pipe and pipe fittings 9. Suggested learning activities a. Students study and complete pages 154-159 in "General Shop Guide for Vo-Ag Students" b. Visit a construction project and observe plumbing work done and tools used c. Invite plumber to discuss his work with class d. Exercises for student to do (1) Cut off a piece of pipe (2) Ream end of pipe (3) Cut threads on pipe (4) Attach a threaded pipe to a tee (5) Replace leaky washers in a faucet (6) Others	"Occupational Outlook Handbook" "Farm Mechanics Text and Handbook" "Construction and Maintenance for Farm and Home" "The Farm Shop"
II. <u>Introduction to Trowel Trades</u> A. Job opportunties in this field B. Description and nature of work C. Working conditions D. Training and skills required E. Where training may be obtained F. How to enter and advance G. Identification of tools and equipment used in this trade H. Instructional areas 1. History and importance of concrete 2. Sieve test 3. Clay and silt test 4. Working concrete problems	"General Shop Guide for Vo-Ag Students" "Farm Mechanics Text and Handbook" "Occupational Outlook Handbook" "The Farm Shop" "Construction and Maintenance for Farm and Home"

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MAY cont'd

Units	References and Teacher Comments
5. Selecting aggregates 6. Determining correct ratio of mix 7. Mixing concrete 8. Pouring concrete 9. Finishing concrete 10. Curing concrete	
I. Suggested learning activities	
1. Students study and complete pages 160-165 in "General Shop Guide for Vo-Ag Students" 2. Visit a construction project and observe concrete and masonry work being done and tools used 3. Invite a brick mason to discuss his work with class 4. Run a sieve test on fine aggregate to check size of particles 5. Test fine aggregate for clay and silt 6. Test fine aggregate for vegetable matter 7. Make a form 4" wide, 4' long, and 2' high 8. Mix a batch of concrete to fill a form 4" wide, 4' long, and 2' high, using a 1:2:3 mixture (one part cement, two parts sand, and three parts gravel)	
III. <u>Career Guidance</u>	
A. Personal traits necessary for success in any occupation B. Points to consider in selecting an occupation C. Desirable traits in an employee D. Desirable traits of a boss E. Opportunities for advancement F. Where information may be obtained about jobs available G. Suggested learning activities	"Suggested Teaching Outline for Life Science and General Shop" "Agriculture in Our Lives" "An Introduction to Agricultural Business and Industry"
1. Have students make a list of their strong points 2. Students make a list of things they want in an occupation 3. Have students compare their interests and desires with possible jobs 4. Others	

MAY cont'd

Units	References and Teacher Comments
IV. Miscellaneous A. Bring record books up to date B. Plan summer work experience programs C. Clean department for closing of school D. Take inventory of tools, supplies, and equipment E. Others	

REFERENCES

The following books are recommended for teaching Ninth Grade Vocational Orientation, especially the first six. It is highly recommended that these six books be obtained, if not already available, for references in teaching this course. The first six are listed in order of importance.

Textbooks

1. Handbook of Agricultural Occupations, Hoover, N. K., The Interstate Printers and Publishers, 19-27 North Jackson Street, Danville, Illinois 61832. ($5.95)

2. Occupational Outlook Handbook, U. S. Government Printing Office, Washington, D. C. ($4.25)

*3. Farm Mechanics Text and Handbook, Phipps, McColly, Scranton and Cook, The Interstate Printers and Publishers, 19-27 North Jackson Street, Danville, Illinois 61832. ($6.26)

*4. Agriculture in Our Lives, Krebs, A. H., The Interstate Printers and Publishers, 19-27 North Jackson Street, Danville, Illinois 61832. ($5.36)

*5. Careers in Agribusiness and Industry, Stone, A. A., The Interstate Printers and Publishers, 19-27 North Jackson Street, Danville, Illinois 61832. ($4.73)

*6. Exploring Agriculture, Evans and Donahue, Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1963). ($5.25)

*7. Crop Production in the South, Klingman, G. C., John Wiley & Sons, Inc., 605 Third Avenue, New York, N. Y. 10016. ($6.25)

*8. Livestock and Poultry Production, Budny and Diggins, Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632. ($6.03)

9. The Stockman's Handbook, Ensminger, M. E., The Interstate Printers and Publishers, 19-27 North Jackson Street, Danville, Illinois 61832. ($9.90)

10. The Farm Shop, Wakeman and McCoy, The Macmillan Company, New York, N. Y. (Price unknown)

11. An Introduction to Agricultural Business and Industry, Weyant, Hoover, and McClay, The Interstate Printers and Publishers, 19-27 North Jackson Street, Danville, Illinois 61832. ($2.93)

12. General Metalwork (Worktext), Glazener, E. R., Steck-Vaughn Company, P. O. Box 2028, Austin, Texas 78767. ($1.44)

13. New Lessons in Arc Welding, The Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, Ohio. ($1.00)

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*State adopted

14. Metals and How to Weld Them, The Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland, Ohio. ($2.00)

*15. Construction and Maintenance for Farm and Home, Foss, E. W., John Wiley & Sons, Inc., 605 Third Avenue, New York, N. Y. 10016. ($6.20)

16. Auto Mechanics Fundamentals, Stockel, M. W., Goodheart-Willcox Co., 18250 Harwood Avenue, Homewood, Illinois 60430. ($5.97)

17. Small Engines, Vol. I, American Association for Agricultural Engineering and Vocational Agriculture, Coordinator's Office, Agricultural Engineering Center, Athens, Georgia 30601. ($3.54)

18. Now You're Talking, Karr, H. M., The Interstate Printers and Publishers, 19-27 North Jackson Street, Danville, Illinois 61832. ($4.46)

19. General Shop, 3rd Edition, Groneman and Feirer, McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. 10036. ($4.65)

20. Wiring Simplified, Alabama Power Company, 600 North 18th Street, Birmingham, Alabama 35203. (Free--if available)

Other Publications

The following publications have been distributed to teachers of vocational agriculture and should prove valuable as references or teaching aids for the ninth grade.

1. Suggested Teaching Outline for Life Science and General Shop, Vo-Ag Series, Auburn, Alabama.

2. Parliamentary Procedure for FFA Chapters, Vo-Ag Series, Auburn, Alabama.

3. Alabama FFA Contests and Awards, Vo-Ag Series, Auburn, Alabama.

4. General Shop Guide for Vo-Ag Students, Vo-Ag Series, Auburn, Alabama.

5. Plant Food and Fertilizers, Vo-Ag Series, Auburn, Alabama.

6. Ornamental Horticulture for Vocational Agriculture in Alabama, Vo-Ag Series, Auburn, Alabama.

VT 012 683
Electricity--Electronics. Syllabus in Technical Subjects, (Tentative).

New York State Education Dept., Albany. Bureau of Secondary Curriculum Development.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 69 66p.

DESCRIPTORS - *CURRICULUM GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *ELECTRICITY; *ELECTRONICS; *ELECTRONIC TECHNICIANS; TEACHING GUIDES; DRAFTING; ELECTRIC CIRCUITS; VOCATIONAL EDUCATION; TECHNICAL OCCUPATIONS; BIBLIOGRAPHIES

ABSTRACT - Developed by the Bureau of Secondary Curriculum Development of the New York State Education Department in cooperation with an advisory committee, this tentative curriculum guide is for instructor use in teaching technical electricity and electronics over a 2 or 3-year period. Topics are: (1) Electricity, which consists of 20 units, including circuits, measurements, conductors, magnetism, DC motors and generators, transformers, batteries, and relays, (2) electronics, which consists of 11 units, including electron theory and devices, communications, and circuiting, (3) Electrical Construction, which consists of four units, and (4) Electrical-Electronic Drafting, which consists of 13 units, including lettering, schematic layout procedures, and block diagram. Each unit is outlined with suggestions for teacher presentations. A bibliography is included, and an introductory section provides objectives, suggestions for the teacher, course descriptions, scheduling suggestions, and diploma requirements. (GEB)

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Syllabus in Technical Subjects

Electricity - Elect

TENTATIVE MATERIAL
FOR TEACHERS OF TECHNICAL
ELECTRICITY - ELECTRONICS

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THE UNIVERSITY
THE STATE EDU
BUREAU OF SEC
ALBANY / 1969

Syllabus in Technical Subjects

Electricity - Electronics

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OFFICE OF EDUCATION
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TENTATIVE MATERIAL
FOR TEACHERS OF TECHNICAL
ELECTRICITY - ELECTRONICS

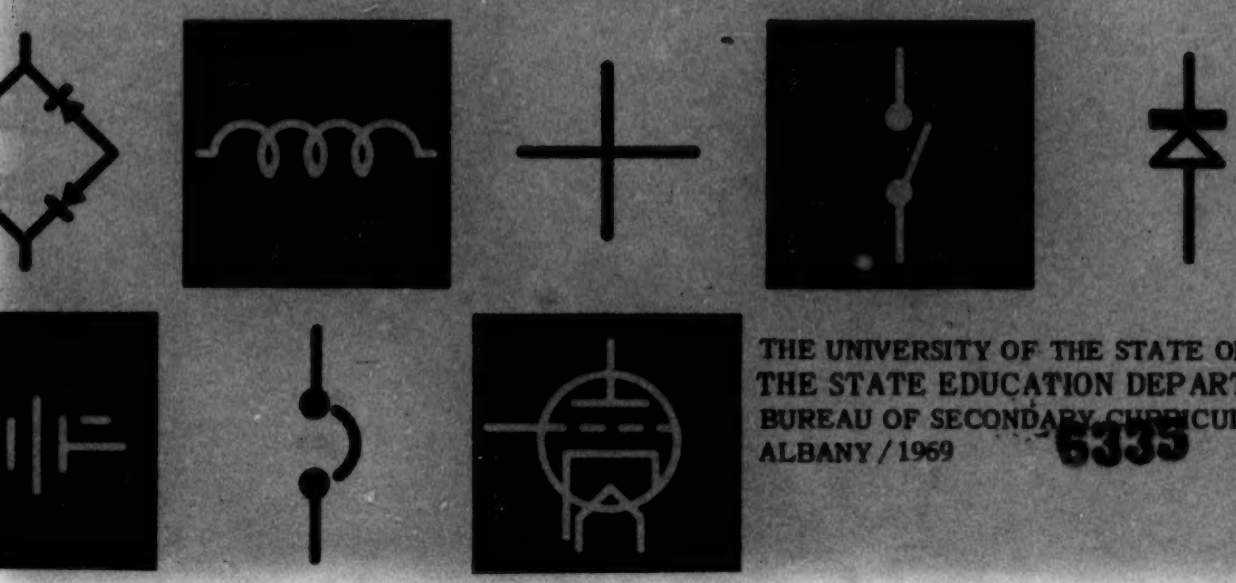

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT
ALBANY / 1969

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Syllabus in

Technical Subjects

ELECTRICITY — ELECTRONICS

The University of the State of New York/The State Education
Bureau of Secondary Curriculum Development/Albany/19

6338

Experimental Material
For Discussion Purposes
Only

Syllabus in

Technical Subjects

ELECTRICITY — ELECTRONICS

University of the State of New York/The State Education Department
Bureau of Secondary Curriculum Development/Albany/1969

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6339

FOREWORD

The material presented in this publication for *Technical Electricity and* and expansion of the syllabus in Technical Subjects Electricity and Electroni

A curriculum advisory committee composed of Neil Lash, Technical and Tra County BOCES; Arthur Lefgren, George Westinghouse Vocational and Technical Hi Nagi, Hudson Valley Community College; and James Quinn, Brooklyn Technical Hi for the reorganization of the syllabus.

Serving on a curriculum writing committee were Neil Lash; Rocco Lapenta, High School, Yonkers; Stanley Odre, Hutchingson Central Technical High School Brooklyn Technical High School, New York, The committee prepared content and for this revised syllabus in Technical Electricity-Electronics.

The project was initiated by Nelson J. Murbach, former Chief of the Bure Education, and C. Thomas Olivo, former Director of the Division of Industrial and recommendations were provided by Alfred Davies and Harold Wassmer, Associ Coordination of the curriculum project was provided by Earl Hay, Supervisor o

This material is being distributed to all schools in New York State offe nical Electricity and Electronics with the hope that personnel involved will material, evaluate it, and submit suggestions for its improvement to this bur before final adoption.

Gordon E. Van Hooft
Chief, Bureau of Seco
Curriculum Developmen

William E. Young
Director, Curriculum
Development Center

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FOREWORD

esented in this publication for *Technical Electricity and Electronics* is a revision
syllabus in Technical Subjects Electricity and Electronics last revised in 1960.

visory committee composed of Neil Lash, Technical and Trade Training Center, Nassau
Lefgren, George Westinghouse Vocational and Technical High School, New York; John
Community College; and James Quinn, Brooklyn Technical High School, made suggestions
on of the syllabus.

rriculum writing committee were Neil Lash; Rocco Lapenta, Saunders Trade and Technical
; Stanley Odre, Hutchingson Central Technical High School, Buffalo; and Lloyd Temes,
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were provided by Alfred Davies and Harold Wassmer, Associates in Industrial Education.
curriculum project was provided by Earl Hay, Supervisor of Vocational Curriculum.

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d Electronics with the hope that personnel involved will critically review the
t, and submit suggestions for its improvement to this bureau for consideration
n.

Gordon E. Van Hooft
Chief, Bureau of Secondary
Curriculum Development

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ELECTRICAL CONSTRUCTION. . . . . .
ELECTRICAL-ELECTRONIC DRAFTING . . . . . .
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OBJECTIVES

- To provide the student with a thorough groundi
  principles and practices of electricity and el
- To provide the student with sufficient backgro
  enter industry in a technical or semi-technica
- To provide the student with a technical educat
  which he may readily advance through further s
- To aid the student in adapting himself to a te
  which electricity and electronics play a part
- To develop, through the study of technical ele
  with other technical subjects, a type of indiv
  characteristics will include:
  - An established habit of judgment based
    facts
  - The practice of facing new situations,
    apply known principles and reflective
  - A desire to finish a job
  - An appreciation of the need for cooper
  - An appreciation of the laws and forces
    implications
  - A regard for the importance of safety
    cedures

C6664

OBJECTIVES

provide the student with a thorough grounding in the fundamental inciples and practices of electricity and electronics

provide the student with sufficient background material so he may ter industry in a technical or semi-technical position

provide the student with a technical educational foundation from ich he may readily advance through further study

aid the student in adapting himself to a technical environment in ich electricity and electronics play a part

develop, through the study of technical electricity in conjunction th other technical subjects, a type of individual, some of whose aracteristics will include:

- An established habit of judgment based on observed and verified facts
- The practice of facing new situations, based on the ability to apply known principles and reflective thought
- A desire to finish a job
- An appreciation of the need for cooperation and loyalty
- An appreciation of the laws and forces of nature and their implications
- A regard for the importance of safety and correct safety procedures

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TO THE TEACHER

The material in this experimental syllabus was developed following the r
advisory committee. The material contained in this publication has the endor
and writing committee. At the suggestion of the Bureau of Trade and Technica
distributed to all schools offering a Technical Electricity-Electronics progr
review and recommendations before final approval and adoption as a State syll

The two-column format was used to identify suggested *CONTENT* on the left
IONS on the right. It is intended that these suggestions will help the teach
depth that should be used in presenting the topic or to suggest an approach c
This publication does not intend to show sequence of presentation which would
study to be developed at the local level.

At the back of this publication is a questionnaire which should be compl
this technical program and returned by school administrators to the Bureau o
velopment within 2 months of the time this publication is received. These s
will be considered before final revision and adoption of this syllabus.

The syllabus has not been divided into separate advanced optional course
here should be allocated to the appropriate course by those teachers completi

Descriptions of the basic and advanced option courses are given here for
study development.

A suggested scheduling arrangement is outlined to show how this technica
2- or 3- year pattern. Basic diploma requirements for Regents endorsement ar
Science, mathematics, and mechanical drawing should be taken at the home scho
subjects at the vocational school. A minimum of 4 1/2 units in Basic Electri
vanced option should be included in the Group II technical electives.

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TO THE TEACHER

ntal syllabus was developed following the recommendations of the
contained in this publication has the endorsement of the advisory
gestion of the Bureau of Trade and Technical Education it is being
g a Technical Electricity-Electronics program for their critical
final approval and adoption as a State syllabus.

d to identify suggested *CONTENT* on the leftside and *TEACHING SUGGEST-*
that these suggestions will help the teacher identify the scope or
nting the topic or to suggest an approach or method of presentation.
o show sequence of presentation which would be part of the course of
level.

on is a questionnaire which should be completed by the teachers in
ed by school administrators to the Bureau of Secondary Curriculum De-
time this publication is received. These suggestions and comments
evision and adoption of this syllabus.

ided into separate advanced optional courses. The content identified
propriate course by those teachers completing the questionnaire.

advanced option courses are given here for guidance in local course of

gement is outlined to show how this technical program can be fitted into a
oma requirements for Regents endorsement are outlined for your guidance.
al drawing should be taken at the home school concurrent with the technical
A minimum of 4 1/2 units in Basic Electricity, Basic Electronics, and ad-
n the Group II technical electives.

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DESCRIPTION OF COURSES

BASIC ELECTRICITY - includes all phases of direct and alternating curre insulating materials, resistance, voltage, current distribution, energy struments and techniques; magnetism, inductance, and capacitance in alt of these concepts as analytical tools. The subject content is applied and teacher demonstrations throughout the course. Stress is placed upo oratory reports throughout all technical courses.

BASIC ELECTRONICS - subject content includes elements of electrical cir and gas tubes (diode, triode, and multi-electrodes) power supply system controls. Solid state physics is emphasized in order to assist student their association with other circuits. Laboratory experiments provide concepts through the use of standardized instruments.

ADVANCED ELECTRICITY - the basic power requirements of modern electrica phasized through generation and distribution of three phase power. Pow systems and the instrumentation of transformers is covered through the wye and delta transformers.

The latter section of the course includes rotary and magnetic ampli equipment, thyratron and silicon-controlled rectifier and their associa and servomechanisms with the transistor servoamplifier polyphase vacuum

ADVANCED ELECTRONICS - standard procedures used in industry in the des an electronic unit are studied. The performance of an electronic syst and frequency response is analyzed. Filter coupling, peaking, feed-ba veloped to achieve desired performance. The principles learned are ap and instrumentation circuits.

Also, the generation and shaping of pulse and ramp waves is studie are applied in the development of TV sweep, radar, and digital circuit

COMPUTER CIRCUITRY - various number systems including binary and octal diagrams and systems are analyzed. Problems in computer design stress using half and full-adder, shift register, and counters.

Computers are analyzed through the use of block diagrams and typic explained through the application of the atomic theory of matter and s symbols and configurations are integrated into circuit analysis. Tran current gain as it is effected by temperature is stressed in circuit d device, and control circuits as well as input-output devices is applie maintenance.

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DESCRIPTION OF COURSES

phases of direct and alternating current. The concepts of conductors
, voltage, current distribution, energy, work and power, measuring in-
ism, inductance, and capacitance in alternating currents; and the uses
tools. The subject content is applied in student laboratory experiments
ghout the course. Stress is placed upon proper format in writing lab-
echnical courses.

ent includes elements of electrical circuits, characteristics of vacuum
d multi-electrodes) power supply systems, simple amplifiers and industrial
s emphasized in order to assist students to analyze active devices and
cuits. Laboratory experiments provide practical application of electronic
dardized instruments.

power requirements of modern electrical and electronic technology as em-
distribution of three phase power. Power measurements in the three phase
of transformers is covered through the subject content of three phase

urse includes rotary and magnetic amplifiers, rotary energy conversion
-controlled rectifier and their associated control equipment; synchros
nsistor servoamplifier polyphase vacuum tube and semiconductor rectifiers.

procedures used in industry in the design, development, and production of
The performance of an electronic system with respect to noise, distortion,
zed. Filter coupling, peaking, feed-back, and push-pull circuits are de-
ormance. The principles learned are applied to audio, AM, FM, TV control,

aping of pulse and ramp waves is studied analytically. These principles
of TV sweep, radar, and digital circuits.

mber systems including binary and octal are studied in this course. Logic
ed. Problems in computer design stress Boolean algebra as well as circuits
t register, and counters.

ugh the use of block diagrams and typical circuits. Transistor theory is
on of the atomic theory of matter and semiconductor physics. Transistor type
integrated into circuit analysis. Transistor stabilization in regard to
by temperature is stressed in circuit design. The theory of logic, memory
well as input-output devices is applied through experiments in computer

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ELECTRICAL ELECTRONIC DRAFTING - can be introduced at the home sch
ing course that stresses orthographic projection. The area center
ing block diagrams and electronic symbols and conventions. Schema
explain electrical-electronic theory in required laboratory experi
ment of working drawings needed to manufacture electronic equipmen

ELECTRICAL CONSTRUCTION - tools and techniques of the electrical
the construction of experimental models as they relate to student
integral part of all student activity.

Suggested Scheduling of Technical Electricity

Two Year Program

10th	11th
English 10	English 11
Social Studies	Social Studies
Mathematics 10	Mathematics 11
Mechanical Drawing	Chemistry
	Basic Electricity and Electronics - 3 perio

Three Year Program

10th	11th
English 10	English 11
Social Studies	Social Studies
Mathematics 10	Mathematics 11
Mechanical Drawing	Chemistry
Basic Electricity - 2 periods	Basic Electronics - 2

0350

RAFTING - can be introduced at the home school through the usual mechanical draw-
s orthographic projection. The area center can build on this background by teach-
electronic symbols and conventions. Schematic layout diagrams are stressed to
tronic theory in required laboratory experiments. Emphasis is placed upon develop-
s needed to manufacture electronic equipment.

- tools and techniques of the electrical and electronic industry are used during
erimental models as they relate to student experiments. Shop and eye safety is an
udent activity.

ested Scheduling of Technical Electricity and Electronics

Two Year Program

11th	12th
English 11	English 12
Social Studies	Physics
Mathematics 11	Health
Chemistry	Basic Electronics and Advanced Option - 3 periods
Basic Electricity and Electronics - 3 periods	

Three Year Program

11th	12th
English 11	English 12
Social Studies	Physics
Mathematics 11	Health
Chemistry	Advanced Option - 3 periods
- 2 periods Basic Electronics - 2 periods	

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ELECTRICITY AND ELECTRONICS

Requirements for Regents Endorsement for a Loc

Group I Required Constants

English . . . . . .
Social Studies (including 1 year of American History) . . .
Science . . . . . .
Mathematics . . . . . .
Health. . . . . .

Group II Required Technical Subjects

Basic Electricity . . . . . .
Basic Electronics . . . . . .
Advanced Electricity, Advanced Electroni or Computer Circuitry. . . . . .
*Mechanical Drawing Involving Electrical Concepts . . . . . .
*Physics . . . . . .

Group III Required Related Technical Subjects

Mathematics 10. . . . . .
Mathematics 11 (Recommended). . . . . .

A minimum of 18 units is required for Regents endor

*May be taught in home school

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ELECTRICITY AND ELECTRONICS

r Regents Endorsement for a Local High School Diploma

Constants	Units
. . . . .	4
udies (including 1 year of American History)	3
. . . . .	1
cs	1
. . . . .	1/2
Total. . .	9 1/2

Technical Subjects

ctricity	1 1/2
ctronics	1 1/2
Electricity, Advanced Electronics, ter Circuitry.	1 1/2
l Drawing Involving Electrical	1
. . . . .	1
Total. . .	6 1/2

Related Technical Subjects

cs 10.	1
cs 11 (Recommended).	1
Total. . .	2

s is required for Regents endorsement for a local high school diploma.

me school

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ELECTRICITY

I. Theory of current flow . . . . . .
II. Circuits . . . . . .
III. Measurements, standards, and toleran
IV. Conductors . . . . . .
V. Magnetism. . . . . .
VI. Electromagnetic induction. . . . . .
VII. Motor action . . . . . .
VIII. Alternating current. . . . . .
IX. Single phase circuits. . . . . .
X. Basic instruments. . . . . .
XI. Overload protection. . . . . .
XII. D.C. generators. . . . . .
XIII. D.C. motors. . . . . .
XIV. Three-phase system . . . . . .
XV. Alternators. . . . . .
XVI. Transformer principles . . . . . .
XVII. Alternating current motors . . . . .
XVIII. Grounding. . . . . .
XIX. Batteries. . . . . .
XX. Delays . . . . . .

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ELECTRICITY

I. Theory of current flow 2
II. Circuits 3
III. Measurements, standards, and tolerances. 3
IV. Conductors 4
V. Magnetism. 5
VI. Electromagnetic induction. 5
VII. Motor action 6
III. Alternating current. 6
IX. Single phase circuits. 8
X. Basic instruments. 9
XI. Overload protection. 9
XII. D.C. generators. 10
III. D.C. motors. 10
XIV. Three-phase system 11
XV. Alternators. 11
XVI. Transformer principles 11
VII. Alternating current motors 12
III. Grounding. 13
XIX. Batteries. 13
XX. Delays 13

6354 6355

ELECTRICITY

OUTLINE OF CONTENT

CONTENT	*TEAC*
I. Theory of current flow	
A. Construction of atom: electron flow	Use Bohr concept of si
B. Law of action between charges	Discuss law of charges
C. Concepts of voltage, current, and resistance	Define potential in te
	Define current as a fl
	Define resistance as t across a conductor t
	Mention units of curre
D. Conductors, semiconductors, and insulators	Discuss the nature of ductors. List examp
E. Sources of e.m.f.	Discuss qualitatively
1. Electromagnetic induction	
2. Chemical	
3. Thermal	
4. Piezoelectric	
5. Photovoltaic	
6. Static	
7. Other	

Note: Topics labeled "General Treatment" are to be covered in class prehensive examination.

Both theory and laboratory required.

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ELECTRICITY

OUTLINE OF CONTENT

	TEACHING SUGGESTIONS
electron	Use Bohr concept of simple atoms
charges	Discuss law of charges and electrostatic field concept.
current,	Define potential in terms of work.
	Define current as a flow of electric charge.
	Define resistance as the ratio of the potential difference across a conductor to the current in it.
	Mention units of current, voltage, and resistance.
tors, and	Discuss the nature of insulators, semiconductors, and conductors. List examples.
	Discuss qualitatively the various sources of e.m.f.
duction	

atment" are to be covered in class but shall not be tested on the com-

required.

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II. Circuits	
A. Ohm's law	Discuss Ohm's law. Solv
B. Series	State series and parall illustrative examples
C. Parallel	
D. Combinations	Stress concept of poten script notation.
E. Kirchhoff's laws	Give statement of laws
III. Measurements, standards, and tolerances	
A. Current	
1. Ammeter	Show how ammeter is con cautions in using an itatively.
2. Shunt calculations	
B. Voltage	
1. Voltmeter	Show how a voltmeter is
2. Multiplier calculations	Calculations of sensiti
3. Meter sensitivity and loading	Quantitative treatment
C. Resistance	
1. Voltmeter-ammeter method	Demonstrate resistance Point out that the p the circuit is impor readings.
2. Ohmmeter	Discuss both the series are required. Discu
a. Uses	
b. Circuitry	
3. Wheatstone bridge	Discuss the theory of several of its applica Work simple problems w

ELECTRICITY

Discuss Ohm's law. Solve problems.

State series and parallel circuit principles and give illustrative examples.

Stress concept of potential difference using double subscript notation.

Give statement of laws with simple illustrative examples.

s, and

Show how ammeter is connected in a circuit. Explain precautions in using an ammeter. Discuss Aryton shunt qualitatively.

ions

Show how a voltmeter is used in a circuit.

culations

Calculations of sensitivity required.

ity and

Quantitative treatment of loading is required.

ter method

Demonstrate resistance measurement by the V-A method. Point out that the proper location of the meters in the circuit is important to get accurate resistance readings.

Discuss both the series and shunt ohmmeters. Calculations are required. Discuss precautions in use of the ohmmeter.

dge

Discuss the theory of the Wheatstone Bridge. Point out several of its applications and its greater accuracy. Work simple problems with formula.

036859

D. Power	Define power.
1. Units - watts to horsepower	State that power c
2. Voltmeter-ammeter method	voltage across, Ohm's Law show t $W=I^2R$ and $W=\frac{E^2}{R}$
3. Wattmeter	Discuss the method
E. Energy	Define electrical multiplied by ti
IV Conductors	
A. Factors affecting resistance	Discuss the effect area, and length
B. Resistivity	
C. $R=\frac{Kl}{d^2}$	
D. Wire size	
a. Permissible voltage drops	Line drop calculat *Underwriter's* st made to local or
b. Use of wire tables	Use wire tables as conductors. Der
c. Calculation of wire size	Determine minimum which will satis tables to select
E. Temperature effect calculations	Determine resistar $\frac{R_1}{R_2} = \frac{234.5 + t_1}{234.5 + t_2}$ General treatme efficient of re mistor control

ELECTRICITY

	Define power.
o horsepower	State that power can be determined from the product of the voltage across, and the current through a circuit. Using Ohm's Law show that power can be expressed as $W=I^2R$ and $W=\frac{E^2}{R}$
er method	Discuss the method of connecting a wattmeter in a circuit.
	Define electrical energy. Explain that energy is power multiplied by time. Specify energy unit.
esistance	Discuss the effect of material composition, cross sectional area, and length on resistance at a constant temperature.
tage drops	Line drop calculations should use *National Board of Fire Underwriter's* standards. However, reference should also be made to local ordinances as required.
les	Use wire tables as sources of information about electrical conductors. Demonstrate use of wire gauge and micrometer.
wire size	Determine minimum circular mil area of copper conductor which will satisfy line drop specifications. Use wire tables to select available wire size.
calculations	Determine resistance or temperature (°C.) for copper, using: $\frac{R_1}{R_2} = \frac{234.5 + t_1}{234.5 + t_2}$ General treatment of materials having a negative coefficient of resistivity. Discuss their use in thermistor control devices.

V Magnetism	
A. Permanent magnets	Discuss the basic c
1. Properties	
a. Laws of interaction	
b. Lines of force	
c. Permeability and saturation	Discuss B-H curve.
2. Molecular theory	Use simple molecula uration, residual Discuss magnetizi concept of magnet
3. Materials	Indicate distinctio and paramagnetic
B. Electromagnets	
1. Direction and distribution of magnetic fields about current carrying conductors and coils	Discuss fields asso coil. Use right and coil.
2. Factors affecting strength	
a. Ampere turns	Discuss effect of c on magnet strengt
b. Permeability	Define permeability
VI Electromagnetic induction	
A. Faraday's law	Point out the facto duced e.m.f.
B. Lenz's law	Discuss the polarit
C. Induction coils	
1. Self-induction	Define self-inducti it.
2. Mutual-induction	Define mutual-induc it. Mention some

ELECTRICITY

Discuss the basic concepts of magnetism and magnetic fields.

action
e
and saturation

Discuss B-H curve.

Use simple molecular theory to explain permeability, saturation, residual magnetism, permanent magnets, etc. Discuss magnetizing, demagnetizing, shielding and the concept of magnetic domains.

Indicate distinction between ferromagnetic, diamagnetic, and paramagnetic materials.

tribution of
bout current
rs and coils

Discuss fields associated with straight conductor and with coil. Use right hand (current) rules for straight wire and coil.

strength

Discuss effect of changing turns, current, and core material on magnet strength.
Define permeability.

Point out the factors which determine the magnitude of induced e.m.f.

Discuss the polarity of induced self e.m.f.

Define self-induction and discuss the factors which affect it.

Define mutual-induction and discuss the factors which affect it. Mention some applications.

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VII Motor action	
A. Principle of operation	
1. Force on a conductor	Discuss the for electromagnet
2. Relative directions	Show the magnet current held Motor Rule to carrying cond
B. Applications	
1. D.C. Motors	Introduce conce inforced at a
2. D'Arsonval meter movement	Point out that precision spr inherently ar
VIII Alternating current	
A. Basic concepts	
1. Sine wave development	Discuss and ill press the fu
2. Frequency	Define frequen and period.
3. Maximum value	Define maximum
4. Effective value	Define effecti Point out th values for s
5. Average value	Define average geometric fi
6. Instantaneous value	Define instant
7. Effective resistance	Discuss the di resistance.

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ELECTRICITY

on

ctor — Discuss the force on a conductor carrying a current in an electromagnetic field.

ons — Show the magnetic field formation of a conductor carrying current held in a magnetic field. Explain the Left Hand Motor Rule to show the direction of motion of a current carrying conductor in a magnetic field.

Introduce concept of counter e.m.f. at this point to be reinforced at a later date.

movement — Point out that force on a conductor acts against a pair of precision springs. Mention that this type of meter is inherently an average reading device.

ment — Discuss and illustrate the generation of a sine wave. Express the function both in terms of degrees and radians.

Define frequency and periodic function. Relate frequency and period.

Define maximum and peak-to-peak values.

Define effective value (R.M.S.) in terms of heating effect. Point out the relationship between effective and maximum values for sine and square waves.

Define average value. Illustrate for sine wave and regular geometric figures as waves.

lue — Define instantaneous value and illustrate with problems.

ance — Discuss the difference between d.c. resistance and effective resistance.

8. True power (watts)	Define true power as e ably converted to an chanical.
9. Reactive power (vars)	Define reactive power between sources and
10. Apparent power (va)	Define apparent power and ammeter readings powers analytically
11. Power Factor	Define power factor as power. Relate the p phase angle of the c
B. Inductive circuits	
1. Factors affecting inductance	Define inductance. Di of inductance on geo
2. Calculation of inductive reactance	State that inductive r to current flow in a induction.
3. Phase relationships	Discuss the concept of Explain the phase la inductive circuit.
4. Mutual inductance	Discuss qualitatively.
C. Capacitive Circuits	Define capacitance in
1. Basic concepts	. the opposition . the storage of Define capacitor. D and discharging.
2. Factors affecting capacitance	Discuss qualitatively physical constructio of connecting capaci
3. Calculation of capacitive reactance	State that capacitive offered to current f
4. Phase relationships	Discuss the effect of between circuit volt

6366

ELECTRICITY

Define true power as electrical - power which is nonrecoverably converted to another form of power, e.g., heat, mechanical.

rs) Define reactive power as electrical power which oscillates between sources and load.

Define apparent power as the product of circuit voltmeter and ammeter readings. Relate true, reactive, and apparent powers analytically and in a phasor diagram.

Define power factor as the ratio between true and apparent power. Relate the power factor to the cosine of the phase angle of the circuit.

nductance Define inductance. Discuss qualitatively the dependence of inductance on geometry and composition of the coil.

ctive State that inductive reactance represents the opposition to current flow in a circuit due to the voltage of self-induction.

Discuss the concept of phase relationship (lead and lag). Explain the phase lag of current behind voltage in an inductive circuit.

Discuss qualitatively.

Define capacitance in terms of:

- the opposition to voltage change.
- the storage of charge.

Define capacitor. Discuss action of capacitor charging and discharging.

apacitance Discuss qualitatively the dependence of capacitance on the physical construction of the unit. Consider the effect of connecting capacitors in series and in parallel.

citive State that capacitive reactance represents the opposition offered to current flow by a capacitor.

Discuss the effect of capacitance on the phase relationship between circuit voltage and current.

6367

IX Single phase circuits	
A. Series circuits involving R, L, and C	
I. Voltage, current and power calculations	Introduce the opposition and graphic Thoroughly power, reac
2. Phasor diagrams	Develop phaso current.
B. Parallel circuits involving R, L, and C	
1. Voltage, current, and power calculations	Consider pure only single voltage, po
2. Phasor diagram	Develop phaso
C. Resonance	
1. Series	Define series resonant ci versus freq of circuit
2. Parallel	Define parall parallel re current ver (Q < 10) an sistance (i is to be ne
D. R-L and R-C time constants	Discuss the r across all which a ste
	Study the eff on the rise universal a emphasizing

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olving R,

t and power

Introduce the concept of impedance as the total circuit opposition to current flow. Present both analytical and graphical solution for impedance (Phasor diagram). Thoroughly develop the concepts of true power, apparent power, reactive power, and power factor.

Develop phasor diagrams both for impedance and for voltage current.

nvolving

t, and
ons

Consider pure components only, and branches containing only single elements. Calculations of impedance, current, voltage, power, and power factor required.

Develop phasor diagrams for voltage and current.

Define series resonance. Discuss characteristics of series resonant circuits and curves of impedance and current versus frequency. Define bandwidth and Q, and the effect of circuit resistance and L/C ratio on bandwidth.

Define parallel resonance. Discuss characteristics of parallel resonant circuits and curves of impedance and current versus frequency. Distinguish between low Q ($Q < 10$) and high Q ($Q \geq 10$) circuits. Effect of resistance (in inductive branch) on resonant frequency is to be neglected.

nstants

Discuss the rise and decay of current through and voltage across all components in basic R-L and R-C circuits to which a step voltage is applied.

Study the effect of changing the value of circuit parameters on the rise and decay curves. Discuss the use of the universal ascending and [illegible]ing time constant curves, emphasizing values at one-and two-time constants.

6369

E. Power factor correction	Discuss the need for application of this
X Basic instruments	
A. D'Arsonval	Discuss construction
B. D'Arsonval with rectifier	Note applications,
C. Iron vane	sired, measured fre
D. Electrodynamometer	surable with instru
	etc.)
E. Use of	
1. Watt-hour meter	Stress use rather tha
2. Oscilloscope	accuracy, frequency
3. Frequency meter	
4. VOM	
5. VTVM	
6. Digital readout meters	
XI Overload protection	
A. Fuse	Give general treatmen fuses and indicate briefly time-delay types.
B. Circuit breaker	Introduce the general principle of operati
	As an optional feature quick-break, trip fr pressed air and oil.
C. Semiconductor	Discuss the applicatio of circuits or devic the protection of me

6370

ELECTRICITY

Discuss the need for power factor correction and illustrate application of this concept with examples.

Discuss construction and basic operation of instruments. Note applications, considering relative precision desired, measured frequency, sensitivity, quantity measurable with instrument (e.g., RMS or average, ac or dc etc.)

Stress use rather than theory of operation. Consider accuracy, frequency response, loading effect, etc.

Give general treatment of low-voltage plug and cartridge fuses and indicate voltage and current ranges. Discuss briefly time-delay fuses made in both plug and cartridge types.

Introduce the general idea of circuit breakers, including principle of operation, and, uses in preference to fuses.

As an optional feature briefly discuss features such as quick-break, trip free, and types such as magnetic, compressed air and oil.

Discuss the application of semiconductors in the protection of circuits or devices against overloads for example, the protection of meters with diodes

6371

XII D.C. generators	
A. Construction and basic theory	Describe dynamo c lying the gener sider the actio relating termin
1. Separately excited	
2. Self-excited (shunt)	
B. Factors affecting build-up	Discuss the facto shunt generator
C. Commutation (general treatment)	Discuss qualitati mutation, menti
D. Characteristics of generators	
1. Magnetization curve	Briefly discuss m
2. External characteristics	Consider the exte generators, and change of termi ulation.
3. Voltage control	Discuss method fo generators.
XIII D.C. motors	
A. Theory	Discuss the basic torque in a d.c counter electro lating terminal
B. Characteristics	Discuss the opera shunt, and comp and torque. Li motors.
C. Starting requirements	Discuss the start basic starting
D. Operation	Discuss the opera motors. Consid trolling speed, tion.

6372

theory	Describe dynamo construction, and the basic concepts underlying the generation of a voltage in the armature. Consider the action of the commutator. Develop the equation relating terminal voltage and generated voltage.
-up	Discuss the factors affecting the build-up of a self-excited shunt generator.
eatment)	Discuss qualitatively the problems surrounding proper commutation, mentioning the need for interpoles.
rators	
	Briefly discuss magnetization curve.
stics	Consider the external characteristics of shunt and compound generators, and discuss briefly the factors affecting the change of terminal voltage with load. Define voltage regulation.
	Discuss method for controlling the terminal voltage of d.c. generators.
	Discuss the basic concepts underlying the development of torque in a d.c. motor. Consider the generation of a counter electromotive force and develop the equation relating terminal voltage and CEMF.
	Discuss the operating characteristics of the d.c. series, shunt, and compound motors considering speed regulation and torque. List applications of the various types of motors.
	Discuss the starting of d.c. motors and briefly consider basic starting equipment.
	Discuss the operation of d.c. series, shunt, and compound motors. Consider reversing direction of rotation, controlling speed, and precautions to be observed in operation.

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XIV Three-phase systems.	
A. Voltage, current, and power	Discuss the adv rent and volt sent the form
1. Wye	
2. Delta	
B. Three-phase, four-wire transmission and distribution system.	Discuss the app to generators
C. Measuring power in a three-phase system	Point out the a measurement o readings unde
XV Alternators	
A. Construction	Discuss the typ
B. General principles of operation (general treatment)	Discuss the gen speed and num
C. Applications	Consider the us
XVI Transformer principles	
A. Transformer action	Discuss how the output.
B. Current and voltage	Define the phra directly prop versely propo
C. Polarities and connections	Discuss subtract concepts unde sidering pola tribution of capacity conn former connect (a) wye (b) delt (c) wye (d) delt (e) oper

6374

t, and power	Discuss the advantages of poly-phase systems. Show the current and voltage relationships in both connections. Present the formula for calculation of power.
ur-wire trans- tribution system.	Discuss the application of this type of connection as applied to generators and transformers.
in a three-	Point out the advantages of the two wattmeter method in the measurement of three-phase power. Discuss the wattmeter readings under resistive-reactive loads.
	Discuss the types of construction.
les of ral treatment)	Discuss the generation of e.m.f. and show the effects of speed and number of poles on frequency.
	Consider the use of alternators in the automotive industry.
les	
ion	Discuss how the power input adjusts to changes in power output.
tage	Define the phrase volt/turn. Explain that the voltages are directly proportional to turns ratio, and currents are inversely proportional to the turns ratio.
connections	Discuss subtractive and additive polarities. Discuss the concepts underlying the paralleling of transformers, considering polarity and voltage. Mention the unequal distribution of loads between two transformers of different capacity connected in parallel. Show three-phase transformer connections with diagrams of: (a) wye - wye (b) delta - wye (c) wye - delta (d) delta - delta (e) open delta

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6375

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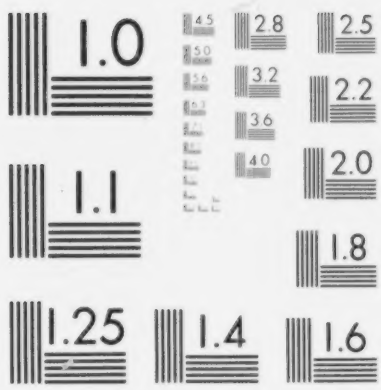

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

D. Special types

1. Instrument

Discuss the use of instrument tr
as part of control systems and
cuss the current transformer (
cision current step-down trans
rect connections, and stress s
and danger of allowing seconda
Calculate line currents from a

Note: A possible enrichment for
use of P.T. and C.T. with
of obtained information i
and volt-ampere-reactive

Discuss the potential transforme
precision, voltage stepdown tr
correct connection to a high v
aspects of the grounded second
from secondary voltmeter readi
Phasing should involve correct
(H and X) and dot.

2. Autotransformer

Discuss construction and basic p
illustrating current distribut
step-up and step-down connecti

3. Losses

Qualitatively discuss transforme

XVII Alternating current motors

A. Three-phase induction

Discuss the construction and imp
the polyphase induction motor
little maintenance required).
operation, elaborating on the
transformer action, and slip.
versing direction of rotation

B. Single phase

Demonstrate and discuss common
repulsion, shaded pole, capac

6376

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ELECTRICITY

Discuss the use of instrument transformers in measurement as part of control systems and as isolation devices. Discuss the current transformer (C.T.) as a low-capacity, precision current step-down transformer. Demonstrate correct connections, and stress safety aspects of grounding and danger of allowing secondary to become open-circuited. Calculate line currents from a meter reading.

Note: A possible enrichment for some classes might be the use of P.T. and C.T. with a voltmeter and the use of obtained information in calculating power factor, and volt-ampere-reactive (vars).

Discuss the potential transformer (P.T.) as a low capacity, precision, voltage stepdown transformer. Demonstrate correct connection to a high voltage line, and the safety aspects of the grounded secondary. Calculate line voltage from secondary voltmeter reading and P.T. ratio. Phasing should involve correct use of standard markings (H and X) and dot.

ormer

Discuss construction and basic principles. Include diagrams illustrating current distribution and voltages in both step-up and step-down connections.

Qualitatively discuss transformer losses.

t motors

luction

Discuss the construction and important characteristics of the polyphase induction motor (essentially constant speed, little maintenance required). Develop the principles of operation, elaborating on the rotating magnetic field, transformer action, and slip. Mention the method of reversing direction of rotation.

Demonstrate and discuss common types:universal, split-phase, repulsion, shaded pole, capacitor start, and synchronous.

6374
6377

XVIII Grounding	Discuss grounding as a safety electrical circuits. Consi possible injury when workin consider use of ground as a
XIX Batteries (general treatment)	Demonstrate factors necessary dissimilar metals and elect
A. Types	Display different sizes of co mercuric oxide-zinc). Disc binations of cells. Display common storage cells(lead-acid).
B. Characteristics and care	Compare batteries as to appli lyte, charge and discharge Demonstrate and discuss in and safety considerations i batteries. Consider the in ampere-hour rating.
XX Relays	
A. Operation	Consider relays with regard t (a) Basic operation (b) Power (c) Coil ratings
B. Characteristics	Discuss the operate and relea (a) Definition (b) DC relay (1) operating ti (2) mechanical i (c) AC relay (1) phase displa (2) operating ti
C. Types	Discuss the factors to consid

1868 6378

ELECTRICITY

Discuss grounding as a safety and protective feature in electrical circuits. Consider methods for minimizing possible injury when working in electrical circuits. Also consider use of ground as a point of reference.

treatment)

Demonstrate factors necessary for simple voltaic action: dissimilar metals and electrolyte.

Display different sizes of common dry cells (carbon-zinc, mercuric oxide-zinc). Discuss series and parallel combinations of cells.

Display common storage cells(nickel-iron, nickel-cadmium, lead-acid).

and care

Compare batteries as to applications, cell voltage, electrolyte, charge and discharge rates, and general maintenance. Demonstrate and discuss in detail, the care, maintenance and safety considerations in the use of lead-acid storage batteries. Consider the internal resistance of a cell and ampere-hour rating.

Consider relays with regard to:

(a) Basic operation
(b) Power
(c) Coil ratings

Discuss the operate and release times of relays:

(a) Definition
(b) DC relay
    (1) operating times
    (2) mechanical inertia
(c) AC relay
    (1) phase displacement in magnetic flux
    (2) operating times

Discuss the factors to consider in selecting a relay.

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ELECTRONICS

I. Electron theory . . . . . .
II. Electronic devices . . . . . .
III. Basic circuits . . . . . .
IV. Cascade amplifiers . . . . . .
V. Feedback . . . . . .
VI. Communications . . . . . .
VII. Circuit analysis and troubleshooting . .
VIII. Pulses and pulse trains . . . . . .
IX. Circuitry . . . . . .
X. Number systems . . . . . .
XI. Logic . . . . . .

6382

ELECTRONICS

ctron theory. 16
ctronic devices 17
ic circuits 25
cade amplifiers 35
dback 36
munications 37
cuit analysis and troubleshooting 42
ses and pulse trains. 45
cuitry. 45
ber systems 46
ic. 46

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I Electron theory	
A. Conduction in semiconductor materials	Define a semiconductor as a tween a conductor and ins 5 to 8 valence electrons, 4.
1. Intrinsic	List silicon and germanium most prevalent today.
	Describe lattice structure lent bonds.
	Establish the fact that imp more useful material.
2. Doping	Define a donor impurity as electrons. Inform the st
a. N-type	are arsenic and antimony. valent impurities. Indic containing controlled amo "doped." Illustrate how lattice structure leaving
	Emphasize that this materia electrons outside the lat
	Indicate that the material ly charged, since the tot equal.
b. P-type	Define an acceptor impurity 3 electrons.
	Inform the students that ty doping are boron, aluminu types.
	Illustrate how the acceptor structure leaving holes. P-type but is also neutra equal numbers of electron of minority carriers. Me incident light variations

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6384

r Define a semiconductor as a material whose resistance falls between a conductor and insulator. Indicate that insulators have 5 to 8 valence electrons, conductors have 1 to 3, semiconductors 4.

List silicon and germanium as the types of semiconductor materials most prevalent today.

Describe lattice structure of pure germanium or silicon and covalent bonds.

Establish the fact that impurity atoms must be added to create a more useful material.

Define a donor impurity as one whose valence ring contains 5 electrons. Inform the students that typical donor impurities are arsenic and antimony. Mention that these are called pentavalent impurities. Indicate that the semiconductor materials containing controlled amounts of impurities are referred to as "doped." Illustrate how the donor impurity atom fits into the lattice structure leaving one free electron.

Emphasize that this material is defined as N-type since there are electrons outside the lattice structure.

Indicate that the material is electrically neutral, not negatively charged, since the total number of electrons and protons are equal.

Define an acceptor impurity as one with a valence ring containing 3 electrons.

Inform the students that typical acceptor impurities used for doping are boron, aluminum, indium, and gallium; all trivalent types.

Illustrate how the acceptor impurities atoms fit into the lattice structure leaving holes. Mention that this material is called P-type but is also neutral from a charge standpoint as it has equal numbers of electrons and protons. Introduce the concept of minority carriers. Mention the effect of temperature and incident light variations on available current carriers.

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B. Electron emission	
1. Thermionic emission.	Discuss the energy for e Explain how heat suppl from the attraction of used. Discuss high ef
2. Photoelectric emission	Compare light with heat electrons are released
	List the more common typ
	State that the number of material is proportion
3. Secondary emission	Define secondary emissio
	Mention that secondary e times has a negligible
II Electronic devices	
A. Diodes	Discuss the formation of N-Type semiconductor. and the formation of t
1. Semiconductor	
a. P-N junction	
b. Forward bias	Define forward bias and to its effect. Discus need for current limit
c. Reverse bias	Define reverse bias and ity carriers. Discuss Voltage (PIV) ratings
d. Characteristic curve	Present the volt-ampere conductor diode. Disc characteristic curve. can be calculated. Di resistance. Discuss t germanium and silicon
e. Temperature effects	Discuss the effect of te current carriers. Men of silicon diodes.

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iscuss the energy for emission. Define work function. Explain how heat supplies energy to the electrons to free them from the attraction of the nucleus. List the types of materials used. Discuss high efficiency emitters.

ompare light with heat as a form of energy. Explain how valence electrons are released by light.

ist the more common types of photoelectric materials.

tate that the number of electrons released from a photoelectric material is proportional to the intensity of the incident light.

efine secondary emission.

ention that secondary emission occurs in vacuum tubes and at times has a negligible effect.

iscuss the formation of a junction diode by joining P-Type and N-Type semiconductor. Mention the initial flow of electrons and the formation of the "depletion region."

efine forward bias and explain current flow within the diode due to its effect. Discuss the thermal breakdown effect and the need for current limiting resistors.

efine reverse bias and explain its effect on majority and minority carriers. Discuss the zener potential. Define Peak Inverse Voltage (PIV) ratings and factors affecting it.

resent the volt-ampere characteristic curve of a typical semiconductor diode. Discuss leakage current and its effect on the characteristic curve. Show how forward and reverse resistance can be calculated. Discuss the ratio of reverse to forward resistance. Discuss typical forward and reverse resistance of germanium and silicon diodes.

Discuss the effect of temperature on the quantity of available current carriers. Mention the higher temperature capabilities of silicon diodes.

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f. Zener diode	Show the characteristic cu power dissipation and se circuit applications.
g. Special types (general treatment)	Mention special types of d variable resistance, pho
2. Vacuum tube (general treatment)	Explain the operation of t limitions due to the gla quirements.
a. Effect of filament temperature on plate current	Review the effect of heat plate current and voltag
b. Effect of plate voltage on plate current	Show the relationship betw the characteristic curve
d. Construction	Discuss construction and l
B. Active devices	
1. Physical characteristics (general treatment)	Discuss the physical chara containers used with sem
a. Containers	Note the need for heat sin characteristics of some.
	Compare the physical const ductor devices.
b. Internal composition	Discuss the transistor as
	Note the origin of the wor
c. Lead and pin recognition	Describe the pin and lead
d. Symbolic representation	Require that the student b tion of the NPN and PNP rectifier, the triode, t
2. Theory of operation	Qualitatively discuss the they pass through the tr biased junction and the
	Discuss how current, volta

ELECTRONICS

Show the characteristic curve of a zener diode. Explain maximum power dissipation and selection of limiting resistor. Discuss circuit applications.

(general Mention special types of diodes such as variable capacitance, variable resistance, photoconductive, thermistor, etc.

ral Explain the operation of the vacuum tube diode. Mention its limitions due to the glass envelope and filament voltage requirements.

ament
n plate Review the effect of heat on cathode emission and its relation to plate current and voltage.

te voltage Show the relationship between plate current. Define and present
ent the characteristic curves for the diode.

Discuss construction and lead arrangement.

ristics Discuss the physical characteristics of a few of the most popular
t) containers used with semiconductor devices. e.g. TO-1, TO-3

Note the need for heat sinks to dissipate heat and the physical characteristics of some.

Compare the physical construction of vacuum tubes and semiconductor devices.

osition Discuss the transistor as two P-N diodes back to back.

Note the origin of the word transistor from transfer - resistor.

Describe the pin and lead arrangement of active devices.

esenta- Require that the student be familiar with the symbolic representation of the NPN and PNP transistor, the silicon controlled rectifier, the triode, tetrode, and pentode vacuum tubes.

on Qualitatively discuss the paths taken by holes and electrons as they pass through the transistor. Note the effect of the forward biased junction and the reverse biased junction.

Discuss how current, voltage and power gains are determined.

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Mention how electron fl
tubes.

Compare the imput resis

Discuss photo-voltaic a

3. Characteristic curves

a. Output curves

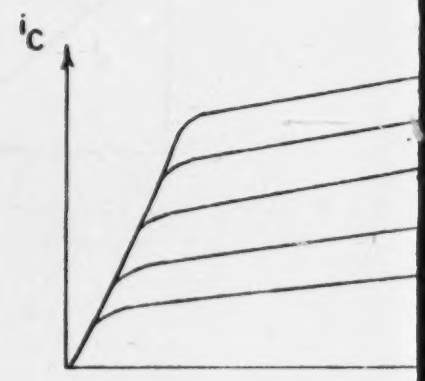

b. Input curves

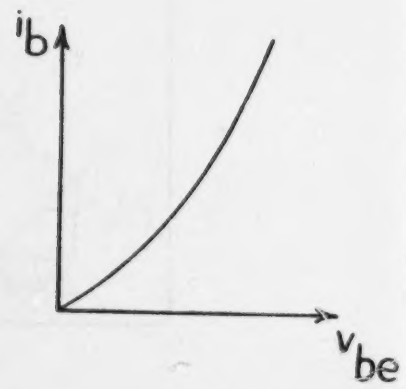

Input curves are not ne
theoretical infinite

Impart to the student t
input resistance of t

Make use of input curve
current.

ELECTRONICS

Mention how electron flow is controlled by the grid in vacuum tubes.

Compare the input resistance of semiconductors and vacuum tubes.

Discuss photo-voltaic action.

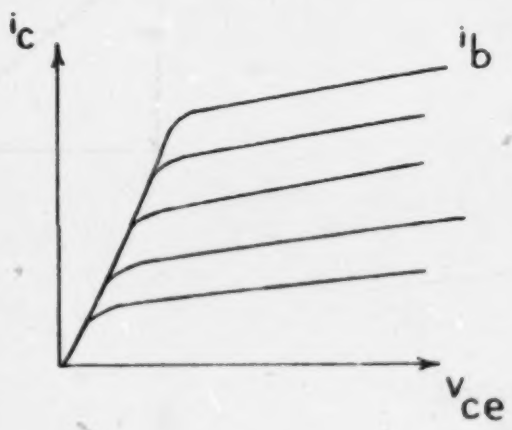

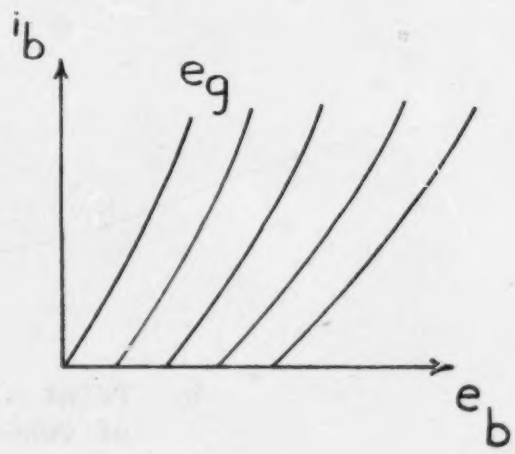

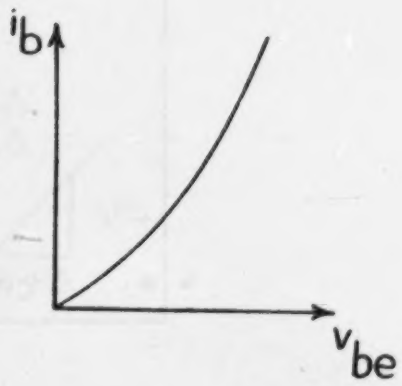

Input curves are not necessary for vacuum tubes because of the theoretical infinite input resistance.

Impart to the student that the slope of the input curve is the input resistance of the device.

Make use of input curves to relate input voltage and input current.

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4. Load line

   a. Intercept method of construction

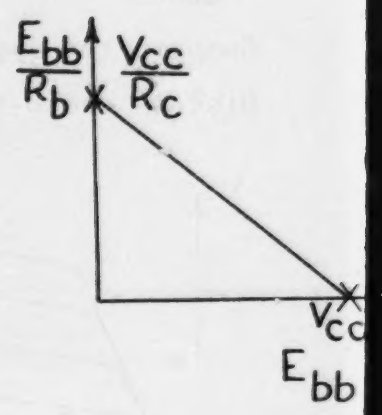

   b. Point slope method of construction

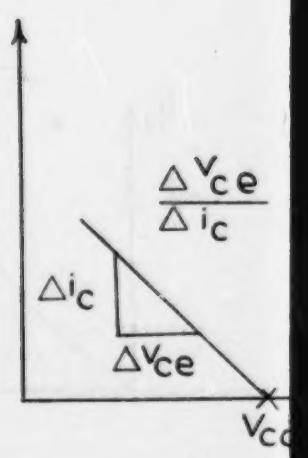

5. Bias and quiescent point location — Discuss the function of bias operating point on the loa a device to the linear por and saturation.

6. Equivalent circuits — Develop the representation c impedance (Thevenin) equiv (Norton) equivalent circui

   a. Voltage equivalent (Thevenin)

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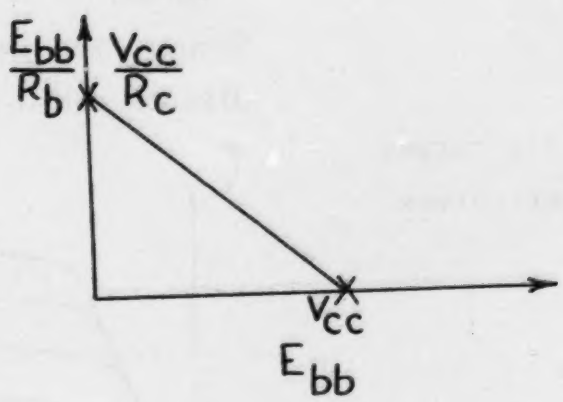

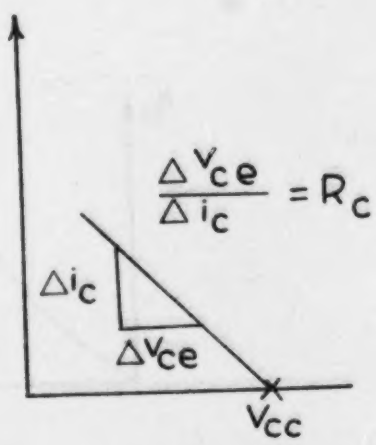

Discuss the function of bias with respect to location of quiescent operating point on the load line. Note the need for biasing a device to the linear portion of operation, avoiding cut off and saturation.

Develop the representation of any two terminal device by a voltage - impedance (Thevenin) equivalent circuit or current - impedance (Norton) equivalent circuit.

b. Current equivalent

Consider 3 terminal d
two terminals and t
Norton equivalents.

c. h-parameter equivalent

Develop the h-paramet
lent of the input p
port. Limit the di
h's.

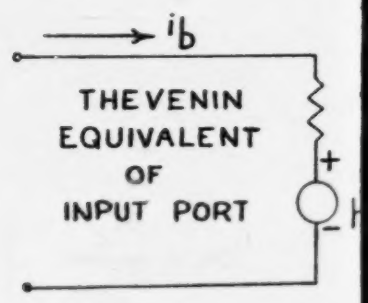

Discuss h_{ie} as the in
output resistance,

d. Vacuum tube equivalent circuit

Relate the Thevenin e
cuits to vacuum tub

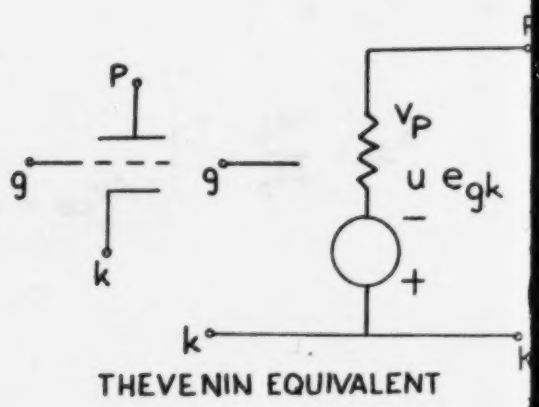

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quivalent

Consider 3 terminal devices as two-port networks, each having two terminals and thereby representable by Thevenin and/or Norton equivalents.

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t

Develop the h-parameter equivalent circuit as Thevenin equivalent of the input port and a Norton equivalent of the output port. Limit the discussion of h parameters to common emitter h's.

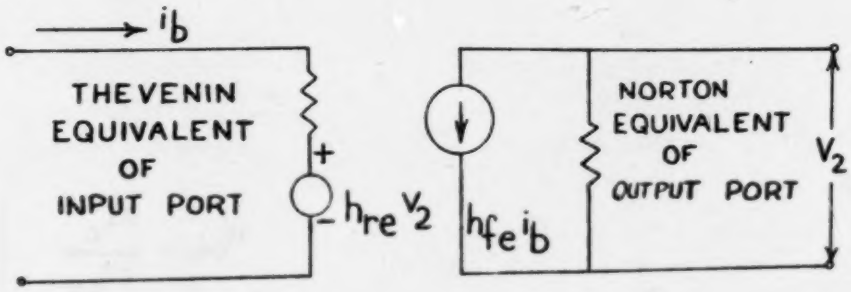

Discuss h_{ie} as the input resistance of transistor, $\frac{1}{h_{oe}}$ as the output resistance, and h_{fe} as the short circuit current gain.

ube
nt circuit

Relate the Thevenin equivalent and the Norton equivalent circuits to vacuum tubes.

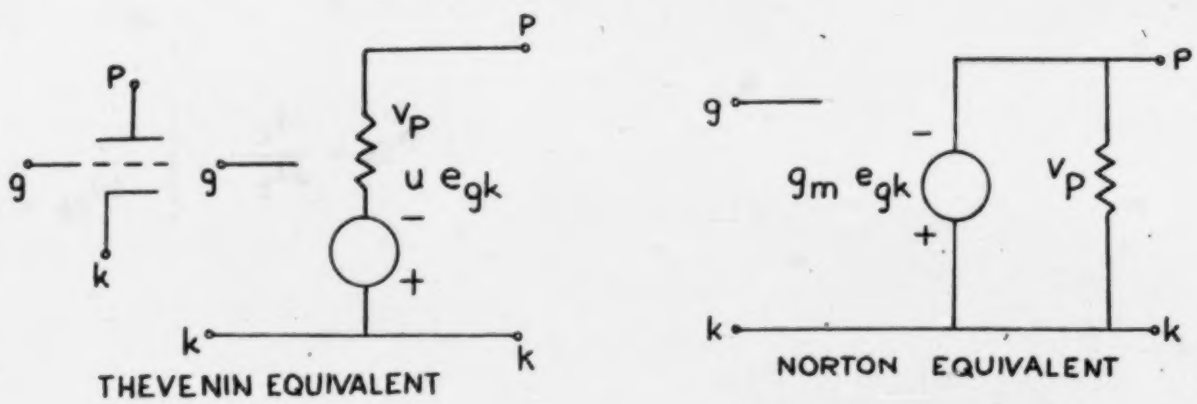

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7. Parameters

a. h parameters

Define:

$$h_{ie} = \frac{\Delta v_{be}}{\Delta i_b} \Bigg|_{\Delta v_c}$$

$$h_{oe} = \frac{\Delta i_c}{\Delta v_{ce}} \Bigg|_{\Delta i_b}$$

$$h_{fe} = \frac{\Delta i_c}{\Delta i_b} \Bigg|_{\Delta v_c}$$

Determine from charac

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Define:

$$h_{ie} = \frac{\Delta v_{be}}{\Delta i_b}\Bigg|_{\Delta v_{ce} = o}$$

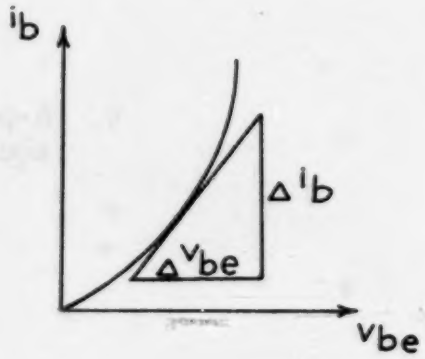

$$h_{oe} = \frac{\Delta i_c}{\Delta v_{ce}}\Bigg|_{\Delta i_b = o}$$

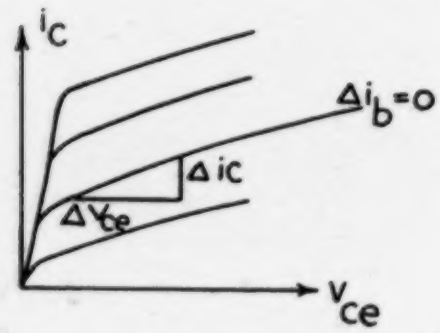

$$h_{fe} = \frac{\Delta i_c}{\Delta i_b}\Bigg|_{\Delta v_{ce} = o}$$

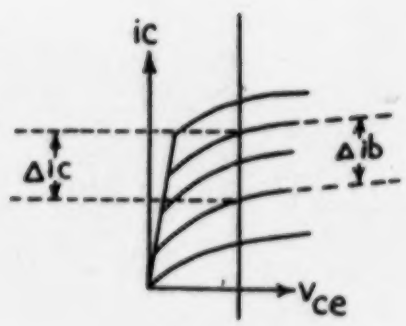

Determine from characteristic curves.

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h_{re} should be discussed and then quickly dropped since under most conditions the effect of $h_{re}\ v_2$ is small enough to be ignored.

Simplified h parameter equivalent circuit of the transistor.

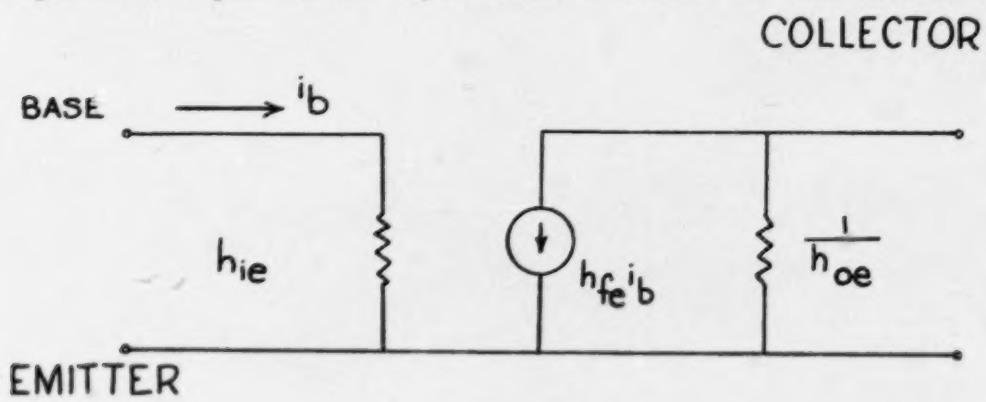

Define

$$r_p = \frac{\Delta e_b}{\Delta i_p} \Bigg|_{\Delta e_g = o}$$

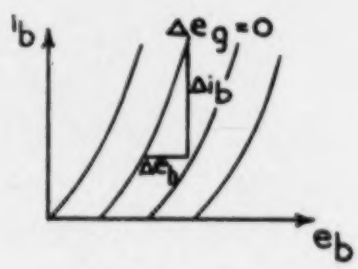

$$u = \frac{\Delta e_b}{\Delta e_g} \Bigg|_{\Delta i_p = o}$$

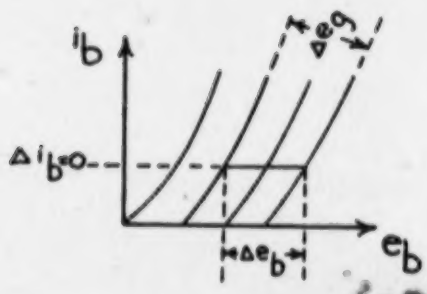

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$$gm = \frac{\Delta i_p}{\Delta e_g} \Bigg|_{\Delta e_b = o}$$

ELECTRONICS

$$gm = \frac{\Delta i_p}{\Delta e_g} \Bigg|_{\Delta e_b = o}$$

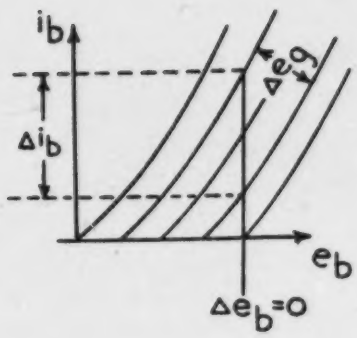

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III Basic circuits

A. Rectifiers

1. Concept of rectification — Instill the concept of re current flow.

2. Circuits — Explain the functioning o one-half cycle and clos

a. Half-wave — The output waveshape of t to be the sum of a DC 1 quency being equal to 1

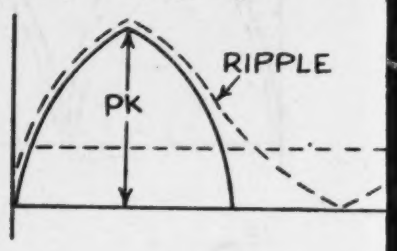

$$E_{DC_{HW}} = \frac{E_{PK}}{\pi}$$

$$E_{ripple_{P-P}} = E_{PK}$$

Given the current and vol the required transforme the diode (also vice-ve type. Discuss the need even when a step-up or

Indicate that there is a AC-DC radios and TV's.

b. Full-wave

(1) Center-tapped Transformer type — Indicate that by using tw a circuit can be develo halves of the input cyc

6402

tification

Instill the concept of rectification providing a unidirectional current flow.

Explain the functioning of a diode as a switch which is open for one-half cycle and closed for the other one-half cycle.

The output waveshape of the half wave rectifier can be considered to be the sum of a DC level and a ripple component, ripple frequency being equal to line frequency.

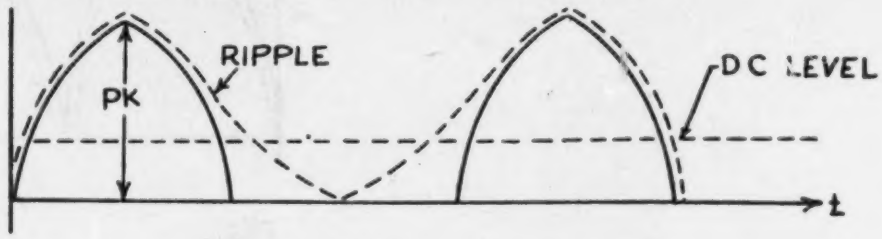

$$E_{DC_{HW}} = \frac{E_{PK}}{\pi} \qquad I_{DC_{HW}} = \frac{I_{PK}}{\pi}$$

$$E_{ripple_{P-P}} = E_{PK} \qquad I_{ripple_{P-P}} = I_{PK}$$

Given the current and voltage requirements of the load, determine the required transformer turns ratio and required PIV rating of the diode (also vice-versa). Have students do problems of this type. Discuss the need for a transformer for isolation purposes even when a step-up or step-down of line voltage is not necessary.

Indicate that there is a shock hazard from transformerless and AC-DC radios and TV's.

er-tapped

sformer type

Indicate that by using two diodes and a center-tapped transformer a circuit can be developed which allows conduction during both halves of the input cycle.

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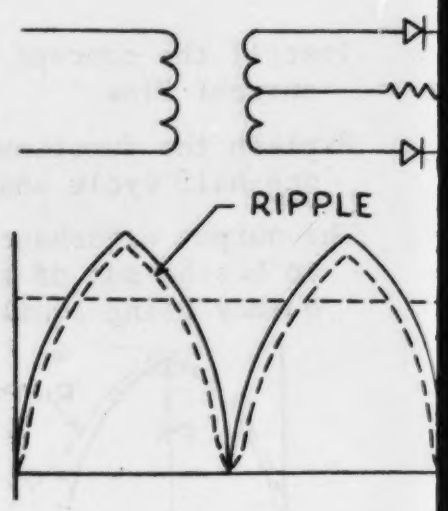

$E_{DC} = \frac{2E_{PK}}{\pi}$ I_D

$E_{ripple\ P-P} = E_{PK}$ $I_{r\ P}$

Ripple frequency is twice 1
the above.

Indicate that the peak outp
from the center tap to on

Determine PIV and note that
rectifier.

(2) Bridge type

Elaborate on the need for a
wave rectifier circuit an
ing a transformer when op
with a bridge-type recti

Indicate that the output vo
ary voltage for the bridg

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6404

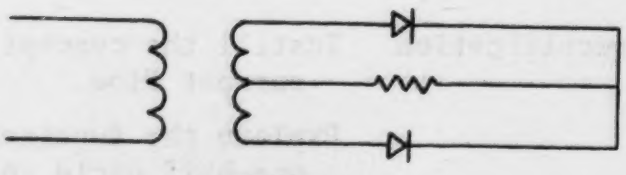

$$I_{AVG\ PER\ DIODLE} = \frac{1}{2} I_{DC\ OUTPUT}$$

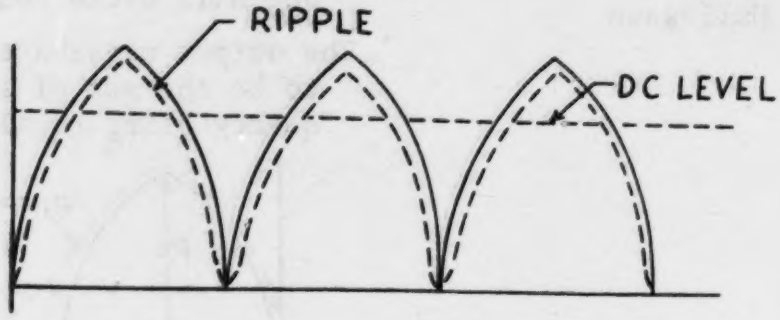

$$E_{DC} = \frac{2E_{PK}}{\pi} \qquad I_{DC} = \frac{2I_{PK}}{\pi}$$

$$E_{ripple\ P-P} = E_{PK} \qquad I_{ripple\ P-P} = I_{PK}$$

Ripple frequency is twice line frequency. Assign problems using the above.

Indicate that the peak output voltage is dependent upon the voltage from the center tap to one outside leg of the transformer.

Determine PIV and note that it is twice that for the half-wave rectifier.

Elaborate on the need for a center-tapped transformer for the full wave rectifier circuit and establish the advantage of not needing a transformer when operating directly from the power line with a bridge-type rectifier circuit.

Indicate that the output voltage is dependent on the full secondary voltage for the bridge rectifier.

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Assign problems.

Discuss PIV and re

$I_{AVG/diode} = \frac{1}{2} I_{D}$

c. Voltage-doubler

Study the operatio that the DC outp peak value of th

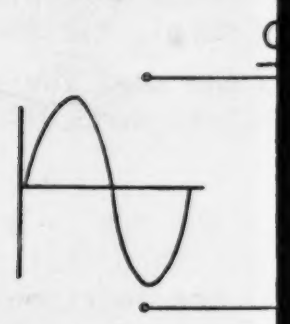

$PIV_{D_1} = 2E_{PK_{IN}}$

$PIV_{D2} = 2E_{PK_{IN}}$

f ripple = f input

Assign problems

The half-wave volt Doubler".

3. Filter

Develop the need f

a. Types

(1) Capacitor

Develop RC charge circuit in light

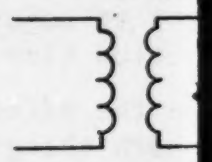

Construct the outp

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Assign problems.

Discuss PIV and required current rating of the diodes.

$I_{AVG/diode} = \frac{1}{2} I_{DC\ out}$

er

Study the operation of the half-wave voltage doubler indicating that the DC output voltage is equal to approximately twice the peak value of the input voltage

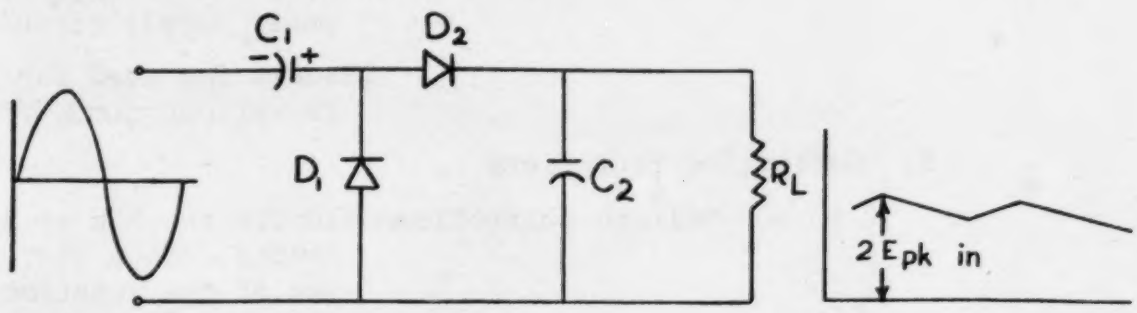

$PIV_{D_1} = 2E_{PK_{IN}}$

$PIV_{D2} = 2E_{PK_{IN}}$

f ripple = f input

Assign problems

The half-wave voltage doubler is also known as the "Cascade Voltage Doubler".

Develop the need for filtering the output of a rectifier circuit.

tor

Develop RC charge and discharge curves. Study the Capacitor filter circuit in light of the RC discharge curve.

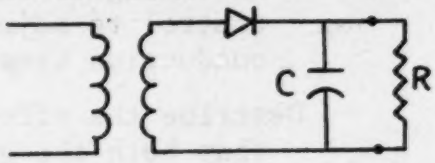

$E_{dc} = \frac{2fRC}{2fRC+1} E_{pk}$

$I_{dc} = \frac{F_{dc}}{R}$

Construct the output waveshape given E_{PK} and RC

6407

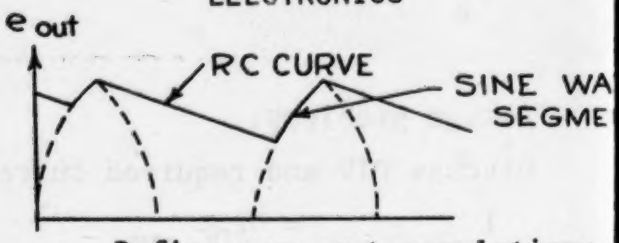

(2) RC π

4. Regulation

Define per cent regulation:

$$\frac{E_{no\ load} - E_{full\ load}}{E_{full\ load}} \times 100 =$$

Have students determine per
power supply circuit.

Discuss the need for good re
in various parts of the ba

5. Controlled rectifiers

a. Silicon controlled

Describe the SCR as a four l
device. Show that forward
one of the junctions to be
of the gate in causing cur
junction.

Explain gate-trigger current
is independent of gate cur
ed off by decreasing anode
current. Present schemati

Explain AC triggering in ter
verse biased junction capa

Mention turn-on and turn-off

b. Thyratron

Describe the thyratron and s
and present characteristic
argon to eliminate the eff

Explain the effect of the gr
in extinguishing the arc.
control to adjust the firi
conduction time.

Describe the effect of AC on
that both the grid and pla
and E_p have to be of the
neously for the thyratron

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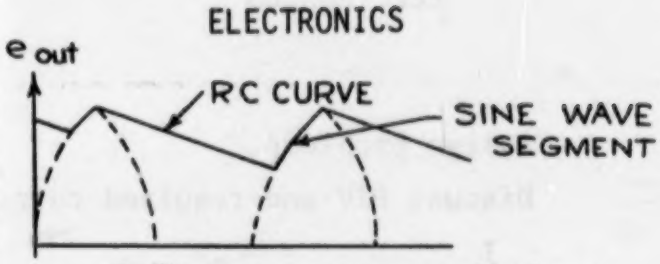

Define per cent regulation:

$$\frac{E_{no\ load} - E_{full\ load}}{E_{full\ load}} \times 100 = \%\ regulation$$

Have students determine per cent regulation of a given particular power supply circuit.

Discuss the need for good regulation and emphasize the voltage drop in various parts of the basic rectifier circuit. $E_{out} = E_{dc} - E_{drop}$

s

rolled Describe the SCR as a four layer, three junction, semiconductor device. Show that forward bias from anode to cathode will cause one of the junctions to be reverse biased. Discuss the function of the gate in causing current to flow across the reverse biased junction.

Explain gate-trigger current and show that conduction once started is independent of gate current. Show how the device can be turned off by decreasing anode-to-cathode bias or by a reverse gate current. Present schematic symbol.

Explain AC triggering in terms of the charging current of the reverse biased junction capacitance.

Mention turn-on and turn-off time.

Describe the thyratron and show construction. Explain the operation and present characteristic curves. Mention the use of neon and argon to eliminate the effect of temperature on firing potential.

Explain the effect of the grid on firing and its lack of control in extinguishing the arc. Emphasize the idea of variable grid control to adjust the firing point and thus control the plate conduction time.

Describe the effect of AC on the plate of the thyratron. Point out that both the grid and plate are fed with AC. Show how both E_g and E_p have to be of the correct polarity and amplitude simultaneously for the thyratron to fire.

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B. Amplifiers

1. Voltage amplifiers

a. Load line

(1) Static
(2) Dynamic

Explain that a coupling
component of the plate

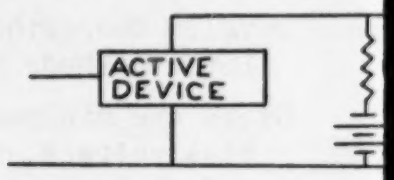

Assign problems in which
static and dynamic loa

b. Wave forms

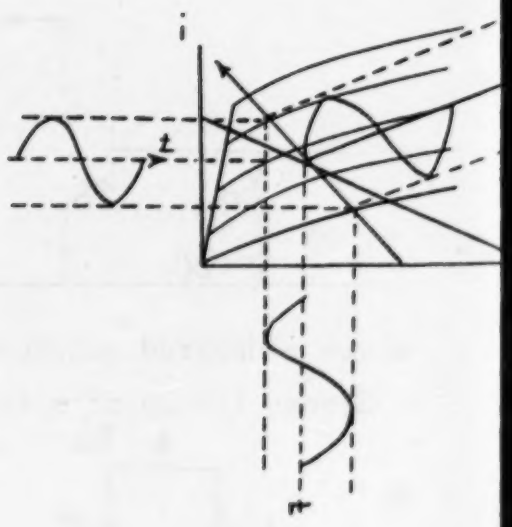

c. Voltage gain

Define voltage gain.

Determination of voltage

Develop voltage gain for
band.

d. Current gain

Define current gain.

Determination of current
mid-band.

6410 6413

fiers Explain that a coupling capacitor may be needed to block the DC component of the plate signal.

ic
nic

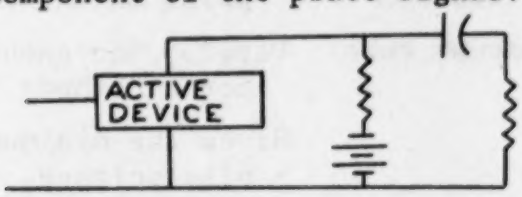

Assign problems in which the student is required to plot both static and dynamic load lines.

s

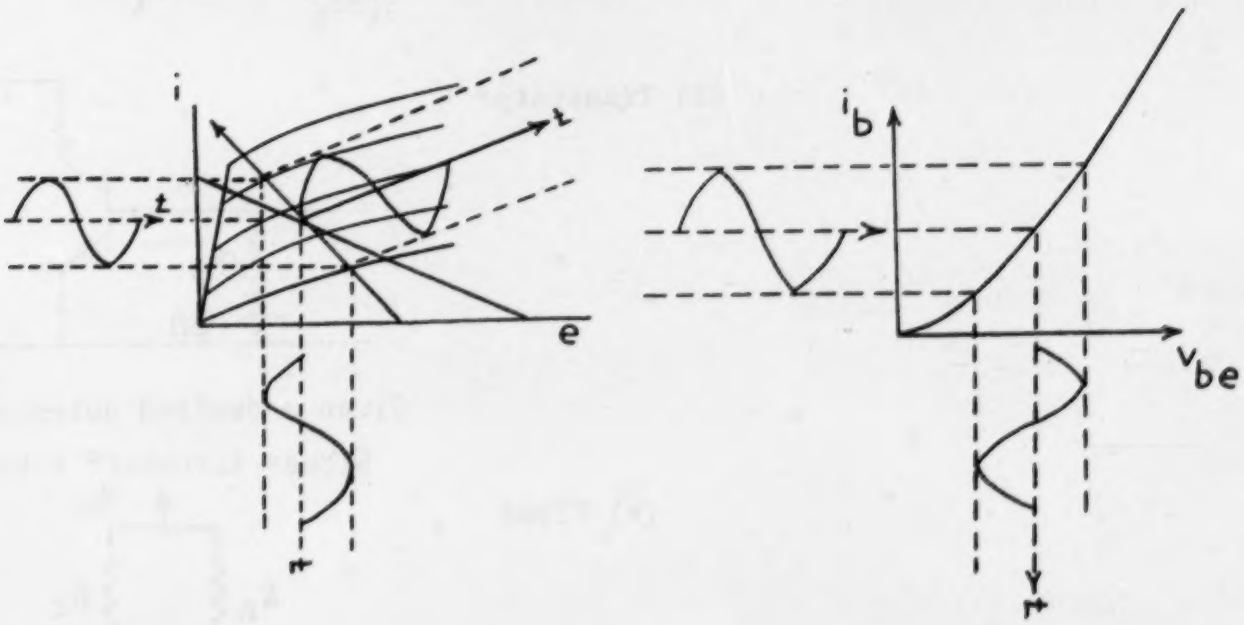

ain Define voltage gain.

Determination of voltage gain from input and output waveshapes.

Develop voltage gain formulas from equivalent circuit at mid-band.

ain Define current gain.

Determination of current gain from input and output waveshapes at mid-band.

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Develop current gain formul

e. Bias and stabilization

Discuss bias as a means of point on the characterist

(1) Vacuum tube

Develop the cathode-resisto for a cathode bypass capa

Given the minimum frequency bias voltage, calculate and the acceptable capaci

$$\frac{1}{2\pi f c_k} < 0.1R_k$$

(2) Transistor

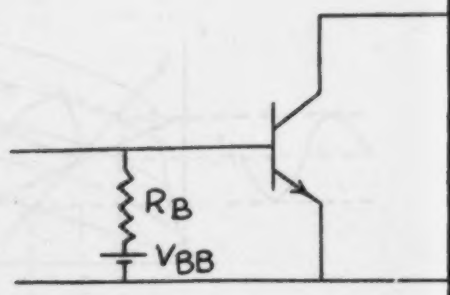

Given a desired quiescent

Stress Kirchhoff's volta

(a) Fixed

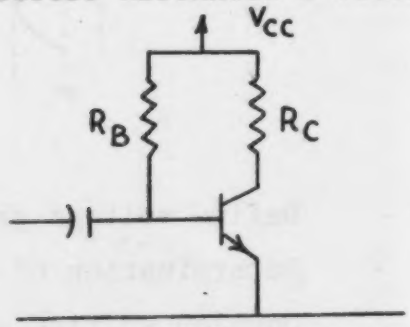

Given a desired quiescent

Stress Kirchhoff's volta

1183 6412

Develop current gain formula from equivalent circuits.

and lization — Discuss bias as a means of positioning the quiescent operating point on the characteristic curves.

acuum tube — Develop the cathode-resistor bias arrangement. Indicate the need for a cathode bypass capacitor.

Given the minimum frequency, the plate current, and the desired bias voltage, calculate the resistance of the cathode resistor and the acceptable capacitance of the bypass capacitor.

$$\frac{1}{2\pi f c_k} < 0.1R_k$$

ransistor

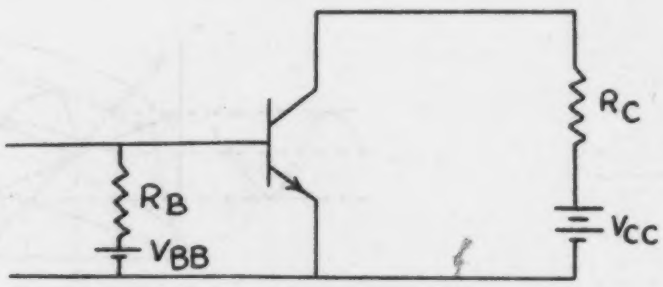

Given a desired quiescent base current and V_{BB}, determine R_B.

Stress Kirchhoff's voltage law.

a) Fixed

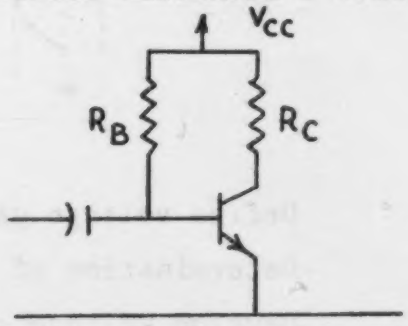

Given a desired quiescent base current and V_{CC}, Determine R_B.

Stress Kirchhoff's voltage law.

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(b) self

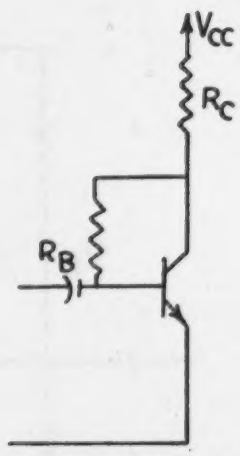

Note the connection of R_B directly
stabilizing effect this introdu
stabilizing circuitry because o
transistors.

(c) Emitter stabilizing resistor

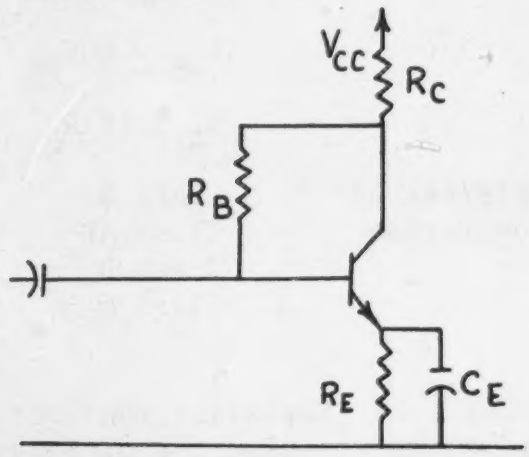

Develop R_E as a means of stabiliz
the function of R_E is different
cuits. Discuss effect of R_E on

6414

(b) self

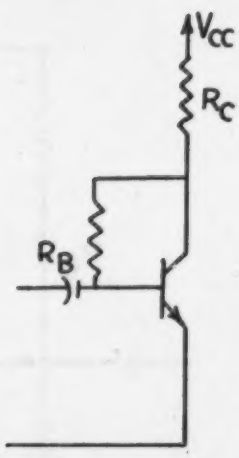

Note the connection of R_B directly to collector. Discuss the stabilizing effect this introduces. Develop the need for stabilizing circuitry because of inherent instability of transistors.

(c) Emitter stabilizing resistor

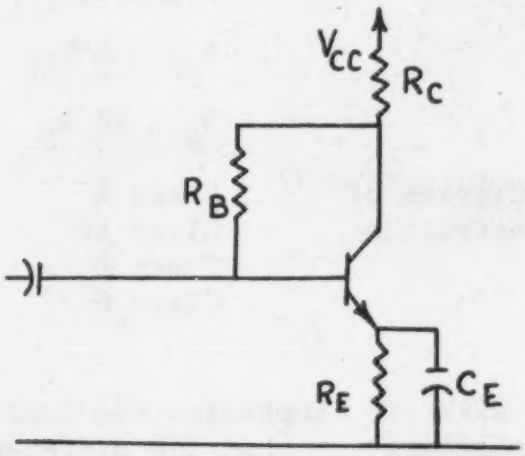

Develop R_E as a means of stabilizing the circuit. Emphasize that the function of R_E is different than that of R_K in tube circuits. Discuss effect of R_E on gain of amplifier.

6415

(d) Voltage divider

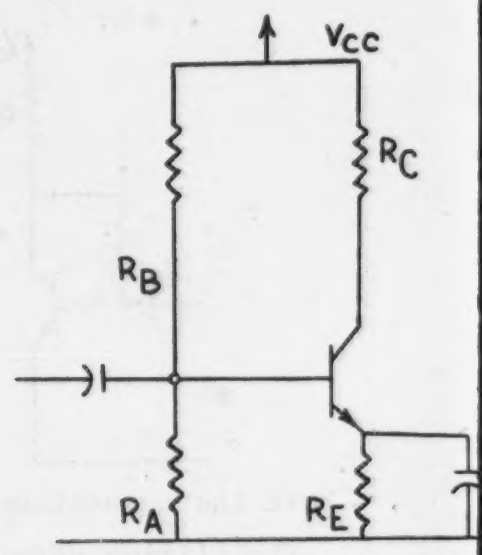

Note increased stabilizatio
the amount of stabilizati

$V_{RE} \geq 5\ V_{BE}$

$R_A \geq 10\ R_E$

(e) Classes of operation

Class A
Class AB
Class B
Class C

2. Power amplifiers

a. Comparison with voltage amplifiers

Emphasize the fact that all
that the differentiation
is mainly in the intent o

b. Maximum power limitations

Have students plot maximum
put characteristic curves

c. Impedance matching

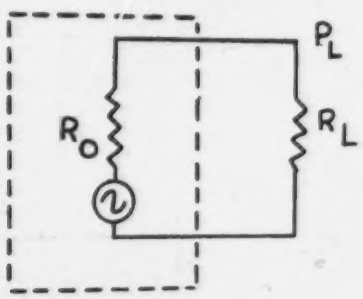

6416

(d) Voltage divider

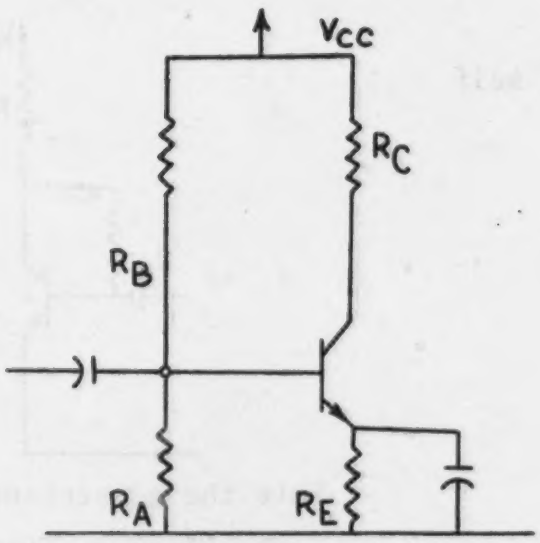

Note increased stabilization. Resistance of R_E, R_A, R_B deter- the amount of stabilization. A reasonably good design criteria:

$$V_{RE} \geq 5\ V_{BE}$$

$$R_A \geq 10\ R_E$$

(e) Classes of operation

Class A
Class AB
Class B
Class C

ers

rison with ge amplifiers

Emphasize the fact that all amplifiers provide power gain and that the differentiation between voltage and power amplifiers is mainly in the intent of the designer.

um power ations

Have students plot maximum power dissipation hyperbola on output characteristic curves.

ance ing

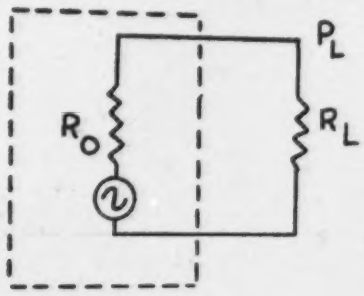

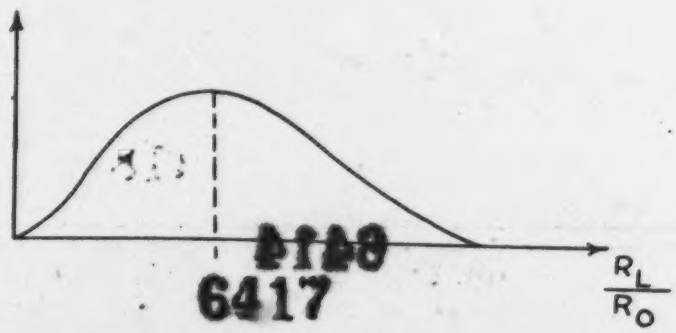

6417

(1) Transformer

$$\frac{R_{TOTAL}}{R_{fl}} = \left(\frac{N_1}{N_2}\right)^2$$

Construct static and d
of the final load to

Discuss factors other
transfer.

(2) Emitter follower

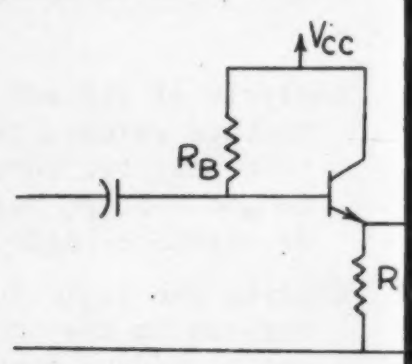

$R_{in} = h_{ie} + (B+1)\ R$

$R_{out} =$

Emphasize advantages o
matching transformer

d. Power gain

(1) Ratio

$$A_p = \frac{\text{Pout (signal)}}{\text{Pin (signal)}}$$

$A_{Power} = A_{Voltage} \times A_C$

ELECTRONICS

1) Transformer

$$\frac{R_{TOTAL}}{R_{fl}} = \left(\frac{N_1}{N_2}\right)^2$$

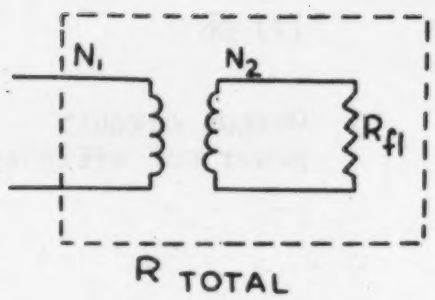

Construct static and dynamic load lines for transformer coupling of the final load to the amplifier.

Discuss factors other than $\frac{R_L}{R_0} = 1$ that affect "optimum" power transfer.

2) Emitter follower

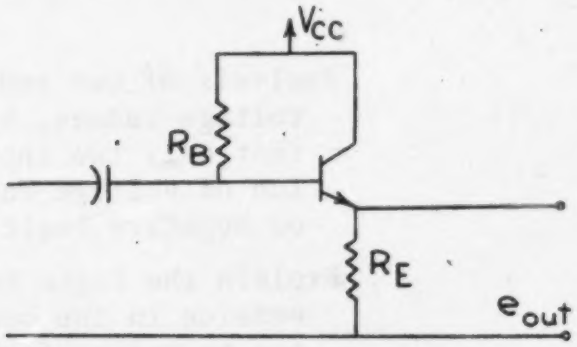

$R_{in} = h_{ie} + (B+1)\,R_E$

$R_{out} =$

Emphasize advantages of this circuit as a replacement for the matching transformer.

in

io

$$A_p = \frac{\text{Pout (signal)}}{\text{Pin (signal)}}$$

$$A_{Power} = A_{Voltage} \times A_{Current}$$

(2) Db	$A_{Pdb} = 10 \log \frac{P_{larger}}{P_{smaller}}$
e. Output circuit power and efficiency	$P_{DC} = V_{cc} I_{cavg}$
	$P_{INDC} = E_{BB} I_B$
	$P_{out} = \frac{Eout\ p\text{-}p \times Iout\ p}{8}$
	$Efficiency = \frac{P_{out} \times 100}{P_{InDC}}$
	Discuss the advantages o
C. Logic circuits	
1. Diode AND, OR	Analysis of two and thre voltage values, bias o that only two input le ion of voltage corespo or negative logic.
2. Invertor	Explain the logic functi version in the common- age to reduce forbidde versus input voltage.
3. NAND, NOR	Analysis of two input NA of AND, OR, and Invert logic blocks, and that Mention "direct couple

ELECTRONICS

$$A_{Pdb} = 10 \log \frac{P_{larger}}{P_{smaller}}$$

circuit
nd efficiency $P_{DC} = V_{cc} \; I_{cavg}$

$$P_{INDC} = E_{BB} \; I_B$$

$$P_{out} = \frac{Eout\ p\text{-}p \times Iout\ p\text{-}p}{8}$$

$$\text{Efficiency} = \frac{P_{out} \times 100}{P_{InDC}}$$

Discuss the advantages of the different classes of operation.

Analysis of two and three input gates in terms of instantaneous voltage values, bias conditions, and logic function. Stress that only two input levels are permitted. Explain that selection of voltage coresponding to "1" level determines positive or negative logic.

Explain the logic function of the invertor. Review phase inversion in the common-emitter amplifier. Introduce clamp voltage to reduce forbidden zone. Develop the graph of output versus input voltage.

Analysis of two input NAND and NOR gates developed as a combination of AND, OR, and Invertor. Explain that NAND and NOR are basic logic blocks, and that AND and OR can be constructed from them. Mention "direct coupled transistor logic."

6421

IV Cascade amplifiers	
A. Coupling	Explain the function of the coupling capaci high-and low-frequencies. Study DC and A blems in which it is necessary to plot bo
1. RC	
2. Transformer	Discuss the transformer-coupled amplifier, ing AC and DC load lines.
	Solve problems to determine the gain of tra fiers. Allow for transformer turns-ratio gain).
3. Push-pull	Develop the push-pull amplifiers.
	Discuss crossover distortion and its prevent power efficiency.
	Discuss limitations imposed by transformers.
4. Phase inversion	Discuss phase invertors qualitatively. Sho to replace the input transformer in the p
5. Complementary symmetry	Discuss complementary symmetry as a means o sistor circuits. Show how this technique pull amplifier.
6. Tuned transformer	Mention applications in RF, IF, and video a
a. Q of coil	Define the Q of a resonant circuit as $Q = \frac{XL}{R}$ parallel resonance. Mention single, doub amplifiers.
b. Selectivity and band width	Define band width. Show that it may be cal Discuss half-power points, upper and lowe Mention peaking techniques for tuned ampli
B. Amplifier decoupling	Discuss the need for power supply decoupling
C. Frequency response	Emphasize the fact that an amplifier respond medium, and high frequencies. Discuss the high and low frequency response.
	Discuss phase distortion qualitatively.
	Solve problems relating to amplifier frequen

6422

Explain the function of the coupling capacitor and its effect at high-and low-frequencies. Study DC and AC load lines. Solve problems in which it is necessary to plot both load lines.

Discuss the transformer-coupled amplifier, quantitatively developing AC and DC load lines.

Solve problems to determine the gain of transformer coupled amplifiers. Allow for transformer turns-ratio in calculating overall gain).

Develop the push-pull amplifiers.

Discuss crossover distortion and its prevention. Mention increased power efficiency.

Discuss limitations imposed by transformers.

Discuss phase invertors qualitatively. Show how they may be used to replace the input transformer in the push-pull amplifier.

etry Discuss complementary symmetry as a means of direct coupling transistor circuits. Show how this technique may be used in the push-pull amplifier.

Mention applications in RF, IF, and video amplifiers.

Define the Q of a resonant circuit as $Q = \frac{XL}{R}$. Review series and parallel resonance. Mention single, double, and stagger-tuned amplifiers.

Define band width. Show that it may be calculated as equal to $\frac{fo}{Q}$. Discuss half-power points, upper and lower cutoff frequencies. Mention peaking techniques for tuned amplifiers.

Discuss the need for power supply decoupling in cascade amplifiers.

Emphasize the fact that an amplifier responds differently at low, medium, and high frequencies. Discuss the factors effecting high and low frequency response.

Discuss phase distortion qualitatively.

Solve problems relating to amplifier frequency response.

6423

V Feedback	Define the term "feedback" as output energy of a circuit system.
	(It is not necessary to limit
A. Effect on amplifier gain	
1. Gain formula	Develop the formula for the g $A' = \frac{A}{1-AB}$
2. Negative feedback	Note the effect on A' of (AB
3. Positive feedback	Note the effect on A' of (AB
B. Effect on distortion	Discuss the effect of feedbac $D' = \frac{D}{1-AB}$
	Assign problems which make us mulas.
C. Oscillation	Discuss the possibility of th of input).
1. Sustained	
2. Undesired	Relate this to AB = 1 at an a the conditions for self sus teria).
	Reinforce the concept of osci solve problems in which the fier to an oscillator by in
D. Oscillator circuits	Develop the astable multivib circuits which provides an
1. Astable multivibrator	$AB = 1\angle 0^{\circ}$
	Require that the student det given the values of R's an when given pulse repetitio

ELECTRONICS

Define the term "feedback" as the returning of a sample of the output energy of a circuit to a prior point in that circuit or system.

(It is not necessary to limit the system to an electronic one.)

gain

Develop the formula for the gain of an amplifier with feedback.

$$A' = \frac{A}{1-AB}$$

k Note the effect on A' of (AB) being negative.

k Note the effect on A' of (AB) Being positive.

Discuss the effect of feedback on distortion.

$$D' = \frac{D}{1-AB}$$

Assign problems which make use of the gain and the distortion formulas.

Discuss the possibility of the system being self-excited (removal of input).

Relate this to AB = 1 at an angle of zero or multiple of 360 degrees, the conditions for self sustained oscillation (Barkhausen criteria).

Reinforce the concept of oscillation conditions by having students solve problems in which they are asked to convert a given amplifier to an oscillator by introducing a feedback loop.

Develop the astable multivibrator as one of the simplest electronic circuits which provides an

rator

$$AB = 1\angle 0^{\circ}$$

Require that the student determine the pulse repetition rate when given the values of R's and C's. Also, determine R's or C's when given pulse repetition rate.

6425

2. Resonant circuit	Introduce the problem of predete and therefore a need for serie
	Have students determine the reso resonant circuits. Given freq determine L or C. Given L and of the circuit.
3. Other circuits	
(a) Crystal	Discuss the use of crystals as f units in oscillators.
(b) RC phase shift	Explain the operation of an RC p frequency and/or component va
(c) Wien bridge	Discuss the operation of the Wi
VI Communications	
A. Modulated carriers	Discuss the use of high frequen frequency intelligence.
1. Amplitude Modulated	Define and develop the followin carrier modulation modulating signal modulated wave modulator
a. Sidebands	Show that the major output freq f carrier f carrier + f modu f carrier - f modu
	Show how f modulation falls out width and does not appear in

6426

ELECTRONICS

Introduce the problem of predetermining the frequency of oscillation and therefore a need for series and parallel resonant circuits.

Have students determine the resonant frequency of series and parallel resonant circuits. Given frequency requirements and L or C, determine L or C. Given L and C, determine the resonant frequency of the circuit.

Discuss the use of crystals as frequency and waveshape determining units in oscillators.

Explain the operation of an RC phase shift oscillator. Solve for frequency and/or component values.

Discuss the operation of the Wien bridge oscillator.

Discuss the use of high frequency carrier signals to transport low-frequency intelligence.

Define and develop the following terms:

carrier
modulation
modulating signal
modulated wave
modulator

Show that the major output frequencies are:

f carrier
f carrier + f modulation
f carrier - f modulation

Show how f modulation falls outside the final tank circuit bandwidth and does not appear in the output.

6427

6427

Draw the spectrum distribution o

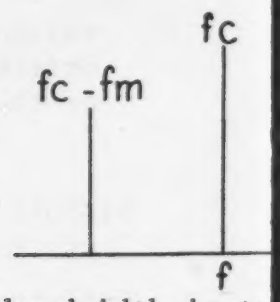

Explain that the bandwidth is tw
quency.

b. Percentage of modulation — Solve problems in modulation per
modulating signal levels.

c. Band width — Show how the power is distribute

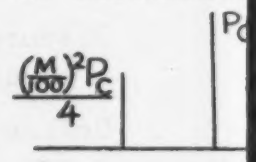

Introduce the use of single side
and improve efficiency.

2. Frequency modulated — Develop the need for frequency m
advantage over that of AM.

a. Frequency deviation — Note that f_d is proportional to
signal.

b. Bandwidth — Discuss the bandwidth as being c
modulating frequency.

c. FCC regulations — Discuss appropriate FCC regulati
modulation and modulation inde

3. AM-FM (TV)

a. Carriers — Note the use of AM for the trans
use of FM for the transmission
use of two separate carriers,

b. Bandwidth — Develop the need for an extreme
amount of video information wh

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ELECTRONICS

Draw the spectrum distribution of the output signal as shown below.

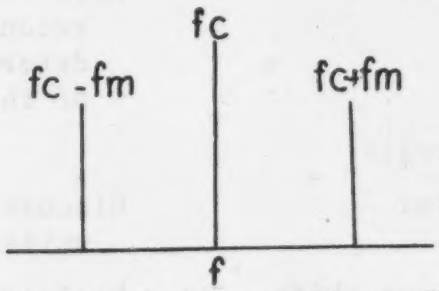

Explain that the bandwidth is two-times the highest modulating frequency.

Solve problems in modulation percentage for various carrier and modulating signal levels.

Show how the power is distributed in an AM signal, as below.

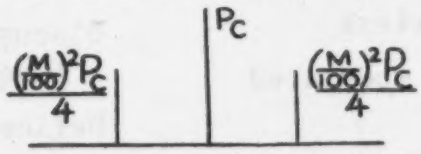

Introduce the use of single sideband techniques to conserve spectrum and improve efficiency.

Develop the need for frequency modulation because of its S/N ratio advantage over that of AM.

Note that f_d is proportional to the amplitude of the modulating signal.

Discuss the bandwidth as being determined by frequency deviation and modulating frequency.

Discuss appropriate FCC regulations. Discuss and use percent modulation and modulation index.

Note the use of AM for the transmission of video information and the use of FM for the transmission of audio information. Discuss the use of two separate carriers, one for audio and one for video.

Develop the need for an extremely large bandwidth because of the amount of video information which must be transmitted.

6429

	Introduce and explain the term "vestigia Describe the removal of one sideband e carrier.
	Show the 6Mhz channel allocation and the and sound carriers, and the sidebands.
c. The composite signal	Display the composite video signal. Ind and blacker-than-black areas of the co
d. Synchronization	Develop the need for an orderly and stan enable the reassembling of the picture
	Explain the need for synchronizing the C receiver with the beam in the camera t chronizing pulse.
4. Pulse modulation (general treatment)	Discuss the following: Pulse-width modulation Pulse-amplitude modulation Pulse-position modulation Pulse-time modulation Pulse-code modulation
B. Superheterodyne receiver	Draw the block diagram of a typical supe show the waveforms present at each poi
1. RF amplifier	Explain why an RF amplifier is used in a
2. Convertor	Develop the concept of heterodyning. Sh oscillator and how its signal acts on
3. IF amplifier	Define the IF amplifier and locate it in a typical IF amplifier circuit and exp tively. Show how the IF transformers sponse curve.
4. Detector	Explain the operation of the detector a circuit. Discuss the operation of au
5. Audio amplifier	circuits.

6430

Introduce and explain the term "vestigial sideband transmission". Describe the removal of one sideband except for a vestige near the carrier.

Show the 6Mhz channel allocation and the location of the picture and sound carriers, and the sidebands.

te signal

Display the composite video signal. Indicate the white, grey, black, and blacker-than-black areas of the composite video signal.

tion

Develop the need for an orderly and standard scanning process to enable the reassembling of the picture elements at the receiver.

Explain the need for synchronizing the CRT electron-beam in the receiver with the beam in the camera tube. Introduce the synchronizing pulse.

n (general

Discuss the following:

Pulse-width modulation
Pulse-amplitude modulation
Pulse-position modulation
Pulse-time modulation
Pulse-code modulation

eiver

Draw the block diagram of a typical superheterodyne receiver and show the waveforms present at each point.

Explain why an RF amplifier is used in a superheterodync receiver.

Develop the concept of heterodyning. Show the circuit of the oscillator and how its signal acts on the mixer.

Define the IF amplifier and locate it in the block diagram. Show a typical IF amplifier circuit and explain its operation qualitatively. Show how the IF transformers determine the amplifier response curve.

Explain the operation of the detector as a rectifier and filter circuit. Discuss the operation of automatic volume control (avc) circuits.

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430

C. Transmission lines	Define a transmission line as any p electromagnetic energy from one p transmission lines are those used in telephone communication.
	Discuss the meaning of wavelength. $f\lambda = 3X10^8$ meters/sec
1. Types of lines	Show and describe the physical cons and coaxial transmission lines. disadvantages.
2. Characteristic impedance	Define the characteristic impedance impedance which would be measured infinitely long transmission line
3. Standing wave ratio	Demonstrate that when the length of same order of magnitude as the wa standing waves may appear on the
	Show that standing waves do not exi feeding a load whose impedance is impedance of the line.
	Demonstrate that standing waves app is feeding a load which is not ma impedance of the line.
	Explain that Standing Wave Ratio (S total RMS voltage to the minimum the line. (Or Maximum total RMS current.)
	Indicate that the Standing Wave Rat in practice for discussing line p most desirable.
	Solves problems in which the follow $SWR = \frac{E \cdot RMS_{max.}}{E \cdot RMS_{min.}}$ $SWR = \frac{I \cdot RMS_{max.}}{E \cdot RMS_{min.}}$

ELECTRONICS

Define a transmission line as any pair of conductors used to carry electromagnetic energy from one place to another. The most common transmission lines are those used in power systems and those used in telephone communication.

Discuss the meaning of wavelength.

$f\lambda = 3X10^8$ meters/sec

Show and describe the physical construction of the two-wire parallel and coaxial transmission lines. Compare their advantages and disadvantages.

Define the characteristic impedance of a transmission line as that impedance which would be measured at the input terminals of an infinitely long transmission line of a particular type.

Demonstrate that when the length of a transmission line is of the same order of magnitude as the wavelength of the signal handled, standing waves may appear on the line.

Show that standing waves do not exist on a line when the line is feeding a load whose impedance is equal to the characteristic impedance of the line.

Demonstrate that standing waves appear on the line when the line is feeding a load which is not matched to the characteristics impedance of the line.

Explain that Standing Wave Ratio (SWR) is the ratio of the maximum total RMS voltage to the minimum total RMS voltage appearing on the line. (Or Maximum total RMS current to minimum total RMS current.)

Indicate that the Standing Wave Ratio is the most common term used in practice for discussing line performance, and SWR of 1:1 being most desirable.

Solves problems in which the following formulas are used:

$$SWR = \frac{E \cdot RMS_{max.}}{E \cdot RMS_{min.}} \qquad SWR = \frac{I \cdot RMS_{max.}}{E \cdot RMS_{min.}} \qquad SWR = \frac{Z_L}{Z_o}$$

6433

4. Quarter - wave matching section

Discuss the 1/4 λ matching section. characteristic impedance of a matc impedance and load impedance

$$Z_o = \sqrt{Z_s Z_L}$$

D. Antennas

Indicate that when a high frequency ductor, a power loss which cannot $P = I^2R$ formula, takes place. Poi plaining this phenomenon as simple because of the distances and magni fact that the losses continue even ductor) is available to absorb the

Explain that this loss is due to ele

1. Half-wave dipole

Emphasize that this electromagnetic separating the ends of a transmiss right angles to the transmission l

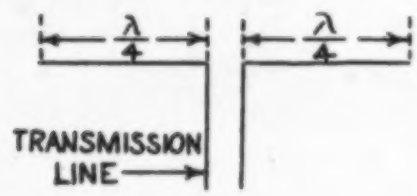

The antenna thus created is known as basic of antennas. The dipole is

Explain that the length of the dipol of the signal being transmitted o

Point out that the same antenna can and reception.

2. Quarter-wave Marconi

Discuss the 1/4-wave vertical antenn antenna).

6494

tching Discuss the 1/4 λ matching section. Determine the required characteristic impedance of a matching section when given a source impedance and load impedance

$$Z_o = \sqrt{Z_s Z_L}$$

Indicate that when a high frequency current passes through a conductor, a power loss which cannot be accounted for by the simple $P = I^2R$ formula, takes place. Point out that attempts at explaining this phenomenon as simple magnetic coupling are precluded, because of the distances and magnitudes involved, as well as the fact that the losses continue even if no receptor (second conductor) is available to absorb the energy.

Explain that this loss is due to electro-magnetic radiation.

Emphasize that this electromagnetic radiation can be maximized by separating the ends of a transmission line so that they are at right angles to the transmission line.

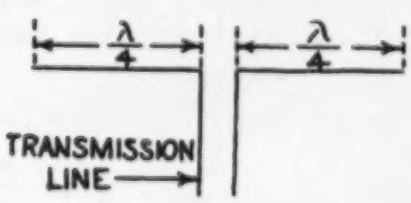

The antenna thus created is known as a dipole antenna; the most basic of antennas. The dipole is also known as a Hertz antenna.

Explain that the length of the dipole is one-half the wave length of the signal being transmitted or received.

Point out that the same antenna can be used for both transmission and reception.

Discuss the 1/4-wave vertical antenna (also known as a Marconi antenna).

Show that the Marconi a
a vertical dipole, th
reflection in the gro

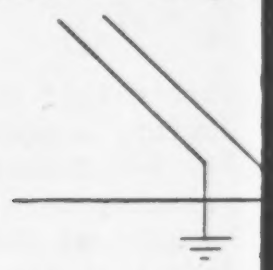

3. Directors

Define a director as a
in front of the dipo
radiation) for the p
antenna.

4. Reflectors

Define a reflector as a
behind the dipole (be
diation) for the purp
antenna.

VII Circuit analysis and trouble-shooting

A. Diagrams

1. Block

2. Schematic

Introduce the need whe
in a single stage or
be done by observati
functions of the blo

ELECTRONICS

Show that the Marconi antenna can be explained as a special case of a vertical dipole, the second half of the antenna appearing as a reflection in the ground.

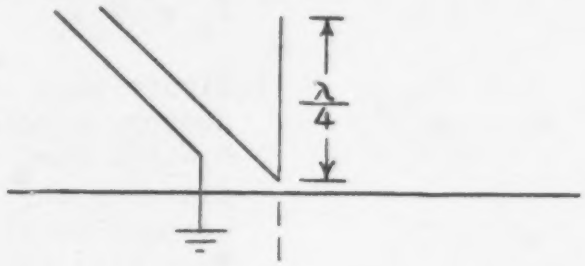

rectors

Define a director as an element added to the basic dipole antenna in front of the dipole (front being the direction of desired radiation) for the purpose of increasing the directivity of the antenna.

flectors

Define a reflector as an element added to the basic dipole antenna behind the dipole (behind being the direction of undesired radiation) for the purpose of increasing the directivity of an antenna.

alysis and trouble-

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hematic

Introduce the need when troubleshooting, to locate the difficulty in a single stage or block of a system. Explain how this can be done by observation of symptoms, and understanding of the functions of the block in large systems such as TV or radar.

B. Test equipment

1. Characteristics

   a. Frequency response
   b. Loading effects
   c. Accuracy
   d. Sensitivity

Emphasize the need for understanc and circuit under test, and fo of test equipment available whe shooting purposes. Use specifi Will an AC VTVM (input impedanc curacy 1% 40hz - 2Mhz) be sati across 100K plate load at 100Kh

2. Use of

   a. Oscilloscope

Develop the use of the oscillosc measure frequency, phase shift,

   b. Signal generator

Point out the use and characteris generators, intended for repair square wave generators, and ser porating RF,IF, modulated, and

   c. Capacitance bridge
   d. Impedance bridge

Instruct in the use of bridges to and resistance. Point out char of equipment used.

C. Techniques

1. General

2. Signal tracing

Develop general troubleshooting t cation of signal tracing in loc the method of signal injection cautions that must be observed capacitors, etc. Application of superhetrodyne receiver may be

3. Voltage computations and measurements

Point out precautions to be obser ments in a circuit; for exampl measuring voltage across two po grounded meter.

Illustrate a typical voltage char of equipment. Explain how exac chart to be valid. Note items s

Control settings
Presence (or lack
Use of VOM or VTVM

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ng effects
acy
tivity

Emphasize the need for understanding both the nature of the signal and circuit under test, and for understanding the characteristics of test equipment available when selecting equipment for trouble-shooting purposes. Use specific illustrations to elaborate. Will an AC VTVM (input impedance 10MΩ in parallel with 8pf, accuracy 1% 40hz - 2Mhz) be satisfactory to read AC plate voltage across 100K plate load at 100Khz ?

loscope

Develop the use of the oscilloscope to observe wave forms and to measure frequency, phase shift, and amplitude.

l generator

Point out the use and characteristics of standard laboratory signal generators, intended for repair work including audio generators, square wave generators, and service-shop type generators incorporating RF,IF, modulated, and audio signals.

itance
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ance
e

Instruct in the use of bridges to measure capacitance, inductance and resistance. Point out characteristics and specifications of equipment used.

acing

Develop general troubleshooting techniques. Point out the application of signal tracing in localizing trouble. Also illustrate the method of signal injection in troubleshooting. Outline precautions that must be observed such as blocking and isolation, capacitors, etc. Application of these methods in servicing a superhetrodyne receiver may be useful.

mputations
rements

Point out precautions to be observed when taking voltage measurements in a circuit; for example, note the problem involved in measuring voltage across two points above ground when using a grounded meter.

Illustrate a typical voltage chart for a specific circuit or piece of equipment. Explain how exact conditions must be met for the chart to be valid. Note items such as:

- Control settings
- Presence (or lack of) signals
- Use of VOM or VTVM

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	Point out that in taki circuit, a voltage o generally indicative
4. Resistance computations and measurements	Note that the ohmmeter in the equipment. P when taking resistan the circuit of takin circuits.
D. Applications (simple combination circuits)	
1. Complete audio amplifiers	Using a typical audio ques by posing speci
	Point out the use of a fier's performance.
	Show that the insertio output wave-shapes d characteristics of t
2. Superhetrodyne receivers	Illustrate troubleshoo superhetrodyne recei
3. Control circuits	Consider practical ind nature from a troubl ties and analyze cir

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ELECTRONICS

Point out that in taking voltage measurements in a transistorized circuit, a voltage of 0.2v- 0.8v between emitter and base is generally indicative of a properly functioning stage.

omputations ents

Note that the ohmmeter is never to be used with voltage present in the equipment. Point out the need to consider parallel paths when taking resistance measurements, and the inherent danger to the circuit of taking resistance measurements in transistorized circuits.

mple uits)

io

Using a typical audio amplifier, practice troubleshooting techniques by posing specific problems.

Point out the use of a square-wave signal in evaluating an amplifier's performance.

Show that the insertion of a perfect square-wave can produce various output wave-shapes depending on the frequency and phase shift characteristics of the amplifier.

ne

Illustrate troubleshooting techniques by posing difficulties in a superhetrodyne receiver.

uits

Consider practical industrial control circuits of a fairly simple nature from a troubleshooting point of view. Suggest difficulties and analyze circuit.

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VIII Pulses and pulse trains

A. The ideal pulse

Define the terms used in pulse technique

Leading edge
Trailing edge
Pulse duration
Resting time
Pulse repetition time
Pulse repetition rate

B. Application

Mention the application of pulses to:

Computers
TV
Radar

C. The distorted pulse

Define rise time and fall time

1. Rise time
2. Fall time
3. Effect of low pass filter
4. Effect of high pass filter

Discuss the effect of low pass and high p

Assign problems requiring the student to fall time

IX Circuitry

A. Bistable multivibrator

Develop the need for the bistable multivi a circuit will function as a bistable m off and saturation as the stable condit requiring determination of design limit

Discuss trigger techniques and sketch wav above to transistor bistable multivibra to cut-off and saturation.

B. Monostable multivibrator

Discuss the applications of the monostabl that the monostable multivibrator is re astable multivibrator and one-half of a Sketch output waveforms. Limit the abo monostable multivibrator.

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ELECTRONICS

Define the terms used in pulse techniques

- Leading edge
- Trailing edge
- Pulse duration
- Resting time
- Pulse repetition time
- Pulse repetition rate

Mention the application of pulses to:

- Computers
- TV
- Radar

Define rise time and fall time

Discuss the effect of low pass and high pass filters quantitatively

ter
lter

Assign problems requiring the student to determine rise time and fall time

Develop the need for the bistable multivibrator. Determine if a circuit will function as a bistable multivibrator with cut-off and saturation as the stable conditions. Assign problems requiring determination of design limits on component values.

Discuss trigger techniques and sketch waveshapes. Limit the above to transistor bistable multivibrators which are driven to cut-off and saturation.

Discuss the applications of the monostable multivibrator. Note that the monostable multivibrator is really one-half of an astable multivibrator and one-half of a bistable multivibrator. Sketch output waveforms. Limit the above to the transistor monostable multivibrator.

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C. Operational amplifier	Discuss qualitatively.
D. Integrator and differentiator	Discuss the RC circuit as an
E. Wideband amplifier (general treatment)	Discuss double tuned amplifie and series compensated amp
F. Clippers (limiters)	Discuss diode clippers, diode
G. Clamps	Develop the need for clamp ci Develop lower extremity cl quire that students solve output waveshapes when give
X Number systems	Explain the construction of system as demonstrated by
A. Binary	Demonstrate the binary numbe in conversion to-and from- traction in the binary sys
B. Octal	Demonstrate the octal number
C. Codes	Mention the need for codes a code and a number system.
1. BCD (binary coded decimal)	Explain the BCD system as a decimal digits. Stress th
2. Gray code (general treatment)	Present first sixteen charac that only one column chang characters. Mention its a
XI Logic	
A. Diagrams	Discuss the function of the logic-block diagrams and s
1. Binary variables	Define a binary variable as in either of two states (o Describe conditions and si as binary variables.

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ELECTRONICS

Discuss qualitatively.

entiator Discuss the RC circuit as an integrator and as a differentiator.

Discuss double tuned amplifiers, shunt compensated amplifiers, and series compensated amplifiers.

Discuss diode clippers, diode slicing, and active device clipping.

Develop the need for clamp circuits (e.g. DC restorer in TV) Develop lower extremity clamps and upper extremity clamps. Require that students solve problems in which they determine output waveshapes when given input waveshapes.

Explain the construction of a positional significance number system as demonstrated by the decimal system.

Demonstrate the binary number system. Develop student facility in conversion to-and from-decimal system. Addition and subtraction in the binary system should be practiced.

Demonstrate the octal number system.

Mention the need for codes and explain the difference between a code and a number system.

Explain the BCD system as a four bit binary representation of decimal digits. Stress that it is not a number system.

1 Present first sixteen characters of gray code and point out that only one column changes between any two consecutive characters. Mention its application in shaft-position systems.

Discuss the function of the logic diagram. Differentiate between logic-block diagrams and schematic diagrams.

Define a binary variable as an unknown quantity which may exist in either of two states (on-off, yes-no, true-false, etc). Describe conditions and situations which may be represented as binary variables.

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2. Logic symbols

Present logic symbols as shown b
does not exist at this time.)
Describe the logic function pe
blocks shown using switch anal

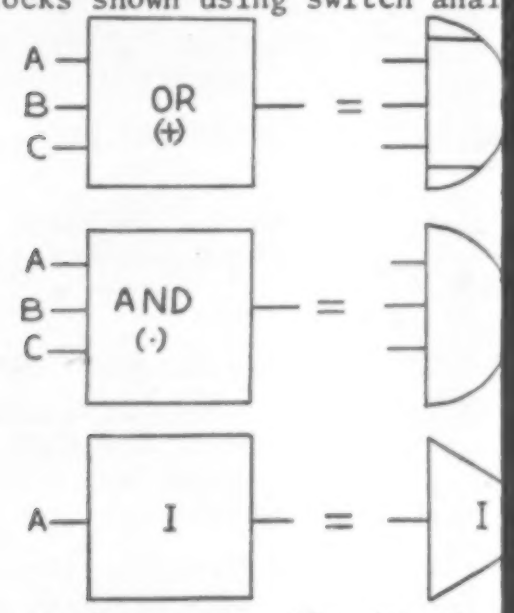

3. Truth table

Present the truth table for the
that the truth table is a devi
tigation of a logic diagram fo
variable. Show that for n var
tions to investigate. Stress
in ascending numerical order t
tions.

A	B	C	f(A,B,C)
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

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Present logic symbols as shown below. (Standardization of symbols does not exist at this time.) Other symbols may be shown. Describe the logic function performed by each of the logic blocks shown using switch analogy.

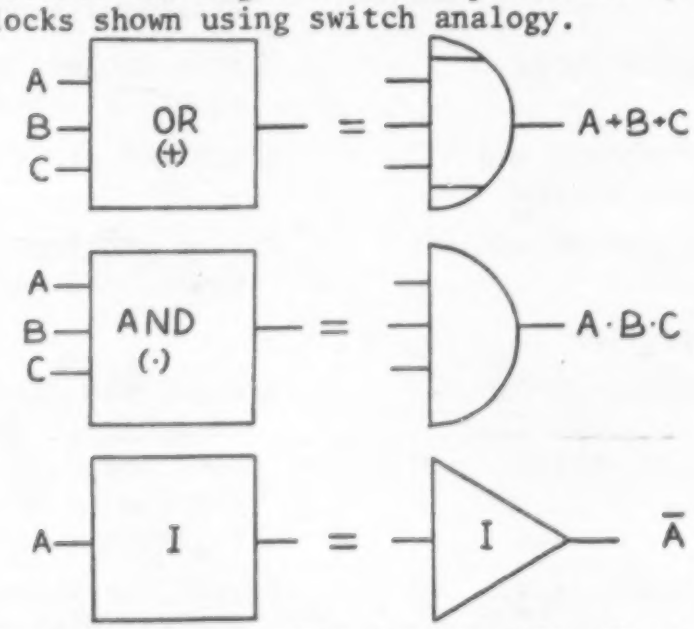

Present the truth table for the AND, OR, and INVERTOR. Explain that the truth table is a device used to simplify the investigation of a logic diagram for all conditions of each binary variable. Show that for n variables, there will be 2^n combinations to investigate. Stress listing combinations of variables in ascending numerical order to insure inclusion of all combinations.

A	B	C	f(A,B,C)
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

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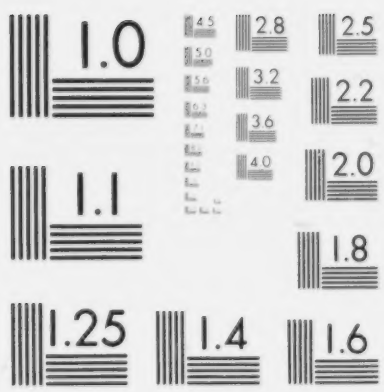

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

B. Design	Mention areas in which logic design is Distinguish between logic design and
1. Boolean algebra	Define Boolean algebra as a mathematic equations involving binary variables
(a) Theorems and postulates	State and prove the theorems and postu
(b) Equation reduction	Assign problems in binary equation red Explain "Standard Sum" form of the
2. Minimization	
(a) Karnough map (through four variables)	Present the layout of a Karnough map f variables. Demonstrate the relation Plot the Karnough map of a binary eq form, also write the minimum standar Karnough map.
(b) Truth table	Stress the importance of the truth tab the validity of a binary equation re
C. Circuits	
1. Half and full-adder	Review binary addition. Develop a tru carry of a one-bit binary adder. Ha block diagram from the truth table. the full adder.
2. Shift register	Review the flip flop as a storage devi duce the steered flip-flop and show from one to another. Discuss shift shift right (division) registers.
3. Counters	Show how steered flip-flops may be con up or count-down). Combine counters initiate a function on a specified c on a specified count.
D. Computer	Discuss block diagram analysis of a ty half-adders, full adders, shift regi used.

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ELECTRONICS

Mention areas in which logic design is used and give simple example. Distinguish between logic design and circuit design.

Define Boolean algebra as a mathematical technique for reducing equations involving binary variables.

nd — State and prove the theorems and postulates of Boolean algebra.

eduction — Assign problems in binary equation reduction using Boolean algebra. Explain "Standard Sum" form of the binary equation.

ap
our — Present the layout of a Karnough map for two, three, and four variables. Demonstrate the relationship between adjacent blocks. Plot the Karnough map of a binary equation in standard-sum form, also write the minimum standard-sum form equation from a Karnough map.

e — Stress the importance of the truth table as a device for proving the validity of a binary equation reduction.

dder — Review binary addition. Develop a truth table for the sum and carry of a one-bit binary adder. Have students draw the logic block diagram from the truth table. Extend this technique to the full adder.

Review the flip flop as a storage device for binary data. Introduce the steered flip-flop and show how a bit can be shifted from one to another. Discuss shift left (multiplication) and shift right (division) registers.

Show how steered flip-flops may be connected as counters (count-up or count-down). Combine counters with other logic gates to initiate a function on a specified count or to reset themselves on a specified count.

Discuss block diagram analysis of a typical computer showing how half-adders, full adders, shift registers, and counters might be used.

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ELECTRICAL CONSTRUCTION

I. Safety . . . . . .
II. Basic hand skills. . . . . .
III. Construction . . . . . .
IV. Residential and power wiring . . . . . .

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ELECTRICAL CONSTRUCTION

Safety	50
Basic hand skills.	50
Construction	50
Residential and power wiring	50

SCA 6451

ELECTRICAL CONSTRUCTION

I Safety	Discuss general shop saf artificial respiration Eye Safety should be inc
II Basic hand skills A. Hand tools B. Drilling tools C. Measuring tools D. Soldering tools	Tools and techniques use taught and practiced. a commercially accepta The basic skills will in drilling, tapping, rea ing, etc. Use of the
III Construction A. Layout B. Wiring C. Testing D. Reporting	The construction of a pr all students to apply practical work-type-ex cover layout, wiring, a report. Time shoul catalogs and test equi
IV Residential and power wiring (general treatment)	Attention will be given dential and industrial skills (manual and mer ing jobs involving the A familiarization with ing codes will be requ

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ELECTRICAL CONSTRUCTION

Discuss general shop safety considering safety precautions and artificial respiration techniques.

Eye Safety should be included.

Tools and techniques used in the electronics industry will be taught and practiced. Students will be required to demonstrate a commercially acceptable degree of proficiency.

The basic skills will include wire stripping, soldering, lacing, drilling, tapping, reaming, filing, grinding, crimping, splicing, etc. Use of the micrometer and wire gauges will be taught.

The construction of a project or projects will be required of all students to apply basic mechanical skills and develop practical work-type-experiences. The scope of this work will cover layout, wiring, testing, troubleshooting, and writing of a report. Time should be devoted to becoming familiar with catalogs and test equipment instruction manuals.

ing

Attention will be given to the fundamental principles of residential and industrial wiring to include development of the skills (manual and mental) important in performing basic wiring jobs involving the use of armored cable and conduit.

A familiarization with the National Electric Code and local wiring codes will be required.

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ELECTRICAL-ELECTRONIC DRAFTING

I. Conventions, symbols, and standards . . . . . .
II. Lettering . . . . . .
III. Use and care of drafting instruments and materials
IV. Measuring and measuring instruments . . . . . .
V. Dimensioning. . . . . .
VI. Notes . . . . . .
VII. Orthographic projection . . . . . .
VIII. Block diagram . . . . . .
IX. Electronic symbols and conventions. . . . . .
X. Schematic layout procedure. . . . . .
XI. Schematic diagrams. . . . . .
XII. Chassis and enclosures. . . . . .
XIII. Chassis assemblies. . . . . .

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ELECTRICAL-ELECTRONIC DRAFTING

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I	Conventions, symbols, and standards	Introduction and f
	A. Layout of sheet B. Terminology C. Alphabet of lines	
II	Lettering	Stress importance o for photo-reducti
	A. Style B. Technique	purpose. The use style in the elec
III	Use and care of drafting instruments and materials	Importance of "squa Selection of penc
	A. T-square, parallel, straightedge, and board B. Triangles C. Pencils D. Paper E. Instruments F. Special devices G. Reference-handbooks	able linework. S drafting instrume lates and referen electronic drafti
IV	Measuring and measuring instruments	
	A. Engineer's scale B. Combination scale C. Calipers D. Dividers E. Mechanical aids F. Radius gauge G. Protractor bevel H. Micrometer	Measuring devices. a scale. Importa sions for repeata

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ELECTRICAL-ELECTRONIC DRAFTING

nd standards Introduction and familiarization with terminology

Stress importance of proper lettering for legibility, especially for photo-reduction. Techniques used in lettering and their purpose. The use of guidelines. The recommended lettering style in the electronics industry.

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oard

Importance of "squareness" in maintaining dimensional stability. Selection of pencil and proper pointing techniques for acceptable linework. Standard paper sizes and types. The use of drafting instruments, especially compass and dividers. Templates and reference books as aids in the proper execution of electronic drafting.

Measuring devices. Scaling with the Engineer's scale. Reading a scale. Importance of accurately measuring physical dimensions for repeatability. How to use a micrometer.

V Dimensioning	
A. Units B. Lines C. Arrowheads D. Methods E. Angles and arcs	Standard methods of dimensioning Techniques used in dimensioni head practice.
VI Notes	
A. Material B. Number required C. Trade terms D. Title block	The function of notes on a drawi on drawing. Modification indi methods of component and diag
VII Orthographic projection	
A. Relationship of views B. Selection of views 1. Necessary views and choice locating on plate	The orthographic projection as a diagrams. Transferring inform Selection of views to best dis
VIII Block diagram	
A. Block layout 1. Inline layout 2. Row layout 3. Complex layout 4. Columns and rows 5. Line work B. Flow path C. Block size D. Graphical symbols	The role of the block diagram in of the block diagram in electr specifications for block diag
IX Electronic symbols and conventions	
A. Resistors B. Capacitors C. Inductors and transformers	Standard and special electronic Color codes. Pictorial repres base diagrams for tubes and tr

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ELECTRICAL-ELECTRONIC DRAFTING

Standard methods of dimensioning. Importance of accuracy. Techniques used in dimensioning, base line, centerline. Arrowhead practice.

The function of notes on a drawing. Methods of placing notes on drawing. Modification indication. EIA and MIL specification methods of component and diagram numbering.

The orthographic projection as an introduction to pictorial diagrams. Transferring information from view to view. Selection of views to best display a piece of equipment.

The role of the block diagram in electronic drafting. The use of the block diagram in electronic troubleshooting. Military specifications for block diagrams.

Standard and special electronic symbols (EIA and military). Color codes. Pictorial representation. Pin numbering and base diagrams for tubes and transistors.

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	D. Electron tubes E. Semiconductor devices	
X	Schematic layout procedure	
	A. Data B. Trial layout C. Estimating dimensions D. Symbol locations E. Note selection	Decisions to be made b Determination of spa Determination of nee
XI	Schematic Diagrams	All phases of electron practiced. Students laboratory experimen to other assigned pl lettering and symbol
XII	Chassis and enclosures	Emphasis to be placed ings needed to manuf Students will be rec one of their constru
	A. Types B. Layout C. Marking	Human factors in panel
		Hole size and mounting components.
		Degree of tolerance an
		Chassis marking. Stan Prototype markings a to use dry letterin
XIII	Chassis assemblies	
	A. Pictorial drawing B. Assembly breakdown C. Panel drawing	Relation of subassembl Standards for subass
		Selection of chassis
		Panel drawings for ma

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ELECTRICAL-ELECTRONIC DRAFTING

es
r devices

procedure

Decisions to be made before drafting. Selection of paper size. Determination of spacing. Techniques of layout for eye appeal. Determination of need for notes.

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All phases of electronic schematic diagrams will be taught and practiced. Students will prepare diagrams to accompany their laboratory experiments and construction projects in addition to other assigned plates. Heavy emphasis on layout, linework, lettering and symbols.

sures

Emphasis to be placed on the development of all working drawings needed to manufacture a piece of electronic equipment. Students will be required to develop a set of drawings for one of their construction projects.

Human factors in panel layout.

Hole size and mounting methods for all common electronic components.

Degree of tolerance and its effect on cost of manufacture.

Chassis marking. Standard abbreviations. Warning labels. Prototype markings as opposed to production markings. How to use dry lettering kits.

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kdown

Relation of subassemblies to the overall piece of equipment. Standards for subassembly designations.

Selection of chassis breakdown.

Panel drawings for manufacturing.

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ABSTRACT - Prepared by a curriculum committee of the New York State Department of Education, this curriculum guide on mechanical technology presents a description and outline of suggested high school courses. Topics are: (1) Course Descriptions, (2) Suggested Scheduling, (3) Diploma Requirements, (4) Strength of Materials, (5) Machine Design, (6) Technical Drafting, (7) Machine Shop, and (8) Metallurgy. A bibliography is appended. (GB)

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Experimental Field

Trial Edition

Syllabus in

Technical Subjects

MECHANICAL TECHNOLOGY

STRENGTH OF MATERIALS

TECHNICAL DRAFTING

MACHINE DESIGN

MACHINE SHOP

METALLURGY

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The University of the State of New York/THE STATE EDUCATION DEPARTMENT
Bureau of Secondary Curriculum Development/ Albany/1969

FOREWORD

We are in the period of rapid technological change. To reflect this change it is necessary to periodically review and revise a curriculum offered in schools where learners are being prepared to take their place in the world of work or to continue their technical preparation in college.

The following suggested minimum syllabus was developed by a committee working during the summer of 1967. It is a revision of previous syllabus materials released in 1958. It is presented here for your reaction before adoption as the State program in Mechanical Technology.

Working on the committee were Armand Bassi, Brooklyn Technical High School; Donald Haver, Mont Pleasant High School, Schenectady; and Robert Laube, Sewanhaka High School, Floral Park. Adolph Harden, Assistant Professor, Hudson Valley Community College, was a member of the advisory committee. Harold Wassmer, Associate in the Bureau of Trade and Technical Education, reviewed the work of the committee. Earl Hay, Supervisor of Vocational Curriculum, coordinated the work of the committee.

This publication is being released to all schools in the State offering this technical curriculum. Your cooperation in reviewing this material and returning the attached evaluation questionnaire is solicited. It is through such cooperation that curriculum development and improvement becomes a continuous process.

Gordon E. Van Hooft
Chief, Bureau of Secondary Curriculum Development

William E. Young
Director, Curriculum Development Center

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OBJECTIVES

- To provide the student with a thorough grounding in the fundamental principles and practice of mechanical design
- To provide the student with sufficient background material to enter industry in a technical or semitechnical position
- To provide the student with a technical educational foundation from which he may readily advance through further study
- To aid the student in adapting to a technical environment in which mechanical technology plays a part
- To develop, through the study of mechanical technology in conjunction with other technical subjects, a type of individual whose characteristics will include:
  - An established habit of judgement based on observed and verified facts
  - The practice of facing new situations, based on the ability to apply known principles and reflective thought
  - A desire to complete a task
  - An appreciation of the need for cooperation and loyalty
  - An appreciation of the laws and forces of nature and their implications
  - A regard for the importance of safety and correct safety procedures

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TO THE TEACHER

In this revision of the Suggested Technical Mechanical Syllabus, several significant departures have been recommended:

- The name of the curriculum has been changed from Mechanical Design and Construction to Mechanical Technology because it is more descriptive of the areas studies.

- The content of some subject areas has been expanded to keep abreast of the latest developments in the field.

- Metallurgy has been added as one optional subject unit to be offered in lieu of a second unit in either machine shop or technical drafting.

- To facilitate the implementation of metallurgy the machine shop and technical drafting have been divided into separate content outlines for each unit.

- An attempt has been made to indicate the depth to which certain areas are to be covered. If the need becomes evident through an evaluation questionnaire, plans may be made to prepare an instructional guide for each subject area to further define the scope of this curriculum.

The Machinery's Handbook is designated as the standard reference for all subjects. Other references have been indicated where applicable.

It is expected that the comprehensive Regents examination will begin to reflect the unit values assigned to the various subject areas.

This revised minimum syllabus defines the material which every school must teach to prepare its students to take the comprehensive technical examination. This syllabus is not intended to limit the inclusion of subject matter which is appropriate to a particular locality.

Areas which might be included as optional topics have been placed at the end of each major section in the syllabus. It is assumed that no school will be satisfied to teach only the material in a minimum syllabus.

Berton P. Plummer
Chief, Bureau of Trade and Technical Education

John E. Whitcraft
Director, Division of Occupational Education Instruction

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DESCRIPTION OF COURSES

Strength of Materials

This course includes the type of stresses occurring in the materials of construction under varying conditions of direct and indirect stress. They include tension, compression, shear, and bending. Also the effects of temperature and concepts of elastic limits, modulus and elasticity, modular of rupture, ultimate strength, factor of safety, and stress-strain relationship of materials under load. Determination of centroids, moment of inertia and radius of gyration of rectangular and complex sections are made. Design of simple and double overhanding beams, deflection of beams, torsional stresses in shafting, and design of wood and steel columns are part of classroom work. Laboratory work includes physical tests on a variety of testing machines using the standards of the American Society of Testing Materials. Laboratory reports are made which are based upon test performance and include observed data, calculations, and interpretations of test results. Laboratory experiments are made in tension, compression, bending, impact, and hardness of ferrous and nonferrous metals, wood, and cement.

Machine Design

A course in which the design principles of machine elements are taken up and calculations are made in determining the size and shape of various machine parts. It includes factors which influence the selection of the materials to be used in designing such elements as beams, bearings, clutches, brakes, shafts, bushings, screws, rivets, gears, and belts. Attention is given to various types of loading conditions, stresses, deformations, fits, finishes, and other factors which must be considered in the design of machine elements.

Opportunities in advanced drafting room practice are also offered in this course. The student applies his knowledge of mathematics, science, and drawing to practical problems while he is designing complete machines or component parts of machines. He analyzes the problem, gathers data, sketches ideas on paper, does all necessary mathematical calculations, makes working drawings, and finally checks his work. Throughout the course he is encouraged to use his judgment and work on his own initiative.

Technical Drafting I

This is a beginning course for students who have had little or no previous experience in drafting. The principal objectives are: basic understanding of orthographic projection; skill in orthographic, isometric, and oblique sketching and drawing; ability to produce accurate and complete detail and assembly working drawings; understanding of princples and appropriate application of descriptive geometry; experience in using handbooks and other resource materials; elementary understanding of design principles in machine parts used as drawing projects; and use of simplified drafting practices in industry. A.S.A. standards are stressed. Interpretation of industrial sketches and prints is introduced when feasible not only to emphasize accepted drawing practice but also to develop an early appreciation of the functions involved in production.

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Technical Drafting II

This course is a continuation of Drafting I. The instructional units provide additional understanding of drafting problems, skills, and techniques that are essential to the work of the draftsman; emphasize design application and the depth of background knowledge needed to carry out drafting and design functions. Emphasis is placed on interpretation of industrial prints, familiarity with simplified drafting practices, ability to use handbooks and other source materials, adherence to American Standards for Drafting, and the development of skill in sketching. The units dealing with design of parts such as gears, cams, jigs, and fixtures pave the way for greater depth of instruction.

Machine Shop I

This course is for students who have not had any previous instruction in this shop. The purpose of this shop is not to provide instruction on a craftsman level. It is to provide an understanding of the limits and type of operations that can be performed on each machine. However, sufficient skill is taught so that the students can make effective entrance into the industrial field and through careful application advance through junior assignments to positions of greater responsibility.

Instruction is provided in layout, threading, inspection, lathe, bench work, drill press, milling machines, shapers, surface grinder, and bench grinder. These machines are correlated with instruction in drafting and mathematics. Emphasis is on proper techniques and the part that each machine plays in industry. Stress is also placed on principles and theories of precision measurements during which students use micrometers, verniers, height gauges, comparators, electronic gauges, and other measuring devices.

Machine Shop II

This is a continuation of Machine Shop I. Instruction continues in greater depth. Practice is provided in handling precision tools to obtain closer tolerances. Projects designed in machine design are produced but this is usually limited to interrelated movable parts. Students have an opportunity to see the construction of machine parts from their working drawings. The number of operations performed on the milling machines, shaper, surface, and cylinder and cutter grinders become increasingly complex. Schools equipped with numerically controlled machines stress sequence of operations, processing planning charts, tape processing, operation of the controls, and the setting up of the machine.

Metallurgy

This course is designed to acquaint the students with a wide variety of metallurgical concepts. Many of the basic physical properties are developed and related to the behavior of metals and alloys. A study is made of the atomic structure of metals with reference to the formation of alloys. Phase diagrams with special emphasis on the iron-carbon diagram are treated extensively.

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The student acquires a working understanding of the field of physical metallurgy. Various alloy systems will be compared as to physical and mechanical properties. The theory and practice of heat treatment, sample preparation, and metallography are studied. The relationship of microstructures and physical properties are demonstrated and explained in class sessions and experimentally determined in the laboratory.

SUGGESTED SCHEDULING OF MECHANICAL TECHNOLOGY

Two Year Program

9th	10th	11th	12th
English 9 Social Studies Math (Elem. Alg.) Science	English 10 Social Studies Math 10	English 11 Social Studies Math 11 Chemistry	English 12 Physics
Industrial Arts Mechanical Drawing	Industrial Arts Metals	Strength of Materials Technical Drafting (2 periods)	Machine Design (2 periods) Metallurgy

Three Year Program

9th	10th	11th	12th
English 9 Social Studies Math 9 (Elem. Alg.) Science	English 10 Social Studies Math 10	English 11 Social Studies Math 11	English 12 Physics
Industrial Arts Metals or Mechanical Drawing	Technical Drafting I Machine Shop I (2 periods)	Technical Drafting II (2 periods) Strength of Materials	Machine Design Machine Shop II (2 periods)

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MECHANICAL TECHNOLOGY

Requirements for a Local or State High School Diploma in Technical Subjects

Group I	Required Constants	Units
	English	4
	Social Studies (including 1 year of American History)	3
	Science	1
	Mathematics	1
	Health	1/2
	Total	9 1/2
Group II	Required Technical Subjects	
	Strength of Materials	1
	Machine Design	1
	Technical Drafting	1-2
	Machine Shop	0-2
	Metallurgy	0-1
	Physics	1
	Mathematics 10	1
	Total	8
Group III	Elective Subjects	
	(Recommended Math 11 or Chemistry if Metallurgy is selected)	1
	Total	1

A minimum of 18 units is required for Regents endorsement for a local high school diploma.

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STRENGTH OF MATERIALS

Strength of materials is considered a prepared subject and, when given five periods per week for 1 year, has a value of one unit.

Refer to the "Instructional Guide for Strength of Materials" for a list of teaching points, suggested laboratory equipment, and a list of suggested texts and references.

OBJECTIVES

- To provide a knowledge of the basic relationships of stress and strain in the design of materials of construction under various load conditions
- To provide practice in the application of basic knowledges, accepted standards*, and engineering practice to the solution of problems involving investigation and design
- To become familiar with standard testing equipment and procedures, to verify theoretical deductions and calculations, and to develop logical methods of observation, tabulation, plotting curves, and report writing of experiments

*The standard reference texts for this subject shall be the "Machinery's Handbook" and the AISC "Steel Construction Manual."

I. PRELIMINARY CONCEPTS

- A. Definition
- B. Force (loads)
  - 1. Static
    - a. Resultant forces and equilibrants
    - b. Moments - sign conventions
    - c. Conditions of static equilibrium
  - 2. Dynamic

II. STRESS

- A. Definition
- B. Direct stresses
  - 1. Tension
  - 2. Compression
  - 3. Shear
- C. Indirect stresses (discussion only)
  - 1. Bending
  - 2. Horizontal shear
  - 3. Torsion
- D. Unit stress
  - 1. Definition
  - 2. Design (allowable) stress
    - a. Factor of safety (design factor)
  - 3. Working (actual) stress
- E. Stress concentration (discussion only)

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III. STRAIN (deformation)

A. Definition

B. Unit deformation

1. Elastic (Proportional) limit
2. Yield point

C. Stress-strain diagrams

1. Hooke's law
2. Modulus of elasticity (Young's Modulus)
3. Elastic limit
4. Yield point
5. Ultimate strength
6. Percent elongation
7. Percent reduction in area

D. Poisson's ratio (discussion only)

IV. PROPERTIES OF MATERIALS

A. Strength

1. Tension
2. Compression
3. Shear
4. Bending

B. Elasticity

C. Stiffness

D. Resilience

E. Ductility

F. Hardness

G. Malleability

H. Toughness

I. Machinability

J. Fatigue

K. Creep

L. Durability

V. ENGINEERING MATERIALS

A. Ferrous metals

1. Cast iron
   a. Gray
   b. White
   c. Malleable
2. Wrought iron
3. Steel
   a. Carbon
      (1) Mild
      (2) Medium
      (3) Hard
   b. Alloys

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B. Nonferrous metals
   1. Aluminum
   2. Copper
   3. Magnesium
   4. Nickel
   5. Tin
   6. Titanium
C. Nonferrous alloys
D. Nonmetallic
   1. Wood
   2. Masonry
   3. Ceramics
   4. Plastics
   5. Concrete
   6. Fibrous materials

VI. BEAMS (transverse static loading)

A. Conditions for equilibrium
   1. Principle of moments
   2. Summation of forces
B. Types of loading
   1. Concentrated
   2. Uniform
   3. Partially distributed uniform
   4. Combinations of above
C. Determination of reactions
   1. Simple beams
   2. Cantilever beams
   3. Overhanging beams
D. Vertical shear
   1. Calculations
   2. Diagram
E. Bending moment
   1. Calculations
   2. Diagram
F. Internal resistance
   1. Resisting moment
   2. Horizontal shear (timber only) (discussion only)
G. Flexure formula
   1. Determination of section modulus
   2. Selection of beam
      a. Timber
      b. Steel
H. Deflection
   1. Simple beam calculations

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a. Concentrated load at center
b. Uniform load
c. Combination of "a" and "b"

2. Cantilever calculations
a. Uniform load
b. Concentrated load at free end
c. Combination of "a" and "b"

3. Allowable deflection

VII. CENTROIDS

A. Use of tables
1. Simple areas (rectangle, triangle, circle, semicircle, quadrant)
2. Standard structural shapes

B. Composite areas - moment of area method
1. Simple areas
2. Standard structural shapes

VIII. MOMENT OF INERTIA (rectilinear only)

A. Simple areas
B. Combination of simple areas
C. Rolled structural shapes
D. Built-up structural members

IX. STRUCTURAL CONNECTIONS

A. Types of joints
1. Lap
2. Butt

B. Method of fastening
1. Riveted
2. Bolted
3. Welded

C. Types of stresses
1. Shear
a. Plate
b. Fastener
2. Bearing
3. Tension
a. Plate
b. Member

D. Efficiency of riveted and bolted joints

X. COMPRESSION MEMBERS (concentrically loaded)

A. Short columns
B. Long columns
1. End conditions
2. Materials

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a. Timber
b. Steel
3. Formulas
a. Timber
(1) Winslow
(2) Forest products
b. Steel
(1) AISC
(2) Local codes (discussion only)
c. Other materials - refer to applicable design handbook

XI. EFFECT OF TEMPERATURE CHANGES

A. Change in dimension
B. Stresses induced

XII. THIN WALL PRESSURE VESSELS (optional)

A. Cylindrical
B. Spherical

XIII. TORSION (optional)

A. Torque (twisting moment-external)
1. Tangential force
2. Radial distance to force
B. Resisting moment (internal)
1. Polar section modulus (hollow and solid shafts)
a. Polar moment of inertia
b. Outside radius
2. Torsional shear unit stress
C. Torsional strain
1. Angle of twist
2. Circumferential strain
a. Total
b. Unit
D. Modulus of rigidity
E. Power
1. Torque
2. Rotary speed
F. Design of shafting

XIV. MATERIAL TESTING LABORATORY

A. Type of test
1. Hardness
2. Tension
3. Compression
a. Simple
b. Columns

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4. Shear
5. Torsion
6. Impact
7. Flexure

B. Materials
1. Steel
2. Other metals
3. Wood
4. Cement, mortar, and concrete
5. Plastics

XV. OPTIONAL TOPICS

A. Combined loading stresses
B. Repeated stresses
C. Force polygon
D. Trusses
E. Eccentric loading

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MACHINE DESIGN

Machine design is considered a prepared subject and, when given five periods per week for 1 year, has a value of one unit.

OBJECTIVES

- To develop a logical approach to the solution of typical design problems
- To apply the knowledge gained in strength of materials to the design of specific machine elements with the aid of handbooks and/or manufacturers' catalogs
- To consider the feasibility and economics of manufacture as they affect design

*The standard reference text for this subject shall be the "Machinery's Handbook."

I. FACTORS AFFECTING DESIGN

- A. Operational requirements
- B. Appearance
- C. Material
- D. Method of manufacture
- E. Industry standards
- F. Fabrication costs
- G. Transportation

II. FUNDAMENTAL MECHANICAL CONCEPTS

- A. Mechanical advantage and efficiency
  - 1. Screw jack (simple approach)
    - a. Work in - work out - efficiency
    - b. Mechanical advantage
  - 2. Hydraulic jack (simple lever actuation suggested)
    - a. Work in - work out - efficiency
    - b. Mechanical advantage
- B. Torque, velocity, horsepower, efficiency
  - 1. Gear trains (simple and compound)
    - a. Tangential forces
    - b. Torque and power transmission
    - c. Ideal and actual systems
  - 2. Pulley systems (simple and compound)
    - a. Tangential (resultant) forces
    - b. Torque and power transmission
    - c. Ideal and actual systems

III. SOLID AND HOLLOW ROUND SHAFTING

- A. Static and dynamic loads
- B. Torsion only (review - Strength of Materials)

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C. Combined bending and torsion
   1. Equivalent torque method
   2. Equivalent bending moment
D. Torsional deflection (review - see Strength of Materials)
E. Effect of keyways on strength of shaft

IV. KEYS

A. Types and purpose
B. Shear and bearing stresses in square and flat keys
C. Plain and taper pins in double shear

V. BEARINGS

A. Sliding (calculations)
   1. Journal
   2. Collar thrust
   3. Step thrust
   4. Heat loss
B. Roller and ball (no calculations)
   1. Terminology and typical construction
   2. Types of radial bearings
   3. Types of thrust bearings
C. Lubrication

VI. GEARS

A. Materials and methods of fabrication
B. Tooth forms and applications (emphasis on 14 1/2° composite to the form)
C. Types of gears (use, characteristic, and advantages)
   1. Spur
   2. Helical
   3. Herringbone
   4. Rack
   5. Worm and wheel
   6. Bevel
   7. Internal
   8. Special gears - optional
D. Spur gear nomenclature and tooth proportions
   1. Calculations and use of tables
E. Center distance
   1. Spur gear and pinion
   2. Rack and pinion
F. Strength of spur gears
   1. General design considerations
   2. Calculations based on Lewis or similar equations

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VII. PULLEYS

A. Materials and construction

B. Types

1. Flat
2. Crowned
3. Vee

C. Simple and compound pulley trains

VIII. ARM AND WEB CALCULATIONS

A. Gears

B. Pulleys

IX. BELTS

A. Types and construction

1. Flat (including joints and fasteners)
2. Vee
3. Timing (toothed)
4. Others

B. Vee belt selection (using standard tables or manufacturers' catalogs)

1. Choosing proper section
2. Speed ratio
3. Sheave diameters and belt speed
4. Belt length
5. Arc - length connection factor
6. Net power per belt
7. Number of belts required

C. Flat belt design (optional)

X. COUPLINGS

A. Types and purpose

1. Rigid
2. Chain
3. Sliding
4. Gear
5. Flexible
6. Universal

B. Rigid coupling problems

1. Sleeve
   a. Set screws needed (number and size)
2. Flanged
   a. Number and size of bolts
   b. Flange thickness (shear at hub)
   c. Flange thickness (bearing at bolt circle)

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Mechanical Technology

XI. CLUTCHES (friction type)

A. Plate
1. Uniform pressure
2. Uniform wear

B. Cone
1. Uniform pressure
2. Uniform wear

C. Block
1. Angles of contact less than 60°
2. Angles of contact greater than 60°

D. Band - design requirements and constants

XII. BRAKES

A. Block
1. Actuating mechanism considerations
2. Self-energizing and self-locking brakes

B. Band
1. Direction of rotation consideration
2. Self-energized brake

C. Friction material limitations (optional)
1. Design factors
2. Heating of brakes

XIII. SPRINGS

A. Helical coil springs (tension or compression)
1. Stresses
2. Deflection
3. Design
a. Compression type
1. Spring end consideration
2. Buckling considerations
b. Tension type
1. Design of coil spring ends
2. Effect of initial tension

B. Torsion coil spring
1. Stresses induced
2. Determination of wire size

XIV. COMBINED STRESSES

A. Determination of working stresses and safe loads
1. Symmetrical sections
2. Unsymmetrical sections

B. Design of simple symmetrical sections
1. Circular
2. Rectangular

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XV. FITS AND TOLERANCES

A. Definitions
B. Classes of fits
C. Interference fits (assuming deformation of ring only)
   1. Force determination
   2. Maximum torque transmission
D. Stresses in force and shrink fits

XVI. CAMS

A. Nomenclature and definitions
B. Types (positive and nonpositive)
   1. Plate
   2. Cylindrical
   3. Translating
   4. Special
C. Displacement diagrams
   1. Dwell
   2. Constant velocity
   3. Simple harmonic motion
   4. Uniform acceleration and deceleration
D. Followers
   1. Point
   2. Roller
   3. Flat face
   4. Offset
E. At least one plate cam should be constructed using each type of follower. These drawings should include the use of all the various motions listed in C

Optional Topics

Basic Linkages
Chain Drives
Flywheels
Pipes and Cylinders
Stress Concentrations
Followers
   1. Oscillating
   2. Secondary

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TECHNICAL DRAFTING I

This outline has been divided into two 1 year courses. The first year is considered a basic course covering the minimum fundamentals that every graduate of the course should know. The second year is to some extent an amplification of the first but includes other topics that broaden the scope of the subject content.

If drafting is offered for only 1 year, consideration should be given to the inclusion of at least the basic fundamentals of charts and graphs.

Technical drafting is considered an unprepared subject and, when given ten periods a week for 1 year, has a value of one unit.

OBJECTIVES

- To develop special visualization and become familiar with graphic representation of physical objects
- To provide knowledge of the tools used by the draftsman and experience in their use
- To enable the student to interpret and make working drawings
- To gain an understanding of:
  - accepted drafting room standards and practices
  - modern techniques of drafting, as developed
  - the relationship of design, drafting, and fabrication

*The standard reference text for this course shall be the "Machinery's Handbook."

I. LETTERING

A. Freehand - upper case only
1. Vertical (major emphasis)
2. Inclined

B. Method
1. Style and form
2. Technique
3. Guidelines
4. Spacing
5. ASA standards

II. CONVENTIONS AND SYMBOLS

A. Alphabet of lines
B. Sheet layout

III. FREEHAND SKETCHING

A. Pencil technique
1. Straight lines
2. Curves

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B. Orthographic projection

C. Pictorial

IV. USE AND CARE OF INSTRUMENTS

A. Pencil

B. Paper

C. T-square and/or parallel straightedge

D. Triangles

1. Rigid

2. Adjustable

E. Protractor

F. Compass

G. Dividers

H. Scales - architect's and engineer's

1. Full size only

I. Eraser and erasing shield

J. Drafting machine

K. Irregular curves (rigid only)

V. DRAFTING AIDS

A. Templates

1. Circle

2. Radius guide

3. Ellipse

B. Lettering devices (for guidelines only)

VI. GEOMETRIC CONSTRUCTION

A. Nomenclature

B. Dividing lines into equal parts

C. Duplicating angles

D. Bisecting lines and angles

E. Triangles

F. Circles and arcs

1. Fitting arc between two given lines and/or arcs

2. Tangent points

3. Fillets and rounds

G. Regular polygons

VII. ORTHOGRAPHIC PROJECTION

A. Relationship of views

B. Number of views required (one, two, or three)

C. Selection of views

D. Hidden line conventions

E. Locating drawing on paper (centering)

F. Required drawings

1. From pictorial drawing

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2. From measured object
3. From written or oral specifications

VIII. DIMENSIONING

A. Lines
1. Dimension
2. Extension
3. Leader
B. Arrowheads
C. Dimension figures
1. Fractional
2. Decimal
D. Types of dimensions
1. Size
a. Partial
b. Overall
c. Arcs (including fillets and rounds)
d. Circles (including drill, ream, bore, etc.)
e. Angles (including chamfers)
2. Location
a. From centerlines
b. From finished surfaces
c. From baseline

IX. AUXILIARY VIEWS

A. Purpose
B. Complete views
C. Partial views
D. Secondary views
E. Location of dimensions

X. SECTION VIEWS

A. Purpose
B. Material symbols
C. Types
1. Full
2. Half
3. Revolved
4. Removed
5. Broken out
6. Offset
D. Dimensioning conventions

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XI. THREADS (UNIFIED AND AMERICAN STANDARD)

A. Types of screws

1. Machine
2. Cap
3. Set

B. Simplified representation only

C. Dimensioning notes

XII. DETAILED WORKING DRAWINGS (simple)

XIII. ASSEMBLY DRAWINGS (involving few parts)

XIV. PICTORIAL DRAWINGS (simple objects involving straight lines, circles, and circular arcs)

A. Oblique

B. Isometric

TECHNICAL DRAFTING II

I. USE OF INSTRUMENTS AND DRAFTING AIDS

A. Compass

1. Drop bow
2. Beam

B. Scales - architect's and engineer's

1. Reduced scale
2. Enlarged scale

C. Adjustable irregular curves

D. Templates

1. Screw
2. Nut
3. Gear
4. Others

E. Pressure-sensitive tape

1. Lines
2. Lettering - numbers

II. DIMENSIONING

A. Finish marks

B. Limits and tolerances

C. For N/C machines

D. Welding symbols

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E. Simplified
   1. Use of dots for arrowheads
   2. All dimensions read from bottom
   3. Use of typical dimensions
   4. Tabular
   5. Other modern methods as they are developed

III. THREADS

A. Types and purpose
B. Methods of drawing
   1. Simplified (emphasize)
   2. Schematic (regular)
   3. Semiconventional (detailed)
   4. Large sizes
   5. Pipe threads
C. Use of tables
   1. Thread dimensions
   2. Tap drill sizes
   3. Clearance drill sizes
D. Dimensioning
   1. Internal
   2. External

IV. FASTENERS AND SPRINGS

A. Screws
   1. Machine
   2. Cap
B. Bolts
C. Studs
D. Nuts
E. Washers
   1. Plain
   2. Lock
F. Springs
   1. Helical
   2. Torsional
   3. Flat

V. KEYS

A. Square
B. Flat
C. Tapered
D. Gib head
E. Kennedy
F. Spline
G. Woodruff

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VI. PINS

A. Plain
B. Tapered
C. Cotter

VII. GEARS

A. Working drawings of spur gear only

VIII. ORTHOGRAPHIC PROJECTION

A. Complex shapes
B. Four or more views required
   1. Auxiliary views
   2. Section views
   3. Partial views
C. Phantom lines - alternate position lines

IX. DETAILED WORKING DRAWINGS

A. From pictorial drawing
B. From assembly drawing
C. Parts involving mating dimensions, tolerances, notes, etc.
D. For N/C machines
E. Using pressure sensitive tape

X. RECORDS AND NOTATIONS

A. Title block
B. Parts list (bill of materials)
C. Numbering systems
   1. Parts
   2. Drawings
D. Revisions
E. Individual parts
   1. Name
   2. Material
   3. Type of finish
   4. Number required
   5. Stock sizes
F. General notes
   1. Fillets and rounds
   2. Tolerances (fractional and decimal dimensions)
   3. Special notes (order of operations, fitting, symmetrical pieces, reference to other drawings, etc.)

XI. ASSEMBLY DRAWINGS (with parts list)

A. Orthographic
   1. Simple
   2. Complex (requiring full or portion sectional views)

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B. Exploded pictorial

XII. PICTORIAL DRAWINGS

A. Types (discussion, illustration and comparison)
1. Oblique
a. Cabinet
b. Cavalier
2. Axonometric
a. Isometric
b. Dimetric
c. Trimetric
3. Perspective

B. Drawings required (problems involving straight lines, circles, arcs, irregular curves and combinations thereof)
1. Isometric
2. Oblique

C. Dimensioning pictorial drawings
1. Isometric
2. Oblique

XIII. FREEHAND SKETCHING

A. Detailed working drawings
B. Assembly drawings
C. Pictorial working drawings

XIV. DEVELOPMENTS

A. Parallel line
1. Prisms
2. Cylinders

B. Radial line
1. Pyramids
a. Regular
b. Truncated
2. Cones
a. Regular
b. Truncated

C. Triangulation
1. Transition pieces

XV. INTERSECTIONS

A. Straight lines of intersection
B. Curved lines of intersection

XVI. CHARTS AND GRAPHS

A. Purpose

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B. Types of graphs
   1. Line
   2. Bar
   3. Pie
   4. Selection
C. Coordinates
   1. Rectilinear
   2. Polar
   3. Types of variables
   4. Selection
D. Scales
   1. Uniform
   2. Logarithmic
      a. Semilogarithmic
      b. Full logarithmic
   3. Angular
   4. Selection
E. Commercial graph paper
   1. Selection
F. Making of graphs
   1. Layout
   2. Title
   3. Symbols used to plot points
   4. Methods of connecting points
      a. Point-to-point
      b. Straight line
      c. Curve
G. Reading graphs
   1. Interpolating
   2. Extrapolating
H. Use of pressure sensitive tapes

XVII. PIPING AND TUBING

A. Types and sizes
B. Fittings
C. Materials
D. Methods of drawing
   1. Schematic (single line)
      a. Orthographic
      b. Isometric
   2. Conventional (information only)

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XVIII. OPTIONAL TOPICS

A. Axonometric projection
B. Perspective
C. Shading
D. Revolutions
E. Inking
F. Descriptive geometry
G. Lettering devices (templates, mechanical aids, typewriter)
H. Proportional dividers
I. Bevel gears
J. Worm and worm wheel
K. Structural

XIX. DESIGN DRAFTING

Design and draw a simple tool, mechanism, or machine such as a drill jig, vise, arbor press, paper punch, geneva drive, mechanical can opener, etc.

The design should be basically empirical but some simple calculations may be involved.

The drafting should require an assembly drawing and detailed working drawings (free-hand or with instruments). Particular emphasis should be given to mating dimensions, feasibility, and ease of manufacture, and the ability to perform the required function(s).

It is desirable for the student to have the opportunity to fabricate his design in the machine shop.

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MACHINE SHOP I

This outline has been divided into two 1 year courses. The first year is considered a basic course covering the minimum fundamentals that every graduate of the course should know. The second year is to some extent an amplification of the first year but also includes other topics that broaden the scope of the subject content.

Machine shop is considered an unprepared subject and when given ten periods a week for 1 year has a value of one unit.

OBJECTIVES

- To gain a thorough knowledge of the fundamental principles and applications of hand and machine tools
- To develop habits of safety through proper work practices
- To correlate mathematics, science, and drawing with machine shop procedure
- To familiarize student with modern manufacturing methods
- To develop habits of orderliness, initiative, perseverance, and efficiency
- To become acquainted with resource materials and sources of information pertaining to modern machine shop practice

*The standard reference texts for this subject shall be the "Machinery's Handbook" and the "American Machinists' Handbook."

*Items preceded by an asterisk should be covered at least on a theoretical or informational basis, as this equipment is not available in every school. Instruction should be expanded where equipment and facilities are available.

I. INTEGRATED GENERAL TOPICS

These topics generally apply to all areas. Specific instruction applying to each area should be given at the appropriate time.

A. Safety
B. Work habits and attitudes
C. Preventive maintenance
D. Cutting tools
E. Materials
   1. Ferrous metals
   2. Nonferrous metals
   3. Plastics
F. Speed and feeds
G. Coolants and lubricants

II. BENCHWORK

A. Layout - flat surfaces
B. Filing

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1. File selection
2. Technique

C. Threading
1. Internal
a. Types of taps
b. Tap drill sizes (tables)
c. Hand tapping technique
2. External, using a die
a. Types of dies
b. Technique
3. Cutting Lubricants

D. Inspection of simple production parts
1. Measuring instruments
a. Steel rule
b. Outside micrometer
c. Inside micrometer
d. Squares
e. Snap gages
f. Thread gages
g. Radius gages
2. Technique

III. SAWING

A. Selection of blade type and size
B. Hand hacksaw
*C. Power saws
1. Power hacksaw
2. Cutoff bandsaw
3. Contour bandsaw
4. Abrasive cutoff saw

IV. LATHE

A. Chuck work
1. Facing
2. Turning
3. Center drilling
4. Drilling
5. Reaming

B. Work between centers
1. Cylindrical
2. Taper
3. Angular
4. Chamfering
5. Necking
6. Shouldering
7. Knurling

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C. Precision bench lathe
   1. Collet work
      a. Facing
      b. Turning
      c. Center drilling
      d. Drilling
      e. Reaming
      f. Angular turning

V. DRILL PRESS (sensitive)
   A. Methods of holding work
      1. Vise
      2. V-blocks
   B. Operations
      1. Drilling
      2. Reaming
      3. Countersinking
      4. Counterboring

VI. MILLING MACHINE (plain-horizontal and vertical)
   A. Methods of holding work
      1. Vise
      2. Index head
      3. Fixtures
   B. Operations
      1. Plain surface milling
      2. End milling
         a. Flat surfaces
         b. Angular surfaces
      3. Angular milling
      4. Slotting
      5. Sawing
      6. Form milling
         a. Concave
         b. Convex
         c. Corner rounding
      7. Indexing (direct, simple)
   C. Nomenclature and selection of standard milling cutters

VII. SHAPER
   A. Method of holding work
      1. Vise
   B. Operations
      1. Parallel surfaces
      2. Squaring

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VIII. SURFACE GRINDER

A. Method of holding work
   1. Magnetic chuck
   2. Vise
B. Operations
   1. Truing and dressing wheels
   2. Parallel surfaces

IX. PEDESTAL OR BENCH GRINDER (offhand grinding)

A. Tool bit grinding
B. Drill grinding
C. Machine parts

X. HEAT TREATMENT (for schools not teaching metallurgy)

A. Annealing
B. Hardening
C. Tempering
D. Surface hardening
E. Testing

MACHINE SHOP II

I. INTEGRATED GENERAL TOPICS

These topics generally apply to all areas. Specific instruction applying to each area should be given at the appropriate time.

A. Time problems
B. Planning
   1. Job
   2. Production
C. Local employment practices

II. BENCH

A. Casting layout
B. Precision layout
C. Threading
   1. Unified screw thread system
   2. Thread classes, internal and external
   3. Tap drill size, calculations
D. Inspection
   1. Measuring instruments
      a. Vernier calipers

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b. Vernier height gage
c. Vernier protractors
d. Vernier gear tooth caliper
e. Dial indicator
f. Gage blocks
g. Sine bar
*h. Comparators
*i. Electrical gages
*j. Optical gages

2. Screw threads
a. Thread micrometer
b. 3-wire method

3. Techniques
a. Precision parts
b. Castings

E. Assembling and fitting
1. Tolerance and allowance
2. Standard fits
3. Surface finish standards
4. Lapping and honing

F. Part identification
1. Stamping
2. Electric pencil
3. Vibrator

III. LATHE

A. Chuck work
1. Truing and indicating
2. Boring
3. Internal threading
4. Cutting off
5. Deep hole drilling

B. Work between centers
1. Threading
2. Mandrel
3. Spherical

C. Faceplate work
1. Clamping and balancing
2. Use of toolmakers buttons
Note: see appropriate operations under A and B

*D. Production lathes
1. Turret lathe
2. Screw machines
3. Tracer lathes

IV. DRILL PRESS (heavy duty)

A. Methods of holding work
1. Clamps
2. Jigs
3. Fixtures

B. Operations
1. Drilling, large diameter
2. Reaming, large diameter
3. Tapping
4. Spot facing

*C. Radial drill press
1. Locating centers

*D. Turret drill press
1. Setting up turret stations

V. MILLING MACHINES (including universal)

A. Methods of holding work
1. Clamps
2. Angle plate
3. Rotary table

B. Operations
1. Face milling
2. Indexing
3. Spur gear cutting
4. Spiral milling
5. Circular milling
6. Boring
7. Keyway cutting
8. T-slotting
9. Gang milling

C. Nomenclature and selection of standard and special milling cutters

*D. Special milling machines
1. Tracer
2. Pantograph contour
3. Planer-type

VI. SHAPER

A. Method of holding work
1. Clamping

B. Shaping operations
1. Angular surfaces
2. Slotting
3. Contour

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VII. SURFACE GRINDER

A. Method of holding work
   1. Angle plate
   2. Fixtures
B. Operations
   1. Installing wheels
   2. Squaring
   3. Grinding angular surfaces
C. Selecting wheels

VIII. CYLINDRICAL GRINDER (external and internal)

A. Methods of holding work
   1. Between centers
   2. Chuck
B. Grinding operations
   1. Cylindrical
      a. External
      b. Internal
   2. Taper and angular
      a. External
      b. Internal
   3. Shouldering
   4. Filleting

IX. GRINDER

A. Methods of holding work
   1. Between centers
   2. Special attachments
B. Grinding Operations
   1. Peripheral
   2. Side
   3. Angular
   4. Form
   5. End mill
C. Wheel selection - shapes

*X. PROCESSES (for schools not teaching metallurgy)

A. Stamping
B. Casting
   1. Sand
   2. Precision
C. Forging
D. Chem-milling
E. Electrical discharge machining
F. Weldment

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G. Extrusion

H. Explosive forming

I. Rolling

J. Electrolytic grinding

K. Other modern methods as developed

*XI. NUMERICAL CONTROL MACHINES

A. Programming

1. Numeric drawing
2. Sequence of operation
3. Process planning charts (program sheet)

B. Tape processing

1. E.I.A. standard tape
2. Operation of tape punching machines
3. Reading and checking of tapes

C. Operation of control cabinet

1. Installing tape
2. Setting controls

D. Operation of N/C machine

1. Setting up job
2. Selecting cutting tools
3. Setting controls

Optional topics

Jig borer

Boring mill

Spring winding

Change gear calculations

Steady rest

Follower rest

Broaching

Templates

Differential indexing

Compound indexing

Bevel gears

Centerless grinding

Welding

Brazing

Flame cutting

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METALLURGY

Metallurgy is considered a prepared subject and, when given five periods a week for 1 year, has the value of one unit.

OBJECTIVES

- To acquaint the student with an understanding of the fundamentals of metallurgy to enable him to select the optimum material, heat treatment, and process of fabrication, in the desigining of machine elements
- To give the student a knowledge of metallurgical properties and their relationship to physical properties
- To provide experience in the various accepted techniques of specimen preparation and metallurgical processes in accordance with the standards of industry

*The standard reference text for this course will be the "Machinery's Handbook."

I. INTRODUCTION TO METALLURGICAL TECHNIQUES

A. Temperature measurement
   1. Instrumentation
      a. Liquid and gas thermometers
      b. Thermocouples
      c. Radiation and optical pyrometers
   2. Limitations and instrument selection
      a. Temperature range
      b. Sensitivity
      c. Remote control

B. Microscopy
   1. Specimen preparation
   2. Etchants
   3. Optical instruments

C. Nondestructive testing
   1. Radiography
   2. Magnetic particle inspection
   3. Fluroescent-penetrant inspection
   4. Ultrasonic inspection

II. METAL STRUCTURE AND CRYSTALLIZATION

A. Atomic structure

B. Periodic table

C. Atomic bonding
   1. Ionic
   2. Covalent
   3. Metallic

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D. Metal structure
   1. Atomic diameter
   2. Crystal structure
   3. Crystallographic planes
E. Application of Miller indices to atomic planes
F. Mechanism of crystallization
G. A study of crystal imperfections
   1. Vacancies
   2. Interstitials
   3. Dislocations
H. A study of casting processes
   1. Mold design
      a. Flasks
      b. Risers
      c. Gates and runners
   2. Solidification and heat dissipation
I. Macro defects in castings

III. PLASTIC DEFORMATION

A. Deformation by slip
B. Mathematical derivation of planes of highest shear
C. Mechanism of slip
   1. Use of Miller indices to identify slip planes
   2. To show slip mechanism on basis of crystal imperfections
D. Comparison of slip in different space lattice
E. Deformation by twinning
F. Comparison of slip, twinning, cleavage
G. Cold working effects

IV. ANNEALING AND HOT WORKING

A. Annealing process
   1. Recovery (stress relief)
   2. Recrystallation
   3. Grain growth
B. Grain size
C. Effect of annealing on properties
D. Hot working
   1. Effect of working temperature on properties and grain size
   2. Comparison with cold working

V. METALLOGRAPHIC LABORATORY PRACTICE

A. Procedure for specimen preparation
B. Etchants
   1. Types and purpose
   2. Selection

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C. Microscopes and photomicrography
   1. Variables affecting magnification and clarity of image
   2. Types of illumination and the function of each
D. Macroscopic examination of metals
   1. Principles and procedure of macroetching
   2. Interpretation of conditions in steel as revealed by fractures and macroetching

VI. SHAPING AND FORMING METALS

Note: This topic may be covered in either Machine Shop or Metallurgy, whichever seems more advantageous

A. Casting - general
B. Cast ingot steel - major defects
   1. Pipes
   2. Dendritic structure
   3. Blowholes
   4. Segregation
   5. Slag inclusions
   6. Checking, cracks, internal stresses
C. Hot working
   1. Hot rolling
   2. Forging
   3. Extrusion
   4. Benefits from hot working
      a. Grain refinement
      b. Better distribution of constituents
      c. Development of fiber
      d. Improvement of soundness or uniformity
D. Cold working
   1. Cold rolling
   2. Pressing
   3. Drawing
E. Welding
   1. Fusion welding (no pressure required - metal fused)
      a. Gas
      b. Arc welding
      c. Thermit welding (molding or casting temperatures)
   2. Pressure welding (pressure required - with or without fusion)
      a. Forge welding
      b. Resistance welding
      c. Thermit welding (temperature barely at fusion temperature)
F. Metal cutting
   1. Single point cutting tool
      a. Lathe
      b. Shaper

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2. Multiple point cutting tool
   a. Milling
   b. Broach
   c. Grinding
3. Special machining processes
   a. Ultrasonic machining
   b. Electrical - discharge machining
   c. Electro-arc machining
   d. Electrolytic machining
   e. Chem-milling

G. Powder metallurgy
1. Processes
2. Characteristics of metal powders
3. Preparation of metal powders
4. Powder mixing
5. Compacting
6. Sintering
7. Hot pressing
8. Supplemental operations
9. Applications

VII. CONSTITUTION OF ALLOYS

A. Cooling curves for metals and alloys
B. Intermediate alloy phases or compounds
C. Solid solutions
D. Substitutional solid solutions
E. Interstitial solid solutions

VIII. EQUILIBRIUM DIAGRAMS

A. Rule I - chemical composition of phase
B. Rule II - relative amounts of each phase
C. Type I alloy
   1. Equilibrium cooling of a solid solution alloy
   2. Nonuniform cooling - origin of coring
   3. Homogenization
   4. Variation of Type I
D. Type II alloy
   1. Insolubility in solid phase
   2. Eutectic point
E. Type III alloy
   1. Partial solubility in solid phase
   2. Terminal solid solutions
F. Age hardening - effect on properties
G. Properties in eutectoid systems
H. Allotropy

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IX. THE IRON-IRON CARBIDE EQUILIBRIUM DIAGRAM

A. Definition and description of equilibrium structures
B. Carbon solubility in iron
C. A study of slow cooling of steel
D. The critical - temperature lines
E. Classification of steels - AISI

X. THE HEAT TREATMENT OF STEEL

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Revised Edition.

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ABSTRACT - Designed to assist teachers and students of vocational agriculture to best use the time allotted for general shop, this teaching guide was prepared by the Agricultural Education Service of the Alabama State Department of Education. Units are: (1) Shop Management and Safety, (2) Hand Tool Identification, (3) Use and Care of Hand Tools, (4) Power Tool Study, (5) Sketching and Drawing, (6) Identification: Wood Joint and Hardware, (7) Carpentry and Woodworking, (8) Painting, Varnishing, and Glazing, and (9) Introduction to Electrification, Sheet Metal and Soldering, Arc Welding, Plumbing, Concrete Work, and Mechanics. Each illustrated unit of instruction includes an introduction, the main points students should learn, a list of exercises for students to perform, a step by step procedure for each exercise, and a series of review questions. (LM)

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GENERAL SHOP GUIDE FOR VO-AG STUDENTS

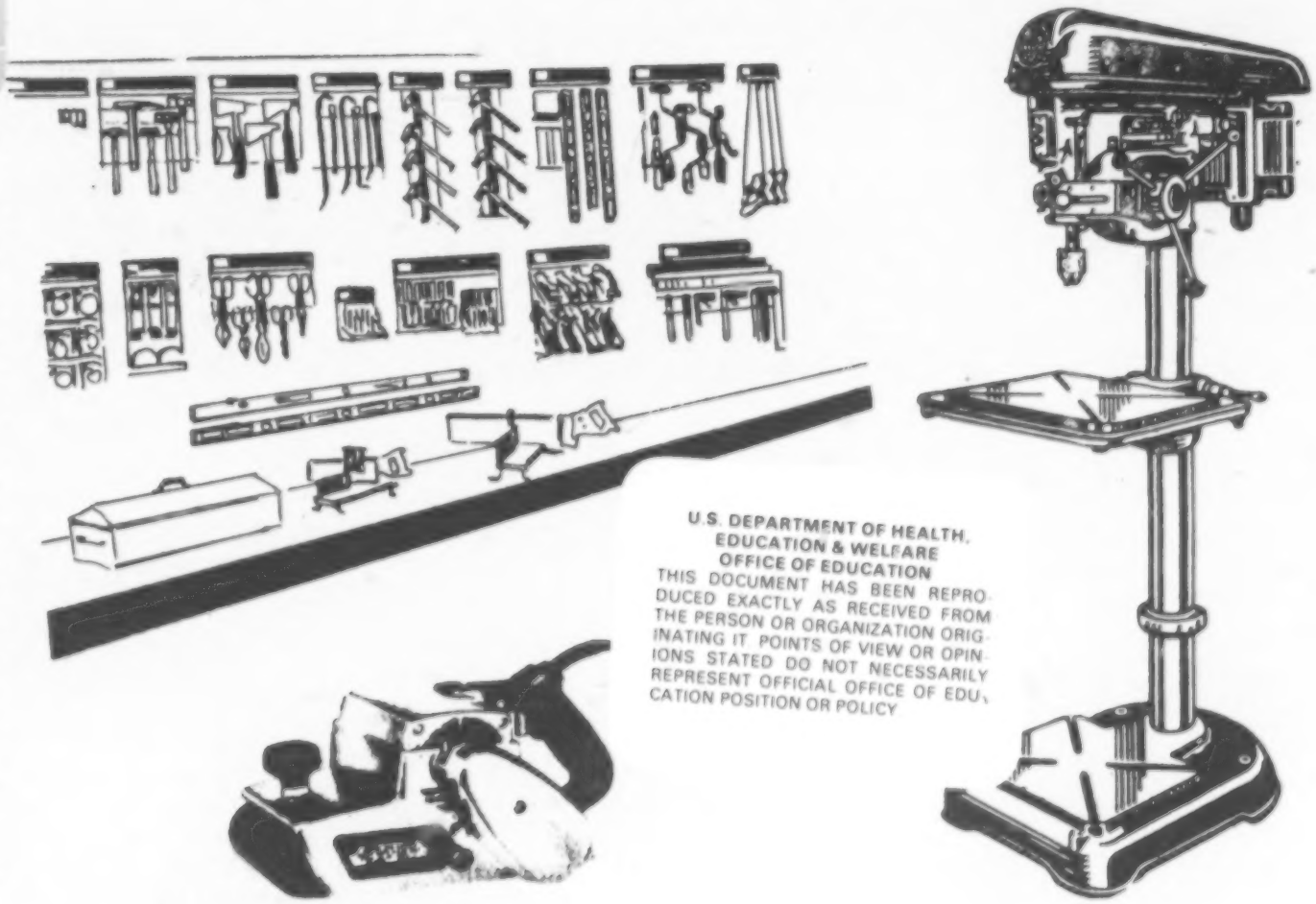

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STATE OF ALABAMA
STATE DEPARTMENT OF EDUCATION
Vocational Division
Agricultural Education Service
Montgomery, Alabama

Revised Edition

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STATEMENT OF PURPOSE AND USE OF THIS GUIDE

This guide was developed in order to assist the teacher and student of vocational agriculture to make the best use of the time allotted for instruction in general shop. By doing the work as outlined in this guide, the student will be faced with a large variety of skill situations. After the skills are developed, the student should make fewer mistakes in working out a shop project of his own creation. The fact that he has learned how to use tools properly adds to his interest and desire in constructing a project of his own choosing.

The jobs outlined in this guide should be considered as minimum requirements for the general course. In addition to the exercises given for each unit the student should plan, design, and construct a useful project of his own. For instance, upon completing the jobs outlined under the soldering unit, the boy could make a funnel from galvanized steel. The size and shape of the funnel should be left up to the student.

The materials needed in working out the exercises in this guide can be obtained at a small cost, and should fit the budget of the average department.

We realize that much of the equipment demonstrated in this guide will not be available in some departments. We hope the needed equipment can be obtained in the near future.

It is recommended that each student have his own "General Shop Guide," as it will greatly add to his proficiency in doing a good job in the shop. This complete set of directions will at all times be useful to the student.

The guide may also serve as a reference in future years, regardless of what vocation a student chooses to pursue.

ACKNOWLEDGEMENTS

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The State Supervisory and Teacher Training Staff of Agricultural Education; Moore Handley Hardware Company; Rockwell Company; Stanley Tool Company; Teachers of vocational agriculture in Alabama; and Auburn Extension Service. Mr. D. N. Bottoms, Associate Professor, made major contributions.

T. L. Faulkner, State Supervisor
Vocational Agricultural Education
State Department of Education
Montgomery, Alabama

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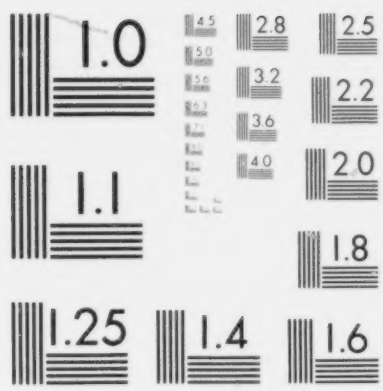

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

GENERAL SHOP GUIDE FOR VO-AG STUDENTS

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SHOP MANAGEMENT AND SAFETY

Agricultural Mechanics helps train students to become effective members of society. They should have a voice in organizing and maintaining the shop facilities. Good housekeeping is vital to effective maintenance and is extremely important to safety.

General safety rules to follow in shop management and the use of safety devices are discussed in this unit. Safety may form the basis for a large segment of the group instruction.

Management Practices Discussed on the Following Pages

1. Arrangement of tools and equipment
2. Housekeeping in the agricultural shop
3. Student behavior in the shop
4. Safety precautions
5. Safety devices

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Arrangement of Tools and Equipment

Some general principles of farm-mechanics shop arrangement are as follows:

1. Disposition of equipment is according to instructional use. A common practice is to organize the shop by areas. The areas included in general shop are woodworking and farm carpentry, metals, welding, farm electricity, concrete, tool fitting, plumbing, and power mechanics.

2. Tools are hung on panels or in tool cabinets, placed according to areas of use.

3. The slogan "a place for every tool and every tool in its place" applies to the agricultural shop.

Student Behavior in the Shop

Democratic action, freedom of movement, and consideration of the rights and property of others must prevail in all shop activities. Agricultural mechanics students should conduct themselves in a workmanlike manner. Practical jokes can be dangerous, especially in shop situations. Pushing, scuffing, throwing objects, and other such acts have no place in the shop. Self-discipline should be the ultimate goal of each individual.

HOUSEKEEPING IN THE AGRICULTURAL SHOP

Every student of vocational agriculture will probably agree that good housekeeping in the farm mechanics shop has a definite place and purpose. A few of the purposes in good housekeeping are as follows:

1. A clean orderly shop tends to develop a good working attitude and morale on the part of the students.

2. More work and learning can be accomplished in a clean, well-kept shop.

3. A clean well kept shop is good public relations. Parents, administrators, school patrons, and other visitors are favorably impressed by the neatness and order of a clean shop.

4. If each shop class leaves the shop clean, friction between classes that use the shop can be prevented.

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Suggested Plans for Keeping Shop Clean

In the area or unit system of farm mechanics shop, the boys working in each area should clean up the area in which they are working each day. Each student will assume the responsibilities and duties of cleaning up his area. The following suggested plans will assist the student in determining his responsibility toward keeping the shop clean.

1. Table-like Schedule

   The table-like schedule is illustrated here showing an example of the alternate method of housekeeping. The chart may be set up in the following manner: First, determine the number of students in the class. Second, divide the jobs to be done into a number equal to the number of students. Third, decide on the amount of time to alternate jobs. The time may be by days or weeks, but the number of days or weeks must equal the number of students in the class. Fourth, with these suggested items as shown:

Student		Number of Weeks										Job
No.		1	2	3	4	5	6	7	8	9	10	
1.	John B.	1	2	3	4	5	6	7	8	9	10	Sweep main floor
2.	Joe Z.	2	3	4	5	6	7	8	9	10	1	Do job for absentee
3.	Ben L.	3	4	5	6	7	8	9	10	1	2	Soldering area
4.	Troy K.	4	5	6	7	8	9	10	1	2	3	Main tool room
5.	Frank C.	5	6	7	8	9	10	1	2	3	4	Woodworking tools
6.	Roy R.	6	7	8	9	10	1	2	3	4	5	Foreman
7.	Otis L.	7	8	9	10	1	2	3	4	5	6	Sweep main floor
8.	Jack J.	8	9	10	1	2	3	4	5	6	7	Clean table, suppy rm.
9.	Bill S.	9	10	1	2	3	4	5	6	7	8	Arc welding booth
10.	Tom T.	10	1	2	3	4	5	6	7	8	9	Bath room

2. Disc or wheel plan

   a. Draw duty indicator 14 x 14 inches
   b. Draw one circle in center 12" in diameter
   c. On another piece of cardboard draw a circle 8" and cut out. Lay out divisions necessary to take care of boys (name dial).
   d. Attach the larger piece of cardboard permanently to a piece of light lumber and place the name dial on this larger piece of cardboard so that it will be movable. Make name dial temporary.
   e. Name duties (form duty chart).
   f. Prepare for each class.
   g. It is better to have all lines and names done in India ink.

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Disc or Wheel Plan

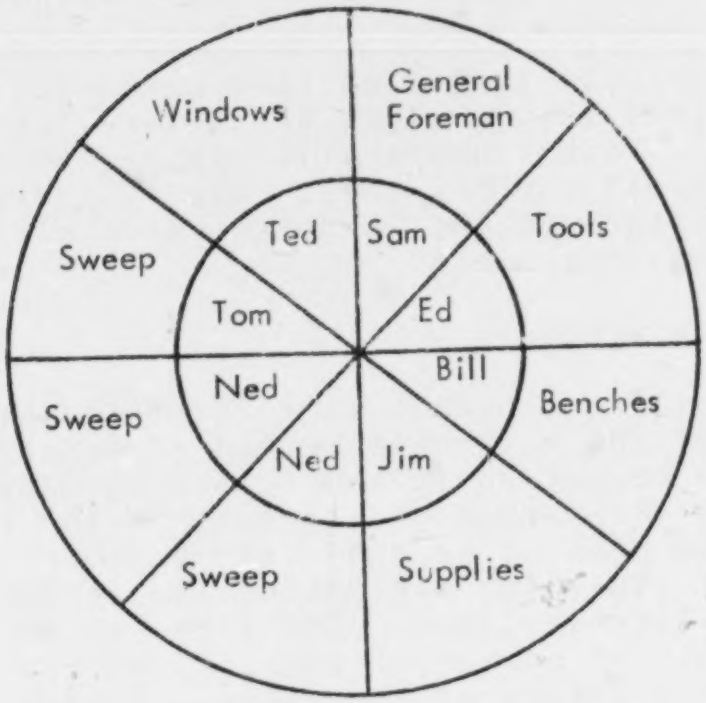

3. Chart Plan Monthly, Weekly, or Daily--Suggested Duties

a. Foreman - It shall be the duty of the foreman to see that the shop is in good order when students leave and oversee the other jobs, reporting any discrepancies to the teacher. He will be responsible for unlocking the tool lockers, and main tool room.

b. Tool Checkers - There shall be a tool checker for the tool cabinets and storage rooms. It shall be the duty of each to check to see if tools are properly returned and put away. He shall keep the tools clean and in good condition. He shall lock the cabinets and storage rooms when through. In checking the welding equipment, the dark lens will be checked to be sure they are not cracked or broken.

c. Floor Sweepers - It shall be their duty to sweep the entire floor and pick up shavings and waste from the entire shop area. Be sure to sweep corners and under benches.

d. Bench Brushers - It shall be their duty to sweep off tables, closing vises and drawers and removing any paint, spots or dirt. It shall also be their duty to pick up usable material and discard residue.

e. Paint keeper - It shall be his duty to be sure all paint is put away with lids on tight, paint tables clean and all brushes cleaned and put away.

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f. Supply Man - It shall be his duty to put away all school lumber and keep racks in order. He will have charge of the small hardware and supply on hand.

g. Power Equipment Man - It shall be the duty to be sure all power saws and machinery are cleaned, oiled and left in readiness to be used the next period.

h. Floorman - It shall be his duty to pick up odd parts and centralize them so as to leave the floor cleared and in neat order. Put away oil pans, cleaning rags and other pails, blocks, chains, sawhorses, and jacks.

i. Arc and Acetylene Welding Man - It shall be his duty to shut off all welders, valves, bleed lines, put away the hose and torches, making sure that tips are in place and that tables are cleaned off and in order.

j. Refilers - It shall be the duty of the refiler to be familiar with files and put all blue prints, drawings, books, etc. in proper place.

k. Door and Window Man - It shall be his duty to close all windows, lock them, adjust curtains, turn off lights, close ventilators, and close the doors after everyone has left the shop. Be responsible for getting the key and opening the shop at the beginning of the period, opening necessary windows and ventilators, and watching the ventilations.

l. Lavatory and Locker Room Man - Keep bowls clean, replace clean paper towels and soap, remove waste paper. Be sure all lockers are closed and clothing left in lockers.

m. Reserves - Should be names in the event of absences. Mimeograph copies of duty and give to each member of the class. Also post on the bulletin board. Put the best and most respected leader as foreman the first month.

Shop Safety

The vocational agriculture shop can be very dangerous. It is vitally important that every student observe all safety precautions prescribed by the teacher. Most accidents that happen can be prevented by development and use of safety habits. The student must assume the responsibility of learning and observing all safety practices. A dangerous or safe vocational agriculture shop is determined to a great extent on how well the students observe the safety rules and use the protective devices prescribed by the teacher.

Safety Rules to follow in shop management:

1. Keep materials away from places where people walk.

2. Pile all material in a neat pile, with no sharp objects sticking out. A sharp stick, wire, or rod in the wrong place can poke out an eye.

3. Keep floors clean of oil, water, or other fluids which can cause slipping.

4. Keep all oil rags and oily debris in a metal container. Spontaneous combustion can result from piling oily material in the corner of shop.

5. After use, put all tools back in proper place in shop. Wipe tools of oil and grease.

6. All fuels and combustibles such as paint, turpentine, solvent, and gasoline should be stored in approved metal containers.

7. Students must be instructed in the use of machines before being permitted to operate them.

8. Power equipment not operating properly should not be used until repairs and/or adjustments are made.

9. Be sure all safety appliances on machine are properly attached before starting the machine.

10. Adequate first-aid equipment should be provided.

NOTE: Additional safety precautions are listed with other units.

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Identify and give uses of each item. (Write on next page.)

1

2

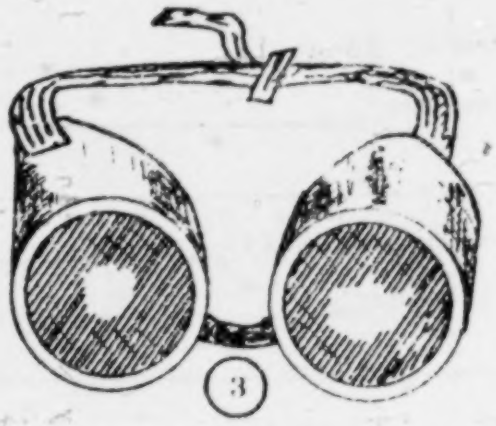

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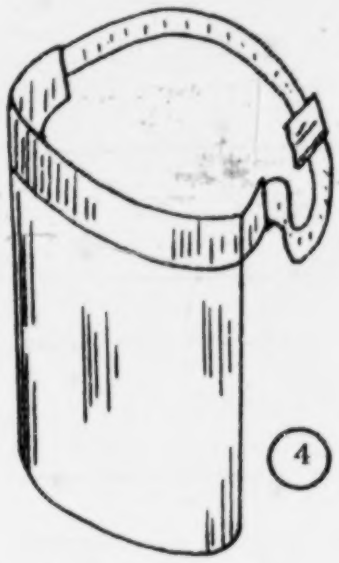

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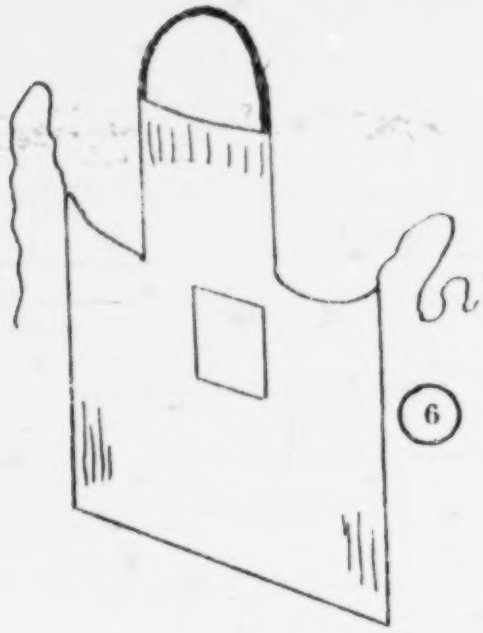

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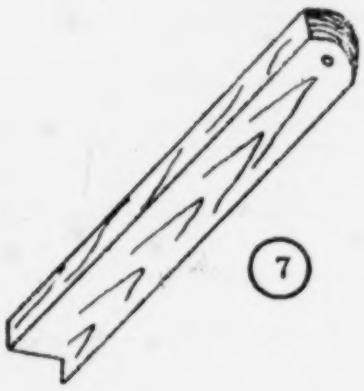

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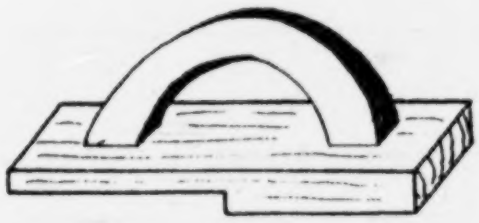

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9

10

11

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Identify and give principal uses of each of the safety items on preceding page.

Item 1. Identify: _____

Give use: _____

_____

Item 2. Identify: _____

Give use: _____

_____

Item 3. Identify: _____

Use: _____

6 _____

Item 4. Identify: _____

Use: _____

_____

Item 5. Identify: _____

Use: _____

_____

Item 6. Identify: _____

Use: _____

_____

Item 7. Identify: _____

Use: _____

_____

Item 8. Identify: _____

Use: _____

_____

Item 9. Identify: _____

Use: _____

Item 10. Identify: _____

Use: _____

Item 11. Identify: _____

Use: _____

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1. Why is "Horseplay" prohibited in the shop?

2. Why is it objectionable from a safety standpoint to talk loudly or to shout when working in the shop?

3. Specifically, what may occur to the operator of a machine if the floor near that machine is littered with pieces of scrap wood?

4. Why is it dangerous to have tools, pieces of lumber, or other items on a machine while it is running?

5. Why is it objectionable to have observers crowd about you when you are operating a machine?

6. Where is the medicine cabinet located in your shop?

7. Why must slight injuries be reported to the instructor for treatment?

8. A student whose injury was severe enough to warrant the attention of a doctor walked over to the doctor's office alone. Explain what is wrong with this procedure.

9. Why is it wise to examine any board carefully before feeding it into a machine?

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10. While operating a machine, a student was observed talking to another student. Evaluate this practice.

11. Why is it wrong to walk away from a machine while it is running?

12. You observe a student engaged in an unsafe practice which the instructor does not immediately notice. What is the proper action for you in this case?

13. Why should you report to the instructor when a machine or tool needs repair?

14. Where are the fire extinguishers located in your shop?

15. Do you <u>honestly</u> understand the safety regulations as discussed?

Yes_____ No_____

Signed_____

Date_____

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NAME OF STUDENT _____

RECORD OF STUDENT'S SHOP WORK

UNIT	Safety practiced by the student	The use of safety devices by the student	Teacher-assigned activities	Study questions	Shop projects	Housekeeping	Grade on test	(Others)										Unit shop grade	Final shop test	Final Shop grade
Shop Safety																				
Hand Tool Identification																				
Identification and Use of Power Tools																				
Sketching and Drawing																				
Joint & Hardware Identification																				
Woodworking																				
Painting and Glazing																				
Farm Electrification																				
Sheet Metal and Soldering																				
Arc Welding																				
Plumbing																				

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HAND TOOL IDENTIFICATION

It is very important that every student familiarize himself with the name and use of hand tools. It is also important to learn the location and area that these tools are stored in the school shop. If each tool is returned to its proper place after use, students in the succeeding classes will also know where the tools may be found. Each hand tool is designed to do specific jobs. It is the responsibility of the student to be able to identify the proper tool to use in performing the different jobs.

Hand Tool Identification

1. Marking and measuring tools
2. Boring and drilling tools
3. Smoothing and cutting tools
4. Clamping devices
5. Hammers and wood malls
6. Saws
7. Metal tools
8. Screw Drivers and files
9. Painting and glazing
10. Levels

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Hand Tool Identification (Select correct names from list at bottom of page)

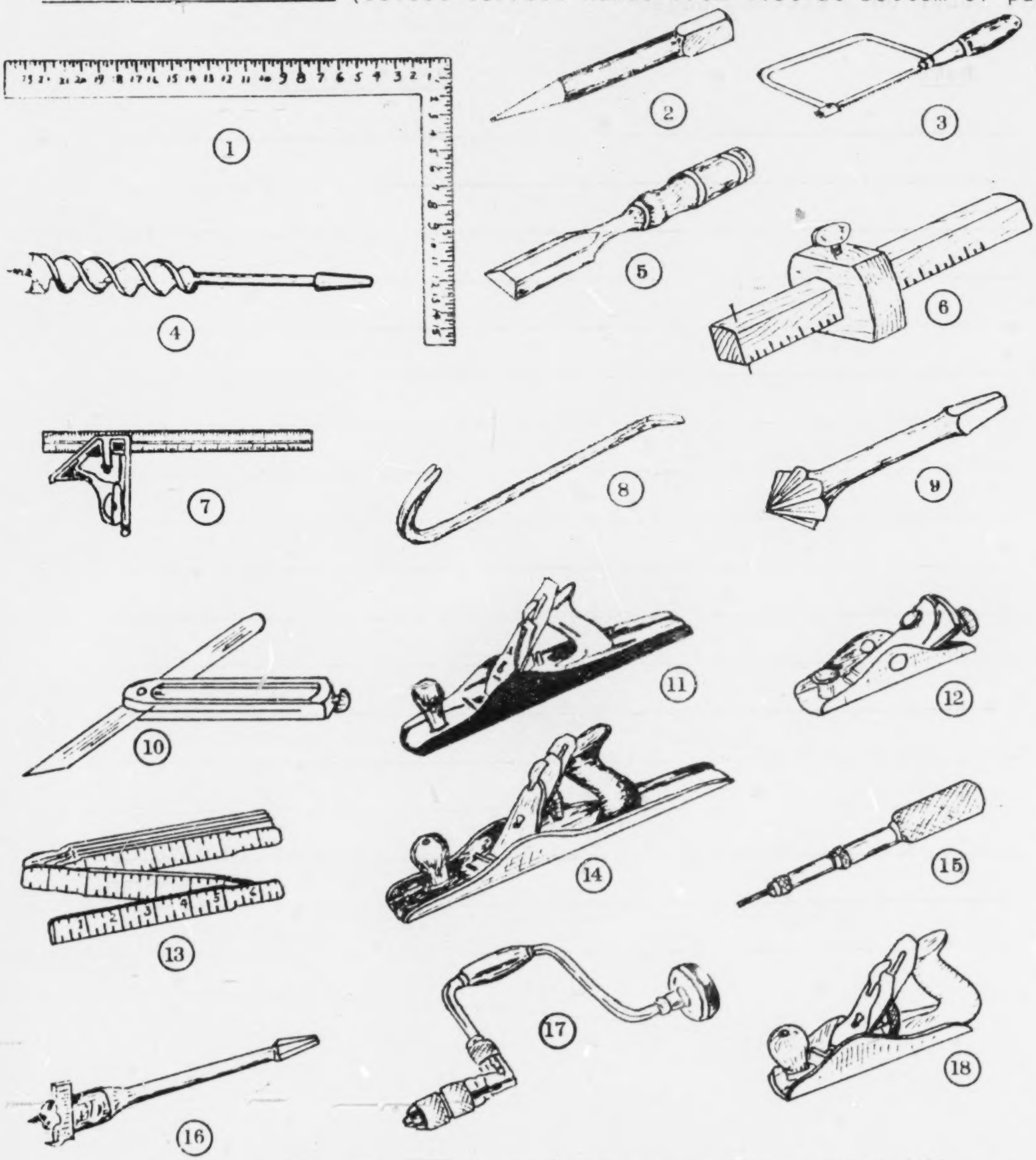

Jack plane, T-bevel, coping saw, framing square, auger bit, expansive bit, jointer plane, wrecking bar, wood chisel, nail set, block plane, auger counter sink, marking gauge, auger brace, hand drill, combination square, smoothing plane, folding rule

Identify and give principal uses of each of the hand woodworking tools shown on preceding page.

	Name	Principal Uses
1.		
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6536

Hand Tool Identification (Select correct name from list at bottom of page)

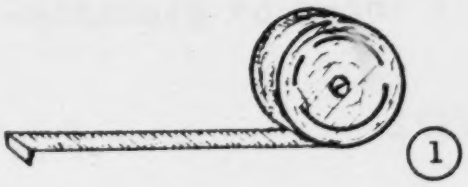
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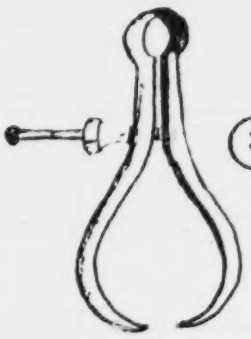
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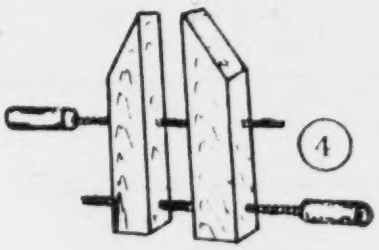
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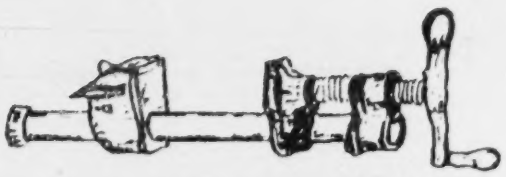
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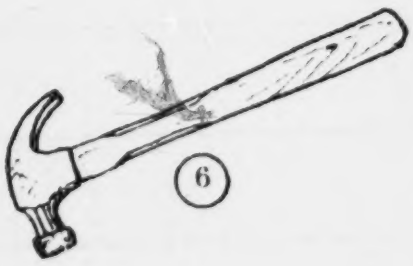
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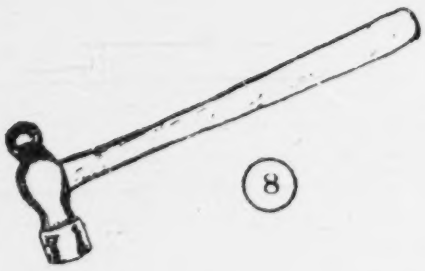
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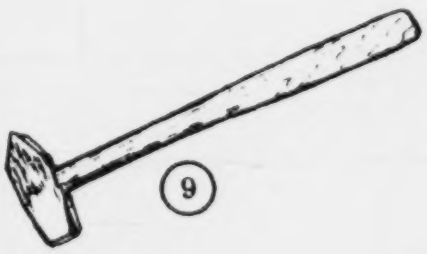
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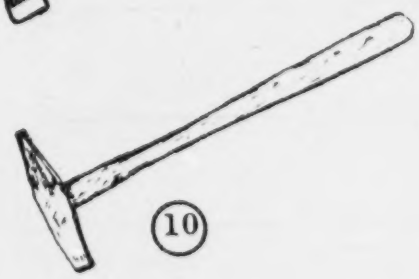
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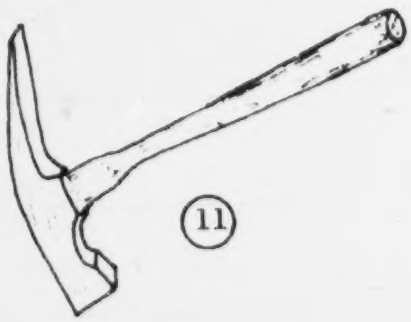
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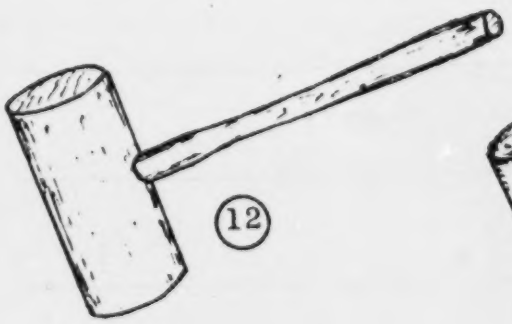
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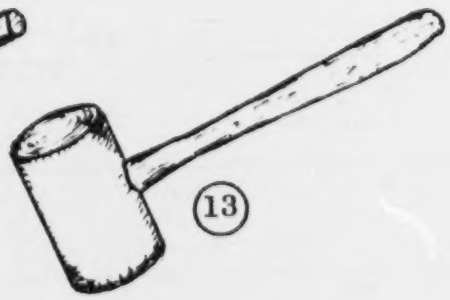
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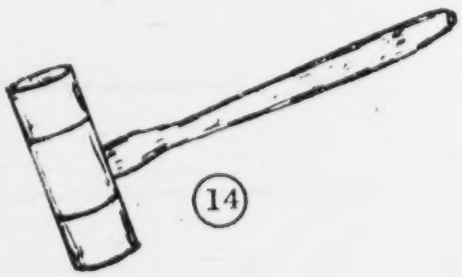
14

Claw hammer, level-plumb, hand screw, ball pein hammer, Tinner's hammer, wooden mallet, plastic mallet, push-pull rule, caliper (outside), bar clamps, rip hammer, forge hammer, brick hammer, rubber mallet.

Name and give uses of each of the hand tools shown on preceding page.

	Name	Uses
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658829

Hand Tool Identification (Select correct names from list at bottom of page)

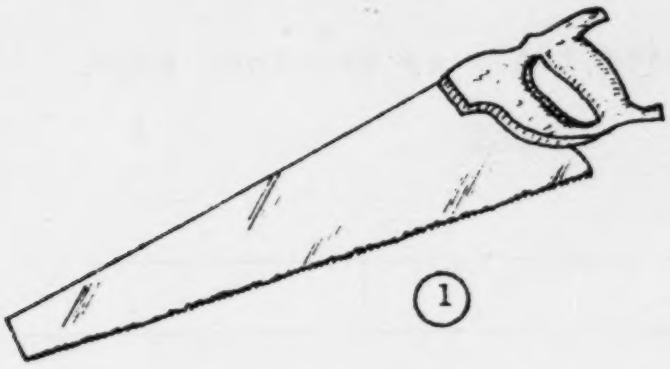

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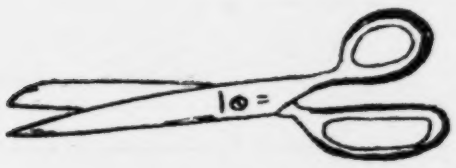

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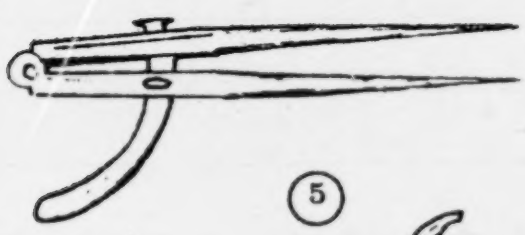

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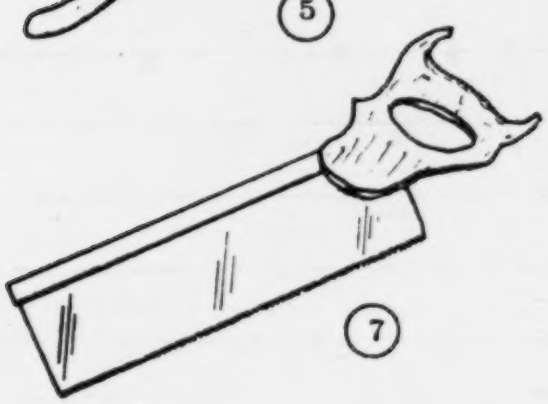

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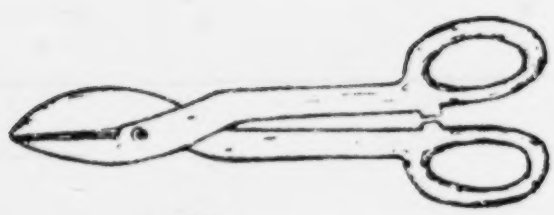

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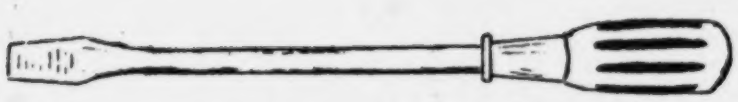

9

10

Putty knife, hand saw, electric soldering copper, shears or scissors, phillip's screw driver, tin snips, C-clamp, back saw, screw driver, dividers.

6539

Identify and give uses of each of the hand tools on previous page.

	Name	Use
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<u>Hand Tool Identification</u> (Select proper names from list at bottom of page)

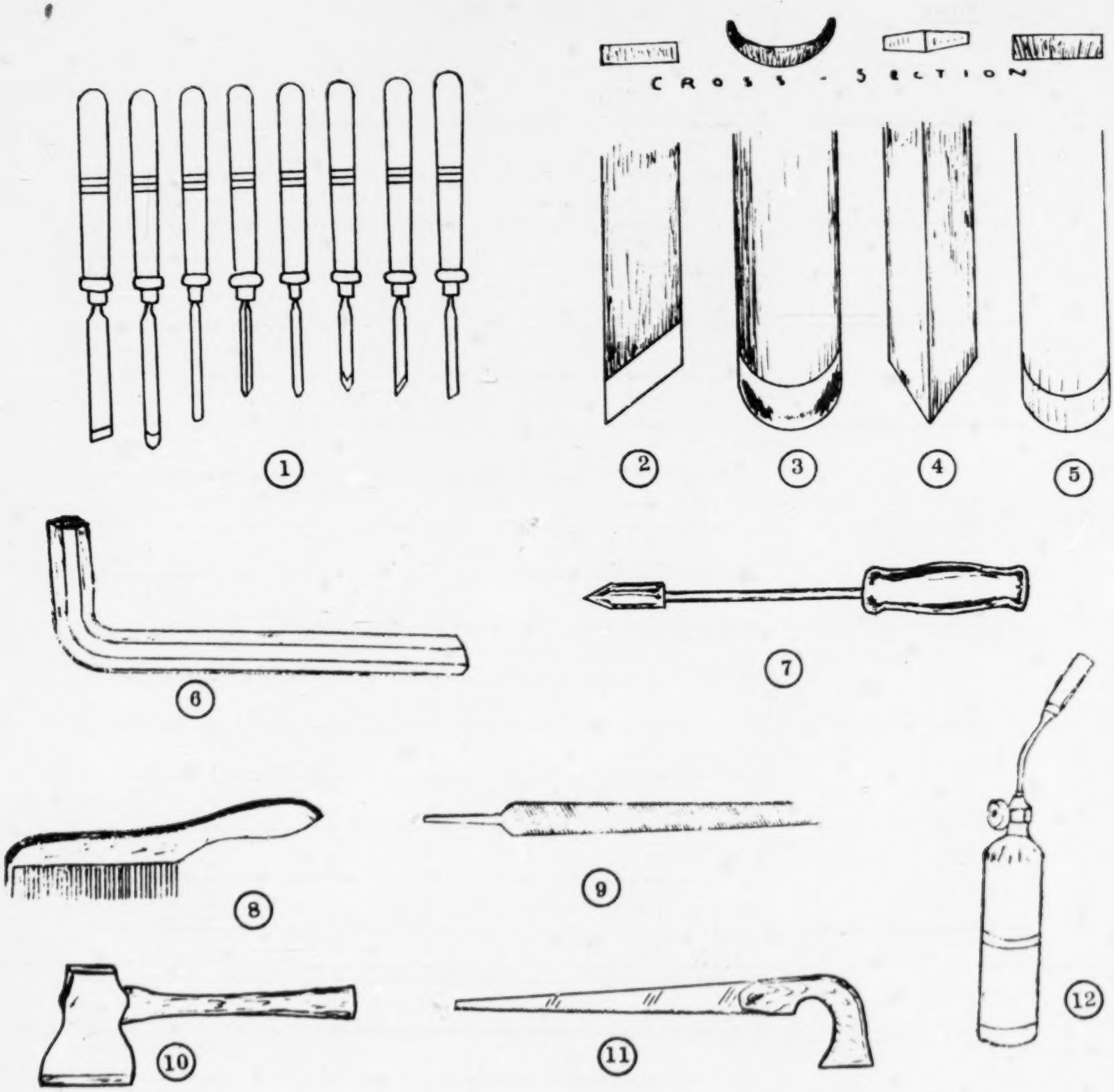

Soldering copper, lathe tools, propane torch, skew chisel, bull-nose chisel, wire brush, gouge chisel, mill file, parting chisel, allen wrench, hatchet, keyhole saw.

Hand Tool Identification (Select correct name from list at bottom of page)

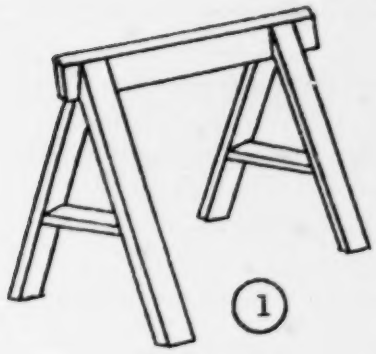

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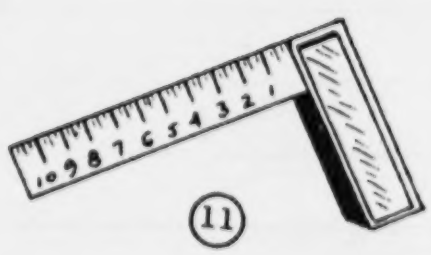

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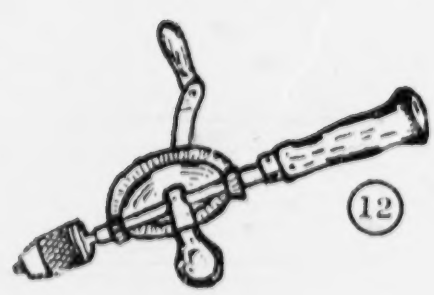

12

Round file, oil can, glass cutter, paint brush, try square, saw horse, bench brush, triangular file, hydraulic oil can, wood rasp, push drill, twist drill.

6543

Identify and give uses of each of the hand tools shown on preceding page.

Name	Use
1. _____	_____
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6544

Hand Tool Identification (Select correct names from list at bottom of page)

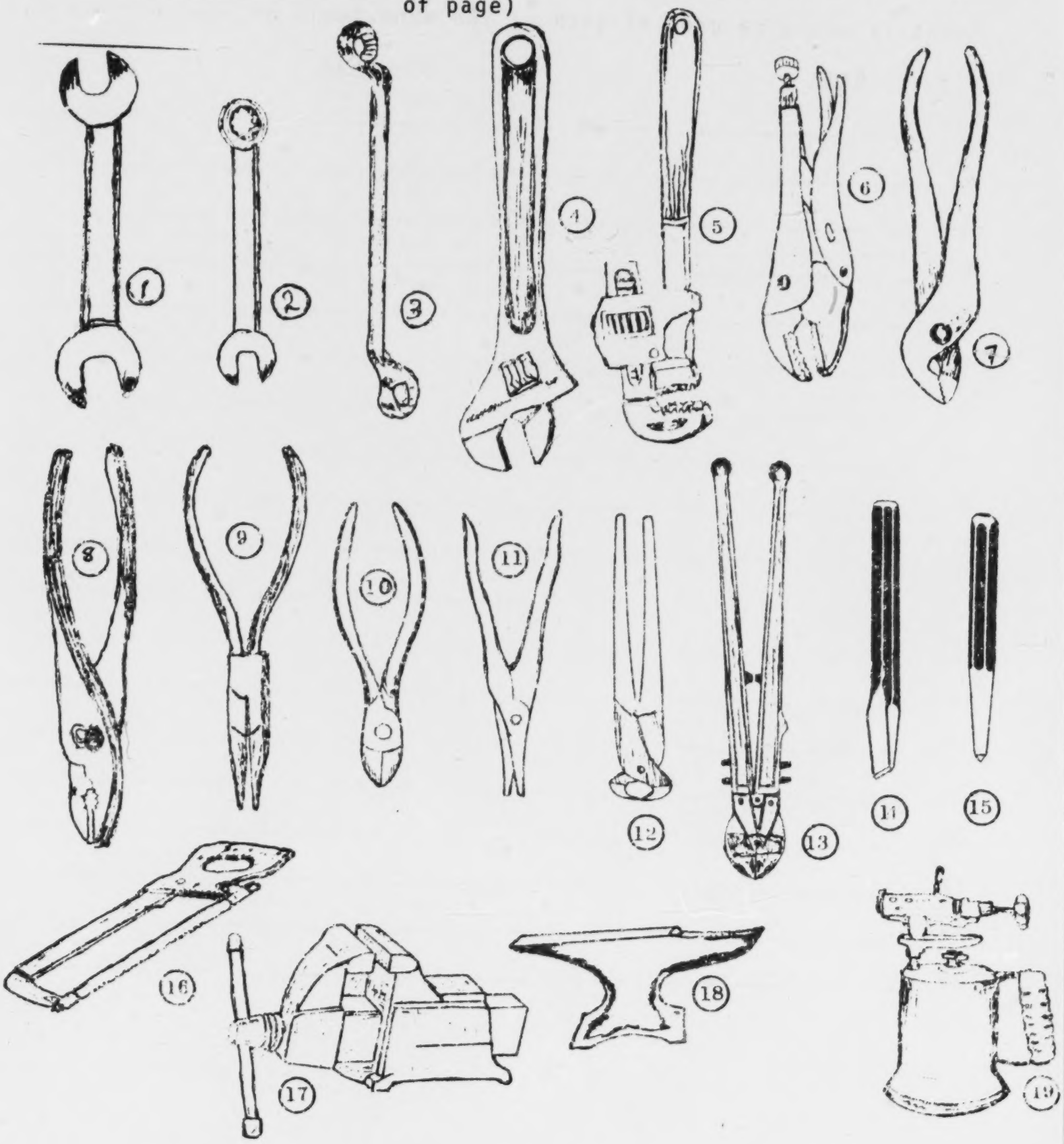

Combination pliers, diagonal cutting pliers, nippers, cold chisel, hack saw, anvil, open end wrench, box wrench, pipe wrench, slip joint pliers, long nose pliers, blow torch, aviation snips, combination box-open end wrench, metal vise, crescent wrench, vice grips, bolt cutters, steel punch.

6545

Identify and give uses of each of the hand tools on preceding page.

	Name	Use
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CPCS

PRINCIPLES, USES, AND CARE OF HAND TOOLS

If it is true, "that a student is known by the company he keeps," it is quite true that a craftsman is known by the tools he keeps, and how he keeps them. More than anything else, good tools will give the beginner the best possible start towards acquiring skills. The life of the tool and the degree of the skill developed oftentimes depends upon using the correct tool properly.

The student must realize that vocational agriculture shop equipment must last for a long time. In order for tools to last and stay in good working condition, each student must assume the responsibility of caring for the tools properly while in his possession.

It is recommended that the student have a thorough knowledge of the proper use and care of the tools found on the following pages. Sufficient time should be devoted to practice to enable the student to learn to use and care for the tool properly.

Use and Care of Hand Tools

A. Safety rules to follow

B. Hand tools

1. Wood chisels
2. Automatic drill (Text Reference)
3. Hand drill (Text Reference)
4. Brace & bits
5. Saws
6. Hammers
7. Squares
8. Screw drivers
9. Marking devices
10. Cross pein, straight pein, and ball pein hammers
11. Hand planes
12. Twist drills
13. Cold chisels
14. Steel punches
15. Knives
16. Axes and hatchets

6547

SAFETY RULES TO FOLLOW WHEN USING HAND TOOLS

1. When using sharp tools, such as knives, chisels, axes, be sure the direction of movement is away from body, hands, and feet. For instance, if a wood chisel slips when pointing toward your hands, it can cause a deep, dangerous gash.

2. When driving in a nail, be sure the nail is well started before hitting hard blows. Otherwise, the nail can fly loose and could hit somebody in the eye causing permanent blindness. Hold all nails near the head of the nail.

3. Always wear goggles when grinding, using a cold chisel, or welding.

4. Before using cold chisels and punches, see that mushroomed heads are properly ground off.

5. See that head of hammers, axes, sledges are securely fastened to handle.

6. Use only sharp tools. Dull tools can be dangerous because of slippage on work.

7. Be extremely careful when tightening objects with a wrench. See that wrench fits tightly on nut, with no slack. Turn adjustable wrenches in proper direction. See that pressure applied by hands is not in direction of sharp cutting objects when using wrench. In case the hand or wrench slips, hand can get badly cut. Knuckles can get badly skinned when wrench slips off nut when working around machinery.

8. Place saws so that no one can brush against the teeth. Keep the edge either covered or turned in such a manner that cuts are eliminated.

9. Plane irons are sharp and should never be left where they could cause a cut.

10. Do not apply too much pressure in the boring operations. This is especially true for a bit or auger about to run through a piece of stock.

11. Use a handle on the rasp and file at all times.

12. Balance yourself well on your feet while using cutting tools.

6548

HOW TO USE

THE STANLEY BIT BRACE

STANLEY

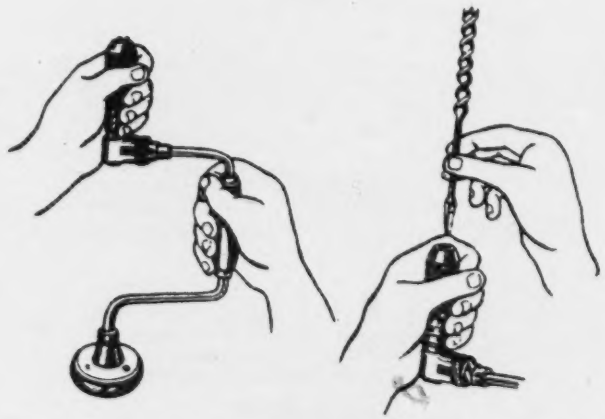

TO PLACE THE BIT IN THE CHUCK, GRASP THE CHUCK SHELL AND TURN THE HANDLE TO THE LEFT UNTIL THE JAWS ARE WIDE OPEN. INSERT THE BIT SHANK IN THE SQUARE SOCKET AT THE BOTTOM OF THE CHUCK AND TURN THE HANDLE TO THE RIGHT UNTIL THE BIT IS HELD FIRMLY IN THE JAWS.

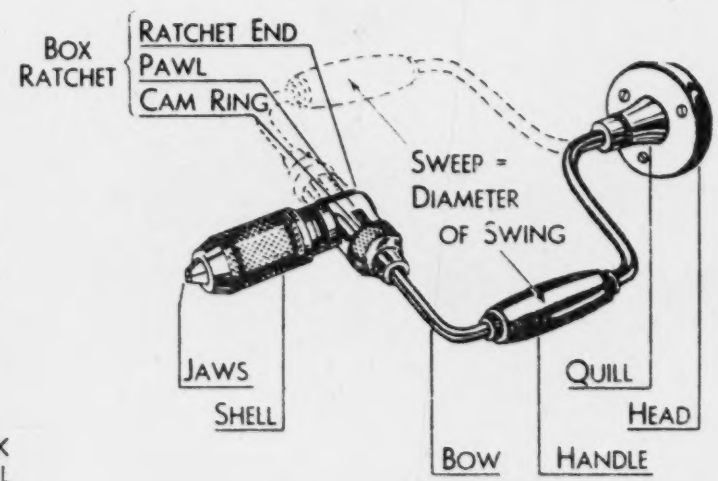

THE ILLUSTRATION IS OF STANLEY RATCHET BIT BRACE No 923-10 IN. SWEEP

STANLEY

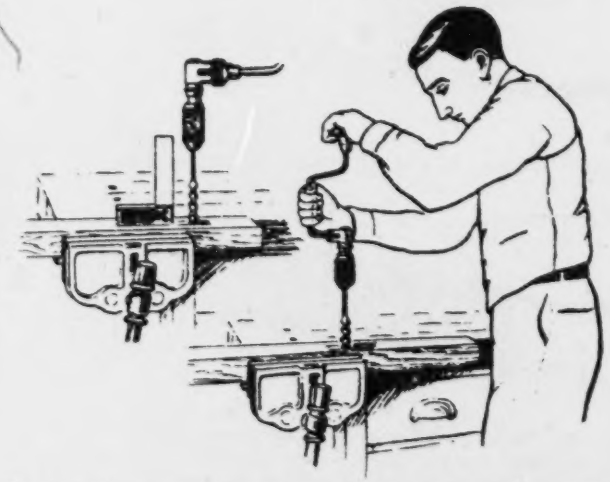

TO BORE A VERTICLE HOLE, HOLD THE BRACE AND BIT PERPENDICULAR TO THE SURFACE OF THE WORK. TEST BY SIGHT. COMPARE THE DIRECTION OF THE BIT TO THE NEAREST STRAIGHT EDGE OR TO SIDES OF THE VISE. A TRY SQUARE MAY BE HELD NEAR THE BIT.

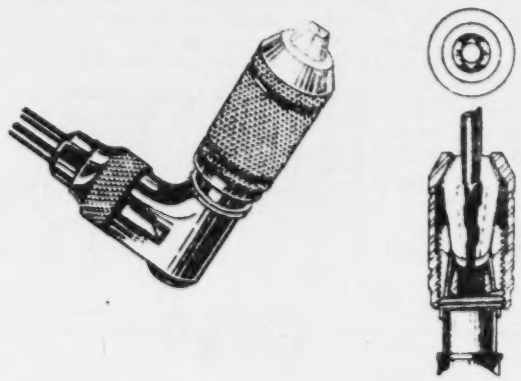

BIT BRACE CHUCKS OF THE ABOVE DESIGN WITHOUT A SQUARE SOCKET ARE OPERATED IN LIKE MANNER. THE CORNERS OF THE TAPER SHANK OF THE BIT SHOULD BE CAREFULLY SEATED AND CENTERED IN THE V GROOVES OF THE JAWS.

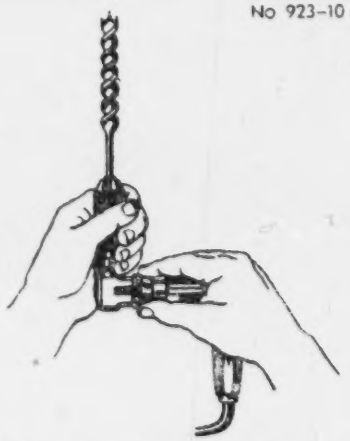

TO OPERATE THE RATCHET TURN THE CAM RING. TURNING THE CAM RING TO THE RIGHT WILL ALLOW THE BIT TO TURN RIGHT AND GIVE RATCHET ACTION WHEN THE HANDLE IS TURNED LEFT. TURN THE CAM RING LEFT TO REVERSE THE ACTION.
THE RATCHET BRACE IS INDISPENSABLE WHEN BORING A HOLE IN A CORNER OR WHERE SOME OBJECT PREVENTS MAKING A FULL TURN WITH THE HANDLE.

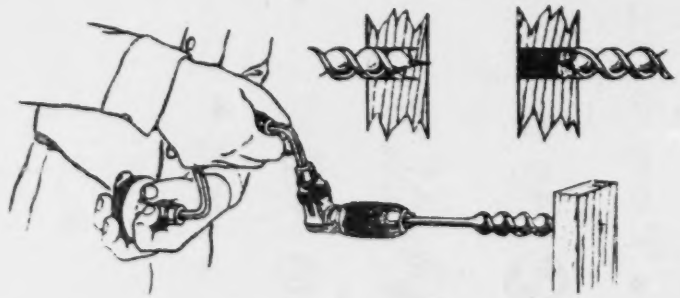

TO BORE A HORIZONTAL HOLE, HOLD THE HEAD OF THE BRACE CUPPED IN THE LEFT HAND AGAINST THE STOMACH AND WITH THE THUMB AND FOREFINGER AROUND THE QUILL. TO BORE THRU WITHOUT SPLINTERING THE SECOND FACE STOP WHEN THE SCREW POINT IS THRU AND FINISH FROM THE SECOND FACE. WHEN BORING THRU WITH AN EXPANSIVE BIT IT IS BEST TO CLAMP A PIECE OF WOOD TO THE SECOND FACE AND BORE STRAIGHT THRU.

STANLEY TOOLS
NEW BRITAIN CONN. U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 26

PRINTED IN U.S.A.

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HOW TO USE BORING TOOLS

STANLEY

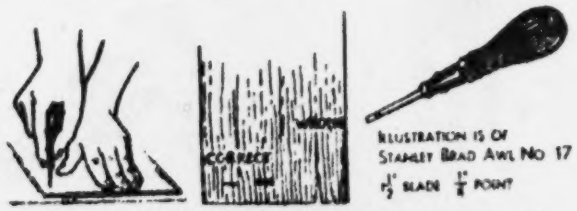

ILLUSTRATION IS OF STANLEY BRAD AWL NO 17
1/2" BLADE 1/4" POINT

BRAD AWLS ARE USED TO MAKE HOLES FOR SMALL SCREWS AND NAILS. TO AVOID SPLITTING THE WOOD, START THE AWL WITH ITS EDGE ACROSS THE GRAIN, TURNING IT BACK AND FORTH SLIGHTLY AS YOU PRESS DOWN. DO NOT LET THE EDGE COME PARALLEL WITH THE GRAIN

TWIST BITS FOR WOOD ARE USED TO MAKE HOLES FOR SCREWS, NAILS OR BOLTS. THEY ARE SIZED BY 32NDS OF AN INCH AND RANGE FROM NO 2-1/16" AND LARGER.

BIT STOCK DRILLS ARE DESIGNED AND TEMPERED TO MAKE HOLES IN METAL, BUT MAY ALSO BE USED IN WOOD, ESPECIALLY IN REPAIR WORK WHERE CONTACT WITH NAILS OR METAL IS POSSIBLE. THEY ARE SIZED BY 32NDS OF AN INCH AND RANGE FROM NO 2 - 1/16" AND LARGER

ILLUSTRATION IS OF STANLEY COUNTERSINK NO 139 FOR BIT BRACES

ILLUSTRATION IS OF STANLEY COUNTERSINK NO 137 FOR HAND DRILLS

COUNTERSINK BITS ARE USED TO WIDEN SCREW HOLES SO THAT THE HEADS OF FLAT-HEAD SCREWS MAY BE FLUSH, OR SLIGHTLY BELOW, THE SURFACE OF THE WORK

FORSTNER BITS ARE USED TO BORE HOLES PARTWAY THROUGH WHERE THE AUGER BIT SCREW OR SPUR WOULD GO THROUGH THE WORK ALSO ON END GRAIN, THIN WOOD, OR NEAR AN END WHERE AN AUGER BIT WOULD SPLIT THE WORK. TO CENTER OR START A FORSTNER BIT SCRIBE A CIRCLE THE SIZE OF THE HOLE WITH DIVIDERS AND PRESS THE RIM OF THE FORSTNER BIT INTO IT. FORSTNER BITS ARE SIZED BY 16THS OF AN INCH FROM NO 4-1/4" AND LARGER

STANLEY TOOLS
NEW BRITAIN CONN USA

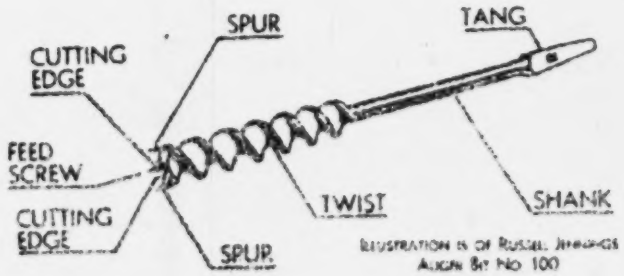

ILLUSTRATION IS OF RUSSELL JENNINGS AUGER BIT NO 100

AUGER BITS ARE SIZED BY 16THS OF AN INCH, MEASURING THE DIAMETER. BITS VARY IN LENGTH FROM 7" TO 10". DOWEL BITS ARE SHORT AUGER BITS ABOUT 5" LONG

THE STANDARD DOUBLE THREAD FEED SCREW IS BEST FOR GENERAL WORK WITH SEASONED WOOD. IT IS PREFERRED FOR CABINET AND PATTERN MAKING

THE SINGLE THREAD FEED SCREW IS BEST FOR FAST CUTTING IN GREEN OR GUMMY WOOD

THE DIAMOND POINT IS USED FOR MACHINE BORING WITH POWER FEED

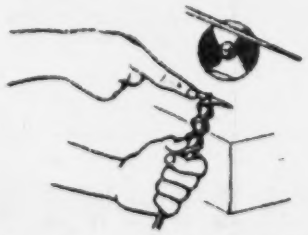

SHARPEN AUGER BITS WITH A BIT FILE FOR A KEEN EDGE. ALSO WHET WITH A SLIPSTONE. SHARPEN THE SPURS ON THE INSIDE TO PRESERVE THE DIAMETER

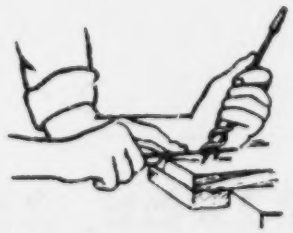

SHARPEN THE CUTTING EDGES ON THE TOP TO MAINTAIN THE CLEARANCE ON THE UNDER SIDE. THE CUTTING EDGES MUST BE KEPT EVEN

STANLEY

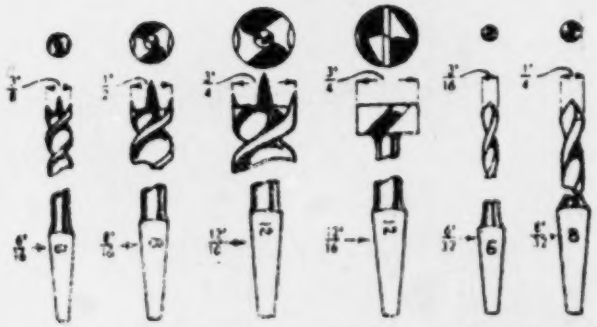

AUGER BITS, 16THS OF AN INCH — FORSTNER BITS 16THS — TWIST BITS 32NDS OF AN INCH

BITS ARE MARKED FOR SIZE BY A SINGLE NUMBER. THE NUMERATOR OF THE FRACTION STANDS FOR THE DIAMETER OF THE BIT. AUGER AND FORSTNER BITS ARE MARKED BY 16THS OF AN INCH. NO 8 STANDS FOR 8/16" OR 1/2". TWIST BITS FOR WOOD ARE USUALLY MARKED IN THE SAME WAY, BY 32NDS OF AN INCH. NO 8 STANDS FOR 8/32" OR 1/4"

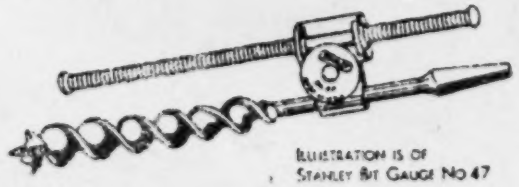

ILLUSTRATION IS OF STANLEY BIT GAUGE NO 47

AN ADJUSTABLE BIT GAUGE MAY BE USED TO REGULATE THE DEPTH OF HOLES

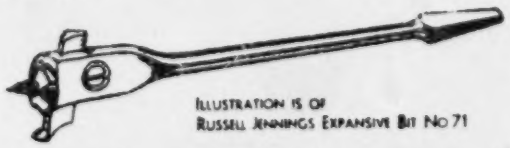

ILLUSTRATION IS OF RUSSELL JENNINGS EXPANSIVE BIT NO 71

THE EXPANSIVE BIT TAKES THE PLACE OF MANY LARGE BITS. THE CUTTER MAY BE ADJUSTED FOR VARIOUS SIZED HOLES. MOVING THE CUTTER ADJUSTING SCREW ONE COMPLETE TURN ENLARGES OR REDUCES THE HOLE 1/8". ONE HALF TURN 1/16". TEST THE SIZE ON A PIECE OF WASTE WOOD. FOR BORING THROUGH, CLAMP A PIECE OF WASTE WOOD ON THE BACK OF THE WORK TO PREVENT SPLITTING

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CHART NO. 23

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HOW TO USE

THE STANLEY CHISEL

HORIZONTAL CHISELING

STANLEY

TO CUT, HORIZONTALLY, WITH THE GRAIN: THE CHISEL IS HELD SLIGHTLY TURNED TO ONE SIDE AND THEN PUSHED FROM THE WORKER. IT IS HELD WITH THE BEVEL DOWN FOR A ROUGHING CUT AND WITH THE BEVEL UP FOR A PARING CUT.

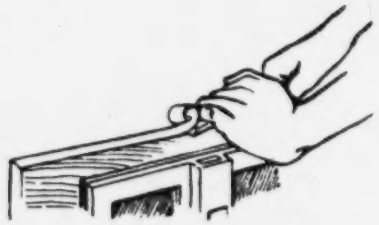

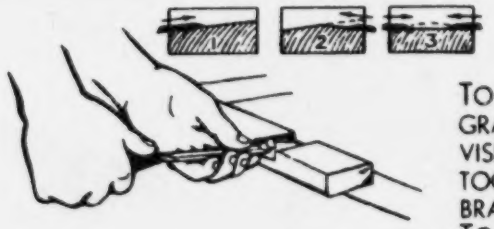

STANLEY

TO CUT HORIZONTALLY, ACROSS THE GRAIN WITH THE WORK HELD IN THE VISE: PRESS THE FOREFINGER AND THUMB TOGETHER ON THE CHISEL TO ACT AS A BRAKE.

TO AVOID SPLINTERING THE CORNERS, CUT HALF WAY FROM EACH EDGE TOWARD THE CENTER. REMOVE THE CENTER STOCK LAST.

KEEP YOUR CHISEL SHARP

SEE STANLEY CHARTS NO. 10 AND NO. 11 FOR GRINDING AND WHETTING PLANE IRONS. THE SAME APPLIES TO CHISELS

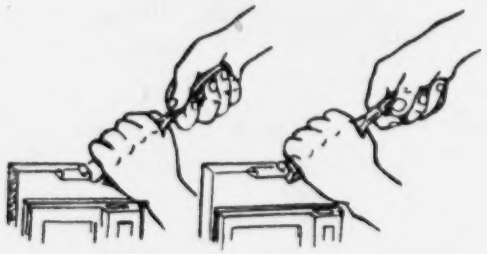

TO CUT A CHAMFER: HOLD THE CHISEL INCLINED TO ONE SIDE PARALLEL TO THE SLOPE OF THE CHAMFER AND CUT AS IN CHISELING HORIZONTALLY WITH THE GRAIN.

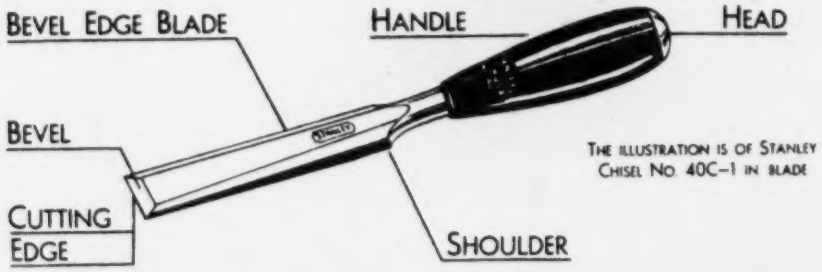

THE ILLUSTRATION IS OF STANLEY CHISEL NO. 40C-1 IN BLADE

THE CHISEL IS CONTROLLED WITH THE LEFT HAND, PRESSING FIRMLY ON THE CHISEL AND THE WOOD. THE POWER IS APPLIED WITH THE RIGHT HAND. THE CHISEL IS HELD SLIGHTLY TURNED SO THE EDGE SLIDES ACROSS THE WORK OR THE CHISEL IS MOVED TO THE RIGHT AND LEFT AS IT IS ADVANCED, TO GIVE A SLIDING ACTION TO THE CUTTING EDGE. THIS IS EASIER THAN A STRAIGHT THRUST AND LEAVES A SMOOTHER SURFACE ON THE WORK.

AT ALL TIMES KEEP BOTH HANDS BACK OF THE CUTTING EDGE.

TO CUT ACROSS THE GRAIN WITH THE WORK HELD AGAINST THE BENCH HOOK, THE HEEL OF THE LEFT HAND STEADIES THE WORK WHILE THE FINGERS PRESS THE CHISEL FIRMLY AGAINST THE WOOD.

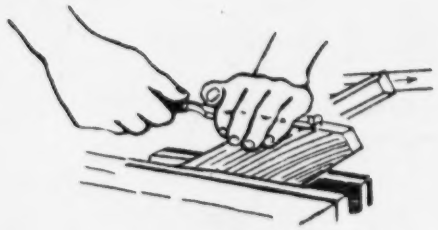

TO CUT A STRAIGHT SLANTING CORNER IS THE SAME AS HORIZONTAL CHISELING. THE WORK IS HELD IN THE VISE WITH THE GUIDE LINE HORIZONTAL.

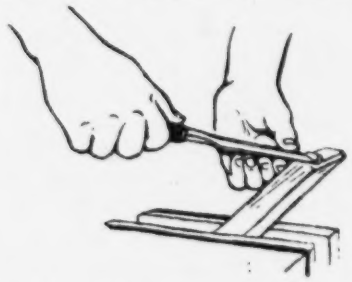

TO CUT A CHAMFER ON END GRAIN THE CHISEL IS MOVED SIDEWAYS ACROSS THE CORNER OF THE WORK HELD SO THAT THE CHISEL MAKES A SLIDING HORIZONTAL CUT.

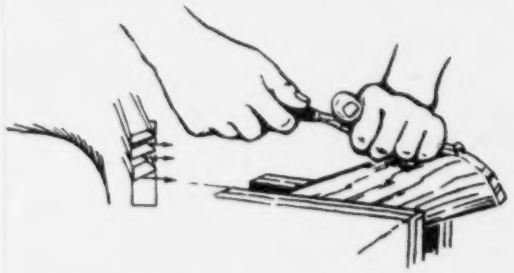

TO CUT A ROUND CORNER. THE CHISEL IS MOVED SIDEWAYS ACROSS THE THE WORK MAKING A SERIES OF CUTS CLOSE TOGETHER EACH ONE TANGENT TO THE CURVE.

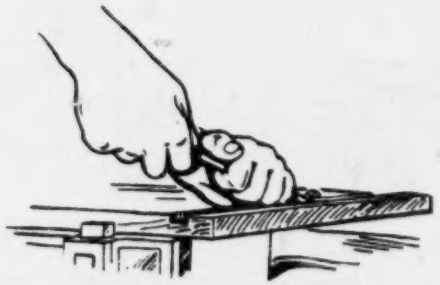

IF THE WORK IS WIDE THE CHISEL IS HELD BEVEL DOWN SO THE HANDLE WILL CLEAR THE WORK AND THE BLADE WILL NOT DIG IN TOO DEEP AS IT IS PUSHED FORWARD.

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NEW BRITAIN CONN. U.S.A.

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CHART NO. 17

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HOW TO USE

THE STANLEY CHISEL

VERTICAL CHISELING

STANLEY

TO CUT VERTICALLY ACROSS THE GRAIN a THE CHISEL SHOULD BE SLIGHTLY TILTED TO ONE SIDE TO GIVE A SLIDING ACTION TO THE CUTTING EDGE, OR IT MAY BE HELD STRAIGHT AND MOVED TO ONE SIDE AS IT IS ADVANCED b IF THE SURFACE IS WIDER THAN THE CHISEL PART OF THE CHISEL PRESSED AGAINST THE PORTION JUST CUT HELPS TO GUIDE AND KEEP IN LINE THE PART OF THE CHISEL CUTTING A NEW PORTION OF THE SURFACE c CUT WITH THE GRAIN SO THE WASTE WOOD WILL SPLIT AWAY FROM THE GUIDE LINE

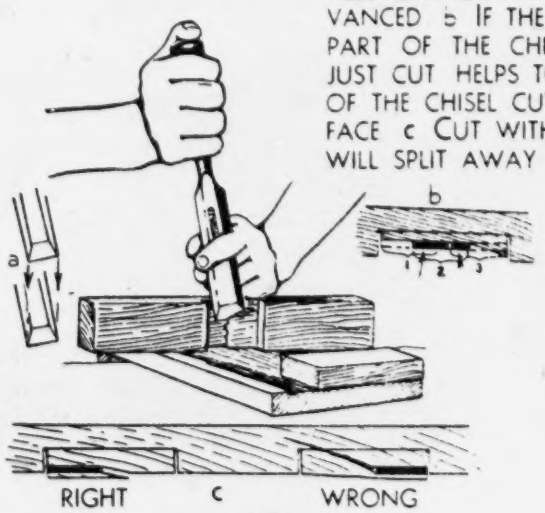

STANLEY

TO CUT VERTICALLY A SLANTING CORNER USE THE CHISEL IN THE SAME MANNER AS IN VERTICAL CUTTING ACROSS THE GRAIN ALWAYS WORK FROM THE EDGE TOWARD THE END SO THE WOOD WILL SPLIT AWAY FROM THE LINE WORKING FROM THE END TOWARD THE EDGE WILL SPLIT AND RUIN THE WORK AS IT IS CUTTING AGAINST THE GRAIN

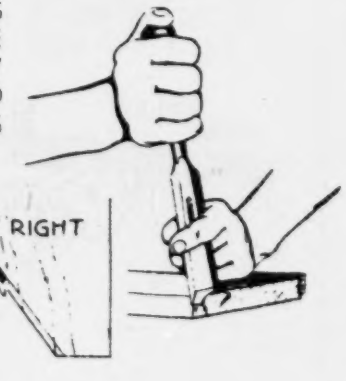

KEEP YOUR CHISEL SHARP

SEE STANLEY CHARTS NO 10 AND NO 11 FOR GRINDING AND WHETTING PLANE IRONS THE SAME APPLIES TO CHISELS

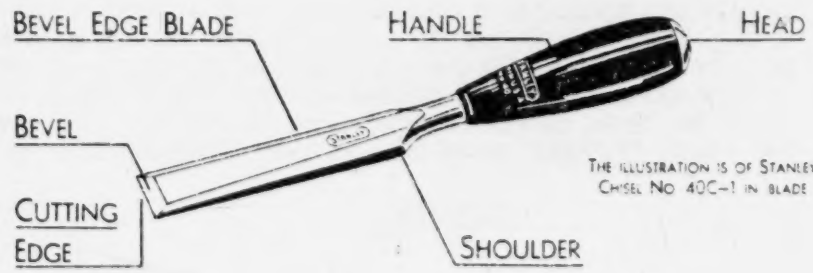

THE ILLUSTRATION IS OF STANLEY CHISEL NO 40C-1 IN BLADE

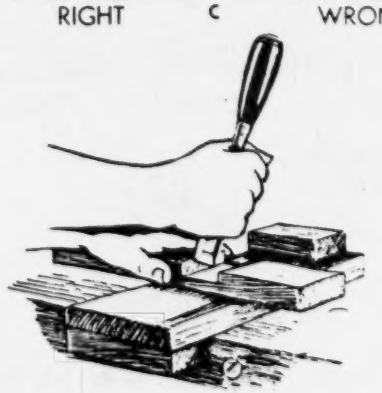

TO CLEAN THE CORNERS OF A TENON NOTCH DADO OR RABBET GRASP THE CHISEL BY THE BLADE NEAR THE EDGE RAISE ONE CORNER OF THE CUTTING EDGE BY TILTING THE HANDLE AWAY AND DRAW THE CHISEL TOWARD YOU THE WORK IS HELD BY THE LEFT HAND WHILE THE CHISEL EDGE AND ONE CORNER GUIDED BY THE RIGHT HAND ACT LIKE A KNIFE

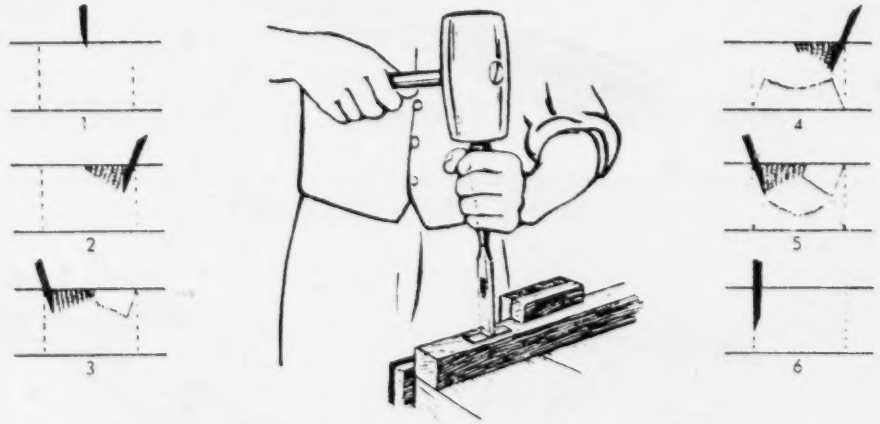

THE MALLET MAY BE SAFELY USED ON THE CHISEL WHEN THE CUTTING EDGE IS ACROSS THE GRAIN WHEN THE EDGE IS WITH THE GRAIN THE USE OF THE MALLET IS VERY LIKELY TO SPLIT THE WOOD THE MALLET MAY BE USED ON THE CHISEL TO BEAT OUT A MORTISE TO CUT THE ENDS OF A MORTISE WHEN THE BULK OF THE MATERIAL HAS BEEN BORED OUT WHEN THE WOOD IS HARD AND IN ROUGHING OUT WHEN THERE IS A LARGE AMOUNT OF MATERIAL TO BE REMOVED

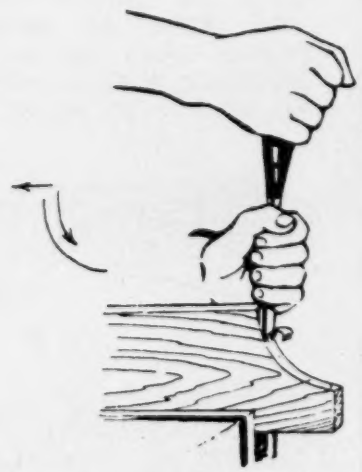

TO CUT A CONCAVE CURVED CORNER HOLD THE BEVEL SIDE OF THE CHISEL AGAINST THE WORK WITH THE LEFT HAND, WITH THE RIGHT HAND PRESS DOWN AND DRAW BACK AT THE SAME TIME GIVING A SWEEPING CURVED DIRECTION TO THE CUT
ALWAYS WORK WITH THE GRAIN FROM THE EDGE TOWARD THE END

STANLEY TOOLS
NEW BRITAIN CONN U.S.A.

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CHART NO. 18

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CHISELS, BIT BRACES, HAND DRILLS AND BORING TOOLS

1. Explain the proper way to cut horizontally with the grain with a wood chisel.

2. Explain the proper way to cut horizontally across the grain with a wood chisel.

3. Explain how to cut a chamfer with a wood chisel.

4. Explain the proper way to cut a round corner on the end of a board with the wood chisel.

5. Explain the proper way to cut vertically across the grain with a wood chisel.

6. Why should we use a mallet rather than a hammer when using the wood chisel?

7. Explain the proper way to place a wood bit in a brace.

8. Name the parts and tell what each part does on a bit brace.

9. Explain how you would bore a straight, vertical hole through a piece of wood with a brace and bit.

10. Explain how you would bore a hole in a corner with a brace and bit if some object prevents a full turn of the handle on the brace.

11. How should the cutting edge on a wood bit be sharpened?

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12. Explain how you would bore a horizontal hole through a piece of wood with a bit brace without splintering the second face.

13. What size bit should be used for a pilot hole if you were using the following screws : Number 4, number 6, and number 8?

14. What size bit should you use for the smooth shank of the screw if you were using the following size screws: Number 3, number 5, number 7?

15. What is the purpose of the brad awl?

16. Name the parts of a wood bit and describe what each part does.

17. How is the size of a wood bit determined?

18. Name five different kinds of bits that are used in a brace and tell where each is used.

19. What is the difference between a double thread feed screw and a single thread feed screw on a wood bit? Where is each used?

20. Where is the expansive bit used?

21. Where is the hand drill used and what advantages does it have over the bit brace? (Text Reference)

22. How may you control the depth of holes while using the hand drill? (Text Reference)

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HOW TO USE HAND SAWS

STANLEY

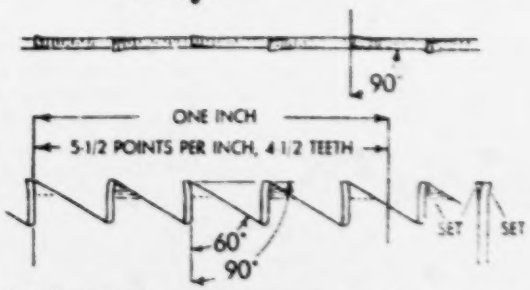

RIP SAW TEETH ARE SHAPED LIKE CHISELS. THEY CUT LIKE A GANG OF CHISELS IN A ROW

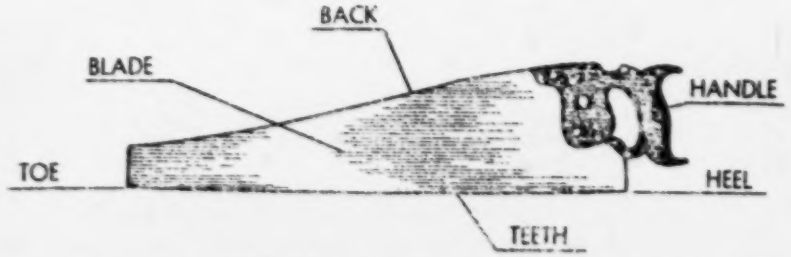

THE SIZE OF A SAW IS DETERMINED BY THE LENGTH OF THE BLADE IN INCHES. SOME POPULAR SIZES ARE 24" AND 26".
THE COARSENESS OR FINENESS OF A SAW IS DETERMINED BY THE NUMBER OF POINTS PER INCH.
A COARSE SAW IS BETTER FOR FAST WORK AND FOR GREEN WOOD.
A FINE SAW IS BETTER FOR SMOOTH ACCURATE CUTTING AND FOR DRY SEASONED WOOD.
5-1/2 AND 6 POINTS ARE IN COMMON USE FOR RIP SAWS.
7 AND 8 POINTS ARE IN COMMON USE FOR CROSS CUT SAWS.
SAW TEETH ARE SET; EVERY OTHER TOOTH IS BENT TO THE RIGHT AND THOSE BETWEEN TO THE LEFT, TO MAKE THE KERF WIDER THAN THE SAW.
THIS PREVENTS THE SAW FROM BINDING IN THE KERF OR SAW CUT.
QUALITY SAWS IN ADDITION ARE TAPER GROUND, RUNG THINNER AT THE BACK THAN AT THE TOOTHED EDGE.
KEEP SAW TEETH SHARP AND PROPERLY SET.

STANLEY

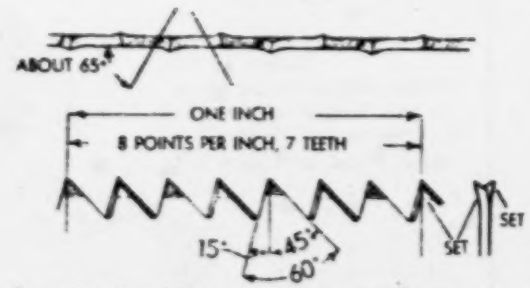

CROSS CUT SAW TEETH ARE LIKE KNIFE POINTS. THEY CUT LIKE TWO ROWS OF KNIFE POINTS AND CRUMBLE OUT THE WOOD BETWEEN THE CUTS.

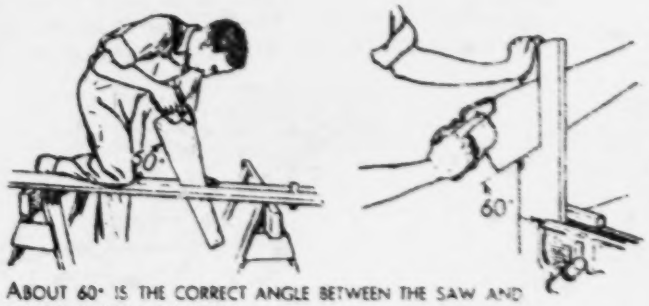

ABOUT 60° IS THE CORRECT ANGLE BETWEEN THE SAW AND THE WORK FOR RIP SAWING

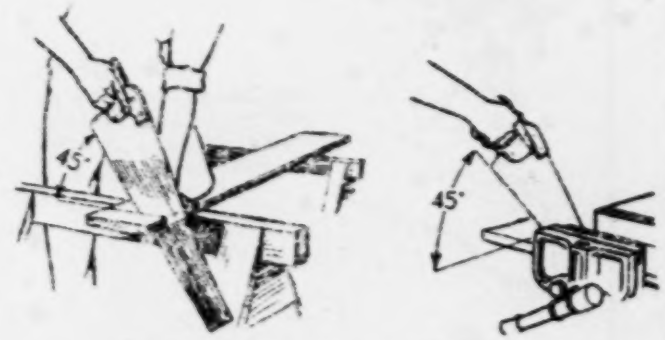

ABOUT 45° IS THE CORRECT ANGLE BETWEEN THE SAW AND THE WORK FOR CROSS CUT SAWING

BE SURE TO SAW CAREFULLY ON THE WASTE SIDE OF THE LINE AS AT A AND B. SAWING ON THE LINE OR ON THE WRONG SIDE OF THE LINE MAKES THE STOCK TOO SHORT AS AT C OR THE OPENING TOO LARGE AS SHOWN AT D.

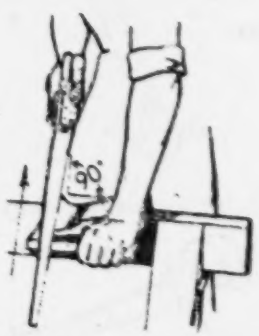

START THE SAW CUT BY DRAWING THE SAW BACKWARD. HOLD THE BLADE SQUARE TO THE STOCK. STEADY IT AT THE LINE WITH THE THUMB

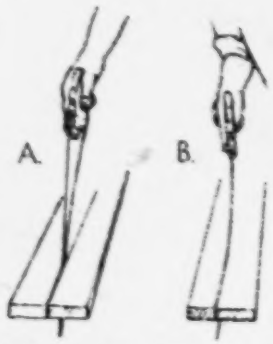

A. IF THE SAW LEAVES THE LINE TWIST THE HANDLE SLIGHTLY AND DRAW IT BACK TO THE LINE.
B. IF THE SAW IS NOT SQUARE TO THE STOCK, BEND IT A LITTLE AND GRADUALLY STRAIGHTEN IT. BE CAREFUL NOT TO PERMANENTLY BEND OR KINK THE BLADE

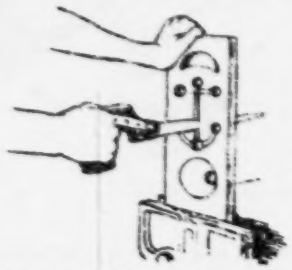

COMPASS OR KEYHOLE SAWS ARE USED TO CUT CURVED OR STRAIGHT SIDED HOLES

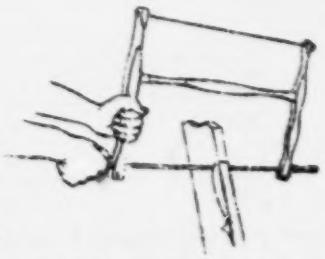

THE WEB OR TURNING SAW IS USED TO CUT IRREGULARLY CURVED SHAPES BY HAND

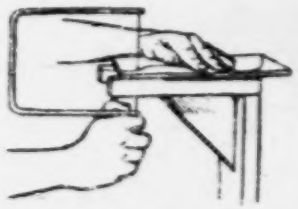

THE COPING SAW IS USED TO CUT IRREGULAR SHAPES AND INTRICATELY CURVED PATTERNS IN THIN WOOD

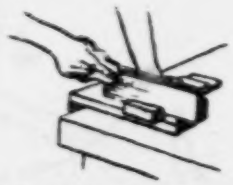

THE BACK SAW IS A THIN CROSS CUT SAW WITH FINE TEETH, STIFFENED BY A THICK BACK. A POPULAR SIZE IS 12" WITH 14 PTS PER INCH. IT IS USED FOR FINE ACCURATE WORK

STANLEY TOOLS
NEW BRITAIN CONN. U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 19
BY R. D. REGER

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HOW TO USE

THE STANLEY NAIL HAMMER

STANLEY

GRASP THE HAMMER FIRMLY NEAR THE END

HE BLOW IS DELIVERED THROUGH THE WRIST, THE ELBOW AND THE HOULDER, ONE OR ALL BEING BROUGHT INTO PLAY, ACCORDING TO HE STRENGTH OF THE BLOW TO E STRUCK REST THE FACE OF THE AMMER ON THE NAIL, DRAW THE HAMMER BACK AND GIVE A LIGHT AP TO START THE NAIL AND TO DETERMINE THE AIM

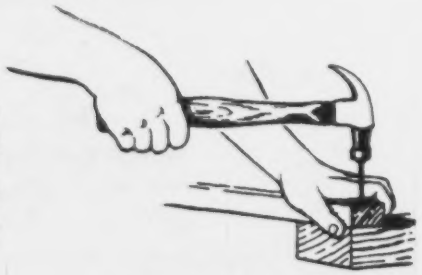

TRIKE THE NAIL SQUARELY TO VOID MARRING THE WOOD AND ENDING THE NAIL KEEP THE FACE F THE HAMMER CLEAN TO AVOID LIPPING OFF THE NAIL IF A NAIL ENDS DRAW IT AND START A NEW ONE IN A NEW PLACE

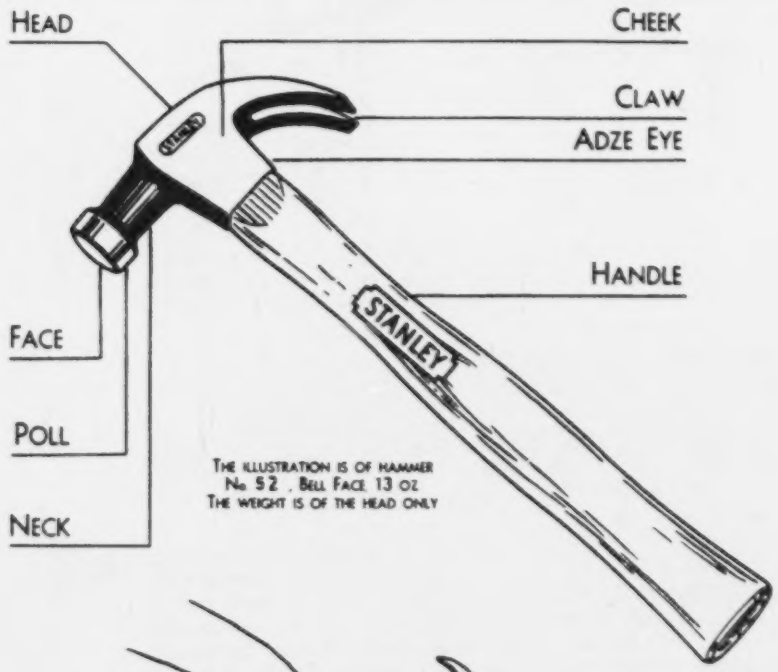

THE ILLUSTRATION IS OF HAMMER No 52, BELL FACE 13 OZ THE WEIGHT IS OF THE HEAD ONLY

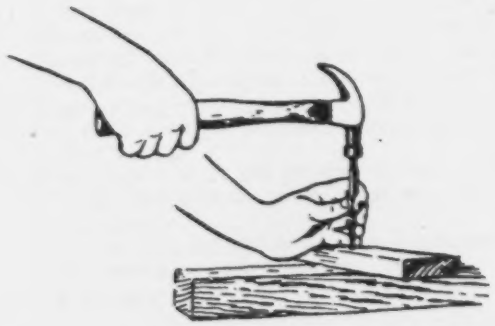

USE A NAIL SET TO DRIVE NAILS BELOW THE SURFACE OF ALL FINE WORK TO PREVENT THE NAIL SET SLIPPING OFF THE HEAD OF THE NAIL, REST THE LITTLE FINGER ON THE WORK AND PRESS THE NAIL SET FIRMLY AGAINST IT SET NAILS ABOUT 1/16" BELOW THE SURFACE OF THE WOOD

ALWAYS STRIKE WITH THE FACE OF THE HAMMER IT IS HARDENED FOR THAT PURPOSE DO NOT DAMAGE THE FACE BY STRIKING STEEL HARDER THAN ITSELF DO NOT STRIKE WITH THE CHEEK AS IT IS THE WEAKEST PART

STANLEY

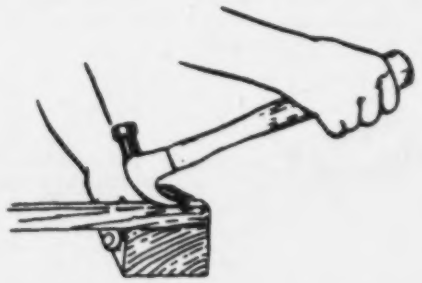

TO DRAW A NAIL SLIP THE CLAW OF THE HAMMER UNDER THE NAIL HEAD, PULL UNTIL THE HANDLE IS NEARLY VERTICAL AND THE NAIL PARTLY DRAWN

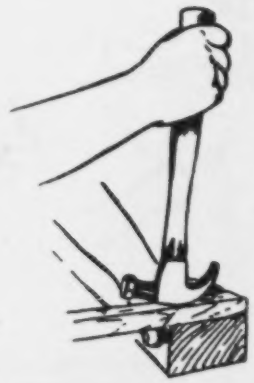

IF THE PULL IS CONTINUED, UNNECESSARY FORCE IS REQUIRED THAT WILL BEND THE NAIL, MAR THE WOOD AND PERHAPS BREAK THE HAMMER HANDLE

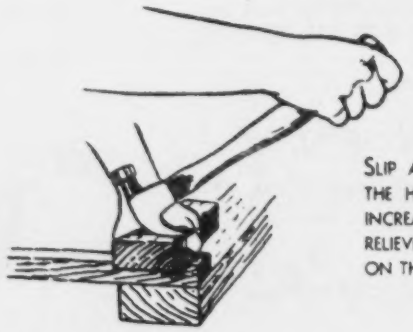

SLIP A PIECE OF WOOD UNDER THE HEAD OF THE HAMMER TO INCREASE THE LEVERAGE AND TO RELIEVE THE UNNECESSARY STRAIN ON THE HANDLE

A BELL FACE HAMMER IS SLIGHTLY MORE CONVEX THAN A PLAIN FACE HAMMER WITH IT A NAIL CAN BE DRIVEN FLUSH, OR SLIGHTLY BELOW THE SURFACE OF THE WORK, WITHOUT LEAVING HAMMER MARKS IN THE WOOD

STANLEY TOOLS
NEW BRITAIN, CONN. U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 20
BY R. D. REGER

PRINTED IN U.S.A.

HOW TO USE

THE STANLEY SCREW DRIVER

AND INFORMATION FOR DRIVING SCREWS

STANLEY

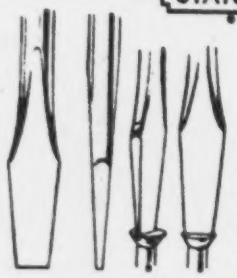

SELECT A SCREW DRIVER OF LENGTH AND TIP FITTED TO THE WORK
SCREW DRIVERS ARE SPECIFIED BY THE LENGTH OF THE BLADE
THE TIP SHOULD BE STRAIGHT AND NEARLY PARALLEL SIDED IT SHOULD ALSO FIT THE SCREW SLOT, AND BE NOT WIDER THAN THE SCREW HEAD

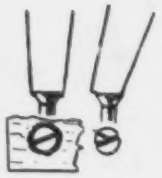

IF THE TIP IS TOO WIDE IT WILL SCAR THE WOOD AROUND THE SCREW HEAD
IF THE SCREW DRIVER IS NOT HELD IN LINE WITH THE SCREW IT WILL SLIP OUT OF THE SLOT AND MAR BOTH THE SCREW AND THE WORK

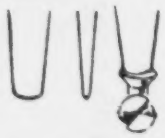

IF THE TIP IS ROUNDED OR BEVELED IT WILL RAISE OUT OF THE SLOT SPOILING THE SCREW HEAD REGRIND OR FILE THE TIP TO MAKE IT AS SHOWN ABOVE

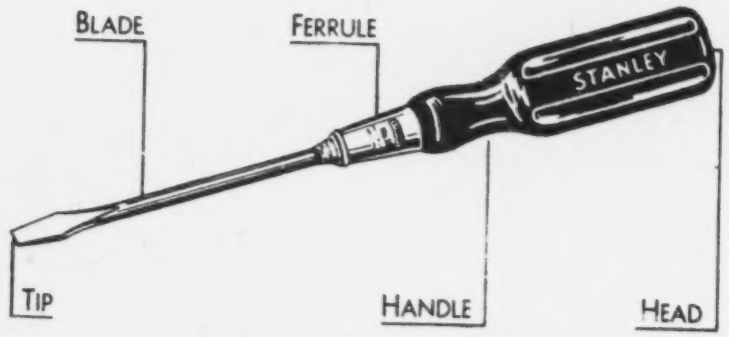

THE ILLUSTRATION IS OF
STANLEY SCREW DRIVER NO 25-4 IN BLADE

STANLEY

USE THE LONGEST SCREW DRIVER CONVENIENT FOR THE WORK MORE POWER CAN BE APPLIED TO A LONG SCREW DRIVER THAN A SHORT ONE, WITH LESS DANGER OF ITS SLIPPING OUT OF THE SLOT
HOLD THE HANDLE FIRMLY IN THE PALM OF THE RIGHT HAND WITH THE THUMB AND FOREFINGER GRASPING THE HANDLE NEAR THE FERRULE WITH THE LEFT HAND STEADY THE TIP AND KEEP IT PRESSED INTO THE SLOT WHILE RENEWING THE GRIP ON THE HANDLE FOR A NEW TURN

IF NO HOLE IS BORED FOR THE THREADED PART OF THE SCREW THE WOOD IS OFTEN SPLIT OR THE SCREW IS TWISTED OFF
IF A SCREW TURNS TOO HARD, BACK IT OUT AND ENLARGE THE HOLE
A LITTLE SOAP ON THE THREADS OF THE SCREW MAKES IT EASIER TO DRIVE

TO FASTEN TWO PIECES OF WOOD TOGETHER WITH SCREWS

1. LOCATE THE POSITIONS OF THE SCREW HOLES
2. BORE THE FIRST HOLE IN THE FIRST PIECE OF WOOD SLIGHTLY LARGER THAN THE DIAMETER OF THE SCREW SHANK, AS AT a
3. BORE THE SECOND HOLE SLIGHTLY SMALLER THAN THE THREADED PART OF THE SCREWS, AS AT b BORE AS DEEP AS HALF THE LENGTH OF THE THREADED PART
4. COUNTERSINK THE FIRST HOLES TO MATCH THE DIAMETER OF THE HEADS OF THE SCREWS, AS AT c
5. DRIVE THE SCREWS TIGHTLY IN PLACE WITH THE SCREW DRIVER

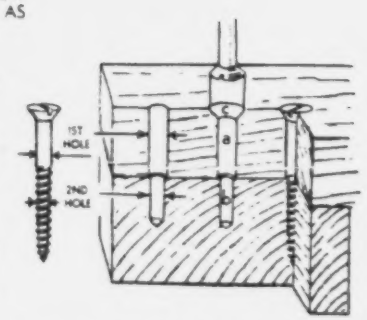

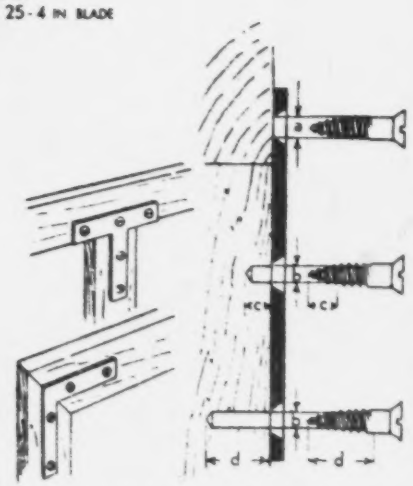

TO FASTEN HINGES OR OTHER HARDWARE IN PLACE WITH SCREWS

1. LOCATE THE POSITION OF THE PIECE OF HARDWARE ON THE WORK
2. RECESS THE WORK TO RECEIVE THE HARDWARE, IF IT IS NECESSARY
3. LOCATE THE POSITIONS OF THE SCREWS
4. SELECT SCREWS THAT WILL EASILY PASS THRU THE HOLES IN THE HARDWARE, AS AT a
5. BORE THE PILOT HOLES (SECOND HOLE) SLIGHTLY SMALLER THAN THE DIAMETER OF THE THREADED PART OF THE SCREWS, AS AT b
6. DRIVE THE SCREWS TIGHTLY IN PLACE

IF THE WOOD IS SOFT, BORE AS DEEP AS HALF THE LENGTH OF THE THREADED PART OF THE SCREW, AS AT c IF THE WOOD IS HARD, (OAK), THE SCREW SOFT (BRASS), OR IF THE SCREW IS LARGE, THE HOLE MUST BE NEARLY AS DEEP AS THE SCREW, AS AT d HOLES FOR SMALL SCREWS ARE USUALLY MADE WITH BRAD AWLS

FLAT HEAD

ROUND HEAD

OVAL HEAD

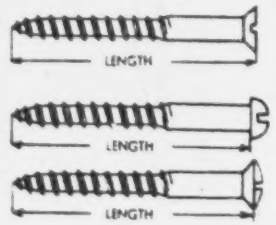

SIZES OF BITS OR DRILLS TO BORE HOLES FOR WOOD SCREWS

NUMBER OF SCREW		1	2	3	4	5	6	7	8	9	10	12	14	16	18
BODY DIAMETER OF SCREW		073	086	099	112	125	138	151	164	177	190	216	242	268	294
		5/64	3/32	3/32+	7/64+	1/8	9/64	5/32	11/64	11/64+	3/16+	7/32	15/64+	17/64+	19/64
FIRST HOLE	TWIST DRILL SIZE	5/64	3/32	7/64	7/64	1/8	9/64	5/32	11/64	3/16	3/16	7/32	1/4	17/64	19/64
	AUGER BIT NUMBER							3	3	3	3	4	4	5	5
SECOND HOLE	TWIST DRILL SIZE		1/16	1/16	5/64	5/64	3/32	7/64	7/64	1/8	1/8	9/64	5/32	3/16	13/64
	AUGER BIT NUMBER												3	3	4

EXACT SIZES CANNOT BE GIVEN FOR THE HOLES FOR WOOD SCREWS THE ABOVE ARE APPROXIMATELY RIGHT FOR AVERAGE NEEDS VARIATIONS IN HARD AND SOFT WOOD MOISTURE CONTENT AND SNUG OR LOOSE FITS IF DESIRED SHOULD BE CONSIDERED NUMBER AND LETTER SIZES OF DRILLS ARE AVAILABLE IF MORE EXACT SIZES ARE WANTED A TRIAL FIT IN SCRAP WOOD IS PRACTICAL

DETERMINE SCREW SHANK SIZES BY COMPARISON BELOW

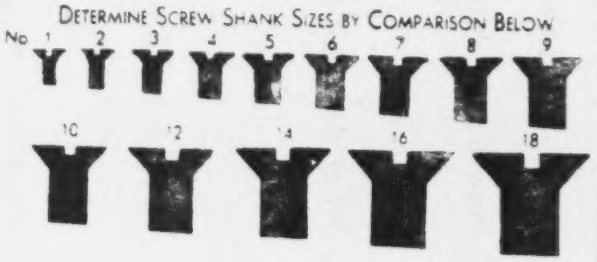

STANLEY TOOLS
NEW BRITAIN CONN U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 21
BY R. D. REGER

PRINTED IN U.S.A.

6557

SAWS, CARPENTERS' HAMMERS, SCREW DRIVERS

1. How do we determine the size of a handsaw?

2. What determines the coarseness or fineness of a handsaw? Where is each kind used?

3. What is the purpose of set in a handsaw?

4. What angle should the saw be held for ripping? Cross cutting?

5. How do we get a saw back on the line once it is off?

6. Where is the compass or keyhole saw used?

7. Where is the coping saw used?

8. Where is the back saw used?

9. Where should the nail hammer be held when driving a nail and why?

10. Where is a nail set used?

11. Explain how you would draw a nail.

12. How is the size of a screw driver determined?

13. What happens if we use a screw driver with a tip wider than the screw head?

14. What happens to the screw head if the tip of the screw driver is rounded?

ED 6558

15. How do we prevent wood from splitting when joining two pieces of wood together with screws?

16. What are the popular sizes of handsaws?

17. What do we mean by kerf?

18. Name the parts of a handsaw.

19. What position should the eye, shoulder, arm and hand be in for sawing with a handsaw?

20. Where is the web or turning saw used?

21. Name the parts of a bell face hammer.

22. What is the difference in a bell face hammer and a plain face hammer?

23. Name the parts of a screw driver.

24. What materials can be applied to screws to make them easier to drive?

25. Name the three kinds of screws.

26. Name the parts of a "yankee" ratchet screw driver. (Text Reference)

27. What are the advantages of the "yankee" screw driver over the regular screw driver? (Text Reference)

6559

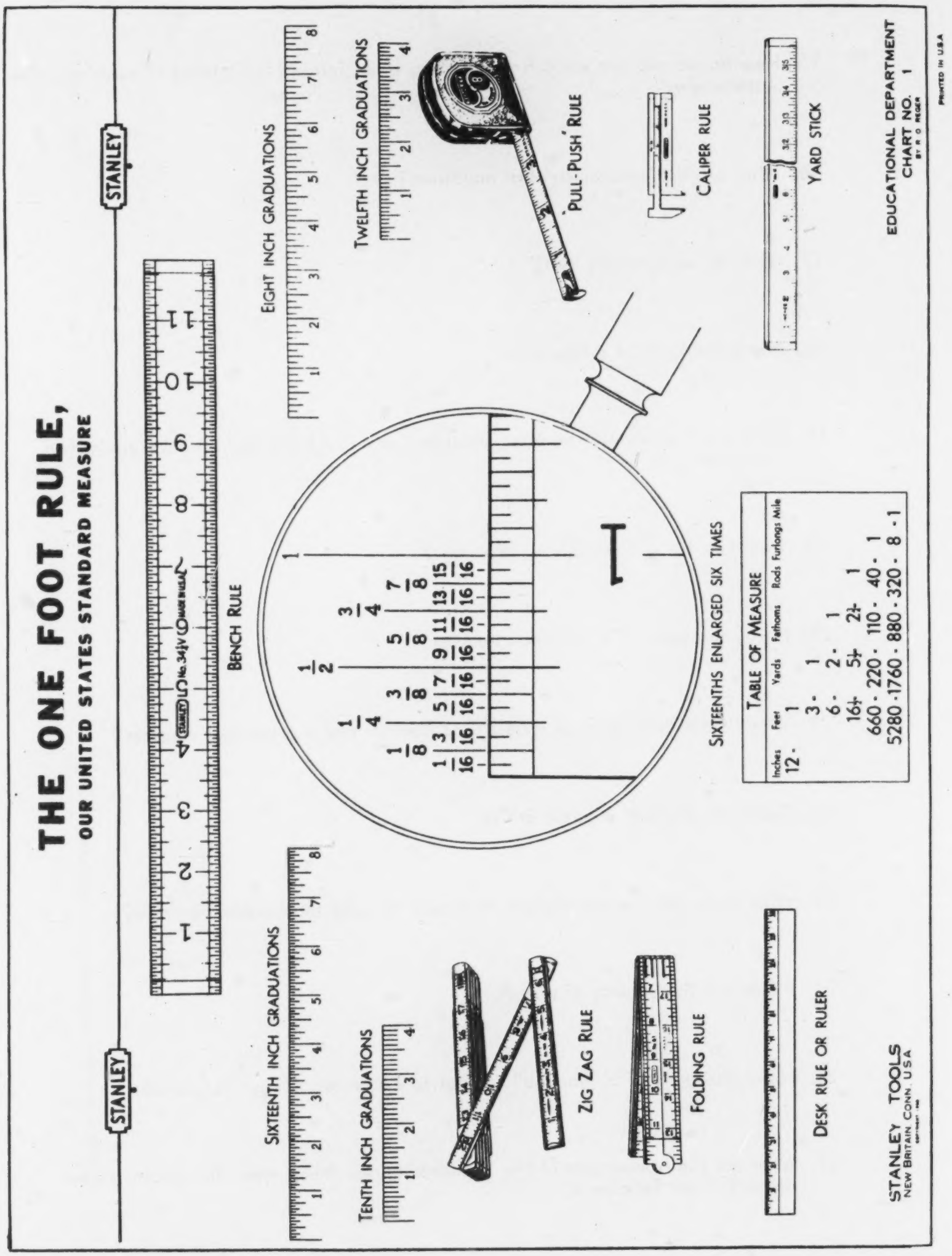
THE ONE FOOT RULE,
OUR UNITED STATES STANDARD MEASURE
STANLEY
BENCH RULE
EIGHT INCH GRADUATIONS
TWELFTH INCH GRADUATIONS
'PULL-PUSH' RULE
CALIPER RULE
YARD STICK
EDUCATIONAL DEPARTMENT
CHART NO. 1
PRINTED IN U.S.A.
SIXTEENTHS ENLARGED SIX TIMES
TABLE OF MEASURE
Inches Feet Yards Fathoms Rods Furlongs Mile
12 - 1
3 - 1
6 - 2 - 1
16½ 5½ 2½ 1
660 - 220 - 110 - 40 - 1
5280 - 1760 - 880 - 320 - 8 - 1
SIXTEENTH INCH GRADUATIONS
TENTH INCH GRADUATIONS
ZIG ZAG RULE
FOLDING RULE
DESK RULE OR RULER
STANLEY TOOLS
NEW BRITAIN, CONN. U.S.A.

6229
6560

HOW TO USE

THE STRAIGHT AND CROSS PEIN HAMMERS

STANLEY

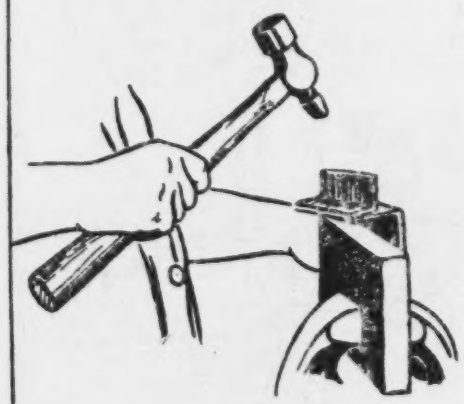

OR MANY JOBS OF SWAGING, RIVETING STRETCHING OR BENDING, A BALL PEIN HAMMER IS NOT SUITABLE USE A CROSS PEIN OR A STRAIGHT PEIN HAMMER, ACCORDING TO THE WORK

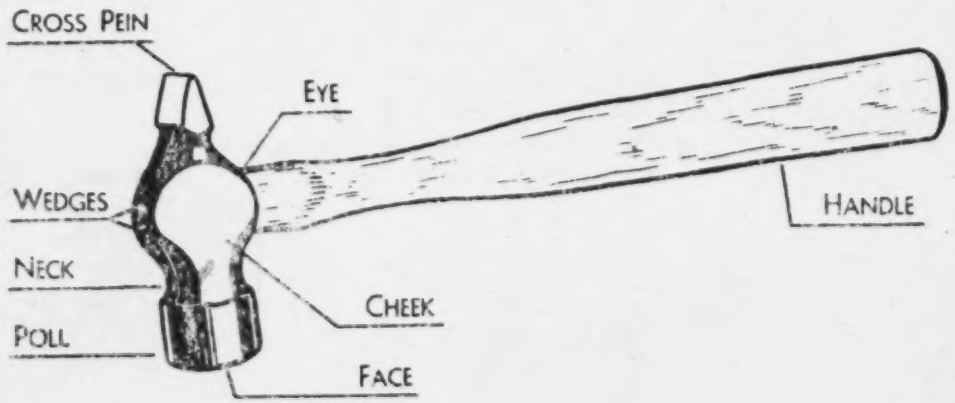

STANLEY

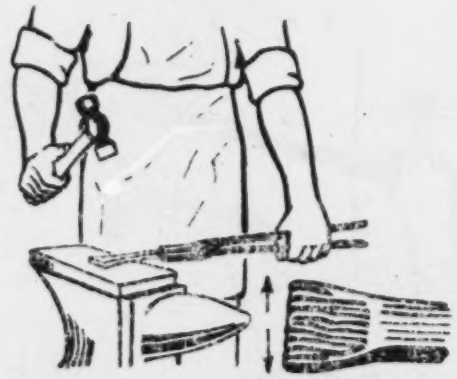

TO STRETCH A PIECE OF STOCK IN THE DIRECTION OF ITS WIDTH, USE A CROSS PEIN HAMMER

TO STRETCH A PIECE OF STOCK IN THE DIRECTION OF ITS LENGTH, USE A STRAIGHT PEIN HAMMER

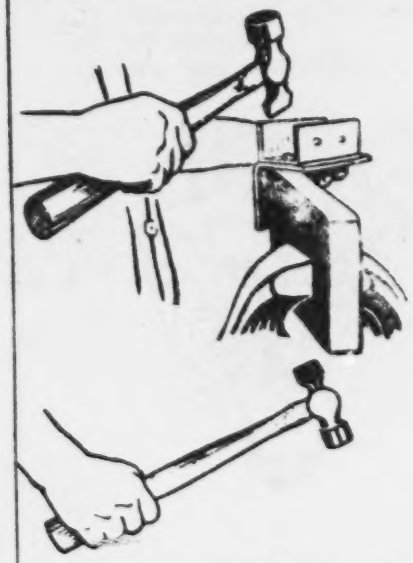

THE MACHINIST USUALLY HOLDS HIS THUMB AROUND THE HAMMER HANDLE

TO STRIKE HEAVY AND MEDIUM BLOWS, GRASP THE HAMMER FIRMLY NEAR THE END OF THE HANDLE AND SWING IT WITH A FREE GRACEFUL SWEEP, WELL OVER THE SHOULDER

TO STRIKE LIGHT BLOWS, AS IN DRIVING RIVETS, GRASP THE HANDLE NEARER THE HEAD AND SWING IT WITH A SLIGHT MOTION AT THE ELBOW BUT CHIEFLY AT THE WRIST

TO AVOID ACCIDENTS

USE GOGGLES TO PROTECT YOUR EYES.

INSPECT THE HAMMER EVERY TIME IT IS CHECKED OUT OF THE TOOL ROOM BE SURE THE HEAD IS FIRMLY ATTACHED AND THE WEDGES DRIVEN TIGHTLY IN PLACE

AVOID STRIKING THE HANDLE TO SAVE IT FROM BREAKAGE

AVOID CHIPPING THE EDGES OF THE HAMMER FACE WHEN STRIKING HARD METALS

AVOID STRIKING WITH THE CHEEK OF THE HAMMER AS IT IS THE WEAKEST PART

THE BLACKSMITH USUALLY HOLDS HIS THUMB ALONG THE BACK OF THE HAMMER HANDLE

STANLEY TOOLS
NEW BRITAIN CONN. U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 34

6561 8828

29562 ecel

HOW TO USE

THE STANLEY BALL PEIN HAMMER

STANLEY

THE BALL PEIN HAMMER IS THE MECHANIC'S ALL AROUND HAMMER.
FOR CHIPPING, USE A BALL PEIN HAMMER, 1 TO 2 LBS. IN WEIGHT, ACCORDING TO THE WORKMAN'S PREFERENCE.

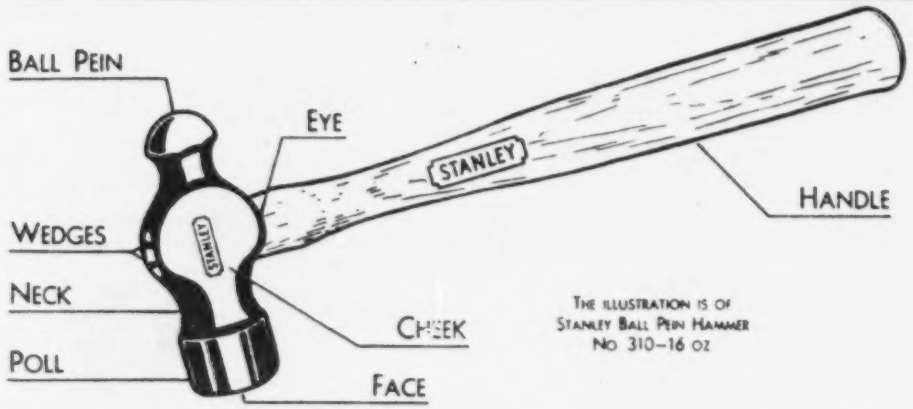

THE ILLUSTRATION IS OF STANLEY BALL PEIN HAMMER No 310–16 OZ

TO STRIKE HEAVY AND MEDIUM BLOWS, GRASP THE HAMMER FIRMLY NEAR THE END OF THE HANDLE AND SWING IT WITH A FREE GRACEFUL SWEEP, WELL OVER THE SHOULDER.
TO STRIKE LIGHT BLOWS, AS IN DRIVING RIVETS, GRASP THE HANDLE NEARER THE HEAD AND SWING WITH A MOTION SLIGHTLY AT THE ELBOW BUT CHIEFLY AT THE WRIST.

STANLEY

THE BALL PEIN HAMMER, WEIGHING ABOUT 1½ TO 2 LBS., IS A GOOD GENERAL PURPOSE LIGHT WEIGHT HAND HAMMER FOR FORGE WORK. NOTICE THE BLACKSMITH EXTENDS HIS THUMB ALONG THE BACK OF THE HANDLE.

TO RIVET WITH A BALL PEIN HAMMER, SUPPORT THE RIVET ON SOMETHING HARD, A STAKE OR A DOLLY ETC. DRAW THE PARTS TOGETHER WITH A RIVET SET OR WITH A DRIFT; STRIKE STRAIGHT DOWN ON THE RIVET WITH THE BALL PEIN, HEAD THE RIVET OVER WITH THE BALL PEIN OR WITH THE FACE OF THE HAMMER.

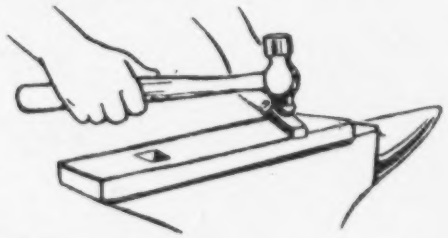

TO CHANGE A CENTER PUNCH MARK, HAMMER OUT THE OLD MARK WITH THE BALL PEIN.

TO AVOID ACCIDENTS

USE GOGGLES TO PROTECT YOUR EYES.
INSPECT THE HAMMER EVERY TIME IT IS CHECKED OUT OF THE TOOL ROOM. BE SURE THE HEAD IS FIRMLY ATTACHED AND THE WEDGES DRIVEN TIGHTLY IN PLACE.
AVOID STRIKING THE HANDLE TO SAVE IT FROM BREAKAGE.
AVOID CHIPPING THE EDGES OF THE HAMMER FACE WHEN STRIKING HARD METALS.
AVOID STRIKING WITH THE CHEEK OF THE HAMMER AS IT IS THE WEAKEST PART.

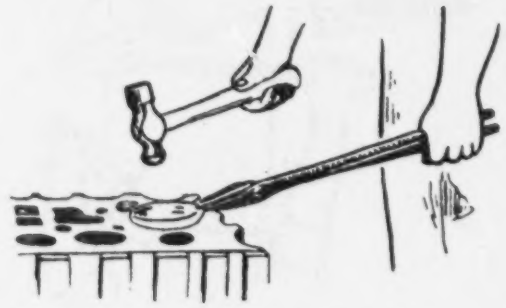

TO RAISE A BOWL SHAPED FORM, SUCH AS THE BOWL OF A SOLDER LADLE, HOLD THE WORK OVER A SWAGE BLOCK OR SUITABLE FORM OR STAKE AND BEAT IT OUT WITH THE BALL PEIN.

STANLEY TOOLS
NEW BRITAIN CONN. U.S.A.

EDUCATIONAL DEPARTMENT
CHART NO. 33

HOW TO SET THE

STANLEY PLANE

STANLEY

1.

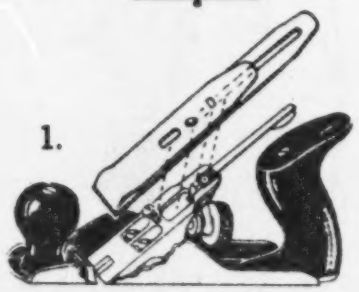

TO PUT THE PLANE TOGETHER LAY THE PLANE IRON BEVEL SIDE DOWN ON THE FROG BE SURE THE ROLLER ON THE LATERAL ADJUSTING LEVER THE END OF THE "Y" ADJUSTING LEVER AND THE HEAD OF THE PLANE IRON CAP SCREW ARE CORRECTLY SEATED

2.

SLIP THE LEVER CAP UNDER THE LEVER CAP SCREW AND PRESS DOWN THE CAM IF THE PLANE IRON IS IN THE CORRECT POSITION THE CAM WILL EASILY SNAP IN PLACE IF THE CAM WILL WILL NOT SNAP IN PLACE EASILY, SLIGHTLY LOOSEN THE LEVER CAP SCREW

IF THE PLANE IRON IS NOT FIRMLY HELD WHEN THE CAM IS IN PLACE SLIGHTLY TIGHTEN THE LEVER CAP SCREW

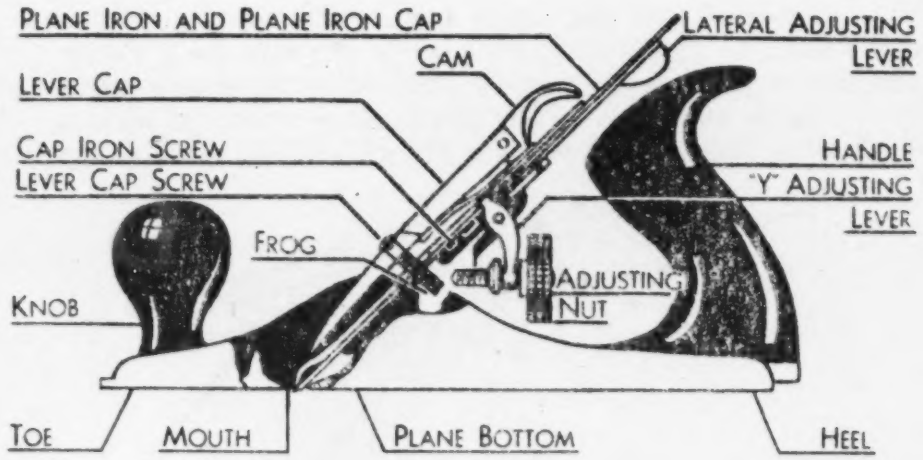

TO ADJUST FOR THE THICKNESS OF THE SHAVING SIGHT ALONG THE BOTTOM OF THE PLANE AND TURN THE ADJUSTING NUT UNTIL THE CUTTING EDGE PROJECTS ABOUT THE THICKNESS OF A HAIR

3.

THE PLANE IRON IS PUSHED OUT WHEN THE ADJUSTING NUT MOVES OUT TOWARD THE HANDLE

THE PLANE IRON IS DRAWN IN WHEN THE ADJUSTING NUT MOVES IN TOWARD THE FROG

STANLEY

4.

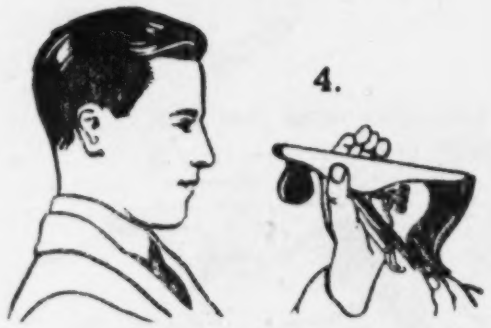

TO ADJUST FOR THE EVENNESS OF THE SHAVING SIGHT ALONG THE BOTTOM OF THE PLANE AND MOVE THE LATERAL ADJUSTING LEVER TOWARD THE RIGHT OR THE LEFT

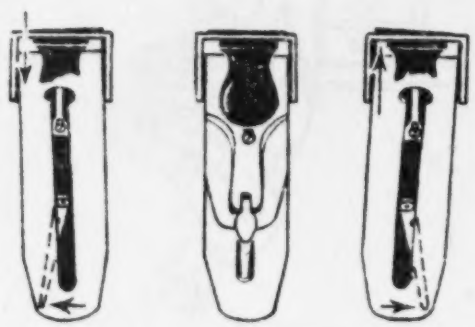

KNOB LEVER CAP AND PLANE IRON CAP REMOVED TO SHOW THE ACTION OF THE LATERAL ADJUSTING LEVER

STANLEY TOOLS
NEW BRITAIN CONN. U.S.A.
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EDUCATIONAL DEPARTMENT
CHART NO. 13
BY R. C. REGER

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HOW TO USE THE

STANLEY PLANE

STANLEY

TO START PLANING TAKE AN EASY BUT FIRM POSITION DIRECTLY BACK OF THE WORK.

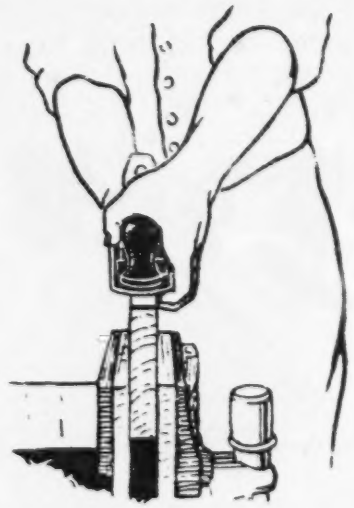

HOLD THE PLANE SQUARE WITH THE WORK FACE OF THE WORK.

STANLEY TOOLS
NEW BRITAIN CONN U.S.A.

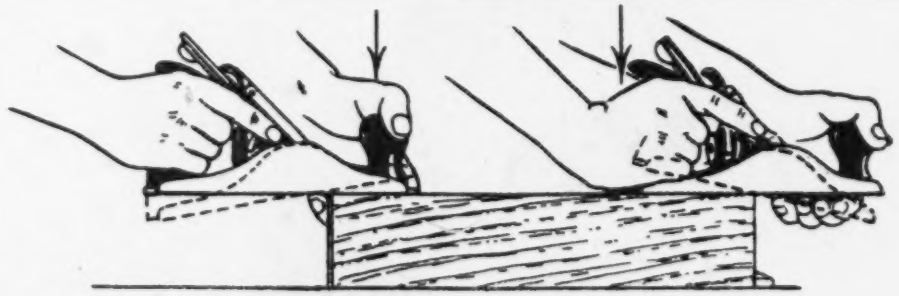

TO CUT A SMOOTH STRAIGHT EDGE THE PLANE IS PUSHED WITH THE GRAIN, THAT IS IN THE UP HILL DIRECTION OF THE FIBRES.
TO KEEP THE PLANE STRAIGHT PRESS DOWN ON THE KNOB AT THE BEGINNING OF THE STROKE AND ON THE HANDLE AT THE END OF THE STROKE. AVOID DROPPING THE PLANE AS SHOWN BY THE BROKEN LINES. IT ROUNDS THE CORNERS.

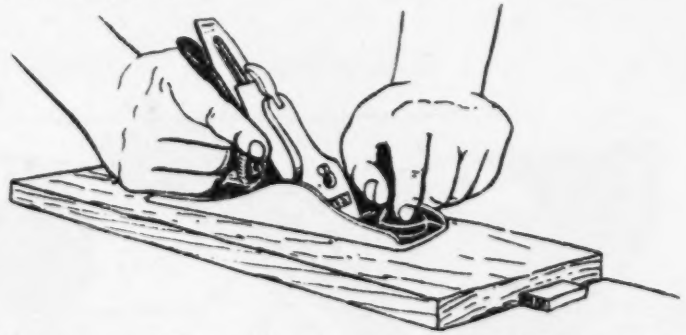

TO OBTAIN A SMOOTH SURFACE PLANE WITH THE GRAIN. IF THE GRAIN IS TORN OR ROUGH AFTER THE FIRST STROKE REVERSE THE WORK.
IF THE GRAIN IS CROSS OR CURLY, SHARPEN THE PLANE IRON CAREFULLY. SET THE PLANE IRON CAP AS NEAR THE CUTTING EDGE AS POSSIBLE AND ADJUST THE PLANE IRON TO TAKE A VERY THIN EVEN SHAVING.

IT IS EASIER TO PLANE A LONG EDGE STRAIGHT WITH A LONG PLANE THAN WITH A SHORT ONE. A LONG PLANE BRIDGES THE LOW PARTS AND DOES NOT CUT THEM UNTIL THE HIGH SPOTS ARE REMOVED.

STANLEY

AT THE END OF THE STROKE THE WEIGHT OF THE BODY SHOULD BE CARRIED EASILY ON THE LEFT FOOT.

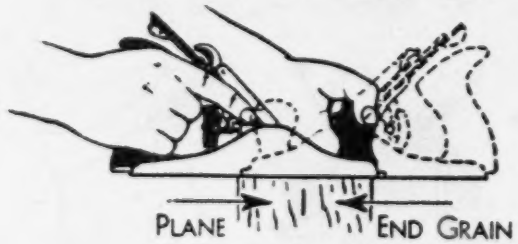

HALF WAY FROM EACH EDGE.

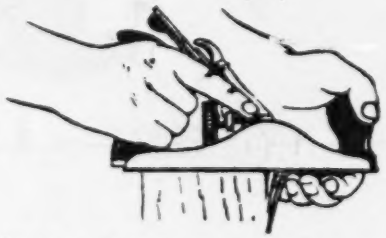

IF THE PLANE IS PUSHED ALL THE WAY THE CORNERS WILL BREAK.

EDUCATIONAL DEPARTMENT
CHART NO. 14
BY R. O. REGER

MEASURING DEVICES, SHOP HAMMERS AND PLANES

1. Name several kinds of measuring devices and explain where each is used.

2. Give several uses of the T Bevel square.

3. Explain how you would mark parallel lines using the rule.

4. What advantage does the pull-push rule have over the zig zag rule?

5. What is the difference in a cross pein, straight pein and ball pein hammer? Where is each used?

6. Name the parts of a ball pein hammer.

7. How is the ball pein hammer held for forge work?

8. How is the ball pein hammer held for riveting?

9. Name several ways to avoid accidents while using the ball pein hammer.

10. Name the parts of a cross pein hammer.

11. What hammer would you use to stretch a piece of stock in the direction of its width?

12. What hammer would you use to stretch a piece of stock in the direction of its length?

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13. When should we grind a plane iron?

14. What angle should a plane iron be ground?

15. Why is it necessary to dip a plane iron in water while grinding?

16. Which way should the grind stone turn while sharpening a plane iron?

17. Why is it necessary to use a guide while sharpening a plane iron?

18. Explain the procedure to follow in putting a real sharp cutting edge on a plane iron with an oil stone.

19. How do we remove the wire edge from a sharpened plane iron?

20. Explain how to put the plane iron and plane iron cap together.

21. What happens if the edge of the plane iron cap doesn't fit tight?

22. How do we adjust a hand plane for the thickness of the shaving?

23. How do we adjust the hand plane for evenness of the shaving?

24. Why should a hand plane be left on its side after use?

25. Explain how you would plane the end of a board with a hand plane.

26. What position should a person stand while using the plane?

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Tool Sharpening

Materials and Equipment

1. Electric grinder* with tool rest
2. Oil stone (flat)
3. Files
4. Grinding wheel dresser
5. Knives
6. Axes or hatchets
7. Set wood chisels
8. Cold chisels
9. Steel punches
10. Screwdrivers
11. Auger bits
12. Twist drills
13. Plane blades

Exercises for Student

1. Dress a grinding wheel.
2. Sharpen a knife.
3. Sharpen an axe.
4. Sharpen a plane blade.
5. Sharpen a wood chisel.
6. Sharpen a cold chisel.
7. Sharpen a steel punch.
8. Re-shape a screwdriver.
9. Sharpen a twist drill.
10. Sharpen an auger bit.

Exercise 1. Dress a grinding wheel.

A. Select wheel dresser.
B. Adjust grinder guards and shields for complete protection.
C. Set wheel dresser on tool rest and approach revolving grinder wheel.
D. Dress wheel until square edge is formed with the sides.

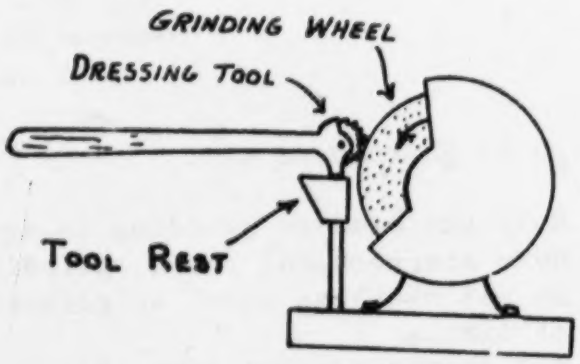

*The basic operations of the grinder should be taken up before completion of this section on tool sharpening.

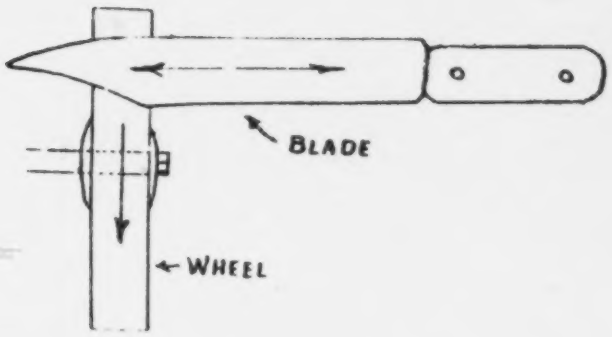

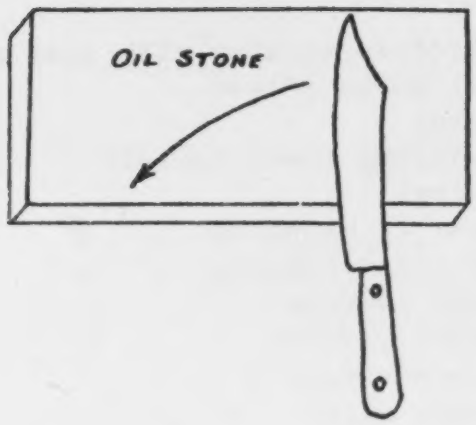

Exercise 2. Sharpen a knife.

A. Make certain knife handle is secure on blade.
B. Have water coolant present.
C. Adjust grinder guards and shields for complete protection.
D. Choose a finer grinding wheel for this work.
E. Hold knife blade against wheel so wheel surface is turning against knife edge.
F. Gradually approach knife blade to face of revolving wheel and keep moving blade from one end to other to avoid overheating. Occasionally dip knife in coolant if necessary
G. Grind a bevel on both sides of the blade to a feathered edge.
H. Using an oilstone, whet the blade by laying the blade nearly flat on the stone and stroking against blade edge. (Use oil on stone.)

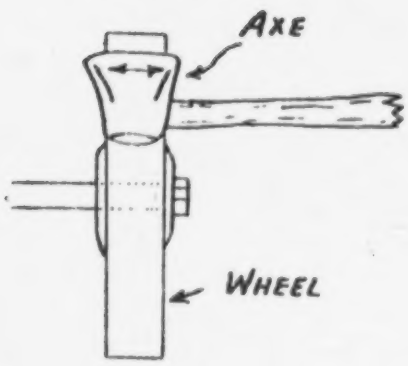

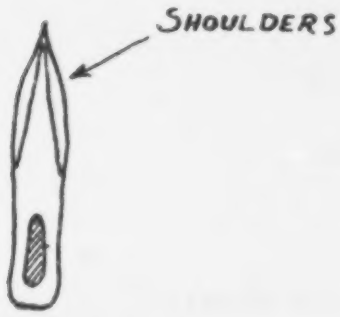

END VIEW OF AXE GROUND INCORRECTLY

END VIEW CORRECTLY GROUND

Exercise 3. Sharpen an axe.

A. Hold axe head so grinding is against cutting edge.
B. Move axe back and forth, grinding entire width of blade.
C. Do not overheat steel by grinding in one area for a long period of time.
D. Wet sharpened edge with oilstone.

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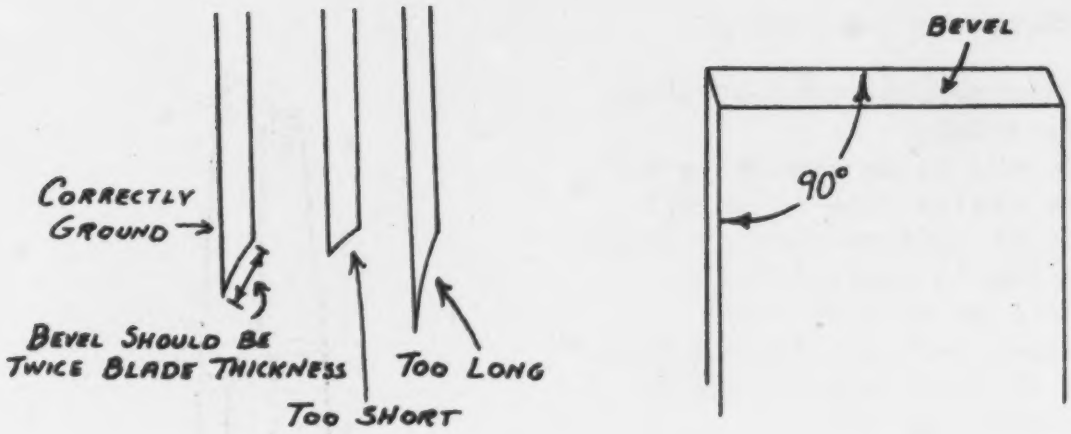

Exercise 4. Sharpen a plane blade.

A. Square the cutting edge of the blade with the sides.
B. Bevel on the blade should be twice as long as the thickness of blade.
C. Hold blade against face of wheel so grinding is against blade. Bevel must be on one side of blade only.
D. Move blade back and forth across surface of the sheel until a sharp cutting edge appears.
E. Hold blade on oilstone so cutting edge and back side of bevel are touching oilstone.
F. With a circular motion on oilstone whet a keen edge. (Free of barbs)

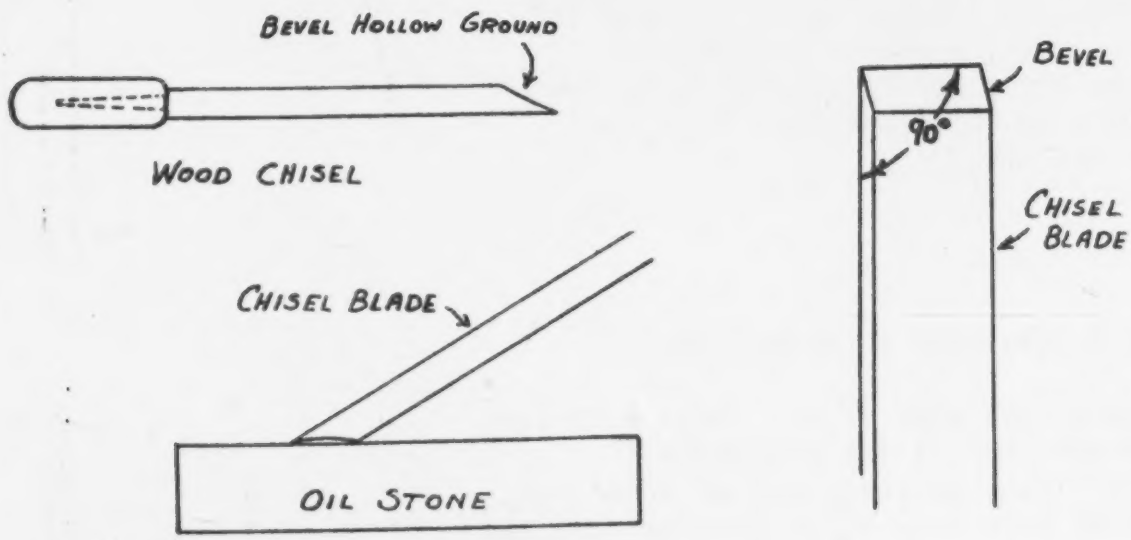

Exercise 5. Sharpen a wood chisel.

A. Square the cutting edge of blade with the sides.
B. Bevel on chisel should be twice as long as thickness of the blade.
C. Hold chisel against face of wheel so grinding is against blade. Bevel should be on one side only.
D. Move chisel back and forth across surface of wheel until a sharp cutting edge appears.
E. Hold blade on oilstone so cutting edge and back side of bevel are touching oilstone.
F. With a circular motion whet a keen edge. (Free of barbs)

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Exercise 6. Sharpen a cold chisel.

A. Square the cutting edge of blade with the sides.
B. Bevel on the blade should be 35° with the center line of chisel.
C. Hold chisel against face of wheel so grinding is against blade. Bevel will be on both sides.
D. Move chisel back and forth across surface of wheel until a sharp cutting edge appears.
E. When the grinding operation is complete, a 70° angle will be formed at the cutting edge.

Exercise 7. Sharpen a steel punch (center punch).

A. The circular bevel should be 35° with the center line of the punch.
B. Hold punch against face of wheel and rotate at correct angle between fingers until a sharp tip appears.
C. When the grinding operation is complete, a 70° angle will be formed at the tip.

Exercise 8. Re-shape a screwdriver.

A. Square the edge of the blade with the center line of the screwdriver.
B. Hold blade against face of wheel and grind to a long taper (nearly parallel) as illustrated in diagram at right. The side of the wheel may be used for larger screwdrivers.
C. A square tip should result from this operation.

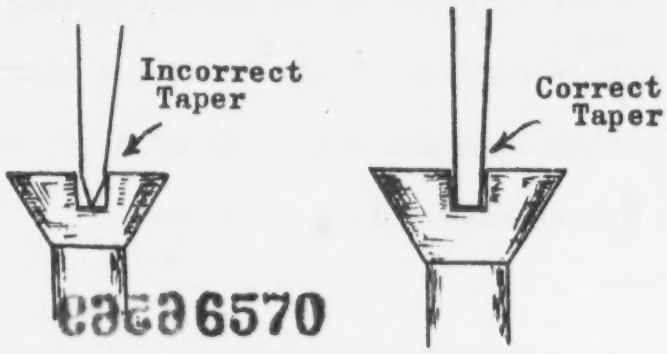

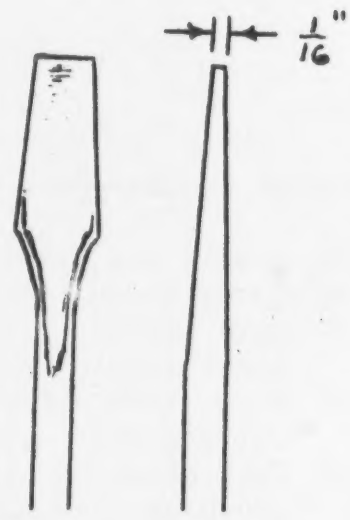

Face View Edge View

Screwdriver

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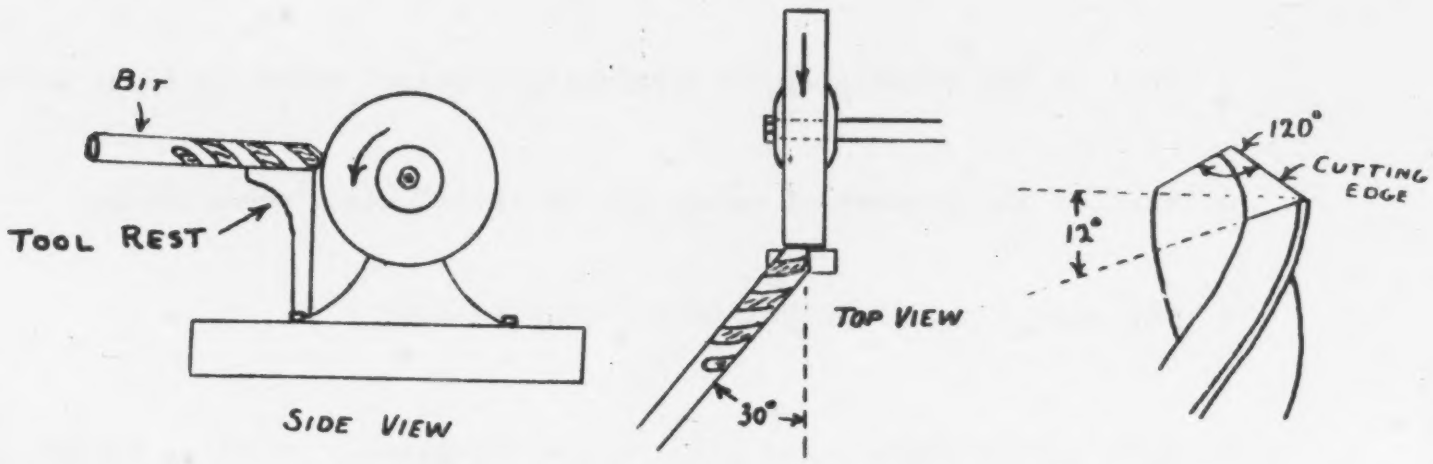

Exercise 9. Sharpen a twist drill.

A. Arrange the tool rest level with the shaft of the wheel.
B. Hold the drill cutting lip up, horizontal and against the grinding wheel supported by the tool rest.
C. Swing shank end to the left 30° from the perpendicular to the shaft of the wheel.
D. Grind slowly and end the grinding with a downward motion of the shank.
E. The cutting edge of the lip should be the highest point on the bevel.
F. Do the same with other lip, making sure each cutting edge is the same length and same angle.

Exercise 10. Sharpen an auger bit.

A. Using an auger bit file, sharpen the bottom side of the cutting lip next to the shank. (On two-lipped bits sharpen both lips.)
B. Sharpen the cutting spurs on inside only. (Make certain leading edge and top are sharp.)

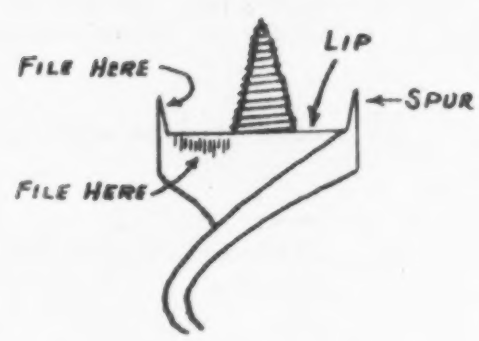

1. What is the purpose of dressing a grinding wheel?

2. What is the first step in sharpening a chisel which is badly nicked?

3. What is the purpose of using oil on an oil stone when honing?

4. When should shoulders be removed from an axe?

5. When should chisels and plane blades be given a grinding on the grinding wheel?

6. When sharpening a twist bit, explain why the cutting edge must be the highest point on the bevel.

7. What three places must be filed on an auger bit?

8. How could you be sure the sharp edge of a plane blade is at right angles to the sides?

9. What is the purpose of honing after tools are ground on grinding wheel?

10. How is the wire edge removed in the honing process?

11. List the essential grinding and sharpening equipment needed by the average home owner.

12. What 3 precautions should be observed when sharpening tools?

13. List all tools around the home that require sharpening from time to time.

14. How should tools be cared for to prevent nicking of sharp edges?

15. What damage results by over-heating a tool while grinding?

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POWER TOOL STUDY

Students will discover in this unit that power tools are more efficient than hand tools in performing skills and constructing useful projects. The previous study of hand tools should be helpful to students in being familiar with shop procedure and safety practices.

In order to make the best use of power tools, a student must first learn what the equipment will do, the best and safest way to use, and the proper care that the equipment should receive.

The exercises on the following pages, if performed as directed, will give the student the necessary practical experiences to operate power equipment safely and effectively.

<u>List of power tools student will learn to operate in this unit of work.</u>

1. The circular saw (tilting arbor)
2. The band saw
3. The jig saw
4. The drill press
5. The portable electric drill
6. The grinder
7. The disk sander
8. The portable belt sander

THE CIRCULAR SAW (TILTING ARBOR)

Give the principal use of the following parts of the circular saw:

1. Miter gage

2. Fence

3. Front graduated guide bar

4. Fence clamp handle

5. Fence micro set knob

6. "T" slot for miter gage

7. Lock knob

8. Saw tilt handwheel

9. Saw raising handwheel

10. Saw tilt scale

11. Switch

12. Splitter

13. Sawdust clean out

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Circular Saw

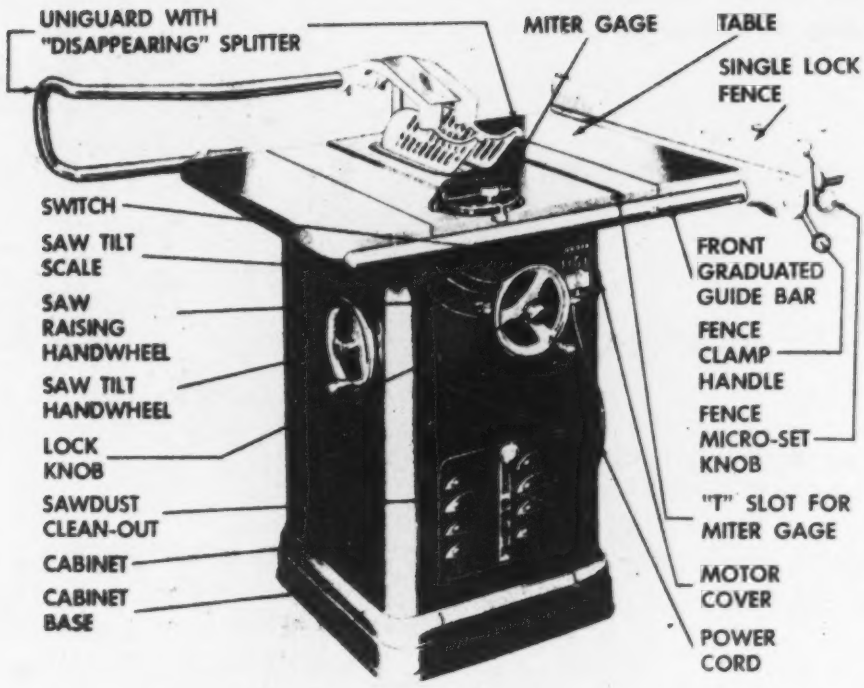

DELTA 10" TILTING ARBOR UNISAW®

(Courtesy Rockwell Mfg. Co.)

II. Safety Rules for the Circular Saw:

1. The guard must be kept down over the saw while machine is in operation.

2. The saw blade must not be raised above the table more than necessary to make the cut.

3. Use a push stick when ripping narrow pieces of lumber.

4. A clearance block must be fastened to fence when cutting off pieces of lumber.

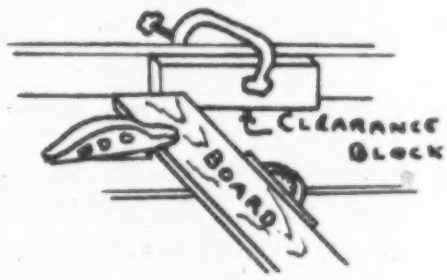

5. Fence must be adjusted only when saw is <u>completely</u> stopped.

6. Fingers must be kept clear of track of saw. Hands must never be allowed to cross saw line while machine is in operation.

7. Dado heads and special set-ups must be inspected by instructor before turning on power.

8. The dado head must be taken off the saw arbor after use.

9. Never attempt to clear away scraps close to the saw with fingers. A stick at least two feet long should be used. Care should be taken not to allow scraps or stick to touch moving saw.

10. Students should never pull on a board being ripped. The person assisting at tail of saw should hold board up and allow operator to push stock through the saw.

Circular Saw

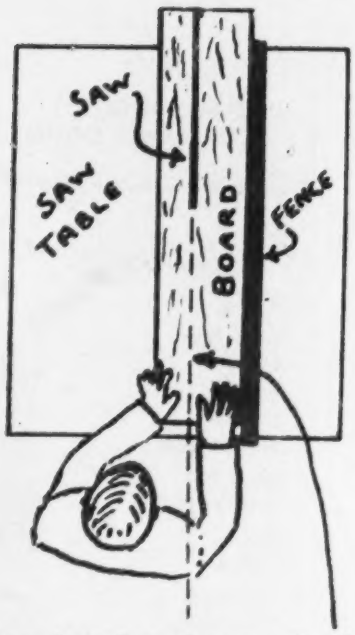

Keep hands clear of this area. Stand a little to left of saw line. Push board with right hand; guide board with left hand.

11. Re-sawing on circular saw should be done only after receiving permission from the instructor.

12. Never cut round stock on a circular saw.

13. It is a dangerous operation to lower stock down over the saw, an operation sometimes performed when cutting holes in rails for drawer fronts. This type of work requires the permission of the instructor before it is attempted.

14. It is extremely dangerous to rip stock without the use of the ripping fence or to crosscut stock without the use of the sliding crosscutting fence. These practices are forbidden. This rule also applies to dado head work.

15. Be sure the fence of other set-up is not in line of saw before power is turned on.

16. Be sure the blade on a tilting arbor saw will clear on both sides of the insert plate before turning on power.

17. Angle cutting or tilting arbor requires permission from the instructor.

18. Always use miter gauge when doing crosscut work.

    (a) Always keep hands on miter gauge side of the saw blade. Never push from both sides of blade.
    (b) Never use fence for length gauge in crosscutting unless a stop is clamped on.
    (c) Never stand in line of the saw blade.

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III. Basic Operations Student Should Learn about the Circular Saw:

The following operations should be demonstrated and each student should be given the opportunity to perform the operations.

1. How to loosen arbor nut.

2. How to set correct height of saw blade above stock.

3. How to position hands for ripping wide stock.

4. How to position hands for ripping narrow stock.

5. How to position both operators when ripping long stock.

6. How to position hands for crosscutting stock.

7. How to position attachments (miter gauge, clamps, and stop) for setting clearance block.

IV. Operations Involving Use of Circular Saw.

Exercise 1. Cut square stock.

A. Select stock.
B. Raise saw blade $\frac{1}{4}$" above stock.
C. Set miter joint at 90°.
D. Measure and cut stock to length.
E. Test stock for squareness with a try square.

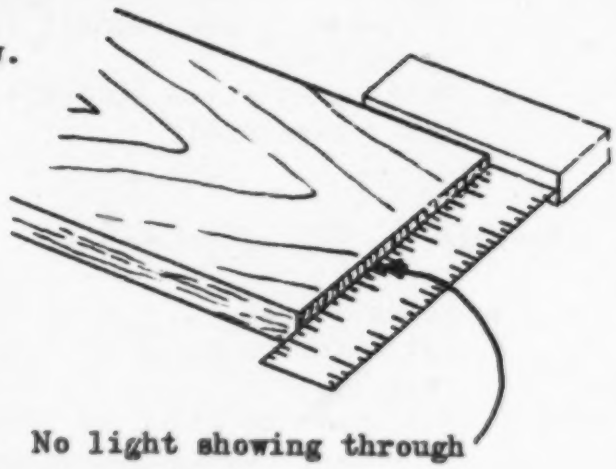

Exercise 2. Cut bevel on stock (with grain).

A. Select stock.
B. Set angle of blade to bevel selected.
C. Raise saw blade $\frac{1}{4}$" above stock.
D. Position fence to width of finished stock.
E. Make cut with push stick and test for correct angle with T-bevel.

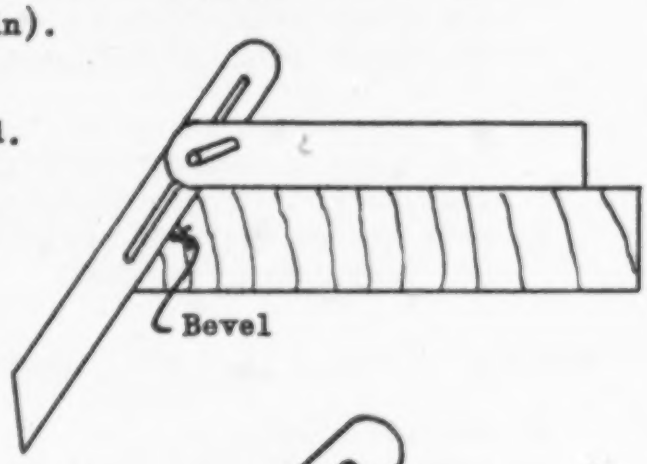

Exercise 3. Cut a chamfer.

A. Select stock.
B. Set angle of blade to chamfer angle.
C. Raise saw blade $\frac{1}{4}$" above stock.
D. Position fence to width of finished stock.
E. Make cut with push stick and test for correct angle.

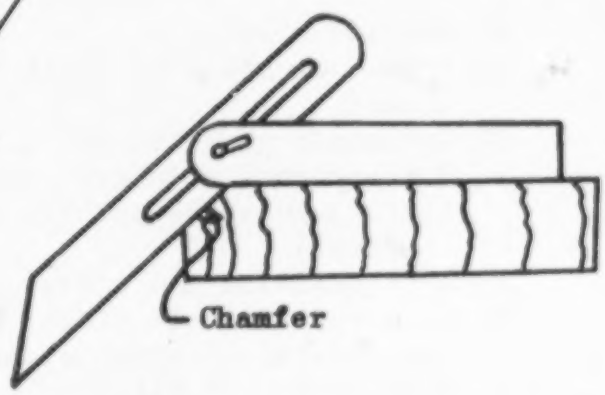

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Exercise 4. Cut a Miter joint.

A. Select stock.
B. Raise saw above stock $\frac{1}{4}$".
C. Set miter gauge to 45° and lock.
D. Firmly hold stock against miter gauge and cut angle.
E. Cut two pieces and test squareness of fit with try square.

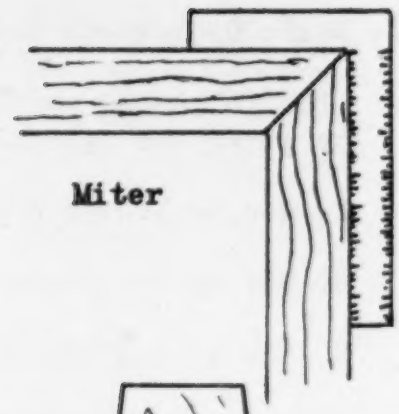

Exercise 5. Cut a crosslap joint.

A. Select stock and plane edges straight and parallel.
B. Raise saw to $\frac{1}{2}$ thickness of stock.
C. Set miter gauge to 90° and test with try square.
D. Make all outside cuts first, followed by the removal of inner stock.
E. Test joint for a snug fit. (hand assembled)

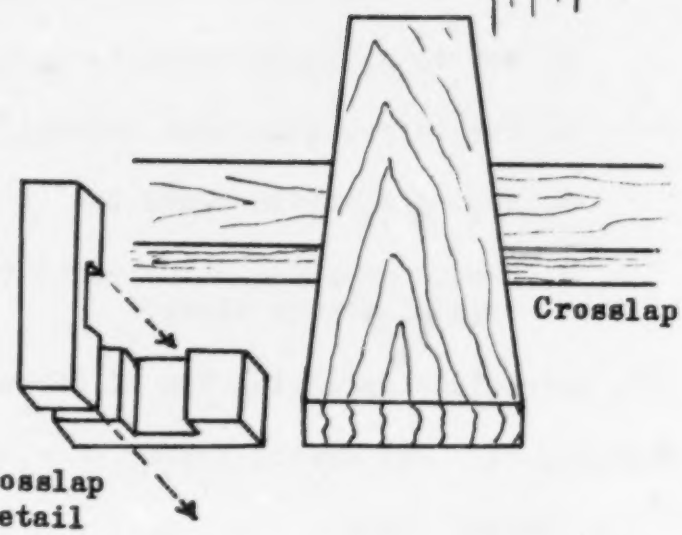

Exercise 6. Cut rabbet joint.

A. Select stock.
B. Raise saw to depth of joint selected.
C. Set fence to width of joint selected. Caution: For an end grain rabbet joint use the miter gauge in addition to the fence.
D. Make first cut using push stick and reset block and fence if necessary for complete cutout.
E. Make second cut with push stick and test joint for size.

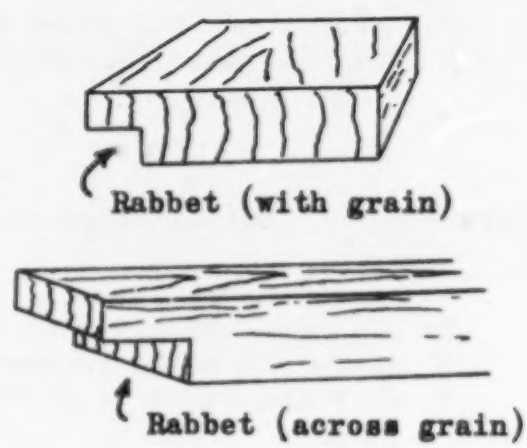

Exercise 7. Cut a dado joint (across the grain).

A. Select stock.
B. Raise saw blade to depth of joint needed.
C. Set miter gauge to 90° and test for accuracy with try square. (Dado joints are usually at right angles.)
D. Mark position and width of dado joint.
E. Make outside cuts first, followed by the removal of inner stock.
F. Test joint for fit.

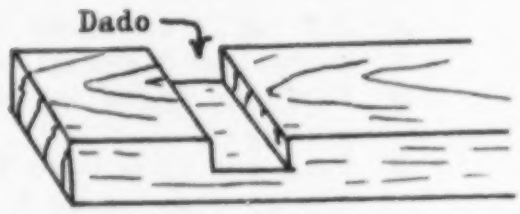

6578

Exercise 8. Cut a groove (with the grain).

A. Select stock.
B. Adjust saw blade to depth of groove selected.
C. Set fence to width of shoulder.
D. Make outside cuts first, followed by the removal of the inner stock.
E. Test joint for fit.

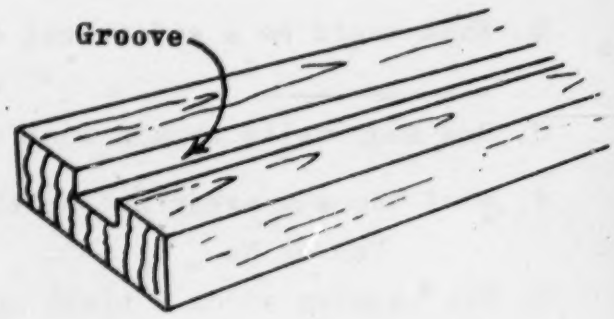

Exercise 9. Cut a gain.

A. Select stock.
B. Adjust saw blade or dado head to depth of gain.
C. Locate fence to position of gain on the stock.
D. Locate and clamp stop blocks to begin and end the cutting operation.
   CAUTION: This operation requires instructor's permission and supervision.
E. Using push stick carefully, make cut.
F. Test for size.
G. Cut out ends of gain with sharp wood chisel.
H. Test for size.

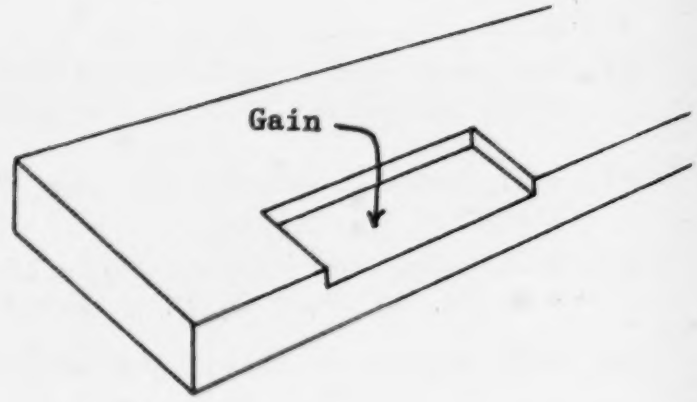

COMPOUND ANGLE CHART

Tilt of Work (degrees)	Equivalent taper per inch	4 Side Tilt	Butt Miter Gauge	4 Side Tilt	Miter Miter Gauge	6 Side Tilt	Miter Miter Gauge	8 Side Tilt	Miter Miter Gauge
5	.087	½	88	44¾	88	29 3/4	87½	22½	88
10	.176	1½	80½	44½	80½	29½	84½	22	86
15	.268	3 3/4	75½	43½	75½	29	81 3/4	21½	84
20	.364	6½	71½	41 3/4	71½	28½	79	21½	82
25	.466	10	67	40	67	27½	76½	20½	80
30	.577	14½	63½	37 3/4	63½	26	74	19½	78½
35	.700	19½	60½	35½	60½	24½	71 3/4	18½	76 3/4
40	.839	24½	57½	32½	57½	22 3/4	69 3/4	17	75
45	1.000	30	54 3/4	30	54 3/4	24	67 3/4	15 3/4	73 3/4
50	1.190	36	52½	27	52½	19	66½	14½	72½
55	1.430	42	50 3/4	24	50 3/4	16 3/4	64 3/4	13½	71½
60	1.730	48	49	21	49	[illegible]	[illegible]	11	70½

6570

Circular Saw Study Questions:

1. What is the average blade diameter of a cabinet shop or school circular saw? _____"

2. What would be a sufficient size of blade for a home shop circular saw? _____"

3. How many volts should most circular saws operate on? _____ volts

4. Must the saw arbor nut be tightened with an extreme amount of pressure? Yes or No

5. For ripping stock a blade must have an adequate amount of _____.

6. The saw blade should never project more than _____ inches above stock.

7. Can you push stock too slowly through a ripping operation? Yes or No

8. What is the recommended R. P. M. for most circular saws? _____RPM

9. Crosscutting on a circular saw should always, if possible, be done with the use of what attachment on the saw? _____

10. When making a dado cut, should the outside or inside cuts be made first? _____

11. At least what length should the stock be before a person should have a stand or helper support the work? _____ feet

12. When dadoing, should the same throat plate be used as when using a rip blade? Yes or No.

13. When using the ripping fence an occasional check or measurement should be made to see that it is parallel with the saw blade. True or False

14. What should be added to a miter gauge to give added support to the work?

15. When tilting the saw arbor and blade, care must be taken to keep blade from striking the _____ _____.

16. Describe the two settings to be made when making a compound angular cut on a circular saw.

17. Name the two materials that the saw blade teeth are generally made of.

_____ and_____

18. For most average work where an extremely smooth cut is not necessary the _____ blade can be used.

19. For the ripping of a quantity of stock a _____ blade should be used with a maximum of set.

20. A new safety blade that reduces most kickbacks is called the _____ blade.

6580

Circular Saw Safety Exam:

1. The guard should always be in position while the saw is being used for ripping or crosscutting. True or False

2. The saw blade should never project far above the stock being cut. T or F

3. A _____ must be used to push narrow stock through the saw.

4. The fence should never be used for a guide for cutting off short pieces of stock. True or False.

5. When should the fence be adjusted?

6. The face and body should never be in line with the saw blade when running. True or False

7. Who should inspect special set-up or dado cuts? _____

8. Is it ever permissible to clear scraps away from the blade when it is running? Yes or No With what? _____

9. The dado head should be removed from the saw arbor immediately after use. True or False

10. When assisting someone in ripping long stock, one should only hold up on the board and never pull the stock. True or False

11. Re-sawing is never done on a circular saw. True or False

12. Round stock should never be cut on the circular saw if at all possible to cut it somewhere else. True or False

13. The miter gauge is used chiefly for ripping long boards. True or False

14. How many persons should be operating the circular saw at one time? _____

15. When removing a blade from the circular saw, operator should leave electric plug attached to outlet. True or False

16. How tight should the burr be holding the blade on the arbor?

17. For general sawing the _____ blade is much safer and more practical.

18. If stock should become pinched while sawing, what steps should you take? Answer completely.

19. Do you understand each question fully?

Yes_____ No_____

Signed_____

Date_____

6581

THE BAND SAW

Give the principal use of the following parts of the band saw:

1. Upper wheel guard

2. Blade guard

3. Blade guides

4. Table

5. Rear blade guard

6. Lower wheel guard

7. Ball bearing blade support

8. Guide post

9. Blade support lock screw

10. Blade guide lock screw

11. Table insert

12. Miter gage groove

13. Ball bearing blade support adjusting screw

14. Adjusting screw for blade guides

6582
1829

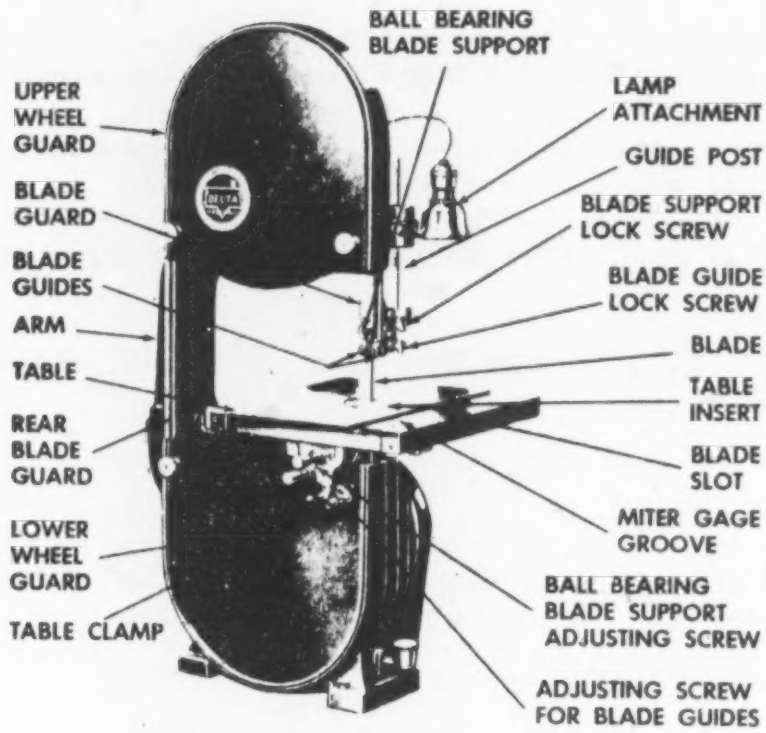

DELTA 14" BAND SAW

(Courtesy Rockwell Mfg. Co.)

II. <u>Safety Rules for Band Saw</u>

1. Be sure you have observed a class demonstration by the instructor.

2. Be sure the instructor gives you permission and observes you the first time you operate a band saw.

3. You must pass a written safety test on the band saw before operating it.

4. Check adjustment of the blade by moving the wheels by hand.

5. Adjust top guide to within $\frac{1}{4}$" of the work.

6. Before starting the cut, see that the guide wheels are barely turning.

7. Do not twist the blade trying to force it to cut too sharp a curve. The friction developed crystallizes the blade and will cause it to break.

8. A cracked or partially broken blade will saw for a short time, with a knock or kick. Stop the saw and report it to the instructor.

9. Always saw through stock whenever possible. When necessary to back out of a cut, go slowly, and be sure not to pull blade away from guides.

10. Always use special jig for sawing cylindrical stock.

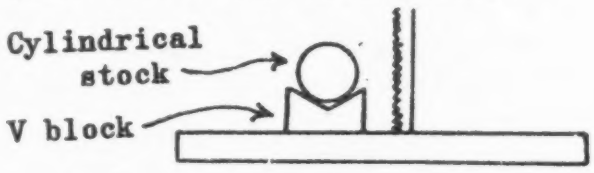

11. Always consult instructor before sawing stock with small or irregular bearing on the saw table.

12. Replace a worn throat plate because chips of wood may fall through and be caught between blade and lower wheel causing blade to break.

13. If blade breaks, step away from it quickly, and shut off power. Do not touch blade until both wheels have stopped.

14. The operator or spectators should not stand in line with revolving band saw.

15. Keep hands and fingers away from front of blade. Use extreme care when sawing small pieces.

III. Basic Operations Students Should Learn about the Band Saw:

The following operations should be demonstrated and each student should be given the opportunity to perform them.

1. How to saw irregular curves.

2. How to re-saw stock.

IV. Exercises Involving Use of Band Saw:

Exercise 1. Saw an irregular curve.

A. Select stock.

B. Lay out the desired shape on stock.

C. Adjust height of guide post to the stock.

D. Examine the machine for properly placed guards.

E. Approach stock slowly to moving blade and make the prescribed cut. Anticipating the path of the blade insures accuracy and faster work.

F. When finished, observe accuracy of work.

Exercise 2. Re-saw 3/4" stock.

A. Select stock.

B. Clamp fence at correct distance from blade.

C. Adjust height of guide post to the stock.

D. Examine the machine for properly placed guards.

E. Approach stock slowly to moving blade and complete the cut. Steady pressure of the stock against the fence insures desired thickness.

F. When finished, measure thickness of stock at various points.

6584

Study Questions on the Band Saw

1. A band saw is used for cutting_____ as well as wood and soft materials.
2. When mounting and lining up a blade on a band saw, the teeth should point _____(up or down).
3. The upper guide should clear the stock by how much? _____inch.
4. What is the function of the upper guide and rollers?
5. When sawing freehand work with a band saw, one should look slightly ahead or directly in front of the blade. Why?
6. What attachment is needed for resawing on the band saw?
7. What is generally the maximum thickness of stock that can be cut on your shop band saw?

Safety Test on the Band Saw

1. Why is it advisable to check adjustment of the blade by moving wheels by hand?
2. How close should the top guide be to the work?
3. Why is it poor practice to twist the blade in an effort to cut a sharp curve?
4. A student stopped the saw because he said he heard a series of clicks or knocks while cutting. Explain why this was good procedure.
5. Explain why great care should be taken when backing out of a cut.
6. What precaution should be taken when sawing cylindrical work?
7. What procedure should you follow when sawing stock with small or irregular bearing on the saw table?
8. Why is a worn throat plate considered a hazard?
9. Explain your procedure if a blade breaks while you are operating a band saw.
10. Why is it poor practice to allow observers to stand in line with the revolving band saw blade?
11. Explain the precautions about the positions of your hands and fingers.
12. Do you understand each question fully? Yes_____ No_____

Signed_____ Date_____

6585

Portable Electric Drill

I. Identify

1. _____

2. _____

3. _____

4. _____

5. _____

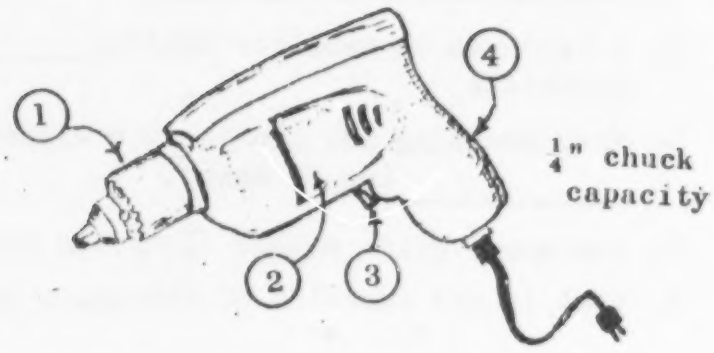

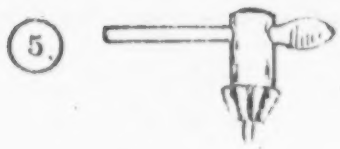

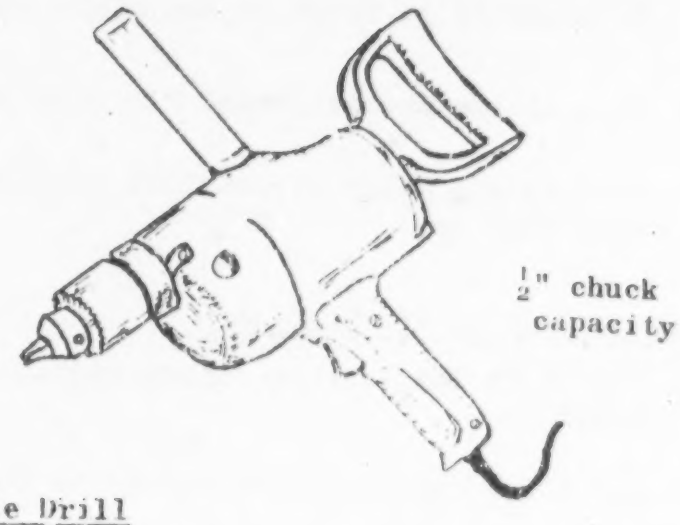

II. Safety Rules for the Portable Drill

1. Make certain third wire is used and is fastened securely to a proper ground.

2. Make certain chuck key is removed from chuck before drill is switched on.

3. Keep a firm grip on the drill while using to avoid being twisted free and causing injury.

III. Basic Operations for Student to Learn

All following operations should be demonstrated and students should be given an opportunity of performing the operations.

1. How to use a twist drill.

2. How to use a speed drill.

3. How to use a countersink.

4. How to use a buffing pad.

5. How to use a masonry drill.

6. How to use a hole cutter.

7. How to use a sanding disk.

6586

Study Questions on Portable Electric Drill

1. What does $\frac{1}{4}$" mean when designating drill size?

2. What does $\frac{1}{2}$" mean when designating drill size?

3. What speed (R. P. M.) does the $\frac{1}{4}$" drill operate at? _____R. P. M.

4. What speed (R. P. M.) does the $\frac{1}{2}$" drill operate at? _____ to _____R.P.M.

5. Considering the speed of each drill, which one should you use for drilling wood and soft materials? Give reason for your answer.

6. Considering the speed of each drill, which one should you use for drilling metal? Give reason for your answer.

7. To save unnecessary wear on a drill and to save time in what condition should a twist drill always be kept?

Safety Exam on Portable Electric Drill

1. Why is it always advisable to attach a ground wire to a portable electric drill?

2. Why should you always remove chuck key from chuck immediately after tightening or loosening?

3. Explain why one should keep a firm, steady grip on a portable electric drill.

4. With the pin lock trigger switch found mostly on larger drills what precaution must be observed while using it in locked position?

5. Do you understand above questions? Yes_____ No_____

Signed_____

Date_____

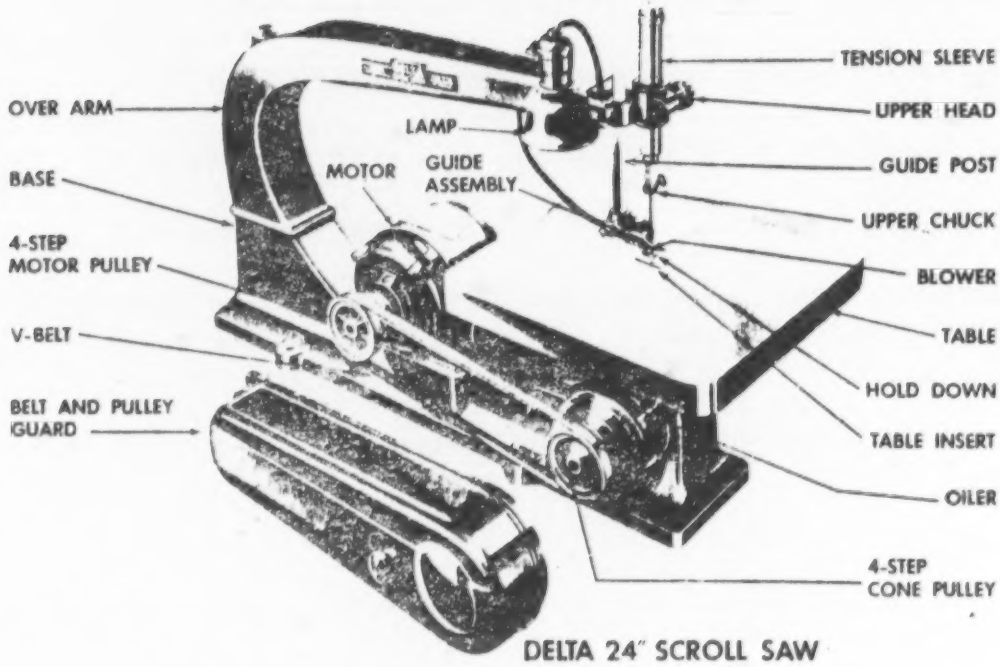

DELTA 24" SCROLL SAW

(Courtesy Rockwell Mfg. Co.)

II. Safety Rules for the Jig Saw

1. The hold down foot should be dropped directly on the stock being cut.
2. Fingers should be kept clear of the path of the saw blade.
3. No adjustments should be made when the machine is in operation.
4. Keep head and face at a distance from reciprocating plunger column.
5. Belt changes should be made only when power is off.

III. Basic Operations on Jig Saw

1. How to cut thin stock.
2. How to cut thick stock.
3. How to make an internal cut.

IV. Exercises Involving Use of Jig Saw:

Exercise 1. Cut thin stock.

A. Set motion of saw at faster speed.

B. Select and mount a fine blade.

(Continued on next page.)

6588

C. Adjust lamp for a well lighted area.

D. Drop hold down foot securely on stock being cut.

E. Approach stock to moving blade and cut at proper rate of feed.

F. Make turns as stock is cut being cautious not to twist blade.

Exercise 2. Cut thick stock.

A. Set motion of saw at slow speed.

B. Select and mount a coarse blade.

C. Adjust lamp for a well lighted area.

D. Drop hold down foot securely on stock being cut.

E. Approach stock to moving blade and cut at proper rate of feed.

F. Make turns as stock is cut being cautious not to twist blade.

Exercise 3. Make internal cuts.

A. Select motion of speed desired.

B. Select the proper blade for the stock being cut and mount only in lowe clamp.

C. Drill hole near area to be sawed for entrance of blade.

D. Slip stock over end of blade through hole and fasten blade at top clamp.

E. Adjust lamp for a well lighted area.

F. Drop hold down foot securely on stock being cut.

G. Approach stock to moving blade and cut at a proper rate of feed.

H. Make turns as stock is cut being cautious not to twist blade.

I. When internal cut is complete, loosen upper clamp and remove stock from blade.

6589

Study Questions on the Jig Saw

1. How coarse a jigsaw blade should be used for thin work?

2. How coarse a jigsaw blade should be used for thick work?

3. What is the advantage of having a lamp mounted on a jig saw?

4. What is the purpose of a blower on a jig saw?

5. Why should the upper blade clamp always clear the overhead cylinder?

6. At what speed should a jig saw be run with thin stock?

7. At what speed should a jig saw be run with thick stock?

8. How is speed of saw in your shop selected?

Safety Test on the Jig Saw

1. What danger is involved when a jig saw blade becomes dull?

2. Why should the hold down foot always be set down upon the stock being cut?

3. Why should a guard always be placed over the pulleys and V-belt?

4. Why should adjustments never be made when machine is in operation?

5. Do you understand above questions? Yes_____ No_____

Signed_____

Date_____

6590

THE DRILL PRESS

Give the principal use of the following parts of the drill press:

1. Safety guard for belt and pulley

2. Push button switch

3. Depth stop

4. Quick lock quill

5. Key chuck

6. Tilt angle scale

7. Tilting table

8. Clamp lodge

9. Index pin

10. Table locking clamp

11. Universal feed lever

12. Head support safety collar

13. Belt tension knob

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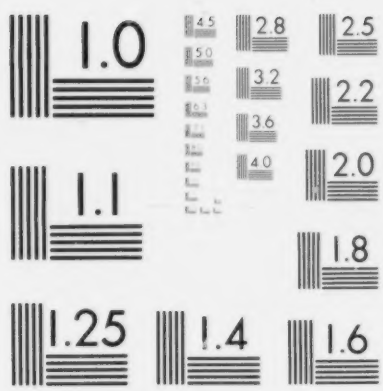

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

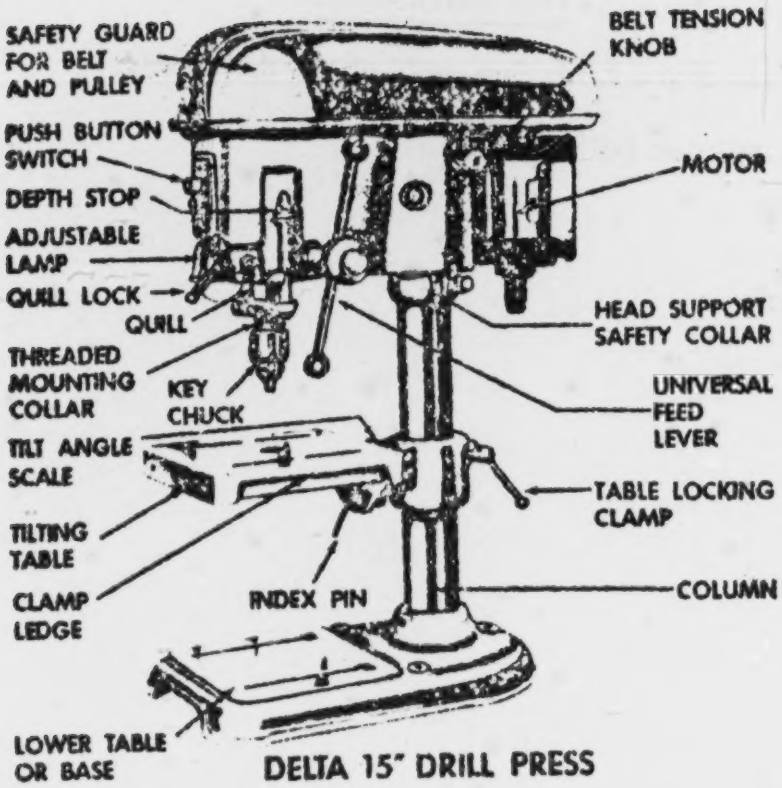

DELTA 15" DRILL PRESS

(Courtesy Rockwell Mfg. Co.)

II. <u>Safety Rules for the Drill Press</u>:

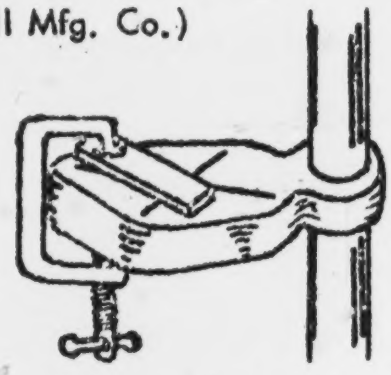

1. Clamp small work in the vise or fasten to table. If piece is held in hand, severe injury can result.

2. Chips and shavings should be removed with brush or a piece of wood. Fingers must be kept away from moving bit.

3. Keep hair, gloves, loose clothing away from moving parts of drill press.

4. Remove all tools, keys, drifts, and wrenches before starting machine.

5. Remove gloves, ties, rings, and wrist watch before operating a drill press.

6. Floor around drill press should be kept free of scrap or other material. Scrap and material around machine can cause tripping and injury.

7. Oil on floor around drill press should be cleaned and saw dust sprinkled in the area.

8. Paint danger zone for operator to stand in while operating machine.

9. Do not touch or talk to operator while drill press is running.

10. Power should always be shut off when leaving the machine.

6592

11. Work must be set up in such a manner that drill will not touch vise or table during the operation.

12. Use only such drills which are properly ground. Acceptable work can not be done with dull drills. Also, there is greater chance for work to stick and cause injury to operator.

13. When setting up or making adjustments be sure the power switch is "off".

III. Basic Operations Students Should Learn about the Drill Press:

The following operations should be demonstrated and each student should be given the opportunity to perform the operations after he fully understands the principles and reasons.

1. How to drill flat stock with C-clamp hold down.

2. How to drill round stock with "V" rest.

3. How to drill small stock with vise.

4. How to buff or sand.

5. How to change 4 speed cone pulley.

IV. Exercises Involving Use of Drill Press.

Exercise 1. Change spindle speed.

A. Pull plug from outlet.

B. Remove pulley guard.

C. Change belt (V or flat) from large pulley towards smaller.

D. Change opposite belt position to corresponding pulley.

E. Record speed with R. P. M. indicator.

Exercise 2. Reverse above pulley change and record speed with indicator.

6593
6234

Study Questions on Drill Press

1. List articles of clothing that should be removed before operating a drill press.

2. When drilling metal a _____ (slow or fast) spindle speed should be selected.

3. When drilling wood a _____(slow or fast) spindle speed should be selected.

4. What device on a drill press is used to insure the drilling of equal depth holes?

5. To operate a slow speed spindle the belt must be driving the _____ (large or small) 4-speed cone pulley at the spindle head.

6. How should you hold small work or sheet stock for drilling?

7. The handiest and safest clamp for holding stock securely for most work is the _____.

8. A _____ is always used to tighten the chuck before the drilling operation begins.

9. What block is used to drill any round stock?

Safety Exam for Drill Press

1. When tightening the chuck on a drill press, what should you always do immediately with the key?

2. When drilling small parts and stock what precaution should you always take in holding stock on drill press table?

3. While changing pulley speed by removing belts, what precaution should be taken?

4. Do you understand each question? Yes_____ No_____

Signed_____

Date_____

6594

THE GRINDER

Give the principal use of the following parts of the grinder:

1. Safety shield

2. Water pot

3. Adjustable tool rest

4. Adjustable spark deflector

5. Wheel guard

6. Dust chute

THE SCROLL SAW OR JIG SAW

1. 4 step motor pulley

2. Belt and pulley guard

3. Guide assembly

4. Tension sleeve

5. Upper head

6. Guide post

7. Upper chuck

6595

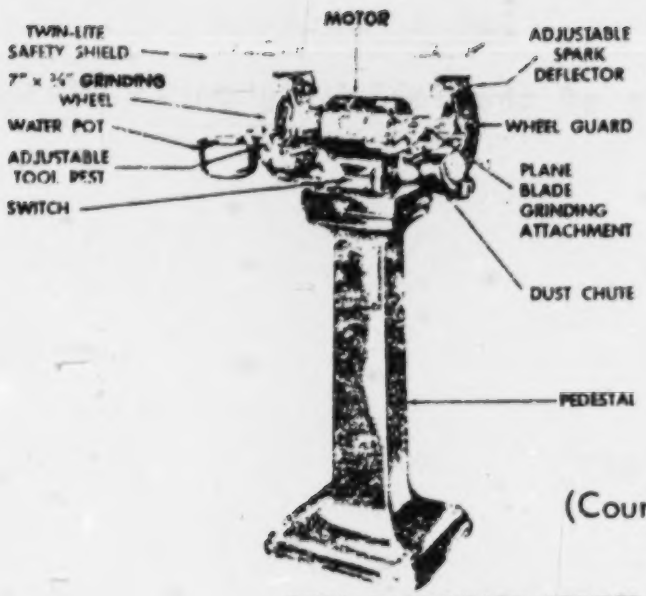

(Courtesy Rockwell Mfg. Co.)

DELTA 7" STANDARD GRINDER

II. Safety Rules for Grinder

1. Use a face shield or goggles for all grinding operations.

2. Keep goggles clean and replace broken or cracked lenses.

3. Goggles and shields should be shatter proof.

4. Before attempting a job get proper instruction in use of grinder.

5. Tool rest must be set close to stone to prevent piece from catching between the rest and stone.

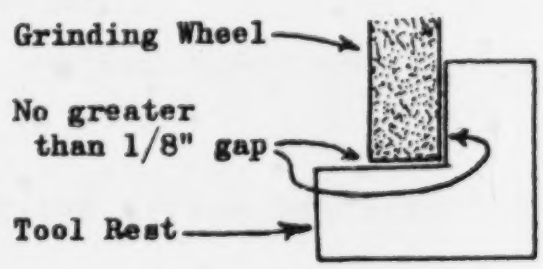

6. Stand to one side of grinder when throwing on the power. If stone is faulty, it ordinarily breaks at the start.

7. Keep fingers away from moving wheel.

8. Loose clothing, necktie, long sleeves should not be worn while grinding.

9. Mark a danger zone in which operator stands while working. No one should disturb, touch, or speak to operator while he is grinding.

10. Face and eyes should not be touched until hands have been cleaned to remove abrasive.

(Safety rules continued on next page.)

6596

11. Grind on face of wheel, never on side of wheel.

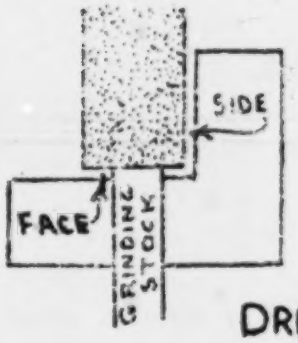

12. Before dressing a grinder wheel, get proper instructions.

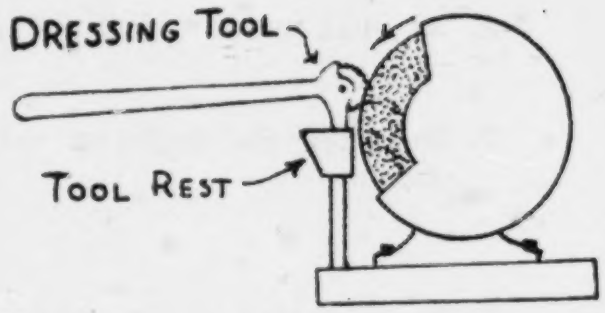

13. If injury occurs on the grinder, get first aid immediately.

14. Shut off power if anything seems wrong with machine. Call instructor.

15. When setting up or when making adjustments, be sure main power switch is "off".

III. Basic Operations to Learn on Grinder

The following is a list of important operations the student should learn to perform on the grinder. These operations are outlined in greater detail in the unit on *Tool Sharpening. Refer to this unit for the proper steps in working out the exercises.

1. How to dress a grinding wheel.
2. How to sharpen a knife.
3. How to sharpen an axe.
4. How to sharpen a plane blade.
5. How to sharpen a wood chisel.
6. How to sharpen a cold chisel.
7. How to sharpen a steel punch.
8. How to re-shape a screw driver.
9. How to sharpen a twist drill.

*Tool sharpening is included in the use and care of hand tools section, page 45.

Study Questions on Grinder

1. How can a tool rest be re-shaped inexpensively without purchasing a new one?

2. At what speed (in R.P.M.) should most grinders be operated?

3. Describe the angle at which tool rest should be set in relation to drive shaft.

4. What must always be near grinder to keep stock from over-heating and losing its temper?

5. Why should the grinding wheel be dressed frequently?

6. While grinding stock and the grinder motor labors and slows down, what should you do?

Safety Exam on Grinder:

1. What safety precautions should you always take first before adjusting the grinder?

2. Describe proper position of grinding shields (glass shields).

3. How close should the tool rest be from the grinding wheel?

4. Why should you never stand in line of a revolving grinding wheel?

5. Why is it advisable to wear gloves while grinding or working with metal?

6. Do you understand the above questions? Yes_____ No_____

Signed_____

Date_____

6598

Disk Sander

I. Identify

1. _____

2. _____

3. _____

4. _____

5. _____

(Courtesy Rockwell Mfg. Co.)

II. Safety Rules for the Disk Sander

1. Position sander near overhead exhaust fan or on exhaust system to rid the area of dust.

2. Make certain abrasive disk is securely fastened to the metal disk plate before power is turned on.

3. Never stand in line of revolving disk.

4. Keep hands far enough back from revolving disk to avoid injury.

5. Sand on downward stroke of disk only.

6. Always move stock back and forth to avoid burning disk and stock.

X — Area for sanding

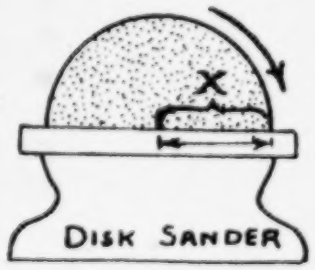

III. Basic Operations to Learn on Disk Sander

1. How to sand freehand.
2. How to sand square and miter angles.
3. How to sand compound angles.
4. How to sand cylindrical stock.

IV. Exercises Involving Use of Disk Sander.

Exercise 1. How to sand freehand.

A. Turn on exhaust system.
B. Observe abrasive disk's bond.
C. Hold stock firmly and approach revolving disk.
D. Use downward stroke only, never allowing stock to touch table. (Unless stock lays flat against table, it may be drawn between disk and table.)
E. When operation is completed, turn off sander and exhaust system.

Exercise 2. How to sand square and miter angles.

A. Turn on exhaust system.
B. Observe abrasive disk's bond.
C. Set table at 90° to disk surface.
D. Set miter gauge at proper angle and set in to track.
E. Hold stock firmly against miter gauge and approach revolving disk.
F. Move stock back and forth across surface of disk.
G. When operation is completed, turn off sander and exhaust system.

Exercise 3. How to sand compound angles.

A. Turn on exhaust system.
B. Observe bond on abrasive disk.
C. Set table to correct angle found on compound angle chart.
D. Set miter gauge at proper angle found on compound angle chart. Set gauge in track on table.
E. Hold stock firmly against miter gauge and approach revolving disk.
F. Move stock back and forth across surface of disk.
G. When operation is completed, turn off sander and exhaust system.

Exercise 4. How to sand cylindrical stock.

A. Turn on exhaust system.
B. Observe abrasive disk's bond.
C. Set table to correct angle.
D. Set miter gauge at correct angle.
E. Hold stock firmly against miter gauge and approach revolving disk.
F. Move stock back and forth across surface of disk.
G. When operation is completed, turn off sander and exhaust system.

6600 6239

Study Questions on Disk Sander

1. Describe the type of adhesive used for fastening the abrasive paper to the disk.

2. How can you check the squareness of the revolving disk with the table?

3. Describe the steps taken to insure a square joint when setting up the disk sander.

4. On what parts of stock should the disk sander never be used? Give reason.

5. Why should stock never be held in one place on sanding surface but instead should be moved back and forth?

Safety Exam on Disk Sander

1. Give two reasons why a disk sander should be near an exhaust system.

2. What could happen if an abrasive disk were not fastened securely to the disk?

3. Give two reasons why one should not sand on upward section of revolving wheel.

4. Any abrasion caused by a sander on the skin should be coated with an _____ to prevent _____.

5. Do you understand the above questions? Yes_____ No_____

Signed_____

Date_____

6601

Portable Belt Sander

Portable Belt Sander

I. Identify Parts:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

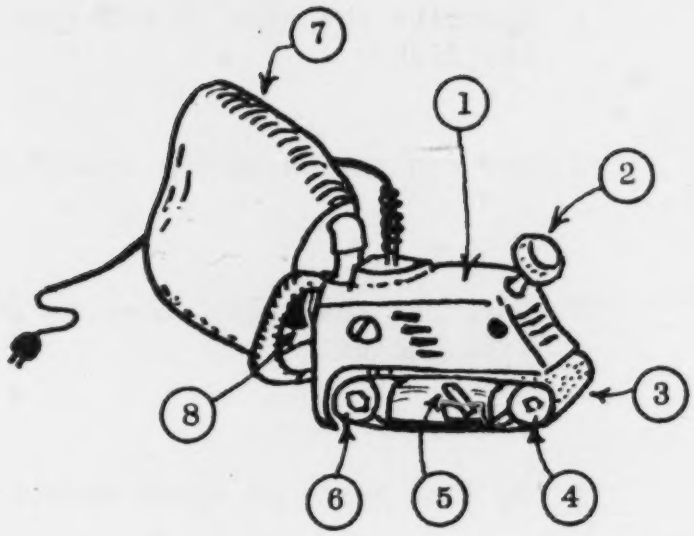

II. Safety Rules for the Belt Sander:

1. Always use ground wire when operating machine.
2. Observe condition and grit of abrasive belt.
3. Empty dust collection bag before use.
4. To align abrasive belt set unit on heel and switch power on momentarily. The adjustment of the alignment screw will correct any irregular tracking of the belt.
5. Always maintain a firm grip with both hands when operating a belt sander.
6. Always have stock being sanded set against solid cleat or clamped firmly to a table.
7. Never release grip on portable sander until machine has come to a complete stop.
8. When not in use, set portable sander on side or in wooden saddle.

III. Basic Operation to Learn on Portable Disk Sander

1. How to smooth new surfaces.
2. How to cut down uneven surfaces rapidly.
3. How to remove old finishes.
4. How to change abrasive belts.

IV. Exercises Involving Use of Portable Belt Sander

Exercise 1. How to smooth new surfaces. (CAUTION: Only solid stock should be sanded with a belt sander.)

A. Plug in unit making certain ground wire is in place.
B. Check alignment and grit of abrasive belt.
C. Fasten stock securely to bench or table.
D. With firm grip start machine going with the grain. All movements of the machine should be gradual so machine has chance to do sufficient job over cut surface of stock.
E. When operation is complete, turn machine off and lay it on side.

Exercise 2. How to cut down uneven surfaces rapidly.

A. Plug in unit making certain ground wire is is place.
B. Check alignment and grit of abrasive belt.
C. Fasten stock securely to bench or table.
D. With firm grip first start machine and go across the grain of the stock rapidly removing uneven surfaces.
E. When the surface of the stock is quite even, sand with the grain to remove any deep scratches on the stock surface.
F. When operation is complete, turn machine off and set it on its side.

Exercise 3. How to remove old finish.

A. Plug in unit making certain ground wire is in place.
B. Check alignment and grit of abrasive belt.
C. Fasten stock securely to bench or table.
D. With firm grip start machine going with the grain. All movements of the machine should be gradual so abrasive belt cuts evenly over entire surface of stock.
(CAUTION: If abrasive belt should gum up with old finish, a new belt should replace old belt to reduce burning of surface of stock)
E. When operation is complete turn machine off and lay it on its side

Exercise 4. How to change an abrasive belt.

A. Select new abrasive belt.
B. Set machine on its side and unplug power.
C. With flat of hand push idler wheel into housing to reduce belt tension.
D. Remove old abrasive belt and replace with new one. (CAUTION: Make sure belt will travel the direction indicated by arrow inside belt.)
E. Pull release pin to replace tension on belt.
F. With portable sander setting on its heel, switch power on momentarily to determine alignment of belt. New belts always have different alignments than the ones replaced.
G. When operation is complete, turn machine off and lay it on its side.

Study Questions on Portable Belt Sander:

1. The width of an abrasive belt for a portable electric saw generally is _____ inches.

2. Portable electric sanders may be laid on their side for stationary operations. (True or False) _____

3. Portable electric sanders are generally operated on _____volts.

4. Portable electric sanders must always be operated with _____ (one or both) hands to insure control.

5. Improper _____ of the abrasive belt will cause undue wear and cutting on frame of sander.

6. A _____ unit is necessary on a portable sander because of the excessive amount of dust and wood particles removed by the sanding operation.

7. Portable sanders should generally be directed with the grain because of the _____ (speed or coarseness) of the abrasive belt.

8. Should a fine or a coarse abrasive belt be used for removing old finishes and why?

Safety Exam on Portable Belt Sander:

1. Why is it always advisable to attach a ground wire to a portable sander?

2. Give two reasons why the dust collection bag should be emptied regularly.

3. Sparks coming from the frame of the sander while operating indicates what?

4. Why is it necessary to keep a firm grip on the sander even after the switch has been released?

5. Do you understand fully the questions above? Yes _____ No _____

Signed_____

Date_____

SKETCHING AND DRAWING

Have you ever tried to tell someone the directions to a place? They could not quite understand your directions. So what did you do? You took a piece of paper and made a little map showing just how they should go. Instead of telling them with words you used a drawing. Drafting, sketching, mechanical drawing, and blueprints are really a process of drawing pictures rather than saying something in words. To be sure drafting, mechanical and blue print drawings are more precise and exact than the crude sketch you made to show one the direction; nevertheless, it serves the same purpose. As someone once said, "A picture is worth 10,000 words."

In order to eliminate waste of materials and have the finished product look as desired, the student must learn to draw and follow a plan while constructing shop projects. The following chapter will assist the student in mastering the skills necessary to draw plans of shop projects.

Sketching and Drawing

1. Drawing equipment
2. Lettering
3. Determining angles
4. Angle layout
5. Alphabet of lines
6. Placing dimensions
7. Reading the architect's scale
8. Learning to draw to scale
9. Isometric drawing principles

6605

6033

Drawing Tools Identification (Select correct names from list at bottom of page)

1

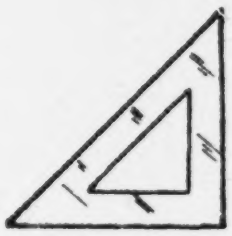

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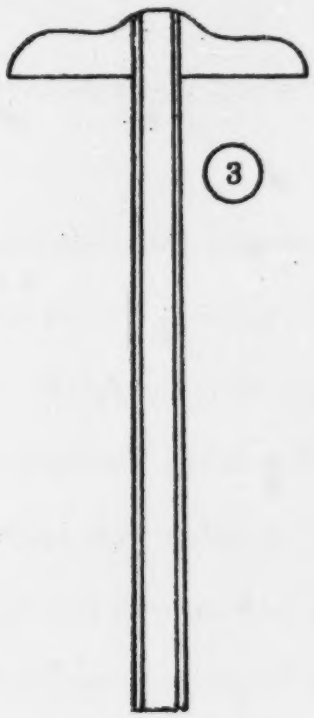

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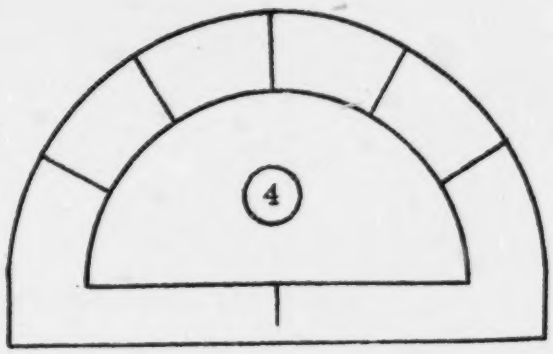

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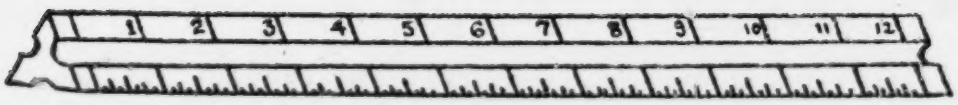

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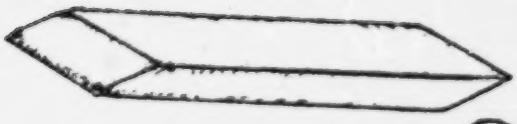

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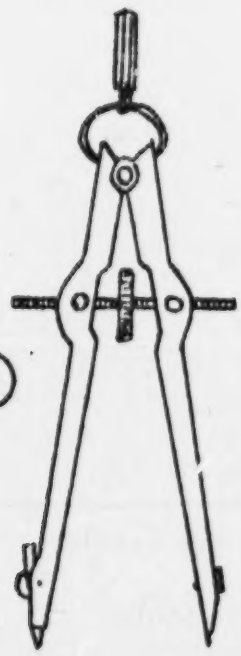

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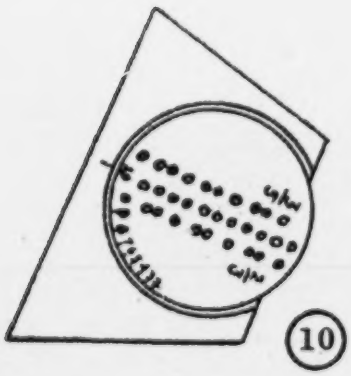

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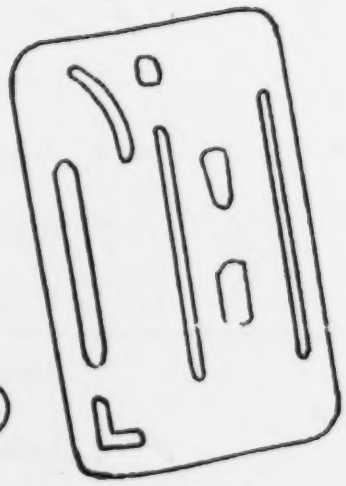

11

Irregular curve, erasing shield, drawing board, 45° triangle, compass, eraser , lettering guide, 30°-60° triangle, T-square, architect's scale, protractor.

Identify and give principal uses of each of the drafting tools shown on the preceding page.

Item 1. Identify:_____

Use:_____

_____

Item 2. Identify:_____

Use:_____

_____

Item 3. Identify:_____

Use:_____

_____

Item 4. Identify:_____

Use:_____

_____

Item 5. Identify:_____

Use:_____

_____

Item 6. Identify:_____

Use:_____

_____

Item 7. Identify:_____

Use:_____

_____

Item 8. Identify:_____

Use:_____

Item 9. Identify:_____

Use:_____

Item110. Identify:_____

Use:_____

Item 11. Identify:_____

Use:_____

A B C D E F G H I J K L M N O P Q R S

T U V W X Y Z 1 2 3 4 5 6 7 8 9 0

I. VERTICAL CAPITAL LETTERS ABCDEFGHIJKLMNOPQRSTUVWXYZ

1ST SET (STUDENT TO LETTER BELOW)

2ND SET (BELOW)

3RD SET (BELOW)

4TH SET (BELOW)

II. INCLINED CAPITAL LETTERS ABCDEFGHIJKLMNOPQRSTUVWXYZ

1ST SET (STUDENT TO LETTER BELOW)

2ND SET (BELOW)

III. VERTICAL LOWER CASE LETTERS abcdefghijklmnopqrstuvwxyz

1ST SET

2ND SET

3RD SET

4TH SET

IV. INCLINED LOWER CASE LETTERS abcdefghijklmnopqrstuvwxyz

1ST SET

2ND SET

V. VERTICAL NUMERALS 1234567890

STUDENT REPEAT BELOW

VI. INCLINED NUMERALS 1234567890

STUDENT REPEAT BELOW

VII. FRACTIONS $1\frac{1}{2}$ $2\frac{3}{4}$ $5\frac{6}{7}$ $8\frac{9}{10}$ $3\frac{3}{5}$

STUDENT REPEAT FRACTIONS BELOW

6608

ADDITIONAL LETTERING PRACTICE

Directions: Construct same spaced guide lines as on previous page and complete lettering as before: (Alphabet)

I. Vertical Capital Letters: (3 lines, 3/32" spacing) 1. ABCDEFGHIJKLMNOPQRSTUVWXYZ

2. 3.

4. 5.

II. Inclined Capital Letters: (same spacing as above) 1.

2. 3.

III. Vertical Lower Case Letters:(1/16" top,1/8"bottom) 1.

2. 3.

4. 5.

IV. Inclined Lower Case. (same spacing as III.) 1.

2. 3.

V. Vertical Numerals. (same spacing as I, above) 1.

2. 3.

4. 5.

VI. Inclined Numerals. (same spacing as I, above) 1.

2. 3.

VII. Fractions. (space between bottom and top line—3/8") Draw these: $1\frac{1}{2}$ $2\frac{3}{4}$ $3\frac{5}{6}$ $4\frac{6}{7}$ $5\frac{8}{9}$ $6\frac{1}{2}$ $7\frac{3}{4}$ $8\frac{5}{6}$ $9\frac{7}{8}$ $10\frac{2}{5}$

1.

2.

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Lettering Practice Page

6610 0039

I. Exercise in Determining Size of Angles.

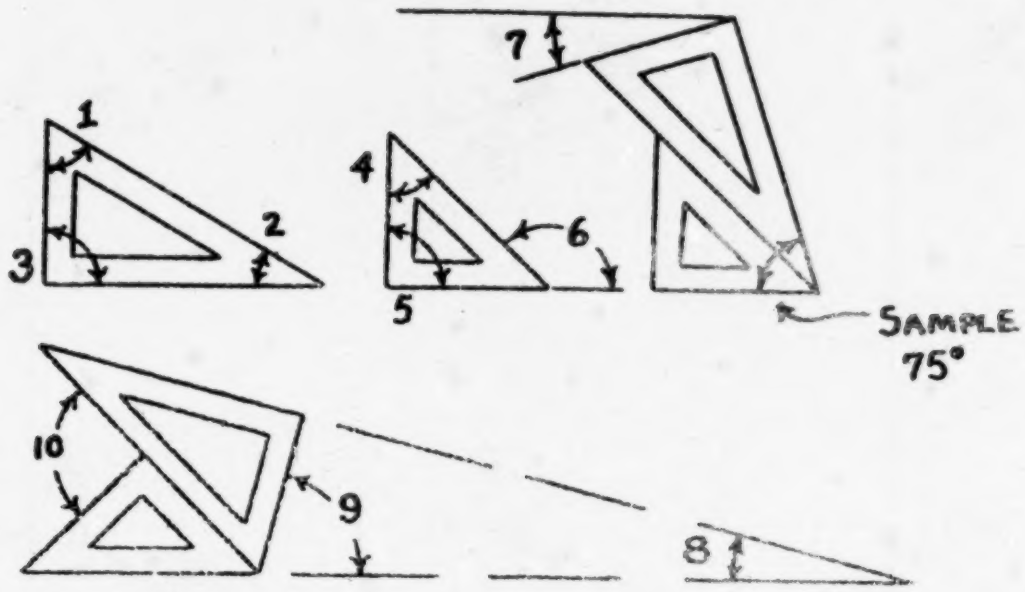

Indicate the size of angle between each pair of arrowheads.

1._____degrees 2._____degrees 3.____degrees 4._____° 5._____°

6._____ 7._____ 8._____ 9._____ 10._____

II. Exercise in Reading a Rule.

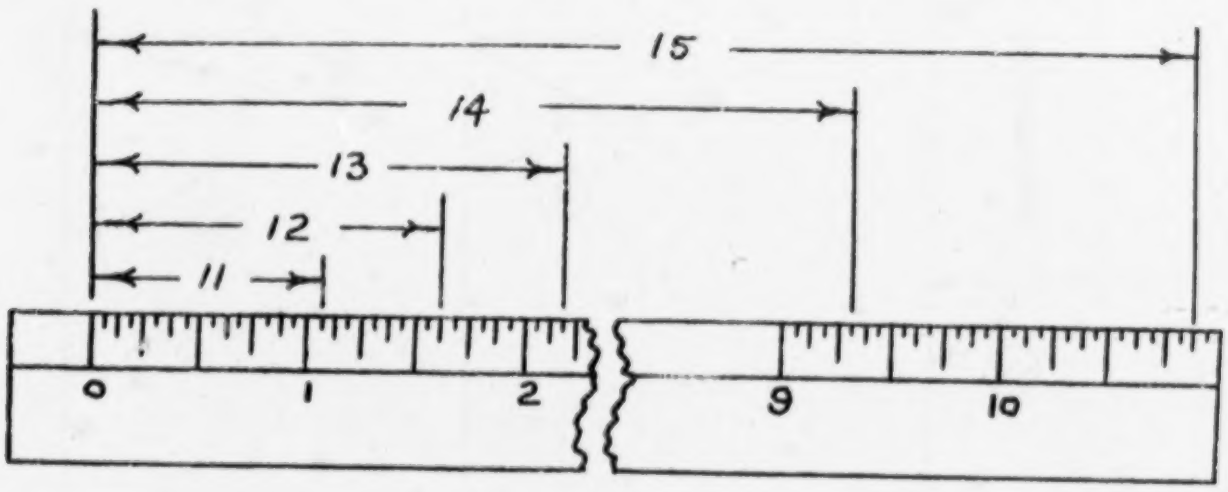

Indicate size of each dimension in the above diagram:

11. _____ inches 12. _____ 13. _____ 14._____ 15._____

Alphabet of Lines

1. What does each of the following lines represent. Give answer in blank at right. Also know the purpose of each line.

a. 3'-6" _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

h. _____

i. _____

2. Using drawing instruments, draw 3 lines of each of the following across the page. Space the lines about 1/8" apart.

(a) Outline of parts:

(b) Section Lines:

(c) Hidden Lines:

(d) Center Lines:

(e) Dimension Lines:

(f) Practice making several lines of dimension arrows.
Make them like this |← →| Not like this |← →|

Placing Dimensions

Exercise for Student: Place dimensions on the 4 drawings on bottom half of page. Use aligned system for drawings at left of page and unidirectional system on right side.

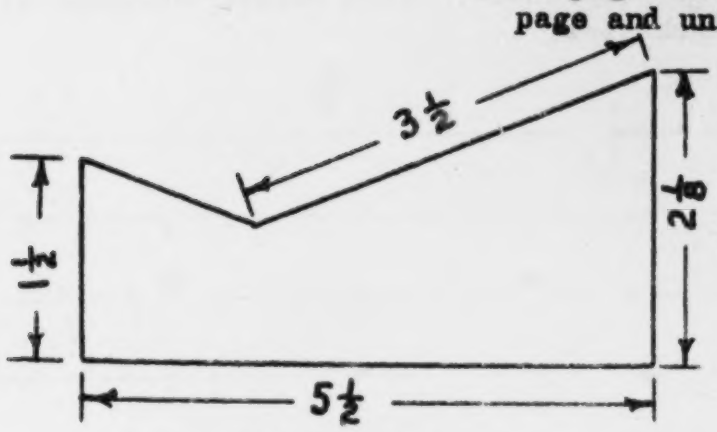

Aligned System
(Most Common)

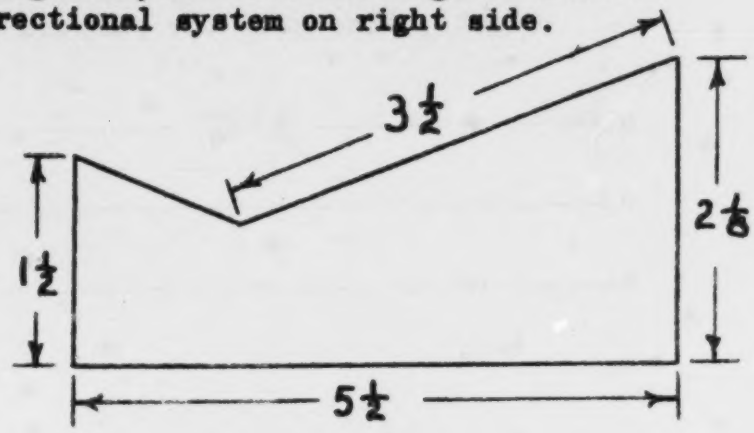

Unidirectional System

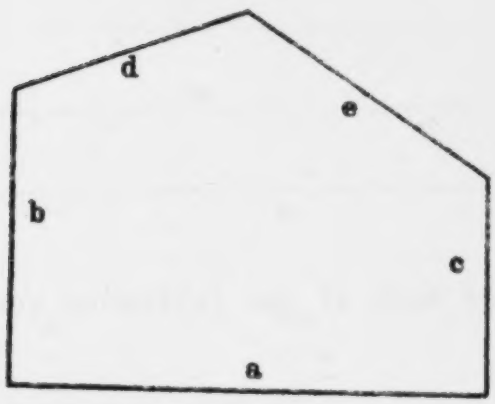

In figure above, base line a = 8 3/4"; b = 5½"; c = 4"; d = 4½"; e = 5½"
Distance from peak to base is 7 inches.

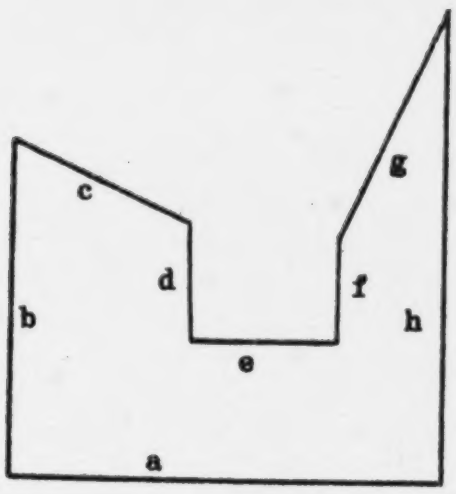

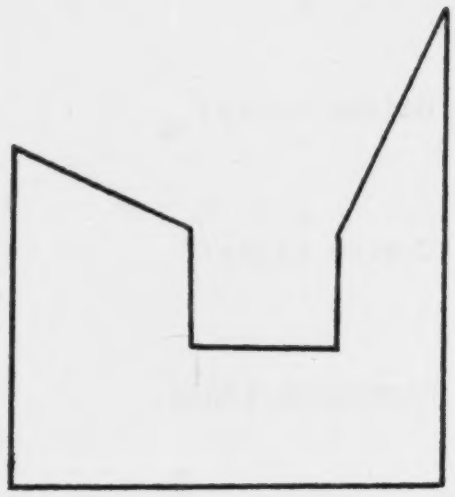

In figure above, base line a = 10½"; b = 8½"; c = 4 3/4"; d = 3"; e = 3½"
f = 2½"; g = 6½"; h = 12"

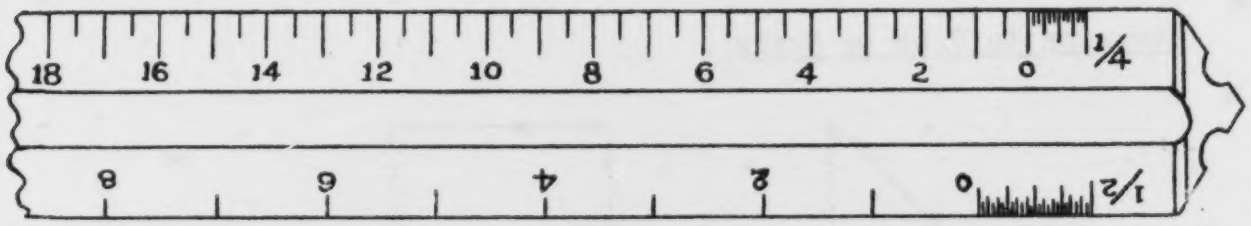

Architect's Scale showing $\frac{1}{2}$ and $\frac{1}{4}$ scale

I. Reading the Scale. Using the Architect's Scale with the indicated scale record on the blank spaces at the right the length of each line corresponding to the number.

Use FULL SCALE or 16 (in inches) Items 1 to 4 — Give answers below.

1. _____ 1._____
2. _____ 2._____
3. _____ 3._____
4. _____ 4._____

Use 1/2 Scale (in feet and inches) Items 5 to 7

5. _____ 5._____
6. _____ 6._____
7. _____ 7._____

Use 1/4 Scale (in feet and inches) Items 8 to 13

8. _____ 8._____
9. _____ 9._____
10. _____ 10._____
11. _____ 11._____
12. _____ 12._____
13. _____ 13._____

II. Using 1/2 scale, construct a horizontal line beginning at each point with indicated dimension.

7' 6" .
8' 9" .
10' 0" .

III. Using 1/4 scale, repeat work with following dimensions:

15' 0" .
16' 9" .
24' 6" .

Learning to Draw to Scale

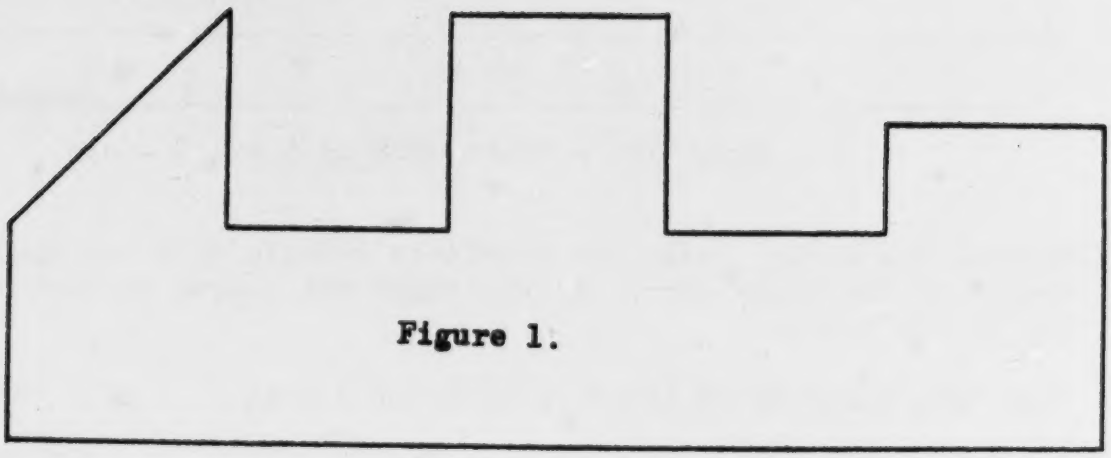

Figure 1.

1. Draw figure 1, using 1/2 scale.

2. Draw figure 1, using 1/4 scale.

3. Draw figure 2 twice the size shown.

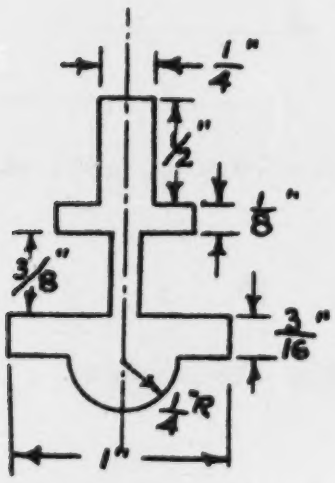

Figure 2.

6616

<u>Learning to Lay Out the Working Drawing from a Given Sketch</u>. 1st problem is already illustrated. Student is to draw neatly and accurately the <u>top</u>, <u>front</u>, and <u>end</u> views of each of the drawings.

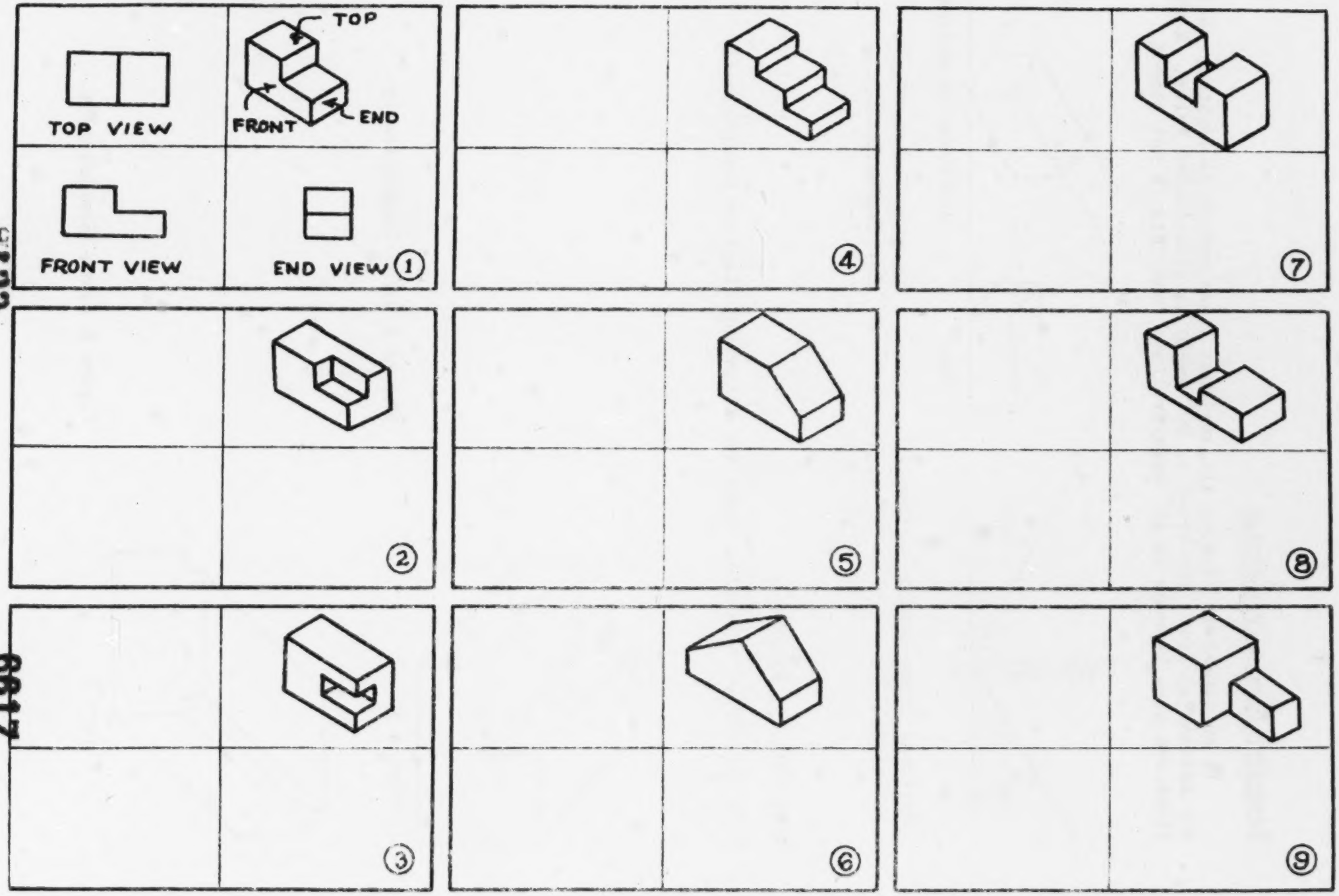

66177

Isometric Drawing Principles

In an isometric drawing all vertical lines remain in vertical postion. All horizontal lines are drawn on 30° angle as illustrated below. Horizontal lines can also be made on 45° angular lines, but this is not common.

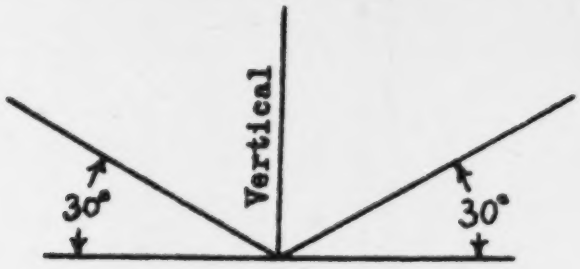

Vertical lines remain vertical.
Horizontal lines are at 30° angle.

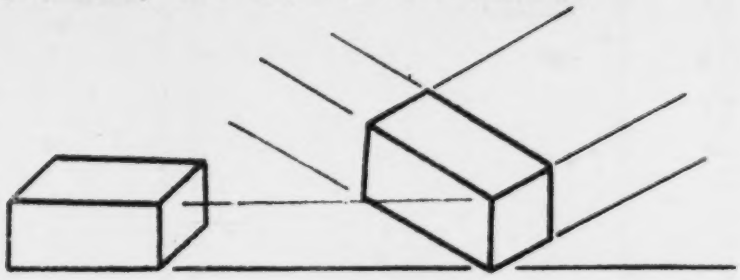

Box Box Drawn Isometrically

Showing How to Draw a Box Isometrically.

Exercises for Student

With the aid of triangles, draw the following diagrams isometrically.

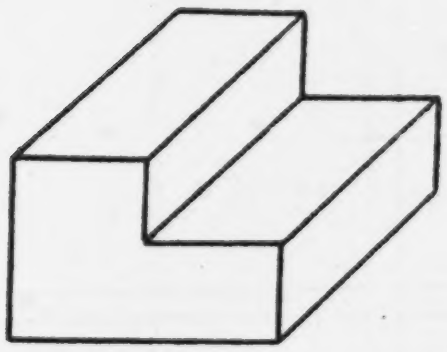

Figure A

Figure A Drawn Isometrically.

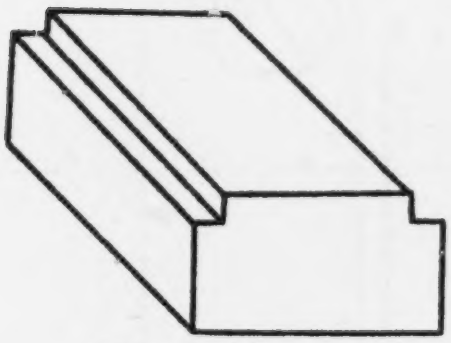

Figure B

Figure B Drawn Isometrically.

1. What is the purpose of a working drawing?

2. How many views are generally shown in an orthographic projection?

3. What are the advantages of an orthographic projection?

4. What kind of a line represents the invisible outline of an object?

5. State a common use of center lines.

6. Name the line that is used to indicate the limits of a dimension line.

7. What is the purpose of dimension lines?

8. Where both dimension and arrowhead are crowded for room illustrate two methods of indicating short dimensions.

9. What does the figure (or dimension) indicate when you dimension (a) an arc; (b) a circle?

10. What is a template?

11. What is the advantage of using a template?

12. What is a regular hexagon?

13. Where may a hexagon be used?

14. What is an octagon?

15. What part of a circle is used to determine a hexagon?

16. What is drawn first in laying out a regular octagon?

17. How is the center of an arc for a rounded corner located by measurement?

18. When a drawing is symmetrical, why make only half a pattern?

19. What is the use of cross-sectioning in transferring curves?

6619

IDENTIFICATION - WOOD JOINT AND HARDWARE

The selection of lumber and the way materials are fastened together often makes the workmanship in a project look poor. The student should have a knowledge of the different kinds of lumber and the qualities that each possesses. He should also be familiar with the different kinds of wood joints and the common hardware found in the shop and around the home.

1. Selection of wood
2. Joint identification
3. Qualities of wood
4. Size and kind of nails
5. Size and kind of screws
6. Identification of common hardware

6620

I. Identify each of the following items. Write answers in space provided below. (Select from list at bottom of page)

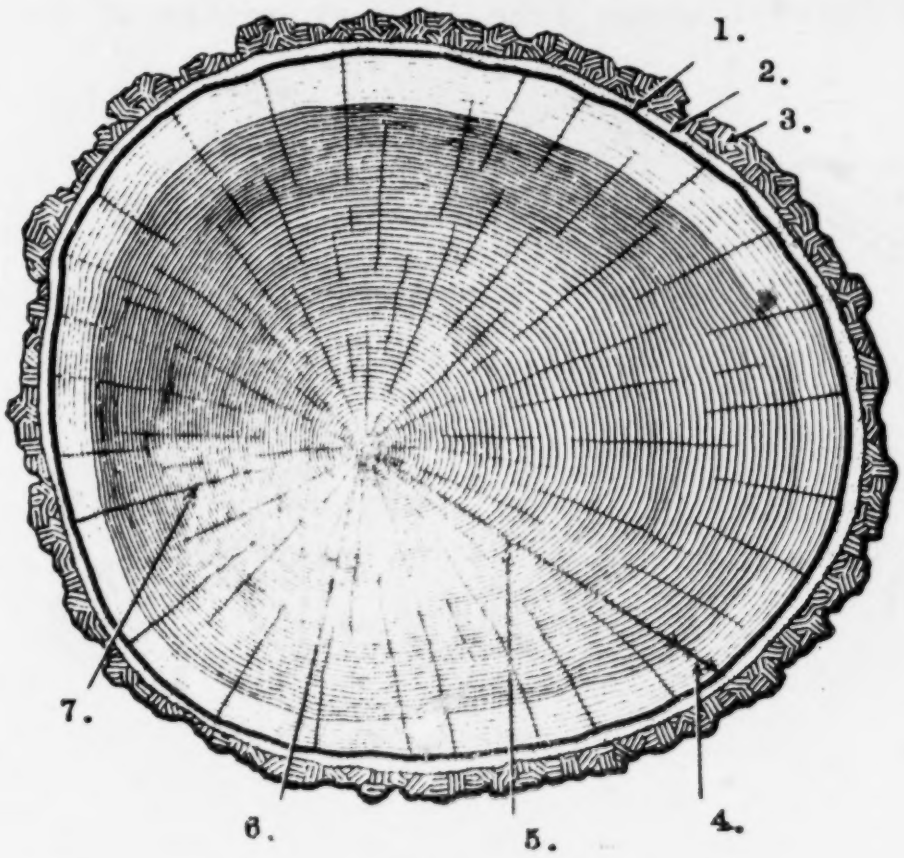

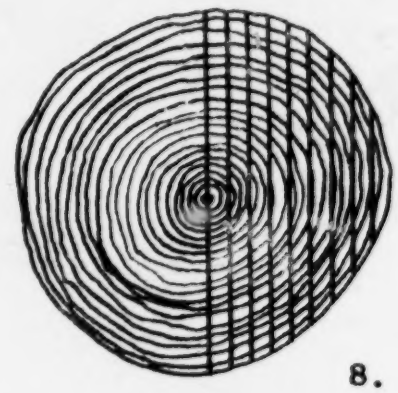

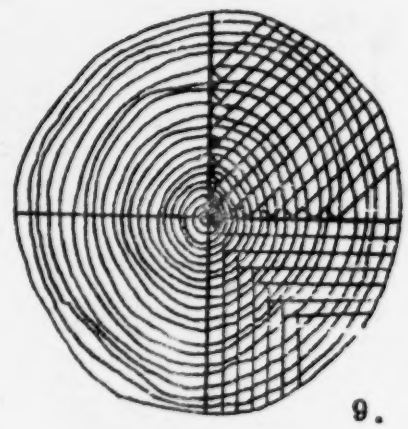

Courtesy (U. S. Forest Service)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

Pith rays, sapwood, plain sawing, pith, twist warp, bow warp, outer bark, cambium layer, cup warp, inner bark, heartwood, quarter sawing.

<u>Joint Identification</u>: On following page identify and indicate where each joint is used.
(Select correct names from list at bottom of page)

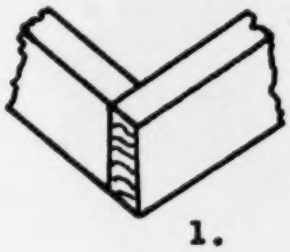
1.

2.

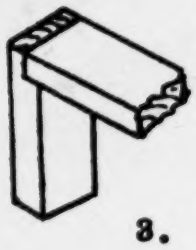
3.

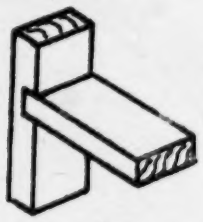
4.

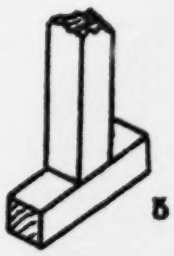
5.

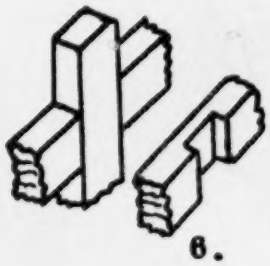
6.

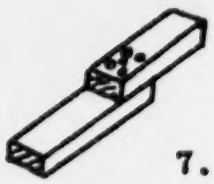
7.

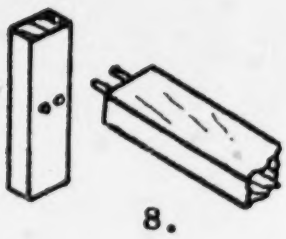
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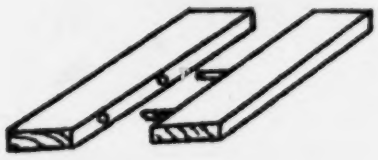
9.

10.

11.

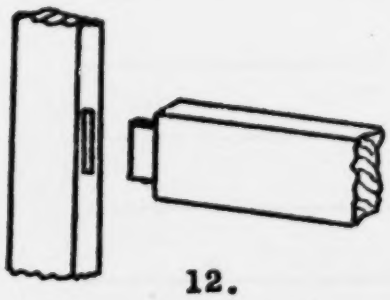
12.

13.

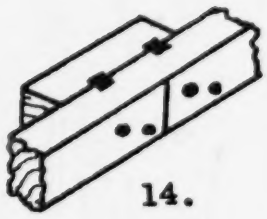
14.

15.

16.

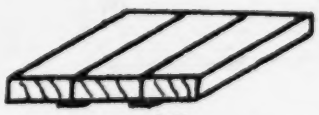
17.

Spline miter, fished and key, batten, butt, rabbet, end lap, splined butt, mortised tenon, tongue and groove, dowelled, glued and blocked, toenailed, cross lap, dovetail, dado, edge butt.

Identify and give common places where the joints are used. (Shown on previous page.)

Identify joint	Where joint is used commonly
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	

WOOD STUDY CHART

Instructions: Fill in the blanks below with one correct answer. Answers must include one of several given as follows:

Outside Qualities: (How well it can withstand weather.) Poor, Medium, Good
Grain: Open or Closed
Strength: Poor, Medium, Good
Type: Hardwood or Softwood
Weight: Light, Medium, or Heavy
Use: Construction or Cabinet

Specie	Outside Qualities	Grain	Strength	Type	Weight	Use
Oak						
Maple						
Birch						
Cherry						
Ash						
Cedar						
Pine						
Mahogany						
Spruce						
Walnut						
Fir Plywood						
Preswood						
Pegboard						

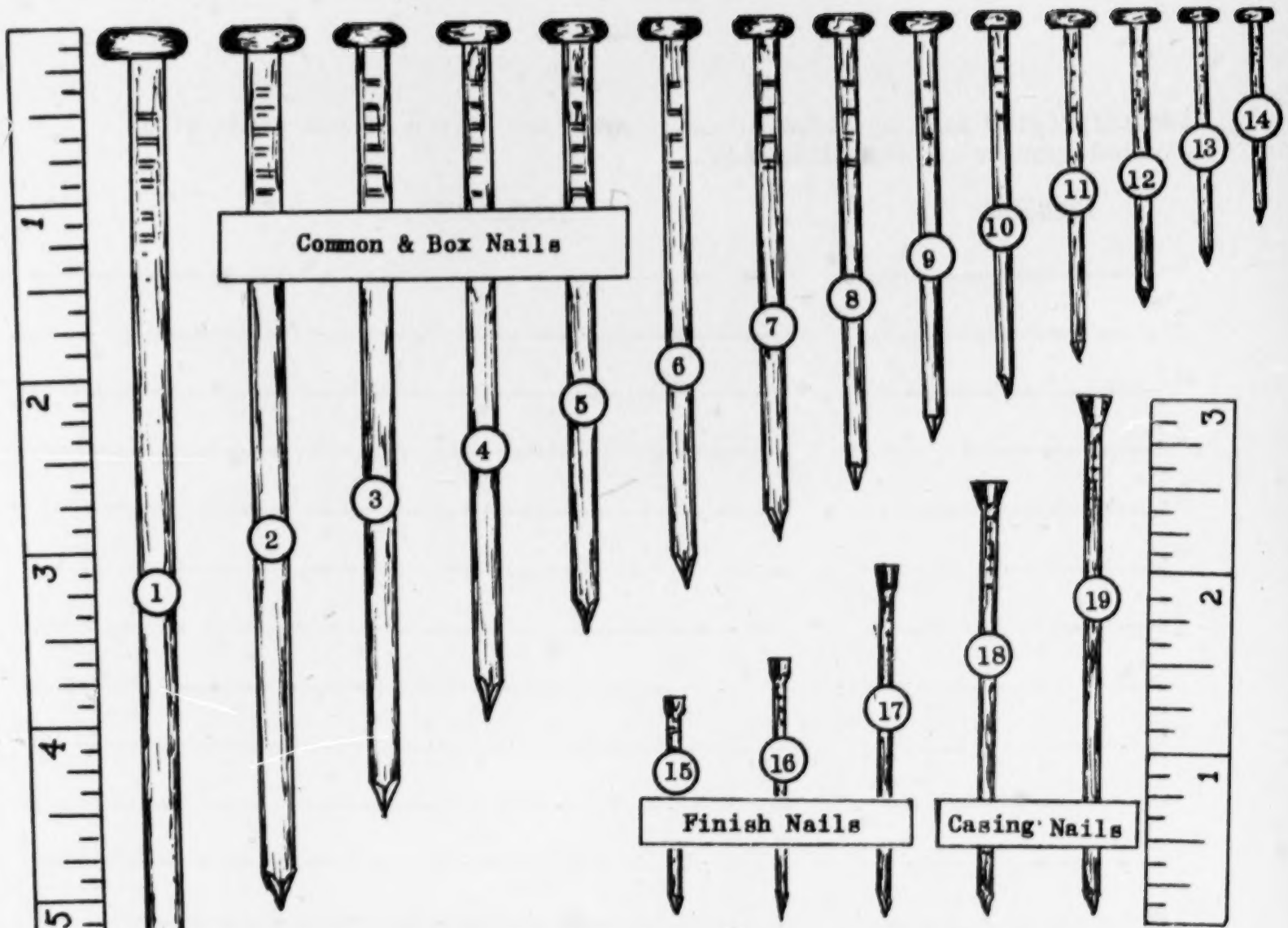

Chart of various size wood screws below. Numbers indicate common gauge for corresponding length.

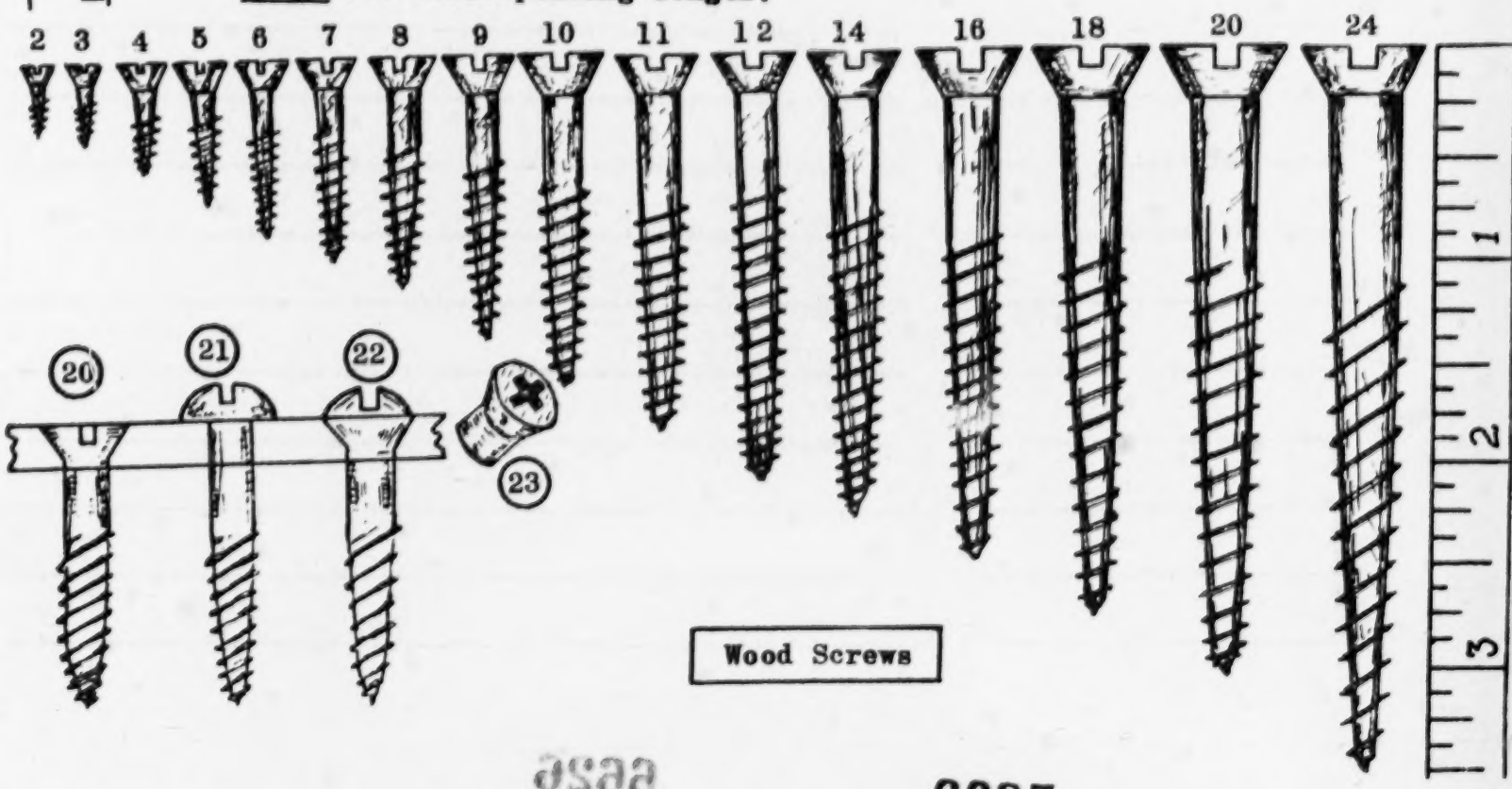

Identify (give size and kind of nail) and use of each of the items with circled numbers on preceding page.

Identify	Where used
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	

6626 6652

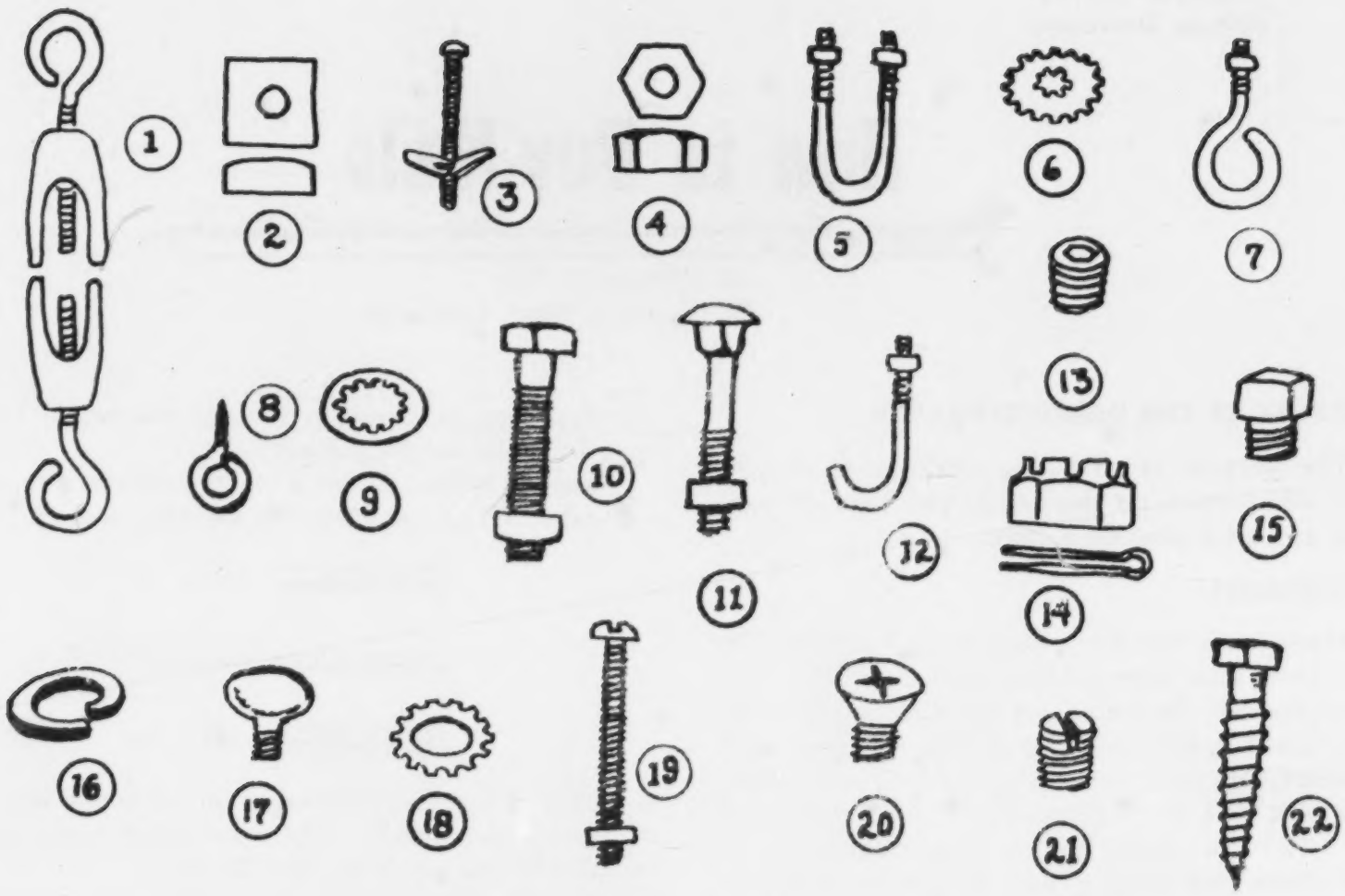

Student Exercise -- Identify the fasteners shown above by writing their correct names in blank spaces. Select from list at bottom of page.

1. _____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

7. _____ 8. _____ 9. _____

10. _____ 11. _____ 12. _____

13. _____ 14. _____ 15. _____

16. _____ 17. _____ 18. _____

19. _____ 20. _____ 21. _____

22. _____

Flat head (Phillips recessed) bolt, Lock washer, Socket set screw (for Allen hex keys), Eye bolt, Carriage bolt, Headless set screw (slotted), Lock washer (external type), Thumb set screw, Turnbuckle, Hexagonal nut, Square nut, Screw eye, Lag bolt, Machine screw, Lock washer (internal type), Cotter pin and castellated hex nut, Machine bolt, Lock washer (external-internal type), Toggle bolt, Square head set screw, Hook bolt, U bolt

Extension Service
Auburn University

How to Buy Nails

By William T. Cox
Specialist in Farm Buildings

PURPOSE OF THE DEMONSTRATION

The purpose of this demonstration is to give you information on the kinds and sizes of nails that are used most on a farm.

DISCUSSION

Many years ago nails were made by hand. At that time, nails were sold in batches of 100. The price for 100 depended on the size of the nails. For example, 100 nails of a certain size cost eight pennies. As time went by, people started calling that size nail an 8 penny nail. And they used the letter *d* to stand for the word *penny*. So in the stores and other places, *8d* meant *8 penny*. The size nails that cost 20 pennies per 100 were called 20d nails, and so on for all the different sizes.

NEEDED FOR DEMONSTRATION

Casing nails
Finishing nails
Several different sizes of common nails
Some change

DEMONSTRATION

Buying nails today. Today, you buy nails by the type you want and by the size you want. You pay for nails by the pound.

Types of nails. There are many different types of nails. Those most used on the farm include:

Common nail

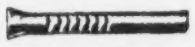

Casing nail

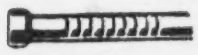

Finishing nail

You can tell the difference in the types listed above by their heads. Also most other types can usually be identified by their heads.

Sizes of nails. Today we still use the word *penny* and the letter *d* to refer to the size of a nail, though prices have changed. To find out the size of a nail, you measure it.

A common nail is measured from under the head to the point. But a casing nail or a finishing nail is measured from the top of the head to the point.

A common nail 1 inch long is called a 2d nail. One 4 inches long is called a 20d nail. Suppose you need some 2½-inch nails. How would you ask for them in the store? You'll find the answer in this picture.

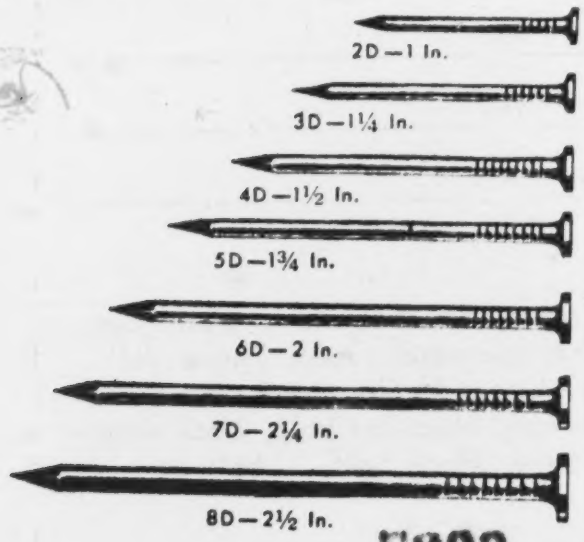

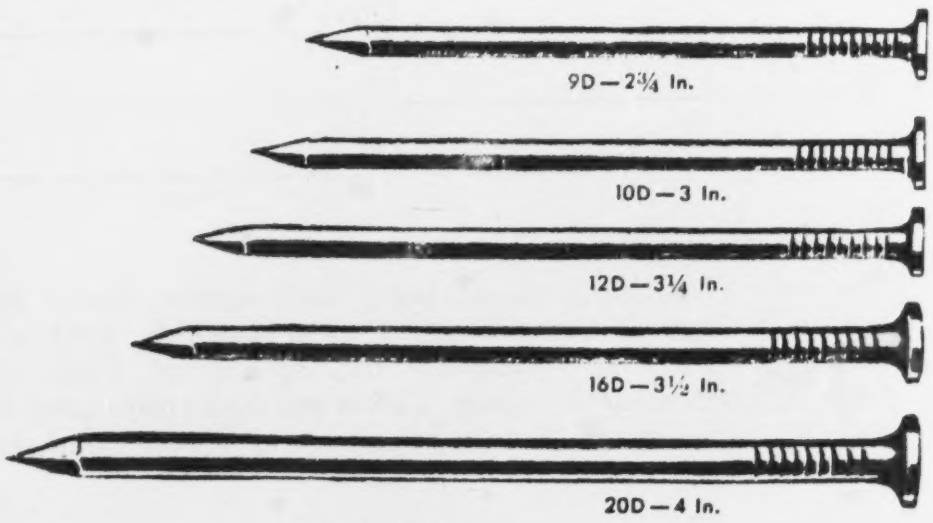

6628

Identify the following hardware items in the spaces provided:

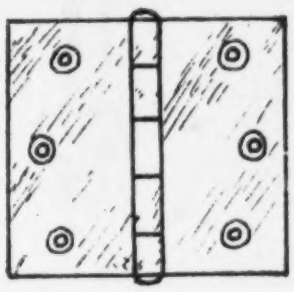

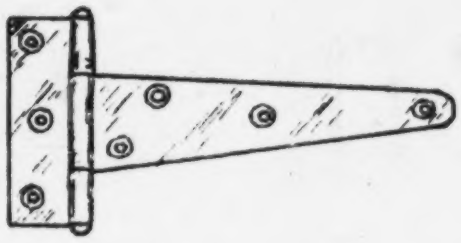

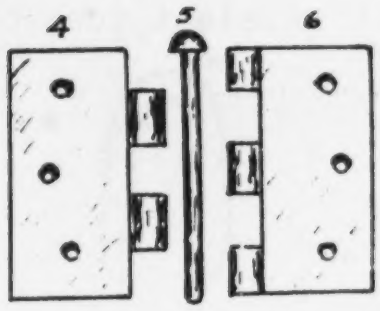

1._____.

2._____

3._____

4._____

5._____

6._____

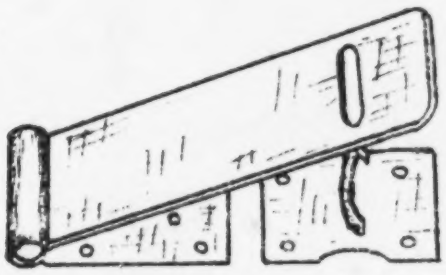

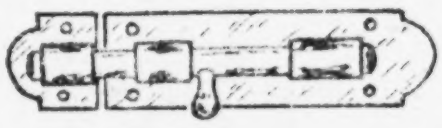

7._____

8._____

9._____

10._____

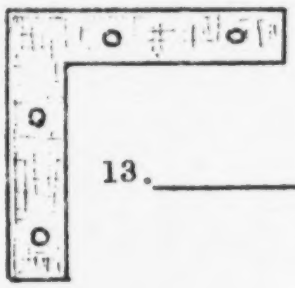

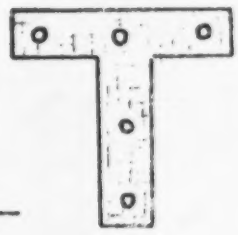

11._____

12._____

13._____

14._____

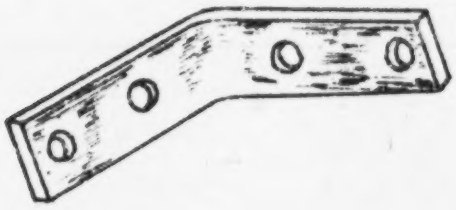

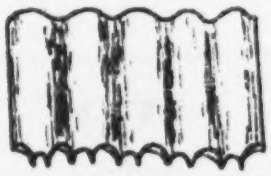

15._____

16._____

17._____

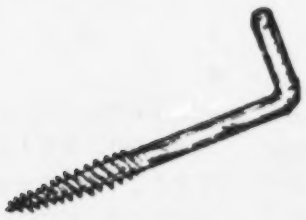

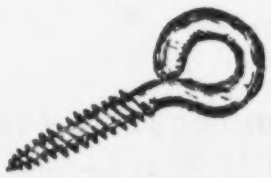

18._____

19._____

20._____

21._____

Identification of hardware items (cont'd)
(Select correct names from list at bottom of page)

22._____

23._____

24._____

25._____

26._____

27._____

28._____

29._____

30._____

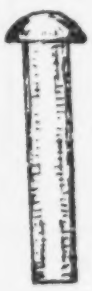

31._____

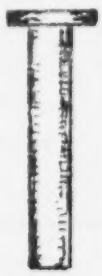

32._____

33._____

34._____

Window lift, drawer pull, T-plate, corrugated fastener, square bent screw hooks, friction catcher, butt hinge, strap hinge, hinge bolt, hasp, door stop, window lock, corner iron, bent corner iron, screw hook, screw eyes, gate hook, T-hinge, two knuckle leaf, three knuckle leaf, sliding bolt, insulated staple, fence staple, roundhead rivet, steel washer, flathead rivet, flathead stove bolt, roundhead screw nail, oval head sheet metal screw, countersink flat head screw nail, flat head sheet metal screw, blued staple, roundhead sheet metal screw, flat head screw nail.

6630

CARPENTRY AND WOODWORK

At this point, the student should have learned to identify and use the various tools properly. He also had an opportunity to develop skill in using them. The next step will be to perform some teacher-assigned activities. These activities will allow the student to demonstrate his proficiency and degree of development of the skills studied on the preceeding pages. It should be thoroughly understood by the student that the assigned activities will be performed for a grade.

Materials and Equipment

1. Claw hammer
2. Crosscut, rip, keyhole, coping, and back saws
3. Carpenter's square and try square
4. Dividers
5. Clamps
6. Set of wood chisels (1/4", 3/8", 1/2", 3/4", 1")
7. Jack and block plane
8. Scrapers, wood files
9. Brace and set each of auger and turit bits
10. Countersink
11. Screw drivers, standard and Phillips
12. Dowel pins
13. Draw knife
14. Lumber (several sizes of soft wood and some oak)
15. Sandpaper
16. Glue pot and glue

Exercises for Student

1. Saw off a board square.
2. Cut a round hole 4" in diameter in an inch board.
3. Glue two pieces of wood together.
4. Plane a glued piece of wood surface smooth.
5. Plane end grain of a piece of wood smooth.
6. Plane chamfers around a board.
7. Prepare wood for finish.
8. Make a dado.
9. Make a cross lap.
10. Make a through mortise.
11. Make a dowel joint.

Additional Projects

12. Make a flower tub.
13. Make a book end.
14. Make a nail and tool box.
15. Make a magazine rack.
16. Make a saw horse.

Exercise 1. Saw off a board square.

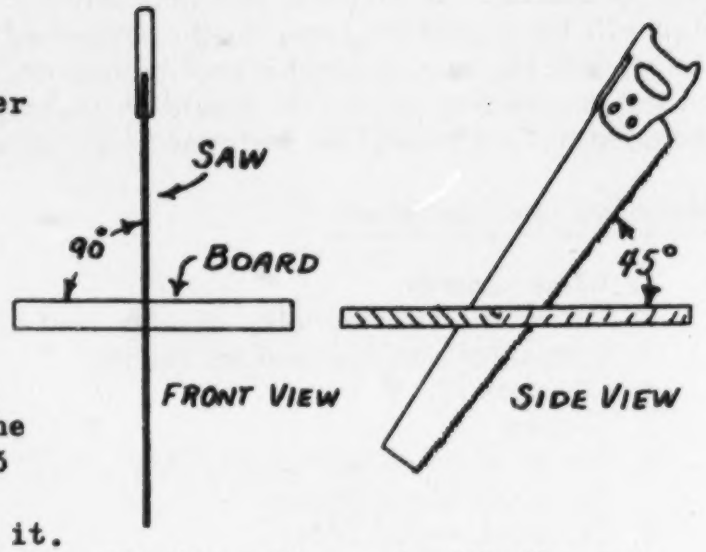

A. Secure a 1" x 6" piece of lumber about two feet long.
B. Place board, one end over saw horse or low table.
C. With a square, mark off a line perpendicular to the sides near one end.
D. Holding a hand crosscut saw blade perpendicular to surface of board, saw on one edge of the line with strokes that angle 45 degrees with board surface.
E. Guide saw, do not bear down on it.
F. Check the cut for squareness, both with the sides and with the surfaces of the board using a try square.

Exercise 2. Cut a round hole 4" in diameter in a 1" board.

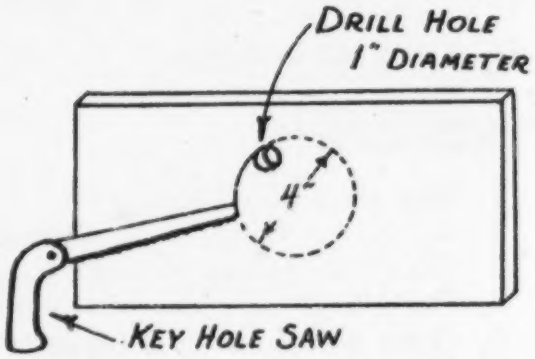

A. Use a piece of board 1" x 6" and about 1 foot long.
B. On its surface mark out a 4" circle with dividers.
C. Use a brace and 1" auger bit; drill a hole inside the circle so edge of bit falls on circle.
D. Use a keyhole saw and start from drilled hole and follow circle line until hole is completed.
E. Use wood file to smooth out any irregularities in saw cut.

Exercise 3. Glue two pieces of wood together.

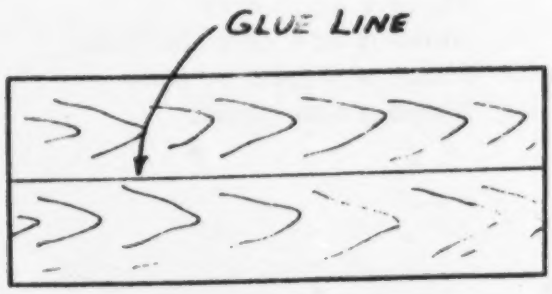

GRAIN SHOULD RUN SAME WAY ON BOTH BOARDS

A. Secure two pieces of oak boards 1" x 6" and 1½' long.
B. Use a jack plane to smooth edges of boards and square the edges with the sides of the board.
C. Fit two smoothed edges together so grain of wood on flat surfaces runs in the same direction.
D. Lay boards in clamps and apply an ample amount of properly prepared glue to the edges to be glued.
E. Tighten clamps, keeping plane surfaces flat.
F. Allow to dry for 24 hours.
G. Check glue joint by planing lengthwise on glue joint and observing close blend of two boards.

6632

Exercise 4. Plane the surface of two glued pieces of board smooth.

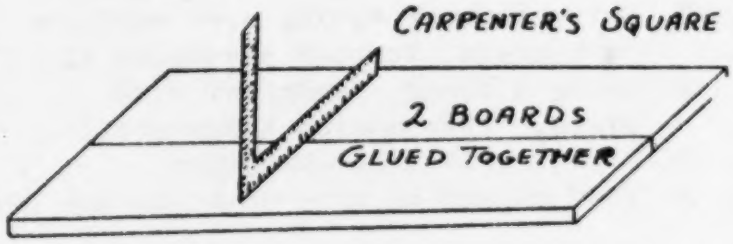

A. Properly glue two pieces of board together, preferably large enough for a bread board.
B. Secure glued board to work bench.
C. Lay a carpenter's square edgeways on surface and check for high places.
D. Using a sharp jack plane, properly adjusted, plane the high surfaces off first, always planing with the grain.
E. Keep checking for high places with square.
F. Bias planing is permissible to get the rough surfaces.
G. Finish by planing entire surface with the grain and ending with a smooth level surface.
H. Do the other side in a similar manner.
I. Use for bread board if desired.

Exercise 5. Plane end grain of piece of 1" x 6" lumber.

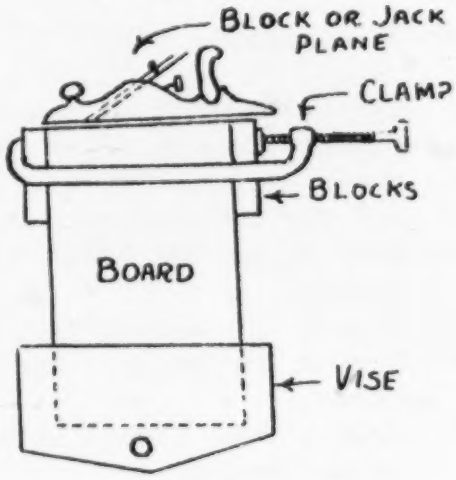

A. Use a piece of 1" x 6" lumber about 1 foot long. Square the ends.
B. On each edge of board, flush with the end, clamp a piece of 1" x 1" board tightly. (Put clamp near end of board.)
C. Clamp other end of board in a vise.
D. Use a jack plane and plane across the end of board.
E. Check with try square the squareness of edge with board surface.
F. Remove 1" x 1" pieces.
G. Repeat procedure on other end of board.

Exercise 6. Plane chamfers around edges of board.

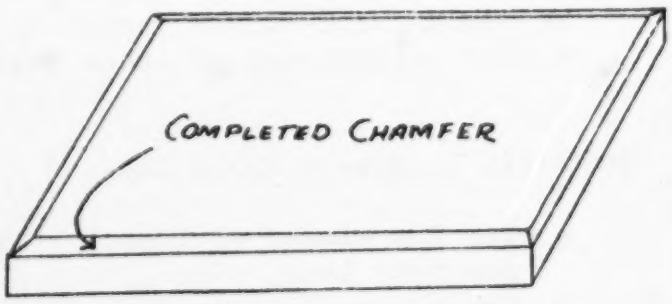

A. Use a board about 1" x 6" and a foot or more long.
B. Have edges planed and squared.
C. With a marking gauge, mark off $\frac{1}{4}$" in from all edges of board.
D. Chamfer end grains first, fastening board in vise properly.
E. Holding a correctly adjusted plane at 45 degree angle with surface of board, plane off the sharp edges.
F. Bevel down the edges with plane until both marks on the adjacent surfaces are reached simultaneously.
G. Use full length strokes to finish chamfer. (Avoid multiple bevels.)
H. After ends are finished, complete sides.

Exercise 7. Prepare wood for finish.

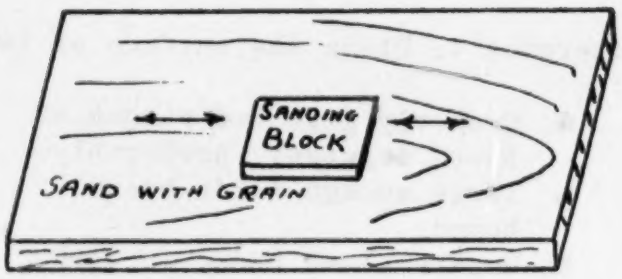

A. Plane a surface as smooth as possible, planing with the grain.
B. Use a scraper, going over surface with grain, further smoothing it.
C. Using a block, sandpaper with grain. (Use medium sandpaper.)
D. Repeat with fine sandpaper.
E. Wood should be free of marks and perfectly smooth.

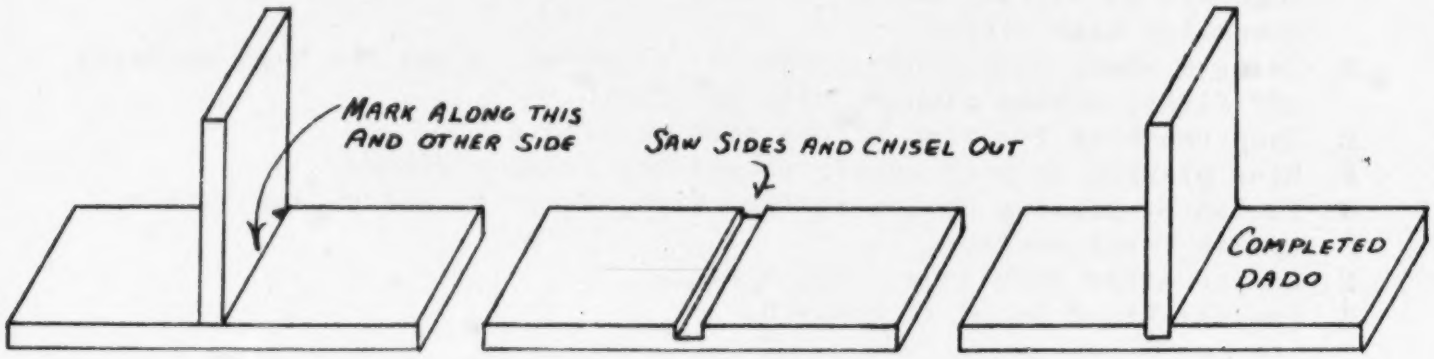

Exercise 8. Make a dado.

A. Use two pieces of board 1" x 6" and about a foot long.
B. Square the end of one accurately.
C. Place the squared end across the other board so sides are flush and the boards are perpendicular to each other.
D. Mark along the sides of the perpendicular board on the face of the other.
E. Remove the perpendicular board.
F. With a try square, mark half way down the sides of the board at the lines.
G. Draw a line across bottom of the side lines parallel to the surface of the board.
H. Do same on other side.
I. Using a back saw and a block for a guide, saw across the board to the depth line on both sides of board.
J. Do same along other line.
K. Use a wood chisel with bevel down to cut out wood between saw cuts.
L. Finish with chisel, bevel up and flat side level with bottom of groove.
M. Fit squared end of other board in groove, completing dado.

Exercise 9. Make a cross lap.

A. Use two pieces of lumber 2" x 2" and about one foot long.
B. Cross one piece on the other in middle of the pieces so as to form four 90 degree angles.
C. Mark with a pencil along sides of each piece where they cross on the other.
D. Continue as indicated in previous exercise.

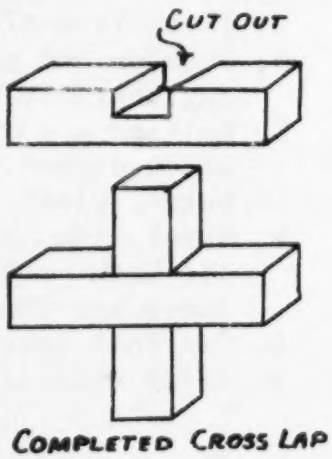

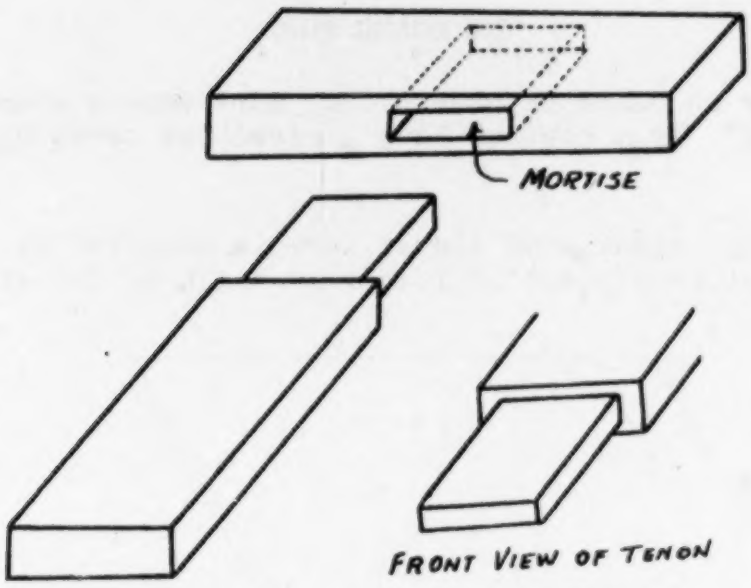

DETAIL OF THROUGH MORTISE TENON

Exercise 10. Make a through mortise.

A. Use two pieces of wood about 1" x 2" and 8" long.
B. Make the tenon first from one piece of wood.
C. Mark off a line two inches from end on all four sides with a try square.
D. With a back saw, cut down ¼" on each line, keeping saw level with board.
E. With a wood chisel, cut out the ¼" deep cut to the end of the board on all four sides. (Result is a tenon.)
F. Place end of tenon lengthwise against the side edge of second board about equal distance from each end.
G. Mark around tenon, or measure tenon and mark on edge.
H. Using a bit of proper size, drill holes through mortise board edgeways within marks.
I. Use a chisel to cut out remainder of wood in mortise to lines.
J. Insert tenon in mortise. (A tight fit should result.)

Exercise 11. Make a dowel joint.

A. Plane one edge of two 1" x 3" x 12".
B. Drill two 3/8" holes in middle of planed edge of one board about 8" apart and about 2" deep.
C. Drill two corresponding holes in planed edge of second board.
D. Cut two dowel pins 3/8" in diameter, about 3-3/4" long.
E. Insert dowel pins in holes of one board.
F. Place other board with holes over dowel and fit together.
G. Dowels and edge of two pieces may be glued and clamped to make a dowelled glue joint.

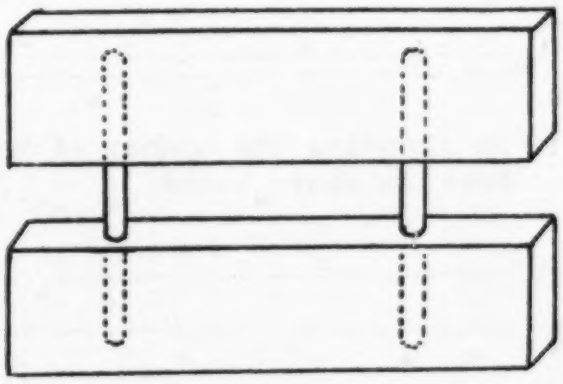

DETAIL OF DOWEL JOINT

6635

THE BOARD FOOT

Lumber whether in board or sheet form, must have a standard by which it is measured to be sold. From that we have derived the terms Board Foot and Square Foot.

Lumber in board, plank, and timber form is measured by the board foot standard. One board foot is a piece of lumber 1" thick by 12" wide by one foot long.

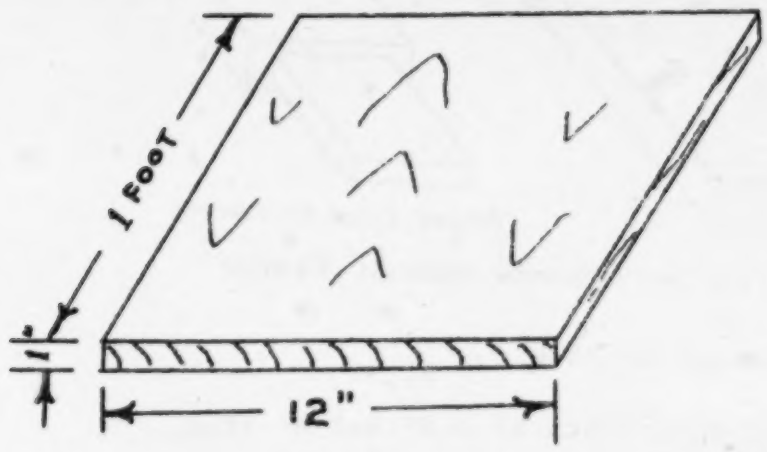

Equivalents of one board foot are illustrated on diagram below:

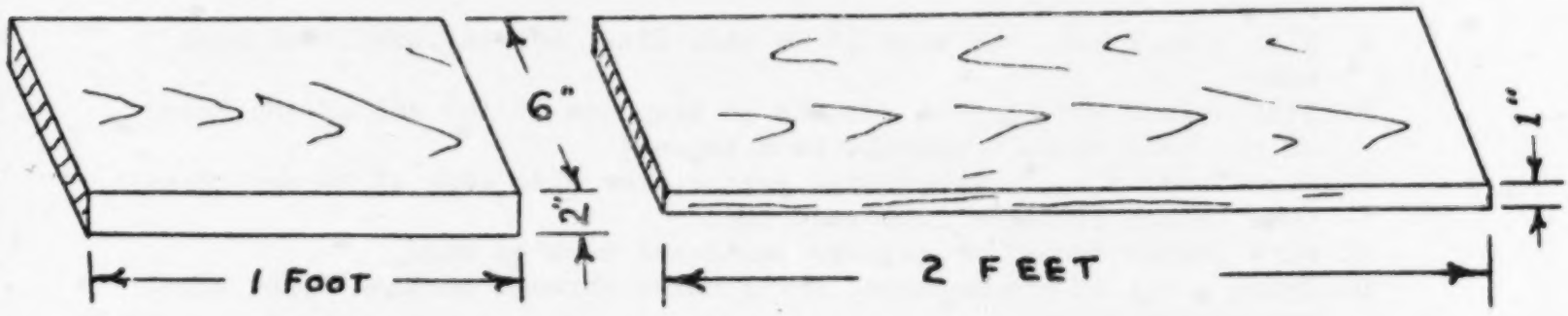

Shown below are various size boards showing how you can visualize the layout of the number of board feet in a piece of stock.

1. By counting the number of board foot sections give the number of board feet in above board. _____ number of board feet.

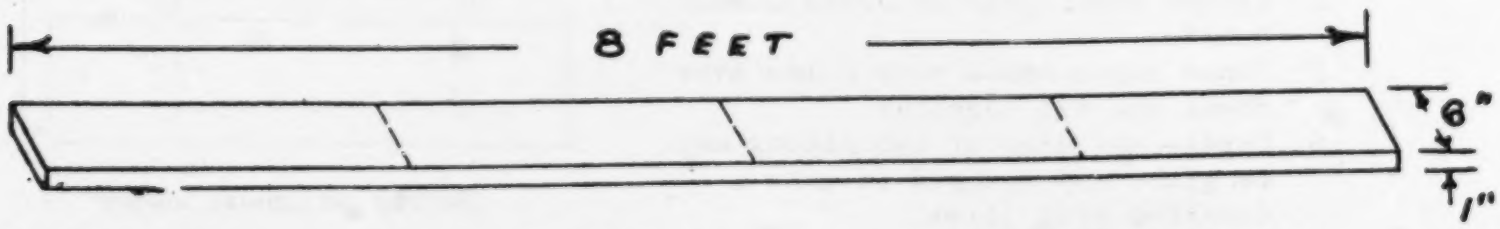

2. How many board feet in above board? _____ number of board feet.

3. How many board feet in the board shown above? _____No. of Bd. Ft.

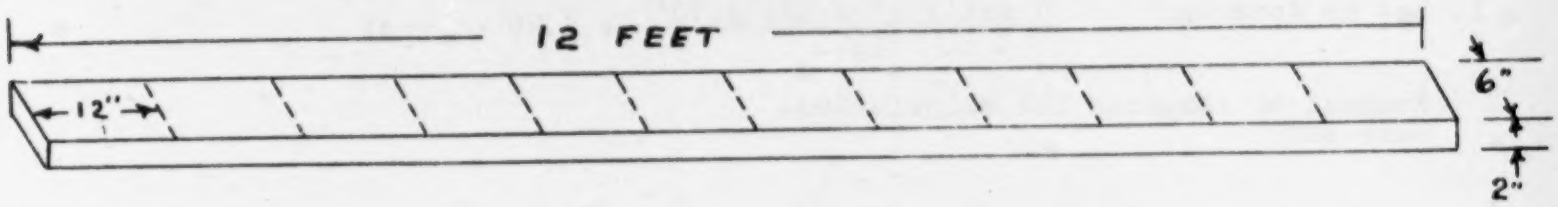

4. How many board feet in above board? _____Number of board feet.

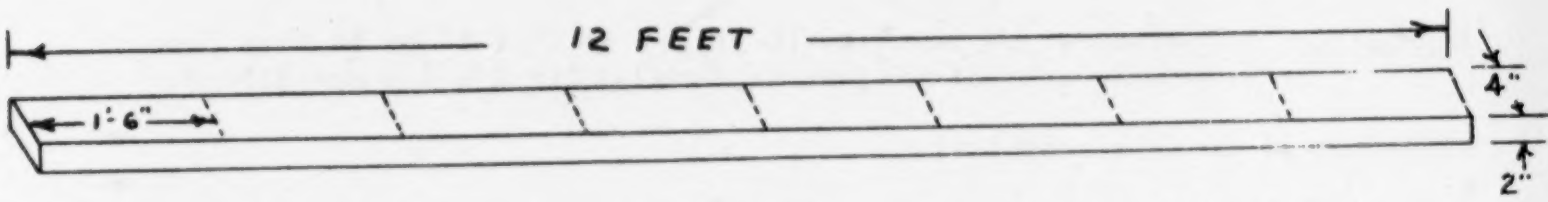

5. Give number of board feet in above board. _____Number of board feet.

The board foot formula should be applied to any problem where there is any doubt about the estimate. To use this formula substitute all known quantities and solve for the unknown.

BOARD FOOT FORMULA:

$$\frac{\text{Number of pieces x Thickness in inches x Width in inches x Length in feet}}{12}$$

Note: If length is given in inches, divide by 144 in place of 12.

Note: /M means per thousand as lumber is often priced. Divide by 1000 for cost per board foot. For example, to calculate price per board foot when price per M is $120.00, divide $120.00 by 1000, which gives 12¢ per board foot.

Determining Number of Board Feet by Using Board Foot Formula

Example A: A job requires 6 pieces of one inch thick material, 6 inches wide and 12 feet long. Determine number of board feet.

1. Set up formula: $\frac{6 \text{ pcs. x } 1'' \text{ x } 6'' \text{ x } 12'}{12}$ = Board Feet

2. Cancel when possible: $\frac{6 \times 1 \times 6 \times \cancel{12}^{1}}{\cancel{12}_{1}}$ = Board Feet

3. Multiply: $\frac{6 \times 1 \times 6 \times 1}{1} = \frac{36}{1}$ = 36 Board Feet

6638

Example B: A project requires 7 boards, 1 inch thick, 12 inches wide by 10 ft. long. The cost of this grade of lumber is $200/M. Determine cost of project. (First, calculate cost of 1 board foot)

1. Set up formula: $\frac{7 \text{ pcs} \times 1'' \times 12'' \times 10'}{12} \times \$.20 = \text{Cost}$

(Student to complete the calculation)
Show work.

Cost of project_____

Example C: A carpentry job requires 16 pieces of 2" x 4" by 14 feet long. Determine cost of project if Douglas fir 2 x 4's are $150/M.

(Student to do this computation)

The term "square foot" is applied to any stock manufactured in sheet form such as plywood, presdwood, insulation board, counter topping, etc. These prices are always priced by the square foot; thickness is not considered in estimating quantity and cost.

SQUARE FOOT FORMULA:

$$\frac{\text{Number of pieces} \times \text{width in inches} \times \text{length in feet}}{12}$$

Note: Divide by 144 if length is given in inches.

Example A: A project requires 7 pieces of $\frac{1}{4}$" plywood that is 24" wide by 36" long. How many square feet of plywood is required? (Suggestion: Change 36" to 3')

1. Set up formula: $\frac{7 \text{ pcs.} \times 24'' \times 3'}{12} = \text{Number of square feet}$

2. Cancel when possible: $\frac{7 \times \overset{2}{\cancel{24}} \times 3}{\underset{1}{\cancel{12}}} =$

3. Multiply: $\frac{7 \times 2 \times 3}{1} = \frac{42}{1} = 42$ square feet

6639

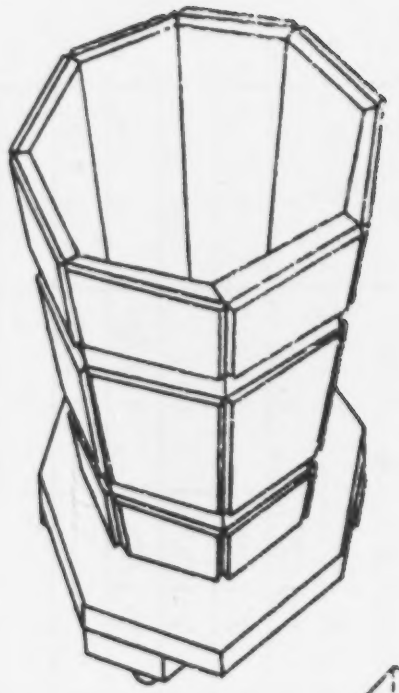

FLOWERPOT

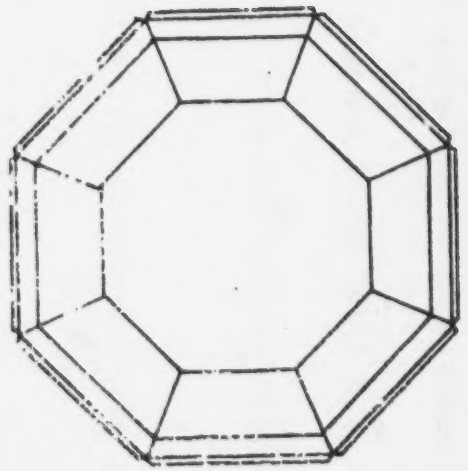

TOP VIEW

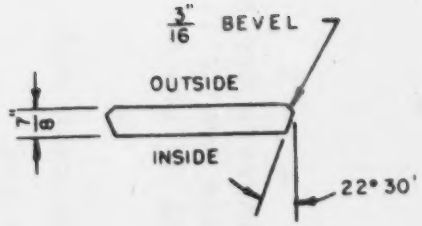

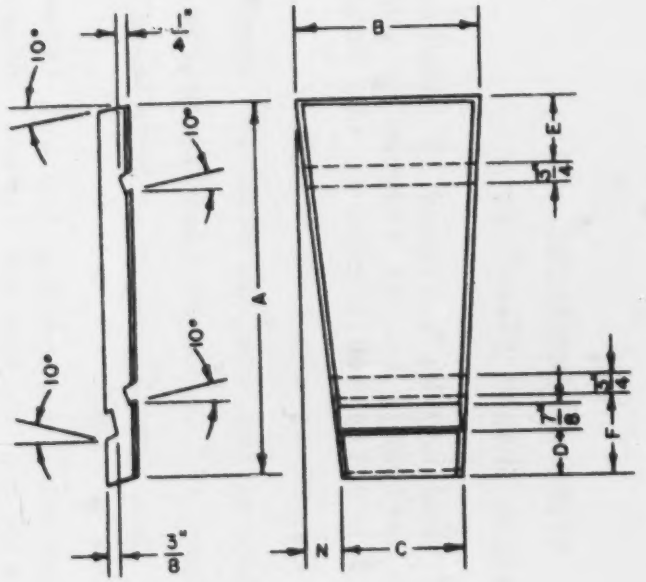

SIDE PIECE

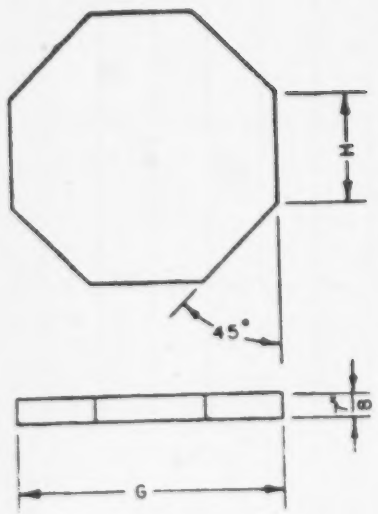

FLOOR

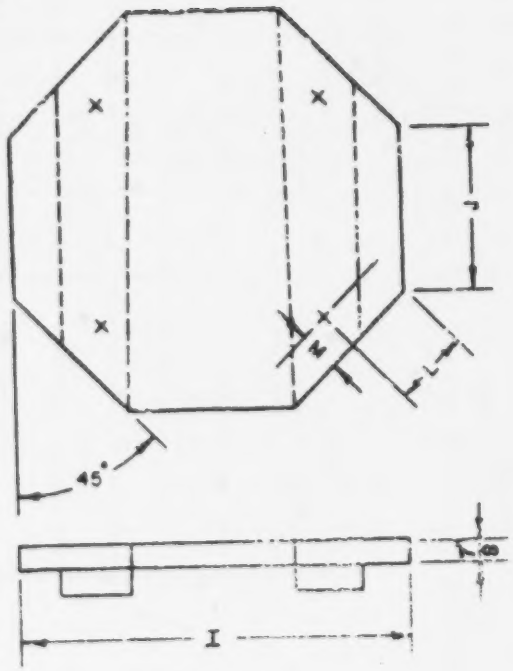

PLATFORM

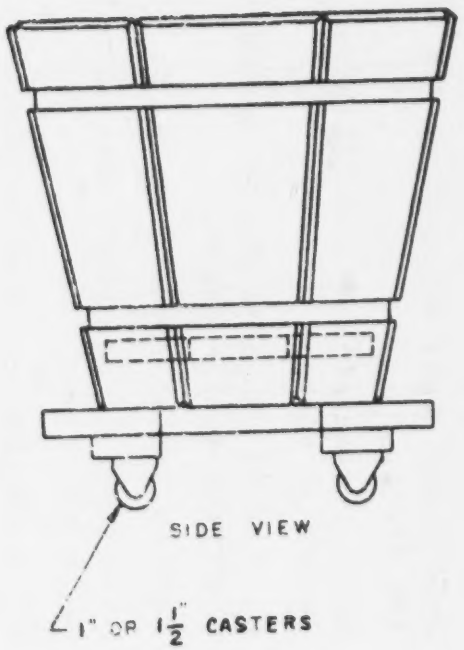

SIDE VIEW

FLOWERPOT
SCALE - 3/16" = 1"
DATE - 6 JULY 1965
USED - COURTESY C WESTON
DRAWN & TRACED BY - B W
PLAN NUMBER - 851

Columbia, Missouri

117

STEPS OF PROCEDURE

Octagon Shaped Flower Pots

1. Select wood (any species of wood may be utilized if plastic inserts are used). Without inserts it would be desirable to use redwood or cypress due to its weather resistance qualities and its resistance to the rotting action of the soil.
2. Cut 8 billets to width and length as shown on chart.
3. Cut billets as shown on accompanying diagram with 10° bevel on each end.
4. Cut 7/8" wide dado x 3/8" deep 10° angle to receive bottom of pot.
5. Cut two 3/4" wide dado 1/8" deep at 10° angle to hold metal banding ties on opposite side of dado cut for bottom.
6. Tilt saw blade to 22 $1/2^{o}$ and with a tapering jig cut left side of billet with single dadoed side (inside) up and bottom end first. Measurements for setting tapering jig are to be figured from the chart.
7. Double the angle on tapering jig and cut the remaining side of the billets top end first.
8. Bevel the outside of the billet on both sides with 3/16" bevel running entire length of sides.
9. Cut bottom of pot first by making a square the proper size and then cutting the 4 corners at 45° angle.
10. Sand to remove any sharp edge or dirty spots.
11. Flower pot is now ready for assembly. A metal banding machine is desirable for securing flower pot.
12. Apply desirable finish to assembled flower pot.
13. Cut and assemble flower pot base according to dimensions given on chart.
14. Adding casters would be desirable for ease in moving flower pot.

DIMENSION CHART

Measurements	Small	2nd.	3rd.	Large
A	9 1/4"	11"	12 3/4"	14"
B	4 3/8"	5"	5 5/8"	6 3/4"
C	2 7/8"	3 1/4"	3 1/2"	4 3/8"
D	1 3/4"	1 1/2"	1 1/4"	1 3/4"
E	1"	1 1/2"	2"	2 1/4"
F	2"	2 1/2"	2 1/2"	3 1/4"
G	6 3/4"	7 1/2"	9"	10 1/4"
H	2 3/4"	3 1/4"	3 5/8"	4 1/4"
I			12 1/2"	14 1/2"
J			5"	6"
K			2 1/2"	2 1/2"
L			2 1/2"	3"
M			1 1/2"	1 1/2"
N	1"/12"	1"/12"	1"/12"	1"/12"

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6641 1939

BOOK ENDS

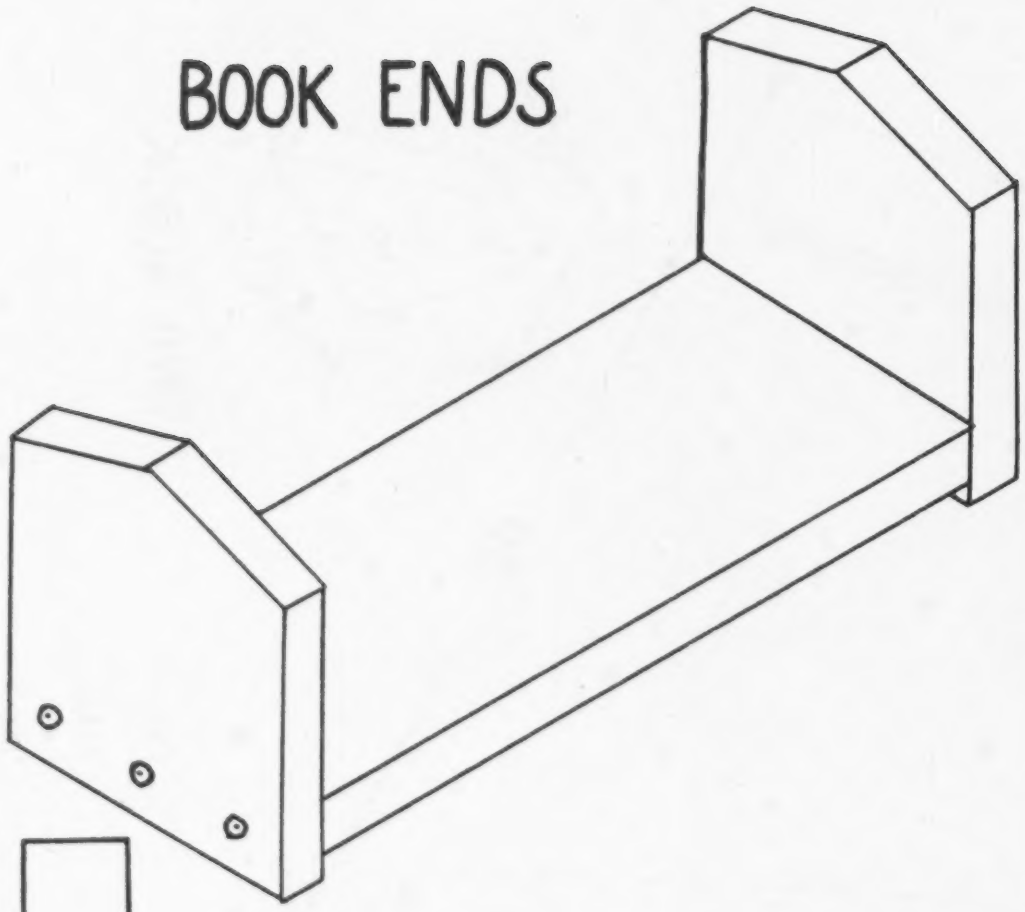

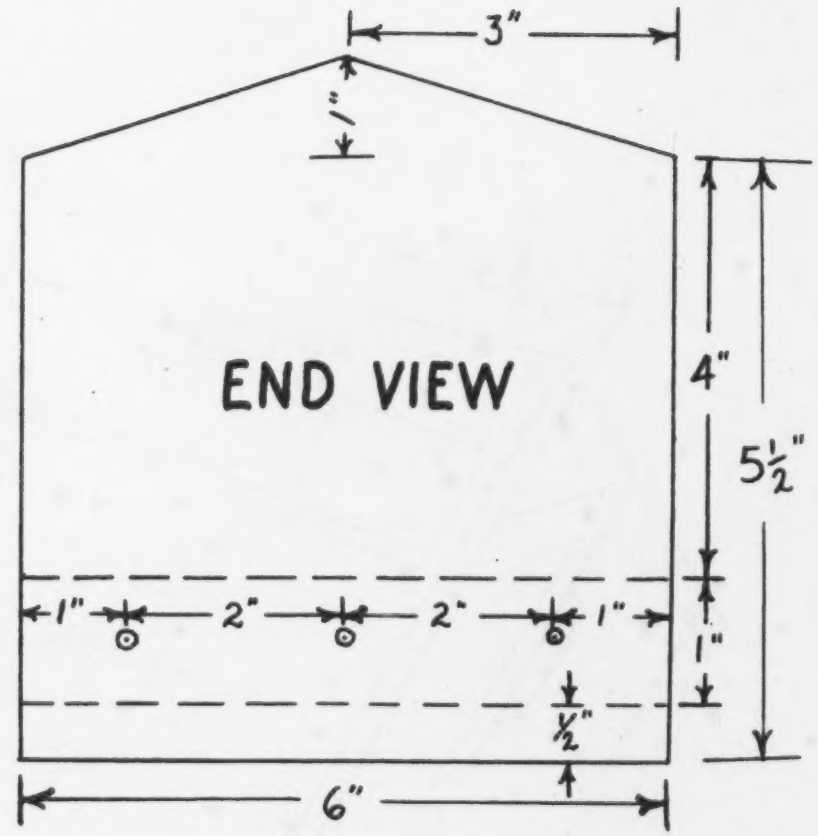

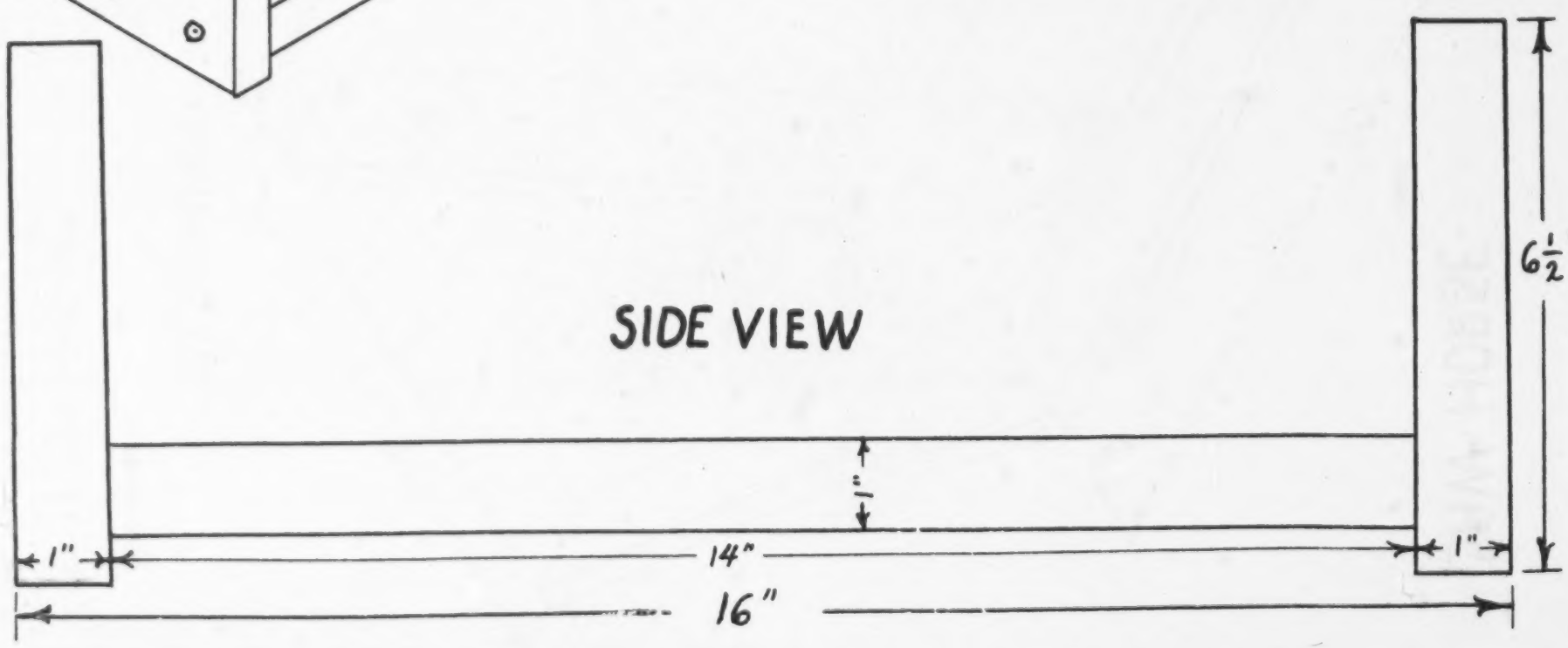

SAW HORSE

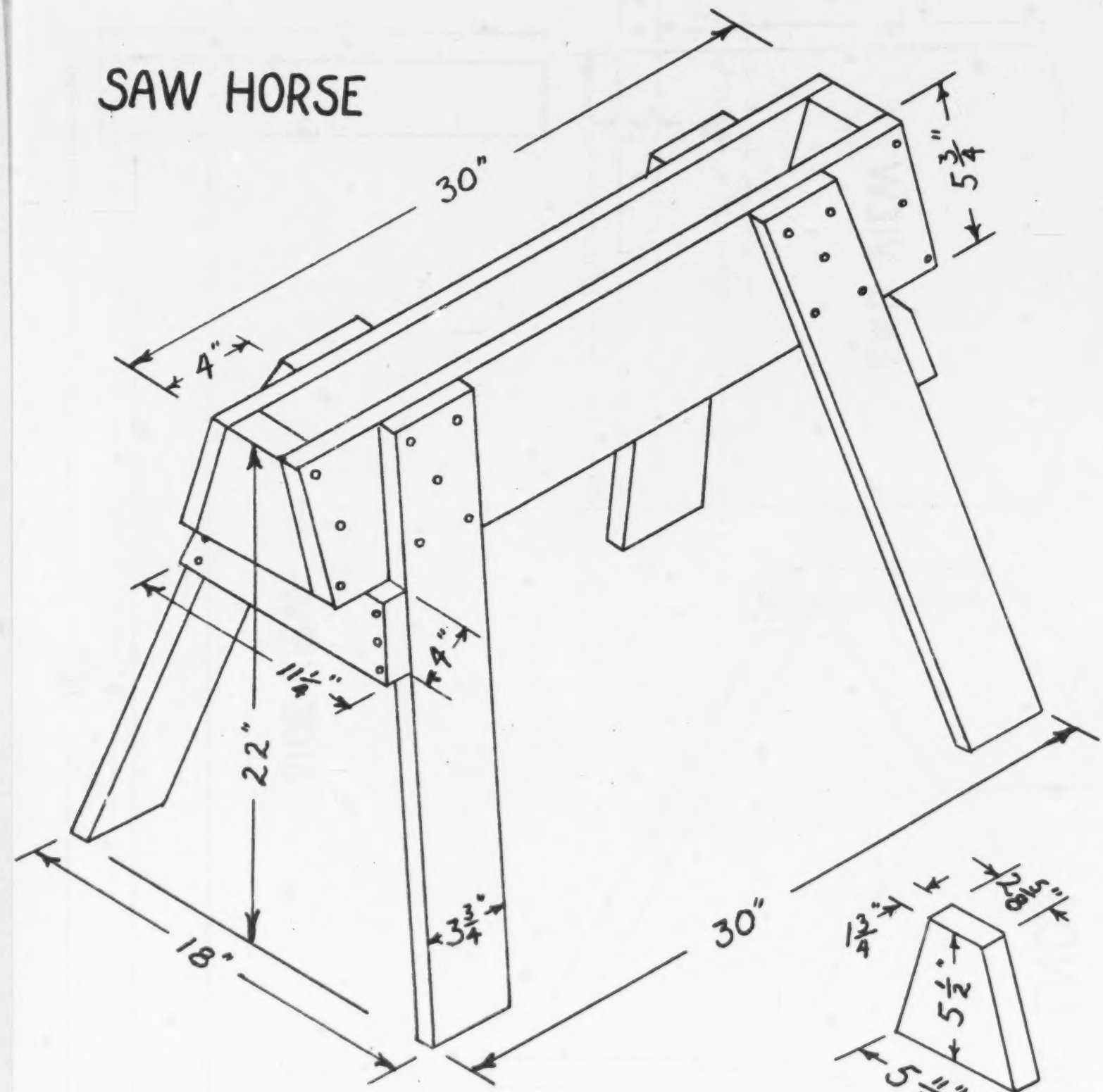

BILL OF MATERIALS

Materials	Use
2 pcs. 13/16" x 5-3/4" x 30"	Sides
4 pcs. 13/16" x 3-3/4" x 24"	Legs
2 pcs. 1-3/4" x 5-1/2" x 5-11/16"	End Blocks
2 pcs. 13/16" x 4" x 11-1/4"	Aprons
20 flat head bright wood screws, 1-1/2" No. 9	
24 flat head bright wood screws, 1-3/4" No. 10	

END BLOCK

1433

6642

NAIL AND TOOL BOX

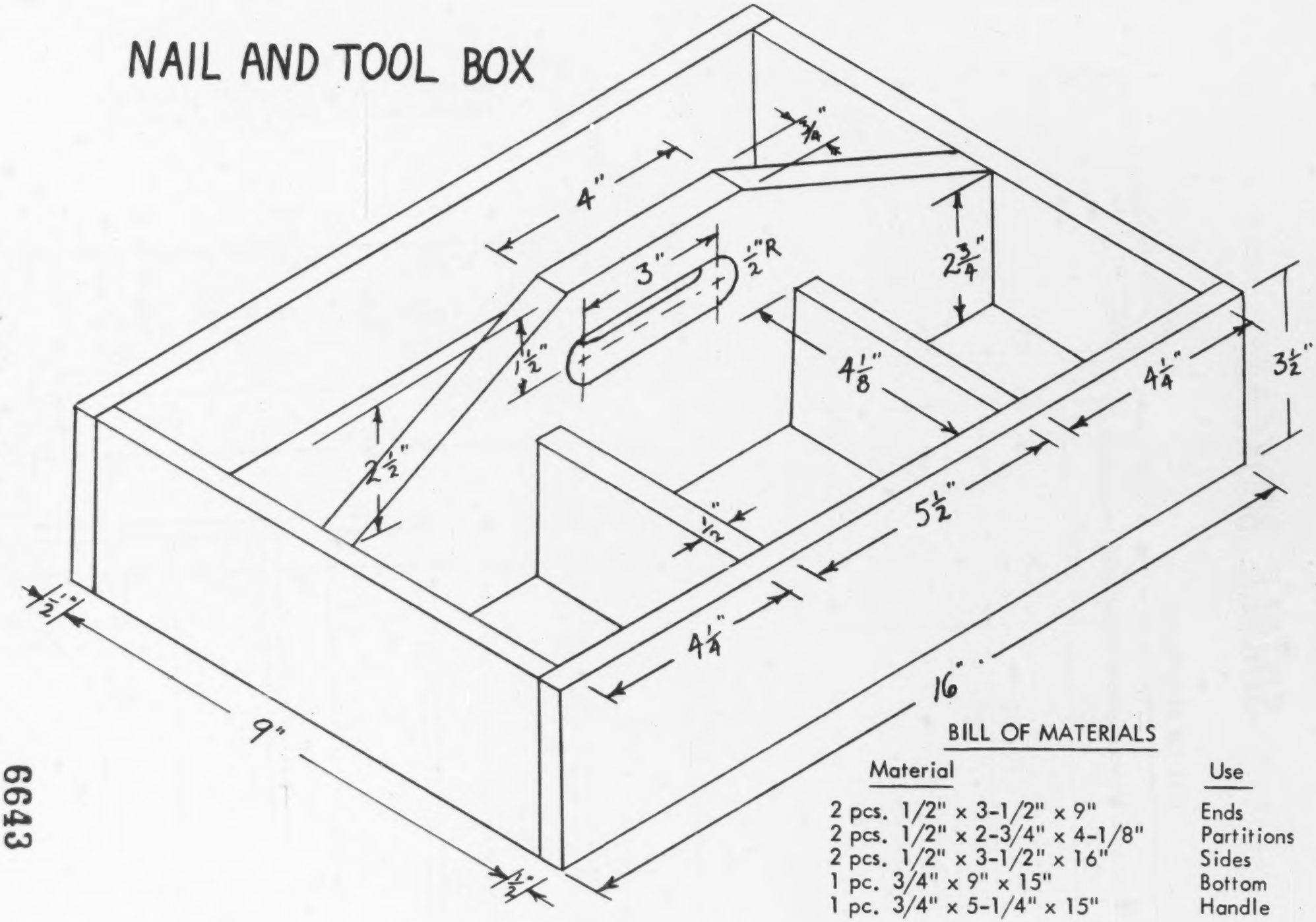

BILL OF MATERIALS

Material	Use
2 pcs. 1/2" x 3-1/2" x 9"	Ends
2 pcs. 1/2" x 2-3/4" x 4-1/8"	Partitions
2 pcs. 1/2" x 3-1/2" x 16"	Sides
1 pc. 3/4" x 9" x 15"	Bottom
1 pc. 3/4" x 5-1/4" x 15"	Handle

6643

SIMPLE BOOKCASE

BILL OF MATERIALS

No	Size	Use
4	9-1/2" x 5/8" x 30"	Shelves
2	9-1/2" x 3/4" x 44"	Ends
1	5" x 3/4" x 29-1/2"	Bottom Board
3	2-1/2" x 1/2" x 29-1/2"	Back Boards
1	2-3/8" x 1/2" x 29-1/2"	Top Back Board
2	Dozen Screws	To Secure Shelves
3	Dozen Nails	Secure Other Parts

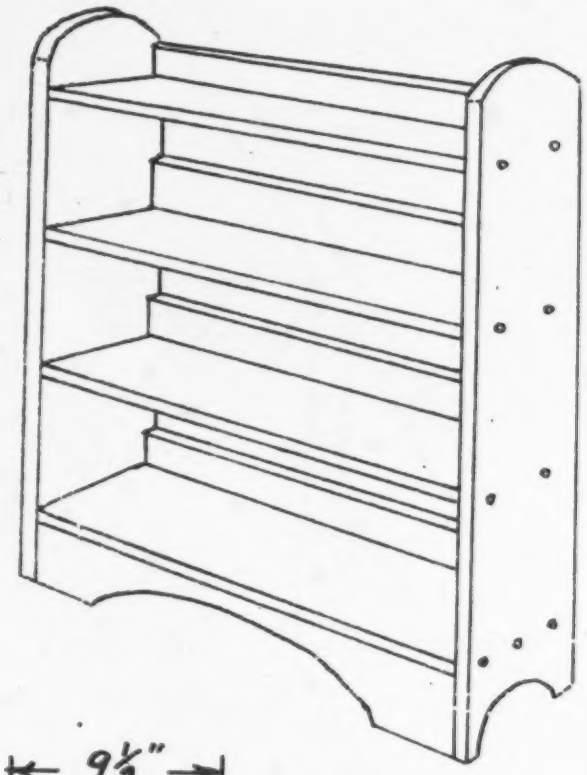

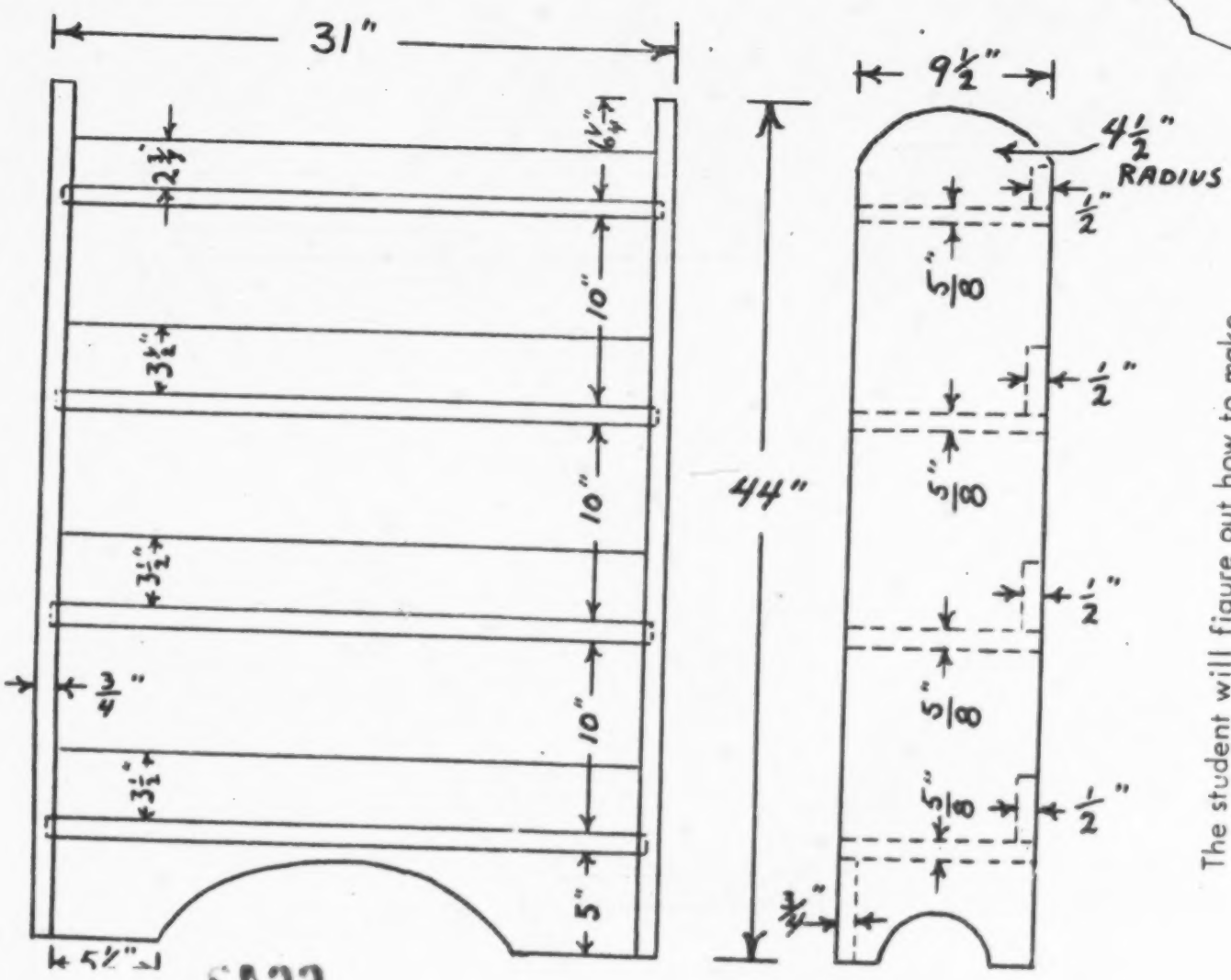

The student will figure out how to make the bottom radial cuts on this book case.

6644

MAGAZINE BASKET

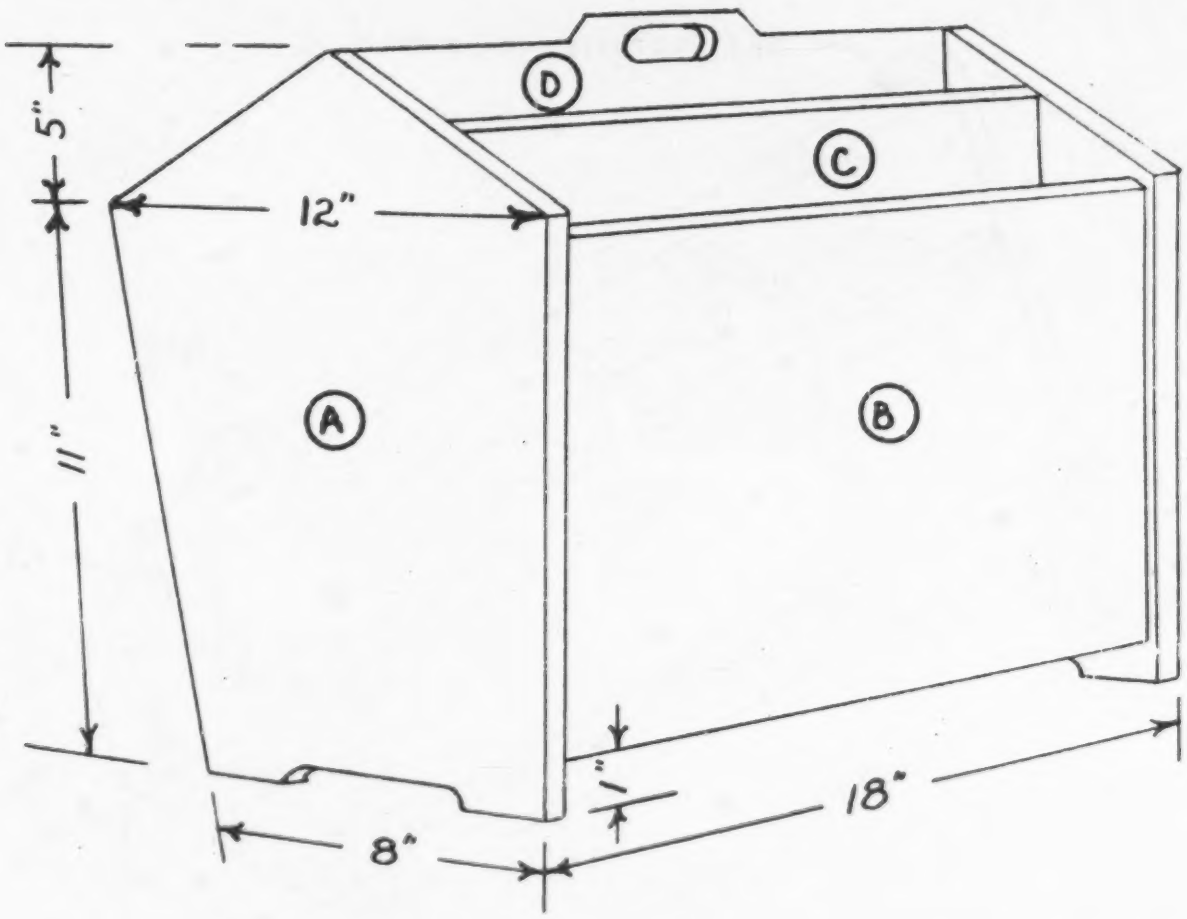

Code	Use	Size
A	Sufficient 7/16" material for two ends	Each 12" x 16"
B	Sufficient 5/16" material for two sides	Each 9-13/16" x 17-1/8"
C	Sufficient 5/16" material for two partitions	Each 11-3/4" x 17-1/8"
D	Sufficient 9/16" material for center partition	16-6/16" x 17-1/8"
E	Sufficient 5/16" material for bottom	7-1/2" x 17-1/8"

TOOL CARRYING BOX

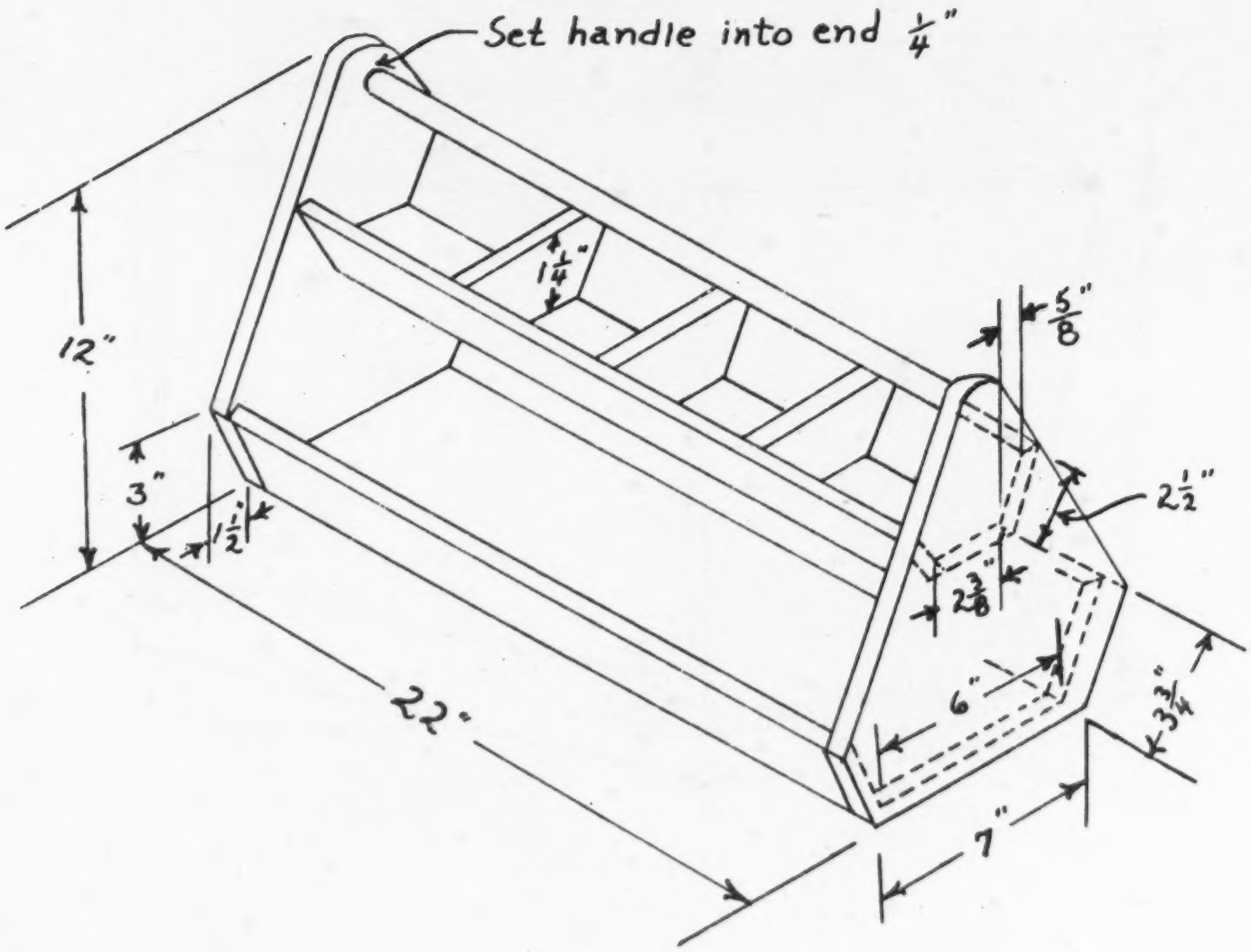

BILL OF MATERIALS

Material	Use
2 pcs. 3/4" x 10" x 12"	Ends
1 pc. 3/4" x 6" x 20-1/2"	Bottom
2 pcs. 3/4" x 3-5/8" x 20-1/2"	Sides of Bottom
1 pc. 1/2" x 2-3/8" x 20-1/2"	Bottom - Nail tray
2 pcs. 1/2" x 2-1/2" x 20-1/2"	Sides - Nail tray
3 pcs. 1/2" x 1-3/4" x 4-1/8"	Partitions - Nail tray
1 pc. 7/8" Round x 21" long	Handle

6646

PAINTING, GLAZING, VARNISHING AND STAINING

The durability of paints oftentimes depends to a large degree upon how they are applied. The following exercises will give the students an opportunity to learn to apply the different paints and varnishes, and to recognize many of the common paint failures.

Glazing does not require a great amount of skill, but certain fundamental practices must be followed.

The following exercises are designed to give the student practical experiences in painting and glazing. The work is divided into two parts. The first part in on painting, varnishing and staining. The second part is on glazing.

Main Points Student Will Learn in This Chapter

1. Mixing Paint
2. Preparing surfaces ready to paint
3. Applying paint
4. Common paint failures
5. Applying varnishes and stains
6. Caring for paint brushes
7. Figuring amount of paint needed
8. Cutting glass
9. Installing windowpanes using glazier points and putty
10. Grinding the edge of a piece of glass smooth

Materials Needed

1. White lead paint mixture
2. Other paints
3. Shellac, varnishes, wood filler
4. Turpentine, linseed oil, oil stain, thinner, alcohol
5. Brushes, small and large
6. Sandpaper, steel wool
7. Soft wood and hard wood

Exercises for Student

1. Mix paint ready to use.
2. Prepare a board surface for painting.
3. Apply paint to wood surface.
4. Show blistering and peeling.
5. Show alligatoring.
6. Show running or sagging.
7. Prepare a board for a varnished finish.
8. Apply varnish to the surface (open grain wood).
9. Caring for brushes between periods of use.

Additional Exercises

10. Put a satin finish on a piece of wood.
11. Put a blond finish on a piece of wood.
12. Finish a piece of sand blasted plywood with color or paint desired and two-tone it.

6647

Exercise 1. Mix paint ready for use.

A. Use a can of paint with white lead in its formula.
B. Pour off about half the oil that is on top of the settled portion into another can.
C. With a flat paint mixing stick stir contents in original bucket until it is all smooth.
D. Use a motion to the stick whereby the heavy material on bottom will be brought upward.
E. Add the rest of the oil gradually until all the oil is thoroughly mixed with the paint.
F. If smaller amounts are desired, use the stick and spoon out some paste into another can. Add oil and mix until correct consistency.

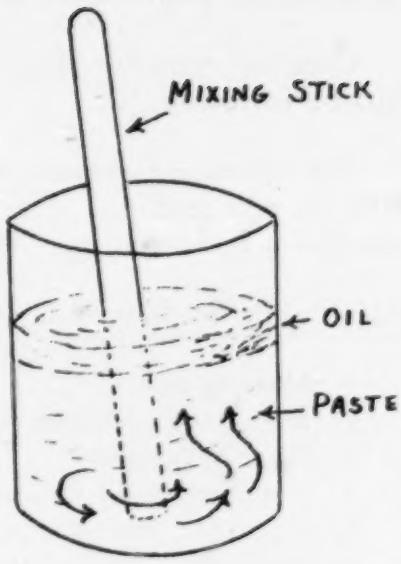

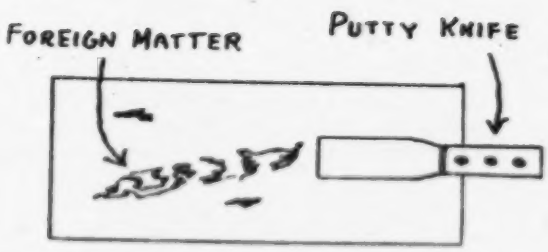

SCRAPE SURFACE CLEAN

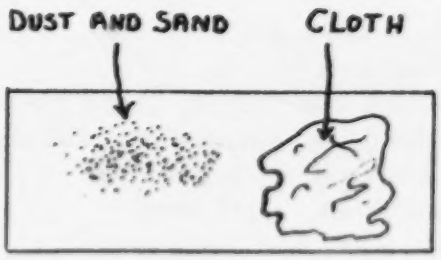

WIPE CLEAN WITH CLOTH

Exercise 2. Prepare a board surface for painting.

A. For smooth surface, lumber must be planed.
B. Dry lumber thoroughly.
C. Clean any foreign matter off the surface to be painted.
D. Avoid boards heavily laden with pitch.
E. Sand surface with fine sandpaper.

6648

Exercise 3. Apply paint to wood surface.

A. Wipe surface free of dust.
B. Select and prepare primer paint for first coat.
C. Use a clean brush free of any foreign substance.
D. For first coat use small amount of paint on surface.
E. Cover surface completely with overlapping strokes.
F. Paint with the grain, holding paint brush handle between thumb and index finger, using the fingers to guide the brush.
G. Brush out the paint well, allowing no heavy smears of paint.
H. Allow first coat to dry completely.
I. Sand lightly and wipe surface free of dust.
J. Apply second coat using proper paint, properly mixed.
K. Apply second coat in same manner as first except that a little more paint may be applied to the surface.
L. Allow to dry completely.
M. Sand lightly and wipe surface free of dust.
N. Apply third coat using proper paint, properly mixed.
O. Third coat should be applied in same manner as second, with ample coat of paint applied.
P. Result should be a smooth even surface with no lap marks.

PAINT WITH GRAIN

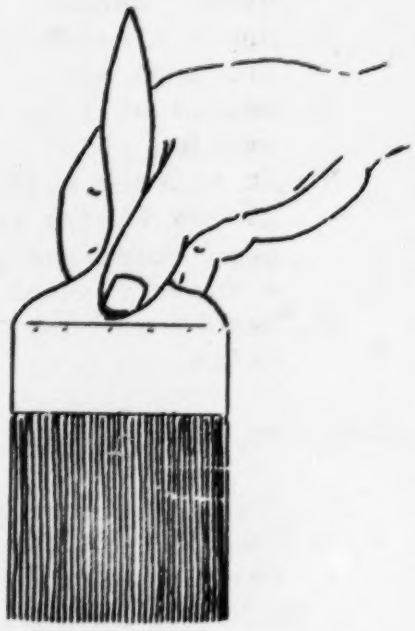

PROPER WAY TO HOLD BRUSH

Exercise 4. Show blistering and peeling.

A. Prepare a board for painting.
B. Allow surface to be soaked with water or become completely wet.
C. Apply three coats of paint over a three day span, keeping board in cool place.
D. Set board in the sunlight or near heated place and blistering or peeling will result.

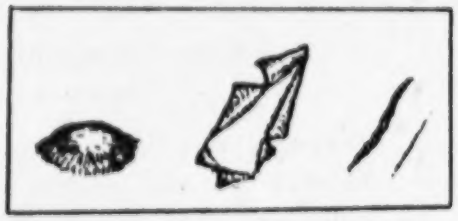

BLISTERING AND PEELING

Exercise 5. Show alligatoring.

A. Prepare a board for painting.
B. Apply a first coat with plenty of linseed oil in the paint.
C. Allow 24 hours to dry.
D. Apply a second coat of paint that has been thinned with turpentine instead of linseed oil, or use a

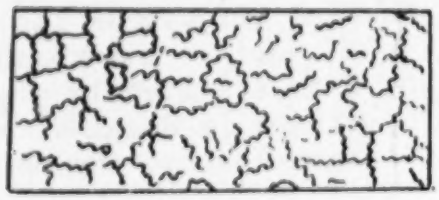

ALLIGATORING

quick drying paint.

E. Apply a third coat 24 hours later, using same kind of paint as for second coat.

F. In a few days notice the alligatoring and irregular cracking.

Exercise 6. Show running and sagging.

A. Prepare a board for painting.

B. Apply a first coat of paint in the usual manner. Allow to dry.

C. Apply a heavy second coat having too much oil.

D. Result will be a surface with sagging paint.

E. On another surface that has a glossy finish paint that has not been roughened or treated, apply a heavy coat of paint.

F. Result will be running or sagging paint.

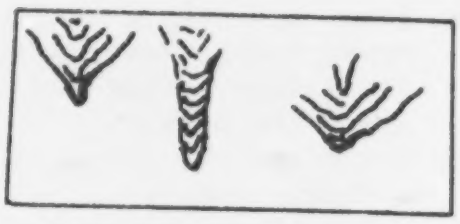

RUNNING AND SAGGING

Exercise 7. Prepare a board for a varnished finish.

A. Plane the wood smooth and even.

B. Using a scraper, scrape out any small plane marks. Scrape in direction of grain.

C. Use medium sandpaper attached to a block for flat surfaces. Sand surface in direction of grain.

D. Use fine sandpaper attached to a block for flat surfaces. Sand in direction of grain.

E. With a soft, dry cloth wipe off sanding dust.

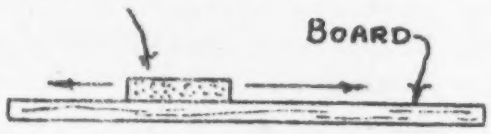

SAND WITH GRAIN

Exercise 8. Apply varnish to the surface (open grain wood).

(Note: When finishing closed grain woods, eliminate the filling operation.)

A. Prepare surface in proper manner.

B. Select an oil stain of proper color for wood used.

C. Brush on stain, using ample stain to cover surface.

D. Wipe off excess stain with cloth, working with the grain.

E. Apply wash coat of shellac (2 lb. cut.)

F. Allow shellac to dry completely.

G. Apply wood filler (to open grained wood) with a brush or coarse cloth across the grain.

H. Wipe off excess filler (only the open pores should contain filler.)

I. If surface has roughened, sand lightly with fine sandpaper.

J. Sand off lightly with fine sandpaper. At this point, if a shellac finish is desired, several coats of shellac may be applied. Allow each coat to dry before next coat is applied.

(Continued next page)

K. If a varnish finish is desired, sand lightly and wipe free of dust.
L. Apply first coat of varnish and let dry for 24 hours.
M. Sand lightly and wipe free of dust.
N. Apply second coat of varnish and let dry for 24 hours.
O. Sand lightly, preferably with wet or dry paper. Wax with paste wax. Buff.
P. If a satin finish is desired, rub surface with rubbing compound (rottenstone or pumice), clean and wax and buff.

Exercise 9. Caring for brushes between periods of use.

A. Use a can large enough so brush will not touch sides and will hang in can without touching bottom.
B. Drill a hole through the small of the brush handle. Hole should be large enough to insert a wire to support brush.
C. For over-night storage suspend brush by wire in can and fill can so brush bristles only are covered with proper liquid. For varnish and paints use turpentine. For shellac use alcohol.
D. For longer periods of time clean paint, varnish, or shellac thoroughly from brush with proper liquid.
E. Wash brush with warm soap suds.
F. Rinse in clean warm water and shake out excess water.
G. While brush is still damp, wrap well in plain paper and store in a dry place.

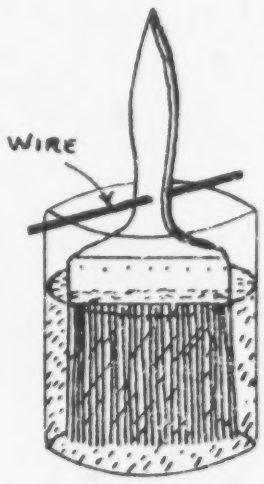

BUCKET FOR STORING BRUSHES BETWEEN USES

1. What is meant by pigment? Its purpose?

2. What is the vehicle in paint? Its purpose?

3. What is the purpose of adding turpentine to paint?

4. What is the difference in the action of raw and boiled linseed oil as a paint vehicle?

5. What is the cause of alligatoring?

6. What is the cause of blistering and peeling?

7. What are the qualities of white lead which make it a desirable paint ingredient?

8. On new wood what is the purpose of the first priming coat?

9. What should be done with the skin that forms over left over paint that has been improperly stored?

10. How should paint be stored to prevent the formation of skin?

11. What is the best size paint brush for general project painting? For house painting? For general varnishing?

General project painting_____ House_____ Varnish_____

12. List steps necessary to care for paint brushes after use.

13. What is the purpose of applying paste filler to open grain woods?

14. What is the importance of sanding between finish coats rather than after last coat?

15. What is the importance of painting and finishing in a dust free room?

16. Describe how to guard against "runs" on vertical surfaces.

17. When painting metal surfaces, what type of primer coat is required?

How to Figure the Amount of Paint Needed

1. Suppose a gallon of paint will cover 500 square feet, how many gallons are needed to cover an area 20 feet by 40 feet?

   _____ gallons

2. A gallon of paint will cover 275 square feet using 2 coats of paint. How many gallons are required to cover an area 15' x 40'? (applying 2 coats.)

3. Figure how many gallons of paint, applying one gallon per 350 square feet are needed for this shed. (Roof is not painted—do not deduct door or window space, as window frames, door, and door frame also need paint.)

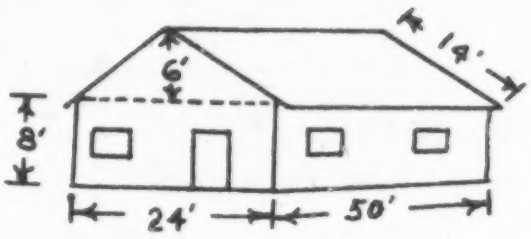

4. How much barn paint must I buy for this barn to cover all walls. One gallon covers 400 sq. feet? (Do not compute eave trim or under eaves) (b) What is the cost of paint required at $4.25 per gallon?

   (a) Gallons paint needed_____

   (b) Cost of paint $_____

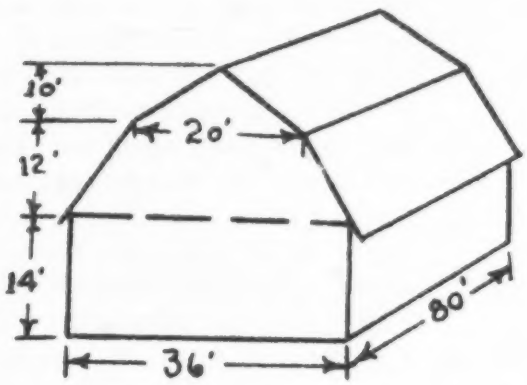

Materials and Equipment

1. Glass (regular pane)
2. Glass cutter
3. Glazier points and putty knife
4. Glazier's putty
5. Steel rule
6. Window sash
7. Light hammer
8. Old wood chisel
9. Flat grind stone
10. Linseed oil

Exercises for Student

1. Cut a piece of glass 3" x 8".
2. Cut a pane and fit into a sash about 8" x 10".
3. Install a pane in a sash using glazier points and putty.
4. Grind a smooth edge on a piece of glass.

Additional Exercises

5. Use double strength glass and make a table top.
6. Drill holes in glass tumblers and stack them to form base of a lamp.

Exercise No. 1. Cut a piece of glass 3" x 8".

A. Lay glass stock on flat surfaced table.
B. Chip edge with glass cutter to mark off 3" along one side.
C. Lay steel rule along 3" markings.
D. With glass cutter and medium steady pressure, cut along ruler, making a cut mark on glass. (Do not go over mark second time.)
E. Hold glass on edge of table top, tapping along cut mark from under side. (Tap at center first, working towards edges.)
F. Another method of breaking glass is to slide glass on edge of table up to scratch. Apply downward pressure with hands.

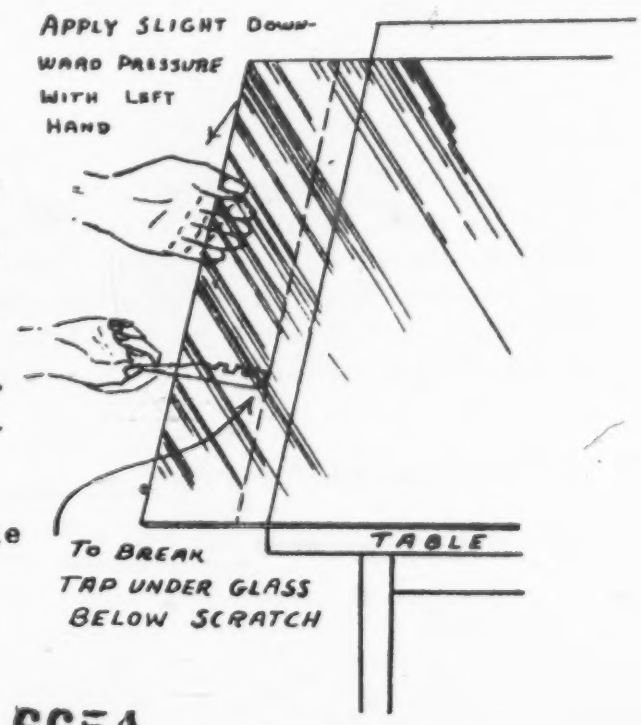

Exercise 2. Cut pane and fit in a sash about 8" x 10".

A. Measure exact opening of a sash. (Measurement can be drawn on a piece of paper. Place paper under glass and cut at line.)
B. Allowing about 1/8" clearance, cut a pane to fit the sash.
C. Slide pane into rabbet and see that all the opening is covered.

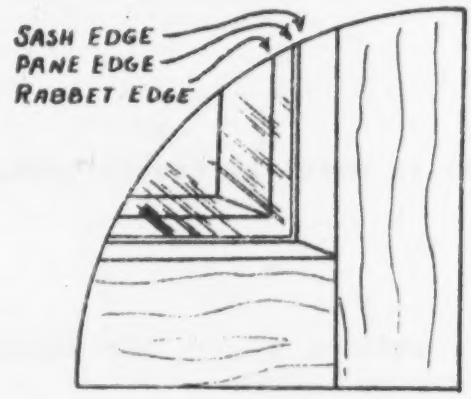

ENLARGED CORNER VIEW OF WINDOW SASH SHOWING HOW GLASS FITS IN

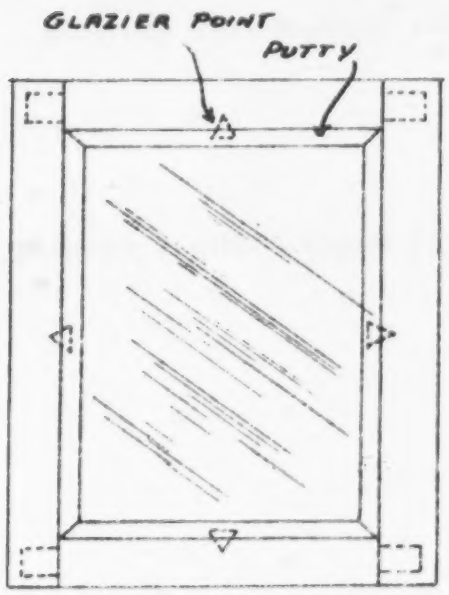

SASH SHOWING VARIOUS PARTS OF WINDOW INSTALLED

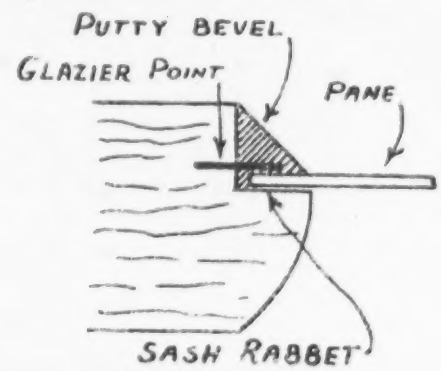

CROSS SECTION OF SASH

Exercise 3. Install a pane in a sash using glazier points and putty.

A. Check rabbet in sash to see that all old putty and glass are removed.
B. Apply a little linseed oil or thin paint to rabbet.
C. Fit pane into sash properly.
D. Set glazier points flat on glass, point toward the sash, and drive about halfway in with wood chisel.
E. On small panes, one glazier point on each side will suffice. On larger panes, place glazier points 6" apart.
F. Warm glazing putty by working it in hand until pliable and smooth.
G. Apply putty to edges of sash at 45 degree angle, using putty knife.
H. Clean window of oil and excess putty.

Exercise 4. Grind a smooth edge on piece of glass.

A. Cut a piece of glass, 3" x 8".
B. Holding glass on edge, use a flat stone to grind edges smooth.
C. Hold stone at angle to get slightly rounded edges.
D. Grind all four edges.
E. Check to see that sides are straight.

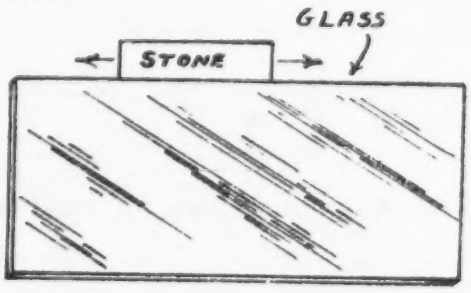

6655

1. What is meant by single strength glass? Where is it usually used?

2. What is meant by double strength glass? Where used?

3. When cutting glass, why should you not run the cutter over scratch the second time?

4. How can any irregularities be removed from cut edges without causing large breaks in the glass?

5. What is the purpose of the rabbet in a window sash?

6. Why is it necessary to apply a coat of paint or linseed oil to the rabbet before applying putty?

7. What is the purpose of applying putty to the sash?

8. How should left-over putty be stored to prevent it from drying?

9. How can putty be made soft and pliable?

10. When should paint be applied over putty?

INTRODUCTION TO ELECTRIFICATION

The following pages are designed to introduce the student to electrification. The student should become familiar with the common electrical terms and materials. The following exercises are suggested to give the student practice in a few of the fundamental skills.

1. Electrical Terms
2. Methods of Generating Electricity
3. Conductors of Electricity
4. Wiring Materials
5. Fundamentals of Wiring
6. Student Projects

6657

ELECTRICITY--HOME WIRING

Materials and Equipment

1. Knife (pocket type)
2. Three sizes wooden handle screwdrivers
3. Electrician's pliers -- 8 inch
4. Wire gauge
5. Solder, flux, electric soldering copper
6. Electrician's rubber tape
7. Electrician's friction tape
8. Appliance wire and appliance plug
9. Electric copper wire (several sizes)
10. Outlet plugs, light sockets, outlets
11. Flush switches, outlet boxes, insulators, switch boxes
12. Single pole and three-way switches
13. Rigid conduit

Exercises for Student

1. Record size of three wire diameters with wire gauge.
2. Western Union or end splice.
3. Romex cable splice, wrap with insulation.
4. Knotted tap splice.
5. Pigtail splice.
6. Hook end of wire.
7. Underwriter's knot.
8. Attach plug and socket to cord.
9. Attach appliance plug to cord.
10. Attach rigid conduit to octagon box.
11. Install switch box in a wall.
12. Attach romex cable to switch box.
13. Install wall switch to switch box.
14. Hook up a single pole switch to light fixture and source of electricity.
15. Hook up a three-way switch to light fixture and source of electricity.
16. Hook up convenience outlet to source of electricity.

Additional Projects

17. Make up an extension cord for home use.
18. Wire or re-wire a table lamp.
19. Repair an electric appliance from home.

6658

Exercise 1. Record size of three wire diameters with wire gauge.

A. Cut three different size wires 4" long.
B. Bare 3/4" from each wire.
C. Using metal and wire gauge measure each wire.
D. Record size of each wire below:

Wire 1: _____ gauge

Wire 2: _____ gauge

Wire 3: _____ gauge

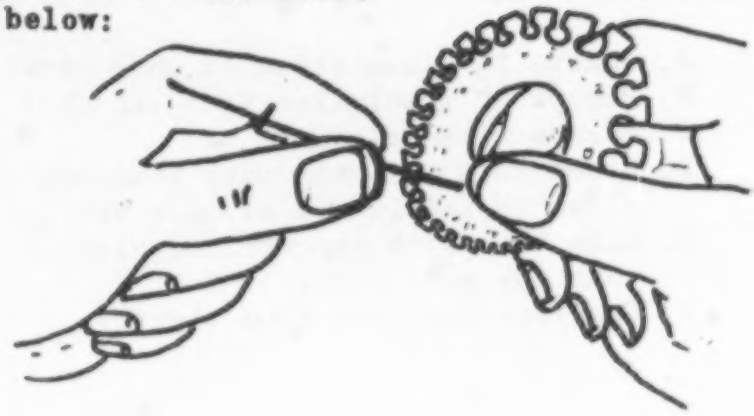

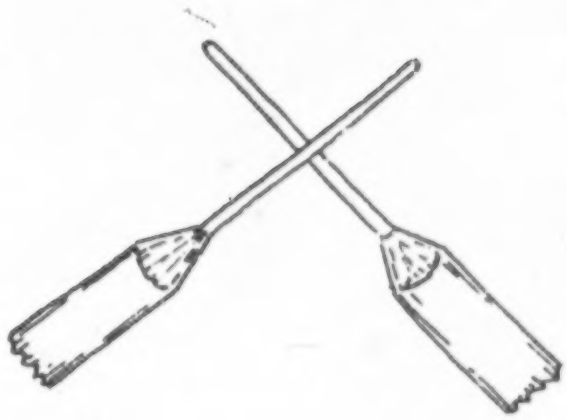

Exercise 2. Western Union or end splice.

A. Remove 3 inches of insulation from end of wires.
B. Clean wires with knife before crossing them.
C. Wind one end around other wire toward insulation.
D. Keep windings close together (about 4 to 5 windings).
E. Make duplicate windings with other free wire.
F. Cut excess wire close to splice leaving no sharp ends.

Exercise 3. Romex cable splice, wrap with insulation.

A. Use two Western Union splices as in Exercise 2.
B. Stagger splices eliminating short circuits.
C. Wrap each splice separately with electrician's rubber tape.
D. Wrap wires together with electrician's friction tape.

Exercise 4. Knotted tap splice.

A. Remove $1\frac{1}{4}$" insulation on main wire.
B. Remove 3" insulation from tap wire.
C. Scrape wires clean.
D. Start knot with tap wire crossing close to insulation of main wire.
E. Make knot with tap wire, insulation near the main wire.
F. Complete knot and wind tightly.

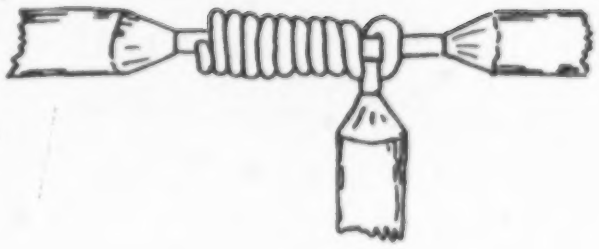

Exercise 5. Pigtail splice.

A. Correctly remove insulation from three wires.
B. Clean wires with knife.
C. Holding bare wire ends together, begin twisting all three wires together.
D. Twist until windings are close to insulation.
E. Solder to insure good permanent splice.

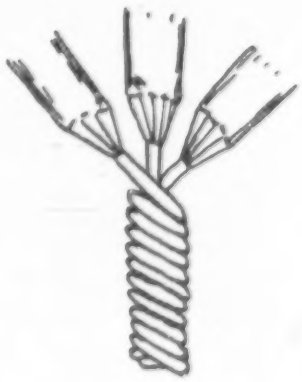

Exercise 6. Hook end of wire.

A. Remove $1\frac{1}{4}$" insulation from wire.
B. Make hook in bare wire so it centers in line with wire.
C. Make sure loop is made so a terminal screw tightens loop instead of spreading it.
D. Allow only 3/16" of bare wire from insulation to hook.

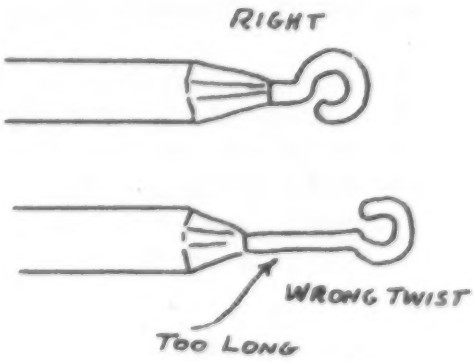

Exercise 7. Underwriter's knot.

A. Insert lamp cord wire through cap of lamp socket.
B. Split wires about 3 inches back.
C. Tie Underwriter's knot in wires.
D. Pull knot tight against cap.

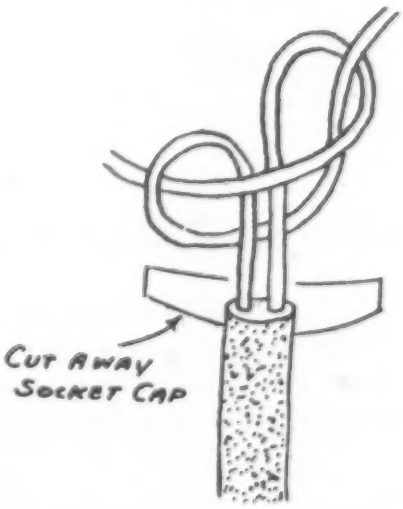

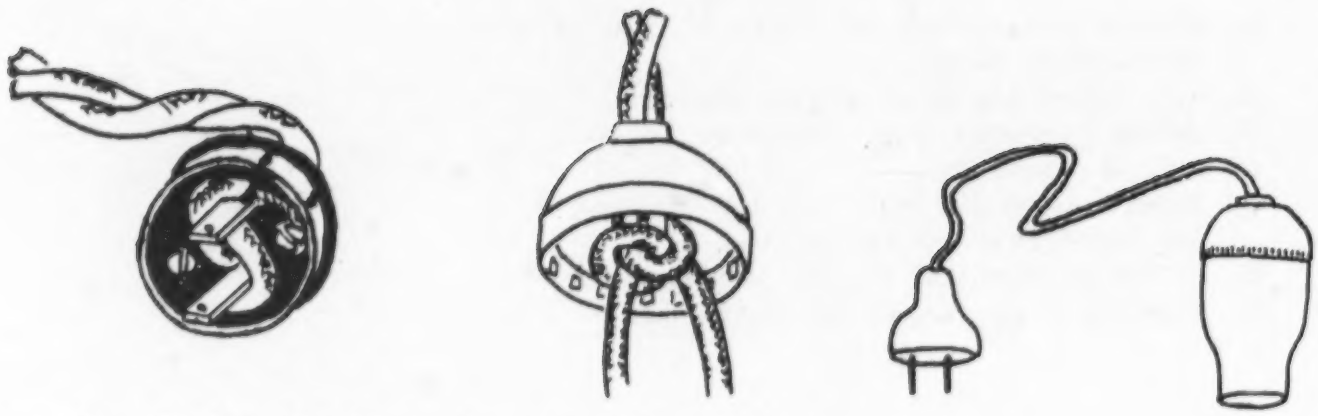

Exercise 8. Attach plug and socket to a cord.

A. Use Underwriter's knot in lamp cap socket.
B. Remove 3/4" insulation on free ends of wire.
C. Attach to terminals of socket so wire will tighten with terminal screw, allowing no frayed wires.
D. Using Underwriter's knot, if appropriate, attach plug to other end of cord.

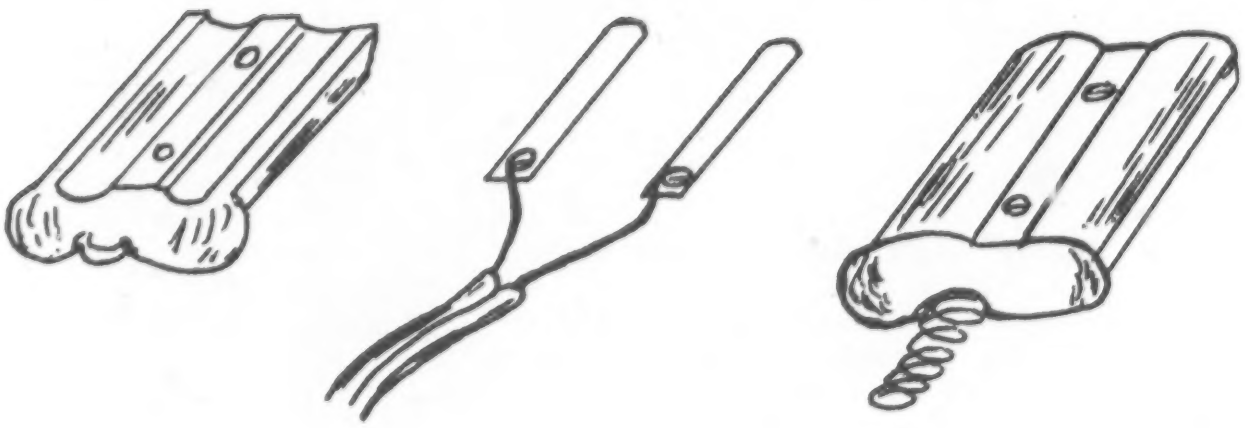

Exercise 9. Attach appliance plug to cord.

A. Remove screws from case of appliance.
B. Loosen terminal post screws.
C. Bare insulation from appliance wire 3/4" back.
D. Wrap wires around terminal post screws and tighten with screwdriver.
E. Assemble appliance case.

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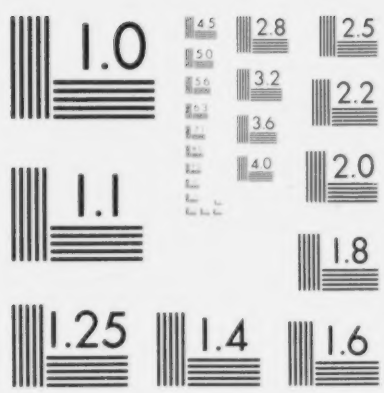

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Exercise 10. Attach rigid conduit to octagon box.

A. Attach outlet box to board 1" x 6" x 4' or display panel.
B. Cut short piece of rigid conduit.
C. Using threaded end, screw on lock-nut at least $\frac{1}{2}$".
D. Insert threaded end through punched out perforated hole in box.
E. Screw on bushing inside box to conduit.
F. Tighten lock washer against box.

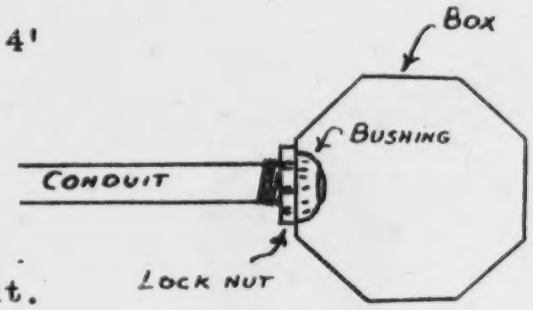

Exercise 11. Install switch box in a wall.

A. Use two short pieces of lumber to substitute for wall studdings.
B. Use wood strips between studdings to support switch box.
C. Insert switch box between strips and secure firmly with screws.
D. Attach another switch box into studding by spiking it in as illustrated.

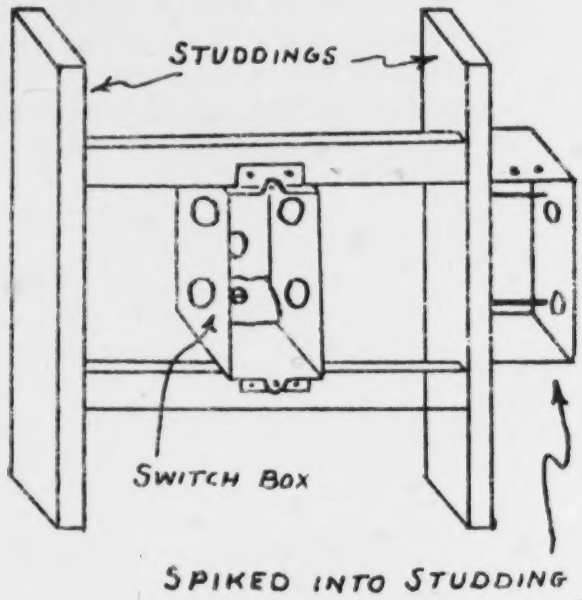

Exercise 12. Attach romex cable to switch box.

A. Use short piece of non-metallic cable.
B. Insert one end through punched out perforated hole and into the switch box.
C. Secure cable with clamp provided inside box allowing about 6" for wire attachments.

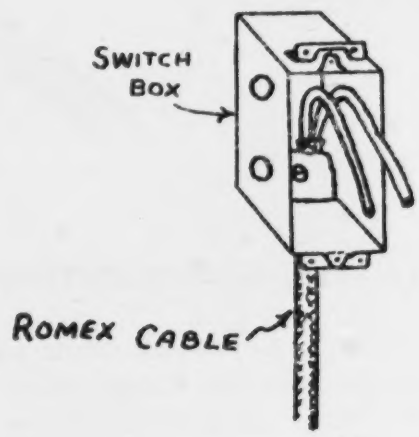

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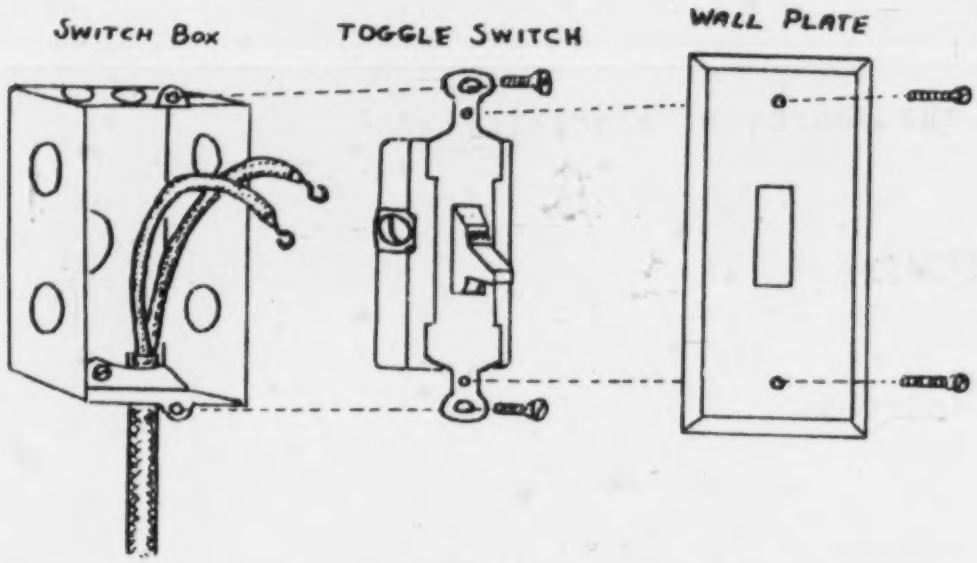

Exercise 13. Install wall switch to switch box.

A. Cut off outside insulation of cable entering switch box close to clamp holding cable, allowing 6 inches of wire protruding in box.
B. Remove insulation from two wires about 1 inch back.
C. Scrape wires clean.
D. Hook end of each wire correctly.
E. Attach hooks to terminals of switch securely.

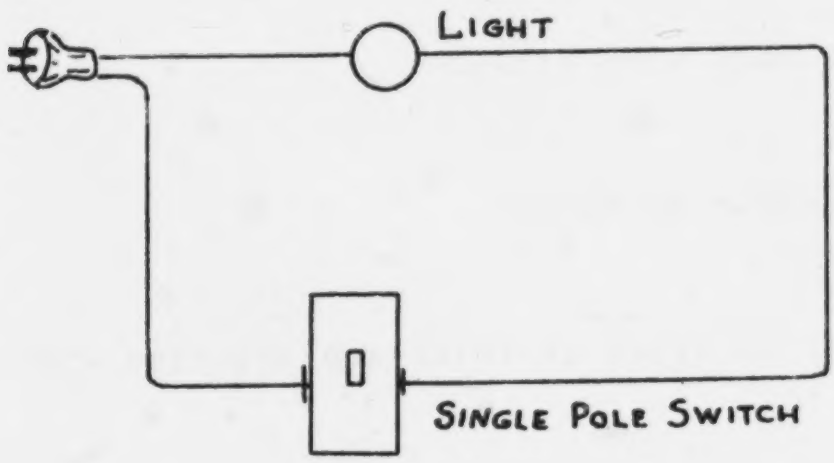

Exercise 14. Hook up a single pole switch to light fixture and source of electricity.

A. Use single conductor wires and attach to plug.
B. To one line attach a light socket or fixture.
C. Using drawing as a guide, hook up single pole switch.
D. Plug in circuit to live outlet and test circuit and switches with light bulb in socket.

1. What is electricity?

2. What is the source of electricity?

3. Define protons.

4. Define neutrons.

5. Define nucleus.

6. Define Ohms Law.

7. What are the methods of generating electricity?

8. What are the common conductors of electricity?

9. What are the common wire sizes?

10. What is the purpose of fuses?

11. Name the different types of fuses and describe where they may be used.

12. What do we mean by National Electrical Code?

13. Define the following electrical terms:

    (a) Circuit

    (b) Volt

    (c) Amper

    (d) Watt

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INTRODUCTION TO SHEET METAL AND SOLDERING

Due to the increased mechanization of farms, and the constant improvements of conveniences found in the home, the use of sheet metal has increased rapidly in recent years. The ability to cut, bend and fasten sheet metal is important because a student will frequently need to replace or repair sheet metal gadgets around the farm and home.

The exercises found on the following pages will assist the student in developing skills in the use of sheet metal and at the same time give the student an opportunity to make a useful project for the home or farm.

Sheet Metal and Soldering

1. Operate a blow torch
2. Operate an electric soldering copper
3. Operate a propane torch
4. Clean and tin a soldering copper
5. Bending and fastening sheet metal
6. Repairing sheet metal projects
7. Making teacher-assigned sheet metal projects

Materials and Equipment

1. Blow torch, propane torch
2. Soldering copper, electric soldering copper
3. Fluxes and applicator
4. Cleaning materials (wire brushes, files, steel wool, cloth, sal ammoniac, emery cloth, knife.)
5. Solder (bar and acid core)
6. Small piece of tin plate
7. Galvanized iron--sheet of light and heavy gauge
8. Copper tubing
9. Copper wire (thin)
10. Electric wire
11. Tin snips, pliers, sidecuts, hammers, mallet
12. Tinner's rivets

Exercises for Student

1. Operate a blow torch.
2. Operate an electric soldering copper.
3. Operate a propane torch.
4. Clean and tin a soldering copper.
5. Repair small holes.
6. Patch large holes.
7. Solder a lap seam.
8. Make and solder a lock seam.
9. Solder a rivet joint.
10. Sweat out a wire joint.
11. Repair a leaky copper tube.
12. Solder tin plate to galvanized iron.

Additional Exercises

13. Solder a hole in ..ad plate.
14. Make and solder a lap joint of stainless steel.
15. Make and solder a seam from two pieces of sheet aluminum.

Suggested Projects to Build

1. Feed scoop
2. Dust pan
3. Metal magazine rack
4. Funnel
5. Jewel box (brass, hinged lid)
6. Tool box (metal)
7. Fishing tackle box
8. Metal chick feeders
9. Chicken feed hoppers
10. Poultry water fountain
11. All metal lamp
12. Sugar scoop from tin can
13. Milk sampling dipper
14. Milk sample box (metal)
15. Metal waste basket
16. Galvanized pail

Look through shop books, bulletins, and magazines for ideas. Make a rough sketch of the project you are planning to build. In many instances, it is a good idea to cut out a pattern first from paper to see that all parts are of the right size and fit properly. This is especially true for such projects as funnels, feed scoops, water fountains.

Exercise 1. Operate a blow torch.

A. Pump up air pressure.
B. Fill burner cup with gasoline by placing left hand tightly on end of burner and turning on gasoline needle valve.
C. Ignite gasoline in cup with match. Hold match below gasoline cup and stand at arm's length.
D. Turn on gasoline valve when nearly all gasoline in cup has burned.
E. Regulate gasoline valve to get a blue flame.
F. Pump in additional air as needed.
G. To shut off blow torch, close off gasoline valve, but not too tightly as needle can be damaged.
H. Release air pressure, being sure flame is completely out.

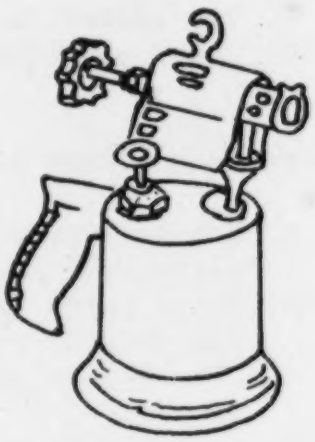

Exercise 2. Operate an electric soldering copper.

A. Clean and point copper with file.
B. Plug in copper and heat (approx. 4 min.)
C. Melt some solder, allowing it to drop in hole in cake of sal ammoniac.
D. Rub point against sal ammoniac block until point is coated with solder.

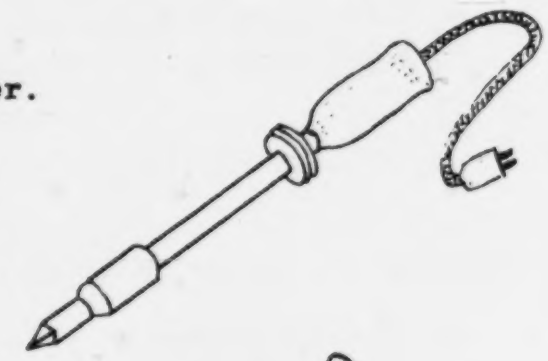

Exercise 3. Operate a propane torch.

A. Select tip for torch.
B. Open valve $\frac{1}{4}$ turn and light flame.
C. Keep tip at correct distance from object being heated. Too close will snuff out flame and too far will not heat the work thoroughly.

Exercise 4. Clean and tin soldering iron.

A. Clean and point iron with a file.
B. Heat iron, but not red hot.
C. Melt some solder, allowing it to drop in hole in cake of sal ammoniac.
D. Rub point against sal ammoniac block until point is coated with solder.

Exercise 5. Repair small holes.

A. Drill holes in piece of galvanized iron.
B. Clean area to be soldered with steel brush or steel wool.
C. Use solder to close hole.*
D. Leave area free of roughness.

Exercise 6. Patch large holes.

A. Cut an inch-square hole in a piece of galvanized metal.
B. Cut a patch of galvanized metal to lap over hole edges at least ¼" inch.
C. Clean patch and area around hole to be patched.
D. Apply solder to area around hole.
E. Place patch over hole and use iron heat to sweat patch on.
F. Hold edges down to insure thin seams.
G. Apply more solder around edges if necessary.

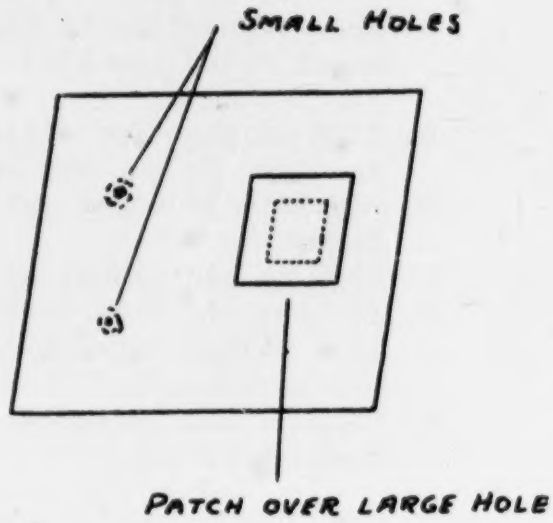

* Use flux if bar solder is used.

Exercise 7. Solder on a lap seam.

A. Cut two pieces of galvanized iron 2" x 2".
B. Clean edges to be soldered.
C. Lap one edge over other 1/4".
D. Solder edge lapped over to second piece.
E. Be sure lapped piece is flat to insure thin seam. (Apply pressure if necessary with an old file.)
F. Solder only one side. (Trapped moisture rusts metal.)

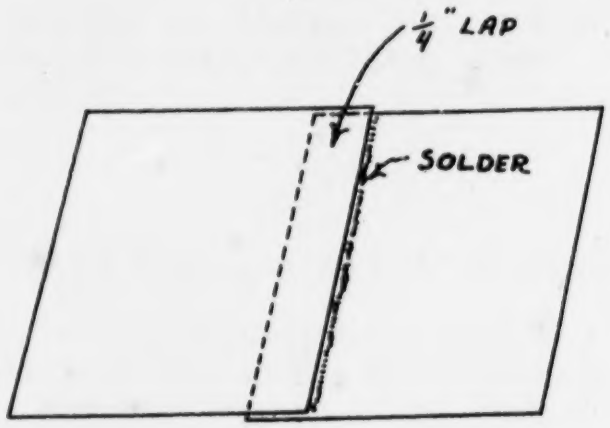

Exercise 8. Make and solder lock seam.

A. Cut two pieces of galvanized iron 2" x 2".
B. Form a hooked edge on each piece.
C. Hook edges together and pound flat.
D. Clean edge to be soldered with file, steel wool, emery cloth, knife.
E. Solder, leaving smooth joint.
F. Solder one side only.

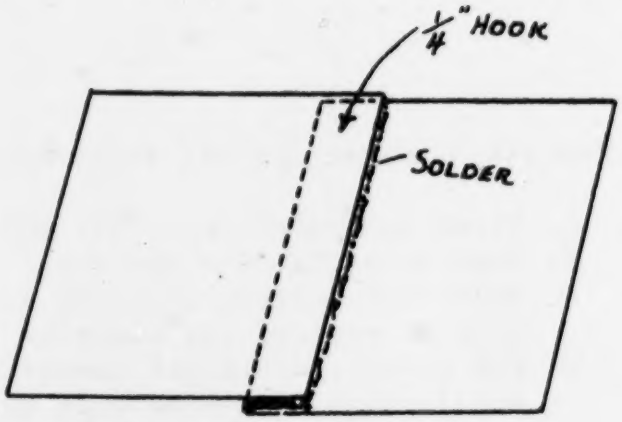

Exercise 9. Solder a rivet joint.

A. Make a lap joint of two pieces of metal.
B. Using tinner's rivets, fasten them together.
C. Flatten rivets properly.
D. Clean around rivets thoroughly.
E. Solder.

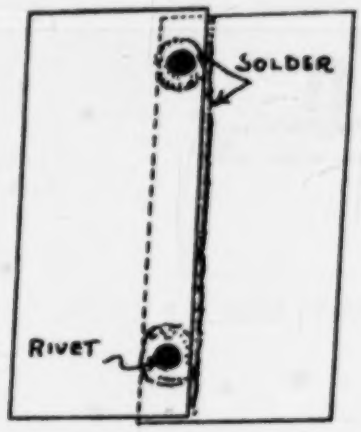

CROSS-SECTION VIEW

Exercise 10. Sweat out a wire joint.

A. From two wires strip insulation 3 inches back.
B. Clean wires thoroughly.
C. With pliers make a Western Union (end) splice, as shown.
D. Heat wire joint with hot iron.
E. Apply solder directly to wire, allowing it to melt through joint.

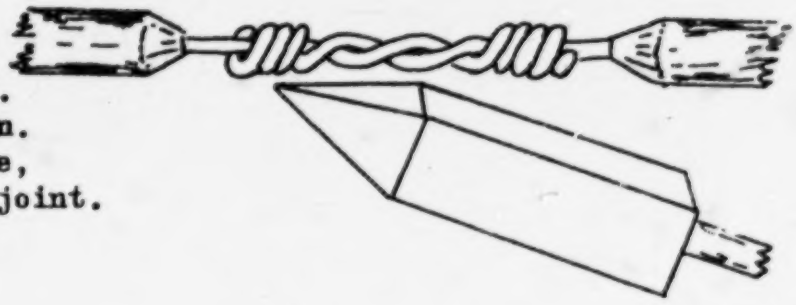

Exercise 11. Repair a leaky copper tube.

A. Make a hole in a 3" piece of copper tubing.
B. Clean tubing thoroughly.
C. Using clean copper wire, wrap tubing so hole is well covered.
D. Apply solder.
E. With heat of iron allow solder to run through the wire windings.
F. Test for leaks by blowing through pipe, closing one end.

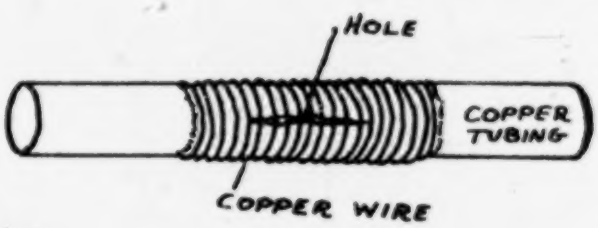

Exercise 12. Solder tin plate to galvanized iron.

A. Cut two pieces of metal 2" x 2", one of tin and one of galvanized iron.
B. Lap the tin over the galvanized iron, 1/4".
C. Clean edges to be soldered.
D. Using proper flux on each metal, solder together.

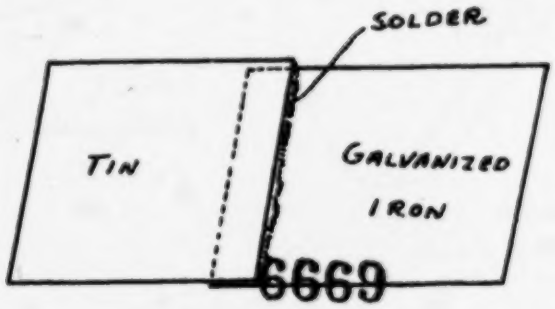

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Here are a few ideas on soldering projects for the student.

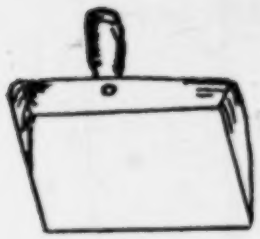

DUST PAN

SMALL FUNNEL

DUST PAN

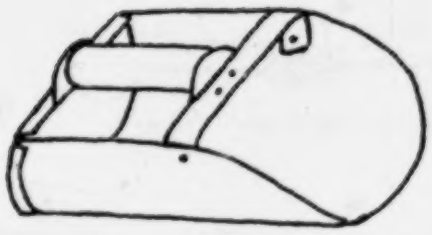

FEED SCOOP

GALVANIZED PAIL

RE-INFORCE RIMS WITH WIRE

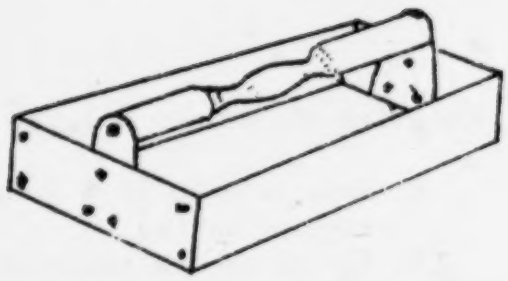

TOOL BOX

SUGAR SCOOP MADE FROM TIN CAN

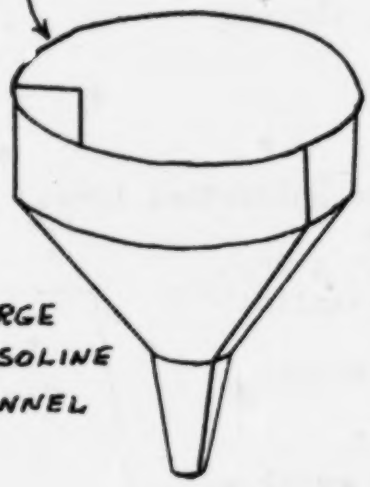

LARGE GASOLINE FUNNEL

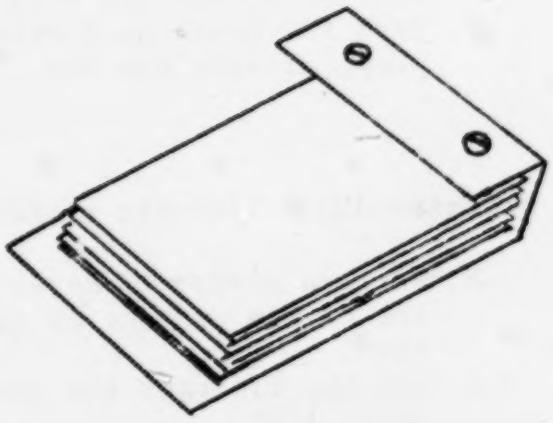

NOTE PAD

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1. How does soldering differ from welding?

2. What is solder made from?

3. What is the meaning of 50-50 solder?

4. Why is it necessary to clean thoroughly the area to be soldered?

5. How should metal be cleaned for soldering?

6. What is the cause of oxidation when soldering is being done?

7. What is the purpose of applying a flux to the area to be soldered?

8. What fluxes are used for the following metals?

(a) Tin (new)_____ (e) Lead_____

(b) Galvanized iron_____ (f) Electric wiring_____

(c) Black iron_____ (g) Zinc_____

(d) Copper_____

9. What chemical action takes place when hydrochloric (muriatic) acid is used as a flux on galvanized iron?

10. List 4 parts of an electric soldering copper.

11. When is an electric soldering copper ready for soldering?

12. When is a gas heated soldering copper ready for soldering?

13. What is the purpose of tinning a soldering copper?

14. How is a propane torch refueled safely?

15. Name 3 practical uses of the propane torch (at home or in shop).

INTRODUCTION TO ARC WELDING

The arc welder is a common piece of equipment found in the school and farm shop. This machine will allow farmers to construct and repair many jobs quickly and economically. The following basic fundamentals of arc welding should be included in general shop:

1. Safety in using the arc welder
2. Selecting electrodes
3. Amperage settings
4. How to set up a welder for welding
5. How to strike an arc
6. How to run a bead

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Arc Welding

Materials and Equipment

1. Electric arc welder
2. Head shields
3. Welding table with hood and exhaust fan
4. Electrodes (Several sizes: 1/16", 1/8", 3/16", 1/4")
5. Flat steel stock (Different sizes and thicknesses)

Exercises for Student

1. Set up arc welder for use.
2. Strike an arc and run a bead.
3. Make a pattern of beads.
4. Show a bead with too long, too short, and correct arc.
5. Show a bead with too much, not enough, and correct amount of current.
6. Show a bead with too slow, too fast, and correct rate of travel.
7. Make a butt joint of two flat pieces of steel stock with one pass.
8. Make a butt joint of two flat pieces of stock using multiple pass.
9. Make a lap joint of two flat pieces of stock.
10. Make a tee joint from two pieces of flat stock.
11. Make a corner joint from two pieces of flat stock.
12. Make an outside corner weld of two pieces of flat stock.

****

Refer to chart below for selecting size of rod for work.

— AMPERAGE CHART —

ROD SIZE	METAL THICKNESS 22 GA.	1/16"	1/8"	3/16"	1/4"	5/16"
5/64	20	30				
3/32	20	30	65			
1/8				105	130	140
5/32			90	140	150	170
3/16				150	170	180
	CARBONS 5/16"-75 AMPS. 3/8"-90 AMPS					

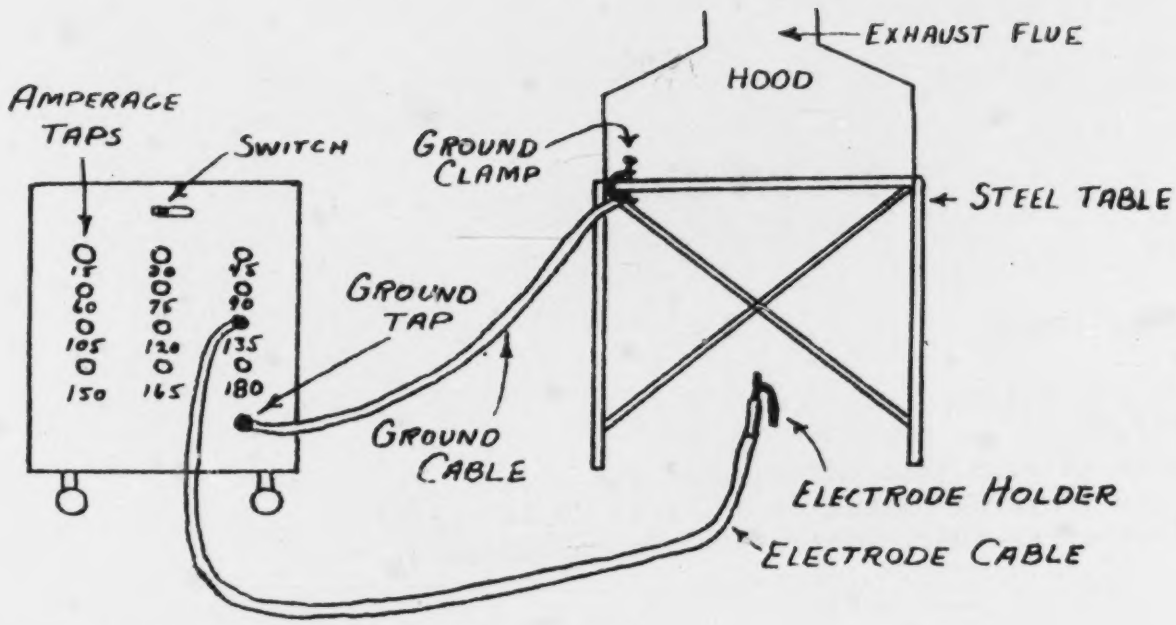

Exercise 1. Set up arc welder for use.

A. Attach ground cable clamp to welding table or metal to be welded.
B. Plug ground cable holder in welder in proper place.
C. Plug electrode holder cable into welder tap in proper place.
D. Attach welding rod to electrode holder.
E. Turn on exhaust fan.
F. Have shield adjusted to head size.

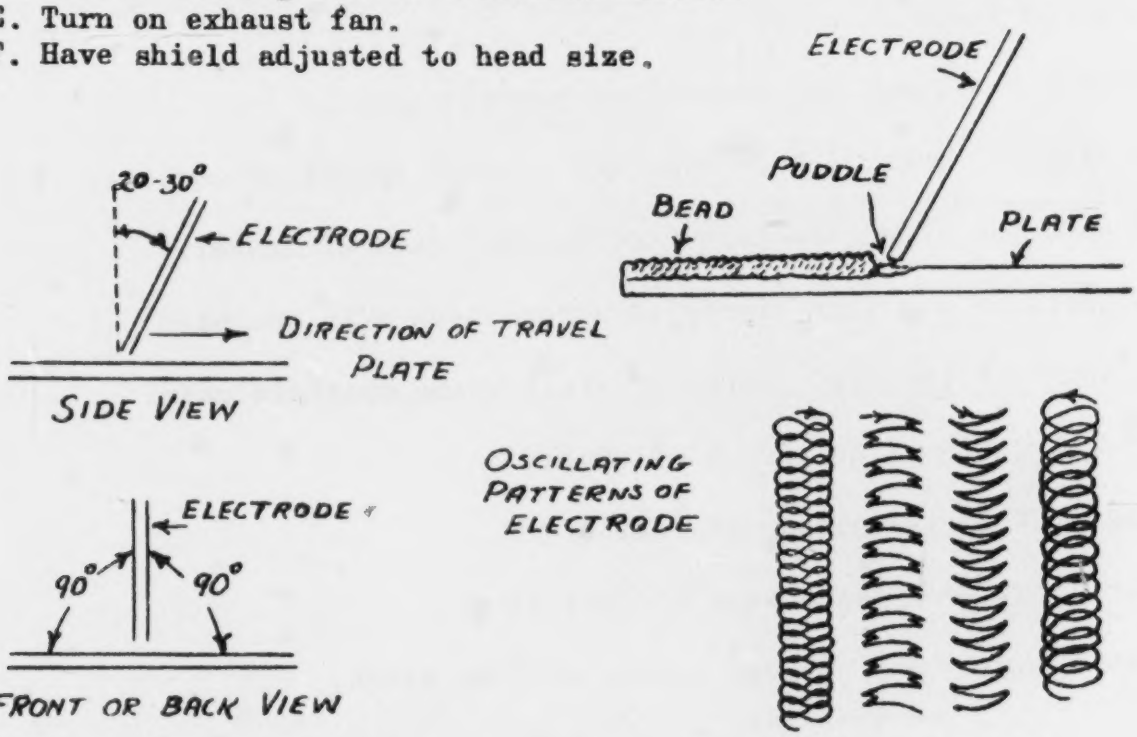

Exercise 2. Strike an arc and run a bead.

A. Set up welder for use.
B. Ground a flat piece of metal to table.
C. Take electrode holder with rod attached in one gloved hand.
D. Turn on electricity on welder.
E. With other hand pull helmet down over eyes.
F. Hold electrode at approximately 30 degrees from verticle.
G. Strike an arc by scratching metal or by moving electrode near metal.
H. When arc is struck, oscillate electrode in small arcs as desired.
I. Move electrode away from verticle making a running bead.

1. What furnishes the heat in electric arc welding?

2. Why is good penetration of base metal necessary in arc welding?

3. What is the cause of eye burn?

4. What are the two main kinds of electrodes with respect to coating of flux?

5. What is meant by amperage?

6. What amperage is required for the following electrode sizes:

3/32 _____ 5/32 _____

1/8 _____ 3/16 _____

7. What size electrodes are needed for the following thicknesses of plate in horizontal welding? Verticle welding? Overhead welding?

Plate Thickness	Horizontal	Verticle	Overhead
20 Gauge	_____	_____	_____
18 Gauge	_____	_____	_____
1/16 inch	_____	_____	_____
1/8 inch	_____	_____	_____
3/16 inch	_____	_____	_____
1/4 inch	_____	_____	_____
5/16 inch and up	_____	_____	_____

8. Why should you make a V-groove on thick pieces for welding?

9. What should you do if the electrode sticks to work?

10. Describe a weld resulting from using too low amperage.

11. Describe a weld resulting from using too high amperage.

12. Why would poor penetration result from moving electrode too rapidly?

INTRODUCTION TO PLUMBING

Plumbing is the piping and pipe attachments used to carry water into buildings and to drain away sewage and waste. With a little knowledge of some of the more common pipe-fitting tools and their uses, many simple plumbing jobs can be done in the home and on the farm. The exercises on the following pages will assist the student in becoming familiar with selecting and using plumbing equipment.

Main Points Student Will Learn in This Chapter

1. Identification of pipe fittings
2. Measuring pipe
3. Cutting and reaming pipe
4. Pipe threading
5. Assembling pipe and pipe fittings

Materials and Equipment

1. Galvanized pipe (1", 3/4", 1/2")
2. Couplings, tees, elbows, reducing couplings, unions, reducing elbows, plugs
3. Joint cement
4. Pipe wrenches, screw driver, adjustable wrench
5. Pipe cutter, pipe reamer, rachet die, hack saw
6. Cutting oil and can
7. Vises, hinged pipe vise
8. Faucets
9. Hot water tank (second hand, old type, can be used for practice)

Exercises for Student

1. Cut off a piece of pipe
2. Ream end of pipe
3. Cut threads on pipe end
4. Attach a threaded pipe to a tee
5. Replace leaky washers in a faucet
6. Complete plumbing from source to hot water tank to sink.

Identify each of the following plumbing items and give their principle uses.

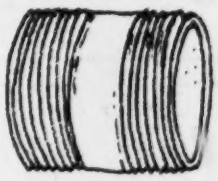

1. a. Name _____
   b. Use _____

2. a. _____
   b. _____

3. a. _____
   b. _____

4. a. _____
   b. _____

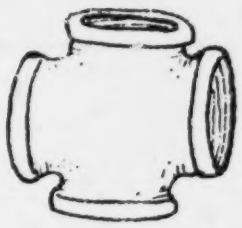

5. a. _____
   b. _____

6. a. _____
   b. _____

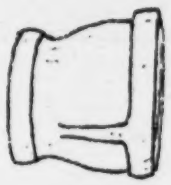

7. a. _____
   b. _____

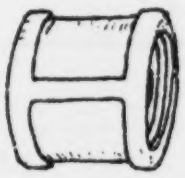

8. a. _____
   b. _____

9. a. _____
   b. _____

10. a. _____
    b. _____

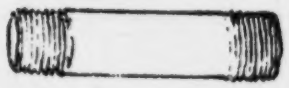

11. a. _____
    b. _____

12. a. _____
    b. _____

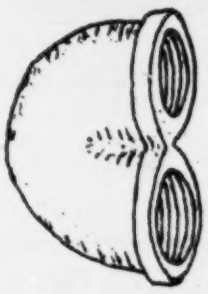

13. a. _____
    b. _____

14. a. _____
    b. _____

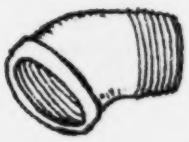

15. a. _____
    b. _____

16. a. _____
    b. _____

17. a. _____
    b. _____

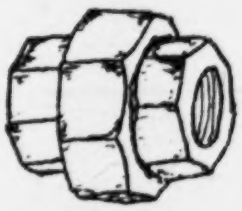

18. a. _____
    b. _____

19. a. _____
    b. _____

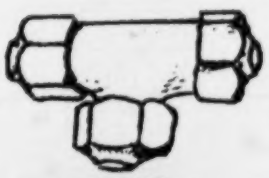

20. a. _____
    b. _____

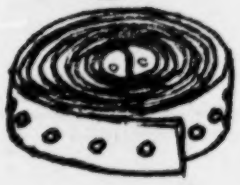

21. a. _____
    b. _____

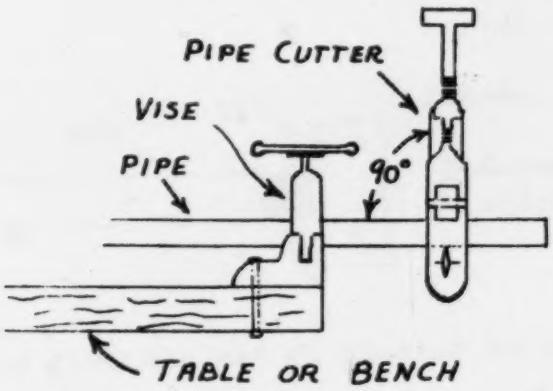

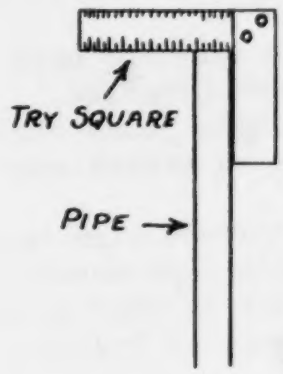

Exercise 1. Cut off a piece of pipe.

A. Mark off length of pipe desired on 3/4" pipe.
B. Fasten pipe in hinged pipe vise so mark is at least 4 inches from vise.
C. Open pipe cutter and slip over pipe end.
D. Tighten pipe cutter by screwing in handle until small cutting wheels snug against pipe on mark.
E. Holding handle perpendicular to the pipe, tighten handle until cutting wheels penetrate metal.
F. Turn pipe cutter around pipe, screwing handle of pipe cutter in each turn until pipe is cut off.
G. Check for squareness of cut.

Exercise 2. Ream end of pipe.

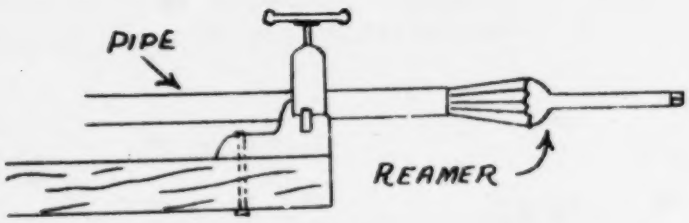

A. Cut off a 1/2" or 3/4" pipe.
B. With cut end protruding from vise, insert end of reamer.
C. Holding reamer in line with pipe, turn reamer clockwise until inside burr is cut off.
D. Remove reamer and check with finger to see if burr is cut away. (Do not cut more than necessary as first threads on pipe will be weakened.)

Exercise 3. Cut a thread on a pipe.

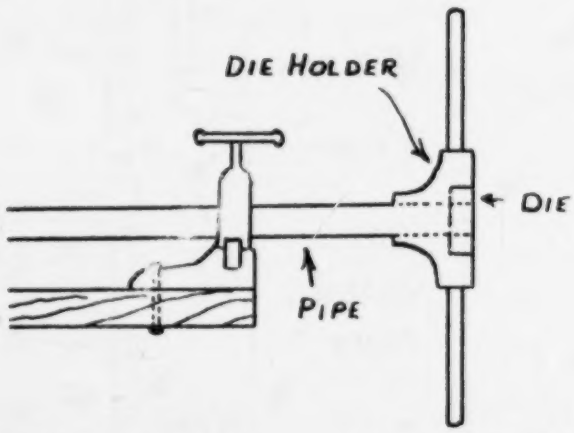

A. Grind off any outside burr that may be on pipe end caused by cutting pipe.
B. Insert pipe to be threaded into vise, end protruding at least 6".
C. Using proper size die in die holder slip guide end over pipe to be threaded.
D. Using a little starting pressure against die holder, turn clockwise until die starts cutting thread.
E. Use plenty of cutting oil on the threading area at all times.
F. Cut threads until about one thread protrudes beyond die.
G. Back off die and inspect threads. (A bad thread means—poor dies, not enough oil, or uneven pressure on handles of die holder.)

Exercise 4. Attach a threaded pipe to a tee.

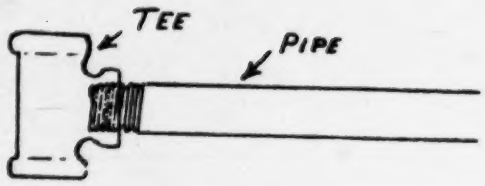

A. Fix a pipe that has been cut off, reamed and threaded properly.
B. Apply a little joint cement to threaded area, keeping cement away from inside of pipe.
C. Screw on correct size tee.
D. Tighten with pipe wrench.
E. Check to see if pipe is to the end of threads in tee and that no excess cement is inside.

Exercise 5. Replace leaky washers in a faucet.

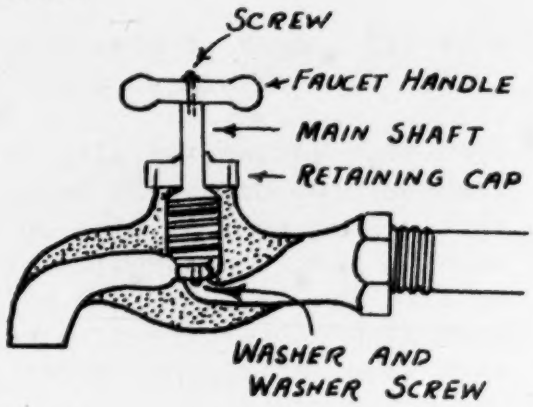

A. Shut off supply of water if faucet is connected.
B. Remove faucet handle by removing screw on top of handle.
C. Remove retaining cap with an adjustable wrench.
D. Take out main shaft and core of faucet by turning it out.
E. Remove screw that holds washer in place.
F. Replace washer with new one.
G. Re-assemble faucet and test for leaks.

Exercise 6. Complete plumbing from source to hot water tank to sink as indicated on diagram below.

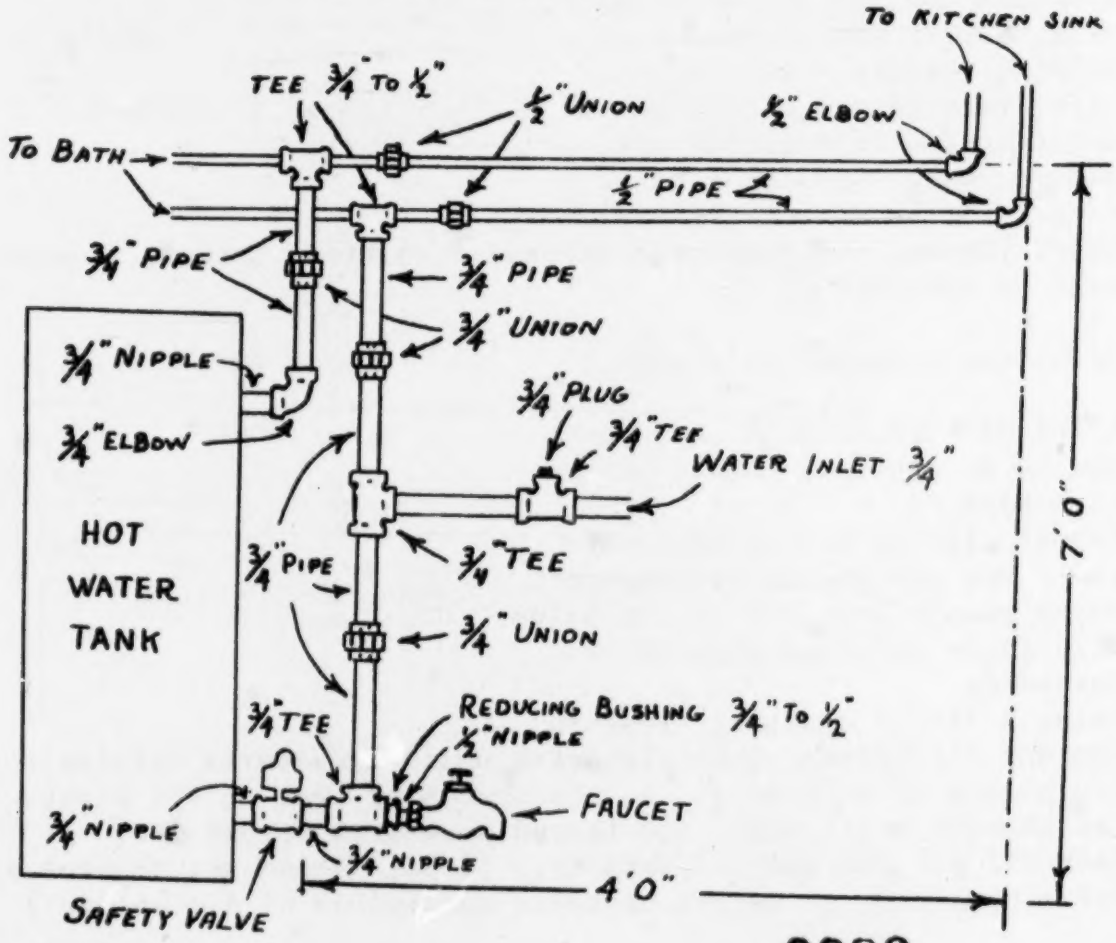

6680

1. Give the purpose of each of the following fittings:

   (a) Elbow _____

   (b) Tee _____

   (c) Coupling _____

   (d) Reducer _____

   (e) Union _____

   (f) Street ell _____

   (g) Bushing _____

   (h) Nipple _____

2. With diagrams show two ways you can connect a 3/4" pipe to a 1" pipe. Name the parts.

3. What is a trap and indicate by a cross-sectional diagram how a trap works.

4. What is a stack and give its purpose.

5. List 6 precautions to observe in doing plumbing work:

   (a) _____

   (b) _____

   (c) _____

   (d) _____

   (e) _____

   (f) _____

6. Give steps in cleaning out clogged pipes.

6682

Concrete

A concrete mixture such as 1:2:4 means 1 part cement, 2 parts sand, and 4 parts gravel by volume. There are 7 parts in all. If 7 cubic feet of materials are used in a mixture, after the mixing is complete, there are less than 7 cubic feet because the fine particles of sand and cement fill in the empty spaces between the coarser gravel particles. Also cement fills spaces between sand particles.

On the average it takes about 43 cubic feet of unmixed cement, sand, and gravel to make one cubic yard (27 cu.ft.) of concrete. The ratio of 27 to 43 is the same as 1 to 1.6 (43 ÷ 27 = 1.6). In other words for each 1 cubic foot of concrete you must have 1.6 cubic feet of the unmixed ingredients of sand, cement, and gravel.

If I were to build a wall 1 foot thick, 10 feet long and 5 feet high, the volume is 50 cubic feet. (1 x 10 x 5 = 50 cu. ft.) This 50 cubic foot volume of concrete would require 80 cubic feet of the unmixed ingredients. Multiply 50 by 1.6 gives 80 cubic feet. If I use a 1:2:4 mix, I would need the following amounts of cement, sand, and gravel:

1/7 x 80 = 11.4 cubic ft. cement
2 x 11.4 = 22.8 cubic ft. sand
4 x 11.4 = 45.6 cubic ft. gravel

Problems:

1. How much cement, sand, and gravel using a 1:2:4 mix are needed for a sidewalk 4" thick, 3 feet wide, and 20 feet long?

   _____cu. ft. cement

   _____cu. ft. sand

   _____cu. ft. gravel

2. You are ready to order a batch of ready-mixed concrete from the conrete mixing company for a foundation of the following dimensions: The building is 80' x 36', wall thickness is 12" and depth of foundation is 4 feet.
   (a) How many cubic yards would you order? (1 cu. yd. = 27 cu. ft.)
   (b) At a cost of $14.00 per cubic yard what would the concrete cost?

   (a) _____cu. yds.

   (b) _____cost

3. At $15.00 per yard of concrete, what would be the cost of pouring a driveway 4" thick, and 100 ft. long by 10 ft. wide?

   _____cost

Exercise 1. Run a sieve test on fine aggregate to check size of particles.

A. Obtain a set of sieves with openings from 1/4" to 1/64".

B. Stack sieves so largest is on top and finest is at bottom.

C. Pass a measured amount of fine aggregate through sieves by shaking until sifting is complete.

D. Check the results by measuring the aggregate in each of the sieves.

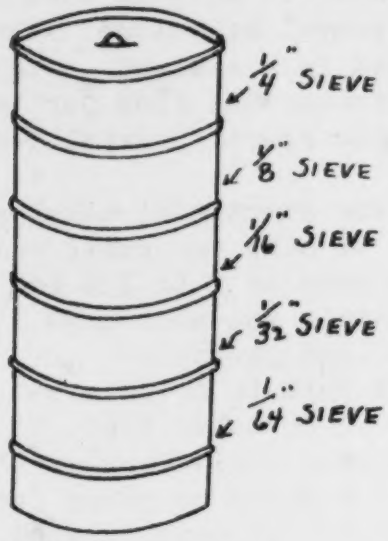

SIEVE CHECK FOR FINE AGGREGATE

Exercise 2. Test fine aggregate for clay and silt.

A. Use an ordinary quart glass fruit jar.

B. Pour about two inches of aggregate in the jar.

C. Use clean water to fill jar about 3/4 full.

D. With lid attached shake jar well for a minute.

E. Allow to stand over-night.

F. Check results. Gravel and sand will be at bottom, silt will form a layer on top of sand. Clay will color water and eventually settle on top of silt.

G. If more than 1/8" of silt forms, aggregate should be discarded or washed before using.

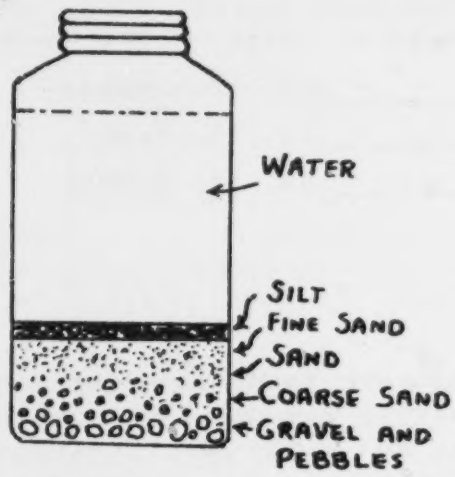

FRUIT JAR TEST FOR SILT AND CLAY

Exercise 3. Test fine aggregate for vegetable matter.

A. Dissolve 1½ teaspoons of lye in a pint of clean water.

B. Add ½ pint of fine aggregate to lye water.

C. Cover and shake for 1½ minutes.

D. Allow to stand for 24 hours.

E. Note color of water. If water is darker than cider vinegar, aggregate has too much vegetable matter in it for concrete use.

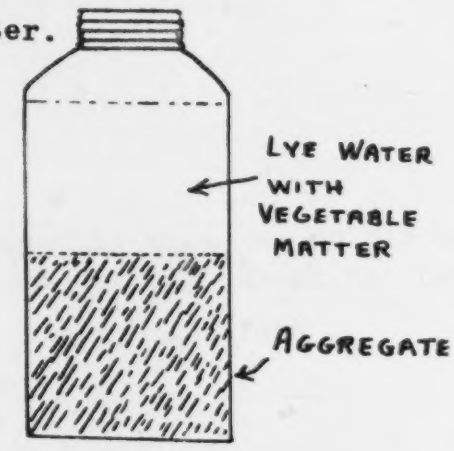

TESTING FOR VEGETABLE MATTER

6684

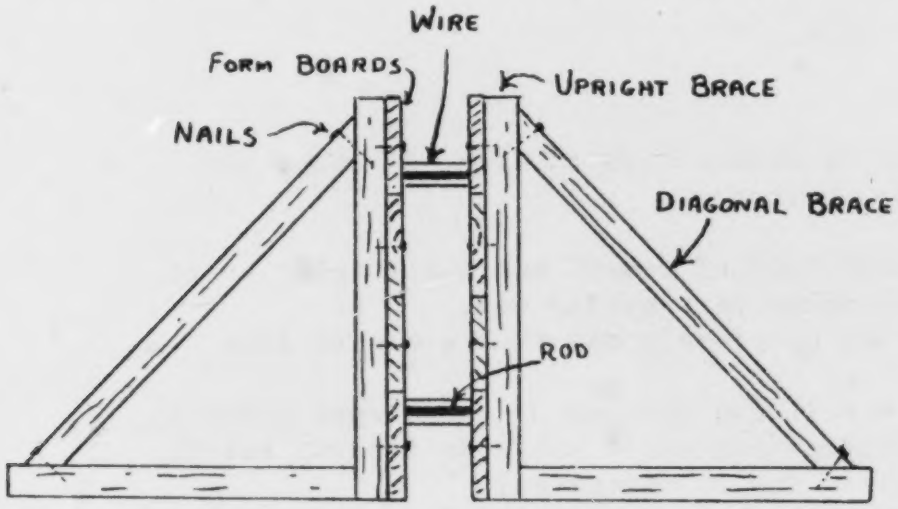

CROSS-SECTION OF FORM AND BRACING

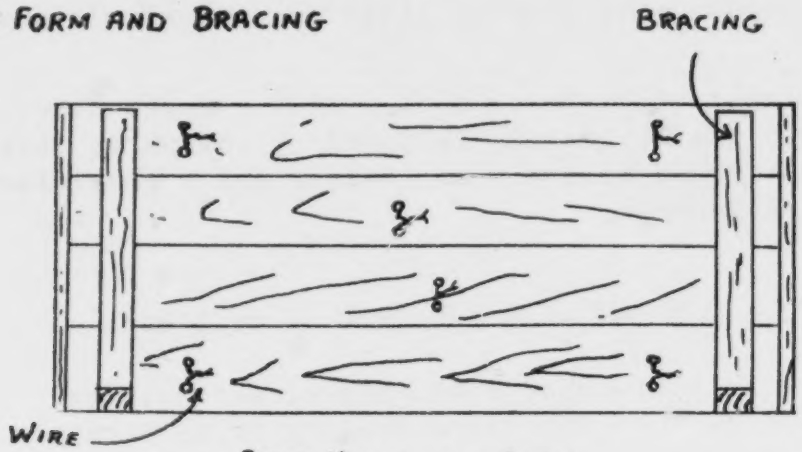

SIDE VIEW OF FORM

Exercise 4. Make a form 4" wide, 4' long, and 2' high.

A. Obtain enough 1" x 6" — 3S soft lumber for the form sides.
B. Some additional pieces of lumber will be needed for bracing and upright supports.
C. Nail up the forms on upright supports so one side of form may be set up.
D. Brace this form by butting ends of 2" x 4" to the bottom of form support and extending 2" x 4" about two feet.
E. From top of form support nail a diagonal piece to the extended end of the 2" x 4".
F. At least one more brace will be needed for a form this long.
G. Make another form as specified above.
H. Apply old crankcase oil to face of forms to prevent concrete from sticking to forms.
I. Face plane surfaces of the forms four inches apart.
J. Drill two 1/16" holes, one above the other, about two inches apart several places throughout the forms. Each set of holes in one form should have a corresponding set in the other form.
K. Use a rod about 3/8" in diameter, cut to 4" lengths to keep form spread at each set of holes.
L. Insert wire across form opening in each set of holes and prepare for tightening.
M. Insert a 4" rod across form opening near the wire and tighten wire so form will press against rod.
N. Repeat process for each set of wire holes.
O. Form should be rigid and ready for mortar after ends of form openings are blocked off.

Exercise 5. Mix a batch of mortar to fill a form 4" wide, 4' long, and 2' high, using a 1:2:3 mixture.

A. Mix together a strong $\frac{1}{2}$ cubic foot of cement and a strong $2\frac{1}{2}$ cubic feet of fine aggregate thoroughly in a mortar box.
B. Add water to this mixture and completely mix with a hoe or some other flat edged tool.
C. Add enough water so mixture will run instead of stand when piled up. (Thin walls need wetter mixture than thick walls or floors, but in no case should water stand on top of concrete.)
D. Pour mortar in form, making sure that no pockets of air are left. Tamp concrete with probing stick to prevent air pockets.

Note: When mixing concrete or mortar with a power mixer, add water first, sand and gravel second, followed by cement or mortar. By this procedure a clean mixer is maintained and a consistently proportioned batch is insured.

Exercise 6. Remove forms when concrete is well set.

A. At least 24 hours should be allowed for setting.
B. Using pliers, cut the wires holding forms together.
C. Pull forms from cement wall.
D. After about three days wires may be removed by bending back and forth until they break next to concrete.

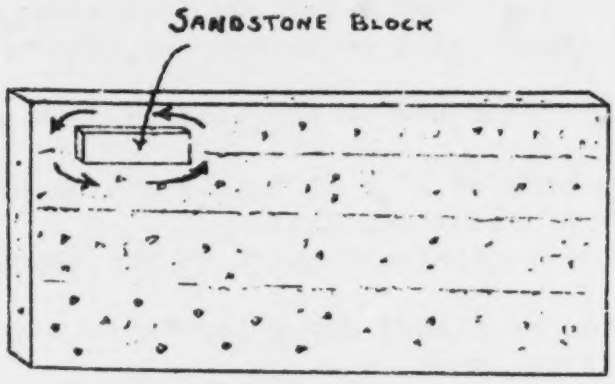

Exercise 7. Make a smooth finish on one side of poured concrete wall.

A. Use a piece of sandstone about 3" x 2" x 6".
B. Mix a combination of one part cement and one part fine sand. Add water to this until it is a thin mixture.
C. Dip bottom flat side of sandstone into this mixture and immediately rub it against dried wall of concrete.
D. Use circular motion of sandstone on flat wall adding more of the mixture as a section is completed. Water may be added to rubbing area if mortar gets too stiff.
E. When an area feels smooth while rubbing with sandstone and all small holes are filled, area is complete and a smooth slick surface results.

6686

1. What is the objection to silt and clay in a mixture of concrete or mortar?

2. What is meant by a 1 : 2 : 3 mixture?

3. What is a good mixture for most general concrete work?

4. What is the difference between a mortar mix and a concrete mix?

5. Generally, should mortar for brick or blocklaying require a stiff or a thin mixture?

6. In what type of concrete pouring would you need a thin mix?

7. In what type of concrete pouring would you need a stiff mix?

8. About how much concrete can be made from 1 cubic foot of cement, 2 cubic feet of sand, and 4 cubic feet of gravel? Give reasons for your answer.

9. Estimate how many bags of cement, using a 1 : 2 : 3 mix, would you need for the following wall : 8 feet high, 50 feet long, and 12 inches thick.

10. Why should you use plenty of field rock in concrete foundations and footings?

11. How can you get a dense concrete wall without air pockets?

12. Where outside surfaces such as sidewalks, drives, etc., are laid, should a wood float or a metal trowel be used for final finish?

13. How should forms be treated to keep concrete from sticking to them?

14. When is it necessary to use reinforcing rod in concrete work?

15. Why should large paved yards be laid in sections rather than in one solid slab?

INTRODUCTION TO MECHANICS

Mechanics and repairmen make up one of the fastest growing occupational groups in the Nation's labor force. They are the skilled workers who keep our farm equipment, automobiles, airplanes, industrial machinery, household appliances, small gasoline engines and similar equipment operating properly. The exercises on the following pages will assist the student in becoming familiar with the type of work mechanics engage in with emphasis on small gasoline engine maintenance.

Main Points Student Will Learn in This Chapter

1. Main parts of an engine
2. Types of engines
3. Classification of engines
4. Theory of operation--four-cycle and two-cycle
5. Small gasoline engine maintenance

Materials and Equipment

1. Set-socket wrenches
2. Set-open and box end wrenches
3. Pliers, screw drivers, adjustable wrenches
4. Compressed air and hose
5. Supply of cleaner liquids and brushes
6. Spark plug cleaner and tester
7. Ignition tester
8. Small gasoline engines

Exercises for Student

1. Clean, adjust, and test spark plugs
2. Check for faulty breaker points and set gap
3. Clean and adjust carburetor
4. Clean and service air cleaner

MAIN PARTS OF AN ENGINE

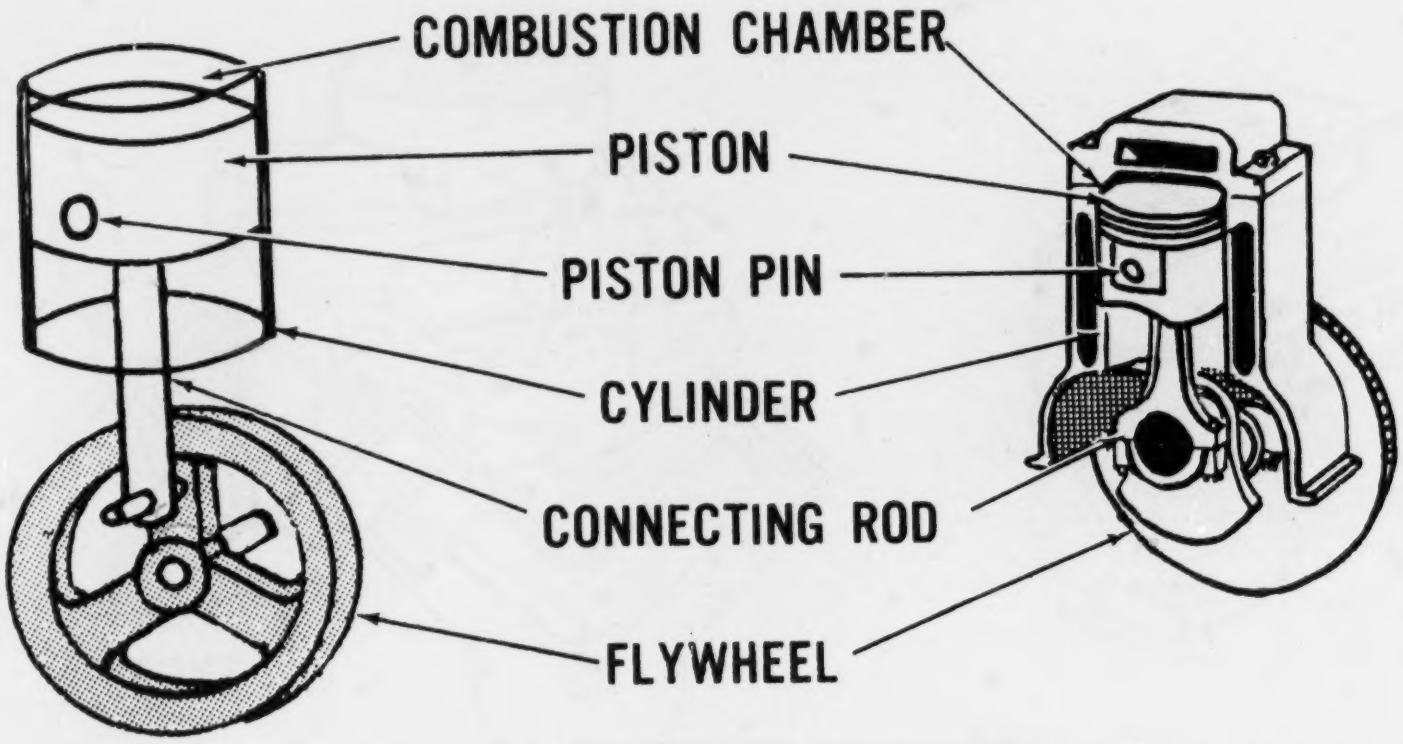

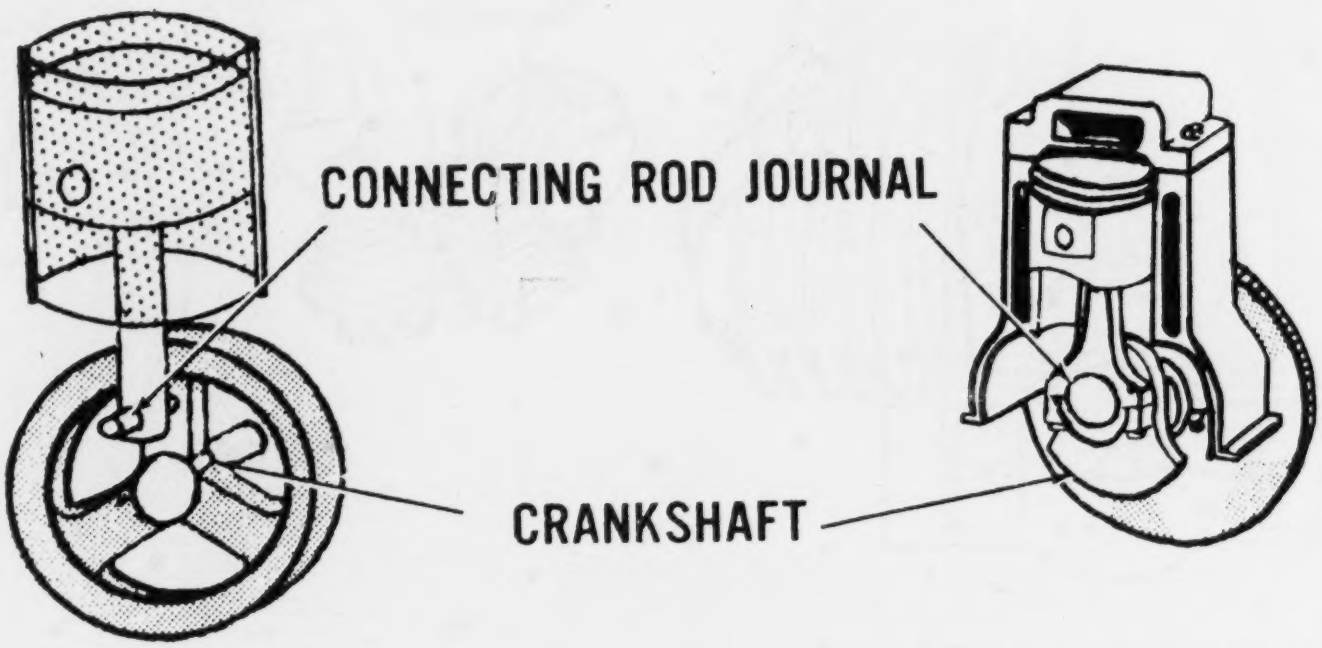

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TYPES OF ENGINES

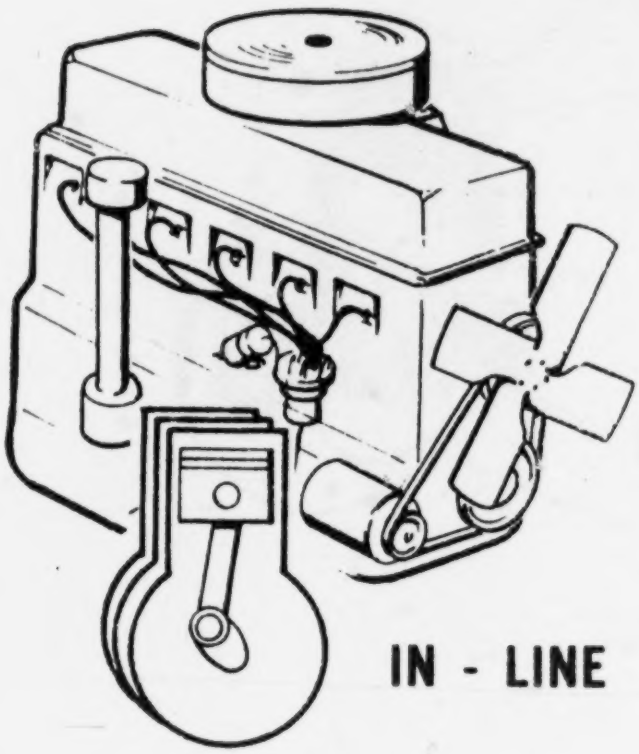

IN - LINE

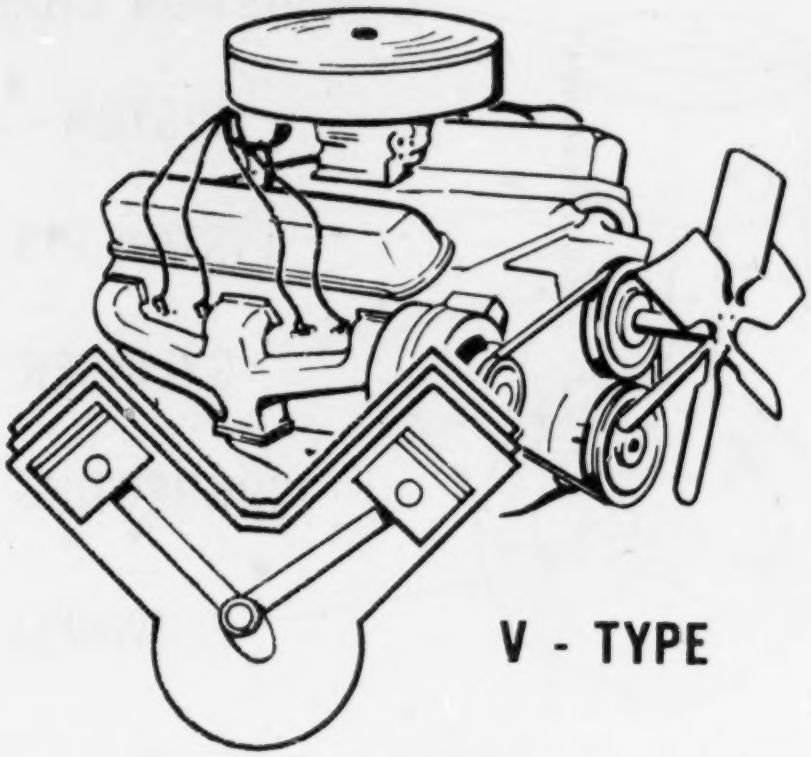

V - TYPE

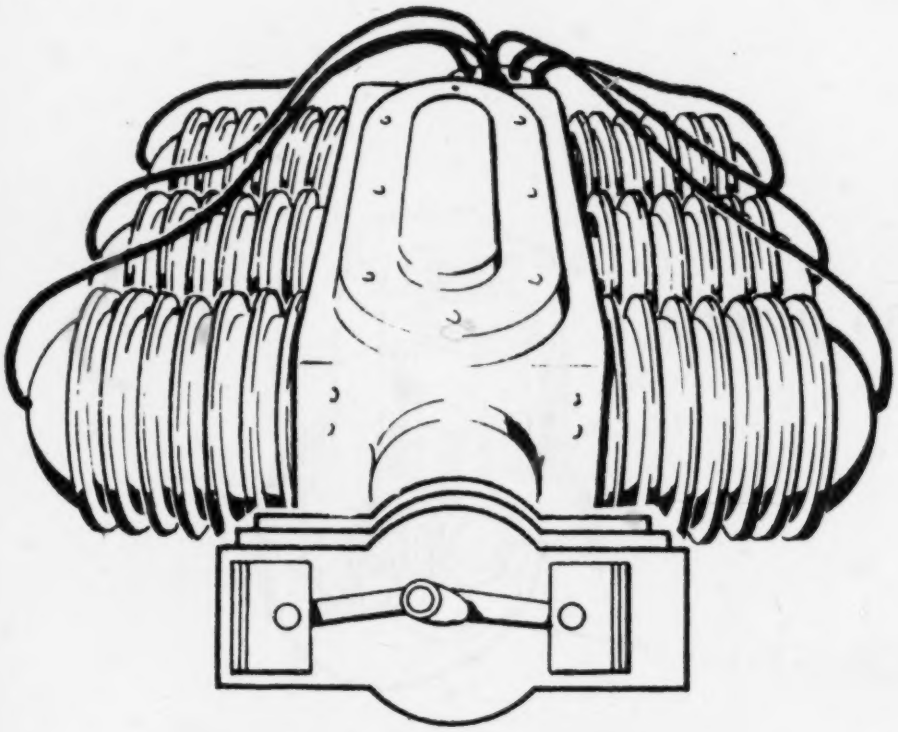

HORIZONTAL - OPPOSED

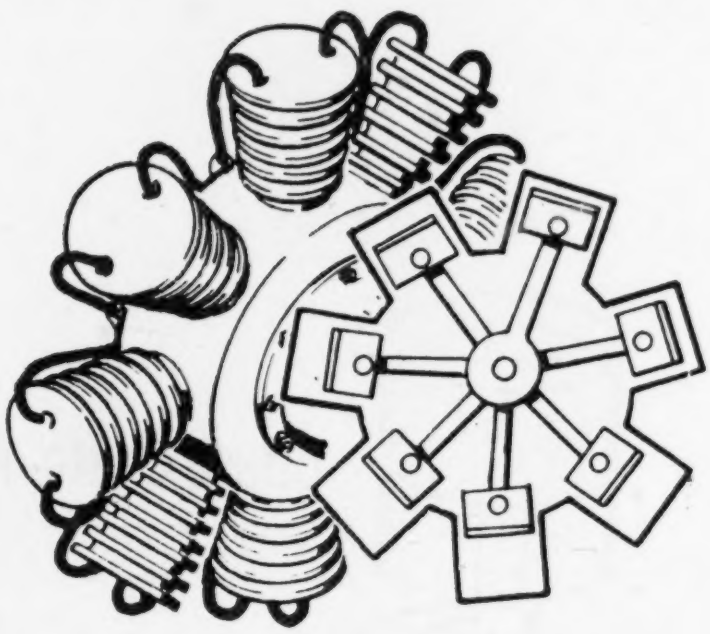

RADIAL

6690

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FOUR CYCLE ENGINE

INTAKE STROKE

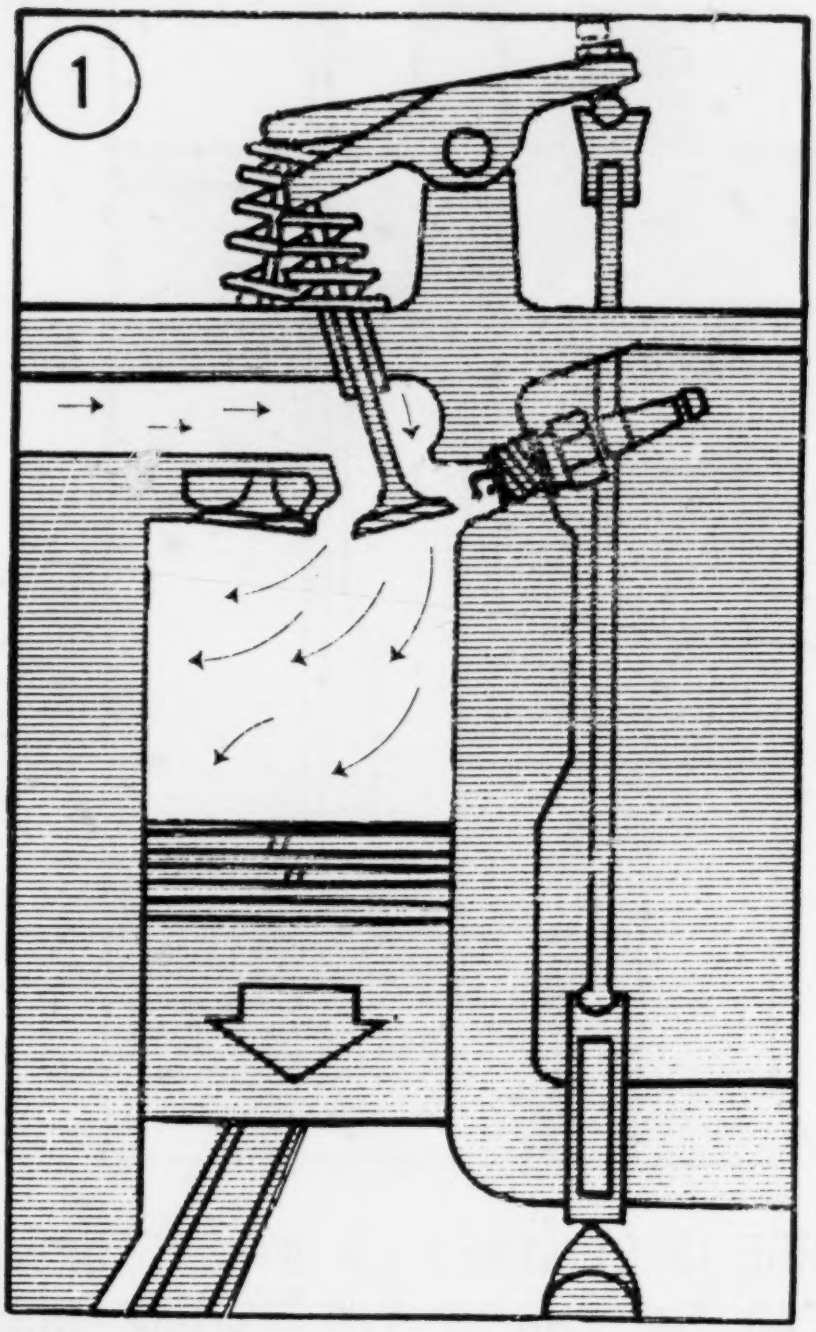

A COMBUSTIBLE AIR-FUEL MIXTURE FROM THE CARBURETOR IS FORCED INTO THE CYLINDER

SCIENCE - 19E
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FOUR CYCLE ENGINE

COMPRESSION STROKE

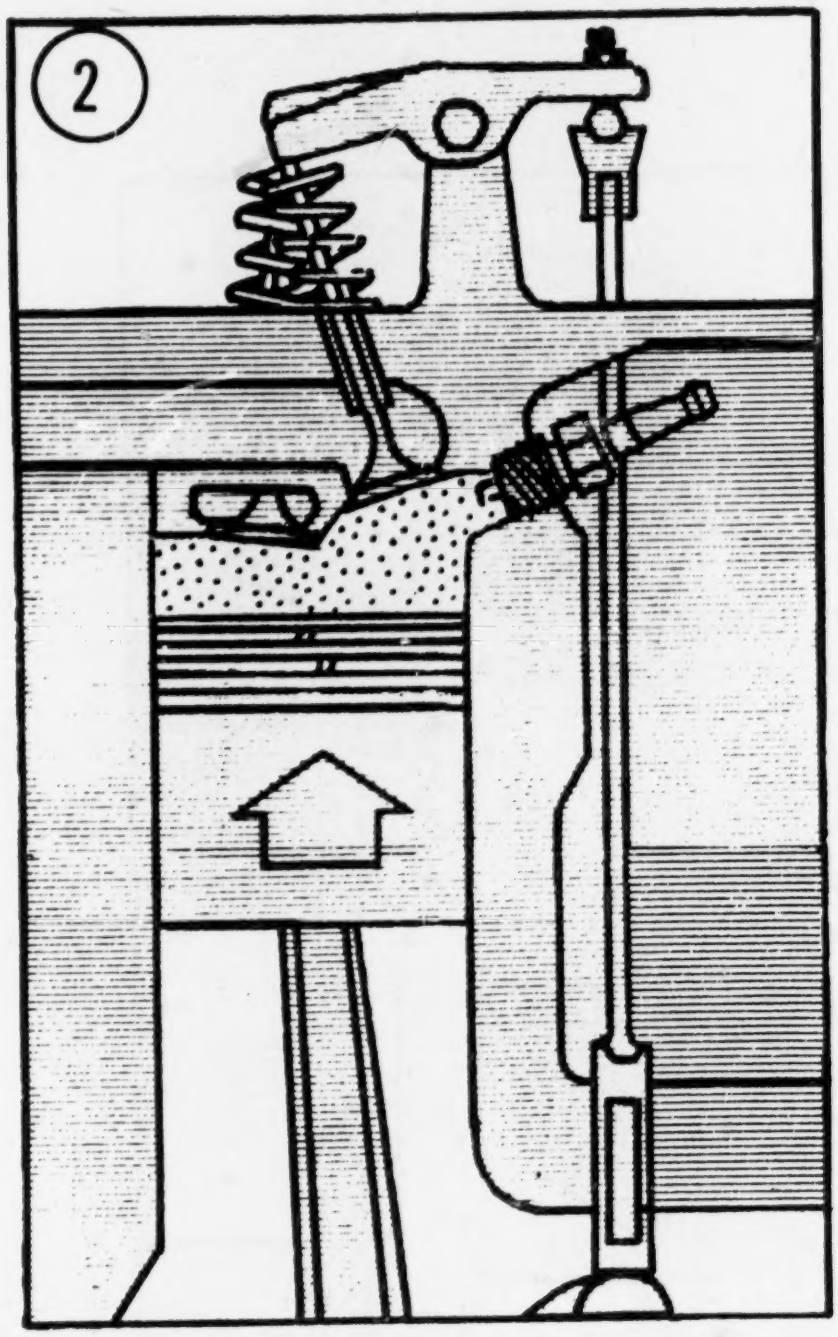

THIS AIR-FUEL CHARGE IS COMPRESSED BY THE UPWARD STROKE OF THE PISTON. NEAR THE END OF THE STROKE, IGNITION OCCURS WHEN A SPARK LEAPS BETWEEN THE SPARK-PLUG ELECTRODES.

1633

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FOUR CYCLE ENGINE
POWER STROKE

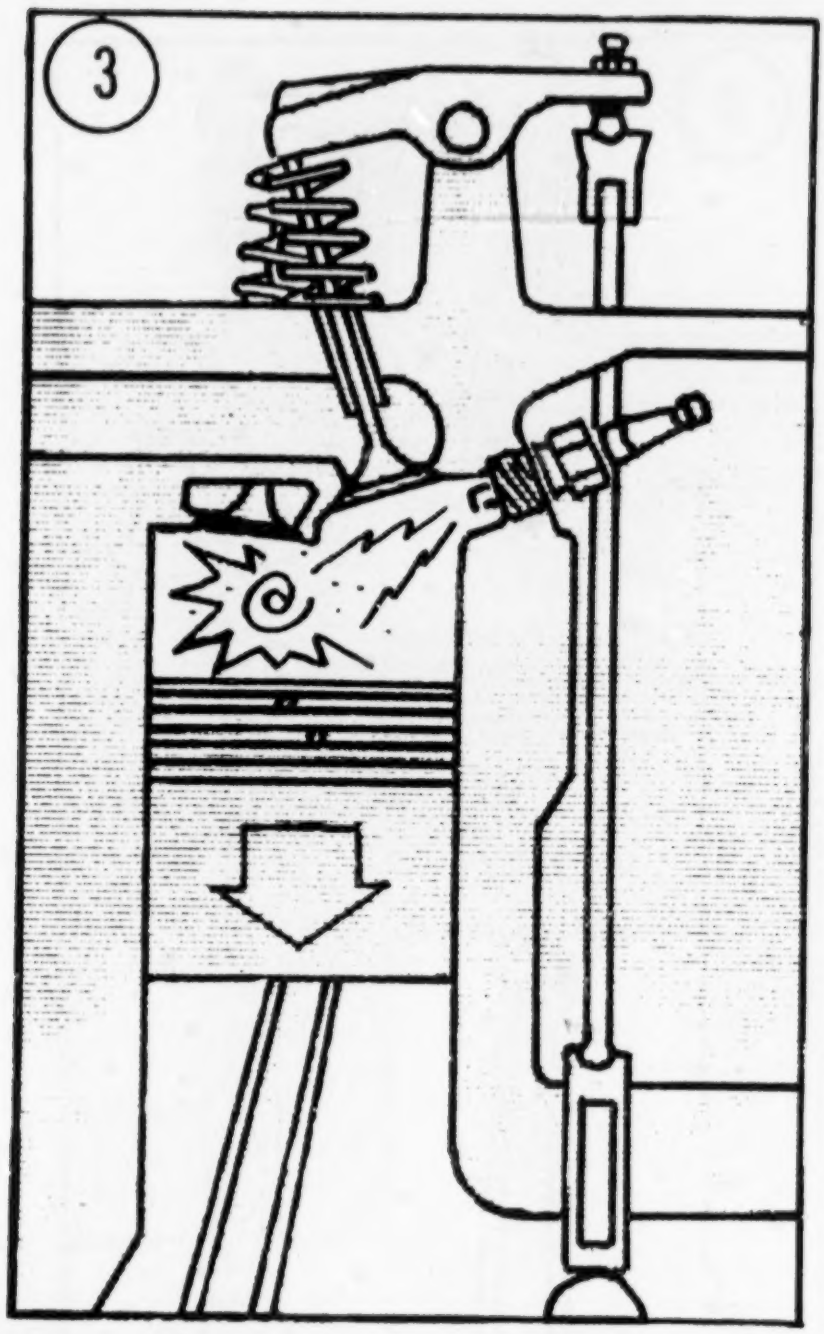

THE AIR-FUEL MIXTURE EXPLODES, FURNISHING THE ENERGY WHICH PUSHES DOWN THE PISTON. THE PISTON TURNS THE CRANKSHAFT AND FLYWHEEL, DEVELOPING THE POWER WHICH ULTIMATELY REACHES THE WHEELS.

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FOUR CYCLE ENGINE

EXHAUST STROKE

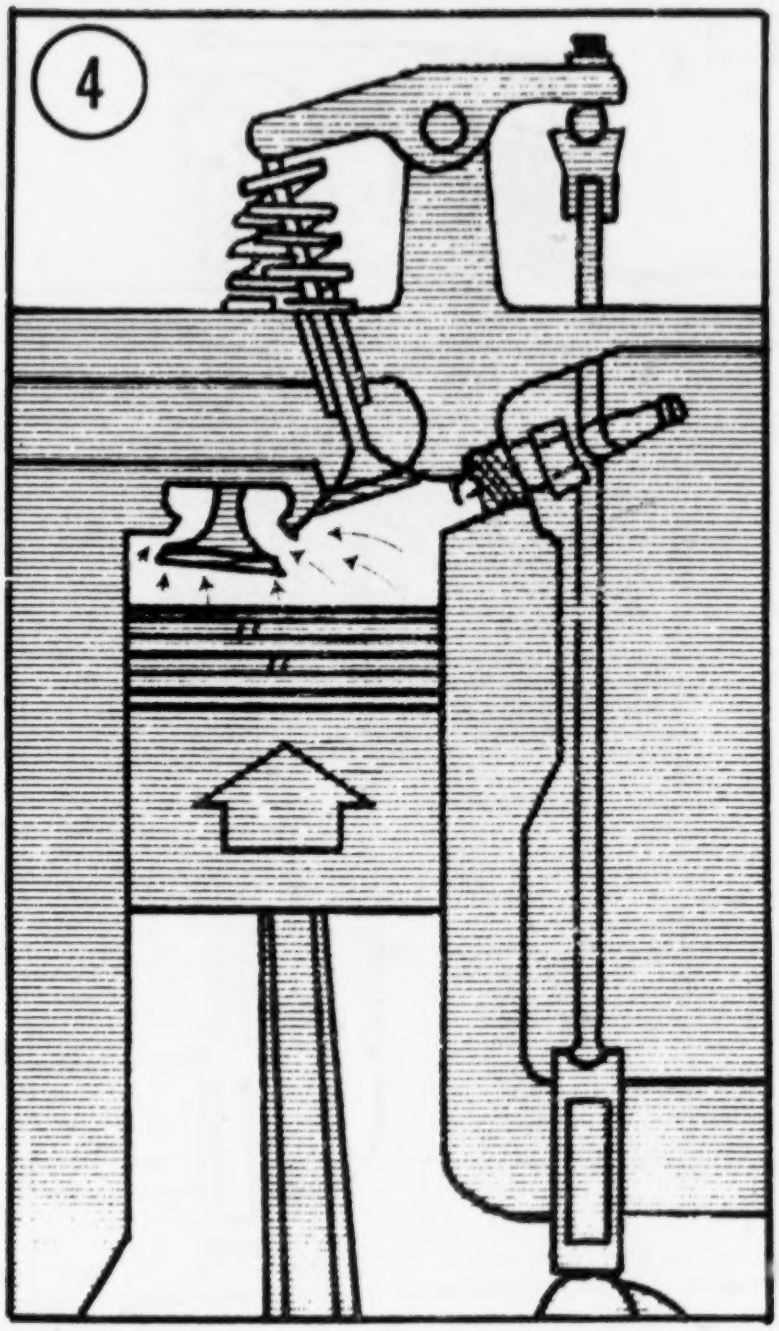

ON THE EXHAUST STROKE, THE USED OR SPENT COMBUSTION GASES ARE FORCED BY THE PISTON OUT OF THE CYLINDER THROUGH THE OPEN EXHAUST VALVE.

6694

SCIENCE - 19H
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TWO-CYCLE ENGINE — INTAKE AND COMPRESSION

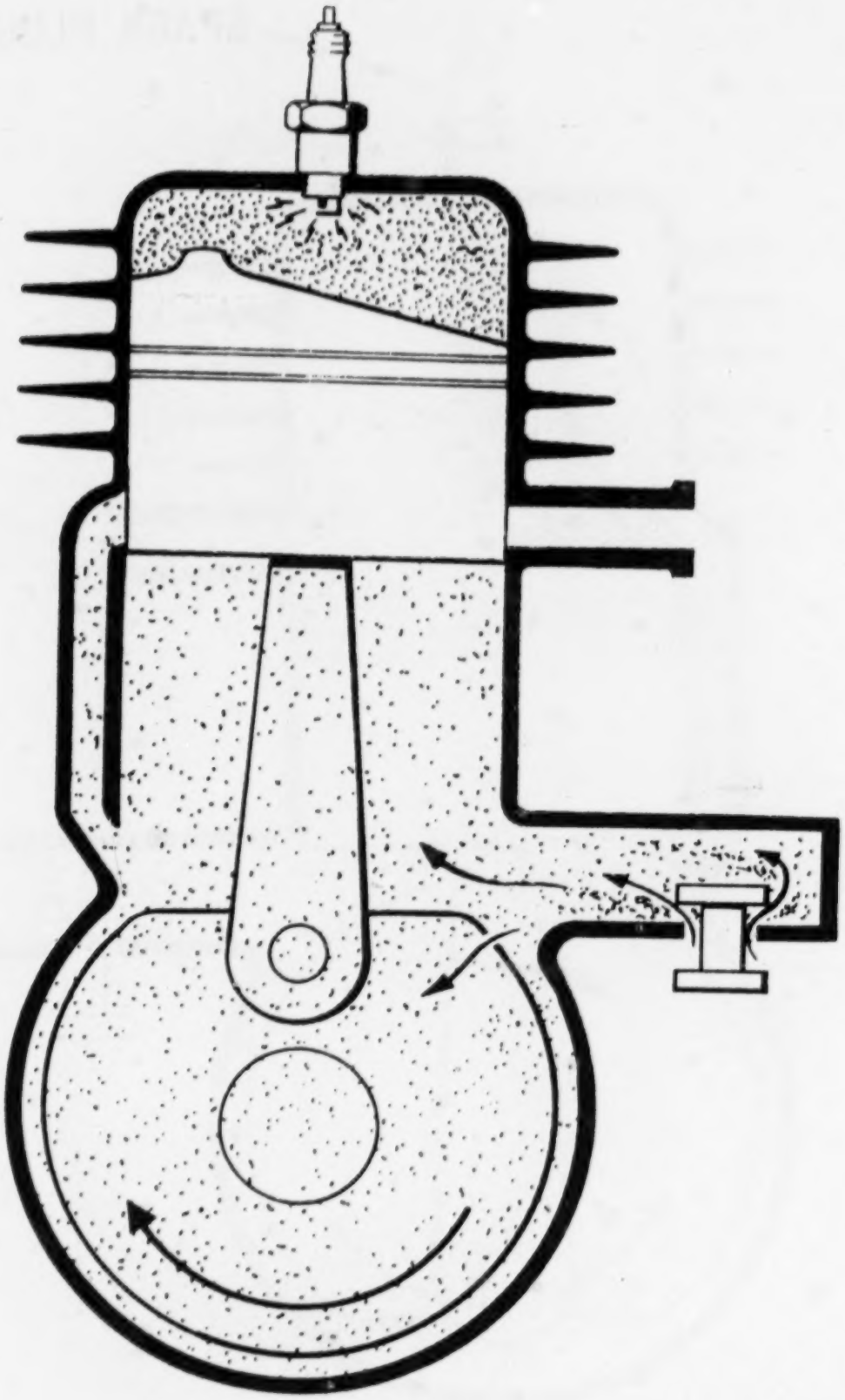

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TWO-CYCLE ENGINE – POWER AND EXHAUST

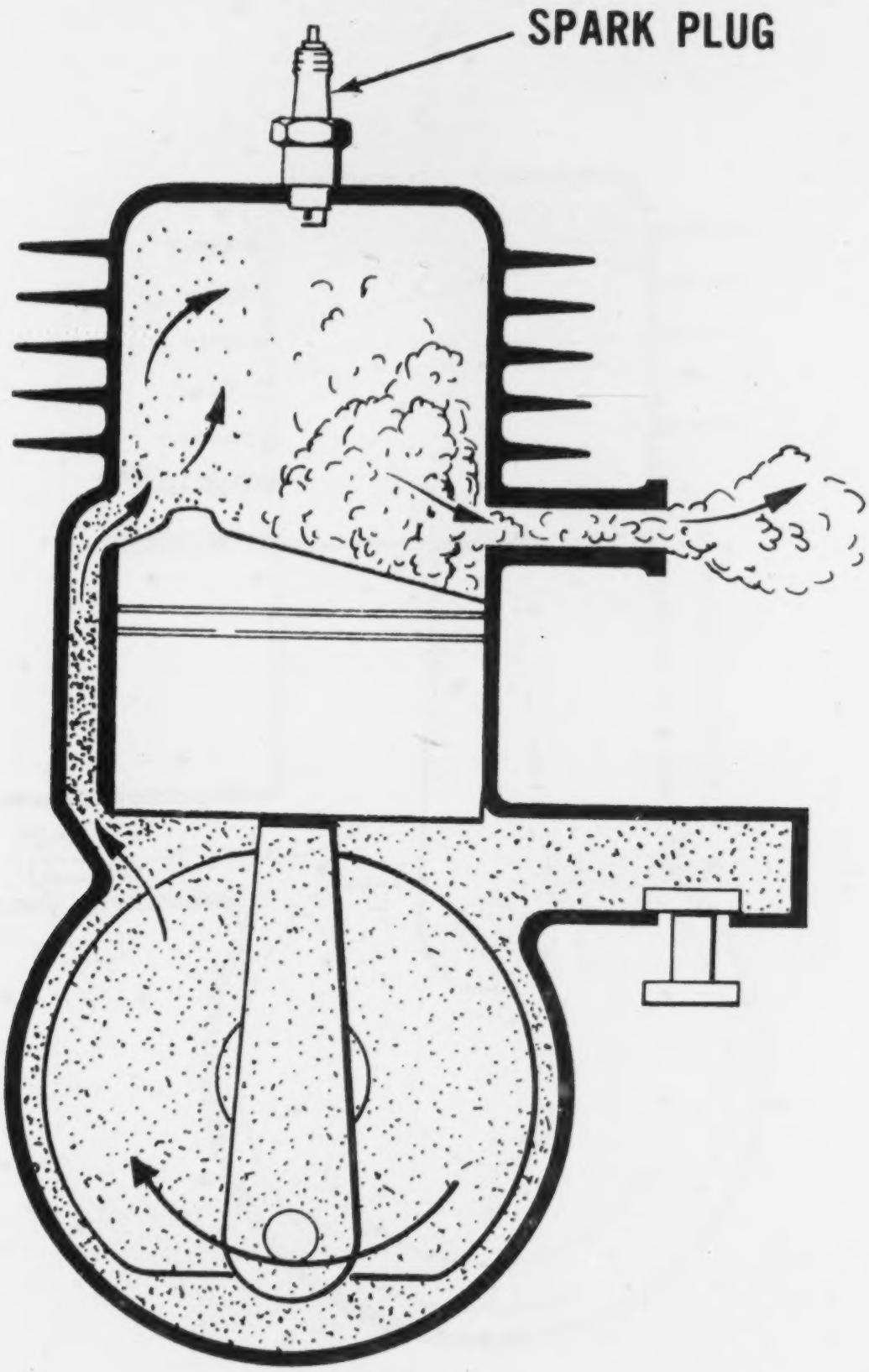

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THE AUTOMOBILE ENGINE

Identify the following parts of the cutaway view of V-type engine. Select from list below.

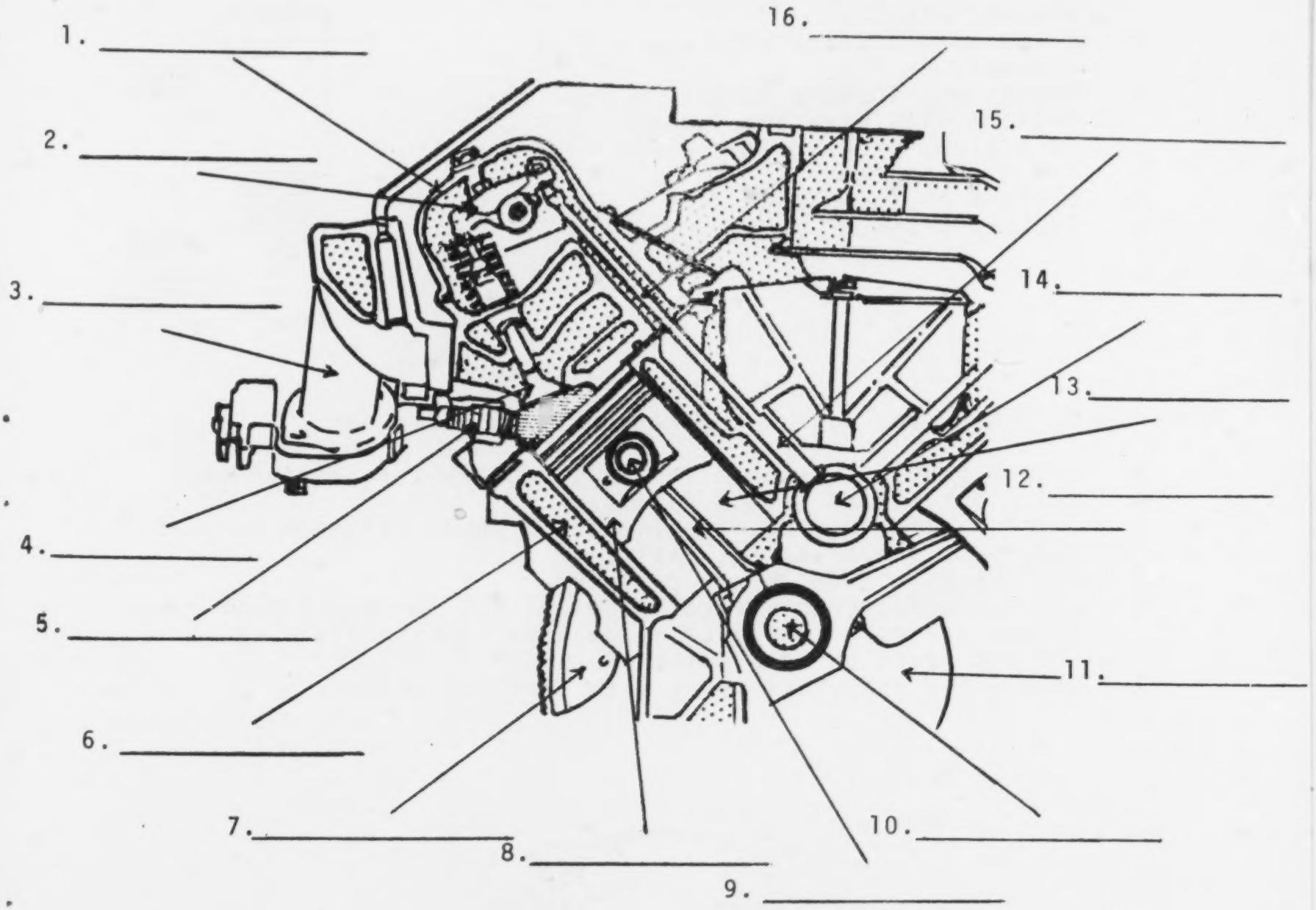

Exhaust manifold, cylinder, piston, wrist pin, lifter, flywheel, valve, camshaft, connecting rod, counter balance, push rod, crankshaft, rocker arm cover, water jacket, rocker arm, spark plug.

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SMALL ENGINE MAINTENANCE

No. 1 Ignition System

Exercise 1. Clean, adjust, and test spark plugs.

A. Remove plugs with spark plug wrench.
B. Check for cracked porcelain.
C. Check points. (If too badly burned, discard plugs.)
D. Clean usable plugs with spark plug cleaner.
E. Adjust gap to manufacturer's specifications with wire type gauge.
F. Test plugs under pressure for fouling. Use plug tester.
G. Discard faulty plugs.
H. Replace plugs.

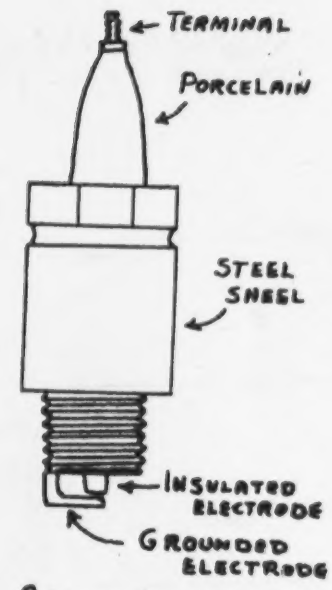

SPARK PLUG

Exercise 2. Check for faulty breaker points and set gap.

A. Remove blower, housing, flywheel, and breaker point cover.
B. Check for burned pitted points.
C. Usable points may be dressed with a point file and re-used. Deep pits render points useless.
D. Replace points in proper position.
E. Using manufacturer's specifications set for point gap. (Check points with feeler gauge when rubbing block of the arm rests on high point of cam.)
F. Reassemble and check spark with ignition tester.

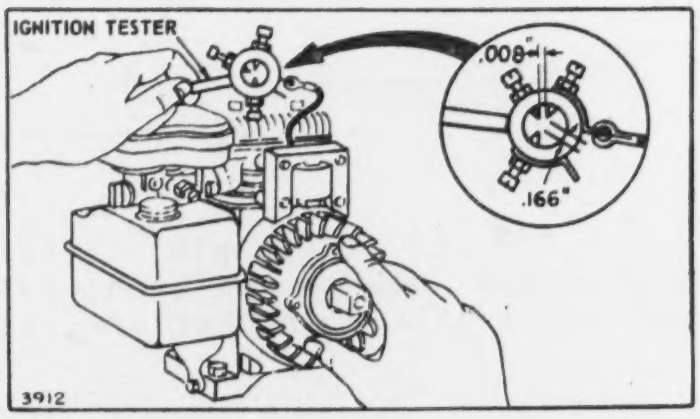

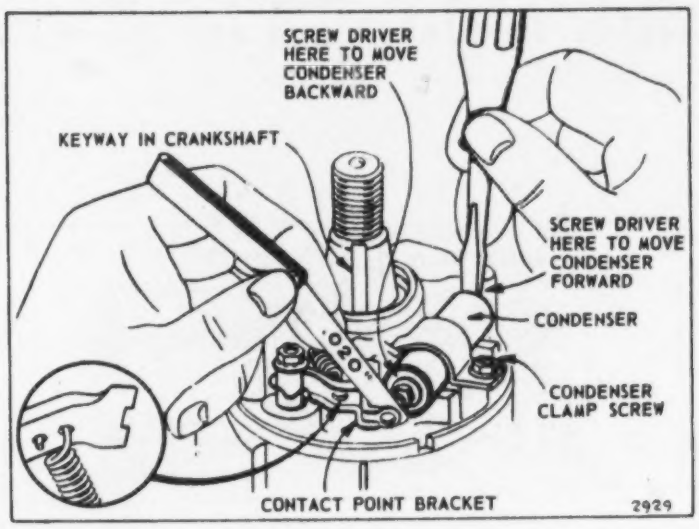

Adjusting Breaker Point Gap

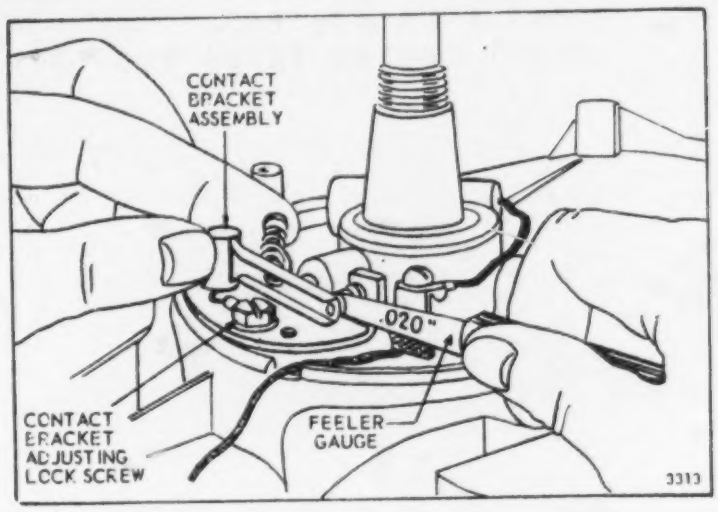

Adjusting Breaker Point Gap

No. 2 Fuel System

Exercise 1. Clean and adjust carburetor.

A. Remove carburetor and disassemble. Remove the carburetor and fuel tank as one unit if vacu or pulsa jet carburetor.
B. Put parts in cleaning solution.
C. Remove parts after cleaning and blow off with compressed air.
D. Inspect each part thoroughly for worn, broken or bent parts.
E. Replace unusable parts.
F. Re-assemble carburetor and fuel tank.
G. Attach carburetor to engine, checking manifold gasket.
H. Adjust carburetor--Pulsa Jet, Vacu-Jet
Initial adjustment: Turn needle valve clockwise to close it. Then open 1 1/2 turns.
Final adjustment: With engine running at normal operating speed, turn needle valve clockwise until engine starts to lose speed. Then slowly turn needle valve counter-clockwise past the point of smoothest operation, until engine first begins to run unevenly. Hold throttle in idle position. Turn idle speed adjusting screw until fast idle is obtained (1750 RPM).
I. Flow-Jet Carburetor Adjustment
Screw in neddle valve and idle valve until they just seat. Back off needle valve 1 1/2 turns. Back off idle valve 3/4 turn. Start engine and allow to run at normal operating speed. Turn needle valve in until engine misses (lean mixture), then turn it out past smooth operating point until engine runs unevenly (rich mixture). Turn needle valve to the mid-point between rich and lean so engine runs smoothly.

Hold throttle at idle position and set idle speed, adjusting screw until engine idle speed is 1750 RPM or 1200 RPM for cast iron engines. Turn idle valve in (lean) and out (rich) until engine idles smoothly.

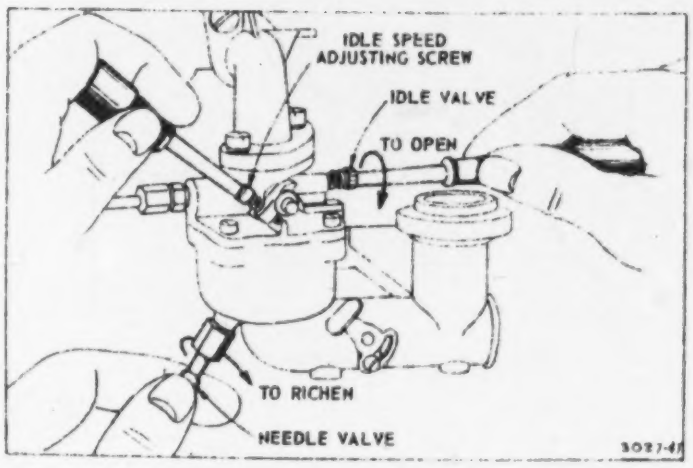

Flo-Jet

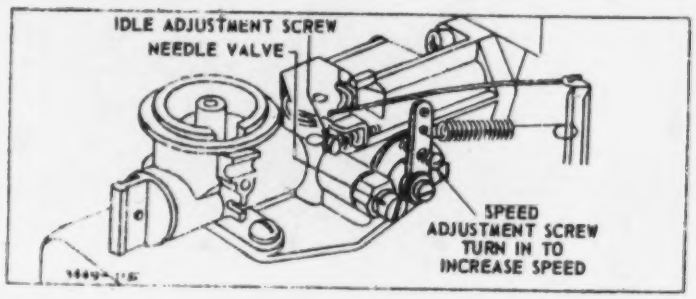

Pulsa Jet Carburetor

Exercise 2. Clean and service air cleaner.

A. Remove entire air cleaner.
B. Disassemble and wash in cleaning solution.
C. Visually inspect for cleanliness.
D. Re-assemble cleaner and fill oil cup to proper level with oil.
E. Install on engine.

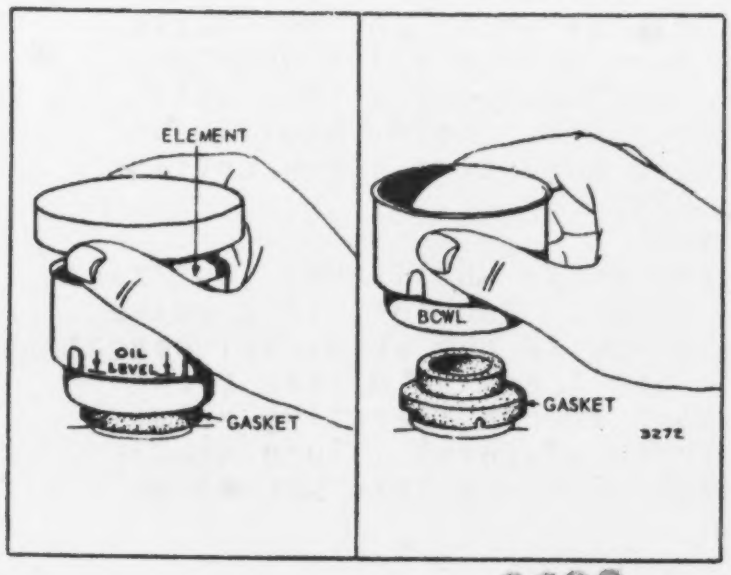

Oil Bath Air Cleaner

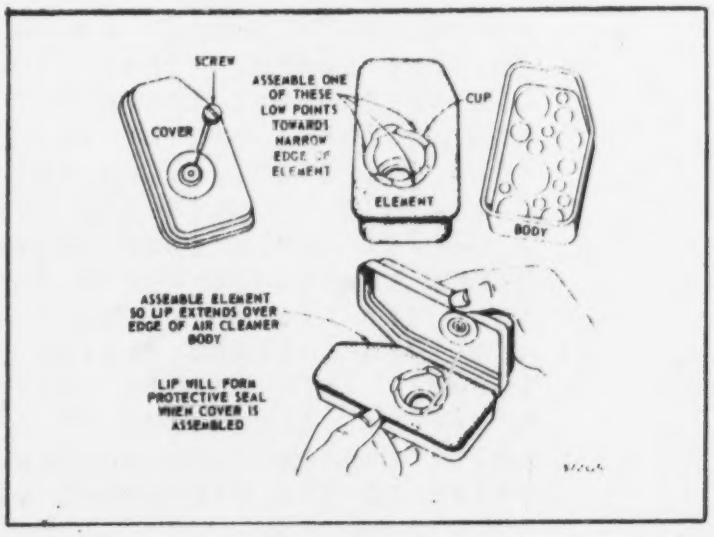

Oil Foam Air Cleaner

ecaa

6700

Check your "horsepower rating" by answering the following questions.

1. Name five types of mechanics that work with internal combustion engines.

2. List the strokes in a four-stroke cycle engine--in their proper order.

3. List the strokes needed in the two-stroke cycle engine.

4. Explain the sequence of events during these strokes (two-cycle engine).

5. What are the basic differences between four-stroke cycle and two-stroke cycle engines?

6. Using cylinder arrangement, list the three most popular engines in use today.

7. In fuel classification, what three principal fuels are concerned?

8. Explain where the valves are located in I-head, F-head, and L-head engines?

9. What are the various systems of an engine?

10. When is it necessary to replace spark plugs and breaker points in an engine?

11. What should be the breaker point gap? Spark plug gap?

12. What is the purpose of the carburetor?

13. What does most of the cleaning in an air cleaner?

14. What type of oil should be used in small gasoline engines?

15. How often should oil be changed in small engines?

16. What type of fuel should be used in small engines?

VT 012 697
Advanced Shop Guide for Vo-Ag Students.

Alabama State Dept. of Education, Montgomery.
Agricultural Education Service.
MF AVAILABLE IN VT-ERIC SET.
Vocational Agricultural Education, Field Office, 101 Petrie Hall, Auburn, Alabama 36830 (available in limited supply for $1.00).
PUB DATE - ND 194p.

DESCRIPTORS - *AGRICULTURAL EDUCATION; *VOCATIONAL AGRICULTURE; VOCATIONAL EDUCATION; SECONDARY EDUCATION; *WORKBOOKS; STUDY GUIDES; *TEACHING GUIDES; CURRICULUM GUIDES; SCHOOL SHOPS; *FARM MECHANICS (OCCUPATION)

ABSTRACT - This teaching guide, prepared by the Agricultural Education Service of the Alabama State Department of Education, is designed for use as both a reference for the teacher of vocational agricultural mechanics and a workbook for the high school student enrolled in advanced agricultural mechanics. Units are: (1) Arc Welding, (2) Simple Farm Plumbing, (3) Small Gasoline Engines, (4) Power Wood Working Tools, (5) Farm Electricity, (6) Acetylene Welding, (7) Painting Farm Machinery, and (8) Hot and Cold Metal Work. Each illustrated unit contains an introduction, a list of objectives, materials and equipment needed, and suggested exercises for students along with related reference material. (LM)

VT 012 697

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ADVANCED SHOP GUIDE
FOR
VO-AG STUDENTS

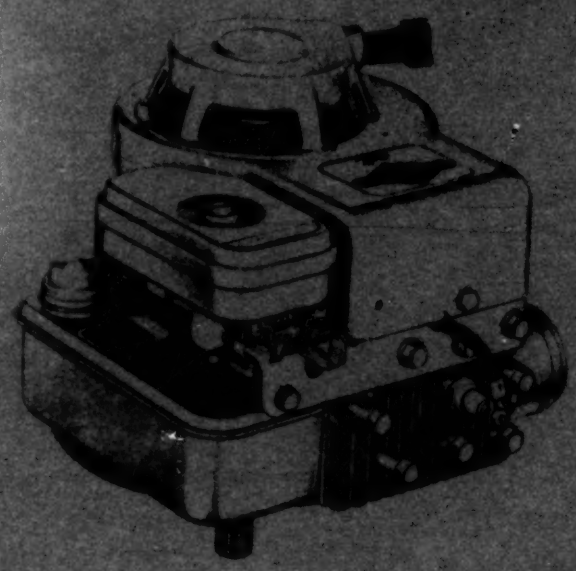

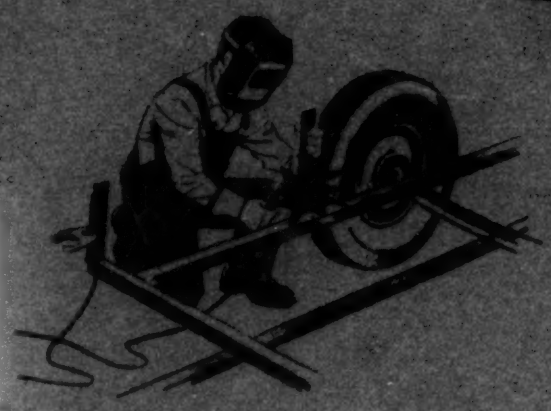

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STATE OF ALABAMA
STATE DEPARTMENT OF EDUCATION
Division of Vocational Education
Agricultural Education Service
Montgomery, Alabama

VT012697

6703

STATEMENT OF PURPOSE AND USE OF THIS GUIDE

Instruction in agricultural mechanics is an integral part of the program in vocational agriculture in the secondary schools in Alabama. Recent years have brought about many changes in agricultural mechanics which makes it increasingly necessary for the teachers and students of vocational agriculture to be aware of the need for greater emphasis in this field.

This guide has been prepared for use as a reference for the teacher and as a reference and workbook for the student. It is designed to illustrate the course of study in advanced agricultural mechanics for the student enrolled in vocational agriculture. It will be noted that the guide follows the Alabama course of study very closely. The purpose of this guide is not to replace teaching; however, it should serve as a valuable aid for the teacher to demonstrate and illustrate many of the skills taught students in advanced shop.

For effective use, each student should have his own "Vo-Ag Shop Guide." This will allow him to observe the many illustrations while performing the different skills in the shop as well as answering questions on the various units in the classroom.

ACKNOWLEDGEMENTS

A tremendous amount of assistance from many people was necessary in the preparation of this guide, and appreciation is expressed to the following:

The State Supervisory and Teacher Training Staff of Agricultural Education; Moore-Handley Hardware Company; Rockwell Company; Teachers of Vocational Agriculture in Alabama; Minnesota Mining and Manufacturing Company; Lincoln Arc Welding; Sears Roebuck and Company; Briggs and Stratton Corp.; Association for Agricultural Engineering and Vocational Agriculture.

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REFERENCES

1. The Farm Shop, Wakeman, T. J. and McCoy, Vernon Lee; The Macmillan Co., New York, N.Y.

2. Farm Mechanics Text and Handbook, Phipps, L. J., and others; The Interstate, Danville, Illinois.

6705

ARC WELDING

6706

INTRODUCTION TO ARC WELDING

Arc welding is the process of fusing two pieces of metal with the heat of an arc produced by an electric arc welding machine. But this is only one of the many jobs that can be done with the arc welder.

The arc welder is standard equipment in the vocational agriculture shop. This unit provides information complete enough to enable the student welder to gain valuable knowledge and practice in welding. It will also provide a foundation on which he can expand his welding experience.

Arc Welding

1. Safety in arc welding
2. Arc welding equipment and supplies
3. Electrode classification
4. The correct welding position
5. The correct way to strike an arc
6. The correct arc length
7. The correct welding speed
8. Types of welded joints
9. Welding cast iron
10. Cutting with the arc welder
11. Piercing holes with the arc welder
12. Position welding
13. Welding pipe
14. Hardsurfacing
15. Use of the carbon arc torch

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Materials and Equipment

1. Welder and a supply of electrodes
2. Slip-joint pliers
3. Chipping hammer
4. Wire brush
5. Six-inch outside calipers and a twelve-inch metal rule
6. Welding table
7. Bucket
8. Soapstone
9. C clamps
10. Welding helmets
11. Welding gloves
12. Welding apron
13. Metal
14. Carbon arc torch
15. Pipe

Exercise for Students

1. Practice the proper way to strike an arc.
2. Practice maintaining the correct arc length.
3. Practice the correct welding speed.
4. Practice running beads on a flat plate.
5. Practice the proper welding positions.
6. Make the following welds: Beveled butt weld, bevelled fillet weld, fillet weld, single pass fillet weld, multiple pass fillet weld, single vee-groove weld, multiple pass verticle fillet weld, overhead welding, outside corner welding, verticle welding, weavlap welding.
7. Practice welding a piece of pipe.
8. Practice hardsurfacing.
9. Practice using the arc torch.

6708

SAFETY RULES TO FOLLOW

Follow these rules when using the welder:

1. Protect eyes at all times by using the proper welding lens.
2. Protect bare skin from exposure to the arc rays. Use a good head shield, leather or canvas gloves; roll down sleeves and button up shirt front.
3. Always chip slag away from you and have the eyes covered.
4. Protect on-lookers' eyes by cautioning them to turn away.
5. Watch for sparks that might land in the cuffs of pants or pockets.
6. Do not carry matches in the shirt pocket while welding.
7. Keep welding equipment dry and weld in a dry place.
8. Make sure the electrical circuit is safely connected.
9. Be careful in disposing hot electrode stubs. Put them in a container, they are a hazard on the floor.
10. Make sure the handle of the electrode holder is properly insulated.
11. Never strike an arc until everyone nearby has a hood on or a shield before his eyes.
12. Protect all cables from hot metals or sharp edges.
13. If the electrode sticks, turn off the welder switch and allow the electrode to cool before breaking loose.
14. Provide adequate ventilation while welding.
15. Never weld around gas or any other combustible materials.
16. Avoid welding any containers or tanks until you can be certain of what they have contained.
17. Make sure the welding table is properly grounded and clean.
18. Do not leave hot metals on the welding tables when you leave the welding area.
19. Always keep handy appropriate first aid materials and a fire extinguisher.
20. Do you thoroughly understand the safety regulations as discussed?

yes:_____ no:_____

Signed:_____

Date:_____

D-C ARC MACHINE

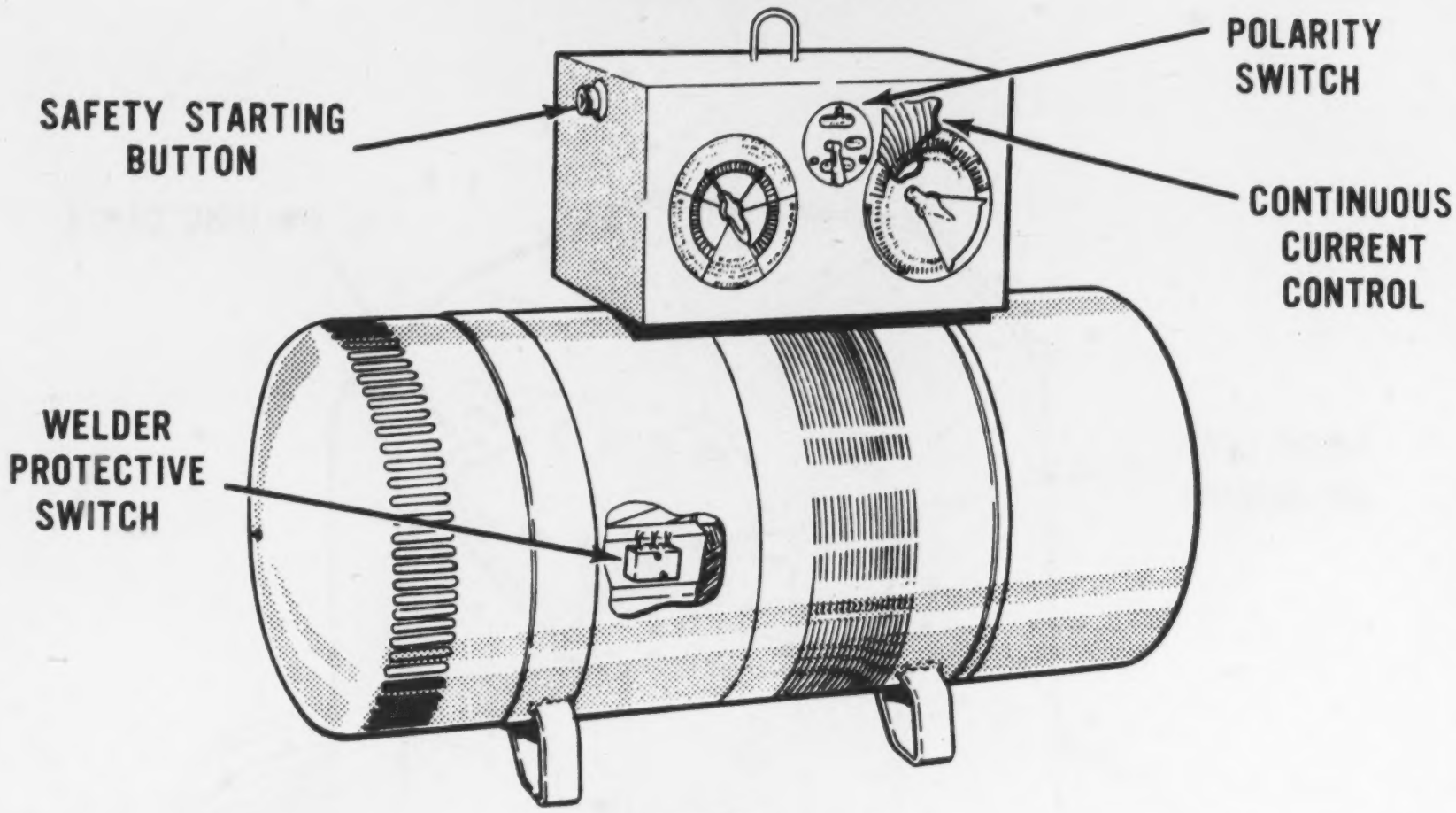

DUAL CURRENT CONTROLS

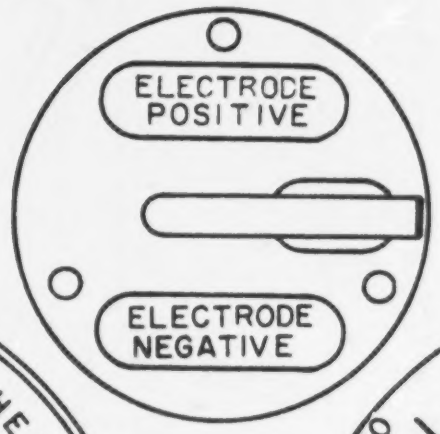

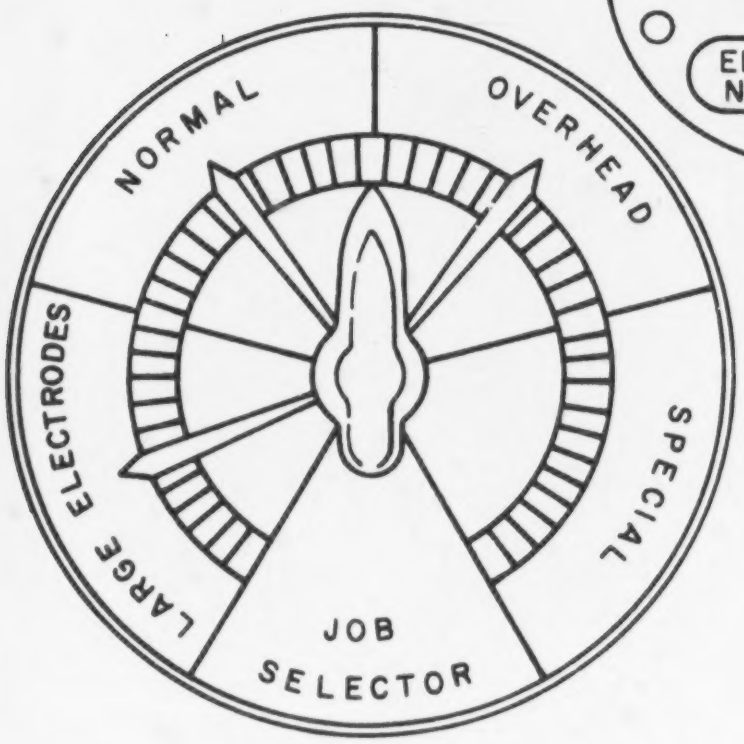

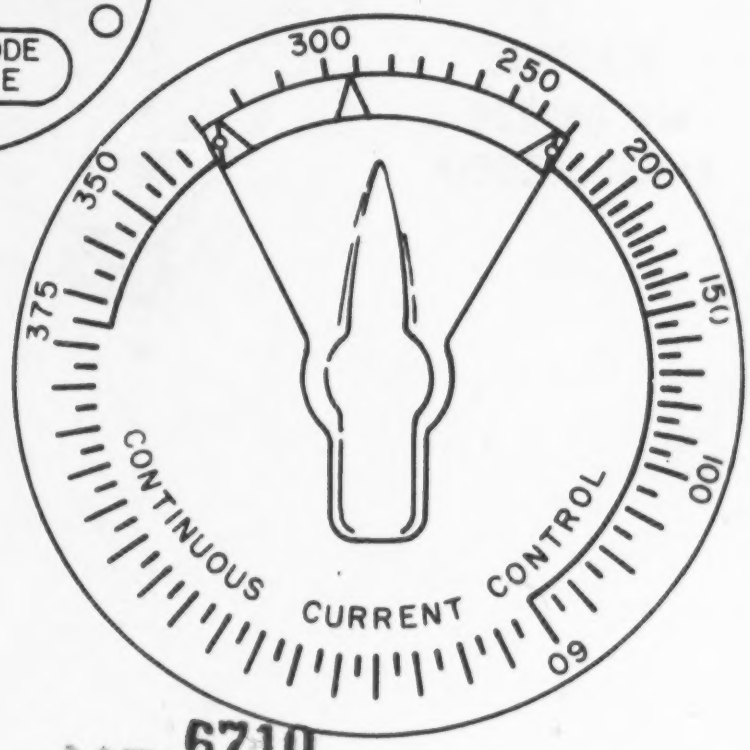

A-C ARC MACHINE

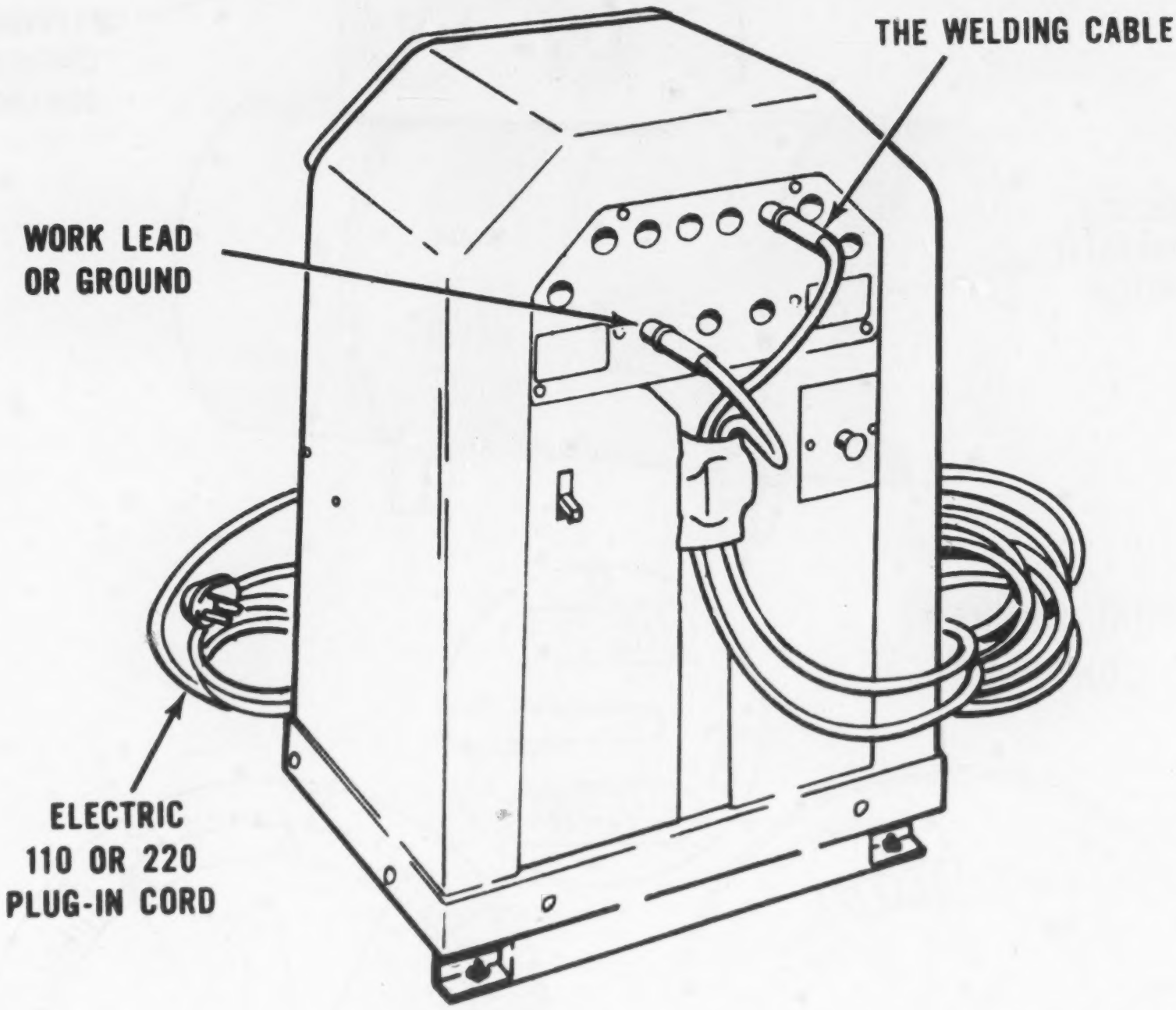

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THE WELDING HOOD

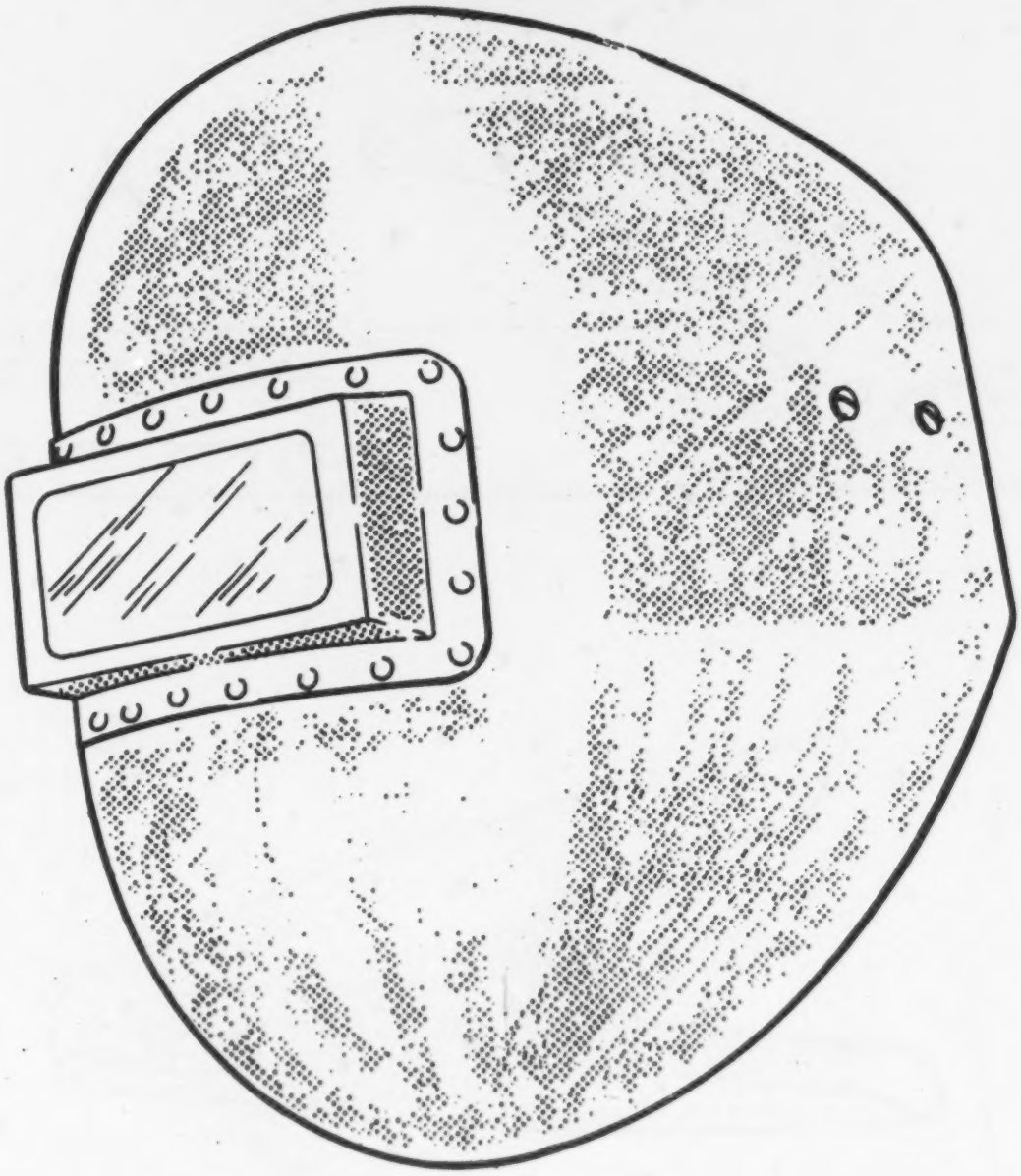

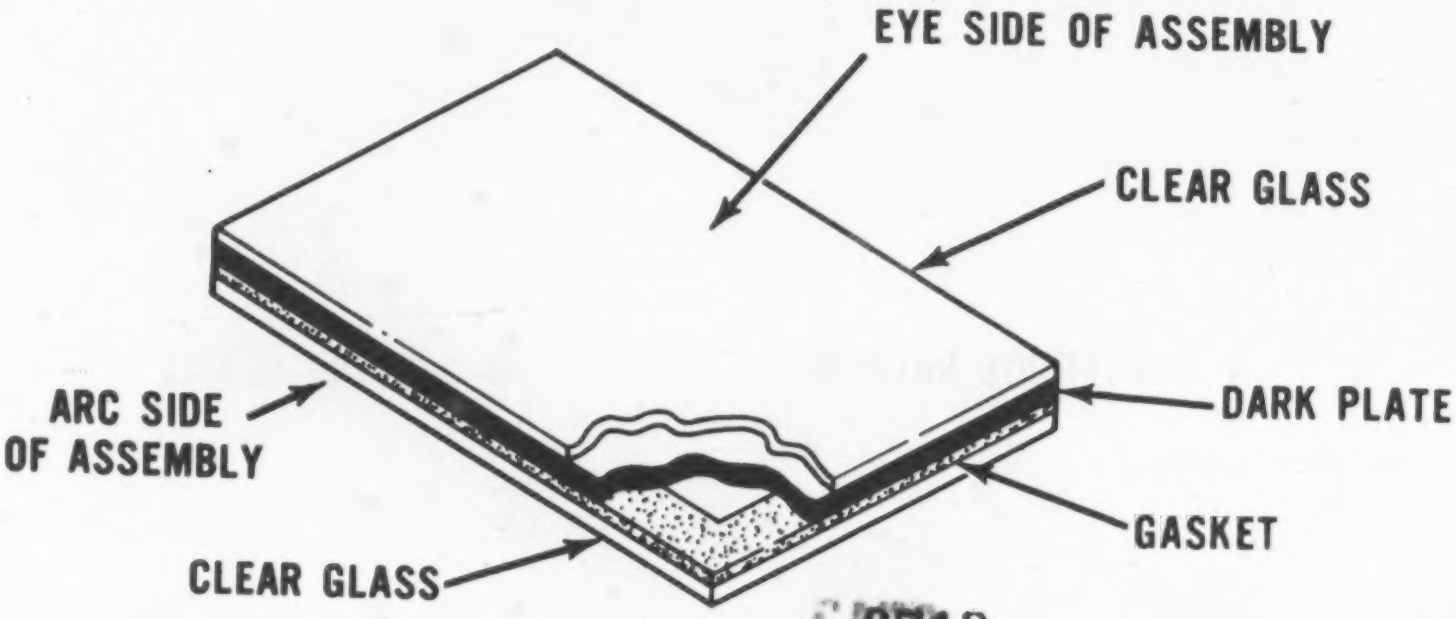

ELECTRODE HOLDER AND GROUND CLAMP

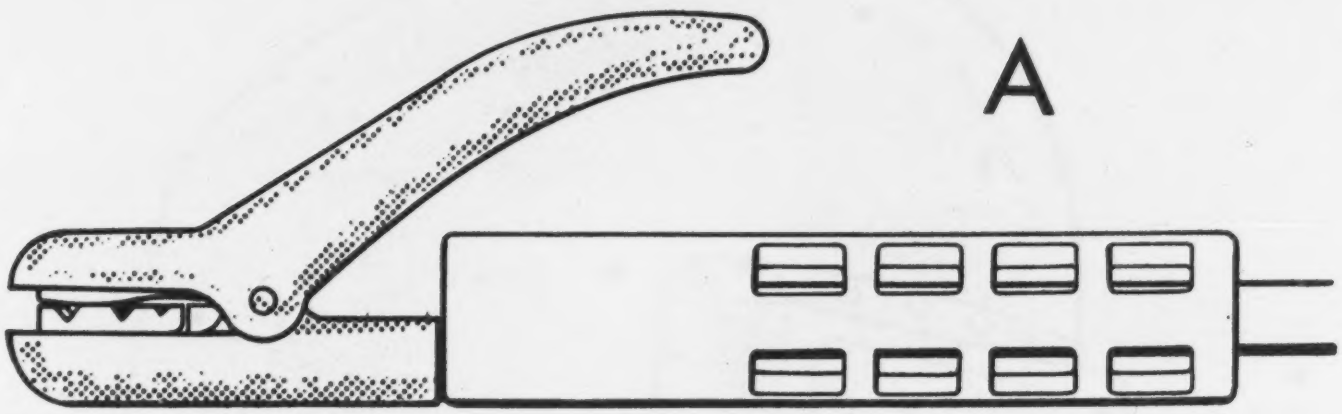

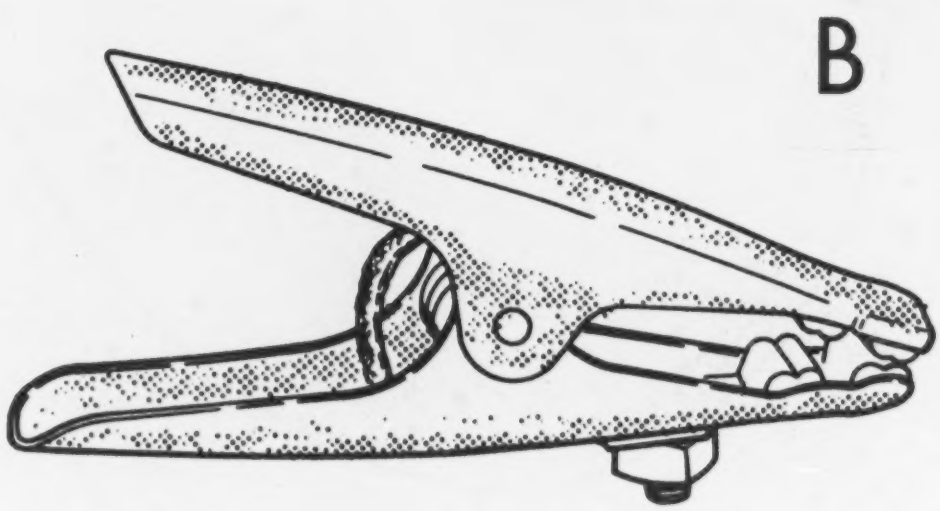

A- ELECTRODE HOLDER

B- GROUND CLAMP

S 16713

ELECTRODE CLASSIFICATION

The American Welding Society and the American Society for Testing Materials have prepared a code of specifications for electrodes which is now used by all the major manufacturers of welding electrodes.

The specifications for each classification are expressed by a four-digit number preceded by an "E". The meanings are as follows:

1. "E" stands for "Electrode".
2. The first two digits express tensile strength of the material in terms of thousands of pounds per square inch.
3. The third digit denotes welding positions.
4. The fourth digit denotes penetrating ability of the electrode.

EXAMPLE

"E" stands for electrode — E

60 stands for 60,000 lbs. per sq. inch — 60

1. All positions
2. Flat or horizontal
3. Flat only

— 10

0-deep penetration, moderate spatter, DC electrode positive

1-deep penetration, moderate spatter, DC negative or positive, or AC

2-medium penetration, slight spatter, DC electrode negative, AC industrial

3-medium penetration, steady arc, slight spatter, DC negative, or AC

6-deep penetration, low spatter, for hi-carbon steels, DC negative or AC (Industrial only)

For additional information on electrode classification see table 16, page 582, in The Farm Shop, by Wakeman and McCoy.

STRIKING THE ARC AND DEPOSITING SHORT BEADS

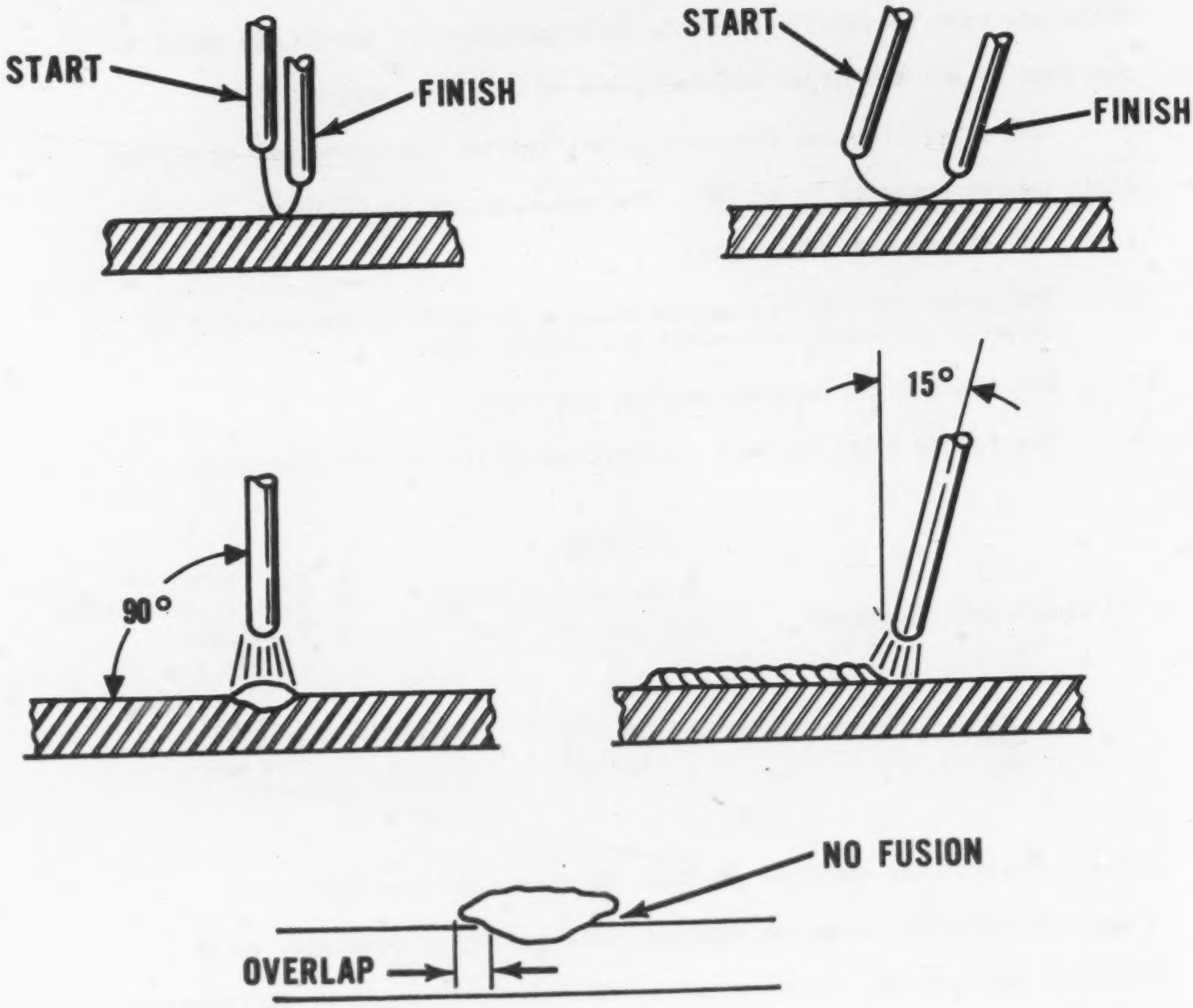

DEPOSITING CONTINUOUS BEADS

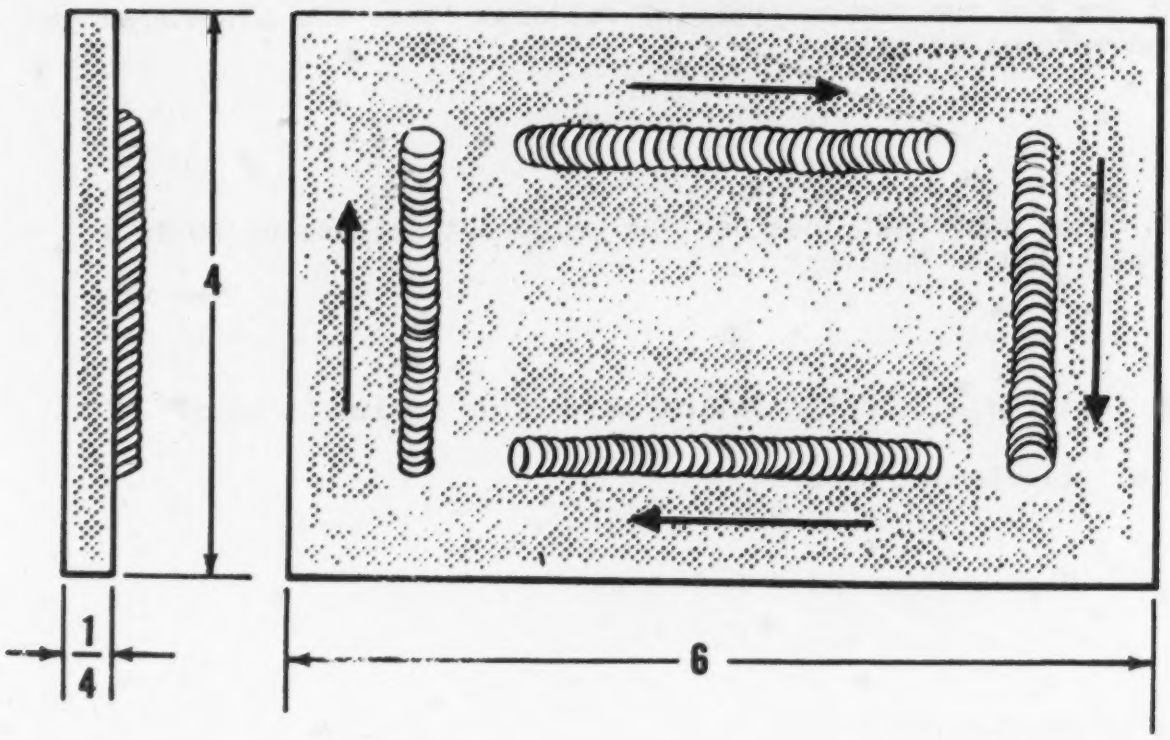

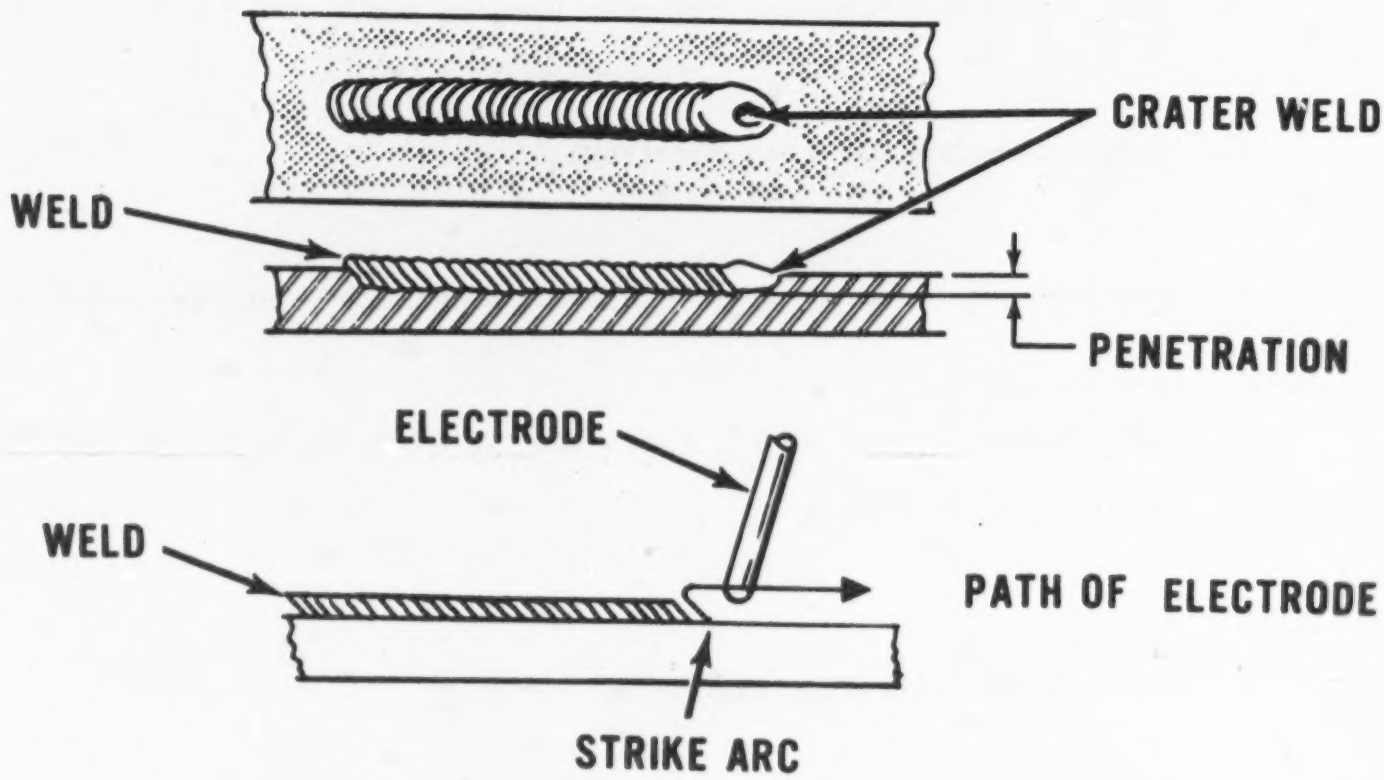

Arc Welding

Types of welders, welding equipment and striking the arc

1. What are the two common types of welders? Give the advantages and disadvantages of each.

2. What other equipment, besides the welder, is necessary to do a thorough job of welding?

3. What features should the following welding equipment have?

   a. Electrode holder:

   b. Head shield and filter lens:

4. What is an electrode?

5. What size electrodes are commonly used on the farm?

6. What determines the size electrode to use?

7. What are the three kinds of electrodes used for most farm welding jobs?

8. What is the purpose of the electrode coasting found on the electrode?

9. Classify the following electrode: E 6013

10. What are the two methods generally used in starting an arc?

11. Explain the proper way to strike an arc.

12. What appearance would the bead have if the electrode is held too far from the metal?

13. What will the bead look like if the electrode is moved too fast? Too slow?

14. If the arc length is correct, what kind of sound may be detected from the arc?

15. What angle to the metal should the electrode be held while welding in horizontal, vertical, and overhead positions?

16. Generally speaking, how fast should you move the electrode while welding?

17. Why is it important to maintain uniform arc length while welding?

18. How long a bead should one electrode weld?

19. Where should the electrode be aimed while welding pipe?

20. How do you prepare metal for welding that is thicker than 3/16 inches? Why?

BEVELED BUTT WELD

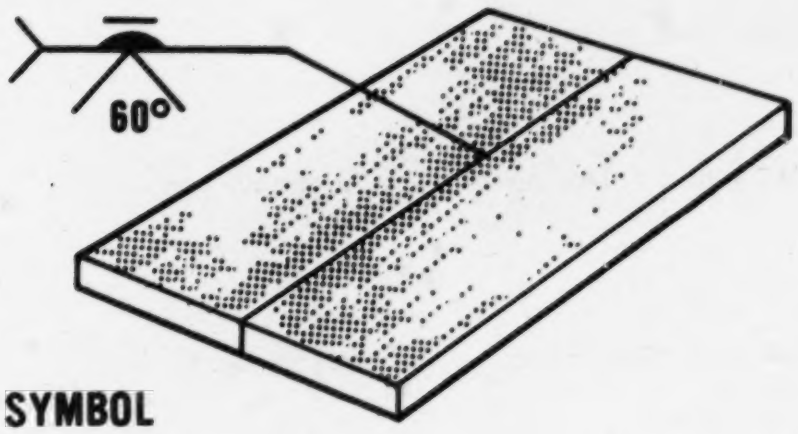

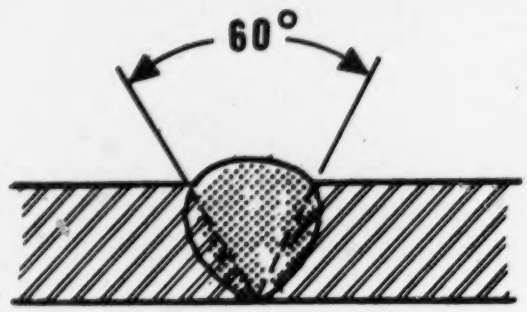

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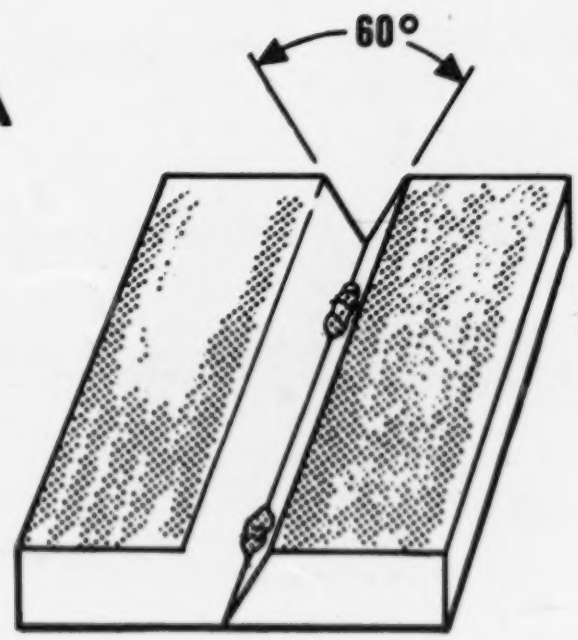

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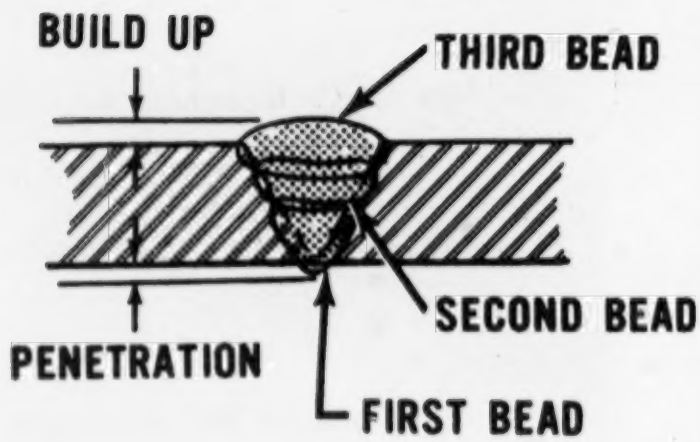

BEVELED FILLET WELD

A

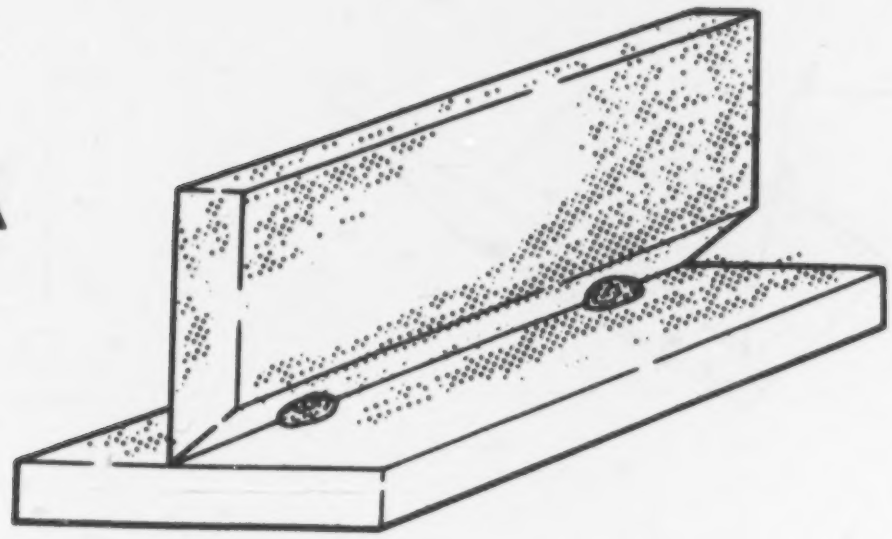

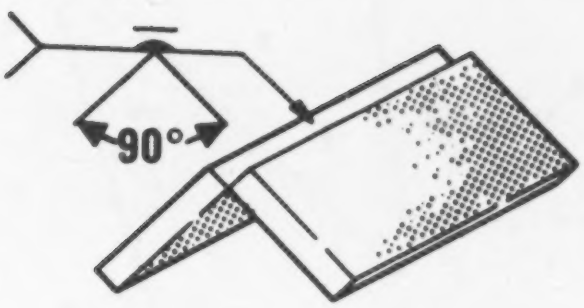

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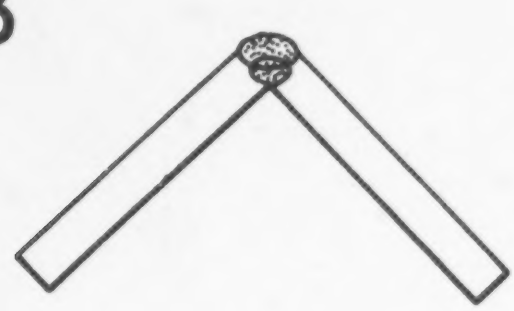

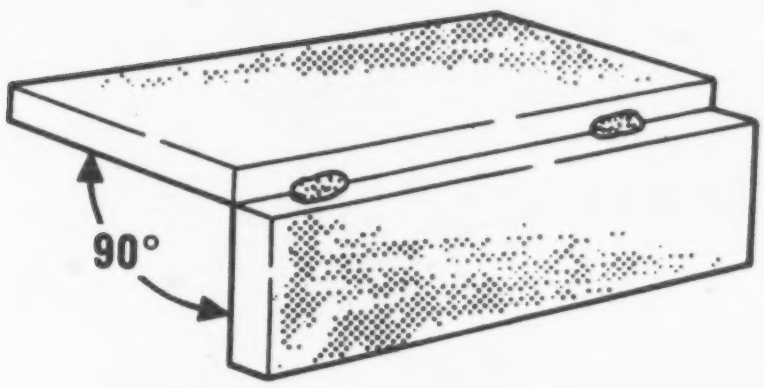

C

FILLET WELD

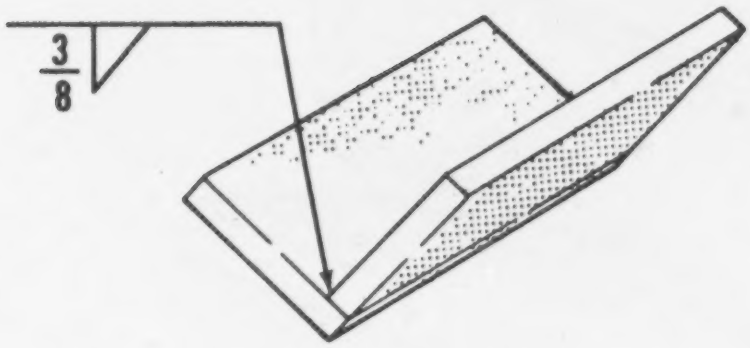

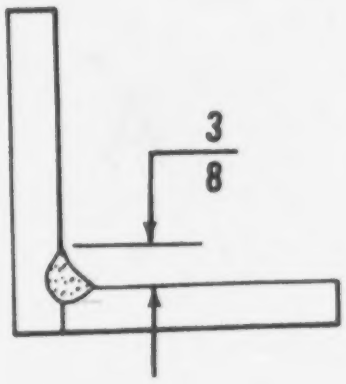

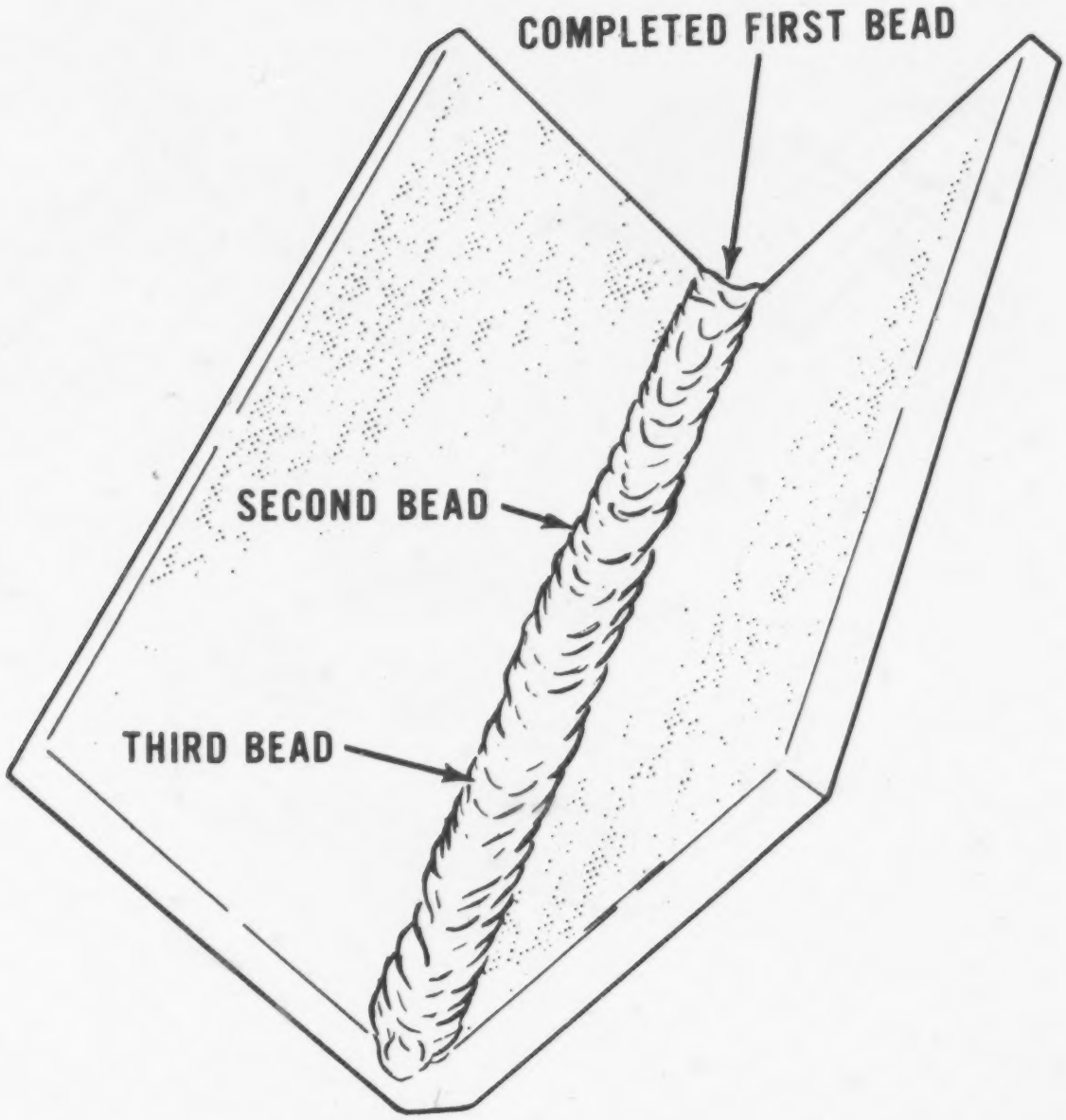

GROOVE WELD TEST SPECIMEN

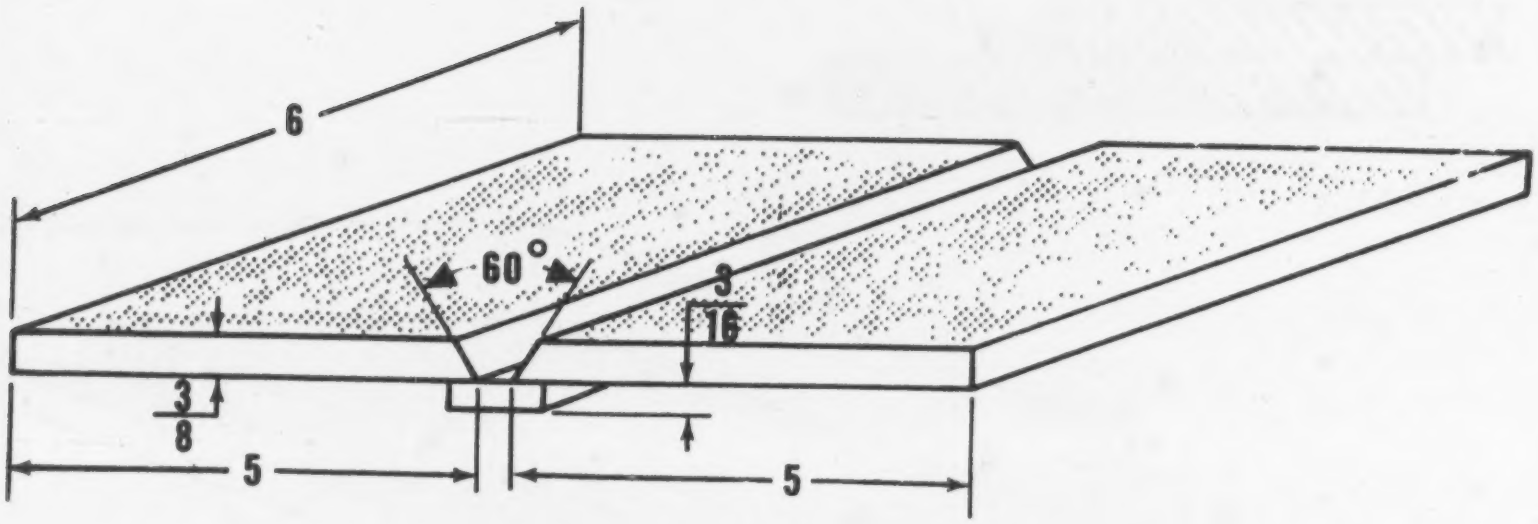

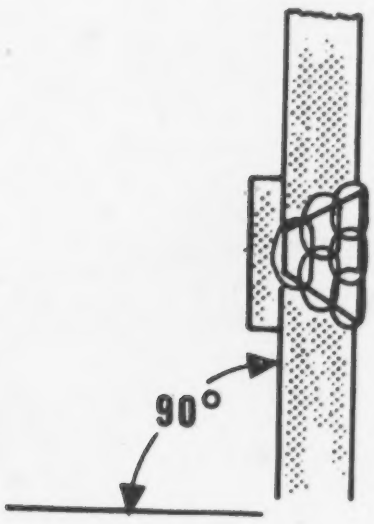

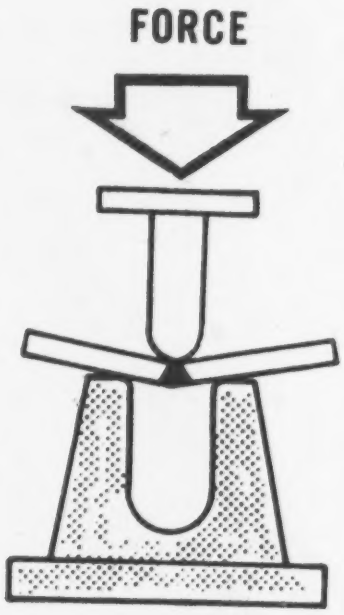

SINGLE PASS FILLET WELD

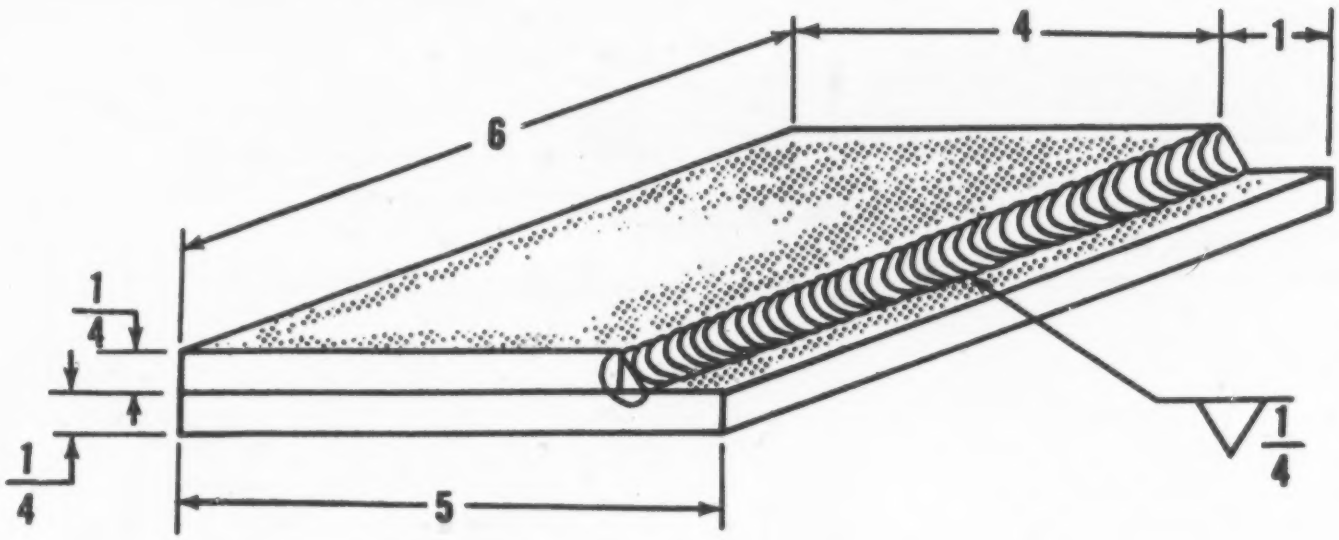

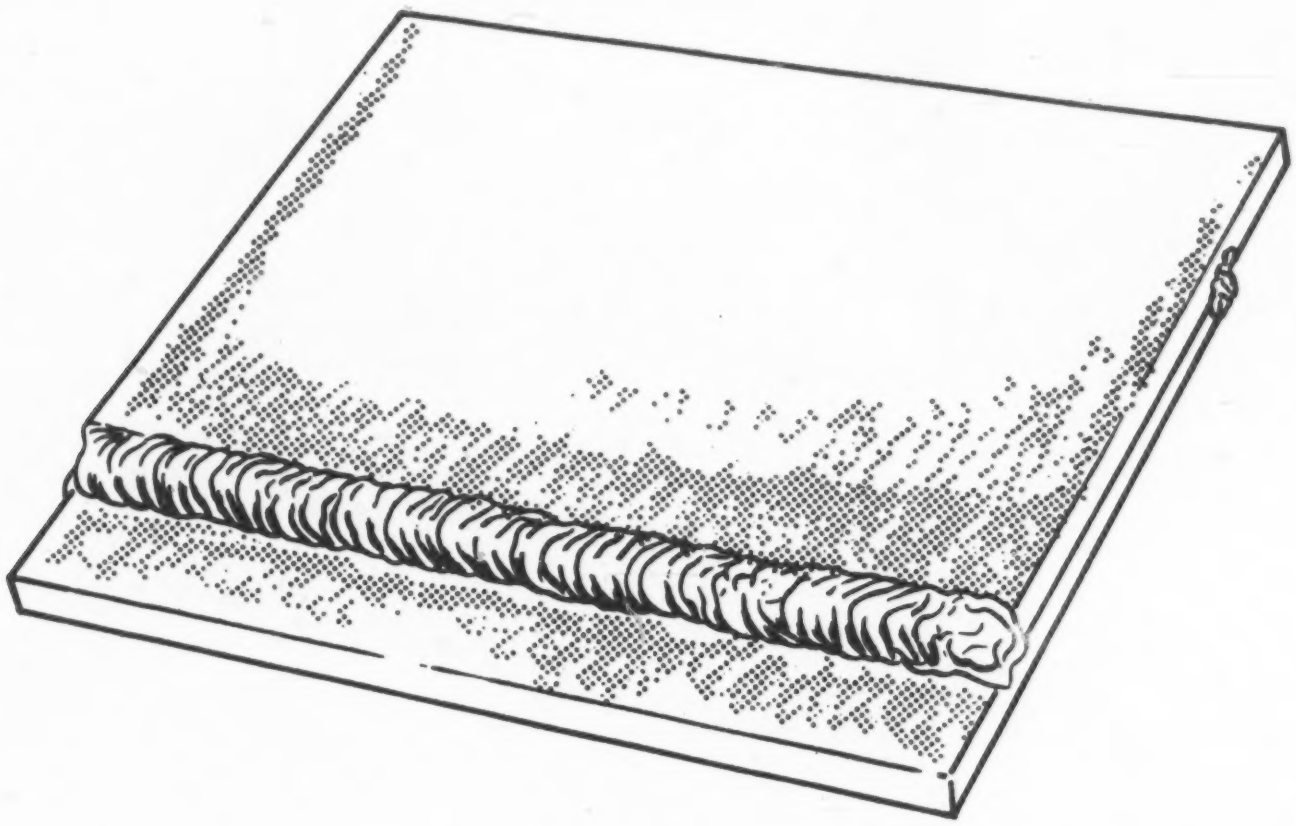

MULTIPLE PASS FILLET WELD

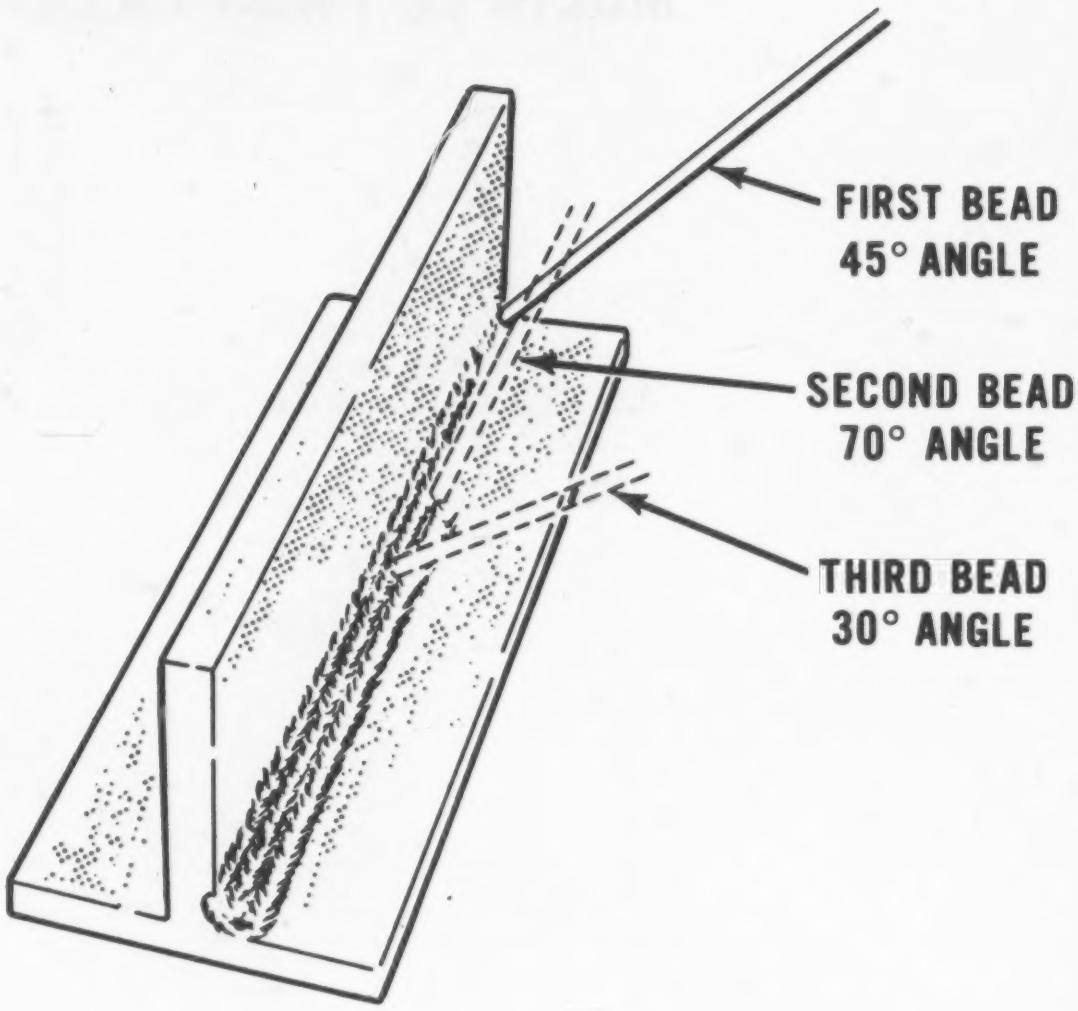

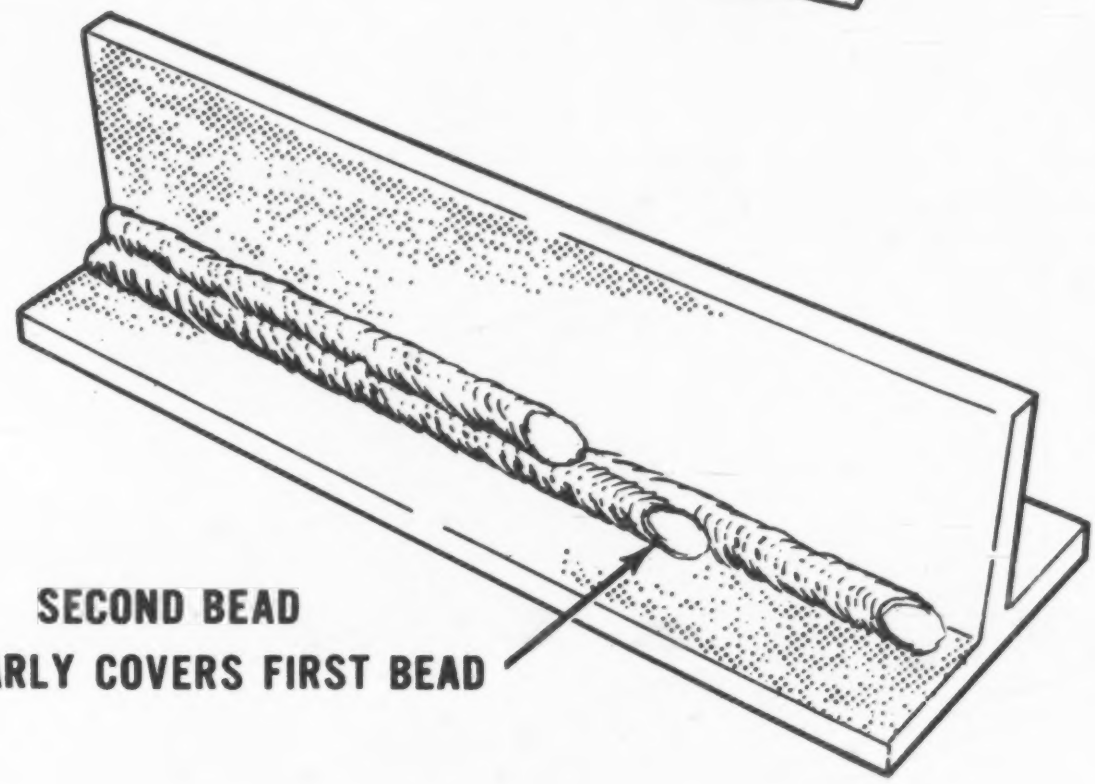

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MULTIPLE PASS FILLET WELD

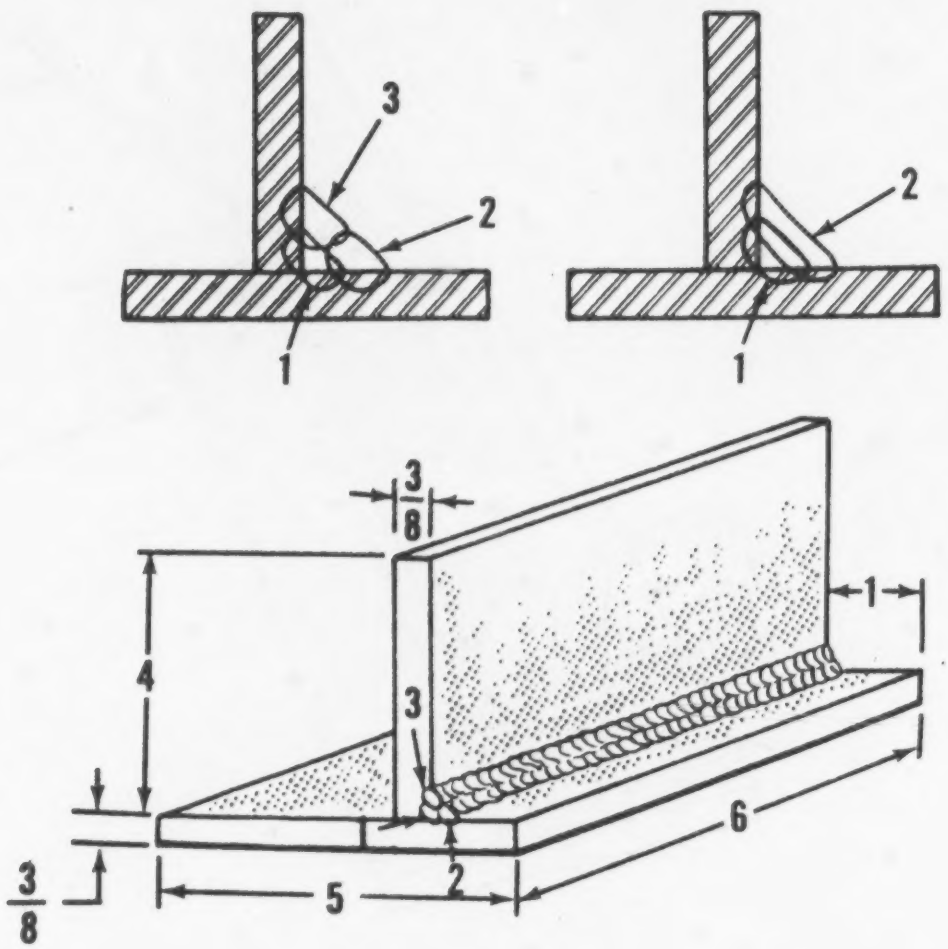

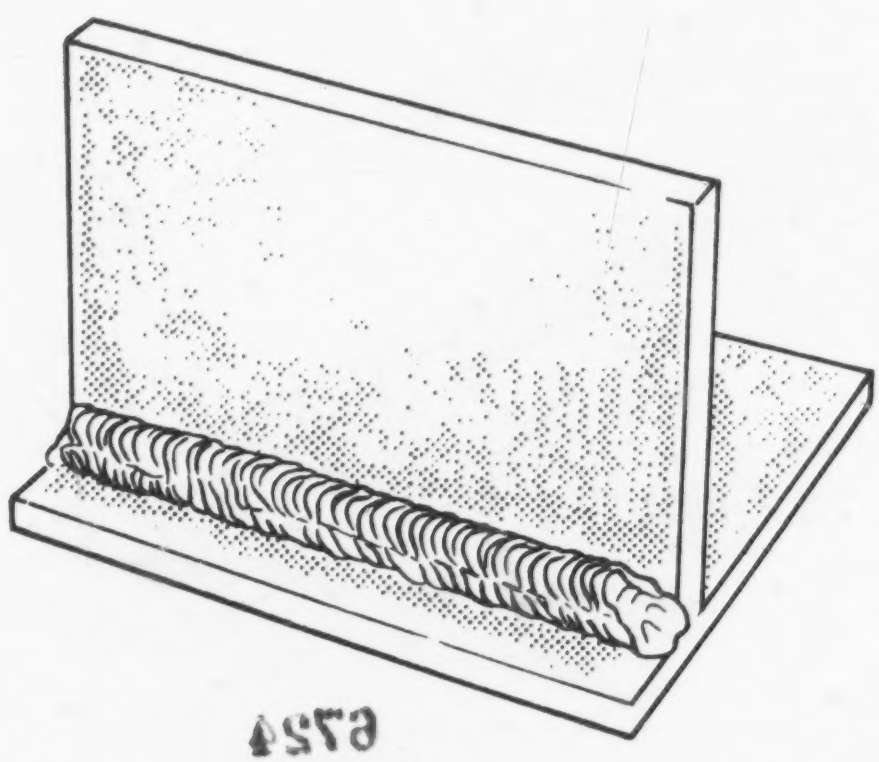

ROLL PIPE WELDING

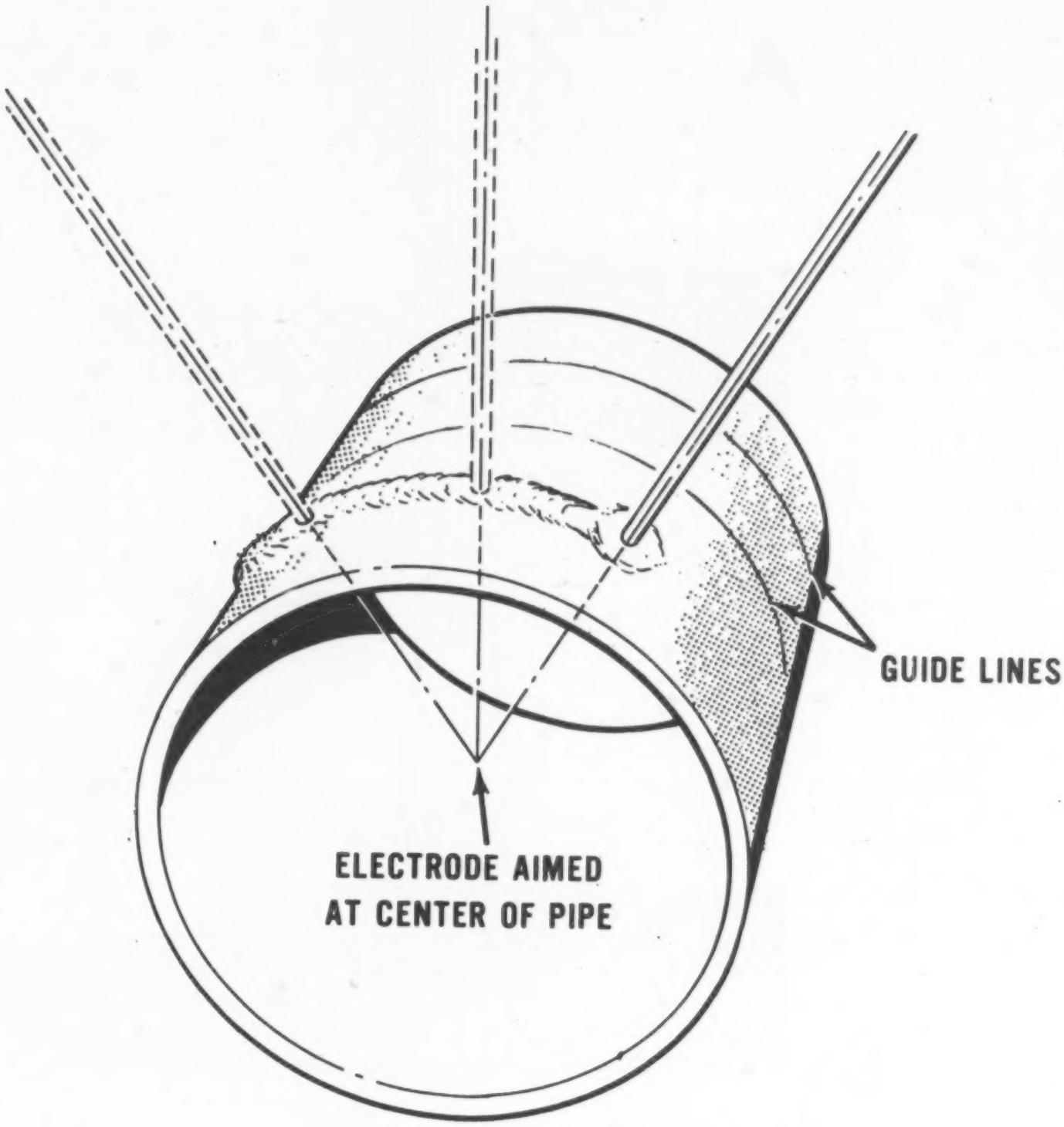

ELECTRODE TYPES

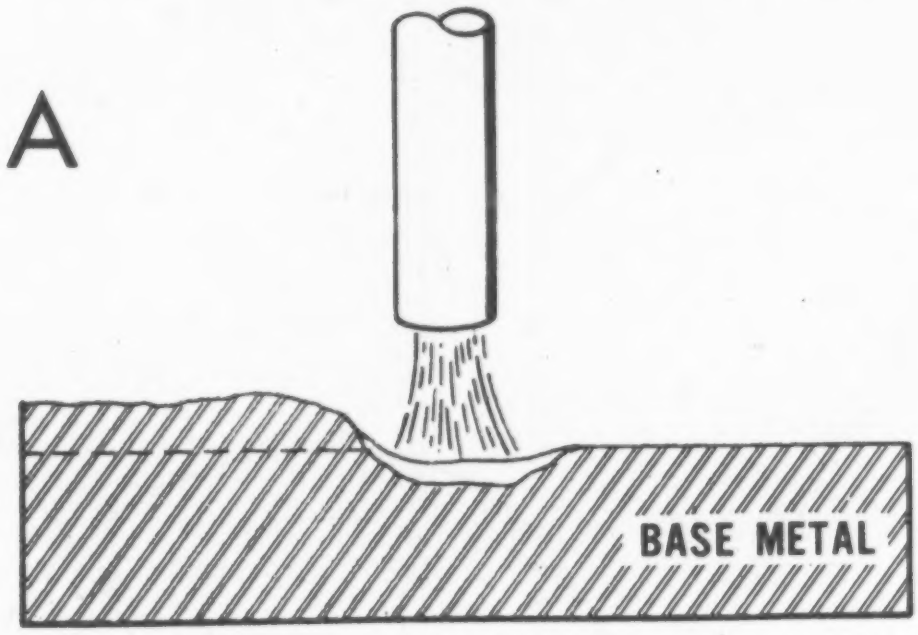

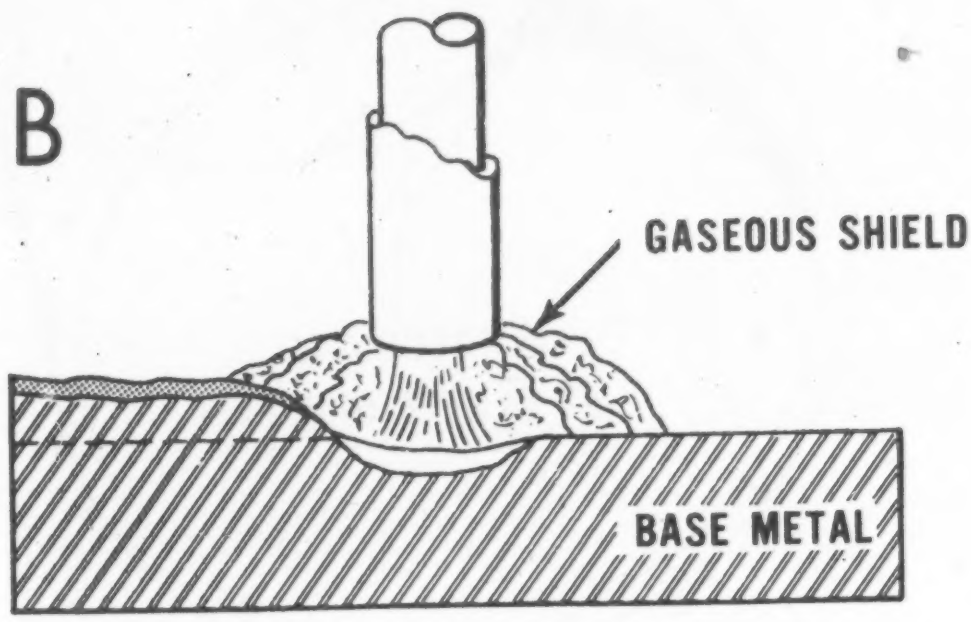

A- BARE ROD (UNSHIELDED ARC) B- COATED ROD (SHIELDED ARC)

TESTING A WELD

A

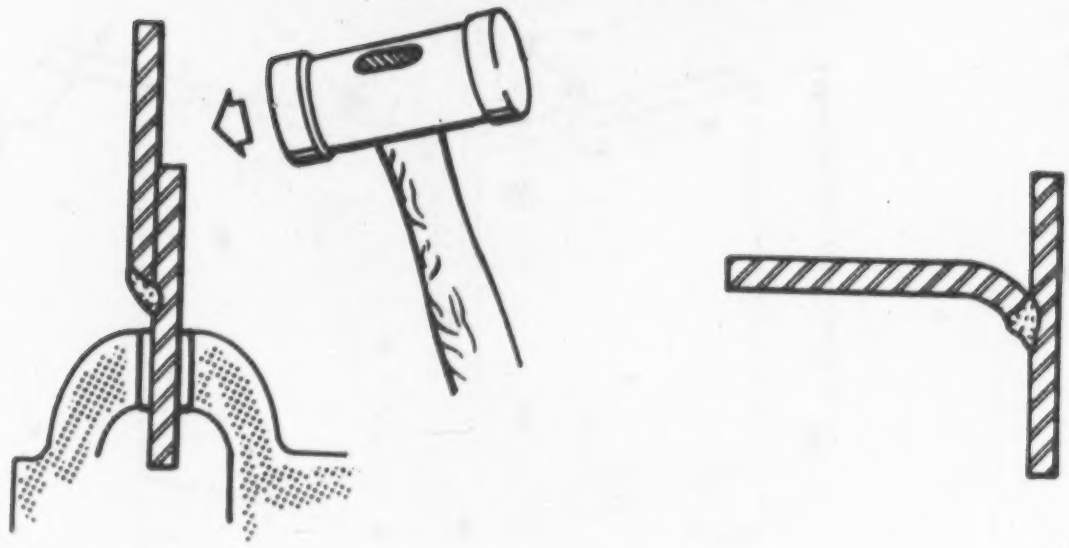

B

C

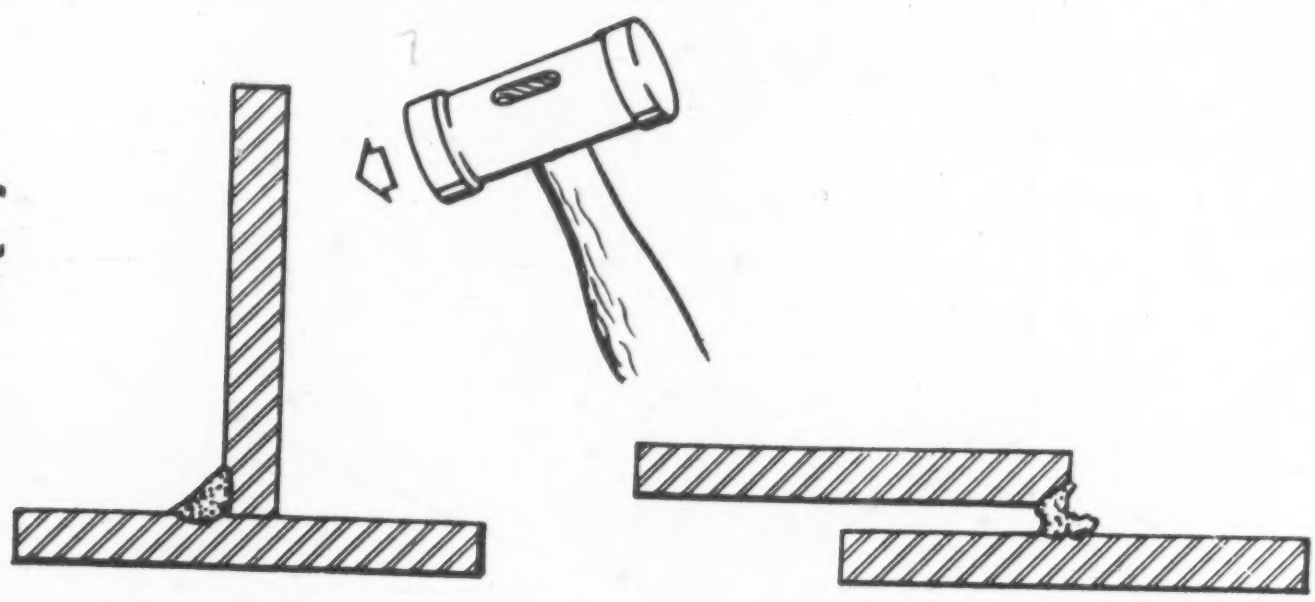

A- LAP WELD

B- STRINGER BEADS

C- FILLET WELD

6728

SINGLE VEE GROOVE WELD

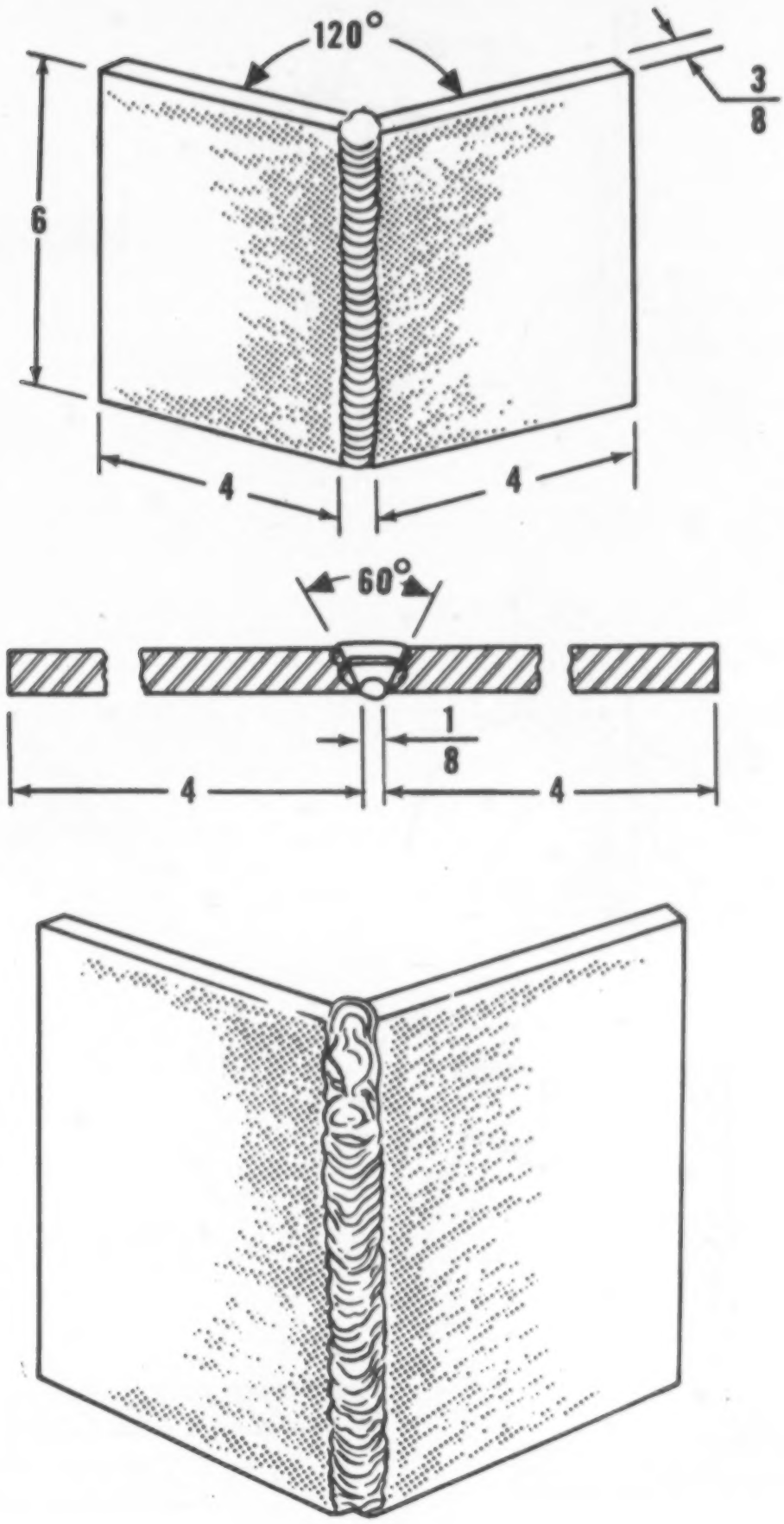

MULTIPLE PASS VERTICAL FILLET WELD

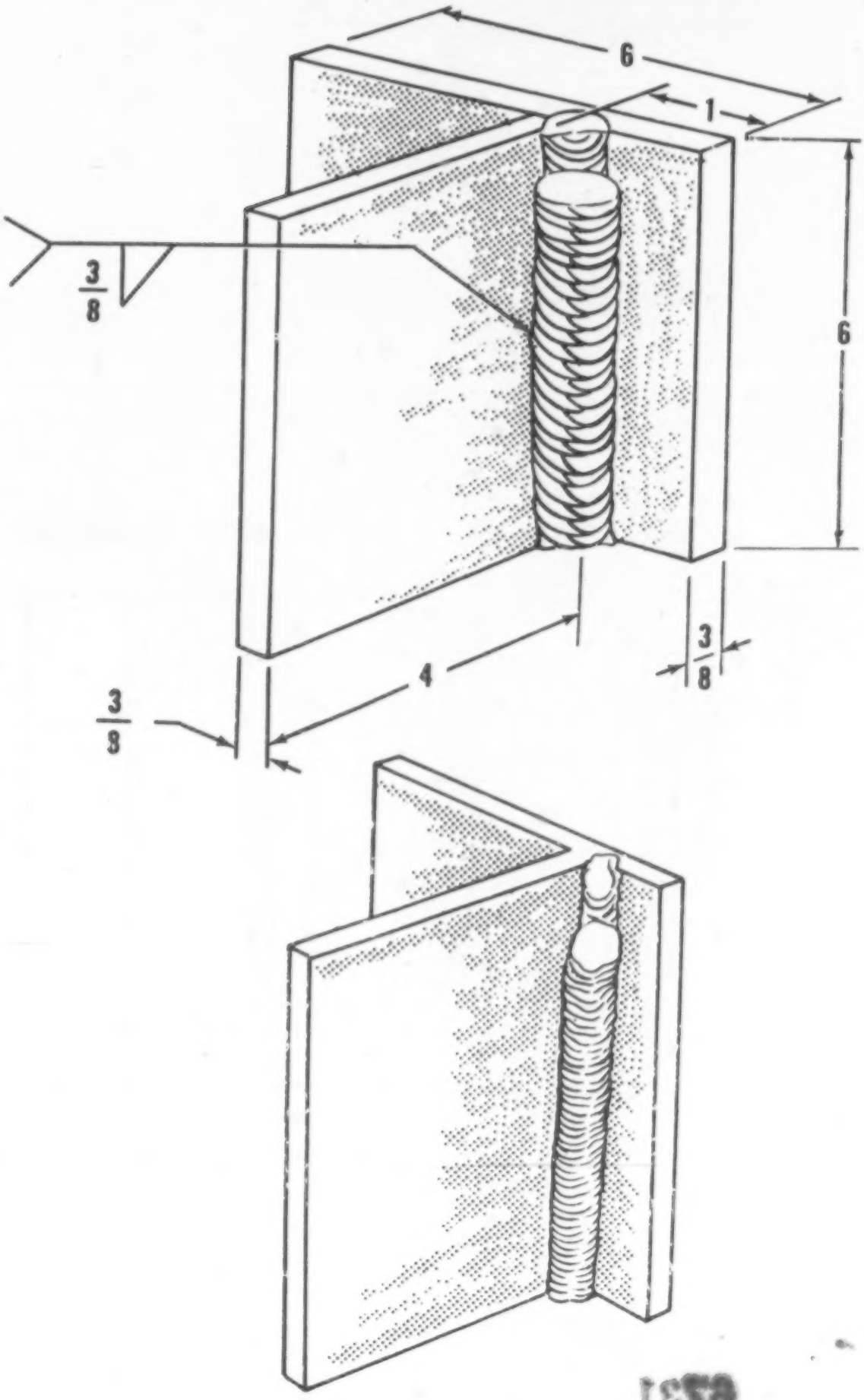

OVERHEAD WELDING

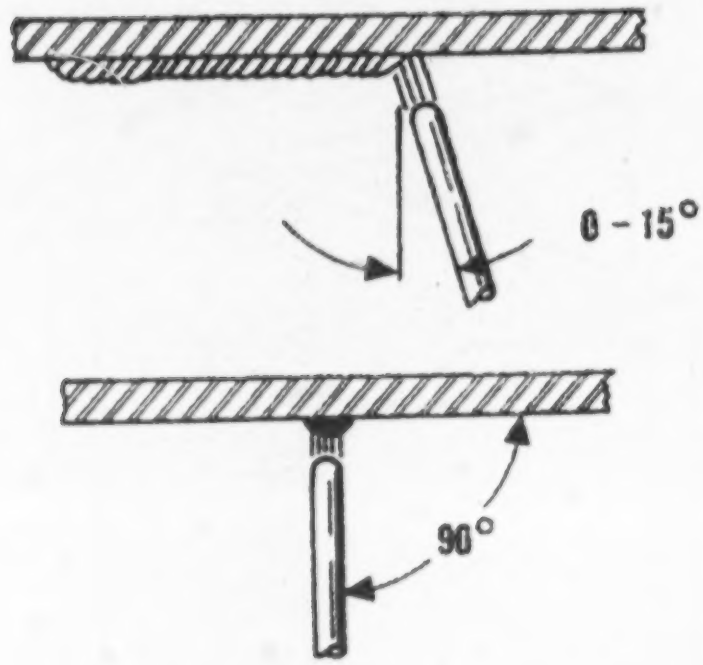

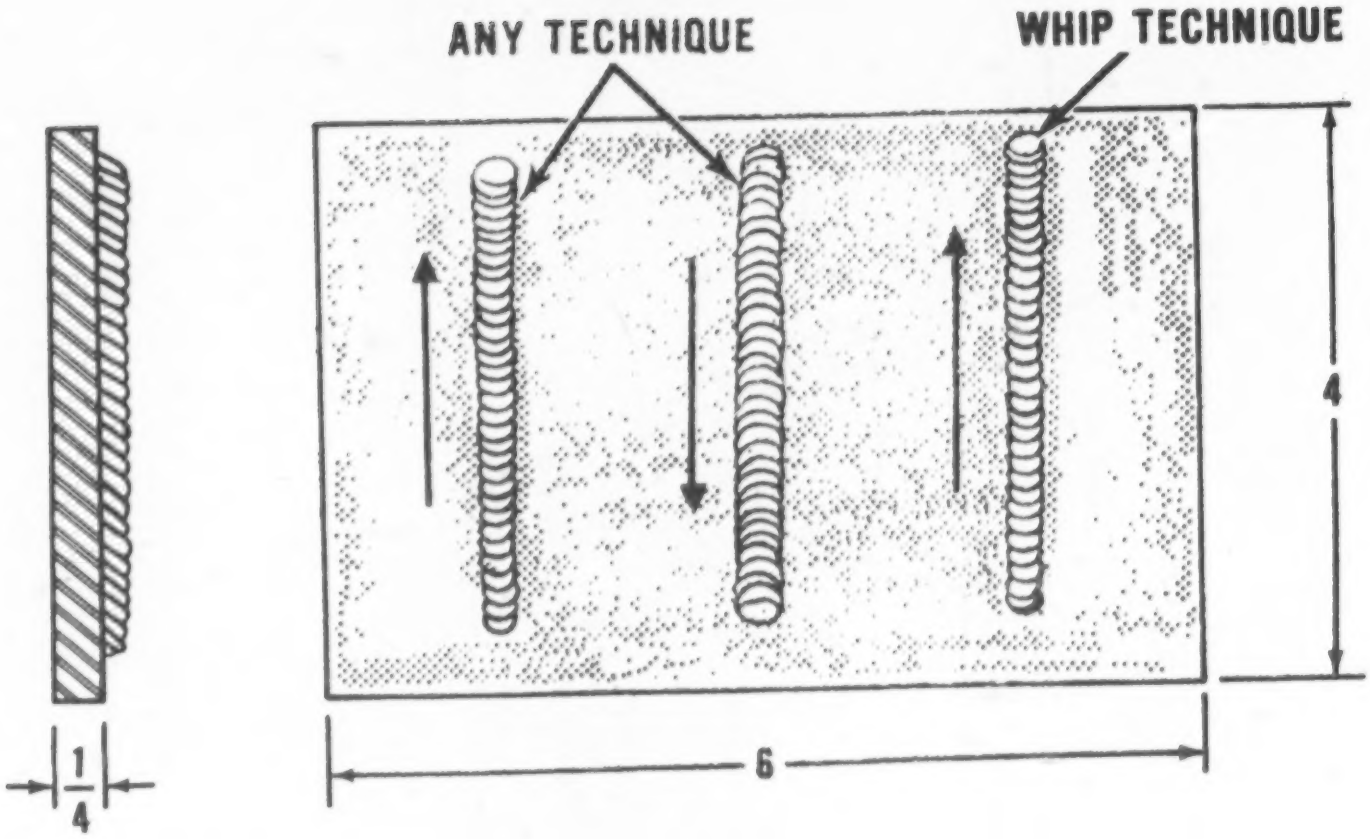

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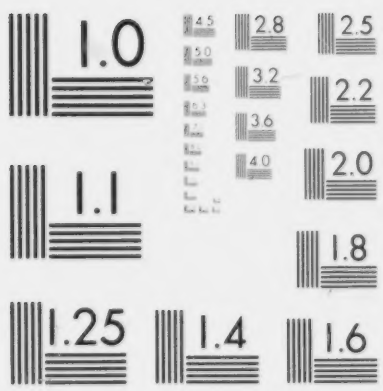

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OUTSIDE CORNER WELD

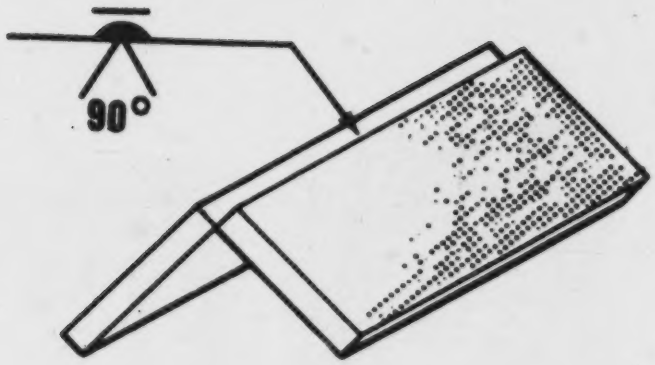

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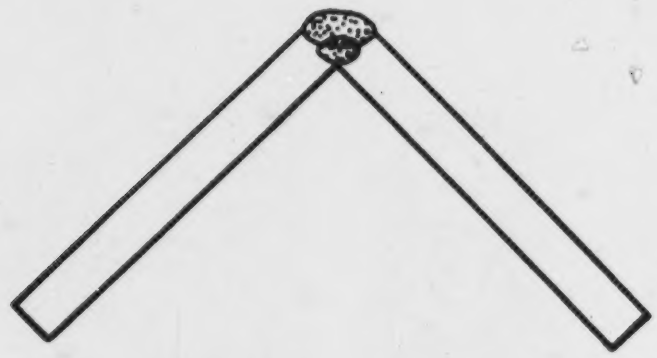

SIGNIFICANCE

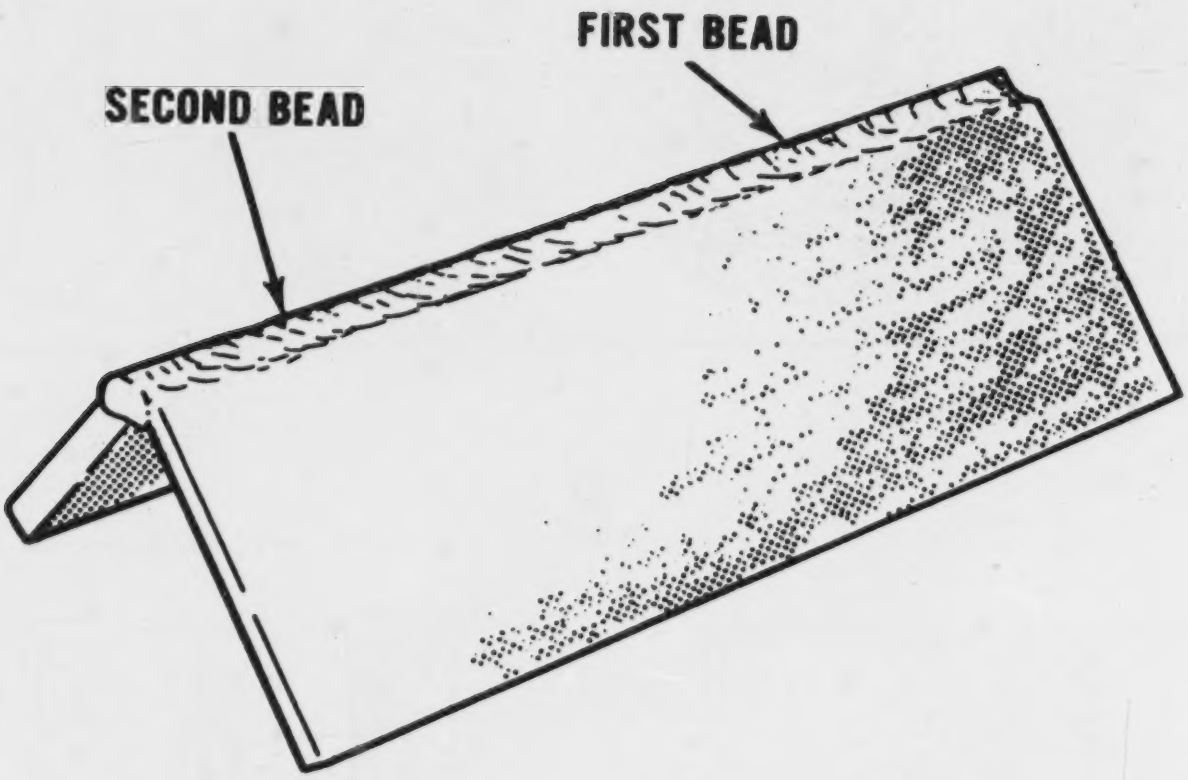

6732

VERTICAL WELDING

A

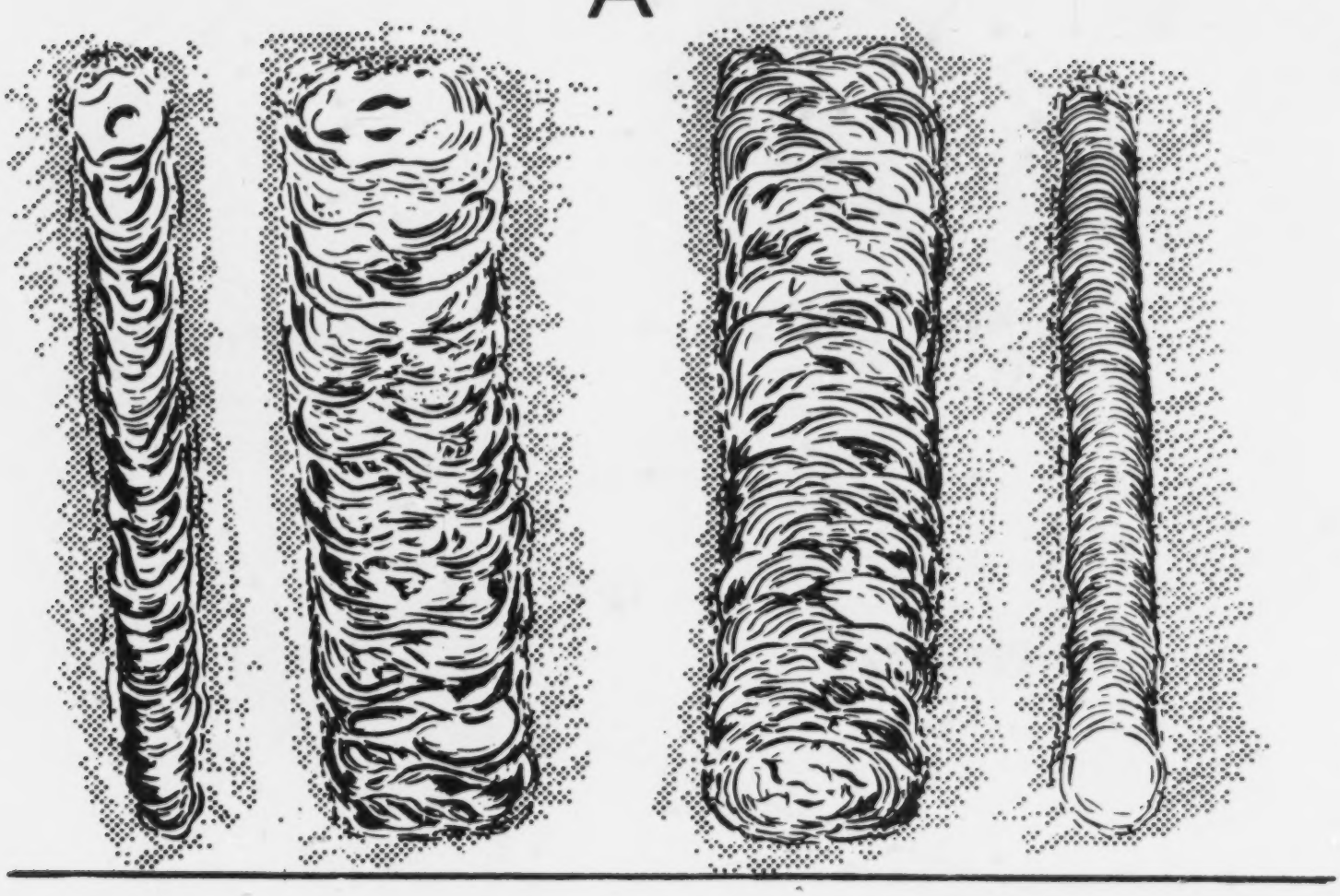

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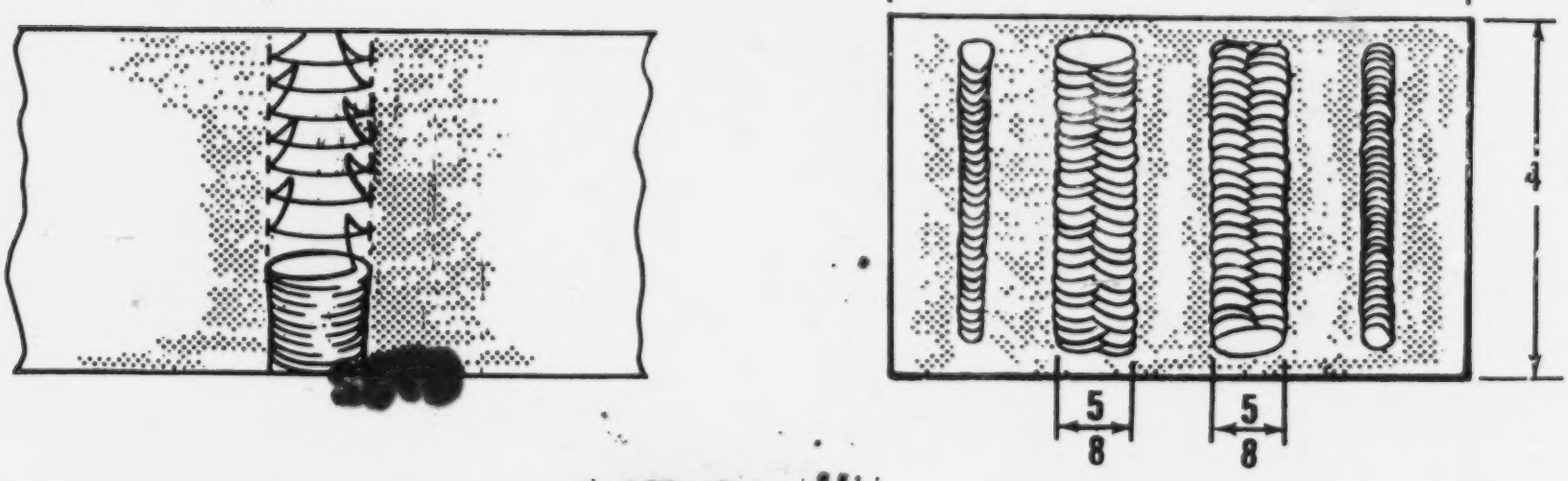

A- DEPOSITING BEADS

B- THE WEAVE

WEAVE LAP WELD

A

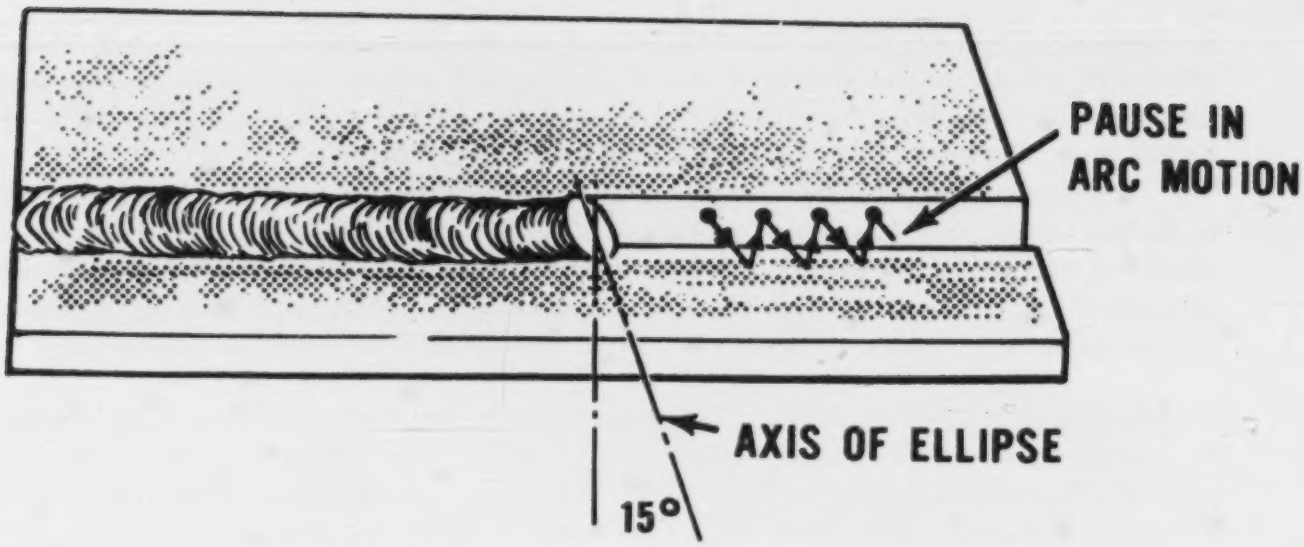

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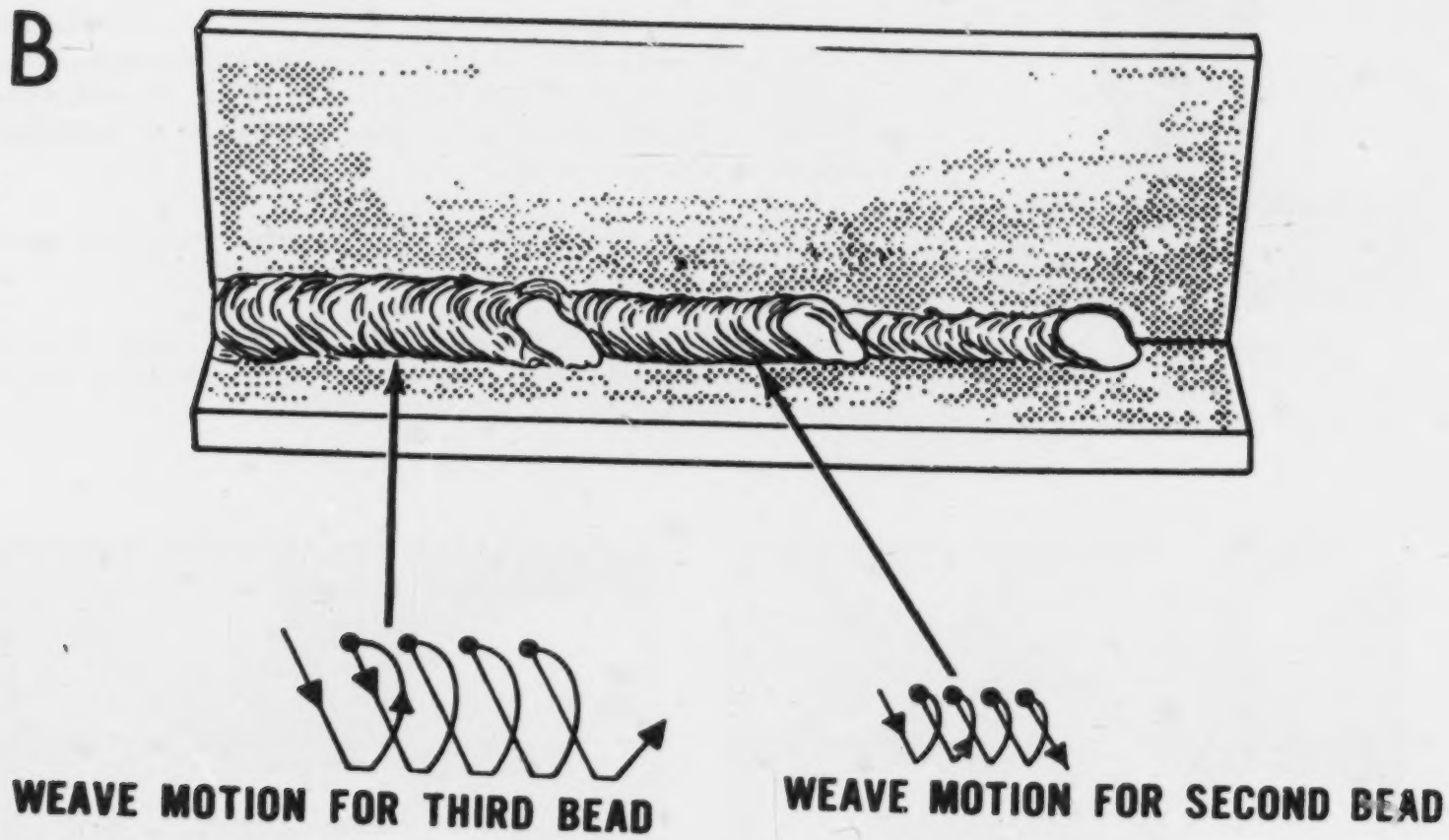

HOW TO WELD PIPE

1. PREPARATION OF WORK. To secure sound, non-porous welds with round stock, the areas to be welded should be as clean as possible, free of rust, grease, scales, zinc oxide or other foreign substances. Used pipe often has impurities. E6011 type electrodes will do a good job of welding, even if pipe is moderately rusty, but it may be better to clean weld area by grinding.

The zinc coating on galvanized pipe must burn off as the bead progresses in order to deposit the weld in the base metal. Multiple-pass beads burn off more of the zinc coating and the weld has less porosity and somewhat more strength than when a single bead is used. Use E6011, deep penetrating electrodes to weld galvanized pipe joints. This type electrode burns off zinc coating and floats out impurities. Always weld galvanized material outside or in well ventilated area. Fumes produced are poisonous.

2. PROPER ELECTRODE ANGLE. The angle of the electrode to the pieces of pipe being welded is highly important to successful joint welding. When welding pipe joints, you use all the basic fundamentals practiced in position welding -- flat, vertical, horizontal and overhead. When pipe is of equal thickness, the arc is directed so that equal parts of the two sections being joined are heating alike, bisecting the angles of the joint equally. (Figure A)

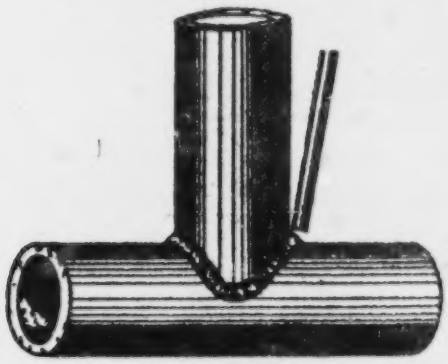

When welding pipe of unequal thickness, position the electrode so that the greatest portion of heat is on the heavier area. Thus, the two sections are heated to approximately the same temperature and the deposited metal is fused into both pieces. If this compensation is not allowed, burn-through results in the thin section of the pipe, and there is not sufficient penetration in the heavier section.

FIGURE A. Position electrode so that the arc is concentrated on the heavy section.

3. LAYING OUT ELL ANGLE JOINTS. A simple way to lay out an angle joint calls for a bucket of water and a T-bevel square, as in Figure B. The pipe is placed in position where it is to be used and the T-bevel square is adjusted to the desired angle.

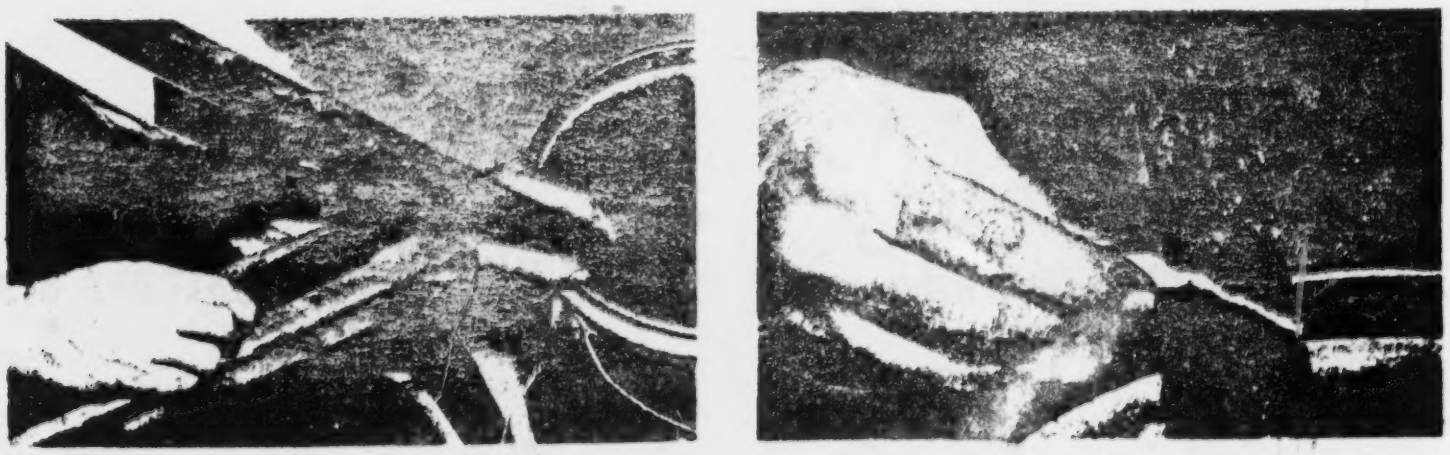

FIGURE B. A T-bevel square and a pail of water aid in marking pipe to fit angle joint.

After securing the angle, place the pipe on the edge of the water container and adjust to fit the angle on the T-bevel square. A saw horse helps to hold the square in place. When the pipe is aligned, move it down along the edge of the container into the water to the point where the cut is to be made. Be careful to maintain the same angle at all times. Then remove the pipe and mark along the water line. The edge of the cut can be trued or dressed in the grind[illegible]e joint fits snugly. It may be necessary to bevel the joint to secure penetration of the weld.

6735

4. QUICK TEE JOINT. A quick way to prepare the end of a piece of pipe for making a Tee joint with another is to flatten the end. (Figure C)

FIGURE C. Flattening end of pipe is quick way to prepare joint for tee weld.

The shaping usually is done while the pipe is cold. However, if the pipe is too thick for this, heat it with the carbon arc torch. Flatten only enough to allow the weld joint to be made. Excessive flattening weakens the pipe.

5. WELDING THE JOINT. After the joint has been properly fitted, it is ready for welding. Remember to bevel the joint if metal thickness exceeds 1/8 inch. It is desirable to grind or polish the joint if the pipe is coated with zinc or is excessively greasy, dirty or rusty. Tackweld the joint in place. Figure D shows suggested points where tack welds can be made.

Remember that when the tack weld cools, metal pulls together toward the joint where the tack was made. So keep it held rigidly in place. Place the tack welds opposite each other to counteract the stresses. Make the tack welds in rapid succession, before the contraction begins.

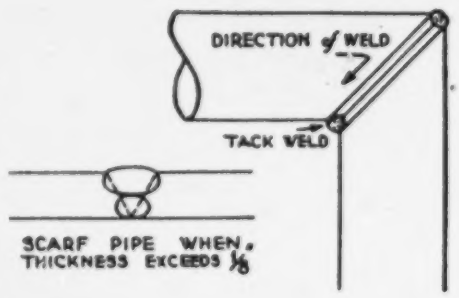

FIGURE D. Ell joint weld.

6. STRAIGHTENING PIPE. Welding joints in pipe sets up heat around the weld, causing the metal to upset in this area. The contraction results in a convex shape on the side opposite the welded joint. The pipe can be straightened by heating spots on the convex side with the carbon arc. Spots the size of a half dollar are heated to a bright cherry red and then cooled immediately by pouring on water. One spot is heated at a time until the pipe has pulled back into position.

7. COLD BENDING PIPE. Small-diameter pipe, such as 3/8, 1/2, 3/4 and one-inch, can be shaped by bending cold. Place the pipe between two fixed points and apply pressure as shown in Figure E. A frame on a piece of farm machinery or a partially opened vice will serve this purpose. Note in the diagram that as soon as each section of pipe is bent, it is advanced out of the bending zone. The section used for leverage is always kept straight. The pipe can be filled with sand to prevent flattening.

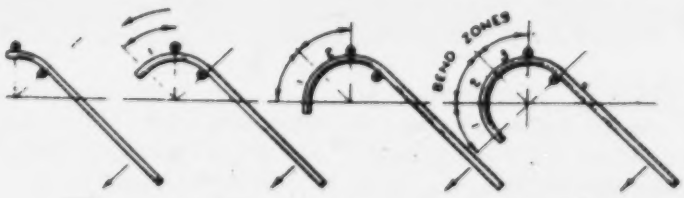

FIGURE E. Steps for cold-bending p

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HARDSURFACING

Hard-surfacing or hard-facing is the application of a wear-resistant layer of metal to the surface or edge of a part to increase its life.

PREPARATION

Use grinder to remove rust and scale and brighten the surface.
Select an electrode of the impact and abrasive work-hardening type, such as Lincoln's Abrasoweld.
Use amperage range lower than for mild steel electrode.

Arc electrode	Ampere range
1/8"	75-110
5/32"	75-200
3/16"	110-270

APPLICATION

Apply in thin, even layers having only shallow penetration into the base metal. Use a weaving bead not wider than 3/4" to 1". Brush all slag from the surface before laying additional beads.

The electrode must be manipulated carefully to secure penetration into adjoining beads. Hesitate a moment with the tip of the electrode when at the edge of a bead. This allows heat to be built up in the the adjoining area and reduces undercutting.

Cold or chilled machine parts must be preheated to room temperature before they are hard-faced. Otherwise the high carbon content of the part may cause cracking or checking.

Worn tools requiring a thick edge are reshaped by forging to desired thickness and the edge then polished by grinding. Replaceable points and edges for worn tools are available for some farm equipment, such as plowshares, cultivator shovels and planter shovels. The old point or edge is cut off and the replaceable point welded on, using a mild steel electrode. The new edge of the tool can then be hard-faced.

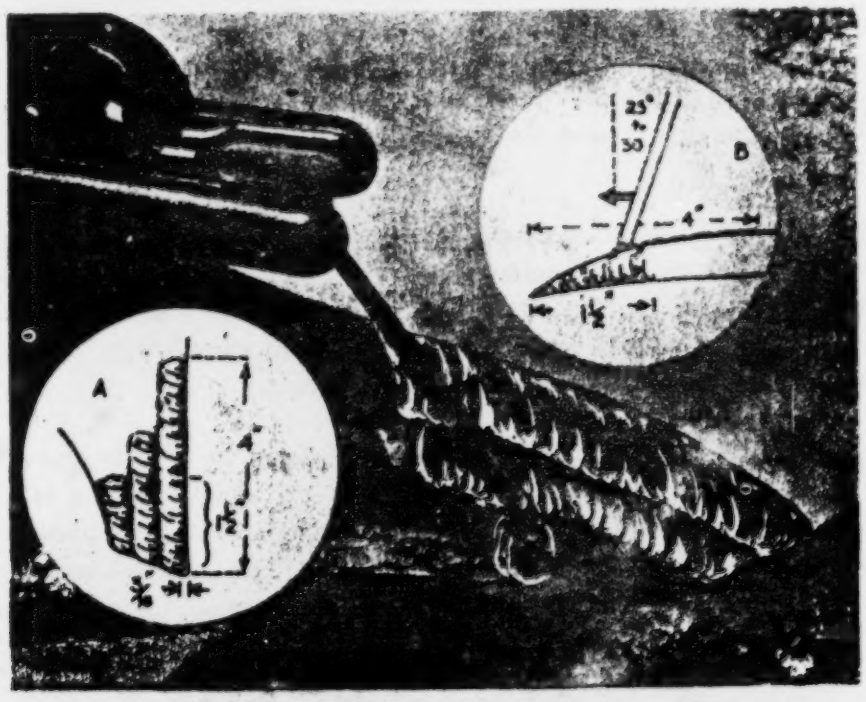

FIGURE F. *Plowshare points. Lay three beads approximately 1" wide on the top surface, using a weaving pass with 1/8" or 5/32" electrode and welder amperage setting 75-100 for 1/8" or 130-140 for 5/32". The beads are run from the heavy portion towards the point, parallel to the land side, with the electrode pointing towards the plowshare point, and tipped [illegible] to 30 degree angle so that the point of the electrode is dire[illegible] the top of the share point. See sections A and B.*

BUILDING UP WORN PARTS

PREPARATION

Buff or grind rust from surface. Select 1/8" or 5/32" electrode. For steel parts, use an iron-powder, build-up type electrode, which makes a deposit 25 to 50 per cent more abrasive resistant than conventional mild steel electrodes. If not available, use regular E6013 mild steel electrodes. For cast iron parts, use non-machinable type, steel electrodes for welding cast iron.

Amperage setting. For steel, select amperage in range 110 to 130. Use trial setting of 120. For cast iron, choose range 75-110 for 1/8" electrode; 90-135 for 5/32" electrode. Use trial setting of 100 for former, 110 for latter.

PADDING WORN SHAFTS

To prevent distortion, vary bead sequence as shown at left in Figure G. Lay the beads parallel to the longest dimensions of the weld, as shown at right in the illustration. Note that a bead is run around the shaft at the point where the beads will end. This allows the hole left by the crater to end in this bead.

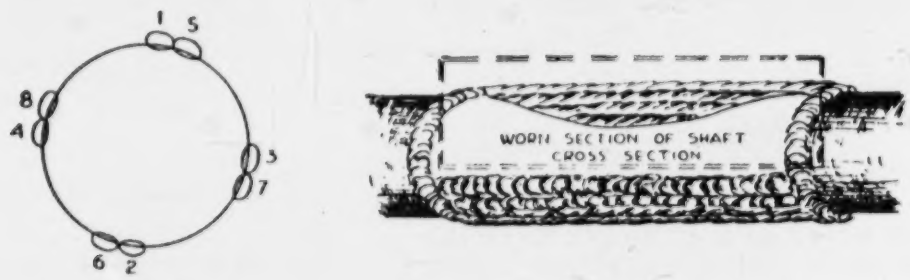

FIGURE G. *Sequence followed in building up worn shaft.*

PADDING FLAT SURFACE

First layer. Run straight stringer bead along edge of metal. Chip slag from bead. Lay additional beads parallel to each other. Make certain fusion is obtained in base metal and edge of previously run bead. Make sure each bead is same height as previous bead. Clean surface thoroughly after each pass.

Succeeding layers. Run them at right angles to the first layer.

FIGURE H. *Worn surface on the landside of a plow is built up by padding.*

BUILDING UP HOLES

Carbons shaped to fit the original opening are placed in the hole and the metal deposited in the worn area until the carbon is reached. If a precision hole is needed, fill in the worn area completely and drill a new hole. For gear teeth, use carbons shaped to fill space between teeth and build up broken tooth.

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11. CUTTING WITH THE ARC

When making, fitting, and repairing articles in the shop, it is often necessary to cut bolts, pipe, bars, plate or angles, or to pierce holes. Light and heavy material may be cut with the arc welder, using a mild-steel electrode. Cutting with the arc welder uses the intense heat generated by the electric arc to melt the metal. The force of the arc then pushes this molten metal away. Steel, cast iron, and non-ferrous metals can be cut with the electric arc. Avoid fumes from brass, bronze, galvanized metals, lead, and paint. The excess heat of cutting produces more fumes than welding, so cut only in a well-ventilated place.

1. Remove flammable materials from area. Excessive amperage forces sparks great distances.
2. Put 1/8" shielded electrode in the electrode holder. (E6011)
3. Set amperage at 160 to 180.
4. Position the plate so it projects over the edge of the table with a container of sand underneath to catch the molten metal. Keep cables clear of hot metal.
5. Strike the arc at the edge of the plate.
6. Hold a long arc until a large puddle is melted at the edge.
7. Move the electrode down to shorten the arc and force the molten puddle from the plate. Clear the bottom of the plate with each pass to keep "icicles" from forming on the bottom. Continue to move upward carrying a long arc and downward with a short arc as you move across the plate (Fig. J).

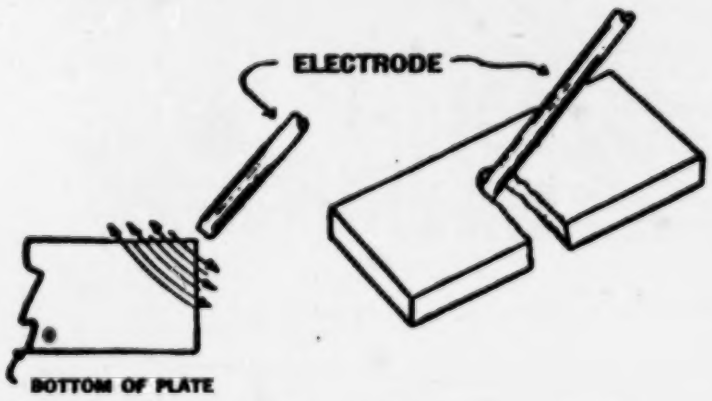

Fig. J. Metal can be quickly cut with an electrode.

Holes may be pierced in plate, 3/8" or less, by striking the arc and holding it in one spot until a large crater is formed. Feed the electrode downward and force it through the plate as the metal becomes molten (Fig. I). Holes in heavier material may pierce easier if the plate is laid on edge so that molten metal can run out.

Cutting and piercing heavier metals may be done more rapidly with a 5/32" or 3/16" electrode if the welder is larger than 180 amp capacity.

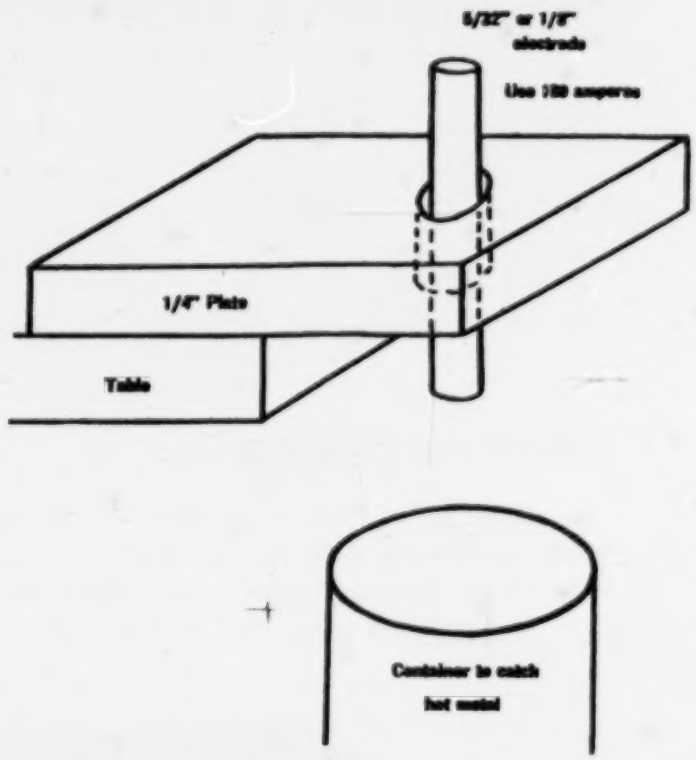

Fig. I. An electrode can be used to pierce holes in metal.

A single carbon may be used for cutting with a DC welder, operating on straight polarity. Sharpen the carbon in a long taper, down to half its diameter on the end. Grip it close to the cutting end to avoid overheating. Use the same electrode movement as in cutting with the metallic arc, but come in at the bottom of the metal at an angle to melt the metal out. The carbon arc does not have as much force to push the metal out as the metallic electrode.

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PREPARATION FOR WELDING

TORCH CONNECTIONS

One arc torch lead has a straight ferrule at the end for insertion into the jaws of the regular electrode holder. The other arc torch lead has a spring clip for connection to the welding machine ground lead.

In using the torch, the distance that the carbons are held away from the work controls the amount of heat going into the work. Raising the carbons will decrease this amount of heat.

TORCH ADJUSTMENTS

The copper jaws are grooved and will hold 1/4", 5/16" or 3/8" diameter carbons. Use only Lincoln cored AC carbons with copper coating to avoid excessive heat in the holder and to promote even burning of the carbons. The carbons should extend 2-2 1/2" beyond the copper jaws. Adjust the arc length (distance between carbons) as often as necessary to keep the arc going smoothly and to concentrate the flame in a small cone. There is just enough play in the gear train to automatically give the proper flame by bringing the carbons together, then reversing the thumb control 1/8 of an inch to take up the play between the gear teeth.

As the carbons burn away, this same thumb control can be moved to shorten the arc, thus using up the play in the oposite direction. The proper use of this play in the gears keeps the arc length just right and helps the operator to make adjustments quickly.

CAUTIONS

The carbon arc torch rays will cause severe sunburn on the face and arms if they are exposed. Of necessity, a good weldor's headshield is recommended rather than a handshield since the operator will need both hands free to manipulate both the arc and the filler rod. A pair of light gloves, sleevelets and an apron should be used to protect from the rays of the arc. Use an arc welding headshield or handshield with a No. 11 or 12 lens. Oxyacetylene goggles do not provide adequate protection.

When adjusting length of carbons, be sure welder is turned off or that carbons do not touch, because of the danger of electric flash and consequent burning of hands and eyes.

When laying the torch down, lay it on the side with the leads hanging down over the bench so that the handle will rest on the bench top and avoid the carbon shorting to the grounded bench, or lay it on an insulated surface if available. Better yet, switch the machine "off" when not actually using the arc torch.

Be careful to avoid exceeding the output duty cycle of your welder. Most 180 - 225 amp welders have a 20% duty cycle rating, which means they can be operated 2 minutes out of 10. Exceeding this duty cycle, which is easy to do with an arc torch, may damage the welder.

CONNECTIONS AND ARC TORCH POSITION

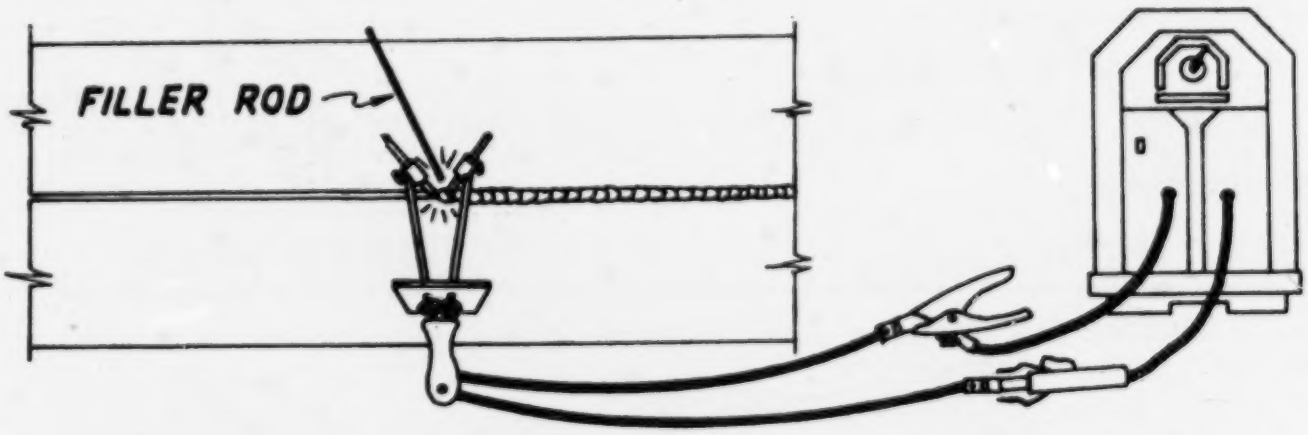

Fig. K This connection of the carbon arc torch permits the arc to operate between the two carbons with the heat on the work controlled by the height of the arc above the work surface.

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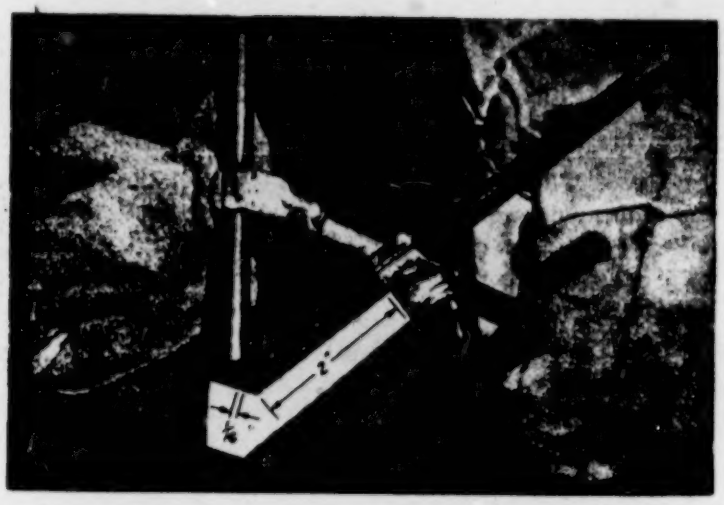

Fig. L - The gap between the carbons should be adjusted as shown above.

Recommended Currents and Carbons

Thickness of Base Metal	Approximate Current Setting	Carbon Diameter
1/16"	50-60 amps	1/4"
1/8"	70-80 amps	5/16"
1/4"	90-100 amps	3/8"
over 1/4"	110-125 amps	3/8"

Fig. M - Use these currents and carbon sizes for any arc torch application.

WORK PREPARATION

Below are pictured some suggested edge preparations and types of joints for different thicknesses of base metal. All welds are to be made in the horizontal downhand position. This may require rotating round parts.

JOINTS

THINNER THAN 1/16"
(Use clamps or many small tack welds, before welding continuous be[illegible])

EDGE WELD

BUTT WELD WITH IRON OR STEEL BACKING

1/16" - 3/16"

BUTT WELD

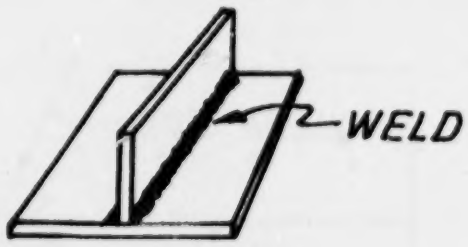

FILLET WELD

OVER 3/16" (edges must be beveled to assure proper strength)

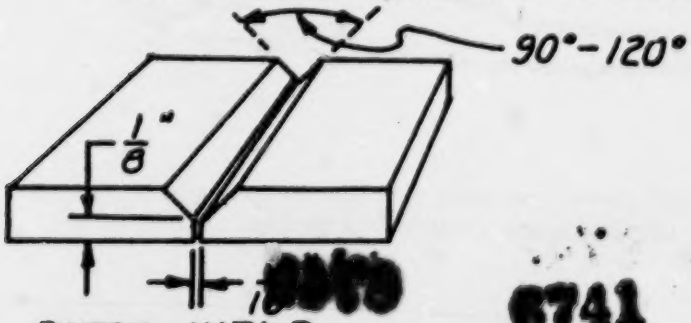

BUTT WELD

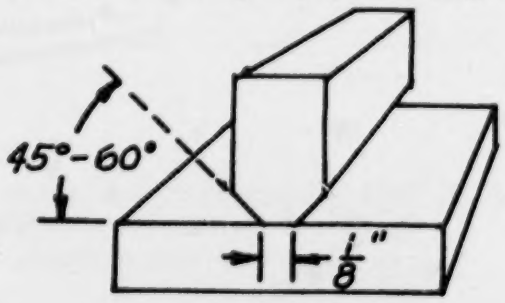

FILLET WELD

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Types of welds, welding cast iron, welding pipe, hardsurfacing, use of the carbon arc torch.

1. Name the common welding joints.

2. How can a weld be tested for strength?

3. Name two electrodes recommended for welding cast iron.

4. Explain how to control the heat while welding cast iron.

5. How can cast iron be preheated?

6. Where can the recommended amperage setting and electrode size for welding cast iron be found?

7. What size electrode should be used to pierce holes with the electric arc welder?

8. What should the amperage setting be to pierce holes?

9. Explain the procedure for cutting metal with the electric arc welder.

10. Describe how to pierce holes with a cutting electrode.

11. Why is it very important to weld pipe outside of a building or in a well ventilated place?

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12. Describe how to prepare pipe for welding.

13. What is the proper electrode angle for welding two pieces of pipe that are the same size?

14. What position should the electrode be in when welding two pieces of pipe that are not the same size?

15. Describe a quick way to prepare the end of a piece of pipe for a tee joint.

16. What is meant by "hardsurfacing"?

17. What is the purpose of hardsurfacing?

18. Why must cold machine parts be preheated to room temperature before they are hardsurfaced?

19. Explain how to clean metal for hardsurfacing.

20. How are thin edges hardsurfaced?

21. What are the uses of the carbon arc torch?

22. What determines the size of carbon to be used with the carbon arc torch?

23. Describe how to start an [illegible]h the torch.

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SIMPLE FARM PLUMBING

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INTRODUCTION TO FARM PLUMBING

With some knowledge of the common pipe-fittings, pipe tools and their uses, many simple plumbing jobs can be performed around the home and farm. For the average home -or farm- plumbing installation and maintenance, elaborate plumbing equipment is not necessary.

This exercise is designed to allow the student to learn and practice some of the simple plumbing skills. After the student has performed the skills in this unit, he should be able to maintain the home water system.

Simple Farm Plumbing

1. Identifying plumbing equipment and supplies.
2. Selecting pipe.
3. Identifying pipe fittings and valves.
4. Measuring, cutting, and reaming pipe.
5. Threading and connecting pipe.
6. Flaring copper tubing.
7. Soldering joints on rigid copper.
8. Repairing leaky faucets.
9. Protecting plumbing from freezing.

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PLUMBING EQUIPMENT, FITTINGS, MEASURING, CUTTING, THREADING AND REPAIRING FAUCETS

Material and Equipment

1. Galvanized pipe (1/2", 3/4", 1")
2. Pipe fittings, (couplings, elbows, unions, tees, etc.)
3. Rigid copper tubing and fittings
4. Flexible copper tubing and fittings
5. Solder
6. Joint cement
7. Pipe wrenches
8. Pipe die cutter and reamer
9. Pipe vise
10. Hacksaw
11. Cutting oil
12. Set of flaring tools
13. Blow torch
14. Faucets
15. Waste
16. Soldering flux or paste
17. Cast iron pipe

Exercises for students

1. Identify plumbing equipment and supplies.
2. Select the proper pipe to use (galvanized, rigid or flexible copper).
3. Identify the different pipe fittings and valves.
4. Cut off a piece of pipe with the cutter or hacksaw.
5. Ream the end of the piece of pipe.
6. Thread the piece of pipe on both ends.
7. Cut, thread, and assemble a plumbing project.
8. Flare a piece of felxible copper tubing and place a flange nut on a fitting.
9. Prepare a piece of rigid copper tubing and make a solder connection.
10. Repair a leaky faucet.
11. Wrap a pipe to protect from freezing.
12. Mark and cut a piece of cast iron pipe.

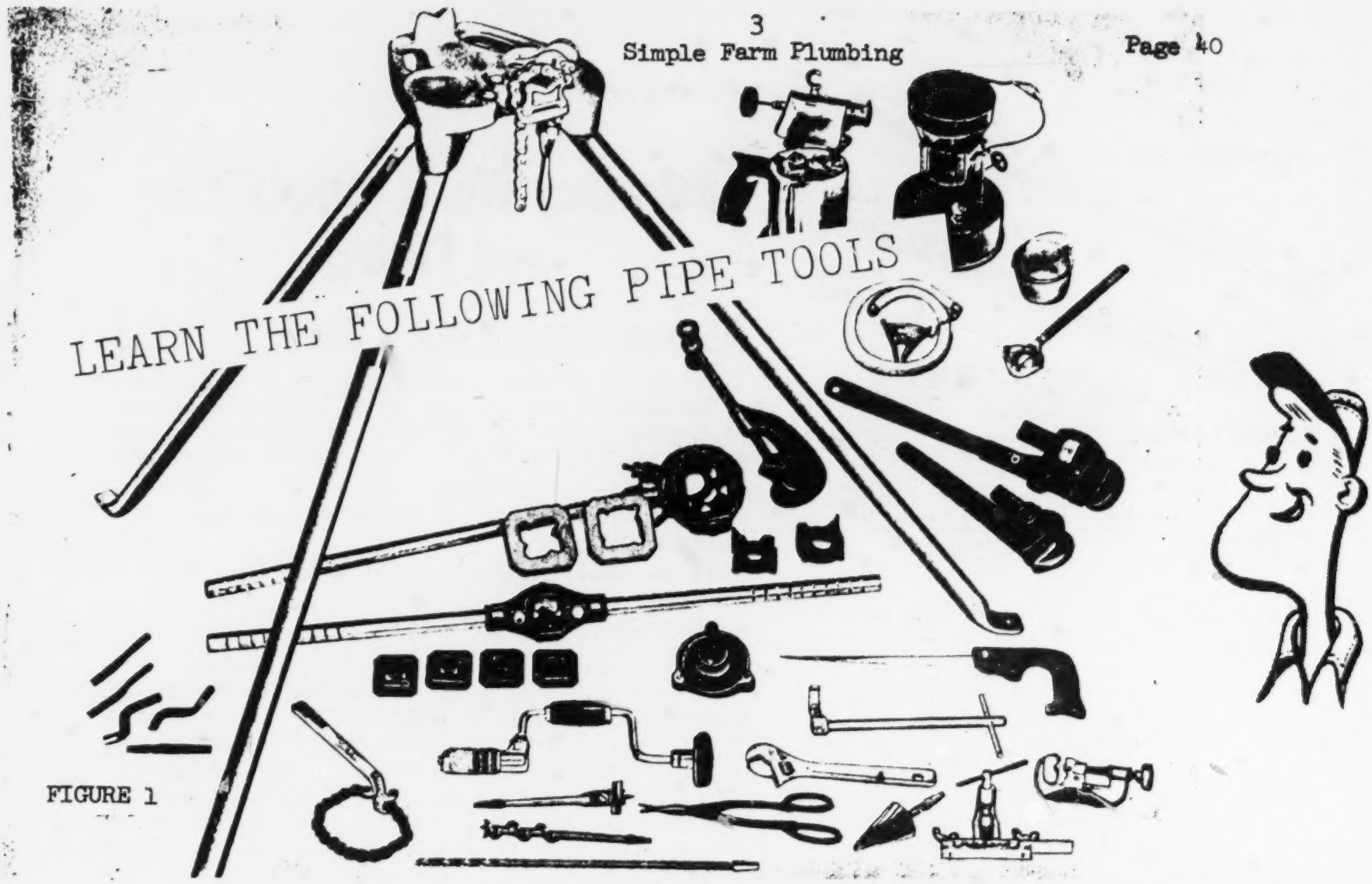

FIGURE 1

You Make the Installation, and Save Money!

A WORD ABOUT WRENCHES

Different wrenches are intended for different purposes — and you can damage the wrench, or the pipe and fittings, by using the wrong wrench or by using a wrench improperly.

Pipe and chain wrenches are intended for turning pipe or other round objects. Do not use these wrenches on nuts, bolts or flanges which have flat gripping surfaces, as they will slip and round off the corners so that the piece cannot be gripped easily. The only exception is that a large pipe wrench may be used on a large nut, etc. (one that is 1-inch or more across).

When using adjustable wrenches of any kind (a pipe or adjustable head wrench) always plan to turn the wrench so that the handle end moves toward (not away from) the open side of the jaws. This makes the wrench tighter; turning the wrong way loosens it and it may slip off. Also, don't twist a wrench sideways — the jaws are made only for turning the wrench round-and-round.

Use two wrenches together, as illustrated below, for loosening or tightening of pipe and fittings. When the wrench at left (in illustration) is in front of the right-hand wrench, the joint is being *loosened.* Putting the right-hand wrench in front of the left-hand one reverses the rotation, and the joint will be *tightened.*

Never use pliers on nuts or bolts.

FIGURE 2

FIGURE 3

FIGURE 4

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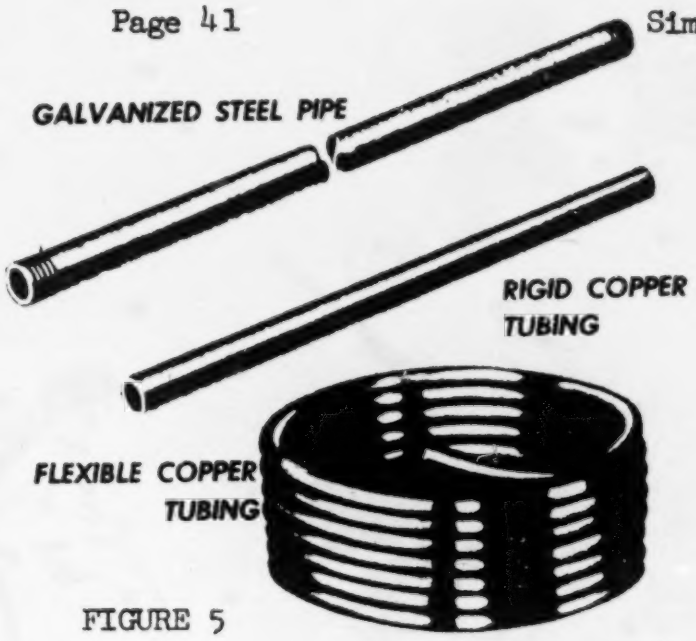

FIGURE 5

Selecting Water Supply Pipe and Fittings

THE THREE TYPES OF WATER PIPE

Three kinds of water supply pipe are in general use: *1*) Galvanized steel pipe; *2*) Rigid copper tubing; and *3*) Flexible copper tubing. Each has certain advantages, such as economy or ease of installation. The galvanized, however, is nearly always used for lines larger than 1-inch diameter. Copper is usually used for lines buried in the earth.

Sizes are always given in internal diameters.

GALVANIZED STEEL PIPE

This is the same pipe that is used for drainage — but ordinary (galvanized malleable) fittings (the kind you receive *if you do not* specifically ask for drainage fittings) are used in assembling it -- and smaller sizes (seldom over 1-inch diameter) are all that are required. The standard 21-foot lengths are threaded at each end — shorter lengths can be ordered threaded if you are able to state exact lengths desired, or you can cut and thread shorter lengths on the job.

Galvanized is the most economical type of pipe to buy — and it will last many years. It also seems easier for the amateur to assemble, as joints are simply screwed together. However, when you have to work in tight places (as between two rafters, or up against the corner of a wall) it is sometimes difficult to swing a wrench — and in such cases, screw-type fittings are more difficult to assemble than the soldered fittings used with copper tubing. Actually, it takes more time to assemble galvanized threaded pipe lines, and more physical effort.

RIGID COPPER TUBING

Rigid copper tubing with solder-type fittings makes the most permanent possible installation — will last the lifetime of any building. It comes in 10-foot lengths, is very easy to cut to size — and, once you learn how easy it is to use solder-type fittings, can be very quickly assembled with a minimum of physical effort.

This tubing comes in two weights: *1*) Standard (Type L) for interior use; and *2*) Heavy-duty (Type K) for exterior or underground use. Both are commonly available in 3/8-inch, 1/2-inch and 3/4-inch diameters. Larger diameters are available, but cost factors usually make galvanized more desirable in the larger sizes.

Solder-type fittings are ordered by specifying the tube size, and the sequence of openings,
Fittings like Ts and Ls are available with threaded branch openings for joining onto threaded pipe or fixture fittings. You can therefore combine copper tubing with threaded pipe, in the same installation. Flare-type fittings *are never used* with rigid tubing.

TYPICAL GALVANIZED MALLEABLE FITTINGS

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FLEXIBLE COPPER TUBING

Flexible (soft) copper tubing is available in 60-foot coils, in the same diameters as rigid tubing. There are also two kinds (Types L and K, as above) for indoor and outdoor use. It is slightly more costly; but has the very considerable advantage of being able to turn corners — so that fewer fittings are required.

Either the solder-type fittings (above) or flare-type fittings may be used with the flexible tubing. Flare-type fittings hold by compressing the soft copper to seal the joint — and the fittings are threaded so that they may be drawn up tight enough to accomplish this purpose. They are very easy to install and require no skill whatsoever — however, solder-type fittings are recommended instead for any connection which is to be sealed into a wall (as the solder-type is more positive and lasting).

VALVES AND FAUCETS

Valves are used as a means of stopping the flow of water in a water line — and are installed in the line like a fitting is installed. There are three general kinds: Gate valves, Globe valves and Ground Key valves. A gate valve operates by raising or lowering a gate — and thus, when fully opened, allows full flow through the line because the obstructing gate is entirely removed. The globe valve has a seat that is somewhat smaller than the pipe size — so that even when fully open this type offers considerable resistance to the water flow. A ground key valve also restricts flow, as the opening through the key is smaller than the pipe. Valves are designated by the size of pipe that will fit the openings.

Gate valves are used in a line, wherever it is desired to have the flow either fully ON or OFF. Globe and ground key valves are used wherever it is desired to control the flow, from minimum to maximum.

Stop and waste valves are either globe or ground key valves which have a provision for draining the line.

Faucets are globe valves which are intended for use at the end of a water line, instead of in a line. For this reason, a faucet has one opening only that is threaded to fit a pipe. The other opening may be threaded to fit a standard water hose (the threads of which are quite different from pipe threads), or it may be unthreaded.

A check valve is a valve designed to let water flow through it in one direction only.

FIXTURE SUPPLY LINES

These are pipes and fittings designed to be attractive — as they are used wherever the water supply lines must be out in the open (as the connections from a wall into a lavatory). They may be threaded pipe, rigid tube or flexible tube (with suitable fittings) — but, whichever type is used, they are generally made of brass or copper heavily chrome plated. It is best to purchase these with the fixtures so that you will get the type of fittings needed for each particular fixture.

FIGURE 7

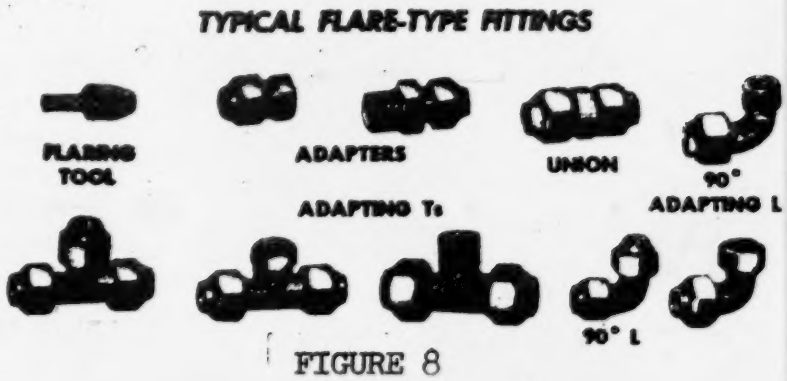

FIGURE 8

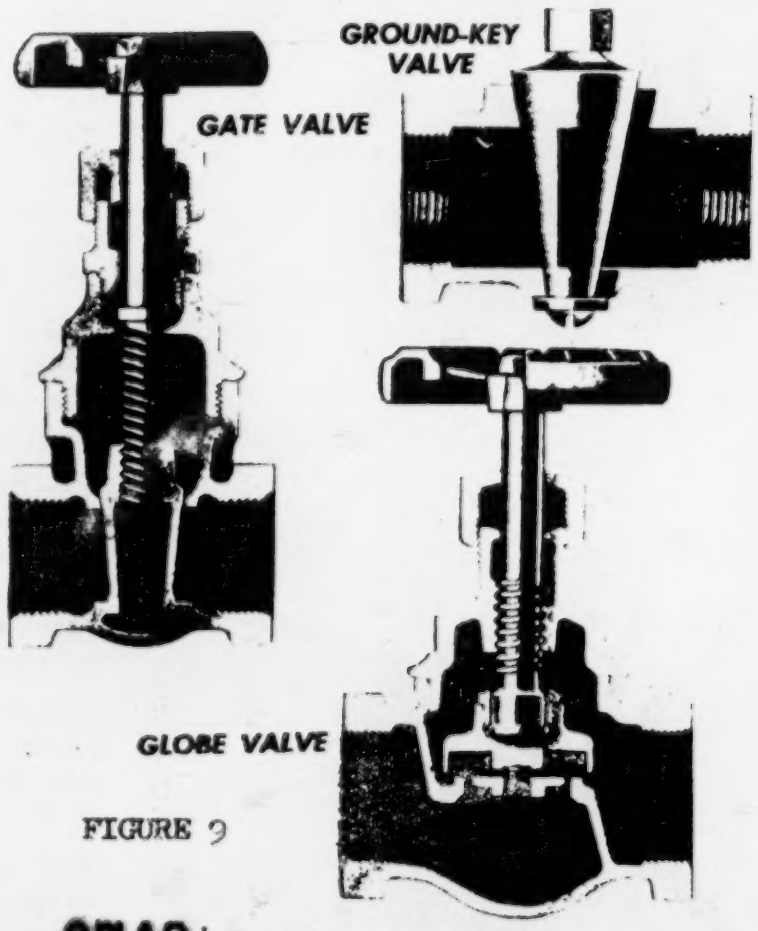

FIGURE 9

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CUTTING

Use either a hacksaw or a pipe cutter. Proper threading of the pipe depends largely on how the pipe is cut. If not cut squarely across and cleanly, threading will be difficult. For this reason, the pipe should be held in a pipe vise. Mount the vise solidly. Place it so there is ample room on each side for handling the longest pipe to be cut or threaded (see figure 10).

FIGURE 10

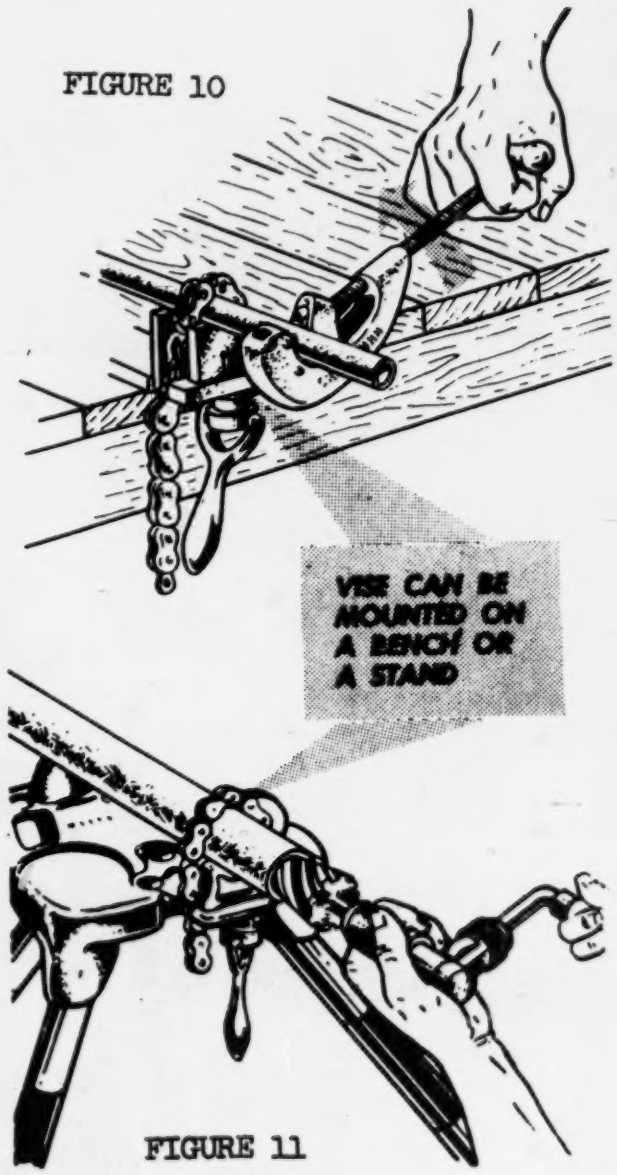

FIGURE 11

Using A Hacksaw

Mark the pipe where it is to be cut and tighten it in place in the vise. Hold the saw at a 90° angle to the pipe, and make your cut with smooth, even strokes. With the pipe still positioned in the vise, remove the burrs with a pipe reamer or round file.

Using A Pipe Cutter

Loosen the cutter wheel by turning the handle until the cutter will slide over the pipe (fig. 10). Place the cutting wheel exactly on the cutting mark, and tighten the handle until the cutting wheel is forced slightly into the pipe. Apply thread cutting oil to the cutter wheel and the pipe. Now rotate the cutter one complete turn around the pipe. Tighten the cutter wheel and go around the pipe again. Repeat this operation until the pipe is cut off. Remove the burrs with a pipe reamer (fig. 11) or file.

THREADING

This operation should be performed carefully to insure clean-cut threads for engagement with the fittings. Pipes are threaded by using a stock and die. The stock contains a receptacle on one side in which the die sets, and an opening on the other side for inserting a guide. The guide makes it possible to start the die squarely.

Each die is marked with its size. Select the same size die as the size of the pipe to be threaded. Loosen the thumb nut on the stock, slide the cover plate over, and insert the die. Make certain the printing on the die faces up toward the cover. Slide the cover plate back in place and tighten the thumb nut.

Either an adjustable guide or individual guides can be used. Each individual guide is marked for the size pipe it fits. Select the correct size guide, insert it in the opening in the stock, and tighten it in place with the lock bolt.

Place the pipe in the vise, and slide the stock over the end of the pipe with the guide on the inside. Push it onto the pipe until the die catches the pipe. Turn the stock slowly in a *clockwise* direction, keeping the die pressed firmly against the pipe. After cutting just enough thread so the die is firmly on the pipe, apply plenty of cutting oil to the threads of the die and those on the pipe.

Continue to turn the stock, backing off about 1/4 turn after each 1/2 turn forward — to clear away the chips. Continue the threading, applying cutting oil often, until the pipe protrudes to the face of the die (figure 12).

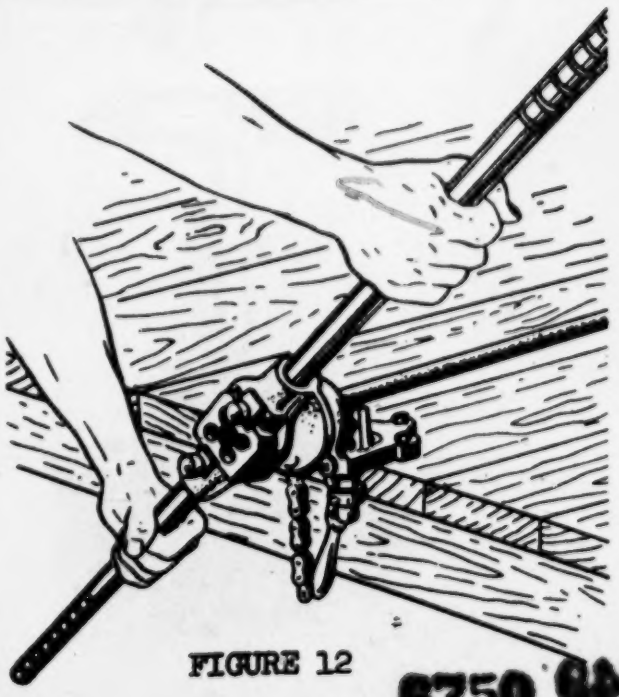

FIGURE 12

To remove the tool after threading, turn it *counterclockwise.* Wipe off the surplus oil, and all chips from the thread — before [illegible]ing the pipe.

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Use of Tools - Assembling Pipe

FIGURE 13

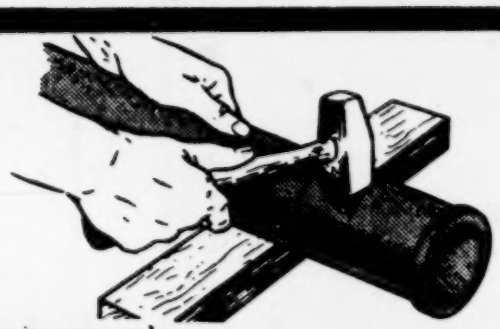

FIGURE 14

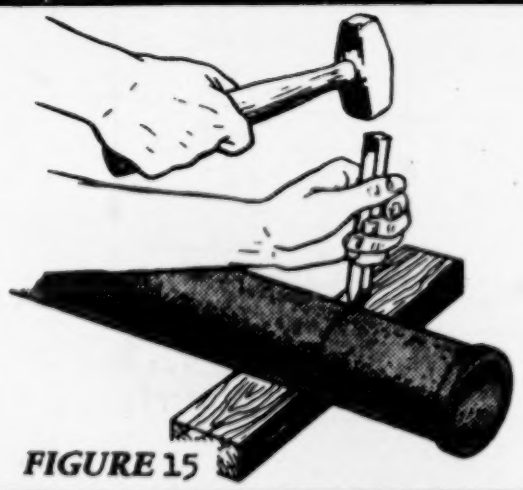

FIGURE 15

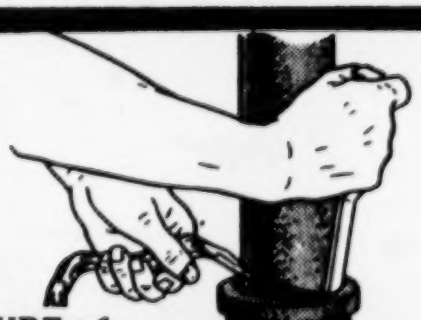

FIGURE 16

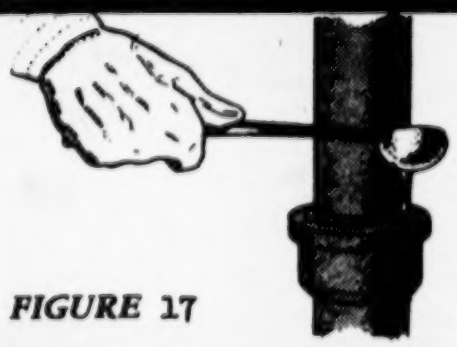

FIGURE 17

CAST IRON SOIL PIPE

MEASURING

When pieces of pipe under 5 feet are needed, use double-hub pipe — then, when pipe is cut, each end will have a hub. Carefully measure the length of pipe needed, making sure you allow the additional length necessary for engagement with the hub of the adjoining piece. Mark around the soil pipe with chalk where it is to be cut. Hub allowances are as follows:

2-inch pipe: 2½ inches; *3-inch pipe:* 2¾ inches; *4-inch pipe:* 3 inches.

CUTTING

To cut service-weight pipe, take a hacksaw and make a 1/16-inch cut all around the pipe (*figure* 13). Make sure your cut is square with the pipe to insure a clean, even break. Now tap the pipe with a hammer until it breaks at the cut (*figure* 14).

To cut extra-heavy pipe, first file around the pipe on the mark (using a triangle file) to scratch the surface and provide a guide line. Now lay a piece of 2x4 flat on the floor and place the pipe across it. Take a hammer and cold chisel, use your knee to turn the pipe — and make a light cut all around the pipe, once (*figure* 15). Continue cutting around the pipe, striking the chisel harder each time you go around — until the pipe breaks off.

MAKING CONNECTIONS

Every joint must be properly calked to provide a good water-tight connection. A good joint is easy to obtain if you follow the proper procedure, and use reasonable care.

A Vertical Joint

When erecting pipe vertically, each piece is positioned hub end up. First make sure the ends of the pipes to be joined are clean and dry. Place the spigot (plain) end of the next higher section into the hub to its full depth, and secure the upper pipe in position. Make absolutely certain the two lengths are perfectly straight up and down. Check with a level or taut cord.

Light the plumbers furnace and place the calking lead in the melting pot. If your code requires a full inch of lead, use one pound of lead for each inch of pipe diameter. If it permits 3/4 inch of lead, use 3 lbs. for 4-inch pipe; 2¼ lbs. for 3-inch pipe; and 1½ lbs. for 2-inch pipe.

Pack the joint with oakum while the lead is melting. Oakum comes in the form of a rope. About 1 ounce is required for each inch of pipe diameter. Wrap the oakum around the pipe at the joint, and drive it to the bottom of the hub space with the yarning iron (*figure* 16). Continue packing until the joint is filled to within about ¾ inch from the top of the hub. Make sure the oakum is packed tightly and evenly, as this makes the water-tight seal. The joint is now ready for leading.

WARNING

Heat the ladle by placing it alongside the melting pot before dipping into the molten lead. An explosion may result if a cold or wet ladle is dipped into molten lead.

MAKING CONNECTIONS

Pipe wrenches are used for connecting this pipe and fittings. Use a 10-inch wrench for pipes up to 1 inch; an 18-inch wrench for pipes up to 2 inches; and a 24-inch wrench for pipes up to 2½ inches. (Wrenches are sized according to the over-all length of the wrench). Use an open-end, adjustable-head, or monkey wrench on nuts, unions, valves — and to hold fittings which have flat surfaces to be gripped. Never use a pipe wrench on any plated or polished pipe, as the finish will be marred if you do. Do not tighten the jaws of a pipe wrench too tightly or they will tend to crush the pipe (this wrench gets tighter when you turn it).

Pipe Size	Distance Pipe Is Screwed Into Fitting	
	Standard Fitting	Drainage Fitting
½"	½"	—
¾"	½"	—
1"	⅝"	—
1¼"	⅝"	⅝"
1½"	⅝"	⅝"
2"	¾"	⅝"
3"	—	⅞"
4"	—	1"

EXAMPLE

The *face-to-face* measurement is 5 feet. If ¾-inch pipe is being used, the chart shows that ½-inch is needed for engagement with the fitting at one end. If both ends are to be engaged with a fitting — then *twice* this, or 1 inch of extra length is required. Total length of pipe will be 5 feet 1 inch.

COPPER PIPE (RIGID TUBING)

MEASURING

This tubing is measured *face-to-face* in the same manner as galvanized steel pipe (p. 9) — but add on the depths of the soldering hubs in the fittings to be used.

CUTTING

If considerable tubing is to be cut, you will find it advantageous to build a jig (shown in fig.20) for holding the tubing and guiding the hacksaw. This will enable you to get an even, square cut. To cut the tubing, use a fine tooth hacksaw blade (preferably a No. 24 blade). You can also use a tube cutter, without a jig. After the tubing is cut, remove all burrs by reaming.

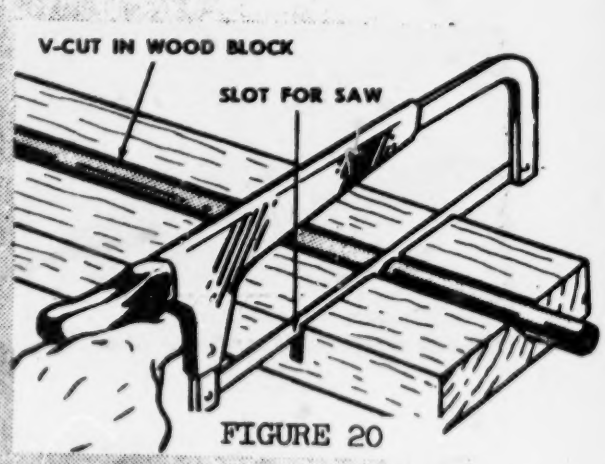

FIGURE 20

MAKING CONNECTIONS

Clean and brighten the end of the tube — and the inside of the fittings to be soldered — with steel wool or fine emery cloth. Clean surfaces are essential in forming good solder connections. Do not use a file as it will score the surface. Also, the tube end *must be perfectly round,* not out-of-round or dented.

Apply a thin coat of non-corrosive flux or soldering paste on the cleaned portion of both the tube and fitting. Place the tube in the fitting and rotate it a few times to spread the flux coat evenly (fig. 21). Remove excess flux from outside of the fitting.

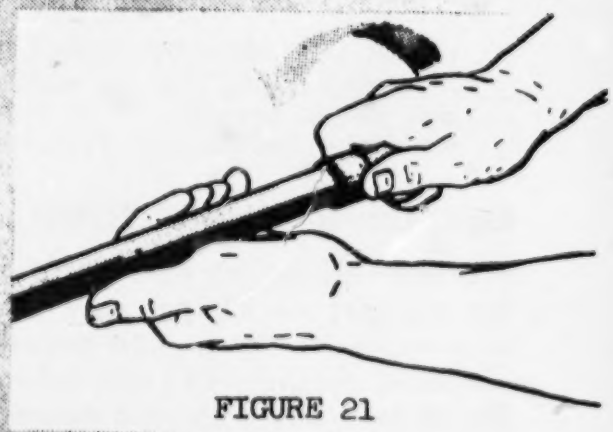
FIGURE 21

Heat the connection evenly with a blowtorch by applying the flame directly to the fitting. Use two blowtorches simultaneously on the larger (1¼ to 2 inch) sizes, applying one to each side of the fitting to obtain uniform heating. When the flux bubbles out, remove torch and touch the end of your solder stick to the edge of the fitting (fig. 22). If the fitting and tube are hot enough (which they should now be), the solder will flow and fill the joint immediately. (The solder will be drawn into the space between the tube and fitting by capillary attraction — even if it has to travel upward into the fitting). When a line of solder shows completely around the joint, the connection is filled with solder. Do not hold the flame on the connection after it is filled, as further heating will only result in loss of solder from the connection (which might make it necessary to start over again).

When the joint is completed, remove all surplus solder with a small brush or soft cloth, while the metal is still hot.

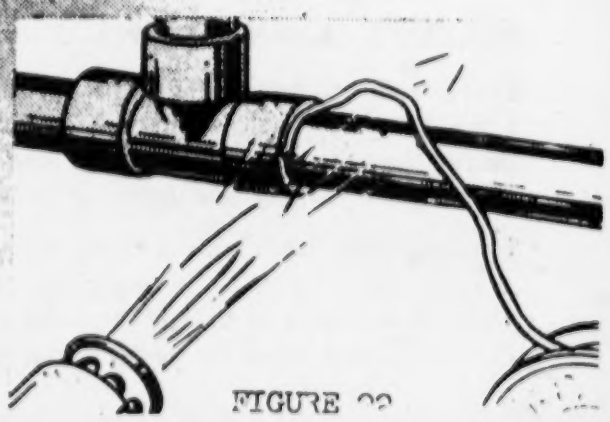
FIGURE 22

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CAUTION

Make sure the pipe and fitting do not move while the solder is cooling. Movement may result in a weak joint. If you have not overheated the connection, the solder will be firm in less than a minute.

If you make other solder connections to the same fitting, wrap the finished joints with wet rags. This will prevent the solder in these joints from melting.

If you find it necessary to unsolder a connection, simply heat it until the solder runs — then pull the tube out. Use wet rags (as above) to keep from unsoldering other connections to the same fitting.

NOTE

Experts often assemble a complete piping system without soldering (but with the joints cleaned and fluxed) — then go back and do all soldering at once. This is very fast as each fitting need be heated only once — and the blowtorch can be kept going continuously. There are two disadvantages to this method, however:

1. Some of the unsoldered connections may sag down under the weight of the pipe, so that when the soldering is done the joints are not perfectly straight (and good soldering may not be obtained).

2. Assembled joints cannot be left much over an hour before soldering or they may become dirty — in which case a poor soldering job results.

Best practice is to use this method only for handling all joints at any one fitting — or possibly at two or three fittings, at most.

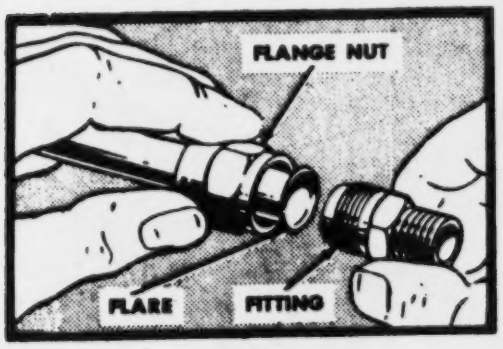

FIGURE 23

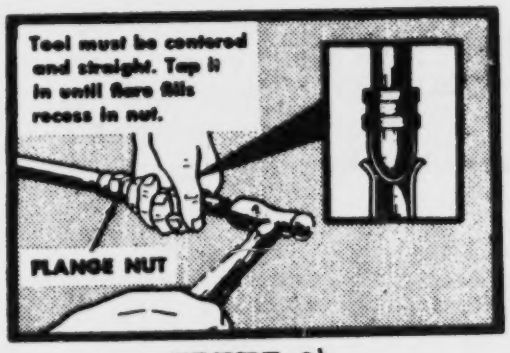

FIGURE 24

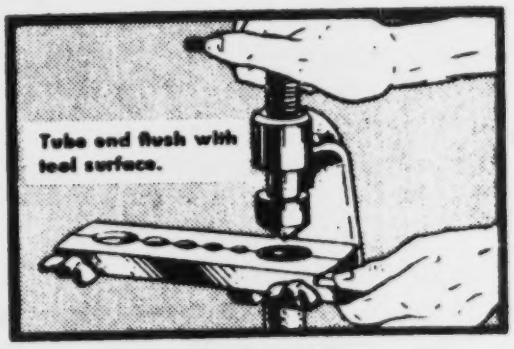

FIGURE 25

FLEXIBLE COPPER TUBING

NOTE

If used with solder-type fittings, flexible tubing is handled exactly like rigid tubing. This tubing may also be assembled with flare-type fittings, however — and the procedures are as follows:

MEASURING AND CUTTING

Measure and cut this tubing just like rigid tubing. Or, you may use a pipe cutter (fig. 10), instead of a hacksaw. (If the end becomes slightly out-of-round, flaring will re-round it). After cutting, file off any burrs — the end *must be perfectly smooth.*

MAKING CONNECTIONS

Flare-type fittings have threaded flange nuts (fig. 23) to hold the tubing in place. Remove a flange nut from the fitting — *and slide it onto the tube before flaring the tube.*

Flaring can be done either with a flaring tool (fig. 24), or with a flanging tool (fig. 25). Put a few drops of oil on the tube end when flaring it. Hold the tube in your hand while usi[illegible] flaring tool — do *not* rest opposite end on a solid object (as it might be damaged).

Slide the nut back up to the end of the tube (it can't come off now), and start it on the fitting threads. Finish making the connection by tightening the nut securely with wrenches (preferably open-end or adjustable-head wrenches) one on the nut, the other on the fitting. This forces the flare at the end of the tube up against the cupped end of the fitting — to form a tight seal. Never use one wrench alone; if the fitting isn't held stationary by a second wrench it will turn and loosen the connection at the other end.

NOTE

If a connection of this type must be broken and later re-made, examine the flare carefully to be sure it is still round, straight and smooth. Often, after being taken off, the flare will be found to be damaged — and must be re-done.

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WATER SUPPLY SYSTEM and MAINTENANCE

LEAKY FAUCETS

Most installations now use compression-type faucets (fig. 26), in which water flow is controlled by a washer that is compressed by turning the threaded valve stem down onto the valve seat. This washer is usually the cause of a leaky faucet.

A new washer is easily installed — just be certain to have the size and type required to fit your valve stem (use the old one as a sample, if need be). Some are flat and some are cone shaped, but all must fit snugly within the rim on the stem end, or they will not work properly. If this rim is broken, you must either secure a new valve stem — or you can use a special fitting which screws into the old stem to form a new stem end.

Shut off the water to the faucet. Remove the handle. Remove the packing nut and lift the stem out with it. Now remove the washer, being very careful not to damage the rim (fig. 27) on the stem, and install a new washer (putting it in small side out, if it is a cone type). Examine the seat (down in the faucet) for dirty or hard particles, and clean it if necessary, before replacing the stem, packing nut and handle. If this seat is rough or scratched, a new seat can be installed — it simply screws out.

If the packing nut leaks, tightening it (but not so much that the handle won't turn) may correct this. Otherwise, new packing (or, if threads are worn, even a new nut) is required.

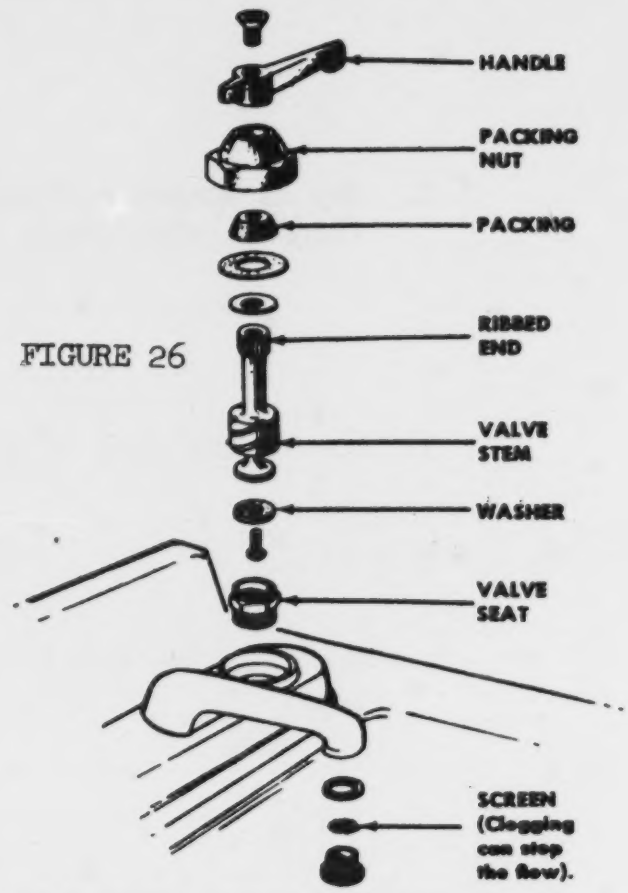

FIGURE 26

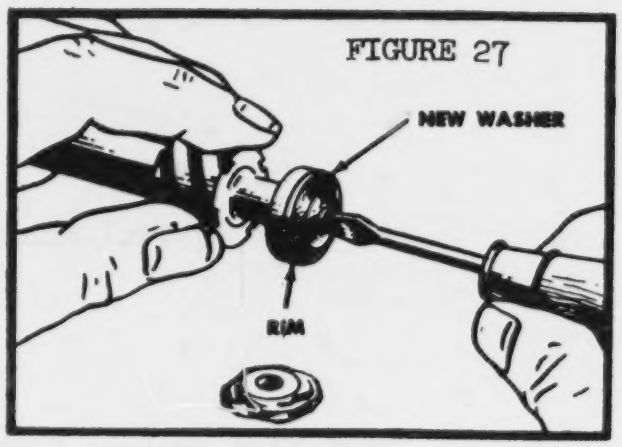

FIGURE 27

Faucet Seat Dresser
With 4 Cutters

CUTTERS FOR SEAT DRESSER

Size	
1/2"	Diameter
5/8"	"
3/4"	"
7/8"	"

FIGURE 28

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Simple Farm Plumbing

1. Name the basic plumbing tools.

2. Why is it not recommended to use pipe wrenches on nuts, bolts or flanges, which have flat gripping surfaces?

3. How is the size of a pipe wrench designated?

4. What are the three types of water pipe? List the advantages of each type.

5. List ten common galvanized pipe fittings and tell where each is used.

6. List ten typical solder-type fittings.

7. List five typical flare-type fittings.

8. List three types of valves. What is the difference in the three?

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9. What tools may be used to cut galvanized pipe? Explain the procedure used in cutting pipe with both tools.

10. What is the purpose of reaming pipe?

11. Explain the proper way to thread a piece of pipe.

12. Why is it necessary to use cutting oil when threading pipe?

13. What is thread cutting oil made of?

14. Why is it necessary to use joint compound when connecting water pipe?

15. How far is a one-inch pipe screwed into a standard fitting?

16. What is the proper way to measure rigid copper tubing?

17. How is rigid copper tubing cut?

18. Explain the proper way to make a rigid copper pipe connection.

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19. How do you treat a joint that has been soldered if you wish to solder another nearby?

20. How can flexible copper tubing be cut?

21. Explain the proper way to use a flanging tool.

22. List the parts of a compression-type faucet.

23. Explain how you would replace a washer in a leaky faucet.

24. Explain how you would clean a faucet seat by using the dressing tool.

25. How can you determine if a faucet valve seat is replaceable?

26. How deep should water pipe be buried in the ground?

27. How can exposed water pipe be protected?

28. Explain how and where you would use a stop and waste valve?

29. Explain how you would measure and cut cast iron pipe.

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SMALL GASOLINE ENGINES

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INTRODUCTION TO SMALL GASOLINE ENGINES

A thorough study of small gasoline engines is a major part of the farm mechanics portion of the course for second year students enrolled in vocational agriculture. Even though we deal mainly with the small, one-cylinder Briggs and Stratton Engine, most of the principles will apply to the multi-cylinder engine.

This exercise will present valuable information that will assist the student in understanding the basic principles and theory of operation of the four-cycle engine. It will also allow the student to gain practical experience in disassembling, inspecting parts, and reassembling the engine.

Small Gasoline Engines

1. General theories of operation
2. Compression
3. Carburetion
4. Ignition
5. Easy spin starting
6. Governing
7. Disassembling the engine
8. Inspection of parts
9. Reassembling the engine
10. Repairing engines

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DISASSEMBLING, INSPECTING PARTS, REASSEMBLING

Materials and Equipment

1. Gasoline engine
2. Tool kit for small engines
3. Briggs and Stratton repair instruction manual
4. Gas and oil
5. Waste or rags

Exercises for Students

1. Identify make and model from the identification plate on the engine.
2. Disassemble and reassemble the engine and make the following inspections as the engine is being reassembled:
   a. Air cleaner: inspect for dirt deposit and oil level
   b. Carburetor: inspect governor control and linkage
   c. Check air gap
   d. Breaker points: inspect adjustment and wear, check plunger and plunger hole for wear
   e. Crankshaft: inspect for end play
   f. Cam gear: check procedure for timing
   g. Piston: check the ring gap, how to assemble rings to the piston and ring groove
   h. Cylinder: inspect for wear
   i. Tappets: inspect for clearance
   j. Valves: inspect for damaged seat or valve
3. Replace worn parts
4. Reassemble engine
5. Make the necessary adjustments
6. Trouble shoot

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SECTION 1 - - - - - - - - - - COMPRESSION
SECTION 2 - - - - - - - - - - CARBURETION
SECTION 3 - - - - - - - - - - IGNITION
SECTION 4 - - - - - - - - - - EASY SPIN STARTING
SECTION 5 - - - - - - - - - - GOVERNING

SECTION 1 - COMPRESSION

The general subject of compression is a familiar one to most mechanics. It has been discussed in detail by valve manufacturers, ring manufacturers, piston manufacturers, and by makers of valve grinding equipment. The home mechanic, or handy-man, thinks nothing of getting out his grinding compound, lapping in the valves and putting a new set of rings on the piston – all without knowledge of proper fit or tolerance. Whether he does the job right or not, he thinks it is easy. And, it is easy. There is nothing difficult or mysterious about compression, and the nice part is that a good job that will create lasting customer satisfaction is about as easy to do as a poor job.

We must keep in mind, however, that the Briggs & Stratton engine is an air-cooled, single cylinder engine. The rules that hold true on liquid-cooled, multi-cylinder engines do not always apply to Briggs & Stratton engines. For example:

The operating temperature of a liquid-cooled engine is quite constant. The operating temperature of an air-cooled engine, however, may vary greatly with changes in air temperature, the load, and the speed. This necessitates differences in tolerances and clearances of parts like pistons, which must be fitted to Briggs & Stratton's established clearances. These can differ from those used in most automotive engines.

The advantages of an air-cooled engine are many. There is no need for a complicated cooling system. The engine is lighter in weight and occupies less space than its liquid-cooled counterpart, and is comparatively easy to repair.

Before we get into the mechanics of the subject, let us clarify some of the terms in common use.

On single cylinder engines we think of good compression, not in terms of pounds of pressure per square inch, but in terms of horsepower output. If the engine produces the power for which it was designed, we believe the compression must be good. It is extremely difficult to make an accurate compression test on a small, one cylinder engine without expensive machinery. The reasons for this are the lack of a starter to crank the engine at a constant speed and the small displacement of the cylinder. Therefore, we do not publish any compression pressure figures. As a simple compression test, give the flywheel a quick spin. If the flywheel rebounds on the compression stroke, the compression is at least good enough to start the engine.

We talk about "compression" stroke and "power stroke". What are they? The Briggs & Stratton engine is a four stroke cycle engine, or as it is commonly called, a four cycle engine. It operates on the same principle as an automobile engine. The crankshaft makes two complete revolutions to each power stroke of the piston.

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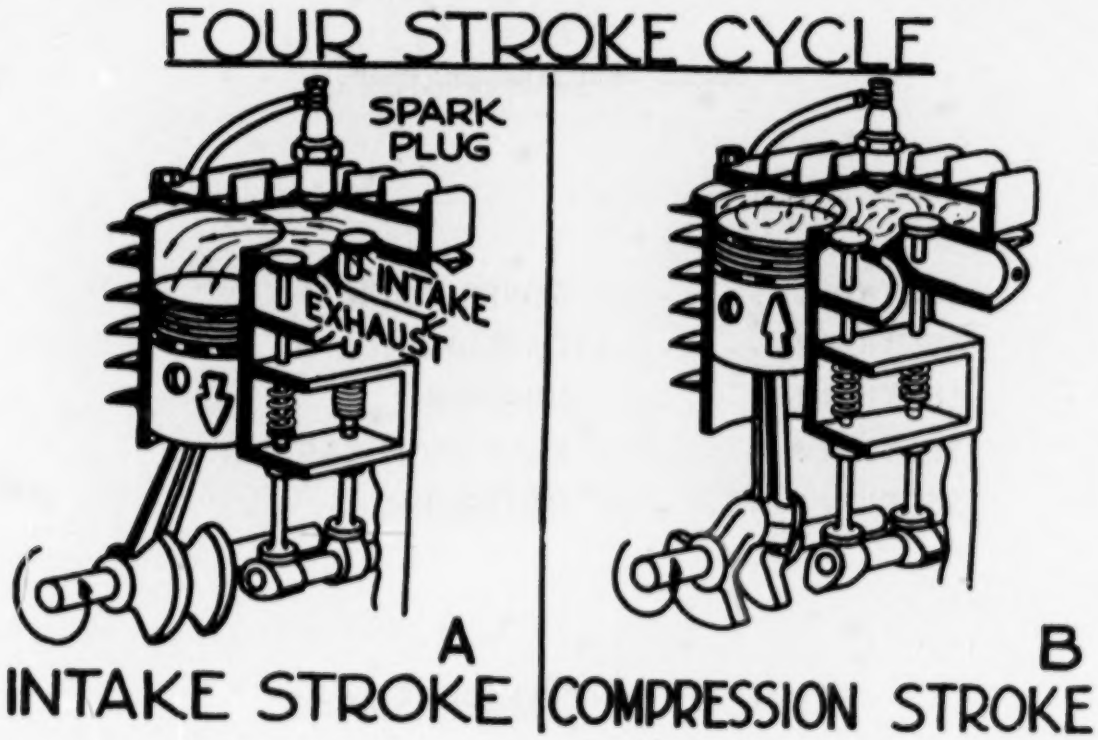

Figure 1

First is the intake stroke. With the exhaust valve closed and the intake valve open, the piston moves downward and the air-fuel mixture is drawn into the cylinder. (A – Fig. 1)

Then, the intake valve closes, and the piston moves upward on the compression stroke. The air-fuel mixture becomes greatly compressed in the small space between the top of the piston and the cylinder head. (B – Fig. 1)

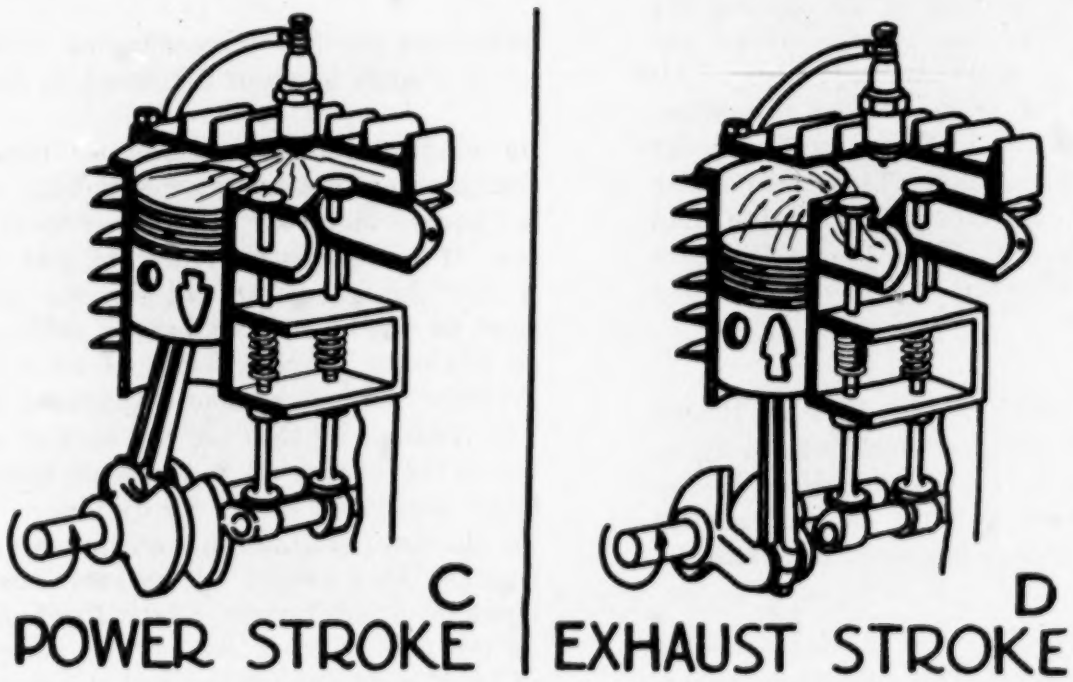

Figure 2

The spark occurs, igniting the mixture, and the force of the expanding gases push the piston down. This is the power stroke. (C – Fig. 2)

The exhaust valve opens, and the upward movement of the piston on the exhaust stroke forces the burnt gases out of the cylinder. (D – Fig. 2) Then the exhaust valve closes, the intake valve opens, and the engine is ready to repeat the cycle just described. Thus four strokes complete the cycle.

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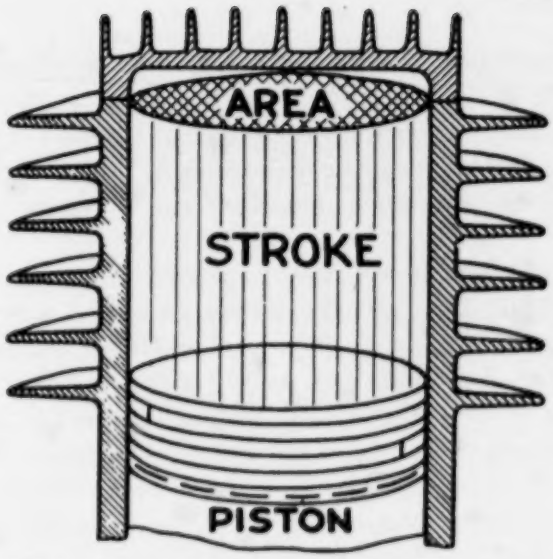

PISTON DISPLACEMENT

Figure 3

What is "piston displacement"? It is the space displaced by the piston in its up and down movement or the volume shown above the piston in Figure 3. The bigger the bore and the longer the stroke, the greater the piston displacement. Displacement is computed by the following formula:

$$\text{Displacement} = \frac{(\text{Bore})^2}{4} \times \pi \times \text{Stroke}$$

Let us compute the displacement of a Model 6 engine which has a 2" bore and a 2" stroke. Using the above formula:

$$\text{Displacement} = \frac{2 \times 2}{4} \times 3.1416 \times 2$$

Displacement = 6.2832 cubic inches

Our specification sheets show 6.28 cubic inches as the displacement for the Model 6 engine.

The model numbers of the current engines indicate the approximate piston displacement. Model 60000 has 6.65 cubic inches; Model 14 has 14.21 cubic inches, etc.

Piston displacement indicates the relative size of the engine, and usually horsepower is in direct proportion to size.

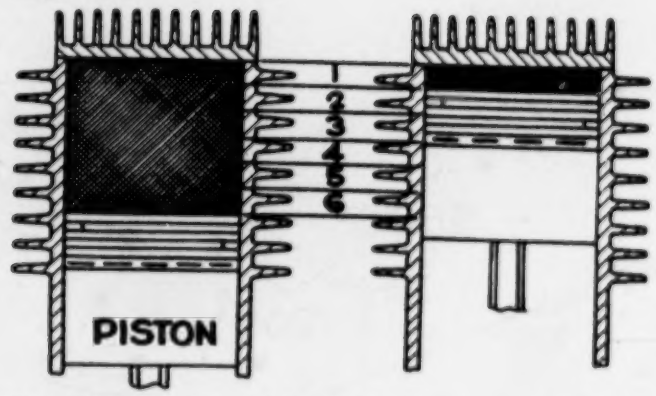

COMPRESSION RATIO 1 TO 6

Figure 4

What do we mean when we say an engine has a 6 to 1 compression ratio? We mean that the space in the cylinder when the piston is at the top of the stroke is only one-sixth as great as when the piston is at the bottom of the stroke.

Compression ratios do not tell us the horsepower of an engine. They do have a meaning as regards the efficiency of an engine.

Generally, the higher the compression ratio, the greater the efficiency. However, as compression ratios are increased, the loads and stresses upon engine parts become more severe. Premium fuels may be required with high compression ratios. Experience has proven that compression ratios in the range of 5-1 to 6-1, currently used in Briggs & Stratton engines, are the best for the work and the conditions under which these engines must operate. Therefore premium fuel is not needed and "regular" is recommended.

It is generally conceded that the valves are the most important factor in good compression. They operate under more severe conditions than any other parts of the engine. This is particularly true of the exhaust valve.

TIMING

Figure 5

The valves open and close in a little less than one revolution. When the engine is operating at 3000 RPM, each valve opens and closes in about 1/50 of a second.

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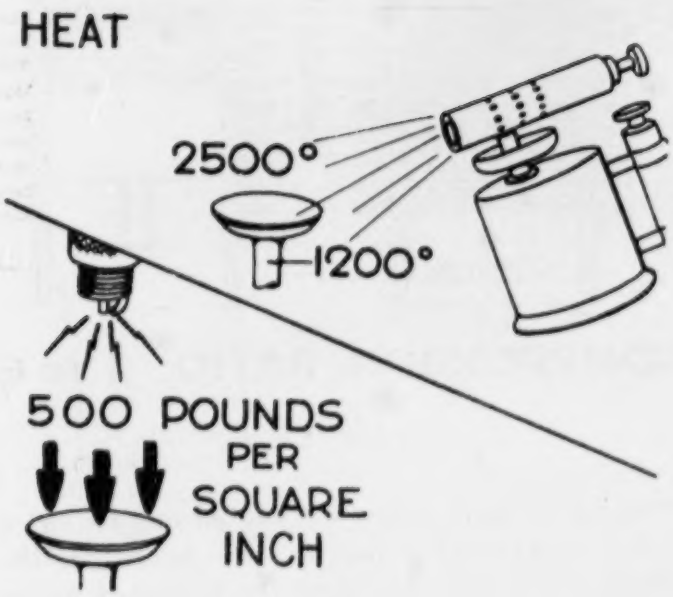

Figure 6

Valves have to seal well enough to stand pressures up to 500 pounds per square inch. Under full load, the exhaust valve is exposed to temperatures high enough to cause it to operate at a red heat. The temperature of the valve under these conditions may be 1200° F. or more. The intake valve is cooled by the incoming mixture. The exhaust valve is subjected to high temperature exhaust gases passing over it on their way out of the cylinder. It is, therefore, very difficult to cool the head of the exhaust valve. The cylinder head, the cylinder, and the top of the piston are exposed to this same heat, but these parts are cooled by air from the flywheel fan and oil from the crankcase. Very special steel is required in the exhaust valve to enable it to withstand the corrosive action of the high temperature exhaust gases.

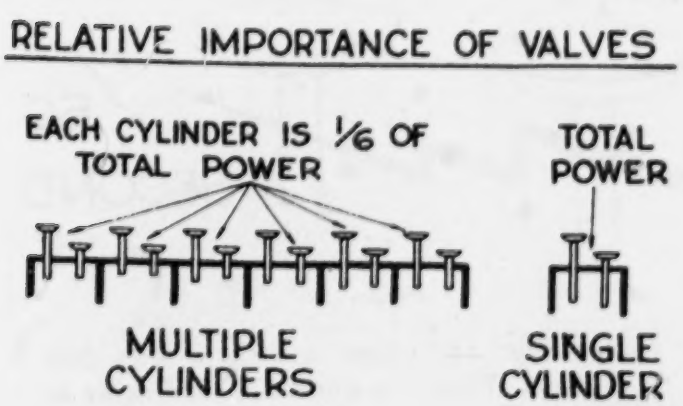

Figure 7

Remember again that the Briggs & Stratton engine is a single cylinder engine with two (2) valves as compared to the customary 12 or 16 valves in an automotive engine. The fewer the valves, the more important they become.

In a 1 cylinder engine one bad valve can cause a great drop in horsepower or cause the engine to stop entirely. In a multicylinder engine, one valve may fail and only 1/6th or 1/8th of the power is affected as the bad cylinder may be motorized by the other good cylinders. Hence, good valve condition is even more important in 1 cylinder engines than it is in multicylinder engines.

Now if the valves and seats are so important, how do we do a good valve job on a Briggs & Stratton engine?

The first requirement is good equipment. A valve refacer and valve seat grinders are necessary. If you do not have them, arrangement should be made with your local Briggs & Stratton dealer.

After the valves are removed, they should be thoroughly cleaned on a wire brush wheel to remove all carbon deposits. You will find sometimes it is easier to polish carbon than to remove it, but it must come off. Also, remove carbon from valve guides. When the valves are clean, they should be visually inspected.

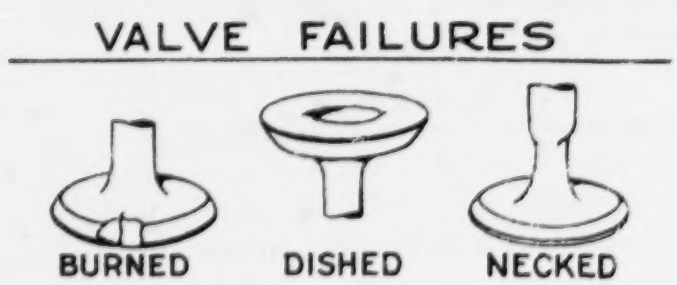

Figure 8

As mentioned above, when a valve becomes defective in a multicylinder engine, the bad cylinder is motorized by the other cylinders. This may cause serious damage to the valve and seat. Briggs & Stratton engine valves are seldom subjected to the extremes of abuse that automotive valves are. While valves may burn to some extent, it is very seldom that a valve seat or face is very badly burned. Dished or necked valves are almost never found.

Valve seat burning is usually caused by an accumulation of carbon or fuel lead either on the valve stem or on the valve face, or from insufficient tappet clearance. These deposits on the valve stem or on the face will hold the valve open, allowing the hot flames of the burning fuel to eat away the valve face and seat. A dished valve is one that has a sunken head. This is caused by operating at too high a temperature with too strong a spring, or the head can be eroded away by highly leaded fuels. A necked valve is one that has the stem directly beneath the head eaten away badly by heat or where the stem has been stretched.

Valve sticking is caused by fuel lead, gum or varnish forming on the valve stem and in the valve guide. We believe that most of the deposits formed are caused by carbon, fuel lead, or gum. Since the amount of lead in different fuels varies, the rate of deposit build-up naturally will vary. When an exhaust valve no longer closes properly, due to excess deposits, the hot gases escaping from the combustion chamber heat up the valve stem and guide excessively. This causes the oil on the valve stem to oxidize into varnish which holds the valve partially open and causes burning. Intake valve sticking may be caused by the use of fuels having an excessively high gum content. Fuels that are stored for too long a period of time may contain high amounts of gum.

If burning occurs in a rather limited area on the valve face, it indicates that something may have caused the valve to tip. This could be due to a bent valve stem or a deposit on one side of the valve seat or stem.

Such a condition would leave an opening for the passage of hot exhaust gases which could burn the valve so badly that it could not be refaced. These valves must be discarded.

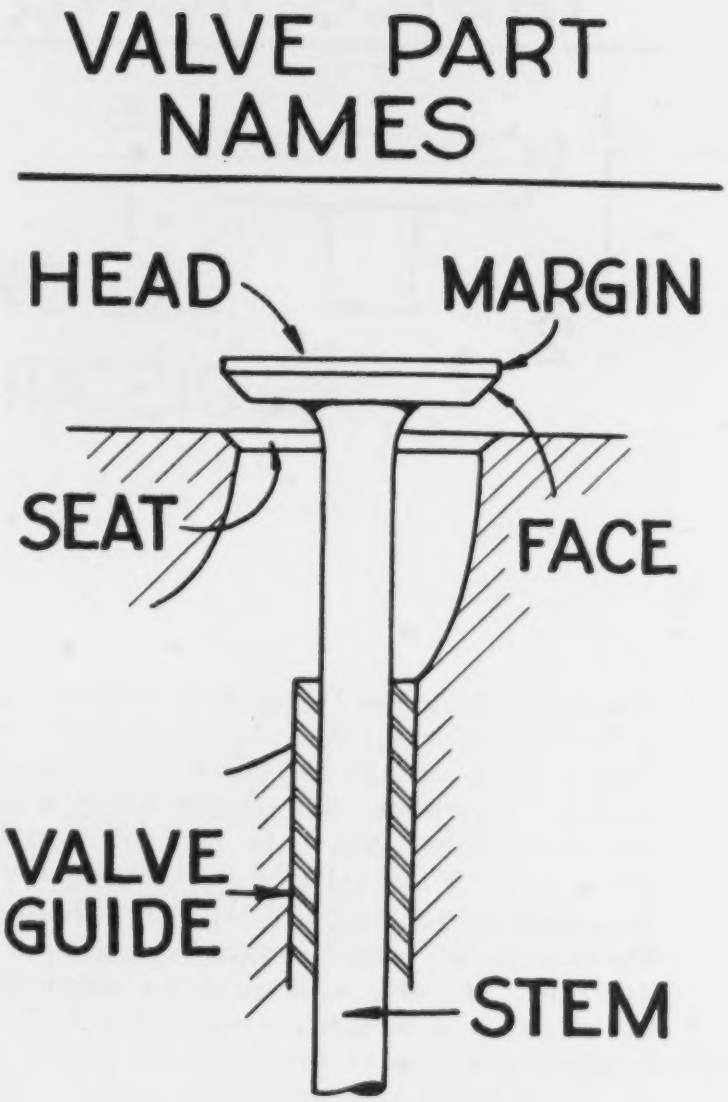

Figure 9

The important parts of a valve are the head, the margin, face, and stem. They make contact with the seat and the valve guide in the cylinder. The margin is the edge of the valve head. As a general rule, the valve should be discarded when the margin becomes less than one-half of the original thickness.

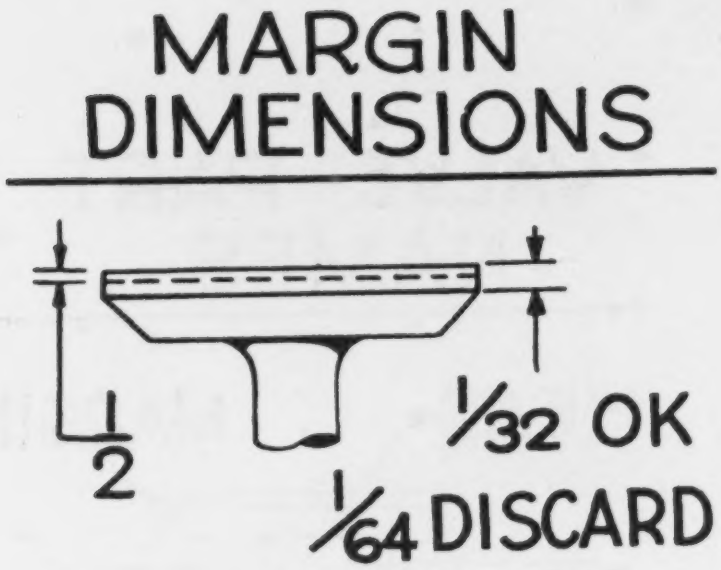

Figure 10

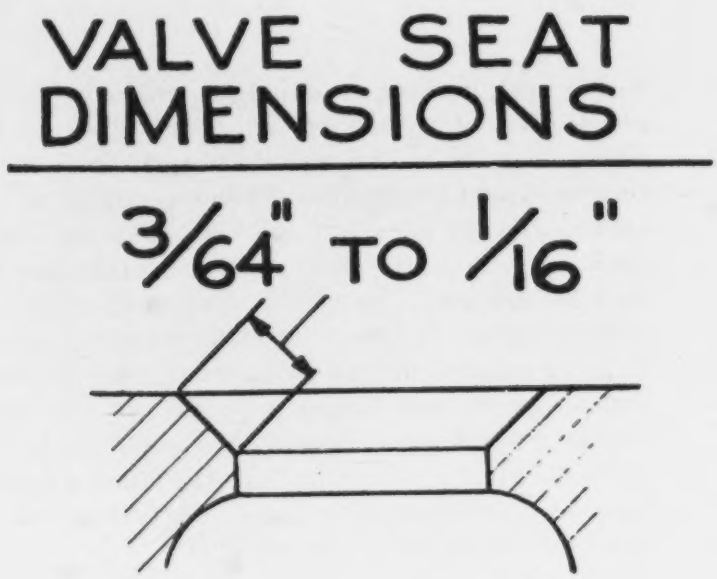

Figure 11

The margin on a new Briggs & Stratton valve is 1/32 of an inch, so that when it becomes less than 1/64 of an inch the valve should be discarded. Remember, this is after all pit marks and burn marks have been removed from the valve face. If the valve is bent, the face will be ground unevenly, and if the margin becomes too thin on one side the valve should also be discarded. A valve with too thin a margin will not be able to withstand the heat and will quickly crack and burn. After facing the valves and the valve seats to a 45° angle, place a little fine grinding compound on the valve face, and very lightly lap the valve to the seat. Use of fine grinding compound removes any grinding marks and gives a clear picture of the valve seat width. Be sure to remove all grinding compound from seat and valve.

The valve seat width is usable up to 5/64 of an inch, but a new seat should be between 3/64 and 1/16 of an inch, and it should be in the center of the valve face. After the valve seat and faces are ground, the valve should be installed in the guide, the cam gear turned to the proper position, and the tappet clearance checked. Refer to Repair Instructions for tappet clearance. Usually the clearance will be too small, and the end of the valve stem will have to be ground off to obtain the proper clearance. Care should be taken not to overheat the end of the valve stem while this grinding is taking place; be sure the end is square with the stem. It is recommended that the valve springs and retainers be assembled immediately after setting the tappet clearance to prevent chances of dirt getting under the valve seat.

Compression

1. Name the four strokes of a four-stroke cycle engine.

2. How is the air-fuel mixture drawn into the cylinder?

3. What is the position of the intake and exhaust valve on the compression stroke?

4. What causes the power stroke?

5. What happens on the exhaust stroke?

6. Define "piston displacement".

7. How is displacement computed?

8. What do we mean when we say an engine has a 6 to 1 compression ratio?

9. What type fuel is recommended for engines with a compression ratio of 6 to 1?

10. What part of the engine plays the most important part in assuring good compression?

11. How often do the valves open and close in a one-cylinder engine?

12. Why is the exhaust valve made of very special steel?

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13. What keeps the intake valve cool?

14. Why is it difficult to cool the exhaust valve?

15. Why are the valves more important in a one-cylinder engine than a multi-cylinder engine?

16. Describe three valve failures.

17. What causes valve seat burning?

18. What causes a dished valve?

19. What causes a necked valve?

20. What causes the valves to stick?

21. Name the parts of the valve.

22. When should a valve be discarded?

23. After valves have been ground, how do we get the proper tappet clearance?

24. Where is a two-cycle engine used? Why?

SECTION 2 - CARBURETION

The basic purpose of a carburetor is to produce a mixture of fuel and air on which an engine will operate; to do so is relatively easy. However, producing economical fuel consumption and smooth engine operation over a wide range of speeds creates the need for a more complicated mechanism than a mere mixing valve. There is an additional problem in that the price of such a carburetor must be held in proportion to the price of the engine. The price of a Briggs & Stratton engine is not much greater than the price of the carburetor on an automobile.

Atmospheric Pressure

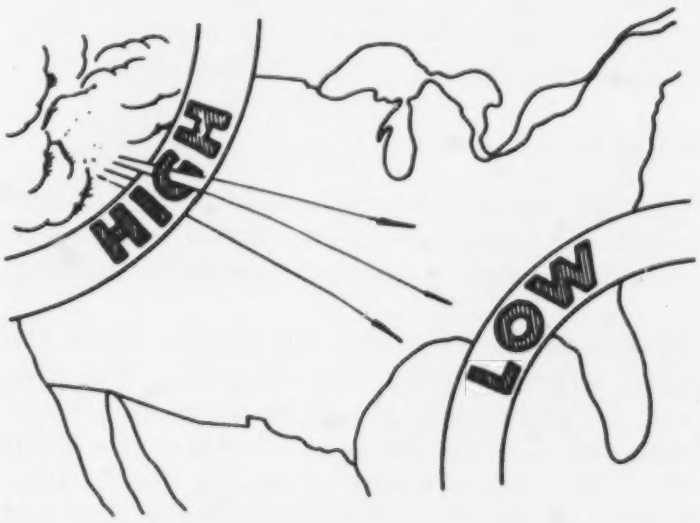

Figure 12

Keeping this in mind, we must utilize the force of atmospheric pressure and the principles of the venturi and the airfoil.

Atmospheric pressure, while it may vary slightly due to altitude or temperature, is a constant potent force which tends to equalize itself in any given area. It is the weight of the air in the atmosphere pushing down and outward in all directions and is commonly figured as between 13 and 15 pounds per square inch. We know that air moves from a high pressure area to a low pressure area.

To use this force of atmospheric pressure in a carburetor, we artificially create low pressure areas and thus obtain movement either of air or of intervening fuel. We will show you how a little later.

The greater the difference in pressure between the two areas the greater the velocity or the greater the distance we can raise the fuel.

In the interest of brevity we often use the terms vacuum or suction when we actually mean the difference in pressures.

Venturi

What is a venturi? Have you ever noticed that the wind blowing through a narrow space between two buildings always seems to be much stronger than in the open? In other words, the velocity is greater. The same thing can be seen in a river. The current is always faster in a narrow, shallow place than in the deep wide pools.

In a fashion, these narrow places are venturi's. The great bulk of air or water suddenly forced through a constricted space has to accelerate in order to maintain the volume of flow.

This is the way a venturi is placed in a carburetor. Fig. 13. The shape is carefully designed to produce certain air flow patterns.

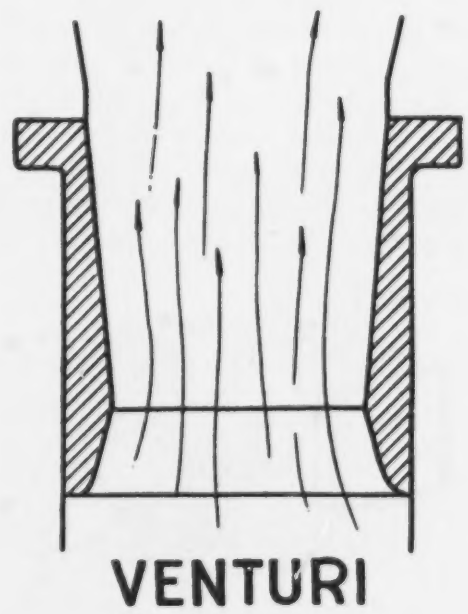

Figure 13

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Airfoil

Now, what is an airfoil? Here is a picture of a tube in an air stream. When still, the pressure is equal on all sides. Under movement, an air pattern is formed, Fig. 14, so that we have a high pressure area and a very low pressure area.

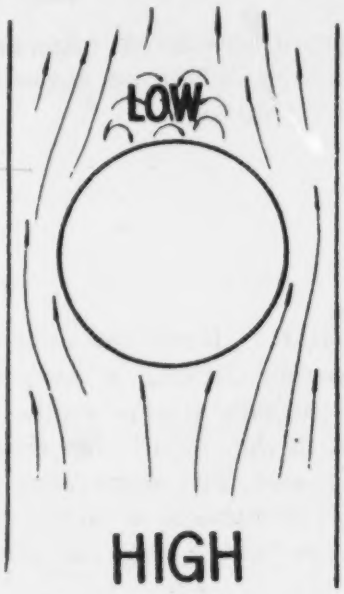

Figure 14

Now how does all this apply to Briggs & Stratton engines that employe three types of carburetors, the Flo-jet (gravity feed or float type), the Vacu-jet (suction feed) and the newer Pulsa-jet (fuel pump) type?

FLOW-JET CARBURETORS OR GRAVITY FEED

First, let us consider the gravity feed system. The tank is above the carburetor and fuel flows by gravity. Notice an air vent hole in the tank cap so that air can flow in as fuel flows out and a vent hole in the carburetor bowl so that air can flow out as fuel flows in. If one or both of these holes were plugged, the flow of fuel would cease and stop the engine. See Fig. 15 and 16.

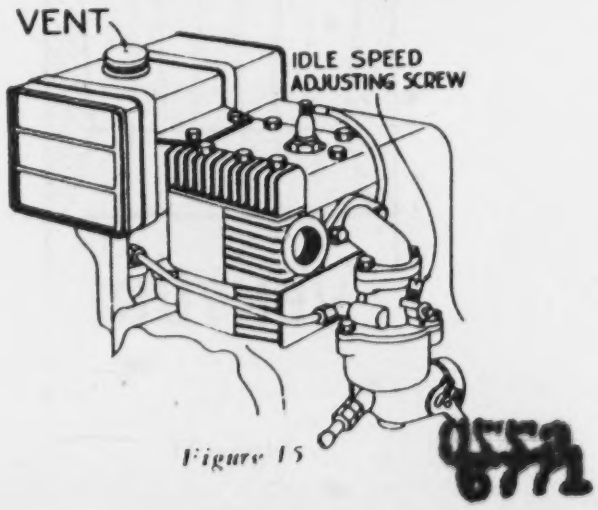

Figure 15

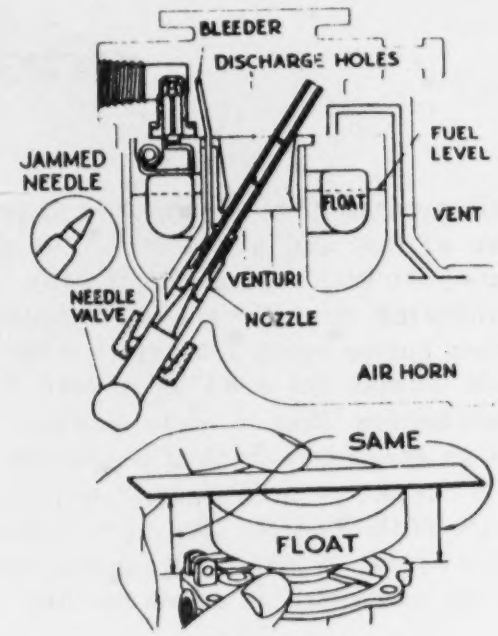

Figure 16

As the fuel enters the bowl, it raises the float. The float in turn raises the needle in the float valve. When the needle touches the seat, it shuts off the fuel flow, and the position of the float at this time is called the float level.

Float Level

The float level in general should be high enough to afford an ample supply of fuel at full throttle and low enough to prevent flooding or leaking.

To set the level on the carburetor, invert the upper body as shown. See Fig. 16. The float and the body cover should be parallel. If not, bend the tang on the float to obtain this position. The actual distance on the small carburetors is 5/16 of an inch between the float and the gasket. On the larger models it is 3/16 of an inch. It is seldom necessary to measure this distance. The float level is not as critical as on some carburetors. Remember, however, that there should be one gasket between the float valve seat and the carburetor. No gasket or two gaskets will change the float level.

Now, the fuel is down into the bowl but how does it get into the cylinder?

Here is shown the position of the nozzle and the fuel level. See Fig. 16. The fuel in the bowl seeks its own level, which is well below the discharge holes. Notice that the discharge holes are in the venturi, the place of greatest air velocity. As the piston in the cylinder moves down with the intake valve open it creates a low pressure area that extends down into the carburetor throat and venturi. Two things start to happen.

The air pressure above the fuel in the bowl pushes the fuel down in the bowl and up in the nozzle to the discharge holes. At the same time the air rushes into the carburetor air horn and through the venturi where its velocity is greatly increased.

The nozzle extending through this air stream acts as an air foil, creating a still lower pressure area on the upper side. This allows the fuel to stream out of the nozzle through the discharge holes into the venturi where it mixes with the air and becomes a combustible mixture ready for firing in the cylinder.

A small amount of air is allowed to enter the nozzle through the bleeder. This air compensates for the difference in engine speed and prevents too rich a mixture at high speed.

The story of carburetion could end right here if the engine were to run at only one speed and under ideal conditions. However, since smooth economical operation is desired at varying speeds, some additions must be made to the carburetor.

The ideal combustion mixture is about 14 or 15 pounds of air, in weight, to one (1) pound of gasoline. Remember that an engine operating under heavy load requires a richer mixture than under light load. In order to regulate the mixture, we place in the carburetor a threaded needle valve with a tapered point which projects into the end of the nozzle. See Fig. 16.

To adjust the carburetor for maximum power, run the engine at the desired operating speed, then turn in the needle valve until the engine slows down, which indicates a lean mixture. Note the position of the needle valve, then turn the needle valve out until the engine speeds up and then slows down, which indicates a rich mixture, Note the position of the needle valve, then turn the needle valve to midway between the lean and rich position. Adjust the mixture to the requirement for each engine. Remember that too lean a mixture is not economical. It causes overheating, detonation, and short valve life. Also, since there is no accelerator pump, the mixture must be rich enough so that the engine will not stop when the throttle is suddenly opened. Engines which run at constant speeds can be slightly leaner than those whose use requires changes in speed.

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The inset of Fig. 16 shows what happens when the needle valve is turned too far. A square shoulder is produced on the taper. It is possible, of course, to adjust the carburetor with the needle valve in this condition, but it is quite difficult, because a small movement of the needle makes a big difference in the amount of fuel that can enter the nozzle. And, if you do get it adjusted, the vibration can soon throw it off.

Throttle

Figure 17

To allow for different speeds, a flat disc called a butterfly, mounted on a shaft, is placed in the carburetor throat above the venturi. This is called the throttle. See Fig. 17.

The throttle in the wide open position does not affect the air flow to any extent. However, as the throttle starts to close, it restricts the flow of air to the cylinder and this decreases the power and speed of the engine. At the same time it allows the pressure in the area below the butterfly to increase. This means that the difference between the air pressure in the carburetor bowl and the air pressure in the venturi is decreased, the movement of the fuel through the nozzle is slowed down; thus the proportion of fuel and air remain approximately the same. As the engine speed slows down to idle, this situation changes. See Fig. 18.

At idle speed the throttle is practically closed, very little air is passing through the venturi and the pressure in the venturi and in the float bowl are about the same. The fuel is not forced through the discharge holes, and the mixture tends to become too lean.

Idle Valve

To supply fuel for the idle, the nozzle is extended up into the idle valve chamber. It fits snugly in the upper body to prevent leaks. Because of this tight fit, the nozzle must be removed before upper and lower bodies are separated, or the nozzle will be bent.

The idle valve chamber leads into the carburetor throat above the throttle. Here the pressure is low, and the fuel rises in the nozzle past the idle valve and into the carburetor throat through the discharge slot. The amount of fuel is metered by turning the idle valve in or out until the proper mixture is obtained. Here again we see what happens if the needle is screwed in too far. A damaged idle valve can result.

Adjustment of the idle valve is similar to that of the needle valve but should be made after the needle valve has been adjusted. The idle speed is not the slowest speed at which the engine will run. On small engines it is 1750 RPM. On larger engines the idle speed may be as low as 1200 RPM. Use a tachometer to set the speed.

Turn the idle speed adjusting screw (located on throttle shaft) until the desired idle speed is obtained and hold throttle closed. Turn the idle valve in until speed decreases, then out until speed increases and again decreases. Then turn the idle valve to a point midway between these two settings. Usually the idle speed adjusting screw will have to be reset to the desired idle speed.

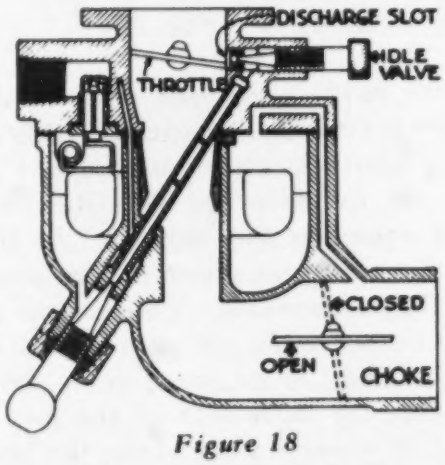

Figure 18

The next problem is starting the engine in different temperatures and with different fuels. A butterfly, mounted on a shaft, is placed in the air horn. With this choke we can close, or almost close, the air horn and get a low pressure area in the venturi and throat. See Fig. 18.

Thus, a rush of fuel is obtained from the nozzle with a relatively small amount of air. Even with low vaporization this extra rich mixture will give easy starting. Only a portion of the fuel will be consumed while choking, and a large portion will remain in the cylinder. This raw gasoline will dilute the crankcase oil and may even cause scuffing due to washing away of the oil film from between the piston rings and the cylinder wall. For this reason, prolonged choking should be avoided.

This now is our complete carburetor.

VACU-JET CARBURETORS OR SUCTION FEED

Now let us take a look at the Vacu-jet or suction feed system. Here the fuel tank is below the carburetor, so obviously the fuel will not flow by means of gravity. Therefore, the force of atmospheric pressure must be employed.

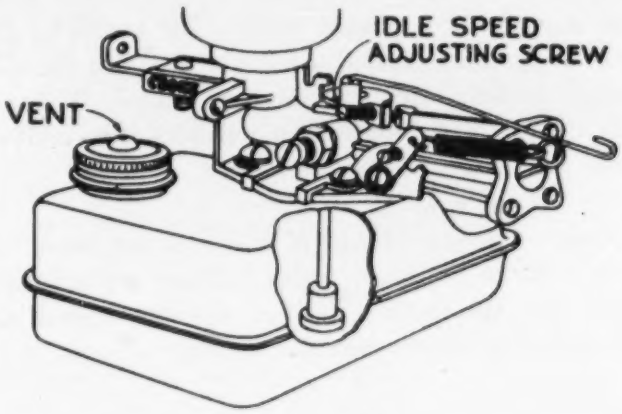

Figure 19

Again we have a vent hole in the fuel tank cap to allow the pressure in the tank to remain constant. Now here is something important. Before adjusting the carburetor pour in enough fuel to HALF fill the tank. The distance the fuel has to be lifted will affect the adjustment. At half full we have an average operating condition, and the adjustment will be satisfactory if the engine is run with the tank full or nearly empty.

As the piston goes down in the cylinder with both the intake valve and the throttle open, a low pressure area is created in the carburetor throat. A slight restriction is placed between the air horn and the carburetor throat at the choke. This helps to maintain the low pressure.

The difference in pressure between the tank and the carburetor throat forces the fuel up the fuel pipe, past the needle valve, through the two discharge holes. The throttle is relatively thick, so we have, in effect, a venturi at this point, thus aiding vaporization. A spiral is placed in the throat to help acceleration and also to help keep the engine from dying when the throttle is opened suddenly.

The amount of fuel at operating speed is metered by the needle valve and seat. Turning the needle valve in or out changes the setting until the proper mixture is obtained. This adjustment must always be done while the engine is running at operating speed, not at idle speed. While the needle valve may look like an idle valve due to its position, it is a true high speed mixture adjusting valve.

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Since no accelerator pump is used on this carburetor and since many of these engines are used on lawn mowers where rapid acceleration is needed, the mixture should be rich. Turn the needle valve in until the engine begins to lose speed, indicating a lean mixture. Then, open the needle valve past the point of smooth operation until the engine just begins to run unevenly. Since this setting is made without load, the mixture should operate the engine satisfactorily under load.

These carburetors do not have an idle valve, but the mixture at idle speed is controlled in a different way. As the throttle closes to idle, the leading edge takes a position between the two discharge holes. The larger of the discharge holes is now in the high pressure area, and the flow of fuel through it will cease. The small hole will continue to discharge fuel but the amount will be metered by the hole size and will be in proportion to the reduced air flow. For this reason it is important that the small discharge hole be of the proper size. The needle valve will allow much more fuel to pass than should go through the small discharge hole. A number 68 drill can be used as a plug gauge to check the small hole. A number 56 drill can be used to check the larger hole. This can be done with the needle valve and seat removed. See Fig. 20.

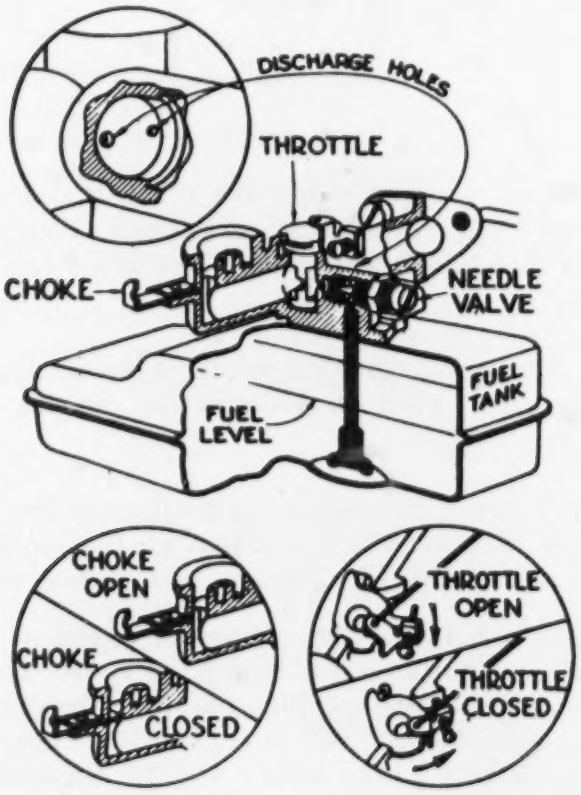

Figure 20

You will notice a small section is milled out of the throttle where it meets the discharge hole. This concentrates the flow of air past the hole and assures good vaporization.

The idle speed adjusting screw should be set to obtain an idle speed of 1750 RPM. This may seem fast to people accustomed to auto engines, but it is necessary in order to have fast acceleration. It also helps cooling and lubrication. A slight unevenness may be noticed at idle speed, but this is normal and no readjustments of the needle valve should be made.

The choke is the sliding plate mounted at the outer end of the carburetor. Fig. 20 and 21. The choke is pushed in to close the air intake for starting but should be pulled out as soon as the engine starts. The use of this choke should be understood clearly. Many complaints of engine trouble, upon investigation prove to be nothing more than failure to properly use the choke, especially where the choke is operated by a remote control. The choke must close fully.

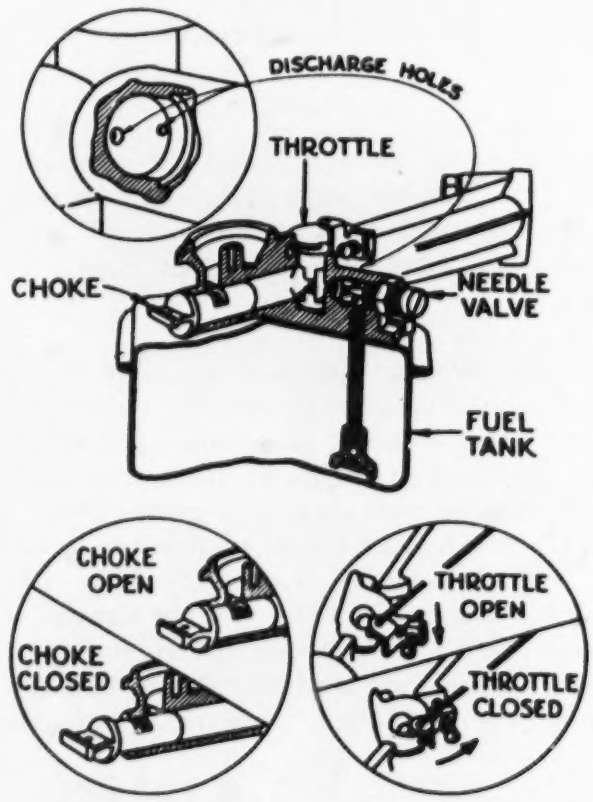

Figure 21

The latest engines with Vacu-Jet carburetors incorporate a ball check in the fuel pipe which assures a steady flow of fuel to the needle valve and discharge holes.

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PULSA-JET CARBURETORS

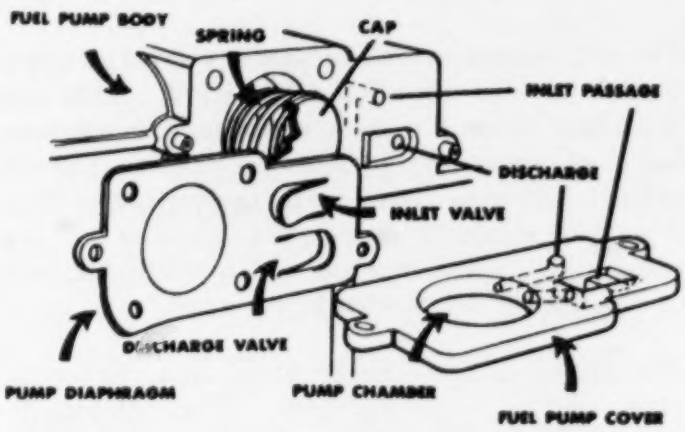

Figure 22

The Pulsa-Jet is a full carburetor incorporating a diaphragm type fuel pump and a constant level fuel chamber.

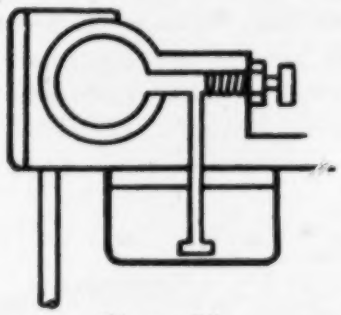

Figure 23

The fuel tank, the fuel pump and the constant level fuel chamber serve the same functions as the gravity feed tank, the float and the float chamber of conventional "float type" carburetors.

This new design makes it possible to obtain just as much horsepower from the Pulsa-Jet carburetor as is obtained from more complex "float type" carburetors. This is due to the fact that the Pulsa-Jet provides a constant fuel level directly below the venturi as illustrated in Fig. 23. With this design, very little fuel "lift" is required to draw gasoline into the venturi. The venturi can be made larger, permitting a greater volume of fuel-air mixture to flow into the engine with a consequent increase in horsepower.

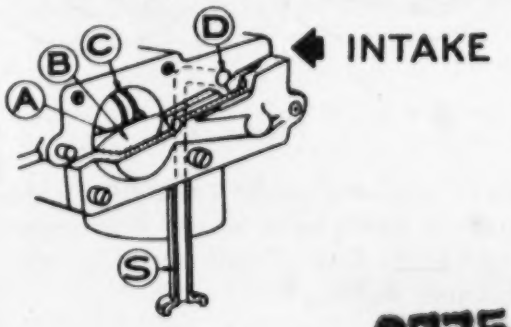

Figure 23A

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Vacuum created in the carburetor elbow by the intake stroke of the piston pulls cap A and pump diaphragm B inward and compresses spring C.

The vacuum thus created on the "cover side" of the diaphragm pulls gasoline up suction pipe S and under intake valve D into the pocket created by the diaphragm moving inward.

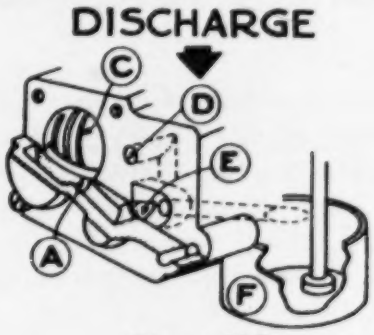

Figure 23B

When engine intake stroke is completed, spring C pushes plunger A outward. This causes gasoline in the pocket above the diaphragm to close inlet valve D and open discharge valve E. The fuel is then pumped into fuel cup F.

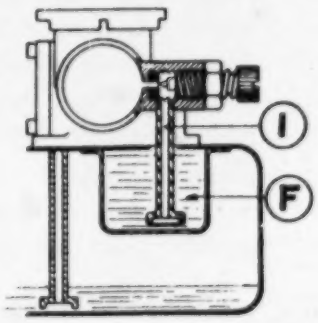

Figure 23C

On the next intake stroke the cycle is repeated and this pulsation of the diaphragm keeps the fuel cup full. Excess fuel flows back into the tank.

The venturi of the carburetor is connected to intake pipe I which draws gasoline from the fuel cup F.

Since a constant level is maintained in the fuel cup, the engine gets a constant air-fuel ratio no matter what fuel level exists in the main tank.

From this point on the carburetor operates and is adjusted in the same manner as is the Vacu-Jet carburetor except that the fuel tank does not have to be half full as in the Vacu-Jet. It can be full or almost empty and the adjustment will be the same since the fuel level in the small cup is always the same. There are no valve chambers in the fuel pipes. The flaps on the diaphragms serve as valves.

8773

Gas and Oil

We recommend the use of fresh, clean, "REGULAR" gasoline. Do not use store gas, naptha or other such low-test fuels that have a rating below 80 octane. Neither is it necessary to use highly leaded premium fuels.

It is recommended also that fuel be purchased in amounts that will be used up within a short time. Stale gasoline can cause gum or varnish in the fuel tank, carburetor, and combustion chamber. If the engine is not to be used for a period of 30 days or more, drain the fuel tank and carburetor to avoid gum deposits.

The recommended oils are those identified as being "suitable for service MS". For summer (over 40° F) use SAE 30. If not available, use 10W-30 oil. For winter (under 40° F) use SAE 5W-20. If not available, use 10W oil and dilute with 10% kerosene.

The air entering the engine is important in engine performance and engine life. Power will decrease 3½% for every 1,000 feet above sea level.

Power will also decrease 1% for every 10 degrees Fahrenheit above the standard temperature of 60 degrees Fahrenheit. In addition the ambient temperature is important in the cooling of the engine. (Ambient temperature is the temperature of the air immediately surrounding the engine.)

One of the reasons for engine wear is dirt that gets into the engine. When you consider that one of these 3 HP engines operating at 3600 RPM uses about 390 cubic feet of air an hour entering at the rate of about 24 miles an hour and that many such engines operate in very dusty conditions you can visualize the amount of dust and dirt that can enter an engine if it does not have an air cleaner or if the air cleaner is not functioning properly. If dirt gets past the air cleaner it enters the combustion chamber. Some may be blown out through the muffler but some may adhere to the cylinder where it creates ring wear or it may work down the walls into the crankcase where it causes wear on all the moving parts.

While speaking of the air cleaner we should remember to stress regular and proper maintenance of this important device. Occasionally, we have reports of operators adding oil to the exact center of the air cleaner body. Of course, this fills the air cleaner elbow and carburetor with oil, causing starting trouble and excess smoking. The operator should add oil to the air cleaner body only – and not to fill above the oil level mark.

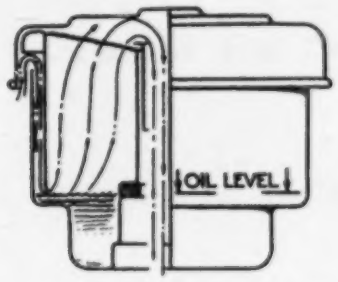

Figure 24

Dirt that enters the engine through the breather also can wear out any engine. It is very important to see that the breather is vented on all engines used in dusty surroundings.

Oil Foam No Spill Air Cleaners

For many years the oil bath air cleaner, see Fig. 24, was considered the best, but recently Briggs & Stratton developed the Oil Foam "No Spill" Air Cleaner. See Fig. 25. This cleaner employs a polyurethane element. The important patented feature is that it is sealed. Other cleaners are made with a polyurethane element but some are merely blocks of material with no seals of any kind thus allowing the air and dirt to by-pass the element. The Briggs & Stratton cleaner uses the edges of the element as gaskets so that the air must pass through the element.

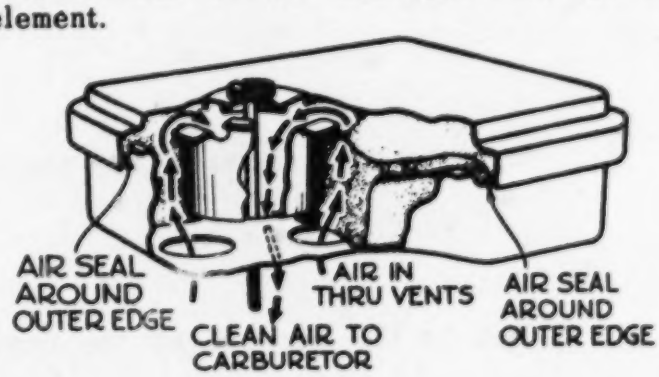

Figure 25

There are two other important features of the "No Spill" cleaner. Oil will not spill if the engine is tilted. If the element becomes loaded with dirt the air supply will be shut off so the engine will lose power or stop entirely. Then the element can be cleaned, reoiled and reinstalled as good as new. The element must be re-oiled after cleaning.

6776

Carburetion

1. What is the purpose of the carburetor?

2. What is a venturie?

3. What is an airfoil?

4. Where are the two air holes located on a gravity-fed fuel system?

5. What is the purpose of a float in a gravity-fed carburetor? Explain how it works.

6. How is the float level adjusted in a Briggs and Stratton carburetor?

7. What mixture of air and gas will give an ideal combustion mixture?

8. Explain how to adjust the carburetor for maximum power.

9. Why is a lean mixture for the carburetor not economical?

10. What is the purpose of the butterfly in the carburetor throat?

11. Explain how the butterfly increases and decreases the speed of the engine.

12. What is the purpose of the idle valve on a carburetor?

13. What is the purpose of the butterfly in the air horn? Explain how it works.

14. What are the main differences between a gravity-fed carburetor and a suction fed carburetor?

15. How much fuel should be in the tank when adjusting a suction-fed carburetor?

16. Explain how to adjust a suction-fed carburetor.

17. Explain how the Pulsa-jet carburetor works.

18. Why should we drain the fuel tank during the winter?

19. What type oil is recommended for the one-cylinder engine?

20. What maintenance is necessary for the air cleaner?

21. What are the two different type air cleaners?

6778

SECTION 3 - IGNITION

A magneto in a sense consists of two simple circuits, one called a primary circuit and the other the secondary circuit. Both circuits have windings which surround the same iron core and the magnets in the flywheel or rotor act on both circuits. Current can be induced in each by changing the magnetism in or around the coils of the circuit.

The primary circuit has relatively few turns of heavy wire and the circuit includes a set of breaker points and a condenser.

The secondary circuit has a coil with many turns of lighter wire which are wound around the outside of the primary winding, and includes a spark plug. There are about 60 turns in the secondary to each turn in the primary.

A permanent magnet is mounted in the flywheel or rotor. As the flywheel rotates, the magnet is brought into proximity with the coil and core.

The Briggs & Stratton new ignition magneto system differs from ordinary magnetos in that the voltage produced is tailored to the needs of the engine. See Fig. 26. The magnet used in this new type is a ceramic which develops a very high magnetic strength in a very short distance. The length of this magnet is 3/8" as compared with the Alnico magnet length of 7/8".

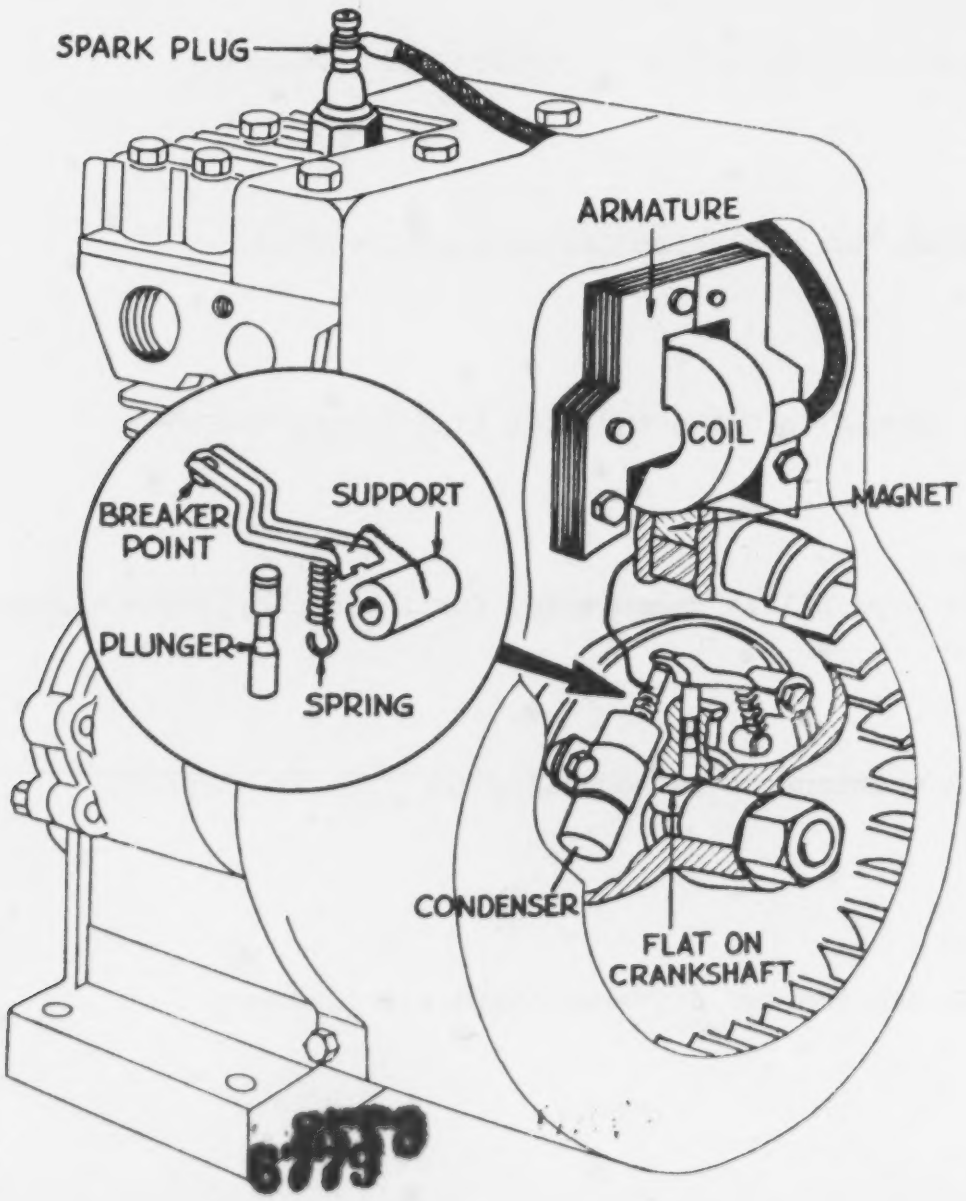

Figure 26

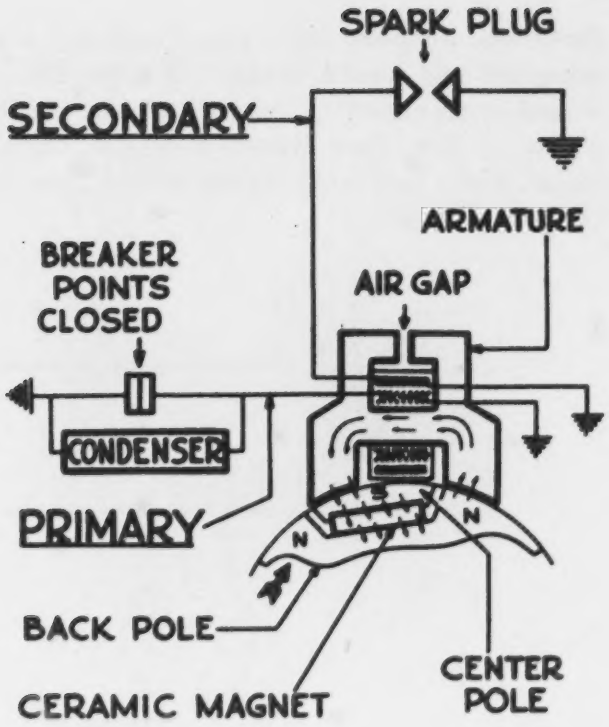

Figure 27

Fig. 27 shows the flow of magnetism through the iron core of the coil as the magnet in the flywheel approaches the armature. The arrows indicate the direction of flow of the magnetic field. You will notice that there is no (or very little) magnetism flowing through the upper part of the core. This is because of the air gap at the top which causes a resistance. In this position our breaker points close.

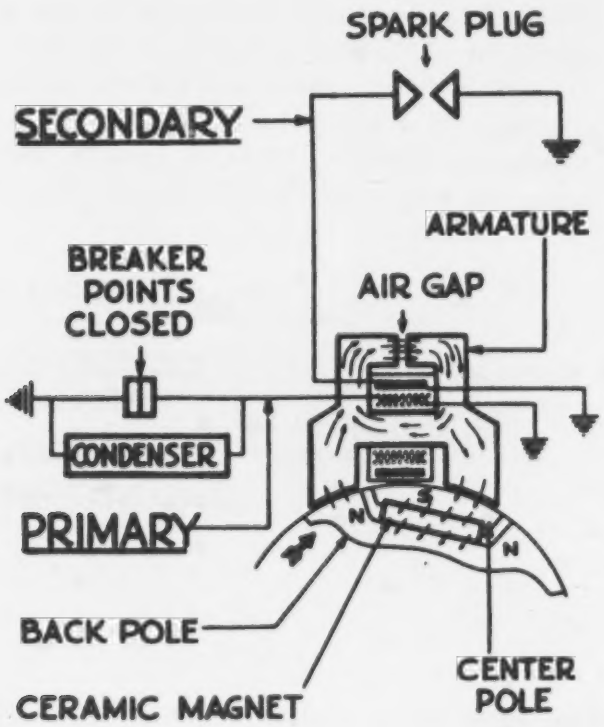

Figure 28

The flywheel continues to rotate to the position shown in Fig. 28. The magnetism continues to flow in the same direction and magnitude through the center of the core because of primary current. However, the magnetism flows in an opposite direction through the outer portion of the core and through the top air gap because of the change of flywheel position. Since the shunt air gap provides a path for the flux from the armature legs and the core, the required current flow through the primary circuit is low, assuring long breaker point life.

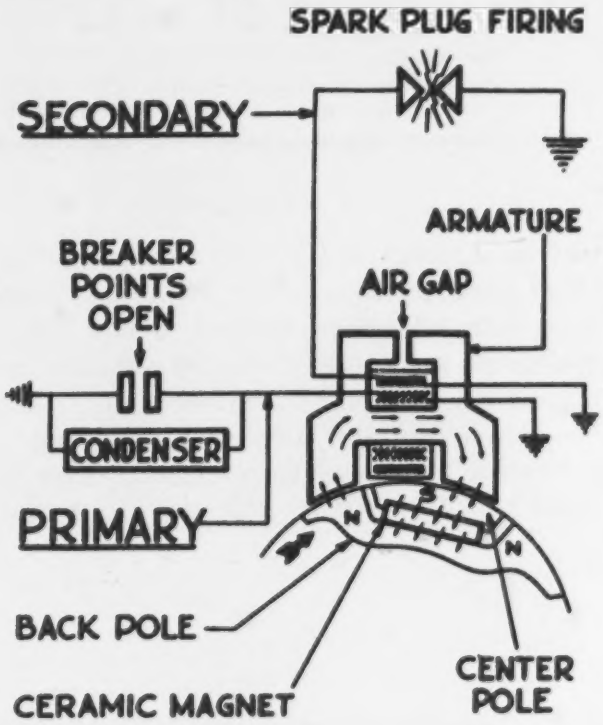

Figure 29

At this position our breaker points open, the current stops flowing in the primary circuit and therefore the electromagnetic effect ceases. The magnetism instantaneously changes from the flow shown in Fig. 28 to that shown in Fig. 29. Note the opposite direction of the arrows indicating a complete reversal of magnetism which has happened so fast that the flywheel magnet has not had a chance to move any noticeable amount.

The rapid change in magnetism produces 170 volts in the primary winding. A voltage is also induced in the secondary but it is in proportion to the turns ratio, i.e., 60 to 1 or 10,000 volts. This voltage is more than ample to fire across the spark plug electrodes. This rapid magnetism change is very short and therefore the flow of current across the spark plug gap is as long as necessary, but short enough to afford long electrode life. Thus we achieve our aims of full power plus long life and dependability.

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Now, we haven't said much about one thing, the condenser. The condenser is a sort of safety valve on the primary circuit. It is connected across the breaker points to prevent the circuit from jumping the breaker point gap, arcing, as it is called.

Figure 30A

Let us explain it this way. Suppose we had a large pipe through which we forced water at a high rate of speed, Figure 30A. This corresponds to our primary circuit. Coming out of the large pipe is a much smaller pipe. This is our secondary circuit. As long as the large pipe is unobstructed, the water is free to flow and very little will flow out through the small pipe.

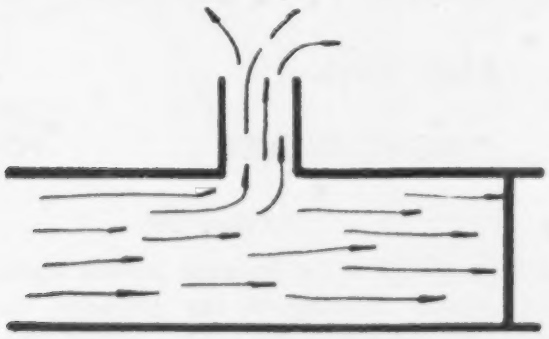

Figure 30B

Now suppose we could suddenly shut off the large pipe, Figure 30B. The water will stop flowing through the large pipe, but the inertia of the water back in the large pipe will force the water out through the small pipe at a tremendous velocity until the pressure is dissipated. This corresponds to the high voltage in our secondary circuit.

Figure 30C

However, suppose our valve could not stand the pressure and would break. (Figure 30C.) This would correspond to arcing across the breaker points. The flow would continue through the large pipe, and very little would flow through the small pipe.

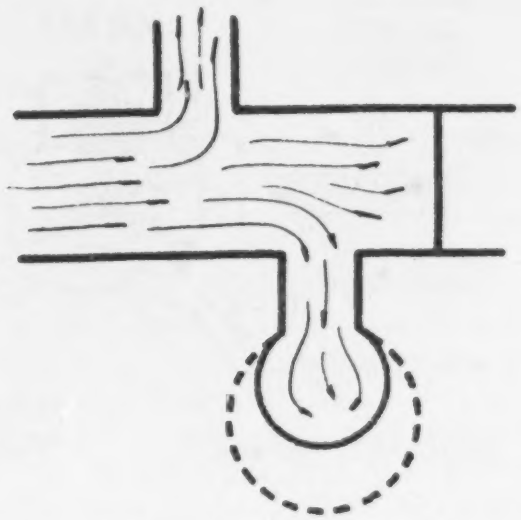

Figure 30D

If we put another small pipe near the valve, (Figure 30D) and over the end place a strong rubber bag, we have the equivalent to our condenser. Thus, when we close our valve, the pressure on the valve would be partially absorbed by the rubber bag, the valve would not break and water would stream out the small pipe where we want it to go.

The rubber bag must be of the proper size and strength. If it is too small, it will not take up enough of the pressure and the valve will break anyway. If it is too large, it will hold too much water, and there will not be enough pressure to force the water out through the small pipe.

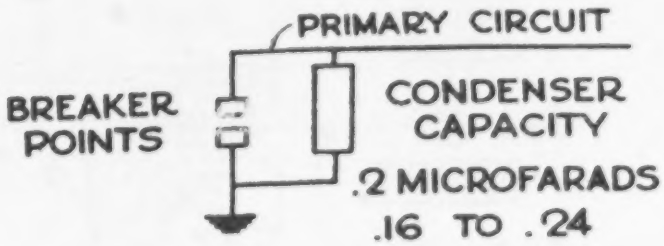

Figure 31

The same thing applies to the condenser. The proper capacity should be about .2 microfarads [illegible] .24. This is just right to prevent arcing at the points and still cause the primary current to stop flowing.

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Spark plug cables are molded into the coil so that moisture cannot short out the spark as could happen on older coils that had an open connection between coil and spark plug cable.

We would like to point out that at one time some mechanics would try to judge the condition of the magneto system by the brightness and the noise or "snap" of the spark. This is not a good criterion as you can quickly demonstrate by using a resistor type spark plug and a regular type spark plug. Lay them on top of the cylinder head and connect the spark plug cable to first one and then the other. Spin the flywheel and notice the spark across the electrodes. You will see that the spark across the resistor plug will be much thinner and makes less noise and yet we know that engines run very well on these plugs.

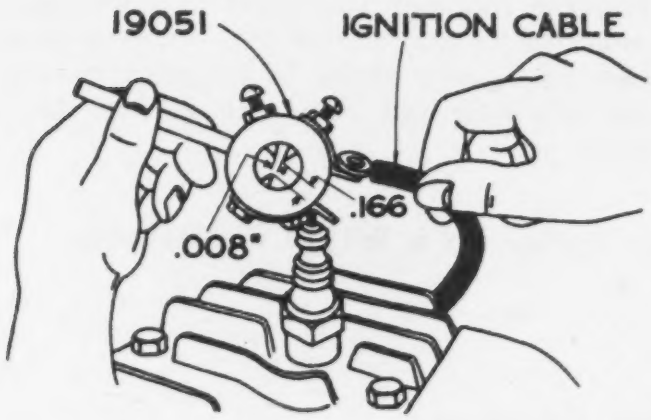

Figure 32

The magneto can be tested by placing the spark tester, #19051, between the ignition cable and the spark plug as shown in Fig. 32. Then spin the flywheel vigorously. The spark should jump the .166" gap.

This test can also be performed with the engine running but the cable should be shifted quickly from spark plug to tester or from tester to spark plug. Damage to the coil can result if the engine spins more than just a few revolutions with the cable disconnected. This running test should not be performed on the Models 9, 14, 19, 23 with the Magnematic ignition system.

Through the years the magneto systems on the various Briggs & Stratton engines have differed somewhat in the design of the parts. However, the basic principle of a primary and a secondary circuit is used in all models.

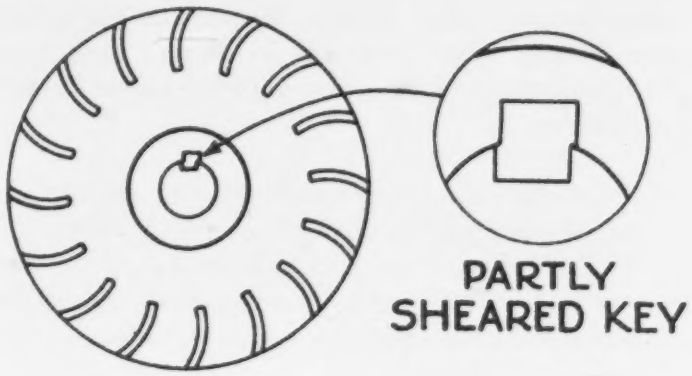

Figure 33

On small engines, be sure that the flywheel key is not partially sheared as this can cause the timing to be off enough to result in hard starting. Do not, however, use a steel key. The soft metal key is used so that if the flywheel should become loose the key will be sheared, allowing the flywheel to shift and stop the engine before any further damage occurs. Remember that the flywheel key is a locater and not a driver.

6782

SECTION 4 - "EASY SPIN" STARTING

Good compression is necessary in order to obtain the full horsepower of the engine but at the same time this makes it more difficult to turn the engine over fast enough to start it. The resistance of compression is most noticeable during the first few revolutions after which the momentum of the flywheel and crankshaft help until firing starts in the cylinder.

In order to reduce this resistance during starting time, various types of compression releases have been used. However, none proved entirely satisfactory until Briggs & Stratton developed the "Easy Spin" starting system. This is so simple one wonders why it was never thought of before.

The intake lobe on the cam gear is ground with a small ramp which holds the intake valve open 1/100 of an inch for a tiny fraction of the compression stroke. At slow starting speed the interval of time that the valve is open is relatively long and therefore enough air escapes to noticeable reduce the compression. However, at operating speeds the interval of time is so short that there is practically no escape and therefore horsepower is unimpaired. Actually at 3600 RPM the valve is opened for a mere 1/200 of a second. In all other respects the valves operate as in any other four stroke cycle engine.

The force required to start an engine is reduced by 50% with "Easy Spin" and would be noticed most by a person who has difficulty starting the ordinary engine.

One thing we must remember. When testing the compression of "Easy Spin" engine one must spin the flywheel "backward", in the opposite direction to normal rotation. This will bring the compression stroke on the opposite side of the cam lobe and allow you to feel the compression.

1. What are the major parts of the ignition system in a Briggs & Stratton engine?

2. Explain how the breaker points are opened and closed.

3. What is the purpose of the condenser in the primary circuit?

4. What happens if the flywheel key is partially sheared?

5. What is the purpose of the governors on an engine?

6. What are the two basic type governors on a Briggs and Stratton engine?

7. How can the magnets be tested?

8. Why is the flywheel key made of soft material?

SECTION 5 - GOVERNING

While some people think that a governor on an engine is to prevent overspeeding, the real purpose in the small engine field is to maintain a desired speed regardless of load. With a fixed throttle position, the engine could speed up if the load was lightened; if the load is increased the engine would slow down or even stop.

A governor on the other hand will close the throttle if the load is lightened or open the throttle to obtain more power if the load is increased.

Basically, governors consist of two types – the pneumatic or air vane type, Fig. 34, and the mechanical or flyball weight type, Fig. 35.

The pneumatic governor as illustrated in Fig. 34 is operated by the force of the air from the flywheel fins. When the engine is running the air from the fins pushes against the air vane. The air vane is connected to the carburetor throttle by means of a link. The force and movement of these parts tends to close the carburetor and thus slow down the engine speed.

Opposed to this is the governor spring which tends to pull the opposite way, opening the throttle. This spring is usually connected to an adjustable control of some kind so that the tension on the spring can be changed at the will of the operator. Increasing the tension of the spring will increase the engine speed. Decreasing the tension will lower the engine speed. The point at which the pull of the spring equals the force of the air vane is called the "governed speed"

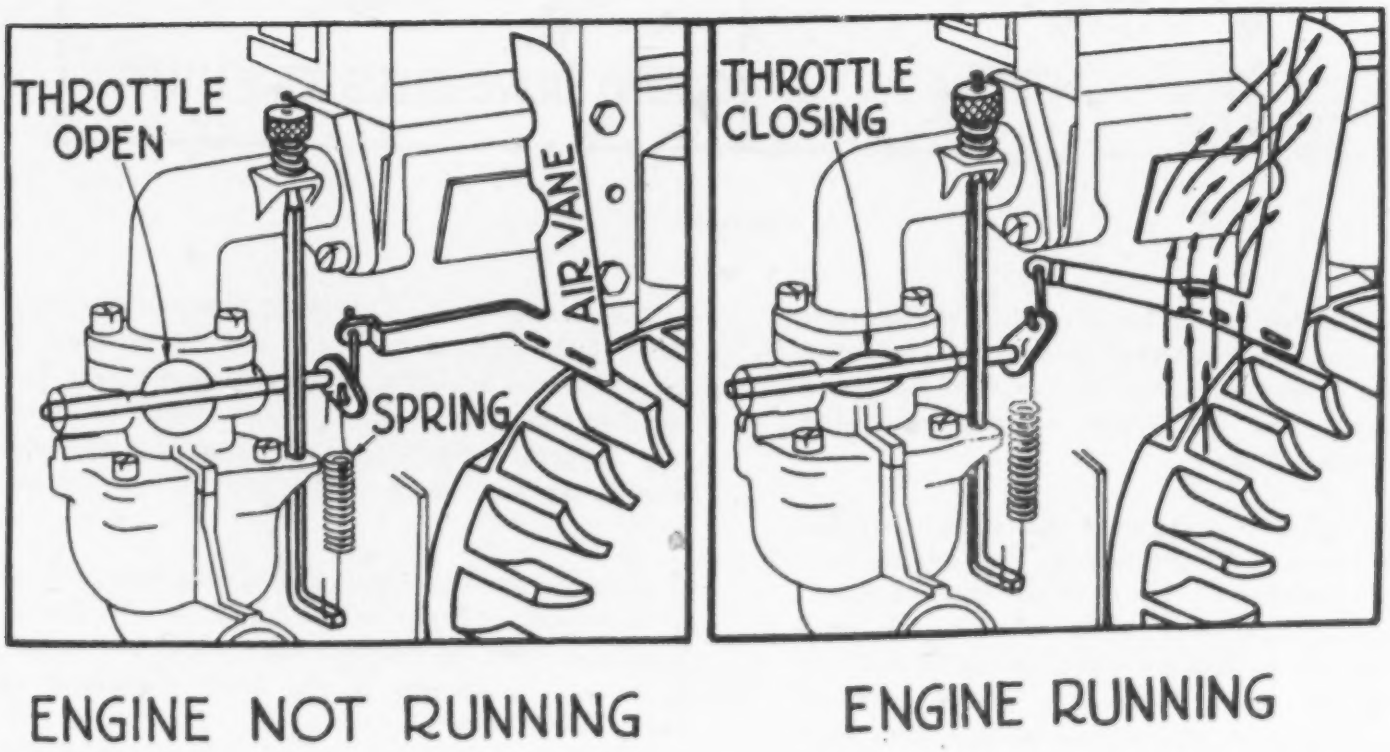

Figure 34

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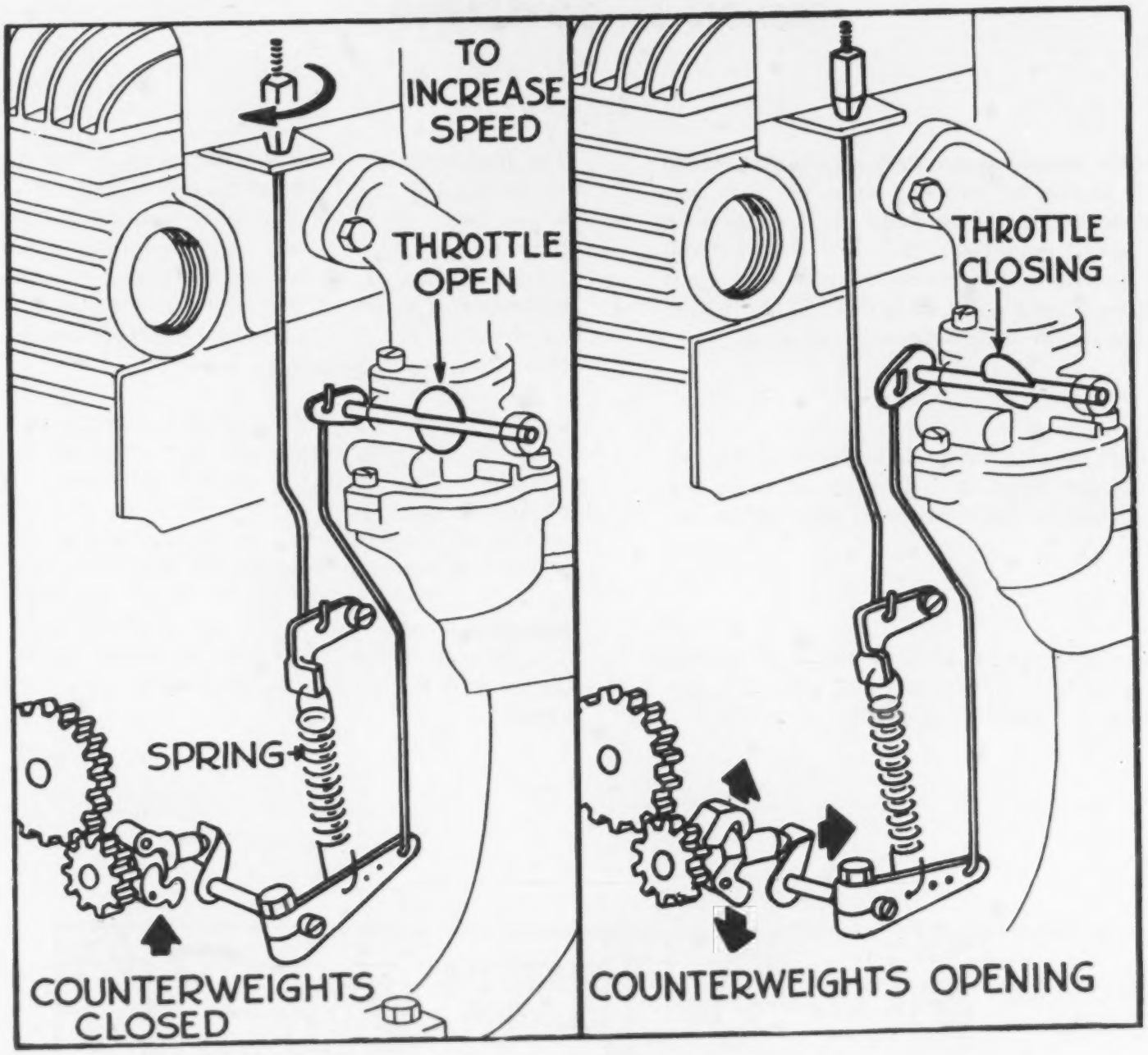

Figure 35

The mechanical governor, Fig. 35, works in a similar manner except that instead of the force of the air blowing against the vane, we have the centrifugal force of flyball weights opposing the governor spring.

In either case, operation is the same. As the load on the engine increases, the engine will start to slow down. As soon as this happens, the centrifugal force of the flyball weights lessens. This allows the governor spring to pull the throttle open wider increasing the horsepower to compensate for the increased load and thus maintain the desired governed speed.

If the load on the engine lessens, the engine starts to speed up. This will increase the pressure of the centrifugal force and the spring will be stretched a little farther thus closing the throttle and reducing the engine power. A properly functioning governor will maintain this desired governed speed within fairly close limits.

In general, an engine that has good compression, carburetion, and ignition will operate efficiently. However, dirt or neglect can ruin an engine quickly. It should be the duty, therefore, of every salesman or repair man to instruct the customer in the proper operation and care of the engine so that he will obtain the long service life that is built into the engine at the factory.

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POWER WOODWORKING TOOLS

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INTRODUCTION TO POWER WOODWORKING TOOLS

The power woodworking tools discussed in this unit may be used for a variety of operations.

The jointer is designed for jointing edges of boards and for rabbeting. It can be used for beveling, surfacing, and tapering.

The radial arm saw is used to crosscut, cutting angles, miters, and dadoing. For these operations it is quicker and much more convenient than a circular saw.

The wood turning lathe is used to turn rounded objects, such as, table legs, lamps, etc. Turning wood on the wood turning lathe will probably be the most interesting operation in woodworking for the student.

The planer is used to remove rough surfaces of lumber in order to obtain a smooth finish and a desirable thickness.

The shaper is used to cut the edges and ends of stock for molding, decorative effects, and joints.

All of these machines are dangerous to operate. A complete study of the operation procedures and safety precautions by the student must precede actual operation of the machine.

Power Woodworking Tools

1. Safety
2. The jointer
3. The wood turning lathe
4. The radial arm saw
5. The planer
6. The shaper

6787

SAFETY PRACTICES TO FOLLOW WHILE OPERATING THE JOINTER:

1. Never joint lumber less than 10 inches long.
2. Always use a push stick on small stock.
3. Joint with the grain to prevent splintering.
4. Use care when jointing knotty lumber.
5. Make sure the fence is locked before starting the machine.
6. Keep hands away from the area above the cutterhead.
7. Avoid deep cuts.
8. Avoid wearing loose clothing.
9. Stop the machine before making any adjustment.
10. Keep your mind on the job to be performed.
11. Hold the board tightly against the fence.
12. Do you thoroughly understand the safety regulations as discussed?

Yes:_____ No:_____

Signed:_____

Date:_____

SAFETY PRACTICES TO FOLLOW WHILE OPERATING THE RADIAL ARM SAW:

1. Disconnect current before replacing the saw blade.
2. Never leave tools or metal on the saw table.
3. Stop the saw before making adjustments.
4. Avoid all horseplay while operating the saw.
5. Never attempt to stop the blade by pushing lumber into it.
6. Never wear gloves or loose clothing.
7. Use the anti-kickback while ripping.
8. Always push the saw back before removing stock.
9. Use a push stick when ripping.
10. In ripping, be sure to start the board on the side opposite the anti-kickback. The bottom of the saw must be turning toward the board being ripped.
11. Pull the saw slowly when cutting off stock.
12. Be sure the lumber is flat on the table and tight against the fence.
13. Do not saw warped or crooked lumber.
14. Keep the floor around the saw clean.
15. Inspect the lumber for nails and other materials.
16. Do you thoroughly understand the safety regulations as discussed?

Yes:_____ No:_____

Signed:_____

Date:_____

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SAFETY PRECAUTIONS TO FOLLOW WHILE OPERATING THE WOOD TURNING LATHE:

1. Make sure the centers are properly imbedded in the stock before starting the lathe.
2. Select stock that is free of loose knots and splinters.
3. Clamp the tailstock firmly in place and lock the tailstock spindle before starting the lathe.
4. Keep the tool rest tight and close to the work.
5. Operate the lathe at the recommended speed for the size stock you are turning. (Table 22, page 585, The Farm Shop, by Wakeman and McCoy)
6. Stop the motor before making adjustments.
7. Remove the tool rest when sanding or polishing.
8. Avoid loose clothing.
9. Keep all tools sharp.
10. Never use a gouge for inside turning.
11. Hold the tool firmly in both hands.
12. Stop the lathe for calipering.
13. Observers should stand in front or to the end of the lathe.
14. Keep the area around the lathe clean.
15. Wear goggles or a face shield.
16. Place tools in the tool rack when not in use.
17. Do you thoroughly understand the safety regulations discussed?

Yes:_____ No:_____

Signed:_____

Date:_____

SAFETY PRECAUTIONS WHILE OPERATING THE PLANER AND SHAPER:

1. Obtain instructor's permission to operate the machine.
2. Make all adjustments with the power off.
3. Always keep hands away from moving parts.
4. Never overload the machine by taking too much cut.
5. Be certain the lumber to be surfaced is free of loose knots, nails, dirt and grit.
6. Do not wear loose clothes.
7. Never clean shavings from the machine while it is in operation.
8. Pass the lumber around the planer and not over it when running it through the second time.
9. Do you thoroughly understand the safety regulations discussed?

Yes:_____ No:_____

Signed:_____

Date:_____

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THE RADIAL ARM SAW

Give the principal use of the following parts of the radial arm saw:

1. Track locking lever

2. Blade guard

3. Handle

4. Arm track

5. Elevating crank

6. Sawdust spout

7. Motor control

8. Adjustable fence

9. Anti-kickback

Materials and Equipment

1. Radial Arm Saw
2. One piece of 2 x 4 x 8"

Exercises for students

1. Make all adjustments on the saw.
2. Crosscut a piece of lumber.
3. Cut a bevel on a board.
4. Cut a 45° angle on a board.
5. Cut a compound angle on a board.
6. Rip a board (with caution).
7. Cut a dado.

6790

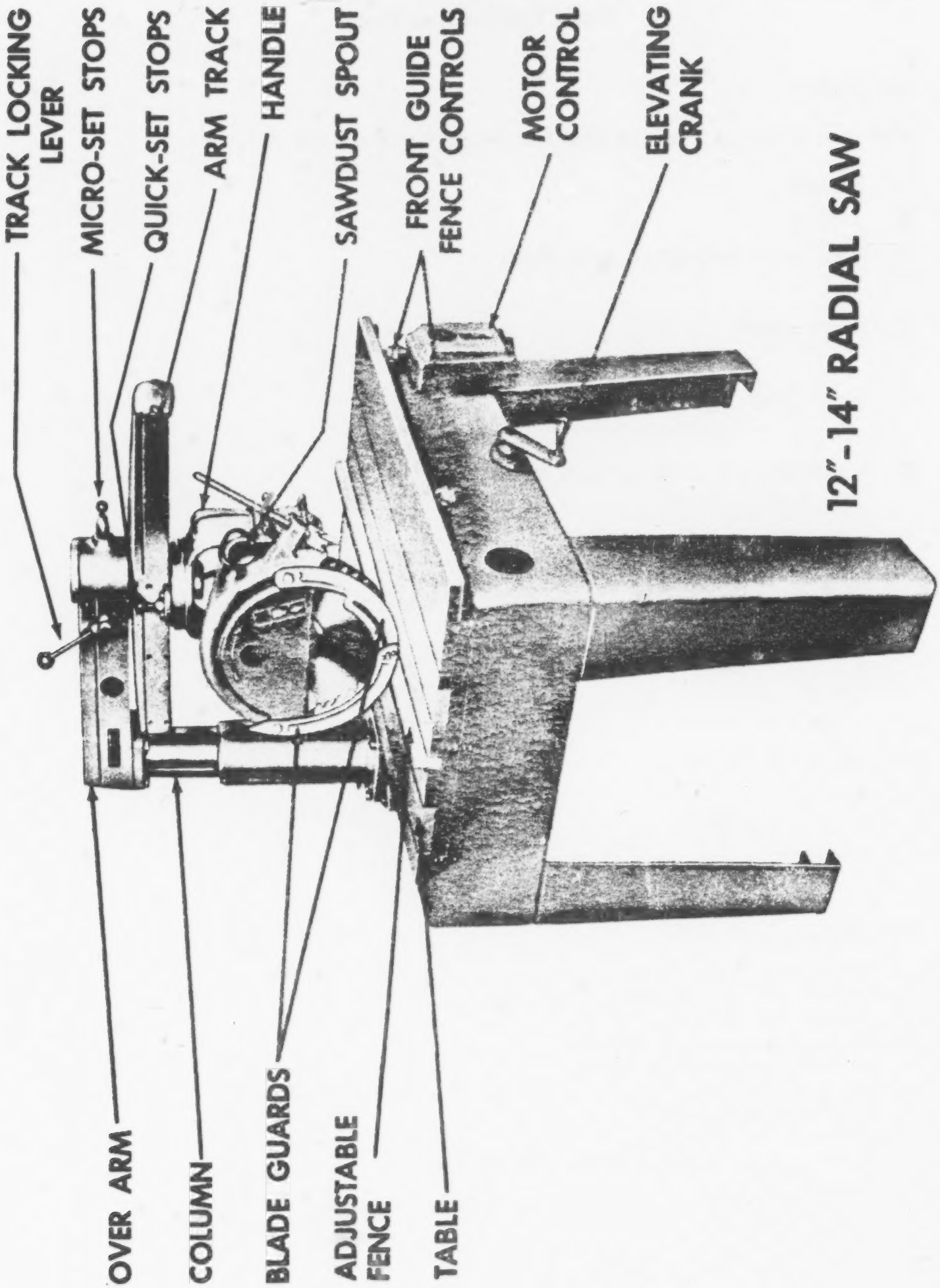

12"-14" RADIAL SAW

6791

THE JOINTER

Give the principal use of the following parts of the jointer:

1. Fence

2. Rear table adjusting hand wheel

3. Front guard

4. Depth scale

5. Front table adjusting hand wheel

6. Dual fence control handle

7. Tilt scale

Materials and Equipment

1. Jointer
2. One 2 x 4 x 8"
3. Wrenches

Exercises for students

1. Adjust the rear table.
2. Adjust the front table.
3. Adjust the fence.
4. Replace and adjust knives.
5. Joint the edge of a board.
6. Joint a chamber.
7. Make a rabbet cut.
8. Joint a 30° bevel.
9. Joint a flat surface using the push stick.

6792

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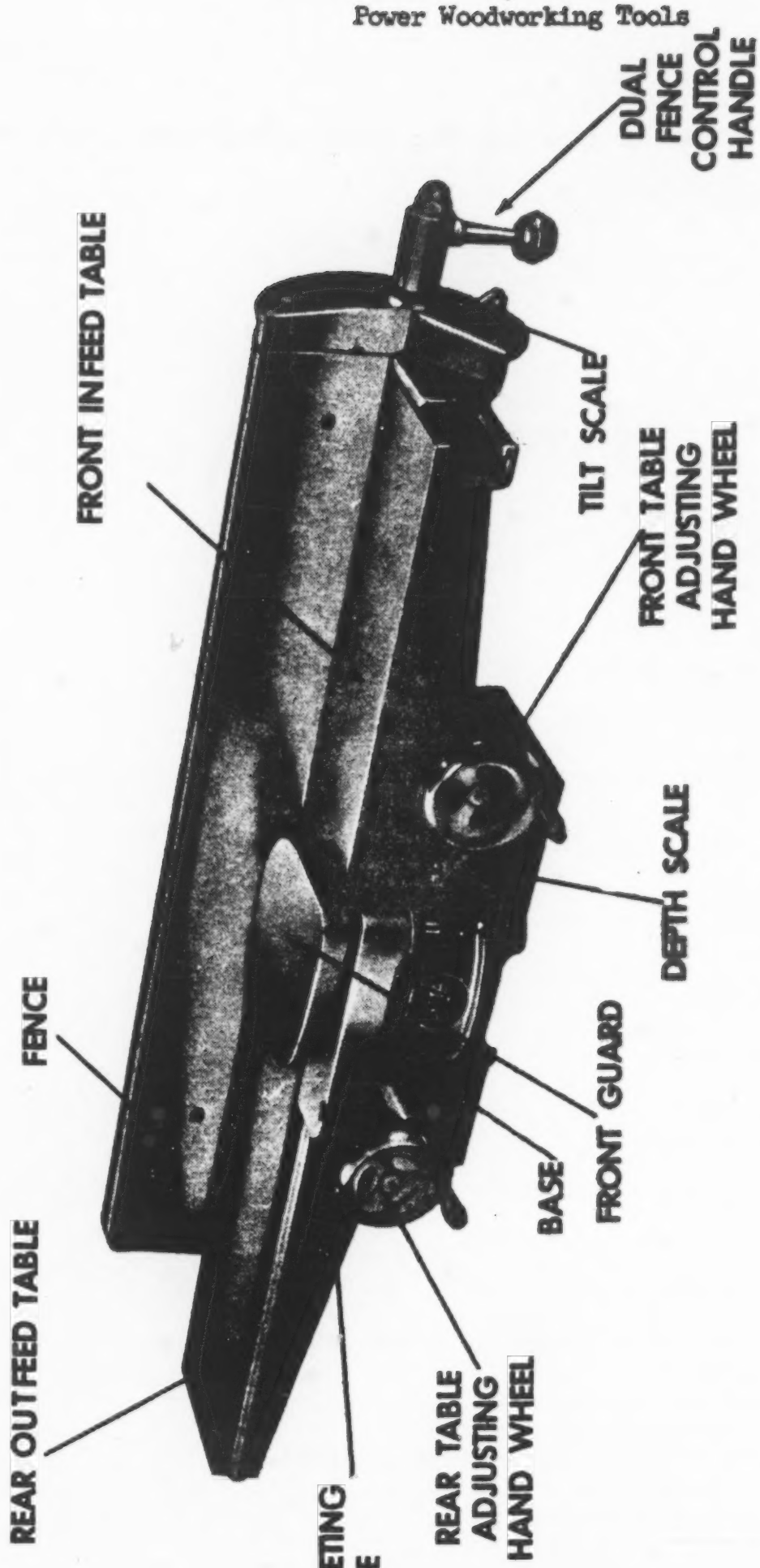

DELTA 6" JOINTER

6793

THE WOOD LATHE

Give the principal use of the following parts of the wood lathe:

1. Speed control wheel

2. Tool support

3. Locking handle for tool support

4. Variable speed dial

5. Tailstock locking clamp

6. Hand wheel

7. Spindle lock

Materials and Equipment

1. Wood turning lathe.
2. Wood turning chisels.
3. Calipers.
4. Wood turning stock.

Exercises for students

1. Practice making all adjustments on the lathe.
2. Select wood turning chisels.
3. Center a round and square stock.
4. Practice the procedure for turning.
5. Practice using dividers and outside calipers.
6. Sand cylindrical work.
7. Glue wood together for turning.
8. Practice faceplate turning.
9. Make a table lamp.
10. Make a salad bowl.

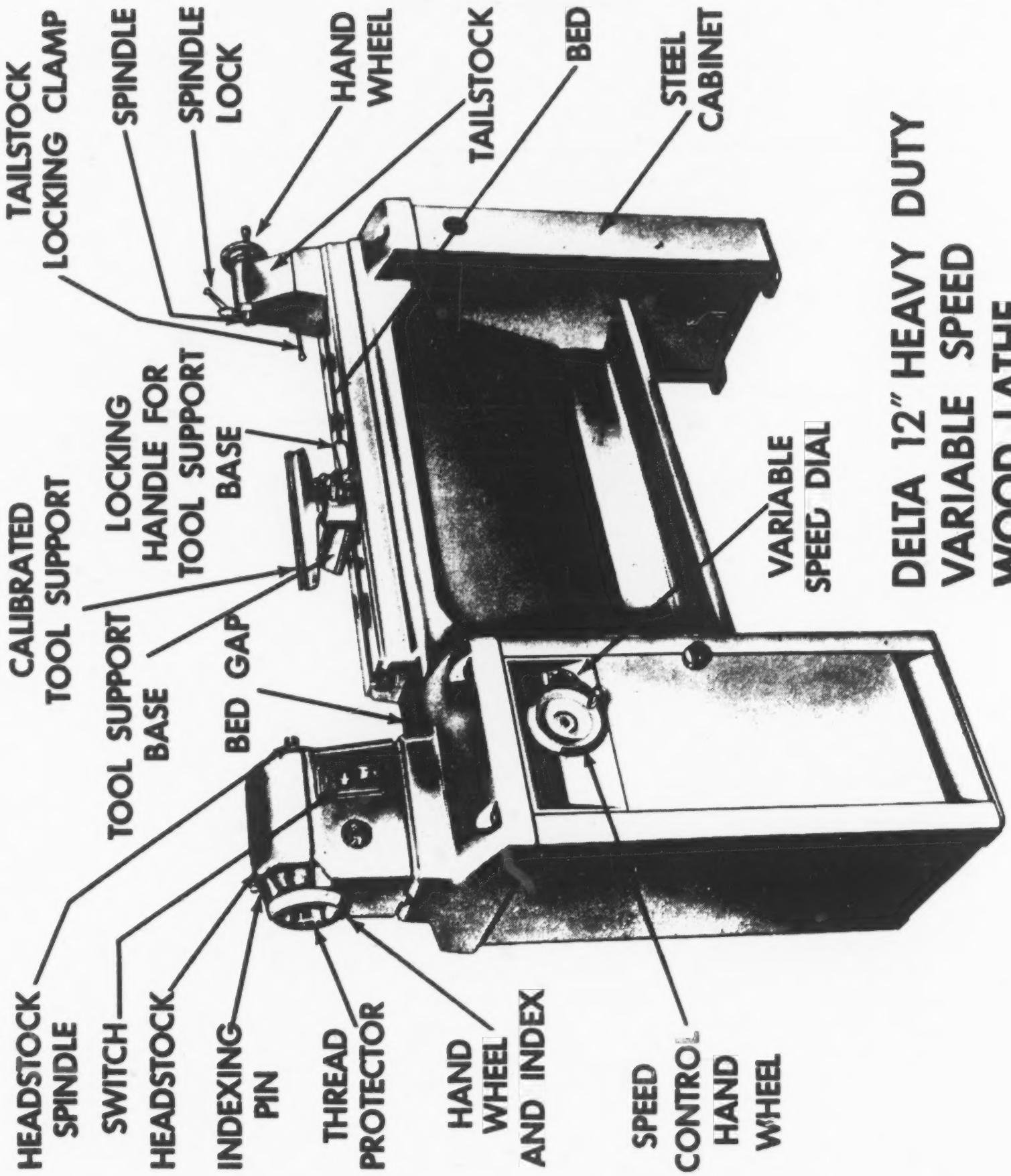

DELTA 12" HEAVY DUTY VARIABLE SPEED WOOD LATHE

6795

THE PLANER

Give the principal use of the following parts of the planer:

1. Feed roll

2. Table bed and upper wedge

3. Elevating handwheel

4. Variable speed feed roll control

5. Depth of gage

Materials and Equipment

1. One 13" x 5" planer
2. Wood stock

Exercises for students

1. Make all of the adjustments on the planer with the power disconnected.
2. Plane a piece of lumber.

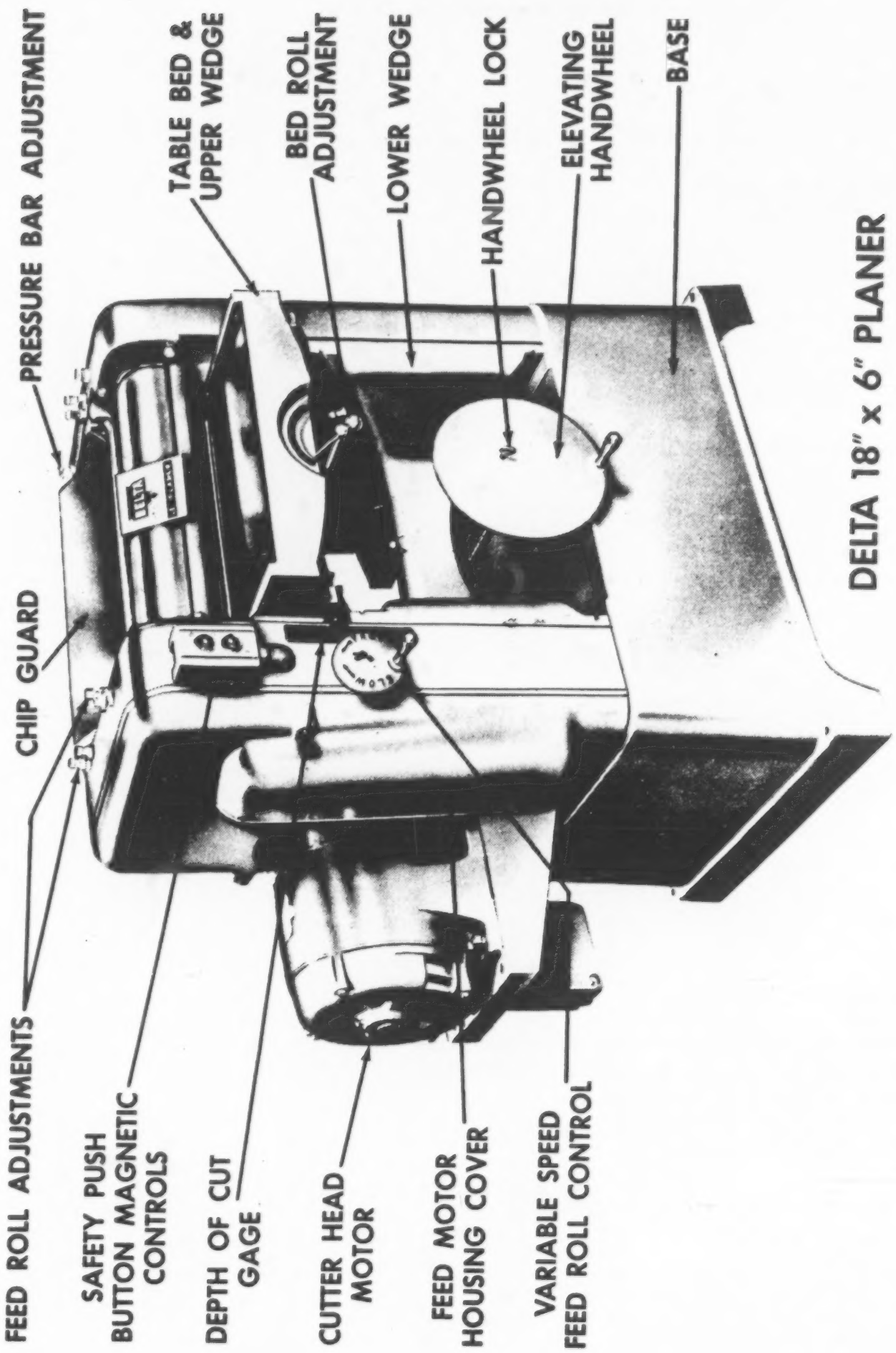

DELTA 18" x 6" PLANER

THE WOOD SHAPER

Give the principal use of the following parts of the shaper:

1. Miter Gage Groove

2. Spindle Raising Hand Wheel

3. Adjustable Fence

4. Hand Wheel Lock

Materials and Equipment

1. Shaper
2. Wood Stock

Exercises for Students

1. Make all the adjustments on the shaper.
2. Use all of the different cutter heads.
3. Make a piece of molding.
4. Make a piece of quarter round.
5. Cut several designs on stock.

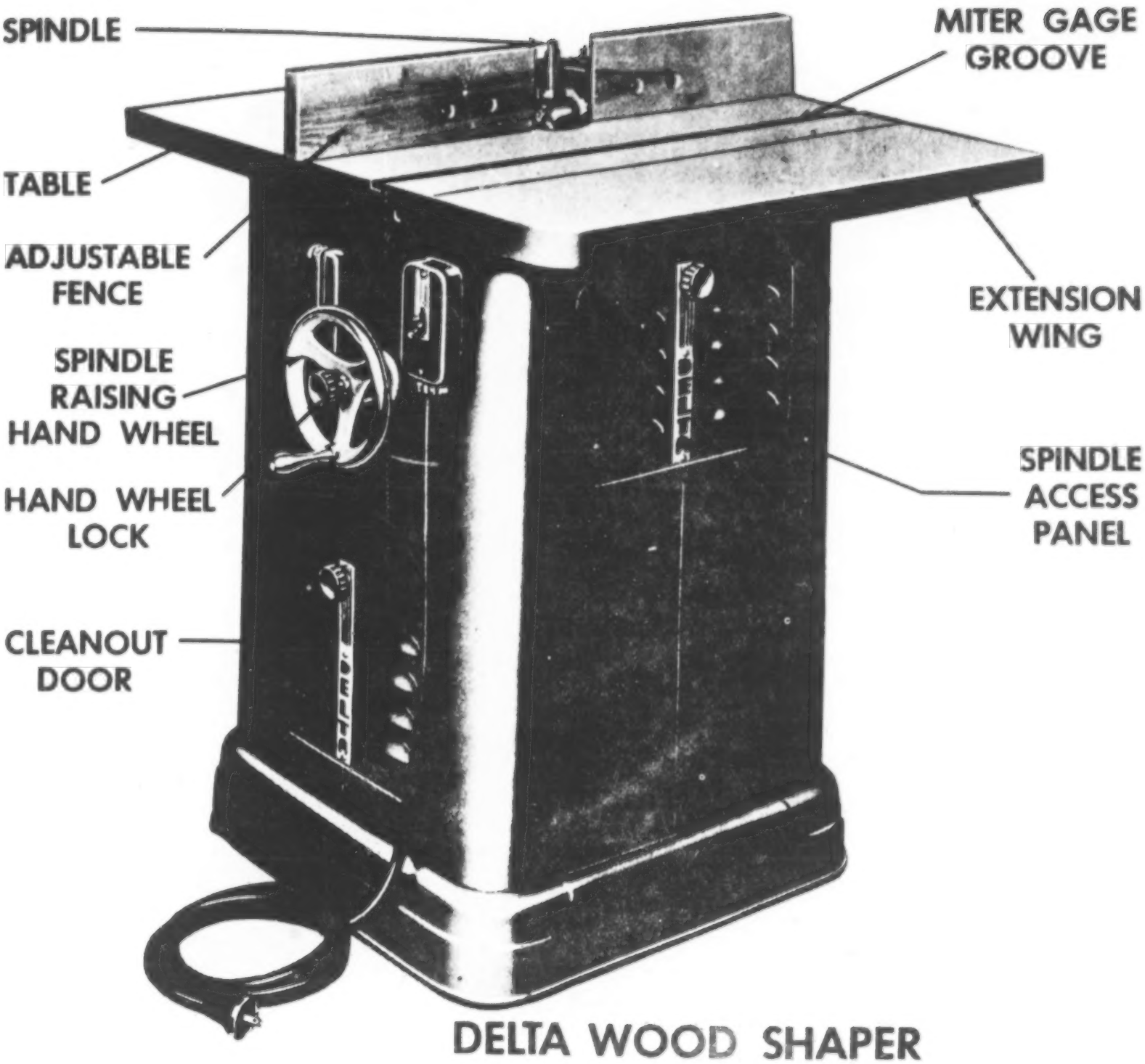

DELTA WOOD SHAPER

Power Woodworking Tools

1. What kind of cuts may be made on the jointer?

2. Describe how to adjust the rear table on the jointer.

3. Describe how to adjust the front table on the jointer.

4. Explain how to bevel a board on the jointer.

5. Explain how to cut a rabbet with the jointer.

6. What safety device must be used when jointing short boards?

7. What advantage does the radial arm saw have over the circular saw?

8. Describe how you would cut a 45° angle on the radial arm saw.

9. Describe how you would rip a board on the radial arm saw.

10. Explain how you would center stock for turning on a wood lathe.

11. In what way is the gage used? A skew chisel?

12. What is a faceplate used for?

13. How is a parting tool used?

14. Name the uses of the planer.

15. What is the wood shaper used for?

16. Explain how you would surface lumber with the planer.

17. Name [illegible] safety precautions to follow while operating the planer and shaper.

6800

FARM ELECTRICITY

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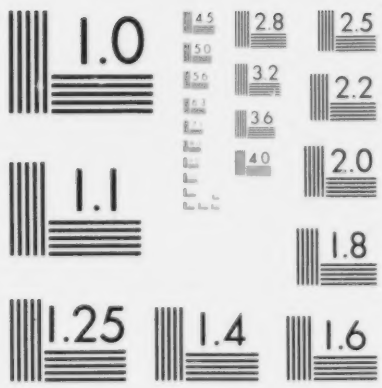

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

INTRODUCTION TO FARM ELECTRICITY

With the increased use of electrical appliances and equipment in the home and around the farm, many wiring systems have become overloaded and out of date. It is a frightful hazard to life and property to live with poorly controlled electric current.

This chapter is designed to give the student a basic understanding of how to go about planning an adequate wiring system. It will also provide practical knowledge, experience and techniques for maintaining and repairing existing wiring systems. The student will have an opportunity to examine his own system and determine the necessary improvements needed to have an up-to-date wiring system.

Farm Electricity

1. Safety
2. Electrical tools and equipment
3. Planning an adequate wiring system
4. Installing the entrance
5. Grounding
6. Wire size
7. Fusing
8. Replacing switches and outlets
9. Trouble shooting and testing devices
10. Modern wiring materials

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SAFETY PRACTICES IN ELECTRICAL WORK

1. Use proper type of wire, proper insulation, sufficient circuits and thoroughly ground the entire wiring system.

2. Never handle electrical equipment with wet hands or while standing on a damp floor.

3. Always disconnect the main switch when working on a circuit or changing a fuse.

4. When a fuse blows, correct the trouble before installing a new fuse.

5. Never insert coins or other metal devices behind the fuse.

6. Make sure the circuit is fused according to the wire size.

7. Do not install pull chain switches near plumbing fixtures.

8. Avoid using extension cords permanently.

9. Use only electrical equipment and supplies that have the "U L" label.

10. Repair any equipment that gives a shock, before using it any more.

11. Be careful when moving the television antenna around the home. Avoid touching electrical wires.

12. Make all electrical connections in a junction box.

13. Do you thoroughly understand the above safety regulations?

Yes:_____ No:_____

Signed:_____

Date:_____

GRAPHICAL ELECTRICAL SYMBOLS FOR FARMSTEAD WIRING PLANS

These symbols have been extracted or adapted from American Standards Association Standard ASA Z32.9-1943, wherever possible. Adaptations and new symbols included in this list have been proposed for inclusion in the next revision of that standard.

General Outlets

- Lighting Outlet
- Ceiling Lighting Outlet for recessed fixture (Outline shows shape of fixture.)
- Continuous Wireway for Fluorescent Lighting on ceiling, in coves, cornices, etc. (Extend rectangle to show length of installation.)
- (L) Lighting Outlet with Lamp Holder
- (L)PS Lighting Outlet with Lamp Holder and Pull Switch
- (F) Fan Outlet
- (J) Junction Box
- (D) Drop-Cord Equipped Outlet
- (C) Clock Outlet

To indicate wall installation of above outlets, place circle near wall and connect with line as shown for clock outlet.

Convenience Outlets

- Duplex Convenience Outlet
- 3 Triplex Convenience Outlet (Substitute other numbers for other variations in number of plug positions, such as 1 for single convenience outlet).
- Duplex Convenience Outlet — Split Wired
- GR Duplex Convenience Outlet for Grounding-Type Plugs
- WP Weatherproof Convenience Outlet
- X" Multi-Outlet Assembly (Extend arrows to limits of installation. Use appropriate symbol to indicate type of outlet. Also indicate spacing of outlets as X inches.)
- S Combination Switch and Convenience Outlet
- R Combination Radio and Convenience Outlet
- Floor Outlet
- R Range Outlet
- DW Special-Purpose Outlet. Use subscript letters to indicate function. DW-Dishwasher, CD-Clothes Dryer, etc.

Switch Outlets

- S Single-Pole Switch
- S_3 Three-Way Switch
- S_4 Four-Way Switch
- S_D Automatic Door Switch

Switch Outlets (continued)

- S_P Switch and Pilot Light
- S_{WP} Weatherproof Switch
- S_2 Double-Pole Switch

Low-Voltage and Remote-Control Switching Systems

- S Switch for Low-Voltage Relay Systems
- MS Master Switch for Low-Voltage Relay Systems
- R Relay-Equipped Lighting Outlet
- Low-Voltage Relay System Wiring

Auxiliary Systems

- Push Button
- Buzzer
- Bell
- Combination Bell-Buzzer
- CH Chime
- Annunciator
- D Electric Door Opener
- Interconnection Box
- (T) Bell-Ringing Transformer
- Outside Telephone
- Interconnecting Telephone
- R Radio Outlet
- TV Television Outlet

Miscellaneous

- a,b Special Outlets. Any standard symbol given above may be used with the addition of subscript letters to designate some special variation of standard equipment for a particular architectural plan. When so used, the variation should be explained in the Key of Symbols and, if necessary, in the specifications.
- Feeder
- Branch Circuit
- Branch Circuit, Concealed in Floor
- Switch Leg Indication. Connects outlets with control points.
- Service Entrance Equipment
- Distribution Panel for Feeders and/or Branch Circuits

The electrical symbols appearing on this page provide a key to the wiring symbols used in the drawings appearing in this Handbook.

6805

FIVE SURE SIGNS your wiring is out-of-date

1. Fuses blow . . circuits trip frequently
2. Lights dim, blink, flicker annoyingly
3. Television picture wobbles and shrinks
4. Appliances take longer to heat
5. Air conditioner fails to do its job

Use of electricity has tripled in the average home in the last 20 years

. . and it mounts, year by year. Your wiring that so adequately took care of your needs in the 30's . . does it stand your new equipment without blowing fuses, tripping circuit breakers?

If these things happen regularly, your home is inadequately wired right now. Don't ignore these danger signals. Plan now to live better electrically by bringing your wiring up to date.

Speed work and quality of jobs

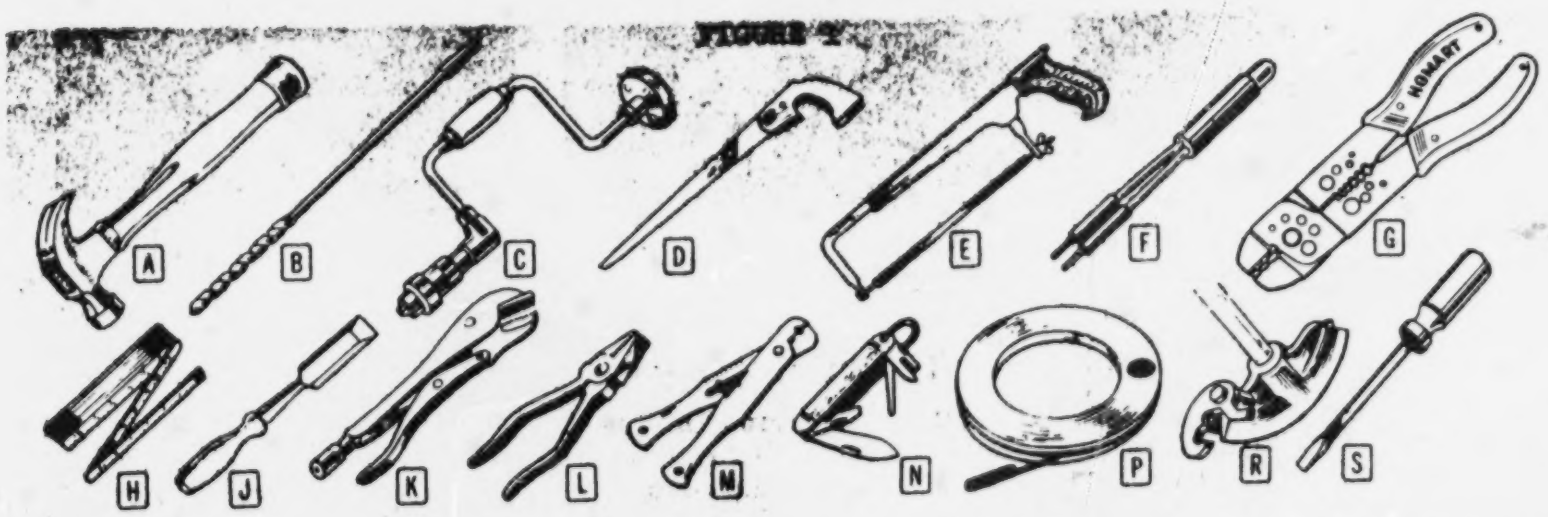

A Hammer. For driving staples, nails, fastening hangers.

B ⅝ inch Bit or Drill. For boring wood or soft metal.

C Bit Brace. For use with drill, screwdriver, reamer.

D Keyhole Saw. For cutting circles and shapes.

E Hack Saw. For cutting cable, plaster or laths.

F Test Light to trace circuits, test fuses and lines.

G Multi-purpose tool. Cuts and skins wire, attaches terminals, etc.

H 6-foot Folding Rule. For measuring wire, openings.

J Chisel. For notching studs, joists, plaster, flooring and lath.

K Lever-jaw Wrench. Use as plier, lock wrench, pipe wrench.

L Linesmen's Pliers. For gripping locknuts, cutting wires.

M Wire Cutter, Stripper. For details, turn to page 31.

N Jack Knife for cutting insulation.

P Fish Tape and Reel—fish wire thru wall and conduit.

R Conduit Bender. A handy time-saver.

S Screwdriver to tighten screws, locknuts.

6806

Up-to-date Wiring provides enough

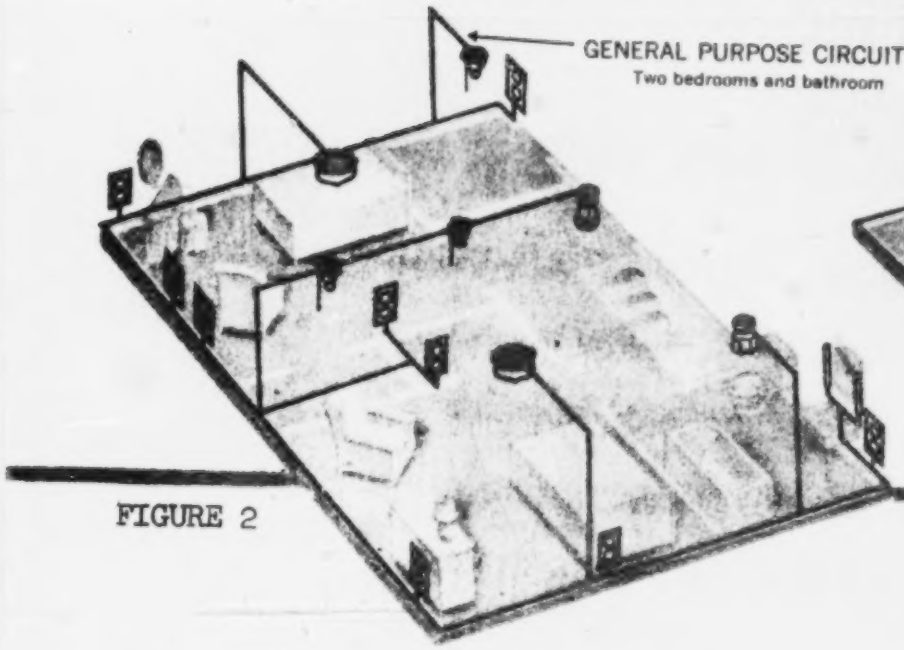

FIGURE 2

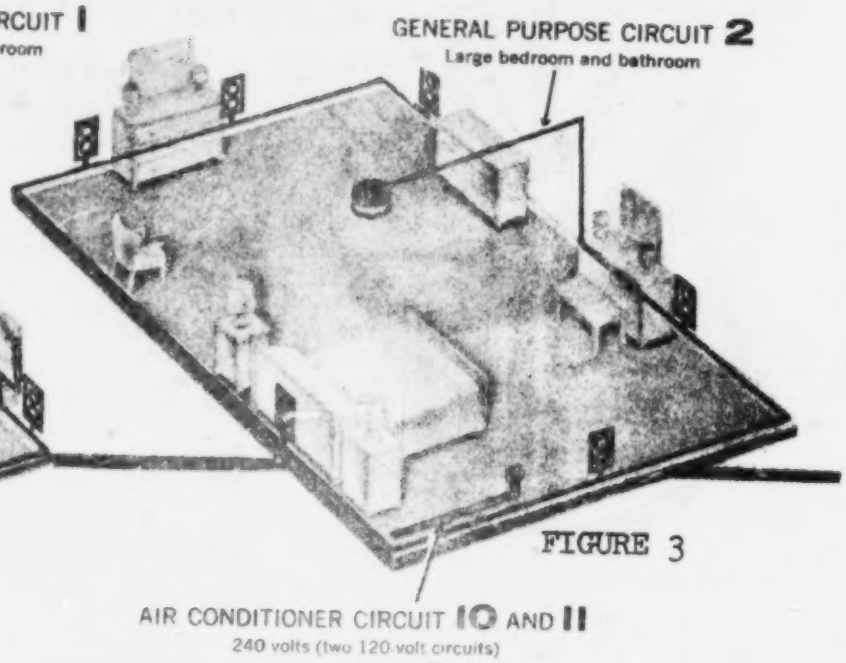

FIGURE 3

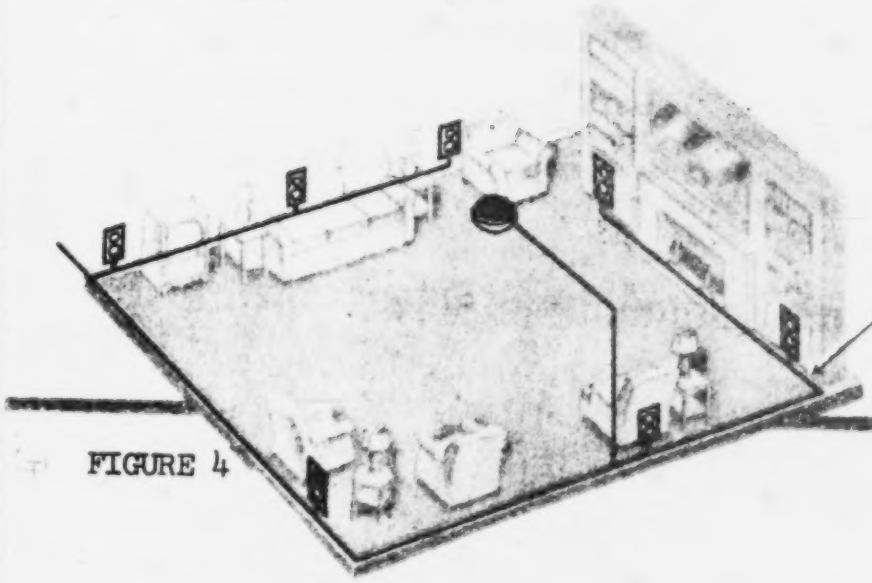

FIGURE 4

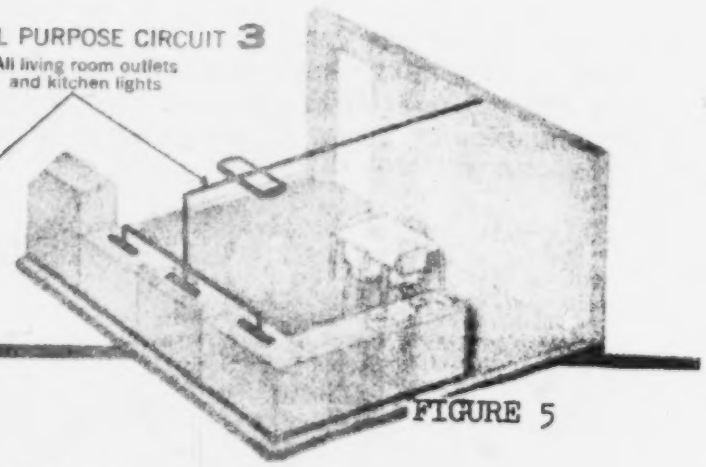

FIGURE 5

FIGURE 6

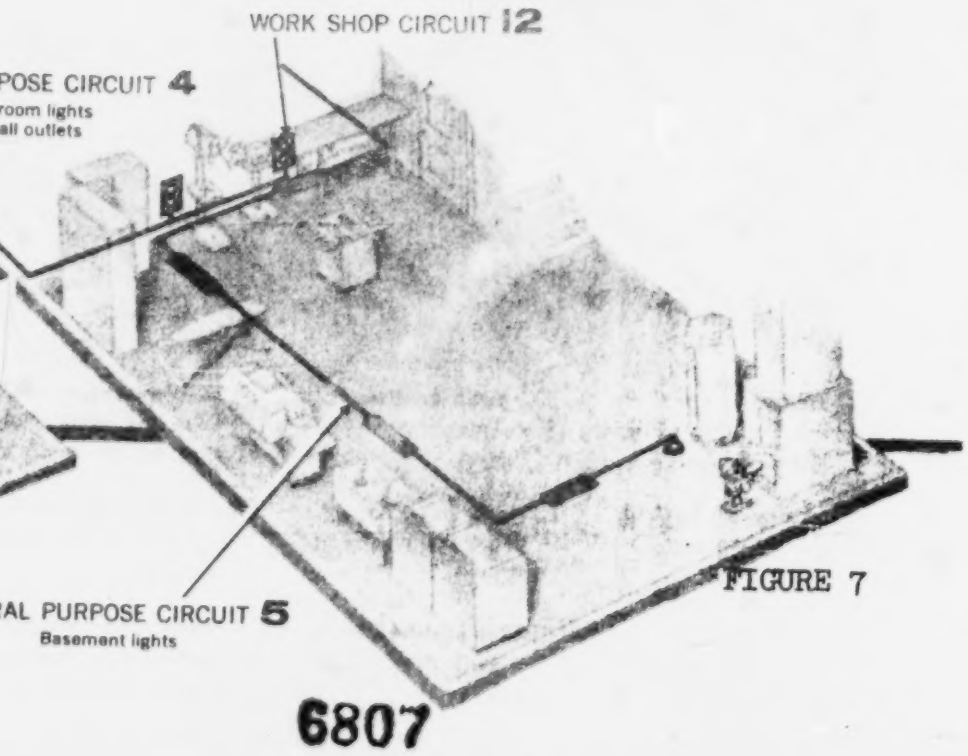

FIGURE 7

circuits for present and future needs

These floor sketches show a typical, average-size six room home with a large basement, and containing the usual number of modern electric servants. The wiring diagrams show why at least 15 circuits are now recommended by electrical experts. It takes this many to provide adequately for proper lighting and all needed appliances, including an electric range, water heater, power tools and air conditioner.

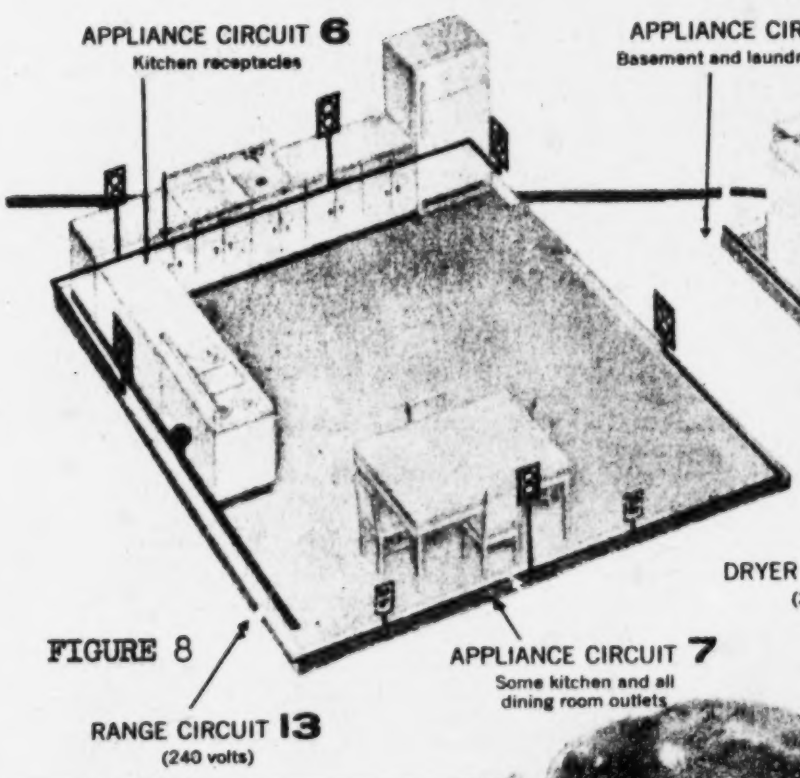

FIGURE 8

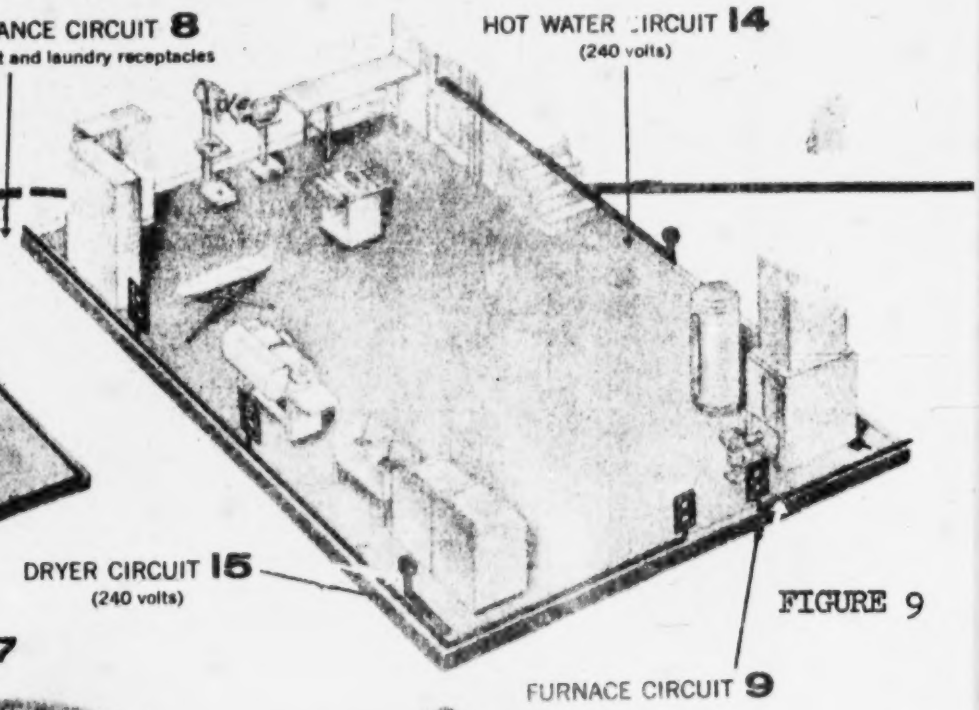

FIGURE 9

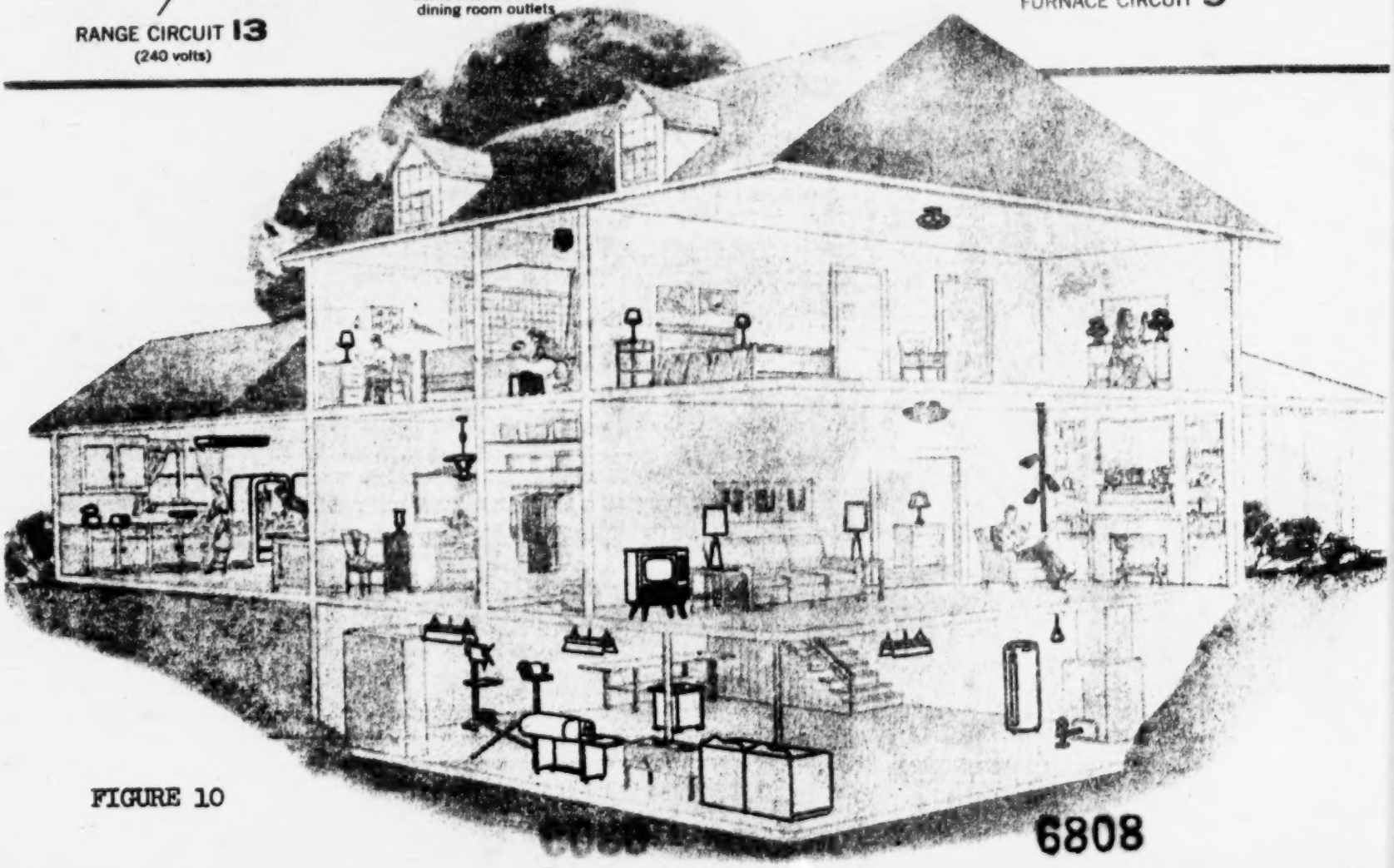

FIGURE 10

6808

3 important MUSTS

1 You must install electric service with capacity to meet present and future needs

Never forget the importance of providing plenty of EXTRA capacity when you plan your wiring. The size of the service entrance switch, the size of the connecting wires, determine the total amount of electricity you can use at any one time. With extra capacity, you can keep on adding new electrical servants as you need them, without fear of overloading wires or blowing fuses. A properly planned "Service Entrance" (as shown at left) including switch and connecting wires will relieve you of the annoyance and loss of power and current caused by overheated wires. Proper capacity assures you of getting top performance from your electrical tools at all times. For further details and specific recommendations as to the correct size Service Entrance for your plans, see pages 10-11.

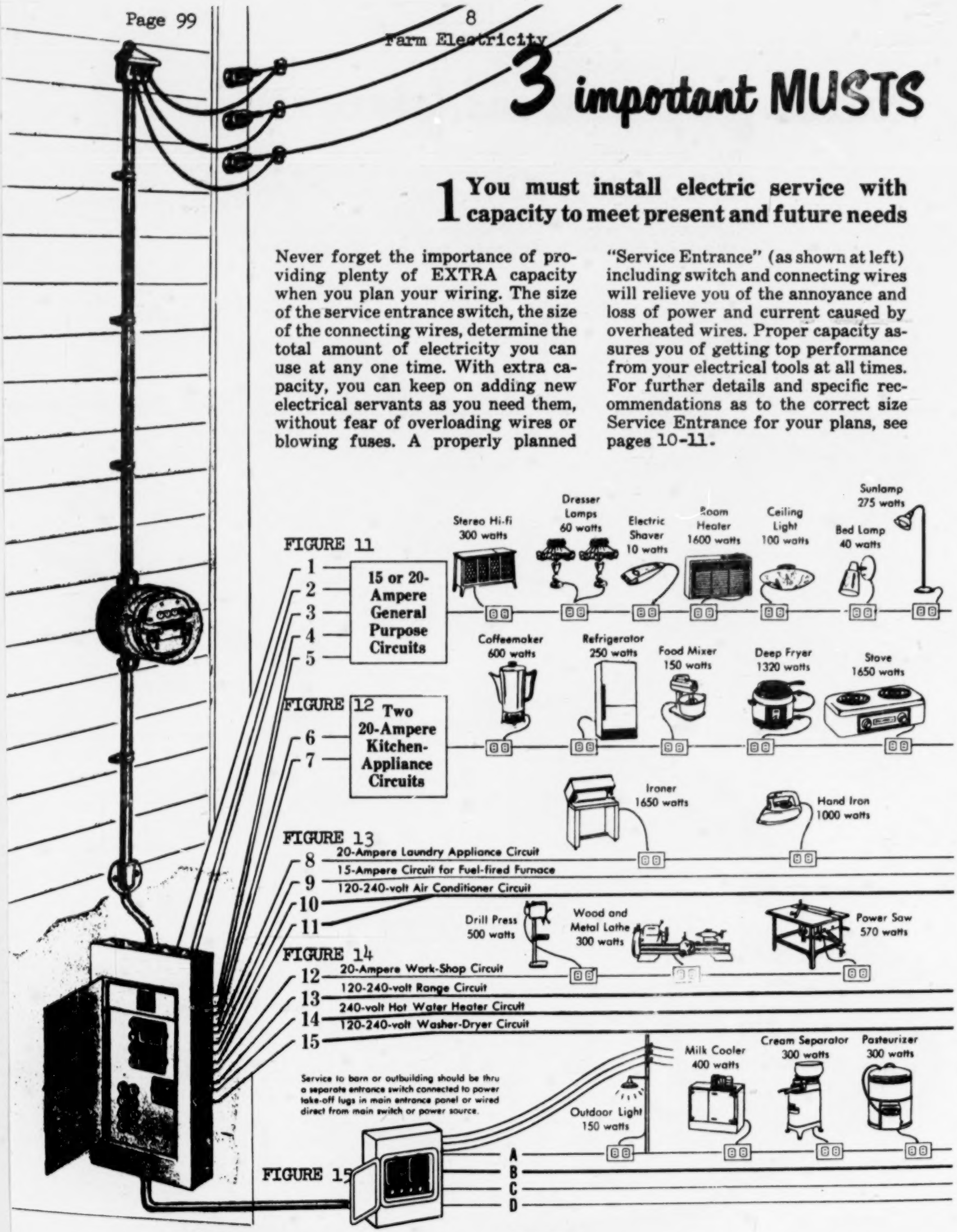

in planning up-to-date wiring

2 You must plan enough circuits to deliver full power always

Divide lights and outlets into various branch circuits as shown. Be sure that not too many of either are together on one circuit at one time.

CODE REQUIREMENT: at least TWO 20-amp appliance grounded type circuits for kitchen, laundry, dining room, independent of lighting fixtures. We recommend three.

A separate 20-amp general purpose circuit is recommended for every 500 square feet or a 15-amp circuit every 375 square feet of floor space.

3 You must provide enough outlets on each circuit for convenience

A convenience outlet located every 12 feet of running wall space provides complete flexibility in furniture placement, prevents unsightly long extension cords, assures better lighting in every room.

IN KITCHENS, an outlet every 4 feet of counter space provides quick plug-in of appliances without moving them around, lets you make the most of your work space.

And be sure to plan a few outdoor outlets for holiday lighting, appliances or summer fun.

FIGURE 16

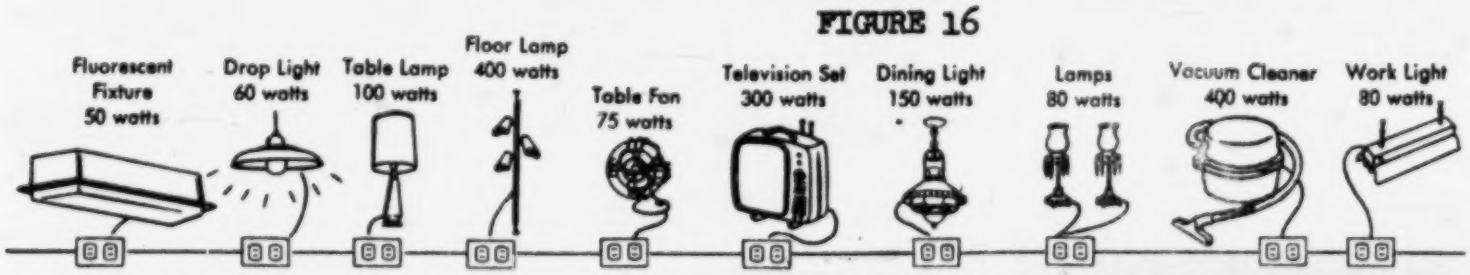

FIGURE 17

Figure total wattage for each circuit

FIGURE 18

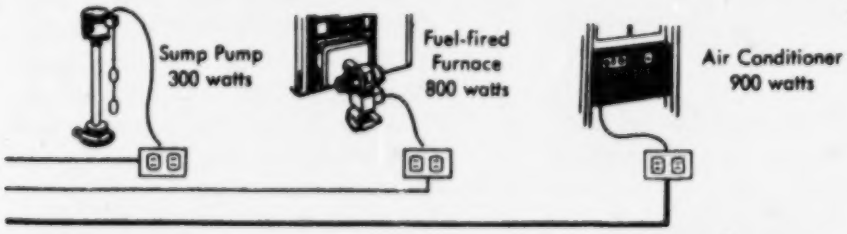

NOTICE: that good planning insures that all outlets on a floor are not on one circuit. This prevents one blown fuse from throwing a whole floor into darkness. Note 4 circuits on 2nd floor. Note also that dining room, kitchen and laundry are on separate circuits. Put most circuits where load is heaviest.

FIGURE 19

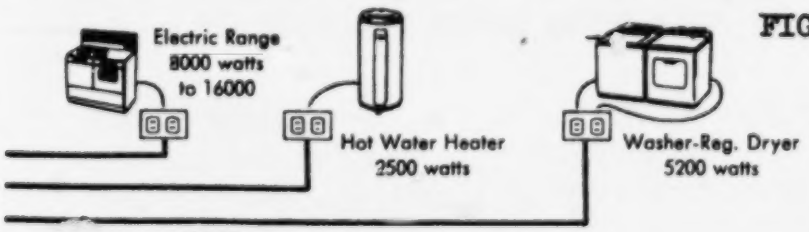

CAUTION!

Maximum carrying capacity of a 20-ampere general-purpose or appliance circuit with Number-12 wire is 2400 watts. Check wattages shown here. No combination of appliances exceeding that wattage should be used on any one circuit at any one time.

FIGURE 20

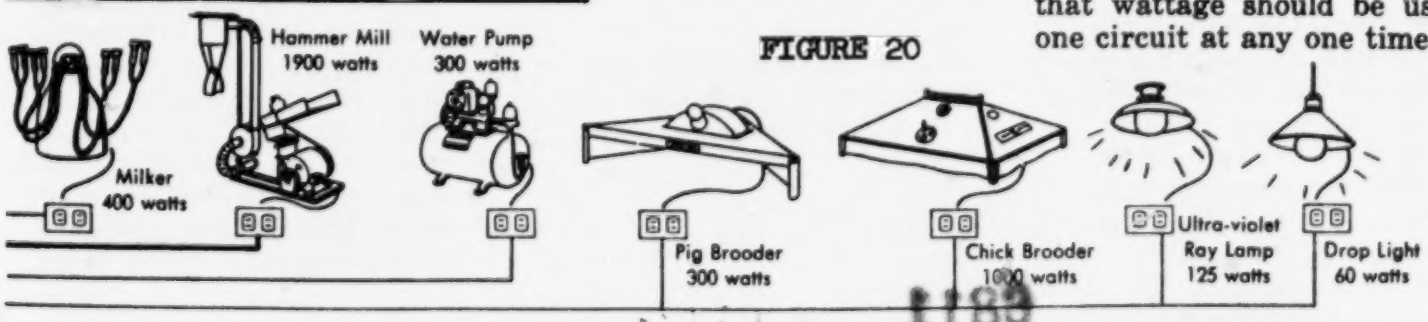

Select the right Service and Circuits

Facts to help you decide which size Electric Service you should install

150 and 200 Ampere Service

Number 1/0 or number 3/0 (type RHW insulation), 3-wire Electric Service with 150 or 200-ampere service panel respectively, is preferred for modern, up-to-date wiring where full "housepower" is desired. In homes equipped with an electric range, water heater, high speed dryer or central air conditioning together with lighting and the usual small appliances, you will need a 150-ampere service as a minimum. With the addition of electric heating, a 200-ampere service is necessary.

Most farms and ranches are also finding 150 and 200-ampere service necessary using yard pole distribution.

A 150-ampere service provides sufficient electric capacity for lighting and portable appliances including ironer, roaster, rotisserie and refrigerator, 12000 watt range, and 8700-watt clothes dryer and also for 5000 watts (3 to 5 tons) of central or room air conditioning plus any of the appliances listed in table at left, up to 5500-W.

A 200-ampere service provides the same capacity as the 150-ampere service but will also handle electric house heating equipment.

Modern farms and ranches, especially those with dairy and poultry operations, are best with a 200-amp. service.

Appliance	Watts
Fuel-fired Heating Mechanism	800
Dishwasher-Waste Disposer	1500
Room Air-conditioner (3/4 ton)	1200
Automatic Washer	700
Automatic Dryer (regular)	4500
Automatic Dryer (high-speed)	8700
Water Heater	2500
Water Pump	300 to 700
Home Freezer	350
Built-in Room Heater	1600

FIGURE 21

100 Ampere Service

Number 2 or number 3 (type RHW insulation), 3 wire electric service with 100-ampere service panel is recommended by the Adequate Wiring Bureau for homes up to 3000 square feet in floor area. In most areas, the minimum Electric Service for new homes is 100 ampere for lights, roaster, ironer, refrigerator and 8000-W. range plus appliances in table above up to 10000-W. total.

60 Ampere Service

Number 6, 3-wire Electric Service is still the minimum "to get by" according to the National Electric Code. This has been the standard for years but in most cases it is now too small. This service provides capacity for lighting and portable appliances including range, dryer (regular), or hot water heater **but no additional major appliances can be added at any time.**

30 Ampere Service

This service consists of Number 8, 2-wire Electric Service (for 120-volts only) with a 30-ampere service panel. This service provides only limited capacity for lighting and a few of the smaller appliances and should never be used except for temporary service or one room buildings. You would have to enlarge the service capacity before using any major electrical appliances.

FIGURE 22

When buying a home be sure to check the entire wiring system before you buy

When buying a new home

Be certain you check the size of the Electric Service wires and Electric Service Panel before you buy. If you are planning to build, be sure the proper size electrical service, branch circuits and outlets are specified. The additional cost of up-to-date wiring over minimum wiring is only 1% to 2% of the original cost of the home.

When buying an old home

Check the capacity of the Electric Service, panel, circuits and outlets just as you check roofing, paint and general condition. A home with 3-wire service has more value than one with 2-wire service.

In existing homes

Remember that few homes 5 years or older, have been rewired for up-to-date convenience and safety. 90% of all homes need some rewiring to provide for today's needs. Check the size of your electric service, panel, circuits and outlets . . . then expand and modernize your wiring system to meet present and future needs.

6811

FIGURE 23

0180

to custom-build full "housepower"

Easy-to-set-up Efficient Circuits for all lights and appliances

General Purpose Circuits, No. 1 to 5

For Diagramed Illustrations of all Circuits, 1 through 15, see Pages 6 and 7

Circuits No. 1 to No. 5 supply all the lighting outlets and all the convenience outlets except in the kitchen, dining area and laundry. These circuits should be set-up on the basis of one 20-ampere, 120-volt circuit for not more than each 500 square feet of floor space, or one 15-ampere 120-volt circuit for not more than 375 square feet of floor space.

Outlets supplied by these circuits should be divided equally among the circuits. Convenience outlets should be placed every 12 feet along the wall. Use standard duplex outlet for small appliances or you may wish to install the extra convenient interchangeable devices.

Appliance Circuits, No. 6 and 7

There should be at least two 20-ampere circuits in the kitchen and dining area. One of these can also extend to the laundry. However, we recommend that a separate circuit to the laundry be installed as indicated by No. 8 on pages 6 and 7.

Do not install lighting on the kitchen, dining area or laundry circuits. Provide plenty of convenience outlets . . . at least one for every 4 feet of kitchen counter work area.

FIGURE 24

Circuits No. 8 to No. 15

Number 8 is a 20-ampere, 120-volt circuit to the laundry appliance outlets. **Number 9** is a 15-ampere, 120-volt circuit to the fuel-fired heating equipment. **Number 10-11** is a 240-volt circuit to the air conditioner.

Number 12 is a 120-volt circuit to the garage or workshop. **Number 13** is a 50-ampere, 120/240-volt circuit to the electric range. **Number 14** is a 20-ampere, 120/240-volt circuit to the water heater.

Number 15 is a 30-ampere 120-240-volt circuit for automatic washer and electric dryer. The washer uses 120-volts . . . dryer uses 120/240-volts.

Power Take-off, Circuits

For the most efficient electric service on farms, many farmers now install a 60-ampere subpanel in the barn connected from the power take-off lugs in the main service panel on the yard pole or any other location.

FIGURE 25

Note. .Number 12 wire is recommended throughout the house. However, Number 14 wire can be used for 15-ampere circuits, and Number 12 for 20-ampere circuits.

Follow recommendations in this Handbook and avoid dangers

When Fuses Blow. A fuse is a safety valve. It protects wires from overloads. Never substitute a fuse rated higher than the ampere capacity of the circuit wire. Before replacing a fuse, locate the cause of the short or overload. Then shut off current at main switch. Wear gloves or rubbers and stand on a dry wood board. Touch one hand only to the fuse—keep other hand free, not touching wall or anything.

Caution Notice: Any wiring can become red hot if you attempt to draw too much current through it. Overloaded wires, or improperly fused wires, may cause fires or serious damage to the wiring system. You will save in the long run by observing the recommendations in this Handbook, particularly those about fuses. If in doubt about the size of your Electric Service always select the larger size.

FIGURE 26

6812

PLANNING A WIRING SYSTEM

1. What are five sure signs that your home wiring system is out of date?

2. Name the tools necessary to do a quality electric job with speed.

3. How many general purpose circuits are found in the house on the preceding pages and where does each circuit go?

4. How many appliance circuits are found and where do they go?

5. What voltage is the air conditioner circuit?

6. What voltage is the range circuit?

7. What voltage is the hot water heater circuit? Dryer circuit?

8. What are the three important "musts" in planning up-to-date wiring?

9. How far apart should convenience outlets be located?

6813

10. How many circuits does the code require for the kitchen, laundry and dining area? How many are recommended?

11. A house has 1,500 square feet of floor space, how many 20 amp general purpose circuits are recommended?

12. How far apart should convenience outlets be on the counter space in the kitchen?

13. What is the maximum carrying capacity of a 20 amp general purpose circuit with No. 12 wire?

14. Figure the total wattage of each of the 15 circuits on the preceding pages. Determine how many amps are on each circuit. What wire size would you use for each circuit? What size fuse would you use on each circuit?

15. Draw your home wiring system on the chart on the preceding pages and bring to class the following information: Capacity of switch box, number of circuits, size fuses, fixtures or appliances on each circuit. Figure the total number of watts on each of the circuits. Determine if your home is adequately wired.

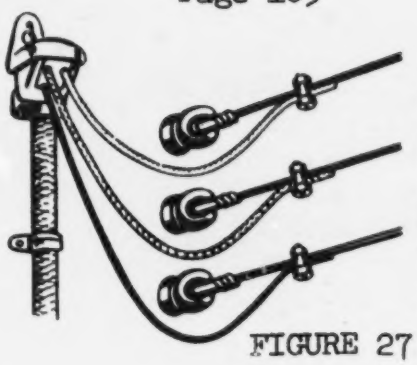

To Connect Wires from Entrance Head to Overhead Wires the National Electric Code requires that the service Entrance Head should be installed above the top insulator of incoming power wires. Drip loops shall be formed on individual Conductors. This will prevent water from entering the electric service system.

FIGURE 27

To install Electric Service using Entrance Cable

Attach Entrance Head to building at least 10 feet above ground. Strip outer cover from Entrance Cable so that wires can be extended through Entrance Head for at least 36 inches. This allows plenty of length for connecting to power lines. The power lines attach to the building with insulators, located high enough to clear trucks or wagons.

Anchor cable every 4 feet with straps. To hold cable in meter socket use 2 connectors . . . one where cable enters meter, one where cable leaves meter. Run cable down wall and through hole drilled through building. Connect to Service Panel which should be located within one foot of where cable comes in. Use sill plate to protect cable where it enters building.

Connections to Service Panel. Black wire of cable connects to left terminal of main disconnect and red wire to right terminal. Third or bare neutral wire to the neutral strip which is grounded by connecting it with a bare wire to water pipe system.

Branch Circuits: Below each fuse is a terminal to which a black wire is connected. White wires are connected to neutral strip. A black and a white wire give a 120-volt circuit. Black wire is fused with a 15 or 20 amp. fuse. Panel has 4 branch circuits.

To add Circuits to Power Take-off

Most Service Panels have 2 Power-take off Lugs set between the two left and two right plug fuses. To add additional circuits, a new fuse panel or safety switch can be installed as illustrated below. The two black wires go to the Power-Take-off Lugs and the white wire connects to the neutral strip. This will give 120-volts between the black and white wires or a 240-volt circuit between the two black wires, at the subpanel. Such a subpanel is necessary for circuit protection because the Power Take-off is fused at 60-amperes in the main disconnect.

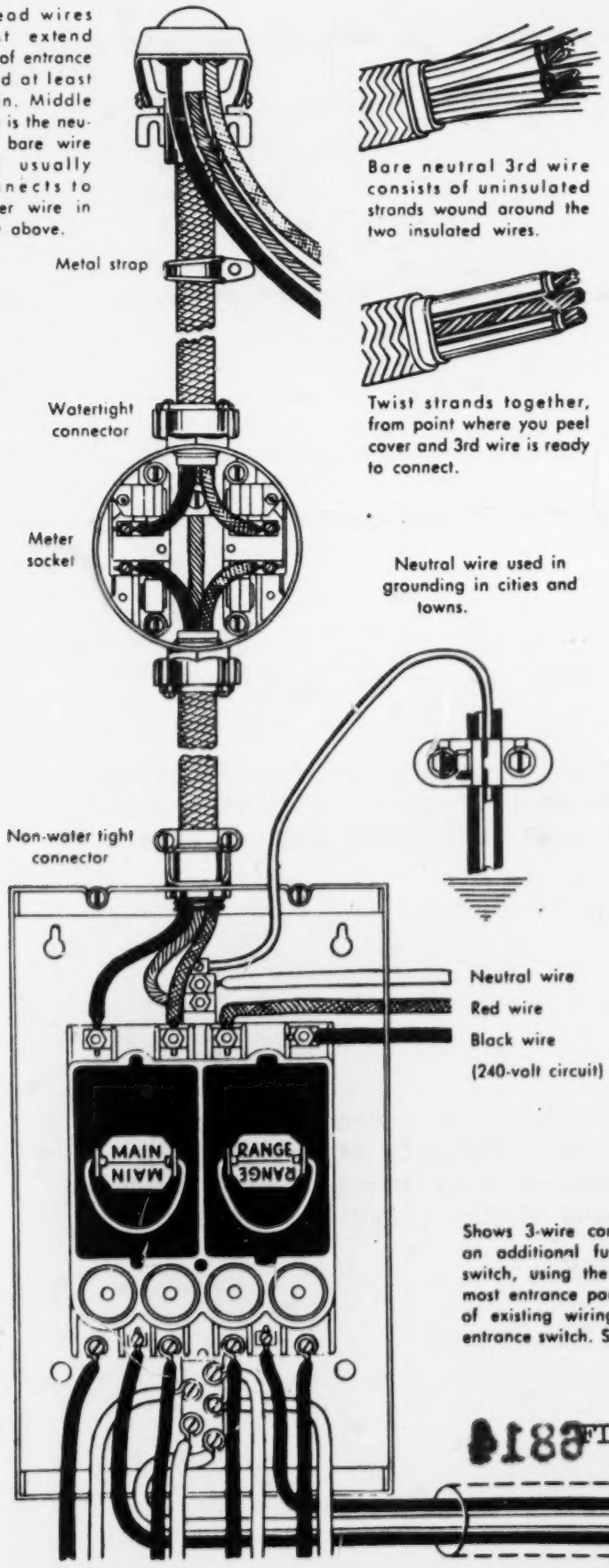

Shows 3-wire connections for installation of either an additional fuse panel or an additional safety switch, using the Power Take-off Lugs available in most entrance panels. This permits partial extensions of existing wiring without installation of a bigger entrance switch. See paragraph above for full details.

FIGURE 28

6815

Grounding the Electric Service

HOW TO GROUND YOUR ELECTRIC SERVICE CORRECTLY

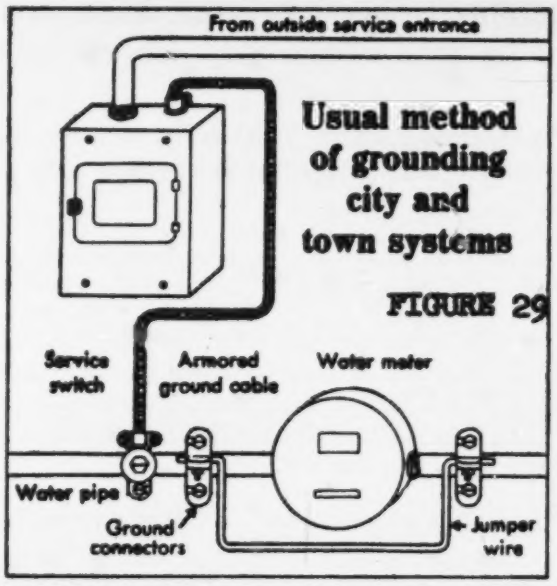

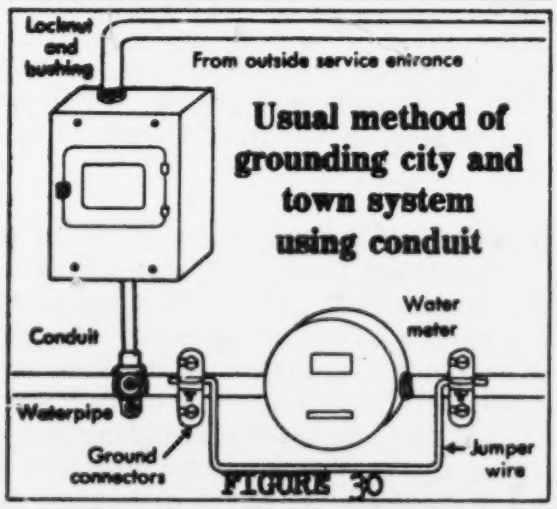

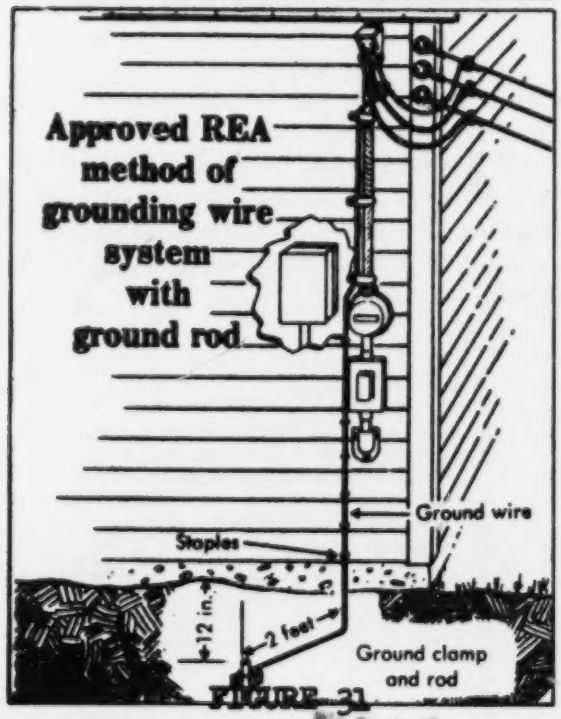

Color coding or polarization of system

- **The black wire is HOT**
- **The white wire is NEUTRAL**

Etch this wiring rule in your memory and keep it there. NEVER CONNECT THE BLACK (HOT) WIRE TO THE WHITE (NEUTRAL) WIRE. (Exception: see page 18-19.)

Connect the black wire to the brass-colored terminal on switches, receptacles, sockets, fuse boxes, and to the black wires on pull chain fixtures. The white (neutral or ground wire—also called the "continuous wire") is grounded at the electric service switch. Connect it to the silver or light-colored terminal of all receptacles, etc., and to the white wire on all lighting fixtures. Again—never hook to the hot wire!

What is a ground?
An electrical ground is any conductor connecting directly, or through other conductors to the earth. The white (or neutral) wire of all alternating current systems must be grounded. What's more, metal raceways, the enclosure for conductors and exposed frames of all electrical equipment must be grounded. This grounding assures that the conductor will always be at ground potential, thus reducing effects of high voltage and lightning strokes. Such grounding also prevents shocks, should exposed metal be accidentally livened.

The National Electric Code covering grounds is strict, and *must* be complied with. See your power company or REA.

What grounding wire do you use?
A No. 6 or No. 4 copper ground wire is normally heavy enough to be exposed, (if wire is free from danger of mechanical damage). If No. 8 is used, it must be armored (see top diagram) or bare wire enclosed in conduit. (See center diagram.) Check with your REA or power company.

What's different about a ground rod installation for a farm?
One major thing, one major rule: ground wire for farm systems does not go through entrance switch, but is tapped off the neutral overhead wire, and brought down the side of the house or yardpole and fastened to the ground rod or to an **underground metallic water pipe system** wherever available. Use a copper ground rod at least ½-inch in diameter, or a galvanized iron or steel pipe at least ¾-inch diameter. Rod must be at least 8 feet long, located at least 2 feet from any building, and driven at least 12 inches below the surface. Then attach ground wire to rod by a ground clamp.

What's a ground installation for city systems?
See top diagram. Note ground wire running from neutral bar of electric service switch to the cold water pipe of the water system. Attach wires securely to pipe by a ground connector. Best: make water pipe connection on street side of meter. If impractical, connect to any point on pipe but install a jumper around water meter as shown in diagram.

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To install Electric Service using Conduit

Installation at lower left shows the use of thin-wall conduit. It gives a grounded system if conduit or armored cable is used for all runs to outlets inside the home.

Conduit is not difficult to install. Only tools needed are conduit bender, hacksaw, screwdriver, hammer, pliers. In some areas conduit must be used exclusively. Check code.

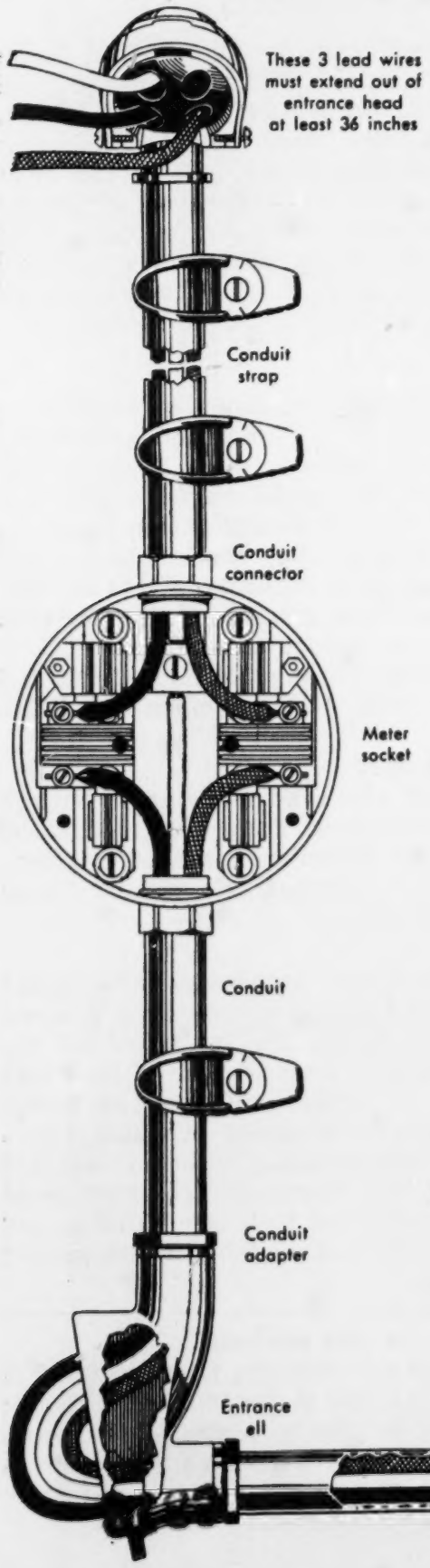

FIGURE 32

A 3-wire Electric Service uses 1 black, 1 red and 1 white wire. See page 10 for wire sizes. Then determine conduit size as follows:

Conduit size	Conduit capacity
¾ inch	3 Number 8 wires
1¼ inch	3 Number 2 wires, 3 Number 3 wires, 3 Number 4 wires, 3 Number 6 wires
1½ inch	3 Number 1 wires
2 inch	3 Number 1/0 wires, 3 Number 2/0 wires, 3 Number 3/0 wires

Entrance conduit runs cannot be over 50 feet

Wires from utility company's pole to your building are called the "Service Drop". . . usually furnished by the company. These wires must be high enough to provide proper clearance above grade and must not come within 3 ft. of doors, windows, fire exit or any opening. The structure to which service drop wires are fastened must be sturdy to withstand the pull under ice and wind storms and all weather conditions. Power Company or REA can advise.

Installation procedures. Attach Service Entrance Head to building or nearby pole. Locate at least 10 ft. above ground. Then connect conduit as shown at left. Use a metal strap every 4 ft. to fasten conduit to building. Connect to meter with conduit connectors. Use an entrance ell to turn conduit into house. Ell has two threaded openings corresponding to conduit size. Use an adapter to fasten conduit into threaded opening at top of ell. Into lower opening fasten a piece of conduit to run through side of house. Use connector to attach the conduit to the electric Service Panel.

How to insert wire in conduit. After conduit is installed push wires through top hub of meter up through conduit into and out of entrance head. All 3 wires must extend at least 36 in. out of service head to allow plenty of length for connecting to power lines. Then the wires are brought down from meter to entrance ell. Remove ell cover and pull wires through to the service panel inside house.

Connections to electric service switch are the same as described and illustrated on preceding page, except that for conduit a white covered insulated wire should be used as the neutral or grounded wire.

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ENTRANCE CABLE AND GROUNDING THE SERVICE

1. How high should the entrance head be from the ground?

2. What length should the wire extend past the entrance head? Why?

3. How far apart should the metal straps be that hold the entrance cable to the building?

4. What type connecter is used in the top of the meter base?

5. Where is the black, red, and neutral service entrance cable connected to the service panel?

6. What is a ground?

7. Where is the ground wire usually fastened in a city electrical system? Farm electrical system?

8. What size copper wire should be used for grounding?

9. Explain the procedure for grounding an electrical system with a ground rod.

10. What size wires will 1½" conduit carry?

Wiring diagrams for Switches

3 and 4-way Switches below **Other Switches at right**

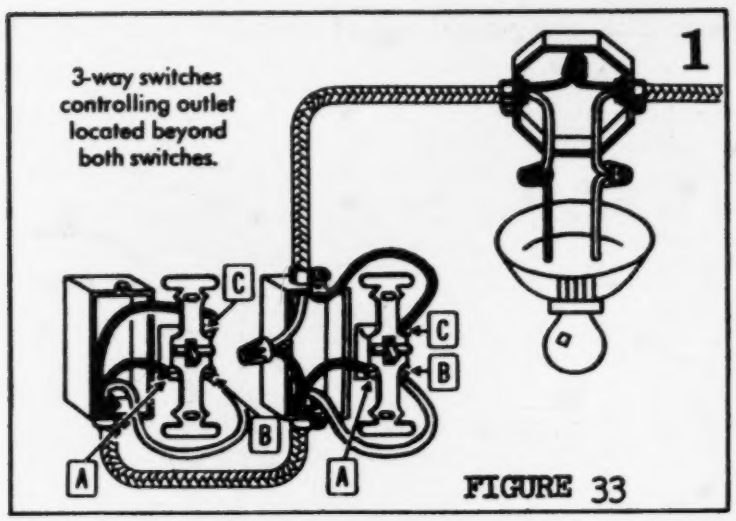

FIGURE 33

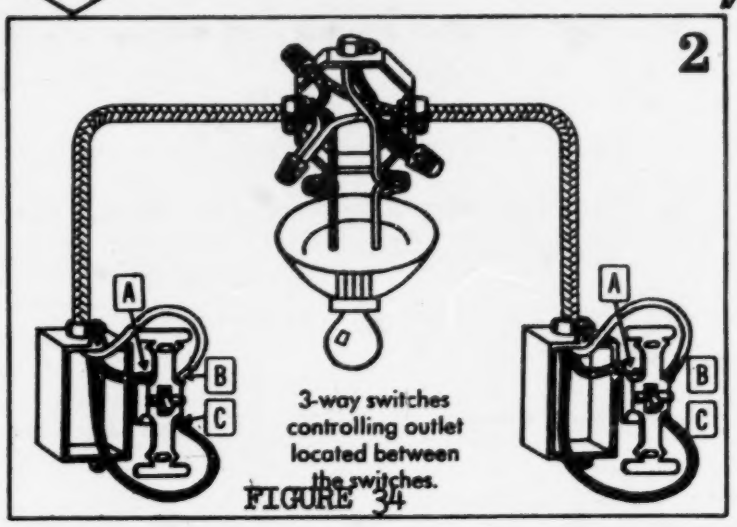

FIGURE 34

FIGURE 35

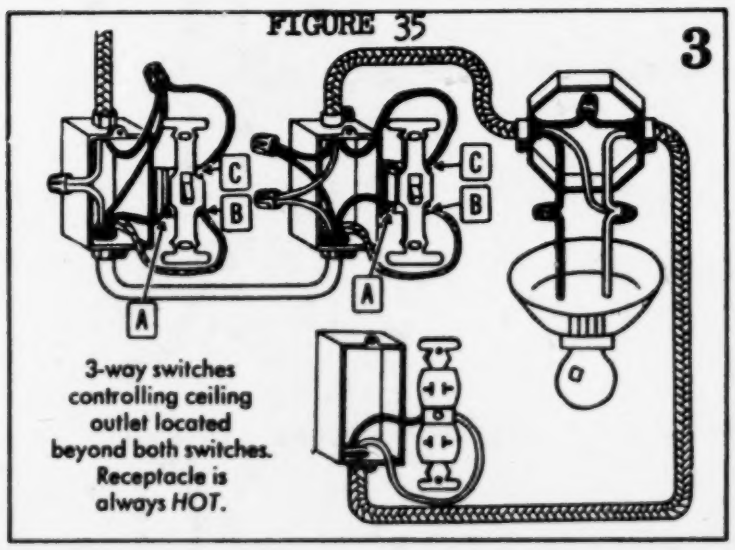

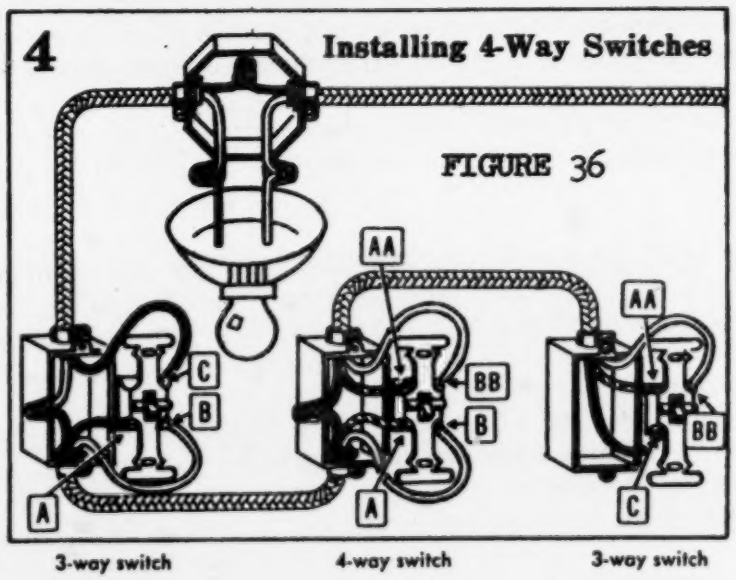

FIGURE 36

NOTE: In all cases, the white wire from switches must be painted black, both at the switches and at light outlet.

3-way switches are most frequently used to control one or more lights from two different points so that light can be turned on or off by either switch. For example; in a long corridor or large room with entrances on opposite sides, or at top and bottom of a stairway so that light can be turned on as you start up stairway and off as you reach the top. Helps avoid fumbling in dark.

Follow diagrams above when connecting 3-way switches. Just be sure to connect the black, white and red wires as shown. In all cases, the terminals marked A and B are the light-colored terminals to which red and white wires must be connected. Terminal C, in all cases, is the dark colored terminal to which the black wire must always be connected. Check diagrams carefully.

You will notice that 3-wire cable is required for some of the runs from box to box. In all cases the white wire from the switch must be painted black at the switch and at light outlet.

In illustration (number 3) you can use two 2-wire cables between switches, in case 4-wire cable is not readily available.

Combination of 3 and 4-way switches

This combination of switches is used wherever you wish to control one or more lights from three separate locations. If more than three control points are desired, just use an additional 4-way switch for each. Connect each 4-way switch as shown for the center 4-way switch above.

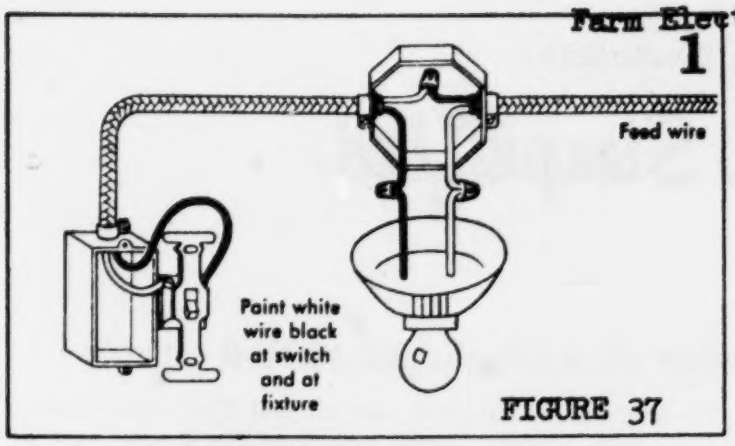

To add a wall switch to control ceiling light at end of run

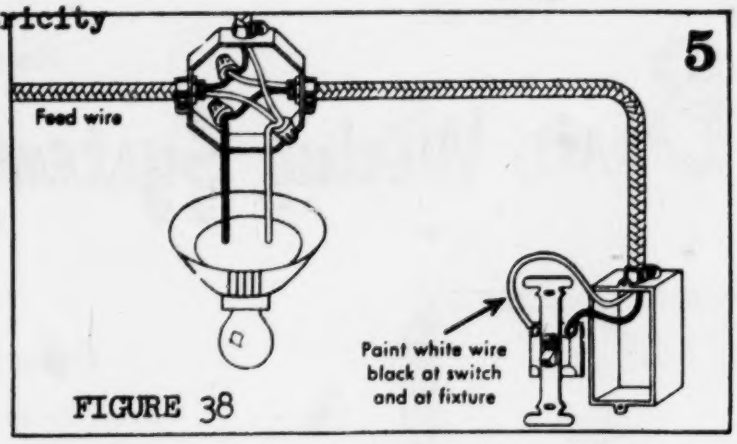

To add wall switch to control ceiling light in middle of run

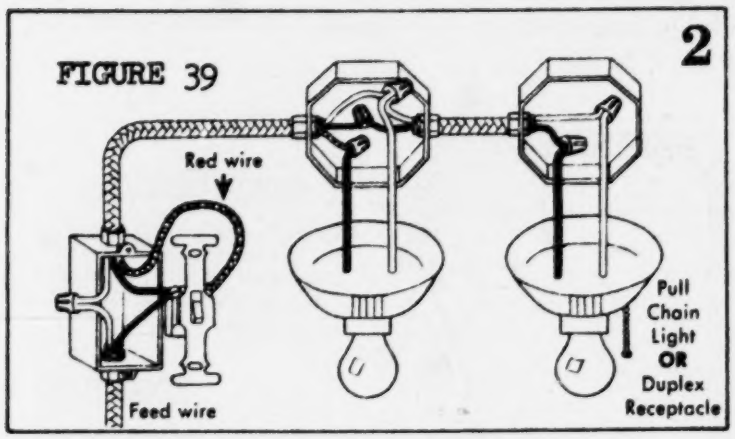

To install two ceiling lights on same line; one controlled by switch

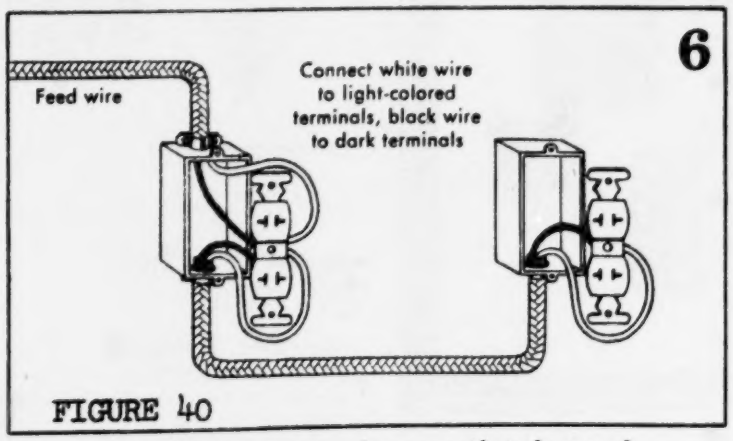

To add new convenience outlets beyond old convenience outlets

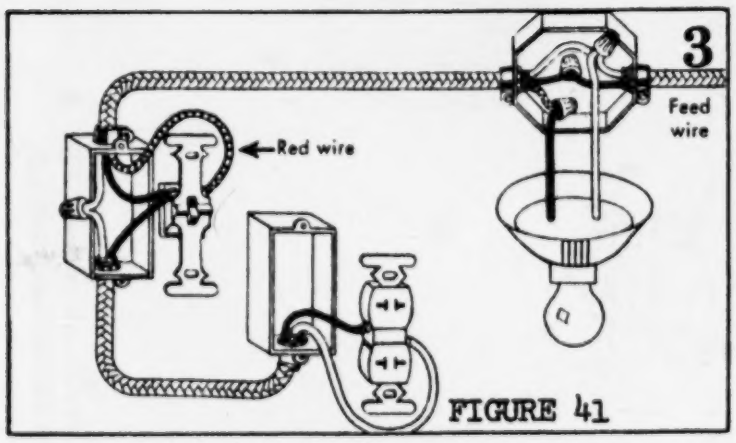

To add a switch and convenience outlet beyond existing ceiling light

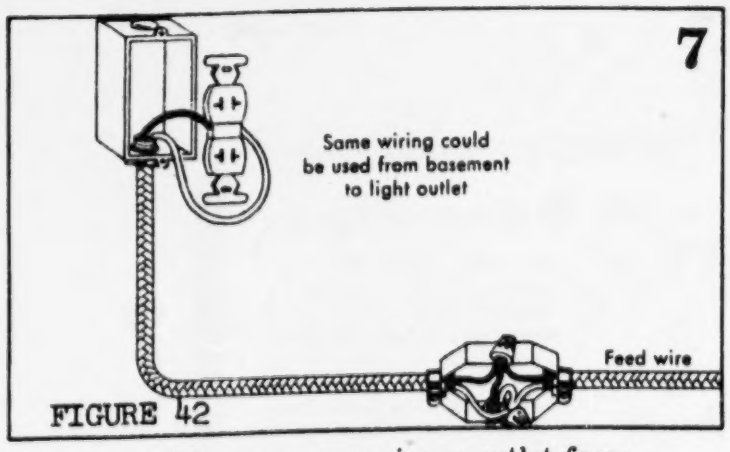

To add a new convenience outlet from an existing junction box

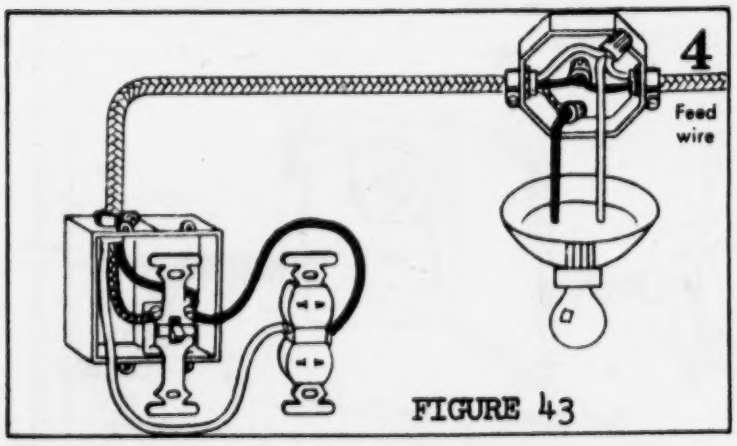

To add a switch and convenience outlet in one outlet box beyond existing ceiling light

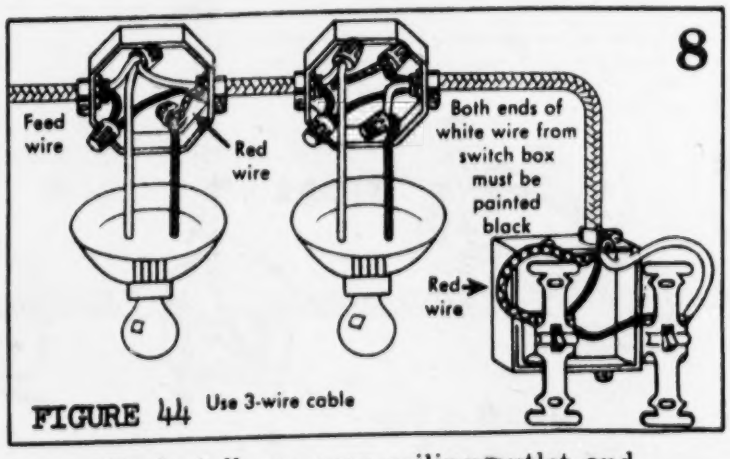

To install one new ceiling outlet and two new switch outlets from existing ceiling outlet

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Basic Wiring System Simplified

Operation of a single, simplified circuit

Here, in simple diagram form, you are shown the elementary principles of a wiring system. Note how the black and white wires are connected within the boxes for all basic devices. You will see that almost anyone capable of using his hands and head can master these principles and install a wiring system that will be dependable and efficient. This book, if studied carefully, will show you how to do it.

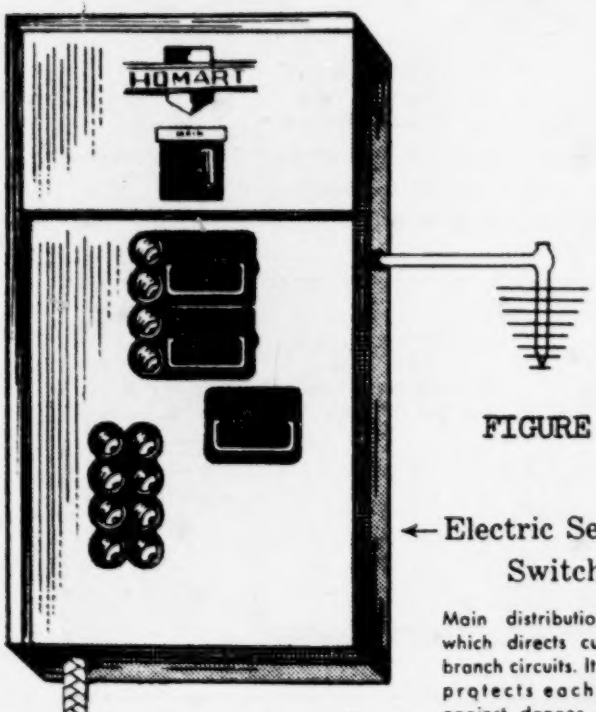

FIGURE 45

← Electric Service Switch

Main distribution panel which directs current to branch circuits. It not only protects each circuit against danger of overload, but lets you disconnect your entire wiring system instantly in emergencies or when altering wires or making repairs.

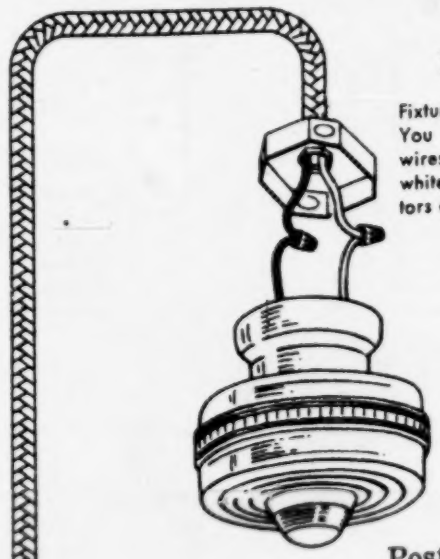

Light Fixture

Fixtures come already wired. You merely connect the outlet wires, black to black, white to white, using solderless connectors as shown.

FIGURE 47

Post-top Lantern

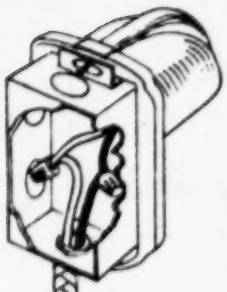

Wall Bracket Fixture

For kitchen, bathroom or over mantel. Usually controlled by separate switch at base of fixture. Easily installed in an ordinary switch box. No solder or tape needed—simply use solderless connectors as shown. (Note black hooked to black, white to white.)

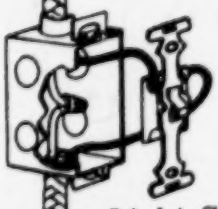

Light Switch

Single pole switch, used to control light from 1 point. For 2-point control use two 3-way switches. See page 24 for wiring instructions.

Receptacle Outlet

A handy tap. Just insert plug to obtain current. Plan on plenty of these so you can plug in lamps and appliances without using long extension cords.

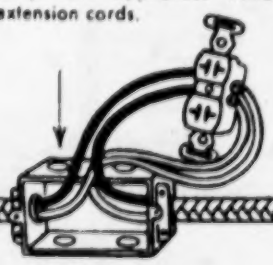

FIGURE 46

Junction Box

A device used to run wiring of a branch circuit in two or more directions. Connect white wire to white, black to black, using solderless connectors. The junction box is occasionally used as a ceiling box for lights, or as an outlet box for receptacles.

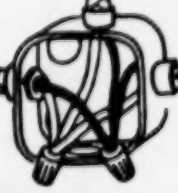

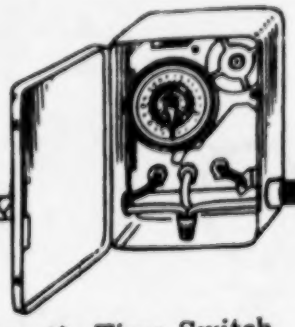

Automatic Time Switch

Turn lights or power on and off at any set time. Note that the wiring is exactly the same as for any other switch. The two black wires are connected to the switch terminals. The white "neutral" wires, you will see, are connected to each other. White to white . . always!

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A. HOW WIRING PROTECTION IS PROVIDED

Wiring-system protection can be provided by either of two means: (1) **fuses** or (2) **circuit breakers.** Both devices are intended to be the "weak link" in your wiring system.

If you are using **fuses** and have installed the proper size, the fuse will heat and "blow" before there is over-heating of any part of the wiring system (Figure 50). You will have to insert a new fuse before service can be restored on a fuse-protected circuit.

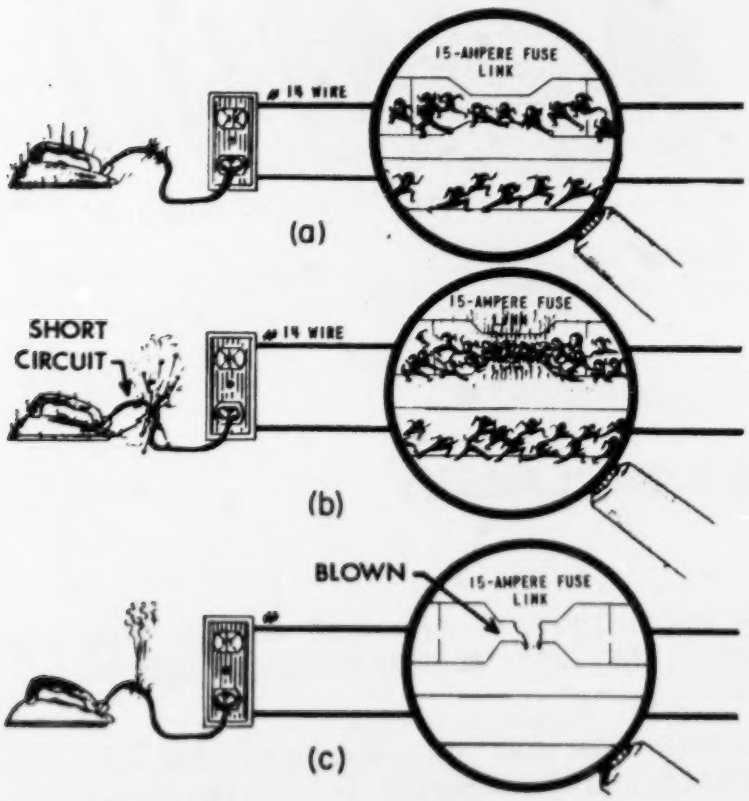

Figure 50. How a **fuse** works. (a) Animated movement of electrons (current) through a fuse when operating within its rated capacity. The narrow portion of the fuse link is designed to handle a definite amount of current flow. (b) When the current flow becomes greater than the capacity of the fuse link, the link heats. (c) Heat melts the fuse link (blows the fuse) which opens the circuit so no further current can flow.

The **circuit breaker** also heats when the load gets too heavy. The sensitive part is a bi-metallic strip. When the strip becomes hot enough, it bends (Figure 51) and releases the trigger on the switch. This automatically opens the circuit until the metal strip cools and you reset the breaker by hand.

Both types of wiring protection provide ample safety for your wiring system unless you tamper with them. It is difficult to tamper with circuit breakers. But, until recently, it has been rather

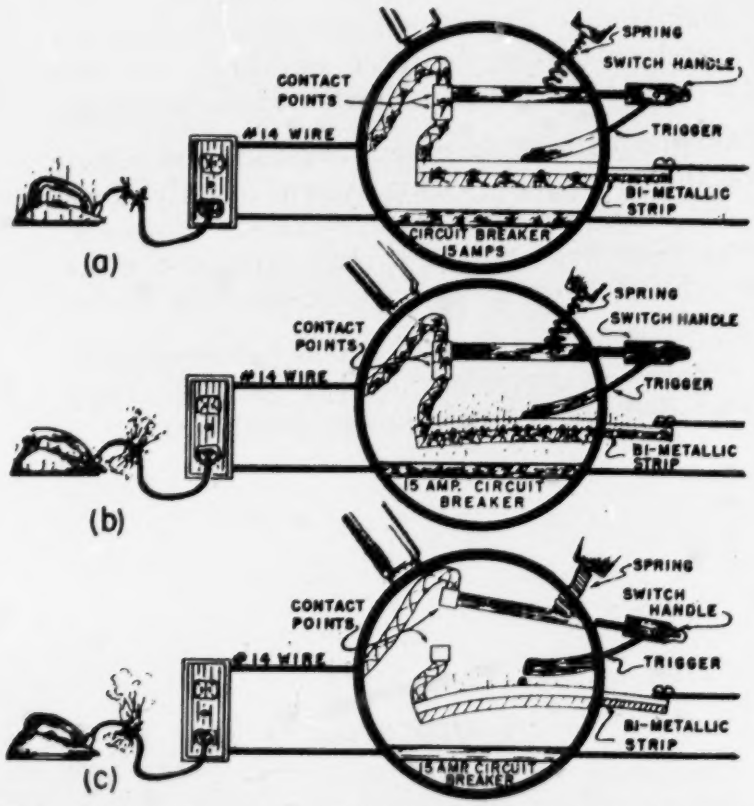

Figure 51. How a **circuit breaker** works. (a) Animated movement of ~~electrons~~ (current) through a circuit breaker when operating within its rated capacity. (b) With an overload, the bi-metallic strip heats and bends. (c) When heated sufficiently, the bi-metallic strip bends enough to release the trigger. The spring pulls the contacts apart, thus opening the circuit. After the bi-metallic strip has cooled, it straightens to its original position as in (a). Then, you can raise the switch handle and reset the breaker which turns on the current.

easy to tamper with fuses so they provided little or no protection. New fuse-panel installations, that meet the present requirements of the National Electrical Code, are tamper resistant. Consequently, the discussion that follows regarding tampering applies mostly to the many wiring installations made before 1962 — before tamper-resistant installations were required. With most of these older fuse installations it is still possible to use a standard plug fuse. These are the ones that lend themselves to tampering.

B. AVOIDING TAMPERING AND OVERFUSING

People who do not understand the function of fuses, or who are careless, will sometimes tamper with fuses. There are several forms of tampering, and it is important that you know what they are.

One example of tampering is shown in Figure 52a. If a **penny is placed in the fuse socket,** and the fuse screwed into place, the current bypasses it whether the fuse is a blown one or a good one. This means that the fuse provides no protection on that circuit.

In order to meet the problem of fuse tampering, manufacturers of fuses have developed **tamper-resistant fuses.** One type is shown in Figure 53b. It replaces the common plug fuse (Figure 53a). The tamper-resistant fuse has an adapter that locks it into position in the fuse socket. The design of the fuse base along with the adapter arrangement makes it almost impossible to tamper with this type of fuse in the manner shown in Figure 52.

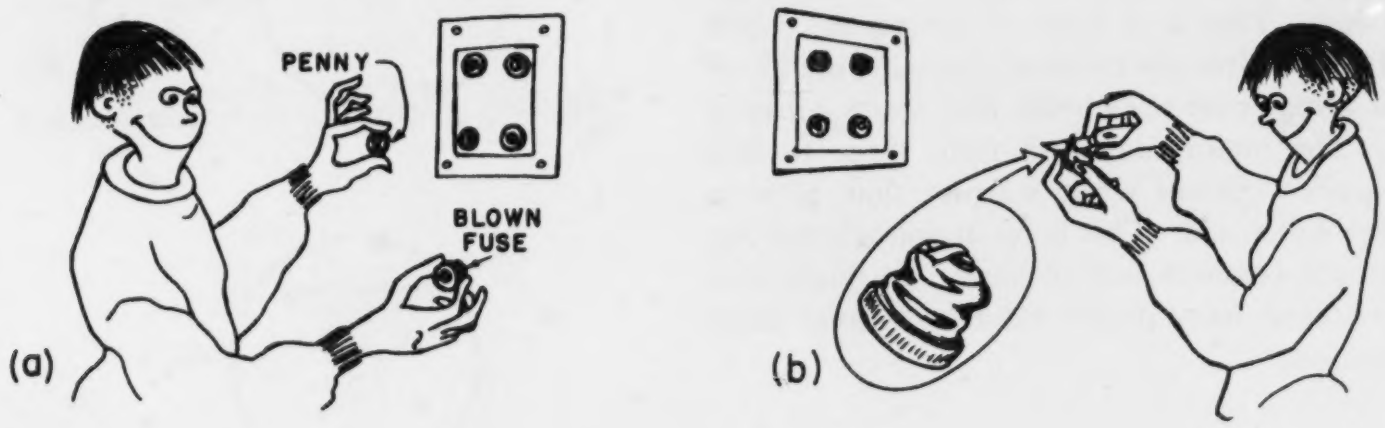

Figure 52. Two extremely dangerous forms of tampering (a) Placing a penny back of a fuse. (b) Tearing a strip from the fuse screw shell and bending it over to touch the center contact, then replacing the fuse in the socket.

Another form of tampering is to **tear back a portion of the metal screw shell** on the fuse and bend it over so it touches the center base terminal (Figure 52b). This has the same effect as placing a penny back of the fuse. There is no wiring-system protection.

When you have removed all of the protection, there is nothing to keep the wiring system from overloading and heating as more equipment is added. Gradually, as the wires overheat, the wiring insulation hardens and flakes off. The wires may become bare in spots. If the bare wires contact each other or a water pipe or anything that completes a circuit to ground, a short circuit develops. The wires may heat enough to burn themselves free and open the circuit before starting a fire. If not, anything that will burn in the vicinity of the short — such as dust, wood or paint — will probably catch fire. This is the reason proper wiring protection is so important.

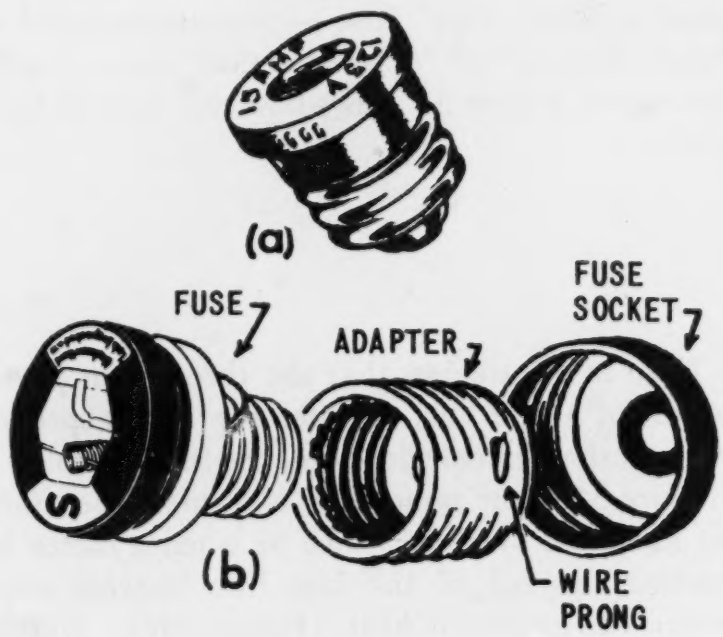

Figure 53. (a) Common type of plug fuse. (b) Tamper-resistant fuse with special adapter that fits in screw-socket base. Wire prong that extends from side, locks adapter in place.

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There are three different sizes of adapters: for 15-ampere circuits, for 20-ampere circuits and for 30-ampere circuits. Each of these adapters differs in length and in thread type. Consequently, once an adapter is locked into place for a 15-ampere fuse, a fuse of higher amperage can't be inserted.

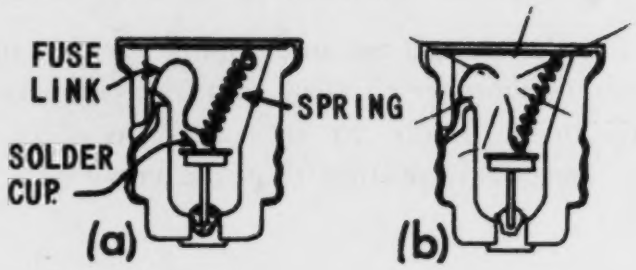

When a 15- or 20-ampere **fuse blows rather frequently,** some people replace it with a 30-ampere fuse. This is a form of tampering called **overfusing.** Often the cause of frequent fuse blowing is a motor on the circuit that starts a heavy load. The motor may pull from three to five times more current while starting than after it reaches full speed. This is often enough current to cause a common fuse to blow. No doubt this has irritated many people enough to cause them to overfuse.

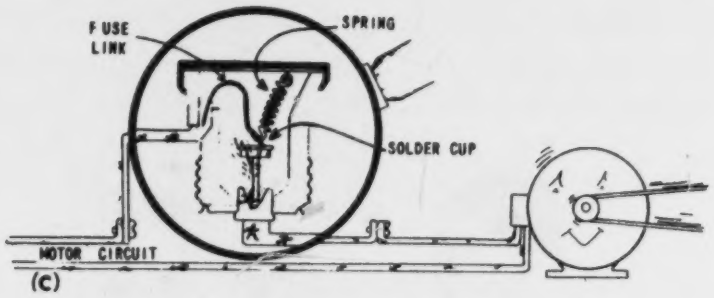

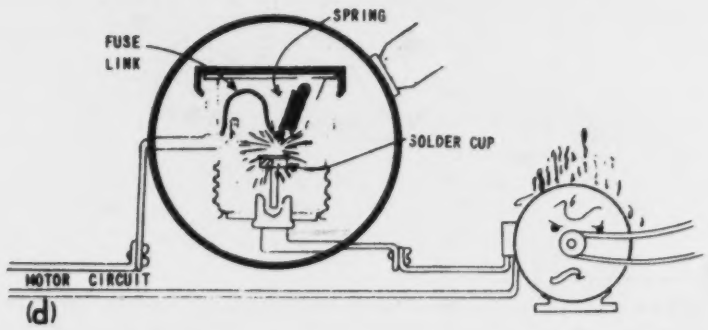

Figure 54. Operating principle of a time-delay fuse. (a) Principal parts consist of a fuse link, solder cup and spring. (b) In case of a short circuit, the fuse link blows as with a common fuse. (c) When there is a temporary overload, such as when a motor starts, the solder in the solder cup heats, but cools again when the overload stops. (d) If the overload continues, the solder softens enough for the spring to pull the fuse link from the solder cup.

Since this heavy current for starting the motor lasts for a very short time, there is no problem of overheating the wiring circuit. To meet this need, a "time delay" fuse — sometimes called a "dual-element" or "delayed-action" fuse — was developed. Figure 54 shows how this type of fuse works.

Note in Figure 54a that the three main parts consist of a fuse link, a solder cup and a spring. When a **short circuit develops,** the fuse link blows (Figure 54b) the same as in a regular fuse. But for **moderate overloads,** such as when a motor is starting, instead of the fuse link blowing, the solder cup starts to heat (Figure 54c). If the overload continues, the solder in the solder cup softens, and the spring pulls the fuse link out of the solder cup (Figure 54d) thus opening the circuit. This is the arrangement that provides the delayed fuse action needed for starting motors.

Note in Figure 55a, that **the tamper-resistant fuse is a time-delay type.** You can also get cartridge fuses of the time-delay type (Figure 55b).

Circuit breakers provide the same time-delay action for motor starting that is provided by time-delay fuses. With the types of electrical loads found in most residences and on farms at the present time, it is best that all circuits be protected with time-delay fuses or circuit breakers. This is the protection the **National Electrical Code now specifies for all electrical circuits, with 20-ampere capacity or less, in residences.**

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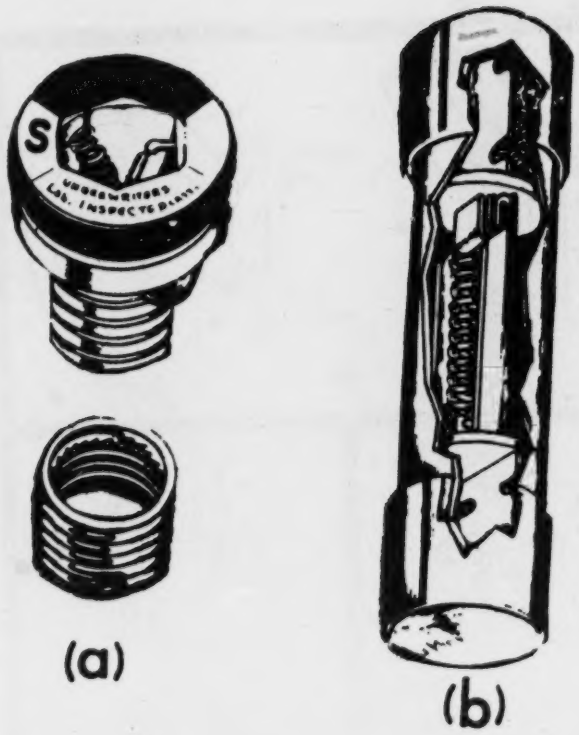

Figure 55. Time-delay fuses. (a) Adapter-type fuse for tamper-resistant use. (b) Cartridge-type fuse with the same type of delayed action as provided in the plug fuse.

B. ASSEMBLING TOOLS AND MATERIALS

For fuses:

Tools:

Medium screw driver

Slip-joint pliers

Materials:

New fuse(s)

C. LOCATING CAUSE OF TROUBLE

It is usually easy to see the cause of the trouble, such as a short in the equipment cord you are using (Figure 49b), or an overload due to too much equipment (Figure 49a).

If you know the cause of the trouble, disconnect the appliances, omit the next three steps and proceed with step 4.

If you don't know the cause of the trouble, proceed as follows:

1. *Check light fed by other circuits to make certain the power is on.*

2. *Check for equipment that is hot or has a burned odor.*

   If found, disconnect it from outlet and proceed with step 4. If not, proceed with step 3.

3. *Disconnect any equipment that has been added to the circuit within last 20 or 30 minutes.*

4. *Locate the circuit breaker, or fuse box, that protects this circuit (Figure 56).*

   It is probably located in the service-entrance panel (Figure 56a and b) where the service entrance cable enters the building.

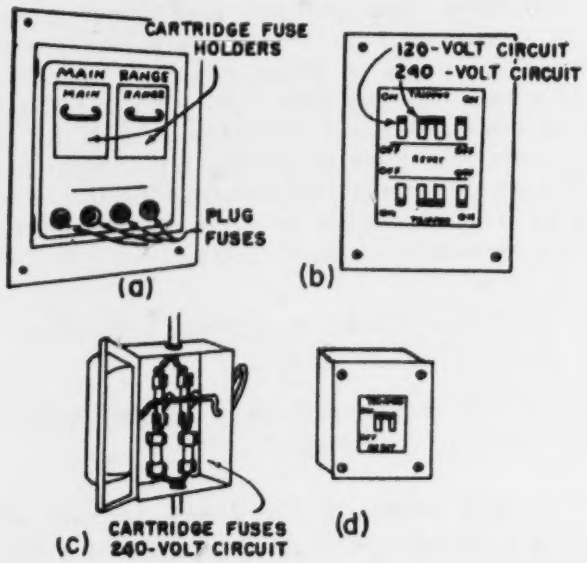

Figure 56. (a) Service-entrance **fuse panel** commonly used in homes to protect most or all of the circuits. (b) Service-entrance **circuit-breaker** panel commonly used in homes. (c) 240-volt fused switch for individual equipment circuit such as for a water heater. The type shown is for cartridge fuses. (d) 240-volt circuit-breaker switch for an individual equipment circuit.

5. *Locate which fuse has blown or which circuit breaker has opened.*

   a. If your circuit is protected with a **circuit breaker** (Figures 56b and d):

      (1) *Note which breaker switch is in the "OFF" or "TRIPPED" position (Figure 58).*

      (2) *Proceed with steps outlined under D: "Re-establishing Service on Circuit Breaker."*

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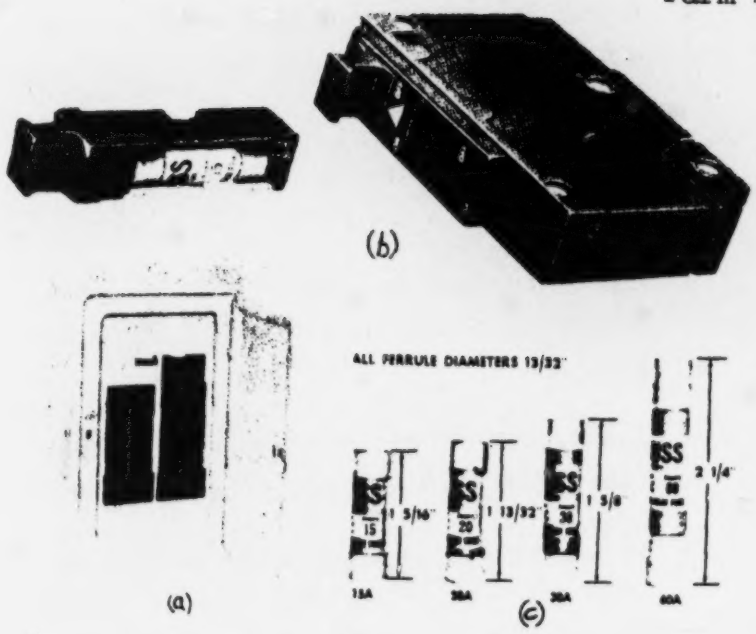

Figure 57. (a) New type pull-out fuse-holder panel is similiar in appearance to a circuit-breaker panel. Cartridge fuses are used in place of plug fuses. (b) When fuse is blown, the indicator light glows. Pull-out fuse holder is removed when cartridge fuse is to be replaced. (c) New fuse sizes (Type SC) have been approved by the Underwriters' Laboratories for use with these panels so it is impossible to overfuse. All of the fuses are of the time-delay type. (Courtesy Square D Co.)

b. If your circuit is protected with **plug fuses** (**Figure 56a**):

(1) *Inspect each fuse to see which one is blown.*

If none of the fuses appear to be blown, it may be due to a defective fuse. The procedures that follow may have to be repeated with each fuse until the defective one is found.

(2) *Proceed with steps outlined under E: "Re-establishing Service on Plug-Fuse Panel."*

c. If your circuit is protected with **cartridge fuses** (Figures 56c and 57):

Proceed with steps outlined under F: **"Re-establishing Service on Cartridge Fuse Panel."**

D. RE-ESTABLISHING SERVICE ON CIRCUIT BREAKER

1. *Check instructions on front of breaker panel (Figure 58).*

The procedures given will reset the trigger mechanism.

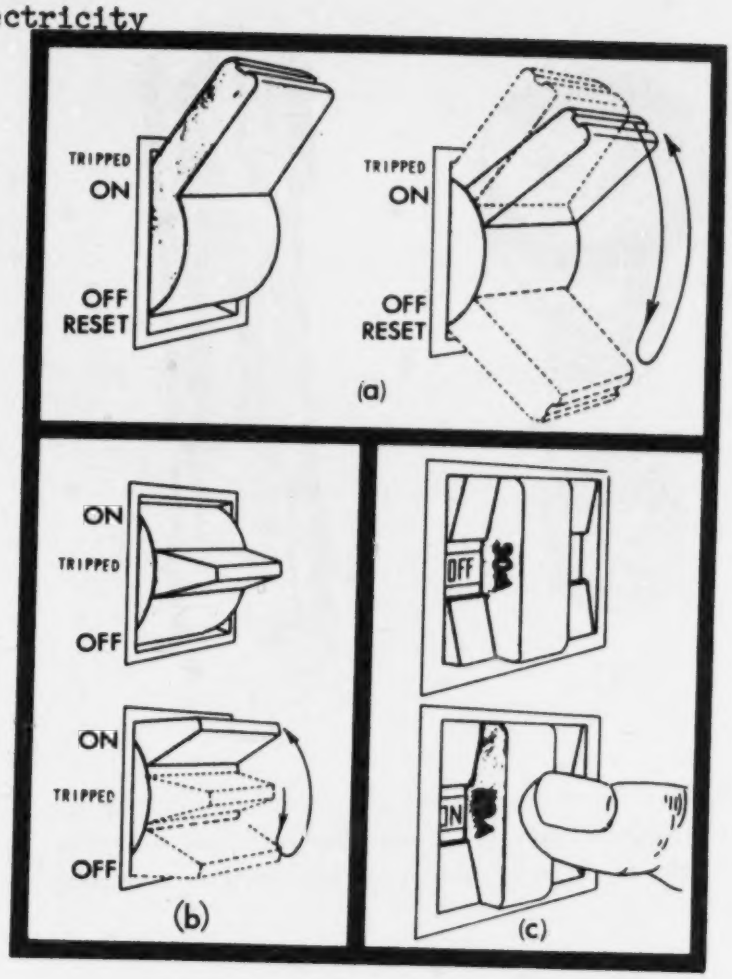

Figure 58. Procedures for setting different kinds of circuit breakers. (a) When "tripped," lever is past the "ON" position. To reset, handle is moved to "RESET" and back to "ON." (b) When tripped, handle is in center position between "ON" and "OFF." To reset, move handle to "RESET" position and back to "ON." (c) Push-type breaker. When tripped, "OFF" shows in window of switch. Press in on switch and release. If reset, "ON" will show in window when switch returns to normal position.

2. *Reset circuit breaker and move to "ON" position (Figure 58).*

If the breaker won't remain in the "ON" position, wait for a minute or two and reset again. The heater strip requires a short time to cool before the breaker can be reset.

If, after a cooling period, the breaker still won't stay in the "ON" position, the short circuit or overload condition is still present.

E. RE-ESTABLISHING SERVICE ON A PLUG-FUSE PANEL

1. *Pull main switch (Figure 59a or b).*

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Pulling the main fuse block of the service entrance switch (Figure 59a) will discontinue service all over the building. If this causes inconvenience to other operations in the building, leave the current on and proceed directly to the next step.

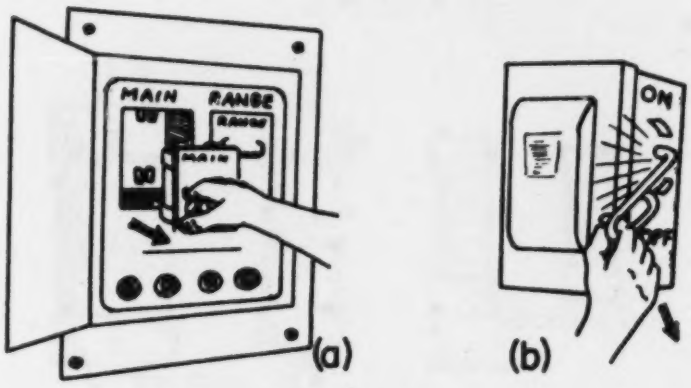

Figure 59.

2. *Screw out blown fuse (Figure 60a).*

If the main switch is "ON," be sure you are standing on a dry floor. If the floor is wet, stand on a dry board or rubber mat (Figure 60b). This protects you against shock in case you happen to touch a live part while screwing out the fuse. Do not touch metal parts on box or any pipes.

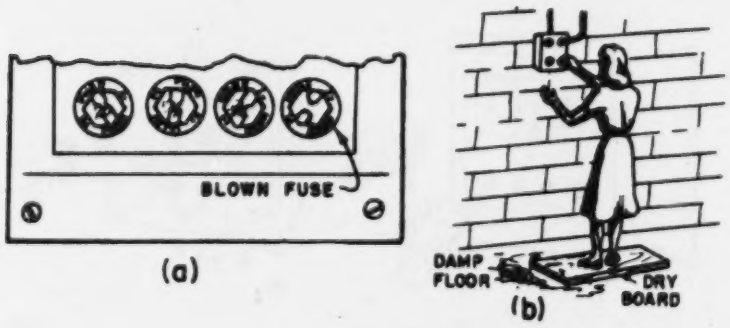

Figure 60.

3. *Examine fuse to determine which type of plug fuse it is (Figure 61).*

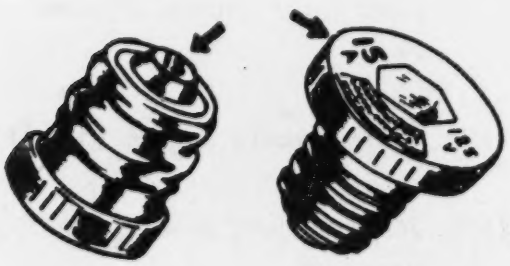

Figure 61.

4. *Note number on top or bottom of fuse plug that shows amperage (Figure 61).*

5. *Replace with fuse of correct size.*

If the fuse you removed was an old-style common fuse, replace it with the same size tamper-resistant type if possible. It costs very little more to modernize your wiring-protection system by installing tamper-resistant fuses.

6. *Throw main switch to "ON" if it was turned off.*

F. RE-ESTABLISHING SERVICE ON CARTRIDGE FUSE PANEL

a. If your fuse panel is one designed for the new type SC fuses (Figure 57), proceed as follows:

(1) *Check to see which indicator light is glowing.*

(2) *Remove pull-out fuse holder next to it.*

(3) *Replace fuse with type SC cartridge fuse of the size.*

Type SC fuses are the ones shown in Figure 57. They are of different design and size than the standard fuse shown in Figure 65. If you are replacing a 20-ampere fuse, you can use either a 15-ampere size or 20-ampere size. But if you are replacing a 15-ampere fuse, you will have to use another 15-ampere fuse. A 20-ampere fuse will not fit the holder.

(4) *Insert fuseholder into original socket.*

The fuseholders are also designed so you can't make the mistake of putting a 20-ampere fuseholder into a 15-ampere socket.

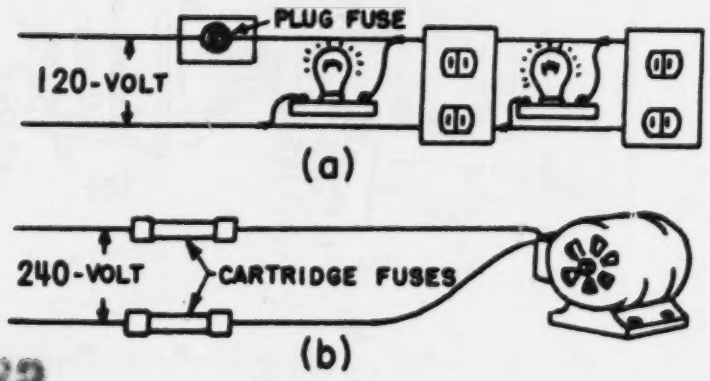

Figure 62.

6828

b. If your fuse panel, or fused switch, is similar to those shown in Figures 63 and 64, it uses **standard cartridge fuses** like those shown in Figure 65. Keep in mind that cartridge fuses of this type are most commonly used on 240-volt circuits. In that case, the circuit has two fuses to be checked (Figure 62b) instead of one as with a 120-volt lighting circuit (Figure 62a).

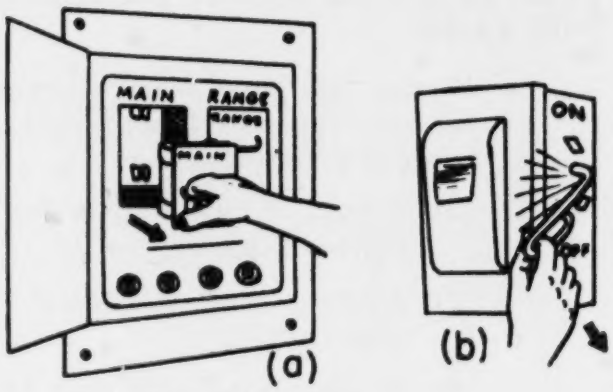

Figure 63.

(1) *Remove main fuse holder (Figure 63a) or throw main switch to "OFF" (Figure 63b).*

(2) *Remove one fuse from fuse clips (Figure 64a or b).*

Sometimes the outer shell is browned from heat. If so, it is the one most likely to be blown. If both look the same, it makes no difference which one is checked first.

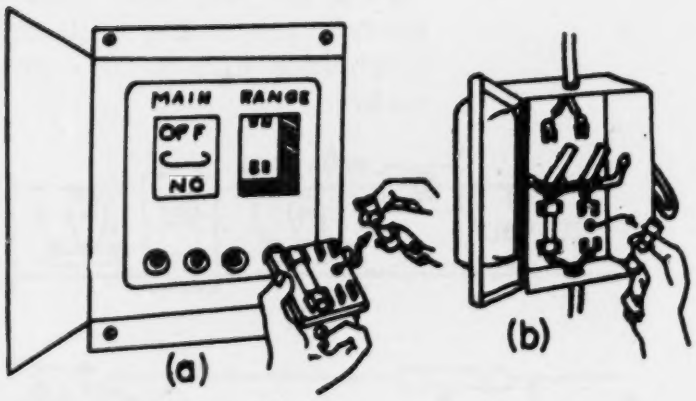

Figure 64.

(3) *Examine old fuse to determine which kind it is (Figure 65).*

(4) *Replace old fuse with new one of same amperage rating.*

(5) *Throw main switch to "ON."*

(6) *See if service is restored. If not, proceed with 7.*

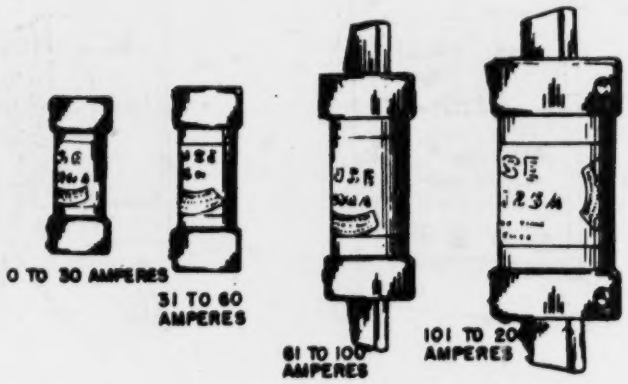

Figure 65. Kinds of standard cartridge fuses.

(7) *Throw main switch to "OFF."*

(8) *Remove new fuse and put old one back in place.*

(9) *Remove second old fuse and replace with new one (Figure 66a or b).*

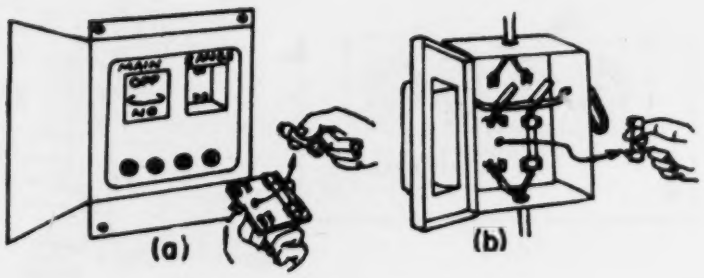

Figure 66.

(10) *Throw main switch to "ON."*

(11) *See if service is restored on circuit. If not, it is probable both fuses have blown. Proceed with 12.*

(12) *Throw main switch to "OFF."*

(13) *Replace first fuse checked with new one.*

(14) *Throw main switch to "ON."*

II. REPLACING A SINGLE-POLE SWITCH

Single-pole switches are used when a light is turned on, or off, from only one location. Figure 67a shows the use of this type of switch in a bathroom. Switches will wear with use until they finally fail completely. Note in the simplified sketch (Figure 67b) that there are only two wires connected to the switch. This makes it very simple to replace.

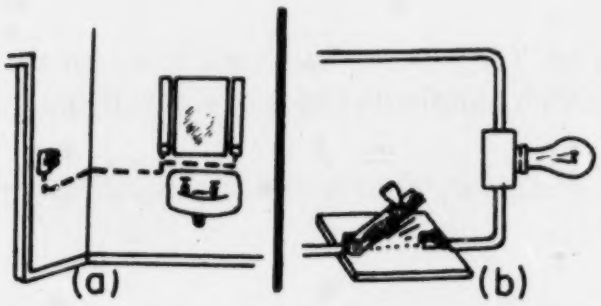

Figure 67. (a) A single-pole switch controls lights from from only one location. (b) Simplified sketch of how a single-pole switch works. (An exposed switch such as this one is a hazard and should never be used.)

When purchasing a new switch it is often difficult to decide which one to purchase. There are a wide variety of trade names and a wide range of prices. Your first check should be to see that it has the UL label of approval stamped or molded on it. This is assurance that the switch has met certain safety standards established by Underwriters' Laboratories. Among other tests a UL approved switch must stand being turned on and off at least 6,000 times at its rated amperage.

More durable switches are "T" rated by Underwriters' Laboratories. A 'T" rated switch has met the established safety standards and will stand being turned on and off at least 12,000 times under normal lighting conditions. You will find the "T" rating on the switch, or on the container, or both. A "T" rated switch is usually the best buy.

A. ASSEMBLING TOOLS AND MATERIALS

Tools:

Screw driver
Pocket knife
Electrician's pliers
or thin-nose pliers
Neon test lamp

Materials:

New single-pole switch

B. REMOVING OLD SWITCH

1. *Pull main switch or remove fuse (or trip circuit breaker) on circuit supplying wall switch.*

2. *Remove screws holding switch plate (Figure 68).*

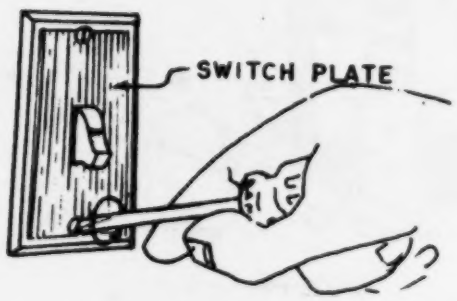

Figure 68.

3. *Remove switch plate.*

If there is any question about the circuit being "dead," check it with a neon test lamp* (Figure 69). If lamp glows, the circuit is still "hot." Check further for main switch that controls the circuit.

*A neon test lamp is inexpensive and available almost any place where electrical supplies are sold. It will glow on an extremely small amount of current and a wide range of voltages. For this reason it is more accurate, can be used under a wider range of conditions and is safer than a light-bulb test lamp. A regular light-bulb test lamp will not work satisfactorily on this kind of test unless it is of low wattage as compared to the lamp controlled by the switch.

6830

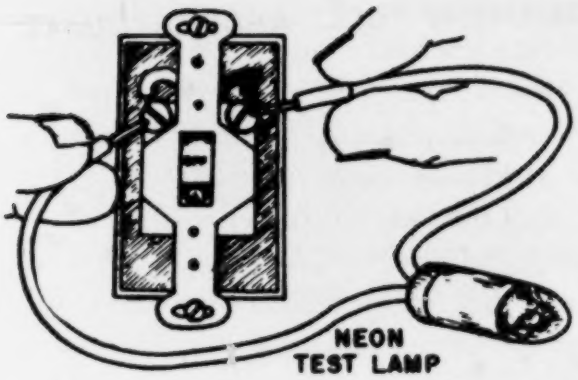

Figure 69.

4. *Remove screws holding switch in place (Figure 70).*

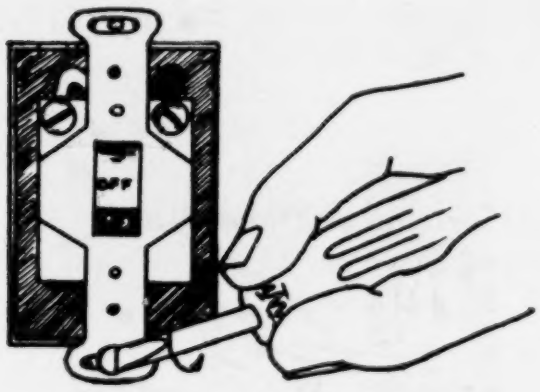

Figure 70.

5. *Pull switch from outlet box (Figure 71).*

   There should be plenty of slack wire in the outlet box back of the switch.

6. *Loosen screw terminals and unhook wires from switch (Figure 71).*

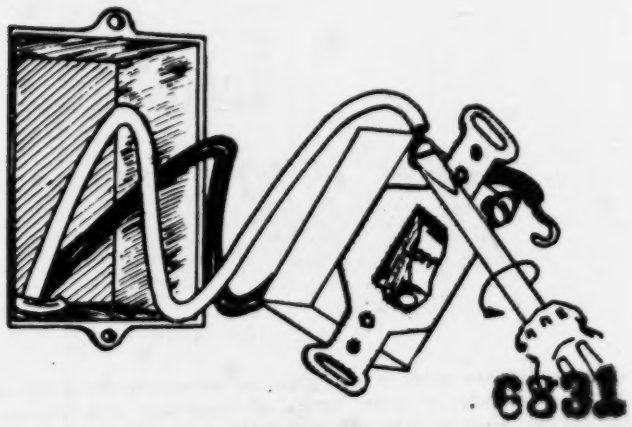

Figure 7

C. INSTALLING NEW SWITCH

1. *Scrape bare ends of wire to remove dirt and corrosion.*

2. *Loose screw terminals on new switch. Don't remove them.*

3. *Examine switch to see which end should be up.*

   The "OFF" and "ON" markings on the switch handle should read rightside up.

4. *Connect wires to terminal posts (Figure 72).*

   Either wire can be connected to either post.

   Be sure the hook on each wire extends around the terminal post in the same direction that the screw tightens.

   Switches vary in design. Many of them are front-connected like the one shown here. Some have the terminal screws on the sides while others have them on the ends of the switch.

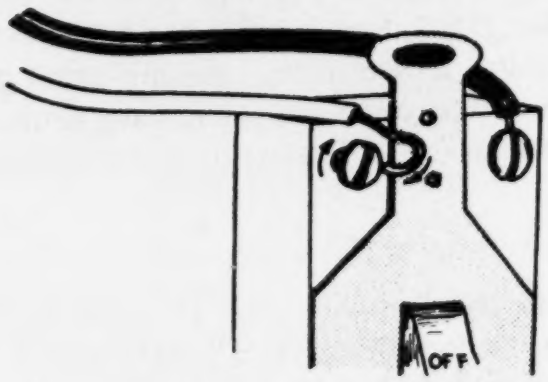

Figure 72.

5. *Push switch into outlet box.*

   If you have trouble getting the slack wire back into the box, bend both wires so they will "accordion" back into the outlet box (Figure 73).

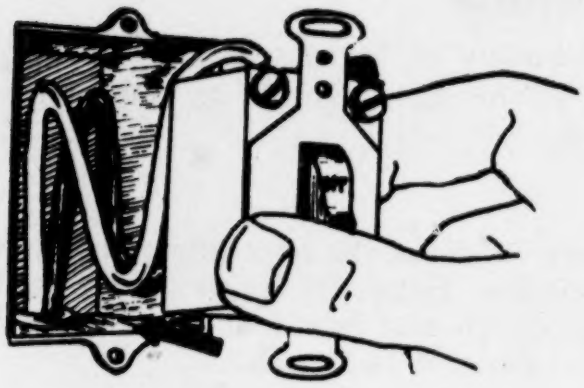

Figure 73.

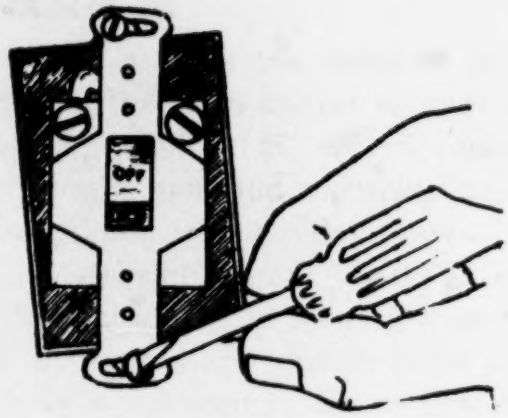

Figure 74.

6. *Replace screws that hold switch in place (Figure 74).*

   Note that the holes in the switch mounting straps are slotted. This is so the switch may be adjusted to a straight up-and-down position even though the box is set crooked.

7. *Replace switch plate and screws.*

   If the switch plate is of plastic material, don't tighten screws too much. It may crack the plate.

8. *Re-establish service to circuit.*

9. *Test switch to see if it works.*

WIRING DIAGRAMS, POLARIZED DEVICES, TESTING DEVICES

1. Where are three-way switches used?

2. Where are four-way switches used?

3. What is the purpose of a fuse?

4. What two types of switch boxes may be used in a circuit?

5. How do you reset a circuit breaker?

6. Why is it not safe to put a penny behind a fuse?

7. Explain how a time delayed fuse works.

8. What is the first step in reestablishing service on a plug fuse panel?

9. What precautions should be observed while changing a fuse with the power on?

10. What is the difference in a "UL" and a "T" rated switch?

11. Explain the procedure to follow in replacing a switch.

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III. REPLACING A 3-WAY SWITCH*

Three-way switches are used so that a light (or lights) may be turned on or off at either of two locations (Figure 75). Some people call them "2-way" switches but that is not correct. The term "3-way" refers to the number of wire connections, not to the number of switches. They are widely used because of their convenience in saving steps when passing from one room to another. A 3-way switch is used for a yard light when you wish to turn the light on or off at either of two locations, such as either at the house or at another building.

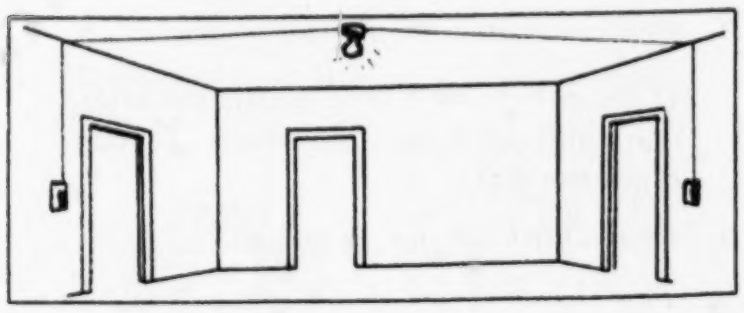

Figure 75. Three-way switches turn a light on or off at two different locations.

The quality of 3-way switches can be determined in the same manner as with single-pole switches.

Figure 76 shows the operating principle of 3-way switches. Figure 76e shows one type of commercial switch and how it is connected. Other types are shown in Figure 77.

It is more difficult to replace a 3-way switch than a single-pole switch. In fact, you will have trouble reconnecting a new 3-way switch unless you know how the switches work together, or unless you follow very carefully the procedure given here. If no one has tampered with the switch—changed the wire connections or completely removed the switch—it won't be necessary to use all of the following procedures.

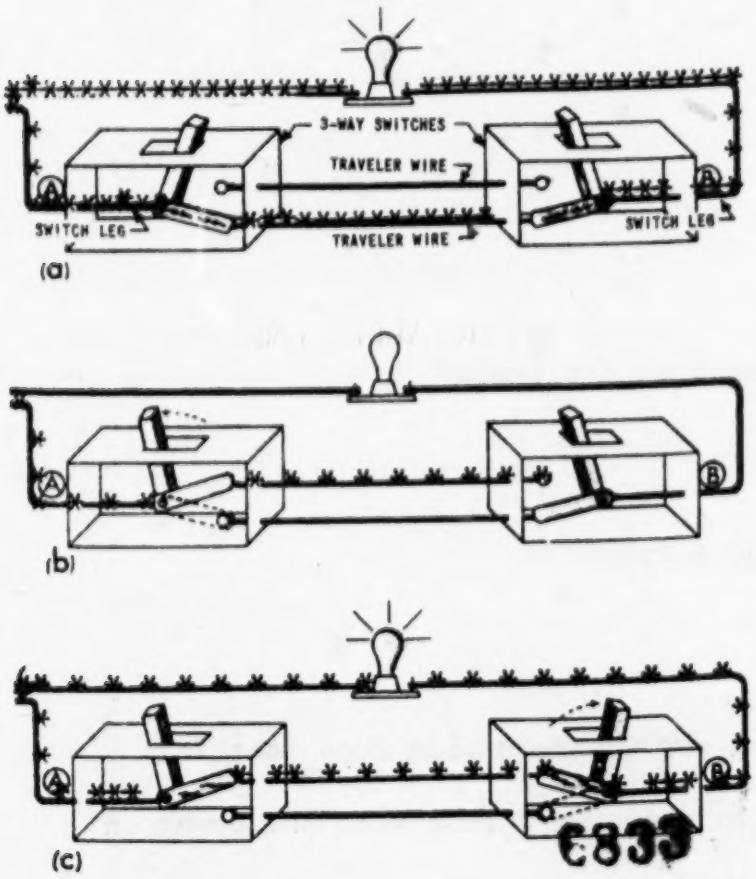

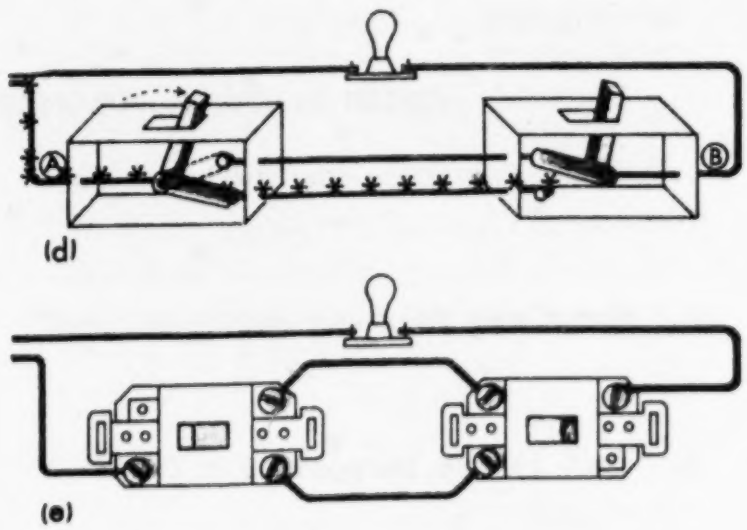

Figure 76. How 3-way switches work. (a) Current entering switch-leg "A" flows through the left hand switch and lower traveler wire, then through the right-hand switch-leg "B" to the light. The light is **on**. The path being followed by the current is shown by **. (b) Light is turned **off** when left-hand switch is moved to opposite position which connects it to the upper traveler wire. Right-hand switch is still connected to lower traveler wire. (c) Light is turned **on** when right-hand switch is moved so it connects to the upper traveler wire to complete the circuit. (d) With left-hand switch changed to connect to the lower traveler wire, the circuit is broken. The light is **off**. (e) Wire connections as they appear on standard commercial-type switches.

*These procedures are for the standard snap-type switches in most common use. The same testing procedures will not work with mercury switches or low-voltage remote-control [illegible]

It is usually difficult to know which of the two switches is giving trouble until you test them. Either switch may turn the light on at times, while at other times both switches have to be worked to get any light. This may lead you to think that both switches are faulty. The trouble is usually in only one switch.

(If someone has **disconnected and removed the switch** before you had a chance to check it, it will take longer to do your testing. Read the following procedures through operation F to get acquainted with the problem. Then follow the steps under operation G.)

A. ASSEMBLING TOOLS AND MATERIALS

Tools:

Screw driver with insulated handle
Pocket knife
Pair pliers (preferably thin-nosed pliers)
Neon test lamp
Pencil

Materials:

New 3-way switch

B. IDENTIFYING SWITCHES AS TO TYPE

1. *Remove screws holding switch plate on one of the switches (Figure 68).*

2. *Remove switch plate.*

   CAUTION—**The wires are still "hot"** so the switch may be tested. There is no danger of shock if you are standing on a dry floor and if you keep away from any plumbing or other metal objects while testing the switch. If you must stand on the ground or on a damp or wet floor, provide electrical insulation by using a dry board or box.

3. *Examine your switch to see which type it is.*

   Figure 77 shows the different 3-way switch wire-connection arrangements. If your switch does not look like one of these, see if it does when turned upside down. A 3-way switch works equally well either way.

   If your switch is side-connected or end-connected (Figure 77b and c), proceed with operation C.

   If your switch is front-connected (Figure 77a) proceed to operation D.

   If it has four wires connected to it, it is a 4-way switch.

C. REMOVING SIDE-CONNECTED OR END-CONNECTED SWITCHES

A side-or end-connected switch is removed from the switch box so as to reach the terminals. Since the screw terminals on a front-connected switch are easy to reach, the switch is left in place until the testing operation is completed.

1. *Remove screws holding switch in place (Figure 70).*

2. *Pull switch from outlet box.*

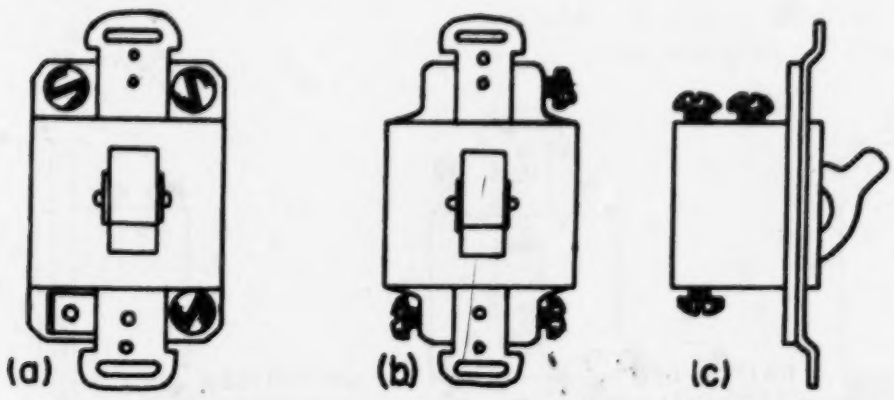

Figure 77. Types of 3-way switches in relation to wire connections: (a) front-connected, (b) side-connected, and (c) end-connected.

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D. TESTING FOR FAULTY SWITCH

1. *Work both switches until light burns (Figure 78).*
2. *Snap each switch to opposite position.*

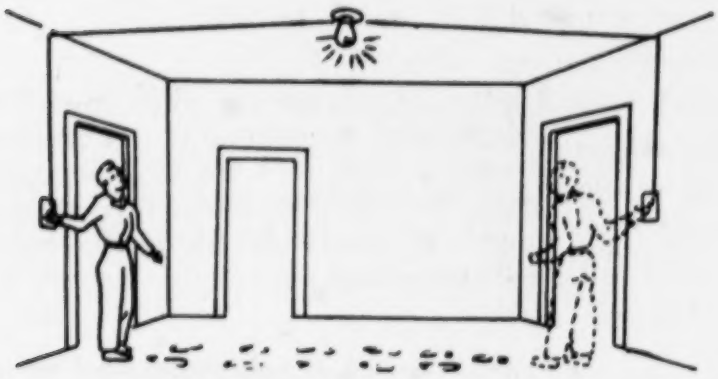

Figure 78.

3. *Label the terminal screws on switch: "A" "B" "C" (Figure 79).*

   Pencil the letters on the wall next to the screw terminals; or cut a hole the size of the switch box in a blank piece of paper and fasten it to the wall over the switch box.

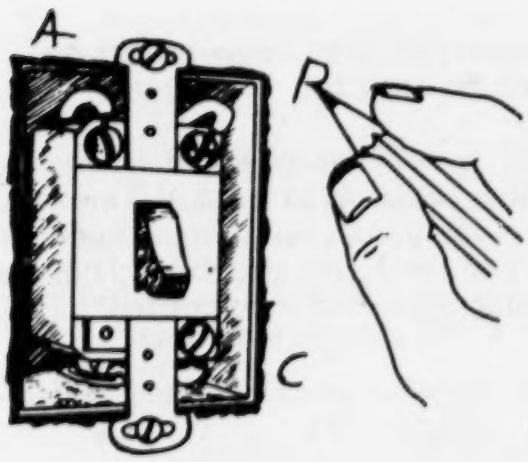

Figure 79.

4. *Touch test lamp wires to terminals A and B, then to terminals A and C, then to terminals B and C (Figure 80).*

   If the **test light burns with two of the combinations,** your switch is connected by the so-called "hot" system. The remainder of these procedures do not apply. It is wired differently than shown in Figure 76. Employ a competent electrician to change your switch since it is important that certain safety precautions be followed.

   If the **test light burns** with one of these combinations, the switch you are testing is FAULTY. It should be replaced with a new one. Proceed with E.

   If the **test light does not burn** with any of these combinations, the switch you are testing is GOOD. It's the other switch that is faulty. Reassemble this switch and start over again with the other switch.

E. LOCATING SWITCH-LEG WIRE AND TERMINAL

When replacing a 3-way switch, your most important job is to find which is the **switch-leg terminal** (Figure 81), and which is the **switch-leg wire** that connects to it.

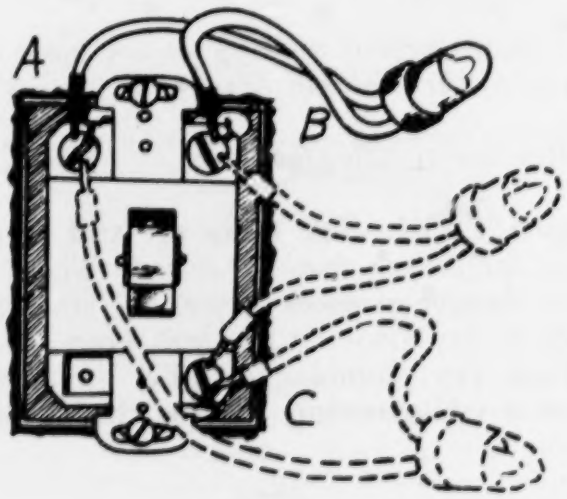

Figure 80.

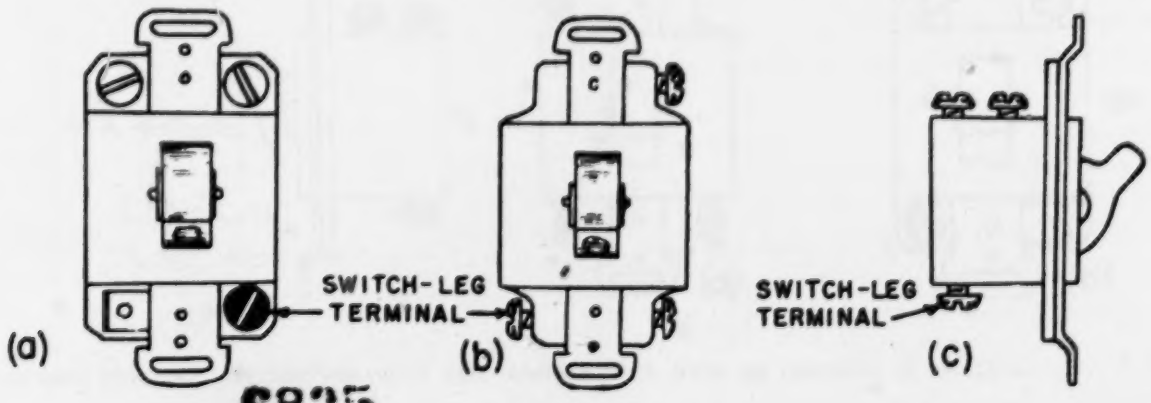

Figure 81.

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On most **front-connected switches** the switch-leg terminal is either black or copper colored (Figure 81a).

On **side-connected switches** the switch-leg terminal is by itself on one side of the switch (Figure 81b).

On **end-connected switches** the switch-leg terminal is by itself on one end of the switch (Figure 81c).

If you are able to locate the switch-leg terminal on your switch, proceed to operation F.

If you can't tell which is the switch-leg terminal, you probably have a front-connected switch with all brass screws. To find the switch-leg terminal proceed as follows:

1. *Work both switches until light burns that is controlled by switches (Figure 78).*

2. *Turn light off at FAULTY switch.*

3. *Label the three terminal screws on faulty switch: "A," "B" and "C" (Figure 79).*

   Follow procedure outlined in D, step 3, page 34.

4. *Touch test-lamp wires to terminals A and B, then to terminals A and C, then to terminals B and C (Figure 80).*

5. *Draw a pencil line between the two letters of terminals that produced a light.*

6. *Snap the GOOD 3-way switch to the opposite position.*

7. *Repeat step 4 on FAULTY switch.*

   The test lamp should again burn in one of the other positions.

8. *Draw pencil line between two letters of terminals that produced light.*

   The letter with two pencil lines to it is the switch-leg terminal. If you didn't get a light in two positions with these procedures, you have probably made an error. Follow your steps through again.

F. REMOVING SWITCH

1. *Throw main switch, or circuit breaker, to "OFF" or remove fuse to circuit on which you are working.*

2. *Disconnect wire from switch-leg terminal and bend it away from switch (Figure 82) so you can tell it from the other wires.*

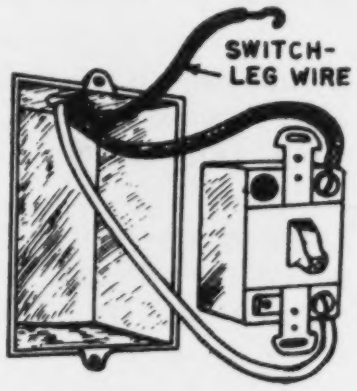

Figure 82.

3. *Disconnect remaining two wires and bend them to another position (Figure 83).*

   If you completely **disconnected the 3-way switch without identifying the switch-leg wire** or else forgot which wire it was, proceed with operation G.

   If you have the switch-leg wire identified, proceed with operation H.

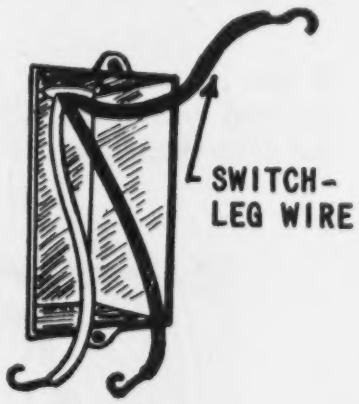

Figure 83.

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G. FINDING SWITCH-LEG WIRE AFTER SWITCH HAS BEEN REMOVED

1. *Separate wires so ends are at least 2 or 3 inches apart.*

2. *Label each wire "A," "B," "C" (Figure 79).*

3. *Throw main switch, or circuit breaker, to "ON" or replace fuse.*

4. *Touch neon test lamp to wires A and B, then to wires A and C, then to wires B and C (Figure 80).*

5. *Draw a pencil line between the two letters representing the wires that produced a light (if you were able to get a light).*

6. *Snap other switch to opposite position.*

7. *Repeat step 4.*

8. *Draw a pencil line between the two letters representing the wires that produced a light (if you were able to get a light).*

   If you have **two pencil lines between lettered terminals,** the switch that was removed was the faulty one. The letter with two lines to it is the switch-leg terminal. Proceed with operation H.

   If you have only **one line between your lettered terminals,** the other switch is the faulty one. Proceed as follows:

1. *Remove faulty switch from outlet box, but don't remove wires from terminals.*

2. *See if you can locate the switch-leg terminal (Figure 81).*

   If you can locate the switch-leg terminal, proceed with operation H. If you can't, proceed with next step.

3. *Twist bare ends of wires together at switch box where switch has already been removed.*

4. *Disconnect wires from faulty switch.*

5. *Repeat main steps 2 through 5, left-hand column, this page.*

   You will get a light in two positions with this test. Be sure to draw a line between each of the lettered terminals that produces a light. The terminal letter with two lines to it is the switch-leg terminal.

6. *Proceed with operation H.*

7. *Repeat operation G when you replace the other switch.*

H. INSTALLING NEW 3-WAY SWITCH

1. *Disconnect circuit if it is not already "dead."*

2. *Examine new switch to find switch-leg terminal.*

   The switch-leg terminal will probably be like one of those in Figure 81. If all terminal screws are the same color, look for a wiring sketch on the box containing the switch; or a sketch similar to Figure 84b may be on a slip of paper in the box.

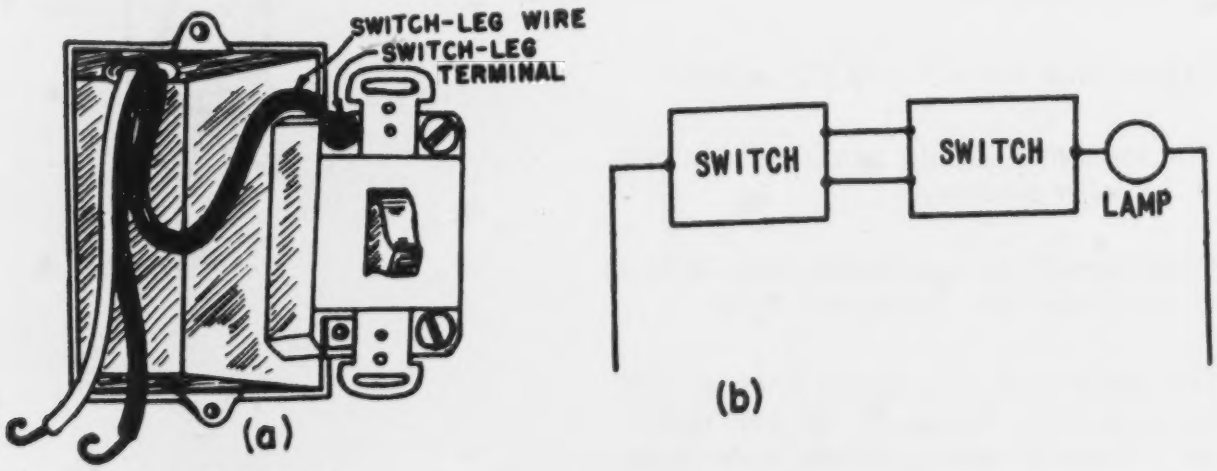

Figure 84.

6837

3. *Connect switch-leg wire to switch-leg terminal on new switch (Figure 84a).*

4. *Connect other two wires to remaining terminals (Figure 85).*

   If you have selected the right wire for the switch-leg, it makes no difference which one of the other two wires is connected to the other two terminals.

5. *Follow same procedures as for installing single-pole switch,*

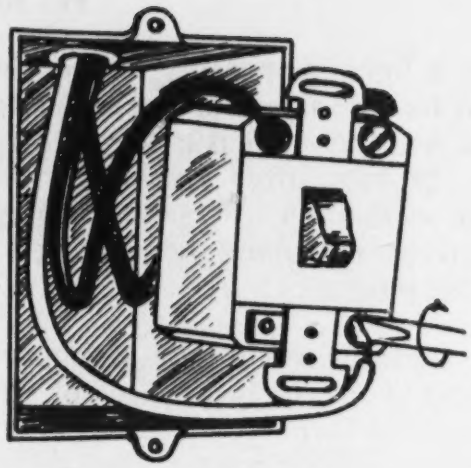

Figure 85.

THREE-WAY SWITCHES

1. Where are three- and four-way switches used?

2. Explain how you would detect a faulty 3-way switch.

3. Explain how you would locate a switch-leg wire and terminal.

4. Explain how you would find a switch-leg wire after the switch has been removed.

5. Explain how you would install a new 3-way switch.

IV. REPLACING A 4-WAY SWITCH

When a light is operated by switches at three different locations, two of the switches are 3-way switches and the other is a "4-way switch" (Figure 86. In fact, after two 3-way switches are installed, as many 4-way switches may be added as desired for controlling the same light (or lights) from other points.

Such switch combinations are often used in homes and about the farm. One of their greatest advantages on farms is for controlling a centrally-located yard light from several different buildings.

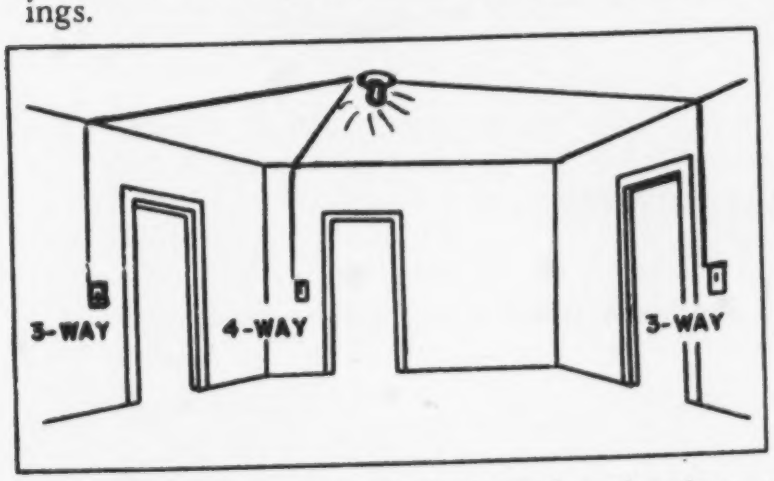

Figure 86. To operate a light from three locations, a 4-way switch is used with two-3-way switches. Additional switches would be of the 4-way type.

Four-way switches, like 3-way switches, get their name from the number of wire connections on the switch. They are easier to replace than 3-way switches. However, the explanation of how a 4-way switch functions is a little more difficult to understand. Figure 87 shows how a 4-way switch works with 3-way switches.

The quality of 4-way switches can be determined in the same manner as with single-pole switches.

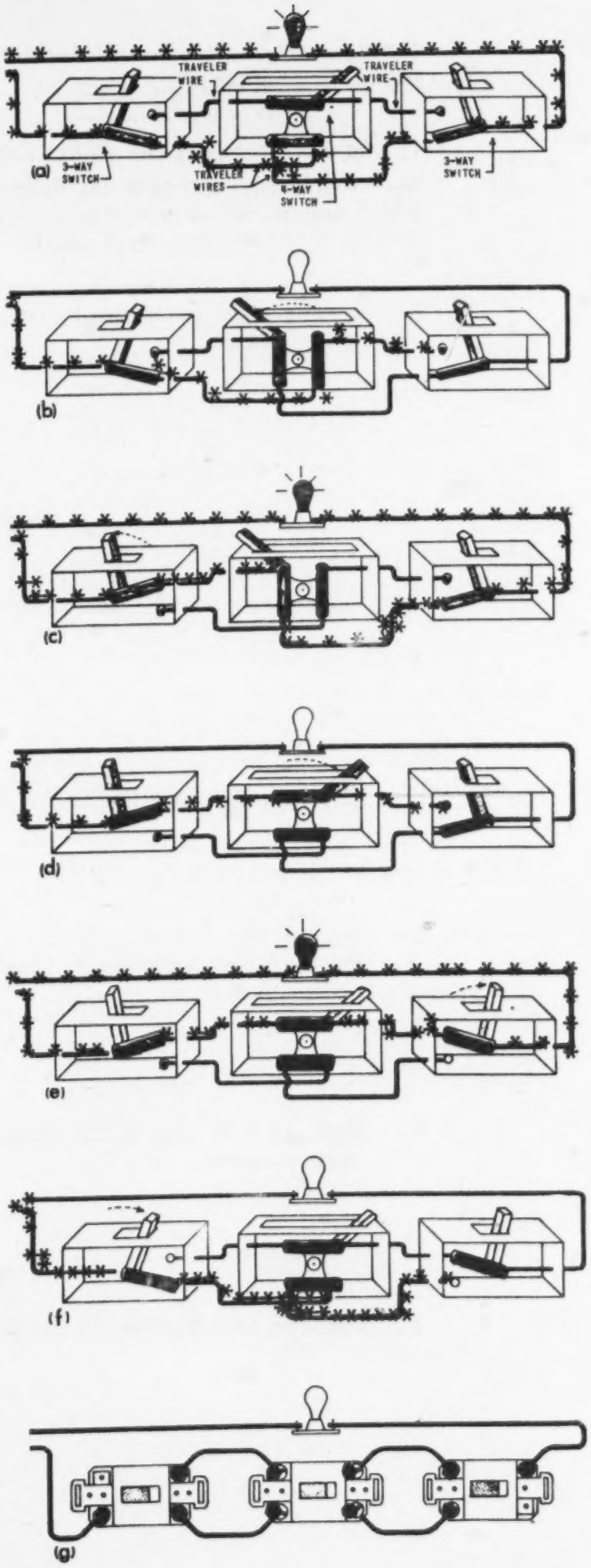

Figure 87. How a 4-way switch works. Note that a 4-way switch is used with two 3-way switches and that the design is different from that for 3-way switches. (a) One combination of switch positions which will permit current to travel through the circuit and light the lamp. *** lines show path traveled by electric current. (b) Four-way switch is given ¼ turn. This combination of connections provides for an open circuit at the right-hand 3-way switch. Light is **off**. (c) Left-hand switch connection is changed from lower to upper traveler wire. Light is **on**. (d) Four-way switch is given ¼ turn. New combination of connections turns light **off**. Circuit is open at right-hand 3-way switch. (e) Right-hand 3-way switch is changed from lower to upper traveler wire. Light turns **on**. (f) Left-hand 3-way switch is changed from upper to lower traveler wire. Light is **off**. (g) Wire connections as they appear on [illegible] comme[illegible]ial-type switches.

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A. ASSEMBLING TOOLS AND MATERIALS

Tools:

Screw driver
Pocket knife
Pliers (preferably thin-nose pliers)

Materials:

New 4-way switch

B. CHECKING FOR FAULTY SWITCH

1. *Disconnect circuit at main switch, circuit breaker or fuse panel.*

2. *Remove old 4-way switch. (Follow procedures under II B, page 29, steps 1 through 6).*

   If there is any question as to whether or not the switch is a 4-way, check to see if it has four wires connected to it.

3. *Hook bare wires from opposite cables together temporarily (Figure 88).*

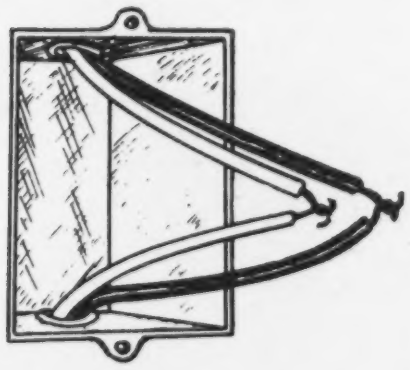

Figure 88.

4. *Reconnect circuit.*

5. *Operate all remaining 3-way (and 4-way switches if any) to see if they operate properly.*

   If the other switches turn the light on and off properly, you have found the faulty switch. Proceed with C.

   If the other switches work only in certain positions, you have not found the faulty switch. In that case proceed with step 6.

6. *Disconnect circuit.*

7. *Reinstall old 4-way switch following procedures given under C.*

8. *Check other 4-way switches, if there are any more, before checking the 3-way switches.*

   If you check the 3-way switches, follow procedures under III, page 32. Don't operate any of the 4-way switches while testing the 3-way switches.

C. INSTALLING NEW 4-WAY SWITCH

1. *Disconnect service at main switch, circuit breaker or fuse panel.*

2. *Connect two wires from one cable to two lower terminals (Figure 89a).*

   Connect either wire to either terminal.

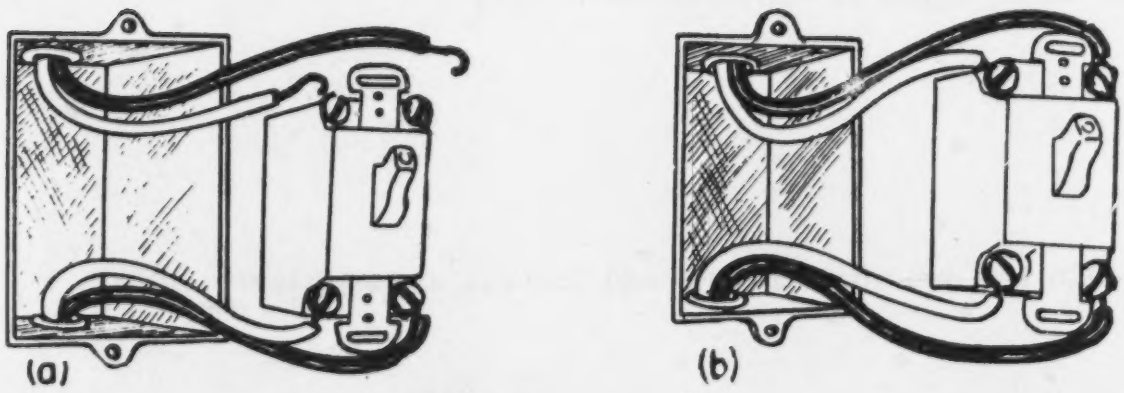

Figure 89.

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3. *Connect two remaining wires to two top terminals (Figure 89b).*

Connect either wire to either terminal. Figure 87a through f shows the two lower traveler wires crossing over each other to connect at opposite screw terminals. This crossover is built into a commercial switch so connections can be made as shown in Figure 87g and 89b.

4. *Complete installation of switch.*

If your switch doesn't work it may be necessary to disconnect the two wires on one side of your switch and interchange them.

FOUR-WAY SWITCHES AND CONVENIENCE OUTLETS

1. What is the purpose of a four-way switch?

2. How does a four-way switch get its name?

3. Explain how you would check for a faulty four-way switch.

4. Explain how you would install a four-way switch.

5. Name three types of convenience outlets.

6. Explain how you would remove and install a convenience outlet.

V. REPLACING A CONVENIENCE OUTLET

Convenience outlets — also called "receptacles" —have to be replaced much less often than switches. However, they eventually wear to a point where attachment plugs are not held securely.

By far the most common convenience outlet is the **duplex type** (Figure 90a). Some of the **triplex type** are used (Figure 90b), but very few of the **single type** (Figure 90c) are used.

Some convenience outlets have "T" slots (Figure 90d). As shown, you can attach either the standard **2-prong plug** or **polarized 2-prong plug** to this type of receptacle.

shown in Figure 90a, b, and c, have only one contact strip in the receptacle for each prong on the attachment plug. These are not very durable. The better types have double contact strips — one to press against each side of each prong. These provide much better electrical connections. If you look into one of the slots of a receptacle, you can usually see if there is one contact or two per prong. The "T" slotted receptacles are usually of this more durable type.

When buying a new convenience outlet, check to see that it has the UL (Underwriters' Laboratories) mark of approval stamped on it. This means it meets their established standards for safety. It does not necessarily mean it will be durable.

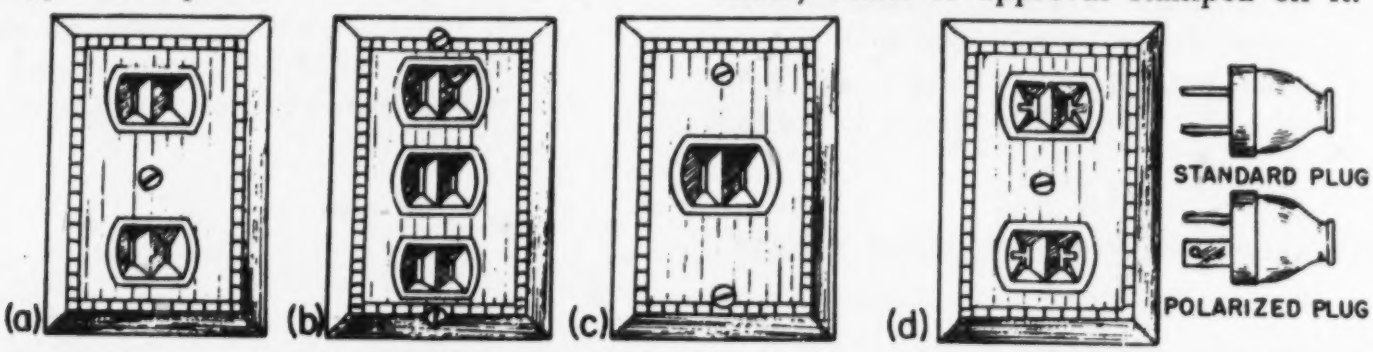

Figure 90. Types of convenience outlets: (a) duplex, (b) triplex, (c) single and (d) "T" slot. The latter can be used with a polarized plug. This is not the same asthe grounding-type polarized plug shown in Figure 90A.

Most new wiring installations have **grounding-type convenience outlets** (Figure 90A). This type of receptacle can be used for connecting either a standard 2-prong plug or a three-prong grounding plug (Figure 90A). The grounding - type receptacle has provision for attaching three wires to it. The third wire leads directly to a ground rod (Figure 90A), or to a (metal) electrical conduit or sheathing which connects to a ground.

The **third prong** on the attachment plug connects to the third wire in the receptacle. Through a third wire in the service cord, it also connects to the frame or case on the equipment you are using. With this arrangement, when the insulation wears off of a "hot" wire and it comes in contact with the equipment frame, the electric current flows through the third wire to the ground connection. This is an important safety provision to keep you from getting shocked.

There are different **qualities of receptacles.** Some of the inexpensive, parallel - slot types,

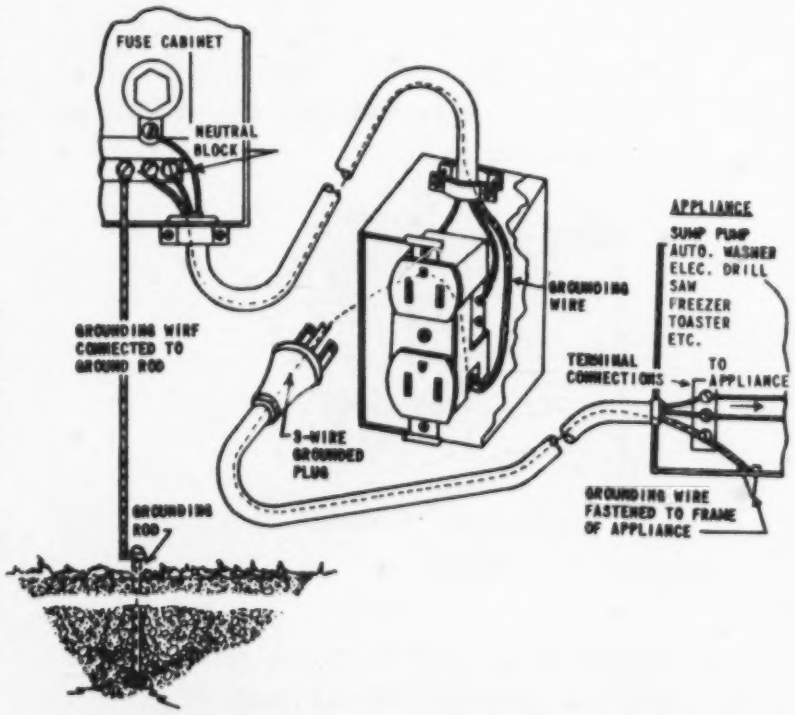

Figure 90A. Grounding-type receptacle now required by the National Electrical Code on newly installed 15- and 20-ampere circuits in residences and on farms.

A. ASSEMBLING TOOLS AND MATERIALS

Tools:

Screw driver
Pocket knife
Pliers (preferably thin-nose pliers)

Materials:

New convenience-outlet receptacle

B. REMOVING OLD CONVENIENCE OUTLET

Follow procedures outlined on page29, under B, "Removing Old Switch."

CAUTION—**When circuit has been disconnected be sure to plug in a floor or table lamp or check with a test lamp to make certain the circuit is "dead."**

C. INSTALLING NEW CONVENIENCE OUTLET

1. *Hook white wire on aluminum-colored terminal post (Figure 91).*

   Be sure wire hook points in the same direction as terminal screw tightens.

   If a second white wire was connected to the old convenience outlet, reconnect it to the second aluminum-colored terminal (Figure 91). The extra white and black wires continue the circuit to the next outlet.

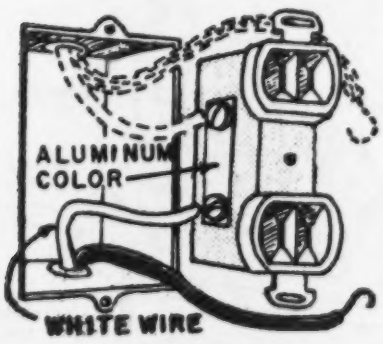

Figure 91.

2. *Hook black wire to brass screw terminal on opposite side (Figure 92).*

   If a second black wire was connected to the old convenience outlet, reconnect it to the second brass terminal post.

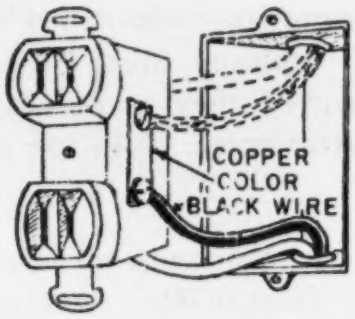

Figure 92.

3. *(Connect grounding wire to grounding (green) terminal post (Figure 93).)*

   If yours is a wiring installation that has been installed for several years, there will probably be no grounding wire.

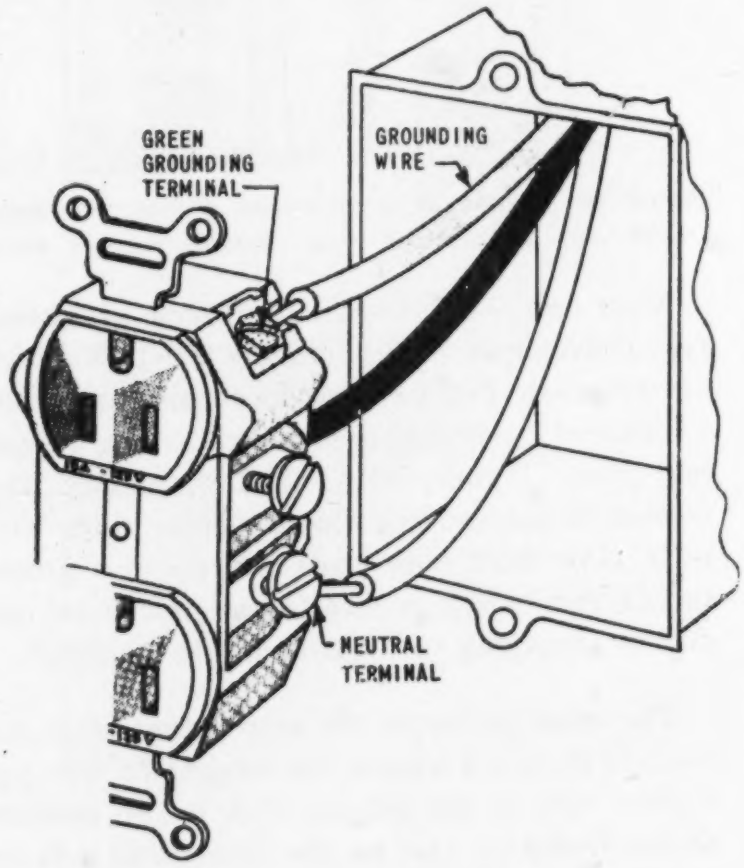

Figure 93.

4. *Recheck connections.*
   An error in connecting convenience-outlet wiring will cause a short circuit.

5. *Complete installation. Follow procedures outlined in II C, steps 5 through 8, page 30.*

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Testing Devices locate trouble quickly

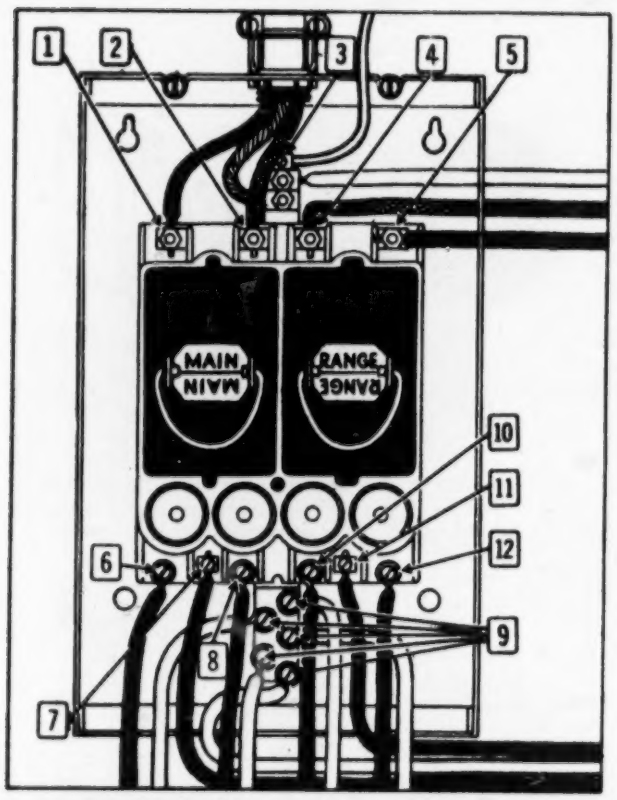

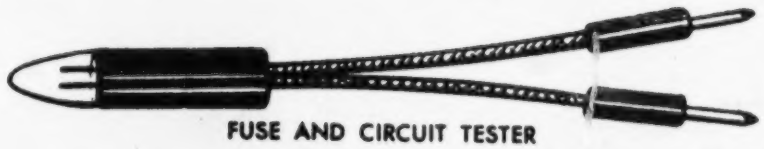

FUSE AND CIRCUIT TESTER

It's simple to locate blown fuses with this little tester. On a panel similar to the one at left, here's the trick. Hold the insulated tips of the tester, and touch terminal 1 with one tip, terminal 3 with the other. If lamp glows, everything's fine. Then repeat the procedure on terminals 2 and 3. To test the range fuse, use terminals 3 and 4. Repeat on 3 and 5. Remember: lamp will glow if fuses are OK.

To test lighting and appliance circuits. Touch tester tips to terminals 6 and 9. Repeat on terminals marked 8 and 9, 9 and 10, 9 and 12. To test main fuse, use terminals 7 and 9, then repeat test on terminals 9 and 11. That's all there is to it, and how easy it is.

REMEMBER: IF LAMP GLOWS THE FUSE IS GOOD. IF LAMP DOES NOT GLOW, REPLACE FUSE.

To test fuse blocks having 2 fuses for each circuit, start with procedure shown in Figure A to the left. If light glows, main fuses are good. If no glow, replace main fuse, and continue testing as shown in Figures B-C-D. If no glow, replace fuse.

To locate a short circuit: If one fuse continually blows, it may indicate a short in your circuit wiring, or a defective lamp, light fixture, or appliance.

To discover the cause, turn off all ceiling lights, shut off all wall switches, and disconnect all cords, lamps and appliances on the circuit you suspect. Then take a 100-watt light bulb, and screw it into the fuse socket that is giving you trouble. If bulb lights with nothing plugged in, there's a short in the circuit. If bulb does **not** light, there is a short in one of the items on the circuit. Leaving bulb in fuse socket, plug lamps and light fixtures in, one at a time. If bulb in fuse socket lights, and lamp doesn't, you've found your short. Irons, toasters, etc. are not shorted if they work at normal speed, while bulb in fuse socket burns brightly at the same time.

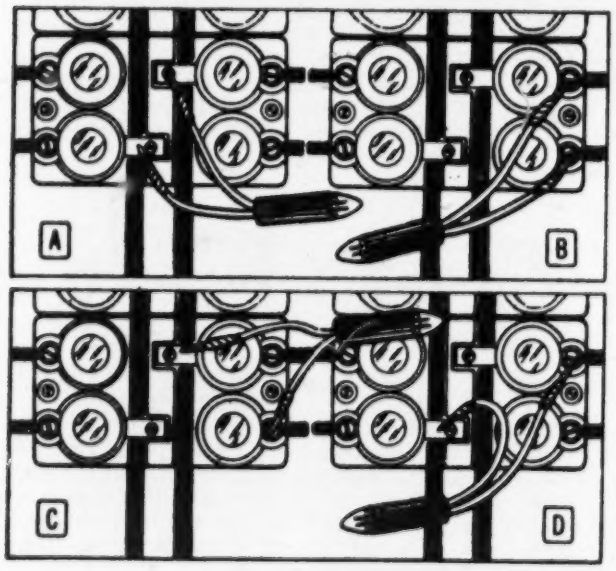

Universal tester for testing fuses, circuits, cords, appliances

This little device belongs wherever electricity performs. It locates current leakage in appliances and motors, finds defective cords, locates shorts.

It will perform all the tests mentioned above and more. Complete testing instructions are enclosed with every Universal Continuity and Line Tester.

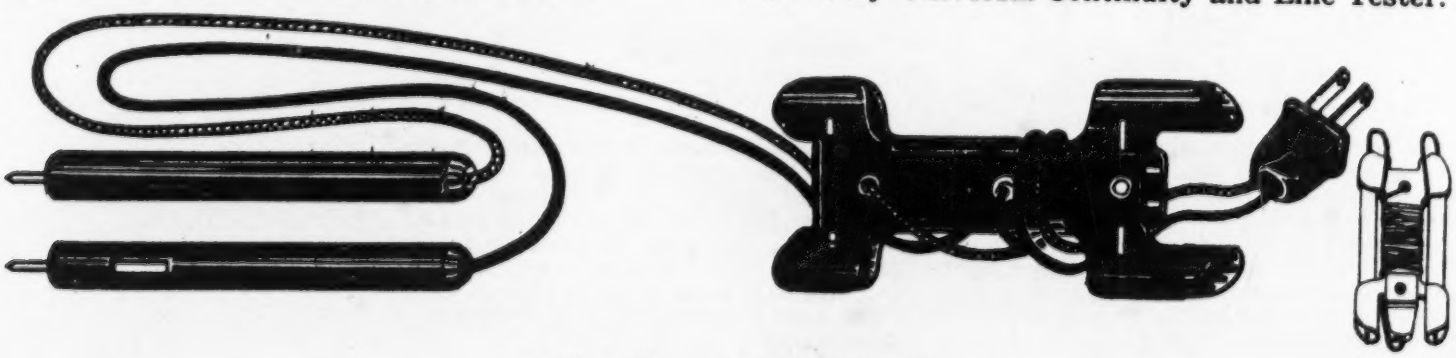

Modern devices easily installed

Converts fuse box into automatic circuit breaker. Just screw into fuse socket. Trips at once on overloads, but takes temporary overloads in stride. (Such as washer, etc.). Colored trip ring points out blown Circuit Saver. Simply push button to restore to use.

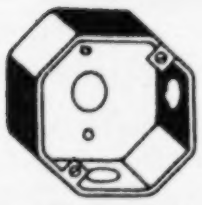

Octagon boxes for use with fixture or junction outlets. These are for use with conduit, or armored or non-metallic cable. Available in steel with half-inch knockouts or with cable clamps. Important hint: use bar hangers with studs wherever ceiling fixtures are to be installed. Recommended for in-home use.

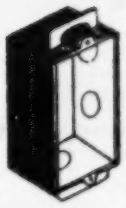

Use steel boxes for switch, receptacle and bracket outlets in the home. Available with or without clamps. Gang two or more by removing one side plate on each box. Then hook boxes together.

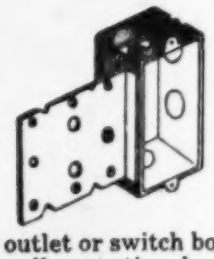

Steel outlet or switch boxes with wall mounting bracket. Mount brackets to allow correct depth for lath (or sheetrock), plaster or paneling. Available for use with connectors or with handy built-in clamps. Warning: use only in new work.

Plug and cartridge fuses with safety valves to protect wires against overloads. Fuse amperage should never exceed amperage capacity of the wire you are using.

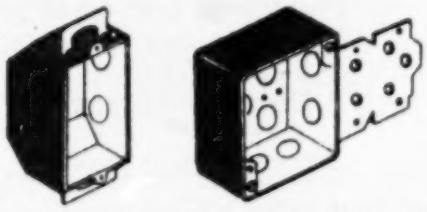

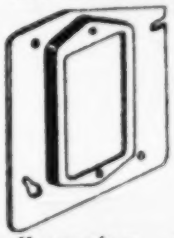

At left: beveled corner box. Fits easily into wall opening in old buildings. Has clamps for loom or non-metallic sheathed cable. No connector needed. Side-bracket box (center) used with cover (right) in new work, wherever extra space is needed for wires. Used for switches, receptacles, bracket outlets. Combination ½ and ¾-inch knockouts, requires connectors. Use with armored, non-metallic or plastic cable, or with conduit.

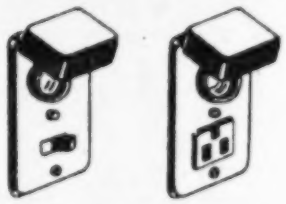

Fuse devices—designed to protect low ampere capacity motors on appliances, power tools, etc. Fit standard switch boxes. Device on the right has fuse holder for lag fuse; also a receptacle with "U"-shape ground. Device on the left has a fuse holder for lag fuse and a toggle switch.

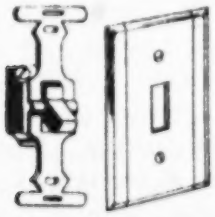

Bakelite toggle switch and plate fits any standard switch box. Choice of single-pole, 3-way or 4-way types, ivory or brown finish. Available too, in silent "Mercury" type, for bed and sick rooms. Also comes in illuminated type. Tiny bulb glows in the dark.

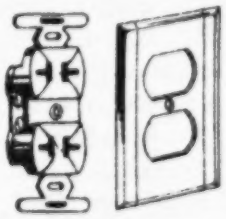

Bakelite duplex wall outlet and plate. Fits any standard flush or surface mounted switch box. Has mounting bracket for aligning with wall surface.

Clock outlet with hanger. The receptacle is recessed to hold both plug and wire. This permits electric clock to hang flush with any wall surface.

Porcelain pull chain outlet with receptacle. Fits any octagon box. Receptacle always "alive." Use porcelain to protect against rust and corrosion in damp places.

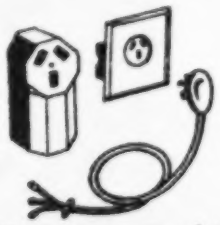

Dryer or range pigtails and receptacles are more convenient than permanent type because appliances can be moved easily for cleaning. Receptacle connects from entrance switch.

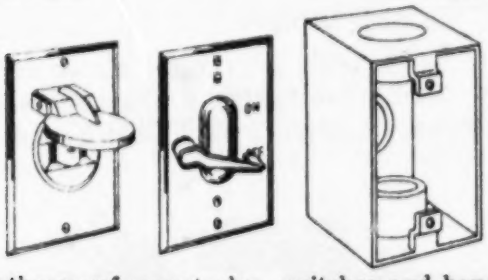

Weatherproof receptacles, switches and boxes for outdoor use. Receptacles, with weatherproof snap covers, come in single and duplex types. Switches available in single and 3-way. Boxes available with four ½-inch openings. Use these outdoor devices for decorative lighting, Christmas lighting, for temporary yard lighting, patio or garden lighting, or any other outdoor installation.

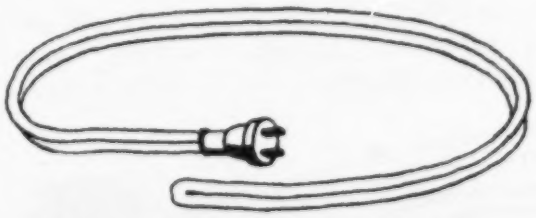

Heating cable helps in preventing frozen water pipes, gutters, troughs or animal drinkers. Keeps hot-bed plants from freezing. Lead-covered but flexible; easy to handle. Insulated, weatherproof; use indoors or out. Plugs into any 120-volt AC line. Available in 20-40-60 foot loops that can prevent many cold-weather annoyances.

Materials and Equipment

1. Electricity tools
2. Samples of the different kinds and sizes of wire
3. Samples of the different kinds of convenience outlets, boxes, connectors, switches, fuses, conduit, etc.
4. Electric panel board

Exercises for Students

1. Wire a wall switch to control a ceiling light at the end of the line.
2. Wire two ceiling lights on the same line; one controlled by a switch.
3. Wire a switch and convenience outlet beyond a ceiling light.
4. Wire a switch and convenience outlet in the same box beyond a ceiling light.
5. Wire a switch to control a ceiling light in the middle of a run.
6. Wire two convenience outlets on the same run.
7. Wire a three-way switch with the controlling outlet located beyond both switches.
8. Wire a three-way switch with the controlling outlet located beyond both switches. Add a receptacle beyond the fixture that is always hot.
9. Wire a three-way switch with the controlling outlet located between the two switches.
10. Wire a four-way switch.
11. Trouble shoot for a blown fuse.
12. Reset a circuit breaker.
13. Replace a cartridge fuse.
14. Remove an old switch and replace with a new one.
15. Test and replace a three-way switch.
16. Test and replace a four-way switch.

INDIVIDUAL STUDENT WIRING BOARD

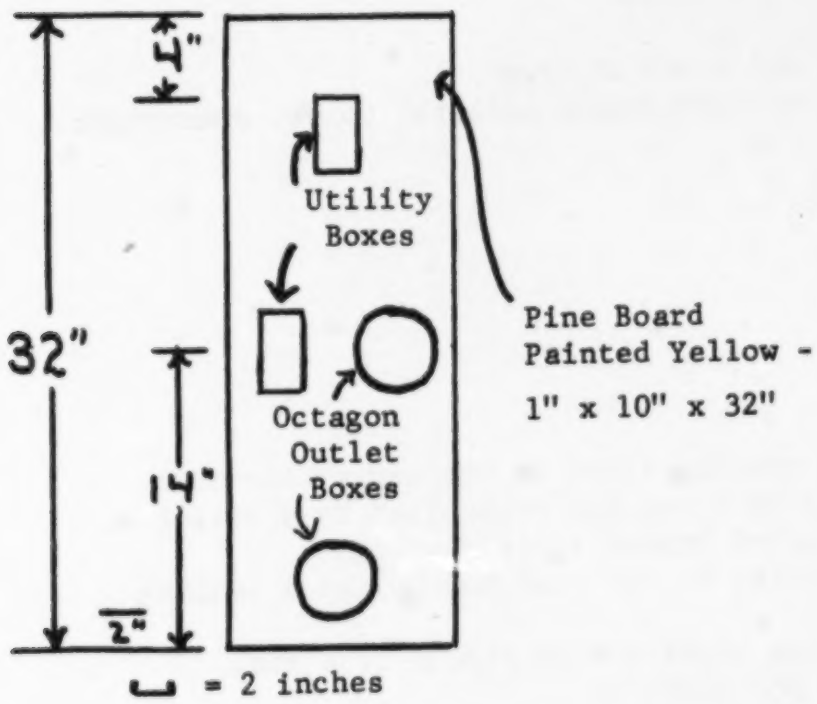

Skills to Learn

1. Use 2-wire and 3-wire nonmetallic cable and dropcord with ground
2. Rip nonmetallic cables and dropcord, strip wires, and prepare them for wiring
3. Polarization or identifying conductor colors and terminal colors
4. System ground and equipment grounding
5. Use grounding clips or other means of grounding to boxes
6. Install parallel grounded receptacles
7. Install lamp receptacles
8. Operation of SPST and SPDT switch
9. Install a toggle switch or two 3-way switches in a circuit
10. Make proper splices in junction boxes
11. Use solderless connectors
12. Use box clamps
13. Attach grounded cap to dropcord and connect to 115 volt circuit

Materials

1. Board with two utility boxes and two octagon outlet boxes screw mounted as shown above
2. Electrical Apparatus:
   a. Switches: One toggle, and two 3-way
   b. Two parallel grounded duplex receptacles
   c. Cover plates: Two for duplex receptacles, two for switches, one blank for utility boxes, and one blank for octagon box
   d. Two keyless porcelain lamp receptacles
   e. Ten feet of NM or NMC, AWG #14 two wire conductor with ground; 6 feet NM or NMC #14 three wire conductor with ground
   f. Four feet of AWG #16, type S or SJ service cord with parallel grounded cap attached
   g. Ten cable (NMC) to box connectors, unless boxes have clamps contained
   h. Six grounding clips
   i. Ten solderless connectors
   j. Several 40w, 115v bulbs
3. Tools:
   a. Wire cutter and stripper
   b. Cable ripper
   c. Needle nose pliers
   d. Standard screwdriver

Wiring Procedure

1. Wire the board for job assigned to you. Plan carefully and exactly what you need to do by sketching the circuit and labeling conductor colors on page 23.
2. Use ample length conductors since other students will use the same conductors. Rip the cable back 6 to 8 inches and strip wires back about 3/4 inch, so that the insulation on the wire will be close to the terminal when connected. Make neat rounded loops for screw terminals and fasten clockwise. Make sure all connections are inside of boxes and that clamps tighten on cables, not on wires. Have end of ripped cable area about 1/4 inch inside of box clamp. Put proper cover plates in place.
3. When finished have your instructor check the circuit before plugging into 115 volts; this is to avoid the possibility of short circuiting error, blowing fuses or electrical shock. If battery or low voltage transformer (10v) powered checking equipment is available, check it yourself for grounding and polarity before energizing to 115 volts.

6847

ACETYLENE WELDING

6848

INTRODUCTION TO ACETYLENE WELDING

Acetylene welding is a method of joining together, with or without an additional metal, with heat produced by a burning mixture of gases. Acetylene welding is more expensive than arc welding. This may force limited practice by the student in order to hold the cost within the limited budget.

Acetylene Welding

1. Safety in acetylene welding
2. Acetylene welding equipment and supplies
3. Welding and cutting torches
4. Torch tips
5. Testing for leaks
6. Hose connections
7. Lighting the torch
8. Acetylene welding flames
9. Welding techniques
10. Welds - good and poor
11. Welding positions
12. Overhead positions
13. Welding pipe
14. Tack and fillet welds
15. Corner welds
16. Lap welds
17. Testing fusion welds
18. Oxy-acetylene cutting

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Acetylene Welding

Materials and Equipment

1. Acetylene welding rig complete
2. Assorted welding tips
3. Cutting attachment and tips
4. Friction type flint lighter
5. Welding goggles
6. Leather gloves
7. 12-inch slip joint pliers
8. C clamps
9. One set of tip cleaners
10. Flux for bronze, brass, copper, malleable iron and galvanized metal
11. Welding rods
12. Soapstone stick

Exercises for Students

1. Practice lighting the acetylene welding and cutting torches
2. Test for leaks
3. Practice adjusting acetylene welding flames
4. Practice welding techniques
5. Practice welding positions
6. Practice welding pipe
7. Make the following welds: tack and fillet, corner, lap
8. Practice cutting techniques
9. Practice cutting holes

SAFETY RULES TO FOLLOW

Follow these rules when using the acetylene welder:

1. Do not use oil or grease on any part of the welding equipment.
2. Check acetylene rig daily for leaks by using soap and water.
3. Never turn on gas until ready to light.
4. Wear clothes without cuffs.
5. Keep hot metal away from hose.
6. Keep inflammable materials away while welding.
7. Be sure you are wearing the correct welding goggles.
8. Always keep tip pointed away from you when lighting.
9. Keep tanks in an up-right position.
10. Keep flame and heat away from the tanks.
11. Use only hose that are in good condition.
12. Be sure the flame is out before laying the torch down.
13. Place hot metal in a protected area to prevent burns.
14. When welding galvanized iron, be sure to have ventilation.
15. Close tank valves tightly when welding is complete.
16. Do you thoroughly understand the safety regulations as discussed?

Yes:_____ No:_____

Signed:_____

Date:_____

WELDING OUTFIT

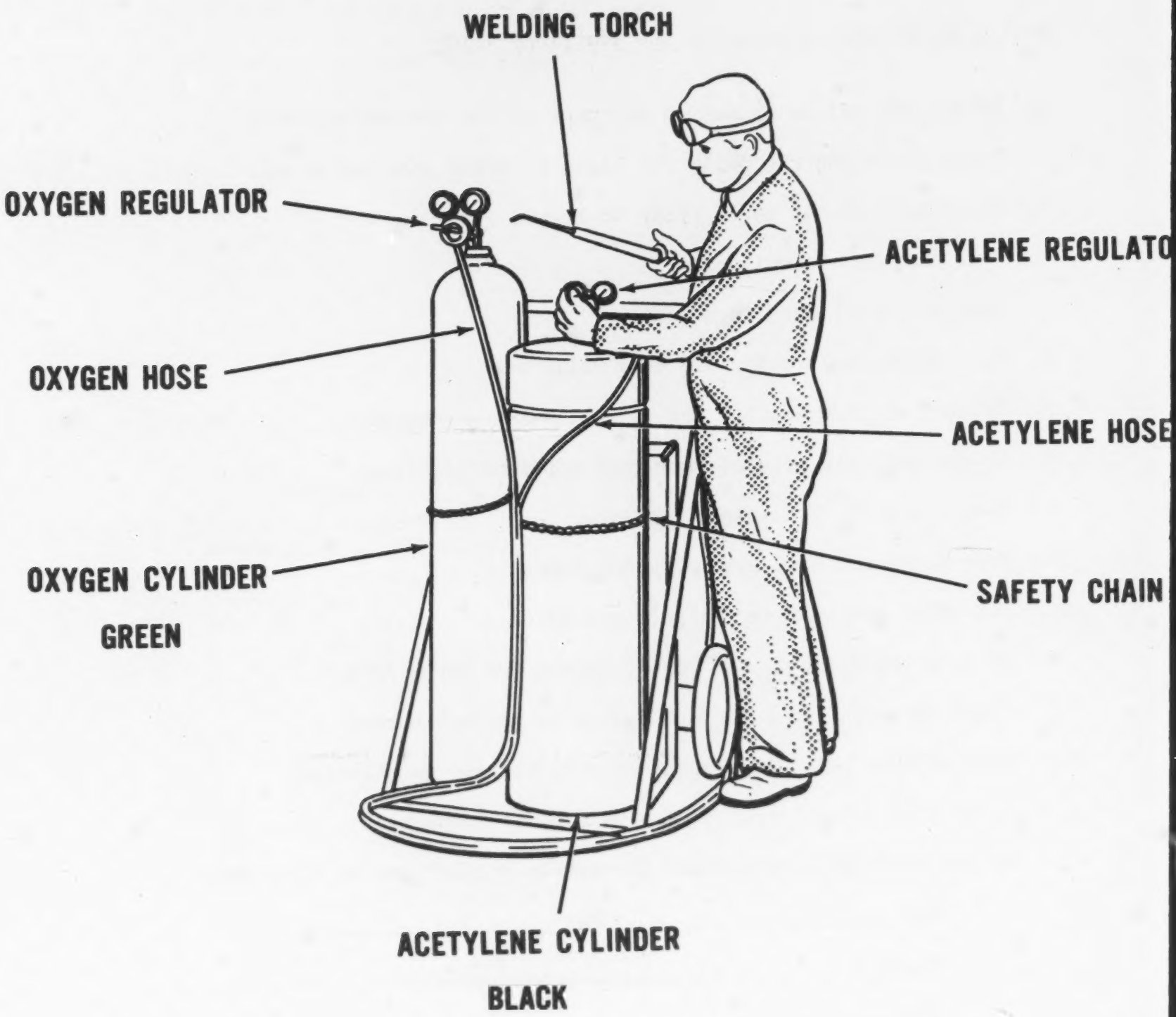

OXYGEN VALVE

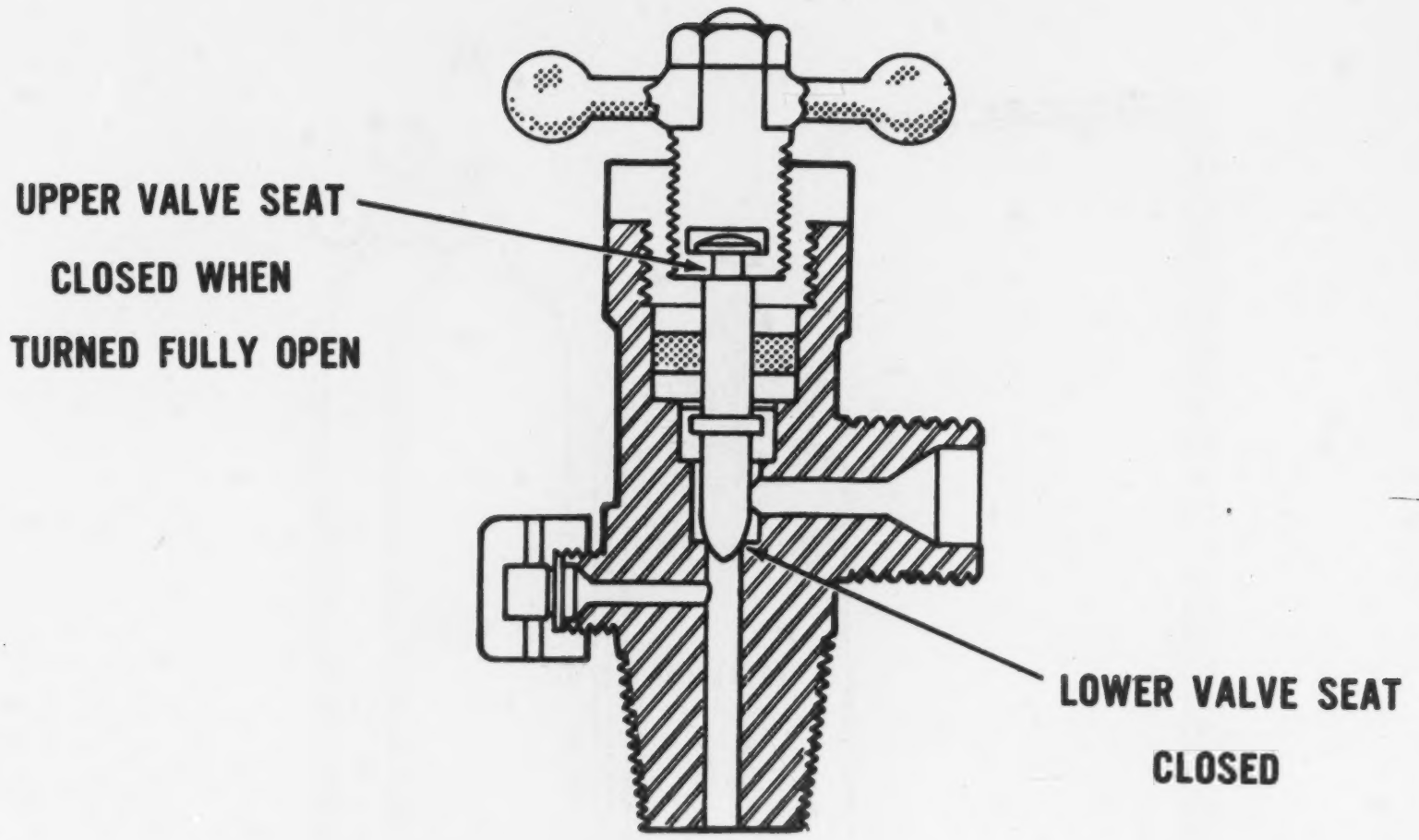

OXY-ACETYLENE CYLINDERS SETUP

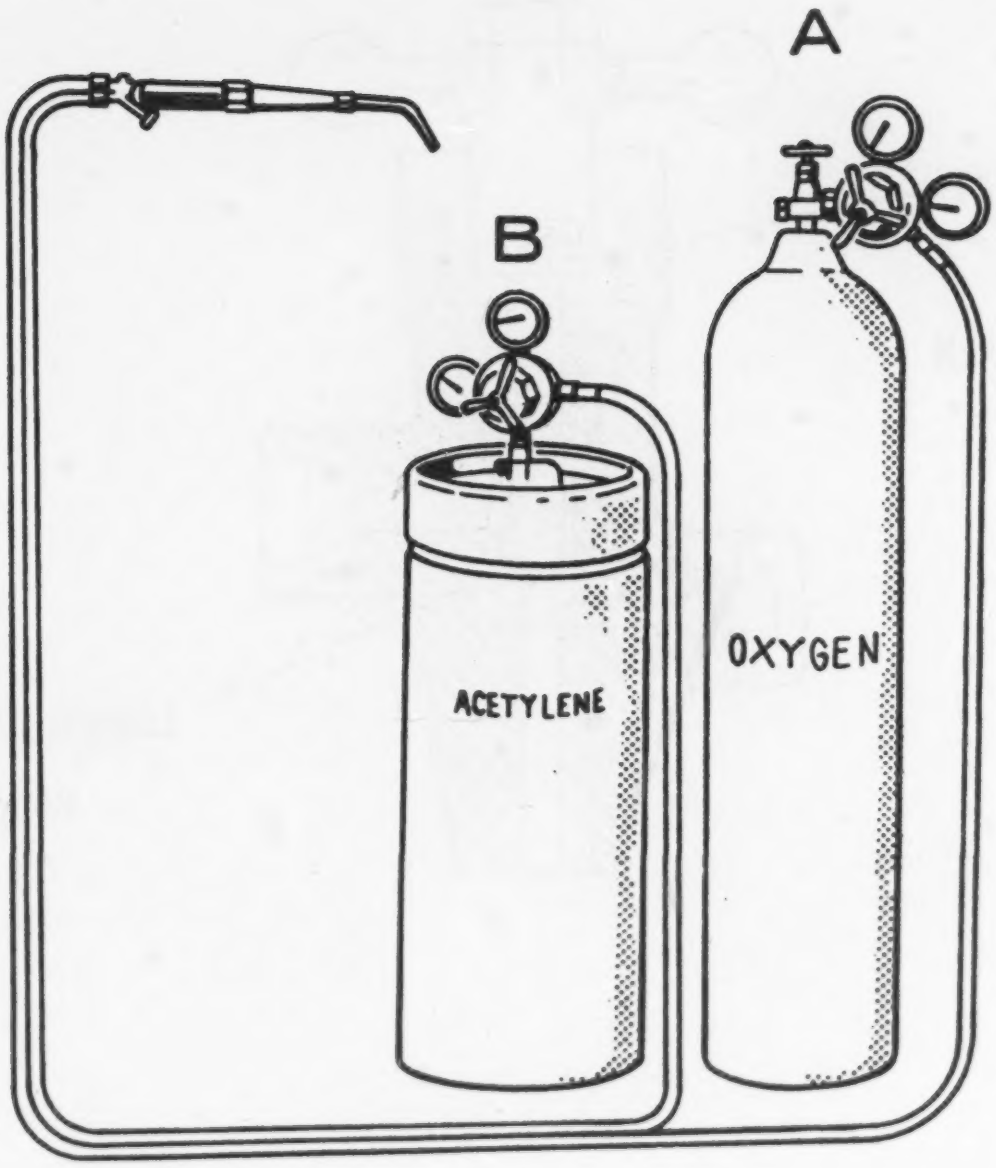

A - OXYGEN TANK B - ACETYLENE TANK

WELDING TANKS

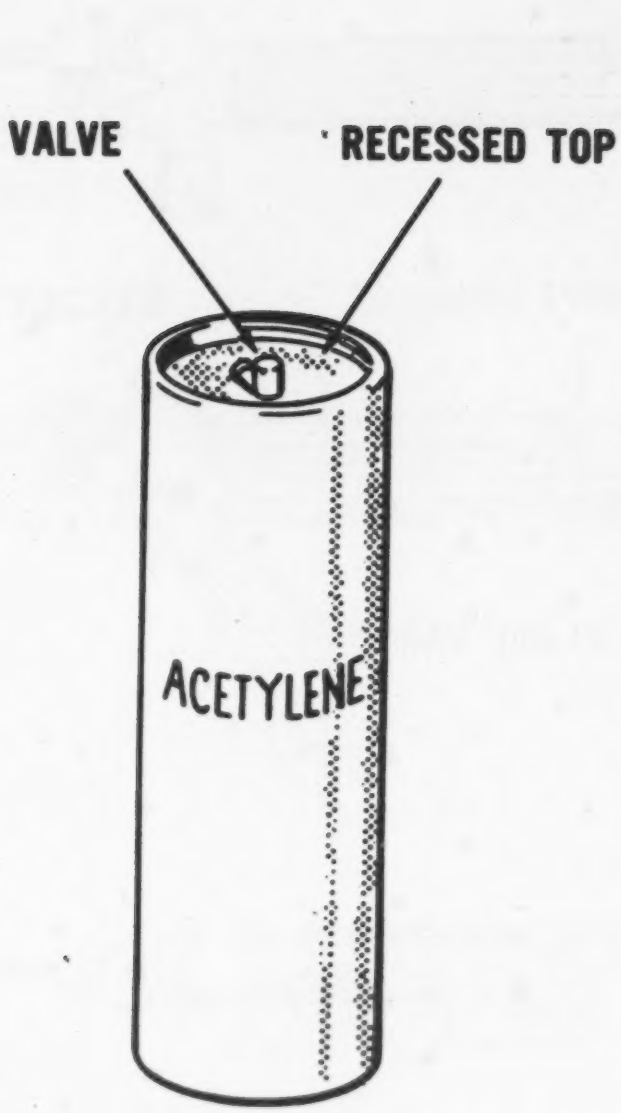

CONTENTS

1 - POROUS COMPOUND

2 - CARBIDE

3 - ACETONE

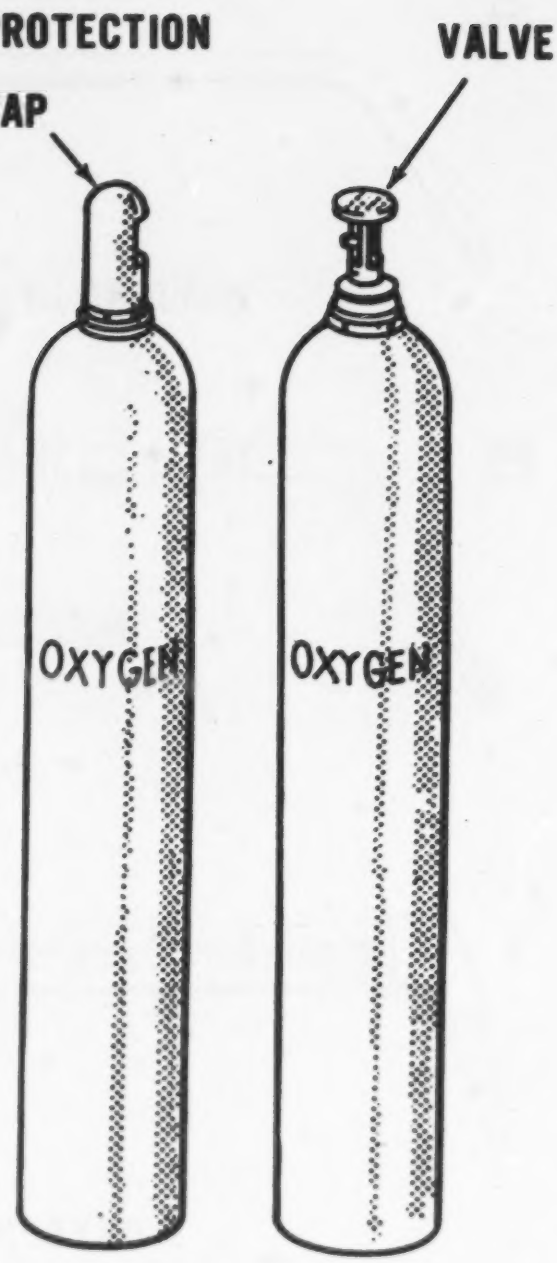

CONTENTS

PURE AIR, COMPRESSED

WELDING AND CUTTING TORCHES

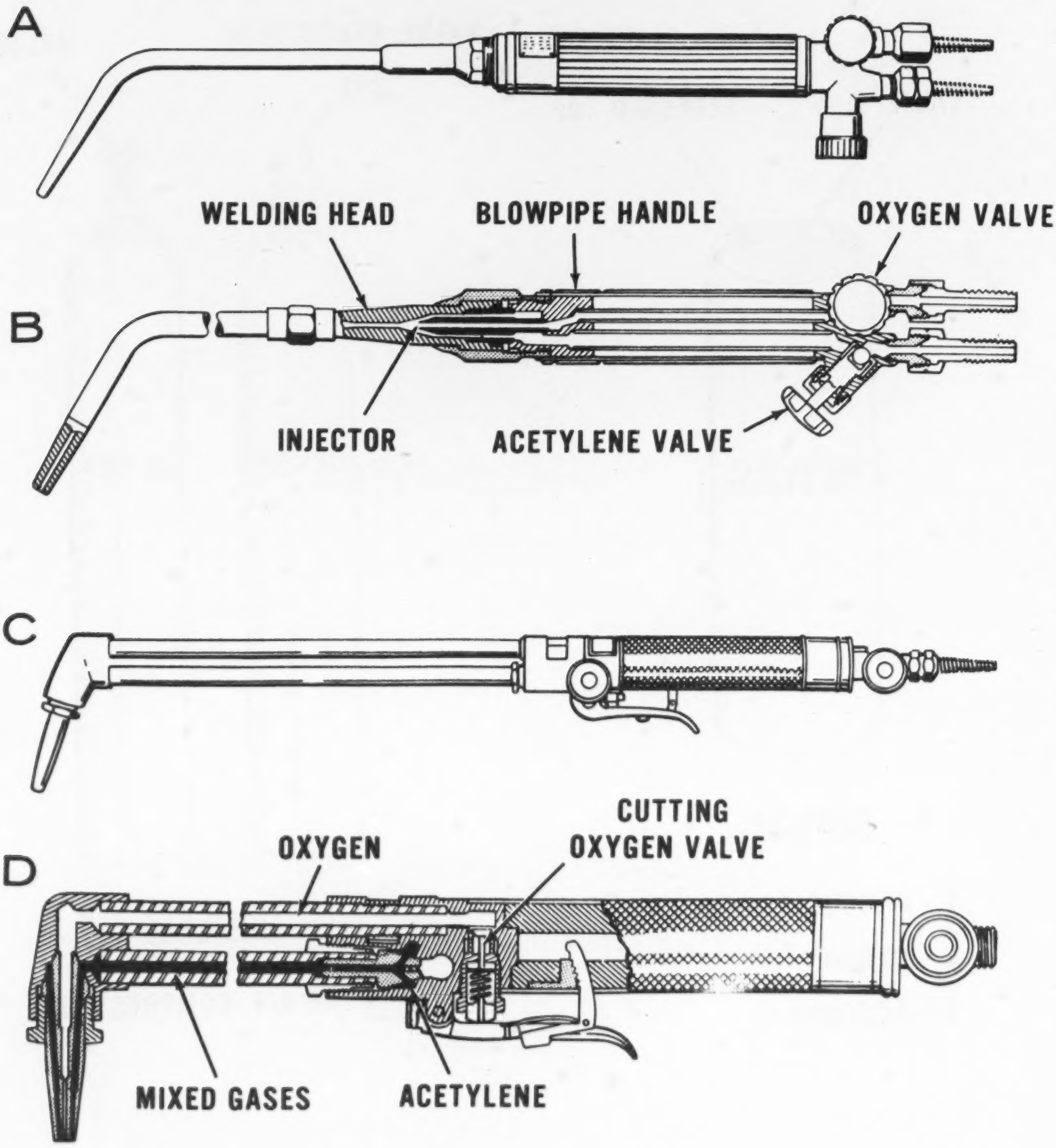

A - WELDING TORCH

B - WELDING TORCH

C - CUTTING TORCH

D - CUTTING TORCH

TORCH TIPS

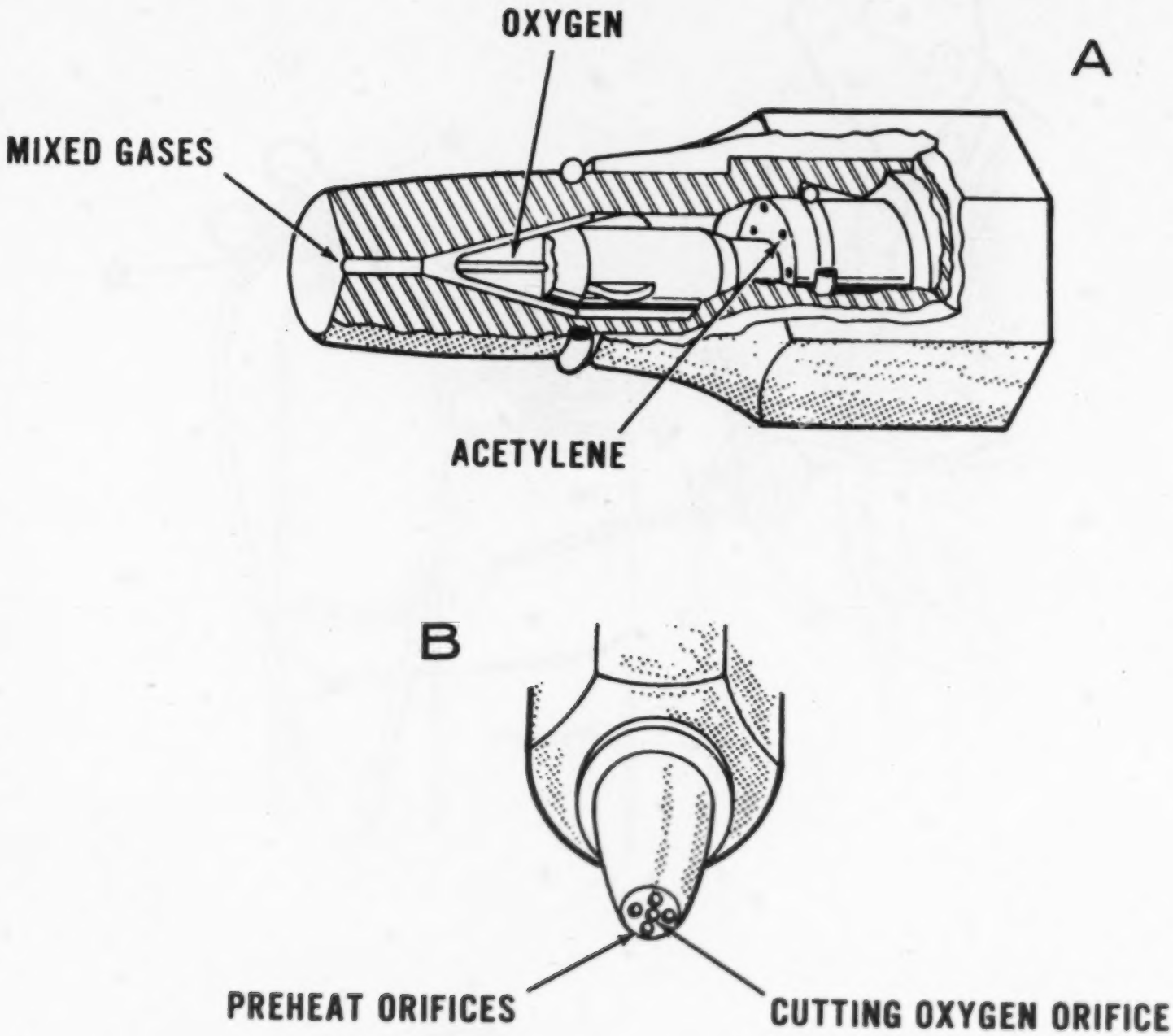

A - WELDING TIP

B - CUTTING TIP

6857

TESTING FOR LEAKS

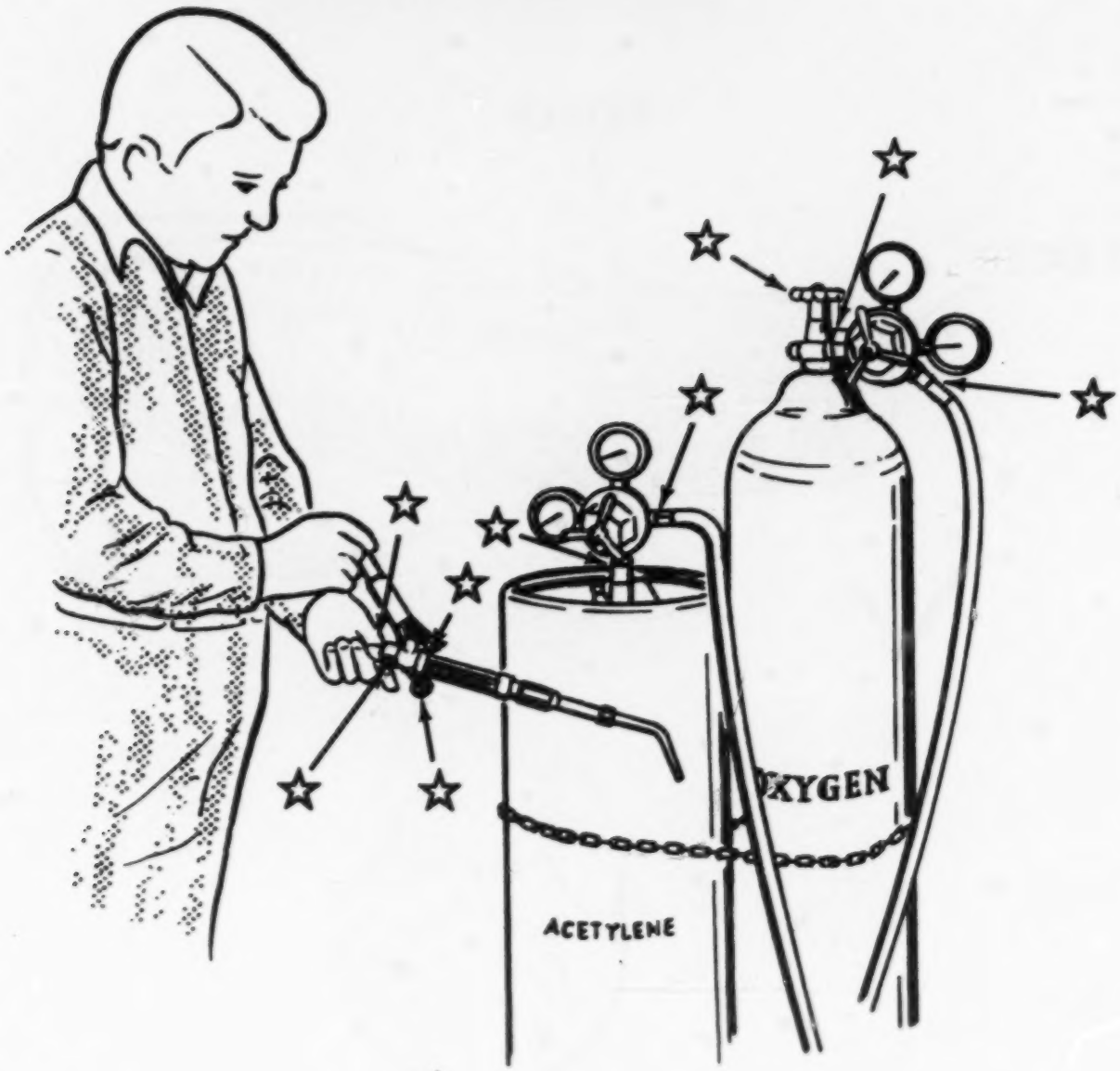

HOSE CONNECTIONS

A

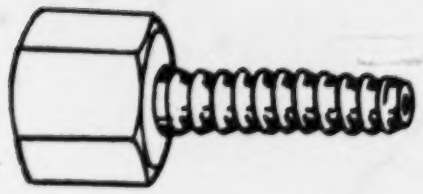

B

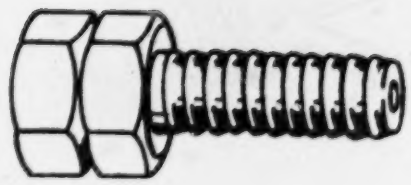

C

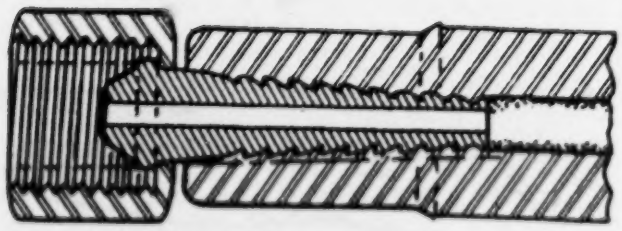

A - OXYGEN

B - ACETYLENE

C - FERRULE-TYPE HOSE

LIGHTING THE TORCH

A

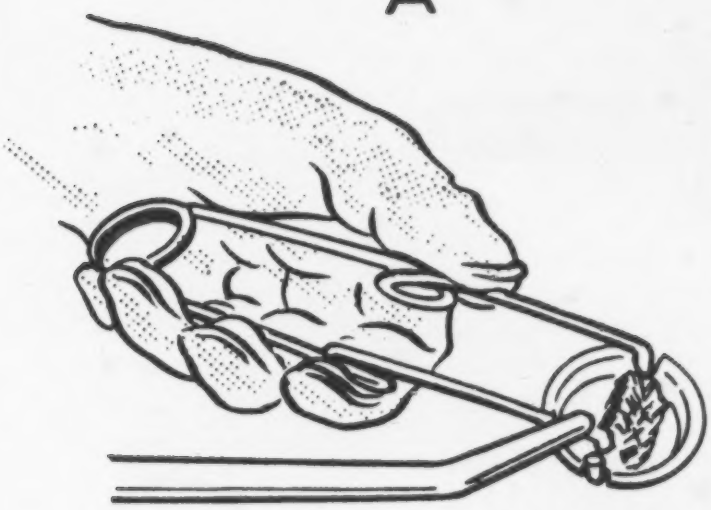

B

C

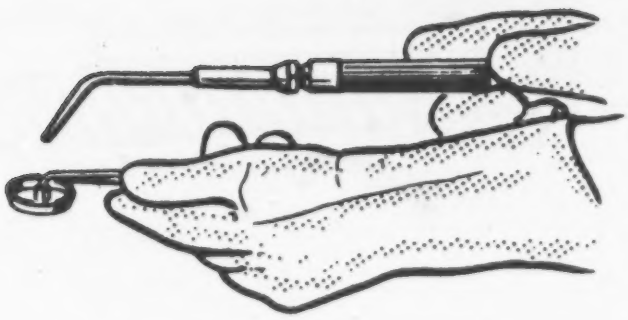

A - TORCH LIGHTER B - WELDING GOGGLES C - LIGHTING PROCEDURE

ACETYLENE WELDING FLAMES

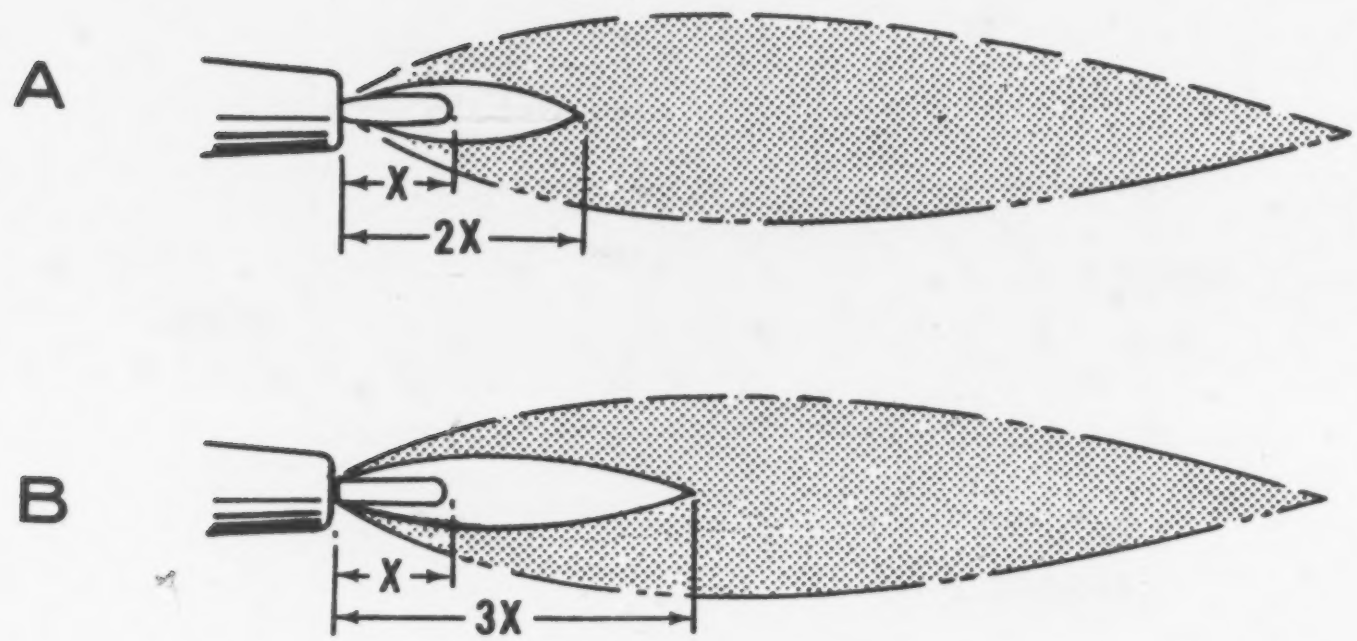

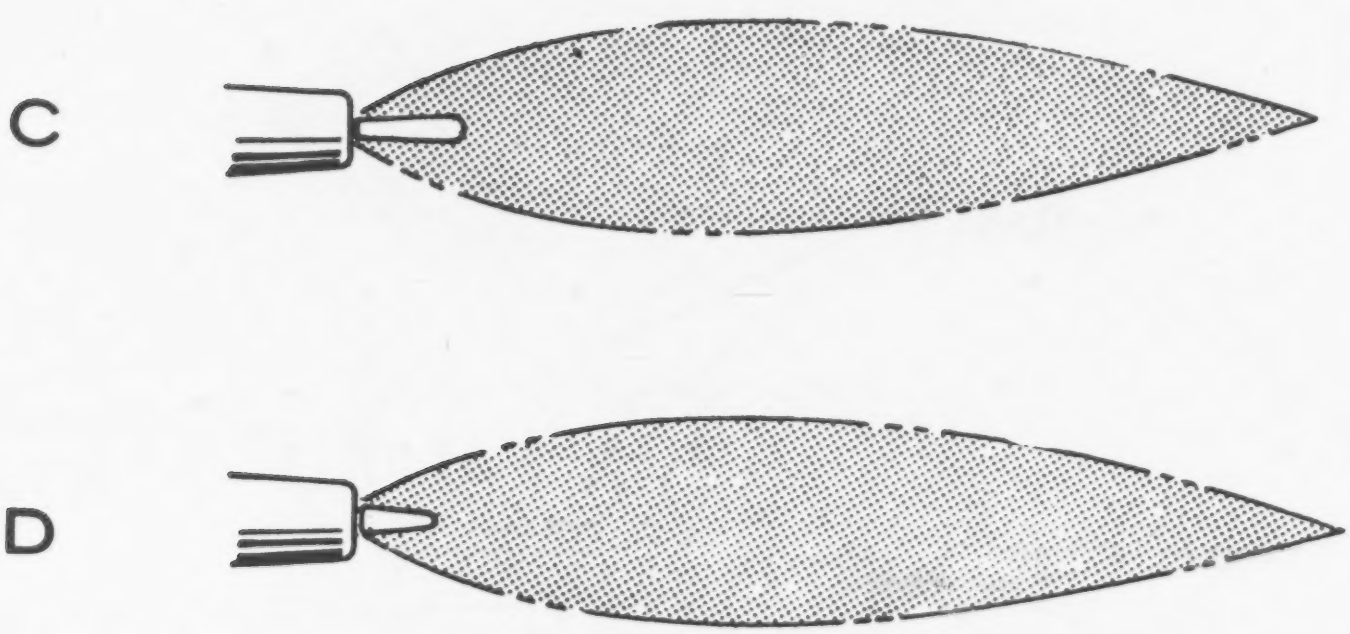

A and B - CARBONIZING C - NEUTRAL D - OXIDIZING

WELDING TECHNIQUES

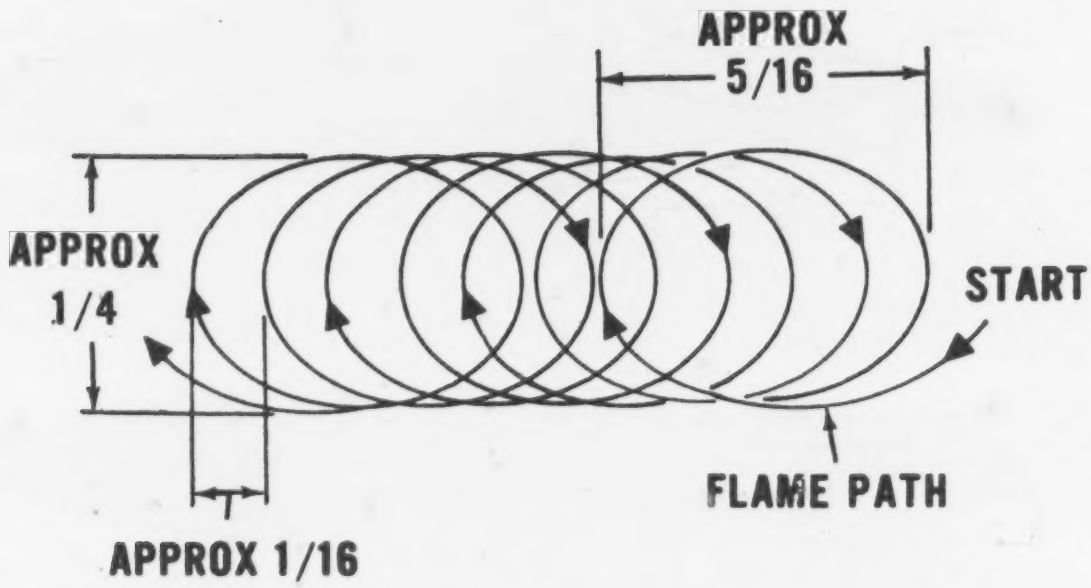

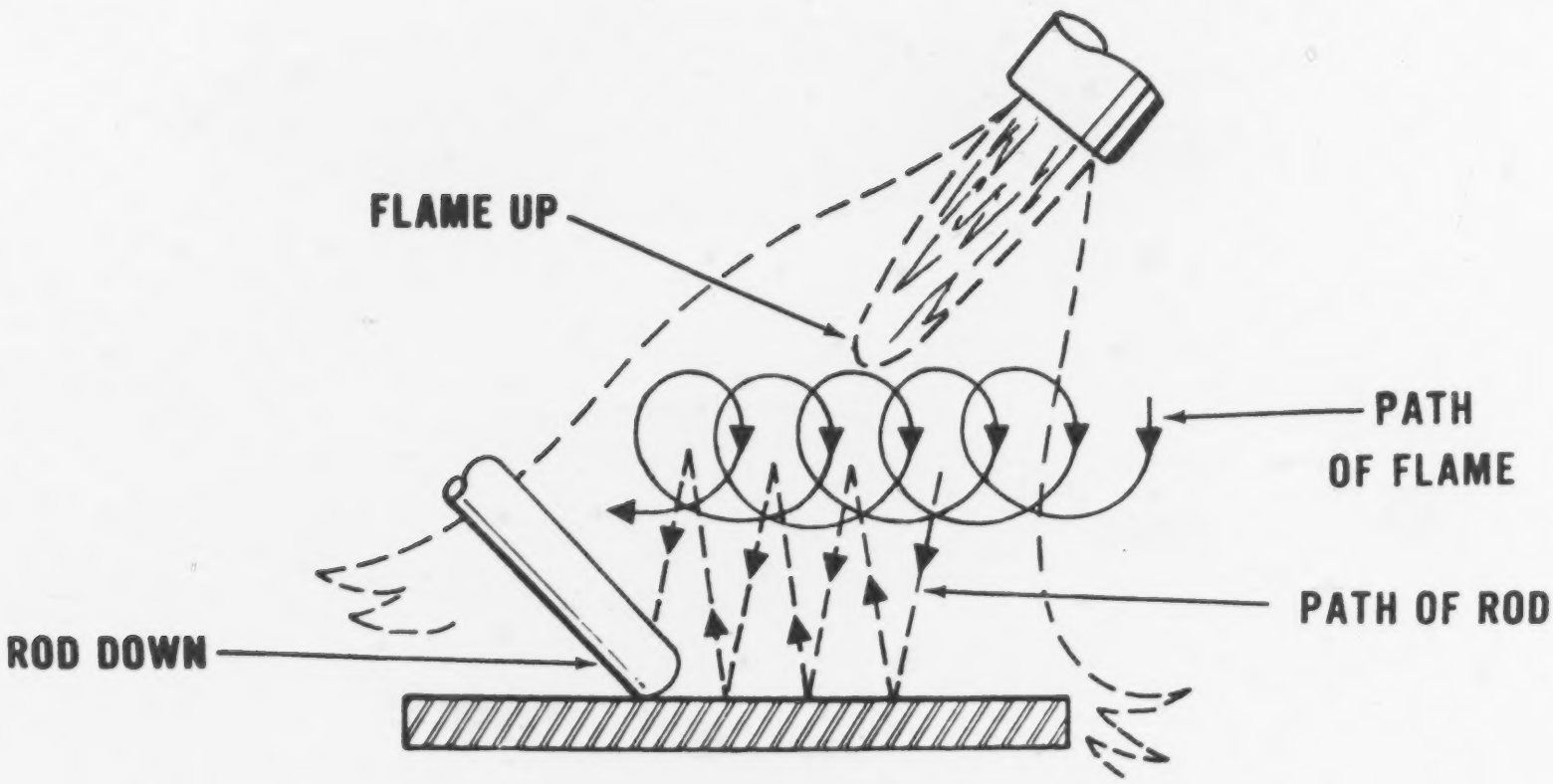

WELDS — GOOD AND POOR

A

B

C

D

A - GOOD WELD B - OVERHEATING C - INSUFFICIENT MELTING D - SATISFACTORY

16
Acetylene Welding

WELDING POSITION

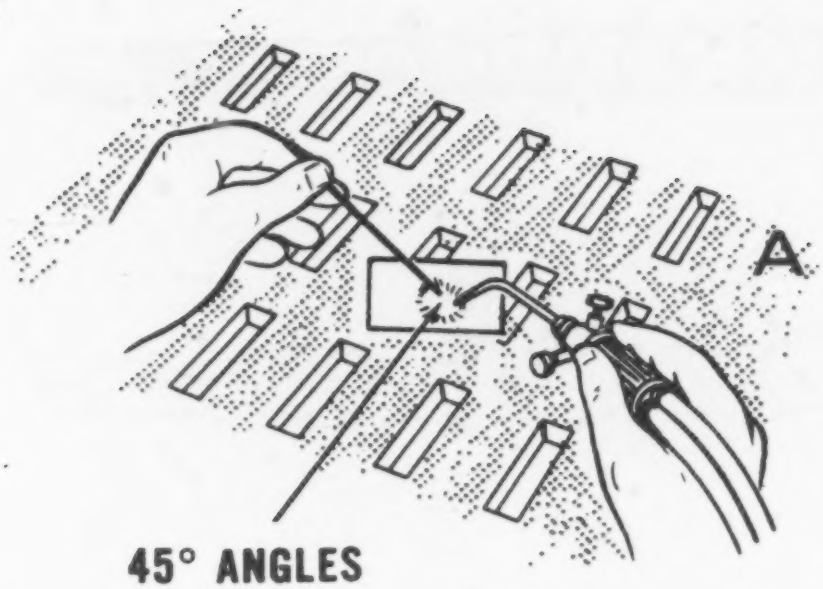

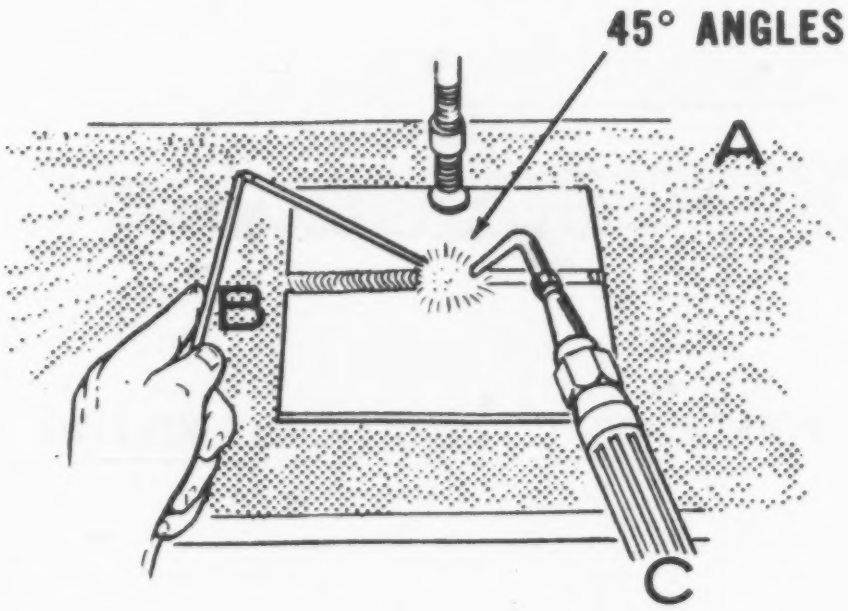

A - WELDING BENCH PLATE B - WELDING ROD C - TORCH

OVERHEAD POSITIONS

A

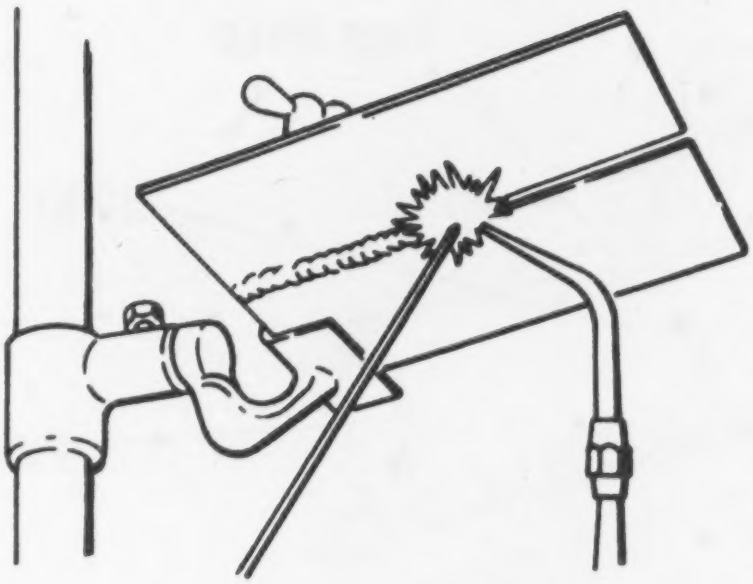

B

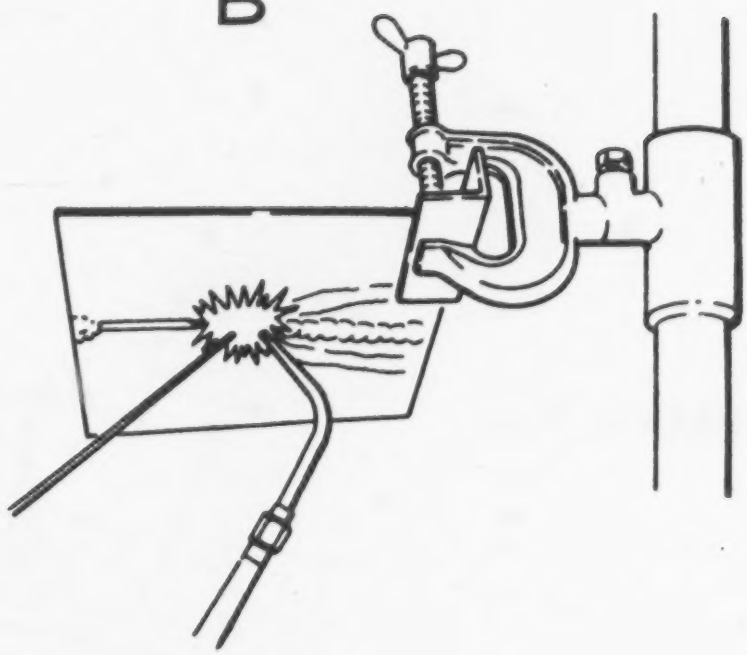

A - PREVENT METAL DROP

B - TORCH POINTS DIRECTLY INTO WELD

6865

WELDING PIPE

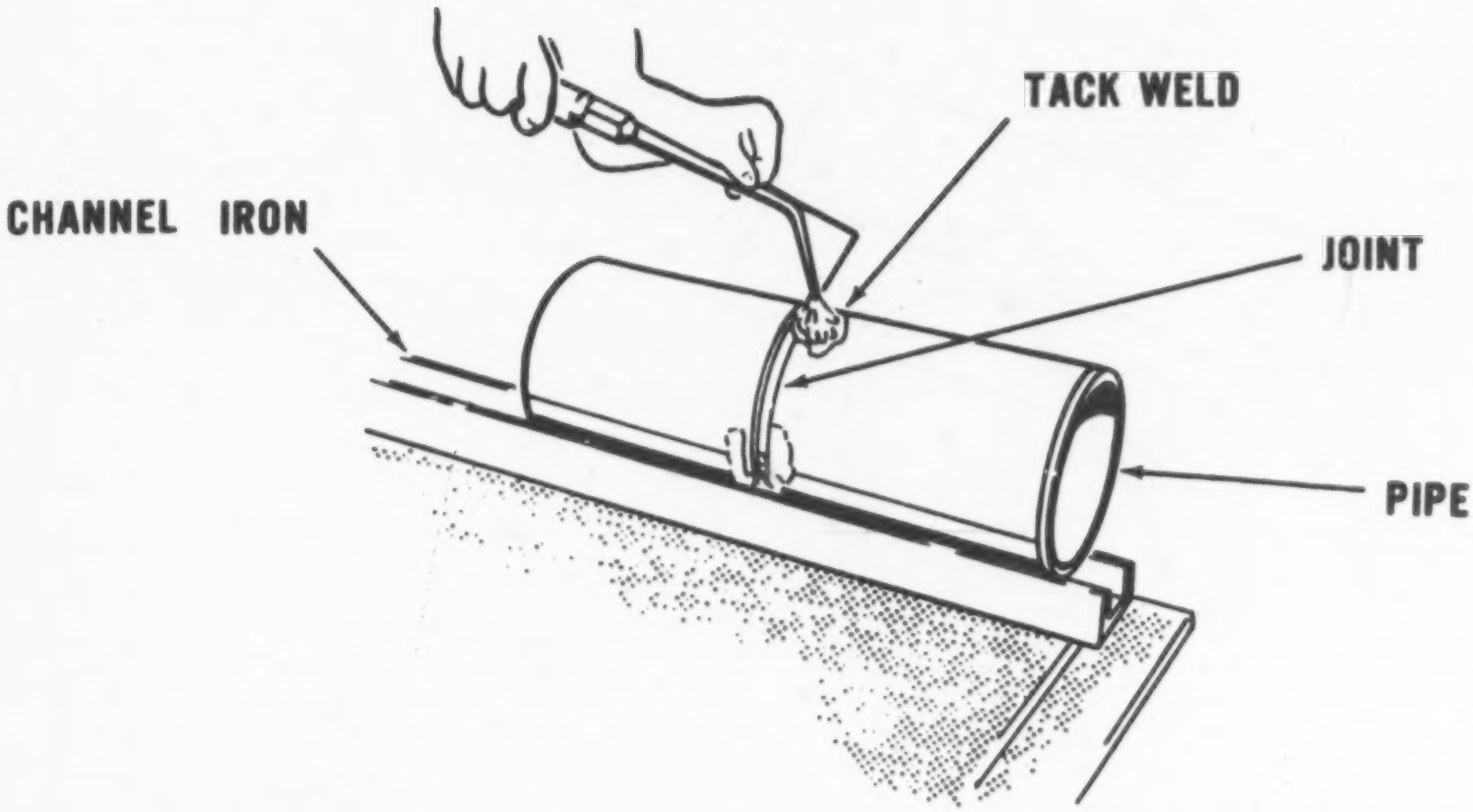

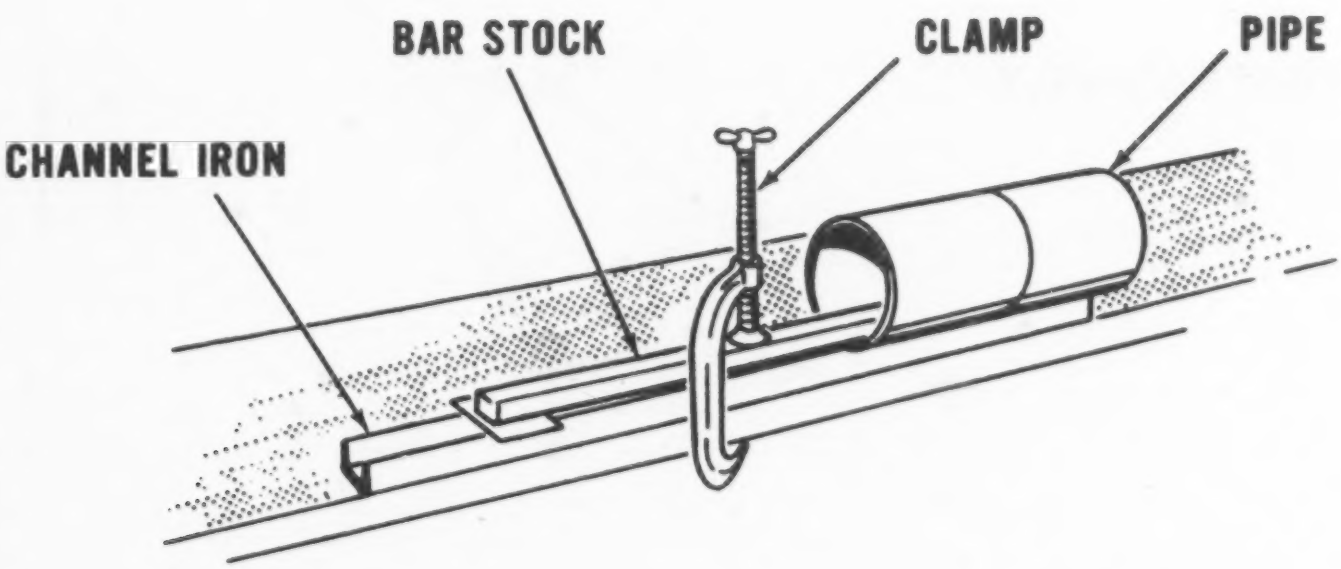

TACK AND FILLET WELDS

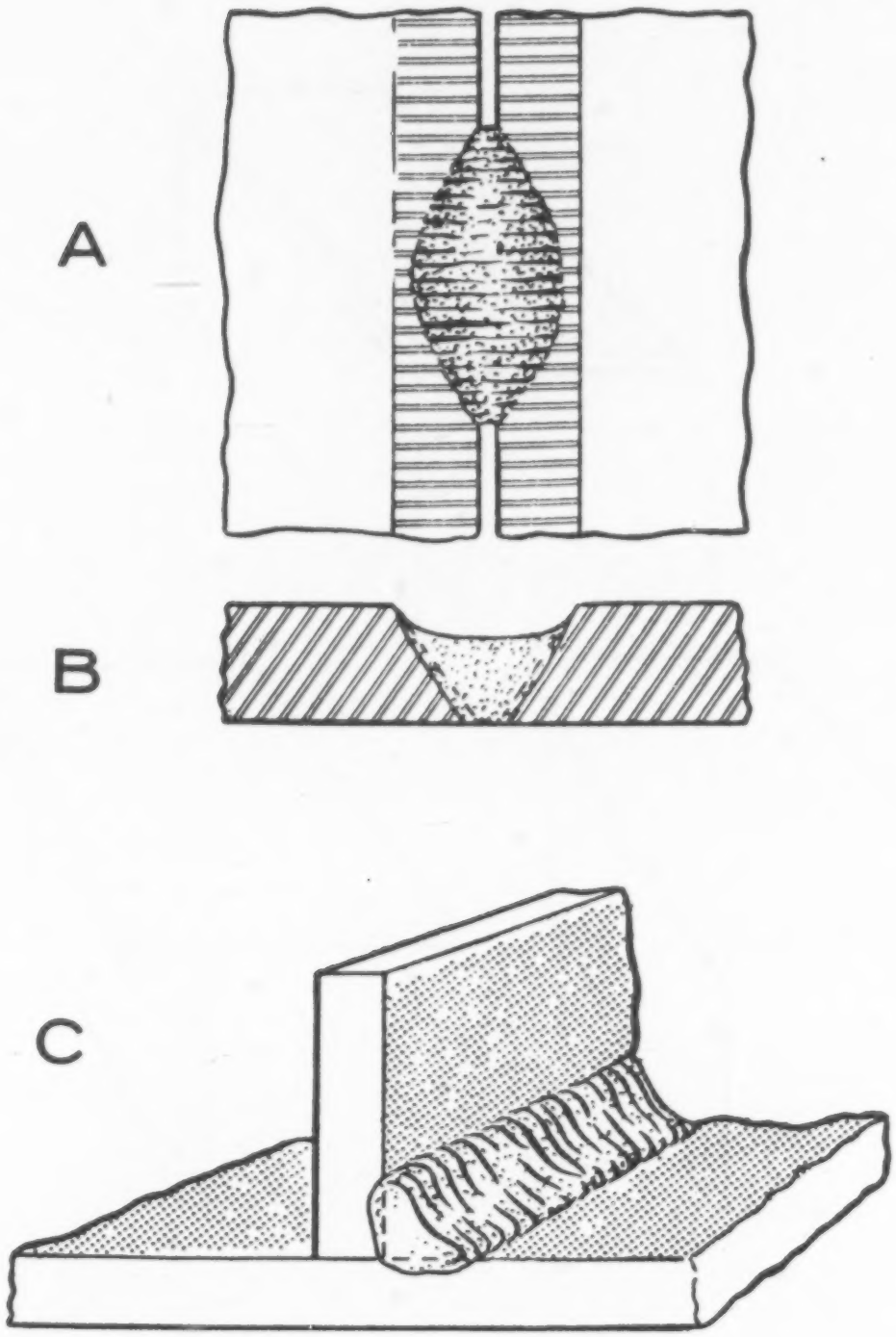

A - TACK WELD B - CROSS-SECTION TACK WELD C - FILLET WELD

CORNER WELDS

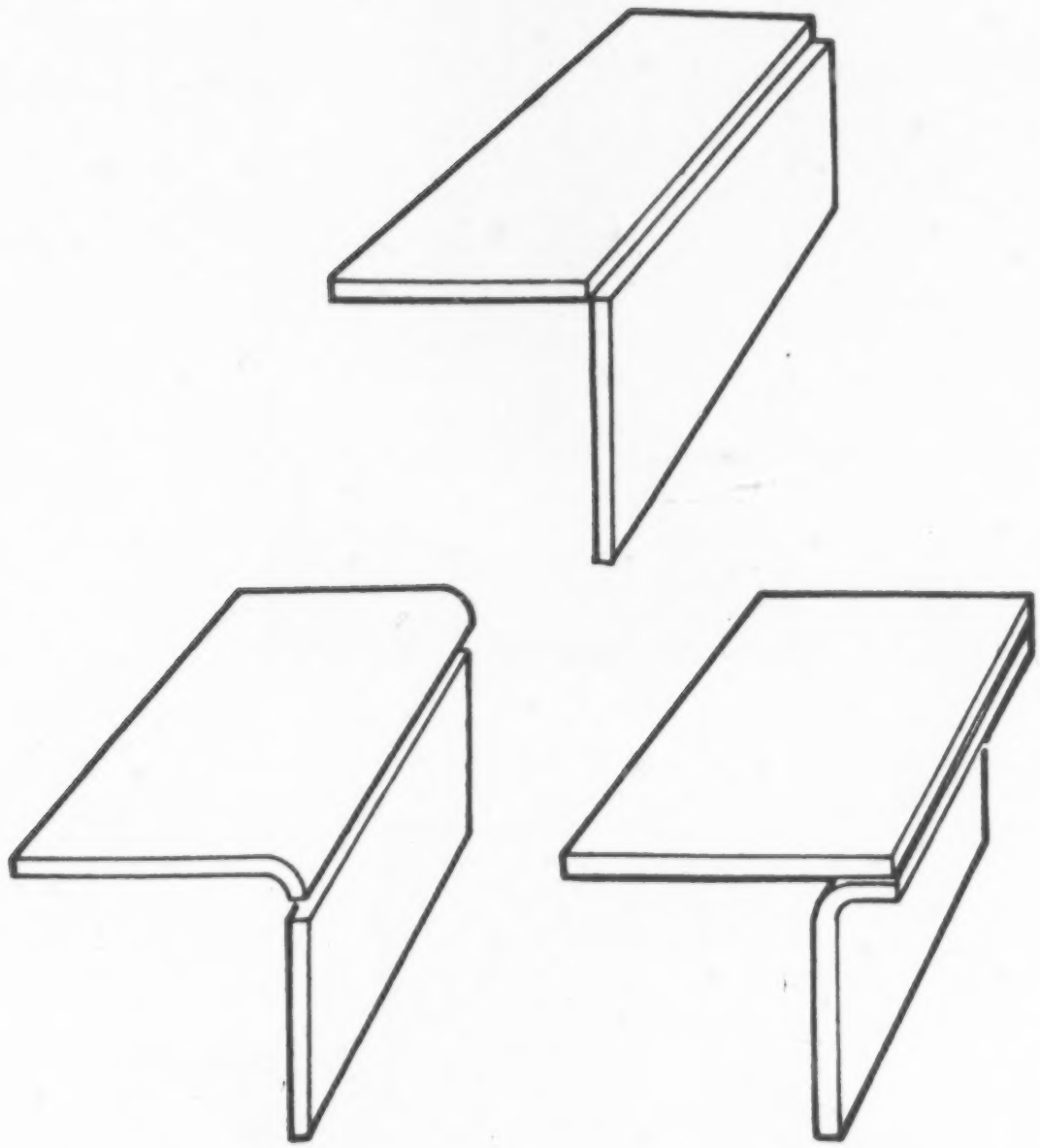

TESTING FUSION WELDS

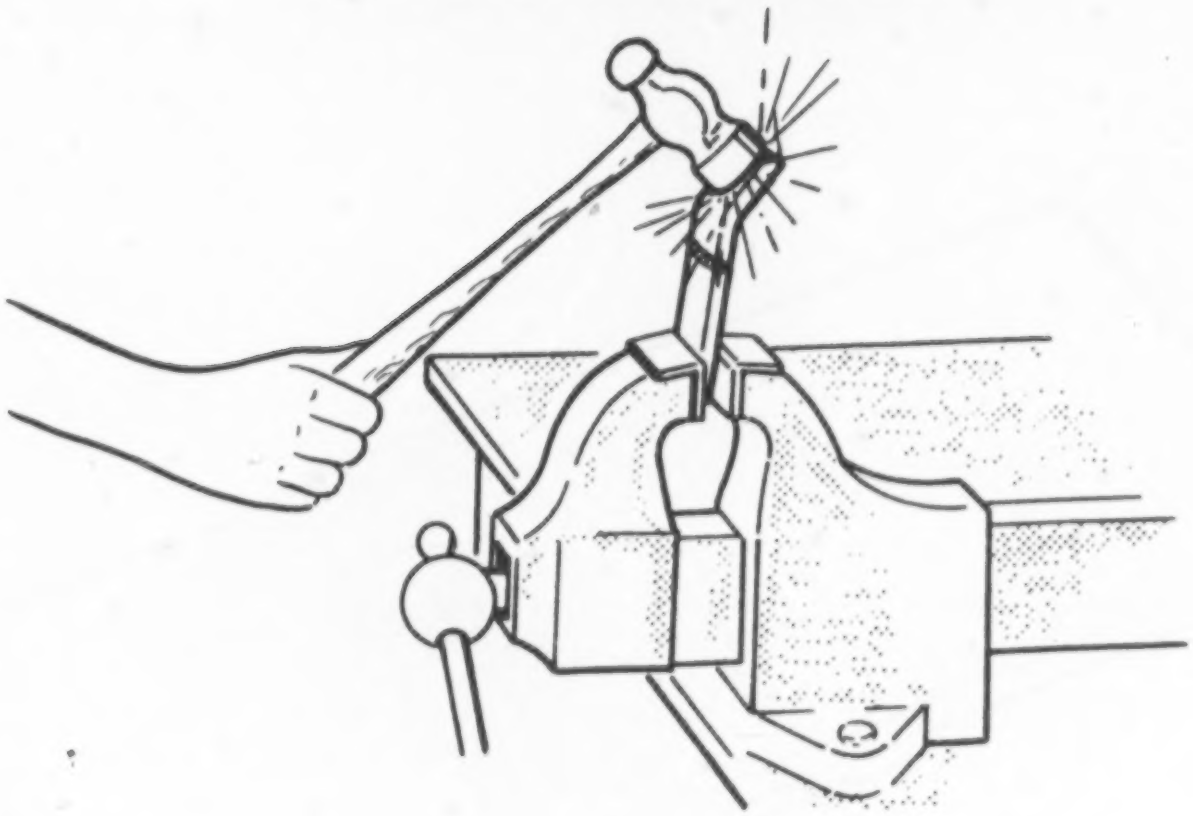

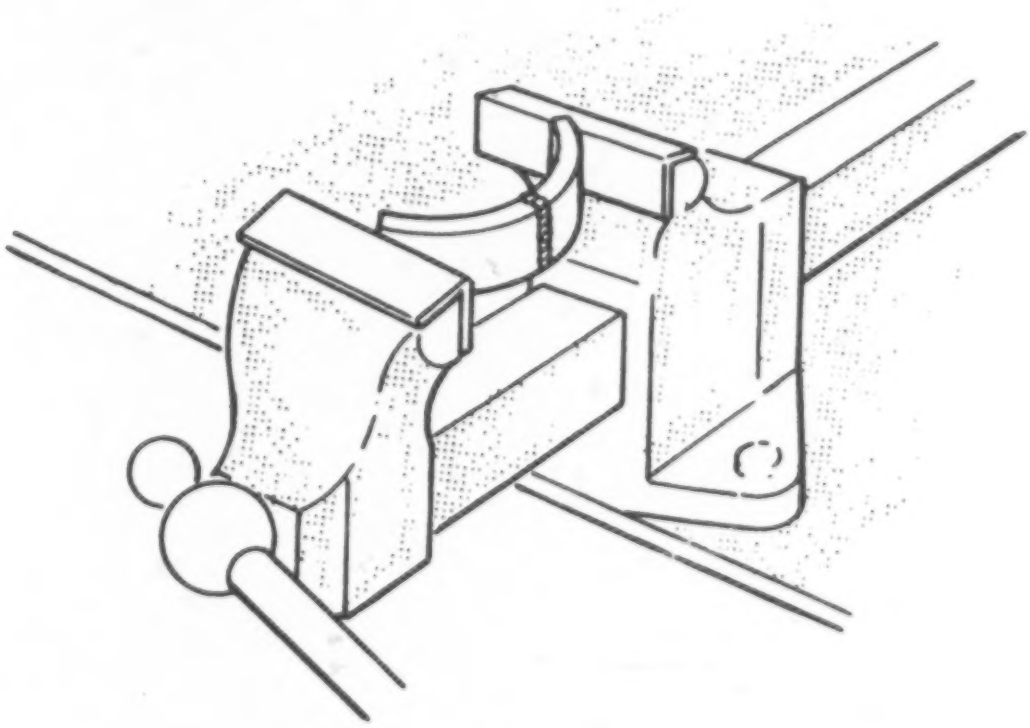

LAP WELD

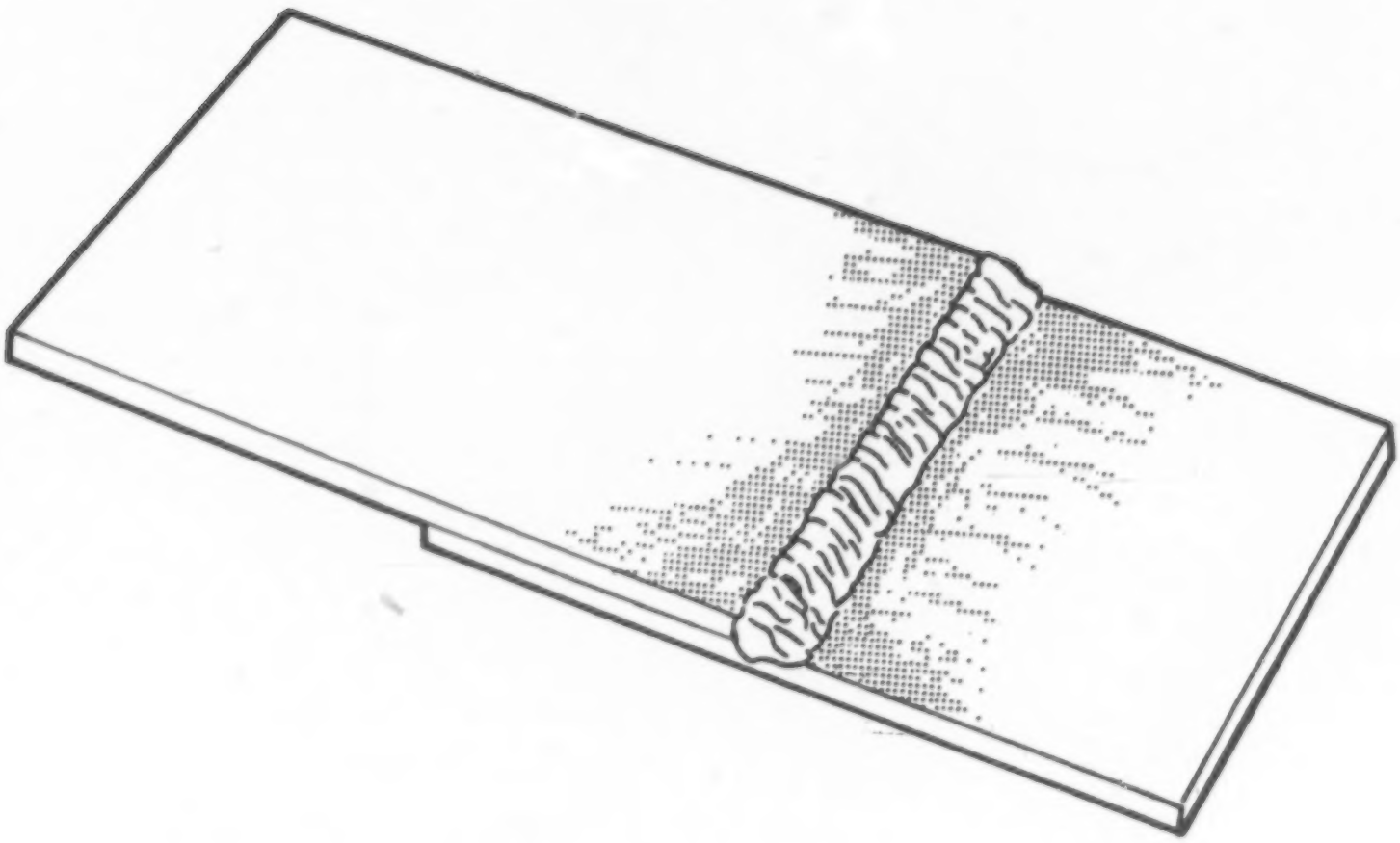

JIG WELDING

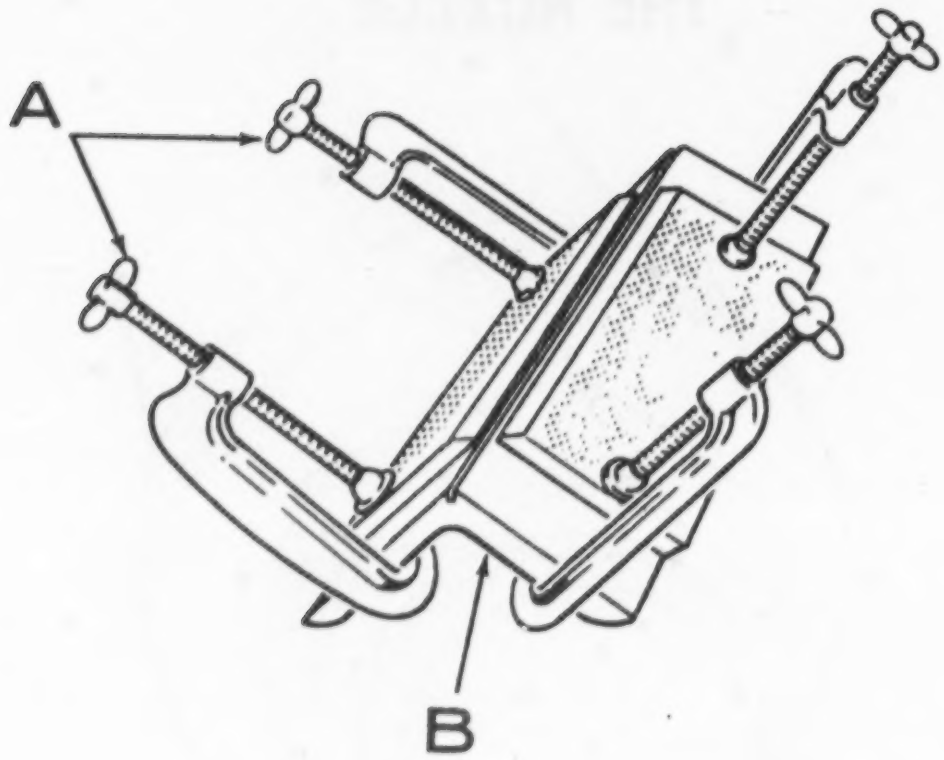

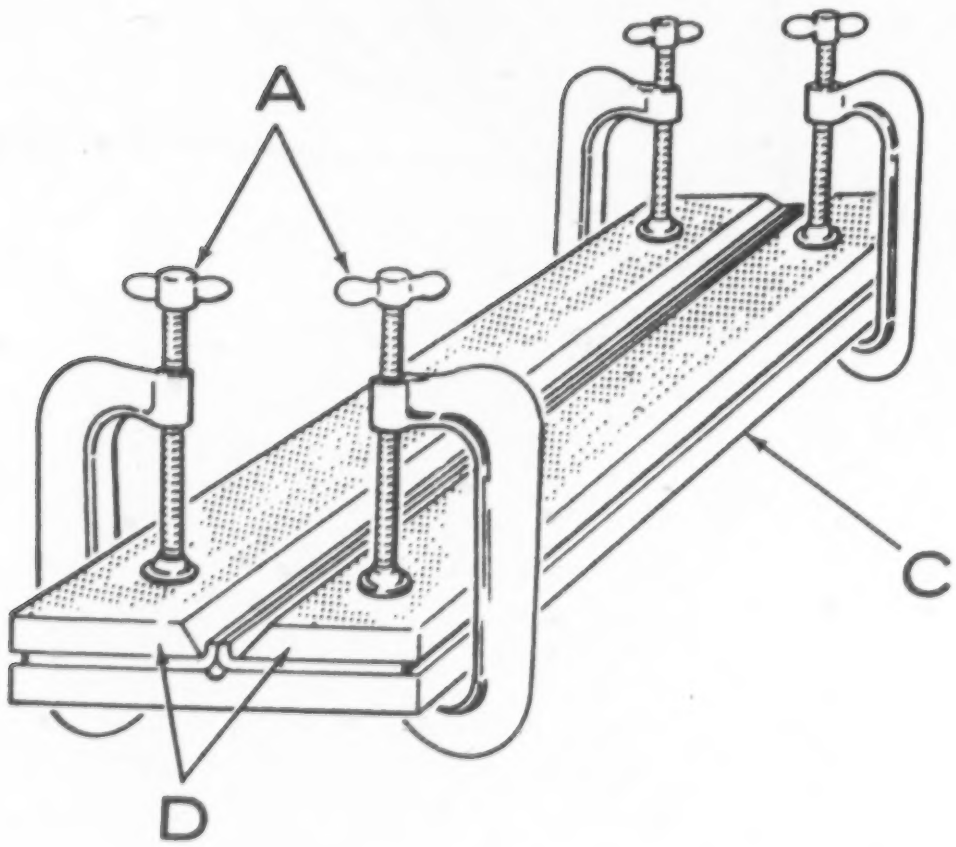

A - C-CLAMP

B - 1/2 INCH ANGLE IRON

C - FLAT PLATE

D - PLATES TO BE WELDED

6871

100 OF 327

ED

056 238

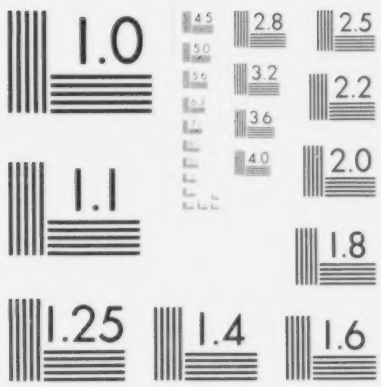

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

OXY-ACETYLENE CUTTING

THE NOZZLE

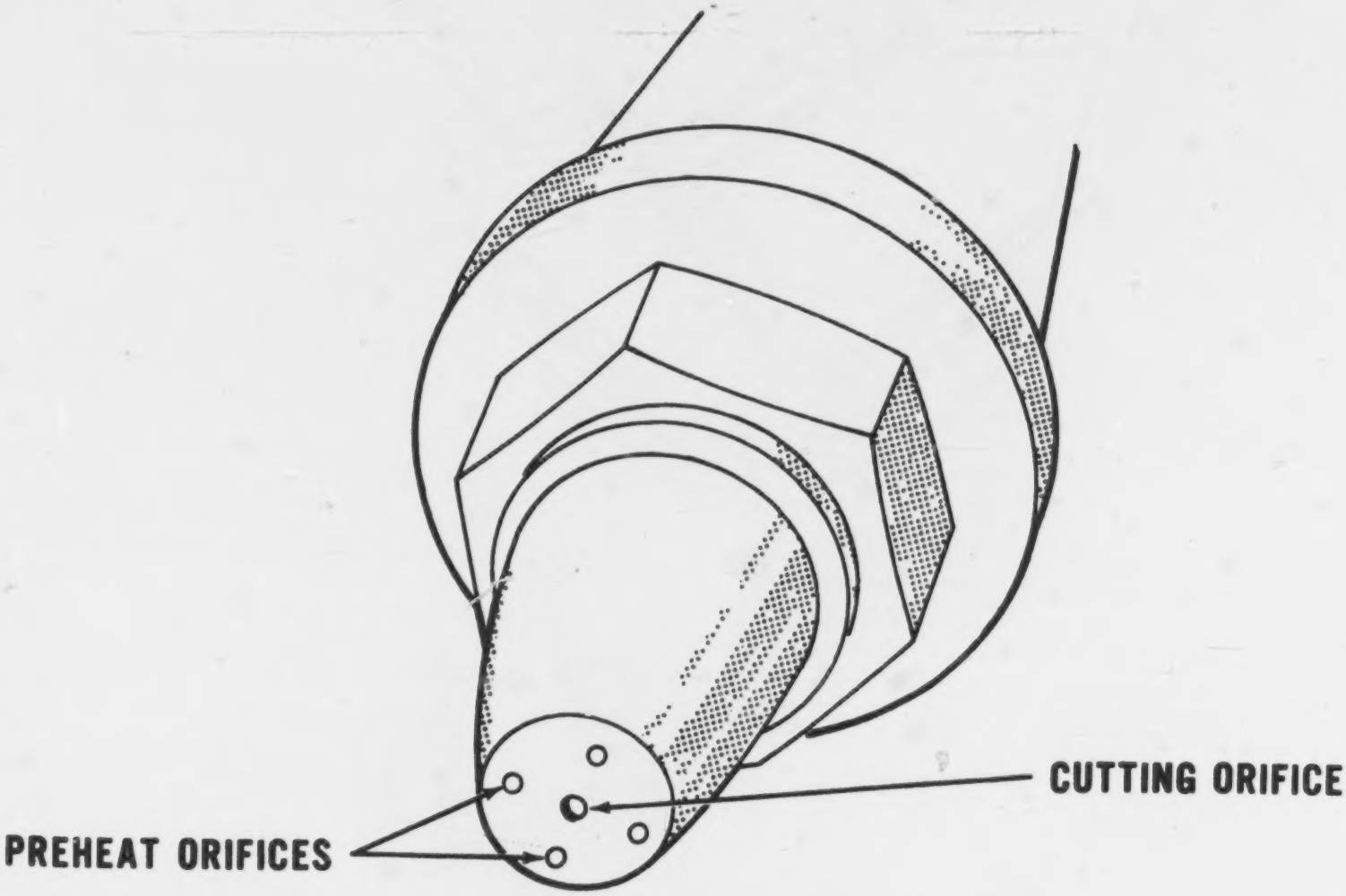

1788 6872

NOZZLE SETTING

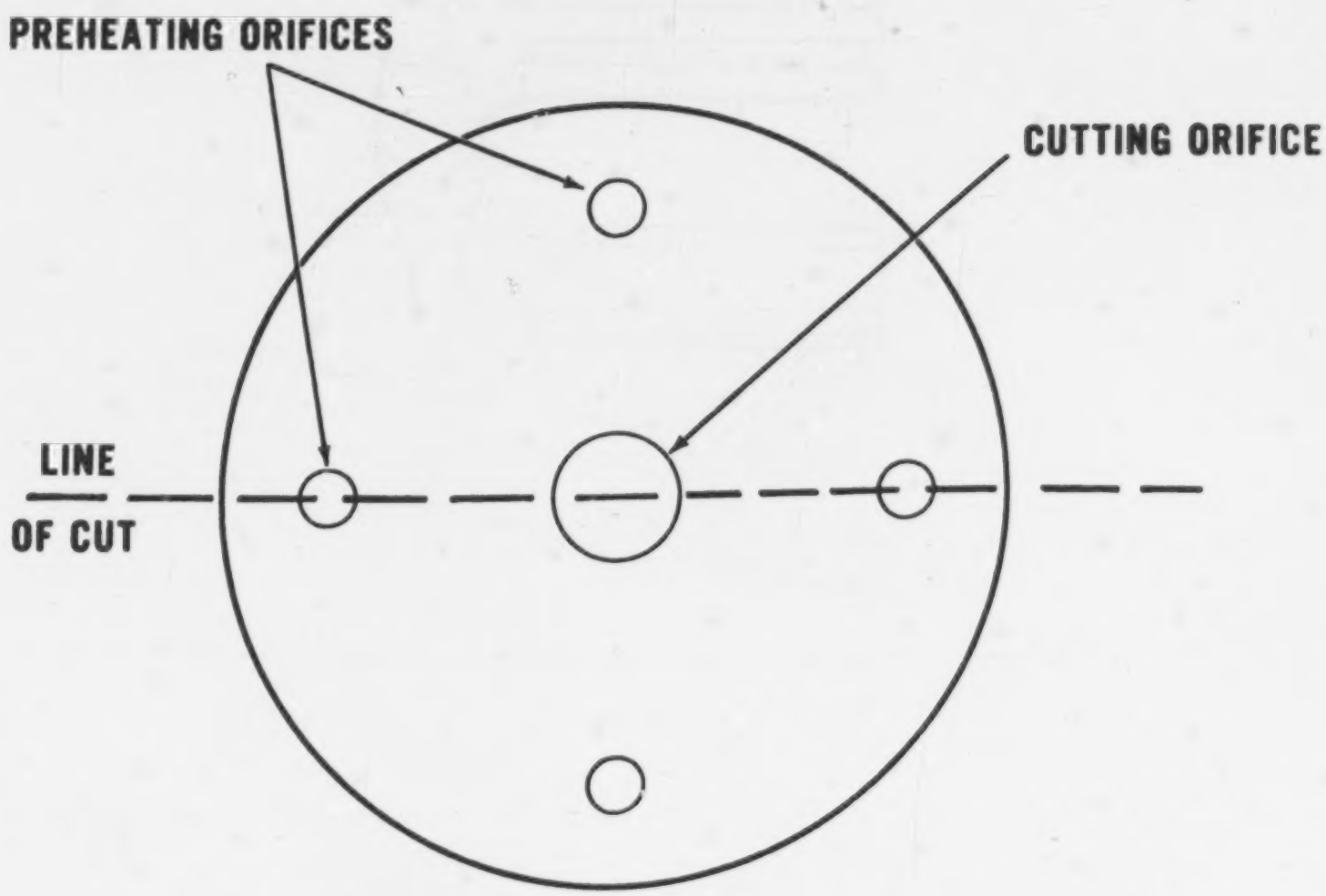

CUTTING TECHNIQUES

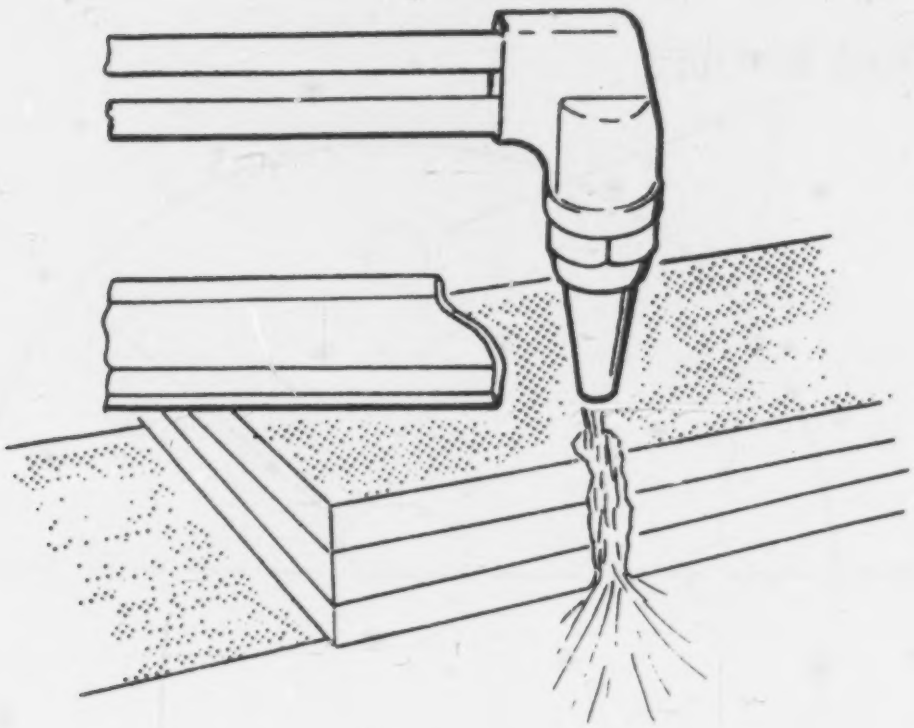

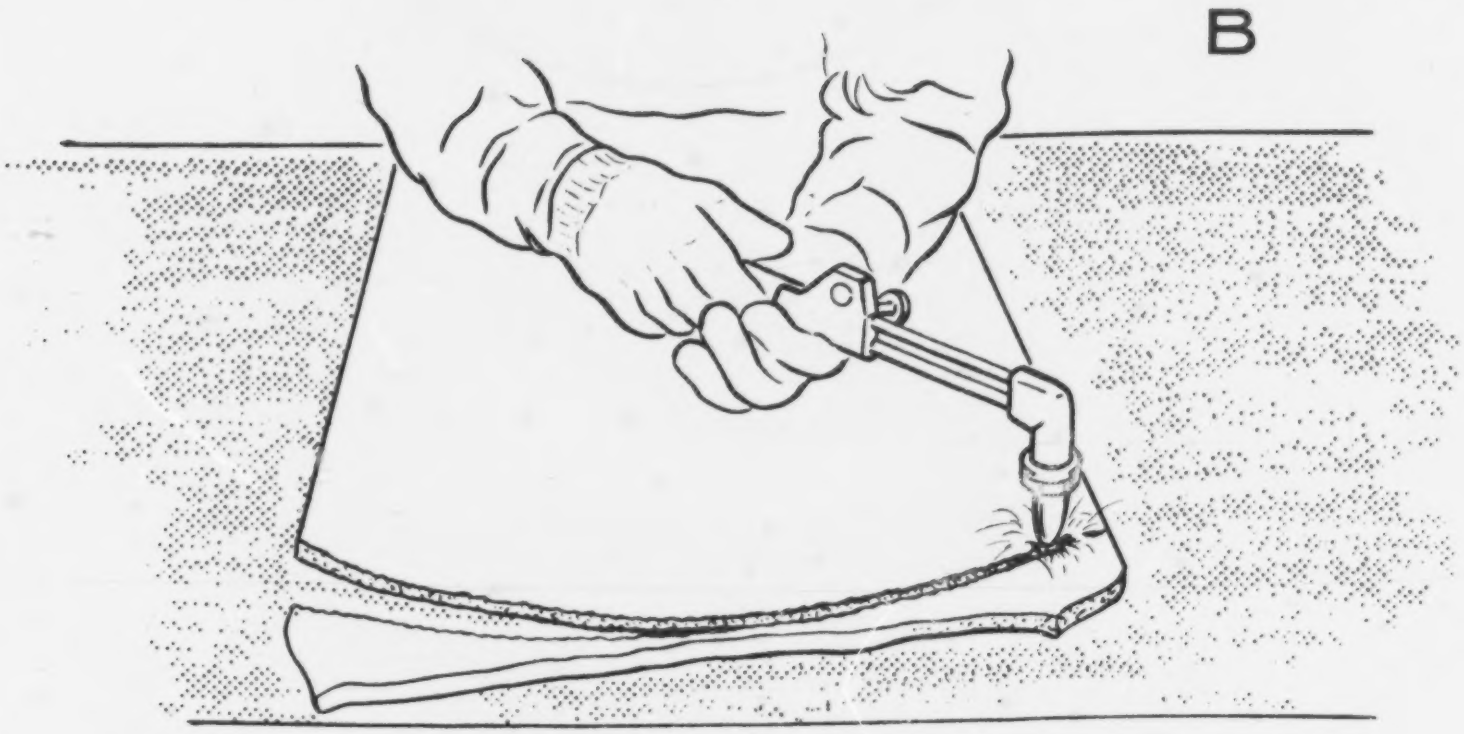

A - STRAIGHT LINE CUT

B - CURVE CUT

6874

CUTTING A HOLE

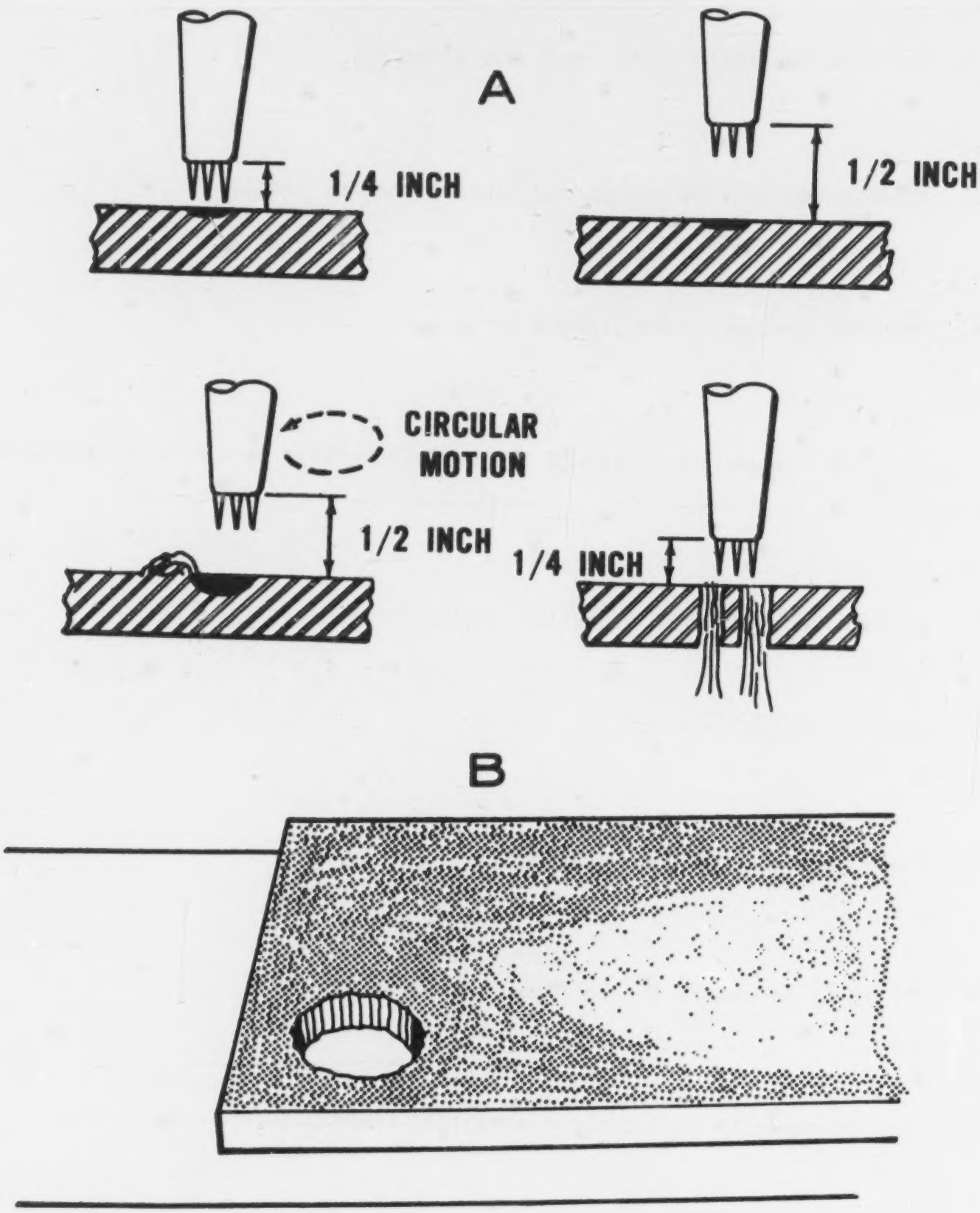

A - TORCH POSITIONS

B - FINISHED HOLE

6875

Acetylene Welding

1. List the basic supplies needed for acetylene welding.

2. To which regulator is the red hose attached?

3. Explain how to test valves and connections for leaks.

4. Describe how you would light a torch.

5. Describe how you would adjust the acetylene valve to obtain a desirable flame.

6. Explain how you would clean the welding tips.

7. What is fusion welding?

8. Where is bronze welding used most?

9. Why is it necessary to use flux in bronze welding?

10. What is meant by an excessive acetylene flame?

11. Describe how you would hardsurface a plowshare?

12. Explain how you would cut with a cutting torch

6876

INTRODUCTION TO PAINTING FARM MACHINERY

Paint and other preservatives prevent wood from decaying, cracking and warping and metal from corroding. A continuous painting program helps to hold repair cost to a minimum, maintains property value, and the painted surface presents a good appearance.

This unit contains drawings designed primarily to illustrate various phases and techniques used in spray painting farm equipment. The illustrations provide definition of terms, descriptions of various painting equipment and basic painting techniques.

Painting Farm Machinery

1. The compressor system
2. The air supply system
3. The spray gun
4. Paint gun parts
5. The complete system
6. Cleaning the spray gun
7. Common spray paint troubles
8. Correct spraying
9. Diagnosing troubles
10. Do's and Don'ts in spray painting
11. Paint temperature
12. Correcting distorted patterns
13. Applying primer
14. Sanding primer
15. Feather edging
16. Safety rules
17. Spraying plan
18. Paint mixtures

6877

Painting Farm Machinery

Materials and Equipment

1. A compressor system
2. An air supply system
3. A paint spray gun
4. Solvent
5. Paint
6. Sandpaper
7. Blow torch
8. Paint brush
9. Primer

Exercises for students

1. Learn the parts of a spray gun and their function.
2. Learn the common paint troubles.
3. Practice cleaning spray gun.
4. Practice correct movements with gun for spraying paint.
5. Mix paint for spraying.
6. Prepare the surface of a farm tractor or lawn mower, prime and paint.

6878

6878

PAINTING FARM MACHINERY

6879

AIR SUPPLY SYSTEM

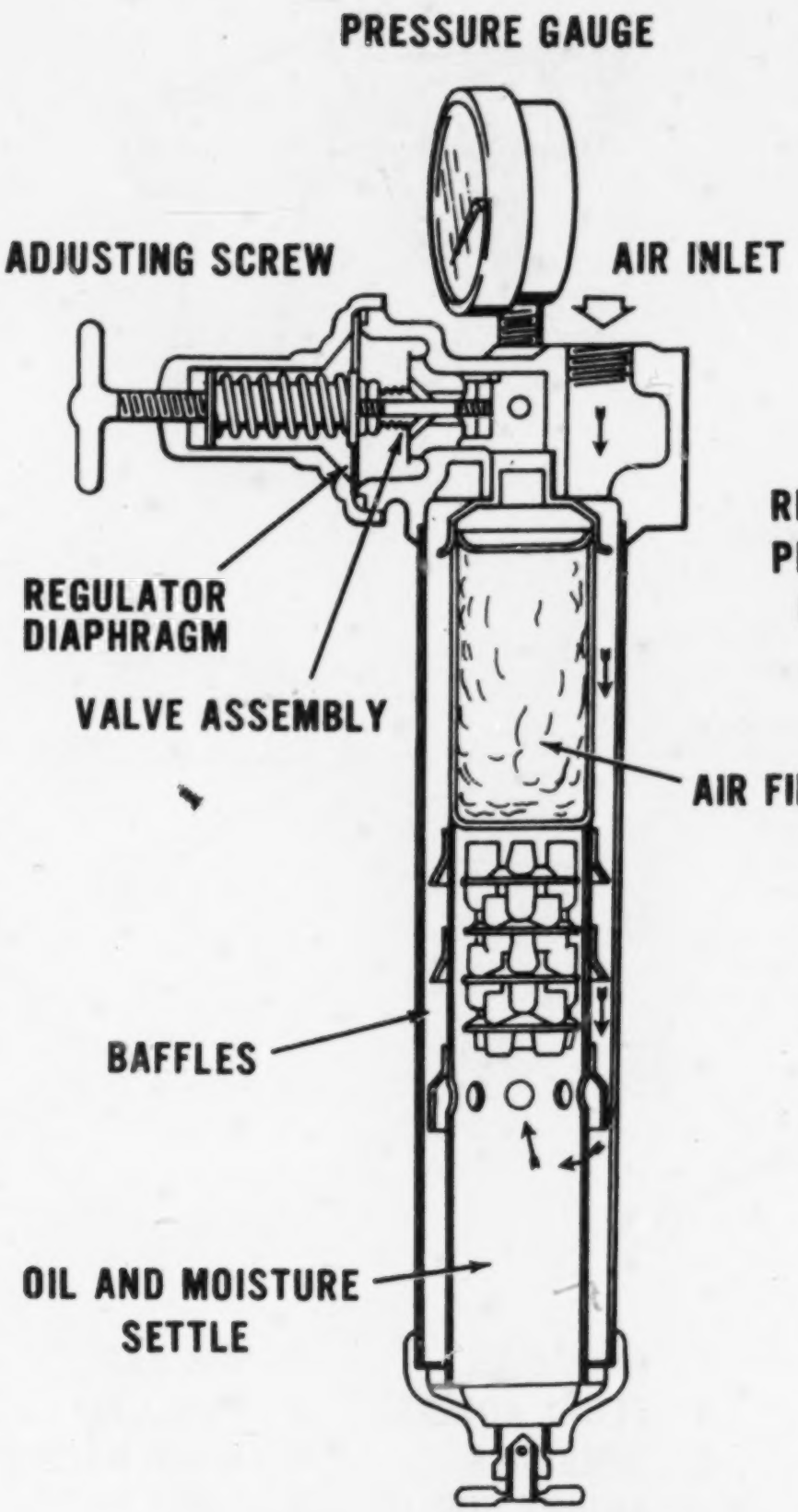

AIR TRANSFORMER

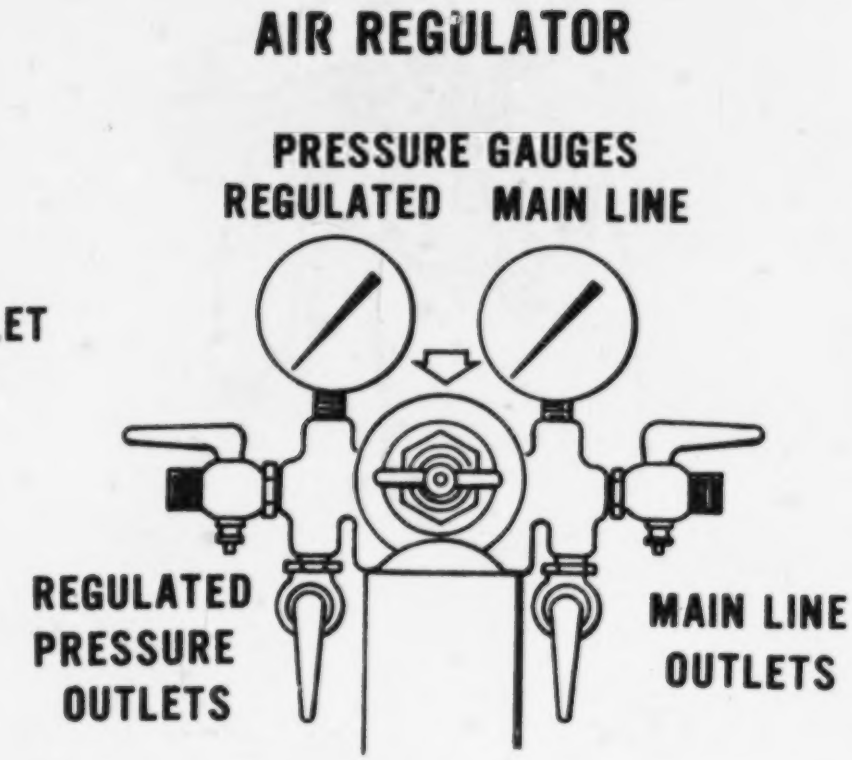

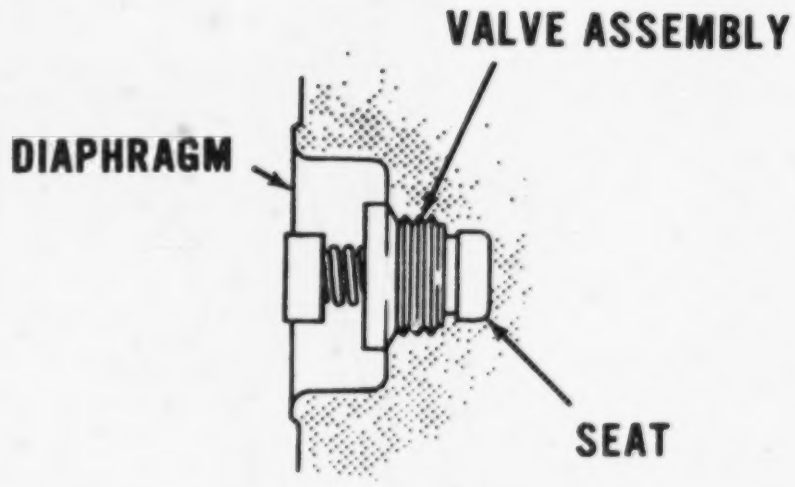

PRESSURE REGULATOR VALVE

4

Painting Farm Machinery

THE SPRAY GUN

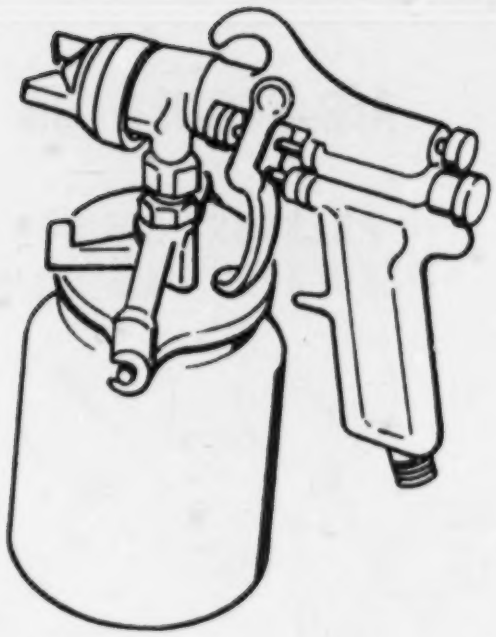

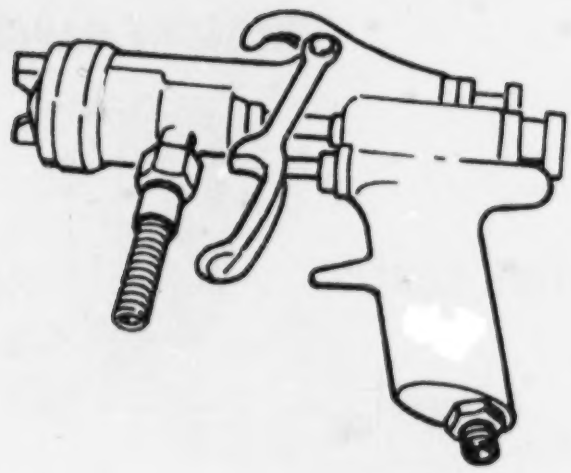

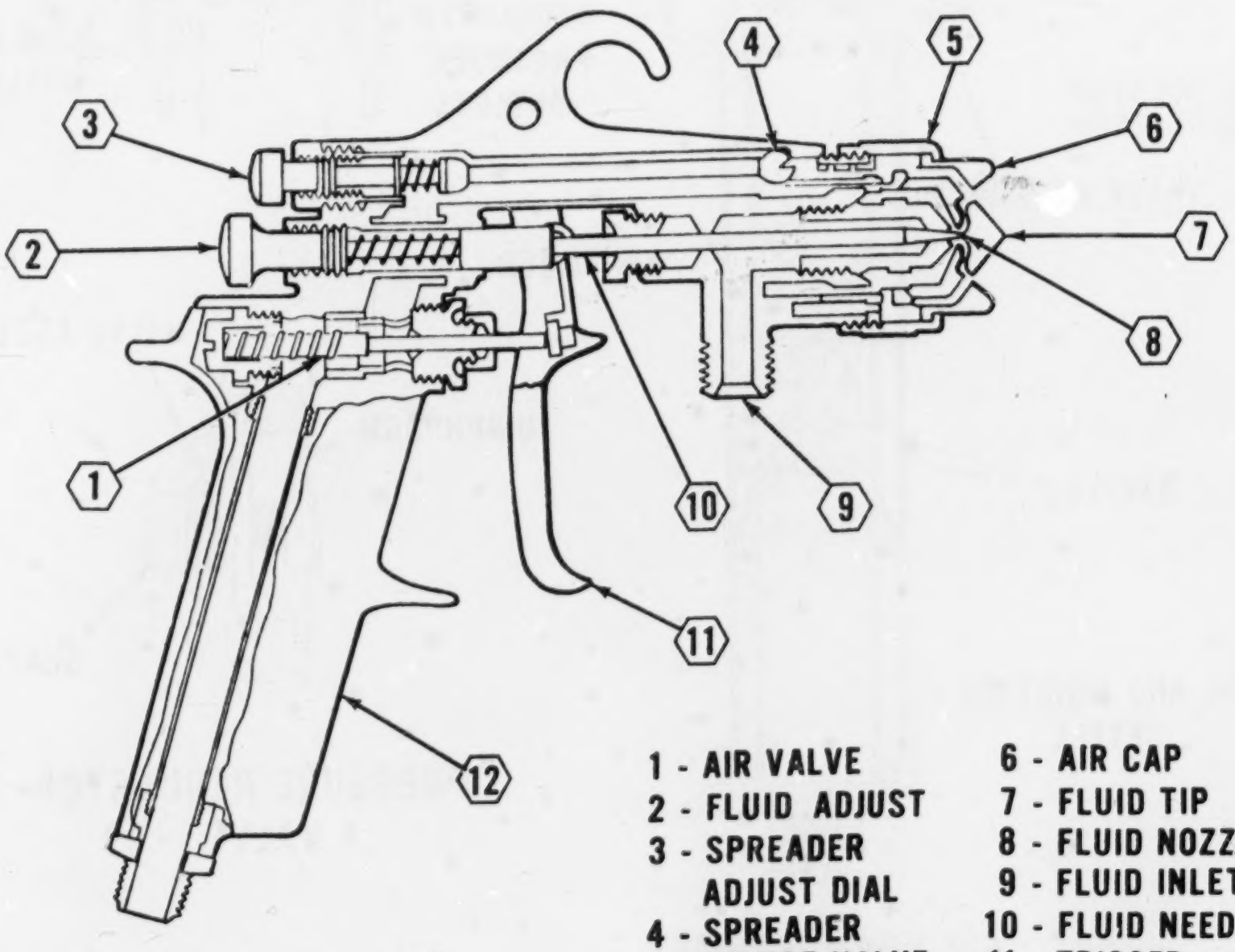

1 - AIR VALVE
2 - FLUID ADJUST
3 - SPREADER ADJUST DIAL
4 - SPREADER ADJUST VALVE
5 - SPRAY HEAD
6 - AIR CAP
7 - FLUID TIP
8 - FLUID NOZZLE
9 - FLUID INLET
10 - FLUID NEEDLE
11 - TRIGGER
12 - GUN BODY

0888 6831

PAINT GUN PARTS

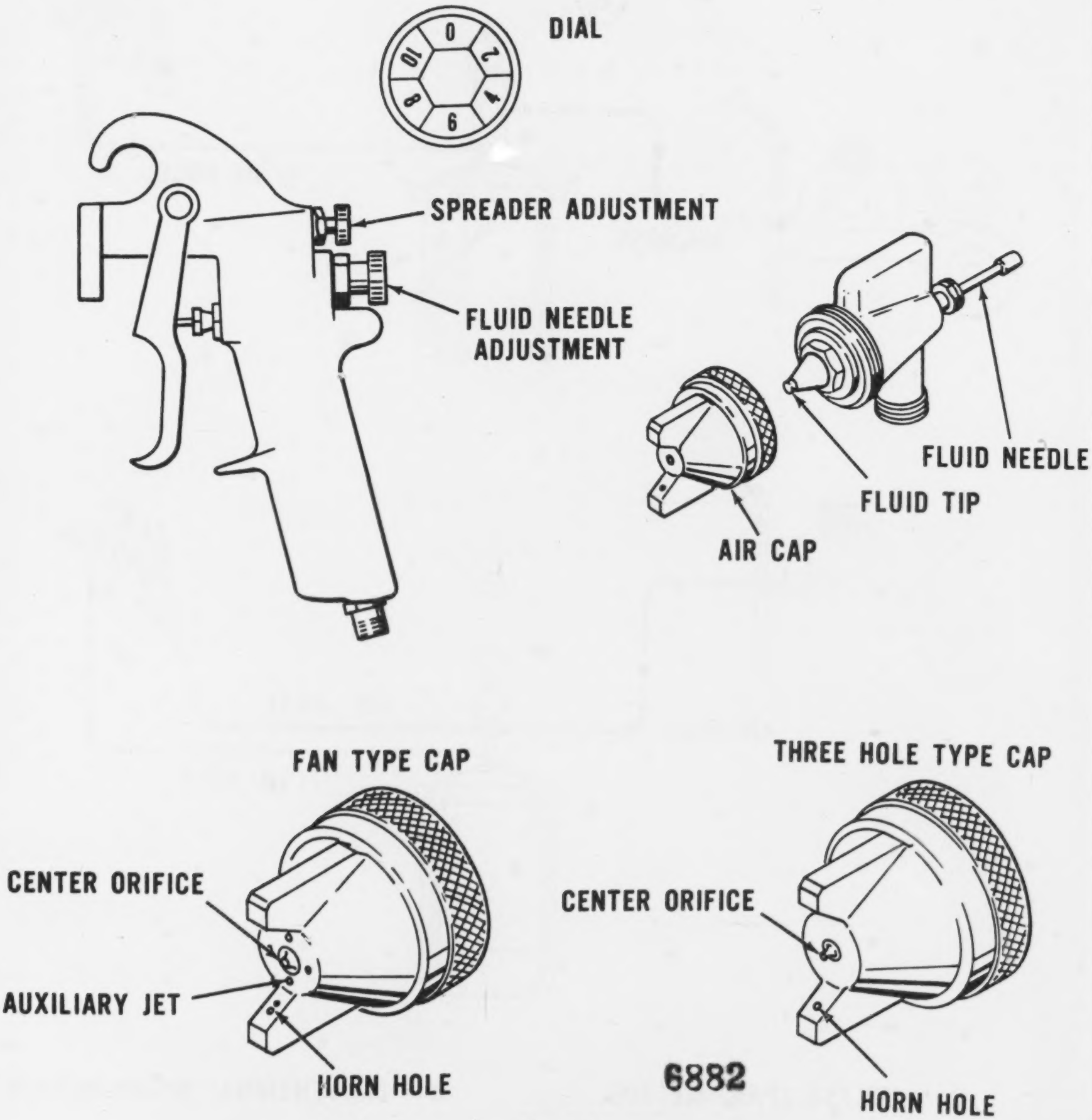

THE COMPLETE SYSTEM

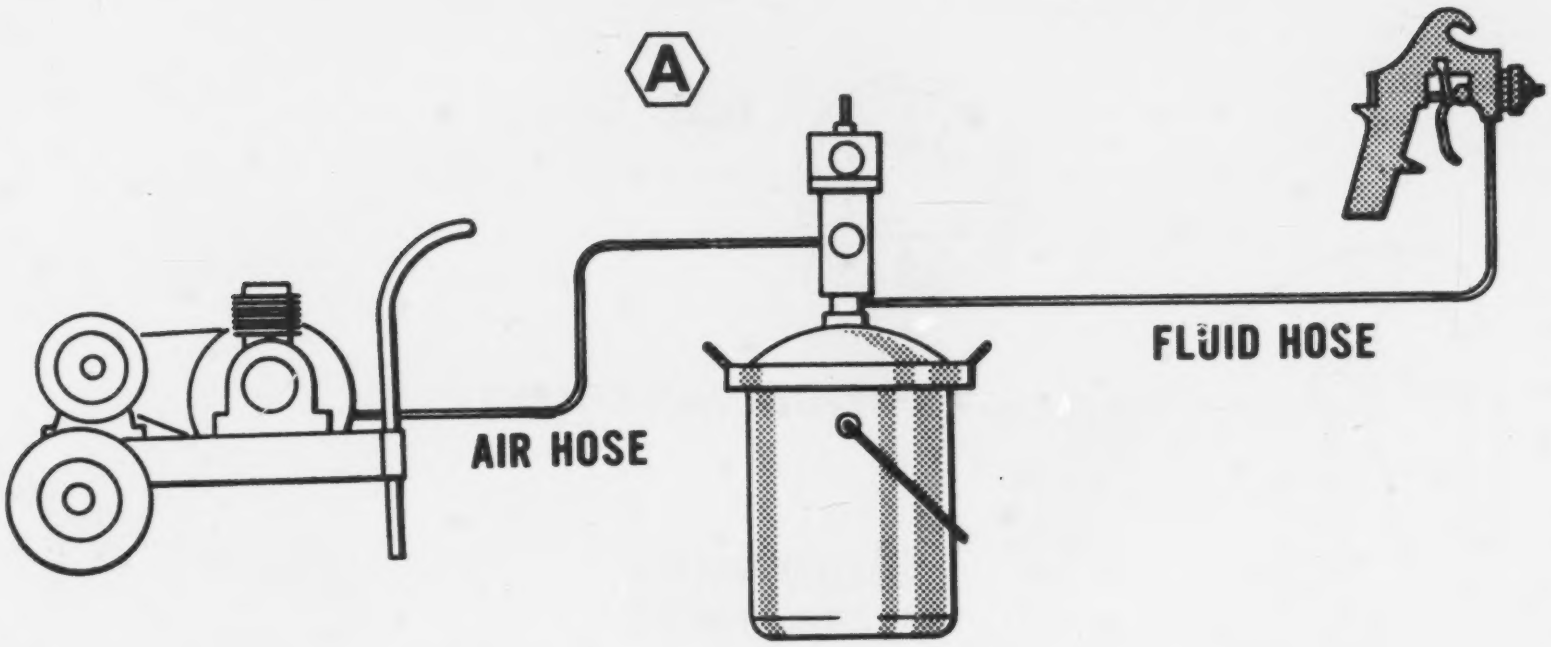

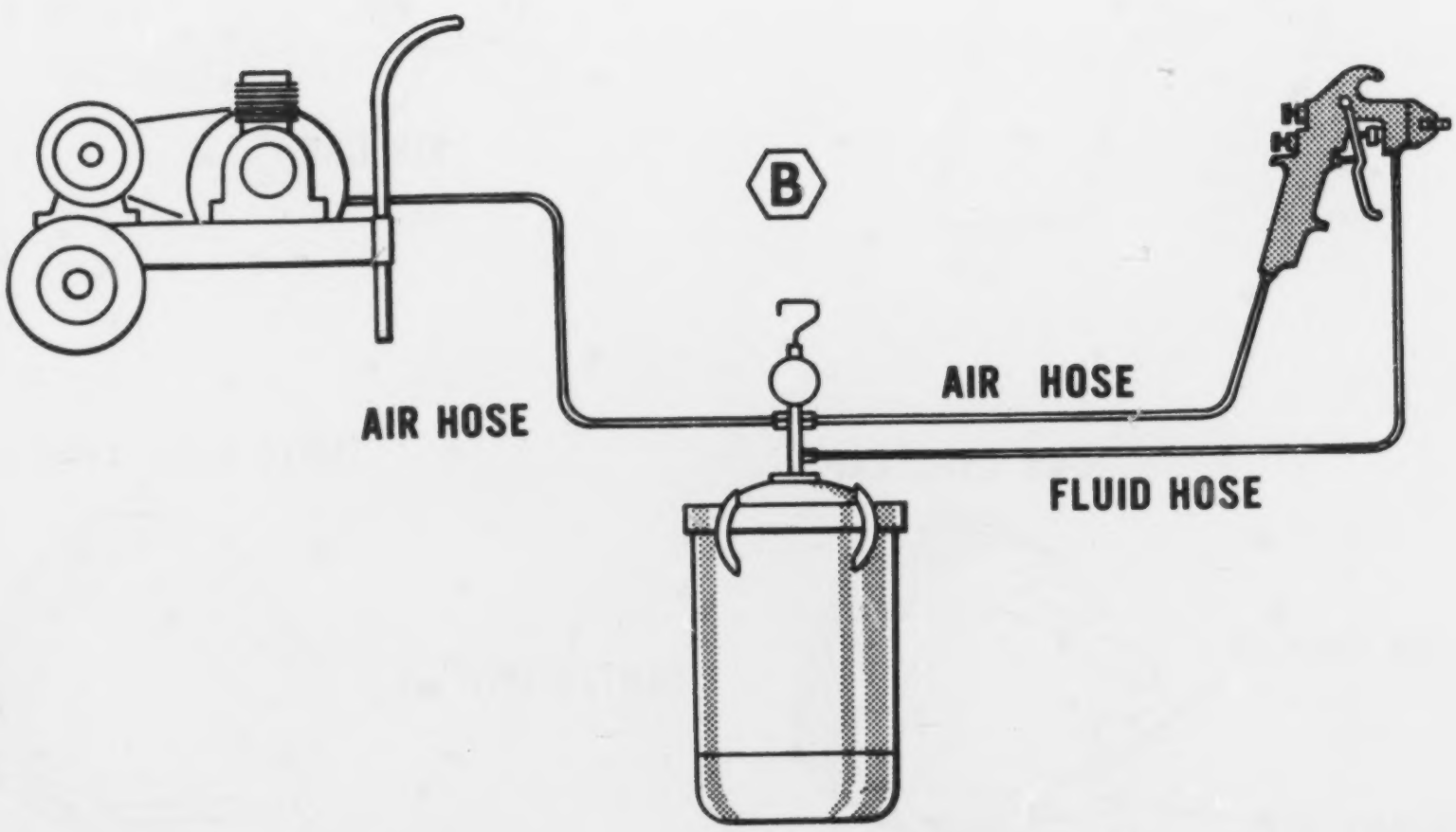

A – AIRLESS SPRAY METHOD

B – CONVENTIONAL SPRAY METHOD

6883

CLEANING SPRAY GUN

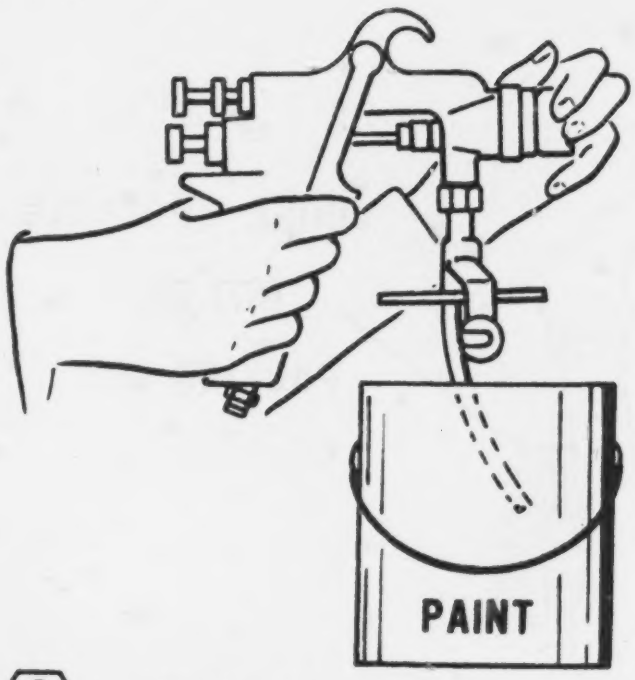

A AIR TO GUN OFF.
CLOSE HOLES AND
PULL TRIGGER.

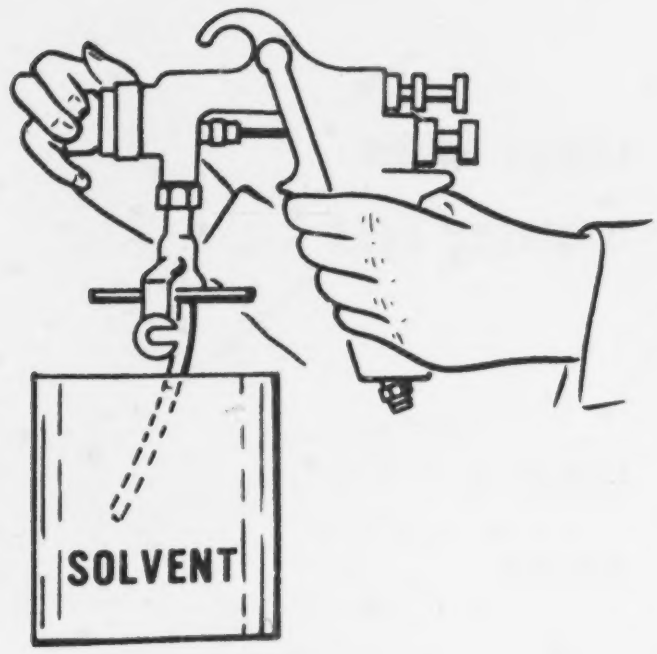

B CLOSE HOLES AND
PULL TRIGGER TO
CLEAN FLUID HOSE.

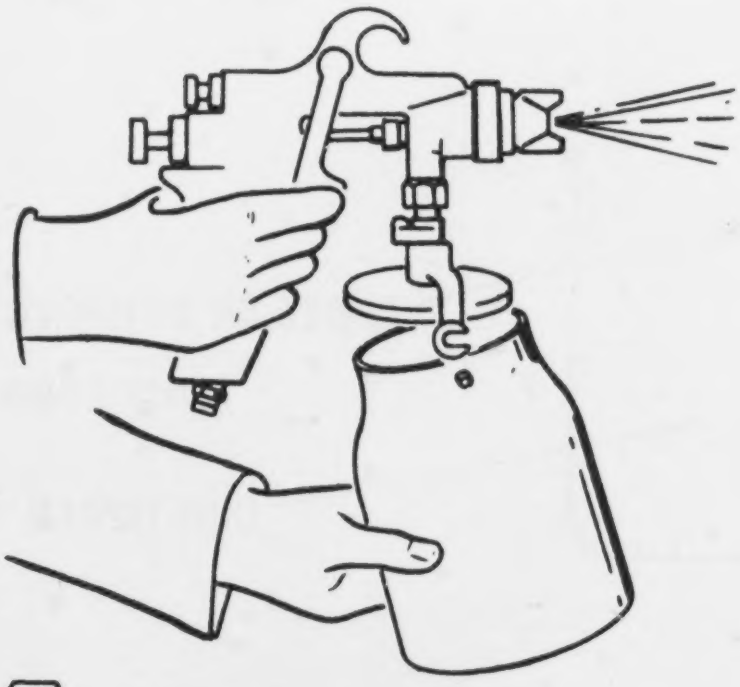

C CLEAN CUP THEN
SPRAY SOLVENT
THROUGH GUN.

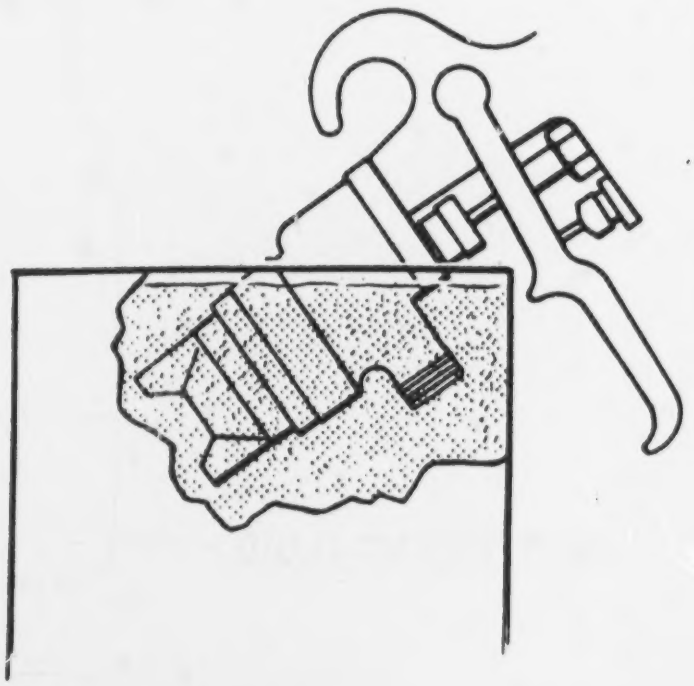

D RINSE NOZZLE AND
FLUID CONNECTION
IN SOLVENT.

COMMON TROUBLES

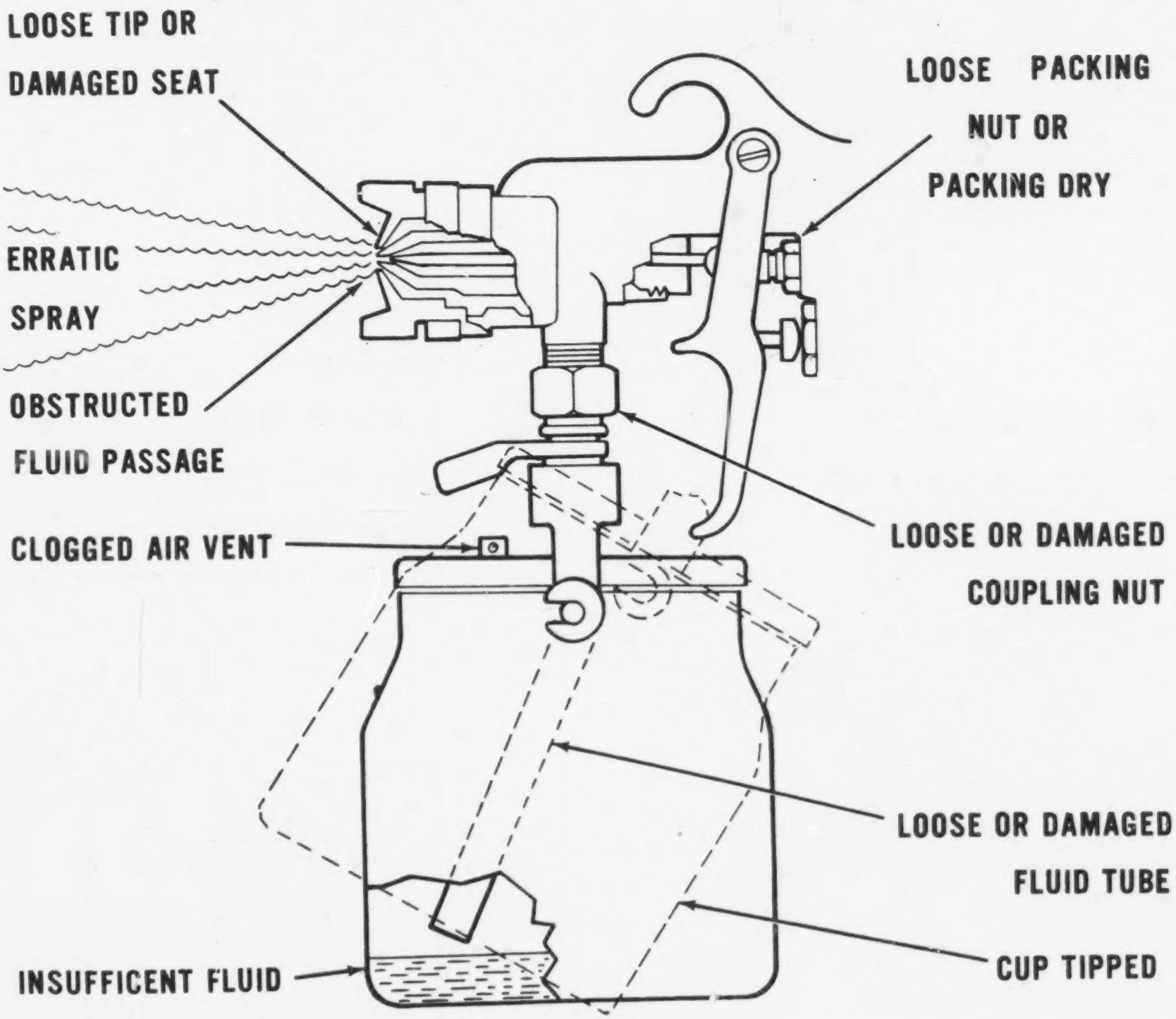

CORRECT SPRAYING

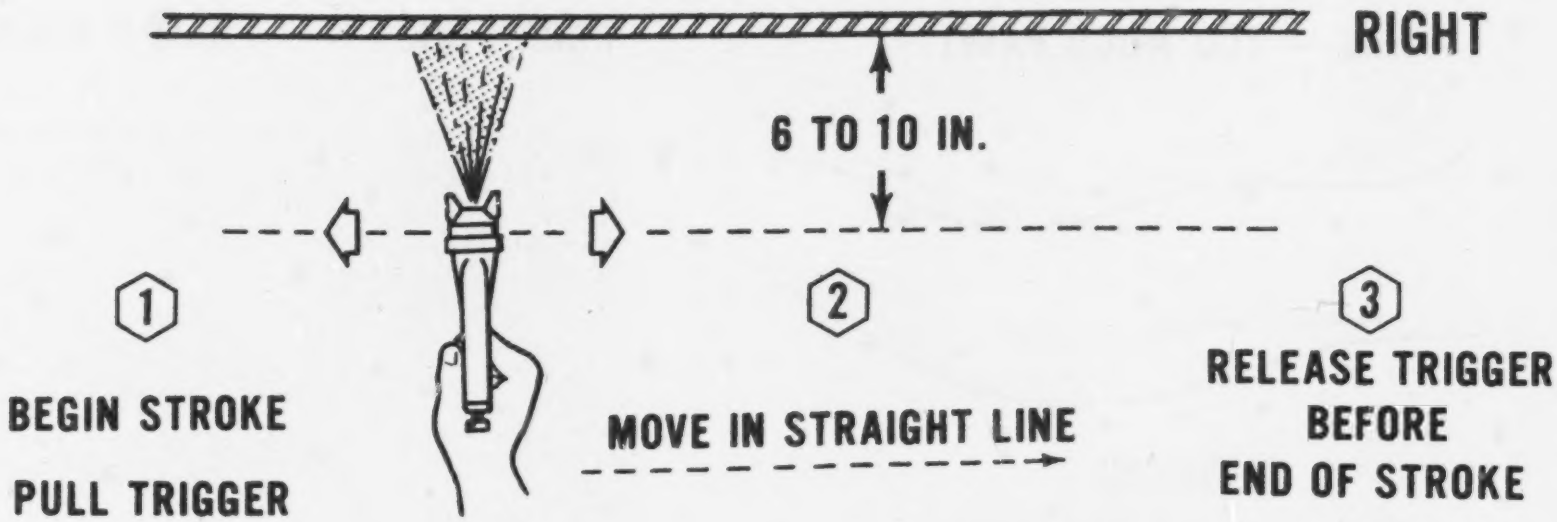

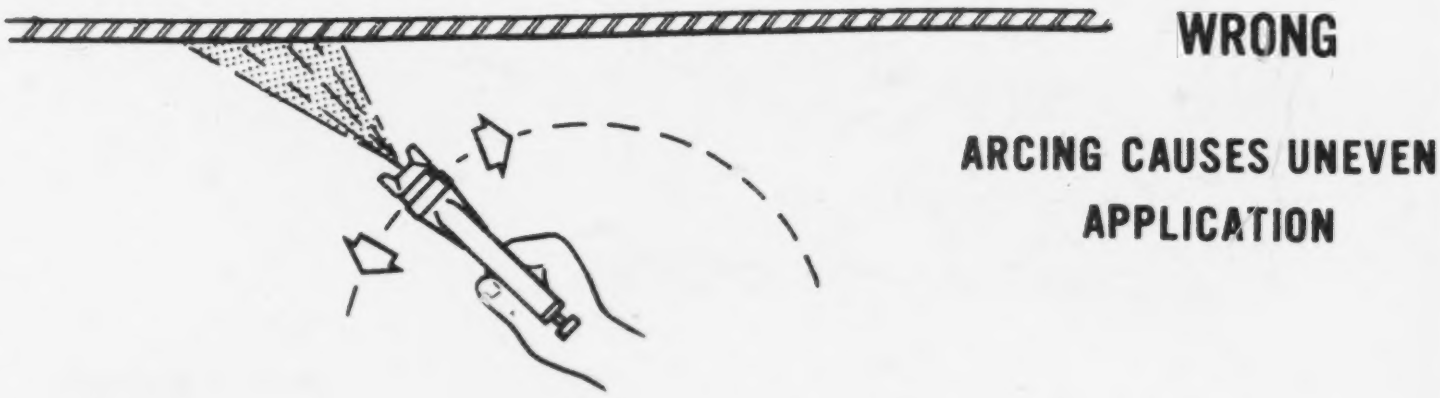

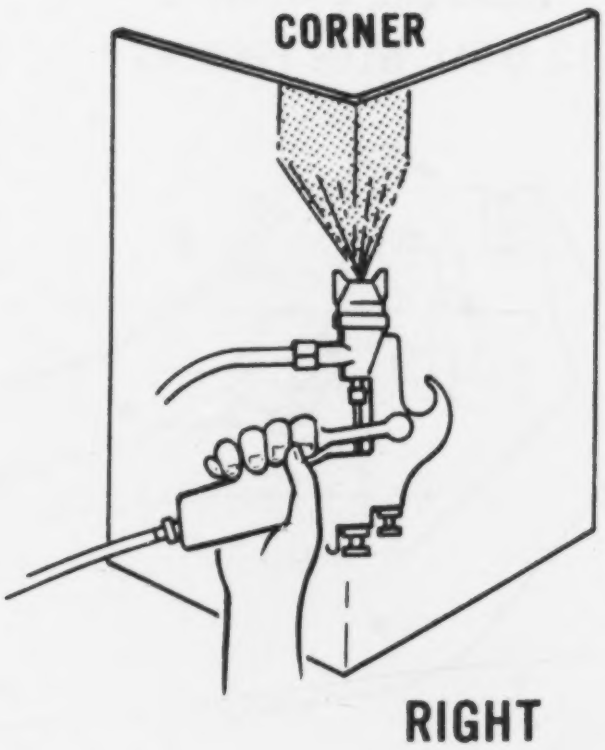

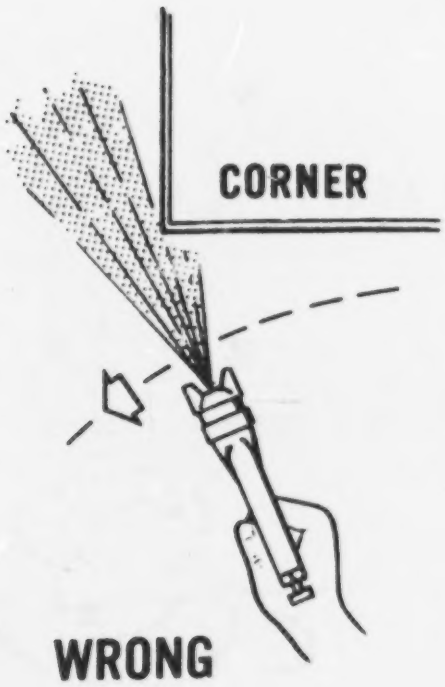

6886

DIAGNOSING TROUBLE

WRONG

SAG – TOO MUCH PAINT

WRONG

POOR FINISH – FAULTY TECHNIQUE

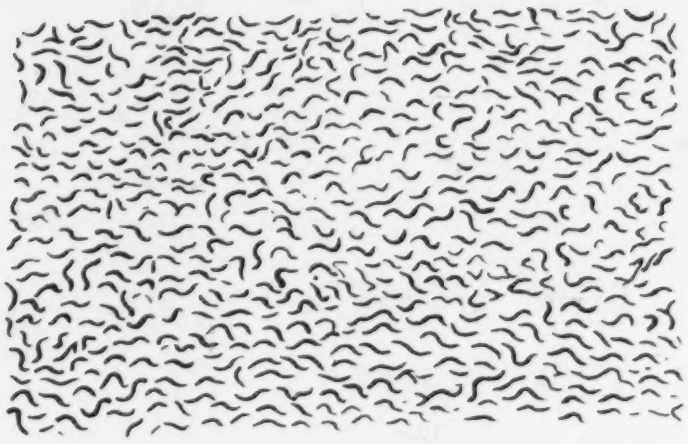

WRONG

RUN – PAINT TOO THIN

WRONG

GUN TOO FAR AWAY

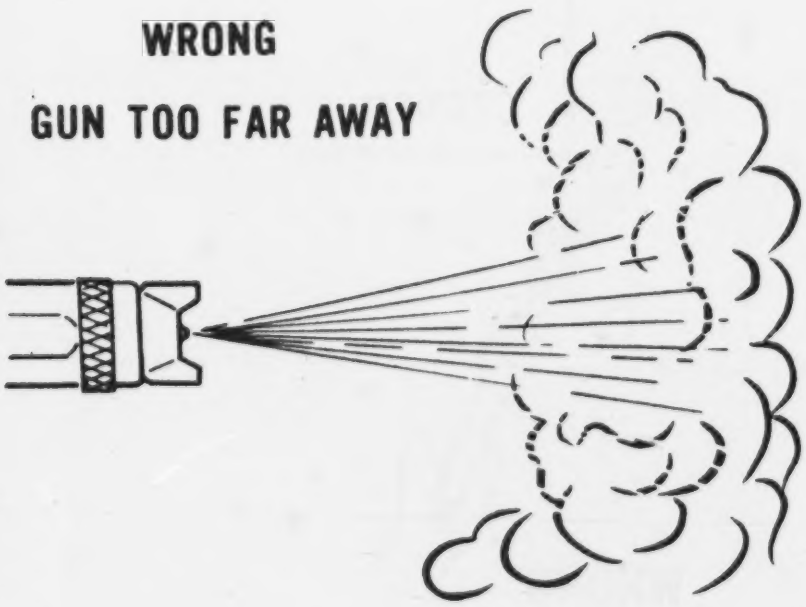

RIGHT

MEASURE DISTANCE TO WALL WITH FINGERS

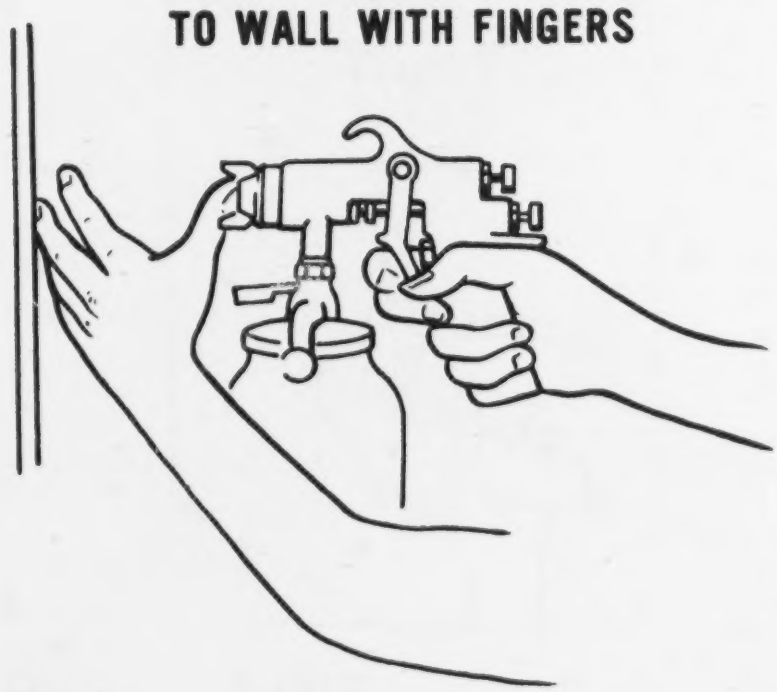

DO'S AND DON'TS

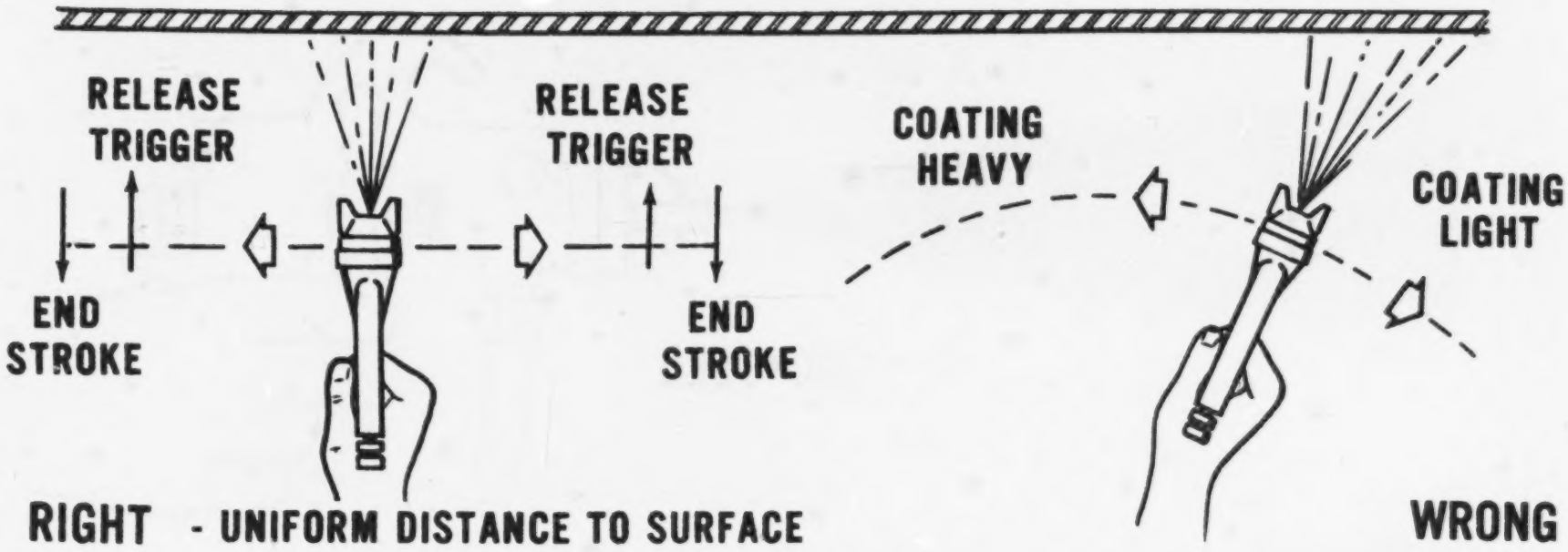

GUN ADJUSTMENTS

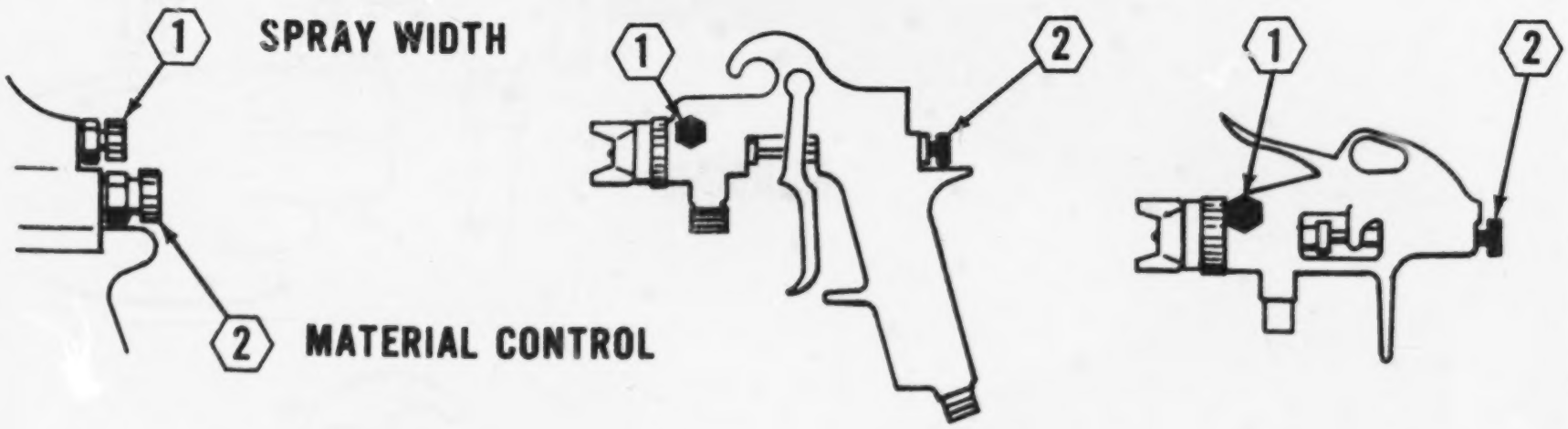

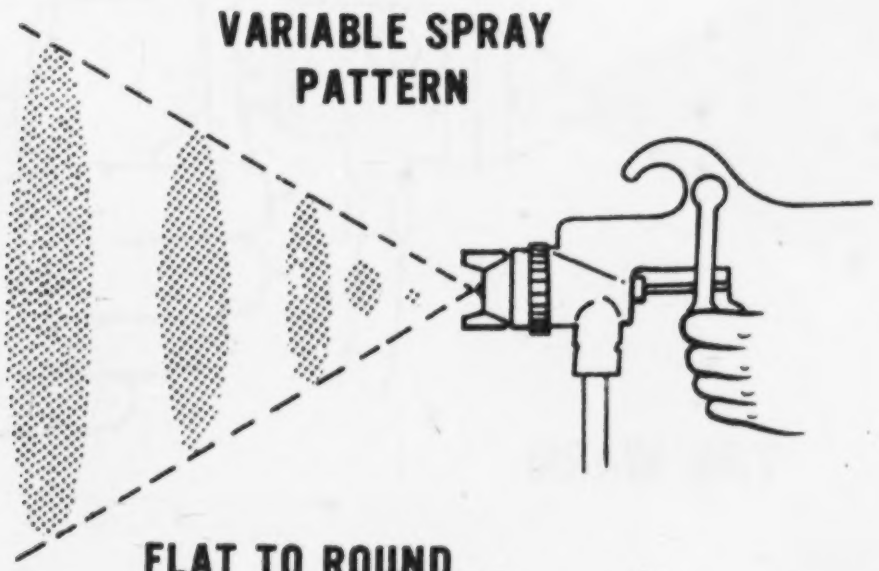

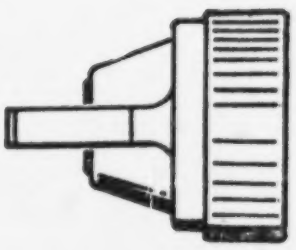

WINGS OF NOZZLE NORMALLY HORIZONTAL

PAINT TEMPERATURE

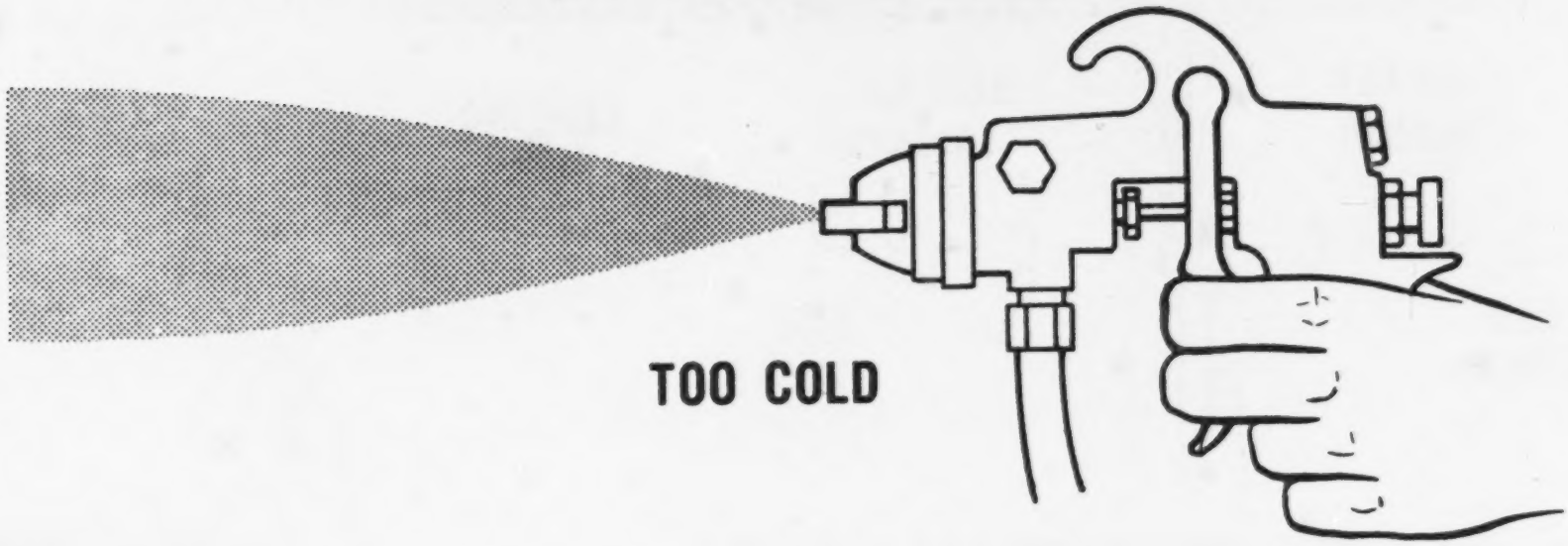

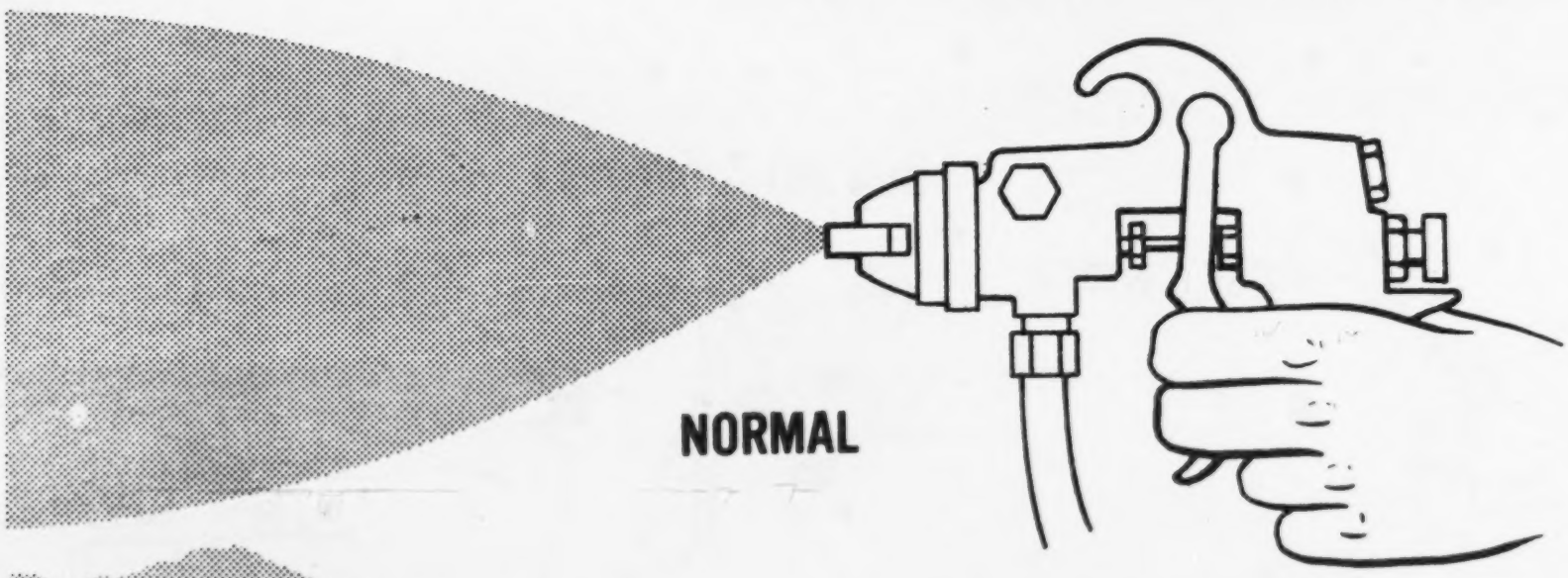

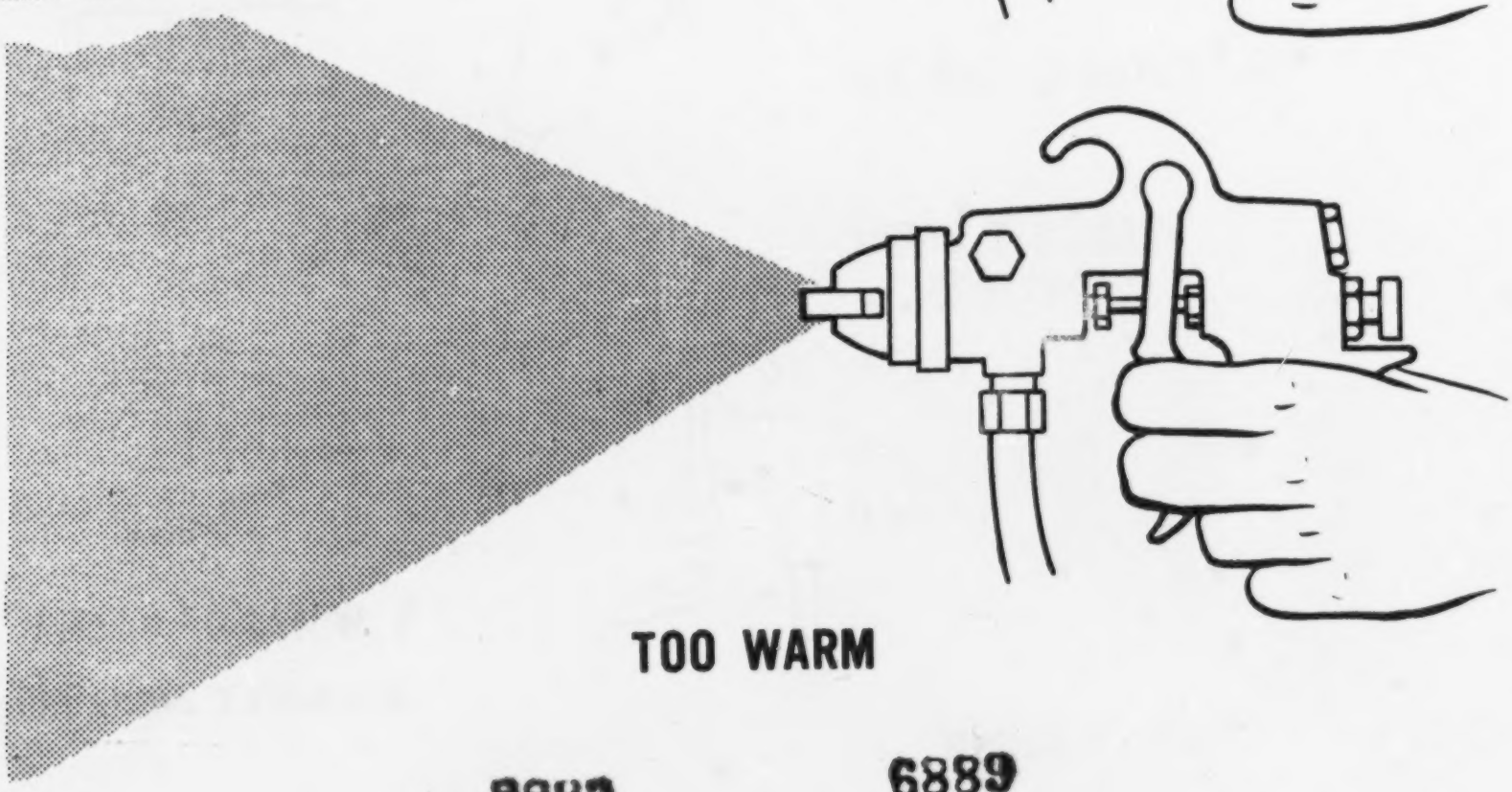

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SAFETY RULES

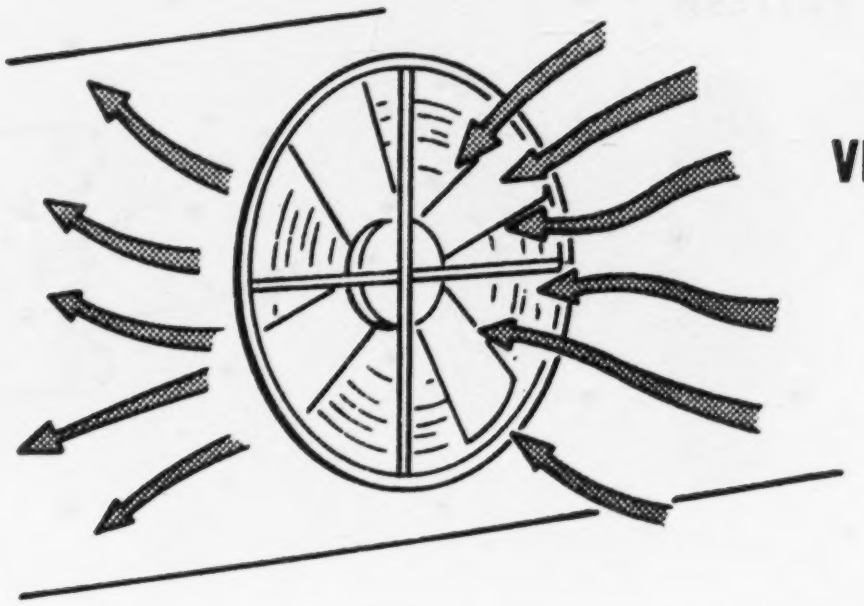

VENT PROPERLY

DANGER SIGN AND EXTINGUISHERS GO HAND-IN-HAND

CORRECTING DISTORTED PATTERNS

CORRECT PATTERN

ELONGATED ELLIPSE WITH UNIFORM DISTRIBUTION

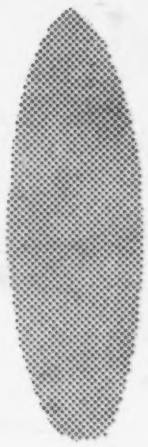

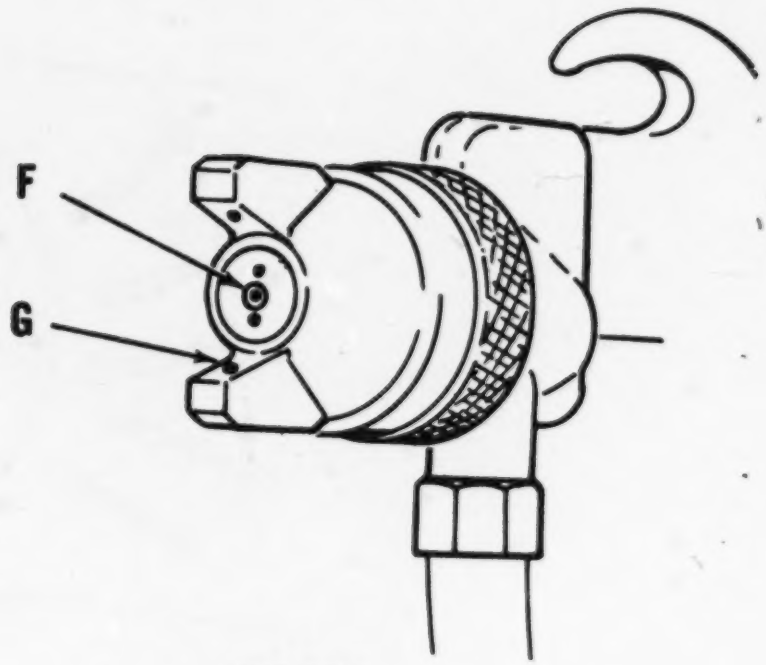

WRONG

HEAVY IN MIDDLE. INCREASE AIR PRESSURE.

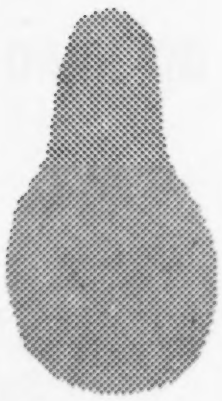

WRONG

SPLIT PATTERN, HEAVY ENDS. REDUCE AIR PRESSURE

WRONG

CRESCENT PATTERN.

CLEAN PORT G.

WRONG

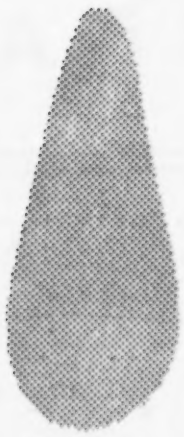

HEAVY AT BOTTOM OR TOP. CLEAN PORT F.

6891 e830

MIXTURE, ENAMELS

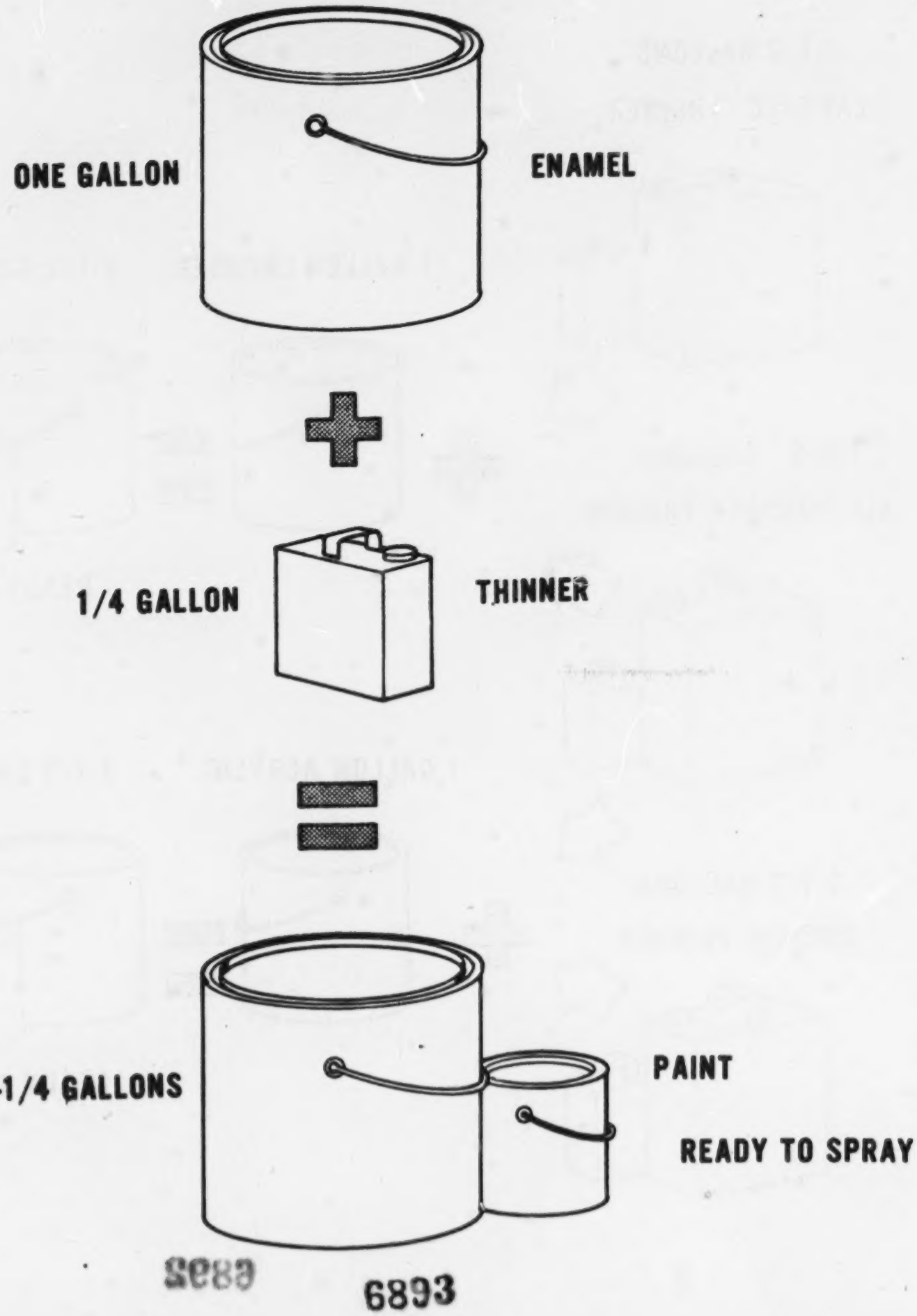

REMOVING OLD FINISH

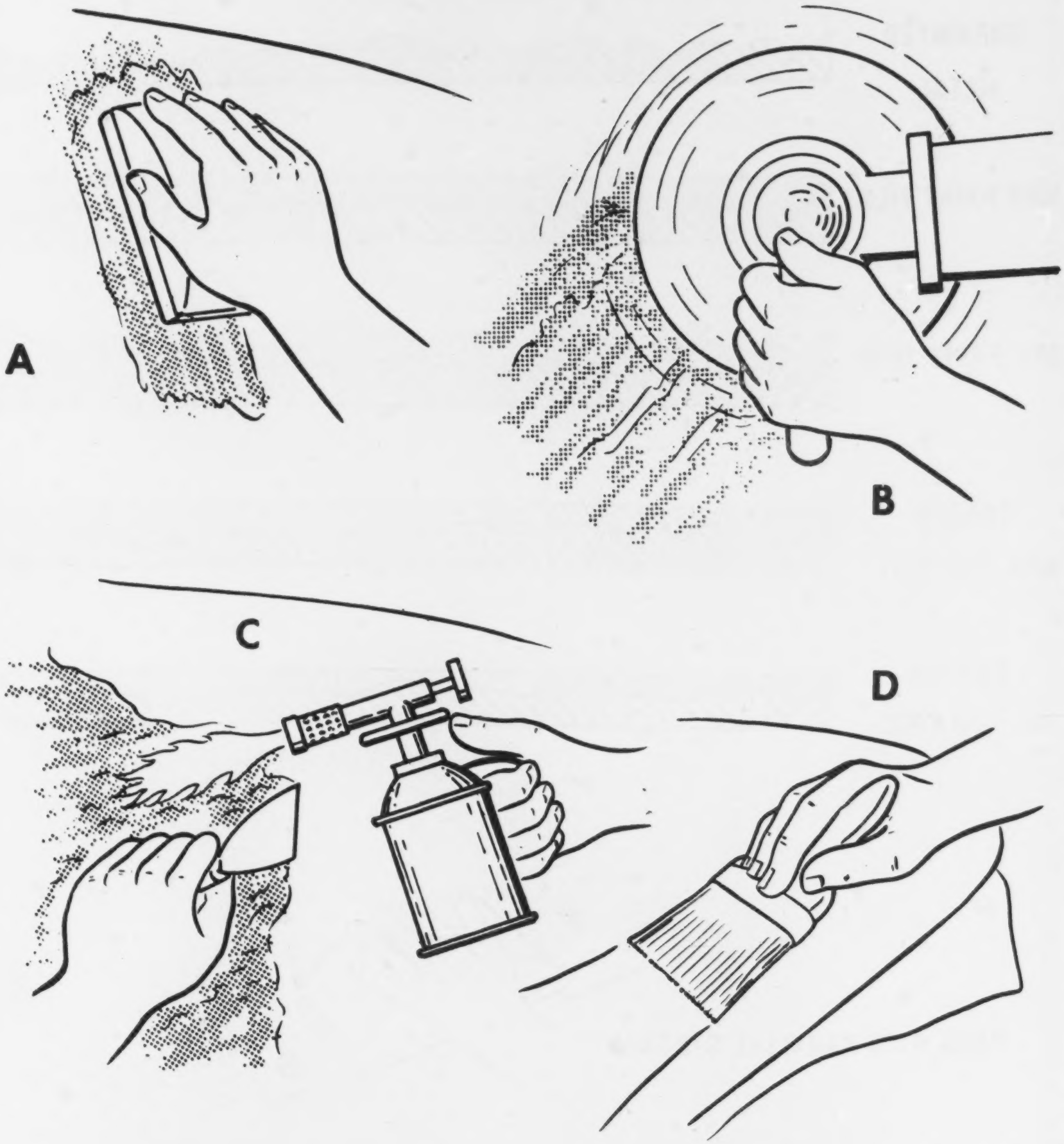

A – HAND SANDING

B – DISC SANDING

C – BLOW TORCH

D – PAINT REMOVER

SANDING PRIMER

UNPAINTED METAL

WET PAINT FILM

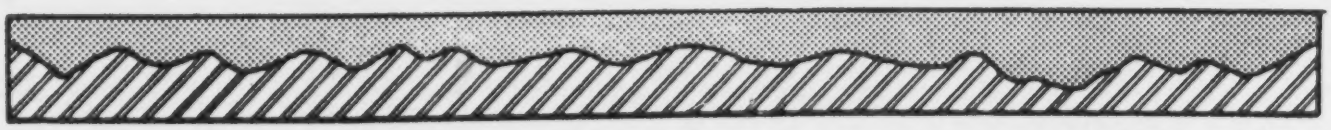

DRY PAINT FILM

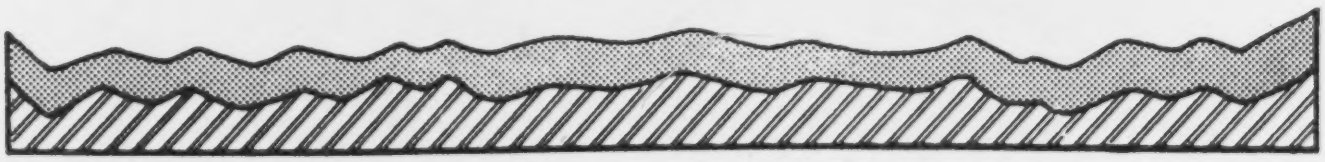

SANDED NO. 240 GRIT

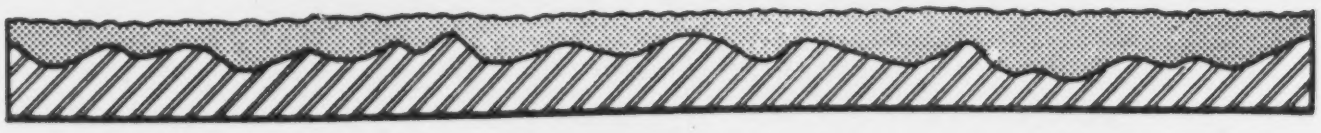

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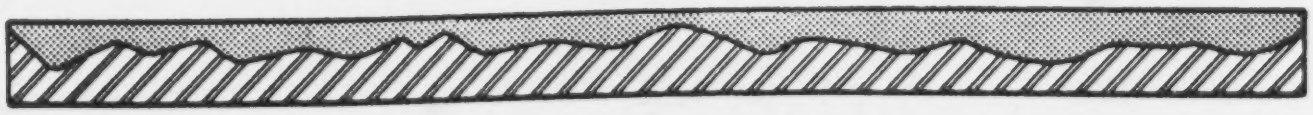

SAND WITH PARALLEL STROKES

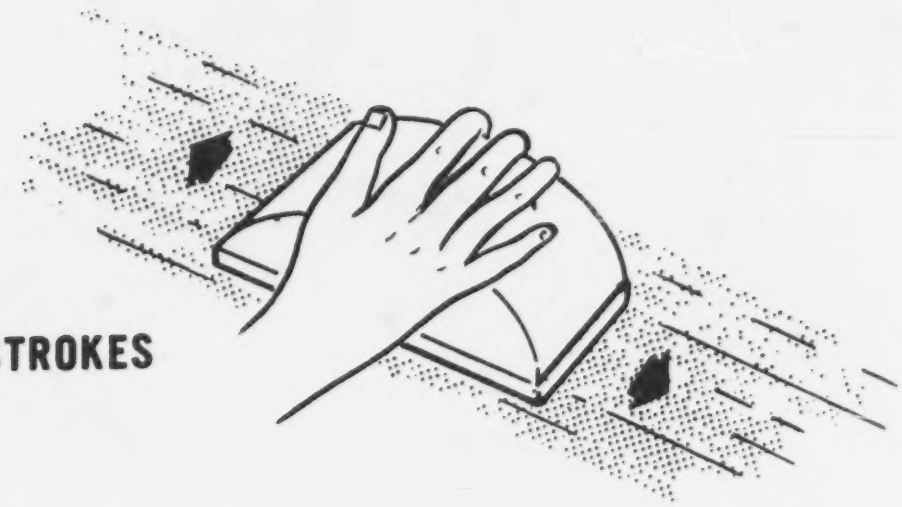

6895

exa4

Painting Farm Machinery

1. Name the parts on an air supply system.

2. Label the parts of a paint spray gun.

3. List the steps to follow in cleaning a spray gun.

4. Name the common spray gun paint troubles.

5. How far should the gun be held from the surface being painted?

6. Describe the correct spraying movements.

7. Draw the paint pattern from a paint gun when the paint is too cold. Normal. Too warm.

8. Name the safety rules to follow while spray painting.

9. What should be done to correct a paint pattern that is heavy in the middle?

10. What should be done to correct a paint pattern that is heavy on the ends?

6896

Painting Farm Machinery

11. What should be done to correct a paint pattern that is heavy at the top or bottom?

12. What is the proper mixture of lacquer paint and lacquer thinner for spraying?

13. What is the proper mixture of enamel paint and thinner for spraying?

14. Name four ways to remove an old finish.

15. What is the purpose of primer and how is it applied?

16. What grit sandpaper should be used for the first sanding after painting a tractor? What grit paper should be used on the final sanding?

17. What type stroke should be used when sanding a finished painted surface?

18. What grit sandpaper should be used for feather edging?

6897

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HOT AND COLD METAL WORK

6898

INTRODUCTION TO HOT AND COLD METAL WORK

Many simple repair jobs may be done by the student that has a knowledge of hot and cold metal working tools and that has developed the ability to use them properly. A thorough study of chapter four and five from the book, The Farm Shop, by Wakeman and McCoy, will furnish the needed information to develop most skills in hot and cold metal work.

Hot Metal Work

1. Selecting hot metal equipment
2. Safety practices in hot metal work
3. Heating metal
4. Cutting metal
5. Drawing out metal
6. Upsetting metal
7. Bending and shaping metal
8. Punching holes in hot metal
9. Heat treating steel
10. Shaping and tempering a cold chisel

Cold Metal Work

1. Identifying metals by the spark test
2. Selecting and using layout tools
3. Cutting cold metal
4. Shaping stock
5. Filing
6. Drilling
7. Tapping and threading
8. Bolting and riveting
9. Removing broken bolts
10. Using a power hack saw

6899

Hot and Cold Metal Work

HOT METAL WORK

1. Name the parts of an anvil.

2. What should be the height of the anvil?

3. What are straight-lip tongs used for?

4. What are handled punches used for?

5. A flatter is used for what purpose?

6. List five safety practices to observe when working with hot metal.

7. What part of a piece of metal heats the fastest?

8. Describe how to cut metal with a hardy.

9. How do you cut metal with a handled hot cutter?

10. What is meant by drawing out metal?

11. What is meant by upsetting metal?

12. How do you determine the length of stock needed for an eye that has an inside diameter of 2"?

13. Explain how to make an eye.

6900

14. Explain how to punch a hole in hot metal with a handled punch.

15. What do we mean by tempering metal?

COLD METAL WORK

1. How do you identify metals by the spark test?

2. List the common tools needed for cold metal work.

3. How many teeth per inch should a hacksaw blade have for average sawing?

4. Explain how to cut a piece of metal with a hand hack saw.

5. How is the cutting capacity of bolt cutters determined?

6. List the parts of a file.

7. Describe how to clean a file properly.

8. Name five ways of drilling holes in metal.

9. How are high speed twist drills marked?

10. How is metal held while it is being drilled?

11. What lubricants are recommended for drilling?

12. Define NC threads, NF threads and tell where each are used.

13. Name three types of taps and tell where each is used.

14. Explain the meaning of the following stamping on a tap: $\frac{1}{2}$ NC13.

15. Explain how to tap a $\frac{1}{2}$" hole.

16. Name three types of threading dies.

17. What is a screw plate and how is it used?

18. Explain how to cut threads on an iron rod.

19. Explain the methods used to remove a broken bolt.

20. What is the power hack saw used for?

21. What safety practices should be followed when using the power hack saw?

22. Which direction should the teeth point in a power hack saw blade when it is installed in the saw?

23. Explain the proper procedure to cut metal with a power hack saw.

Materials and equipment

1. Hot metal working tools
2. Cold metal working tools and equipment
3. Method of heating metal
4. Iron rods
5. Flat metal

Exercises for students

1. Cut a piece of hot metal.

2. Draw out a piece of hot metal.

3. Upset a piece of hot metal.

4. Bend and shape a piece of hot metal.

5. Make a two-inch eye on a $\frac{1}{2}$-inch rod.

6. Punch a hole in a piece of hot metal.

7. Run the spark test on cast iron, malleable iron, wrought iron and tool steel.

8. Cut a piece of flat metal with the hand hack saw.

9. Cut a 3/16" rod with the bolt cutters.

10. Thread a 5/8" rod with NC threads and NF threads.

11. Tap a hole in a fitting.

12. Thread a $\frac{1}{2}$-inch rod or bolt.

13. Saw metal on the power hack saw.

VT 012 703
Electronics Technician 3 and 2. Navy Training Course.

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Bureau of Naval Personnel.
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PUB DATE - 68 546p.

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ABSTRACT - This training course was prepared by the Department of the Navy and is intended for U.S. Navy and Naval Reserve personnel who are interested in qualifying for Electronics Technician for Third and Second Class. Chapters are: (1) Advancement, (2) Maintenance, (3) Use of Special Test Equipment, (4) Radio Receivers, (5) Radio Transmitters, (6) Multicouplers and Distribution Systems, (7) Teletype and Facsimile Terminal Equipment, (8) Communications Multiplexing, (9) Electronic Aids to Navigation, (10) Search Radar, (11) Radar Repeaters, (12) Special Purpose Equipments, and (13) Satellite Navigation. A training film list is appended. (Not recommended for hard copy reproduction due to print size.) (GB)

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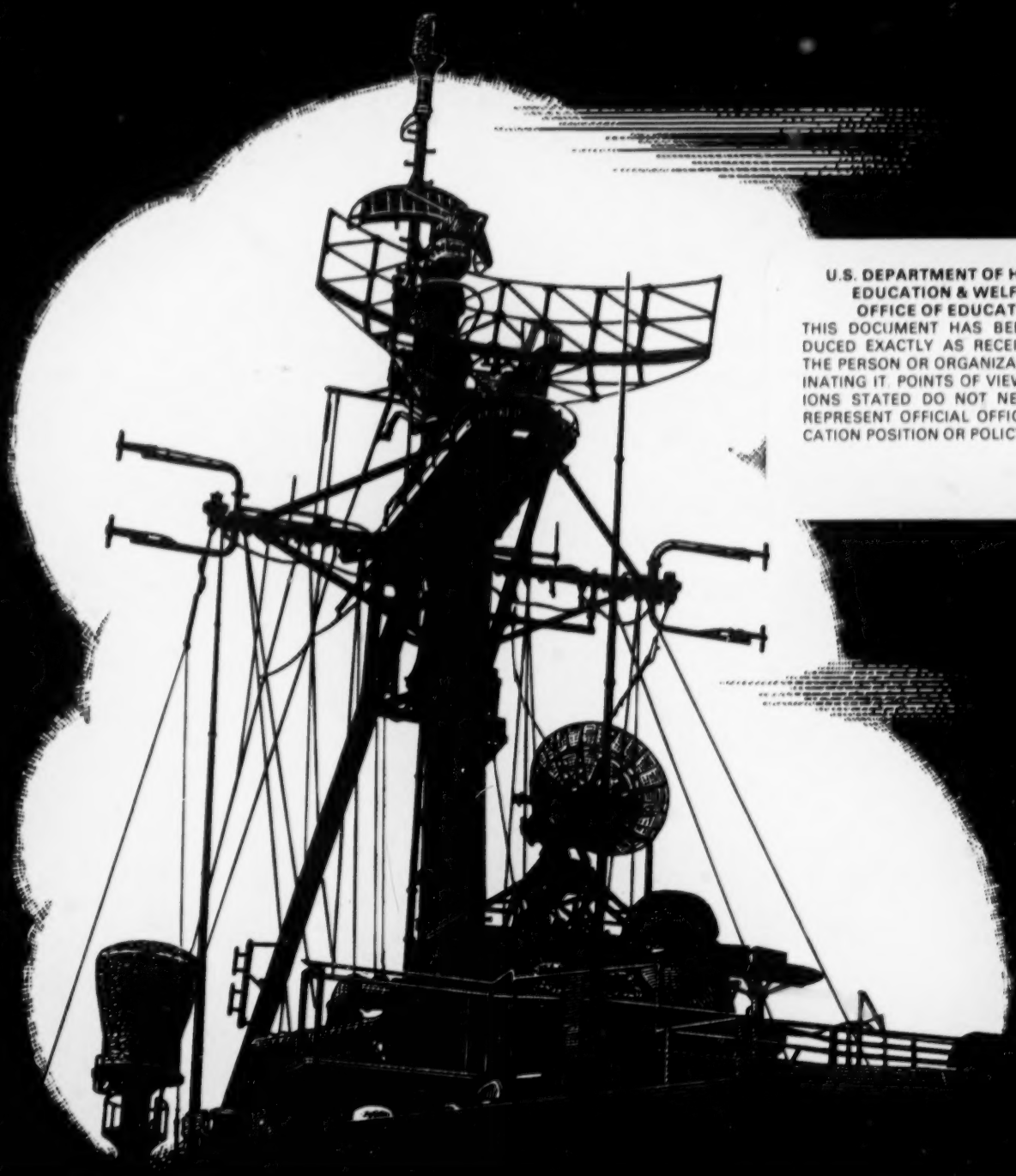

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ELECTRONICS TECHNICIAN 3 & 2

VT012703

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10195

PREFACE

This training course is written for men of the U. S. Navy and Naval Reserve who are interested in qualifying for Electronics Technician Third and Second Class. Combined with the necessary practical experience, this training course will aid you in preparing for the advancement-in-rating examination.

The qualifications for advancement are listed in the Manual of Qualifications for Advancement in Rating, NavPers 18068-B. Because examinations for advancement in rating are based on these qualifications, you should refer to them for guidance.

This training course was prepared by the Training Publications Division, Naval Personnel Program Support Activity, Washington, D. C., for the Bureau of Naval Personnel. Technical assistance was provided by the Electronics Technician School, Naval Training Center, Great Lakes, Illinois; Naval Ship Systems Command; and other activities cognizant of electronic equipments and the duties of Electronics Technicians.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

NAVY TRAINING COURSES

Basic Electricity, NavPers 10086-A
Basic Electronics, NavPers 10087-B
Introduction to Electronics, NavPers 10084
Basic Handtools, NavPers 10085-A
Blueprint Reading and Sketching, NavPers 10077-B
Mathematics Vol. 1, NavPers 10069-C
Mathematics Vol. 2, NavPers 10071-A
Mathematics Vol. 3, NavPers 10073
Standard First Aid, NavPers 10081-B

OTHER PUBLICATIONS

Naval Ships Technical Manual, Chapter 9670

USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Educations Services' Officer.* The following courses are recommended:

A788	Introduction to Electronics I
A789	Introduction to Electronics II
C166	Advanced Algebra
C176	Plane Geometry I
C177	Plane Geometry II
C188	Trigonometry

*"Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified on the active duty orders."

CHAPTER 1

ADVANCEMENT

This training course has been prepared for men of the Navy and of the Naval Reserve, who are studying for advancement to the rates of Electronics Technician 3 and Electronics Technician 2.

The Electronics Technician qualifications used as a guide in the preparation of this training course are those contained in Revision A of the Manual of Qualifications for Advancement in Rating, NavPers 18068.

Chapter 2 of this training course contains information on the Navy 3-M system, records, and reports as they pertain to the Electronics Technician. Chapter 3 discusses the operation and use of the radio interference measuring set, spectrum analyzer, absorption wavemeter and echo box. Chapter 4 covers radio receiving sets AN/SRR-11, 12, and 13, AN/WRR-2, and AN/WRR-35.A. This chapter also includes a brief discussion of SSB converter CU-591A/URR.

Chapters 5 and 6 describe radio transmitters with special circuits of the AN/SRT-14, 15, and 16, such as antenna tuning and keying circuits being discussed. A brief discussion of shore-based transmitters is contained in chapter 6. Chapter 7 discusses various multicouplers used by the fleet; the types of switching systems used for the transfer of equipment control, antenna selections, and radar information distribution.

Chapter 8 presents teletype terminal equipment and facsimile equipment used throughout the Navy. The basic principles of communications multiplexing are presented in chapter 9 along with a discussion of telegraph terminal set AN/UCC-1(V). Electronic Aids to Navigation are presented in chapter 10 and 11, using the TACAN system AN/SRN-6, radio direction finder equipment AN/URD-4, and LORAN receiving set AN/UPN-12 as representative equipments. Radar is covered in chapter 12 and radar repeaters are discussed in chapter 13. Special purpose equipment, such as electronic countermeasures, inertial navigation, and satellite communication equipment is presented in chapter 14. Chapter 15 is devoted entirely to Satellite Navigation which covers the overall Navy Satellite Navigation System and the AN/SRN-9 as the representative equipment.

The remainder of this chapter gives information on the enlisted rating structure, the Electronics Technician rating, requirements and procedures for advancement in rating, and references that will help you in working for advancement and in performing your duties as an Electronics Technician. Therefore, it is strongly recommended that you study this chapter carefully before beginning intensive study of the remainder of this training course.

Throughout this training course, the term "cycle," or "cycles per second," or the abbreviation CPS is used to express electrical frequency in cycles per second. Recently, in effecting world-wide standardization of various units of measurement, the term "Hertz" abbreviated H_z) has been adopted to express cycles per second and will be used in later revisions of this training course.

THE ENLISTED RATING STRUCTURE

The two main types of ratings in the present enlisted rating structure, are general ratings and service ratings.

GENERAL RATINGS identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

SERVICE RATINGS identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

THE ELECTRONICS TECHNICIAN RATING

Electronics Technicians maintain, repair, calibrate, tune, and adjust electronic devices and equipment. Electronics Technician ratings are included in the personnel allowance for practically all Navy ships including repair ships and tenders. The rating was established in 1948, and includes service ratings ETR (radar) and ETN (communications) at petty officer 3 & 2 levels. For advancement to ET1, the candidate must be qualified in both service ratings. Enlisted classification codes for the rating are listed in the Manual of Navy Enlisted Classifications, NavPers 15105 (revised). Classification codes identify men with special training and/or qualifications on equipments such as special radars, AEW systems, automatic landing systems, communications security devices equipment, inertial navigation equipment, ground controlled approach systems, TACAN systems and electronic standards equipment.

ADVANCEMENT IN RATING

Some of the rewards of advancement in rating are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

But the advantages of advancing in rating are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating, you increase your value to the Navy in two ways. First, you become more valuable as a specialist in your own rating. And second, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy.

HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement in rating? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and occupational training courses.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1. In some cases the Record of Practical Factors may contain the old form number, NavPers 760.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Demonstrate your KNOWLEDGE by passing a written examination on (a) military requirements and (b) occupational qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your division officer or training officer to be sure that you know the most recent requirements.

Advancement in rating is not automatic. After you have met all the requirements, you are ELIGIBLE for advancement. You will actually be advanced in rating only if you meet all the requirements (including making a high enough score on the written examination) and if the quotas for your rating permit your advancement.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement in rating? You must study the qualifications for advancement, work on the practical factors, study the required Navy Training Courses, and study other material that is required for advancement in your rating. To prepare for advancement, you will need to be familiar with (1) the Quals Manual, (2) the Record of Practical Factors, NavPers 1414/1, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052, and (4) applicable Navy Training Courses. The following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

The Quals Manual

The Manual of Qualifications for Advancement in Rating, NavPers 18068 B (with changes), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals Manual," and the qualifications themselves are often called

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	#† E3 to E4	# E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3. AME 3, HM 3			Class B for AGC MUC, MNC.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS**	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5 and E-6; 2 years for E-6, E-7, E-8 and E-9.
# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.

Figure 1-1.—Active duty advancement requirements.

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INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam	Standard Exam or Rating Training.	Standard Exam required for all PO Advancements.			Standard Exam, Selection Board. Also pass Mil. Leadership Exam for E-4 and E-5.		
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-2.—Inactive duty advancement requirements.

"quals." The qualifications are of two general types: (1) military requirements, and (2) occupational qualifications.

MILITARY REQUIREMENTS apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

OCCUPATIONAL QUALIFICATIONS are requirements that are directly related to the work of each rating.

Both the military requirements and the occupational qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

In most subject matter areas, you will find both practical factor and knowledge factor qualifications. In some subject matter areas, you may find only practical factors or knowledge factors. It is important to remember that there are some knowledge aspects to all practical factors, and some practical aspects to most knowledge factors. Therefore, even if the Quals Manual indicates that there are no knowledge factors for a given subject matter area, you may still expect to find examination questions dealing with the knowledge aspects of the practical factors listed in that subject matter area.

In summary, then, the written examination for advancement in rating may contain questions relating to the practical factors and to the knowledge factors of both the military requirements and the professional qualifications. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

You are required to pass a Navy-wide military/leadership examination for E-4 or E-5, as appropriate, before participating in the occupational examinations. The military/leadership examinations for both levels are given quarterly. Candidates are required to pass the applicable military/leadership examination only once. Each of these examinations consists of 100 questions based on information contained in the Manual of Qualifications for Advancement in Rating, NavPers 18068-B and Training Publications for Advancement in Rating, NavPers 10052.

The Navy-wide occupational examination for pay grades E-4 and E-5 will contain 150 questions related to occupational areas of your rating.

The Quals Manual is kept current by means of changes. The occupational qualifications for your rating which are covered in this training course were current at the time the course was printed. By the time you are studying this course, however, the quals for your rating may have been changed. Never trust any set of quals until you have checked it against an UP-TO-DATE copy in the Quals Manual.

Record of Practical Factors.

Before you can take the servicewide examination for advancement in rating, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the occupational qualifications. A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 1414/1 is used to keep a record of your practical factor qualifications. This form is available for each rating. The form lists all practical factors, both military and occupational. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement in Rating, and revised forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 1414/1 form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

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area

NavPers 10052

Training Publications for Advancement in Rating. NavPers 10052 (revised), is a very important publication for anyone preparing for advancement in rating. This bibliography lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052 for your rating.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Navy Training Courses are marked with an asterisk (*). Any course marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you can be eligible to take the servicewide examination for advancement in rating. Each mandatory course may be completed by (1) passing the appropriate enlisted correspondence course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the training course; or (3) successfully completing an appropriate Class A course.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military requirements for advancement. Personnel of ALL ratings must complete the mandatory military requirements training course for the appropriate rate level before they can be eligible to advance in rating.

The references in NavPers 10052 which are recommended but not mandatory should also be studied carefully. ALL references listed in NavPers 10052 may be used as source material for the written examinations, at the appropriate rate levels.

Navy Training Courses

There are two general types of Navy Training Courses. RATING COURSES (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the occupational qualifications of ONE rating. SUBJECT MATTER COURSES or BASIC COURSES give information that applies to more than one rating.

Navy Training Courses are revised from time to time to keep them up to date technically. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether any particular copy of a Navy Training Course is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists all current training courses and correspondence courses; you will find this catalog useful in planning your study program.)

Navy Training Courses are designed to help you prepare for advancement in rating. The following suggestions may help you to make the best use of this course and other Navy training publications when you are preparing for advancement in rating.

1. Study the military requirements and the occupational qualifications for your rating before you study the training course, and refer to the quals frequently as you study. Remember, you are studying the training course primarily in order to meet these quals.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training course intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book without any particular plan, looking at the

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illustrations and reading bits here and there as you see things that interest you.

4. Look at the training course in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the qualifications for advancement in rating?

5. When you have a general idea of what is in the training course and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training course, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Navy Training Courses or on other appropriate texts. As mentioned before, completion of a mandatory Navy Training Course can be accomplished by passing an Enlisted Correspondence Course based on the Navy Training Course. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master the information given in the training course, and also helps you see how much you have learned.

10. Think of your future as you study Navy Training Courses. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCES OF INFORMATION

Besides training courses, NavPers 10052 lists official publications on which you may be examined. You should not only study the sections required, but should become as familiar as possible with all publications you use.

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the occupational qualifications of your rating.

PUBLICATIONS YOU SHOULD KNOW

Electronic technical publications include various handbooks, bulletins, and manuals published and distributed by the Ship Systems Command, and manufacturers' technical manuals. The Requisitioning Guide and Index of Forms and Publications, NavSandA 2002, furnishes a complete list of NavShips technical publications along with instruction for ordering copies.

One bulletin of great importance to the ET is Electronics Information Bulletin (EIB), NavShips 0967-001-3(---), published bi-weekly for naval electronics activities. A complete file of these bulletins should be maintained.

This bulletin lists field changes and corrections that must be made in instruction books and other publications that are used in the maintenance of electronic equipment. It also lists electronics publications that become available, and gives valuable suggestions, from case histories, for servicing electronic equipment.

The recently revised Electronics Installation and Maintenance Book (EIMB) furnishes data applying to all types of electronics equipment including the theory of operation of basic

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electronic circuits. The EIMB is organized and issued as 12 separate handbooks, each with its own NavShips number. A complete listing of all handbooks, stock numbers, and most recent changes can be found in current issues of the EIB.

Another NavShips publication of importance to the ET is the Naval Ships Technical Manual, NavShips 250-000. This manual is the basic doctrine publication of the Naval Ship Systems Command. Chapter 9670 (formerly chap. 67) is of particular importance to the ET and should be a part of the ET library.

The Naval Ship Systems Command Technical News is a monthly publication which contains interesting and useful articles on all aspects of shipboard engineering. This magazine is particularly useful because it presents information which supplements and clarifies information contained in the Naval Ships Technical Manual and because it presents information on new developments.

The manufacturers' technical manuals that are furnished with most electronic equipment are valuable sources of information on operation, maintenance and repair. The manufacturers' technical manuals that deal with Naval Ship Systems Command equipment are usually given NavShips numbers.

Some publications are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you to do your work or to advance in rating; it is likely to be a waste of time and may even be seriously misleading.

TRAINING FILMS

Training films available to naval personnel are a valuable source of supplementary information on many technical subjects. A selected list of training films that may be useful to you is given in Appendix I of this training course. Other films that may be of interest are listed in the United States Navy Film Catalog, NavWeps 10-1-777. This catalog, published in 1966, supersedes three earlier publications: the former catalog with the same title but numbered NP 10000-A; the Supplement, NavWeps 10-1772; and the Navy Classified Film Catalog, NavPers 10001-A.

As you know, procedures sometimes change rapidly. Thus some film become obsolete rapidly. If a film is obsolete only in part, it may still have sections that are useful, but it is important to note procedures that have changed. If there is any doubt, verify current procedures by looking them up in EIMB, EIB, Naval Ships Technical Manual, or other applicable sources.

CHAPTER 2

MAINTENANCE

Maintenance, as defined by the Naval Ships Technical Manual, is the function of retaining material in, or restoring it to, a serviceable condition. Its phases include servicing, repair, modification, modernization, overhaul, and testing.

PREVENTIVE MAINTENANCE

Preventive or scheduled maintenance is defined as those measures taken periodically to achieve maximum efficiency in performance, to ensure continuity of service, to reduce major breakdowns, and to lengthen the useful life of the equipment or system. This form of maintenance consists principally of cleaning, lubrication, and periodic tests aimed at discovering conditions which, if not corrected may lead to malfunctions.

To realize optimum results from the regular functional tests, a careful record of the performance data on each equipment must be kept. The value of these records may be demonstrated in a number of ways. Comparison of data taken on a particular equipment at different times may reveal slow, progressive drifts that may be too small to show up significantly in any one test. While the week-to-week changes may be slight, they should be followed carefully so that necessary replacements or repairs may be effected before the margin of performance limits is reached. Any marked variations should be regarded as abnormal, and should be investigated immediately. Another advantage in keeping systematic records of performance and servicing data is that maintenance personnel develop a more rapid familiarization with the equipment involved. The accumulated experience contained in the records serves as a guide to swift and accurate troubleshooting.

THE 3-M SYSTEM

The Navy Maintenance and Material Management (3-M) System has been implemented in the Navy as an answer to the ever-present problem of maintaining a high degree of material readiness. Although the (3-M) System is designed to improve the degree of readiness, its effectiveness and reliability are dependent upon you, the individual. The accuracy with which you perform your work, along with the neat and complete recording of required data on the prescribed forms, is one of the keys to the degree of readiness of your ship and therefore is a reflection of your success as a petty officer.

The two basic elements of the 3-M System are the Planned Maintenance System (PMS) and the Maintenance Data Collection System (MDCS). The Planned Maintenance System provides a uniform system of planned preventive maintenance. The Maintenance Data Collection System provides a means of collecting necessary maintenance and supply data, in a form suitable for rapid machine processing. A Man-hour Accounting System is used aboard repair ships and tenders in conjunction with the Maintenance Data Collection System.

Preventive maintenance should not be confused with corrective maintenance. Preventive maintenance is a scheduled check on select parts of a piece of equipment. Corrective maintenance is the repair of equipment.

As a third or second class ET, you will be concerned with both the Planned Maintenance System (PMS) and certain portions of the Maintenance Data Collection System (MDCS) as discussed in this chapter.

THE PLANNED MAINTENANCE SYSTEM

Planned maintenance reduces casualties and saves the cost of major repairs. The PMS is

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designed to define the minimum planned maintenance required, to schedule and control performance, to describe the methods and tools to be used, and to aid in the prevention and detection of impending casualties.

In establishing minimum planned maintenance requirements for each piece of equipment, the Naval Ships Technical Manual, manufacturers' technical manuals, and applicable drawings are critically reviewed. If the planned maintenance requirements are found to be unrealistic or unclear, they are modified or completely revised before being incorporated into the PMS.

It is possible that the planned maintenance prescribed in the PMS may conflict with that prescribed in other documents such as the Naval Ships Technical Manual. Should this happen, it must be remembered that the PMS supersedes and takes precedence over existing requirements set forth in various technical publications inso/far as preventive maintenance is concerned.

The Planned Maintenance System Manual

A master Planned Maintenance System Manual is tailored to each department of a specific ship. It contains the minimum planned maintenance requirements for each maintainable component installed in that particular department. The department Master Manuals are normally kept in the department offices and are primarily used by the department heads in planning and scheduling the maintenance requirements in their departments.

The departmental Master Manual contains a section for each division or maintenance group within the department. Each divisional section contains a table of contents and a Maintenance Index Page (MIP) for each system, subsystem, or component involved.

Applicable portions of the PMS Manual (referred to as Space Manuals) are kept in the working space for the equipment involved and serve as a ready reference to the planned maintenance required. Each MIP contains a brief description of the maintenance requirements and the frequency with which maintenance is to be effected. The frequency code is: D—daily, W—weekly, M—monthly, Q—quarterly, S—semiannually, A—annually, C—overhaul cycle, and R—situation requirement. The frequency codes for the daily, weekly, monthly, quarterly, semiannual, and annual planned maintenance actions are self-explanatory. Certain planned maintenance actions are performed once each operational cycle between shipyard overhauls, during a specified quarter of the cycle, and are designated by the code C. The code R is used to identify those planned maintenance actions which are to be performed prior to getting underway, after a specified number of hours of operation, or to meet other requirements that only arise during a specific situation (prior to overhaul, for example).

Figure 2-1 shows a Maintenance Index Page (MIP) taken from a typical PMS Manual. Information to be found on the MIP includes the system or component involved, a short description of each maintenance requirement, the maintenance frequency code plus a consecutive number starting with "1" for each frequency code assigned, the rate or rates recommended to perform the maintenance, the average time required to perform the maintenance, and related maintenance requirements. The related maintenance listed is additional planned maintenance which can be completed prior to, in conjunction with, or immediately after the scheduled maintenance.

Because shipboard application of the PMS will vary slightly from one ship to another, the information found on the MIPs regarding rates recommended to perform the maintenance and the average time required for the task requires certain clarification. The maintenance taska are actually performed by personnel available and capable, regardless of what rate is listed on the MIP. The average time required, as listed on the MIP, does not take into account the time required to assemble the necessary tools and materials nor the time required to clean the area and put away the tools at the end of the task.

SCHEDULING OF PLANNED MAINTENANCE.—For each division or maintenance group, a cycle schedule which provides a visual display of the planned maintenance requirements (based on the operational cycle of the ship between shipyard overhauls) is displayed in the departmental office. The information to be found on the cycle schedule (fig. 2-2), for any particular division or maintenance group includes the MIP number (column 1) from the PMS Manual, a listing of all the equipment within that particular group for which planned maintenance is required, and the specific quarter

System, Subsystem, or Component	Reference Publications
AN/USM-105A, 105V Oscilloscope	NAVSHIPS 93658(A)

Bureau Card Control No.					Maintenance Requirement	M.R. No.	Rate Req'd.	Man Hours	Related Maintenance
CT	290ATG2	85	BA38	W	1. Clean air filter.	W-1	ETSN	0.1	None
CT	290ATG2	85	BA39	M	1. Verify speed of blower motor.	M-1	ETSN	0.1	None
CT	290ATG2	85	BA40	Q	1. Clean and inspect. 2. Lubricate the blower motor.	Q-1	ETSN	0.4	Q-2
CT	290ATG2	85	BA41	Q	1. Test operation.	Q-2	ET3	0.4	None
CT	290ATG2	85	BA42	S	1. Inventory accessories. 2. Test operation. 3. Deliver oscilloscope to calibration activity.	S-1	ETSN	0.2	Q-2
					These maintenance cards were prepared for this equipment in which the following field changes have been accomplished: 1 Of these, the following field changes affect the maintenance actions: none New maintenance requirement cards and maintenance index pages will be made available as future field changes are accomplished that affect the prescribed planned maintenance.				

MAINTENANCE INDEX PAGE
OPNAV FORM 4700-3 (4-64)

BUREAU PAGE CONTROL NUMBER T-3/2-85

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Figure 2-1.—Maintenance Index Page.

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EQUIP PAGE (1)	TYPE / CLASS / MAINTENANCE GROUP: COMMUNICATIONS / COMPONENT	SCHEDULE AS INDICATED — QUARTER AFTER OVERHAUL: 1 5 9	2 6 10	3 7 11	4 8 12	EACH QUARTER
C-1	AN/URR-35A					M-1
C-2	TED					M-1
C-3	AM/1365-URT					M-1
C-11	AN/WRR-2		S-1		S-1	M-1, Q-1
C-12	MAY-1	S-1		S-1		

CYCLE SCHEDULE OPNAV FORM 4700-4 (4-64) 0107-766-4000 C-40994

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Figure 2-2.—Cycle schedule.

in which the semiannual, annual, and overhaul cycle planned maintenance actions are to be performed. The cycle schedule also lists the quarterly and the situation requirement planned maintenance actions which must be scheduled, as well as the monthly planned maintenance requirements.

The cycle schedule is used by the department head, in conjunction with his division officers and leading petty officers, to make out the quarterly planned maintenance schedule. The quarterly schedule (fig. 2-3) displayed adjacent to the cycle schedule in a holder known as the maintenance control board, gives a visual display of the ship's deployment schedule and the planned maintenance to be performed during that particular quarter.

The quarterly schedule has thirteen columns, one for each week in the quarter, for the scheduling of maintenance throughout the 3-month period.

At the end of each week, the leading petty officer of the division or maintenance group will update the quarterly schedule by crossing out (with an X) the preventive maintenance performed. If a planned maintenance action is not completed during the week it is scheduled, the leading petty officer will circle the action on the quarterly schedule. The uncompleted maintenance is then rescheduled (as shown in figure 2-3) for another week within the same quarter, normally as soon as the operating schedule of the ship will allow.

At the close of each quarter, the quarterly schedule is removed from its holder and retained on board as a record of the planned

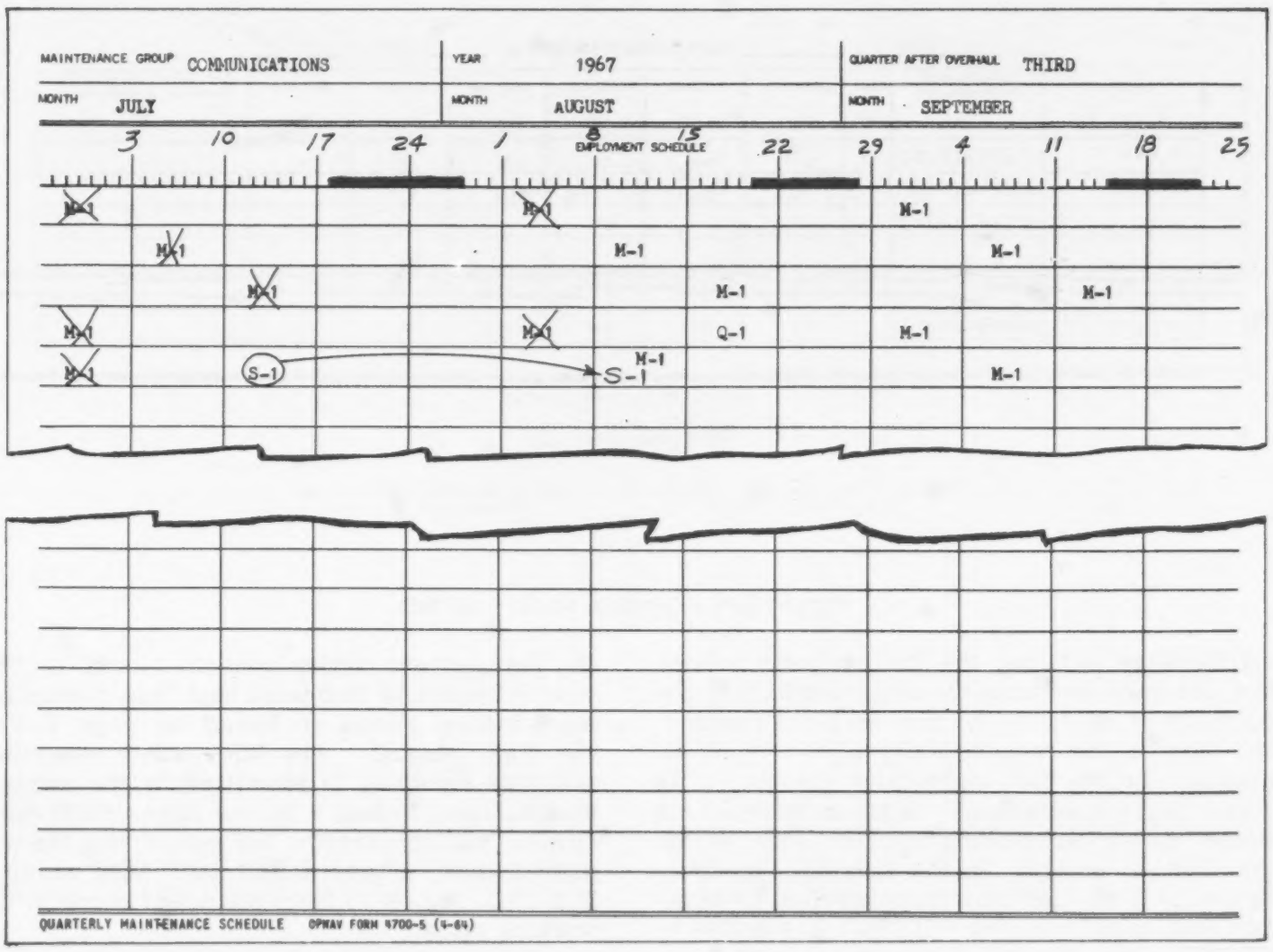

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Figure 2-3.—Quarterly maintenance schedule.

maintenance completed. This record may be discarded at the beginning of the second quarter after the next shipyard overhaul.

The quarterly schedule is also used by your leading petty officer to make out a weekly planned maintenance schedule which is posted in the space where you work. The weekly schedule of planned maintenance should not be considered as the total work for the week. This schedule only covers the scheduled planned maintenance and is in addition to the other routine work, upkeep, and corrective maintenance to be done.

The weekly schedule provides a list of the components in the working area, the appropriate page number of the PMS Manual, and spaces for the leading petty officer to use in the assignment of planned maintenance tasks to specified personnel. The daily and weekly planned maintenance actions are preprinted on the forms and the other maintenance actions are written in by the leading petty officer as required. When the leading petty officer is assured that a maintenance task has been completed, he crosses out the maintenance requirement number on the weekly schedule. If for some reason a task cannot be completed on the day scheduled, the leading petty officer will circle the maintenance requirement number and reschedule it for another day. The status of scheduled maintenance is readily available by looking at the weekly schedule.

A sample weekly schedule is shown in figure 2-4. In addition to the weekly

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GROUP RADAR WORK SCHEDULE FOR WEEK OF AUGUST 14-20

COMPONENT (1)	MAINTENANCE RESPONSIBILITY (2)	PAGE (3)	MONDAY	TUESDAY	WEDNESDAY (4)	THURSDAY	FRIDAY	SAT/SUN	OUTSTANDING REPAIRS AND P.M. CHECKS DUE IN NEXT 4 WEEKS (5)
AN/SPS-10	CRIDER, RD2	R-6	~~M1~~ ~~M2~~	~~M2~~ ~~M3~~	~~M3~~ D1	D1	D1	D1	A-1
AN/SPS-T1	WILLIAMS, ET1	R-7		~~M3~~ M3		M3			
VK-5	DWYER, ET3	R-8			S1				
COFFEE MESS	BAUMBACH, SA		D1	D1	D1	D1	D1	D1	

SAMPLE WEEKLY WORK SCHEDULE

FORMAT INCLUDES ALL DAILY & WEEKLY CHECKS PREPRINTED

WHERE USED: Posted in Maintenance Group work space in aluminum holder.

WHO USES: Maintenance Group Supervisors and maintenance personnel.

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Figure 2-4.—Weekly work schedule.

maintenance actions, the leading petty officer has assigned Williams the responsibility of requirements M-1, M-2, and M-3 on Tuesday, and Dwyer the responsibility of S-1 on Wednesday. In the far right-hand column, it is noted that maintenance requirement A-1 is listed under outstanding repairs (due within the next 4 weeks). In the schedule shown in figure 2-4, all maintenance scheduled for Monday was completed, but Williams was unable to complete the scheduled requirement M-3 for Tuesday, and the action is rescheduled for Thursday of the same week.

THE MAINTENANCE REQUIREMENT CARD.—The Maintenance Requirement Card (MRC) 5 by 8 inches, has the planned maintenance task defined in sufficient detail to enable assigned personnel to perform the task (see fig. 2-5). A master set of MRCs is maintained in the departmental office and those applicable to the equipment with which you are concerned are maintained in your working space. If a card in the working space becomes lost or mutilated, a new card can be made from the master set and used until a feedback report is sent in and a new card obtained.

The MRC is one of the primary tools of the PMS with which you will be concerned. Suppose that on a Monday morning Dwyer looks at the weekly schedule and finds that he is assigned the maintenance action identified as M-1. The weekly schedule indicated that this particular maintenance action is listed on page T-3 of the PMS Manual. The MRC which describes the task assigned is identified by the number combination T-3 M-1 in the upper right-hand corner. In preparation for performing the assigned task, Dwyer would pull MRC number T-3 M-1 (fig. 2-5) from the set of cards in the working space.

The MRC identifies the component involved; gives a brief description of the maintenance requirement; lists the safety precautions to be followed; and lists the tools, parts, and materials needed to accomplish the task. This information is listed to enable you to be ready to perform completely the prescribed maintenance prior to actually working on the equipment involved. The procedure listed on the MRC is standardized and is the best known method of performing that particular task. Any related maintenance requirement listed on the MRC should be done at the same time or in conjunction with the assigned task for the purpose of time conservation.

The 16-digit number on the lower right-hand side of the MRC is the bureau card control number which can also be found on the MIP. Each MRC has a bureau card control number, which must be referred to in any correspondence concerning the card.

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SYSTEM	COMPONENT	M.R. NUMBER
Communications and Control	AN/USM-105A, 105V Oscilloscope	T-3 M-1
	MAINT. SIGNIFICANT NO.	
SUB-SYSTEM	RELATED M.R.	RATES / M/H
Test Equipment,	None	ETSN / 0.1
M.R. DESCRIPTION		TOTAL M/H: 0.1
1. Verify speed of blower motor.		ELAPSED TIME: 0.1

SAFETY PRECAUTIONS

1. Observe standard safety precautions.

TOOLS, PARTS, MATERIALS, TEST EQUIPMENT

1. Stroboscope, TS-805A/U or equivalent

PROCEDURE

1. Verify Speed of Blower Motor.
   a. De-energize the oscilloscope.
   b. Remove air filter from rear of cabinet.
   c. Energize stroboscope and adjust to measure 1750 rpm.
   d. Energize the oscilloscope.

CAUTION: Do not operate the oscilloscope longer than necessary to perform step c with filter removed.

   e. Measure speed of blower motor using the stroboscope.

NOTE: If speed of motor has dropped to 1600 rpm, or less, the motor should be disassembled, cleaned, and lubricated.

   f. Return equipment to normal condition.

CT 290A TG2 85 BA39 M

LOCATION | Date 2 August 1965

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Figure 2-5.—Maintenance requirement card.

On some ships, two or more divisions may have identical equipment. When this occurs, each division will have separate (but identical) MRC cards for the equipment.

Feedback Report

The PMS Feedback Report, OPNAV Form 4700-7 (fig. 2-6), is designed to report any discrepancies or suggested improvements in the PMS as installed aboard ship. The report is to be filled out by the man who discovers the discrepancy or suggests an improvement, signed by anyone designated by the commanding officer, and mailed via the type commander to the appropriate field office listed on the reverse side of the originator's copy of the form. Atlantic Fleet ships use the Norfolk address and Pacific Fleet ships use the San Diego address.

When submitting a feedback report, be sure it is filled out completely and legibly. Handwritten copies are acceptable but a ballpoint pen must be used to ensure that all copies are legible. Instructions for filling out the feedback report are listed on the back of the form and are discussed here for the purpose of clarification.

You are required to complete the "TO" line with the appropriate (San Diego or Norfolk) address. In the "FROM" line insert the hull number of your ship (DDG 11, DD789, AD 36, etc.); and in the "VIA" line indicate the type commander. The date will be the day you discover the discrepancy or suggest an improvement. The serial number indicates the number of feedback reports sent in by your ship. If your ship has previously forwarded five feedback reports, the next report will be numbered 6.

The blocks concerning the system, subsystem, component, M.R. number, and the bureau card control number should be filled in with information from the appropriate MIP and/or MRC. If the MRC or MIP is missing and the bureau card control number is not available, the equipment should be identified by its name and its APL/CID or AN number. The APL/CID number identifies the parts list for the equipment and is found in the index to the Coordinated Shipboard Allowance List (COSAL). The "Technical Publication" block in the "Discrepancy" section of the report is intended to include all Naval Ship Systems and Naval Ordnance Systems Command publications. In the event that any of these are in error, identify the publication number, volume, revision, date, change number, page paragraph, and/or figure.

Prior to the distribution of the report (as indicated on the original and each of the four carbon copies), check it for completeness. The discrepancy should always be explained clearly and a suggestion for its correction must always be offered.

THE MAINTENANCE DATA COLLECTION SYSTEM

The Maintenance Data Collection System is designed to provide a means of recording maintenance actions in substantial detail so that a great variety of information may be collected

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INSTRUCTIONS ON BACK OF GREEN PAGE

FROM: DD-712

SERIAL #: 6

DATE August 16, 1967

TO: Buships/Buweps Maintenance Management Field Office Norfolk, Virginia 23511

VIA: ComCruDesLant

SUBJECT: PLANNED MAINTENANCE SYSTEM FEEDBACK REPORT

SYSTEM Communication and Control	COMPONENT AN/USM-105A, 105V Oscilloscope
SUB-SYSTEM Test Equipment	M.R. NUMBER T-3 M-1
	BU. CONTROL NO. CT 290A TG285 BA39 M

DISCREPANCY

- [x] M. R. Description
- [ ] Equipment Change
- [ ] Typographical
- [ ] Safety Precautions
- [ ] Missing Maintainance Index Page (MIP)
- [ ] Technical Publications
- [ ] Tools, Etc.
- [ ] Technical
- [ ] Miscellaneous
- [ ] Missing Maintainance Requirement Card (MRC)
- [ ] Procedure

MRC prodedure is to adjust stroboscope to measure blower motor speed at 1750 RPM.

AN/USM-105A aboard has Field Change #4, requiring a blower motor speed of 2400 RPM.

Recommend rewording of MRC procedure:

Item #1.c. - Energize stroboscope and adjust to measure 2400 RPM.

NOTE: If speed of motor has dropped to 2250 RPM or less, the motor should be disassembled, cleaned, and lubricated.

SIGNATURE OF CO OR DESIGNATED REPRESENTATIVE
M.F. NEAL LT, USN.

THIS COPY FOR: ADDRESSEE I

OPNAV Form 4700/7 (10-65)

40.101

Figure 2-6.—PMS Feedback Report, OPNAV 4700-7.

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concerning maintenance actions and the performance of equipment involved. In addition, the system provides data concerning the initial discovery of a malfunction, how the equipment malfunctioned, how many man-hours were expended, which equipment was involved, what repair parts and materials were used, what delays were incurred, the reasons for delay, and the technical specialty or work center which performed the maintenance.

Codes must be used in recording maintenance actions in order to allow converting the information to a language that can be read by automatic data processing machines. As a third or second class Electronic Technician, you will be required to fill out various maintenance forms, using the codes listed in the Equipment Identification Code (BIC) Manual. The forms are sent to a data processing center where the coded information is punched into cards which are machine processed to produce the various reports for use in maintenance and material management.

The reports that are produced by the automatic data processing machines will be accurate and useful only if the information is clearly and accurately entered on the maintenance forms. Therefore it is very important that the codes which you enter on the forms be accurate and clearly written.

Maintenance Data Collection System Forms

The MDCS forms on which you may be required to make coded entries include OPNAV Form 4700-2B (Shipboard Maintenance Action), OPNAV Form 4700-2C (Work Request), and OPNAV form 4700-2D (Deferred Action). Detailed descriptions of the entries to be made on these forms are listed in the EIC Manual and in chapter 3 of the 3-M Manual (OPNAV 43P2). Brief descriptions of these entries are also listed here to help you become familiar with the forms, which are shown in figures 2-7 through 2-10.

Block A, Ship Name and Hull No./Activity: Enter the name and hull number of your ship--for example, USS Now (DD 746).

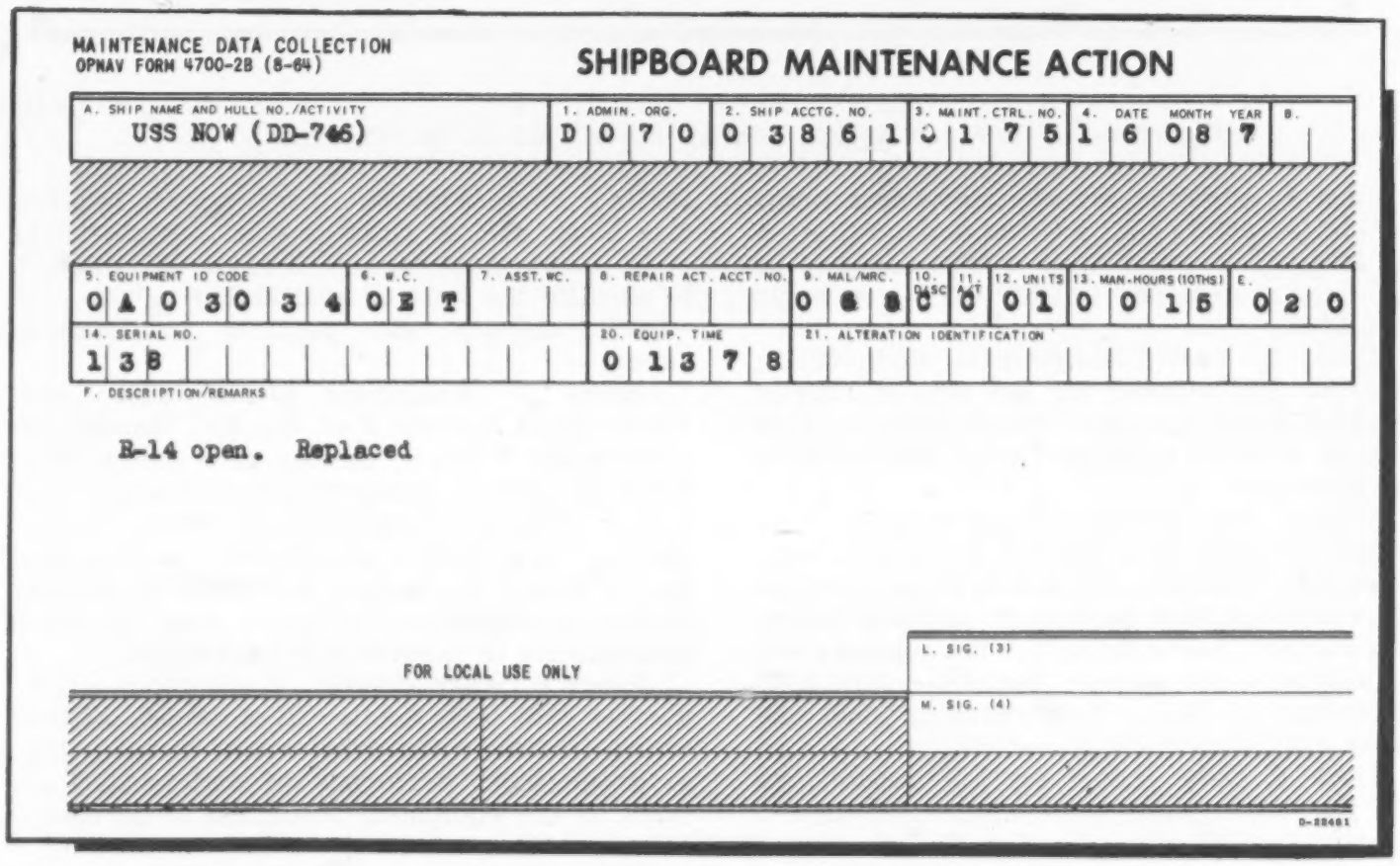
MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2B (8-64)

SHIPBOARD MAINTENANCE ACTION

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE MONTH YEAR	B.
USS NOW (DD-746)	D 0 7 0	0 3 8 6 1	0 1 7 5	1 6 0 8 7	

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. WC.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DASC	11. ALT	12. UNITS	13. MAN-HOURS (10THS)	E.
0 A 0 3 0 3 4	0 E T			0 6 8	0	0	0 1	0 0 1 5	0 2 0

14. SERIAL NO.	20. EQUIP. TIME	21. ALTERATION IDENTIFICATION
1 3 B	0 1 3 7 8	

F. DESCRIPTION/REMARKS

R-14 open. Replaced

FOR LOCAL USE ONLY

L. SIG. (3)

M. SIG. (4)

D-22481

17.81B

Figure 2-7.—Shipboard Maintenance Action, OPNAV 4700-2B(8-64).

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS NOW DD-746	D 0 7 0	0 3 8 6 1	0 1 7 6	1 6 0 8 7	G

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. ACT	12. UNITS	13. MANHOURS	E.
D B 0 1 0 7 1	0 E T			0 8 0	0	J	0 1	0 0 2 5	

14. SERIAL NO.	20. EQUIP/TIME	21. ALTERATION IDENTIFICATION
1 - 6 4 - 2		

F. DESCRIPTION/REMARKS

DC Drive Motor failed during operation. Investigation indicated armature winding burned out. No rewinding facilities onboard.

FOR LOCAL USE ONLY

L. SIG. (3) G. Dwyer ET1

M. SIG. (4) G. Dwyer ET1

17.81D

Figure 2-8.—Deferred Action, OPNAV Form 4700-2D (8-64), sheet 1.

Block 1, Administrative Organization: Enter the 4-letter/number code (from section II of the EIC Manual) to which your ship is assigned (if your ship is assigned to DESRON 7, you would enter D070).

Block 2, Unit Identification Code (UIC): Enter the UIC number for the ship or activity for which the maintenance was performed. This entry is obtained from NavCompt Manual, Volume 2, chapter 5.

Block 3, Maintenance Control Number: This number is used to relate all documents submitted on a specific job and is filled in by the maintenance control section of your ship before the documents leave the ship. The numbers will be assigned consecutively beginning with 0001 and ending at 9999. Upon reaching 9999, the series will be started again at 0001.

Block 4, Date: Enter the day, month, and year the maintenance is accomplished; or, for a work request, enter the date the request is submitted.

Block B, Type Availability: This block is left blank on all forms except the Work Request, OPNAV Form 4700-2C. On the work request, this block will be filled in with a single-letter code, taken from section IX of the EIC Manual, to identify the type of availability in which the repair activity will perform the maintenance.

Block 5, Equipment Identification Code: Enter, from section X of the EIC Manual, the appropriate 7-letter/number code which identifies the system, subsystem, component, and/or lowest designated assembly on which maintenance is requested or performed. Caution must be exercised to ensure that the EIC number correctly identifies the exact item on which maintenance is requested or performed.

Block 6, Work Center: Enter the 3-letter/number code from section III of the EIC Manual which identifies the department, rating, shop, or group which performs the maintenance actions on the equipment identified in the equipment identification code, block 5.

Block 7, Assisting Work Center: Leave blank. When information is required in this block it will be filled out by your supervisor

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MAINTENANCE DATA COLLECTION
OPNAV 4700-2C (8-64)

WORK REQUEST

1

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO	4. DATE	B
USS NOW DD-746	D 0 7 0	0 3 8 6 1	0 1 7 6	1 6 0 8 7	0

5. EQUIPMENT ID CODE	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	12. UNITS	C.
D B 0 1 0 7 1	0 4 6 3 9	0 8 0	0	0 1	

14. SERIAL NO.	15. T/A	16. REQ. W.C.	17. DESIRED CMPLN. DATE	18. SERV	D.
1 - 6 4 - 2		0 1 2	2 8 0 8 7	A	

F. DESCRIPTION/REMARKS

1. Motor, D.C. Drive

2. Armature winding burned out

3. Rewind, dip, bake and turn down commutators.

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G. NO. 1 CONTACT	J. SIG. (1)
G. Crider ET1	G. Block ET2
H. NO. 2 CONTACT	K. SIG. (2)
C. Dwyer ET1	M. T. Neal LT USN

17.81C

Figure 2-9.—Work Request, OPNAV 4700-2C (8-64).

in accordance with the EIC Manual and chapter 3 of the 3-M Manual.

Block 8, Repair Activity Unit Identification Code (UIC) obtained from NavCompt Manual, Volume 2, chapter 5.

Block 9, How Mal/MRC: If the action is a result of a malfunction, list the 3-digit code from section IV of the EIC Manual which best describes the trouble. If the action is planned maintenance (MRC), enter a 3-letter/number combination code which identifies the frequency check on the equipment. For example, if the situation is an M-1 PMS action, enter MO1. For all other actions three zeroes (000) will be entered.

Block 10, Discovered: Enter the appropriate code from section V of the EIC Manual which identifies when the maintenance requirement was discovered.

Block 11, Action Taken: Enter the code from section VI of the EIC Manual which best describes the maintenance action taken. "Not Repairable This Ship" (NRTS) codes will be used only by repair activities.

Block 12, Units: Enter the number of identical items, identified in block 5, on which the same maintenance action was attempted, performed, or requested. If identical alterations or significant maintenance actions are accomplished on identical equipment bearing different serial numbers, each equipment will be reported on a separate document.

Block 13, Man-hours: On completion of the maintenance action, enter the total man-hours (to the nearest tenth) expended by all shipboard personnel. If the task was completed in 1-1/2 hours, for example, you would enter "0015". Enter a "0" in any space not used.

Block E, Blank: Leave blank, (explained later).

Block 14, Serial Number: When several equipments aboard a ship have identical EIC's, Block 14 is used to identify the specific equipment on which maintenance is performed. This information is required for accountability at the System Command level and for equipment history purposes at the local level. Serial numbers

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will be used for electronics and ordnance equipments. For example, the serial number of the radar, the radio, the computer, or the test equipment will be reported; the serial numbers of the major components of these equipment, however, will not be reported even though all work is done in a component such as a radar transmitter assembly.

Blocks 15 thru 19 (block 19 not shown) apply only to OPNAV 4700-2C, Fig. 2-9.

Block 15, T/A: Leave blank.

Block 16, Requesting Work Center: Enter the letter/number code that identifies the department, rating, shop, or group that is requesting assistance from the repair activity. Work center codes may be found in section III of the EIC Manual.

Block 17, Desired Completion Date: Enter the day, month, and year that the outside repair activity must complete maintenance in order for the requesting activity to meet its operational commitments. If this date were 28 Aug. 1967, for example, you would enter 28087.

Block 18, Service: Enter the single-letter code from section VII of the EIC Manual which identifies the type of assistance the requesting ship will furnish the repair activity in completing the requested maintenance.

Block 19, Scheduled Start Date: This entry, which is for repair activities only, is the estimated starting date of the requested maintenance.

Block D, Leave Blank.

Block E and 20, Equipment Downtime and Equipment Operating Time: These entries are required only for equipment identified by green pages in the EIC Manual. Detailed instructions for these blocks may be found in section I of the EIC Manual and chapter 3 of the 3-M Manual.

Block 21, Alteration Identification: If an alteration is to be accomplished, this block will contain the alteration identification from the authorization directive.

The Shipboard Maintenance Action Form (fig. 2-7) (OPNAV Form 4700-2B) is a single-sheet document used to record the completion of planned maintenance actions, corrective

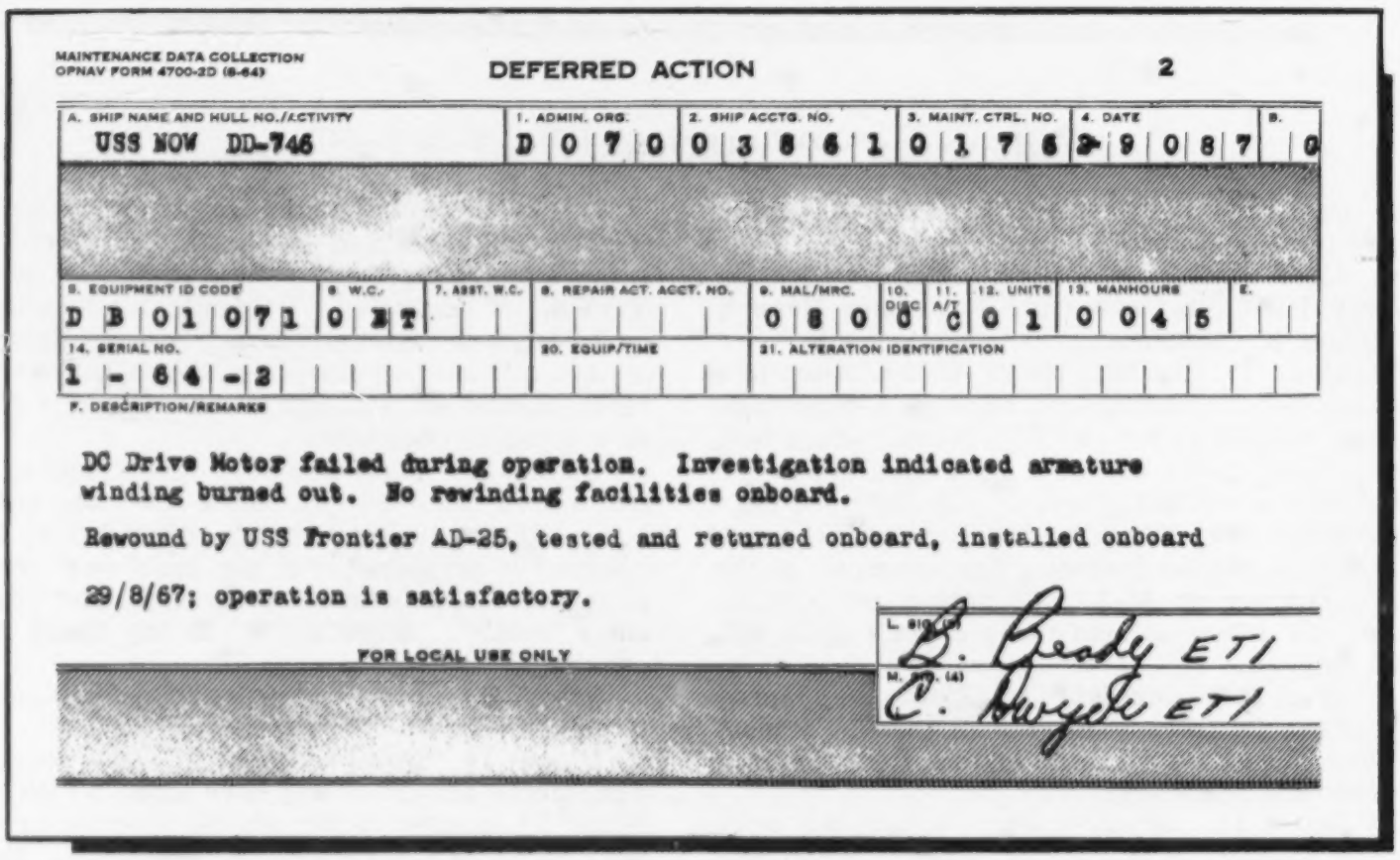

MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 2

A. SHIP NAME AND HULL NO./ACTIVITY	1. ADMIN. ORG.	2. SHIP ACCTG. NO.	3. MAINT. CTRL. NO.	4. DATE	B.
USS NOW DD-746	D 0 7 0	0 3 8 6 1	0 1 7 6	2 9 0 8 7	0

5. EQUIPMENT ID CODE	6. W.C.	7. ASST. W.C.	8. REPAIR ACT. ACCT. NO.	9. MAL/MRC.	10. DISC	11. A/T	12. UNITS	13. MANHOURS	E.
D B 0 1 0 7 1	0 E T			0 8 0	0	C	0 1	0 0 4 5	

14. SERIAL NO.	20. EQUIP/TIME	21. ALTERATION IDENTIFICATION
1 - 6 4 - 2		

F. DESCRIPTION/REMARKS

DC Drive Motor failed during operation. Investigation indicated armature winding burned out. No rewinding facilities onboard.

Rewound by USS Frontier AD-25, tested and returned onboard, installed onboard 29/8/67; operation is satisfactory.

L. SIGN (3) B. Brady ET1

M. SIGN (4) C. Dwyer ET1

FOR LOCAL USE ONLY

17.81D

Figure 2-10.—Deferred Action, OPNAV 4700-2D (8-64), sheet 2.

maintenance actions and authorized alterations that have been performed at the shipboard level by shipboard personnel. All planned maintenance actions except daily and weekly planned maintenance actions must be recorded on this form in addition to checking them off on the weekly and quarterly schedules. Routine preservation such as chipping, painting, and cleaning should not be reported.

Any corrective maintenance actions that are deferred because of the ship's operations, lack of repair parts, or the requirement of outside assistance are reported on the Deferred Action Form (fig. 2-8)(OPNAV 4700-2D). The first sheet of this 2-sheet document is used to record and report the reason for deferral and the second sheet is used to report the completion of the maintenance action. If a corrective maintenance action must be deferred, this form is required at the time a malfunction is noted. A sample sheet 1 of the Deferred Action Form which could have resulted is shown in figure 2-8. The action taken code, block 11, and the man-hours expended, block 13, on sheet 1 of the Deferred Action Form apply only to the action taken man-hours involved at the time of the discovery of the malfunction.

Figure 2-9 shows a Work Request (OPNAV Form 4700-2C) to have the motor starter rewound. In completing block F (Description/Remarks) of the work request, note that:

1. The component must be identified by name.
2. The CID number of the component must be listed.
3. The alterations number must be given, if applicable. If not applicable, it must be listed as N/A.
4. A description of what is wrong with the equipment and what you desire the repair activity to do must be given.

The signature blocks G, H, and J are to be signed by three leading petty officers, one from each duty section, who are familiar with the work to be done by the repair activity. Signature block K will be used by the commanding officer or his authorized representative to indicate command approval of the request for repair assistance.

After the repairs have been completed by the repair activity, "sheet 2" of the Deferred Action Form (fig. 2-10) is completed by entering the date of completion in block 4, the action taken code in block 11, the additional man-hours in block 13, and appropriate remarks in block F. The form is then signed by the man doing the work and by his supervisor, and is then submitted to the data processing center.

The information contained in blocks A, 1 and 2 of OPNAV Forms 4700-2B, 4700-2C, and 4700-2D will be identical on all forms for any particular ship; if desired, this information may be preprinted in by the ship. Each maintenance action is assigned its own unique maintenance control number; if a maintenance task requires more than one form, as in the example using figures 2-8 through 2-10, the numbers will be identical.

Personnel attached to repair activities are required to record certain information on a Work Supplement Card (not shown) for each repair job. Work supplement cards will be explained to you by your division petty officer if you are assigned to a repair activity.

Material Usage and Cost Data

The documentation of material usage and cost data on maintenance transactions requires the joint effort of the supply and maintenance personnel on board your ship. Economy of effort and the elimination of duplicate recordings are highly desirable.

Any time that repair parts or materials are drawn from the supply department for shipboard maintenance, a NAVSANDA Form 1250 is used to request the materials from supply. Maintenance personnel are required to furnish the work center code and the EIC taken from the EIC Manual, the component identification (CID) number, the maintenance control number, the name of the part, quantity required, and the stock number when submitting this form to the supply department. The supply personnel will then complete the form; the cost is documented from this form if the ship does not have data processing equipment aboard. If the ship has data processing equipment, a DD Form 1348 is used instead of the Form 1250.

When the material to support a maintenance action is obtained from outside the normal supply channels or from pre-expended material bins, the reverse side of the appropriate OPNAV form (OPNAV 4700-2B, 4700-2C, or 4700-2D) is used. The reverse sides of OPNAV 4700 series forms are essentially the same. The reverse side of OPNAV Form 4700-2B is shown in figure 2-11. On this side of the form, when appropriate, you will enter the CID number, the

6930[illegible]

CID/APL/AEL/AN
55376101

SOURCE CODE	FEDERAL STOCK NO./PART NO. COG.		REFERENCE SYMBOL/NOUN	MATERIAL REQ. UNITS	MATERIAL REQ. QUANTITY	MATERIAL USED UNITS	MATERIAL USED QUANTITY	UNIT PRICE
1	1N	5905-258-0034	R1445			EA	2	.38

OPNAV FORM 4700-2B (8-64) BACK

17.81BCD

Figure 2-11.—Reverse side of OPNAV 4700-2B.

source code taken from section VIII of the EIC Manual, the cognizance symbol taken from supply publications to identify the supply account and the inventory manager of the item used, the Federal Stock Number, the reference symbol taken from circuit diagrams or the name of the part being replaced, the unit of issue of the material used, quantity used, and the unit cost (except on pre-extended material) of the item.

THE MAN-HOUR ACCOUNTING SYSTEM

The Man-hour Accounting System, sometimes referred to as Exception Time Accounting (ETA), is designed and intended for use by repair activities in conjunction with the Maintenance Data Collection System. It is basically a management tool and accounts for deviation from a normal working day.

As a third and second class petty officer assigned to a repair activity, your only concern with this system will be when you are absent from your assigned working space for more than 20 minutes at a time. If this occurs, your leading petty officer will hand you a Daily Exception Card on which you will be required to fill in the date of change and the number of hours concerned to the nearest tenth of an hour, and then return the card to your supervisor.

In the example card shown (fig. 2-12) Jones, K. P., ET3 (004 code) assigned to the electronics repair shop (67A code) for direct labor (01 code) was absent for one and a half hours. This absence was to take care of personal affairs and is therefore a non-duty absence as shown by the reverse side of figure 2-12.

MAINTENANCE HISTORY REPORT

The Maintenance History Report (MDC-5) will serve as a record of equipment history. Figure 2-13 shows an example of the Maintenance History Report (MDC-5) which will be received by each ship on a monthly basis.

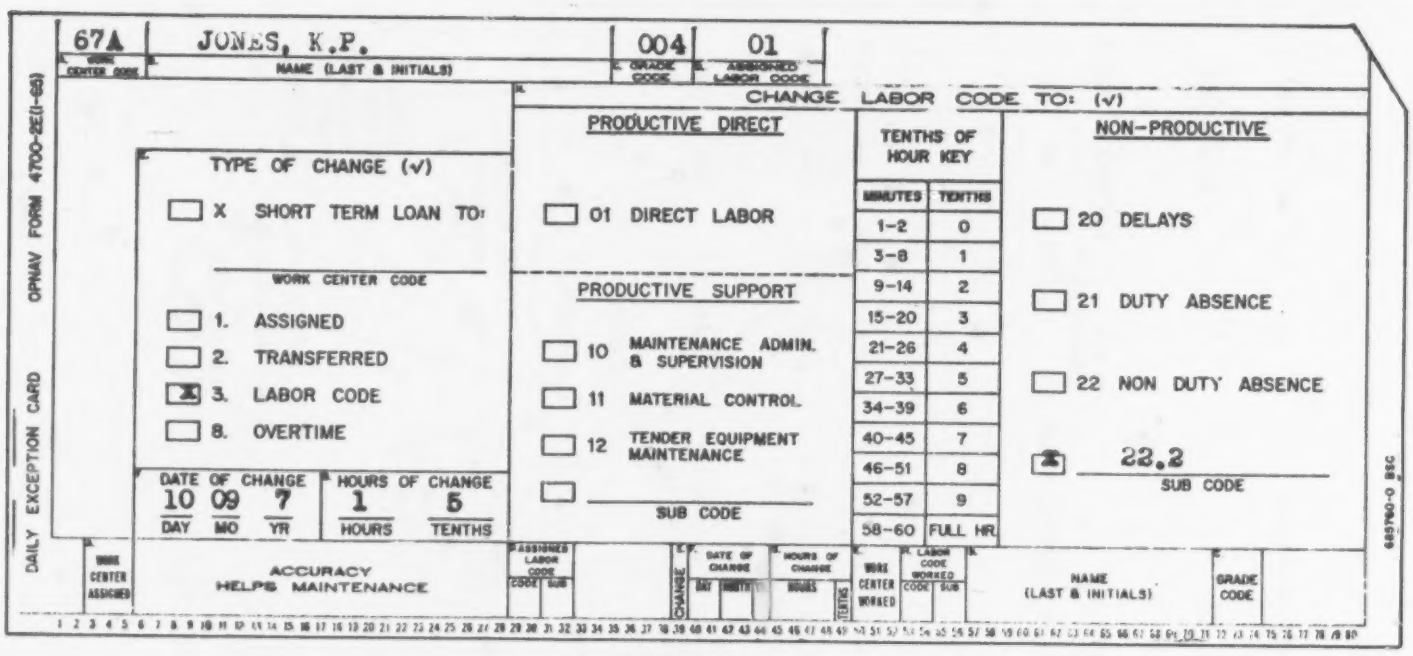

FRONT SIDE

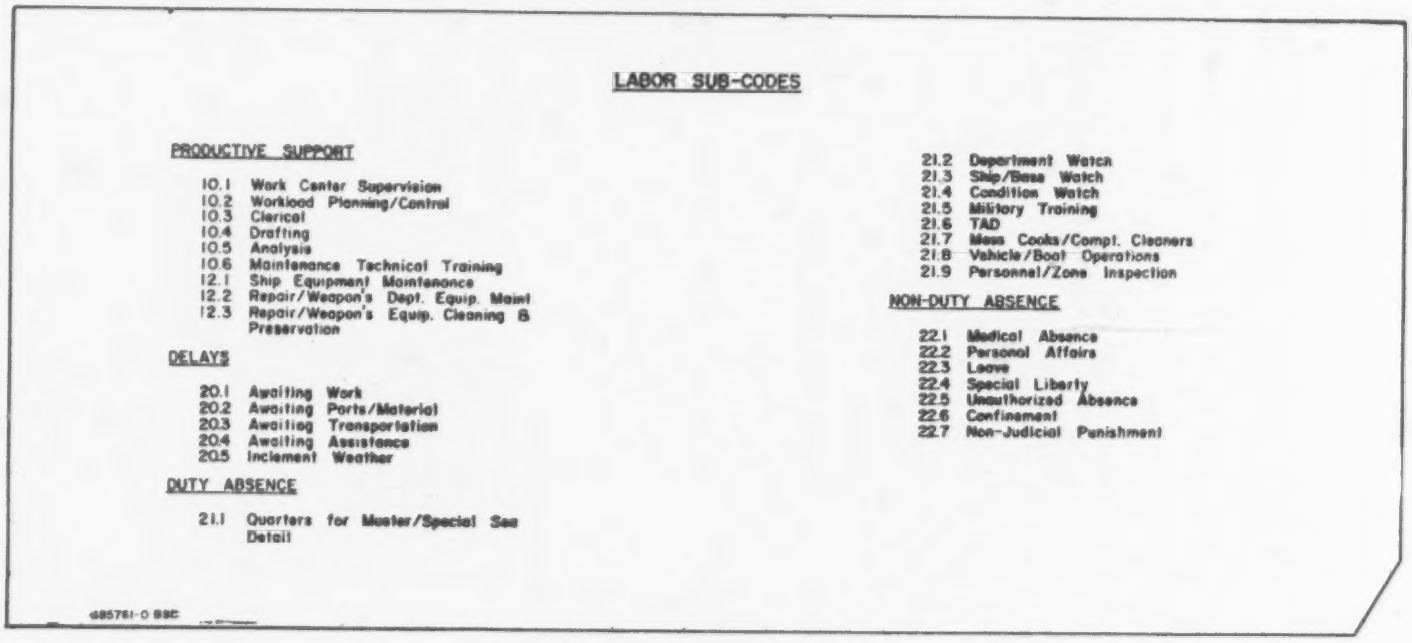

REVERSE SIDE

17.81E

Figure 2-12.—Daily Exception Card, OPNAV 4700-2E (1-65).

The report provides a comprehensive maintenance manhour and material history of all actions (different MCNs) received from a reporting activity monthly. It embodies a three line printout with the first line basically identifying the maintenance action and manhours charged, the second line, equipment time and intermediate repair activities, and the third, line material usage. The report is organized at the EIC equipment level and is further summarized at the subsystem and system levels. Ship totals for actions, active maintenance time, and manhours are also included. The report is a basic tool for the analysis of recurring

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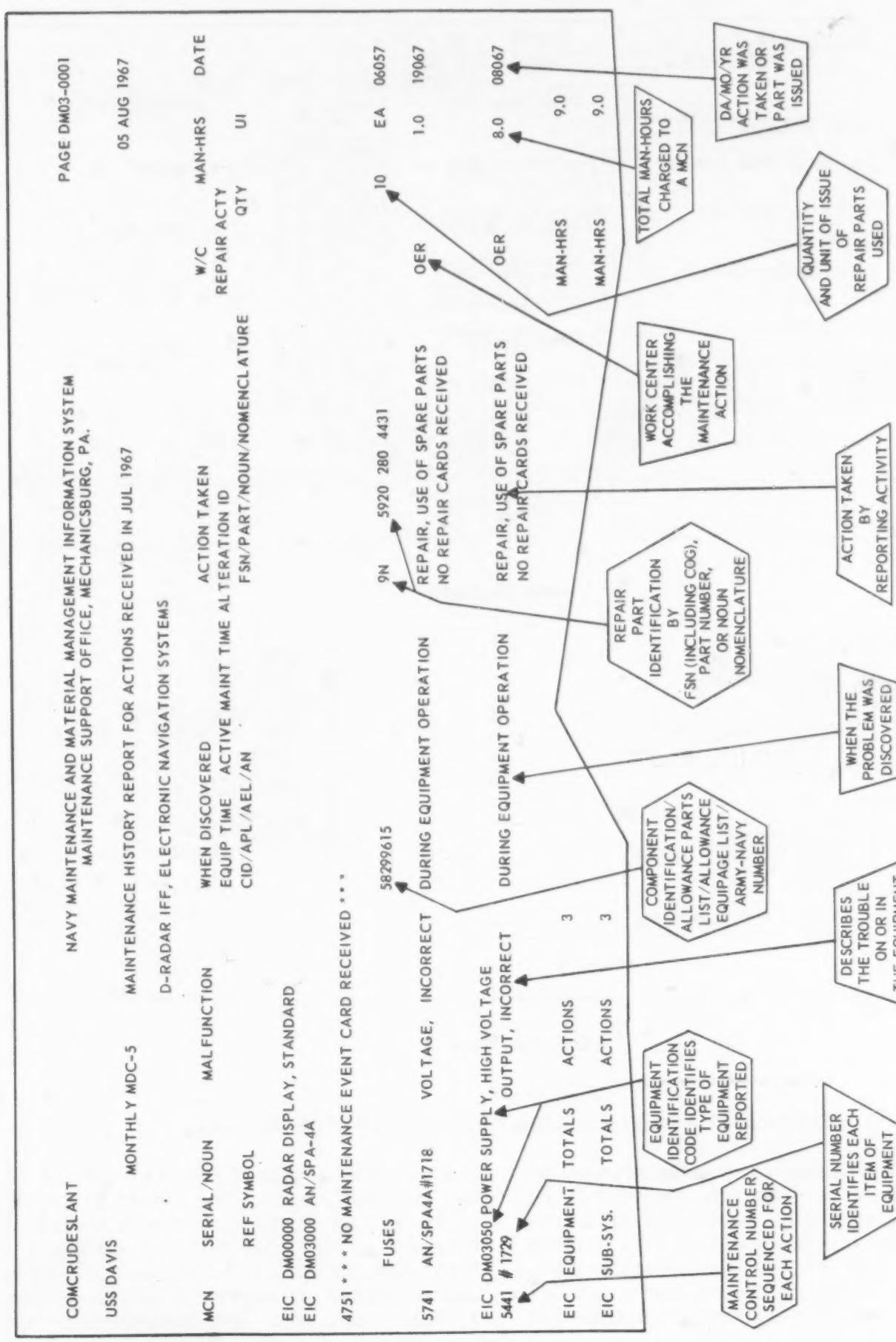

Figure 2-13.—Maintenance History Report (MDC-5).

equipment and structural maintenance problems in terms of both manhour and material usage, in addition to furnishing a monthly recapitulation of equipment history.

When fully implemented the PMS and MDCS systems are intended to supercede any other records or reports previously required under other maintenance systems. In the meantime, ships and stations will find they have to operate under several systems simultaneously. It is for this reason that the other maintenance systems, such as POMSEE and CSMP, are explained in this chapter.

A good explanation of which system to use, if you are in the middle of a changeover, can be found in EIB 707 of 27 May 1967, and by reference to type commanders' instructions. It is anticipated that some of the forms previously described will also be changed before the system is fully implemented throughout the Navy, so it is a good idea to always check the latest EIB for up to date information regarding maintenance procedures.

MAINTENANCE STANDARDS BOOKS

Tests and maintenance procedures prescribed in the Maintenance Standards Books provide maintenance and operation personnel with systematic and efficient methods for checking equipments and for performing scheduled preventive maintenance. These books contain a series of reference standard tests (fig. 2-14). These tests, when performed on properly operating equipment, provide quantitative results (reference standards), which collectively represent the design performance of the specific serial numbered equipment or system for which the book is assigned. When these tests are accomplished as scheduled (weekly, monthly, quarterly, etc.), the test results are compared against the reference standards to determine the condition of the equipment. Charts (time schedules) are provided for logging the results of each test so that a performance history of the equipment can be developed (fig. 2-15). In addition to these functional tests, the book also contains the specific procedures and schedule necessary to provide for mechanical and electrical maintenance for the equipment or system (fig. 2-16).

The maintenance checkoff is gradually being superseded by the Planned Maintenance System. If the Planned Maintenance System (PMS) portion of the 3-M system has been implemented, recording under the POMSEE program is no longer a NavShips requirement. This does not mean that the Maintenance Standards Books can be discarded: Maintenance Standards Books must be retained to make up a complete series of records, even though no new entries are to be made. Directives as to exactly which records are required are promulgated by type commanders, or similar level for shore activities.

PERFORMANCE STANDARDS SHEET

The Performance Standards Sheet (fig. 2-17) establishes the standards for the optimum performance of the equipment which must be met upon installation. The sheet contains a table of standards (table I), for operational performance and a list of standards for equipment measurements (table II). The information on the sheets may be used as the basis for acceptance tests and electronics material readiness inspections.

The standards for operational performance is a tabulated nontechnical description of satisfactory equipment performance which could be tables of expected radar ranges of detection, maximum radio ranges, and voltage ranges. The operational performance values are obtained from design data and by actual field measurements under normal conditions while the equipment is operating satisfactorily in the location of its intended use.

Special information relative to such operational performance as range and bearing accuracy and discernible characteristics of signals may be given on the performance standards sheet in another table. This special information is obtained from actual measurements as well as from design data.

The list of standards for equipment measurements, Table II, provides a record of measurements (standards) that indicates satisfactory overall equipment performance. The test results entered in the Maintenance Standards Book may be compared at any time with the data given in the Performance Standards Sheet to determine if the equipment or system meets the standards as specified.

TECHNICAL MAINTENANCE

Technical maintenance is normally limited to maintenance consisting of replacing unserviceable subassemblies or parts and the alignment, testing, and internal adjustment of equipment.

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QUARTERLY STEPS Q1 thru Q8

NAVSHIPS 94715.42

AN/WRR-2, -2A
AN/FRR-59, -59A

OPERATING CONDITIONS AND CONTROL SETTINGS:

Equipment in full operation and conditioned for A1 reception.
O. L. THRES: OFF

STEP NO.	ACTION REQUIRED	READ INDICATION ON	REFERENCE STANDARD
Q1	Record over-all sensitivity of Mode A1 at low end of 2-4 mc band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	*PROCEDURE: Connect signal generator to the ANT IN jack (J957). Adjust generator for a 2-mc unmodulated signal and set output at 5 µv. Set BAND selector to 2-4. Tune receiver to 2 mc and adjust the ANT COMP and HF ADJ controls for maximum indication on the RESONANCE meter. Reduce generator output to zero and adjust RF GAIN for a -2 db indication on the LINE A OUTPUT meter. Set generator output to 5 µv and adjust generator frequency for a maximum indication on the RESONANCE meter. Readjust generator output for a +18 db indication on the LINE A OUTPUT meter. Record the generator output in microvolts.		
Q2	Repeat for high end of band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	PROCEDURE: Tune receiver to 4 mc and repeat step Q1.		
Q3	Record over-all sensitivity of Mode A1 at low end of 4-8 mc band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	PROCEDURE: Set BAND selector to 4-8. Tune receiver to 4 mc and repeat step Q1.		
Q4	Repeat for high end of band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	PROCEDURE: Tune receiver to 8 mc and repeat step Q1.		
Q5	Record over-all sensitivity of Mode A1 at low end of 8-16 mc band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	PROCEDURE: Set BAND selector to 8-16. Tune receiver to 8 mc and repeat step Q1.		
Q6	Repeat for high end of band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	PROCEDURE: Tune receiver to 16 mc and repeat step Q1.		
Q7	Record over-all sensitivity of Mode A1 at low end of 16-32 mc band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	PROCEDURE: Set BAND selector to 16-32. Tune receiver to 16 mc and repeat step Q1.		
Q8	Repeat for high end of band.	Signal Generator AN/URM-25	____ µv (1.5 max.)
	PROCEDURE: Tune receiver to 32 mc and repeat step Q1.		

36.100

Figure 2-14.—Sample page from Maintenance Standards Book, reference standards tests.

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TIME SCHEDULE
QUARTERLY STEPS

NAVSHIPS 94715.42

AN/WRR-2, -2A
AN/FRR-59, -59A

Q1 thru Q8

Q19 and Q20

TIME SCHEDULE: Record and initial.

1ST YEAR OF OPERATION

1. Date			2. Date			3. Date			4. Date		
No.	μv	Init.	No.	μv	Init.	No.	μv	Init.	No.	μv	Init.
Q1											
Q2											
Q3											
Q4											
Q5											
Q6											
Q7											
Q8											

1ST YEAR OF OPERATION

1. Date			2. Date			3. Date			4. Date		
No.	kc	Init.	No.	kc	Init.	No.	kc	Init.	No.	kc	Init.
Q19											
Q20											

36.100

Figure 2-15.—Sample page from Maintenance Standards Book, time schedule.

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AN/WRR-2, -2A
AN/FRR-59, -59A

NAVSHIPS 94715.42

UNSCHEDULED
U8 thru U10

OPERATING CONDITIONS AND CONTROL SETTINGS:

Equipment de-energized.
AC power plug (P1808) removed from POWER IN jack (J1808).
Drawers extended (in turn) from cabinent.
Decks tilted or separated to gain access.

STEP NO.	ACTION REQUIRED
U8	Clean equipment
	PROCEDURE: Clean cabinets and chassis with vacuum cleaner. Check air filter; clean and recharge if necessary (see Quarterly Step Q29).
U9	Perform mechanical inspection.
	PROCEDURE: Note action of drawer mechanisms. Operate all controls, observing mechanical action. If control stick or binds DO NOT FORCE MOVEMENT. Find the cause (bent shaft, loose mounting, etc.) and correct it. Observe action of counter mechanisms and all gearing. Note condition of lubricant and replace if necessary. Turn blower fan by hand, observing freedom of rotation. Inspect switches for arcing damage. Burnish contacts by rotating switch, if necessary. Lock all tube shields and/or tube clamps.
U10	Perform electrical inspection.
	PROCEDURE: Inspect all electrical components, wiring and cabling. Look and feel for loose connections, kinks, strain, and damanged insulation; correct defects or report them to a qualified technician. Look for evidence of overheating; take corrective action if any is found. Replace bulging or leaking capacitors, after first removing any residue.

36.100

Figure 2-16.—Sample page from Maintenance Standards Book, preventive maintenance steps.

CORRECTIVE MAINTENANCE PROCEDURES

To perform effective corrective maintenance the ET must have a good working knowledge of the basic principles of electricity and electronics. The only way to acquire this knowledge is by diligent study. The ET must also be thoroughly familiar with the theory of operation of the equipments that he must service. A knowledge of the theory of operation can be acquired through a study of the equipment instruction book. This knowledge should be broadened to include other equipments at the earliest opportunity. As a matter of fact, ETs are generally rotated on the various electronic equipments so that their knowledge will be broadened and they will therefore be more valuable to the fleet.

Skill in the use of test equipment (and handtools) is also necessary for effective corrective maintenance. Skill in the use of test equipment comes with practice and with careful study of the instruction book that comes with each piece of test equipment. The ET should take advantage of every opportunity to learn more about every type of electronic test equipment used aboard ship. The ability to use test equipment effectively is an absolute must for every well-trained ET.

Chapter 3 of this training course introduces some of the special type test equipments. Additional valuable information (both on test equipment and methods of troubleshooting) is contained in Test Methods and Practices, NavShips 900,000.103.

Tests (opens, grounds, and shorts) and measurements (currents, voltage, resistance, frequency, power, etc.) enable the technician to

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6 April 1964 NAVSHIPS 94715.32 AN/WRR-2, -2A
AN/FRR-59, -59A

PERFORMANCE STANDARD SHEET
for
RADIO RECEIVING SETS AN/WRR-2, -2A, AN/FRR-59, -59A

TABLE I - OPERATIONAL PERFORMANCE
The many variables involved, such as radio propagation conditions at the time of the test, power output of the transmitter being received and the type of antenna installation, preclude definitive predictions of operation ranges. To achieve optimum reliable ranges, frequency selection should be madé in accordance with DNC-14, as corrected by half-hourly radio propagation predictions given over WWV and WWVH.

TABLE II - STANDARDS FOR EQUIPMENT MEASUREMENT

MEASUREMENT	STEP	STANDARD
Bandwidth (IF, 1.0 kc)	Q19 and Q20	0.8 kc min. (at 6 db) 2.4 kc min. (at 60 db)
Receiver Sensitivity (Sr)	Q1 thru Q8	1.5 μv max.
Performance Figure (PF)*	Calculate	1.5 max.

* PF = Sr (μv)

Total time required to perform Table II measurements - 1 hour.

All steps refer to tests in the Maintenance Standards Book, NAVSHIPS 94715.42

This Performance Standards Sheet supersedes NAVSHIPS 93550.32

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Figure 2-17.—Performance standards sheet.

diagnose troubles so that repairs may be made. In many instances tests and measurements will indicate conditions that may be corrected before an actual breakdown occurs. Thus, tests and measurements (particularly measurements) are important both in preventive and corrective maintenance.

The purpose of any type of electronic test equipment is to measure accurately certain circuit values or to indicate certain circuit conditions. Each of these measurements or indications is used to determine the operating condition of electronic or electrical equipment. The accuracy with which measurements are

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made depends on the type of instrument used, its sensitivity, its rated accuracy, its useful range, and the care that the technician uses in making the measurement.

The exact procedure for making tests and measurements is given in the technical manuals (instruction books) that accompany the various electronic equipments.

It should be emphasized that the mere taking of measurements means little unless they can be properly interpreted. For example, the presence of a voltage across a grid resistor in an audio amplifier would mean little to an ET unless he could interpret this in terms of a possible leaky coupling capacitor. In this connection, the necessity for a knowledge of basic circuit operation must be emphasized.

Before any attempt is made to interpret the results of measurements, an understanding of how the equipment operates should be acquired by a careful study of the applicable technical manual or instruction book.

The actual voltage, resistance, and current measurements that should be obtained are indicated in the circuit diagrams, charts, or in the maintenance standards books. The same is true of waveform measurements. Any deviation from the standard values (beyond the tolerance limits) means that some component is not doing the job that it should. By applying effect-to-cause reasoning, the defective component may be located. This is, of course, a job for a skilled technician.

Maintenance personnel must try to find the source of the trouble causing the equipment failure, particularly when the trouble is a recurrent one. The recurrence of a fault usually indicates that the EFFECT, not the CAUSE, has been remedied.

There are numerous ways to isolate a fault to a component of a system, depending on the type of equipment. The technician must, first of all, know what each component does before he can know that it is not functioning properly.

Assume, for example, that the display on a certain radar repeater is faulty. The trouble could be in the repeater or it could be in one of the circuits that feeds into the repeater. If the other repeaters are working properly, it is probable that the trouble is in the repeater having the faulty display or in its power supply or in the transmission lines or switching system.

The best way (the most economical in time and effort) to isolate a fault is by using a logical troubleshooting method.

Keep in mind throughout this study, that by far the largest section of the average instruction book is the one devoted to corrective maintenance (troubleshooting). This is the section written especially for the ET and when used with the six-step logical troubleshooting procedure (described later) can be for him the most valuable part of the book. The section on the theory of operation, however, is also very important and should be studied with care.

Good troubleshooting is not a talent with which a person is born. It is, however, a skill that can be acquired by anyone with a suitable electronics background. One can become a good troubleshooter if he has:

1. Sufficient electronic knowledge to learn, or to be taught how an equipment works.
2. Suitable skill in reading and interpreting data contained in the equipment's technical manual.
3. Suitable skill in operating test equipment and interpreting test readings.
4. Learned how to troubleshoot in a logical manner.

Logical troubleshooting is a time-proven procedure used by all accomplished technicians. Most of them have applied the procedure so often that they no longer pay attention to its fine points. Through habit and years of experience they may have forgotten its specific details, but the procedures are there and have remained the same.

Probably no two technicians would explain the procedure alike, but all would agree that logical troubleshooting consists of a series of sequential steps based on valid electronic decisions that systematically narrows the trouble down to the faulty part. Some would list the procedure in three or four steps, others would count a dozen, fifteen, or more. Regardless of the number, the principle would be the same. Six steps have been chosen as the easiest method of learning and applying this procedure. The steps in their sequential order are:

1. Symptom recognition
2. Symptom elaboration
3. Listing the probable faulty functions
4. Localizing the faulty function
5. Localizing the faulty circuit
6. Failure analysis

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SYMPTOM RECOGNITION

The first step in any troubleshooting problem is recognition of a trouble indication. Recognizing a trouble condition in an equipment is not always easy to do since all conditions of less than peak performance are not always apparent. Lack of targets on a scope, timing error in a loran set, and a decrease in signal-to-noise ratio in a receiver are just a few of the hundreds of examples occurring throughout the Navy. Each of these is a trouble symptom that requires recognition and elimination.

There are many ways in which the existence of a trouble can be detected by a technician. The obvious troubles will undoubtedly be reported by the operator. These usually include complete or almost complete malfunction of the equipment. Troubles that are not easily noticed are those that cause a gradual decrease in equipment performance. For example, a 125-mile radar that is reaching only 105 miles, a 100-watt transmitter that is putting out only 87 watts, or a multimeter that provides readings that are 10% off, are equipment faults that are difficult to recognize because there are no visible or audible indications (built-in) that say they exist.

Since a ship must depend on full-performance equipment, the hidden trouble symptoms must be found, the cause of the trouble located, and the repair made. If the technician makes a point of looking for them every time he touches an equipment most of the decreasing performance symptoms can be easily recognized. Often he can compare the performance between two similar equipments. He can actually make the Performance Standards sheet checks contained in the POMSEE program. By using the POMSEE books, he can verify any change in performance since the last time he tuned, calibrated, or aligned the equipment. Also while troubleshooting, he may look for and probably find symptoms that signify decreasing performance and future breakdown if left unnoticed. Trouble symptoms can be recognized if the technician will only look for them.

SYMPTOM ELABORATION

Breaking out test equipment and equipment prints and proceeding headlong into troubleshooting on just the original identity of a trouble symptom is a very shaky premise. It could also be an unnecessary expenditure of energy. A dead scope, a hum in a receiver, a zero reading on a panel meter, or a missing transmitter pulse, by itself, is not sufficient identification of a trouble symptom. There is a tendency among less efficient technicians to attempt a solution of a troubleshooting problem before they have completely defined it.

The procedures involved are dependent upon the available aids designed in the equipment and the nature of the original symptom. The aids include front panel controls and built-in performance measuring indicators. Additional information can be obtained about any malfunction as the result of a systematic front panel check. If the technician has a fair knowledge of how the equipment works, manipulation of appropriate controls and switches and corresponding checks of equipment meters and scopes will reveal to the technician how the trouble is affecting the entire equipment. From these clues he is able to narrow down the probable areas of the equipment that could contain the trouble.

LISTING THE PROBABLE (FAULTY FUNCTIONS)

The third step requires that the troubleshooter make an educated guess as to the probable cause of the trouble. From the elements of the trouble symptom, as he has identified it, he determines its most logical locations. Locations are to be confined to the major subdivisions (major or functional units) of an equipment. Educated guesses are made from the knowledge of how the equipment works and a study of the equipment's functional block diagram.

For example, using a malfunctioning radar that has no targets on the PPI but the transmitter and modulator indications read good, the educated guesses could include: (a) remote indicator unit, (b) receiver unit, (c) low-voltage power supply, and (d) duplexer. Making an educated guess that a tube is bad (just because the greater percentage of all equipment troubles are caused by bad tubes) is not acceptable. The purpose here is to use valid reasoning to isolate all probable, technically sensible functional areas which may contain the trouble. It may well be that the specific trouble is a bad tube, but wholesale tube substitution takes a lot of time and quite often introduces additional troubles, particularly in those circuits that operate close to critical tolerances.

Even the accomplished technician may not be able to list all the functional units that

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are probable sources of the trouble. However, with the exception of a very obvious trouble, a multi-unit equipment will have many functional units that are probable sources of a trouble.

LOCALIZING THE FAULTY FUNCTION

In this step one of the educated guesses must be selected for testing. It is not necessarily the one that was thought of first nor the one that past experience suggests as being the most attractive. The selection of the functional unit to be tested (or verified) first should be based not only on priority of validity but also on the difficulty in making the necessary tests. Under some circumstances, a troubleshooter might elect to test the second best educated guess rather than the first because the latter might involve testing difficulties that should be initially avoided or require tampering with circuit parts that might later prove to be unnecessary. Like all the others, this step in the troubleshooting procedure places emphasis on common sense thinking rather than the resultant action.

After selecting the order in which the listed units will be checked, the troubleshooter proceeds to verify his first selection. This check normally is made at the output test point of the suspected unit. The test equipment reading is compared with the desired signal contained in the technical manual. No output is relatively easy to recognize. A distorted or nonstandard output, however, should be carefully verified before arriving at a technical conclusion.

If the technician does his mental work properly, manual work in gaining access to test points and using the test equipment can be limited to a bare minimum. This procedure is opposed to trial-and-error methods where the technician searches from point to point with test prods, hoping to locate the faulty test reading that identifies the trouble. Not only does the illogical technician waste valuable time, but his unwillingness to rely on his technical knowledge indicates that he will be very lucky if he finds the trouble.

Upon completing the verification of the propable faulty unit selected, the technician will have arrived at one of several conclusions. The test may verify that this is the unit in which the trouble lies; or that the trouble could be in this unit plus another unit(s) from which it receives signal or control voltages; or that the trouble is not in this unit at all; or that the output looks suspicious and further verifying tests need to be made.

Whatever the conclusion, the technician has discovered information that can be used to substantiate or eliminate suspected units or provide evidence for adding another. Tests of suspected unit outputs are continued until the single faulty unit is identified. At that point, the technician has narrowed down the trouble to a fraction of the total number of circuits and parts in the equipment. If at this time the proper procedure was carried out the search can be confined to the functional area isolated. NOTE: There are some equipments such as communications receivers, that cannot be easily divided into functional units. If this type of equipment is involved, steps 3 and 4 above, can be eliminated from the overall troubleshooting procedure.

LOCALIZING THE FAULTY CIRCUIT

After the faulty unit has been isolated, the next step is to identify the faulty circuit. The same narrowing-down procedures are used here as before. The unit is mentally subdivided into circuit groups by function, and valid technical reasoning is employed to select those that might probably contain the trouble. Using this procedure the technician can find the faulty circuit without going through the unnecessary time-wasting chore of test-point to test-point checking from one end of the unit to the other.

The technician works from the servicing block diagram of the unit. He then applies the information obtained from the preceding steps regarding the nature of the trouble. In narrowing down the trouble to a single functional group of circuits, the process used is called "bracketing." In this process brackets are placed, mentally or in pencil, around the area in which the trouble lies. Initially, a bracket is placed at the input(s) to the units that are known to be good and at the output(s) known to be bad. As each deduction is made and verified by a test, the input or output bracket is moved to the next point in the block diagram where the test was made. In this manner the closing brackets systematically narrow the fault to a single circuit.

In selecting a point on the servicing block diagram to which one of the brackets is to be

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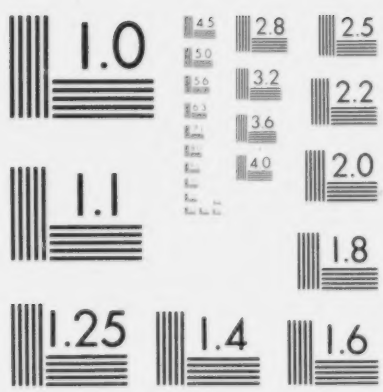

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

moved, the technician must consider two things: (1) the faulty characteristics of the improper output signal and (2) the types of signal paths contained in the unit. The waveshape of a signal contains characteristics—voltage, time, bandpass, noise content, frequency, etc.—that can be measured or observed. When these characteristics are in accordance with the designed standards, the signal is considered to be good. Bad signal characteristics that are improper can reveal clues that will help to identify a circuit group whose function is to originate or control that portion of the waveshape. For example, the output of a unit is supposed to be a sawtooth waveform with six pulses, equally spaced on its slope. If the pulses are there but the slope is insufficient or improper, the sawtooth generating and shaping circuits would be suspected. If the proper slope is there but there is insufficient number of pulses, the pulse generating or controlling circuit groups may contain the trouble.

Types of signal paths contained in the unit are the other items to be considered before moving a bracket. There are four general types: linear, switching, convergent/divergent, and feedback. In a linear signal path, the signal is processed through circuits that are connected in series. When identification of the faulty circuit group is difficult or impossible, brackets can be moved to successively smaller half-points in the linear string. Signals from two or more circuit channels that meet at a common point or a signal that leaves a common point into two or more channels are examples of convergent/divergent paths. Moving a bracket to the common point (after making the appropriate test) will separate the bad from the good signal paths. In the same manner, a test and bracket at the point where signal paths are connected by a switch will reveal the same information. The remaining type (feedback loops) provides a means of bracketing a group of circuits in the narrowing-down process.

There are no hard-and-fast step-by-step procedures in bracketing. But there are some realistic general rules.

1. Examine the characteristics of the faulty output to determine the circuit group function that either generates or controls the improper characteristic.

2. Study the servicing block diagram to determine the least number of bracket moves that will isolate the faulty circuit. Such moves will be dependent upon the types of signal paths contained in the unit and the electronic functions of circuit groups that may be responsible for distortions contained in the unit's output.

3. Move only one bracket at a time after verifying the suitability of the signal by making a test.

4. When the test does not reveal sufficient information for a valid bracket move, make another educated guess.

5. The determination of which bracket to move is dependent upon circuit configuration within the unit and the smaller number of circuits that will be enclosed.

The servicing block diagram can serve as the instrument for the completed bracketing process. In some cases it may be necessary to refer to a schematic diagram for bracketing or testing information. In any event there is sufficient diagram information available in the technical manual to support the bracketing procedure and preclude the wastefulness of unreliable circuit to circuit checking. This step is completed when the technician has isolated the trouble to a single circuit and verified that the output of this circuit is the cause of the distortion read at the output of the unit.

FAILURE ANALYSIS

The troubleshooting procedure thus far has narrowed the trouble to a single circuit consisting of a tube (or transistor) and a few electronic components. If there is no output from the circuit, it may be permissible to resort to testing of tube pin numbers. However, such checks can be minimized if there is an output that can be examined for distortions that will reveal the circuit part that is most likely at fault. Quite often the waveform will identify the malfunction to be in the grid, cathode, plate, or screen portion of the circuit. Such a study should be made before any of the parts are checked.

When the faulty part has been identified, it should not be replaced until the technician can SUBSTANTIATE THAT IT IS CAUSING THE ACTUAL TROUBLE. A suspected open resistor, shorted capacitor, detuned coil, or weak tube may not be the reason or the only reason causing the faulty output of the circuit. If the technician replaces the part without an adequate technical reason, he may (when replacing the part) not have cured the trouble and he may yet cause further trouble. ANALYZE THE FAILURE BEFORE MAKING THE REPAIR.

It can now be seen that the six-step troubleshooting procedure is designed to isolate a

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trouble in an orderly manner. Success in using the procedure is dependent upon the technician's knowledge of electronics, the equipment under test, and his skill in using the technical manual and test equipment. The process is no more complicated than the ability to subdivide an equipment into progressively smaller functional areas, such as functional units into functional circuit groups, to a circuit, and finally a part or an adjustment within the circuit. It is the only logical way to troubleshoot any equipment, and it is more reliable and faster than any other method.

RECORDS AND REPORTS

Each activity engaged in the operation of electronic equipment is required to maintain cards for recording the results of inspections of equipments, and records of any tests, repairs, and field changes made. These cards provide a comprehensive record of the items concerned. They are kept up to date and available for inspection at all times and are integrated into preventive maintenance programs such as the Current Ships Maintenance Project (CSMP).

All records and reports discussed in the following paragraphs are required except where the 3-M System has been implemented AND where the type commander has indicated that they have been superseded by 3-M data products or procedures.

ELECTRONIC EQUIPMENT MATERIAL HISTORY

The material history of electronic equipment consists of the Electronic Equipment History (Unit Location Card), NAVSHIPS 536-1 (8-66), (fig. 2-18) and the Electronic Equipment History Record Card, NAVSHIPS 536 (Rev 8-66) (fig. 2-19). One set of electronic equipment history cards is to be prepared and maintained for each electronic equipment (or set) on board. The two cards (NAVSHIPS 536 and 536-1) are companion items. The initial or "top" card is the Electronic Equipment History

AN/SPS-10 D	Radar Set	1234	N.S. 93684	(CHECK)	1
EQUIPMENT MODEL DESIGNATION	NAME OF EQUIPMENT	EQUIP. SERIAL NO.	TECH. MANUAL (NAVSHIPS) NO.	T.M. ON BOARD	CARD NO.

NAME OF CONTRACTOR	CONTRACT NO.	DATE INSTALLED	INSTALLING ACTIVITY
Daystrom, Inc.	NObsr 75672	10/10/63	Phila. Naval Shipyard

UNIT TYPE NO.	NAME OF UNIT	UNIT SERIAL NO.	LOCATION (by name and compartment No.)
AS-936A/SPS-10B	Antenna Assembly	1110	Tripod Mast Platform (010 Level)
C-1134A/SPS-10	Radar Set Control	1201	CIC (02-60-0-C)
CCJE-30AAP-1	Voltage Regulator	997	Radar Transmitter Room (02-52-1-Q)
J-510B/SPS-10	Interconnecting Box	1001	↑ ↑ ↑ ↑
MD-176A/SPS-10	Radar Modulator	1227	
MX-1399A/SPS-10	Indicator Adapter	1093	
PP-866A/SPS-10	Power Supply	875	↓ ↓ ↓ ↓
RT-272A/SPS-10	Radar Receiver-Transmitter	1144	Radar Transmitter Room (02-52-1Q)

ELECTRONIC EQUIPMENT HISTORY (UNIT LOCATION CARD) NAVSHIPS 536-1 (8-66) (FRONT) S/N-0105-501-2308

Figure 2-18.—Electronic equipment history unit location card.

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ELECTRONIC EQUIPMENT HISTORY RECORD CARD — NAVSHIPS 536 (REV 8-66) (FRONT)

AN/SPS-10D	Radar Set	1234	2
EQUIPMENT MODEL DESIGNATION	NAME OF EQUIPMENT	EQUIPMENT SERIAL NO.	CARD NO.

FAILURE DATE	SYMPTOMS	CORRECTIVE ACTION TAKEN	UNIT TYPE NO.	UNIT SERIAL NO.
12/1/66	No sweep on master or remote indicators.	Open filament in rep rate Oscillator tube. Replaced tube, V-109 (6SJ7)	MD-176 A	1227
2/2/67	No targets; no receiver crystal current.	Receiver Crystal opened because of faulty T/R tube. Replaced T/R tube V-3002, and receiver crystal CR-3003 (1N23B)	RT-272 A	1144

S/N-0105-501-2305

1.2

Figure 2-19.—Electronic equipment history record card.

(Unit Location Card), NAVSHIPS 536-1, which is to be used as an inventory list. It provides space for tabulating all units of an equipment, together with serial numbers and installation locations. The Electronic Equipment History Record Card, NAVSHIPS 536, is used to record all failures and other work accomplished on an equipment. The NAVSHIPS 536 card has been arranged for chronological listing of all entries, regardless of the unit in which work was done. However, separate cards may be maintained for each unit, as deemed necessary by the individual activities.

All cards for a complete equipment are to accompany that equipment when it is removed from the ship or activity. In cases where an individual unit of an equipment is removed or substituted, a separate history record card, containing information pertinent to that unit, is to accompany the unit upon removal. If a chronological listing is used, it will be necessary to transcribe applicable data to a separate card.

NOTE: The two history record cards described and illustrated in figures 2-18 and 2-19 supersede the Electronic Equipment History Record Card, NAVSHIPS 536 (Rev. 9-48), and are to be used on all new equipment installations. It is not mandatory that existing history records be revised to incorporate these new cards. Such revision may be accomplished at the option of the individual Electronics Material Officer.

The following instructions are to be followed in filling out the forms:

1. NAVSHIPS 536-1; This form is to be completed as soon after equipment installation as possible. The heading of the card should be typed, but entries on the body of the card may be typed or written in ink or indelible pencil as shown in figure 2-19. Individual column entries should be made in accordance with the following guidelines.

Equipment Model Designation: All letters and numbers should be included to indicate the specific equipment. For instance, AN/SPS-10D should not be entered SPS-10.

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Equipment Serial Number: This is the main equipment serial number and can be found on the nameplate bearing the overall equipment model designation. (In the case of the AN/SPS-10D, it is located on the receiver-transmitter unit.) Do not use the unit serial. Where it is definitely established that an equipment does not bear a serial number, an asterisk (*) is to be entered in this space.

Technical Manual (NavShips) Number: Enter the applicable NAVSHIPS number in this space. For commercial manuals, enter the abbreviation "Coml" and any other identifying numbers or data.

T. M. On Board: This space is to be checked when the final technical manual is received. If only the manuscript form of the manual is on board, the block should be left blank and a pencil notation inserted to indicate the status of the edition that has been received (whether manuscript is preliminary or advance). The pencil notation is then erased when the final edition is received.

Card No.: This space is to indicate the card serial. The numbering should follow, in consecutive order, that of the Unit Location Card(s). If there is only one Unit Location Card, the number to be entered on the first History Record Card is "2"; all numbering of additional cards filed for this equipment is to follow in sequence. If individual cards have been prepared, letter suffixes may be used to identify additional cards for each unit, e.g., 2A, b, etc.

Name of Contractor: Enter the name of the contractor, in full, as given on the overall equipment nameplate or the technical manual.

Contract No.: This is to include all letters and numbers given on the equipment nameplate.

Date Installed: This refers to the date the equipment was installed. If the installation was accomplished over an extended period of time, the completion date is to be entered.

Installing Activity: This is the name of the activity or organization which actually installed the equipment.

Unit Type No.: This column is to list the official type (A-N) designations of all units that comprise the complete equipment. If commercial equipment, the manufacturer's designation is to be entered. All letters and numbers are to be included.

Name of Unit: These are the official names of the units that make up the equipment.

Unit Serial No.: This column is to list the serial numbers of the units.

Location: Enter the unit locations in this column, using the name and compartment number. If the unit is portable, indicate the space where it is normally stored.

2. NAVSHIPS 536: Since this form is used to list work performed on the equipment or failures that occur, it is not necessary to prepare the card until the first problem is corrected. As shown in figure 2-18, the heading of the card should be typewritten, but entries on the body of the card may be typed or written in ink or indelible pencil. Individual column entries should be made in accordance with the following guidelines:

Equipment Model Designation, Name of Equipment, and Equipment Serial No.: These entries should be identical to those made in the heading of the companion Unit Location Card.

Card No.: This space is to indicate the card serial. The numbering is to follow, in consecutive order, that of the Unit Location Card(s). If there is only one Unit Location Card, the number to be entered on the first History Record Card is "2"; all numbering of additional cards filed for this equipment is to follow in numerical sequence.

Failure Date: This is the date of a failure, the correction of a failure, or other work involving maintenance or repair.

Symptoms: This column is to be used to describe the symptoms exhibited by the equipment to indicate failure or faulty operation. The entry should be brief, but should describe the symptom in such a manner that it can be readily recognized by others.

Corrective Action Taken: This and the preceding column are most important. In this column enter the corrective measures taken to eliminate the fault described in the symptoms column. The entry can be brief, but should be as clear as possible. The clearer the information in this column, the more valuable it will be to the ship, the Navy Department, and the manufacturer. The cause of the problem is to be listed together with the parts replaced or adjustments made to correct the deficiency. Some activities may also wish to record in this column such information as the name and rate of the person who actually accomplished the work, the man-hours consumed, and the signature of the division officer. Such entries are optional.

Unit Type No.: This is to list the unit or units in which the corrective action was taken.

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As shown in figure 2-19, the type number may be abbreviated.

Unit Serial No.: This is to include the serial numbers to the units involved.

Although time consuming, it is still possible to keep a complete and accurate material history by having each man who performs a repair make the entry in the material history as soon as he finishes the job. To ensure that proper entries are being made, the Electronic Material Officer or leading ET should check them once a week for completeness and correctness. Spot check should indicate whether or not entries are being omitted. Large ships often require repairs to be logged in a work book for checking by a supervisor, who then enters the appropriate information in the material history. This procedure is successful where there is sufficient personnel; however, workbooks are not required by regulations. It is suggested that ETs on small ships log the repairs directly into the material history. In many cases it has been found that the ETs fail to log repairs made by personnel other than ship's force, that is, those accomplished by tenders, shipyards, and civilian technicians. These, too, must be recorded in the material history.

CURRENT SHIP'S MAINTENANCE PROJECT

The purpose of the current ship's maintenance project (CSMP) is to provide a current record of maintenance, modifications, and repairs to be scheduled and finally accomplished by ship's personnel or by repair activities afloat or ashore.

The CSMP consists of the following three cards:

NAVSHIPS 529—Repair Record Card (blue)

NAVSHIPS 530—Alteration Record Card (pink)

NAVSHIPS 537 - Record of Field Changes (white)

As a repair is required or an alteration is authorized, the work is scheduled by filling out an applicable CSMP card and placing it so the top line of the card is in view alongside the proper history card, NAVSHIPS 536 (Rev 8-66). These CSMP cards are of distinctive color, which facilitates the indication of outstanding work when the history is examined.

When the item of work has been completed, entries are made in two places. One entry of the completion is made on the CSMP card, and the other entry is made on the history card, NAVSHIPS 536 (Rev 8-66).

Upon completion of work, the Record of Field Changes, NAVSHIPS 537, remains with its NAVSHIPS 536 (Rev 8-66). However, NAVSHIPS cards 529 and 530 are removed from their position adjacent to the history card and filed in a "completed work" section of the CSMP.

The Repair Record Card, NAVSHIPS 529 (blue), and the Alteration Record Card, NAVSHIPS 530 (pink) are identical as to block descriptions, therefore, the description of the entries apply to both cards. Their distinctive colors aid in distinguishing repair from alteration projects.

Repair Record Cards and Alteration Record Cards are retained for a period of 2 years, following which these cards may be destroyed at the discretion of the commanding officer. When ships are decommissioned or placed out of service during this period, the cards are retained onboard.

If the equipment is transferred, these cards are transferred with it.

Field changes scheduled and later made to any portion of an electronic equipment are recorded on the Record of Field Changes, NAVSHIPS 537, which is filed in the binder adjacent to the history card for the equipment to which the change is applicable. Completion of filed change information is also entered on NAVSHIPS 536 (Rev 8-66).

This record is of paramount importance. Without modification, an equipment may be dangerously out of date and subject to numerous serious difficulties. Without a record of field changes it is difficult to determine what modifications, if any, have been made. The information recorded on these cards is essential for routine maintenance, for troubleshooting, and for ordering maintenance parts for the improved equipment.

Figure 2-20 shows the Record of Field Changes Card, NAVSHIPS 537. The spaces for equipment model designation, serial number, date installed, and card number are filled in by typing or writing with ink or indelible pencil.

The columns headed "No.," "Title of Field Changes," and "Authority for Change" are completed in numerical order for all changes affecting a specific equipment. Field changes that affect certain equipments are made known in the Electronic Installation and Maintenance Book (EIMB). Enter applicable extracts from

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RECORD OF FIELD CHANGES — NAVSHIPS 537 (7-60)

AN/SRN-6A	63	3 March 1965	1
Equipment Model Designation	Serial Number	Date Installed	Card No.

U. S. GOVERNMENT PRINTING OFFICE 16—53057-2

NO.	TITLE OF FIELD CHANGE	AUTHORITY FOR CHANGE	CHANGE MADE BY	DATE OF CHANGE
1	Reduction of radiated noise.	EIMB	BRADY, ET1	5/4/66
2	Replaces Heater Stabilized Spectrum Filter with a Temperature Compensated Spectrum Filter	EIMB	NA	

1.4

Figure 2-20.—Record of Field Changes (NAVSHIPS 537).

EIMB on the NAVSHIPS 537 card to indicate exactly its EIMB source and language. The Electronic Information Bulletin (EIB) lists field changes and is also an authority for making such changes.

Do not use obsolete entries on NAVSHIPS 537. Approximately once a year, the Naval Ships System Command determines which EIBs become obsolete because their items are published elsewhere in permanent form (in EIMB and Instruction Book publications). For example, the initial 200 copies of EIB, were named Repair Information Bulletin (RIB) and were canceled (as summarized in EIB 476) along with EIBs from serial numbers 1 through 380. Until further notice, serial numbers above 600 shall be considered authoritative and directive in nature for announcing field changes that are active.

Many field changes are issued directly from the Naval Ships System Command to a ship. Whatever its source, list the authority for such changes in the column provided for it on NAVSHIPS 537.

EQUIPMENT FAILURE AND PERFORMANCE RECORDS

The Naval Ships System Command must receive accurate reports from the fleet concerning equipment performance and failures, in order to evaluate its reliability and maintainability. Reports are also necessary to determine whether new equipments are meeting their design capabilities and operation requirements.

Reported failures are tabulated on IBM cards, and regular summaries are made to show at a glance the number and types of failures of any part of any equipment.

The importance of reporting failures and their causes cannot be too highly stressed, particularly if failures occur under actual operating conditions. The reports are to be filled in completely and in conformity with the instructions accompanying the card. Many reports received by the Naval Ships System

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Command are valueless because they do not give the essential information required by the form or because the information given is incomplete. When indicating the model or type of equipment, include all significant nomenclature, letters, and digits.

Electronic Equipment Failure/ Replacement Report, DD-787

Failures to electronic equipment are reported according to NAVSHIPS Instruction 10550.73. The Electronics Failure Report form, DD-787 (fig. 2-21) and the Electronic Equipment Operational Time Log (discussed later) are submitted only upon failure of special equipments. The initial list of sepcified equipments is shown in the previously referenced NAVSHIPS instruction 10550.73. Additions and deletions will appear in the EIB, which must be checked in each biweekly issue because listed additions will change your reporting requirements.

The DD-787 failure/replacement form is arranged so that all failure information relating to one equipment can be entered on the form. This should simplify the maintenance paperwork which resulted from earlier (obsolete) requirements of listing only a single part on a single card. The DD-787 failure/replacement form, combined with the Operational Time Log, NAVSHIPS 4855, provides the necessary data for accurately showing: (1) mean-time-between failures, (2) mean-time-to-repair, (3) down-time, (4) availability, (5) failure rates, and (6) replacement (consumption) rates.

The report forms are packaged between manila tag covers and flaps, with 50 sets per package.

The covers and flaps have printed codes and instructions for accurately completing the entries on the DD-787 form.

Electronic Equipment Operational Time Log, NAVSHIPS 4855

The Electronic Equipment Operational Time Log (fig. 2-22) serves a twofold purpose. First,

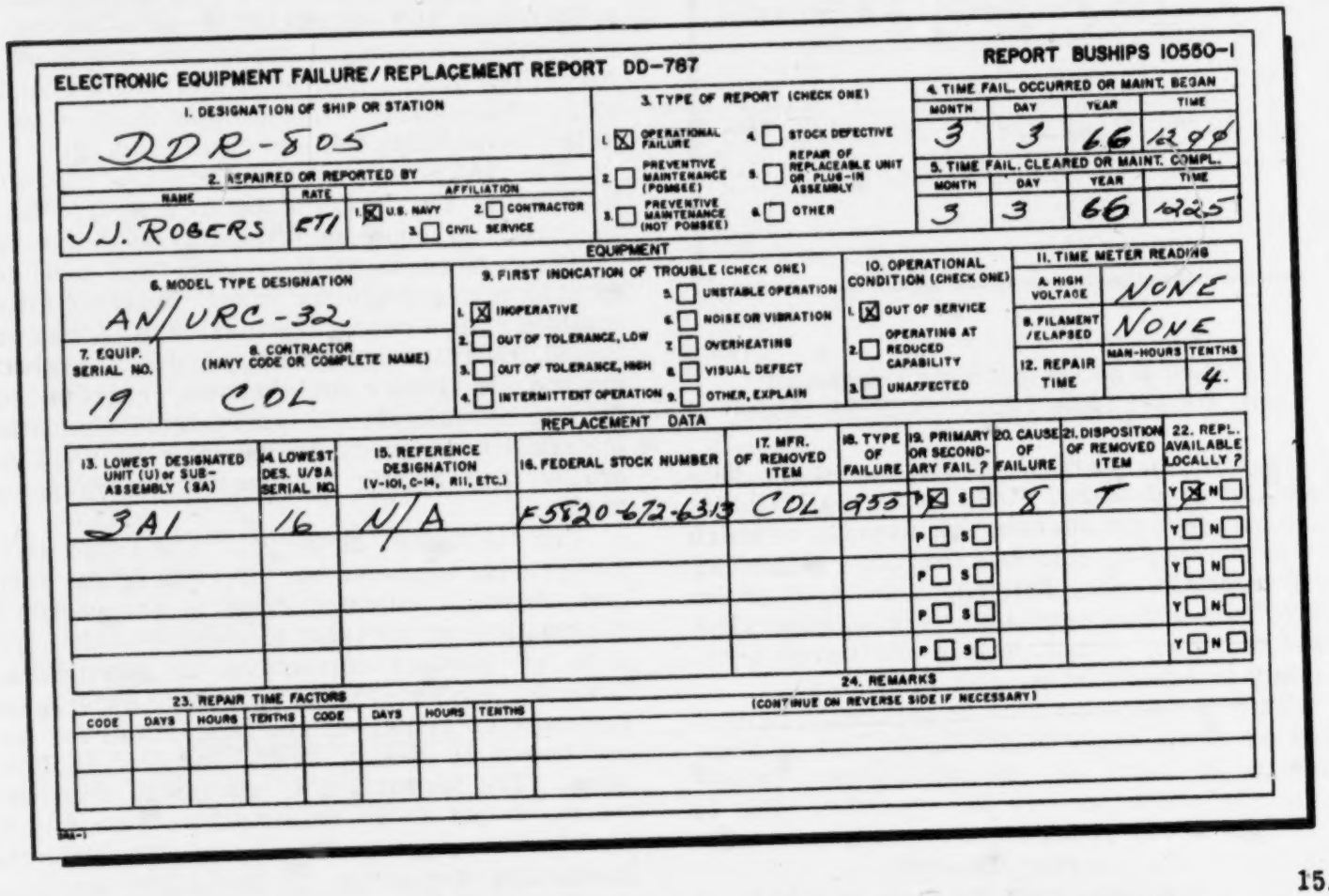

ELECTRONIC EQUIPMENT FAILURE/REPLACEMENT REPORT DD-787 — REPORT BUSHIPS 10550-1

1. DESIGNATION OF SHIP OR STATION: DDR-805

2. REPAIRED OR REPORTED BY: NAME: J.J. ROBERS; RATE: ET1; AFFILIATION: [X] 1. U.S. NAVY [ ] 2. CONTRACTOR [ ] 3. CIVIL SERVICE

3. TYPE OF REPORT (CHECK ONE): [X] 1. OPERATIONAL FAILURE [ ] 2. PREVENTIVE MAINTENANCE (POMSEE) [ ] 3. PREVENTIVE MAINTENANCE (NOT POMSEE) [ ] 4. STOCK DEFECTIVE [ ] 5. REPAIR OF REPLACEABLE UNIT OR PLUG-IN ASSEMBLY [ ] 6. OTHER

4. TIME FAIL. OCCURRED OR MAINT. BEGAN: MONTH 3, DAY 3, YEAR 66, TIME 1200

5. TIME FAIL. CLEARED OR MAINT. COMPL.: MONTH 3, DAY 3, YEAR 66, TIME 1225

EQUIPMENT

6. MODEL TYPE DESIGNATION: AN/URC-32

7. EQUIP. SERIAL NO.: 19

8. CONTRACTOR (NAVY CODE OR COMPLETE NAME): COL

9. FIRST INDICATION OF TROUBLE (CHECK ONE): [X] 1. INOPERATIVE [ ] 2. OUT OF TOLERANCE, LOW [ ] 3. OUT OF TOLERANCE, HIGH [ ] 4. INTERMITTENT OPERATION [ ] 5. UNSTABLE OPERATION [ ] 6. NOISE OR VIBRATION [ ] 7. OVERHEATING [ ] 8. VISUAL DEFECT [ ] 9. OTHER, EXPLAIN

10. OPERATIONAL CONDITION (CHECK ONE): [X] 1. OUT OF SERVICE [ ] 2. OPERATING AT REDUCED CAPABILITY [ ] 3. UNAFFECTED

11. TIME METER READING: A. HIGH VOLTAGE: NONE; B. FILAMENT /ELAPSED: NONE

12. REPAIR TIME: MAN-HOURS: ; TENTHS: 4.

REPLACEMENT DATA

13. LOWEST DESIGNATED UNIT (U) or SUB-ASSEMBLY (SA)	14. LOWEST DES. U/SA SERIAL NO.	15. REFERENCE DESIGNATION (V-101, C-14, R11, ETC.)	16. FEDERAL STOCK NUMBER	17. MFR. OF REMOVED ITEM	18. TYPE OF FAILURE	19. PRIMARY OR SECONDARY FAIL ?	20. CAUSE OF FAILURE	21. DISPOSITION OF REMOVED ITEM	22. REPL. AVAILABLE LOCALLY ?
3A1	16	N/A	F5820-672-6313	COL	955	P[X] S[ ]	8	T	Y[X] N[ ]
						P[ ] S[ ]			Y[ ] N[ ]
						P[ ] S[ ]			Y[ ] N[ ]
						P[ ] S[ ]			Y[ ] N[ ]
						P[ ] S[ ]			Y[ ] N[ ]

23. REPAIR TIME FACTORS

CODE	DAYS	HOURS	TENTHS	CODE	DAYS	HOURS	TENTHS

24. REMARKS (CONTINUE ON REVERSE SIDE IF NECESSARY)

15.2

Figure 2-21.—Electronic Equipment Failure/Replacement Report, DD-787.

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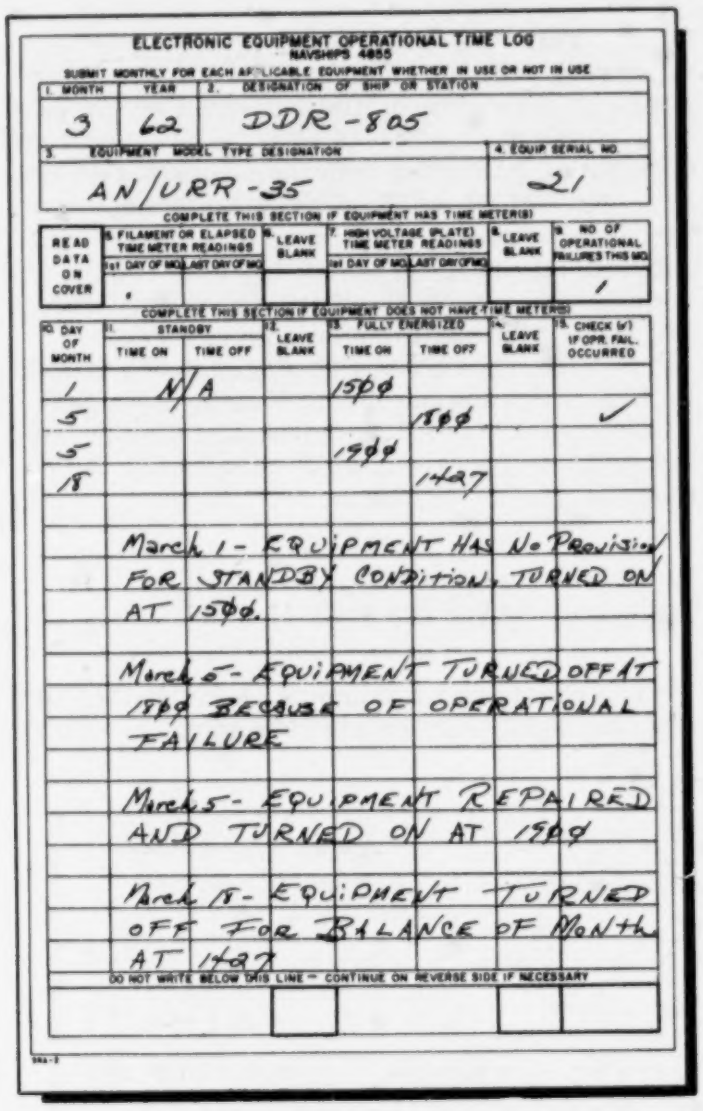

ELECTRONIC EQUIPMENT OPERATIONAL TIME LOG
NAVSHIPS 4855

SUBMIT MONTHLY FOR EACH APPLICABLE EQUIPMENT WHETHER IN USE OR NOT IN USE

1. MONTH	YEAR	2. DESIGNATION OF SHIP OR STATION
3	62	DDR-805

3. EQUIPMENT MODEL TYPE DESIGNATION	4. EQUIP SERIAL NO.
AN/URR-35	21

COMPLETE THIS SECTION IF EQUIPMENT HAS TIME METER(S)

READ DATA ON COVER	5. FILAMENT OR ELAPSED TIME METER READINGS (1st DAY OF MO.)	(LAST DAY OF MO.)	6. LEAVE BLANK	7. HIGH VOLTAGE (PLATE) TIME METER READINGS (1st DAY OF MO.)	(LAST DAY OF MO.)	8. LEAVE BLANK	9. NO. OF OPERATIONAL FAILURES THIS MO.
							1

COMPLETE THIS SECTION IF EQUIPMENT DOES NOT HAVE TIME METER(S)

10. DAY OF MONTH	11. STANDBY TIME ON	TIME OFF	12. LEAVE BLANK	13. FULLY ENERGIZED TIME ON	TIME OFF	14. LEAVE BLANK	15. CHECK (✓) IF OPR. FAIL. OCCURRED
1	N/A			1500			
5					1800		✓
5				1900			
18					1427		
	March 1 - EQUIPMENT HAS NO PROVISION						
	FOR STANDBY CONDITION, TURNED ON						
	AT 1500.						
	March 5 - EQUIPMENT TURNED OFF AT						
	1800 BECAUSE OF OPERATIONAL						
	FAILURE						
	March 5 - EQUIPMENT REPAIRED						
	AND TURNED ON AT 1900						
	March 18 - EQUIPMENT TURNED						
	OFF FOR BALANCE OF MONTH						
	AT 1427						

DO NOT WRITE BELOW THIS LINE — CONTINUE ON REVERSE SIDE IF NECESSARY

15.3

Figure 2-22.—Electronic Equipment Operational Time Log, NAVSHIPS 4855.

it is used to show accurate time-base data for figures-of-merit, which concern all failure-rate or replacement-rate calculations, or which concern other calculations that show reliability and maintainability factors. Second, it shows period of actual operation versus inoperative periods; such period values are known technically as equipment population figures.

Without operation time or population figures that are reasonably accurate, any one or more figures of merit are not significant. Therefore, one realizes how the operation time is essential in evaluating other reports, especially the previously described DD-787.

The operational time log form is relatively simple to complete, especially when an equipment is supplied with time meters. Only five or six entries need to be made on the first day of a month (depending upon the number of meters), and three more on the last day of the same month; a total of 8 or 9 block entries (on a single form) are to be completed per equipment per month.

Equipments without time meters require somewhat greater effort. The format for packaging and using these forms is explained in detail on the covers (similar to the DD-787).

Electronics Performance and Operational Report, NAVSHIPS 3878

The Naval Ships System Command must keep tab on new (and converted) equipments to evaluate their usefulness. This is accomplished with the Electronic Performance and Operation Report, NAVSHIPS 3878, shown in figure 2-23.

It is not desired that reports be submitted on all equipments. Detailed instructions for the preparation and submission, and a listing of equipment requiring a report are contained in NAVSHIPS Instruction 9670-20E. When applicable, NAVSHIPS 3878 is submitted monthly to the Naval Ships Systems Command.

The NAVSHIPS 3878 reports are essential to keeping the Naval Ships System Command informed on equipment performance and operation. Because they provide first-hand information on equipment under actual operating conditions and report the maximum ranges obtained, they are extremely valuable in evaluating the electronics maintenance program, enforcing manufacturers' guarantees, evaluating installation adequacy, improving equipment operation and safety, and improving equipment design.

The NAVSHIPS 3878 report contains a place for general remarks on the back of the form (not shown). Indicated here is any pertinent information not included elsewhere on the form such as detailed information on any unusual difficulty encountered in operation; exceptional maintenance required; and suggestions for improvement in design, tests, and new applications. The forwarding of suggested improvements is not to be construed as authority to modify the equipment in any way. Nor does the forwarding of this report eliminate the separate requirement for forwarding the Electronics Failure Report (DD 787).

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ELECTRONIC PERFORMANCE & OPERATIONAL REPORT
NAVSHIPS 3878 (Rev. 9-60) *Submit original only to Bureau - No forwarding letter required*

FROM: USS RANGER (CVA-61) (Ship name, type and hull no.)
TO: CHIEF, BUREAU OF SHIPS (CODE)
[ ] LANT [ ] FLEET [X] PAC

REPORT CLASSIFICATION: UNCLASSIFIED
DATE: 1 March 1966
REPORTING PERIOD: FROM 1 FEB 66 TO 28 FEB 66

TYPE AND MODEL OF EQUIPMENT: AM-1365/URT Amplifier
SERIAL NUMBER: 383

FIELD CHANGES TO DATE: ACCOMPLISHED: None; NOT ACCOMPLISHED: None
HOURS DURING PERIOD OF THIS REPORT: OPERATED 180; NOT IN OPERATING CONDITION 564

PERFORMANCE FIGURE (PF) & TECHNICAL EVALUATION: [ ] OUTSTANDING [ ] GOOD [ ] SATISFACTORY [X] UNSATISFACTORY
OPERATIONAL EVALUATION: [ ] OUTSTANDING [ ] GOOD [ ] SATISFACTORY [X] UNSATISFACTORY

RADAR:

PEAK POWER OUTPUT (PT) Mw		AVER. VSWR IN TRANSMISSION LINE		AVER. ECHO BOX RING TIME YDS		MIN. DISCERNIBLE SIGNAL (MDS) db	
MAX. RANGE TARGETS DETECTED	MI	MI	MI	MAX. ALTITUDE AT RANGE DETECTED	MI	MI	MI
MAX. ALTITUDE TARGETS DETECTED	FT	FT	FT	RANGE AT MAX. ALTITUDE DETECTED	FT	FT	FT
TARGET CLASS. TYPE - DETAIL (SEE REVERSE)				TARGET CLASS. TYPE - DETAIL (SEE REVERSE)			
MAXIMUM RELIABLE RADAR RANGE MI				MINIMUM RELIABLE RADAR RANGE YDS			

SONAR:

SOURCE LEVEL (LS) db//uBAR	RECEIVING SENSITIVITY db//VOLT/uBAR		SEA STATE	PROCEDURE USED		
NOISE LEVEL db//VOLT	5 KNOTS	10 KNOTS	15 KNOTS	20 KNOTS	25 KNOTS	30 KNOTS
MAXIMUM RANGE SONAR TARGETS DETECTED AND TRACKED	RANGING YDS		LISTENING YDS		SOUNDING FATHOMS	
TARGET CLASSIFICATION TYPE AND DETAIL						
ST PATTERN						
OWN SHIP'S SPEED.	KTS		KTS		KTS	

COMMUNICATIONS:

PERCENT OF TIME OUT OF CONTACT WHILE WITHIN RANGE (IF ANY)	ANTENNA SYSTEMS	INTERFERENCE (Frequencies, intensity, and sources)	
0 %	No problems	No problems	
POWER OUTPUT: Voice 100 WATTS	AVERAGE VSWR: 1.5:1	REL RANGE: 40 miles	RECEIVER SENSITIVITY: NA UVOLTS

ELECTRONIC WARFARE:

MAXIMUM RANGE AND ALTITUDE TARGETS DETECTED	MI	FT	MI	FT	MI	FT
TARGET CLASSIFICATION TYPE AND DETAIL (SEE REVERSE SIDE)						
MAXIMUM RELIABLE RANGE AND ALTITUDE	MI	FT	MI	FT	MI	FT
TARGET CLASSIFICATION TYPE AND DETAIL (SEE REVERSE SIDE)						
MAX. RANGE SONAR TARGETS DETECTED YDS	ST PATTERN		MAX. RELIABLE SONAR RANGE YDS		ST PATTERN	

35.83

Figure 2-23.—Electronic Performance and Operation Report, NAVSHIPS 3878.

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SHIP ELECTRONICS INSTALLATION RECORD, NAVSHIPS 4110

The Ship Electronics Installation Record, NAVSHIPS 4110, furnishes an up-to-date inventory of all electronic equipment aboard each ship to interested fleet and shore activities and is one of the records which will not be replaced by the 3-M system.

To be effective, the NavShips 4110 must be extremely accurate and must be submitted promptly. To indicate the importance and purpose of the document, the NavShips 4110's are specifically used:

(1) By the Naval Ships System Command for determining the equipments to be installed during overhauls and conversions, and the equipment to be procured in the future.

(2) By Naval Shipyards in overhaul planning.

(3) By the Electronic Supply Office to determine repair parts allowances.

(4) To prepare Coordinated Shipboard Allowance Lists (COSAL).

Instructions for preparing, revising, and submitting NAVSHIPS 4110 are contained in NAVSHIPS 900, 135D.

ELECTRONIC MATERIAL IDENTIFICATION

Numbers currently used by the Navy to identify and catalog electronic repair parts are Federal Stock Numbers (FSN). These are the numbers which should be used on all supply and inventory documents.

The FSN used throughout the Department of Defense utilizes a 4-3-4 digit pattern prefixed by a numeric-alphabetical designator called a dual cognizance symbol (fig. 2-24). The numeric-alpha combination identifies the general category of the material, the funding, the Navy Inventory Control Point having cognizance, or the Navy Retail Office having administrative responsibilities for the items under the managership of a Defense Supply Center.

Following the dual cognizance symbol is a four-digit number which indicates the Federal Supply Class. The first two digits represent the Federal Supply Group. In the example shown in figure 2-24, the "59" specifies that the item is an Electrical/Electronic Equipment Component. The second two digits, "20" together with the number "59" show the Federal Supply Class in which fuses and lightning arrestors have been classified. The last seven digits—the 3-4 part of the pattern—are the specific item identifier. They are called Federal Item Identification Numbers (FIINs) and are serially assigned. The same FIIN is never used to describe more than one line item, and once assigned, that number is never reassigned, even though the item identified by the number may have been dropped from the supply system.

Where FSNs are not available, other numbers must be used to identify the repair parts. Such other numbers may be reference numbers or manufacturers' part numbers. Each company or concern which manufacturers material for Government use is assigned a five-digit "manufacturer's code". The use of a reference number, part number, or manufacturer's code is important in the identification of a part when the FSN is unavailable.

U. S. NAVY ELECTRONIC SUPPLY OFFICE

The U. S. Navy Electronic Supply Office (ESO) is located at Great Lakes, Illinois,

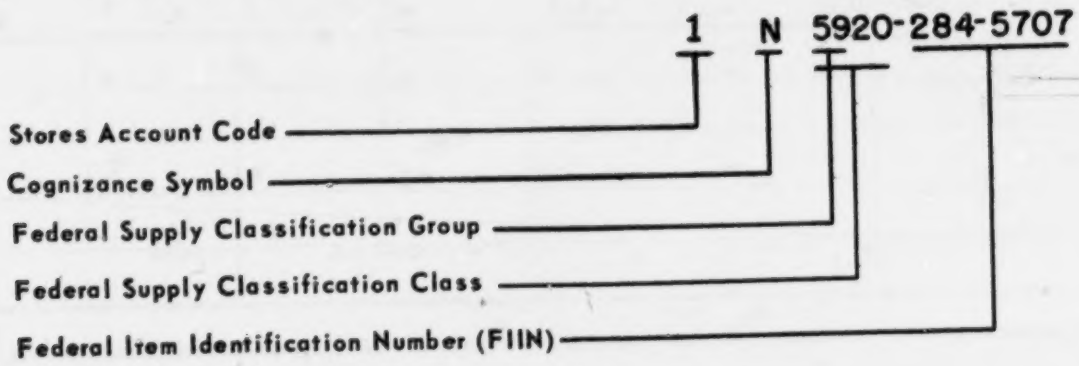

107.13

Figure 2-24.—Breakdown of typical Federal Stock Number.

6951

where inventory control is exercised over assigned electronic material. ESO has been designated by the Secretary of the Navy to serve as the inventory control point for Navy Ships System Command electronic repair parts (less nuclear items) required in the maintenance, upkeep, and overhaul of equipments in ships and at shore stations, other than those for which control is specifically retained by the System Command.

A part of ESO's primary mission of supplying activities in the electronics distribution system with repair parts is to prepare Coordinated Shipboard Allowance Lists (COSAL) for ships and Electronic Repair Parts Allowance Lists (ERPAL) for shore stations, develop and maintain stock numbered parts lists (referred to as SNITs or Stock Number Identification Tables and APLs or Allowance Parts Lists) for individual equipments, and participate in the initial provisioning of parts for new electronic equipments.

The U. S. Navy Electronics Supply Office stocks no material. It controls and directs the flow of assigned electronic material through the electronics supply segment of the Navy Supply System.

MAINTENANCE OF STOCK LEVELS

The necessity for a consumer activity to maintain sufficient stocks to meet its requirements is obvious. Less obvious, but also important, is the necessity to avoid overstocking. Overstocking not only increases the dollar value of an activity's inventory and occupies storage space unnecessarily, but stocks which may be needed elsewhere are immobilized.

Certain parts may require replacement so often that there may be a tendency to consider them as a part of shop stores. In such a case, an increase in the quality of manufacture, an improvement in design, or obsolesence may leave the shop store with a 6-year instead of a 90-day supply. For this reason alone it is desirable to keep shop stores to a minimum.

REQUISITIONS

In order to have on hand replacements for parts which fail, activities operating electronic equipments must make their requirements known to the supply system. This is done by means of requisitions forwarded to the appropriate supporting supply activity. The supply officer is responsible for requisitioning materials, however, he must be told what materials and quantities are needed.

After a requirement is identified it must be transmitted to the supply department in some acceptable form. Ultimately, documentation must be prepared and processed which accomplishes the recording and accountability requirement.

Ashore and on ships with data processing equipment, which include most aircraft carriers, the DD Form 1348 is used as the request and issue document. An example of a properly prepared DD Form 1348 is shown in figure 2-25. The shaded areas on the form indicate which information is furnished by the customer, with the balance of the information being completed by supply department personnel.

On ships operating under manual supply procedures, which include the majority of all ships, the NAVSANDA Form 1250 is used as the request and issue document. An example of a properly prepared NAVSANDA Form 1250 is shown in figure 2-26. The shaded portion of this document indicates which information is furnished by the customer.

EQUIPAGE CUSTODY

Equipage is the term used to designate nonconsumable material. This type of material has greater value than consumable supplies and more functional importance, such as signal generators, multimeters, and oscilloscopes.

A custody signature on Equipage Stock Cards and Custody Record, NAVSANDA Form 306 (fig. 2-27) is mandatory for equipage under Naval Ships System Command cognizance, as listed in NAVSUP Manual, Volume III; and equipage items which the commanding officer determines should have a custody signature.

A copy of the Equipage Stock Card and Custody Record must be furnished to the department head at the time he signs the original custody card. The duplicate copy becomes the department head's record of equipage requiring custody signature for which he is responsible. As equipage is received or expended, appropriate entries are made on all equipage records.

6952

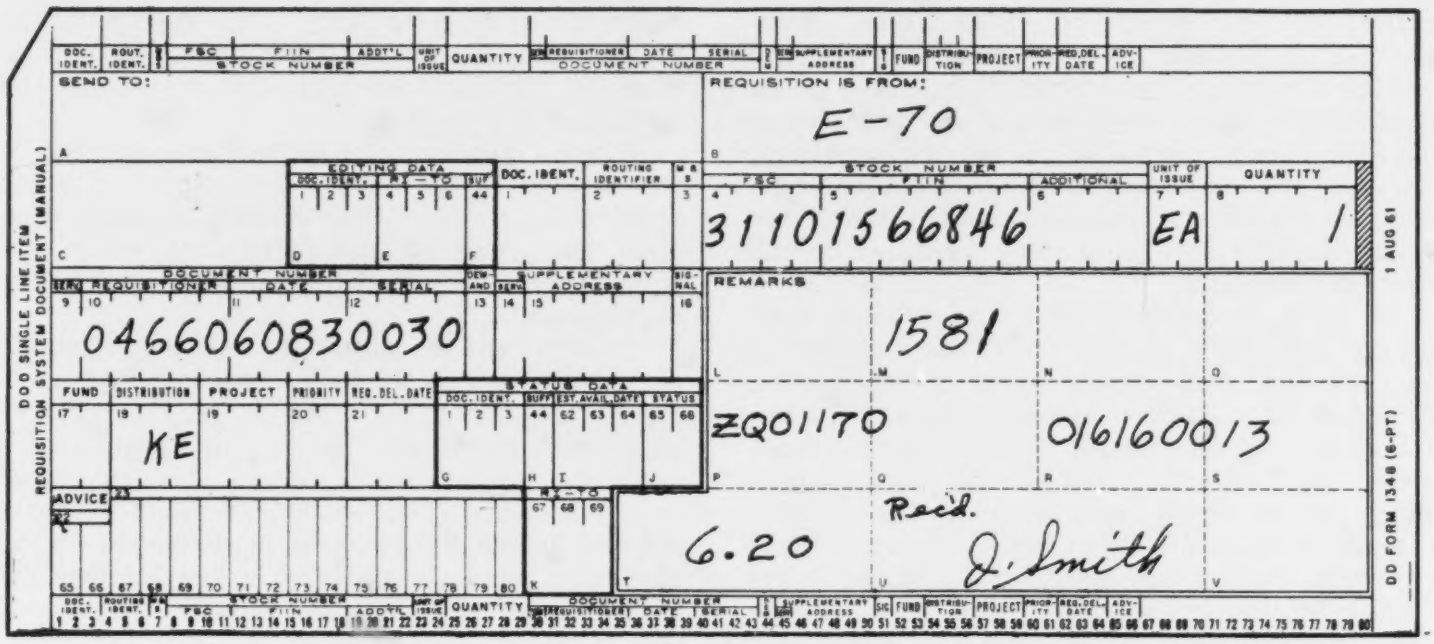

43.24

Figure 2-25.—DD Form 1348.

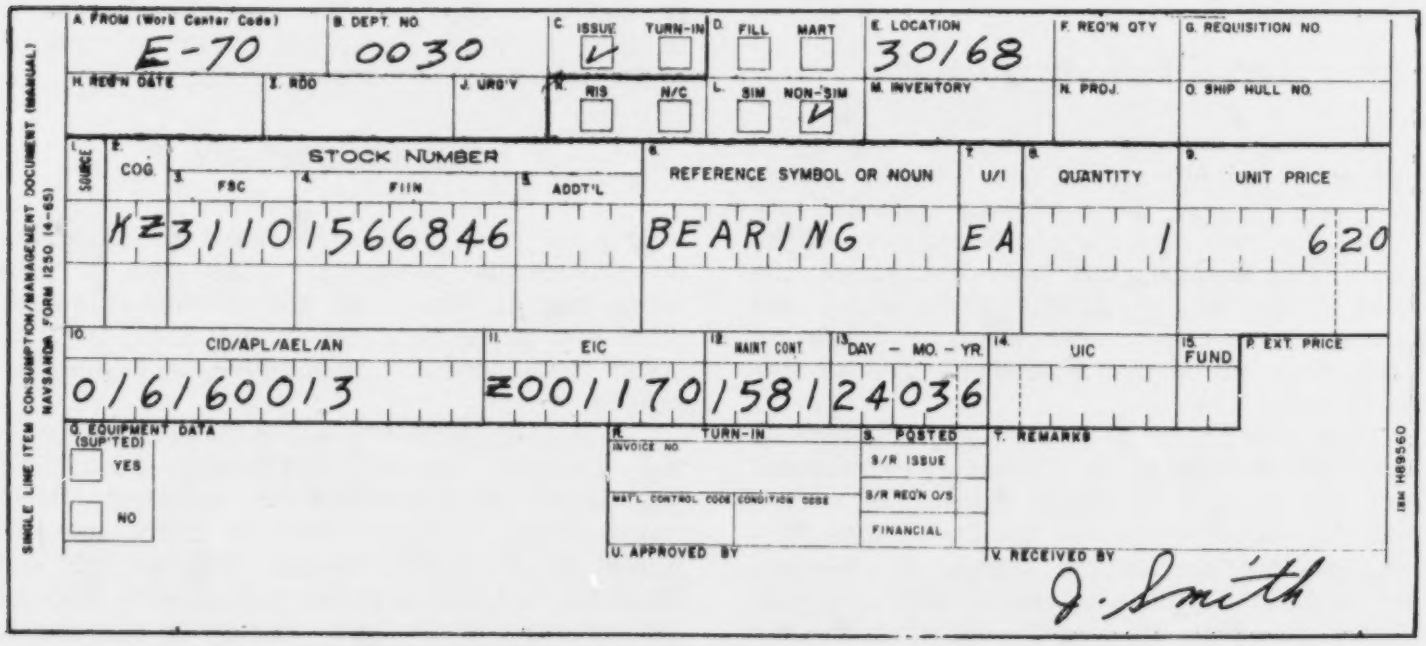

17.84

Figure 2-26.—NAVSANDA Form 1250.

When the department head issues the equipage, he should have that person sign a subcustody receipt; however, this does not relieve the department head of the responsibility for the equipage.

SURVEY REPORTS

A survey is the procedure required by U.S. Navy Regulations when naval property must be condemned as a result of damage,

EQUIPAGE STOCK CARD AND CUSTODY RECORD
NAV. S. AND A. FORM 306 (REV. 8-54)

CUSTODY SIGNATURE REQUIRED ▶ [X] YES [ ] NO

CARD NO. Op 11

DEPARTMENT	ALLOWANCE	STOCK NO.	UNIT	UNIT PRICE	ALLOWANCE LIST NO. 78730709
Operations	2	2RX6625-785-6500	Ea	1333.00	GROUP PAGE LINE

Oscilloscope, AN/USM-105A

DATE	VOUCHER NO.	RECEIVED FROM ISSUED TO	QUANTITY RECEIVED	QUANTITY ISSUED	BALANCE	I acknowledge receipt of quantity of this article as indicated
7/24/67	079825	NSC NORVA	1		1	G.D. Williams

U. S. GOVERNMENT PRINTING OFFICE 16—44373-5

7.3

Figure 2-27.—Equipage Stock Card and Custody Record, NAVSANDA Form 306.

obsolescence, or deterioration, or is acknowledged as nonexistent as a result of loss, theft, or total destruction. A survey is made on Survey Request, Report and Expenditure, NAVSANDA Form 154.

Formal surveys (fig. 2-28) are made by a commissioned officer or a survey board appointed by the commanding officer. A formal survey is required at all times when it appears that responsibility for lost or damaged material may be placed on a person or persons in the naval service. Also, formal surveys are required for certain classes of material or articles designated by the bureau or office concerned. In the absence of instructions from higher authority, the commanding officer determines whether a formal or an informal survey is required.

Informal surveys will be made by the head of the department having custody of the material to be surveyed. A survey will be made when a material condition becomes known or when instructions by higher authority direct a survey.

ADDITIONAL REPORTS

Type commanders and other authorities may require reports in addition to those required by the Navy Department. Instructions concerning such reports may be promulgated via letter, message, or other official means. The Electronics Technician, therefore, must examine all official correspondence regarding electronics forwarded to his activity in order to keep abreast of current instructions.

ELECTRONIC SAFETY PRECAUTIONS

There is great diversity in the dangers inherent in the technician's work. These dangers range from those encountered while working

SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE: 1 Aug. 1967
NUMBER: 5219852180245

ACTIVITY: (52198) USS Jones Ingram (DD-938)

ORIGINATOR (Signature and title): Robert C. Sword
R.C. Sword, LTJG., USNR, Operations Off.

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1	Oscilloscope OS-8E-U 2F 6625-649-9248	1	$120	$120

REASON FOR SURVEY	ACCOUNT IN WHICH CARRIED (APA, NSA, etc. or nonstores)	OTHER DATA (Source, date of receipt, etc.)
Damaged beyond economical repair	Nonstores	NSC, Norfolk 10/25/67

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE) 1 Aug. 1967

TYPE OF SURVEY: [X] FORMAL [ ] INFORMAL

SURVEY TO BE MADE BY:
1. LTJG. R.B. Louer
2. LTJG. H.B. Barnes
3. LTJG. S.M. Lindquist

SIGNATURE (C. O. or delegate): R.E. Spallone
R.E. Spallone, CDR., USN

SURVEY REPORT AND RECOMMENDATION

Condition: Damaged beyond economical repair

Cause: Dropped on deck while being moved during heavy seas; considered unavoidable

Responsibility: None

RECOMMENDATIONS (Est. repair cost)
[X] EXP. FROM RECORDS [ ] TRANSFER TO S-370 [ ] TRANSFER TO MAY'L COND. CODE ($_____) [ ]

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY: (Signature(s))
(1) R B Louer — LTJG. R.B. Louer
(2) H.B. Barnes — LTJG. H.B. Barnes
(3) S.M. Lindquist — LTJG. S.M. Lindquist

REVIEW OF SURVEY REPORT

[X] APPROVED [ ] DISAPPROVED
SIGNATURE (C. O. or delegate): R.E. Spallone, CDR., USN
DATE: 5 Aug. 1967
FORWARD TO (Bureau):

ACCOUNTING DATA
APPROPRIATION: Nonstores Account
EXPEND. ACCOUNT:

BUREAU APPROVAL

DISPOSED OF AS INDICATED
SIGNATURE (Rank and title): R.C. Cairo, LT., USN, Supply Officer
DATE: 7 AUG. 1967

Figure 2-28.—Survey Request, Report and Expenditures, NAVSANDA Form 154.

7.6

aloft to those of nuclear radiation. The technician is also exposed to the dangers of working with high voltage, RF radiation, volatile and combustible materials, and with power tools, etc. The list is almost endless. It must be stressed, however, that these dangers are potential dangers; dangers that can be eliminated, or at least minimized, if the proper safety precautions are observed.

Safety precautions are not stagnant; rather, they are continuously changing. A complete list of safety precautions for today may be inadequate for tomorrow. Advances in technology are often accompanied by new dangers, necessitating new safety precautions. In addition, continuing research in the area of safety periodically brings to light heretofore hidden dangers.

Only by the following actions can you ensure that you are aware of all of the dangers which may be encountered in your work and that you know all of the necessary safety precautions that must be observed:

a. Ensure that all the publications pertaining to safety are aboard. (A complete list of these publications is at the end of this discussion.)

b. Maintain these publications in a current status by making the corrections and inserting the changes as they are received.

c. See that your name is on the routing list for all periodicals that may contain articles on safety; such as the EIB or the Navy Ship System Command Technical News.

SOURCES OF INFORMATION

Unfortunately, all of the precautions necessary to ensure the safety of the technician cannot be found in any one publication. They all exist, however, in the many publications, periodicals, and directives of the various offices and bureaus of the Navy Department. It is the purpose of this discussion to provide a list of authoritative sources of safety information.

OPNAV Notice 5100 of 4 November 1964 states that the Chief of Naval Operations will periodically publish an index of publications, pamphlets, periodicals, and directives, issued by the bureaus, system commands, and offices of the Navy Department, which contain safety precautions applicable to the operating forces. The index is issued as a series of OPNAV Notices under the 5100 subject classification number, and provides an up-to-date list of all published material pertaining to safety precautions. Every Electronics Technician should check this list and ensure that all publications that are applicable to his division are readily available to himself and to others within the division.

The following list of publications was taken from the OPNAV Notice stated above, and includes those of most importance to the technician:

Title	Number
Naval Ships Technical Manual Chap 9670, Sec V	NavShips 250,000
Electronic Installation and Maintenance Book (EIMB) General Handbook	NavShips 0967-000-0110
EIMB Installation Standards	NavShips 0967-000-0130
Electronics Information Bulletin (EIB)	NavShips 900,022A
Instruction	NavShips 6260.5
Instruction	BuMed 6200.5
Various Equipment Technical Manuals	
Standard First Aid Training Course	NavPers 10081-B
Department of the Navy Safety Precautions for Shore Activities	NavSo P-2455
Type Commanders' or Commanding Officers' Directives	

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CHAPTER 3

USE OF SPECIAL TEST EQUIPMENT

The purpose of this chapter is to better acquaint the technician with the purpose and practical use of special test equipment. The test equipment discussed is by no means all that will be encountered; however, it is representative of special types of test equipment that you will find aboard most ships and at shore stations.

RADIO INTERFERENCE MEASURING SET AN/PRM-1A

Radio Test Set AN/PRM-1A (fig. 3-1) can be used for radio interference surveys to determine the source of radiated or conducted interference from any source within its frequency range. Such interference may be generated by gasoline engine generators, motors or electronic equipment. Field intensity measurement surveys may be made with Radio Test Set AN/PRM-1A for adjusting directive antennas or for exploring radiation patterns, where the field intensity may vary over a wide range of values. The equipment may also be used as a sensitive radio frequency microvoltmeter. The test set is portable and is suitable for operation aboard naval ships, at shore stations, in the field, in aircraft, and in military vehicles.

TYPES OF RADIO INTERFERENCE

Radio interference, sometimes called "noise", disrupts the utility of radio frequency receivers. Interference includes many forms of disturbances and may be roughly classified as continuous and discontinuous.

Continuous disturbances include random interference such as thermal agitation. Atmospheric interference, or static, originating in lightning discharges in local storms and in more distant tropical storms, resembles random interference in that the impulses are frequent and overlap, with sharp peaks exceeding the average level. If interference impulses follow each other rapidly and are not clearly distinguishable, then the interference is random.

Discontinuous interference is made up of sharp pulses, the frequency determining the character of the interference. If the pulses are relatively infrequent and clearly separated, the interference is termed impulsive. Impulsive interference may be generated by an internal combustion engine ignition system, power line discharges, electrical switching operations, electronic equipment, and by other electrical and electromechanical devices.

Because of the wide frequency range covered by continuous and discontinuous interference, the magnitude of the interference will depend upon the bandwidth of the measuring equipment. The bandwidth characteristics of the AN/PRM-1A are taken into consideration and are utilized in obtaining average, quasi-peak, and peak values of interference. Shipboard electronic interference is described in the Electronic Installation and Maintenance Book, NavShips 0967-000-0150.

FIELD INTENSITY MEASUREMENTS

Field intensity is the value of the electric field at a given point and is measured in terms of volts-per-meter. One volt-per-meter is equivalent to a potential of one volt induced in a vertical rod antenna having an electrical length of one meter.

There are two principal methods of making field intensity measurements. One method is the substitution method, in which a loop antenna is connected to a receiver, and metering circuits give an indication of the receiver output. The receiver is tuned to the desired signal. The loop is rotated to give maximum signal, and the relative value of the received signal is

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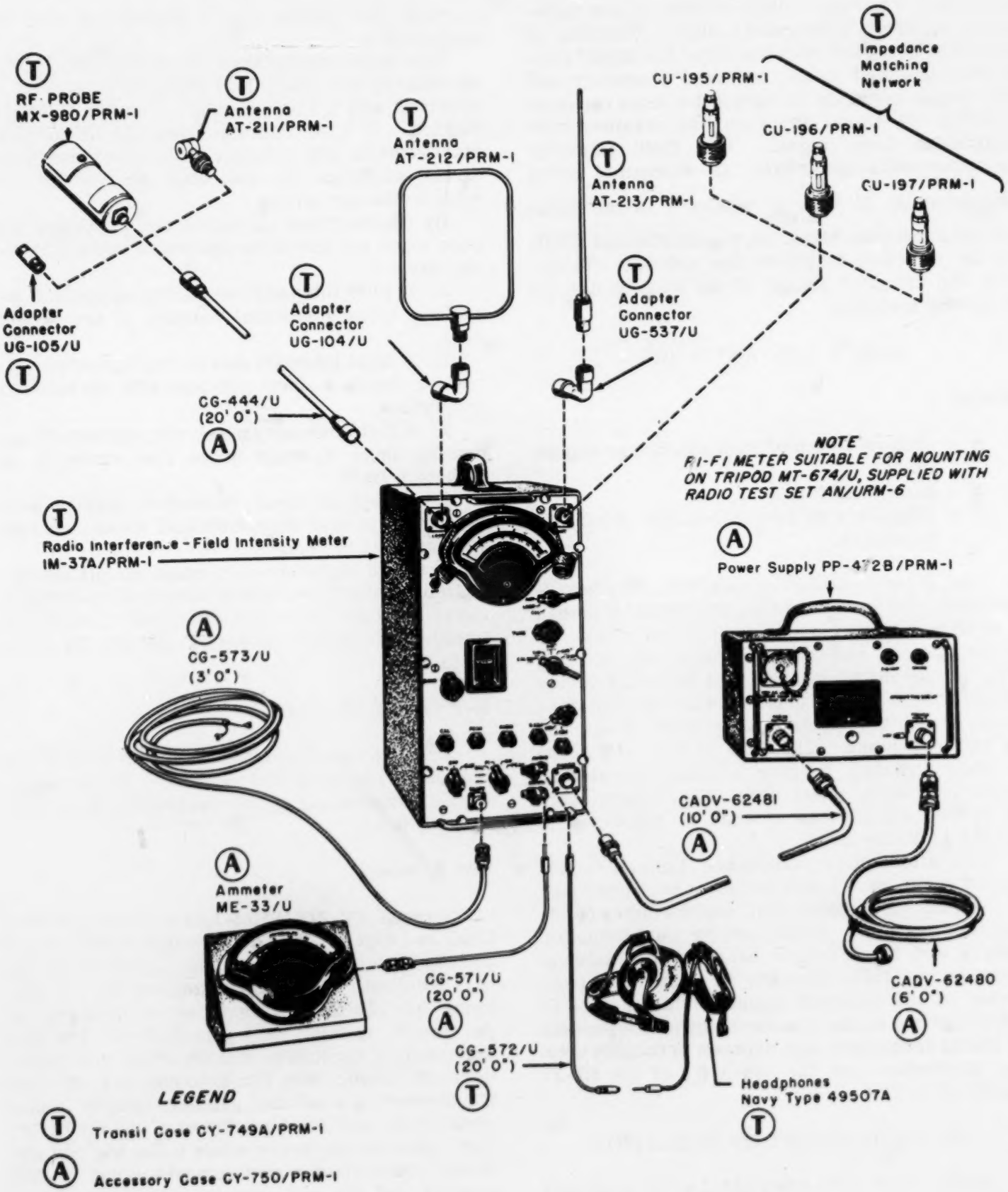

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Figure 3-1.—Radio Test Set AN/PRM-1A, Connection Diagram.

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recorded. The loop is then rotated to give minimum received signal, and a signal generator is inserted in series with the loop. The signal generator is tuned to the received frequency and its output adjusted to obtain the same receiver reading of signal input as was obtained with maximum loop signal. The field intensity in microvolts-per-meter is computed from the formula $E = \frac{V}{H(eff)}$, where V is the value of the substitute signal in microvolts and H(eff) is the effective height of the antenna. To obtain the effective height of the antenna use the following formula;

$$H(eff) = 1.351\ ANF \times 10^8$$

Where

A = area of 1 turn of loop winding in square inches
N = number of turns
F = frequency in kilocycles, and H(eff), is in meters.

The second method of field intensity measurements employed in the AN/PRM-1A uses a specially designed sensitive receiver with built-in attenuators and a calibrated voltage source. The Radio Interference-Field Intensity Meter IM-37A/PRM-1 is tuned to the desired frequency and the calibrated voltage is applied to the r-f input. The gain of the i-f section is then adjusted to give a standard value of calibrator signal input. The calibrating voltage is turned off and the antenna is connected to the RI-FI Meter input.

The attenuators (discussed later) are adjusted for a meter indication at the upper half of the indicating meter dial, and the meter reading thus obtained, multiplied by the attenuator setting and the effective height of the antenna used, is the field intensity in microvolts-per-meter of the received signal. This method is advantageous in that the accuracy is independent of signal frequency, and depends primarily upon the attenuator and the linearity of the RI-FI meter circuits.

GENERAL THEORY OF OPERATION

Radio Test Set AN/PRM-1A is basically a meter intended for intensity measurements of all types of radio frequency energy in the low and medium radio frequency spectrum between the limits of 150 kilocycles and 25 megacycles.

The Radio Interference-Field Intensity Meter IM-37A/PRM-1 (fig. 3-1) includes a sensitive receiver and a vacuum-tube voltmeter (VTVM) section. It also contains internal means for standardizing the receiver gain, thus permitting direct readings in indicated microvolts or microvolts-per-meter.

By special input circuit design, provision has been made for use of the equipment in the following ways:

1. A field intensity measuring equipment operating from a vertical antenna of convenient size.
2. A field intensity measuring equipment operating from a loop antenna with directional properties.
3. A field intensity measuring equipment operating from a small probe responsive to an induction field.
4. A two-terminal voltmeter making both symmetrical and asymmetrical measurements with respect to ground.

A set of eight charts contain simplified operating instructions and a family of calibration curves that are plotted for each individual Radio Interference-Field Intensity Meter IM-37A/PRM-1.

R-F INPUT DEVICES

Input devices for Radio Test Set AN/PRM-1A (fig. 3-1), include a rod antenna, a loop antenna, a loop probe, an r-f probe, and impedance matching networks.

Rod Antenna

Antenna AT-213/PRM-1 is a telescopic vertical rod antenna with an effective length of approximately one-half meter and a physical length of 41 inches. The voltage range of the rod Antenna AT-213/PRM-1 is from two microvolts-per-meter to two volts-per-meter. The rod antenna is a capacitive pickup device, and measurements made with this antenna are affected by conductivity of the ground, nearby metal structures, and the body effect of the operator. For optimum accuracy when using the rod antenna, comparison measurements using the loop antenna and the rod antenna must be made at the frequency in use. The correction factor so obtained is then applied to the rod antenna meter reading.

Loop Antenna

Antenna AT-212/PRM-1 is a shielded loop with rectangular shape and an equivalent diameter of 8 1/4 inches. The loop is a solenoid winding consisting of 2 turns of 13 strand #36 wire, with a voltage range from 10 microvolts-per-meter to 100,000 microvolts-per-meter. The loop antenna may be used as a hand-held probe connected to the end of the 20-foot cable CG-444/U used with the probe antennas.

Loop Probe

The hand-held probe Antenna AT-211/PRM-1 is connected to the LOOP receptacle on the Radio Test Set by means of the 20-foot cable CG-444/U. The loop is a universal winding 1/2" effective diameter, consisting of 13 turns of 15/44 wire. It is enclosed in a phenolic case and can be rotated on its base to utilize the directional characteristics of the loop. The voltage range of the loop probe antenna is from approximately 1,000 microvolts-per-meter to approximately 10 volts-per-meter.

R-F Probe

The r-f Probe MX-980/PRM-1 permits use of the RI-FI meter as a two-terminal voltmeter for measurement of conducted interference on a line. The unit is connected between one side of a line and ground or two lines, balanced or unbalanced to ground. In use, short insulated jumpers are connected to the probe input and the free ends of the jumper are connected to one side of the line and to ground.

Impedance Matching Networks

The three impedance matching networks, CU-195/PRM-1, CU-196/PRM-1, and CU-197/PRM-1 are physically identical except for circuit impedance. They are connected to the ANT receptacle where they present a capacitive reactance equivalent to that of the rod antenna. The 50-ohm unit, CU-197/PRM-1, and the 20-ohm unit, CU-196/PRM-1, are intended for use where it is desirable to terminate a transmission line, an antenna, or other circuits in these resistance values at the input to the RI-FI Meter. The unterminated unit, CU-195/PRM-1, is intended for use with signal generators or other devices whose output is not meant to be terminated in a low resistance.

CONTROL CIRCUITRY

The signal channel, as is evident in the simplified Block Diagram (fig. 3-2), closely

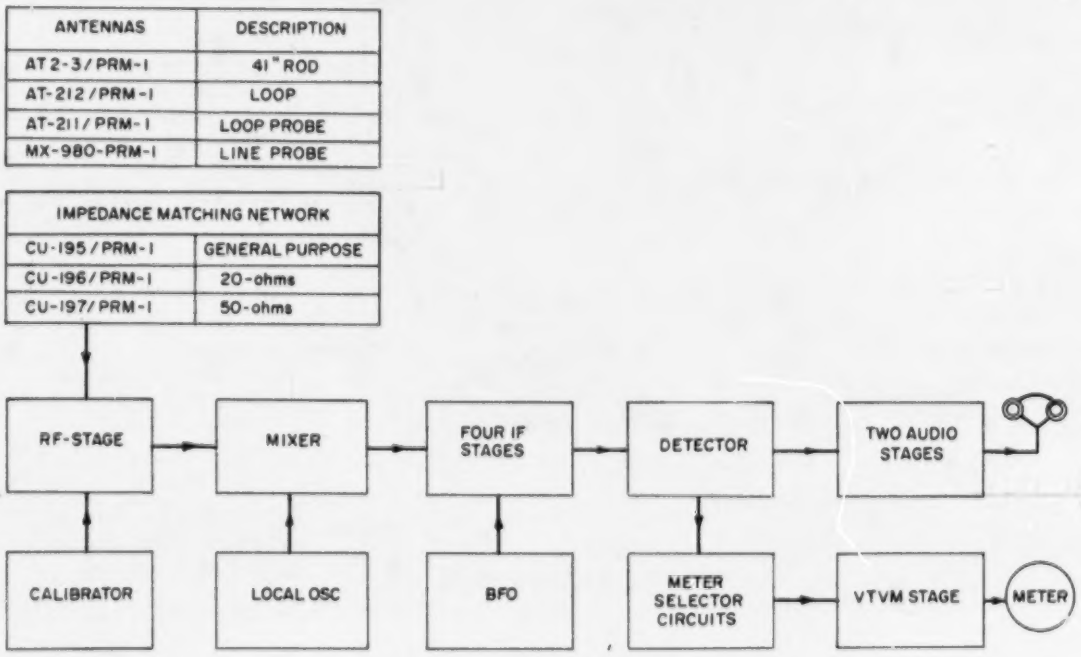

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Figure 3-2.—Radio Test Set AN/PRM-1A, Simplified Block Diagram.

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resembles a superheterodyne receiver in its r-f, i-f, and a-f portions, but differs from most superheterodyne receivers in its provision for attenuation and measurement of detector output.

R-F and I-F Attenuator

The built-in step attenuator provides the following step ratios: 1, 10, 100, 1,000, and 10,000. Provision is made to obtain these ratios by discrete combination of attenuation in the antenna circuit and the first i-f stage.

R-F Stages

The r-f signal or interference (as picked up by the antenna or probe) is delivered to the LOOP or ANTENNA receptacle (fig. 3-3) at the r-f input. The r-f signal is amplified in the r-f stage (fig. 3-2), and mixed with the local oscillator frequency in the mixer stage, to produce the intermediate frequency. The use of two intermediate frequencies (455 KC and 1600 KC) is used to provide continuous

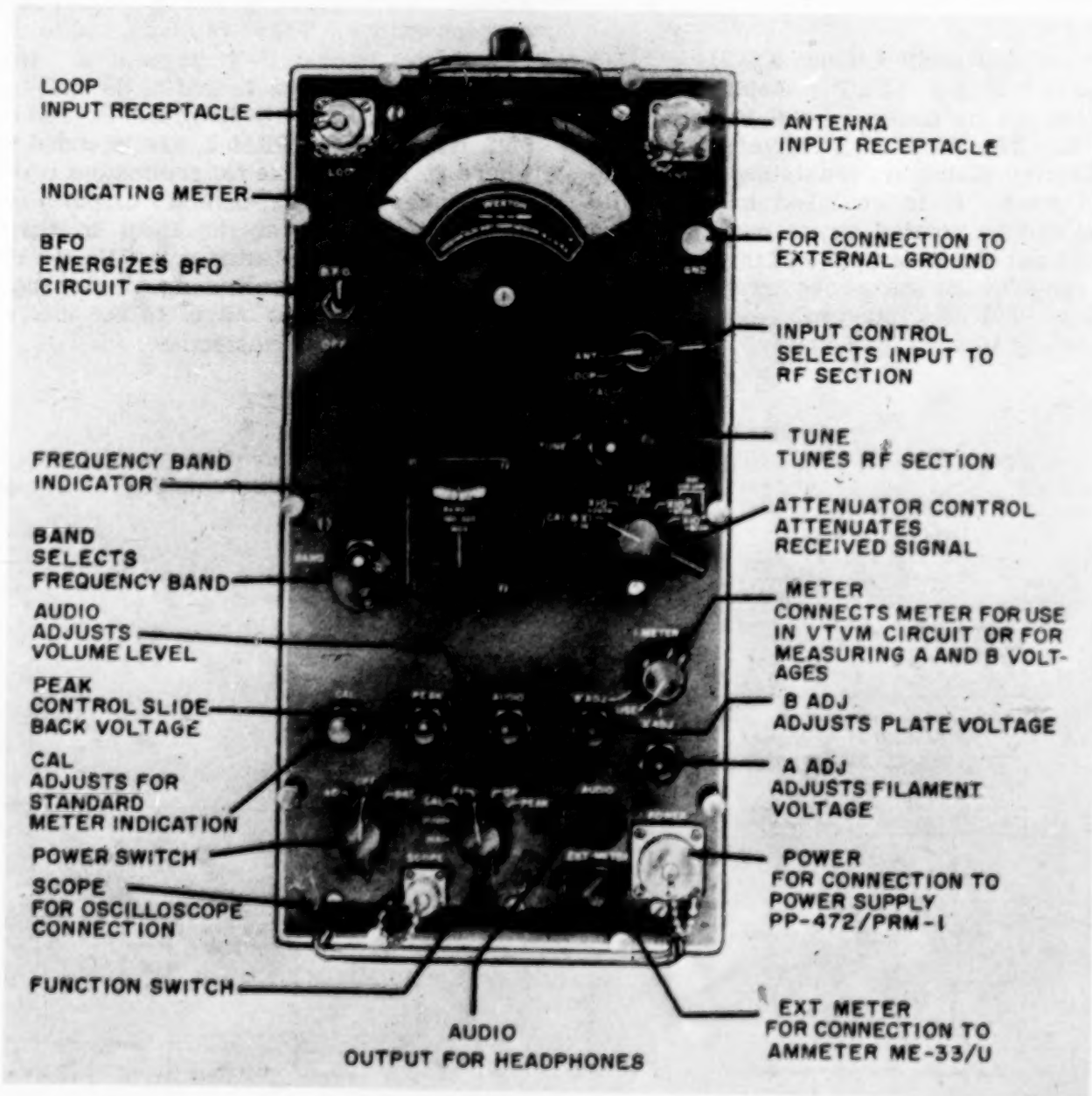

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Figure 3-3.—Radio Interference-Field Intensity Meter IM-37A/PRM-1, Panel Controls and Receptacles.

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Field Intensity Circuit

The AGC and VTVM circuits see a voltage source which charges slowly and discharges slowly so that the meter indication continuously shows an average of the input signal over 600 milliseconds. This is accomplished by the time constant of an RC circuit.

The meter reading for field intensity is proportional to the field intensity of radiated signals, or proportional to the averaged value of r-f interference. The reading will be independent of modulation in the case of modulated CW signals due to a filter preceding the Weighting Circuit.

The Quasi-Peak Circuit

In the quasi-peak function, the time constants of the detector weighting circuits are approximately one millisecond charge and 600 milliseconds discharge. This is arranged by charging a capacitor through the relatively low resistance of a diode and discharging the capacitor slowly, through a resistive load. The meter indication then is near the peak value of an interfering signal, including pulse signals with PRF as low as 300 per second.

The Peak Circuit

In the peak function, the circuit is similar in some respects to the field intensity circuit. The VTVM and AGC circuits are the same, but an additional bias circuit has been added to enable the measurement of peak signal values. The peak value measured is the "peak" as seen by the second detector and not the true peak of the signal at the antenna input. The PEAK function of the function switch acts to apply a d-c voltage in parallel with the signal input. The circuit is similar to an adjustable delayed AGC system, since the d-c voltage is also applied to the detector. The d-c voltage is manually adjusted to the threshold of diode rectification. This measurement technique is similar to that employed in the "slide-back" voltmeter.

POWER SUPPLY

The Power Supply PP-472B/PRM-1, (fig. 3-1) is designed for operation from any a-c power source within the limits of 105-125 and 210-250 volts, and at any frequency between 50 and 1600 cycles per second. It provides a regulated positive 75 volts output for B+ and a 1.1 volts for filament power. When a 230 volt power source is used, the line voltage is reduced to 115 volts by action of an autotransformer. Radio Test Set AN/PRM-1 uses self-contained plate and filament voltage batteries for limited periods of operation in the field. At all times, including periods when the a-c power supply is used, two 4.5 volt and two 1.5 volt bias voltage batteries are required.

RADIO INTERFERENCE CONSIDERATIONS

An open, flat terrain is preferred for making field intensity measurements to avoid the possibility of absorption by dense growths of trees or steep ridges. Also, the face of a nearby cliff may act as a reflector and produce local variations in the intensity of the interference measured.

To isolate the radiated field from the induction field of a source of interference, make radio interference measurements of a radiating source at distances greater than twice the wavelength of the radiated signal. As the amplitude of the induction field energy varies inversely as the square of the distance from the source, the effects of the induction field are negligible at distances greater than two wavelengths.

Interference measurements made near power lines are subject to inaccurate results because of possible reradiation from the power lines. Every attempt should be made to avoid locating the equipment near closed loops present in iron frame buildings and topside structures aboard ship. If possible, avoid locating in the vicinity of underground pipes, trolley cables, or rail lines.

When the equipment is installed aboard ship or in a vehicle, it should be remembered that the metal body or frame tends to distort the pickup pattern of the dipole antenna. In addition, closed loops formed by wiring or structural members will affect the field pattern. In some cases, these errors can be determined with the equipment mounted in a designated location. Correction factors so obtained may then be applied to compensate for pickup pattern distortion.

When a variety of equipment, including radio receivers, is employed at any one site, a check

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for interaction between equipments should be conducted.

The ideal site for making interference surveys is an open, flat terrain at a considerable distance (1000 ft or more) from buildings, electric lines, fences, and other wave obstructing devices. Ideal sites are rare in the more populated sections of the country. Therefore, it is good practice to check a proposed location by making signal measurements of the desired signal at several points in the vicinity. If the same value of field intensity is obtained at each of the points, any one may be considered satisfactory. If it is necessary to use an unsatisfactory site, a series of readings should be recorded at a number of different points in the neighborhood of the selected site, and detailed notes on the site conditions should be appended to the recorded data.

MAKING AN INTERFERENCE SURVEY

An interference survey of a suspected area should begin with a series of measurements, at the frequencies under investigation, made with the appropriate pickup. It is customary in general surveys to make measurements at five frequencies in each band of the equipment with sufficient overlap to ensure complete coverage of all bands. If a station or service is found operating on the frequency selected for measurement, move sufficiently away in frequency to avoid sidebands of the station. The survey report should, however, note the frequency and field intensity of signals from the station.

Certain types of interference surveys require scanning an entire band for evidence of peaks or minima. Any such peaks or minima found must be measured and noted in the survey report.

During the survey, the received signals should be aurally monitored at a volume level that will enable identification of the signal or interference.

Three-point fixes on each source of interference enable the geographic location to be determined by triangulation. Investigate each interference source, moving the RI-FI meter as close as is practical to the source to ascertain the distant fix. When the location has been narrowed down to a small area, use the loop probe to further determine the location of the offending equipment or power line.

If the interference is found to be a power line or other current-carrying conductors, use the RI-FI meter as a two-terminal voltmeter to determine the amount of conducted interference on the line. Standard safety precautions should be considered when connecting to power lines of any equipment, which may be energized from a switch not under the control of the operator of the radio interference measuring set. All connections should be made with the power disconnected from the lines of the equipment under test.

Standardizing Gain

The operator must standardize the gain of the Radio Interference-Field Intensity Meter IM-37A/PRM-1 prior to taking a series of measurements on any one frequency. The operator can detect any radical change in sensitivity of the unit because this condition will necessitate a CAL control setting at a point greatly different from that normally used to obtain the standard gain.

Measuring Sine Wave Signals

Before making any type of measurements, the equipment must be standardized as just discussed. After this procedure has been accomplished the measurement of sine-wave voltages should begin by turning the function switch to the FI position for a rms reading of a CW signal, or to the QP or PEAK positions when the carrier plus modulation is to be measured.

Adjust the position of the attenuator control until the meter reads within the scale range, preferably in the upper portion of the meter scale.

The signal being measured should be close to the frequency of gain standardization, as described above. Otherwise, it will be necessary to standardize the gain at the new frequency before a measurement can be accurately made.

To determine the signal strength, read the indicating meter in microvolts, and multiply this reading by the correction factor obtained from the charts. This product is then multiplied by the attenuator control setting.

OTHER APPLICATION OF THE RI-FI METER

The use of the RI-FI meter previously discussed represents a single test application of the equipment. With a knowledge of the function

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and circuits of the operating controls considered earlier, the ET should recognize the fact that the RI-FI meter makes itself applicable to many test situations.

Measurement as a null instrument in conjunction with r-f bridges and slotted lines, which operate in the 20 to 400 mc frequency range, is possible. Extremely short leads, preferably shielded, must be used and care must be taken to assure proper impedance matching.

Checking the gain of a radio frequency stage in radio equipment by measuring the voltage input to the stage and the signal output of the stage, is another use. It should be noted that the RI-FI meter shunts approximately 50 ohms across the circuit and may upset the stage under test unless appropriately isolated.

You may also check the voltage of any 50-ohm transmission line up to one volt, provided the transmission line is properly terminated. The voltage rating (d-c or a-c power frequencies) that may be applied to the input without damage to the input circuits should not be exceeded.

Another use is determining the loss in a coaxial line connected to a signal generator by comparing the signal level at the input and output ends of the line. The appropriate impedance matching network must be used between the line and the RI-FI meter. To minimize the effects of standing waves, the higher attenuation positions ($X10^2$, $X10^3$, and $X10^4$) should be used when practicable.

FREQUENCY STANDARD AN/URQ-9A

In recent years, dependence on limited quartz-supply sources stimulated instrumentation for crystal-saving devices. Although prompted by crystal-saving, this development also made possible substantially smaller equipments, with multi-channel features; and furnished a means of obtaining increased stabilities.

During the past few years, emphasis in crystal-synthesis development has shifted from crystal-saving capability to precision-frequency generation. For example, in electronic systems today, a synthesizer is used in generating frequencies from a single crystal, internally available or externally supplied. Phase coherence is a prerequisite of performance.

A synthesizer should contain a reference frequency with a stability of at least 1 part in 10^8 part per day, and a means of translating the reference frequency to the required output frequencies. To achieve ideal performance (that is, to deliver one frequency at a time with no spurious output whatsoever), an ideal synthesizer should not contain elements such as oscillators, mixers, and multipliers. Amplification alone should be permissible; and amplifier linearity should be absolute. In reality, the mathematical functions of addition, subtraction, multiplication, and division must be performed in the translation of frequencies.

The method of frequency division has an advantage over that of frequency multiplication. For example; assume that 2 mc and 16 mc are required to be generated; that, in one case, a 16 mc signal is available and that energy is required at 2 mc; and that, in the other case, a 2 mc signal is available when it is necessary to generate 16 mc. When a 2 mc signal must be generated from a 16 mc signal, and a frequency division of 8 is employed, the frequencies developed are harmonically related to the output with a wide frequency separation. However, the multiplication of a 2 mc signal by 8 results in a 16 mc signal with sideband energies at 14 and 18 mc, which require fine tuning circuits to prevent interaction.

Most frequency synthesizers essentially contain a main variable-frequency oscillator (VFO), which will be disciplined by two secondary oscillators of lower frequency, for example, a 10 kc VFO and a 1 kc VFO. All three oscillators are phase locked to the stable crystal-controlled reference oscillator. Thus the stability of the synthesizer output frequencies equal that of the reference oscillator.

The Navy has in use today, transmitters and receivers with frequency synthesizers that require a highly accurate and stable frequency standard so that adjustments can be satisfactorily performed. One of these frequency standards is the AN/URQ-9 with a stability of 1 part in 10^9 parts per day.

The Frequency Standard AN/URQ-9 (fig. 3-4), is a highly stable, multiple-purpose frequency standard designed for continuous-duty use aboard ship and at shore facilities. It provides three output frequencies (5 mc, 1 mc, and 100 kc) at a minimum of 1 volt.

The frequency standard can be used for laboratory frequency measurements and to drive precision timing devices such as a time

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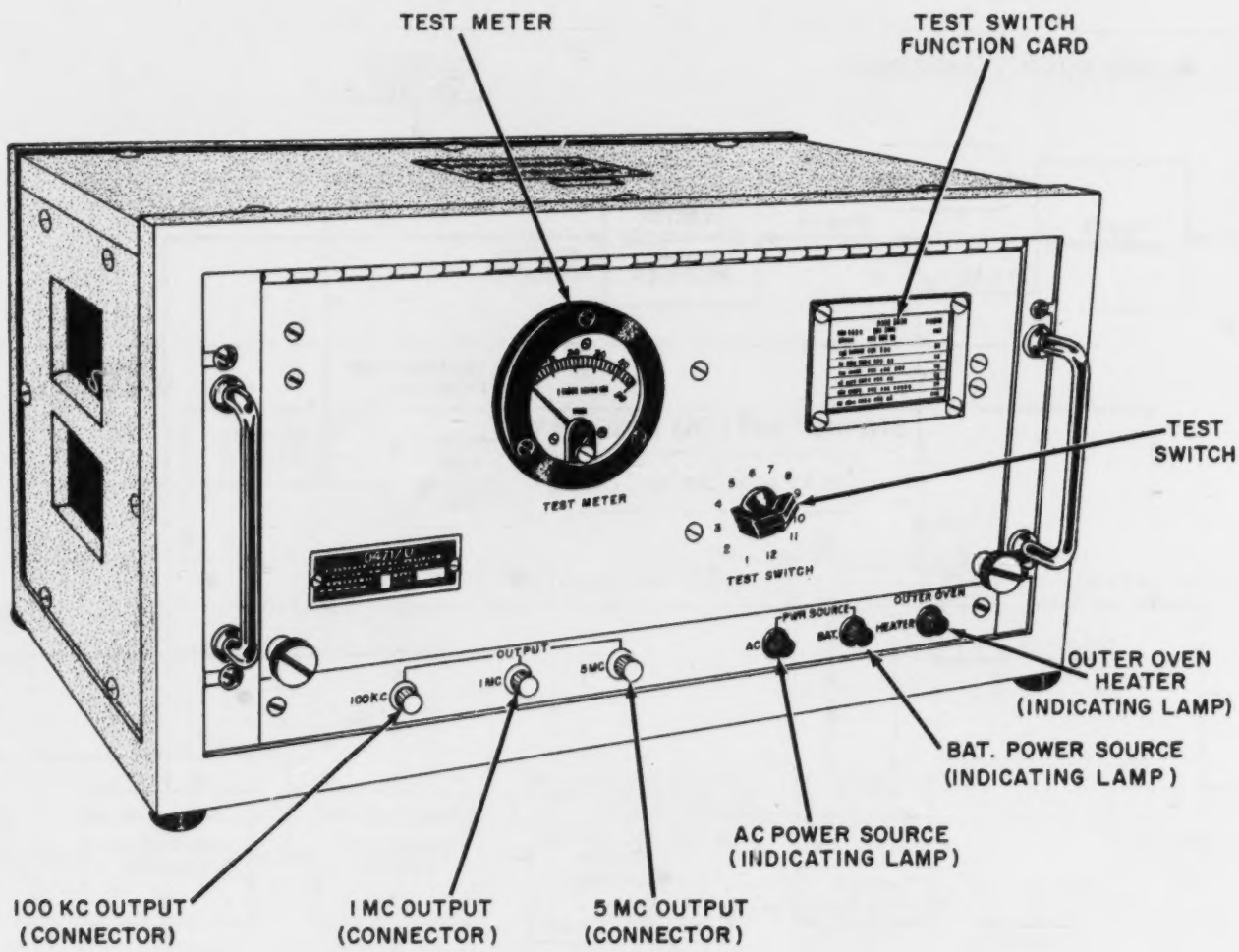

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Figure 3-4.—Frequency Standard, Front Panel Control Locations.

comparator. It can also be used as a standby oscillator unit for other frequency/time-base standards.

The equipment is designed to operate from a nominal 115 volt, 60 cps, single-phase external power source capable of providing 240 watts (approximately 2.0 amps) during periods of maximum battery charging. A battery, which is built into the equipment, is automatically switched into the circuit to maintain operation in the event the external power source fails or is disconnected. When fully charged, the battery is capable of operating the frequency standard for two hours.

The frequency standard consists of three major assemblies (fig. 3-5), a radio-frequency oscillator assembly, a power supply assembly, and a standby battery assembly.

The r-f oscillator assembly contains the crystal, frequency-determining circuit, and amplifiers. The oscillator-amplifier generates a 5.0 mc signal which is fed to the 5.0 mc to 1.0 mc frequency divider. There the signal is amplified and a portion fed to output connectors on the front and back panels of the set. The other portion of the 5.0 mc signal is reduced to a 1.0 mc signal by the frequency divider circuits. The 1.0 mc signal is then amplified and a portion is fed to output connectors on the front and back panels of the set. The other portion of the 1.0 mc signal is fed to the 1.0 mc to 100 kc frequency divider where it is reduced to a 100 kc signal. The 100 kc signal is amplified and fed to output connectors on the front and back panels of the frequency standard.

The power supply assembly and the regulator-converter in the r-f oscillator assembly provide the regulated and unregulated voltages required by the set. If the external power source fails, or the power supply assembly develops a trouble, the set

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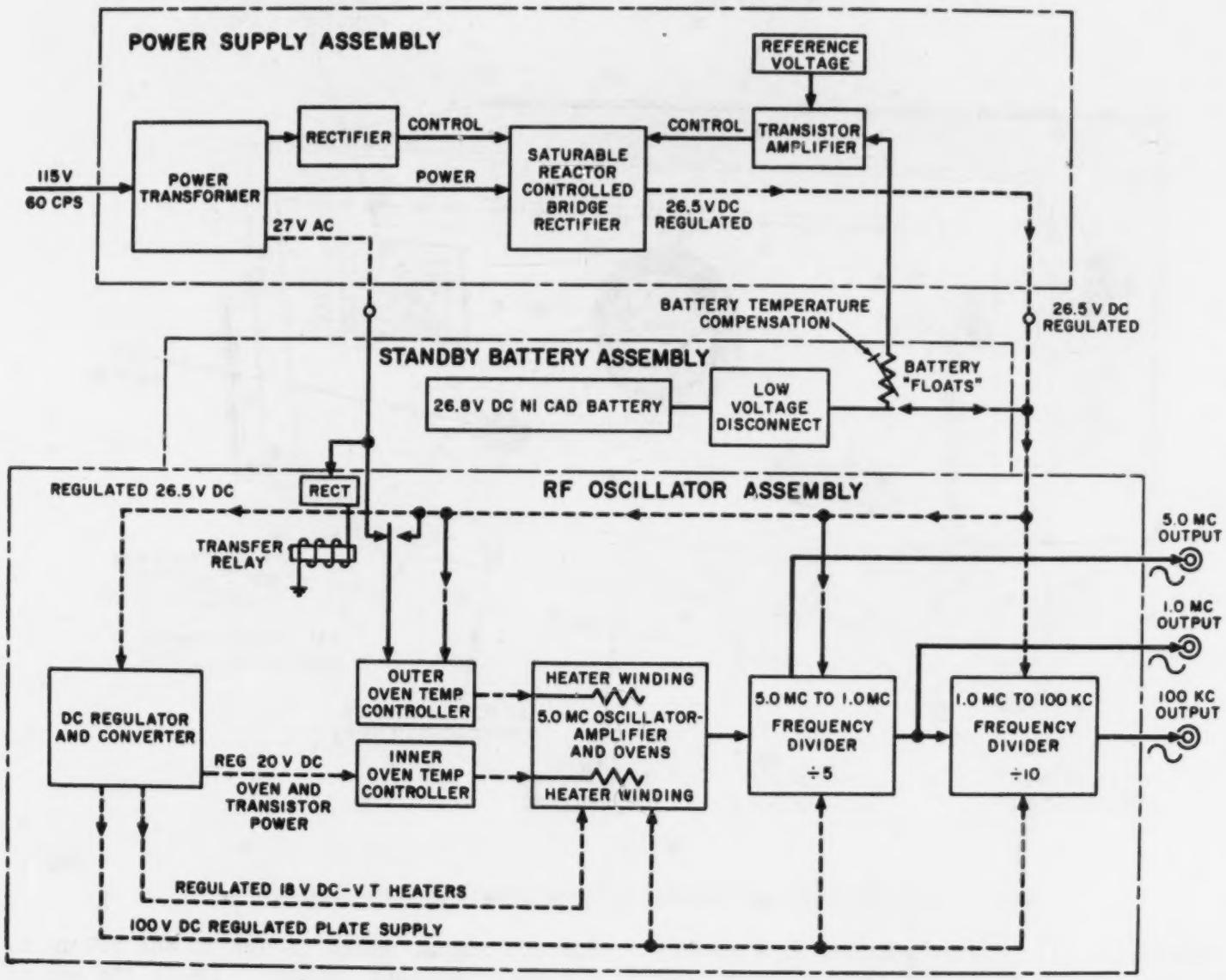

Figure 3-5.—Frequency Standard, Functional Block Diagram. 162.6

automatically switches over to battery operation. The frequency standard will operate from the battery for approximately two hours.

The frequency standard will be received by a calibration laboratory prior to being installed at the using activity. The calibration laboratory technicians will perform initial operation and calibration tests on the set and it will then be transferred to the using activity without being turned off (operating on the standby battery). Once the frequency standard is in operation and is calibrated, it must not be allowed to stop operating as this will cause the ovens to cool and will alter the operating frequency of the crystal. If the set does get turned off, it should be returned to the calibration laboratory for re-calibration; or, if the set is installed at a shore facility or aboard a ship that is in port, it may be allowed to run for one week and checked by the calibration activity for stability and correct frequency before being placed in service.

ELECTRONIC COUNTER 524D

A COUNTER type frequency meter (fig. 3-6), Electronic Counter 524D (Hewlett-Packard), can measure frequencies from 10 cps to 10.1 megacycles and display the readings in digital form on an eight-place indicating system. In addition to making direct frequency measurements, the counter can measure periods (0 cps to 100

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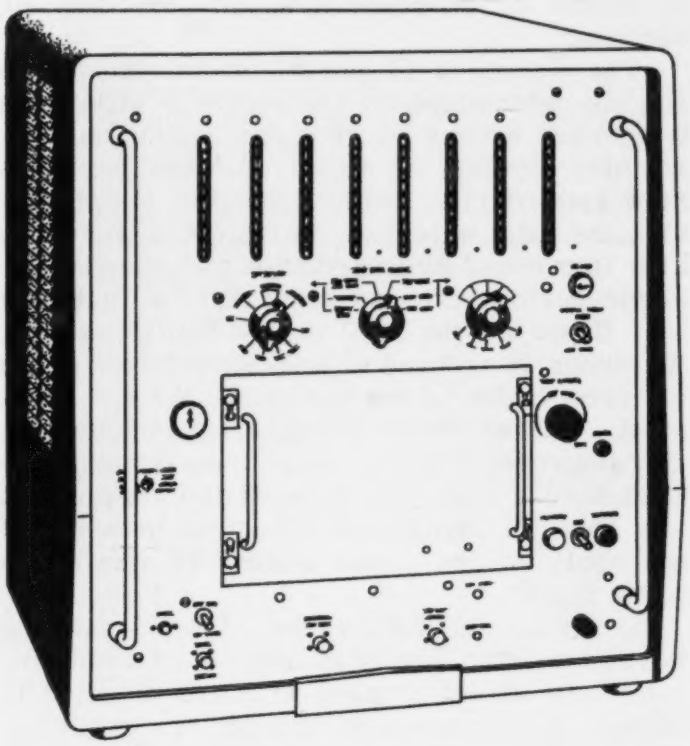

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Figure 3-6.—Electronic Counter, 524D.

kc), frequency ratios, and total events. A self-check feature enables an operator to verify instrument operation for most types of measurements. The internal oscillator is stable within 5 parts of 10^8 per week. Thus these counters make good secondary frequency standards.

To increase the range of measurement, seven accessory plug-in units (not shown) are available. Frequency Converter Units, Models 525A, B, and C, increase the frequency range from 10.1 to 100 mc, 100 to 220 mc, and 100 to 510 mc respectively. Video Amplifier unit 526A increases the basic set sensitivity to 10 mv in the range of from 10 cps to 10.1 mc; Time Interval unit 526B permits measuring time intervals from 1 μsec to 10^7 seconds; Period Multiplier unit 526C extends the period measurement range up to 10,000 periods of unknown frequency; and Phase unit 526D permits measuring phase angle with an accuracy approaching $\pm 0.1^{\circ}$. In addition to the plug-ins, the Model 540B Transfer Oscillator extends, as a companion instrument, the frequency range up to 12.4 megacycles (10^9 accuracy).

To measure frequency the basic circuit arrangement of the Electronic counter is shown in figure 3-7. For frequency measurement the signal is fed through a Signal Gate to a series of digital type counters. A precision time interval obtained from the Time Base Section opens and closes the Signal Gate for an extremely accurate period of time, for example, 1 second. The counters count the number of cycles entering through the gate during the 1-second interval and then display the total. The answer is read directly as the number of kilocycles occurring during the 1-second interval. The period of time the Signal Gate remains open is set by the FREQUENCY UNIT switch (not shown). For each position of the FREQUENCY UNIT switch the illuminated decimal point is automatically positioned so that the answer is always read directly in kilocycles. The answer is automatically displayed for a period of time determined by gate time or the setting of the DISPLAY TIME control on the front panel, whichever is greater.

To measure a period or time interval the application of the two signals reverses as shown by the dotted lines in figure 3-7. The period or time interval to be measured is connected to open and close the Signal Gate while one of the standard frequencies from the Time Base Section is passed through the Signal Gate to the counters. When measuring period, one cycle of the incoming signal opens the gate, the next cycle closes it. The number of cycles of the standard frequency from the Time Base that occurred during the period are then indicated on the counters. The standard frequencies obtained from the Time Base have been selected so that the answer to the measured period will always be displayed in direct-reading units of time: seconds, milliseconds, or microseconds.

Provision is also made in the circuit to permit measurement of the average of 10 periods

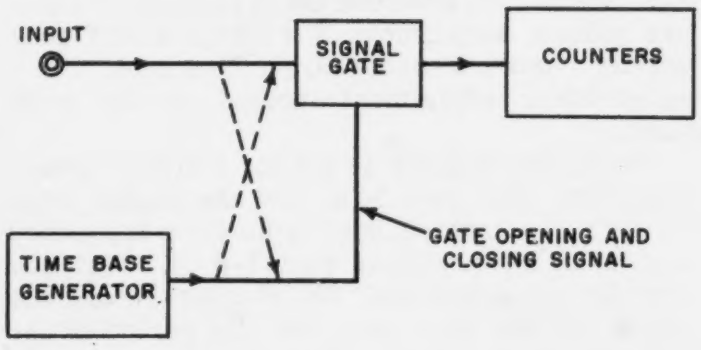

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Figure 3-7.—Basic block diagram of the 524D.

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of the unknown frequency. Higher accuracy can thus be obtained than with single period measurements.

The accuracy of frequency measurements is determined by an internal oscillator and by a possible error of ± 1 count that is inherent in the gate and counter type of instrument. At low frequencies, greater accuracy can be obtained by measuring the period of the signal than by measuring the frequency directly.

The block diagram (fig. 3-8, A) shows the circuit arrangement of the basic counter when measuring frequencies in the range of 10 cps to 10.1 mc. To measure frequencies up to 510 mc, one of three frequency converter units is required (fig. 3-8, B). As stated above, the 525C Frequency Converter unit is used between 100 and 510 mc. In these frequency converters the input signal is mixed with a harmonic of 10 mc so that the difference between the signal and the harmonic is not more than 10.1 mc. The difference frequency is counted and displayed. By adding the count displayed by the counter to the known 10 mc harmonic the input signal frequency is determined.

All three frequency converters have tuning systems to indicate the correct mixing frequency. However, if the mixing frequency is within 1 mc of the unknown frequency, there is a possibility of two answers, for you may not know whether to add or subtract the displayed reading from the mixing frequency. In such cases, make additional measurements using the two adjacent mixing frequencies to determine the unknown frequency. When making the final measurement choose a mixing frequency which is at least 100 kc away from the unknown.

When measuring frequency, the counter will count sine waves, rectangular waves, and positive pulses. To measure the frequency of negative pulses, adjustment of a FREQUENCY sensitivity control is necessary. This control is a screwdriver adjustment located on the front panel.

When the counter is set for PERIOD measurements, the time base and the signal input circuits are interchanged from their frequency measurement positions (fig. 3-8,C). With the circuits so connected, the counters count the output of the time base for the period of the unknown input signal. Thus the standard frequencies generated in the time base are used as units of time to measure the unknown period in terms of microseconds, milliseconds, or seconds.

The accuracy of period measurements is largely determined by the accuracy with which triggering occurs at the same point on consecutive cycles of signal voltages having a slow rate-of-rise. Note that when the signal-to-noise ratio improves, the triggering accuracy also improves. Averaged over ten periods, the single-period error is reduced by a factor of ten. If you use the 526C Period Multiplier unit, the error is reduced an additional factor of ten for each factor of ten you extend the measurement. The accuracy of triggering is considerably improved when the waveforms being measured have a fast rise time. For example, you can obtain a significant reduction in error if you apply square waves instead of sine waves to the input.

In order to follow the slowest-changing waveforms, the period measurement input circuits are direct-coupled and are adjusted to trigger at the zero-volt crossing of a negative-going voltage. Thus any d-c component in the input signal will shift the triggering level so that the maximum slope no longer occurs at the zero-volt level, resulting in a loss of accuracy. If the d-c component is large enough, there may be no triggering at all. An external generator can be used in place of the time base generator for period measurements.

The counter can be used to measure the RATIO of two frequencies. The higher frequency is passed through the signal gate to the counters and is counted for a period of time determined by either one period or ten periods of the lower frequency, which controls the opening and closing of the gate (fig. 3-8,D).

Ratio measurement accuracy is determined by the same factors as period measurement accuracy: consistency of triggering by the lower input frequency and the inherent error of ± 1 count of the higher frequency. The 526C Period Multiplier unit is used to reduce the error by extending the number of periods of the lower frequency over which the measurement is made. For each factor of ten the measurement is extended, the error is decreased by a factor of ten.

Although the time base generator is not used during ratio measurements, you cannot make ratio measurements if the time base generator is not operating. The counter has a holdoff circuit which disables the signal gate if the time base generator fails.

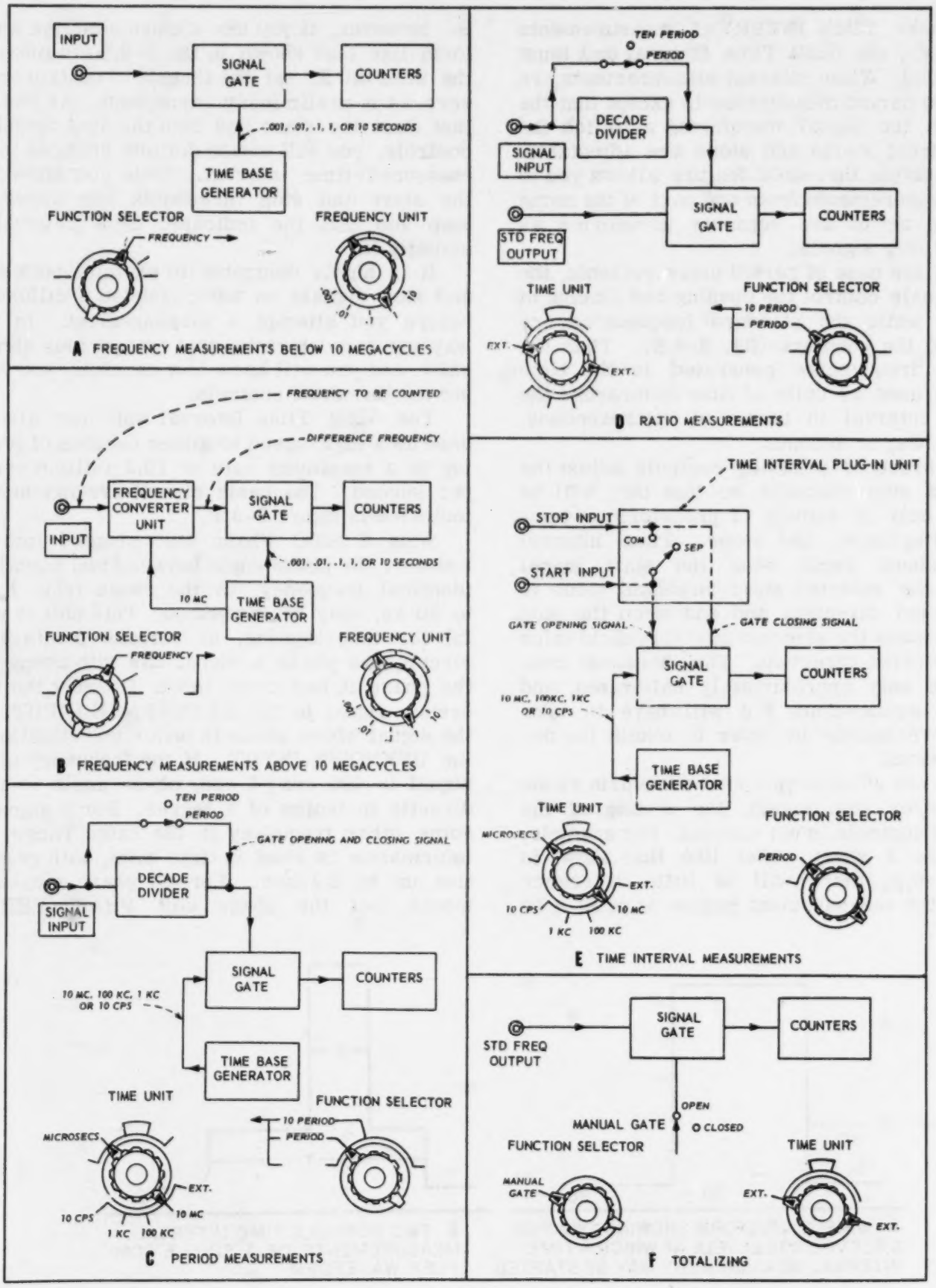

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Figure 3-8.—Test measurement, block diagram.

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To make TIME INTERVAL measurements (fig. 3-8,E), the 526B Time Interval unit must be installed. Time interval measurements are similar to period measurements except that the points on the signal waveforms at which the measurement starts and stops are adjustable. The adjustable threshold feature allows you to make measurements from one part of the same waveform or to use separate waveforms as start and stop signals.

As in the case of period measurements, the input signals control the opening and closing of the gate while the standard frequencies are passed to the counters (fig. 3-8,E). Thus the accurate frequencies generated in the time base are used as units of time to measure the unknown interval in terms of microseconds, milliseconds, or seconds.

The threshold-selecting controls adjust the start and stop channels so that they will be actuated only by signals of predetermined polarity, amplitude, and slope. Time interval measurements begin when the start signal crosses the selected start threshold value in the selected direction and end when the stop signal crosses the selected stop threshold value in the selected direction. The threshold controls are only approximately calibrated, and in some applications you will have to take special precautions in order to obtain the desired interval.

If you use an uncomplicated waveform as the start and/or stop signal, the setting of the threshold controls is not critical. For example, if you use a sharp pulse like that shown in figure 3-9,A, there will be little difference whether the measurement begins at point A or B. However, if you use a more complex waveform like that shown in fig. 3-9,B, to measure the interval X, set the threshold controls near zero as a preliminary adjustment. As you adjust first the start and then the stop threshold controls, you will notice definite changes in the measured time interval. Thus you know that the start and stop thresholds are above the step and that the indicated time interval is actually X.

It is highly desirable to examine both start and stop signals on a d-c coupled oscilloscope before you attempt a measurement. In this way you can determine that no spurious signals exist, and you will know how carefully you must set the threshold controls.

The 526B Time Interval unit may also be used as a high-speed totalizer capable of counting at a maximum rate of 10.1 million events per second. The basic circuit arrangement is indicated in figure 3-8,F.

With a 526D Phase unit plugged into the counter, the phase angle between two signals of identical frequency, in the range from 1 cps to 20 kc, may be measured. This unit is useful for investigating, at various points in a circuit, the phase a signal has with respect to the phase it had at the input. Connect the reference signal to the REFERENCE INPUT, and the signal whose phase is under investigation to the UNKNOWN INPUT. If the frequency of the signal is 400 cps $\pm$4 cps, phase angle is read directly in tenths of a degree. For a signal of some other frequency in the rated range, the information is read in time units, with resolution up to 0.1 μsec. For all phase measurements, set the phase unit PHASE/PERIOD

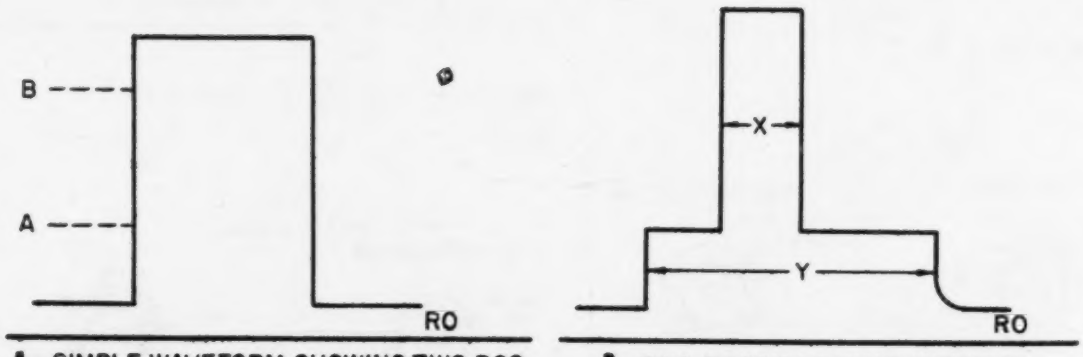

A SIMPLE WAVEFORM SHOWING TWO POSSIBLE VOLTAGE LEVELS AT WHICH A TIME INTERVAL MEASUREMENT MAY BE STARTED

B TWO POSSIBLE TIME INTERVAL MEASUREMENTS OF A SINGLE COMPLEX WAVEFORM

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Figure 3-9.—Time interval waveforms.

switch to PHASE, the REFERENCE LEAD/LAG switch to the type of measurement desired, and the counter FUNCTION SELECTOR to PERIOD.

In general, circuit action for a phase measurement is similar to that for a time interval measurement. Trigger circuits in the Phase unit supply the pulses which open and close the signal gate in the counter. Arrangement of the circuits will be similar to that shown in figure 3-8,E, for time interval measurements.

A recommended method of TUNING RADIO RECEIVERS USING A FREQUENCY COUNTER has been included in the EIB, No. 569. This method will soon become the accepted procedure for all such tuning.

DIGITAL READOUT ELECTRONIC COUNTER AN/USM-207

The AN/USM-207 is a portable, solid-state electronic counter for precisely measuring and displaying on an 9-digit numerical readout the frequency and period of a cyclic electrical signal, the frequency ratio of two signals, the time interval between two points on the same or different signals, and the total number of electrical impulses (totalizing). The counter also provides the following types of output signals:

1. Standard signals from 0.1 cps to 10 mc in decade steps derived from a 1 mc frequency standard, frequency dividers, and a frequency multiplier;
2. Input signals divided in frequency by factors from 10 to 10^8 by a frequency divider;
3. Digital data of the measurement in four-line binary-coded-decimal form with decimal point and control signals for operation of printers, data recorders, or control devices; and
4. A 1 mc output from a frequency standard.

GENERAL DESCRIPTION OF AN/USM-207

The AN/USM-207 (figure 3-10) consists of a major counter assembly, two plug-in

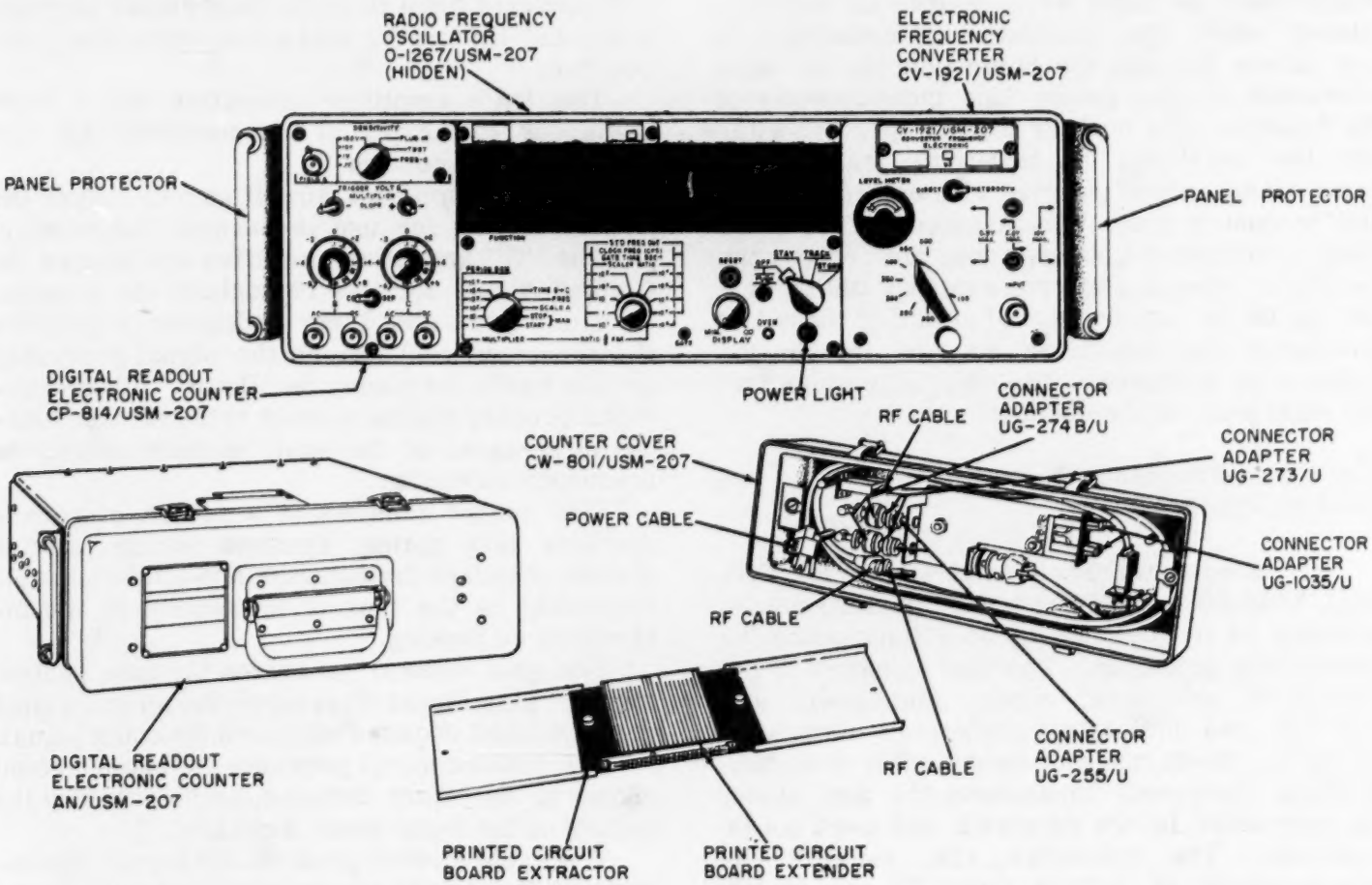

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Figure 3-10.—Digital readout electronic counter AN/USM-207.

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assemblies which install in recesses on the front and rear panel, and a group of accessory cables and connectors stored in the detachable front cover.

Digital Readout Electronic Counter
CP-814/USM-207

The major assembly Digital Readout Electronic Counter CP-814/USM-207 contains the input amplifiers; gate control; display; reset and transfer control; frequency multipliers; time base dividers; decade and readout boards; numerical display tubes; decimal point and units indicators; power supply and regulator; and controls associated with these circuits.

Radio Frequency Oscillator
O-1267/USM-207

The Radio Frequency Oscillator O-1267/USM-207 plug-in assembly develops a 1 mc signal and includes its own power supply. The oscillator includes the 1 mc output receptable which may be used as a source of that frequency when the oscillator is connected to a-c power through the basic counter or when connected to the power line independently of the counter. The counter may be operated without the oscillator in totalizing, scaling the input signal, time interval with external clock, and frequency ratio measurements. For other measurements the counter does not require the oscillator when a separate external 100 kc or 1 mc signal is connected. In either of these two situations the oscillator may be left in the counter or removed. The oscillator plugs into the right rear of the counter.

Electronic Frequency Converter
CV-1921/USM-207

The Electronic Frequency Converter CV-1921/USM-207 plug-in assembly permits measurement of frequencies up to 500 mc using the heterodyne principle. The unit consists of the broadband amplifier, mixer, multiplier, and controls and indicators associated with these circuits. When measurements other than heterodyne frequency measurements are made, the converter is not required, but need not be removed. The converter also permits the measurement of signals from 35 mc to 100 mc with a greater sensitivity than available with the basic counter. The converter plugs into the right front of the counter.

FUNCTIONAL DESCRIPTION

Figure 3-11 is the overall functional block diagram of the counter. To make a measurement, requires two types of information; a count signal, and a gate control signal. These two signals may be generated within the instrument or they may be supplied from outside sources. The type of measurement the counter will make depends upon the relationship of these two signals. In any function the instrument counts the count signal for a period of time determined by the gate control signal. Routing of these signals within the instrument is accomplished by logic circuits. These logic circuits are controlled by means of the front panel controls.

The radio frequency oscillator (0-1267/USM-207) generates a signal of precise frequency for use throughout the counter or to provide a precise 1 mc signal for use outside the equipment.

The electronic frequency converter accepts radio frequencies between 100 mc and 500 mc and converts them to radio frequencies between 5 mc and 100 mc for measurement by the basic counter.

The "A" amplifier amplifies the A input signal or the output of the converter for use throughout the counter.

The "B" amplifier amplifies and shapes the B input signal for use throughout the counter.

The "C" amplifier amplifies and shapes the C input signal for use throughout the counter.

The 10 mc and 1 mc multiplier multiplies the frequency and shapes the signal generated by the radio frequency oscillator. It also provides precise timing signals to the various functional sections of the basic counter and to the frequency converter.

The scaler consists of a series of decade dividers and gating systems which provide divided standard frequencies and control signals depending on the type of measurement the instrument is making.

The gate control generates the gate control signal. This signal determines the length of time that the count decades will count the count signal.

The count control provides the proper count signal to the count decades, as selected by the setting of the front-panel switches.

The cycle control produces all signals necessary to display the measurement results on the readout and to recycle the counter.

The count decades count the count signal when permitted to do so by the gate control.

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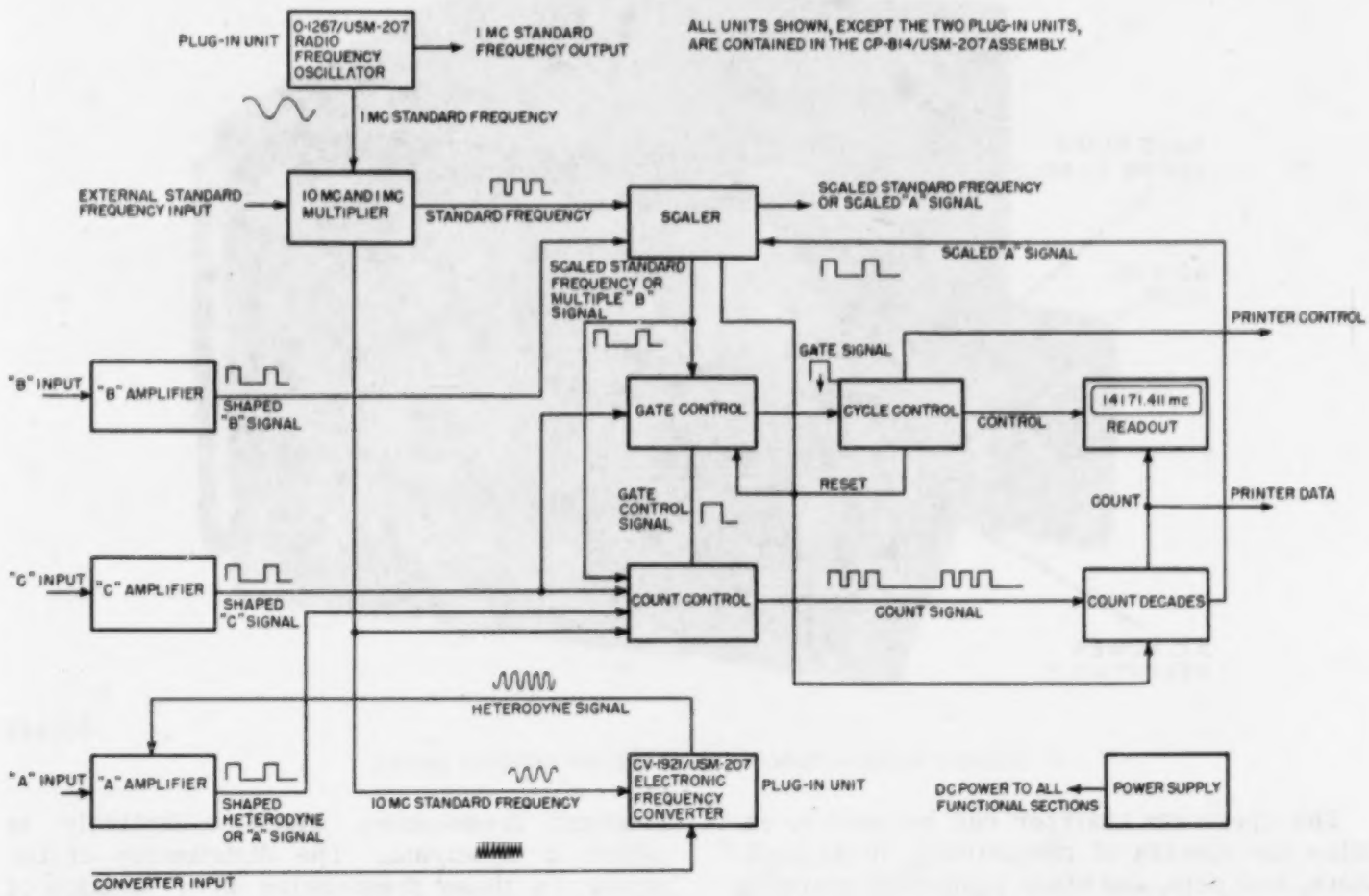

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Figure 3-11.—Digital readout electronic counter AN/USM-207 overall functional block diagram.

The result of their counting becomes the final reading displayed by the readout at the end of each measurement.

The readout receives binary-coded-decimal (BCD) data from the count decades, decodes this data into decimal form and drives the readout indicator tubes. The readout also contains memory circuits which function when the counter is operated in the "Store" mode.

The power supply supplies all d-c power required by the basic instrument and the converters and consists of seven d-c supplies. Five of these supplies (+18 volt, +12 volt, +6 volt, and -12 volt) are regulated and two (+180 volt and +45 volt) are unregulated.

SPECTRUM ANALYZER

A spectrum analyzer is a device that sweeps over a band of frequencies to determine (1) what frequencies are being produced by a specific circuit under test and (2) the amplitude of each frequency component. To accomplish this, the spectrum analyzer presents, on an oscilloscope display, a pattern in which the relative amplitudes of the various frequencies of the spectrum are plotted on the vertical, or Y axis, while the frequencies themselves are plotted on the horizontal, or X axis, of the cathode-ray tube. The overall pattern of this display indicates the proportion of power present at the various frequencies within the spectrum. A representative spectrum analyzer equipment is the AN/UPM-33, which consists of the TS-148/UP Spectrum Analyzer with carrying case and accessories.

The control panel of the TS-148/UP spectrum analyzer is shown in figure 3-12. The circuits of this unit will be discussed in this section since they represent to a great extent spectrum analyzer circuits in general.

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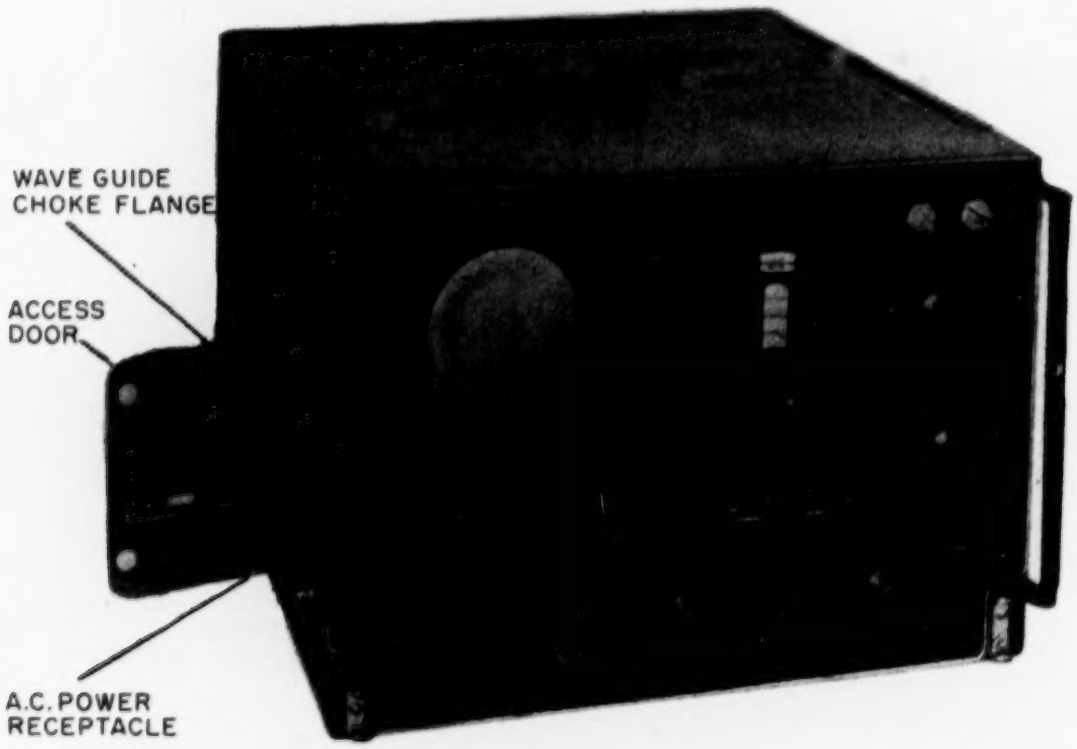

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Figure 3-12.—Spectrum analyzer control panel.

The spectrum analyzer can be used to examine the spectra of magnetrons, local oscillators, test sets, and other equipment operating within its frequency range. The frequency meter is used to measure accurately the frequencies of any of the above equipments, or to set the frequency of radar and beacon local oscillators in radar sets. The spectrum analyzer can also be used as an f-m oscillator to tune T/R boxes and ATR boxes in transmitters.

COMPONENTS OF A SPECTRUM

A common conception of the output of a pulsed oscillator is a single frequency, which is turned on and off for periods of standard duration. This action is similar to the output of a conventional c-w telegraph transmitter. The output of the pulsed radar oscillator does not consist of a fundamental frequency that is turned on and off, but must be considered as a fundamental frequency that is pulse modulated by the waveform of the trigger pulse.

Effects of Modulating Pulses

When modulated, any fundamental frequency will produce a fundamental frequency with sideband frequencies, which collectively is called a spectrum. The distribution of the power on these frequencies is a function of the modulation. Normally, modulation is plotted on an amplitude and time basis as shown in figure 3-13B, C, and D.

Assume F to be the fundamental frequency of the oscillator. Waveform A shows the fundamental frequency plotted as amplitude against time. The number of periods occurring within one second determines the frequency of the oscillation. The amplitude is represented as proportional to the distance between the negative and positive peak of one cycle.

In a spectrum pattern, this same frequency and amplitude would be represented as F in figure 3-13,E. Points along the horizontal axis represent frequency, which increases from left to right, while distance along the vertical axis above the baseline represents amplitude. Thus, two methods of diagramming the results of amplitude-modulating a carrier frequency are shown.

Assume that F_p1 is a modulation frequency applied to the fundamental frequency, F. This is normally represented on an amplitude-versus-time basis. This same type of modulation is shown by two lines on the spectrum pattern.

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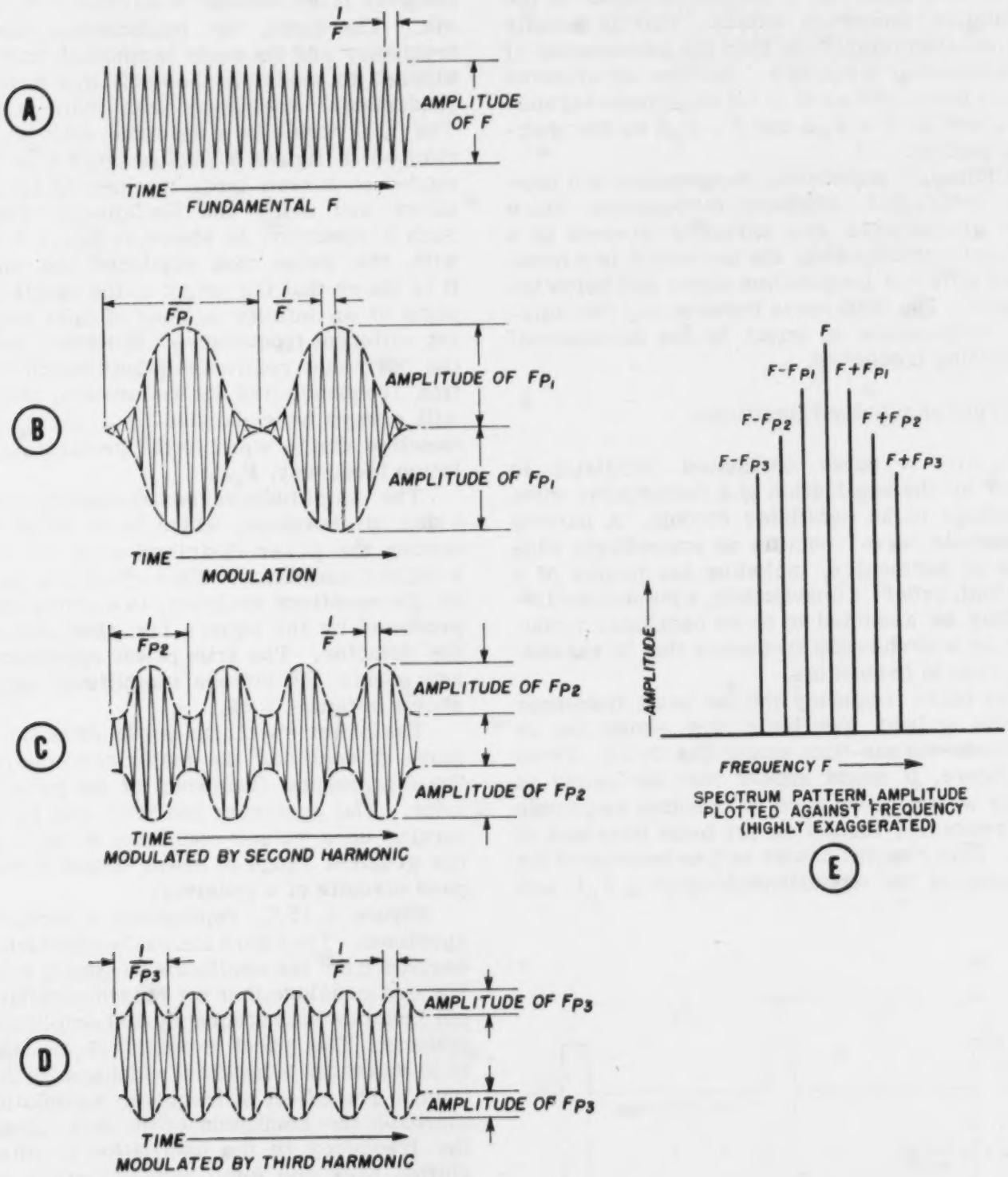

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Figure 3-13.—Comparison of amplitude versus time to amplitude versus frequency.

These lines are marked F+Fp1 and F-Fp1 in figure 3-13,E. The reason for this is that the modulated wave actually represents the results of heterodyning two different frequencies. These frequencies are effectively present in the modulated output, and can be detected by suitable receivers. One of the frequencies is the sum of the two, and the other is the difference. The amplitudes of the new frequencies are each half the amplitude of the modulating frequency.

Assume also that a second harmonic of the modulating frequency exists. This is usually of a smaller amplitude than the fundamental of the modulating frequency. Another set of waves will be developed as at C for amplitude-versus-time, and at $F + F_p2$ and $F - F_p2$ on the spectrum pattern.

Additional modulating frequencies will produce additional sideband frequencies. Since these frequencies are normally present in a harmonic relationship, the net result is a number of different frequencies above and below the carrier. The difference between any two adjacent frequencies is equal to the fundamental modulating frequency.

Spectrum of a Pulsed Oscillator

Usually a pulse modulated oscillator is pulsed by the application of a rectangular wave of voltage to an oscillator circuit. A narrow rectangular wave contains an exceedingly wide range of harmonics, including harmonics of a very high order. Consequently, a pulsed oscillator may be assumed to be an oscillator modulated by a modulation frequency that is exceedingly rich in harmonics.

The pulse frequency and the basic frequency of the pulsed oscillator are shown on an amplitude-versus-time graph (fig. 3-14). From this figure, it might appear that the output is simply a pure c-w wave of constant amplitude and frequency, turned on for brief intervals of time. This concept cannot be true because of the presence of the modulation frequency F_p1, and the very large number of harmonics, F_p2, F_p3, etc. Therefore, the fundamental modulation frequency and its many harmonics may be considered to modulate the oscillator to produce a fundamental frequency with many sidebands. The net result is a spectrum such as was developed in figure 3-13,E, except that it is extended to a very large number of frequencies above and below the fundamental frequency. Such a spectrum is shown in figure 3-15 along with the pulse that produced the spectrum. It is shown that the output of the oscillator consists of an infinite number of lines representing different frequencies. However, because of the harmonic relationship between the modulation frequency and its harmonics, these lines will always be separated by a distance on the baseline that is equal to the fundamental modulation frequency, F_p1.

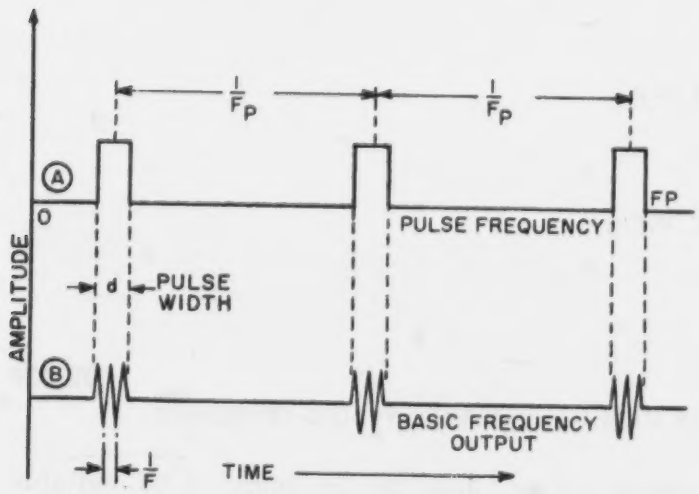

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Figure 3-14.—Output of a pulsed oscillator.

The amplitude-versus-frequency plot provides an envelope, which is of value in estimating the power distribution in the output of a pulsed oscillator. This spectrum, as plotted on the spectrum analyzer, is a power spectrum produced by the square law characteristics of the detector. The true power spectrum, which represents the voltage (amplitude) squared is shown in figure 3-15.

The power spectrum emphasizes the importance of confining the majority of the power at the fundamental frequency of the pulsed oscillator. The spectrum analyzer can be used in turning up a pulsed oscillator so as to provide the greatest range of power output in the bandpass circuits of a receiver.

Figure 3-15,C, represents a sample of the spectrum. The figure shows the effective voltage derived from the oscillator frequency spectrum. We can conclude that the pulsed oscillator output contains both frequency and amplitude components. The effect of amplitude modulation is to increase the number of sidebands in the spectrum. The effect of frequency modulation is to increase the amplitude of the side lobes, since the frequency of the oscillation is effectively shifted back and forth between points on each side of its true fundamental frequency.

BLOCK DIAGRAM

Basically, the spectrum analyzer consists of a superheterodyne receiver with a frequency-modulated, r-f oscillator (fig. 3-16). The analyzer r-f oscillator is modulated with a sawtooth voltage, which causes the oscillator to

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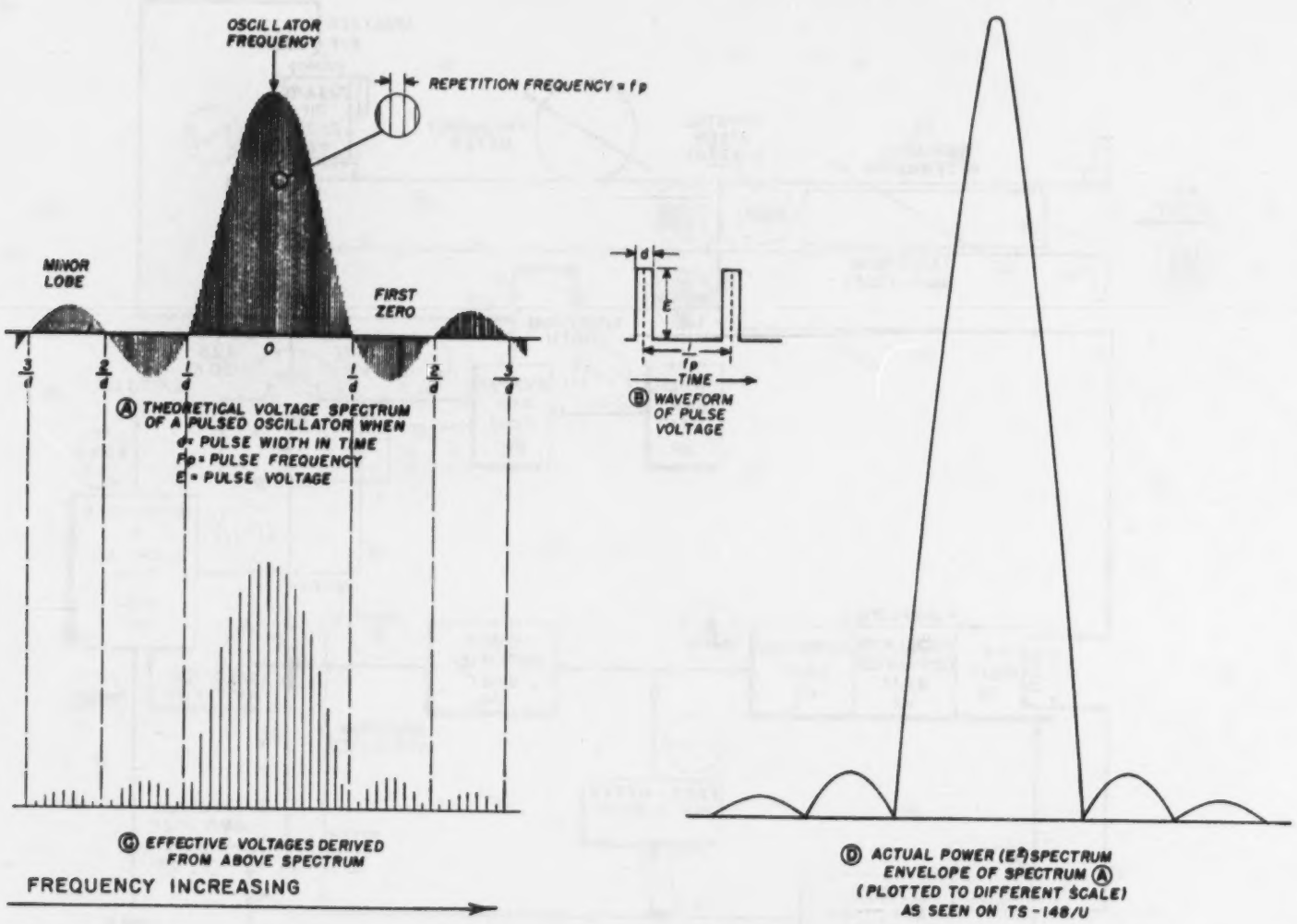

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Figure 3-15.—Relationship between a voltage spectrum and a power spectrum.

operate over a range of frequencies. As the frequency of the analyzer r-f oscillator increases, it beats with the incoming signal to produce an i-f signal for various frequency components present in the spectrum of the received signal. These signals are presented on a cathode-ray oscilloscope as the spectrum pattern.

The r-f input is applied to a variable attenuator. The attenuator controls the spectrum amplitude, and consists of two carbonized resistance cards inserted in the r-f input end of the waveguide. Varying the contour of these cards varies the degree of attenuation. Maximum attenuation is obtained when the cards are flexed together in the center of the waveguides. The attenuator controls the amplitude of the r-f signal either entering the analyzer, or leaving the analyzer when it is used as a signal generator.

The analyzer r-f oscillator is a reflex velocity-modulated klystron. It is frequency modulated by a portion of the sweep voltage, which is applied to the oscilloscope deflection plates. The sweep voltage creates a maximum frequency swing in the oscillator output of 40 to 50 mc. The analyzer r-f oscillator output is matched to the load by the fixed attenuator in the waveguide.

The incoming signal and the output of the r-f oscillator are mixed at the crystal mixer. The output is applied to the input circuit of the tuned i-f amplifier section to produce the intermediate frequency of 22.5 mc.

An absorption-type frequency meter is mounted in the waveguide at a point between the crystal and the r-f oscillator. The meter consists of a cavity with dimensions that can be varied by a front panel control. Each time the frequency of the r-f oscillator passes through

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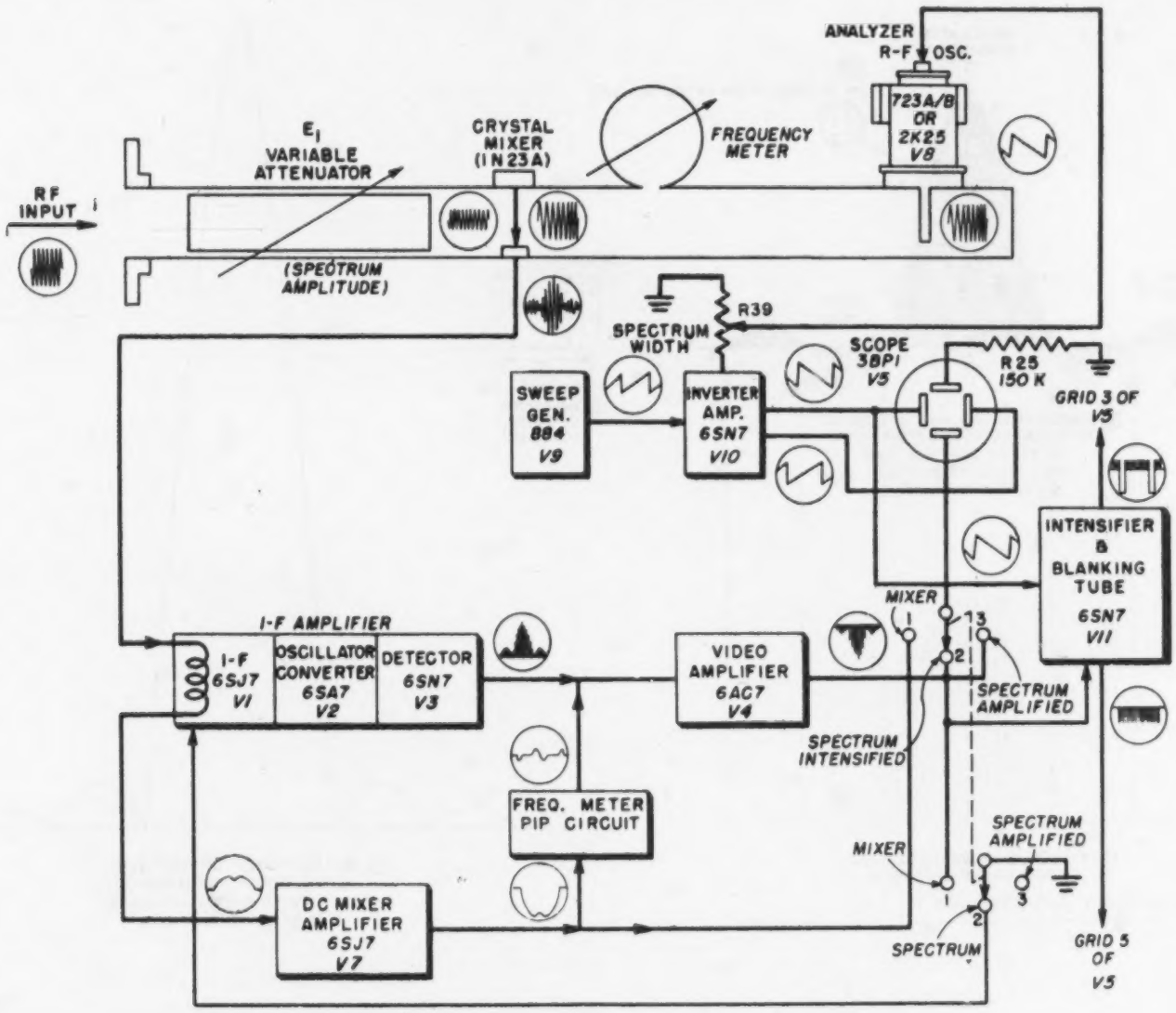

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Figure 3-16.—Spectrum analyzer, block diagram.

the resonant frequency of the frequency meter, the meter absorbs some of the r-f power. This causes a sharp decrease in the amplitude of the output of the r-f oscillator that is applied to the crystal. The change in amplitude is caused to appear on the scope as a sharp pip, which is used as a frequency marker. The pip occurs when the frequency of the r-f input coincides with the frequency of the meter.

The output of the crystal mixer is applied to the input circuit of the 22.5-mc intermediate frequency amplifier. The output of the i-f amplifier section is applied to the oscillator-converter.

The oscillator-converter contains a local oscillator operating at a frequency of 19.5 mc. The intermediate frequency is changed to three megacycles in this stage by beating the 19.5-mc frequency against the 22.5 mc from the crystal mixer. The sharply tuned plate circuit of the oscillator-converter produces a 50-kc circuit bandpass. The output is applied to the detector stage.

The detector section functions as an infinite impedance detector. The rectifier output of the detector is applied to the video amplifier.

The video amplifier stage has two inputs. One is the output of the detector, and the other the frequency meter pip obtained from the d-c amplifier through a differentiating circuit. The output of the video amplifier is coupled to the vertical deflecting plates of the oscilloscope. A portion of the video output is used to trigger the intensifying stage.

When the selector switch on the front panel is in the MIXER position (position 1), the d-c mixer amplifies the output of the crystal mixer and applies it through the selector switch to the vertical plates of the cathode-ray tube for test purposes. In the other two positions of the selector switch, the output of the d-c mixer is applied to the video amplifier. The end pips of the waveshape appearing at the video amplifier grid are derived by differentiation in the plate circuit of the d-c mixer amplifier. The center pip corresponds to the point of resonance of the frequency meter.

The sweep generator is a gas tube relaxation oscillator that generates a sawtooth output at frequencies between 10 and 30 cps. The output of the sweep oscillator is used to drive the sweep inverter amplifier.

The sweep inverter amplifier provides push-pull deflection voltages for the horizontal plates of the cathode-ray tube. It also supplies modulating voltage to the analyzer r-f oscillator and trigger voltage for the blanking section.

When the selector switch is placed in either of the SPECTRUM positions (positions 2 or 3 on the front panel), the video amplifier signal triggers the intensifier tube. The output thus produced is coupled to the intensifying grid of the cathode-ray tube.

The input voltage from a section of the sweep inverter amplifier is used to trigger the blanking tube. The output of this tube is applied as blanking voltage to eliminate the return trace that would otherwise appear on the scope screen.

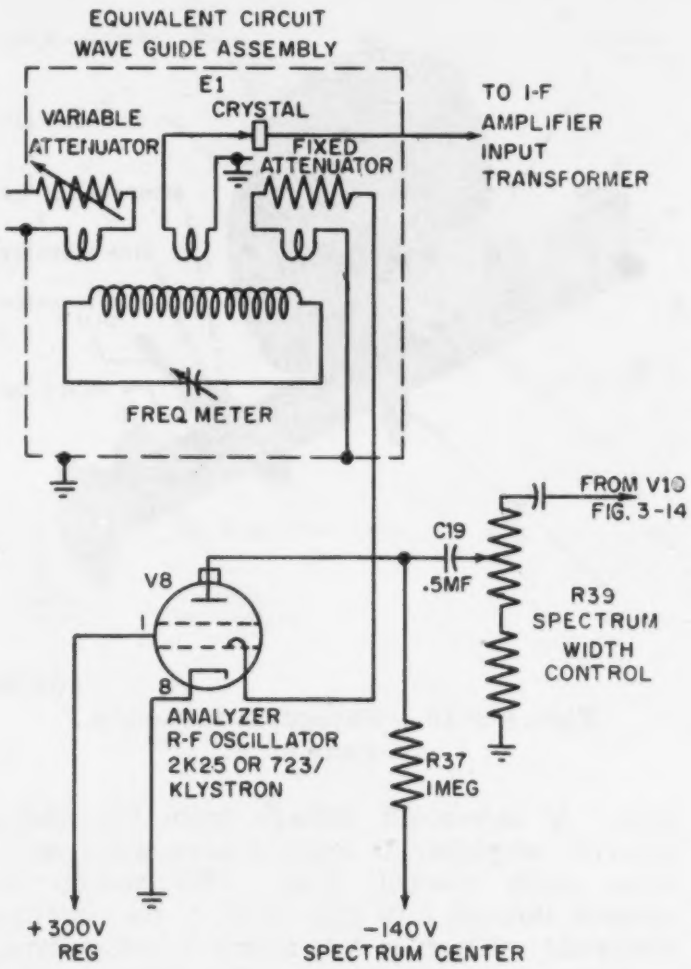

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Figure 3-17.—Wave guide assembly and analyzer oscillator, schematic.

CIRCUIT OPERATION

The attenuator, analyzer r-f oscillator, frequency meter, and crystal mixer circuits of the spectrum analyzer are discussed schematically due to the unique manner in which they have been assembled. The more common oscilloscope circuits such as the sweep generator, and the intensifier, video, sweep inverter, and blanking and d-c mixer amplifiers have been omitted. Also this receiver section including the i-f, oscillator-converter, and detector circuits are not treated further because they have been covered in Basic Electronics NavPers 10087-B.

Attenuator

A schematic diagram of the waveguide assembly circuit and the analyzer oscillator is shown in figure 3-17. Radio frequency signals from an outside source enter the waveguide and pass through the variable attenuator to the crystal mixer. The attenuator (fig. 3-18) controls the amount of signal voltage that reaches the mixer, and therefore controls the amplitude of the pattern on the screen. The control knob for the variable attenuator is marked, SPECTRUM AMPLITUDE, on the front panel.

The attenuator consists of two carbonized coated resistance strips, which lie flat against the walls of the waveguide. The ends are fastened down but still allow the strips to slide slightly as they are bowed into the center of the guide. As the strips move inward, they intersect more and more of the r-f energy and thus cause the attenuation to increase. The range of the attenuator is from 70 db to 3 db.

Analyzer R-F Oscillator

The analyzer r-f oscillator, V8, uses a Type 2K25 or 723A/B Shepard-Pierce reflex klystron

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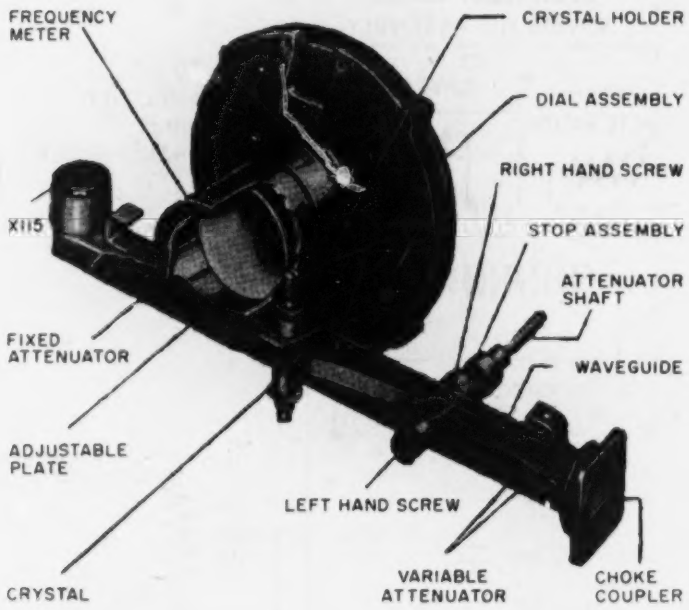

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Figure 3-18.—Waveguide assembly, cut-away view.

tube. A saw-tooth voltage from the sweep inverter amplifier is applied across the spectrum width control, R39. This voltage is coupled through C19 (fig. 3-17) to the repeller electrode. Klystron V8, forms a reflex-type, variable-cavity oscillator. The tube contains an electron gun to emit electrons into the cavity. The cavity is maintained at +300 volts regulated. The repeller electrode is connected to a -140 volt source through R37.

The electrons from the cathode are accelerated as they pass through the positive grids. The a-c potential of the grids (caused by the movement of electrons in and around the grids) changes at the frequency of the oscillator. If a group of electrons arrive at the first grid when it is positive with respect to the second, the electrons are accelerated and pulled away from the electrons that immediately follow. If the second grid is still negative when the group of electrons reach it, the group will be slowed and bunched closer together.

If the second grid is not negative, the electrons pass through it to the negative repeller where they are repelled back into the cavity. If the electrons arrive back at the cavity in phase with the a-c potential of the cavity, they reinforce the bunching effect, giving up energy to the cavity.

The result of this action is a velocity-modulated stream of electrons flowing in the cavity. As the bunched electrons pass through each grid, it becomes alternately positive and negative. The frequency of this oscillating action is determined by the spacing between the grids, the volume and shape of the cavity, the space between the repeller and the cavity, and the voltage on the repeller. Assuming that the d-c potentials on the repeller and the cavity are constant, the voltage and spacing of the repeller act to control the transit time of the electrons, which fixes the frequency of the oscillation.

The analyzer r-f oscillator may be tuned in either of two ways. One way is by means of a mechanical screw (fig. 3-19). The screw, operated by the oscillator frequency control on the front panel, places a stress on a pair of struts on the side of the tube. As the struts are lengthened they expand the cavity to increase the spacing between the two grids and vary the capacity in the resonant cavity.

The second method used to tune the analyzer r-f oscillator involves varying the voltage on the repeller electrode. The spectrum center knob on the front panel is a fine frequency control, which varies the d-c potential on the repeller. The spectrum center potentiometer is not shown on the schematic. Actually, the klystron will only operate within definite ranges of repeller voltage. The ranges are called modes. The analyzer r-f oscillator normally has a d-c potential of -140 volts applied to the repeller electrode, and makes use of the modes that appear in the -100 to -180-volt range.

It is necessary to frequency modulate the analyzer r-f oscillator V8 in order to display on the scope screen each frequency component of the signal under test. The pulse coupled into the waveguide through the variable attenuator contains many frequencies. The klystron frequency is caused to vary by sweep modulation. The two varying frequencies, when heterodyned at the crystal mixer, will produce a 22.5-mc output at various times or at various points along the frequency sweep of the r-f oscillator. Figure 3-20 shows the spectrum, and how the two frequencies are heterodyned to produce the spectrum components.

The signal at the beginning of the sweep represents the lowest frequencies in the lower sideband (fundamental frequency minus the higher order harmonics) and is followed in turn by the higher frequencies in the lower sideband (fundamental frequency minus the higher order harmonics) until the fundamental frequency is reached. The succession of i-f signals continues

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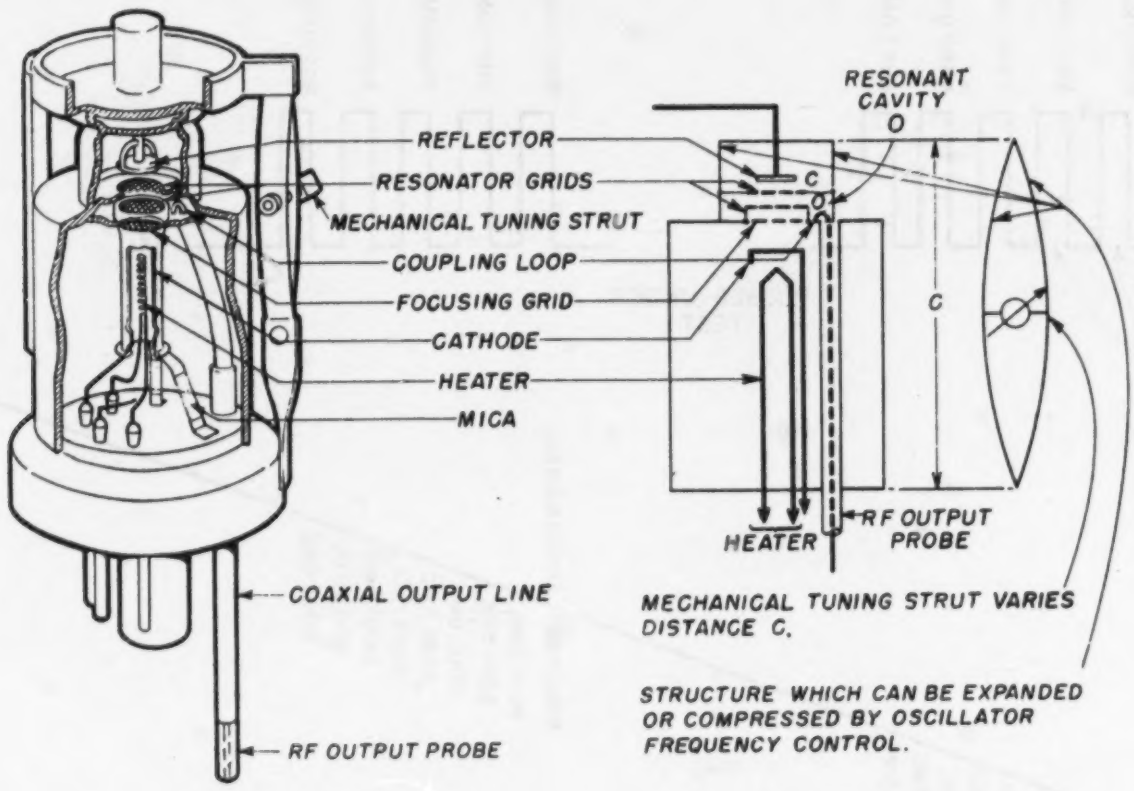

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Figure 3-19.—Analyzer r-f oscillator tube.

through the upper sidebands until the highest frequency is reached. Since the trace on the scope is synchronized in time with the frequency swing of the analyzer r-f oscillator, the sideband frequencies will be spread out from left to right as shown in figure 3-20.

The output of the analyzer r-f oscillator is passed from the coupling loop inside the cavity of the klystron, V8 (fig. 3-17), through a fixed attenuator, to the crystal mixer. The fixed attenuator isolates the analyzer r-f oscillator from the rest of the waveguide so that it is unnecessary to make any adjustments on the mixer when tuning over the frequency range. A portion of the oscillator output is used by the crystal in the heterodyning process. The portion not used in this process moves past the variable attenuator and out into the waveguide. This portion of the r-f is of particular importance when the analyzer is used as a signal generator.

Frequency Meter

The power from the r-f oscillator goes past the frequency meter where a small portion of the energy is absorbed by the cavity of the meter. The frequency meter is a high Q cylindrical cavity-type meter with a mechanically variable length. The frequency range of the meter is 8470 to 9630 mc.

Each time the frequency of the analyzer r-f oscillator sweeps through the frequency to which the frequency meter is tuned, the meter absorbs some of the r-f power. The absorption results in a sharp reduction of the analyzer r-f oscillator component of the crystal current. This reduction, or pip, is applied to the d-c mixer amplifier and is used to indicate the coincidence of the frequency meter with unknown frequencies on the scope screen.

Crystal Mixer

The crystal mixer is used to rectify the heterodyne frequency produced by mixing the f-m output of the analyzer r-f oscillator with the r-f input signal in the waveguide. When the input signal is 22.5 mc above or below the frequency of the analyzer r-f oscillator, the i-f amplifier responds to the output of the crystal.

The crystal is located between the frequency meter and the variable attenuator (fig. 3-18).

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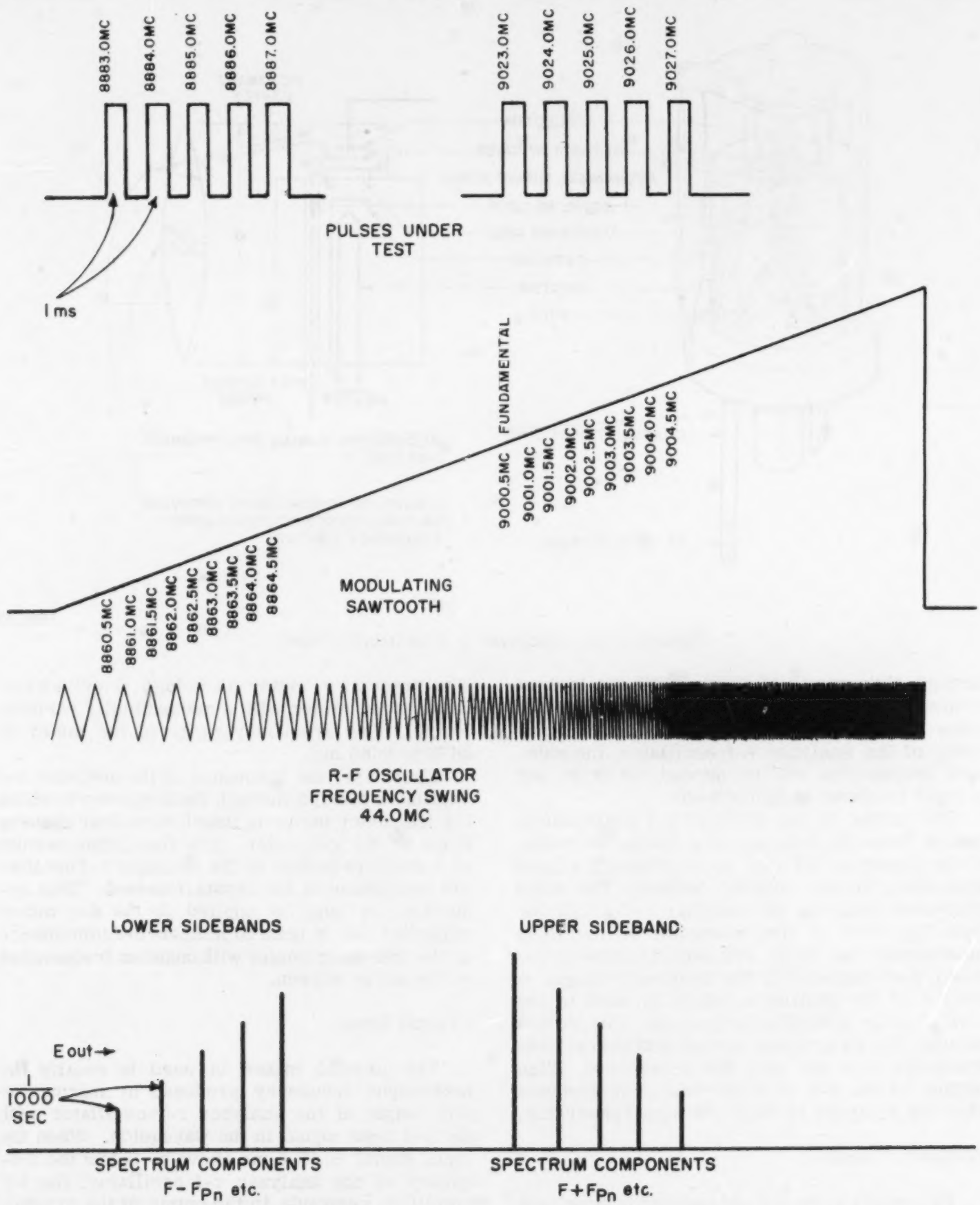

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Figure 3-20.—Method of producing spectrum frequencies.

The current through the crystal represents the rectified components of the signals. The output of the crystal is transformer coupled to the input of the i-f amplifier. The signal contains a rectified component that is proportional to the power output of the analyzer r-f oscillator with respect to the frequency.

PROCEDURE FOR OBSERVATION OF SPECTRA

Assuming that the spectrum analyzer has been installed and turned on, the selector switch should be placed in the MIXER position. In this position of the switch, adjustments may be made on the analyzer r-f oscillator. The spectrum width control should be turned in a clockwise direction until its setting is nearly maximum.

After all necessary adjustments have been made on the analyzer, and the desired width of the scope trace is set, place the selector switch in the SPECTRUM or SPECTRUM AMPLIFIED position. Use the spectrum amplified position if there is no likelihood of interference from any adjacent radar equipment. If interference occurs, spectrum position should be used.

Point the waveguide, which is accessible through the side door shown in figure 3-18, at the radar antenna or to the magnetron output. Coupling the waveguide too close to the source will burn out the attenuator and crystal mixer in the analyzer. Likewise, if the coupling is too close, the probability of magnetron pulling is increased.

An antenna horn and fittings (component parts of the TS-148/UP) may be used if the former method does not supply satisfactory results. This method can be used to pick up the output of the magnetron at distances up to 100 ft if the two antennas are pointing directly at each other.

The operator should never attempt to increase the amplitude of the spectrum trace by increasing the coupling until it is ascertained that the amplitude cannot be increased by adjusting the spectrum amplitude control (attenuator) or by placing the selector switch in its SPECTRUM AMPLIFIED position, or both. To do so would burn up the resistance cards in the attenuator and burn out the crystal, even though the equipment is turned off.

The antenna horn should be pointed directly to the source under test. In the case of an oscillator, it is seldom necessary to remove the oscillator cover. The magnetron and local oscillator spectrums may be observed simultaneously if a proper location for the antenna horn is found that produces sufficient attenuation to the output of the magnetron.

If a very stable method of coupling is desired, remove the antenna horn and connect the cable to the directional coupler or wave selector which is inserted at some convenient place in the transmission line of the radar equipment. The spectrum analyzer will then receive approximately one percent of the power in the directional coupler. This method is very satisfactory when it is necessary to check the antenna while it is in motion to see if it is pulling the frequency of the magnetron.

Observation of Patterns

Adjust the spectrum amplitude control to obtain the desired amplitude on the screen. Rotate the spectrum width control counterclockwise until the spectrum gains sufficient detail to make observation easy. If more pulses are desired in the spectrum, turn the sweep frequency control counterclockwise to a lower sweep frequency.

Frequency Measurement

The frequency meter pip that is visible when the selector switch is in the MIXER position (fig. 3-21) represents the actual frequency of

NO SIGNAL PRESENT EXCEPT THAT OF ANALYZER R-F OSCILLATOR

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Figure 3-21.—Frequency meter pip. (Selector switch in MIXER position.)

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the frequency meter, as read on the frequency meter dial. When the selector switch is in either of its other two positions for frequency measurements, the reading on this dial does not represent the frequency being measured. The unknown frequency must be computed from the dial reading by adding or subtracting the 22.5-mc intermediate frequency of the analyzer.

Whether the intermediate frequency is added or subtracted depends on the image the frequency meter pip is made to coincide. Two images will appear for each component of the spectrum (fig. 3-22). The frequency of the analyzer r-f oscillator increases as the sweep progresses from left to right across the screen. This action causes an image to be produced below and above the 22.5-mc intermediate frequency. In most cases, both images can be made to appear on the screen although, in actual practice, one is centered on the screen so that the other does not appear.

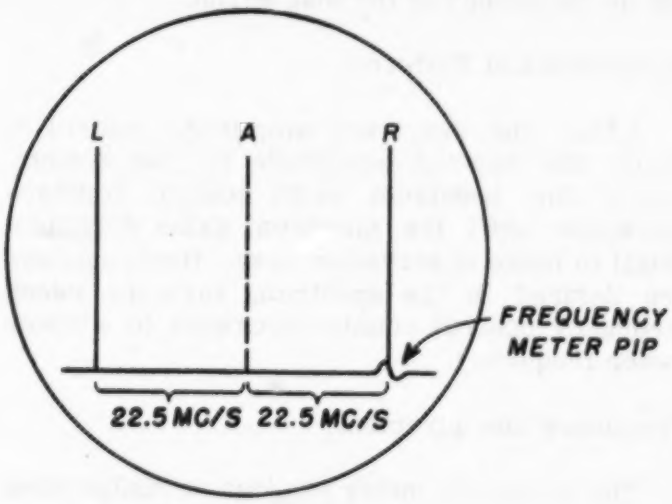

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Figure 3-22.—Right-hand and left-hand patterns.

If the image selected for frequency determination is the one on the right, it is necessary to subtract 22.5 mc from the dial reading. The remainder thus obtained represents the frequency of the unknown signal. If the left image is selected, it is necessary to add 22.5 mc to the dial reading. Since the two images appear above and below the true frequency by 22.5 mc, it is obvious that the two readings may be made directly from the meter, and the average taken to obtain the unknown frequency.

Another very accurate method may be used if the unknown signal is stably coupled to the analyzer. The method consists of tuning the frequency meter until its pip is equidistant from the two images (fig. 3-23). While tuning the meter, both images must be carefully observed. At the instant the resonant frequency of the frequency meter equals the frequency of the unknown signal, it will be possible to see both images dip simultaneously. The reduction in amplitude occurs because the frequency meter absorbs energy from the unknown signal frequency. In this case, the reading on the frequency dial represents the actual frequency of the unknown signal.

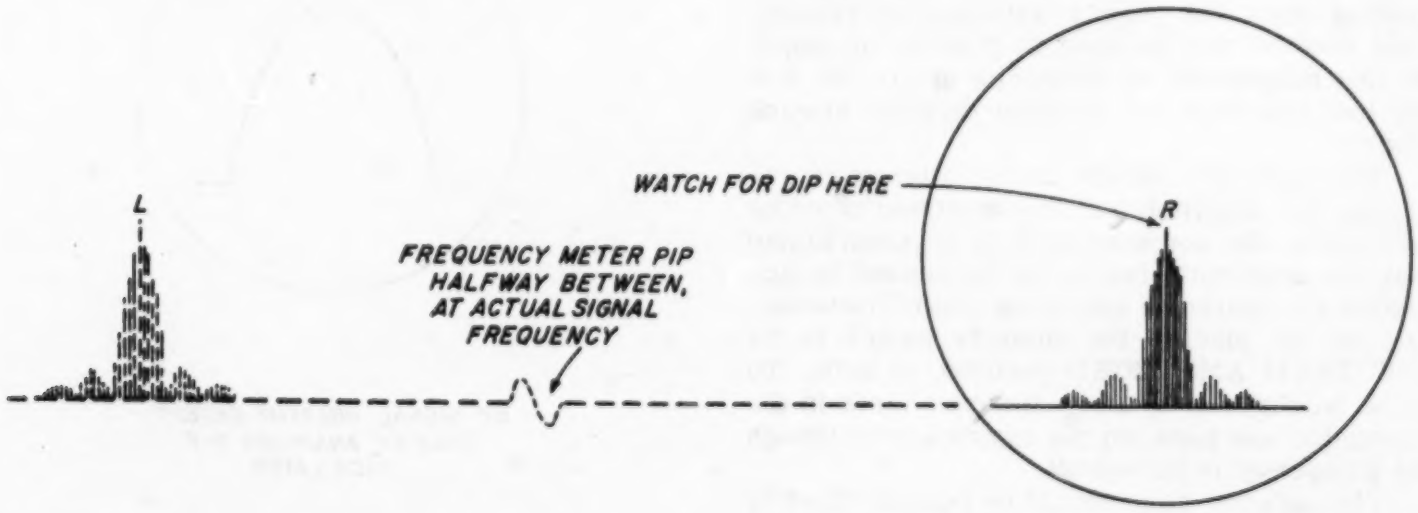

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Figure 3-23.—Determination of frequency by tuning frequency meter for dip in spectrum.

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Measurement of Radar Local Oscillator Frequency

There are two similar methods for measuring the frequency of a radar local oscillator. The choice of methods depends upon whether the intermediate frequency is 30 mc or 60 mc.

Assume that the radar intermediate frequency is 60-mc, and that the local oscillator frequency is above that of the magnetron. It should be noted that two frequencies 60 mc apart cannot be seen on the same scope trace. This is true because the full width of the i-f above and below the analyzer radio frequency is only 45 mc wide (fig. 3-24). In order to see both patterns simultaneously, a unique use is made of the fact that two spectrum images appear for each signal. In practice, the spectrum center control is used to make the right-hand spectrum of the magnetron appear on the left side of the scope. The left-hand pattern of the radar local oscillator should then appear to the right of this pattern. The pattern represented by the dotted lines in the figure does not appear on the scope, but is shown to illustrate the frequency relationship of the two images that do appear.

The accuracy with which the radar local oscillator tracks the magnetron can be determined by measuring the difference between the frequencies of the two images on the screen. This difference should be 15 mc (using the lower magnetron image as the reference). To determine the actual difference, rotate the frequency dial to set the frequency meter pip under the center of the magnetron spectrum, and note the dial reading. Then set the pip under the radar local oscillator pip, and again note the dial reading. If the difference between the dial readings is 15 mc, the radar local oscillator (or AFC discriminator) has been accurately set to follow the excursions of the magnetron frequency.

If the frequency of the radar local oscillator is set 60 mc below the magnetron frequency, the only effect is that the images will be reversed on the screen (fig. 3-24B).

If the intermediate frequency is 30 mc above, the procedure is similar to that first discussed, except that the position of the images is reversed (fig. 3-24,C). This is true since by time relationship, the left-hand spectrum of the radar local oscillator is made to appear on the left side of the screen, while the spectrum of the magnetron now appears on the right. The difference in the frequencies is measured just as it was in the foregoing method, and a frequency difference of 15 mc indicates that the local oscillator is operating at a frequency 30 mc above the magnetron.

If the radar local oscillator operates below the magnetron frequency, the position of the images will again be reversed. That is, the radar local oscillator spectrum will be on the right and the magnetron spectrum on the left.

SPECTRUM ANALYZER USED AS A SIGNAL GENERATOR

The analyzer may be used as a c-w or f-m signal generator, depending upon whether the spectrum width control is set at either of its extreme positions. If it is set completely counterclockwise, the percent of frequency modulation is at a minimum (about 3 mc), and the output is essentially a c-w signal. If the control is turned all the way clockwise, the percent of frequency modulation is maximum, and the output has a width of from 40 to 50 mc, depending upon the particular tube in the analyzer r-f oscillator. The output power ranges between 1 and 2 milliwatts.

THE ECHO BOX TS-275/UP

Good radar performance is of vital importance because radar is the eye that the Navy depends on to detect enemy ships and planes long before they are detected by other methods. It has failed to accomplish this purpose if attacking enemy craft are detected too late for effective countermeasures to be taken. It is therefore extremely important that radar installations be maintained so that they always operate close to their maximum efficiency, and technicians should spare no effort in making this possible.

The ECHO BOX is one of the most important single test instruments for indicating the overall radar system performance. This results from the fact that the echo-box indication reflects the combined relative effectiveness of the transmitter as a transmitter of energy and the receiver as a receiver of energy.

The echo box, or resonance chamber, consists basically of a resonant cavity, as indicated in figure 3-25,A. The resonant frequency of the cavity is determined by the size of the cavity (the larger the cavity, the lower the frequency); and this, in turn, is determined by

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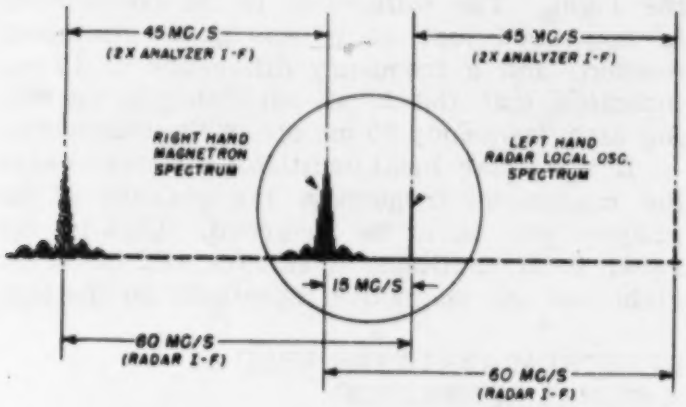

A Measuring the frequency of a local oscillator that is 60 mc above the magnetron.

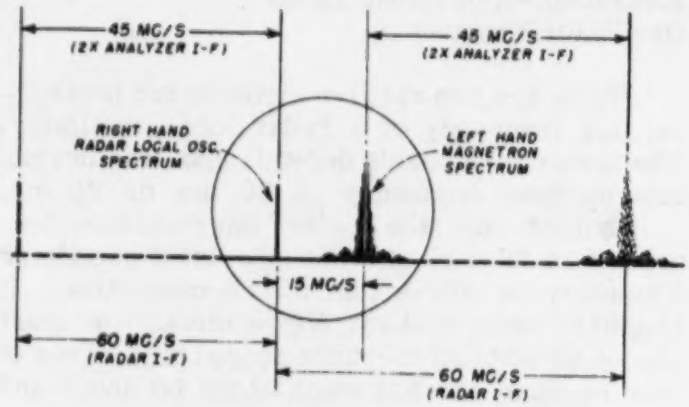

B Measuring the frequency of a local oscillator that is 60 mc below the magnetron.

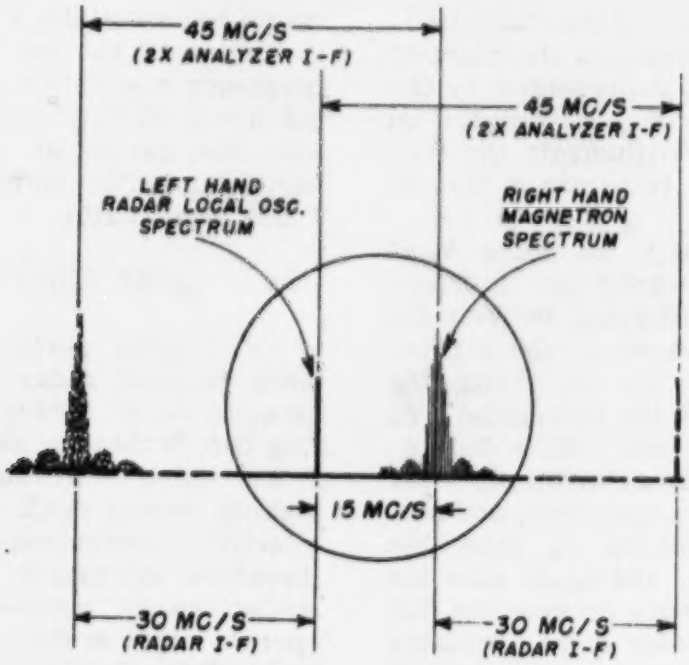

C Measuring the frequency of a local oscillator that is 30 mc above the magnetron.

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Figure 3-24.—Radar local oscillator frequency measurements.

the position of the plunger. The accurately calibrated tuning mechanism controls the position of the plunger and indicates on a dial the resultant resonant frequency, or data that permits the technician to determine the frequency with great accuracy by consulting a set of curves.

Energy is coupled into the cavity from the directional coupler (or pickup dipole) by means of an r-f cable connected to the input loop. Energy is coupled out of the cavity to the rectifier and the microammeter by means of the output loop. The amount of coupling between

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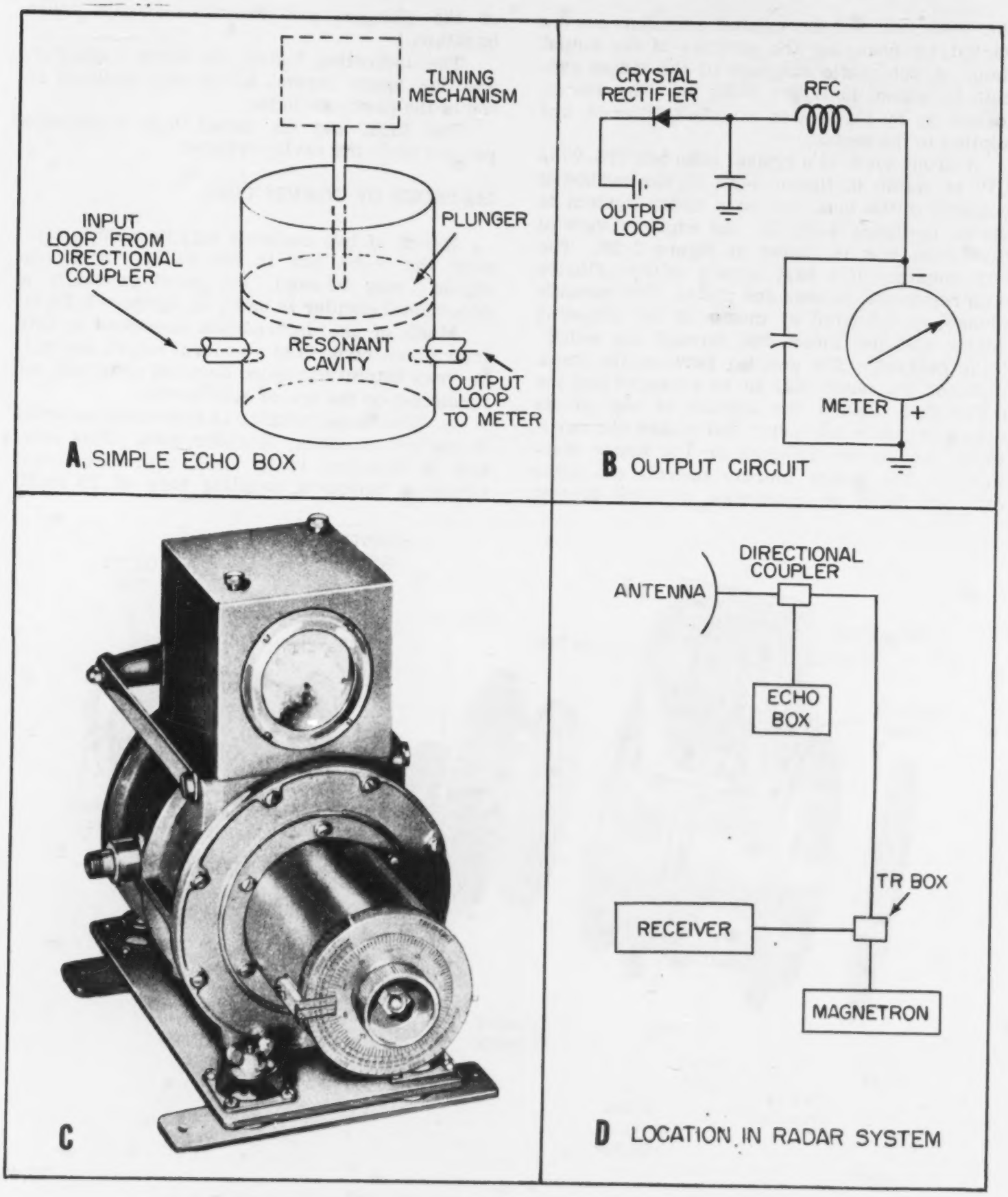

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Figure 3-25.—Echo box.

the echo box and the crystal rectifier can be varied by changing the position of the output loop. A schematic diagram of the output circuit is shown in figure 3-25, B. The energy picked up by the loop is rectified, filtered, and applied to the meter.

A front view of a typical echo box (TS-275/UP) is shown in figure 3-25, C; the method of connecting the echo box in a radar system is shown in figure 3-25, D. An exploded view of this echo box is shown in figure 3-26. The box consists of a cast bronze cavity cylinder with removable bronze end plates. The movable plunger is actuated by means of the adjusting screw and the inner dial through the watertight bellows. The gearing between the inner dial and the outer dial is so arranged that the outer dial travels the amount of one of its divisions while the inner dial makes one revolution (10 major divisions or 100 minor divisions). The gears merely operate the outer dial and have no connection with the driving of the plunger, and therefore do not cause backlash.

The indicating meter, the filter capacitor, and the spare crystal holder are mounted on top of the cavity cylinder.

The input and the output loop connectors project from the cavity cylinder.

METHODS OF CONNECTING

Either of two methods may be used to connect the echo box to the radar. A pickup dipole may be used, but more generally a directional coupler is used, as in figure 3-25, D.

Much of the information contained in this instruction book is of a general nature and will be very helpful to anyone desiring practical information on the use of echo boxes.

A directional coupler is commonly included in the r-f plumbing of radar sets. This echo box is designed to be used with directional couplers having a coupling loss of 20 to 35

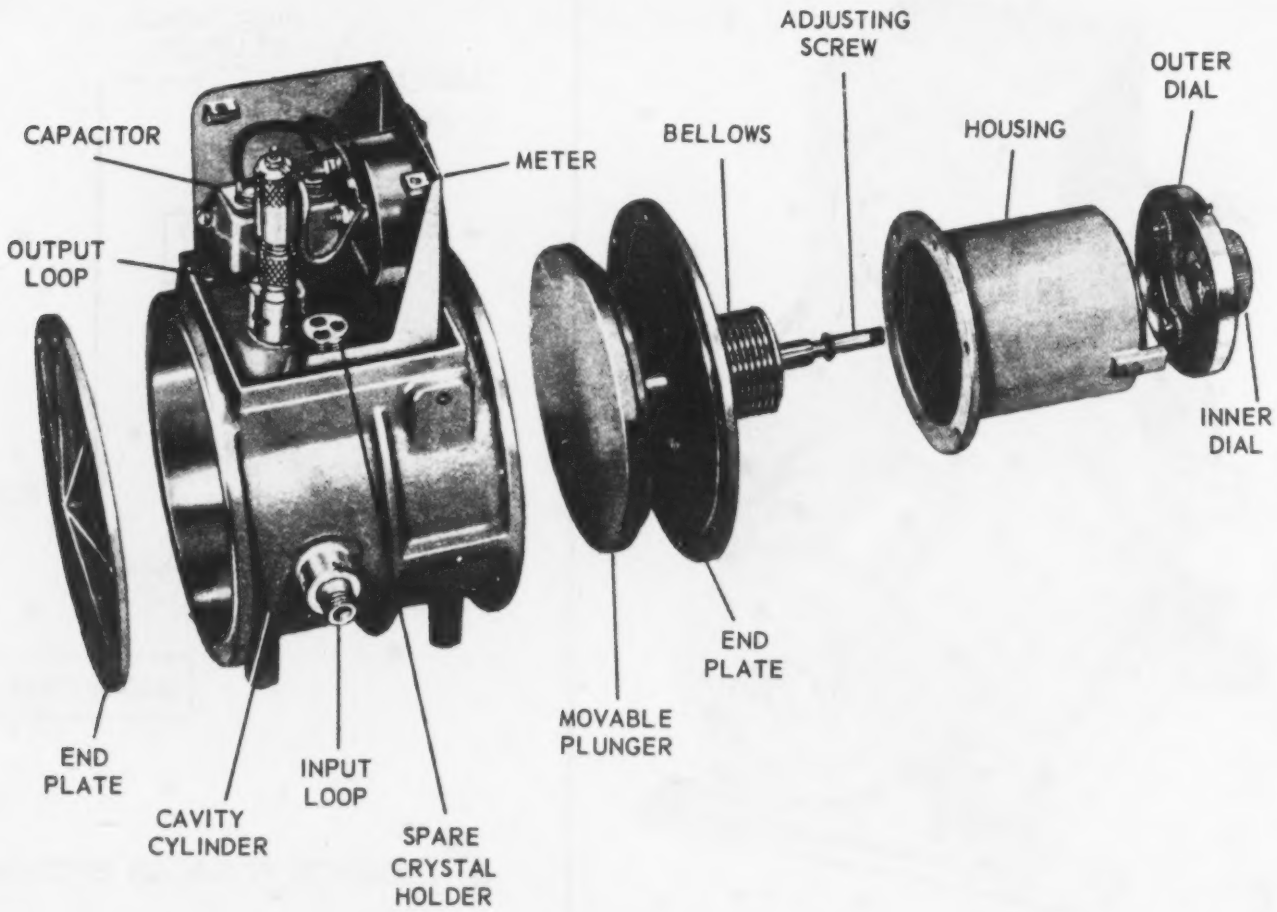

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Figure 3-26.—Exploded view of the TS-275/UP echo box.

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decibels on the usual radar in the frequency range covered by this echo box. The exact value depends on the radar.

FREQUENCY CALIBRATION

The echo box dial is read by reading the middle dial number and then the inner dial number. Figure 3-27, A, shows an example in which the reading is three two point six five (32.65). Each major division on the inner dial is one-tenth of a revolution, and each smaller division is one-hundredth of a revolution. Each division of the middle dial represents one complete revolution of the inner dial.

The frequency calibration curve in figure 3-27, B gives the tuning rate of the echo box with any setting of the tuning dial. The method of using the curve may be best explained by giving an example. Assume that a radar under test is supposed to be tuned to a frequency of 3607 mc. (The direct frequency calibration, marked in red on the instrument, is provided on the outer portion of the outer dial.) The echo box is found to be in resonance when the tuning control is at 27.5 (middle dial divisions) rather than the expected 26 (opposite 3607 mc on outer dial). Obviously, the radar is transmitting on a frequency 1.5 inner dial revolutions higher than intended. From figure 3-27, B, the tuning rate is found to be 15.5 megacycles per (inner) dial revolution. The radar is thus transmitting on a frequency 15.5 x 1.5, or 23.25 mc too high.

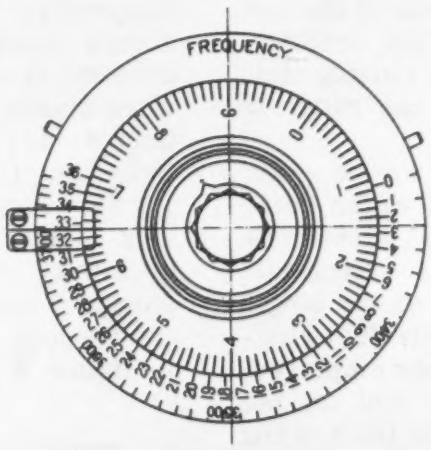

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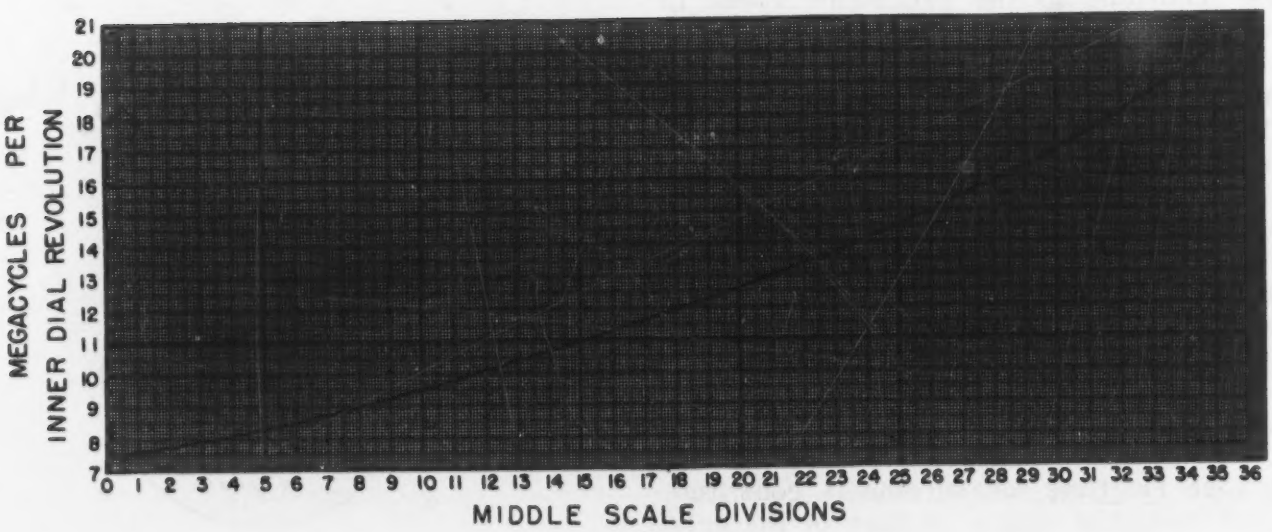

B

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Figure 3-27.—Reading the dial.

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RINGTIME

Some of the energy generated by the radar transmitter is picked up by the echo box via the directional coupler. This energy excites oscillations in the echo box that persist for some time after the end of the radar pulse, much in the fashion of an echo that persists in a large room after a loud noise. As this echo dies down, a part of it is fed back into the radar receiving system, again via the directional coupler. This causes a saturated signal to appear on the radar indicator, which is known as RINGING. The longer this ringing extends the better the performance of the radar—that is, the more powerful the transmitter is and/or the more sensitive the receiver is.

The length of time the echo box SHOULD ring under the particular conditions of the test (called the EXPECTED RINGINGTIME, or RINGTIME) may be compared with the ringing time observed, to determine whether the radar is performing well or not.

The ringtime to be expected on a good radar depends on the particular type of radar being tested; on the way the echo box is installed—that is, for example, whether a directional coupler or a dipole is used, and on the length and type of cable used; on the individual ringing ability of the particular echo box employed; on the frequency of the radar; and on the temperature of the echo box at the time of the test. Corrections are made for all of these factors according to the procedure given in the technical manual for the echo box being used.

An echo box without correction may be used for the purpose of detecting a CHANGE in the performance of a radar. The ringtime is simply noted and compared from day to day. It should be recognized that these readings do not permit the comparison of a particular radar with a standard of performance, and thus to tell whether more may be expected from a radar than its past performance would indicate.

Ringtime Measurements

Because ringtime measurements constitute the most valuable single feature of the echo box, it is essential that they be carried out properly and with due regard for the necessary precautions. Ringtime measurements are made on the A-scope or on the PPI; both methods are discussed later.

In measuring the ringtime, the technician should make sure that it is the echo-box ringtime and not some fixed-target echo or block of echoes that is being received. This condition can be determined by adjusting the radar gain control and noting if there is a back and forth movement of the ringtime on the scope. The echo box echo will change in range; fixed target echoes, however, will not change in range, only in amplitude.

In order to obtain accurate results, every ringtime measurement should be repeated at least four times, and the readings averaged. Care must be taken to ensure that all readings are accurate. If two or more technicians use the same echo box, they should practice together until their ringtime measurements agree.

Radars have a tendency to drift slightly in frequency. When this occurs, the echo box becomes detuned and accurate ringtime measurement is difficult. Therefore, it is necessary when making ringtime measurements for longer than a very few minutes to retune the echo box from time to time.

The radar antenna should not be pointed at a mast or other nearby obstruction because proximity effect may cause the transmitter to change frequency.

A-scope presentation of ringtime is indicated in figure 3-28, A. The receiver gain should be

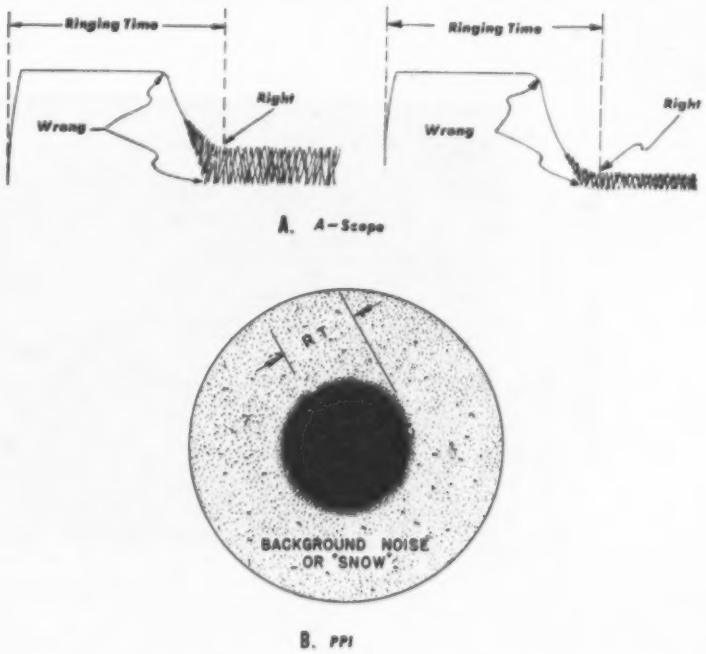

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Figure 3-28.—A-scope and PPI presentation of ringtime.

set so that the 'grass' or noise is one-quarter to one-third the total saturated signal height on the A-scope. When this is done, a good pattern results, such as either of those shown in the figure. In the event that no 'grass' can be seen, the gain of the radar i-f is inadequate and repairs should be undertaken.

The exact end of the ringtime occurs at the furthest point to the right at which the TOP of the 'grass' is noticeably above the general level of the rest of the 'grass.' Do NOT judge ringtime by the BOTTOM of the 'grass' or by the end of the saturated portion of the ringtime because these items are influenced by the receiver gain setting and other factors.

Setting the gain too high or too low may make it difficult or impossible to read the ringtime with accuracy. (It is essential that 'grass' be present.)

An A-scope indicator measurement of ringtime is usually best performed when the radar antenna is stopped.

PPI presentation of ringtime is indicated in figure 3-28, B. In this instance, the same general principles apply as did in the case of the A-scope presentation.

The following procedure should be followed. With the radar antenna rotating, set the receiver gain at a minimum and adjust the intensity (bias) so that there is a very slight radial trace on the PPI indicator. Increase the receiver gain until the PPI-indicator area seems to be just half covered with flecks of snow.

A PPI ringtime pattern, with proper receiver gain adjustment (and the radar antenna rotating), is shown in figure 3-28. In this case, the echo box is used with a directional coupler.

It should be emphasized that the end of the ringtime signal is NOT at the place where the bright or saturated part of the signal ends, but where the fainter portion of the signal disappears into the background noise. Therefore, when reading the ringtime on a PPI indicator, be sure to observe to the extreme edge of the grass and NOT JUST TO THE END OF THE BRIGHT PORTION OF THE PATTERN. Read to the last point at which the 'snow' is unusually bright. As indicated in figure 3-28, B ringtime (RT) is measured from the center of the pattern to the outer edge.

SPECTRUM ANALYSIS

Every time a radar transmitter generates an r-f pulse, it produces a certain amount of r-f energy in the form of electromagnetic waves. Not all of these waves, however, are of the same frequency; in fact, only a small portion of them have exactly the same frequency as that to which the transmitter is tuned. The rest of the radiation is at slightly higher or slightly lower frequencies, forming the sideband frequencies. This is the natural result of pulse modulation and cannot be avoided.

Actually, the radar energy is distributed more or less symmetrically over a band of frequencies, as illustrated in figure 3-29, A. This frequency distribution of energy is known as the SPECTRUM. An analysis of its characteristics may readily be carried out with the aid of the echo box.

When properly performed and interpreted, a spectrum analysis will disclose maladjustments and troubles that would otherwise be difficult to locate. It is important, therefore, that the technician who uses the echo box be able to carry out a spectrum analysis and understand the results.

When a spectrum analysis is to be made, the tuning control of the test set (fig. 3-25, C) is first turned until a maximum output meter deflection is obtained, then the tuning control is turned slowly from a point well below this maximum to a point well above it.

While this is being done, the output meter readings are noted for various settings of the tuning control. It is good practice to cover the frequency range desired by turning the tuning knob slowly in the same direction to each new position, not by turning it back and forth. This is done to minimize any possible error due to backlash. A reading should be taken about every 0.02 revolution of the tuning knob.

Finally, an accurate graph is constructed with the meter readings plotted against the tuning control dial settings. The resulting graph should resemble one of those shown in figure 3-29.

A radar transmitter in satisfactory condition should give a spectrum curve similar to curve A or curve B. Good curves are those in which the two halves are symmetrical and contain deep, well-defined minimum points on both sides of the main peak.

A curve without deep minima, as in curve C, indicates that the transmitter output is frequency modulated during the pulse. This may be due to the application of a negative pulse to the magnetron that does not have sufficiently steep sides or flat extremities. It may also be due to

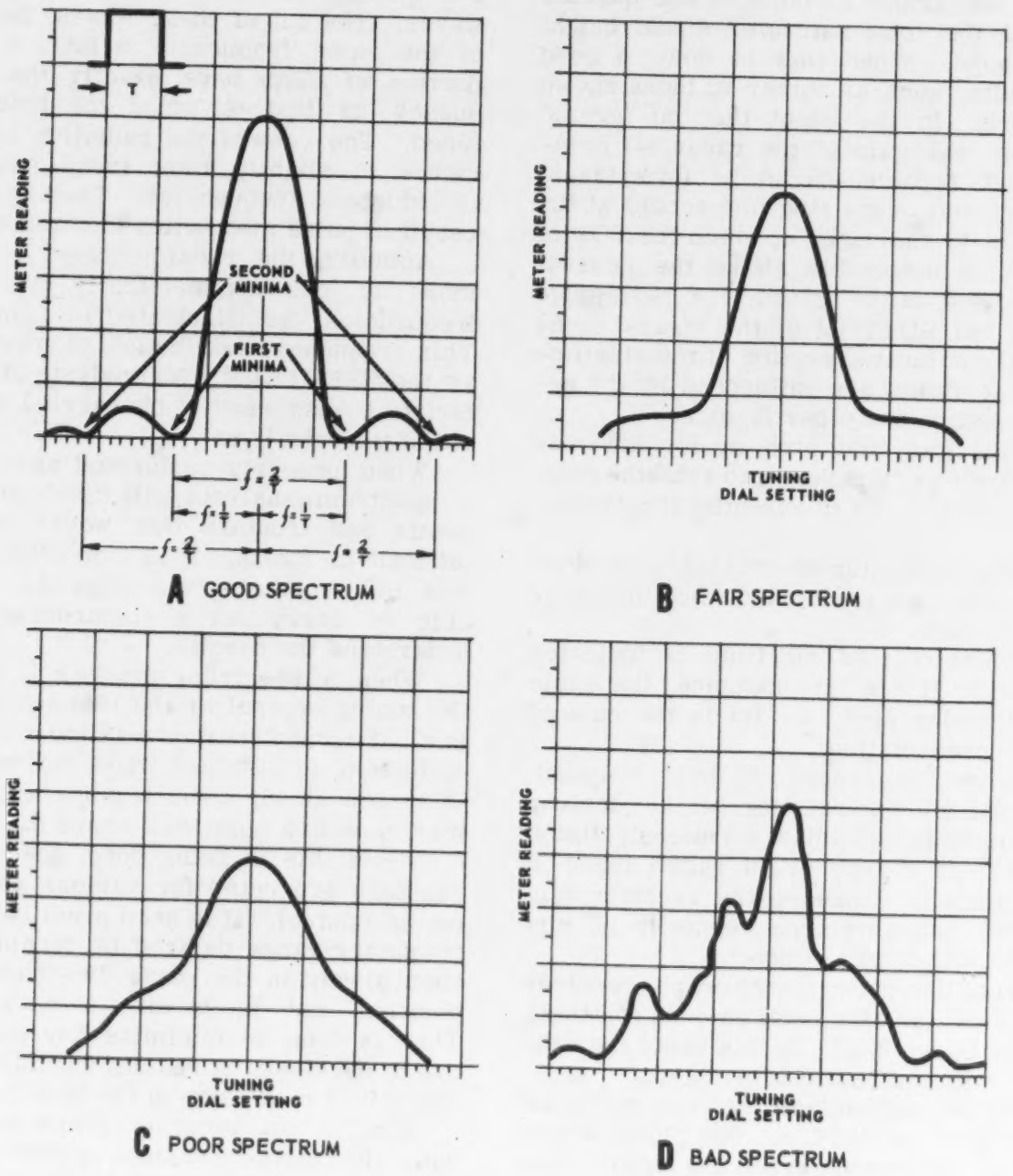

Figure 3-29.—Typical radar spectra.

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a transmitter tube that is unstable or is operated with improper voltage, current, or magnetic field.

When the spectrum is extremely irregular, as in curve D, it is an indication of severe frequency modulation. This will probably cause trouble in the receiver automatic frequency control as well as general loss of signal strength. When the spectrum has two large peaks, quite far apart, it indicates that the transmitter tube is double moding, perhaps because of unwanted standing waves in the transmission line or a bad transmitter tube. A faulty spectrum can often be improved by adjustment of the transmission line stubs or by replacement of the transmitter tube. Standing waves may be due to a faulty line connection, a bad antenna rotating joint, or obstructions in the line.

In the case of a good or fair spectrum curve with sharply defined minima on both sides of the main peak, the distance between these two minima is proportional to the duration of

the transmitted pulse. Because the duration of the pulse determines the distribution of power in the sideband frequencies, the pulse length may be found from the spectrum graph. The procedure is to determine the distance in megacycles between the minima on either side of the main peak. These minima are separated by a frequency (in megacycles) equal to $\frac{2}{T}$, where T is the pulse length in megacycles and $\frac{1}{T}$ is the number of sideband frequencies contained in either upper or lower sideband (from the carrier frequency to the first minimum on either side of the carrier). Expressed as an equation,

$$\text{pulse length in microseconds} = \frac{2}{\text{distance between minima in megacycles}}$$

Suppose, for example, that the echo box is being used to check the pulse length of a radar. The graph of the spectrum is plotted, and the tuning distance between the minima is from 17 divisions on the middle dial (fig. 3-27, A) to 17.17 divisions (17 divisions on the inner dial). From figure 3-27, B, it is found that for the particular frequency range in question (3480-3490 mc) the echo box tunes at a rate of 11.65 mc per revolution (corresponding to 17 divisions on the middle dial). The frequency span between minima is

$$11.65 \times 0.17 = 1.98 \text{ mc.}$$

Applying the equation given in the last paragraph, the pulse length in microseconds $= \frac{2}{1.98} = 1.01$ microseconds. The value thus calculated can be readily compared to the standard value for a radar of the type under test by reference to the radar manual. Any great change in the test value compared to the standard value indicates an improper pulse length.

The shorter the pulse length, the wider will be the frequency band that the signals occupy. This effect will appear on the graph as a wide span between the first minima of the spectrum curve.

An abnormally narrow spectrum shows that the transmitted pulse is too long. Such a pulse could result in a long ringtime and high power reading on the echo box output meter, thus falsely indicating superior system performance.

Power Output

At the time of installation, the meter reading on the echo box, TS-275/UP, should have been set between 40 and 80 divisions (by adjusting the orientation of the output loop) while the echo box was tuned to resonance with the radar transmitter.

The output meter reading is closely proportional to the average radar power picked up by the echo box and to the transmitter pulse length, when the echo box is tuned to the maximum output signal of the spectrum. If the pulse length is long, the spectrum curve is consequently high and narrow, and the meter reading is high. Where the pulse length is shorter, the spectrum curve is flatter and the meter reading will be lower.

The power output of a radar is generally good if the transmitter current is normal. Loss in the transmission line may cause loss of power, and in the event that low power is observed at the antenna of the radar by means of a pickup dipole and echo box, the transmission line may be suspected. Because of the high initial cost of radar transmitting tubes, the echo box and its accessories should be checked carefully before discarding such a tube. Transmitter tuning stubs are NEVER adjusted for maximum power output, as indicated at the echo box. These stubs provide a transmitter frequency adjustment, the net effect of which is observed at the receiver indicator rather than at the echo box. The correct procedure for checking the radar frequency is described in this chapter.

OTHER TESTS

GENERAL PROCEDURE.—A variety of radar equipment checks can be carried out with the aid of the echo box. The exact nature of these tests, as well as the detailed methods of procedure, may vary to some extent between different types and models of radar equipment. The typical procedures given in the following paragraphs will be useful in establishing test routines to be followed in radar maintenance. Practice and experience may suggest variations as the technician becomes more familiar with the use of the echo box.

In the testing procedures outlined in the following paragraphs it is assumed that the echo

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box is properly installed, and that the expected ringtime and output meter reading are known for the particular radar under test.

All measurements should be recorded in the radar log and/or on forms provided for this purpose. One such form for ringtime, from the Maintenance Standards Books, Part II Preventive Maintenance Checkoff for Radar Set AN/SPS-8, NavShips 91522.41, is included in figure 3-30. The figure includes complete

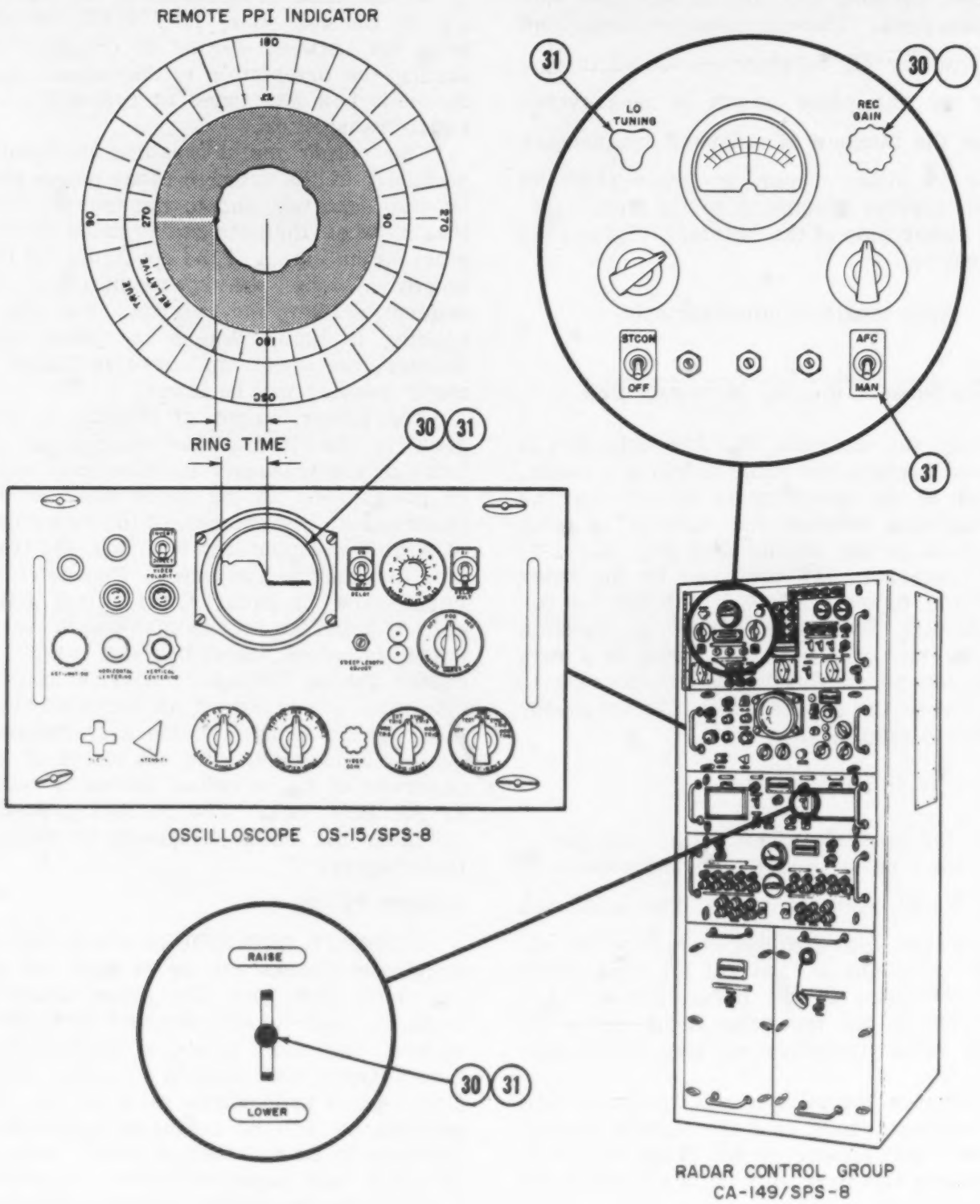

36.100(70)A

Figure 3-30.—Steps for recording ringtime.

instructions for making the test. Another form for listing echo box meter readings from the same publication is included in figure 3-31.

As a preliminary step in all tests, the radar equipment should be allowed to warm up fully to the normal operating temperature. The directional (or bidirectional) coupler or the pickup dipole (when used) should be correctly coupled to the echo box. All antijamming provisions (provisions to reduce the effects of the enemy jamming the radar) and the sensitivity time control, if provided, should be turned off.

Overall Performance

Adjust the echo-box tuning knob for a maximum reading of the output meter, indicating that the echo box is tuned to resonance with the radar. Then adjust the radar receiver local oscillator frequency for maximum ringtime on the indicator. Measure the ringtime as accurately as possible, preferably by taking an average of at least four readings. Ringtime is most conveniently measured on an A-scope with the antenna stopped, and on a PPI-scope

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
30	Record radar ring time with AFC.	Set REC GAIN (R7142) for one-half inch of grass on Oscilloscope screen. Tune Echo Box with RAISE-LOWER switch (S7404) for maximum ring time indication on Oscilloscope screen. The ring time is obtained directly in yards on the remote PPI indicator. Rotate Antenna and set the range ring slightly beyond the solid echo portion of pattern as shown on illustration page.	Range Dial Remote PPI Indicator.	YDS (3200 or more)
31	Record radar ring time in manual tuning position.	Same as Step 30 except AFC-MANUAL switch (S7104) in MANUAL position, and LO TUNING (R7138) varied for maximum ring time.	Range Dial Remote PPI Indicator.	YDS (3200 or more)

STEP NO	30	31		30	31		30	31		30	31		30	31		30	31	
Month	JAN 19_			FEB 19_			MARCH 19_			APRIL 19_			MAY 19_			JUNE 19_		
Week	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init
1																		
2																		
3																		
4																		
5																		
Month	JULY 19_			AUG 19_			SEPT 19_			OCT 19_			NOV 19_			DEC 19_		
Week	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init	Yds	Yds	Init
1																		
2																		
3																		
4																		
5																		

36.100(70)A

Figure 3-30.—Steps for recording ringtime—Continued.

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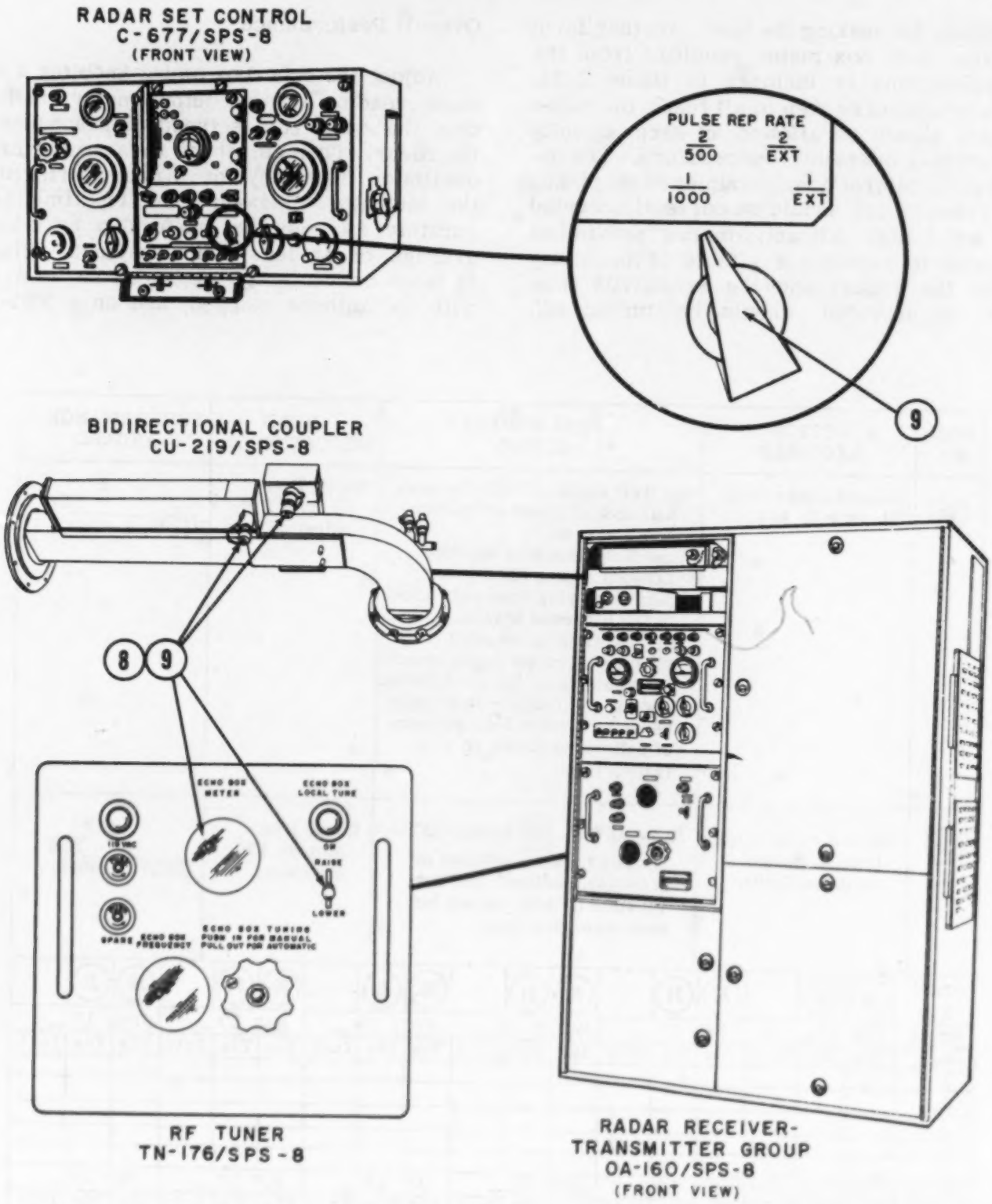

36.100(70)B

Figure 3-31.—Steps for recording transmit/receive ratio.

with the radar antenna rotating. Record the ringtime on the forms provided. Compare this figure with the corresponding value of the performance standard.

If the output meter and ringtime measurements are both satisfactory (compared with the expected values), the radar transmitter and receiver are both functioning well. If the meter

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STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	PERFORMANCE STANDARD
8	Record Echo Box ratio as an indication of transmission line voltage standing wave ratio (VSWR) with a 1-microsecond pulse. (These ratios are inversely proportional; if actual VSWR is desired see interpolation curves in Section 6 of NAVSHIPS 91522 (A)).	Connect echo box to J3007 on transmitter arm of bidirectional coupler. Vary RAISE-LOWER switch (S3501) for maximum reading on Echo Box Meter. Note reading. Connect echo box cable to J3008 on receiver arm of bidirectional coupler. Vary RAISE-LOWER switch (S3501) for maximum reading on Echo Box Meter. Note reading. Divide the first reading by the second reading and record the ratio.	Echo Box Meter First reading Second reading	Ratio (1.1 or larger)
9	Record Echo Box ratio as an indication of transmission line voltage standing wave ratio (VSWR) with a 2-microsecond pulse. (These ratios are inversely proportional; if actual VSWR is desired see interpolation curves in Section 6 of NAVSHIPS 91522 (A)).	Throw PULSE REP RATE switch (S6205) to 2/500 and repeat Step 8	Echo Box Meter First reading Second reading	Ratio (1.1 or larger)

STEP NO.	1st QUARTER 19__			2nd QUARTER 19__			3rd QUARTER 19__			4th QUARTER 19__		
	Ratio	Initial	Date	Ratio	Initial	Date	Ratio	Initial	Date	Ratio	Initial	Date
8												
9												

36.100(70)B

Figure 3-31.—Steps for recording transmit/receive ratio—Continued.

reading is satisfactory but the ringtime is low, the radar receiver is the probable source of the trouble. Service the receiver, consulting the appropriate instruction book for the detailed procedure.

Transmitter Power

The echo-box output meter reading is closely proportional to the average energy radiated from the radar on a particular frequency. The measurement of relative transmitter power is, therefore, a direct and simple procedure. Tune the echo box to resonance and then stop the radar antenna. Record the maximum reading on the output meter. This measurement, compared with the corresponding value on previous tests, gives an index of transmitter power. If the meter reading is satisfactory the radar

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power output is good. If the meter reading and ringtime are low, the transmitter power output is low, and a spectrum analysis should be made.

Radar Frequencies

To check the TRANSMITTER FREQUENCY, adjust the echo-box tuning knob for maximum deflection of the output meter, and stop the antenna. Read the tuning-knob scale and determine the transmitter frequency by reading the red calibration on the outer portion of the face of the outer dial, or by referring to the echo-box frequency calibration curve (fig. 3-27, B). If the transmitter frequency is found to be different from the frequency intended, the cause may be the transmitter tube or the transmitter tuning adjustments. Reference should be made to the appropriate instruction book.

To check the LOCAL OSCILLATOR FREQUENCY, the echo box is disconnected from the directional coupler (or pickup dipole). It is then coupled directly to the local oscillator output. (A special connector may have to be improvised to fit the local oscillator output of certain radars. It is desirable to insert 10 to 20 db of attenuation between the local oscillator and the echo box.) Adjust the echo-box tuning control for maximum deflection of the output meter. Read the tuning-control scale and, referring again to the echo-box calibration data, record the local oscillator frequency. The echo-box meter reading is likely to be excessive if attenuation is not inserted, and the output loop (fig. 3-25, A) should be adjusted to protect the meter (the loop may be adjusted with a wrench).

The DIFFERENCE BETWEEN THE TRANSMITTER AND THE LOCAL OSCILLATOR FREQUENCIES is easily checked by the curve in figure 3-27, B. It is necessary to have not only the correct frequency difference but also to have the local oscillator operating on the proper side (above or below) the transmitter frequency. This frequency difference is, in each case, identical with the frequency of the radar i-f amplifier. Using the tuning curve in figure 3-27, B, the technician can readily check the frequencies and determine whether the difference between them is correct.

To TUNE THE LOCAL OSCILLATOR, couple the echo box to the local oscillator. From the echo-box calibration data, find the echo-box setting for the correct local oscillator frequency, and adjust the echo-box tuning control accordingly. Then adjust the local oscillator, referring to the radar manual for the correct procedure, until the echo-box output meter shows maximum deflection. The oscillator is then approximately tuned to the correct frequency. Final tuning of the oscillator should be such as to produce maximum ringtime and proper radar crystal current.

Erratic Transmitter Operation

Adjust the echo-box tuning control for maximum deflection of the output meter with the echo-box connected to the directional coupler, and stop the antenna. If the transmitter is operating normally, a good ringtime pattern will be displayed on the A-scope (fig. 3-28). If the ringtime is erratic, or extra background noise traces appear in the pattern, then the transmitter may be multiple moding (transmitting on two or more distinct frequencies) or failing to fire on every pulse. This may be due to faulty pulsing; transmission-line troubles, especially arcing; or other causes. Examine the spectrum in order to help localize the trouble. Refer to the appropriate instruction book for help in correcting the trouble.

Transmitter Pulling

Magnetron frequency pulling results from a change in the loading as the antenna is rotated. As a check for magnetron pulling, turn off the automatic frequency control on the radar receiver. Adjust the echo-box tuning control for maximum deflection of the output meter. With the radar antenna rotating, observe the pattern on the PPI indicator. If the transmitter is operating normally, a good ringing pattern will be seen, as in figure 3-32, A. If there are blank spaces on the PPI indicator or if the ringtime is reduced on certain azimuths, as in fig. 3-32, B, then the transmitter frequency is being pulled. In such a case, the output meter reading will also fluctuate as the radar antenna is rotated slowly. Transmitter frequency measurements at several azimuths may also be used to confirm this difficulty. The pulling may be caused by a bad rotating joint or by a reflecting surface near the antenna. Refer to the appropriate instruction book for corrective measures.

Automatic Frequency Control (AFC)

To determine whether the local oscillator is following the transmitter when it is pulled,

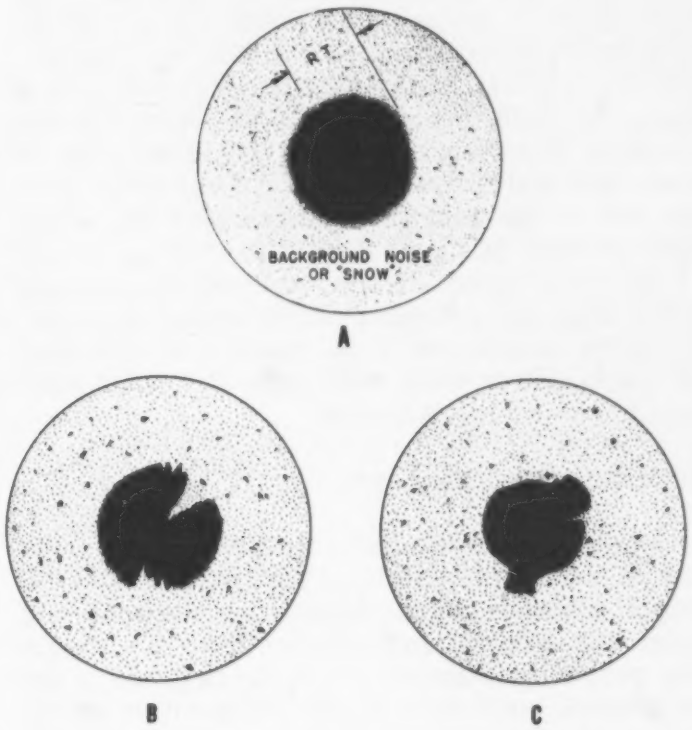

55.121(70)B

Figure 3-32.—Indication of magnetron pulling.

first stop the antenna on an azimuth where the ringtime pattern is broken, and then retune the echo box to resonance. Rotate the radar antenna and again examine the PPI pattern. If the ringtime is now good on the azimuth at which the echo box was retuned (fig. 3-32, C), the AFC is in operation on that azimuth and the local oscillator is following when the transmitter is pulled. As may be seen in part C, the ringtime may have now decreased in those azimuths where it was originally good. If the AFC does not follow, the pulling may be excessive or the AFC may be at fault. If the ringtime is greatly decreased at certain azimuths, and the AFC does not follow, the radar must be considered inoperative at those azimuths and should be so reported.

A simple procedure will show whether the AFC is locked on the proper frequency. Stop the radar antenna and tune the echo box for maximum meter reading. Turn off the AFC switch and tune the local oscillator for maximum ringtime, thus putting the local oscillator in proper tune. Turn the AFC switch on again. If the ringtime decreases, even slightly, the AFC is locking on the wrong frequency, or is failing to lock. The proper instruction book should be consulted for corrective procedure. The probable cause of the AFC failure is a bad spectrum or the fact that the local oscillator is tuned to a frequency on the wrong side of the transmitter frequency.

T-R Box Recovery

The time required to permit T-R (transmit-receiver switch) recovery is determined by the time it takes the T-R switch to deionize after each transmitter pulse. It is usually defined as the time required for the receiver to return to within 6 db of normal sensitivity after the end of the transmitter pulse. T-R recovery time is the factor that limits the minimum range of a radar because the radar receiver is unable to receive signals until the T-R switch is deionized. In various radar sets, the recovery time may vary from about 3 to 20 μs.

To test for T-R box recovery, adjust the echo-box tuning control for maximum deflection of the output meter, and stop the radar antenna. Adjust the A-scope for a good ringtime pattern, such as curve E in figure 3-33. Slowly and gradually reduce the radar receiver gain setting, or better, detune the local oscillator. A pattern will result, such as curve D in figure 3-33, having the same relative shape as curve E. Further slight reduction in gain setting will produce another pattern, such as curve C, again similar in shape to curve E. Continue until a change occurs in the slope of the curve, as in curve B. This point of change marks the

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Figure 3-33.—Checking T-R box recovery.

T-R box recovery time of the radar, as indicated in the figure. For a good surface search radar, the T-R recovery time should correspond to a range of one mile or less.

If the gain control is reduced still further, a greatly distorted pattern will appear, such as curve A in figure 3-33. This curve shows that the T-R box has not recovered. Refer to the appropriate instruction book for corrective procedures. If the above procedure does not produce a series of curves (as indicated) giving a T-R recovery point, and if the ringtime is short, then it is probable that the T-R recovery time is much too high (greater than the ringtime) and a new T-R tube is needed. Check the keep-alive current. The keep-alive current should be negative and between 0.1 and 0.2 ma.

Receiver Recovery

Adjust the echo-box tuning control for maximum deflection of the output meter, and stop the radar antenna. Then detune the echo box, and adjust the radar receiver gain control until the indicator shows a pattern similar to one of those illustrated at the left of figure 3-34. Now retune the echo box to resonance and again observe the indicator pattern. If the receiver recovery time is normal, the background noise will reappear immediately after the end of the ringtime pattern, and this noise will be approximately as strong as the noise previously observed with the echo box detuned. If the receiver recovery is slow, the noise will be weak and will not reappear for some time after the end of the ringtime pattern (see the right-hand portion of figure 3-34). In extreme cases of receiver nonrecovery, normal background noise may not reappear on the indicator at all. Receiver nonrecovery is usually an i-f tube or video defect which will make the radan susceptible to enemy jamming.

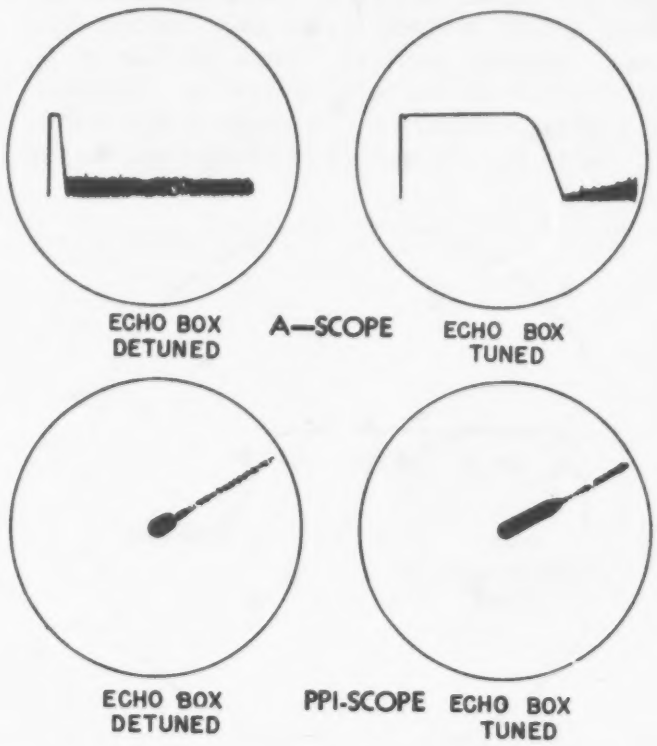

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Figure 3-34.—Receiver nonrecovery.

Transmission Line Loss

Using the directional coupler, tune the echo box to resonance. Record the ringtime and the output meter reading. Disconnect the echo-box from the coupler and connect it to the dipole (the proper location of the dipole is given in the instruction book; it is located at a position somewhere in the antenna radiation field). Again tune the echo-box to resonance and again record the ringtime and the output reading. Comparing these measurements, while allowing for the normal difference due to the difference between the coupler attenuation and the antenna space loss (losses are indicated in tables in the echo-box instruction book), an indication can be obtained of the loss in the radar r-f transmission line. If there is unusual loss in the radar transmission line, there will be greater differences than usual in the ringtime and also in the output meter reading. Repair or adjustments may then be undertaken.

Intermittent defects in the transmission line can often be found by rapping on the line while observing the echo-box meter reading.

Rapid Troubleshooting Chart

When the technician has become familiar with the test procedures and measurements, the echo-box may be used for rapid troubleshooting. Radar troubles may be more readily checked with the aid of the cause-and-effect chart of figure 3-35 which is essentially a summary of the information given on the use of the echo-box as a test instrument.

FREQUENCY-POWER METER TS-230

Frequency-Power Meter TS-230 measures the power (and frequency) of unmodulated and

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EFFECT	APPEARANCE ON		PROBABLE CAUSE
	RADAR INDICATOR	ECHO BOX METER	
RINGTIME — NORMAL ECHO BOX METER — NORMAL			RADAR PERFORMANCE SATISFACTORY.
RINGTIME — LOW ECHO BOX METER — NORMAL			RECEIVING TROUBLE: DETUNED MIXER OR LOCAL OSCILLATOR, BAD CRYSTALS, EXCESSIVE I-F NOISE, ADJUSTMENT OF PROBES IN MIXER CAVITY, DETUNED T/R BOX.
RINGTIME — LOW ECHO BOX METER — VERY LOW			LOW POWER OUTPUT-CHECK SPECTRUM.
RINGTIME — LOW ECHO BOX METER — LOW			TROUBLE PROBABLY IN TRANSMITTER AND RECEIVER AND/OR TROUBLE IN TRANSMISSION LINE.
RINGTIME — ERRATIC ECHO BOX METER — STEADY			ECHO BOX DETUNED-BAD PULSING, DOUBLE MODING TRANSMITTER, OR LOCAL OSCILLATOR POWER SUPPLY TROUBLE. CHECK SPECTRUM.
RINGTIME — ERRATIC ECHO BOX METER — ERRATIC			FAULTY TRANSMISSION LINE OR CONNECTION — CONDITION WORSE WHEN LINE IS VIBRATED.
END OF RINGTIME SLOPES GRADUALLY, POSSIBLY EXCESSIVE RINGING. GRASS APPEARS COARSE. ECHO BOX METER-STEADY AND SATISFACTORY.			OSCILLATING I-F STAGE
PRONOUNCED DIP IN RINGTIME AT END OF PULSE.			FAULTY T/R TUBE
RINGTIME-SLIGHTLY LOW POOR OR BAD SPECTRUM.		POOR SPECTRUM	TRANSMITTING TROUBLE
BLANK SPACES OR ROUGH PATTERN ON PPI RINGTIME INDICATOR. ECHO BOX METER READING VARIES AS ANTENNA IS ROTATED.			FREQUENCY PULLING OF TRANSMITTER DUE TO BAD ROTATING JOINT OR TO REFLECTING OBJECT NEAR RADAR ANTENNA.

55.122

Figure 3-35.—Troubleshooting chart.

pulsed signals in the range from 8500 to 9600 mc ± 4 mc. It measures average power within the limits of 0.1 and 1000 mw (-10 to + 30 dbm). A front view of the meter is shown in figure 3-36.

A general idea of how the power-measuring circuit in the meter works can be obtained from the following consideration. The thermistor (fig. 3-37) is actually the heart of the power-measuring circuit. This circuit operates on

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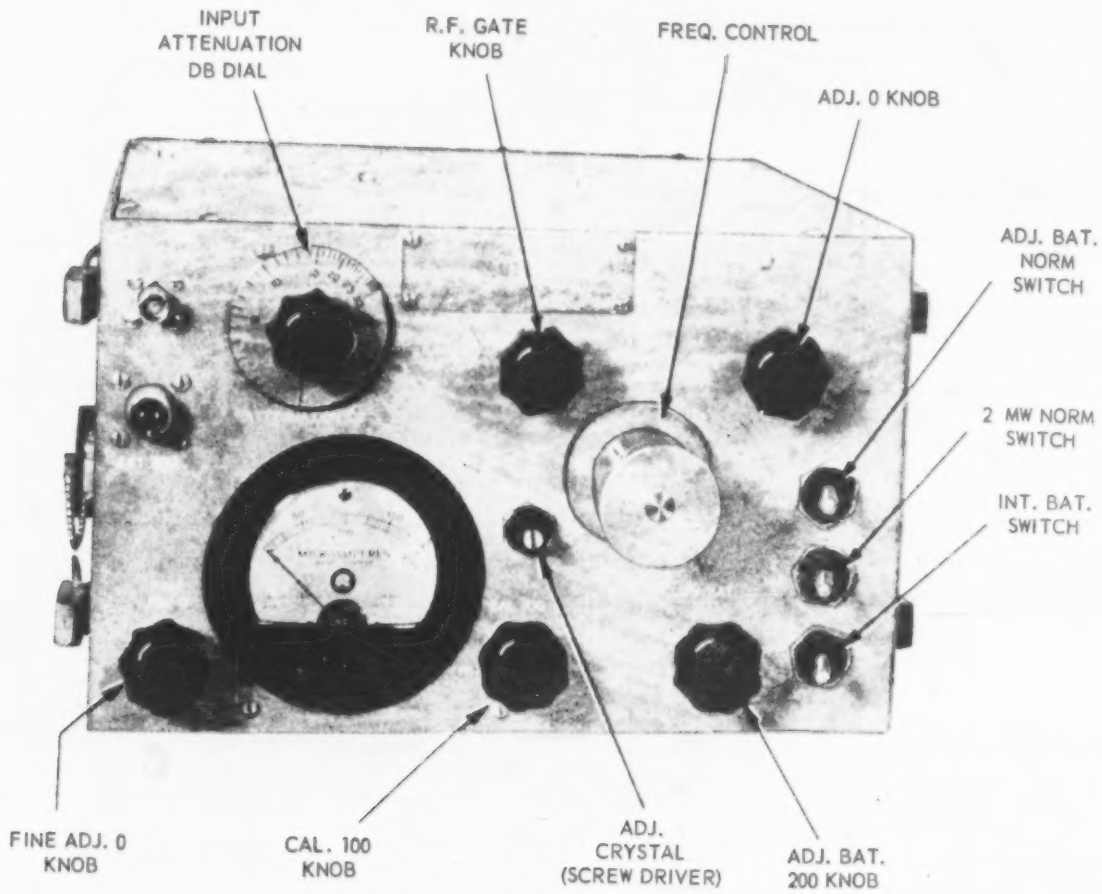

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Figure 3-36.—Front view of Frequency-Power Meter TS-230.

the basic principle of applying the r-f power to be measured to a thermistor and observing the heating effects of that power in changing the thermistor resistance. A thermistor has a high negative temperature coefficient; that is, its resistance decreases rapidly as its temperature increases.

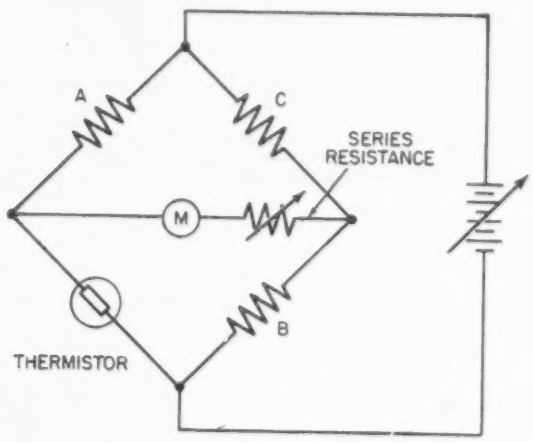

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Figure 3-37.—Thermistor bridge circuit.

The thermistor is used in one arm of a balanced bridge so that any change in its resistance can be detected and measured. The thermistor is placed so that it will absorb r-f energy from the r-f field without applying r-f voltage directly to the bridge. Thus the d-c meter, M, is not subjected to an r-f voltage and the bridge is isolated electrically from the r-f source.

The power required to bring the thermistor to the right resistance for balancing the bridge varies from about 2 to 20 mw, depending on the individual thermistor and the surrounding temperature. This type of bridge is balanced when the meter reads zero. The condition of balance may be expressed mathematically as:

$$\frac{\text{thermistor resistance}}{\text{resistance of A}} = \frac{\text{resistance of B}}{\text{resistance C}}.$$

In the simplified circuit, the bridge is balanced by varying the d-c supply to the bridge, thereby heating the thermistor with enough d-c power to bring it to the right temperature so

S0003

that its resistance will balance the bridge (meter reads zero). When the bridge has been balanced, the addition of power (either d-c or r-f) to the thermistor will, through the associated heating effect, unbalance the bridge and cause the meter to move up scale. The meter sensitivity is adjusted so that 1 mw of added power in the thermistor will give a meter reading of 100 (center of dial). Over a limited range (up to 1 mw) the meter reading is directly proportional to the added power.

When measurements are made, the bridge is first balanced by applying the correct amount of d-c power to the thermistor; the resistance in series with the meter is then adjusted so that 1 mw of added power from the d-c supply will cause the meter to read 100. The d-c power is then reduced until the meter deflection is again zero. The r-f power to be measured is applied to the thermistor and the meter deflection again noted. One milliwatt of r-f power is equivalent to one milliwatt of d-c power and will cause the meter to read 100 divisions.

A correct impedance match between the thermistor and the waveguide in the meter is obtained so that substantially all of the r-f power will be absorbed—that is, will be converted to heat energy.

A functional block diagram of the equipment is shown in figure 3-38, A. R-f power is fed to the waveguide by means of an r-f cable adaptor.

The guillotine db input attenuator moves an energy-absorbing element (carbon-coated blade) into the waveguide. The position of the blade is calibrated on the attenuator db dial in terms of loss in decibels.

The thermistor is mounted between top and bottom faces at the center of the waveguide and parallel with the electric lines of force. The bottom end of the thermistor is grounded to the waveguide face, and the top end connects through an r-f by-pass capacitor, which consists of a plastic disc between the outside face of the waveguide and thermistor mount. The d-c power-measuring circuit is connected between this post and ground. Short-circuited coaxial stubs are in the top and bottom faces of the waveguide—one at each end of the thermistor. The bottom stub is tunable; also, the reflector plate at the end of the waveguide section can be tuned by means of a screw. The stub and reflector (in combination with the thermistor adjustment) serve to match the thermistor to the impedance of the waveguide, thus making the standing-wave ratio satisfactory.

The r-f gate is used for making a check of zero balance in the bridge without disturbing the setting of the attenuator. When the r-f gate plunger in the waveguide is pushed in, nearly all the r-f power will be reflected and will not reach the thermistor.

The thermistor may be heated with power from the battery in the battery case. This is the most convenient method for locations remote from external power, especially when the tests are made during a short period of time. If the internal battery is used for extended periods, its voltage decreases and frequent adjustments are needed during tests. External batteries may be connected to the external battery jack.

In order to measure power, the frequency-power meter is calibrated (as outlined in the instruction book) and the ADJ ZERO control (in the main control circuit from the battery to the bridge network) is set to the position that makes the meter read zero. The frequency-power meter is connected to the radar system; the radar transmitter is turned on and the input attenuator adjusted until a reading of 100 is obtained on microammeter, M. The input attenuator reading then represents the level in db above 1 mw at the input of the waveguide. If the input attenuator dial is turned toward zero and the meter reads progressively less than 100, the meter reading will represent the power absorbed by the thermistor in hundredths of a milliwatt (one division equals 0.01 mw).

To obtain the average power output in the radar waveguide, the input attenuator reading is added to the db loss of the directional coupler (not shown in the figure) between the radar waveguide and the frequency-power meter. The loss in the directional coupler is stamped on the coupler; if a horn pickup antenna is used, the accompanying instruction book will give instructions on figuring losses. The power in watts corresponding to the total dbm (db, above 1 mw) is read directly from a table (not shown). This represents the average power of the radar output.

The meter reading indicates only the average levels of pulsed power throughout the pulse cycle. The peak power can be computed from the average power (Peak-to-Average power conversion method) if the duty cycle ratio is known. The duty-cycle ratio is obtained from the radar technical manual or by assuming a

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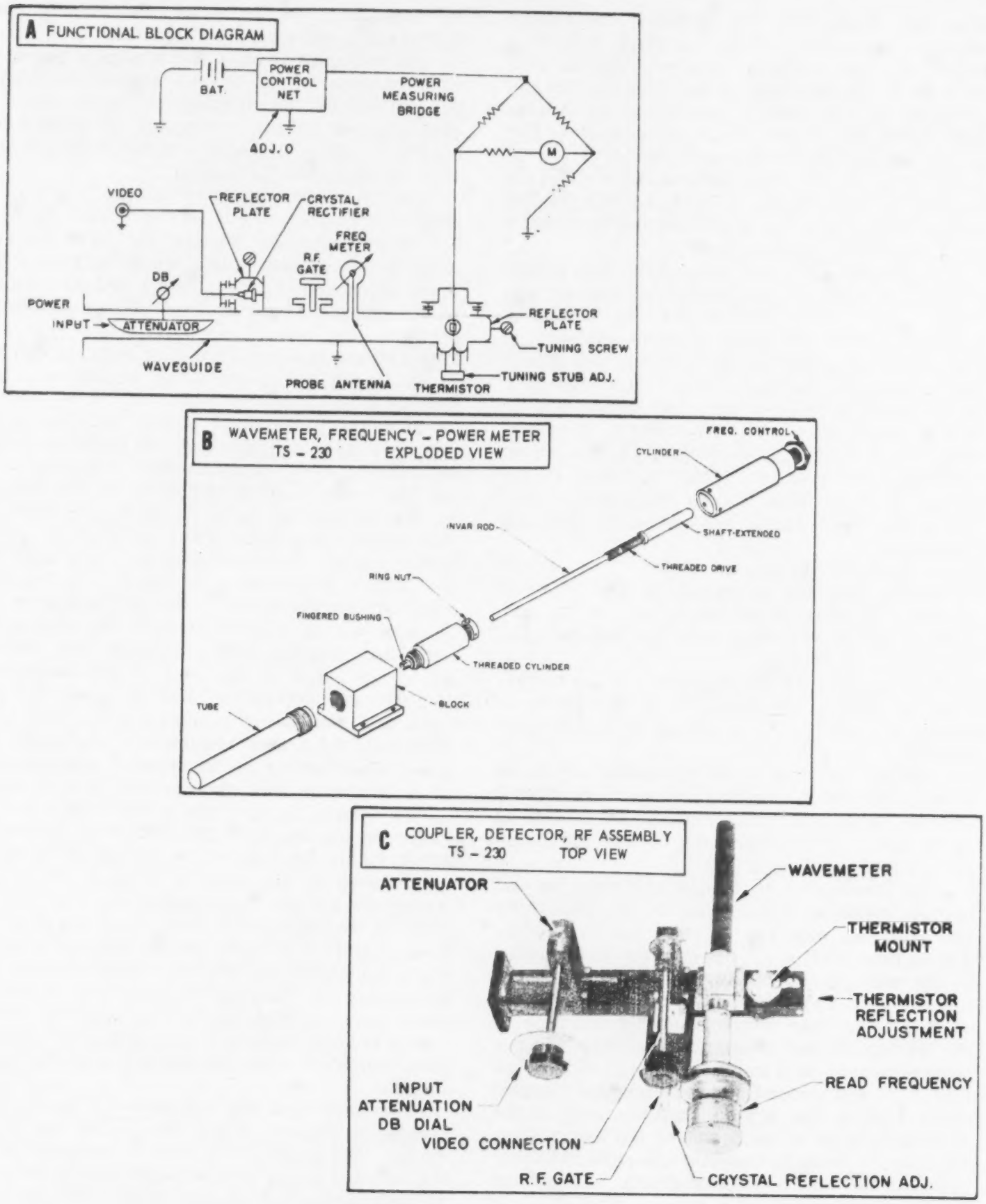

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Figure 3-38.—Functional block diagram and r-f plumbing of frequency-power meter.

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rectangular pulse shape and using the following formula:

$$\text{Duty-cycle ratio} = \frac{\text{pulse length}}{\text{pulse repetition rate}}$$

Where pulse length is in seconds and the pulse repetition rate is given in number of pulses per second.

In the preceding formula, a perfect square-wave pulse is assumed. For this reason, duty-cycle ratios given in instruction books for particular radars may differ somewhat from these computed values. The instruction book value should be used if it is available.

The peak power is obtained by dividing the average power by the duty-cycle ratio. As an example, let it be assumed that the average power of a radar transmitter, as determined by the frequency-power meter, is 25 w. Assume also that the transmitter radiates pulses 0.5 μs long 600 times per second. The calculations are as follows:

1. The duty-cycle ratio (on a square-wave basis) is the product of the pulse length in microseconds and the repetition rate in pulses per second divided by 10^6. That is,

$$\text{duty-cycle ratio} = .5 \times 10^{-6} \times 600 = 3 \times 10^{-4}$$

2. The peak power is equal to the average power divided by the duty-cycle ratio, or

$$\text{peak power} = \frac{25}{3 \times 10^{-4}} = 83{,}000 \text{ w}$$

$$\text{peak power} = 83 \text{ kw}$$

TEST SET TS-147/UP

Test Set TS-147 /UP (fig. 3-39) is a portable microwave signal generator used for testing and adjusting beacon equipment and radar systems that operate within the band of 8500 to 9600 mc. The set measures the power and frequency of external pulsed and continuous wave signals and supplies output signals that are continuous wave (CW) or frequency modulated (FM). The test set also has a provision to allow for external modulation to produce a pulsed RF signal.

Frequency modulation is produced by applying a sawtooth sweep to a reflex klystron. The amplitude (and slope) of the sawtooth can be continuously varied to give frequency excursions over a range of zero (CW) to over 40 mc.

Average power measurements are made by a temperature compensated thermistor bridge type wattmeter and a calibrated r-f attenuator. The test set can measure the power level of the test signals generated within the instrument and of external signals supplied to the test set. Power is measured in dbm in the ranges of -42 to -85 dbm and from -7 to 45 dbm for test signals supplied by the test set. The range of + 7 to + 30 dbm is for external power supplied to the test set. The accuracy of these measurements is within 1.5 db. These ranges are for the calibration given at the point of the r-f connector and the attenuation of connecting cables and coupling devices must be added to these values.

Frequency measurements are made by an absorption frequency meter that uses a thermistor bridge wattmeter as a tuning indicator. The range of the frequency meter is 8470 to 9630 mc. The accuracy is within 2.5 mc over this range. The frequency difference between any two signals not more than 60 mc apart can be measured to within 1.0 mc. At 9310 mc, the frequency meter accuracy is calibrated to within 1.0 mc.

FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

A block diagram of Test Set TS-147 /UP is given in figure 3-40, and the arrangement of r-f plumbing is illustrated in fig. 3-41. The test set receives and measures the power level and frequency of incoming signals and supplies and measures the power level and frequency of outgoing modulated and CW signals.

Normally positive video trigger pulses are applied to the TRIGGER IN connector where they are detected by a crystal diode. The detected r-f pulse is fed to a three stage resistance-coupled amplifier which has a voltage gain of approximately 500. The negative output pulses are capacitively fed to the primary winding of the blocking oscillator transformer and inversion takes place, thus delivering a positive pulse to trigger the blocking oscillator sweep circuit. The output of the blocking oscillator is fed to an integrating network wherein the actual sawtooth waves are formed.

When it is desired to modulate the test set with pulses (square waves, etc.), an external pulse generator producing a negative pulse of

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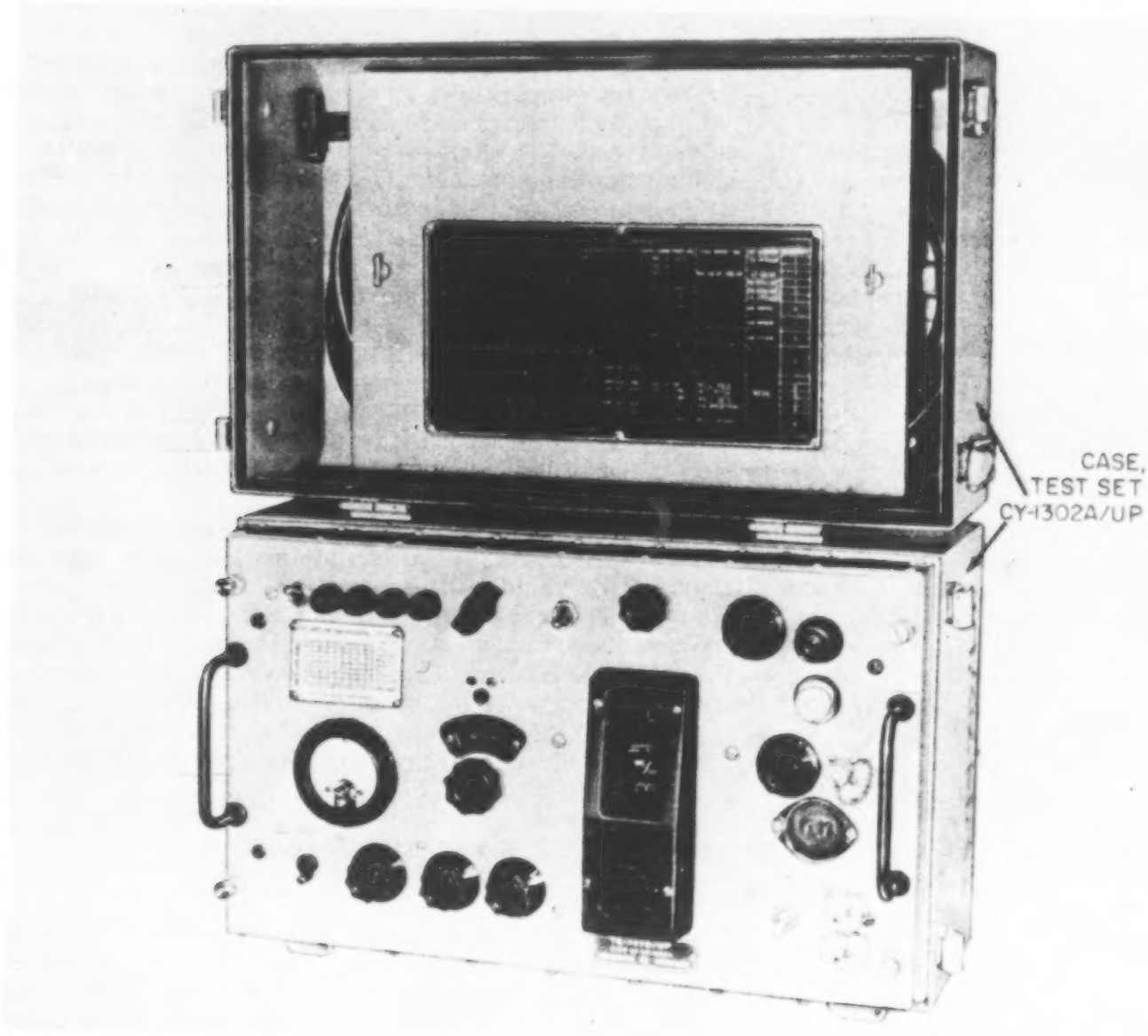

Figure 3-39.—Test Set TS-147 /UP complete equipment.

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approximately 50 volts can be connected to the EXT MOD connector which puts the external modulation onto the reflector of the klystron oscillator.

The oscillator uses a 2K25 reflex klystron tube and is a velocity modulated microwave oscillator, and can be tuned mechanically by varying the volume of the resonator chamber and electrically by varying the reflector voltage.

The Power Set attenuator is a rectangular strip of glass coated with a resistive material that dissipates some of the energy, and is placed longitudinally in the wave guide. Since the electric field strength varies from maximum at the center to zero at the edge, the power dissipated by the glass strip increases as it is moved toward the center of the wave guide.

The frequency meter assembly consists of a cavity resonator with a dial and a T-section of wave guide that contains the RF cut-off switch. This switch is simply a sliding door that opens or closes the entrance that connects with the oscillator wave guide.

The frequency meter itself is a cylindrical cavity resonator, the volume of which may be varied by moving a plunger in or out and is calibrated to read directly in megacycles/10 (tens of megacycles). That is, each reading

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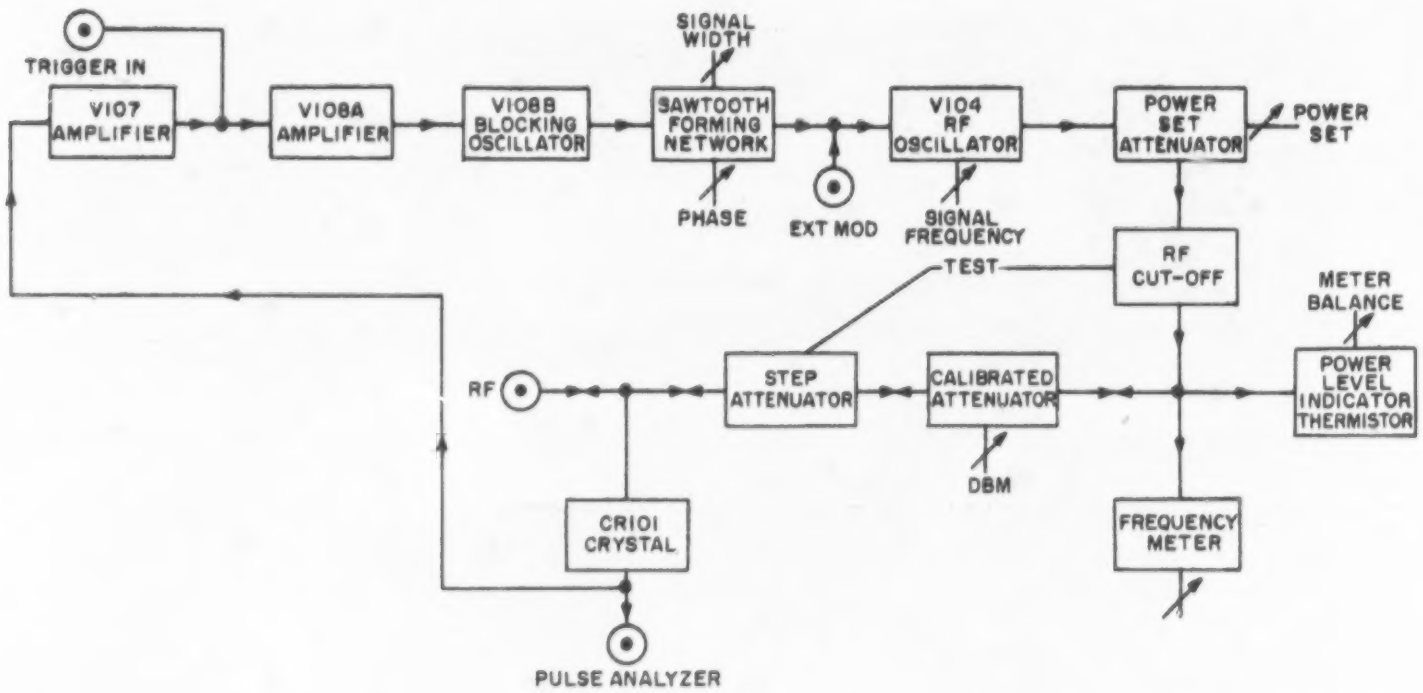

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Figure 3-40.—Block Diagram of Test Set-147 /UP.

must be multiplied by ten to give the frequency in megacycles.

The test set is provided with attenuators so that external sources of r-f signal levels may be measured up to 30 db above 1 milliwatt average; also, so that the internal signal generator may deliver signals at levels down to a value of 85 db below 1 milliwatt. Each attenuator is a thin strip of glass coated with resistive material and mechanically mounted so that its position in a section of wave guide can be varied.

The step attenuator inserts a fixed 5 db loss or 40 db loss depending upon the position of its front panel control. The variable DBM assembly at the counterclockwise setting has a loss of 2 db; and when it is in series with the 5 db minimum of the step attenuator the total loss of both units is 7 db. The dial of the DBM assembly is engraved to show 1 db markings.

The power measuring device of the test set (power level indicator thermistor) is a thermistor bridge wattmeter. It is composed of a Wheatstone bridge circuit having a thermistor element in one arm which varies its resistance with temperature. A thermistor decreases in resistance as the temperature increases. When current passes through the thermistor, a small amount of power is dissipated in it, which raises the temperature, thus lowering the resistance. This current may be used by the dc bridge voltage, the r-f field around the thermistor, or both. When the dc current in the circuit and the effects of the ambient temperature are properly controlled, the thermistor is used to establish a reference level of power.

The thermistor bridge circuit is designed to read a reference power level of 1 milliwatt and the two attenuators are calibrated. Therefore, by reducing an unknown incoming r-f signal to a power level of one milliwatt, by means of the calibrated attenuators, the power input at the r-f connector can be calculated. Similarly the power output from the klystron oscillator to the attenuator and the thermistor bridge circuit can be adjusted to one milliwatt. The attenuation from that point to the r-f connector is then determined from the settings of the front panel controls:

The frequency of the output signal is measured by the frequefcy meter. When its cavity is tuned to the frequency of the test signal, part of the energy is absorbed, causing a dip in the bridge meter reading and a decrease in the power output of the test set. If the test set is frequency modulated and the frequency meter is tuned within the swept frequency band, power will be absorbed each time the sweep reaches the resonant frequency of the

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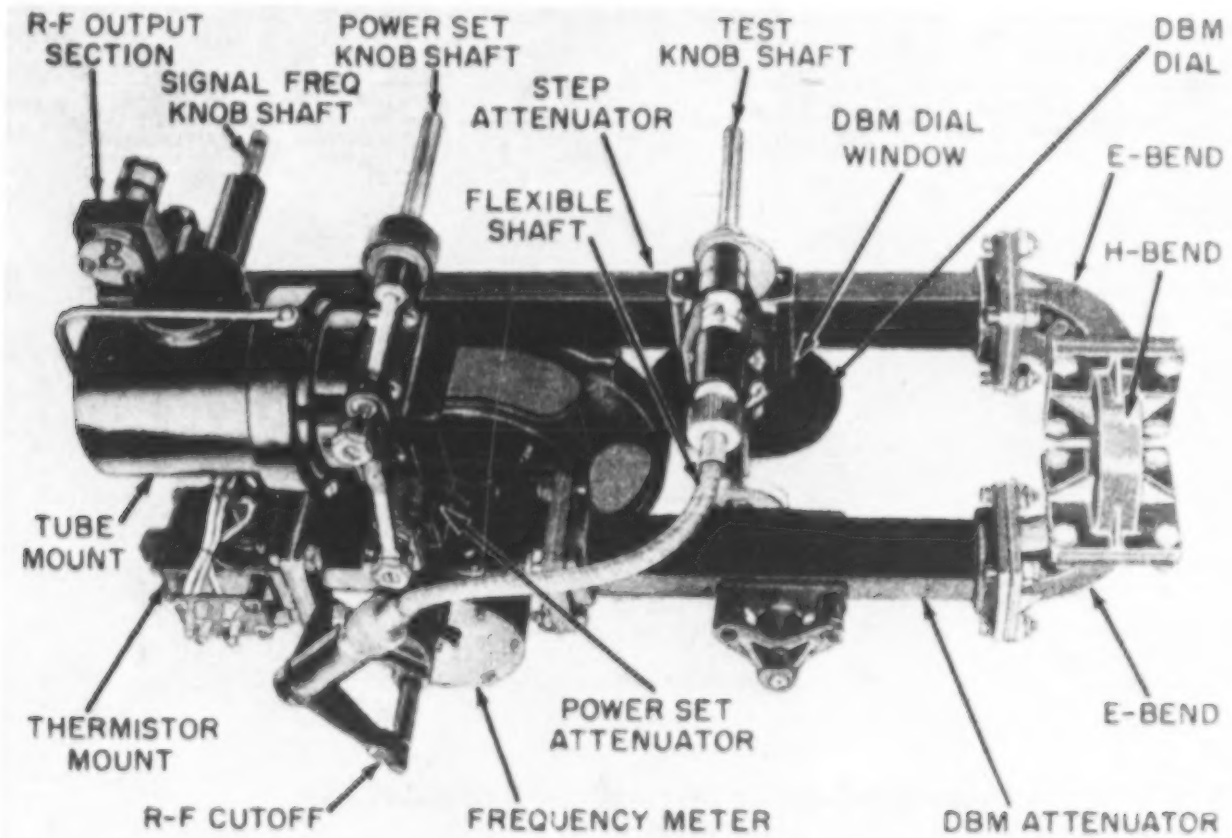

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Figure 3-41.—RF plumbing arrangement.

meter. The resulting decrease in power output will appear as a small dip in the frequency response curve seen in a synchroscope of oscilloscope.

The frequency of input signal is measured in the same way as the frequency of output signal. The energy to be measured is fed into the r-f connector, and the frequency meter absorbs part of the power at resonance causing a dip in the meter reading.

The following example will illustrate the principles of power measurement. Assume that a certain radar transmitter with a built-in directional coupler having a 20-db attenuation is connected to the test set with an r-f cable having a 3.5 db loss.

The test set power-measuring bridge is first properly calibrated. When r-f power is applied, the dbm dial reads 17.5 dbm when the bridge R-F power meter indicates 1 mw. The total db attenuation with reference to 1 mw is 20 db + 3.5 db + 17.5 db = 41 dbm (1-mw reference).

The average power output of the radar transmitter in watts is 41 db above 1 mw. From the dbm-to-watts conversion chart (fig. 3-42), the corresponding average power output of the radar system in watts is approximately 12.5 w.

The peak power is equal to the average power divided by the duty-cycle ratio. The duty-cycle ratio (for a square wave) is equal to the product of the pulse length in microseconds and the pulse repetition rate, PRF, in pulses per second, divided by 10. Expressed as a formula, the peak power is

$$\text{peak power} = \frac{\text{average power}}{\text{duty-cycle ratio}} = \frac{\text{average power}}{\text{pulse length} \times (\text{PRF})} = \frac{\text{average power} \times 10^6}{\text{pulse length} \times (\text{PRF})}$$

Where the peak power and the average power are in watts.

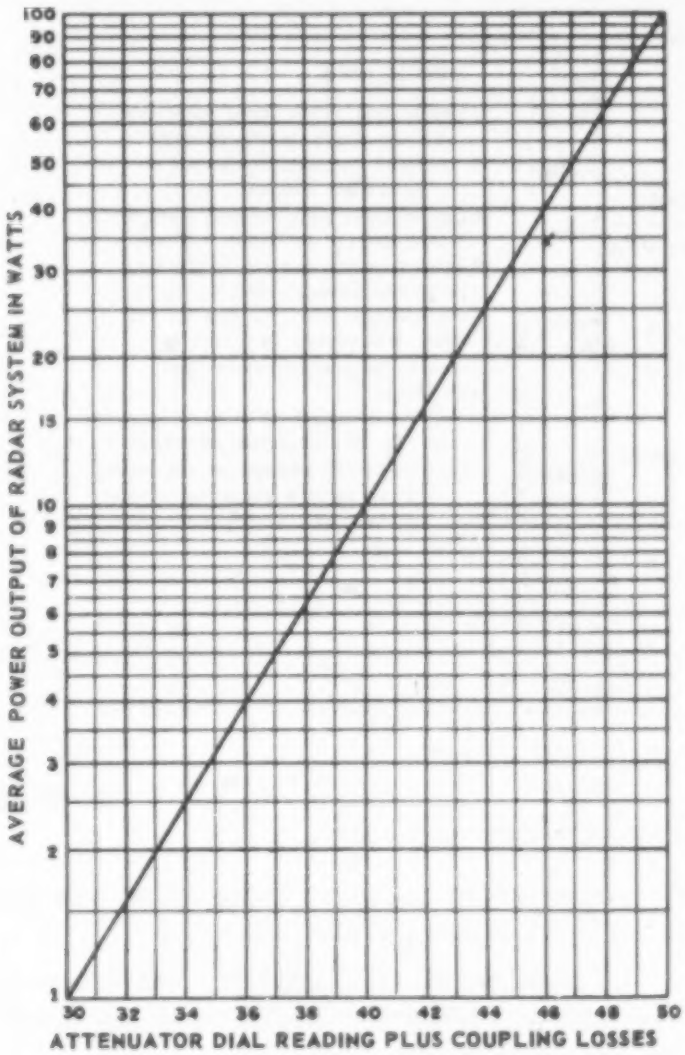

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Figure 3-42.—Dbm-to-watts conversion chart.

If the pulse length is 0.8 μs, the pulse repetition rate is 1706 pulses per second, and the average power is 12.5 w, the peak power will be

$$\text{peak power} = \frac{12.5 \times 10^6}{0.8 \times 1706} = 9150 \text{ w (approx)}$$

A chart for converting average power to peak power is illustrated in figure 3-43. From this chart the db value is indicated for the example being considered as 28.6 db at point C. From this value the peak power is found from the formula,

$$\text{db} = 10 \log \frac{\text{peak power}}{\text{average power}}$$

$$28.65 = 10 \log \frac{\text{peak power}}{\text{average power}}$$

$$\frac{\text{peak power}}{\text{average power}} = 733$$

$$\text{peak power} = 733 \times 12.5 = 9150 \text{ w (approx)}$$

RADAR PERFORMANCE FIGURE

Although ringtime measurements are valuable in indicating the overall performance of a radar system, they are not as precise as Radar Performance Figure (RPF) measurements. However, neither of these measurements indicates much about how efficient the waveguide or antenna is in performing its function. Ringtime measurements are relatively easy to make; RPF measurements are more difficult to make.

The maximum range of a radar system depends on several factors—for example, (a) transmitter power, (b) receiver sensitivity, (c) the performance of the waveguide and antenna, (d) the effectiveness of the target in reflecting radar energy, and (e) atmospheric conditions.

The first two of the factors listed are especially significant insofar as equipment performance is concerned and are used in determining the RPF of a radar system. The RPF of a radar system is the ratio of the peak (pulse) power, P_p of the radar transmitter to the power of the minimum discernible signal (P_{mds}), expressed in decibels (db) or in decibels with a reference of 1 mw (that is, dbm). Expressed mathematically,

$$\text{RPF (db)} = 10 \log \frac{P_p}{P_{mds}}$$

Because P_{mds} is a very small fraction, its log has a negative sign, and therefore

$$\text{RPF (db)} = 10 \left[\log P_p - (+\log P_{mds})\right]$$

$$\text{RPF (db)} = 10 \log P_p + 10 \log P_{mds}$$

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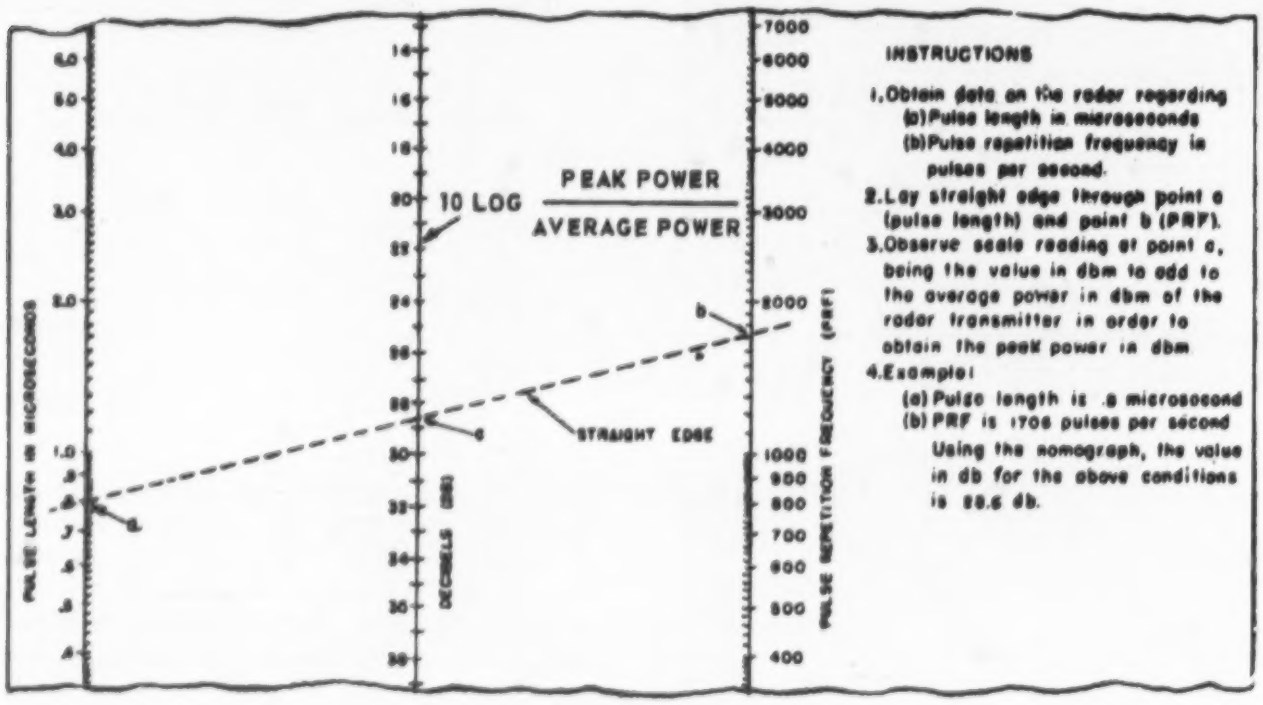

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Figure 3-43.—Average-to-peak power conversion chart.

If the power reference is 1 mw, the equation becomes

$$RPF\ (dbm) = P_p\ (dbm) + P_{mds}\ (dbm)$$

To determine the RPF of a radar system it is necessary first to determine the transmitter average power by means of a power meter (previously discussed) and to convert the average power in dbm to peak power in dbm. The various losses must be taken into consideration in determining the power output. It is also necessary to determine the power of the minimum discernible signal.

The measurement of the minimum discernible signal (MDS) in dbm involves the use of a signal generator and an oscilloscope. The exact method of making the measurement depends on the radar set being tested. For example, the procedure for making MDS measurements on Radar Set AN/SPS-10 is given in the Maintenance Standards Book for the AN/SPS-10.

An external pulse-modulated signal and a method of viewing this signal is required. These requirements are satisfied by the use of Signal Generator TS-419/U and Oscilloscope OS-8B/U or equivalents. The test equipment is connected as shown in figure 3-44 and the correct procedures are as follows:

1. Deenergize the radar equipment (depress S102) and apply power to the signal generator and the oscilloscope.

2. Adjust the signal generator to the assigned transmitter frequency, set the FUNCTION switch to ZERO SET and adjust the ZERO SET control until the meter indication is zero.

3. Set the FUNCTION switch to CW and adjust the POWER SET control until the meter pointer is at the power set marker.

4. Set the FUNCTION SELECTOR switch to the RATE x 10 position, the PULSE WIDTH control to 2 and the PULSE RATE control to 30.

5. Make certain that all connections to the test equipment are correct, and that the oscilloscope is adjusted for maximum clarity of presentation.

6. Depress MAIN POWER ON switch (S101) on the radar set, and set MANUAL-AFC switch to MANUAL. The RADIATION switch (S104) is OFF.

7. While observing the pulse-modulated signal on the oscilloscope, slowly decrease the

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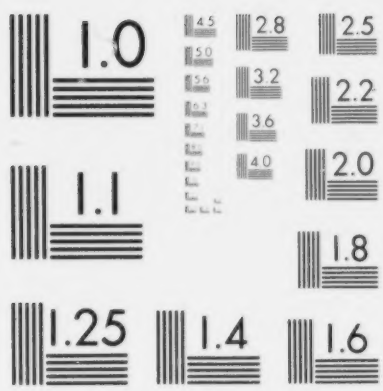

MICROCOPY RESOLUTION TEST CHART

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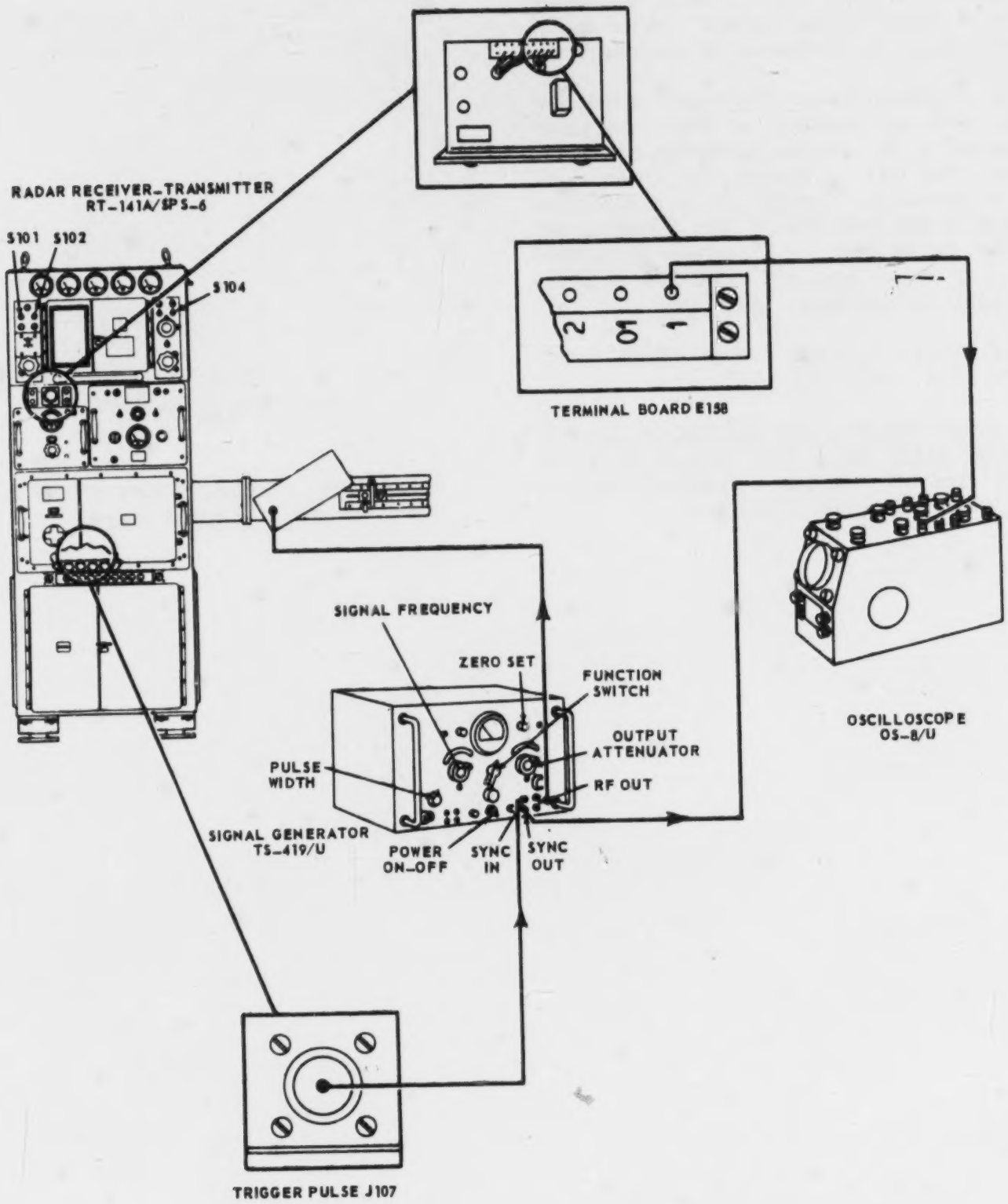

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Figure 3-44.—Test setup for making MDS measurements.

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output of the signal generator with the OUTPUT ATTENUATOR control until the signal is barely visible in the "grass" on the oscilloscope. Read the indication of the attenuator dial in dbm.

The minimum discernible signal is the sum of the test set reading in dbm, the cable attenuation in db, and the waveguide connector in dbm. For this equipment, the power of the MDS is normally between 100 and 115 dbm.

Thus, if the peak power (Pp) output is assumed to be 90 dbm and the power of the MDS (that is P mds) assumed to be 105 dbm, the radar performance figure (RPF) is

RPF (dbm) = Pp (dbm) + Pmds (dbm)
RPF (dbm) = 90 + 105 = 195

A graph showing the percentage loss in maximum radar range for various db losses in RPF and for various percentages of loss in ringtime is shown in figure 3-45.

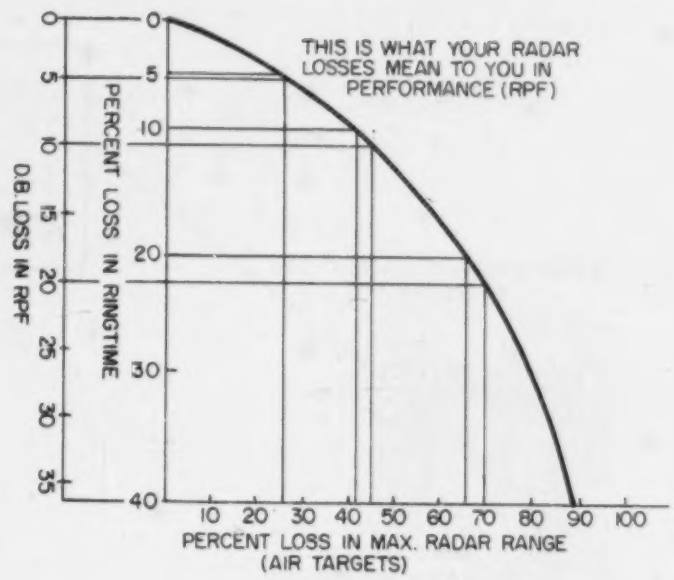

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Figure 3-45.—Effects of loss in RDF and ringtime on radar range.

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CHAPTER 4

RADIO RECEIVERS

This chapter describes several representative types of Navy radio receivers. Modern Navy receivers use rugged components, that utilize circuits to make them easy to operate and maintain. They are capable of receiving several types of signals and can be tuned accurately.

RADIO COMMUNICATIONS FREQUENCIES

Radio frequencies extend from 10 kc to 300,000 mc and are divided into various bands for convenience. The bands used for military purposes are shown in table 4-1.

Table 4-1.—Frequency Spectrum

Band	Frequency range
Very low frequency (VLF)	10 to 30 kc
Low frequency (LF)	30 to 300 kc
Medium frequency (MF)	300 to 3,000 kc
High frequency (HF)	3 to 30 mc
Very high frequency (VHF)	30 to 300 mc
Ultrahigh frequency (UHF)	300 to 3,000 mc
Superhigh frequency (SHF)	3,000 to 30,000 mc
Extremely high frequency (EHF)	30,000 to 300,000 mc

Each of the bands have certain transmission characteristics, which are peculiar to that band. Occasionally the characteristics within a band may differ, but generally they are consistent. The terms "long range, medium range, and short range", correspond to 1500 miles, 200 to 1500 miles, and under 200 miles, respectively (table 4-2).

WHERE USED

The very low frequency band (from 10 to 30 kc) is not covered by shipboard transmitters, because transmitting antennas required for these frequencies are too long to use aboard ship. However, shore stations, such as NAVCOMMSTA Washington (NSS) employ the VLF band for fleet broadcasts. Stations using such frequencies are capable of transmitting signals through magnetic storms that ordinarily blank out the higher frequency bands.

The direction-finding equipment used by the Navy generally employs frequencies in the 30-to 300-kc range. Reliable long-range communication can usually be obtained in the LF band with low frequency equipments and antennas aboard ship. Frequencies in the LF band (like those in the VLF band) do not depend on skywaves, and provide stable communications with little seasonal variation.

Transmission of frequencies in the 300- to 3000-kc range usually employs the use of groundwaves even though skywave transmission and reception of MF waves are also possible. At the upper end of this band, the ionosphere has a great effect on the skywave. If the correct frequency is used at the proper time, transmissions over relatively large distances can be obtained by using this band. Propagation characteristics vary from season to season, and from nighttime to daytime transmission.

Commercial broadcast as well as some Navy stations employ frequencies in the MF band. Modern Navy transmitters designed to operate in the MF band are the AN/SRT-14, 15, and 16. Special circuits for these transmitters are described in chapter 6 of this training course.

The HF band includes frequencies from 3 to 30 mc. The skywave is used for long-range transmission in this band. Propagation characteristics of frequencies in this range also

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Table 4-2.—Frequency Transmission Characteristics

Band	Range		Power required	Antenna length requirements
	Day	Night		
VLF	Long	Long	Very high	Very low
LF	Long	Long	Very high	Long
MF	Medium	Long	High to medium	Long
HF (3 to 10 mc)	Short	Medium to long	Medium	Medium
HF (10 to 30 mc)	Long	Short	Low	Short
VHF	Short	Short	Low	Very Short

change with the time of day and the season of the year.

The HF band is divided into two parts (see table 4-2) to show the characteristics of each part.

The antennas used in the 30- to 300-mc band require less space than lower frequency antennas and thus have an advantage for shipboard use. In addition, the power required for transmission in the VHF range is relatively low.

For frequencies greater than 30 mc, the surface wave component of the ground wave is rapidly attenuated through the dielectric constant of the earth. For this reason, the direct wave (that component of the groundwave traveling directly from the transmitting antenna to the receiving antenna) is the primary component of VHF propagation. The distance covered by a given transmission in this range however, is not always limited to the distance of the horizon, or the line-of-sight distance from the transmitter. Research has shown the early line-of-sight theory to be frequently in error because radio waves of these frequencies may be refracted.

From this discussion, it is easy to see that several factors must be considered when a certain frequency is to be selected for transmission. The Electronics Technician has little to say about the choice of this frequency. A knowledge of the factors discussed, however, should be helpful in determining why that particular frequency was chosen.

RADIO RECEIVING SETS AN/SRR 11, 12, 13, AND 13A

The AN/SRR-11, 12, 13, and 13A receivers represent equipments widely used in the Navy and cover the frequency range from 14 kc to 32 mc. They consist of several major assemblies, each physically independent of the other. Individual subassemblies, however, are mounted with each assembly, and they plug into an appropriate socket of their major assemblies. When it is necessary to make repairs quickly, a defective assembly or subassembly can be replaced with a spare one.

The AN/SRR-11, 12, 13 and 13A receivers (fig. 4-1) are designed for tabletop mountings. Each is self-contained in a metal case with operating controls, switches, meters (tuning and output), phone jack connectors, and main tuning dial assembly mounted on the front panel. The receiver chassis is mounted on rails in the receiver cabinet and can be withdrawn and positioned 45° or 90° (up or down) for ease in servicing.

The frequency range of each receiver is divided into five bands. Continuous tuning is available throughout each band. The frequency range of the AN/SRR-11 receiver is from 14 to 600 kc (low frequency), that of the AN/SRR-12 receiver is from 0.25 to 8 mc (medium frequency), and the range of the AN/SRR-13 receiver is from 2 to 32 mc (high frequency).

The AN/SRR-11 receiver is provided with circuits and switching to receive A1 (c-w telegraphy) signals, A2 (m-c-w telegraphy) signals, and F1 (telegraphy by frequency-shift keying) signals. In addition, the AN/SRR-12 and 13 receivers are capable of receiving A3 (radiophone) emissions.

The basic receiver represented by the AN/SRR-11, 12 and 13 sets is a double superheterodyne having two stages of r-f amplification ahead of the first mixer and oscillator.

A first intermediate frequency amplifier (which is essentially the second converter) follows, and its output is fed to the second i-f assembly. Signals of A2 (m-c-w) and A3 (phone) emissions are rectified in a diode

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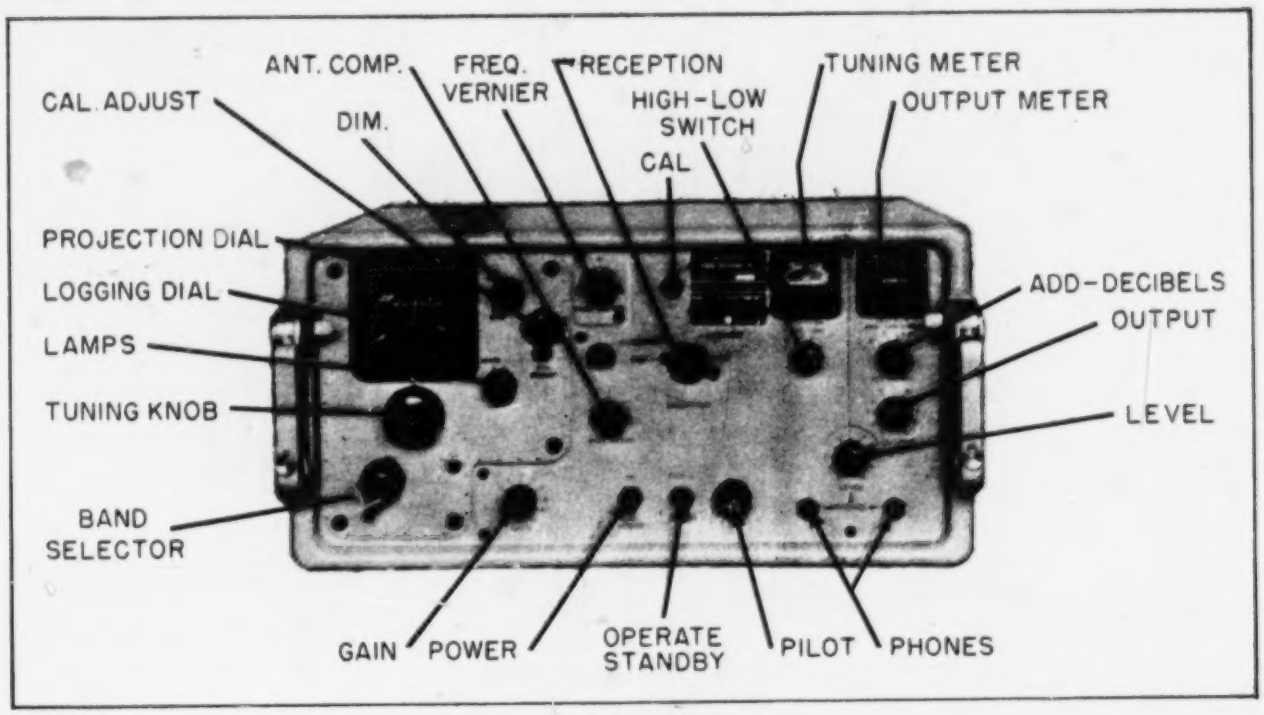

A AN/SRR 11

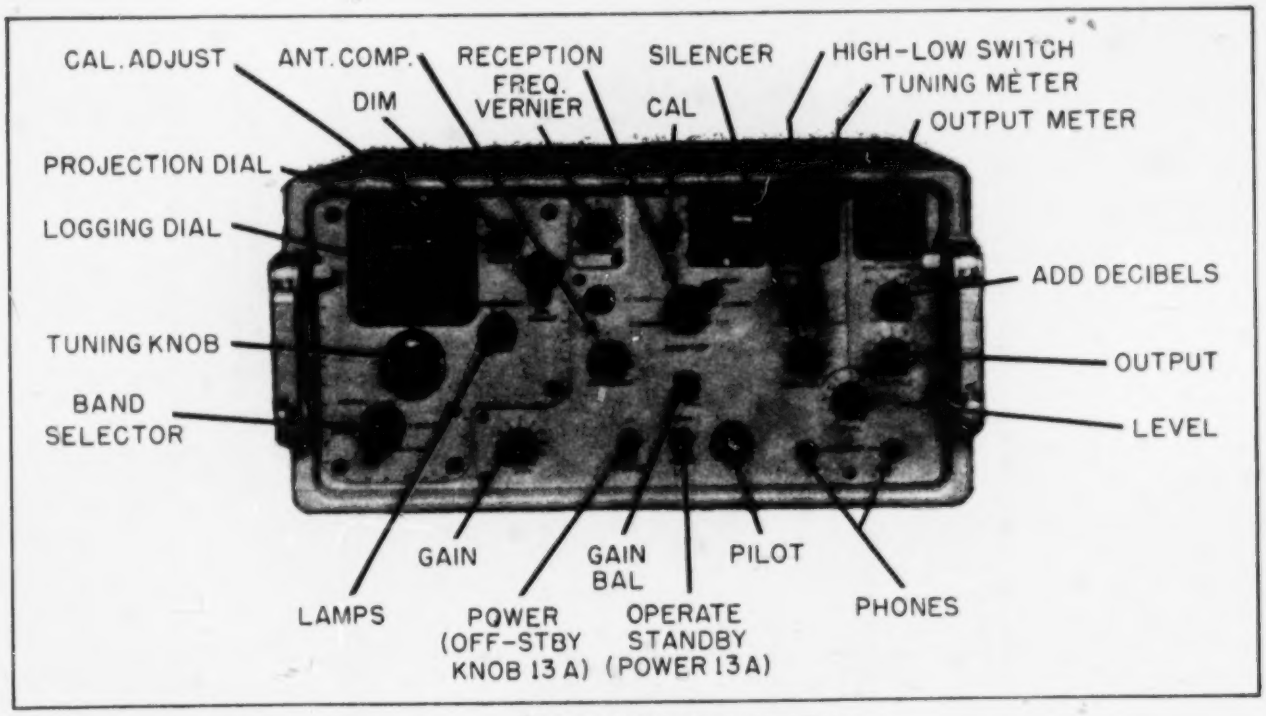

B AN/SRR 12-13-13A

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Figure 4-1.—Radio receiving sets AN/SRR-11, 12, 13, and 13-A front panel controls.

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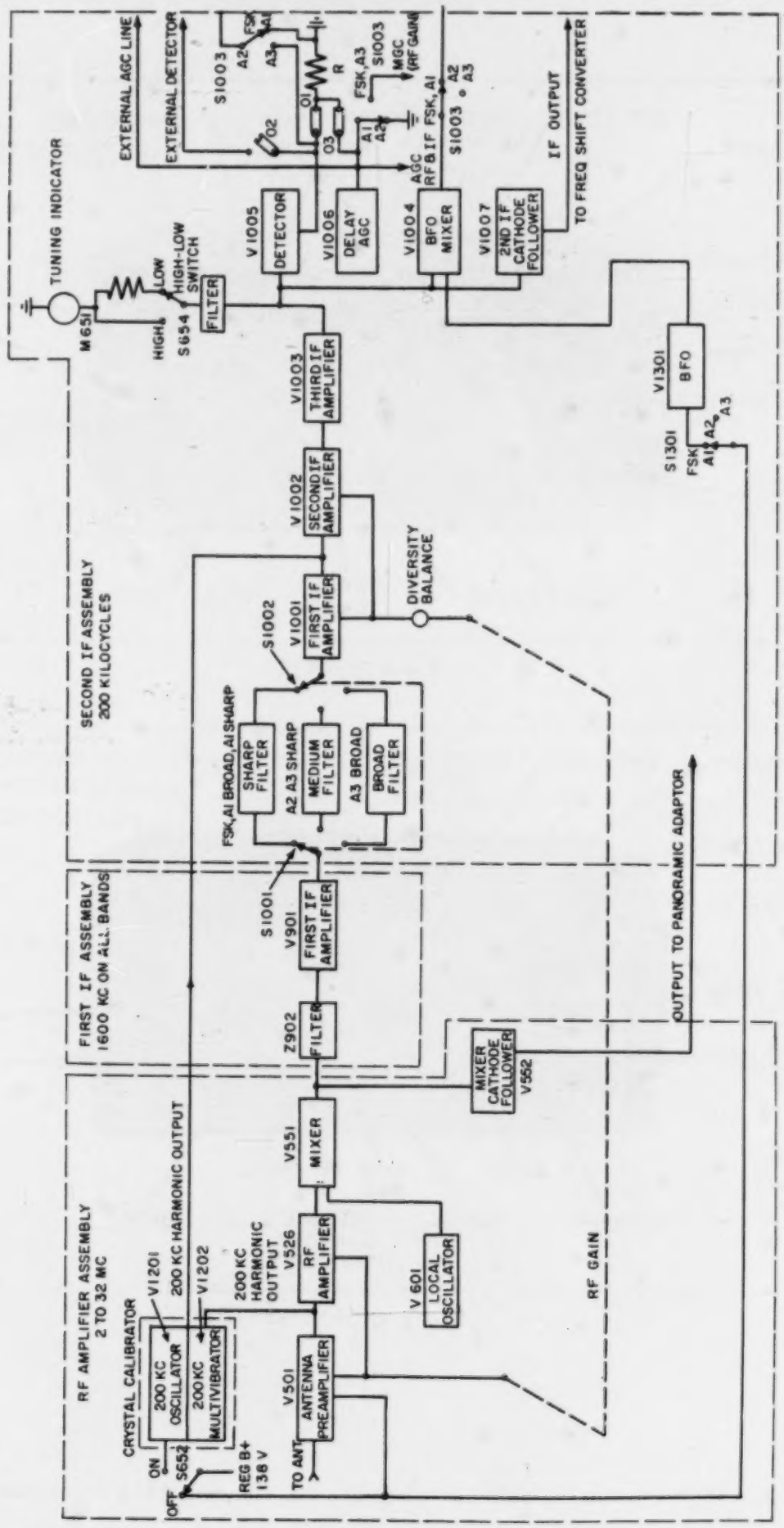

Figure 4-2.—Block diagram of radio receiving set AN/SRR-13A.

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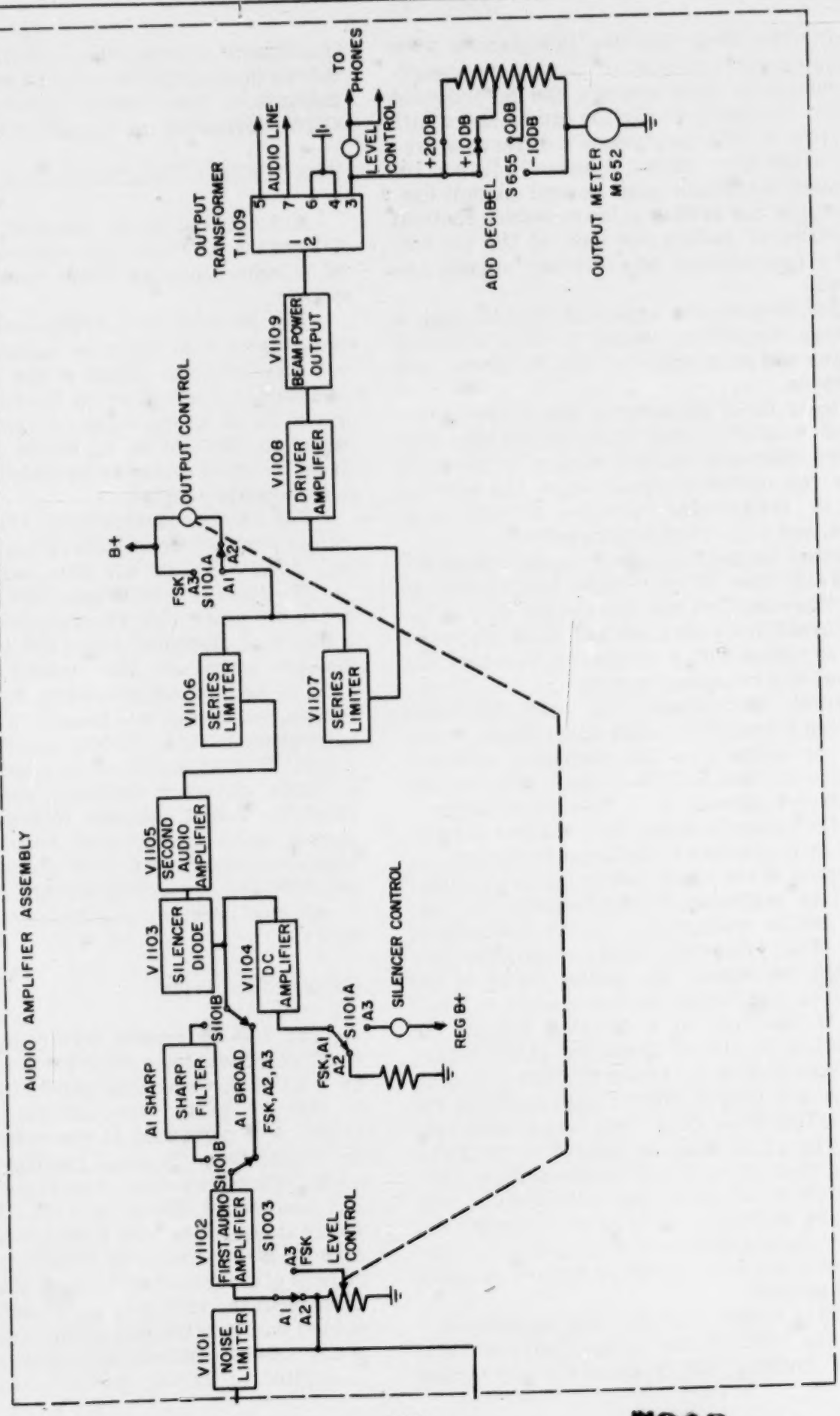

Figure 4-2.—Block diagram of radio receiving set AN/SRR-13A—Continued

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detector. The diode detector is bypassed when the receiver is switched to c-w or frequency-shift reception. Such signals are heterodyned in a beat frequency oscillator mixer stage with those from a BFO to produce a difference frequency in the audio range. A manual gain control or delayed automatic gain control circuit (depending upon the setting of the reception control) is provided to reduce the gain of the r-f and second i-f amplifiers when strong signals are received.

Audio frequencies are amplified through a four-stage amplifier, which feeds a balanced audio line and an unbalanced line for phone jack connections.

Circuits from the antenna stage through the first i-f amplifier are designed so that they will have different characteristics in order to provide for optimum reception on the several bands of frequencies covered by the low, medium, and high frequency receivers.

External connections are furnished from the AN/SRR-12 and 13 receivers to provide an AGC voltage and circuit connection to a common external diode load, so that these receivers may be operated with a companion receiver in a dual diversity reception system.

External connections are also furnished for feeding a frequency-shift converter of either the i-f or audio type. An additional external connection on the AN/SRR-12 and 13 is provided to supply i-f signals to a panoramic adapter.

The frequency to which the receiver is tuned appears projected on a translucent screen (tuning dial) located at the upper left of the front panel. The dial is calibrated in kilocycles on the AN/SRR-11 and in megacycles on the AN/SRR-12 and 13. The projection system consists of a glass disk on which the tuning range of the receiver is calibrated in five scales. A light source is mounted in a housing behind the tuning dial. A portion of one of the optical scales on the glass disk is projected through a system of lenses and onto a mirror that reflects the image of the scale back upon the translucent screen. The glass disk is rotated by gears as the tuning knob is turned. When the setting of the band switch is changed, the dial light and lens housing are moved up or down by a cam driven from the band switch gears to align the lens system with the corresponding frequency scale on the glass disk.

The CAL adjust knob and locking screw located to the right of the tuning dial provide a means of shifting the frequency scale on the translucent screen when recalibrating the receiver in conjunction with the crystal controlled calibrator. This action is accomplished by a slight horizontal movement of the lens system.

FUNCTIONAL DESCRIPTION AN/SRR-13A

A functional block diagram discussion (fig. 4-2 of the AN/SRR-13A is given as a description of a representative Navy communications receiver.

The receiver is a double-conversion superheterodyne a-m receiver having two stages of r-f amplification ahead of the first mixer and oscillator. The output of the first mixer is fed via a filter to the first i-f amplifier which is tuned to 1600 kc on all bands. A second output from the first mixer is provided as an output to a panoramic adaptor.

The local oscillator (V601) (a Hartley) in the r-f assembly tracks 1600 kc higher than the signal frequency on all five bands (2-32 mc).

The first i-f amplifier (V901) also serves as a crystal controlled Pierce type oscillator operating at a frequency of 1400 kc to produce a 200-kc output to the second i-f assembly.

The second i-f assembly includes 3 filters (sharp, medium, and broad), 3 stages of amplification (V1001, V1002, and V1003 at 200 kc, a BFO (V1301), and its associated mixer (V1004), a diode detector (V1005), AGC delay diode (V1006), and a cathode follower (V1007) to supply a frequency shift converter or other accessory equipment. Link connections are also provided for connecting the AN/SRR-13A with a companion receiver in a dual diversity reception system.

Crystal Calibrator

The 200-kc crystal calibrator (V1201-1), is a cathode coupled multivibrator locked to 200 kc by a 200-kc crystal. One output rich in harmonics of 200 kc is fed through the r-f amplifier (V526) and combined in the mixer (V551) with the signal from the local oscillator (V601). The combination frequency signal goes through S1001 and associated filters to V1001 then to V1002 where it combines with a second output from the crystal calibrator. The combination of the two signals gives a beat note at every 200-kc interval throughout the tuning range of the receiver. (The second output is taken from the common cathodes of the 200-kc multivibrator, and its 4th harmonic is applied to V1002, the second i-f assembly.)

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The main tuning dial can thereby be calibrated independently of external signals if the CAL switch (S-652) is turned to the ON position.

The crystal calibrate switch is connected so that in the OFF position, B+ voltage is not applied to the crystal calibrator. In the ON position, B+ voltage is applied to the calibrator and is removed from the antenna preamplifier (V501) and BFO (V1301) thereby preventing interference with the crystal calibrator from either externally applied signals or the BFO.

Audio Section

Signals at 200 kc from the plate of V1003 are applied to the diode detector, V1005. The audio output of V1005 is applied to the noise limiter V1101 when the reception control is in the A2 or A3 position.

The diode detector voltage developed across R is applied through link 03 to the delay AGC diode, V1006, when the reception control is in the FSK or A3 position. Delayed AGC is effective only for F1 and A3 reception.

Links 01, 02, and 03 are provided for applying a rectified signal voltage and AGC voltage to a second AN/SRR-12 or 13 designated as the companion receiver for dual diversity reception. With the diversity connection, the diode load resistor and the delayed AGC circuit of the local receiver are made common to the companion receiver. In diversity operation the gain of both receivers must be balanced. This action is accomplished by regulating the amount of gain in V1001 and V1002 of each receiver by adjustment of the Diversity Gain Balance control, a recessed screwdriver adjustment on the front panel.

Silencer Circuit

The silencer circuit (V1103 and V1104) is active in the audio assembly when the reception control is in the A3 sharp or A3 broad position to prevent noise from being further amplified by succeeding stages in the absence of signals.

The silencer diode V1103 (fig. 4-3) is connected in series between the first and second audio amplifiers V1102 and V1105. Plate voltage on the diode V1103 depends on the magnitude of plate current through the d-c amplifier V1104. The cathode voltage of the diode V1103 is determined by voltage divider R1115 and R1116. Grid voltage of the d-c amplifier V1104, is determined by the setting of the silencer potentiometer R656 (mounted on the front panel

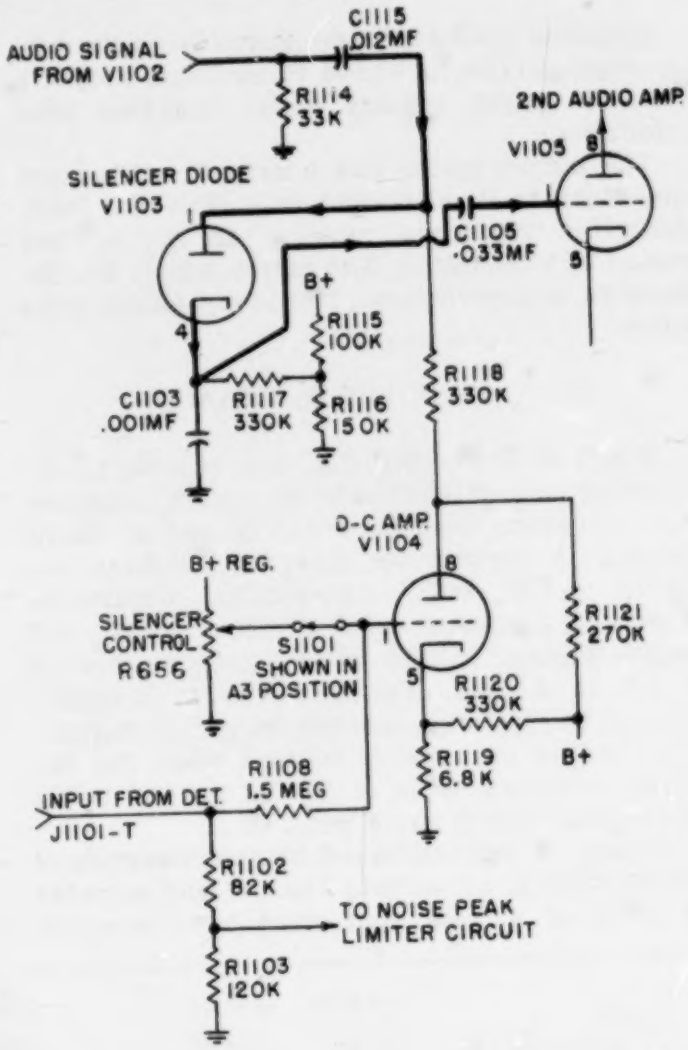

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Figure 4-3.—Silencer circuit, simplified schematic.

of the receiver) and by the average d-c level of the detector output.

When the grid voltage of V1104 is positive, the plate of V1103 becomes negative with respect to its cathode, and the diode cannot conduct. When the grid voltage of V1104 is reduced (as by the presence of a strong carrier), the triode plate current is reduced and the plate of V1103 becomes positive with respect to its cathode, thus causing the diode to conduct.

When the reception control is set to any other position but A3 sharp or A3 broad, the silencer control is inoperative because switch S1101A returns the grid circuit of V1104 to ground instead of to the silencer control.

Two series diode limiters (V1106 and V1107, fig. 4-2), are combined to clip equally on positive and negative portions of the audio cycle when the reception control is set for A1 or A2.

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Negative feedback is employed from the output stage V1109 to V1108 to maintain a nearly constant output voltage under changing load conditions.

The output meter has a zero db calibration equivalent to 6 milliwatts in a 600-ohm load. Multiplier resistors provide an appropriate amount of attenuation. The power supply for the receiver is conventional, and is not shown in the figure.

RADIO RECEIVER R-390A/URR

Model R-390A/URR (fig. 4-4) is a high performance, exceptionally stable, general-purpose radio receiver used aboard ship and at shore stations throughout the Navy. It provides reception of CW, MCW, conventional amplitude-modulated, frequency-shift RATT and FAX, and single-sideband signals within a frequency range of 0.5 to 32 mc. The receiver is a superheterodyne type with multiple frequency conversion. Double conversion is used when the receiver operates from 8 to 32 mc and triple conversion from 0.5 to 8 mc.

Tuning is accomplished by the insertion of powdered-iron cores into the r-f and variable i-f coils at a rate controlled by a complex mechanical arrangement of gears, shafts, and cams. The frequency is indicated by a counter-type indicator that is accurate to within 300 cps, an accuracy that permits use of the receiver as an accurate frequency meter.

RECEIVER BLOCK DIAGRAM

Figure 4-5 shows the path of the receiver signals from the antenna input to the audio output and i-f output.

Radiofrequency signals are fed into the receiver by either a balanced two-wire antenna such as a doublet, or an unbalanced antenna such as a whip or long wire. Antenna relay K101 disconnects and grounds the antenna during standby calibration, or break-in operation. When K101 is not energized, the balanced antenna is connected to the input of one of the antenna transformers, T201 through T206, which is selected by the megacycle change switch. The transformers are tuned by the megacycle change and the kilocycle change tuning controls. The output of these tuned circuits is fed into r-f amplifier V201. If an unbalanced antenna is used, the signal is fed directly to the grid circuit of the r-f amplifier.

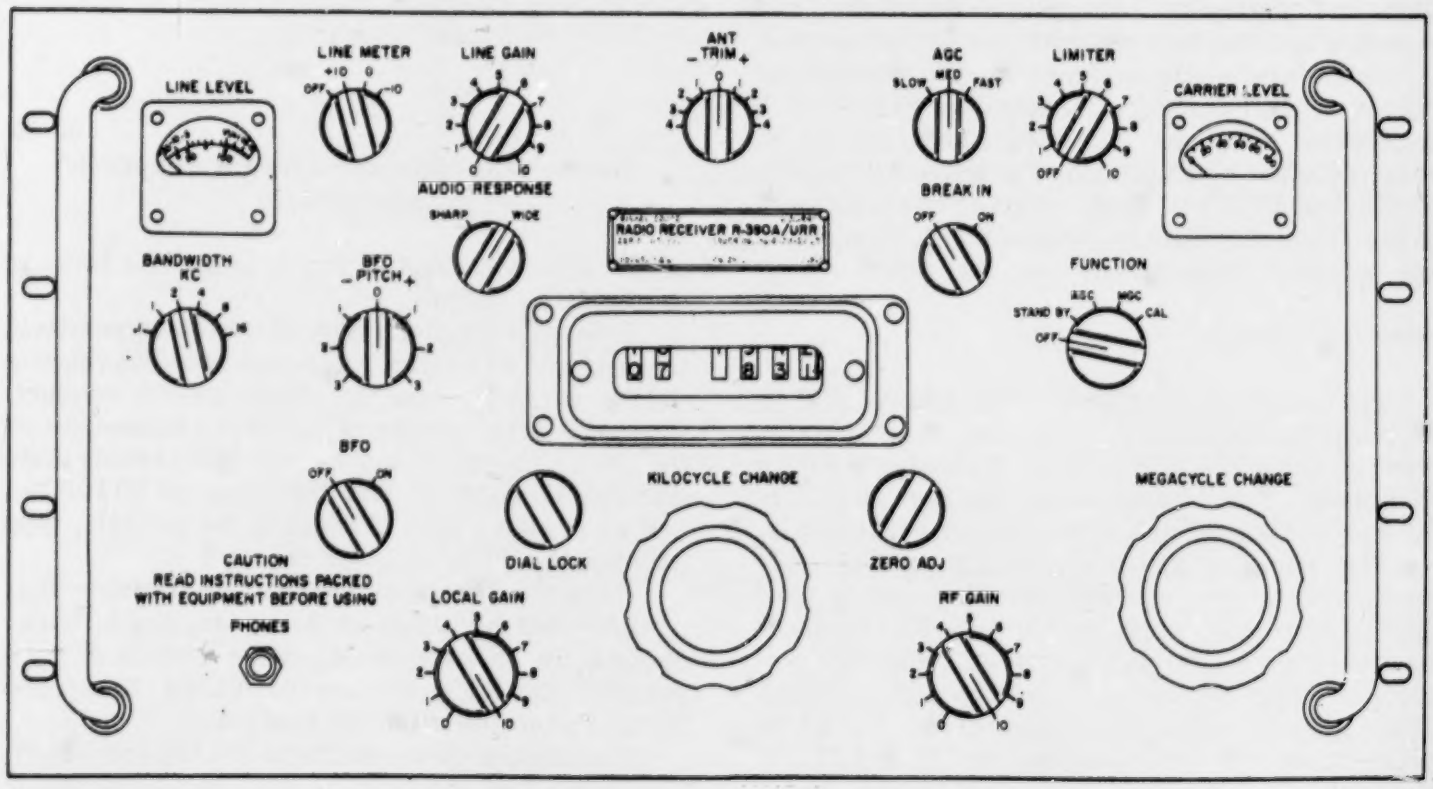

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Figure 4-4.—R-390A/URR radio receiver.

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The calibration circuit, consisting of 200-kc crystal calibration oscillator V205A, 100-kc multivibrator V206, and 100-kc cathode follower V205B, injects 100-kc markers into the input circuit of r-f amplifier V201. When the function switch is in the CAL position, B+ is connected to the calibration circuit.

Radiofrequency amplifier V201 amplifies the signals from the antenna before they are fed to first mixer V202. Six tuned circuits are selected by a switch that is connected to the megacycle change control. The tuned circuits are adjusted by the kilocycle change and megacycle change controls. The frequency range of tuned circuits Z201 through Z206 is 0.5 to 32 mc.

Signals from 0.5 to 8 mc are coupled from r-f amplifier V201 and fed into the input circuit of first mixer V202. The 8- to 32-mc signals from V201 are switched around the first mixer and fed directly into second mixer V203. When the receiver is operated between 0.5 and 8 mc, the first mixer combines the r-f signals with a 17-mc signal from first crystal oscillator V207. The output (sum) frequency is the first variable i-f signal, and its frequency varies from 17.5 to 25 mc. Tuned circuit Z213 is a triple-tuned device that is permeability tuned as the megacycle change and the kilocycle change controls are operated.

The 17.5- to 25-mc output of the first mixer stage (when the receiver is tuned from 0.5 to 8 mc) or the 8- to 32-mc output from r-f amplifier V201 (when the receiver is tuned from 8 to 32 mc) is selected by the operation of the megacycle change control and fed into second mixer V203. Also fed into V203 is a signal from crystal oscillator V401. The output frequency of V401 is changed as the megacycle change control is operated so that the difference between signal frequency and oscillator frequency is always between 2 and 3 mc. When the frequency reading on the receiver dial is between 0.5 and 0.999 mc, V401 feeds a 20-mc signal into V203. The output frequency of V203 thus varies downward from 3 to 2 mc, except on the 0.5- and 1-mc band, where the output frequency of V203 varies between 2.5 and 2 mc. This is the second variable i-f signal. Another set of triple-tuned coils, Z216, tunes the output of V203 as the kilocycle change control is operated.

The 3- to 2-mc output of the second mixer and its tuned output circuit Z216 is fed into the input circuit of third mixer V204. This stage beats the 3- to 2-mc signal with a continuously variable signal from variable-frequency oscillator V701. This precision oscillator has accuracy comparable with a frequency standard and is controlled by the kilocycle change control. The output of V204 is a fixed frequency of 455 kc. This is the third i-f.

The 455-kc signal is fed into or around 455-kc crystal filter Y501, as determined by the setting of the bandwidth control. When this control is in the .1-kc or 1-kc position, the 455-kc signal is fed through crystal filter Y501, and in any other position it is bypassed around the filter directly to first i-f amplifier V501. The output of V501 is fed into one of four mechanical filters. The output from the selected filter is fed successively through the second, third, and fourth i-f amplifiers (V502, V503, and V504, respectively).

The output of the fourth i-f amplifier, V504, is fed into half-wave diode detector V506B and audiofrequency voltage is produced. This a-f signal is fed to the limiter stage V507, which clips off noise peaks that might render reception difficult.

Beat-frequency oscillator V505 generates and feeds signals variable in frequency from 452 to 458 kc to detector stage V506B. The resultant beat frequency is adjustable continuously from zero to 3000 cps whether the BFO is above or below the carrier signal. Setting the BFO switch to the ON position turns on the BFO.

The audio output from limiter V507 is fed to the first a-f amplifier V601A. This stage amplifies the audio signal and passes it through or around 800-cps bandpass filter FL601, depending upon the setting of the audio response switch. The audio signal is then fed to a-f cathode follower V601B. This stage feeds the audio signals to the local and line audio channels. The local audio channel consists of local a-f amplifier V602A and local a-f output tube V603. This audio source is used for 600-ohm headsets or loudspeakers. The line audio channel is similar to the local audio channel, consisting of line a-f amplifier V602B and line a-f output tube V604. The output provided matches a balanced 600-ohm line.

Intermediate-frequency signals (455 kc) present at the input to fourth i-f amplifier V504 are also fed to the input of i-f cathode follower V509B. This stage provides a 50-ohm source of 455-kc signals for use with a frequency-shift converter for RATT operation. The i-f output connector for this type of service is located on the rear panel of the receiver. Tube V509B also feeds 455-kc signals into the AGC circuit.

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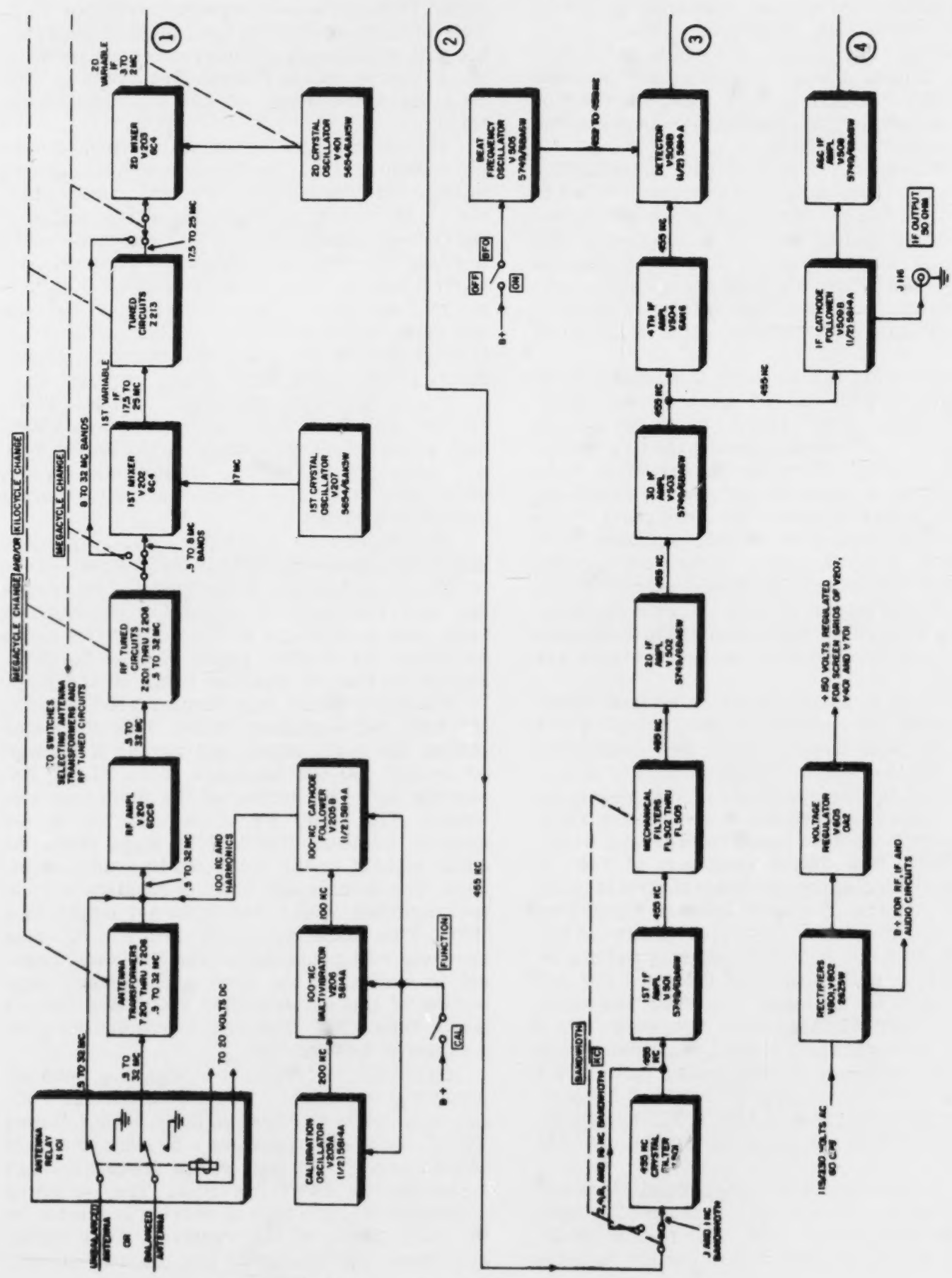

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Figure 4-5.—Block diagram of radio receiver, R-390A/URR.

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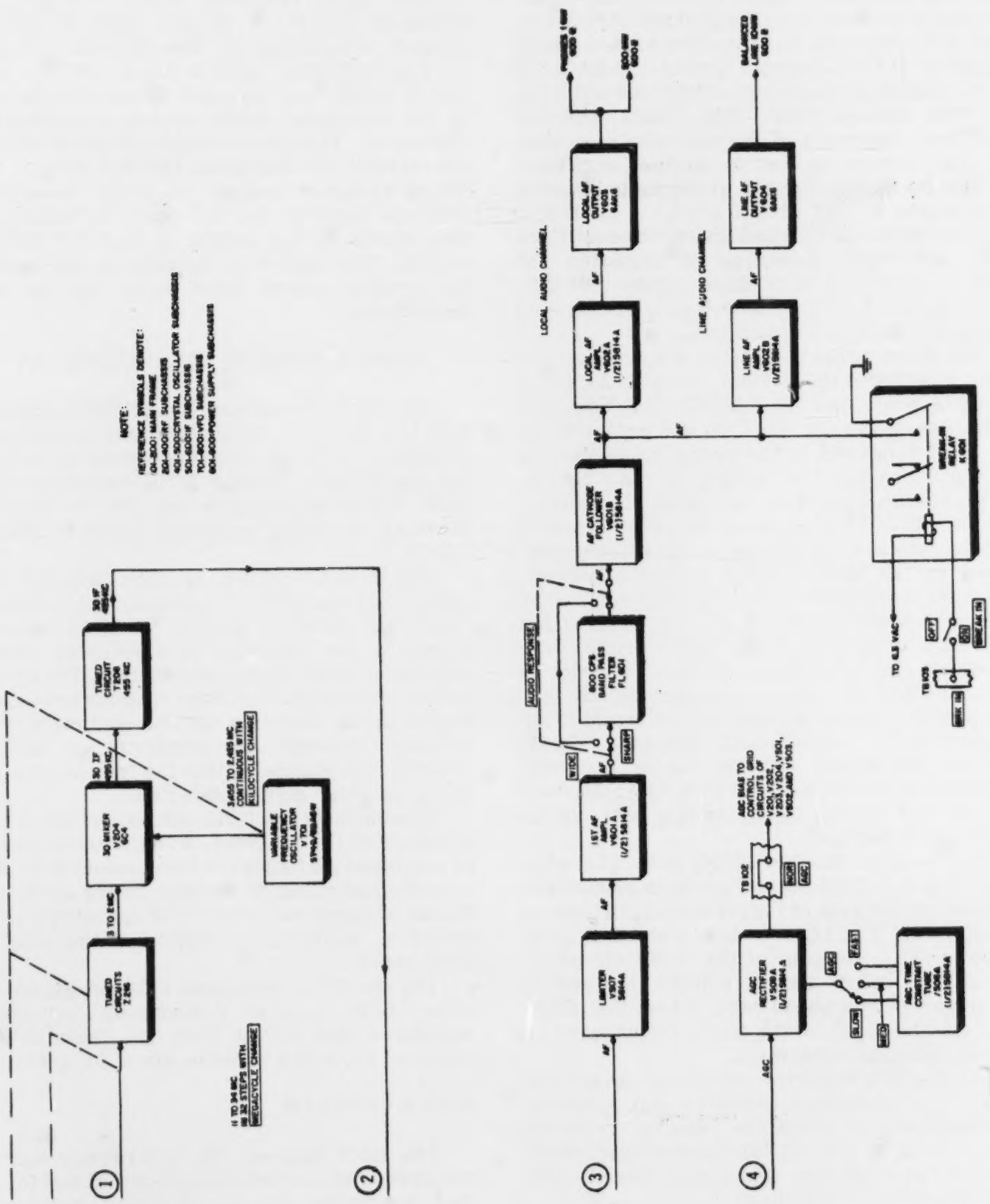

Figure 4-5.—Block diagram of radio receiver, R-390A/URR—Continued

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The first tube of this circuit is AGC i-f amplifier V508. This stage amplifies the 455-kc signal and feeds it to AGC rectifier V509A. The rectifier stage rectifies the i-f signal into direct current, with amplitude in proportion to the average amplitude of the i-f signal. This AGC bias is fed to the control grid circuits of V201 through V204 and V501 through V503. Tube V506A provides AGC time constants of various durations when the AGC switch is set to various positions.

The B+ supply for the receiver is powered by a source of 115 or 230 volts a-c at 60 cps. This a-c power is changed into d-c by rectifiers V801 and V802. A source of regulated 150 volts is provided by voltage regulator V605. This regulated voltage is used as a screen grid supply for V207, V401, and V701.

Two front panel knobs (fig. 4-4) provide the tuning control of the R-390A, the MEGACYCLE CHANGE knob and the KILOCYCLE CHANGE knob. The MEGACYCLE CHANGE knob selects any 1-mc bandwidth of the tuning range. Turning this knob changes the reading of the first two digits of the frequency indicator. The KILOCYCLE CHANGE knob tunes the receiver to any desired frequency within the megacycle band selected by the MEGACYCLE CHANGE control. The last three digits of the frequency indicator dial provide the kilocycle reading. The tuning controls actually adjust the tuned circuits in the r-f stages and in the local oscillator in order to select the desired station frequency and to provide simultaneously the desired i-f signal to the i-f portion of the receiver. The DIAL LOCK knob is associated with the tuning controls. This knob locks the KILOCYCLE CHANGE control so that the frequency setting will not be accidentally changed.

The R-390A has three front panel gain controls. The RF GAIN control permits manual adjustment of the gain of the r-f and i-f portions of the receiver. The LOCAL GAIN and LINE GAIN knobs control the gain of the audio circuitry. The LOCAL GAIN control adjusts the level of the output to the phone jack. The LINE GAIN controls the level of the audio output used to operate terminal equipment.

The R-390A has three indicators on the front panel. The frequency indicator dial indicates the frequency to which the receiver is tuned. This dial is of the digital-counter type which permits the frequency to be read directly with little chance of misreading.

The CARRIER LEVEL indicator is a meter which measures the level of the r-f signal appearing at the input of the receiver. The operator will find this meter valuable in tuning to the exact frequency which will give the strongest signal. It is also used to indicate proper adjustment of the antenna trimmer.

The indicator labeled LINE LEVEL is a meter which may be used to monitor the level of the line audio output used to drive terminal equipment. This meter is placed across the output circuit by the LINE METER switch. The three available values of meter sensitivity (voltage required for full-scale deflection) are determined by the setting of the LINE METER switch. This meter is valuable in maintaining the proper output level when making tape recordings.

RADIO RECEIVING SET AN/URR-35A

The Radio Receiver Set, AN/URR-35A (fig. 4-6) is a receiver equipment designed to provide reception of voice amplitude-modulated (A-3) and MCW (A-2) signals in the frequency range from 225 to 400 megacycles. The set replaces the RDZ receiving equipment which is now obsolete.

The Radio Receiving Set, AN/URR-35A contains a dual conversion (double-superheterodyne) VHF/UHF receiver chassis which is designed primarily for operation as a pretuned, single-channel crystal-controlled receiver. The crystal holder and various receiver controls are located behind small doors to the left and right of the receiver chassis. By employing a suitable crystal, any channel within the frequency range of the receiver may be selected.

Continuously variable manual tuning is also a feature of the receiver. A single tuning control is employed for tuning to any frequency for either crystal-controlled or manual tuning operation. Either of these two methods of operations is selected by an oscillator switch on the receiver front panel.

The receiver produces a 10-db signal-to-noise ratio when an 8-microvolt r-f signal modulated 30% with a 1000 cps audio note is received from the antenna via a 50-ohm line.

BLOCK DIAGRAM

The block diagram (fig 4-7) reveals that the receiver is of conventional design except for the dual conversion feature. However, because of the high frequencies at which the receiver operates (225 to 400 mc) many special circuits

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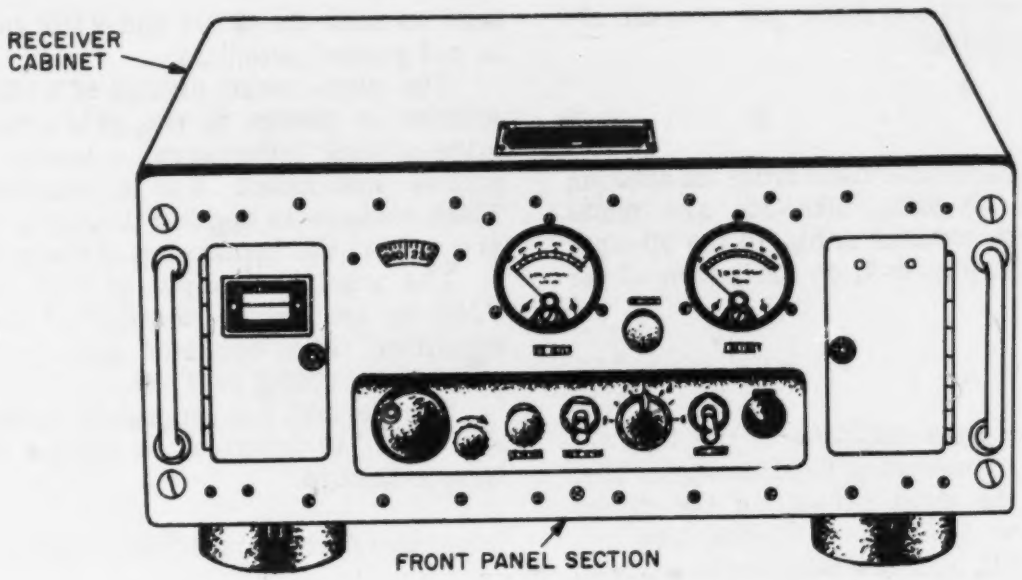

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Figure 4-6.—Radio receiving set AN/URR-35A.

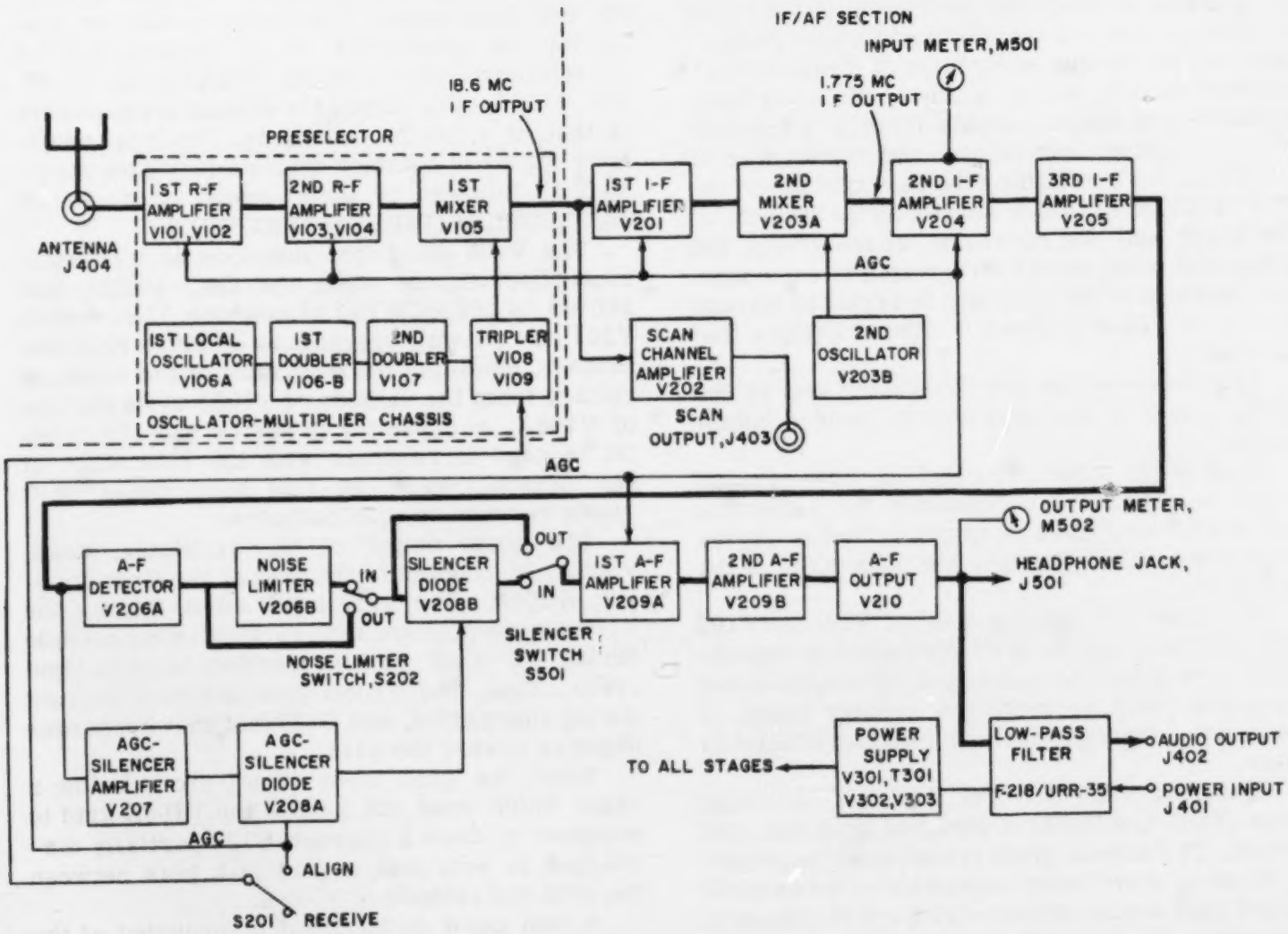

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Figure 4-7.—Radio receiver, R482/URR-35, block diagram.

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are employed which improve the overall efficiency of the receiver.

Antenna Input

The signal input connections from the antenna to the receiver (R-482A/URR-35) are made through a 52-ohm coaxial cable to the 50-ohm antenna jack, J404 (fig. 4-7) on the bottom of the low-pass filter.

R-F Amplifiers

The grid and plate circuits of the two r-f amplifier stages, comprising V101 through V104, (fig. 4-7), and the grid circuit of the mixer stage, comprising V105A and V105B, are arranged in push-pull, and are tuned by a balanced type five-gang air dielectric capacitor, C101- (not shown).

Concentric type trimmer capacitors are used for aligning the high frequency end of the tuned circuits in the r-f amplifier and mixer stages. Each of the trimmers consists of a metal block mounted on one stator section, and a partially threaded rod which extends from a bracket on the other stator section into the center bore of the block. An insulating tube is contained in the bore of the block which serves as the dielectric. The block and rod constitute, respectively, the stator and rotor plates of the trimmer capacitor. The capacity of the trimmer is varied by turning the rod to adjust the amount of the projection into the block.

Alignment at the low frequency end of the tuning range is accomplished by padder inductances.

Each of the inductors consists of two parallel round rods which are connected by a shorting bar. Positioning the shorting bar, by turning the adjustment screw, varies the inductance of the padder coil.

The push-pull arrangement of V101 and V102 approximately halves the interelectrode capacitance that would be presented by single-ended operation, thus permitting a greater range of frequency coverage with higher circuit efficiency range.

Operating bias for the first r-f amplifier tubes (V101 and V102) is obtained from the AGC circuit. The screen grids are bypassed to ground by stray or distributed capacitances between the socket pins and/or socket wiring and the chassis. Capacitors in the cathode circuit tune out the inductance of the cathode leads, and therefore tend to hold the V101 and V102 cathode nearer to r-f ground potential.

The plate tuned circuit of V101 and V102 is similar in design to the grid circuit, and contains a tank inductance, a tuning capacitor, a padder inductance, and a trimmer capacitor. Plate voltage is applied through a dropping resistor, and the center-tap of the tank inductance.

The amplified output of V101 is coupled to V103 in the upper section of the second r-f amplifier (also operated push-pull); and V102 couples its output to V104.

The second r-f amplifier, comprising V103 and V104, is identical in design to that of the first r-f stage.

Local Oscillator and Multipliers

The oscillator-multiplier section of the preselector (fig. 4-7) generates a local injection signal which is 18.6 mc higher in frequency than the received signal. The basic oscillator frequency is generated in a cathode-coupled crystal-controlled circuit, comprising V106A and V106B. The oscillator circuit arrangement is that of a Butler oscillator. The local oscillator signal is obtained from an oscillator stage, V106A, followed by three stages of frequency multiplication (V106B through V109).

The V106 oscillator functions as a crystal-controlled circuit when the OSC switch (not shown) is in the CRYSTAL position. The crystal, Y201 (not shown), operates in a series resonant mode to establish the frequency of the feedback voltage from the cathode of V106B to the cathode of V106A. A capacitor in series with the crystal is used to resonate with the inductance of the crystal leads, so that zero phase shift exists between the two cathodes.

The plate output of the oscillator stage, V106A, is coupled to the grid of the first doubler, V106B. The grid input signal drives the V106B grid positive with respect to its cathode during the most positive portion of each input cycle. Thus, the V106B grid draws a current during this period, and C137 (not shown) charges negative toward the grid.

When the grid input signal drops below a value which does not permit the V106B grid to continue to draw a current, C137 partially discharges to establish a grid leak bias between the grid and cathode of V106B.

A test point (not shown) is provided at the grid of the first doubler (V106B) to facilitate measurement of the d-c bias on the tube. The

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measured voltage is indicative of the amount of drive from the oscillator. The doubler output is developed across the plate components, and transformer coupled to second doubler, V107A.

The second doubler stage employs V107A and V107B in a push-push circuit arrangement (grids in pushpull, plates in parallel).

The output of the second doubler (V107) is coupled to the tripler stage.

The push-pull circuit arrangement of the tripler stage (V108 and V109) and the center-tapping of the coupling coil, L113 (not shown), suppress the amplification of even order harmonics in this stage. Thus, the push-pull arrangement minimizes the amplification of undesired spurious signals which might otherwise be amplified and radiated by the receiver antenna.

The V108 and V109 tripler plate circuits are tuned to a frequency which is three times their grid input frequency. Thus, the multiplier chain produces a total multiplication of 12, and a resulting output frequency which is 18.6 mc higher than the receiver input frequency.

First I-F Amplifier

The output of the mixer stage (V105A and V105B) is coupled to the grid circuit of the first i-f amplifier stage, V201. Amplifier V201 functions as a conventional i-f amplifier, except that the i-f gain control, R233 (not shown), is connected in the plate and screen circuits as opposed to its more common location in the cathode. The effect of varying R233 is to change the plate and screen voltages, and thus change the gain of the first i-f stage.

The V201 output signal is applied to the primary of the first i-f output transformer. This transformer is shielded, and double-tuned to resonate at the 18.6 mc intermediate frequency by the adjustable iron slugs.

Second Oscillator and Second Mixer Stages

The second oscillator, V203B, is crystal controlled to produce the second heterodyning frequency required for the operation of the receiver. The second mixer stage, V203A, receives the 18.6 mc i-f signal from V201 at its control grid (through a suppressor resistor), while a signal 1.775 mc below the V201 output from the second oscillator, V203B, is applied to the second mixer (V203A) cathode.

The V203B oscillator circuit is connected as a conventional crystal-controlled oscillator, with the crystal and the crystal holder applying a parallel resonant frequency voltage between the control grid and cathode of V203B.

The 18.6 mc signal from V201, and the 16.825 mc input from V203B are both applied between the control grid and cathode of the second mixer, V203A. The mixing of the two input signals takes place in V203A to produce the sum and difference frequencies at the V203A plate.

Second and Third I-F Amplifier Stages

The second and third i-f amplifier stages, V204 and V205, respectively are connected as conventional i-f stages. The components and circuitry of the two stages are almost identical. The essential difference between the two i-f amplifier stages is that the gain of the second i-f amplifier stage, V204, is controlled by the AGC voltage, while the third i-f amplifier stage, V205, is self-biased. The i-f output from V205 is rectified and filtered in the detector stage, V206A.

Scan-Channel Amplifier

A panoramic adapter may be used with the receiver when it is desired to view the received signals. The scan-channel amplifier, V202, is provided to amplify the signal which is to be fed to the adapter. The stage functions as a conventional amplifier which receives the 18.6 mc i-f output of V105. The V202 output, is applied to the 50-ohm scan jack, J403, on the low-pass filter.

Detector and Noise Limiter

The stage to which the detector (V206A) output is coupled is determined by the setting of the silencer and noise limiter switches, S501 and S202 respectively. With these switches in the position shown, the detector output is fed through a noise limiter, V206B, and a silencer diode, V208B. Tube V206A functions as a conventional diode detector stage, and V206B functions as a series diode noise limiter.

AGC-Silencer Amplifier

The AGC-silencer amplifier, V207, is a conventional amplifier circuit used to amplify

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the output from the i-f amplifiers to a level which is suitable for use in the AGC and silencer circuits. A -9-volt fixed bias potential from the power supply is applied to the V207 grid.

The V207 plate load consists of a parallel resonant tank which is tuned to the intermediate frequency (1.775 mc). The amplified output of V207 is fed to the AGC-silencer diode, V208A.

AGC-Silencer Diode

The AGC-silencer diode, V208A, functions to produce the negative voltage for the AGC and silencer circuits. The V208A output is also used to assist in aligning the receiver when the align-receive switch, S201, is placed in the ALIGN position.

The conducting and nonconducting condition of V208B is determined by the combined action of the -AGC silencer amplifier, V207, and the AGC-silencer diode, V208A. When both of the switches (S501 and S202) are in the OUT position (opposite to the setting shown) the detector (V206A) output is applied through the switch (OUT) contacts to the first audio amplifier, V209A.

Audio Amplifier Stages

The audio signal is amplified in three stages of audio amplification comprising V209A, V209B, and V210. The audio output, V210, is applied to the headphone jack, J501, and to output meter M502. The output signal is also applied through the low-pass filter to the audio output jack, J402.

SINGLE SIDEBAND CONSIDERATIONS

Because single sideband has become increasingly important in Navy applications, it is necessary that Navy technicians acquire an understanding of the basic principles of operation. If the technician understands the principles of operation, he will experience little difficulty in utilizing the instruction books or technical manuals in corrective maintenance work.

The advantages of SSB cannot be realized without the use of specially designed components and circuitry. First of all, there is the problem of frequency stability, especially when the carrier is totally suppressed. This means that the oscillators in the transmitter and in the receiver must not drift more than a few cycles. Actually, the permissible frequency variation for SSB systems is $\frac{1}{100}$ of that for an AM system.

In one type of double-sideband generations, filters of extreme selectivity are needed. Linear power amplifiers, which are difficult to design, are also needed.

Another problem, when SSB equipment is used on high-speed aircraft, is that of Doppler shift. This is especially noticeable at the higher radiated frequencies.

Basic information on generating SSB signals, filters, and oscillators has been covered in Basic Electronics, NavPers 10087-B. The EIMB 0967-000-0000, also contains information on SSB circuitry with a complete discussion on theory and troubleshooting on individual typical sections of receivers and transmitters.

A comparison of the frequency and power relationships between a 50-watt, single-sideband transmission and conventional AM transmission show that in SSB, only one sideband (upper or lower) with a peak-envelope power (PEP) of 50 watts is needed to transmit intelligence because the carrier is surpressed or not radiated. A 1-kc tone on a 1-mc carrier would result in a radiated signal of (1 mc ±1 kc) either 999 kc or 1001 kc. In some systems both sidebands may be utilized independently.

Whereas the same intelligence transmitted by an AM system requires that the radiated signal include the carrier and an upper and a lower sideband frequency for each frequency in the modulating signal. For example, if a 1-mc carrier is modulated by a 1-kc tone, the radiated signal will include the 1-mc carrier, the lower sideband frequency (1 mc - 1 kc = 999 kc), and the upper sideband frequency (1 mc + 1 kc = 1001 kc). If the modulating signal contains many frequencies, there will be, of course, many frequencies in the sidebands. In this system of transmission, none of the transmitted intelligence is contained in the carrier; therefore all of the power put into the carrier is wasted insofar as transmitting intelligence is concerned. Likewise, because duplicate information is contained in each of the two sidebands, the intelligence content of the transmitted signal could be recovered from one sideband only.

In a conventional AM system where both sidebands and the carrier are transmitted, the power in the sidebands is dependent upon the amount of modulation. For 100% modulation the power in the sidebands is equal to one-half that in the carrier. Thus, a conventional AM

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transmitter with 100-watts carrier power will have 50 watts in the sidebands (25 watts in the upper sideband and 25 watts in the lower sideband) at 100% modulation, making the total power transmitted 150 watts. It can be seen, then, that two-thirds of the total radiated power in a conventional AM system (assuming 100% modulation) is in the carrier and is therefore not useful in conveying intelligence.

When the r-f signal is demodulated in the conventional AM system, the audio output is a combination of the upper and lower sidebands. In this conventional type of detection (known as coherent detection) the audio output is proportional to the power contained in the two sidebands.

In a single-sideband system, only one sideband is transmitted and therefore the audio output of the SSB receiver is proportional to the power contained in the one sideband.

It therefore becomes apparent that an SSB transmitter and an AM transmitter will perform equally (same signal-to-noise ratio) under ideal propagating conditions, if the total sideband power of the two transmitters is equal. Considering the relationship between sideband power and carrier power in a conventional AM system, it is evident that an SSB transmitter will perform as well as an AM transmitter of twice the power rating under ideal propagating conditions. Thus, a single-sideband transmitter rated at 50 watts will produce the same signal intelligence level at a receiver as a conventional AM transmitter rated at 100 watts of carrier power.

As propagating conditions become less than ideal, the SSB system will show even a greater advantage over an AM system. An AM transmission is subject to deterioration under poor propagation conditions because all three components of the transmitted signal (the upper sideband, the lower sideband, and the carrier) must be received exactly as transmitted to realize perfect reception. Because there is only one component in the transmitted signal for an SSB system, it is not so affected by poor propagating conditions. Studies have shown that the SSB system will give from zero to nine decibel improvement under various conditions of propagation when the total sideband power in SSB is equal to that in conventional amplitude modulation.

It has been proven that under average conditions, the SSB system shows about a 3 db advantage over the AM system. In other words, in normal use, an SSB transmitter rated at 100 watts (PEP) will give equal performance with an AM transmitter rated at 200-watts carrier power.

As far as bandwidth is concerned (assuming one sideband only), the SSB system requires only about one-half the frequency spectrum that the conventional AM system requires.

The advantages of SSB over the conventional AM system may be summarized as follows:

1. The SSB transmitter will perform as well as an AM transmitter of twice the power rating under ideal propagating conditions. Under average conditions there is also an additional 3 db advantage of a SSB system over an AM system having the same sideband power.
2. If only one sideband is used, the SSB system requires only one-half as much r-f spectrum as the AM system.
3. The SSB transmitting system uses smaller units than comparable AM units because less power is required.
4. By virtue of less power in the antenna, lower voltages are required, with attendant reduction of potential breakdown.
5. The SSB system is subject to less noise interference because the bandpass is narrower.

RADIO RECEIVING SET AN/WRR-2

The AN/WRR-2 radio receiving set (fig. 4-8), is designed for shipboard installation and is intended primarily for the reception of single sideband transmissions with full carrier suppression in the frequency range of 2 mc to 32 mc. The set will also receive conventional AM signals of various types including CW, MCW, voice, facsimile, and frequency shift teletype. Simultaneous use of both upper and lower single sideband channels for receiving two different types of intelligence is possible. This capability however, does not extend to concurrent reception of single sideband and AM signals.

The receiver will net with any transmitter capable of operating in the same frequency range, provided the signal is one of the previously mentioned types and the receiver is compatible with existing shipboard auxiliary equipments which process facsimile and frequency shift teletype data.

The receiver consists of Electronic Frequency Converter CV-920/WRR2 (converter drawer) and Intermediate Frequency-Audio Frequency amplifier AM-2477/WRR2 (demodulator drawer) in individual, joined cabinets.

The demodulator drawer is above the converter drawer.

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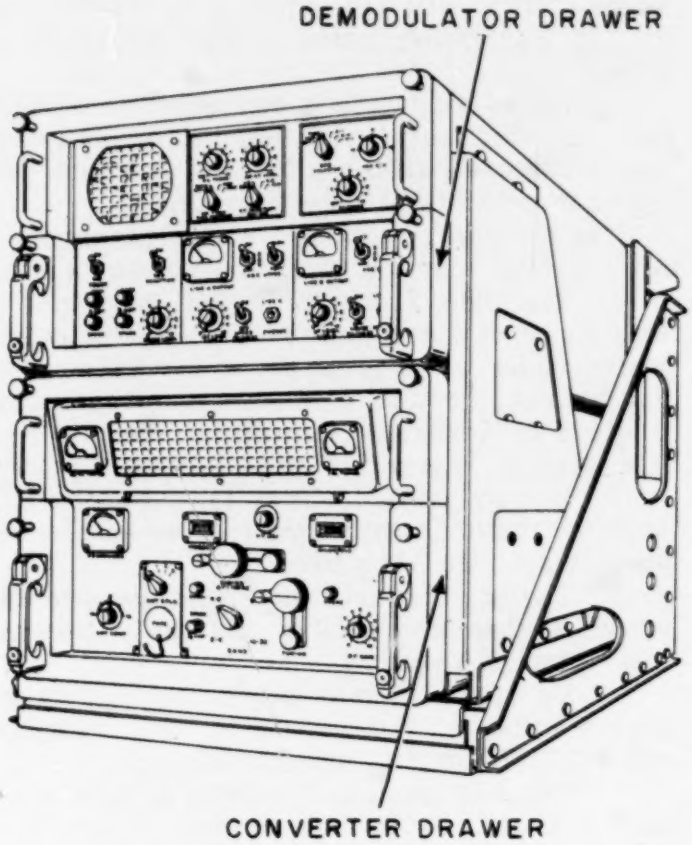

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Figure 4-8.—Radio receiving set AN/WRR-2.

Signal voltages applied at the receiver antenna (fig. 4-9), are fed to the converter circuits through a coupling device that offers protection from excessively high signal voltages. In the converter drawer the frequency range is divided into four tuning bands. A selection switch and direct reading counters facilitate band selection and tuning. Tuning from 2 mc to 32 mc may be either incremental or continuous. In the incremental method a crystal-controlled internal frequency standard permits accurate settings in increments of a whole kilocycle. Cancellation of oscillator frequency drift is achieved and a frequency stability of one cycle in 10 mc per day is obtained.

Cancellation of the effects of oscillator drift is achieved as follows: The output of the H-F oscillator (V301 fig. 4-9A) is injected into two mixer stages, V151 and V251. The incoming signal is applied to one stage (V151), and a locally generated reference frequency from the crystal oscillator is applied to the other stage (V251). The outputs of the mixers are applied to separate i-f amplifiers, and both i-f amplifier outputs are applied to another mixer stage, V502. Thus any drift in oscillator frequency affects the outputs of the first two mixers by equal amounts, thereby maintaining the output of the second mixer (V502) constant.

Continuous tuning must be used for frequencies which terminate in a fraction of a kilocycle, and this method reduces slightly the stability of the receiver.

After the process of tuning, triple frequency conversion and i-f amplifications are performed in the converter drawer. The i-f signal is passed to the demodulator drawer where further i-f and AF amplifications are performed. This drawer contains three detector amplifier sections. One processes conventional AM signals and has a BFO for CW, facsimile, and frequency shift teletype signals. The other two sections detect and amplify signals in the upper and lower sideband channels. Each section has its own AGC and silencer circuits.

PRESELECTOR

The preselector consists of two stages of r-f amplification and the first conversion mixer. The AGC voltage developed in the detector amplifier section is applied to V51 and V101. Manual r-f gain control is also applied to these stages. The r-f gain control is a dual section control which also adjusts the gain of i-f amplifiers V1602 and V1603 in the AM unit and V1003 (not shown) in the USB unit.

Mixer V151 receives signals from the high frequency oscillator (V301) and r-f amplifier (V101) and heterodynes these inputs to produce the first i-f signal (1625-1725 kc) to the tunable i-f filter.

TUNABLE I-F FILTERS

The tunable i-f filter is a continuously tunable four-section filter which follows the preselector.

The four sections are tuned from 1625 kc to 1725 kc by a four-section variable capacitor. The filter selects the first conversion frequency from the output of the preselector mixer, V151.

INJECTION I-F AMPLIFIER

The injection i-f amplifier section develops the converter's final intermediate frequency (80 kc) from the outputs of the tunable i-f filter (1625 kc-1725 kc), the interpolation oscillator (V401) (580-kc-680 kc), the harmonic mixer V251 (825 kc), and the synthesizer (140 kc).

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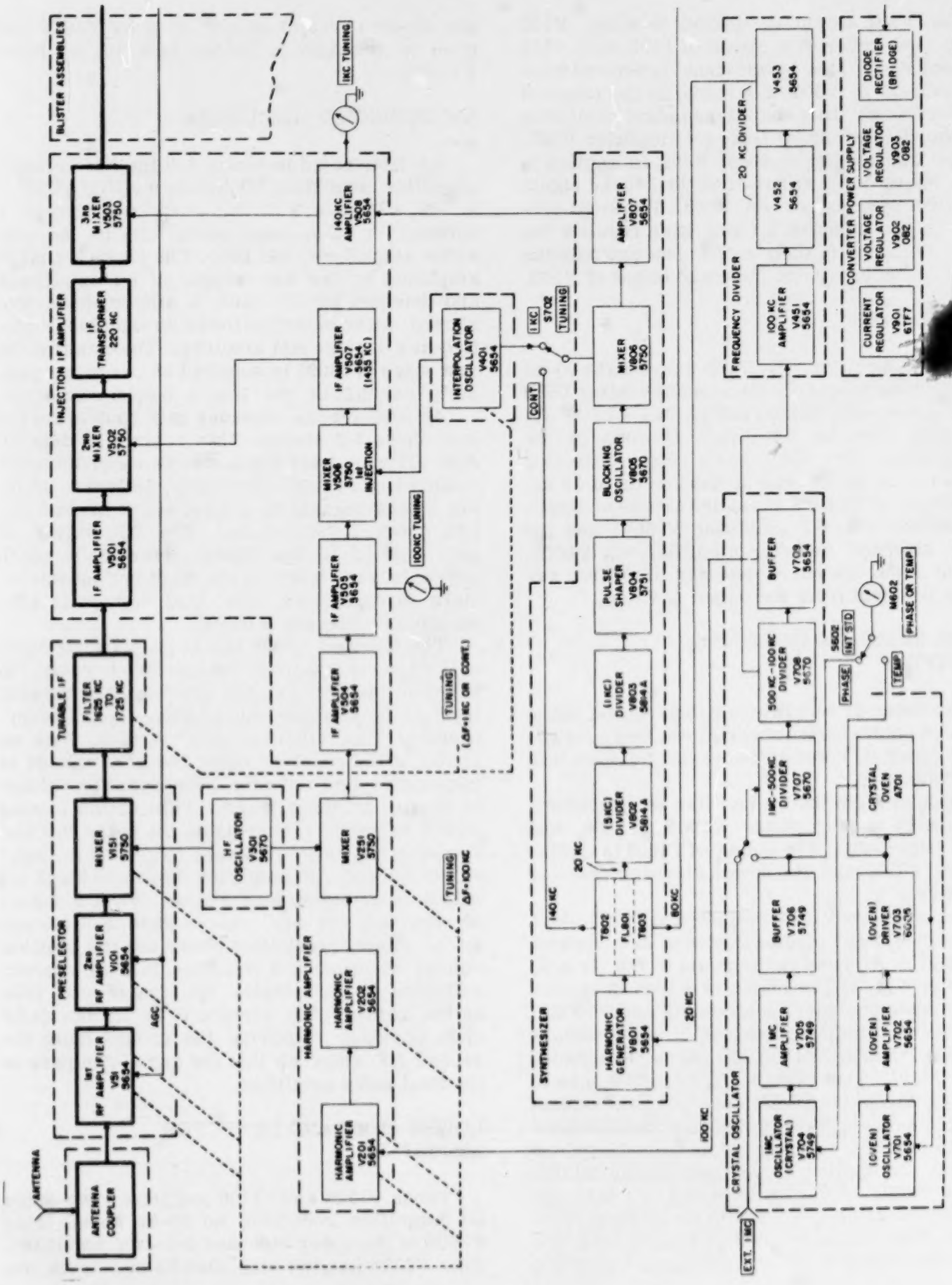

Figure 4-9.—Radio receiving set AN/WRR-2, block diagram.

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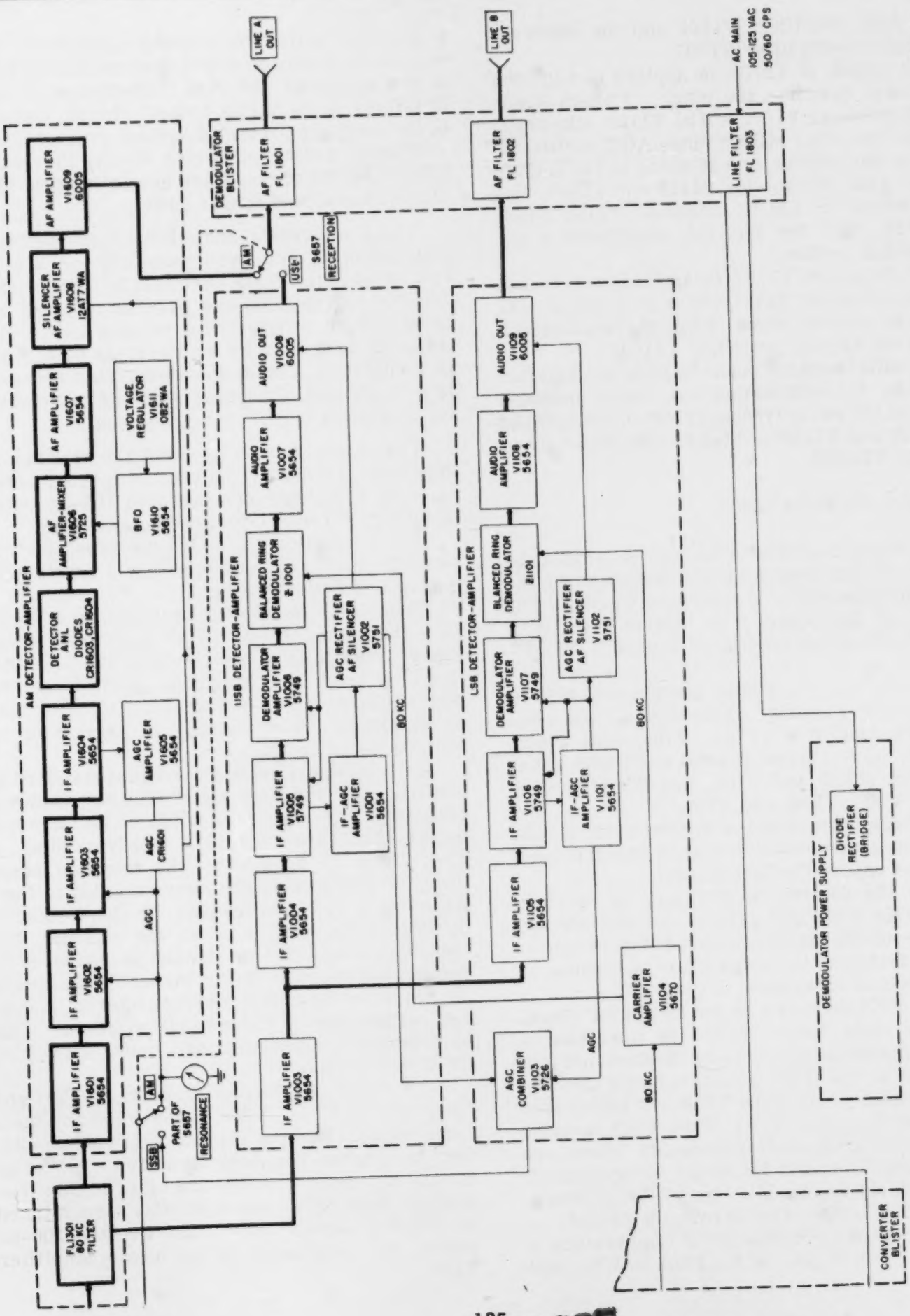

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Figure 4-9.—Radio receiving set AN/WRR-2, block diagram.—Continued

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to i-f AGC amplifier V1101 and the other to demodulator-amplifier V1107.

The output of V1101 is applied to a silicon AGC diode rectifier the output of which is applied to silencer V1102B. The V1101 output also goes to two other silicon diode AGC rectifiers. One has two outputs, one of which is fed back to provide gain control for V1106 and V1107. The other output is fed to combiner V1103 which furnishes AGC for the r-f amplifiers in the preselector section.

The output of V1107 is applied to balanced ring demodulator Z1101 where it is mixed with the 80-kc carrier signal from the synthesizer section via carrier amplifier V1104.

The difference between the 80-kc carrier and the 80-kc i-f (containing the lower sideband signal) is the audio frequency which is amplified by V1108 and V1109 and fed to line output B via AF filter FL1802.

CRYSTAL OSCILLATOR

The crystal oscillator section generates the standard 1-mc frequency for operation of the spectrum generator and frequency dividers. The stability of the receiver is related directly to the stability of the oscillator (1 part in 10 million).

The crystal oscillator section consists of three major circuits. These include the oven oscillator amplifier (V701, V702, and V703), (fig. 4-9, A) a Pierce crystal oscillator V704, amplifiers V705 and V706, and the frequency dividers V707, V708, and V709.

The temperature of the crystal oven is controlled by a proportional method which is continuous as opposed to thermostatic.

When the desired temperature is reached, bridge arms come into balance and provide only enough feedback signal to maintain that temperature. A deviation in temperature will cause an imbalance and subsequent correction.

Tube V701 operates as the oscillator stage. When its plate tuned circuit is operating, a positive feedback signal from the oven heaters is applied to the V701 grid producing oscillations at about 2 kc. Tube V702 is a buffer amplifier which drives V703. Tube V703 supplies power to the oven heating elements. There are four of these elements forming a bridge circuit. Two terminals are supplied by V703 via a transformer. The other two terminals provide an output signal proportional to the temperature of the oven. This signal is fed back to V701 with a polarity suited to produce oscillation. The size of the feedback voltage determines the level of heater power and oven temperature. In case of failure of the heater control circuit, contents of the oven are protected against overheating by a thermal switch connected across the heater terminals. Its contacts are normally open: when closed they divert heater power.

The 1-mc crystal and related components are also parts of the oven assembly but are not functional parts of the oven oscillator-amplifier assembly. The complete oven is mounted in a Dewar flask similar to a vacuum bottle. The bottle is protected by a fiberglass blanket and is mounted in a steel container. This assembly is a single unit. Components cannot be removed for individual repair or replacement.

The crystal oscillator-amplifier circuit produces the standard 1-mc frequency from which, through frequency division, the 100-kc output of the crystal oscillator section is derived.

The oscillator is a Pierce type, and the basic frequency is determined by a crystal connected in the plate circuit.

Tube V705 follows the oscillator and amplifies the signal. Buffer V706 provides further signal amplification and isolates the oscillator circuits from the frequency divider section which follows. The 1-mc amplifier V705 includes an amplitude control circuit to provide an unvarying 1-mc signal.

When a signal from an external standard is applied, and the two signals are of identical frequency and phase, the phase or temperature meter M602 will produce a steady reading. If they differ in frequency, the resultant phase difference will cause the meter reading to fluctuate at a rate determined by the frequency difference or beat between the signals. The coincidence of the two signals is measured by timed observations of the meter fluctuation in response to the beat frequency. Internal standard adjustment of the crystal oscillator V704 is obtained by adjustment of a tuning capacitor, C719 (not shown).

The frequency divider consists of V707 and V708 with a buffer V709. Tube V707 obtains a 1-mc signal from the crystal oscillator amplifier and makes the first division to 500 kc by means of a plate tank circuit, tuned to this frequency. Tube V708 has a similar circuit tuned to 100 kc. Divider V708 amplifies the 100-kc signal and applies it to harmonic amplifier V201.

HARMONIC AMPLIFIER

The harmonic amplifier and mixer produce a 100-kc spectrum from the frequency range of 2.9 mc to 32.9 mc when driven by the 100-kc signal from the crystal oscillator section. Basically, the harmonic amplifier and mixer sections consist of harmonic generator V201, tuned amplifier stage V202, and an output mixer V251. The mixer combines the generated spectrum with a signal from the high frequency oscillator V301 for incremental tuning at 100-kc intervals. The tuning control of the HF oscillator and harmonic amplifier and mixer sections are ganged for simultaneous operation.

The 100-kc signal from the crystal oscillator section is applied to harmonic diode CR201 (not shown). The signal clipping action of CR201 provides the control grid of harmonic amplifier V201 with a wide range of harmonics from the 100-kc input signal. The operating frequency is selected by the tank circuit in the plate of V201. This tank circuit is tuned simultaneously with the tuned circuits of the HF oscillator sections. The output of V201 is applied to a second harmonic amplifier, V202, where again the signal amplitude is increased and applied to mixer V251. Mixer V251 combines this selected harmonic signal with a signal from the HF oscillator to produce a difference frequency of 825 kc. The plate load of V251 is located in the injection i-f amplifier section.

HIGH FREQUENCY OSCILLATOR V301

High frequency oscillator V301 covers a frequency range of 3.725 mc to 33.725 mc in four bands. Its outputs are used in the preselector for the first frequency conversion and in the harmonic mixer V251 for the 825-kc signal used by the injection i-f amplifier section. The high frequency oscillator is a modified grid tuned Armstrong circuit with cathode feedback. One output is provided to mixer V251 and another to preselector mixer V151.

INTERPOLATION OSCILLATOR V401

Interpolation oscillator V401 produces frequencies in the 580-kc to 680-kc range. These are applied to the injection i-f amplifier and the synthesizer sections. The synthesizer receives its signal through the TUNING switch S702 located on the crystal oscillator. Tube V401 is a triode connected in a grid tuned Armstrong circuit.

FREQUENCY DIVIDER

The frequency divider (V451, V452, and V453) produces frequency division from 100 kc to 20 kc. The 100-kc input signal is supplied by the frequency dividing circuit in the crystal oscillator sections, and the 20-kc output signal is applied to the synthesizer section for further division. Tubes V452 and V453 form a locked oscillator similar to those in the crystal oscillator frequency divider V707 and V708.

SYNTHESIZER

The very high operating stability of the AN/WRR-2 receiver can be attributed largely to the receiver's crystal-controlled, temperature-compensated master oscillator V704. Frequency dividers, harmonic generators, and harmonic filters process the original locally generated signal to provide signals of frequencies related to submultiples of the master oscillator frequency. These are picked off at stage outputs in the synthesizer section which perform as follows:

1. Contribute to the final conversion to 80 kc.
2. Provide a fixed i-f signal of 140 kc for use in continuous tuning.
3. Furnish an 80-kc carrier signal to the lower sideband amplifier via V1104.
4. Trigger a blocking oscillator for the production of precise 1-kc incremental pulses in conjunction with an interpolation oscillator of variable frequency in its 100-kc range.

Harmonic generator V801 in the synthesizer section receives from the frequency divider section a 20-kc signal processed from the master oscillator V704.

Filter FL-801 picks off the basic 20-kc signal, T802 the seventh harmonic (140 kc), and T803 the fourth harmonic (80 kc), and all three signals are passed to associated circuits in the synthesizer and lower sideband detector amplifier. In the lower sideband detector amplifier, the 80-kc signal is amplified and directed to balanced ring demodulators in both upper and lower sideband detector amplifiers to serve as injected carriers for the demodulator circuits.

Block T802 supplies its 140-kc signal only when the receiver is set for continuous tuning by the continuous tuning switch S702.

Filter FL-801 passes the 20-kc signal through a pair of frequency divider circuits (V802 and V803) with a 1-kc output. This signal

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excites pulse shaping circuit V804 to trigger the next stage blocking oscillator, V805.

This oscillator generates a harmonic spectrum in 1-kc incremental steps, making available output frequencies at least as high as the 820th harmonic.

To use this harmonic spectrum with the variable frequency output of interpolation oscillator V401, a bandpass filter with a 100-kc bandwidth in the range of 720 kc to 820 kc (not shown) is connected to the output of blocking oscillator V805.

When a particular harmonic of 1 kc in the above mentioned range combines in mixer stage V806 with a properly related signal from the interpolation oscillator, a difference frequency of 140 kc is produced in the output of the mixer stage. This 140-kc signal is amplified in V807 and passed on to i-f amplifier V508 in the injection i-f section. Mixing the 140 kc with a 220-kc signal generated in the injection i-f results in an 80-kc i-f (final conversion) output from the injection i-f section.

Harmonic generator V801 gets its 20-kc signal from the frequency dividers via V453. Frequency dividers V802 and V803 are locked oscillators which divide the 20-kc signal from the harmonic generator and filter FL-801 by 4 (V802) and then by 5 (V803) to 1 kc which is applied to pulse shaper V804 for use as an accurately controlled trigger signal.

Triggered by pulse shaper V804, blocking oscillator V805 produces sharp pulses ranging in 1-kc steps from a fundamental 1 kc to beyond its 820th harmonic. A portion of this spectrum, 720 kc to 820 kc, provides harmonics to be mixed in the injection i-f amplifier with signals from variable output interpolation oscillator V401 to produce a difference frequency of 140 kc for use in the development of the final receiver i-f of 80 kc.

The pulse shaper V804 is a dual triode. The control grid of V804A receives from the frequency divider a 1-kc signal, the positive half of which is clipped by grid limiting, and the negative half by the tube being driven into cutoff. The 1-kc output of V804A is a square wave which is differentiated into narrow positive and negative going spikes which correspond to the leading and trailing edges of the square wave. These spikes are amplified and inverted by V804B.

The positive spikes provide a 1-kc sync pulse which locks V805 in by occurring at a time slightly earlier than the free-running frequency of V805.

Triode section V805A acts as a triggering tube for blocking oscillator V805B. The output of V805B is applied through bandpass filter FL-803 (not shown) to amplifier mixer V806 to combine with another input signal from the interpolation oscillator or from T802.

Amplifier mixer V806 produces a 140-kc signal for later use in establishing the final conversion signal of 80 kc. One of the inputs to V806 is the 1-kc harmonic in the range of 720 kc to 820 kc from blocking oscillator V805. During incremental tuning the other input is a signal in the range of 580 kc to 680 kc from interpolation oscillator V401. The difference frequency is 140 kc applied to bandpass filter FL-804 (not shown).

During continuous tuning, the 140 kc is picked off directly from filter T802 and passed to FL-804 (not shown). At the continuous setting of the tuning switch S702, plate voltage is removed from blocking oscillator V805B so that the only signal now applied to V806 is the 140-kc signal from T802. The 140-kc signal is fed to i-f amplifier stage V807 the output of which goes to the injection i-f amplifier section.

CONVERTER POWER SUPPLY

The receiver has two power supplies, converter (fig. 4-9,A) and demodulator (fig. 4-9, B). The converter power supply serves all circuits except those of the three detector amplifiers, upper and lower sideband, and AM. Voltage and current-stabilizing circuits are incorporated in the converter power supply to ensure steady inputs for voltage sensitive components in accordance with stability requirements. A full-wave bridge rectifier comprising silicon diodes provides the necessary high voltage output.

DEMODULATOR POWER SUPPLY

Operation of the demodulator power supply is similar to that of the unregulated portion of the converter power supply. The demodulator power supply is a conventional bridge type rectifier connected to a choke input filter. Functional sections of the demodulator get their filament voltages from a 6.3-v a-c winding of the power supply transformer.

RADIO RECEIVER R-1051/URR

The R-1051/URR (fig. 4-10) is a superheterodyne receiver capable of receiving lower

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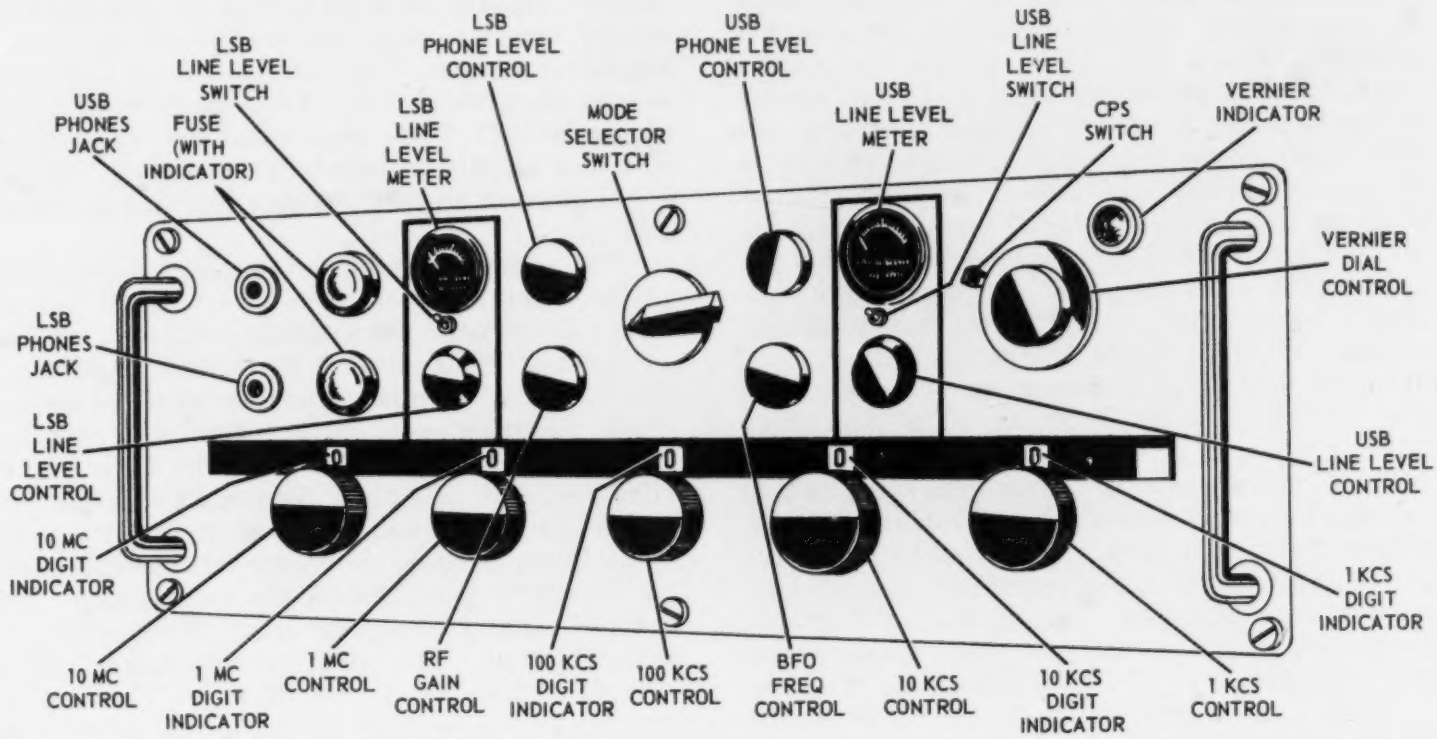

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Figure 4-10.—Radio Receiver R-1051/URR.

sideband (LSB), upper sideband (USB), independent sideband (ISB), frequency shift keyed (FSK), (conventional) amplitude modulated (AM), and continuous wave (CW) transmissions in the 2.0- to 30.0 megacycle frequency range. The ISB mode of operation allows two different types of intelligence to be received simultaneously, one on the LSB channel and one on the USB channel. FSK reception is obtained by using suitable ancillary equipment, such as Teletype Converter-Comparator AN/URA-17 or AN/URA-8. The R-1051/URR may also receive tone-modulated continuous wave (MCW), compatible amplitude modulated (compatible AM), and facsimile (through the use of suitable ancillary equipment) transmissions. The R-1051/URR may be operated in conjunction with a transmitter, as a transmitter-receiver in systems such as Radio Set AN/WRC-1. In this application either simplex or duplex operation is possible. The R-1051/URR may also be used as a separate, self-contained receiver requiring only a headset, antenna, and a nominal 115-v a-c primary power source for full operation.

Radio Receiver R-1051/URR is a triple-conversion superheterodyne receiver, tunable over the high frequency range from 2 to 30 mc. Tuning of the R-1051/URR is accomplished digitally by five controls (MCS and KCS) and a switch (CPS) located on the front panel (fig. 4-10). A display window directly above each control provides a digital readout of the digits to which the controls are set. The displayed frequency can be changed in 1 kc increments. The front panel switch allows the operating frequency to be changed in 500-cps increments. This tuning provides 56,000 discrete frequencies in which the receiver is locked to a very accurate frequency standard. Each 1-kc increment can be continuously tuned through by selecting the VERNIER position of the CPS switch. When using the vernier, the full accuracy of the frequency standard is sacrificed. Over the frequency range, the input sensitivity for an audio output signal-plus-noise to noise ratio of 10 db is better than 1 microvolt for ISB, LSB, USB, and FSK, 2 microvolts for CW, and 4 microvolts for AM.

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BLOCK DIAGRAM

A received signal from the antenna passes through closed relay contacts in the antenna overload circuit (fig. 4-11), to the r-f amplifiers. Should a signal in excess of 15 volts appear at the receiver input, the antenna overload circuit will open the relay contacts. The excessive voltage is thereby prevented from being applied to the r-f amplifiers, which form a part of the RF Amplifier Electronic Assembly. Within the r-f amplifiers, the signal passes through a double-tuned input circuit, two r-f amplifier stages, a single-tuned interstage circuit, and output circuits. All of the resonant tuned circuits are tuned by the MCS, 100 kc (KCS), and 10 kc (KCS) frequency controls on the front panel. The MCS controls operate a code generator, which activates a motor-driven turret containing 28 strips. Each strip contains a tuned transformer and a portion of the capacitance required by each of the four tuned circuits. For each megacycle increment, a different tuned transformer and capacitor are switched into place. The remaining tuned circuit capacitance is mechanically switched into the four tuned circuits by the 100 kc (KCS) and 10 kc (KCS) controls on the front panel. These capacitors are located on circular boards stacked in the center of the turret. The tuned circuits provide the frequency selectivity required to prevent undesired off-channel signals from distorting the desired signal by cross-modulating or overloading the r-f amplifier stages. The gain of the r-f amplifier stages ensures that the weak-signal sensitivity of the R-1051/URR is maintained. The gain of both r-f amplifier stages is controlled by the application of an AGC voltage from the step AGC circuit.

The output from the r-f amplifiers is applied to the mixers, which form a part of RF Translator Electronic Subassembly located in the Translator/Synthesizer Electronic Assembly (not shown). The mixers consist of three transistor mixer stages, with interstage coupling provided by selective filters. The first mixer receives the injection frequencies from MC Synthesizer Subassembly. The injection frequency is determined by the megacycle band selected by the MCS controls on the front panel. The desired output frequency from the first mixer always falls within two frequency bands, either 19.5 to 20.5 mc or 29.5 to 30.5 mc. The high or low band is also determined by the megacycle band to which the R-1051/URR is tuned. The output from the first mixer is gated through the appropriate 20 or 30-mc filter. This signal is mixed in the second mixer stage with the

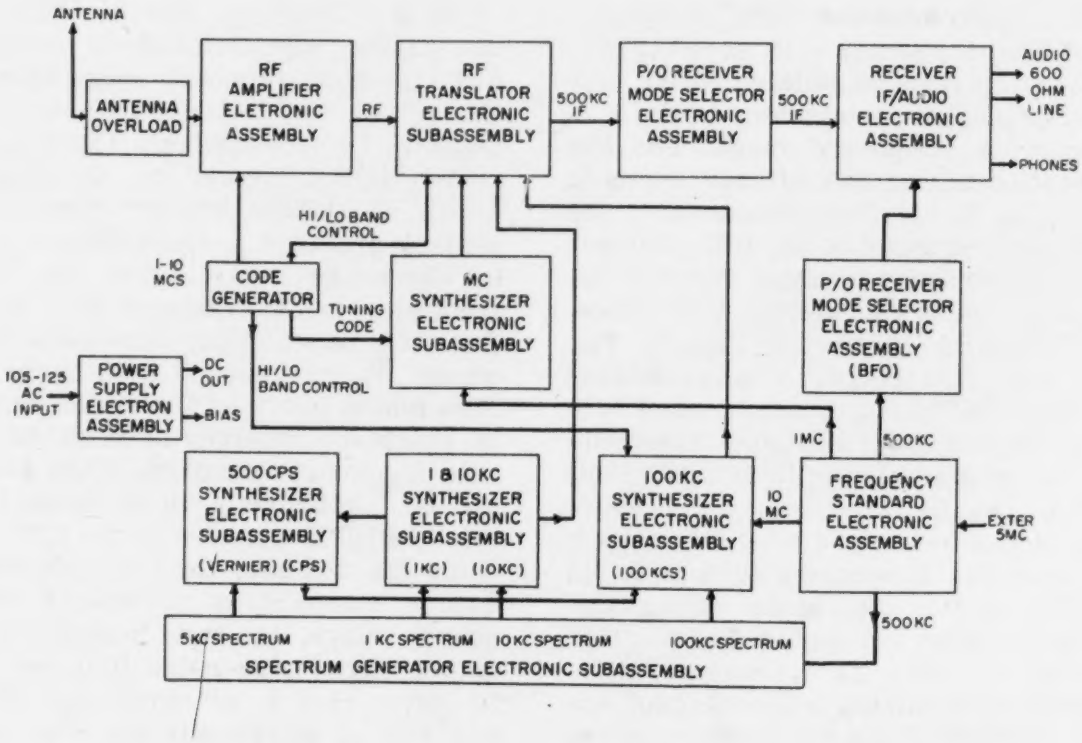

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Figure 4-11.—Radio Receiver, R-1051/URR, simplified block diagram.

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injection frequencies supplied from the 100-KC Synthesizer Electronic Subassembly. The desired frequency band from the second mixer is 2.8 to 2.9 mc. This signal is coupled through a 2.85-mc filter to the third mixer. The injection frequencies for the third mixer are supplied from the 1- and 10-KC Synthesizer Electronic Subassembly. The output from the third mixer is a 500-kc i-f signal. Signal flow from the antenna input through the output of the third mixer is identical, regardless of the selected mode of operation.

The 500-kc i-f output from the third mixer is applied to the mode gates. Three parallel paths are presented to the signal. The path that passes through the LSB mechanical filter (also used in ISB) is not gated since it has an independent output from the Mode Selector Electronic Assembly. Because the outputs from the USB mechanical filter (also used in FSK and ISB) and the AM mechanical filter (also used in CW) are paralleled for a common output, the input paths to these two filters must be gated so that only one path is open at any given time. Application of the correct gating potentials is determined by the mode of operation selected at the front panel.

The output from the LSB filter is applied to the i-f amplifiers in the IF/Audio Amplifier Electronic Assembly. The common output of the USB and AM filters is also applied to the i-f amplifiers in the TF/Audio Electronic Assembly.

The operating d-c voltage is applied to the proper electronic assembly according to the mode of operation selected at the front panel. In the ISB mode of operation, a d-c operating voltage is applied to both i-f amplifiers. AGC voltage from the step AGC circuit controls the overall gain of the i-f amplifiers by varying the attenuation of the input and the gain of the second i-f amplifier stage. The input to the step AGC circuit is derived from the output from the second i-f amplifier stage.

The output from the i-f amplifiers is applied to the detector circuits, consisting of a product detector and an AM detector. Depending on the mode of operation selected at the front panel, either the balanced product detector or the AM detector is powered by a d-c operating voltage. The product detector demodulates the USB, LSB, FSK, and ISB signals. In these modes of operation, a 500-kc injection, originating at a multiplier-divider in Frequency Standard Electronic Assembly, is applied to the product detector for carrier re-insertion. This 500-kc injection passes through the 500-kc gate in the Mode Selector Electronic Assembly with little attenuation in these modes of operation. In AM and CW modes, this gate presents a high attenuation, since no carrier re-insertion is required by the AM detector. In the CW mode of operation, the BFO assembly in Mode Selector Electronic Assembly is turned on, and a variable 500-kc output is applied to the input of the AM detector in the IF/AF Assembly. The output frequency from the BFO circuit is controlled by the BFO FREQ control on the front panel.

The audio derived from the detector circuits in the IF/AF Assembly is applied to the USB LINE LEVEL control on the front panel which controls the audio level prior to its application to the audio amplifiers. The LSB LINE LEVEL control sets the audio level from the product detector in the IF/AF Assembly. Each Receiver IF/Audio Amplifier Electronic Assembly has two outputs. One is a 600-ohm remote output, which is applied to a connector at the rear of the case. The second output is to the PHONES jacks on the front panel. The PHONES output passes through a PHONE LEVEL control on the front panel, which adjusts the phone signal amplitude without altering the level of the remote output. Each remote output is monitored at the front panel by a LINE LEVEL meter, which has two scale ranges controlled by the LINE LEVEL switch on the front panel.

The step AGC circuit, which forms a part of the Receiver IF/Audio Amplifier Electronic Assemblies, controls the gain of the r-f amplifiers and i-f amplifiers according to the received r-f signal strength. The output from the i-f amplifiers is applied to the step AGC circuits, where it is converted to a d-c voltage that is applied to both the r-f and i-f amplifiers. One level (step) AGC voltage is used for voice and another level AGC for tone reception. The gain of the r-f and i-f amplifiers may be manually controlled by applying a d-c voltage on the AGC lines with the RF GAIN control. This manual action overrides the normal AGC voltages.

A combination of error cancelling loops and phase-locked loops is used in the frequency synthesizer circuits of the R-1051/URR to ensure that the injection frequencies applied to the mixers are correct. The 5-mc frequency standard produces an accurate, stable reference frequency upon which all frequencies used in the R-1051/URR are based. The circuit is housed in

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an oven assembly maintained at a nearly constant temperature of 85° C by the oven control circuit. The accurate output from the 5 mc frequency standard is applied to a switching and compare circuit. An external 5-mc frequency may also be applied to this circuit. The switching and compare circuit routes the internal or external 5-mc signal to the multiplier-divider circuits or to the compare circuit. The compare circuit compares the internal 5-mc frequency with the external 5-mc frequency for an indication of the accuracy of the internal frequency standard. The 5-mc output from the switching and compare circuit is applied to the multiplier-divider circuit, where it is converted to frequencies of 500 kc, 1 mc, and 10 mc. These three outputs are used in the mixing processes required to produce the injection frequencies used in the r-f conversion process. The 500-kc output is also applied to the 500-kc gate circuit for insertion into the product detector for demodulation. The 5-mc frequency standard, oven control, multiplier-divider, and switching and compare circuits comprise the Frequency Standard Electronic Assembly.

The injection frequencies used in the first frequency conversion in the mixers circuit are generated within the MC Synthesizer Electronic Subassembly. This circuit consists of a phase-locked crystal oscillator that is automatically tuned to produce 1 of 17 frequencies between 2.5 mc and 23.5 mc. The output is applied to the high frequency mixer. The output frequency depends on the setting of the front panel MCS controls. The MC Synthesizer Electronic Subassembly employs a phase-locked loop to ensure the accuracy of the mc injection frequencies. The 1-mc output from the multiplier-divider in the Frequency Standard Electronic Assembly is applied to the spectrum generator to produce a spectrum of frequencies spaced at 1-mc intervals between 1 mc and 25 mc. The output from the spectrum generator and the output from the mc oscillator are mixed. Any error in output from the mc oscillator is detected and an error voltage is produced. This error signal is applied to the mc oscillator to lock it to the correct frequency. The accuracy of the oscillator output is the same as that of the 5-mc frequency standard.

The injection frequencies used in the second frequency conversion in the mixers circuit are generated within the 100-KC Synthesizer Electronic Subassembly. This circuit consists of a crystal oscillator, the output from which is 1 of 10 frequencies spaced at 100-kc intervals between 4.553 and 5.453 mc. The output frequency is determined by the setting of the front panel 100-kc (KCS) control. If a low band injection frequency is required, the 17.847-mc output from the 17.847-mc mixer is additively mixed in the lo-band mixer with the output from the 100-kc oscillator (4.553 mc to 5.453 mc, in 100-kc steps) to provide a frequency in the 22.4 to 23.3-mc range. If a high-band injection frequency is required, the 27.847 mc output from the 27.847-mc mixer is additively mixed in the high-band mixer with the output from the 100-kc oscillator (4.553 mc to 5.453 mc, in 100 kc steps) to provide a frequency in the 32.4- to 33.3-mc range. In either case, the resultant frequency is applied to the midfrequency mixer.

The 100-KC Synthesizer Electronic Subassembly employs an error cancelling loop to ensure the accuracy of the 100 kc-injection frequencies. The 500-kc output from the multiplier-divider is applied to the 100-kc spectrum generator to produce a spectrum of frequencies spaced at 100-kc intervals between 15.3 mc and 16.2 mc. The output from the 100-kc oscillator (4.553 mc to 5.453 mc, in 100-kc steps) is applied to the 10.747-mc mixer, where it is mixed with that spectrum point of the 100-kc spectrum which will result in an output of 10.747 mc. The 10.747-mc signal is additively mixed with the 7.1-mc output from the 7.1-mc mixer to produce the 17.847-mc signal, which is used in one of two mixing processes. It is mixed with the 100-kc oscillator output to cancel any oscillator frequency error and produce the low-band injection frequencies, or it is mixed with the 10 mc-output from the multiplier-divider. This mixing produces a 27.847-mc signal, which is mixed with the 100-kc oscillator output to cancel any oscillator frequency error and produce the high-band injection frequencies. The high or low band of injection frequencies is determined by the voltage level on the high/low band control line output from the code generator. If an error were present in the 100-kc oscillator output, it would be cancelled in this mixing scheme. This is accomplished as follows. Assume that the output from the oscillator should be 4.553 mc, but is 200 cycles high (4.5532 mc), and that the desired frequency output is 22.4 mc (in the low band). The subtractive mixing of the oscillator output with whichever 100-kc spectrum point will produce an output as close as possible to 10.747 mc, results in a 10.7468-mc output (15.3 mc - 4.5532 mc = 10.7468-mc).

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This signal is then additively mixed with the 7.1-mc signal, producing a 17.8468 mc output. The 17.8468-mc signal is then additively mixed with the oscillator output (17.8468-mc + 4.5532 mc = 22.4 mc), resulting in the desired 22.4-mc output. Assume that the output from the oscillator should be 4.953 mc, but is 300 cycles low (4.9527 mc), and that the desired frequency output should be 32.8 mc (in the high-band). Subtractively mixing the 100-kc spectrum point (15.7 mc) with the 4.9527-mc signal results in an output of 10.7473 mc. This signal is then mixed with the 7.1-mc signal, resulting in a frequency of 17.8473 mc. The 17.8473-mc signal is further mixed with the 10-mc signal to obtain a frequency of 27.8473 mc, which is additively mixed with the 4.9527-mc output from the oscillator to obtain the required 32.8-mc output. Therefore, it can be seen that any error existing in the output from the 100-kc oscillator will be cancelled, resulting in the exact 100-kc injection frequency required.

The injection frequencies used in the third frequency conversion in the mixers circuit are generated within the set and 10-KC Synthesizer Electronic Subassembly. This circuit consists of two crystal oscillators, each of which has 10 possible output frequencies. The output from the 1-kc oscillator (1.850 mc to 1.859 mc in 1-kc steps) is determined by the setting of the front panel 1-kc (KCS) control, and the output from the 10-kc oscillator (5.25 mc to 5.16 mc, in 10-kc steps) is determined by the setting of the front panel 10-kc (KCS) control. The outputs from the two oscillators are subtractively mixed to provide one of 100 possible output frequencies spaced at 1-kc intervals between 3.301 mc and 3.400 mc. The output is applied to the low frequency mixer.

Any error existing in the 1- and 10-kc oscillators is cancelled in the following manner. The 100-kc pulses from the 100-kc spectrum generator are applied to the 10-kc spectrum generator producing an output from 3.82 to 3.91 mc in 10-kc increments. The 10-kc spectrum generator also produces 10-kc pulses which are applied to the 1-kc spectrum generator to produce a spectrum of frequencies spaced at 1-kc intervals between 0.122 mc and 0.131 mc. The output from the 10-kc oscillator (5.25 mc to 5.16 mc, in 10-kc steps, is additively mixed with whichever spectrum point of the 10-kc spectrum will result in a frequency of 9.07 mc. The output from the 1-kc oscillator (1.850 mc to 1.859 mc in 1-kc steps) is additively mixed with whichever spectrum point of the 1-kc-spectrum will result in a frequency of 1.981 mc. The 1.981-mc and the 9.07-mc signals are then subtractively mixed, producing the 7.089-mc signal, which contains the errors of both oscillators. The 1-kc spectrum generator also produces 5-kc pulses, which are applied to the 5-kc spectrum generator to produce an output, consisting of two spectrum points, 110 kc and 115 kc. These spectrum points are used to lock the output frequency of the 500-cps phase-locked oscillator to 110 kc or 115 kc when desired. With the front panel CPS switch in the 000 position, the output from the phase-locked oscillator is 110-kc and is locked to that exact frequency by the 110 kc spectrum point applied to the phase detector. This 110-kc signal is divided by ten and applied to the 7.1-mc mixer, where it is additively mixed with the 7.089-mc output from the 7.089-mc mixer. The resulting 7.1-mc signal is then applied to the error loop of the 100-KC Synthesizer Electronic Subassembly. Therefore, if an error exists in the 1- or 10-kc oscillators, the same error will exist in the 100-kc injection frequencies. This error is then cancelled in the low frequency and midfrequency mixers of the mixers circuit in the following manner. Assume that the output from the 10-kc oscillator should be 5.25 mc, but is actually 5.2502. Also assume that the output from the 1-kc oscillator should be 1.852 mc but is actually 1.8521 mc. Subtractively mixing these two frequencies results in an injection frequency to the low frequency mixer of 3.3981 mc, rather than the desired 3.3980 mc. Therefore, a 100-cycle error exists in the injection signal. The additive mixing of the 5.2502-mc signal and the 10 kc spectrum point (3.82 mc) results in a frequency of 9.0702 mc. The additive mixing of the 1,8521-mc signal and the 1-kc spectrum point (0.129 mc) results in a frequency of 1.9811 mc. Subtractively mixing the 9.0702-mc and the 1.9811-mc signals results in a frequency of 7.0891 mc. The 7.0891-mc signal is mixed with the 11 kc signal from the divide-by-ten-circuit resulting in a frequency of 7.1001 mc, which is mixed with the 10.747-mc signal to produce a frequency of 17.8471 mc. If the output from the 100-kc oscillator is assumed to be 4.553 mc, then the 100-kc injection frequency would be 22.4001 mc. The 100-kc injection is then also 100 cycles high. Therefore, when the 1-and 10-kc injection frequency of 3.3981 mc (which is 100 cycles high) is

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subtractively mixed in the low frequency mixer with the output from the mid frequency mixer (which is 100 cycles high), the error will be cancelled. Therefore, since any error that existed in the 1- and 10-kc injection also exists in the 100-kc injection, the error is cancelled during the translation process.

The R-1051/URR can be tuned to 0.5-kc increments using the 000 and the 500 positions of the CPS switch as well as any frequency inbetween, using the VERNIER position of the CPS switch and the VERNIER control, both located on the front panel. When the CPS switch is in the 000 position, the phase-locked oscillator output in the 500-cps oscillator circuit is locked to 110 kc. Therefore, when the 11.0-kc signal (after division by ten) is mixed with the 7.089-mc error frequency, a frequency of 7.1000 mc is obtained. When the CPS switch is in the 500 position, the output from the phase-locked oscillator is locked to 115 kc. Therefore, when the 11.5 kc (after division by ten) is mixed with the 7.089-mc error frequency, a frequency of 7.1005 mc is obtained. Therefore, the 100-kc injection frequency will be 500 cps greater. Thus, the output from the midfrequency mixer may be varied in 500 cps increments. When the CPS switch is in the vernier position, the output from the phase-locked oscillator can be varied between 108 and 122 kc. As a result, the 7.1000-mc error frequency can be varied between 7.0998 and 7.1012 mc. Thus, the output from the midfrequency may be varied continuously between any two 1-kc increments.

The r-f signal from the antenna is converted to the 500-kc i-f as follows: Assume that the front panel controls are set for a frequency of 13,492,500 cps. The 1-mc injection corresponding to the selected mc digits (13) is 16.5 mc in the high-band. The 16.5-mc is additively mixed in the high frequency mixer with 13,492,500 cps producing 29,992,500 cps which is filtered and applied to the midfrequency mixer. Since the mc digits (13) are in the high-band and the CPS switch is in the 500 position, the 100-kc injection frequency corresponding to the 100-kc digit (4) will be 32.8005 mc. The midfrequency mixer subtractively mixes the 29,992,500 cps and the 32.8005 mc thereby producing a frequency of 2,808,000 cps, which is filtered and applied to the low frequency mixer. The 1- and 10-kc injection is that frequency of the 10-kc oscillator corresponding to the 10-kc digit (9) minus that frequency of the 1-kc oscillator corresponding to the 1-kc digit (2). This results in an injection frequency (5.16 mc minus 1.852 mc) of 3.308 mc. The 3.308 mc is subtractively mixed with the 2,808,000 cps producing the 500-kc i-f. Similarly, any frequency between 2 and 30 mc may be translated into the 500-kc i-f.

The operating voltages for all circuits in the R-1051/URR are produced by Power Supply Electronic Assembly (fig. 4-11). The 105 to 125-v a-c primary power is converted to d-c voltages of 110 volts (r-f amplifier tubes plate and screen supply) -30 volts (r-f amplifier tubes bias), and 28 volts (general use). The 28 v DC is also regulated to 20 v DC for use in all semiconductor circuits of the R-1051/URR.

SSB CONVERTER, CV-591A/URR

The CV-591A/URR single sideband converter (fig. 4-12) is used to convert standard communication receivers such as the R-390/URR for SSB use.

The overall selectivity of most receiving systems is greatly sharpened, rejecting unwanted adjacent signals or interference with no detrimental effect to the desired signal. The tuning of single-sideband signals is greatly simplified since the final tuning is done at the converter, not the receiver. A mechanical and electrical bandspread tunes over the i-f bandpass. This effective vernier easily tunes SSB or exalted carrier AM signals within cycles of correct tone. Either sideband is selectable, either with the bandpass tuning feature or by inverting the oscillator separation. Continuous Wave, MCW, and FS signals are easily tunable with the bandspread feature.

For extreme stability, the first oscillator is switched to crystal control for both upper and lower sideband positions.

The local or remote tuned VFO feature of the converter permits operation with any receiver having an i-f nominally centered at 455 kc. When the oscillator is switched to crystal control and the proper crystals inserted however, most any receiver i-f may be accommodated.

All operational controls are located on the front panel. These controls are similar in function and effect to those found on any receiver. The BANDSPREAD control tunes the converter over a limited frequency range. A MANUAL/XTAL switch sets the first oscillator to either variable or fixed crystal operation. The BFO, AVC and AUDIO GAIN controls perform similar functions as on a receiver.

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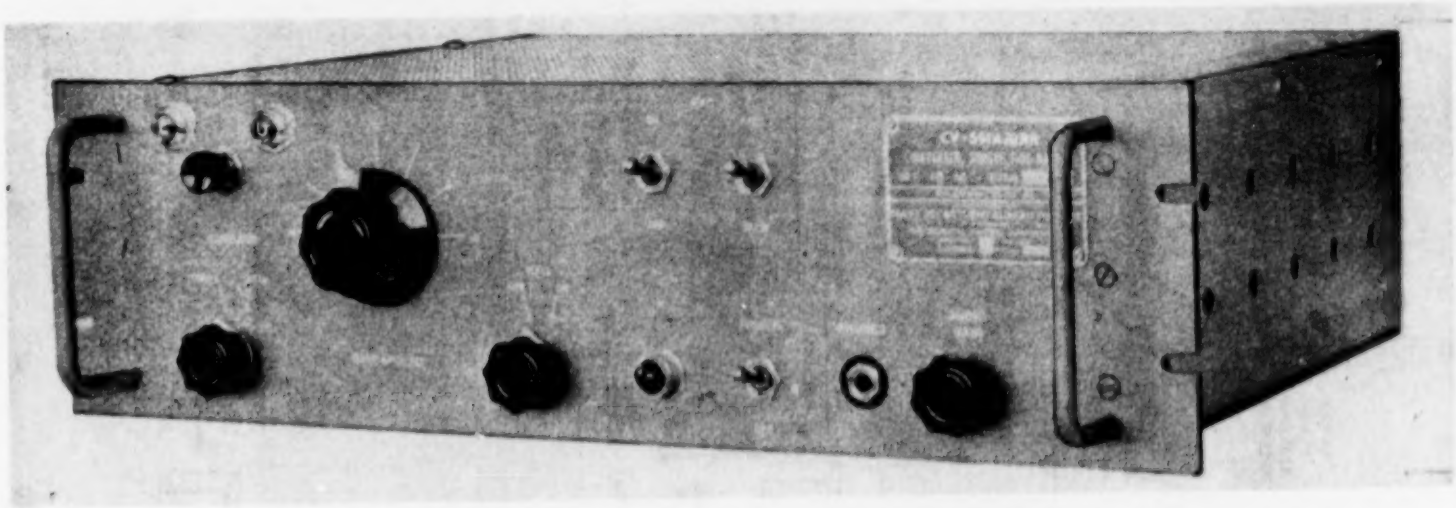

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Figure 4-12.—SSB converter, CV-591A/URR, front view.

Terminals at the rear panel provide simple connections for remote control of the main features of the converter without modifications or the use of additional lines or tones.

By this means it is possible to remotely or locally tune the converter across the receiver i-f passband, select sidebands with a remote indication of which sideband is in use, and still retain all of the remote control features of the remote control system. The converter may be used with remote control system AN/FRA-19(V) or AN/FRA-501, without modification to the system.

BLOCK DIAGRAM

The block diagram (fig. 4-13) presents a simplified outline of the functions of the converter and how they are accomplished.

The AVC Amplifier and Rectifier (V1), provides two kinds of control on the first amplifier. A fast time constant is used to control signals which have an ever-present component; i.e., AM, MCW, FS. A slow time constant will hold the amplifier gain steady for a longer period for SSB and CW signals. The gain of the amplifier is wide open when the AVC is OFF.

The first mixer (V3) (1st product detector), mixes the incoming signal with the first oscillator to place the signal in proper position relative to the bandpass filter. Since the filter extends from 17.3 kc to 20.5 kc and the 17-kc BFO follows, the signal carrier position must be placed at 17 kc to produce the correct tone.

The first oscillator (V7), provides the tunable frequency source for correctly tuning the signal in the bandpass filter. It may be either variable or crystal controlled. When variable it is tuned with the front panel BANDSPREAD control or with the reactance control for remote operation.

The reactance modulator (V8) is placed across the first oscillator tuned circuit and varies the reactance to change frequency. A 4.5-v DC change in output to the reactance stage is sufficient to vary the oscillator 3 kc. The voltage is obtained from the BFO channel of the Remote Control Receiver System.

As the r-f gain control on the remote control system is turned to reduce the gain of the receiver the required voltage out of the remote control system performing this action reaches a certain level. When the level is such that the receiver is fully silent, its negative level will be sufficient to cut off the relay driver (V9A) and deenergize sidetone relay K3 (not shown). This action in turn trips the sideband two-step relay K2.

Operation of the relay driver or the front panel push-button advances the sideband selector relay K2 one position. This changes the first oscillator frequency from upper to lower sideband selecting frequency or vice versa.

After the first mixer, the filter (Z1) passes a band of frequencies between 17.3 kc and 20.5 kc. The skirts of the selectivity curve provide the sharpness required for attenuation of undesirable adjacent signals.

The signal passed by the bandpass filter to the second detector (V4) is demodulated in either of two ways. If a carrier is normally present

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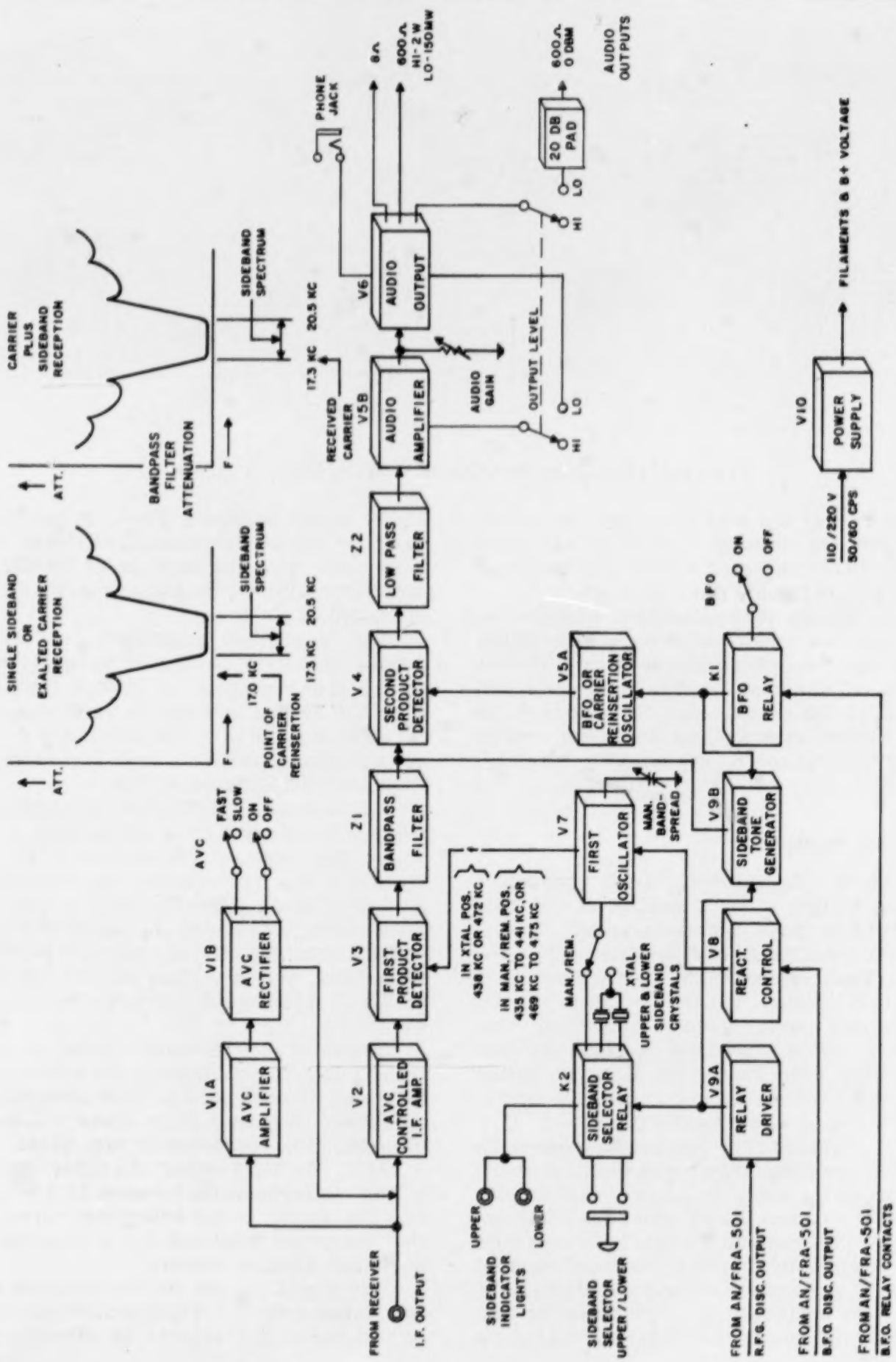

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Figure 4-13.—SSB converter CV-591A/URR, block diagram.

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and allowed to pass through the filter, such as AM, normal demodulation will take place. If no normal carrier is present, such as SSB, a carrier is reinserted.

The BFO or carrier reinsertion oscillator (V5A) is a stable 17-kc oscillator which provides the reinserted carrier for SSB and exalted AM, and produces the beat note for CW and FS signals.

The BFO relay (K1) turns the BFO on or off by proper actuation of the relay. The front panel BFO switch or a remote paralleled switch actuates the relay.

Sideband tone generator (V9B), by proper manipulation of the r-f gain control of the remote control system, generates a tone, high or low, which will indicate to the remote operator which sideband (upper or lower) is in use. The tone becomes strong enough to be heard only after the r-f gain has succeeded in fully silencing the normal receiver action.

Following the second mixer, the low pass filter (Z2) attenuates any products above 5 kc. The resultant is the desired audio.

The audio amplifiers (V5B, V6) provide three levels of output. The output level control in the HIGH position permits the full 2 watts of the amplifier to be available for the 600-ohm line or 8-ohm loudspeaker. In the LOW position, the gain of the amplifier is reduced so that 150 milliwatts are available for the 600-ohm line or 8-ohm loudspeaker, and 0 dbm or 1 milliwatt for 600-ohm telephone line. A phone jack on the front panel permits monitoring of the output without disabling the speaker.

The power supply (V10) is self-contained and provides the necessary a-c filament and d-c B+ voltages. A regulated +150 v stabilizes the first oscillator and BFO.

RADIO RECEIVER SET AN/FRR-60(V)

The AN/FRR-60(V) (fig. 4-14) is a general purpose Diversity Radio Receiver system designed mainly for use at Navy shore communication receiver sites. This receiver is the companion equipment for the AN/FRT-39/40 shore transmitters (discussed in chapter 6). The receiver covers the radio frequency range of 2 to 32 mc. The equipment is capable of reception in the following modes of operation:

(1) SSB (suppressed carrier).
(2) SSB (with carrier).
(3) DSB (suppressed carrier).
(4) DSB (with carrier).
(5) FSK.

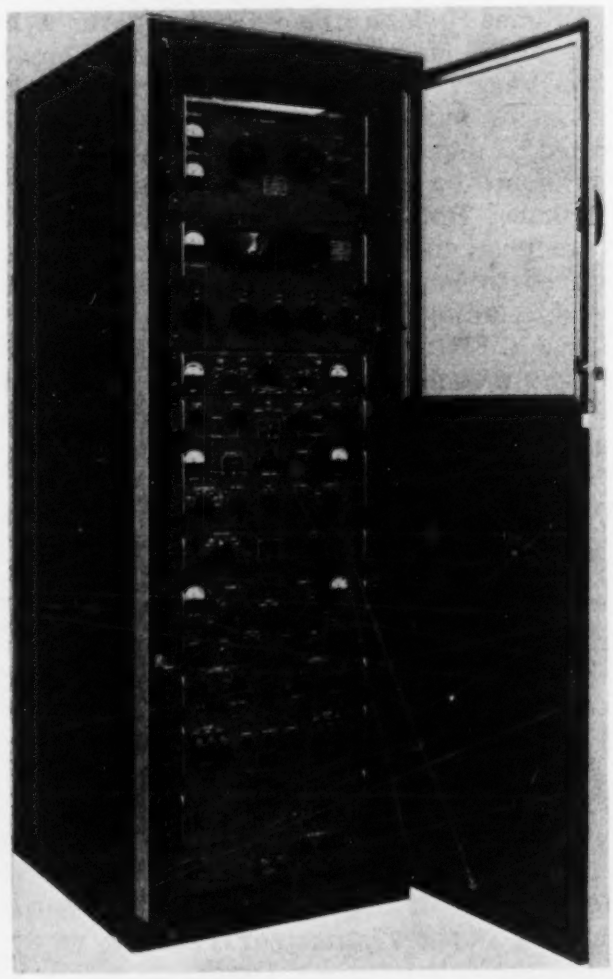

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Figure 4-14.—Diversity Radio Receiver, AN/FRR-60(V).

(6) FAX.
(7) CW.
(8) MCW.
(9) Pulse modulation.
(10) Phase modulation.

The 2- to 32-mc range covered by the AN/FRR-60(V) is divided into eight continuous bands. Continuous coverage is provided in either synthesized (controlling the receiver VFO with an external frequency standard) or non-synthesized type of operation. In the synthesized type of operation a frequency standard output is provided over the entire frequency range of the receiver in 100-cycle steps. One complete AN/FRR-60 by itself can only be operated in nondiversity; however, when two complete AN/FRR-60's are operated together and their AGC lines are interconnected, the equipment may be operated in either space diversity or frequency diversity. In space-diversity operation the two

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receiver antenna inputs are connected to separate antennas which are spaced several wavelengths apart. In frequency-diversity operation the two receiver antenna inputs are connected to the same antenna but the two receivers are operated on separate frequencies which are being transmitted simultaneously with identical intelligence. Both types of diversity operation are designed to overcome the difficulties encountered in long-range communications which are due to fading.

The AN/FRR-60(V) comprises various modular units mounted in a single rack, and is used in fixed-station or mobile communications systems.

The receiver is capable of receiving input signal variations of 70 db without the use of AGC and signal variations of 100 db with the use of AGC. These variations will not affect the usability of receivers output signal. Further, the receiver will continue to provide a useable output signal over a dynamic range of 150 db. Front panel controls are provided so that the AGC voltage can be adjusted to cope with various signal conditions.

Front-panel meters are provided on the receiver to facilitate the monitoring of r-f input signals, audio output signals, automatic frequency control drift, carrier level, i-f output, and locking of the synthesizer frequency with the HFO of the Continuous RF Tuner.

An internally generated low-level r-f alignment signal, which is provided by the synthesizer, facilitates accurate and rapid tuning of the complete system in the absence of any received radio signal. The locally generated signal is also useable as a maintenance "tool" for checking the alignment of the AN/FRR-60(V).

A forced-air cooling system using electric blowers incorporated within the equipment cabinet. Washable air filters are used to filter out external dust.

CONTINUOUS RF TUNER TN-376/UR

The Continuous RF Tuner (fig. 4-15) provides for frequency coverage from 2 to 32 mc in eight bands and displays the tuned frequency on a 14-inch slide-rule type scale. The tuner will accept synthesized control voltage from the synthesizer unit 0-941/UR for extreme frequency accuracy and stability. The RF Tuner converts the input r-f frequency to their lower first i-f of 1.75 mc. The TN-376/UR obtains its operating power from an external power supply unit, PP-3341/FRR-60(V).

The front panel controls and instruments of the RF Tuner (see fig. 4-16) are arranged to permit ease of tuning through any of the eight r-f bands to the desired frequency within the range of 2 to 32 mc, non-synthesized continuous coverage operation or synthesized operation in 100 cycle steps, and alignment and sensitivity checks of the tuner. All operating controls are identified by front panel markings. The following numeral and panel designations list the controls, instruments and the function of each (see fig. 4-16).

(1) MEGACYCLES. The megacycle indicator displays the r-f band selected by operation of the band control knob; refer to designation number (3).

(2) TUNE. The tuning knob moves the slide-rule pointer along the megacycle indicator to the appropriate frequency desired. This control is fitted with a locking device; refer to designation number (7).

(3) BAND. The band control rotates the illuminated MEGACYCLE indicator to the desired r-f band. The r-f bands are arranged as follows:

BAND 1	2-3 mc
BAND 2	3-4 mc
BAND 3	4-6 mc
BAND 4	6-8 mc
BAND 5	8-12 mc
BAND 6	12-16 mc
BAND 7	16-24 mc
BAND 8	24-32 mc

(4) SYNC IND. The synchronizing indicator lamp lights to indicate that the synthesizer is in synchronization with the HFO in the r-f tuner unit.

(5) NOISE SILENCER/OFF/ALIGNMENT SIGNAL. In the NOISE SILENCER position, this three position control activates the noise silencer circuits; disables the alignment signal generator, and connects the antenna (ANT) input jack to the first r-f amplifier circuit. In the OFF position, the control disables the output of the noise silencer, disables the alignment signal generator, and connects the ANT input jack to the first r-f amplifier circuit. In the ALIGNMENT SIGNAL position the control activates the alignment signal generator, disables the output of the noise silencer, and connects the calibration (CAL) input jack to the first r-f amplifier circuit.

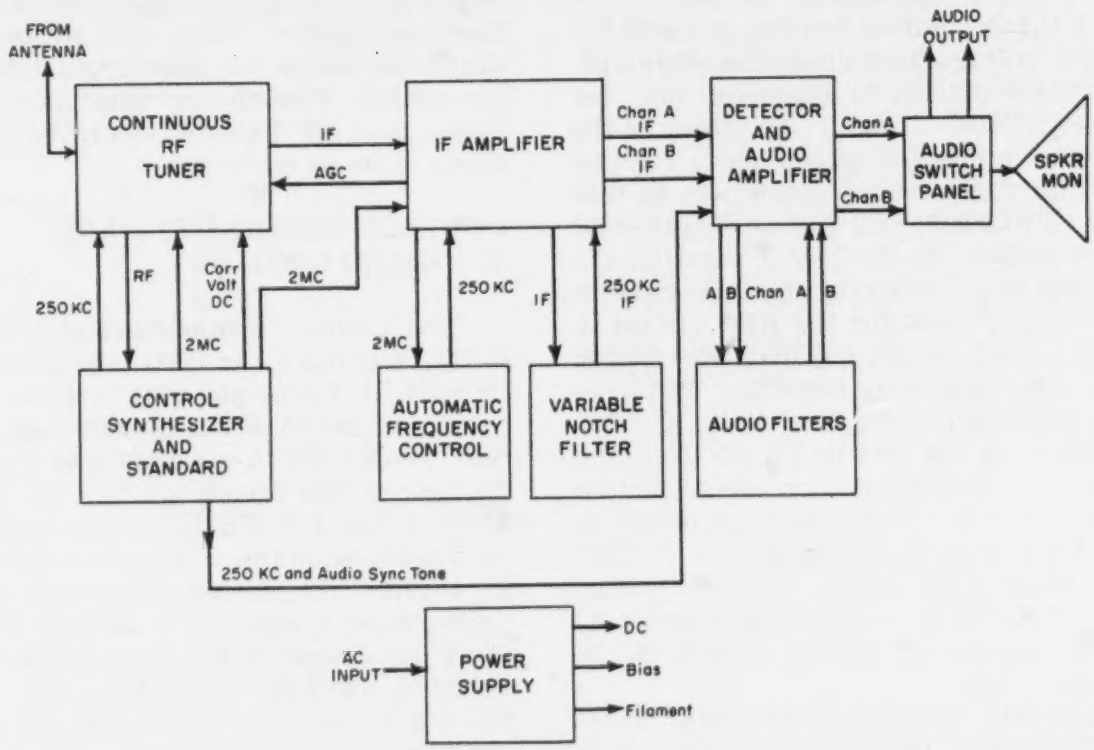

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Figure 4-15.—AN/FRR-60(V), simplified block diagram.

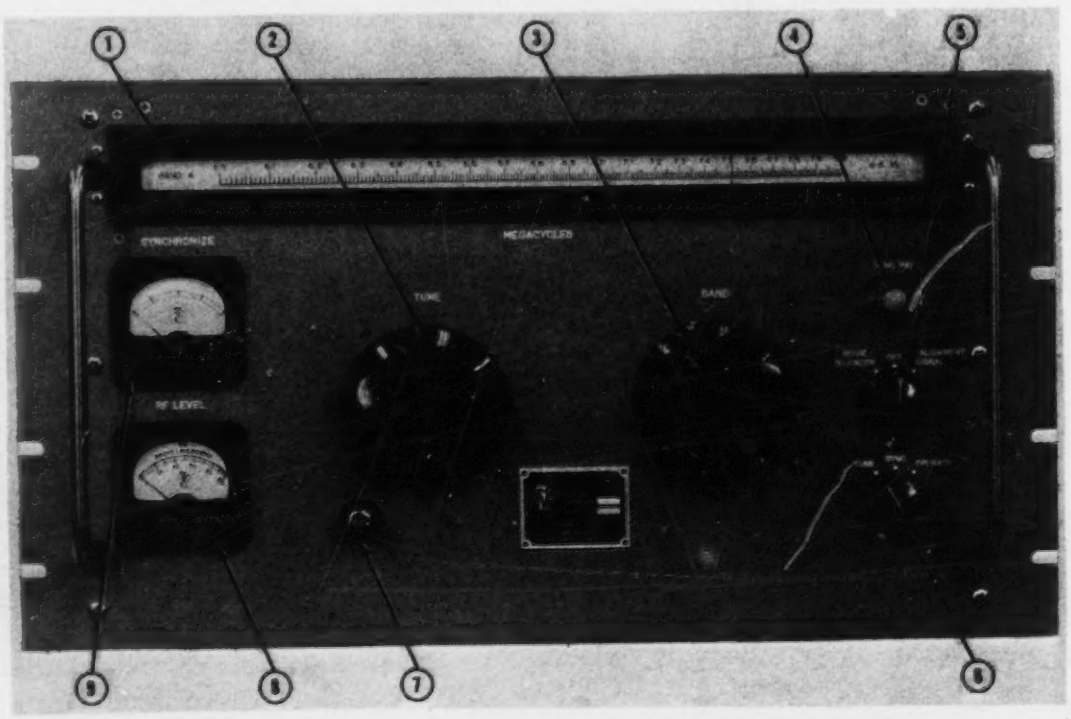

Figure 4-16.—Continuous RF Tuner, TN-376/UR.

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(6) TUNE/SYNC/OPERATE. In the TUNE position, this three position control grounds the d-c correction voltage from the synthesizer unit, causing the HFO circuit to run free, and de-energizes the AUDIO SYNC TONE relay of the audio frequency amplifier unit so as to remove the audio sync tone from channel A. In this position the SYNCHRONIZE meter should read zero (center scale). In the SYNC position the control grounds the d-c correction voltage from the synthesizer unit, causing the HFO circuit to run free, and energizes the AUDIO SYNC TONE relay of the audio frequency amplifier unit so as to inject an audio sync tone in channel A of the audio amplifier. In the OPERATE position, the control causes the synthesizer circuits to control the HFO circuits for synthesized operation in 100-cycle steps, and de-energizes the AUDIO SYNC TONE relay of the audio amplifier unit so as to remove the audio sync tone from channel A.

(7) LOCK. Locks the tuning control (2) in the desired position.

(8) RF LEVEL. The r-f level meter indicates the strength of the antenna input signal or the alignment signal in db above a reference level of 1 μ V.

(9) SYNCHRONIZE. The sync meter indicates the amount and polarity of the d-c voltage required to keep the HFO in sync with the synthesizer output. When the system is out of synchronization, the meter will read zero (center scale). This meter functions only when the Continuous RF Tuner is operating in the synthesized mode of operation.

CONTROL SYNTHESIZER AND STANDARD 0-941/UR

The Control Synthesizer and Standard (fig. 4-15), monitors the HFO frequency of the Continuous RF Tuner and provides correction voltage to maintain the free-running oscillators in the TN-376/UR to a stability of 1 part in 10^8 in 24 hours. The frequency that is to be synthesized in the TN-376/UR by the Synthesizer unit is displayed on the front-panel of the 0-941/UR in 1-inch illuminated numerals. A change of synthesized frequency in 100-cycle increments is accomplished by means of manually controlled detented switches located on the front panel of the equipment. The 0-941/UR obtains its operating power from an external power supply unit PP-3341/FRR-60(V).

The controls and indicators of the Control Synthesizer and Standard (fig. 4-17) are arranged to permit the selection of any frequency from 2

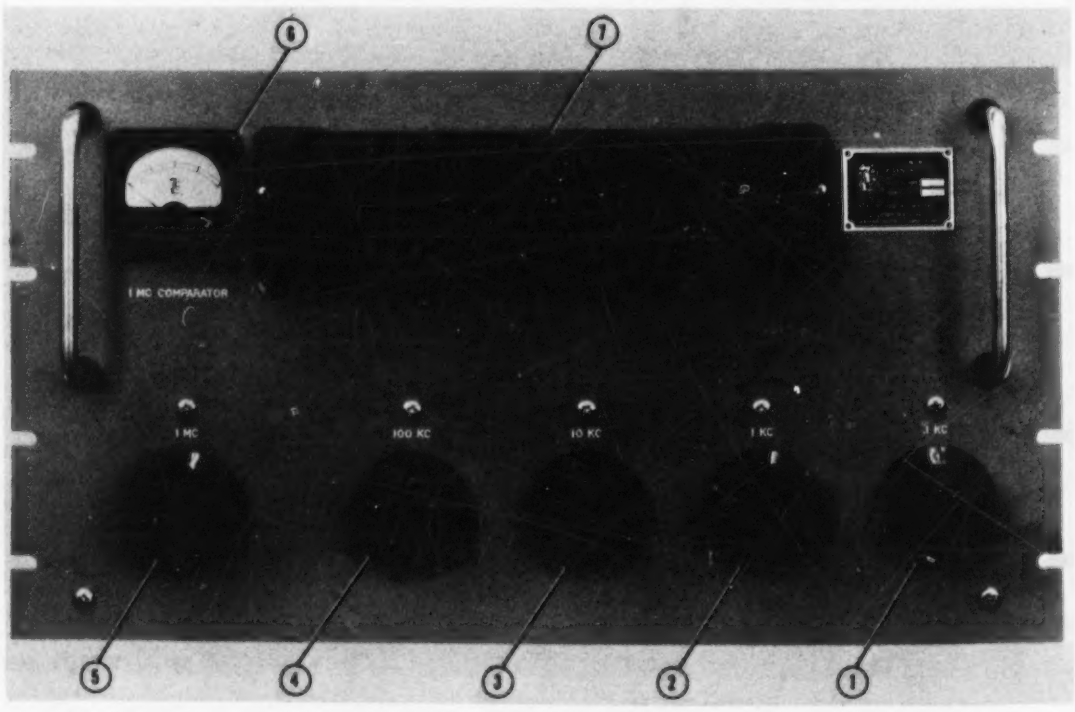

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Figure 4-17.—Control Synthesizer and Standard, 0-941/UR.

to 32 mc in 100-cycle steps. By rotation of the frequency selector switches the used frequency is indicated by the nixies (solid state or vacuum tube, luminous numerical indicating devices) on the front panel. The following numeral and panel designations list the controls, instruments and function of each (see fig. 4-17).

(1) 0.1 KC. The 0.1 kc control tunes the synthesizer in 100-cycle steps.

(2) 1 KC. The 1-kc control tunes the synthesizer in 1,000-cycle steps.

(3) 10 KC. The 10-kc control tunes the synthesizer in 10-kc steps.

(4) 100 KC. The 100-kc control tunes the synthesizer in 100-kc steps.

(5) 1 MC. The 1-mc control tunes the synthesizer in 1-mc steps.

(6) 1-MC COMPARATOR. The 1-mc comparator meter indicates the frequency error of the internal 1-mc frequency standard.

(7) NIXIE FREQUENCY INDICATOR. It indicates (using nixie units) the frequency that the equipment is tuned to.

AUTOMATIC FREQUENCY CONTROL UNIT C-4099/FRR-60(V)

The Automatic Frequency Control Unit (AFC) (fig. 4-15), accepts a 250-kc input signal from the IF Amplifier Unit, AM-3295/FRR-60(V), and provides automatic frequency control which will compensate for a frequency drift in the received transmission. The AFC unit automatically synchronizes to a received signal within ± 50 cps when the received signal is suppressed as much as 30 db at 1 microvolt above noise threshold and will remain synchronized for approximately ± 1,000 cps of drift at a maximum drift rate of 10 cps/second. The C-4099/FRR-60(V) obtains its operating power from an external power supply unit, PP-3341/FRR-60(V).

The AFC unit (fig. 4-18) is normally operated with the CARRIER selector switch in the OSC position. With the switch in the OSC position, the receiver product detector receives a corrected 250-kc injection frequency from the AFC product detector oscillator. Also, in this position, the AFC responds to correct the carrier drift at the speed rated (10 cps/second maximum): the 250-kc injection frequency will be in phase with the carrier input within 1 cycle (or 360°). In cases where phase is of primary importance, it may be elected to place the CARRIER SELECTOR switch in RCC (reconstructed carrier) position. This effectively strips the 250-kc carrier of its sidebands, amplifies the carrier, and feeds this carrier back into the receiver product detector as the injection frequency. The following numeral and panel designations list the controls, instruments and the function of each (see fig. 4-18).

(1) DRIFT. The DRIFT meter indicates the total drift of the receiver i-f carrier. A center scale reading indicates zero drift. The meter scale is color coded as follows:

Color	Drift (approx)
Green	500 cps
Yellow	500 cps to 1 kc
Red	1 kc or more

(2) ALARM. The alarm lamp will light when the carrier frequency has drifted off center frequency by more than ± 750 cps.

(3) SENSITIVITY. The SENSITIVITY controls the gain of the carrier amplifier stage. The sensitivity may be increased or decreased depending on the ratio of signal to noise.

(4) RESET. The RESET control re-centers the AFC oscillators when the operator is required to tune the receiver to another frequency or resynchronize the receiver due to a drifting signal.

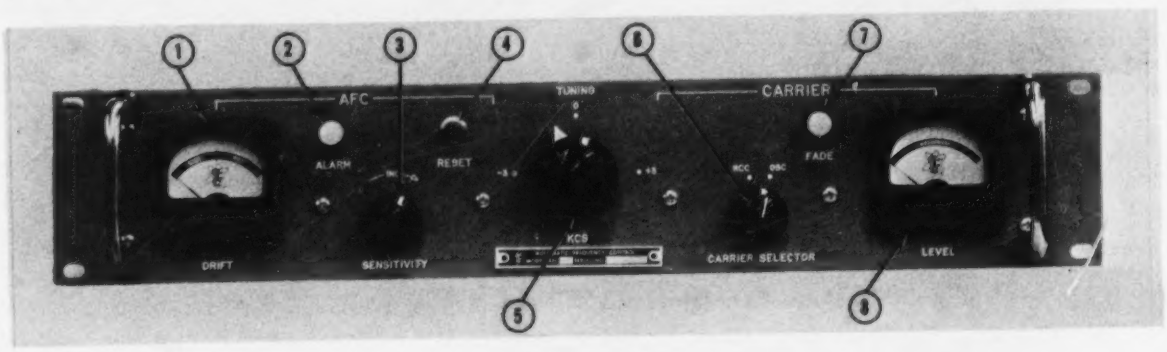

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Figure 4-18.—Automatic Frequency Control, C-4099/FRR-60.

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(5) TUNING KCS. The TUNING KCS control tunes the AFC unit's converter injection oscillator to enable the operator to synchronize to the received signal.

(6) CARRIER SELECTOR. The carrier selector control is used to select either the product detector oscillator (OSC) or the reconstructed carrier (RRC) position. The function of both positions was explained in a previous paragraph.

(7) FADE. The FADE lamp will light when the received signal fades below a predetermined level.

(8) LEVEL. The LEVEL meter indicates the strength of the received carrier.

IF AMPLIFIER AM-3295/FRR-60(V)

The IF Amplifier unit (fig. 4-15), accepts a 1.75-mc input signal from the Continuous RF Tuner, TN-376/UR, processes the input signal through manually controlled selectable bandpass filters, and converts the input signal to 250 kc for further demodulation in the Audio Amplifier, AM-3298/FRR-60(V). Rear panel facilities are provided for connecting the Notch Filter, F-711/FRR-60(V).

The i-f amplifier unit (fig. 4-19) is designed to operate with a high degree of versatility. The two i-f channels are identical and the controls for each channel are functionally grouped. By the use of two IF BANDWIDTH KC front switches, either a symmetrical upper or lower sideband may be switched to channel A or B. This type of versatility is helpful, especially during independent sideband operation where voice information may be transmitted on one sideband and multichannel information on the other sideband. When information is transmitted in this manner, sideband orientation of information need not be maintained at the transmitter. The following numerical and panel designations list the controls, instruments and the function of each (see fig. 4-19).

(1) and (3) OUTPUT. The OUTPUT meter indicates the output level of the channel.

(2) MANUAL GAIN. The MANUAL GAIN controls the overall gain of the i-f amplifier.

(4) and (8) IF BANDWIDTH KC. The IF BANDWIDTH KC controls the bandpass of the i-f amplifier and selects either the upper or lower sideband in single-sideband operation, or both sidebands in double-sideband operation.

(5) and (7) AGC DECAY. The AGC DECAY controls the amount of time it takes the AGC to decay after a signal starts to fade.

(6) AFC ON-OFF. The AFC ON-OFF activates or disables the AFC circuits.

VARIABLE NOTCH FILTER F-711/FRR-60(V)

The Variable Notch Filter (fig. 4-15), accepts a 250 kc input signal from the IF Amplifier and, when used, will attenuate an interfering signal within ± 8 kc of the 250-kc input signal. Filtering by the F-711/FRR-60(V) can be engaged or disengaged by means of front panel

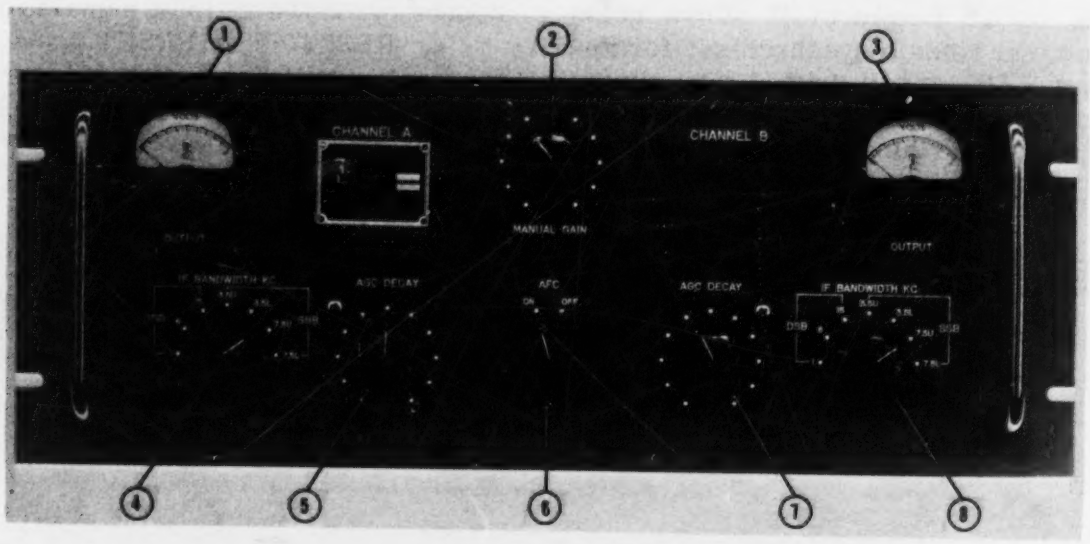

Figure 4-19.—Intermediate Frequency Amplifier, AM/3295/FRR-60(V).

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controls. Signals from the Variable Notch Filter are returned to the IF Amplifier for the purpose of bandpass filtering. The F-711/FRR-60(V) obtains its operating power from an external power supply unit, PP-3341/FRR-60(V).

The Variable Notch Filter (fig. 4-20) controls are located on the front panel and allow the operator to select an audio filter to tune an unwanted signal into a notch filter for elimination from the desired signal. If an i-f signal exists with no interfering signal, the notch may be turned off. The following numeral and panel designations list the controls and the function of each (see fig. 4-20).

(1) NOTCH ADJUST. The NOTCH ADJUST control is used to vary the center frequency of the notch filter either plus or minus from the center i-f by as much as ±8 kc.

(2) NOTCH OFF-ON. The NOTCH OFF-ON controls the 250-kc i-f input to the filter. In the OFF position the signal bypasses the filter.

DETECTOR AND AUDIO AMPLIFIER AM-3298/FRR-60(V)

The Detector and Audio Amplifier unit (fig. 4-15), accepts dual 250-kc input signals from the IF Amplifier unit, demodulates these signals and provides dual audio channel outputs. Facilities are incorporated on the rear panel to channel the output signals to a passive dual audio filter. The AM-3298/FRR-60(V) obtains its operating power from an external power supply unit, PP-3341/FRR-60(V).

The Detector and Audio Amplifier (fig. 4-21) is divided into two identical channels (A and B). Each channel has identical controls which are functionally grouped. The following numeral and panel designations list the controls and instruments and the function of each (see fig. 4-21).

(1) POWER. The POWER control switch has two positions. The STANDBY position is used to disconnect the operating voltages from the unit.

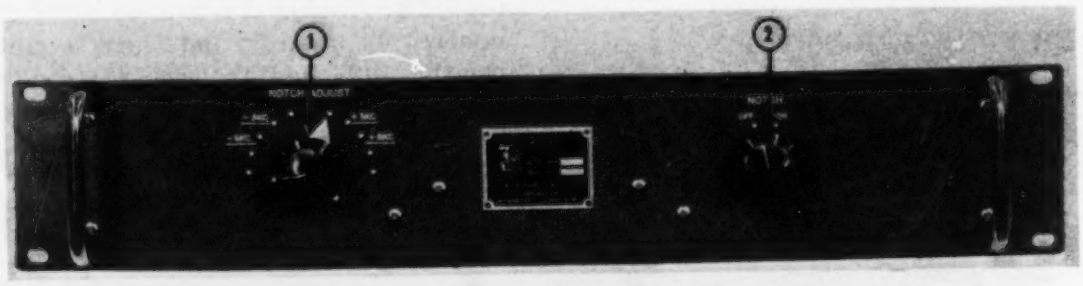

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Figure 4-20.—Variable Notch Filter, F-711/FRR-60(V).

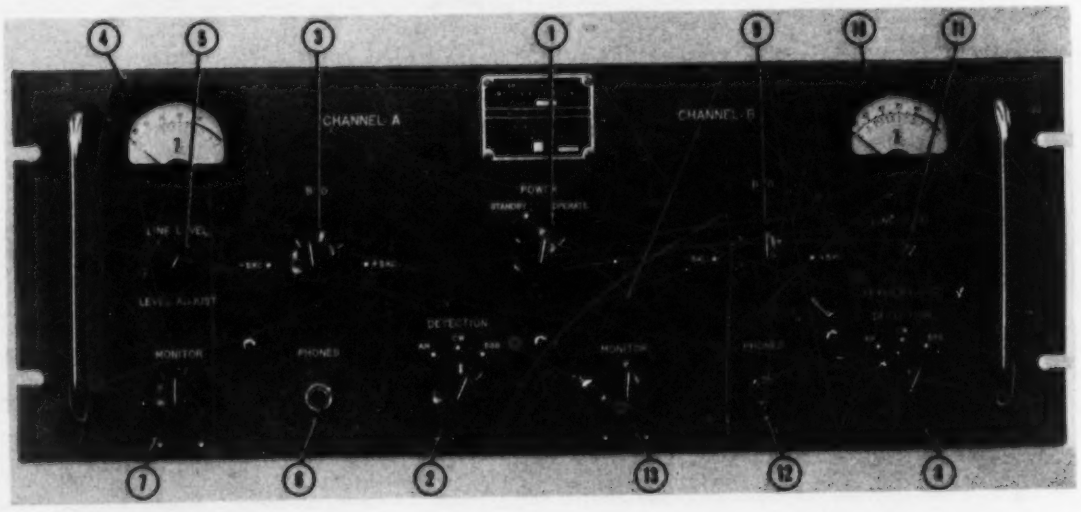

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Figure 4-21.—Detector and Audio Amplifier, AM-3298/FRR-60(V).

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The OPERATE position is used when the equipment is in operation and connects the operating voltages to the unit.

(2) and (8) DETECTION. The DETECTION control selects the mode of detection and is capable of operating in AM, CW, or SSB, depending on the position of the switch.

(3) and (9) BFO. The BFO control is used in the CW position and will vary the BFO ± 5 kc (maximum) about the center i-f of 250 kc.

(4) and (10) LINE LEVEL. The LINE LEVEL meter indicates the audio level across the output line.

(5) and (11) LEVEL ADJUST. The LEVEL ADJUST control varies the audio output level across the output line.

(6) and (12) PHONES. The PHONES jack is used to connect a standard headset to the unit for the purpose of monitoring the output signal.

(7) and (13) MONITOR. The MONITOR control is used to vary the level of the signal in the monitor phone jack headset.

AUDIO FILTER F-712/FRR-60(V)

The Audio Filter (fig. 4-15) requires no operating voltages other than the signals fed to it by the Detector and Audio Amplifier, AM-3298/FRR-60(V). The F-712/FRR-60(V) accepts dual audio signals from the audio amplifier and is adjustable by front panel controls which vary the upper and lower frequency cutoff point of each audio filter to suit operational requirements. Front panel controls have been engineered to minimize confusion when establishing audio bandpass.

The Audio Filter (fig. 4-22) is used to pass a particular band of frequencies in the audio range for either Channel A or Channel B. An example would be to pass a 2-kc band with the low end of the band starting at 0.5 kc and ending at the high end with 2.5 kc. Set the low cutoff control to 0.5 kc and the high cutoff control to 2.5 kc. As another example, to pass all frequencies above 2.5 kc set the low cutoff control to 2.5 kc and set the high cutoff control to the OUT position. The following numeral and panel designations list the controls and the function of each (see fig. 4-22). (1) and (3) LOW CUTOFF. The control is used to set the low cutoff frequency for the indicated channel. (2) and (4) HIGH CUTOFF. The control is used to set the high cutoff frequency for the indicated channel.

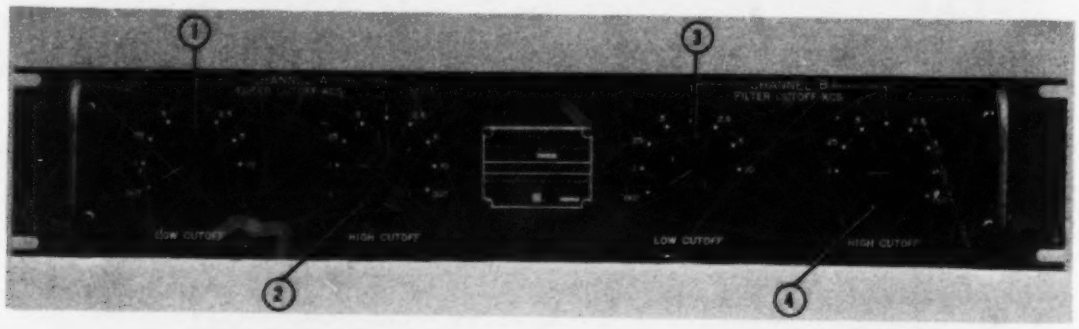

Figure 4-22.—Audio Filter, F-712/FRR-60(V).

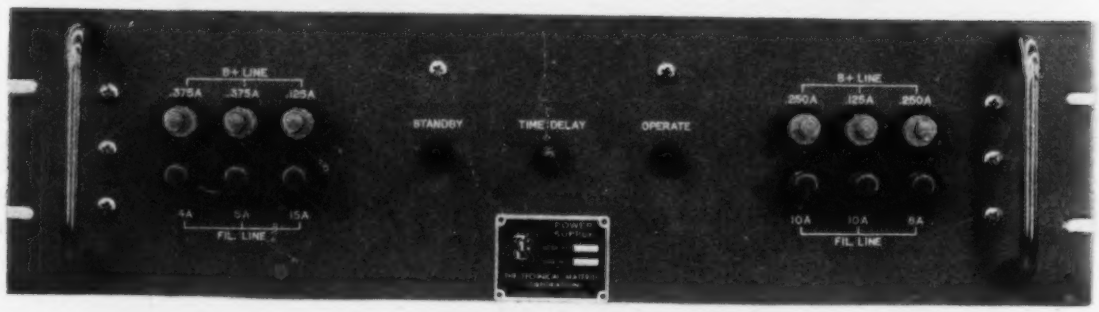

Figure 4-23.—Power Supply, PP-3341/FRR-60(V).

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POWER SUPPLY PP-3341/FRR-60(V)

The Power Supply (fig. 4-15), provides for regulated B+, regulated bias voltage, and filament voltages for one complete rack of AN FRR-60(V) units.

The Power Supply (fig. 4-23) contains no front panel controls. On the front panel are indicator lamps and indicator fuses. There are also indicator fuses located on the top panel just behind the front panel.

AUDIO SWITCH PANEL SB-1865/FR

The Audio Switch Panel (fig. 4-15), filters and interconnects the two audio output channels (Channels A and B) to a terminal strip for further wire transmission to local or remote terminal equipment such as single-channel or multi-channel teletypewriter converter equipment. The Audio Switch provides front panel controls to apply Channel A or Channel B audio signals to the loudspeaker, disconnect audio signals from the loudspeaker, adjust the audio level of signals applied to the loudspeaker, and combine or separate the AGC of both receivers when used in diversity/non-diversity.

SPEAKER PANEL LS-491/FR

The Speaker Panel (fig. 4-15), houses a single 4-inch permanent-magnet (p-m) speaker that is used to monitor the receiver outputs.

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CHAPTER 5

RADIO TRANSMITTERS, PART I

This chapter presents a block diagram discussion of the AN/SRT-14, 15, and 16, the AN/WRT-2 Radio Transmitting Set, and the SSB Transceiver AN/URC-32.

RADIO TRANSMITTING SETS AN/SRT-14, 15, and 16

Radio Transmitting Sets AN/SRT-14, 15, and 16 provide radio-frequency energy at any frequency from 0.3 to 26 mc for the transmission of voice, facsimile, and c-w or frequency shift telegraph communication. A manual frequency selection process permits all three sets to cover the entire frequency range in steps of 10 cycles at the 100-watt output level. The AN/SRT-15 and AN/SRT-16 can also operate at the 500-watt carrier level in the frequency range from 2 to 26 mc.

The AN/SRT-14 with its major components consists of a 100-watt transmitter bay and the antenna tuning equipment. The Radio Transmitting Set AN/SRT-15 consists of a transmitter bay and booster and the antenna tuning equipment. The booster provides the necessary facilities for producing the 500-watt operating output level. Therefore, the set may transmit an r-f carrier of either 100 or 500 watts. The Radio Transmitting Set AN/SRT-16 (fig. 5-1) consists of two transmitter bays, each of which is equipped with its antenna tuning units. The dual transmitter is therefore capable of transmitting two carriers simultaneously. One of the outputs is limited to the 100-watt level, while the other may be transmitted at either 100 or 500 watts.

Either of the transmitter sets may be arranged for remote operation with start-stop control, keying, and radiophone. Standard Navy six-wire radio transmitter control circuits are used for all remote control operation.

OVERALL BLOCK DIAGRAM

In the discussion of the AN/SRT-14, 15 and 16 in this chapter, it is sometimes best to use abbreviations for major components of the sets. These major components and abbreviations are:

Radio-Frequency Oscillator (RFO)
Low-Voltage Power Supply (LVPS)
Medium-Voltage Power Supply (MVPS)
High-Voltage Power Supply (HVPS)
Low-Level Radio Modulator (LLRM)
High-Level Radio Modulator (HLRM)
Radio-Frequency Amplifier (RFA)
Antenna Tuning Unit (ATU)
Load Adjusting Unit (LAU)

Because of the similarity of the three transmitters, a single functional block diagram is shown in figure 5-2. The diagram is used to show the relationship existing between the major units and the progression of the signal through the set.

Radio-Frequency Oscillator

The radio-frequency oscillator is the master frequency source for the transmitting set. It contains three individual oscillators and several supporting units including frequency converters, step generators, and frequency multipliers, which are necessary to produce the required frequencies for the transmitter. The radio-frequency oscillator unit consists of 14 sub units, which in this discussion, will be referred to by their common name and unit number, as shown in the radio-frequency oscillator block diagram of figure 5-3.

UNIT 1.—The crystal oscillator (unit 1) produces a 100-kc output, which is fed to a frequency multipler (unit 2), a frequency converter (unit 5), the 10-kc step generator (unit 6),

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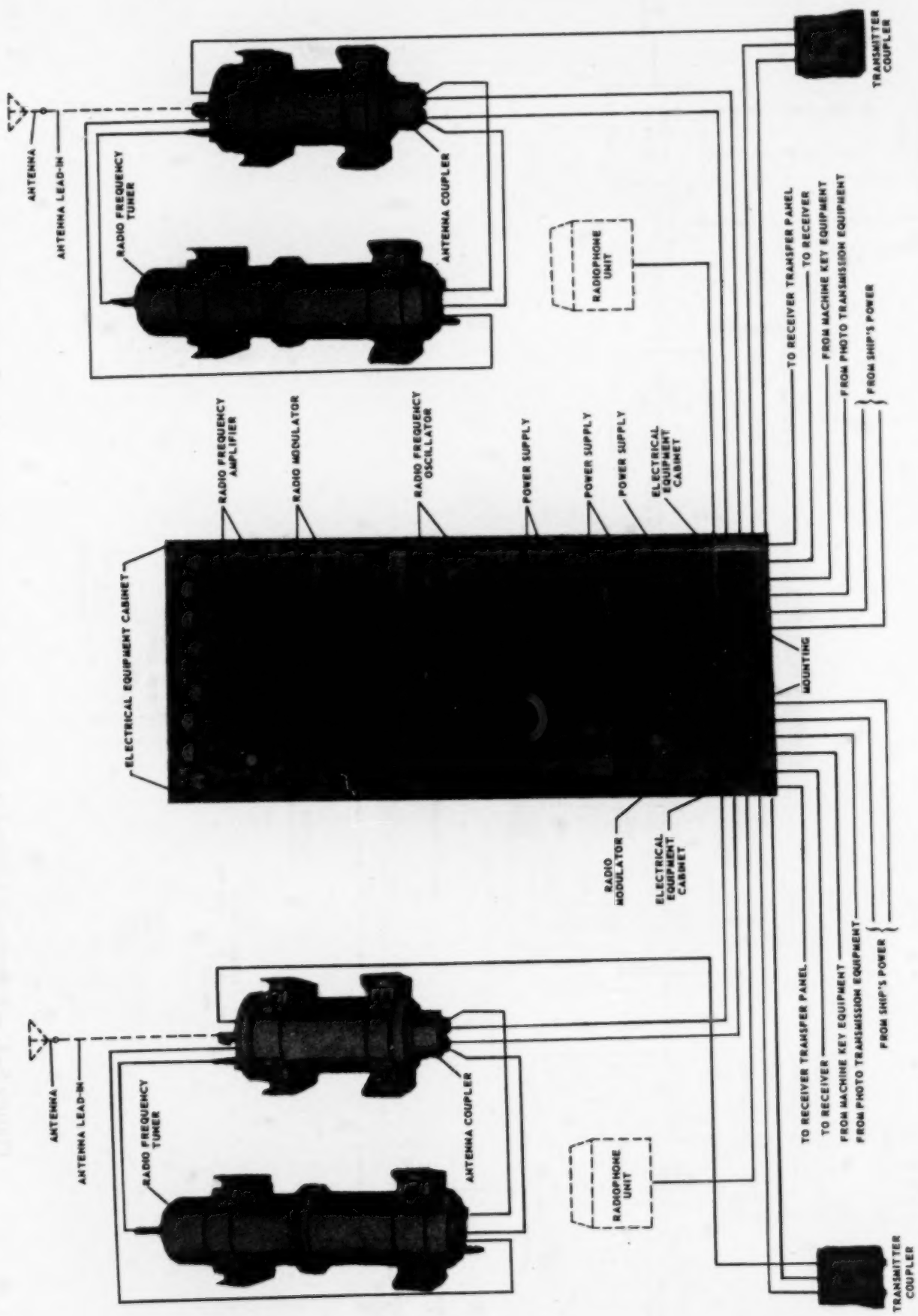

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Figure 5-1.—Radio Transmitting Set AN/SRT-16, relationship of units.

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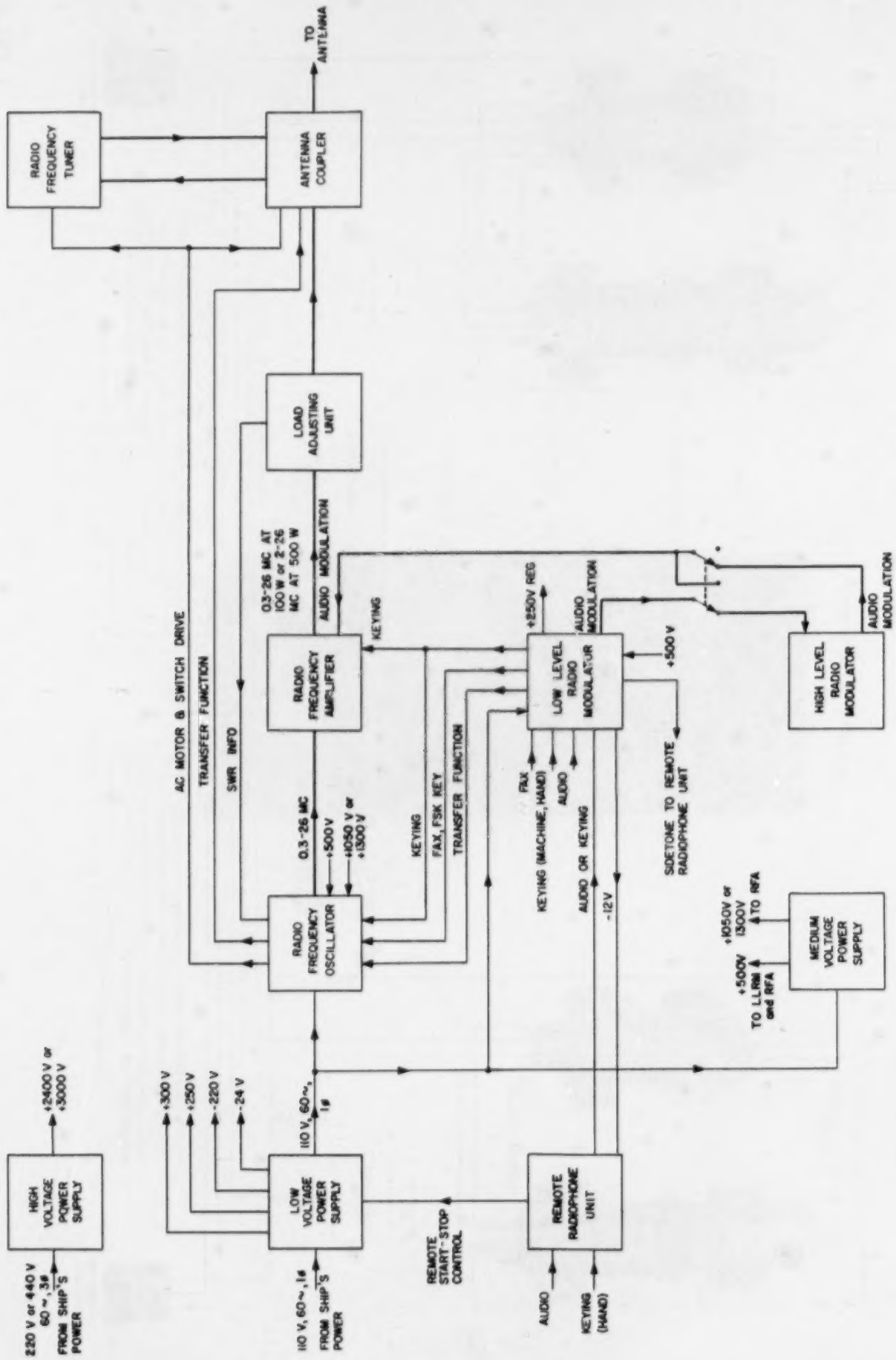

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Figure 5-2.—Functional block diagram of Radio Transmitting Set AN/SRT-14, 15, and 16.

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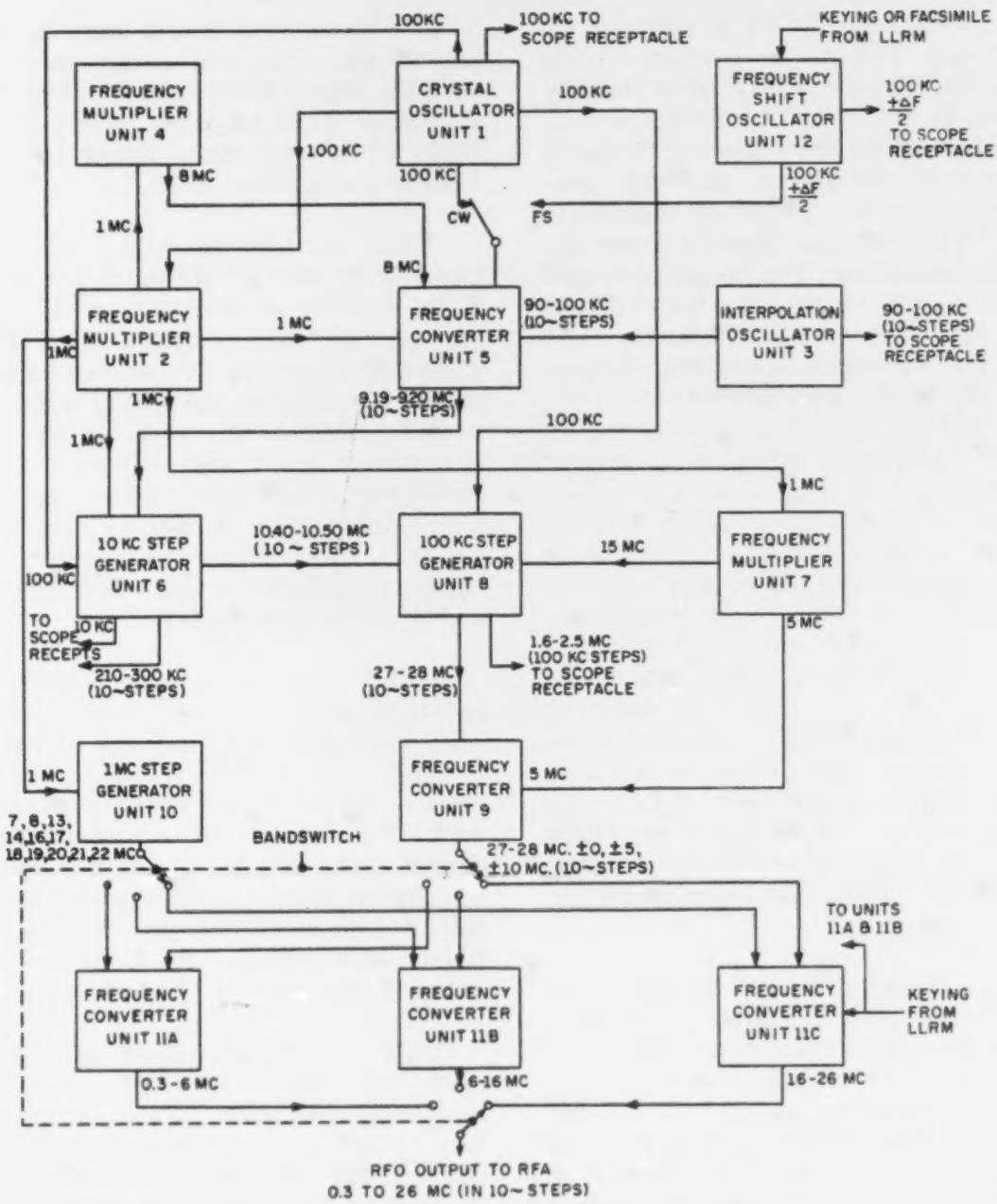

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Figure 5-3.—Functional block diagram of radio-frequency oscillator.

and the 100-kc step generator (unit 8). This output synchronizes the step generators, and through frequency multipliers, provides higher frequencies as required by other units of the radio-frequency oscillator. Another portion of the 100-kc output is fed to a zero adjust indicating circuit to enable the operator to check the output of the interpolation and frequency-shift oscillators. Finally, a portion of the 100-kc output of the crystal oscillator is fed to an oscilloscope test receptacle for servicing or checking as required.

UNIT 2.—In the frequency multiplier (unit 2), the 100-kc output of the crystal oscillator is increased to 1 mc and fed to another frequency multiplier (unit 4), a frequency converter (unit 5), a 10-kc step generator (unit 6), a frequency multiplier (unit 7), and a 1-mc step generator (unit 10). Unit 4 multiplies the 1-mc input frequency from unit 2 and produces an 8-mc output, which is fed to the frequency converter (unit 5).

UNIT 5.—In addition to the 1-mc input from unit 2 and the 8-mc input from unit 4, the frequency converter (unit 5) receives outputs from the interpolation oscillator (unit 3) and either the crystal oscillator or the frequency-shift oscillator. The interpolation oscillator produces an

output of 90 to 100 kc, adjustable in steps of 10, 100 and 1000 cps. The major portion of this output is fed to the frequency converter (unit 5). Another portion is fed to an oscilloscope test receptacle located on the front panel of the RFO. The frequency-shift oscillator (unit 12) generates an outout of 100 kc, frequency modulated in accordance with signals applied from the low-level radio modulator. For frequency-shift keying operations, the output may be shifted a maximum of ±1000 cps or $\Delta f/2$ from the knob set frequency. For facsimile operation, the output frequency shift may be adjusted from +500 to +2000 cps (or Δf) for a positive 20-volt signal from the facsimile equipment. During either frequency-shift keying or facsimile operation, the output of unit 12 is fed to the frequency converter (unit 5) to replace the 100-kc signal normally supplied by the crystal oscillator (unit 1). Another portion of the frequency-shift oscillator output is fed to an oscilloscope test receptacle. The frequency converter (unit 5) consists of a series of conventional mixers, tuned filters, and an amplifier to heterodyne its four input frequencies. The output of unit 5 is adjustable in steps of 10 cps from 9.19 to 9.2 mc for c-w and phone, or 9.19 to 9.2 mc ±1000 cps (maximum) for frequency-shift telegraphy, and 9.19 to 9.2 mc +2000 cps (maximum) for facsimile operation.

UNIT 6.—The output of unit 5 is fed to the 10-kc step generator (unit 6) whose major component is a phase-locked oscillator. The 10-kc step generator receives, in addition, a 100-kc signal from the crystal oscillator and a 1-mc signal from unit 2. The 100-kc input is reduced to a 10-kc signal which is used to phase lock the 210- to 300-kc oscillator with the output frequency of unit 1. Both of the above signals are applied to oscilloscope test receptacles. A portion of the oscillator frequency is then mixed with the input from unit 2 and unit 5 to produce a final output from unit 6 of 10.4 to 10.5 mc (in steps of 10 cps), which is fed to the 100-kc step generator (unit 8).

UNIT 7.—The frequency multiplier (unit 7) receives a 1-mc signal from unit 2 and multiplies it to provide first a 5-mc signal for the frequency converter (unit 9) and, secondly, a 15-mc signal for the 100-kc step generator (unit 8). Unit 8 uses the 100-kc input from the crystal oscillator (unit 1), to produce an output of 1.6 to 2.5 mc, adjustable in 100-kc steps. A portion of this output may be fed to an oscilloscope. The remaining portion is mixed with the inputs from unit 6 and unit 7 to produce an output of 27 to 28 mc, which is adjustable in steps of 10 cps. This output is fed to the frequency converter (unit 9).

UNIT 9.—Unit 9 mixes the 27- to 28-mc input from unit 8 with the 5-mc input from unit 7 to produce frequencies of 27 to 28 mc (±0, ±5, or +10 mc), adjustable in 10-cps steps. These frequencies are amplified by remainder of unit 9 and then fed to one wafer of the bandswitch. The 1-mc step generator (unit 10) receives a 1-mc signal from unit 2 and passes it through a harmonic generator that produces frequencies of 7, 8, 13, 14, 16, 17, 18, 19, 20, 21, and 22 mc. These frequencies are amplified by the remainder of unit 10 and fed to the second wafer of the bandswitch.

UNIT 11.—The outputs of units 9 and 10 are fed to one of the three final converters (units 11A, 11B, and 11C), only one of which is used at a time. The output frequency desired determines which of the three converters will be used. The chosen unit is connected to the outputs of unit 9 and unit 10, and to the radio-frequency oscillator mounting (unit 14) by the bandswitch. Unit 11A is used for frequencies between 0.3 and 6 mc, unit 11B for the 6- to 16-mc range, and unit 11C for outputs of 16 to 26 mc.

UNIT 14.—The mounting (unit 14) serves as a rack into which the other units of the radio-frequency oscillator are connected. Unit 14, in turn, plugs into the transmitter group cabinet wiring. The control indicator, which mounts on the unit 14 front panel contains controls for antenna tuning and an indicator for measuring the standing wave ratio existing on the r-f transmission line.

Radio-Frequency Amplifier

The radio-frequency amplifier accepts from the radio-frequency oscillator a signal in the frequency range from 0.3 to 26 mc. The radio-frequency amplifier consists of three stages: the buffer, the intermediate power amplifier (IPA), and the power amplifier (PA). The signals from the radio-frequency oscillator are received at a level of approximately 0.1 watt, and amplified to either 100 or 500 watts. During 100-watt operation, the radio-frequency

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amplifier amplifies all frequencies in the 0.3- to 26-mc range. In 500-watt operation, only signals within the range from 2 to 26 mc are amplified in the radio-frequency amplifier. Selection of a frequency between 0.3 and 2 mc during 500-watt operation automatically switches the output to the 100-watt level.

The RFA output may be either modulated by audio from the low-level radio modulator or high-level radio modulator, or it may be keyed on and off by keying voltages from the low-level radio modulator. During frequency-shift keying and facsimile operation, the r-f signal from the RFA is frequency modulated in the radio-frequency oscillator.

The tuning of the RFA is accomplished manually by three controls: the bandswitch, the tune IPA Control, and the tune PA control. To enable the RFA to tune through the entire range from 0.3 to 26 mc, the total range of frequencies has been grouped into six bands.

The function of the buffer stage is to isolate the RFO from the effects of a varying load caused by keying signals received by the RFA from the low-level radio modulator (LLRM).

Low-Level Radio Modulator (LLRM)

The LLRM (fig. 5-4) accepts voice, telegraphy (hand or machine keyed), or facsimile signals from the external circuits and amplifies and shapes them as required to modulate the carrier. A serivce selector switch is provided for manual selection of the mode of operation. The unit contains audio amplifying and modulating circuits for the modulation of the carrier at the 100-watt level. During 500-watt operation, the low-level radio modulator feeds a high-level radio modulator, which boosts the audio signal to the required level. Either a carbon or dynamic microphone may be used to apply voice signals to the input.

The term "low-level," as used in the unit title, implies that this particular modulator is used as the modulating source for the RFA during the 100-watt operation. Among the circuits contained in the low-level radio modulator are an audio amplifier chain, a squelch circuit, the automatic gain circuit, a keying multivibrator, and circuits that control the on-off condition of the transmitter.

AUDIO INPUT.—The audio input signal to the LLRM is received locally through a handset or microphone jack. This signal is coupled to the local-remote switch, S1, in the local position. If the input is from a carbon microphone, -12 volts will be supplied. With dynamic microphone input, the -12 volts is disconnected. When the audio input is applied, it is impressed across a transformer (through contacts of the local-remote switch, S1) to a voltage divider.

To compensate for the lower signal amplitude from the dynamic microphone, the voltage divider output is taken from a higher voltage tap by means of a dynamic-carbon switch (not shown).

The audio signal is fed to a two-stage audio preamplifier consisting of V1 and V2A. The output of V2A feeds a cathode follower, V2B, whose function is to match the impedance between the preamplifier stage and the clipper stage, which follows. The cathode follower output is also fed to the automatic gain control (AGC) circuit. The latter circuit provides a negative voltage (under strong signal conditions) to the V1 grid, causing this stage to have a constant output level over a large range of input signal amplitudes.

By applying the audio signal input to the suppressor grid of V1 and the AGC voltage to the control grid, less AGC voltage is required to produce a highly sensitive AGC circuit. This represents an improvement over the conventional system of AGC in which both signals are applied to the control grid. In the conventional method, more AGC voltage is required to produce the desired effect.

AUTOMATIC GAIN CONTROL (AGC).—The cathode of the AGC rectifier, V6A, is approximately +20 volts (no signal) and the plate voltage is +12 volts. Therefore, when a positive peak of the audio signal exceeds 8 volts (with respect to the no-signal voltage) the AGC rectifier V6A, will conduct, and any additional peak signal voltage will be developed across a capacitor.

The resulting signal, which approaches a d-c voltage is fed through the AGC switch in the ON position to the control grid of V1. The polarity and magnitude of this voltage increases the bias on V1, thereby decreasing its gain. The higher the signal appearing across the output of the cathode follower, the larger will be the negative bias built up. The gain of V1 is controlled by the AGC rectifier so that a 30-db range of input will cause less than a 10-db range of output.

CLIPPER STAGE.—Limiting of the audio signal amplitude to prevent overmodulation of

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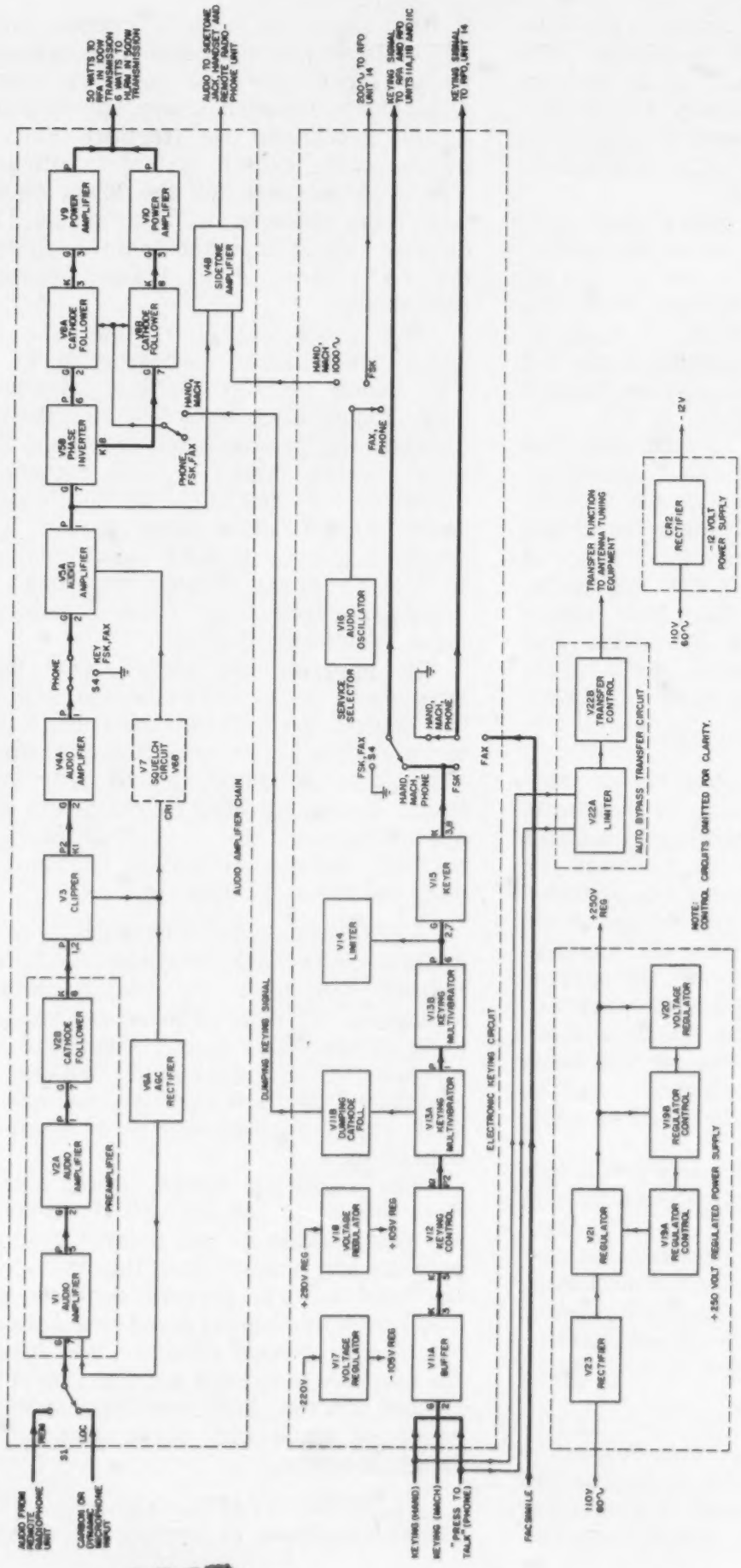

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Figure 5-4.—Low-level radio modulator, block diagram.

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the carrier is accomplished in V3, a twin diode clipper. A potentiometer designated CLIPPER SYMMETRY may be adjusted so that the positive and negative peaks of the audio signal are clipped at the same level. The clipper output is coupled to the audio amplifier, V4A.

AUDIO AMPLIFIER.—V4A receives the output of the clipper, amplifies the signal, and couples this signal to the bandpass filter network, Z1 (not shown). The filter is designed to pass frequencies in the range from 200 to 4500 cycles and assist in cutting out high-frequency harmonics of the audio signal introduced by the clipper action in the previous stage. The circuit also eliminates noise frequencies outside the pass band of the filter.

With the service selector switch, S4, in any position other than phone, the output of V4A will be grounded. The service selection switch, S4, is divided into front and rear sections. The front section is designated F on the switch contacts, and the rear section, R. In phone operation, the keying relay is energized by depressing the press-to-talk button. This action removes the ground on the handset. The signal then passes to the input of V5A.

In addition to the audio signal being coupled to the grid of V5A, there is a negative bias applied from the squelch circuit, V7 and V6B, which is sufficient to cut off V5A if the level of the audio is not high enough. The output of V5A is coupled to the phase inverter, V5B, and to the sidetone amplifier.

SQUELCH AND SQUELCH RECTIFIER CIRCUITS.—A squelch circuit is provided to prevent the transmission of noise in the absence of an audio input signal (when the press-to-talk button is depressed). The squelch circuit prevents amplification by biasing the V5A grid beyond cutoff. The squelch circuit consists of a one-shot multivibrator, V7, a crystal rectifier, CR1, and a limiter, V6B. The audio signal coupled to the grid of V7A must be large enough to overcome the grid-to-cathode bias to effect the operation of the squelch multivibrator. The multivibrator output pulses are coupled to the squelch rectifier, CR1. The output of CR1 is filtered and applied to the V5A grid. This action raises the grid potential of V5A above cutoff, allowing it to amplify the audio signals being received from V4A.

The time constant of the filter circuit is sufficiently long to allow the bias voltage to be essentially constant and at a level needed to keep the tube operating in the linear portion of its characteristic curve.

The diode limiter, V6B, acts to prevent the application of a positive potential to the V5A grid. If the positive pulses from the multivibrator are of high enough amplitude to make the resultant voltage applied to V5A grid positive with respect to ground, the plate of V6B becomes more positive than its cathode. The diode therefore conducts heavily, limiting the voltage applied to the grid of V5B to a maximum of zero volts with respect to ground. Peak positive voltages above the ground level are developed across resistor R29, which is in the plate current path of V6B.

THE SIDETONE AMPLIFIER.—The output of the audio amplifier, V5A, is monitored by the sidetone amplifier, V4B.

The output of the sidetone amplifier, V4B, is coupled by an output transformer to three monitoring points: the handset receptacle, the sidetone jack, and the remote radiophone unit.

A 1000-cps signal from the audio oscillator, V16, is applied to the grid of V4B in hand-key or machine-key operation during the key down (mark) condition for monitoring purposes.

AUDIO OUTPUT CIRCUIT.—The output signals of V5A are fed to the phase inverter, V5B, which produces two signals of equal amplitude, but of opposite phase. These two signals are coupled to a push-pull cathode follower, V8, which acts as a driver for the push-pull power amplifiers, V9 and V10, that constitute the final stage of amplification of the audio amplifier chain. In the AN/SRT-14, the final audio output (50 watts) is fed directly to the radio-frequency amplifier. It should be recalled that the AN/SRT-15 and 16 provide two levels of audio output, depending on the power level at which the transmitter is operating. For 500-watt operation, the output (6 watts) of the LLRM is fed to the HLRM.

PHASE INVERTER.—The circuit components of the phase inverter, V5B, are such that two waveforms, equal in amplitude but opposite in phase, will be developed at the output. The waveforms are taken from the cathode and plate, respectively.

PUSH-PULL CATHODE FOLLOWERS.—V8A and V8B (push-pull cathode followers) act as

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drivers for the push-pull power amplifiers, V9 and V10. Since the power amplifier stage is operated class AB2, the cathode followers V8A and V8B are required to supply energy to a low input impedance during the portion of the cycle when grid current flows in V9 and V10.

The audio amplifier chain is not required to amplify audio signals during hand-key and machine-key operation. Therefore, the cathode followers and power amplifiers perform a different function during these two modes of operation. The fact that the power amplifiers use +500 volts for a plate supply is utilized to provide a dumping (loading) circuit to eliminate transient voltage variations imposed on the power source when the transmitter is keyed. The dumping control is fed to the grids of the cathode followers, V8A and V8B, when in either the HAND or MACHINE position.

The +500-volt power supply provides plate voltage for the IPA and the screen voltage (during 500-watt operation) to the PA in the radio-frequency amplifier. In space condition the RFA is keyed off, and IPA plate current and PA screen current are at minimum, while in mark, they are at maximum. If these sudden changes in load current drawn from the 500-volt supply are not modified, transient voltages will appear across the power supply filter chokes.

At the start of a mark condition, the polarity of the transient voltage in the power supply filter will be such as to oppose the sudden rise in current, thus causing a dip to appear in the power supply output voltage. Conversely, at the start of a space condition, the transient voltage will be aiding, opposing the sudden decrease in current, thus increasing the supply output voltage.

The function of the dumping circuit is to provide a load during space condition only, to compensate for the reduction in load current when the IPA is keyed off. Thus, the load to the 500-volt supply will be approximately equal during mark and space due to this elimination of transient variations. The method employed to keep the power supply current from decreasing during a space is to supply a keying voltage from the keying circuit of -65 volts during mark and zero volts during space to the grids of the push-pull cathode followers. This voltage is obtained from the cathode of the dumping cathode follower, V11B. The input to the cathode followers is reproduced at the cathodes, which are directly tied to the grids of the power amplifiers.

POWER AMPLIFIERS.—The no-signal grid bias of the power amplifiers, V9 and V10, applied by way of the V8 cathode followers is approximately -40 volts. With a screen voltage of + 30 volts and a plate supply of + 500 volts, the value of bias is such that the stage operates as a class AB2 push-pull amplifier. Operation at this level allows high-power outputs with high plate efficiency and low distortion.

The modulation transformer is provided with two secondaries. The 50-watt secondary is used only during 100-watt operation of the transmitter, and the 6-watt secondary is used during 500-watt operation.

The AN/SRT-14 operates at the 100-watt level only and is not controlled by the 500-watt disable line because of the absence of the high-voltage power supply. With the AN/SRT-15 and 16 in 500-watt operation the circuit of the 6-watt secondary is completed through the high voltage supply.

KEYING CIRCUIT.—In hand-key operation the keying circuit accepts keying signals that determine the on-off condition of the carrier. In machine-key operation, keying signals are sent to the keying circuit from a teletypewriter or other keying equipment which also controls the on-off condition of the carrier. In both hand-key and machine-key operation an audio oscillator, V16, produces an audio signal for aural monitoring of the keying signal. In FSK operation, keying signals are received by the keying circuit from machine-key equipment, and signals are produced that control the operation of the frequency-shift oscillater in the RFO. Signals are received from an audio oscillator, which phase-modulate the carrier to minimize the effects of selective fading. In phone operation, audio signals are fed to the audio circuits when the press-to-talk button on the microphone is depressed, which also keys the carrier on and off.

The keying circuit of the LLRM consists of the keying and press-to-talk relay buffer, V11A; keying and control, V12; keying multivibrator, V13; dumping cathode follower, V11B; limiter, V14; keyer, V15; and audio oscillator, V16. The outputs of the keying circuit and their functions are listed in table 5-1.

Power Supply in LLRM(+250 V)

The power supply contained in the LLRM provides a regulated + 250 volts, which is used

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Table 5-1.—Functions of Keying Circuits Outputs

Output	Delivered to	Function
RF keying signal	Buffer in RFA and output of RFO	To key the carrier
FSK keying signal	FS oscillator in RFO	Control frequency of FSO
Keying signals to circuit	LLRM	Load compensation for + 500-volt power supply
200-cycle signal	FS oscillator in RFO	Phase-modulate the FSO
1000-cycle signal	Sidetone amplifier in LLRM	Monitoring of keying signals

in the criticial keying and audio circuits of the LLRM and RFO. The power supply consists of rectifier V22, regulator control tube V19, and and voltage regulator V20. The a-c power is supplied from the low-voltage power supply through the main power switch. The circuits contained in this power supply are generally the same as those considered in Basic Electronics, NavPers 10087 (revised).

-12 VOLT POWER SUPPLY.—A metallic bridge rectifier, CR2, is used in the -12-volt power supply and is connected so as to yield a negative output. The rectifier receives a 16.5-volt rms signal from an input transformer. The -12-volt output is filtered and supplied to the dynamic-carbon switch for use as operating voltage for the carbon microphone. The output is also fed to the remote radiophone unit where it serves as the operating voltage for a carrier-on idicator, the control relay, and the carbon microphone.

High-Level Radio Modulator

During phone operation at the 500-watt level, an audio signal of 250 watts is required to amplitude-modulate the plate of the RFA power amplifier. This is accomplished by feeding a 6-watt signal from the LLRM to the HLRM (fig. 5-5) where it is amplified to the required level. During hand-key, machine-key, FSK, and FAX operation, the plate voltage for the RFA power amplifier is routed through the HLRM. In the AN/SRT-16 the output of the HLRM is fed to the RFA in one transmitter group only. This means that only one transmitter group may operate at the 500-watt level. The AN/SRT-15, which has only one transmitter group, may employ the HLRM in 500-watt phone operation. The HLRM is not used with the AN/SRT-14 because this transmitter operates at the 100-watt level only.

PUSH-PULL AMPLIFIERS.—During 500-watt operation, the audio modulating signal from the LLRM is fed to the control grids of the push-pull amplifiers, V1 and V2 in the HLRM (fig. 5-5). The signals are equal in amplitude but 180° out of phase, making possible the push-pull amplification. The amplified signals are applied across the output modulation transformer, T1. Plate voltage (+2400 volts during phone) is delivered to the center tap of the transformer primary. The GROUND FOR 500-w PHONE line is supplied from the medium voltage power supply to relay K1. If the -24v after standby line is activated, K1 energizes. This action supplies the screen grids of V1 and V2 with a +360-volt potential. The potential is applied through contacts 2L and 3L of the now energized K1.

R1 is a dropping resistor for the + 350-v screen indicator, I1, which indicates the HLRM screen supply is present. In phone operation the -24-v after standby line is energized by the press-to-talk button such that it controls the operation of K2 and the application of the screen voltage to the HLRM.

In phone operation, +2400 volts from the HVPS is applied to the plates of the power amplifiers in the RFA through T1 in the HLRM. The 250-watt audio signal, which also appears across this transformer, is applied to the PA plates. Protection against excessively high voltage across the secondary of T1 is provided by spark gap E1. In other than phone operation at the 500-watt level, +3000 volts is applied directly to the PA plates through the shorting contacts 4 and 5 of relay K2 in the HLRM. The shorting action takes place in the deenergized condition of the relay. K2 becomes energized through contacts 3R and 4R of energized relay K1. The latter relay energizes when the press-to-talk button is depressed, activating the -24v-after standby line. When K2 energizes and removes the short across the secondary of T1, the transformer is placed in series with the high voltage supplied from the HVPS.

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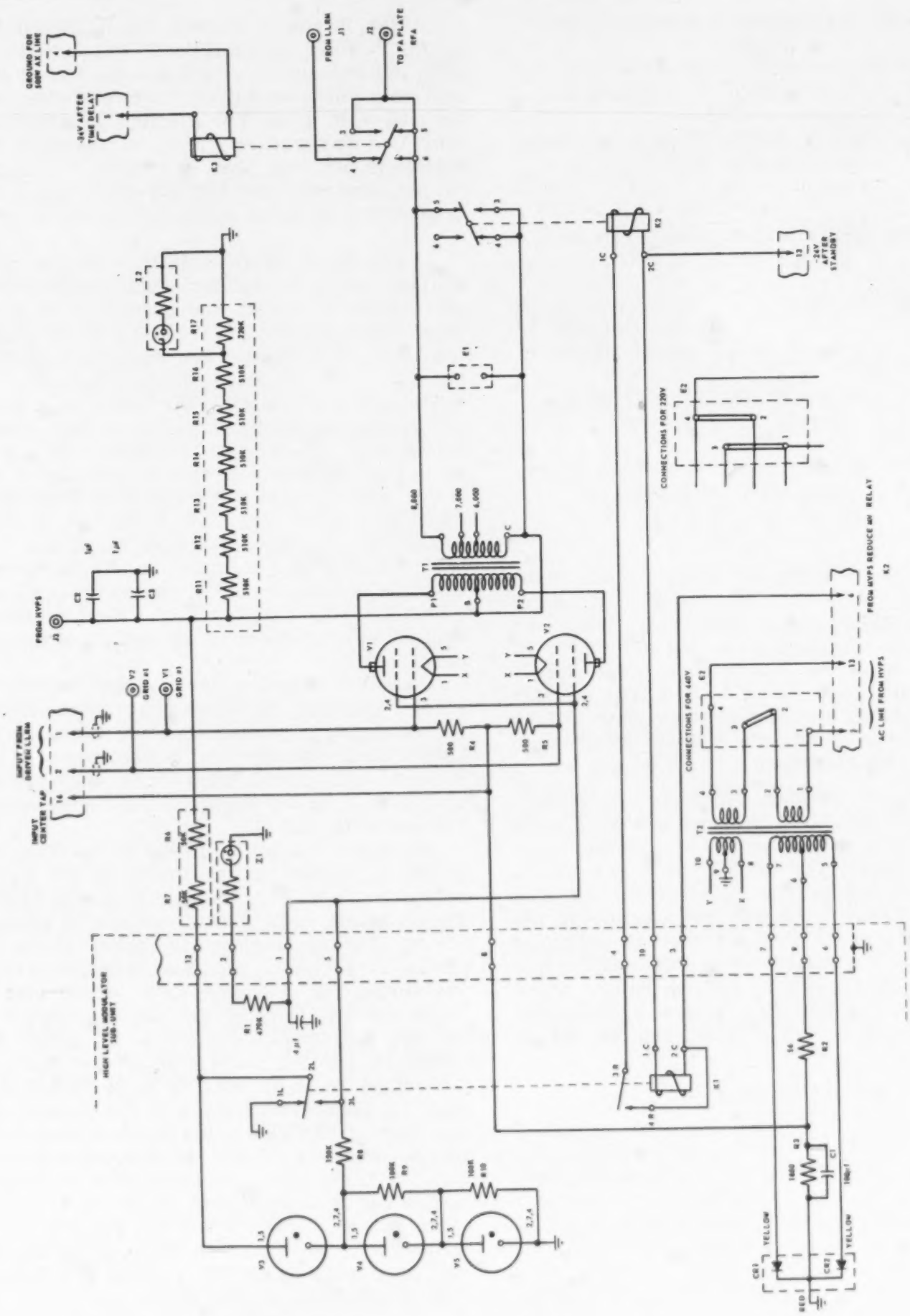

Figure 5-5.—High-level radio modulator, simplified schematic.

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When the transmitter is operated at the 100-watt level, the GROUND FOR 500-W AX line is open and K3 is not energized. Therefore, the LLRM connected to J1 passes its output through contacts 4 and 5 of K3 and to J2, which connects to the power amplifier plates in the RFA. In 500-watt operation, the GROUND FOR 500W AX line is completed, and K3 is energized after the time delay. This action applies the output of the HLRM to the power amplifiers through contacts 6 and 3 of energized relay K3. In the AN/SRT-16, the output of the HLRM to the PA plates occurs in one transmitter group only. In the other group, the plate potential and the modulating voltage is received from the LLRM directly. As the output of the HLRM is a permanent interconnection, the transmitter group to which this output is fed in the AN/SRT-16 will be the group that can be placed in 500-watt operation.

In order to generate a bias voltage to operate the audio amplifiers at the desired class AB2 point on its characteristic curve, a -50 volt bias source is included in the HLRM.

Power Supplies

There are three separate power supplies other than the one previously discussed; low-voltage power supply, medium-voltage power supply, and the high-voltage power supply.

LOW-VOLTAGE POWER SUPPLY.—The LVPS receives 110 volt a-c from the ship's supply and distributes this power to other units. It contains rectifier circuits that provide B+ voltage of +300 volts, +250 volts, -24 volts for control circuits and motor lines, and -220 volts for bias.

MEDIUM-VOLTAGE POWER SUPPLY.—The MVPS receives 110 volts from the low-voltage power source, and supplies +500 volts and +1300 volts, respectively. The +500 volts is applied to the low-level radio modulator and the radio-frequency amplifier. During phone operation, the +1300 volts is reduced to +1050 volts and applied to the radio-frequency amplifier. The medium-voltage power supply contains a relay, which ensures that the 500-volt source is activated before the 300-volt source in the low-voltage power supply comes on. This action is necessary since the 300 volt-source is primarily a screen voltage supply and will cause damage to the tubes it serves if plate voltage has not been applied.

HIGH-VOLTAGE POWER SUPPLY.—The HVPS used only in the AN/SRT-15 and 16 during 500-watt operation is provided with a separate input of 220 volt, or 440 volt, three-phase, 60-cycle a-c from the ship's supply. This circuit has a d-c output of +3000 volts that replaces the 1300-volt output of the medium-voltage power supply during 500-watt operation. During phone operation, the 3000 volts is reduced to +2400 volts.

RADIO TRANSMITTING SET AN/WRT-2

Radio Transmitting Set AN/WRT-2, is capable of delivering an average power output of 500 watts and a peak envelope power (PEP) of 1000 watts in 1—kc steps (or continuously) over a frequency range of 2.0 to 30.0 megacycles. The set provides for emission of machine (MACH) or break-in (C-W) hand-keyed telegraphy, frequency-shift-keyed (FSK) teletype, compatible amplitude-modulated speech, single sideband suppressed carrier (SSB), independent sideband (ISB), and facsimile by using appropriate terminal equipment. The AN/WRT-2 may be installed aboard ships, submarines, and at shore stations. The major components of the set (fig. 5-6) are the transmitter group, (radio-frequency amplifier, radio-frequency oscillator, electrical frequency control, amplifier power supply, and power supply) and the radio frequency tuner.

The radio transmitter group contains all of the equipment required for transmission by machine or break-in c-w, independent sideband (ISB), single sideband (SSB), a-m phone, and/or frequency-shift-keying (FSK), except such accessories as the key (machine or hand), antenna, and remote operating components. Facsimile transmission requires additional terminal equipment.

The transmitter may be operated from a three-phase, 60 cps ship's supply of 115 v, 220 v, or 440 volts. The transmitter group is coupled to an antenna (not shown) through a radio-frequency tuner and associated antenna control circuits.

Provision is made for a total of six audio inputs. Front panel handset jacks are furnished for local phone operation of the equipment with a handset. Remote phone- and/or hand-key operation is also possible.

Provision is made for interconnections to teletype and telegraphy equipment and to a

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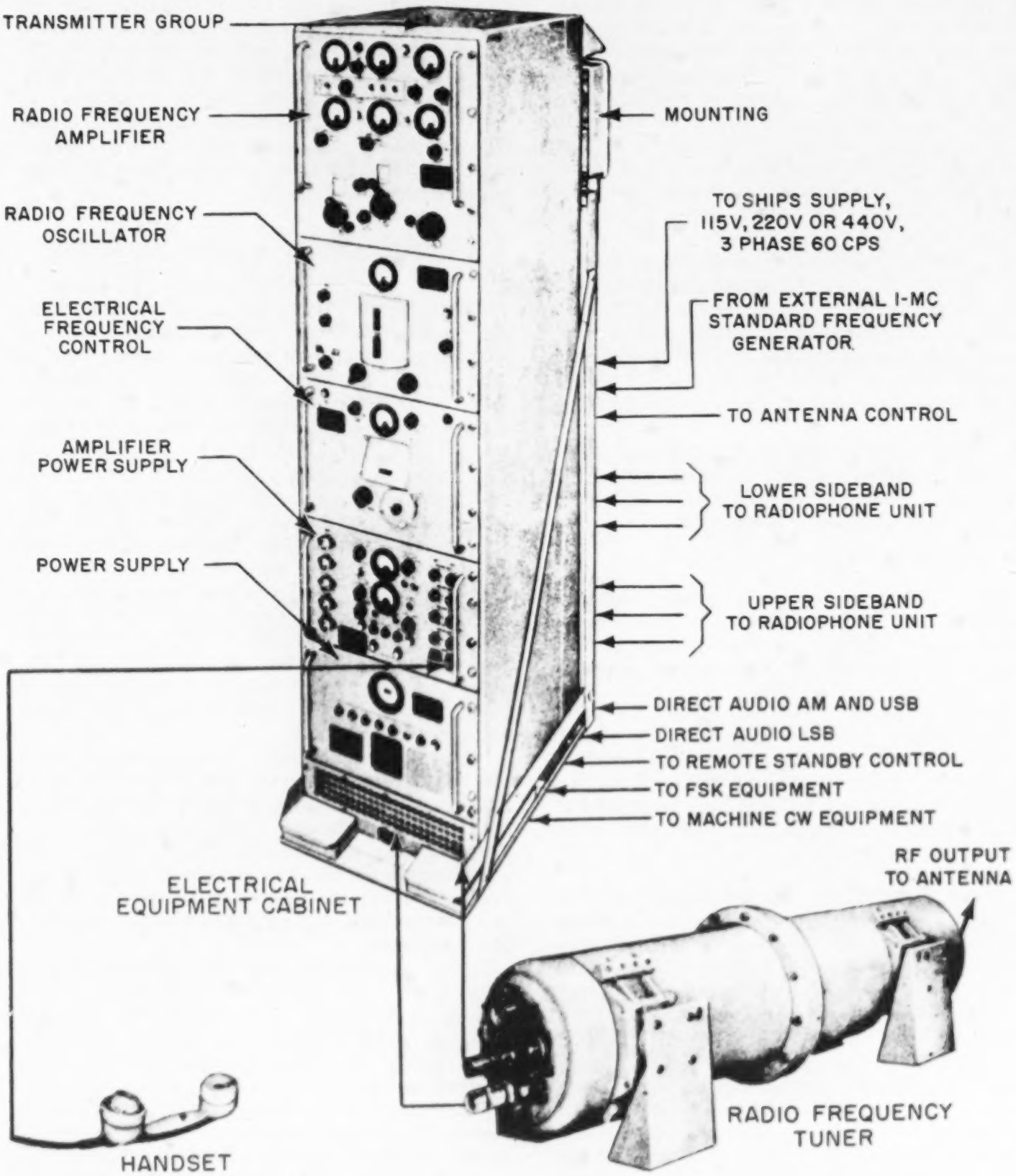

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Figure 5-6. Radio Transmitting Set AN/WRT-2, relationship of units.

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remote transmitter standy control. An internal dummy load is provided for transmitter tuneup.

OVERALL BLOCK DIAGRAM

The AN/WRT-2 consists of the following functional sections: r-f generating, power amplifier, modulating, primary power, and low-voltage power supply, as shown in figure 5-7.

The r-f generating section produces the r-f signal in conventional master oscillator-frequency multiplier circuits and applies it to the power amplifier. The master oscillator is slaved to the assigned operating frequency by a unique frequency control circuit treated in detail later in this chapter.

The power amplifier section raises the r-f signal input power from the r-f generating section to the desired operating power level. The output of the power amplifier is fed to the antenna via the r-f tuner circuits.

The modulating section accepts audio signals or d-c keying signals (for C-W or FSK operation) and suitably transforms these signals to modulate or control the r-f energy generated by the r-f generating section. The output of the modulating section is applied to the input mixer in the power amplifier section.

The low voltage section contains all the circuits which supply low d-c voltages to the transmitting set. The high voltage supply is a separate section and supplies the plate voltage for the power amplifier tubes.

The primary power section supplies all a-c voltages for the transmitting set. The transformers in the primary power section have taps to provide input voltages of 115 v, 220 v, and 440 v at 60 cps.

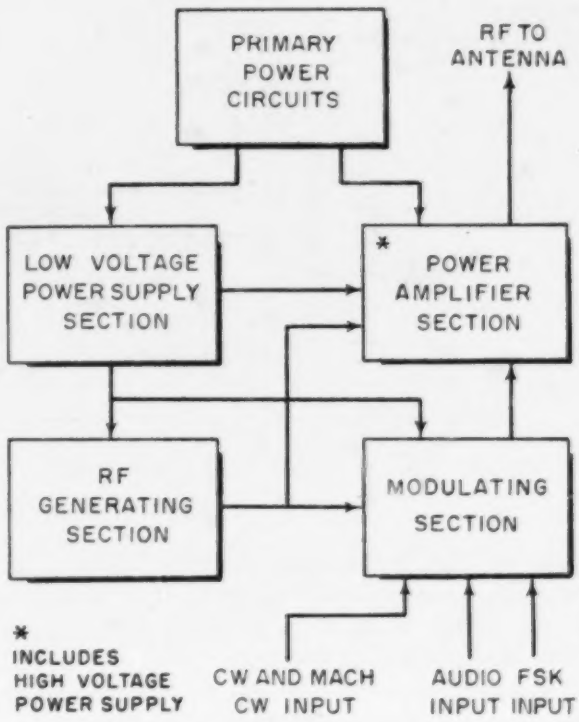

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Figure 5-7. Overall block diagram

R-F Generating Section

The complete frequency coverage of Transmitting Set AN/WRT-2 is accomplished in 12 bands. The master oscillator, V301 (fig. 5-8), which is located in the radio-frequency oscillator chassis, generates r-f signals from 1.5 mc to 7.5 mc. These signals are amplified by V302. For bands 1 through 6, the fundamental frequencies (1.5 to 7.5 mc) of the master oscillator are fed directly to the power amplifier section through S302. For bands 7 through 9, the fundamental frequencies of bands 4 through 6 (3.75 to 6.75 mc) are doubled by the first doubler, V303, and fed through S302 to the power amplifier section. For bands 10 through 12, the fundamental frequencies of bands 4 through 6 are multiplied four times by the action of the first and second doublers, V303 and V304, before being applied to the power amplifier section.

In addition to supplying the power amplifier section input, the S302 output is also fed to the electrical frequency control circuit (fig. 5-9). This circuit supplies a frequency-correction voltage to the master oscillator, V301, which keeps the oscillator operating at the selected frequency with the stability of 1 part in 10^8 cps.

The control of the master oscillator frequency is accomplished by two independent operations. First, the output of the master oscillator (via amplifier V302 and the frequency doublers) is compared with that of an interpolation oscillator in a master oscillator phase detector. Any difference between these two frequencies causes a correction voltage to be applied to the master oscillator (MO), and thereby forces the oscillator to return to the proper operating frequency.

Second, when operating in 1 kc steps, the interpolation oscillator is frequency stabilized in order to provide improved accuracy in correcting the master oscillator frequency. The

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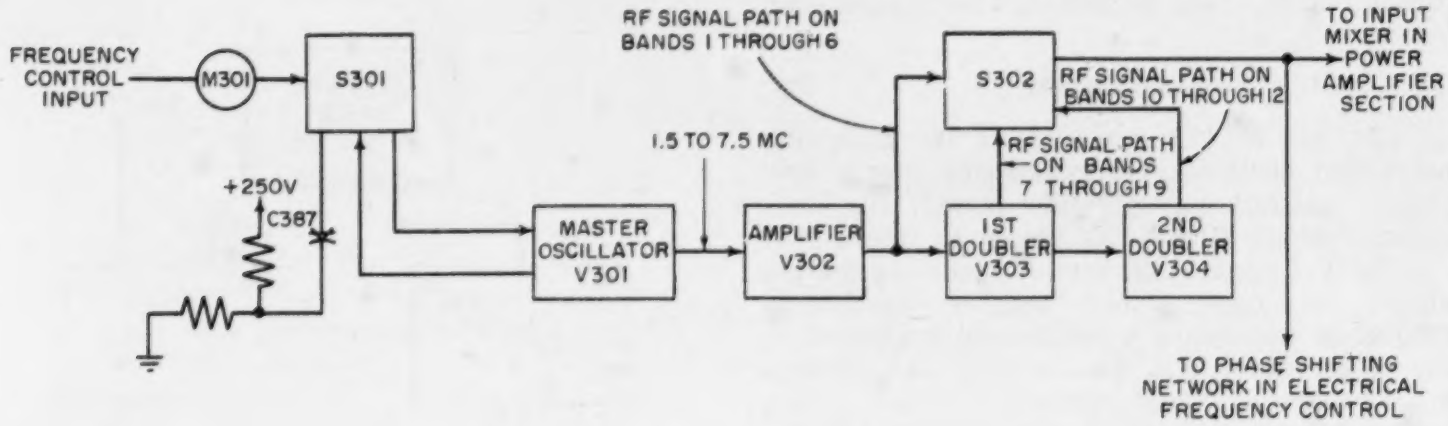

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Figure 5-8—Radio-frequency oscillator.

control of the interpolation oscillator (IO) involves the locking-in of this circuit to multiples of 1 kc. This action is accomplished by comparing the output of the interpolation oscillator with a 1-kc crystal stabilized reference signal to develop an interpolation oscillator correction voltage. The correction voltage is applied to the interpolation oscillator and holds it at the required frequency. Thus, the controlled stability of the IO results in an added stability of the MO.

The front panel of the radio-frequency oscillator and electrical frequency control chassis showing the indicators and controls is shown in figure 5-10. A more detailed block diagram of the electrical frequency control circuit is shown in figure 5-11.

The r-f input from the radio-frequency oscillator circuit (fig. 5-8) is applied to the frequency control circuits through a phase-shift network consisting of FL603 (fig. 5-11). Sealed unit FL603 contains two independent-phase-shift networks. The networks are so designed that the signal coupled to the top balanced mixer always leads the signal coupled to the bottom mixer by 90°. The outputs of the phase-shift network (FL603) are therefore sine and cosine functions of the r-f signal.

A second input to the mixers is received from the 1-mc oscillator and divider circuits from T608.

Crystal Oscillator (1 mc)

The 1-mc crystal oscillator (Q1301 and Q1302) is used as a frequency standard to provide maximum frequency stability of 1 part in 10^8. The crystal operates in a precisely controlled constant-temperature oven (not shown). The 1-mc output is amplified by 1-mc amplifiers Q1303 and Q1304 and applied to a 10:1 frequency divider circuit consisting of transistors Q1305 through Q1308, and Q1313 through Q1316. The first stage of the divider circuits divides the 1-mc frequency in half. This 500-kc signal is applied to the 500-kc selector in the modulator section, the 1-mc phase detector, and to the rest of the 10:1 divider circuits. The final output of the frequency divider is a 100-kc signal.

The 100-kc signal is amplified by 100-kc amplifier Q1317 and buffer amplifier V605 and applied to T608. The signal appearing at terminal T3, of T608 is coupled to saturable core reactor L614 where a harmonic-rich peaked waveform is produced. The 100-kc signal and its harmonics are applied to the balanced mixer stages where, due to the simultaneous application of the master oscillator signal, sum and difference frequency components of the two applied signals are produced. The sum and difference frequencies (upper and lower sidebands) contain the r-f oscillator error frequency component.

Sideband Generating Method

The phase-shift method of generating sideband (sum and difference) frequencies is employed. The r-f input signal is shifted 90° in phase by FL603 and applied to the balanced mixers as previously discussed. The mixers are connected in a push-pull circuit arrangement. The combined action of the mixers and

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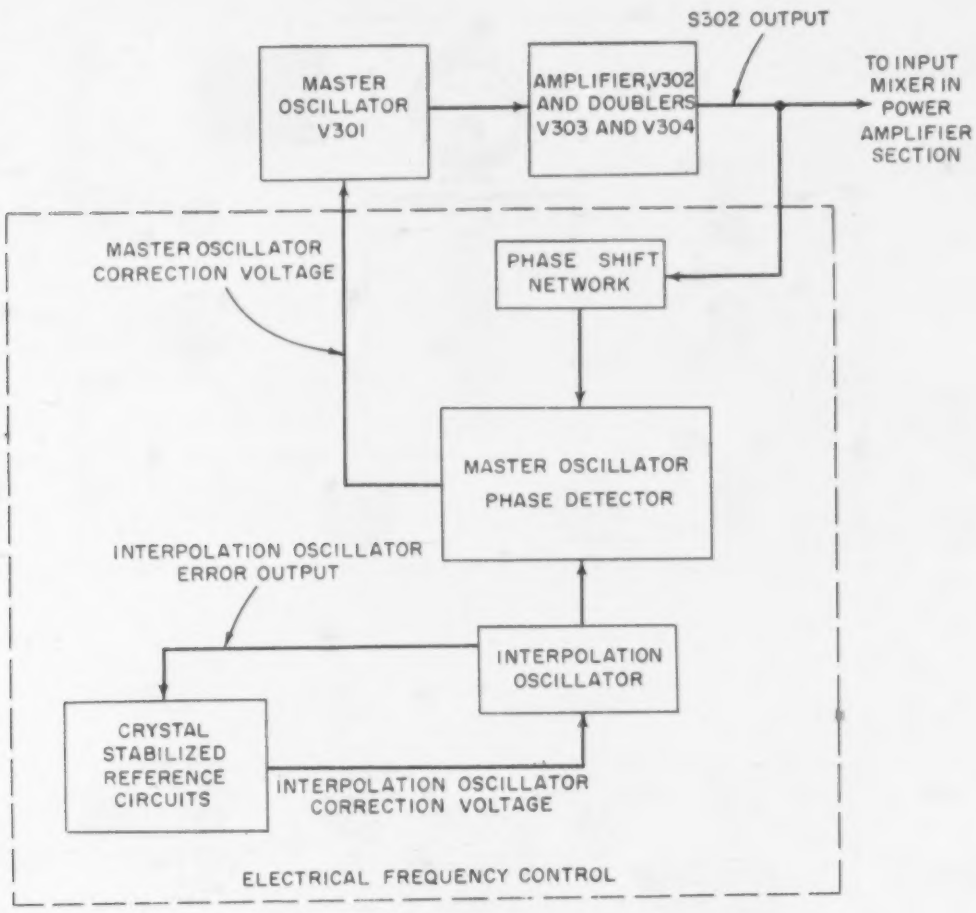

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Figure 5-9.—Electrical frequency control circuit, simplified block diagram.

phase shift networks FL1 and FL2 (at the mixer outputs) assure that the desired sideband frequencies are added and the other sideband frequencies are canceled in the output. This action produces only one of the sidebands at the grid of i-f amplifier V601A, and the need for narrow band filters is eliminated.

For example, a master oscillator (MO) frequency of 2460 kc is heterodyned with 2400- and 2500-kc harmonics of the L614 output to produce 2460 - 2400 or 60-kc, and 2500 -2460 or 40-kc sidebands in each of two mixers. The 40-kc sidebands are shifted 180°, and cancel at the output of the FL1 and FL2. The 60-kc sidebands are brought into phase (0°), and the amplitudes add at the V601A grid.

When the MO frequency is 2440 kc there are 2500 -2440 or 60-kc, and 2440 - 2400 or 40-kc sidebands produced. In this example, the 60-kc and 40-kc phase relations in the two mixers are reversed from their original relation. For the two 60-kc sidebands the reversal is due to the fact that in the first example the 2460-kc MO frequency is above the 2400-kc harmonic and in the second example the 2440-kc MO frequency is below the 2500-kc harmonic. Thus the 40-kc sidebands are shifted to cancel and the 60-kc sidebands are shifted to add.

The acceptable sideband signal is then passed through five cascaded amplifiers, V601A, V601B, V602A, V602B, and V603A. A band-pass filter (not shown) between the first and second i-f amplifiers limits the response of the i-f amplifier strip to the frequency range of 50 to 100 kc. The plate output of the fifth i-f amplifier, V603A, is applied to the master oscillator-phase detector (MOPD). The cathode output of V603A is applied to the 100-kc phase detector for purposes described later.

The selected sideband signal is heterodyned in the master oscillator-phase detector with a signal input from the interpolation oscillator (IO) to produce the master oscillator error voltage. For comparison with the interpolation oscillator output, the range of which is 50 to 100 kc in 5 bands, the sideband frequencies

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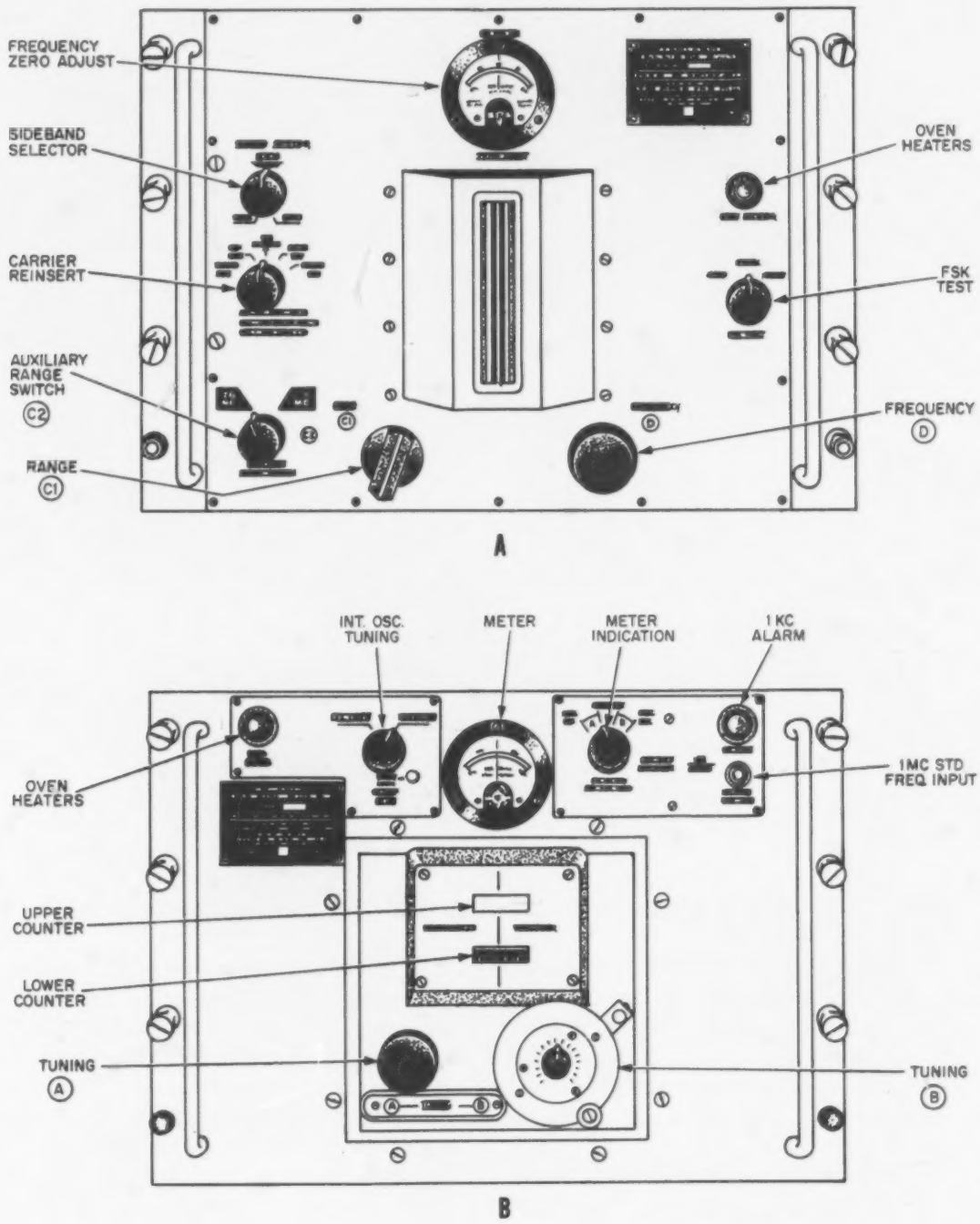

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Figure 5-10.—Pictorial diagrams AN/WRT-2. A. Radio frequency oscillator. B. Electrical frequency control (front panels).

generated at the balanced mixers must be limited to the range of 50 to 100 kc. Therefore, when the last 10-kc digits of the sideband frequency are in the range of 0 to 50 kc, the output of one of the balanced mixers is reversed by mechanical means and the sideband phase relationships are maintained as in the first example. A relay (not shown) which is energized by the IO tuning A control, located on the electrical frequency control (fig. 5-10, B), controls the output switching when the last 10-kc digits of the sideband frequency are less than 50 kc.

Master Oscillator-Phase Detector

The master oscillator -phase detector (MOPD) provides a d-c correction voltage

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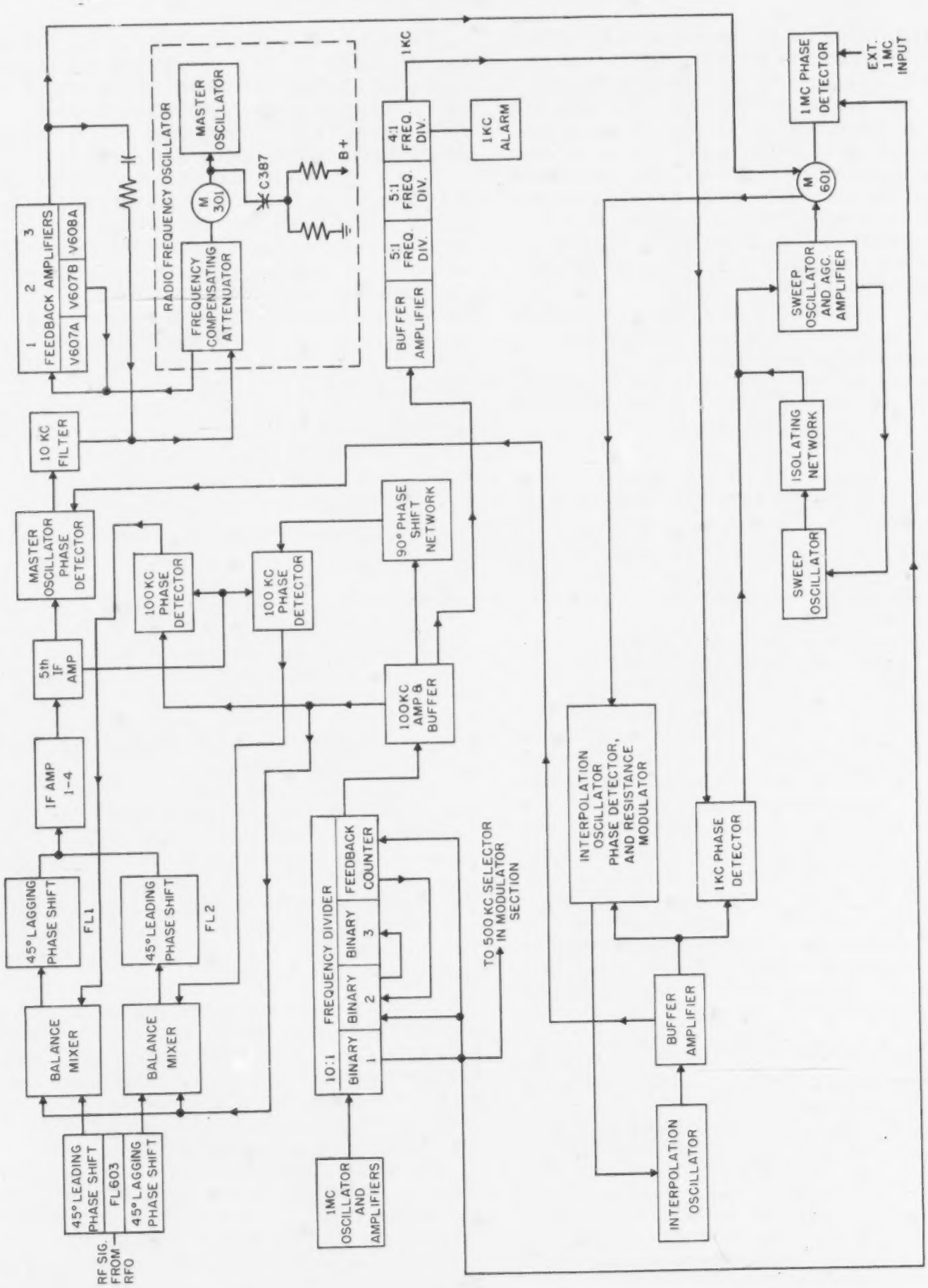

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Figure 5-11.—Electrical frequency control, detailed block diagram.

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stabilizing signal for the master oscillator (MO) when the oscillator is not operating at the proper frequency. The polarity depends upon the direction of the error and the amplitude upon the amount of error. The MOPD (fig. 5-12) consists of crystal diodes CR606 through CR609, current limiting resistors R653 through R656, and transformers T604 and T605. The i-f signal from the fifth i-f amplifier V603A is applied (via T604) to the junction of crystal diodes CR606-CR607, and CR608-CR609. The signal from the interpolation oscillator (IO) is applied to the T605 secondary which is connected between points B and D of the circuit. The MOPD output is a d-c correction voltage developed across C652.

When the MO is locked on frequency, the i-f signal is 90° out of phase with the IO signal (i-f signal leading) and no correction voltage is fed back to the MO circuit.

Let us assume that the amplitudes of both the i-f and IO signals (fig. 5-12) are 2.0 volts peak-to-peak. The polarities shown on the bridge (fig. 5-12) are for the first quarter-cycle of the waveforms. The waveforms represent the voltage variations to ground at the four corners of the bridge.

The IO signal is used as a reference frequency. Figure 5-13 illustrates the relative phase of the IO and i-f signals for zero error (i-f leading the IO by 90°), lagging error (i-f leading the IO by 45°) and leading error (i-f leading the IO by 135°). Also shown is the conducting period for each diode (CR606 through CR609) for one complete cycle.

Phase error is generally limited to a few degrees or even a fraction of a degree. In most cases, large errors exist only when the equipment is first turned on or when the circuit is not properly aligned. A large error (45°) is assumed here because it lends itself better for a simple circuit analysis.

When the i-f leads the IO by exactly 90° (the zero error condition), the phase detector will not produce a d-c correction voltage output across C652. Instead, an a-c voltage is produced. The manner by which this voltage is produced is indicated in figure 5-14, A.

At t = 0°. the i-f voltage is positive maximum and the IO voltage is zero. Diodes CR607 and CR609 are conducting as shown by the arrows representing electron flow. Tracing around path FCDGF, the voltage from F to C is equal and opposed to the drop from C to D, so that there is no charge accumulated on C652 (C652 is relatively large).

Likewise, at t = 45° (fig. 5-14, A) the arrows and polarities indicate the applied voltage and conducting diodes. The series aiding voltages in the lower half of the T604 secondary and the right half of the T605 secondary cause a current which charges C652 negative to ground.

At 90° (fig. 5-13) the i-f voltage is zero and the IO voltage is positive maximum. Diodes CR609 and CR608 are conducting; and again there is zero voltage across C652. Note when either the i-f voltage or the IO voltage is zero, the output voltage is zero. At 135° (fig. 5-14, A), the series aiding voltages in the lower half of the T604 and left half of the T605 secondaries cause a current flow which charges C652 positive to ground. A similar analysis at 180°, 225°, 270°, and 315° will further indicate that the C652 output voltage for zero error is alternately negative and positive to ground, and no d-c error voltage is fed to the RFO when the IO and i-f signals are exactly 90° out of phase.

Now consider the phase detector action to produce a d-c correction voltage when the i-f signal leads the IO signal by only 45° (lagging error, fig. 5-14B). At zero degrees no voltage is developed across C652. At 67.5°, the series aiding voltages in the lower half of the T604 secondary and the right half of the T605 secondary cause a current which charges C652 negative to ground. Likewise, at 90°, C652 is still charged negative to ground. However, at 135°, no charge is accumulated on C652.

At 135° (fig. 5-13) diodes CR608 and CR609 are conducting and the output voltage on C652 is positive to ground (135° to 180°, fig. 5-14, B). However, the output voltage is predominantly negative (0° to 135°) for a lagging phase error (i-f leading the IO by only 45°). Thus, the voltage fed to the RFO for this error condition will be a negative d-c voltage with an a-c component (pulsating direct current).

A leading phase error between the IO and i-f signals exists when the i-f leads the IO by more than 90°. This condition will produce an a-c voltage across C652 which is predominantly positive to ground. Figure 5-14, C shows the polarities, conducting diodes, and C652 charge at 112.5° and 292.5° of the reference IO signal.

The C652 output (fig. 5-12) is fed through a filter (L621-R692), switch section S302H, and the selected portion of a voltage divider to a voltage-sensitive capacitor (C387). The filter removes the a-c component of the correction voltage.

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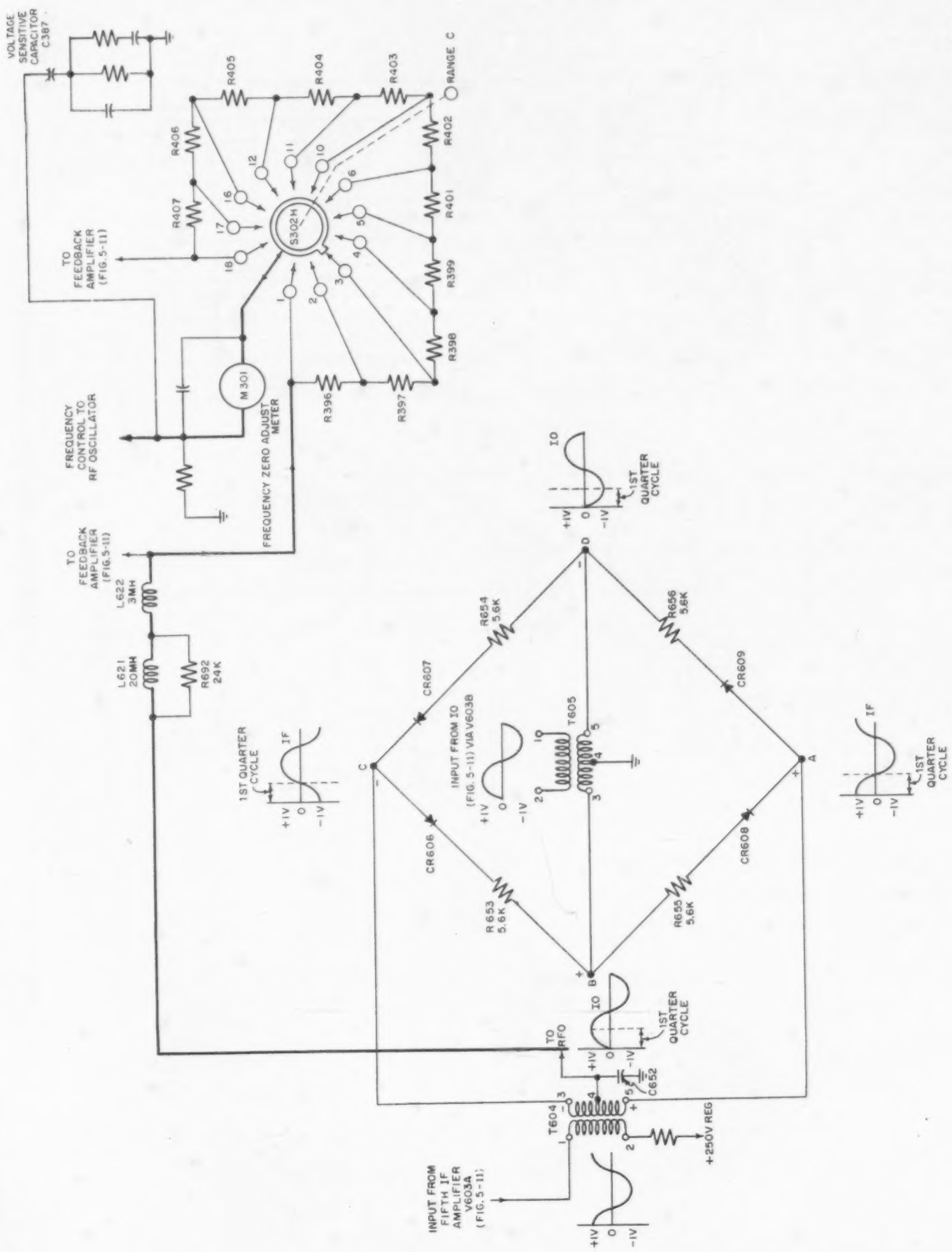

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Figure 5-12.—Master oscillator-phase detector analysis. Simplified diagram with waveforms.

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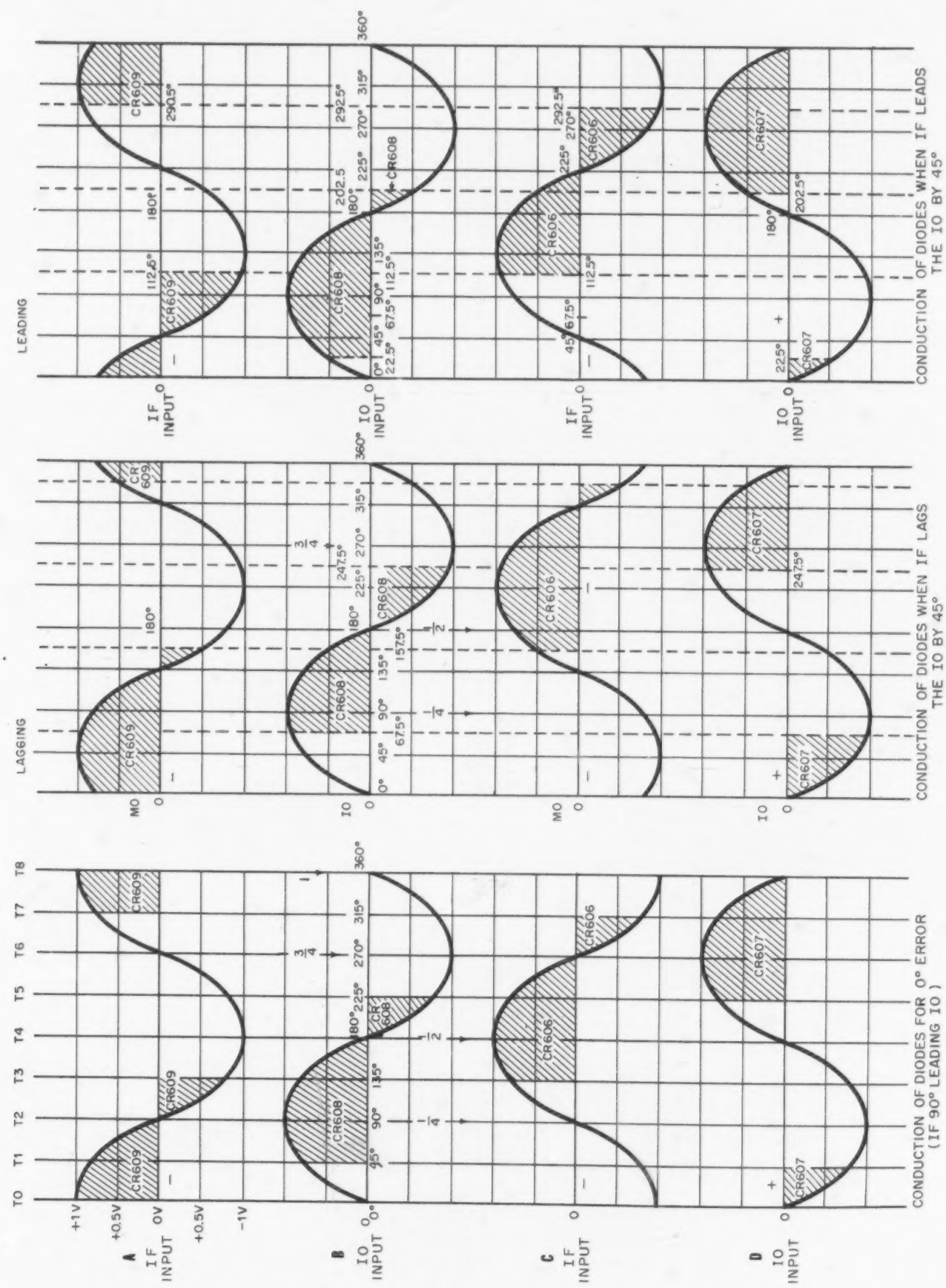

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Figure 5-13.—Master oscillator-phase detector analysis. Conduction of diodes.

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The voltage-sensitive capacitor is placed in shunt with the master oscillator tuned circuit. The capacitance of C387 changes in accordance with the magnitude of the d-c correction voltage from the MOPD. The change in the oscillator tank capacitance corrects the oscillator frequency.

The action of S302H and the voltage divider (comprising R396 through R399 and R401 through R407) corrects the amount of error voltage fed back on the selected band so that the amount of oscillator frequency change on all bands is the same for a given d-c error voltage developed at the MOPD.

Phase Detector (100 kc)

The fundamental 100-kc signal at L614 (fig. 5-11) is of greater amplitude than any of the generated harmonics. If the mixers are not in exact balance, it is possible for the 100-kc signal to be fed through the balanced mixers and the i-f stages to the master oscillator-phase detector. This action would cause an erroneous d-c correction signal to be fed from the master oscillator-phase detector to the master oscillator and thereby cause the oscillator to operate at an undesired frequency.

Because the i-f band pass will accept and pass the 100-kc fundamental, it is necessary to keep the mixer stages extremely well balanced. Aging of circuit components and ambient temperature variations inevitably introduce some imbalance; therefore an automatic balancing circuit is provided to null the unwanted 100-kc signal.

The 100-kc balancing network consists of two 100-kc phase detectors. A sample of the i-f signal is taken from the cathode of V603A and applied to both of the 100-kc phase detectors. As shown in figure 5-11, a 100-kc reference signal is also applied to the phase detectors via T608 from buffer amplifier V605.

The 100-kc signal output of one of the balanced mixers is 90° out of phase with the output of the other mixer as discussed previously. Because of this relationship, a phase shift at the detector input shifts the phase of the reference signal applied to one of the 100-kc phase detectors. When no i-f error is introduced, no correction voltage is developed. The presence of an i-f error input from the V603A cathode causes a d-c correction voltage to be developed at the 100-kc phase detector output. The phase of the i-f input from V603A indicates which mixer is unbalanced. The polarity of the 100-kc phase detector output voltage is proper to provide bias to the mixer which is passing the 100-kc signal. This action causes the 100-kc signal in the two balanced mixers to again cancel and thus nullify any master oscillator error which might otherwise be caused by the 100-kc signal.

Interpolation Oscillator

Interpolation oscillator V606 provides a stabilized reference signal which is compared in the master oscillator-phase detector with the signal delivered through the i-f amplifiers.

The comparison i-f signal from V603A and the IO signal from V606 (via V603B) are fed to the MOPD. As shown earlier, when the two signals are exactly 90° out of phase, no correction voltage is fed back to a voltage-sensitive capacitor (not shown) in the MO circuit and the MO frequency remains unchanged. When any other phase difference is present, due to a shift in the frequency of the MO, a correction signal of proper polarity is applied to the MO to bring this circuit back to the proper frequency. FREQUENCY ZERO ADJUST meter (fig. 5-10, A) in the r-f oscillator indicates the magnitude and polarity of the correction current.

Frequently it is necessary to determine the interpolation frequency. The IO circuit is designed so that only signals in the 50- to 100-kc range are produced, although the frequency applied to the MOPD can be varied over the 2- to 30-mc range. In order to determine the IO frequency it is important to interpret the frequency readings on the front panel counters of the frequency control group correctly. The following information is useful for interpretation of the IO frequency: When the two last place digits of the master oscillator frequency are greater than 50 kc (such as 2355, 2460, 1670, or 1990 kc), the IO frequency is the same as that indicated by the last two digits on the upper counter (fig. 5-10, B). If the MO frequency is 2460 kc, the i-f and also the IO frequencies are 60 kc.

However, when the two last place digits of the MO output are less than 50 kc (such as 2345, 2440, 1630, or 1910 kc) the IO frequency is 100 kc minus the last two digits of the frequency indicated by the lower counter. Thus, when the MO frequency is 2430 kc, the i-f signal and the IO frequencies are 100 - 30 = 70 kc.

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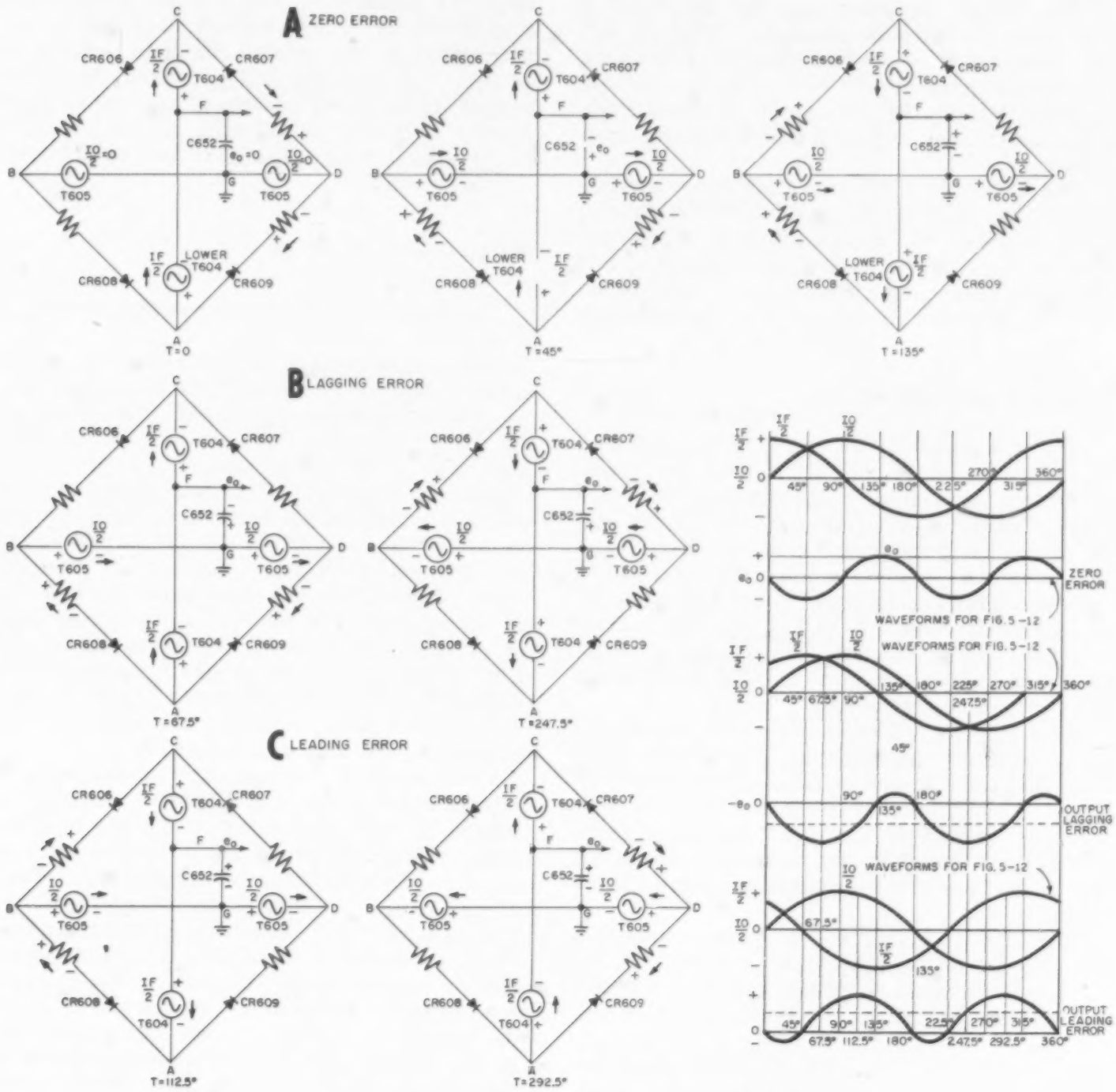

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Figure 5-14.—Master oscillator-phase detector analysis. A. Zero error. B. Lagging error. C. Leading error.

The d-c correction voltage for the MO contains some harmonics of the comparison i-f signal frequency. These harmonics are removed by a 10-kc low-pass filter inserted between the MOPD and voltage-sensitive capacitor in the master oscillator. However, low frequency spurious signals may still be present in the output of the low-pass filter. In order to remove such spurious signals, feedback amplifiers V607A, V607B, and V608A (fig. 5-11) have been inserted in this circuit. Any spurious signals appearing at the output of the low-pass filter

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are fed to grid 7 of first feedback amplifier V607A. The first, second, and third feedback amplifiers amplify the spurious signals. The V608A is applied as a degenerative feedback to the MO input to cancel the spurious signal.

The d-c correction voltage is not affected by the feedback circuit because the amplifiers do not pass the d-c component of the correction voltage. Meter M601 is used to zero the IO tuning. This meter is also used to measure the amount of deviation between the 1-mc crystal oscillator (Q1301, Q1302) and an external 1-mc standard frequency.

In order to keep the frequency control loop as stable and rapid-acting as possible, it is necessary to keep the gain in the a-c loop containing the 10-kc filter and feedback amplifiers approximately constant. However, at high operating frequencies a given d-c control signal to the voltage-sensitive capacitor in the master oscillator produces a greater amount of frequency correction than that which occurs at low frequencies.

In order to overcome this change in sensitivity, the input to V607A is shunted by a capacitive feedback network which is connected between the V607B cathode and the V607A control grid. The feedback network (not shown) is contained in the frequency compensating attenuator. The voltage at the V607A input thus lags the applied voltage. As the operating frequency increases, the voltage developed across the input network decreases. This action, in effect, lowers the input impedance to the feedback amplifiers and slows down the correction response as the operating frequency increases.

A third feedback signal from the feedback amplifier applies a regenerating control signal from the V607B cathode through a filter network (not shown) to the V607A control grid. This signal permits the feedback amplifier circuit to oscillate at approximately 2 cps when the oscillator control circuit is not locked-in at the proper operating frequency. The oscillator sweeps across a limited frequency range until the control circuits lock-in. When the frequency is correct the regenerative feedback drops to zero and oscillations in the feedback amplifiers are no longer sustained.

It was stated earlier that frequency error in the interpolation oscillator frequency is corrected by comparing the IO frequency with that of the 1-mc crystal oscillator reference frequency. The crystal oscillator frequency is first converted to a 1-kc signal. This frequency is compared with the IO frequency to produce a correcting voltage when operating in 1 kc steps.

The 100-kc pulse signal, which is derived from the 1-mc crystal oscillator, Q1301 and 1302 (fig. 5-11), is applied from L614 to buffer amplifier V604A. The 100-kc input is divided 100 times to produce a 1-kc output by the combined actions of two 5:1 dividers (V604B and V610A) and a 4:1 divider V610B.

The 1-kc signal from V610B is delivered to the 1-kc phase detector circuit consisting of T616 and crystal diodes CR632 and CR633. Here it is compared with the signal from the IO and a d-c correction voltage is developed. This correction voltage is applied to sweep oscillator and d-c amplifier circuit V609A.

When the IO circuit is not locked-in at a multiple of 1 kc, a positive-going error voltage signal is applied to the grid of sweep oscillator and d-c amplifier V609A. The plate voltage decrease of V609A is applied to the grid of sweep oscillator V609B. The resultant plate output of V609B is applied through an isolation network as a regenerative input to the V609A grid. This action produces a sweep voltage which is fed from the cathode of V609A through M601 to the interpolation oscillator phase detector reactance modulator which causes the IO to sweep over a narrow band and "hunt" for the proper lock frequency. Meter M601 provides an indication of the amount of the correction voltage.

SSB TRANSCEIVER AN/URC-32

One of the Navy's most versatile modern communication equipments is the AN/URC-32 (fig. 5-15). It is a transceiver operating in the 2- to 30-mc range, with a transmitter peak envelope power (PEP) of 500 watts.

The AN/URC-32 is designed chiefly for single-sideband transmission, and for reception on either the upper or lower sidebands, or on both sidebands simultaneously, with separate audio and i-f channels for each sideband. In addition to single-sideband operation, provisions are included for a-m (carrier reinserted), CW, or FSK operation.

The frequency range of 2 to 30 mc is covered in four bands. The desired operating frequency is selected in 1-kc increments on a direct-reading frequency counter. Frequency accuracy and stability are controlled by a self-contained frequency standard.

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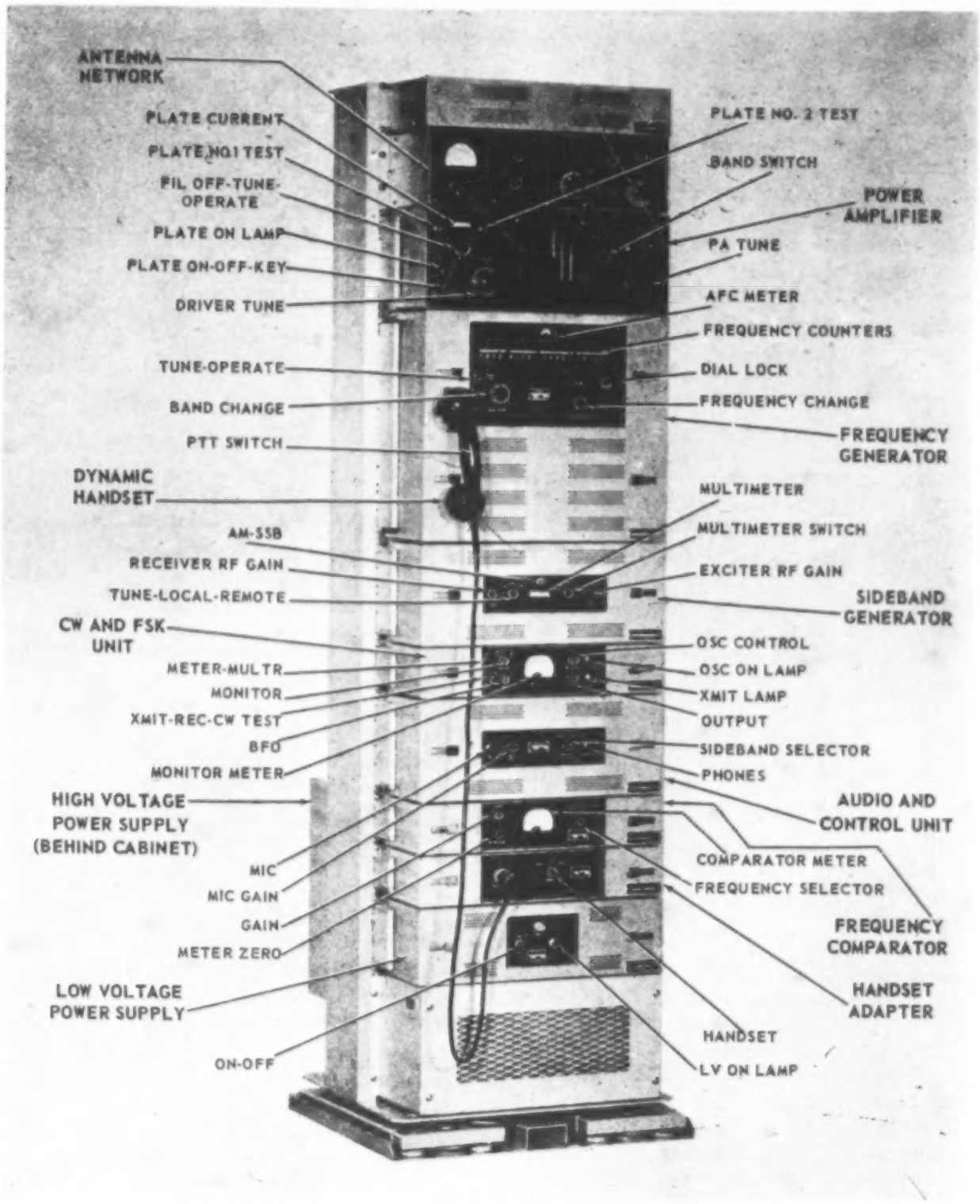

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Figure 5-15.—Radio Set, AN/URC-32, relationship of units and operating controls.

BLOCK DIAGRAM

The transmitter of the AN/URC-32 (fig. 5-16) produces voice, CW, or FSK modulated signals on a single-sideband r-f carrier, or a compatible amplitude modulated r-f carrier.

Voice input signals from the dynamic handset or input signals from a remote control unit are

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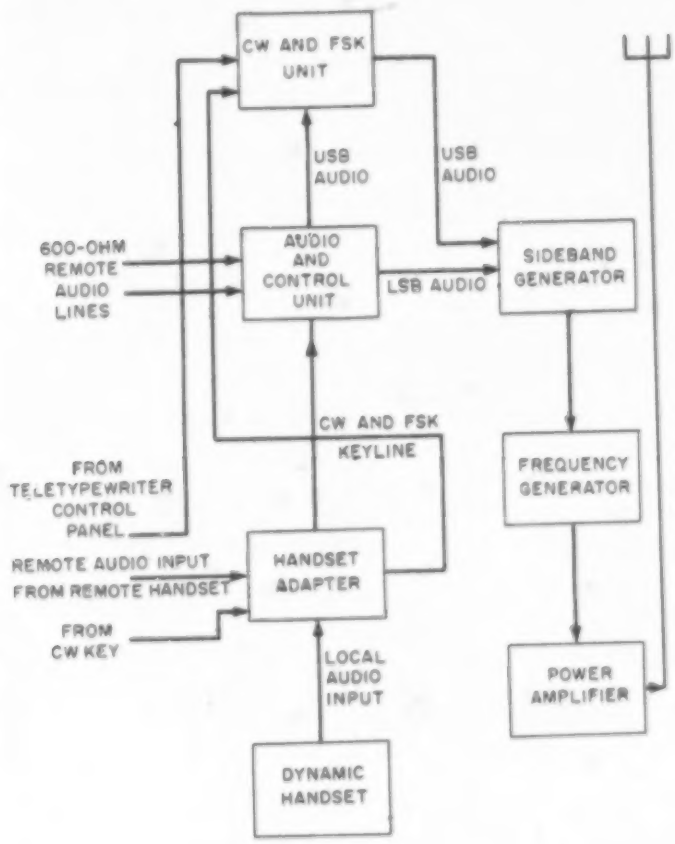

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Figure 5-16.—Radio Set AN/URC-32, transmit function block diagram.

applied to the handset adapter, permitting the operator to select either the local or remote audio input. Teletypewriter signals are applied directly to the CW and FSK unit, which provides separate audio tones for the mark and space conditions. These frequencies are later converted to the required frequency shift signals for FSK transmission.

The output from the handset adapter is amplified in the audio and control unit. Two separate audio input paths to the audio and control unit are provided through the 600-ohm remote audio lines.

The audio and control unit amplifies the audio signal and feeds it to the sideband generator. During single-side-band voice operation, the audio and control unit output is fed through a selector switch in the CW and FSK unit. For CW or FSK operation, the CW and FSK unit supplies audio tones to the sideband generator.

The sideband generator converts the audio input to the selected sideband of a 300-kc intermediate frequency. The modulated 300-kc output is fed to the frequency generator. This unit provides the necessary number of heterodyning processes (while preserving the signal intelligence) to produce the selected carrier frequency in the 2- to 30-mc range. The output signal is amplified in the power amplifier to the required peak envelope power of 500 watts and fed to the antenna.

During receive operation (fig. 5-17) the antenna input signal in the range from 2 to 30 mc is heterodyned in the frequency generator so that the output will be a modulated 300-kc signal. This signal is detected and amplified in the sideband generator, further amplified in the audio and control unit, and fed to the speaker.

During CW reception, the CW and FSK unit supplies a 300.550-kc signal to the sideband generator as a beat frequency for the received signal. The beat frequency can be changed over a range of ± 1 kilocycle.

AUDIO AND CONTROL UNIT

The audio and control unit (fig. 5-18) is a dual-channel amplifier, which can provide audio inputs from two 600-ohm balanced lines, a 600-ohm unbalanced line, or a high-impedance microphone. In the normal AN/URC-32 installation, the 600-ohm balanced lines and the dynamic microphone input are not used.

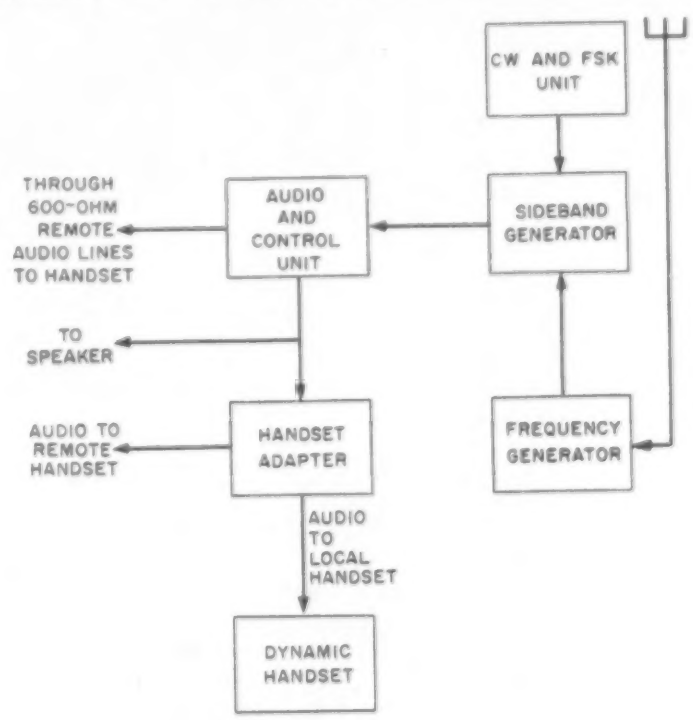

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Figure 5-17.—Radio Set AN/URC-32, receive function block diagram.

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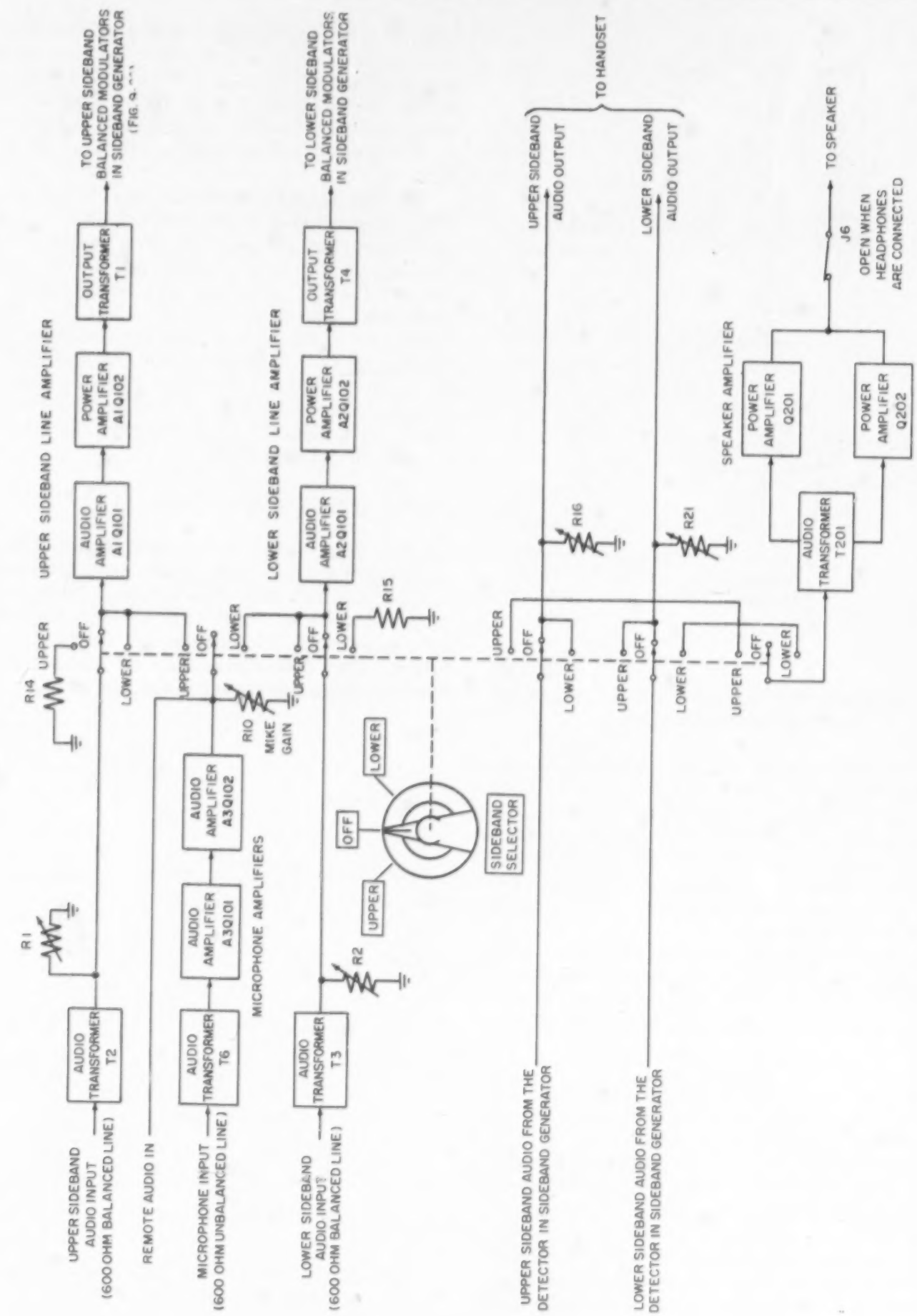

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Figure 5-18.—Audio and control unit block diagram.

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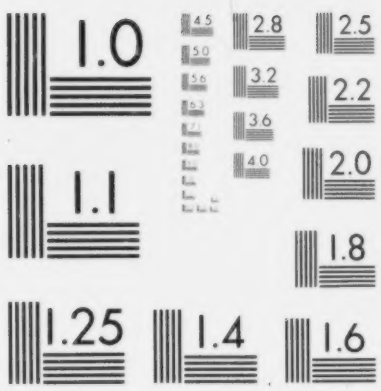

MICROCOPY RESOLUTION TEST CHART

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On transmit, when using the 600-ohm unbalanced input, the audio signal from the handset adapter is fed to the audio and control unit via audio transformer T-6. This input, after amplification, can be applied to the upper sideband line amplifier or to the lower sideband line amplifier in the audio and control unit.

The sideband selector switch controls the signal transmission and reception. With the switch in the OFF position, the microphone amplifier circuits and the remote audio input are disconnected from the line amplifiers. This also connects the upper and lower sideband 600-ohm audio line inputs to the line amplifiers.

With the sideband selector switch in the UPPER position, the microphone audio or remote audio is fed into the upper sideband line amplifier. This also selects the upper sideband audio output from the sideband generator and applies it to the speaker amplifier circuits.

The reverse of this action happens when the sideband selector is placed in the LOWER position. When earphones (not shown) are plugged into the phone jack on the front panel, the audio output normally fed to the speaker is removed.

The upper and lower sideband line amplifiers are controlled by the upper and lower sideband audio inputs. With the sideband selector switch in the OFF position, the two sideband amplifiers can be used either individually or simultaneously.

Assume the audio input is on the upper sideband. This input is coupled by audio transformer. T2 and the sideband selector switch (in the OFF position) to the first upper sideband line amplifier A1Q101 for amplification. The amplified output of A1Q101 is coupled to the power amplifier A1Q102 for further amplification. The output is fed via T1 to the upper sideband balanced modulator in the sideband generator. The gain of the sideband line amplifier is controlled by antenuator R1. Operation of both the upper and lower sideband line amplifiers is the same.

When the sideband selector switch is in the UPPER position, the upper sideband audio is removed from the audio amplifier A1Q101 and is correctly terminated by R14. Either the microphone amplifier circuit or the remote audio is then connected to the audio amplifier A1Q101.

With the sideband selector switch in the LOWER position, the lower sideband audio is removed from A2Q101 and correctly terminated by R15. The microphone amplifier circuits are then connected to the audio amplifier A2Q101.

SIDEBAND GENERATOR

The sideband generator (fig. 5-19) translates audio frequencies to intermediate frequencies during transmit condition, and intermediate frequencies to audio frequencies during receive condition.

Transmit Function

The balanced modulator, carrier generator, and transmitter gain control (TGC) operate during transmit condition. The audio input to the sideband generator is taken from the audio and control unit and applied to the sideband generator via T3 and T4. Audio input transformers T3 and T4 couple the upper sideband and lower sideband audio inputs to the balanced modulators.

The balanced modulators modulate a 300-kc carrier to produce separate and distinct upper and lower sideband signals with the carrier suppressed. The 300-kc carrier is produced in the carrier generator by tripling the 100-kc reference oscillator signal from the frequency generator.

The balanced modulator contains two 300-kc balanced modulators. Because of a frequency inversion in the r-f tuner, the lower sideband balanced modulator is followed with an upper sideband filter, and the upper sideband balanced modulator is followed with a lower sideband filter.

The outputs of the balanced modulator are connected in parallel and fed to the transmitter gain control. The TGC circuit is controlled by a TGC voltage, which is received from the power amplifier unit. This circuit maintains the 300-kc i-f output voltage at a sufficiently low level to prevent overdriving any of the subsequent stages.

The 300-kc SSB signals are fed via line TX to the r-f tuner and power amplifier. During tune and a-m transmit conditions only, the unmodulated 300-kc carrier generator output is reinserted in the upper sideband signal at the input of V1A in the r-f tuner. Reinsertion of the carrier at the transmitter eliminates reinsertion at the receiver and the necessity for having special equipment to receive the transmitted signal. The absence of the lower sideband does not affect the quality of the received signal. However, only one sideband plus carrier is transmitted, and the received signal is considerably stronger than it would be for double sideband a-m operation.

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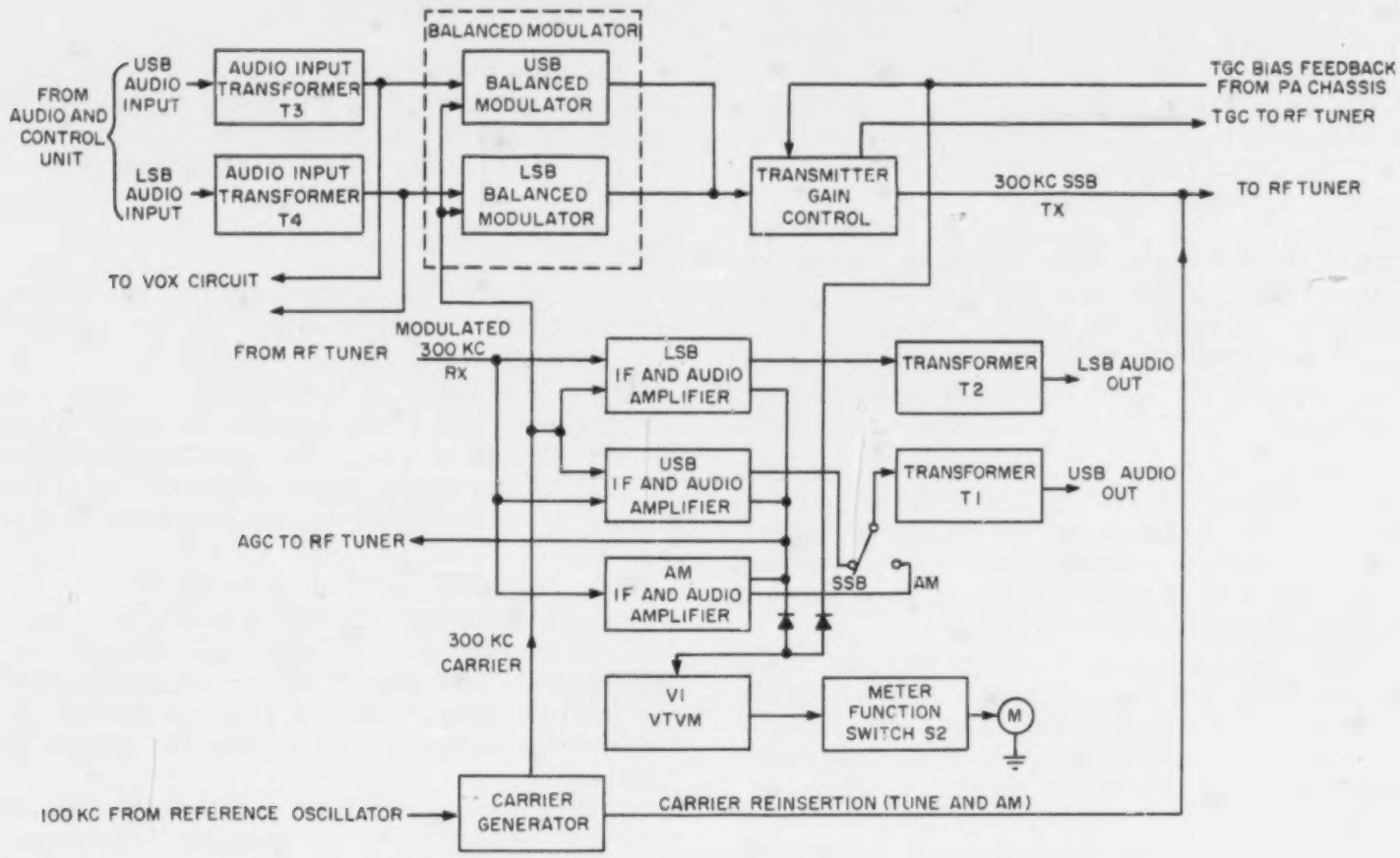

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Figure 5-19.—Sideband generator, block diagram.

Receive Function

The i-f audio amplifier (lower sideband, upper sideband, and a-m) operate only during the receive condition to amplify the modulated 300-kc i-f signal from the r-f tuner (via line RX). These units also demodulate the signal and amplify the detected audio. A 300-kc carrier is reinserted into the lower sideband and upper sideband i-f/a-f amplifier from the carrier generator.

When the front panel SSB a-m switch is in the a-m position, the lower sideband and upper sideband i-f/a-f amplifiers are disabled. The carrier generator (a-m receive only) also is disabled. The audio output from the a-m i-f/a-f amplifier is fed through the SSB a-m position to the upper sideband audio output lines via transformer T1. The a-m i-f/a-f amplifier is disabled when the SSB a-m switch is in the SSB position.

CW AND FSK UNIT

The CW and FSK unit (fig. 5-15) enables the AN/URC-32 transceiver to be operated in the CW and FSK modes of operation. On FSK transmit operation (tone modulation), the CW and FSK unit converts the keying input from a teletypewriter current loop to audio tones of 1575 cps for space (no loop current) and 2425 cps for mark (loop current). On CW transmit operation the unit provides a keyed audio tone of 1000 cps or 1500 cps as selected by the OSC control switch on the front panel.

During FSK receive operation, the CW and FSK unit provides a bfo (beat-frequency oscillator) signal required for FSK reception. This signal is centered on 300.550 kc, and is variable approximately 1 kc above or below this frequency.

The function of the CW and FSK unit is determined by the position of the oscillator control switch, which is located on the front panel. In

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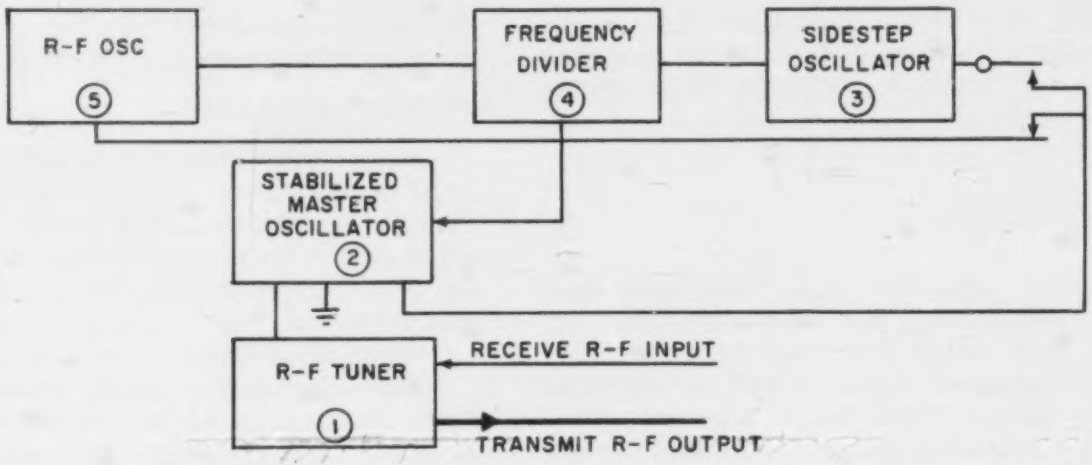

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Figure 5-20.—Frequency generator, simplified block diagram.

the OFF position, a section of the switch disables the CW and the FSK unit by removing the B + voltage (+130 v) from the circuits. Another section connects the USB transmit audio input line from the audio and control unit to the USB transmit audio output line. This line is connected to the USB balanced modulators of the sideband generator, which, in turn, feeds the transmit circuits. Thus, in the OFF position, the CW and FSK unit circuits are deenergized, and the voice input signals from the handset are transmitted.

FREQUENCY GENERATOR

The frequency generator produces the desired radio frequency as determined by the setting of the BAND CHANGE and FREQUENCY CHANGE controls. This unit also provides frequency control and r-f amplification for either transmitted or received signals.

The frequency generator (fig. 5-20) consists of a main chassis and five plug-in units. These units are:

1. R-f tuner.
2. Stabilized master oscillator.
3. Sidestep oscillator.
4. Frequency divider.
5. Reference oscillator.

The r-f tuner of the frequency generator is an i-f to r-f translator during transmit condition, and an r-f to i-f translator during receive condition. During the transmit condition, the r-f tuner accepts the 300-kc single sideband signal from the balanced modulators of the sideband generator via the TGC circuit, and translates it to the desired frequency (in 1-kc steps) ranging from 2.0 to 30.0 mc.

During receive condition, the r-f tuner accepts and amplifies the selected signal from the antenna (as indicated on the band dial) and

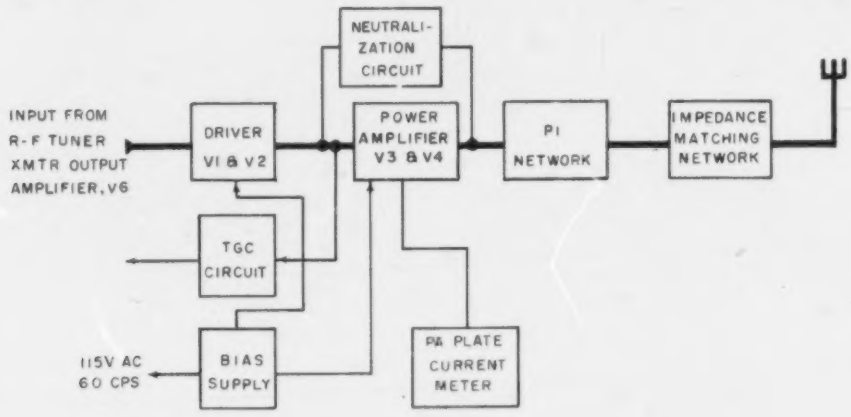

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Figure 5-21.—Power amplifier, block diagram.

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translates it to a 300-kc i-f signal. This signal is fed to the i-f/a-f amplifier of the sideband generator (or a-m i-f/a-f amplifier depending on the type of reception) for demodulation and amplification.

POWER AMPLIFIER

The power amplifier (fig. 5-21) is a two-stage r-f power amplifier which amplifies the 0.15-watt PEP signal from the frequency generator to a nominal output power of 500 watts PEP. It contains a driver stage, a power amplifier stage, a transmit gain control (TGC) rectifier, a bias and filament supply, and the necessary control and interlock circuits.

The driver and power amplifier plate circuits are manually tuned through the frequency range of 1.7 to 31.7 mc in four bands. The power amplifier plate circuit uses a tuned pi network to obtain an unbalanced 50-ohm output impedance over the complete range of frequencies.

POWER SUPPLIES

Plate voltage for the power amplifier tubes is obtained from the + 2000-volt high-voltage supply. The high-voltage power supply utilizes eight series-connected silicon rectifiers in each leg of a bridge circuit. Silicon rectifiers operate efficiently at much higher temperatures than selenium or germanium rectifiers.

The 400-volt d-c supply consists of 12 rectifiers connected in a conventional full-wave bridge rectifier circuit. The output is fused and filtered by a conventional LR filter.

A low-voltage power supply provides several outputs of relatively low voltage as follows: +250 volts, + 130 volts, unfiltered + 28 volts partly filtered +28 volts, regulated + 28 volts and -90 volts.

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CHAPTER 6

RADIO TRANSMITTERS, PART II

This chapter contains information on non-conventional circuits of two transmitters discussed in chapter 5. In addition, two shore-based transmitters and two radio sets are presented in a functional block diagram discussion.

SPECIAL CIRCUITS AN/SRT-14, 15, and 16

Non-Conventional circuits concerning the transmitter and antenna tuning equipment for the AN/SRT-14, 15, and 16 are discussed below. Reference to the block diagrams in chapter 5 of this training course will be helpful.

500-W OPERATE RELAY AND 500-W DISABLE LINE

The 500-watt operate relay, K1 (fig. 6-1) control the GROUND FOR 100-watt line, the GROUND FOR 500-watt line, and the GROUND FOR 500-watt AX line.

The GROUND FOR 500-watt line and GROUND FOR 500-watt AX line allow circuit completion for several control circuits. They are responsible for turning on control circuits in the high voltage power supply, for connecting the output of the low-level radio modulator to the input of the high-level radio modulator, for switching the input to the PA plate from the low-level radio modulator output to the high-level radio modulator output, and for supplying screen grid voltage to the high-level radio modulator during phone operation. The GROUND FOR 500-watt line and GROUND FOR 500-watt AX line are completed when K1 is energized. The completion is made through contacts 8R and 9R, and 1 L and 2 L, respectively, of K1.

The GROUND FOR 100-watt line is completed when K1 is not energized. This line completes the control circuits in the medium voltage power supply, which then supplies the required PA plate potential for 100-watt operation.

To place the transmitter in 500-watt operation, the Push for 500-watt button, S3, is depressed. If the -24 volts after time delay relay, K5 (to be discussed later), has timed out (contacts 2-8 closed), depressing the 500-watt button will apply the -24 volts to the winding of K1. The necessary ground for completion of this circuit is accomplished through a series of protective devices, constituting the 500-watt disable line. The circuit must be complete before the transmitter will switch to the 500-watt level. The protective devices included in the 500-watt disable line are the bandswitch, S2N; the disable 500-watt pushbutton, S4; the Radio Frequency Oscillator (RFO) unit 14 door interlock, S5; the time delay relay, K5; the thermostat, S6; the blower switch, S7; the overload relay, K4 (contacts 2R and 3R); and the plate thermostat, S8. If any one of these controls or protective devices is not closed, the ground will not be completed to K1, and the transmitter can operate at the 100-watt level only. When K1 energizes, the -24 volt after time delay connects to the windings of K1 through its contacts, 1R and 2R, allowing S3 to be released.

The 500-watt disableline contains a switch, S2N, which is ganged to the bandswitch control. The switch allows the circuit to be completed in all bands except 1 and 3. It should be recalled that those frequencies up to and including 2 mc may be transmitted at the 100-watt level only.

The disable 500-watt pushbutton, S4, which is normally closed, may be depressed to open the circuit as desired.

A transparent door covers the control knobs of the RFO. The door contains a switch, S5. This door interlock controls the open and closed condition of the 500-watt disable line, and, if open during normal 500-watt operation, the transmitter output will be reduced to the 100-watt level.

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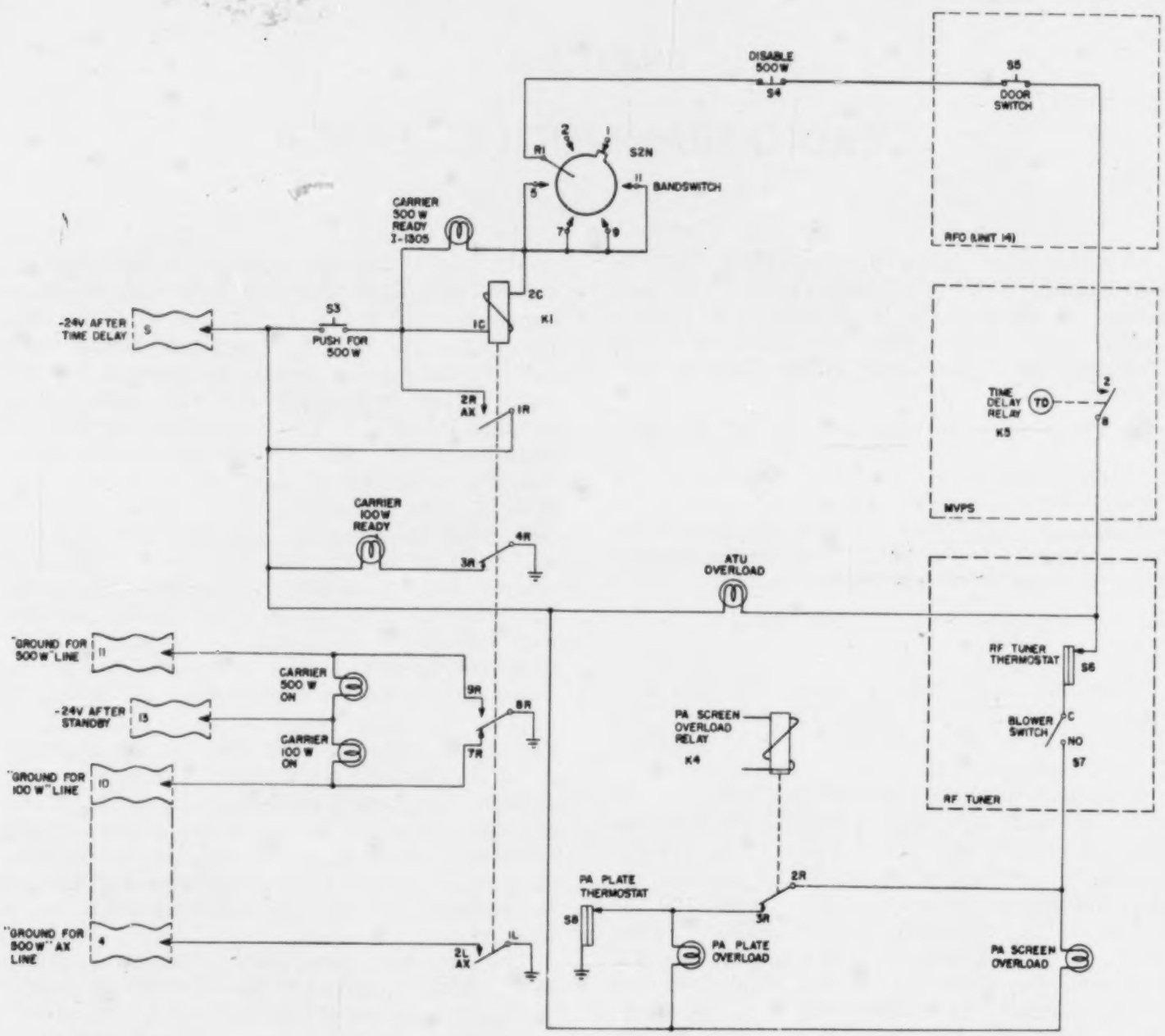

Figure 6-1.—500-watt operate relay and 500-watt disable line simplified schematic. 50.45

The heaters of the tubes in the high-voltage power supply are allowed to warm up before power is applied to the plate transformer. The contacts, 2 and 8, of the time delay relay, K5, are held open until the time delay is over. After this time, the contacts (2 and 8) are closed to complete the circuit.

Thermostat S6 is normally closed. When excessive heat is radiated by tuning coils in the r-f tuner, S6 will open the circuit.

Blower switch S7 is a centrifugal switch operated by the blower motor in the r-f tuner. The circuit is closed through S7 only if the blower is operating.

The contacts, 2R and 3R, of the PA screen overload relay are normally closed. When K4 is energized, due to excessive PA screen grid current, contacts 2R and 3R are opened, and the ground is removed from the 500-watt disable line.

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Four indicator lamps controlled by the action of K1 indicate the power level of the transmitter and also whether or not the transmitter is on the air.

Contacts are provided on the antenna switching relay, K2 (fig. 6-2), for connecting a receiver to the antenna when the transmitter is off the air. When the transmitter is on the air, the output of the RFA is coupled to the antenna system, and the receiver input is grounded.

During hand-key operation (using S5, in fig. 6-2) the circuit for K2 is completed from the -24 volt after time delay, through the winding of K2, into the low-level radio modulator, through contacts 1L and 2L of relay K6, and through the closed contacts of the test key to ground. Energizing the antenna switching relay, K2 actually operates the keying relay, K6, in the LLRM. This action shifts the ground on K2 from 1L and 2L of K6 to the contacts 2L and 3L of K6. C1 is provided to continue the ground on K2 during the time of the changeover. The antenna relay, K2, therefore becomes energized when the test key is closed, corresponding to a mark, moving its contacts, 3L and 2L (fig. 6-2), to the transmit position. When the hand-key is up, corresponding to a space, there is no ground for relay K2 and the antenna is switched to the receive position.

In machine c-w, frequency-shift keying, and facsimile operation, a permanent ground is placed on the keying line (through the keying equipment), which keeps K2 energized.

TRANSMITTER COUPLER LOAD ADJUSTING UNIT (LAU)

The function of the load adjusting unit (fig. 6-3) is to improve the impedance match between the 50-ohm output impedance of the radio-frequency amplifier and the impedance presented by the antenna tuning equipment. The improved matching permits the final PA stage of the radio-frequency amplifier to operate at maximum plate efficiency, and improves the transfer of power to the antenna system. The load adjusting unit consists of the standing-wave ratio monitor and the impedance transformer circuits.

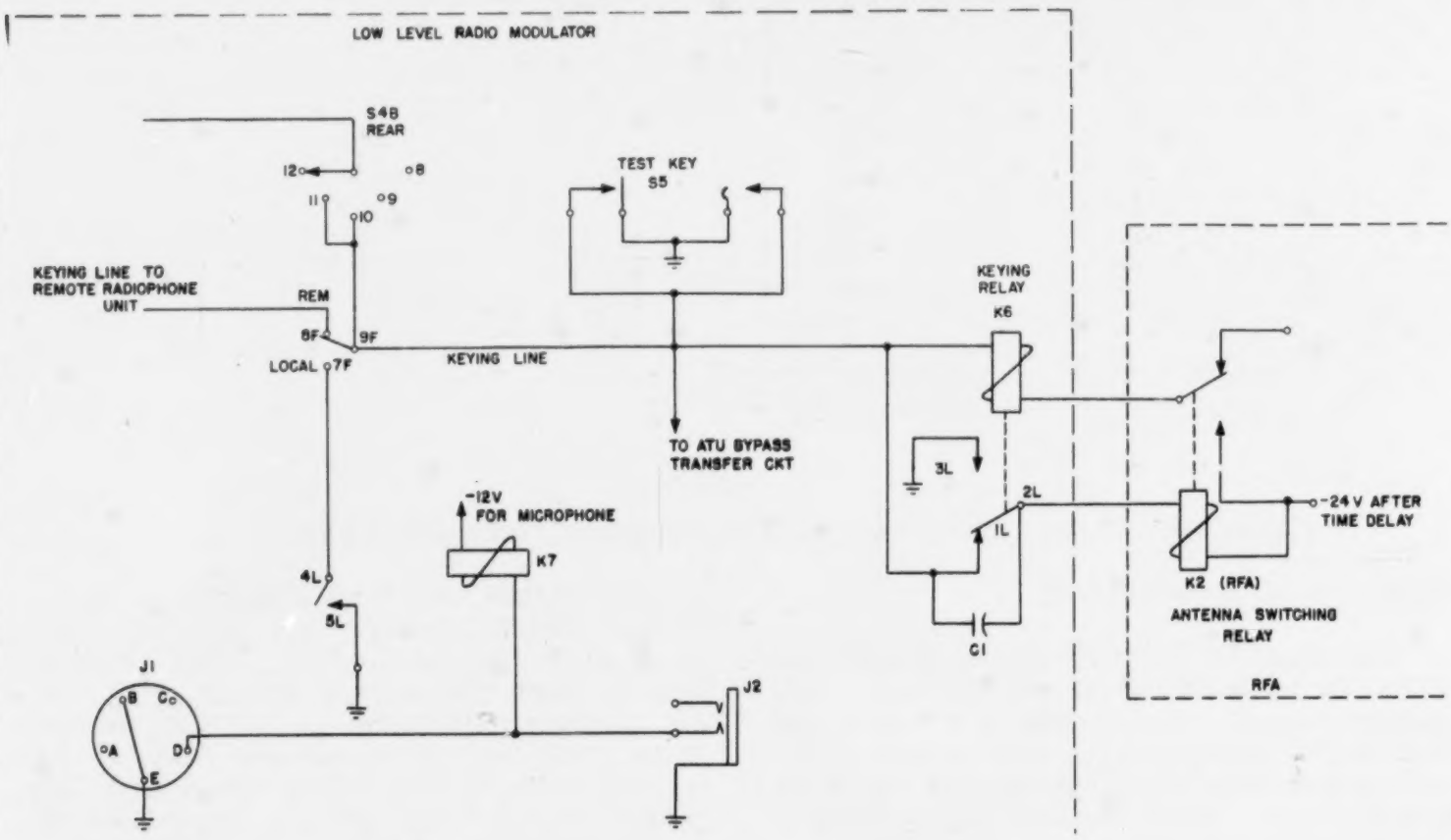

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Figure 6-2 —Antenna switching relay and associated circuits.

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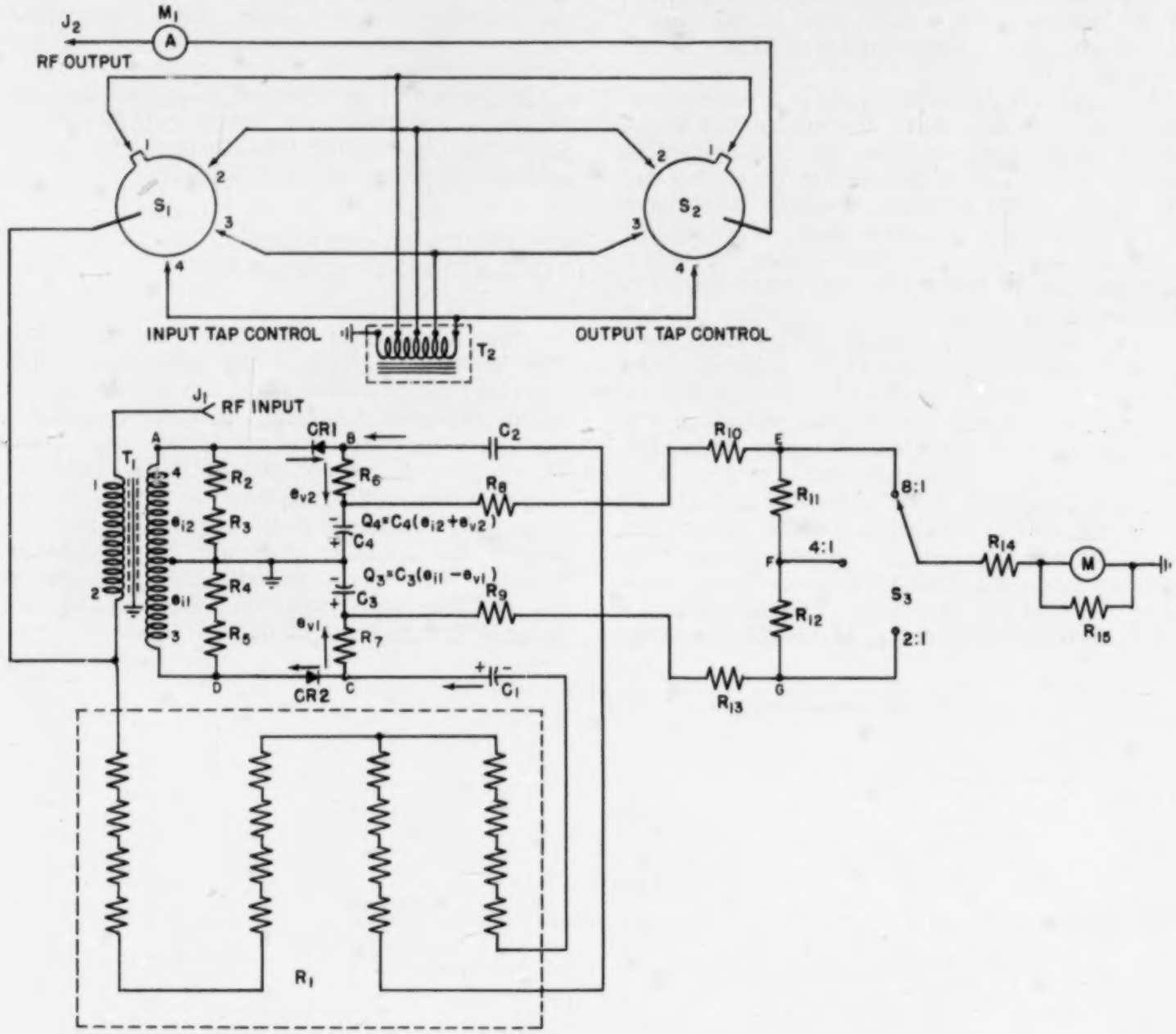

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Figure 6-3.—Transmitter coupler (load adjusting unit), schematic diagram.

Standing Wave Ratio Monitor

The output of the radio-frequency amplifier (RFA) is connected to the standing-wave ratio monitor circuit, which functions to detect and monitor the standing-wave ratio present on the r-f transmission line. The components of the standing-wave ratio monitor circuit form a unit designated the transmitter coupler.

The r-f transmission line from the RFA is connected through J1 to the standing-wave ratio monitor circuit and to the impedance transformer circuit. Voltages ev1 and ev2, proportional to the r-f line voltage are obtained directly from the voltage divider, R1, and d-c blocking capacitors C1 and C2, respectively. Voltage ev_1 is between point C and ground. Voltages ev_2 is between point B and ground. Voltages ei_1 and ei_2 proportional to the current in the r-f line, are obtained from the lower and upper halves, respectively, of the secondary winding of the transformer,

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T1. The center tap of the secondary is grounded, and ev_1 and ev_2 are in phase with each other and are of equal magnitudes.

Circuit ABCD supplied by the T1 secondary and also by a portion of the line voltage via C1 and C2 includes capacitors C3 and C4, which acquire a charge through the action of crystal diodes CR1 and CR2 and the voltages ei_1, ev_1 and ei_2, ev_2.

On one half-cycle, CR1 and CR2 are conducting, and on the other half cycle they are nonconducting. During the time the diodes conduct, ei_1 and ei_2 attempt to establish a charging current clockwise around circuit ABCD so as to charge C3 and C4 with the polarity shown. During this time ev_1 opposes the charge on C3, and ev_2 aids the charge on C4.

As stated before, ei_1 and ei_2 are proportional to the line current; ev_1 and ev_2 are proportional to the line voltage. Now the quantity of charge in C3 is proportional to $ei_1 - ev_1$; the quantity of charge in C4 is proportional to $ei_2 + ev_2$. Thus, the voltage on C3 is proportional to the difference of two quantities, and C4 is proportional to the sum of two quantities. These quantities are proportional to line current and line voltage.

The ratio of these quantities is proportional to the line impedance; for a matched line with no standing waves, the ratio is proportional to the characteristic impedance of the line. If the line is mismatched, the ratio is upset, and the amount of charge on C3 and C4 is altered.

A voltage divider comprising R8, R9, R10, R11, R12, and R13 is connected across the series combination of C3 and C4. The voltage across this divider is equal to the sum of the voltage across C3 and C4. The meter, M, is connected effectively between the common junction of C3 and C4 and a point on the voltage divider, depending on the position of switch S3. In this bridge circuit the current through the meter is proportional to the unbalanced condition of the bridge.

The values of R10, R11, R12, and R13 are such that if the standing wave on the r-f line is 8:1, the potential at point E with respect to ground is zero. If the SWR CALIBRATE switch, S3, is in the 8:1 position, the SWR BALANCE meter, M, would give an indication at the center null position. If the standing-wave ratio is less than 8:1, with the switch in this position the meter will read to the left of the null position. Conversely, if the standing-wave ratio is greater than 8:1, with the switch in this position the meter would indicate a reading to the right of the null position. The voltage at point F with respect to ground will be zero when the standing-wave ratio is 4:1. Similarly, a 2:1 ratio will give a zero reading at point G. R14 in series with the meter is a current-limiting resistor.

Impedance Transformer

A method for improving the match between the characteristic impedance output of the RFA and that impedance presented to the RFA by the antenna and antenna tuning equipment is provided through the use of the impedance transformer. Matching is accomplished through the use of a tapped autotransformer T2 (fig. 6-3) which has been introduced into the r-f transmission line. The output of the standing-wave ratio monitor may be connected to one of the taps of T2 as shown. The input connections are made through switch S1, the input tap control. The output of the transformer selected by the position of the tap on the output tap switch, S2 is connected through the r-f ammeter M1, to the jack, J2, which is the output to the antenna coupler.

With the input and output tap controls set at position 4, the full winding of the impedance matching autotransformer will be shunted across the line. This is the normal setting of these controls. If, after all tuning procedures have been completed, the standing-wave ratio balance meter indicates a reading higher than 2:1, the controls should be reset for optimum impedance match. The tuning controls of the PA stage are also used in making the adjustment for maximum reading on the r-f ammeter of the load adjusting unit.

ANTENNA TUNING EQUIPMENT

The AN/SRT-14, 15, and 16 transmitting sets are designed to work into a 35-foot whip antenna Navy type C66047 or into a 60- to 130-foot single wire with a 40-foot down lead. If the impedance presented by the antenna is other than 50 ohms, energy will be reflected back along the transmission line, reducing the energy being radiated and causing voltage nodes to exist on the line. The standing-wave ratio measurement indicated by the standing-wave ratio balance meter represents the extent of the mismatch. The ideal matching condition of the antenna load to the RFA output would yield a standing-wave ratio of 1:1. This would occur when the reactive component of the antenna is reduced to zero and the

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resistive component is equal to 50 ohms. Acceptable tuning of the antenna load by the antenna tuning equipment is achieved if the standing-wave ratio can be reduced to at least 4:1 for any frequency in the transmitter range.

If the antenna length is an exact multiple of quarterwave lengths corresponding to the frequency in use, the antenna will be resonant and will present zero reactance to the transmission line. It should be understood, however, that since the antenna length is constant, the resonant condition will not remain constant for all frequencies. Further, at even multiples of quarter-wavelengths, the resistive component (for end fed) is high, while at odd quarter-wavelength multiples, the resistive component presented by the antenna (at the same feed point) is low.

The function of the antenna tuning equipment is to make the antenna length, together with the selected tuning component, appear at the feed point as some odd multiple of a quarter-wavelength for all frequencies within the tuning range from 0.3 to 26 mc.

Antenna Coupler

A schematic diagram of the antenna coupler is shown in figure 6-4. The loading switch, S1, permits additional components to be placed into the transmission line to increase its effective length when the length of the main tuning coil is insufficient to achieve the required tuning. This is particularly true at low frequencies when the antenna length should be increased. At frequencies where the effective length of an antenna is an even multiple rather than the desired odd multiple of a quarter-wavelength, a capacitor may be switched in the line. Without this action, poorer match would exist between the antenna and the RFA because the antenna impedance would be further separated from the characteristic impedance of the line.

The input of the r-f tuner is permanently connected to the loading switch of the antenna coupler. If one of the loading components is required in the tuning process, the required component is switched into the transmission line through the two-section loading switch, S1. If the loading components are not required, the transmission line is connected directly through the switch shown in the figure. Loading switch S1 has six positions: one for direct connection and five (ABCDE) for different combinations of loading components. The components selected may be easily located after proper rotation of the switch. The antenna coupler loading control, S2, supplies operating voltage to an actuator, B1, in the antenna coupler. The actuator then functions to position the loading switch as required to select the proper loading component. Table 6-1 shows the components selected by the different positions of the antenna coupler loading control.

Table 6-1—Components Selected in Each Position of the Loading Switch, S1.

Positions of antenna coupler loading switch, S2	Loading components selected by S1
Direct	None
A	C1 in series
B	L2 in series
C	C1 in series, C3, C2, shunted across the line
D	L1 in series
E	C3, C2, shunted across the line

For example, assume that the antenna coupler loading switch, S2 (fig. 6-4), is placed manually in position A. This action establishes a circuit from one side of the 110-volt a-c line through 11-14 of S2, through contacts NO and C of microswitch S4, to one side of the actuator winding, B1. The other side of the actuator winding is directly connected to the other side of the 110-volt a-c line. The closed contacts NO and C of S4 allow the actuator to rotate until the roller arm of S4 falls into the notch of the positioning cam. This action will open the contacts of S4, breaking the a-c supply to the actuator. The magnetic actuator is ganged to S1 in such a way that the switch is caused to rotate to the A position.

At certain frequencies, the actual antenna impedance is such that no tuning is required to meet the standing-wave ratio readcng of 2:1 required at the r-f output of the radio frequency amplifier. At other times, it is necessary to use one or more of the tuning components described in the discussion of the

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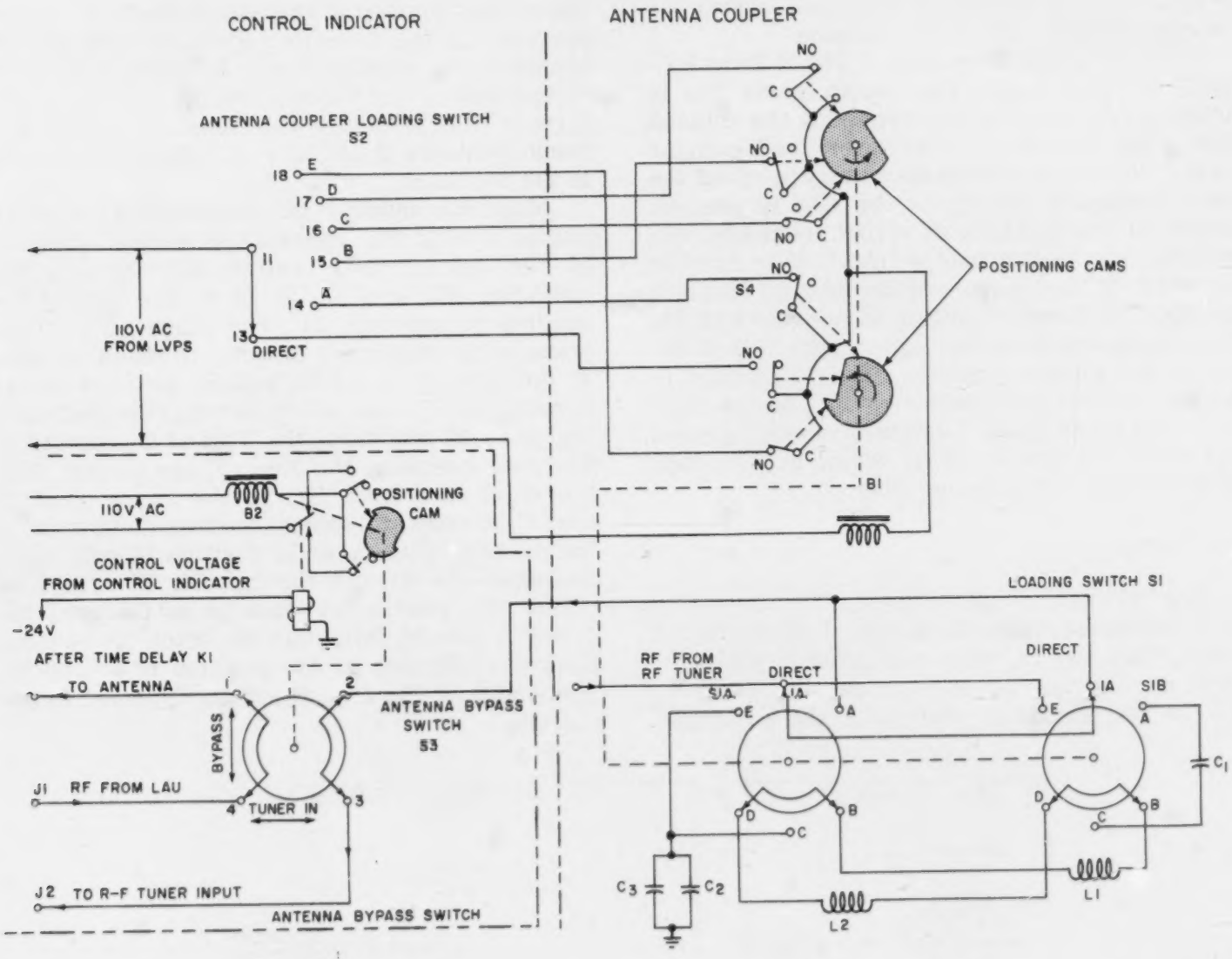

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Figure 6-4.—Simplified circuit of antenna coupler.

loading switch in the above paragraphs. To meet these conditions the antenna bypass switch, S3, is introduced into the transmission line.

The antenna bypass switch is controlled by the antenna transfer switch on the control indicator. The switch is a double-pole double-throw toggle switch with three positions. These positions are designated TUNER IN, BYPASS, and REMOTE. The REMOTE position is not shown in the figure. S3 is positioned by a magnetic actuator, B2. One side of the a-c line is permanently connected to one side of the actuator. Relay K1, when energized, completes the line voltage circuit allowing the actuator to energize, which, in turn, rotates the positioning cam. In this manner, the antenna bypass switch is caused to position itself in accordance with the position chosen by the antenna transfer switch. Relay K1 receives its operating voltage from the -24 volt after time delay line.

With the antenna bypass switch in the BYPASS position (as shown), relay K1 is not energized, and the r-f output from the load-adjusting unit is directly connected to the antenna through J1 and contacts 4 and 1 of S3. When it is desired to have the tuning elements in the line, the antenna transfer switch is placed in the TUNER IN position. S3 is therefore rotated so that the r-f energy now passes through contacts 4 and 3 of S3, and then out through connector J2 to the r-f tuner output. The output of the r-f tuner is permanently connected to the loading switch, S1. The loading switch selects the desired tuning component. The output of S1

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is connected to contact 2 of bypass switch S3, through contact 1 and to the antenna.

When S3 is switched from TUNER IN to BYPASS, or vice versa, the transmission line is momentarily interrupted, removing the antenna load. When the antenna load is removed, even for a short time, it becomes necessary to cut off the radio frequency energy at the IPA to prevent surges in the transmitter output caused by this removal. Grounding cam A (fig. 6-5) is fixed to the shaft of the bypass switch, S3, and controls the open or closed condition of microswitch S2. The configuration of the cam is such that it removes the ground from the R9, R10 junction in the IPA control grid circuit during the time that switching takes place. The absence of this ground will cause the IPA to cut off, which, in turn, cuts off the output of the transmitter.

R-F Tuner

The antenna coupler applies its output to the transformer switch, S1 (fig. 6-6) in the r-f tuner. This switch, when connected so that circuits are completed through the 1-2 contacts and the 3-4 contacts, will place the 9:1 impedance transformer in the transmission line. The purpose of the transformer is to step up the signal to the required level. In the other position of the switch (as shown), the impedance transformer is bypassed by the connection made between contacts 2 and 4 to the main tuning coil of the r-f tuner.

Magnetic actuator B1, responsible for positioning switch S1, operates under the influence of the transformer switch, S2, through the contacts, NO and C, of S3 to one side of the winding of actuator B1. The other side of the actuator is connected directly to the other side of the line. Actuator B1 rotates until the roller actuator of S3 falls into the notch of the positioning cam. At this time, the NO and C contacts of S3 open, breaking the line voltage circuit. The transformer switch, S1, is now in the position that eliminates the impedance transformer from the circuit. Placing S2 in position 14 will again energize the circuit through S4. B1 will then cause the positioning cam to rotate until the actuator for S4 falls into the notch of the cam. This corresponds to the position of switch S1, which places the impedance transformer in the circuit.

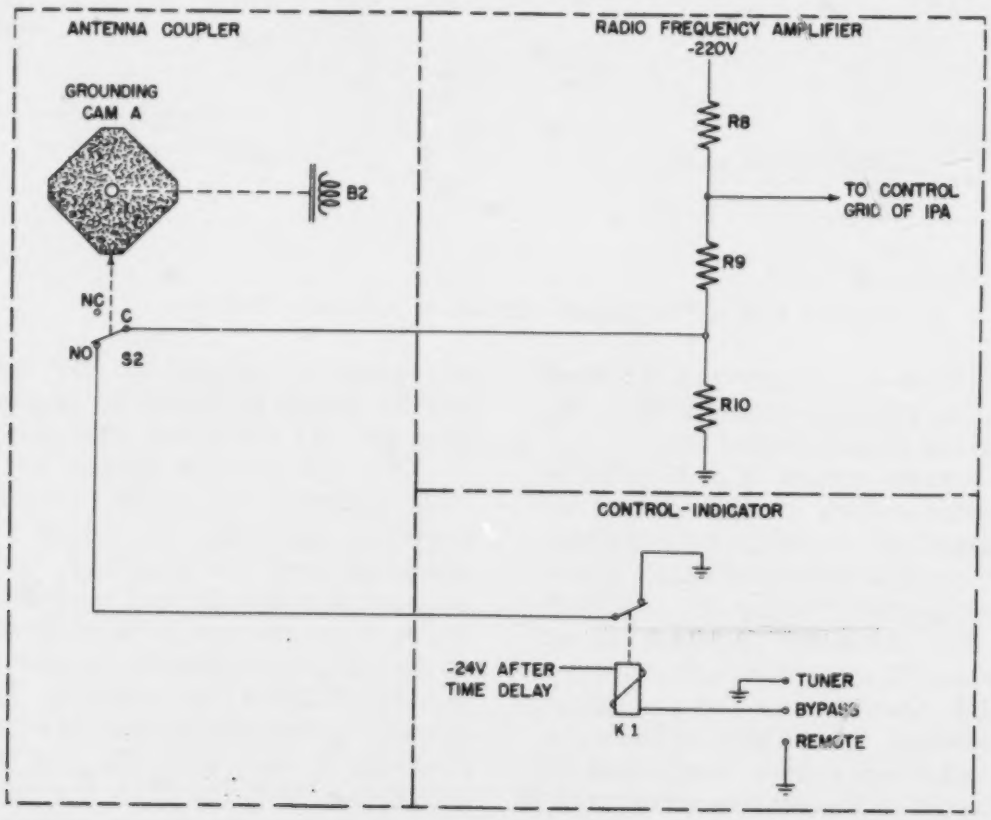

Figure 6-5.—Grounding cam circuit, simplified schematic.

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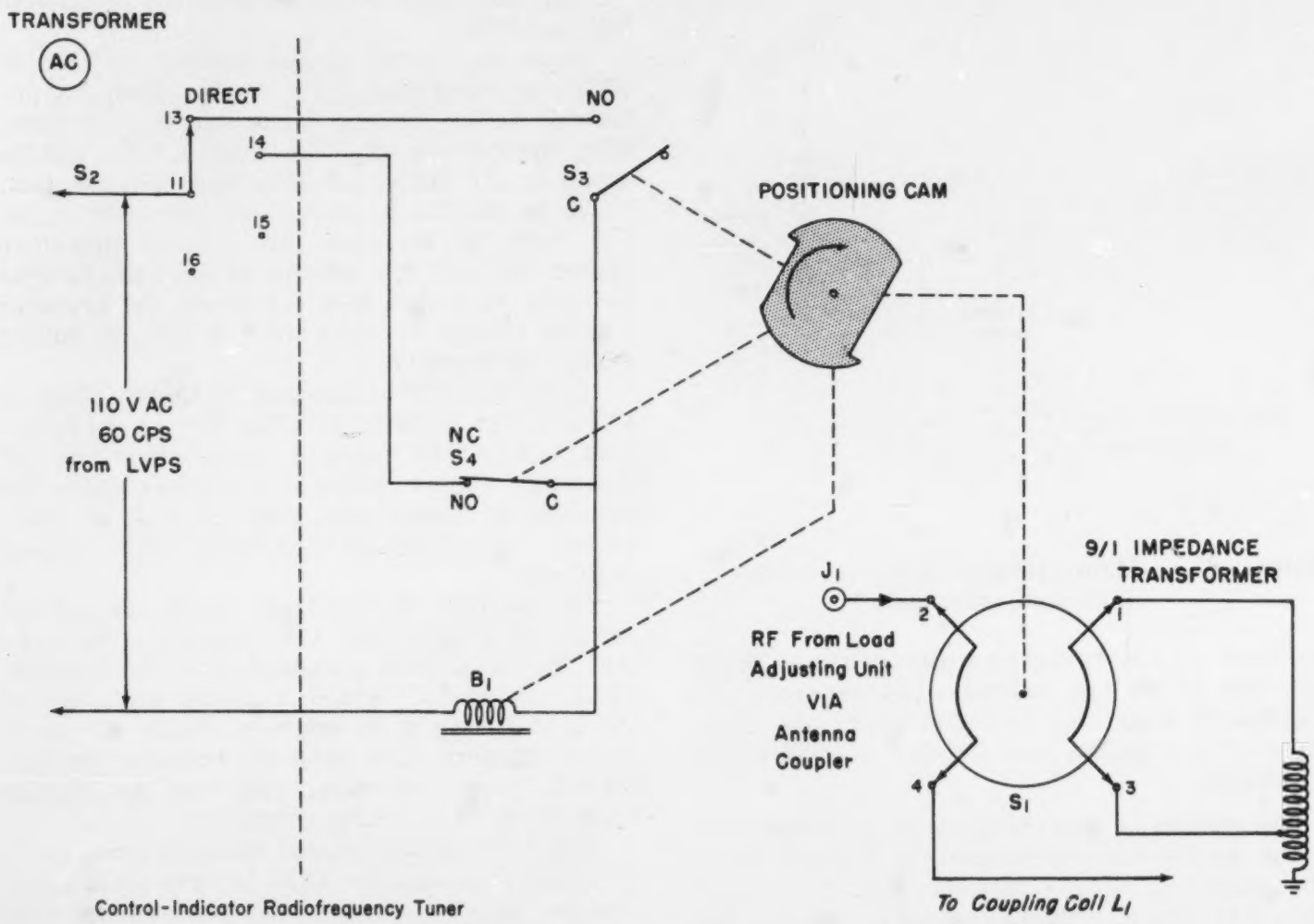

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Figure 6-6.—Impedance transformer (r-f tuner) simplified schematic.

The transmission line is coupled to the main coil (fig. 6-7) of the r-f tuner by a single loop conductor coil. L1, mounted on the shorting ring. The length and configuration of the single loop coil is such that optimum coupling exists above 1 mc if a standard Navy 35-foot whip antenna is used. The resistive component of the antenna impedance is so low at a frequency of 1 mc or lower that the impedance transformer will be necessary to bring the radiated signal to the minimum allowable limit.

The main tuning coil of the r-f tuner is equipped with an adjustable sliding short. The tuning coil is the main tuning component in the r-f tuner.

If the impedance transformer (fig. 6-6) is not required in the antenna tuning process, the r-f tuner input to its loading components is connected to the main tuning coil, L2. This tuning coil (fig. 6-7) is a section of a helical center conductor transmission line and is adjustable as forestated, by a sliding short. The short is adjusted so that the effective length of the main coil, together with the effective antenna length, is an odd multiple of a quarter-wavelength at the particular frequency in use. This is the point of resonance or zero reactance.

The position of the sliding short may be adjusted either manually by an adjustment control or remotely by a drive motor, B1. The UP, DOWN, and SLOW pushbuttons control the speed and direction of the motor.

ATU Bypass Transfer Circuit

The antenna tuning system may be bypassed in the absence of a transmitter carrier, allowing the antenna to be switched to a receiver. The

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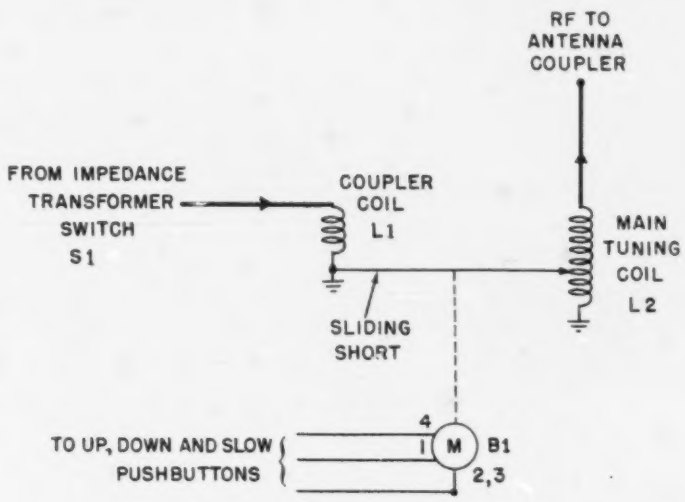

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Figure 6-7.—Main tuning coil (r-f tuner), simplified schematic.

receiver may be tuned to a different frequency than that of the transmitter. The presence or absence of a carrier is indicated by the condition of the keying line in the low-level radio modulator.

The antenna bypass transfer circuit is mounted in the LLRM for convenience of location only. The circuitry of the antenna bypass transfer circuit is shown in figure 6-8. It is undesirable to have the antenna switching attempt to follow the speed of the hand-key signals. The antenna bypass transfer circuit therefore functions to provide a signal that will place the antenna tuning system in the circuit at the time of the first hand-key signal, and keep the system in contact with the antenna until after the last hand-key signal has been transmitted.

The relay, K2 (fig. 6-2), when energized completes the signal path through contacts 3 and 4 to the antenna tuning system, which keeps the antenna and antenna tuning equipment in the line. Conversely, when deenergized, the contacts open, and the antenna tuning system is bypassed. Reference to figure 6-2 shows that the keying line during key-up condition (S5 contacts open) is at a potential of -24 volts, while in key-down condition (S5 contacts closed), the keying line is at ground potential.

The control grid of the antenna transfer control tube, V22B and the cathode of the limiter, V22A, receive a -10-volt potential when V22A is nonconducting.

The -10 volts is taken from the junction of R61 and R62.

Since the plate of the limiter section of V22A is connected to the keying line, its potential during key-up condition is -24 volts. With the cathode of V22A at -10 volts and the plate at -24 volts, the tube does not conduct. V22B is also held in the cutoff condition by the -10 volts at its grid. No current therefore passes through the winding of K2, and contacts 3-4 are open. In this condition, the transfer control circuit is open and the antenna tuning system is bypassed.

Capacitor C60 connected from the plate of V22B to the cathode of V22A is charged to approximately 260 volts. A charge in excess of the plate supply voltage is evident since the cathode, to which one side is tied, is connected to a point of -10 volts with respect to ground.

On arrival of the first mark (key-down) signal of a hand-key transmission, the keying line is at zero potential, and the limiter, V22A, conducts, which reduces the bias of V22B, allowing it to conduct. Relay K2 energizes, closing the antenna transfer control circuit, which, in turn, removes the bypass from the antenna tuning equipment.

When the keying signal changes from mark to space (key-up), the V22A limiter plate again returns to -24 volts, which renders the tube non-conducting. As V22A begins to move toward cutoff, capacitor C60 begins to recharge. Since the grid of V22B is going more negative, a reduction in plate current is evidenced. The recharge of C60 opposes the tendency of the grid to assume the negative 10 volts and V22B moves slowly toward cutoff. The relay, K2 will remain energized until the current through V22B is reduced to 0.5 milliampere.

The time constant for the charging of C60 and, likewise, the rate at which the grid of V22B returns to the -10 volt potential is determined by the value of K2 winding resistance; the resistance of the B supply; and the value of C60, R63, R64, and R62. Resistor R64 serves as the time constant adjust control, which varies the charge time of C60 from 0.5 to 6 seconds. The relay, K2, can therefore be made to remain energized for any length of time, within this limit, after the final mark signal.

KEYING CIRCUIT

The keying input circuit, containing service selector switch, S4A, selects the input to

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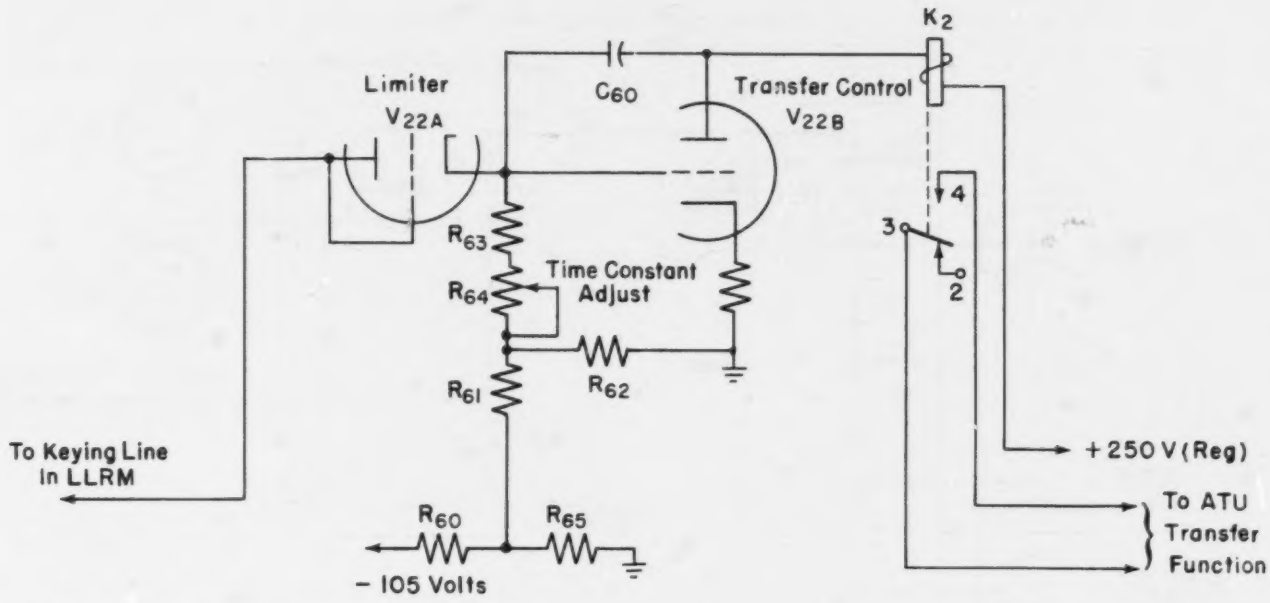

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Figure 6-8.—ATU bypass transfer circuit, simplified schematic.

the keying circuit. In hand-key and phone operation, the keying signals are introduced to the LLRM through the action of the keying relay, K6 (fig. 6-9). With the local-remote switch S1, in the REM position, the keying line is completed to ground in a radiophone unit through contacts 8F and 9F of S1 (if the key is in the MARK or DOWN position). When the key is up, there is no ground. Therefore, the transmitter is keyed on by a mark, and off by a space in c-w operation. The antenna switching relay, K2, is also operated to switch the antenna to the transmitter when the ground is supplied. When in phone operation, the press-to-talk button also supplies ground to the keying line when it is depressed.

If the phone is connected locally, S1 is in the LOCAL position, and the ground from the press-to-talk button also supplies ground to the keying line when it is depressed.

If the phone is connected locally, S1 is in the LOCAL position, and the ground from the press-to-talk button operates K7 from the +12-volt supply. With K7 operated, ground is fed to K6 through contacts 5L and 4L of K7 and contacts 7F and 9F of S1.

The test key, S5, parallels the keying line so that depressing S5 also supplies a ground to operate K6. With the service selector switch, S4, in either FSK or FAX position and the local remote switch, S1, in the REM position, a permanent ground is placed on the keying line through contacts 10 and 6 or 11 and 6 of S4B, from the keying equipment.

Two gas tube voltage regulators V17 and V18 supply a regulated -105 volts and +105, respectively, for use in the keying circuit. The -105 volts is connected to contact 4R of relay K6, and the +101 volts is connected to contact 6R. In hand-key operation, when the key is depressed (mark), K6 operates, and +105 volts is connected through contact 6R and 5R of K6, resistor R40, contacts 8 and 6 of switch S4A, contacts 8R and 10R of S6 in the operate position through R41 to ground.

When the key is up (space), K6 is not energized, and -105 volts is now applied through contacts 4R and 5R of K6 and through the same circuit as stated above. Resistors R40 and R41, acting as a voltage divider across either V18 or V17, provide either +85 volts or -85 volts for mark and space, respectively, to the grid of the buffer stage, V11A during hand-key operation. In phone operation, the same control of the buffer stage is accomplished through contacts 12 and 6 S4A except that the press-to-talk button replaces the hand key. The result of this action applies +85 volts to the grid of the buffer when the press-to-talk button is

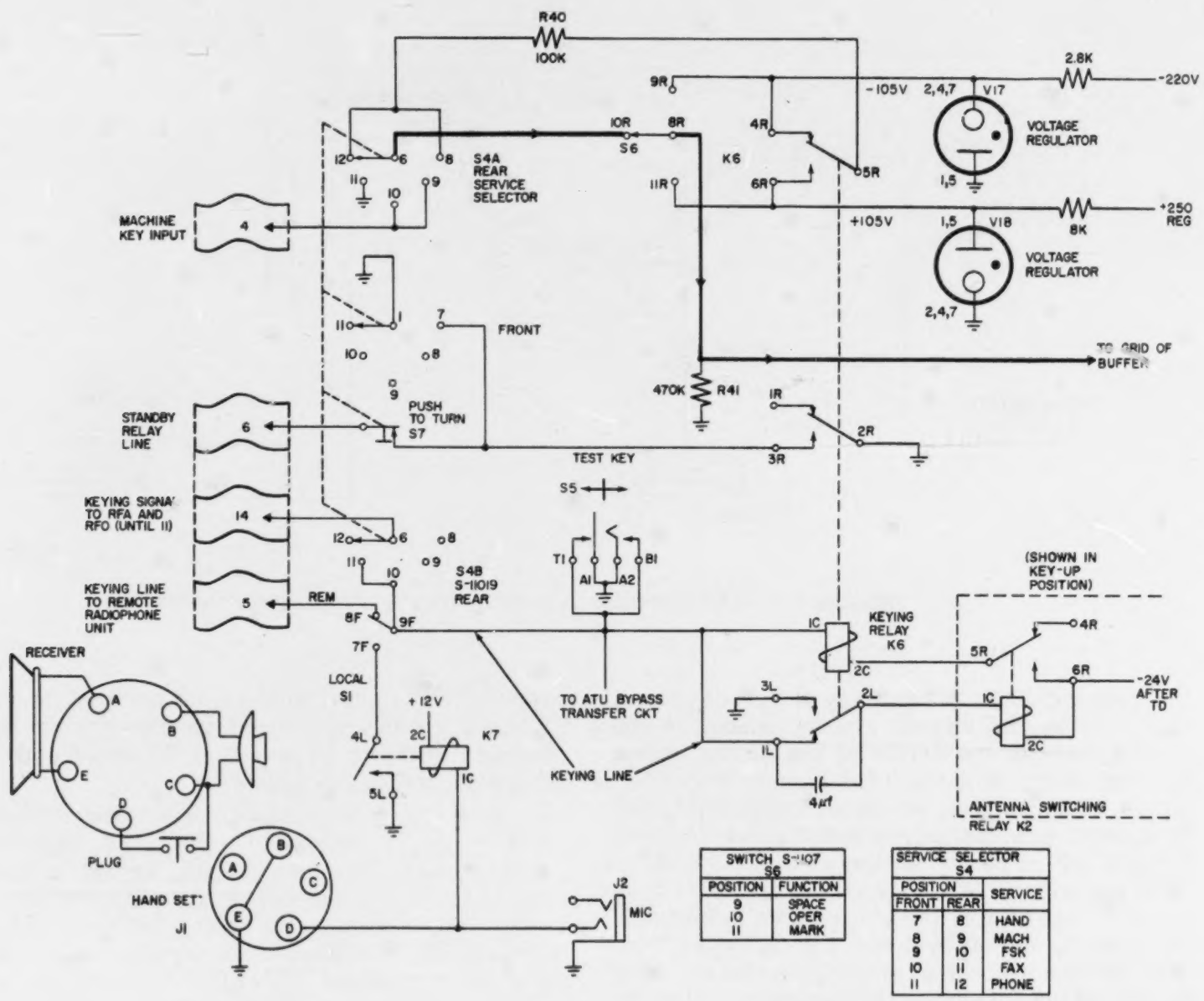

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Figure 6-9.—Keying input circuit, simplified schematic.

depressed and -85 volts to the grid when the button is released

A permanent mark or space signal can be produced at the grid of the buffer by the action of S6. Setting this switch to mark connects +105 volts to the grid of the buffer through contacts 11R and 8R of S6. In the space position. S6 connects -105 volts through its contacts 8R and 9R to the buffer grid.

In addition to providing keying voltages for the keying circuit, the keying relay, K6, also controls the action of the standby relay. K1, located in the low-voltage power supply (not shown).

The operation of K1 provides the -24 volt after time delay, which controls the operation of the MVPS, HVPS, and HLRM. The latter two units are found in the AN/SRT-15 and 16 only. The standby relay, K1, is unable to follow the keying signals, making it necessary to keep the relay energized at all time during hand-key operation. In other modes of transmission, the transmitter cannot go on the air unless K6 is energized, supplying the ground to operate K1. In machine-key, FSK, and facsimile transmission, a ground is supplied over the keying line from the remote radiophone unit that

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energizes K6 and provides a standby operate control for K1. In phone operation, K6 is operated only when the press-to-talk button is depressed, either locally or remotely. Therefore, the output circuits of the power supplies controled by K1, which, in turn, is controlled by K6, are completed in phone operation only when the press-to-talk button is depressed.

Buffer

The purpose of cathode follower V11A (fig. 6-10) is to isolate the action of the keying input signals from the keying multivibrator, V13. During weak signal the cathode of V11A is power biased to + 40 volts by the voltage divider connected from the regulated +105 volts to the regulated -105 volts. The keying voltages for the different modes of operation are applied at the grid of V11A, and are reproduced at the cathode. When the negative input exceeds approximately -45 volts, V11A will cut off, with the result that the maximum amplitude of a negative keying signal appearing at the cathode is about 40 volts.

Keying Multivibrator

The keying control tube, V12, and keying multivibrator, V13A, receive the output of the cathode follower. In the space condition V13B conducts. The voltage developed across R 48 is sufficient to cut off V13A even though a small positive voltage is developed between the V13A grid and ground. The keying control tube, V12B, ensures that V13B conducts and V13A is cut off during space. The plate of V12B is connected in the grid circuit of V13A. If V12B were not included in the circuit the junction of the resistors R46 and R47 would be about +5 volts during space.

The cathode of V12B during neutral keying is tied to the cathode of the buffer, V11A, through contacts 2 and 1 of the neutral polar switch, S8, in the NEUTRAL position. During space this point is at either +4 volts for neutral machine keying or -40 volts for hand keying. As these values are at or below the normal +5 volts to which the plate of V12B is tied, V12B conducts, effectively tying the junction of R46 and R47 to the space voltage appearing at the buffer cathode. Therefore, the grid circuit of V13A during space is at a lower (less positive) potential than the grid of V13B, causing the desired condition of having V13A cut off and V13 B conducting. When a spacing signal is applied the same action occurs in polar keying, except that the keying control, V12B, is connected so that its cathode goes to about +4 volts when the grid of the buffer, V11A, is at -30 volts. This action is accomplished by connecting the cathode of V12B to a tap on potentiometer R 44 through contacts 2 and 3 of S8 in the POLAR position.

The polar space control R44, is a part of a voltage divider consisting of R43, R44, and R45, which is connected between the +105 volt and -105 volt supplies. The tap of the potentiometer is tied to the cathode of the buffer. In space, with a -30-volt keying signal on the grid of the buffer its cathode will be a potential of about -27 volts. The setting of R44 will be such that the tap will be about +4 volts. With the multivibrator in the space condition, the plate voltage of V13A will be approximately +235 volts, and the plate of V13B approximately +100 volts.

As the keying signal changes from space to mark, the potential of the buffer cathode starts to rise. As this potential reaches +5 volts in neutral keying or -27 volts in polar keying, the keying control tube, V12B, no longer conducts and has no effect on the grid of V13A. The potential at the latter grid rises as a result of this action, but does not rise sufficiently high to overcome the common cathode bias developed across R48. As the mark potential rises higher keying control tube, V12A, comes into action. The cathode of V12A is tied to the grid of V13B. The plate of V12A is connected to the tap of potentiometer R45, the cathode resistor of the buffer circuit. One end of the buffer cathode resistor is tied to the -105 volt source.

The potentiometer, R45, is known as the neutral-polar-mark control. In order for V12A to conduct, its plate potential must be higher than that at the grid of V13A. As the mark voltage increases at the cathode of the buffer, the voltage of the tap of R45 will become higher than the grid of V13A, allowing V12A to conduct. When V12A conducts, it effectively makes the potential at the grid of V13A the same as that developed at the tap of R45. The tap is set so that as the mark signal reaches +30 volts at the grid of the buffer, the voltage at the tap, and also at the grid of V13A will be sufficient to overcome the bias potential developed across the common cathode resistor, causing V13A to conduct. The tube remains in conduction throughout the marking impulse. Therefore, in the mark condition, the plate of V13A is at a potential of approximately 70 volts, while the plate of V13B has a potential of about +235 volts.

As the keying voltage changes from mark to space, the potential of the grid of V13A must be

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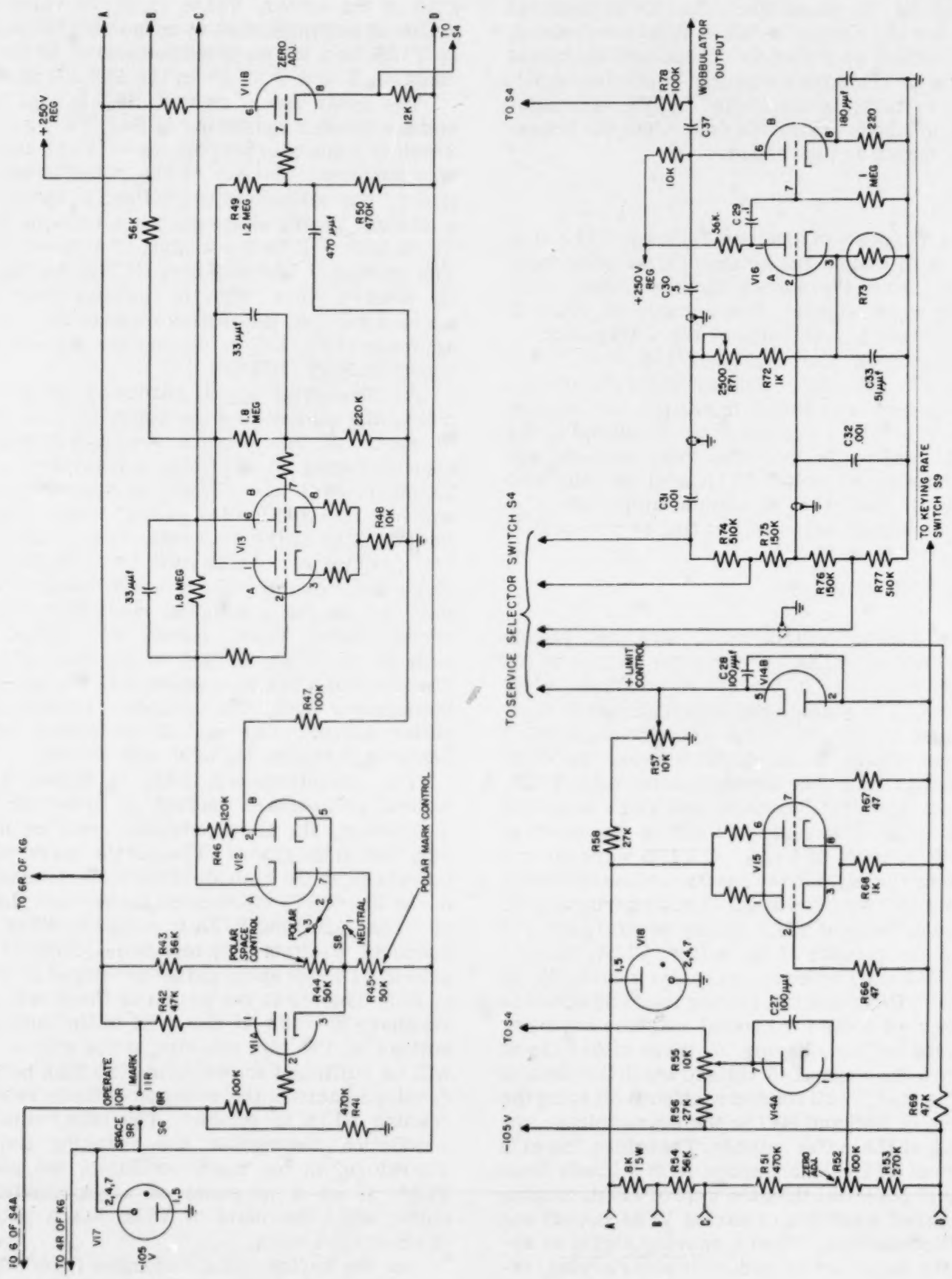

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Figure 6-10.—Low-level radio modulator keying circuit, simplified schematic.

7099

lowered enough to cause a reduction in the tubes current flow, which will initiate the cumulative flip-flop action. During the mark condition, the junction of R46 and R47 (to which the plate of V12B is tied) is about +11 volts. Therefore, when the keying signal reduces to a point where the cathode of V12B (which is tied to the cathode of the buffer in neutral keying and to the polar space control in polar keying) goes below +11 volts, V12B conducts, lowering the grid potential of V13A. In neutral keying when the keying signal has reduced to about +7 volts, V12B will conduct a sufficient amount to lower the V13A grid below the saturation point, and the flip-flop action takes place. In polar keying the polar space control, R44, is set so that when the negative or space keying signal reaches about -28 volts, the keying control, V12B, conducts enough to lower the grid potential of V13A below the saturation value, and the multivibrator returns to the space condition.

The keying multivibrator, V13, has two outputs. One of the output voltages is developed in the plate circuit of V13A, and the other, which is out of phase with reference to the first, is developed in the plate circuit of V13B. The keying voltage developed in the plate of V13A is fed to the dumping cathode follower, V11B, for use in the push-pull cathode followers of the audio amplifier chain of the LLRM. A keying signal of zero volts for space and -65 volts for a mark is delivered to V11B from a voltage divider in the plate circuit of V13A. The dumping cathode follower provides a low impedance to the input of the push-pull cathode followers. The time constant in the output circuit of the dumping cathode follower is such that the waveshape is not destroyed. The output is taken directly from the cathode of V11B. The output signals are connected to the push-pull cathode followers through the service selector switch, S4 in the HAND and MACHINE positions. In frequency-shift keying and fascimile operation, the transmitter is functioning continuously, and no load compensation is required. In phone operation, load compensation is not required since the +500-volt supply is turned off when the press-to-talk button is up by the action of the keying relay, K6.

The keying signal from V13B, which is +25 volts for mark and -30 volts for space, is delivered to the limiter, V14A and V14B. This range of voltage is obtained from a voltage divider connected from the plate of V13B, through R51, zero adjust control R52, and R53, to the regulated -105 volts. The keying signal is developed across a value of capacitance that is selected by the keying rate switch, S9. The time constant involved in charging and discharging this capacitance (not shown) gives the required rise and decay time to the keying signal wave-shape. In HAND and MACH positions of the service selector switch, a second set of wave-shaping capacitors are connected in parallel with the first set.

Limiter

The plate of the limiter, V14A, is tied to the tap of a potentiometer, R55, known as the limit keyer out control. Potentiometer R55 is adjusted for -10 volts at the tap. Therefore, any negative (space) keying signals in FSK operation are clipped at a maximum of 10 volts by the action of the limiter diode, V14A. In other modes of operation the ground is removed from R55 by the service selector switch, S4, and the plate of V14A is tied to the -105 volts.

In hand-key, machine-key, and phone operation, the cathode of the limiter, V14B, is grounded through service selector switch, S4 for hand, mach, and phone. In these positions of the switch, potentiometer R57 in the cathode of V14B is shorted through the switch contacts. In FSK operation, the short on the cathode of V14B is removed. The cathode is then connected to the tap of the potentiometer R57, which is part of a voltage divider from +105 volts to ground Potentiometer R57 is the (+) limit control, and is adjusted for 10 volts at the tap. In this condition, V14B clips positive (mark) keying signals at +10 volts. Therefore, positive (mark) signals in hand-key, machine-key, and phone operation are clipped at zero, whereas in FSK operation, they are clipped at +10 volts.

Keyer

The keying signals, as supplied by the limiters, are fed to the grids of the keyer V15. This stage utilizes a twin triode operating in parallel. When a mark keying signal (zero volts) is applied to the grid of the keyer, the cathode is driven to about 2 volts positive. Since the stage is operated class A, the mark signal as applied to the buffer of the RFA should not go above zero volts. For this reason the output is taken at the junction of R68 and R69 to reduce the mark voltage from +2 volts to zero.

7100

The output of zero volts for mark and -30 volts for space is the same in hand key, machine key, and phone operation. These signals are used to cut off the buffer in the RFA and the output stage of the RFO in the KEY UP (space) condition for the two keying modes or the press-to-talk button UP in phone operation. Both the buffer in the RFA and the output of the RFO are keyed off to assure that the key-up radiation from the transmitter group is below the minimum allowable level of 400 picowatts

In FSK operation the output for the keyer, which is+10 volts for mark and-10 volts for space, is fed to the radio frequency oscillator to frequency modulate the frequency-shift oscillator in the RFO. Contacts 4R and 6R (of K6, fig. 6-9 control the keying circuits that supply the FSK output to the FSO in the RFO. The signals are fed from the junction of R68 and R69 (fig. 6-10) to the service selector switch S4. Other positions of S4 are grounded since the frequency-shift oscillator is not used in hand-key, machine-key, or phone operation.

Audio Oscillator

A Wien bridge circuit, V16 (fig. 6-10), functions as the audio oscillator and provides two outputs. In FSK operation the output is 200-cycle signal whose purpose is to phase modulate the frequency-shift oscillator in the RFO whenever it is necessary in order to prevent the effects of selective fading. The amplitude of the 200-cycle signal is sufficient to produce a one-radian phase shift in the carrier. This amount of shift can be varied between zero and one radian by a PHASE MOD control (not shown). In hand-key and machine operation, the audio osciallator produces a 1000-cycle signal during the key down (mark) condition that is fed to the sidetone amplifier in the audio chain for monitor purposes.

With the service selector switch, S4, in the HAND or MACH position, R74 is shorted out and R76 is grounded through contacts of S4. Therefore, in hand-key or machine-key operation, the reactive half of the bridge is composed of C31, R75, R76, and C32.

Since R73 is the cathode resistor of V16A, a degenerative feedback voltage is obtained across R73 in the resistive half of the bridge, A regenerative feedback signal obtained in the reactive half of the bridge is applied to the grid of V16A. At a frequency determined by the components of the reactive half of the bridge the regenerative voltage will be in phase with the signal at the grid of V16A. This voltage will be equal to or slightly larger than the degenerative voltage.

The relative amplitude between the two voltages is controlled by the setting of the AUDIO OSC FEEDBACK control R71. The resonant frequency of the circuit, when all the components of the reactive half are used, is 200 cycles. This frequency is used during FSK operation. In hand-key and machine-key operation, with R74 and R77 removed by the action of S4, the resonant frequency becomes 1,000 cycles. In facsimile and phone operation the regenerative feedback in the reactive half of the bridge is grounded through contacts of S4, which disables the circuit.

In the cathode circuit of V16A, R73 (a ballast lamp) is used instead of a resistor to stabilize the amplitude of the oscillation. If the amplitude tends to increase, the current through the lamp also increases. The increase in temperature of the lamp filaments cuases the lamp resistance to increase, thereby increasing the amount of degenerative feedback. The gain of V16A is reduced in such a manner as to maintain the output voltage at a nearly constant amplitude. If the amplitude of the voltage is kept small, the oscillator tube will operate in the linear portion of its characteristic curve, producing a sinusoidal output.

In FSK operation the 200-cycle signal is fed to a FSK PHASE MOD control (not shown). The control contains an on-off switch that controls the application of the 200-cycle signal. The voltage developed across this potentiometer may be adjusted to produce a one-radian phase shift in the output of the frequency-shift oscillator, varying around the fundamental output frequency of 200 cps. The amount of shift introduced into the frequency-shift oscillator is multiplied throughout the remaining units of the RFO. The resulting wobbulating action presented by the 200-cycle shifting causes the transmitter output frequency to shift accordingly.

In hand-key or machine operation, the 1000-cycle output is coupled through resistor R78 and contacts of the service selector switch S4 to the grid of the sidetone amplifier in the audio chain. In hand-key operation a parallel connection, through contacts of S4 is made to keying relay, K6. In space, K6 is not energized, and the 1000-cycle output is grounded. In mark, K6 is energized and the ground is removed, allowing the signal to be applied to the grid of the sidetone amplifier.

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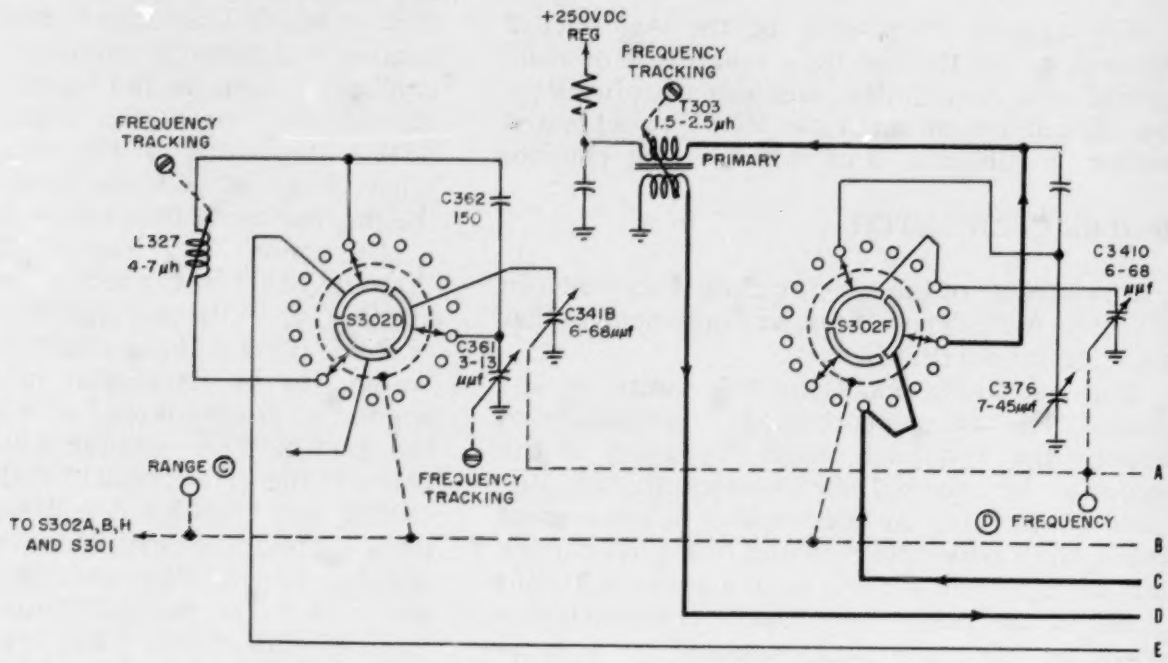
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FREQUENCY
TRACKING
T303
1.5-2.5μh
PRIMARY
FREQUENCY
TRACKING
L327
4-7μh
C362
150
S302D
C3418
6-68μμf
C361
3-13
μμf
FREQUENCY
TRACKING
S302F
C3410
6-68
μμf
C376
7-45μμf
RANGE Ⓒ
TO S302A,B,H
AND S301
Ⓓ FREQUENCY
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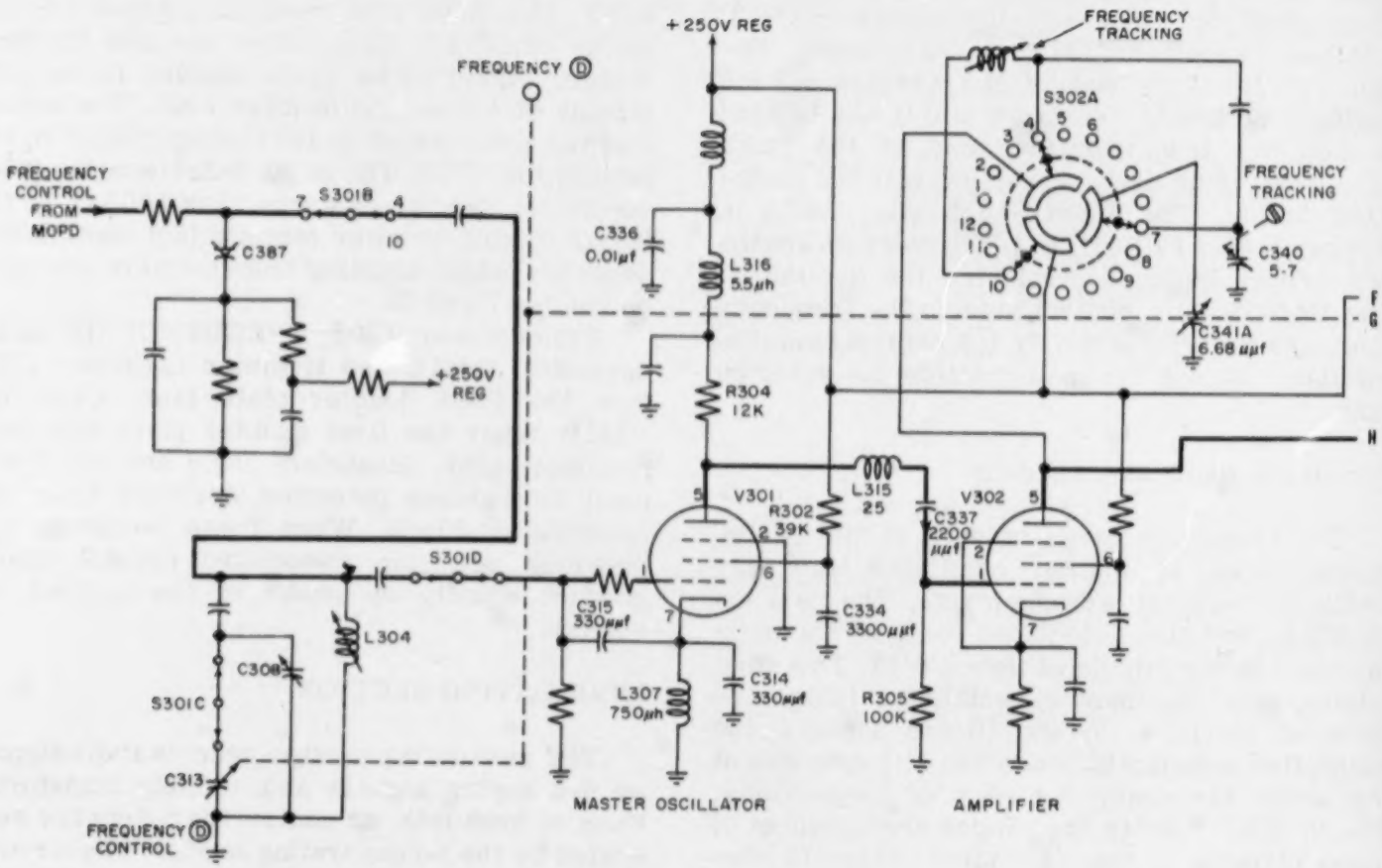
+250V REG
FREQUENCY Ⓓ
FREQUENCY
TRACKING
S302A
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CONTROL
FROM
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C387
10
C336
0.01μf
L316
55μh
FREQUENCY
TRACKING
C340
5-7
C341A
6.68 μμf
+250V
REG
R304
12K
V301
R302
39K
L315
25
V302
C337
2200
μμf
S301D
C315
330μμf
C334
3300μμf
L304
C308
S301C
L307
750μh
C314
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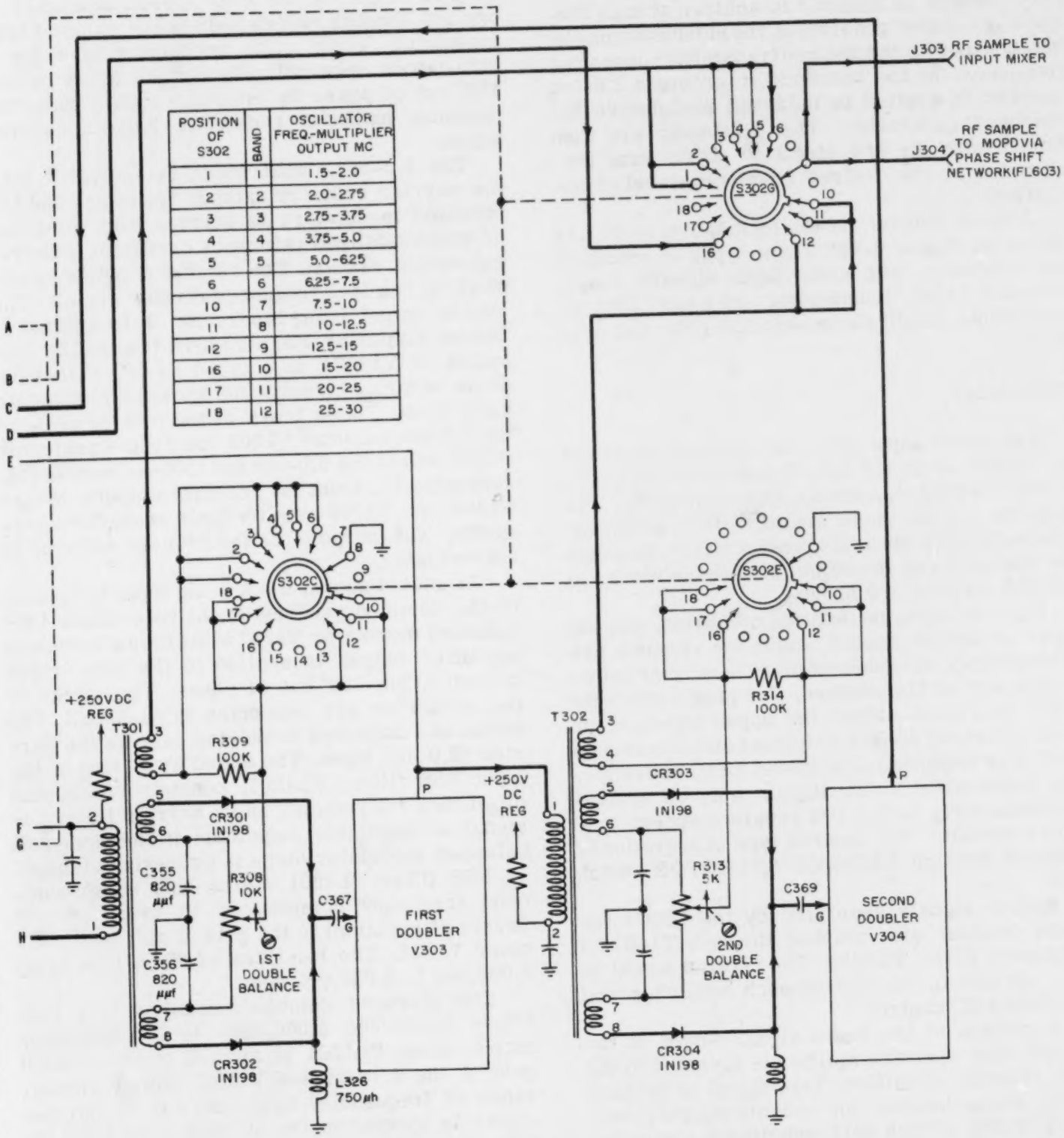

POSITION OF S302	BAND	OSCILLATOR FREQ.-MULTIPLIER OUTPUT MC
1	1	1.5-2.0
2	2	2.0-2.75
3	3	2.75-3.75
4	4	3.75-5.0
5	5	5.0-6.25
6	6	6.25-7.5
10	7	7.5-10
11	8	10-12.5
12	9	12.5-15
16	10	15-20
17	11	20-25
18	12	25-30

32.285

Figure 6-11.—Master oscillator-frequency multiplier, simplified schematic.

7104

units of the transmitter: the radio frequency oscillator and the amplifier-power supply.

The filter method of generating single sidebands is used in the modulator. With this method, sideband operation must be accomplished at a low frequency level since accurate filter design is difficult to achieve at high frequencies. After generation, the sidebands may be heterodyned to the desired transmitter operating frequency. In the transmitter group, a 2.0-mc carrier is applied to balanced modulators for sideband generation. The sidebands are then mixed with the MO signal to obtain sum frequencies at the desired frequency level of operation.

A block diagram of the modulation section is shown in figure 6-12. Three types of emission are available with audio input signals: single sideband (A3a), independent sideband (A3b), or compatible amplitude modulation (USB and carrier).

Audio Stage

The audio input from the microphone is fed via T1407 or T1408 and filter FL1401 to either of two idential speech amplifier channels. The channels are the upper sideband (USB) and lower sideband (LSB) channels, respectively. Because the channels are the same, only those blocks in the USB channel are shown.

For amplitude modulation operation, only the upper sideband speech amplifier circuits are used and only one sideband plus the carrier (compatible AM) is transmitted. For single sideband (SSB) operation either the upper sideband or lower sideband speech amplifier circuits may be used. For independent sideband (ISB) operation, two independent audio signals may be applied simultaneously to the two separate speech amplifier circuits. The desired type of operation is selected through EMISSION SELECTOR switch S508.

Speech signals generated by the USB telephone handset are coupled through T1407 to band-pass filter FL1401. The filtered signal is then applied to the USB speech amplifier and the USB-AGC control.

A portion of the audio signal output of the second USB speech amplifier is diverted to the USB sidetone amplifier. This signal is fed back to the phone handset for monitoring purposes. TEST TONE switch S511 substitutes the output of the 425-cycle test oscillator, Q1411 and Q1412, for that of the audio when a single-tone test signal is desired. Meter amplifier Q501 and Mod level meter M502 provide a visual indication of the speech amplifier output levels. Meter M502 is connected in the output circuit by MOD LEVEL switch S512.

The output of the USB speech amplifier is applied through switch S508 to the grids of USB modulator V1201. The modulator contains a twin-triode tube with its control grids driven 180° out of phase by an audio signal, while the common cathodes receive a 2.0-mc carrier signal.

The 2.0-mc signal which is applied to both the carrier reinsert cathode followers and the sideband modulators is derived from the 1-mc crystal-stabilized reference oscillator in the r-f generating section. The oscillator output is applied to the 10:1 frequency divider circuit. The 500-kc output from binary No. 1 is applied to 500-kc amplifier stage V1207A (fig. 6-12). The output of V1207A is coupled to two half-wave diode rectifier circuits (not shown) for harmonic generation. Tuned tanks at the control grids of the 2.0-mc selector V1208 and 1500-kc selector V1209 select the 2.0-mc and 1500-kc harmonics. respectively, from the rectifier outputs. Stages V1208 and V1209 amplify their respective harmonic. The purpose of the 1500-kc selector is treated later.

As stated above, the 2.0-mc input is applied to the common cathodes of the twin-triode USB balanced modulator V1201 while the audio speech amplifier output is applied to the twin triode control grids 180° out of phase. The plates of the modulator are connected in push-pull. The action of a balanced modulator cancels the carrier (2.0 mc) input. The signal appearing at the input USB filter, FL1201, consists of sum and difference frequencies and a carrier frequency signal of negligible magnitude if the push-pull balanced modulator stage is properly balanced.

USB filter FL1201 allows only upper sideband frequency components to pass (without severe attenuation) to the grid of sideband combiner V1203. The bandpass of Fl1201 is from 2,000,300 to 2,008,000 cps.

The sideband combiner consists of a twin triode tube. The 2,000,300- to 2,008,000-cps output from FL1201 is applied to the control grid of the A section of V1203, while a similar range of frequencies below the 2.0-mc carrier signal is applied to the V1203B grid from the LSB filter FL1202 (not shown). The plates of V1203A and V1203B have separate plate loads in the carrier reject filter FL1203. The filter

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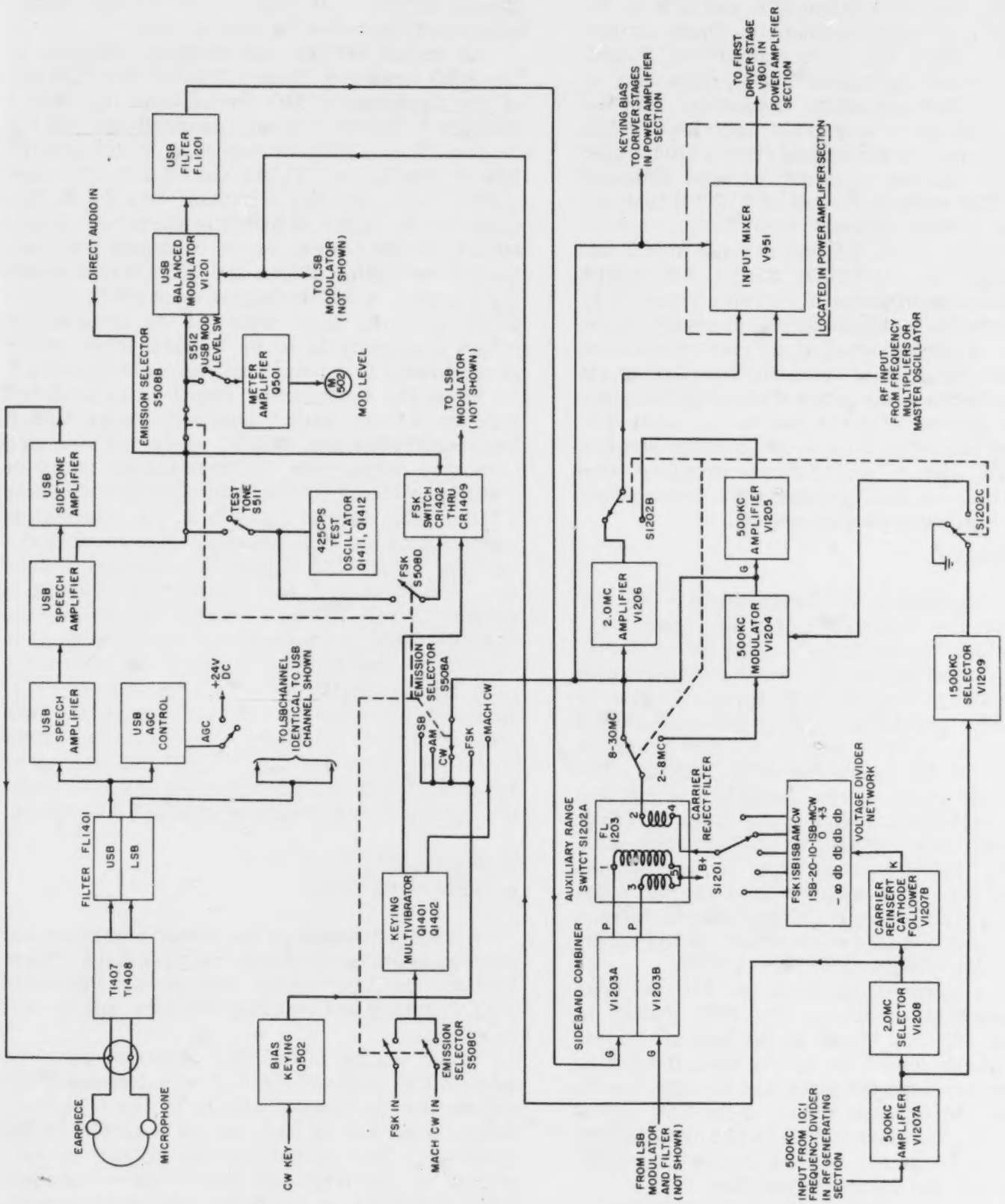

Figure 6-12.—Modulating section, block diagram.

7106

(filter components not shown) rejects the 2.0 mc carrier at the V12-3 output. The common secondary coil connected betwjen terminals 2 and 4 of FL1203 receive both the USB and LSB signal components as separate signals. These outputs are fed to either the 2.0-mc amplifier, V1206, or to the 500-kc modulator V1204, depending on the transmitter operating frequency, and the position of auxiliary range switch section S1202A.

The 2.0-mc carrier signal from V1208 is also applied to carrier reinsert cathode follower V1207B. The cathode circuit of V1207B contains a voltage divider network from which various voltage levels of the 2.0-mc carrier signal can be selected by CARRIER REINSERT switch S1201. Varying degrees of carrier reinsertion are required to facilitate signal recovery at the receiver. A higher level of carrier reinsertion is possible during c-w operation than during AM operation because the peaks of the speech signals limit the amount of drive that can be applied to the power amplifier stages. Attenuation settings of -∞, -20, -10, 0, and +3 db are provided. For AM, MACH c-w, and c-w operation it is necessary to transmit a carrier signal.

Keying Circuits

Three classes of d-c keying signals are accepted by the modulating section: frequency-shift neutral keying from a teletype or multiplex unit, machine or c-w keying signals from an automatic coder, or hand-keyed c-w signals.

In FSK operation, the S508C and S508D contacts are closed. Switch section S508B is open and S508A is in the FSK position. The FSK or MACH c-w input signals are applied through S508C to a keying multivibrator, Q1401 and Q1402. The output of the 425-cps test oscillator Q1411 and Q1412 is applied through S508D to the FSK switch. This circuit comprises CR1402 through CR1409 and is a symmetrical electronic switch which is driven by keying multivibrator Q1401 and Q1402.

When a space signal is on the line, the keying multivibrator causes the FSK switch to route the 425-cps signal to the LSB modulator. When a mark signal is on the line, the keying multivibrator changes state and the FSK switch transfers the 425-cps signal to the USB modulator. Thus, the mark signal is 425 cycles above the carrier frequency and the space signal is 425 cycles below the carrier frequency.

During c-w operation, the c-w keys actuates a bias keying stage, Q502, the output of which is applied through S508A to the grid of the 2.0-mc amplifier, V1206, to the grid of the 500-kc amplifier, V1205, and to the grids of the mixer and driver stages of the radio frequency amplifier (shown later). This action cuts off the transmitter carrier when the key is open.

As stated earlier, the master oscillator in the RFO operates from 1.5 to 7.5 mc. The use of the fundamental MO frequencies for band 1 through 6 (2.0 to 8.0 mc) necessitates the inclusion of the 1500-kc selector, V1209 and the 500-kc modulator, V1204. On the lowest transmitter rane, the MO frequency is 1.5 mc. Because of the action of S302 the master oscillator output on the lowest range bypasses the frequency multiplier stages and is fed directly to an input mixer. A 500-kc signal must also be introduced into the input mixer if the transmitter output frequency is to be 2 megacycles, which is the lowest frequency that can be transmitted.

When the transmitter output is to be in the 2.0- to 8.0-mc range, auxiliary range switch sections S1202A and S1202C apply the sideband combiner output (via FL1203) and the output of 1500-kc selector V1209 to the 500-kc modulator V1204. The 500-kc modulator is identical in operation to the USB modulator described earlier. The push-pull output of V1204 suppresses the 1500-kc signal and a tuned tank in the grid circuit of the 500-kc amplifier V1205 selects only the difference-frequency components generated by the modulator, plus or minus the modulation (intelligence) contained in the original 2.0-mc signal. The 500-kc signal then passes through auxiliary range switch S1202B to the mixer in the PA section and serves as the injection frequency to the PA mixer throughout the frequency coverage of bands 1 through 6.

POWER AMPLIFIER AND ANTENNA SECTION

A block diagram of the power amplifier and antenna sections is shown in figure 6-13. These sections include driver and power amplifier stages, tuning and coupling circuits, and the r-f monitor.

After mixing in the input mixer stage of the modulating section, the r-f signal contains the modulation component and is in the frequency range from 2.0 to 30.0 mc as selected by the operator. The output of the mixer is amplified in the first and second driver stages, V801 and V802, in the power amplifier section. The smplified r-f is then applied to the power amplifier stages, V804 through V807.

7107

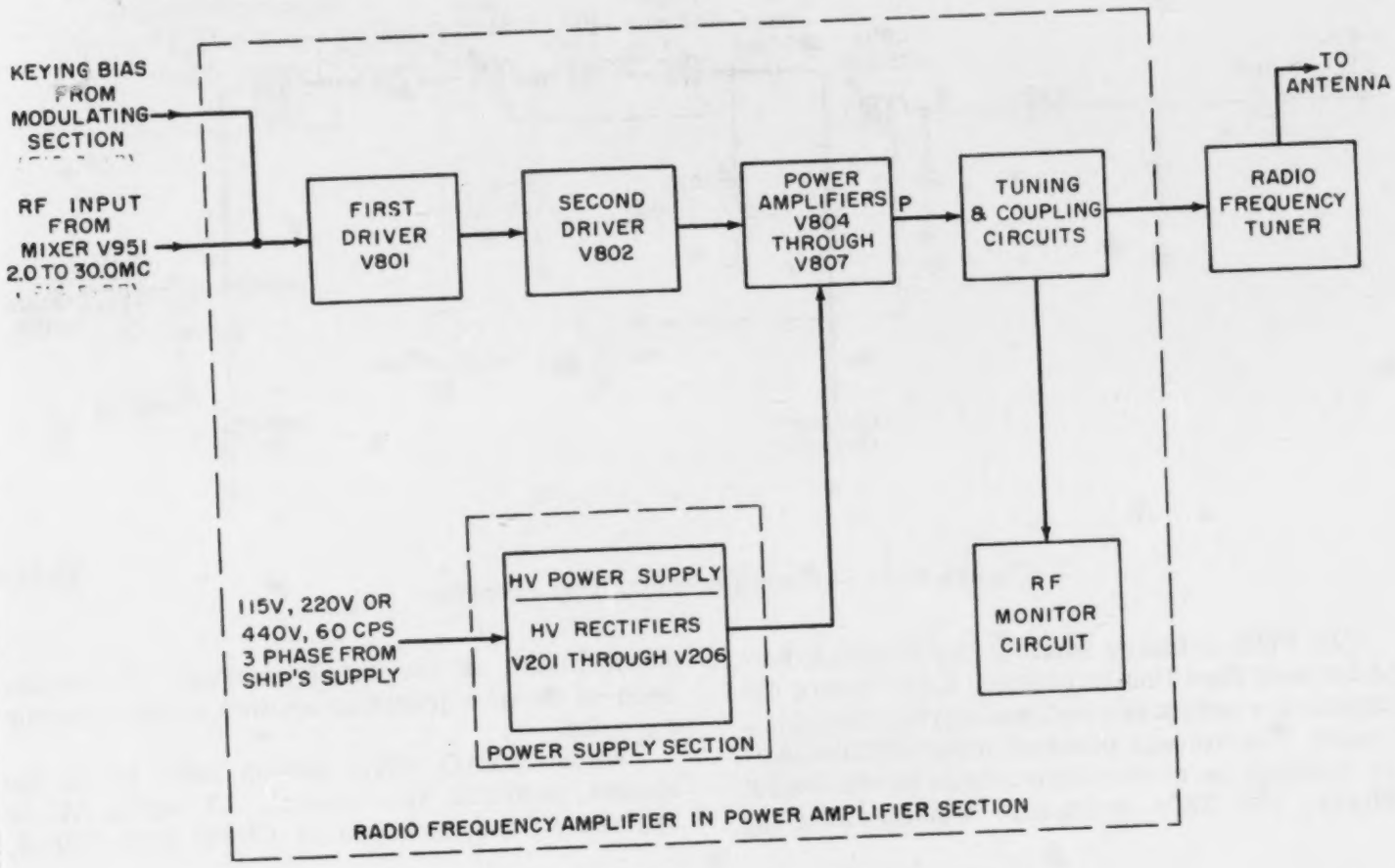

Figure 6-13.—Power amplifier section, block diagram.

The power amplifier stages consist of four 4CX300 tetrode tubes connected in parallel (not shown). Plate voltage for these tubes is supplied by high voltage rectifiers V201 through V206. The power amplifier output is fed through the tuning and coupling circuits and the radio frequency tuner to the antenna.

A portion of the output from the tuning circuit is fed to the r-f monitor circuit, which consists of a modulation monitor for measuring the modulation percentage, and a reflectometer for measuring the output power level and voltage standing wave ratio on the line which feeds the antenna. A circuit analysis of the r-f monitor is treated later.

Because the circuits of the driver and power amplifier stages are conventional in most respects, the circuit analysis of these stages is not treated in this discussion. The antenna tuning and coupling circuits used in the AN/WRT-2 are not conventional and are therefore treated with the aid of schematic diagrams.

Tuning and Coupling Circuits

The plate output of the power amplifier tubes is fed into the tuning and coupling circuits by C827 (fig. 6-14). The resonant frequency of tuning components L803 through L805 and C836 and C837 is adjusted by a PA TUNING Ⓖ control and PA COUPLING Ⓗ control located on the radio frequency amplifier front panel. These components form a pi network low-pass filter at the operating frequency. The PA tuning control adjusts all five tuning components simultaneously while the Ⓗ control adjust only C837 and L805.

R-F Monitor

As forestated, the r-f monitoring circuit contains a modulation monitor circuit which indicates percentage of modulation, and a reflectometer circuit which measures the transmitter power output and the VSWR on the line of the antenna. Figure 6-15 is simplified schematic of the r-f monitor circuit.

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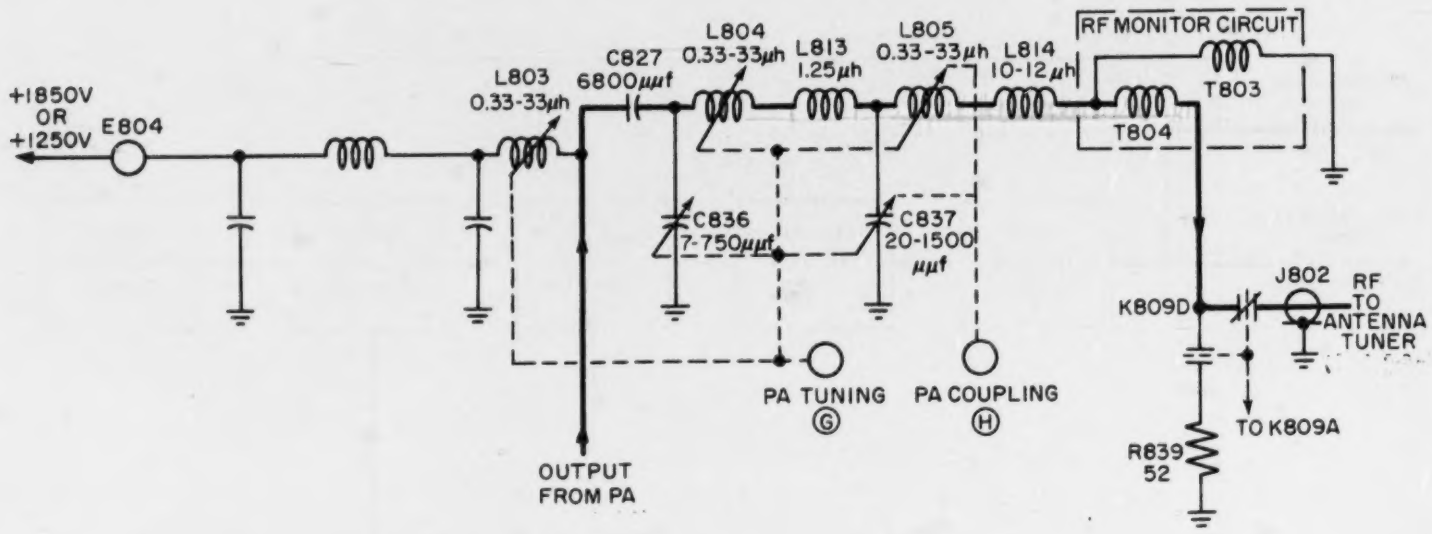

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Figure 6-14.—Tuning and coupling circuits.

The T803 primary winding is connected from the antenna feed line to ground. A portion of the transmitter output is developed across the transformer. The voltage induced in the T803 secondary winding is of the same phase as the output voltage. The T804 secondary winding is of the same phase as the output current. The vector sum of these voltages is applied to the detector circuits.

When READ SWR switch S807 is in its closed position (as shown), 17 volts AC is applied to the cathodes of CR806 and CR812,

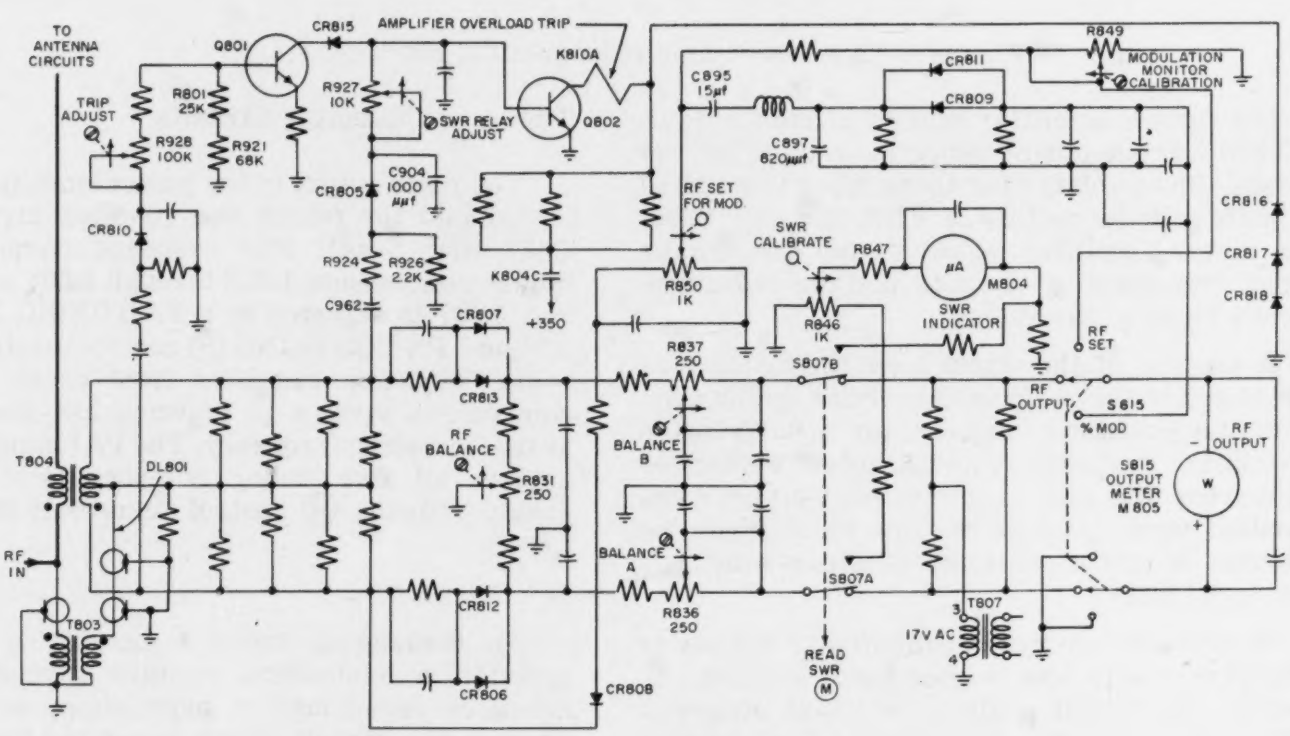

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Figure 6-15.—R-f monitoring circuit, simplified schematic diagram.

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and CR807 and CR813. The 17 volts AC places a bias on these diodes so that they operate as square-law detectors, their d-c output voltage being proportional to the square of the applied voltage. The output of one set of diodes is proportional to incident power and the output of the other set of diodes is proportional to reflected power due to a mismatch of impedances. R-F OUTPUT meter M805, connected to the two output lines through OUTPUT METER switch S815, measures the difference between the incident and reflected power or the true power. BALANCE A control R836 and BALANCE B control R837 provide for zero adjustment and upper scale calibration of meter M805.

READ SWR switch S807 is spring loaded and normally in the position shown. R-F BALANCE control R831 is used as a means of balancing conduction irregularities in the two sets of diodes, CR806, CR812, and CR807, CR813. To measure the standing wave ratio, the switch is pushed to its momentary position, and the power monitoring circuit is removed. The removal of the 17 volts AC from the sets of diodes permit the diodes to become linear detectors. SWR INDICATOR meter M804 is connected into the monitor circuit when switch S807 is closed to its upper contacts and the SWR is indicated.

For monitoring modulation, an r-f sample of the transmitter output is obtained from the bottom of T804 and applied to CR808. A negative DC voltage is developed across R-F SET FOR MOD control R850. When OUTPUT METER switch S815 is in R-F SET position a portion of the d-c voltage across R850 is applied to OUTPUT METER M805, and R850 is adjusted so that M805 deflects to its R-F SET marker. When switch S815 is in %MOD position, a pulsating voltage is applied from the arm of R850 through C895. The d-c voltage from R850 is rectified by parallel diodes CR809 and CR811 and filtered to remove the r-f and permit an a-f signal to be applied to M805.

When a known modulation % is applied to a carrier, OUTPUT METER switch S815 is placed in R-F SET position and MOD MON CAL potentiometer R849 is adjusted to indicate the known modulation %. Thereafter, when switch S815 is placed in % MOD position, and the transmitter emission is of the A3 type, M805 indicates percentage of modulation.

To avoid possible equipment damage, SWR protection stages (Q801 and Q802) are provided to remove the high voltage from the PA stage when the SWR becomes excessive. When no SWR exists on the feeder line to the antenna the base voltage of Q802 (developed across R926 in parallel with Q801) is 180° out of phase with the voltage applied to the base of Q801. This voltage relationship exists because the base signal input for Q801 and Q802 is obtained from opposite ends of the T804 secondary. The 180° phase shift in Q801 causes the signal from the Q801 collector to be in phase with the R926 voltage at the Q802 base. The voltage across R926 increases as the SWR increases. When the ratio becomes greater than 4:1, the collector current of Q802 is sufficient to energize relay K810; and initiates the removal of all d-c voltages. The setting of SWR relay adjust R927 determines the amount of voltage that must be developed across R926 before the overload relay, K810 energizes.

Transistor Q801 is provided in order that the overload circuit may still function properly at low power levels. The collector resistance of Q801 is a function of the base-emitter bias developed across R801 and R921. When operating at low power levels, the base bias of Q801 decreases and therefore its collector resistance increases. At the same time the voltage across R926 has decreased, but the base-emitter bias for Q802 does not decrease substantially due to the increased collector resistance of Q801. Thus, an excessive SWR will still cause relay K810 to energize even when the power output level is reduced. The setting of SWR ALARM TRIP ADJUST potentiometer R928 determines the amount of base-emitter bias applied to Q801.

Antenna Tuner

The radio frequency tuner increases or decreases the effective physical length of the antenna by removing or inserting inductance in series with the antenna. As shown in figure 6-16 drive motor B3301 and 2-speed drive MP-3301 drive a sliding short up and down the main coil L3302 which can be switched in series with the antenna via antenna transfer switch S3301. A pictorial illustration of L3302 is shown in figure 6-17. The arm of R3301 is geared to the mechanical drive mechanism and electrical contact is made to POSITION INDICATOR meter M806 on the front panel of the RFA. The meter indicates the relative position of the sliding short on the main coil.

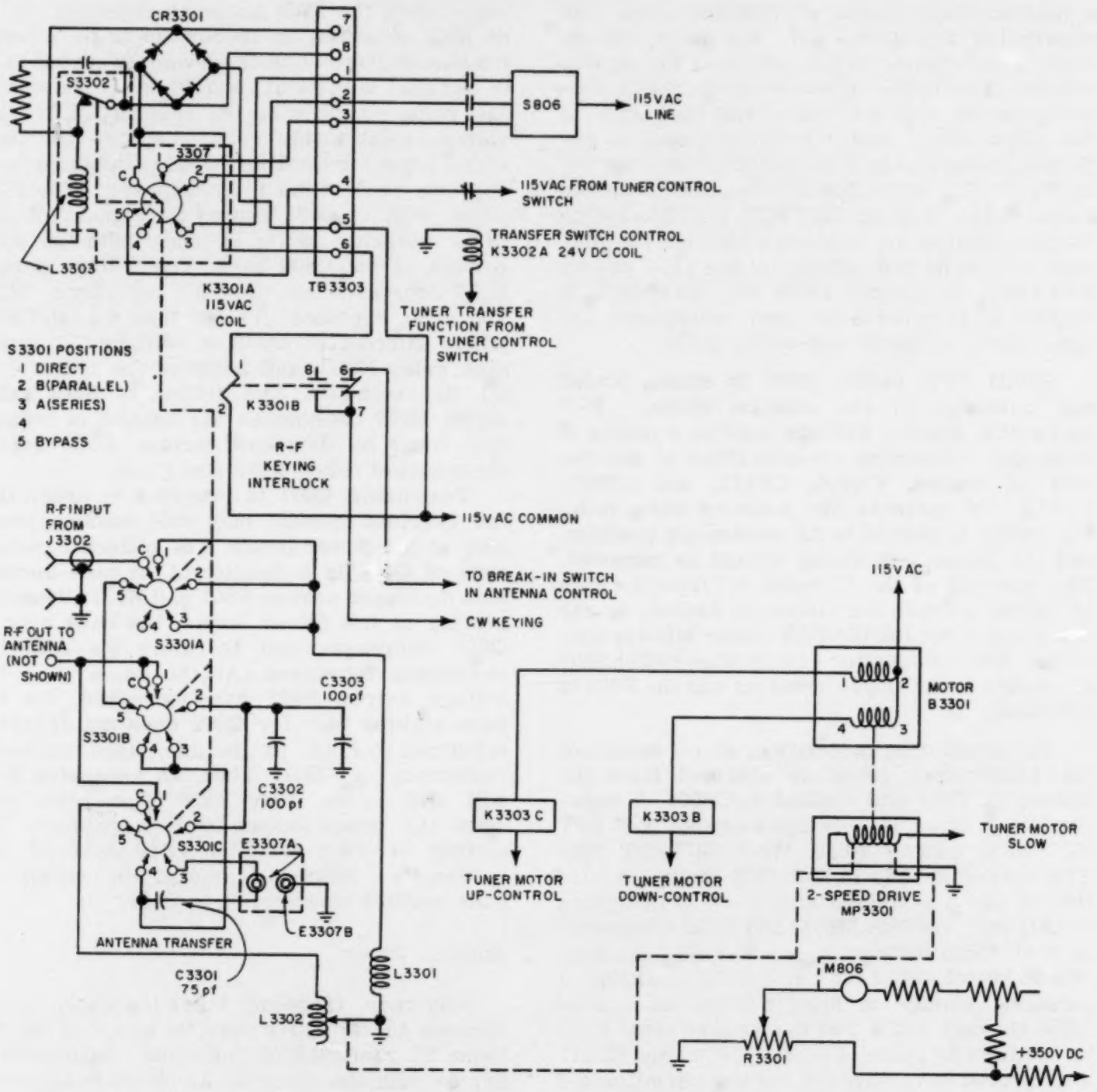

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Figure 6-16.—Radio frequency tuner, schematic diagram.

Fixed capacitance may also be inserted in series or in parallel with the antenna for tuning purposes.

Switch S806 (COUPLER ANTENNA, not shown,) provides 115 volts AC for the actuator L3303 (fig. 6-16) when placed in the DIRECT, A, or B position. These positions correspond to positions 1, 2, and 3 on S3301. A tuner control switch on the front panel applies 115 volts AC to the actuator when the bypass function is desired. In this position (as shown) relay K3302A is energized. When the tuner

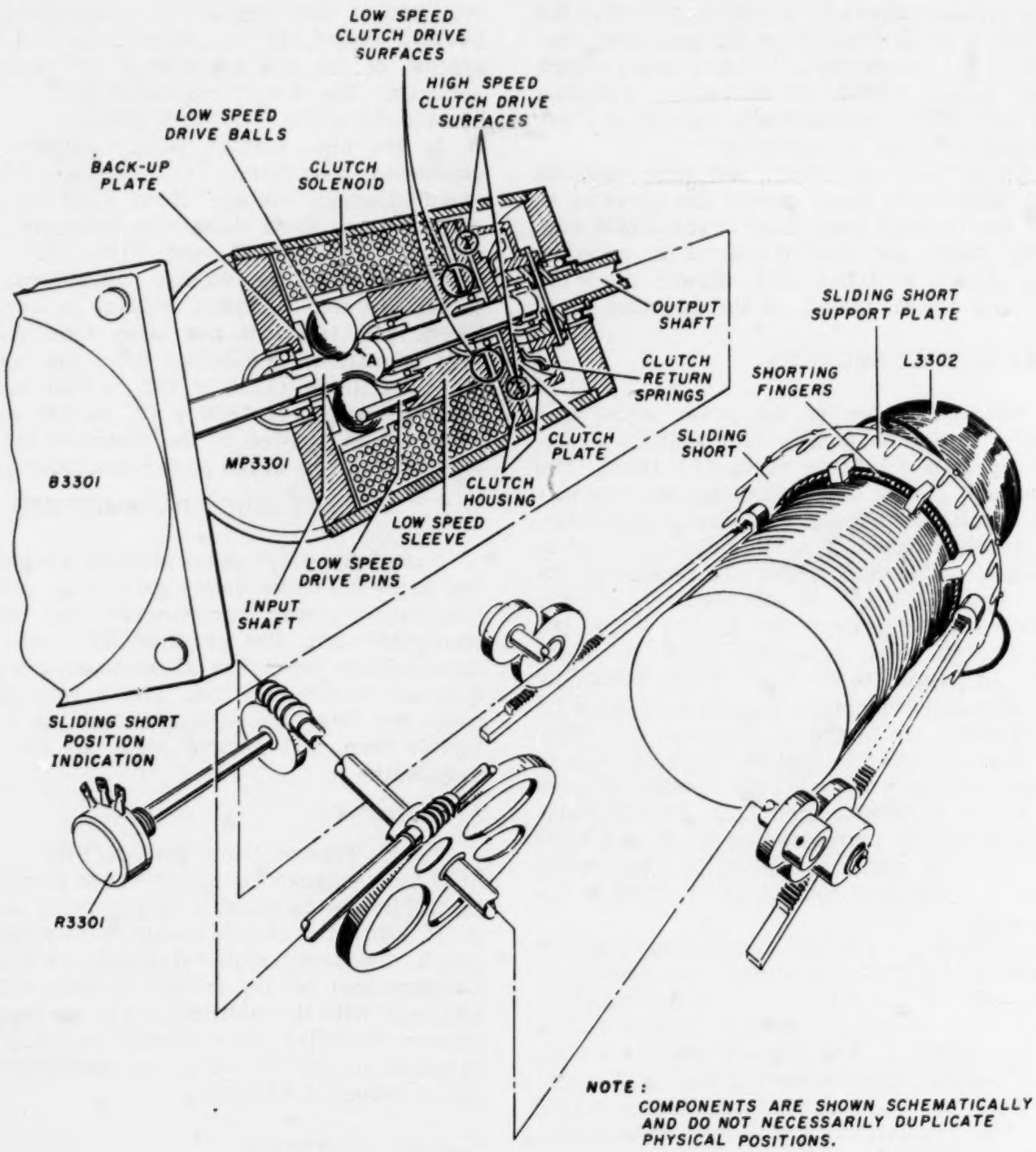

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Figure 6-17.—Antenna tuner coil, L3302.

components are to be used, the tuner control switch is placed in the TUNER-IN position, and K3302A deenergizes. This again permits the desired tuning components to be selected by S806.

Switches S3307 and S3301, driven by actuator L3303, place C3302 and C3303 in parallel with the antenna when switch S806 is in the B position. When S806 is in the A position, C3301 is placed in series with the antenna, and

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when in the DIRECT position, only L3302 is in series with the antenna. The setting of COUPLER Ⓙ switch S806 depends on the operating frequency of the transmitter. If the transfer switch control relay, K3302, is energized, switches S3307 and S3301 automatically return to position 5 and the tuner is bypassed.

Antenna tuner up, down, and slow controls on the RFA front panel enable the operator to select the desired movement of the L3302 arm (sliding short) and also to control the speed of tuning. Limit switches (not shown) limit the upper and lower travel of the shorting arm.

POWER SUPPLY SECTION

A block diagram of the power section is shown in figure 6-18. The high voltage rectifiers supply d-c voltage to the PA tubes. The low voltage power supply supplies the remaining d-c voltages needed for proper operation, such as the +350-volts -350 volts, -24 volts, +12-volts, -12-volts, 250-volts regulated, +24 volts regulated, and a -6 volt regulated supply.

The primary power input of 115 volts, 220 volts, or 440 volts, depending upon the ship's supply, is applied to the T501, T201, T202, and T203 primary windings. Tapped terminals on T501 provide an output of 220 and 115 volts. The output of T501 is applied to the circuits of the low voltage power supply section through FILAMENT POWER switch S502. The 220 volts is applied to the primaries of T502 and T503 while the 115 volts is applied to T617 in the electrical frequency control and to T204 in the PA circuits.

The output of T502 is rectified by the plus and minus 350-volt rectifiers, and applied to the circuits of the RFA. Part of the output of the 350-volt rectifier is also applied to the 250-volt regulator. The 250-volt regulator consists of series regulators V321 and V322, regulator amplifier V323, and voltage reference tube V324. The regulated output is applied to stages in the electrical frequency control circuit and r-f oscillator.

The output of T503 is rectified by the -24-volt rectifiers, and fed to the various circuits throughout the transmitter which require this potential. A second output of T503 is applied to the 12-volt rectifier. The negative output of the 12-volt power supply is fed to the speech amplifier and control circuits. The positive output is fed only to control circuits in the amplifier-power supply and mike circuits.

The output of T617 is rectified by the 24-volt and 6 volt regulators, respectively. The 24-volt output is regulated and fed to the circuit of the r-f generating and modulating sections. The 6-volt regulated supply is used by circuits of the 1-mc oscillator.

In the high voltage power supply, bridge connected rectifiers V201 through V206 get their filament voltage from T204 and their plate voltage from delta-wye connected transformers T201, T202, and T203. The secondaries of the high voltage transformers are tapped so that a lower voltage is applied in TUNE and 100-watt operation than for 500-watt operation. The output from the high voltage rectifiers (1250 v DC in tune and 100-watt operation, or 1850 v DC in 500-watt operation) is applied to the plates of the power amplifier tubes in the power amplifier section.

SHORE BASED TRANSMITTERS

Transmitters at shore stations are basically the same as those used aboard ship. Some are low output power transmitters used for local communication. The greatest difference is the transmitters used for shore-to-ship and long distance communication. The power requirement for this type of communication is much higher than that aboard ship, 10 kw up to 2 megawatts.

AN/FRT-5/6

Radio Transmitting Set AN/FRT-5, figure 6-19, is designed for shore-based communication. The set is capable of providing an output of 15 kilowatts of continuous-wave radio-telegraph, frequency-shift-telegraph, or facsimile transmission on any frequency from 4.0 mc to 26.0 mc. With the addition of a power supply and power amplifier (not shown) the AN/FRT-5 becomes an AN/FRT-6 and is capable of supplying an output of 40 kilowatts.

General Description

The equipment is composed of the following four major units as shown in figure 6-19; RF unit T-226/FRT-5; Power Supply PP-490/FRT-5; Power Transformer TF-122/U and Power Control C-587/FRT-5.

Power Supply PP-490/FRT-5 and RF Unit T-225/FRT-5, the two main enclosures, are installed side-by-side in one cabinet and constitute the main portion of the transmitter.

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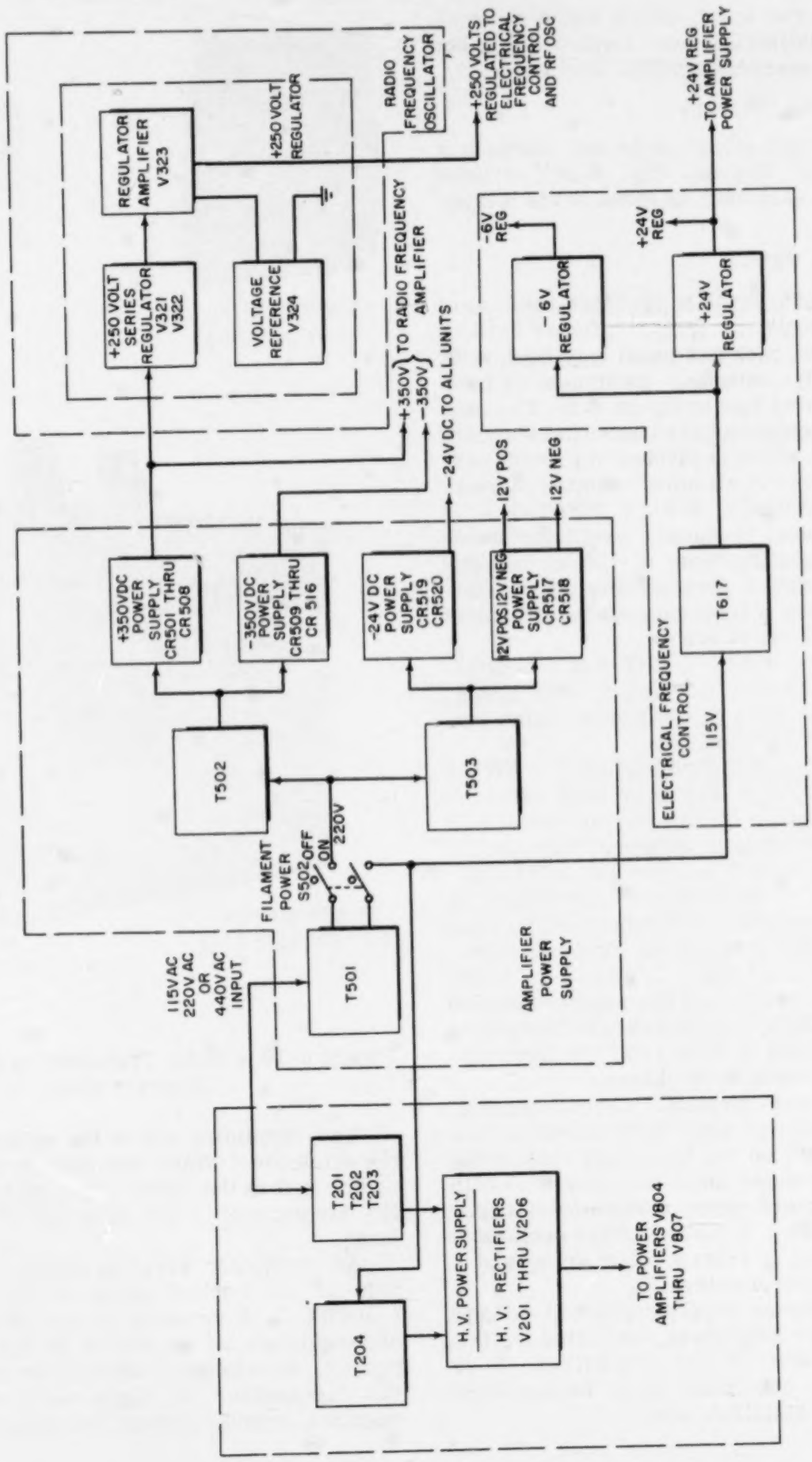

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Figure 6-18.—Power supply section, block diagram.

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The other two units, which might be considered as auxiliaries, are located near, but outside of, the main transmitter enclosure.

Functional Block Diagram

The major and minor units are shown in a functional block diagram (fig. 6-20); a brief description of each unit is given in the following paragraphs.

RF Unit T-225/FRT-5

RF Unit T-225/Frt-5 is the right-hand one of the two main bays, as shown in figure 6-19. It contains integral rack and panel type equipment and permanently mounted equipment as indicated by the dotted line in figure 6-20. The rack and panel type equipment is mounted in a standard equipment rack which is pivoted to provide easy access to the rear of all units mounted thereon.

The RF Oscillator 0-91 ( )/FRT-5 is a stabilized variable frequency oscillator which derives its stability from a 100-kc crystal standard. Utilizing a permeability tuned oscillator, it provides a frequency stabilized output in the range of 2 mc to 4.5 mc.

RF Oscillator 0-92 ( )/FRT-5 is a crystal-controlled 10-channel oscillator, With proper crystals, the oscillator provides an output frequency of 2 mc to 4.3 mc.

The Frequency Shift Keyer KY-45 ( )/FRT-5 is used to provide a frequency shift which is linear with respect to the keying voltage. It causes the transmitter to emit one frequency for a "mark" signal and another for a "space" signal. Because of its linearity with respect to the keying voltage or current, it may also be used for "photo" and teleprinter transmissions.

Power Supply PP-454 ( )/FRT-5 is a dual supply furnishing plate and filament voltages to RF Oscillator O-91 ( )/FRT-5 and Frequency Shift Keyer KY-45 ( )/FRT-5. It also supplies a regulated bias to the keyer.

There are six identical interchangeable, plug-in servo control amplifiers mounted in a common enclosure on the equipment rack in the r-f bay. One of these units is associated with each of the six tuned servo-positioned circuits. in RF Unit T-225 ( )/FRT-5. Each contains a voltage amplifier, a relay control tube, and a pair of motor-control relays.

The servo power supply furnishes voltage to all of the servo amplifiers, and drive motors located in RF Unit T-225 ( )/FRT-5. It is mounted on the equipment rack, immediately below the servo amplifier unit.

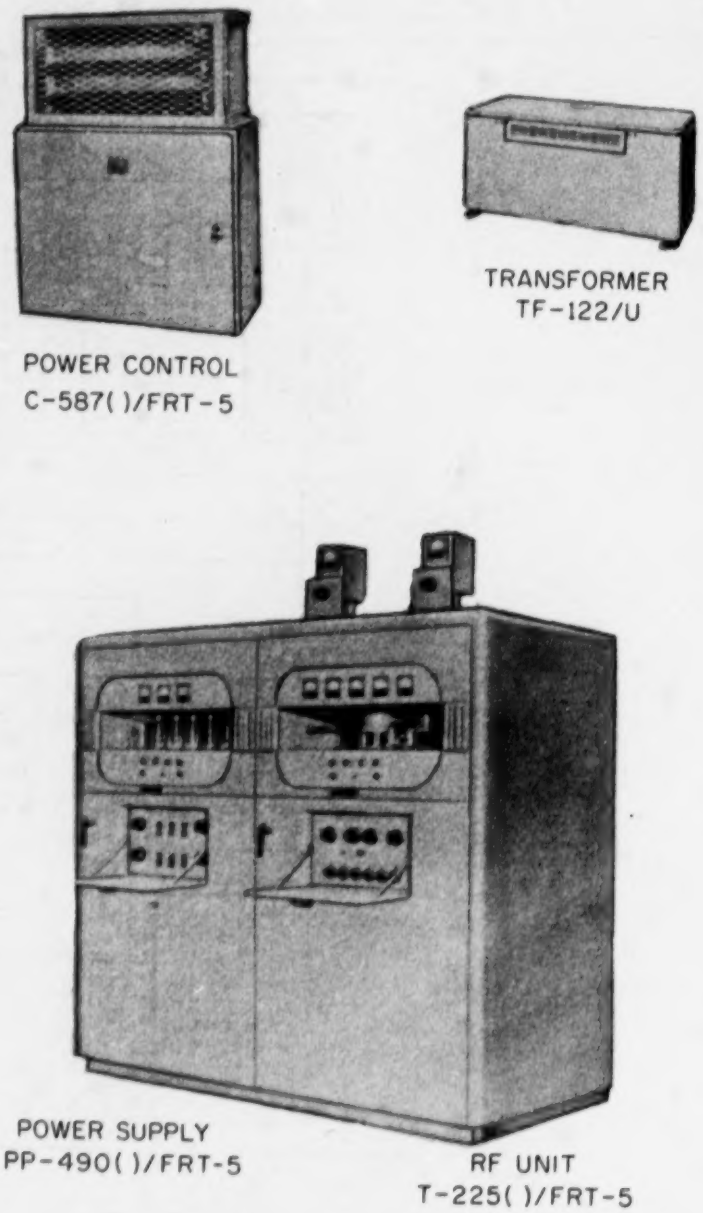

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Figure 6-19.—Radio Transmitting Set AN/FRT-5, major units.

The remaining unit in the equipment rack is the patch panel which contains the two oscillator output jacks, the keyer input and output jacks, the transmitter input jack and several spare jacks.

An electronic keyer is mounted on the right side of the control panel of RF Unit T-225 ( )/FRT-5. It receives the keying impulses and accomplishes off-on keying of the transmitter proper. Provision is also made for keying of the transmitter by negative, positive, polar negative, or polar positive impulses for "mark".

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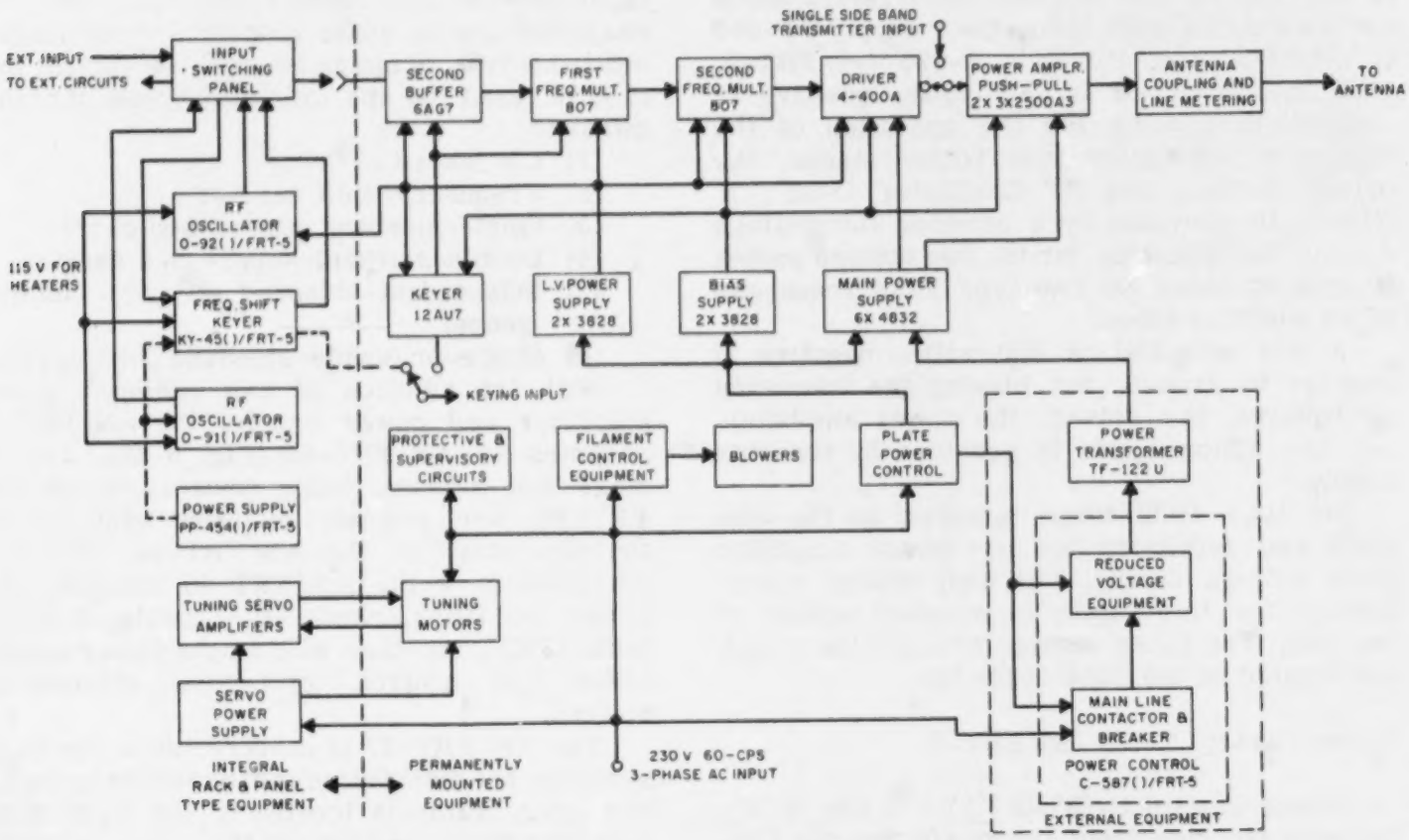

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Figure 6-20.—Functional Block Diagram Radio Transmitting. Set AN/FRT-5.

The control panel carries the basic transmitter tuning and checking controls and is located behind the lower front door. Easy access to these controls is provided by a small drop door located at the top center of the main lower door as shown in figure 6-19.

The buffer amplifier, frequency multipliers, and driver unit are contained within a subassembly which is mounted to the left ot the control panel. Inside are located a broad-band buffer-amplifier and two frequency-multiplier stages. The driver tube is mounted on top of the assembly.

The power amplifier is located on the top deck of RF Unit T-225 ( )/FRT-5. It is a push-pull, cross-neutralized, grounded-cathode amplifier with both grid and plate circuits resonant and continuously variable from 4 mc to 26 mc. Cooling air for these tubes is forced into the grid circuit, which is mounted in an enclosure, by a blower in the lower rear of the cabinet, and air flows upward through the tube sockets to cool the radiators.

An alternate provision is available for operating the power amplifier as a linear amplifier driven by a single sideband suppressed-carrier exciter. The grid circuit of the power amplifier is arranged to be modified so that it presents a 200-ohm balanced load to the exciting single side-band transmitter. Approximately 500 watts of peak exciting power are required.

The coupling network occupies the top of RF Unit T-225 (B)/FRT-5. It is a resonant circuit continuously variable across the entire frequency range. Magnetic coupling from the plate tank coils to the inductors of this coupling network is varied by the positioning of the coupler on rails or tracks suspended from the top of the cabinet.

Power Supply PP-490 (B)/FRT-5

The Power Supply PP-490 ( )/FRT-5 consists of the lefthand bay of Radio Transmitting Set AN/FRT-5. It contains the following units and circuits:

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A vertical panel inside the lower front door of Power Supply PP-490 ( )/FRT-5 mounts all of the control, overload and timer relays which are associated with both Power Supply PP-490 ( )/FRT-5 and RF Unit T-225 ( )/FRT-5.

A d-c potential of 600 volts, positive in respect to ground, for the operation of the frequency multiplier and buffer stages, the driver screen, and RF Oscillator O-92 ( )/FRT-5 is provided by a common low voltage supply. Rectification for the low voltage supply is accomplished by two type 3B28 xenon-gas filled rectifier tubes.

A d-c potential of 400 volts, negative in respect to ground, for biasing the frequency multipliers, the driver, the power amplifier, and the off-on keyer is provided by the bias supply.

Six type 4B32 tubes mounted on the tube shelf are rectifiers for the power amplifier plate voltage supply. The high voltage transformer for this supply is mounted outside of the unit. The filter components for the supply are located on the floor of the bay.

Power Control C-587 (B)/FRT-5

Power Control C-587 (B)/FRT-5 (fig. 6-19), includes the line input terminals for the 230-volt power supplying all parts of the transmitter, except the high voltage plate supply transformer. It houses the following components; a fused three-phase circuit to the transmitter for filaments; blowers, etc.; a combination overload protection breaker and start-stop contactor; and a "delta-wye" switch for the PA stage plate transformer primary. Also included are a set of series line resistors for tune-up purposes, contained in a ventilated cage on top of the cabinet.

Power Transformer TF-122/U

Power Transformer TF-122/U is a separate unit mounted apart from the cabinets. It is a three-phase, dry-type, air-cooled unit and supplies the high voltage for the power amplifier plate voltage supply.

AN/FRT-39/40

The radio transmitter set AN/FRT-39 (fig. 6-21) is a general purpose radio communication transmitter capable of providing 10,000 watts peak envelope power (PEP) output throughout a frequency range of 2 mc to 28 mc. The principle function of the equipment is to provide long range communications from shore-to-ship or point-to-point by the single-sideband type of operation. The equipment may also be used for the following types of transmission:

(1) CW (keyed carrier)
(2) Frequency-shift carrier
(3) Single-sideband suppressed carrier
(4) Double-sideband suppressed carrier
(5) Independent sideband (separate intelligence)
(6) Single-or double-sideband (with carrier)

With the addition of two cabinets, power amplifier and power supply, the AN/FRT-39 becomes an AN/FRT-40 (Fig. 6-22). The PA stage and antenna tuning controls of the AN/FRT-39, are slightly modified and become the IPA stage of the AN/FRT-40. The final PA section of the AN/FRT-40 consists of a power amplifier, class AB, capable of 40,000 watts (PEP), together with ample power supply, relay and control, protective circuits and meters.

The AN/FRT-39 is constructed in two basic sections, the main frame and the auxiliary frame. The main frame is located to the right of the auxiliary frame and houses the power amplifier (PA), the intermediate power amplifiers (IPA), the main power supply and high voltage section, the PA loading and tuning controls, the relay and indicator control panels and the meter panel. The auxiliary frame is located to the left of the main frame and houses all of the sideband exciter equipment, exciter power supply equipment, and other control equipment for the various modes of operation.

Auxiliary Frame Components

The block diagram of the AN/FRT-39 (fig. 6-23) illustrates the auxiliary frame components to the left of the dotted line in the figure.

The sideband exciter (CBE), will accept two channels of intelligence each having a bandwidth of 7.5 kc and processes them for modulation of an intermediate sideband carrier (250 kc) by means of two balanced modulators. The 250 kc carrier is generated in the regenerative divider network, which is part of the radio-frequency amplifier (CHG). The two 7.5 kc intelligence channels are used to modulate the upper sideband (channel 1) and the lower sideband (channel 2).

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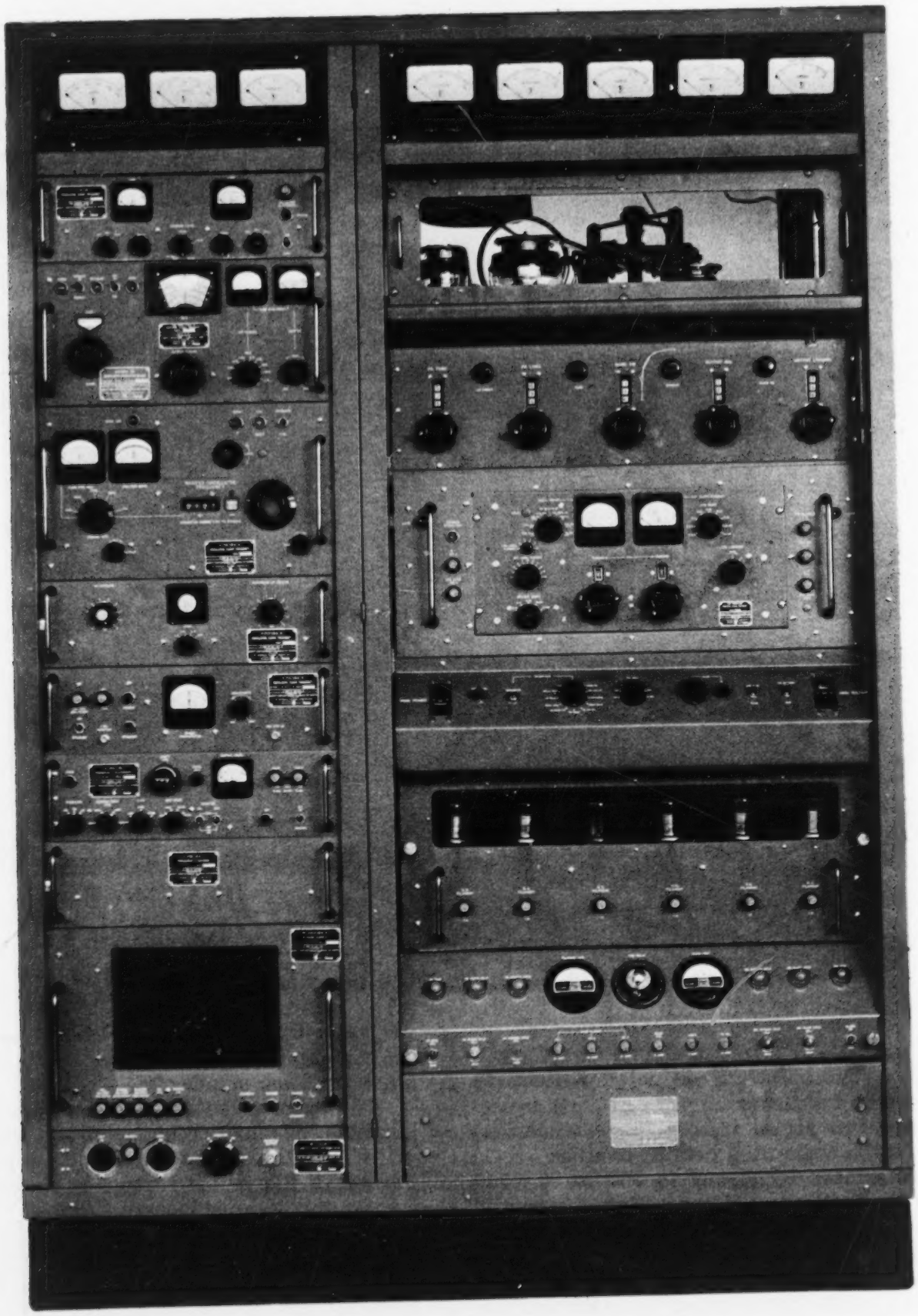

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Figure 6-21.—Radio Transmitting Set (synthesized), AN/FRT-39.

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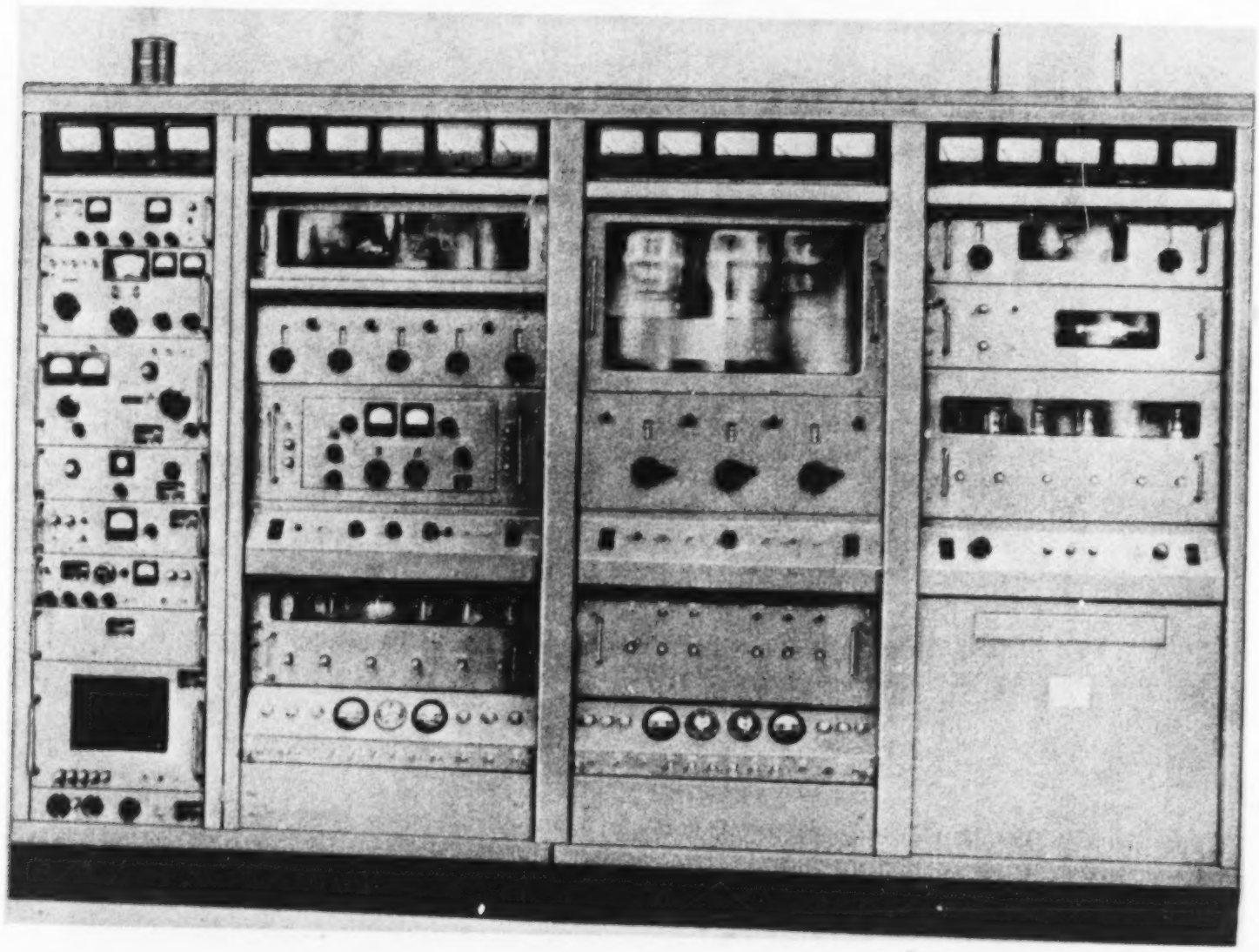

Figure 6-22.—Radio Transmitting Set (synthesized), AN/FRT-40. 162.17

The power supply (CPP-1) is mounted behind the auxiliary frame and supplies 200 volts unregulated and 150 volts regulated d-c outputs.

The radio frequency amplifier (CHG), is provided with two signal inputs: the sideband exciter, and the controlled master oscillator. The sideband exciter frequency is 250 kc $\pm$ 7.5 kc and the controlled master oscillator frequency is from 2 mc to 4 mc. The input frequencies are modulated by a balanced modulator with the 2 mc to 4 mc input and sideband exciter frequency, and subsequently heterodyned by additional precise high frequencies in order to bring the final r-f output into the 1.75 mc to 33.75 mc range.

The additional precise high frequencies are generated, by a crystal oscillator using different crystals (8 to 15 mc) for various bands, within the r-f amplifier unit and are synthesized by the accurate 1 mc standard.

The controlled master oscillator (CMO) supplies precise frequencies to the r-f amplifier in the 2 mc to 4 mc range. The accuracy of the output frequency is derived from the precise 1 mc standard.

The controlled oscillator (CLL) provides the low frequencies in 100 cps steps for stabilizing the controlled master oscillator. These frequencies are in the range of 510 kc to 519.9 kc and are fed to the master oscillator's phase detector to frequency stabilize the master oscillator's 2 mc to 4 mc output in the 100 cycle and 1000 cycle steps.

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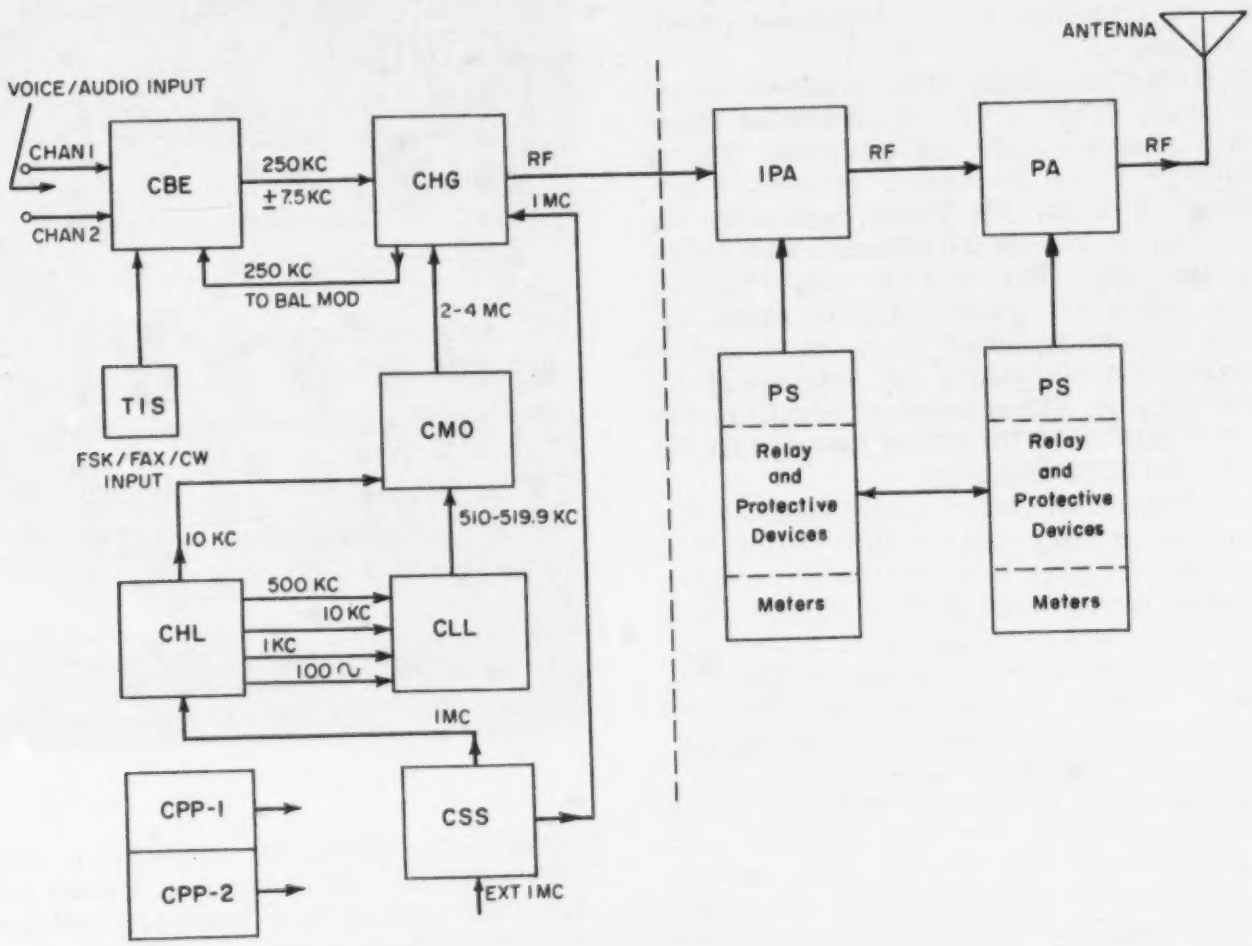

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Figure 6-23.—AN/FRT-39 block diagram (synthesized).

The primary standard (CSS) is a precision oscillator within a temperature controlled oven. The oscillator has a frequency stabilization of one part in 10^8 per day. The frequency output of the primary standard is 1 mc and is used to regulate all of the frequency generating oscillators.

The divider chain (CHL) is used to count down the primary standard 1 mc output by using flip-flop multivibrators. The output frequencies available from the divider chain are: 500 kc, 10 kc, 1 kc, and 100 cps.

The power supply (CPP-2) provides:

(1) +380 volts unregulated
(2) -400 volts unregulated
(3) +160 volts regulated
(4) +75 volts regulated
(5) -6 volts regulated
(6) 6.3 (AC) volts regulated

The tone intelligence unit (TIS) accepts three types of d-c signals (FSK, CW, FAX) and converts them into audio frequency output signals for sideband transmission via the sideband generator unit.

Main Frame Components

The block diagram of the AN/FRT-39 (fig. 6-23) illustrates the main frame components to the right of the dotted line in the figure.

The r-f amplifier which consists of a first amplifier stage (class A), a second amplifier stage (class A), and an intermediate power amplifier (class AB1), is commonly called the IPA. The input to the first amplifier stage is supplied by the sideband exciter (CBE) as explained earlier. The IPA is manually tune loaded and includes a multimeter with switching capabilities for direct reading of d-c and r-f voltages or currents. A second meter is mounted on the front panel for the purpose of reading the IPA plate current.

The IPA is rated at 1 kw r-f output and can be fed to the PA or independently to an antenna

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by bypassing the PA when it is desirable to operate the transmitter at a maximum power output of 1 kw.

The power amplifier (PA), consists of one vacuum tube, rated at 10 kw, operating class AB1 in a grounded grid configuration. Tuning and loading of the PA output network is accomplished with the PA TUNE capacitor, PA LOAD capacitor, tapped inductance coils, OUTPUT balance capacitor, and the output loading inductors which are tuned by ferrite slugs. PA switching is accomplished by a band switch which progressively shorts out sections of the tuning inductance. Either balanced or unbalanced output is available by the use of jumpers on the OUTPUT LOADING inductors.

The r-f amplifier power supply consists of a high voltage rectifier and a bias rectifier. The high voltage rectifier is a full-wave rectifier and supplies unregulated plate voltage to both the first and second r-f amplifiers. It also supplies unregulated screen voltage for the IPA, first, and second r-f amplifiers. The bias rectifier is a half-wave rectifier and supplies -300 volts for the PA grid and PA bias relay. The relay provides protection for the PA in the event of bias failure. The bias rectifier also supplies -150 volts bias for the first, second, and intermediate power amplifiers. The power supply also supplies filament voltage for the IPA's.

The PA high voltage power supply circuits consist of high voltage rectifier tubes, circuit breakers, control equipment, 50 and 60 cycle power transformers, filament transformer, choke coils, high voltage capacitors, blower motors and other miscellaneous components. The power supply provides 7.5 kv PA plate voltage, 1.2-kc PA screen voltage, PA filament voltage, and 3-kc IPA plate voltage.

The relay and indicator control panels are equipped with control circuits for the purpose of disabling the transmitter when serious or abnormal conditions prevail. The relays are also used to apply voltage to the various circuits in proper sequence.

RADIO SETS

Radio Sets generally consist of both transmitter and receiver with associated power supplies and control units. The transmitter and/or receiver may or may not have the capability of being operated seperately. Radio Sets have the advantages of simplicity of operation, ease of maintenance, small size, and are adaptable to both ship and shore communication. Although most transmitter-receiver sets are limited to low output power, due to size, the versatility of such equipments offer wide use as radio links in communication networks throughout the Navy.

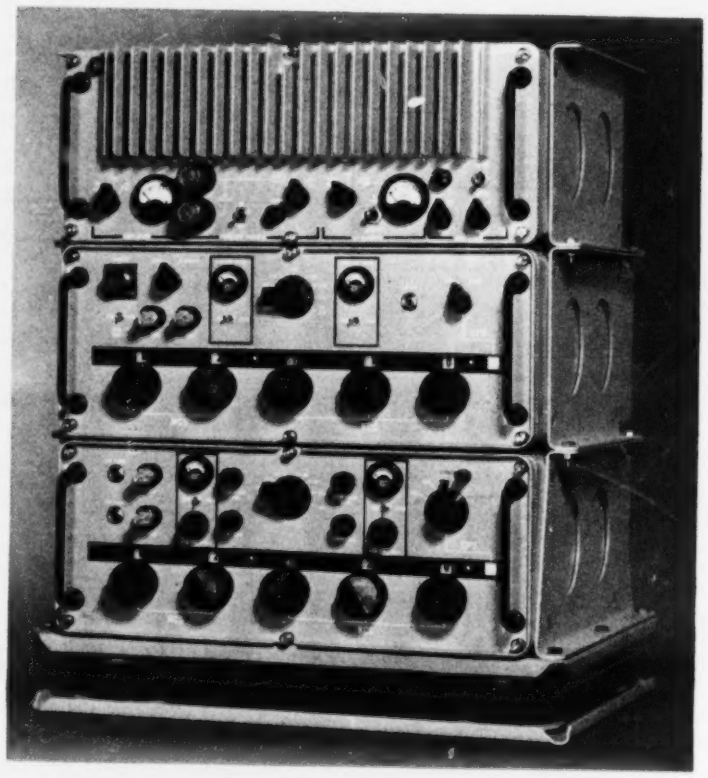

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Figure 6-24.—Radio Set AN/WRC-1. Top unit: AM-3007/URT RF Amplifier; center unit: T-827/URT transmitter (exciter); bottom unit: R-1051/URR receiver.

AN/WRC-1

The AN/WRC-1 (fig. 6-24) is a single sideband radio set capable of transmitting on any one of 56,000 channels, spaced in 0.5 kc increments, in the 2.0 mc to 29.9995 mc frequency range. Vernier (continuous) tuning enables reception on any frequency in the 2.0 mc to 30.0 mc frequency range.

The AN/WRC-1 is capable of transmitting and receiving upper sideband (USB), lower sideband (LSB), continuous wave (CW), compatible amplitude modulated (compatible AM, frequency shift keyed (FSK), and independent sideband (ISB) signals in either a simplex or duplex operation. Tone-modulated continuous wave (MCW), standard amplitude modulated

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(AM), and facsimile reception may also be made with the AN/WRC-1.

The AN/WRC-1 consists of Radio Receiver R-1051/URR, Radio Transmitter T-827/URT, RF Amplifier AM-3007/URT, and Interconnection Box J-1265/U. The relationship of these units, the Antenna Coupler CU-927/UR, and associated auxiliary equipment is illustrated in a functional block diagram in figure 6-25.

Radio Receiver R-1051/URR

The Radio Receiver R-1051/URR employs a digital tuning scheme for automatically tuning to any one of 56,000 operating channels, with vernier tuning providing continuous tuning throughout the frequency range. Since the R-1051/URR contains its own power supply, it may be operated as an independent unit, as was previously discussed in Chapter 4 of this training manual.

Radio Transmitter T-827/URT

The Radio Transmitter T-827/URT is a low level transmitter, which produces a nominal 0.1 watt r-f output of USB, ISB, LSB, CW, FSK, or compatible AM r-f signal, making it capable of driving the AM-3007/URT. Like the R-1051/URR, the T-827/URT employes a digital tuning scheme for automatically tuning to any one of 56,000 channels in 500-cps steps in the 2.0 mc to 29.9995 mc frequency range. All circuits of the T-827/URT (except two r-f amplifier stages) utilize solid-stage devices. These circuits are assembled into plug-in electronic assemblies, some of which are interchangeable between the R-1051/URR and the T-827/URT. The frequency generation circuits, which are referenced to an ultra-stable master frequency standard with a stability better than 1 part in 10^8 per day provide an extremely stable transmitter output.

RF Amplifier AM-3007/URT

The RF amplifier AM-3007/URT is a two-stage power amplifier. With an r-f input of 0.1 to 0.25 watt, it will produce an output of

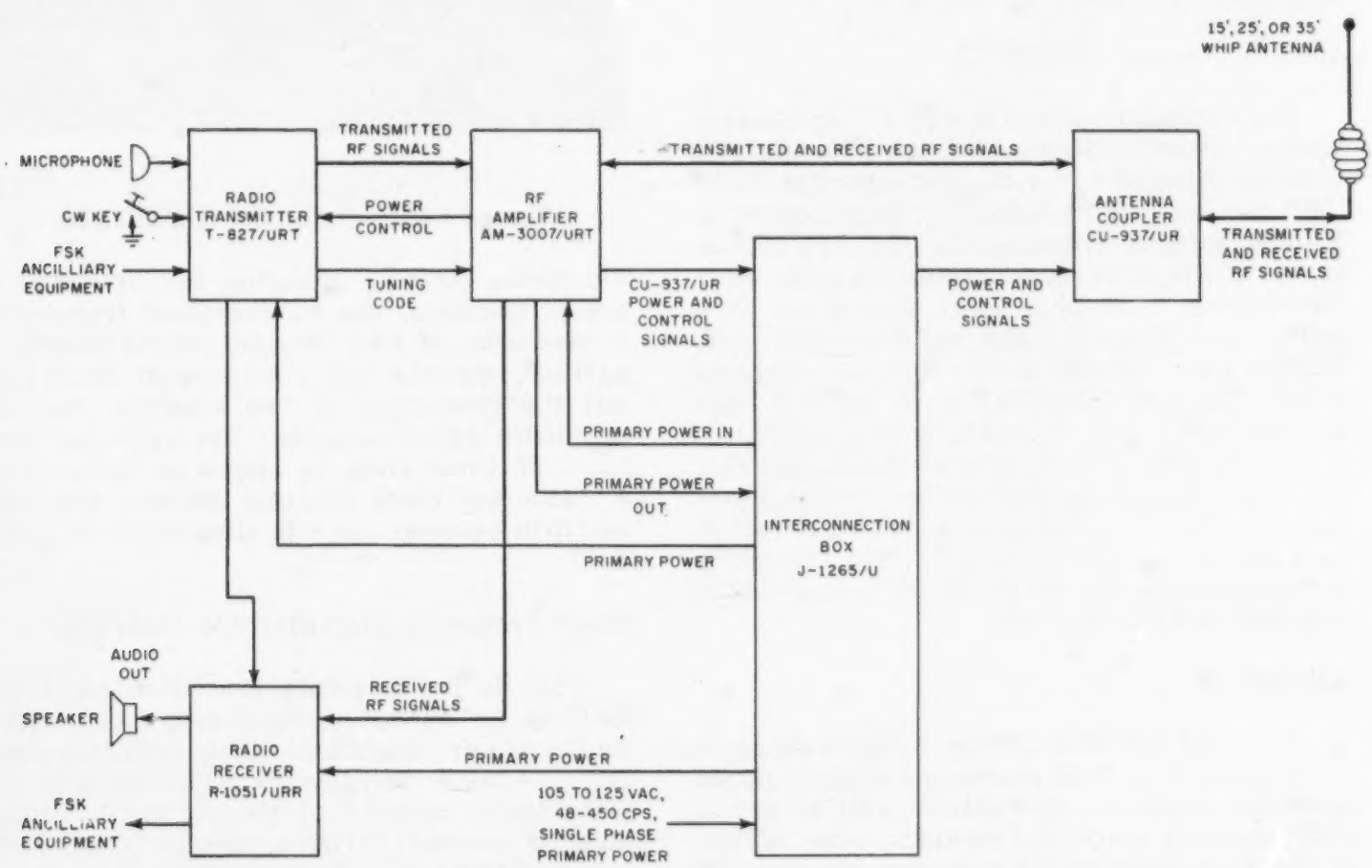

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Figure 6-25.—Radio Set AN/WRC-1, functional block diagram.

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100 watts PEP for SSB and ISB, 25 watts AM carrier, or 50 watts average CW or FSK into a 50-ohm load. In the AM and SSB modes, the AM-3007/URT is a linear amplifier. In the CW and FSK modes, the AM-3007/URT operates more nearly class C to increase efficiency. The AM-3007/URT is automatically tuned by a five-wire code from the T-827/URT. This code controls a motor that positions a turret containing broadband coils. These broadband coils act as tuned inter-stage and output circuits for the two amplifier stages. An inverse feedback loop is used in the AM-3007/URT to improve linearity and decrease intermodulation distortion.

Interconnection Box-J-1265/U

The Interconnection Box J-1265/U contains no active electronic circuits, but it furnishes the physical interconnection components for the system. Programming for the CU-937/UR for either the 15-, 25-, or 35-foot whip antenna, is accomplished by jumpering various terminals on two of the seven terminal boards in the interconnection box.

Antenna Coupler CU-937/UR

The Antenna Coupler CU-937/UR matches the system antenna (15-foot, 25-foot, or 35-foot whip antenna) to the 50-ohm r-f output of the AM-3007/URT (not used with submarine, multicoupler, or 50-ohm antenna systems). The CU-937/UR operates at power levels up to 100 watts PEP, while maintaining a 50-ohm input impedance at a better than 1.5:1 voltage standing wave ratio (VSWR) over the 2.0 mc to 30.0 mc frequency range. The CU-937/UR is tuned entirely from the AM-3007/URT. A tuning code is generated in the AM-3007/URT to course tune the CU-937/UR. Final fine tuning to bring the VSWR to better than 1.5:1 is then accomplished with controls on the front panel of the AM-3007/URT. The VSWR is indicated by the RF OUTPUT meter on the AM-3007/URT front panel.

AN/SRC-20

Radio Set AN/SRC-20 (fig. 6-26), is designed for shipboard or fixed station operation. This set provides amplitude modulation (AM) on any of 1750 channels spaced 0.1 mc apart in the 225 mc to 399.9 mc range with a minimum power output of 16 watts into a 50-ohm resistive load. Nineteen of the 1750 channels can be present.

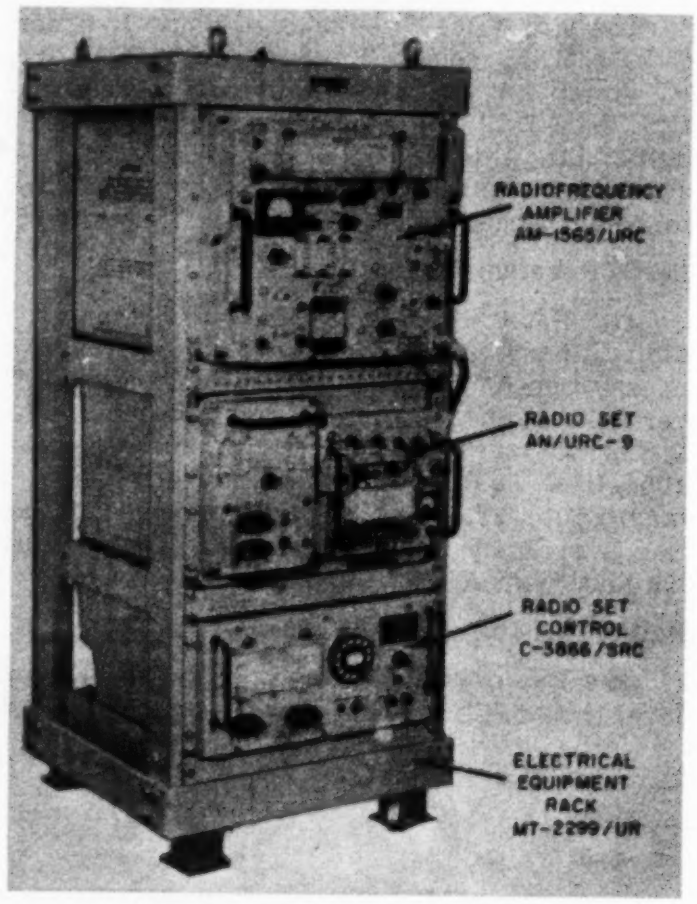

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Figure 6-26.—Radio Set AN/SRC-20.

Complete control, including the selection of preset channels, can be exercised from up to a maximum of four remote control points. In addition, circuits are incorporated which permit the connection of two sets for two-way automatic retransmission. The radio set consists of three units as shown in figure 6-26. A functional block diagram showing interconnections between units is illustrated in figure 6-27.

Radio Frequency Amplifier AM-1565/URC

The Radio Frequency Amplifier AM-1565/URC is an automatically tuned, fixed station linear power amplifier which operates from 225 to 399.9 megacycles. The cathode and plate tuned circuits of the r-f amplifier are high Q coaxial cavities, servo-tuned to the selected frequency. Because the r-f amplifier is linear, interference due to transmitter intermodulation is minimal. An internal power supply

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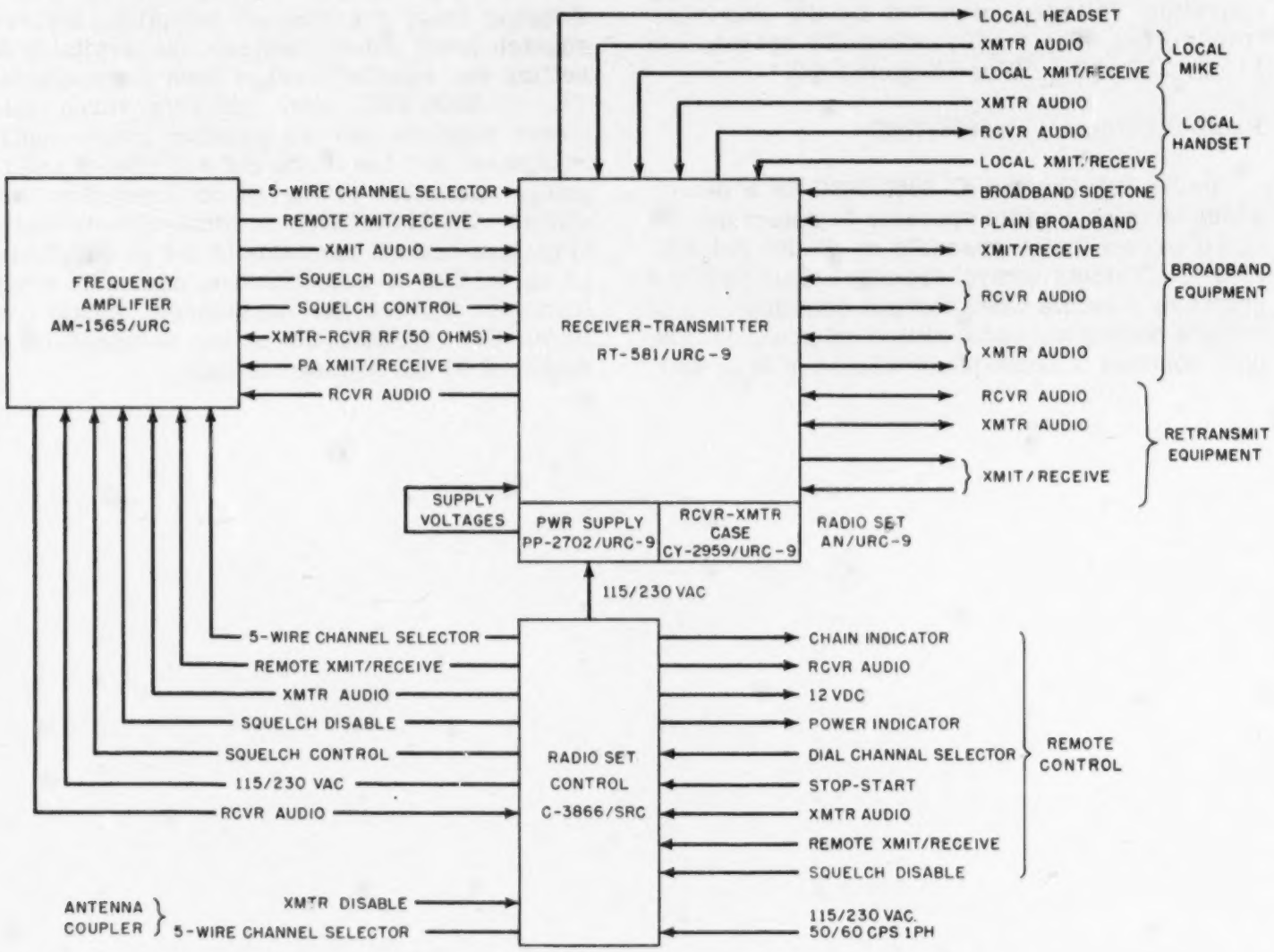

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Figure 6-27.—Radio Set AN/SRC-20, functional block diagram.

operates from a 115/230-volt, 50-60 cps power source.

Channel selection is accomplished by an "Autopositioner". The r-f amplifier is continuously tunable over the frequency range, with provisions for presetting 19 channels for remote or local selection. The twentieth channel allows manual tuning. All channel information is made available to the associated exciter. A remote control unit may be used to control the r-f amplifier.

Radio Set AN/URC-9

Radio Set AN/URC-9 is the major unit of the AN/SRC-20 and consists of Receiver-Transmitter RT-581/URC-9 and Power Supply PP-2702/URC-9. The unit functions as a triple-conversion, superheterodyne receiver during standby operation. When the microphone push-to-talk switch is pushed, a series of T/R (transmit-receive) relays convert the unit to a transmitter which uses many of the same r-f, i-f, and audio circuits used on receive. Three crystal-controlled oscillators provide stable r-f and i-f frequencies on both transmit and receive. Receiver-Transmitter RT-581/URC-9 is automatically tuned by standard "auto-positioners", which are controlled on the front panel or by remote control. Any of 19 preset channels from 225.0 mc to 399.9 mc can be selected from the front panel or the remote control. Any one of the 1750 channels within the frequency range can be automatically selected using the manual frequency control on the front panel.

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Power Supply PP-2702/URC-9 provides all operating voltages required by the receiver-transmitter. The supply nominally operates on 115 or 230 volts, 50 or 60 cycles AC.

Radio Set Control C-3866/SRC

Radio Set Control C-3866/SRC is a device which enables a radio operator to select any one of 10 preset radio channels on Radio Set AN/SRC-20. Remote control from up to four distance points is possible when correct combinations of remote dialing and audio equipment are used. The unit contains a front-panel telephone-type dial, and the relays necessary to operate an internal stepping relay for channel selection. Nineteen squelch level potentiometers are available for setting the squelch level of each radio channel. The C-3866/SRC also contains three relay power supplies and the primary power control equipment for the Radio Set AN/URC-9 and the power amplifier of the Radio Frequency Amplifier AM-1565/URC. A local-remote switch transfers control functions to the parallel group of up to four remote stations, and audio transformers convert the unbalanced inputs from Radio Set AN/SRC-20 to the balanced output required by the remote stations.

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CHAPTER 7

MULTICOUPLERS AND DISTRIBUTION SYSTEMS

Although there are many new types of multicouplers in various power handling, shapes, and sizes, essentially all work on the same theory. Thus if the technician works on multicouplers not described in this chapter, he will find the same basic principles apply. Several UHF and HF multicouplers are discussed with the reason for, and operation of, multicouplers.

MULTICOUPLERS

Because of space limitations and the large number of communications equipments on board ships, it is impractical, if not impossible, to use separate antennas for the various equipments. It is possible to use one antenna over a wide range of frequencies provided the antenna system is properly tuned and coupled to the equipment so that the antenna appears as a nonreactive (pure resistance) load. It is also possible to use a coupling system that allows operation of several transmitters and/or receivers at the same time. It is not, however, normally possible to use an antenna for both transmitting and receiving simultaneously.

One satisfactory approach to the problem of antennas is provided by multicouplers. The multicouplers that are discussed in this chapter are representative of those in current use on naval vessels.

VHF/UHF MULTICOUPLERS

One antenna coupler widely used is the CU-255/UR. When assembled into a group of two to six units, they provide a system for operating two to six UHF transmitters and/or receivers into or from a single antenna. One coupler is required for each transmitter or receiver. Figure 7-1 shows a group of six multicouplers installed in a rack.

The equipment was designed to operate in the frequency range between 230 and 390 mc. Although it can be used with any transmitter or receiver that covers the frequency range, the AN/GRC-27 and AN/GRC-27A transceivers are normally used with the coupler group in figure 7-1.

All of the couplers in the group can be tuned manually to any frequency within the limits given above. When they are used with the equipment listed each tuner may be manually preset to a channel within the band frequencies. It then becomes possible for the operator to dial any preset channel automatically either from the transceiver or on a remote channel selector.

Each CU-255/UR antenna coupler consists of two major components: a coupling cavity or r-f section and an automatic drive mechanism.

The importance of matching impedances has been mentioned previously in this chapter, and the r-f section of the multicoupler is essentially an impedance matching device. It is capable of matching an antenna feedline impedance of 50 ohms to antenna input impedance that mismatch the feedline impedance as much as 2.5 to 1. Thus, the multicoupler provides a means of maximum power transfer between the transmitter and the antenna. The same matching action takes place when the system is used for receiving.

A meter on the front panel of each multicoupler indicates when the unit is correctly tuned. The meter is a part of a reflectometer and indicates the magnitude of the power reflected back from the coupler. When the tuning meter shows zero, there are no standing waves on the transmission line, and the impedances are matched. A discussion of a reflectometer will be given later in this chapter.

The internal arrangement of a multicoupler is shown in the perspective view of figure 7-2. The drive mechanism that permits manual and

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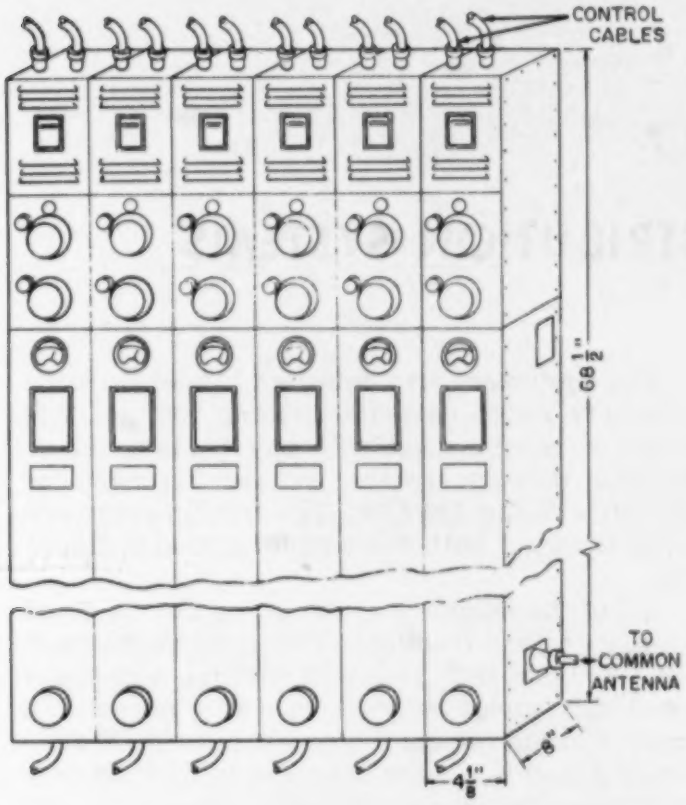

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Figure 7-1.—Group of six type CU-255/UR antenna couplers.

automatic tuning of the coupler fits into the top of the r-f section to form a long thin unit. It can be removed for servicing, when necessary. The normal frequency coverage is from 230 to 390 mc, and the median range is from 227 to 396 mc.

Any device inserted into a transmission line will cause some loss, called the insertion loss. The multicoupler introduces an insertion loss of about 1 db over its tuning range, however the power gained by matching impedances more than compensates for the small insertion loss.

The type CU-332/UR multicoupler covers the same frequency range as the CR-255/UR multicoupler, and both types may be used for either transmitting or receiving. The only difference in the two units is that the CU-332/UR has provision for manual tuning only.

Other multicouplers covering frequencies between 225 and 400 mc are the CU-274/UR, CU-284/UR, CU-355/UR, CU-377/UR, CU-691/U, and CU-692/U.

The CU-274/UR was designed primarily for use with radio transmitter TDZ and radio receiver RDZ, but it may be used with other UHF

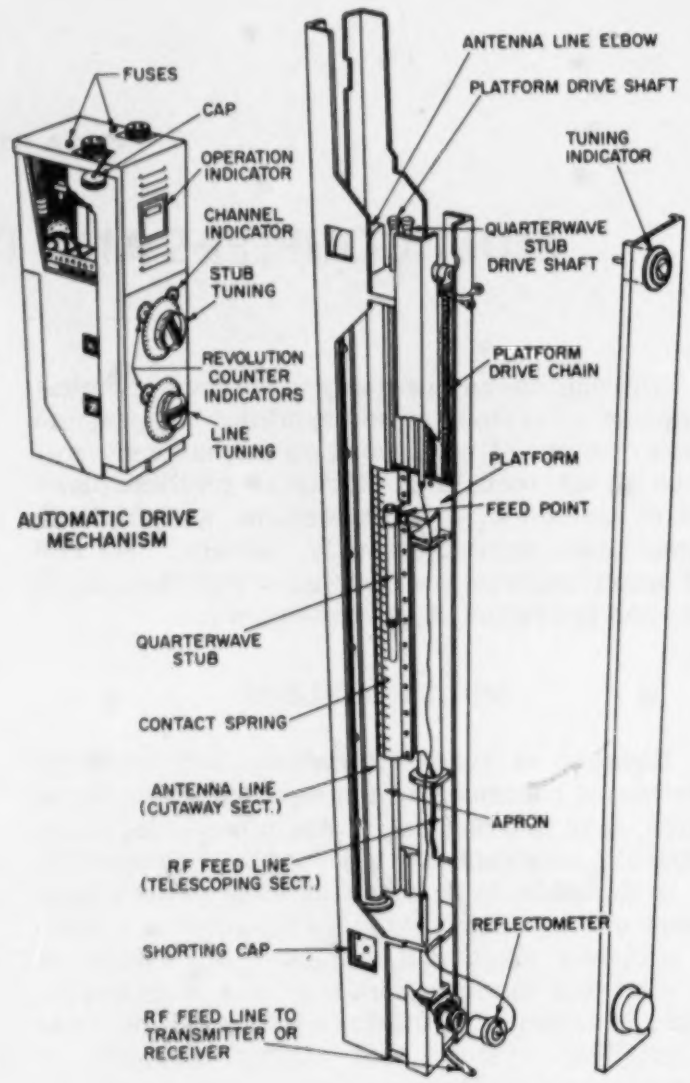

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Figure 7-2.—Perspective view of CU-255/UR multicoupler.

equipments such as the TED, AN/URR-13, AN/GRC-27, AN/GRC-34 and AN/GRC-35. The coupler provides for simultaneous operation of four UHF radio channels into a single antenna in the frequency range of 225 to 400 mc. The four cavities are independently tuned either automatically or manually. For automatic tuning each cavity must first be pretuned to 10 corresponding frequency channels in the frequency range of the attached receiver or transmitter, and thereafter it is automatically retuned by an auto-tune mechanism. Manual tuning of each cavity is possible when the clutch-release knob is released. Any one of the channels may be used interchangeably for transmitting and receiving.

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The CU-284/UR multicoupler permits simultaneous operation of two UHF transmitters or receivers into a single antenna. It is primarily designed for installation on submarines and other small vessels. The coupler is manually tuned and consists of two capacitively tuned resonant cavities, each of which has a 50-ohm terminal impedance. The CU-284/UR is similar to the CU-274/UR except that it can be tuned manually only and accommodates two radio channels instead of four.

The CU-355/UR multicoupler has provisions for the simultaneous operation of four UHF transmitters and/or receivers into a single antenna on the frequencies between 225 and 400 mc. Either manual or automatic tuning may be used with each of the four cavities. Each cavity has its own power monitor and standingwave indicator. A 12-position switch on the front panel provides the necessary switching to read the power or standing-wave ratio at any one of the four input connections. The operating frequencies of the units connected to the multicoupler must be separated by one megacycle or more, depending on the characteristics of the auxiliary equipment.

The CU-377/UR permits the simultaneous operation of two UHF transmitters or receivers into a single antenna in the frequency range of 225 to 400 mc. This coupler is similar to the CU-284/UR.

The CU-691/U provides for the simultaneous operation of four transmitters or four receivers into, or from, a single antenna. This coupler has four cavities that are tuned manually. Before the cavity can be tuned, it is necessary to loosen the clutch release.

The CU-691/U multicoupler is completely shielded and does not produce r-f interference. A meter on the coupler indicates when maximum energy is being transferred while transmitting. There is no meter indication when receiving.

The CU-692/U permits two separate transmitters and/or receiver combinations to operate simultaneously into a common antenna. Except for the number of channels and physical dimensions, the CU-692/U is identical to the CU-691/U.

H-F MULTICOUPLERS

A group of high-frequency antenna couplers (AN/SRA--3, 14, 15, and 16) permits the simultaneous operation of one to four transmitters into the same antenna on frequencies between 2 and 26 mc. These couplers are made up into four-channel groups. Each group operates in one of the following bands: 2 to 6 mc, 4 to 12 mc, 6 to 18 mc, or 9 to 26 mc. To obtain complete coverage from 2 to 26 mc, four coupler groups and four broad-band antennas are needed.

AN/SRA-15

The type AN/SRA-15 (6-18 mc) antenna coupler is representative of the h-f group. It has provisions for the simultaneous operation of four transmitters, each rated at 500 watts, into one broad-band antenna. The coupler covers the range between 6 and 18 mc and will operate into any antenna provided the standing-wave ratio is not more than 3 to 1. All four transmitters can be operated at the same time as long as a separation of 10% or better is maintained between carrier frequencies.

Each antenna coupler consists of four drawers and a cabinet to enclose them. Each drawer provides a means of coupling a transmitter to the common antenna. Figure 7-3 shows the drawer and cabinet arrangement of the AN/SRA-15.

A flexible coaxial line extends from the antenna line connector, shown at the lower right side of the cabinet in figure 7-3, to the top coupler unit in the cabinet. The coaxial line ends at this point and is short circuited. Where the line passes through a coupler unit, a section of the outer braid on the cable is removed. The center conductor is also cut, and the ends are connected to two terminals on the coupler unit. A one-turn loop has its ends connected to these terminals so that it is in series with the center conductor at each coupler unit. These loops provide inductive coupling between the antenna and the inductance in the tuner tank circuit.

The tank capacity in each tuner is tapped, and forms an impedance type divider that always presents a 50-ohm input impedance when the unit is correctly tuned. The combination of tunable tank and variable coupling forms a transformer that matches the input impednace of the antenna to the 50-ohm line that leads to the transmitter. The tank circuits have high Q, providing the necessary selectivity for isolation between channels.

Reflectometer

Each coupler unit has a reflectometer, located in the transmission line from the

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transmitter, to indicate when the tuner is correctly adjusted by indicating the amount of reflected energy on the line. Thus, any mismatch between the coupler and the 50-ohm transmission line is readily apparent, and it can be corrected by returning the coupler.

Figure 7-4A is the movable section of the reflectometer separated from the fixed section. The schematic diagram (fig. 7-4B) shows how the parts are connected in the moving section. A cable connects the meter to the circuitry of the moving section.

The reflectometer housing is made in the form of a T, and the center conductor of the line passes through the top of the T. The moving part of the bridge slides into the short arm of the T so that the disc is close to the center conductor and capacitively coupled to it. There is also inductive coupling between the loop to which the disc is connected and the center conductor. Because it is necessary to maintain the capacity at the same value when a test is in progress, an adjustable coupling screw passes through the cover of the moving section. The end of this

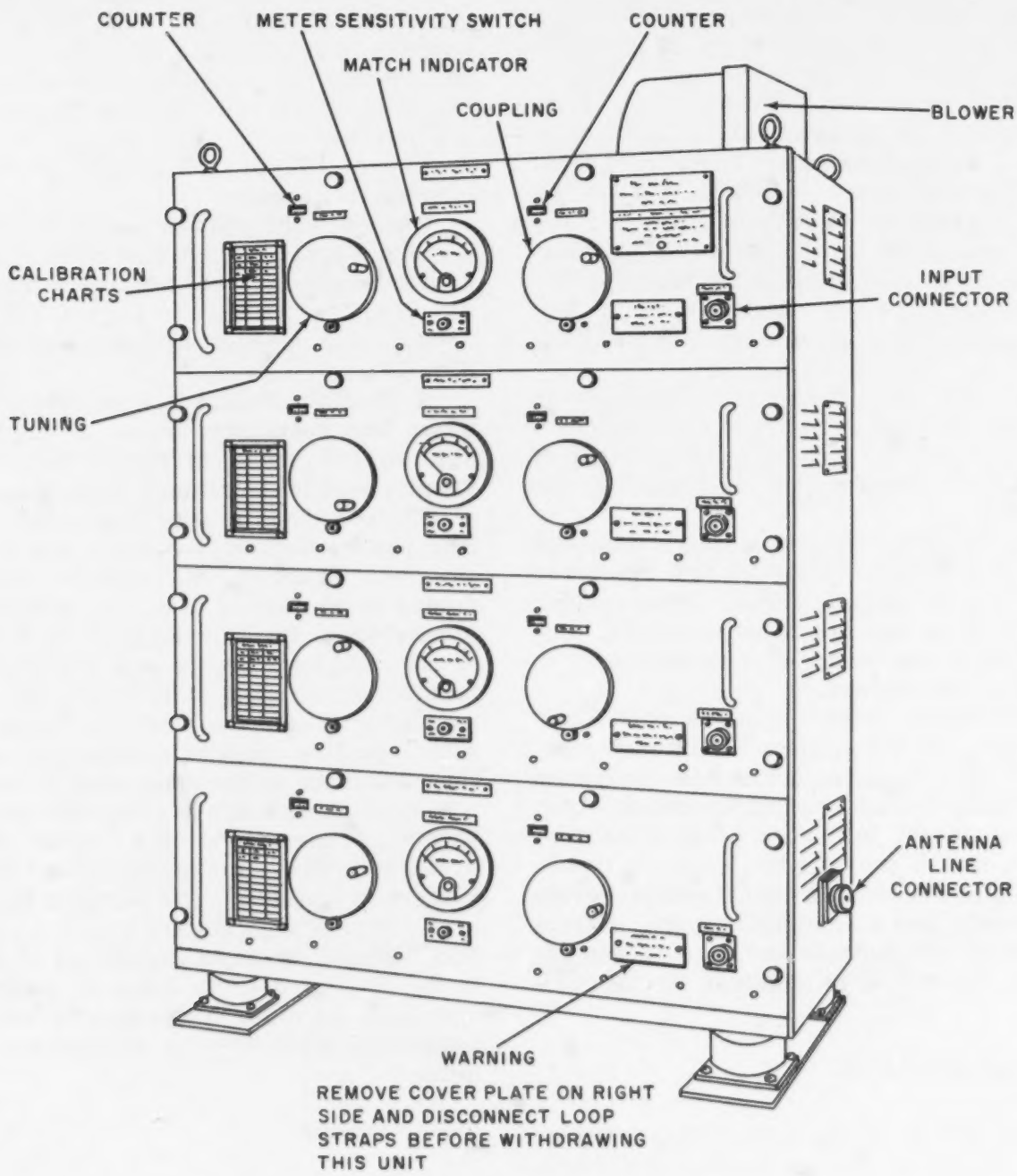

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Figure 7-3.—Antenna milticoupler AN/SRA-15.

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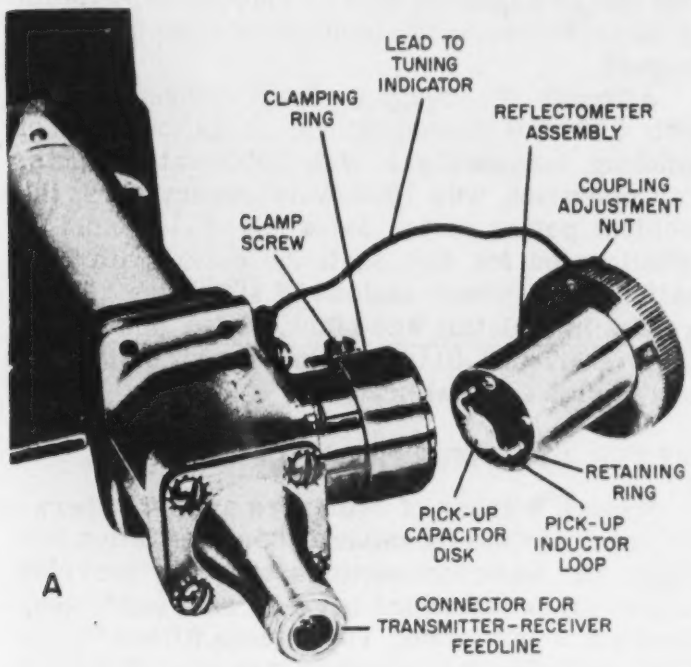

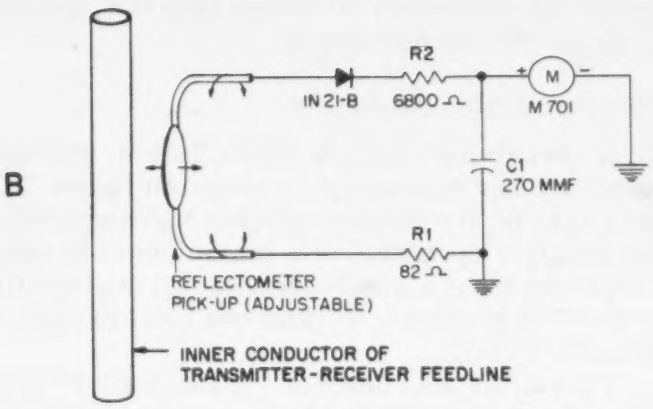

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Figure 7-4.—Reflectometer.

screw rests on a shoulder that is a part of the fixed section and maintains constant spacing regardless of how the movable section is turned. Thus, the movable section can be oriented to adjust the pickup loop in relation to the center conductor of the coaxial line.

Normally, the plane of the U-shaped loop (fig. 7-4B) is parallel to the axis of the feedline. One end of the loop is connected to ground through R1, and the other end is connected to a diode crystal detector. Resistor R2 is a current limiting resistor, and C1 is an r-f bypass for the meter. The meter has a 200-microampere movement and is located on the panel of the coupler.

When the reflectometer is in use, the voltage applied to the detector is the vector sum of the components because of inductive and capacitive coupling. As the angle formed by the loop and axis of the feedline changes, the amplitude of the inductive component varies from zero to maximum as the capacitive component remains unchanged. The phase of the inductive component is reversed by turning the loop through 180 degrees. Therefore, at some orientation of the loop the currents of the two components will cancel.

The same cancellation can be obtained by leaving the loop parallel to the feedline axis and adjusting the position of the capacitive plate by turning the adjustment screw in or out until cancellation occurs. This will happen when there is no reflected wave on the feedline because (1) the capacitive coupling is very small, (2) the loop inductance is negligible compared to the resistance of R1 (82 ohms), and (3) R1 is noninductive.

After cancellation has been obtained, as indicated by a zero meter reading, the movable section is clamped in position. Thereafter, zero meter reading indicates the impedances are matched and maximum power is being transferred.

There is some hazard in using this method, however, because a mistuned coupler can cause a high standing-wave ratio, which would produce enough reflectometer current to burn out the microammeter and crystal diode.

A more practical method of using the reflectometer is to tune the transmitter and coupler for minimum standing-wave reflection and then use the reflectometer for final fine tuning. Usually zero readings will not be obtained, but a minimum of two to six microamperes can be accepted as an indication of correct tuning.

The multicoupler has two controls. One operates the input coupling capacitor and the tank tuning capacitor which are ganged together, and the other operates the coupling-loop position in relation to the tank inductance. The last-named control is used to adjust the loading, and the first-named control is used to tune the tank to resonance.

All four antenna coupler types have the same general design. However, the AN/SRA-16 (9-26 mc) uses capacitance coupling instead of inductive coupling to the transmission line, and parallel operation instead of series operation as is done in the other three couplers. The input circuitry and the method of control, tuning

indication, and operation are essentially the same for all units.

Operation

When a multicoupler installation is first put into operation, the transmission line is first terminated with a noninductive, 50-ohm load at the point where it will connect to the antenna couplers. The power-handling capability of the resistor (load) must be such that it can handle the entire output of the transmitter. The transmitter is then operated into the load, and the controls on the transmitter are adjusted for best operation. Tuning for the various channels to be used is set up at this time and, after the transmitter adjustments are completed, the controls need not be touched again unless it becomes necessary to change frequency.

The noninductive load is then disconnected from the transmission line and the line connected to the antenna connector on the multicoupler cabinet. The antenna couplers are adjusted for minimum standing-wave ratio at each operating frequency while the transmitter is being operated. When a minimum standing-wave ratio has been obtained at each frequency, the antenna and coupler are furnishing a 50-ohm load to the transmitter. It is theoretically possible to obtain a standing-wave ratio of 1 to 1, but it is not always possible to eliminate reflections in actual practice. In any event, the tuning of the multicoupler should be done carefully to get the meter reading as close to zero as possible. Otherwise power will be wasted in reflected waves.

AN/SRA-23

Antenna coupler group AN/SRA-23 permits the simultaneous operation of up to eight 500-watt transmitters covering the frequency range of 2 to 27 mc in one broad-band antenna system, with a minimum frequency separation between channels of approximately 10 percent. One antenna coupler group is required for each transmitter in the system. The group consists of five major components as shown in figure 7-5. The three antenna couplers are similar in principle of operation, but their circuit components differ to provide different frequency ranges. A trunking and switching unit (fig. 7-6) is also supplied for combining four coupler groups into a system. This provides a switching system for selection of the desired coupler, dummy antenna load, and the desired broad-band antenna. A four-group system can be expanded into an eight-group system by interconnecting two four-group systems back-to-back.

Although the coupler was developed for use with 500-watt transmitters, it is capable of handling transmitters with 1000-watt outputs. For operation with 1000-watt transmitters, the incident power meter M401 (fig. 8-12) must be recalibrated for full-scale deflection with 1000 watts of r-f power instead of 500 watts. Electronics Installation and Maintenance Book, NavShips 0967-000-0110, contains instructions to accomplish this calibration.

FILTER TYPE MULTICOUPLERS

When a number of receivers are to be operated from a common antenna, some isolation between the input connections must be provided to prevent interference between sets and to keep losses at a minimum. The antenna filter assemblies used for this purpose are the AN/SRA-9 and AN/SRA-12. Since the filters are the same except for frequency coverage only one, the AN/SRA-12, will be discussed.

Receiver Filter Assembly

A receiving-antenna distribution system, using a filter assembly, is shown in figure 7-7. This type of distribution system makes possible the multiple operation of a maximum of 28 radio receivers from a single antenna. It is generally preferable however, to limit the total number of receivers to 7.

This filter assembly or "multicoupler" provides 7 r-f channels in the frequency range from 14 kc to 32 mc. Any or all of these channels may be used independently of, or simultaneously with, any of the other channels. Connections to the receivers are made by means of coaxial patch cords and a patch panel.

An external view of the filter assembly is shown in figure 7-7,A. Separation of the frequency range into channels is accomplished by combinations of filter subassemblies, which plug into the main chassis. Each filter subassembly consists of complementary high-pass and low-pass filter sections, the common crossover frequency (F_c) of which marks the division between channels.

The filters not only guard against interference at frequencies falling outside the channel being used, but also prevent receivers connected to alternate rows of jacks from interacting with each other when their tuning and trimming adjustments are made.

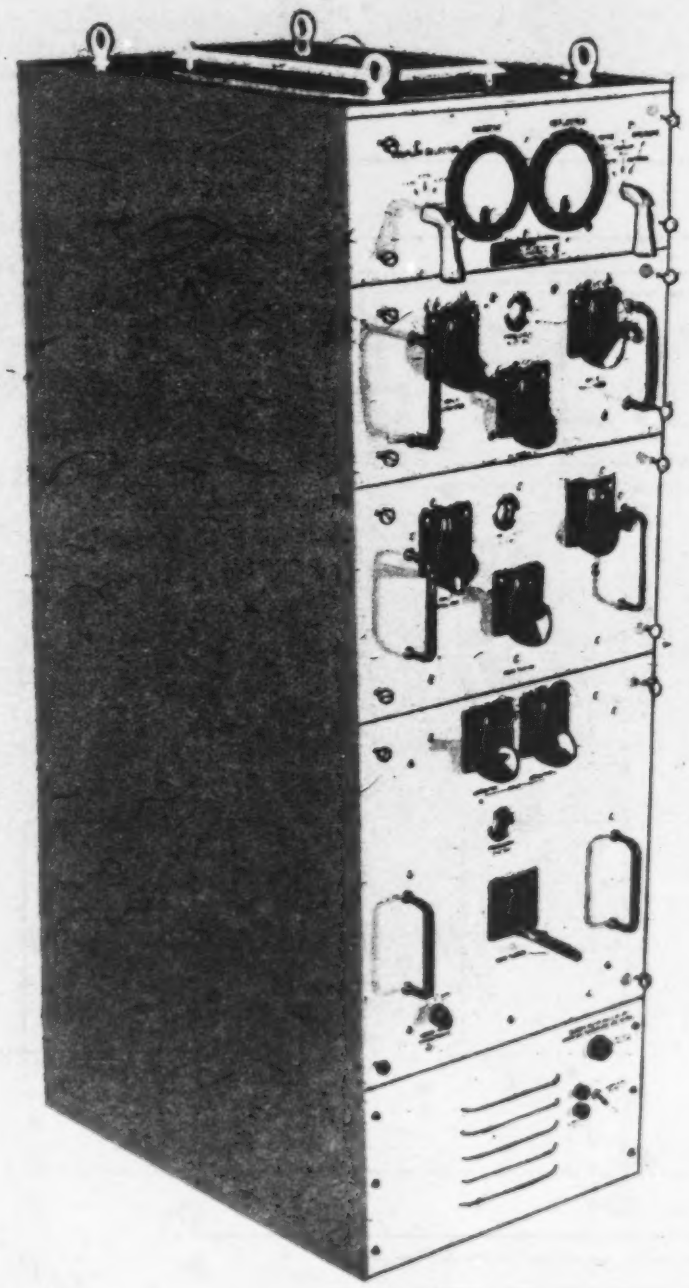

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Figure 7-5.—Antenna coupler group AN/SRA-23.

A set of nine filter subassemblies is available, any six of which may be used at one time. The filter subassemblies are sealed units consisting of inductors and capacitors and are terminated in 4-terminal plugs, which are designed to engage octal receptacles on the main chassis. The subassemblies have numbers stamped on them that indicate their crossover frequencies. These numbers can be viewed through windows in the front panel. The six subassemblies that are used are assembled in the order of decreasing frequencies from left to right, as viewed from the front of the panel.

The filter panel (fig. 7-7,B) contains 1 antenna input jack, 28 output jacks, 21 decoupling resistors, and 6 octal sockets. The antenna input jack and the 28 output jacks are all Navy type-49120 r-f connectors. (In the AN/SRA-12

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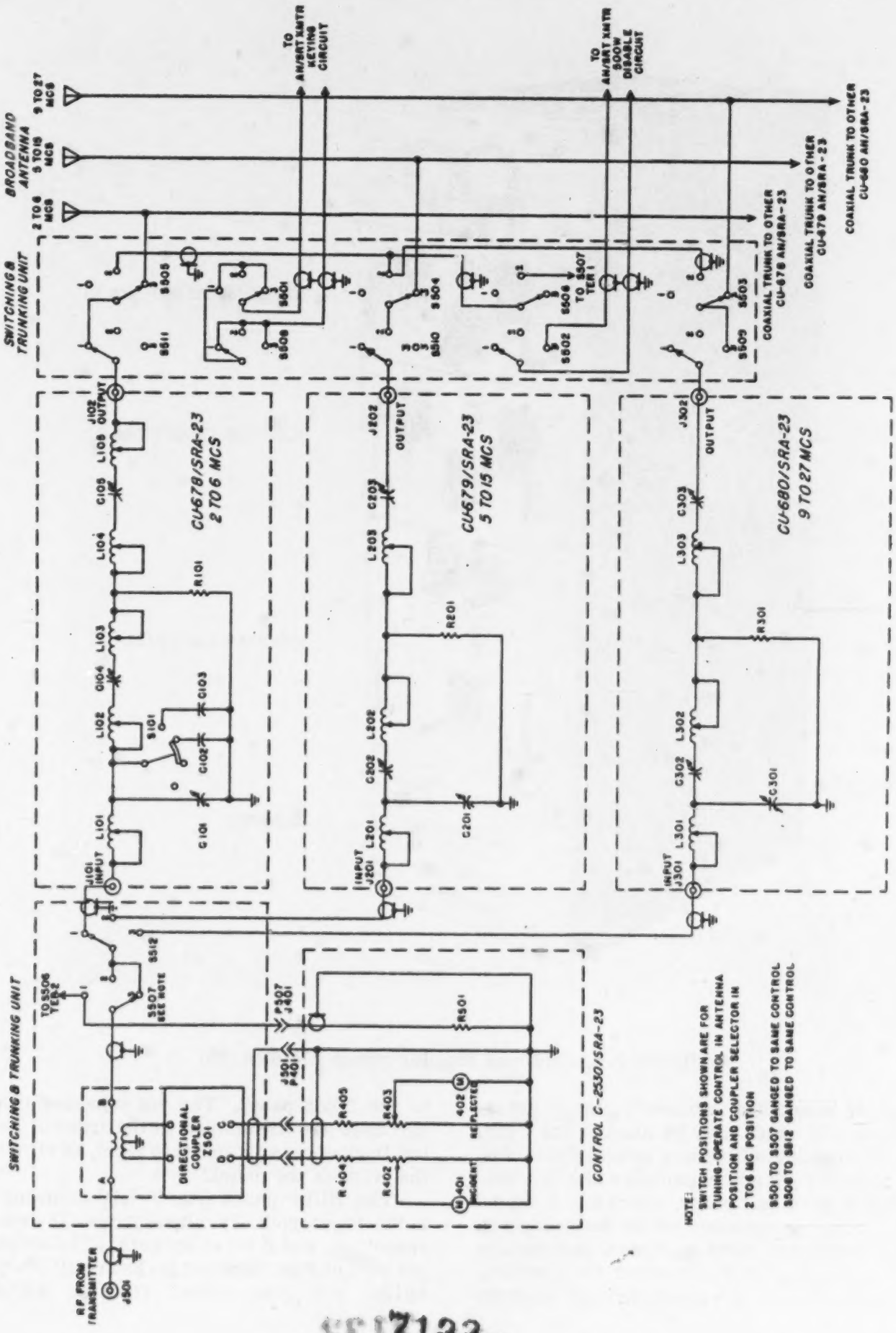

Figure 7-6. — Antenna coupler group AN/SRA-23, simplified schematic.

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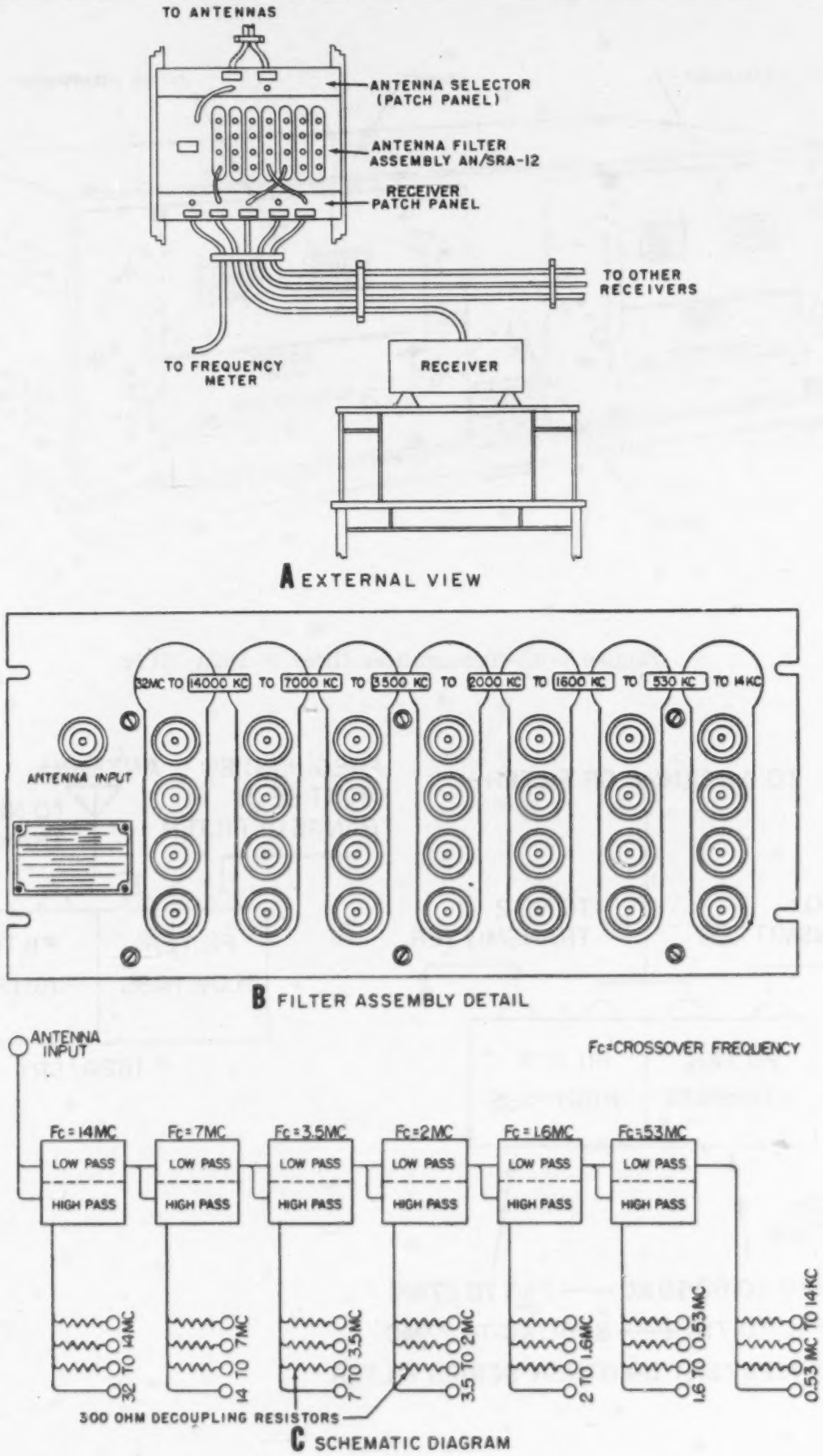

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Figure 7-7.—Receiving-antenna distribution system, using antenna filter assembly.

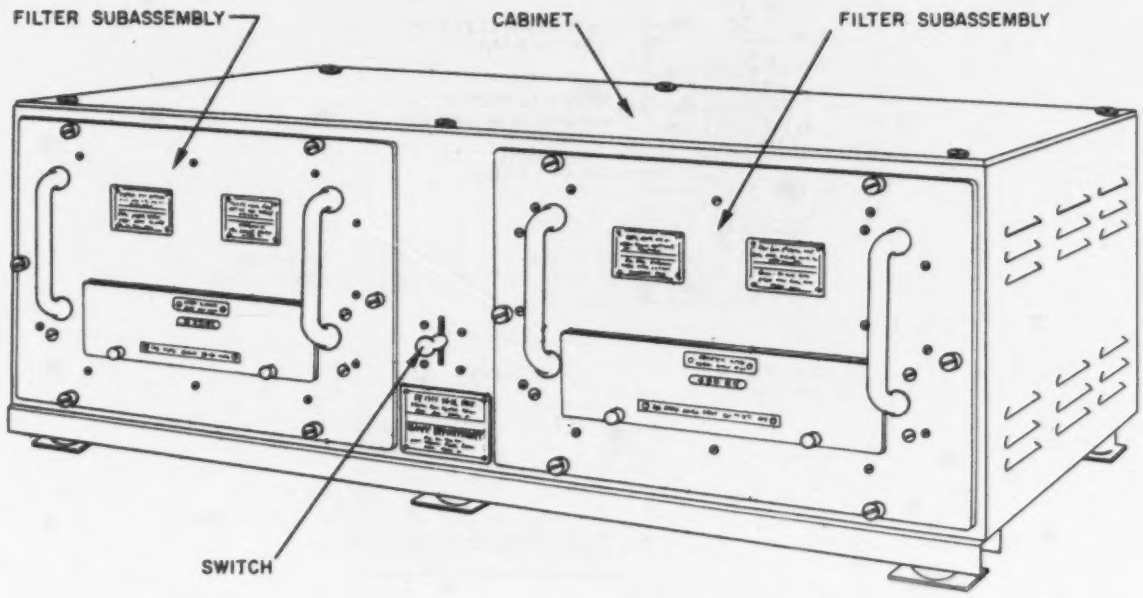

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Figure 7-8.—Transmitter filter F-162A/SRT.

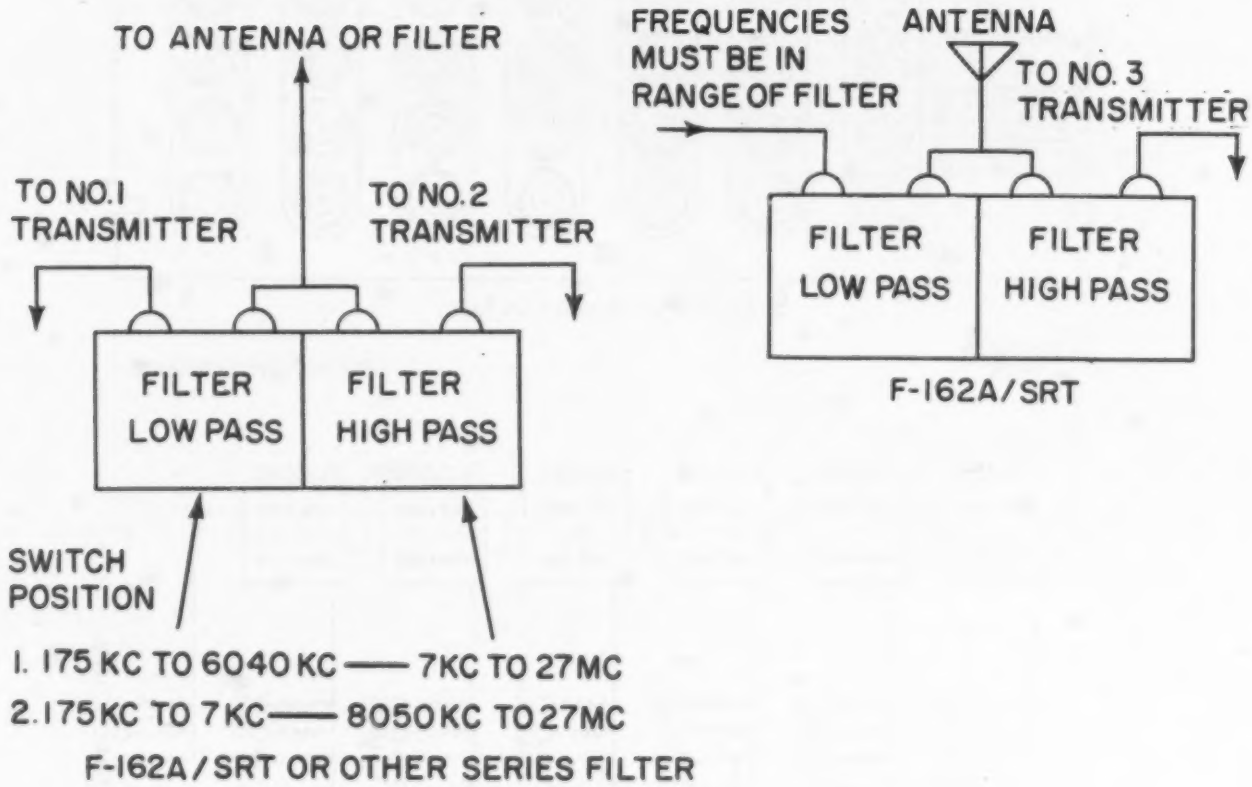

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Figure 7-9.—Representative F-162A/SRT installations.

Receiving Filter Assembly, these connectors have been changed to receptacle connectors UG-1111/U (and plug connectors UG-968/U) which are improved quick-disconnect type r-f connectors.) The filter subassemblies plug into octal sockets in the rear of the main chassis (not shown).

To keep the losses to a minimum, the input and output of the filter assembly should be terminated in 180 ohms, however, only a slight reflection loss (of the order of 1.0 db) results when the input is terminated in 70 ohms.

Because Navy communications receivers generally operate throughout frequency bands that exceed the widths of the channels normally provided by the filter subassemblies, a given receiver must be connected to the particular row of output jacks that provides the signals of the desired frequency. For example, if a receiver is tuned from some frequency in the 7- to 14-mc band, to some frequency in the 14- to 32-mc band, the patch cord would have to be moved from the output of the 14- to 7-mc subassembly unit to the output of the 32- to 14-mc subassembly unit.

When necessary, the bands of frequencies available in a given row of output jacks may be changed either by using different combinations of filter subassemblies or by removing various subassemblies and inserting "shorting plugs." provided with the equipment. These shorting plugs provide continuity between successive subassemblies, as required when testing or when a subassembly is removed for any reason, without the necessity for changing the position of the remaining subassemblies.

The red-painted jacks at the bottom of each row are directly connected to the subassemblies and should be used whenever maximum signal strength is desired. The other 3 jacks in each row are decoupled by 300-ohm resistors and are best suited for use with relatively strong signals (fig. 7-7,C). In the ideal arrangement, only one receiver is connected to each vertical row or jacks, and that receiver is connected to the bottom jack in each row. This means that seven receivers are fed from each antenna. At frequencies somewhat removed from the crossover points, the performance of each of these seven receivers should be comparable with that obtained if a given one of the receivers were connected directly to an antenna. Likewise, the performance of 21 receivers connected to the "decoupled jacks" should be comparable with the performance of 3 receivers decoupled in like manner, using conventional patch panels (with a 600 ohm isolation resistor between jacks) on a given antenna.

Transmitting Filter Assemblies

The filters that will now be described have been designed for use with shipboard transmitters and antennas that are unbalanced to ground. This series includes Electrical Filter Assemblies F-159/SRT, F-160/SRT, F-161/SRT, F-162/SRT, and F-163/SRT.

A representative filter assembly of this series, the F-162A/SRT, is shown in figure 7-8. Each filter assembly consists of low-pass and high-pass subassemblies. They are used with transmitters operating in the frequency range between 175 kc and 27 mc. Single filter assemblies (fig. 7-9) can be used alone or combined with other subassemblies to operate two or more

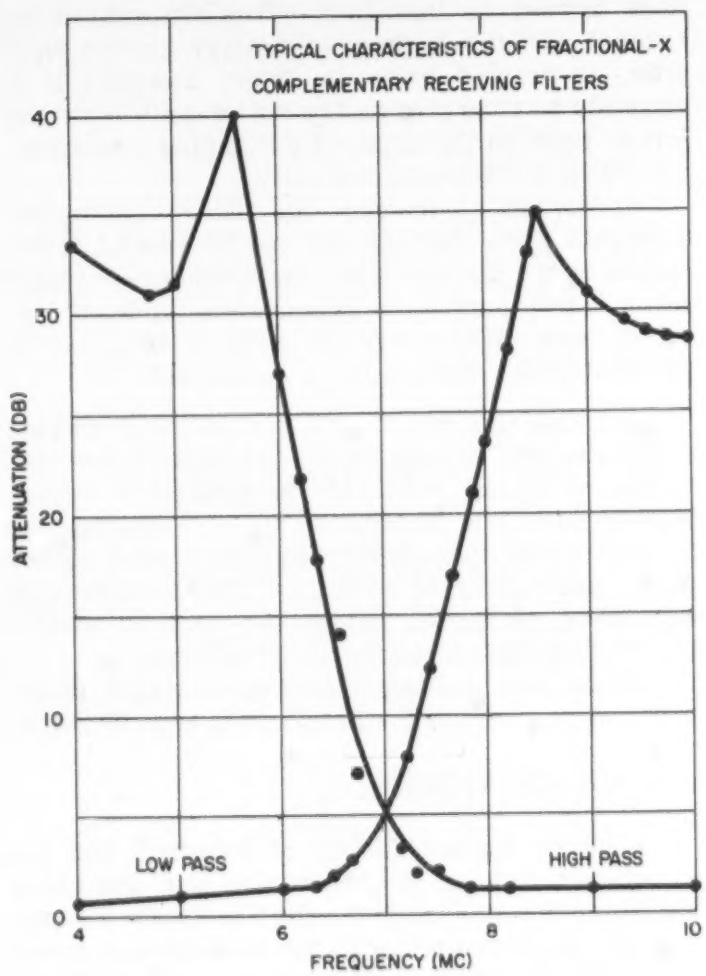

109.43

Figure 7-10.—Filter curves.

TC 7136

transmitters (using different frequencies) into a single antenna.

Because a low-pass filter and a high-pass filter are used in each filter assembly, there is a definite crossover frequency for each filter. In the vicinity of the crossover frequency there is a band of frequencies, called the precluded band, which cannot be used because appreciable power would be lost in the filter. When frequencies in the vicinity of the crossover frequency are to be used, it is necessary to change the crossover point. By removing the crossover point around as the precluded band is approached, it is possible to obtain continuous coverage of the 175-kc to 27-mc frequency range. A switch in the center of the front panel on all assemblies except the F-160/SRT, permits shifting of the crossover frequency.

Figure 7-10 shows curves for both low-pass and high-pass filters for the F-162A/SRT.

The filter assemblies are constructed in the form of plug-in drawers. Normally, the low-pass drawer is installed on the left side of the cabinet and the high-pass drawer on the right side, as viewed from the front, however it is possible to interchange the subassemblies from left to right in the cabinet by changing a connecting strap in each subassembly.

In normal operation, the filter assemblies dissipate less then 20 percent of the r-f power output of the transmitter. Because it is possible for a fault, such as a grounded antenna, to develop, each filter subassembly is designed to dissipate over 500 watts, if necessary.

Because the low-pass filter section provides a termination for the high-pass section and vice versa, it is not advisable to operate a transmitter into one section alone. If it becomes necessary to operate a transmitter when either filter section is removed, a jumper assembly furnished with each cabinet is used to connect the transmitter directly to the antenna.

Other transmitting filter assemblies presently in use include the F-156, 157, and 158/URT.

SWITCHING SYSTEMS

A basic understanding of switches and the functional use of switchboards and switching systems is a necessity for the Electronics Technician. In some instances, the switching systems used with electronic equipment are more difficult to understand than the operation of the equipment itself. In general, however, although switching systems are becoming more complex, the methods of operation are being simplified. Switchboards make use of multisection switches that are not difficult in themselves to understand, but the entire switching function performed by switchboards, or by combinations of switchboards, may be somewhat involved. In this chapter a typical receiver switchboard and a typical transmitter switchboard are treated.

Simplified diagrams, showing how switchboards are connected to receivers, transmitters, radiophone units, and accessory equipment, are included. For completeness, block diagrams of the switching circuits between Radio Central, Radio II, and Radio III in one type of installation, are also included.

Finally, the more complex radar data switching system is described with the aid of block diagrams and simplified switching circuits.

Bear in mind that in many of the switching systems described there are a large number of possible circuit arrangement. In this chapter a great deal of simplification is employed; and in general, only the less complex arrangements are included. Enough basic information is included however, to give the prospective ET- the

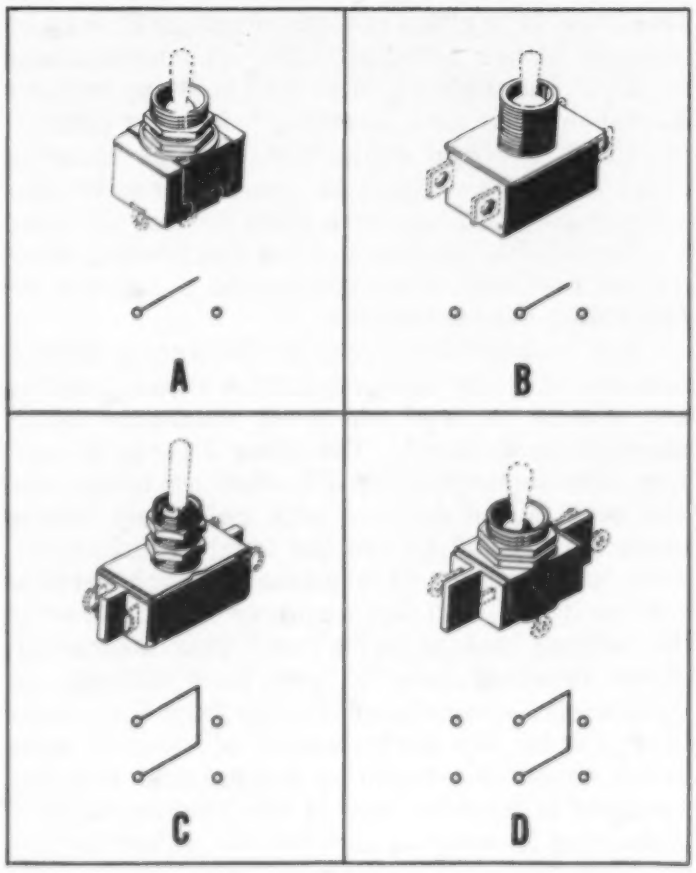

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Figure 7-11.—Toggle switches.

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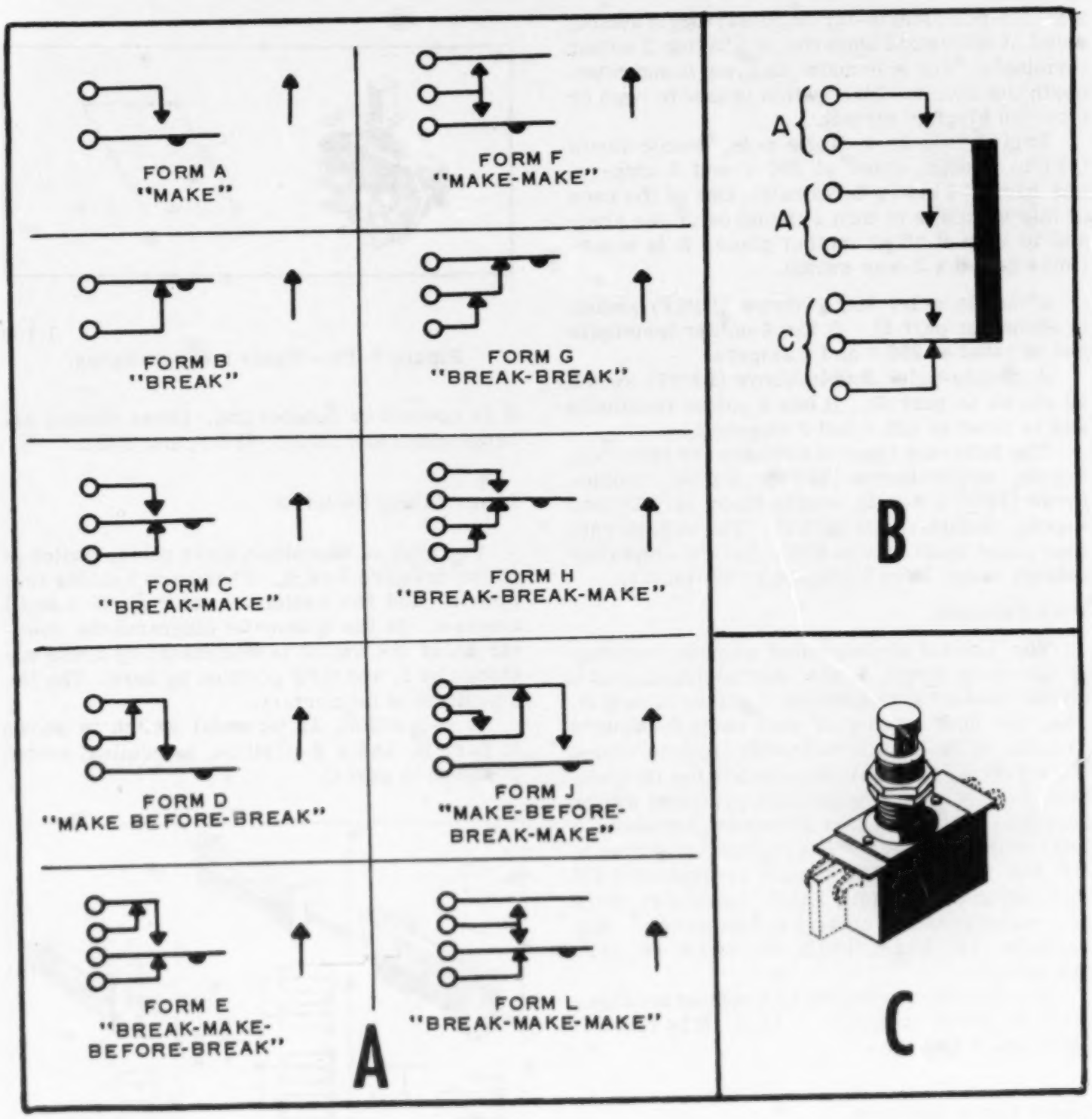

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Figure 7-12.—Push switches.

necessary background for further study on the subject.

TYPES OF SWITCHES

Some of the more common types of switches used with electronic equipment are illustrated and described briefly in this portion of the chapter. There are many variations of each type of switch; however, only a few representative examples are included here.

Toggle Switches

Representative examples of toggle switches are shown in figure 7-11. In part A is shown

a single-pole, single-throw (SPST) toggle switch, rated at 200 v and 2 amperes, and having 2 solder terminals. The schematic diagram is shown beneath the switch. This switch is used to open or close an electric circuit.

Part B shows a single-pole, double-throw (SPDT) switch, rated at 250 v and 1 ampere, and having 4 screw terminals. One of the uses of this switch is to turn a circuit on at one place and to turn it off at another place. It is sometimes called a 3-way switch.

A double-pole, single-throw (DPST) switch is shown in part C. It has 4 solder terminals and is rated at 250 v and 1 ampere.

A double-pole, double-throw (DPDT) switch is shown in part D. It has 6 solder terminals and is rated at 125 v and 3 amperes.

The following types of switches are also used: 3-pole, single-throw (3PST); 3-pole, double-throw (3PDT); 4-pole, single-throw (4PST); and 4-pole, double-throw (4PDT). The voltage ratings range from 20 v to 600 v, and the amperage ratings range from 1 ampere to 30 amperes.

Push Switches

The contact arrangement of push switches is shown in figure 7-12A, and an example of a typical contact arrangement is shown in part B. The type and quantity of each basic form used to make up the contact assembly are determined from Part A. Part B illustrates how the illustrations in part A may be used in a practical switch assembly. Thus, in part B the switch contains a total of three separate basic forms: two forms A, and one form C. The contact arrangement for this switch is therefore 2A1C. Obviously, there are many possible contact arrangements. For example, 1A, 1A1A, 1A1B, 2A, 2A1B, 1B, etc., are common.

A push switch enploying a 2A contact arrangement is shown in figure 7-12, C. It is rated at 250 v and 3 amperes.

Wafer Lever Switches

A wafer lever switch is shown in figure 7-13. It is a double-pole, triple-throw (DP3T) type of switch rated at 110 v and 0.150 ampere. It locks in position and is nonshorting, that is one circuit is opened before the next circuit is closed. In switches of this type the action may be locking or momentary, and the contacts may be shorting (for example, one circuit remains closed until an instant after the next circuit is closed; then

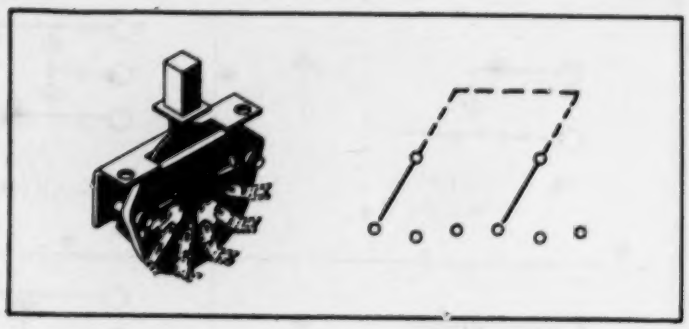

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Figure 7-13.—Wafer lever switches.

it is opened) or nonshorting. Other contact arrangements are DPDT, 4PDT, and 6P3T.

Lever Pileup Switches

One type of 2-position lever pileup switch is shown in figure 7-14, A. There are 9 solder terminals, and the switch is rated at 48 v and 1 ampere. In the schematic diagrams the downstroke of the switch is designated by 2, the upstroke by 1, and OFF position by zero. The No. 2 position is momentary.

A 3-position, 21-terminal switch is shown in part B, and a 2-position, 9-terminal switch is shown in part C.

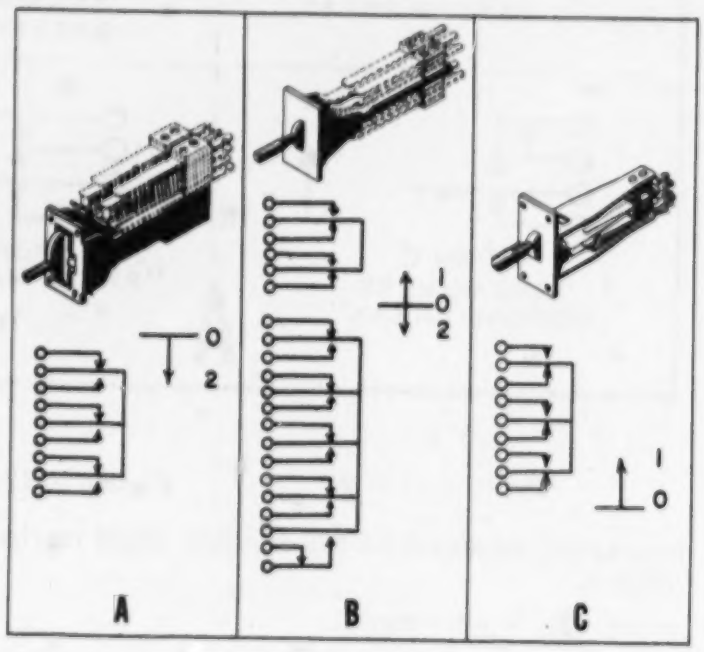

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Figure 7-14.—Lever pileup switches.

Nearly a hundred types of lever pileup switches are available for various uses. They may have up to 75 terminals, and the associated switch contacts may be arranged in various ways.

In addition to lever pileup switches, rotary pileup switches (activated by a rotary motion) and the jacktype pileup switches (activated by the thrust of the plug) are used in automatic telephone systems.

Thermostatic Switches

Thermostatic switches are designed to either open or close when the temperature reaches a certain value. A large number of different types of thermostatic switches are used by the Navy to control the temperatures in compartments and rooms, to regulate dampers, to maintain constant crystal temperatures in some radio transmitters; they are also used in many other heating and cooling applications. Switches of a given type may have different contact arrangements, be operated at different temperature range, or have different voltage or current ratings.

A large number of thermostatic switches employ a bimetallic strip as the active element. The basic operating principle is illustrated in figure 7-15A. One side of the bimetallic strip is brass and the other side is iron (other metals may also be used) welded to the brass. When the strip is heated, the brass expands more than the iron and the strip bends downward to open the switch contacts. Thus, power is removed from the load when a certain temperature is exceeded. Although not shown in the figure, various refinements such as adjustments and snap action may be incorporated in the switch.

In mercury thermostatic switches the mercury itself completes the circuit as it expands upward between two metallic contacts. The basic operating principle is illustrated in figure 7-15,B. When the temperature decreases, the mercury contracts and opens the circuit.

The principle of operation of gas thermostatic switches is illustrated in figure 7-15,C. When the gas is heated, it expands the bellows and closes the switch; when it is cooled, it contracts the bellows and opens the switch.

In each of the illustrations, only the basic principle of operation is shown. Certain refinements are generally added.

Figure 7-15,D, shows the thermostatic switch used in the crystal oven of one type of radio transmitter. The contact arrangement is for a single-pole, single-throw operation, and the switch is rated at 115 v and 0.75 ampere. The operating temperature is 170.6° F to 179.6° F, the temperature differential being 9°.

Rotary Pileup Switches

Rotary pileup switches are so constructed that they open and/or close one or more electrical circuits; the contacts are arranged in a

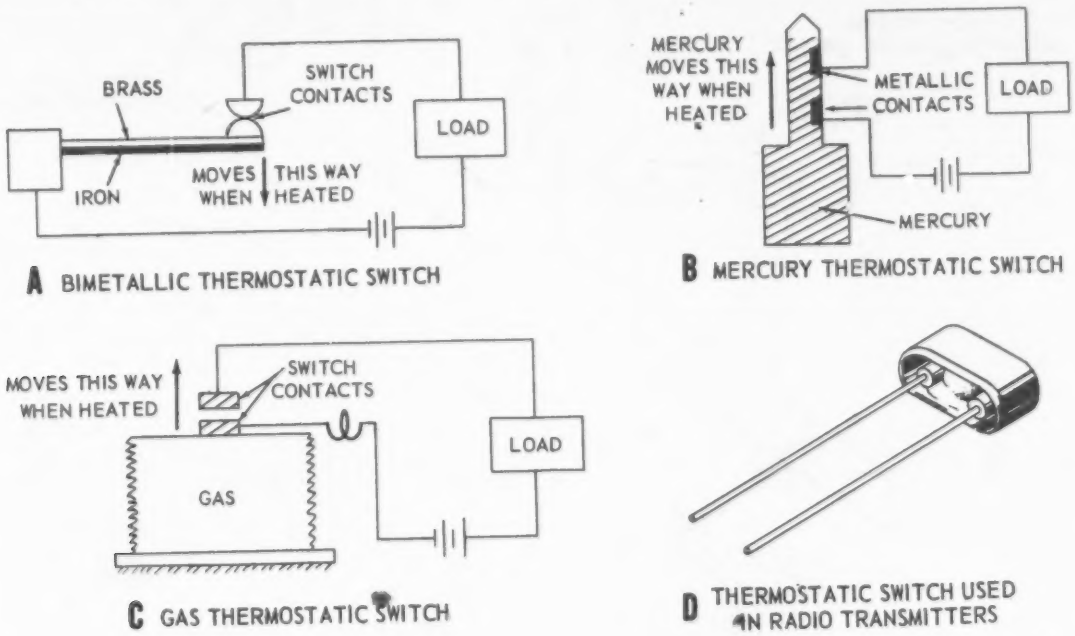

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Figure 7-15.—Thermostatic switches.

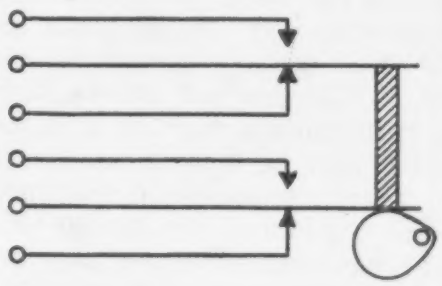

1.104

Figure 7-16.—Rotary pileup switches.

leaf, or pileup, fashion and they are actuated by a rotary motion.

One type of rotary pileup switch is illustrated in figure 7-16. As may be seen in the figure, there are six terminals. When the armature is moved upward by the rotary motion of the switch knob, two circuits are opened and two other circuits are closed.

This type of switch has numerous applications in low-voltage signal circuits.

Rotary Selector Switches

Rotary selector switches, or nonpileup rotary switches, have many applications in electronic equipments. They may be made up of any number of sections, decks, or wafers depending upon the switching functions required. There are hundreds of possible contact arrangements.

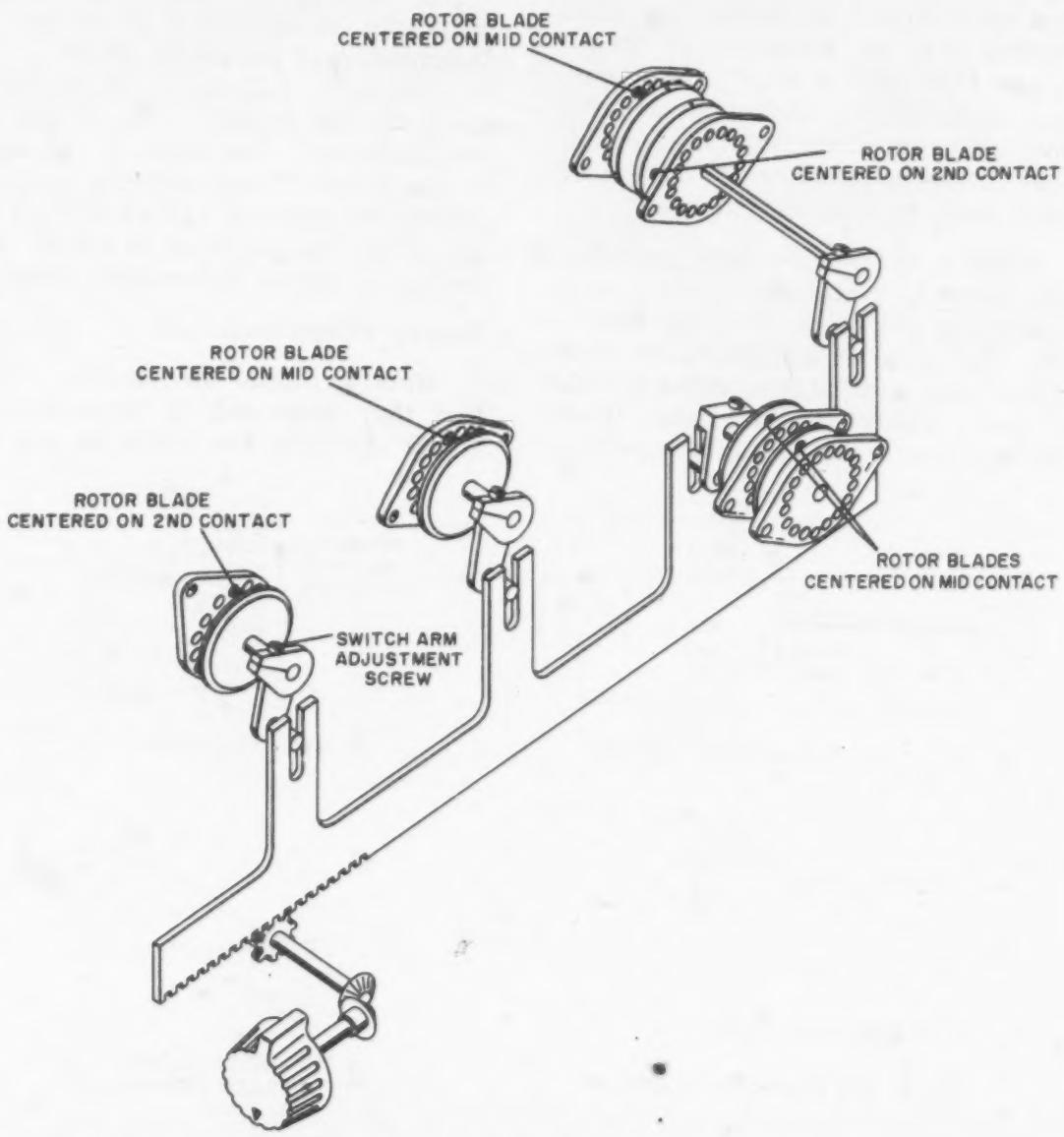

70.62

Figure 7-17.—Rotary selector switches operated by gear and sliding bar.

In many applications the switches are mechanically ganged to operate simultaneously from a single control (fig. 7-17).

One deck of a rotary selector switch is shown in figure 7-18. The code letters are also included at the leads extending from the various terminals. Short clips are indicated by the letter, X. Dummy lugs are indicated by the letter, D. Nonshorting rotary teeth (or blades) are indicated by crossed lines. The word, nonshorting, means that the width of the rotor tooth is less than the distance between adjacent contact clips. This means that as the rotor is turned, one circuit will be opened before the next one is closed. The shorting type is shown without the crossed lines. In this case the rotary tooth is wider than the distance between adjacent clips, and therefore as the rotor is turned, one circuit is closed before the preceding one is opened. Clips that are insulated from their associated lugs are indicated by the letter, S; long clips thus insulated are indicated by the letters, YS. When a clip is thus insulated, the lug may be connected to a clip on the reverse side. A through electrical connection is indicated when the rotor (or a portion of it) is shown in black. This means that the section of the rotor so marked in the figure is connected through to a bottom rotor, not shown.

Telephone Type Jacks

The contact assemblies on telephone type jacks are divided into two categories: (1) the plug contact assembly and (2) the pileup contact assembly. The plug contact assembly includes the contact springs (and all others making electrical connection with them) that make direct contact with the plug when it is inserted. Both categories are illustrated in figure 7-19,A.

Figure 7-19,C, illustrates the common varieties of plug contact assemblies used on jacks and indicates the code designation for each.

The proper contact arrangement for jacks is determined with the aid of figure 7-19,B. The plug contact assembly (J7) is distinguished from the pileup contact assembly (B). and the code designation for the plug contact assembly is determined from figure 7-19,C. The type and quantity of each basic form used to make up the pileup contact assembly are determined. In the case of part B of the figure the proper contact arrangement designation for the jack is "J7-1B."

Jacks are used in plug panels, teletype panels, phone units, and in many other applications.

RADIO RECEIVER BAND-SWITCHING CIRCUITS

Band-switching circuits in radio receivers commonly employ rotary selector switches. In order to trace the various circuits through these switches, it is necessary to pay careful attention to the schematic diagrams. The band-switching circuit of a receiver that is relatively easy to follow is included in figure 7-20.

The 4-position switch, S101B, in the input grid circuits of the oscillator tube, V105, selects 1 of 4 crystals. An additional set of contacts on S101B provides for grounding the three crystals that are not in use at any given time. The operating crystal is connected directly to the grid of V105. In the switch position, 1, shown in the figure, crystal X106 is connected between the grid of V105 and ground; the other three crystals are shorted to ground. In position 2, X107 is connected to the grid, and crystals X106, X108, and X109 are grounded.

The 4-position switch, S101A, mounted on the same shaft as crystal-selector switch S101B,

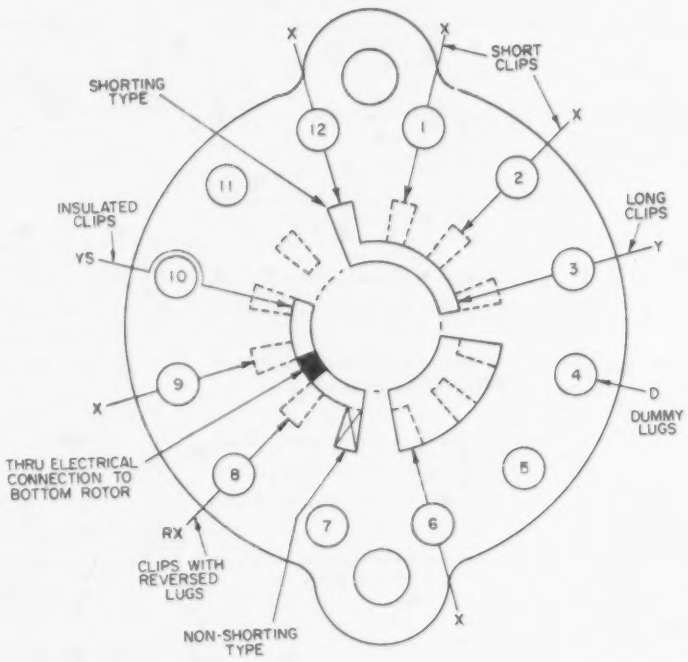

1.105

Figure 7-18.—Deck of rotary selector switch, showing contact arrangement and code letters.

connects filament potential to the proper channel-indicating lamp through S102. In the position shown in the figure, S101A provides circuit continuity for lamp (1); the other three lamps are open at the switch contacts.

Rheostat R117 enables the operator to control the brilliancy of the channel-indicator lamp and the dial lamps E109, E110, and E111.

The band-switching circuits of the AN/SRR-11 (fig. 7-21) are somewhat more involved, however, careful circuit tracing will enable one to follow the signal path.

Band switching for radio receiving set AN/SRR-11 is accomplished through the use of four 2-section, and two single-section rotary selector switches. The 5-position band selector on

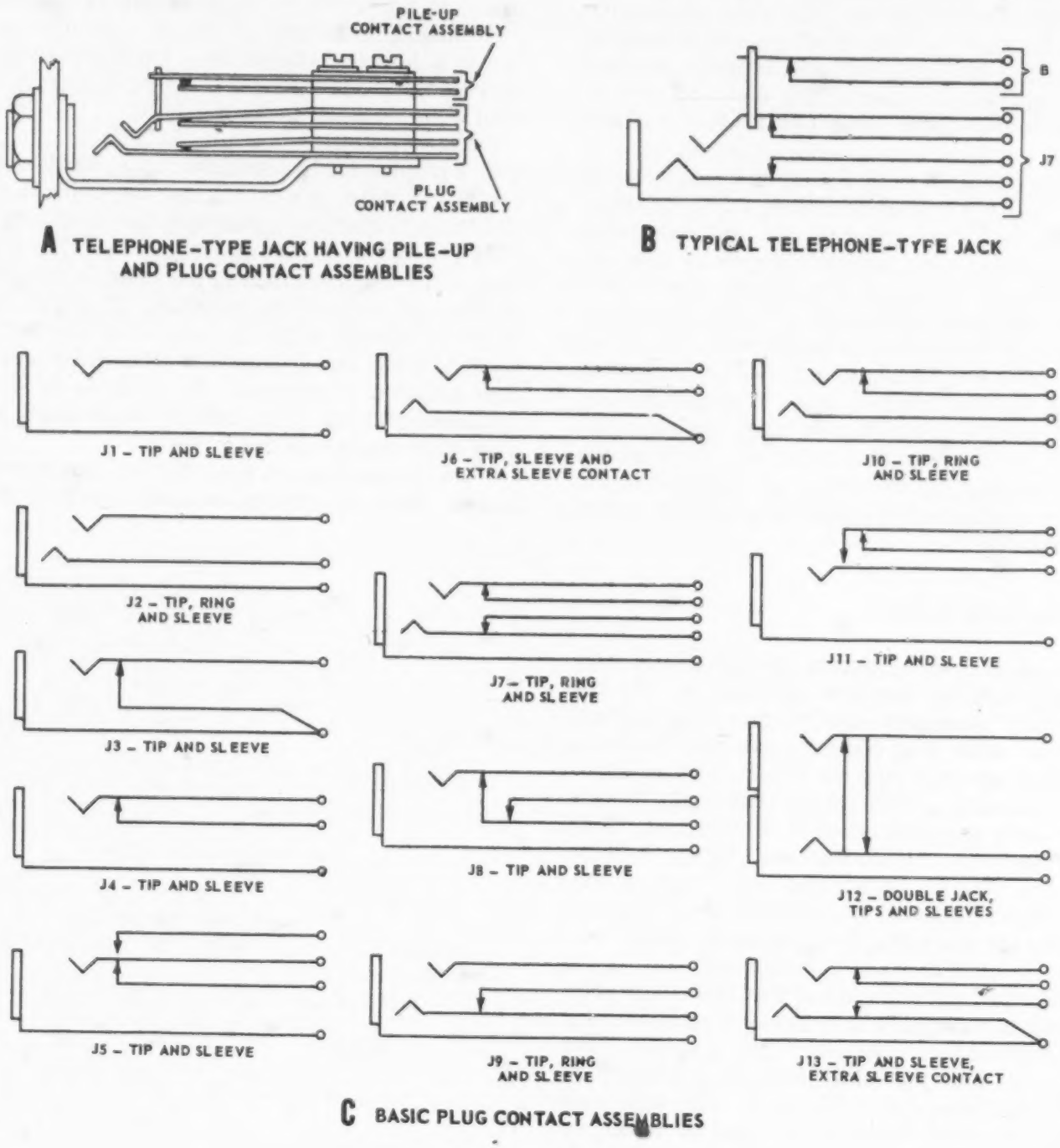

Figure 7-19.—Telephone-type jacks.

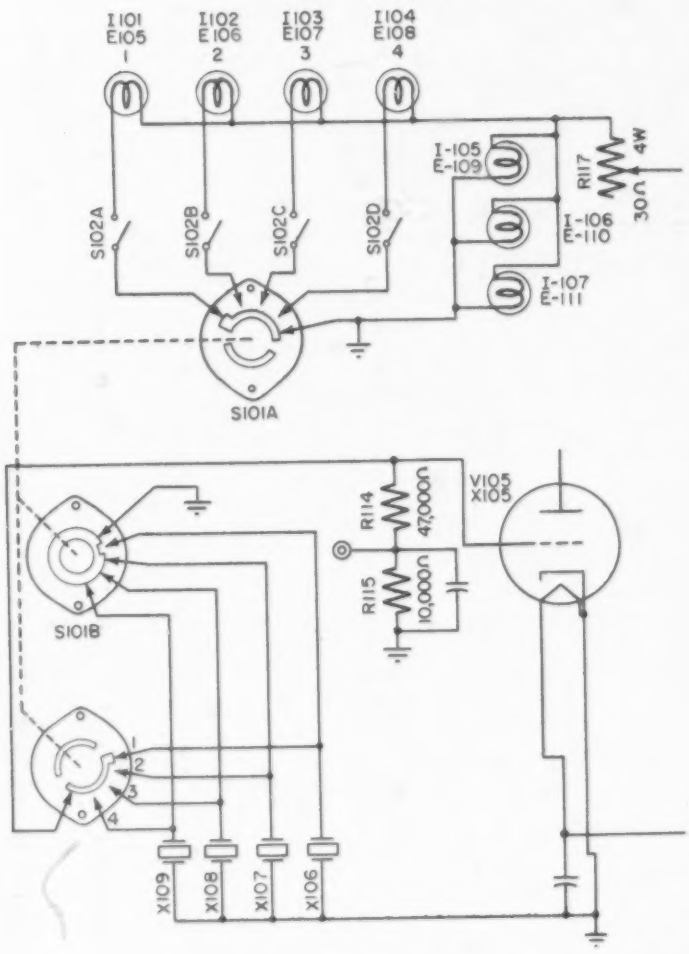

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Figure 7-20.—Band-switching circuit of a receiver.

the front panel of the receiver is geared to a sliding bar similar to figure 7-17, and operates the selector switches to connect the appropriate components for the frequency band selected.

These selector switches connect the appropriate input and output transformers for the selected band, and connect the ganged sections of tuning capacitor C251 across the selected transformers to maintain tuning within the band. They also serve to short out transformers used for bands lower than the selected band, thereby preventing any absorption of the signal on the band in use.

Antenna matching links 0101 and 0102 (fig. 7-21) are provided to match antenna transformers T101 through T105 to either a high or low impedance input. With the links in the low impedance position the antenna is connected across the primary of the selected transformer with capacitor C106 connected between the center tap and the low side of the secondary. With the links in the high impedance position (as shown in fig. 7-21), the antenna is connected between the tap and the low side of the selected transformer secondary.

Antenna compensation switch S102 and capacitor C103, operated by the antenna compensation control on the front panel of the receiver, compensate for variations in antenna capacitance.

The wafers of all selector switches (fig. 7-21) are shown in band 1 position. The signal from the antenna is through C102, matching link 0101, C107 to S101A, and out of S101A via contact 3, through R101 to pin D of T101 in the first r-f amplifier section. The output signal voltage developed by the autotransformer action of T101 is fed back into S101A through contact 15 and out to the grid of the first r-f amplifier V101. S101A also connects the antenna section of tuning capacitor C251D across the secondary of T101. S101B is used to short out transformers associated with lower frequency bands than the selected band, and therefore is not used in band position 1.

The output of V101 (terminal H on J103) is fed to S126A in the second r-f amplifier section, out of S126A via contact 9 to pin B on the primary of r-f coupling transformer T126. The output from pin D on T126 is fed into S126A via contact 3, and out to the grid of the second r-f amplifier V126. C251C is connected across the secondary of T126 by contact 15 of S126A. S126B serves to short out transformers associated with bands below the selected band, and to connect capacitor C139 across the primary of T127, T128, or T129 when operating on bands 2, 3, or 4. S126B, therefore, is not used in band position 1.

The output of the second r-f amplifier V126 at terminal H on J128 is coupled to the grid of mixer V151 through transformer T151. Transformer T151 is connected in the circuit by S151A in the same manner as described for T126 and S126A. S151B also is not used for band position 1.

Oscillator assembly Z201 in the oscillator section generates 60 kc above the signal frequency on frequency bands 1 and 4, and 200 kc above the signal frequency on the remaining bands. Oscillator signals for band 1 operation are from pin D on L201, into S201A via contact 9, out of S201A through R201, to the grid of V201. Oscillator feedback is from pin E on

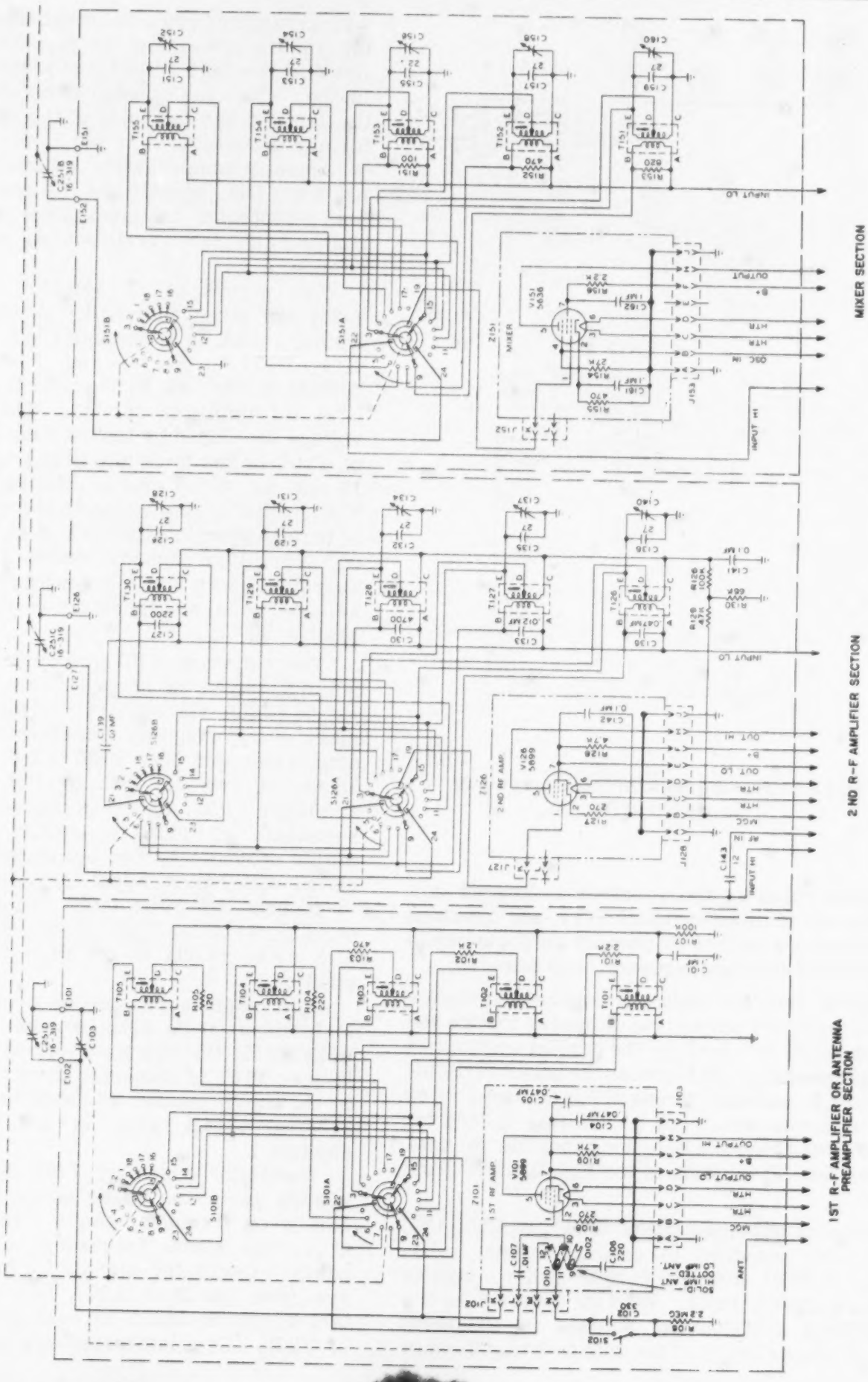

Figure 7-21A.—Band-switching circuits - Radio Receiving Set AN/SRR-11.

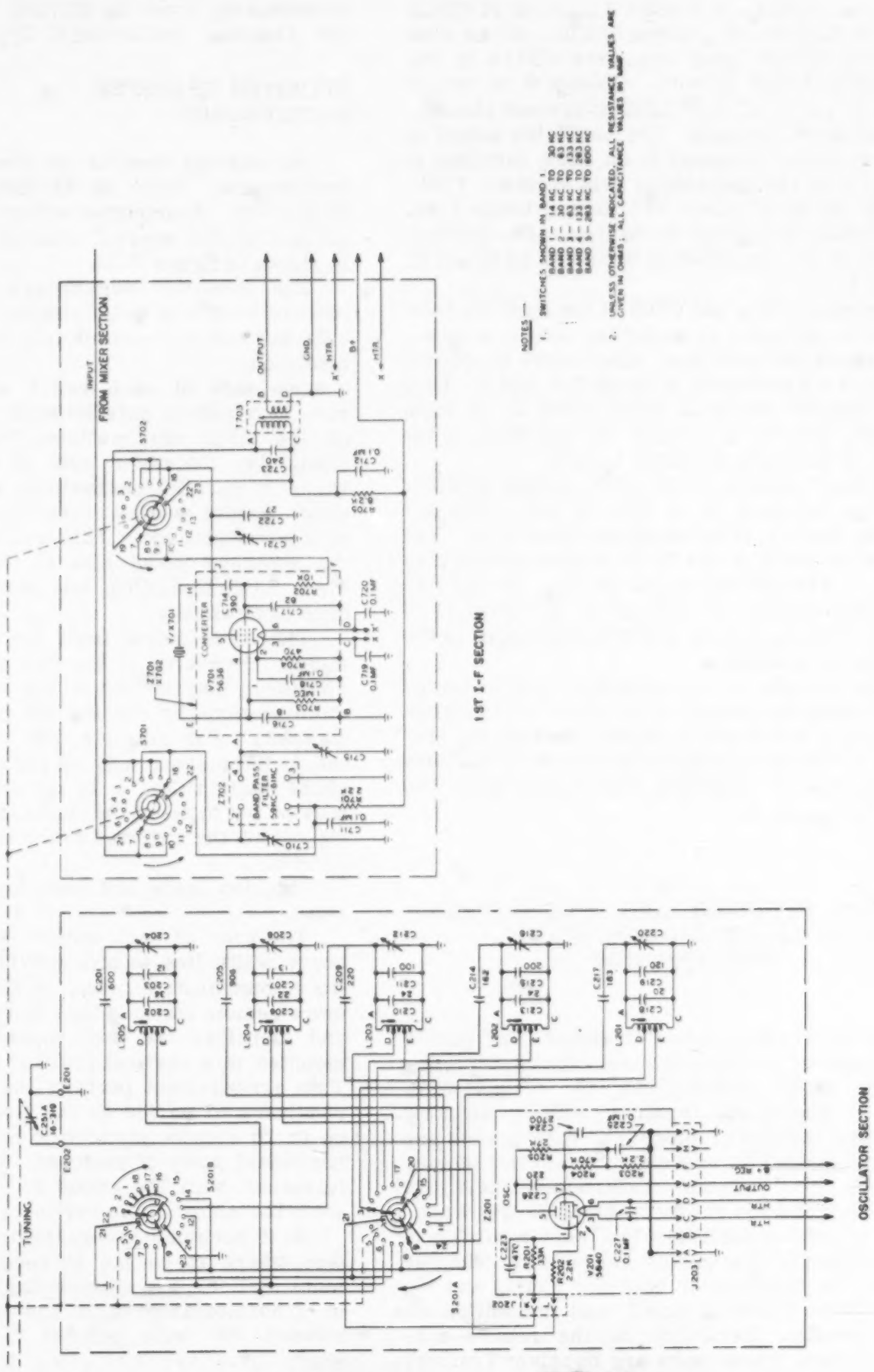

Figure 7-21B.—Band-switching circuits - Radio Receiving Set AN/SRR-11.—Continued.

L201 into S201A via contact 3, and out of S201A through R202 to the cathode of V201. S201A also connects tuning gang capacitor C251A in the oscillator tuned circuit. Contact 9 on S201B grounds pin D of coil L202 to prevent absorption of band 1 signals. The oscillator output is through C226, terminal E on J203, terminal B on J153, to the suppressor grid of mixer V151.

The output of mixer V151 during bands 1 and 4 operation is applied to the first i-f amplifier. The first i-f amplifier is bypassed on bands 2, 3, and 5.

Switches S701 and S702 in the first i-f section are two-pole, six-position, single-section, rotary selector switches. They serve to bypass the first i-f assembly in bands 2, 3, and 5. They also connect bandpass filter Z702 in the input circuit, and the B+ supply for operation of the first i-f assembly in bands 1 and 4.

In band position 1, the 60-kc output of mixer V151 at terminal H on J153 is fed to S701 and out on contact 16 to bandpass filter Z702. The output of Z702 is fed to the suppressor grid of V701. The 200-kc output of V701 is fed into S702 via contact 16 and out to the primary of T703. The secondary of T703 is the output to the second i-f assembly.

The circuits for band position 2 may be traced by rotating the arrows in all wafer switches one position in the direction shown. To trace the circuits for the remaining bands, rotate the switches the number of positions corresponding to the band to be traced.

RADIO RECEIVER AND TRANSMITTER REMOTE-CONTROL TRANSFER SWITCHBOARDS

Radio remote-control transfer plug panels have become too cumbersome to be used in shipboard radio installations or modern Navy ships. Therefore, control panels utilizing switches instead of plugs and patchboards are being installed in new construction and in conversion jobs. Two unit-constructed panels (one for receivers and one for transmitters) now provide all of the facilities that were available in three types of plug panels (the receiver transfer panel, the transmitter transfer panel, and the radiophone transfer panel), and in addition afford greater flexibility in the remote-control system. These units are Receiver Transfer Switchboard, Type SB-82/SRR, and Transmitter Transfer Switchboard, Type SB-863/SRT.

RECEIVER TRANSFER SWITCHBOARD

An external view of the Receiver Transfer Switchboard, Type SB-82/SRR, is shown in figure 7-22. A simplified schematic diagram of a portion of the internal switching arrangement is shown in figure 7-23.

The receiver switchboard has 5 vertical rows of 10 double-pole, single-throw (ON-OFF) switches that are continuously rotatable in either direction.

One side of each switch within a vertical row is wired in parallel with the same sides of the other nine switches within that row. Similarly, the other side of each switch is wired in parallel horizontally with the corresponding sides of each of the other four switches in a horizontal row. This method of connecting the switches gives rise to the term CROSS-MAT PARALLELING, and permits a high degree of flexibility.

The audio output from the receiving equipments, connected to the five vertical rows of switches, may be fed to any or all of the remote stations by closing the proper switch or switches. For example, the audio output from the L-F receiver may be fed to remote radiophone station No. 1 by closing switch 16; it may be fed to all of the remote stations by closing all of the switches in the left-hand vertical column.

Shielded leads are used for the audio circuits.

The knob of each switch is marked with a heavy white line to provide visual indication of the communication setup. In general, there are more remote stations than there are receivers, and therefore the switchboards are normally mounted in a vertical position (as in fig. 7-22). This arrangement permits the outputs from 5 receivers to be fed to the 5 vertical rows and up to 10 remote stations to be fed from the 10 horizontal rows of switches. Switchboards are furnished with the knobs in the OFF position when the white line is vertical.

If it becomes necessary to employ a system where there are 10 receivers and 5 remote stations, the switchboard may be mounted in a horizontal position and each switch knob rotated 90° with respect to the shaft. All shafts have two flat sides for setscrews so

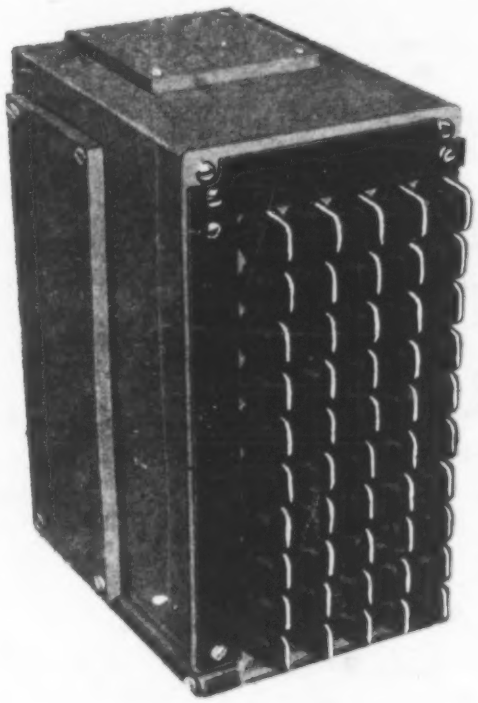

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Figure 7-22.—External view of the Receiver Switchboard type SB-82/SRR.

that this change can be made if desired. The purpose of rotating the switch knobs with respect to the shaft is to standardize the setup so that the switches will be in the OFF position when the white line is vertical. To further standardize all installations, receivers are always connected to the vertical rows of switches, and remote stations are always connected to the horizontal rows of switches after the orientation (vertical or horizontal) of the switchboard has been determined.

It should be noted that only the receiver audio output circuit is connected to the switchboard. This is true also of the receiver transfer plug panel used in earlier installations. Transmitter transfer switchboards, however, handle several other types of circuits in addition to audio circuits.

TRANSMITTER TRANSFER SWITCHBOARD

Transmitter Transfer Switchboard type SB-863/SRT has replaced type SB-83/SRT. The SB-863/SRT (fig. 7-24) has ten 20-position rotary selector switches, in two vertical columns. Each rotary switch corresponds to a remote control station, and each switch position (1 through 19) corresponds to a controlled transmitter. Thus switching control is provided for up to 10 remote control stations, and 19 transmitters. When more than 10 remote stations, or 19 transmitters, are to be connected, additional transfer switchboards may be installed. Position 20 of each rotary switch is provided for connections to an additional transfer switchboard to control extra transmitters. The switches consist of 12 wafers which serve to connect the start-stop indicator, keying, 12-v d-c microphone, carrier control, and carrier indicator circuits for the various transmitters.

Any of the remote stations may be connected to control any of the transmitters in the system. For example, to connect remote station No. 1 (fig. 7-25) to control the TED transmitter, rotary switch No. 1 (S1) is placed in position 1. To control the AN/GRC-27 from remote station No. 1, switch S1 is placed in position 2. Switch 2(S2) is used for remote station No. 2 in the same manner.

The remote stations assigned to each rotary switch, and the transmitters assigned to positions 1 through 19, are engraved on the engraving plates when the switchboard is installed (fig. 7-24). If an extra switchboard is installed, switch position No. 1 on the second switchboard is assigned to transmitter No. 20, position No. 2 to transmitter No. 21, etc. Thus, if remote station No. 2 is to have control of transmitter No. 22, switch No. 2 on the first switchboard is placed in position 20, and switch No. 2 on the additional switchboard is placed in position 3.

Figure 7-26 illustrates possible interconnections between the various switchboards located in Radio Central, Radio II, and Radio III.

Increased flexibility may be obtained by the use of a large number of switchboards in Radio Central and a smaller number of switchboards in Radio II and Radio III. Most of the space on two bulkheads may be taken up by the switchboards in Radio Central.

SWITCH CONNECTIONS BETWEEN RADIOPHONE UNIT AND TRANSMITTER

Generally, a radio transmitter connects through the transmitter transfer switchboard to a radiophone unit. However, in figure 7-27 the transmitter transfer switchboard has been omitted and only a simplified diagram of the

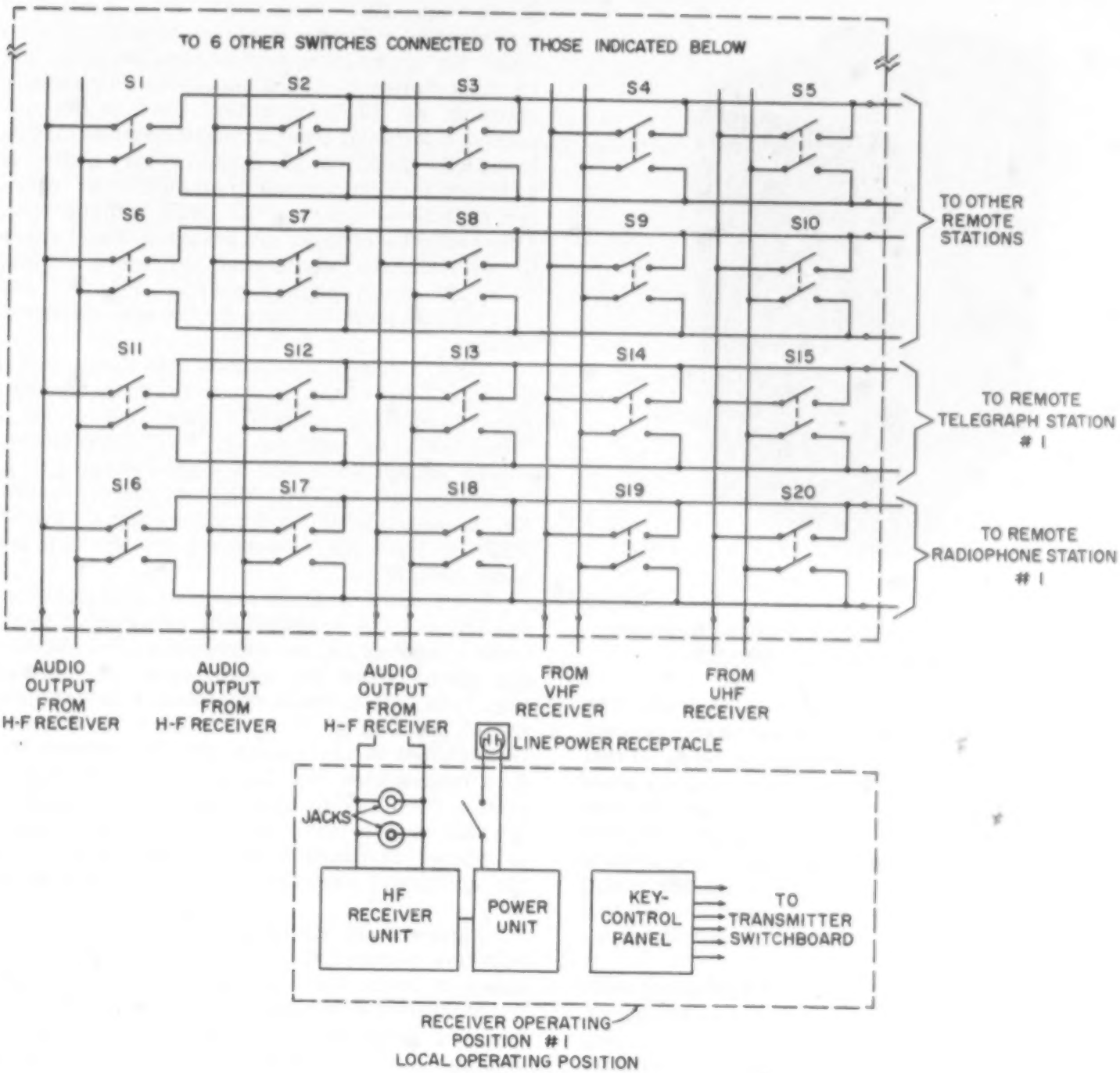

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Figure 7-23.—Simplified schematic diagram of the receiver transfer switchboard type SB-82/SRR.

transmitter (Navy Model TED-8), showing the control circuits, is included.

The line power switch, S1, is a 2-pole, single-throw switch in the 60-cycle, single-phase, power-line circuit and must be closed before the equipment can be started with the start-stop switch at the transmitter or RPU. In an emergency, power can be quickly removed from the entire equipment by throwing the line power switch to the EMERGENCY OFF position.

The local start-stop switch, S2, in the transmitter is a momentary contact (nonlocking) switch used to start or stop the equipment after S1 has been closed. Momentary closure of S2 on the START side energizes the equipment start-stop relay, K1, which locks itself in the closed position through contacts K1A,

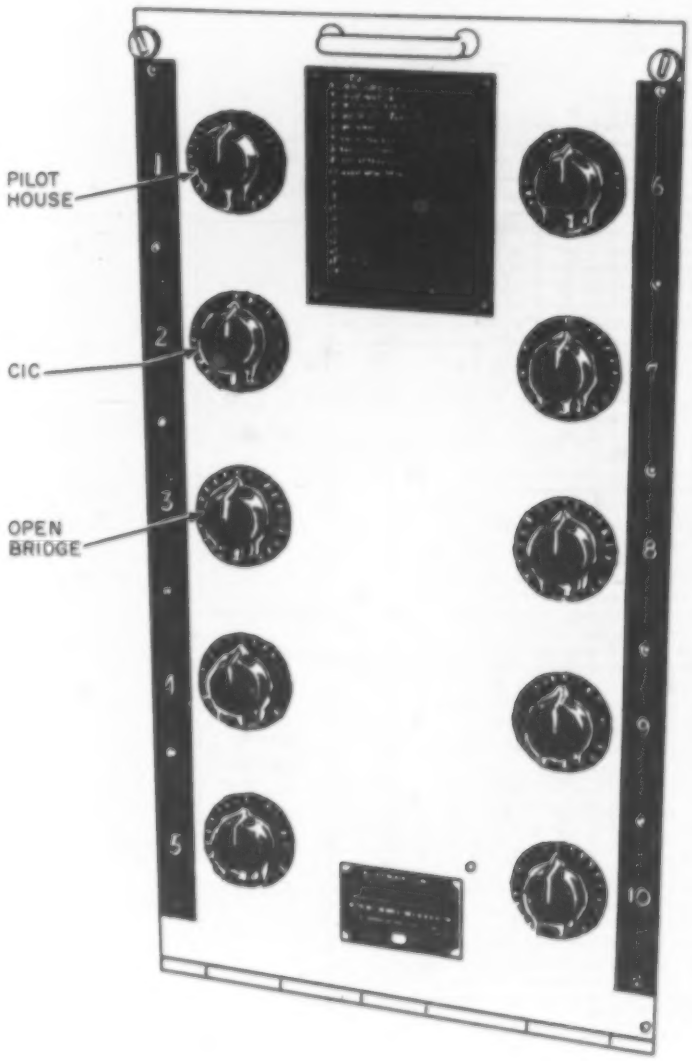

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Figure 7-24.—Transmitter transfer switchboard-SB-863/SRT.

the thermal cutout relay contacts, and resistor R. Relay K1 remains energized until its coil is shorted when S2 is moved to the STOP position.

The local remote switch, S3, affords local or remote control of the operation of the transmitter. When S3 is set to LOCAL, S3(a) connects the parallel combination of the local handset, the microphone jack, and the local carrier-control switch in series with the input windings of the input transformer, T1 (winding 1-2 in series with winding 3-4), thus providing local control of the carrier. Indicating and control functions are disconnected from all remote units by operation of S3(a), S3(b), S3(c), and S3(d).

When S3 is turned to the REMOTE position, the following sequence of events takes place:

1. Switch S3(a) connects the T2 secondary and the microphone or key jack in the RPU as a parallel combination across the transmitter T1 primary (1-2 winding in series with the 3-4 winding) and disables the local carrier-control circuits. The circuits through the handset microphone in the RPU are from the -12-v supply (terminal 7), the T2 primary, terminals C and D of the handset extension jacks by way of the push-to-talk switch (not shown in the RPU), and ground return at terminal 8. The circuits through the handset receiver in the RPU are from terminals A and B of the handset extension jacks, the earphone-level potentiometer, and terminals 13-14 to the associated receiver via the receiver transfer switchboard (not shown).

2. Switch S3(b) connects the common lead to the start-stop circuit to the stop switch in the RPU.

3. Switch S3(c) connects one side of the 115-v a-c line to the RPU power indicator by way of terminal 4. The other side of the 115-v line is always connected directly to the other side of the power indicator.

4. By means of S3(d), -12 v is applied to the RPU for microphone current.

The audio monitoring circuit involves the circuits connected to terminals 5, 6, 10, 13, and 14 on the terminal board. The audio monitoring circuit enables the operator to listen to the output of the receiver when the transmitter is off and to listen to speech "sidetone" when the transmitter is being used. Circuits are provided so that this may be done either locally or at a remote location. The audio signal from the receiver is brought into terminals 13 and 14.

When the transmitter carrier is off, relay contacts K2(a) are closed (K2 is deenergized), and the audio signal from the receiver is fed via K2(a) to the earphone-level volume control at the transmitter and to the 7-8 winding of T1. The receiver may be monitored locally by plugging the earphones into the earphone jack at the transmitter, because this jack is connected across a part of the earphone-level volume control.

When the transmitter carrier is on, relay K2 is energized and contacts K2(a) are open. This condition disconnects the receiver audio signal circuit from the earphone-level control at the transmitter, the associated earphone jack, the receiver handset plug terminals A and B,

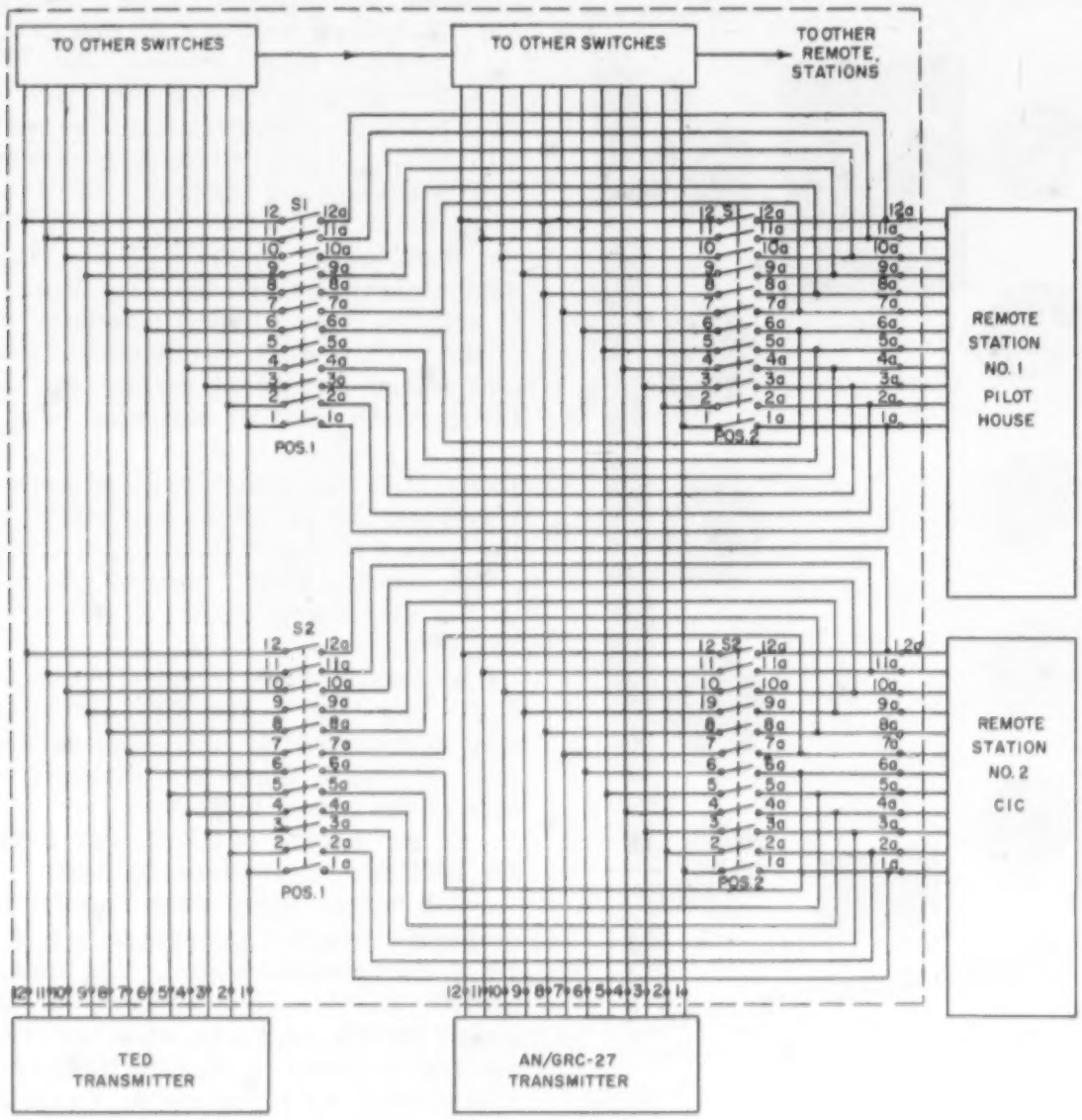

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Figure 7-25.—Simplified schematic diagram of transmitter transfer switchboard SB-863/SRT, showing first two positions of rotary switches 1 and 2.

and the 7-8 winding of T1. The transmitter sidetone signal is picked up by the secondary, 7-8, winding of T1 and impressed across the earphone-level control for local monitoring. The remote monitoring signal is picked up from the control lines on which the signal is normally present during voice operation.

When S5 is in the PHONE position and the local microphone handset press-to-talk switch is operated, keying relay K3 is energized. This action indirectly energizes carrier control relay K2, which disconnects the receiver from T1, as previously described. Thus, the receiver is disconnected when the transmitter carrier is on. The same action takes place in remote operation, except that relay K4 in the RPU energizes K3 by applying ground to terminal 3 of the 3-4 winding of T1 via terminals 8 and 11 and contacts K4(a).

DISTRIBUTION OF RADAR INFORMATION

The distribution of radar information is somewhat involved, and complex switching equipment is needed. There are various types of switching gear and various combinations of radar equipments and radar repeaters.

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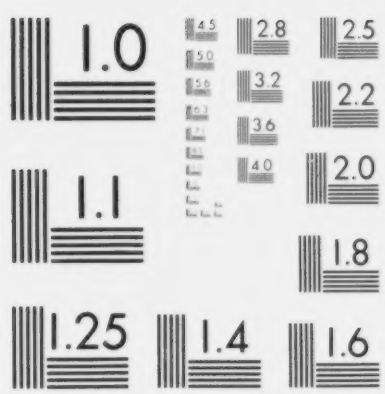

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

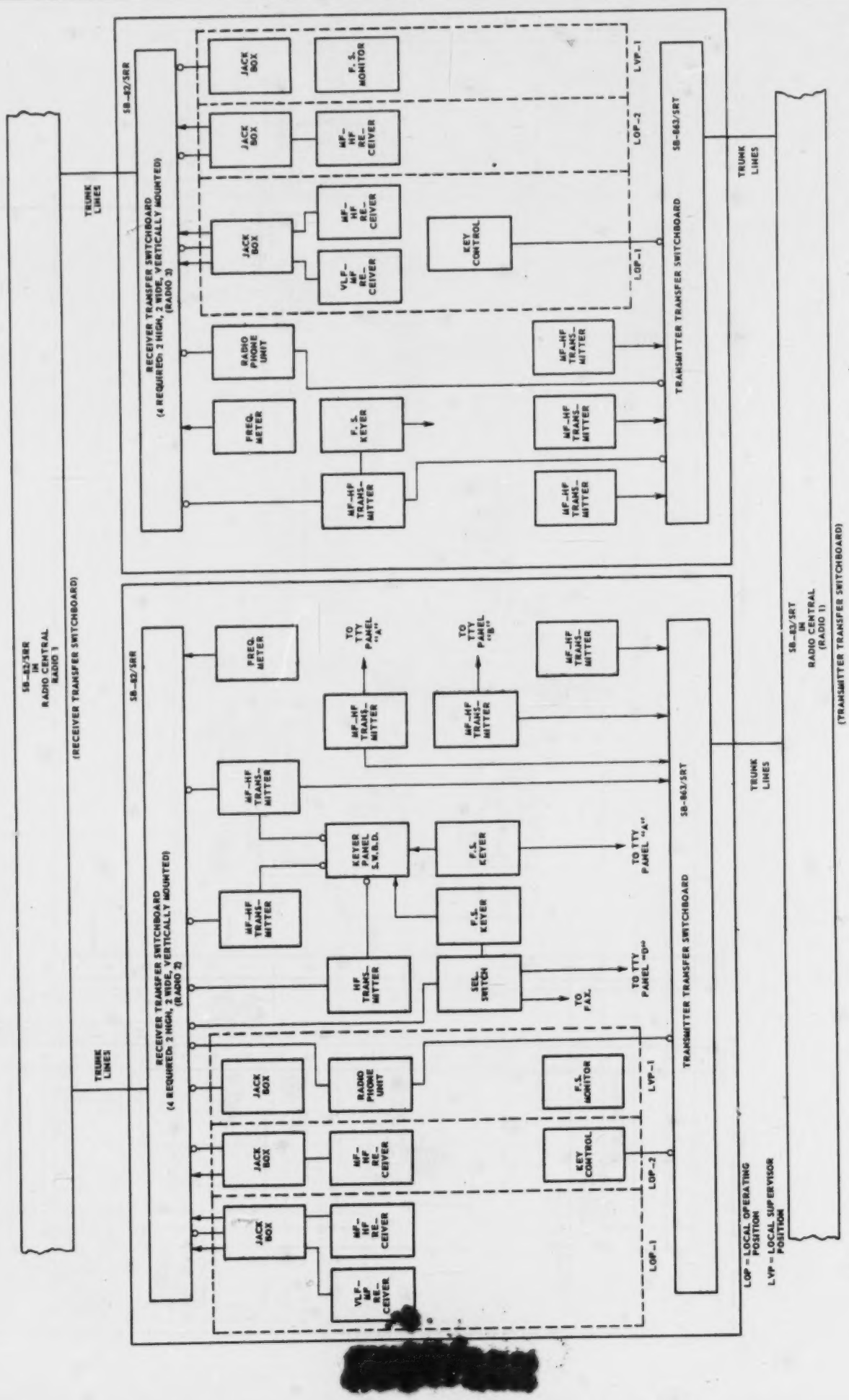

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Figure 7-26.— Interconnections between transfer switchboards.

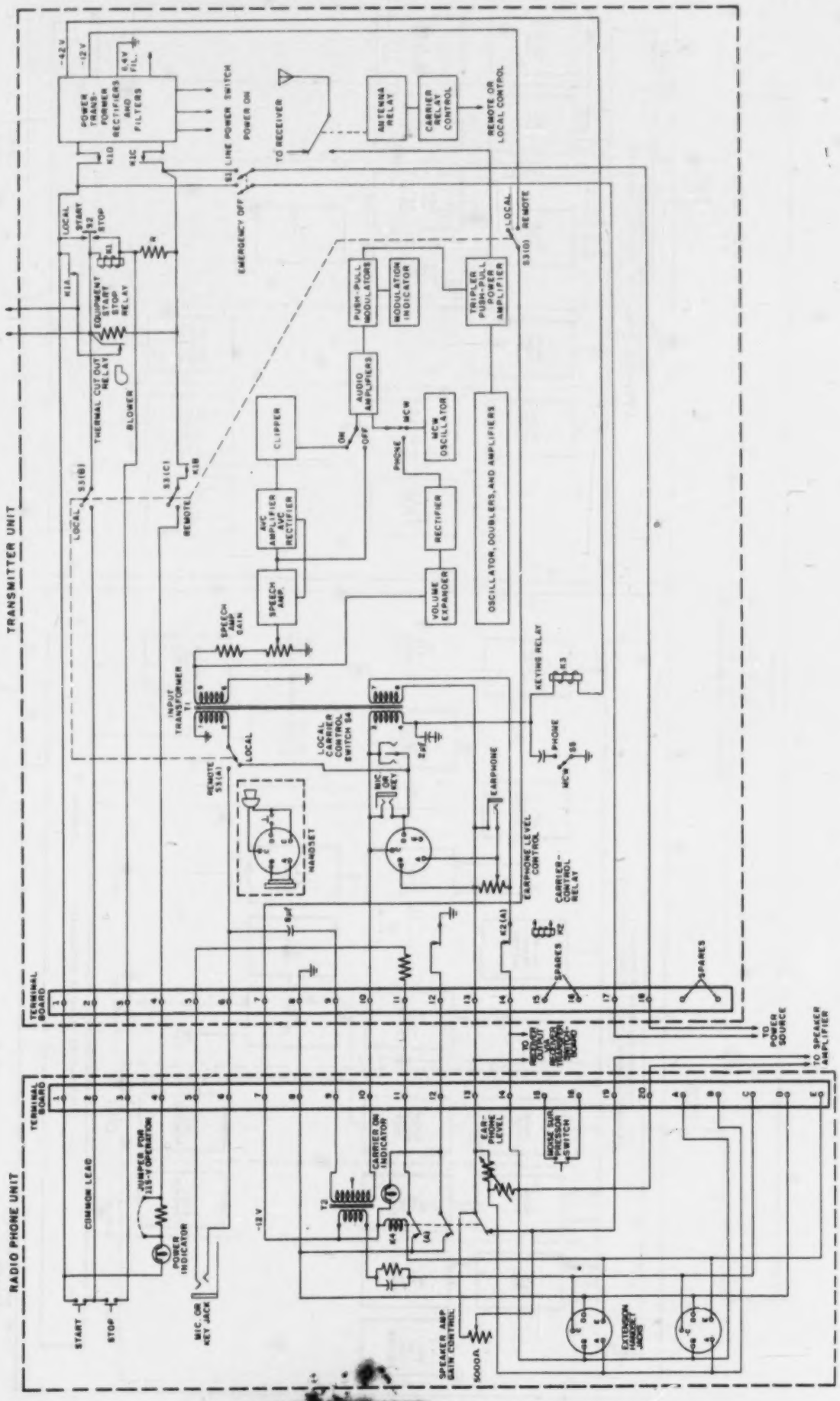

Figure 7-27.— Switch connections between radiophone and transmitter.

For the purpose of this chapter, a brief discussion of Data Switching Group OA-496/SSA is included. Included with this switching group is Video Amplifier Assembly AM-518/SSA, Rotary Switch SA-243/SSA, and Rotary Switch SA-247/SSA (fig. 7-28). For remote servo operation, Rotary Switch SA-243/U (not shown) is also needed at other repeaters.

As indicated in the block diagram (fig. 7-29), the purpose of the equipment is to distribute radar information to remote indicators throughout the ship. The number of data switching groups actually required in any particular installation depends on the number of signal sources and the number of repeaters to be served. Only a relatively simple system is shown in this figure.

Each of the 10 radar selector switch units in the data switching group provides for the selection (remote or local) of any one of seven

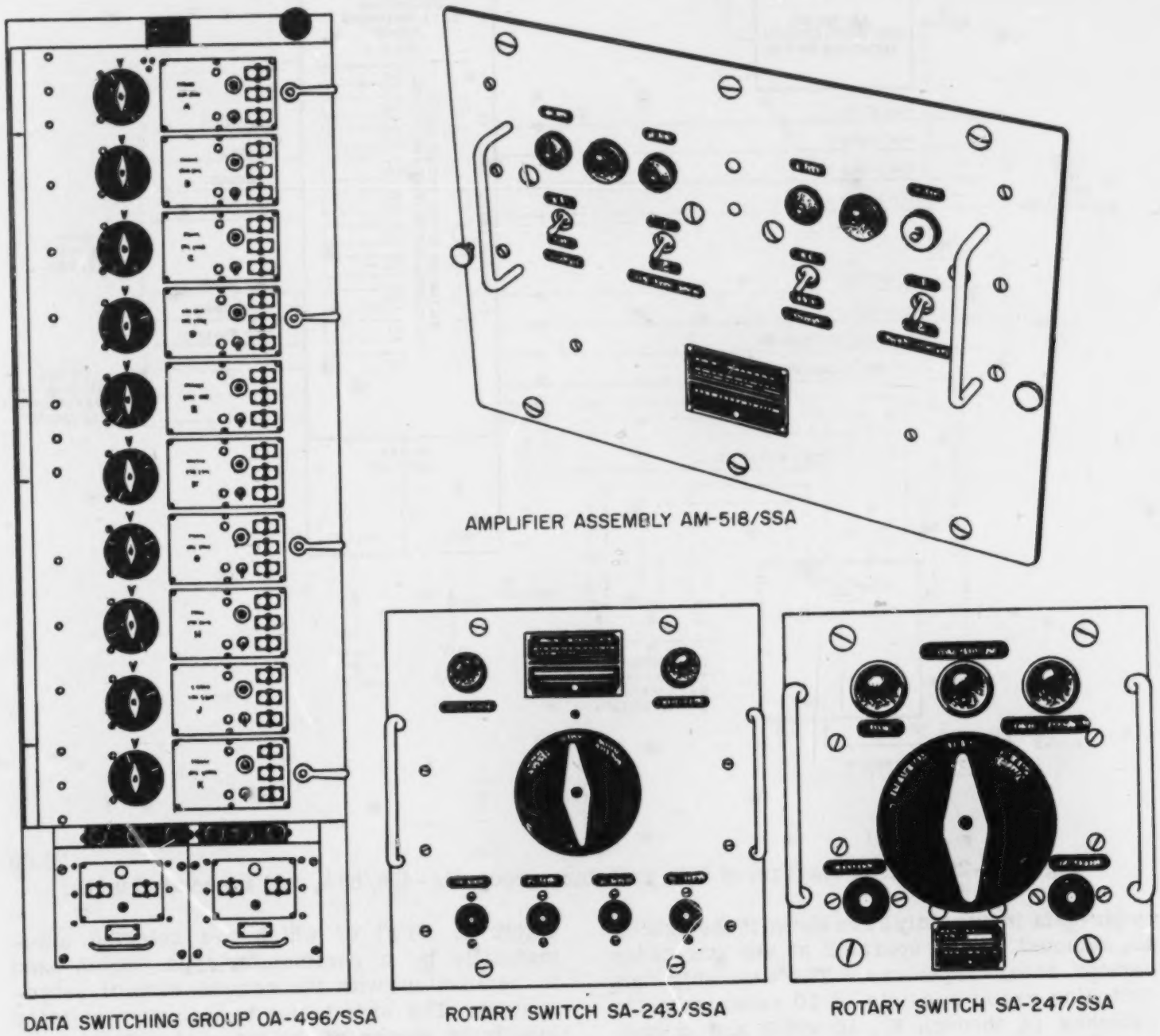

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Figure 7-28.—Data switching group OA-496/SSA, Amplifier Assembly AM-518/SSA, and Rotary switches SA-243/SSA and SA-247/SSA-front panels.

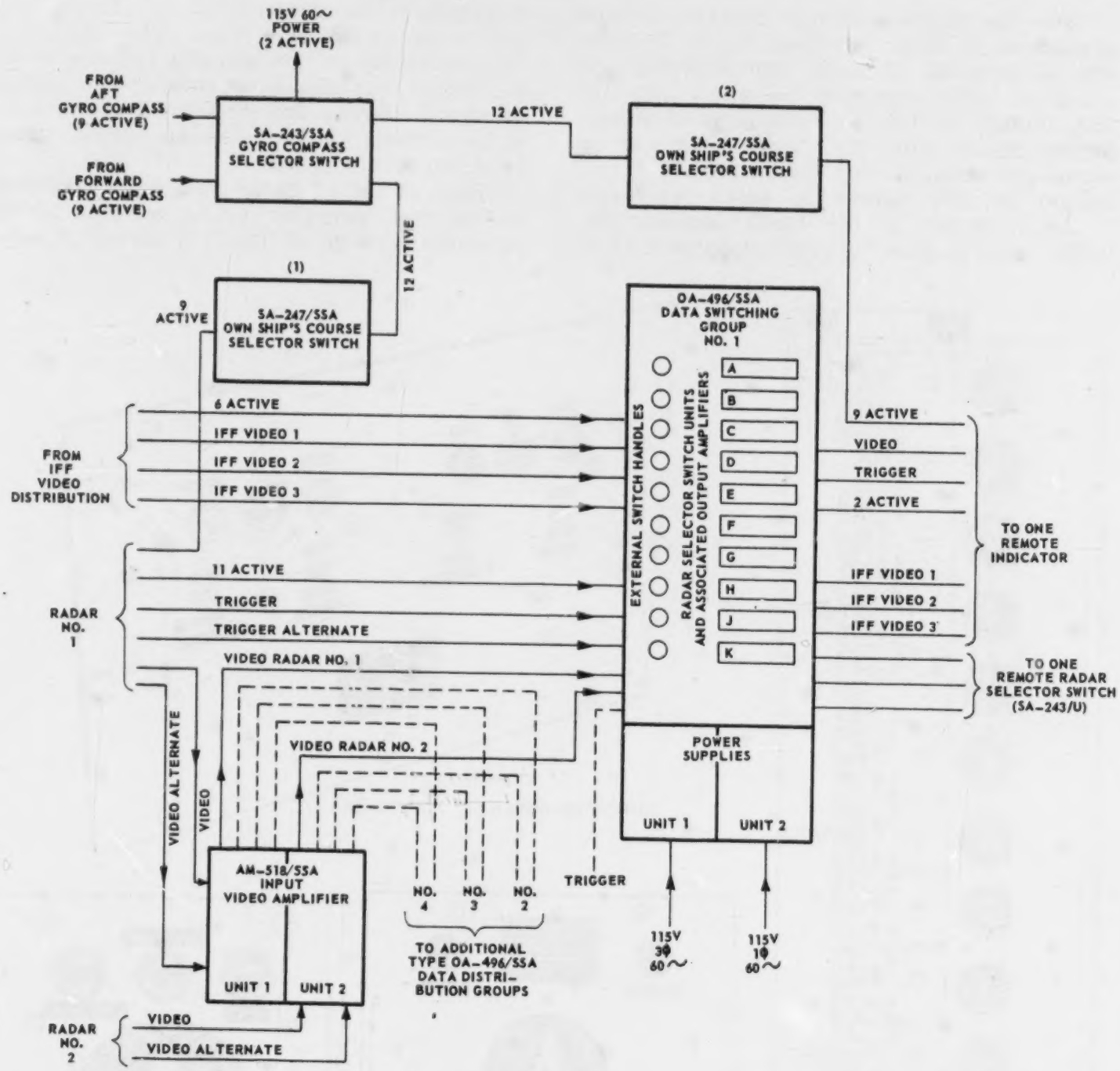

Figure 7-29.—Block diagram of data switching group OA-496/SSA, and associated units. 70.69

radar-data inputs (only 2 are shown in the figure), as selected by the operator at any one of ten remote radar repeaters. The assembly data switching group consists of 10 radar selector switches (A through K), 10 video and trigger cathode follower subassemblies, and 2 power supplies.

Each selector switch has 25 data sections (decks), the 8 positions (7 active positions; the eighth is OFF) of which are selected automatically by a commutator-type switch used in connection with the remote-control servo-system. The switch may be manually operated locally by means of the external switch handle or remotely by means of the remote selector switches. Each switch section has seven input circuit contacts and one output contact from the common arm.

A 3-section video and trigger switch is installed on the back end of the 25-section switch.

Video signals from the radar receivers are fed through Video Amplifier Assembly AM-518/SSA to the data switching group. This amplifier is capable of providing an essentially flat frequency response for any input signal over a range from 100 cycles through 10 mc. The assembly consists of two amplifiers, each providing for one regular and one alternate input, and four outputs so that the input signal may be delivered to four data switching groups, (one is shown in figure 7-29).

Trigger voltages and IFF video signals are fed directly to the data switching group where they are distributed to the desired remote location.

SWITCHING-CONTROL SERVOSYSTEM

A simplified schematic diagram of the switching-control servosystem is shown in figure 7-30. The system consists of a 3-phase motor, which drives the 8-position, rotary type switch through a gear train; and a split phase motor, which controls the operation and direction of rotation of the 3-phase motor by means of switch S502.

Two multitapped, single-phase autotransformers, one in the data switch selector servo unit and one in the remote selector switch unit, provide the required control power to the split-phase motor. These transformers are energized from 1 phase of the 3-phase supply. At the remote selector switch unit, the operator turns the switch to the position that will bring in the desired radar information. The transformer in the switch unit develops an opposing voltage to that developed by the transformer in the servo unit. The voltage contributed by the transformer in the servo unit is zero when S503 is in the H, or OFF position. The potential difference (the potential not balanced out by the action of the two transformers) is applied

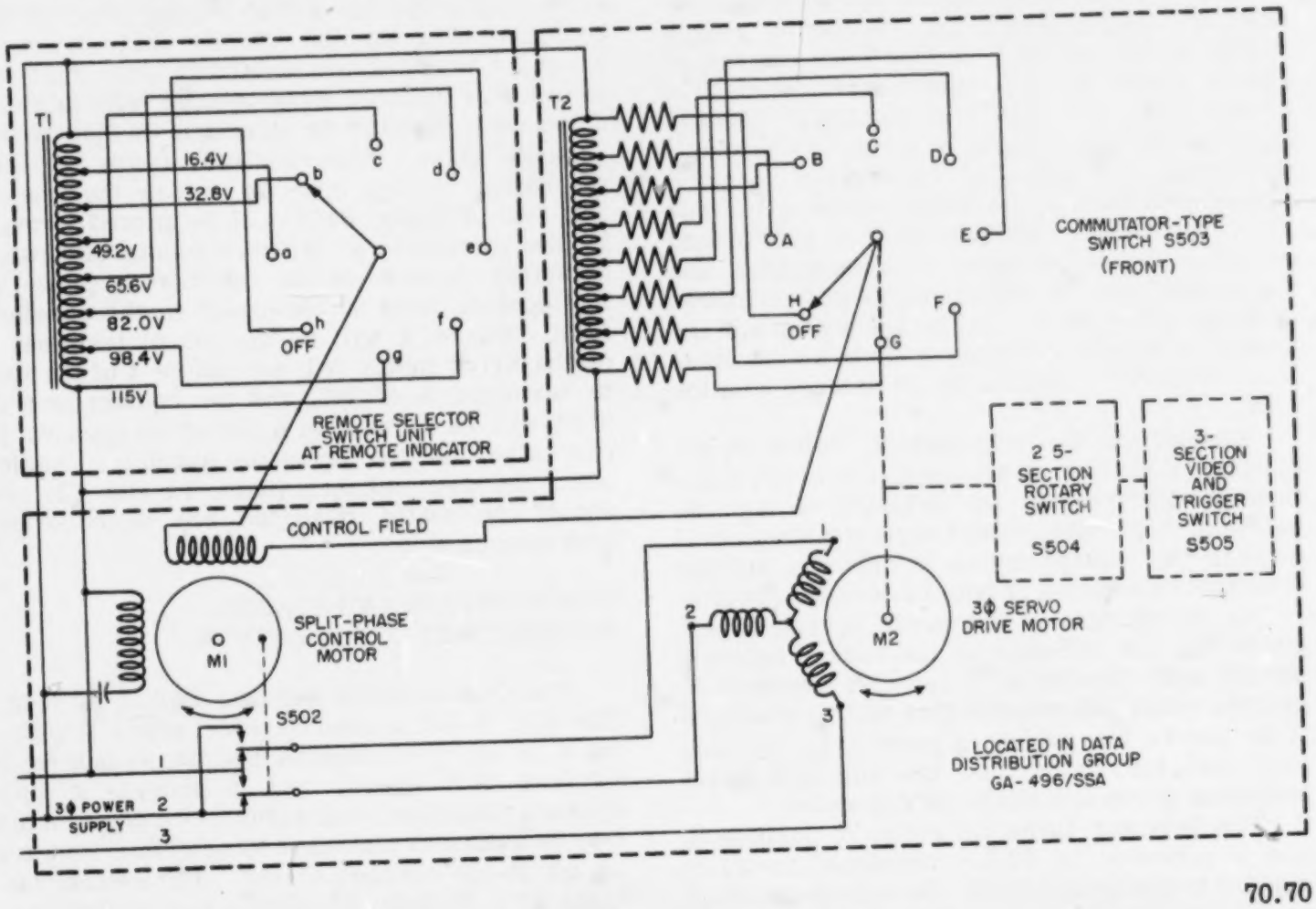

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Figure 7-30.—Switching-control servo system.

to the control winding of the split-phase motor and causes it to develop a torque in one direction or the other, depending on the condition of unbalance. A vane on the shaft of the control motor actuates the sensitive switches, S502 (upward or downward against spring action), depending upon the direction in which the torque is developed. The switches apply 3-phase power to the 3 windings of the 3-phase drive motor. The drive motor, M2, drives S503 to zero the voltage on the control field of M1, thereby removing the torque developed by M1 and opening S502 to stop the drive motor.

The drive motor is reversed by reversing the torque on M1 to operate S502 in the opposite direction. This action interchanges two line leads to M2 to reverse its direction of rotation. The reversal of torque on M1 is brought about by the reversal of the control field of M1 with respect to the constant field of M1. The relative phase of the control field depends upon the relative magnitudes of the voltages at T1 and T2 that are applied to the control field.

The 3-phase drive motor drives the commutator switch, S503; the 25-section rotary switch, S504; and the 3-section video and trigger switch, S505. As the commutator switch arm contacts the tap that corresponds to the one selected at the remote selector switch unit, the unbalanced potential is reduced to zero. The control field of the control motor is then deenergized, switch S502 returns to the neutral position, the drive motor is deenergized, and the switch arm of S503 remains in the desired position. The 25-section rotary switch and the 3-section video and trigger switch, on the same shaft with S503, remain in the desired position also.

Rotation of the commutator switch in the opposite direction is accomplished in the same manner, except that the polarity of the unbalanced difference voltage applied to the control field of the control motor is opposite, and the direction of rotation of both motors is opposite.

As an example of automatic operation, assume that the operator at the remote selector switch unit (located at a repeater) desires to receive radar information that will be available if he moves his switch to position b. Assume also that his switch and the one in the data switching group are in the OFF position.

The operator turns his switch to position b, and a potential of 32.8 v developed by T1 is applied to the control field. The opposing voltage in T2 is zero. The control motor turns (for example, clockwise) because of the phase relationship of the control and the constant fields. The motion of the control motor moves S502 downward (for example) and applies phase 1 to terminal 1 and phase 2 to terminal 2 of the 3-phase drive motor. The drive motor rotates switch S503 through position A. The 16.4 v developed by T2 at position A opposes the 32.8 v developed by T1, but a net potential difference of 16.4 v is still applied to the control field of M1. Motor M1 continues to rotate clockwise and M2 moves the contact of S503 to position B. In this position, the voltages developed by T1 and T2 are equal and opposite and no voltage is applied to the control field of M1. Motor M1 stops, S502 springs open, power is removed from M2, and the contact of S503 remains in position B.

The example just given applies to all cases where the remote controller calls for higher position in the alphabet than the initial position of the setting at the data switching group.

For the opposite case, where the remote controller calls for a dial setting lower in the alphabet than the one at the data switching group, a similar analysis will show that the unbalanced control field voltage will produce a current opposite in direction to that of the example given. This results from the fact that the higher voltage now comes from the taps on T2. Accordingly, S502 will be moved upward by the movement of M1 in a counterclockwise direction because of the reversal in phase of the control field with respect to the constant field. Phase 2 will be applied to terminal 1 of the drive motor M1 and phase 1 of the line to terminal 2 of M2, and the contact arm of S503 will be rotated in a direction opposite to that given in the previous example. Again, when the two voltages (from T1 and T2) are equal, the switch positions are matched and both motors stop.

GYROCOMPASS AND STABLE ELEMENT SELECTOR SWITCH

The Gyrocompass Selector Switch, SA-243/SSA (fig. 7-31) is used to select either the forward or aft gyrocompass synchro output (both 1X and 36X speed) and to provide a 78-v synchro electrical zero reference voltage. This type of switch is also used to select the forward or aft stable element output. The switch consists of a 20-pole, 3-position type switch controlled by a relay. Electrical zero reference

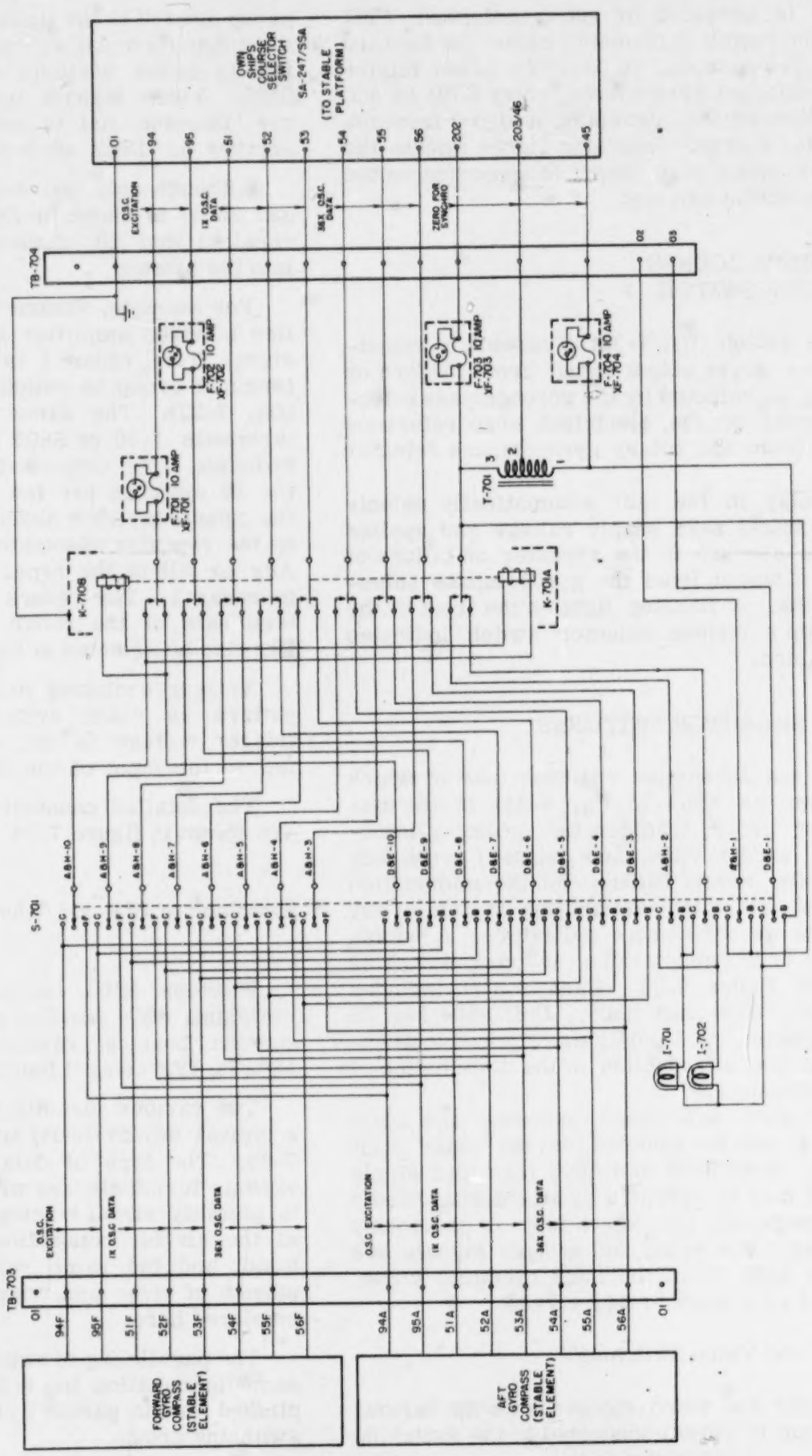

Figure 7-31.— Gyrocompass selector switch.

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voltage is provided by autotransformer T701 when the switch is turned to either the forward or aft gyro position. In case of a power failure of the selected gyro source, relay K701 (A and B) is deenergized, providing a signal from the alternate source. Indicator lights inform the operator which gyro output is appearing on the switch position selected.

OWN SHIP'S COURSE SELECTOR SWITCH

This switch (fig. 7-32) is capable of selecting either a gyro output signal (from the fore or aft gyro, as selected by the gorocompass selector switch) or the electrical zero reference voltage from the rotary gyrocompass selector switch.

A relay in the unit automatically selects the electrical zero supply voltage and applies it to the synchro in the repeater on failure of the gyro output from the gyrocompass selector switch. A flashing light on the front of the own ship's course selector switch indicates gyro failure.

RADAR SELECTOR SWITCHES

The ten 25-section switches (one of which is shown as S504 in fig. 7-33) in the data switching group, transfer the incoming information (except video and trigger) from any one of the seven radars and the information from the IFF video distribution system to any or all of the 10 remote indicators. A wiring diagram of a typical radar selector switch is shown in figure 7-33. Each switch includes two units, S504 and S505. Unit S504 has 25 data sections and 8 positions referred to previously in the introduction to the distribution of radar information.

Unit S505 has three sections and eight positions and is mounted on the same shaft as S504. Both S504 and S505 turn as a single unit and may be operated by an external handle or automatically by a servo unit, as previously described. The video and trigger signals are fed into S505 from the input terminal group, indicated as a block in figure 7-33.

Trigger and Video Switching

Trigger and video signals from the various radars (up to seven) connected to the switching group are fed to the input terminal group. From the input terminal group, trigger voltages are fed to seven sections of deck section 1 of S505. Video signals from the seven radars are likewise fed to seven sections of deck section 3. Deck section 2 serves as ground.

Although only one switch (made up of S504 and S505) is shown in figure 7-33, it should be recalled that 10 of these switches are wired into the system.

For example, assume that after being amplified in video amplifier AM-518/SSA, the video signal from radar 1 is fed through the input terminal group to switch terminal 1-80 of S505 (fig. 7-33). The same signal is also fed to terminals 1-80 of S505 in the nine remaining switches. The outputs (from terminal 180) of the 10 switches are fed independently through the output amplifier associated with each switch to the repeater associated with each amplifier. Any or all of the repeaters may be switched to radar 1. The radars connected to the other terminals of the radar selector switch may likewise be selected at the repeater.

Trigger switching follows the same general pattern as video switching, except that the trigger voltage is not amplified before it is fed to the input of the data switching group.

The detailed connections of one switch unit are shown in figure 7-34.

Switching of IFF and Other Data

Whereas S505 handles video and trigger switching, S504 handles such additional data as antenna bearing, relative bearing IFF video signals, IFF control functions, etc.

The various circuits feeding into and out of a typical switch (S504) are illustrated in figure 7-35. The type of data passing through the various terminals are written on the terminals to simplify signal tracing. The parallel nature of the circuit connections should be kept in mind, and the same reasoning that was employed in video and trigger switching may be employed here.

The paralleling of switch contacts bearing the same information in the 10 switches is accomplished in the parallel circuits section of the switching group.

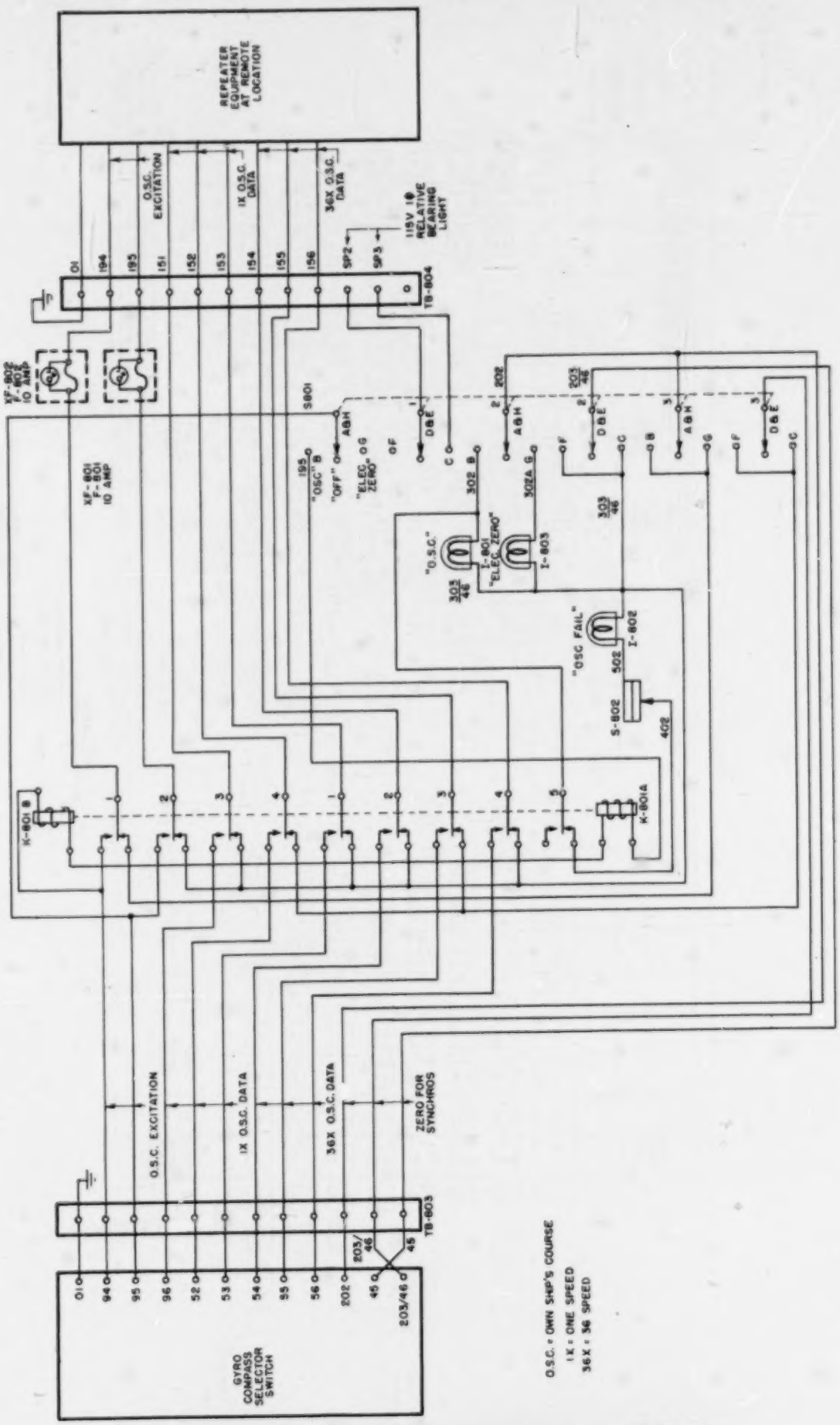

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Figure 7-32.— Own ship's course selector switch.

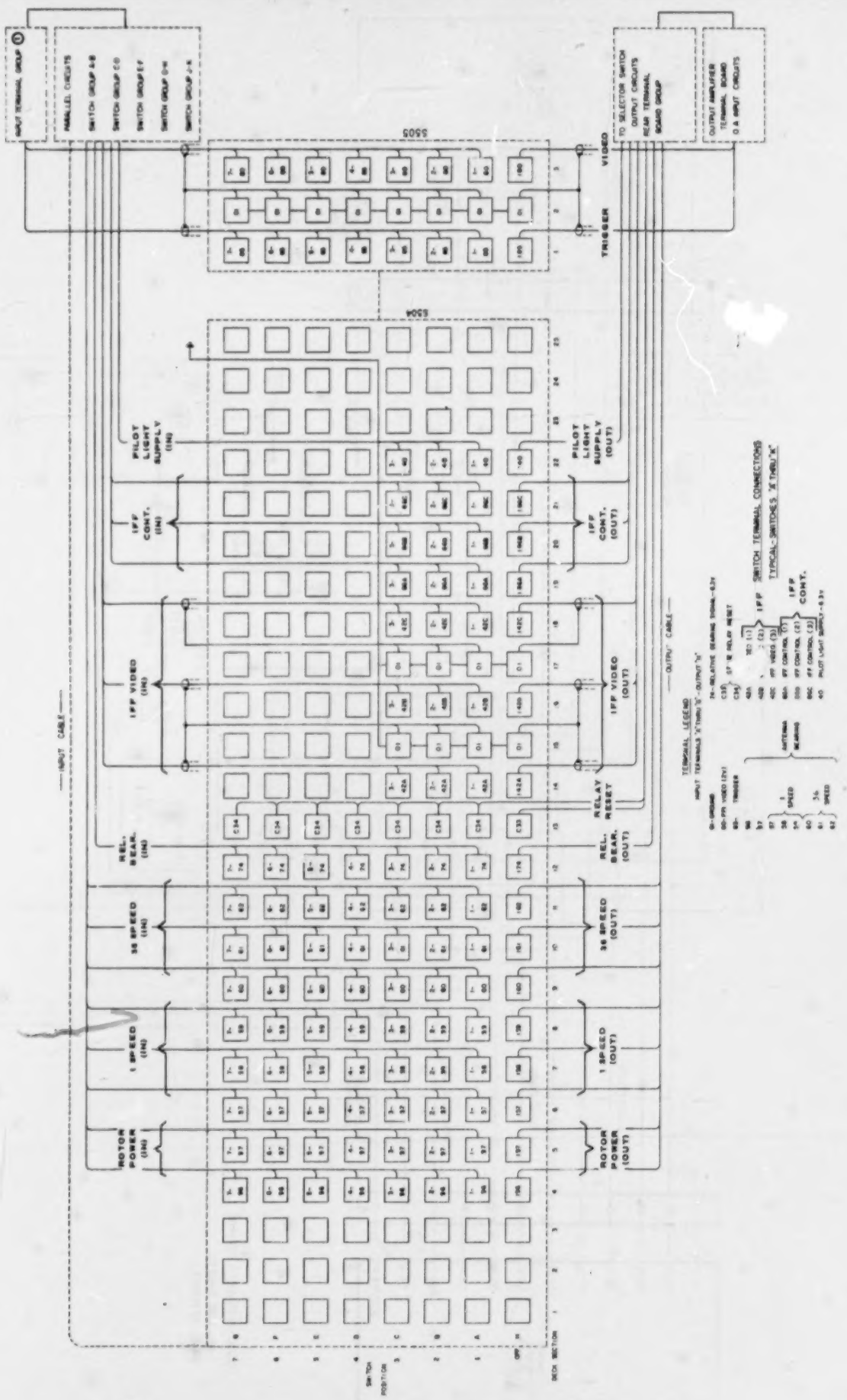

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Figure 7-33.— Radar selector switch in the data switching group.

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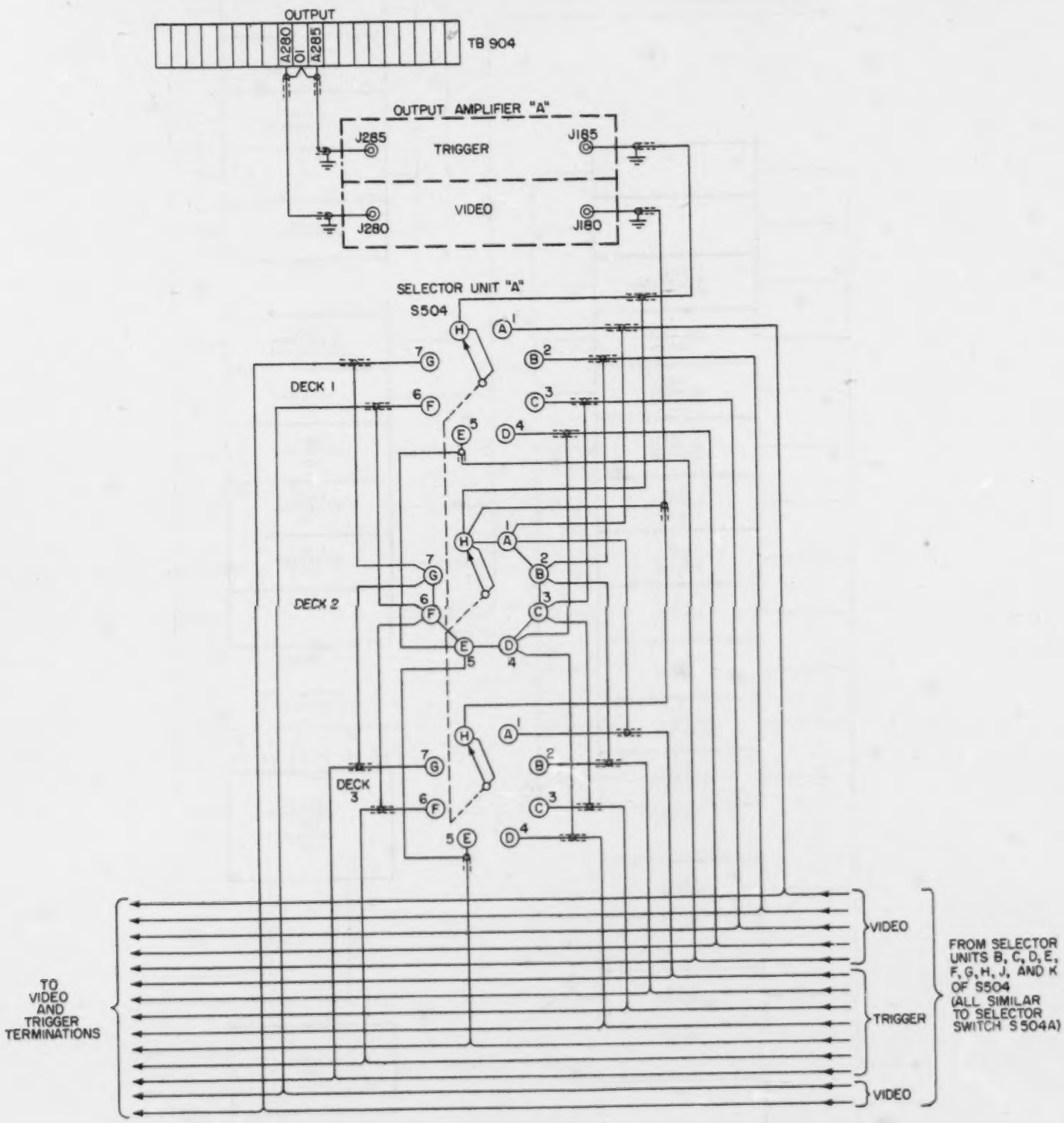

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Figure 7-34.—Wiring diagram of video and trigger switching circuits.

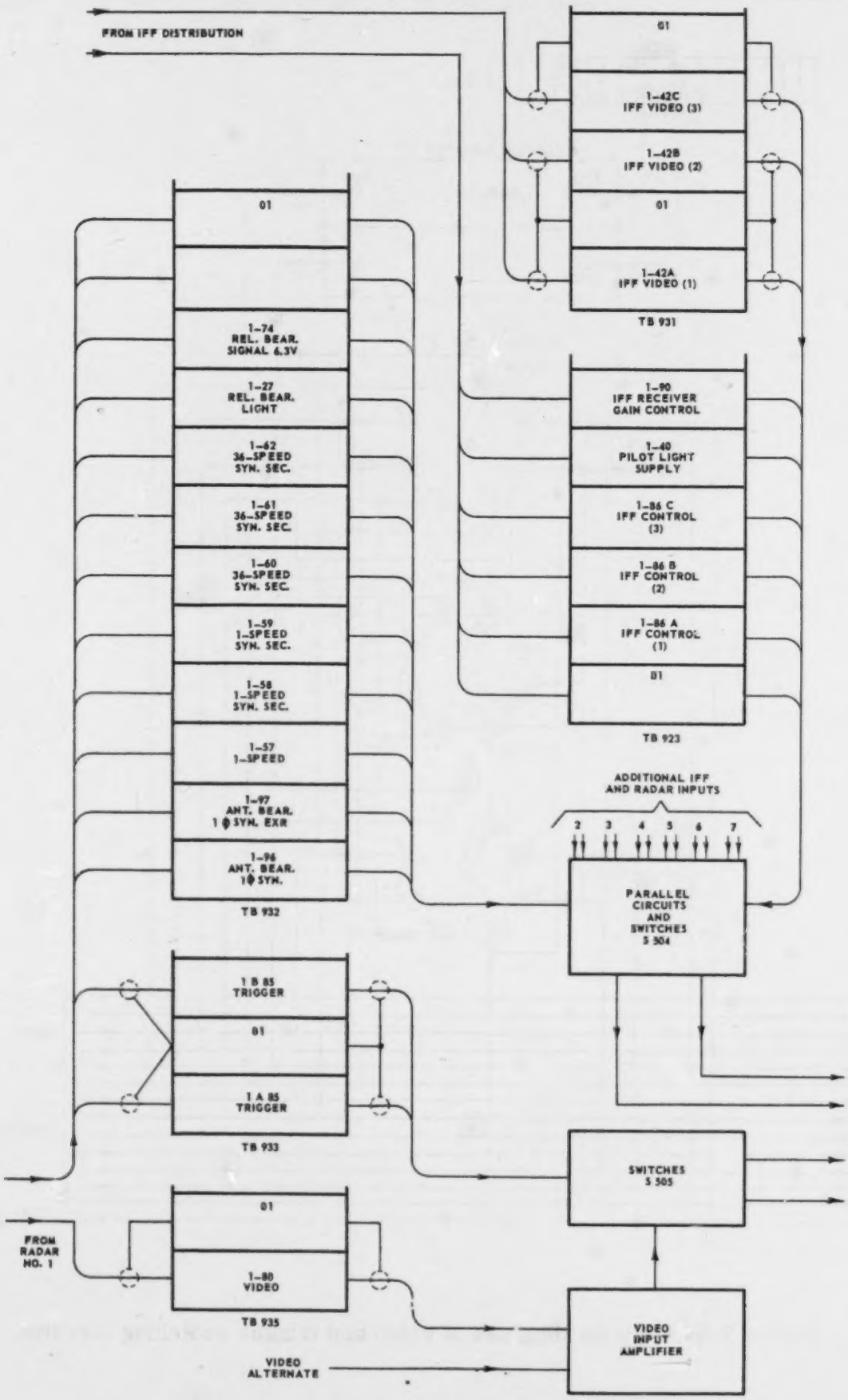

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Figure 7-35. — Diagram showing route of signals from radar to repeater through the radar switchboard

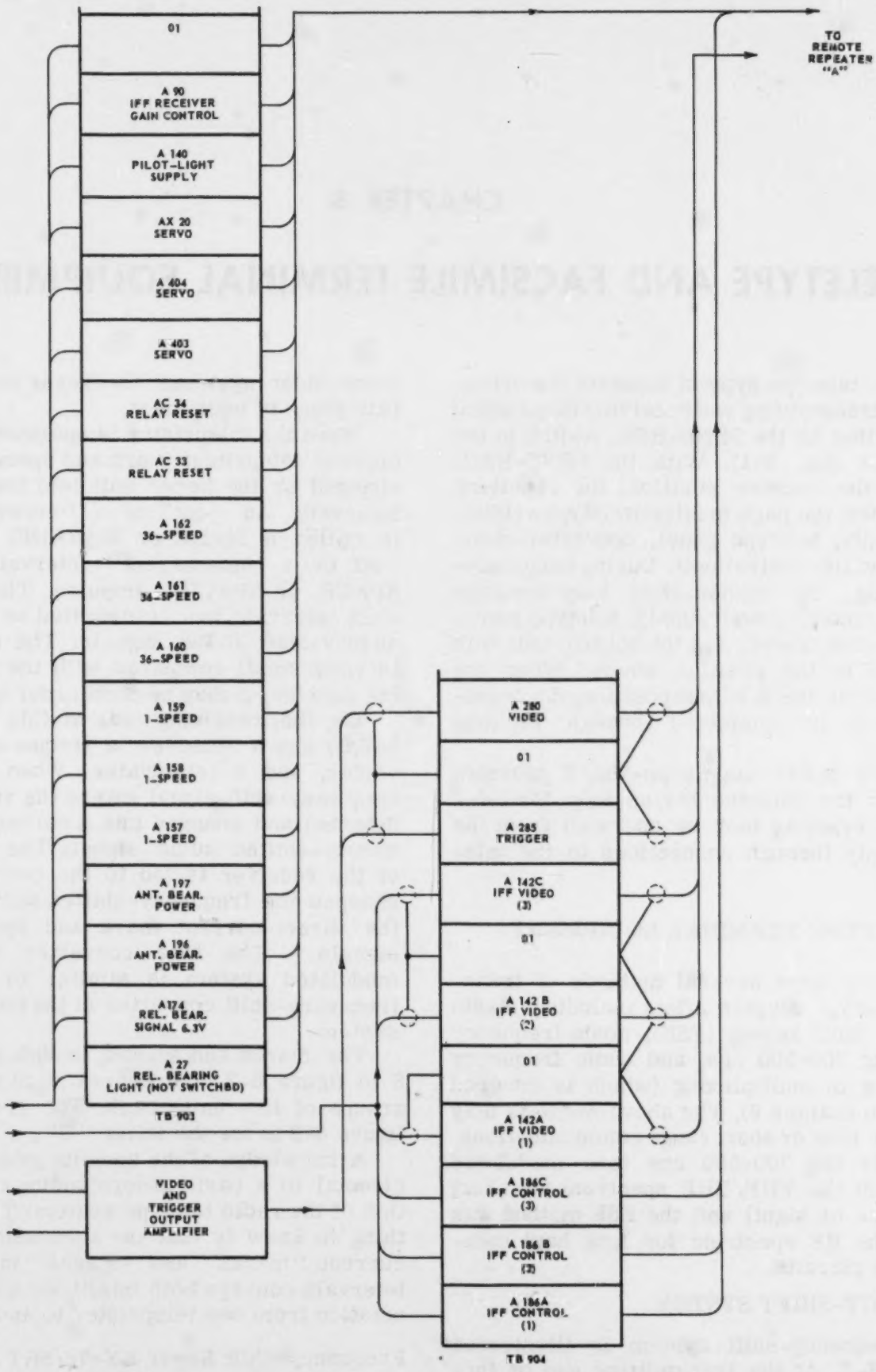

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Figure 7-35. — Diagram showing route of signals from radar to repeater through the radar switchboard — Continued.

CHAPTER 8

TELETYPE AND FACSIMILE TERMINAL EQUIPMENT

A radio teletype system consists of series-connected transmitting and receiving loops which are controlled by the SEND-REC. switch in the control unit (fig. 8-1). With the SEND-REC. switch in the receive position, the receiving loop includes the page printer (teletypewriter), power supply, teletype panel, converter-comparator, and the control unit. During frequency-shift keying, the transmitting loop includes the page printer, power supply, teletype panel, frequency-shift keyer, and the control unit with the switch in the position shown. When the switch is set to the S/R tone position, the transmitting loop is completed through the tone converter.

A single power supply pp-765/U provides current for the selected series loop. Six teletypewriter systems may be operated from the power supply through connections to the teletype panel.

TELETYPE TERMINAL EQUIPMENT

The Navy uses several methods of transmitting teletype signals afloat including: Radio Frequency shift keying (FSK), audio frequency shift keying 700-500 cps, and audio frequency shift keying in multiplexing (which is covered in detail in chapter 9). The above methods may be used for long or short range communications. Historically the 700-500 cps tone modulated was used in the VHF/UHF spectrum for short ranges (line of sight) and the FSK method was used in the HF spectrum for long haul communication circuits.

FREQUENCY-SHIFT SYSTEM

The frequency-shift system is illustrated in figure 8-2. At the transmitting end of this system (fig. 8-2,A) are a teleprinter; a frequency-shift keyer unit, which is built into the transmitters; and a transmitter (XMIT). In some older systems, the keyer unit is a separate piece of equipment.

When the teleprinter is operated, the direct-current teleprinter mark and space signals are changed by the keyer unit into frequency-shift intervals. An "on" or a "current" interval is called a MARK or MARKING impulse. An "off or a "no-current" interval is called a SPACE or SPACING impulse. The frequency-shift intervals are transmitted as carrier frequency-shift (CFS) signals. The carrier shift is very small compared with the frequency of the carrier; it may be of the order of 850 cycles.

On the receiving side of this system (fig. 8-2,B) are a receiver, a frequency-shift converter, and a teleprinter. When the carrier frequency-shift signal enters the receiver, it is detected and changed into a corresponding frequency-shifted audio signal. The audio output of the receiver is fed to the converter, which changes the frequency-shifted audio signal into the direct-current mark and space teletype signals. The tone converter in the tone-modulated system is similar to the carrier frequency-shift converter in the frequency-shift system.

The marks and spaces, designated as M and S in figure 8-3, are generated in various code groups of five units each. The group shown in figure 8-3 is for the letter "H".

A knowledge of the specific groupings is incidental to a basic understanding of the operation of the radio teletype system. The important thing to know is that the succession of direct-current "marks" and "spaces" in fixed-timed intervals conveys both intelligence and synchronization from one teleprinter to another.

Frequency-Shift Keyer KY-75/SRT

The KY-75/SRT frequency shift keyer (fig. 8-4) used aboard ship is a calibrated frequency shift exciter in which signaling is accomplished

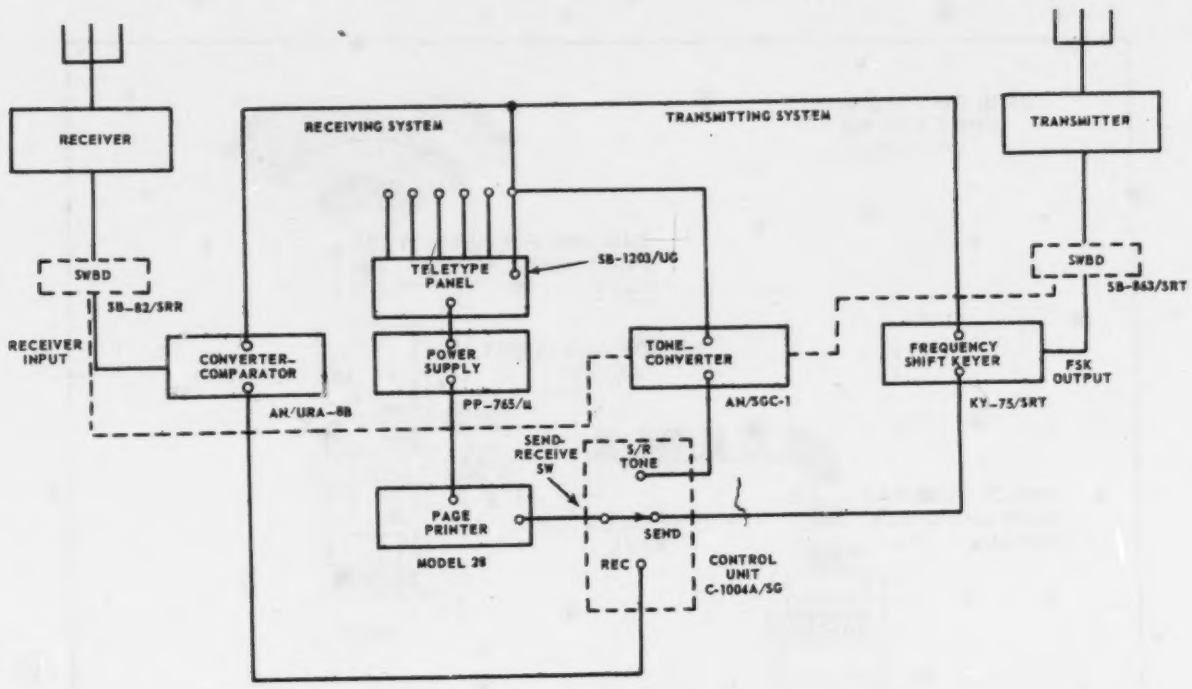

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Figure 8-1.—Block diagram of a representative radio teletype system.

by shifting a constant amplitude carrier between two fixed frequencies. The two frequencies represent marking and spacing conditions of the teletypewriter code.

An identical keyer, intended for shore station use, is the KY-58/GRT.

For radio teletypewriter operation, the keyer functions so that current impulses from the teletypewriter keyboard produce a marking signal. This action causes the transmitter to emit a frequency above its mean frequency. Conversely, opening of contacts on the keyboard produces a spacing signal. The spacing signal, or open keyboard, causes the transmitter to emit a frequency below its normal assigned frequency.

The primary purpose of the frequency shift keyer is to replace the conventional exciter of the CW transmitter with a source of RF excitation that can be shifted (in frequency) a small amount upward and downward to produce RF telegraph code. The unit responds to both neutral (DC) and polar input signals. Neutral signals cause a current flow in the line during the marking condition, and no current flow during the spacing condition. Polar signals allow current in one direction through the line for mark, and in the opposite direction for space. The keyer is used principally for comparatively long-distance communications in the high-frequency range.

The keyer is composed of two subunits, which are the modulator-power supply and the amplifier-oscillator. The modulator-power supply (lower panel) incorporates the power supply and all modulator circuits up to but not including the reactance tube (discussed later). The amplifier-oscillator section (upper panel) comprises the crystal oven, reactance tube, 200 KC oscillator, and all RF circuits and controls. All frequently used operating controls are located on the front panel. Additional controls are mounted on a subpanel behind the front panel.

The input radiofrequency to the frequency shift keyer may be derived from an external oscillator, such as the master oscillator of the transmitter. Or from the self-contained crystal oscillator (fig.8-5). The overall output frequency range of the keyer is 1.- to 6.7 MC. Because the RF input is mixed with a 200 KC signal from the frequency-modulated oscillator to obtain the sum frequency, the input frequency must range from 0.8 to 6.5 MC.

The frequency of the 200 KC oscillator is frequency-modulated by the balanced reactance modulator. The reactance modulator varies the amount of reactance across the oscillator tuned circuit, causing oscillator frequency to increase or decrease a small amount in response to mark and space signals.

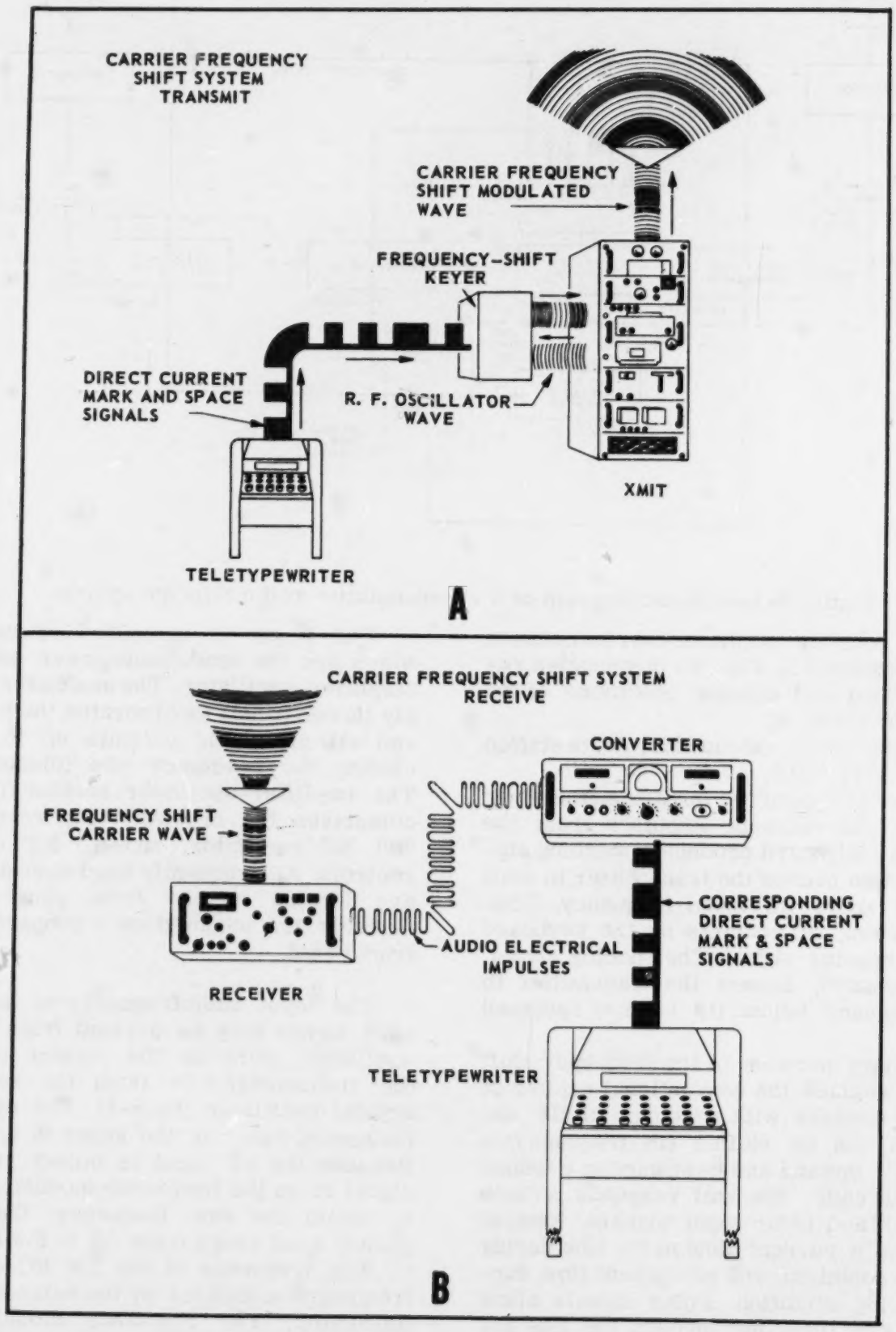

Figure 8-2.—Frequency-shift system.

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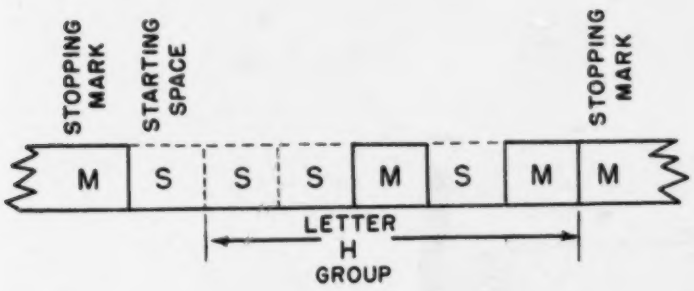

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Figure 8-3.—Teletype code group.

The magnitude of the frequency shift is adjustable over a range from 0/ to ±500 CPS or 1000 CPS total shift. The transmitter frequency usually is adjusted for an 850-cycle shift, which means that the mark signal is 425 cycles above assigned frequency, whereas the space signal is 425 cycles below the carrier. The equipment is capable of being keyed up to 240 dot cycles (transitions from mark to space and vice versa) per second.

The radiofrequency output of the cystal oscillator and the frequency-modulated output of the 200 KC oscillator are combined in the balance mixer circuit. The frequency of the crystal oscilator is balanced out. Therefore, only the sum and difference frequencies resulting from mixing the two oscillator frequencies are present in the output of the balanced mixers. The circuits of the balanced mixers are tuned to the sum frequency.

The buffer amplifier serves to isolate or premit light loading at the balanced mixer output circuit, providing greater discrimination against unwanted modulation components. A ganged tuning control simultaneously tunes the output of the crystal oscillator, balanced mixers, and buffer amplifier. The power amplifier supplies an output of 6 watts into a 75-ohm noninductive resistive load.

The test-operate and calibrate circuit comprises a five-position switch utilized to select the circuit arrangement required for frequency shift or facsimile operation. It also selects the arrangement required to perform alignment adjustments for carrier, mark, and space.

Two diode pulse limiters are employed to furnish a modulating wave effectively free from amplitude and wavefront variations of the incoming telegraph signal. The output of the second limiter is coupled to a cathode follower, which acts as an impedance transforming device to match the low-impedance pulsing circuits to relatively high-impedance calibration circuits.

The phase modulation oscillator supplies a 200-cycle phase shift signal, which provides a means of reducing effects of selective fading during adverse operating conditions. Phase modulation, which causes a slight shift in frequency, normally is not used if the total frequency shift between mark and space signals is less than 600 CPS or if the dotting speed is faster than 35 dot cycles per second. The phase-modulation control provides a means of adjusting the shift in phase from 0 to 1 radian (57.3°).

The frequency shift signal transitions are wave-shaped to restrict sideband radiation by means of four low-pass filters incorporated in the pulse shaper. If the square waves from the limiting circuit are rounded before being passed to the reactance modulator, fewer sidebands are generated because of the partial elimination of the harmonic content of the square wave. The reduction of sidebands permits the assignment of closer radio channel spacing for telegraph operation with the keyer.

During high-frequency transmission, when RF carrier frequency is multiplied by some factor in the transmitter, the amount of devaition of frequency shift is multiplied simultaneously by the same factor. It therefore becomes necessary to reduce the amount of deviation by a factor equal to the multiplication factor of the transmitter. This action is accomplished by the deviation multiplier, which provides a means of dividing frequency deviation by a factor of 1, 2, 3, 4, 5, 8, 9, or 12. Thus, the transmitter output is held to a certain preset deviation regardless of the frequency multiplication employed in the transmitter.

The deviation control circuits act to keep wave-shaping termination at a fixed value. The calibrated dial of the deviation control reads the actual amount of deviation realized at the output of the transmitter.

When the test-operate switch is placed in PHOTO position, the equipment is in readiness for facsimile operation. Photo facsimile operation is similar to frequency shift key (FSK) operation, except that during photo operation, limiting and wave-shaping circuits are not utilized. The photo control circuit provides a means of adjusting photo input voltages.

The power supply contained in the modulator-power supply is designed to operate from a 115- or 230-volt, AC, single-phase, 60 cycle

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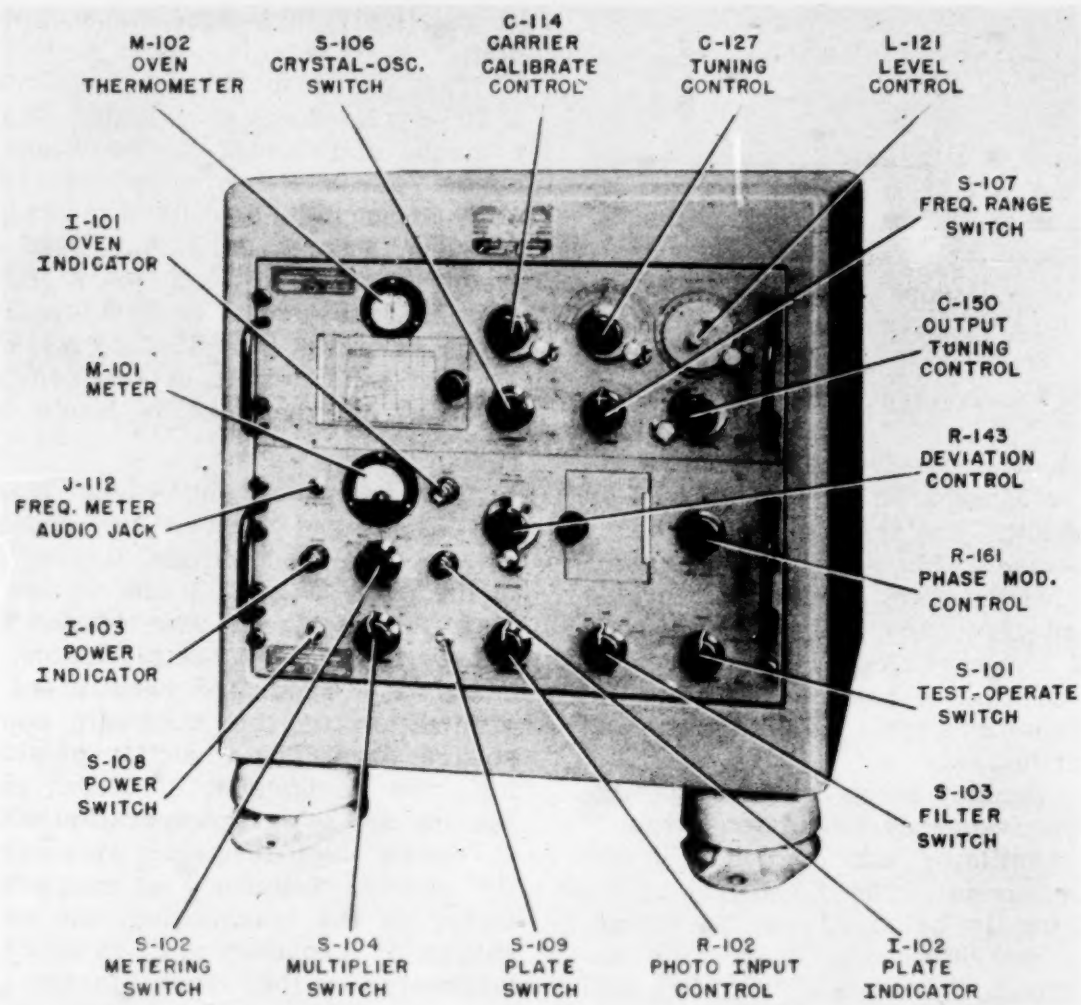

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8-4.—Frequency-shift keyer KY-75/SRT, front panel compartment identification.

input source. The supply furnishes 270 volts DC at 220 ma, 4.35 amp at 6.3 volts AC, 0.6 amp at 12.0 volts AC and 3 amp at 5.0 volts AC. A 5.0-volt winding furnishes filament voltage for the rectifier tube.

TONE-MODULATED SYSTEM

The tone-modulated system is illustrated in figure 8-6. The teleprinter (TTY) sends out a signal consisting of direct-current, on-and-off pulses.

To transmit messages by the tone-modulated system (fig. 8-6, (1)), a teleprinter, a tone terminal, and a transmitter are needed. The teleprinter sends out a direct-current signal of marks and spaces, and the signal is changed to either of two audio tones in the tone terminal. The tones may be 500 cycles for a space and 700 cycles for a mark. The transmitter impresses the audio tones on the carrier and sends out an amplitude or tone-modulated carrier wave.

To receive messages with the tone-modulated system (fig 8-6, (2)), a radio receiver, a tone converter, and a teleprinter are needed. The tone-modulated carrier wave enters the receiver, which extracts the signal intelligence and sends the audio tones to the tone converter. The converter changes the audio tones into direct-current mark and space pluses for the teleprinter.

In practice, the same tone terminal is used for both the sending and the receiving circuits because it contains both a transmit "keyer" unit and a receiver "converter" unit.

Tone Converter AN/SGC-1A

Shipboard communications employ tone modulation for short range (UHF and VHF) transmission. Tone modulation employs a tone

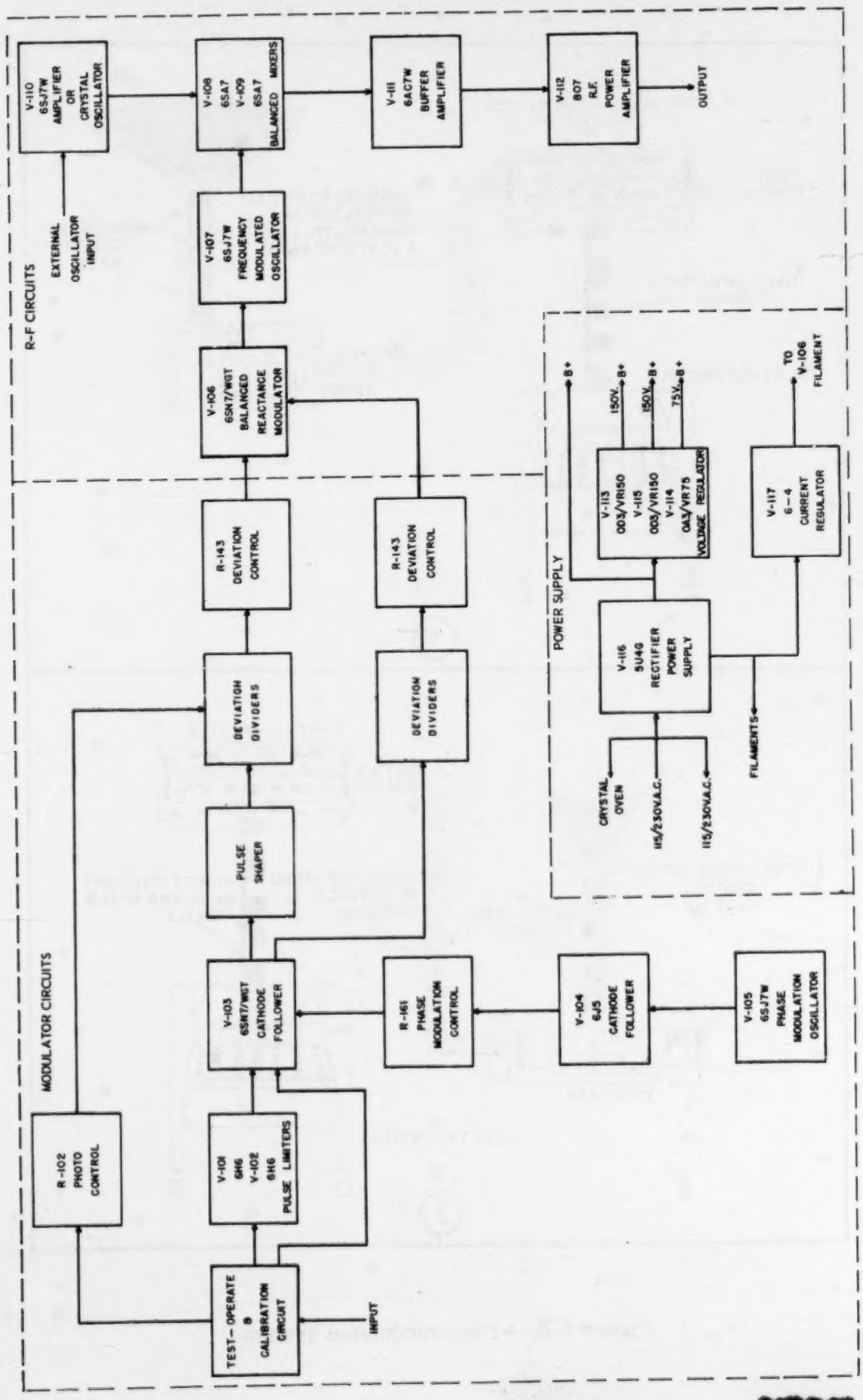

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Fig. 8-5.—Block diagram of frequency-shift keyer KY-75/SRT, front panel compartment identification.

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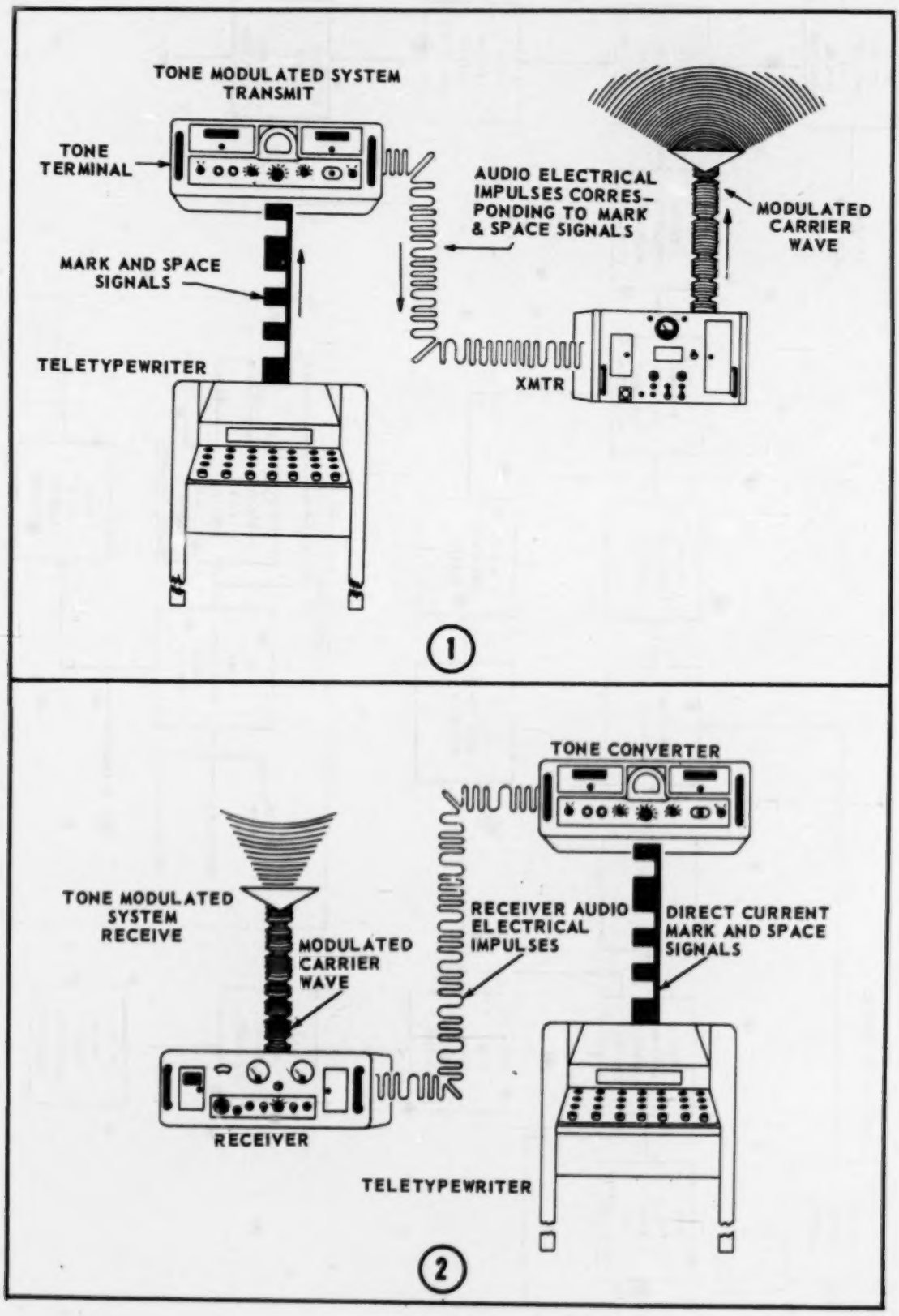

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Figure 8-6.—Tone-modulated system.

The send bias rheostat is located at the right of the meter. This control permits correction of any teletype distortion (for example, unequal length of mark and space signals) in the local teletypewriter loop when sending a teletype message.

At the far right is a jack marked, TTY monitor. A test or monitoring teletypewriter may be patched into this jack, thereby placing it in series with all other equipments in the loop. NOTE: headphones must not be plugged into this jack.

The power indicator light is located at the lower left side of the front panel of the tone converter. The power ON-OFF switch is located next to it.

The receive bias potentiometer is located at the right of the power switch. This control enables correction of distortion (unequal length of mark and space tones) in the receiving tone circuit.

The control switch is located at the right of the meter switch. The position of the control switch determines the function of the tone converter to either receive or to transmit teletype signals.

A 115-volt, 60-cycle convenience outlet is provided at the lower right of the front panel. It bypasses the power switch.

A block diagram of the tone converter is illustrated in figure 8-8. Typical oscilloscope patterns are included. The attenuator is located at the input of the receive circuit to permit adjustment of the level of the incoming 2-tone signal. The bandpass filter passes all frequencies in the band from 400 to 800 cycles and rejects all other frequencies. The amplifier limiter stages have a constant-output level. The frequency discriminator filter selects the fundamental frequencies of 500 cycles and 700 cycles and routes them via separate germanium rectifiers to corresponding d-c amplifiers (in the DC amplifier block) and associated relay coils in the receiver relay block. A 700-cycle signal causes the receive relay to close the teletype DC loop, a 500-cycle signal causes the relay to open the loop. Thus, corresponding mark and space signals are developed in the teletype loop circuit.

In sending, the mark and space signals in the DC loop cause the send relay to apply either a DC voltage or no DC voltage

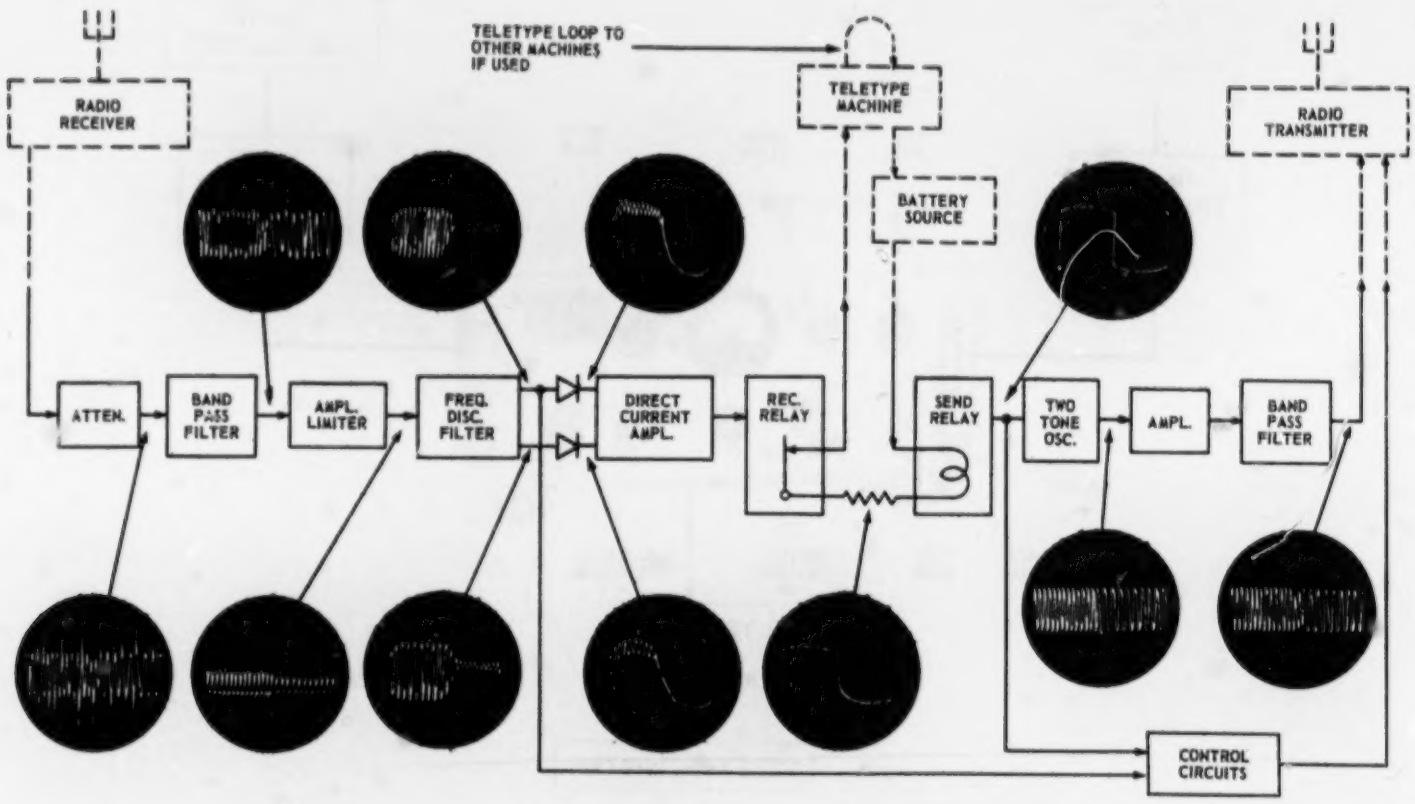

Figure 8-8.—Block diagram of tone converter.

respectively to the two-tone oscillator. A mark signal causes the oscillator to operate at 700 cycles; a space signal causes it to operate at 500 cycles.

The output of the oscillator passes through a level-controlling potentiomenter (not shown in the diagram) to the amplifier stage. The output of the amplifier passes through a bandpass filter to the ship's radio transmitter.

The control switch is used to change from one operating condition to another or to permit the accomplishment of specific operating or maintenance functions. If it is desired to prevent the sending of a message by the teletypewriter, the control switch may be turned to REC/STDY. Thus, the equipment cannot change to the transmit condition even though the teletypewriter is operated, but it can receive messages or remain in the standby condition.

In carrying on communications, the equipment should not be operated with the control switch turned to TRS because the equipment is then locked in the transmit condition and cannot receive any message until released by turning the control switch to one of the other two operating positions.

Usually, for half-duplex communication, this switch is set at the AUTO position. In auto condition, operators at two or more stations having this equipment can engage in full communication. After a station has completed sending its message, it is ready for reception of any return message after an automatic three-second time delay. When the switch is in the AUTO position, the tone converter may be in one of three conditions: receiving, transmitting, or standby. When in the standby condition, the reception of an incoming mark tone causes the control circuit to change to the receiving condition. Following the end of the incoming message, the internal circuits of the equipment shift back to the standby condition. When in this condition the operation of the local teletypewriter causes the circuits to change from standby to the transmit condition. After the last letter of the message is sent, there is a time delay of about three seconds and then the internal equipment circuits shift back to the standby condition. The interlocking functions prevent the equipment from shifting directly from transmit to receive, or vice versa. Thus, an incoming signal will not interrupt an output signal, nor will keying the local teletypewriter, when receiving, cause the circuit to shift to the transmit condition. The control circuits also, when shifted to transmit condition, cause the control contacts of the transmit control relay to the radio transmitter to close, thereby placing the transmitter carrier on the air.

After a station has sent its message, it is ready for reception of any return message following an automatic three-second time delay. Because of the small time delay inherent in the operation of the control circuits of the local and distant terminals the first character transmitted is usually lost. Therefore, the first character typed should be the "letters" key.

When placing the tone converter in operation, proceed as follows:

1. Turn the power switch (fig. 8-7) to ON.
2. Turn the control switch to TRS (transmit position). If the transmitter power has been turned on, the transmitter will send out a continuous tone; however, this does not matter for a few moments. If desired, the transmitter power may be left off until certain other adjustments have been performed.
3. Turn the meter switch to LOOP CURRENT. Adjust the control marked, LOOP CURR, until the meter reads 60 on the upper scale. If the meter reads zero, the source of loop current may not be energized.
4. Turn the control switch to AUTO. Then hold down the space bar on the teletypewriter and turn the meter switch to SEND BIAS. The meter should read zero on the upper scale. If it does not read zero, correct the reading to zero by means of the send bias control. Turn the meter switch to OFF <u>before</u> releasing the space bar.
5. The radio transmitter may be turned on if it was left off. When a teletypewriter message is received from a distant station, turn the meter switch to RECEIVE LEVEL and adjust the receive level control until the meter indicates 0 dbm (lower scale).
6. The last adjustment is the receive bias control adjustment for which an incoming teletypewriter signal is required from a distant station. The ET should request that a distant operator hold down his teletypewriter space bar for a minute. While he is holding down the space bar, turn the meter switch to RECEIVE BIAS and adjust the receive bias control until the meter reads zero on the upper scale. Then return the meter switch to the OFF position.

The equipment is now adjusted for operation with its associated teletypewriter receiver and

transmitter for communication with other stations similarly equipped.

The AN/UGC-9 tone shift keyer converter (not illustrated) is the transistorized version of the AN/SGC-1. It serves the same purpose and performs in the same manner. Because transistors are much smaller than conventional electron tubes, the AN/UGC-9 is smaller in size than the AN/SGC-1. Thus, it is better suited for shipboard installation.

Basic Radio Teletype System

When the carrier frequency-shift system (long range) is combined with the tone-modulated system (short range), several more pieces of equipment are needed-a TELETYPE PANEL, a POWER SUPPLY, a SWITCHING CONTROL, a TRANSMITTER SWITCHBOARD, and a RECEIVER SWITCHBOARD, as illustrated in figure 8-9.

The teletype panel is capable of handling six channels, or "loops." The power supply furnishes the direct "looping" current for all teletype direct-current signals. Located at the teleprinter is the switching control, which is used to select the desired system. The transmitter and receiver switchboards are used to join the radio teletype systems with other communication systems on board ships.

As has been stated, the tone-modulated system and the carrier-frequency-shift system are combined to form one teletype system in shipboard communications. The tone-modulated system is used only for short-range, or "line-of-sight," communications in the UHF band. Manmade and atmospheric static and signal fading are not major problems in this band, and no special equipment to counteract these effects is needed.

The frequency-shift system, used in the LF to HF bands, is the best way to send the rapidly keyed signals of the teletypewriter over long distances. Fading and interference are sometimes major problems in these bands.

Because a single carrier usually does not fade simultaneously in areas separated by more than one wavelength, and because fading of carriers of different frequencies usually

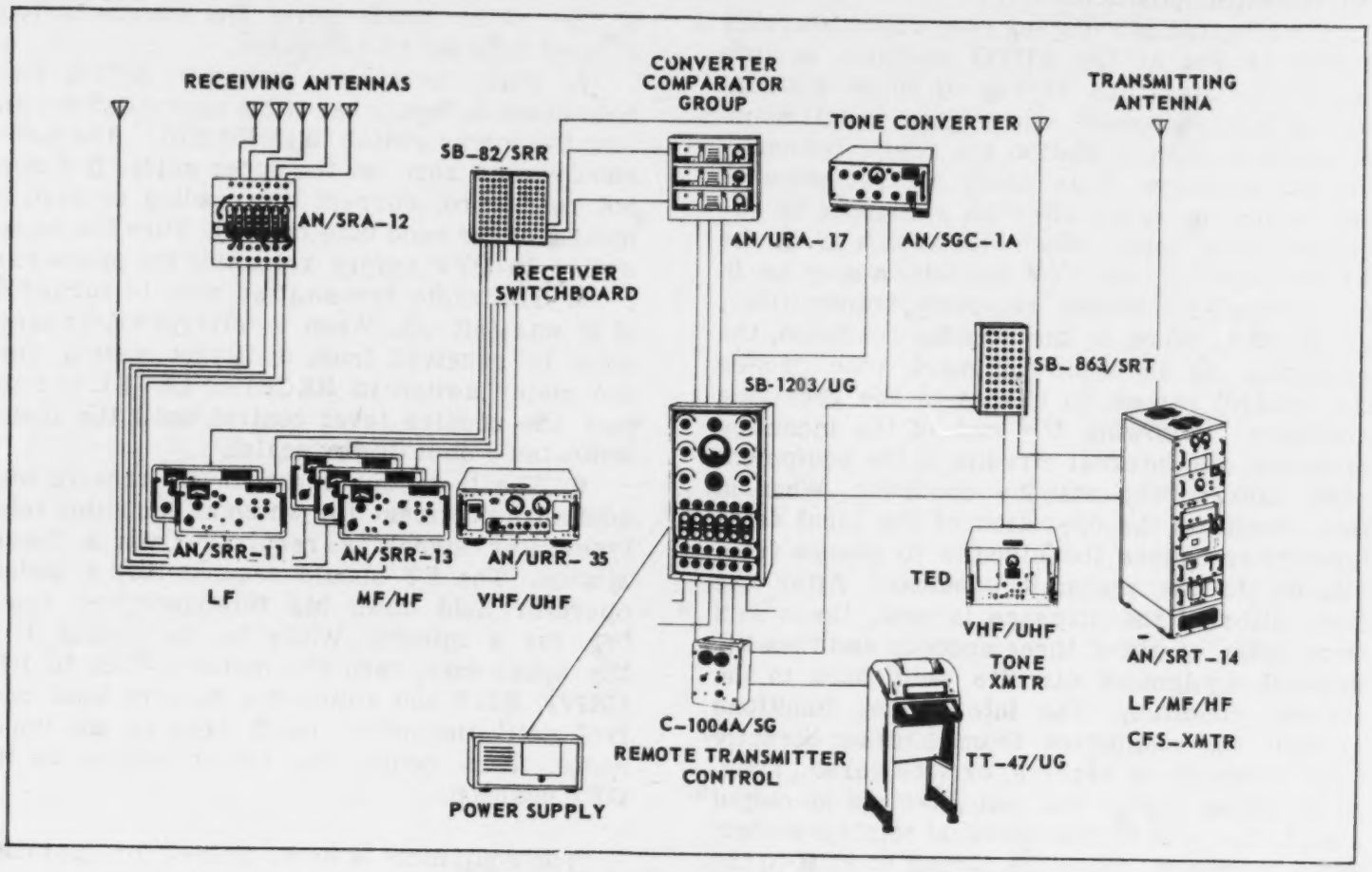

Figure 8-9.—Teletype system (basic).

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does not occur simultaneously at the same point, the Navy has taken advantage of this situation by the use of two methods of DIVERSITY RECEPTION (fig. 8-10).

In SPACE DIVERSITY reception (fig. 8-10, A), one signal is transmitted, and this signal is received by two receivers. Antennas for these receivers are separated by a distance greater than one wavelength. The outputs of the receivers are fed into two frequency-shift converters and then into a COMPARATOR, which selects the best signal for the teletypewriters.

In FREQUENCY DIVERSITY reception (fig. 8-10,B), two or more identical signals are transmitted on different frequencies. Two receivers, two converters, and a COMPARATOR are used, as in space diversity. The receiving antennas are not separated.

For the tone-modulation system (higher frequencies), the transmitter may be the TED and the receiver may be the AN/URR-35; for the carrier frequency-shift system (lower frequencies), the transmitter may be the AN/URC-32, and the receiver may be the AN/SSR-11 and AN/WRR-2, system.

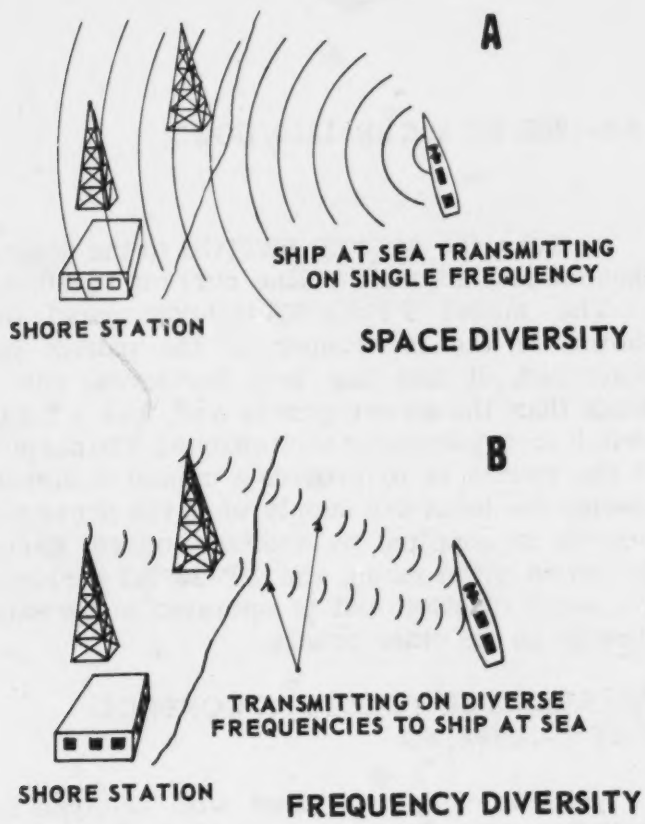

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Figure 8-10.—Diversity reception.

A basic teletype system employing diversity reception is illustrated in figure 8-9.

COMMUNICATION PATCHING PANEL SB-1203/UG and SB-1210/UGQ

Teletype panels and communication patching panels are used to interconnect the page printers and terminal equipments. Communication patching panels SB-1203/UG and SB-1210/UGQ (fig. 8-11) contains 6 channels. The SB-1210/UGQ is intended for use with cryptographic devices, whereas the SB-1203/UG is a general-purpose panel. Since the panels are almost identical only the SB-1203/UG will be discussed.

The permanent and patching connections provide many circuit arrangements. Each channel comprises a circuit of 3 looping jacks (LPG), 1 SET jack, 1 MISC. jack, and a rheostat for adjusting line current. The LPG and MISC. jacks are identical, and are standard type phone jacks. The SET jacks incorporate the features of a double-pole double-throw switch, as will be seen later. The 6 line current rheostats provide individual channel current adjustment.

The CURRENT METER is a DC milliammeter. The METER SWITCH is a two-pole, seven-position, rotary selector switch. When the METER SWITCH is turned to any one of the 6 channels, line current in the selected channel will be indicated on the CURRENT METER.

Figure 8-12 shows a simplified schematic of a single channel. The other five channels are identical. Terminal equipment is connected to terminals 1 and 2 of terminal board TB-101, and the teletypewriter is connected to terminals 1 and 2 of TB-102. When line current is not supplied by the remote station loop, provisions are made to connect a local source of 115 volts d-c across terminals 1 and 2 of TB-104. These connections are paralleled across the corresponding terminals of each loop, and local current can be connected in or out of each loop by removable straps.

Resistor R119 limits the current in each loop to a maximum of 100 ma. Line current is adjusted by the 2500-ohm rheostat R108. One terminal of the rheostat is connected to the first looping jack J101. The SET jack J119 is connected to terminals 1 and 2 of TB-102 completing the circuit between the terminal equipment and the teletypewriter.

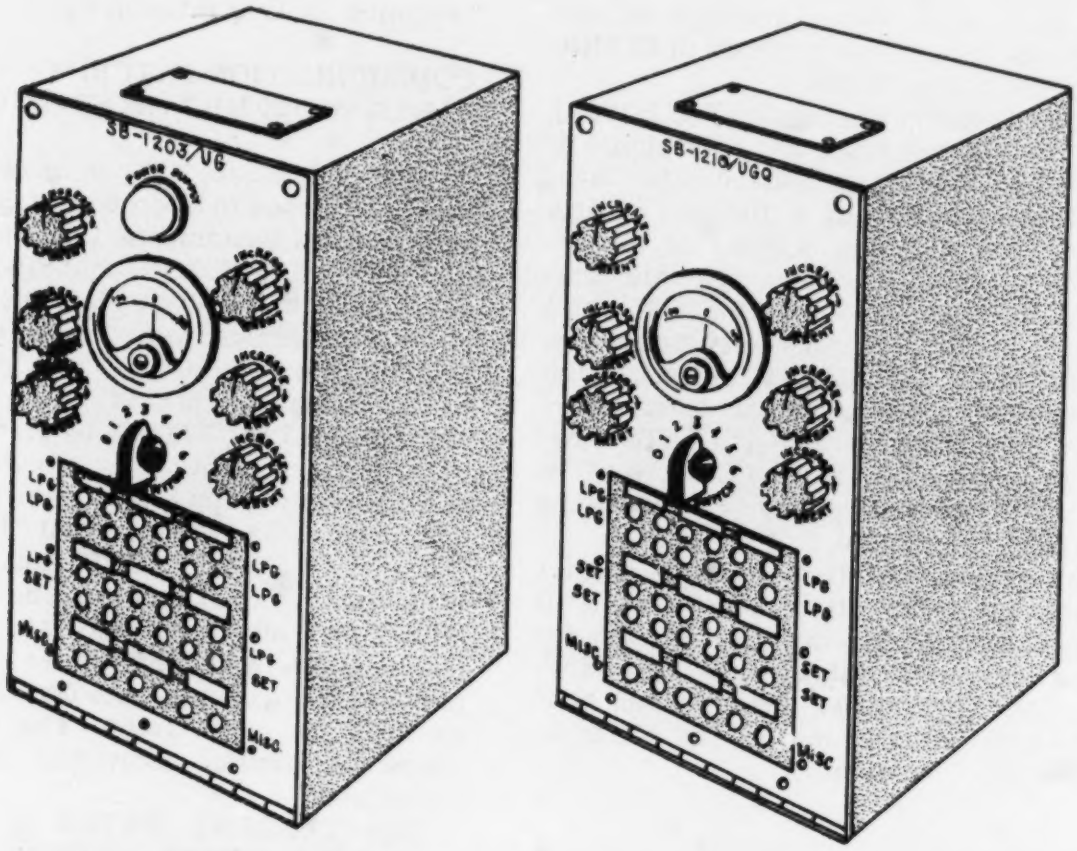

Figure 8-11.—Teletype patch panels SB-1203/UG and SB-1210/UGQ.

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The teletypewriter may be transferred to any other channel by patching it from the SET jack J119 to one of the looping jacks in the channel desired. If it is desirable for the teletypewriter in this channel to be inoperative, a dummy plug is inserted in SET jack J119. An additional teletypewriter may be connected to the MISC. jack and patched into any channel.

Operating Adjustments

1. Turn all line current rheostats counterclockwise to allow minimum current.
2. Turn on local or remote power.
3. If the teletypewriter to be used is wired in the same looping channel as the terminal equipment to be used, no patching is required. If the teletypewriter is not wired in the same channel as the terminal equipment, insert one end of a patchcord in the proper SET jack and the other end in either of the looping jacks in the desired channel.
4. Turn the METER SWITCH to the desired channel and adjust the line current to 60 MA.

The model TT-23/SG teletype panel (not shown) is the forerunner of the panels just described. It has one less horizontal row of jacks than the newer panels and, has a toggle switch incorporated in each channel. The purpose of the switch is to provide a means of disconnecting the local d-c supply when the necessary current is supplied by another source. Except for these differences, the TT-23/SG performs the same function and is operated in the same manner as the other panels.

TRANSMITTER TELETYPE CONTROL UNIT C-1004A/SG

Another equipment used with teletype installations aboard ship is a control unit, for example, Navy Model C-1004A/SG (fig. 8-13). This unit permits control of a teletypewriter radio circuit from a remote position. It provides

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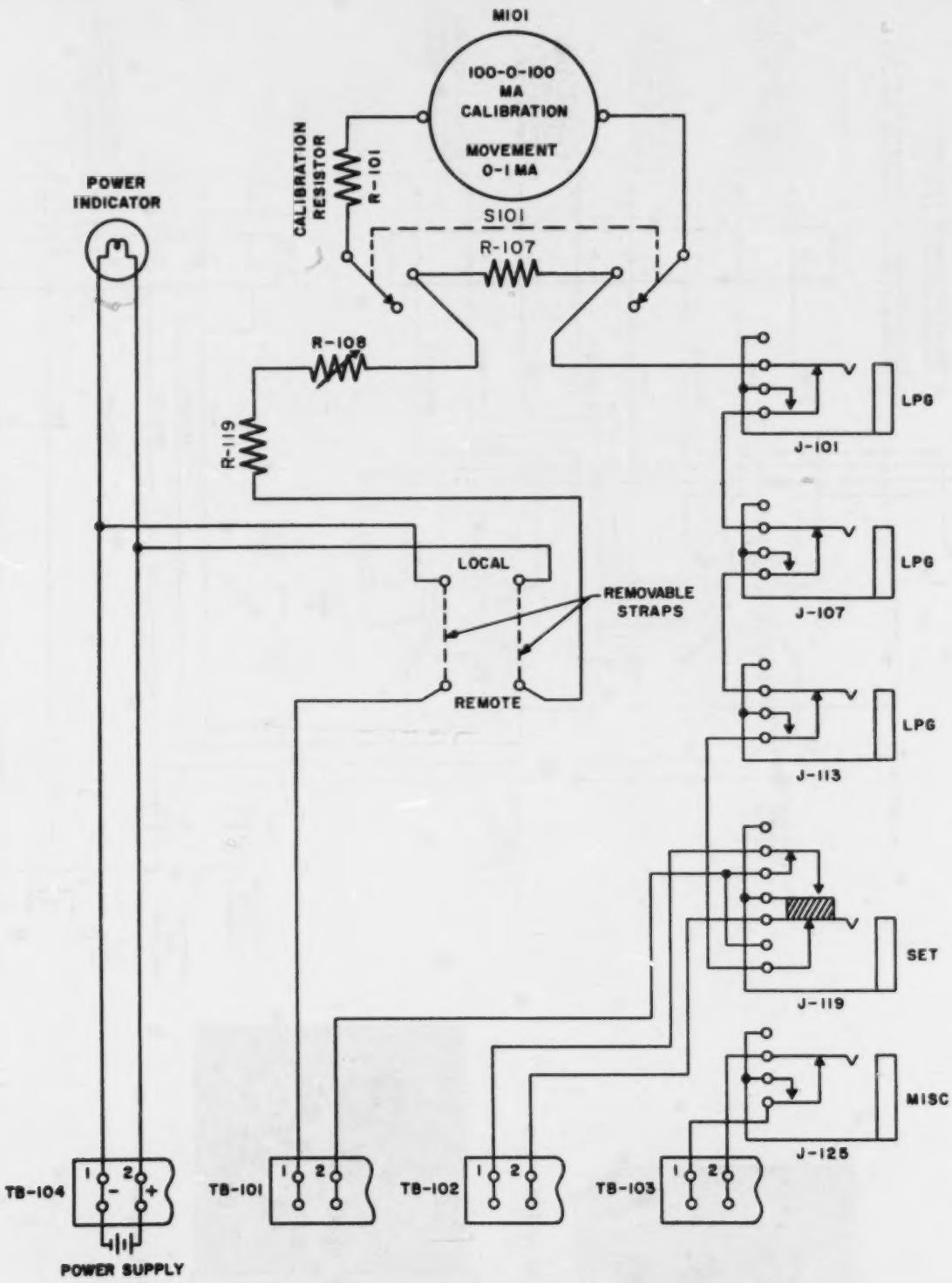

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Figure 8-12.—Communication patching panel SB-1203/UG, single channel simplified schematic diagram.

a transmitter power ON-OFF switch, a power-on indicator lamp, a carrier-on indicator lamp, and a three-position rotary selector switch. The rotary selector switch, S103, provides the following functions:

1. Connects a send-receive teletypewriter to (A) a frequency-shift keyer circuit (CFS send), (B) a frequency-shift converter or comparator circuit (CFS receive) or, (C) a tone terminal on a send receive basis (tone S/R).

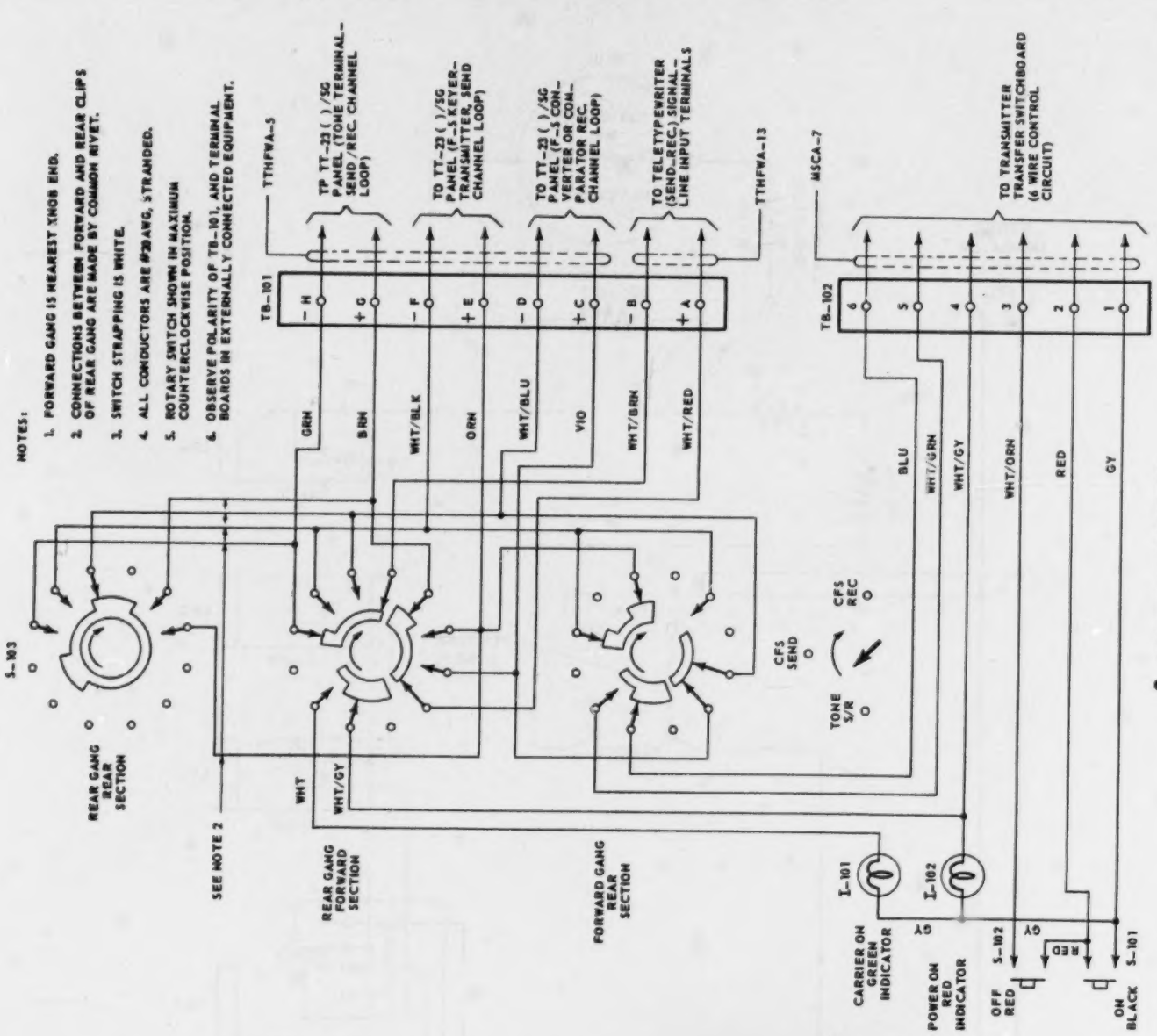

C CIRCUIT DIAGRAM

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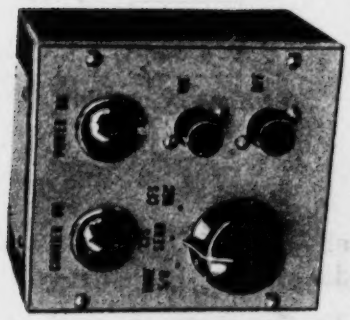

A EXTERNAL VIEW

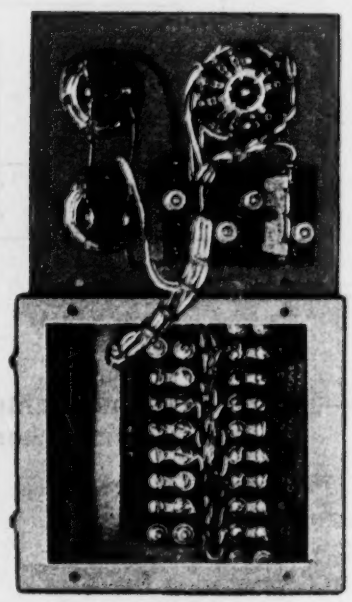

B INTERNAL VIEW

Figure 8-13.—Transmitter teletype control unit C1004A/SG.

2. Shorts the other two unused sets of terminals when the send-receive teletypewriter is connected to the set of terminals associated with a particular switch position; that is, when the switch is in the TONE S/R position, the frequency-shift keyer terminals, E and F (CFS) send) and the frequency-shift converter terminals, C and D (CFS receive) are shorted (close circuited).

3. Turns on the transmitter carrier by closing a circuit in the radio transmitter (terminals 5 and 6 are shorted in the CFS send position only).

4. Energizes the carrier-on indicator lamp in the CFS SEND position only.

When S103 (Fig. 8-13C) is in the TONE S/R position, the carrier-on indicator lamp and the transmitter carrier are off; the teletypewriter is connected to the tone terminal loop (terminals G and H) while the unused terminals, frequency-shift keyer terminals E and F and frequency-shift converter terminals C and D, are shorted.

When S103 is in the CFS RECEIVE position, the carrier-on indicator light and the transmitter carrier are off; the teletypewriter is connected to the frequency-shift converter circuit while the unused terminals, tone terminals G and H and frequency-shift keyer terminals E and F, are shorted.

CONVERTER-COMPARATOR GROUP AN/URA-17

The AN/URA-17 consists of two identical converter units (fig. 8-14), one of which is shown in closeup in figure 8-15. Each converter has its own comparator circuitry. This design feature achieves a considerable reduction in size from model AN/URA-8B (discussed later), wherein the comparator occupies a separate chassis. The physical size of the AN/URA-17 is further reduced through use of semiconductors and printed circuit boards. The complete equipment is less than half the size of the AN/URA-8B.

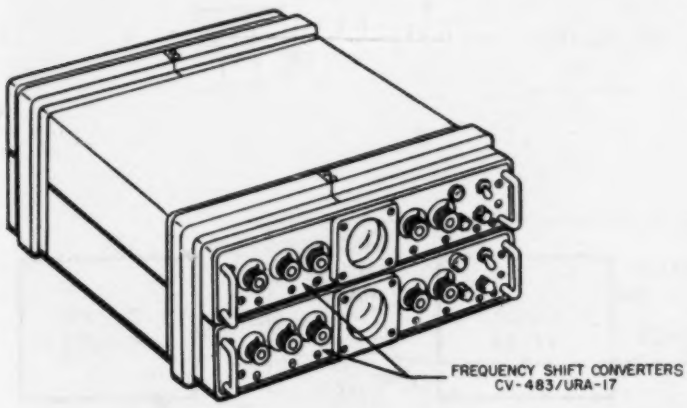

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Figure 8-14.—Converter-comparator group AN/URA-17.

The comparator-converter can be operated with two radio receivers in either space diversity or frequency diversity receiving systems. When conditions do not require diversity operation, each converter can be used separately with a single receiver for reception of frequency shift RATT signals. In this latter usage, the two converters can be operated in two independent communication circuits.

For diversity operation, the function switch (fig. 8-15) on both converters must be placed in the diversity position. The teletypewriter may be connected to either converter.

The simplified block diagram (fig. 8-16), indicates the basic functions of converting the RF frequency shift signal into a signal for controlling the DC loop of the teletypewriter. The frequency shifts of the audiofrequency output of the radio receiver are converted into DC pulses by action of the audiofrequency discriminator. The DC pulses are fed into the loop keyer, which opens and closes the DC loop of the teletypewriter in accordance with mark and space characters received.

The principal functions of the circuits of the complete equipment are represented in figure 8-17. Two receivers and a teletypewriter are also shown, connected for diversity operation. The two converters are identical. One is shown as a single block for simplicity.

Frequency-Shift Converter

Each converter of the AN/URA-17 (fig. 8-17) is a single unit whose filters and transformers are mounted around the sides of printed circuit boards. In the following discussion, the converter is covered as three functional sections: (1) signal processing circuits, (2) keyer circuits, and (3) power supplies.

The input signal from the receiver is applied to the audio input connector at the rear of the converter. The input transformer matches the 8000-ohm impedance of the bandpass filter to the 600-ohm line from the receiver. A center tap is provided for accommodation of balanced inputs. The input transformer is encased with the bandpass filter.

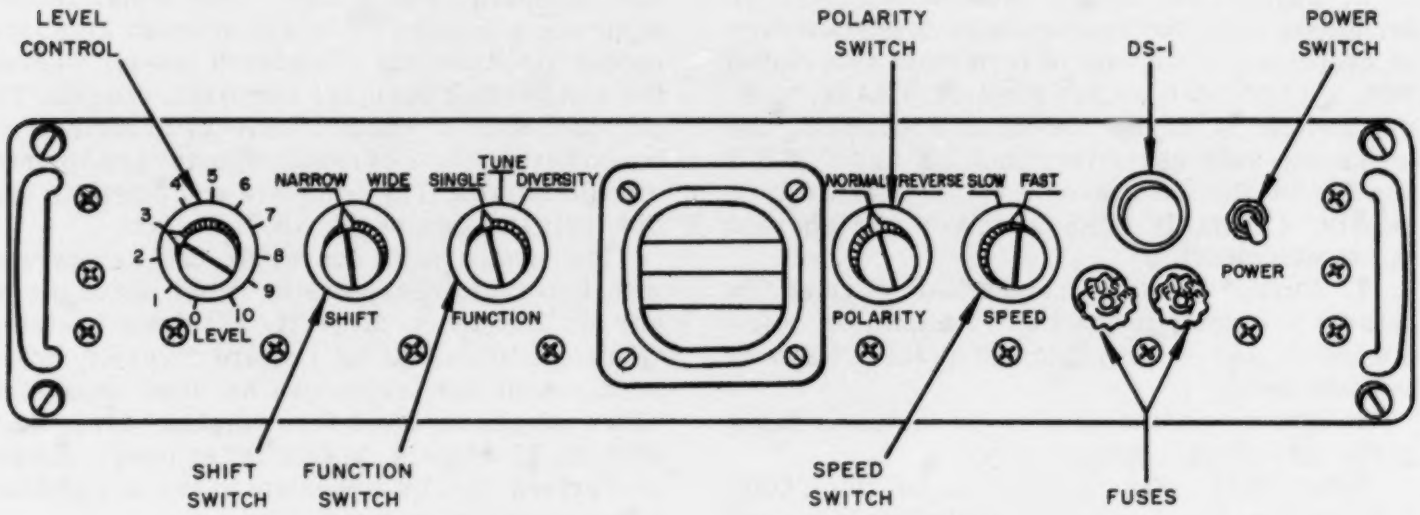

50.77

Figure 8-15.—Frequency-shift converter CV-483/URA-17, front panel controls.

High-frequency noise pulses are attenuated by bandpass filters, and both extremes of the shifted audio signal are passed to the limiter. The shift switch selects the correct filter for the shift width of the input signal. The narrow filter is used when the center frequency of the input signal is 1000 cps, with shifts of 5 to 100 cps each side of center. The wide filter is used when the center frequency of the input signal is 2550 cps, with shifts of 100 to 500 cps each side of center.

The detector output level is held to within 2 db by the limiter, with input signals of from 60 microwatts to 60 milliwatts. Both diodes have a high forward resistance to signals below approximately 0.6 volt in amplitude. Their resistance to signals of greater amplitude is low. Strong noise pulses are removed from the input signal, and the signal to the discriminator is held at a constant level with fading input signals. The signal level is maintained at approximately 0.6 volt. The output from the limiter is amplified by a common emitter amplifier that uses the level control as the collector load. The level control is used for adjusting the signal level to the discriminators. During reception of a narrow-shift signal, the level must be higher than when receiving a wide-shift signal. The amplified signal is applied to the discriminator through the shift switch.

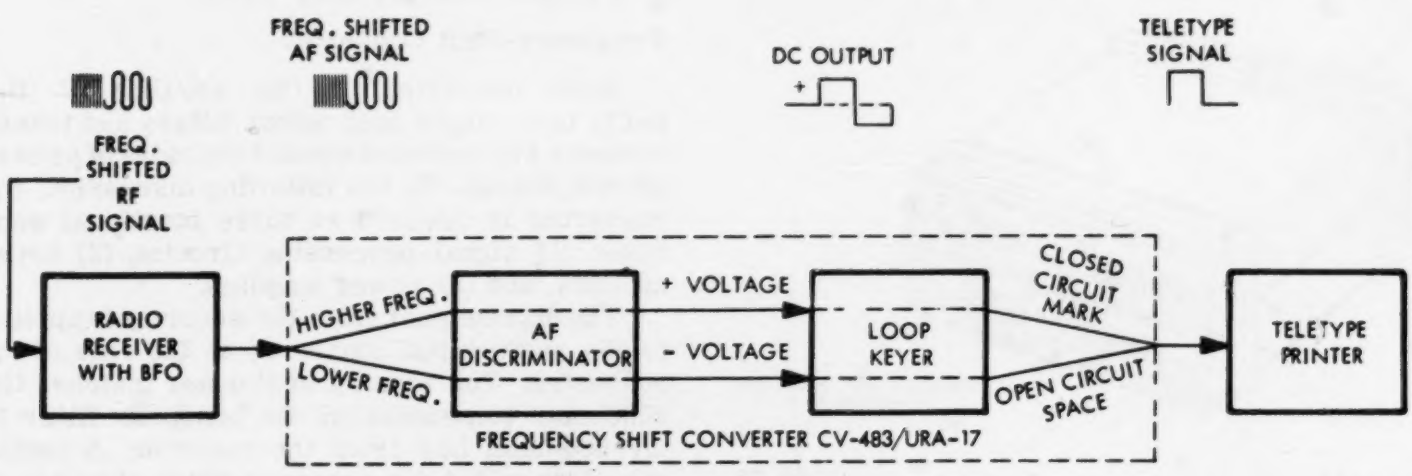

162.23

Figure 8-16.—Frequency-shift receiving system, simplified block diagram.

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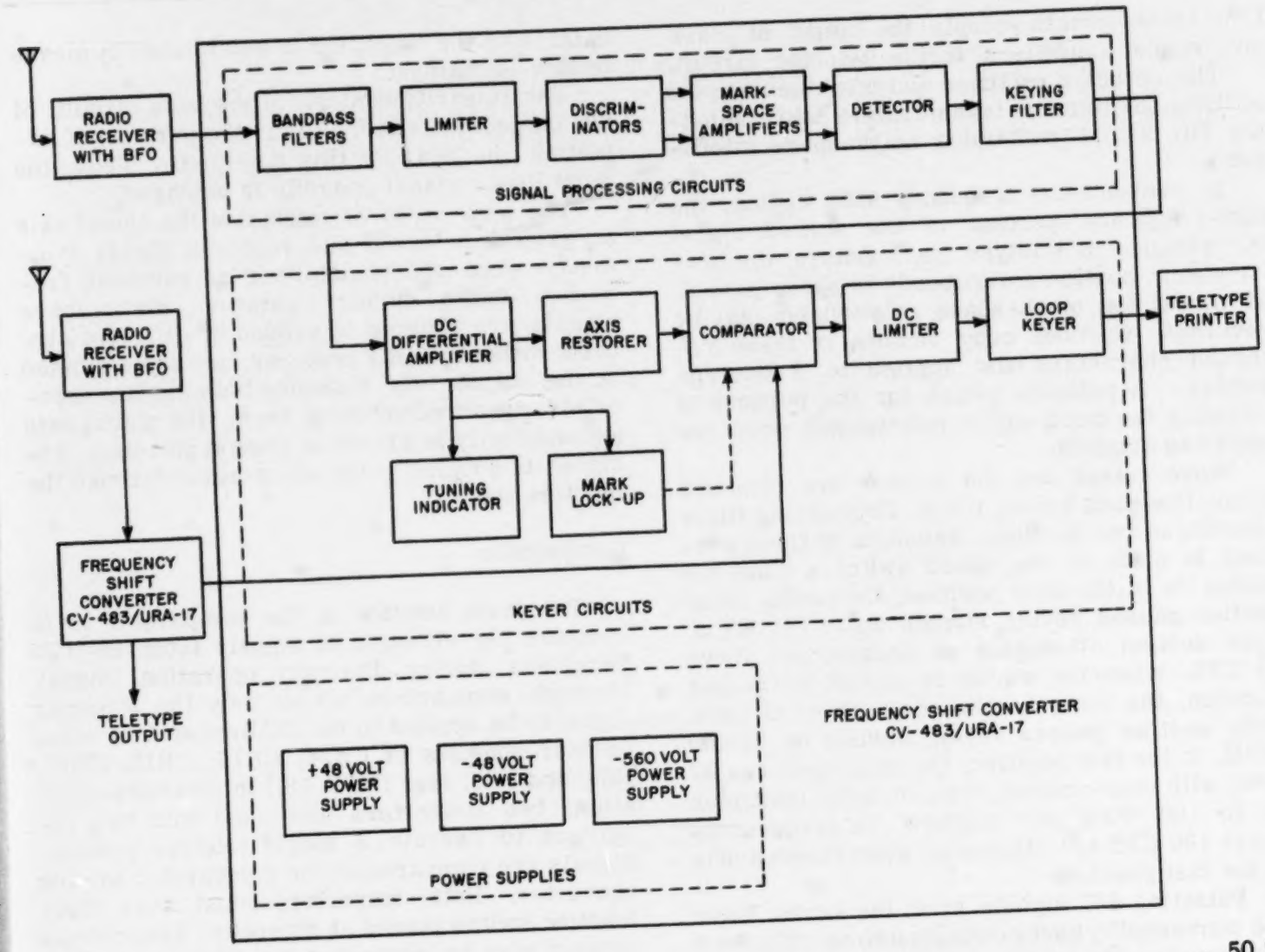

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Figure 8-17.—Converter-comparator group AN/URA-17, functional block diagram.

Discriminators determine the frequency versus amplitude slope of mark and space signals. Each discriminator is a frequency-selective network, consisting of two resonant networks with overlapping frequency response patterns.

The narrow-shift discriminator is used for signals with shift widths of 10 to 200 CPS. At one terminal of the narrow-shift discriminator, voltage output increases with frequency to maximum at approximately 1200 CPS. At the other terminal, voltage output increases as frequency decreases to a maximum at approximately 800 CPS. The crossover point, at which voltages from the two output terminals are equal, is 1000 CPS ±15 CPS.

The wide-shift discriminator is used for input signals, with shift widths between 200 and 1000 CPS. Crossover frequency of the two resonant networks is 2550 CPS ± 40 CPS. One of the outputs increases with frequency to maximum at about 3400 CPS. The other output increases as frequency decreases to a maximum at approximately 1700 CPS.

The output from one terminal of the discriminator is applied to the base of the first mark amplifier (mark-space amplifier block). Output from the other terminal is applied to the base of the first space amplifier.

The first mark amplifier is a common emitter with fixed base biasing. The mark gain control in the collector circuit provides adjustment of signal gain by controlling degeneration in the emitter circuit. The mark signal is capacitor coupled to the base of the second mark amplifier. Space amplifiers are identical to mark amplifiers. The space gain control is in the collector circuit of the first space amplifier.

Two transformers couple the output of mark and space amplifiers to the detector circuit.

The detector rectifies and combines outputs of the discriminator transformers into a pulsating DC signal containing mark-space intelligence.

In conventional frequency shift keying, the high-frequency portion of the shifted signal corresponds to teletype mark pulses; the low-frequency portion corresponds to space pulses. At times, the mark-space relationship may be reversed. Garbled copy results if these reversed characters and applied to a teletype printer. A polarity switch for the purpose of inverting the mark-space relationship when required is available.

Noise pulses and the carrier are removed by the low-pass keying filter. This keying filter consists of two sections. Selection of these sections is made by the speed switch. When the switch is in the slow position, the keying filter section passes keying signals up to 100 WPM. This section attenuates all frequencies above 45 CPS. When the switch is moved to the fast position, the other section of the filter is used. This section passes keying signals up to 400 WPM. In the fast position, the equipment can be used with four-channel, time division multiplex up to 100 WPM per channel. All frequencies above 180 CPS are attenuated when the switch is in the fast position.

Pulsating DC signals from the keying filter are converted by keyer circuits into on-off pulses for operating the teletype printer relay.

The DC differential amplifier amplifies the mark-space signals before they are applied to the DC limiter. This differential amplifier contains five transistors, four of which form two emitter-coupled amplifiers. The fifth transistor is the output and feedback transistor.

The input signal from the keying filter is applied to the base of one of the transistors in the first emitter-coupled amplifier. Input to the base of the other transistor in this amplifier is from the collector of the fifth transistor in the output circuit of the DC differential amplifier. The feedback signal from the output stabilizes the gain of the DC differential amplifier.

Both the input signal and feedback signal are amplified by the other emitter-coupled amplifier. This amplifier also mixes these two signals and applies them to the output transistor.

The vertical center control, in the emitter of the first transistor, adjusts the vertical centering of the tuning indicator display. Zero balance of the amplifier is established by means of this adjustment.

The linearity control, in the base circuit, of the output transistor, is for the purpose of adjusting the bias of this transistor. Thus, the most linear signal possible is provided.

The axis restorer maintains the signal axis at ground potential and restores signal symmetry when the transmitter or receiver frequency drifts during operation. Mark-space signals are clamped to ground by different circuits within the axis restorer, and are combined at the output. By clamping both signals separately, then recombining them, the signal axis automatically is placed at ground potential. The signal is coupled to the comparator through the function switch.

Comparator

The main function of the comparator is to compare the strength of signals from the two receivers during diversity operation. Signal strength comparison allows only the stronger signal to be applied to the DC limiter. The comparator consists of CR14, CR15, CR16, CR17, R54, and R55. (See fig. 8-18.) In diversity operation, two converters are used with two receivers to operate a single teletype printer. Signals are compared at the comparator in each converter. Both converters must have their function switch placed at diversity. The teletype printer may be connected to either converter.

In figure 8-18, peak amplitudes of both input signals are equal, but the signal from converter A contains noise. The signal from converter B, which has a constant peak value of 20 volts, will develop a greater voltage across R54 and R55. This action places a reverse bias of 2 volts on CR14 and CR16, preventing converter A from actuating the DC limiter.

Besides diversity setting, the function switch has two other positions—single and tune. In single, positive mark pulses cause CR16 to conduct; negative space pulses cause CR14 to conduct. In the tune position, the signal input to the DC limiter is removed while the receiver is being tuned.

The DC limiter is a class B push-pull circuit. This circuit supplies about 20 db of post-detection limiting, and aids in proper operation during reception of signals, containing strong noise pulses.

The signal from the comparator is applied simultaneously to the base of two transistors.

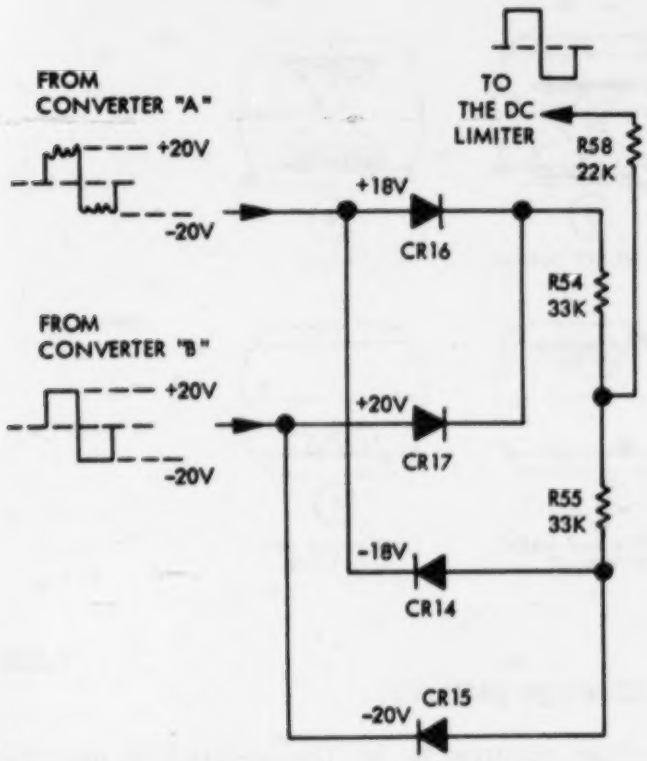

162.24

Figure 8-18.—Comparator circuit, simplified schematic diagram.

A positive mark signal causes the mark transistor (an NPN transistor) to conduct, but cuts off the space transistor. The signal is phase-shifted 180° and is fed to a PNP transistor, causing it to give a strong positive signal at the output. A negative space signal causes the space transistor (a PNP transistor) to conduct and at the same time cuts off the mark transistor. This signal is shifted 180° and delivered to an PNP transistor, causing a strong negative signal at the output. Mark and space signals then are combined and fed to the loop keyer. Switching action of the loop keyer is controlled by the DC limiter.

The function of the loop keyer is to operate the teletype printer loop relay. Two transistors are contained in the loop keyer circuit. Depending on the signal applied, the first transistor causes the second to conduct or not conduct. When the second transistor conducts, the teletype printer relay closes, causing a mark signal to be transmitted. When the transistor doesn't conduct, the relay opens, causing a space signal to be transmitted. A positive signal from the DC limiter activates the loop keyer circuit; a negative signal cuts off the loop keyer circuit.

During traffic interruptions, the mark lockup circuit provides a strong, artificial mark signal to the DC limiter. When a deep fade in the signal occurs, or if the signal-to-noise ratio is low, noise pulses could cancel the small positive bias on the DC limiter input, allowing garbled copy to be printed. A steady mark signal is transmitted between messages.

The tuning indicator is a cathode-ray tube. Controls for horizontal adjustment, centering, focus, intensity, vertical adjustment, vertical center, and linearity are provided on the converter chassis as screwdriver adjustments. When the associated receiver is tuned properly, the CRT pattern (fig. 8-19) is centered vertically. Correct level control adjustment is achieved when horizontal lines of the pattern coincide with those on the bezel.

Three DC power supplies furnish all operating voltages and operating current required by the converter. Tapped primaries on the two power transformers allow operating one-line voltages of 105, 115, or 125 volts.

Both the positive and negative 48-volt supplies consist of a full-wave bridge rectifier and a series regulator circuit. Each circuit has a voltage adjust control, enabling voltage to be maintained at a constant level.

The negative 500-volt supply uses two diodes connected as a half-wave rectifier. A voltage divider provides the high voltages required by the cathode ray-tube.

AN/URA-8B

The AN/URA-8B (fig. 8-20) is the tube version of the AN/URA-17. The units of the AN/URA-8B are much larger and require an extra unit for the comparator in a diversity set-up with two converters. The same functions are carried out as with the AN/URA-17.

FACSIMILE EQUIPMENT

Facsimile equipment is used to transmit still images over an electrical communications system. The images, called pictures or copy in facsimile terminology, may be weather maps, photographs, sketches, typewritten or printed text, or handwriting. The still image serving as the facsimile copy or picture cannot be transmitted instantly in its entirety. Three distinct operations are performed. These are (1) scanning, (2) transmitting, and (3) recording.

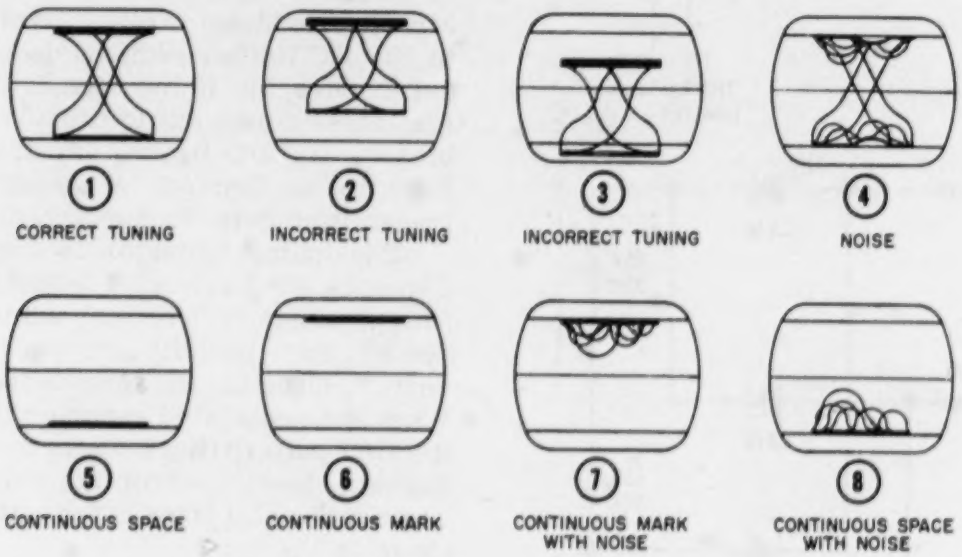

1.239

Figure 8-19.—Monitor oscilloscope patterns.

The SCANNING operation is that of subdividing the picture in an orderly manner into a large number of elemental segments. This process is accomplished in the facsimile transmitter (fig. 8-21) by a scanning drum and photocell arrangement.

The picture to be transmitted is mounted on a cylindrical scanning drum, which revolves at a speed of 1 revolution per second and travels along a lead screw at the rate of 12.5 inches in 20 minutes. (The lead screw has 96 threads per inch.) Light from an exciter lamp illuminates a

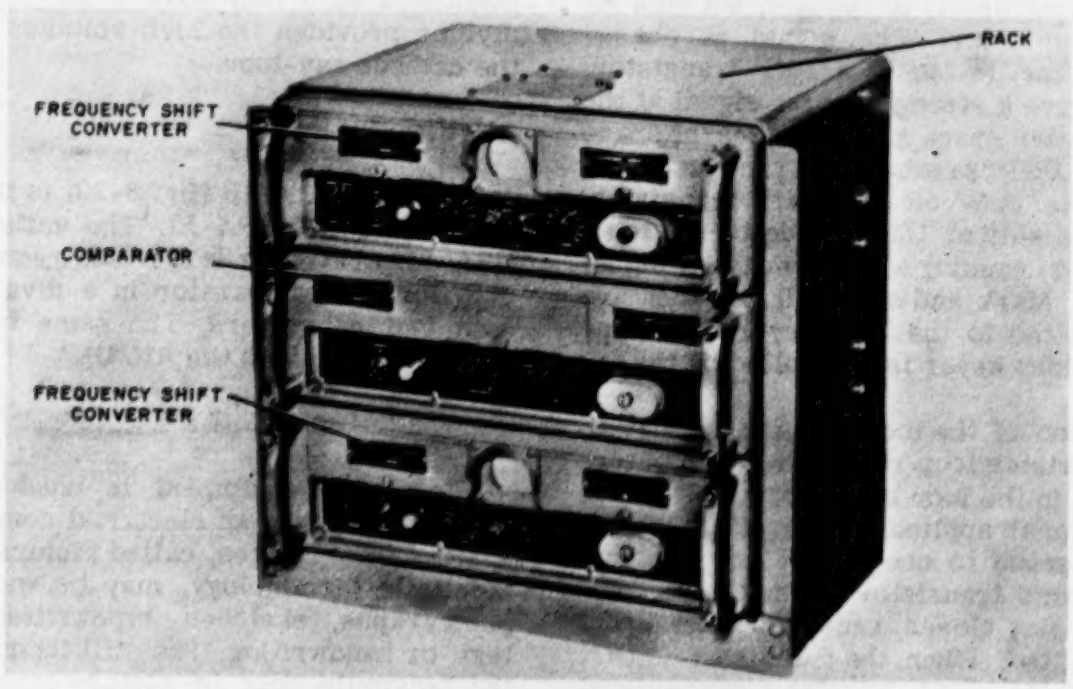

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Figure 8-20.—Frequency shift converter-comparator group AN/URA-8B.

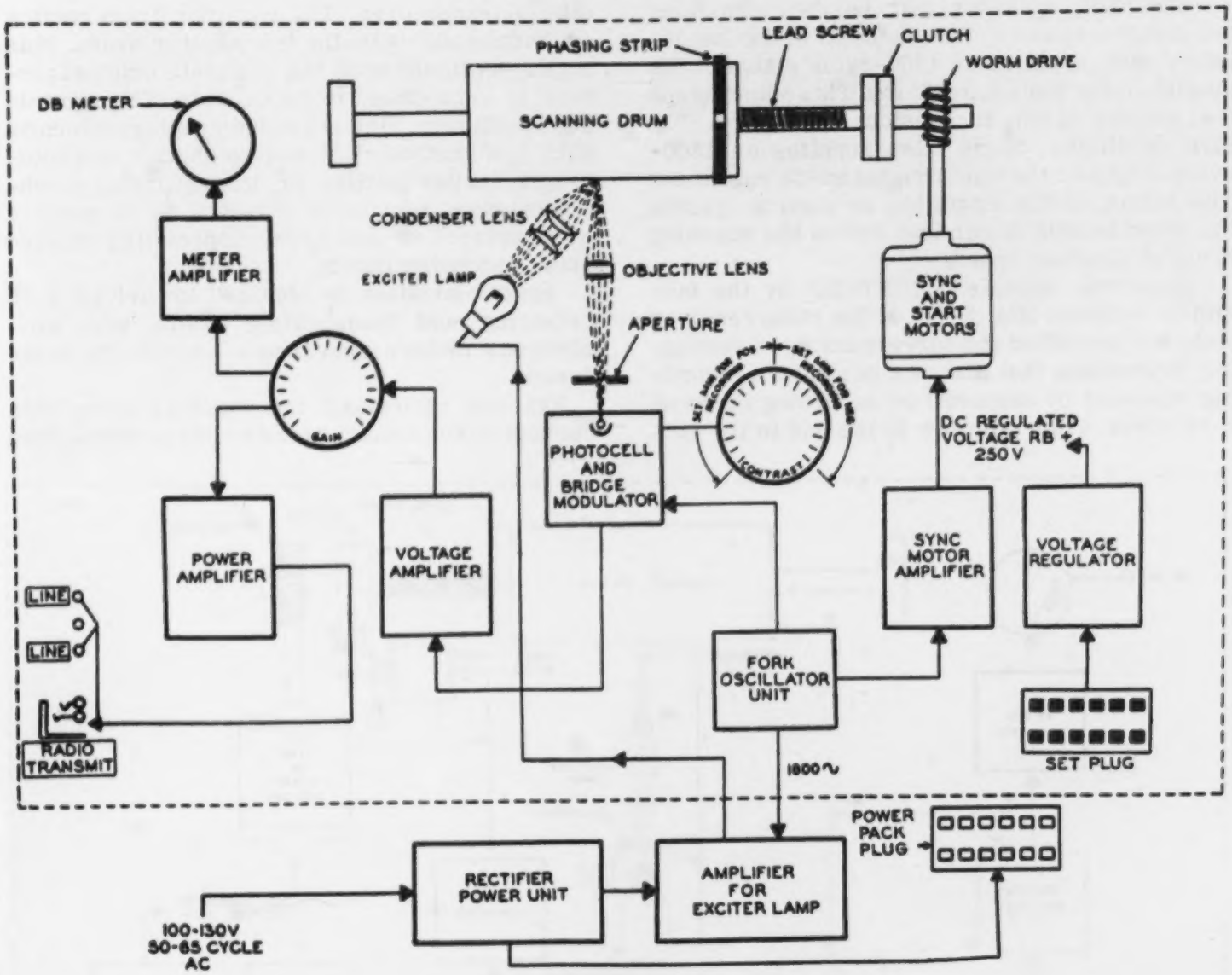

70.12

Figure 8-21.—Facsimile transceiver-transmitting block diagram.

small segment of the moving picture and is reflected by the picture through an aperture to a photocell. During the transmission of a complete picture, the light traverses every segment of the picture as the drum slowly spirals past the fixed lighted area.

At any instant, the amount of light reflected back to the photocell is a measure of the lightness or darkness of the tiny segment of the picture that is being scanned. The photocell transforms the varying amounts of light into varying electrical signals.

The fork oscillator unit develops an output voltage (MODULATION VOLTAGE) that is applied across the bridge modulator. The frequency of this voltage is 1800 cycles. When the bridge is balanced (photocell dark), the output voltage is zero. When the amount of light falling on the photocell varies, the resistance of the cell varies. This action unbalances the bridge and produces an output voltage that varies in amplitude with the variations in light. Thus, the 1800-cycle voltage is amplitude modulated in the bridge modulator.

The modulated signal is amplified in the voltage amplifier, the proper level is established in the gain control, and the signal is further amplified in the power amplifier before going to the radio transmit output jack. The modulated signal is fed to external equipment (discussed later) and then to a radio transmitter for transmission as desired.

The fork oscillator unit, besides furnishing the carrier signal to the photocell bridge modulator, also supplies an 1800-cycle signal to the amplifier for the exciter lamp. This output keeps the exciter lamp at constant brilliancy. The fork oscillator output also supplies an 1800-cycle output to the synchronous motor amplifier. The output of the amplifier is used to operate the synchronous motor that drives the scanning drum at constant speed.

Electrical signals RECEIVED by the facsimile receiver (fig. 8-22) at the radio receiver jack, are amplified and serve to actuate a recording mechanism that makes a permanent recording (segment by segment) on recording paper on a receiver drum similar to the one in the facsimile transmitter. The receiver drum rotates synchronously with the transmitter drum. This action continues until the complete original picture is reproduced in its entirety. The recording mechanism may reproduce photographically with a modulated light source shining on photographic paper or film; or, the recording mechanism may reproduce directly by burning a white protective coating from specially prepared black recording paper.

Synchronization is obtained by driving both receiving and transmitting drums with synchronous motors operating at exactly the same speed.

Framing (orienting) the receiver drum with respect to the transmitter drum is accomplished

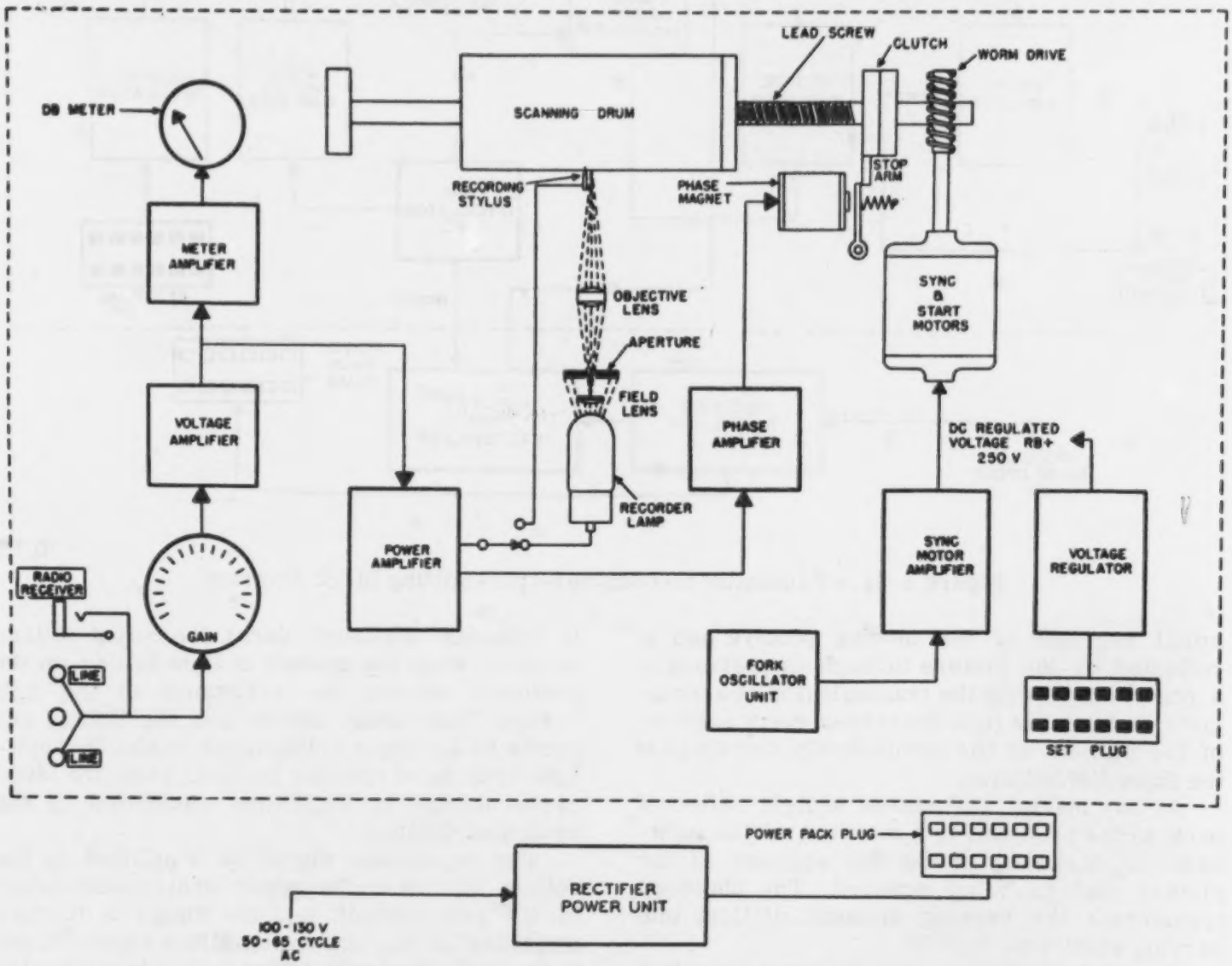

70.13

Figure 8-22.—Facsimile transceiver-receiving block diagram.

by transmitting a series of phasing pulses just before a picture transmission is to begin. The pulses operate a clutch mechanism that starts the scanning drum in the receiver so that it is properly phased with respect to the starting position of the scanning drum in the transmitter.

A start motor mechanically coupled to the synchronous motor serves to increase the synchronous motor speed above synchronism during the starting period after which it coasts down to synchronous speed when operating on 1800-cycle power.

The facsimile signal from the radio receiver circuit (fig. 8-22) is attenuated at the gain control, then amplified in the voltage and power amplifiers. The power amplifier output drives either the recording lamp for photographic recording, or the recording stylus for direct recording.

Another circuit from the power amplifier transmits phasing pulses to the phase amplifier, which operates the phase magnet and clutch during the phasing process just before each picture transmission.

The fork oscillator serves a single purpose of receiving. It generates an 1800-cycle signal, which is amplified to operate the synchronous motor at the same speed as the motor in the transmitting transceiver.

FACSIMILE TRANSCEIVER TT-41B/TXC-1B

Facsimile Transceiver TT-41B/TXC-1B is an electro-mechanical optical facsimile set of the revolving-drum type for the transmission and reception of page copy. It is used for transmission of maps, photographs, sketches and printed or handwritten text over regular voice communications channels, either wire or radio, between two or more stations. Colored copy may be transmitted, but all reproduction is in black, white and intermediate shades of gray. Received copy is recorded either directly on chemically treated paper, or photographically in either negative or positive form. The equipment will transmit or receive a page of copy 12 by 18 inches in 20 minutes at regular speed or in 40 minutes with half-speed operation. A block diagram of the overall equipment is illustrated in figure 8-23.

The complete electrical circuit of the transceiver and power unit may be subdivided into the following eight principal components: (1) fork oscillator unit, (2) photo cell bridge modulator, (3) signal amplifier circuit, (4) phasing circuit, (5) motor circuit, (6) B+ regulator circuit, (7) rectifier power supply, and (8) exciter lamp supply.

The fork oscillator unit (V1, V2, and V3) generates a highly stable 1800-cycle audio signal for distribution to the bridge modulator circuit, the motor amplifier circuit, and the exciter lamp circuit.

The bridge modulator circuit, built around a 5652 photo tube, V24, is used only on transmission. It amplitude-modulates the 1800-cycle signal in accordance with the variations in light intensity of the small portion of the transmitted copy being scanned at any instant.

The signal amplifier circuit (V10, V11, V12, V13, and V14) amplifies the 1800-cycle AM signal. On transmission the circuit is fed by the photo tube bridge modulator; the output goes to the line terminal and thence via auxiliary equipment to the radio transmitter. On reception the circuit is fed by the signal on the line from a radio receiver; the output drives either the stylus for direct recording or the recorder lamp for photo recording. The signal amplifiers are also used in the talk-back circuit.

The phasing circuit, V15 and V16, is used for phasing of the facsimile receiver before each transmission. A series of phasing pulses from the transmitter actuates a clutch mechanism, which positions the receiver drum so that the clamp bars of both drums (receiver) and transmitter) pass the scanning mechanisms at the same time. The clamp bars hold the copy to the drum (fig. 8-24).

The motor circuit (V4, V5, and V6, fig. 8-23) amplifies the 1800-cycle signal from the fork oscillator unit and drives the synchronous motor at constant speed. A multivibrator, V26, is used to provide half-speed operation of the synchronous motor.

The B+ regulator circuit (V7, V8, V9, and V25) provides a closely regulated voltage of 250 volts from the rectifier power supply of 250 volts. Regulated B+ voltage is used on critical transceiver circuits.

The rectifier power supply (V22 in the power unit) provides an unregulated 450-volt B+ output. The power unit also provides 6.3 volts a-c for filament operation and 115 volts a-c for starting the synchronous motor (not shown in the figure).

The exciter lamp supply (V17, V18, V19, V20, V21, and V23 in the power unit) amplifies and regulates the 1800-cycle signal from the fork oscillator unit to provide a constant amplitude,

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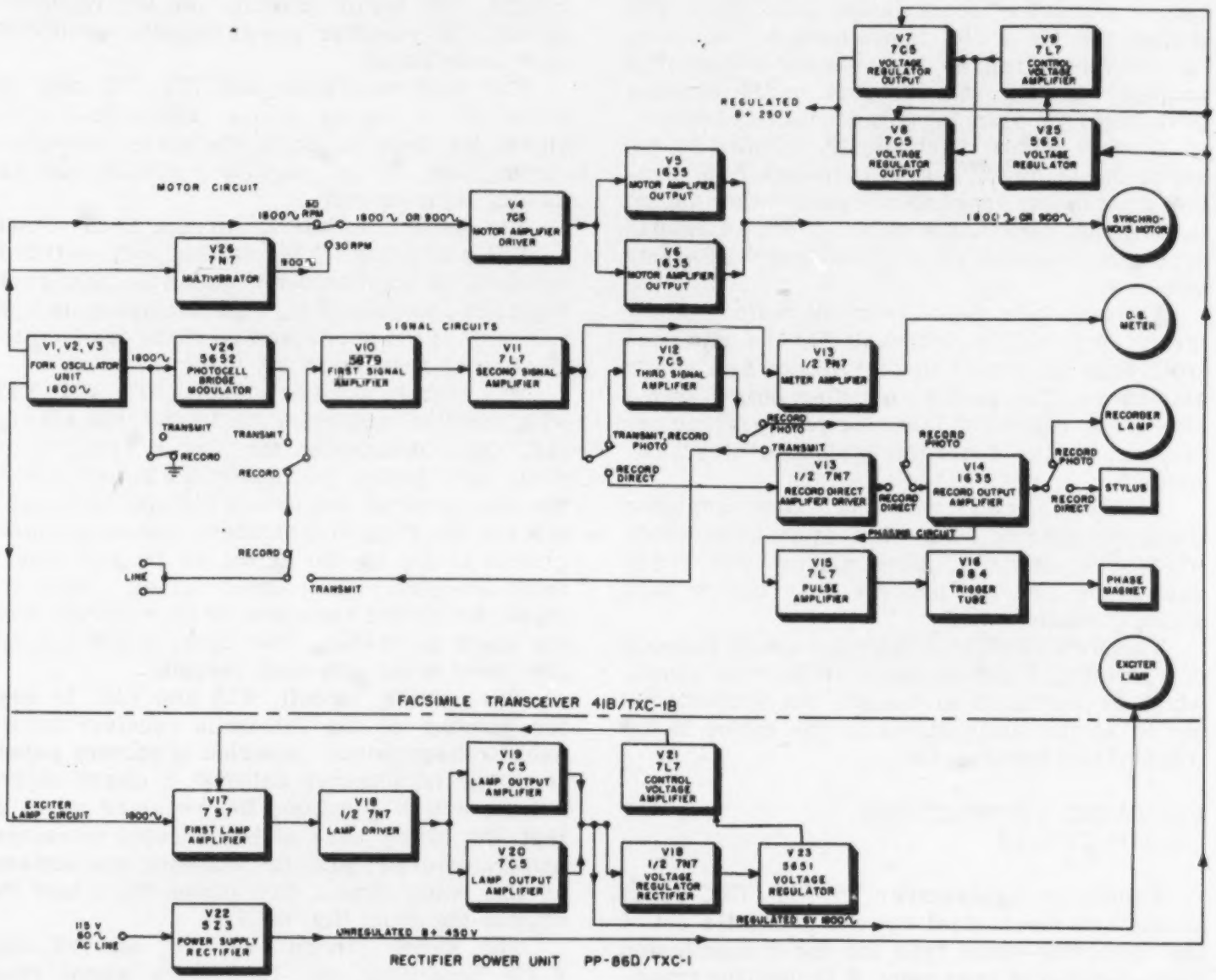

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Figure 8-23.—Block diagram of facsimile transceiver TT-41B/TXC-1B and rectifier power unit PP-86-D/TXC.

constant frequency signal for the transceiver exciter lamp, which illuminates the transmitter copy with a constant brilliancy.

All electrical operating controls of the facsimile transceiver, except the motor speed-control switch are located on the sloping front panel of the transceiver (fig. 8-25). The motor speed-control switch is located on the left end of the base of the transceiver. Two mechanical controls, the drum engaging lever and the clamp bar, are located on the drum. Input and output connections are located on the right-hand end of the transceiver. The power unit has no operating controls.

The power ON-OFF switch is located on the right-hand side of the control panel. It makes and breaks one side of the 11-volt, 60-cyle AC line circuit feeding the primary of the main power transformer located in the rectifier power unit. In the OFF position power is removed from all parts of the facsimile set. In the ON position plate and filament voltages are applied to all tubes, and power is available for starting and operating the synchroneous motor.

The selector switch located to the left of center on the front panel is the principal control for determining the function of the transceiver. It

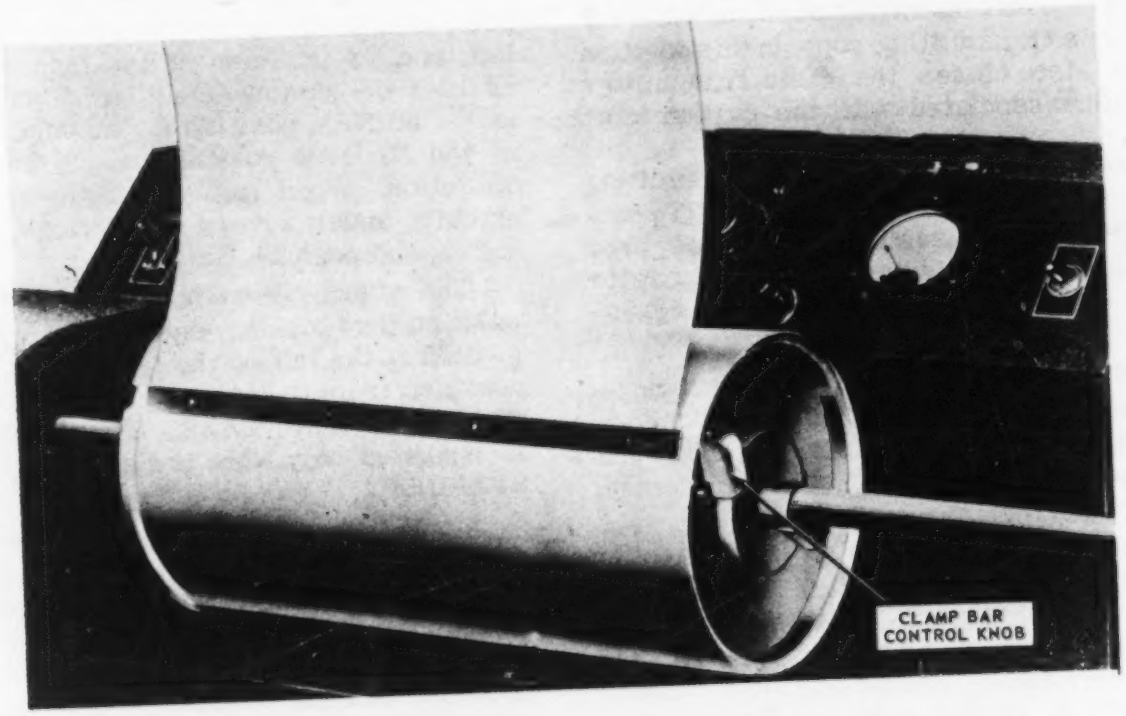

70.80

Figure 8-24.—Placing copy on drum.

has five positions, which are labeled (from top to bottom) TRANSMIT, SET RANGE, STANDBY, RECORD PHOTO, and RECORD DIRECT.

In the TRANSMIT position the facsimile transmitting circuit is established, and impulses representing elements of the facsimile

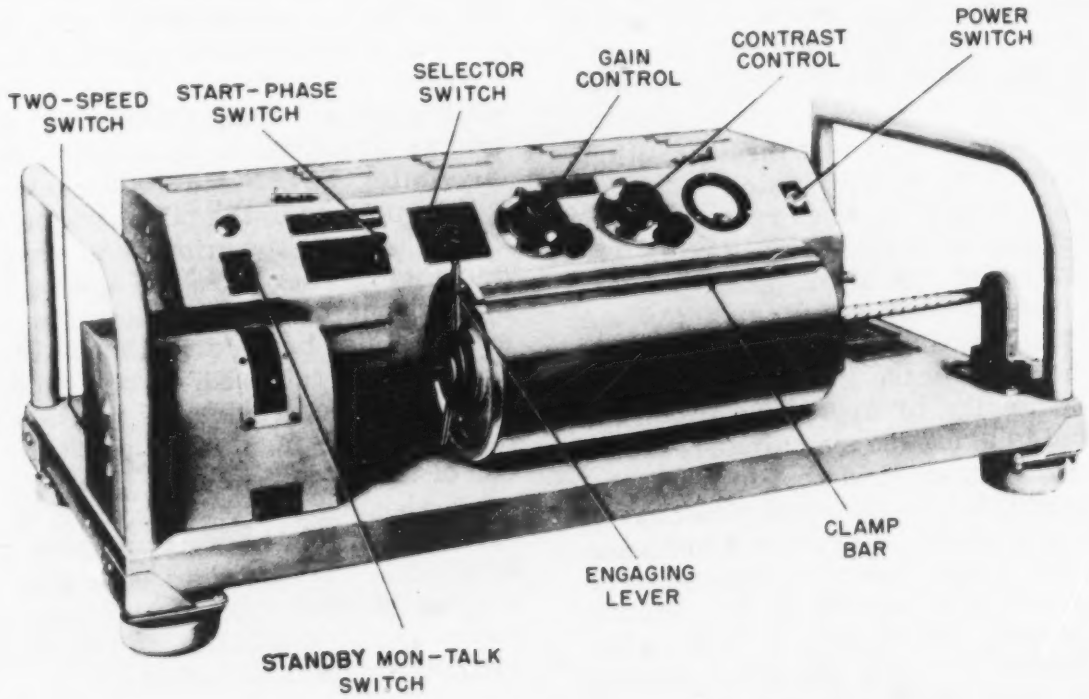

13.70

Figure 8-25.—Facsimile transceiver controls.

copy are sent out over the facsimile circuit. This is the normal operating position when the transceiver is transmitting copy. In this position the switch also closes the radio transmitter relay circuit associated with the carbon mike jack.

In the SET RANGE position the transmitting circuit is established as in the TRANSMIT position, except that impulses are not sent out over the line. This position is used when the operator is engaged in setting the contact range for transmitting a specific piece of copy.

In the STANDBY position the electron tubes are kept ready for operation of the transceiver. This is the normal setting during periods when copy is not being transmitted or received.

In the RECORD PHOTO position the receiving circuit is established to permit use of the recorder lamp for recording the received copy on photographic paper. This switch position is used to set the gain and to phase the receiving transceiver before recording either "photo" or "direct." A raised stud on the selector switch nameplate enables the operator to set the switch at record PHOTO by "feel" in the dark room.

In the RECORD DIRECT position the receiving circuit is established to permit use of the stylus instead of the recording lamp. The stylus causes recording of received copy on electrosensitive recording paper. Moving the selector switch to the RECORD DIRECT position mechanically moves the stylus into contact with the paper.

The start-phase switch is a three-position, nonlocking lever type switch, which is spring loaded to return to neutral when released from either the START or PHASE positions. The switch is located on the front panel between the selector switch and spare fuse for the motor. The transmitting and receiving operators throw the start-phase switch to the START position momentarily to apply power to the start motor and to bring the synchronous motor above the normal operating speed. When the switch is released, the synchronous motor slows down to its normal operating speed and continues to operate at that speed. The receiving operator throws the start-phase switch to the PHASE position to energize the phasing circuit of the receiving transceiver while the transmitting operator is sending phasing pulses. When the relatively short-phasing operation is completed, the machines remain synchronized.

The motor speed control switch is a three-pole, double-throw toggle switch located on the left end of the base of the transceiver to the rear of the motor cover (fig. 8-25). It is used in the 60 RPM position for normal operation or in the 30 RPM position to provide half-speed operation. When transmitting over long radio circuits under adverse conditions, the 30 RPM half-speed position can be used.

The standby-mon-talk switch is a three-position (two locking, one nonlocking) key switch located at the left on the front panel. The three position, from the top to the bottom, are labeled STANDBY, MON, TALK. The talk-back circuit is operated only when the selector switch is on STANDBY.

In the STANDBY position, with a speaker plugged into the speaker jack, the speaker will be connected in the circuit and the operator can monitor the communication channel. If the standby mon-talk switch is in the STANDBY position, and the selector switch is also in the STANDBY position, the synchronous motor will not operate. This position is used to receive voice communications when it is not necessary to have the motor running.

In the MON position, with a speaker plugged into the speaker jack, the speaker is also connected and the operator can monitor the communication channel. In this position, however, the motor receives power and can be started and run at synchronous speed. This is the normal position for receiving voice communications, when phasing transmitting and receiving equipments, preparatory to sending and receiving facsimile copy. Some 1800-cycle interference will be noticed in the talk-back circuit.

In the TALK position, with a speaker plugged into the speaker jack, the speaker becomes the microphone of a voice intercom system. The switch must be held in the TALK position; if pressure is released, it will snap back to the MON position. The TALK position is used when talking to the facsimile operator on the other end of the circuit.

It should be noted that the talk-back circuit only operates when the selector switch is at STANDBY. Voice communications cannot be carried on over this circuit when the selector switch is at TRANSMIT, SET RANGE, RECORD PHOTO, or RECORD DIRECT.

It should also be noted that the talk-back circuit will not function over a radio circuit that uses auxiliary radio equipment unless the

auxiliary equipment is bypassed for voice communications.

The contrast control is a calibrated potentiometer located to the left of the db meter on the front panel of the transceiver; it adjusts the contrast range (difference between minimum and maximum signal strength) of the transmitted signal by adjusting the magnitudes of the currents in the photo-tube bridge circuit. This control is operated only by the transmitting operator. The dial on this control is numbered from 1 to 100, with the applicable ranges for use when transmitting either positive or negative indicated on the dial.

The contrast control may be used to balance the bridge in the photo-cell bridge modulator (V24, fig. 8-23) either on maximum light (white) or on minimum light (black). In either case when the bridge is balanced, the output signal has a minimum amplitude. Thus, if the contrast control is adjusted so that the bridge is balanced when the light is a maximum, the output signal will have minimum amplitude on white and maximum amplitude on black. This type of transmission is called positive transmission. When the bridge is balanced on minimum light, the output signal will have minimum amplitude on black and maximum amplitude on white. This type of transmission is called negative transmission.

The gain control, located between the contrast control and the selector switch, is a dual potentiometer, which serves to control the level of the signal handled by the transceiver both in transmitting and receiving. It does not change the contrast range.

The front panel db meter, which serves as a guide in setting gain and contrast controls, is calibrated in db with reference to a zero-power level of 6 milliwatts in 600 ohms.

To turn the transceiver on, throw the power on-off switch to ON and turn the selector switch to SET RANGE. Normally a 5-minute warmup period should be allowed before making adjustments or actually transmitting.

To place copy on the drum, raise rear edge of clamp bar (fig. 9-24) by turning the clamp-bar control knob to its clockwise position. Place the lower edge of the copy (face up) under the rear edge of the clamp bar. Turn the knob to its counterclockwise position, thus closing the clamp on the leading edge of the copy and opening the other clamp. Revolve the drum forward, wrapping the copy around the drum. Insert the loose edge of the copy under the clamp; pull the copy tight around the drum with a wiping motion of the hand, and close the clamp by turnng the clamp-bar control knob back to its center position. Examine the copy after it is placed on the drum to make sure there are no bulges.

The following adjustments (fig. 8-25) should be made for transmitting positive for direct recording:

1. Turn selector switch to SET RANGE.
2. As a starting point, set the gain control at 65 and the contrast control near zero.
3. Turn the drum so that the whitest portion of the copy is illuminated by the spot of light. Carefully turn the contrast control to a higher setting until the meter reads the required minimum. Check the meter reading and move the drum slightly backward and forward while examining a different white portion of the copy to be sure that the whitest spot is used. For radio operation, the required minimum will depend on the type of auxiliary equipment being used with the radio transmitter. The wire line minimum (1/16 inch below the -10 calibration mark on the db meter) is recommended.
4. Move the drum so that the blackest portion of the copy is illuminated by the spot of light. Be sure that the blackest portion actually is used by again rotating the drum slightly backward and forward while checking the meter.
5. Adjust the gain control so that the meter reads +2 DB.
6. Shift back to the whitest portion of the copy and readjust the contrast control for a minimum reading of -10 DB on the meter.
7. Repeat steps 4, 5, and 6 until the final adjustments of the gain and contrast controls give meter readings, differing by at least 12 DB between the blackest and whitest portions of the copy.

Adjustments for transmitting negative are not given here in the interest of brevity but may be obtained by referring to the appropriate technical manual.

The transmission of facsimile signals by amplitude modulation on the radio channel ordinarily results in a change in the loudness or levelness of the received signals with fading. If fading occurs, streaks or level changes will appear, in the record picture. Therefore it is desirable to transmit a type of signal over radio circuits whose amplitude when demodulated, at the receiving station will be independent of changes in the volume or level of the radio signal. This action may be accomplished by a

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frequency shift of the signal in which different picture values are represented by different frequencies. Because the facsimile transceiver generates an amplitude-modulated signal in transmitting and the recorder is designed to operate on an amplitude-modulated signal, picture signal conversion equipment is necessary between the facsimile transmitter and the radio transmitter, and between the radio receiver and the facsimile recorder.

The TT-66( )/TXC facsimile transceiver, not shown, is a newer transceiver that performs the same functions as the TT-41B/TXC-1B. Because they have different operating speeds, however, the two transceivers are not compatible. The newer set has selectable operating speeds of either 90 RPM or 45 RPM, whereas the older equipment operates at either 60 RPM or 30 RPM.

The components of two radio facsimile transmission systems (fig. 8-26, B) will be described in the following portion of this training course. The first system employs audio frequency=shift (AFS) keying (normally short range) and includes one auxiliary unit between the facsimile transmitter and the radio transmitter. This unit is the modulator, radio MD-168/UX. The other system is carrier frequency-shift (CFS) keying (long range), and includes two auxiliary units between the fascimile transmitter and the radio transmitter. These units include Keyer Adapter KY-44A/FX and Frequency-Shift Keyer KY-75/SRT. (Only the Keyer Adapter will be required if the Frequency Shift Keyer is built into the radio transmitter.)

Modulator, Radio MD-168/UX

Modulator, Radio MD-168/UX (fig. 8-27) is designed to convert amplitude modulated facsimile signals from a facsimile transmitter (for example, Facsimile Transceiver TT-41B/TXC-1B acting as a transmitter) to audio frequency-shift facsimile signals of 1500 to 2300 cycles suitable for modulating a radiophone transmitter.

A block diagram of the modulator is illustrated in figure 8-28. Basically, the unit consists of a preamplifier; a keyer (detector); a variable-frequency, phase-shift oscillator; a

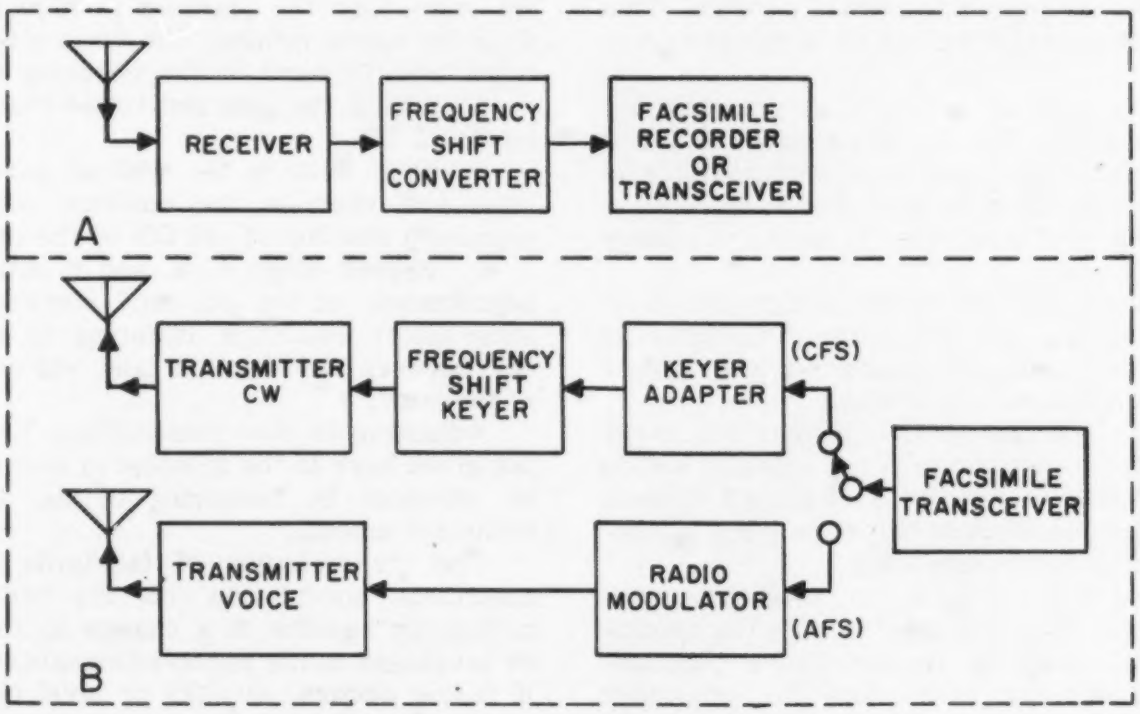

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Figure 8-26.—Radio facsimile systems.

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Figure 8-27.—Modulator radio MD-168/UX.

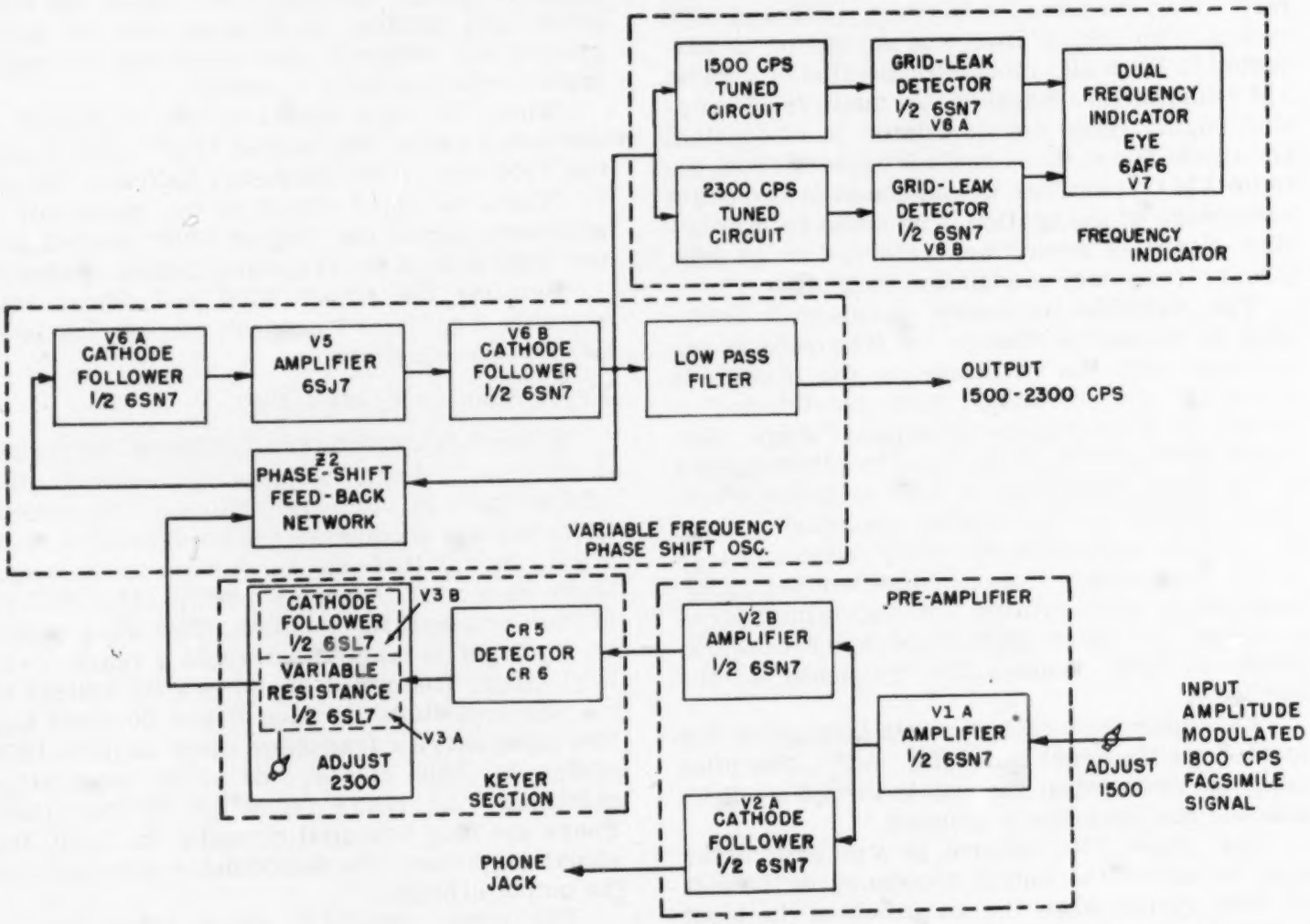

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Figure 8-28.—Block diagram of modulator radio MD-168/UX.

frequency indicator; and a power supply (not shown). The amplifier increases the received facsimile signal to the proper level for operating the phase-shift oscillator and a pair of earphones. The input signal to the modulator may be monitored by using the phone jack. The frequency limits of the output signal may be monitored by means of a dual-type, tuning-eye indicator.

The input signal to the modulator has a frequency of 1800 cycles and an amplitude that varies in accordance with the light and dark segments of the picture being scanned at the facsimile transmitter.

The output signal from the modulator is an audio signal in which 1500 cycles represent the maximum signal input (in amplitude) and 2300 cycles represent the minimum signal input (in amplitude) to the modulator from the facsimile transmitter. Amplitudes between maximum and minimum signals are changed to corresponding frequencies between 1500 and 2300 cycles. The output from the modulator is connected to the audio modulator section of a radio AM transmitter. Because the audio frequency-shift signal from the modulator is of constant amplitude the emitted radio frequency from the radio AM transmitter is modulated at a constant percentage of modulation. The audio frequency-shift signal is sometimes referred to as subcarrier-frequency modulation (SCFM).

The variable-frequency, phase-shift oscillator is caused to change its frequency in accordance with the variations in the magnitude of the DC output voltage from the detector by means of a reactance modulator stage. The phase shift network is so connected that changes in the plate resistance of the reactance modulator (caused by the varying magnitude of the DC voltage applied to its grid) cause a change in the time constant of one branch of the oscillator phase shift network. This action introduces a change in phase shift through the network, which in turn changes the frequency of the oscillator.

The operating controls and indicators are located on the front panel (fig. 8-27). The pilot lamp operates when the set is turned on. Both sides of the powerline are fused.

The adjust 2300 control is a potentiometer used to adjust the output frequency of the unit to 2300 cycles when the amplitude of the input facsimile signal is a minimum.

The adjust 1500 control is a potentiometer used to adjust the output frequency of the unit to 1500 cycles when the amplitude of the input facsimile signal is a maximum.

The 2300-1500 frequency indicator is used to indicate the proper frequency limits of the output audio frequency-shift signal. The left half of the indicator closes when the output signal has a frequency of 2300 cycles and the right half closes when the output signal has a frequency of 1500 cycles.

The gain of the amplifier is such that when the adjust 1500 control is set at the proper position, the audible level at the earphones will be a comfortable level.

When the power ON-OFF switch is in the OFF position, power is removed from the entire unit.

When operating the unit, throw the power switch on and allow a 5-minute warmup period.

Turn the adjust 1500 control to the extreme clockwise position. When an incoming signal is being received, the 2300-1500 tuning eye indicator will flicker; monitoring with the headphones will indicate when maximum and minimum levels are being received.

When the input signal to the modulator is maximum adjust the "adjust 1500" control until the 1500 side of the frequency indicator closes.

When the input signal to the modulator is minimum, adjust the "adjust 2300" control until the 2300 side of the frequency indicator closes.

Because the adjust 2300 and adjust 1500 controls are interdependent, repeat the preceding two adjustments.

Keyer Adapter KY-44A/FX

Keyer Adapter KY-44A/FX (fig. 8-29) is used to provide DC keying signals for frequency-shift exciter units in radio transmitters. The input is an amplitude-modulated, audio-frequency, facsimile signal that may be similar to the output from Facsimile Transceiver TT-41B/TXC-1B in the transmitting position. The input signal level should be maintained within a range of -20 to +6 DBM. The output signal is a DC voltage of varying amplitude between 0 and 20 volts DC. The input carrier frequency range is from 1500 cycles to 7000 cycles, while the modulation sidebands can range from 100 to 7000 CPS. There are four essential circuits: the input, the signal amplifier, the demodulator circuits, and the output circuits.

The power ON-OFF switch turns the set completely on or off. A preliminary warmup period of a few minutes should be allowed before using the set.

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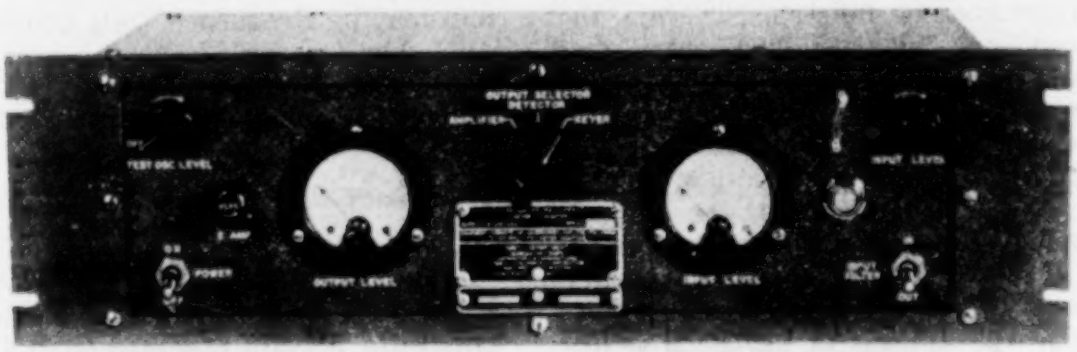

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Figure 8-29.—Keyer adapter KY-44A/FX.

The test osc. level control is used for alignment of the unit, and to set the frequency shift keyer. Setting the level control to 12V will shift the FS keyer to mark, a zero setting will present a space signal to the keyer (such as KY-75/SRT). This control should be in the OFF position for normal operation.

The input-filter IN-OUT switch should be in the IN position only when receiving frequencies in the range of 900 to 2500 cycles and when signals are noisy. The switch should be in the OUT position for all other input frequencies.

The output selector switch determines the type of output from the unit. In the AMPLIFIER position the unit becomes a linear amplifier. In the DETECTOR position the unit becomes a detector with the carrier still unfiltered from the detected envelope. The output level meter reads average DC values. The KEYER position converts the unit into a detector with the carrier removed to provide only the DC keying signals.

FREQUENCY-SHIFT KEYER KY-75/SRT.—Frequency-shift keyer KY-75/SRT was discussed previously with teletype equipment. Some common operating adjustments for photo transmission are listed below.

1. Set the test operate switch at PHOTO. In this position the limiting (V-101 and V-102, fig. 8-5) and waveshaping circuits are not used.

2. Set the crystal-oscillator switch at the position corresponding to the socket position of the crystal providing the desired channel frequency.

3. Set the freqency range switch to the desired output frequency of the keyer. This frequency is the sum of the crystal frequency and the 200 KC frequency from V-107.

4. Set the input filter switch at PHOTO.

5. Set the multiplier switch at the position corresponding to the frequency multiplication factor employed in the transmitter. For example, if the multiplcation factor is 8, the switch should be set at "X8."

6. Set the phase-modulation control at OFF (extreme counterclockwise position).

7. Set the metering switch at GRID.

8. Unlock the tuning control. Set the tuning control at a setting corresponding to the keyer output frequency and carefully adjust it about this setting for a maximum meter reading. A normal reading is about 1.5 MA (actual meter reading 0.5 MA). Lock the tuning control.

It will be noticed that two current peaks are observed on the panel meter. These peaks correspond to the resonant peaks for the lower sideband, and the upper sideband, respectively. The tuning control is normally set at the position that corresponds to the upper sideband resonant peak.

9. Set the metering switch at PLATE.

10. Release the lock on the output tuning control. Adjust the output tuning control for minimum plate current, as indicated on the meter.

11. Release the lock on the output level control. Set the output level control for the maximum grid drive required to drive the first amplifier or multiplier stage of the transmitter, as indicated by a maximum reading on the grid meter of the associated transmitter.

Care should be taken in this adjustment because if the tuning range is located near the lower markings on the tuning dial it is possible that a dip may also be obtained in the plate current near the higher markings of the dial due to the second harmonic of the keyer frequency.

12. Set the deviation control at the desired deviation. This control functions to vary the amount of frequency deviation. The control dial has a multiplication factor of 100 for FSK operation and 200 for photo operation.

In normal operation the deviation control is adjusted to obtain the desired deviation, as read directly on the calibrated dial of the control. After the multiplication factor employed in the transmitter is determined, the multiplier switch is set at a position corresponding to this factor. In this manner the amount of deviation is determined and held constant despite any ensuing multiplication in the transmitter. Fine adjustment of the shift may be checked on a receiver test setup, by varying the KY44A/FX test. oscillator level control from 12 V to OV and reading the total shift of the keyer (900 cycles for photo).

FACSIMILE RECEIVING EQUIPMENT

To receive radio facsimile signals of either radio carrier frequency-shift transmission or audio frequency-shift transmission, conventional superheterodyne receivers may be used. With either system, the signal output of the radio receiver is an audio frequency-shift signal in which 1500 cycles represent the maximum signal and 2300 cycles represent the minimum signal output from the facsimile transmitter at the sending terminal.

In order to convert the audio frequency-shifted signal output of the radio receiver into an amplitude-modulated signal suitable for operation of a facsimile recorder or transceiver, an additional unit must be interposed between the receiver and the recorder (fig. 8-26, A). This unit may be Frequency Shift Converter CV-172-A/U. The facsimile recorder may be similar to Facsimile Recorder RD-92A/UX or the previously discussed transceiver TR-41B/TXC-1B.

Frequency-Shift Converter CV-172A/U

Frequency-Shift Converter CV-172A/U (fig. 8-30) is used to convert 1500- to 2300-cycle facsimile signals received from a radio circuit to AM signals suitable for operating a facsimile recorder (for example, Facsimile Recorder RD-92A/UX). The unit contains provision for audible monitoring of the incoming signal and for visual checking of the frequency limits.

Another method that may provide for even more reliable tuning is to turn off the auxiliary oscillator and tune slowly through the frequency-shift signals. As the signals are approached from one side a thumping sound will be heard. Continuing to rotate the tuning dial slowly in the same direction will cause this sound to disappear almost completely and then to reappear again before it disappears on the other side of the signal. The proper tuning position corresponds to the quiet zone between the two thumping sounds.

Satisfactory frequency-shift reception may be obtained with high stability radio receivers without the need for an auxiliary oscillator provided the receivers are properly tuned. If the converter and BFO have been sufficiently stabilized, the BFO can be used as the heterodyne oscillator to provide the audio frequency

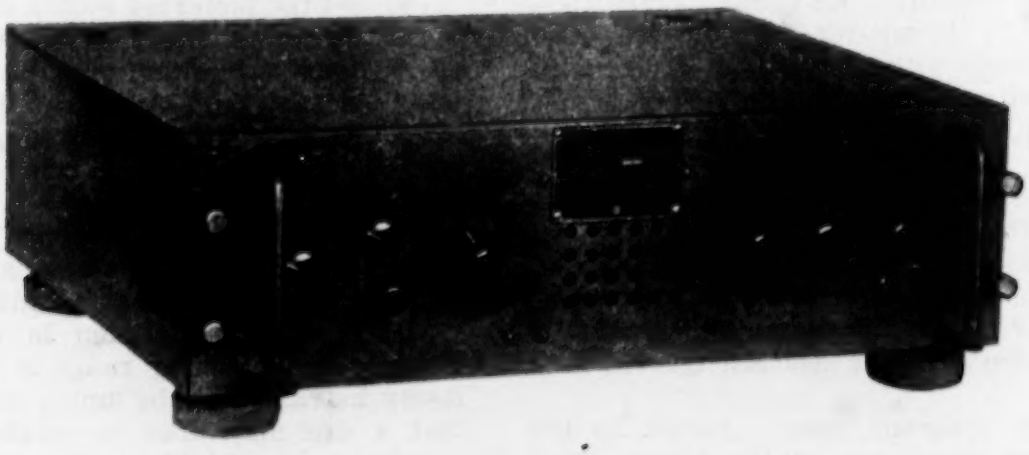

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Figure 8-30.—Frequency-shift converter CV-172A/U.

output. Turn off the BFO before making the tuning adjustments. After the proper tuning adjustments are made, as previously described, turn on the BFO and vary its control for the proper audio frequency output (1500 to 2300 cycles) from the radio receiver. Do not change the receiver tuning to vary the audio frequency.

The ET who is familiar with tuning c-w radio signals has observed that a-f or tone output from the radio receiver changes as either the main tuning dial or the BFO control is moved. Thus it is possible to have the right sense of signals (no inversion) and still not be tuned properly for optimum results. Improper tuning results in an inferior signal-to-noise ratio and may cause broadening of lines or multiple images somewhat similar to those caused by multipath transmission of the radio signals.

The facsimile signal obtained from the radio receiver is fed through an amplifier and filter to a limiter and then through a frequency discriminator (fig. 8-31). The output of the amplifier is controlled by an input level control potentiometer to adjust the signal level to the limiter. A loudspeaker with a separate volume control connects to the output of the line amplifier. This output also feeds two tuned circuits resonated at 1500 and 2300 cycles respectively to operate a tuning eye frequency indicator.

The input signal from the radio receiver is an audio frequency-shift signal in which 1500 cycles represent black and 2300 cycles represent white for the RD-92A/UX recorder. The discriminator is a low-pass filter having a cutoff frequency of 1500 cycles. The output from the filter at 2300 cycles can be adjusted to be from 10 to 20 DB lower than the output at 1500 cycles. Thus, the input signal to the coverter is changed from an a-f-s signal of substantially constant amplitude to an output signal of varying amplitude in which the maximum amplitude (corresponding to 1500 cycles) is 10 to 100 times the minimum amplitude (corresponding to 2300 cycles).

To operate the frequency-shift converter, turn the input level control clockwise (fig. 8-30). This action applies power to the unit. Allow a few minutes warmup time.

Adjust the input level and volume controls fully clockwise until a signal is received.

When a signal is received, adjust the input level control until the speaker does not distort. (Distortion exists when there are overtones.) This adjustment provides sufficient level to operate the limiter.

Adjust the volume control for a convenient speaker level.

When a 1500-cycle signal is being received, the "1500" tuning eye will close and the output will be the maximum signal level for the facsimile recorder. Also, when a 2300-cycle signal is being received, the "2300" tuning eye will close. The difference in output levels will depend upon the trimmer control (not shown), which provides a variable-resistance bypass around the discriminator circuit.

When the radio receiving equipment is properly adjusted, the tuning eye indicators will show that 1500- and 2300-cycle signals are being fed to the input of the frequency-shift converter. When a copy that has mostly background is being received, the high stability radio receiver output may be adjusted by changing the BFO frequency to close the tuning eye corresponding most closely to the background signal frequencies.

The CV-172 A/U is not the only frequency shift converter used by the Navy in facsimile installations, but it is the one most commonly found aboard ship. Others you may encounter are models CV-97/UX and the CV-1066/UX. They all perform the same function.

Facsimile Recorder RD-92A/UX

The output of Frequency-Shift Converter CV-172A/U may be fed to Facsimile Recorder RD-92A/UX (fig. 8-32) to make recordings of copy transmitted by Facsimile Transceiver TT-41B/TXC-1B (previously described) or equipment having the same transmission characteristics. The facsimile recorder is a self-contained unit comprising an amplifier-power supply chassis and four plug-in assemblies. The assemblies (fig. 8-33) are: (1) the audio frequency oscillator, (2) the amplifier detector, (3) the amplifier modulator, and (4) the recorder subassembly. A circuit test switch mounted on the front panel provides means for quickly testing all important circuits. Neon light indicators across individual fuses and tube heaters instantly indicate a blown fuse or burned out tube heater filament.

Facsimile Recorder RD-92A/UX performs its functions of recording pictures, drawings, or messages by rotating a drum at a constant speed, while feeding a stylus needle along the drum, one scanning line for each revolution until the complete drum has been covered. This function is performed by means of three

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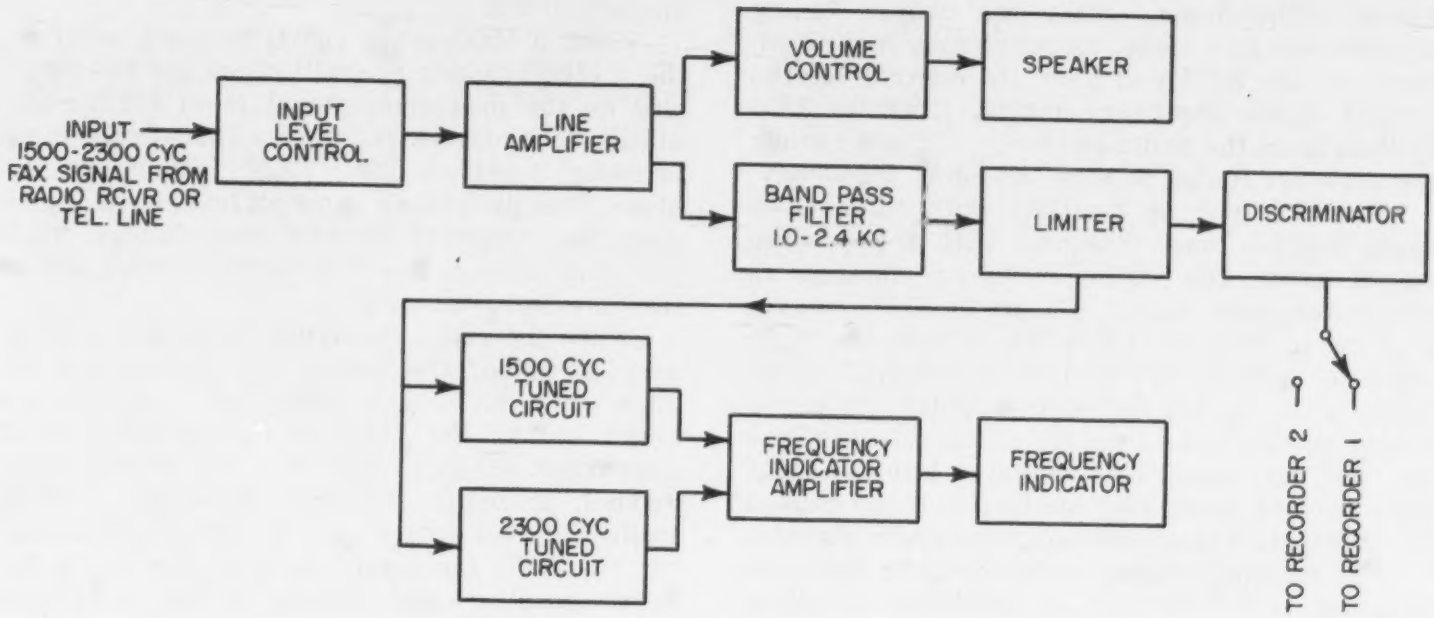

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Figure 8-31.—Block diagram of frequency-shift converter CV-172A/U.

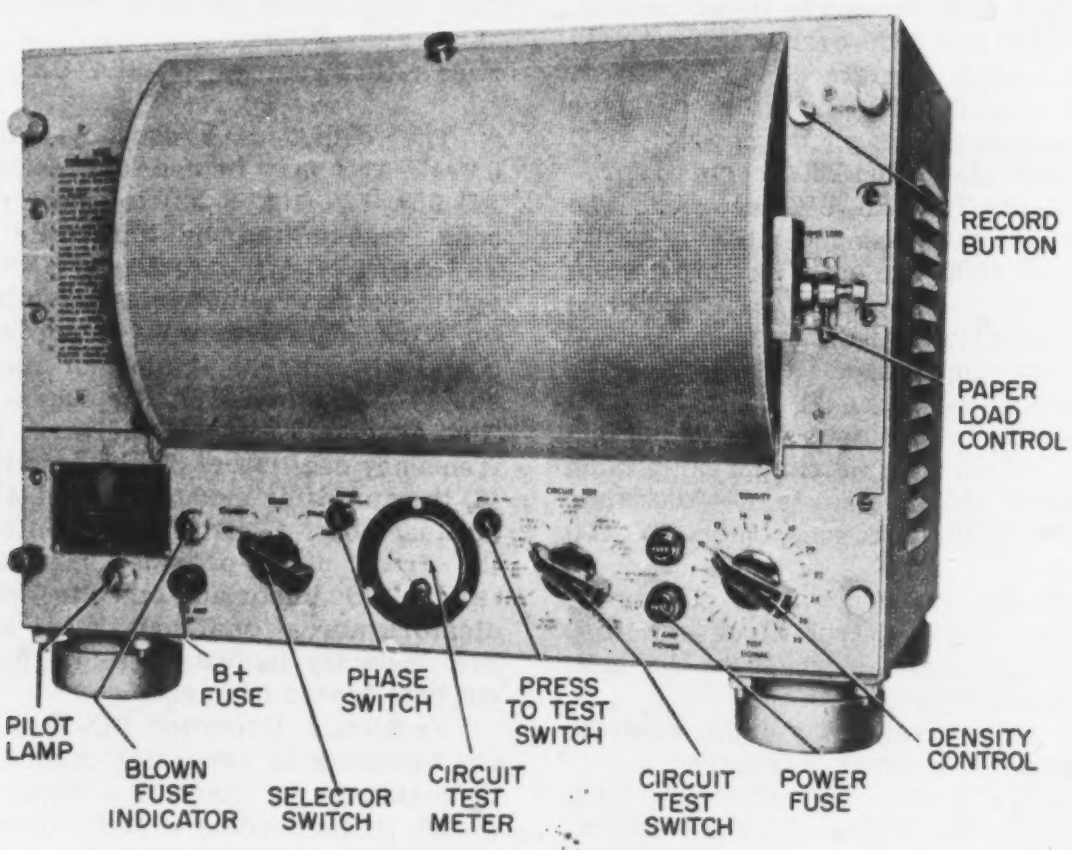

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Figure 8-32.—Facsimile recorder RD-92A/UX.

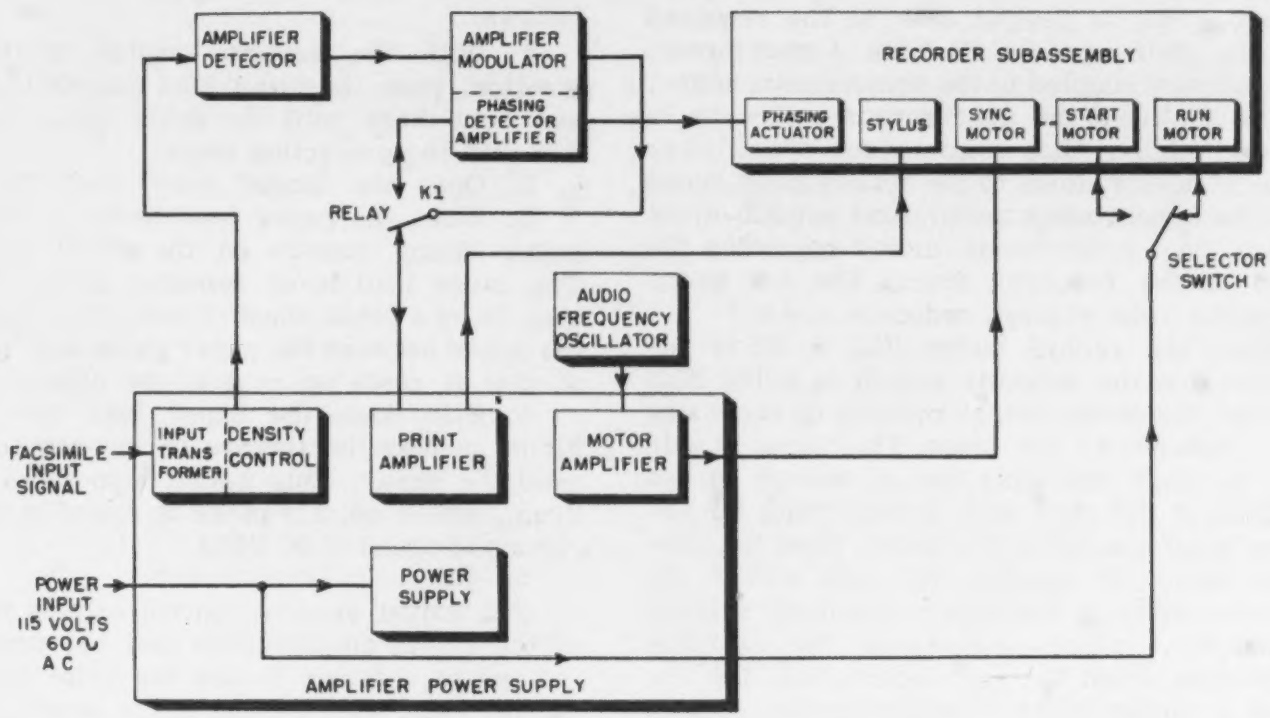

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Figure 8-33.—Simplified block diagram of facsimile recorder RD-92A/UX.

motors and suitable gears and mechanical linkages contained within the recorder subassembly. The power, signal, and phasing currents for proper operation of the recording mechanism are obtained from the outputs of the electronic subassemblies.

The amplifier-detector unit (fig. 8-33) receives the input facsimile signal. This signal, consisting of phasing pulses and facsimile intelligence between the frequency limits of 900 and 2700 cycles, is amplified by a class A amplifier and demodulated through the action of a full-wave rectifier and low-pass filter to form a varying DC facsimile signal.

The varying DC facsimile signal output of the amplifier-detector unit is coupled to the amplifier modulator subassembly where it combines with a signal from a 15 KC oscillator in a modulator stage. The 15 KC output of the modulator varies with the amplitude of the d-c facsimile signal. The resulting modulated signal connects through the normally closed contact of relay K1 to the print driver and amplifier in the amplifier-power supply assembly.

The signal from the amplifier modulator unit is amplified by the print driver and amplifier to sufficient intensity, so that, when connected to the stylus needle in the recording mechanism assembly, it will record on the recording paper points representing varying shades of dark elements of the transmitted copy.

For phasing pulses, relay K1 is operated to transfer the signal from the amplifier modulator to the phasing detector and amplifier, located in the amplifier-modulator subassembly. The phasing pulses, which are transmitted at the beginning of each copy, are amplified to operate the phasing actuator in the recorder subassembly.

The phasing actuator, on receiving the phasing pulses, releases the stop bar on the synchronous-drive mechanism in the proper position to frame the recorder drum with the drum of the facsimile transmitter.

The AF oscillator generates an 1800-cycle signal which is amplified by the buffer amplifier (not shown) and motor amplifier in the amplifier-power supply assembly and the coupled to the recording mechanism assembly to operate the synchronous motor. The 1800-cycle signal also connects to the test signal position on the density control (fig. 8-33), where it is available for connection to the input of the signal amplifier for testing the various circuits with the circuit test switch.

The synchronous motor, rotating at a speed of 1800 RPM, is geared down to the required recorder drum speed of 60 RPM. A start motor, mechanically coupled to the synchronous motor, serves to bring the synchronous motor up to a speed higher than synchronous speed after which it coasts down to the synchronous speed when the synchronous motor runs on 1800-cycle power. The synchronous motor regulates the speed of the recorder drum. The run motor drives the drum through reduction gears.

When the record button (fig. 8-32) is depressed and the selector switch is in the RUN position, the stylus needle records on recording paper fastened to the drum. The stylus is held in a carriage assembly that is moved across the drum to the right when engaged with a lead-screw shaft geared to the drum. When the carriage assembly reaches the right end of the recorder paper, it operates an automatic release mechanism, which disengages the carriage mechanism from the lead screw and lifts the stylus from the paper. A return spring, located in the left side gear box, then pulls the carriage back to the left side of the drum so that it will be ready for the next copy.

OPERATING ADJUSTMENTS—To operate Facsimile Recorder RD-92A/UX (fig. 8-32) proceed as follows:

1. Turn the selector switch to the STANDBY position. Note that the pilot light lights up, indicating that power is being applied to the recorder. Wait about 1 minute for the tubes to warm up. The recorder may be left at STANDBY While waiting for a transmission so that the set is ready for immediate operation.

2. Turn the selector switch to the START position. Wait about 5 seconds for the start motor to bring the synchronous motor above synchronous speed.

3. Turn the selector switch to the SYNC position. Wait until the synchronous motor coasts down, then locks in synchronous speed. This is distinguished by a distinctive high-pitch tone.

4. If the motor does not lock in but falls below the synchronous speed, switch back to the START position and repeat steps 2 and 2. If the motor does not come down to synchronous speed, turn to STANDBY and allow the motor to stop. Omit step 2 and switch directly to the SYNC position.

5. Turn the selector switch to the RUN position. It is necessary for the drum to rotate into the proper position for loading the paper.

To load paper on the drum, proceed as follows:

1. With the selector switch in the RUN position, push the paper load control to the left and hold there until the drum stops rotating. Then lift the projecting lever.

2. Open the hinged cover over the drum.

3. When the paper load lever is lifted, the paper clamp fingers on the drum will open. The paper load lever remains in the UP position. Drop a fresh sheet of recording paper into the space between the paper guide and the drum so that it rests up against the clamp fingers.

4. Flip down the paper load lever. This action causes the fingers to close quickly and grab the paper. This action also releases the drum, which quickly picks up speed to the synchronous speed of 60 RPM.

5. Close the hinged cover.

The adjust density control affects the gain of the signal amplifier so that the proper d-c voltage is obtained to key the print oscillator circuit. Incorrect setting of the density control may result in faulty recording. Proceed as follows:

1. Set the density control when facsimile signals are being received. When steady signals of maximum signal level are received, preferably on phasing signal, start near zero and advance the control to the lowest point that gives maximum reading on the meter on the front panel. This reading is normally about 100.

2. In some types of copy it is desirable to advance the dial setting of the density control slightly beyond the point that gives a maximum meter reading. Try this procedure if the copy is too light.

3. Leave the density control at the setting that gives the best recording.

The phasing operation is performed with the recorder drum stationary. Phasing pulses may be identified by a downward dip of the meter pointer occurring once a second. To phase the recorder proceed as follows:

1. Switch to the SYNC position and wait for the drum to stop.

2. Turn the phase button to LOCAL.

3. When phasing pulses are received, depress the phase button and hold depressed for five pulses. While phasing, two clicks per second are usually heard; one when the phasing actuator trips, and another when the stop bar passes the drum drive coupler. Press and hold for 5 meter pulses.

4. Turn the selector switch to the RUN position. The drum will rotate in the properly phased position.

5. Press record button when the copy starts. This is indicated by a change in meter pulses. Usually the meter reading drops down to about zero and flicks upward instead of downward. The stylus now feeds across the drum to print the copy, and releases automatically at the end of travel.

If it is desired to take less than a complete copy, release the stylus by (1) turning the selector switch from the RUN to SYNC position, or (2) operating the paper load lever. The stylus returns automatically to the left-hand end of the drum when it is released.

Facsimile Recorder Set AN/UXH-2

Facsimile Recorder Set AN/UXH-2 (fig. 8-34) is a continuous page recorder designed to make direct recordings transmitted over land wires or radio. The set is designed to operate at 60, 90, or 120 scans per minute. When receiving from a transmitter with the proper signals, the unit will automatically phase start recording at the beginning of a transmission, stop when the transmission is complete, and compensate for changes in signal level during the recording. When this automatic operation is utilized the set may be left unattended. Manual operation may be utilized when the transmitting station is not equipped to transmit the necessary control signals for automatic operation.

The AN/UXH-2 consists of three major assemblies: (1) Recorder RO-76/UXH-2, (2) Power Supply PP-1901/UXH-2, and (3) Electrical Control Amplifier AM-1845/UXH-2.

Recorder RO-76/UXH-2

The recording mechanism consists of the SYNC system, run system, stylus and base assembly, and paper feed system. The synchronous (SYNC) motor (fig. 8-35) is brought up to speed by a split-phase induction start motor (not shown). The SYNC motor is then supplied with power by a fork-controlled oscillator circuit, and operates at a synchronous

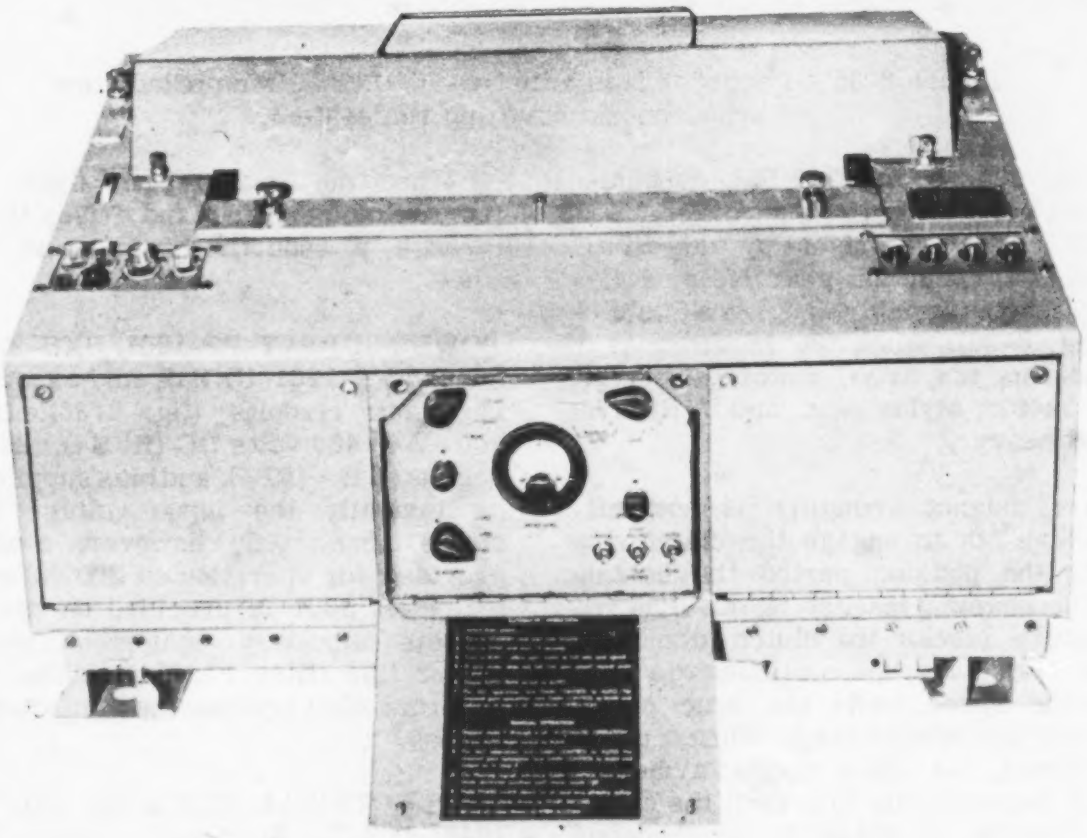

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Figure 8-34.—Facsimile recorder set AN/UXH-2.

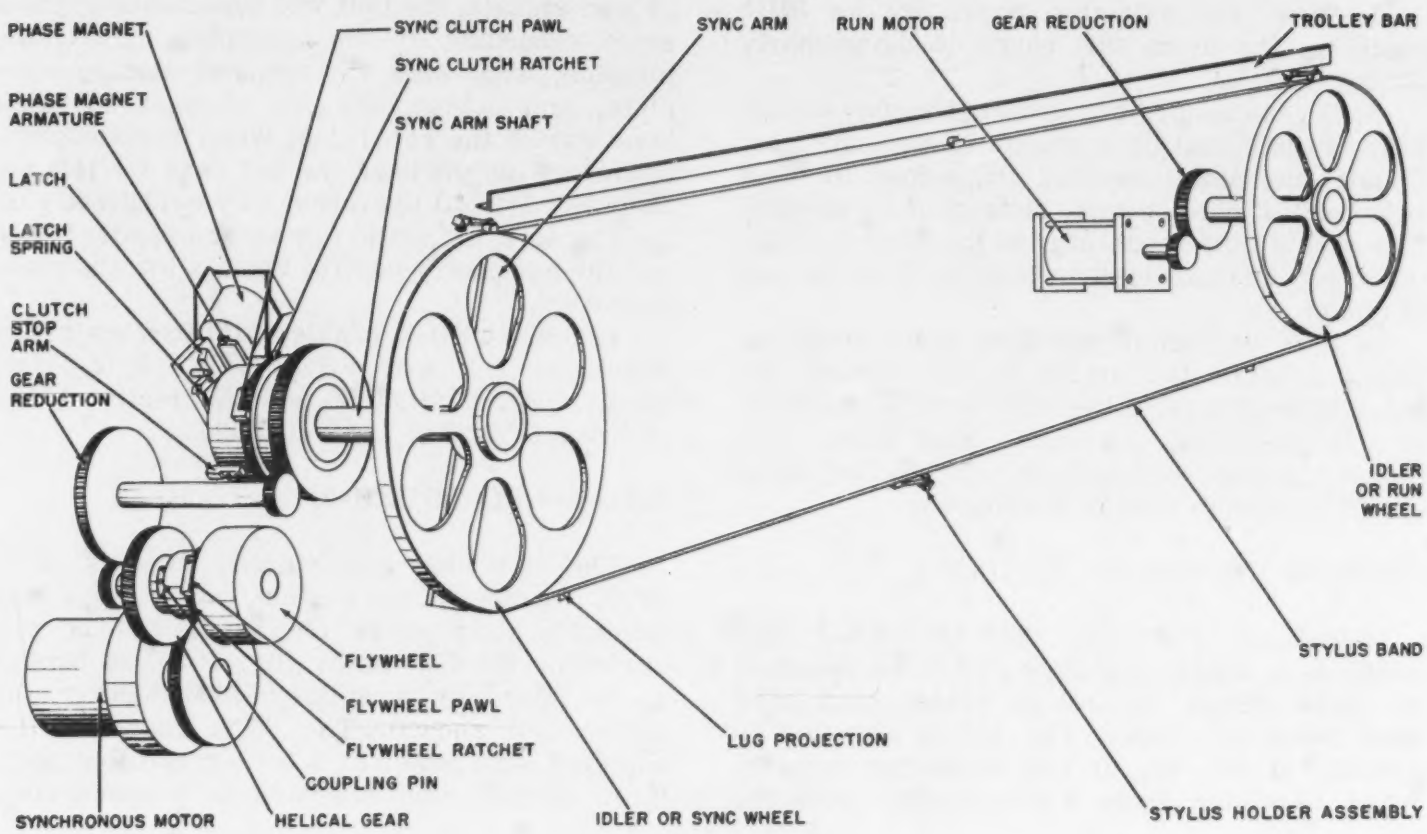

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Figure 8-35.—Recorder facsimile RO-76/UXH-2, simplified view of synchronous drive and run system.

speed of 600, 900, or 1200 RPM, depending upon the scans per minute to be recorded.

The SYNC shaft is driven by the SYNC motor through a reduction gear train, a flywheel and ratchet assembly, and SYNC clutch assembly (fig. 8-35). When the recorder is in standby condition, the SYNC motor is running and the run motor, stylus band, and SYNC arm shaft are stationary.

The phase magnet armature is normally held back so as not to engage the clutch stop arm. During the phasing period the holding current to the phasing magnet is off. The released armature blocks the clutch stop arm, but the sync clutch ratchet continues to rotate at synchronous speed while the sync clutch pawl slips over the ratchet teeth. When a phase pulse is received, the phase magnet armature is pulled back momentarily to permit the clutch to resume rotating in phase at synchronous speed. Subsequent phase pulses will pull the phase magnet armature back each time the stop arm passes it.

When the start-record signal is received, the run motor starts and drives the stylus band through a reduction gear train and the run wheel.

POWER SUPPLY PP-1901/UXH-2.—The Power Supply PP-1901/UXH-2, and associated voltage regulator circuits (fig. 8-36), furnishes 6.3 volts AC, 400 volts DC (HI B+), 225 volts DC regulated B + (RB+), and bias supplies for the set.

Normally the input voltage is 115 volts single phase AC, however, connections are provided for operation on 220 volts AC. A utility outlet J601 is provided on the input line to operate auxiliary equipment when desired. Power line filter FL 601 isolates the recorder set from other equipments connected to the power line.

ELECTRICAL CONTROL AMPLIFIER AM-1845/UXH-2.—Electrical Control Amplifier AM-1845/UXH-2 consists of signal amplifier circuits, automatic level control and print amplifier circuits, automatic control circuits, fork

oscillator and SYNC motor drive circuits, and speaker amplifier and test signal circuits.

SIGNAL, AMPLIFIER, ALC, AND PRINT CIRCUITS.—The input facsimile signal from the secondary of T301 (fig. 8-36), is fed through gain control R301 to ALC amplifiers V1A and V1B. ALC lockout switch S306 is a single-pole double-throw switch and is part of gain control R301. If the gain control is set at the automatic position, the ALC feedback network controls the bias on V1A and B, automatically compensating for variations in the level of the facsimile signal. Setting the control at the manual position locks out the feedback network, and bias voltage 3 derived from the regulated power supply is applied to the ALC amplifiers. Resistor R301 is then used to adjust the magnitude of the signal input to V1A.

The output signal voltage from V1B is fed to print driver amplifier V4A, then to print amplifiers V5 and V6. Contrast potentiometer R27B is used to control the amount of bias on the grids of V5 and V6. Potentiometer R27A is ganged to R27B so as to vary the signal input to V4A to correspond to the contrast setting, thus maintaining the same recording density. There is no plate voltage on V5 or V6, and consequently no voltage on the trolley bar and stylus needles, until relay K102 is energized.

AUTOMATIC CONTROL CIRCUITS.—When selector switch S301 is turned from OFF to SYNC, start/stop relay K101 is energized by a positive potential applied to the grid of start/stop relay tube V102B to keep the tube conducting and relay K101 energized. This prevents the recording mechanism from starting before S301 is turned to RUN. When S301 is turned to RUN and awaiting a transmission, the positive potential is removed from V102B so that it will respond to the transmitted control signals.

The amplified signal output from V4B is fed through high-pass filter FL103 to control signal detector CR104, and out to the automatic start/stop and start-record circuits. When the amplitude-modulated 300-cycle start signal is received, it is detected by CR104, and filtered by FL102 which is tuned to 300 cycles. The 300-cycle output from FL102 is fed to start/stop signal amplifier V101A. The output of V101A is rectified by CR102 to cut off start/stop relay amplifier V102B, and deenergize relay K101. Deenergizing K101 operates contacts to release the armature of phase actuator E501, energize phasing timer K1, and tune FL102 to the 450-cycle stop signal frequency.

After the start signal, phasing pulses are transmitted for 15 seconds. The phase pulse is filtered and fed to the grid of phase amplifier V205A. The amplified pulse output of V205A is fed to phase delay lamp DS202 which fires thyratron V204. Holding current is supplied to phase actuator E501 pulling back the armature. Contacts of timer K1 remain open during phasing, then close maintaining holding current to actuator E501.

When the start record signal is received, it is filtered by FL101 and applied to the start-record signal amplifier V101B. The output of V101B is rectified by CR101 and fed to record relay amplifier V102A. The output of V102A operates record relay K102. Relay K102 operates contacts to apply power to the run motor B502 to start the stylus band rotating. Timer K1 is released, and holding current for the phase actuator is maintained through relay K102 contacts. Plate voltage is applied to print amplifiers V5 and V6, and print power is fed to the trolley bar and stylus needles.

At the end of the transmission the 450-cycle stop signal is detected by CR104 and fed to FL102 (now tuned to 450 cycles). The output from FL102 is amplified by V101A, rectified by CR103, and fed to start/stop relay amplifier V102B energizing start/stop relay K101. The contacts of K101 are restored to the original positions setting up the recorder for the next transmission.

If the set is operated manually, auto/man switch S305A shorts the inputs to the start/stop and start-record signal filters. A positive potential is applied to start/stop relay amplifier V102B by S301D to operate start/stop relay K101. Holding current is applied to the phase actuator E501 through relay K101 and phase switch S303A. When the phasing signal is received, the operator activates phase switch S303, and S303A removes holding current from the phase actuator. Section S303B applies plate voltage to thyratron V204, and phasing pulses fire V204 as described previously. After three phasing pulses the operator releases S303 to reapply holding current to E501.

When copy signals start, the operator throws the start/record switch (S304B) momentarily to start-record. This places a positive potential on the grid of record relay amplifier V102A causing it to conduct, energizing relay K102.

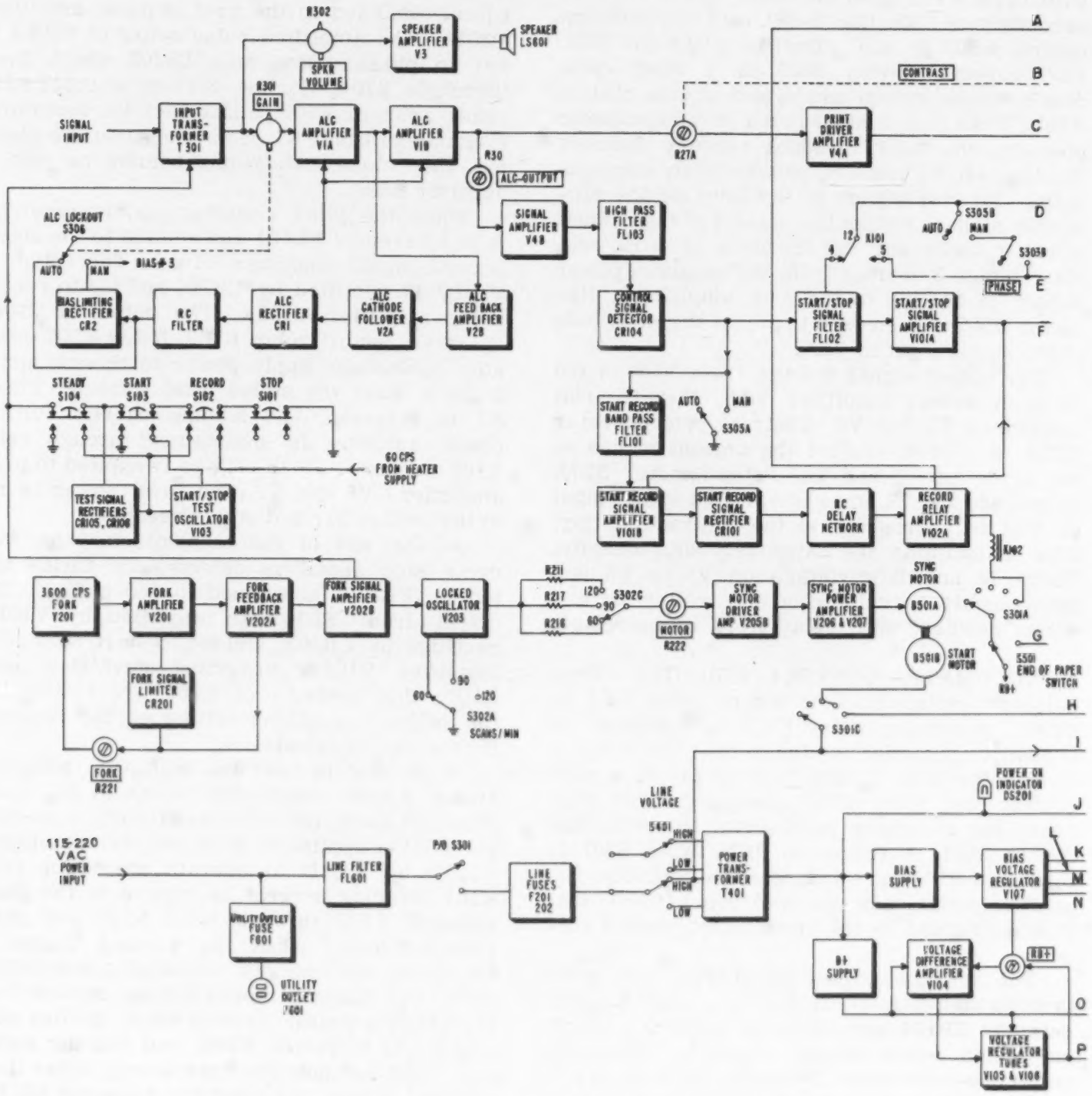
SIGNAL INPUT
INPUT TRANS-FORMER T301
R301 GAIN
R302 SPKR VOLUME
SPEAKER AMPLIFIER V3
SPEAKER LS601
ALC AMPLIFIER V1A
ALC AMPLIFIER V1B
R30 ALC-OUTPUT
R27A
CONTRAST
PRINT DRIVER AMPLIFIER V4A
SIGNAL AMPLIFIER V4B
HIGH PASS FILTER FL103
ALC LOCKOUT S306
AUTO
MAN
BIAS#3
BIAS LIMITING RECTIFIER CR2
RC FILTER
ALC RECTIFIER CR1
ALC CATHODE FOLLOWER V2A
ALC FEED BACK AMPLIFIER V2B
CONTROL SIGNAL DETECTOR CR104
START/STOP SIGNAL FILTER FL102
START/STOP SIGNAL AMPLIFIER V101A
S305B
S305A
X101
PHASE
STEADY S104
START S103
RECORD S102
STOP S101
60 CPS FROM HEATER SUPPLY
TEST SIGNAL RECTIFIERS CR105, CR106
START/STOP TEST OSCILLATOR V103
START RECORD BAND PASS FILTER FL101
START RECORD SIGNAL AMPLIFIER V101B
START RECORD SIGNAL RECTIFIER CR101
RC DELAY NETWORK
RECORD RELAY AMPLIFIER V102A
X102
3600 CPS FORK Y201
FORK AMPLIFIER V201
FORK FEEDBACK AMPLIFIER V202A
FORK SIGNAL AMPLIFIER V202B
FORK SIGNAL LIMITER CR201
FORK R221
LOCKED OSCILLATOR V203
R211
R217
R216
S302C
S302A
SCANS/MIN
MOTOR R222
SYNC MOTOR DRIVER AMP V205B
SYNC MOTOR POWER AMPLIFIER V206 & V207
SYNC MOTOR
B501A
B501B
START MOTOR
S301A
S301C
S501 END OF PAPER SWITCH
B+
115-220 VAC POWER INPUT
UTILITY OUTLET FUSE F601
UTILITY OUTLET J601
LINE FILTER FL601
P/O S301
LINE FUSES F201 202
LINE VOLTAGE
S401
HIGH
LOW
POWER TRANS-FORMER T401
POWER ON INDICATOR DS201
BIAS SUPPLY
BIAS VOLTAGE REGULATOR V107
B+ SUPPLY
VOLTAGE DIFFERENCE AMPLIFIER V104
VOLTAGE REGULATOR TUBES V105 & V106
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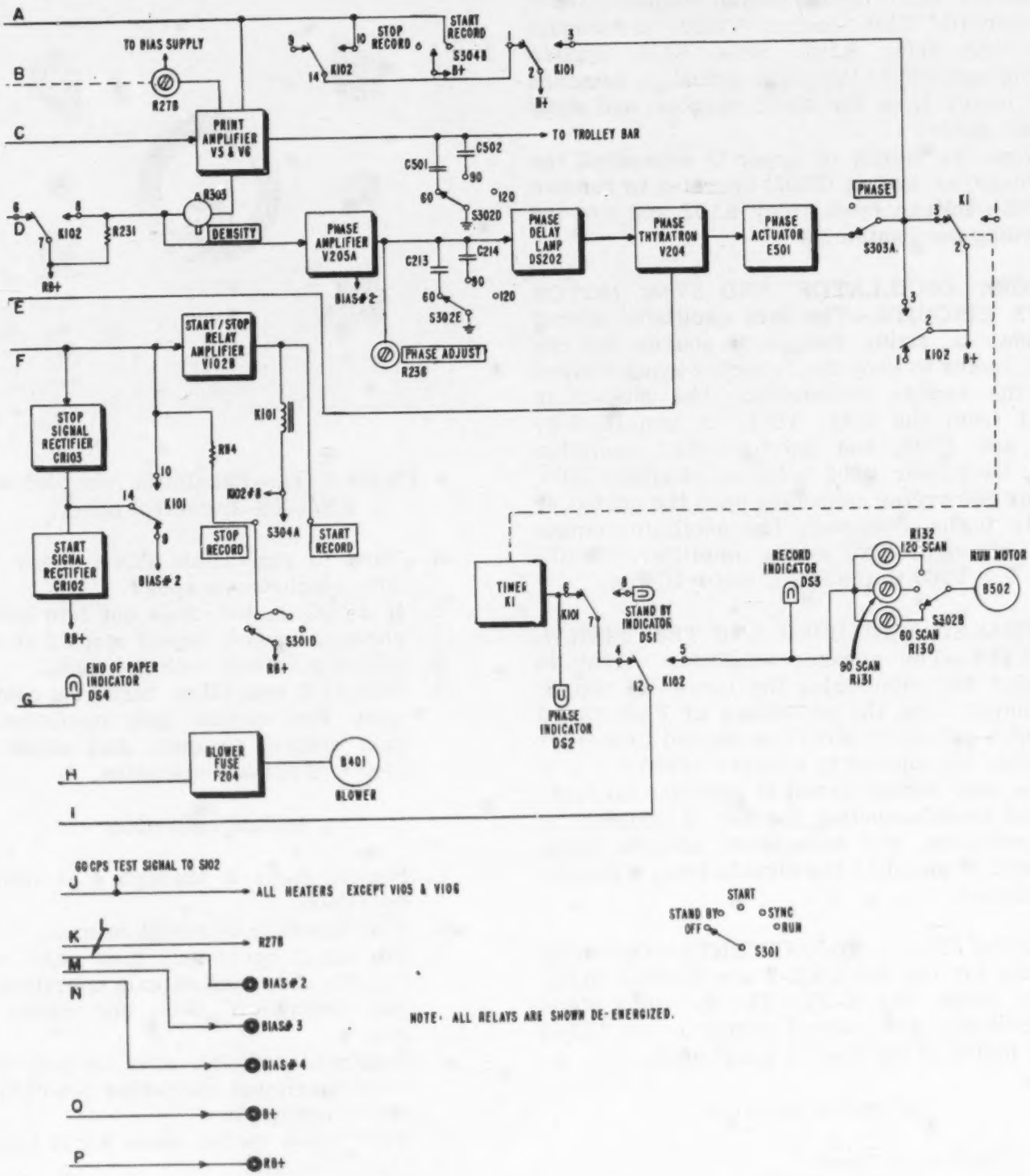

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Figure 8-36.—Facsimile recorder set AN/UXH-2, overall block diagram.

Relay K102 applies power to the run motor and sets up the set to record.

When the transmission ends, the operator throws the start-record switch momentarily to stop-record. This causes V102B to conduct energizing relay K101. Relay K101 applies holding current to the phase actuator, removes print power from the stylus needles, and stops the run motor.

When the supply of paper is exhausted, the end-of-paper switch (S501) operates to remove the RB+ voltage from relay K102 and stop the recording mechanism.

FORK OSCILLATOR AND SYNC MOTOR DRIVE CIRCUITS.—The fork oscillator circuit provides a stable frequency source for the SYNC motor to keep the recorder synchronized with the remote transmitter. The 3600-cycle signal from the fork, Y201, is amplified by V201 and V202, and fed to locked oscillator V203. Oscillator V203 is locked at either 1200, 900, or 600 cycles depending upon the scans per minute to be recorded. The oscillator output is fed through SYNC motor amplifiers V205B, V206, and V207 to the SYNC motor B501A.

SPEAKER AMPLIFIER AND TEST SIGNAL CIRCUITS.—The speaker amplifier circuit is provided for monitoring the facsimile signal. The output from the secondary of T301 is fed through a volume control (not shown) to speaker amplifier V3, and out to speaker LS601.

The test signal circuit is provided for testing and troubleshooting the set. It consists of four switches, and associated circuits which are used to simulate the signals from a remote transmitter.

OPERATING ADJUSTMENTS.—Operating controls for the AN/UXH-2 are located on the control panel (fig. 8-37). The following steps for automatic and manual operation are listed on the inside of the control panel door.

Automatic operation

1. Select scan speed.
2. Turn to standby and wait one minute.
3. Turn to SYNC and wait 15 seconds.

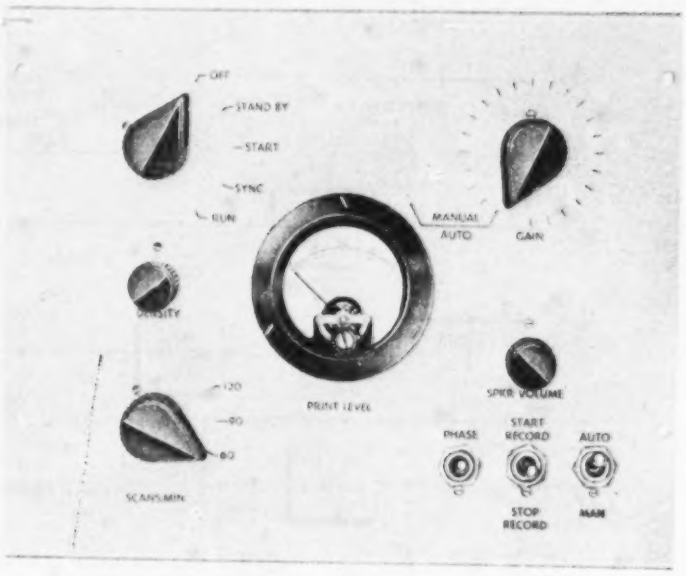

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Figure 8-37.—Facsimile recorder set AN/UXH-2, control panel.

4. Turn to run—allow SYNC motor to fall into synchronous speed.
5. If SYNC motor does not fall into synchronous speed, repeat steps 3 and 4.
6. Throw auto/man switch to auto.
7. For ALC operation, turn gain control to auto. For manual gain operation, turn gain control to man. and adjust as in step 4 of manual operation.

Manual operation

1. Repeat steps 1 through 4 of automatic operation.
2. Throw auto/man switch to man.
3. For ALC operation, turn gain control to auto. For manual gain operation, turn gain control to man. and adjust as in step 4.
4. On phasing signal, advance gain control from maximum clockwise position until meter reads 100.
5. Hold phase switch down for at least two phasing pulses.
6. When copy starts, throw to start-record.
7. At end of copy, throw to stop-record.

CHAPTER 9

COMMUNICATIONS MULTIPLEXING

The number of communications networks in operation per unit of time throughout any given area is constantly increasing. As a result, all areas of the RF spectrum have become highly congested.

To a great extent, the maximum permissible number of intelligible transmissions taking place in the radio spectrum per unit of time is being increased through the use of multiplexing. Multiplexing involves the simultaneous transmission of several intelligible signals using only a single transmitting signal. Either of two methods of multiplexing may be used. These are time-division and frequency-division multiplexing.

This chapter will present basic principles relating to multiplexing with a discussion of telegraph terminal set AN/UCC-1C(V).

TIME-DIVISION MULTIPLEXING

With AM voice and tone communications, it is desired to transmit and receive the full 360 of each sine wave (fig. 9-1,A). However, an audio signal may be transmitted and received satisfactorily by periodically sampling the signal. The result of the sampling process yields a received signal such as that shown in figure 9-1,B. Although there is no limit to maximum number of samples that may be made, an approximate minimum of 2.5 samples per cycle of audio will give satisfactory results. In practical systems, 2.4 samples per cycle are usually taken. This concept of sampling forms the basis for time-division multiplex operation.

Figure 9-2, A, illustrates in a highly simplified form the basic principle of time-division multiplexing. Assume that a 3,000-cycle tone is applied to each of the six channels in the transmitter. Assume also that the rotating switch turns fast enough to sample, in turn, each of the six channels 2.4 times during each cycle of the 3,000-cycle tone. The speed of rotation of the switch must then be 2.4 x 3,000 or 7,200 rotations per second.

If the transmitter and receiver switches are synchronized, the signals will be fed in the proper sequence to the receiver channels. The transmitted samples from transmitter channel 1 will be fed to receiver channel 1. Thus, in the time-division method of multiplexing, many channels of audio are combined (with time spacing between components of the separate channels) to form a single output (multiplexed) chain. The chain is transmitted (via wire or radio facilities) to distant demultiplexing receivers, each of which functions to select only the information pertaining to its particular channel.

A mechanical system is shown here for the sake of simplicity. In actual operation, no mechanical switching arrangement will provide the high speed of switching used in practical multiplexing systems. For this reason, electronic switching is used.

A sine wave sampled four times for each channel is illustrated in figure 9-2,B. In an actual transmission, segments from the waveforms in all of the channels will be interspaced with these four segments on a time-sharing basis. In other words, only one segment can be transmitted at a time; and the segments are taken in sequence from the wave-forms existing in the six channels.

More than six channels (perhaps 24 or more) may be used. However, as the number of channels increases the sampling rate must be increased (28,800 CPS for 24 channels as opposed to 7,200 CPS for 6 channels using the above example). In addition the width of each segment must be proportionately reduced. Decreasing the pulse width will decrease the minimum required rise time and increase the required bandwidth even more because of the

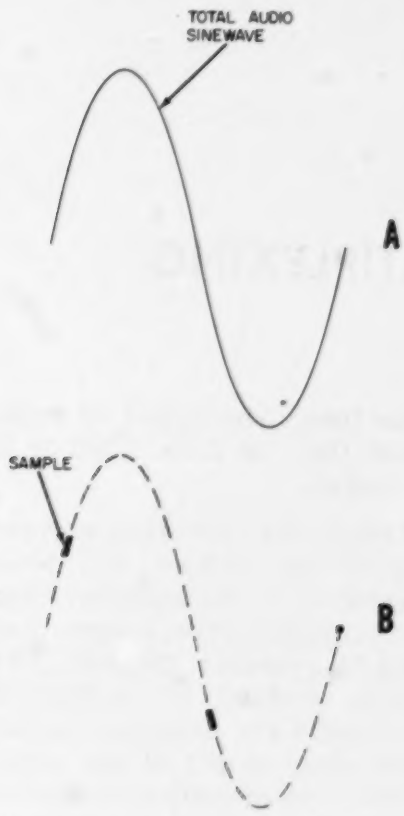

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Figure 9-1.—Components of a sine wave

increase in the number of harmonics contained in the sharper leading edge of the pulse.

The bandwidth is also affected by the shape of the sampling pulse and the method of varying the pulse to carry the modulation. Commonly used methods of time division multiplexing include pulse amplitude modulation (PAM), pulse width or duration modulation (PWM or PDM), pulse position modulation (PPM), and pulse code modulation (PCM). Pulse amplitude modulation is the type illustrated in figure 9-2.

In time-division multiplexing, to use time in the most efficient manner, the bandwidth necessary to transmit n channels would be only slightly wider than n times that necessary for one channel. However to prevent crosstalk, etc., the minimum bandwidth is not generally utilized.

FREQUENCY-DIVISION MULTIPLEXING

Frequency-division multiplexing (fig. 9-3) is the older of the two methods of multiplexing. In this system, different subcarrier frequencies are modulated by the signals of different channels and then transmitted simultaneously over the same cable or on the same radio frequency carrier. On the receiving end the channels are separated by filters and are demodulated individually. The total bandwidth required for a frequency-division multiplexing system is the sum of the bandwidths of the individual channels, plus the sum of the necessary guard-band frequencies between channels.

The resultant signal in each channel will be approximately the same as that which would be produced by the use of a single independent channel, except that nonlinear elements in the system may cause mixing of the various carrier frequencies and crosstalk between channels. Frequency-division multiplexing is a satisfactory multiplexing method for transmission by cable (land line) because equipment is available which gives good fidelity, good signal-to-noise ratio, nearly constant gain, and very low nonlinear distortion.

A greatly simplified block diagram of a frequency-division multiplexing system is illustrated in figure 9-3. For simplicity it may be assumed that the signals are transmitted over a cable; nevertheless a radio carrier could be used.

Channels 2 through 6 each employ an oscillator whose frequency is heterodyned with the audio input to the respective channels in a balance modulator. The frequency produced in the channel as a result of the heterodyning represents an audio modulated subcarrier. A sharp cutoff filter is used in each channel and allows only the passage of the upper sideband. Channel 1 and the 5 upper sidebands are used to modulate the carrier output (transmitter end). There is no need for channel 1 to employ an osciallator; it feeds its audio input (between 300 and 3,000 cycles) directly to the transmitter, and fills the low end of the modulating spectrum.

The bandwidth and position (with respect to frequency) of each of the six channels are indicated at the bottom of the figure. The total spectrum that may be occupied in this particular example is 19.5KC.

Only the upper sideband (sum frequencies generated in the balanced modulator) is utilized in each channel. The suppressed carrier frequency is indicated by a dashed line between the various channels. This is the frequency used to generate the sideband indicated to the right-hand side of the line. For example, 3.3 KC is the oscillator frequency for channel 2.

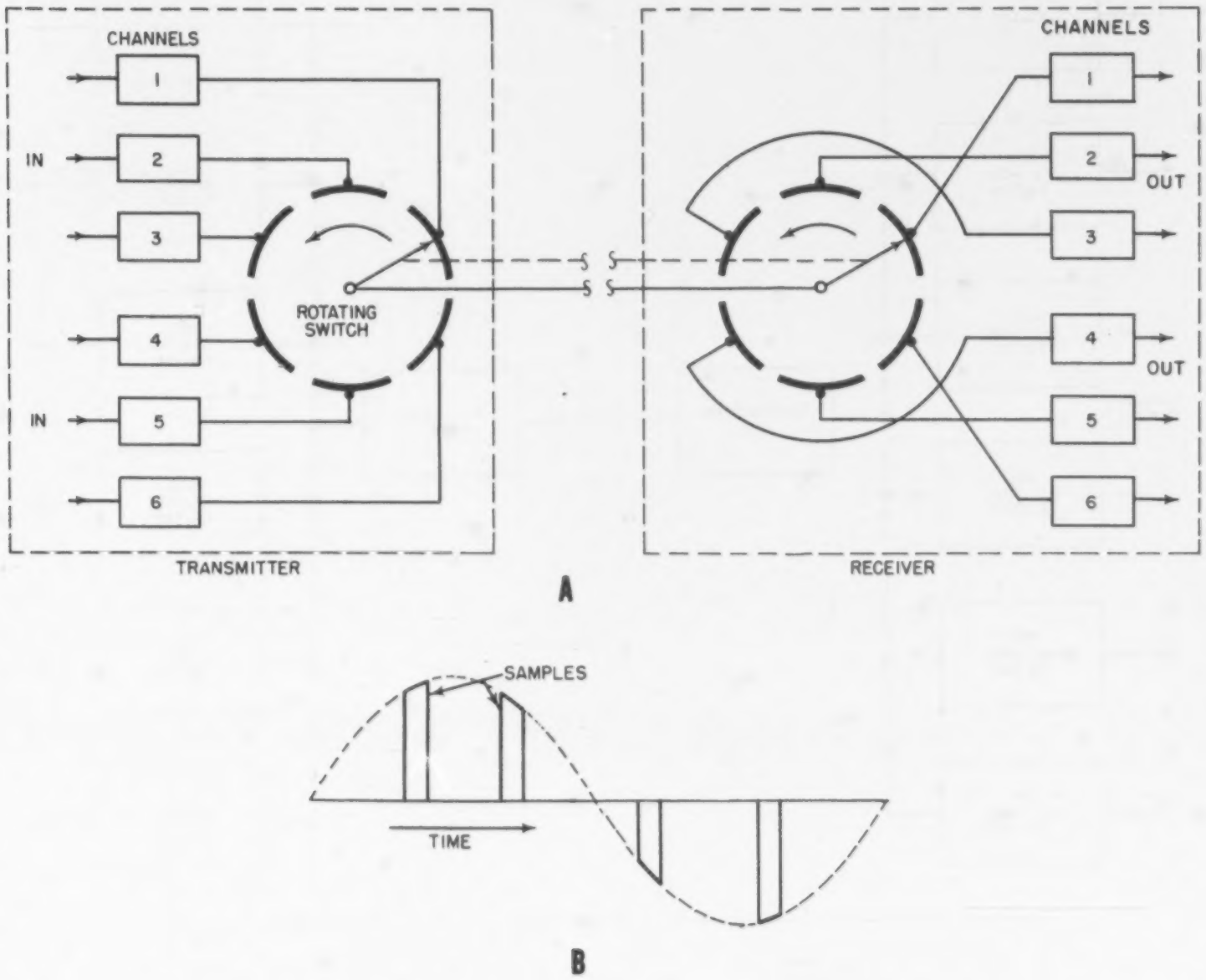

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Figure 9-2.—Basic principle of time division multiplexing.

Although the upper sidebands are transmitted in this example, the lower sidebands could have been transmitted just as well.

The channel 2 circuits at the transmitter and the receiver are used as examples in the block diagram of figure 9-4. For simplicity, a 1-KC tone is assumed to be the channel input.

At the transmitter, the 1-KC signal is fed to the balanced modulator; a 3.3-KC signal is also fed to the balanced modulator from the channel 2 oscillator. The balanced modulator suppresses the carrier and generates upper (4.3 KC) and lower (2.3 KC) sidebands. Only the upper sideband is passed by the channel 2 filter.

The channel 2 demodulator in the receiver accepts the 4.3-KC signal and heterodynes this input with the channel 2 oscillator signal (3.3 KC). The carrier is suppressed, and the two sidebands (7.6KC and 1-KC are fed to the channel 2 demodulator filter. The filter passes the 1-KC signal to the reproducer.

TIME-DIVISION MULTIPLEX SYSTEMS (GENERAL)

Either the amplitude or the frequency of the transmitter signals (samples) from the respective channels may be varied to affect

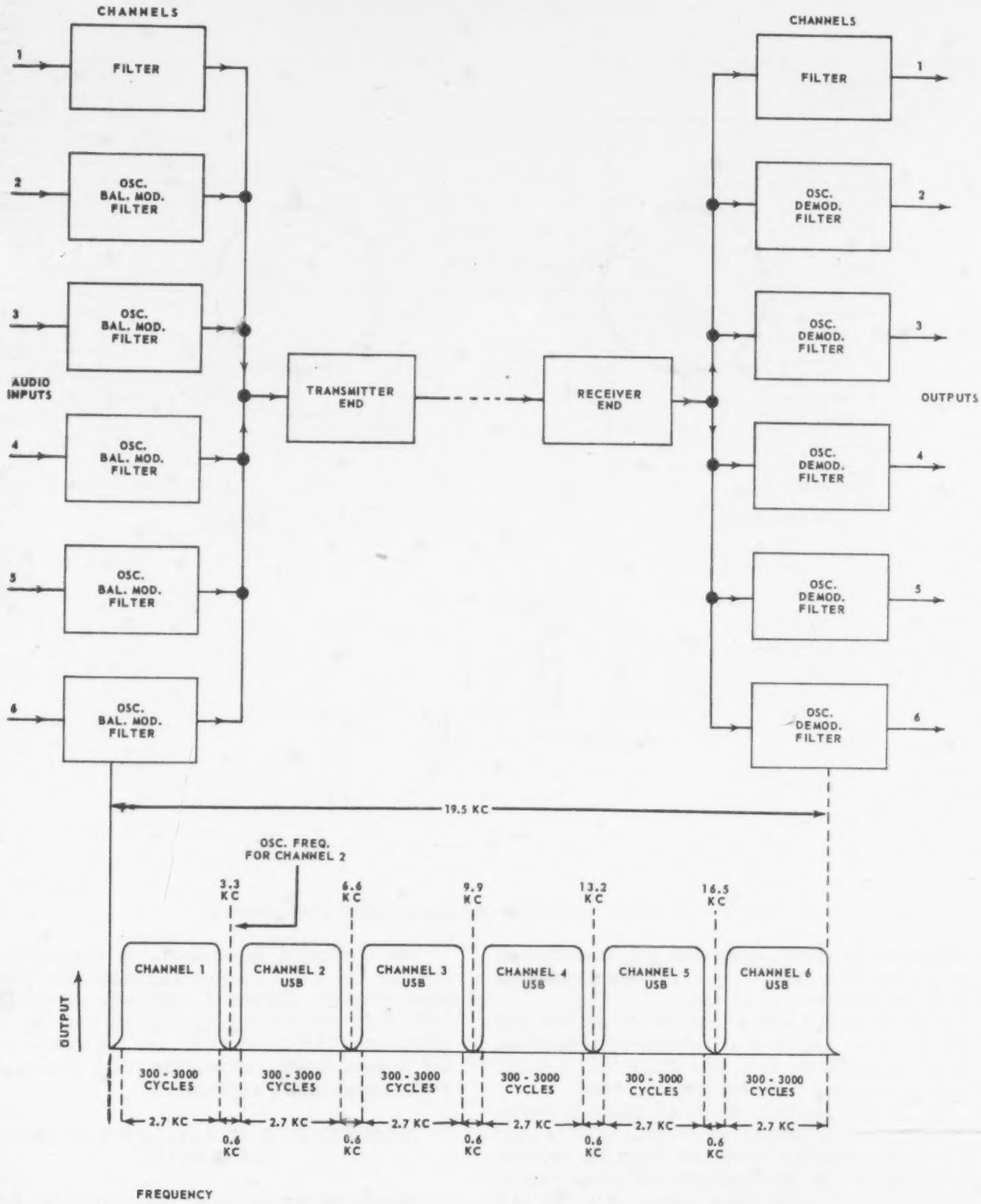

Figure 9-3.—Block diagram of a frequency division multiplexing system.

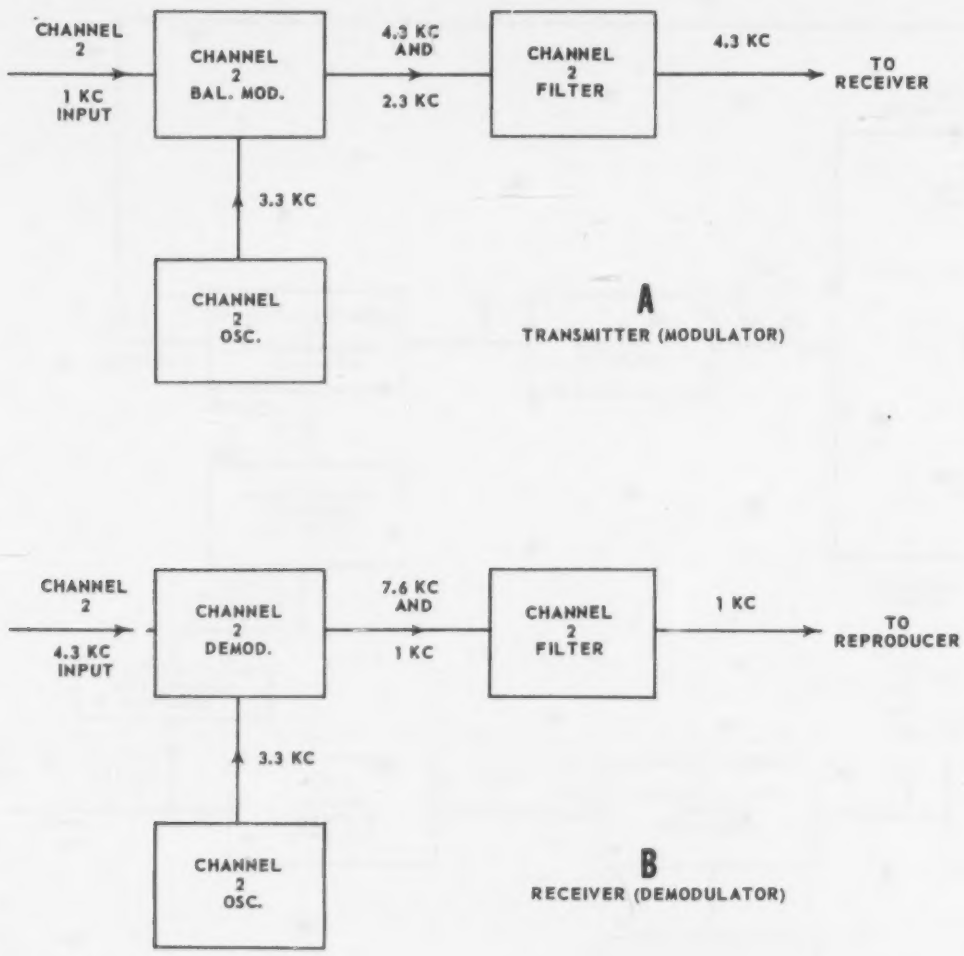

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Figure 9-4.—Block diagram of a modulator and demodulator units.

modulation. Four practical methods of pulse modulation are used as mentioned previously. In each case, a modulating pluse is made to vary with respect to the amplitude of the audio signal.

The sampling process allows modulating pulses at a fixed rate to be introduced to the RF transmitter carrier, or to the wire cable equipments. No less than 2.4 of these samples must be transmitted for each cycle of the audio in order to produce an intelligible signal at the reproducer.

If the rate of sampling throughout the multiplex system is adjusted to 9.3 KC, then the maximum allowable audio frequency $= \frac{9300}{2.4} = 3875$ CPS. This frequency represents the highest audio frequency that may be used. In practice, for better fidelity translation it is desirable to provide more than the minimum number of samples per second. For this reason, filters would be employed in this system to eliminate frequencies above about 3000 CPS.

BLOCK DIAGRAM

Sampling the audio signal of several channels through the use of electronic switching can be accomplished in several ways. A block diagram analysis of one method used in time-division multiplex is shown in figure 9-5. In this system, it is first necessary to develop a voltage that varies linearly with time to establish the basis for time-division multiplex. A bootstrap type sawtooth (time base) generator, which uses a linearity stage to improve both voltage output and voltage linearity is used for this purpose.

The sawtooth generator output voltage (through the rise time) is applied to the grid of a normally cutoff sawtooth selector stage (V4). Conduction of this stage occurs when the

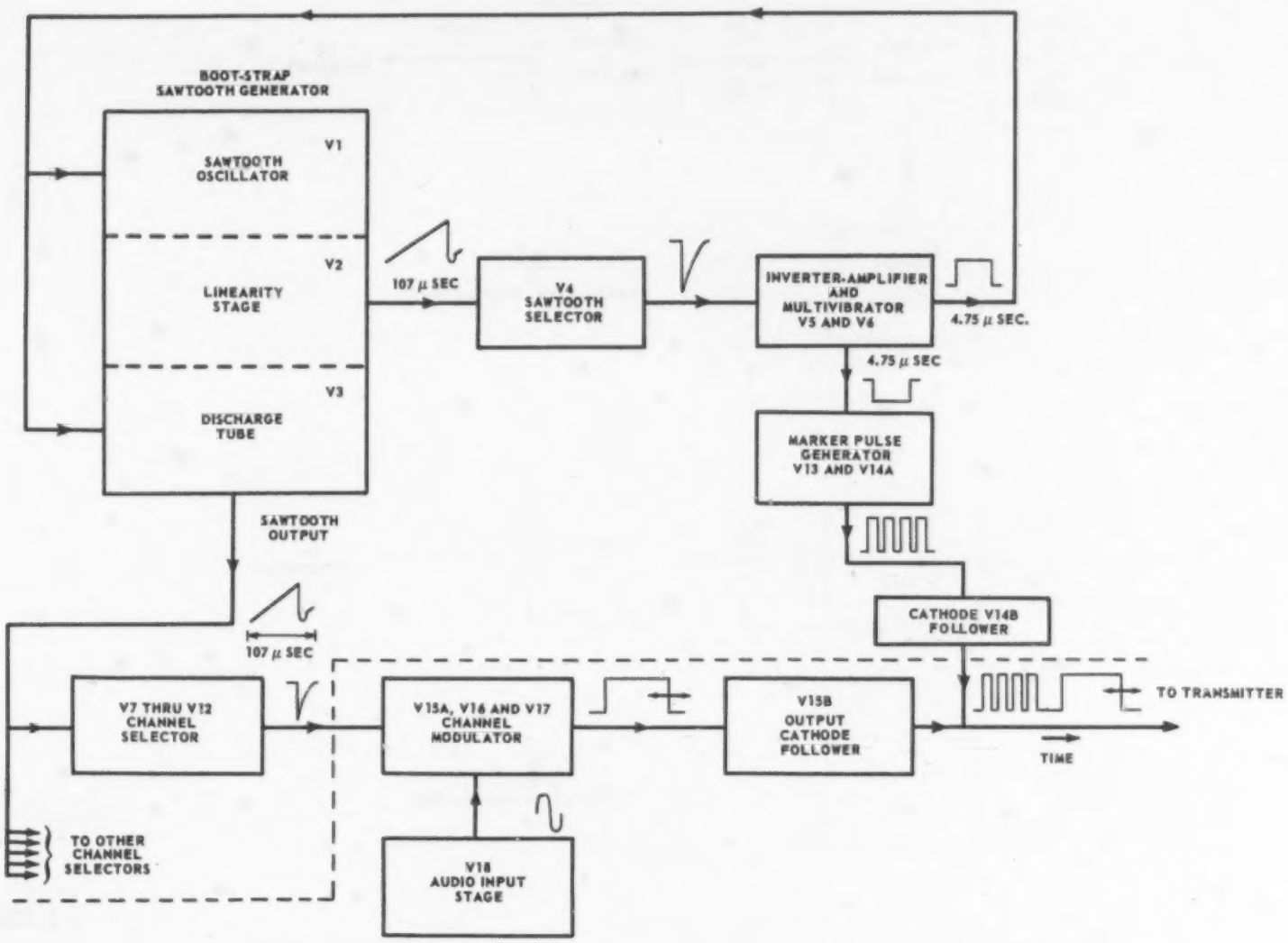

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Figure 9-5.—Time-division multiplex block diagram.

sawtooth amplitude reaches a potential slightly less than the bias voltage on the selector. When the sawtooth voltage becomes sufficiently high to cause conduction of the selector, a trigger pulse is produced at the grid of a one-shot multivibrator (V5 and V6). The multivibrator output is returned along dual paths to the sawtooth generator osciallator and discharge tube to cause the sawtooth flyback. The amplitude of the sawtooth may be varied by manually varying the bias on the selector.

The sawtooth generator output waveform is fed along paralleled paths to the channel selectors (V7 through V12) one of which is contained in each channel of the multiplex system. Each individual selector is biased at a different level so that each is energized at a different time by the sawtooth voltage.

As each channel selector is energized, it feeds a pulse to its respective channel modulator, causing this circuit to produce a channel pulse. The channel pulse thus produced (for this channel alone) is then modulated in accordance with the type of pulse modulation used by the incoming audio.

Included in the transmitter output is a marker pulse(s) (sometimes called a sync group). The primary purpose of the marker pulses is to act as a synchronizing voltage between the receiving and transmitting multiplex terminals. These pulses may be of any form but are usually of a nature that makes them easily distinguishable from the modulation pulses at the receiving terminal of the multiplex system. The marker pulse (or pulses), along with the total modulation pulses from each channel

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(in time) presented to the transmitter carrier during one complete cycle of the sawtooth waveform, constitutes a video frame.

The marker pulses are formed by the negative gate from the multivibrator (occurring at the same time as the positive pulse that produces the sawtooth decay) which gates an oscillator (marker pulse generator) circuit to cause the generation of the marker pulses. In figure 9-5, four.5-μs pulses spaced 0.8 μs apart are produced. These pulses are passed through a cathode follower (impedance matching) circuit to the transmitter. Both marker pulses and channel pulses are coupled along the same line to the transmitter, because each of the pulses is added to the video frame at a different time interval.

FUNCTION OF DELAY LINE

In any time-division multiplex system, the development of an accurate method of energizing the various channels at a given time is of utmost importance. The system must employ some type of highly stabilized master oscillator. In the system just discussed, a triggered bootstrap sawtooth oscillator was used in both the multiplex and demultiplex equipments. A crystal-controlled oscillator would serve equally as well.

A block diagram of a time-division multiplex system using a crystal-controlled master oscillator and delay line is shown in figure 9-6. The oscillator generates an 8-KC sine wave, which is clipped by the pulse generator circuit to produce a square wave output. The oscillator frequency (8 KC) is the frame or base frequency of the multiplex system. This output is coupled along dual paths to a marker pulse generator, and to an artificial delay line.

The artificial delay line comprises 24 sections of pi-connected inductors and capacitors, each of which introduces a delay (5.2-μs) to the passage of the pulse along the line. A connection is made to a modulator channel from each section of the delay line. Thus, 23 channel modulators can be activated at time intervals of 5.2 μs (fig. 9-7,A) by the trigger pulses from the line. The presence of the controlling pulse enables the modulator to generate one channel pulse per frame (8,000 per second). The frequency of the audio signal applied to the modulator varies the position of the pulse (as indicated by the double-headed arrow through the waveform) and this comprises the signal intelligence for the channel. Thus the 24 section delay produced up to 23 channels, and during the 24th part of the frame interval a double-pulsed marker (three pulses in latest equipment) is produced for synchronizing the multiplex system.

To minimize crosstalk, the modulators are arranged in three groups of eight. The output of each group of eight modulators is combined in the mixer shaper, which shapes each modulator output into a narrow pulse. The output of each of the mixer-shaper stages is applied to a single mixer line amplifier, which combines all the channel pulses and marker pulses into a single video frame. The mixer line amplifier output is applied to the RF transmitter circuits.

The pulse train input to the demodulator (fig. 9-8) comprises the marker, and up to 23-pulse position (time) modulated channel pulses. The signals are shaped in a clipper-shaper stage and applied to the marker-separator.

The marker-separator circuit extracts (detects) the double-pulsed marker and converts it to a suitable square waveform, which is fed to a 24-section delay line. This delay line is identical to that employed in the multiplex circuits.

The line produces the controlling pulses (properly spaced in time sequence) for activating the individual channel demodulators. The first output pulse is delayed 5.2 μs from the input pulse. Each of the remaining pulses is delayed successively 5.2 μs from the preceding pulse.

The first 23 pulses from the delay line form the control or deblocking pulses for the 23 demodulators. Each demodulator employs a coincidence stage (not shown), which requires the simultaneous application of the channel pulse and the delay line deblocking pulse to cause conduction. The entire video frame is applied to each demodulator. Since the deblocking pulses from the delay line are applied at specific intervals, only one demodulator will be activated for a single interval. The demodulated signals are filtered and amplified and reproduced at the output.

The time division multiplex system just discussed is widely used at Navy communication stations for radio line systems to remotely key transmitters or to modulate transmitters. Each channel could carry a set (3 KC) of telegraph terminal tones (discussed later) or 1 (3 KC) voice channel.

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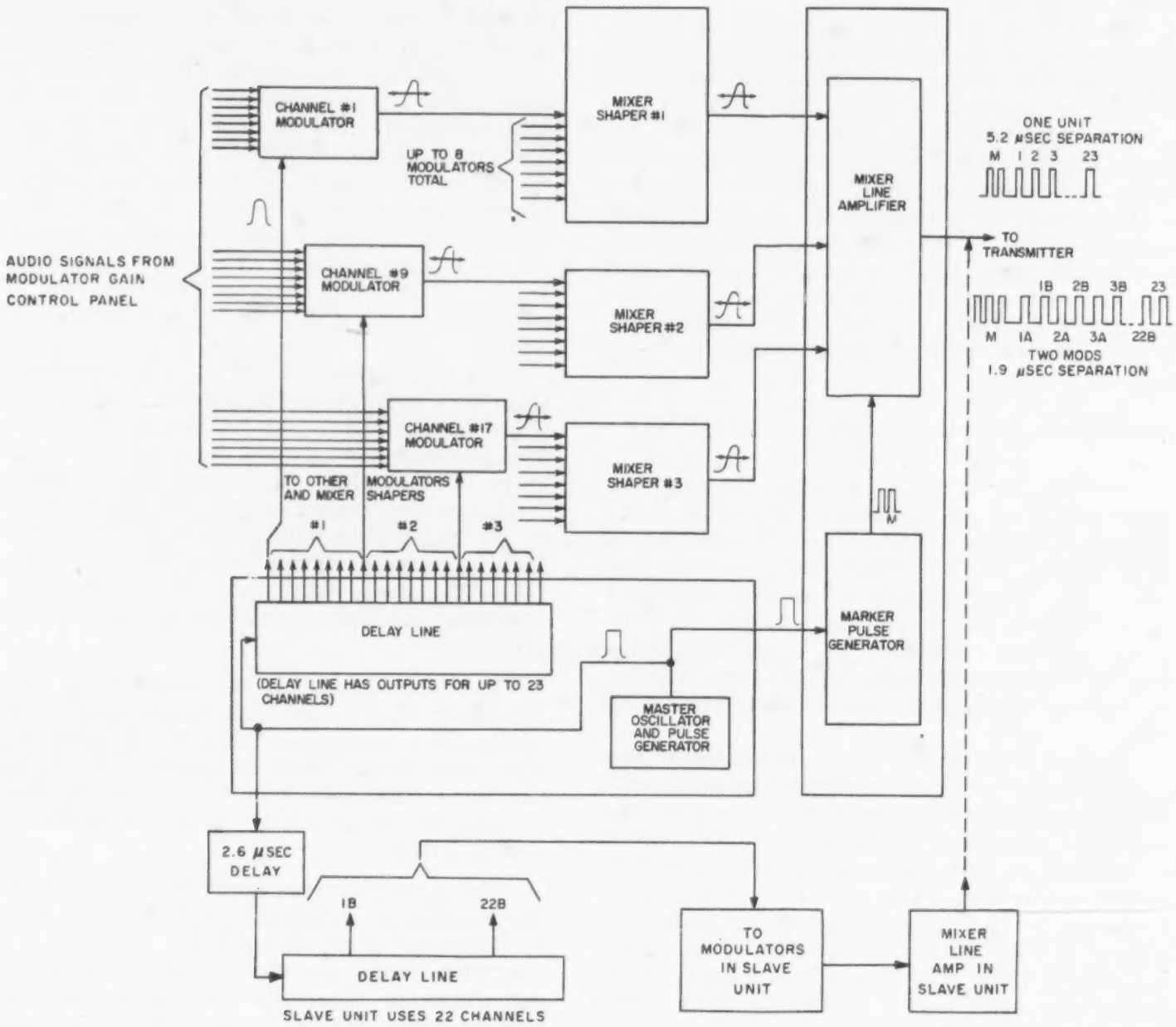

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Figure 9-6.—Block diagram of multiplex modulation circuits.

If the circuits are needed, another modulator (demodulator) at the receiving end) may be slaved to the first modulator to give a 45 channel output. This may be 45 channels (300-3600 CPS) or 22 channels (300 - 7200 CPS). Figure 9-6 shows a simplified hookup of the slave unit modulator.

The pulse from the master oscillator (fig. 9-6) is delayed for 2.6 usec and applied to the slave delay line. This gives a combined pulse train spaced 2.6 usec apart (fig. 9-7,B). The marker channel and channel 23 are not used; so the output train contains 3 markers and 45 information pulses.

Figure 9-8 shows the demodulator system which requires a demultiplexer unit to separate the master and slave pulses and 2.6 delay line to synchronize the slave delay line gates.

TELEGRAPH TERMINAL AN/UCC-1C(V)

The AN/UCC-1C(V) (fig. 9-9) is a frequency division multiplex carrier-telegraph terminal

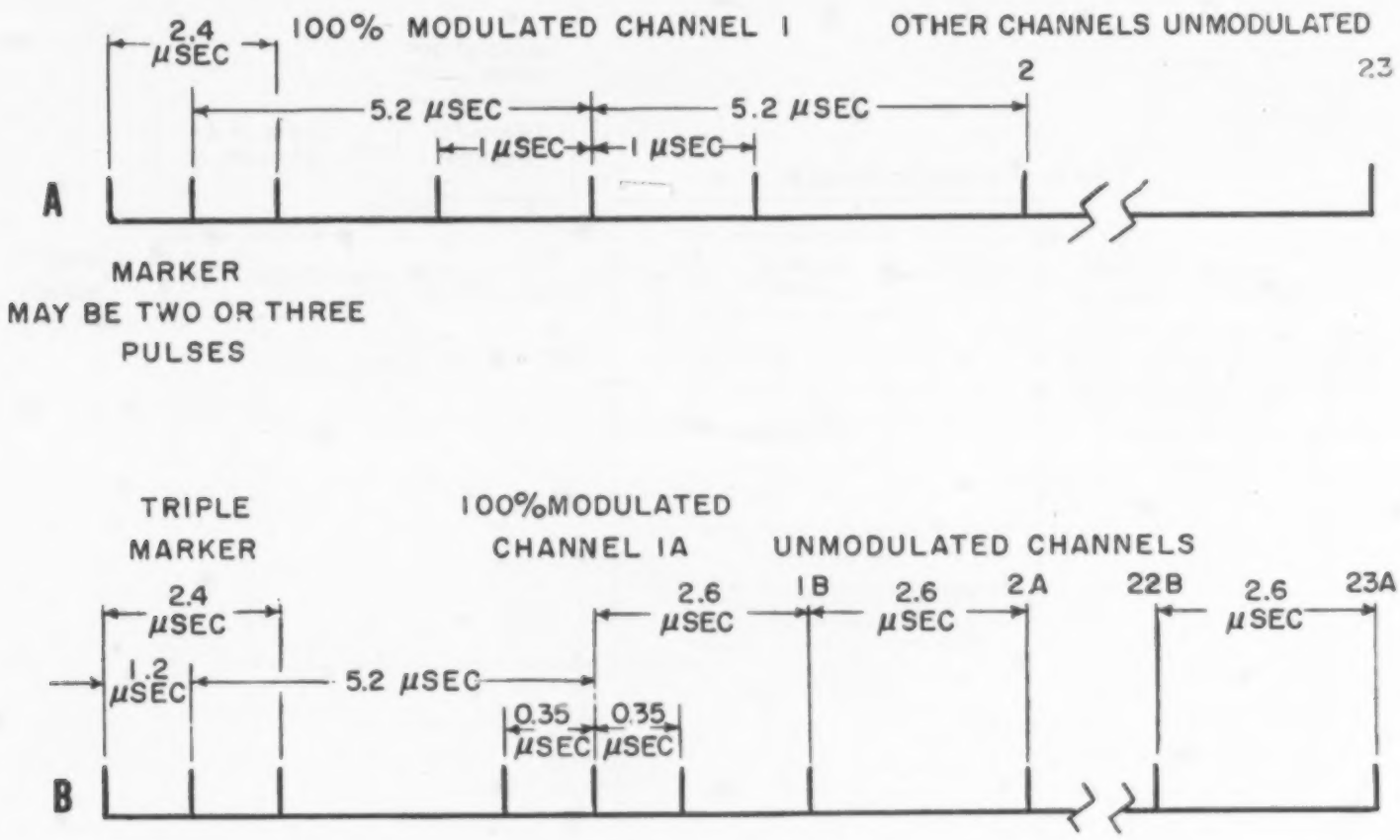

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Figure 9-7.—Pulse relationship, 23 channel and 45 channel.

equipment for use with single sideband or double sideband radio circuits, voice frequency wire lines or microwave equipments. The equipment is of modular construction comprised of solid state components.

FUNCTIONAL DESCRIPTION

The terminal provides up to 16 different narrow-band voice-frequency tone channels, each passing a different band of frequencies. Associated with each channel are two oscillators and a gate circuit. One oscillator constantly generates the mark frequency; the other constantly generates the space frequency. The gate circuit is keyed by a telegraph loop causing one frequency or the other to pass (frequency-shift keying). The two frequencies are symmetrically disposed with respect to the center of the channel pass-band. The output from any set of different channels (fig. 9-10) can be combined on a single line for transmission over a single 3-kilocycle bandwidth communication link. In place of 16 narrow-band channels, the Telegraph Terminal can provide eight narrow-band and four wide-band channels. The wide-band channels use the band portion of the upper band narrow-band channels plus the band extending from 3025 to 3815 CPS. However, extension of the wide-band channels above 3265 (CPS) prevents the use of the multiplexing function.

The Telegraph Terminal is modular in construction so that the number of channels can be varied by increasing or decreasing the total number of modules.

Two 3-kilocycle bandwidth voice-frequency signals can be accommodated by the Telegraph Terminal by a multiplexing unit for transmission over a single 6-kilocycle communication link. The two 3-kilocycle signals may contain 16 telegraph tone channels in each 3-kilocycle band or 16 telegraph tone channels in one 3-kilocycle signal and speech in the other 3-kilocycle signal.

Diversity-combination switching is provided in the telegraph terminal at both the transmitting and receiving stations; thus, one telegraph signal can be used to key two different tone channels (Keyers) at the transmitting

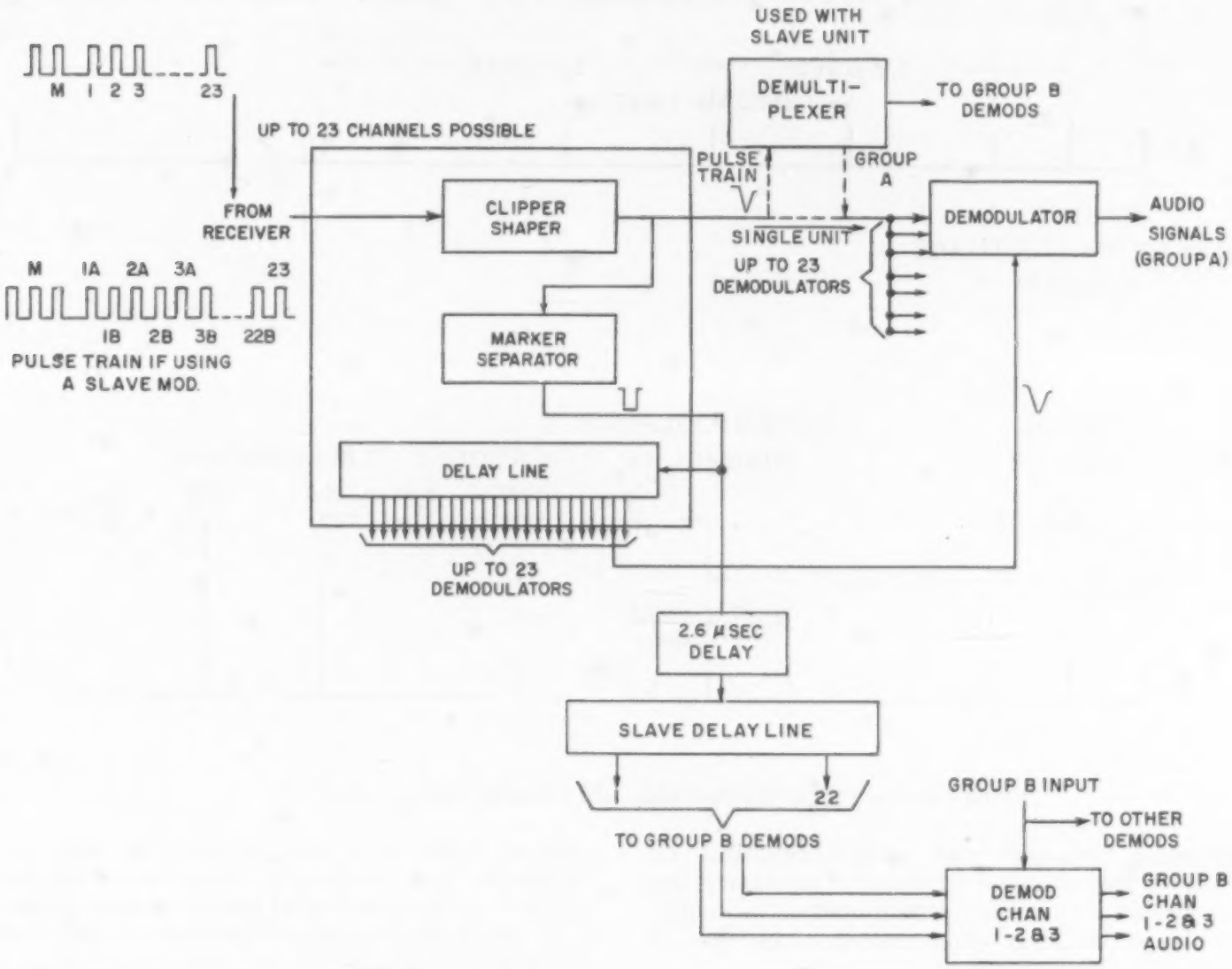

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Figure 9-8.—Block diagram of multiplex demodulation circuits.

station. In this case, the corresponding tone channels (Converters) at the receiving station both develop keying signals. However, the best signal of the diversity pair operates the receiving telegraph loop, thereby preserving the telegraph signals when fading occurs in one of the two channels in the frequency-diversity pair. Diversity switching at the receiving station also permits space-diversity or RF diversity operation, in which tone signals obtained from two different radio receivers are used to operate two identical sets of tone channels. For this type of operation, each pair of identical tone channels (Converters) provides a single keying signal. Frequency-diversity operation can be combined with either space diversity or RF diversity operation. In this case, one set of four tone channels produces a single keying signal.

Integrated circuits of two types, a differential amplifier and a flip-flop, are used throughout Telegraph Terminal AN/UCC-1C(V). Although each integrated circuit is housed in a transistor enclosure, it performs a much more complex function than a single transistor. External electronic components such as resistors and capacitors are used with integrated circuits, as they are with transistors, when the application of the device requires their use.

The integrated circuit consists of a number of transistors or diodes and other circuit elements formed on a single chip of N-type,

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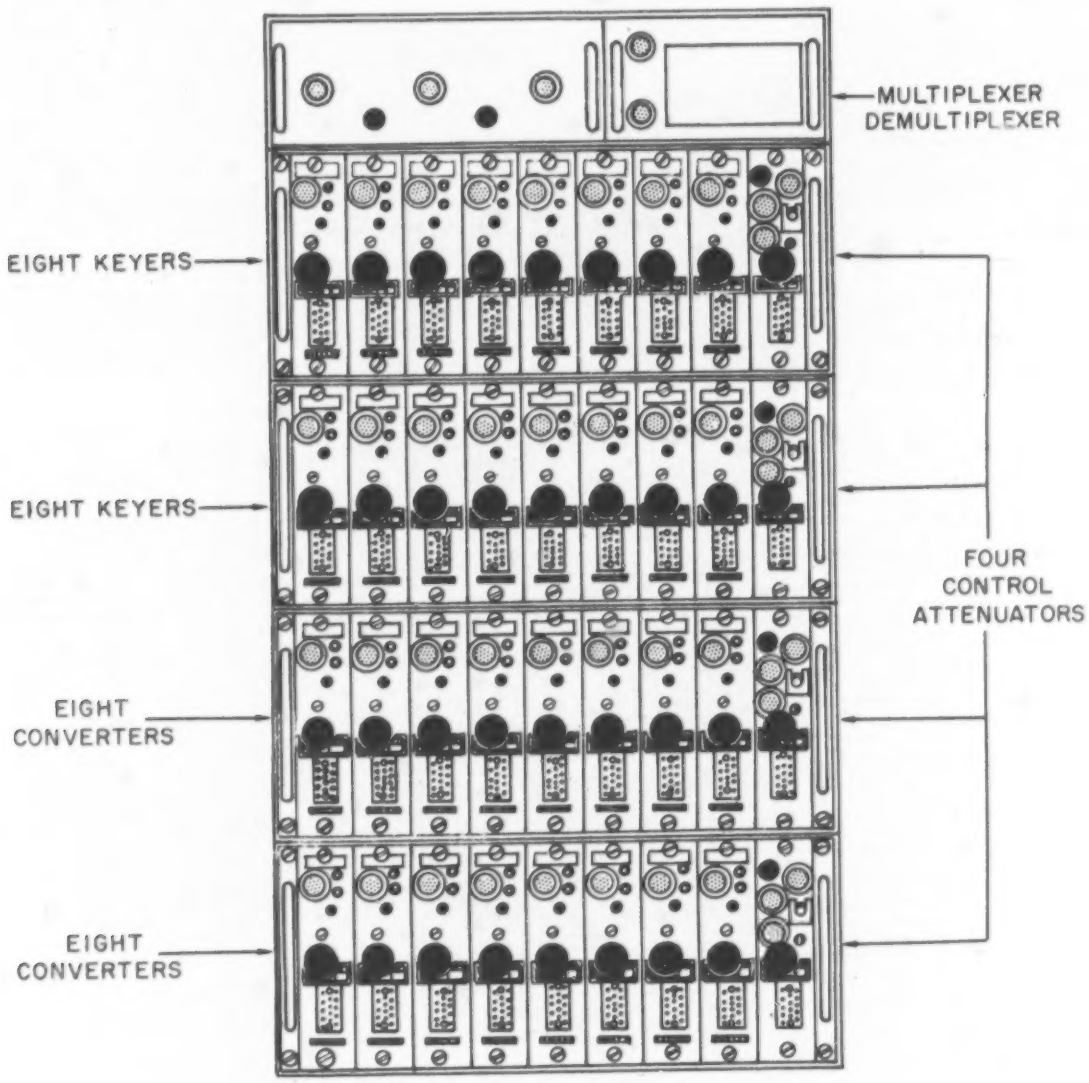

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Figure 9-9.—Telegraph terminal AN/UCC-1C(V)

doped silicon crystal. The circuit elements are formed by semiconductor construction methods including masking, oxide photolithographic etching, diffusion, evaporation, epitaxial growth, and deposition. Then, lead wires are connected to the integrated circuit by thermal compression bonding and it is sealed in the enclosure or envelope.

In addition to the basic application as a differential amplifier, the integrated differential amplifier is used in a Schmitt trigger, a crystal-controlled oscillator, and a free running multivibrator. The adaption of this integrated circuit to these applications was undertaken in the design of Telegraph Terminal AN/UCC-1C(V) to improve reliability and to reduce the number of spare parts required. External electronic components are connected into the circuit to adapt it to these applications.

Standard schematic symbols for integrated circuits have not been adopted as yet. The symbols used to represent the differential amplifier and the flip-flop have been approved for use in this application by the Naval Ship Systems Command, Technical Publications Section. These symbols were developed by placing the standard logic symbol for the circuit within a standard envelope or enclosure. All signal paths have been drawn through the envelope to the logic symbol. Other connections to the circuit such as voltage supplies, common connections, gain control, and operating bias are drawn only to the envelope.

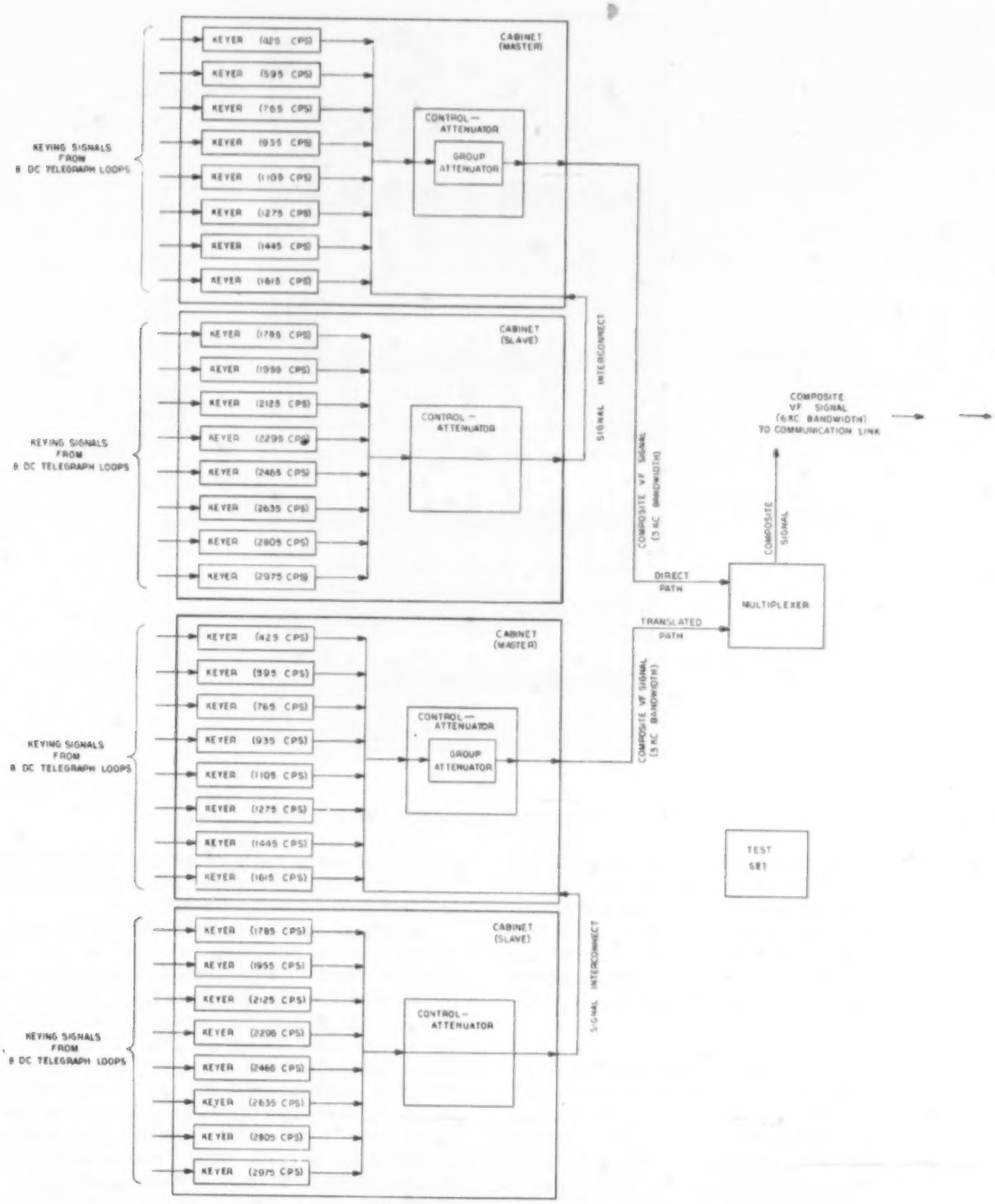
KEYING SIGNALS FROM 8 DC TELEGRAPH LOOPS
KEYER (425 CPS)
KEYER (595 CPS)
KEYER (765 CPS)
KEYER (935 CPS)
KEYER (1105 CPS)
KEYER (1275 CPS)
KEYER (1445 CPS)
KEYER (1615 CPS)
CABINET (MASTER)
CONTROL — ATTENUATOR
GROUP ATTENUATOR
KEYER (1785 CPS)
KEYER (1955 CPS)
KEYER (2125 CPS)
KEYER (2295 CPS)
KEYER (2465 CPS)
KEYER (2635 CPS)
KEYER (2805 CPS)
KEYER (2975 CPS)
CABINET (SLAVE)
CONTROL — ATTENUATOR
SIGNAL INTERCONNECT
COMPOSITE VF SIGNAL (3 KC BANDWIDTH)
COMPOSITE VF SIGNAL (6 KC BANDWIDTH) TO COMMUNICATION LINK
COMPOSITE SIGNAL
DIRECT PATH
TRANSLATED PATH
MULTIPLEXER
TEST SET

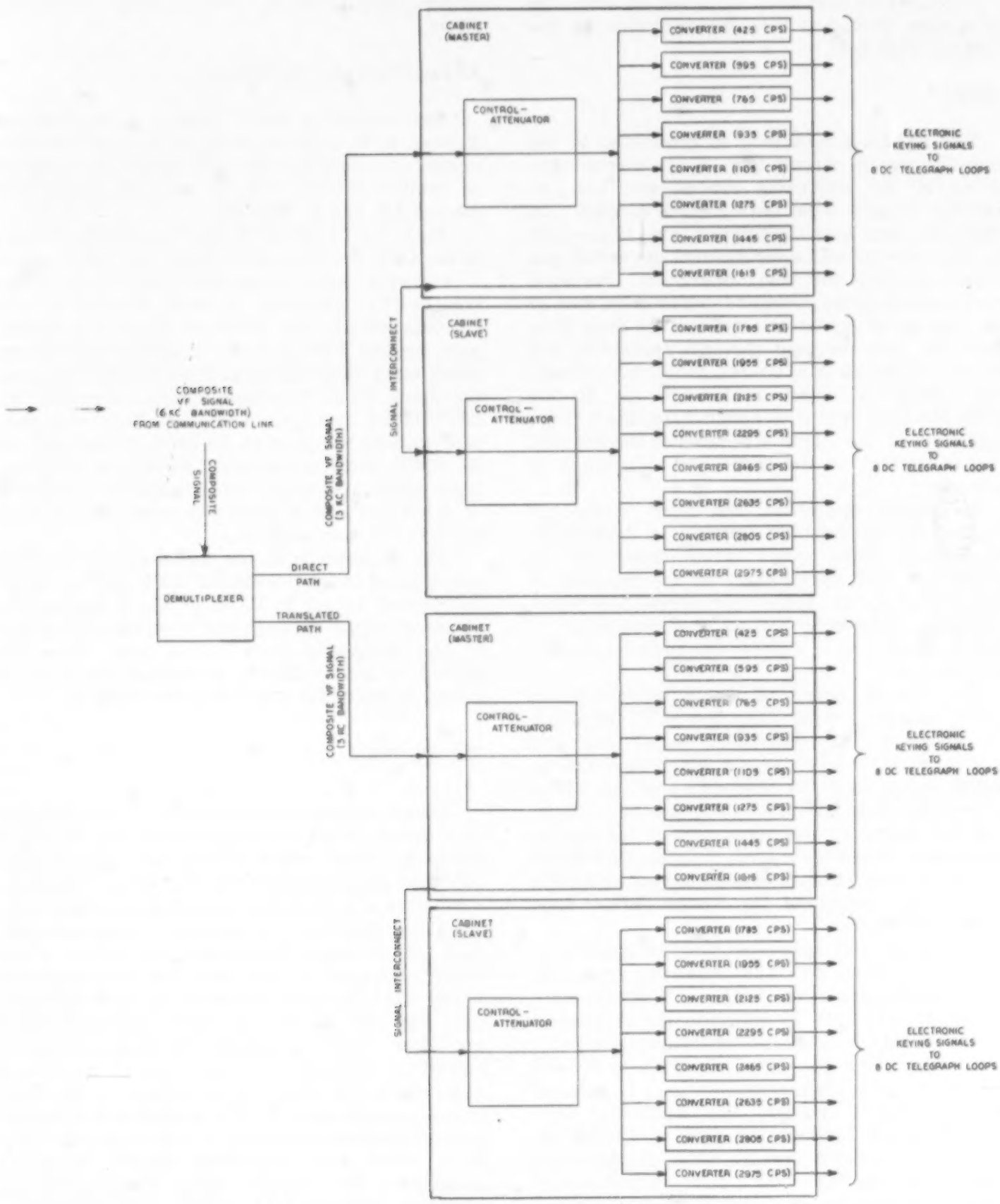

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Figure 9-10.—Telegraph terminal AN/UCC-1C(V), overall functional block diagram.

Special test facilities required to align the Telegraph Terminal are incorporated in the portable Test Set.

KEYER

The DC telegraph loop is connected to the Schmitt trigger circuit (fig. 9-11) through the 20-MA/60-MA switching circuit and the adjustable trigger-level bias control circuit. The adjustable bias sets the trigger level at one-half the loop current value for netural operation and at zero current for polar operation. The input level applied to the Schmitt trigger is the sum of the trigger-level bias and the voltage drop produced by loop current through resistors (not shown), of the 20-MA/60-MA switching circuit. The change of input resistance for 20-MA or 60-MA loop operation assures that the voltage amplitude of the signals applied to the Schmitt trigger circuit is the same for both types of operation.

In netural operation, the input transistor section of the Schmitt trigger is turned on (conducting) when loop current flows and is turned off (not conducting) in the absence of loop current. In polar operation, the input transistor section is turned on during positive loop current and is turned off during negative loop current.

The output signal of the Schmitt trigger circuit and the output frequencies of the mark and space crystal-controlled oscillators are used to drive the diode gates. When the SIGNAL SENSE switch is in the NORMAL position, a loop current (mark input) causes the gate circuits to pass the output of the mark (higher frequency) osciallator. When the switch is in the REVERSE position, a loop current causes the gate circuits to pass the output of the space (lower frequency) oscillator.

The mark and space oscillators operate at frequencies which are 128 times the mark and space frequencies of the channel. They are controlled by crystals to maintain the frequency within a close tolerance. Both oscillators operate at all times but the output of each is passed through its gate only when the gate is enabled by the Schmitt trigger. The oscillator frequnecy passed through the gate is divided by 128 in the divider circuit. The divider is a seven-stage digital count down circuit, each stage is a flip-flop integrated circuit device. The output of the divider circuit (channel mark or space frequency) is applied through the output amplifier to the output bandpass filter.

Keyer Diversity Combinations

The cabinet is wired in such a way that the Keyers in specific cabinet stations can be connected in frequency-diversity pairs. These pairs of cabinet stations are: A1 and A2, A3 and A4, A5 and A6, and A7 and A8.

With the DIVERSITY switches of the Keyers in the ONE position, each Keyer is connected to a separate input telegraph loop. Turning the DIVERSITY switches of two Keyers in the stations which are wired to form a diversity pair, to the TWO position connects them to the same input telegraph loop. Both channels process the same input telegraph signals. Turning the DIVERSITY switches of the four Keyers in cabinet stations A1 through A4 or in A5 through A8 to FOUR, connects the four Keyers to the same input telegraph loop. The DIVERSITY switches of all Keyers in a diversity combination must be in the proper position.

The signals from the output bandpass filter are applied to the TONE OUTPUT switch. When the switch is set to PARALLEL, it applies the channel output through the Control-Attenuator to the composite tone output line. When the switch is set to INDIV, it applies the channel output directly for individual tone output.

CONVERTER

Either a composite tone signal or an individual tone signal is fed to the input filter, (fig. 9-12), a bandpass filter which blocks all channel frequencies except those of the Converter's channel. The filter also contains the adjustable delay network that provides the means for equalizing delays for diversity operation. The output of the filter is applied to the attenuator and bias network. This network provides the AGC attenuation and also biases the input gain-controlled amplifier. The output of the gain-controlled amplifier is coupled to the input of the second gain-controlled amplifier generator in the integrated circuit device. The output of the second gain-controlled amplifier is applied to the input of a fixed gain amplifier whose output is coupled to the limiter stage which clips the signal removing any amplitude-modulated components from the waveform applied to the discriminator.

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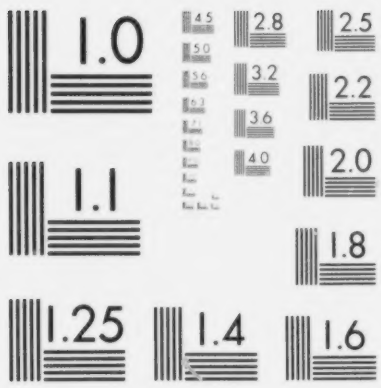

MICROCOPY RESOLUTION TEST CHART

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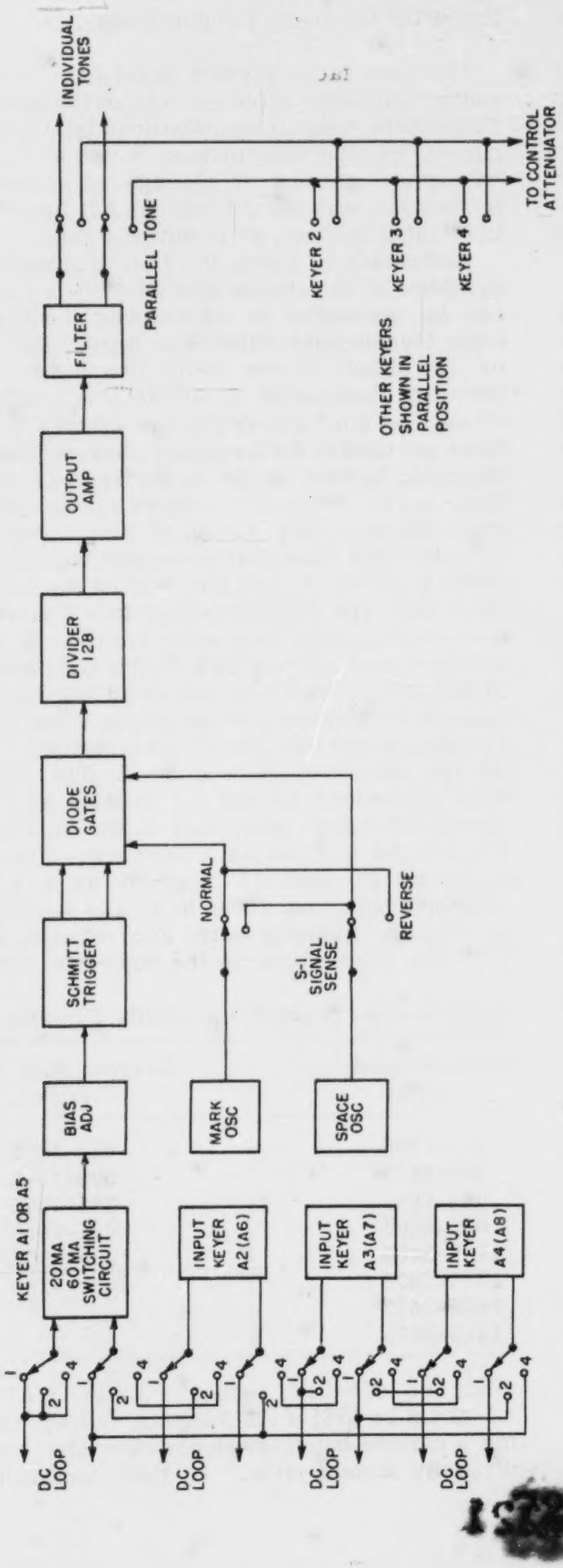

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Figure 9-11.—Block diagram, frequency shift keyer.

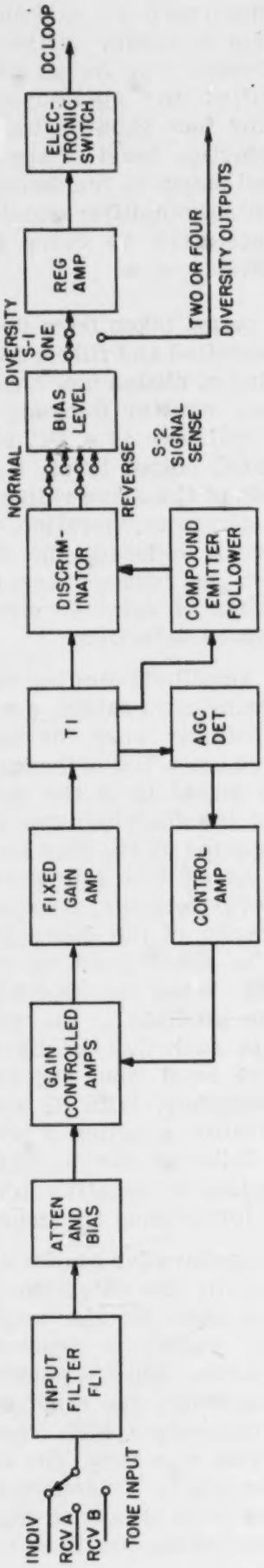

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Figure 9-12.—Block diagram, frequency shift converter.

Transformer T1 couples the output of the fixed gain amplifier to the gain and level control circuits. The output taken at one terminal is rectified and applied to the AGC detector transistor (not shown), this voltage establishes the conduction level of the AGC detector. The amplified output of the detector is applied to the AGC control amplifier which provides the power gain necessary to drive the gain-controlled amplifiers.

The output taken from two other terminals of T1 is rectified and filtered by a rectifier-filter consisting of diodes (not shown), and applied to a compound emitter follower. The output of the emitter follower is a DC voltage proportional to the AGC output level. It is used to limit the amplitude of the drive voltage to the discriminator. In diversity operation, when the gain of the receiver is reduced, the discriminator drive waveform is reduced assuring that a linear combination of detected signals results in the mark space detection.

The amplitude-limited output is applied to the discriminator which generates a DC signal of one polarity when the tone signal is at the mark frequency and of the opposite polarity when the tone signal is at the space frequency. The output of the discriminator is added to the bias level supplied by the bias level network and fed through an emitter follower (not shown) to the output level detector, a regenerative amplifier. The polarity of the discriminator output connection is determined by the SIGNAL SENSE switch S2. When the SIGNAL SENSE switch S2 is set to NORMAL, the polarity of the connection is such that the discriminator supplies a negative level when the tone signal is at the mark frequency. With S2 set to REVERSE, the discriminator supplies a positive level to the emitter follower for a mark frequency tone and supplies a negative level to the emitter follower for a space frequency tone.

The regenerative amplifier provides a stable reference for the detection threshold. A negative input cuts off the amplifier holding the electronic switch in conduction so that loop current flows. When a positive input is applied to the amplifier, the electronic switch is held off and presents a high impedance so that no loop current can flow. The regenerative action of the amplifier transistors assures that the output switch is always in either a nonconducting or full conducting condition.

Converter Diversity Combinations

The two factors which determine diversity connections are switch settings on the individual Converters and Cabinet positions (stations) occupied by the Converters. Because Cabinet wiring for stations A1 through A4 is identical to that for stations A4 through A8, figure 9-13 illustrates only one four-station group.

Referring to figure 9-13, each channel, regardless of the station into which it is plugged, can be connected to an associated individual input transformer within the input filter FL1, or to either of two composite input transformers (designated as RCVR A and RCVR B) within the input filter. The two composite input lines are used in the frequency-diversity/space-diversity system shown in figure 9-13. In this system, two Converter modules are assigned to each channel. One group of four Converters (for the eight channels) processes signals from radio receiver A, which appear on the RCVR A input line: the other group of four Converters processes signals from radio receiver B, which are furnished on the RCVR B input line. With the TONE INPUT switches set as shown, the Converters in stations A1 and A3 are connected to receiver A and the Converters in stations A2 and A4 are connected to receiver B: The converters in stations A1 and A3 function as a frequency-diversity pair, and those in stations A2 and A4 function as a frequency-diversity; those in A1 and A2 function as a space-diversity pair, and those in A3 and A4 function as a space diversity pair. For example, (table 9-1) the Converters in the first two stations

Table 9-1.—Frequency-Diversity Combinations

Narrow-Band (CPS)	Narrow-Wide Band (CPS)
425-1785	425-1105
595-2125	595-1445
765-1955	765-1275
935-2295	935-1615
1105-2465	1955-2805
1275-2805	2380-3230
1445-2635	
1615-2975	

might be 425-CPS channels; those in A3 and A4 would be 1785-CPS channels, thereby forming a narrow-band, frequency-diversity/space-diversity combination. In this combination,

outputs of the four channel discriminators are added in series and applied between the bias network and the emitter-follower input to the regenerative amplifier of the Converter in station A1. This can be verified by tracing the path through the DIVERSITY switches on figure 9-13, which are shown in the FOUR position. In order to combine the outputs of all four channels, the circuit grounds of the four channels must be tied together. This function is performed through one bank of the DIVERSITY switch and cabinet wiring.

To use the Converters in stations A1 through A4 as two separate frequency-diversity pairs, the DIVERSITY switch on each Converter must be set to TWO and the Converters must be rearranged. For example, the Converters used in stations A1 through A4, respectively, might be 425-CPS, 1785-CPS, 595-CPS, and 2125-cps channels, the first two and the last two functioning as narrow-band frequency-diversity pairs.

With the DIVERSITY switches of the four Converters set to TWO:

1. Discriminator outputs of the modules in stations A1 and A2 are placed in series between the bias network and the input to the regenerative amplifier of the Converter in station A1.
2. Discriminator outputs of the modules in stations A3 and A4 are placed in series between the bias network and the input to the regenerative amplifier of the Converter in station A3.
3. The grounds of the Converters in stations A1 and A2 are tied together as are the grounds of the Converters in stations A3 and A4.

Since no space-diversity pairs are involved, all four of the TONE INPUT switches are set to the same position so that all four Converters are connected to the same composite tone line.

The composite input lines are connected to the composite tone lines in the cabinet through the MODE switches on the Control-Attenuator, and the composite-tone lines are connected to the INTERCONNECT A and INTERCONNECT B connectors. The composite-tone lines are connected to the corresponding lines in other Cabinets when more than one Cabinet is used; in this case, the MODE switch is set to MASTER in one of the Cabinets and to SLAVE in each of the other Cabinets. The tone inputs are then received through the input transformers in the Cabinet which has the MODE switch set to MASTER. For example, in the system shown in figure 9-13, which employs four Cabinets containing Converters, the input lines of the top Cabinet and of the third Cabinet from the top are used.

Each converter can be set to operate individually as a receiving channel by turning the DIVERSITY switch on the module to ONE. Each converter can be connected to an individual input line by setting the TONE INPUT switch on the module to INDIV.

Figure 9-13 illustrates the intermediate AGC circuit connections for diversity operation. Notice that these connections are made through another bank of the DIVERSITY switch.

When a group of Converters is used in a diversity combination, the inputs to the AGC control amplifiers of all modules in the group are connected together. This common connection is at the collector of the AGC detector of each module. The Converter receiving the strongest input signal produces the most negative output from the AGC detector. This signal overrides those of the other Converters and drives all AGC control amplifiers in the group. The AGC control amplifiers of all Converters in the group are driven by the AGC signal of the Converter receiving the strongest input signal. This causes the discriminator drive signals of all Converters except the one with the strongest input signal to be attenuated with respect to the discriminator drive signal of the Converter receiving the strongest input signal. Thus, only the strongest input signal produces sufficient discriminator output to drive the regenerative amplifier (output level detector) and the output switch.

CONTROL-ATTENUATOR

When the Keyer TONE OUTPUT switches are in the PARALLEL position (fig. 9-11), the signals are combined and applied to the input transformer, T1 (fig. 9-14) of the Control-Attenuator through the MODE switch. The output signal from T1 is applied to the input attenuation and bias network. The attenuation of this network is sufficient to provide the operating range for the amplifiers.

The output is applied to the gain controlled amplifier and coupled to the input of the fixed-gain amplifier. The output of the fixed gain amplifier is transformer coupled by A1T1 to the output amplifier. It is also transformer coupled, through other terminals of A1T1, rectified, and applied to the base of the AGC detector transistor (not shown). Because the voltage required

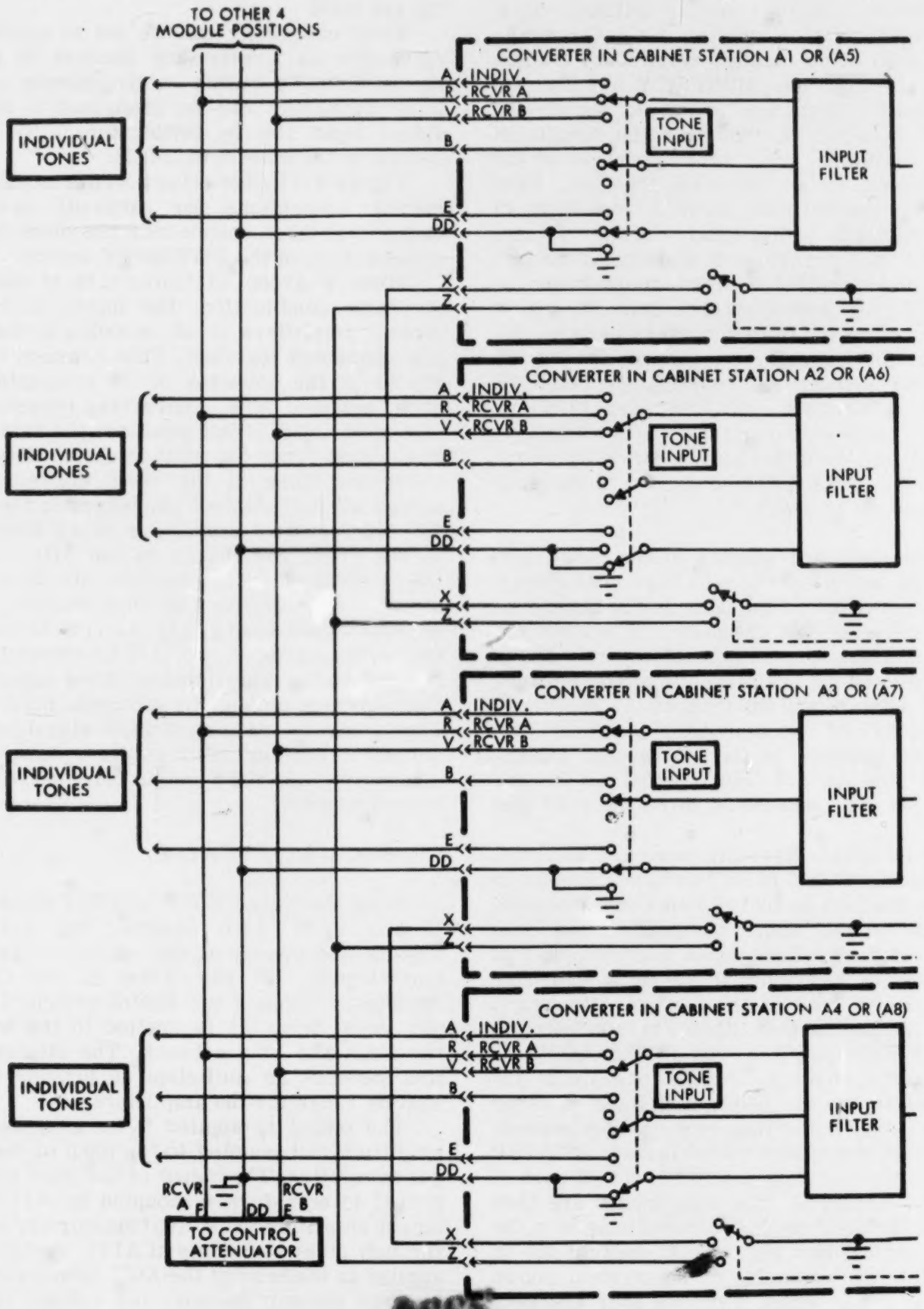
TO OTHER 4 MODULE POSITIONS
CONVERTER IN CABINET STATION A1 OR (A5)
CONVERTER IN CABINET STATION A2 OR (A6)
CONVERTER IN CABINET STATION A3 OR (A7)
CONVERTER IN CABINET STATION A4 OR (A8)
INDIVIDUAL TONES
A INDIV.
R RCVR A
V RCVR B
B
E
DD
X
Z
TONE INPUT
INPUT FILTER
RCVR A F
DD
RCVR B E
TO CONTROL ATTENUATOR

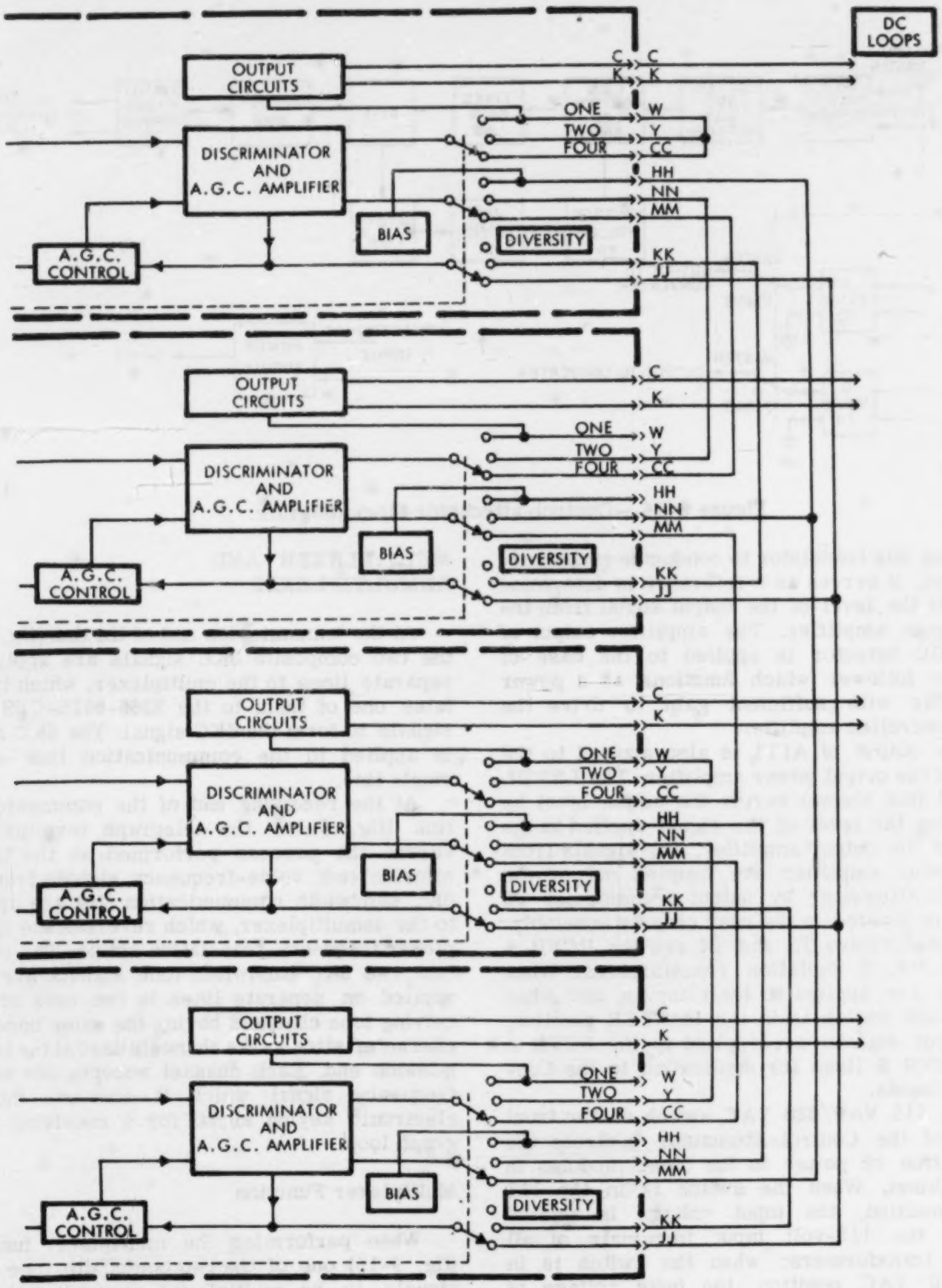

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Figure 9-13.—Converter diversity combination, block diagram.

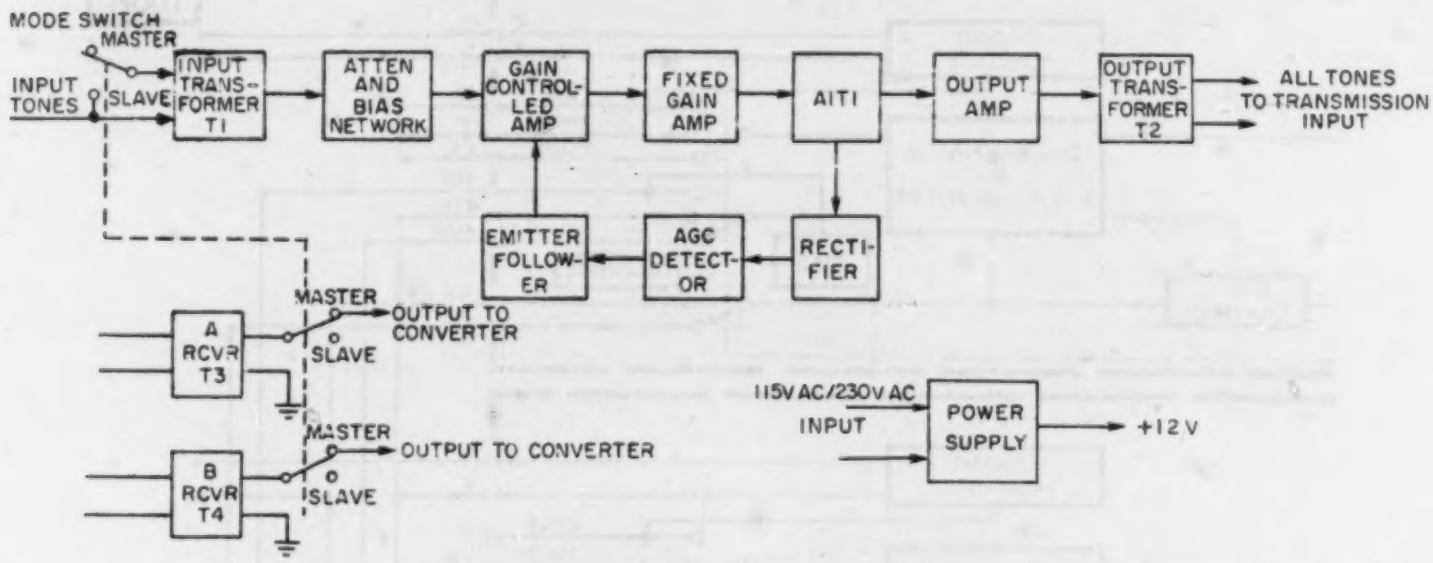

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Figure 9-14.—Control-attenuator block diagram.

to cause this transistor to conduct is essentially constant, it serves as a reference to determine (detect) the level of the output signal from the fixed-gain amplifier. The amplifier output of the AGC detector is applied to the base of emitter follower which functions as a power amplifier with sufficient gain to drive the gain-controlled amplifier.

The output of A1T1 is also applied to the base of the output power amplifier. The LEVEL control (not shown) varies the output level by adjusting the level of the signal applied to the base of the output amplifier. The signals from the power amplifier are coupled out of the Control-Attenuator by output transformer T2 which is located in the rear chassis assembly.

Transformers T3 and T4 are the RCVR A and RCVR B isolation transformers. When signals are applied to their inputs, and when the MODE switch is in the MASTER position, the input signals are applied to the RCVR A and RCVR B lines for application to the Converter inputs.

The 115 VAC/230 VAC switch on the front panel of the Control-Attenautor controls the application of power to the other modules in the Cabinet. When the switch is in the 115 VAC position, the input voltage is applied across the 115-volt input terminals of all power transformers; when the switch is in the 230 VAC position, the input voltage is applied across the full primary windings of all power transformers.

MULTIPLEXER AND DEMULTIPLEXER

At the transmission end of the link (fig. 9-10) the two composite 3KC signals are applied on separate lines to the multiplexer, which translates one of them to the 3265-5915-CPS band signals to form the 6KC signal. The 6KC signal is applied to the communication link on the single line.

At the receiving end of the communication link (fig. 9-10) the telegraph terminal reverses the process performed at the transmission end; voice-frequency signals from the 6KC bandwidth communication link are applied to the demultiplexer, which reverses the multiplexer frequency-translation action. The resultant two 3KC bandwidth tone signals are then applied on separate lines to two sets of receiving tone channels having the same bandpass characteristics as the channels used at the transmission end. Each channel accepts one voice-frequency signal which it converts into an electronic keying signal for a receiving telegraph loop.

Multiplexer Function

When performing the multiplexer function (fig. 9-15) one of the two composite-tone input signals to be multiplexed is applied to the DIRECT PATH jack, and the other to the TRANSLATED PATH jack (Mux-Demux inputs).

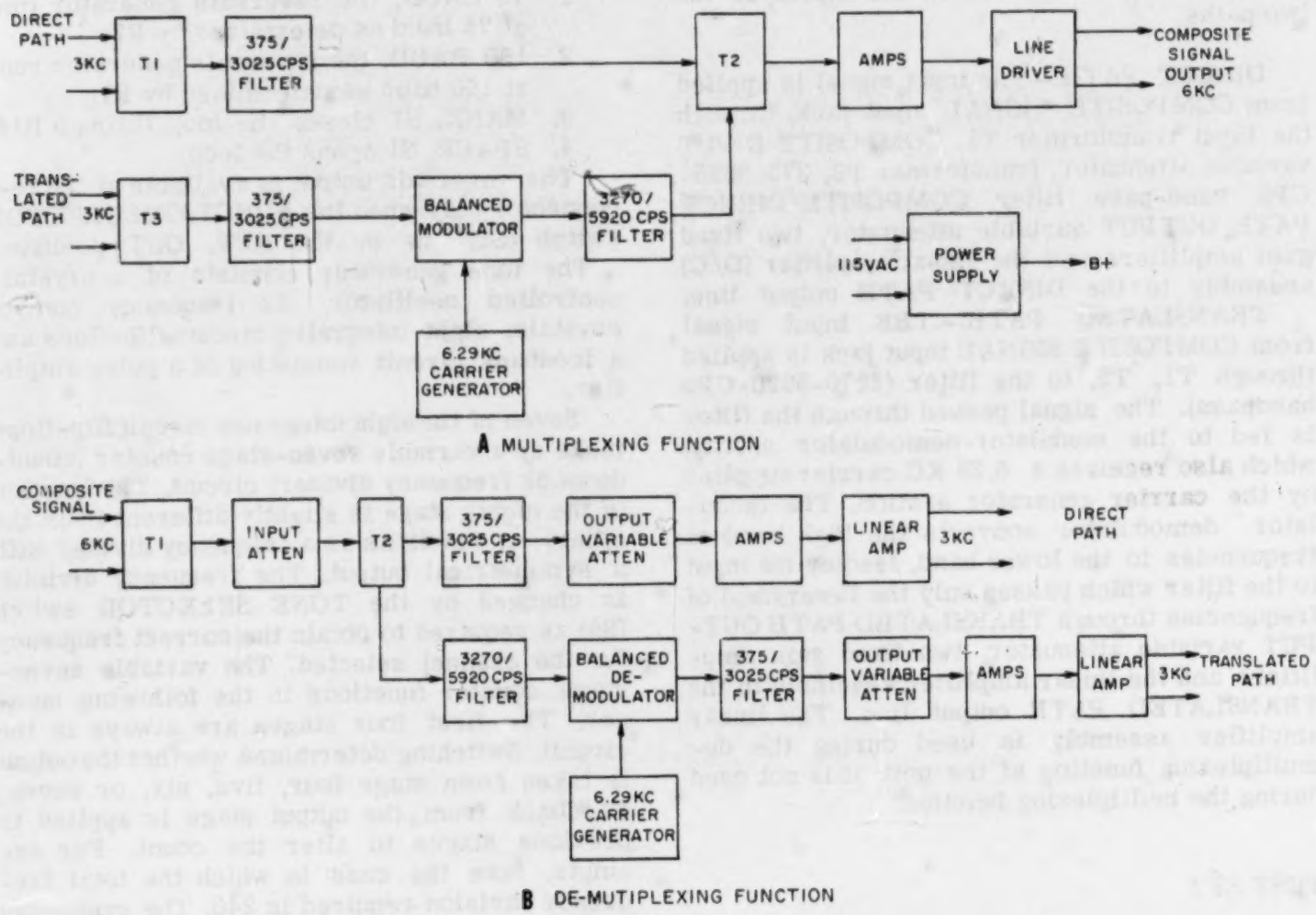

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Figure 9-15.—Multiplexer demultiplexer block diagram.

The DIRECT PATH input passes through an input transformer which isolates the floating input circuit from the Mux-Demux ground. The output is applied to a bandpass filter which passes the 375-3025-CPS band of frequencies for summing with the translated path output signal.

The TRANSLATED PATH input is applied to an input transformer which isolates the floating input from the Mux-Demux ground and matches the low impedance of the input circuit to the higher input impedance of the bandpass filter. A filter removes signals that are outside the 375-3025-CPS pass-band, the output is fed to the modulator-demodulator section which also receives a 6.29KC carrier supplied by the carrier-generator assembly. The modulator-demodulator, a balanced lattice type modulator, suppresses both the input and the carrier frequencies, and passes the upper and lower sidebands. Of the modulator-demodulator output fed to the bandpass filter, only the lower sideband of the modulated signal is passed (the upper sideband falling outside the 3270-5920-CPS pass-band). The translated path signal is summed with the direct path signal in T2 to form a composite signal with a pass-band of 375-5920 CPS. The composite signal is then amplified to the desired level and applied to a transmission input.

Demultiplexer Function

Demultiplexer operation is essentially the reverse of the multiplexer operation described above. Because two separate outputs are furnished in the demultiplexing function, two variable attenuators and linear amplifiers are used; a third variable attenuator establishes the proper composite input signal level for

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application to the filters at the inputs of the two paths.

DIRECT PATH.—The input signal is applied from COMPOSITE SIGNAL input jack, through the input transformer T1, COMPOSITE INPUT variable attenuator, transformer T2, 375-3025-CPS band-pass filter COMPOSITE/DIRECT PATH OUTPUT variable attenuator, two fixed gain amplifiers and the linear amplifier (D/C) assembly to the DIRECT PATH output line.

TRANSLATED PATH.—THE input signal from COMPOSITE SIGNAL input jack is applied through T1, T2, to the filter (3270-5920-CPS bandpass). The signal passed through the filter is fed to the modulator-demodulator section which also receives a 6.29 KC carrier supplied by the carrier generator section. The modulator demodulator converts the high band of frequencies to the lower band, feeding its input to the filter which passes only the lower band of frequencies through TRANSLATED PATH OUTPUT variable attenuator, two fixed gain amplifiers and the linear amplifier assembly to the TRANSLATED PATH output line. The linear amplifier assembly is used during the demultiplexing function of the unit; it is not used during the multiplexing function.

TEST SET

The Test Set (fig. 9-16) consists of a reversals generator, a tone generator, an audio amplifier and loudspeaker, a meter, switches to control operation, and a power supply circuit. THE FUNCTION SELECTOR switch is the primary control of Test Set operation. It determines the connection and routing of input and output signals. Because, in various positions, it functions with the various circuits in the Test Set, these positions will be discussed with the circuits they affect.

The reversals generator (fig. 9-17) consists of a free running multivibrator driving a transistor switch output circuit. The active element of the multivibrator is an integrated circuit differential amplifier. The MODE SELECTOR switch S1 determines the mode of operation of the reversals generator, controlling the timing circuitry and providing loop closure to pins A (output) and P (ground) of the test connector P1. The positions of S1 and the functions of the reversals generator are as follows:

1. 75 BAUD, the reversals generator runs at 75 baud as determined by R2.
2. 150 BAUD, the reversals generator runs at 150 baud as determined by R1.
3. MARK, S1 closes the loop through R16.
4. SPACE, S1 opens the loop.

The reversals output is available at the test connector only when the FUNCTION SELECTOR switch (S2) is in the REV. OUT position.

The tone generator consists of a crystal-controlled oscillator, 12 frequency control crystals, eight integrated circuit flip-flops and a feedback circuit consisting of a pulse amplifier.

Seven of the eight integrated circuit flip-flops make up a variable seven-stage counter (countdown or frequency divider) circuit. The function of the eighth stage is slightly different from the others; it functions as a frequency divider with a symmetrical output. The frequency division is changed by the TONE SELECTOR switch (S4) as required to obtain the correct frequency for the channel selected. The variable seven-stage counter functions in the following manner. The first four stages are always in the circuit. Switching determines whether the output is taken from stage four, five, six, or seven. Feedback from the output stage is applied to previous stages to alter the count. For example, take the case in which the total frequency division required is 240. The symmetry

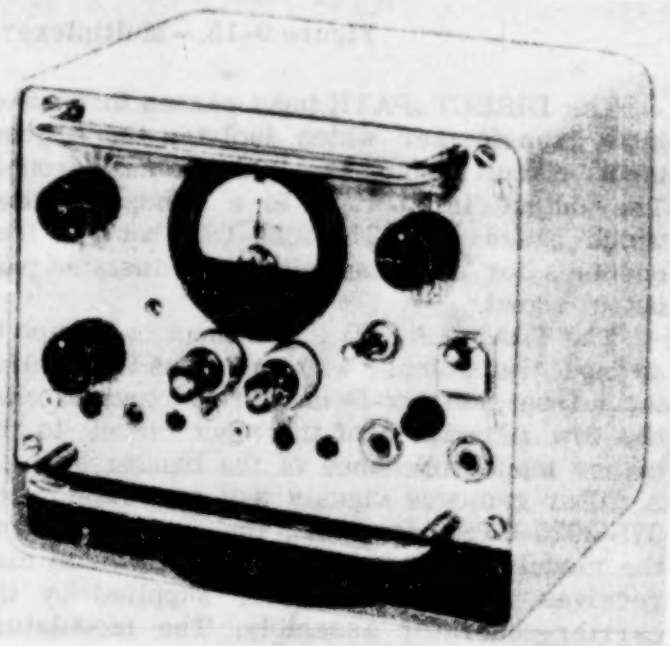

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Figure 9-16.—Telegraph test set.

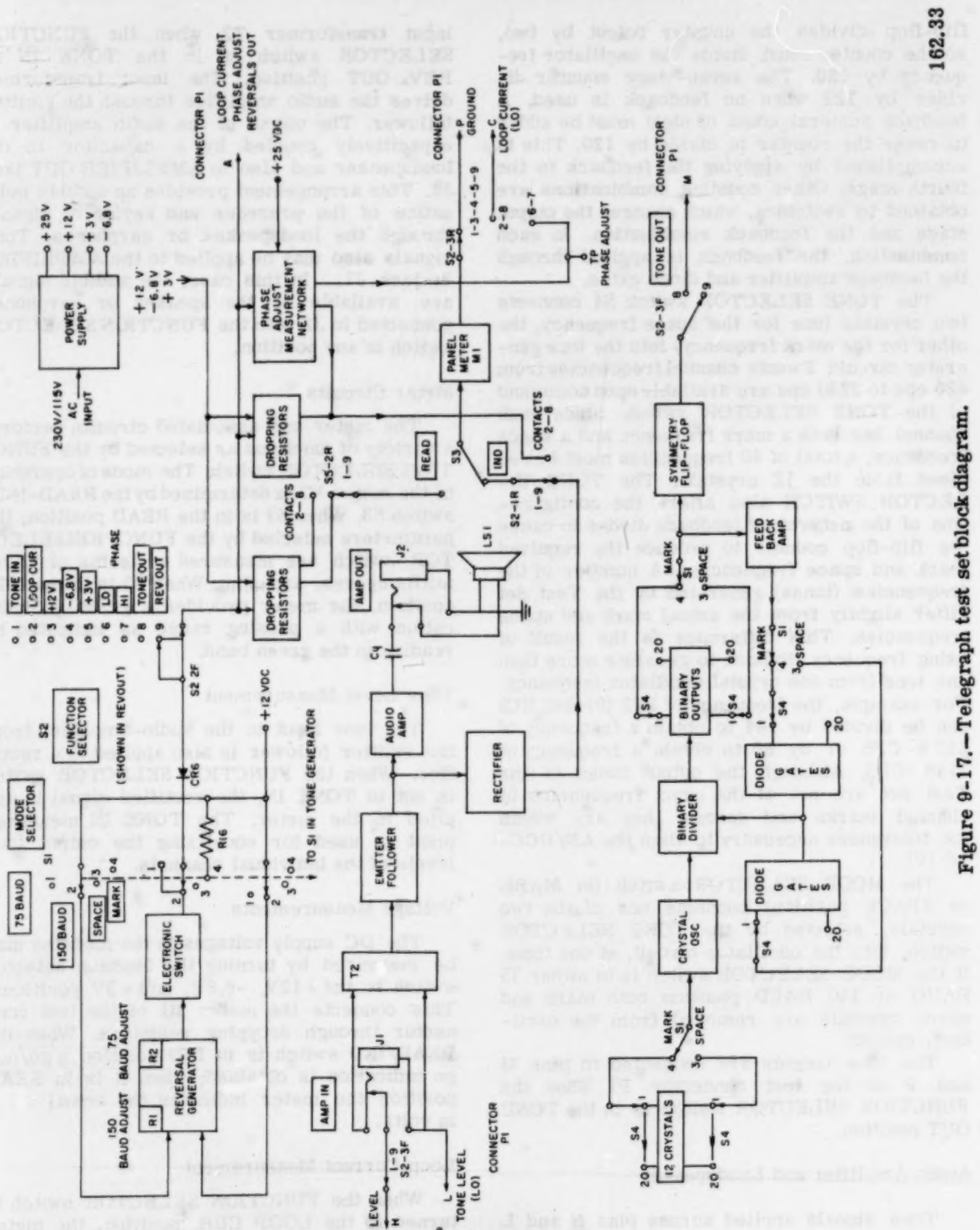

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Figure 9-17.—Telegraph test set block diagram.

flip-flop divides the counter output by two, so the counter must divide the oscillator frequency by 120. The seven-stage counter divides by 128 when no feedback is used. A feedback numeral count of eight must be added to cause the counter to divide by 120. This is accomplished by applying the feedback to the fourth stage. Other counting combinations are obtained by switching, which changes the output stage and the feedback combination. In each combination, the feedback is applied through the feedback amplifier and diode gates.

The TONE SELECTOR switch S4 connects two crystals (one for the space frequency, the other for the mark frequency) into the tone generator circuit. Twenty channel frequencies from 425 cps to 3230 cps are available upon command of the TONE SELECTOR switch. Since each channel has both a mark frequency and a space frequency, a total of 40 frequencies must be derived from the 12 crystals. The TONE SELECTOR SWITCH also alters the configuration of the network of feedback diodes to cause the flip-flop counter to produce the required mark and space frequencies. A number of the frequencies (tones) generated by the Test Set differ slightly from the actual mark and space frequencies. This difference is the result of using frequency division to generate more than one tone from one crystal oscillator frequency. For example, the frequency of 2Y2 (91,840 KC) can be divided by 144 to obtain a frequency of 637.8 CPS or by 80 to obtain a frequency of 1148 CPS. Although the output tones of the Test Set are not at the exact frequencies of channel marks and spaces, they are within the tolerances necessary to align the AN/UCC-1C (V).

The MODE SELECTOR switch (in MARK or SPACE position) connects one of the two crystals, selected by the TONE SELECTOR switch, into the oscillator circuit, at one time. If the MODE SELECTOR switch is in either 75 BAUD or 150 BAUD position both mark and space crystals are removed from the oscillator circuit.

The tone outputs are connected to pins M and P of the test connector P1 when the FUNCTION SELECTOR switch is in the TONE OUT position.

Audio Amplifier and Loudspeaker

Tone signals applied across pins N and L of the test connector are connected to input transformer T2 when the FUNCTION SELECTOR switch is in the TONE IN or REV OUT position. The input transformer drives the audio amplifier through the emitter follower. The output of the audio amplifier is capacitively coupled by a capacitor to the loudspeaker and also to AMPLIFIER OUT jack J2. This arrangement provides an audible indication of the presence and keying of signals through the loudspeaker or earphones. Tone signals also may be applied to the AMPLIFIER In jack J1. In this case, the audible signals are available at the speaker or earphones connected to J2 with the FUNCTION SELECTOR switch in any position.

Meter Circuits

The meter and associated circuits perform a variety of functions as selected by the FUNCTION SELECTOR switch. The mode of operation of the meter M1 is determined by the READ-IND. switch S3. When S3 is in the READ position, the parameters selected by the FUNCTION SELECTOR switch are measured in terms of volts, milliamperes, and dbm. When S3 is in the IND. position, the meter provides a go/no-go indication with a passing range as indicated by reading in the green band.

Tone Level Measurement

The tone input to the audio-amplifier from the emitter follower is also applied to a rectifier. When the FUNCTION SELECTOR switch is set to TONE IN, the rectified signal is applied to the meter. The TONE IN measurement is used for equalizing the output tone levels of the individual channels.

Voltage Measurements

The DC supply voltages in the modules may be measured by turning the function selector switch to the + 12V, -6.8V, and + 3V positions. This connects the meter M1 of the test connector through dropping resistors. When the READ/IND switch is in IND position a go/no-go indication is obtained; when it is in READ position the meter indicates the actual value in volts.

Loop Current Measurement

When the FUNCTION SELECTOR switch is turned to the LOOP CUR. position, the meter indicates loop current. Each module contains

a resistor in series with the DC loop. The voltage which is proportional to loop current is applied to pins A and C of the TEST connector of the module. This voltage is coupled through the test connector of the Test Set, dropping resistor, and the LOOP CUR, contacts of the FUNCTION SELECTOR switch, to the meter.

Delay Adjustment

The phase angles of the channel signals applied to pin A of the test connector and to the PHASE ADJ test point are compared by a delay comparison network. The DC component of the output of this network is proportional to the difference in phase of the input signals and dependent in polarity upon which channel has the greater delay. The output of the delay comparison network is applied to meter M1 through the FUNCTION SELECTOR switch when it is set to PHASE LO or PHASE HI. The delays of the two channels may be equalized by adjusting the modules to obtain a zero indication on the meter.

CHAPTER 10

ELECTRONIC AIDS TO NAVIGATION, PART I

Electronic aids to navigation include electronic equipments such as radio direction finders, radio compass equipment, loran equipment, and tacan equipment. This chapter will discuss radio direction finder and loran equipments using the AN/URD-4 and AN/UPN-15 as representative equipments. An overal block diagram of the equipments will be presented along with circuit analyses of special circuits.

RADIO DIRECTION FINDER AN/URD-4

Essentially, the radio direction finder (RDF) is a sensitive receiver to which a directional antenna is connected. Radio direction finding is used primarily in air navigation. It is also used in the location of personnel afloat in liferafts or lifeboats, provided these craft are equipped with a radio transmitter, and that the RDF equipment is capable of receiving the transmitted frequencies.

Radio Direction Finder, AN/URD-4 (fig. 10-1) produces a visual indication of the bearing of a received signal. Fundamentally, this is accomplished by means of an indicator unit, which presents an oscilloscopic display of the output of a receiver.

Direction finding information is presented in the form of a propeller-shaped pattern on the face of the cathode-ray tube of the indicator. The pattern can be made to shift position to form a distorted figure 8 "sense bend" the apex of which indicates the relative bearing of the received signal. The method of obtaining the propeller-shaped pattern and sense bend will be treated later. Directional information is displayed with a bearing accuracy of plus or minus five degrees.

Provision is made on the indicator cabinet for headphones, which are used for aural reception simultaneously with D/F (direction finding) operation. Aural receiption is possible on AM or FM signals only. Direction finding information is displayed on the cathode-ray tube for any received signal whether modulated or unmodulated. The equipment is designed for either shipboard or shore installation. A functional block diagram of the shipboard system is illustrated in figure 10-2. Signal data converter CV-538/URD-4 is not required for shore installations.

ANTENNA

The antenna of the AN/URD-4 direction finding system is a two-dipole vertically polarized, Adcock array, which is rotated about the vertical axis by a motor at a constant speed. The antenna is most sensitive to signals in the vertical plane and least sensitive to signals in the horizontal plane. Accurate direction finding information is provided, however, from signals polarized as much as 45° from vertical.

Each time a dipole passes in a plane with a given signal, maximum voltage is generated in the antenna. Because there are two dipoles in the antenna array, the separate dipoles pass through the maximum signal path at different times to introduce a modulated component on the receiver RF signal. The modulated RF voltage is fed to the receiving portion of the equipment.

The rotating portion of the antenna is coupled to the stationary portion (fig. 10-2) through a rotating capacitance joint. The energy transfer from the antenna to the receiver is accomplished through this capacitance connection.

A two-phase alternator generates horizontal and vertical sweep voltages for application to the horizontal and vertical deflection plates of the cathode-ray tube. The phase of the two voltages are correct to form a circular pattern on the indicator. This pattern is present when no signal is being received.

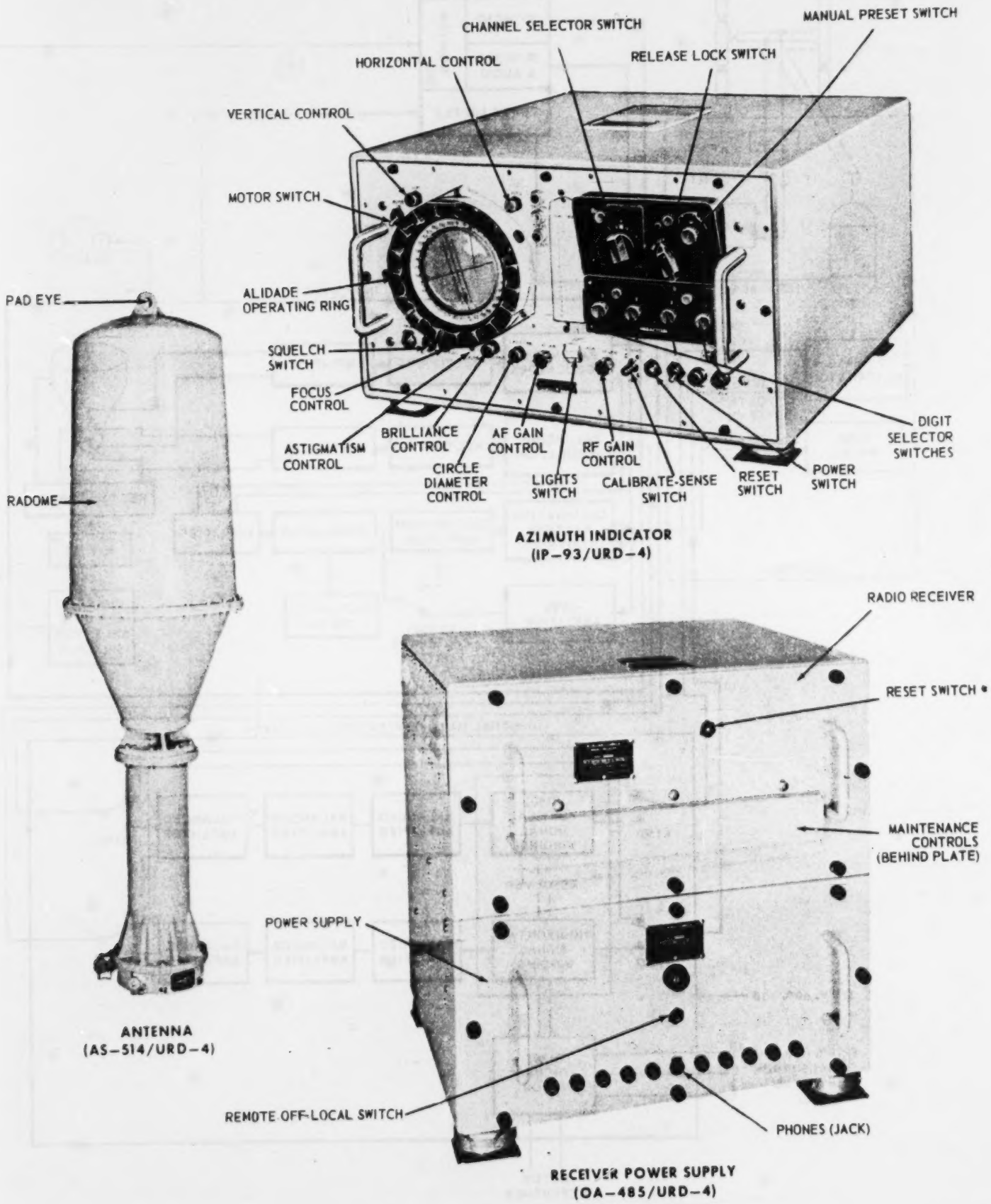

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Figure 10-1.—Direction finder set AN/URD-4, major components.

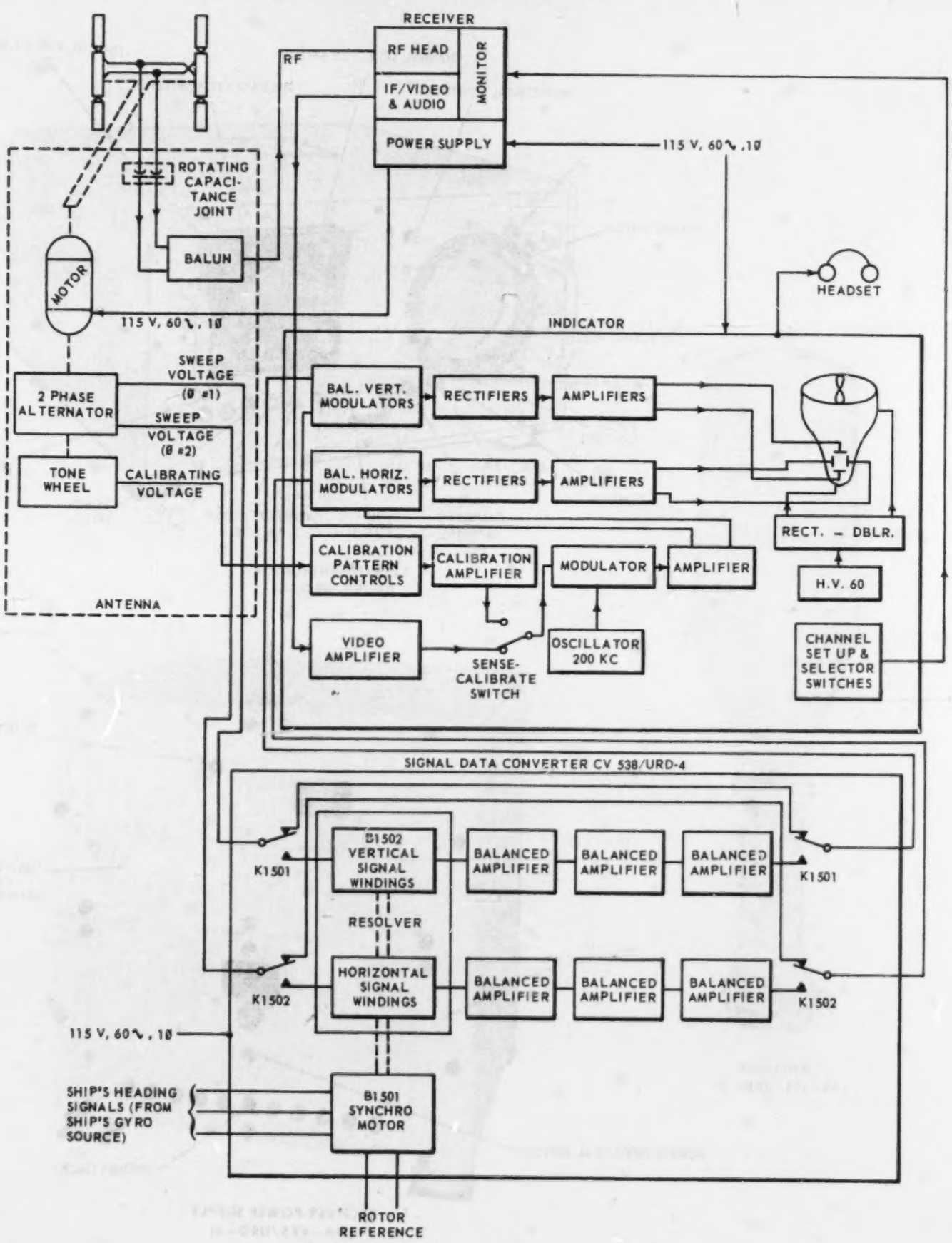

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Figure 10-2.—Direction finder set AN/URD-4A, overall functional block diagram.

Calibration voltage for calibration of the indicator unit is generated by a tone-wheel, which is connected to the alternator. The antenna array, the two-phase alternator, and the tone-wheel are all driven by the antenna drive motor.

RF antenna voltage is fed to the receiver through a balance-to-unbalance device referred to as a "balun." The balanced output of the antenna is unbalanced by the balun to allow RF voltage to be transferred to the receiver by means of coaxial cable.

SIGNAL DATA CONVERTER

In shipboard installations of the direction finder set, the signal data converter is connected between the receiver and the azimuth indicator. Its purpose is to shift the phase of the sweep signals with respect to the video signal to produce a true geographical bearing indication at the azimuth indicator. If the video and sweep signals are applied to the azimuth indicator in the same phase relationship that exists at the antenna, the signal bearing indicated by the azimuth indicator is relative to the ship's bearing. To determine the true bearing of the received signal, it is necessary to add the ship's true heading. When the equipment is set for true bearing operation the signal data converter performs this addition automatically. Resolver B1502, positions synchro motor B1501 which receives ship's heading information from the ship's gyro circuits. When the signal data converter is in use, the true bearing of the signal is read directly from the indicator.

Relays K1501 and K1502 are controlled by the TRUE-STBY-REL switch located on the azimuth indicator front panel. When this switch is placed in its REL position, relays K1501 and K1502 are deenergized and the sweep signals are fed directly to the indicator for application to the deflection plates of the CRT to produce a relative signal bearing. When this switch is placed in its TRUE position, relays K1501 and K1502 are energized and the sweep signal currents are caused to pass through the windings of resolver B1502. The sweep signals are then fed through their respective amplifiers to the azimuth indicator to produce a true geographical bearing indication. Amplification of the sweep signals is necessary to compensate for losses in the windings of the resolver.

The signal data converter has a self-contained power supply for operation of the signal amplifier stages.

RECEIVER

The receiver group (fig. 10-2) includes the r-f head, monitor, IF video and audio chassis, and the power supply. The RF head of the receiver is essentially a tuned amplifier unit. The receiving frequency passed by the RF head is determined by the monitor circuit.

The monitor controls the frequency of a variable frequency oscillator (VFO). The output of the VFO is multiplied and used as the heterodyning frequency (in the first mixer) for the signal input to the RF head.

The monitor consists of several stages of heterodyning. It provides its controlling action to the VFO by operating a tuning capacitor (which is controlled by a tuning motor driven by the monitor) and by controlling a reactance tube shunted across the VFO.

Essentially, the frequency control system performs in the following manner: A sample of the output of the variable frequency oscillator in the RF head is beat against a series of crystal-controlled frequencies in the monitor to produce a frequency to be fed to a crystal-controlled phase discriminator. The discriminator output, in turn, causes the frequency of the VFO to approach the correct frequency by controlling either the tuning motor or the reactance tube. The frequency at which the monitor operates is determined by the selection of the various crystal-controlled frequencies in the monitor.

An isolation amplifier stage in the RF head (fig. 10-3) couples the output of the VFO through another isolation amplifier to a first mixer circuit in the monitor. The first mixer receives another input from a harmonic generator, which, in turn, is supplied from the first crystal oscillator. This oscillator produces the fundamental frequency generated in the monitor circuit.

The harmonic generator produces frequencies ranging from the 4th to the 13th harmonic of the oscillator fundamental frequency. Either of these harmonics may be selected from the generator circuit by tuning a transformer. The selected output is heterodyned with the VFO frequency output in the 1st mixer.

If the monitor is set to a frequency in the 225- to 299.9-MC range, a selector switch permits the output of the 1st mixer to be fed to a low bandpass filter. This signal is subsequently passed to a bandpass amplifier, and to a 2nd bandpass filter. When the monitor is

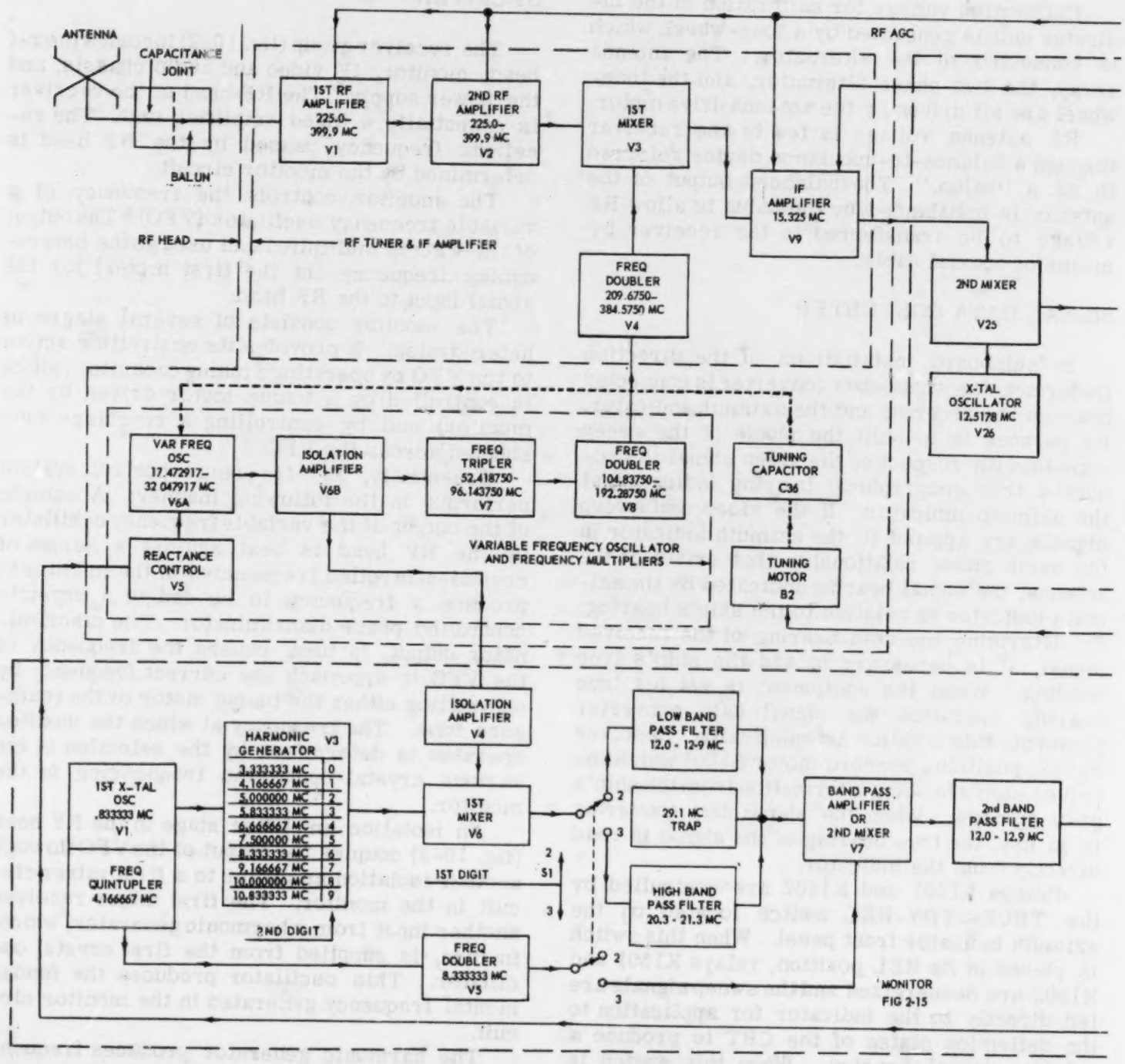

set to a frequency in the 300.0- to 399.9-MC range, the 1st mixer output is fed to a high bandpass filter and, in turn, is mixed with the tenth harmonic of the 1st crystal oscillator at the 2nd mixer. This action produces a beat frequency, which is fed to a 2nd bandpass filter. The bandpass amplifier or 2nd mixer stage functions as an amplifier for frequencies from 225 to 299.9 MC and as a mixer stage for frequencies from 300.0 to 399.9 MC. The tenth harmonic of the 1st crystal-oscillator frequency is produced by the action of a frequency quintupler and frequency doubler, which are cascade connected between the oscillator and 2nd mixer circuits.

A 2nd crystal oscillator provides a choice of five frequencies. The 3rd mixer combines the output of the second bandpass filter with the selected output of the 2nd crystal oscillator to produce a beat frequency. This output is fed through the 3rd bandpass filter to the 4th mixer. The 3rd crystal oscillator provides a

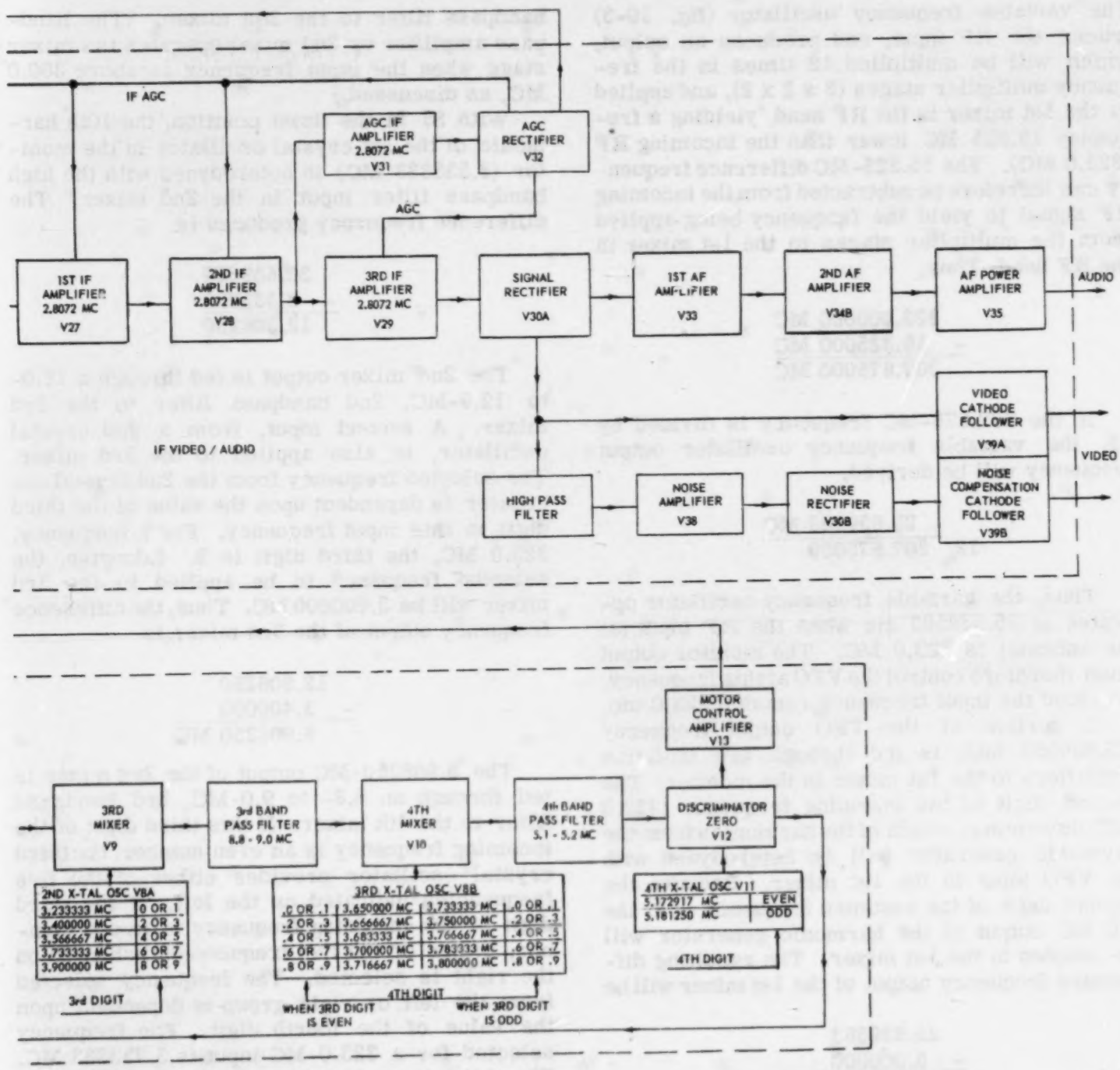

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Figure 10-3A.—Block diagram of RF head, monitor, and video-audio chassis.

choice of 10 frequencies. Either of five of these frequencies may be selected when the chosen frequency has an even third digit, with either of the other five frequencies being selected when the third digit of the chosen frequency is an odd number. The selected crystal-controlled frequency is heterodyned in the 4th mixer stage with the input from the 3rd bandpass filter. The resulting output is passed through the 4th bandpass amplifier to the discriminator. The [illegible] frequency applied to the discriminator will always be 5.172917 MC when the fourth digit is even, and 5.181250 MC when the fourth digit is an odd number.

In order to gain a better understanding of the monitor operation, consider the following example.

Assume that a frequency of 323.0 MC is selected by the channel selector switch (fig. [illegible]) as the input frequency to the RF head.

The variable frequency oscillator (fig. 10-3) tracks the RF input, and produces an output, which will be multiplied 12 times in the frequency multiplier stages (3 x 2 x 2), and applied to the 1st mixer in the RF head, yielding a frequency 15.325 MC lower than the incoming RF (323.0 MC). The 15.325-MC difference frequency can therefore be subtracted from the incoming RF signal to yield the frequency being applied from the multiplier stages to the 1st mixer in the RF head. Thus,

$$\begin{array}{r} 323.000000 \text{ MC} \\ -\ 15.325000 \text{ MC} \\ \hline 307.675000 \text{ MC} \end{array}$$

If the 307.675-MC frequency is divided by 12, the variable frequency oscillator output frequency will be derived.

$$12\overline{)\ 307.675000}\quad 25.639583 \text{ MC}$$

Thus, the variable frequency oscillator operates at 25.639583 mc when the RF input (at the antenna) is 323.0 MC. The monitor output must therefore control the VFO at this frequency, provided the input frequency remains 323.0 mc.

A portion of the VFO output frequency (25.639583 MC) is fed through two isolation amplifiers to the 1st mixer in the monitor. The second digit of the incoming frequency (323.0 MC) determines which of the harmonics from the harmonic generator will be heterodyned with the VFO input in the 1st mixer. Because the second digit of the assumed frequency is 2, the 5.0 MC output of the harmonic generator will be coupled to the 1st mixer. The resulting difference frequency output of the 1st mixer will be

$$\begin{array}{r} 25.639583 \\ -\ 5.000000 \\ \hline 20.639583 \text{ MC} \end{array}$$

When the frequency selected by the channel selector (fig. 10-1) is in the range from 225.0 to 299.9 MC, the switch, S1, at the output of the 1st mixer in the monitor (fig. 10-3) will be in the position shown (up). For input frequencies from 300.0 to 399.9 MC, S1 is in the position opposite to that shown (down).

Since the chosen frequency is 323.0 MC, S1 at the 1st mixer output in the monitor is down (opposite to that shown), and the output frequency of the mixer is fed through the high bandpass filter to the 2nd mixer. (The bandpass amplifier or 2nd mixer operates as a mixer stage when the input frequency is above 300.0 MC, as discussed.)

With S1 in the down position, the 10th harmonic of the 1st crystal oscillator in the monitor (8.333333 MC) is heterodyned with the high bandpass filter input in the 2nd mixer. The difference frequency produced is

$$\begin{array}{r} 20.639583 \\ -\ 8.333333 \\ \hline 12.306250 \end{array}$$

The 2nd mixer output is fed through a 12.0- to 12.9-MC, 2nd bandpass filter to the 3rd mixer. A second input, from a 2nd crystal oscillator, is also applied to the 3rd mixer. The selected frequency from the 2nd crystal oscillator is dependent upon the value of the third digit in this input frequency. For a frequency, 323.0 MC, the third digit is 3. Likewise, the selected frequency to be applied to the 3rd mixer will be 3.400000 MC. Thus, the difference frequency output of the 3rd mixer is

$$\begin{array}{r} 12.306250 \\ -\ 3.400000 \\ \hline 8.906250 \text{ MC} \end{array}$$

The 8.906250-MC output of the 3rd mixer is fed through an 8.8- to 9.0-MC, 3rd bandpass filter to the 4th mixer. If this third digit of the incoming frequency is an even number, the third crystal oscillator provides either of the five frequencies indicated on the left. If the third digit of the incoming frequency is an odd number, either of the five frequencies indicated on the right is selected. The frequency selected from the left or right group is dependent upon the value of the fourth digit. The frequency selected for a 323.0-MC input is 3.733333 MC. Thus, the input frequency to the discriminator will be

$$\begin{array}{r} 8.906250 \\ -\ 3.733333 \\ \hline 5.172917 \text{ MC} \end{array}$$

Since the fourth digit of the input frequency (323.0 MC) is even, the 4th crystal oscillator also supplies an input of 5.172917 MC to the discriminator.

The discriminator is a phase-sensitive device, which develops an output voltage representing the resultant of any phase deviation

between the two frequencies. When the two frequencies are exactly 90° out of phase, the discriminator error voltage produced represents zero error. Any deviation in phase develops either a positive or negative discriminator voltage output, the polarity depending upon whether the 4th bandpass filter frequency is leading or lagging the 4th crystal-oscillator frequency in phase. The amplitude is dependent upon the phase angle existing between the two frequencies.

If the error voltage is large, the discriminator output voltage is fed to a motor control amplifier whose output controls a tuning motor. The tuning motor, in turn, drives a VFO tuning capacitor. The discriminator output and associated circuits cause the tuning motor to tune the VFO to that frequency which, when fed through the monitor unit, is approximately the same frequency as that of the 4th crystal oscillator.

When the frequency is close to that of the desired operating frequency, the reactance tube in the RF head takes control of the VFO to bring the circuit to the exact frequency. This action is described later. Since the discriminator voltage output tunes the VFO to a frequency that equals the sum of all the crystal-controlled frequencies, it follows that the VFO frequency may be changed a given amount by changing any one of the crystal-controlled frequencies the same amount.

The output of the VFO is coupled through an isolation amplifier and multiplier stages to the 1st mixer in the RF head. The 1st and 2nd RF amplifiers in the RF head amplify the input signal to a level sufficeint to provide proper heterodyning of the two signals. The 1st mixer output of 15.325 MC is amplified in the 1st IF stage and coupled through a coaxial cable to the IF, video-audo chassis. The RF and 1st IF amplifiers are AGC controlled.

A second frequency heterodyning process takes place at the input to the IF, video-audio chassis to produce a 2.8072-MC, IF frequency. The remaining circuits of the IF video-audio chassis are conventional receiving circuits.

INDICATOR

A block diagram of the indicator unit is shown in figure 10-4. The indicator provides the means by which the detected signal is amplified and mixed with the sweep voltages, which were originated at the antenna. The indicator also presents an oscilloscopic display of the received direction finding information. Because the receiver must be installed a relatively close distance to the antenna, the indicator unit is normally situated at a remote location relative to the receiving and antenna equipments. The frequency of operation of the equipment is usually selected remotely from the front panel of the indicator.

Mounted just behind the front panel of the indicator is a 20-position rotary turret assembly (fig. 10-5). The memory cylinder fits inside the removable turret assembly and mechanically actuates various contacts of the channel selector switch. Arranged around the periphery of the memory cylinder are 20 evenly spaced detented bars, which are parallel to its longitudinal axis. Along each bar are four tabs, which can be positioned laterally along the length of the cylinder. The bars and their tabs are accessible through a slot in the cylinder case. By positioning the four tabs on a particular bar in relationship to a series of indexing digits on the cylinder, a particular channel frequency can be set up. Since there are 20 longitudinal bars along the cylinder, it follows that 20 of the total 1750 frequencies available within the tuning range of the equipment can be selected as channel operating frequencies by presetting the cylinder.

The alternator voltages from the antenna are fed to the indicator, as discussed. These voltages serve as the horizontal and vertical sweep input voltages, respectively. The phase of the vertical input is shifted 90° from that of the horizontal to produce a circular (Lissajous) pattern on the cathode-ray indicator in the absence of a video signal.

The input video signal is amplified and fed through a sense D/F calibrate switch (fig. 10-4) to the first modulator circuit when the switch is in the sense D/F position. A 200-kc carrier oscillator output is also fed to the first modulator, and is therefore modulated in this stage by the video signal. The resulting signal output is amplified and applied from a cathode follower circuit to both the vertical and horizontal modulator stages.

The input video signal is applied to the video differential amplifier. The video differential amplifier is a duo-triode tube, one section of which receives a d-c control voltage whose magnitude is proportional to the amplitude of the prevailing noise. The other section of the tube receives a negative-going video signal.

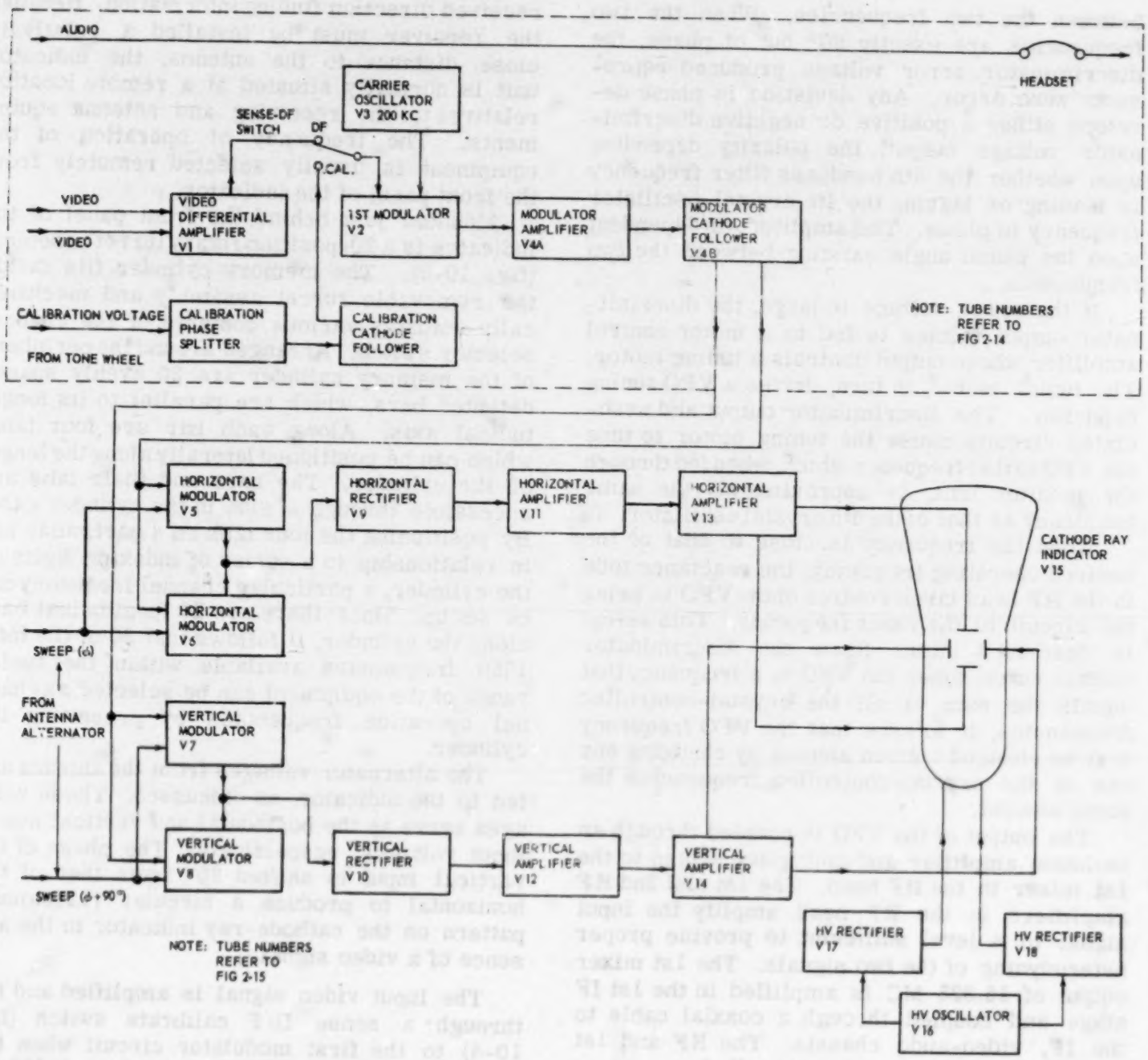

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Figure 10-4.—Azimuth indicator, block diagram.

The video output of the video section causes the current in the noise section of the video differential amplifier to vary.

When the video input is maximum negative (representing the maximum input at the antenna) the current through the noise section of the tube is maximum, and is effective in supplying a negative-going grid voltage, which cuts off the first modulator tube. When the first modulator is cut off, no video signal can pass through the subsequent stages to the indicator, and a spot appears in the center of the indicator screen.

Conversely, when the video input is minimum negative, the conduction of the noise section of the video differential amplifier is minimum, and the first modulator stage is effective in supplying a video signal through the subsequent stages to the indicator screen. Thus, a video signal is fed to the indicator during the time of the nulls at the antenna, and the tips of the propeller-shaped pattern produced on the

applied to the vertical and horizontal deflection plates, respectively. The modulation process in the horizontal and vertical modulators, in the presence of a video signal, produces a voltage, which when applied to the respective deflection plates causes the pattern to assume a propeller shape (fig. 10-6 A).

A sense circuit is put into operation when it is desired to determine the direction from which the signal is being received. Normally, both sides of the antenna are in exact balance. The sense circuit causes the operation of a relay (shown later), which alters the electrical characteristics of the antenna. The electrical change of the antenna creates an unbalance, and a phase shift in the field response pattern, which causes the propeller-shaped pattern on the cathode-ray indicator to be distorted. The distorted pattern is in the form of a distorted figure 8 (fig. 10-6B), the apex of which points in the direction of the signal origin.

As stated earlier, when the sense D/F calibrate switch is in the sense D/F position, the video signal will be displayed as a propeller-shaped pattern. When the switch is in the CALIBRATE position, calibration voltage will be displayed as a 36-lobe pattern (fig 10-6C) which provides a means of calibrating the indicator.

The high voltage for the cathode-ray tube is obtained by rectifying and RF voltage generated by an RF oscillator. The voltage is applied to the accelerating anode of the tube.

ANTENNA CIRCUITS

The antenna (fig. 10-7) is a two-dipole Adcock array, which is rotated by a direct-coupled, 900-rpm induction motor, B1. The motor also drives an alternator, G1, and a wheel, E1.

Normally, the antenna is electrically connected, as represented in figure 10-8A. Maximum signal voltage will be induced into both antennas simultaneously when the signal is received, as shown in the illustration. Since the dipoles are one-half wavelength at the mean frequency, the voltage induced in the two halves of each dipole will be 180° out of phase. Likewise, the separate dipoles are spaced one-half wavelength apart (at the mean frequency), causing the voltage in the two dipoles to be out of phase 180°.

Assume that the received signal induces a voltage in the antenna of the polarity shown in figure 10-8, A. An antenna current is conducted for dipole 1, which is through L2, C2, T1, C1, and L1. Dipole 2 conducts through L4, C2, T1, C1, and L3. Note that the two signals reinforce each other at the balun. Thus, the receiver input is approximately twice that received by a single antenna.

Relay K1 (fig. 10-7) alters the circuit of the antenna when the sence D/F calibrate switch on the panel of the indicator (fig. 10-1) is moved to the SENSE position. The circuit then appears as shown in figure 10-8 B. In this condition, a phase-shifting network comprising L1, L2, R1, and R2 is connected across the dipole 1 input. Thus, the phase difference between the two voltages from both dipoles is shifted to alter the

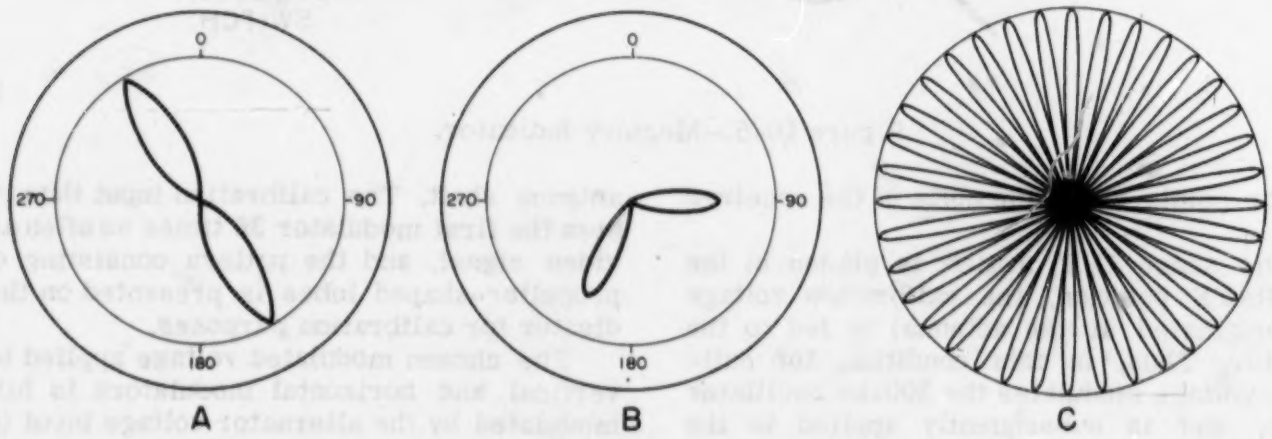

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Figure 10-6.—Indicator patterns.

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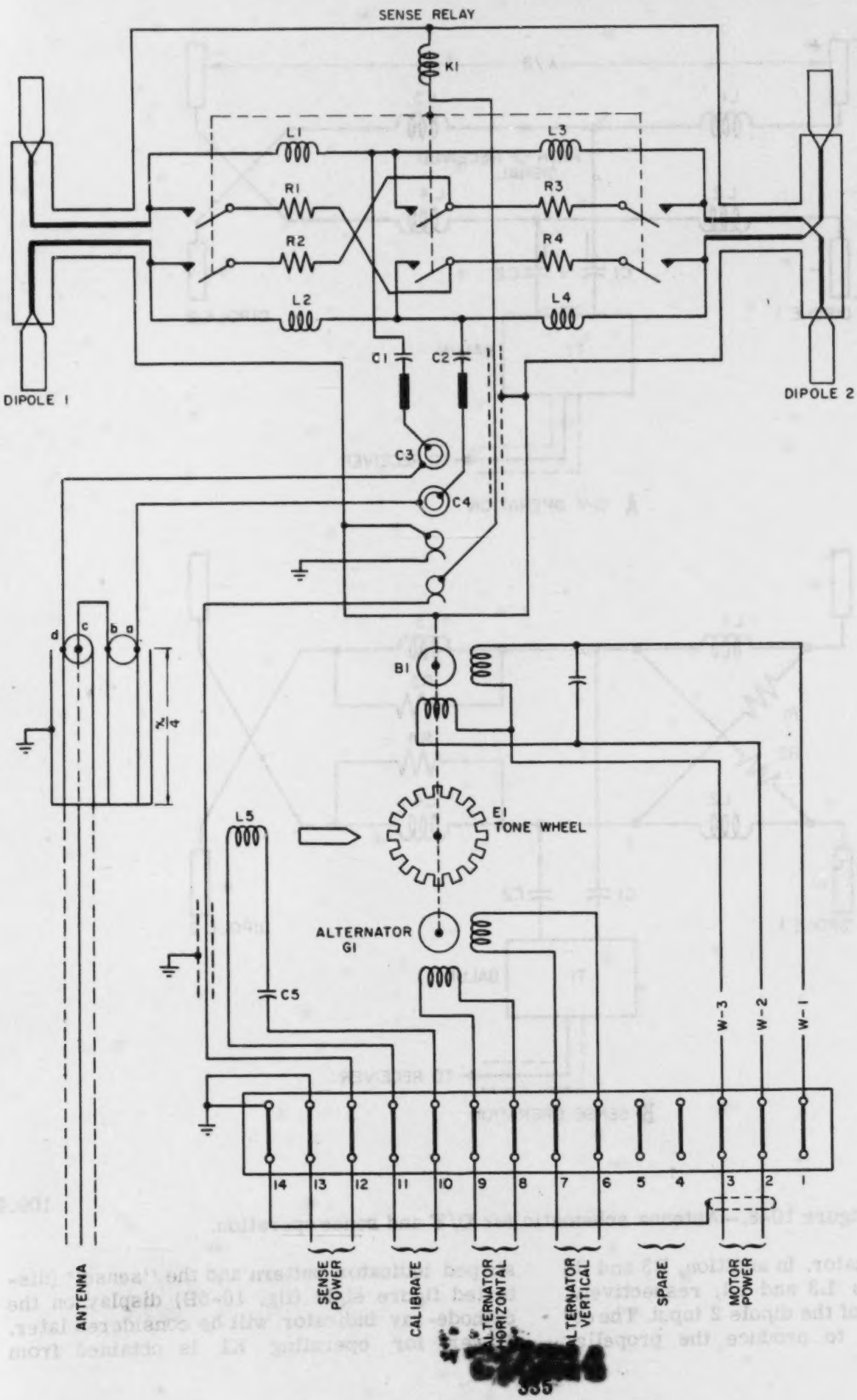

Figure 10-7.—Antenna schematic diagram.

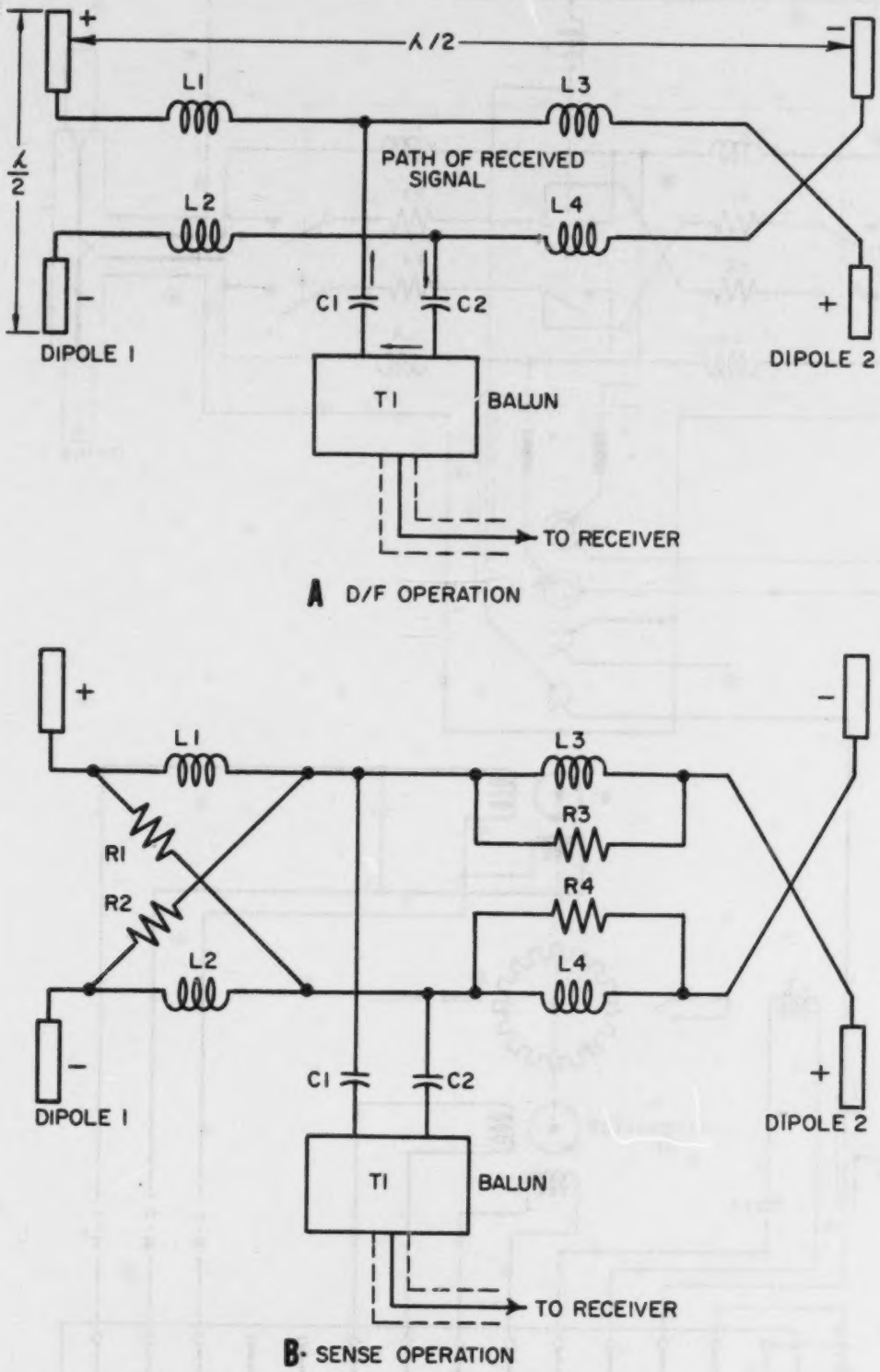

Figure 10-8.—Antenna schematic for D/F and sense operation.

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pattern of the indicator. In addition, R3 and R4 are shunted across L3 and L4, respectively, causing attenuation of the dipole 2 input. The effect of the phases to produce the propeller shaped indicator pattern and the "sense" (distorted figure eight (fig. 10-6B) display on the cathode-ray indicator will be considered later. Power for operating K1 is obtained from

terminal 12 (fig. 10-7), via the sense D/F calibrate switch.

Due to antenna rotation (approximately 900 rpm) the RF voltage induced into each dipole from a given source is caused to vary at a sinusoidal rate. Thus, the input to the balun (and subsequently to the receiver) is a modulated RF voltage.

The output of the antenna array at the antenna terminals is balanced to ground. To permit the use of a coaxial cable for transferring the output of the array to the input of the receiver, the antenna output is made unbalanced. The balance-to-unbalance condition is created by a balun, T1.

The rotating antenna array is coupled to the stationary portion of the antenna through rotating capacitances C3 and C4 (fig. 10-7). The energy is fed into the balun one-quarter wavelength above ground. The voltage at this point is maximum. A coaxial cable connected between "c" and "d" of the balun supplies the input to the receiver.

The antenna drive motor, B1, is an induction-type, single-phase motor, which drives a single antenna shaft at 900 rpm (15 rps). The motor also drives a two-phase alternator, G1. The alternator produces one cycle of sweep voltage for the horizontal and vertical deflection plates, respectively, for each complete rotation of the antenna. Thus the frequency of the sweep voltage to the cathode-ray tube deflection plates is 15 cps.

A 36-lobe calibration pattern (fig. 10-6C) is presented on the indicator tube when the sense D/F calibrate switch (fig. 10-1) is placed in the CALIBRATE position. One lobe appears for each 10 degrees of the 360-degree total.

A 36-toothed tone wheel, E1, driven by the antenna drive motor, affects the highly permeable core of L5 (fig. 10-7) to induce an alternating current into the circuit comprising L5, C5, and the calibration input circuit (connected between 10 and 11 of TB1). C5 tunes L5 so that the voltage developed is correct to cause the production of the 36-lobe pattern. The manner by which the induced voltage affects the indicator circuits is treated later.

RF HEAD CIRCUITS

The signal from the antenna is fed via C1 (fig. 10-7) to the RF head of the receiver (fig. 10-3). The input is a 15-cps modulated RF voltage in the 225.0- to 399.0-mc range.

The first RF amplifier, V1, the second RF amplifier, V2, the mixer, V3, and the frequency doubler, V4, are capacitance tuned by capacitors contained in their respective cavities. This type of tuning is utilized to obtain a high Q and to provide frequency stability.

To understand the operation of the cavities, consider the diagram (fig. 10-9A), which illustrates the physical construction of the cavity. Figure 10-9 B, shows the electrical equivalent of the circuit. The center post of the cavity acts as an inductance, L1. In conjunction with ganged capacitors C1, C2, and C3, L1 is electrically equivalent to a quarter-wavelength rod whose base is grounded, and whose opposite end is at a point of high impedance. The cavity is tuned to resonance by C1, C2, and C3. C4 is a trimmer capacitor, and slug Lv is a tuning vane, which can be utilized to adjust the inductance, L1, of the cavity.

VFO AND REACTANCE TUBE CIRCUITS

It should be recalled that the frequency of the mixer output is 15,325 mc. During frequency selection, reactance tube V5 receives a DC control voltage from a discriminator circuit, which controls the frequency output of the variable frequency oscillator. The VFO circuit comprises tubes V5, V6, V7, V8, and V4, and produces the input frequency, which is fed to the V3 mixer (fig. 10-3).

Remember that the control voltage polarity may be either positive or negative, depending upon the direction of the error frequency from the desired frequency. In actual operation, zero error voltage from the discriminator is slightly positive to ground.

The reactance of C41 in series with C38 (in the reactance tube circuit (fig. 10-10)) develops a capacitive reactance, which is equal to or greater than the resistance of R31. The r-f voltage from the tap of L18 to ground is also developed across C38, R31, and C41. The voltage across C41 is applied to the grid of the reactance tube, V5. Due to the capacitances involved, the r-f voltage at the grid of V5 lags the L18 (variable frequency oscillator) voltage by approximately 90°). The plate current of V5 is always in phase with the grid voltage. Thus, the plate r-f current lags the vfo oscillator r-f voltage by an angle that approaches 90 degrees. V5 is therefore an inductive reactance shunted across the oscillator circuit.

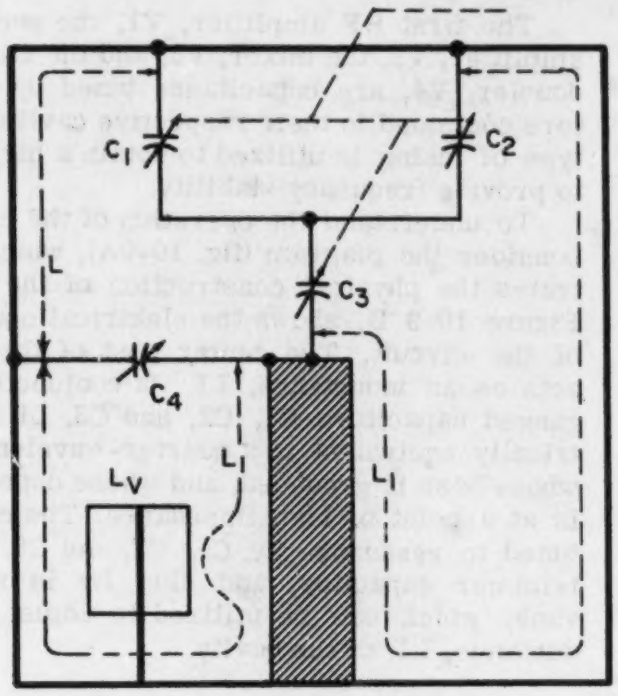

A PHYSICAL CONSTRUCTION OF CAVITY

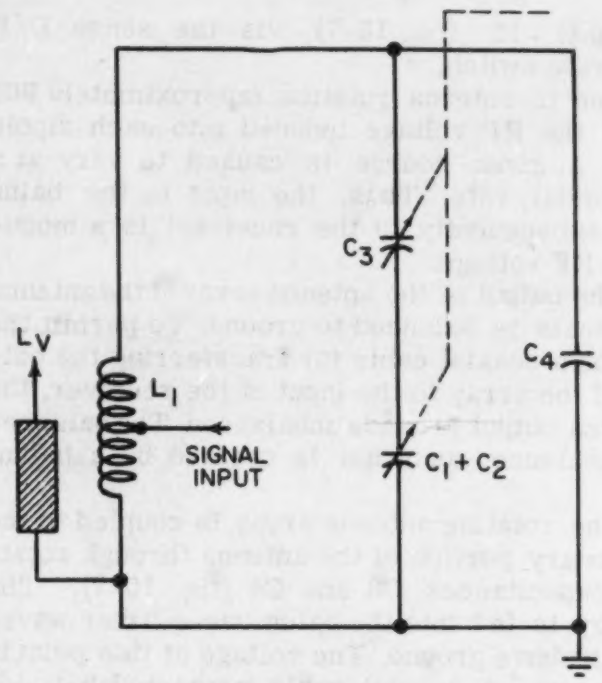

B *EQUIVALENT CIRCUIT

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Figure 10-9.–RF head cavity, physical and electrical equivalent circuits.

The d-c control voltage is fed through a decoupling network comprising C46 and R27 to the L17-C45 junction. Assume that this voltage goes more positive to ground. Tube V5 will conduct a heavier current, and therefore acts as a smaller inductive reactance across the oscillator to increase the oscillator frequency output. Conversely, if the control voltage goes in a negative direction, a larger lagging voltage is applied to the oscillator, and the oscillator frequency decreases. Thus, by controlling the bias at the grid of V5 with the DC control voltage, the tube current and, in turn, the inductive reactance (as seen by the VFO) is also controlled. Cathode resistor R26 develops a bias of such a value that the control voltage up to approximately +5 volts DC is the equivalent of a zero error signal from the monitor.

The variable frequency oscillator circuit, V6A, is connected as a series-fed Hartley oscillator whose feedback is developed between the lower and upper sections of L18. C36A provides oscillator tuning, and C37 is the trimmer capacitor. The corrected oscillator output frequency is coupled by C33 to the control grid of a cathode follower. V6B, which serves as an isolation stage between the oscillator and the frequency tripler stage, V7, and output doubler, V8.

V8 acts as a frequency doubler stage. The V8 output is again doubled by frequency doubler stage V4.

The frequency of this signal is 12 times that at the output of the VFO, V6A. With the VFO frequency corrected, the heterodyning process in the mixer stage, V3, produces a 15.325-MC signal, which is fed through a filer circuit to the grid of the first FF amplifier, V9. This stage, like the first and second RF amplifiers, is AGC controlled. Amplifier V9 is a conventional IF amplifier stage whose output is fed to the IF video-audio chassis.

FREQUENCY SELECTION CONTROL CIRCUITS

As stated earlier, the memory cylinder located behind the front panel of the indicator can be preset to select any one of 20 of the total 1750 available frequencies. Frequency selection is initiated by the four lateral bars (fig. 10-5) which mechanically actuate various contacts of the channel selector switch.

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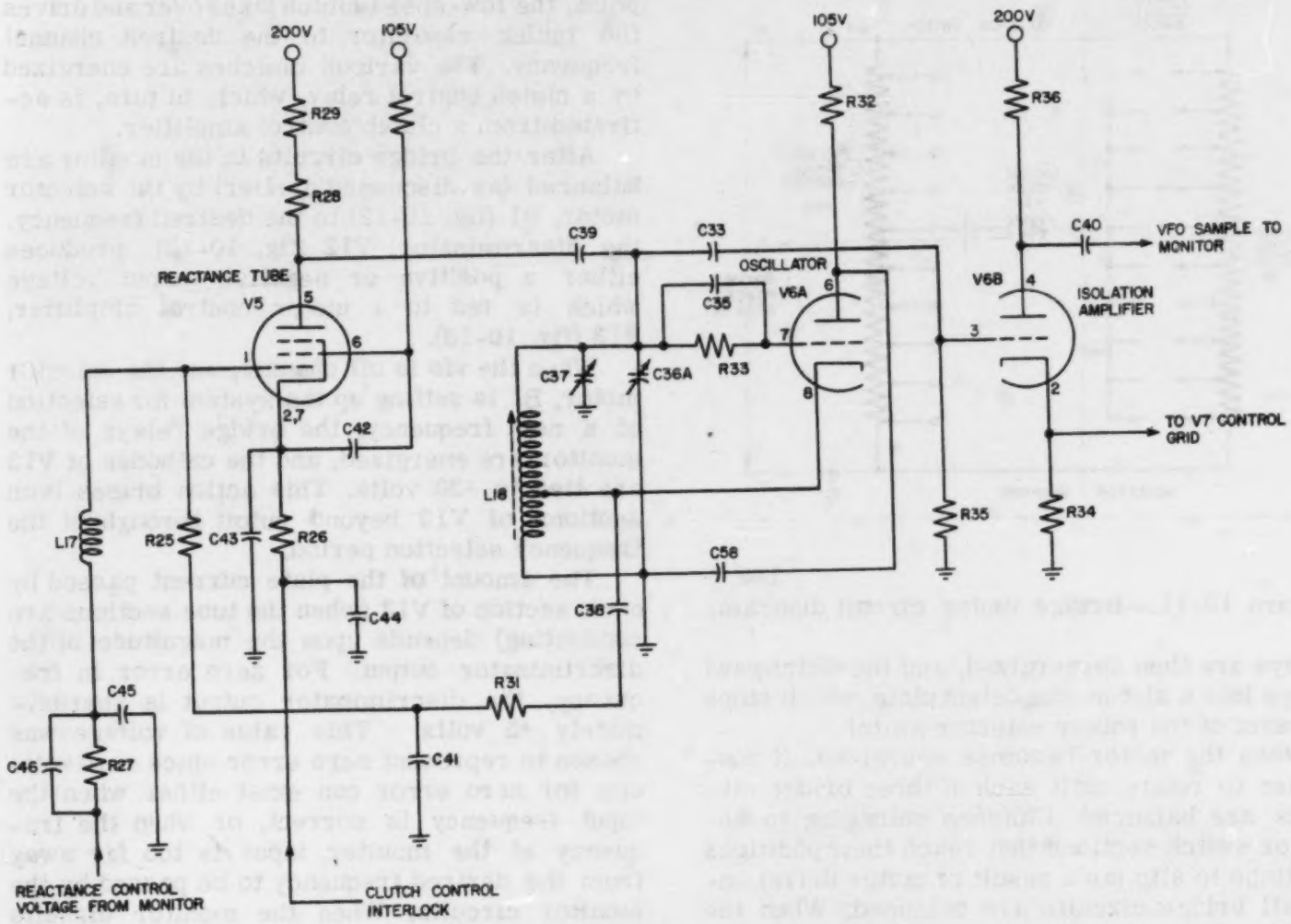

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Figure 10-10.—Reactance control circuit.

When one of the preset frequencies is to be selected, the channel selector switch is turned to the new position, which causes the unbalance of bridge circuits. These circuits are similar to that shown in figure 10-11. Three similar bridge circuits exist, corresponding to the second-third-, and fourth-digit controls of the frequency selection system.

To select the new frequency, the channel selector switch chooses a tap on its associated bridge resistor, which corresponds to the position of the actuating bar on the memory cylinder. It should be recalled from the block diagram discussion that the monitor circuits produce a discriminator DC control voltage, which controls the frequency output of the vfo in the RF head. Thus, a change in the input frequency to the RF head necessitates a change in the monitor frequencies so that the vfo will be locked in at the correct frequency.

The channel selecting bridge circuits (fig. 10-11) are established between the indicator and monitor. If that section of the channel selector switch (for a particular bridge) and associated rotary selector switch in the monitor are not at the same tap on their respective resistors, a difference in potential will exist at the ends of the bridge. The voltage thus established is placed across a bridge relay, K4, and the relay is energized.

With K4 energized, its contacts close to connect a clutch relay, K1 (fig. 10-12), between a +27.5-volt-supply and ground. The 3-4 contacts of K1 close to apply motor power to the selector motor, B1. The clutch relay also releases its associated clutch face by pulling a pawl, P, out of a notch on a detent plate, CP1. The released clutch face allows the selector motor to operate, driving the wiper on the rotary selector switch S1F, until it reaches a tap, which again balances the bridge. The bridge and clutch

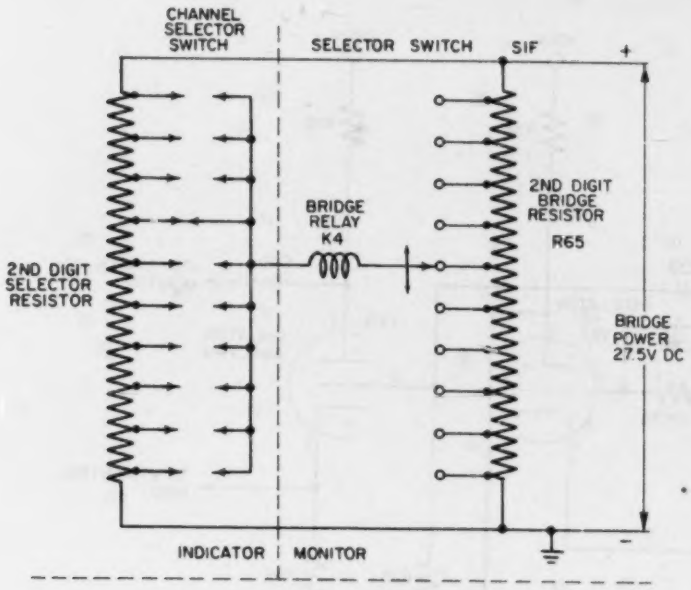

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Figure 10-11.—Bridge tuning circuit diagram.

relays are then deenergized, and the clutch pawl drops into a slot on the detent plate, which stops the arm of the rotary selector switch.

When the motor becomes energized, it continues to rotate until each of three bridge circuits are balanced. Clutches belonging to selector switch sections that reach their positions continue to slip (as a result of motor drive) until all bridge circuits are balanced. When the last bridge relay deenergizes, the clutch relay also deenergizes, and the motor stops.

Sections of the selector switch are ganged to their respective clutch plates (not shown). The clutch plates (when released) drive their respective switch sections to select the proper combination of components in the harmonic generator and mixer, and the second, third and fourth crystal oscillators of the monitor.

TUNING MOTOR CONTROL CIRCUITS

The tuning motor controls the tuning capacitor of the VFO by three clutches designated the high-, medium-, and low-speed clutches, respectively. The total frequency range of the vfo is divided into six equal ranges. The high-speed clutch drives the tuning mechanism at high speed until the segment is reached in which the selected frequency lies. The medium-speed clutch then takes control to drive the tuning capacitor at medium speed until the approximate range of the half power points on the response curve of the 4th mixer is reached. At this point, the low-speed clutch takes over and drives the tuning capacitor to the desired channel frequency. The various clutches are energized by a clutch control relay, which, in turn, is activated from a clutch control amplifier.

After the bridge circuits in the monitor are balanced (as discussed earlier) by the selector motor, B1 (fig. 10-12) to the desired frequency, the discriminator, V12 (fig. 10-13) produces either a positive or negative output voltage which is fed to a motor control amplifier, V13 (fig. 10-13).

When the vfo is off channel, and the selector motor, B1 is setting up the system for selection of a new frequency, the bridge relays of the monitor are energized, and the cathodes of V13 are tied to +30 volts. This action biases both sections of V13 beyond cutoff throughout the frequency selection period.

The amount of the plate current passed by each section of V13 (when the tube sections are conducting) depends upon the magnitude of the discriminator output. For zero error in frequency, the discriminator output is approximately +5 volts. This value of voltage was chosen to represent zero error since zero voltage for zero error can exist either when the input frequency is correct, or when the frequency at the monitor input is too far away from the desired frequency to be passed by the monitor circuits. When the monitor circuits are on frequency, the discriminator output is +5 volts. The grid (pin 7) voltage is +8 to ground, while the cathode is approximately 10.2 volts. The V13B grid (pin 3) is about 5.3 volts to ground. Thus, V13B receives about 5 volts bias and does not conduct a sufficient current to energize its plate relay, K7.

When the input frequency is too far above the chosen frequency to be passed through the monitor (as may be the case when a new channel is selected), the discriminator output voltage is zero. The V13A grid voltage decrease from +5 volts to zero causes a smaller current through K8 (in the V13A plate circuit), and the K8 contacts are released (position shown). Likewise, the smaller current through R53 reduces the V13B bias. The increased V13B current through the solenoid of K7 energizes this relay to move the contacts down (opposite to that shown). This action causes the tuning motor, B2, to turn by completing the motor circuit from ground at the 2-4 contacts of K7 (K7 energized), through S4A (in the position shown), through the motor filter, and through

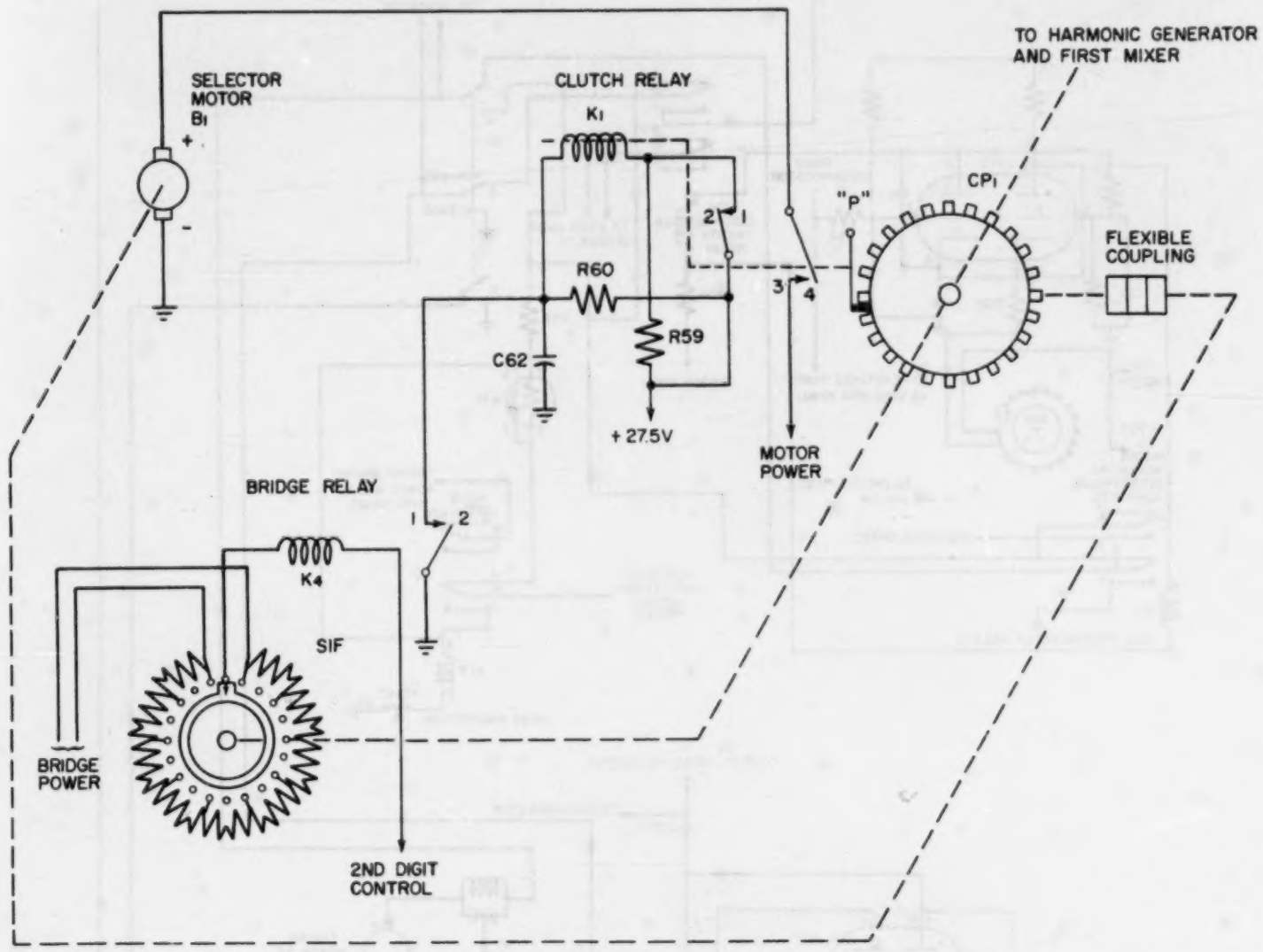

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Figure 10-12.—Frequency selection control circuits.

the motor from a to b, through another motor filter, and the contacts of S4B (in the position shown), through the 8-7 contacts of K8 (K8 deenergized), through R56, the 3-2 terminals of K14, through the 3-4 contacts of K13, and to the +30-volt unfiltered motor power. The polarity of the voltage applied to the motor is such that the vfo tuning capacitor is driven towards the selection of a lower frequency.

When the 4th mixer, V10, output (fig. 10-10) is near the chosen frequency, the discriminator, V12, circuit is functioning, and the reactance tube, V5, (fig. 10-10) begins to operate. The discriminator, V12, output rises to approximately five volts positive. The conduction of V13A (fig. 10-13) increases, and its plate relay, K8, becomes energized. V13B continues to conduct, and both relays are now energized. The 8-7 contacts of K8 are opened when K8 is energized, while the 4-2 contacts of K7 (when the relay is energized) are closed. With S4A in the position shown this action removes drive power from the motor.

If the frequency at the discriminator input tends to fall below the zero error frequency (vfo low in frequency) the magnitude of the discriminator, V12, output voltage will be increased in the positive direction. V13A conducts heavily, and K8 is energized.

The bias increase on V13B causes the V13B plate current to decrease, and K7 is deenergized. Power is now applied to the motor from a ground on the contacts of a high speed clutch control relay, K12 (discussed later). The motor circuit is connected from a ground on S5, through the 7-8 contacts of K9, through

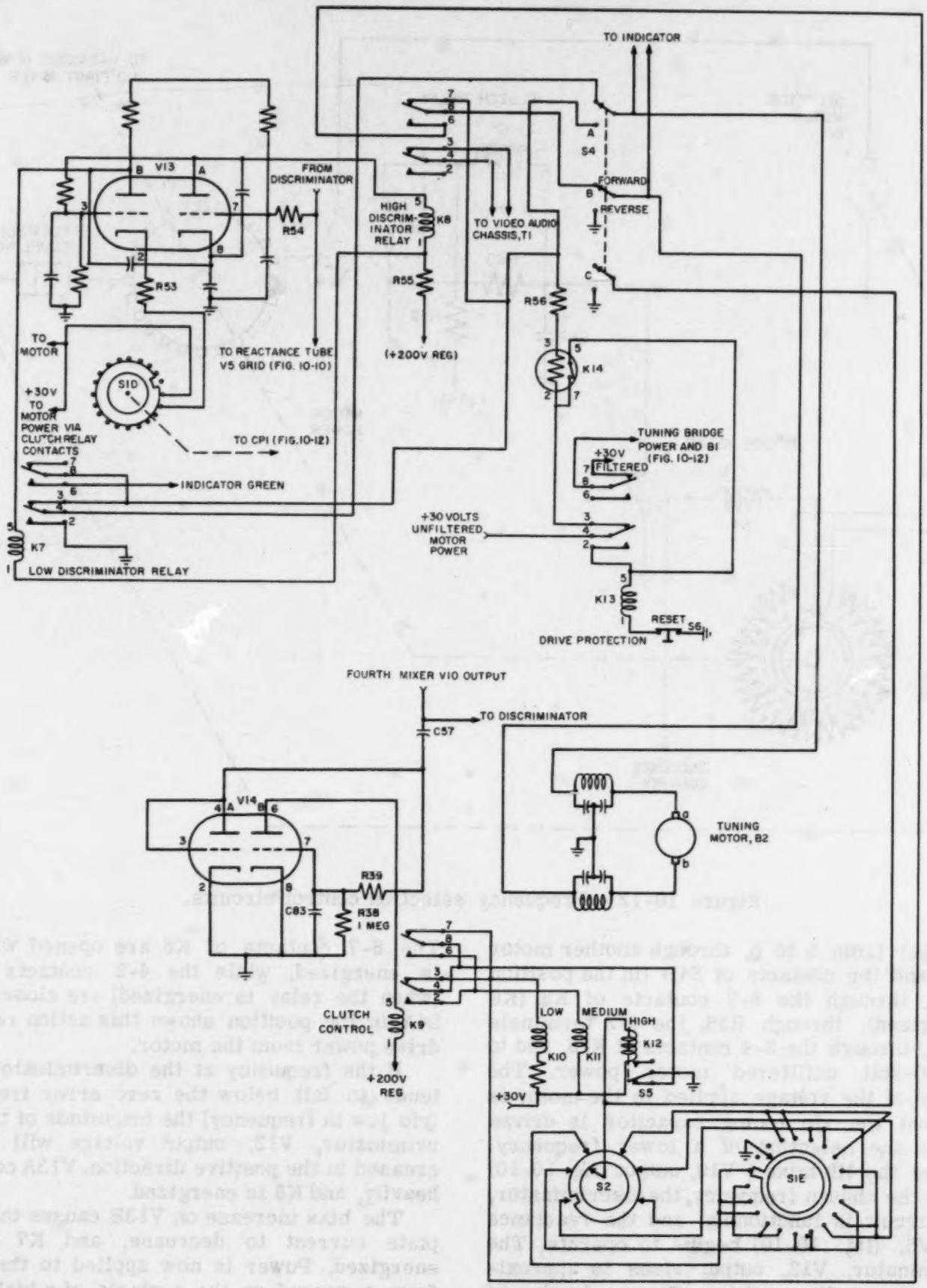

Figure 10-13.—Tuning motor control circuits.

the 6-8 contacts of K8 (closed in this error condition) through the contacts of S4B (in the position shown), and through the motor filter circuit to "B" on the motor, B2. The +30-volts power is applied to the motor through the upper motor filter, through the S4A contacts (in the position shown) through the 3-4 contacts of K7 (deenergized for this error condition) through R56, K14, and the 3-4 contacts of K13, to the motor power. The direction of the current through the tuning motor, B2, is reversed for this error condition. Thus, the motor will run in the opposite direction until the discriminator output is again approximately +5.

From this action, it should be seen that when K7 is energized, a DC voltage is applied to the tuning motor of such polarity that the VFO if driven (by its tuning capacitor C36) (fig. 10-3) towards a lower frequency. If relay K8 (fig. 10-13) is energized, the vfo is driven towards a higher frequency. Both relays are energized when the VFO frequency is correct, and the tuning motor is braked at this point.

Forward-reverse switch S4 is cam operated, and effective in controlling the speed of the tuning motor. When the low end of the tuning capacitor is reached, the contacts of S4 are moved downward, and section C of S4 grounds one end of the high-speed clutch thus energizing K12. When the high-speed clutch is energized, the tuning motor (and consequently the tuning capacitor C36) is driven at a high speed toward the high frequency end of the tuning range.

The action of S1E is to divide the entire frequency range into six frequency segments. When the high-speed clutch, K12, is energized, the tuning motor continues to operate at high speed until the sector in which the preset frequency lies is reached. At this time S1E (which is driven by CP1) operates to remove the ground from the high-speed clutch, K12. When the tuning system is far off frequency, K9 is energized with its 4-2 and 8-6 contacts closed. This action will be considered later. The deenergizing of K12 permits S5 to supply a ground for the medium-speed clutch, K11. The K11 circuit is completed from ground, through the lower contacts of S5, through the 4-2 and 8-6 contacts of K9 in parallel through the K11 solenoid, to the +30-volt motor power. With K11 energized, the tuning motor is driven at medium speed until the selected frequency beings to pass through the monitor.

When the output of the 4th mixer (V10, figure 10-3) is such that it can pass through the fourth band-pass filter circuit comprising the tuned T5 primary and secondary, a signal is coupled by C57 to the clutch control amplifier, V14. V14A is connected as a diode (fig. 10-13), which rectifies the V10 output. Each time the input signal goes positive with respect to ground, V14A conducts to effectively short R39 and R38. Negative portions of the signal are developed across R38 and R39, and applied from the junction of the two resistors to the control grid of V14B.

The negative pulses at the grid of V14B cause a decrease in the V14B plate current. The smaller current through the K9 solenoid deenergizes this relay, and the contacts are released (as shown). With K9 released, the ground is removed from K11 and supplied to the low-speed clutch, K10, through the 3-4 contacts of K9. This action causes the motor to turn at low speed until the exact frequency is reached.

When searching for the desired frequency, the tuning capacitor, C36, travel is always from the high to the low frequency end of the tuning range. If a new channel, which lies between the previous channel and the low frequency end of the tuning range, is selected, the tuning motor will be driven to the new channel and stopped. The tuning drive may start at high, medium, or low speed, depending upon how far removed the new channel lies from the old.

If K12 remains deenergized when the new frequency is selected, S5 grounds K11 (through the 2-4 contacts of K9), and the motor turns at medium speed. If the new frequency is such that the monitor continues to receive an input, K9 will be deenergized as a result of negative pulses at the V14B grid (which reduces the V14B plate current), and the ground from S5 is supplied through contacts 3-4 of K9 to the low-speed clutch. Thus, the motor will turn at low speed to the new frequency.

If a new channel frequency, which lies between the previous frequency and the high frequency end of the tuning range is selected, the tuning capacitor, C36, will first be driven to the high frequency end. Cam operated switch S4 then reverses the direction of rotation of the motor, causing the motor to start back again to search for the new channel frequency.

In the event that the vfo is not set to the new channel frequency after traveling completely across the tuning range, it is returned to its high frequency end at high speed by the reversal of S4. In the reverse position, S4A and S4B connect the motor directly in series with R56,

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K14, and the 3-4 contacts of K13, across the +30-volt power bypassing relays K7 and K8 and thus remove the motor entirely from the control of the monitor.

When the VFO reaches the high frequency end of its range, S4 returns to the position shown. The monitor circuit discriminator relays, K7 and K8, again take control, and the tuning capacitor, C36, is driven back towards its low frequency end in search of the new channel frequency.

VIDEO DIFFERENTIAL AMPLIFIER CIRCUITS

The video differential amplifier, V1 (fig. 10-14) receives the video input signal from V39A at its B section grid. At the same time, a DC cathode potential proportional to the level of the noise is applied to the A section grid of V1 from V39B. Both sections of V1 are connected between the -150- and +87-volt supplies.

The bias applied to each section of V1 is approximately 1 volt, and both sections of V1 are normally conducting. If the noise component of the signal to V39B (fig. 10-3) increases, the cathode-to-ground potential of V39B (across R1, fig. 10-14. decreases. This action lowers the conduction of V1A. Note that the cathode-to-ground potential will decrease for both sections of V1 since the two cathodes are tied together by R2 and R2A. R2 can be adjusted to balance the currents of V1A and V1B in the absence of an input signal.

The video signals to the V1B grid are negative pulses from V30A (fig. 10-3). For zero video input to V39A (or when the received video pulse amplitude reduces to zero) V39A conducts heavily, and the positive voltage at the V1B grid (fig. 10-14) is increased. V1B conducts heavily, and the cathode potential of both sections of V1 increases. Due to the increased common cathode potential, V1A can only conduct a small current through R6. The less positive potential at the top of R6 is applied through R7 and S1B (in the position shown) to the control grid of the first modulator, V2. Since the V1A conduction is small, the corresponding negative-going voltage to the V2 grid is not sufficient to cut off V2.

As the video signal increases in negative amplitude, V1B conducts less. The resulting decrease in cathode potential of both sections of V1 allows V1A to conduct a heavier current through R6. This action decreases the V1A plate voltage and the V2 grid voltage. The decrease control grid potential at V2 cuts off the first modulator stage. Thus, for strong portions of the video (corresponding to maximum received signal at the antenna) the first modulator, V2, is held beyond cutoff to produce zero output. For zero video input, which corresponds to the nulls of the video, the first modulator stage, V2, is above cutoff, and thereby produces an output (as discussed later).

FIRST MODULATOR AND 200-KC OSCILLATOR CIRCUITS

The first modulator stage, V2 (fig. 10-14) provides a method of combining the video signal with an internally generated r-f signal to produce a modulated video output. The modulation process is necessary so that the proper mixing of the video and alternator voltages from the antenna can be accomplished in subsequent modulator stages.

The DC potential at the grid of V2 is determined by the setting of the arm of circle diameter control, R9. The V2 grid potential, in turn, determines the operating level of the modulator.

In the SENSE-D/F position of S1, the signal from the video differential amplifier, V1, is applied across R10 to the V2 control grid. When the video input signal at V1 is zero, V2 is conducting. A 200-KC carrier oscillator (V3 of fig. 10-14) is connected as a transitron circuit. The transitron oscillator utilizes the negative transconductance of the tube to establish oscillations and develop an output frequency. Note that the screen potential of V3 is higher than that of the plate.

Screen grid signal current (which varies at the frequency of the oscillator) causes a negative voltage to be developed at the suppressor grid of V3. The cathode potential of V3 is about +4.6 volts. This further increases the suppressor-cathode negative potential.

Under these conditions (with the screen effectively controlling the tube current) the plate current is greatly reduced because the plate voltage has less influences on the electrons leaving the cathode than the screen. Many of the electrons, which do succeed in passing through the screen grid (and would normally add to the plate current) are repelled by the negative suppressor back to the screen grid. By selection of the proper relationship of plate and screen voltages, the respective currents will be approximately equal.

The negative suppressor potential produces a negative resistance effect in the tube. This is true because above a certain critical screen

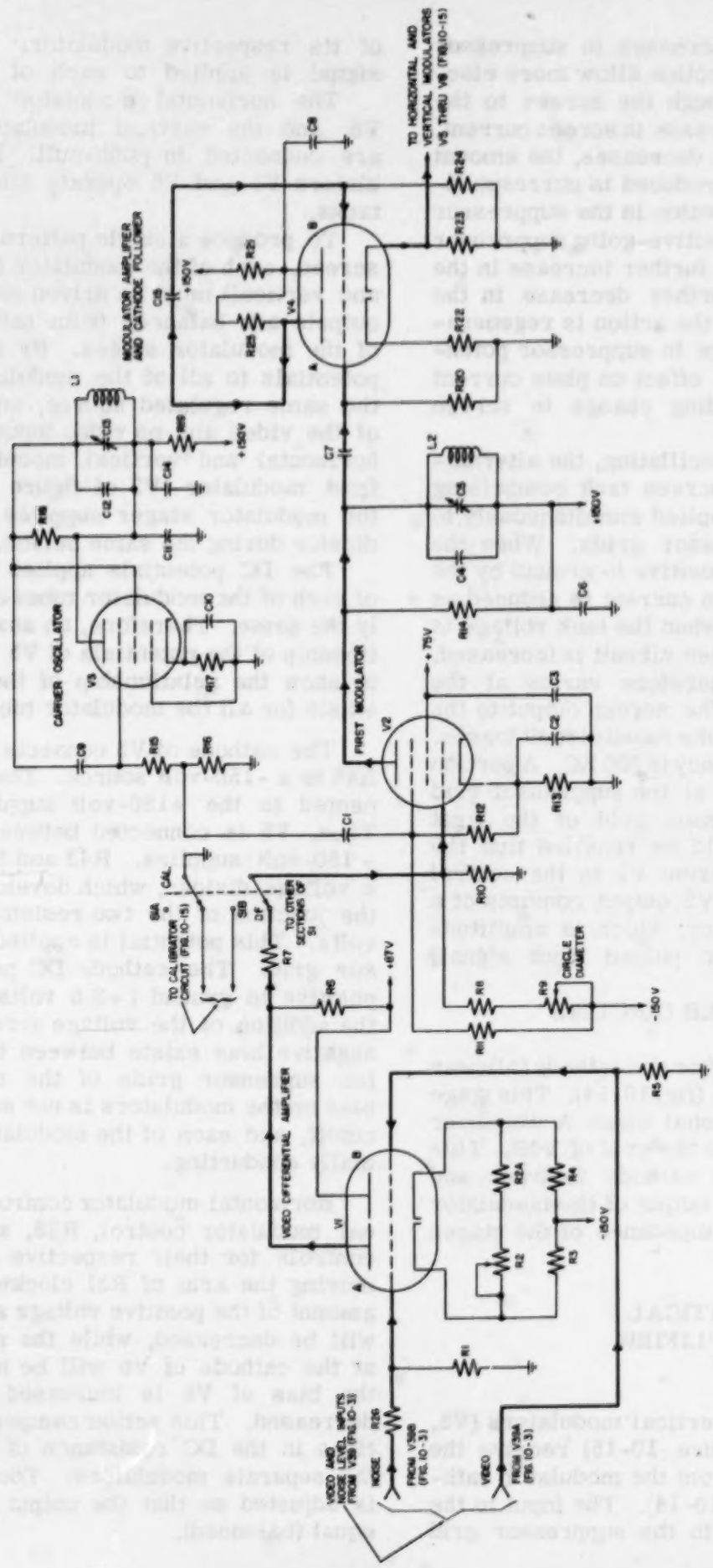

Figure 10-14.—Azimuth indicator (video amplifier and first modulator circuits).

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potential any further increases in suppressor voltage in a positive direction allow more electrons to be passed through the screen to the plate, resulting in a decrease in screen current. Since the screen current decreases, the amount of the suppressor bias produced is correspondingly reduced. The reduction in the suppressor bias is equivalent to a positive-going suppressor voltage, which allows a further increase in the plate current and a further decrease in the screen current. Thus, the action is regenerative, and a small change in suppressor potential produces a greater effect on plate current than will a corresponding change in screen potential.

When the circuit is oscillating, the alternating component of the screen tank comprising L1, C12, and C13 is applied simultaneously to the screen and suppressor grids. When the voltage is made more positive to ground by the tank oscillations, screen current is reduced as discussed. Conversely, when the tank voltage is going less positive, screen circuit is increased. The screen current therefore varies at the oscillator frequency. The screen output to the oscillator tank supplies the tuned circuit losses.

The oscillator frequency is 200 KC. A portion of the signal developed at the suppressor grid is fed to the suppressor grid of the first modulator, V2. It should be recalled that the video input is applied from V1 to the control grid of V2. Thus, the V2 output consists of a 200-kc carrier frequency, which is amplitude modulated by the video pulsed input signal.

MODULATOR AMPLIFIER CIRCUITS

The modulator amplifier and cathode follower are combined in tube V4 (fig. 10-14). This stage functions as a conventional class A amplifier and supplies its output to the grid of V4B. This section functions as a cathode follower and matches the impedance output of the modulator amplifier to the input impedance of the stages that follow.

HORIZONTAL AND VERTICAL MODULATOR AND AMPLIFIER CIRCUITS

The horizontal and vertical modulators (V5, V6, V7 and V8 of figure 10-15) receive the modulated video input from the modulator cathode follower, V4B (fig. 10-14). The input to the modulators is coupled to the suppressor grid of its respective modulator. Thus, the same signal is applied to each of the modulators.

The horizontal modulator stages, V5 and V6, and the vertical modulators, V7 and V8 are connected in push-pull. Horizontal modulators V5 and V6 operate into separate tuned tanks.

To produce a single pattern on the indicator screen, each of the modulator tubes (horizontal and vertical) must be driven so that their video outputs are balanced from saturation to cutoff of the modulator stages. By supplying the DC potentials to all of the modulator stages from the same regulated source, and by the control of the video and no video input condition at the horizontal and vertical modulators from the first modulator (V2 of figure 10-14), each of the modulator stages supplies video to the indicator during the same period.

The DC potentials applied to the elements of each of the modulator tubes are approximately the same. Therefore, an analysis of the relationship of the potentials of V5 will be sufficient to show the relationship of the potentials that exists for all the modulator tubes.

The cathode of V5 connects through R44 and R43 to a -150-volt source. The V5 plate is connected to the +150-volt supply as discussed. Thus, V5 is connected between the -150- and + 150-volt supplies. R43 and R44 are a part of a voltage divider, which develops a potential at the junction of the two resistors of about +0.7 volts. This potential is applied to the suppressor grid. The cathode DC potential is more positive to ground (+3.5 volts) as a result of the addition of the voltage across R44. Thus, a negative bias exists between the cathodes and the supressor grids of the modulators. The bias on the modulators is not sufficient to cause cutoff, and each of the modulator tubes is normally conducting.

Horizontal modulator control, R31, and vertical modulator control, R38, serve as balance controls for their respective modulators. By moving the arm of R31 clockwise (upward) the amount of the positive voltage at the V5 cathode will be decreased, while the positive potential at the cathode of V6 will be increased. Thus, the bias of V6 is increased and its gain is decreased. This action compensates for variations in the DC resistance of the two tubes of the separate modulators. The vertical control is adjusted so that the output of both tubes is equal (balanced).

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In addition to the modulated video input (which is fed to the suppressor grids of the vertical and horizontal modulators), a second input at the control grids is applied from alternator, G1, (fig. 10-7).

As the alternator rotor turns (fig. 10-16), voltages are induced into the stator windings ("a" and "b"), which bear a 90° phase difference. The voltage developed by the "a" winding is applied to the grids of the horizontal modulators, V5 and V6 (fig. 10-15). R105 (fig. 10-16) provides a method of balancing the grid input to the separate modulator amplifiers. Likewise, voltage applied to the vertical modulators is fed from the "b" winding of the alternator. R116 acts as the grid balancing resistor for the input to V7 and V8.

The phase difference between the horizontal and vertical input signals at the alternator should be 90°. This relationship is necessary to produce the circular pattern on the cathode-ray tube of the indicator when no video input is being received.

A phase shifting network, comprising R102 and C58, is connected across the horizontal modulator input. R102 is variable so that the phase of the horizontal input can be adjusted to be exactly 90° relative to the vertical input.

The horizontal and vertical gain balance controls, R96 and R107 (fig. 10-15) respectively, function to control instantaneous changes in tube resistance (and tube conduction) of each of the modulator tubes. The action is necessary to prevent the introduction of distortion, which would otherwise result in nonsymmetrical output amplitude signals from the horizontal (or vertical) modulator tubes.

The simplified diagram of figure 10-17 should be helpful in understanding the circuit operation. Assume that R31 has been set so that the conduction of both sections of the horizontal modulator is equal. The corresponding fixed resistors in each section of the bridge are of equal value so that the current through path abc is equal to the current through path adc, if the V5 and V6 grid-cathode resistances are equal. In this condition, the voltage bd (across R96) is zero.

If the grid-cathode resistance of V6 decreases, the current through path adc increases.

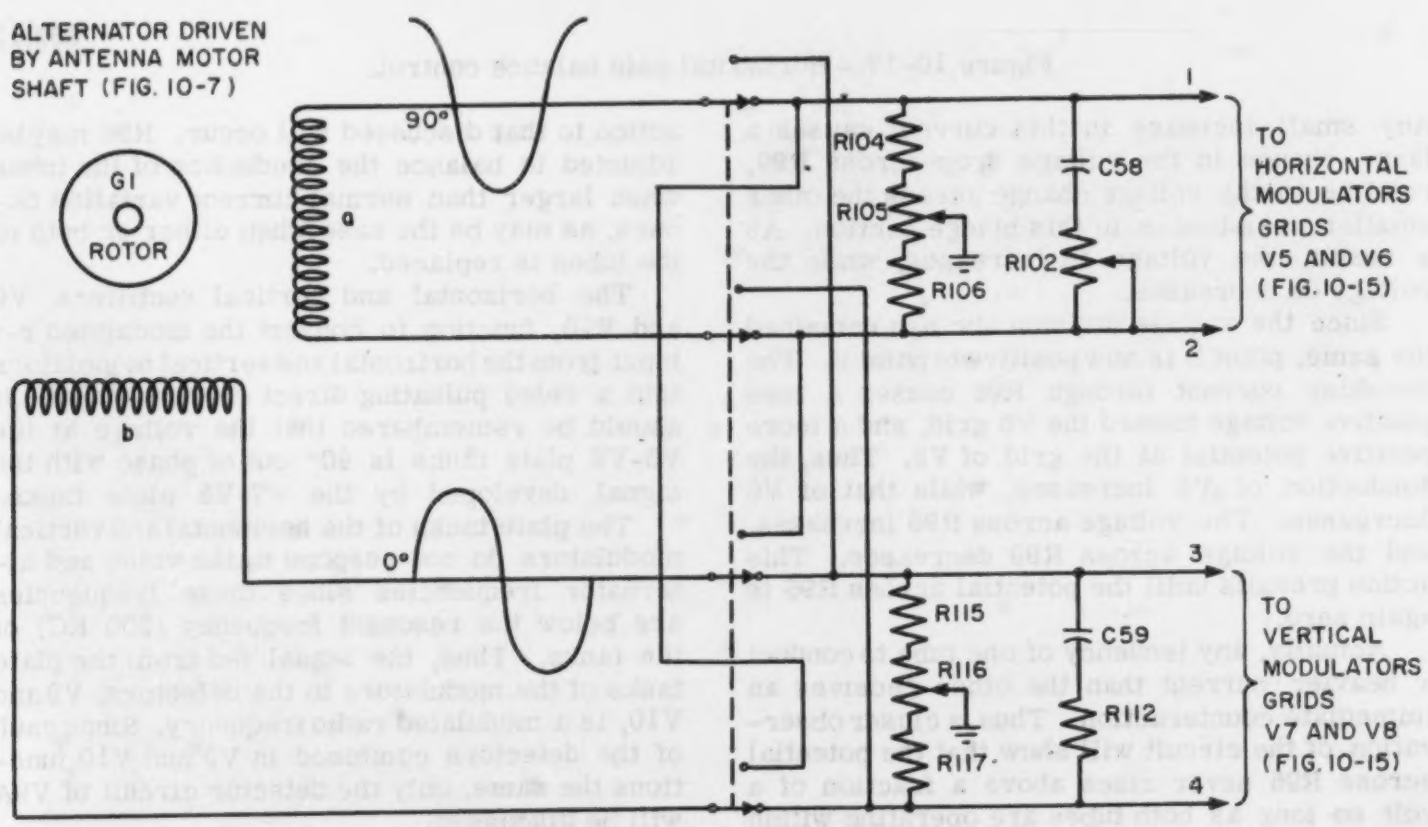

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Figure 10-16.—Alternator and modulator input circuit.

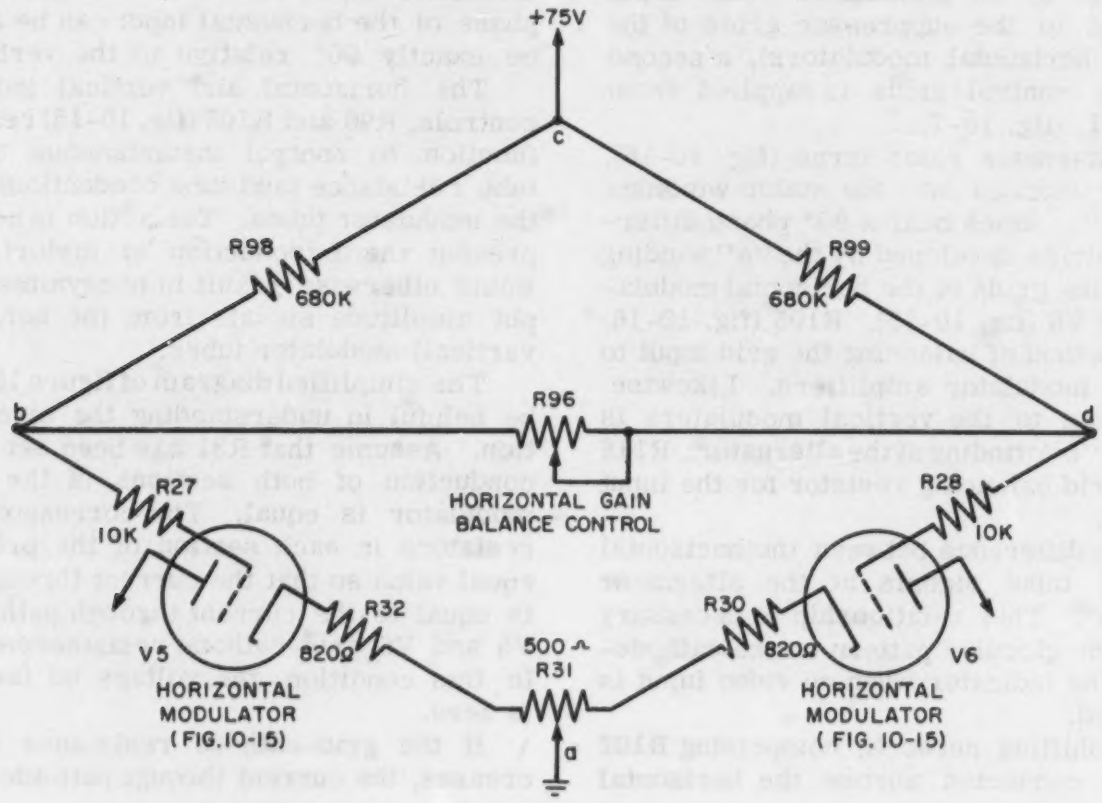

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Figure 10-17.—Horizontal gain balance control.

Any small increase in this current causes a large change in the voltage drop across R99, relative to the voltage change across the other smaller resistances in this bridge section. As a result, the voltage cd increases, while the voltage da decreases.

Since the voltage division abc has remained the same, point b is now positive to point d. The resulting current through R96 causes a less positive voltage toward the V6 grid, and a more positive potential at the grid of V5. Thus, the conduction of V5 increases, while that of V6 decreases. The voltage across R98 increases, and the voltage across R99 decreases. This action prevails until the potential across R96 is again zero.

Actually, any tendency of one tube to conduct a heavier current than the other receives an immediate counteraction. Thus, a closer observation of the circuit will show that the potential across R96 never rises above a fraction of a volt so long as both tubes are operating within their conduction ranges.

If section abc of the bridge attempts to produce a predominating current, the reverse action to that discussed will occur. R96 may be adjusted to balance the conduction of the tubes when larger than normal current variation occurs, as may be the case when either or both of the tubes is replaced.

The horizontal and vertical rectifiers, V9 and V10, function to convert the modulated r-f input from the horizontal and vertical modulators into a video pulsating direct current output. It should be remembered that the voltage at the V5-V6 plate tanks is 90° out of phase with the signal developed by the V7-V8 plate tanks.

The plate tanks of the horizontal and vertical modulators do not respond to the video and alternator frequencies since these frequencies are below the resonant frequency (200 KC) of the tanks. Thus, the signal fed from the plate tanks of the modulators to the defectors, V9 and V10, is a modulated radio frequency. Since each of the detectors combined in V9 and V10 functions the same, only the detector circuit of V9A will be discussed.

Note that the alternator 15-CPS input to the horizontal modulators, V5 and V6, from terminals 1 and 2 (fig. 10-16) will be negative toward

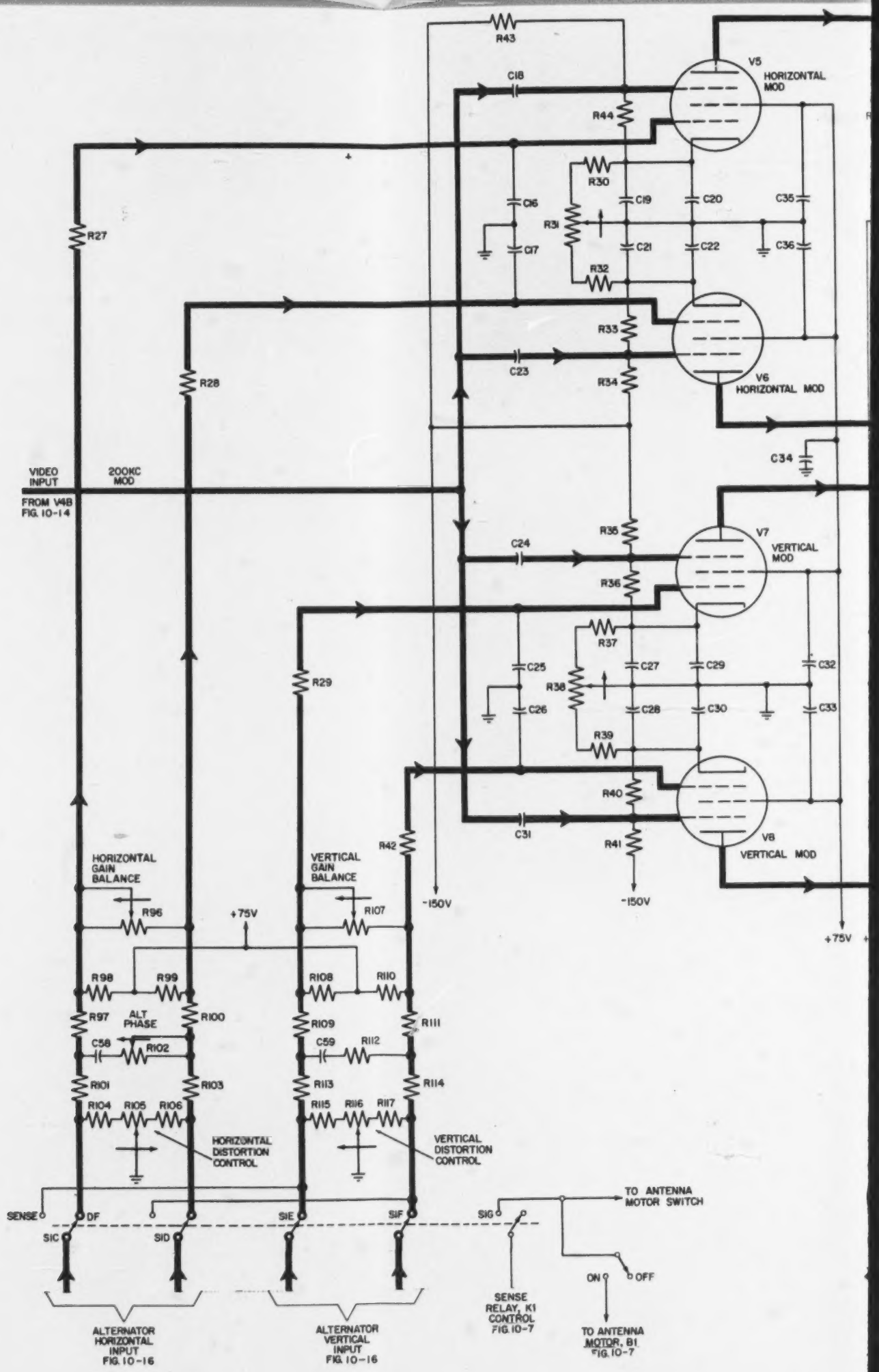
R43
C18
V5
HORIZONTAL
MOD
R44
R30
C16
C19
C20
C35
R31
C17
C21
C22
C36
R32
R27
R33
C23
R34
V6
HORIZONTAL MOD
R28
C34
VIDEO
INPUT
FROM V4B
FIG. 10-14
200KC
MOD
R35
C24
V7
VERTICAL
MOD
R36
R37
C25
C27
C29
C32
R38
C26
C28
C30
C33
R29
R39
R40
C31
R41
V8
VERTICAL MOD
R42
HORIZONTAL
GAIN
BALANCE
VERTICAL
GAIN
BALANCE
R96
+75V
R107
-150V
-150V
+75V
R98
R99
R108
R110
R97
ALT
PHASE
R100
R109
R111
C58
R102
C59
R112
R101
R103
R113
R114
R104
R105
R106
R115
R116
R117
HORIZONTAL
DISTORTION
CONTROL
VERTICAL
DISTORTION
CONTROL
TO ANTENNA
MOTOR SWITCH
SENSE
DF
SIC
SID
SIE
SIF
SIG
ON
OFF
SENSE
RELAY, K1
CONTROL
FIG. 10-7
TO ANTENNA
MOTOR, B1
FIG. 10-7
ALTERNATOR
HORIZONTAL
INPUT
FIG. 10-16
ALTERNATOR
VERTICAL
INPUT
FIG. 10-16

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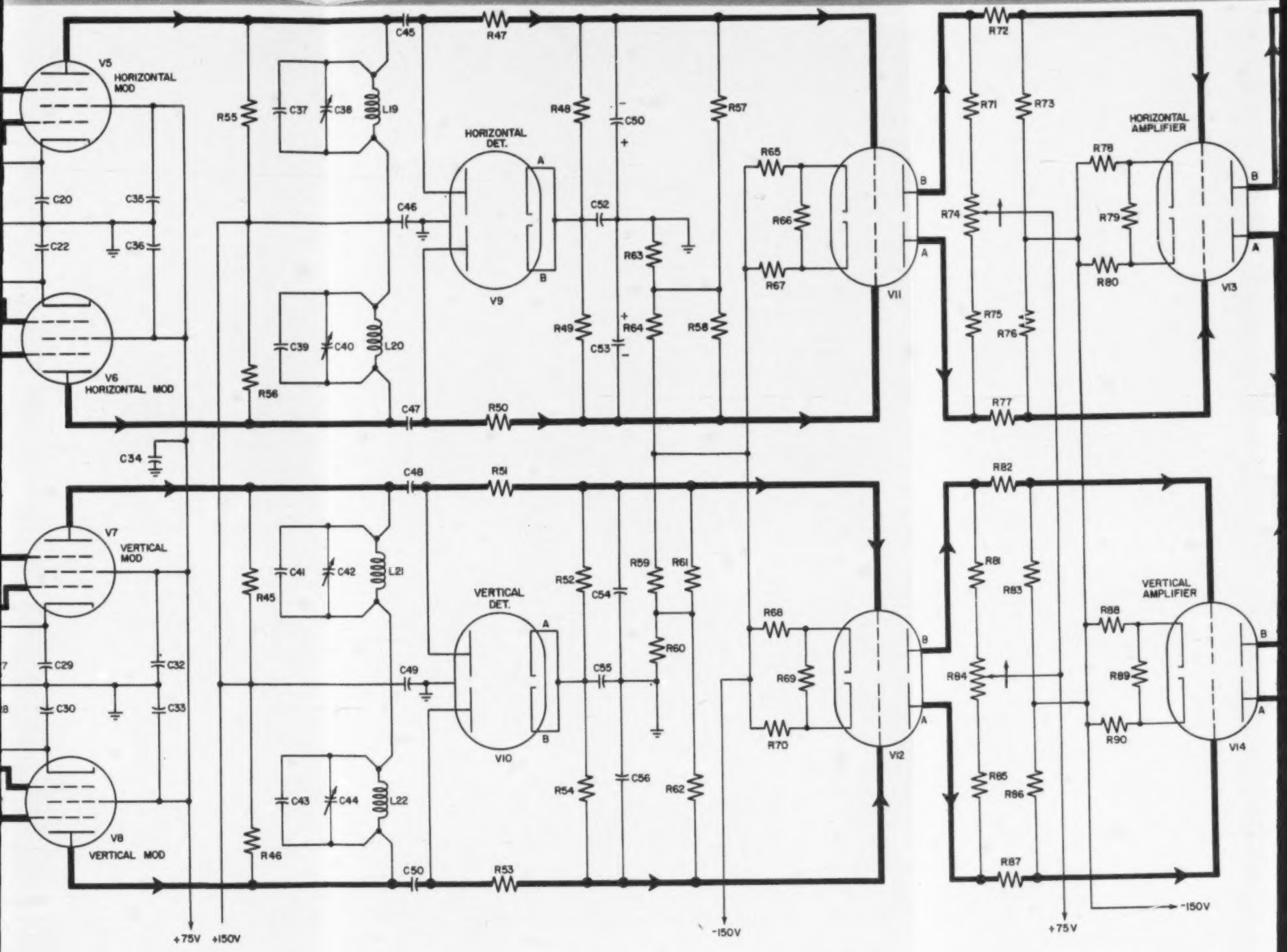

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Figure 10-15.—Azimuth indicator (horizontal and vertical modulators and amplifiers).

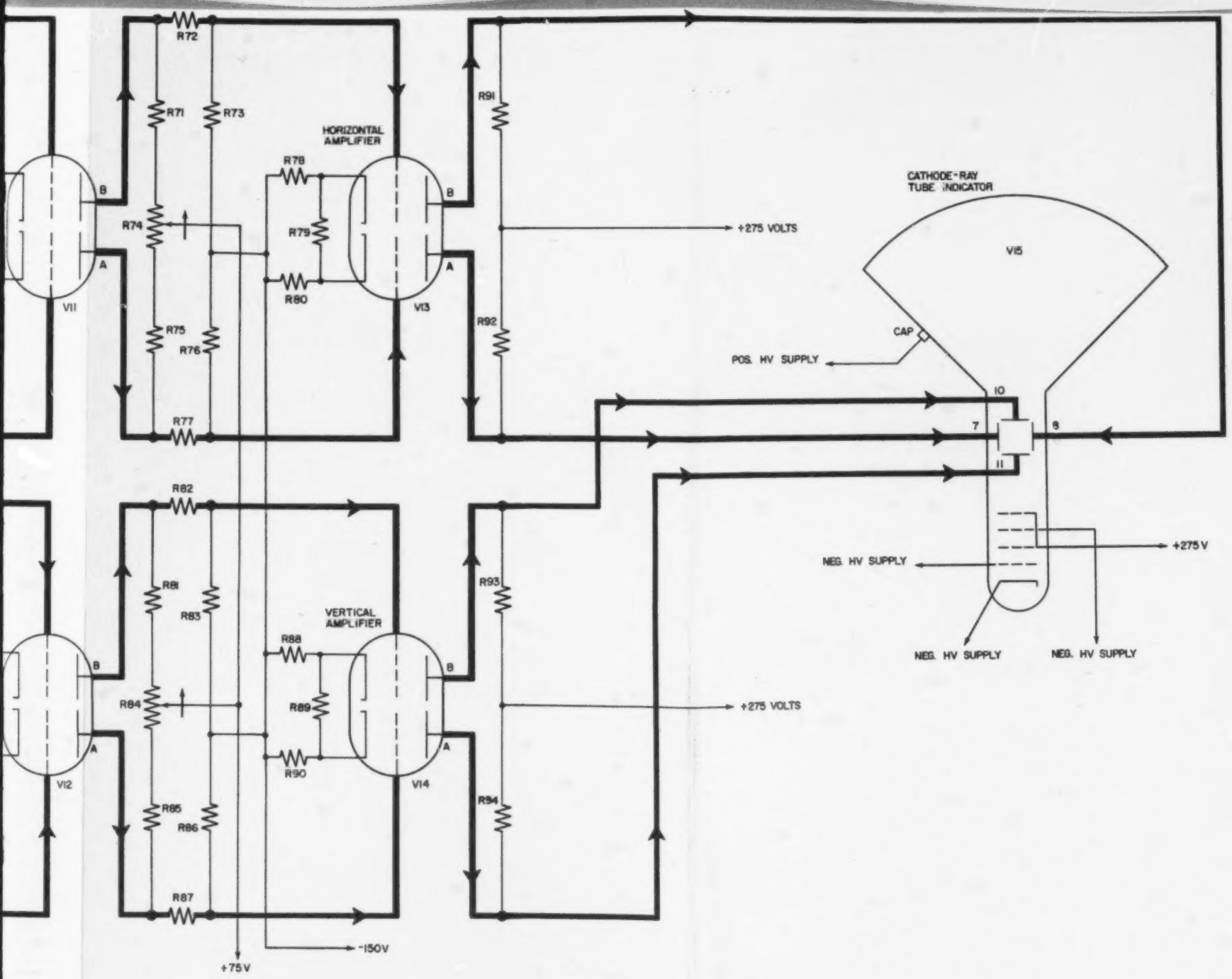

dulators and amplifiers).

one of the grids of the horizontal modulators (fig. 10-15) while positive toward the other grid. In this manner, the grids of V5 and V6 are always fed 180° out of phase as a result of the alternator input.

It should be recalled that the 200-KC AM-signal from V4B (fig. 10-14) is fed in phase (at the suppressor grids) to each of the modulator stages, V5 through V8 (fig. 10-15). Thus, the modulator receives both the video and alternator signals, as discussed. (Video as used in this discussion refers to the component of the signal voltage, which is received at the RDF antenna, and not to the signal frequency.)

Assume an instantaneous input polarity from the alternator to the V5 and V6 grids, as shown. Due to the more positive V5 grid, V5 will produce a greater driving signal to the V5 plate tank than will be produced for the V6 plate tank. As a result of this action, a greater magnitude signal voltage will be applied to the V9A horizontal rectifier through C45 than will be fed to the V9B rectifier through C47.

If an unmodulated 200-KC signal (containing no video or alternator voltage) were applied to V9A and V9B, both diode sections would produce equal voltages negative to ground across C50 and C53, respectively. Since V9A and V9B will produce equal amplitude outputs negative to ground for an unmodulated 200-KC input, the algebraic sum of the voltages will be zero.

When the 200-KC modulated signals from V5 and V6 are developed across the plate output tanks, one output will be of greater magnitude than the other due to the positive alternator input at one control grid (the grid of V5 in this case), and a more negative input to the V6 control grid. Thus, the negative voltage to ground across C50 will be of greater magnitude than the negative voltage to ground across C53. The detector output voltage at any instant is the algebraic sum of the C50 and C53 voltages.

Note that the negative voltage to the control grid of horizontal amplifier, V11B becomes more negative, while the voltage to the V11A control grid becomes less negative. Thus, the two grids of the horizontal amplifiers, V11B and V11A, are fed 180° out of phase.

The video signal applied from the vertical detector, V10A, to the vertical amplifier, V12B (in the same manner as described for V9A), is 90° out of phase with the signal from V9A to V11B. The 90° phase difference in the vertical and horizontal signals must exist, and must be preserved, in order to produce the various indicator patterns that will be discussed later. The 90° phase difference in the vertical and horizontal signals was introduced as a result of the alternator voltage input at the horizontal and vertical modulators, V5 through V8, as discussed.

The horizontal and vertical amplifiers, V11 through V14 (fig. 10-15) increase the video signal amplitude, which is to be applied to the respective deflection plates of the cathode-ray tube in the indicator. Direct-coupled amplifiers are employed in the horizontal and vertical amplifiers, V11 through V14, to eliminate the need for coupling capacitors.

In addition to the phase-shifting action just discussed, it should be noted that if a capacitor were used to couple the video signal from one of the amplifier stages to the other, the charge time of the coupling capacitor would not only delay presentation of the pattern, but would also cause the indicator pattern to move either upward or downward on the screen as the capacitor is charged and discharged by the incoming video signal. Also, the size of the capacitor would have to be relatively large in order to offer low reactance to the various components of the video signal.

Horizontal amplifiers V11 and V13 are series connected between the -150- and 275-volt supplies. The cathode of V11B is connected to the -150-volt supply and maintained at -80 volts. The potential is derived by the conduction of V11B from the -150-volt source, to the +75-volt supply. The grid potential of V11B is held at -55 volts. This potential is obtained from a separate voltage divider (comprising R64 and R63), which is also connected from the 150-volt supply to ground. Thus, during quiescence, the grid potential (-55 volts) of V11B is positive with respect to the cathode (-80 volts), and grid current flows.

The positive-going video signal from V9A increases the current through V11B and causes the V11B plate voltage to decrease. Note that at any given time, the grid input signal to the V11A and V13A sections of the horizontal amplifiers is 180° out of phase with the signal applied to the V11B and V13B amplifiers. Thus, the V13A output to the pin 7 horizontal plate of V15 is less positive during the same period that V13B is supplying a more positive potential to the pin 8 horizontal plate of V15. The simultaneous application of the video signal to both horizontal deflection plates of V15 increases

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the control of the horizontal plates on the electron stream.

The vertical amplifiers, V12 and V14, function the same as the horizontal amplifiers, V11 and V13. The output of V14 is a video signal to the vertical plates (pins 10 and 11) of V15, which is 90° out of phase with the video applied to the horizontal deflection plates (pins 7 and 8), as discussed. The action of the horizontal and vertical voltages at the cathode-ray tube, V15, to produce the various indicator patterns is discussed below.

CIRCULAR PATTERN

If no video input is applied to the first modulator (V2 of figure 10-14) from the video differential amplifier, V1, V2 will conduct continuously, and only the 200-kc oscillator output of V3 will be fed through V2 and V4 to the modulators (V5 through V8 of figure 10-15). In the modulator stages, V5 through V8, the 200-kc radio frequency generated by V3 (fig. 10-14) will be modulated by the vertical and horizontal 15-cycle alternator inputs (fig. 10-15), which are 90° out of phase. The modulators, V5 through V8, conduct continuously, and the resulting output to the vertical and horizontal deflection plates of V15 (after passing through the detector and amplifier stages) produces vertical and horizontal sine wave voltages, respectively, which are 90° out of phase. Thus, the circular pattern shown in figure 10-18 A, is produced, representing zero video signal input at the antenna.

PROPELLER-SHAPED PATTERN

Signals received at the antenna are 15 cps modulated by the antenna rotation. The modulation introduced on the incoming signal is effective in controlling the output of the video differential amplifier, V1 (fig. 10-14), as discussed earlier.

The video signal at the V1B grid is negative going. When the V1B input is maximum negative (corresponding to maximum received signal at the antenna) the effect is to increase the V1A plate current through R6, which cuts off the first modulator stage, V2, and no 200-kc carrier from V3 can pass to the modulators, V5 through V8 (fig. 10-15). When the V1B input is minimum (corresponding to the nulls of the received signal), the V1A plate current through R6 is decreased and the first modulator, V2, is conducting. A video signal will be passed through the modulators, detector, and amplifiers of figure 10-15 only when the first modulator, V2, is conducting, or when the nulls of the received signals are being applied to the V1B grid.

The period of conduction of the first modulator, V2, is small as compared to the total duration of a single pulse of the video signal. Thus, the signal applied to the vertical and horizontal deflection plates of V15 is a pulse, which corresponds in time to the reception of the nulls of the received signal.

The phase relationship of the vertical and horizontal pulses is always 90°, as discussed. If the vertical and horizontal voltages were complete sine waves, a circular pattern would be produced for the 90° phase relationship. However, since the vertical and horizontal inputs are pulses, the pattern displayed on the indicator (V15) is in the form of a propeller (fig. 10-18E) the tips of which point in the direction of the nulls of the received video. An azimuth scale which encircles the cathode-ray tube screen permits the operator to read, in degrees, the position of the two nulls of the received signal.

SENSE PATTERN

The circuit of the antenna in D/F operation is as shown in figure 10-8A. The two sections of the Adcock array are in exact balance during D/F operation, as discussed.

When the calibrate-sense switch on the front panel of the indicator is held in the SENSE position, a sense relay, K1 (fig. 10-7) energizes, allowing its contacts to alter the antenna electrical connections to that shown in figure 10-8B. The effect is to introduce a phase lag in one section of the array, while simultaneously introducing a phase lead in the other section. This action causes the nulls to appear at a different position in the rotation of the antenna, and at a different position on the indicator screen.

In addition to the action just discussed, when the sense-D/F switch is depressed, sections S1C, S1D, S1E, and S1F or S1 (fig. 10-15) interchange sweep voltages to the balance modulators, V5 through V8. This causes the pattern to be shifted 90° on the indicator screen.

The combined effects of the sense-D/F switch, S1, and the sense relay, K1 (fig. 10-18F) causes the rotation of the pattern by 90° and a shift in the position of the nulls, so that the distorted figure 8 (fig. 10-18F) is formed. The

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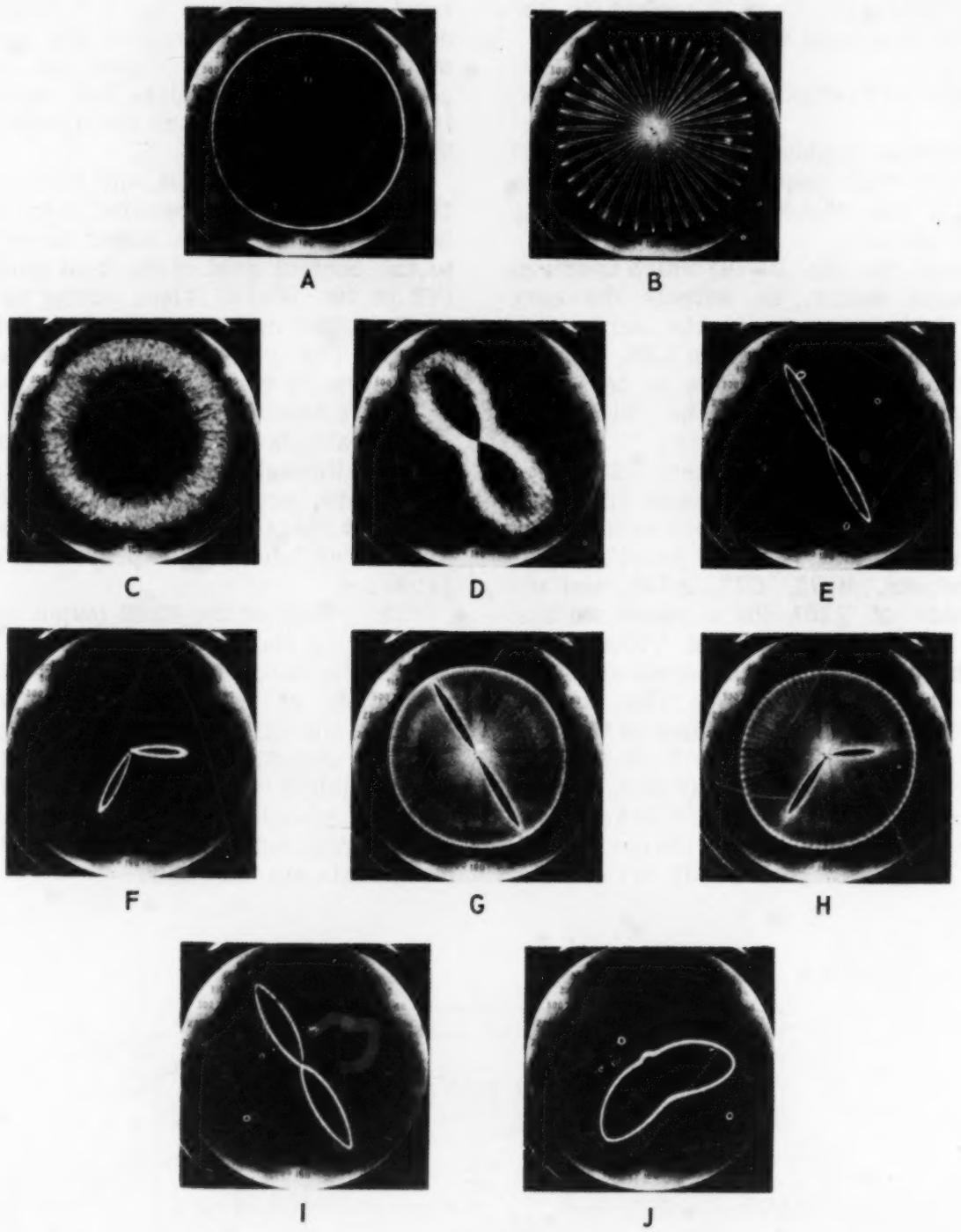

A. CIRCULAR PATTERN
B. CALIBRATE PATTERN
C. NOISE PATTERN
D. BEARING PATTERN, NO MODULATION, WITH NOISE
E. BEARING PATTERN, NO MODULATION
F. SENSE PATTERN NO MODULATION
G. BEARING-100 PER CENT TONE MODULATION
H. SENSE-100 PER CENT TONE MODULATION
I. BEARING PATTERN-- STRONG SIGNAL - r-f GAIN LOW
J. SENSE PATTERN - STRONG SIGNAL - r-f GAIN LOW

109.14

Figure 10-18.—Typical operation patterns.

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apex of the distorted figure 8 points in the direction of the received signal.

CALIBRATION PATTERN

The calibration display is a 36-lobe "daisy" pattern (fig. 10-18B) displayed on the cathode-ray tube, V15. The 36-lobe pattern is used to calibrate the indicator.

A tone wheel, E1 (fig. 10-19) which is driven by the antenna motor, B1 Affects the core material of L5A to generate the calibration voltage in the circuit comprising L5A, C5, and the primary of T1. This voltage is developed at the T1 secondary across the calibration gain control, R173.

The calibration phase splitter, V23A, receives the calibration signal input from the arm of R173. The plate and cathode resistances of V23A are of equal value to provide equal amplitude outputs. R175, C77, R174, and the tube resistance of V23A for a phase shifting network for the plate output of V23A. The amount of the phase shift is determined by the position of the arm of R174. The cathode potential of V23A (which is applied to the arm of R174) is degenerative, since it is approximately 180° out of phase with the plate output. The degenerative action is reduced by a smaller regenerative action due to the charge of C77 through R177 on the negative half cycle of the input, and the discharge of C77 through V23A during positive portions of the input. The resulting phase of the signal obtained from the combination of the plate and cathode voltages is applied to the grid of conventional amplifier, V23B.

When sections S1A and S1B of the sense-D/F cal switch are operated to the CAL position (as shown), the V23B output is coupled by C79 to the control grid of the first modulator stage (V2 of fig. 10-14). Thus, during calibration the V23B output causes the first modulator, V2, to produce an output pulse 36 times for each revolution of the antenna. The resulting signal to the vertical and horizontal deflection plates of the cathode-ray tube, V15 (fig. 10-15), after passing through the modulators, detector, and amplifiers, produces 36 lobes on the indicator screen during the same period normally required for the two-lobe (single-propeller) pattern to be produced.

The phase of the V23B output can be shifted by rotating the cal-phase control, R174. This action simultanously changes the position of all the lobes of the calibrate pattern. In this manner, the calibration necessary for determining the direction of a received signal can be accomplished by moving the tips of the 36-lobe pattern (spaced every 10 degrees) until 4 of the tips correspond with 0, 90, 180, and 270 degrees on the azimuth indicator.

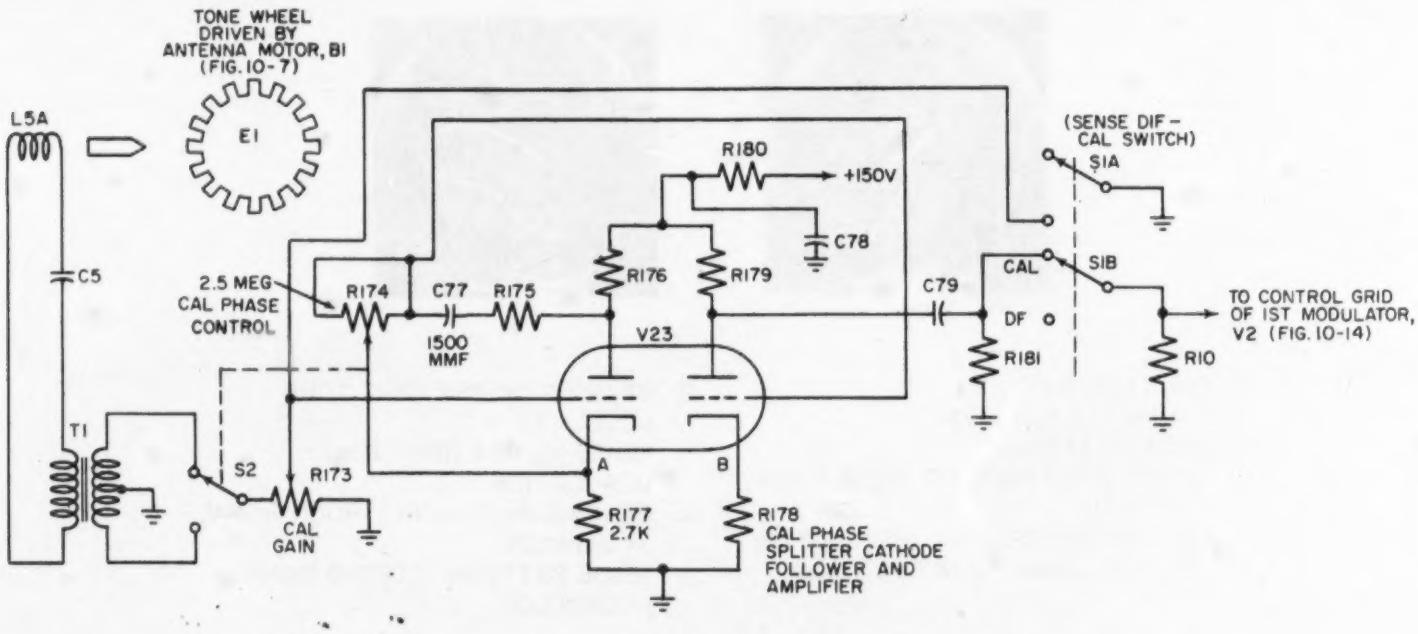

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Figure 10-19.—Calibration voltage input.

The cal-gain control, R173 is used to set the output voltage level at V23B. This action will adjust the amplitude of the signal pulses at the deflection plates of V15. The control is properly adjusted when the spokes of the 36-lobe pattern converge in a spot near the center of the cathode-ray tube screen.

When the sense-D/F-cal switch, S1 is placed in the D/F position, the grid of V23A is directly grounded. This prevents the amplification of the calibrate signal in V23, and eliminates the possibility of allowing an amplified calibrate signal to be capacitively coupled to the CRT deflection plates through the open contacts of S1.

LORAN

The principle of loran navigation involves establishing a fix at the intersection of two or more "lines of position" as discussed in Basic Electronics, NavPers 10087-B. A loran line of position is a line of constant time difference between the arrival of two pulse modulated RF signals transmitted from a pair of loran transmitting stations (master and slave transmitters). The stations are usually located several hundred miles apart. Because RF energy travels at a constant velocity, the time difference in reception of the two signals is a measure of the difference in the distance from the transmitting stations to the point of observation.

An obtained time-difference reading is used to locate a specific line of position on a special chart. The chart contains various loran lines of position.

If a second time difference is obtained from a second loran transmitting pair, the new time difference is used to locate a second line of position on the chart. The intersection of the two lines of position obtained from the time difference readings establishes a "fix."

The receiving set of the loran system (fig. 10-20) is basically an instrument for measuring the very small periods of time that elapse between the arrival of signals from the two stations of the loran transmitting pair. To accomplish this, a variable timed interval is generated within the receiving set and displayed on the screen of a cathode-ray tube. When the received signals are positioned at the beginning and end of the timed period, the time difference between arrival of the signals at the location of the receiving set may be read from a revolution type time-difference counter.

A second reading obtained in the same manner from a different transmitting pair produces a second time-difference reading on the counter. The first and second time-difference readings are used to determine geographical location from loran charts and tables (not shown).

LORAN RECEIVING SET AN/UPN-15

Originally designed for loran A operation only, many AN/UPN-12( ) receiving sets have been modified to accommodate both loran A and loran C signals. Modification is accomplished by adding a small receiver-control unit and associated components to the existing AN/UPN-12( ) set (fig. 10-20). When so modified, the nomenclature of the receiving set is changed from AN/UPN-12( ) to AN/UPN-15( ).

When functioning as a loran C receiver-indicator, the set utilizes the signals received by the receiver-control unit mounted atop the main chassis. This unit contains a 100-KC radio receiver of the tuned radio frequency type. The controls that affect its operation as a loran C receiver are on the front panel of the unit.

With the equipment set for loran A operation, the 100-KC receiver is isolated from the set and the four-channel superheterodyne receiver in the main chassis is used to receive the loran signals.

The indicator unit of the set displays either loran A or loran C signals. When the received pulses are aligned as prescribed for the particular mode of operation, time difference readings are taken from a counter. By taking a second reading from a different set of loran stations and referring to loran charts and tables the geographic position of the ship is determined.

ANTENNA COUPLER

The antenna coupler (fig. 10-21) permits matching of the antenna impedance to the input impedance of the receiver. The antenna coupler consists of a 17-position rotary switch, a tapped inductor, a neon lamp, and a spark gap.

When the rotary switch, is adjusted for maximum signals on one of the four channels, the antenna and antenna lead-in reactance, and the section of the inductor in use, form a tuned circuit, which is broadly resonant over the band of frequencies that the equipment is designed to receive. The multiple taps on the

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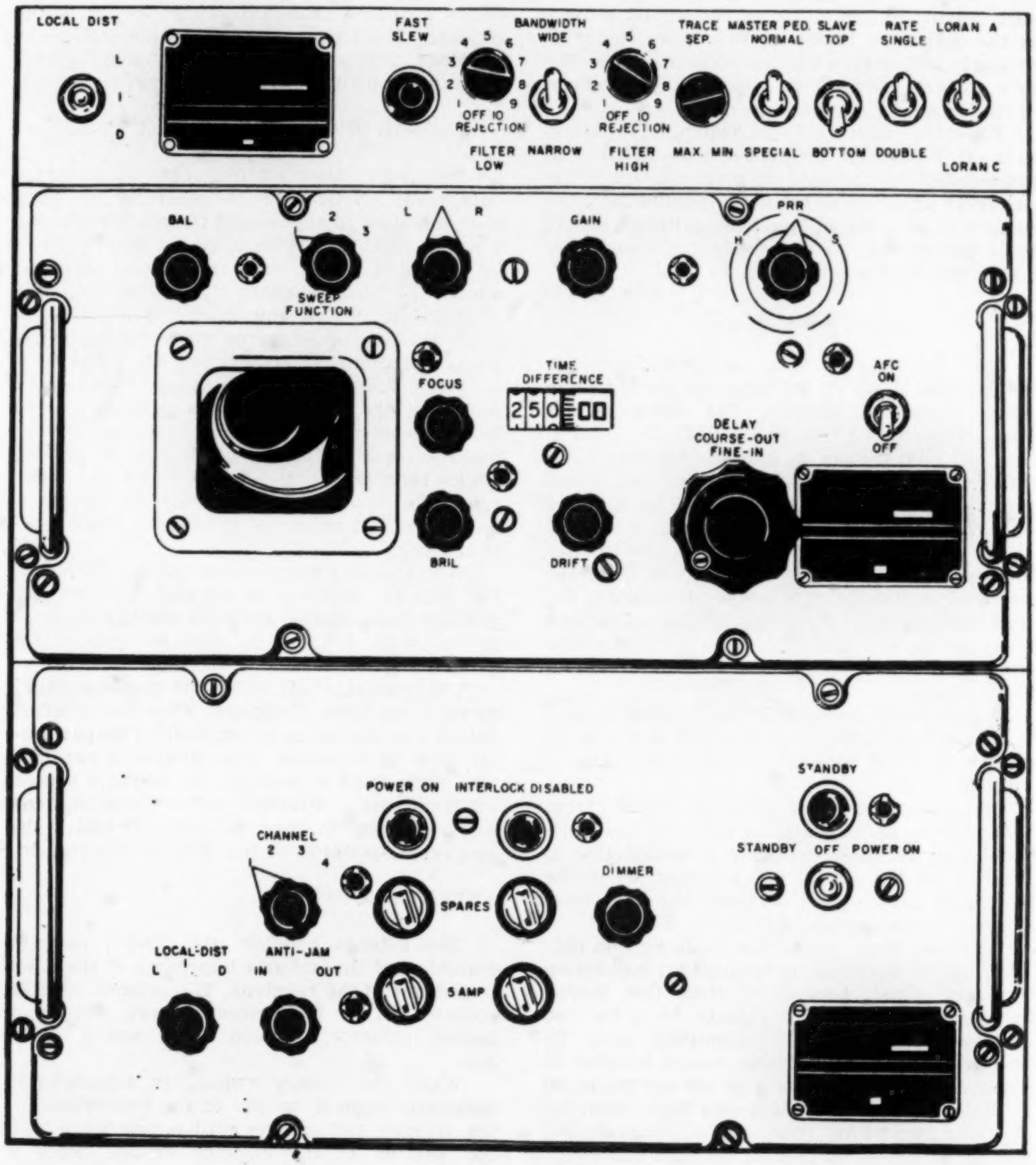

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Figure 10-20.—Loran receiving set, AN/UPN-15.

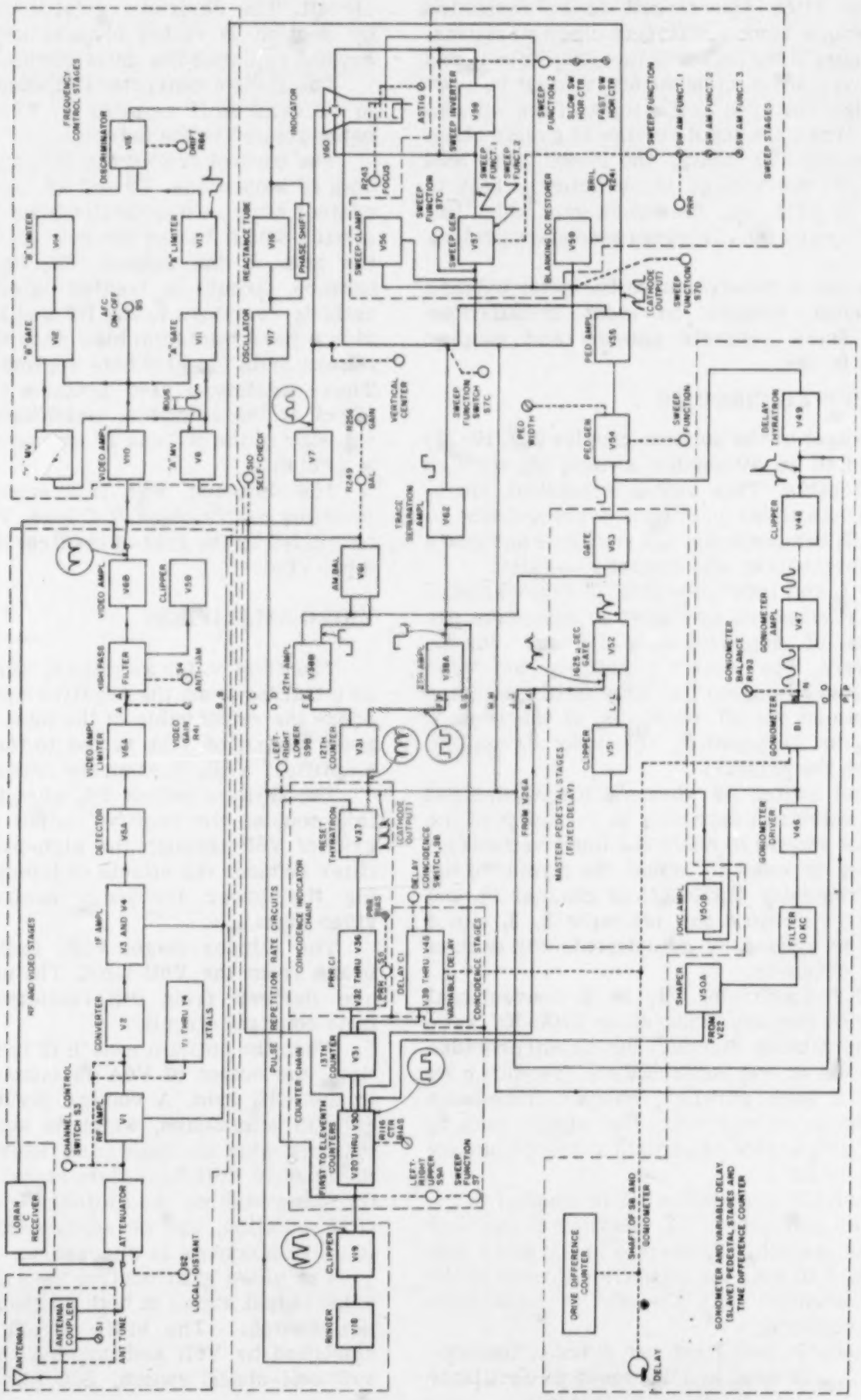

Figure 10-21.—Loran receiving set AN/UPN-15, block diagram.

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inductance allow the circuit to be resonated with antennas having different characteristics.

The neon lamp protects the coupler coil and the receiver input components against burnout due to high voltages at the input of the antenna coupler. When the input voltage is greater than approximately 60 volts, the neon lamp will conduct. If the voltage is sufficiently high to cause it to burn out, the spark gap, which has a higher breakdown, provides secondary protection.

The loran C receiver uses the same antenna and antenna coupler on most installations although some separate antenna and coupler units are in use.

R-F RECEIVER CIRCUITS

The output of the antenna coupler (fig. 10-21) is applied to an attenuator switch, S2, through a coaxial cable. This switch is marked, local-dist, and has three positions corresponding to L, I, and D, respectively. The positions designate local, intermediate, and distant reception.

In the L and I positions of S2, T-type resistor network attenuators are used to introduce attenuations of approximately 20 and 40 db, respectively. The proper impedance match for the interconnecting coaxial cable and the primary is maintained in all positions of the switch, S2. In the D position, the input is applied directly to the primary.

Channel switch S3 when set for the desired channel, selects a capacitor in section A of the switch (not shown) to shunt the input secondary. Slug tuning is used to adjust the circuit to the highest frequency (1950 KC of channel 1), and trimmer capacitors for channels 2, 3, and 4 provide the necessary adjustments for each of the other channels.

The RF amplifier, V1, is a conventional circuit with the exception of an 1100-KC wave trap in the cathode circuit. This circuit provides degeneration at the intermediate frequency by inserting a high parallel resonant impedance effectively in series with the signal path to increase attenuation of signals at the frequency in the V1 output.

The amplified output of V1 is coupled to the grid of the converter, V2. Sections B and C of the channel switch, S3, operate in the same way as section A to tune the input transformer to the selected channel with the aid of associated trimmer capacitors.

The cathode and first two grids of the converter, V2, are used in a Pierce-type oscillator circuit. The desired crystal is connected to V2 by section D of the channel switch, S3. The crystal replaces the more common tank circuit.

The 1100kc converter (V2) output is amplified in the cascade IF amplifiers, V3 and V4, before being applied to the detector.

The control grid of the RF amplifier, V1, and both IF amplifiers, V3 and V4, are returned to a control bias gain potentiometer in the balance circuit which varies the grid bias to determine the gain of the stages. The operation of the balance circuit is treated later. Unbypassed cathode resistors in the RF and IF stages provide a fixed minimum bias when the gain control is maximum (no grid bias applied to the stages). These resistors also produce a degenerative effect at the cathodes, which tends to prevent detuning of the RF and IF stages due to changes in grid bias.

The detector, V5A is a conventional diode rectifier with a shunt R C load. The V5A output is applied to the grid of the first video amplifier tube, V6A.

VIDEO AMPLIFIERS

The first video amplifier, V6A, also serves as a limiter when the negative input voltages exceeds the cutoff value of the tube. The positive-going output of V6A is fed to the second video amplifier, V6B, through the antijam switch, S4.

The antijam switch, S4, when in the IN position couples the positive output of V6A to the grid of V6B through the high-pass filter. This filter reduces the effects of jamming by removing the lower frequency components of the video signal.

The clipper stage, V5B, removes negative peaks from the V6B input. The negative pulses are derived from differentiation in a short time constant circuit.

When the antijam switch is in the OUT position, the output of V6A is coupled through S4 to the V6B grid. A voltage divider inserted to give an attenuation, which is equal to the loss obtained when the high-pass filter is used. Thus, the input to V6B for a given signal level remains the same whether the switch, S4, is in the IN or OUT position, and no adjustment of the front panel gain control is necessary.

The video gain control sets the level of the video output signal in both positions of the antijam switch. The video signal from V6A is amplified by V6B and coupled through a relay and self-check switch, S10 (discussed later),

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to the video amplifier, V7. The video is also applied to the grid of another video amplifier (V10) for a purpose which will be considered later.

Video amplifier V7 is essentially a clipper and amplifier stage. Detector V5B operates to remove negative portions of the video output of V6A. Some of the negative portions of the video, which are generated by differentiation at the V6B grid will be amplified in V6B. These negative voltages at the V6B plate, cause the V7 grid to draw a current through the grid limiting resistor. This action develops a negative voltage at the V7 grid, and therefore limits positive alternations of the grid input.

Negative alternations at the V7 grid (from V6B) are amplified by V7, and appear as positive-going pulses at the V7 plate. These positive video pulses are coupled to the upper deflection plate of the cathode-ray tube, V60.

When loran C is selected, a relay connects the common antenna and coupler to the loran C receiver (fig. 10-21).

The loran C receiver is simple in design and operation, it differs from conventional receivers in that it is a TRF (tuned radio frequency). Consequently, the received RF frequency and the intermediate frequency (100 KC) are the same, and undetected intermediate frequency is applied as video through a relay to V7 and V10 the indicating circuits.

The relay to select loran A or loran C also disables the receiver not in use.

The circuits described in the following pages pertain to loran A counting and timing. Loran C is the same but some of the circuits as shown have been modified to present the loran C signals correctly. Several units of amplification and dividers along with multiple ganged switches and relays are not shown on figure 10-21.

TIMER AND INDICATOR

To this point in the discussion, the loran signal input has been selected (by the antenna, RF amplifiers and converter stages), amplified (in the IF stages), detected (by video detector), and fed through stages of video amplification and clipping to the upper vertical deflection plate of the CRT. To hold the loran signal stationary on the screen of the indicator tube while readings are being taken, it is necessary to employ frequency control circuits to synchronize the repetition rate of the loran receiving set with the loran signals from the transmitting pair. This action is accomplished in the timer and indicator chassis.

Oscillator and Reactance Circuits

The time base for the synchronization system in the receiver is an 80-KC sine wave oscillator, V17 (fig. 10-22). The oscillator, V17, is crystal controlled by Y5 (at the normal frequency of 80 KC), and is essentially a tuned-plate, tuned-grid oscillator. The 80-KC crystal is connected in series with parasitic suppressor R94 at the grid of V17 to prevent oscillations at frequencies not controlled by the oscillator.

The reactance tube, V16 receives at its grid a small portion of the 80-KC voltage appearing across the crystal. The V16 grid is held negative with respect to the cathode by a negative voltage received from the AFC circuits (discussed later) supplemented by cathode bias developed at the V16 cathode.

The value of the apparent capacity across the crystal, Y5, depends upon the gain of the reactance tube, V16, which in turn depends upon the V16 bias. The value of bias is controlled (to an extent) by a negative voltage from the AFC circuit. The range of frequency control as a result of the action of the reactance tube, V16, is small (less than ± 30 cps), but is sufficient to compensate for differences in pulse repetition rate between the transmitting and receiving systems.

Frequency Control Circuits

As stated earlier, the basic timing system of the receiving set is controlled by the 80-KC crystal oscillator, V17. However, to hold the received pulse stationary on the screen of the indicator tube, the timing base must be synchronized to an exact multiple of the reception rate of the received signals.

Both AFC (Automatic Frequency Control) and manual drift circuits are available for use in synchronizing the receiving set with the received signals. In both cases, the control is accomplished by variation of the grid bias applied to the reactance tube, V16. The AFC circuit automatically changes the grid bias of V16, which changes the constants of the oscillator, V17, sufficiently to lock in the receiving set repetition rate at the proper relation to that of the transmitting group. Adjusting the drift

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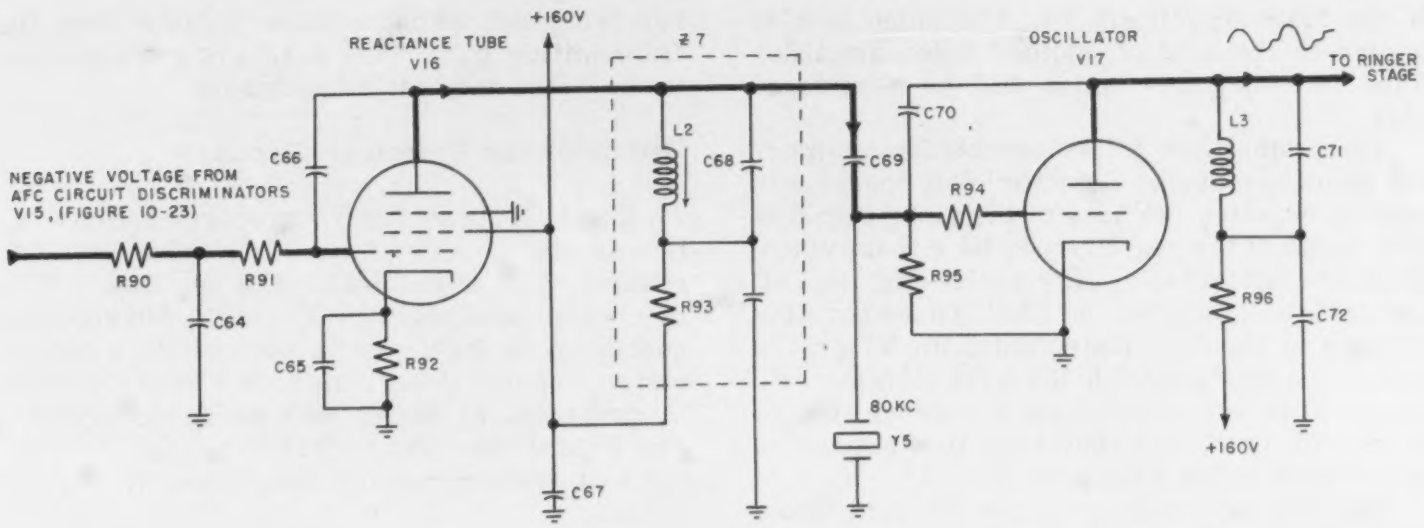

109.17

Figure 10-22.—Frequency control circuits (oscillator and reactance tube).

control on the receiver front panel will manually set the grid bias to control the reactance tube, V16.

The automatic frequency control circuits are shown in figure 10-23. V8 and V9 are one-shot multivibrators referred to as the A and B multivibrators, respectively. The one-shot cycle is described below. In the quiescent condition, V8B conducts, and V8A is cut off. The positive pulse on the V8A grid causes V8A to conduct. The resulting decrease in V8A plate voltage lowers the V8B grid below cutoff. The V8B plate voltage rises sharply as V8B plate current is cut off. The V8B grid rises above cutoff in approximately 80 μs, at which time V8B again conducts. The accompanying sudden increase in voltage cuts off V8A, and the one-shot cycle is completed.

The A multivibrator, V8, receives a positive rectangular trigger pulse from the pedestal amplifier. (The origin and purpose of the pedestal pulses are treated later.) The control grid of V8B is returned to the +160-volt supply, and is therefore the normally conducting section of V8. The positive rectangular output of the pedestal circuit is coupled through isolating resistor R46 and a differentiator circuit. The positive pulse resulting from the differentiation of the input triggers V8A into conduction to initiate the A multivibrator cycle.

The A multivibrator, V8, furnishes a positive rectangular pulse from V8B, to the suppressor grid of the A gated amplifier tube, V11, and a negative rectangular pulse from V8A, to the B multivibrator, V9. The duration of the output of each section of V8 is approximately 80 μs The pulse furnished to the grid of the B multivibrator, V9, is differentiated to form a sharp negative pulse. This pulse occurs at the same time as the leading edge of the input pulse to V8A. The operation of the B multivibrator, V9, is identical to that for the A multivibrator, V8.

Since a positive pulse from V8A is required to trigger V9A, the V9A conduction occurs 80 μs later (in time) than V8A when the V8A plate output (shown in dotted lines) is positive going. The positive rectangular output of V9B is applied (80 μs later than the pulse from V8B) to the suppressor grid of the B gated amplifier, V12, and is also approximately 80 μs in duration.

The A and B gated amplifiers, V11 and V12, respectively, are normally held beyond cut off by the negative bias (from the -180-volt supply) applied to the suppressor grids of V11 and V12. The suppressor grid of V11 is connected to the -108-volt supply.

Before the A multivibrator, V8, is triggered (at V8A) the plate voltage at V8B is approximately 45 volts, and the voltage divider comprising R50 and R63 applies about -36 volts to the suppressor grid of V11.

When V8A receives its positive trigger pulse, this tube section conducts; and the accompanying drop in the V8A plate potential is fed through C52 to the grid of V8B. V8B is cut off as a result of the negative-going grid input from V8A, and the V8B plate voltage rises toward the +160-volt supply potential. Likewise, the suppressor grid potential at the V11 grid (from the

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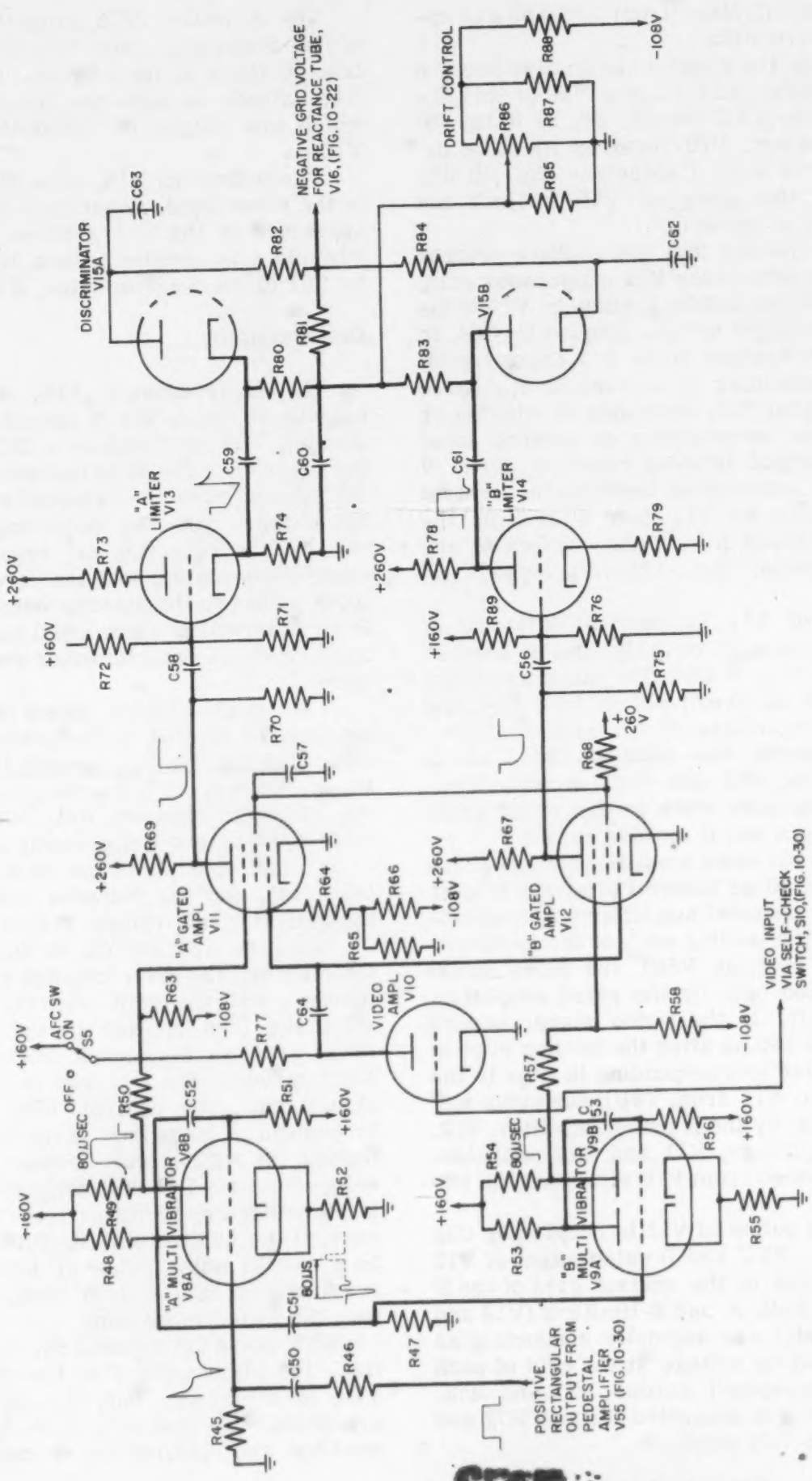

109.18

Figure 10-23.—Frequency control circuits (A and B gating circuits and discriminator).

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R50-R63 junction) rises from -36 volts to approximately zero volts.

Note at this time that V11 can also receive the positive video pulses from V10 at its control grid if the AFC switch, S5, is in the ON position, as shown. V10 receives its video input from Loran A or C receiver (fig. 10-21) and functions the same as V7B to limit and amplify the video signals.

During the period that the positive trigger from V8B prevails at the V11 suppressor grid, a coincident firing action occurs in V11 if the positive video output of V10, coupled by C64, is simultaneously applied at the V11 control grid.

Video signals may or may not be applied to the V11 grid from V10, depending on whether or not the system is receiving an antenna input signal. If no signal is being received, about -7 volts bias is established between the control grid and cathode of V11 (and V12) from the junction of R65 and R66. These resistors are connected between the -108-volt supply and ground.

Operation of V11 is identical with that of V12. The control grid of both tubes is coupled to the plate of V10 by C64. The video amplifier (V10) output is differentiated by C64, R64, and R65 so that, regardless of the received video signal pulse width, the input of the A and B gated amplifiers, V11 and V12, is held to approximately the same width as that of the gated pulses from the A and B multivibrators.

When the (V10) video amplifier output occurs during the first 80-μs interval after the trigger pulse from the pedestal amplifier (corresponding in time to the leading edge of the rectangular pulse to V11 from V8B), the video signal will be amplified only by the gated amplifier, V11. Conversely, if the video signal occurs between 80 and 160 μs after the leading edge of the pedestal pulse (corresponding in time to the trigger pulse to V12 from V9B), the video will be amplified only by the B gated amplifier, V12. Both gated amplifiers, V11 and V12, will conduct when the video from V10 straddles the two gated periods.

The A gated output of V11 is coupled by C58 to the A limiter, V13. The B gated output of V12 is coupled by C56 to the control grid of the B limiter, V14. Both A and B limiters (V13 and V14, respectively) are normally conducting as a result of positive voltage at the grid of each of the tubes developed across R71 and R76. These resistors are connected through R72 and R89, to the +160-volt supply.

The A limiter, V13, clips the positive peaks of its input signal from V11, but amplifies negative portions of the signals. The output at the V13 cathode is negative (less positive) pulses, which are coupled by C59 to the discriminator, V15A.

The B limiter, V14, also clips positive peaks of the video input. Negative portions of the video appearing at the V14 grid are developed at the V14 plate as positive pulses, which are coupled by C61 to the discriminator, V15B.

Discriminator

The discriminator, V15, utilizes the gated outputs of the A and B circuits comprising V8 through V14 to produce a DC output voltage, the polarity of the discriminator output depending upon whether the received signals are faster or slower than the receiving set repetition rate. If the receiving set repetition rate is in exact synchronism with the received signal, the input pulses to the discriminator from the A and B circuits will produce equal and opposite voltages, and the discriminator resultant output is zero.

The discriminator output at the R81-R82 junction is applied to the grid of the reactance tube, V16 (fig. 10-22), causing the V16 output to the oscillator, V17, to change as the voltage of the V17 grid changes. Accordingly, the oscillator (V17) output changes until it is synchronized to an exact multiple of the receiving set repetition rate, and the patterns being observed on the indicator will remain stationary.

When the AFC switch, S5 (fig. 10-23) is in the ON position, the discriminator operates in conjunction with the drift control, R86, to determine the bias applied to the reactance tube (V16) grid, as discussed. Normally, when the AFC circuits have locked in on the received signal, the drift control, R86, may be varied throughout a large part of its range without affecting the AFC circuit because the voltage developed across R81 will compensate for changes in the voltage applied by the drift control. However, if the AFC circuit should lose control due to a sudden noise pulse or interfering signal, readjustment of the drift control setting would stop the signal movement.

With the AFC switch, S5, in the OFF position, the plate voltage of the video amplifier, V10, is removed. Thus, the signal to the discriminator is removed, and the drift control governs, the bias on the reactance tube, V16.

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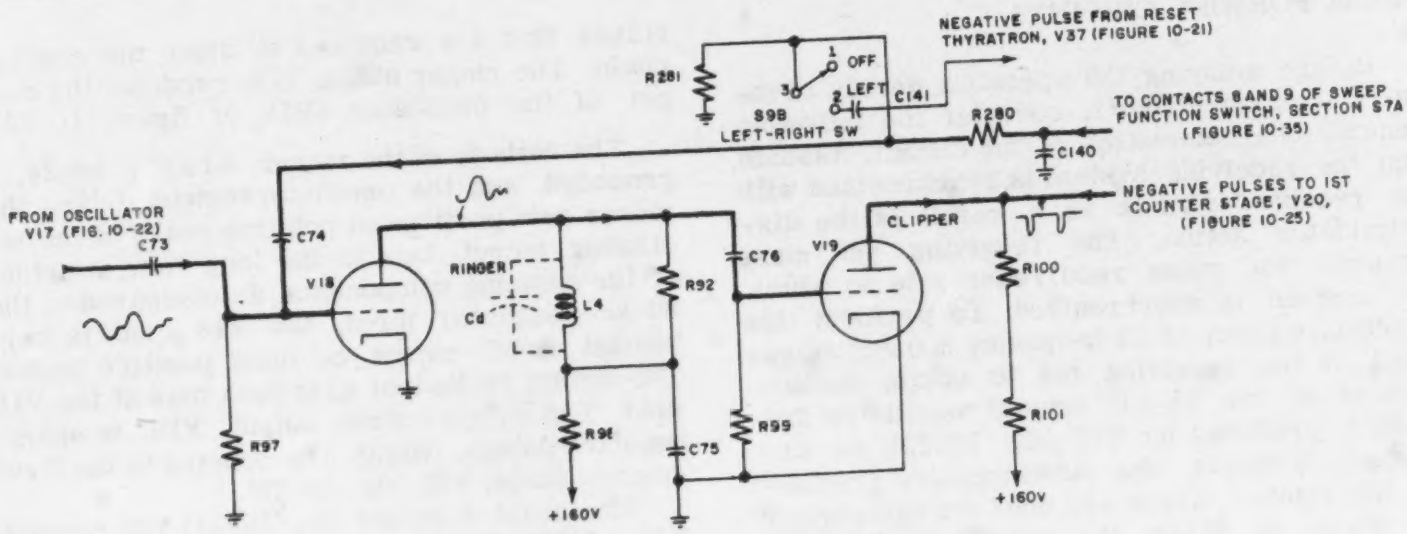

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Figure 10-24.—Pulse-forming circuits (ringer and clipper).

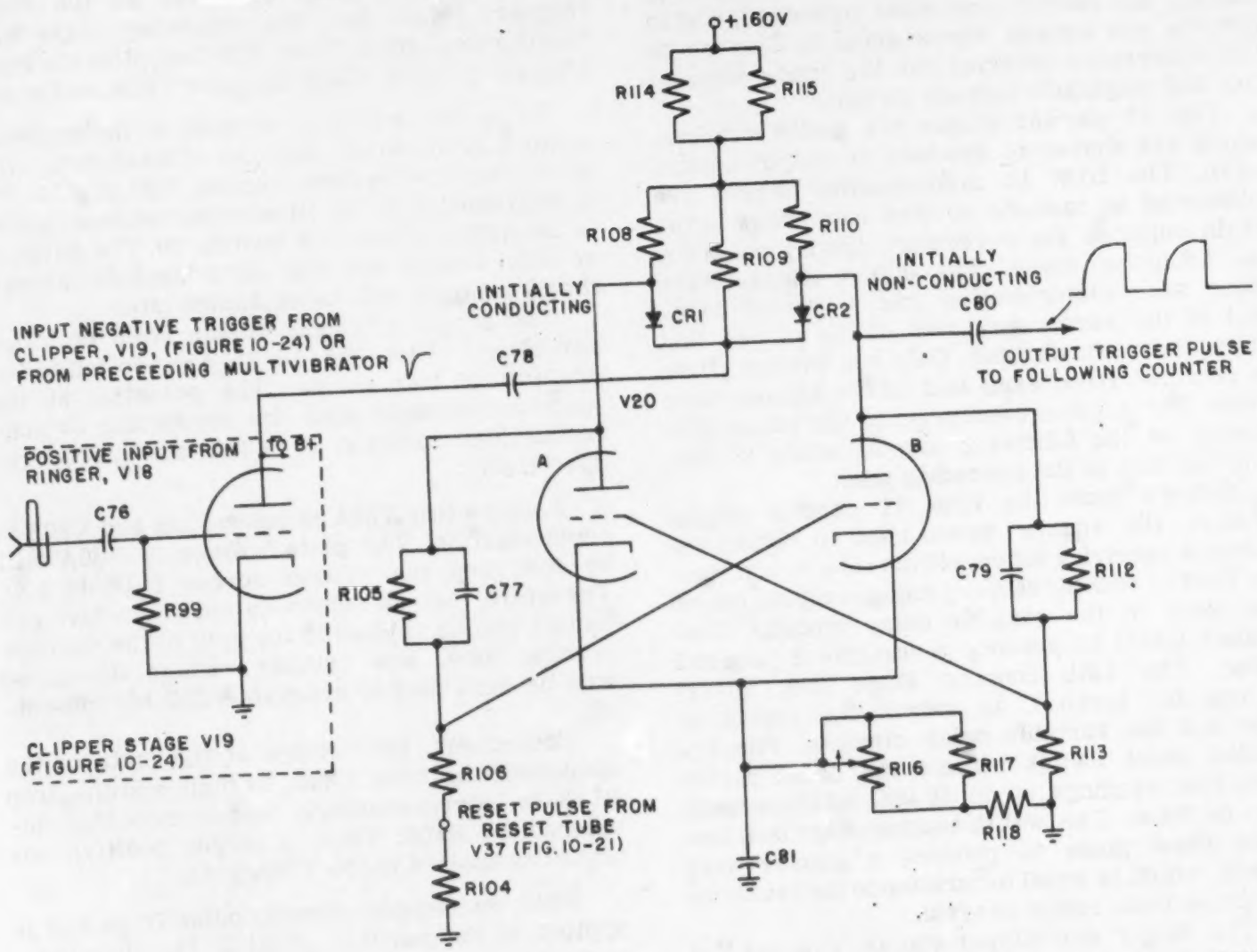

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Figure 10-25.—Representative counter circuit.

PULSE FORMING CIRCUITS

Before studying the operating details of the pulse forming circuits, consider the following general characteristics of the circuit. Assume that the receiving system is synchronized with the received signals as a result of the discriminator action. The receiving set must generate the pulse recurrence rate to which the system is synchronized. To perform this function a group of 13 frequency counter stages used in the receiving set to obtain subharmonics of the 80-KC crystal oscillator frequency produced by V17 (fig. 10-22), as discussed. Actually, the subharmonics produced by the counter stages are used for three major purposes: to obtain the receiving set pulse repetition rate as selected by the PRR (Pulse Repetition Rate) switch on the receiver front panel, to produce the trigger pulses used to initiate the master and slave pedestals, and to provide two square waves equal in duration to the recurrence interval for the trace separation and amplitude balance circuits.

The 13 counter stages are multivibrators, which are driven to produce an output square wave. The first 11 multivibrator stages are connected in cascade so that each stage in the chain supplies the necessary driving pulse for the following stage. The output square wave from each multivibrator has a period twice that of the recurrence rate of the pulses that drive the multivibrator. Only one driving pulse is obtained from each half of the square-wave cycle (for a given counter), and the output frequency of the following counter stage is thus one-half that of the preceding one.

Outputs from the first 11 counter stages produce the square waves used to obtain the Loran A receiving set repetition rate. In addition, the first 11 counter stages produce outputs, which are used in the variable delay circuits (discussed later) to produce a variable B pedestal pulse. The 13th counter stage (fig. 10-21) is use for loran C to extend the repetition rate and the variable delay circuits. The extended count switch affects the count period such that readings up to 50,000 microseconds may be taken. The twelfth counter stage is driven by a reset pulse to produce a square wave output, which is equal in duration to the receiving set pulse recurrence interval.

The ringer and clipper stages, V18 and V19 (fig. 10-24) are included in the pulse-forming circuits to produce the sharp, negative driving pulses that are required to drive the counter chain. The ringer stage, V18, receives the output of the oscillator (V17 of figure 10-22).

The cathode of the ringer, V18 (fig. 10-24) is grounded, and the oscillator output drives the ringer grid positive on positive peaks of the oscillator output. Due to the long time constant of the coupling components, as compared to the 80-kc oscillator input, the V18 grid is held beyond cutoff except on input positive peaks. The action is that of grid-leak bias at the V18 grid. The clipper stage output, V19, is sharp, negative pulses, which are coupled to the first counter stage, V20 (fig. 10-25).

The counter stages (fig. 10-21) V20 through V31 (V951 for Loran C) are flip-flop (Eclles-Jordan) multivibrators. The cascade connection of the 13 multivibrators allows the output pulse of one counter stage to serve as the input trigger pulse for the following stage, as mentioned earlier. Thus, V20B supplies the input trigger to V21A. V21B triggers V22A, and so on.

Since the operation of each of the multivibrators is the same, only one of the circuits will be explained. The first counter, V20 (fig. 10-25) is represented in the illustration without regard to the action of the L-R switch, S9. The purpose of this switch and the input applied through the S9 contacts will be explained later.

The negative trigger pulses from the clipper stage, V19 (fig. 10-24) are applied to the junction of two diodes. The potential at the junctions depends upon the conducting or nonconducting condition of V20A and V20B, respectively.

Assume that V20A is conducting and V20B is nonconducting. The plate voltage of V30A will be low, and the voltage across R106 is low. Therefore, only a relatively small positive potential will be applied to the grid or the nonconducting tube. The cathode voltage developed will be sufficient to maintain V20B beyond cutoff.

Conversely, the voltage at the plate of the nonconducting tube, V20B, is high, and the drop R113 is correspondingly larger than that developed by R106. Thus, a larger positive potential is applied to the V20A grid.

When the negative trigger pulse from V19 is applied at the junction of R109, the diode connected to the "off" plate will have the larger voltage difference placed across its terminals and will therefore conduct a heavy current.

Due to the action of the diodes, the trigger is applied only to the nonconducting stage. The regenerative action originating from the effect of the input pulse on the nonconducting tube causes the generation of a square wave having a fast-rise and fast-fall time. The counter stage output (V20 in this case) is taken from the B section of the tube, and applied through 080 to the following counter stage.

The cathodes of all the counter stages (V20 through V30) are returned through the counter bias network to ground. Resistor, R116, can be adjusted to set the counter bias at the proper level.

The pulse repetition rate coincidence stages, V32 through V36A (fig. 10-21), utilize the various outputs of the counter chain to drive a particular pulse repetition rate for the receiving system chosen by the PRR switch on the receiving set front panel. Because each counter stage must be triggered twice by a negative pulse before it produces a trigger pulse for the following stage, the point (in time) at which any tube switches can be represented by a given count of driving pulses applied to the input of the counter chain.

By combining the voltage values of the output square waves present at the various counter plates, it is possible to determine the point at which a given count is reached. The count will correspond to a selected pulse repetition rate.

Let us analyze this concept with the aid of the plate waveforms of V28A, V29A, and V30A shown in figure 10-26. Each of the three plate outputs of V28A, V29A, and V30A will be negative going only at counts between 1792 and 2048 on the scale shown. This coincident occurrence

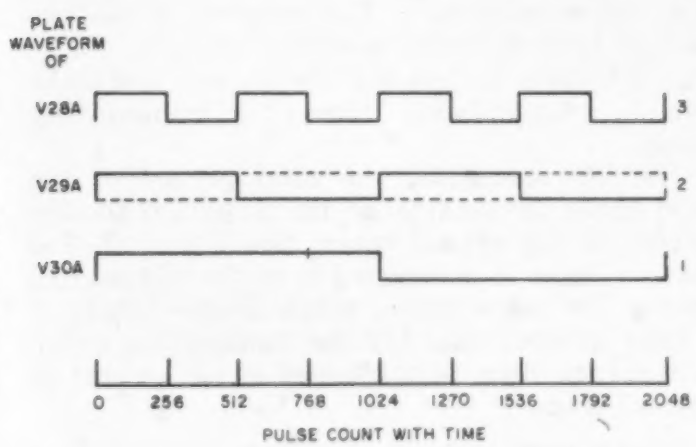

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Figure 10-26.—Negative coincidence indication from combined plate waveforms.

of all negative voltages at the chosen plates correspond in time to a given count selected by the PRR switch.

If the B section output of V29 shown on dotted lines were substituted in place of the A section output, the simultaneous, negative indication would be obtained only at counts from 1270 to 1536. This corresponds in time to a different setting of the PRR switch.

It is possible to obtain a negative output from the counter stages during any of the intervals plotted on the bottom scale (if the proper counter plates are chosen). If the outputs of all the binary plates were properly combined, it would also be possible to secure a unique negative indication for every count from 0 to 2048. Since only 24 different repetition rates are used by the various transmitting groups it is not necessary to use all of the outputs of the first 11 (13 for Loran C) counter stages.

The plates of the third through the tenth stages of the counter chain (V22 through V29) are direct-coupled through an isolating resistor to the PRR switch, S6. The switch selects the proper counter plates to produce the negative output that corresponds to a predetermined count. The chosen plate output is coupled to the grid of one of the amplifying tubes, V32 through V35 (fig. 10-21).

The pulse count (fig. 10-26) represents the number of pulses in time required to produce the effect indicated for either of the tubes V28A, V29A, or V30A. Only counts above 1024 are used. The A plate of V30 is negative for the entire period from 1024 to 2048. The negative pulses from V30A are always used in determining the pulse repetition rate of the receiving set, and are applied to the V36A control grid (fig. 10-21). The plates of V32 through V36A are connected together and returned through a common load resistor to the +160-volt supply. Cathode PRR bias control permits the bias to the tubes to be adjusted.

Recall that the input (grid) voltage of any one of the tubes, V32 to V35, may be positive or negative, depending upon the potential applied from the counter plate to which the grid of the tube is connected through a section of the PRR switch, S6. The V36A input from V30A may also be either positive or negative. When the input pulse from a counter to any section of the coincidence indicator chain comprising V32 through V36A is positive, that section will draw saturation current. When the counter input to a particular section of any one of the tubes

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(V32 through V36A) is negative, that section will be held beyond cutoff for the duration of the counter input. V32 through V36A are paralleled, with a common plate load resistor connected to the +160-volt B supply.

Since an output is produced from the coincidence indicator chain during the time that all sections of V32 through V36A are cut off, the width of the output cannot be greater than the width of the negative half of the smallest square wave applied to the chain. The first counter output pulse to the coincidence indicator chain is applied from V22A (or V22B) through S6 to one of the grids of V32. One of the V22 outputs will always be applied to V32, depending on the position of S6. The output frequency of the third counter V22, is 10 kc, and the width of the negative pulse is 50 μs (one-half the total pulse duration). This represents the maximum time that all of the tubes in the coincidence indicator chain (V32 through V36A) can be held cut off, and likewise sets the output pulse width of the coincidence indicator.

Changes in the plate to ground voltage of V32 through V36A are coupled to the control grid of the clipper amplifier stage, V36B. The V36B grid is normally held at about -34 volts negative to the cathode, and V36B is nonconducting. Positive inputs at the V36B grid cause an output at the V36B plate. Negative input voltages are not amplified by V36B because negative inputs drive the V36B grid further into cutoff.

The negative V36B output is differentiated in the short, time-constant circuit. The positive pulse resulting from the differentiation is applied to the grid of a reset thyratron, V37.

The reset thyratron, V37, is normally held beyond cutoff by a fixed bias voltage from the -108-volt supply. The positive differentiated output of V36B (when the coincidence chain comes back into conduction) triggers V37 into conduction. The resulting positive output at the V37 cathode is a very sharp positive pulse. The point (in time) at which the reset pulse occurs corresponds to 50 μ sec after the time during which the simultaneous negative voltages from the counter plates arrive at the grids of V32 through V36A. Thus, the recurrence rate of the reset pulse at the V37 cathode is determined by the selection of the counter plates by the PRR switch, S6, to supply the simultaneous negative pulses to the grids of all the coincidence indicator chain tubes, V32 through V36A. The output reset pulse from V37 is fed from the V37 cathode to the control grids of the B sections of V21, V22, and V24 through V30 (through their respective grid resistors). The reset pulse is also applied to the first counter, V20, and to the fourth counter, V24, if the L-R switch, S9, is in the OFF position.

The reset pulse causes a switching of all the conducting tube sections in the counter chain, and thereby resets the chain. When the point (in time) is again reached where all of the counter outputs applied to the coincidence indicator chain are negative, another reset pulse will be produced 50 μ sec later and will likewise again reset the counter chain. Thus, the pulse repetition rate (frequency) at which this action occurs is determined by the time required for the counter chain to reach the condition of all negative outputs to the coincidence indicator plus 50 μ sec. This, in turn, corresponds to a given setting of the PRR switch, S6.

The positive reset pulse from the V37 cathode will appear at the B grids of the second, third, and fifth through eleventh counter stages, as a result of a permanent connection. With the L-R switch, S9A, in the OFF position, the positive reset pulse from the cathode of V37 is also applied to the B grid of the first counter stage, V20, and the B grid of the fourth counter, V23. Thus, all counter stages are reset on the same side at a rate determined by the PRR switch, S6.

In the receiving system, two sweeps are produced during the time of one recurrence interval of the signals received from the transmitting groups (fig. 10-27). One reset pulse from V37 is required to produce each of the two sweeps. Thus, the output frequency of the reset thyratron, V37 must be twice the receiving system recurrence rate. The purpose of the two sweeps is to allow the indicator circuits to display separate traces for the master and slave pulses, respectively, from the transmitting group.

During operation, the total period of the first trace is considered the A period and the period of the second trace, the B period. The master pulse is positioned in the first (A period) trace. The slave pulse, which always occurs at a time greater than 1/2 the transmitting group recurrence rate, is positioned on the second (B period) trace.

The twelfth counter stage, V31 (fig. 10-21) is active in producing the A period and B period traces. The operation of the twelfth counter stage, V31, is the same as that discussed earlier with the use of figure 10-25.

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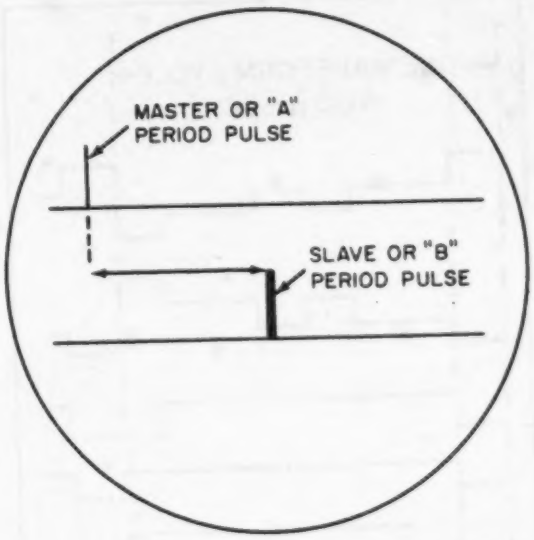

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Figure 10-27.—Cathode-ray tube showing A and B period traces.

VARIABLE DELAY CIRCUITS

The variable delay coincidence stages, V39 through V45 (fig. 10-21), produce a pulse that is continuously variable in delay over the entire B period. The actual delay is read on the time-difference dial on the receiver front panel.

The coincidence action of selected counter outputs of any of the tubes (V20 through V30) with the output of the goniometer circuits (V47 and V48) in the delay coincidence indicator stages (V39 through V45) produces the variable delay. The V39 to V44 output is combined with the output of the twelfth amplifier to produce the variable B pedestal.

It is sufficient at this time to regard the goniometer as a device whose output varies continuously in phase throughout its 100-μs period.

The delay crank controls the position of the lower pedestal within the B period. The delay crank accomplishes this action by operating switch S8 in such a manner that the B pedestal pulse occurs at an interval of time that corresponds to the reading indicated on the time-difference counter.

S8A through S8D are the sections of S8 which connect the grids of V39 to the plates of V22 in the counter chain when the delay crank is rotated. The common cathode voltage at the V39 grid maintains each section of V39 cutoff when its input signals are momentarily disconnected through the rotating contacts of S8.

V39A receives the grid input from the A plate of the third counter, V22, through S8A. The V39B grid input is coupled from the B plate of the third counter, V22. The duration of the third counter output is 100 μs, having positive and negative alternations of 50 μs each. When either section of the tube is conducting, the voltage drop across the common plate load resistor produces a negative rectangular output pulse, which is 50 μs in width. This pulse is direct-coupled from the V39 plate to the grid of V40.

As the delay crank is turned, S8, which is geared to the crankshaft also turns, and the positive alternation of the input wave form from the third counter is constantly being applied to one of the V39 grids.

The time-difference counter changes at a rate of 100 units per revolution of the goniometer (S8) shaft. One revolution of the goniometer corresponds to 100 μs. A gear reduction of 4 to 1 between the S8 shaft and certain switch sections of S8 cause these switch sections to turn 90° for every revolution of the goniometer. Since the goniometer shaft directly drives the mechanical counter, the counter will change 400 units as the output of V39 moves through a 400-μs cycle (one revolution of the S8) and returns to the starting point. Figure 10-28 shows the waveform at the plate of V39 for every 22.5° interval between 0° and 360° points of the S8 drive shaft rotation.

GONIOMETER AND CLIPPER CIRCUITS

The output of the third counter stage, V22, is coupled to the control grid of a shaper stage, V50A (fig. 10-29).

The grid of V50A begins to draw a current because of the connection of the V50A grid to the +160-volt supply. With the square wave applied, negative grid-to-cathode (bias) voltage is established at the V50A grid.

Shaper V50A amplifies the square-wave input and applies its output to a 10-kc filter. The filter output is a 10-kc since wave, shich is applied to the grid of the goniometer driver, V46.

Goniometer driver V46 is a cathode follower with a positive grid bias. The cathode potential of V46, as a result of the V46 tube conduction is about +42 volts. These potentials hold V46 at the proper operating point.

The output of V46 is a 10-KC sine wave, which is coupled to the goniometer, B1. Thus, the period of the goniometer input is 100μs, the

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* DELAY DIAL READING	POSITION OF S8A THRU S8D IN DEGREES (CCW)	WAVEFORM ON TUBE AND PIN NO.
02375	0	V39-7
02375	0	V39-3
02375	0	V39-4-6
02400	22.5	
02425	45	
02450	67.5	
02475	90	
02500	112.5	
02525	135	
02550	157.5	
02575	180	
02600	202.5	
02625	225	
02650	247.5	
02675	270	
02700	292.5	
02725	315	
02750	337.5	
02775	360 OR 0	V39-4-6

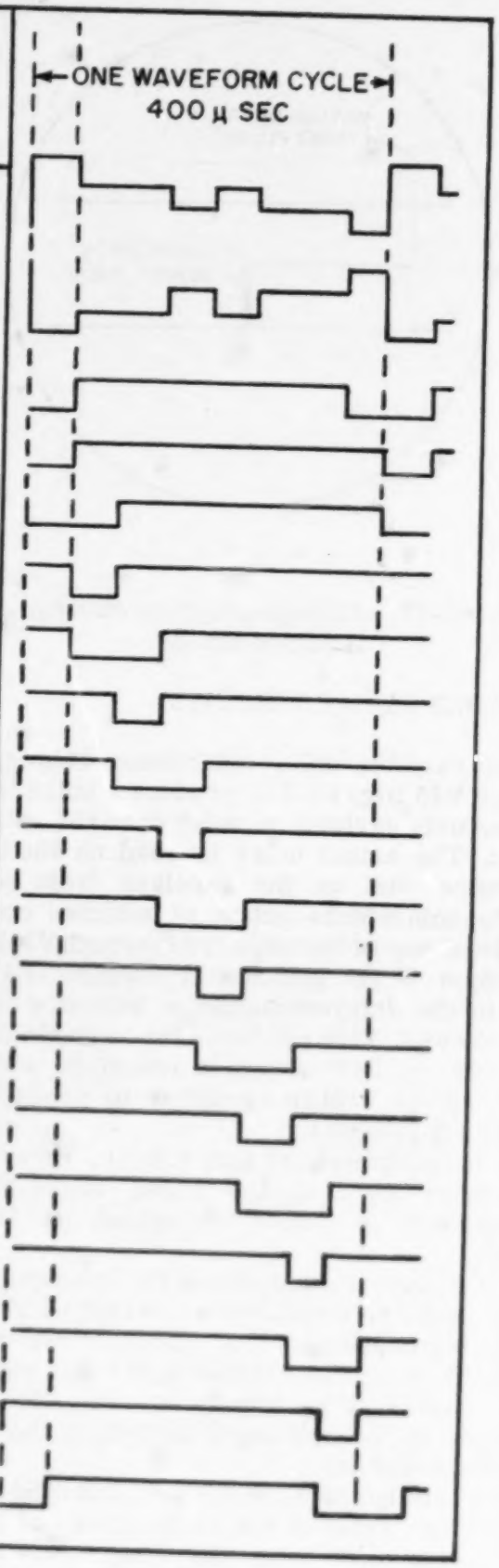

ONE REVOLUTION OF S8

* REPEATS IN 400 μ SEC.

Figure 10-28.—Gating waveforms from delay coincidence indicator.

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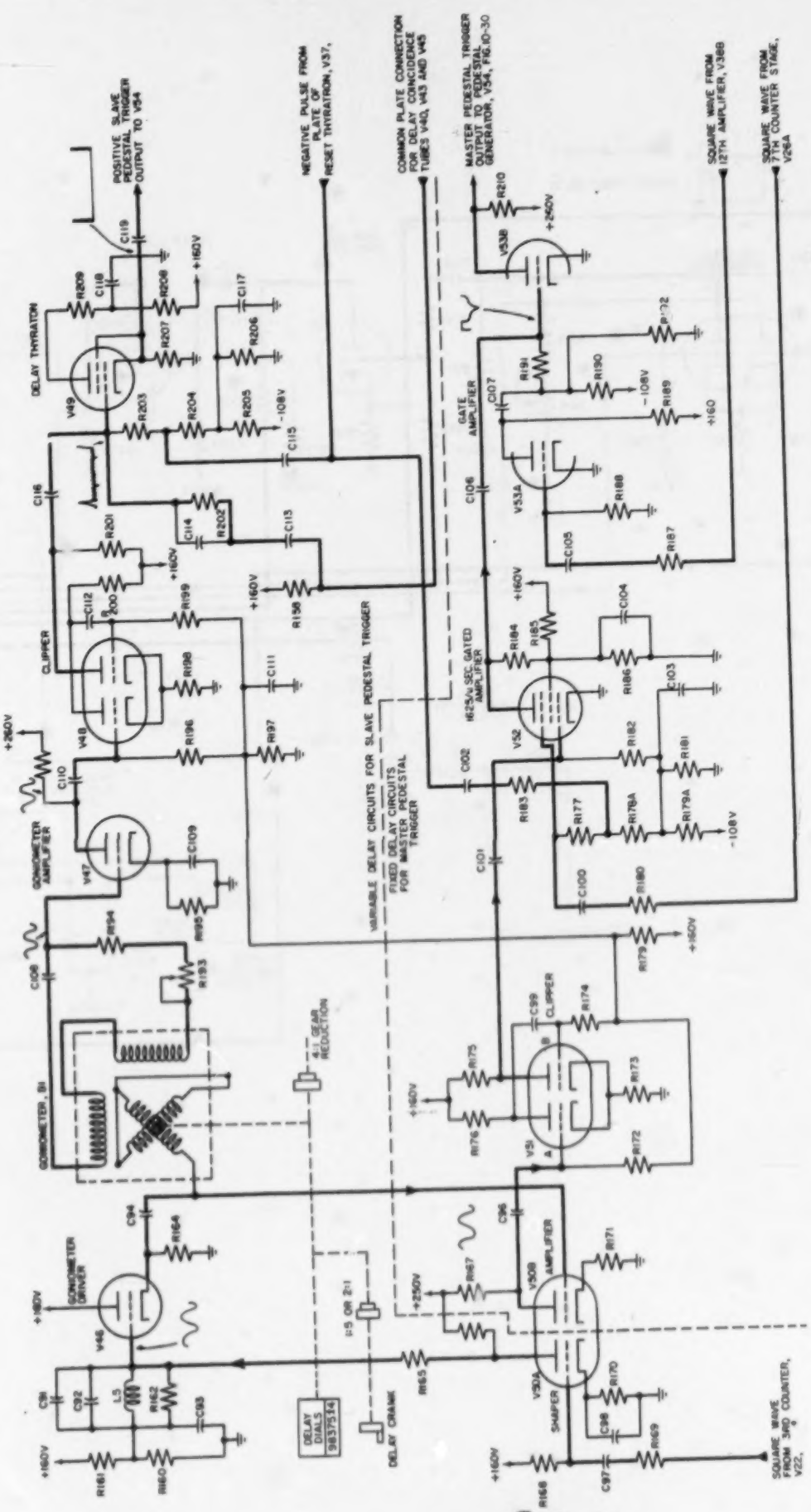

Figure 10-29.—Goniometer, clipper, and fixed delay circuits.

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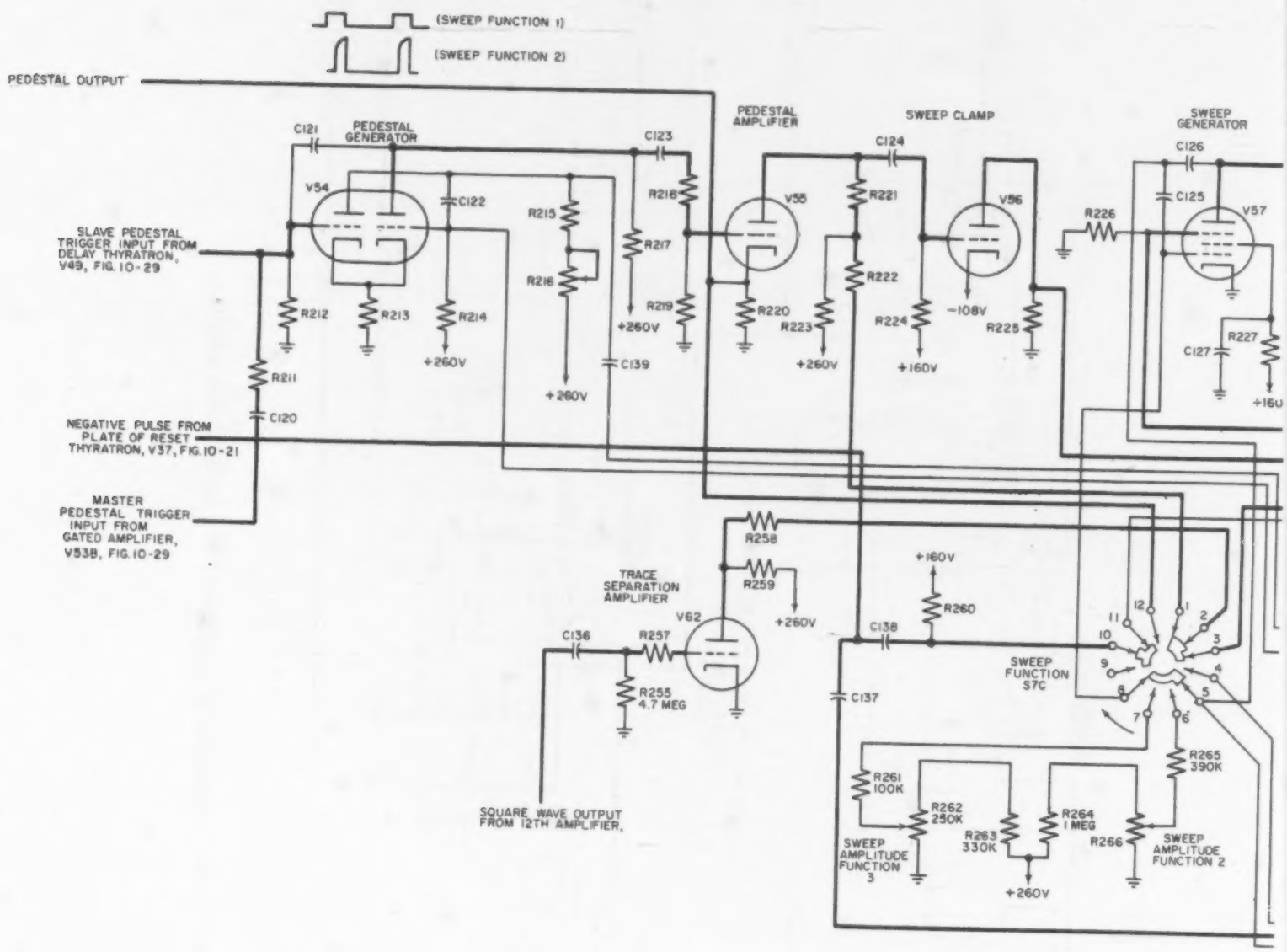
(SWEEP FUNCTION 1)
(SWEEP FUNCTION 2)
PEDESTAL OUTPUT
PEDESTAL GENERATOR
PEDESTAL AMPLIFIER
SWEEP CLAMP
SWEEP GENERATOR
C121
C122
C123
C124
C125
C126
C127
C120
C139
C136
C137
C138
V54
V55
V56
V57
V62
R211
R212
R213
R214
R215
R216
R217
R218
R219
R220
R221
R222
R223
R224
R225
R226
R227
R255 4.7 MEG
R257
R258
R259
R260
R261 100K
R262 250K
R263 330K
R264 1 MEG
R265 390K
R266
+260V
+160V
-108V
SLAVE PEDESTAL TRIGGER INPUT FROM DELAY THYRATRON, V49, FIG. 10-29
NEGATIVE PULSE FROM PLATE OF RESET THYRATRON, V37, FIG. 10-21
MASTER PEDESTAL TRIGGER INPUT FROM GATED AMPLIFIER, V53B, FIG. 10-29
TRACE SEPARATION AMPLIFIER
SQUARE WAVE OUTPUT FROM 12TH AMPLIFIER,
SWEEP FUNCTION S7C
SWEEP AMPLITUDE FUNCTION 3
SWEEP AMPLITUDE FUNCTION 2

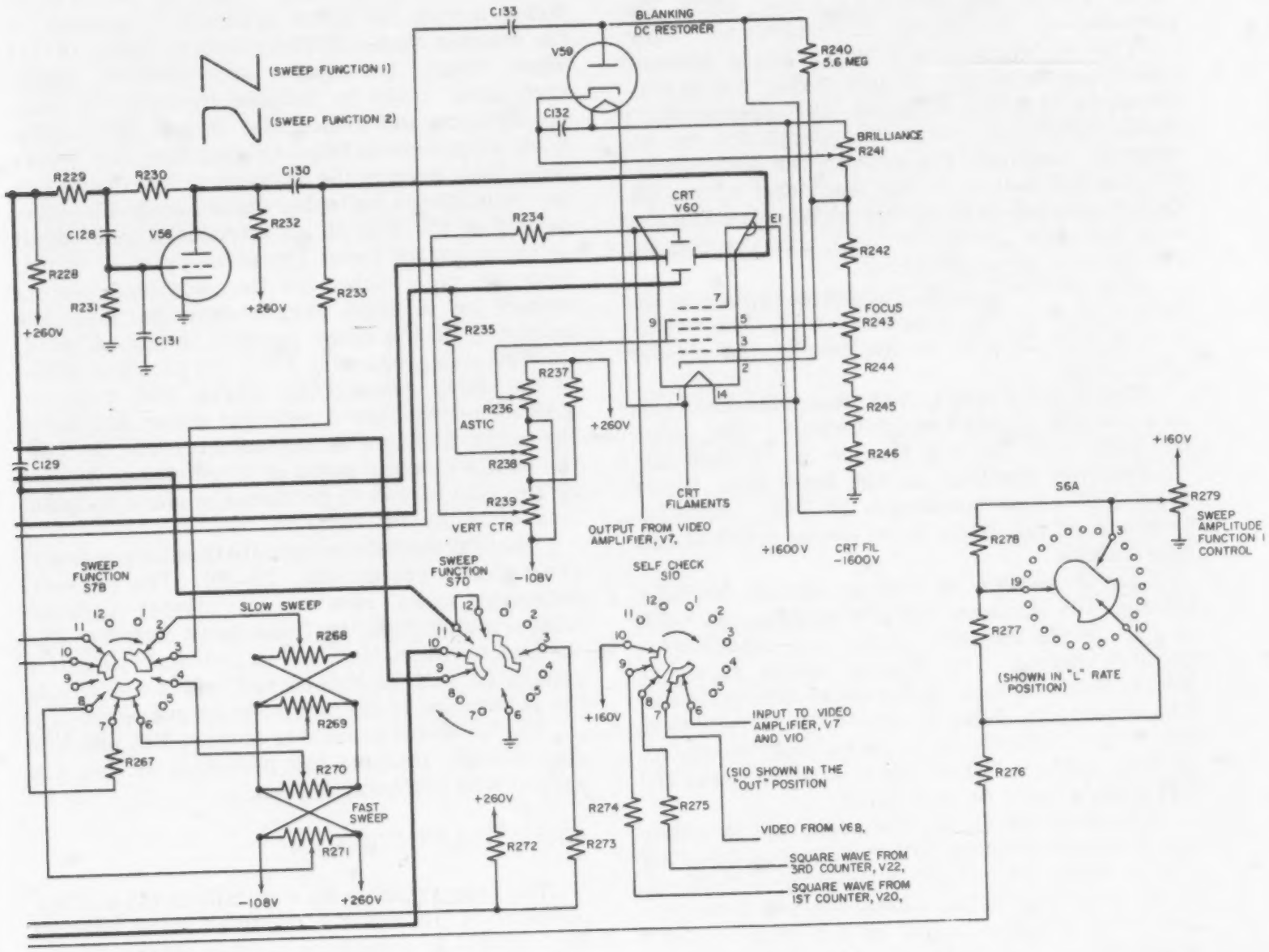

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Figure 10-30.—Pedestal, trace separation, blanking and self-check circuits.

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same as that of the widest pedestal pulse from the delay coincidence indicator, V45.

The goniometer driver output is also coupled to the grid of the 10-KC amplifier, V50B. The purpose of this input is considered later.

The goniometer (B1) output has a constant peak-to-peak amplitude per cycle, but is continuously variable in phase with respect to its input. The goniometer is geared 1:1 to the counter, and both the goniometer and counter are geared 4-to-1 to the shaft that drives S8. One revolution of B1 moves the B1 output through one complete cycle (100 μs), and the counter through 100 scale divisions.

The goniometer (B1) output is applied to the grid of goniometer amplifier V47. The amplified output of V47 is applied to the clipper stage, V48.

The clipper stage, V48, functions similarly to a cathode-coupled multivibrator. The grids of V48A and B are tied to a +17-volt tap.

Positive portions of the input sine waves from V47 cause conduction of V48A. Negative portions of the V48A input cause cutoff of this tube section.

The B section of V48 is coupled to V48A through the common cathode resistance. V48B is cut off for negative inputs and conducts for positive inputs. The clipper output is not a square wave because of the short time constant. The input to the delay thyratron V49, from V48 is therefore a differentiated pulse. Only the sharp, positive differentiated pulse is effective at the V49 grid, as will be seen later.

The delay thyratron, V49, receives two other inputs simultaneously with the application of the clipper input. The negative pulse from the plate of the reset thyratron, V37 is applied to the V49 grid. The positive output of the delay coincidence tubes, V40, V43, and V45 (fig. 10-21) is fed to the grid of V49.

The position (in time) of the positive output of the clipper stage, to the delay thyratron grid varies continuously as the goniometer shaft is turned. The positive trigger, which is applied to the V49 grid from V48 in the presence of the positive delay coincidence input to V49 causes the delay thyratron to produce a positive-going slave pedestal trigger pulse. Because the delay coincidence input pulse from V45 is only available during the B period, and because the input pulse from the goniometer is continuously moving through a 100-μs period as the goniometer shaft is turned, the time of the conduction of V49 can vary throughout the 100-μs interval.

The exponential slope of the input from the reset thyratron, V37, is sufficiently negative to keep the delay thyratron, V49 (fig. 10-29) from firing during the short interval after reset of the counter stages (V20 through V31) (fig. 10-21) when many transients are present. These transients could be coupled through the delay coincidence and goniometer stages with sufficient amplitude to false-trigger the delay thyratron, V49, even in the absence of the normal delay coincidence indicator chain output. The delay period of the V49 firing introduced as a result of the negative reset thyratron pulse is small. Because zero delay for the receiving system occurs an A delay period after the reset the accuracy of the delay reading is not affected.

The delay pedestal from the parallel plates of the delay coincidence stages, V40, V43, and V45 is not the slave pedestal pulse and is not the pulse displayed on the indicator tube. Rather, the positive output pulse of these stages is used at the grid of V49 to produce the slave pedestal trigger at the V49 cathode.

The V49 output is coupled to the slave pedestal generator circuits (fig. 10-30). The pedestal generator also receives a master pedestal trigger pulse from the fixed delay circuits. The method by which the master pedestal trigger is generated will be considered before discussing the generation of the master and slave pedestals.

The pedestal generator stages, V54 and V55 (fig. 10-30), produce the pedestals as they are seen on the indicator screen.

FIXED DELAY CIRCUITS

The trigger pulse used to initiate the master pedestal is produced in the fixed delay circuits (fig. 10-29) by combining a pulse obtained from the leading edge of the sine-wave output of the 10-kc amplifier (after passing through clipper stage, V51) with square waves from the seventh counter stage, V26, and the twelfth amplifier, V38. These inputs produce the master pedestal trigger pulse an A delay period after reset in the A trace period. Thus, the time of the master pedestal trigger corresponds to the leading edge of the master pulse, which begins 1625 μs after the beginning of the A period.

In operation, the time-difference counter is adjusted to give a zero reading 1625 μs after the beginning of the A period. Thus, any change in the time-difference counter reading from zero in the B period trace (when the difference is being determined) represents the actual difference

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is between the master and slave pulses less one-half the recurrence interval.

The 10-KC amplifier, V50B (fig. 10-29) receives the goniometer driver output and couples an amplified 10-KC sine-wave to the grid of clipper stage V51A. The clipping action in V51 is produced in the same manner as the V48 clipper in the variable delay circuits. The 10-KC square-wave output of V51B is differentiated and applied to the control grid of the 1625-μs gated amplifier, V52.

The 1625-μs gated amplifier, V52, also receives a 1600-μs square wave from the seventh counter stage. This input is applied to V52 (a coincidence stage) which requires the simultaneous application of input pulses (from V51 and V26A) before conduction of V52 will occur.

The time constant of the coupling network to the V52 suppressor grid is long enough to hold the suppressor at approximately zero volts for a 25-μs interval before the clipper output is applied to the control grid of V52. When the V51 output arrives at the V52 control grid, a negative output pulse is produced at the V52 plate.

The negative input pulse, coupled to the suppressor grid, from the reset thyratron, V37 (fig. 10-20) prevents firing of the 1625-μs gated amplifier, V52 (fig. 10-29) due to transient voltages present immediately after the reset period. The 1625-μs gated amplifier, V52 produces an output pulse on the A delay period after each reset pulse and at 1600-μs intervals following the first output.

The gated amplifier, V53B, is normally cut off. The output pulse of the 1625-μs gated amplifier, V52, is applied to the control grid of V53B. This input pulse alone is not sufficient to cause the conduction of V53B.

The control grid of V53A receives and amplifies the square-wave output of the twelfth amplifier, V38B (fig. 10-20) which is negative during the A period and positive during the B period. Since in V53A (fig. 10-29) the input pulse is inverted at the V53A plate, the V53A output is positive going during the A period. The time constant (in the V53A coupling network) maintains the V53B grid above cutoff just long enough for the first input pulse from the 1625-μs gated amplifiers to the V53B grid to be amplified in this stage. The V53B output represents the master pedestal trigger output pulse to the pedestal generator circuits (fig. 10-30).

PEDESTAL CIRCUITS

The trigger pulses produced in the fixed and variable delay circuits are used in the pedestal generator stages, V54 and V55 (fig. 10-30) to initiate the pedestal pulses seen on the indicator screen. The master and slave trigger pulses are applied (during separate periods) to the grid of pedestal generator stage, V54. The circuit of V54 is that of a cathode-coupled multivibrator and operates similarly to the A and B multivibrators (fig. 10-23) discussed earlier.

The pedestal generator stage, V54B (fig. 10-30) is normally conducting because its grid is connected to the +260-volt supply. The pedestal trigger pulses (either master or slave from V49 or V58B, respectively, of figure 10-29) are applied to the V54A grid (fig. 10-30), causing this tube section to conduct. The resulting positive-going output pulse of V54B is coupled to the pedestal amplifier control grid. The positive output at the V55 cathode is coupled to the AFC circuits (fig. 10-23) to initiate the action of the A multivibrator, V8.

The sweep function switch, S7 (fig. 10-30) controls the manner in which the pedestal pulses will be used and the nature of the pattern shown on the indicator screen. The modes of the switch, referred to as sweep function 1, sweep function 2, and sweep function 3, describe the manner of the indicator display and the use of the pedestal pulses rather than the position of the switch contacts. The cathode-ray display for each of the S7 modes is shown in figure 10-31.

The loran A display has a master pulse and slave pulse (fig. 10-31, A) which are tuned by the receiver and adjusted by the controls to display the master on the top trace and the slave on the bottom trace. The pulses are brought to the leading edge of the pedestal by the delay (counter) control (fig. 10-20) and then sweep function switch, S7 is placed in step 2 to give display in figure 10-31, B. The pulses are then lined up with the lower pulse adjusted under the upper pulse by the counter control. The function switch, S7 is then placed in step 3 (fig. 10-30), C) and the counter adjusted to superimpose the leading edge of the two pulses. The counter readings are plotted on a loran chart using loran A tables, and usually checked against one or two other station fixes.

The loran C display (figure 10-31, C) shows that the loran C signal is a group pulsed technique instead of the loran A single pulse. The master group transmission is comprised of nine

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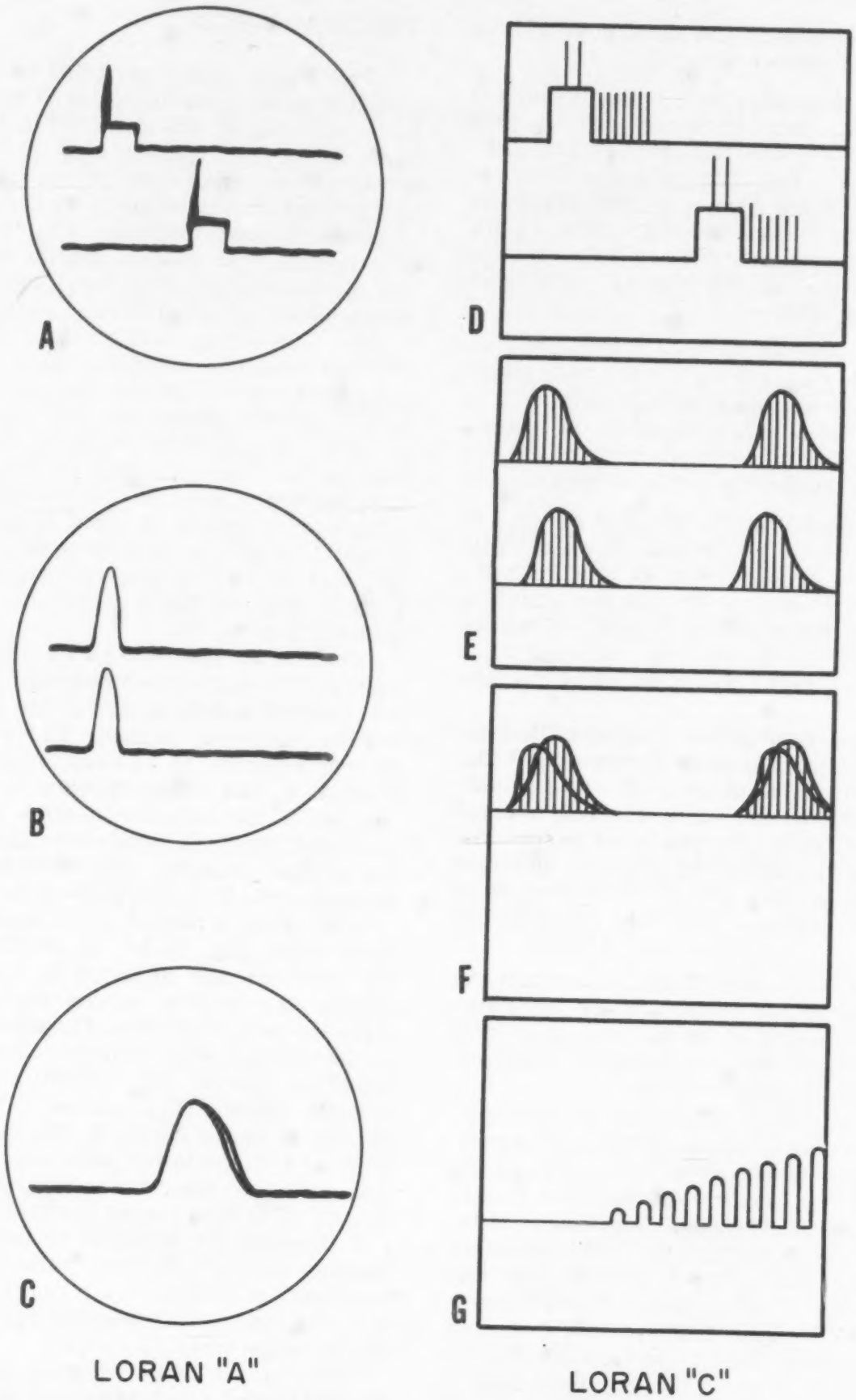

Figure 10-31.—Cathode-ray tube presentations for sweep functions 1, 2, and 3. 70.99

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phase-coded pulses while the slave group comprises eight phase-coded pulses. To take a reading of the counters for a fix, adjust the delay counter crank to line up the two pedestals and pulses. Set the sweep switch (S7) to position 2 (fig. 10-31, E) and again align the two bottom pulses with the top pulses. Adjust the TRACE SEP control to superimpose the two sweeps (fig. 10-31,F). Set the sweep function switch S7, to position 3 (fig. 10-31,G) and adjust the delay counter to align the two RF pulses. Record the counter reading and follow the same procedure to check the same master pulse against a second set of slave pulses. The counter readings are plotted on a loran chart using loran C tables.

TRACE SEPARATION

The output of the twelfth amplifier stage, V38A (fig. 10-21) is fed into the trace separation amplifier, V62 (fig. 10-30). The purpose of the trace separation amplifier, V62, is to produce a potential (at the V60 vertical deflection plates) which causes the electron beam to be presented in the upper section of the indicator (V60) tube screen during the A period, and towards the lower section of the V60 screen during the B period.

The output of V38A is positive during the A period and negative during the B period. The V38A output is coupled to the grid of V62.

When the equipment is initially set into operation, positive portions of the V38A output cause the V62 grid to draw current, and bias is established. V62 amplifies and inverts the input square wave from V38A.

In sweep function 1 the V62 output which is negative going during the A period and positive during the B period, is coupled to the lower deflection plate of cathode-ray indicator tube, V60. Since this output is applied to the lower vertical deflection plate of V60, the V60 electron beam is repelled by the negative-going V62 output during the A periods, and the A period trace is therefore presented on the upper section of the V60 screen. During the B period, the V62 output is positive going, and the B period trace will be attracted downward toward the now more positive lower deflection plate.

Note that during sweep function 1, the pedestal amplifier (V55) plate output (which is also negative going as discussed) is applied through the 1-3 contacts of S7C to be superimposed on the trace separation output of V62. Because the pedestal pulses from the V55 plate are also negative-going voltages, the potential on the lower deflection plate of V60 is made more negative for the duration of the pedestal pulses in the A and B period traces, and the pedestal pulses are presented to the V60 observer (fig. 10-31A).

SWEEP CIRCUITS

In sweep function 1, the negative-going plate output of the reset thyratron, V37 (fig. 10-21) is coupled to the suppressor grid of the sweep generator stage V57 (fig. 10-30) The V37 plate output goes negative at reset, and rises exponentially when V37 again cuts off.

The negative drop in potential that is applied to the V57 suppressor grid, holds the suppressor sufficiently negative to cut off the V57 plate current.

Since the time constant of the charge circuit of C126 is short, C126 will become completely charged by the time that the V57 suppressor input rises sufficiently to allow V57 to again conduct. The suppressor potential goes slightly positive at the end of the negative reset pulse, as a result of the plate potential rise of V37.

When the V57 suppressor grid is driven positive, plate current will again flow. The resulting drop in the V57 plate voltage and rise of plate current cannot occur at a faster rate than that required for C126 to lose its accumulated charge. The negative potential thus developed at the V57 grid to ground is applied to the V57 control grid, and opposes the rise in the V57 plate current.

The high grid-to-ground capacity of V57 permits the grid voltage to change only at a very slow rate. Consequently, the effective time constant for the discharge of C126 is sufficiently large to hold the negative-going V57 plate output linear over the duration of the positive suppressor input.

The resulting V57 plate output is a linear-rising sawtooth waveform. The sawtooth sweep duration during sweep function 1 is approximately 1500 to 25,000 μs, depending upon the PRR switch, S6.

The sweep amplitude function 1 control, R279 (fig. 10-30) adjusts the magnitude of the

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positive-voltage applied to the V57 control grid, thereby locating the operating point of the tube and determining the amplitude (and width) of the V57 plate sawtooth output. For L rates, R277 is shorted by contacts 10 and 19 of S6A (as shown). For S rates (fewer cycles per second than for L rates), both resistors, R277 and R278, are in the C126 discharge path, and the discharge time is increased. Thus, fewer sawtooth voltage wave-forms per second will be produced by V57. For H rates contacts 10 and 3 short R277 and R278, and the sawtooth output frequency is increased.

In sweep function 2 each of the switch sections (S7B, and S7D) is rotated 1 contact to the left from the position shown. For sweep function 3, the switch sections are rotated 2 contacts to the left.

During sweep function 2 and sweep function 3, the pedestal pulses are not displayed on the indicator screen. Instead, the pedestals are coupled through C124 to the grid of the sweep clamp stage, V56. The negative-going grid input is amplified in this stage.

Because of the larger negative voltages at the V56 cathode (-108 volts) V56 will conduct and amplify strong negative signals. The V56 grid is negative to the cathode due to the discharge of C124 through R224.

During sweep function 2 the V56 plate pedestal output is coupled through contacts 11 and 9 of S7D of the suppressor grid of the sweep generator, V57. The sweep amplitude function 2 control, R266, is selected by contacts 8 and 6 of S7C, and is used to adjust the sawtooth amplitude for the sweep function 2 mode of operation. The sweep duration for sweep function 2 is approximately 1250 μs.

For sweep function 3 operation, the sweep clamp (V56) plate pedestal output is coupled through contacts 12 and 9 of S7D to the sweep generator (V57) suppressor grid. The sweep amplitude function 3 control, R262, which is used to adjust the V57 plate sawtooth output amplitude, is selected by contacts 8 and 7 of S7D. The duration of the sweep for sweep function 3 operation is about 160 μs.

As stated earlier, R279 functions to adjust the sweep amplitude (or sweep duration) for sweep function 1. The sweep duration is different for each position of the sweep function switch, S7. To obtain adequate sweep amplitude range for each of the sweep functions (1, 2, and 3) the time constant of the C126 discharge must be changed.

For sweep function 2 (S7 one position to the left) C125 is placed in series with C126.

The resistors in the discharge path during sweep function 3 selected by the 8 and 7 contacts of S7C included R261, R262 (upper section), and R263. Thus, R266 and R262 adjust the sweep amplitude for sweep function 2 and sweep function 3 modes of operation, respectively.

The output of the sweep generator, V57, is coupled through C129 to the left horizontal deflection plate of the cathode-ray tube, V60. The V57 output is also coupled through R229 and C128 to the control grid of the sweep inverter, V58.

The sweep inverter (V58) grid is grounded through C131. This capacitor bypasses the grid resistor, R231, to reduce differentiation of the input, which would otherwise occur across R231, thereby altering the shape (rise time) of the sawtooth input. The V58 input sawtooth is inverted in the stage, and coupled to the right horizontal deflection plate. Inverse feedback through R230 from plate to grid of V58 is used to hold the amplitude of the V58 output equal to the output of V57, thus supplying the same magnitude voltage to the left and right horizontal deflection plate.

BLANKING CIRCUITS

The blanking d-c restorer, V59 (fig. 10-30) prevents the appearance of the sweep voltage retrace on the V60 screen. V59 is connected across the potential difference existing between the V59 plate and cathode. These resistors form a voltage divider from a -1600-volt potential to ground. The plate of V59 is positive to the cathode, and the tube conducts. C133, at the plate of V59, charges from the plate potential (approximately -1600 volts) through contacts 11 and 10 of S7C toward the 160-volt supply.

It will be recalled that the negative pulses arriving from the plate of the reset thyratron, V37 terminate the sawtooth wave-form at the V57 plate. At the same time, the reset thyratron negative plate output is applied to C133. Thus, during the period of the negative trigger, C133 discharges through R240, developing a large negative potential at the control grid of the cathode-ray tube, V60. This action blanks the indicator tube during the periods of the sawtooth waveform flyback.

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CATHODE-RAY TUBE CIRCUITS

The accelerating potentials required for the operation of the cathode-ray tube, V60 (fig. 10-30) are obtained from separate positive and negative supplies (not shown). Both supplies develop a 1600-volt output. The positive supply is connected to the third anode, E1, of V60.

A voltage divider is connected between the -1600-volt source and ground. Potentials obtained from this divider provide the voltages required at the cathode (pin 2) control grid (pin 3) and second anode (pin 5) of V60. The control grid potential is determined by the setting of the arm of the brilliance control, R241, and the resulting conduction of V59. The second anode is connected to the focus control, R243, and the cathode to the junction of R241 and R242.

Since the cathode of V60 is highly negative with respect to ground, the heater (between pins 1 and 14 of V60) is returned to the -1600-volt supply to keep a low potential difference between the heater and cathode of V60. The heater of V59 is also returned to the -1600-volt supply for the same reason.

The voltage at the first anode (pin 9) of V60 is controlled by the astigmatism adjustment, R236. This control is connected between the +260- and -108-volt supplies. Vertical center potentiometers, R238 and R239, limit the voltage range of the controls. The connection of the vertical controls between the -108- and +260-volt supplies provided push-pull vertical centering. The astigmatism control, R236 functions in conjunction with the focus control, R243, to determine the defintion of the presentation.

The DC potentials at the vertical deflection plates of V60 are determined by the settings of R238 and R239. The DC potentials on the horizontal deflection plates depend on the position of the sweep function switch section, S7B. For sweep function 1 (S7B as shown) the settings of R268 and R269 (slow and fast sweep controls, respectively) determine the potential on their respective horizontal plate. For sweep functions 2 and 3, the horizontal deflection plate potentials are obtained from R270 and R271, respectively. Since the sweep period during sweep function 1 is considerably longer (15,000 to 25,000 μs) than the sweep used for sweep functions 2 and 3 (1250 and 160 μs, respectively), the use of two sweep controls (fast and slow) eliminate timely readjustment of the horizontal plate potentials when switching from one sweep function to another.

The self-check switch, S10 permits markers to be produced on the indicator tube so that the sweep length and the alignment of the goniometer and time-difference counter can be checked. When S10 is in the OUT position the video output from V6B (fig. 10-21 is connected through contacts 7 and 6 of S10 (fig. 10-30) to video amplifiers, V7 and V10.

When S10 is rotated one position to the left, 100-μs marker pulses are coupled from the output of the third counter stage, V22 to the video amplifier, V7. This input is subsequently applied to the upper vertical deflection plate of the cathode-ray tube.

When S10 is rotated two positions to the left 25-μs markers are obtained from the first counter stage, V20. These pulses are similarly displayed on the cathode-ray tube.

LEFT-RIGHT SWITCH

In operation, received signals at the selected pulse repetition rate are locked in on the indicator screen by use of either the manual or automatic frequency control circuits.

The L-R (left-right) switch, S9 (fig. 10-24) enables the operator of the receiving set to position the signals at any desired location on the trace without having to disturb any of the other controls.

When S9 is in its normal (OFF) position, the switch is not effective in controlling the position of the indicator pattern.

The reset pulse from the cathode of V37 is applied through the contacts of S9A to the B grid of the first counter stage, V20. The V37 cathode reset pulse is also fed to the B grid of the fourth counter, V23. Since the B grid of all the other counter stages are permanently controlled by the positive reset pulse, all of the counter stages are then reset on the same side, and the counters

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V20 through V31, produce the proper output count selected by the PRR switch. This represents the normal action of the reset and counter stages.

When the L-R switch is operated to the RIGHT position in sweep function 1, the positive reset pulse from the V37 cathode is coupled to the A grid of the first counter stage, V20. The reset pulse is also coupled to the A grid of the fourth counter stage, V23. Thus, the first and fourth counters (V20 and V23, respectively) are reset to the side opposite from normal.

Each counter stage normally produces one output pulse for each two input triggers. However, when the first and fourth counters are reset at the opposite side, the first input trigger pulse from the preceding stage (or from the clipper stage, V19 in figure 10-24) after the reset pulse will cause the first and fourth counters to produce an output. After the first output pulse of V20 and V23 is produced these stages will produce an output on each odd pulse input.

Because the first and fourth counters are driven by trigger pulses with repetition rates of 12.5 and 100 μs, respectively, the count selected by the PRR switch, S6, will be reached 112.6 μs earlier than normal, and the receiving set repetition rate is higher than that of the received signals. The signals will appear at a later time on successive traces, and drift across the screen to the right.

The sweep time for sweep functions 2 and 3 is much less than in sweep function 1, and a slower drift is necessary to permit the operator to control the received signals.

The path for the reset pulse input to the fourth counter, V23, is open. As a result, only the first counter, V22, is reset to the opposite side, and the selected count is reached only 12.5 μs earlier than normal. This produces a much slower drift of the received signal across the indicator screen.

When the L-R switch, S9B (fig. 10-24) is operated to the LEFT position in sweep function 1 the negative plate output of the reset thyratron, V37 is coupled to the control grid of the ringer tube, V18. The input pulse is differentiated. This negative input holds the ringer tube, V18, beyond cutoff for a period of nine driving pulses (112.5 μs). The receiving set pulse repetition rate is therefore made lower than that of the received signals. This action causes the received signals to appear at an earlier time on successive sweep traces, and drift across the screen to the left.

C140 normally charges negative to ground during the period of the negative input pulse.

The C140 discharge maintains the negative cutoff potential at the grid of V18 for the required period.

For sweep functions 2 and 3, the cutoff time of V18 is reduced as necessary to produce a slower drift of the received signals. During sweep functions 2 and 3, C140 is shorted to ground. The cutoff period of V18 is reduced to that equal to 1 driving pulse (12.5 μs). Thus, the drift toward the left end of the cathode-ray tube is made slower.

AMPLITUDE BALANCE

The amplitude balance stage, V61 (fig. 10-32) provides a means of equalizing the amplitude of the received master and slave pulses during the A and B periods, respectively. The cathodes of V61 are tied together and returned to the -108-volt supply. The plates of V61 are connected through separate sections of R249, each section of which is in series with R256 to ground.

Both sections of V61 are normally conducting, and the plate potential of the A and B sections of V61 is negative ground. The negative voltage at the terminal 2 arm of R249 is applied to the control grid of the r-f and i-f stages, V1, V3, and V4 (fig. 10-21).

The twelfth amplifier (V38B) cathode output is applied to the A grid of V61 (fig. 10-32) and is negative during the A period, and positive during the B period. The V38B plate output is fed to the grid of V61B, and is positive during the A period and negative during the B period. The width of the twelfth amplifier output is equal to the width of the recurrence interval of the received signals with the positive and negative alternations equal to one-half the total reccurence period.

The potential at terminal 2 arm of R249 for the separate halves of the twelfth amplifier input depends upon the setting of the terminal 2 arm. If the terminal 2 arm is moved to the right or

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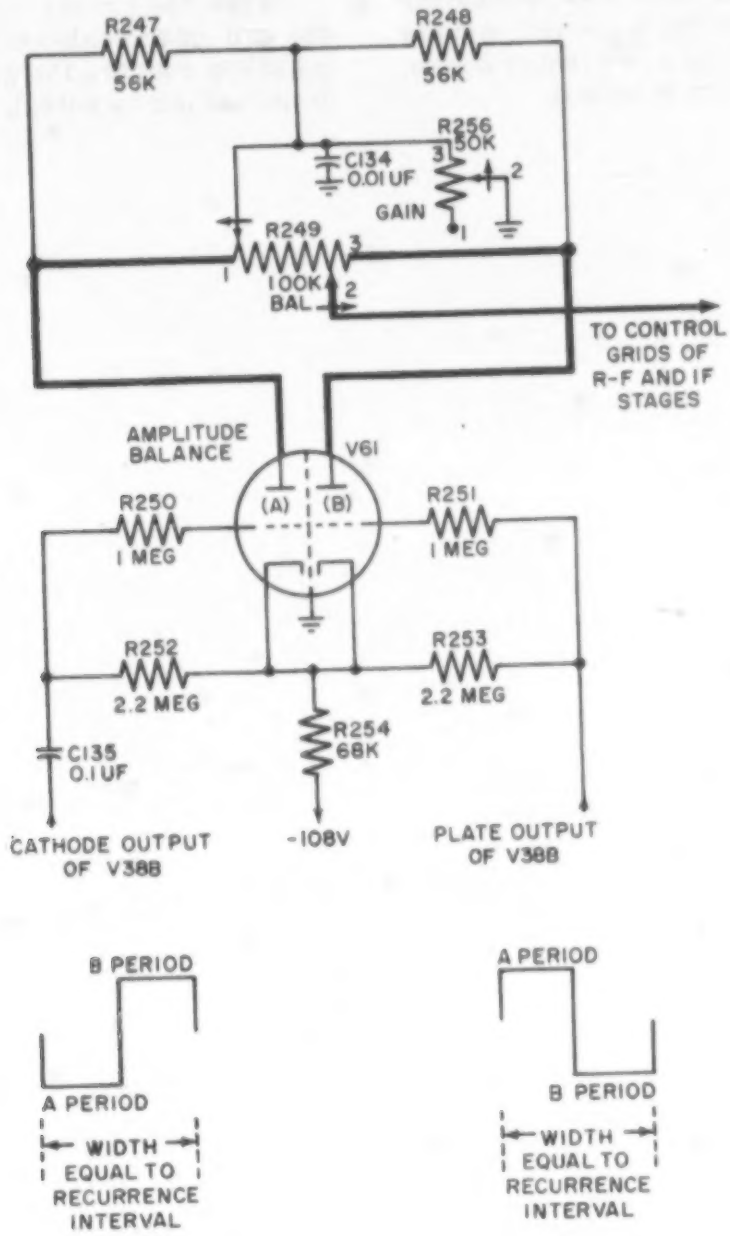

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Figure 10-32.—Amplitude balance circuit.

left, the negative potential fed to the r-f and i-f stages will be larger for one-half cycle of the input (one-half recurrence period) than for the other.

Assume that the terminal 2 arm of R249 is moved to the extreme right (as shown). Since the V61B grid is positive during the A period and negative during the B period, the V61B conduction through R249 and R256 during the A period is greater than the conduction during the B period. Thus, the voltage at the terminal 2 arm of R249 will be more negative during the A period than during the B period. This increased negative potential is fed to the grids of r-f and i-f stages (V1, V3, and V4 of figure 10-31), and the gain of these stages during the A period is less than the gain during the B period. Likewise, the amplitude of the pulse in the B period is increased, and the A period pulse amplitude is decreased.

By positioning the terminal 2 arm of R249 (fig. 10-32) to the extreme left position, the reverse effect to that just discussed can be obtained. Since the input of V61A is negative during the A period and positive during the B period, the conduction of V61A is smaller for the A period than for the B period. Thus, the negative voltages

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at the terminal 2 arm of R249 will be smaller for the A period than for the B period, and the gain of the r-f and i-f stages is greater during the A period than during the B period.

When the proper setting of R249 is reached, the gain of the video during the A period (master pulse) is equal to the gain of the video during the B period (slave pulse).

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CHAPTER 11

ELECTRONIC AIDS TO NAVIGATION, PART II

The U.S. Navy and U.S. Air Force use a radio beacon as an air navigation system, called TACAN. The word TACAN is formed from the underlined letters of the term Tactical Air Navigation. TACAN is an electronic polar coordinate system that enables an aircraft pilot to read—instantaneously and continuously—the distance and bearing of a radio beacon transmitter installed on a ship or at a ground station.

Two types of TACAN systems are available, one for shore installation (AN/GRN-6 series), and one for shipboard installation (AN/SRN-6 series). Each system comprises four major groups (fig. 11-1), receiver-transmitter, antenna, power supply-test set, and monitor (may include remote control unit).

A new TACAN is being introduced into the fleet. The AN/URN-20 is of solid state (transistorized) construction except for the power output tube. Two cabinets will house all units except antenna, including automatic switch off. The AN/URN-20(V) will be two complete TACAN equipments with automatic switching to an active unit if the "on air" equipment fails.

To supply correct information, the antenna must be maintained in a position perpendicular to the earth's surface. Thus the antenna radiation pattern maintains a constant relationship to the azimuth plane. In addition, the antenna radiation pattern must be constantly referenced to magnetic north. The magnetic variation (discussed later) for each area, whether shipboard or shore based, must be set on the equipment.

The shore based antenna, after initial installation, will not vary its position, but the shipboard installation must compensate for magnetic variations, azimuth bearing, roll, and pitch. To correct these variables, the magnetic variation is reset as the ship moves from one magnetic zone to another. The shipboard antennas are constructed with an azimuth, roll, and pitch servosystem to stabilize the antenna in its proper attitude.

This chapter presents a block diagram discussion of the AN/SRN-6 Tacan System, and circuit analysis of the receiver special circuits, coder-indicator, amplifier-modulator, control-duplexer, and antenna system. In the block diagram discussion, particular emphasis is placed on the purpose and relationship of the component parts. In the discussion of the special circuits, emphasis is placed on operation, and how it affects the remaining circuits.

RADIO SET AN/SRN-6

Radio Set AN/SRN-6 is used for shipboard installation to provide the radio beacon or ground portion of an air navigation system. The AN/SRN-6, its associated antenna group and accessories, and Radio Set AN/ARN-21 (located in aircraft) make up a complete air navigation system. The beacon supplies information through which an aircraft equipped with an AN/ARN-21 can accurately determine its position. As many as 100 aircraft may simultaneously obtain navigational information in conjunction with a single installation of the AN/SRN-6. To provide for a large number of transmitting stations, the system is capable of receiving on any one of 126 frequencies (channels) in the range of 1025 to 1150 mc. Transmission of information also takes place on 126 channel frequencies in the ranges of 962 to 1213 mc.

Two types of antenna are available for use, low band and high band. Each antenna operates on 63 channels, corresponding to low-band frequencies and high-band frequencies, respectively. Low-band installations transmit at frequencies between 962 and 1024 mc inclusive, and receive at frequencies between 1025 and 1087 mc. High-band installations transmit in the range of 1151 to 1213 mc, and receive in the range of 1088 to 1150 mc.

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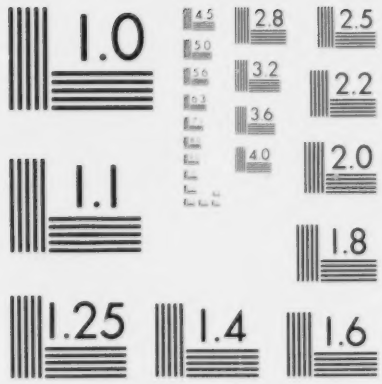

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

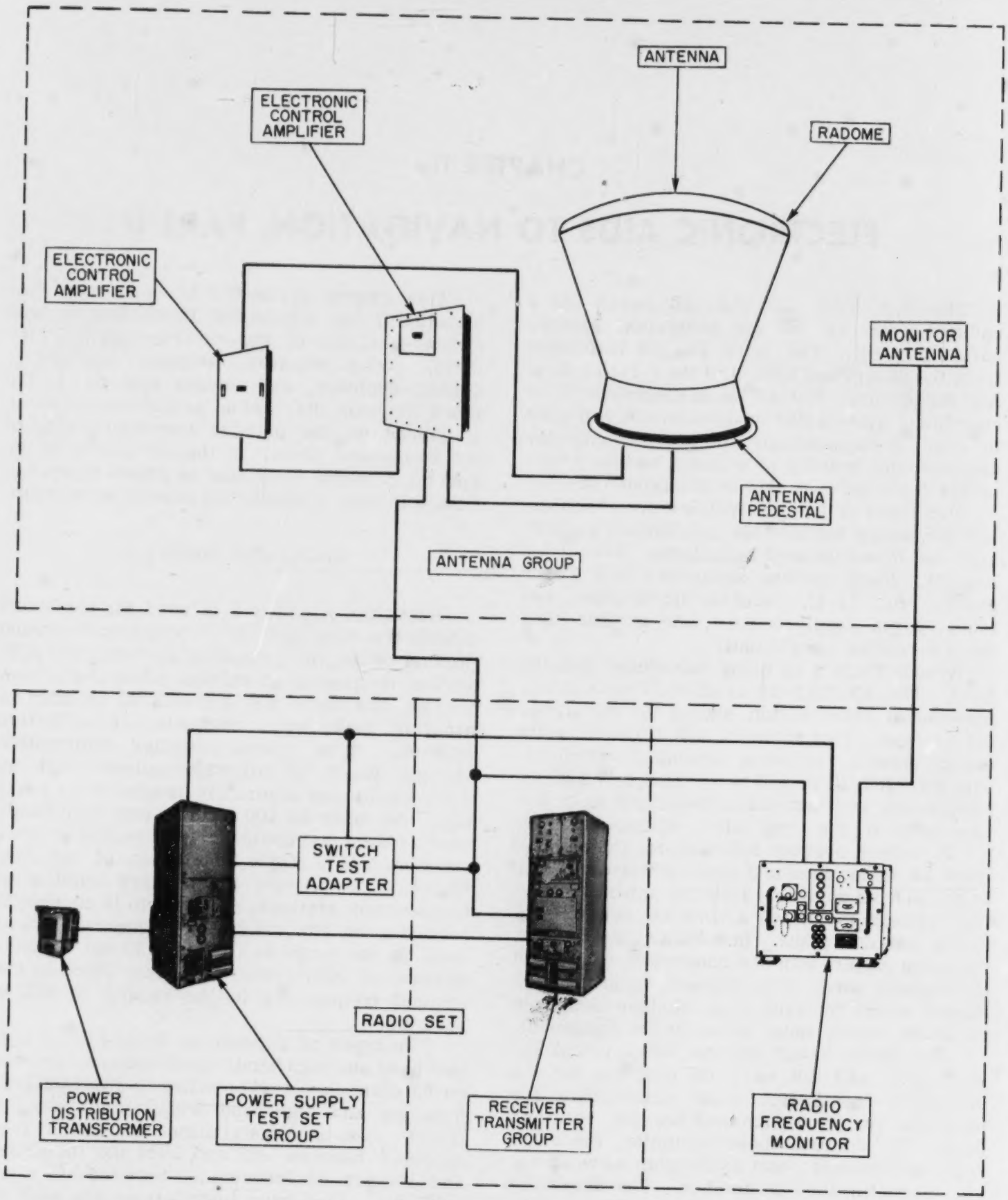

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Figure 11-1.—Major components of radio beacon AN/SRN-6.

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Two frequencies are used in each channel: one for receiving, and one for transmitting. The frequency used for receiving in low-band installations is 63 mc above the frequency used for transmitting in the same channel. In high-band installations, the receiving frequency is 63 mc below the transmitting frequency.

No two stations within interference distance of each other are assigned the same channel. The pilot can switch channels to select any tacan transmitter within range. In aircraft equipped with tacan receiving equipment, an azimuth indicator shows the position of the transmitting source in degrees of magnetic bearing from the aircraft. Also, the distance in nautical miles to the same reference point is registered as a numerical indication, similar to that of an automobile odometer. In the illustration (fig. 11-2) the aircraft is 106 miles from the carrier, and the ship is on a magnetic bearing of approximately 230° from the aircraft.

Two radio frequencies are employed (fig. 11-2), one frequency (Y) is used for transmissions to the aircraft; another frequency (X) is used for transmissions from the aircraft. The surface-to-air frequency carries bearing and range intelligence as well as station identification information. The transmission from the aircraft-to-surface unit is required to trigger the distance-measuring system.

When the pilot closes the proper switch on his set control, his aircraft radio set transmits distance interrogation pulses only (frequency X), spaced 12 μs part. The interrogation pulses are detected by any ship or station operating on the same channel, and in reply, transmits back to the aircraft on the assigned channel pulse-pairs on frequency (Y).

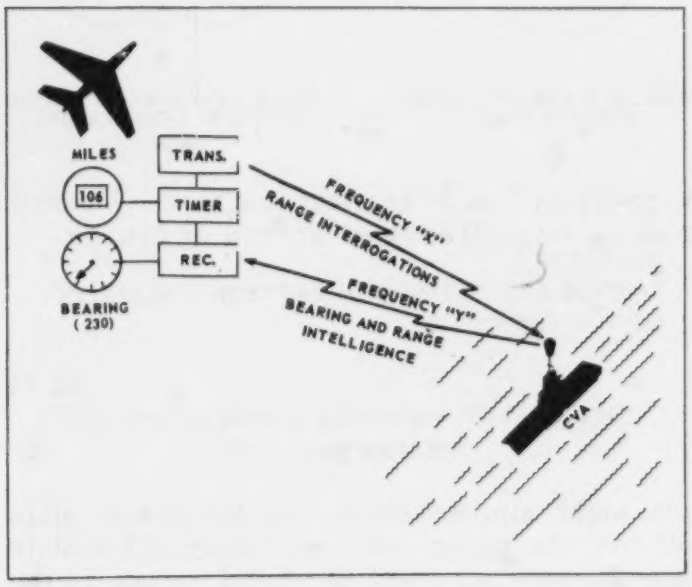

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Figure 11-2.—Dual-frequency transmission.

The time delay between the distance interrogation pulse-pair (transmitted from the aircraft) and the corresponding distance pulse-pair reply (transmitted from the radio beacon) is adjusted at the radio beacon to exactly 50 μs. The aircraft radio set deducts 50 μs from the total time elapsed between the interrogation and reply. The distance between the aircraft and the radio beacon is determined by measuring the total time elapsed between initial transmission of the distance interrogation pulse-pair and the reception of the corresponding radio beacon reply. Other circuits convert the time difference to equivalent dial indication in miles. Bearing information is radiated continuously on frequency Y. Under normal circumstances, the range over which aircraft can obtain reliable distance information from the beacon is about 200 miles.

The Radio Beacon AN/SRN-6 output consists of the bearing information signals, the beacon identification code, distance information signals, and random pulses used to make up a constant duty cycle. To aid the pilot in identifying a particular transmitter, the radio beacon periodically transmits its identifying call in International Morse Code, thus enabling the interrogating aircraft to determine the radio beacon with which it is in contact. The characters of the code consist of a train of pulse-pairs generated at a fixed rate of 2700 pulse-pairs per second. During the transmission of the code, the 2700 pulse-pairs are grouped so that the reproduced tone will be at a frequency of 1350 cps. A motor-driven mechanical keyer in the coder-indicator accomplished the coding. The aircraft receiver detects these regularly occurring pulse-pairs and reproduces the code as a keyed 1350-cps audio tone.

The bearing information reference burst has priority over the identification call. The identification call has priority over the distance information signals. The relative duration of these signals is such that there is, effectively, no interruption of distance information or identification call.

When the radio beacon is in operation, reference burst information will be transmitted at regulated intervals. The beacon identification

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code signals will be transmitted every 37.5 seconds. Any airborne Radio Set AN/ARN-21, which is tuned to the beacon radio frequency, will receive the reference burst and identification signals.

The pulse-pairs sent by the AN/ARN-21 (aircraft equipment) are transmitted on a carrier frequency which is the same as that of the radio beacon. The pulse-pairs are transmitted at a random rate peculiar to the AN/ARN-21 aboard a specific aircraft. When receiving, the AN/ARN-21 selects its own particular distance-measuring reply from all other signals by comparing the repetition rate of the reply pulses with the repetition rate of those originally transmitted. The receiver locks in on the reply pulses whose repetition rate is the same as the rate of its interrogation pulses.

The radio beacon operates on an assigned crystal-controlled carrier frequency. As stated earlier, as many as 100 aircraft can simultaneously interrogate the beacon on its single channel frequency. It is quite possible that two aircraft may interrogate at the same time and with the same pulse rate. If this does occur, each of the aircraft may receive conflicting information. However, the chances of such an occurrence are highly improbable.

ANTENNA CONSTRUCTION

Bearing information originates from the antenna in the radio beacon. A single stationary vertical antenna (fig. 11-3, A) provides an omnidirectional pattern, such as shown in figure 11-3, B. A 15-cps parasitic element is properly spaced from the antenna so as to deflect the r-f energy to produce the cardioid pattern of figure 11-3, C. The parasitic element is motor driven so that it encircles the antenna at a rate of 15 revolutions per second. Thus, the parasitic element of the antenna modulates the total radio beacon output with a subaudio (15 cps) frequency component.

Mounted concentrically with the 15-cps antenna element is an arrangement of nine vertical reflectors embedded in an outer fiberglass cylinder, which rotates simultaneously with the inner cylinder at the 15-rps rate. Mechanically linked to each of the rotating cylinders, and mounted horizontally below the central array is an assembly referred to as the pulser plate (fig. 11-4, A). On the upper edge of the pulser plate (fig. 11-4, B) there is one soft iron slug. On the lower edge of the circular plate there

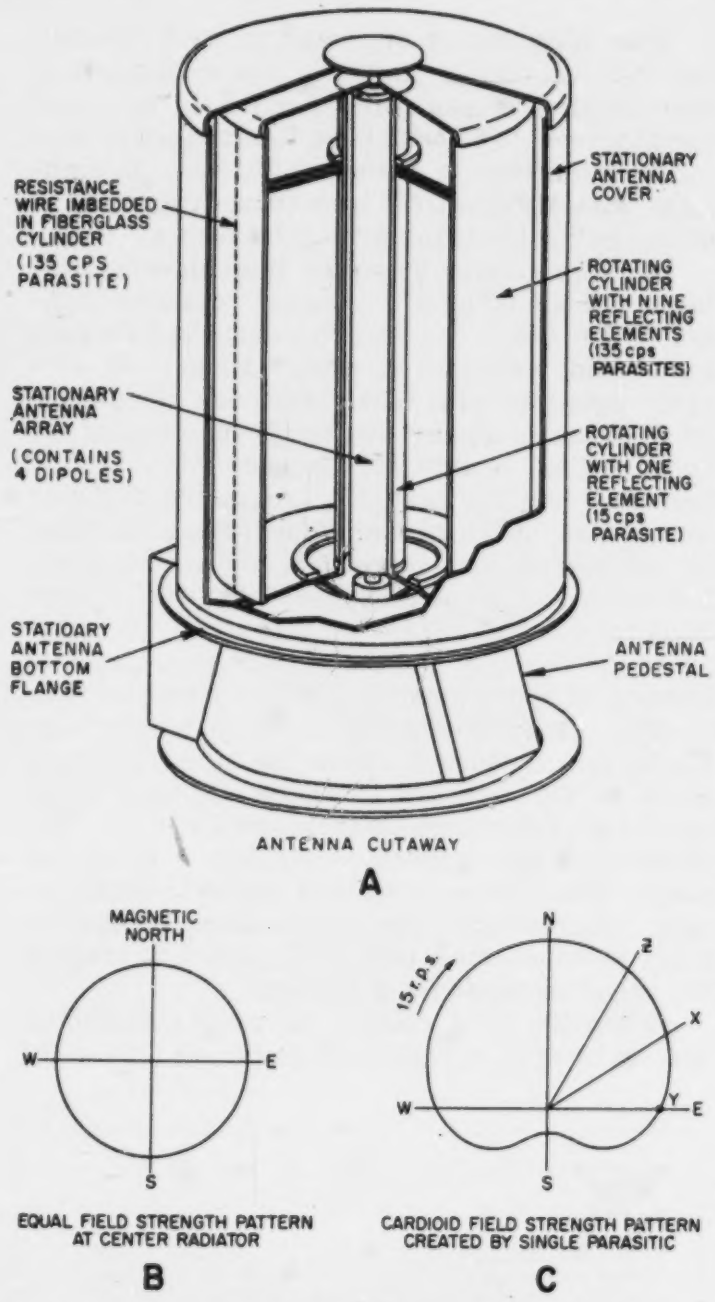

A. CONSTRUCTION OF ANTENNA AND ANTENNA PARTS.
B. EQUAL FIELD STRENGTH PATTERN OF CENTER RADIATOR.
C. CARDIOD FIELD STRENGTH PATTERN CREATED BY SINGLE PARASITIC.

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Figure 11-3.—Antenna construction and antenna patterns.

are eight similar slugs. As the pulser plate rotates, the upper and lower slugs of the plate pass through air gaps of pickup coils. As the slug passes through the air gap of the pickup coil, the net reluctance of the magnetic circuit changes, and a pulse is induced in the coil

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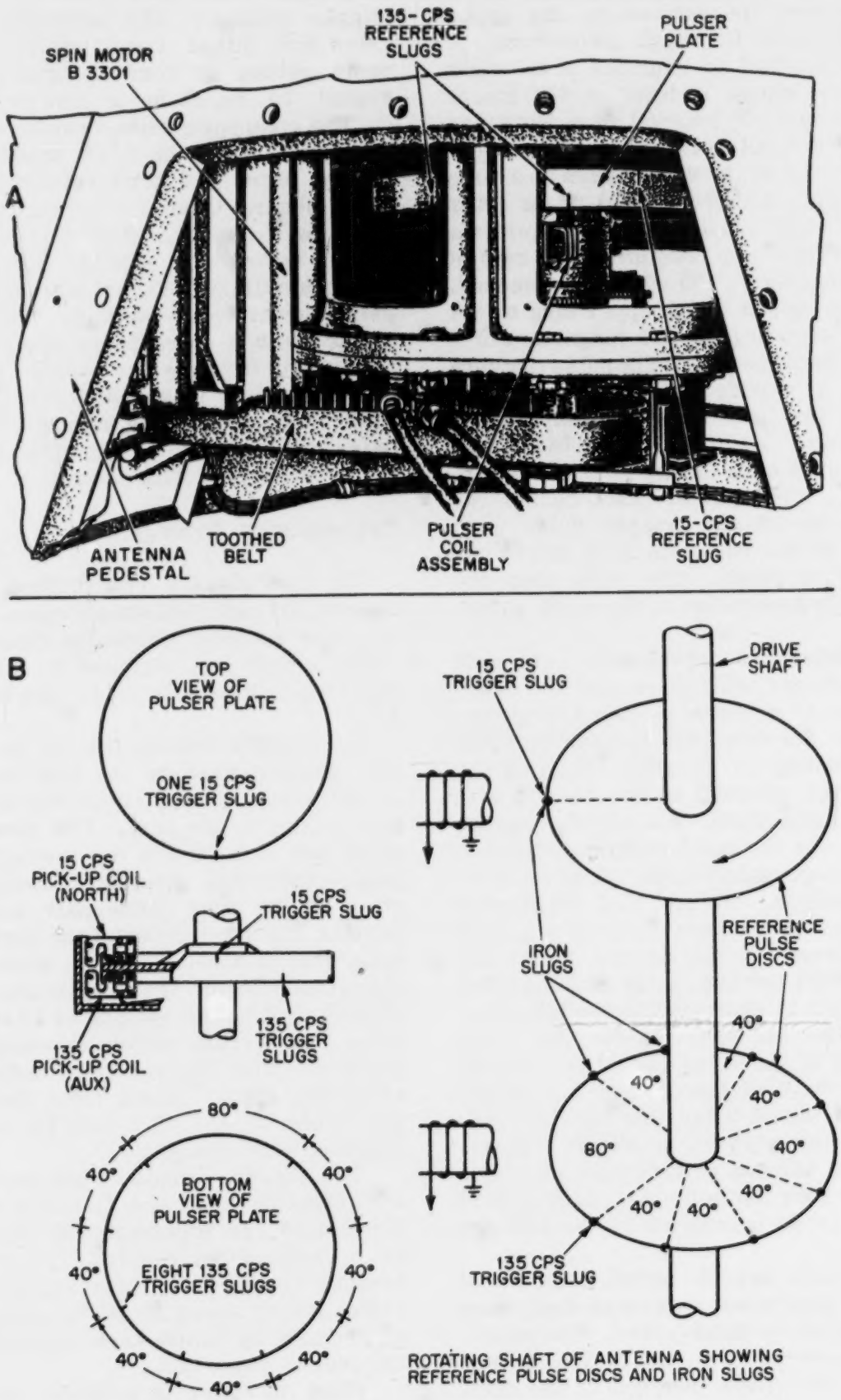

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Figure 11-4.—Reference burst pulser assembly.

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winding. One coil is excited by the upper slug (15 cps) once for each revolution. A second coil is excited by each one of the eight lower (auxiliary) slugs, in turn, at 40° intervals, except for one 80° interval when the space is occupied by the pulse from the upper slug. The pulse from the upper slug occurs at a time between the eighth and first pulse of the outer cylinder. The eight auxiliary slugs generate a total of eight cycles per revolution at a rate of 360°/40° x 15 cycles or 135 cycles per second.

The pulse produced by the upper slug on the pulser plate is used to establish magnetic north as a reference point in time. The pulse triggers the generation of a coded burst, each pulse of which triggers the transmitter r-f output from the beacon antenna. As stated above, the 15-cps pulse is generated once during each revolution of the reflector. The pulser plate causes the generation of the 15-cps trigger pulse each time the peak of the radiation lobe points due east (an arbitrary point). The pulse thus obtained causes the generation of the north reference burst.

The time difference between the reference point on the 15-cps sine wave and the north reference burst is detected by the aircraft receiver of Radio Set AN/ARN-21 and converted to a meter reading in degrees, showing the bearing from the aircraft to the beacon with respect to magnetic north. The aircraft measures bearing from the north reference point to the next positive-going half amplitude point of the modulation envelope. Figure 11-5 illustrates the signal received by four aircraft (in their respective positions as the beacon signal rotates through 360°) and the meter readings that would correspond to their particular bearings. Note that all the aircraft receive the north reference burst at the same instant of time but at a different phase of the 15-cps a-m wave.

The 135-cps signal alters the cardioid pattern to form a new pattern, as shown in figure 11-6. Thus, the antenna pattern basically consists of a large lobe (from the 15-cps director) and 9 smaller lobes (produced by the 135-cps directors).

The total radio beacon output consists of the internally generated reference-frequency modulated or keyed by pulse-pairs. The pulse-pairs are transmitted at a rate of 3600 pulse-pairs per second. Nine hundred of the total pulse-pairs per second are the 15-cps and the 135-cps reference bursts. (The reference bursts are initiated by the 15-cps and 135-cps trigger pulses.) The additional 2700 pulse-pairs are either identification code distance reply pulses or random squitter pulses generated to maintain a constant duty cycle.

The composite radio beacon pattern is shown in figure 11-7. In 1/15 second (1 cycle of 15-cps signal), 12 north reference burst pulse-pairs occur. Over a 1-second period, 12 x 15 pulse-pairs occur, which total 180 north reference bursts per second. Seven hundred and twenty auxiliary (135 cps) reference burst pulse-pairs occur each second. These pairs are divided into 6 pulse-pairs occurring 120 times per second (8 times per cycle). Random pulse-pairs (totaling 2700 pulse-pairs) are inserted between the reference bursts. Identity pulse-pairs are substituted for the random pulse-pairs once every 37.5 seconds.

Transmission Priorities

Of the signals transmitted by the radio beacon, all except distance-measuring information are initiated within the beacon. Distance reply signals are supplied by the radio beacon only when interrogated by the airborne radio set.

All signals transmitted by the radio beacon are characterized by the fact that they consist of pulse-pairs, with 12-μs spacing between the two pulses of the pair. The number of pulse-pairs per second and the spacing between the pulse-pairs (the spacing between the leading edge of the first pulse-pair and the leading edge of the first pulse of the next pair) depend upon the particular signal element and is a characteristic of that particular signal only. However, it is the spacing of 12 μs between the pulses of a pair which provides the aircraft radio set with the means of distinguishing between the signal pulses from the radio beacon and other pulses that may be present on the received radio frequency.

The three elements of information (bearing, identification call, and distance-measuring information) are transmitted by the radio beacon as a train of pulse-pairs. To prevent interference between the three signal elements, the radio beacon is equipped to assign a sequence of priority by which each element enters into the overall pulse train.

First in order of priority are the bearing reference bursts. Because they occur at a fixed rate, they are of relatively short duration and convey the most important portion of

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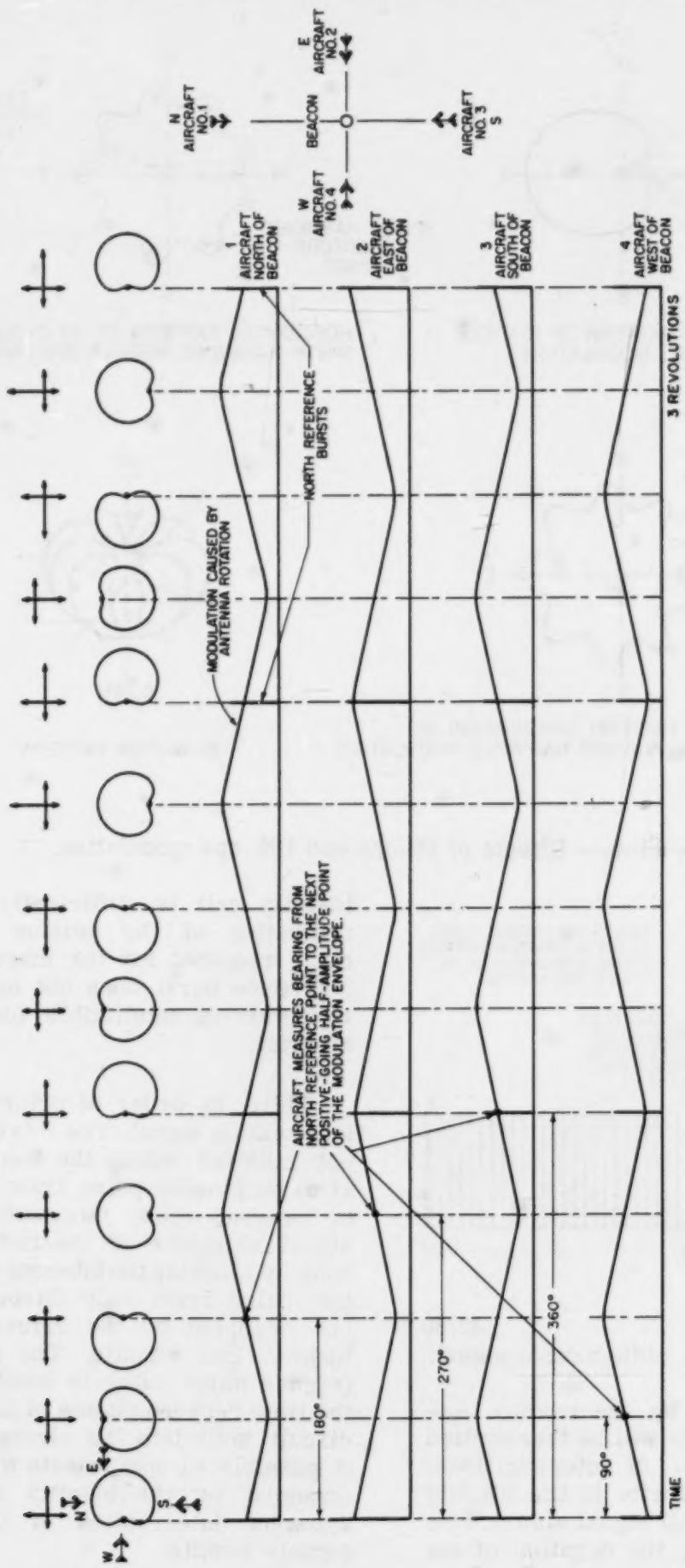

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Figure 11-5.—Meter readings for various aircraft positions.

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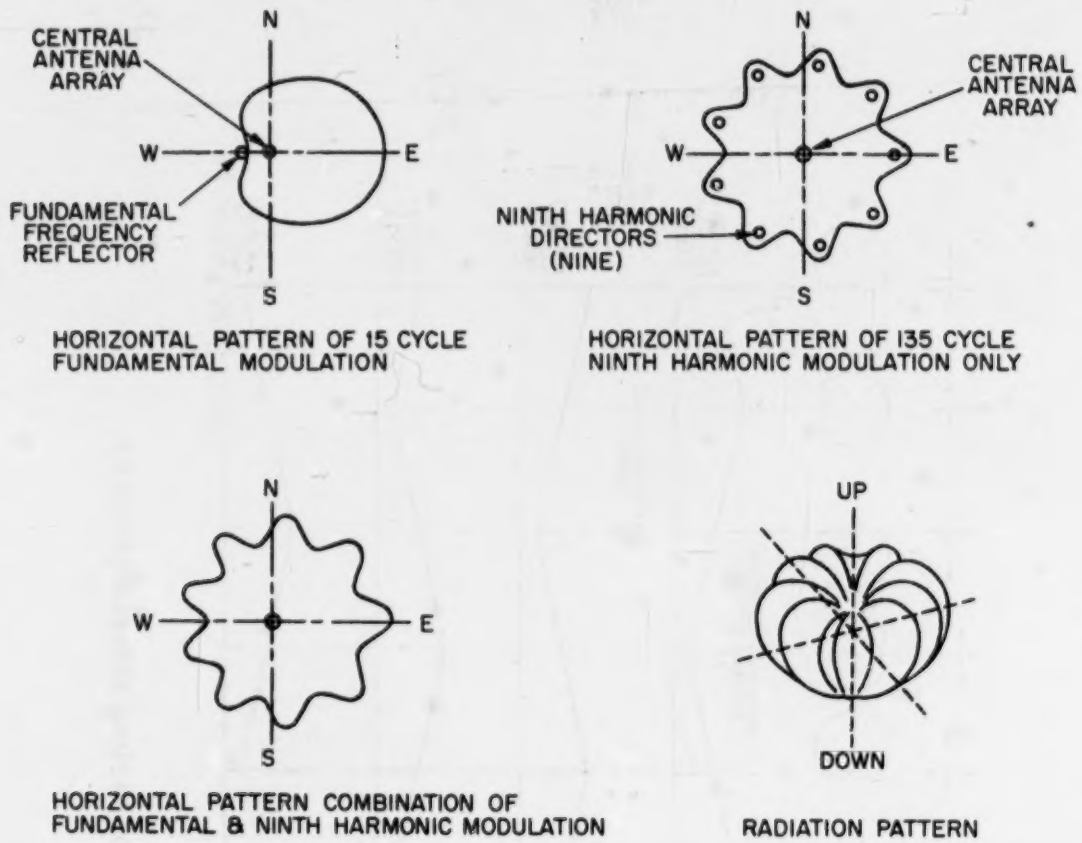

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Figure 11-6.—Effects of 15-cps and 135-cps modulation.

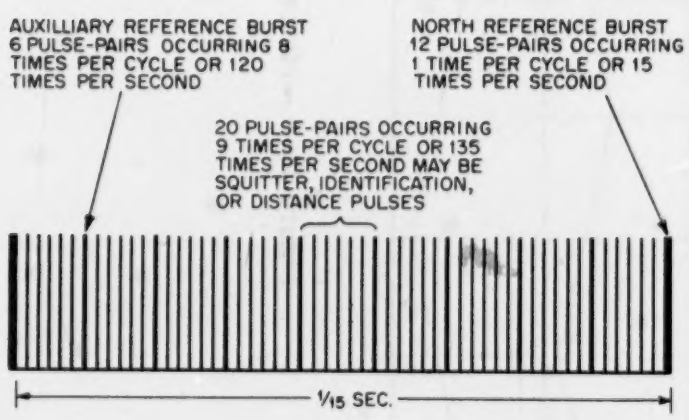

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Figure 11-7.—Composite radio beacon signal.

the information supplied by the beacon. Accordingly, reference bursts will be transmitted regardless of the number of interrogations.

Second in order of priority is the identity call signal. The identity call signal also occurs at a fixed rate. However, the duration of the identity call is sufficiently long, so that the utilization of the portion of the total duty cycle required for the insertion of the bearing reference burst does not materially affect the reception of intelligible identity code by the aircraft.

Third in order of priority is the distance information signal. The interrogation pulses are not initiated within the beacon, and their arrival within the pulse train must be controlled to prevent their interfering with the other signal elements of the radio beacon. This is done by allowing the interrogation pulses to enter the pulse train only during a time interval not occupied by the reference burst or the identity call signals. The period of the reference burst pulse is small in comparison to the time between pulses of the bursts. A memory circuit built into the aircraft receiver makes it possible to compensate for the time interval occupied by the identity pulses so that no apparent interruption of distance-measuring signals results.

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Last in order of priority are "squitter" pulses consisting of random noise pulses, which are used as fill-in signals when the maximum number of aircraft are not interrogating the beacon. This is necessary to maintain the modulation pattern and to permit a constant duty cycle.

The functional arrangement of the major units of the radio beacon is illustrated in figure 11-8. Pertinent waveforms are shown at the input and putput of the stages to aid in understanding the overall system operation.

A single antenna is used for both transmission and reception. This is made possible through the use of the control-duplexer. Distance interrogation pulse-pairs are received by the antenna and passed through a coaxial switch (fig. 11-8A) along a coaxial line, and through the control-duplexer to the radio receiver. In the receiver, the received signal passes through a low-pass filter (fig. 11-8B) to the hybrid mixer stage of the receiver. The low-pass filter, rejects frequencies between 1,650 and 10,000 mc to prevent interference from other pulse-producing equipments operating in or near the beacon frequency range.

The local oscillator signal for the mixer stage is derived from the frequency-multiplier section of the radio beacon. The basic local oscillator frequency is generated in a crystal oscillator and doubler stage. The oscillator-doubler output is further multiplied in three stages of frequency multiplication which include the second doubler, the third doubler, and a tripler stage. The tripler output is applied simultaneously to a keyed r-f amplifer and to the mixer stage in the receiver. The heterodyning process in the mixer produces a 63-mc intermediate frequency signal.

The mixer output is amplified in three stages of preamplification. The output is subsequently amplified in the i-f stages to a level sufficient to drive the Ferris discriminator.

The Ferris discriminator detects the interrogation and random noise pulses from the 63-mc i-f signal and effects adjacent and near-adjacent channel rejection.

The video output is applied to the blanking gate state. During the transmission of output pulses by the transmitter of the beacon, a 10 μs pulse generated in the frequency multiplier-oscillator video chassis is applied to the blanking gate stage. This pulse disables the receiver for the duration of the transmission.

The output of the blanking gate stage is amplified in the final video amplifier, and fed to a coincidence decoder circuit. The decorder produces a single pulse for each input pulse-pair which has the pulses of the pair separated by 12 microseconds. The decoding of each pulse-pair is followed by a 40 μs blanking condition in the receiver to ensure that the 2700 pulses at the receiver output will be distributed over a period of one second. The delay line ensures the generation of one pulse for each input pulse-pair.

The pulse output of the coincidence decoder triggers a one-shot multivibrator, which produces three outputs. One initiates the blanking gate pulse in the blanking-gate generator. This action is described later. A second is applied to a pulse amplifier. The third is fed to the receiver output cathode follower and is applied to the coder-indicator chassis (fig. 11-8, C).

Pulse amplifier V408, pulse counter V409, d-c regulator V407A, and d-c clamp stage V409A (fig. 11-8B) are included in a circuit referred to as a "squitter control circuit." This circuit produces a negative (squitter) voltage which is fed back to the i-f amplifiers, V301 and V302.

CONTROL-DUPLEXER

The control-duplexer consists of a passive duplexer network that permits the transmitter output signal and the receiver input signal to be fed through the same transmission line and antenna (fig. 11-8A) via the switch test adapter. Control circuits located in the control-duplexer permit the radio set to be operated by switches on the front panel of the control-duplexer.

The control-duplexer output signals are routed through a Switch Test Adapter, SA-420/URN-3. The switch test adapter consists of a heavy-duty coaxial switch, S6151, and pickoff diodes, CR6151 and CR6152. The switch, S6151, transfers the radio beacon transmitter output from the antenna to the dummy load as desired. The pickoff diodes supply detected signals to the test equipment. A biasing voltage is applied to CR6152 to permit power measurement by the slide-back method.

The pulsed r-f transmitter output from the Klystron r-f amplifier, V1304, (fig. 11-8B) is fed through matching slug Z1303 to a transmission line r-f filter (Z1156 or Z1157, fig. 11-8A). Each of the filters consists of a pair

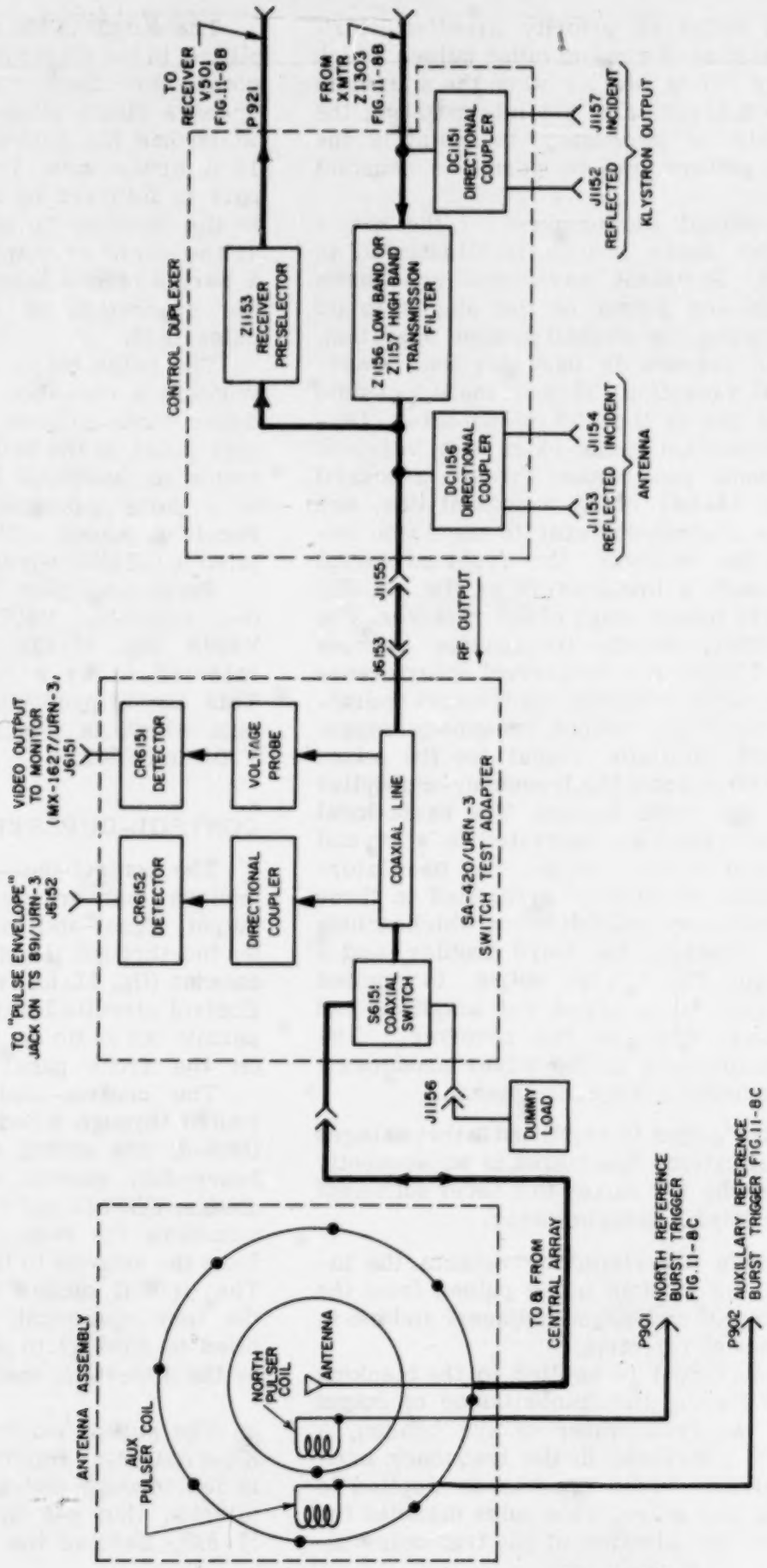

Figure 11-8.—Radio beacon, block diagram. A. Antenna assembly, switch test adapter and control duplexer.

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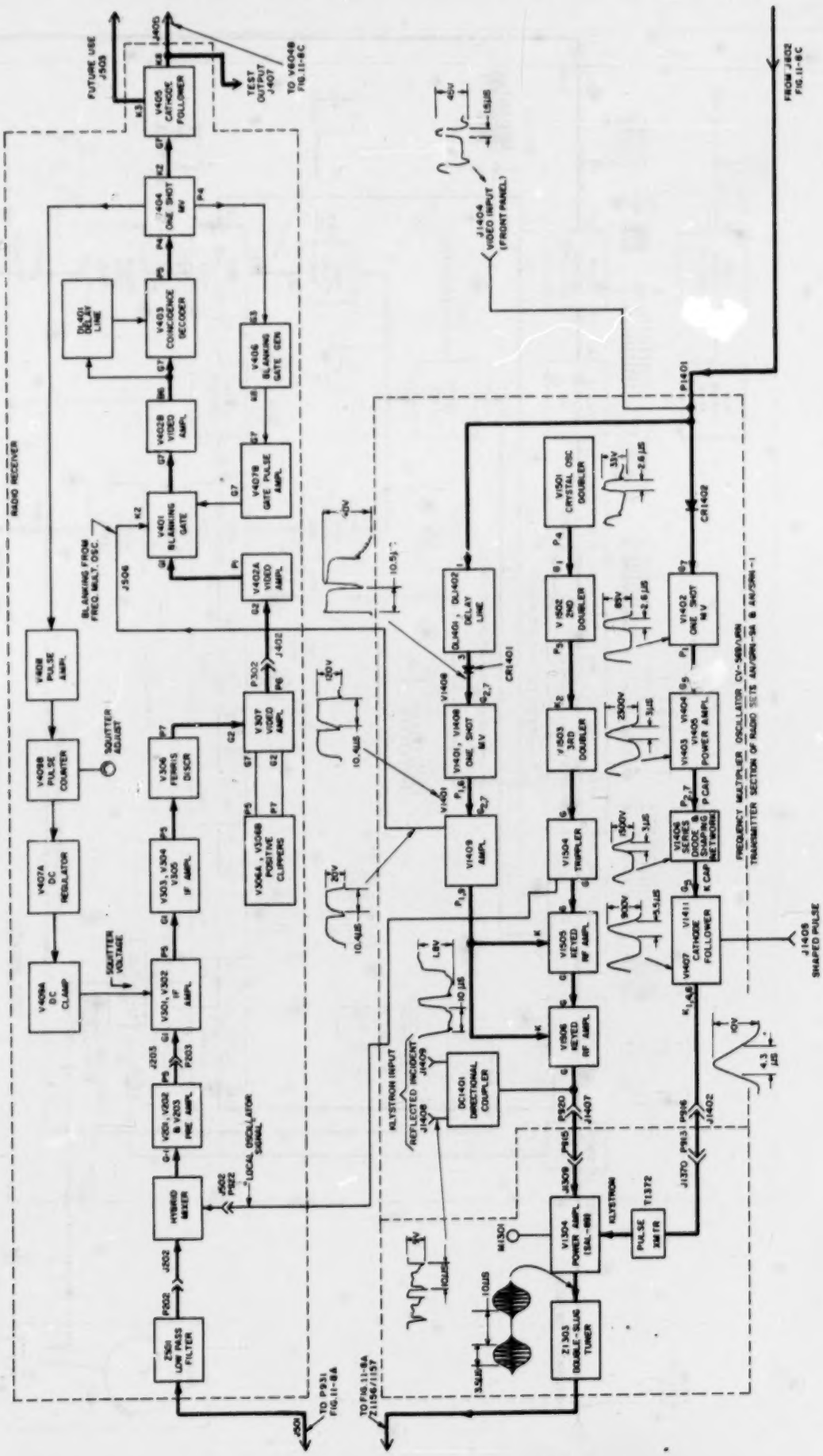

Figure 11-8.—Radio beacon, block diagram. B. Transmitter-receiver.

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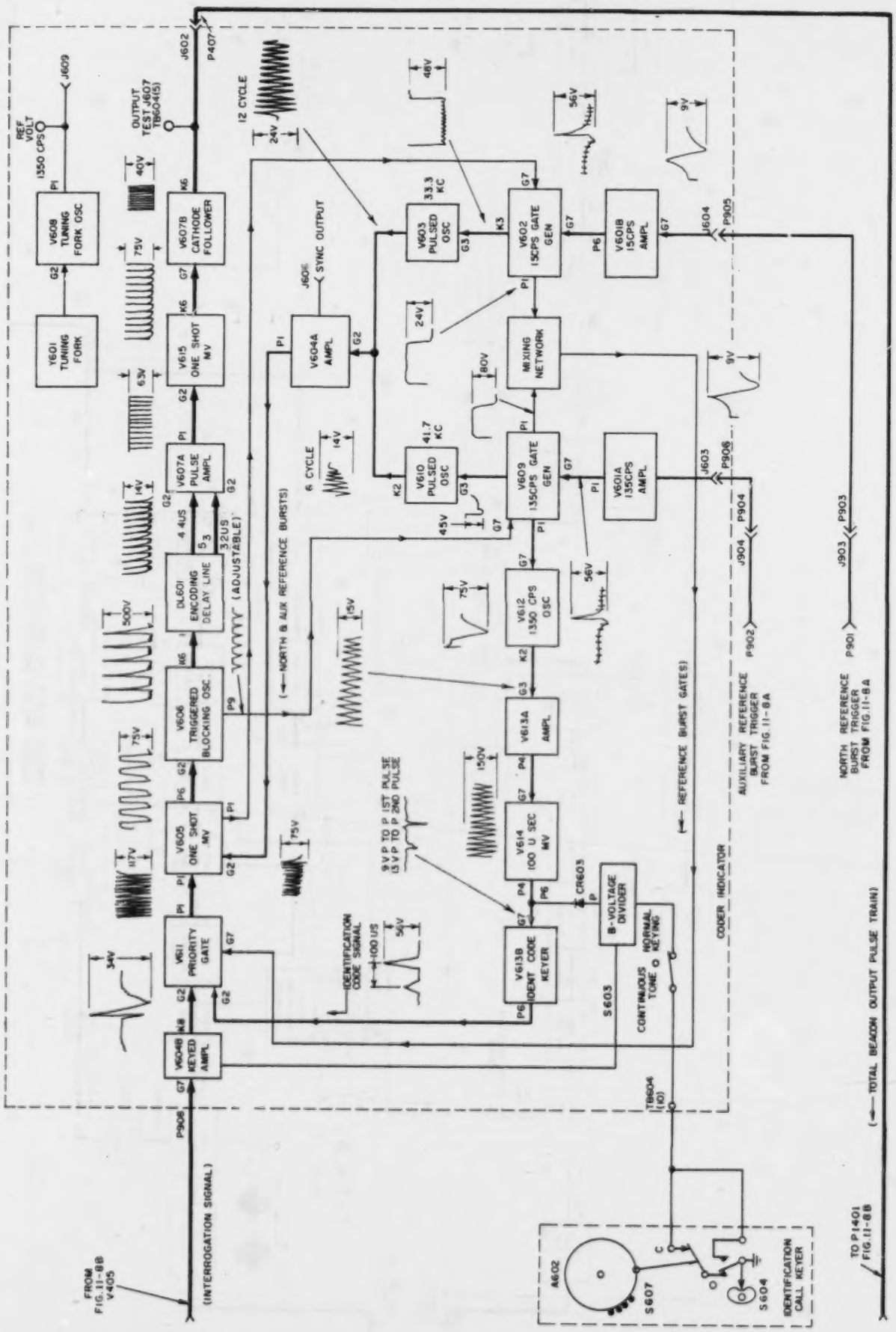

Figure 11-8.—Radio beacon, block diagram. C. Coder-indicator.

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of tunable resonant cavities. These filters are inserted in series with the transmission line to limit the overall spectrum of the transmitter output.

The transmission line filter is located in the line between the transmitter and the antenna, with the receiver input connection branching off on the antenna side of the filter. The receiver input path also contains a filter, Z1153. The transmission line filters (Z1156 and Z1157) are tuned 63 megacycles, one above, and the other below the receiver frequency, so that Z1153 (which is tuned to the receiver frequency) appears as an open circuit at the transmitter frequency. Thus, the transmitter output is fed directly to the antenna.

Samples of the klystron-incident and klystron-reflected fields and of the antenna-incident and antenna-reflected fields are made available (40db down), by directional couplers, DC1151 and DC1156, respectively. During tuning, the klystron output may be obtained at J1152 and J1157, while the antenna output can be obtained at J1153 and J1154.

The control-duplexer contains a desiccator (drying agent) that controls the humidity of the air in the filter cavities (Z1156 or Z1157 and Z1153). Because of temperature changes, the filter cavities tend to breathe (draw in and expel air). This air exchange takes place through the desiccator, with the desiccant absorbing moisture from the air, thereby maintaining a relatively dry atmosphere in the cavities.

RADIO RECEIVER

The radio receiver (fig. 11-8B) with the exception of the special circuits (Ferris discriminator, blanking gate and squitter control), is a conventional superheterodyne type.

Ferris Discriminator

The Ferris discriminator circuit, V306 (fig. 11-9), receives its input signal from the final (fifth) i-f amplifier, V305. The function of the Ferris discriminator is to detect the signal and provide adjacent and near-adjacent channel rejection.

The input signal to the Ferris discriminator is coupled to two tank circuits. Low impedance points on the tank circuits are used to feed the discriminator diodes, V306A and V306B, respectively. In this way, the tube capacitance is shunted across a smaller portion of the total tank impedance. Thus, the discriminator is relatively unaffected by variations in tube capacitance. In addition, the circuits are temperature compensated to maintain frequency stability.

Both of the tank circuits feeding V306 are tuned to 63 mc. Because of the loading difference imposed on the tanks, the "Q" of the tank feeding V306B is reduced to approximately one-third the "Q" of the tank feeding V306A. Each half of V306 had a different frequency output characteristic because of the differences in the signal developed by each tank circuit.

Since the "Q" of the tank feeding V306A is higher than that of V306B, the negative voltage developed by V306A (fig. 11-10) is greater than the positive voltage developed by V306B (fig. 11-10) at the same frequency (63 mc). Therefore, only the negative-going narrow band of frequencies centered at 63 mc are passed.

The algebraic sum of the V306 output voltage is represented in figure 11-10. The normal V306 output is negative interrogation signals, within the 63-mc i-f pass band. Note the positive voltages that appear at the output of V306 for adjacent channel frequencies.

Clamping diodes V308A and V308B (fig. 11-8, B) effectively clamp the grids of V307A and V307B respectively, to ground and thereby eliminate the adjacent channel voltages.

The output of the Ferris discriminator and video amplifier consists of interrogation pulse-pairs spaced 12 μs apart.

The video signal (interrogation pulse-pairs) and noise pulses from V307B are routed to the first video amplifier, V402A (fig. 11-8,B). A portion of the input signal is fed to V405A, which serves as an output stage to provide a portion of the video signal derived from the Ferris discriminator as it appears before decoding.

The video signal is amplified in V402A and coupled to the blanking gate stage, V401. The gating action of this stage will be considered later.

The output of the blanking gate stage is coupled to the final video amplifier, V402B. The output is applied directly to the suppressor grid and through a 12 μs delay line to the control grid of the decoder tube, V403. This tube is biased at cutoff, which requires the simultaneous application of positive voltages on both the control and suppressor grids for conduction. Since the decoder is biased at cutoff, the pulse input must be of sufficient amplitude to cause conduction. This means

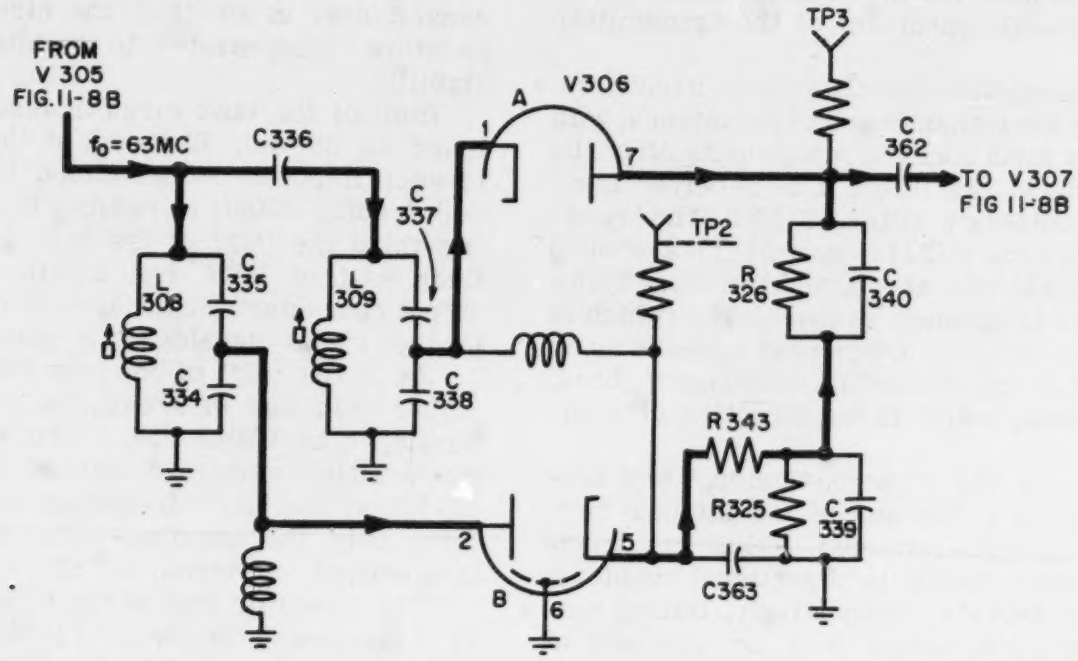

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Figure 11-9.—Ferris discriminator.

that not all decodable noise or interrogation pulse-pairs will be decoded, but only those above a minimum value. The receiver is designed to maintain the number of decoded pulse-pairs at 2700 ± 90 pulses per second.

The decoder output, a single negative-going pulse for each pulse-pair, triggers a one-shot multivibrator, V404. Triode section V404A normally conducts and the negative input from V403 cuts it off, initiating the multivibrator action.

Tube V404 provides three output signals; one feeds the radio receiver blanking one-shot multivibrator, V406, the second is coupled to a pulse amplifier, V408, in the radio receiver squitter-control circuit, and the third feeds cathode follower stage V405.

The output of V405B is a video pulse with an amplitude of about +30 volts and a duration of between 3 and 4μs. This is the output of the receiver which is applied to output jack J504 for connection by inter-unit cabling to the keyer circuits of the coder-indicator. The output is also available at jack J407 for test purposes.

Blanking Gate Circuits

The blanking circuit (fig. 11-11) performs a dual purpose. It controls the decoder input circuit for 40μs after a pulse-pair has entered the circuit, and eliminates undesirable feedback from the klystron during transmission.

The B section of the blanking multivibrator, V406, is normally held beyond cutoff. The A section normally conducts, since cathode bias alone controls the current through this tube section.

The negative-going output from the plate of V404B (fig. 11-8, B) cuts off V406A (fig. 11-11), initiating multivibrator action. The positive output at the cathode of V406B is coupled to the blanking phase inverter and isolation amplifier, V407B. Because V407B receives a high value of bias (-105 volt supply), conduction takes place only on strong positive pulses from V406B. The negative output pulse is fed to the suppressor grid of the blanking gate tube V401.

It should be recalled that the second pulse of the input pulse-pair caused the triggering action at the V404 multivibrator. Likewise, the trigger to the blanking multivibrator, V406A, corresponds in time with the second pulse of the input pair. The blanking pulse to V401 ensures the cutoff of this stage for 40μs from the leading edge of the second pulse of the pair.

An additional blanking time in V401 (fig. 11-8, B) is caused by a positive 10μs pulse received from the frequency multiplier-oscillator. This pulse ensures blanking of the

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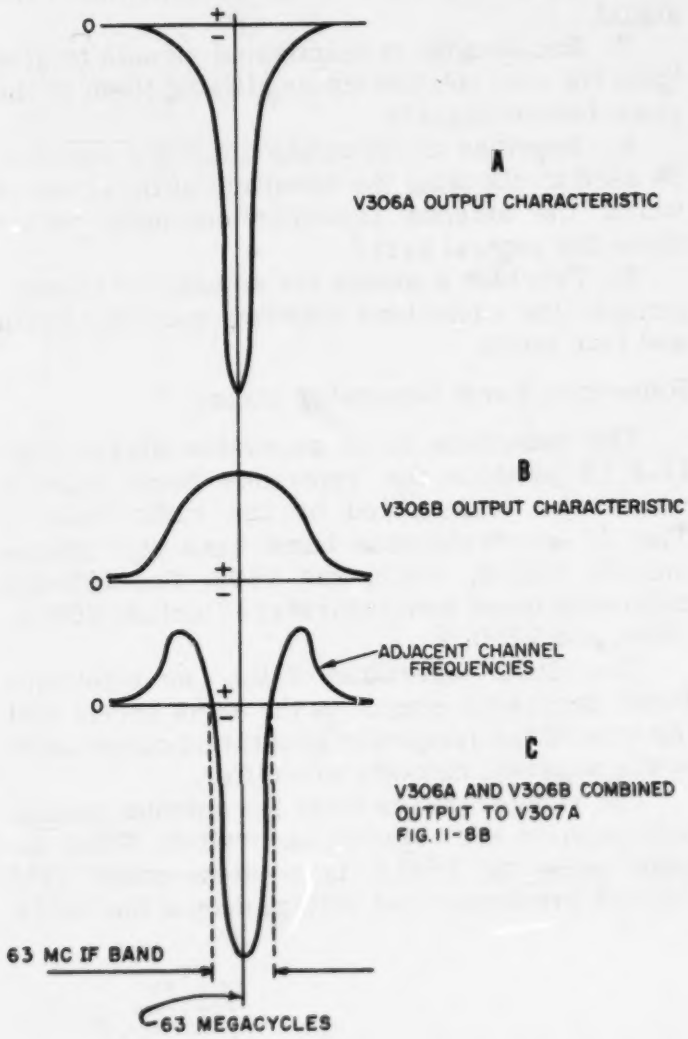

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Figure 11-10.—Ferris discriminator, c-w frequency response characteristics.

receiver during transmission of a pulse from the beacon transmitter.

Since each pulse is approximately 3 μs wide, and the blanking gate input corresponds in time to the second pulse of the pair, the elimination of the first pulse in the pair (by the decoder circuit) adds 3 μs to the total time between the arrival of the leading edge of the first pulse to V401 and the leading edge of the next pulse. Thus, the total time between pulses at the output of the receiver, is equal to the sum of the 40 μs delay in V401, the 10 μs delay caused by the pulse from the frequency multiplier - oscillator, the original 12 μs between pulses of a pair, and the 3 μs created by the omission of the first pulse - pair, or 65 μs.

Squitter Control Circuit

The output of V404B multivibrator cathode (fig. 11-8,B) which is also applied to the pulse amplifier, V408 (fig. 11-11), is used to derive the squitter-control voltage. Squitter control involves the action of a circuit in its use of noise pulses to maintain the total pulse-pairs in the receiver at 2700 + 90 pulses per second.

Grid limiting is permitted at the input to V408, which renders the output of this stage substantially independent of the amplitude of the input pulse. The output of V408 is coupled to the pulse stretcher and counter diode, V409B. As V409B conducts only on negative input alternations, C415 charges negative toward the plate of the diode. Capacitor C415 holds most of its charge during positive alternations at the V409 cathode. As a result of this action, the voltage on the grid of V407A is essentially a negative d-c voltage.

The potential at the cathode of V407A is applied to the first and second i-f amplifiers (V301 and V302) as squitter (gain) control voltage. When the bias voltage on the grid of V407A is correct to effect a squitter rate of 2700 ± 90 pps, the voltage of the cathode of V407A is approximately -5 volts with respect to ground.

Since without the application of the bias voltage to the grid of V407A (when the equipment is initially turned on), the voltage drop may result in a high positive voltage (in excess of +20 volts d-c) applied to the i-f amplifiers, a d-c clamp diode, V409A, operates to prevent the voltage rising above +5 volts while the receiver is warming up. Without the clamping action of V409A, the +20 volts applied to the grids of the amplifiers will completely block the receiver, and may cause damage to the receiver tubes.

Power Supplies

The radio receiver power supplies provide regulated -105 volts d-c for the video amplifier circuits, and regulated +150 volts d-c for the complete receiver.

Metering Circuit

A meter and a 6-position meter selector switch, located on the receiver front panel are used to permit the operator to observe the operating condition of the mixer crystal diodes, the B (+200 volt) and C (-200 volt) master

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power supplies, and the squitter-control output.

CODER-INDICATOR

The coder-indicator of the Radio Beacon, AN/SRN-6 performs the following functions:

1. Generates the 15-cps reference burst each time a 15-cps trigger pulse is generated in the antenna.
2. Generates the 135-cps reference burst each time a 135-cps trigger pulse is generated in the antenna.
3. Generates a radio beacon identification call of 1350 cps in International Morse Code keying for transmission at specific intervals.
4. Processes the distance interrogation pulses appearing at the receiver output, and in combination with time delays in the receiver and transmitter, adjusts their net transit time through the beacon to exactly 50 μ s.
5. Assigns priorities of transmission to the components of the signal, which consists of the bearing reference bursts, the radio beacon identification call, and the replies to distance interrogations and random noise pulses. Generation of the reference burst component has priority over the generation of all other output components.
6. Combines the various components of the signal.
7. Encodes the transmission signals to give them the characteristics identifying them as the radio beacon signals.
8. Provides an accurate 1350 cps signal to be used in checking the accuracy of the speed at which the antenna parasitic elements rotate about the central array.
9. Provides a means for adjustment to compensate for variations between magnetic north and true north.

Reference Burst Generator Stages

The reference burst generator stages (fig. 11-8,C) produce the reference burst signals which are transmitted by the radio beacon. The 15-cps reference burst generator stages include V601B, V602, and V603. The 135-cps reference burst generator stages include V601A, V609, and V610.

The circuit operation of the two reference burst generator stages is the same except that the size of the frequency generating components in the separate circuits will differ.

The trigger pulses from the antenna contain both positive and negative excursions. When the input pulse to V601A is positive-going, grid current produces a net voltage drop at the V601A

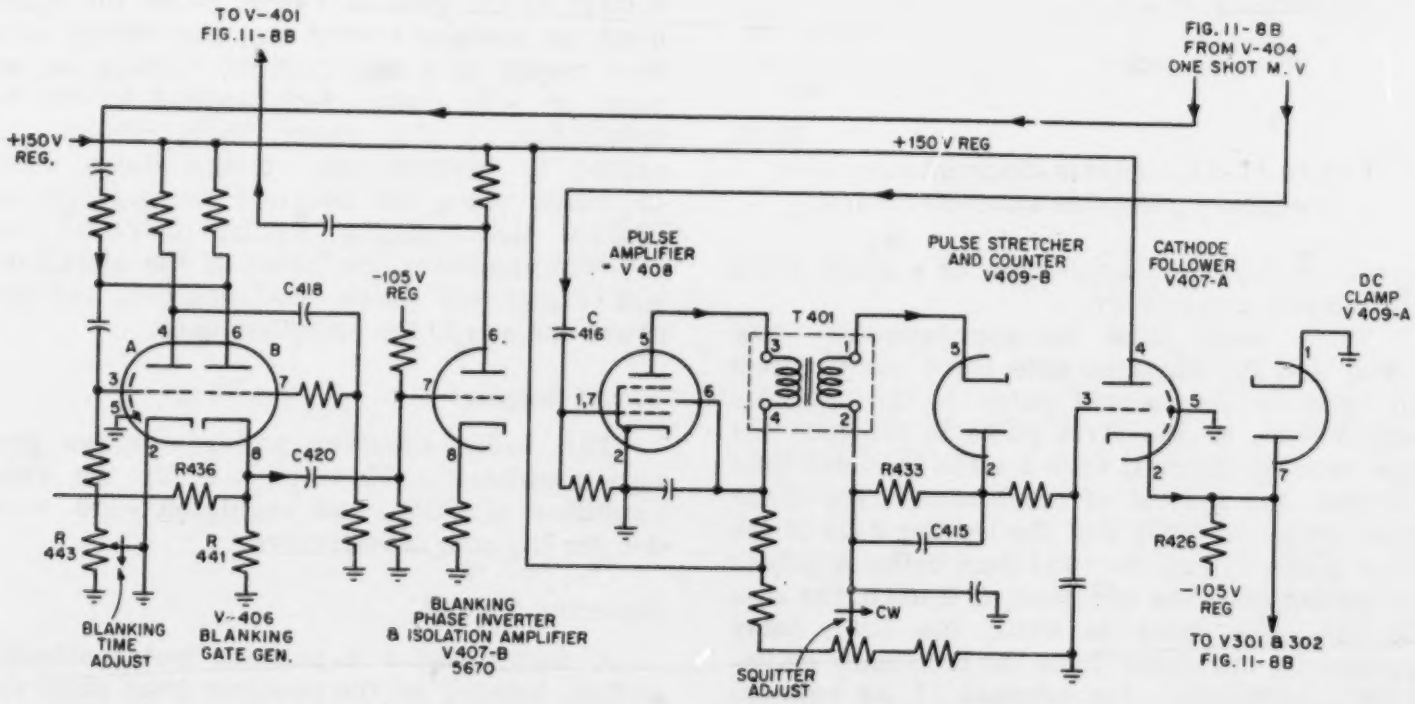

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Figure 11-11.—Blanking generator and squitter control (pulse counter).

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grid which is held very near to zero volts. When the trigger pulse is negative-going, the grid is negative, and the resulting output of V601A is a sharp positive-going pulse, which is coupled to the grid of the 135-cps gate generator, V609.

Tube V609 is a one-shot keying multivibrator which is used to provide a keying or gate pulse to the pulsed oscillator V610A which permits the generation of six pulses of 41.7 kc. These pulses, after amplifying and shaping, represent the 135-cps reference burst pulses and are coupled to V604A.

The pulse output of V609 plate is also coupled to the mixing network with the 15-cps gate and to the control grid of the priority gate state, V611.

The 33.3 kc pulsed oscillator, V603, in the 15-cps reference burst circuit also applies its output to the same reference burst amplifier, V604A. A single amplifier can be used for both the north and auxiliary reference burst since these signals do not occur simultaneously.

Burst amplifier V604A operates at approximately zero bias and is therefore normally conducting. This stage inverts and amplifies the oscillator (V610 or V602) output to an amplitude which is sufficient to trigger the one-shot multivibrator, V605.

Blocking oscillator V606 is employed to produce sharp voltage spikes capable of driving the encoding delay line, DL 601. The V606B section provides two outputs; one of 6 positive-going spikes which are applied to delay line DL 601, and a second of 6 negative-going spikes for each reference burst trigger (at V610A), as a synchronization control for the 135-cps gate generator stage, V609.

The 15-cps reference burst generator circuit, consisting of V601B, V602, and V603, is designed to produce 12 pulses spaced 30 μs apart. The pulsed oscillator, V603 operates at 33.3 kilocycles and is gated by the cathode output of V602B. Diodes in grid of V604A isolate the 15-cps and 135-cps pulsed oscillators. The feedback circuit from V606B to the V609A gird drives V609A further into cutoff during the period of the 12 input pulses developed by V605 to ensure that the 135-cps gate generator does not operate during this time.

Encoding Delay Line and Output Amplifiers

The combined action of the 135-cps reference burst circuits is to produce a group of bearing reference pulses, which consist of 6 pulse-pairs with 12 μs spacing between pulses of a pair, and 24 μs between pulse-pairs. These pulses recur 120 times per second at a 135-cps rate, as determined by the position of the soft iron (auxiliary) slugs on the pulser-plate assembly. The 15-cps reference burst circuits must produce 12 pulse-pairs with a 12 μs spacing between pulses of a pair, and 30 μs between pulse-pairs. The pulses recur 15 times per second as determined by the north slug on the pulser-plate.

The output at the blocking oscillator V606B cathode (fig. 11-8C) is about 166 volts peak-to-peak, and is fed to the primary of autotransformer T603 (not shown). This transformer matches the impedance to the encoding delay line, DL601, and has a step-up ratio of 1:3. Thus, the amplitude of the input signal to the delay line is approximately 500 volts peak-to-peak. The encoding delay line introduces the major portion of the standard zero distance delay for distance reply pulses.

For each pulse input to the encoding delay line, the delay characteristics of the line produces 2 positive pulses spaced 12 μs apart. These pulses are delivered to the pulse amplifier, V607A. These pulses are tapped from the 5 and 3 terminals of DL601, and have an amplitude of approximately 15 volts peak-to-peak. When an input pulse is applied to the line, the initial pulse from the line is delayed 32 μs, while the second pulse is delayed 44 μs.

The negative-going pulses appearing at the plate of V607A are coupled to the grid of the A section of one-shot multivibrator V615.

The V615B cathode output consists of the shaped reference burst pulses (either north or auxiliary) which are coupled to cathode follower V607B. The action of V615 ensures uniformity of the amplitude and width of the reference pulses.

Cathode follower V607B functions to isolate V615 from the output, and to match the output circuit to the 50-ohm line which feeds the signal to the transmitter. A portion of the output of V607B is delivered to test jack J607 on the front panel of the coder-indicator.

Identification Code Circuits

The circuits comprising V612, V613A, V614, V613B, and CR603 (fig. 11-8C) make up the 1350-cps tone generator, the tone of which is keyed to produce the identification code

characters for the radio beacon. Identification call amplifier stage, V613B, actually produces 2 pulses every 740μs, or at a rate of 1350 cps.

The identification tone output of V613B is keyed to V604B and V611, amplified and shaped in V605, V606, DL601, V607A, V615, and V607B before it is fed to the frequency multiplier-ocsillator of the radio beacon. You will remember that the encoding delay line, DL601, produces 2 pulses spaced 12μs apart for each pulse applied at the input to the line. Thus, during a 1-second period of the identification call, 1350 pairs of 100μs-spaced pulses appear at the input to the encoding delay line, with 2700 pulse-pairs at the DL601 output. The resulting beacon pulse output is maintained at the required rate.

The operation of the identification call circuits is as follows: The oscillator tone (1350cps) is generated in V612. A 135-cps synchronization signal obtained from the B section plate of the 135-cps gate generator stage (V609B) is applied to the control grid of V612A. The signal is amplified and applied as a positive (regenerative) synchronization input to the oscillator tank circuit. The tank circuit actually operates at the tenth harmonic of the synchronization input. The 1350-cps output of V612A is the basic identification tone signal. The circuit of V612B is that of a cathode follower. The 1350-cps output of the oscillator is coupled to amplifier, V613A. Negative alternations of the 1350-cps signals at the grid of V613A are amplified in this stage, and coupled to the A section grid of multivibrator, V614.

Twin triode V614 is connected as a one-shot multivibrator. The purpose of this stage is to produce 2 output pluses for each pulse applied at its input. Thus, the output pulse rate of the identification stages during the transmission of the identification tone is 2700 pulses per second, which are grouped at a 1350-cps rate. These pulses are encoded (double-pulsed) and amplified in the shaping stages (V605, V606, and DL601) so that the output pulse rate from the transmitter during the transmission of identification call is maintained at 2700 pulse-pairs per second.

Diode CR603 (fig. 11-8C) functions as a clamping diode which presents either a low or high impedance path to ground for the identification call signals depending on the position of the switches (S607 open, and S604 closed) in the identification call mechanical keyer assembly, A602. When the microswitches (S607 and S604) are closed, ground is applied to the plate side ("P") of CR603. When "P" is grounded, CR603 becomes a low impedance path to ground for the negative pulses which are fed to the grid of V613B. Thus, the tone signal is grounded out through the diode, and does not appear at the V613B grid. When the ground is removed from the diode, by the action of the keyer wheel assembly, a negative bias voltage of approximately -50 volts is applied to plate "P" of the diode. With -50 volts on the plate of CR603, the diode acts as a high impedance, and the tone signals are developed at the V613B grid. Under this condition, V613B passes the 1350-cps pulse-pairs to the priority gate stage, V611.

The keyer assembly, A602, comprises a motor-driven code keying wheel, a code start timing cam, and two microswitches, S607 keying switch and S604 timing switch. The keyer assembly in conjunction with the gate blocked distance reply amplifier, V604B, controls the selection of either identification tone distance reply pulses as input signals to the priority gate stage, V611. The keying wheel and start code timing cam initiate a beacon identification coded call every 37.5 seconds.

The code keying wheel revolves at a speed of 8 rpm. The periphery of the wheel is divided into segments. The segments can be moved outward from the center of the wheel. By positioning the segments, code characters of long or short duration (dots and dashes) can be set on the wheel.

A 1350-cps antenna synchronization oscillator, V608, produces an output voltage, which in conjunction with a signal voltage from the antenna speed tachometer (not shown) can be used to check the speed of rotation of the antenna.

The tachometer produces a 675 cps output. The two voltages will cause a 2 to 1 Lissajous pattern to be formed on an oscilloscope screen when the antenna speed is correct.

TRANSMITTER

Actually, the transmitter can be considered to contain a frequency multiplier-oscillator chassis and an amplifier-modulator chassis. It should not be forgotten however, that the local oscillator signal for the beacon receiver is also obtained from the frequency multiplier-oscillator chassis.

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Frequency Multiplier-Oscillator

The frequency multiplier-oscillator chassis of the radio beacon comprises a carrier generating (r-f) chain and a video chassis. The carrier generating chain produces the beacon radio frequency carrier. The video chassis produces two shaped pulses, one pulse, called the klystron gate pulse, is 10μs wide and is amplified in succeeding stages of the transmitter to a level sufficient to key the high voltage applied to the klystron. The second pulse, called the 3.5μs shaped pulse, is a specially shaped video pulse which is used to intensity-modulate the klystron beam current. This pulse has a relatively long rise and decay time in order that the final r-f output pulse will occupy a minimum of frequency spectrum.

SHAPED PULSE GENERATOR.—The positive 1.5μs pulses from the coder-indicator chassis are applied via J1401 to the oneshot multivibrator, V1402, of the shaped-pulse generator circuit, in the frequency multiplier-oscillator chassis (fig. 11-8B). Multivibrator V1402 ensures uniformity of shape of the input pulses. To prevent false triggering action, CR1402 is inserted in series with the signal path of the trigger pulse to block any negative alternations.

Power amplifiers, V1403, V1404, and V1405 are operated in parallel in order to handle the heavy currents required in producing the high-powered pulse necessary to drive the subsequent shaping circuits. The primary of a step-up transformer (not shown) acts as the common plate load of the power amplifiers. Fixed bias cuts off the power amplifiers in the absence of a signal.

When a positive pulse from V1402B is applied to the power amplifiers, plate current flows and a negative-going rectangular pulse approximately 800 volts in amplitude is developed across the primary of the transformer. A positive pulse, approximately 2300 volts in amplitude is induced in the secondary of the transformer, and is applied to the shaping network through the series diode, V1406.

The shaping network comprises capacitors and coils in a low-pass filter circuit, which produces a 3.5μs pulse. The delay time of the pulse throughout the shaping network (fig. 11-8, B) is approximately 2.8μs.

Positive output pulses from the shaping network are coupled to the paralleled grids of the cathode followers, V140 and V1411. The cathode followers are operated in parallel to lower the output impedance of the 3.5μs pulse shaping network.

The output of V1407 and V1411 is fed to the amplifier-modulator chassis(fig. 11-8, B). The signal is applied to the klystron amplifier, V1304. You will note that in the frequency multiplier - oscilator, each pulse from the coder-indicator is shaped before it is applied to the klystron amplifier. The space between pulses is maintained at 12μs

In addition to applying the 3.5μs pulse to the klystron, the r-f carrier must also be applied at the same time to produce the required beacon output. The r-f carrier frequency is produced in the carrier generating chain by a Butler type crystal-oscillator, V151. The oscillator is followed by a group of frequency multiplier stages. These stages multiply the basic oscillator frequency 24 times.

The V1504 output (fig. 11-8,B) which represents the oscillator frequency multiplied 24 times is applied simultaneously to the hybrid mixer in the receiver, and constantly to the first keyed r-f amplifier, V1505. Tubes V1505 and V1506 are keyed r-f amplifiers operated in cascade and employing lighthouse tubes in conjuction with a broadband coaxial-type resonant cavity. The r-f output of V1505 and V1506 is keyed by the 10μs pulse produced in the frequency multiplier-oscillator and supplied via V1409. This negative pulse, coupled to the cathodes, allows the passage of the r-f carrier.

The 1.5μs pulses at J1401 are also fed through delay lines DL1401 and DL1402 in series to the one-shot multivibrator stage consisting of V1408 and V1401. The total input delay through DL1401 and DL1402 is about 2.8μs. This corresponds with the delay of the shaped 3.5μs pulse through the shaper network to V1304. Positive input pulses from DL1402 trigger V1408 to start a 10μsec multivibrator action. Diode CR1401 blocks negative pulses coming from DL1402 which might cause false triggering of the multivibrator during the time that V1408 is conducting. Pulses from V1401 are coupled to pulse amplifier, V1409.

The positive 10μs pulse from V1401 permits V1409 to conduct, thereby producing a plate output across the primary of a transformer (not shown), which couples the 10μs output pulse from the plate of V1409 to the

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cathodes of r-f amplifiers, V1505 and V1506. The pulses reduce the existing grid-cathode bias on V1505 and V1506 (fig. 11-8, B) to a point which allows these tubes to conduct. The r-f output of V1506 which consists of 10μs pulses of r-f energy at the carrier frequency is fed to the klystron, V1304 (fig. 11-8, B), in the amplifier-modulator. A second output from V1409 is developed across the unbypassed cathode and fed to the receiver blanking gate, V401, to serve as the 10μs receiver blanking pulse. This pulse blanks the receiver during the period that the transmitter is operative.

Amplifier-Modulator

The amplifier-modulator consists of the klystron r-f amplifier, V1304, a regulated bias power supply, and the associated control circuits. A sectional diagram of the klystron tube is shown in figure 11-12. The klystron operates as a three-cavity amplifier, and depends on the changes introduced in the velocity of the stream of electrons in the first and second drift spaces (velocity-modulation). The changes in the r-f potential across the klystron resonator cavities alternately slow some of the electrons and accelerate others. This action causes bunching of the electrons during one period, and creates a space between bunches during the next period. The transit time between the two electron groups (or bunches) produces an alternating r-f current through the klystron.

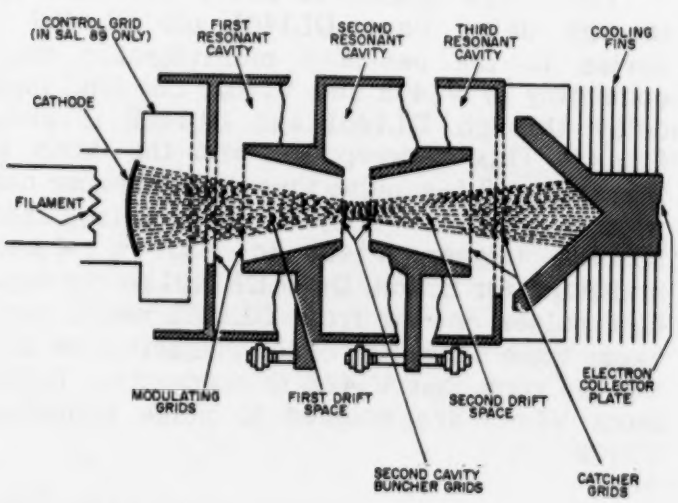

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Figure 11-12.—Sectional diagram of klystron tube.

If the area of the klystron cavity is either increased or decreased, the rate of bunching in the klystron will be changed. Cavity tuning is accomplished by mechanically changing the area of the cavity by adjustable screws.

The combined effect of grid-modulation and velocity-modulation of the klystron beam current results in high-powered r-f output pulses from V1304 (fig. 11-8B). The shape of the pulse is controlled by the 3.5 μs pulse to ensure that the radiated r-f power will occupy a minimum of frequency spectrum about the assigned carrier frequency as discussed.

In the quiescent state a constant negative potential of -12 kilovolts from the high voltage power supply (not shown) is applied to the V1304 cathode. However, the klystron beam current is cut off by a -120 volt potential applied between the control grid and cathode. This potential is obtained from a series regulated bias supply which is ungrounded.

The 10 μs r-f pulse envelope from V1506 is applied to the first cavity of V1304. The 3-5 μs-shaped pulse is applied from V1407 and V1411 via T1372 to V1304 between the cathode and grid so that the peak amplitude of the pulse occurs at about the center of the 10 μs r-f pulse envelope The shaped pulse modulates the r-f to form the output pulse. Thus, the action of the klystron amplifier is like that of a coincidence stage.

The output pulses from the klystron amplifier have a minimum peak power of 7.5 kw, and a repetition rate identical to the repetition rate of the pulse train at the output of the coder-indicator. The output is coupled to a double-slug tuner, 21303, (fig. 11-8,B) which provides a means of matching the output impedance of the klystron with the input circuit impedance of the control-duplexer.

ANTENNA CONTROL SYSTEMS

The shipboard antenna system consists of the antenna proper, antenna pedestal (fig. 11-3), a speed control servosystem, a bearing servosystem, and a roll and pitch stabilization servosystem. The basic functions of the antenna were considered earlier in this chapter. The following discussion presents a block diagram analysis of the various antenna control systems.

Antenna Speed Control System

As discussed previously, the speed of the rotating cylinders carrying the parasitic reflectors must be maintained constant at 900

rpm, since the speed determines the modulating frequencies. To control this speed, a speed control servosystem is employed. A tachometer that is an integral part of the motor which rotates the antenna (spin motor) generates a 675-cps signal when the antenna cylinders are spinning at the required 900 rpm.

The speed control circuit (fig. 11-13) consists of a preamplifier and a power amplifier. The preamplifier comprises a phase-sensitive detector, an equalizing network, a voltage amplifier, and an oven control amplifier with its associated circuits. The power amplifier consists of three saturable reactors with their associated feedback rectifiers and power factor correction transformers.

The spin motor, B3202, which is geared to the tachometer, G3202, causes the tachometer to generate the 675-cps signal when the antenna cylinders are being rotated at the proper speed (900 rpm). Any deviation from this speed causes a corresponding change in the frequency of the signal from the tachometer. This frequency is fed to the input of the antenna speed control preamplifier circuit.

The phase-sensitive detector in the preamplifier contains a tuned circuit which is resonant at 675 cps. If the tachometer frequency is the same as the resonant frequency of the phase detector, no error voltage will be developed. However, if the tachometer frequency varies from the required 675 cps. the phase detector will produce an output voltage which is proportional to the magnitude of the frequency error.

The error voltage is produced in the rectifier unit which is a part of the phase detector. The output of the rectifier unit is fed to the speed error indicator located on the front panel of the coder-indicator, and through an equalizing network to the voltage amplifier.

The heat-controlled oven contributes to the frequency stability of the tuned circuit in the phase-sensitive detector. A separate amplifier used for controlling the oven temperature senses any change in the temperature and operates a relay that controls the current to the heating elements in the oven. Direct current for the heat control elements is supplied by a bridge rectifier, which also supplies d-c bias for the voltage amplifier.

The voltage (magnetic) amplifier receives the speed error voltage developed in the phase-sensitive detector circuit, amplifies it, and converts the error voltage to its equivalent d-c voltage. The equalizing network stabilizes the operation of the amplifier by removing ripples from the error signal, thereby preventing the amplifier from saturating because of noise voltages.

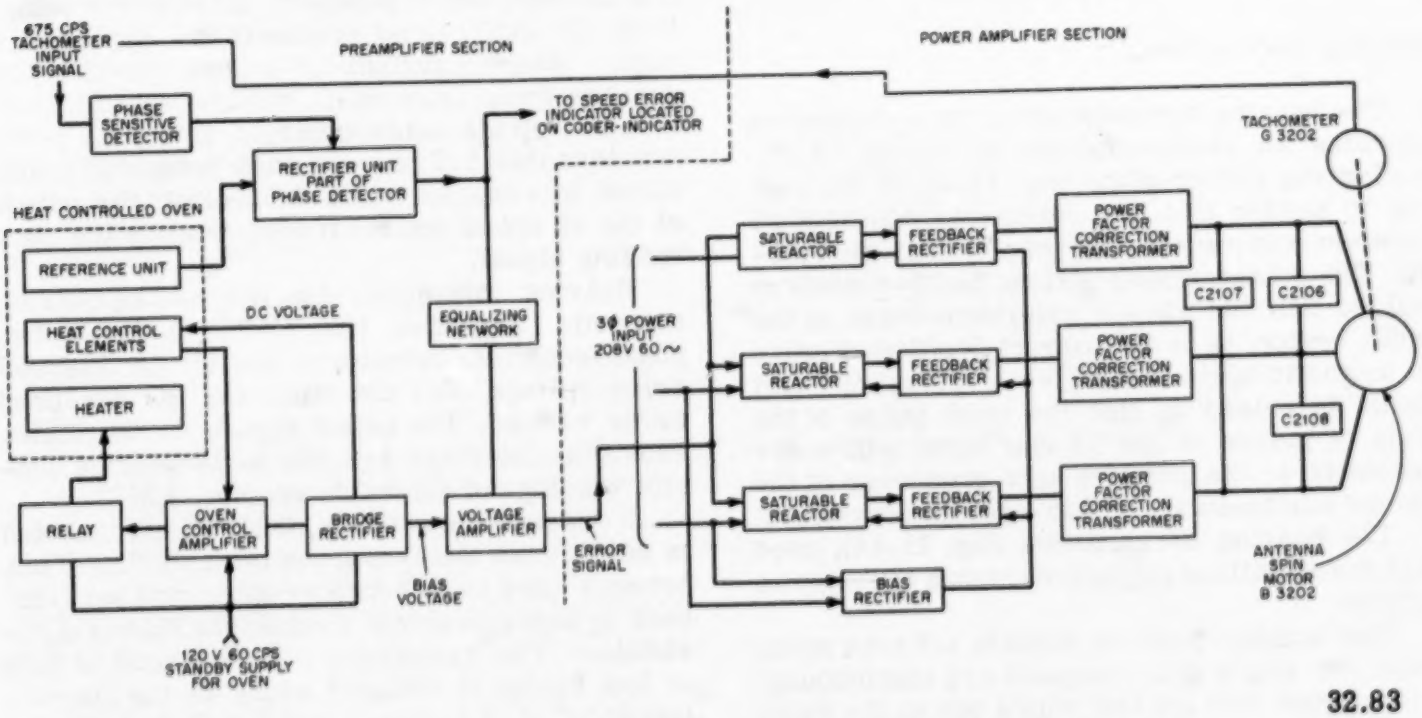

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Figure 11-13.—Antenna speed control circuit, block diagram.

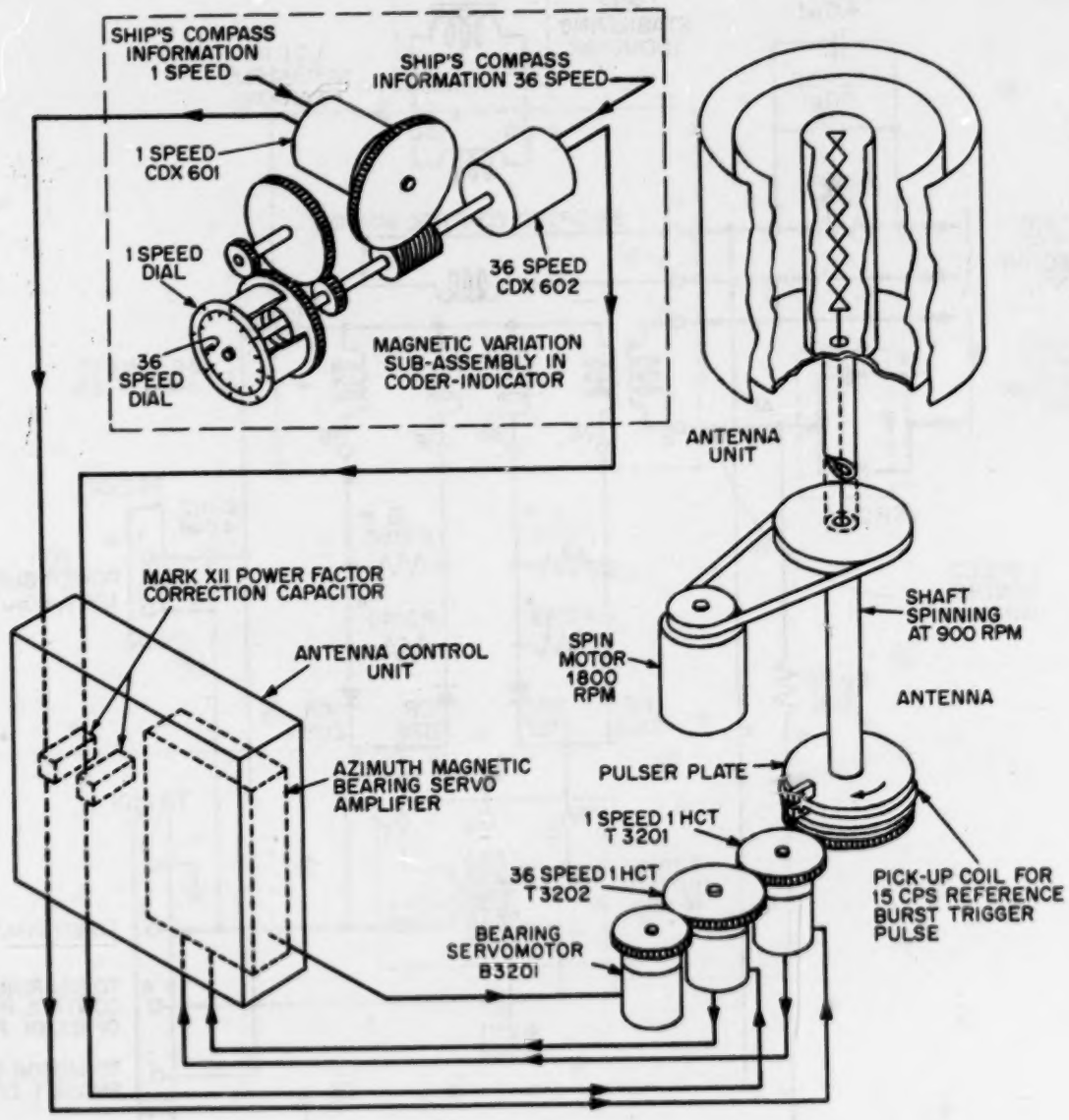

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Figure 11-14.—Shipboard bearing servosystem.

for high levels of voltage. Thus, when the 1-speed transformer error voltage is low, the gain of the 1-speed circuit is decreased. Conversely, when the error voltage is large, the gain is increased and the 1-speed error voltage has the greater control. Under this condition, the lowered resistance of the CR2146 diode pair permits a much higher current to enter the 1-speed control winding.

The series rectifiers, one in each leg of the balanced amplifier circuit, prevent the load current in the leg from reversing. The circuit is said to be balanced, since the center-tap of the output transformer, T2109, is at the electrical center between each branch of the circuit.

The two branches of the amplifier circuit are designated the A and B branches, respectively. The flux of branch A is in opposition to the flux of branch B.

The 120-volt 60-cycle input at terminals 1-2 of TB2107 cause a quiescent current alternately through the two legs of the A and B branches of the amplifier. The resulting voltage developed across the output transformer, T2109, for the quiescent condition is always zero.

Parallel resistances R2148, R2155 and R2149, R2156, connected across the load windings, are used for balancing the a-c output across the 5-4 and 4-3 terminals of output

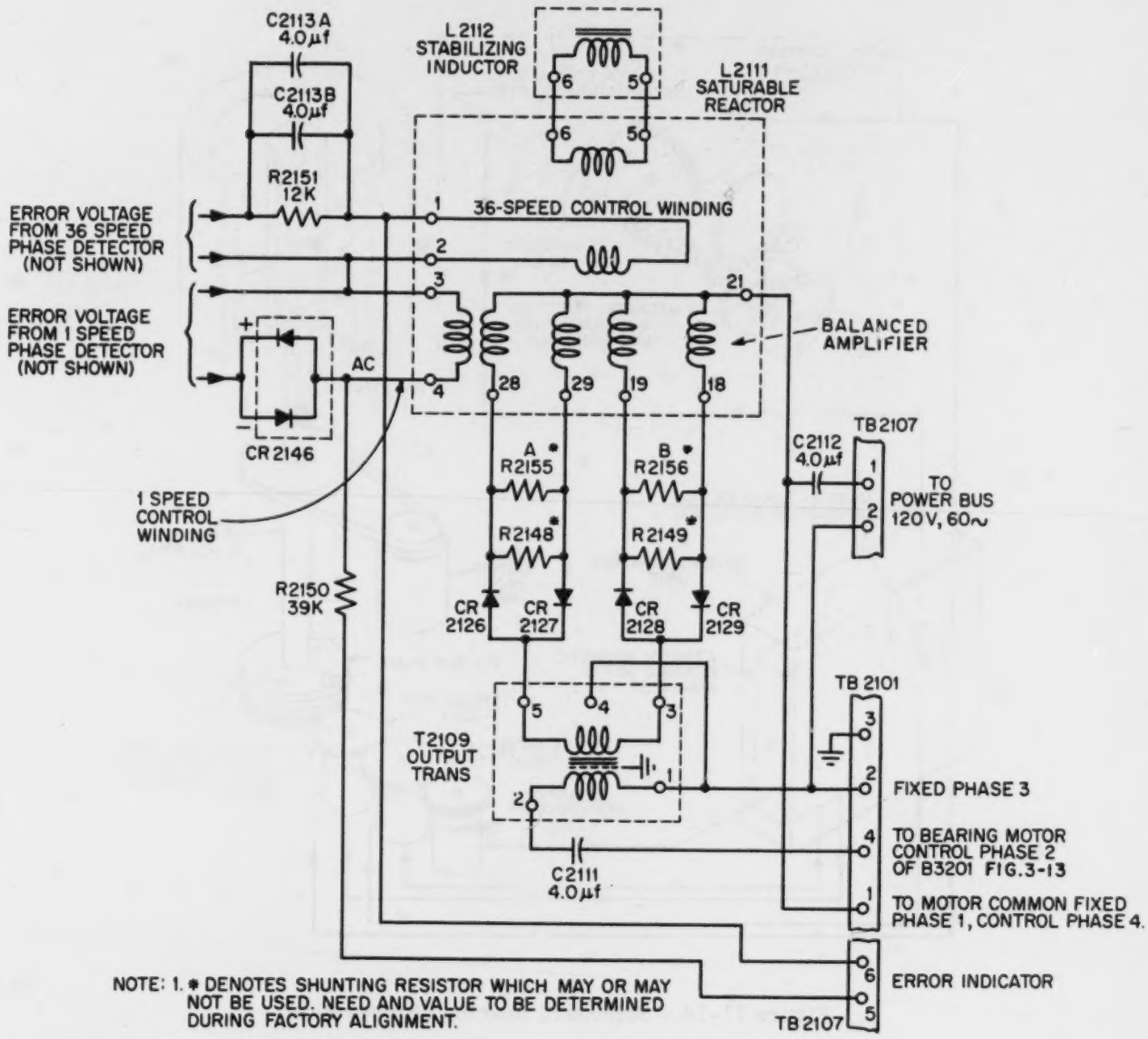

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Figure 11-15.—Balance bearing magnetic amplifier, schematic diagram.

transformer, T2109. The value of the resistances is chosen to give zero a-c voltage output for zero d-c current in the control windings. These resistors also set the bias current in the load windings.

The operation of the amplifier is as follows: The mmf of branch A is in opposition to the mmf of branch B. Assume that there is an error voltage which tends to saturate the core of branch A, and desaturate the core of branch B. This condition unbalances the circuit, resulting in a heavy current flow in the load winding of the saturated branch. If the polarity of the error voltage is reversed, branch B becomes saturated, while branch A becomes desaturated.

The branch conducting the greater current will produce a predominant alternating flux across one-half of the primary of the output transformer, T2109. This output is coupled from

the secondary of T2109 to the control phase winding of the bearing servomotor, B3201.

Because of the balanced arrangement of the two branches of the amplifier with respect to the center-tap, the mmf in the 5-4 section of T2109 will be predominant for one error and the mmf of the 3-4 section of T2109 will predominate for the opposite error. Thus, the current through the motor (and the direction of motor rotation) reverses with a reversal of error voltage.

Antistickoff Voltage.—As stated earlier, signals from the magnetic variation subassembly of the coder-indicator are introduced into the 1- and 36-speed differential transmitters in order to cause the pulser plate assembly in the antenna pedestal to be corrected to magnetic north. A single calibrated from 0 to 360 , and fastened to the coarse (1-speed) differential transmitter and control transformer (CDX601 and T3201, fig. 11-14) yields only a fair degree of accuracy in proving information to the servomotor, B3201. A second dial, fastened to the fine (36-speed) differential transmitter and control transformer, CDX602 and T3202, is calibrated so that one revolution of the fine control transformer, T3202, equals only 10° of the full coverage of the coarse control transformer, T3201. This provides a method of reading the position of the control shaft with 36 times the accuracy of a system when only the coarse control is provided.

The voltage which controls the bearing servomotor is shown in figure 11-16. The curves shown have the appearance of sine waves but actually represent an infinite number of rms voltage values for error signals throughout a 360° rotation of the rotor of the control transformer.

The amplified control transformer output (fig. 11-15) drives the bearing motor. The motor is a 2-phase induction motor having a continuously excited fixed phase and a variable control phase. The direction of the motor torque is determined by the instantaneous polarity of the control voltage from the control transformer with respect to that of the fixed phase.

When the error voltage is any value above the zero reference line, the direction of the motor rotation is assumed to be counterclockwise (ccw). Conversely, when the error voltage is below the axis the instantaneous polarity of the control phase of the motor is reversed with respect to the fixed phase and the motor rotates in the opposite direction (clockwise).

If the error voltage is less than 2.5 a deemphasis network which consists of Zener diodes connected as shown in figure 11-15, permits the 36-speed voltage to control the motor. For error signals greater than 2.5°, the deemphasis network breaks down and the 1-speed voltage controls the motor. Thus in figure 11-16A, the portion of the curve from 357.5° (corresponding to 2.5° on either side of 0°), the 36-speed voltage controls the servo system. For errors larger than 2.5° the 1-speed voltage is shown to be the controlling signal.

The use of an even gear ratio between the fine and coarse control transformers presents a problem in synchronizing the servo system. Note that at 180° the 36-speed voltage crosses the zero axis three times in the area from 175° to 185° to produce a negative voltage at 179° and a positive voltage at 181°. When the system is at 179° the error voltage drives the motor clockwise; at 181° the servomotor is driven counterclockwise. This causes the system to lock-in at 180°, so that the system synchronizes at a false null of 180°.

The elimination of the 180° false null is accomplished by the addition of an a-c voltage, called an antistickoff voltage (fig. 11-17) to the 1-speed voltage (fig. 11-16 B). The addition of the antistickoff voltage shifts the curve upward at 180° so that the crossover point occurs at 185°. The 180° false null condition cannot exist, since for an error condition of 185° or less, the error voltage is positive and the servomotor is driven counterclockwise away from the false null to null at 0°. If the error condition exists above 185° the servomotor will be driven clockwise away from the false null to null at 360° or zero degrees. Thus, the addition of the antistickoff voltage to the 1-speed control transformer voltage causes only the 0° null position to exist as a stable point in the servosystem.

To correct the 1-speed zero at the zero shaft angle position, the 1-speed control transformer is re-zeroed to a point 2.5° from zero. This action cancels the error introduced by the addition of the antistickoff voltage at the zero shaft position, and adds the 5° error to the 180° crossover point.

ROLL AND PITCH SERVOSYSTEMS

The roll and pitch servosystems (fig. 11-18) are separate but similar circuits which

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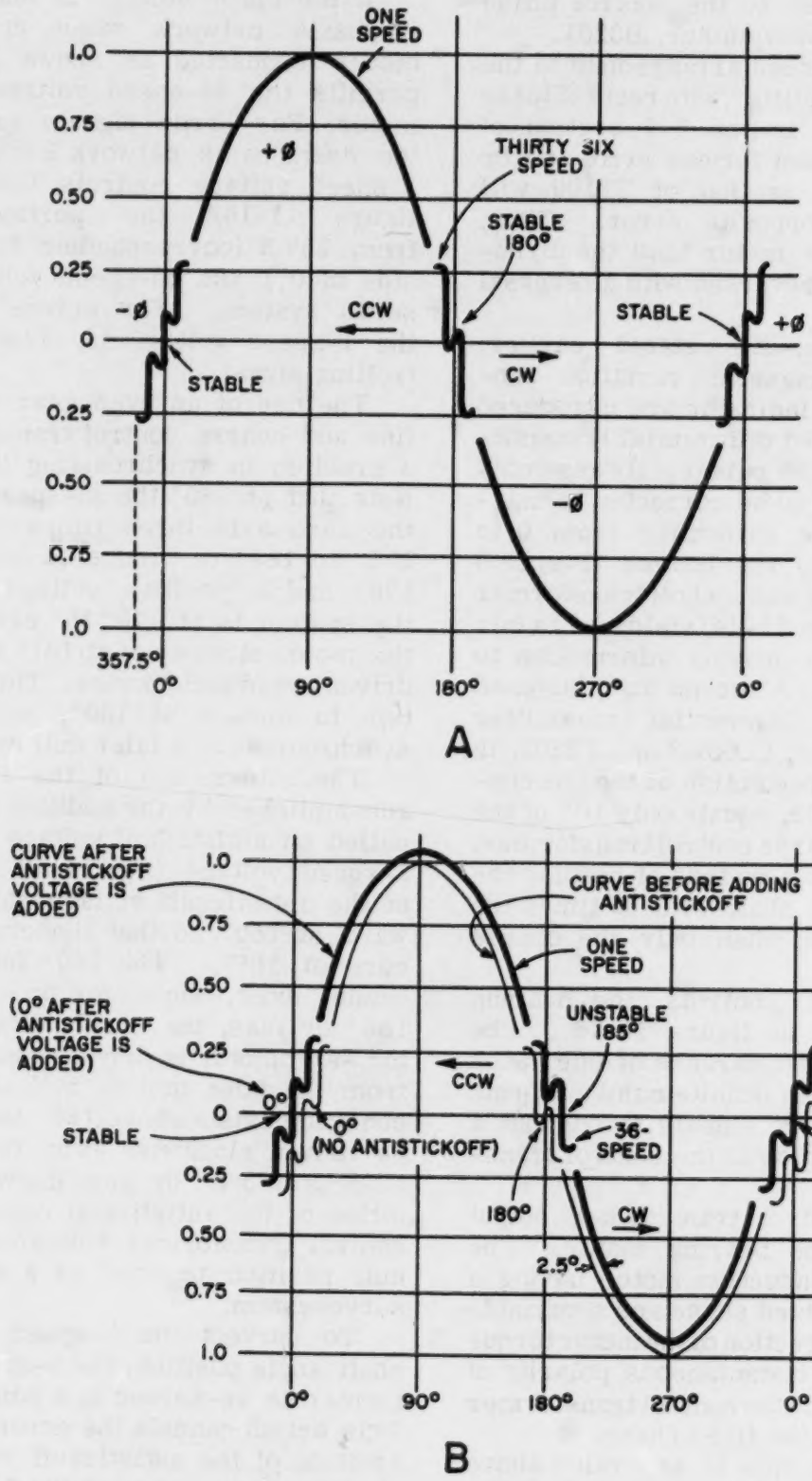

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Figure 11-16.—Addition of antistickoff voltage.

maintain the antenna in the vertical position with respect to a horizontal plane despite roll and pitch motions of the ship.

The roll servosystem can correct up to 25° of roll, while the pitch servosystem can correct up to 6° of pitch. Roll and pitch information is obtained from the stable element of the ship

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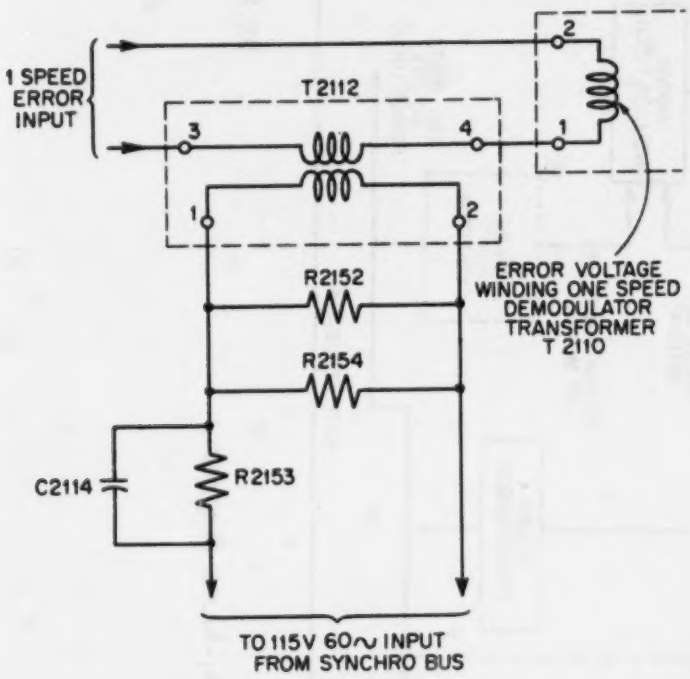

32.107

Figure 11-17.—Method of adding antistickoff voltage.

which is gyroscopically controlled to maintain a true horizontal position.

A 2-position (stow-stabilized) switch, S606, is located on the front panel of the coder-indicator. In the STOW position, the antenna is locked perpendicular to the deck of the ship. When S606 is in the STABILIZED position, (which is its normal position aboard ship) the antenna will be held in a fixed position by the servosystems so long as the roll or pitch of the ship does not exceed the specified limits as described above.

Roll and pitch information is fed from the bus of the ship through the stow-stabilized switch, S606, in the STABILIZED position, to the control transformer. The control transformer passes the error signals to the roll or pitch magnetic amplifier.

The roll and pitch magnetic amplifiers are almost identical units. The following discussion applies to both systems unless otherwise noted.

The synchro error voltage (11-18), from the roll or pitch control transformers is fed to a phase-sensitive detector. The reference voltage for the phase detector is obtained from the 115-volt, 60-cps roll and pitch reference bus.

The d-c output error voltage from the phase detector appears between the center-tap of the two secondaries of a transformer (not shown), The phase-sensitive detector load is connected between these points, and consists of the series, aiding control windings of the magnetic preamplifier.

The tachometer feedback current from either G3001 or G3002, is fed to one set of the control windings of the magnetic preamplifier. Interference between the phase detector and tachometer circuits is prevented by the isolation network (acceleration feedback network).

The isolation network impedance in the tachometer input circuit also serves the purpose of changing the tachometer voltage from rate feedback to acceleration feedback.

Without the use of a rate-to-acceleration feedback circuit, when the load is turning at a constant speed, a steady d-c voltage (proportional to speed) would be fed back to the preamplifier in opposition to the error signal. Therefore, a greater error signal would be required to overcome the d-c voltage and produce a certain unbalance in the amplifier and a certain speed of the servo motor than would be required if there were no feedback.

In order to produce a greater error signal there must be a greater error. Since the feedback voltage is proportional to speed, the error is also proportional to speed. This is called a velocity error, or rate feedback.

To eliminate this velocity error, a group of capacitors (not shown) are connected in the feedback circuit and block the d-c component of the voltage. The a-c component of the voltage at the frequency of hunting (several cycles per second) is fed back without much loss.

With this circuit arrangement, only changes is speed will produce a feedback signal through the capacitors. This action is called acceleration feedback, which further improves the stability of the servosystem.

The bridge rectifier consisting of four diodes (not shown), serves as a high impedance shunt across the feedback capacitors for low amplitude tachometer feedback voltages. For high amplitude feedback voltages, a diode (not shown), with a low impedance, causes the rectifier to act as a low impedance shunt across the feedback capacitors. This feature results in the tachometer feedback signal having a greater damping effect when the servosystem is correcting rapidly than when the system is correcting slowly. The low impedance diode is

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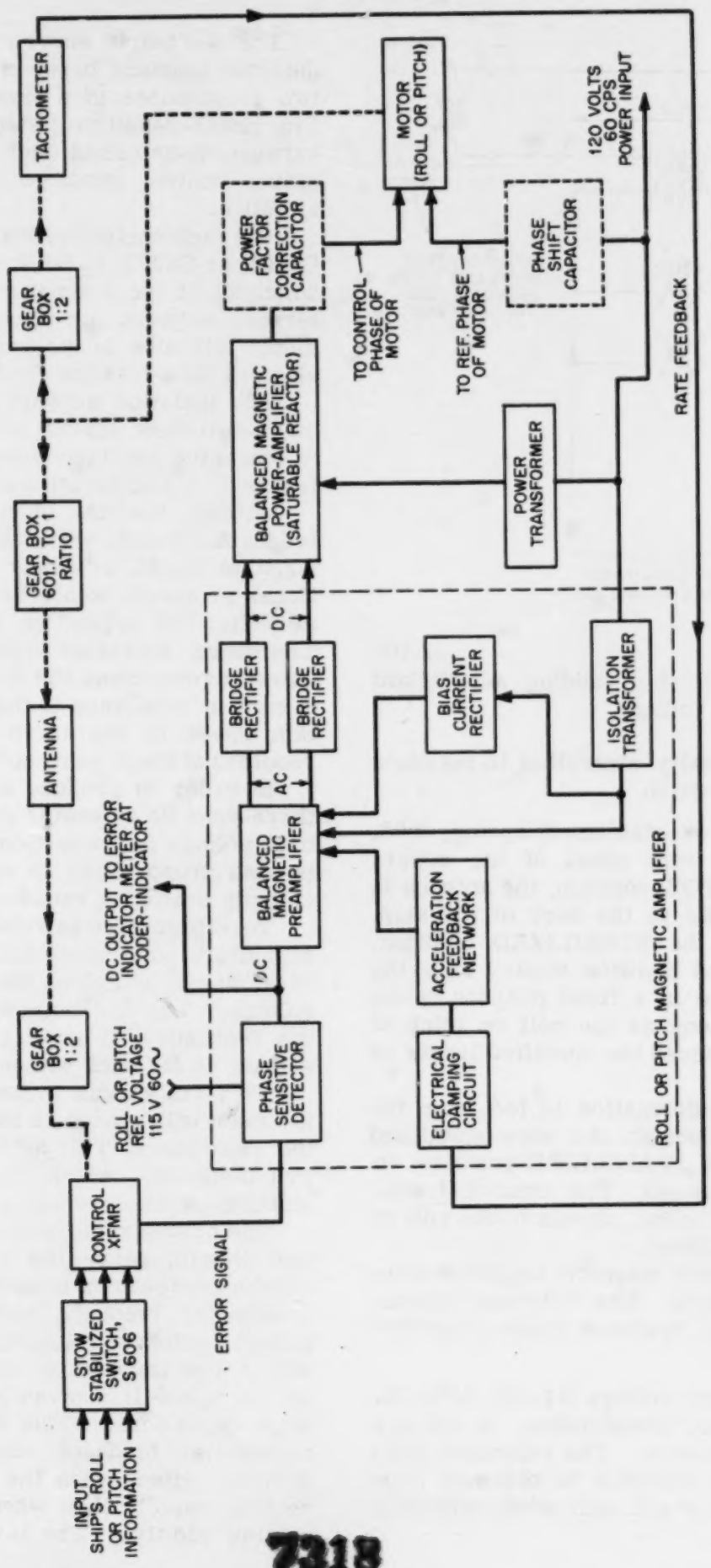

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Figure 11-18.—Roll and pitch servosystem, block diagram.

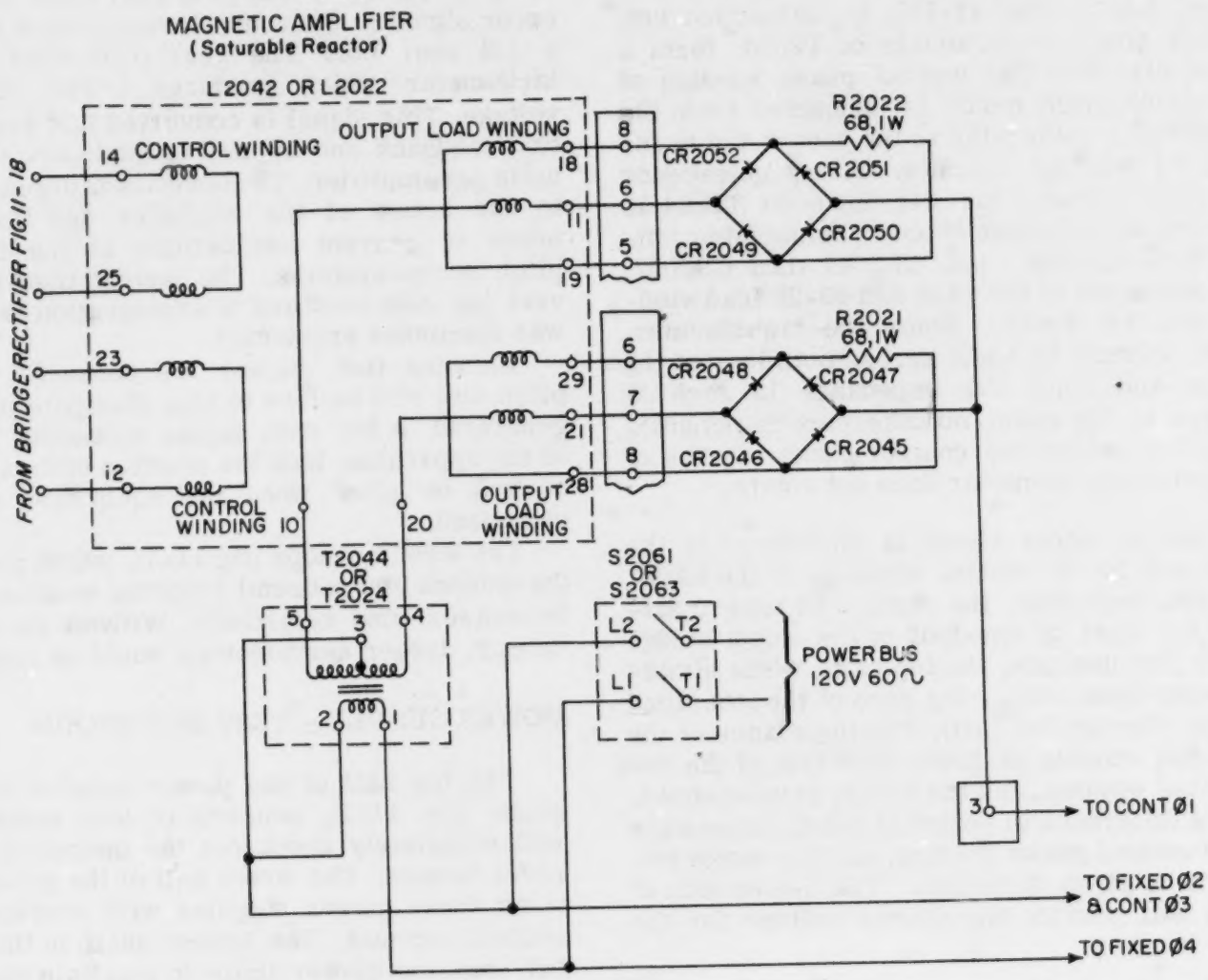

32.108

Figure 11-19.—Roll or pitch magnetic amplifier.

selected for its Zener characteristic, which means that the diode will have a very high front-to-back resistance ratio for low amplitude a-c signals, and a very low front-to-back resistance ratio for signals above a certain amplitude.

As stated earlier, the error signal from the phase-sensitive detector is developed across the three control windings (not shown), of the preamplifier which are connected in series aiding. A rectified bias current is conducted through the bias winding section of the control winding by the action of the bridge rectifier comprising of four diodes (not shown), two resistors (not shown), in parallel for current limiting, and two balancing resistors (not shown), in the separate halves of the bias windings. A capacitor (not shown) filters the bias voltage to produce the required steady bias current.

An error signal in the control windings will cause an impedance increase in one of the load windings (either upper or lower), while simultaneously lowering the impedance in the other load winding. The control windings output, after being rectified in separate bridge circuits, causes a greater controlling signal

to be fed to one of the control windings of the magnetic amplifier than to the other.

The two load windings of the magnetic amplifier, L2022 (fig. 11-19), in conjunction with the 5-4 and 4-3 terminals of T2024, form a bridge circuit. The control phase winding of the roll or pitch motor is connected from the transformer center-tap to the center-tap of the two load winding circuits. During quiescence (no-error signal), the a-c input at T2024 is rectified in the bridge circuits comprising CR-2045 thru CR2048, and CR2049 thru CR2052. The impedance of the 1819 and 29-28 load windings will be equal. Since the transformer, T2024, voltage is equal across both legs of the bridge, and since the impedance in each of the legs is the same, no difference in potential will exist across the control phase winding of the motor and the motor does not rotate.

When an error signal is introduced at the 14-25 and 23-12 control windings of the L2022 magnetic amplifier, the signal will tend to saturate the core of one-half of the output bridge circuit (for instance, the top half), while simultaneously desaturating the core of the other load winding (the bottom half). The impedance of the saturated winding is lower than that of the desaturated winding, and the bridge is unbalanced. Thus a difference in potential exists across the motor control phase winding, and the motor rotates in a given direction. The 5-4 section of T2024 will provide the source voltage for the motor winding.

When the bridge is unbalanced, the motor essentially is placed across one-half of the transformer (T2024) in series with one load winding of the bridge. The current through the motor will be alternating, changing as the transformer secondary voltage changes. If the input error signal from the magnetic preamplifier tends to saturate the core of the lower load winding, the impedance of this winding will be decreased, while the impedance of the upper load winding is simultaneously increased. In this condition, the source voltage for the motor is derived from the 4-3 section of T2024. Note that the instantaneous direction of current through the control phase of the motor will be reversed, since the instantaneous voltages across the separate halves of the transformer (T2024) are 180° out of phase. An instantaneous change in the control winding current with respect to the fixed phase winding will reverse the direction of rotation of the motor.

The servomotor, through its associated gear train, moves the antenna to its corrected position. At the same time, the gear train nulls the error signal at the control transformer through a 1:2 gear box. The gear train also turns a tachometer which produces a rate feedback voltage. This signal is converted into acceleration feedback and applied to the balanced magnetic preamplifier. The feedback is degenerative to the action of the amplifier and therefore tends to prevent oscillations in the roll or pitch servo-systems. The method used to convert the rate feedback to acceleration feedback was discussed previously.

Blowers (not shown) are connected to the pitch and roll motors to help dissipate the heat generated in the unit. Brake solenoids, a part of the apparatus, lock the position of the antenna in roll or pitch when the equipment is de-energized.

The bubble canopy (fig 11-1), which protects the antenna and pedestal from the weather, also decreases wind resistance. Without the bubble canopy, larger servomotors would be required.

POWER SUPPLY - TEST SET GROUP

The top half of the power supply - test set group (fig. 11-1), consists of four units which will completely check out the operation of the radio beacon. The lower half of the group contains three power supplies with overload and control circuits. The lowest shelf in the radio set contains blower units to maintain the units at the proper operating temperatures, and fuses for primary power.

Power Supply Group

The low voltage power supply consists of two d-c regulated outputs of + 250V and -375V from two conventional controlled series resistance, tube type rectifiers. These voltages are used throughout the equipment.

The medium voltage power supply consists of a d-c regulated output of + 1000V, and is used in the frequency multiplier-oscillator.

The high voltage power supply delivers an unregulated output of about -12 KV to the klystron in the amplifier-modulator.

Test Set Group

To premit a rapid check of important operating characteristics and maintenance of the radio

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beacon, four test equipment units are mounted in the power supply cabinet. These units are: (1) TS-891/URN-3 power meter-pulse counter, (2) OS-54/URN-3 oscilloscope, (3) TS-890/URN -3 pulse analyzer-signal generator, and (4) SG-121A/URN-3 pulse generator. An additional unit SA-420/URN-3 switch-test adapter, mounted outside of the cabinet is used with the TS-891/URN-3 power meter-pulse counter to complete the test equipment.

SWITCH TEST ADAPTER.—The switch test adapter SA-420/URN-3 (fig. 11-1), is mounted on a wall or bulkhead near the radio set. The unit (fig. 11-10,A) consists of a coaxial line with a voltage probe and a crystal detector which makes a detected sample of r-f available to the radio frequency monitor MX-1627/URN-3 (discussed later), for power monitoring purposes. The coaxial line also contains a directional coupler and a crystal detector which makes a detected sample of r-f available to the power meter-pulse counter (TS-981/URN-3), for peak power measurements. The switch test adapter provides a manually operated coaxial switch for connecting the transmitter r-f output to either the transmitting antenna or a dummy load.

POWER METER-PULSE COUNTER.—The power meter-pulse counter TS-891/URN-3 (fig. 11-20) measures the peak r-f power output of the AN/URN-3 transmitter in its frequency range of 960 to 1215 mc. The switch-test adapter must be used in conjunction with the power meter-pulse counter for this function, since the power measuring circuit is incomplete without both units. Power is measured by means of a slide-back diode circuit and can then be read in kilowatts on the PEAK RF POWER meter. The R-F POWER SWITCH is used in conjunction with the PEAK PWR VOLTAGE control and the peak r-f power meter circuit, and when depressed, closes this circuit for peak r-f power measurements. The PEAK PWR VOLTAGE CONTROL is used to establish the slide-back voltage for the power meter circuit during power measurements. It is operative only when the RF POWER switch is depressed. The detected r-f pulse envelope is sent through the FUNCTION SWITCH to the oscilloscope for visual observation during peak power measurements. Another circuit measures the average repetition rates of all pulse sources in the AN/URN-3 and its test equipment over a range of 80 to 8000 pulses per second. The repetition rate is counted by means of an analog type circuit and is read in pulses per second on the PULSE COUNT METER on the front panel of the power meter-pulse counter. Suitable gating, phase reversal and pulse shaping circuits are provided in order to perform the necessary counting of both fixed and random rate pulses. The PULSE COUNT CAL adjustment is a locked screwdriver adjustment control which is used for calibrating the PULSE COUNT METER and should be made only by technical personnel. When the COUNTER SELECTOR SWITCH is in the "-" position, the pulse counter will count negative input pulses at the front panel COUNTER INPUT connector. With the switch in the "+" position, the pulse counter will count positive pulses at the same input. In the SQUITTER and REPLY RATE positions, the receiver squitter and reply rates are measured respectively. The RANGE SWITCH has two positions, XI and X10. In the X1 position, the PULSE COUNT METER range is 6 to 800 pulses per second. In the X10 position, the meter range is 0 to 800 pulses per second and all readings on the PULSE COUNT METER dial should be multiplied by 10. The FUNCTION SWITCH controls the functional operation of the unit. The switch is labeled the same as another FUNCTION SWITCH on Oscilloscope OS-54/URN-3. When these two switches are set to corresponding positions, all appropriate interconnections necessary for normal test of the AN/URN-3 are made. With the FUNCTION SWITCH in the GENERAL TESTING position, the power meter-pulse counter can be used as a general piece of test equipment for counting the repetition rate of pulses fed to a front panel receptacle COUNTER INPUT and whose characteristics fall within the equipment capabilities.

Table 11-1 lists the FUNCTION SWITCH positions and the tests that can be performed in those positions.

Table 11-1—Function Switch Positions.

Switch Position	Tests
1. OPERATING TEST	Peak r-f power Visual pulse shape Output pulse count Transmitter spectrum

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Table 11-1—Function Switch Positions—Continued

Switch Position	Tests
2. RECEIVER SENSITIVITY	Squitter count Reply count Reference pulse burst count Receiver sensitivity
3. SYSTEM DELAY	Overall zero-distance time delay Video unit zero-distance time delay
4. GENERAL TESTING	Each test equipment available for individual use

OSCILLOSCOPE.—The oscilloscope OS-54/URN-3 has the basic circuits found in a conventional oscilloscope and differs only in having manually selected preset conditions selected by a FUNCTION SWITCH on the front panel. The switch positions are labeled the same as the pulse meter-pulse counter, OPERATING TEST, RECEIVER SENSITIVITY, SYSTEM DELAY, and General Testing. In the first three positions, vertical, trigger, and sweep, inputs are applied from external equipment through BNC connectors at the rear of the oscilloscope. Circuit parameters are switched in appropriate sections of the oscilloscope to furnish the preset horizontal sweep speed and vertical sensitivity required for the selected function test. Front panel controls capable of affecting fixed conditions are inoperative. In the GENERAL TESTING function, the preset conditions are switched out and vertical, trigger, and sweep inputs can be applied to the front panel receptacles to use the oscilloscope in the conventional manner.

PULSE ANALYZER-SIGNAL GENERATOR.—The pulse analyzer-signal generator TS-890 URN-3 (fig. 11-21) may be functionally divided into two sections, the signal generator portion and the pulse analyzer (receiver) portion. They are related only in that the signal generator output is used in a mixer to beat with the receiver input signal and produce a 63 mc receiver input frequency.

The signal generator produces a 1025- to 1150-mc output, either pulsed or cw, for testing the beacon receiver, and also as a heterodyne signal for turning the pulse analyzer section to the output of the beacon transmitter. The output frequency can be continuously varied over the entire range and can be checked against a single, internal, crystal-controlled frequency. Alternatively, the output can be derived from the internal crystal. Output amplitude is variable over a range of 10 microvolts to 0.5 volts. This output may be set to a standard reference level, as indicated on an OUTPUT LEVEL INDICATOR, by means of a POWER SET control. The standard reference may be attenuated over a wide range by means of an accurately claibrated R.F. OUTPUT (DBM) attenuator. Thus, a signal of known frequency and amplitude is delivered to R.F. OUTPUT jack for application to the beacon receiver. This signal may be either pulse or cw. A suitable modulation pulse is obtained from a companion test unit pulse-sweep generator SG-121A/URN-3 (discussed later).

The pulse analyzer is, in a sense, a radio receiver. The local oscillator for this receiver is the signal generator. The signal fed to the pulse analyzer is taken from the output of the beacon transmitter. It is fed, through an attenuator and filter-mixer circuit in the rf unit, to the receiver i.f. stage as a 63-mc signal. The receiver employs a POWER COMPARISON INDICATOR in an arrangement that permits measuring side-band energy with great ease.

The filter-mixer circuit heterodynes the beacon transmitter output with the signal generator output. A feature of the tacan system is that the receiver and transmitter frequencies of all channels are exactly 63 mc apart. Thus the output of the preselector is always a 63-mc signal.

The receiver can be tuned to any frequency in the two bands from 962 to 1024 mc and from 1151 to 1213 mc. The received signal is applied to a metering circuit through a very narrow band amplifier. The receiver can be tuned to the exact center frequency of the signal by switching crystals (BAND SHIFT knob) in the local oscillator. This gives a narrow band of 63 mc i-f bandwidth at 0.8 mc or 1.0 mc either side of center. This permits metering the spectral distribution characteristic (sideband energy) of the output pulse transmitted by the output pulse transmitted by the beacon. The step attenuator is part of the crystal

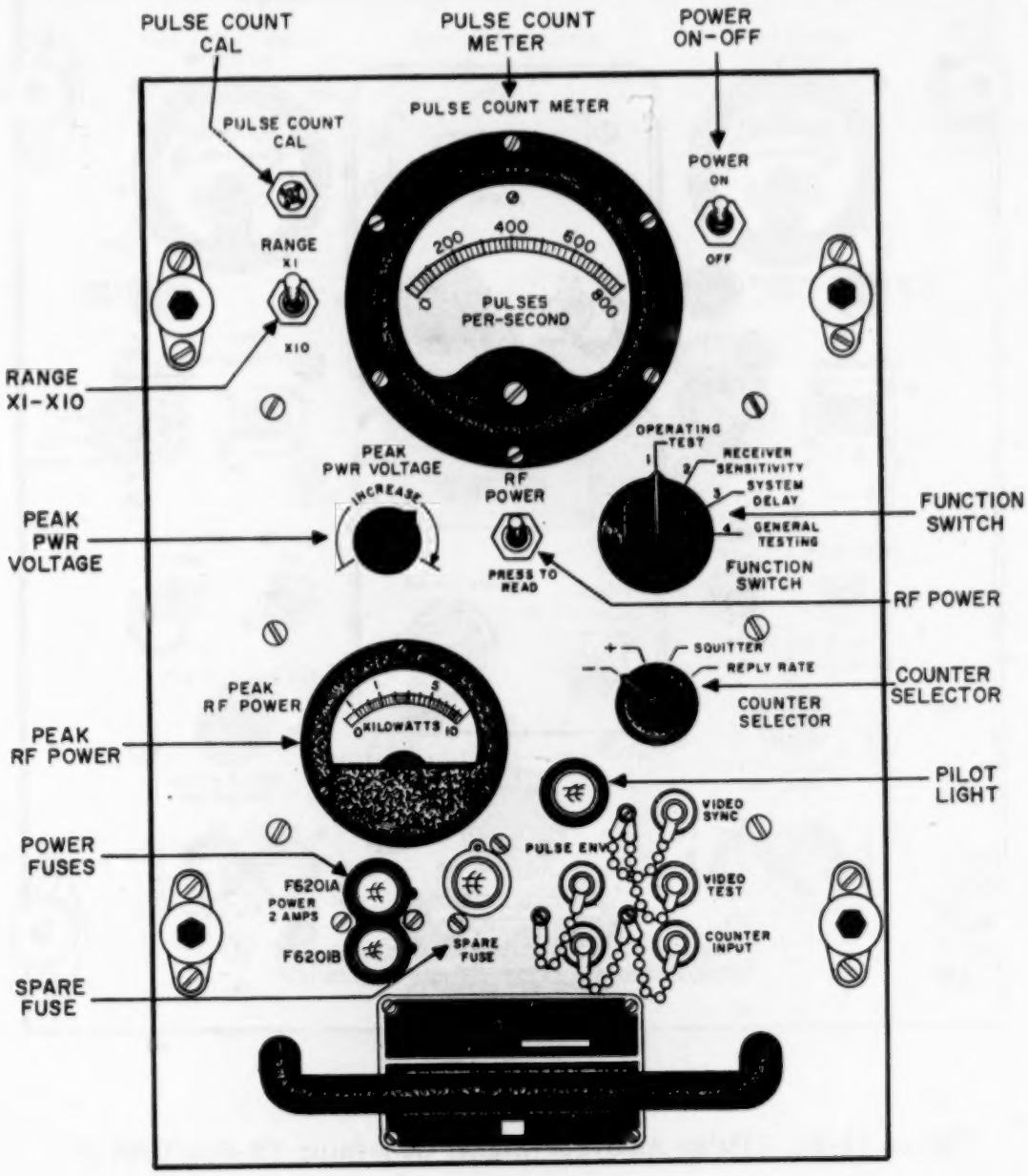

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Figure 11-20.—Power Meter-Pulse Counter TS-891/URN-3.

turret-step attenuator (BAND SHIFT knob) assembly and is arranged to insert a discrete value of attenuation for each crystal frequency. For the on-channel frequency, attenuation is 40 db. For the frequencies 0.8 mc off channel, attenuation is 5 db. For the 1.0-mc off-channel frequencies, attenuation is zero db. These values are used so that if the beacon output pulse has normal spectral distribution, attenuator output will be uniform under all conditions. That is, as the side-band energy falls off with change of receiver frequency, the attenuation is reduced by an amount calculated to keep the output uniform. The output section of the receiver is essentially a metering amplifier. The output is fed to the POWER COMPARISON INDICATOR to provide a relative indication of the signal level at the output of the step attenuator. The narrow bandwidth of the receiver is obtained by means of sharply tuned circuits in this unit.

Thus, to use the pulse analyzer, it is only necessary to set the signal generator to the desired channel on the digital type CHANNEL

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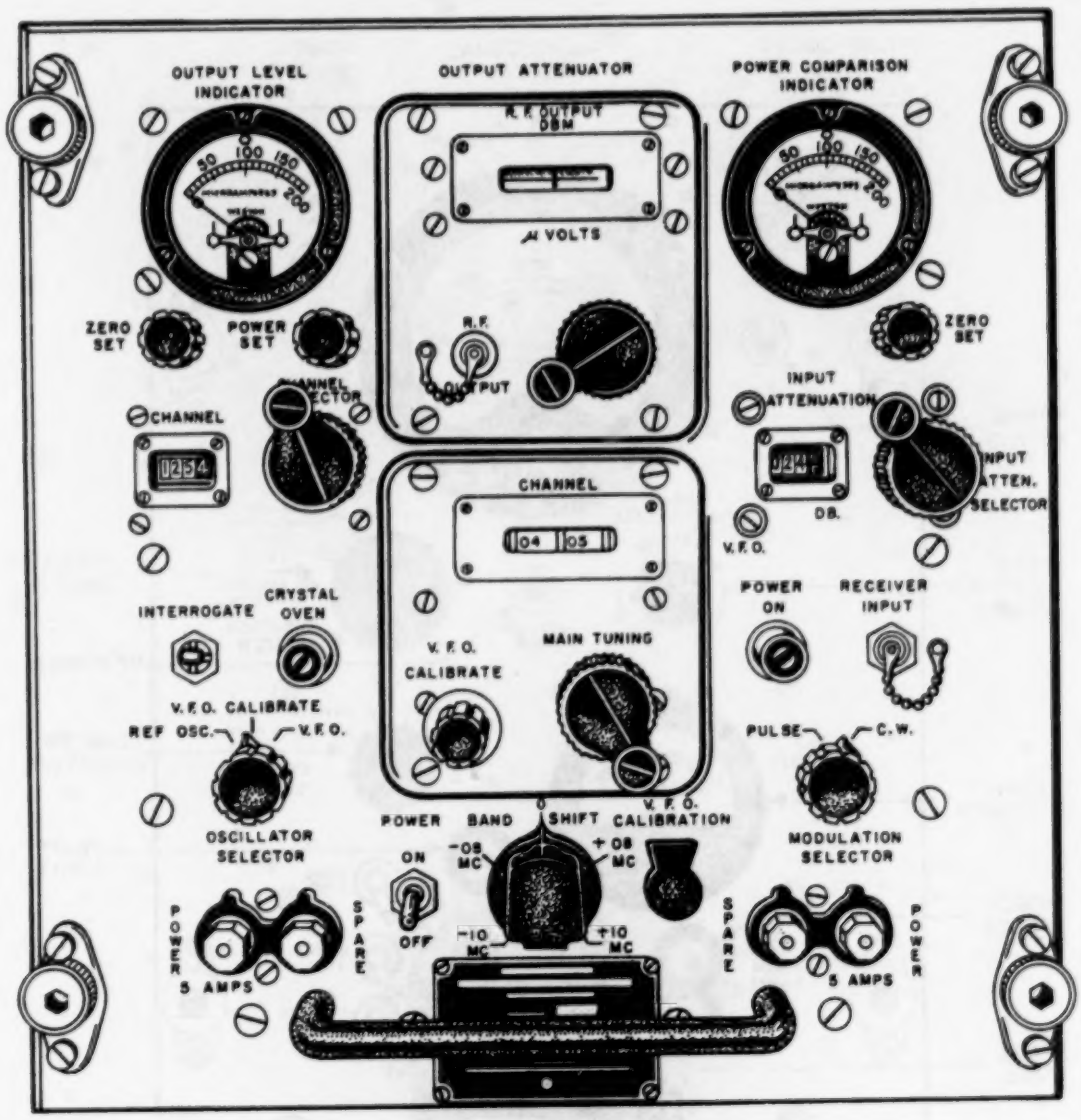

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Figure 11-21.—Pulse Analyser-Signal Generator TS-890/URN-3

indicator, set the input attenuator to make the POWER COMPARISON INDICATOR read midscale, set the signal generator for cw operation, and then read relative output at the upper and lower side-band frequencies. Any deviations from the required spectral distribution characteristic will be shown on the meter as deviations from the midscale reading.

PULSE SWEEP GENERATOR.—Pulse Sweep Generator SG-121A URN-3 is an accurately calibrated test instrument, which provides a quick means of checking the salient features of the AN/SRN-6 beacon performance. Essentially, the pulse sweep generator serves as the pulse modulator for Pulse Analyzer-Signal Generator TS-890/URN-3, and provides the timing circuitry for measurement of zero-distance time delay of Radio Set AN/SRN-6.

The pulse-generating chain of the instrument supplies video pulse-pairs, shaped to correspond to the pulse waveform of Radio Set AN/ARN-21, the airborne interrogator for the AN/SRN-6 equipment. These pulse-pairs are available from the pulse sweep generator at a repetition rate of 40 to 5000 pulse-pairs per second. The spacing between the members within

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a pair of pulses may be adjusted in 0.5 microsecond steps, with a ± 0.2 microsecond tolerance, from 11 to 13 microseconds. The amplitude of this paired-pulse signal is continuously variable, by means of a front panel control from zero to 200 volts when the PULSE OUTPUT jack is loaded with an impedance as low as 650 ohms, shunted by as much as 800 picofarads. Facilities are provided for either internal or external triggering of the pulse-generating chain.

The sweep-generating chain of the instrument generates a sawtooth waveform, and a carefully synchronized trigger for the pulse-generating chain. Both the sawtooth and the trigger are frequency-controlled by a crystal oscillator. The period of this crystal oscillator is a submultiple of the zero-distance time delay of Radio Set AN/SRN-6. Repetition frequencies of 39.840 kc, 40.160 kc, 45.454 kc, or 47.620 kc are selected by the setting of the front panel CRYSTAL SELECTOR control. The peak-to-peak amplitude of the sawtooth waveform is 20 volts, when the output terminal is loaded by an impedance of 100,000 ohms shunted by as much as 270 picofarads.

A video mixer circuit is provided in the instrument as a means of combining two of various types of outputs from Radio Set AN/SRN-6 into a video signal. This output signal is used to allow a presentation of the time difference comparison between the two outputs on Oscilloscope OS-54/SRN-6. By this means, the zero-distance time delay of the AN/SRN-6 beacon is to be measured.

Pulse Sweep Generator SG-121A/URN-3 is utilized in only a few of the test measurements controlled by the function switch, table 11-1. These measurements are:

1. Operating Test - The pulse sweep generator circuitry is not used.

2. Receiver Sensitivity - The pulse sweep generator circuitry is used in measuring squitter count and reply pulse count.

3. System Delay - The pulse sweep generator circuitry is used in measuring overall zero-distance time delay and video unit zero-distance time delay.

4. General Test - The paired-pulse output signals and trigger output signal from the pulse sweep generator are available for other tests, as desired.

RADIO FREQUENCY MONITOR

Radio Frequency Monitor MX-1627/URN-3 (fig. 11-22) and Antenna AT-592/URN-3 (fig. 11-1), which form part of the special test equipment, are a receiver-transmitter and antenna employed in either ship or shore installations to check the performance of Radio Set AN/SRN-6. The monitor interrogates Radio Set AN/SRN-6 with a pulsed signal simulating that of airborne Radio Set AN/ARN-21 and receives the reply of Radio Set AN/SRN-6. The monitor provides a visual (and has provision for an external) alarm signal when Radio Set AN/SRN-6 deviates from its proper performance.

The monitor is fed input signals directly from the AN/SRN-6 transmitter output r-f line J6151 (fig. 11-8A) and radiated signals from the AN/SRN-6 transmitter antenna, via Radio Frequency Monitor Antenna AT-592/URN-3.

The monitor antenna should be mounted in a vertical position. Its center line should line up with a line extended from the N (north) mark line of the AN/SRN-6 beacon antenna which is located on the base of the beacon antenna and also on the radome for shipboard installations. The exact position of the antenna along this line should be 2 feet (measured horizontally) from the bottom flange of the stationary antenna cover and 3 feet above the bottom flange (fig. 11-3).

Basically the monitor (fig. 11-23) consists of a crystal controlled receiver-transmitter. The monitor transmitter emits 30 coded r-f pulse-pairs per second on the AN/SRN-6 receiver channel frequency. These pulses are fed to the monitor antenna which is in the field of the AN/SRN-6 antenna. If the AN/SRN-6 system is functioning properly, a correctly coded pulse-pair is transmitted by the AN/SRN-6 50 micro-seconds after challenge by the monitor. The monitor receives these reply pulses, reference bursts and squitter pulses. The monitor will then give a visual alarm indication whenever any of the monitored properties of the AN/SRN-6 transponder fall outside of tolerance specifications. There are

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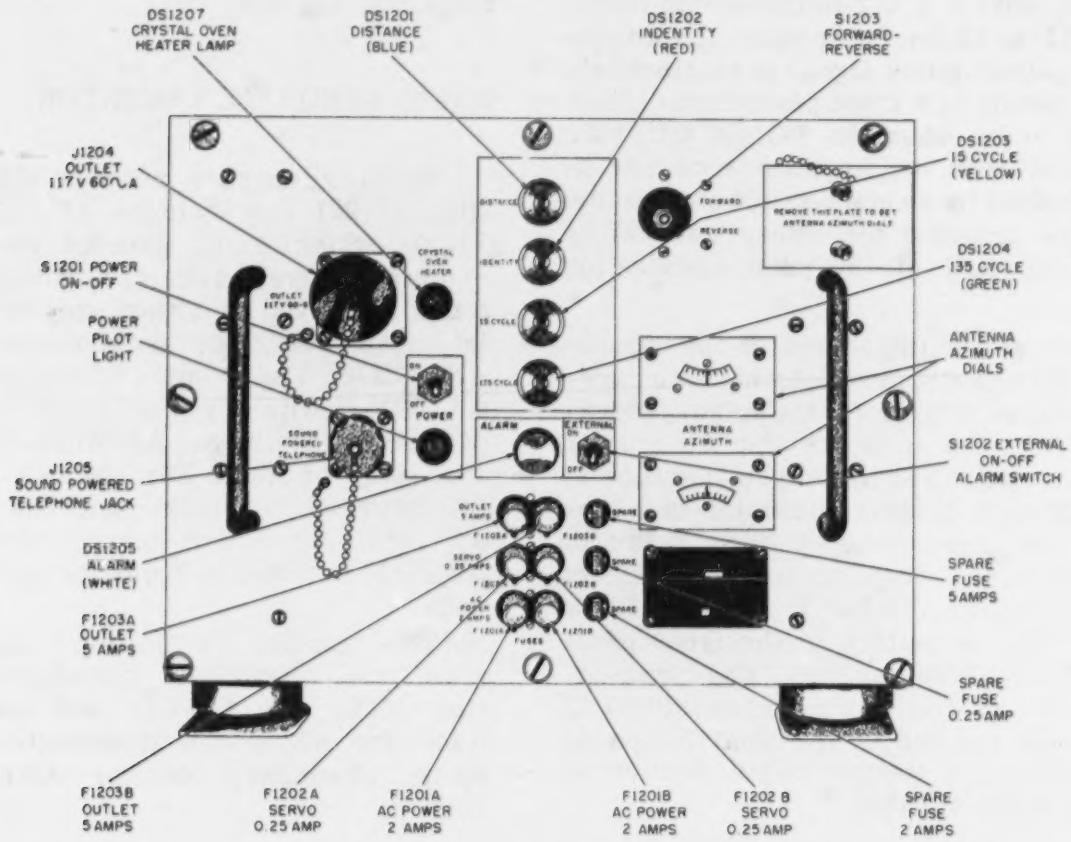

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Figure 11-22.—Radio Frequency Monitor MX-1627/URN-3.

four operating lights plus an alarm light. The faulty replies cause one or more of the alarm lights to go out, giving a rough indication of the nature of the faulty operation. If the fault persists, a visual alarm (on the front panel) is actuated. The monitor also has provision for an external alarm, if desired.

The monitor, therefore, has a vital function providing complete supervision of the functioning of Radio Set AN/ SRN-6 in a form convenient for local or remote indication.

The following visual indicators (fig. 11-22), will indicate when performance requirements of the Radio Set AN/SRN-6 are not within tolerance.

(1) DISTANCE—blue light—normally on (off for five seconds at end of identity keying cycle).

(a) Transponder time delay—light stays on if transponder nominal delay of 50 μsec changes less than ± 2 μsec. Light goes off if delay changes more than ± 5 μsec.

(b) Transmitter frequency—light stays on if change in transponder frequency from nominal is less than 0.2 mc. Light goes off if change is greater than 0.5 mc.

(c) Receiver sensitivity—light goes off if AN/SRN-6 receiver sensitivity decreases by 12 db. Light stays on if decrease is less than 6 db.

(d) Transmitter code—light goes off if pulse separation of transponder transmitted code varies by more than 3 μusec from its nominal value of 12 microseconds.

(e) Reciver decoder—light goes off if transponder receiver is not decoding properly.

(f) Transmitter peak power—light stays on if transponder peak power output decreases up to 4 db. Light goes out if decrease amounts to 8 db.

(g) Transponder count down—light goes out if less than 50 percent of monitor interrogations receive replies. Light stays on if more than 75 percent of interrogations are received.

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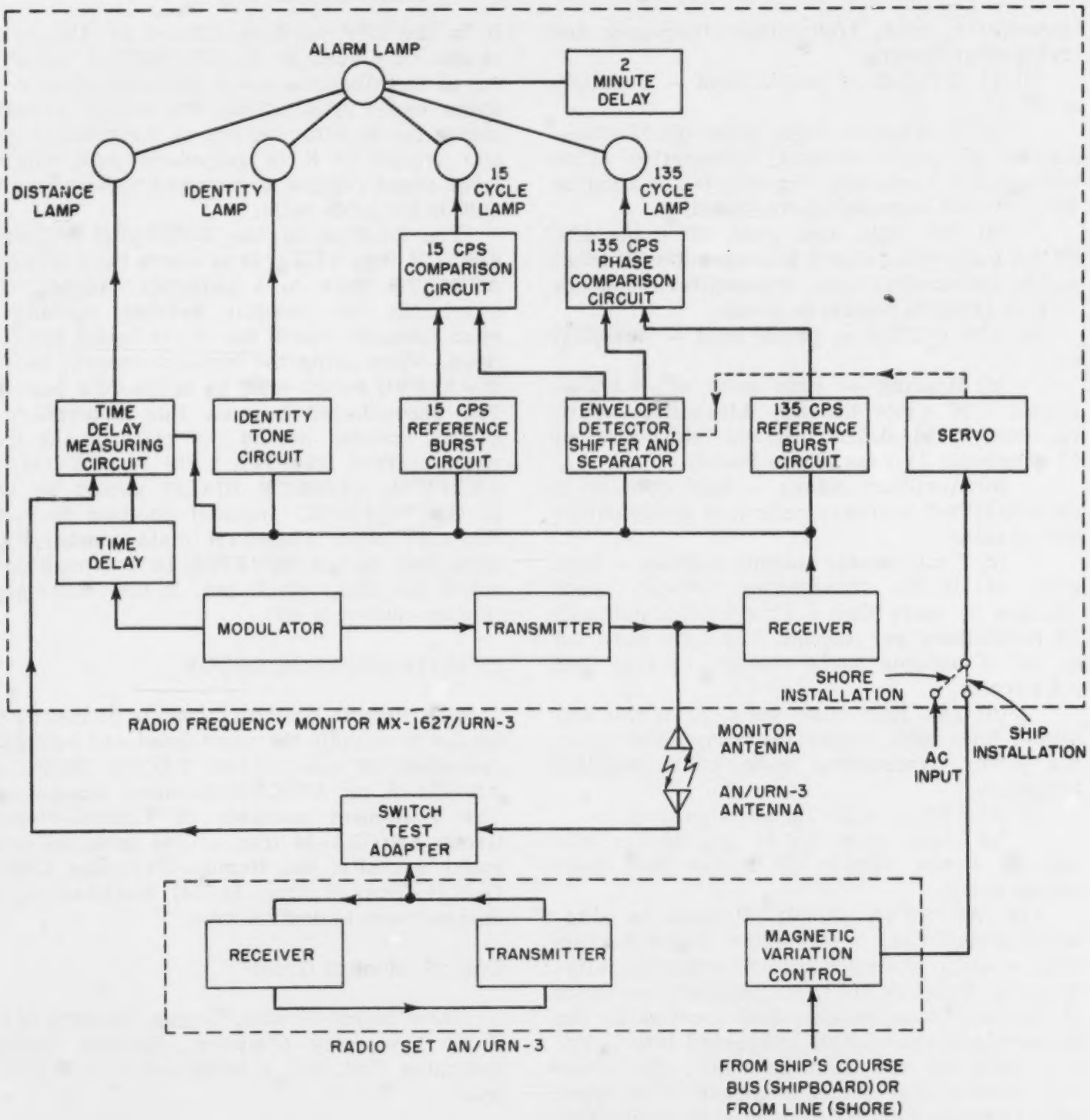

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Figure 11-23.–Overall system, simplified block diagram.

(h) Receiver frequency—light goes off if transponder receiver frequency changes.

(2) IDENTITY—red light.

(a) Normal operation—light flashes on and off following identity keying at 1 1/4 minute intervals. Towards the end of the identity keying cycle, the DISTANCE lamp will go off for a short period of time (approximately 5 seconds) and then light again. This is normal and should not be considered as a possible malfunctioning of the AN/SRN-6.

(b) The light goes off if the AN/SRN-6 fails with respect to transmitter average power,

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transmitter code, transmitter frequency and transmitter identity.

(3) 15 CYCLE — yellow light — normally on.

(a) Bearing — light goes off if transponder 15 cycle bearing information error exceeds ±12 electrical degrees (shipboard) or ±7 electrical degrees (shore-based).

(b) The light also goes off if the AN/SRN-6 fails with respect to transmitter average power, transmitter code, transmitter frequency or lack of north reference group.

(4) 135 CYCLE — green light — normally on.

(a) Bearing — light goes off if transponder 135 cycle bearing information error exceeds ±20 electrical degrees (shipboard) or ±7 electrical degrees (Shore based).

(b) Auxiliary pulses — light goes off if the AN/SRN-6 auxiliary reference group pulses are missing.

(c) Transponder antenna rotation — light goes of if the transponder antenna speed changes by more than 0.8 percent of nominal, 15 revolutions per second. The light does not go off if antenna speed changes by less than 0.2 percent.

(d) The light also goes off if the AN/SRN-6 fails with respect to transmitter average power, transmitter code, or transmitter frequency.

(5) ALARM — white light normally on.

(a) Light goes off if any of the four colored lights remain off longer than their preset delay.

The ANTENNA AZIMUTH dials in shipboard installations indicate the ship's heading with respect to true north. In shore installations the dials are set to the magnetic variation of the particular geographical location by the forward-reverse switch (discussed later). The two dials operate simultaneously, the lower dial rotating nine times the speed of the upper one. The upper dial is graduated in increments of 10 degrees from 0 to 360. The lower dial is graduated in increments of one degree from 0 to 9 and contains four identical scales. The arrangement is therefore a simple vernier in which the reading of the lower dial is added to the reading of the upper dial for all values above 10 degrees. For values below 10 degrees the reading is taken directly from the lower dial.

A SERVO switch (not shown) enables the servosystem in the ON position and disables it in the OFF position. Therefore, the switch should be placed in the ON position for shipbased installations and in the OFF position for shore-based installations. The switch is located inside the monitor on top of the video chassis and access to it is gained by releasing the front panel captive screws and withdrawing the unit on its guide rails.

The function of the FORWARD-REVERSE SWITCH (fig. 11-22) is to rotate the ANTENNA AZIMUTH dials to a particular setting, thus correcting the monitor bearing circuits to read magnetic north for shore-based installations. When using the forward-reverse switch, the SERVO switch must be in the OFF position. For shore-based beacons this momentary-on switch (located behind the plate on the front panel marked REMOVE THIS PLATE TO SET ANTENNA AZIMUTH DIALS) should be held in the FORWARD (raised) position to rotate the ANTENNA AZIMUTH dials counterclockwise and in the REVERSE (down) position to rotate the dials clockwise. In the center position the switch is off.

REMOTE CONTROL GROUP

The Remote Control Group is primarily intended to permit the unattended and automatic operation of one or two TACAN (Radio Set AN/SRN-6 or AN/GRN-9) shore equipments. The equipment consists of Control-Monitor Group AN/GRA-34 (fig. 11-24) installed at the radio set site, and Remote Switching Control C-2234/GRA-34 (fig. 11-24) installed at the desired remote control area.

Control-Monitor Group

The Control-Monitor Group consists of two Radio Frequency Monitors, Antenna Transfer Switching Unit, and a Radio Set Transfer Control.

RADIO FREQUENCY MONITORS.—The switching of the two TACAN radio sets is accomplished by using two identical Radio Frequency Monitors MX-2229/GRA-34 (fig. 11-25), which provide an alarm and voltage source to initiate operation of relays. The MX-2229/GRA-34 monitors are MX-1627/URN-3 monitors (discussed previously), with Field Change 1-AN/GRA-34 incorporated.

The monitors (fig. 11-25) are normally used in a system which contains two TACAN shore

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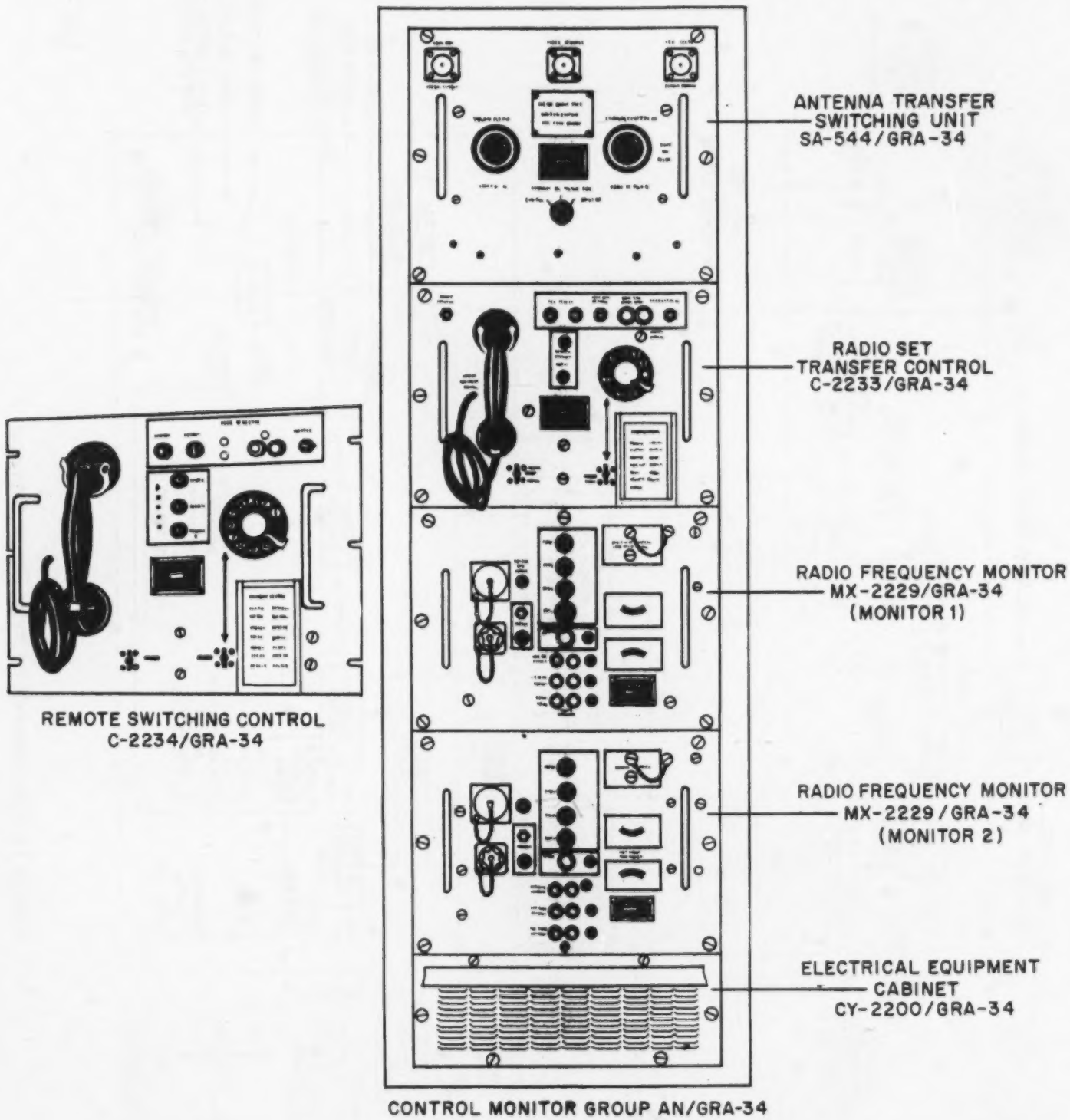

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Figure 11-24.—Control Monitor Group and Remote Switching Control.

equipment transmitters, one in operation and one on standby. Although both monitors will monitor the performance of the operating transmitter, the alarm output of only one monitor at a time will be effective. This monitor will initiate a transfer action when a malfunction somewhere in the system causes an alarm. This is referred to as alarm number 1.

As a result of alarm number 1, the output of the alternate monitor will become effective and the alarm output of the original monitor will be ineffective. If the alternate monitor

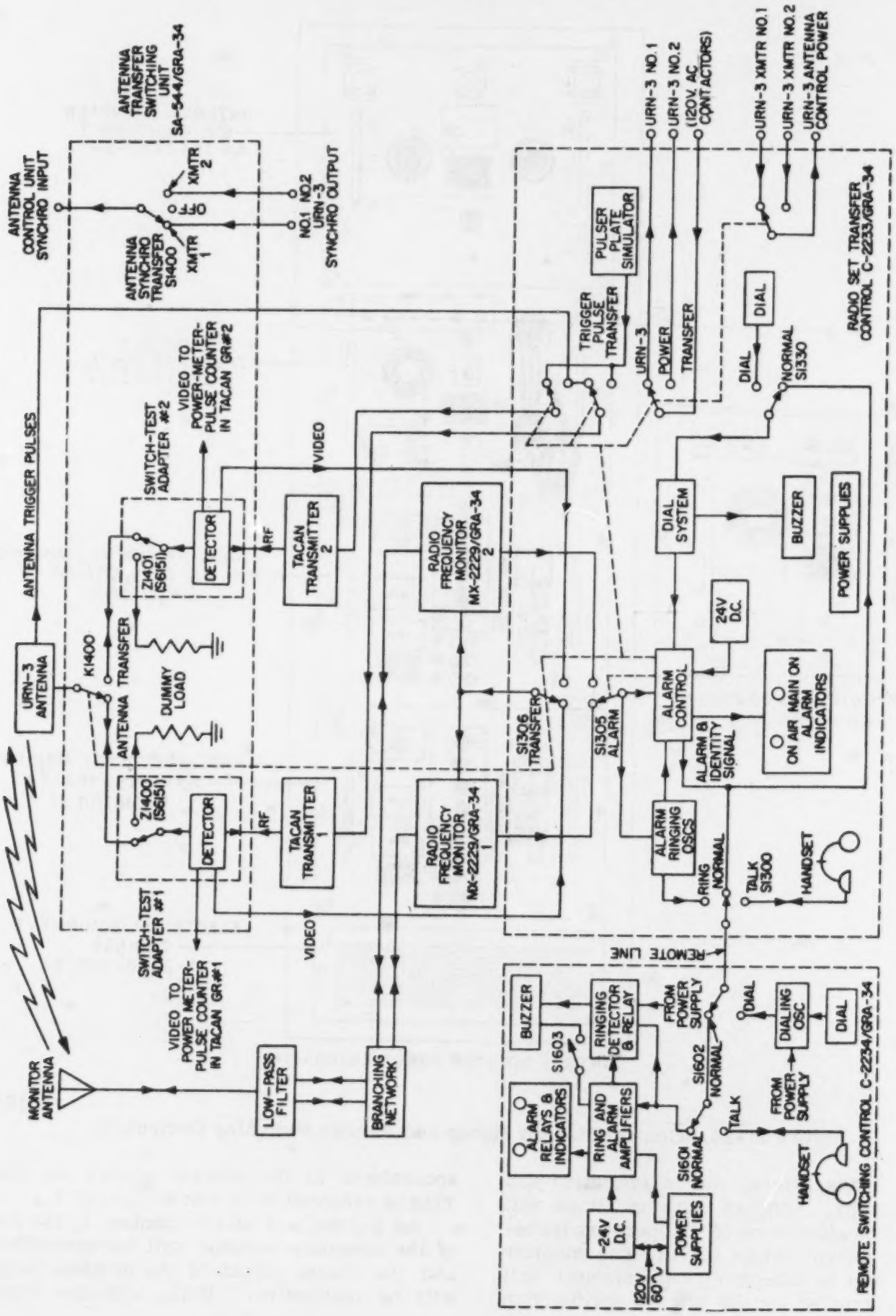

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Figure 11-25.—Overall System, block diagram.

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does not indicate an alarm, the operating transmitter will continue working. However, if the alternate monitor also indicates that an alarm situation exists (alarm number 2), the standby transmitter will be placed in operation and the original transmitter will be turned off. The equipment may be used in a system with one TACAN radio set. In this instance, the TACAN transmitting equipment will cease to function as a result of alarm number 2, since there is no standby transmitter.

After a delay for the monitors to recover from the previous alarms, the alarm output of the original monitor once more becomes effective. The original monitor will initiate an alarm (alarm number 3) if there is a malfunction in the system being monitored. As a result of alarm number 3, the alarm output of the alternate monitor will become effective. If the alternate monitor does not indicate an alarm, the transmitter will remain in operation. If the alternate monitor also indicates an alarm situation (alarm number 4), the operating transmitter and the antenna will be turned off and the TACAN station will be completely shut down. The AN/GRA-34 equipment will remain in operation.

ANTENNA TRANSFER SWITCHING UNIT.—The Antenna Transfer Switching Unit SA-544/GRA-34 (fig. 11-24) automatically switches either of the TACAN transmitters r-f output to one antenna group input in response to an alarm or a proper dialing signal (discussed later). To accomplish this, the chassis (fig. 11-25) contains a relay controlled coaxial switch, two switch-test adapters (dismantled SA-420/URN-3 units), two dummy loads, and suitable connectors. The switch-test adapters (Z 1400 and 1401) can be manually positioned to connect the r-f outputs to a dummy load for maintenance or to the coaxial switch (K 1400) for automatic switching to the antenna group. during normal operation, the switch-test adapters must be in the ANTENNA position. The antenna synchro transfer switch (S 1400) is used in the initial installation of the equipment to set the area magnetic variation. The switch is then kept in the OFF position.

RADIO SET TRANSFER CONTROL.—The Radio Set Transfer Control C-2233/GRA-34 (fig. 11-24) contains all of the equipment pertinent to manual and automatic control, alarm indication, telephone system, and simulation testing. It also contains the power supply which provides power for the entire transfer control chassis.

The MAIN ON light (fig. 11-25) will light when the TACAN radio set master switch is in the remote position and the transmitter high voltage is on. The ON AIR light will light when a monitor is operating with no alarms.

The alarm ringing oscillator (fig. 11-25), during normal operation, will send 1900 cycles modulated by the transmitter keying tone (from the active monitor) to the remote handset to identify which radio set is on the air. When the S1300 switch is placed in Ring, the 1900 cycle oscillator is switched to 800 cycles which is sent over the remote line to sound the buzzer on the remote unit (discussed later). The buzzer in the control unit is energized for ringing from the remote unit by the dial system, dialing "O." The buzzer may be silenced by the Push to Stop Buzzer on the front panel.

Table 11-2.—Dial Digit Code.

Dial Digit	Program or Function	
	Transmitter 1	Transmitter 2
1	OFF	NO CHANGE
2	STANDBY	NO CHANGE
3	ON	STANDBY
4	STANDBY	ON
5	NO CHANGE	STANDBY
6	NO CHANGE	OFF
7	RESET*	RESET*
8	OBSTRUCTION LIGHTS ON	not used
9	OBSTRUCTION LIGHTS OFF	
0	RING LOCAL SITE	

* Resets automatic operation with last "on" transmitter as main.

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Ten different manual control functions may be performed in response to pulses from the dial system as listed in table 11-2.

The Pulser Plate Simulator switch on front of the Radio Set Transfer Control unit controls a unit which provides trigger pulses similar to those normally supplied by the TACAN antenna pulser plate. The purpose of the simulator is to permit testing of a transmitter without disturbing the operating transmitter.

The Monitor servoswitch is used to set the area magnetic variation on initial installation.

REMOTE SWITCHING CONTROL

The Remote Switching Control unit (fig. 11-24) performs the ten manual control functions in response to a dial system in parallel with the control transfer unit. The remote unit (fig. 11-25) also provide visual and aural alarm indications through lights and a buzzer using circuits similar to the control transfer unit. The remote handset monitors the operating TACAN keying tones from the control transfer unit to indicate equipment Main On. The remote handset is also used for voice communications to or from the local unit or control transfer unit.

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CHAPTER 12

SEARCH RADAR

This chapter presents a block diagram analysis of Radar Set AN/SPS-10. The directional coupler and echo box used to obtain systems performance checks are considered. Height finding radar and the moving target indicator (MTI) are also discussed.

RADAR SET AN/SPS-10

Radar Set AN/SPS-10 (fig. 12-1) is used primarily in the detection, ranging, and tracking of surface targets. It can be used to a limited extent to provide the same information regarding low flying air targets.

Target range and bearing intelligence is displayed on a standard Navy Plan Position Indicator (PPI). The AN/SPS-10 can be operated as a beacon or as an IFF (identification, friend or foe) system.

GENERAL DESCRIPTION

Radar Set AN/SPS-10 operates in a frequency range of 5450 to 5825 MC. The pulsed output frequency is generated by keying a magnetron oscillator in the transmitter. The peak power is between 190 and 285 KW.

During radar operation the output pulse duration is either 0.25 or 1.3 μs ($\pm$10%). The pulse repetition rate (PRR) can be adjusted between 625 and 650 pulses per second. Approximately 0.08μs of each magnetron keying pulse is required to place the magnetron in operation. Thus, the widths of the input trigger pulses are 0.33 and 1.38 μs, respectively.

For beacon operation, the pulse duration is increased to 2.25 μs, and the PRR is decreased to a range of from 312 to 325 pulses per second. The total duty cycle of the system (ratio of pulse duration time to pulse repetition time) must be maintained at less than 0.001 to permit magnetron recovery time.

The beacon function of the radar set permits operation of the system in conjunction with responding ships or aircraft. The response signals are mixed in the beacon receiver with the beacon local oscillator output and are ultimately presented on the indicator. The received signal is therefore stronger, and causes bright spots in the indicator pattern. These bright spots are used to identify a responding object.

The antenna rotates at 16 rpm. During radar operation, the horizontal beam width of the radiated pattern is approximately 1.5 degrees. The vertical beam width is within 12 to 16 degrees.

The functional operation of Radar Set AN/SPS-10 can be studied with the aid of figure 12-2. The modulator provides modulating pulses for the transmitter, and synchronizing pulses for the other units of the radar system. The transmitter, when triggered by the modulator output, transmits a series of bursts of radio-frequency pulses (electromagnetic waves). This energy is radiated by a unidirectional rotating antenna reflector.

When the radiated energy strikes an object, or objects, this energy is scattered or reflected. Some of this scattered or reflected energy (echo pulses) returns to the antenna reflector and passes on to the receiver, where it is amplified, detected, and then displayed on the indicators to give the range and direction of the reflecting object. The range of a reflecting object is directly proportional to the time interval required for the transmitted pulse to travel to the reflecting object and return to the receiver. The direction of the reflecting object can be translated into true or relative bearing intelligence by means of the rotating antenna reflector and a synchro system.

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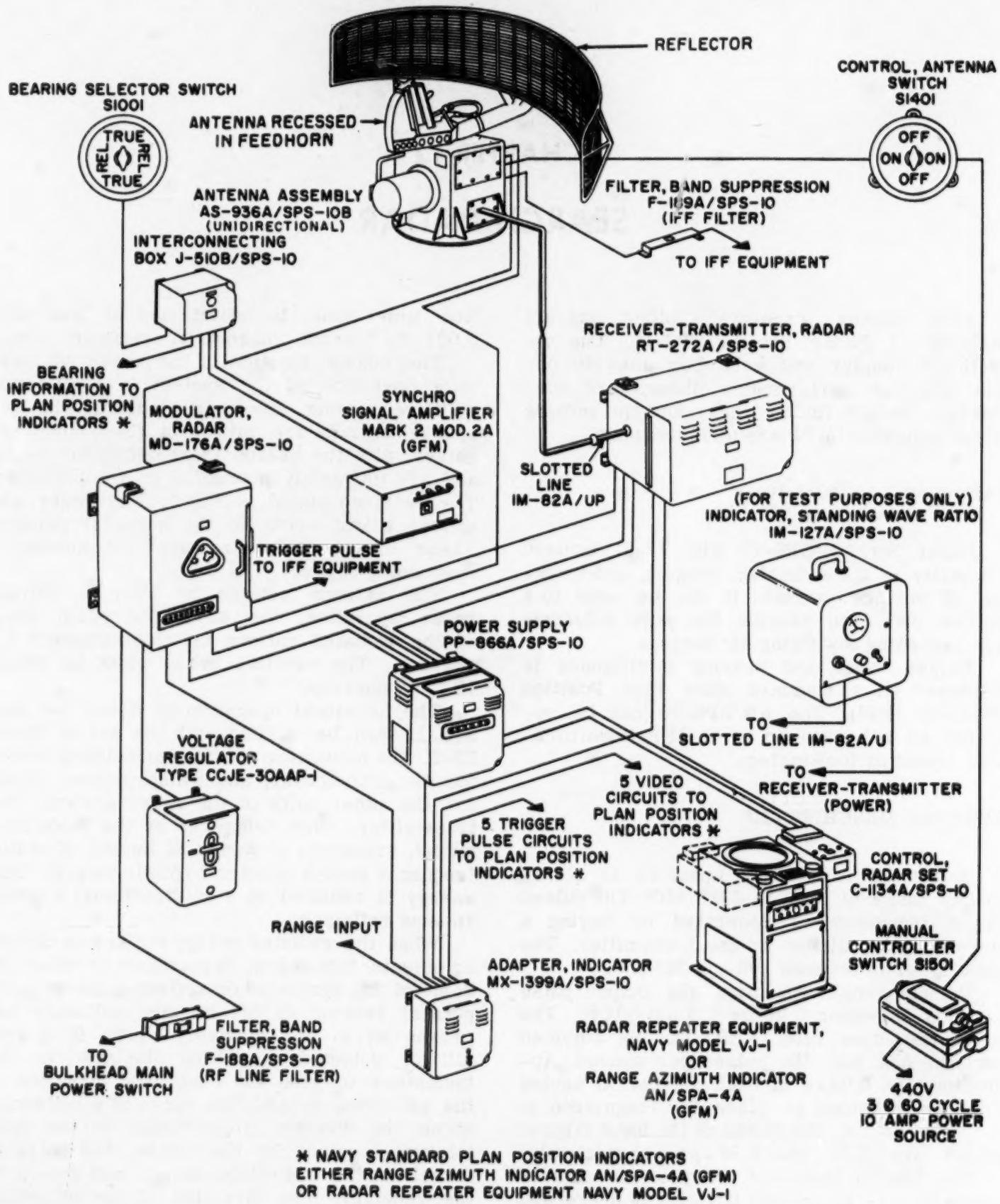

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Figure 12-1.—Radar Set, AN/SPS-10.

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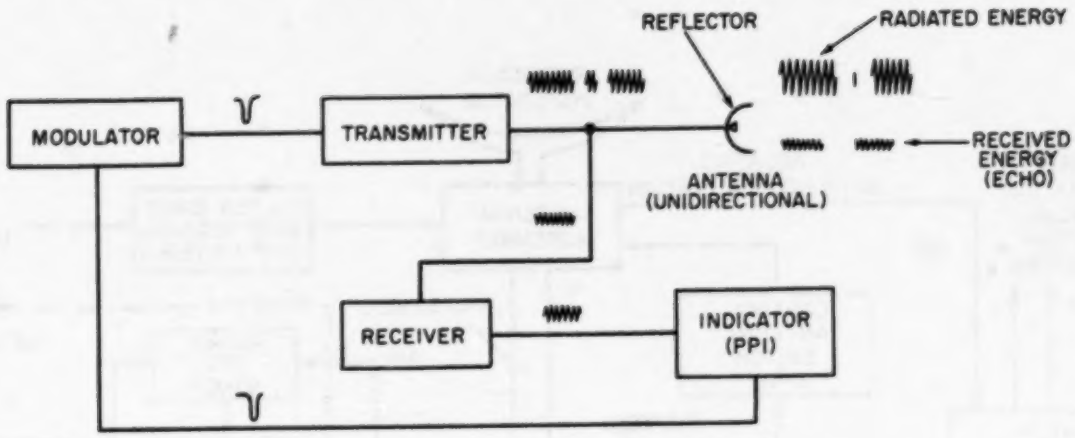

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Figure 12-2.—Radar Set, AN/SPS-10, functional diagram.

RADAR SET AN/SPS-10 DETAILED BLOCK DIAGRAM

A detailed block diagram (fig. 12-3) shows all of the major units of Radar Set AN/SPS-10. The main system flow is indicated by heavy lines, and supplementary circuits by light lines.

Radar Set AN/SPS-10 is designed to operate from a primary power source of 115 volts, ±10%, 60 cycles, single phase, 90% power factor, and requires approximately 3.5 KVA. The antenna requires a power source of 440 volts, 3 phases, 60 cycle, 10 amperes. Primary power for system distribution is fed to the modulator through a line filter (Filter, Band Suppression F-188A/SPS-10). This filter serves to eliminate the transfer of RF noise from the AC power source to the radar set and from the radar set to the power source.

Primary power is delivered to the modulator and divided into regulated and nonregulated sources for distribution to the radar set. An electronically controlled voltage regulator maintains the regulated primary voltage at 115 volts, AC ± 2 percent. A power supply provides the necessary unregulated and regulated DC voltages required for proper operation of the various circuits.

In the modulator the 115 volts AC, is stepped up to a high voltage by a transformer, rectified and filtered. It is then fed through a resonant charging choke and charging diode to one of three pulse-forming networks, (WLP, a long-pulse network: WSP, a short-pulse network: or BEACON, a beacon-pulse network). Any one pulse-forming network may be selected by a motor-actuated high-voltage switch. A charge restorer diode discharges the residual mismatch voltage of the pulse-forming network after each pulse.

A thyratron keyer tube, together with one of the selected pulse-forming networks, converts the high-potential DC voltage into negative, rectangular, high-voltage pulses. The length of the pulses is sufficient to compensate for the delay in the starting of the transmitter. The transmitter then develops RF pulses having the following lengths: 0.25 (WSP), 1.30 (WLP), or 2.25 (BEACON) microseconds, depending on the pulse-forming network selected. The pulse repetition rate is determined by an RC coupled phase-shift oscillator whose frequency is variable from 625 to 650 PPS. Within these limits (625 to 650 PPS) the repetition rate is adjustable by means of a pushbutton switch, which permits the capacitance of the RC network to be varied. The pulse repetition rate for beacon operation is one-half the radar repetition rate.

The negative pulses (main pulses) generated in the modulator are conducted to a pulse transformer in the transmitter, where the amplitude is increased through the pulse transformer and fed to a magnetron oscillator, with no change in polarity or waveform. Application of the pulses to the magnetron places the magnetron in instantaneous operation, and causes it to generate microwave energy for a time interval equal to the length of each pulse.

The microwave output energy of the magnetron oscillator is conducted to the antenna assembly through a duplexer, the slotted line, and rectangular waveguide. This energy is then

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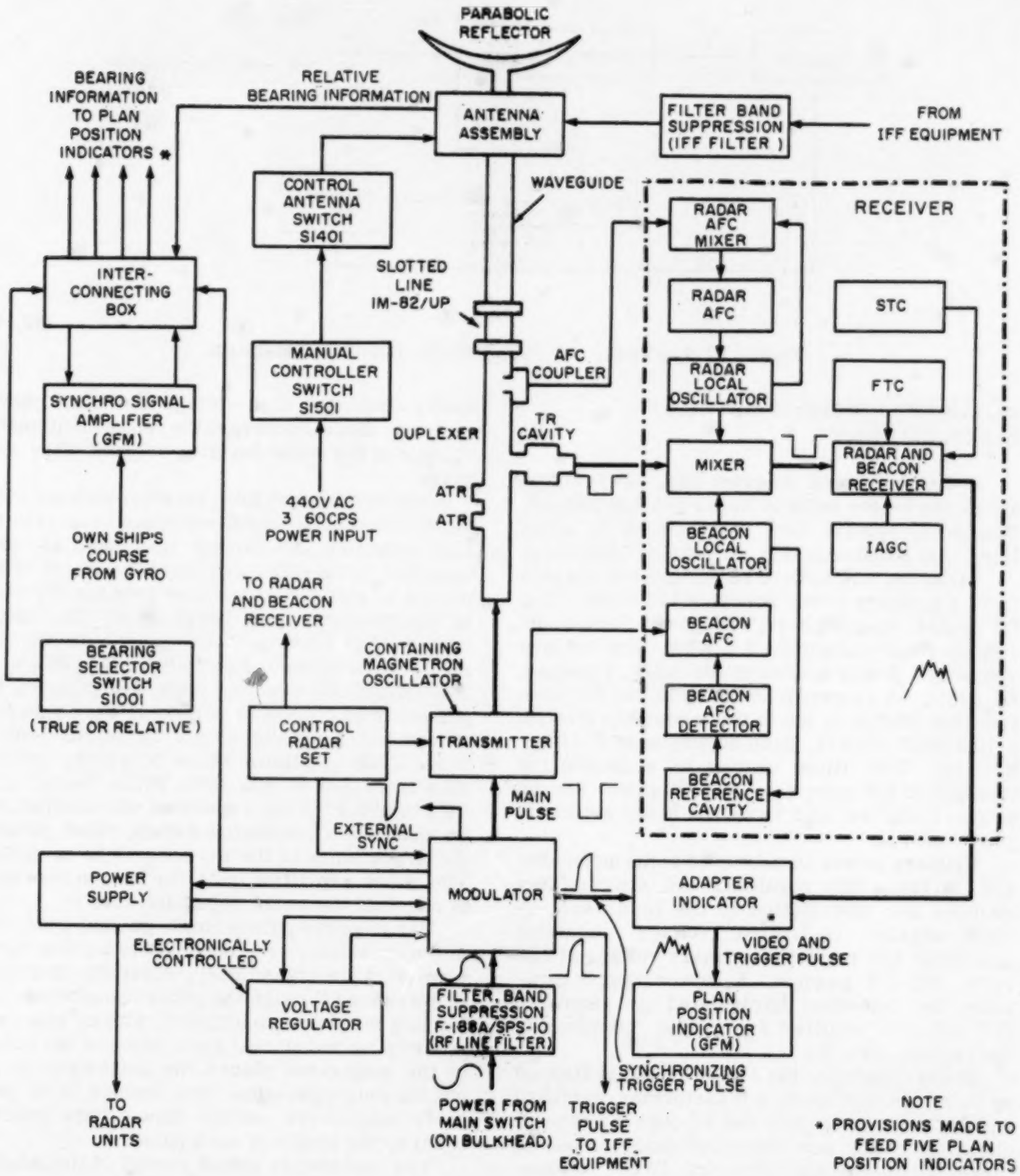

Figure 12-3.—Radar Set, AN/SPS-10, detailed block diagram.

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directed by a feedhorn (foghorn type) to the surface of a slotted parabolic reflector. The antenna-reflector concentrates and radiates the energy into space in a narrow beam having a cosecant-squared vertical pattern. A cosecant-squared vertical pattern permits the radar set to receive returned signals from aircraft targets that otherwise might not be detected. The antenna reflector forms a cosecant-squared pattern by phase addition and subtraction of microwave energy components radiated to its surface by the feedhorn. As the antenna reflector rotates (16 rpm), the beam sweeps over the surrounding areas to search for both surface and aircraft targets within the limits of the height of the antenna reflector and the parameters of the radar set.

When the radiated energy strikes a target, a small portion of this energy returns to the antenna reflector. The reflector directs this reflected energy to the receiver through the waveguide, slotted line, duplexer, and TR cavity. The TR cavity acts as an automatic electronic shorting switch, unblocking the receiver to the waveguide while the transmitter is not radiating, and blocking the receiver from high-energy pulses of the transmitter while the transmitter is radiating. Two ATR (anti-TR) tubes, located near the nagnetron oscillator, present a high impedance to the returned signal energy, thus preventing dissipation of the returned signal at the magnetron oscillator during the receiving interval.

The received signal is directed through the TR cavity to a mixer. In the mixer the returned signal frequency is mixed with the frequency of the radar or beacon local oscillator. The radar local oscillator operates at a frequency 30 MC higher than the returned signal frequency. The beacon local oscillator operates at 5420 MC (30 MC below the received beacon signal). The difference-frequency component of the mixer output (intermediate frequency) is selected and amplified by the IF amplifier in the receiver.

Both the radar local oscillator and the beacon local oscillator are coupled to the receiver mixer. This method of coupling permits the use of a common IF amplifier for either beacon or radar reception. Either the beacon or radar oscillator is turned on independently for the desired type of operation.

After eight stages of IF amplification, the signal is detected to convert it to video pulses, which are then fed through a video limiter and amplifier. The amplified video signal from the receiver is then delivered to the indicator adapter. After two more stages of video amplification, the signal is fed to five cathode followers. These cathode followers couple the video signal to plan position indicators. The low-impedance outputs of the cathode followers minimize distortion and loss of the video signal through coaxial cables.

Automatic-frequency-control (AFC) circuits are provided for the radar and beacon local oscillators. Radar AFC maintains a constant IF frequency in the receiver, regardless of minor drifts in transmitter frequency. The radar AFC circuit, incorporating a 30-MC amplifier and discriminator, compares the magnetron frequency with the radar local oscillator frequency, and thereby provides a voltage to correct the radar oscillator frequency for the proper IF frequency.

The beacon AFC circuit serves to maintain the proper local oscillator frequency during beacon operation. It utilizes a beacon reference cavity pulse which is pretuned to 5420 MC.

The sensitivity-time-control (STC) circuit reduces the gain of the receiver instantaneously in coincidence with each transmitted pulse. The gain is reduced for a short period of the sweep time; it then rises exponentially to normal gain. The STC circuit is of value in reducing sea-return saturation at close ranges so that nearby targets can be distinguished. It does not affect the presentation on the plan position indicator of targets which are beyond the STC range. The time interval needed to fully restore the receiver gain limits the range and determines the maximum effective STC range.

The fast-time-constant (FTC) circuit makes it possible to distinguish more clearly individual targets in a cluttered area, which otherwise would appear as a large mass on the plan position indicator. This feature is useful when there are many strong close-in targets. Blotting out of nearby target areas on the plan position indicator is thus greatly reduced.

The instantaneous-automatic-gain-control (IAGC) circuit prevents intense signals from saturating the IF amplifier. The IAGC circuit reduces the gain of the IF amplifier for the duration of the received signal.

The video signal that is delivered to the plan position indicator is again amplified and applied to the signal grid of the cathode-ray tube in the plan position indicator, causing intensity modulation of the electron beam. The target signal

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is thus converted into visible intelligence on the screen of the plan position indicator, where it appears as a bright spot.

Circuits are provided so that the range and bearing of the target can be determined at the plan position indicator. Target range is determined from the target signal. A synchro signal amplifier, which is connected to the radar set through the interconnecting box, delivers "true bearing" (own ship's course) information to the plan position indicator. A bearing selector switch, located adjacent to the radar set control, directs either true or relative bearing information to the plan position indicator.

An IFF coaxial filter (Filter, Band Suppression F-189A/SPS-10), connected to the Antenna Assembly, minimizes interference from the radar set to the IFF equipment that is used on conjunction with Radar Set AN/SPS-10.

MODULATOR

The modulator of the AN/SPS-10 provides four pulses:

1. A negative 5 KV modulating pulse (50-ohm termination) of variable width for transmitter *(magnetron) operation. (One of three* pulse widths may be selected.)
2. A 25- to 50-volt positive trigger pulse (50-ohm termination for synchronization of IFF equipment.
3. A 25- to 50-volt positive trigger pulse (75-ohm termination for synchronization of the indicator adapter.
4. A 150-volt negative pulse (75-ohm termination) for synchronization of other external equipment used in conjunction with the radar set (such as test equipment).

Modulator Block Diagram

The modulator (fig.12-4) comprises two major sections, namely, the trigger pulse generator and the modulator pulse generator. The trigger pulse generator supplies a+150-volt trigger pulse to the modulator pulse generator causing the latter to produce the output modulating pulse to the transmitter and auxiliary equipment.

Synchronization of all units of the radar set is controlled by a low-power repetition rate (master) oscillator, V109. This oscillator supplies a sine wave to limiter, V108A, at a selected repetition rate between 625 and 650 cps. An RC network, Z103, in conjunction with a PRR control determines the oscillator output frequency and the resulting pulse repetition rate.

Limiter, V108A, clips the sine wave and shaper, V108B, converts the clipped sine wave input into a squared wave output. The square wave is differentiated by R131 and C112 into sharp voltage spikes. Positive portions of the spikes are reproduced at the V106A cathode and fed through T105 to the blocking oscillator V106B input. These pulses trigger the blocking oscillator, V106 B, to produce a negative-going output and are applied to the primary of T105. The T105 secondary output pulse is positive-going to cathode follower, V105. This positive-going, + 150-volt signal is fed through T106 and serves as a trigger pulse for keyer thyratron, V104. The pulse is 4 microseconds in duration and has a sharp leading edge.

The modulator pulse generator circuit produces a high voltage main pulse (and the low-amplitude synchronizing pulses for external and auxiliary equipments) at a rate determined by the trigger pulse to the keyer thyratron, V104. Thus, the V104 trigger pulse rate is the same as the repetition rate of the oscillator, V109. Thyratron, V104 keys a high voltage circuit by periodically short-circuiting the high voltage output at the V104 trigger pulse rate.

The high voltage rectifier of the modulator pulse generator comprises T101, V101, and V102. This supply charges pulse forming network, Z101, through charging diode, V103, to approximately 14 KV. The charging diode presents an easy charge path (during the time that rectified pulsating DC voltage is rising), but at a high discharge resistance when the high voltage pulse tries to decrease. Thus, the pulse forming network cannot lose its charge until V104 fires.

Thyratron, V104, operates as a coincidence stage, and requires the simultaneous application of the high voltage at its plate and the input trigger pulse from T106 at its control grid. The conduction of V104 effectively reduces the V104 plate voltage to ground, and a low resistance path exists in parallel with the charged Z101 network. Thus, Z101 discharges through the conducting resistance of V104. The output pulse from Z101 to ground (at J103) is -5 KV, and is fed to the magnetron in the transmitter.

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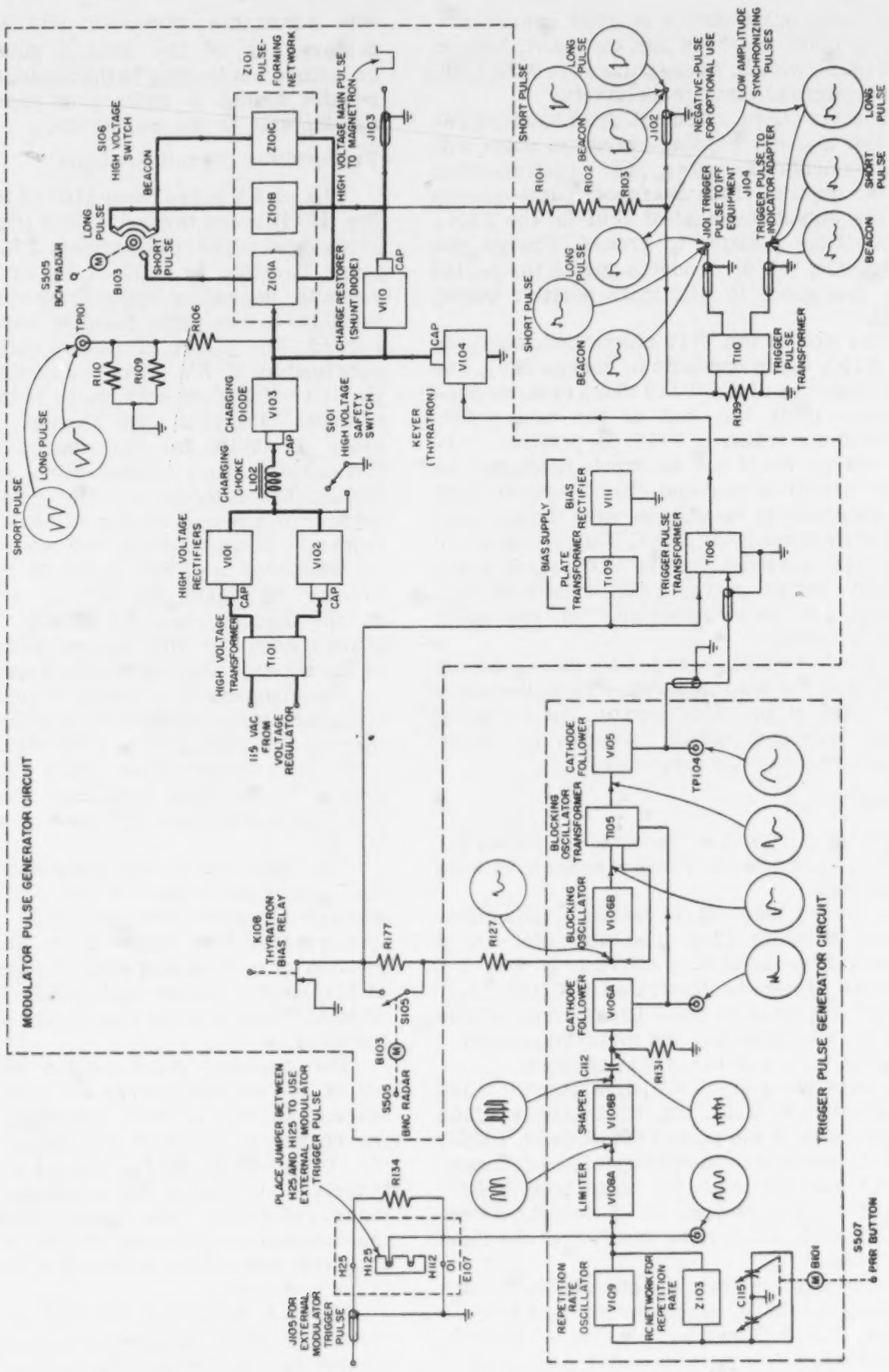

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Figure 12-4.—Modulator, block diagram.

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The main pulse output at J103 can be adjusted by S505 and S106 for the short, long, or beacon pulse widths. These pulses are 0.33, 1.38, and 2.33 microseconds respecitvely.

The main pulse output at J103 is negative-going and a positive-going overshoot pulse will occur immediately after the negative-going pulse has expired. This overshoot pulse tries to make the output terminal of Z101 (at the Z101-R101 junction) positive to ground. Charge restorer diode, V110, conducts during the period of the overshoot to eliminate positive output at J103.

At the end of the V110 conduction, charging diode, V103, again conducts to charge Z101. The charge restores diode, V110 which remains non-conductive until the end of the next pulse.

Without the action of V110, the positive overshoot voltage could not be discharged, and the reverse (positive) residual charge across Z101 would increase in magnitude with the application of each subsequent pulse. This action would accumulate a charge across V104 which would eventually result in thyratron arc-over or a breakdown of the components in the pulse forming network.

A slight mismatch between the pulse forming network and the load impedance is deliberately incorporated at the Z101 output. The resulting positive overshoot pulse is used for rapid deionization of the thyratron keyer.

TRANSMITTER

The transmitter and receiver of Radar Set AN/SPS-10 are operated using the same antenna and duplexer.

The overall view of the receiver-transmitter is shown in figure 12-5. The block diagram of the transmitter section is shown in figure 12-6 and the RF system is illustrated in figure 12-7. Frequent reference to these illustrations will be helpful in understanding the material presented in the remaining portion of this chapter.

The negative-going 5 KV pulse from the pulse forming network, Z101, (fig. 12-4) is fed via J103 to the primary of the pulse transformer, T3002, (fig. 12-6) where it is stepped up in the secondary to 20 KV and applied to the magnetron, V3001. The magnetron produces an RF output between 5450 and 5825 MC for the duration of the input trigger pulse.

RF energy from the magnetron is fed through the duplexer, W3010, to the antenna and antenna reflector. The duplexer contains two ATR tubes, a directional coupler, and a radar AFC coupler with adjustable attenuator (not shown). The duplexer is of the branch guide type, that is, with arms leading to the broadband and do not require tuning. A choke joint (air gap) couples the duplexer to the magnetron.

Transmitter Circuit Analysis

The -5 KV pulse from J103 of the modulator (fig. 12-4) is fed through E3018 (fig. 12-8) to the primary of pulse transformer, T3002. The input pulse duration is 0.33, 1.38, or 2.33 microseconds, depending upon the combination of the sections in the pulse forming network as discussed. The T3002 secondary voltages are approximately 20 KV. The parallel windings equalize the voltage on both sides of the magnetron filament. Filament transformer, T3001, provides 11 volts for the magnetron filaments through the bifilar (noninductive) secondaries of T3002. The cathode and filaments are tied together to prevent arcing between these electrodes by large potential differences.

When the negative pulse is applied to the primary of T3002, the polarity at the left end of the secondaries, terminals 5 and 6, is always negative with respect to the right end of the secondaries, terminals 3 and 4.

The magnetron is manually tunable over its frequency range (5450 to 5825 MC). This enables the operating frequency to be changed to minimize interference from other radar sets operating at the same frequency. The magnetron provides a minimum RF peak power output of 160 KW.

The high-power high-frequency pulse from the magnetron passes to the duplexer, W3010 through a choke joint (air gap). The air gap (not greater than 0.060 inch) allows for expansion of components without appreciable loss of transmitter power and avoids the necessity of hand-fitting parts when a new magnetron is installed.

The duplexer conducts the magnetron RF output to suitable waveguide and then to the antenna and the antenna reflector, from which the energy is radiated into space. A portion of the transmitted energy strikes a target or targets and returns (by reflection) to the antenna reflector. This energy travels through the duplexer and through TR tube, V3002, to the receiver during intervals when the magnetron is not operating.

The 7-8 secondary of T3002 produces a low voltage positive triggering pulse for the STC circuit and the beacon AFC circuit in the radar

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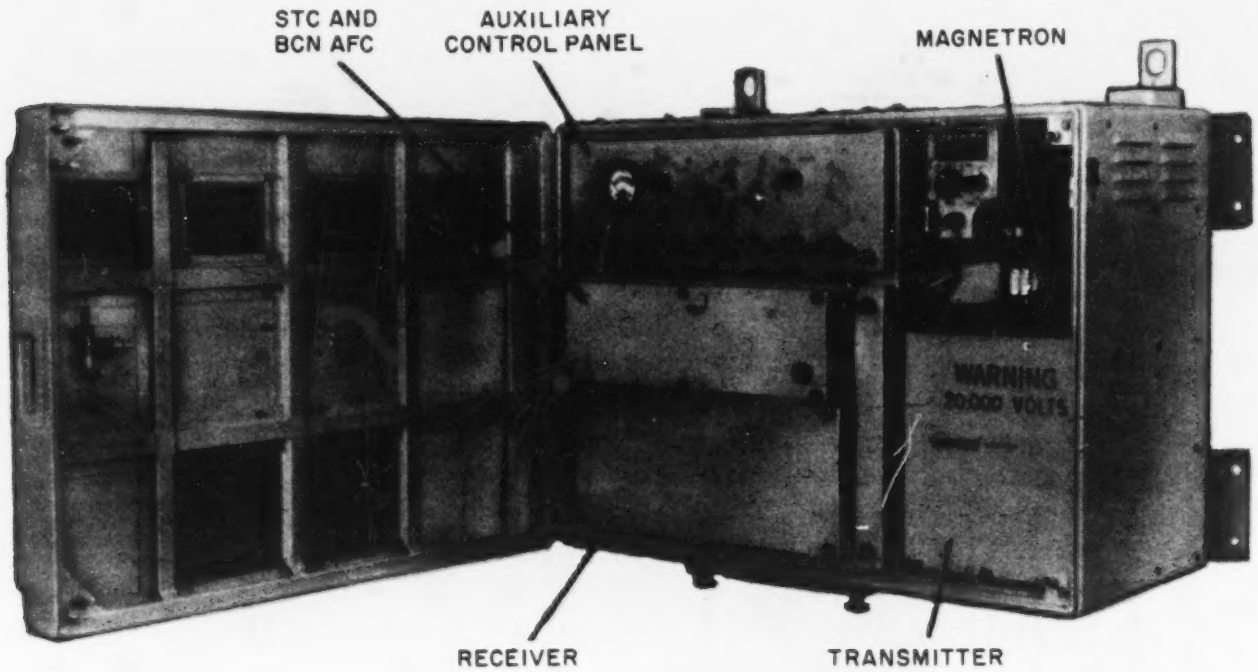

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Figure 12-5.—AN/SPS-10, receiver-transmitter.

receiver. These circuits will be discussed later.

Spark gap, E3006, is a protective device which arcs-over at 2200 volts peak. In case of an open in the magnetron ground lead, the gap will arc-over to prevent excessive transient voltages from appearing in the circuit and causing a breakdown of the capacitors (C3033 and C3004) dielectric material.

MICROWAVE SWITCHING

Th duplexer W3010, of AN/SPS-10 (fig. 12-8) makes possible transmission and reception from a single antenna. It does this without damaging

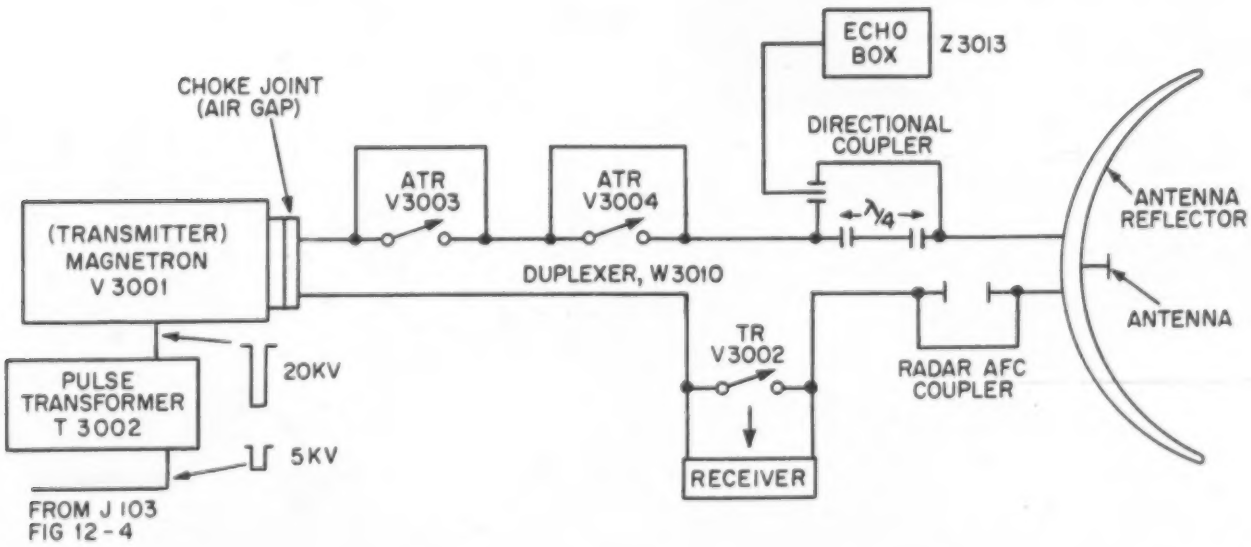

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Figure 12-6.—AN/SPS-10, transmitter, block diagram.

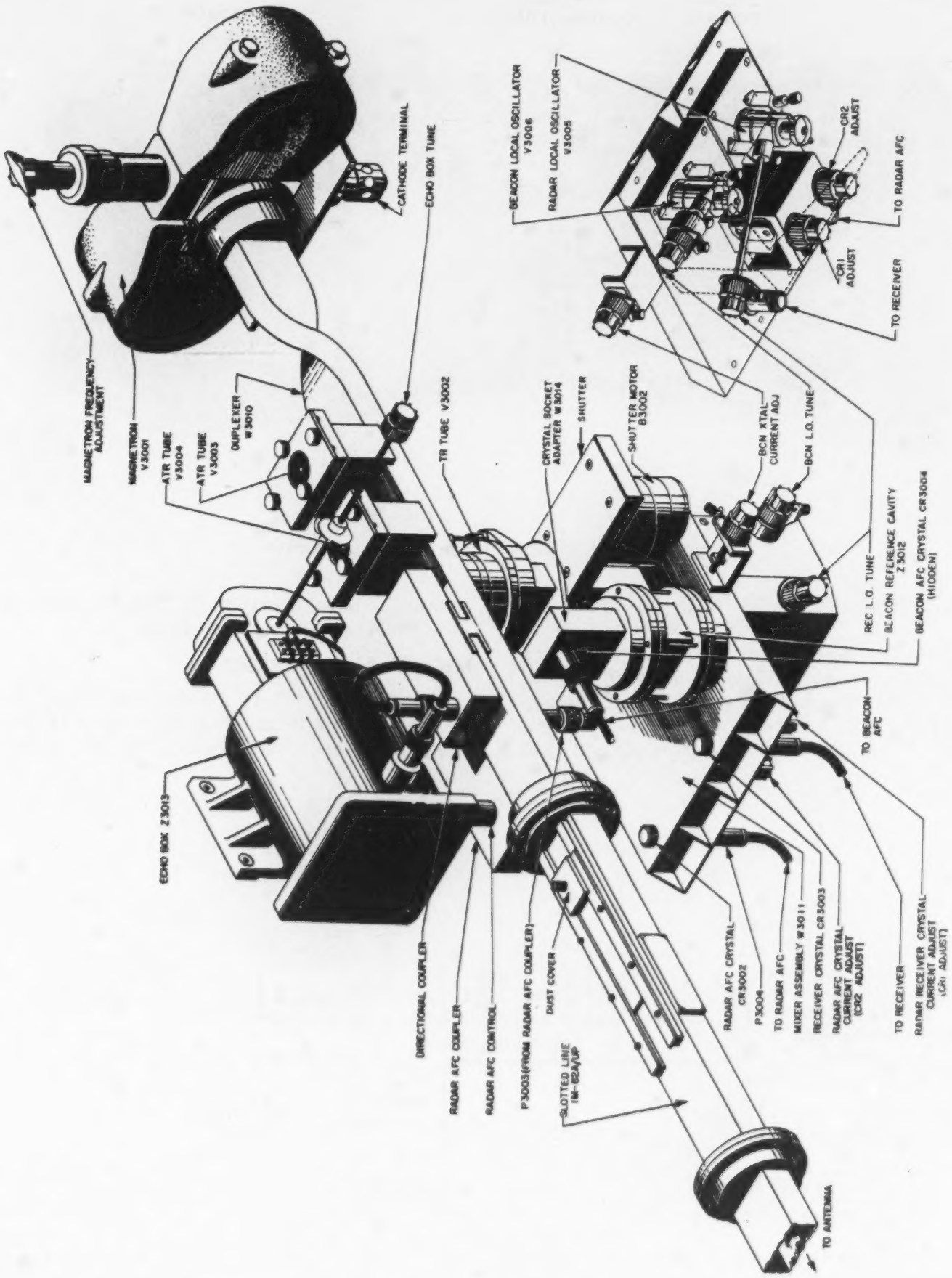

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Figure 12-7.—R-F section of receiver-transmitter in AN/SPS-10.

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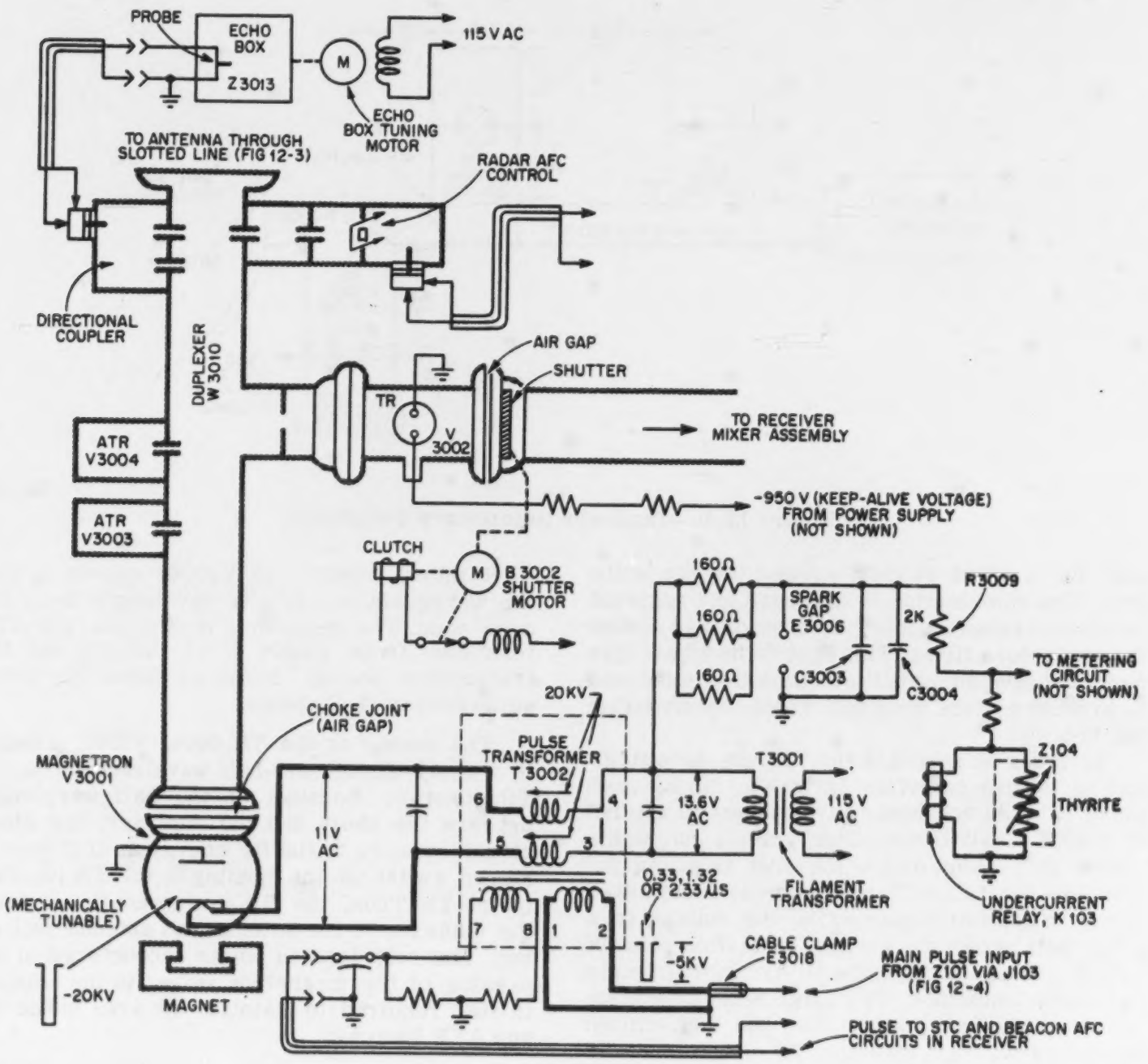

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Figure 12-8.—Transmitter section, schematic diagram.

the receiver during the transmission of the high-power pulse and without undue loss of the received echo signal in the transmitter during reception.

The duplexer uses an arrangement of microwave (TR and ATR) switches which distinguish between the transmitted and received pulses by the relative power levels. One TR (transmit-receive) tube and two ATR (anti-transmit-receive) tubes are used. These tubes are positioned electrically on the duplexer as shown in figure 12-9. The TR and ATR tubes are essentially the same in action, although the ATR tube is less critical in design.

The TR tube V3002 is basically a resonant cavity spark-gap tuned to the transmitter frequency and filled to a low pressure with gas. The switching action of the tube is accomplished automatically by the RF energy, resulting from the difference in power level between the transmitted pulse on and off condition. The transmitted pulse is sufficiently strong to strike an

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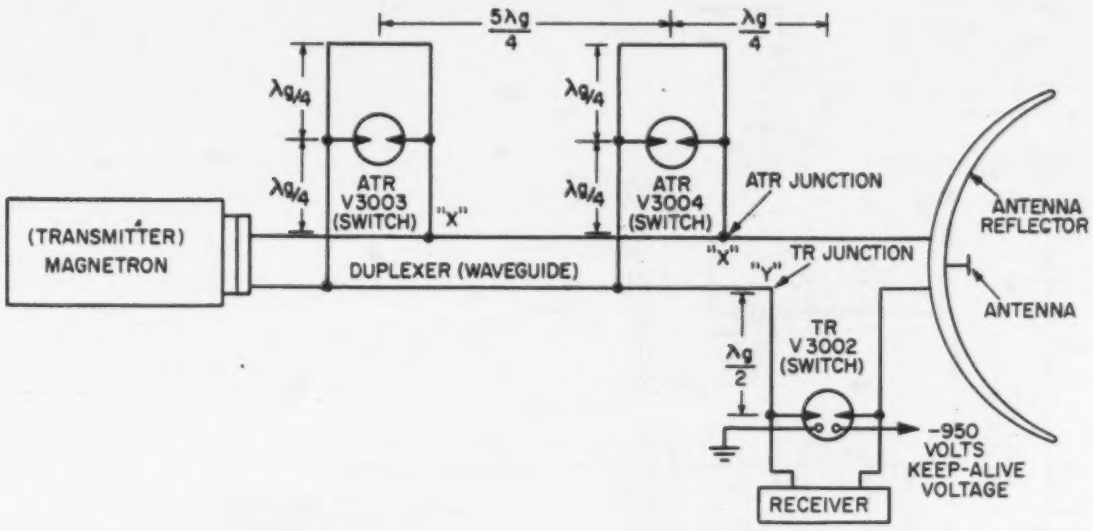

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Figure 12-9.—Duplexer (microwave switching).

arc (for a short circuit) across the gap of the tube. The combination of spark gap and resonant cavity increases the instantaneous voltage across the gap before firing. This causes the tube to fire nearer the beginning of the transmitted pulse, and to present a more complete short circuit during the arc.

In order to increase the TR tube sensitivity and to ensure complete ionization during each pulse, a -950 volt keep-alive voltage is applied to V3002 at all times. This voltage maintains V3002 at a point just below that required for complete ionization. The high-power transmitter pulse will immediately raise the voltage to a point well above the critical ionization point of V3002 and cause the tube to arc more rapidly and more smoothly. The target echoes contain considerably less power than the transmitted pulse and will not fire the TR tube during the interval between transmitted pulses.

The duplexer has two ATR tubes spaced one and one quarter wavelengths apart (mid-band). Two tubes are used in order to ensure effective firing over the full magnetron frequency band. The actual spacing of the tubes is in terms of fractions of the duplexer (waveguide) wavelength which is longer than the free-space wavelength. Because of fringing effects at the waveguide junctions, the actual spacing of these components is determined experimentally.

When the magnetron, V3001, oscillates, the high-power microwave burst passes into the duplexer and energizes the TR and ATR tubes by striking an arc in them. The shorts in the ATR tubes (V3003 and V3004) appear across the waveguide one-fourth wavelength from the open ends. The impedance looking into the ATR junctions from points X is infinite and the transmitter energy continues down the waveguide toward the antenna.

The arcing of the TR tube, V3002, results in a short-circuit one-half wavelength from the TR junction. Because of the half-wavelength between the short and the duplexer, the short circuit appears to the RF energy as if it were a closed switch at the opening to the TR junction (point Y). Thus, the RF energy continues down the duplexer to the antenna and antenna reflector. The only loss in power encountered in the passing of the magnetron output to the antenna is that required to maintain the arcs in the TR and ATR switches.

The input path to the receiver is short-circuited during the arc-over in V3002 so very little of the transmitted energy enters the receiver during magnetron operation. The TR tube arc-over does not represent zero resistance but will be of the order of a few ohms. The small input voltage developed across the input terminals of the receiver is well below a value which will damage the receiver.

When the magnetron, V3001, is off (receive period) the TR tube, V3002, is effectively open, and the waveguide is not short-circuited at the TR junction. The received echo pulse will then pass with ease along the matched input path to the receiver.

During reception, the ATR tubes (V3003 and V3004) are not energized (open). In this condition, the impedance at points X looking toward the ATR switches is zero, since both ATR branches now appear as half-wave shorted stubs. The line is effectively short-circuited at points X and the impedance at Y looking toward the transmitter is that seen at the open end of a shorted quarter-wave stub and a five-quarter wavelength shorted stub (both impedances infinite). Thus, all of the received energy (echo) is routed into the receiver.

DIRECTIONAL COUPLER AND ECHO BOX

The directional coupler (fig. 12-6) and the echo box, Z3013, function together to provide a means of checking the overall performance of the radar set. Transmitted RF energy from the waveguide is fed through the directional coupler to the echo box. The echo box stores the energy during transmission and releases it to the receiver immediately after the transmitting period. This received energy from the echo box is displayed on the PPI-scope and can be interpreted by the observer to give an indication of the system performance.

Directional Coupler

As the name implies, the directional coupler is so connected in the transmission line that either the transmitted energy (traveling down the line) or the reflected energy (traveling in the opposite direction) may be sampled.

The one-way directional coupler (fig. 12-10) samples RF energy traveling from the magnetron to the antenna and rejects energy traveling in the opposite direction.

The unit is coupled to the main waveguide through two small holes located one-quarter wavelength apart. One end of the directional coupler is terminated in its characteristic impedance, and absorbs most of the energy reflected to that end of the coupler. The output from the coupler is taken from a probe at the other end, and fed through a coaxial cable to the echo box probe.

A small portion of the magnetron RF energy (incident wave) is fed into the two holes on the directional coupler. The voltage at the probe in the directional coupler consists of two components (E_{ac} and E_{abc}). The paths traveled by the two components from the magnetron to the

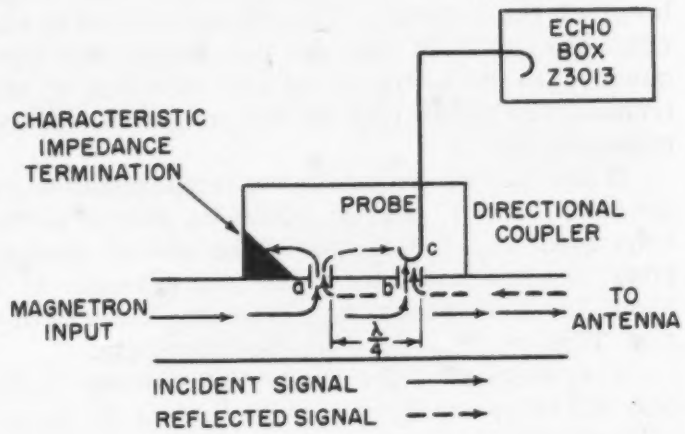

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Figure 12-10.—Directional coupler and echo box.

directional coupler probe are approximately equal and the voltages are only slightly out of phase. These voltages add at the directional coupler probe, and a large incident voltage is produced at the echo box probe.

There are also two paths for reflected energy which exist in the guide because of slight mismatches in impedance between the duplexer and antenna. Along one path the reflected signal (indicated by dashed arrows) passes from b to c in the directional coupler, while in the other path the reflected signal travels one-quarter wavelength farther to a and an additional one-quarter wavelength back to c. The latter path is one-half wavelength longer than the original path. The two reflected voltage components therefore arrive at the directional coupler probe 180 degrees out of phase and cancellation occurs. Thus, the input RF energy from the magnetron to the echo box probe is essentially free of reflected RF signal in the waveguide.

The ratio of power traveling up the waveguide (from magnetron to antenna) to power traveling down the guide (from antenna to magnetron) is greater than 15 db. The standing-wave ratio resulting from the insertion of the directional coupler is negligible.

Echo Box

The echo box, Z3013 (fig. 12-10) is equivalent to a high-Q tuned circuit. The energy stored in the echo box during the transmission interval decays exponentially during the receive interval. The time required for the energy to drop to the noise level of the receiver is known as the "echo box ringtime," and depends on two factors: (1) the amount of the transmitted energy

stored by the echo box; and (2) the overall noise level of the receiver. The energy stored by the echo box, if it is tuned to the transmitter frequency, is determined by the duration of the transmitted pulse and by the magnitude of the pulse energy.

If the power output of the transmitter were decreased, less energy would be stored in the echo box. The discharge of the stored energy after the transmitted pulse would begin at a lower level, and therefore take less time to decay. This would yield a shorter ring time.

A reduction of the transmitter power (echo box charging energy) to one-half (3 db down) will reduce the ringtime approximately 1 microsecond. The noise level of the receiver sets the level at which the ringing is no longer perceptible on the plan position indicator. An increase in the receiver noise level by 3 db will also reduce the ringtime approximately 1 microsecond.

Because the magnetron frequency is tunable, the echo box must be tunable over the same frequency range. An echo box tune knob is provided on the receiver-transmitter (fig. 12-7) to manually tune the echo box cavity to the magnetron frequency.

When the equipment is operated from the radar set control (fig. 12-1), the echo box tuning is accomplished by a motor (not shown). The motor is operated by a pushbutton switch on the radar set control panel marked ECHO BOX. The motor drives the echo box tuning shaft so that the tuning sweeps over the entire range of transmitted frequencies. Ringing will occur whenever the resonant frequency of the echo box is the same as the output frequency of the magnetron.

The echo box ringtime indications appear on the plan position indicator as lobes (fig. 12-11, A). These lobes should extend outward on the indicator a minimum of 4000 yards. The echo box lobes will appear at a rate of 10 times per minute. When the echo box switch is off, the lobes will not appear in the PPI pattern (fig. 12-11, B).

ANTENNA ASSEMBLY AND ANTENNA CONTROL CIRCUITS

The antenna assembly (fig. 12-12) radiates the pulses of microwave energy from the magnetron, and directs the echo signals to the receiver through the waveguide as discussed. The antenna assembly consists of a truncated parabolic reflector, a pedestal, a feedhorn assembly, and a synchro (located in the antenna pedestal) which provides bearing information.

The antenna pedestal also contains a unidirectional 440-volt 60-cycle 3-phase 1-horsepower antenna drive motor, B1301 (fig. 12-13). Power for the motor is applied through manual

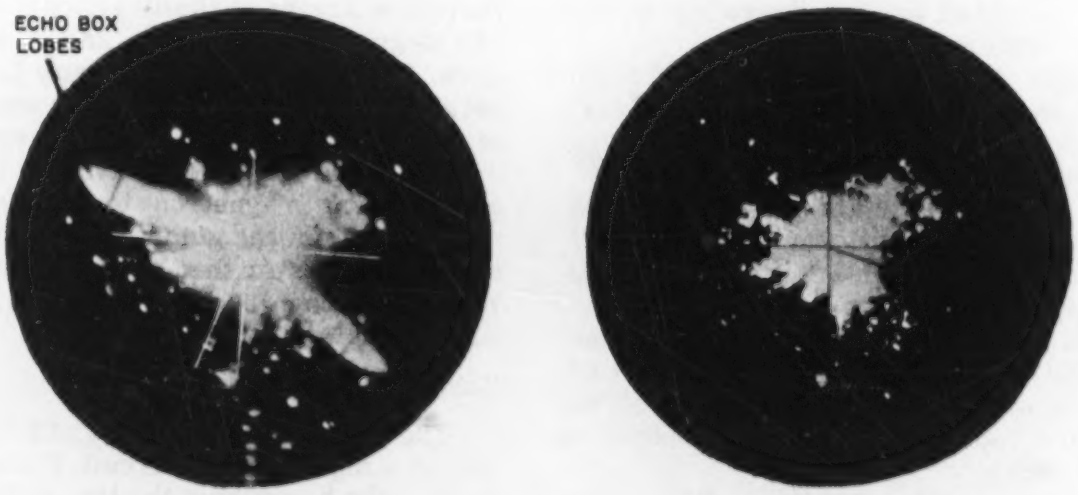

A OPERATION WITH ECHO BOX PUSH BUTTON SWITCH ON.

B OPERATION WITH ECHO BOX PUSH BUTTON SWITCH OFF.

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Figure 12-11.—Echo box patterns.

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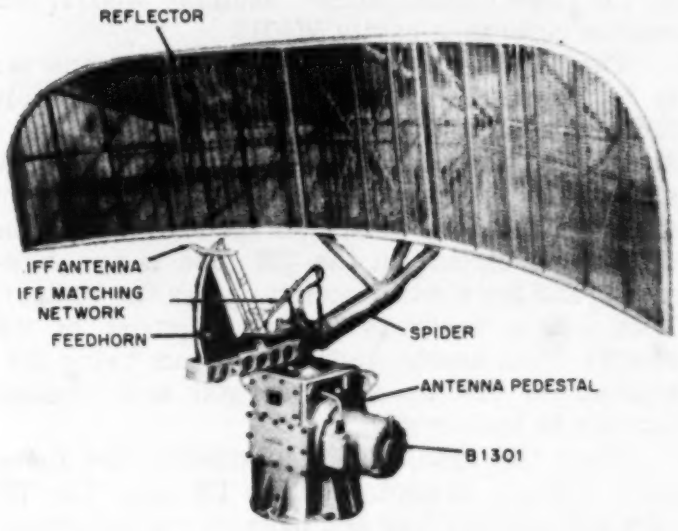

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Figure 12-12.—Antenna assembly.

controller switch S1501, and control antenna switch S1401. The motor turns at 1725 rpm.

An oil heater, HR1301 (in the antenna pedestal) provides a means of maintaining the ambient temperature of the motor lubricant above 25° C. If the temperature drops below this value, a heater switch (not shown) closes to allow a heater warmup current to flow through the heater element.

Drive motor B1301 is mechanically coupled to the antenna through a reduction gear train and a rotary joint. The turning of the rotary joint causes rotation of a main shaft (which drives the antenna), a 5G synchro, and two cam-operated microswitches. The gear reduction to the main shaft causes the antenna to turn clockwise at 16 ± 1 RPM.

The main shaft is sufficiently locked by the action of the gear train during rotation to prevent error introduction in the antenna speed by normal forces acting on the antenna reflector. When S1501 or S1401 is open, B1301 does not rotate. The locking feature provided by the gear train when the antenna is not rotating prevents the reflector from drifting during high winds, and acts as a safety during maintenance.

Synchro B1302 is driven at the same speed as the antenna reflector, and provides an output voltage to the synchro signal amplifier which is proportional to the position of the antenna reflector. During alignment, the antenna reflector is rotated (by operating S1501) until it points directly toward the ship's bow. The synchro, B1302, is then rotated to produce an electrical

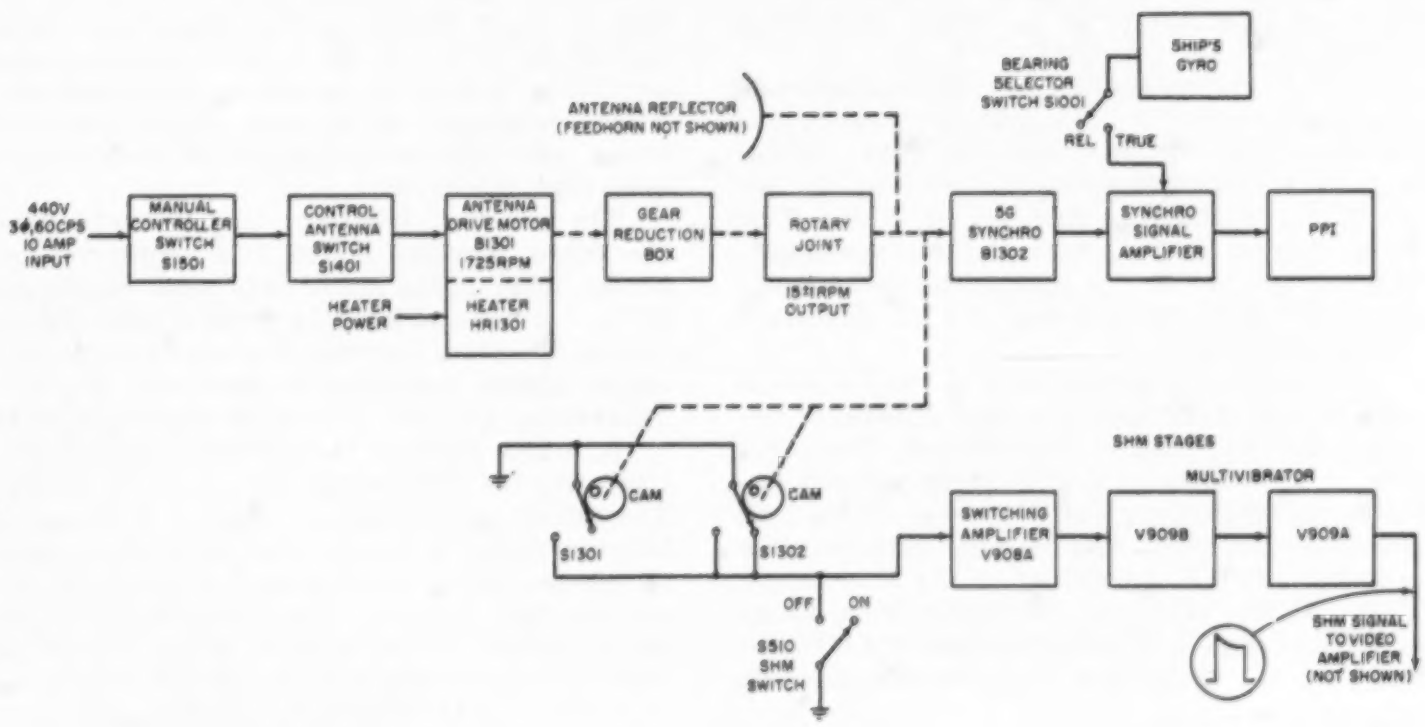

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Figure 12-13.—Antenna pedestal and antenna control circuit, block diagram.

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zero. In operation, the antenna reflector and B1302 maintain correspondence. The B1302 output is fed through the synchro signal amplifier to the PPI-scope. This voltage drives the sweep on the indicator at the same rate and through the same angle as the antenna reflector, and bearing information relative to the ship's bow can be read from the indicator.

The bearing selector switch, S1001, provides a means of selecting either true- or relative-bearing information for presentation on the plan position indicators. When S1001 is in the TRUE position (opposite to the position shown), gyro compass information and relative bearing information (from B1302) are combined in the synchro signal amplifier. With these inputs, the synchro signal amplifier computes true-bearing information for the plan position indicators.

The antenna assembly also contains two cam-operated microswitches, S1301 and S1302. These switches produce the ship's heading marker (SHM) on the indicator each time the antenna reflector crosses the ship's bow. The marker appears as a group of dashed lines which extend outward on the ship's trace. An SHM switch, S510, provides on-off control of the marker signals.

When S510 is in the ON position, the operation of the SHM stages (V908 and V909) is controlled by S1301 and S1302. The cams which operate these switches rotate at the same rate as the antenna reflector (15 rpm).

As the antenna rotates past 000 degrees relative, S1301 momentarily opens, and the ground is removed from the switching amplifier, V908A, permitting the SHM stages to operate. In this condition, a 100-KC SHM signal is fed from multivibrator, V909A, through the video amplifier (not shown) to the indicator, where it appears on the indicator sweep as a 100-KC intensity modulation.

The cam arrangement of S1301 and S1302 is designed so that there is a time difference between the operation of the switches. The S1302 cam is set so that as soon as the antenna reflector rotates past 000 degrees, S1302 will close and shunt S1301, thereby replacing the ground on V908A and cutting off the SHM output. Thus, S1302 prevents the occurrence of an erroneous shm on the display due to the rise and fall time of a single cam-operated microswitch.

RADAR RECEIVER

A simplified block diagram of the radar receiver in the AN/SPS-10 is shown in figure 12-14. The microwave portion of the receiver consists of TR tube V3002, mixer assembly W3011, and beacon reference cavity W3012.

The input echo signal to the radar receiver is fed from the antenna and antenna assembly through a slotted line, a TR tube, V3002, and a shutter to the mixer assembly, W3011. The shutter is operated by a shutter motor (not shown). When the radar set is shut down, the keep-alive circuit in the TR tube is not energized, and the shutter motor closes the shutter. This action prevents a large amount of RF energy from nearby radar sets from being dissipated in the receiver crystal and causing damage to the crystal.

When the radar set is in standby, the keep-alive voltage is applied to the TR tube. The TR tube will readily fire and present a short circuit across the receiver input terminals when strong r-f signals are received. The shutter opens slowly when the radar set is energized, and is not fully open until the TR tube is partially ionized by the keep-alive voltage. When power is removed from the shutter motor, a motor clutch closes the shutter.

Mixer Assembly

As in conventional mixers, two signals are fed to the mixer assembly, W3011 (fig. 12-15). One of these signals is the heterodyne signal applied to W3011 from either the radar local oscillator, V3005, or the beacon local oscillator, V3006, depending on the mode of operation of the radar set. The second signal is the received echo from the antenna.

The mixing in W3011 by CR3003 is similar to the more familiar action in a pentagrid converter tube. In the latter case separate signals on the control and injector grids simultaneously control the plate current. The result yields plate output signal components which are the sum, difference, and two original frequency signals.

In a like manner, the CR3003 output is controlled by the heterodyne and echo input signals. The difference frequency output of W3011 is 30 MC for radar or beacon operation. This signal is selected in the tuned circuit comprising C301 and the T301 primary. The T301 secondary signal is applied to the 1st IF amplifier. There are eight IF stages which are conventional amplifiers with STC (sensitivity-time control) and IAGC (Instantaneous Automatic Gain Control).

The radar local oscillator, V3005, and beacon local oscillator, V3006, are type 6115 reflex

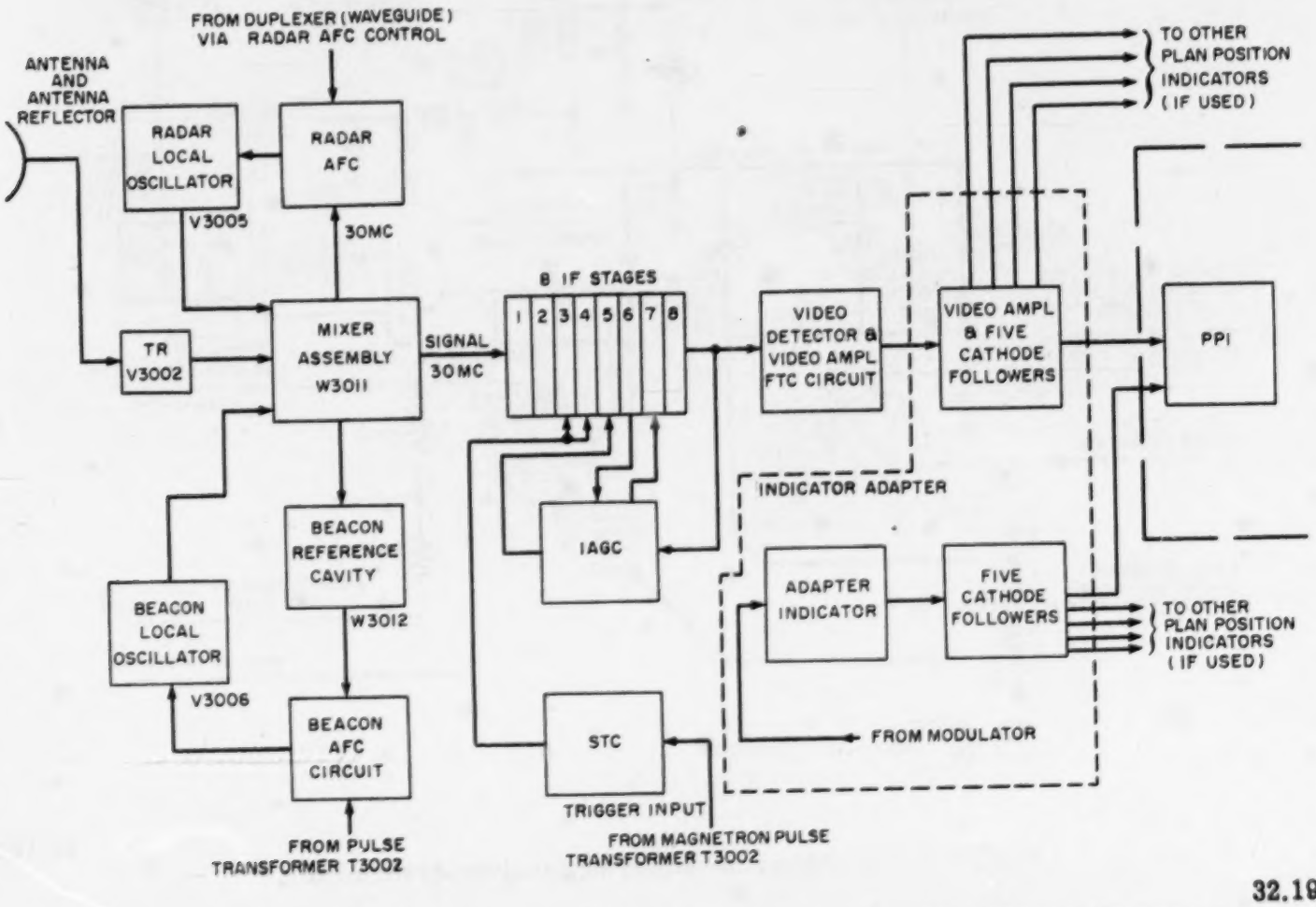

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Figure 12-14.—Radar receiver and adapter indicator, simplified block diagram.

klystrons. These oscillators employ resonant cavities as the frequency controlling device, which supplies microwave energy to the crystal mixer assembly, W3011. The klystrons (V3005 and V3006) are velocity modulated, i.e., the RF potential on the klystron cavity alternately causes acceleration and deceleration of the electron stream. This action produces a grouping or bunching of the electrons in the klystron. The frequency at which the potential changes in the klystron is determined by the resonant frequency of the klystron cavity.

Reflex klystrons V3005 and V3006 each contain a built-in cavity which is tunable by changing the vacity dimensions. A screw attached to the strut on the V3005 klystron (fig. 12-15) is operated by the receive local oscillator tune control. As the control is turned, a stress is exerted on the strut causing it to increase or decrease the cavity dimensions. This permits the radar local oscillator to be tuned 30 MC higher than the incoming frequency, or over a range from approximately 5480 to 5855 MC.

Because beacon reception takes place on 5450 MC only, the beacon oscillator must operate at a single frequency. Klystron V3006 is tuned 30 MC below the incoming frequency by the beacon local oscillator tune control to 5420 MC. The beacon signal is fed through the same IF stages as in radar operation.

Radar AFC Circuit

The radar AFC circuit (fig. 12-16) maintains a constant IF signal in the receiver, regardless of minor drifts in the transmitter (magnetron) frequency. The method used to obtain automatic frequency control is to vary the repeller voltage of the radar local oscillator klystron, V3005, by means of a sawtooth voltage. The AFC circuit locks-in at a frequency which is 30 MC above the magnetron output.

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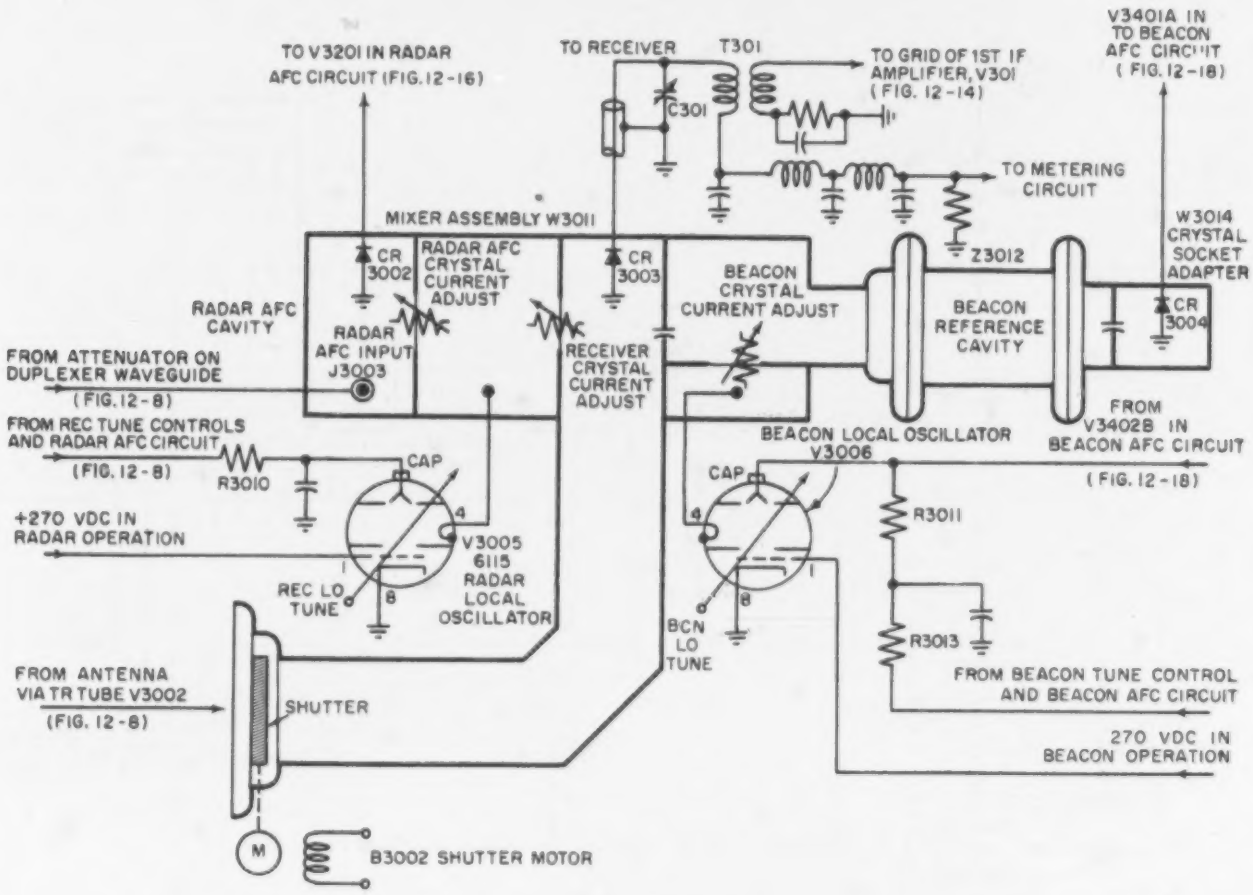

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Figure 12-15.—Mixer assembly of receiver-transmitter.

The radar AFC coupler, connected to the waveguide, couples a small portion of the transmitted energy to CR3002 in the radar AFC mixer. A radar AFC control permits adjustment of the amount of the transmitted signal fed to the mixer.

An input from the radar local oscillator, V3005, is also applied to CR3002 via a radar AFC crystal current adjust. The two mixer input signals differ in frequency by 30 MC ± the transmitter magnetron error frequency.

The output of the AFC mixer crystal, CR3002, consists of pulses of RF energy which recur at the same rate as the transmitted output. This signal is amplified in a two-stage IF amplifier strip comprising V3201 and V3202. The bandwidth characteristics of the IF amplifiers allow passage of the 30 MC ± magnetron error signal but rejects all other frequency components. The output of IF amplifier V3202 is fed to an S/B AFC discriminator, V3203.

A schematic diagram of the radar AFC circuit is shown in figure 12-17. The discriminator (V3203A and B) comprises L3201 and L3202 which are tuned to resonate with distributed capacitance at 32.5 and 27.5 MC, respectively (2.5 MC above and 2.5 MC below the 30 MC desired intermediate frequency).

The radar AFC circuit is actually a closed loop, with the radar local oscillator, V3005, acting as the signal source in the loop. The V3005 output (5480 to 5855 MC) is heterodyned in the radar AFC mixer cavity with the AFC signal from the waveguide (5450 to 5825 MC) as discussed. If the transmitter remains on-frequency, the difference frequency will be constant at 30 MC. However, if the magnetron frequency drifts, it is necessary to produce a comparable drift in the radar local oscillator frequency to maintain the required difference frequency of 30 MC.

The radar AFC circuit performs this function by amplifying (in V3201 and V3202) the difference frequency obtained in the radar AFC cavity and analyzing the IF output in the tuned circuits of discriminator, V3203, to determine the direction and the amount the IF signal differs from 30 MC.

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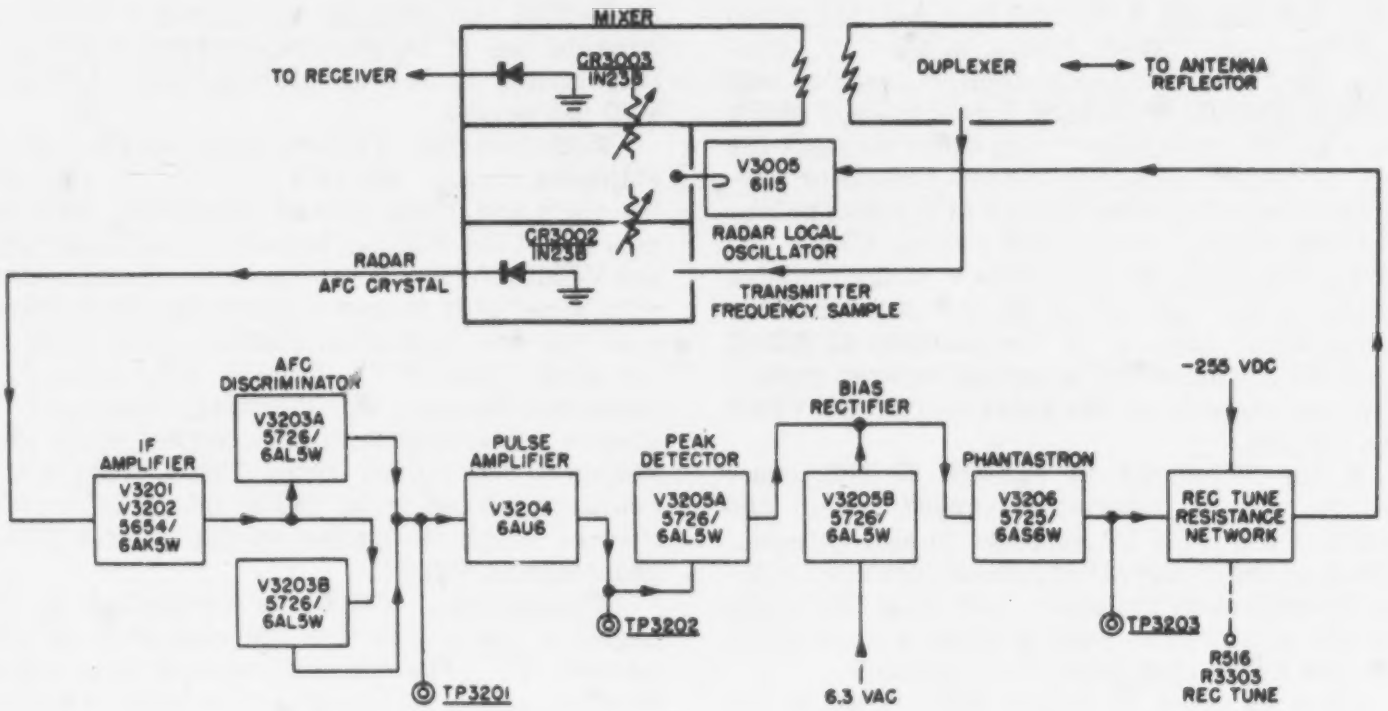

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Figure 12-16.—Radar AFC, block diagram.

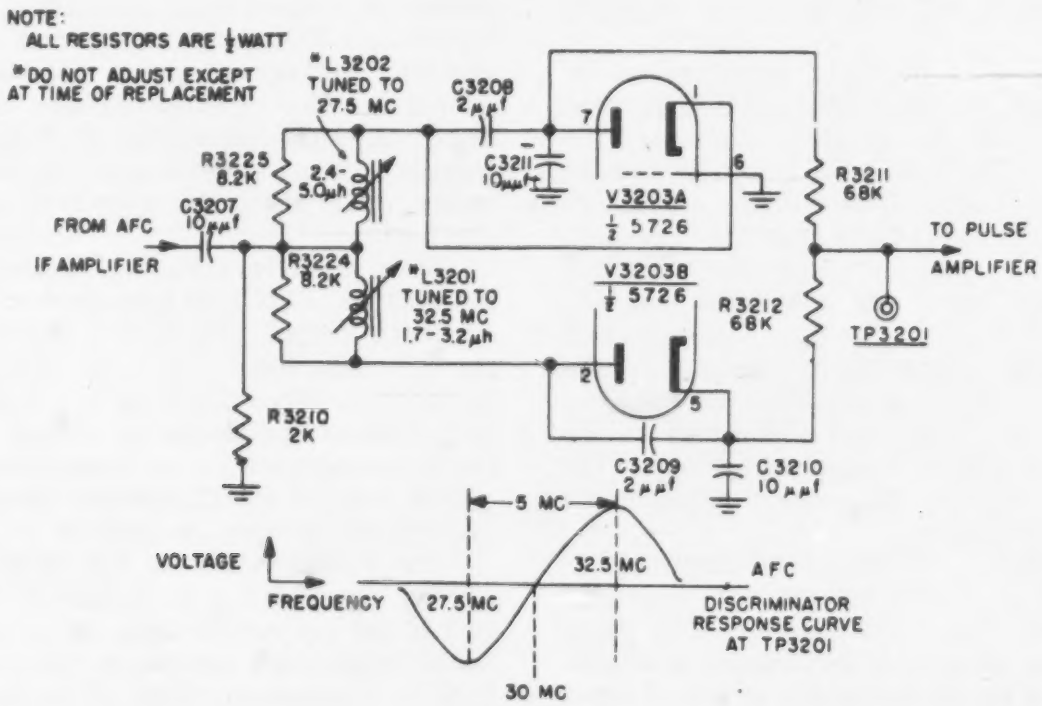

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Figure 12-17.—Radar AFC discriminator, simplified schematic diagram.

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The IF input signal from V3202 is applied to the junction of the two discriminator tuned circuits. The voltage developed by L3202 is applied in series with V3203A, C3211, and R3210. Likewise, the L3201 voltage is applied in series with V3203B, C3210, and R3210. Twin diodes, V3203A and V3203B, are connected in such a way that the AFC IF signal applied to the discriminator circuit produces rectified pulses of opposite polarity with respect to ground across C3211 and C3210. The algebraic sum of the average voltages across these capacitors is the discriminator output which appears at the junction of R3211 and R3212. This output is applied between control grid and cathode of the pulse amplifier, V3204 (fig. 12-16).

If the IF signal is exactly 30 MC, equal voltage will be developed across L3202 and L3201. Tube V3203A conducts on alternate half cycles of the IF signal to produce a negative voltage to ground on the upper side of C3211, while V3203B produces an equal voltage across C3210 with the lower plate positive to ground.

When an input IF signal higher than 30 MC is applied to the discriminator, the L3201 tuned circuit will produce a larger resonant step-up voltage than will L3202. Likewise, a larger voltage positive to ground will be developed at the lower side of C3210 than will negative voltage at the upper side of C3211. The resulting positive voltage is the discriminator output to V3204.

Conversely, when an input signal below 30 MC is received at the L3201-L3202 junction L3202 will produce the larger voltage and the voltage across C3211 will be greater than the voltage across C3210. The voltage applied to the V3204 control grid will be negative to ground.

The response curve for the discriminator circuit is shown below the schematic (fig. 12-17). The negative and positive peaks at 27.5 MC and 32.5 MC respectively, result from the stagger tuning of L3201 and L3202.

Adjustment of L3201 and L3202 may be required after changing a major component in the discriminator circuit. Subsequent adjustments should not be necessary.

Pulse amplifier, V3204, is a conventional pentode amplifier which inverts and amplifies the signal from the discriminator. The pulse appearing at the plate of V3204 varies in amplitude, depending on the frequency of the IF input to the discriminator. As the frequency rises higher than 30 MC, the plate output of V3204 decreases in amplitude. Conversely, as the frequency decreases below 30 MC, the V3204 output increases in amplitude. The waveform at TP3202 indicates the V3204 output which occurs as the IF input sweeps through a range of frequencies above and below the 30 MC IF during a 10 μs period.

Peak detector, V3205A, operates like a diode clamping circuit. Minus 250 volts are applied to the plate and to the cathode. Negative pulses appearing at the V3205A cathode from V3204 permit V3205 A to conduct. A capacitor in conjunction with a resistor forms a relatively short charge time for the capacitor, enabling it to charge to the peak value of the V3205A input pulse. The capacitor has a long discharge time and the charge remains essentially constant at the peak value of the pulses from V3204. This action converts pulses from V3204 into a DC control voltage which is applied to the control grid of phantastron, V3206.

Phantastron, V3206, is controlled by the negative charge across the capacitor as discussed. To make the AFC circuit more sensitive, an initial bias of about 2.5 volts is applied between the control grid and cathode of V3206 by the action of the bias rectifier, V3205B. This enables V3206 to follow a lower amplitude negative signal voltage from V3205A.

Phantastron, V3206, generates a sawtooth voltage at its plate which is applied to the repeller of radar local oscillator, V3005. The klystron, V3005, output frequency changes as the repeller voltage changes, increasing in frequency as the repeller voltage is made more negative, and decreasing in frequency as the repeller is made less negative. R3303 sets the range over which the repeller voltage can be changed.

When the intermediate frequency to the discriminator, V3203, is incorrect, the phantastron sawtooth output provides a corrective voltage for the radar local oscillator until the proper IF is reached. When the IF is correct, peak detector, V3205A, produces an output which is sufficiently negative to maintain the phantastron, V3206, beyond cutoff, thereby locking the oscillator to the correct frequency.

The V3005 output to the radar AFC mixer cavity should be at a frequency 30 MC above that of the magnetron input from the waveguide. If the magnetron frequency decreases, the difference frequency output from the AFC cavity will increase.

If the magnetron frequency increases, the difference will decrease.

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Local oscillator changes in the opposite direction produce the same effects. The sweeping action (searching) occurs only for large intermediate frequency errors, i.e., when the IF error is outside the 6 MC bandpass of the IF stages. For small errors, V3206 acts as a DC amplifier to produce a corrective voltage for the repeller of the local oscillator, V3005.

Assume an output intermediate frequency from V3202 which is slightly higher than 30 mc. The discriminator, V3203, output to the V3204 control grid will be positive-going. The negative-going plate output of V3204 is fed through V3205A (without inversion), and applied as a negative input between grid and cathode of phantastron, V3206. The V3206 plate voltage increases toward ground potential, resulting in amplification of the DC grid input voltage.

Because the intermediate frequency is too high (above 30 MC) the V3206 positive-going plate output to V3005 reduces the negative voltage at the klystron repeller, and thus produces a decrease in the local oscillator frequency. This action produces a local oscillator injection frequency to the radar AFC mixer cavity which nulls the intermediate frequency error.

If the intermediate frequency from V3203 is slightly lower than 30 MC, no input negative voltage will be applied to the grid of V3206, and the V3206 grid will automatically become less negative. The normal discharge action produces a negative-going plate output voltage from V3206. This negative voltage is the corrective voltage which is of the proper polarity to counteract the low-frequency local oscillator error.

Tube V3206 acts like a DC amplifier (as described above) only when there is sufficient bias applied to the control grid (approximately -6 volts). If the control grid bias should drop below this value, the tube would no longer act as a DC amplifier, but would, in effect, become a sweep generator, performing in much the same manner as a free-running multivibrator.

For proper operation of the AFC circuit, the AFC discriminator must be precisely aligned with the signal IF mid-frequency. If the alignment is inaccurate, the AFC circuit will lock on at a local-oscillator frequency which is higher or lower than the signal IF channel midfrequency, and received signals will be poorly represented on the PPI or completely absent from the presentation at the indicator.

The AFC circuit is particularly sensitive to the magnetron frequency spectrum, and will give erratic results if the magnetron doubles its frequency (double-modes) or jumps in frequency beyond the range of the AFC operation.

Beacon AFC Circuit

The general theory of operation of the beacon AFC circuit (fig. 12-18) is essentially the same as given for radar operation. Hence, the beacon AFC circuit will be discussed only as it differs from radar AFC.

During beacon operation the AN/SPS-10 works in conjunction with other beacons (generally shore-based) or landmarks to obtain navigational information. In beacon operation the AN/SPS-10 magnetron sends out a signal on any frequency within its range and triggers other land-based or shipboard beacon transponders which reply on 5450 MC. The reply is mixed with the output of local oscillator V3006 which always operates at 5420 MC (30 MC below the transponder reply frequency).

The function of the beacon AFC circuit is to maintain the frequency of the beacon local oscillator, V3006, at 30 MC below the received beacon signal. The transmitter of the AN/SPS-10, during beacon operation, may operate on any frequency in its range, while beacon reception is limited to a single frequency (5450 MC). Thus, the beacon local oscillator frequency must be held at 5420 MC (30 MC below the received signal) regardless of the frequency output of the transmitter. This action is accomplished through the use of the beacon reference cavity.

The beacon AFC circuit consists of a beacon AFC crystal, CR3004, three pulse amplifiers, V3401A, V3401B, and V3402A, which amplify the pulse from the beacon crystal, a peak detector, V3403A, a phantastron, V3404, a beacon tune resistance network, and a pulse amplifier, V3402B, which amplifies a positive pulse from pulse transformer, T3002.

A portion of the energy from the beacon local oscillator, V3006, is fed through the beacon crystal current adjust in the beacon reference cavity to beacon AFC crystal, CR3004. The beacon reference cavity appears as a high-Q series tuned circuit, and the crystal current through CR3004 is maximum when the frequency of the beacon local oscillator is the same as the resonant frequency of the beacon reference cavity. Thus, the rectified CR3004 current, plotted versus frequency, has a conventional tuned circuit response characteristic, i.e., maximum at resonance and diminishing on either side of resonance.

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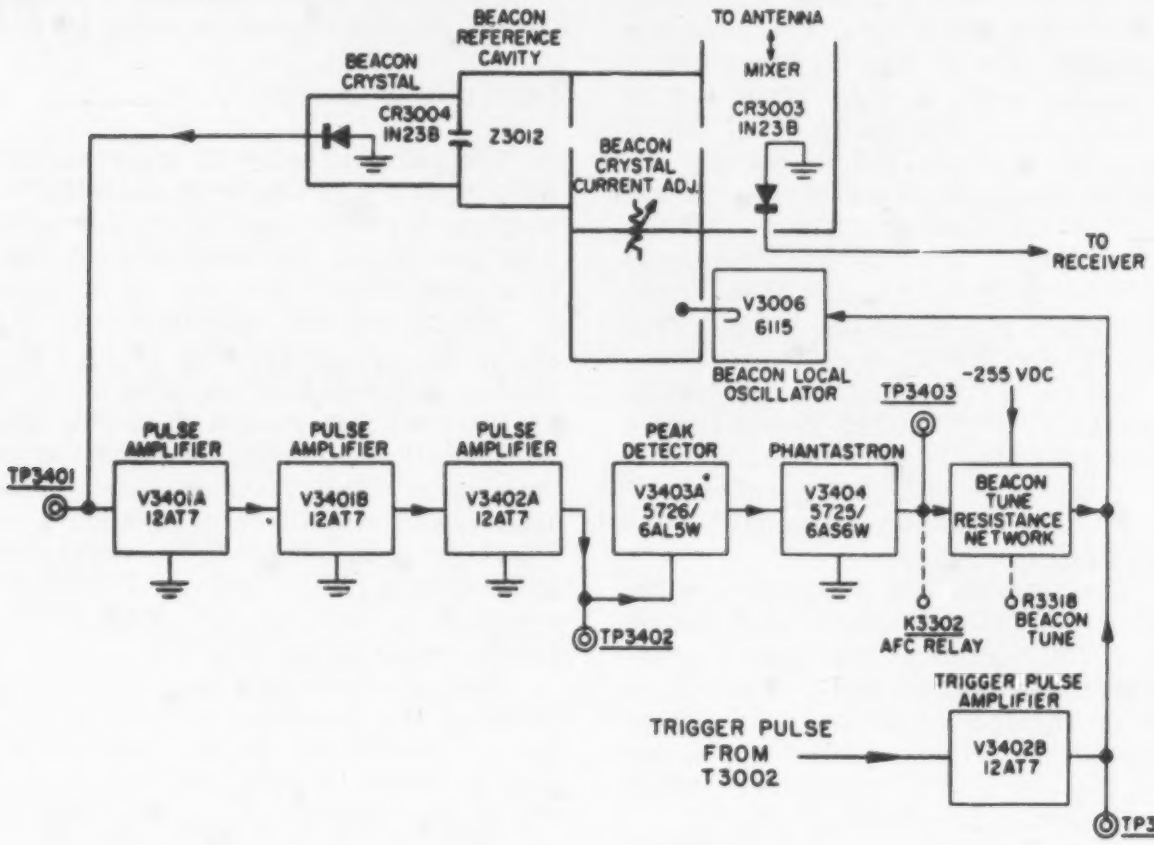

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Figure 12-18.—Beacon AFC circuit, block diagram.

The high-Q characteristics of the beacon reference cavity makes the circuit rigidly tuned to 5420 MC. This rigidity at resonance makes possible the use of the reference cavity as a reference frequency source for the beacon local oscillator. Thus, the primary purpose of the beacon AFC circuit is to maintain the beacon local oscillator at the frequency of the beacon reference cavity, or 5420 MC.

To perform this function, some type of discriminator action must be provided which will provide zero control on V3006 when the oscillator frequency is correct, and a corrective voltage to V3006 when the oscillator frequency is incorrect. A schematic of the beacon AFC circuit is shown in figure 12-19. The method by which discriminator action takes place is as follows:

A positive trigger pulse from T3002 is applied to the grid of pulse amplifier, V3402B. During beacon operation, the recurrence frequency of the pulse is 325 cps. Voltage divider, R3428 and R3429 maintains the cathode potential of V3402B approximately 60 volts above ground. The V3402B grid is at ground potential, and V3402B is cut off. The arrival of the positive pulse from the 7-8 winding of T3002 on the grid of V3402B causes a saturation plate current through R3430. The negative-going plate output of V3402B is applied through C3410 and R3425 to the junction of limiting diodes CR3401 and CR3402. Because V3402B is driven immediately from cutoff to saturation and back to cutoff, the pulse output of V3402B is clipped and will have a much steeper rise and decay time than that of the waveform at its grid.

Diode CR3402 short-circuits positive overshoot in the V3402B negative output pulse. A negative potential is applied to the anode of CR3401 to prevent this diode from conducting until the cathode of CR3401 assumes a more negative potential than the plate. When this occurs, CR3401 conducts and the voltage from the CR3401-CR3402 junction to ground is limited to the voltage developed across R3424. The arm of R3424 can be adjusted to permit a variable negative pulse of approximately zero to 2 volts to be obtained.

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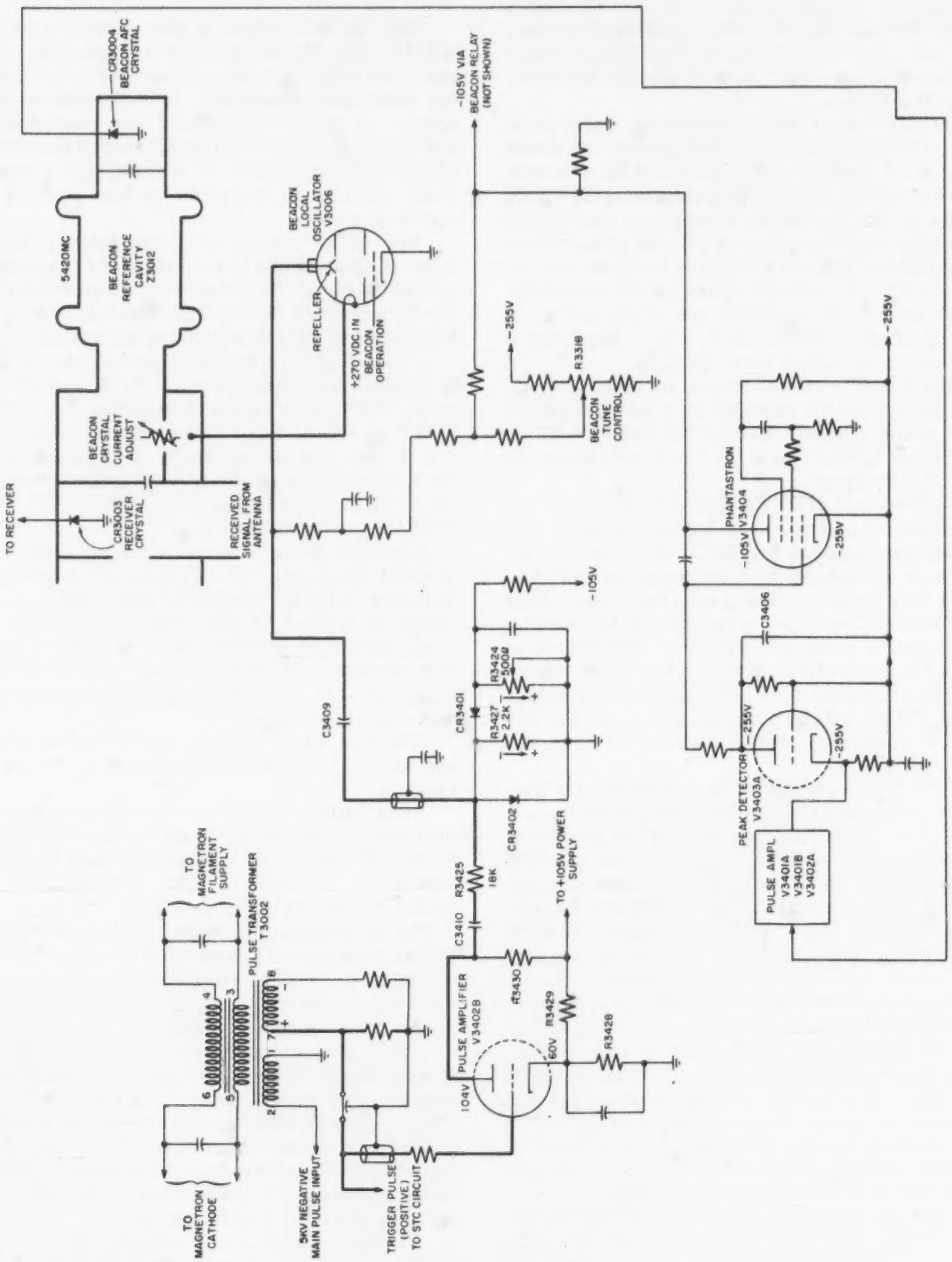

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Figure 12-19.—Beacon AFC circuit, simplified schematic diagram.

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The negative output pulse at the CR3401-CR-3402 junction is approximately 2 μs long, and is applied through C3409 to the repeller of the beacon local oscillator. This negative voltage causes the frequency of V3006 to increase for the duration of the pulse.

You will recall that the CR3004 crystal current output is maximum when the beacon reference cavity input from V3006 is exactly at the resonant frequency of the cavity. The increase in the V3006 frequency during the 2 μs period of the repeller pulse will cause the output of CR3004 to drop from its maximum value to a lower value (provided the local oscillator was operating at the same frequency as the beacon reference cavity at the beginning of the pulse). This action produces a negative-going output from CR3004.

This pulse is amplified and inverted and applied to the V3006 repeller as a positive-going pulse which opposes the initial negative-going pulse from V3402B so as to restore V3006 to its correct frequency.

If V3006 is operating at some frequency above the frequency of the beacon reference cavity, and the negative pulse is applied to the repeller, the oscillator frequency will increase further, and the CR3004 output will decrease even more. This negative CR3004 output is fed through three pulse amplifiers, a peak detector, and phantastron to produce a corrective voltage at the V3006 repeller. The phantastron, (V3404) output to the repeller of V3006 will be positive-going and the oscillator frequency will decrease to null the oscillator error.

If the local oscillator is operating at a frequency below the resonant frequency of the beacon reference cavity, the upward shift in frequency produced by the negative repeller pulse at V3006 will cause an increase in crystal current from CR3004. Thus, the pulse from CR3004 will be positive. Likewise, the phantastron output to V3006 will be negative-going and the oscillator frequency will increase to null the oscillator error.

The action of the local oscillator and reference cavity to produce a negative pulse for frequencies above the desired oscillator frequency and a positive pulse for frequencies below the desired oscillator frequency is very similar to the action of a standard frequency discriminator circuit. This discriminator action corrects the frequency of the local oscillator for a difference frequency of 30 mc below the received beacon signal.

The action of the peak detector, V3403A and the phantastron, V3404, in the beacon AFC circuit is the same as described in the discussion of the radar AFC.

Receiver IF Amplifiers

The 30 MC output of the mixer assembly, W3011, (fig. 12-14) obtained by heterodyning the received echo with either the radar or beacon local oscillator frequency, is amplified in eight stages of IF amplification. An instantaneous automatic gain control (IAGC) circuit is provided at the fifth and sixth IF stages, and a similar IAGC circuit is provided at the seventh and eighth stages.

The IAGC circuit prevents intense signals from saturating the IF amplifiers by reducing the gain of the controlled stages for the duration of the strong received signal. The IF gain is restored to normal immediately following the intense signal.

The operation of the IAGC circuit (fig. 12-20) is controlled by antijam switch, S504, and by IAGC relay, K303. When S504 is in either the IAGC or BOTH position, K303 is energized from the 24 volt supply and the two IAGC circuits operate. In the OFF position of S504, K303 deenergizes, and the IAGC outputs from the cathodes of V311A and V312A are shorted to ground.

A portion of the IF signal from the output of the sixth IF stage (fig. 12-14), is coupled to the plate detector, V311B. A similar output of the eighth stage is applied to plate detector, V312B. The plate detectors provide negative-going controlling signals to their associated cathode follower stages (V311A and V312A, respectively) to produce the IACG output.

The two IAGC circuits are identical and the operation of only one of the circuits will be considered.

Bias voltage of V311B (fig. 12-20) places the tube just above cutoff. Positive half cycles of the 30-MC IF input at the V311B grid cause increased conduction through the tube, and negative half cycles drive V311B below cutoff.

The rectified negative-going plate output video pulses from V311B are coupled to the grid of cathode follower, V311A. The pulses are integrated by C336 to remove the 30-MC IF component and produce a more constant voltage on the V311A grid.

The V311A cathode is returned to a -105 volt supply, while its plate is connected to the 270 volt supply. The normal operating potential of the V311A cathode (during quiescence) is 0 volts to ground. As the conduction of V311A increases, its cathode attempts to become positive to ground, while a decrease in conduction produces a V311A cathode potential negative to ground.

Negative-going input signals from V311B during strong IF signals cause the V311A conduction to decrease. This action produces a

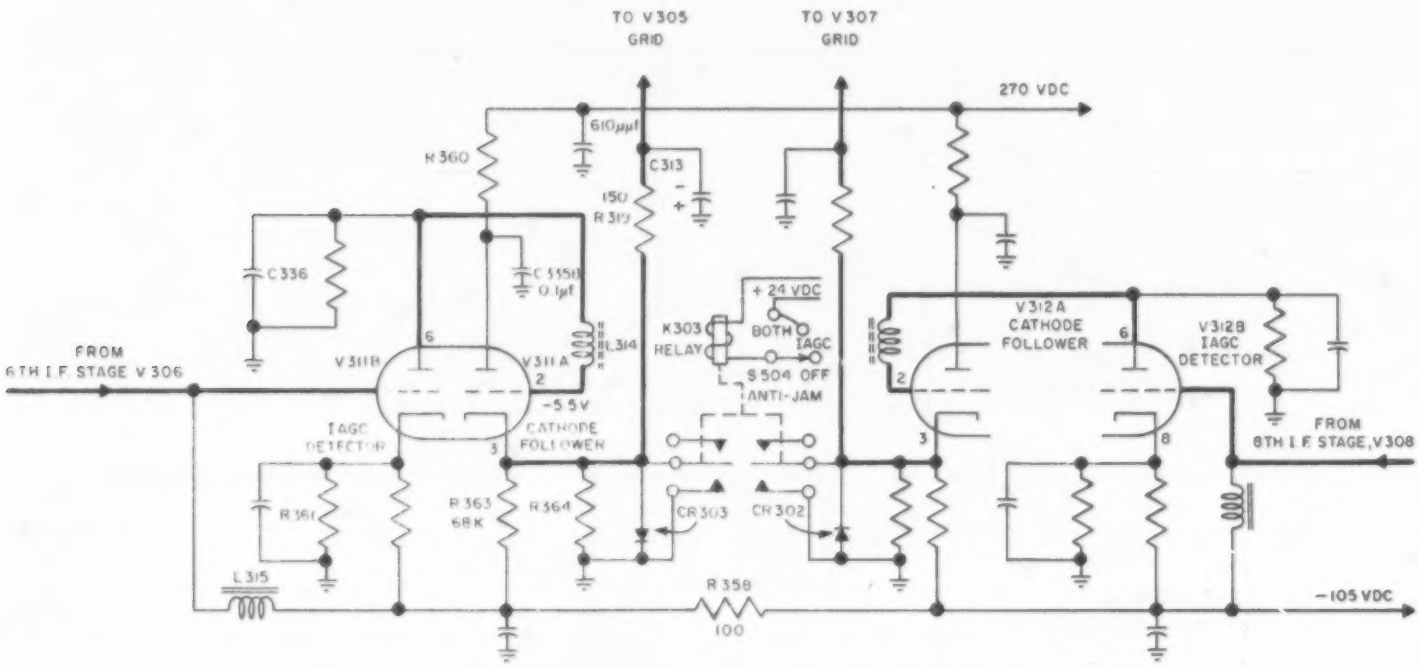

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Figure 12-20.—Instantaneous automatic gain control (IAGC) circuit.

negative voltage to ground at the V311A cathode, and C313 charges to this voltage through the -105 volt supply, R358, R363, and R319. The negative voltage at the top of C313 is applied to the fifth IF amplifier (V305) grid (fig. 12-14). This action reduces the gain of V305 and therefore reduces the input signal amplitude to all of the subsequent IF amplifiers.

The reduction in gain in the IF amplifiers is not instantaneous because the voltage on the grid of C305 can become more negative only as fast as C313 can charge through the path described above. This provides a slight delay in IAGC action. At the end of the video pulse to V311A, C313 can discharge very rapidly through R319, V311A, and C335B, thus permitting an almost immediate return of the control grid bias of V305 to its normal operating level. Rectifier, CR303, prevents the cathode of V311A (and the V305 grid) from going more than a fraction of a volt positive to ground.

Video Circuit

The receiver video circuit (fig. 12-14), consists of an FTC (fast-time constant) circuit, a video detector, a video amplifier, and a cathode follower. The video circuit detects and amplifies the video signal and feeds its output through the indicator adapter to the plan position indicator.

The output of the eight IF amplifier stages is coupled to germanium crystal diode, CR301 (fig. 12-21), which is used as the video detector. The negative video output pulses of CR301 are filtered by C326 and L312 to remove the 30 MC IF signal. The filtered output is fed through the FTC circuit to video amplifier, V309.

The FTC circuit aids in presenting relatively short-duration target signals which occur in the midst of long-duration signals. The FTC circuit is controlled by the anti-jam switch, S504, which is located on the panel of the radar set control.

The FTC circuit changes the time constant of the coupling circuit between the video detector, CR301, and video amplifier, V309. When S504 is in the OFF position (as shown) FTC relay, K301, is in the deenergized position, and its contacts short C327. The coupling circuit consists of C328 and R336, and the input signal is therefore differentiated at the V309 grid across R336. This arrangement represents a relatively long time constant coupling circuit, and, for long-duration signals, the video pulse to V309 may be long enough to blot out neighboring short-duration signals at the video detector output.

When K301 is energized, by placing S504 in either the FTC or BOTH position, its contacts move down (opposite to the position shown). The

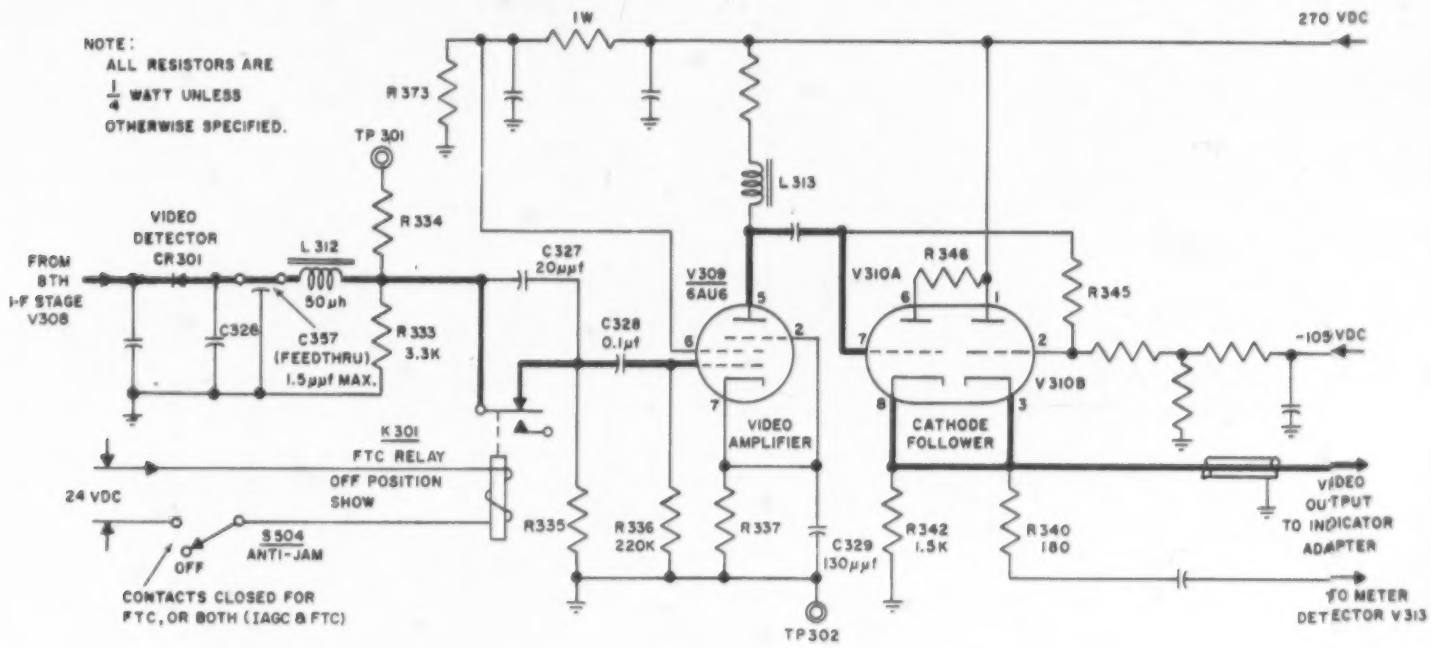

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Figure 12-21.—Video circuit.

detected output video signal is now coupled through C327, which, in conjunction with R335 forms a fast-time constant coupling circuit. Differentiation across R335 produces a shorter duration video pulse than would be obtained from C328 and R336 for the same video pulse input, and the duration of the V309 input for all signals is considerably reduced.

The differentiation of the video signal reduces clusters of target signals on the plan position indicator to make individual targets easily distinguishable. FTC is useful in preventing target area blotting of the plan position indicator to achieve a clearer presentation.

The FTC action differs from IAGC in that FTC affects the time duration of the video pulses, whereas IAGC action affects the amplitude of high-intensity video pulses.

Video amplifier, V309, inverts and amplifies the video signal from CR301. Inductor L313 is connected in the plate circuit of V309 to produce the proper high-frequency response in the leading and trailing edges of the V309 video output pulse. The V309 output is fed to parallel-connected cathode followers a V310A and V 310B. Parasitic oscillations are suppressed by R345 and R346.

The V310 cathode output is fed to the indicator adapter and to the detector meter circuit. The value of R342 is selected so that the total output impedance is 75 ohms.

Sensitivity-Time Control Circuit

The sensitivity-time control (STC) circuit (fig. 12-22), provides a means of reducing the receiver sensitivity for close-in targets, thus minimizing the sea return echo on the plan position indicators so that nearby targets can be distinguished. The circuit is actuated by a positive trigger pulse from pulse transformer T3002.

The circuit is controlled by STC switch S3303, STC magnitude R3310, STC duration R3308, and STC flat R3313. The output of the STC circuit is coupled to the 3rd and 4th IF amplifiers.

Many of the controls mentioned above are located on the radar set control (fig. 12-23). All of these controls are located on the auxiliary control panel (fig. 12-24). These will be discussed later.

The STC circuit (fig. 12-22) consists of multivibrator, V3101, a limiter and clamper network, a grounded grid amplifier, V3102A, and a cathode follower, V3102B.

Stage, V3101, is a monostable multivibrator. In the absence of an input trigger pulse from T3002, the stable state of the multivibrator is V3101A conducting and V3101B cutoff. When a positive pulse enters the STC circuit from T3002, V3101B is driven into conduction and V3101A is cut off. During the period before

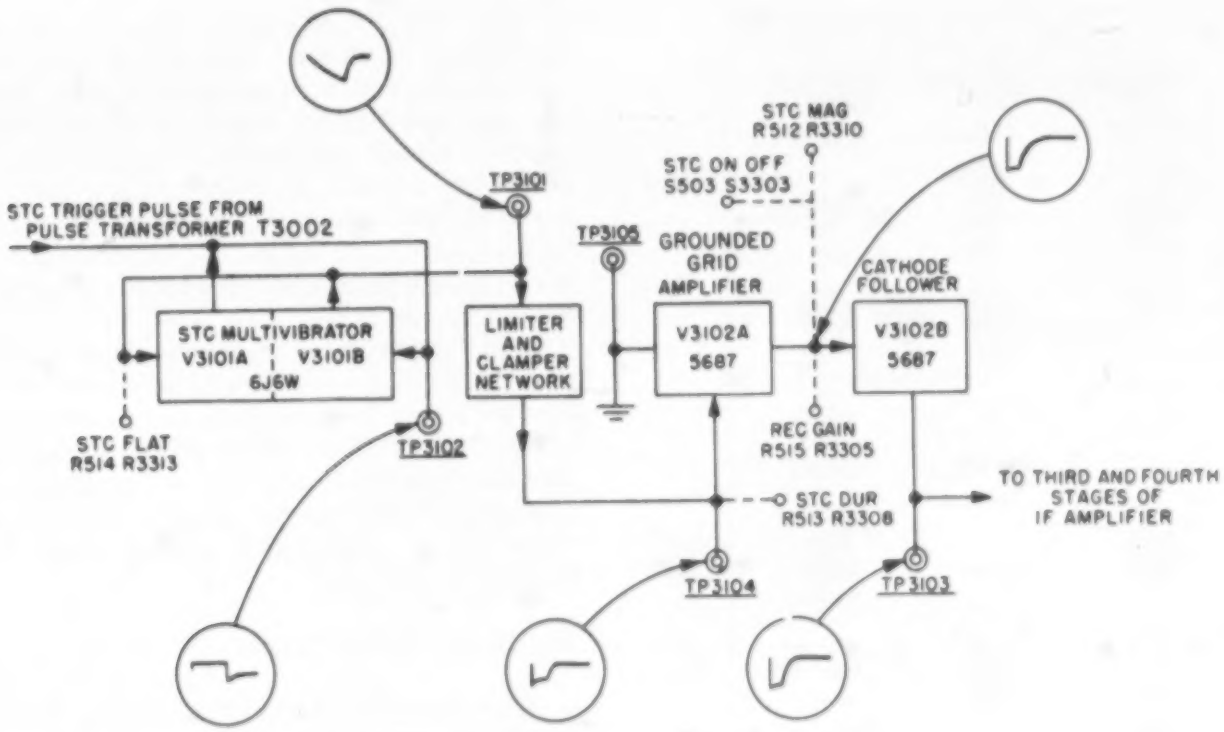

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Figure 12-22.—STC circuit, block diagram.

V3101A again conducts, a negative-going pulse appears at the plate of V3101B. This pulse is the STC multivibrator output pulse which has a width determined by the position of the STC flat control, R3313.

The negative pulse from the V3101B plate is fed through the limiter clamper network to the cathode of ground grid amplifier V3102A. The limiters prevent any positive overshoot portions of the pulse while the clamper references the positive peak of the pulse.

Ground-grid amplifier, V3102A, conducts during the negative input pulse. The time of conduction of V3102A is determined by STC duration control R3308. By the combined actions of the STC flat and STC duration controls, the STC pulse now has a variable flat section and variable decay.

The grounded-grid amplifier output pulse has the same shape as the cathode input. The gain in V3102A depends on the plate voltage, which can be adjusted by STC magnitude control R3310. The resulting output waveform from V3102 A, adjusted for proper flatness, duration, and magnitude, is applied to the V3102B grid.

Cathode follower, V3102B, couples the negative-going STC output pulse to the 3rd and 4th IF amplifier control grids. As the STC input trigger pulse from T3002 occurs at the instant the transmitter magnetron output is keyed-on, the STC circuit output will provide its negative-going input to the 3rd and 4th IF amplifier during the time strong sea return echoes are received.

The cathode follower is connected between a -105 volt and a +105-volt supply. The DC potential at the cathode of V3102B, normally about -14 volts, can be varied by adjusting the receiver gain control, R3305. The range of this adjustment is from 0 to -15 volts. Because the V3102B cathode potential is applied along a DC path to the 3rd and 4th IF amplifier, it follows that the gain of the IF stages and of the receiver can be varied by positioning the arm of R3305. The STC voltage is superimposed on the V1302B cathode potential, and is independent of the receive gain setting.

The action of the STC circuit varies from that of IAGC. The STC circuit attenuates close-range video echo pulses by reducing the IF gain during the first portion of the receive period. This reduces blurred bright spots on the PPI caused by close-in targets. The IAGC circuit is

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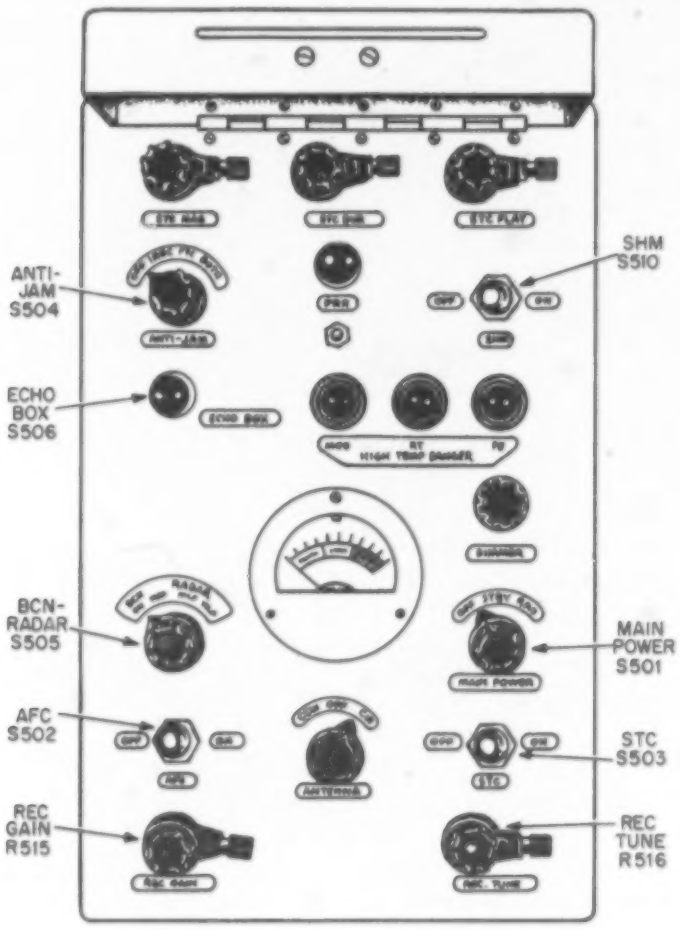

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Figure 12-23.—Radar set control, front panel.

active on strong echo signals regardless of target range.

Indicator Adapter

The primary function of the indicator adapter (fig. 12-14) is to supply trigger pulses and video signals at the proper output levels and at the proper time to the PPI. Provisions are made in this unit for the introduction of range markers and ship's heading marker (SHM) signals.

The indicator adapter consists of a power supply; a trigger pulse delay circuit; a trigger pulse shaper; a video amplifier, an SHM multivibrator circuit, and a range mark input circuit. The trigger pulse delay circuit receives the triggering pulse from the modulator and after a selected time delay, this circuit feeds the trigger pulse to the five plan position indicators. The video amplifier receives the video signal from the receiver and feeds the amplified signal to the five plan position indicators. The SHM and range mark signals are mixed with the video signal in the video amplifier.

Radar Set Control

The radar set control (fig. 12-23), contains operating controls, high-temperature danger indicators, and a monitoring meter. The meter and an associated meter selector switch are used to obtain readings of magnetron current, receiver crystal current, radar AFC crystal current, or beacon crystal current. The scale of the meter is calibrated to indicate current in milliamperes and in POOR, NORMAL, and DANGER areas.

The controls of the radar set control that are duplicated on the auxiliary control panel of the receiver-transmitter are ineffective when LOCAL-REMOTE switch S3301 on the auxiliary control panel is in the LOCAL position. The adjustments on the radar set control are effective when LOCAL-REMOTE switch S3301, is in the REMOTE position.

Auxiliary Control Panel

The auxiliary control panel (fig. 12-24), contains the receiver adjustments and switches necessary for tests, adjustments, and operation of the radar set.

Many of the controls on the auxiliary control panel are duplicated on the radar set control. LOCAL-REMOTE switch S3301 determines which set of controls is activated. With S3301 in the LOCAL position, adjustments must be made at the auxiliary control panel. With S3301 in the REMOTE position, adjustments must be made at the radar set control. The dual arrangement of receiver adjustments can be seen by comparing the controls found in figures 12-23 and 12-24.

HEIGHT FINDING RADAR

The AN/SPS-10 Radar Set has only range and bearing information to consider for presentation of target information on a PPI Height Finding Radar must have a stabilized antenna system and furnish pitch and roll information. Circuits used to properly present this information are similar to those discussed in chapter 11, Electronic Aids to Navigation, Part II.

In Height Finding Radar certain other criteria must be met. This includes the determination of "slant range" or height of the target. This is accomplished by converting the slant range of the target into its X and Y components (actual height and range components). The

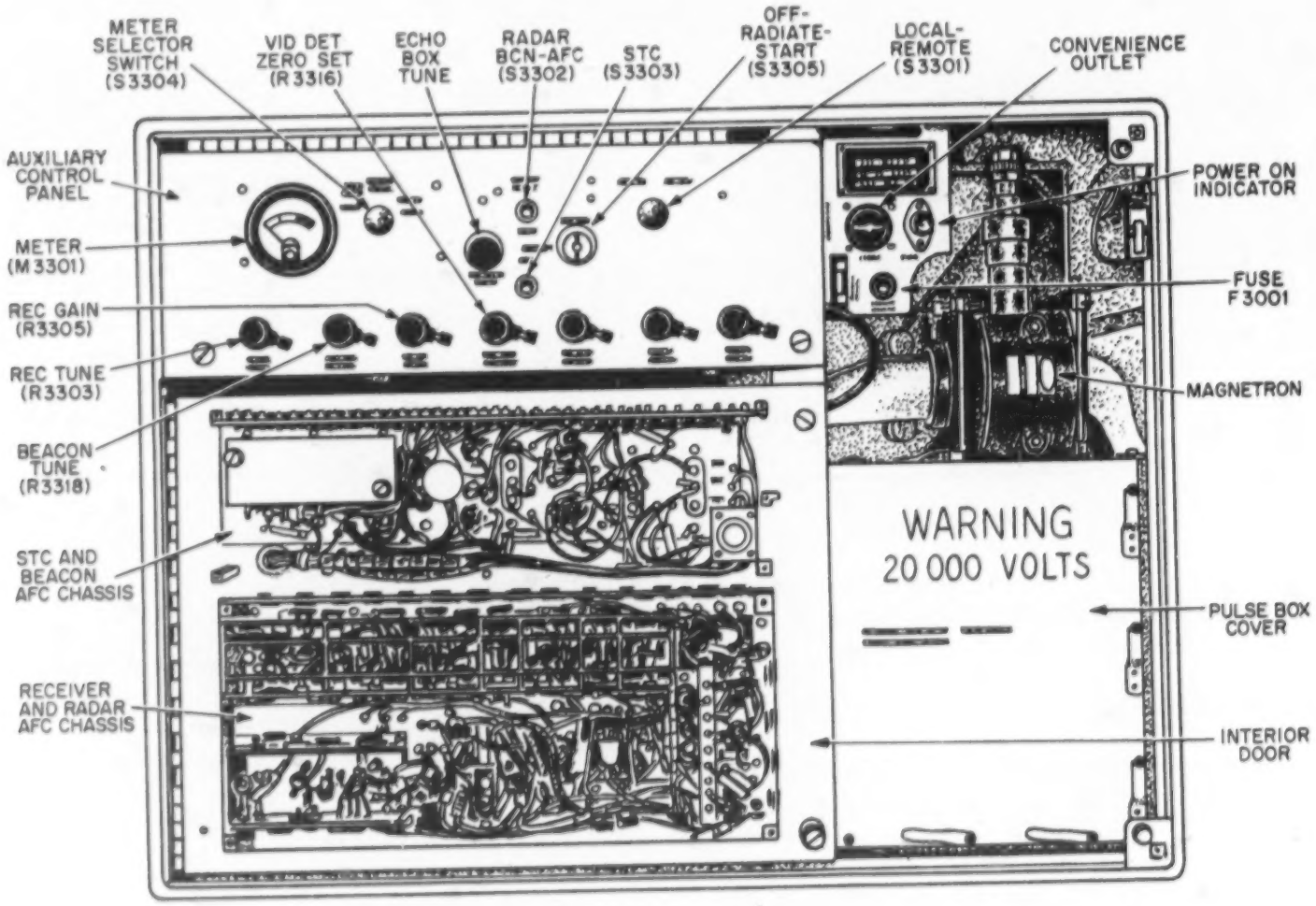

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Figure 12-24.—Receiver-transmitter chassis showing auxiliary control panel.

circuits that perform this function are called sine and cosine circuits.

SINE VOLTAGE

The sine voltage circuit develops a DC voltage proportional to the sine of the beam elevation angle, which is the sum of the reflector elevation angle and the angular position of the antenna scanner. Several methods are available for use in developing the sine voltage. The method that will be described provides maximum accuracy with a minimum of adjustments.

A specially wound precision potentiometer (P1) that includes a fixed 15.474-ohm dropping resistor (R1) and sine commutator are used (fig. 12-25). When the output of a regulated 300-volt supply is connected to the end terminals, 67.6 volts DC will appear across the 4516-ohm section of the potentiometer.

Three moving arms (3, 4, and 5 on the diagram) are used on the potentiometer, and they are mounted on a carriage instead of the usual shaft. These arms pick off voltages that represent the reflector elevation angle. These voltages are applied to the sine commutator, R3, which is a high-speed potentiometer having a resistance taper designed to match the sine potentiometer taper between 10° and 21° rotation. This taper introduces an error in the beam elevation angle voltage for most reflector positions, but the use of arm 4 reduces the error to a negligible amount. Arm 4 also reduces the output impedance of the circuit. The commutator arm, 2, is turned to the scanner angle. Because the angles involved are small, the sum of the sine of two angles is very nearly equal to the sine of the sum of two angles and the arm picks off a voltage that is proportional to the beam elevation angle.

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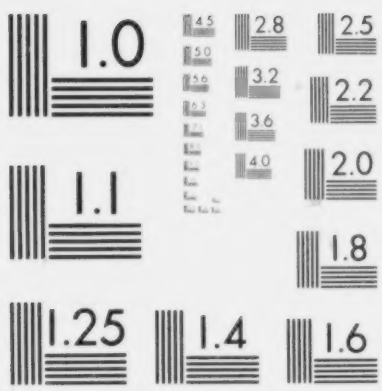

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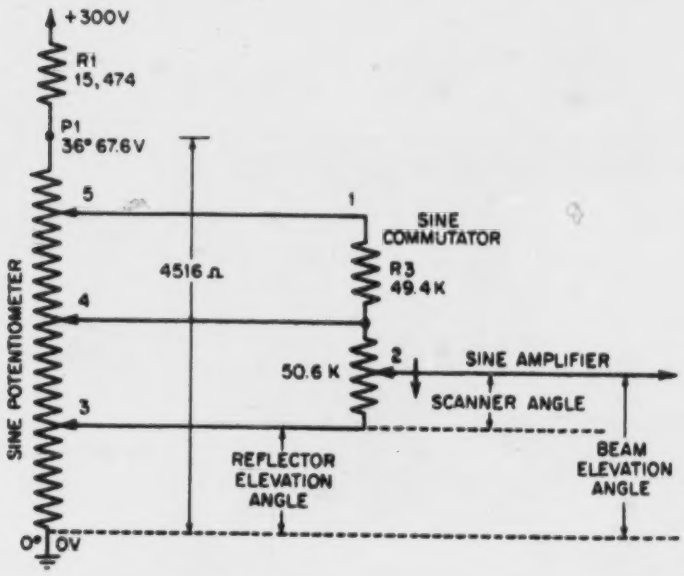

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Figure 12-25.—Simplified schematic diagram for sine voltage network.

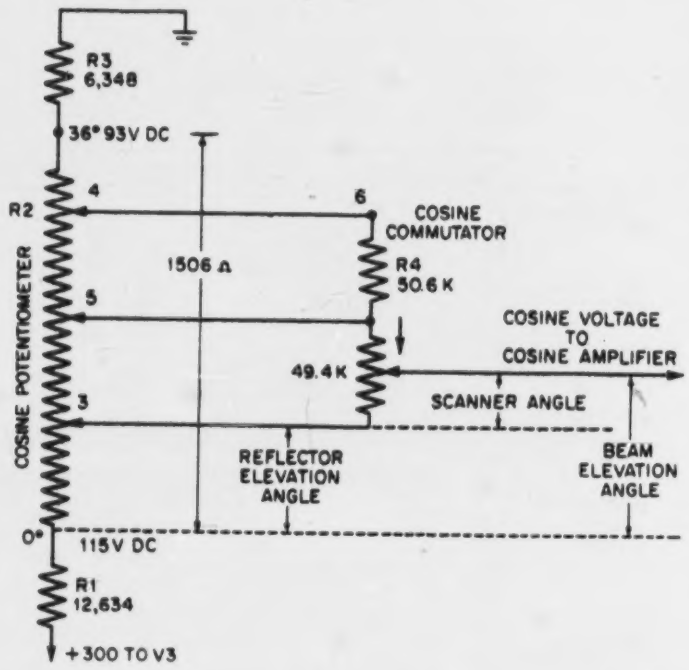

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Figure 12-26.—Simplified schematic diagram cosine voltage network.

COSINE VOLTAGE

The cosine voltage circuit is similar to the sine voltage circuit, but it develops a voltage proportional to the cosine of the beam elevation angle.

The cosine circuit (fig. 12-26) uses a specially wound precision potentiometer that includes a fixed 12,634-ohm dropping section, R1, on the +300-volt (regulated) side and a fixed 6,348-ohm dropping section, R3, on the ground side, of the power supply and a sine commutator, R4. A potential of 115 volts DC corresponds to 0° elevation, and a potential of 93 volts DC corresponds to 36° elevation. The potentiometer arms and cosine commutator are similar in speed, taper, error, and output impedance to those used in the sine voltage network.

The scanner covers a vertical 11° sector. The position of the scanned area depends upon the reflector elevation. Mechanical coupling is used between the scanner and the sine and cosine commutators. The direction of coverage is such that the beam scans the sector from the sky toward the water. Thus, the sine and cosine voltage viewed on an oscilloscope would appear as shown in figure 12-27.

In this system, the reflector elevation can be set anywhere from 4° above the horizon to 29° above the horizon. The 11° sector scan extends from 7° above the reflector elevation to 4° below the reflector elevation. Thus, the beam could be made to scan as far down as 0° or as far up as 36°. The lower limit of reflector elevation, nominally 4°, is called the reflector tilt (T). It is accurately determined at the factory and stamped inside the elevation data box for each antenna.

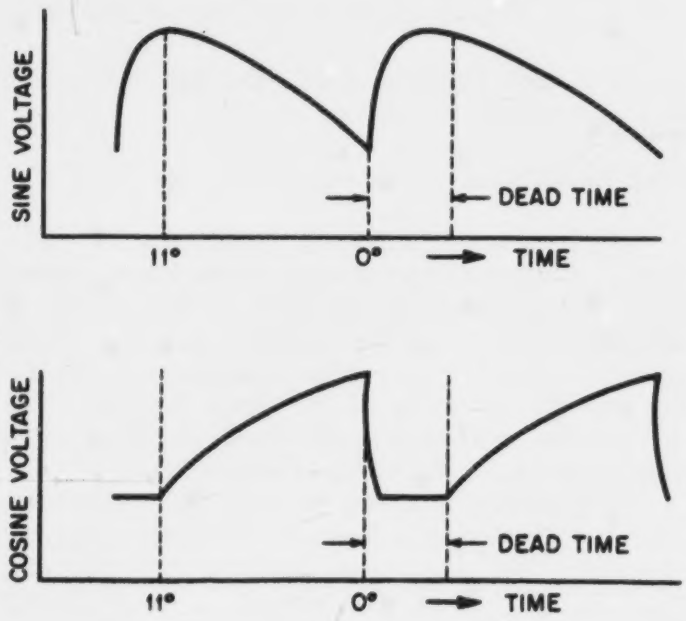

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Figure 12-27.—Sine and cosine waveforms.

The reflector elevation data is transmitted through an 8-to-1 step-up gear train, so that 25° of reflector elevation causes 200 degrees of rotation of the sine and cosine potentiometers. This step-up ratio means that one-degree error at the start of the gear train produces only a one-eighth degree error at the potentiometers and thus provides more accurate data from the potentiometers.

Additional information concerning synchros is contained in Introduction to Electronics, NavPers 10084, Basic Electricity, NavPers 10086-A, and Ordnance pamphlet-1303.

MTI RADARS

Pulse radars, such as the AN/SPS-10, can measure range but they cannot reject clutter echoes from fixed targets. A CW doppler radar can distinguish between fixed and moving targets and measure velocity, but cannot measure range. A combination of the two can be used to measure the range and velocity of a moving target.

Such a combination radar set may be designed either as a pulse-modulated doppler radar or as a moving target indicator (MTI) radar. If the pulse length is more than 10 percent of the wavelength, the radar set is classified as a CW pulse-modulated Doppler system; if the pulse length is less than 10 percent of the wavelength, the set is classified as an MTI system. The shorter pulse length of MTI radars gives them greater resolution and permits them to handle more targets simultaneously. However, the longer pulse length of pulse-modulated Doppler radar permits more efficient recovery of Doppler frequencies and better rejection of clutter echoes from stationary targets.

Although pulse-modulated Doppler has good rejection of ground clutter, the emphasis in development for naval applications is on MTI. This is due to the better resolution of MTI radar.

Although MTI radars are pulse radars, the principles of MTI and pulse-modulated Doppler radars are so similar that the basic principles of MTI will be discussed at this time.

ECHOES

If the echoes from fixed and moving targets, as illustrated in figure 12-28A, are presented on an A scope, they appear as shown. The echoes from a moving target vary in amplitude and give the signal a fluttering appearance; the echoes

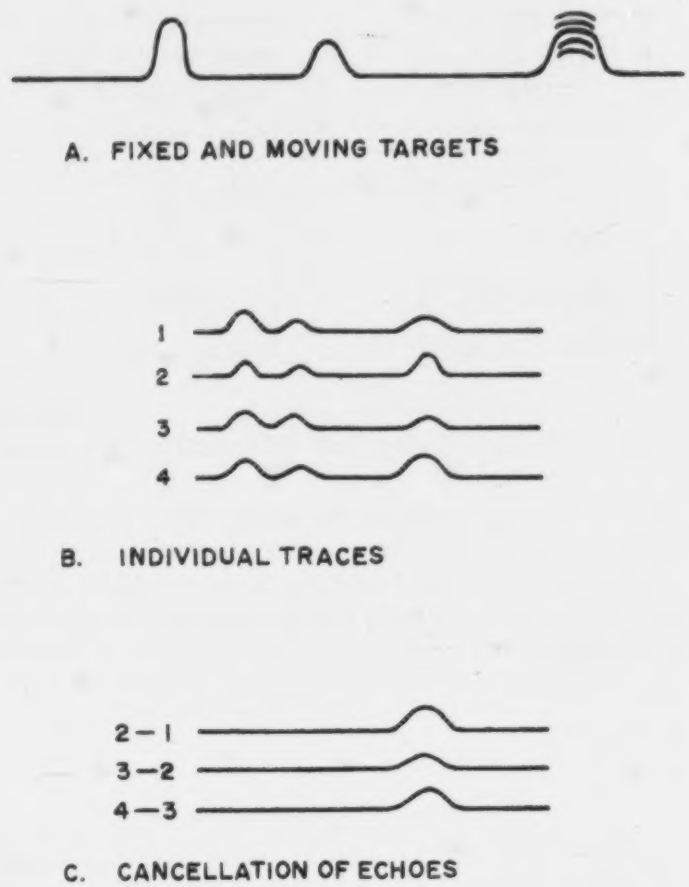

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Figure 12-28.—Echoes from fixed and moving targets.

from a stationary target have steady amplitude. The pulse-modulated Doppler system uses filters to reject the pulses of constant amplitude, whereas MTI systems use pulse-to-pulse cancellation of echoes. The four curves in figure 12-28B are the four individual traces shown superimposed in figure 12-28A. If the signals of sweep 1 are delayed for an interval equal to the repetition period and then subtracted from the signals of sweep 1, all signals of constant amplitude are canceled and only variations between successive pulses remain. The three traces in figure 12-28C show the canceled signals.

DELAY NETWORKS

One method of delaying the pulses is to use a supersonic delay line. The subtraction process can be carried out continuously by the arrangement shown in figure 12-29. The video signals from the receiver are sent through two channels,

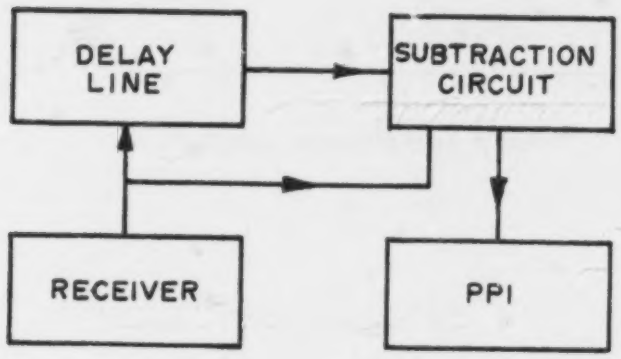

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Figure 12-29.—Delay and subtraction of echoes.

one of which contains the delay line. The undelayed echoes and the delayed echoes are then compared in a subtraction circuit, after which the difference signals are presented on an A or PPI indicator.

One type of supersonic delay line consists of two electro-mechanical (piezoelectric) transducers separated by a medium in which the pulse travels at reduced speed. The video signal is introduced between mercury in the end-cell and that in the delay tube. The voltage across the piezoelectric crystal deforms the crystal. The vibrations are communicated to the mercury in the delay line as a supersonic wave, which travels in the mercury at the velocity of 1,700-feet per second. The length of the delay line and the temperature of the mercury determines the amount of delay. At the output end, the wave causes the crystal to vibrate and produce an alternating voltage. The output voltage is taken from another end cell. The end cells are used as electrodes to introduce and recover the video signals and also to terminate the delay line with the proper impedance.

The response of the crystals does not permit undistorted transmission of the video pulses at

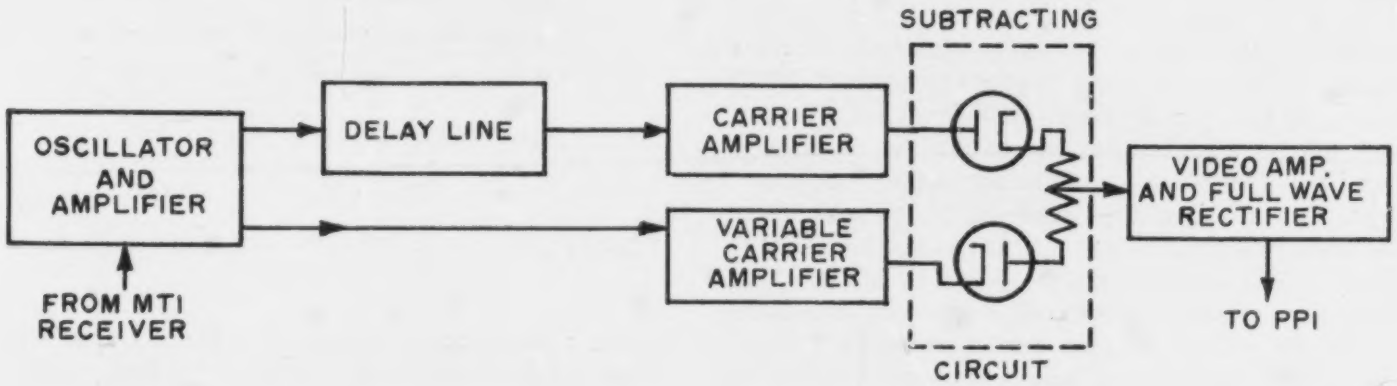

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Figure 12-30.—Compensating for distorted video pulses.

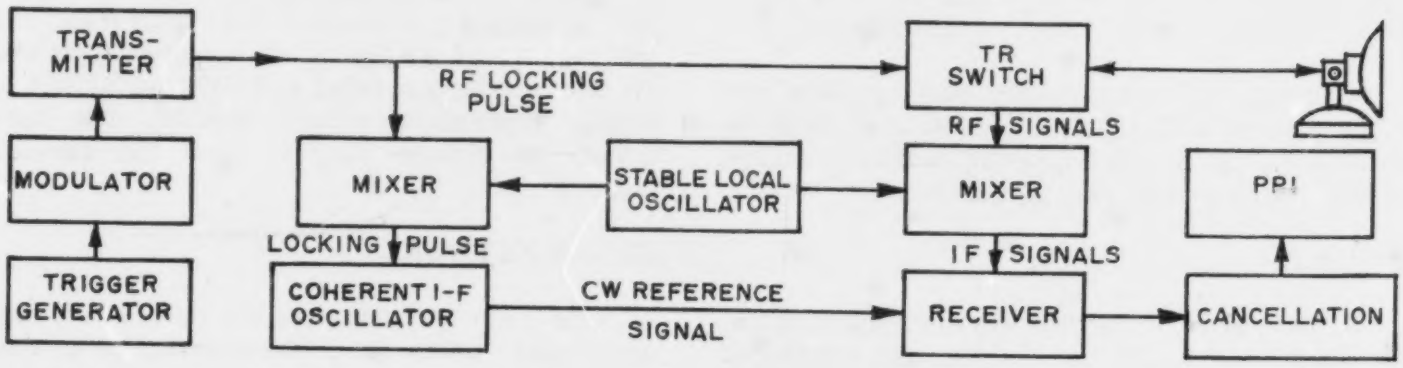

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Figure 12-31.—MTI system.

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the input and output. Also the delaying action of the mercury column causes additional distortion. To overcome this distortion, the delayed video pulses are used to modulate a carrier, the frequency of which is the resonant frequency of the crystal.

The video signals from the MTI receiver amplitude modulate a 15-MC oscillator (fig. 12-30). The amplitude-modulated carrier is sent through the delay line and then subtracted from the undelayed carrier in the subtraction circuit. The subtraction circuit consists merely of two diodes arranged to give opposite polarities at the output, so the signals of equal amplitude produce zero output.

In addition to the supersonic delay line, another device for delaying the echo signals in an MTI system is a storage tube, which is similar to the iconoscope used in television. However, mercury or quartz delay lines are used more often in MTI systems.

MTI SYSTEMS

A complete MTI system is shown in figure 12-31. The echoes are translated to zero frequency by heterodyning in the receiver at the intermediate frequency. The CW reference signal that is used in the heterodyning process is obtained from the coherent IF oscillator.

When pulsed, the transmitter starts with random phase from pulse to pulse. The phase of the reference oscillator must be matched, or locked to that of the transmitter at each instant of pulse transmission, since the phase change beating oscillator and returning echo is the basis for the recovery of the Doppler-shift pulses.

An RF locking pulse from the transmitter is used to phase the oscillator. The locking pulse is said to make the oscillator inherent with the transmitter, and the oscillator is called a coherent oscillator or "coho".

Moving-target indication circuits can be added to a radar aboard planes or ships by compensating for the velocity of the station. The compensation can be done by a phase-shift unit. The phase-shift unit changes the phase of the reference signal at the same rate that the phase of echoes from fixed targets is being changed by the motion of the station. Accurate velocity information could be obtained from an Inertial Navigation system, such as discussed in chapter 14 of this training course.

Various MTI systems are under development for naval purposes. The systems differ in the methods employed for interlocking the transmitter and coho at RF and IF frequencies, and in the type and location of the delay and subtraction circuits employed.

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CHAPTER 13

RADAR REPEATERS

Modern combatant ships are equipped with two or more radar sets. Data provided by these sets is required at various stations, such as CIC, bridge, flag plot, and pilot house. The problems involved with getting this data to these stations are solved with the installation of radar repeaters.

A radar repeater can be compared to extra loudspeakers on a radio set. With radar, as many repeaters as needed can be connected to one radar set, which then becomes the signal source for all repeaters. A Guided Missile Cruiser for example, may have as many as 30 repeaters.

Each repeater has its own power supply, sweep circuits, and CRT. The repeater receives synchronizing triggers, video, and antenna position data from the master radar through connecting cables. An operator at a remote repeater can switch from one radar set to another, thereby obtaining data from several master locations without leaving his station.

Radar repeaters have several different types of displays, depending upon their intended use. We will list three types of displays available (standard, off-center, and range-height) and then give a brief description of each before discussing a representative repeater.

The STANDARD DISPLAY radar presentation is a conventional plan position indicator (PPI). The sweep path is circular around a point located in the center of the CRT screen. This central point represents the location of the radar antenna. The distance to an object being picked up by the radar may then be determined by using the range rings and/or range strobe.

The OFFCENTER DISPLAY is a modified standard display used to enlarge a sector being covered by the sweep. When a target is barely visible on the face of the CRT at some given range, this enlarging property can be utilized by moving (off-centering) the ship's position (trace origin) to some other part or off the screen and centering the target indication at a lower sweep range (sweep speed), thereby increasing the relative size of the target. It is possible to use the off-centering cursor to determine the range and bearing between two targets on the display. The operator may discontinue the normal cursor operation and use the offset hand-crank (or joystick in the AN/SPA-8C) to operate the cursor. By doing this, he can place the cursor over the blip from a friendly plane or ship and determine the range and bearing between them and any target.

The RANGE-HEIGHT DISPLAY is, as the name implies, a radar representation, which makes it possible to determine both the range to an aircraft and the height at which the aircraft is flying.

This representation is so arranged that slant range is measured along the horizontal axis, and height along the vertical axis. Targets appear as vertical pips that are bisected with the height line for height measurement.

BLOCK DIAGRAM

A block diagram of a representative radar repeater (AN/SPA-8 series) and the waveforms at various points (fig. 13-1) show how the various sections are related to the operation of a complete unit.

All of the sections represented by individual blocks in the block diagram are not used for certain types of operation. On the other hand, one section may be connected to several other sections at the same time. In our preliminary discussion we will assume that the panel switch that controls the function of the repeater is in the CURSOR ON position because most of the sections, but not all, will be used for that function. Keep in mind, while reading the next several pages, that a detailed discussion of the

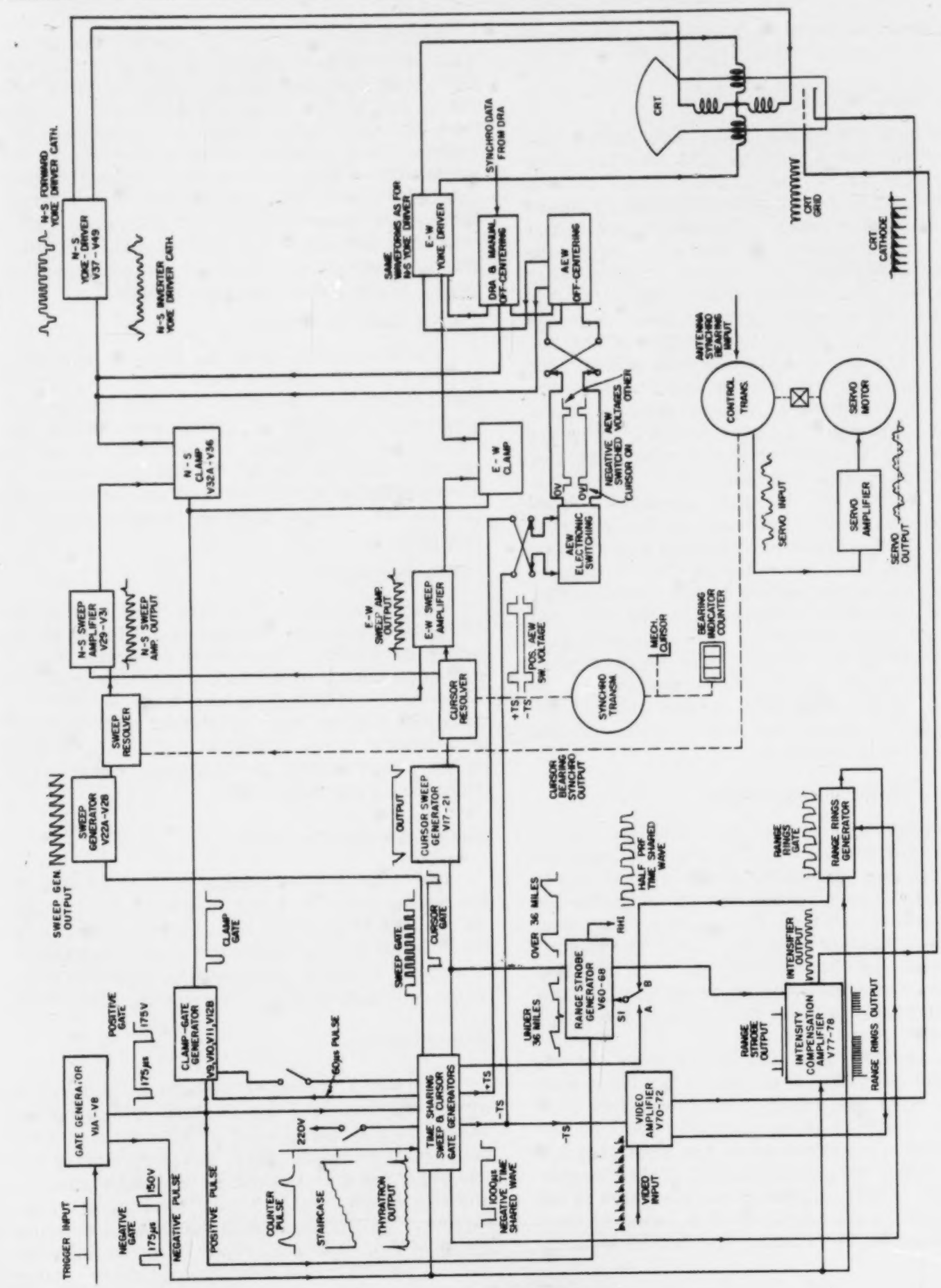

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Figure 13-1.—Block diagram of a representative radar repeater.

theory of operation of each section will be given later.

GATE GENERATOR

The gate generator is the basic timing circuit and furnishes positive and negative gates that trigger all of the circuits in the correct sequence. The repeater is triggered by pulses from the master radar. The input pulses trigger a gate multivibrator (discussed later) so that the multivibrator starts at the same time the radar transmitter pulse starts. The length of the gate from the multivibrator can be varied by the range selector control in another section of the repeater. The pulse repetition rate of the radar transmitter also controls the length of the multivibrator gate. However, the gate generator automatically shortens the gate length if the range selected by the operator is not satisfactory for use with the pulse repetition rate of the radar.

The output of the gate generator which actuates the display circuits of the indicator contains both positive and negative gates having the waveshapes shown in figure 13-1. The negative gate pulse is applied to the time-sharing circuits, intensity compensation circuits, and the range rings generator. The negative gate pulse controls the starting of a shock-excited oscillator in the range rings generator. The positive gate is applied to the clamp-gate, time-sharing, sweep and cursor gate, and the range-strobe generators.

TIME-SHARING GENERATOR

The time-sharing generator contains a staircase counter circuit. This counter is triggered by the trailing edge of the negative pulse and is used as the basic timing unit to determine the type of sweep (PPI or cursor) that will occur during a particular trigger period. The counter actuates a flip-flop multivibrator circuit that furnishes two time-sharing waves used to control coincidence mixers that produce the sweep and cursor gates.

The positive gate fed to the time-sharing generator provides a second coincidence gate that operates the sweep- and cursor-gate generators. Because of the staircase counter circuit action, nine sweep gates are generated and then a cursor gate is generated. This nine-to-one ratio of sweep gates to cursor gates is not maintained for all functions. It is, however, used in the "Cursor On" function that we are describing.

Switch S1 is in the (B) position as shown, when the function control is set for "Cursor ON" operation, and the time-sharing wave output is fed to the range strobe generator. The time-sharing wave provides one of the two coincidence gates required to enable the range strobe generator. The positive gate provides the other coincident gate. The gate pulses coincide during the cursor interval only, and the range strobe occurs at the same time. The output of the time-sharing generator includes a 60-μs pulse that begins at the end of the positive gate.

Clamp-Gate Generator

The 60-μs pulse from the time-sharing generator and the positive gate from the positive gate generator are mixed in the clamp-gate generator to form a clamp gate. After the clamp gate is formed to the shape shown in figure 13-1, it is fed to the N-S and E-W clamp sections to disable them during the video and cursor sweeps when no tracking strobe is required.

Sweep Generator

The sweep gate that occurs on nine out of ten triggers (when time sharing is on) is fed to the sweep generator. The sweep generator uses a sweep oscillator to produce a negative sawtooth waveshape. Provisions are made so that the sawtooth voltage may be divided and switched at a definite range setting so that a voltage wave of the proper slope is delivered to the sweep resolver on all ranges.

Cursor Sweep Generator

The cursor sweep generator is similar to the sweep generator but its sweep occurs only on the 10th trigger out of a group of 10 triggers. The circuit is idle during the other nine sweeps. The cursor sweep generator is actuated by the cursor gate from the time-sharing generator.

Sweep Resolver

The sweep resolver is actually a form of synchro transmitter that has two rotor windings wound on a single rotor displaced 90 electrical degrees from each other, and one primary and one auxiliary stator winding. The rotor is mechanically coupled to the shaft of the control transformer, which responds to the antenna rotation and position. A single, linearly increasing voltage is fed into the resolver primary stator

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winding and produces a current flow in the winding. Because of the current flow in this winding, voltages are induced in the auxiliary stator winding and the two rotor windings. The envelopes of the induced rotor voltages are made to vary as the sine and cosine, respectively, of the shaft angle of the radar antenna. The auxiliary stator winding is used for feedback purposes discussed later.

Cursor Resolver

The cursor resolver is identical to the sweep resolver, except that its rotor is mechanically coupled to the bearing control counter and to the mechanical cursor. By using the mechanical cursor adjustment (handwheel), the operator can place the cursor line anywhere on the CRT display. The electronic cursor will move along with the mechanical cursor and remain parallel to it.

N-S and E-W Sweep Amplifiers

The output voltage of the resolvers is too small for effective use; therefore it must be amplified. Eventually, as we shall show, the cursor voltages in amplified form are applied to the CRT yoke windings. These windings are designated N-S (north-south) and E-W (east-west) to denote their position in the circuitry.

The output voltage from one secondary winding of the sweep resolver and the output voltage from one secondary winding of the cursor resolver are fed to the input of the N-S sweep amplifier. The output voltages of the secondary winding remaining on each resolver are coupled to the input of the E-W sweep amplifier. Both sweep amplifiers are straight voltage amplifiers.

The amplifier input circuitry is arranged so that the sum of the voltages from each resolver is applied to the input of the amplifier. Straight voltage amplification then builds these voltages up to values suitable for clamping and mixing in the yoke drivers.

N-S and E-W Clamps

The clamping circuits are required to prevent shifting of the start time of the sweep voltages as the resolver output varies. To prevent time shifting, the output of the sweep amplifiers is clamped to near zero volts during the off time of the sweep. Feedback type clamp circuits are used. The period of time during which the clamping action takes place is determined by the off time of the clamp gate. As mentioned in the discussion of the clamp gate generator, a 60- μs pulse is mixed with the positive gate to form a clamp gate. The clamp gate is purposely made 60 μs longer than the sweep gate to insure sufficient time for the sweep to recover control before the clamps take hold.

Yoke Drivers

Two separate amplifiers are used to drive the N-S and E-W yokes. Both amplifiers are supplied with sweep and off-centering voltages, and produce deflection-yoke currents proportional to the sum of the input voltages. The rate at which the yoke driver amplifier output varies the current through the yoke coils determines the sweep range in miles per radius. The yoke driver output is determined by the range selector control (not shown). This control is a four-stack, nonlinear potentiometer that controls the amount of feedback in the amplifiers.

N-S and E-W Limiters

The N-S and E-W limiters are used to prevent overloading the yoke drivers, which overload easily. These stages can only supply enough current to deflect the spot on the CRT one radius from the center before they overload. Therefore, it is necessary to keep the amplifier from trying to follow the incoming signal when the signal is strong enough to exceed the limit. Limiter stages are incorporated in the yoke driver circuit, and these stages cause the yoke driver gain to drop almost to zero when the spot is deflected approximately 10 percent of the radius beyond the edge of the screen.

Video Amplifier

The three voltages fed to the video amplifier are the negative time-sharing pulse, the video input signal voltage, and the signal voltage from the range-rings generator. The video amplifier combines these three voltages into a single voltage called the video output voltage. The amplifier output is coupled to the cathode of the CRT through a cathode follower stage that provides the necessary impedance match.

The negative time-sharing signal blanks out the video signal during the cursor time and produces an output pedestal that intensifies the cursor sweep.

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Provisions are made to change the point or points to which the range-rings oscillator voltage is fed. This is done by switching, which provides a means by which range rings centered about the origin of the sweep or range marks on the electronic cursor, or both, are produced.

Intensity Compensation Amplifier

A negative gate from the gate generator and a pulse from the range strobe generator are fed to the intensity compensation amplifier. As the name implies, this amplifier compensates for changes that would cause variations in spot intensity. To do this, a blanking voltage is applied to the CRT grid, except during the interval of the negative gate. The amplifier receives the range strobe pulse and adds it and the cursor origin intensification pulse to the cursor sweep in the CRT display. Compensating circuits in the amplifier help to hold the spot brightness constant for different repetition rates and ranges.

DRA and Manual Off Centering

The DRA and manual off-centering section is used to cancel the motion of the ship so that land masses are stationary on the display. Information from the ship's dead reckoning analyzer (DRA) is required when this type of display is used. The DRA operation uses information from a synchro, but provisions have been made so that the operator can manually control the DRA feature. When manual off-centering is used, the operator can manually control the DRA feature. Also when manual off-centering is used, the operator can center the sweep on some point other than his own ship's position. Distances and angles to a third point can then be determined.

AEW Off-Centering

For airborne early warning applications, equipment in the block labeled, AEW OFF-CENTERING, is substituted for that used for DRA and MANUAL OFF-CENTERING. For plane tracking purposes, the radar operator off centers his scope display so that it is centered on the plane being tracked, and the tracking strobe then follows his own ship. This kind of operation is time-shared off-centering. That is, time-shared off-centering voltages are produced in the AEW electronic switching circuits. These voltages, by electronic switching, determine the time during which the AEW off-centering potentiometers will be effective.

AEW Electronic Switch

The AEW electronic switch provides a DC off-centering pedestal voltage that is applied to the input of the yoke driver through AEW potentiometers. The potentiometer output is used to off-center either the video or cursor sweeps, depending upon the type of operation being used—that is, tracking, final, or general purpose off-centered cursor operation. In the tracking and general purpose operation of the indicator a roving cursor is provided. The name comes from the fact that the operator can move this cursor about over the display. The DC pedestal voltage is applied only during the interval of the cursor sweep.

When the indicator is being used in tracking operations, the roving cursor may be replaced by a tracking strobe. When this is done, the DC pedestal voltage is applied during the tracking strobe time (cursor interval).

To displace the video sweep for fixed operation, the DC pedestal voltage is applied during the video sweep time.

Range Strobe Generator

The positive gate pulse from the gate generator is applied to the input of the range strobe generator and used as one of two coincidence gates for enabling the range strobe generator. If the function control switch S1 is in position A, the positive time-sharing wave from the time-sharing generator is used as the second coincidence gate.

When this connection is used, a range strobe appears on the cursor.

When S1 is in the position B, a half-frequency gate from the range-rings generator is used for the second coincidence gate, and a range strobe ring appears on the display. The position of the range strobe or the radius of the range strobe ring is determined by a control that is geared to the wipers of the potentiometers in the range strobe generator. The control is also geared to counters that indicate the distance of the range strobe from the origin of the cursor, or the distance of the range strobe ring from the origin of the video sweep.

The indications of distance along the cursor are in the form of bright spots. The increased spot intensity at the origin of the cursor sweep is derived by coupling the cursor gate pulse into the circuits of the range strobe generator.

The range strobe generator, marked RHI (Range Height Indicator) furnishes range information to a remote point in the form of an output of a thyratron tube in the range strobe generator.

The thyratron is triggered by the range strobe at the correct time for RHI indications.

Range-Rings Generator

A negative gate from the gate generator is used to enable the range-rings generator. After being triggered by the negative pulse, the range-rings generator delivers uniformly spaced pulses to the video amplifier. The pulses cause spots of increased intensity to appear on the sweep. As the sweep revolves, these bright spots along with the screen persistance of the CRT, cause rings to appear on the display. The spacing between rings is determined by the tuned circuit in use in the range rings generator. By switching in different tuned circuits, the range ring spacing can be set to 1, 2, 5, 10, 20, or 50 miles. This action enables the operator to determine within close limits the range (distance) to a target.

CIRCUIT ANALYSIS

In order to recognize faulty operation and to determine possible causes of trouble, the ET must know how each section (fig. 13-1) in the complete unit functions. In addition, he should know the waveforms that should be present at various test points. Where possible, we will show the kind of waveform that should be expected at the different test points along with the circuit analysis.

GATE GENERATOR

The gate generator section which is regulated by the radar triggers, gate trigger, and gate multivibrator circuits, is the basic timing unit of the indicator and includes the fundamental timing circuits for the whole set. If operating improperly, it will affect the operation of the entire repeater. Therefore, any defect in the gate generator section may cause distortion of waveforms at other circuits.

Gate Generation and Shaping

A schematic diagram for gate generation and wave shaping is shown in figure 13-2. The gate generator is basically a one-shot multivibrator consisting of V2A and V2B, triggered by the amplifier, V1A. Tube V3 is a cathode follower and is the driver for V2B. Other tubes in the generator circuit provide a means for sharpening the leading edge of the gate, and for obtaining continuous variable control of the gate length.

The gate trigger amplifier, V1A, is normally biased below cutoff. The gate action is triggered by the leading edge of a positive 50-μs pulse that is coupled to the grid of V1A by C1. The plates of V1A and V2A are directly coupled to the grids of V3.

The application of a positive pulse (test point 1 waveform) from the trigger multivibrator to the grid of V1A results in a negative pulse at the plate and at the grids of V3. The negative pulse at the grids of V3 is reproduced across cathode resistor R5 and is coupled to the grid of V2B through the RC network composed of C2 and R6. Normally V2A is cut off and V2B is conducting. When the leading edge of the negative pulse from V2A reaches the grid of V2B (V2B normally conducting) the plate current of V2B is reduced. The rise in plate voltage of V2B causes V2A to conduct. The action causes a further decrease in the voltage at the plate of V2A, and thus drives the grid of V2B below cutoff. All of the action that has been described occurs on the leading edge of the negative pulse and completes the multivibrator switching.

When the switching action has been completed, capacitor C2 discharges, and the voltage at the grid of V2B rises exponentially toward the voltage established by the voltage divider R7, R8, and R9. The time constant is determined primarily by C2 and R6. When the grid of V2B rises above cutoff, the tube conducts and its plate voltage drops. This action drives the grid of V2A toward cutoff. The voltage rise at the plate of V2A causes an increase in the voltage drop across R5 which causes the grid potential of V2B to rise sharply to a higher level. The plate voltage of V2B then drops sharply and cuts off V2A. The rapid charging of C2 through the grid circuit of V2B and the cathode of V3 completes the multivibrator cycle, and the circuit is then ready for the next trigger.

The output at the plate of V2B is a positive-going, square-wave gate. Its leading edge starts with the trigger pulse, and its trailing edge occurs when V2B again conducts. The length of the gate is determined by the length of time that V2B is cut off. The cut-off time of V2B is determined by the magnitude of the initial negative

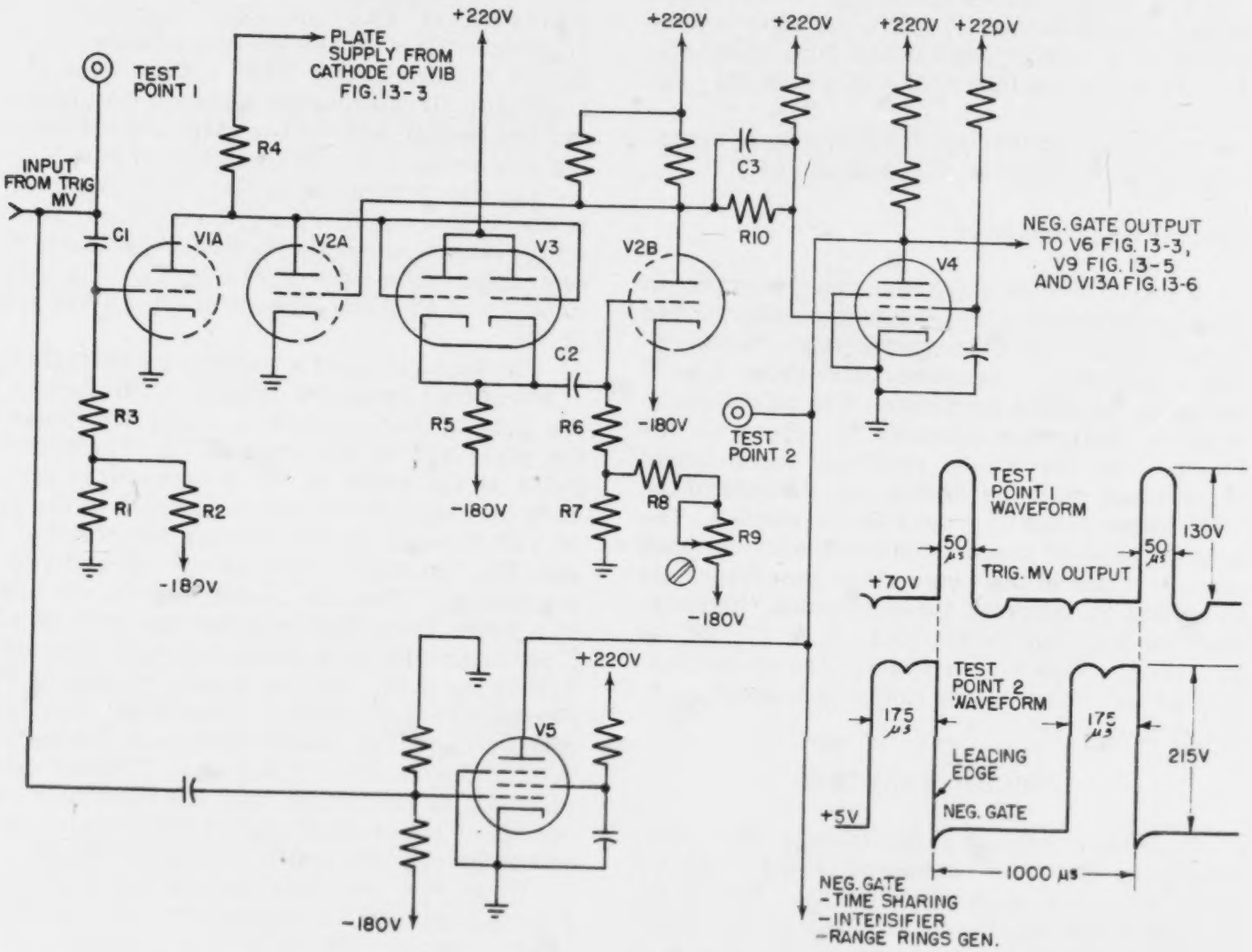

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Figure 13-2.—Gate generation and shaping.

swing at the plates of V1A and V2A. The more negative the grid of V2B is driven, the longer it takes C2 to discharge enough to raise the grid above cutoff level.

Another factor in the cutoff time of V2B is the time constant of the RC network composed of C2 and R6. The longer the time constant, the longer the gate.

The voltage supplied by the voltage divider formed by R7, R8, and R9 also affects the length of the gate. The gate length may be adjusted by setting potentiometer R9. The greater the voltage at the junction of R7 and R8, the faster the grid will rise toward the cutoff level and the shorter will be the gate.

The maximum gate time is preset for a gate length of approximately 3660 μs. This is equivalent to 300 nautical miles, based on one nautical mile for 12.2 μs.

The gate waveform from the plate of V2B is coupled to the control grid of the negative-gate generator, V4, and appears in an inverted form at its plate, as shown in the waveform for test point 2.

The output from the plate of V4 is the negative gate, which provides synchronous enabling of the following circuits in the indicator.

The gate shaper tube, V5, is used to speed up the leading edge of the negative gate. The positive 50-μs trigger pulse input to the gate generator is coupled to the normally cutoff control grid of V5. Because the plate load resistor for V5 is also the plate load resistor for the negative-gate generator, V4, the sharp

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drop in plate voltage is also present at the plate of V4.

The leading edge of the negative shaper pulse occurs at the start of the trigger input pulse. It is slightly ahead of the start of the gate waveform at the grid of V4, and as a result, the negative shaper pulse speeds the start of the leading edge of the negative gate.

Although the pulse at the grid of V5 is of short duration, the wave form at its plate has the full preset gate length duration because the plate voltage of V5 is held down by the output of V4.

A special circuit automatically shortens the length of the gate, when the equipment is connected to a radar having a repetition rate so high that succeeding trigger pulses would ordinarily fall within the gate period.

The waveforms of figure 13-2 indicate that a high repetition rate could cause alternate multivibrator triggers to occur during the negative gate interval and be counted down. The length of the negative gate is automatically shortened when the repetition rate of the radar is so high that there would be less than 175 μs between the end of one negative gate and the start of the next.

Gate Shortening and Length Control

The schematic for an automatic gate shortening and gate length control circuit is shown in figure 13-3. The automatic gate shortening circuit includes tubes V6, V7, and V1B.

The negative gate from V4 is coupled to the grid of V6, and produces a positive gate as shown in figure 13-4 A, at the plate of V6. The positive gate is applied to the grid of V7 through the integrating network, R16, R17, and C6, which partially integrates the pulse so that the rise time of the leading edge and the fall time of the trailing edge are increased. As a result the waveshape is changed to the waveshape shown in figure 13-4, B.

The trigger pulse and the leading edge of each positive gate are mixed at the grid of V7. This means that waveforms A and B are combined with the trigger pulses, and the resultant waveform is shown in figure 13-4, C.

When the PRF is low, the integrated gate voltage has time to return to the base line between gates. The DC voltage at the grid of V7 is adjusted by the recovery time potentiometer, R18, so that at PRFs, which allow about 175 μs or more recovery time, the top of the trigger pulse will be below the cutoff level of V7. Therefore, V7 never conducts when the PRF is low.

At high PRFs when the recovery time is less than 175 μs, the integrated trailing edge of one gate does not have time to return to the base line before the next gate starts. As a result, the trigger pulse, which is added at the start of the next gate, starts at a higher level and reaches a value that is high enough to make V7 conduct. The result is a waveform like the one in figure 13-4, D. Therefore, the voltage output of V7 is a series of pulses which are applied to the grid of V1B. These pulses are reproduced on the cathode of V1B, which supplies the plate voltage for V1A and V2A in the multivibrator.

The amount of plate voltage supplied by V1B controls the magnitude of the initial negative voltage change at the plate of V2A, which in turn controls the operation (cuts off) of V2B. The lower the plate voltage, the smaller the negative change at the plate, and the shorter the cutoff time for V2B. Therefore, the lower the supply voltage, the shorter the gate.

Shortening the gate allows more recovery time, which permits the integrated trailing edge of the gate to reach a lower level so that V7 will conduct less and produce the waveform as shown in figure 13-4, D. The shortening process continues until a balance is reached, and the conduction time of V7 (fig. 13-3) is just sufficient to give the amount of gate shortening desired. The exact condition for this balance is determined by the setting of R18. The final balance condition is effected by the position of S1. If S1 is closed the DC level at the cathode of V7 is raised. However, the operation of the automatic gate shortening circuit remains the same, except that the minimum recovery time has changed to 125 μs.

The gate length control circuit is designed so that there are at least six cathode-ray tube radii or 125 miles of sweep, whichever is shorter, on range selector settings below 34 miles. On settings above 34 miles, there are six radii or up to 300 miles of sweep available, whichever is less. When the range selector is set at 300 miles, the wiper of R20 is near the positive end. In this condition, diodes V8A and V8B cannot conduct because the cathode of V8B is positive with respect to its plate, and the diode acts as an open circuit. If the trigger input PRF is low and there is no automatic gate shortening from V7, the voltage at the grid of V1B is constant at approximately 150 volts, and the gate length is fixed at 300 miles.

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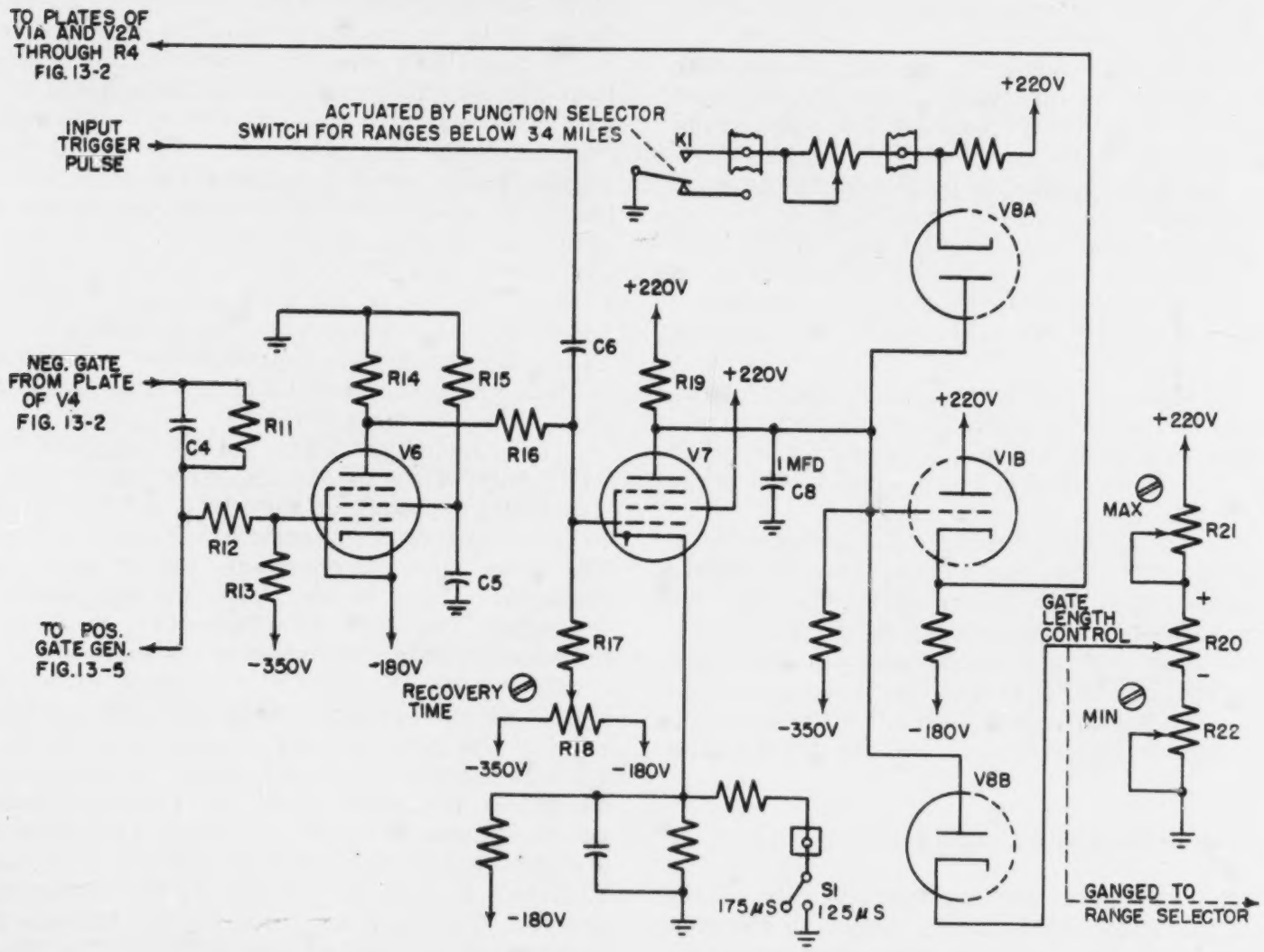

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Figure 13-3.—Automatic gate shortening and gate length control.

When the wiper of R20 is turned toward the negative end of the resistance strip, a lower potential is tapped off the divider. When the potential reaches approximately 150 volts (at about the 50-mile range), the cathode of V8B becomes negative with respect to its plate and the diode conducts, which effectively ties the grid of V1B to the wiper of R20. After V8B conducts, the grid of V1B is no longer held at a constant level, and the grid voltage decreases smoothly as the range selector is turned toward a lower range. Accordingly, the voltage at the grid of V1B decreases and shortens the gate length smoothly.

Starting at the time V8B conducts, the gate length becomes equal to six times the range selector setting. The gate length continues to shorten smoothly until a switchover point from slow to fast range is reached at the 34-mi setting of the range selector. Just before the switchover, the voltage at the grid of V1B is still sufficiently high to provide a gate length of six times the range selector setting, or about 204 miles. As the range selector dial is turned through the switchover point, a cam geared to the shaft of the range selector releases a sensitive switch that energizes relay K1. When the relay pulls in, the cathode circuit of V8A is completed to ground, and the diode, V8A, conducts. This lowers the voltage at the grid of V1B to a value that decreases the gate length from 204 miles to 125 miles. At the time the grid voltage of V1B decreases, V8B will stop conducting. The voltage from the wiper arm of R20 will then no longer affect the gate length.

The reason for switching in the 125-mile limit voltage as the range selector dial is turned through 34 miles is that, on the fast (short)

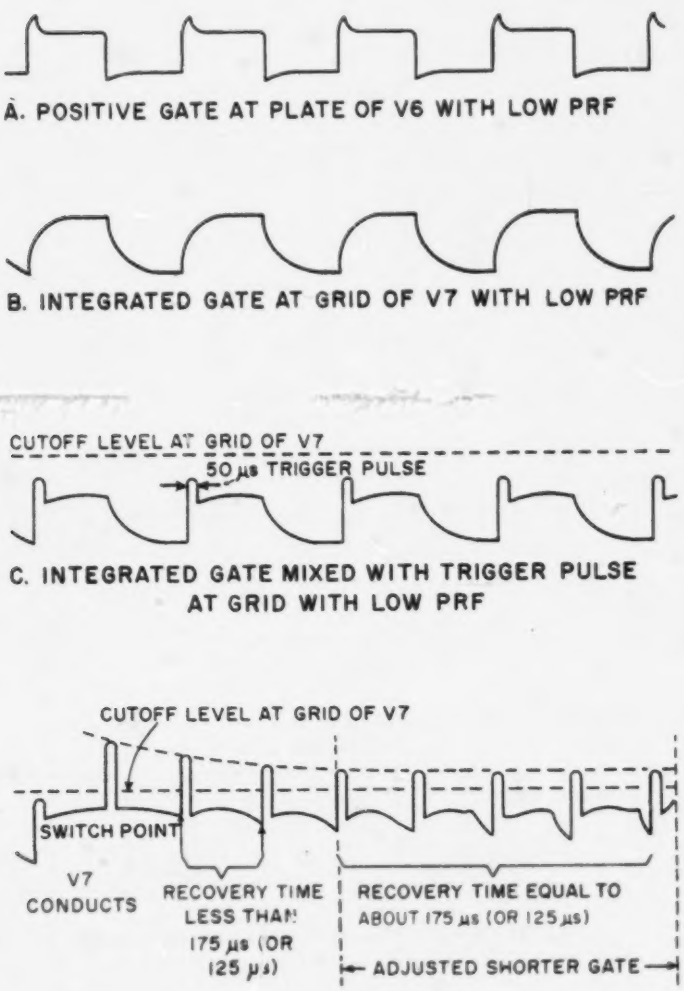

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Figure 13-4.—Automatic gate shortening waveforms.

ranges, the resolver drivers can tolerate no more voltage than that which will provide 125 miles of sweep. This is because the sweep slope for the fast range sweep is four times as steep as for the slow (long) range sweep. Resistors R21 and R22 are the maximum and minimum gate length voltage adjustments.

Positive Gate and Clamp Gate Generators

Figure 13-5 shows the schematic for a positive-gate and clamp-disabling gate generator. The positive-gate generator is V9, and the input to this stage is the negative gate from V4. The normal amplifying action of V9 reverses the polarity of the negative input gate and provides a positive gate at the plate. This positive gate is used to drive the number 2 grid of V10A, which is a clamp gate generator. The signal is also used to drive other circuits described later.

The clamp gate is used to disable the sweep clamp circuits for a period of time longer (by 60 μs) than the sweep waveform. This delay gives the sweeps enough time to recover before the clamps operate to hold the sweep baseline near zero volts between sweeps.

The clamp gate generator, V10, receives signals from two different sources and operates as a mixer. The positive gate is applied to the number 2 grid. The number 7 grid receives a 60-μs, positive, square-wave pulse from the time-sharing counter (fig. 13-6). This 60-μs pulse arrives at the end of the positive gate pulse and lengthens it so that the output at the plates of V10 is a negative gate 60-μs longer than the positive gate.

Tube V11 is an amplifier-inverter and cathode follower. The output of the cathode follower is a positive clamp gate, which starts at the same time as the normal gate but lasts 60 μs longer, and is applied to the sweep-clamp circuits. The clamp gate is used to disable the clamps, and clamping occurs only between clamp gates. When the function selector switch is in the AEW TRACK STROBE position, however, the clamp gate is disabled via V12B during the tracking strobe time, which is the normal time occupied by the cursor sweep.

Time Sharing

Although the video and cursor sweeps appear to be present on the CRT screen at the same time, they are actually present on a nine-to-one shared basis. That is, a sequence of nine video sweeps occur and then the 10th video sweep is disabled, and a cursor sweep occurs.

To obtain the nine-out-of-ten (video) and one-out-of-ten (cursor) sweeps, the negative gate from the gate generator is differentiated and fed to a one-shot, cathode-coupled multivibrator. The pulse output of one-half of the multivibrator is applied to a staircase counter circuit, which delivers one output pulse for every 10 input pulses. It is the counted-down output of the staircase counter that is used to produce simultaneous disabling of the video sweep gate generator and enabling of the cursor sweep gate generator. The pulse output of the second half of the multivibrator is used to reset a time-sharing, flip-flop multivibrator circuit after it has been flipped over by the output

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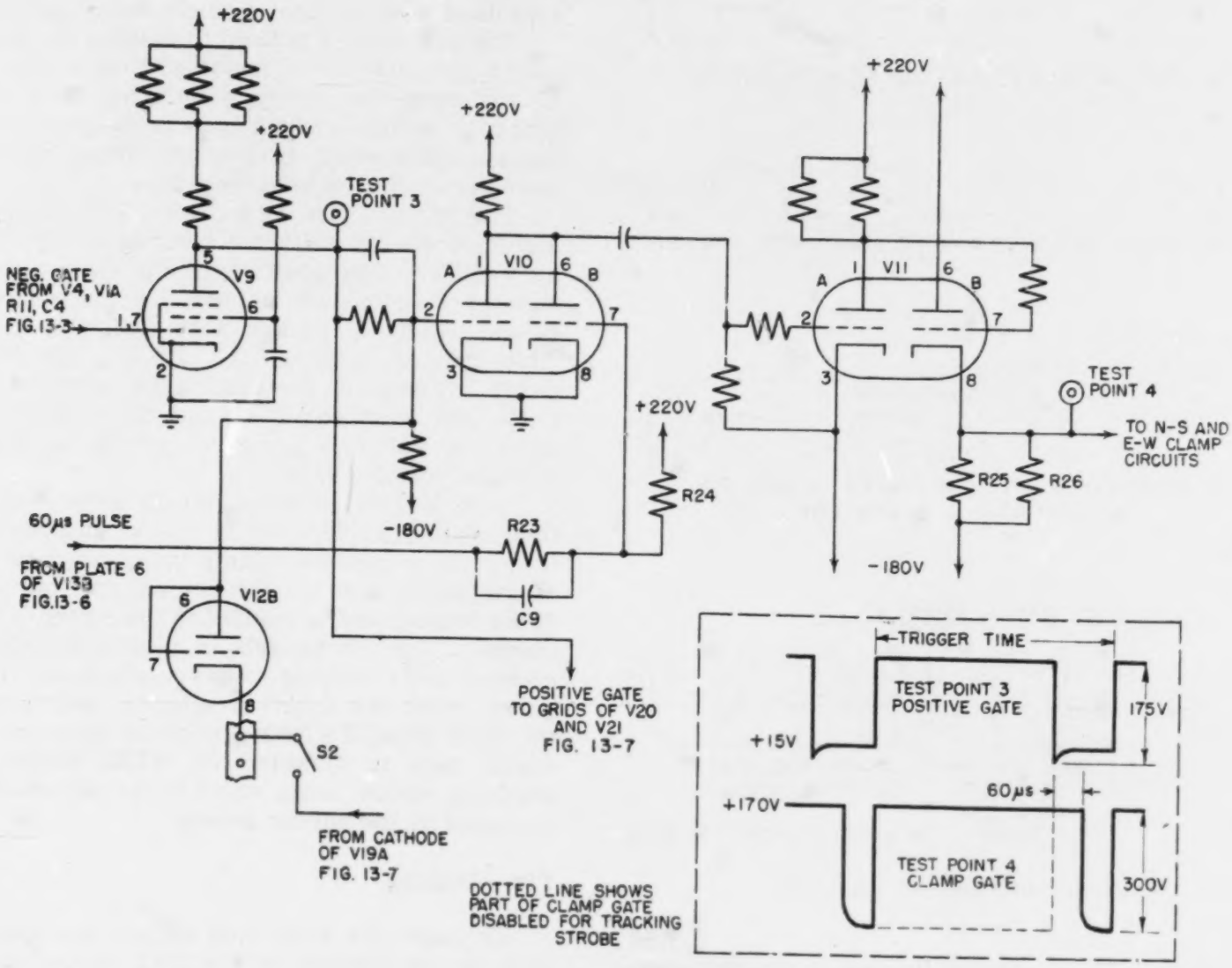

Figure 13-5.—Positive gate and clamp gate generator.

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of the staircase counter section. (The second output of the multivibrator is also coupled to the clamp gate generator.)

The outputs of the flip flop are fed to cathode followers, and the outputs of these stages are two rectangular waveforms of opposite polarity, which form the positive and the negative time-sharing waves. The positive time-shared wave is maintained at approximately +45 volts during the nine video sweep intervals, and swings more positive to +165 volts during the cursor interval. This wave is used to enable the cursor-gate generator. The negative time-sharing wave is maintained at approximately +160 volts during the nine video sweeps, and swings in a negative direction to +30 volts during the cursor interval. This waveform is used to enable the video sweep gate generator.

Figure 13-6 shows the schematic diagram and wave shapes for the time-sharing counter. The negative gate from the plate of V4 is coupled to the number 2 grid of V13 through a differentiating circuit C10 and R27. The leading edge of the gate wave-form produces a negative pulse, and the trailing edge, a positive pulse. Tube V13 is a dual triode, one-shot, cathode-coupled multivibrator, with grid 2 held below cutoff. When V13A conducts, multivibrator action is initiated. This action cuts off grid 7, which reduces the bias on grid 2, driving grid 7 well past cutoff. Section V13B will remain cut off until C11 discharges enough through

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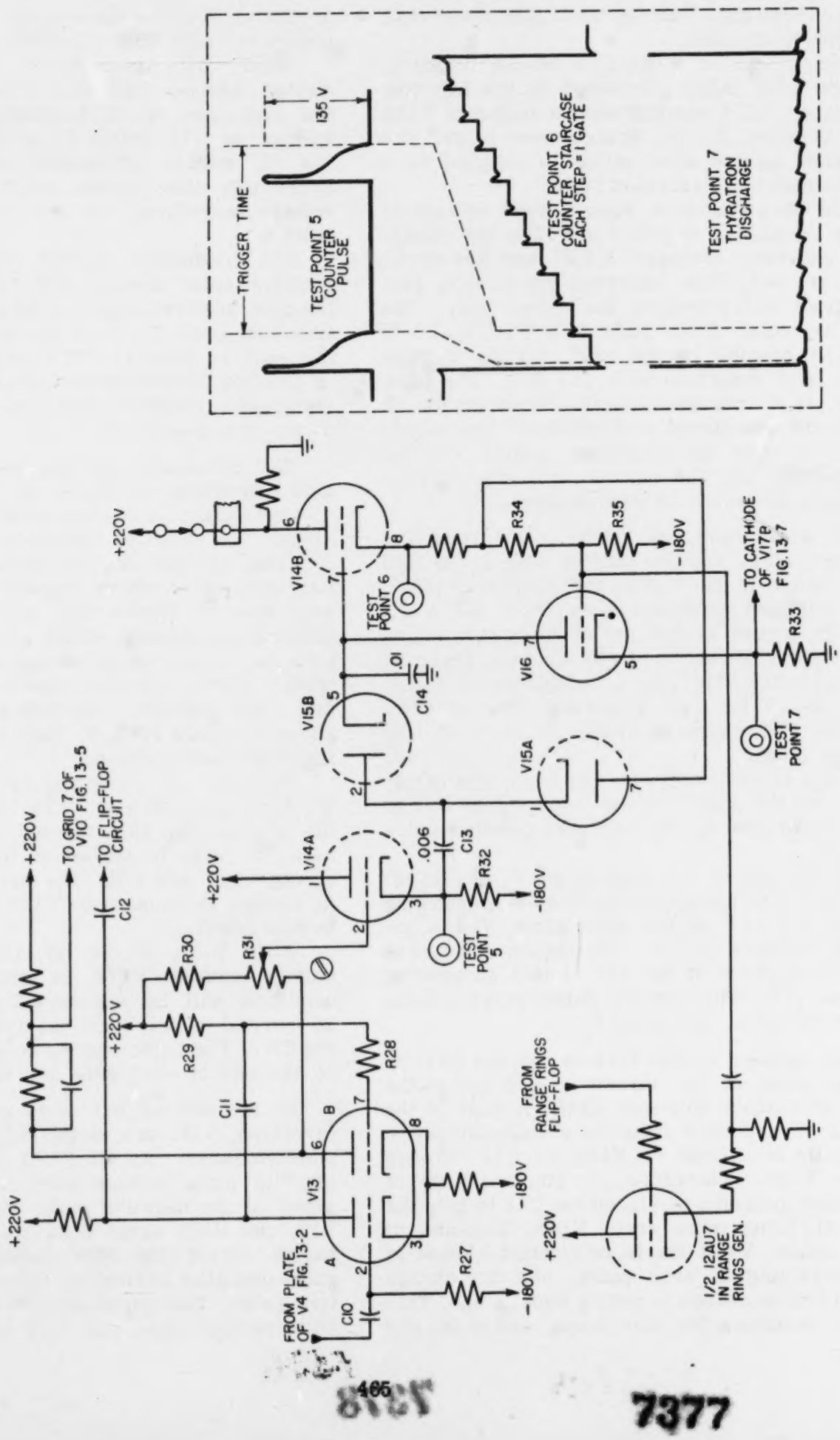

Figure 13-6.—Time-sharing (staircase) counter.

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R29 to raise grid 7 above cutoff then the circuit returns to normal.

The output of V13A is a 60-μs, negative, square-wave pulse controlled by the RC time constant of C11 and R29 and the output of V13B is a positive, 60-μs, square-wave pulse. The negative square-wave pulse is coupled to a flip-flop circuit described later.

The 60-μs positive, square-wave pulse from V13B is coupled to grid 7 of V10 in the clamp-gate generator through C9, R23, and R24 shown in figure 9-5. This lengthens the normal gate by 60μs and produces the clamp gate. The positive pulse from plate 6 of V3 (fig. 13-6) is also coupled to the grid of V14A through plate load resistors R30 and R31. The tube, V14A, is a cathode follower. Potentiometer R 31 is the countdown potentiometer and is adjusted so that the staircase counter will deliver, from the V16 cathode, one positive output pulse for every 10 input pulses.

To understand the action of the staircase counter, start with the trailing edge of the 10th gate, which is the end of the cursor interval. The adjusted positive pulse from the V14A cathode occurs at the end of the cursor interval causing diode V15B to conduct, charging C13 and C14. The output impedance of V14A, C13, and V15B form a low RC time constant so that C14 charges rapidly to the first-step voltage level.

The voltage increase on C14 is approximately equal to the ratio of the capacity of C13 to C14, multiplied by the adjusted positive pulse voltage.

At the end of the first pulse, V15B cuts off and the action maintains the first-step charging voltage on C14. At the same time, V15A conducts, discharging C13. This sequence of operation takes place at the end of each succeeding normal gate. The counter-pulse waveform can be examined at test point 5.

The voltage across C14 is coupled directly to the plate of the thyratron V16 and to the grid of cathode follower V14B. A part of the voltage is fed back from the voltage divider in the cathode circuit of V14B to C13 through diode V15A. Therefore, a slight charge of reversed polarity is placed on C13 to help the next charging pulse from V14A. Because of this action, V15B starts to conduct almost at the beginning of each pulse, and the charge on C14 is increased in nearly equal steps. This action continues for nine steps, and at the end of the ninth pulse the charge on C14 is great enough to cause V16 to ionize.

When V16 conducts, it acts as a short circuit across C14 and rapidly discharges the capacitor. As C14 discharges, the plate voltage of V16 drops to a value that is too low to sustain ionization, and the counting cycle can then repeat itself. The staircase voltage waveform can be examined at test point 6.

The conduction of V16 produces a sharp positive pulse across R33, which constitutes the counted-down output of the staircase counter (see test point 7.) Thus we have one pulse out for each 10 pulses in. The output pulse is used to produce simultaneous enabling of the cursor sweep-gate generator and disabling of the video sweep-gate generator.

The schematic for the sweep and cursor gate generator is shown in figure 13-7, A.

Two outputs from the time-sharing counter circuit are used to actuate the time-sharing, flip-flop circuit of V17 which provides two time-shared waves of opposite polarity. These time-sharing waves are used to enable the coincidence mixers, which generate the sweep gate and cursor gate; to enable the AEW electronic switch circuits; and to control cursor and video intensity. The time relationships are shown in figure 13-7, B. Tube V17 is a bi-stable flip-flop multivibrator.

To trace an operating cycle, assume that V17B is cut off and V17A is conducting. At the end of the 10th normal gate, the 60-μs negative pulse is applied to the plate of V17B through C12 and R36. The corresponding drop in voltage is coupled to V17A driving the grid beyond cutoff.

When V17A is cut off, the rise in plate voltage causes V17B to conduct. This new condition will be maintained during 9 out of 10 normal gates when the video sweep is on the CRT. The pulse coming from V13 (fig. 13-6) at the end of each gate has no further effect.

At the end of the ninth gate, the counter thyratron, V16, discharges C14, and the sharp positive pulse cuts off V17B. When V17B cuts off, its plate voltage rises and cancels the effect of the negative pulse that arrives from V13, and V17A again conducts. This condition exists during the 10th normal gate (cursor gate) until the arrival of the next 60-μs negative pulse. This pulse arrives at the end of the 10th normal gate and cuts off V17A, which

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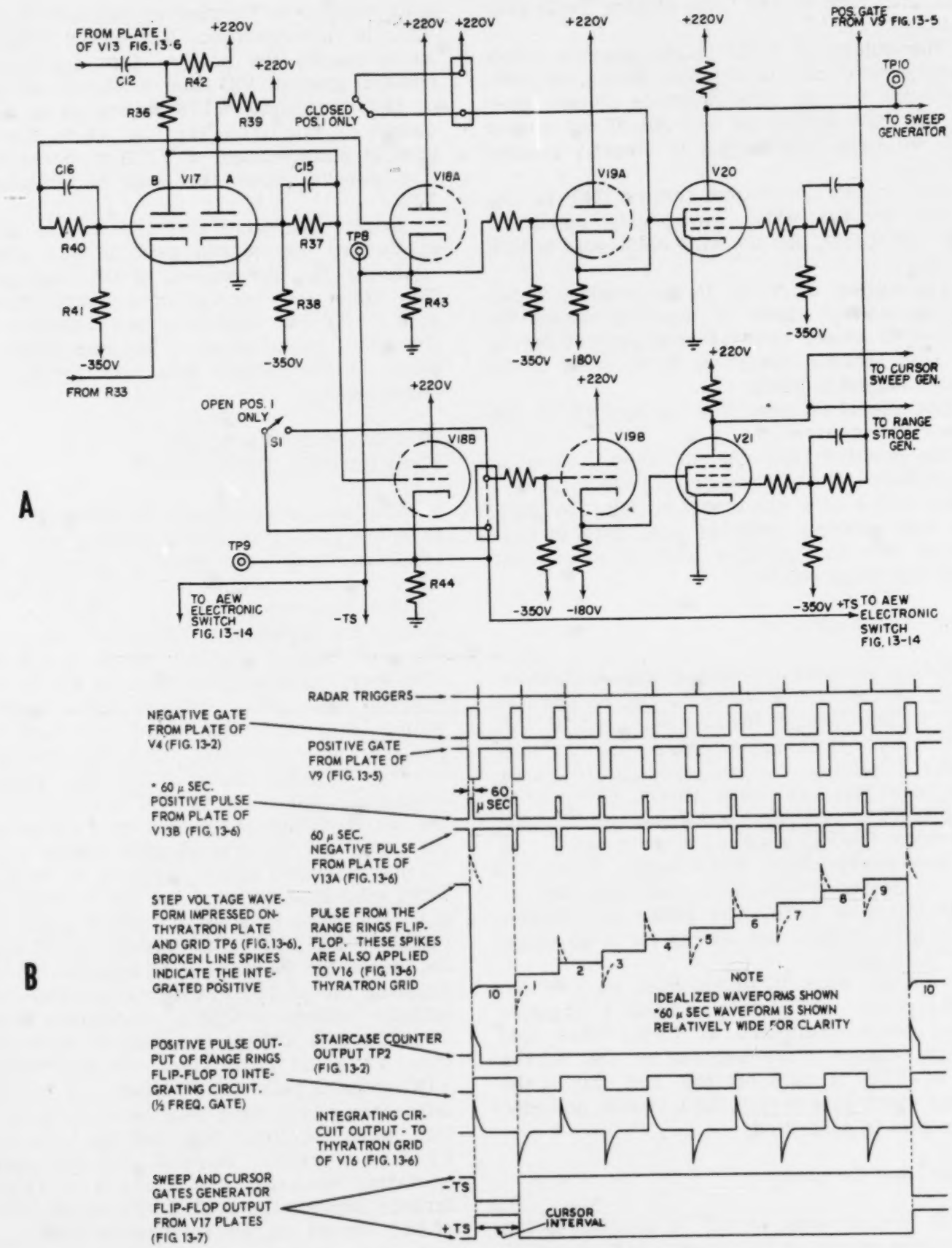

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Figure 13-7.—Sweep and cursor gate generators and time relationships.

starts the nine-to-one time-sharing cycle over again.

The output of V17A is the negative time-sharing wave, and is positive during the nine-out-of-ten normal gate intervals (sweep time) and negative during the one-out-of-ten cursor time interval. The output is directly coupled to V18A.

The signal developed across R43 is delivered to the video sweep-gate generator video amplifier, and the AEW electronic switch circuits.

The output of V17B is the positive time-sharing wave, which is negative during the nine video sweep intervals and positive during the 10th (cursor) interval. This output is directly coupled to V18B.

The signal across R44 is applied to the cursor gate generator.

The positive time-sharing wave is used in conjunction with the negative time-sharing wave to enable the AEW electronic switch. The positive time-sharing wave is also used in connection with the positive gate to enable the range strobe generator.

Sweep-Gate Generator

During the nine-out-of-ten normal gate intervals that section V17A is cut off, its positive plate voltage keeps the screen grid of V20 positive so that this sweep-gate switching tube is able to follow control grid signals during these intervals. At these times, the control grid of V20 is receiving positive-gate voltages. Therefore, the V20 plate output consists of nine negative sweep gates, which occur during the time the screen grid is held positive by the cut-off condition of V17A. The sweep circuits that follow will produce one sweep for each of the nine sweep gates.

However, when V17A conducts on the 10th normal gate, its plate produces a negative square wave (examined at TP8). When this negative square wave arrives at the screen grid of V20, it cuts off the tube during the normal tenth gate period. As a result, no video sweep gate is generated.

Cursor Gate Generator

The cursor gate circuit is similar to the sweep-gate circuit in both design and operation.

During the nine-out-of-ten normal gate intervals when V17B is conducting, its lowlevel plate voltage is coupled to the screen grid of V21. In this condition, V21 is not conducting. As a result, the positve gate applied to the control grid of V21 has no effect. At the end of the ninth gate, V17B is cut off by the discharge of thyratron V16 (fig. 13-6). The sharp rise in plate voltage at V17B produces a positive square wave that can be examined at TP9.

During the time that the square wave is applied to the screen grid of V21, the tube conducts for the interval of the 10th gate. At this time the arrival of a normal positive gate at the V21 control grid produces a negative plate output pulse of one gate length. This pulse is the cursor gate that produces one cursor sweep.

SWEEP GENERATOR AND SWEEP RESOLVER DRIVER

The sweep generator consists of a linear sawtooth generator and a resolver driver. The resolver rotor is driven by the repeater servomotor, which responds to antenna bearing input signals. The resolver driver, V28, is a current source for the magnetic resolver that produces the E-W and N-S sweep inputs to the sweep amplifiers. A schematic diagram for the sweep generator and sweep resolver driver is shown in figure 13-8. Before the sweep gate from V20 is applied, the switch tube, V22A, the cathode follower, V25, and diodes V23A and V23B are conducting. When V23A and V23B are conducting, the initial voltage at the cathode of V25 is nearly the same as the control-grid voltage of V24. When a negative gate is applied to the grid of V22A, the tube cuts off for the duration of the gate. As V22A cuts off, a positive pulse is applied to V23A and V23B cathodes which cuts off the diodes for the pulse time interval. When this happens, the grid of V24 is no longer fixed at the cathode voltage of V25 but increases because C16 charges. During the time of the negative gate, V23A and V23B along with R50, complete a DC feedback path which determines the voltage difference which must exist between the grid of the sweep amplifier V24, and the cathodes of V25. As a result, there is only one possible operating condition that gives a voltage difference between the grid of V24 and the cathodes of V25. Direct current feedback is used to make sure that the sweep will start from the same voltage for each gate and that its average value will not change or drift.

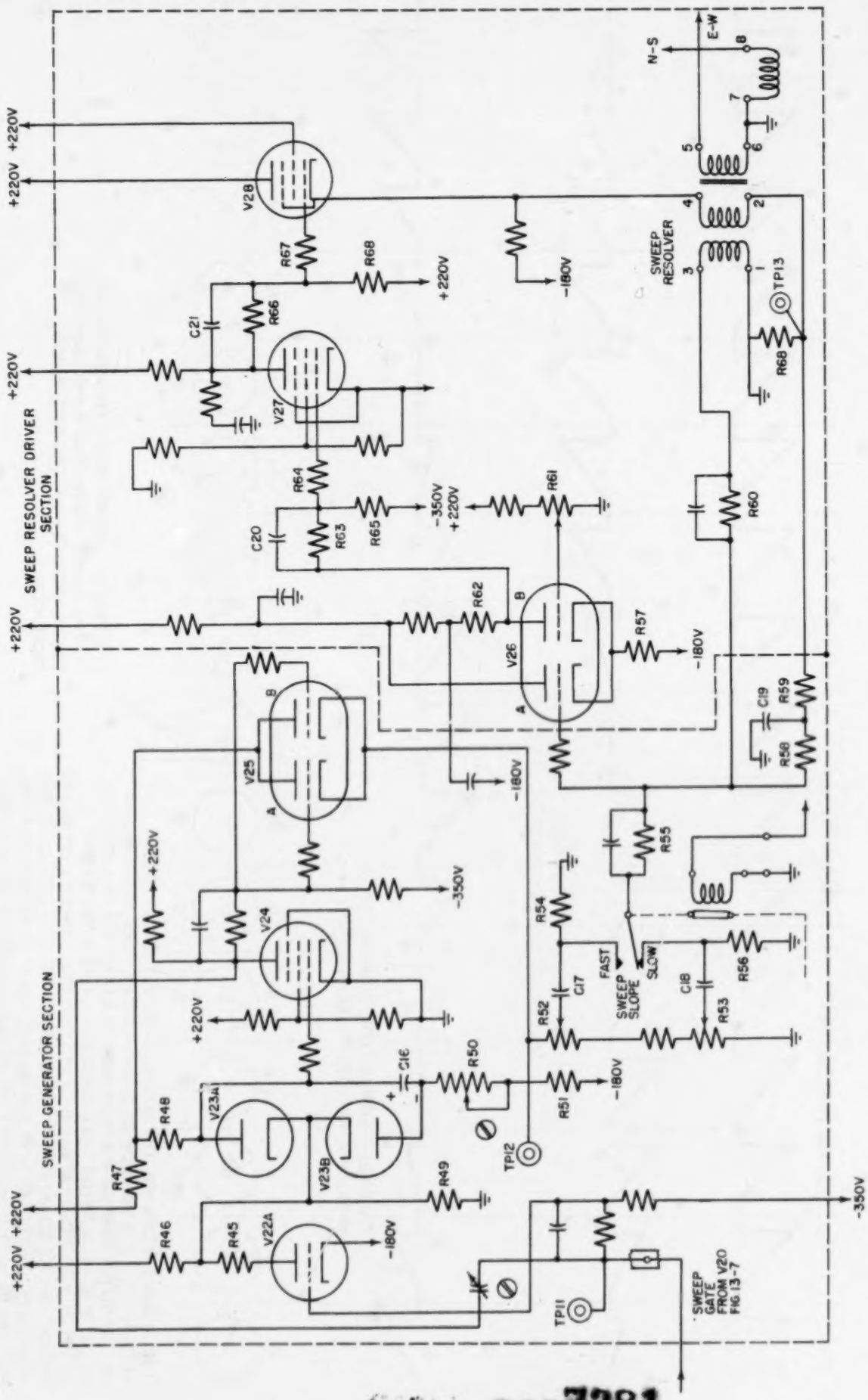

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Figure 13-8.—Sweep generator and sweep resolver driver.

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As soon as V23A and V23B stop conducting, the voltage drop across R48 becomes considerably smaller. As the junction of R48 and C16 is connected to the grid of V24 the grid of V24 tends to rise to nearly the B+ value. A small increase in the control grid voltage of V24 however, results in a much larger decrease in voltage at its plate and at the grids and cathodes of V25. This large drop in plate voltage is coupled back to the grid of V24 through sweep capacitor C16 and sweep step potentiometer R50. The net result is cancellation of most of the original increase in voltage at the control grid of V24. Therefore, the negative feedback action keeps the voltage increase at the control grid of V24 to very small values. There is a small constant current through R48, which flows through C16 and R50 producing a linearly increasing voltage across C16. The voltage at the grid end of C16 increases slightly while at the same time a large linearly decreasing sweep voltage appears at the R50 end of C16.

Because very little voltage drop is developed by the constant-sweep current flowing through R50, the large negative-going sweep voltage appears at the cathodes of V25, test point 12, and the top of the series-connected sweep slope potentiometer, R52 and R53. Resistor, R51, provides the proper operating current for V25 without loading down the output.

The negative sweep output of the sweep generator is fed to the sweep resolver driver, V26, through capacitor C17 or C18. Resistors R54 and R56 are used to discharge the capacitor not in use. By discharging the capacitors in this manner, the DC voltage at the output side of the couping capacitor is maintained near the value it would have if it were coupled to the resolver driver. Operating the circuit in this manner reduces transients caused by switching between the fast and slow ranges.

The first stage of the sweep resolver driver, V26, is a cathode follower (V26A), the second is an amplifier (V26B). A negative sweep voltage is applied to the grid of V26A decreasing the voltage drop across common cathode resistor R57. Therefore, the bias on V26B is reduced and the V26B plate current increases. This causes the plate voltage of V26B to decrease making the grid of V27 more negative and the plate more positive. The application of the positive signal to the grid of V28 causes its plate current to increase and draw more current through the cathode return circuit. Winding 2-4 of the resolver is in series with the cathode, and the increased current through the winding causes voltages to be induced in the feedback winding, 1-3, and the two secondaries, 5-6 and 7-8.

The voltage induced in the feedback winding has a sawtooth characteristic applied to the feedback resistor, R60, and is mixed at the grid of V26A with the sweep voltage coming through R55. As a result of the mixing, a small signal is applied to the grid of V26A. This signal has the effect of making the voltage on the feedback winding a good reproduction of the input sweep voltage.

Direct current feedback is used to hold the operating voltages at the desired levels. This is done by feeding the resolver current through R68 and then filtering the resulting voltage with R59, C19, and R58. The filtered voltage is then applied to the grid of V26A. The DC operating level is controlled by R61, which determines the bias on the grid of V26 B.

Two-Phase Sweep Resolver

The two-phase sweep resolver is essentially a transformer with a rotating secondary. It consists of a primary (stator) winding connected to terminals 2 and 4, two secondary (rotor) windings connected to terminals 5 and 6 and terminals 7 and 8, and an auxiliary stator winding (terminals 1 and 3) used to sample the stator flux and provide degenerative feedback to the input of the driver circuit.

The axes of the two secondary windings are at right angles to each other causing their mutual inductances with respect to the fixed primary inductance to vary as the sine and cosine of the shaft angle of the rotor. Thus, the turning of the rotor through the stator field provides a mechanical means of modulating the amplitude of the sweep generator output, which is applied to the primary. The resulting sweep voltages across the rotor secondary windings are 90° out of phase with each other, and each varies in amplitude according to the angular position of the particular secondary winding in relation to the fixed position of the primary winding. Figure 13-9 shows the output of the two-phase resolver after clamping.

For simplification, we will describe the operation that produces the output sweep voltage across only one of the secondary windings. The operation for the other secondary winding is exactly the same.

The positive-going sweep, sawtooth voltage at the grid of the sweep resolver driver, V28, controls the current flowing in the primary stator winding of the sweep resolver. This changing current sets up a magnetic field around the primary, which varies in intensity with the current waveform. The waveform may be examined at test point TP13.

Assume that the rotor has turned to bring the axis of the secondary (5-6) winding into a position parallel to that of the primary (2-4) winding, as shown at point A in figure 13-9. At this position, the magnetic field of the primary winding cuts the turns of the secondary (5-6) winding at right angles and induces maximum voltage across the secondary. As it is moved from its parallel position in relation to the primary, the secondary is cut by fewer electromagnetic lines of flux, and the induced voltage across it decreases correspondingly as shown at point B.

When the rotating (5-6) secondary has revolved through an angle of 90°, making its axis perpendicular to the axis of the primary (2-4) winding, its turns are parallel to the magnetic field of the primary and there is a minimum of flux linkage. Therefore, negligible voltage is induced as shown at point C.

As the rotor turns past 90°, the secondary winding is now reversed with respect to the primary winding, and the voltage induced across the secondary will be of opposite polarity as shown at point D. However, this induced voltage will increase in amplitude because of greater flux linkage as rotation continues, rising from 0 at the 90° position to maximum voltage at 180°, as shown at point E.

At 180° the secondary output voltage is equal in amplitude, but opposite in polarity to the output voltage at 0°, which is the start of the cycle. As rotation continues, the secondary output decreases until it reaches 0 voltage again at 270° (point F). At 270° the polarity of the output voltage is again reversed, and rises to a maximum at 360° (point A). The secondary output sweep voltage is modulated, therefore, by an envelope that varies sinusoidally as the rotor turns through 360 .

A sweep output voltage is being similarly induced and modulated across the other rotor winding. However, since the axes of the two rotor secondary windings are at right angles to each other, the voltage across the second winding is being developed one quarter of a rotation earlier than the voltage across the first. Therefore, the voltage peaks, nulls, and reversals of the second winding lead those of the first by 90°.

By means of a servo followup system consisting of the synchro bearing input, the servo amplifier, the drive motor, and the control transformer, the shaft angle of the sweep resolver (as shown in the small circle Fig. 13-9) accurately reproduces the bearing angle of the radar antenna. Therefore, the sweep on the PPI display points in the same direction as the radar antenna.

N-S Sweep Amplifier

The purpose of the N-S sweep amplifier, shown schematically in figure 13-10, is to supply a low-impedance source voltage that is approximately 25 times the sum of the output voltages of the N-S windings of the sweep and cursor resolvers. This action provides a voltage level suitable for mixing with the off-centering voltages in the input circuits of the N-S yoke driver.

The voltages from the N-S sweep and cursor resolvers are mixed at the grid of V29. The sweep and cursor input networks are identical, but only the N-S chain may be individually adjusted. The potentiometers, R69 and R70, are in series with the resolver windings and are adjusted to compensate for normal difference in the N-S and E-W sweep signals.

For DC and low frequency signals, the input impedance for either sweep or cursor signals is 20,000 ohms. This impedance is adjusted in the N-S chain only. The d-c feedback impedance is R74 (500,000 ohms). The closed-loop gain to each amplifier input is determined by the ratio of the feedback impedance to the input impedance and, in this case, is 25 to 1.

To operate properly, the input DC voltage to the amplifier must be approximately -3 volts, and the output voltage at the plate of V31(TP14) must be approximately 20 volts under no-signal conditions. Because the input signal from the resolvers are at DC ground under no-signal conditions, it is necessary to bias the feedback network in order to keep the desired relationship between input and output voltages. In adjusting the amplifier, R72 is used to set the bias so that the output voltage at TP14 is + 20 volts under no-signal conditions.

The error signal is amplified and inverted in the plate circuit of V29.

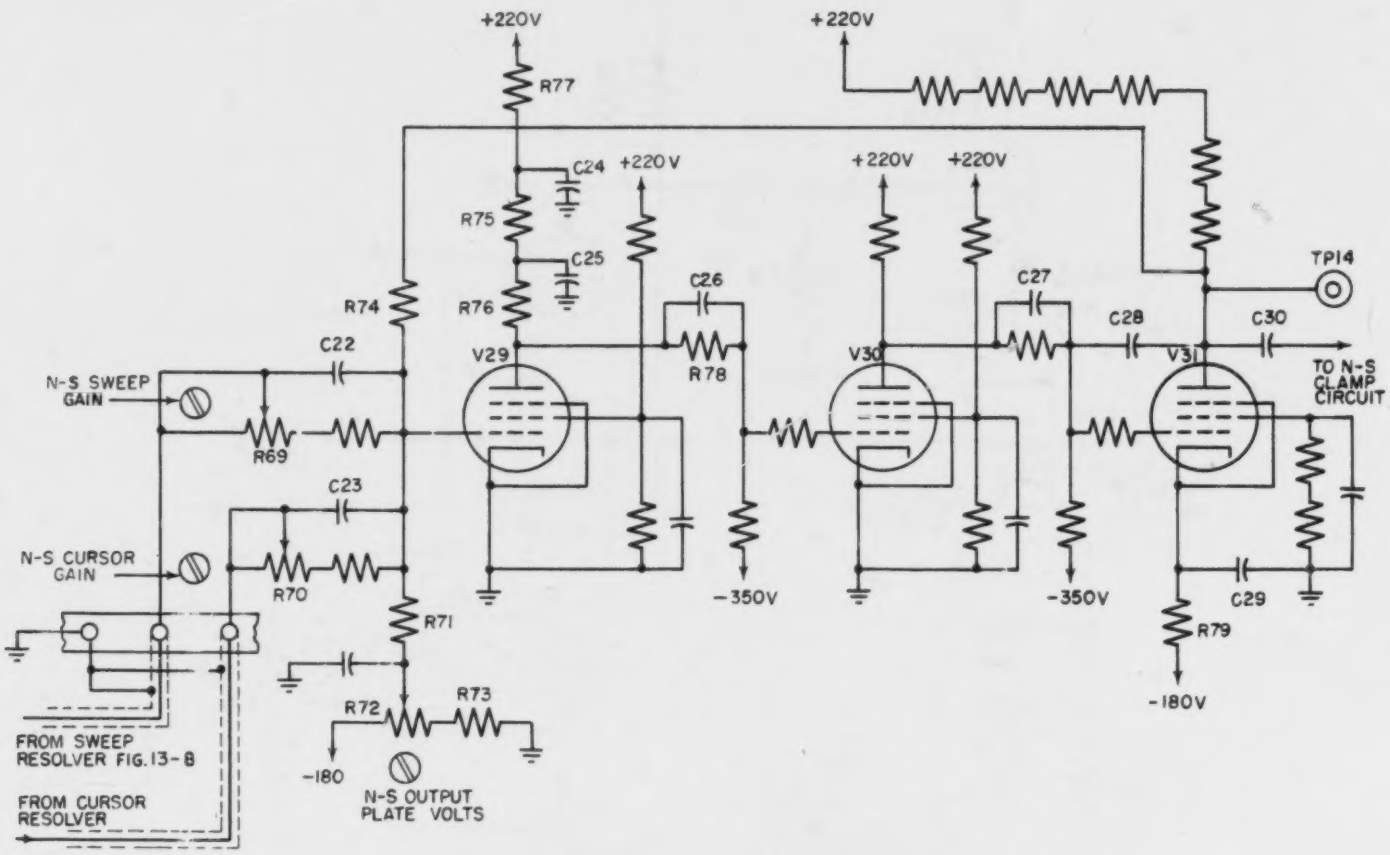

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Figure 13-10.—Schematic diagram of N-S sweep amplifier.

The signal from the plate of V29 is DC coupled to the grid of V30. Capacitor C26 provides an AC path for the high-frequency components in the signal. Tube V30 is a straight amplifier with its output DC coupled to V31. The path for high-frequency signals is through C27. The thrid stage, V31, has a feedback loop through C28 to provide an output characteristic that is free from the limitations that would result from plate bypassing. Another feature of this feedback system is that it permits the amplifier to have low impedance.

The output waveshape of the N-S sweep amplifier can be examined at TP 14. It should be a sawtooth wave with nine sweep slopes going negative or positive, depending on the direction setting of the sweep resolver. The tenth or cursor slope varies in polarity according to the direction setting of the cursor resolver. North is negative and south positive. Capacitor C30 provides a means of coupling the plate of V31 to the clamp circuit.

N-S Clamp

The N-S sweep voltage from the plate of V31 is fed to the clamp circuit shown in figure 13-11.

The purpose of the clamp is to prevent the start of the sweep from shifting with changes of sweep or cursor direction, repetition rate, sweep length, or other causes. To obtain this stability, the base line of the sweep must be restored to a fixed potential (near zero volts) before the start of the next sweep.

The positive-going clamp gate from the cathode follower, V11B, (test point 4 in figure 13-5) controls the turning on and off of the clamp. This gate is a disabling voltage to the clamp, and clamping can take place only on the negative swing of the trailing edge and during the interval between clamp gates. A clamp gate starts simultaneously with the start of each sweep, but is approximately 60 μs longer than the sweep gate. As a result, clamping is off

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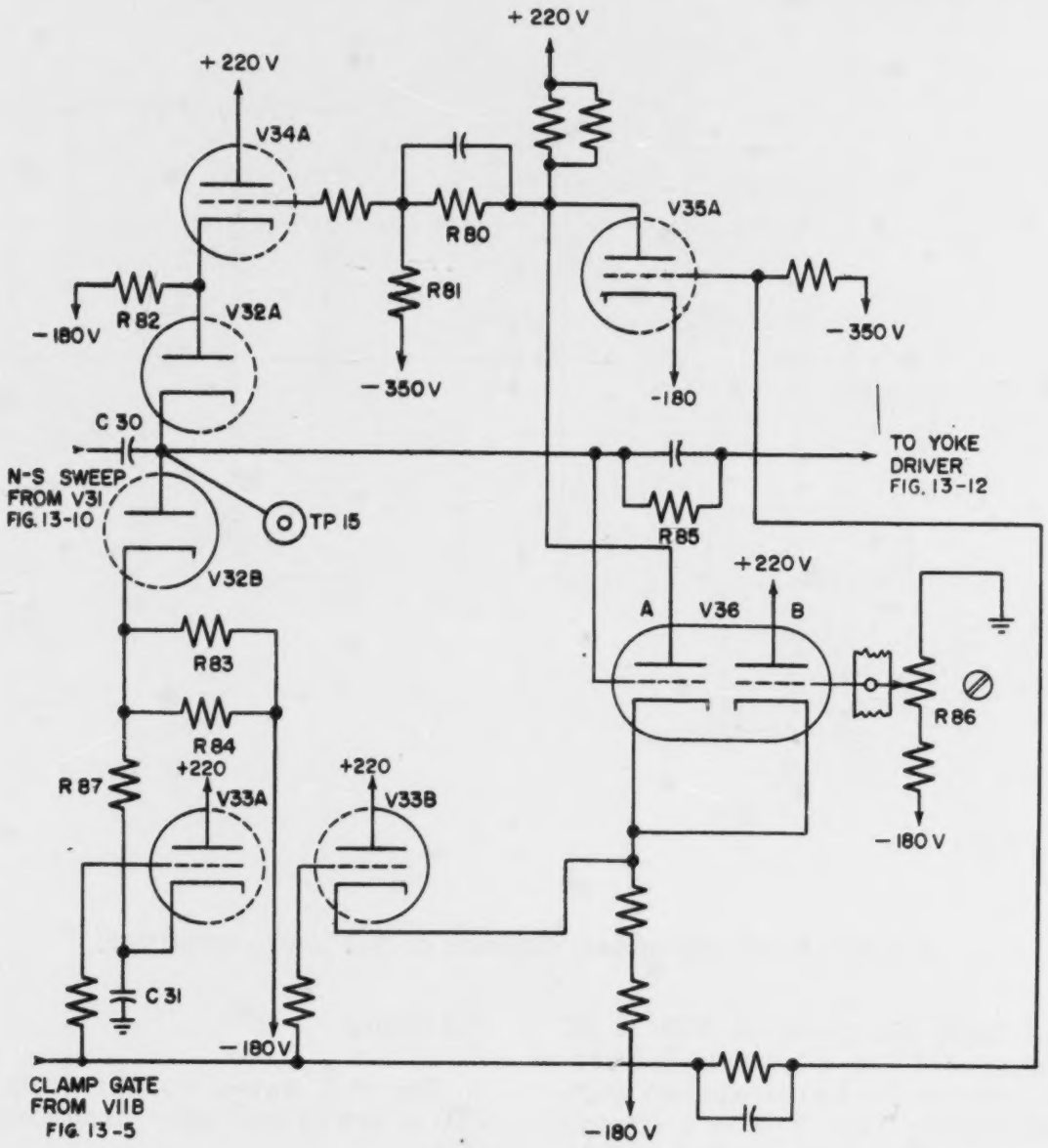

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Figure 13-11.—N-S clamp circuit.

during the sweep time, and for about 60 μs thereafter. The clamp operates at all other times, even when there is no radar trigger.

The clamp gate must be longer than the sweep gate to give the 60 μs additional time to recover toward the base line, thus preventing the circuit from starting to clamp to zero a signal voltage that should not be zero. If the last condition should happen, the baseline shift would increase, and clamping would be more difficult to achieve during the limited available time.

The clamp circuit is designed so that the clamp isolating diodes, V32A and V32B, conduct during the interval between clamp gates. During this time, the plate of V32A is approximately 1.5 volts positive and the cathode of V32B is approximately 1.4 volts negative.

Unclamping takes place when the unclamp switch tubes, V33A, V33B, and V35A conduct. These tubes conduct when the leading edge of the positive clamp gate is applied to their grids. The tubes conduct for the duration of the gate and are cut off between gates.

During the positive clamp gate, sweep and cursor voltages as high as ±100 volts are present at TP15, and these voltages must not be interfered with by the clamp. Each of the three

unclamp switch tubes serves to isolate one possible source of load on the clamp point.

When unclamp tube V33A conducts, its cathode becomes slightly higher than the positive clamp gate voltage. As a result, the cathode of V32B is raised through R87 to approximately 120 volts positive. Tube V32B then becomes nonconductive and isolates this source of load from the clamp point.

When unclamp tube V33B is conducting, the cathodes of V36A and V36B are raised to approximately 120 volts positive. Therefore, the clamp point is never more positive than the cathode of V36A even with the +100-volts sweep signal on it. Consequently, the grid of V36A, which is directly coupled to the clamp point, can never draw grid current. This action eliminates a second source of load on the clamp point.

Another source of loading is eliminated when V35A is conducting. In this condition, the plate of V36A is made negative. The grid of V34A is made over 100 volts negative by the action of voltage divider R80 and R81. The cathode of V34A is energized through R82 and follows the action of the grid. This action makes the plate of V32A negative by a voltage greater than -150 volts. Therefore, no matter how negative the sweep becomes, V32A can never conduct during the positive clamp gate period.

One additional load source is connected to the clamp point (TP15). This is the input to the yoke driver section, which is a necessary load, and the clamp circuit is used to reduce the effect of this load in producing baseline shift.

During the time the clamp gate input is negative, V33A, V33B, and V35A are not conducting. Therefore, the clamp is operating and provides a means of automatically bringing TP15 to a voltage near zero. The action for this is as follows: assume that TP15 tends to go positive. Tube V36A will then conduct, and its plate will go more negative, which makes the grid of V34A go more negative. This action then causes the plate of V32A to go more negative. Less current will then flow through V32A, and some unbalanced current will flow through V32B. The lack of current balance between the two diodes acts to restore TP15 to zero since the unbalance is in a direction that will pull TP15 negative. As soon as TP15 has been restored to the proper voltage, the action stops. A reversed action takes place when TP15 becomes too negative.

Potentiometer R86 controls the voltage on the grid of V36B, which in effect, controls the grid bias voltage of V36A and can change the voltage at which the clamp is in balance.

Resistors R87 and C31 have important functions. When the clamp gate has gone negative and enabled the clamp, it is undesirable for current to be flowing in the negative half of the clamp circuit (V32B). Some time is required before the plate of V36B can rise to the point where feedback action effectively maintains TP15 at the proper potential. Therefore, if V32B were allowed to conduct, it would not be balanced by current from +220 volts, and the clamp point would be pulled negative. This action would make it difficult for the clamp to operate effectively because a charge produced by the unbalanced current would appear on C30. Therefore, C31 is used to delay the drop in the cathode potential of V32B until the other half of the clamp circuit is able to control TP15 properly. When the clamp is disabled, V33A can conduct more current than is normally allowed to flow through R87, R83, and R84. Therefore, C31 does not greatly delay the disabling to the clamp.

During each sweep, current flows from TP15 through R85. Because of the feedback action in the yoke driver, the output side of R85 is essentially connected to ground. The current flowing through R85 during each sweep charges C30. The capacitance of C30 is made as low as practical (0.1 μf) because it must be discharged rapidly during clamp time. The low capacitance produces some distortion of the sawtooth voltage, which is coupled through it to the grid of the N-S yoke driver. The distortion causes the sawtooth to droop back slightly toward its starting potential. However, the sweep generator was designed to produce a negative sawtooth that curved downward. Thus the distortion produced by C30 and R85 is overcome.

NORTH-SOUTH YOKE DRIVER

The N-S yoke driver produces N-S deflection yoke currents that are proportional to the sum of the mixed N-S sweep voltage, manual DRA off-centering voltage, and AEW off-centering voltage. The circuitry used to perform this function is composed of two feedback-amplifier sections, a forward section with variable gain that is controlled by the range selector, and an inverter section whose amplifier gain is fixed. The circuitry also contains positive and negative limiters and a neutralizing system in order to minimize trouble from large input voltages.

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Because electron tube characteristics vary considerably, a special feedback system is used to maintain an exact relationship of inputs and output. This feedback system is composed of adjustable capacitors and precision resistors. These parts are used in gain-determining networks, which mix the inputs with the desired output, and then deliver close to zero voltage whenever the output is in the desired relation with the inputs.

The desired outputs are supplied by two high-gain DC amplifiers, V40-V41, the forward section and V48-V49 the inverter section (fig. 13-12). Those amplifiers, because of their high gain, require very small input signals in order to provide the desired output. The input to each amplifier is supplied by the output of a corresponding feedback network. Part of the amplifier output is fed back to the input (negative feedback) and tends to cancel the voltage fed into the input resistor. The small voltage output from the mixing network represents error in the relation of output to input voltages. Basically, the signal at the amplifier input grid is practically zero, and the amplifier output adjusts itself. Therefore, the stable mixing network controls the input-output relationship, and variations in vacuum tube characteristics are unimportant.

The desired yoke driver output is a current of either polarity. In order to drive current through the deflection - yoke in either direction, the deflection-yoke coil is fed by the halves, L1 and L2, each half producing an opposite effect. When both coil halves carry equal currents, deflection is zero.

Deflection is produced by changing both currents in opposite direction, and by nearly the same amount.

One-half of the deflection coil is fed by the forward section of the deflection yoke driver; the other by the inverter section. The inverter section is driven by the output voltage of the forward section, and produces nearly equal but opposite changes in its output current.

The driver-amplifiers produce output voltages that are proportional to the output current. Therefore, the yoke driver system can be designed as a voltage amplifier, and since these output voltages are not appreciably affected by the yoke coil impedance, the output current is independent of the yoke impedance. In other words, the yoke drivers have constant-current outputs.

Forward Yoke Driver Feedback System

The relay contacts (fig. 13-12) are shown in the position used for sweep speeds from 34 to 300 miles per radius.

The three input networks along with one feedback network are connected to the grid of V37B. The feedback network has no polarity-inverting elements, and must produce near-zero voltage at the grid of V37B. The amplifier output voltage must be of opposite polarity to the inputs.

Changes in output voltage (and yoke current) should be proportional to the sum of the three input signals. In addition, a zero input voltage sum must always produce the same no-signal output current regardless of the gain control setting. Unless this requirement is met, the origin of the centered PPI display will vary as the range selector is varied. The no-signal output voltage is 18.17 volts, which corresponds to 92.7-ma cathode current for the output tube and to 87.0 ma through the forward coil of the deflecting yoke.

The voltage that is fed to the grid of V37B is proportional to the sum of the inputs, less a portion of the output that is fed back.

The sweep-speed selector control, R90, varies the fraction of output voltage fed back through R91 and C34 and controls the amount of feedback required to keep the voltage at the grid of V37B at zero. In order to obtain cancellation the grid voltage at the wiper of R90 must be the same for a given signal no matter what the position of the wiper. Therefore, the closer the wiper voltage is to ground, the more signal needed at the output cathode and the higher will be the input-output gain.

To keep the no-signal voltage (zero input) independent of the setting of the gain control, R90 is fed through a voltage divider, R89 and R92, which is in parallel with several other paths. The junction of these resistors is maintained at zero volts for the desired no-signal output voltage that will produce constant (zero) voltage on R90. Therefore, varying the wiper position on R90 with zero voltages will have no effect under no-signal conditions.

Resistors R93 and R94 form an adjustable load on the voltage divider output. Under no-signal conditions, the divider junction is at zero volts, the adjustable load varies the divider attenuation without changing the DC level.

For sweep speeds below 34 miles per radius, higher gain is required, and the feedback current to the grid of V37B is decreased by switching R95

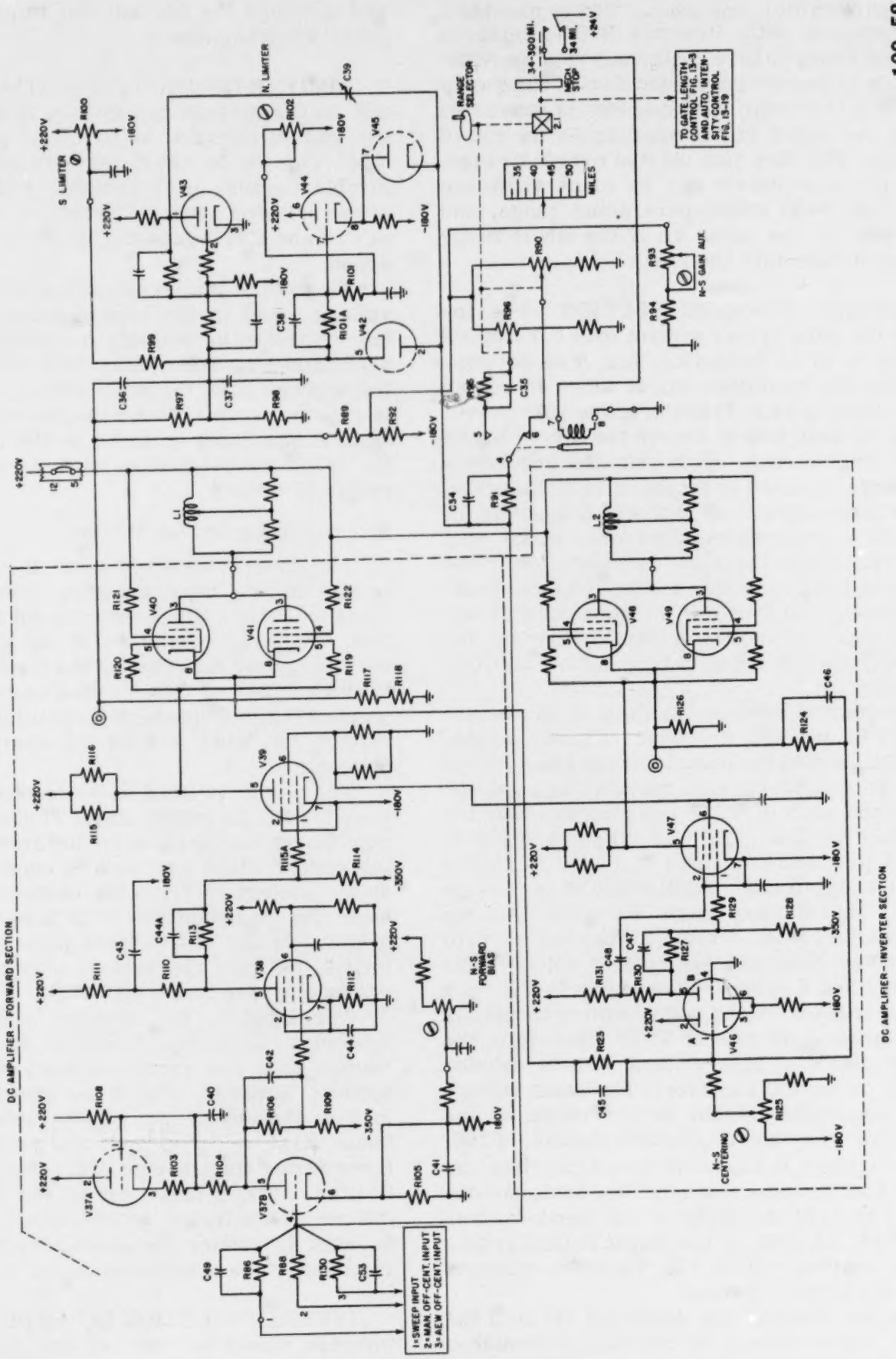

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Figure 13-12.—N-S yoke driver.

in series with R91, and adding C35 to provide a high frequency path. Resistor R90 is replaced by R96 in order to have continuous rotation without a gap or sudden change in value as the sweep speed dial is turned. Resistor R96 is phased so that as the wiper of R90 approaches the end of its range, R96 has just started over its range. Thus, the switchover can be made anywhere within the 34-37 miles-per-radius range, and the result is the same as if the whole range were not broken into two parts.

LIMITERS FORWARD SECTION.—The inputs to the yoke driver system may correspond to many radii of deflection, and it is not possible for the amplifier output tubes to supply the required inputs. Therefore, the yoke driver system is designed to accept the larger inputs without overloading. High gain DC amplifiers using large amounts of feedback as in this case, contain large capacitors that will not permit the amplifier to recover rapidly from a large input signal. To offset the slow recovery, a limiter system is used to modify the input-output feedback network so that the forward yoke driver system gain is lowered enough to prevent the maximum inputs from reaching the amplifier overload point.

The limiter section consists of the biased diodes V42 and V45 which conduct only outside the useful part of the output voltage range. When these tubes conduct, they parallel the feedback path to the grid of V37B and greatly lower the impedance of this path. The output of V37B is reduced to about one-third in order to reduce the tendency toward oscillation by a voltage divider. This divider feeds the cathode of the south limiter, V42, directly. When the forward yoke driver (V40 and 41) cathode voltage falls between 1 and 3 volts, V42 conducts so that very slight increases in the output cancel increases in the inputs to the grid of V37B. Therefore, the system limits at this voltage without causing overload in the DC amplifier. The exact voltage where conduction starts is controlled by the setting of the south limiter control, R100.

For limiting in the north direction, the same voltage that feeds the south-limiter diode cathode is used to feed the plate of the north-limiter diode, V45. As soon as the output amplifier tube cathode reaches +36 to +38, the diode conducts and limits further changes.

Bias for keeping the diode cut off until the desired output voltage is reached is furnished by R102, the north-limiter adjustment. Tube V44 matches the high divider impedance to the lower diode impedance.

LIMITER NEUTRALIZER.—The limiter diodes' interelectrode capacitance is always present and effectively in parallel with C34 and C35. This diode shunt capacity effect is undesirable because it is variable with the sweep-speed selector setting. Therefore, an adjustment of C34 and C35 is good at only one value of sweep speed.

To permit proper operation at all ranges, a voltage equal to the voltage across the diodes, but opposite in polarity is produced by the neutralizer-inverter tube, V43. This voltage is fed through C39, the neutralizing capacitor and is adjusted so that it feeds the grid with a current that is equal and opposite to the current from the diode interelectrode capacitance, and cancellation results.

Inverter Yoke Driver Section

The inverted voltage from the output stage is fed to the inverter grid, V46A. With the desired output voltage and current from V48 and V49, the inverted voltage at the grid of V46A will be nearly canceled by the feedback current through R124 and C46. The N-S centering poteniometer R125 provide a means of adjusting the bias voltage for V46A so that the desired output is obtained.

The Resistor R126 is the feedback sampling resistor for the output stage. The range selector adjustment has no effect on the inverter. Centering control R125 can also be used to provide a small amount of fixed off-centering. Any off-centering introduced by R125 however, must be held below six millimeters (approximately .25 inches) because the system may overlaod and produce severe trace-splitting.

The input to the inverter yoke driver is limited in the forward section so the inverter section does not require special overload protection. However, should the inverter be overloaded, the sweep may wander around with antenna rotation or be split into several parallel lines during timesharing. Therefore, the north-limiter voltage must not be too high and the coarse off-centering resistors (not shown) must be used to reduce the amount of off-centering required of the inverter section.

INVERTER SECTION DC AMPLIFIER.—The inverter signal to V46A is cathode coupled to V46B where it is amplified but not inverted in

the plate circuit. The plate output of V46B is d-c coupled to V47 through R127, C47, and R 128. The signal fed to V47 is amplified, inverted, and directly coupled to the grids of the parallel-connected drivers, V48 and V49. These tubes drive the inverter section of the N-S deflection coil, L2. Their cathode current is closely proportional to the plate current and flows through R126. The voltage across R126 is a good sample of the output current and is used as the output voltage.

The capacitor, C48 which couples R131 to the suppressor grid of V47, is used to obtain the desired frequency response. Capacitor C47 provides an AC path, between the plate of V46B and the grid of V47, for high frequencies by paralleling R127 and thus preventing excess attenuation and phase shifting because of the input capacity of V47.

MANUAL OFF-CENTERING

The manual off-centering controls are geared to the moving arm contacts of two 30-K potentiometers, R132 and R133 (fig 13-13). These contacts pick off DC voltages from the voltage dividers that are connected across the + 220-and the -180-volt power supplies. The arms of the potentiometers feed the yoke drivers the normal DC off-centering voltages of 0.8 volts-per-mile in the fast (short) ranges, and 0.2 volts-per-mile in the slow (long) ranges. The direction of off-centering is the vector sum of the voltages fed to the yoke drivers. Positive voltages off-center the display to the east and south; negative voltages to the west and north.

For the fast ranges the E-S and N-W potentiometers, R134A-B and R-135A-B, are used to preset the voltages at the midpoints of the positive and negative halves of R132 and R133. The positive midpoint on both R132 and R133 is tap 4, and the negative midpoint is tap 2. The voltage at the midpoints is measured with respect to ground, and must be preset for -104 volts from the negative and 104 volts from the positive midpoints. The amount of off-centering will then represent 130 miles.

For the slow ranges, R136 is used to set the voltage between point 3 on both potentiometers and ground to -52 volts, and R137 is used to set the voltage between ground and point 5 on both potentiometers to +52 volts. The 52 volt values represent 260 miles off-centering.

The circuit is switched from slow to fast range condition automatically when the range selector passes 34 miles (range decreasing). When this happens, a circuit is closed to energize K2 and operate switch sections S3 and S4.

The mechanical action is set up so that one revolution of the off-center control is equal to approximately 20 miles off-centering for either fast or slow ranges. A stop is geared to the shaft to allow 51 turns from the zero off-centering position in either direction.

AEW ELECTRONIC SWITCH

In the tracking function of the indicator, the AEW electronic switch (fig 13-14) provides zero volts across R138 and R139 during sweep time, thus permitting no off-centering of the sweep by this circuit. During cursor or tracking strobe time, the circuit applies adjusted d-c voltages of opposite polarity to both ends of the center grounded R138 and R139. Thus during cursor time, voltages of variable amplitude and polarity are available from the arms of R138 and R139 to provide the required off-centering of the cursor or tracking strobe in the direction desired.

The AEW system uses radar carrying aircraft to supply radar information to shipboard installations. To reproduce this information, the tracking indicator uses a tracking strobe, or the origin of the electronic cursor, to follow the position of own ship on its display. The AEW electronic switch is necessary in order to cancel the motion of the radar carrying plane. The information is inverted for the final repeater and then transmitted by synchros to the final indicator where the display is centered on the ship's position.

The inputs to the electronic switch are the positive and negative time-shared waves from V18A and V18B (fig. 13-7). The outputs are positive and negative off-centering waves of about 104 volts, which are applied to the opposite ends of the potentiometer network. The switches, S5A and S5B, are operated by a solenoid. When the switches are in the position shown, the electronic switch applies the off-centering waves during the nine video sweeps, and clamps at near zero during the 10th (cursor) sweep. The amplitude and polarity of the off-centering voltages fed to the yoke drivers are controlled by the potentiometer settings.

With switches S5A and S5B in the position shown, the negative time-shared wave from V18A (fig. 13-7) is applied to the grid of V50, and the positive time-shared wave from V18B is connected to the grid of V53A.

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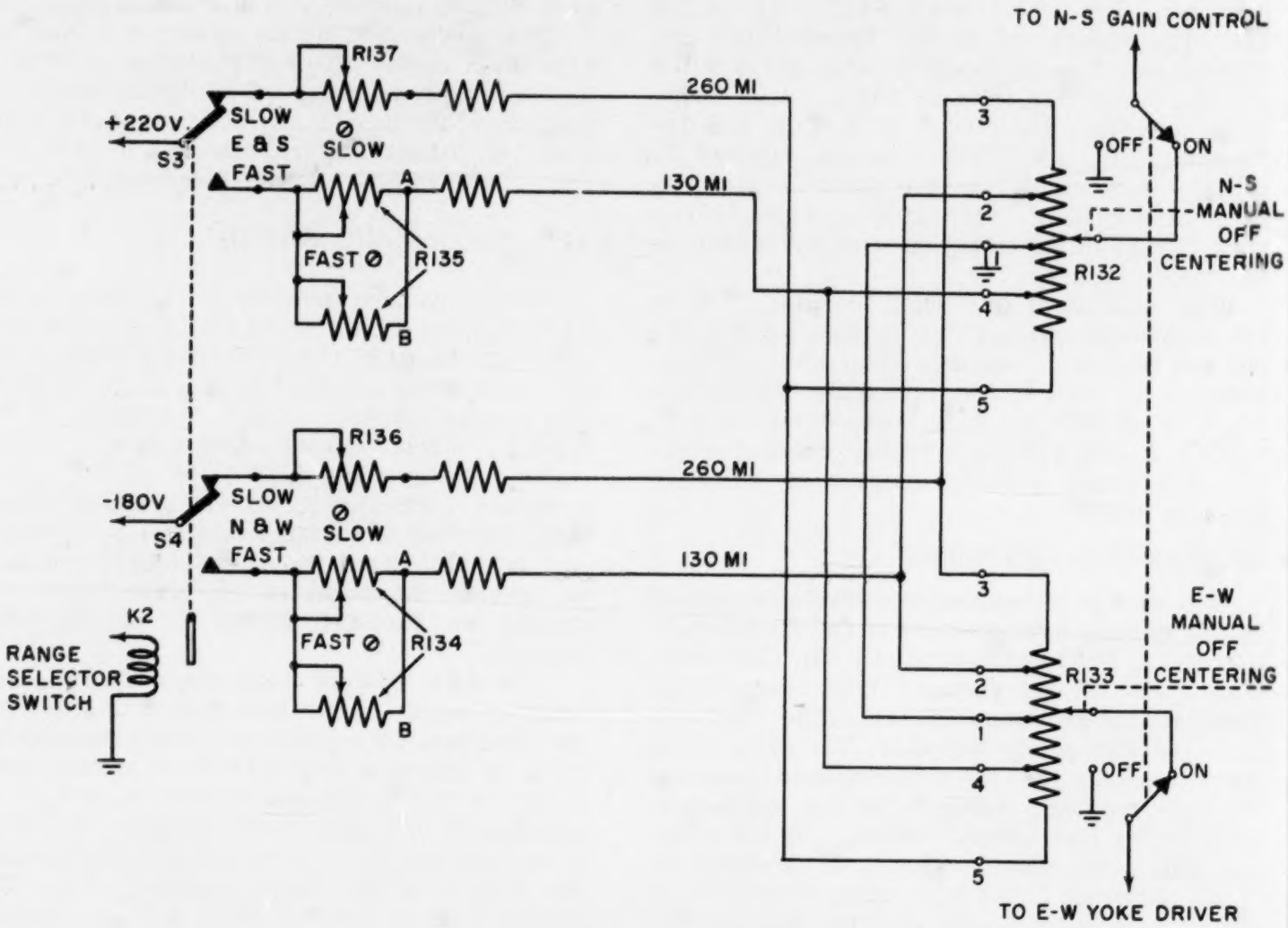

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Figure 13-13.—Manual off-centering circuits.

The negative time-sharing wave cuts V50 off during the cursor interval, and the tube conducts during the nine video sweeps, While V50 is cut off, the clamping diode V15A conducts. This action ties the grid of V52 to the voltage divider network.

The setting of R140 determines the amplitude of the positive driving voltage at the grid of V52 and the amplitude of the positive cathode output applied through S5B to one end of the off-centering network. The pulse may be observed at T P16. Normally R140 is set to maintain 87 volts positive during the cursor interval. Tube V50 conducts during the nine video sweep intervals because the negative time-shared wave is more positive for this interval. When V50 conducts, the grid voltage of V52 becomes less positive, and V51A stops conducting. When V52 stops conducting, the current through R143 drops, causing the voltage at the cathode to drop toward a negative value at the start of the nine video sweep intervals.

When the cathode of V52 falls to zero, the clamping diode, V51B conducts. The conduction of V51B is controlled by the setting of R144. The cathode of V52 will be clamped to zero volts at the start and for the duration of the nine video sweep intervals. As soon as the next cursor interval occurs, the negative time-sharing wave cuts off V50, clamping the grid of V52 as described above. This method ensures rapid switching between the conducting and non-conducting states.

When a positive time-shared wave is fed to the grid of V53A, the tube conducts during the cursor interval and acts as an open circuit during the interval of the nine video sweeps. When V53A conducts, the positive-going output is coupled directly to the cathode of V54A and

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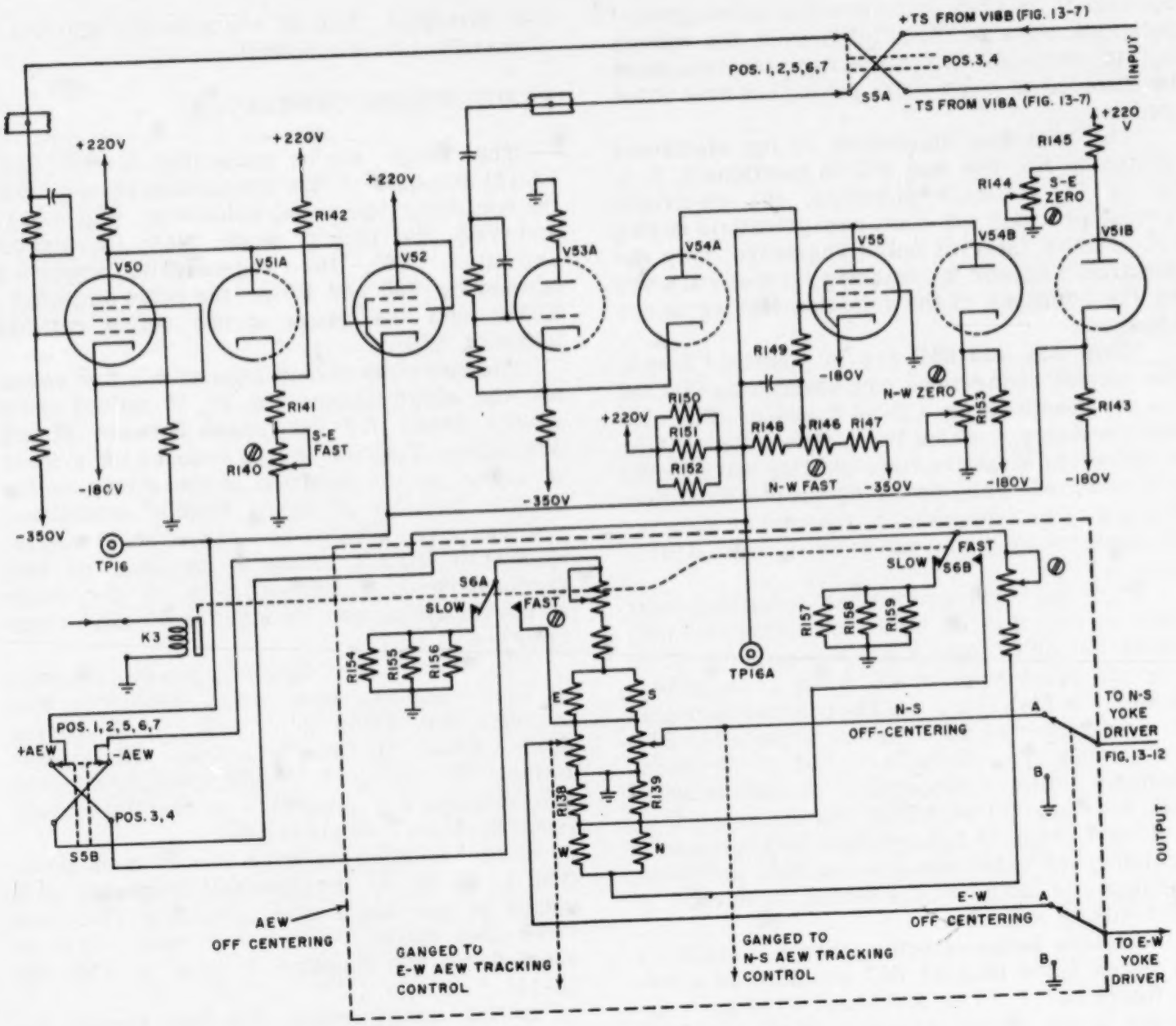

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Figure 13-14.—AEW electronic swtich.

causes V54A to cut off. The plate voltage of V54A rises to the voltage determined by the setting of R146, the values of R147 and R148, and the plate voltage of V55. The plate of V55 will now be negative to ground because the tube is conducting. The voltage to which the plate of V55 drops is normally adjusted by R146 to 87 volts negative. This is the negative off-centering voltage fed to the AEW potentiometer network during the cursor interval. The small voltage fed back through R149 helps to reduce the output voltage drift at the plate of V55.

The positive, time-shared wave input to the grid of V53A cuts the tube off during the nine video sweeps because the positive time-shared wave is negative-going during this interval. Therefore the cathode of V3 goes negative at the start of the video sweeps, and because it is directly coupled to the cathode of V54A, V54A conducts. The resulting drop at the plate of V54A cuts off V55, and the plate of V55 rises. The clamping action of diode V54B keeps the plate of V55 from rising above zero volts because the potentiometer, R153, is set so that V54B will

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conduct if its plate tries to swing above ground potential. As a result of this action, the voltage fed to the AEW off-centering potentiometers is clamped to zero volts during the nine video sweeps.

The previous discussion of the electronic switch is for S5A and S5B in positions 1, 2, 5, 6, or 7. In these positions, the electronic switch provides off-centering potentials during the cursor interval only. Therefore, only the electronic cursor (or tracking strobe) will move as the positions of the potentiometer arms are changed.

When S5A and S5B are in positions 3 or 4, the circuit connections are changed so that the cursor functions as a fixed indicator. The circuit operation remains the same, except that the positive and negative time-sharing wave inputs are reversed. This means that the positive time-sharing wave is applied to the grid of V50, and the negative time-sharing wave is applied to the grid of V53A.

With these connections, off-centering voltages will be applied to the potentiometer networks during the nine video sweeps only. Then, only the video sweeps will move as the potentiometer arms are moved. The positive and negative off-centering voltages are switched by S5B so that they are applied to the ends of the potentiometer networks opposite to the ends to which they were applied when S5B was in position 1, 2, 5, 6, or 7. Thus, it is possible to obtain opposite motion of the video sweep at the final indicator, and opposite motion at the strobe, or cursor, at the tracking indicator.

When the range selector control is set above 34 miles (slow ranges), S6A and S6B, as shown in figure 13-14, R154, R155, and R156 are connected in the circuit of the E-W off-centering potentiometer, R138; and R157, R158, and R159 are connected in the circuit of the N-S off-centering potentiometer, R139. With the resistors connected in this manner, the current distribution in the off-centering circuits is such that one-half of 87 volts (43.5 volts) is available for off-centering in E-W and N-S directions.

When the range selector control is set below 34 miles (fast range), a cam-operated switch causes the coil of K3 to be energized, and the moving contacts cut the resistors, R154, R155, and R156 and R157, R158, and R159 out of the circuits of the E-W and N-S off-centering potentiometers. When K3 is energized in this manner, the full 87 volts output of the electronic switch is available for off-centering in the E-W and N-S direction. The 87 volts is fed into tap 1 of the off-centering potentiometers.

RANGE STROBE GENERATOR

The range strobe generator circuit (fig. 13-15) consists of the coincidence mixer, V60; the bootstrap type sweep generator, V61, V62A, and V63; the pickoff diode, V64; the pickoff amplifier, V65, the regenerative amplifier formed by V66 and V67A; the pulse amplifier, V67B; and the range strobe output cathode follower, V68A.

The bootstrap circuit generates a fast sweep for the short ranges (up to 36 miles) and a slower sweep for the ranges between 36 and 300 miles. The fast sweep reduces the amount of error in the position of the strobe on the cursor because of small voltage variations, and thus gives greater accuracy at short ranges. Bootstrap circuit changes for slow or fast ranges are done automatically as the range strobe crank passes through the 36-mile range in either direction.

The timing unit of the range strobe generator is the bootstrap type sweep generator that includes the clamp tube, V61; the bootstrap diode, V62A; and the bootstrap cathode follower, V63. Although V63 is a dual triode, the two sections are connected in parallel and effectively form a single triode.

If the function selector switch is in position 1, 3, or 5, the one-half frequency gate output of the range rings flip-flop V59A and V59B (not shown), or cursor wave (+T8) is coupled to the number 1 grid of V60 (fig 13-15).

In the range rings flip-flop circuit the squarewave output of the flip-flop is one-half the PRF of the normal gate. Therefore, grids 1 (positive gate) and 3 of V60 (fig. 13-15) will be positive at the same time, only during the interval of every other gate. As a result, the PRF of the negative gate at the plate of V60 is one-half the normal gate, and a range strobe is generated, and appears on, every other video sweep.

When the function selector switch is in position 2, 4, 6, or 7, the cursor sweep appears on the display. For this type of operation, the positive time-sharing wave from V18B (fig 13-7A) is connected to grid 3 of V60, (fig 13-15), and the positive gate from V9 (fig 13-5) is connected to grid 1 of V60. The PRF of the negative range strobe generator

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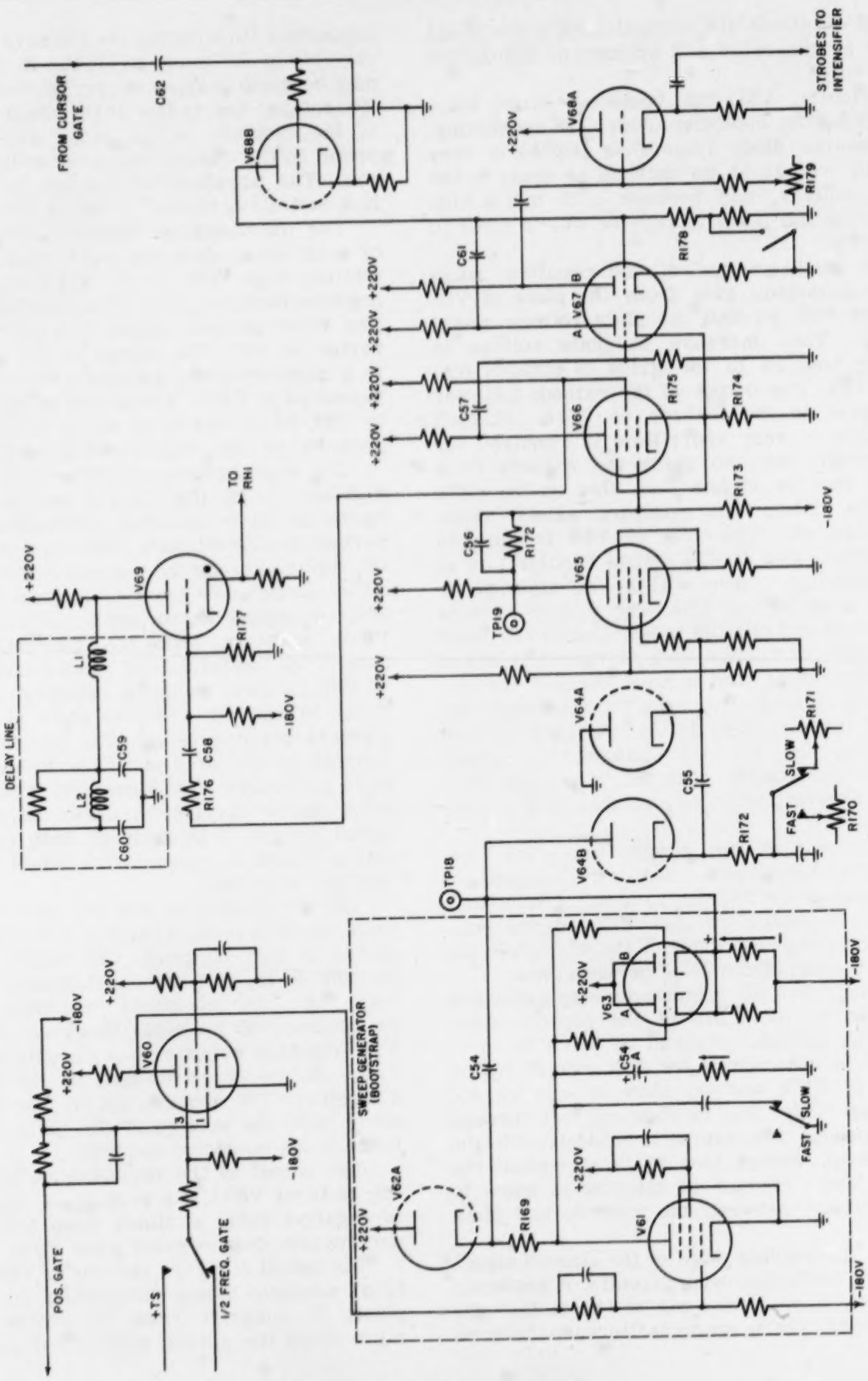

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Figure 13-15.—Range strobe generator.

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gate is one-tenth the normal PRF and a range strobe is generated and appears on the cursor sweep only.

Normally, V61, the bootstrap clamp tube, and V62A, the bootstrap diode, are conducting. Because the diode impedance (V62A) is very low, the voltage at its cathode is close to the supply voltage, and because R169 has a high resistance the plate voltage of V61 is close to zero volts.

The leading edge of the negative range strobe generator gate from the plate of V60 cuts off V61 so that its plate voltage starts to rise. This increase in plate voltage is directly coupled to the grids of cathode follower V63. The output of the cathode follower is coupled to the cathode of V62A through C54. Only a very short time is required for the voltage rise to raise the cathode to a voltage that is higher than that on the plate of V62A. When this condition exists, diode V62A cuts off. The gain of V63 is close to one (unity), and if C54 (large capacity) is in good condition, there will be no appreciable voltage drop across C54. The rate of voltage rise at one end of R169 is practically the same as the rate of voltage rise at the other end of R169. Therefore, the current through the resistor is practically constant. Because the current through R169 is the charging current for C54A, the rate of voltage rise across C54A is practically constant. Charging current is constant when rate of change of voltage is constant.

At the end of the negative gate, V61 conducts and discharges C54A. The cathode of V62A then drops rapidly to a value less than the supply voltage so that V62A again conducts. This action restores the circuit to its original no-signal condition between gates.

The output of the bootstrap sweep generator is applied to the plate of the pickoff diode, V64B. The cathode potential of V64B is variable and is determined for fast ranges by the setting of R170 and on slow ranges by the setting of R171. The cathode current through R172 produces a sweep pattern identical to the plate sweep, except that it is clipped at the bottom. The amount of clipping is equal to the difference between the cathode and plate voltages.

When the leading edge of the clipped signal is applied to the following circuits, it produces the output range strobe pip at the instant the pickoff diode, V64B, conducts. Because the diode conducting time during the sweep is continuously variable by R170 and R171, the range strobe pip may be made to appear at any point on the sweep. Therefore, the radius of the range-strobe ring of the distance of the range strobe from the origin on the display tube are continuously variable. The waveform at the cathode of V64B for fast and slow sweeps is shown in figure 13-16.

The differentiated waveforms at the bottom of each group show a negative backswing at the trailing edge. The diode, V64A, eliminates the negative backswings by shunting them to ground. The differentiated output is amplified and inverted by V65. The signal at the plate of V65 is a negative-going square wave, which may be examined at TP19. The signal is peaked slightly by C56, R172, and R173, which forms a coupling network to the regenerative amplifier, V66.

The regenerative amplifier circuit includes V66 and V67A (fig 13-15), and is similar in operation to a one-shot multivibrator. In the normal, no-signal state, V66 conducts and holds the voltage across the common cathode resistor, R174, sufficiently positive to keep V67 cut off. This condition exists until the pickoff diode, V64B, conducts. Then, the differentiated waveform from the cathode of V64B causes the plate of V65 to start swinging negative. This action tends to cut off V66, the plate of which then starts a positive swing. The positive swing is coupled to the grid of V67A through C57 and R175 and makes V67A conduct. When this happens, more current is drawn through R175, which increases the voltage drop across R174 and provides a regenerative effect by making V66 cut off faster.

Circuit conditions are set up to prevent the plate of V65 from swinging positive immediately. If this happens, C57 would discharge through R175, and the multivibrator would return to its no-signal condition after approximately 60 to 70μs. However, the plate of V65 remains comparatively negative until the range strobe sweep flattens on the fast range. Therefore, V66 remains cut off, and V67A conducts until the voltage at the plate of V65 returns to the no-signal condition.

The output of the regenerative amplifier at the plate of V67A is a rectangular wave, which is negative going at times when V67A is conducting and positive going when V67A is cut off.

The output from the cathode of V69 (a thyratron) provides range information to a remote point. A positive pulse, at strobe time, is taken from the screen grid of V66 and coupled

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to the grid of V69 through R176 and C58. Resistor R176 reduces the loading on the screen of V66. A differentiating network, formed by C58 and R177 produces a sharp, positive spike at the leading edge of the positive pulse, which causes V69 to fire. The thyratron, V69, then conducts, which causes its plate to go negative. This action causes a positive pulse to appear at the cathode of V69.

The negative pulse initiated at the plate of V69 travels along the artificial delay line made up of L1, C59, C60, and L2 and is reflected back to the plate of V69. This action quenches the thyratron, and conduction stops. The round trip time of the pulse through the artificial line is about 1 μs, and the range information at the thyratron cathode is a 1 μs pulse coincident in time with range strobe generation.

The negative and positive pips from the differentiator, C61 and R178, are fed to the grid of V67B. These pips are inverted by V67B, and its plate output is fed to the grid of the output cathode follower, V68A. The grid of V68A is below cutoff, and the negative pip is eliminated. The amount of voltage that holds the grid of V68A below cutoff is determined by the setting of R179.

An intensified spot is made to appear at the origin of the electronic cursor by coupling the negative cursor gate through C62 and V68B to the grid of V67B. Tube V67B then delivers the range strobe pip to the grid of the output cathode follower, V68A, at a time during the sweep that is determined by the range strobe control setting, R179.

VIDEO AMPLIFIER

The schematic diagram for a video amplifier is shown in figure 13-17. The video input line from the radar receiver may be terminated with a 75-ohm matching resistor, R180, by connecting a jumper. JU, between terminals 1 and 2. However, if several indicators are operated in a chain, R180 should be added in the last (most remote) indicator only, to avoid excessive loading of the line.

The video signal is fed to the grid of V70 through a long time constant network made up of C63 and R181. The video gain control, R182, controls the bias at the input grid of V70, and thereby adjusts the stage gain.

The amplifier that consists of V70, V71, and V72, plus a cathode follower in another section is designed for uniform gain over a wide frequency range. The coils, L3 and L4, are connected in series with resistors R183 and R184 to give high-frequency compensation. Otherwise, there would be reduced gain caused by a reduction in plate load impedance because of the shunting effect of the interelectrode capacitances and the distributed capacitance in the coil. The coils resonate with the interelectrode and distributed capacities to extend the high-frequency range of the amplifier, and have no effect on the low frequency response. Coils L5 and L6 form

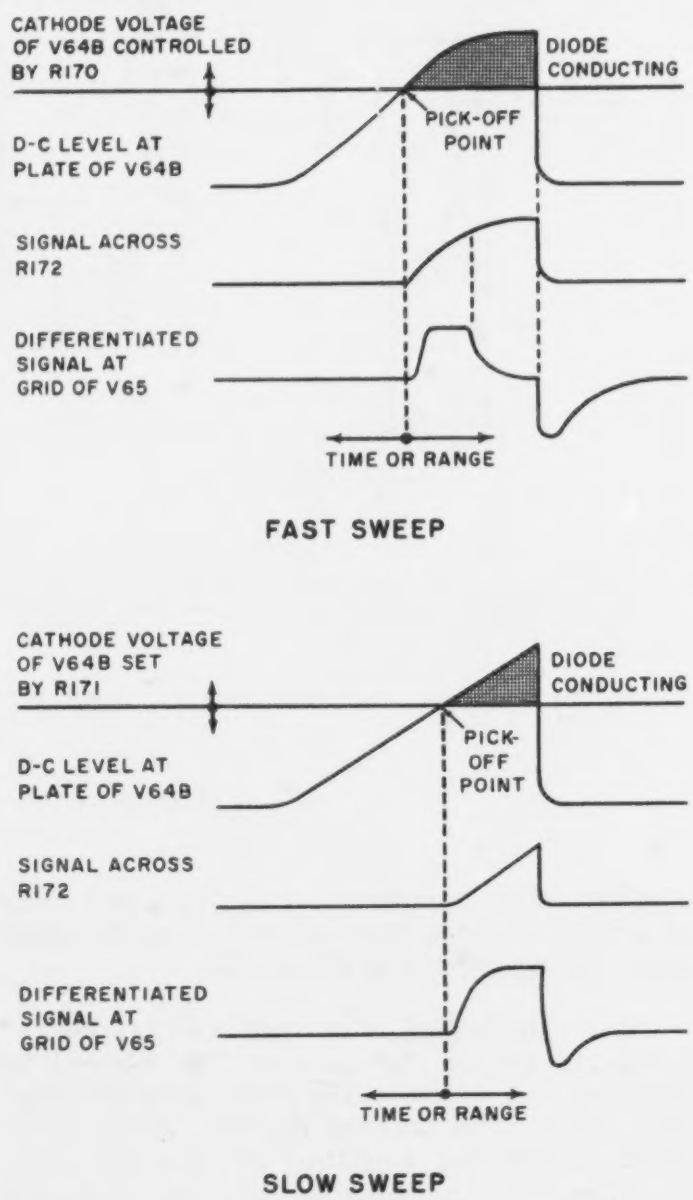

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Figure 13-16.—Differentiated waveform.

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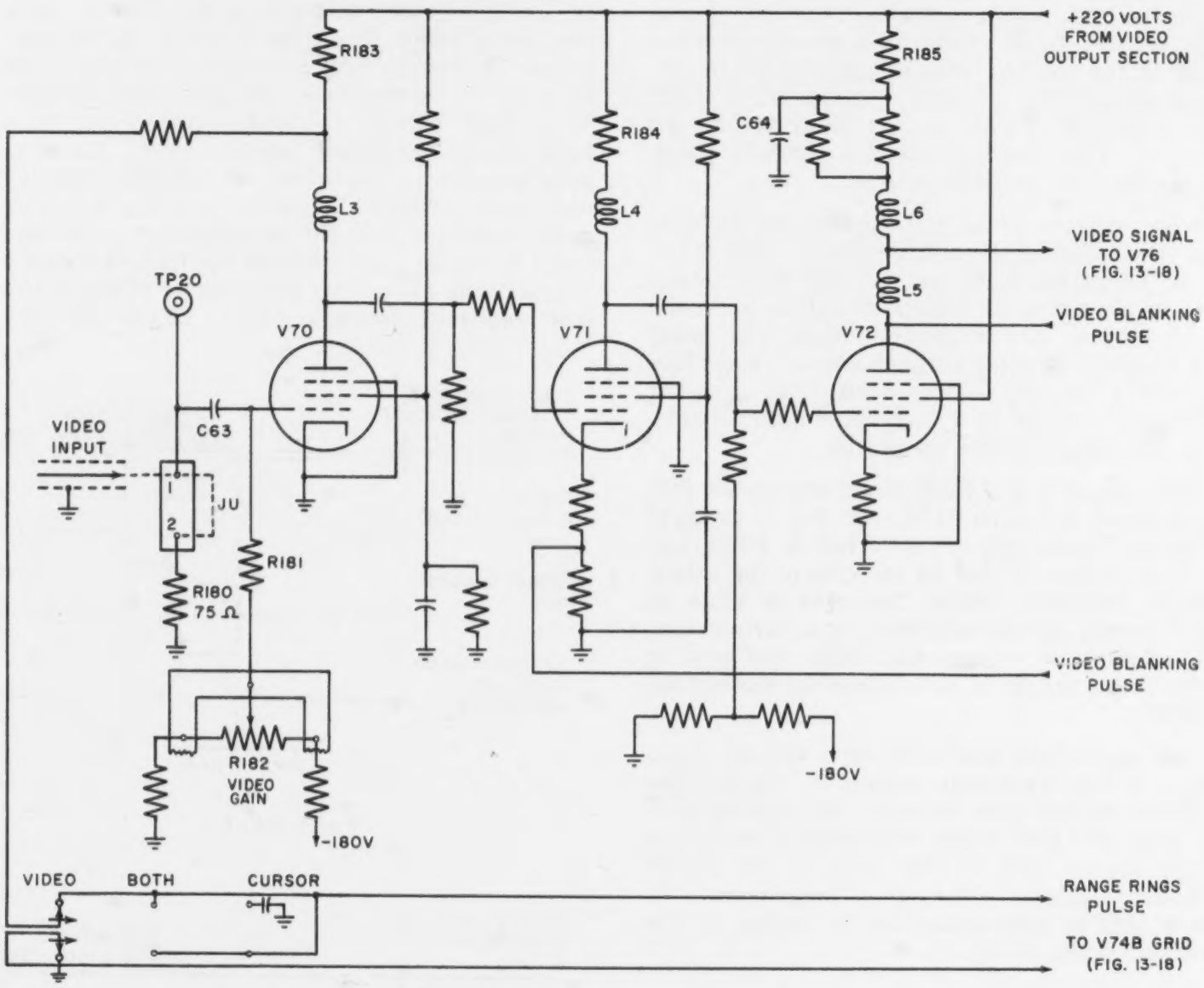

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Figure 13-17.—Video amplifier.

a series-shunt compensating system. Coil L6 is the shunt compensation coil and gives the same high peaking effects as L3 and L4.

The video signal, which may be examined at TP20, is fed to the grid of V70 where it is inverted and mixed, at the plate, with the range ring pulse from another section. These combined signals are amplified and inverted again by V71. The amplification and inversion are again repeated in V72. A decoupling circuit, formed by R185 and C64, prevents feedback to V70 through the power supply.

VIDEO OUTPUT AND CURSOR UNBLANKING

The schematic diagram for the video output and cursor unblanking section is shown in figure 13-18.

The input stage, V73, is a DC restorer that clamps the DC level at the grid of V74A to the voltage set by the sweep intensity potentiometer, R186. If the voltage from R186 to the cathode of V73A is made more positive, the operating point of the grid of the output cahtode follower, V74A, is raised. This action makes

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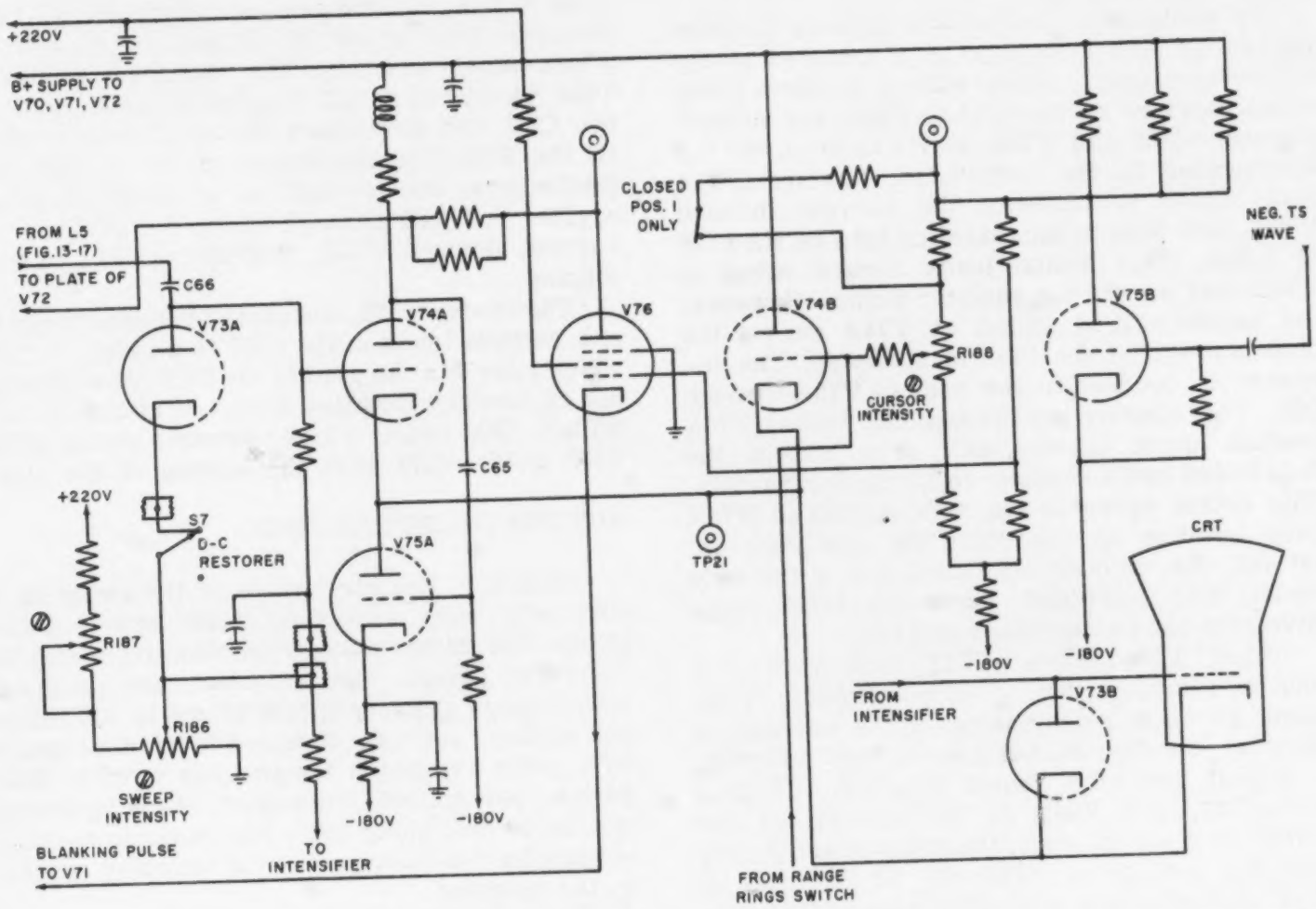

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Figure 13-18.—Video output and cursor unblanking.

the signal to the CRT less negative and decreases the intensity of the sweep video display. The intensity of the sweep video display is increased by adjusting R186 so that the cathode of V73A is made more negative.

Under normal operating conditions, the DC restorer maintains the proper base line for video signals. Thus, it prevents the loss of weak signals because of a shift in base line when signals with large amplitude and high duty cycles are picked up. Under certain jamming conditions, it may be necessary to disable the DC restorer by opening S7. The potentiometer, R187, is used for automatic intensity compensation and will be discussed later.

The output cathode follower, V74A, feeds the negative video signal (examined at TP21) to the cathode of the CRT. Tube V75A is used as a cathode load for V74A to provide a low-output impedance. This provision assures that the cathode output follows the AC signal input to the grid. To explain the action of V75A, consider the cathode load of V74A as a resistor. In shunt with this resistance is a capacity that is equivalent to the distributed capacity of the cable going to the CRT.

When V74A conducts, the capacitance is charged with a positive polarity. The arrival of the leading edge of a large negative going video signal at the grid of V74A reduces the plate current of the tube. The cathode of V74A tries to follow the grid, but the capacity distributed in the cable to the CRT starts discharging through the cathode resistance. As a result, the leading edge of the cathode output signal lags the input signal in proportion to the rate of discharge of the capacity through the resistance. As the grid swings more negative,

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the cathode is prevented from following it by the action of the capacity, the bias increases, and the tube cuts off.

By using V75A instead of a cathode resistor the action just described is eliminated in the following manner. When a large negative going signal arrives at the grid of V74A, the current through V74A and V75A starts to drop, but the discharging to the distributed capacity in the cable tends to maintain the current through V75A, and thus to increase the bias on the grid of V74A. This action leads toward cutoff of V74A just as did the resistor action. However, the negative grid signal at V74A cuases the plate voltage of the tube to increase. The increase is coupled to the grid of V75A through C65. The positive pip through C65 makes V75A conduct more heavily and, as a result, the distributed cable capacity is discharged rapidly. This action prevents the cathode bias of V74A from building up, therefore the tube does not cut off. Its cathode can then follow the grid signal. The combined video and range rings waveform can be examined at TP21.

Tubes V76, V74A, V74B, and V75B are used in a circuit that provides blanking of the video sweep and unblanking of the cursor, or tracking strobe, during the cursor interval.

During the nine sweep intervals, V75B is conducting, and V74B is cut off. During the cursor period, the negative time-sharing gate from the cathode of V18B (fig 13-7A) cuts off V75B and produces a positive gate at its plate. This positive gate is also DC coupled to the grid of V74B through R188 the cursor intensity potentiometer.

The voltage drops at the plate of V76 because its grid has been made more positive by the positive gate and increases the current through the plate resistor. The negative output gate of V76 is DC coupled to the plate of V72 (fig. 13-17) and then through L5 and C66 (fig. 13-18) to the grid of V74A. This action drives the grid of V74A in a negative direction. To make sure V74A cuts off, the positive gate at the cathode of V76 is DC coupled to the cathode of V71 (fig. 13-17). The resulting positive gate at the plate of V71 is amplified and inverted by V72 and appears at the grid of V74A (fig 13-18) at the same time as the negative gate from the plate of V76 and thus assures that V74A will be cut off.

At the same time the above action occurs, a positive gate at the grid of V74B causes the tube to conduct. When this happens, a positive gate is produced at the cathode of V74B and is coupled to the cathode output of V74A. The DC level of this positive gate is controlled by R188. Because V74A is cut off, the positive gate from V74B, alone, produces the waveform at TP21. This waveform is DC coupled to the cathode of the CRT and intensifies the electronic cursor on the PPI. The brightness of the cursor depends upon the strength of the positive pulse applied to V74B through R188. The greater the current through V74B, the dimmer the cursor display.

The diode, V73B, connected between the grid and cathode leads of the CRT is a safety device which prevents the grid of the CRT from becoming excessively positive in the event of a circuit failure. Otherwise, a large positive swing of the CRT grid might burn the screen of the tube.

AUTOMATIC INTENSIFIER

Normally, the birghtness of the sweep on a CRT will vary according to the speed of the sweep and to the pulse repetition frequency of the radar signal. The indicators are provided with a range of sweep speeds from 4 to 300 miles per radius, and are designed to handle signals with pulse repetition frequencies of 60 to 3000 sweeps per second. Therefore, changing sweep speeds or switching from one radar to another requires a readjustment of the intensity control by the operator.

To eliminate this condition, the automatic intensifier shown in figure 13-19 is used.

The automatic intensifier consists of V77A, V77B, V78A, and V78B and maintains the background brightness substantially constant for all sweep speeds and repetition rates without manual adjustment by the operator. The automatic intensity circuit does not affect the video gain.

In operation, a negative gate from the gate generator cuts off the normally conducting V77A, and a positive gate is produced at the plate of V77A, which is directly connected to the control grid of the CRT. Therefore, the positive gate turns on the display. The positive pulse from V77A is also coupled to the grid of V77B by the differentiating circuit made up of C67, R189, and R190. The positive pip of the differentiated waveform causes the normally cut off V77B to conduct. The negative output pip from the plate of V77B is integrated by C68 and R191. Any AC component in the pip is bypassed to ground by C68 and only a negative DC voltage is applied to the grid of V78A. The level of the negative

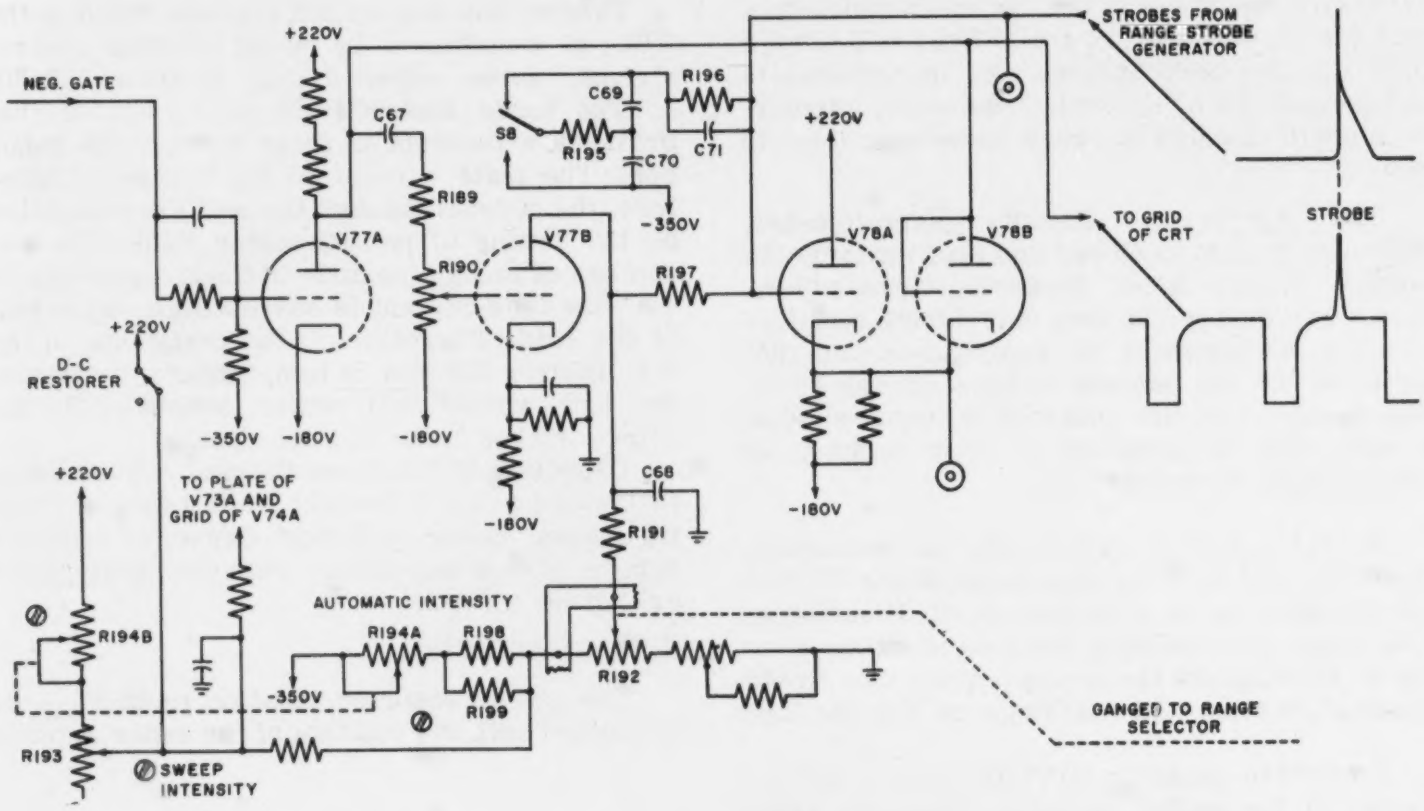

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Figure 13-19.—Automatic intensifier.

DC voltage applied to the grid of V78A is determined by the pulse repetition frequency of the radar because, the higher the PRF, the greater the number of negative charges collecting on C68. Consequently, the greater the total negative bias on the grid of V78A.

The potentiometer, R190, sets the amplitude of the individual negative pulses that charge C68 and thereby determines the rate of change in DC level at the grid of V78A with the repetition rate. The negative DC level from the cathode of V78A is directly coupled to the cathode of V78B. Note that the grid and plate of V78B are tied together to form a diode. The voltage level at the cathode of V78B determines the plate voltage at which it will conduct. The amplitude of the positive gate at the plate of V77A is limited to the level at which V78B conducts.

Thus, an increase in the repetition rate of the positive gate that would normally increase the brightness of the CRT simultaneously produces a proportional increase in negative bias on the cathode of V78A. The increased bias acts to reduce the amplitude of the intensifier voltage and to prevent an increase in brightness. Therefore, the brightness level of the CRT is relatively unaffected by changes in the PRF of the radars.

The intensity of the video display must not vary as the range is changed. The fast sweep used for the shorter ranges would not normally appear as bright on the PPI as the slow sweep of the long ranges. To eliminate this condition, the range selector control on the panel is ganged to potentiometer R192, which controls the bias voltage for V78A as well as the plate voltage for V77B. Therefore, the range selector control moves the potentiometer arm to provide additional bias automatically as the range becomes longer or less bias as the range shortens.

The potentiometer, R193, provides a means of adjusting the CRT intensity voltage. The setting of this control determines, in part, the amount of negative bias available across R192. A more negative setting of the sweep intensity control, R193, lowers the operating point at the grid of the video output cathode follower, V74A, (fig. 13-18). As a result of this action, the signal to the cathode of the CRT is more negative, and the intensity of the video pattern on the CRT is increased. At the same time, the more negative

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setting of the sweep intensity control increases the range of the negative bias across R192. Thus, at different settings of the sweep intensity control the potentiometer arm of R192 will always pick off the correct bias that is required to compensate for variations of the sweep intensity because of changes in sweep speed over the 4-to 300-mile range.

The automatic intensity potentiometer, R194A is ganged to R194B and also controls the voltage across R192. However, these adjustments are preset and used only during installation or maintenance to compensate for differences in the amount of bias across R192. Readjustment of the controls is required when a new CRT is installed or when components change value because of age.

Relay operated switch, S8, in connection with C69 and C70, is used to blank the CRT at the 34-mile range switching point. Blanking at this point is necessary because transient currents develop (in the sweep chain) that would cause distortion and markings on the display.

Protective resistor R195 is used to reduce arcing at the switch contacts. When the relay operates S8 at 34 miles, C69 is connected to -350 volts. This sudden drop in voltage is coupled through R196 in parallel with C71 to the grid of V78A, and causes the cathode voltage of V78A to lower enough to cut off the CRT. Capacitor C69 then charges through R196, R197, R191, R198, R199, and R194 in approximately one second, so that V78A can conduct again and reestablish the normal bias on the CRT grid. The CRT is blanked during the one second that C69 is charging in order that transient currents, because of switching, do not appear on the display.

When the relay operates S8, C70 starts from zero charge and follows the same cycle as described for C69.

During the cursor interval, or the interval of every other sweep, according to the position of the switch in the range strobe generator, positive strobe pips are delivered from the range strobe generator to the grid of V78A. These positive pips produce sharp positive peaks on the positive gate from V77A, and also produce either the range strobe on the electronic cursor or the range strobe ring centered about the origin of the video sweep.

FOCUS

Proper focusing of the electron beam in the CRT is maintained by using a focus control circuit, shown schematically in figure 13-20.

The focus control tube is a pentode that provides a constant current through the focus coil. The plate current of the tube and, therefore, the current through the coil are controlled by the setting of potentiometer R200. The advantage of using a pentode in the focus circuit is that the tube current is essentially independent of the load. Therefore, if the resistance of the coil changes because of temperature variations, the coil current will remain substantially the same, and the focus will not change.

Capacitor C73 reduces the peak voltage swing that would occur if the tube were removed from its socket during operation. Capacitor C72 is a bypass to keep any pickup from the cable off the grid of the pentode.

SERVOAMPLIFIER

The sweep resolver rotation must be synchronized with the rotation of the radar antenna

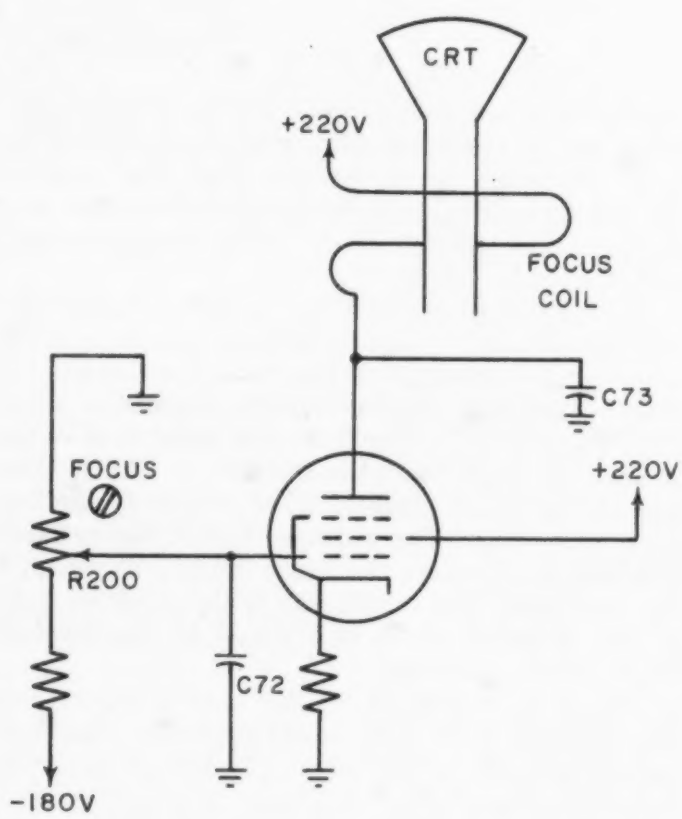

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Figure 13-20.—Focus circuit.

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being used. In one type of radar, a one-speed sychro followup system is used to synchronize the sweep and antenna rotation. The complete control (fig. 13-21) is called a servo loop, which consists of four major parts: (1) synchro bearing information from the radar, which is the input control signal, (2) a 1CT (control transformer), (3) a servoamplifier and (4) a drive motor and the necessary gears.

The bearing input may be north-stabilized by using correction voltages from a gyro compass. If no correction has been applied, bearing information relative to the heading of the ship or AEW plane, as the case may be, is obtained and fed to the servoamplifier.

The servoamplifier is a conventional unit and includes a bridged-T, antihunt network; a phase-shifting network; and a push-pull output stage.

The 60-cycle error voltage from the rotor of the 1CT synchro is applied across capacitor, C74, to filter out high-frequency transient voltages that result from movements of the synchro rotor. The bridged-T network consists of C75, C76, R201, and R202, which is an antihunt control.

The output voltage from the bridged-T network represents the sum of voltages proportional to the error signal and its derivative. The derivative voltage is proportional to the rate of change of the error signal voltage and acts to prevent hunting, thereby stabilizing the system.

The stabilizing action of the bridged-T network takes effect as the system is approaching a null after an error indication. The derivative signal starts slowing the motor down with dynamic braking before the null is reached. Braking in this manner reduces the overshoot so that the system will stabilize quickly. This type of damping is called error rate damping, and it permits the use of higher servo gain and greater freedom from oscillation than would otherwise be possible.

The bridged-T network output is fed to V79A. The output of this tube is fed to a phase-shift network made up of R203, R204, C77, and C78. This network produces approximately 90 degrees phase shaft in order to obtain maximum torque in the split phase drive motor.

The output of the phase-shift network is applied to the grid of V79B for amplification. The plate output of V79B is applied through C79 to R205, which is the servo gain control. A proportional part of the signal is applied to the amplifier and phase inverter V80A and V80B. The output of V80B supplies the push-pull input signal for V81 and V82.

Negative feedback from plate to grid of each tube in the output stage, through R206 and R207, provides additional damping and keeps the motor from operating with no error signal.

JOYSTICK OFF-CENTERING CIRCUITS AN/SPA-8C

Joystick operation provided by the AN/SPA-8C, gives the operator of the indicator greater speed in off-centering the cursor origin and, in most cases, allows him to perform this function in a more natural manner. In addition, joystick operation requires the use of only one hand, permitting the other to be used for a strobe positioning or other operations. It is important to note the following three characteristics of CURSOR ORIGIN joystick operation that distinguish it from the other types of operation available with Indicator Group AN/SPA-8C: (1) it is available for general-purpose operation only, not AEW operation; (2) the amount of the cursor-origin displacement is not indicated on counters; and (3) the displacement information cannot be transmitted to other equipments. Time-shared voltage output of the electronic switch provides zero voltage across the potentiometers during the sweep period, thus permitting off-centering during the cursor period only. The shaft of R-1852 is geared indirectly thru electro mechanical storage clutches to the RANGE SELECTOR knob of the top panel. Depressing CURSOR ORIGIN joystick, deenergizes L-1851, allowing the wipers of R-1852 to select voltages which depend upon the range setting. The two voltages are equal in magnitude but opposite in polarity.

Motion of the CURSOR ORIGIN joystick controls potentiometers that apply the correct amount of cursor off-centering voltage to the E-W and N-S Yoke Drivers. There are two sets of these potentiometers, one set for coarse off-centering control and one set for fine off-centering control. When the joystick handle is depressed, the coarse potentiometers are activated and the joystick becomes a coarse control. In this condition, the cursor origin is capable of being displaced three radii in any direction from the sweep origin. When the handle is released the coarse potentiometers are held at their settings and the fine potentiometers are activated. Movement of the joystick in this condition results in fine control of off-centering

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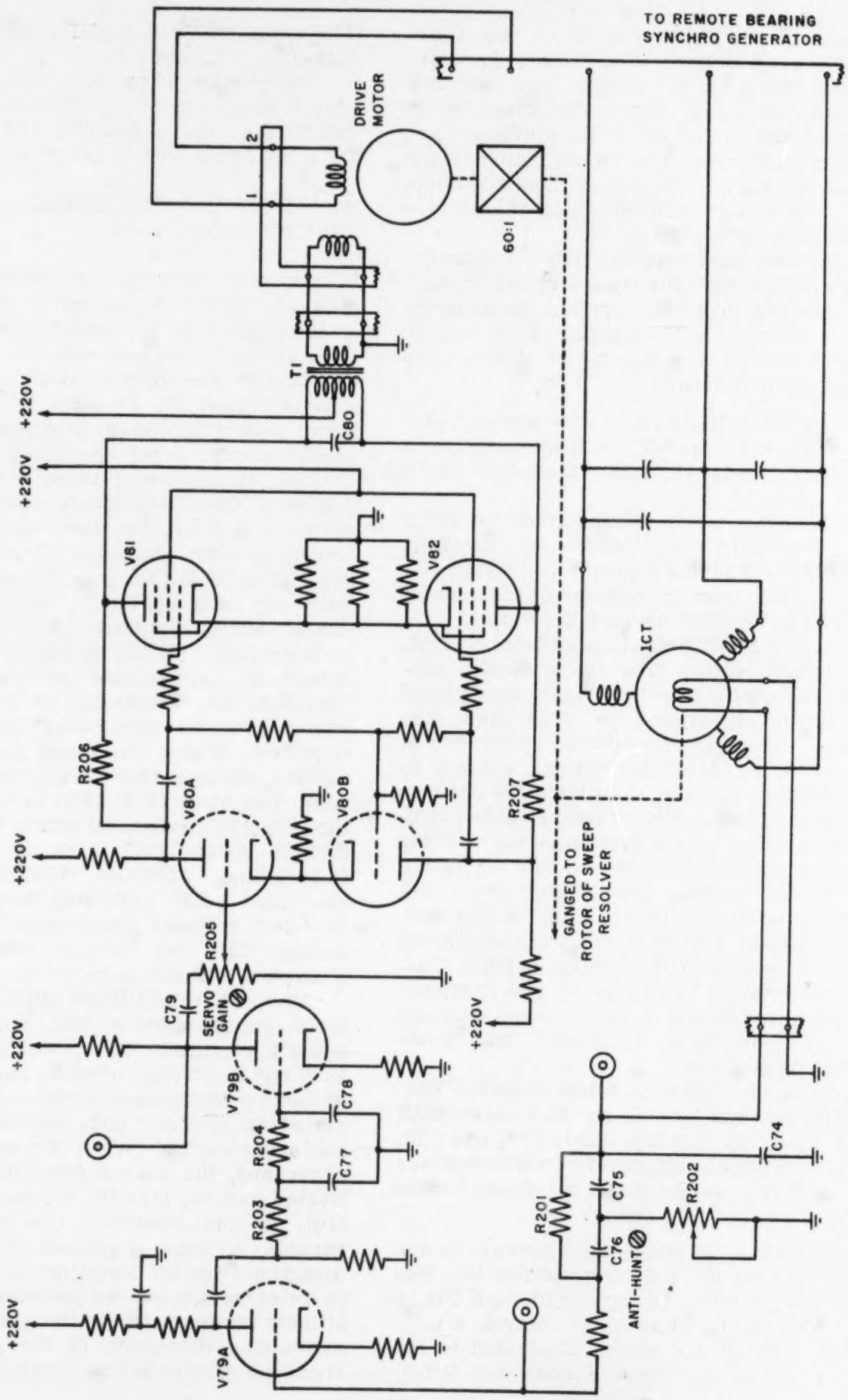

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Figure 13-21.—Servoamplifier section.

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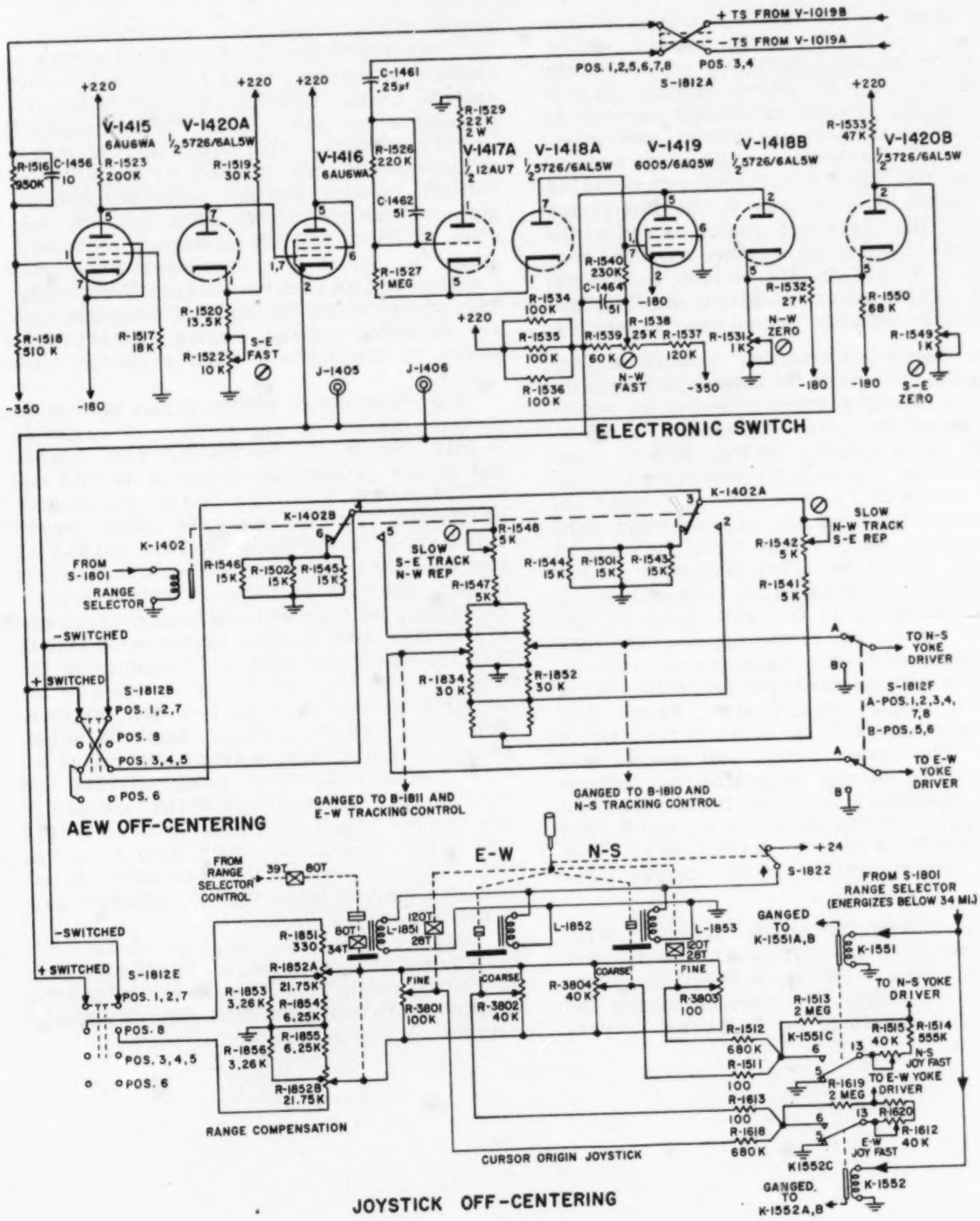

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Figure 13-22.—Electronic switch, AEW, and joystick off-centering circuits, AN/SPA-8C.

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of the cursor origin about the point on the display that was selected in the coarse condition. When the display is expanded by operation of the RANGE SELECTOR control during joystick operation, the amounts of off-centering voltage applied to the yoke drivers are reduced to maintain the above mentioned 3-radius displacement.

When the function selector switch S-1812 (Fig. 13-22), is in position 8, the time shared output of the electronic switch is fed to the non-linear range-compensation network, consisting of R-1853, R-1854, R-1855, R-1856 and tapped potentiometers R-1852A and R-1853B, in the range selector (sweep speed) assembly.

The range-compensation network applies decreasing voltages to the potentiometers as the display is expanded, thereby keeping the cursor displacement (in inches) substantially independent of range selector setting. Without range compensation, a given movement of the joystick would always displace the cursor through the same range (in miles) and, as a consequence the cursor origin might move several inches in an expanded display and only a fraction of an inch in a contracted display. Range compensation is applied because it is desirable, from the operator's standpoint, to see approximately the same amount of cursor displacement, in inches, relative to joystick movement regardless of the degree of display magnification. Range compensation affects only the action of the joystick control. The cursor origin will remain on a target during display magnification, because display expansion acts on both the target and the cursor origin to the same degree, and R-1852 does not rotate when the RANGE SELECTOR knob is rotated until the joystick handle is depressed.

The two range-compensated voltages are fed to opposite ends of CURSOR ORIGIN joystick potentiomenters R-3803 and R-3804 in the North-South cursor-origin off-centering circuit and R-3801 and R-3802 in the East-West cursor-origin off-centering circuit. Potentiometers R-3801 and R-3803 provide fine control of cursor-origin off-centering while R-3802 and R-3804 provide coarse control. The shaft of the fine potentiometers are geared to the CURSOR ORIGIN joystick. The shafts of the coarse potentiometers are coupled to the CURSOR ORIGIN joystick through electromechanical storage clutches which allow rotation only when CURSOR ORIGIN joystick is depressed. When the joystick is depressed it becomes a coarse control of cursor-origin off-centering. The wipers of all the joystick potentiometers are connected, through summing resistor networks, to the inputs of their respective yoke drivers.

The off-centering voltage pulses to the yoke drivers appear at the junction of resistors R-1511 and R-1512 for the N-S yoke drivers and at the junction of resistors R-1613 and R-1618 for the E-W yoke driver. For RANGE SELECTOR settings above 34 miles, switch S-1801 is open and relays K-1551 and K-1552 are energized since the relays are operated through the NO contacts of switch S-1801. Therefore, the input voltages to the yoke drivers are divided down by the networks consisting of R-1513 and the N-S input grid resistors for the N-S yoke drivers, and R-1619 and the E-W input grid resistors for the E-W yoke drivers. For range selector settings below 34 miles, switch S-1801 closes, deenergizing relays K-1551 and K-1552. With relays K-1551 and K-1552 energized, resistors R-1620 and R-1612 are shunted with R-1619, and resistors R-1514 and R-1515 are shunted with R-1513, so that the input impedance to the yoke driver is decreased, thereby increasing the effective gain of the yoke driver circuit.

Variable resistors R-1612 and R-1515 can be adjusted to compensate for small variations in the yoke driver input circuits so that the ratio of gains above and below the 34-mile switch point may be selected precisely.

CHAPTER 14

SPECIAL PURPOSE EQUIPMENTS

This chapter gives a brief overview of selected special purpose equipment used in the Navy. Equipment used in electronic warfare is described, and general information on some of the latest electronic aids to navigation is presented. The chapter closes with a discussion of the latest developments in satellite communications and implications for its use in the future.

ELECTRONIC WARFARE

Electronic Warfare is the science of intercepting the enemy and reducing the effectiveness of his electronic aids, by the utilization of electronic and nonelectronic equipment. It will be treated here under the two general headings: Passive and Active.

PASSIVE

As it pertains to Electronic Warfare, the term "passive" implies the state of being inactive but receptive. This means that a ship at sea which is electronically silent (no radio, radar, or sonar transmissions), with radio receivers on and listening, is engaged in passive Electronic Warfare.

For this purpose, any Navy radio receiver could be used, but in order for the countermeasures to be effective against an enemy radar, as many as possible of the following characteristics should be known about his enemy radar facilities: (1) the frequency, pulse width, pulse-repetition frequency, and peak power of the transmissions; (2) the receiver bandwidth and the time constants of the receiver coupling circuits; (3) antijamming features; (4) amount of shielding; (5) type of indicator; (6) antenna beamwidth; (7) types of scan; and (8) use of the radar. Some of this information is obtained by analyzing the enemy transmission, and some may be obtained by examining captured equipment.

Special equipment has been developed for use in analyzing r-f transmissions. This equipment includes SEARCH RECEIVERS, which search the various frequency bands for the different types of emissions. This type of receiver should cover a wide band of frequencies. Also used with the search receiver is a PANORAMIC ADAPTER and a PULSE ANALYZER. The panoramic adapter measures the frequency, strength, and type of modulation of a transmission in a selected band of frequencies. The pulse analyzer measures the pulse rate and width of these transmissions.

ACTIVE

The act of reducing the effectiveness of the enemy's electronic aids is the "active" portion of Electronic Warfare. For the purpose of this discussion it will be broken down into electronic and nonelectronic countermeasures.

Electronic Countermeasures

In order to use countermeasures most effectively against enemy communication systems, the following information is needed; (1) the frequency of transmissions, (2) type of modulation, and (3) receiver bandwidth. If the foregoing information is known, sucessful jamming of enemy transmissions can be accomplished with special type transmitters designed specifically for this purpose.

Nonelectronic Countermeasures

Units called CORNER REFLECTORS are used to present strong echoes to enemy radars. When suitably placed, corner reflectors produce strong echoes that appear to the enemy radar

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operator as a large naval force. Corner reflectors have other valuable uses. For example, they can be used on liferafts to assist friendly search radars to locate them.

ROPE is the name used for long streamers of aluminum foil. This foil, cut in lengths of about 400 ft, is dropped by aircraft within range of a enemy radar. The twisting and turning of the foil as it falls presents many different effective lengths to the enemy radar. Some of these lengths are highly resonant at the frequency of the radar, and therefore appear as strong target signals.

Window is the name used for short strips of aluminum foil dropped by aircraft to confuse the enemy. The foil is cut to slightly different lengths so that it causes strong reflected signals at the frequency of the enemy radar. The strips are packaged and dropped over enemy territory. While fluttering to the ground, the foil presents a multitude of targets to the enemy radars. His search and tracking radars follow the strong echoes presented by the window and find it difficult to track on the lesser echoes presented by the aircraft.

DECOYS consist of a wide variety of devices. Some of the most effective are balloons towing strips of aluminum foil. These strips, which vary in length, present strong reflections over a fairly wide band of frequencies. Aircraft may also tow streamers of foil as decoys. Corner reflectors might also be considered decoys.

Antijamming measures are used to reduce the effect of enemy jamming on our own equipment. In receivers some of the most important antijamming devices are special filters that pass only the most important parts of echo signals, thus rejecting as much of the jamming signal as possible. In the transmitters, a great many radar equipments have tunable magnetrons whose frequency may be varied at intervals to prevent an enemy jamming transmitter from locking on the radar signal.

FUNDAMENTALS OF INERTIAL NAVIGATION

Navigation is defined as the art or science of conducting a vehicle from one position on the earth to another position. There are two methods of navigation. One is position fixing by measuring position relative to some known object. A common example is celestial navigation. Loran is another example of navigation by periodic position fixes. The other method, dead reckoning, measures speed and heading and, using these measurements, computes position change from an initial position fix. The most common example of this form of navigation is the ship navigator's position plot. One of the oldest automatic navigation systems is the dead reckoning analyzer, which takes its speed from the ship's log and its heading from the ship's gyrocompass to compute latitude and longitude.

An inertial navigation system is a self-contained, refined form of dead reckoning that continuously computes latitude and longitude by accurately sensing the accelerations of the ship with respect to the earth's surface.

Before learning how an inertial navigator operates, it is necessary to review a few fundamentals of physics and motion. The following paragrphs discuss the essential background material required for this purpose.

FUNDAMENTALS OF INTEGRATION

Since the process of integration is so frequently used in navigation systems, a simplified explanation is given. It is used here to explain the relationship of acceleration to velocity and distance traveled. In inertial navigation, distance traveled is calculated from measured acceleration by first integrating acceleration with respect to time to find velocity, and then integrating velocity with respect to time to find distance traveled.

Velocity is defined as a rate of change of distances with respect to time, $V = \frac{ds}{dt}$. The familiar unit of miles/hour is the dimension of velocity. Acceleration is a physical phenomenon equal to the rate of change of velocity with respect to time, $a = \frac{dv.}{dt}$. The unit of acceleration curve is miles/hour^2. Because the area under the acceleration curve is proportional to velocity, if the mathematical process of integration is performed on the quantity acceleration, the result is velocity. Likewise, because the area under the velocity curve is proportional to distance if the mathematical process of integration is performed on the quantity velocity, the result is distance. Figure 14-1 illustrates the relationships of acceleration, velocity and distance.

In order to illustrate these relationships clearly, constant values of accelerations are chosen for each of the first four intervals (time 0 to time 4). Integrating the constant acceleration for time 0 to time 1 gives a

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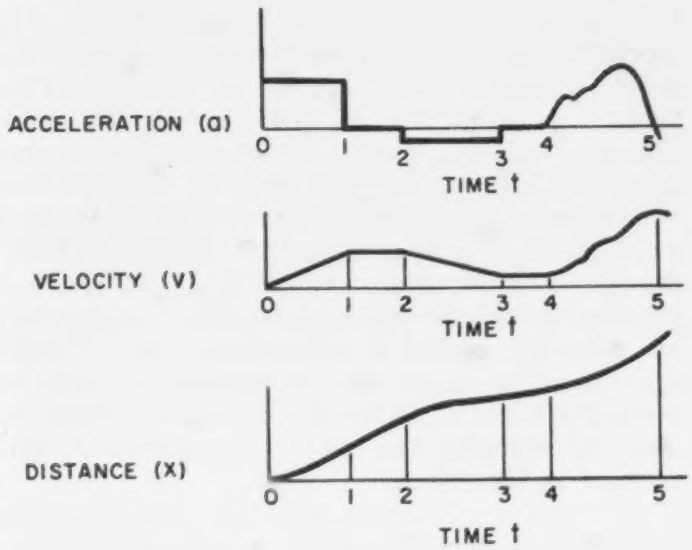

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Figure 14-1.—Integration of acceleration to obtain velocity and distance.

velocity (V) which increases linearly. Velocity at the end of the first interval is actually computed by measuring the area under the acceleration curve (time 0 to time 1).

Recall that the fundamental formula for velocity is V = at; where V = Velocity, a = acceleration, and t = time. The process of integration subdivides each interval shown in figure 14-1 into an infinite number of tiny intervals. Integration is, then, the process of adding, or summing, an infinite number of incremental areas under a curve to obtain the total area. The velocity curve, therefore, is a plot of subtotals of the incremental areas under the acceleration curve.

In the second period (time 1 to time 2), the acceleration is zero, and the velocity remains constant. In the third period, there is a constant negative acceleration which reduces the velocity subtotals at a constant rate. In the fourth period, there is no acceleration and no change in velocity. In the fifth period, a random acceleration and its approximate integral, the velocity, are shown.

The distance curve is a plot of subtotals of the incremental areas under the velocity curve.

An example of integration is a d-c motor driving a counter. If a voltage proportional to velocity is present, it could be used to drive the motor so that the speed of the motor would be proportional to velocity; and the number of revolutions or the counter reading would indicate distance traveled. Thus, velocity would be integrated to find distance.

NEWTON'S LAWS

In our definition of inertial navigation it states that the inertial navigator senses accelerations. The important thing to consider at this point is how to sense the quantity of acceleration. Newton's three laws of motion provide the answer to this problem.

Newton's first law states that a body remains in motion at a constant velocity unless acted upon by a resultant force. Constant velocity means both direction and magnitude, therefore velocity is a vector.

Newton's second law describes the magnitude of the acceleration as $F = M_s A_s$ where;

A_s = the acceleration of the ship

M_s = mass of the ship

F = vector sum of the forces

Two quantities are unknown, A_s and F. The quantity F cannot be directly determined because of the many varying parameters that enter into its solution.

Newton's third law states that for every reaction there must be an equal and opposite reaction.

For this application Newton's three laws result in the statement most familiar to us: a body at rest remains at rest unless acted upon by some external force and a body in motion remains in motion unless acted upon by some external force.

ACCELEROMETERS AND ACCELERATIONS

An accelerometer may be defined as a device which measures accelerations (changes in speed or direction). Its output is usually in the form of a voltage proportional to the acceleration to which it is subjected. Accelerometers are utilized in inertial navigation to provide information to the gyroscopes which in turn provide a stable platform.

Basically, an accelerometer consists of a mass suspended by constraining springs within a case. When the case and pendulum are traveling at a constant velocity, the mass remains in its center position as shown in figure 14-2, A. However, when the frame is accelerated (fig. 14-2, B), the mass will appear to move in the direction opposite to that of the accelerating force. Actually the mass lags behind since

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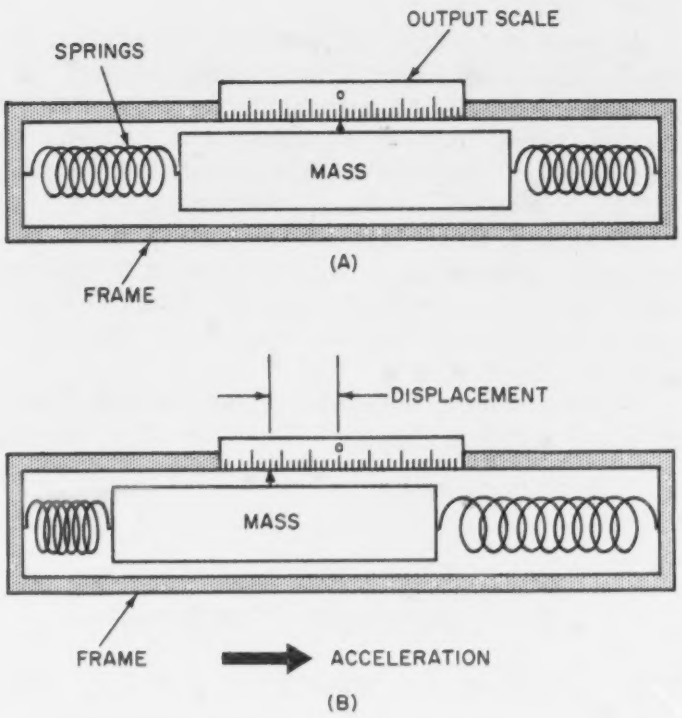

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Figure 14-2.—Basic Accelerometer.

the acceleration is applied to the frame, not the mass. The mass displaces enough for the constraining springs to apply a force proportional to the acceleration. The mass then moves with the frame maintaining its constant displacement. When the acceleration is removed from the frame, the constraining springs cause the mass to move (with respect to the frame or case) back to the neutral position. Thus, a body at rest or a body at constant velocity (zero acceleration) causes no displacement, providing the accelerometer is held horizontal.

In actual practice, the mass is held in its null or zero position with a calibrated spring or springs. To further dampen oscillations, the case is normally filled with a fluid. Since the deflection of the mass is proportional to the accelerating force, the amount of deflection (hence the accelerating force) is measured and through integration, velocity and distance can be determined.

The basic accelerometer demonstrates the principle of operation of inertial accelerometers. It must be kept in mind that these inertial accelerometers are sensitive to more than just the accelerations with respect to the earth. There are two types of forces that can cause a body to move: acceleration forces and field forces. It is important to note that an accelerometer cannot distinguish between these two forces. The most common field force is gravity. This force is represented by the formula ($f = mg$). The term (g) represents gravitational acceleration, 32.17 ft per sec per sec; the acceleration with which a body falls freely toward the earth's surface, neglecting air friction. If the accelerometer is tilted or placed on end, the force of gravity causes the mass to move in the same way as does an actual acceleration, even though the frame is at rest. A compensation must be made for these field forces, such as gravity, so that the quantity left is the acceleration with respect to the earth.

In order to compute the true distance traveled, we must sense the acceleration of the ship parallel to the reference plane of position. The accelerometer senses only components of acceleration parallel to its sensitive axis. Therefore, it must be maintained continuously parallel to this surface, independent of the pitching, roll, or yaw of the ship. This is accomplished by using more than one accelerometer and mounting them on gimbals so that the pivot axis of these gimbals are parallel to the motion caused by pitch, roll, or yaw. A device could be made that would sense the pitch, roll, and yaw of the ship and develop a signal that would be used to drive the associated gimbal with respect to the ship in a direction opposite to the disturbing motion, thereby maintaining the accelerometer's sensitive axis parallel to the reference plane of travel. In order to fully understand a device such as this, it will be necessary to learn a few fundamentals of gyroscopes and take a further look at inertial motions.

GYROSCOPE FUNDAMENTALS

A gyroscope, commonly called a gyro, is defined as a solid mass rotating about an axis contained within the mass. Usually the mass is symmetrically distributed about the axis which is called the spin axis. It is the rotation or spin of the mass which is the important feature of the gyroscope because it gives to the gyro characteristics or properties which distinguish it from other solid bodies. These characteristics are called rigidity and precession and are the result of fundamental laws of motion and inertia.

The principle of conservation of angular momentum (Newton's first law), states that a system will maintain its angular momentum if no external forces are applied to it. Thus the

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rotor (mass) of a gyro must maintain a constant angular momentum about its spin axis if no external forces are applied. Both the amplitude and direction of the angular momentum must be conserved. The spin axis, therefore, tends to maintain the same direction in inertial space. This feature of a gyro is known as gyroscope rigidity and is a fundamental property of gyroscopes.

Because of gyroscopic rigidity, moving the outer supporting frame has no effect on the direction in which the axle of a spinning gyroscope points. To change this direction, it is necessary to apply a force to the gyroscope rotor or its axle. A horizontal force (F) on one end of the axle (fig. 14-3) produces a turning effect which attempts to tilt the gyroscope about the axis ab. If the rotor were not spinning, the axle would tilt in response to the applied force. When the rotor is spinning, however, its rigidity causes it to resist any attempt to tilt the axle about ab, and instead it turns about the axis cd in the direction of arrow e. Conversely, a force attempting to turn the gyroscope about the axis cd is similarly resisted and results in a tilt about the axis ab. If the force is applied in direction H, rotation will occur in the direction of arrow g. This rotation of gyroscope about an axis at right angles to the axis about which a force is exerted is called precession. Precession takes place whenever any force tends to tilt the axle of a spinning gyroscope rotor. The precession caused by the applied force is always about an axis at right angles to the axis about which the force is applied.

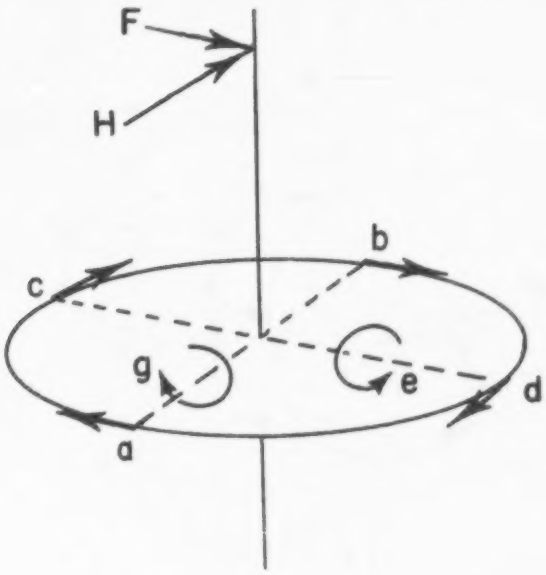

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Figure 14-3.—Spinning rotor with a vertical axis.

As explained previously, a free-spinning gyroscope can be moved in any direction without altering the angle of its plane of rotation. If this free-spinning gyroscope is placed on the earth's surface at the equator with its spinning axis horizontal and aligned east and west an observer in space below the south pole would note that the earth rotates clockwise from west to east and carries the gyroscope along. As the earth rotates, rigidity of plane keeps the gyroscope wheel fixed in space and rotating in the same plane at all times. Figure 14-4A shows how this gyroscope would appear to the observer in space. Assume that the gyroscope is set spinning at 0000 hours with its spinning axis aligned east and west and parallel to the earth's surface. At 0600, 6 hours after the gyroscope was started, the scope is aligned with the original starting position. At 1200 the earth has rotated 180° while the gyroscope retains its original position. At 1800 the earth has rotated 270° while the gyroscope retains its original position. At 0000 the earth has rotated 360° and the gyroscope is back in its original position.

This rigidity of plane appears quite different to an observer on the earth's surface. As the earth rotates, the observer moves with it and the gyroscope wheel appears to rotate about its horizontal axis. Figure 14-4B shows how this gyroscope appears to the observer on the earth's surface beside the gyroscope. Assume that the gyroscope is set spinning at 0000 hours with its spinning axis horizontal and pointing west toward the observer. At 0600, 6 hours after the gyroscope was started, the earth has rotated 90° and the gyroscope axle apparently has tilted. To the observer, the axle is horizontal again, but the axle points away from the observer. At 1800, the gyroscope axle is again vertical and points straight up. At 0000, the earth has rotated 360° and the gyroscope axle is back in its original position.

The rotation of the gyroscope axle as seen by the observer on the earth's surface is known as "apparent precession". If it is desired to have the gyro maintain an orientation referenced to earth, it must be precessed

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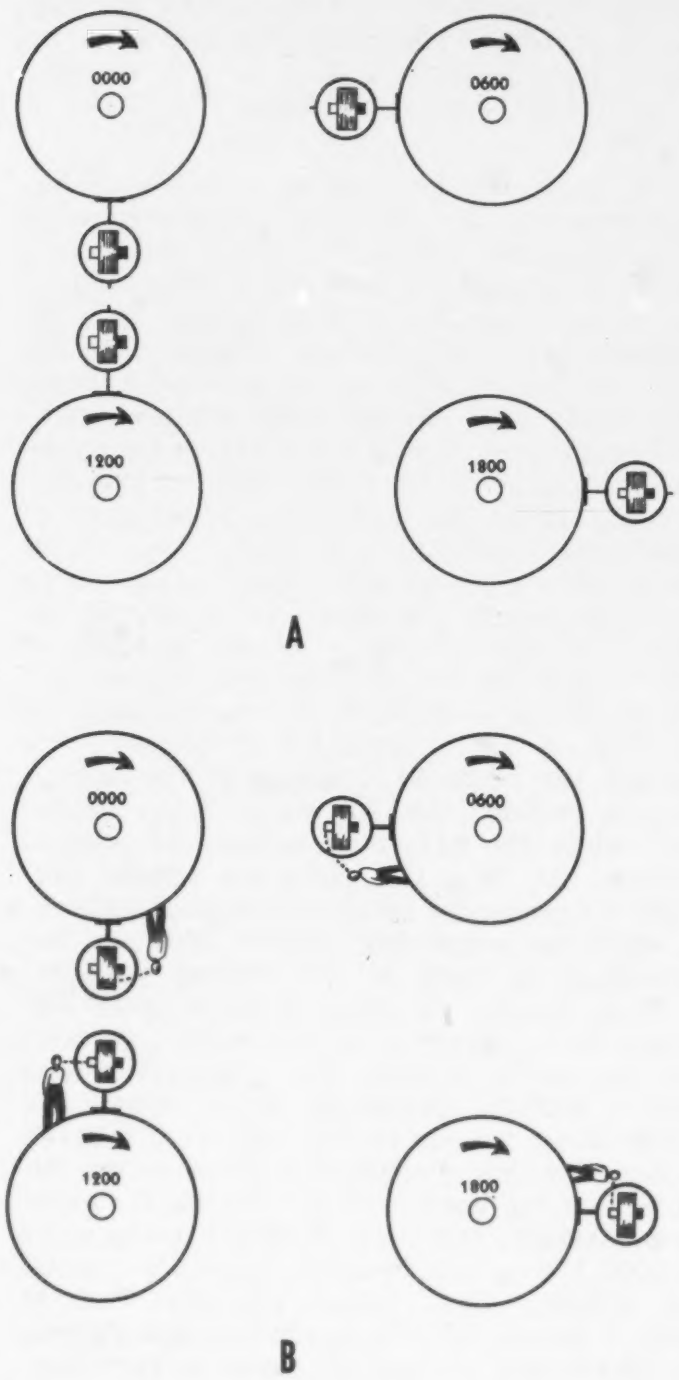

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Figure 14-4.—Apparent precession.

(torqued) in such a manner as to remove the apparent precession.

Gyro Supports

The gyro described above is said to have two degrees of freedom. It consists of an axially symmetrical rotor supported in a case in such a way that one axis is fixed relative to the case and the spin axis itself is free to assume any angular orientation relative to the case. Supporting the rotor within the case and providing the angular freedom is a gimbal system.

An example of such an arrangement is shown in figure 14-5.

The gyro rotor is free to precess about either of the two supporting gimbal axes (ab or cd), depending upon where the force is applied.

For application of the gyroscope in an inertial navigator, it is better to have a gyro which is able to precess about only one axis, called the output axis. Such a gyro will respond (precess) to rotation of the case about only one axis (known as the input axis). This allows the gyro to perform a control function about one axis and with three such gyros, mounted on a platform so that the input axis are mutually perpendicular, three-dimensional control of the platform is obtained.

By attaching the outer gimbal of the gyro (fig. 14-5) rigidly to the case, such a configuration is obtained. The gyro now has just one axis of freedom with respect to the case about which it can precess. This is called a single-degree-of freedom gyro. A gyro of this type with a few refinements is the one used for inertial navigation applications.

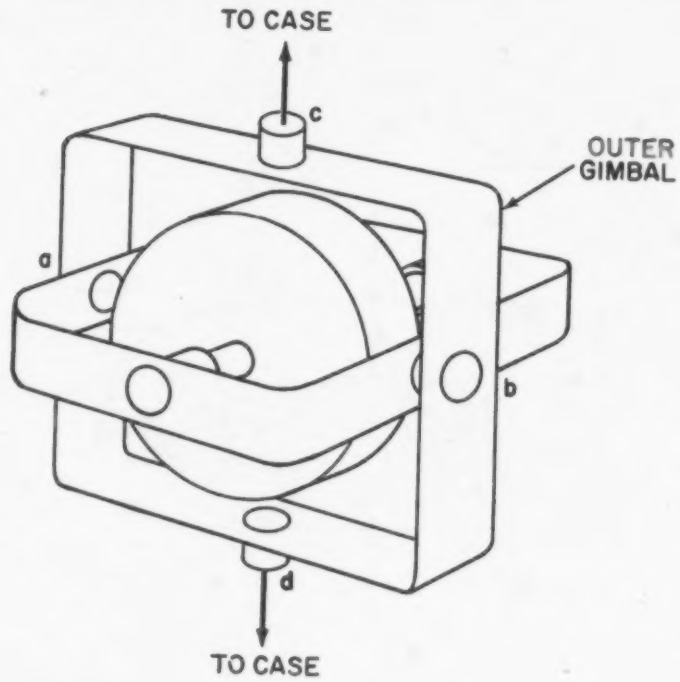

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Figure 14-5.—Two degree of freedom gyro.

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Inertial Navigation Gyroscopes

This refined gyro has as its rotor a 4-pole 3-phase synchronous hysteresis motor, which is supported on air bearings. The stator of the motor is part of the can surrounding the rotor. The motor receives a precision frequency signal so that the rotor speed and angular momentum remain constant.

As shown in figure 14-6, the rotating element and its cylindrical enclosure are enclosed inside another cylinder called the case. Between the two cylinders is a heavy viscous fluid contained by the outer case. The rotor and it's enclosure are adjusted for neutral buoyancy (no tendency to rise or sink) in the fluid and together are called the "float", and rotate about it's output axis on an almost frictionless bearing of oil. Gyro life depends on the number of starts and stops, rather than running time. On any power loss to a gyro, the rotor must be allowed to run-down to a complete stop before power is reapplied.

Mounted on the output axis are a pick-off and a torquer (not shown). The pick-off is a device used to measure any angular displacement of the float with respect to the case about the output axis. The signal representing this measurement from the pick-off is the output of the gyro. The torquer is used to apply a rotational force to the float with respect to the case about the output axis causing an output from the gyro.

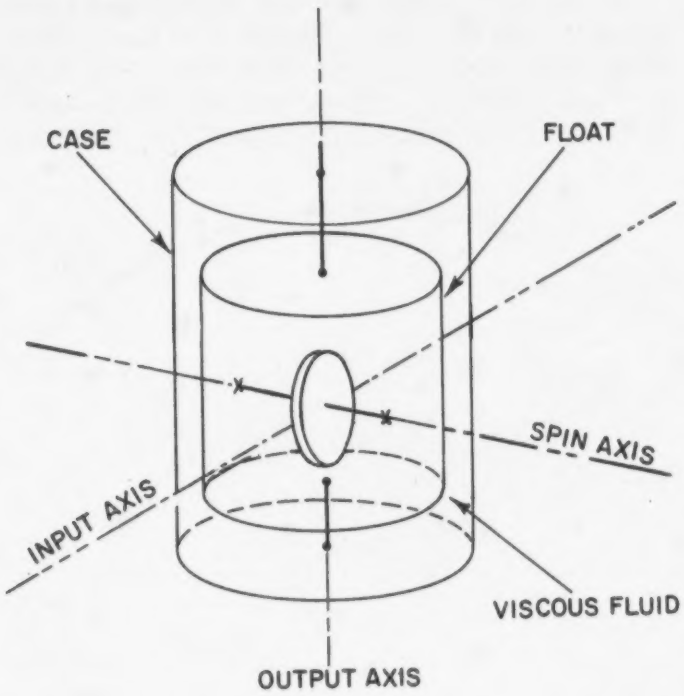

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Figure 14-6.—Inertial navigation gyroscope.

Gyro Drift

Gyro drift is any undesired precession of the rotor. In the case of the free gyro, drift will cause the spin axis to wander from its special orientation. For the single-degree-of-freedom gyro, since it can precess only about the output axis, drift causes the float to rotate about this axis. This produces an output since the case is not rotating about the output axis. This output appears exactly as if it had been caused by the gyro torquer or a rotation of the case about its input axis.

There are many causes of gyro drift. Some of them include bearing friction, unbalance, and change in environment. With each advance in gyro manufacturing, gyro drifts are reduced. Although gyro drifts have not been eliminated, gyros are built so that they will have a constant drift for long periods of time. When the drift remains constant it can be calculated and a compensation made.

In most inertial navigation systems, compensation does not eliminate the drift, but it can remove the effect of the drift. Since the effect is an output, the means to eliminate it is to apply a signal to the torquer. This signal, if proper, will counter the drift and the net result will be no gyro output. If the drift changes, then the signal to the torquer must also be changed. This signal to the torquer of a gyro which is designed to eliminate the output due to drift is called a gyro bias. An error in gyro bias has the same effect as an uncompensated gyro drift.

INERTIAL MOTIONS

As previously mentioned there are several motions in inertial space which are of concern in the study of inertial navigation. For the considerations of motions in this discussion the "fixed" stars are used for the inertial space reference. This is necessary because the inertial elements (gyros and accelerometers) which sense these motions operate using this reference. Some of these motions are desired to produce useful outputs while compensation for the others can only be accomplished if they are known.

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For convenience these motions are divided into two categories; (1) rotations to which the gyro is sensitive and (2) accelerations to which the accelerometer is sensitive. Under rotations there are:

1. Ship's roll, pitch, and yaw
2. Earth's rotation
3. Changes in latitude and longitude

The accelerations of concern are:

1. Ship's accelerations with respect to the earth
2. Acceleration of gravity
3. Coriolis acceleration

Some of these are interrelated. For example, as will be seen, coriolis acceleration results because the earth rotates. The rotation of the earth also has an effect on gravity. There could be no latitude or longitude changes without an acceleration with respect to the earth.

There are a few inertial motions whose effects are negligible. That is, their effects are below the sensitivity level of the inertial elements in use today. These motions are the precession, nutation, and revolution of the earth, and the acceleration of the earth which results from the revolution of the earth about the sun.

Rotational Motions

When discussing rotational motions and their effects within an inertial navigator, it is most advantageous to consider the inertial navigator as maintaining a reference direction. The gyros will maintain a direction in inertial space, but since the inertial navigator is dealing with earth referenced values (position and velocity), the gyros must be controlled to maintain a reference with respect to the earth. The reference we will use is the local vertical (perpendicular to center of earth), and an orientation with respect to north.

The rotation of the earth causes the local vertical for a given position to change its direction in space. This change is not obvious to anyone on the earth because the local vertical maintains the same orientation with respect to the earth. The apparent precession of the gyros (previously discussed) would tend to keep the local vertical indication of the inertial navigator stationary in space. In order to prevent this, and keep the local vertical in respect to earth, gyro torquing signals are used. The value of these signals is determined so that the gyros, and therefore the inertial navigator, will rotate about the earth's spin axis at the same rate that the earth does. As a result the inertial navigator which is controlled by the gyros will maintain the desired orientation with respect to the earth as the earth rotates in inertial space.

This gyro torquing signal which compensates for the rotational motion of earth in inertial space is called the earth torquing signal. It is applied to a particular single-degree-of-freedom gyro as a function of its orientation to the earth's spin axis. The vector sum of the individual signals to the gyros equals earth rate, the rotation rate of the earth in inertial space.

The earth rate torquing signal is only one part of the total torquing signal going to each gyro. The change in position of an inertial navigator on the earth's surface also causes the local vertical to change direction in space. This results from the fact that as the inertial navigator goes from one position to another it is changing from one local vertical to another. This is illustrated in figure 14-7. As the inertial navigator travels over the curved surface of the earth from left to right the "correct" orientation is shown at position 2 in the solid line figure. The dotted line figure at position 2 represents the inertial navigator after the change in position with no compensation for the change in local vertical.

It is necessary that our inertial navigator maintain the correct orientation at each position along the way. Knowing just the total change in local vertical orientation is not enough to have local vertical change exactly as necessary

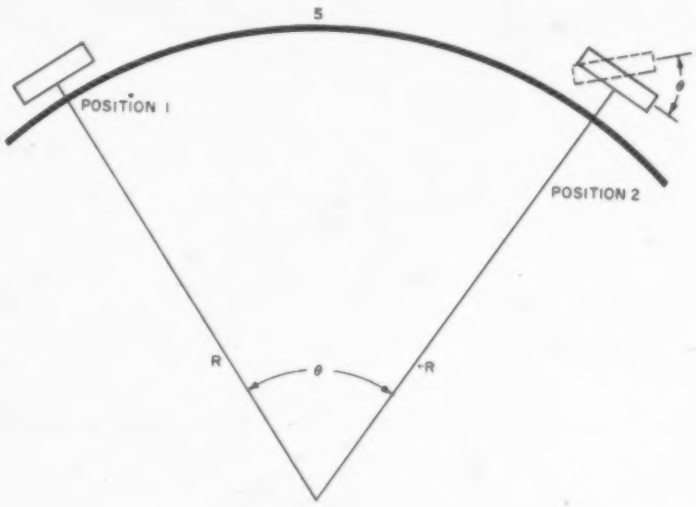

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Figure 14-7.—Vertical change with movement over earth's surface.

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due to change in position. The amount that it must change is the rate of change in respect to time. When R is assumed to be constant the time rate of change is:

$$\frac{d\theta}{dt} = \frac{1}{R}\frac{ds}{dt}$$

Where θ = function of the distance traveled
S = distance traveled
R = radius of the earth

Since the time rate of change of the distance, S, is velocity, V, the above equation becomes: $\frac{d\theta}{dt} = \frac{V}{R}$ and it becomes evident that the angular rate of change of the local vertical is simply the linear rate of change (velocity) converted into an angular rate by scaling to the earth's radius.

This is the rate at which the local vertical change direction in space and the inertial navigator must also change its direction at this rate to track the local vertical. The man who first described this motion and its compensation was a German physicist named Schuler. As a result, when the gyros receive a properly calibrated signal to compensate for the movement of the local vertical due to movement over the earth, the system is said to be Schuler tuned.

The remaining inertial rotation is that of the ship's rotations with respect to the earth. These are called roll, pitch, and yaw. These when converted into the inertial navigator's coordinates of roll, pitch, and heading are used to define the orientation of the local vertical with respect to the ship.

However, in this case it is desired that the gyro's property of precession be used to determine whenever the ship's rotational motions tend to displace the local vertical indication. Therefore, there is no "compensation" of the gyros for this inertial motion.

Accelerations

The accelerometers will sense the forces applied by the case on the mass within the case, and thereby sense the acceleration of the case. These accelerations are measured with respect to inertial space and therefore some of the accelerations which produce outputs do not result in movement of the inertial navigator over the surface of the earth. The main inertial accelerations in this category are gravity and coriolis accelerations.

Gravity, which defines the local vertical, is the sum of two inertial accelerations; gravitational acceleration and centripetal acceleration. The gravitional acceleration is the result of the mass attraction between two bodies. The magnitude of this acceleration is a function of the mass of each body and the distance between the center of mass of each body; in this instance between the earth and the inertial navigator. Since the radius of the earth can be considered a constant and the mass of the earth is many times greater than the mass of the inertial navigator, or any other body on the earth's surface, the magnitude of the gravitational acceleration can be considered a constant. The direction of this acceleration is along the line between the mass centers of the two bodies.

Because the earth is rotating, all bodies on its surface are also subject to a centripetal acceleration in space. This acceleration is directed towards the rotation axis of the earth and is greatest at the equator. It decreases in magnitude as latitude is increased, due to a decrease in the effective radius.

Accelerometers cannot distinguish between the components of gravity. However, they will be affected by gravity if they are tilted. The output which would be produced would not be due to any acceleration of the inertial navigator over the surface of the earth so a compensation must be made. The easiest solution for this elimination of the effect of gravity is to place the accelerometer so that its sensitive axis is perpendicular to gravity. Since all accelerations which result in a change in position are perpendicular to the local vertical this orientation would allow the accelerometer to measure these accelerations without being affected by gravity. Two accelerometers, then, are placed perpendicular to the local vertical and perpendicular to each other so that together they can measure any acceleration which will result in a change of position on the earth's surface.

Another acceleration occurring in inertial space which is not an acceleration with respect to earth is coriolis acceleration. Since the inertially oriented accelerometers produce output due to coriolis acceleration, a compensation must be made to prevent errors.

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A body experiences coriolis acceleration when it travels over a rotating surface in a direction perpendicular to the axis of rotation. A merry-go-round can be used to illustrate this coriolis acceleration.

Suppose we are on a merry-go-round, and we wish to travel from point A to point B, as shown in figure 14-8. Initially the platform is not turning. Naturally the shortest distance is the straight line AB, and this will also appear as a straight line to a person who is not on the platform. However, if the platform is turning in the direction indicated, then by the time we reach point B it will have moved to location B'. To the person who is not on the platform we will appear to have followed the curved line A'B', and according to Newton's First and Second Laws we must have experienced a force, and hence an acceleration, to the left.

Travel on the earth creates the same situation. In the northern hemisphere we will experience an acceleration, to the left of track, with respect to earth. In the southern hemisphere this accelaration is to the right. This acceleration which causes the path over the earth to curve is called coriolis and since an accelerometer makes its measurements with respect to inertial space, it will sense this acceleration, so we must correct for it.

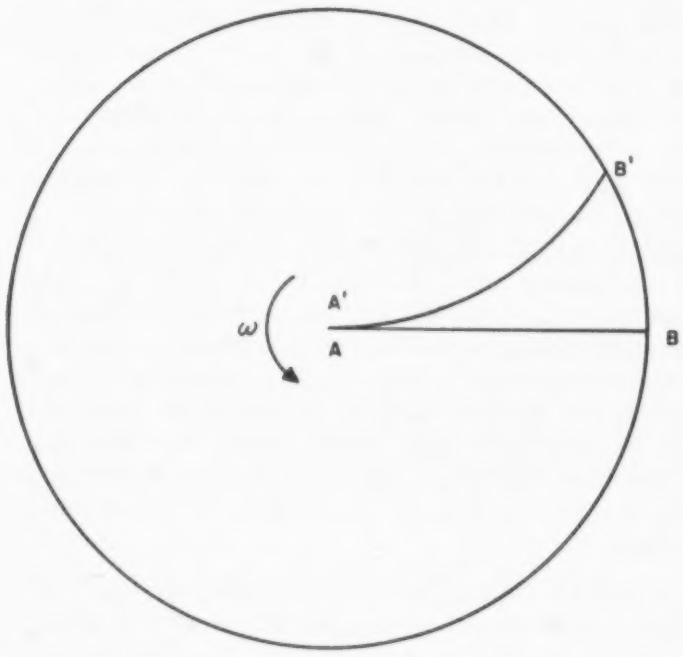

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Figure 14-8.—Motion on a merry-go-round.

The coriolis acceleration is equal to twice the velocity with respect to the rotating base times the rate of rotation of the base, ($a = 2Vw$) and is a function of latitude. A more careful analysis will reveal that the velocity is the component perpendicular to the axis of rotation and acceleration is directed perpendicular to both. Since the earth is rotating, any movement on its surface except in the north-south direction at the equator, has a coriolis acceleration associated with it. This will be sensed only by an inertially sensitive device.

With the effects of both gravity and coriolis accelerations eliminated from the velocity values, the accelerations remaining are those of the inertial navigator with respect to the earth. These accelerations result in position changes on the earth and will be measured by the accelerometers, since they are also accelerations in inertial space.

STABLE PLATFORM

The function of the accelerometers in the inertial navigator is to sense the accelerations of the ship with respect to the earth so that a computer can determine the ship's velocity and position. The function of the gyros is to maintain the accelerometers in the correct position to measure these accelerations. The function of the gimbals is to provide the physical support for the gyros and accelerometers and provide 3 degrees of freedom with respect to the ship. The gimbals, gyros and accelerometers together with associated electronics and gimbal torquer motors form a stable platform.

The purpose of the stable platform is to establish and maintain a reference system in which the measurements necessary to produce the inertial navigator's outputs are taken. The reference system most commonly used is based upon the local vertical and the direction of North. Both of these are referenced in respect to earth. As a result, in our application, "stable" in stable platform means fixed to or stable in respect to the earth. This means that any motion or force which might disturb the reference system must be accounted for and its effect must be eliminated. This would include motions in inertial space previously discussed as well as motions of the vehicle in which the inertial navigator is mounted.

Since the vehicle on which the stable platform is mounted operates in three dimensional

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space, it has three degrees of freedom with respect to earth. In order to maintain a reference fixed to the earth, then, the stable platform must have three degrees of freedom with respect to the vehicle. The stable platform contains three gimbals, one for each degree of freedom necessary for the stable platform. Each gimbal has rotational freedom about one axis with respect to its supporting element. The gimbal can be driven with respect to its support about the gimbal axis by a gimbal torquing motor.

Figure 14-9 is a cutaway view of a simple stable platform. For this discussion, the gimbal which is supported by the vehicle at points a and b is called the pitch gimbal. Rotational movement of this gimbal with respect to the vehicle about its axis is called pitch. The pitch gimbal in turn supports the roll gimbal on an axis perpendicular to the pitch axis. Rotational movement of the roll gimbal about its axis with respect to the pitch gimbal is called roll. The roll gimbal supports the heading or azimuth gimbal. The heading gimbal has one degree of freedom with respect to the roll gimbal, and rotational movement about the heading gimbal axis with respect to the roll gimbal is a change in heading. The heading gimbal through its own axis and the axes of the roll and pitch gimbals has three degree or complete rotational freedom with respect to the vehicle on which the platform is mounted. The heading gimbal is able to assume any orientation with respect to the vehicle within the limits of the gimbal physical restraints.

In order to understand how the stable platform functions to maintain the reference system, a simple sketch of a platform with gimbals, gyros, accelerometers, and servomotors is illustrated in figure 14-10.

Stabilization is accomplished by mounting the accelerometers and gyros on the platform such that the input axis of the gyros are perpendicular to the sensitive axis of the accelerometers. By referring to figure 14-10 it can be seen with the gyros on the stable element that: (1) the heading gimbal axis is always aligned to the Z gyro; (2) the roll gimbal axis is aligned to the X and Y gyros as a function of heading; (3) the pitch gimbal is aligned to the X and Y gyros as a function of heading and roll and to the Z gyro as a function of roll. Any motion about the input axis of the gyro (due to roll, pitch or yaw) causes the gyro to precess

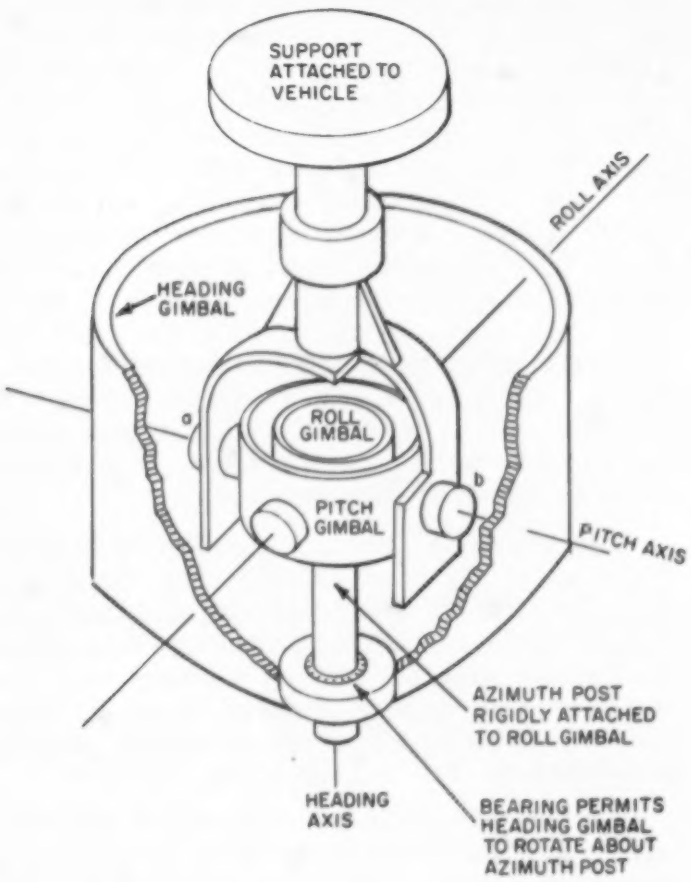

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Figure 14-9.—Cut-away view of a stable platform.

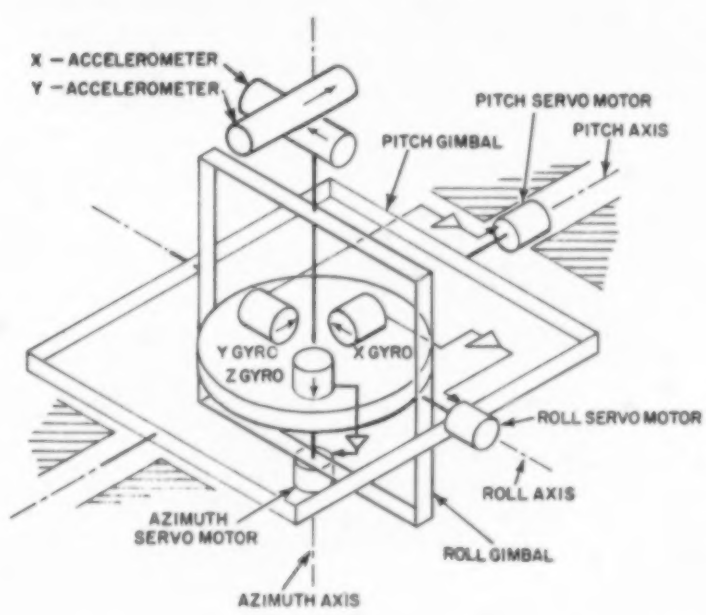

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Figure 14-10.—Stable platform with inertial components.

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about its output axis. The gyro pickoff measures this precession and sends an actuating signal to the gimbal servomotors which in turn drive the platform relative to the vehicle, in a direction opposite to the direction of the ship's motion. The platform is driven until the gyro pickoff signal is zero. The platform therefore moves with respect to the ship but remains stationary or aligned with respect to the reference plane of direction.

Any vector, such as acceleration, can be resolved into two right angle components. Since distance north-south, along a meridian of longitude, can be related to degree of latitude; and distance east-west, along a line of latitude, can be related to degrees of longitude, two accelerometers are mounted on the platform so that their sensitive axes are mutually perpendicular. One, the "X" accelerometer, is always aligned north and the other, the "Y" accelerometer, is always aligned east.

Figure 14-11 shows in block diagrm form how the system computes latitude and longitude. The X direction is defined as an axis along the north-south direction and tangent to the surface of the earth. The Y axis is along the east-west tangent to the earth. The X accelerometer senses accelerations in a north-south direction. Its output is used to compute velocity north and distance north which is related to latitude. The Y gyro senses any rotation of the accelerometer's sensitive axis from its aligned position. The Y accelerometer senses acceleration east-west. From this output is computed velocity and distance east-west which is related to longitude by the ratio 1/cos latitude,

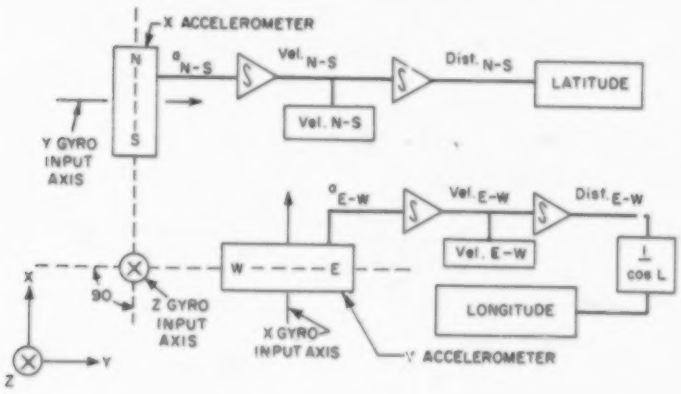

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Figure 14-11.—Block diagram sequence for computing latitude and longitude.

(at the equator, one mile equals one minute of longitude. While at 45 degrees of latitude, one mile equals 1.4 minutes of longitude).

The X gyro senses rotation of the Y accelerometer from its aligned position and the Z gyro has its input axis aligned perpendicular to the plane containing the X and Y axes. The axis is parallel to the local gravity vector. It is precessed whenever the platform moves in azimuth from its northeast orientation.

Since the three gyro input axes are orthogonal (mutually perpendicular) no rotational motion of the platform from its aligned position will escape being sensed by one or more gyros.

Stabilization Loop

In figure 14-10 any ship's motion about its roll axis while headed north, will result in the X gyro sensing this rotation causing a signal to drive the platform with respect to the ship by way of the roll servomotor. Pitching motions will be sensed by the Y gyro which will cause the pitch servomotor to drive, keeping the platform leveled. Figure 14-10 shows electrical connections from the X gyro to the roll servomotor which is satisfactory for a ship headed 000 degrees, but when the ship is headed 090 degrees a roll position will be sensed by the Y gyro which must cause the roll servomotor to drive. However, as seen in the diagram, the Y gyro feeds the pitch servomotor. When on an intercardinal heading both the X and Y gyro will sense a roll motion that only the roll servomotor need drive to maintain stabilization. There must be a circuit which will combine the precessional signals and cause the proper servomotor to drive. This circuit is known as the stabilization loop.

Figure 14-12 is a simplified schematic diagram of the stabilization loop. Note that the gyro pickoffs feed resolvers, and that these resolvers are positioned according to the angles of heading and roll. The heading and roll resolvers are usually mounted on the gimbals, and are driven whenever the particular gimbals are driven by their servomotors.

Many of the problems associated with this type of inertial navigation system have not been discussed in this brief outline. Paramount among these are such things as the effects of Schuler Tuning, gyro drift, accelerometer error, platform misalignment and computer error.

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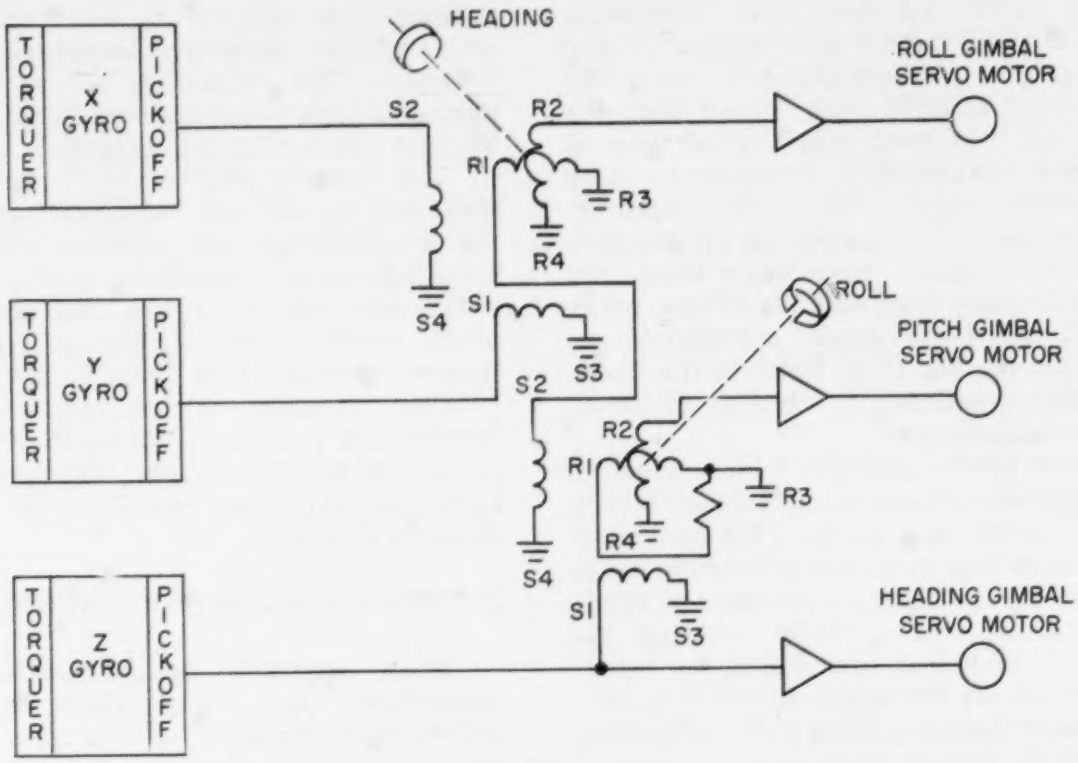

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Figure 14-12.—Three-gimbal stabilization loop.

SATELLITE COMMUNICATIONS

In the year 1888, the first ship-to-ship "wireless" communication was made between a tug and a ship in the New York Navy Yard. This was accomplished by using large coils of wire wrapped around the hull of the ship. The first official U.S. Navy message was sent by wireless telegraph in 1899. In 1954 the U.S. Navy was using the moon as a "passive" relay between Hawaii and Maryland for communications. As early as 1962, the USNS KINGSPORT became the world's first satellite communications terminal afloat. In early 1965 the USS MIDWAY placed a call to the USS CANBERRA, 6,000 nautical miles away, and for the first time in history two combatant ships had established communication by means of satellite.

DEFENSE COMMUNICATIONS SATELLITE PROGRAM

Successful results from the test with satellite communication prompted the Defense Department to establish the Defense Communications Satellite Program (DCSP), under direction of the Defense Communication System. Within this system, satellite communication will form a part of the long-haul links between the switching centers. These links will employ the satellites in addition to other forms of existing communications media.

As the techniques of satellite communications evolve, and are perfected, satellite communications will provide the major part of all intercontinental links in the Defense Communications System.

TYPES OF SATELLITES

There are two basic types of satellites used as communication links, and two distinct orbit types.

The satellites are referred to as either active or passive. In this instance the active satellites are those that incorporate some device to either amplify or otherwise change, and re-broadcast the signal they receive.

Passive satellites do not include electronics equipment for the purpose of amplification of signals transmitted over the link. They provide

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a reflective surface against which the radio waves are bounced. An example of this type would be the moon as previously mentioned.

The two distinct orbits are "random" and "synchronous". A synchronous orbit over the equator at such height and speed that the satellite is synchronized with the rotation of the earth and consequently appears to hang motionless over a point on the earth's surface.

Random orbits actually take in all satellite orbits achieved. These may vary from low altitude to extremely high altitude orbits, polar to equatorial, and from nearly circular to extremely eccentric. The polar orbit of the Navigation Satellite discussed in chapter 15 is an example of a random orbit.

In August of 1966 a multiple launch of seven communication satellites in an equatorial "near-synchronous" orbit was made. This means at an altitude below that required for synchronous orbit, so that the satellites separated in space would drift slowly in a "belt" around the equator. The launch was successful, but minor technical difficulties developed in the satellites resulting in less than desirable communication. Another multiple launch was made in January 1967 and it proven successful, the first continuous coverage satellite communication link around the world will be established.

There are presently several operational communication satellites in use, such as Telstar II, Relay I, Relay II, Syncom II, Syncom III, and Early Bird. Millions of Americans were able to witness the recovery operation of two Astronauts, on their home television sets, via way of Early Bird Satellite.

SATELLITE COMMUNICATIONS TERMINALS

The shipboard communication terminal designed for use as the shipboard link in the DCSP is designated AN/SSC-3. The first of this model was installed in USS PROVIDENCE (CLG-9) in October of 1966. Test results showed the terminal capable of communicating, while underway, voice and teletype through a satellite to another station.

The AN/SSC-3 utilizes a six-foot parabolic antenna; considered the largest communications antenna that can be operated on a combatant ship without seriously interfering with other systems. The antenna is set on a three-axis, gyro-stabilized pedestal which will operate in a 75-knot wind with an accuracy of 0.1 degree.

The control shelter is 7 feet high and 7 feet wide by 12 feet long, and contains its own air conditioning. All antenna acquisition and tracking control, baseband equipment, and status indicators are located on the control console in the shelter. The equipment shelter may be located up to 100 feet from the antenna.

The terminal is self-contained for easy installation and removal, so that when the ship returns from deployment, the terminal may be removed and then installed in another ship about to deploy.

FUTURE SATELLITE COMMUNICATION

When satellite communications are well established and Navy ships have need for permanent terminals, a new type will be integrated into the ship and be fully compatible with other electronic systems and equipment. When this happens, the number of conventional transmitters and receivers aboard ship can be reduced, thus eliminating portions of the maze of antennas which today interfere with each other and reduce the effectiveness of shipboard communications. This will result in better communications in all frequency bands, more capacity for reliable, long-range communications, and overall reduction in shipboard space and weight needed for communications equipment.

Through a rapidly advancing research and development program, the use of higher frequencies, and smaller antennas, relay of NTDS (Naval Tactical Data System) information, via satellite will become possible. Ships will eventually need the capability for tracking and exchanging information with many types of satellites other than communication satellites. Some examples of multiple satellite use might be intelligence, meteorology, navigation, and tactical data.

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CHAPTER 15

SATELLITE NAVIGATION

Satellite Navigation was thought feasible after observation of Russia's first artificial earth satellite, Sputnik I. Scientists listened to the beep generated by Sputnik as it passed by and noted the Doppler-like shift in the received radio frequency signals. Doppler effect is an apparent change in a received frequency because of relative motion between the transmitter and receiver. If the distance between the transmitter and receiver is decreasing, the received frequency is higher than that which is actually transmitted; if the distance is increasing, the received frequency is lower than that transmitted. It was later demonstrated that accurate measurement of this Doppler shift pattern would permit the determination of a satellite orbit. From this successfully proved technique it was further reasoned that, working from a known satellite orbit, a listener could determine his position on the surface of the earth from an observed Doppler pattern. From this point followed the first successful satellite launch in April 1960, and the U.S. Navy Navigation Satellite System became an all-weather, highly accurate, fully operational navigation aid, that enables navigators to obtain accurate navigation fixes from the data collected during a single pass of an orbiting satellite.

NAVIGATION SYSTEM DESCRIPTION

The Navy Navigation Satellite System, shown pictorially in figure 15-1 is a worldwide, all-weather system of high accuracy, which enables navigators to obtain fixes approximately every two hours of the day or night. It consists of four earth-orbiting satellites, four tracking stations, two injection stations, the U.S. Naval Observatory, a computing center, and shipboard navigational equipment (Radio Navigation Set AN/SRN-9) of which there can be any number.

Each of the four satellites is completely transistorized and is placed in a circular polar orbit at an altitude of 500-700 (nominal 600) nautical miles. The orbital planes of the four satellites intersect at the earth's rotational axis and are spaced 45 degrees apart in longitude. Thus the orbital paths cross at the north and south poles as illustrated in figure 15-2. Although the orbital planes remain essentially fixed in space, the satellites appear to traverse the longitudinal meridians as the earth rotates beneath them. To an observer on the earth, the apparent effect is that the satellite orbits are moving westward.

The satellites are of octagonal shape with four windmill-like vanes to carry solar cells, and are stabilized in the earth's gravitational field so that directional antennas are pointed down at the earth rather than into space. The satellites contain an ultrastable oscillator, two coherent harmonically related transmitters, a digital clock, command receiver, digital memory, telemetry, and power supplies.

Each satellite orbits the earth in approximately 108 minutes. Throughout its useful life, each satellite transmits the following phase-modulated data every two minutes on two RF carriers: two synchronization signals, an identification code, a 400-hertz tone, fixed and variable parameters describing its own orbit, and fixed parameters describing the orbits of the other three satellites.

The fixed parameters describe the satellite's nominal orbits and are correct only for a 12 to 16 hour interval. The variable parameters describe the fine structure in the satellite's nominal orbit as a function of time and are correct only for the time interval they are transmitted by the satellite. Thus, the satelite's memory stores sufficient variable parameters to describe its orbit at two-minute intervals between subsequent injections of data

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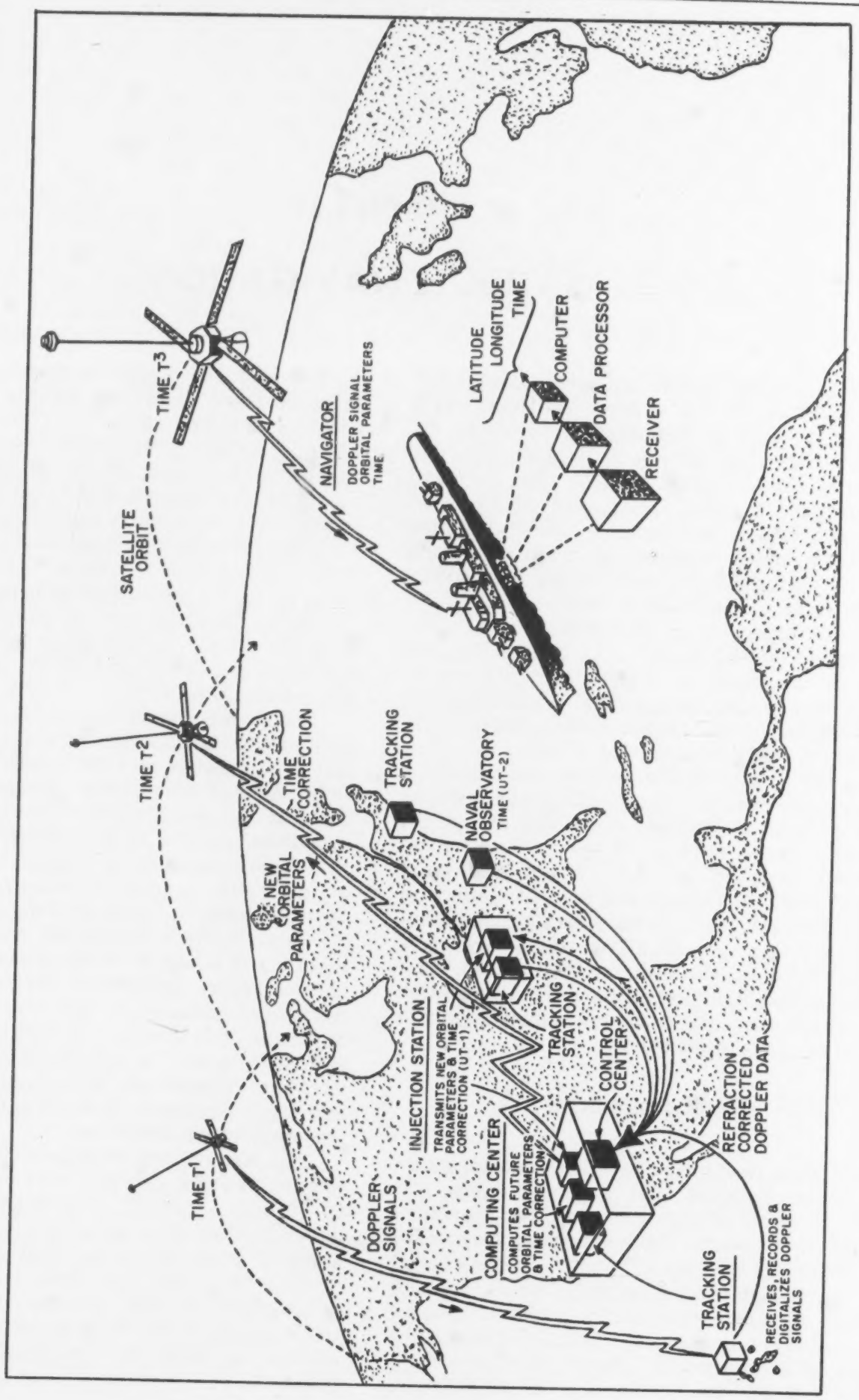

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Figure 15-1. — Navy navigation satellite system.

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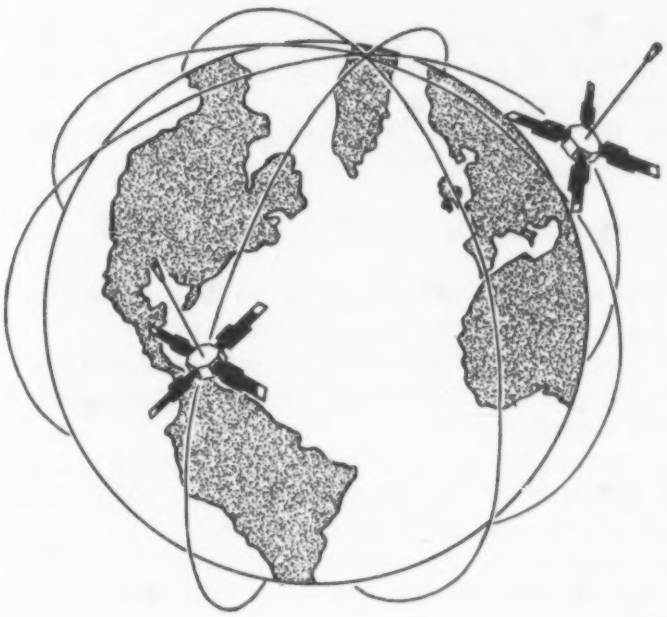

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Figure 15-2.—Four polar orbits with 45° nodes.

into its memory. Each transmission is timed so that the end of the 78th bit, which is the last bit of the second synchronization signal, coincides with the even two minutes of Universal Time (UT-2). Thus, the satellites also serve as an accurate time reference for all navigators that are equipped with Radio Navigation Set AN/SRN-9 to receive and decode satellite transmissions.

Tracking Stations

In order to determine accurately its present and future orbit, each satellite is tracked as it passes within line-of-sight of each of the four fixed tracking stations. Each tracking station includes radio receiving and data processing equipment which functions to receive and decode the satellite transmissions. The received signal is digitized and sent with satellite time measurements, via the control center, to the central computing center. The tracking stations are located in the states of Hawaii, California, Minnesota, and Maine.

Naval Observatory

In addition to the Tracking Stations, the Naval Observatory receives signals during each pass. During a pass, the data processing equipment at the Naval Observatory compares the time of reception of each 78th bit it receives with the even two minutes of Universal Time (UT-2). The times at which satellite time signals are received are then transmitted to the Control Center.

Control Center

The times at which satellite time signals are received are forwarded by the Control Center to the Central Computing Center. The Control Center monitors system operation and acts as a switching central for the routing of data to and from the Central Computing Center.

Central Computing Center

The Central Computing Center continuously accepts data inputs on the satellites from the four Tracking Stations and the Naval Observatory. Periodically, to obtain fixed orbital parameters for a satellite, the Central Computing Center computes an orbit for each satellite that best fits the doppler curves obtained from all Tracking Stations. Then using the computed orbital shape, the central computing center extrapolates the position of the satellite at each even two minutes in universal time for the next 12 to 16 hours, subsequent to data injection. These data together with data on the nominal shape of the orbits of the other three satellites, commands and time correction data for the satellite, and antenna-pointing orders for the Injection Station antennas are supplied to the Injection Stations via the Control Center.

Injection Stations

The Injection Stations, after receiving and verifying the incoming message from the Central Computing Center, store the message until it is needed for transmission to the satellite. As soon as the receiving equipment at the Injection Station receives and locks on the satellite's signals, the Injection Station reads the injection data and commands from storage and transmits them to the satellite. Transmission to the satellite is on a frequency different from those frequencies used by the satellite, and the bit rate is much higher; therefore, injection is completed in a matter of seconds. Once data injection is complete, the satellite continues to transmit at the normal two-minute intervals. Any time corrections for the satellite clock and any commands for the satellite are also

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performed during the period of data injection. These precautions ensure that the navigational equipment, which depends on accurate satellite data for determining its positions, is provided the best possible data from each satellite. Any time that the satellite is within radio line of sight of the navigational equipment and has a maximum elevation angle at time of closest approach equal to or greater than 10 degrees and equal to or less than 70 degrees, the satellite's transmission can be used to compute the exact position on earth of the navigational equipment. Satellite passes suitable for use in obtaining a navigation fix will generally occur at least every two hours.

Shipboard Navigation System

The final link in the satellite navigation system is the shipboard navigation system (fig. 15-3). This equipment receives the satellite signals, measures the doppler shift, decodes the information content of the phase modulation, and performs the computations required to determine the ship's position.

The Radio Navigation Set AN/SRN-9 reduces the received satellite signals to a form which is suitable for navigational computations. One of the following three options may be used to perform the computation:

1. General purpose computer—Data must first be processed through a suitable buffer unit which converts the information into the computer format.

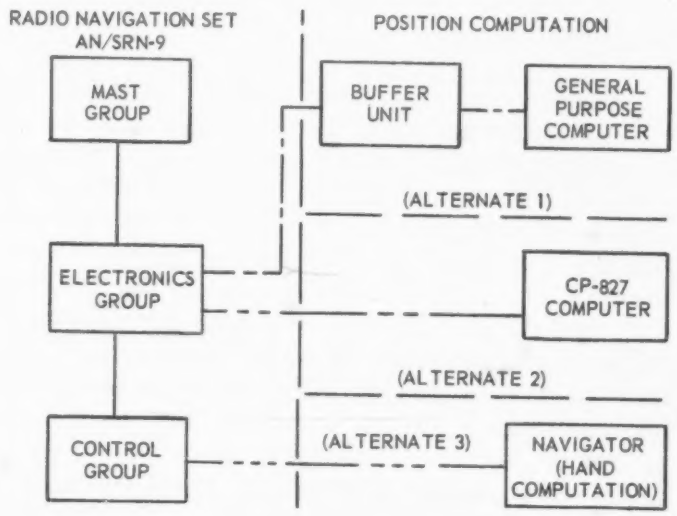

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Figure 15-3.—Shipboard navigation system configuration.

2. CP-827 Computer—This special purpose computer is presently being supplied with the AN/SRN-9 Radio Navigation Set and will be discussed later.

3. Hand computation—Using the printed data available from the Control Group printer.

Accuracy Considerations

There are five factors which determine the final accuracy of the navigational fix:

1. Accuracy of satellite orbit determination.
2. Accuracy of satellite orbit prediction for future times.
3. Accuracy of doppler measurements which is a function of the satellite oscillator and the receiving equipment's local oscillator.
4. Effects of ionospheric refraction, which are minimized by the use of a dual frequency system.
5. Accuracy of determination of ship's course and speed. (A 1-knot error in velocity North or South will contribute approximately a 0.2-nautical mile error to the navigational fix; errors in velocity East or West are less serious.)

INTEGRATED DOPPLER NAVIGATION

The navigational fix computed by Radio Navigation Set AN/SRN-9 is based on the shift in frequency (doppler frequency shift) that occurs whenever the relative distance between a transmitter and a receiver changes. Such a change occurs whenever a transmitting satellite passes within radio range of a receiver on earth and is due to the motion of the satellite in its orbit, the motion of the navigator on the surface of the earth, and the rotation of the earth about its axis.

As previously stated, the satellite message describes the orbital position of the satellite every two minutes on the even minute. To obtain a navigational fix, it is necessary only to determine the ship's location relative to the known satellite positions. The Radio Navigation Set AN/SRN-9 employs a so-called integrated doppler measurement for this purpose. In figure 15-4 positions of the satellite in its orbit are shown for times t_1 through t_4. The slant range from ship to satellite is given by S_1 through S_4. The positions of the navigator, P_1, through P_4, refer to the times at which the SRN-9 receiver recognizes the satellite synchronization signal, $t_1 + \Delta t_1$ through $t_4 + \Delta t_4$. Note that the times of reception are slightly

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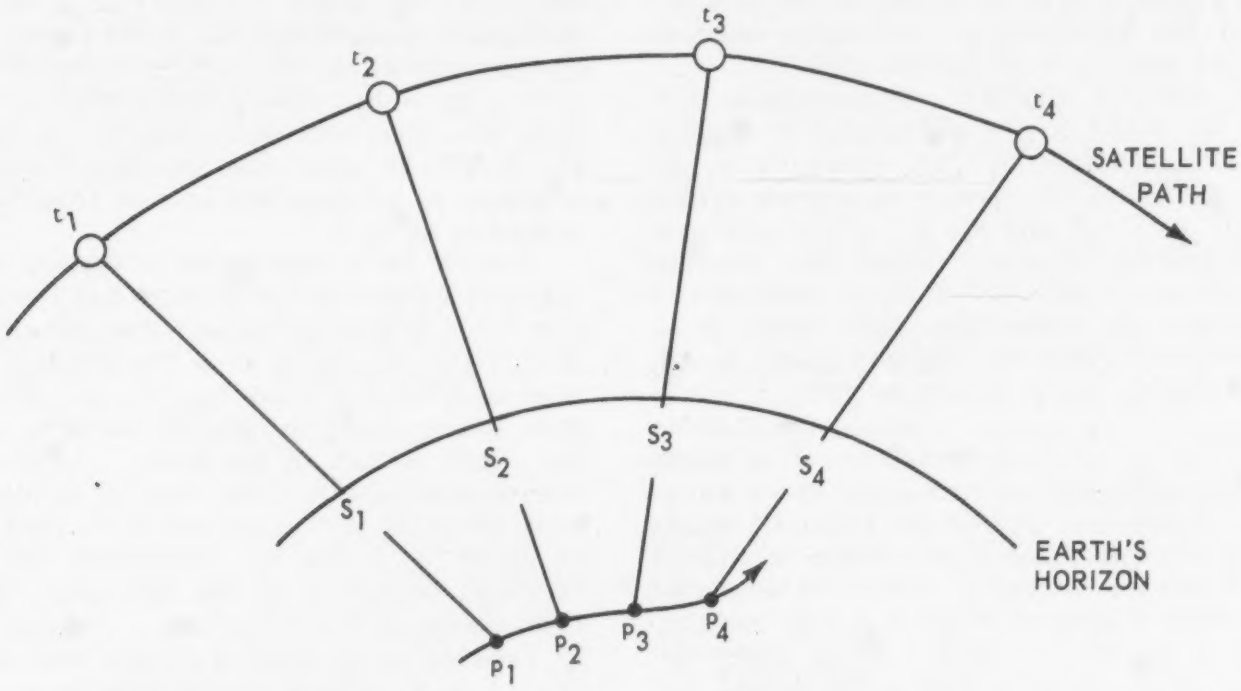

f_o = NOMINAL VALUE OF NAVIGATOR'S REFERENCE FREQUENCY

c = SPEED OF LIGHT

Δ_f = DIFFERENCE BETWEEN NAVIGATOR'S REFERENCE FREQUENCY AND SATELLITE TRANSMISSION FREQUENCY

T = 2 MINUTES (I.E. t_2-t_1, t_3-t_2, ETC.)

λ = LATITUDE

ω = LONGITUDE

t = TIME OF TRANSMISSION OF TIMING MARK

$t+\Delta t$ = TIME OF RECEPTION OF TIMING MARK

N = DOPPLER COUNT

S = SLANT RANGE

$$N_{12} = f_{o/c}\,[S_2(\lambda,\omega)-S_1(\lambda,\omega)] + \Delta f.T$$

$$N_{23} = f_{o/c}\,[S_3(\lambda,\omega)-S_2(\lambda,\omega)] + \Delta f.T$$

$$N_{34} = f_{o/c}\,[S_4(\lambda,\omega)-S_3(\lambda,\omega)] + \Delta f.T$$

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Figure 15-4.—Integrated doppler measurement.

later than the times of transmission due to the radio propagation time over the slant ranges S_1, S_2, S_3, and S_4. Also, since the propagation times Δt_1, Δt_2, Δt_3, and Δt_4, are not equal, the time intervals over which the SRN-9 makes its integral doppler measurements will differ slightly from the exact two-minute value, being somewhat smaller prior to satellite closest approach (while S is decreasing) and somewhat larger after closest approach (while S is increasing). This fact, however, does not affect the result of the measurement because the number of r-f cycles transmitted by the satellite between synchronization signals (exactly

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two minutes apart) must necessarily equal the number received by the navigator between receptions of the synchronization signals since no r-f cycles can be "lost" or "gained."

The integral doppler measurements are simply the count N_{12} of the number of doppler cycles received between $t_{1+\Delta}$ t_1 and $t_{2+\Delta}$ t_2, the count N_{23} of the number of doppler cycles between $t_{2+\Delta}$ t_2 and $t_{3+\Delta}$ t_3, and so on for all two-minute intervals during the satellite pass. These counts are a direct measure of the amount by which the slant range from satellite to navigator has changed (S_2-S_1, S_3-S_2, etc.) during the count intervals. This measure is quite accurate since each doppler count added (or subtracted) due to the relative motion means that S has decreased (or increased) by one wavelength. Therefore, one of the required inputs to the fix computation (slant range increment over two-minute intervals) is directly measured by the SRN-9 integral doppler count, suitably scaled as indicated in figure 15-4. Since the satellite positions at t_1 and t_2 are known, the receiver must be on some surface defined by the measured slant range difference between these two points. This surface is a hyperbola of revolution with foci at the known satellite positions. The ship must be located, therefore, somewhere along the curve defined by the intersection of this hyperboloid and the earth's surface. The next doppler count (between t_2 and t_3) will define a second curve, and the intersection of these curves gives the navigational fix.

In actual practice two factors complicate this simple explanation. First, the doppler signal which is counted consists of the doppler frequency plus a fixed, but not very accurately known, bias frequency (Δ f in fig. 15-4). Therefore, a third doppler count is required in order to solve for the three variables—latitude (λ), longitude (ω), and bias frequency (Δ f) as defined in figure 15-4. This means that integral doppler counts for at least three two-minute intervals must be used (and preferably more than three) in order to determine the three unknowns, λ, ω, and Δ f. The second complication is the motions of the ship during the satellite pass. To account for this, the best estimate of a ship's motion must be entered into the navigational computation along with the doppler counts and the satellite message.

The fact that the integral doppler counts N_{12} through N_{34} are directly affected by Δ f, is illustrated in figure 15-5, wherein f_G is the (constant) frequency of the navigator's reference oscillator, f_T is the (constant) frequency of the satellite's transmitter, f_R is the received frequency containing the doppler component, and $\Delta f = f_G - f_T$. The integral doppler counts, N12, etc., are represented by the shaded area, and it will be noted that the shaded area is increasing as we progress in time from $t_{1+\Delta}$ t_1 toward $t_{3+\Delta}$ t_3.

Figure 15-5 illustrates a typical doppler curve of frequency versus time and is an actual plot from a satellite pass. The received frequency (f_R) is higher than the satellite transmission frequency from time $t_1 + \Delta t_1$ to slightly after time $t_3 + \Delta t_3$, to the point where f_R crosses f_T. This portion of the curve represents the received frequency from time of satellite lock on to the point of closest approach. That portion of curve f_R below f_T represents the actual received frequency as the satellite's distance from the receiver is increasing. The point where f_R crosses f_T is point of closest approach. At this time, f_R equals f_T and there is zero doppler.

There is only one Doppler frequency curve for any one position on earth that can be obtained for a given navigational fix by satellite. Figure 15-6 displays the characteristics of Doppler frequency shift for different locations about an arbitrary reference point on earth. Notice that in all cases the received frequency (f_R) is greater than the transmitted frequency (f_T) as the satellite approaches the navigator, in effect "compressing" the radio waves enroute. Notice also that the received frequency equals the transmitted frequency at the point of closest satellite approach, and that the received frequency decreases as the satellite recedes from the navigator, thereby "expanding" the radio waves between them. The four curves of figure 15-6 show the Doppler frequency variations received at selected positions, with respect to the satellite's subtrack. A subtrack is the path traced on the earth by a satellite passing directly overhead. When the navigator is located on the subtrack, the satellite passes directly overhead and the Doppler frequency variation is similar to that shown in figure 15-6, A. An observer north of the navigator would also be on the subtrack and would receive an identical Doppler frequency curve, but at an earlier time if the satellite were moving north to south, and at a later time if the satellite were travelling south to north. An observer to the west or east would record the variation at the same time as

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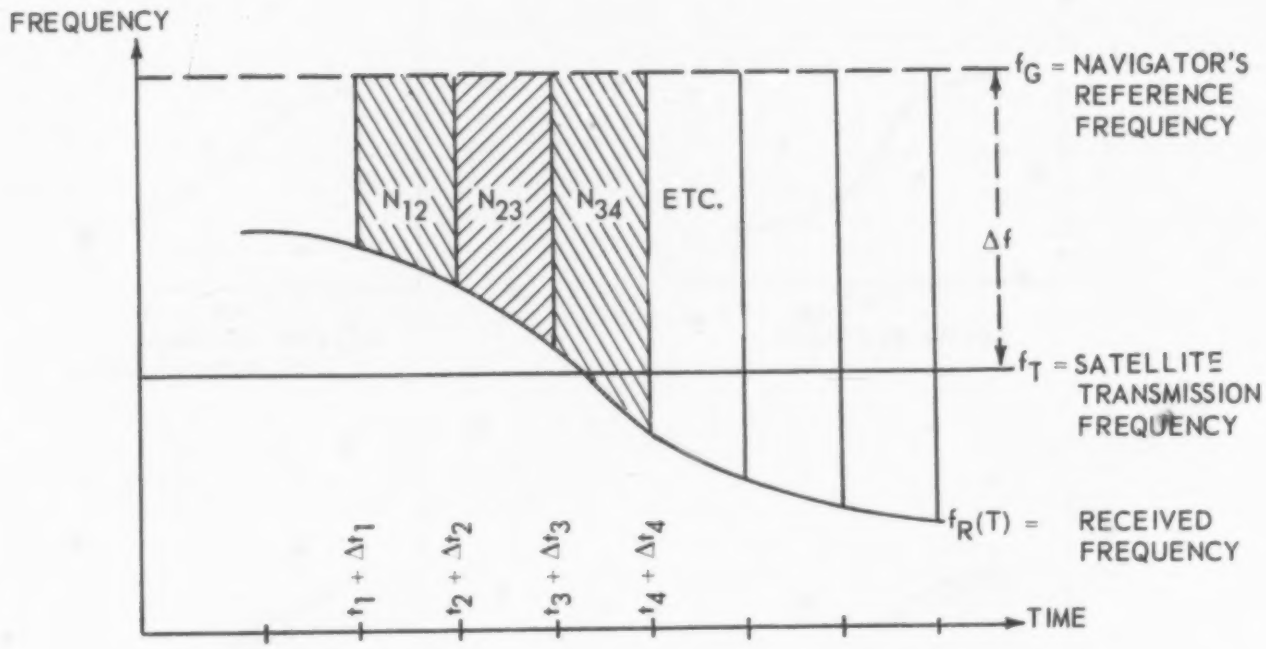

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Figure 15-5.—Doppler frequency variation with time.

the navigator, but with altered shape as shown in figure 15-5,B,C, and D. Figure 15-5,B exhibits the more gradual rate of change of Doppler frequency shift introduced by displacement to either east or west of the subtrack; while the effect of the earth's rotation is added to the curves of figure 15-5, C and D, showing how east and west displacements from the subtrack are distinguished from each other.

Thus, the shape of the received Doppler frequency curve and its time of reception depend on the receiver's position on earth, the satellite's location in space, and the rotation of the earth. If either the receiver's position or the satellite's position is known for the time of reception, the other can be determined from the received Doppler frequency curve.

AN/SRN-9 DESCRIPTION

This section provides a functional block diagram description of the Radio Navigation Set AN/SRN-9. The AN/SRN-9 Radio Navigation Set can be broken down to three major groups; Mast Group, Electronics Group, and Control Group which are treated separately in the following paragraphs.

Mast Group

The Mast Group (fig. 15-7), consists of a vertical whip antenna, upper and lower ground planes, and a housing assembly. The housing assembly contains all the electronic circuits associated with the Mast Group.

The Mast Group receives, separates, and amplifies the two signals from the satellite. The signal flow, in block diagram form, is illustrated in figure 15-8.

The two satellite signals are received by the dual frequency antenna. The antenna (fig. 15-7), is a simple rod of approximately 1/4 wavelength at 150 mc and 3/4 wavelength at 400 mc, mounted above a conical ground plane. A second ground plane consisting of 12 radial rods is located at the base of the Mast Group to isolate the Mast Group from any mounting structure and thus preserve the antenna pattern.

The diplexer (fig. 15-8) separates the combined signal from the antenna into its 150-mc and 400-mc components, each of which is conducted by coaxial cable to its respective preselector (preselective filter). If strong adjacent-channel signals are not anticipated, the output from the diplexer may be inserted directly into

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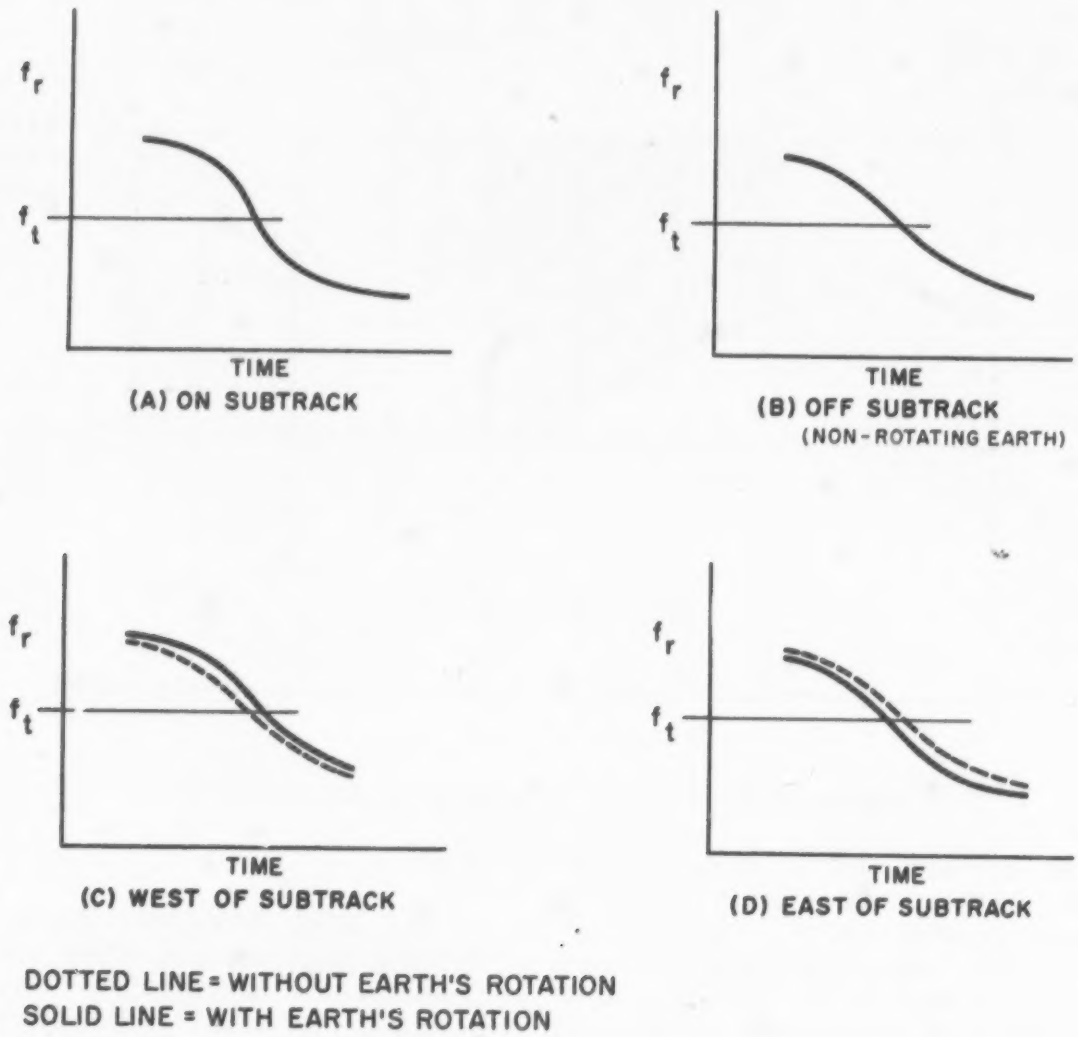

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Figure 15-6.—Doppler frequency response to position changes.

the inputs of the amplifiers, resulting in an improvement in system sensitivity of approximately 3 db. When the preselectors are used, their outputs are connected to the input of the amplifiers. The 400-mc preselector provides discrimination against undesired off-frequency signals.

The 400-mc filter is connected between the second and third stages of the 400-mc amplifiers. Its function is to maintain a relatively constant center frequency and bandwidth characteristics of the amplifier with gain variations from Automatic Gain Control (AGC).

The 150-mc preselector and 150 mc filter are identical units. The preselector provides discrimination against undesired off-frequency signals, while the filter provides a constant bandwidth for the 150-mc amplifier regardless of the AGC voltage applied.

The 400-mc amplifier consists of eight r-f stages and three d-c amplifier stages, which provide AGC and temperature compensation. The amplifier exhibits a nominal gain of 70 db with a 50 db AGC range.

The 150-mc amplifier consists of five grounded-emitter, neutralized transistor stages and three d-c amplifier stages which provide AGC and temperature compensation. The amplifier exhibits a nominal gain of 70 db with a 55 db AGC range.

Electronics Group

The major elements of the Electronics Group (fig. 15-9) are the receiver unit, the data

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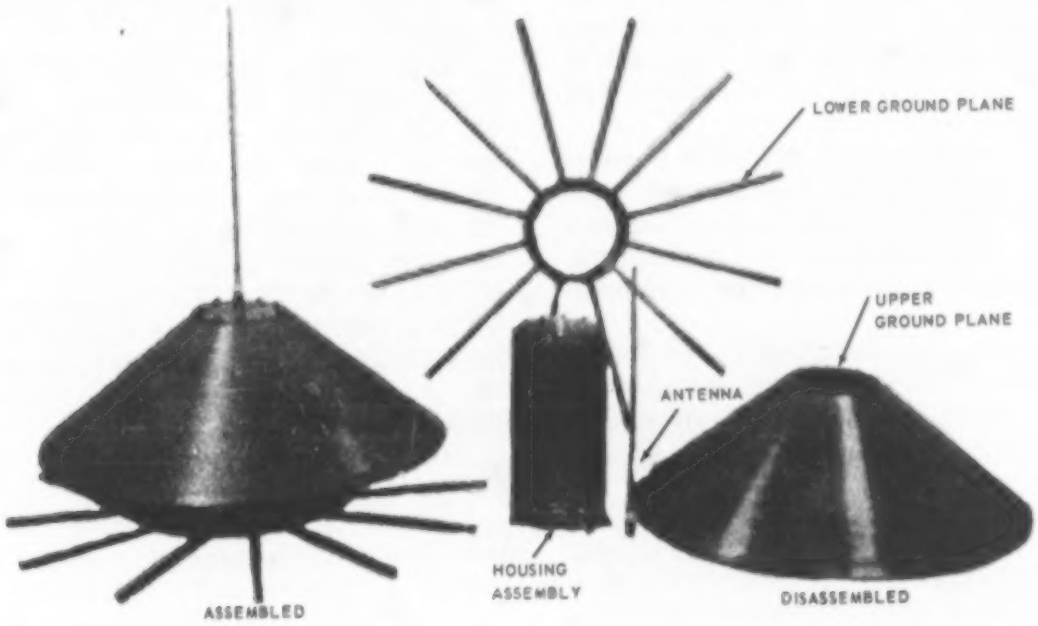

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Figure 15-7.--Mast group.

processor unit, the power supply unit, and the oscillator. Before describing these units it will be necessary to become familiar with the received signal and message organization.

Data is received from the satellite in the form of phase modulation on the carrier

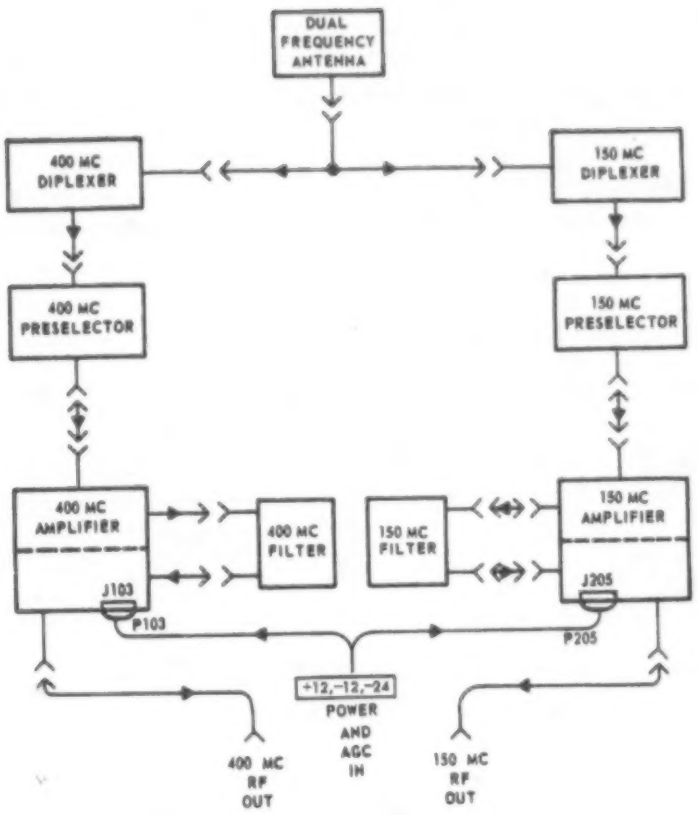

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Figure 15-8.--Mast group, block diagram.

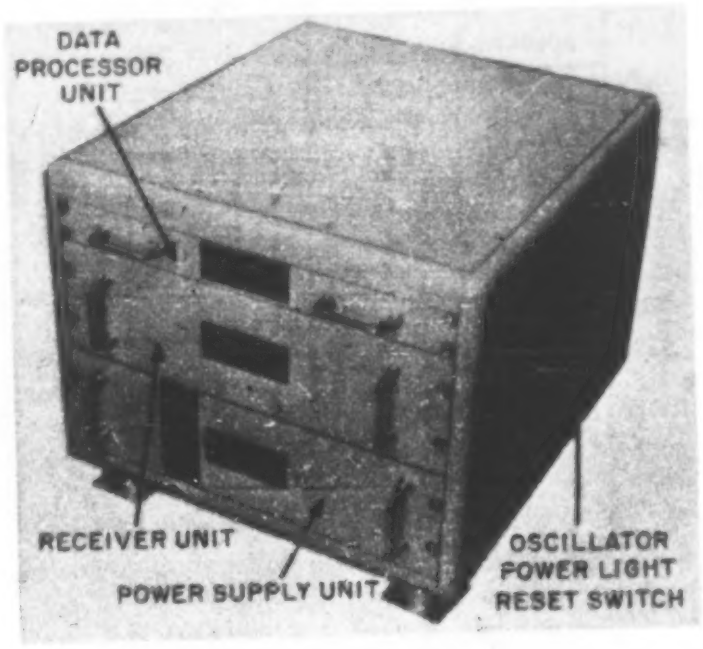

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Figure 15-9.--Electronics group.

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frequency. The data is coded in binary form (fig. 15-10). The basic encoding unit is called a doublet and consists of two intervals of opposite phase shift followed by two intervals of no phase shift. Two successive doublets are required to define a binary bit.

The Radio Navigation Set AN/SRN-9 must make the correct association between adjacent doublets to translate the signal modulation into "logical bits." The process of determining this correct association is called "bit synchronization."

The satellite message received by the Radio Navigation Set AN/SRN-9 in a two-minute interval consists of 6103 binary bits organized into 156 words of 39 bits each plus a 19-bit word.

The last 25 bits of word 2 are a synchronizing pattern consisting of 1 zero, 23 ones, and another zero (0111111111111111111111110). The beginning of the first bit of word 3 is the two-minute time mark. Transmission of the message from the satellite is precisely controlled so that these two-minute time marks are normally transmitted within 1 millisecond of even integar two-minute times as determined by the Naval Observatory. Word 3 can be heard in the head set as a 400-cps tone. The beginning of this so-called "beep" word may be used as a time mark to set the navigator's chronometer.

Only every sixth word starting with word 8 is required for navigation, thus words 8, 14, 20, 26, 32, etc. are all that will be required. Also the Radio Navigation Set AN/SRN-9 uses only the data contained in the first 32 bits of each word. These are transmitted as eight Binary Coded Decimal Excess Three (BCDXS3) digits. For example, the number 5 would normally appear in binary as 00000101. In BCDXS3 it would appear as 00001000, that is, each number is transmitted three higher than its actual value.

The Radio Navigation Set AN/SRN-9 recovers and records doppler data, satellite data, and timing information from the satellite signal. The higher frequency signal transmitted by the satellite is 400 mc - Δ_H, where $\Delta_H \cong 32$ kc since the frequency is offset 80 ppm. (The low channel likewise 150 mc - $_L$, where $\Delta_L \cong 12$ kc.) This signal is shifted in frequency by d_H due to doppler effect and ξ_H due to ionosperhic refraction. The range of d_H is between 8 kc and that of ξ_H is between $\pm$ 3 cps. The signals as received are 400 mc $-\Delta_H + d_H + \xi_H$ and 150 mc $-\Delta_L + d_L$ and $+\Delta_L$. Figure 15-11 illustrates the association of these frequencies on a typical Doppler frequency curve.

The receiver is the middle drawer (fig. 15-9) of the Electronics Group. The received signals are fed from the Mast Group as two

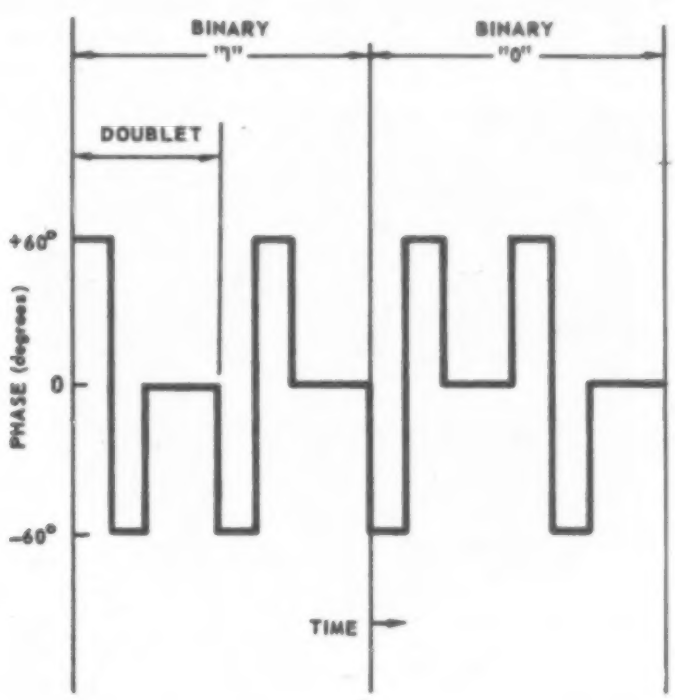

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Figure 15-10.—Modulation characteristics in binary coded form.

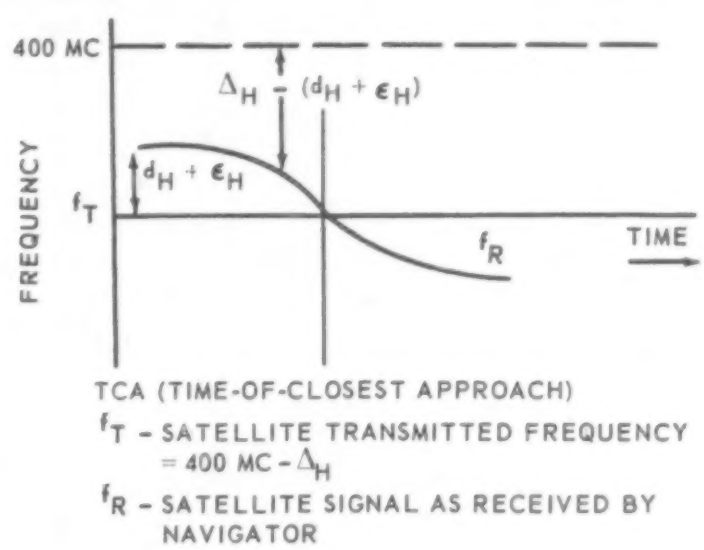

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Figure 15-11.—Doppler frequency curve.

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separate signals and consist of 400 mc - $\Delta H + d_H + \xi_H$ and 150 mc - $\Delta_L + d_L + \xi L$, as shown in fig. 15-12.

The 400-mc signed is fed to the 5-mc i-f amplifier assembly, which consists of a 400-mc mixer and four amplifier stages. The mixer subtracts the 400-mc incoming signal from a 405-mc local oscillator (LO) signal to produce an i-f frequency of 5 mc.

The 5-mc i-f amplifier has an overall gain of approximately 100 db and a bandwidth of 3 kc with AGC being applied to the first two stages.

The 5-mc phase comparator assembly compares the i-f amplifier output with frequency stable quadrature reference signals. The phase comparator circuit is a fullwave, or balanced type, which means there is no output of either the i-f input signal or reference signal but only the sum and difference frequencies of the two inputs. The phase comparator has two outputs, one proportional to the sine and the other to the cosine of the phase difference between the i-f signal and the reference signal.

The 5-mc buffer assembly consists of three identical buffers and a tripler. The buffers supply 5-mc signals to the 5-mc phase comparator, the 1.875-mc converter, and the tripler.

The 16.8-mc voltage-controlled oscillator (VCO) generates the basic frequency from which the r-f mixer reference frequency (405 mc) is derived.

The output of the VCO (16.8 mc) is fed to the 16/101-mc multiplier assembly which synthesizes the signals to drive the mixer section of the i-f amplifier and the 101/404-mc multiplier.

The 101/404-mc multiplier provides reference signals for the mixer section of the 5-mc i-f amplifier and the audio mixer.

PHASE-LOCK TRACKING.—Tracking of the satellite signal is accomplished by the phase-lock loop (fig. 15-13) which consists of the 5-mc mixer and i-f amplifier assembly, the 5-mc phase comparator, a phase loop control network, the VCO, the 16/101-mc multiplier, and the 101/404-mc multiplier. The loop operates to maintain the 101/404-mc multiplier output frequency at exactly 5 mc greater than the input signal from the satellite or 400 mc - $\Delta_H + d_H + \xi_H$ +5 mc. Once lock-on of the satellite signal is accomplished the phase-lock loop will automatically track the satellite as the output of the 101/404-mc multiplier will

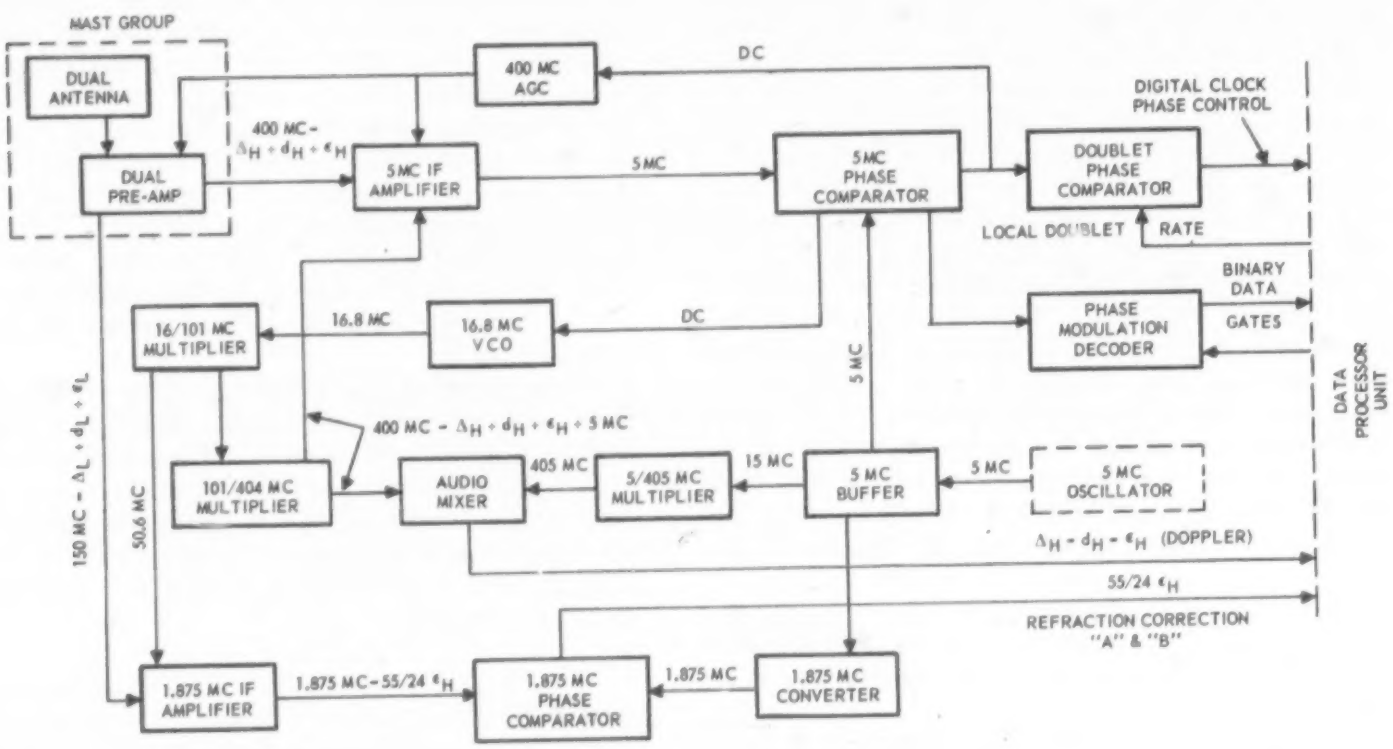

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Figure 15-12.—Simplified block diagram of receiver unit.

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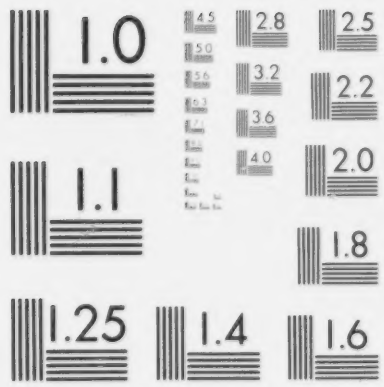

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

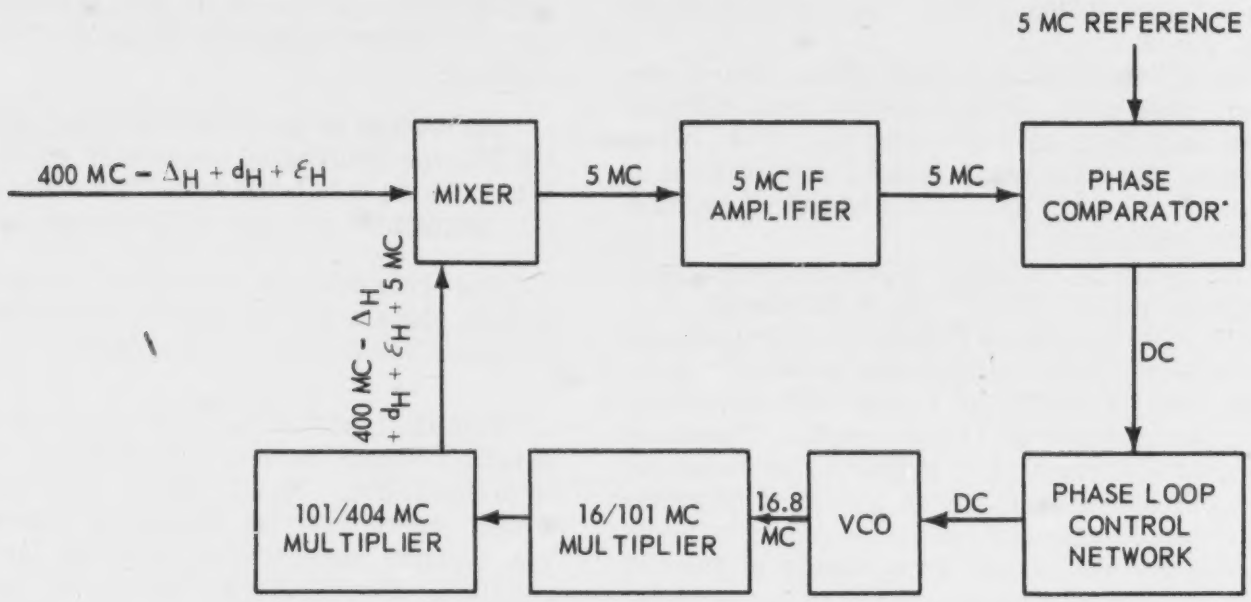

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Figure 15-13.—Phase-locked loop block diagram.

vary in frequency as the satellite signal varies in frequency.

This is possible since the VCO output varies according to the magnitude and polarity of its d-c input, which in turn depends upon the satellite signal and the local reference signal. The phase-lock loop must be in equilibrium, (lock-on has been achieved and the satellite is being tracked), before any useful data can be received. The 150-mc channel does not have the capability of tracking the satellite and is used only for refraction correction, therefore this channel cannot perform its function unless the 400-mc channel is operating properly. In other words the 150-mc channel is slaved to the 400-mc channel. This can be seen by referring to figure 15-12 where it will be noted that one of the inputs to the 1.875-mc i-f amplifier assembly comes from the 16/101-mc multiplier assembly the value of which is determined by the output from the VCO. Both the 16/101-mc multiplier and VCO are in the phase-lock loop as shown in figure 15-13.

5-MC OSCILLATOR.—The 5-mc oscillator (fig. 15-12) is a modified Pierce circuit with the crystal operating near its series resonant frequency of 5 mc.

The frequency stability for short term periods is 4 to 8 parts in 10^{11} and is to 6 parts in 10^{10} per day. The stability that we are interested in is the short term period; the stability during the actual tracking of a satellite. This is apparent when it is recalled that the navigation fix is based upon the actual doppler count for two-minute intervals.

The oscillator must remain on at all times in order to maintain its stability. Provisions have been made for automatic switch to battery power in case of normal power failure. The nickel-cadium battery is good for four hours of operation. Following initial power turn-on or any temporary power interruption, the 5 mc oscillator requires a warmup period for the frequency to stabilize sufficiently for high-accuracy navigation. This warmup period is approximately 10H hours, up to a maximum of 72 hours, where H is the length of power interruption in hours.

The importance of the stability of this 5 mc reference must be stressed. It may be well to remember that in case of failure of this oscillator and a ready spare is not available, a good substitute would be the AN/URQ-9 (described in chapter 3 of this manual), provided sufficient warmup time is allowed before any navigation fix is attempted.

DOPPLER RECONSTRUCTION.—The output of the 5-mc oscillator is fed to a 5-mc buffer stage (fig. 15-12) where two separate amplifiers are used to provide inputs to the 5-mc phase comparator and the 1.875-mc converter. Also included in the 5-mc buffer assembly is a

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tripler where the 5-mc signal is multiplied to produce an output of 15 mc. The 15 mc-signal is fed to the 5/405-mc multiplier.

The output of the 5/405-mc multiplier is fed to the Audio Mixer which combines this input with the 404.9-mc signal from the phase-locked loop to obtain a nominal 32-kc signal containing the desired doppler frequency. The actual frequency present at the output of the audio mixer is approximately 32 kc and is made up of ΔH-dH-ξH as indicated in figure 15-12.

REFRACTION CORRECTION.—The purpose of refraction correction is to eliminate ξ H. This is accomplished because ξ is inversely proportional to transmitted frequency, whereas Δ and d are directly proportional to frequency. A definite relationship exists between these frequencies in that 150 mc is to 400 mc as 3 is to 8.

The 1.875-mc i-f amplifier (fig. 15-12) has as one of its inputs the low frequency signal (150 mc $-\Delta L + dL + \xi L$) with the other input being 50.6 mc derived from the phase-lock loop.

The 1.875-mc signal in the converter is obtained by multiplying the 5-mc signal from the 5-mc buffer by 3/8. This is done by dividing by 8 and then multiplying by 3. The 1.875-mc output is phase locked to the 5-mc input.

The outputs of the 1.875-mc phase comparator are called "Refraction Correction A" and "Refraction Correction B."

The Doublet Phase Comparator (DPC), (fig. 15-12), is a subsystem within the doublet-rate, phase-tracking loop. The DPC compares the phase of the local doublet rate with the satellite doublet rate and provides phase commands to the digital clock in the data processor when the phase error exceeds a certain threshold. The output of the DPC is the same wave shape as the doublet-rate flip-flop in the data processor except it is shifted 90 degrees in phase with respect to it. Phase synchronism is necessary to decode the incoming data and to define the doppler period's end points. When the output exceeds a certain positive value, than an advance or add command is given. If it is more negative than a certain value, a retard or subtract command is given.

The Phase Modulation Decoder takes phase-modulated doublet data from the doublet phase comparator, synchronously detects it, and places it in a binary format compatible with the digital section. Synchronous detection followed by an integration with end-of-bit sampling is used to afford immunity from noise errors. The digital section provides the properly timed gating signals for synchronous decoding.

DATA PROCESSOR UNIT.—The data processor unit (DPU), is the top drawer (fig. 15-9) of the Electronics Group. The DPU organizes the timing signals, satellite orbit parameters, and doppler counts derived from the satellite signals by the previously described sections of the Electronics Group and outputs this information to the computer and to the Control Group for printout. For discussion purposes of the DPU, a binary "one" is defined to be -9 ± 3 volts and binary "zero" to be 0 ± 0.2 volt. A pulse is defined to be a rapid change of state from "one" to "zero" (6 volts/nano sec slope).

Standard medium speed digital circuity is employed in the DPU with germanium transistors and diodes used throughout. All circuitry is standard and will be discussed in block diagram form, by referring to figure 15-14.

The 104-kc oscillator is a two-stage transistor amplifier with feedback through a quartz crystal mounted in an external oven at a temperature of $75 \pm 2°C$. The amplifier gain is sufficiently high so that the output transistor is alternately saturated and cut off, providing a squarewave output. The output of the 104-kc crystal oscillator is applied to FF01. Flip-flops 01-11 are binary dividers reducing the 104 kc to bit rate. FF10 is the doublet-rate flip-flop with an output of 101.7 cps or a period of about 10 msec. FF11 is the bit-rate flip-flop with an output of 50 cps or a period of about 20 msec.

One of the outputs of the bit-rate flip-flop (FF11) is applied to the digital clock which is made up of FF12-25 which performs the function of counting message bits and words. It consists of a "radix-39 counter", a "radix-6 counter", and a "radix-27 counter".

The radix of a numbering system is equal to the sum of the different characters which are necessary to indicate all the various magnitudes. As used here it simply means the number of bits that are to be counted before the counter is reset to zero state. In other words the "radix-39" counter will count 39 bits, the number of bits in each satellite word, and will then reset to zero to begin counting the bits of the next word. The "radix-6" counter will count the number of words so that only every sixth word is used. The "radix-27" counter counts the number of words that are

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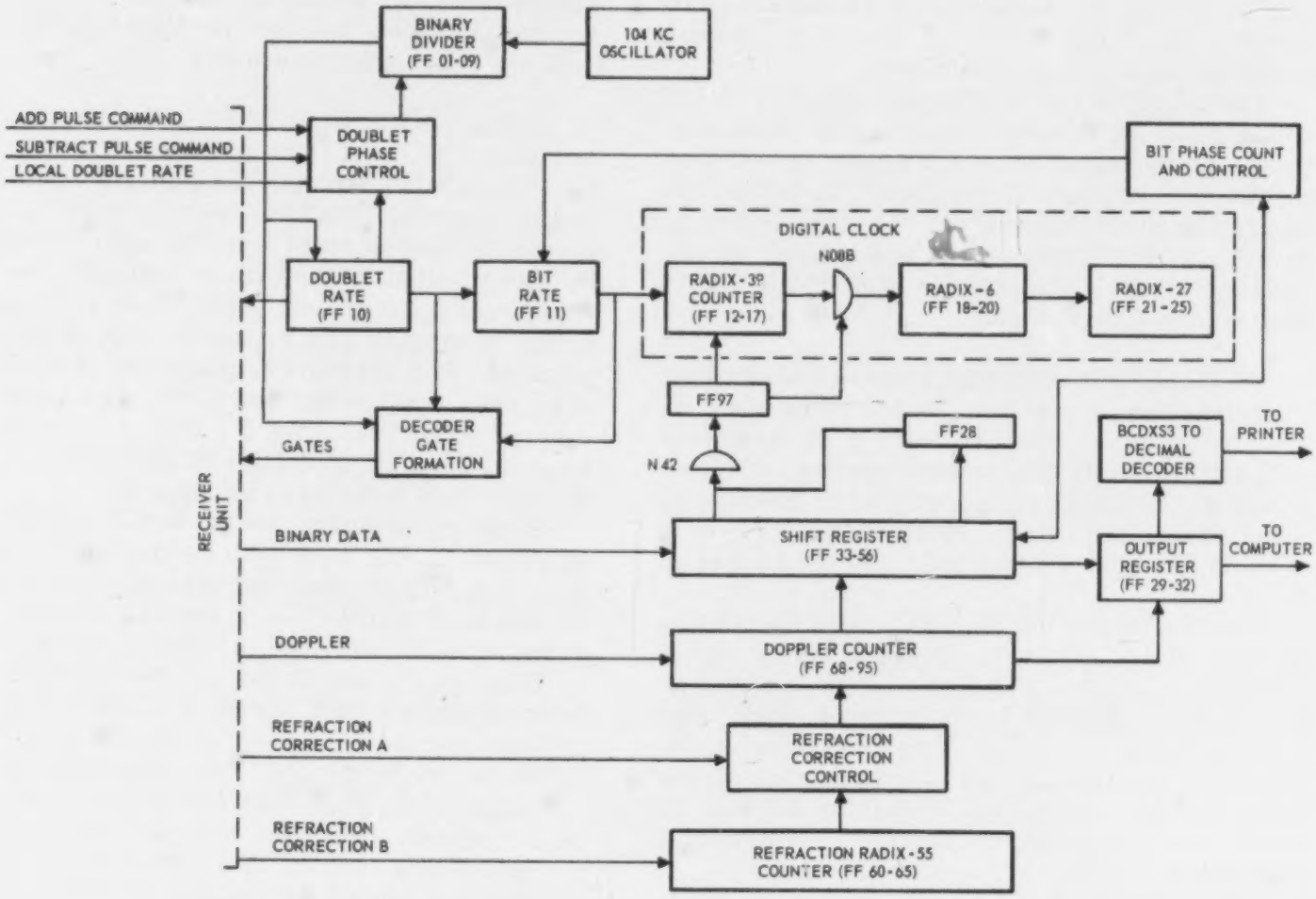

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Figure 15-14.—Simplified block diagram of data processor unit.

used, in each two-minute message. As previously mentioned, only every sixth word is required for a navigational fix, beginning with word 8, with the sequence being 14, 20, 26, 32, etc. to word 152. The radix-27 counter then counts the number of words used, and the entire digital clock is reset to zero before the next two-minute message.

Flip-flops 12-17 form the radix-39 counter. They perform a straight binary count until the 39th state, at which time flip-flops 12, 15, and 16 are set to "one."

One count per word enters FF18 via NO8B. Flip-flops 18, 19, and 20 form the radix-6 feedback counter. When FF20 toggles from "zero" to "one," feedback sets FF19 to "one", thus six is as high as the radix-6 counter can count.

Flip-flops 21-25 form a radix-27 counter. Feedback occurs to set flip-flops 21 and 23 to "one" when FF25 toggles from "zero" to "one."

When the radix-27 counter reaches the 26th state, after six 39-bit words, FF21 is toggled from "zero" to "one" and flip-flops 18, 19, and 20 are immediately set to "one." This prepares the clock to count the last word of 19 bits of the satellite message. When the radix-39 counter reaches the 19th stage, all flip-flops of the radix-39 counter are set to "one". The beginning of the next bit counted by FF11 toggles flip-flops 12-25 to "zero," indicating the beginning of the next two-minute message.

Before any counting is to be done, doublet rate synchronization must be made. This is accomplished by the Doublet Phase Control Assembly. If the DPC in the receiver determines that the doublet-rate flip-flop (FF10) is lagging in phase, pulses are added to FF01. If FF10 is leading in phase, pulses are subtracted from FF01, until the "local doublet-rate" is in sync with the satellite doublet rate.

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Doublet demodulation by the phase modulation decoder in the receiver occurs after doublet rate synchronization. The phase modulation decoder output is applied to the shift register (FF33-56). The serial shift signal enters each doublet into FF33 and shifts the previously entered doublet into FF34. If the doublets in flip-flops 33 and 34 are different, a count pulse is sent to the add/subtract unit which is comprised of flip-flop 49-52 and used as an up-down counter. This count occurs when the satellite bit rate phase to which FF11 must be synchronized is in the "one" state. Once every 39 bits when FF17 toggles from "one" to "zero," flip-flops 49-52 are set to 0111 state (most significant bit given first). Whenever the flip-flops count from 0111 to 1111, a pulse is sent to assure that FF11 is in the "one" state. When FF11 is in the "one" state and FF49 switches from "one" to "zero," FF50 is toggled; and the counter is adding. When FF49 switches from "zero" to "one," FF50 is toggled and the flip-flops are subtracting.

If counts occur when FF11 is in the "one" state, they are added to the preset value of 0111. If counts occur during the "zero" state of FF11, they are subtracted from 0111. In either case eight counts in either direction will drive 0111 to 1111.

After bit synchronization, full bits are demodulated by the phase modulation decoder and shifted through the entire shift register and FF28.

Gate N42 is a 26 input NOR gate connected to flip-flops 33-56 and 28 so that when they contain the 25-bit synchronization pattern (01111111111111111111111110) the gate will be satisfied. The 26th input to N42 is the 26th bit input signal, which can be used to prevent the data processor unit (DPU) from obtaining message synchronization.

When the synchronization pattern is recognized by N42, FF97 is set to "one." When FF97 is set to "one," the following changes take place;

(1) Flip-flops 12-17 are set to the "one state
(2) Count pulses can enter FF18.
(3) No shift pulses can enter FF28.
(4) Message synchronization occurs.

When message synchronization occurs, the last bit of the synchronization pattern enters the shift register. Serial shift pulses occur about 5 milliseconds before each count pulse from FF11. Thus, the count pulse immediately following pattern recognition represents the satellite two-minute mark, or the beginning of word 3. After message synchronization the DPU begins to process data.

The 400-mc doppler signal from the receiver unit is converted to a square wave by a Schmitt Trigger and applied to the doppler counter. Flip-flops 68-95, which form the doppler counter, are divided into seven groups of four flip-flops each. Each group is a radix-10 feedback counter so that the doppler count is accumulated in decimal. The seven decades count in Binary Coded Decimal Excess Three (BCDXS3). Bits enter the decade serially from left to right so are in reverse order. As an example, when flip-flops 72-75 reach the 1100 (9) state the individual flip-flop states would appear as shown in figure 15-15, A.

Since this counter is a radix-10 counter the next pulse toggles FF72 and FF73 to "one" and resets FF74 to "zero." This toggles FF75 to "zero," sending a count pulse to the next decade. The state of the counter would then be as shown in figure 15-15. B. or in the "zero" state, ready for the next count. Figure 15-15, C shows a truth table for each of the 10 states of the radix-10 counter.

Every two minutes under control of the digital clock, the doppler counter transfers its contents to the shift register and resets to "zero." Preparation begins during states 26 and 27 of the digital clock radix-27 counter and it is significant that this reset operation is controlled by the incoming doppler frequency itself. In this

FF72	FF73	FF74	FF75
0	0	1	1

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Figure 15-15A.—Radix-10 feedback counter in the "9" state (BCDXS3).

FF72	FF73	FF74	FF75
1	1	0	0

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Figure 15-15B.—Radix-10 feedback counter in the "zero" state (BCDXS3).

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	FF72	FF73	FF74	FF75
0	1	1	0	0
1	0	0	1	0
2	1	0	1	0
3	0	1	1	0
4	1	1	1	0
5	0	0	0	1
6	1	0	0	1
7	0	1	0	1
8	1	1	0	1
9	0	0	1	1

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Figure 15-15C.—Radix-10 feedback counter truth table (BCDXS3).

way no doppler count can be lost during the transfer and reset operation.

"Refraction Correction A" and "Refraction Correction B" signals are applied to two Schmitt Triggers which will be referred to as ST1 and ST2, respectively. These two signals come from the 1.875-mc phase comparator assembly in the receiver and are in phase quadrature, with a frequency 55/24 times the desired refraction correction rate.

The output of a Schmitt Trigger changes state rapidly each time its input crosses 0 volts. Because noise often accompanies the refraction correction signals as the signal voltage approaches zero, the signal plus noise voltage may cross zero several times. However, only one refraction correction count must occur.

Two outputs from each of the Schmitt Triggers are in phase opposition, so if the input of ST1 crosses zero volts in either direction it will set a flip-flop to "zero". Similarly, ST2 sets the same flip-flop to "one." Thus, the first count pulse from ST2 sets the flip-flop to "one," preventing a count until ST1 resets the flip-flop to "zero." In this way only one count pulse from the Refraction Correction B signal can enter the Refraction Counter until the Refraction Correction A signal again crosses through zero.

Flip-flops 60-55 (fig. 15-14) form a radix-55 feedback counter. The feedback sets flip-flops 60 and 63 to "one" when FF65 toggles from "zero" to "one." With a total of 55 pulses to FF60, the output of the radix-55 counter will be 24 pulses.

This output is taken from the set side of FF60. By utilizing the feedback, FF60 is in the "one" stage 24 times out of 55 input pulses. These pulses are applied to the refraction correction control and during this time are added to or subtracted from the doppler count in the doppler counter.

The primary data output from the DPU (Data Processor Unit) is from flip-flops 29 to 32 (output register). All doppler count and satellite message data is shifted, four bits at a time, into these output flip-flops.

In preparation for the doppler count transfer, the shift register and flip-flops 29 to 32 are filled with binary "zeros". Because the shift register is filled with "zeros," only the binary "ones" need to be transferred from the doppler counter. At time of transfer the doppler count in flip-flops 68 to 91 is put into the shift register while the count in flip-flops 92 to 95 is transferred directly to the output register. This transfer takes place just after the digital clock resets to all "zeros" at which time the two-minute mark timing signal is outputed. The shift register is delayed for four-bit times allowing time for the doppler count digits transferred directly to the output register to be decoded and entered into the printer.

After the four-bit delay the contents of flip-flops 33 to 56 are transferred into the output register and the serial shift pulses begin again. After each set of four bits has been shifted into flip-flops 33 to 56, it is then transferred out. When this process is completed satellite data is again allowed to enter the shift register.

Every bit received from the satellite is entered into the shift register except during the preparation and processing of doppler count data. The output transfers this data into the output register four bits at a time as previously discussed.

The BCDXS3 decoder module is a diode matrix which converts binary-coded inputs to decimal outputs. Certain other signals are provided as outputs of the DPU for use by a navigational computer, paper tape punch, or other device. These are end-of-word, digit rate, bit rate, bit sync signal, two-minute mark, and serial data.

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Control Group

The Control Group (fig. 15-16) contains a number of interacting circuits and performs switching functions. The entire navigational fix can be monitored and controlled from the Control Group and associated computer.

Positions 1, 2, and 3 of the ten-position main control switch (S01) are used to perform a test of the power supply voltages; +12 volts, -12 volts, and -24 volts, respectively. If these voltages are correct, 50 microamps will flow through the 100-microamp meter, M01, and the needle will point to the green line at midscale.

Position 4 of switch S01 puts the navigational set into the search mode. Circuits involved in this operation are:

(1) Frequency search control
(2) Audio monitor
(3) Frequency monitor
(4) Doppler acquisition light

To tune the set, the operator uses two single-pole double-throw frequency search switches which are located under the FREQUENCY SEARCH bar. When the right side of the search bar is depressed, the set is tuned towards a higher doppler frequency by connecting -12 volts to the "manual tune" function. When the left side of the bar is depressed, 12 volts are connected to the "manual tune" function and the set is tuned towards a lower doppler frequency. When neither side of the bar is depressed, a small positive bias is applied to the manual tune" function. This small bias tunes the receiver to a doppler frequency of approximately 26 kc, which is near the frequency at which a satellite signal should first appear. The "manual tune" function circuitry is external to the control group and consists of resistors and capacitors which are used primarily to develop different time constants for the tuning bias which is then applied across the VCO voltage-variable capacitor.

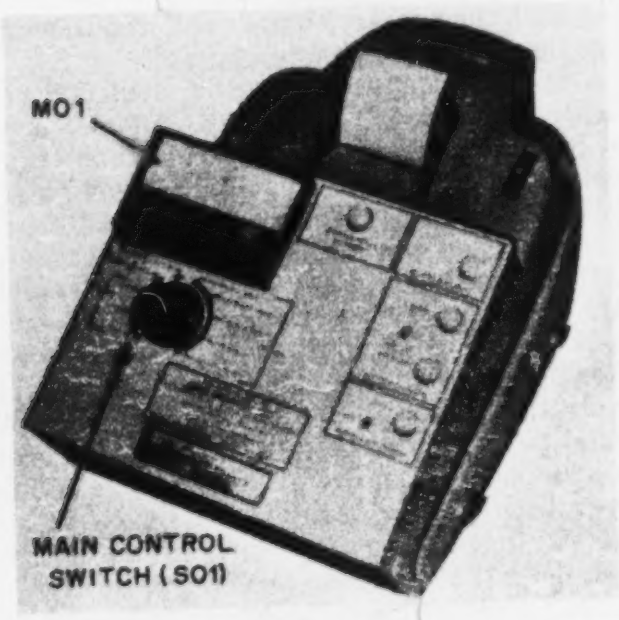

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Figure 15-16.—Control group.

A jack on the left side of the Control Group (not shown) provides an audio monitor signal to high-impedance headphones. This signal is the output of the 5-mc phase comparator monitored through a 100K ohm resistor. When the set is tuned near a satellite signal, the difference frequency may be heard in the headphones. The operator then tunes the frequency until a zero beat, or frequency null, is heard, indicating the receiver is in phase with the satellite signal.

Meter M01 has two scales as illustrated in figure 15-16. In the search mode the top scale of M01 displays the doppler frequency to which the navigation set is tuned. By this means the operator is guided to search for the satellite signal only in the frequency region where it is expected. The scale runs from 22 kc to 42 kc, which is wide enough to accomodate all possible satellite frequencies.

The Doppler ACQ (Acquisition) Light is another aid to the operator in locking on a satellite signal and is located in the upper right-hand corner of the Control Group panel. When the receiver is tuned to within approximately 30 cps of the satellite signal, the light begins to flash at that difference frequency. Thus, the light provides a visual tuning indication to supplement the audio monitor signal.

In the Pause Mode (Main Control switch S01 in position 5) the phase-lock loop in the DPU and Receiver is closed and the frequency search bar will have no effect. The signals reaching the Doppler ACQ light change from 30 cps to 1 cps. Because this signal is derived from the 5-mc phase comparator output, the light comes full on and stops flashing if the receiver is phase-locked to a satellite signal.

When the Main Control Switch is in position 5 (Pause Mode), the meter displays a measure of the phase error between the double rate flip-flop in the data processor unit and the doublet modulation rate received from the satellite. When the data processor unit achieves

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phase-lock, the meter needle will vary about the green center mark.

Positions 6-10 of the Main Control Switch (S01) comprise the track mode. In this mode the receiver tracks the satellite signal, and the data processor processes navigational data. These functions are monitored by the meter and by observing the output of the printer. While the receiver remains locked to the satellite signal, the only control functions are to select whether or not to use the refraction correction signals and, if necessary, to reject a data processor unit synchronization.

The Refraction Rate Light and Switch (fig. 15-16) gets its input from the 1.875-mc phase comparator and is the Refraction Correction B signal. It is a 3-volt peak-to-peak sinusoid with a frequency 55/24 times the refraction error frequency at 400 mc. Thus, the REFRACT CORR RATE light should flash at a rate seldom faster than 10 cps if the 150 mc satellite signal is being received properly.

The refraction control switch (fig. 15-16), allows the operator to select whether or not the data processor unit performs the refraction correction operation. If the REFRACT CORR RATE light is flashing in an erratic manner, it indicates that only noise is being received through the refraction channel, and the refraction control switch should be turned off.

When the Main Control Switch is advanced beyond position 5, the data processor unit is taken out of the high-speed bit track mode, and the "start bit sync" signal allows the data processor unit to achieve a bit synchronization. When this occurs, the DIGIT light (fig. 15-16), goes on. This whole process normally occurs within seconds of advancing S01 to the track mode.

Within two minutes after the DIGIT light comes on, the data processor unit will receive from the satellite a synchronization code. If the code is recognized, the data processor unit will achieve message synchronization and begin to process data. The MESSAGE light (fig. 15-16) will come on, and the printer will begin to print data.

In position 6 and 7 of S01, the two AGC voltages in the receiver are monitored. Position 6 is for the 400 mc AGC and position 7 for the 150-mc AGC. In each case the actual AGC voltages are monitored through 100K ohm resistors located in the receiver. Thus, full-scale deflection represents 10 volts of AGC, on the lower scale of meter M01.

Another monitor function of the meter is the acquisition correlation function. This is the output of the 5-mc phase comparator monitored through a 28.7K ohm resistor. When this signal is at the correct value of +15 volts d-c, the meter will read center scale at the green line. The 400-mc AGC circuit is adjusted to maintain this condition.

DIGITAL COMPUTER CP-827/SRN-9

The navigation system measurements consist of three successive baselines. The satellite message is continuously transmitted during two-minute time periods, each message starting precisely on the even minute mark. A minimum of six full minutes, or three complete satellite messages, is required to calculate these baselines. Additional periods of received satellite transmission will increase the accuracy of these computations. After measuring the doppler shift and decoding the information content of the phase modulation, the computation may be performed in one of several methods.

Hand computation may be made to obtain a position fix, although the complexity of such calculations leads to hours of computational time and an almost certain probability of human error.

A general-purpose computer may be used, although a buffer unit is necessary to process and convert information into the appropriate computer format. The availability and the time sharing aspects of a general-purpose computer, along with the adaptive buffer unit requirement, make this a less desirable choice.

A special-purpose computer, designed specifically to operate with the AN/SRN-9 Navigation Set, can accept data on the format of the received signal. Such a computer must be able to store the results from a single satellite pass, and accept ship's information of estimated longitude, latitude, velocity north, and velocity east. It then must use the satellite and ship's position data to compute the ship's position fix in longitude, latitude, and coincident time. To assure the continuity of the satellite data, the special purpose computer should be able to sense any loss of signal in the lock circuits of the receiver and, when a loss of signal in these circuits is detected, reject information for the two-minute transmission interval as invalid.

The CP-827/SRN-9 is designed as a low cost computer, requiring a minimum of space, and permitting rapid calculation of a position fix to

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meet the immediate needs of the Navy Navigation Satellite System.

In most cases, this computer will not render a "wrong" fix; when a malfunction is present, the computer will not progress through its sequence of operations, whether in response to taped program commands or to operator-controlled commands. Although the same basic circuits are used to execute these operations, an early identification of a source of trouble by isolating a malfunction to a distinct mode of operation permits a more rapid assessment of difficulty by the troubleshooter. To this end, a Test Device is furnished with each computer to give visual display of the binary content of all computer registers by means of a panel of lights in marked groupings.

The satellite message received during a satellite pass is cabled directly into the computer memory to a preprogrammed storage location. A taped program reduces the satellite data to a form which, when manual entry of ship's data has been added, will compute a position fix in a matter of seconds.

The final computations, as well as certain interim data, are printed out on the paper tape of the receiver control group printer. The fix is printed in decimal figures of longitude, latitude, time, and offset frequency.

Equipment Description

The CP-827 is a self-contained computer with three slide mounted drawers. Figure 15-17 shows the external view of the cabinet, its controls, switches, lights, and the tape feed and spools.

The computer consists of four major assemblies; Drawer I, Drawer II, Drawer III, and a Rear Door Assembly. The three drawers have front-mounted handles for their access and removal for maintenance.

Drawer I, the top drawer (fig. 15-18), has a blank front panel. Internally, the drawer is comprised of three rows of printed circuit board multipin connectors. Each row can accommodate up to 27 printed circuit logic cards.

Drawer II is the middle drawer of the cabinet. Most of the controls and indicators of the computer are mounted on the front panel of this drawer (fig. 15-19). An eight-position QUADRANT SELECT rotary switch allows selection of one of four quadrants in each of two planes of the core memory. A ten-position DIGIT SELECT rotary switch permits selection of any digit from 0 through 9. Four incandescent lamps monitor the outputs of the manual entry flip-flops, (W01, W02, W03, and W04), to give visual indication of the sequence of operator's data entry into the computer. Five pushbutton switches control the STEP Y, TRANSFER, PRINT, RESET, and START functions. A single-pole double-throw READ-STORE switch allows either readout of memory or storage of information. The AC POWER ON micro-switch, when depressed, gives an indication that power is being applied to the computer. The ENTER DIGIT microswitch permits entry of the digit selected by the rotary DIGIT SELECT switch, and gives indication that the digit has been entered. The J7 ON-OFF is a two-position microswitch for turning on and off the J7 operational code, which controls whether instruction is to come from tape or from the stored program. The lighted portion of the switch indicates the on or off position. This switch should be left in the position where the ON or OFF condition may be controlled by computer operation.

Drawer II is almost identical to Drawer I in internal construction, with three rows of printed circuit board connectors, each row accumulating up to 27 cards.

Drawer III (fig. 15-20), the bottom drawer of the cabinet, contains the heavier computer components, such as the power supply and tape reader assembly. The tape reader is mounted on the front of the drawer. The stacked power supply inside the drawer furnishes regulated d-c voltages of + 12, +19, -6, -8, -12, -19, and an unregulated +18 volts d-c. Potentiometers are provided for each of the individual power supplies and are adjustable over ±10% range. A zero to 25 VDC voltmeter and a rotary selector switch are mounted inside the drawer to monitor each of the power supply outputs. In the rear of this drawer is a 115 VAC, 50/60-cycle single-phase blower motor. Input line voltage to the computer is 115±10 volts, single-phase, 60 cps power.

The Rear Door Assembly (fig. 15-21), has a four-part receptacle for the cabling harness of the test device. A horizontal multipin connector underneath this harness is for receiver-computer hookup. The blower exit vent is at the bottom of the assembly.

Printed Circuit Logic Cards

The cards used in the drawer of the computer are printed circuit boards with all circuit

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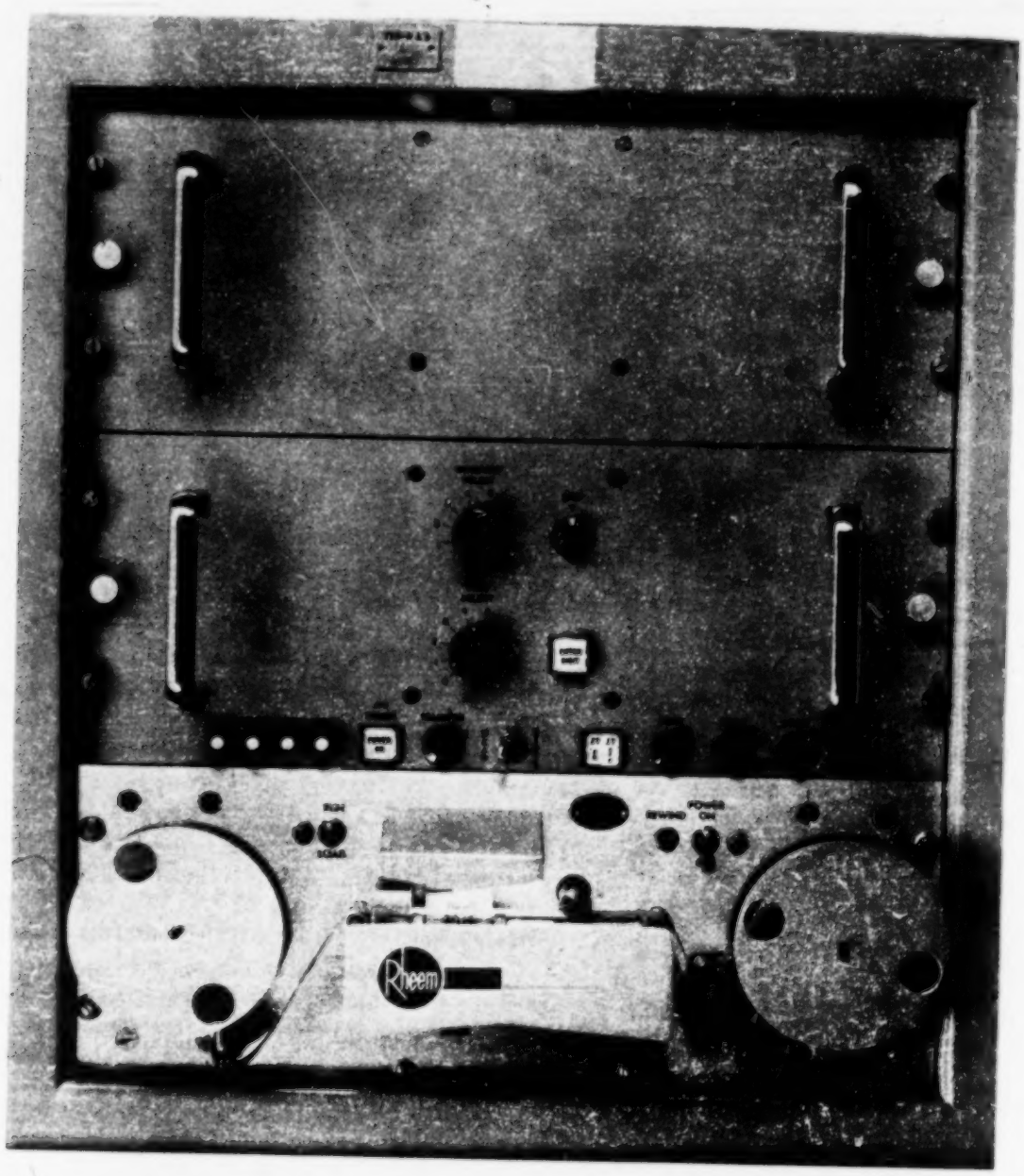

Figure 15-17.—Digital computer CP-827/SRN-9.

162.74

boards having the same card, or part number, being interchangeable. However, certain cards have potentiometer adjustments which may require realignment if they are interchanged.

Silicon semiconductor components are used on all cards. To achieve a minimal noise level on the d-c power distribution lines, the power lines on each card are bypassed with individual capacitors.

The thirteen types of cards in the computer comprise the modular circuitry to perform all of the operational commands by the three types of input (receiver signals, taped instructions, or manual entries).

Tape Reader

The tape reader mounted on the front of Drawer III (fig. 15-17), is a Rheem Model RRS-102 Reader-Spooler combination. It uses an 8-channel punched tape with a reading speed of approximately 10 inches per second. Operating as the input medium, the function of the tape reader is to convert information from its

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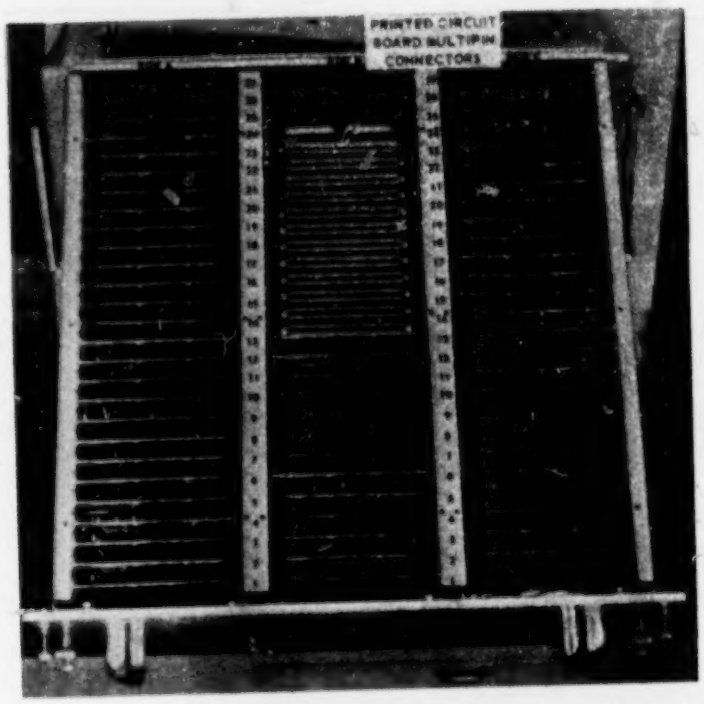

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Figure 15-18.—Drawer I, top view, showing logic cards and multipin connectors.

perforated form to electronic signals. As the tape passes under the reading lamp, the holes are recognized by means of photoelectric cells. Each cell is gated with certain logic circuits amplified, and sent to the output receptacle for external routing. The switches on the panel of the tape reader consist of two toggle switches, for power ON-OFF and tape RUN and LOAD conditions, and a pushbutton for the rewind condition of the tape spool.

The light source is a horizontally mounted cartridge lamp with an average life of 4,000 hours. Care must be taken to properly focus the lamp and to ensure that no obstructions, such as dirt, incomplete tape perforations, etc., cover the photocell block apertures.

Receiver Data

The satellite data received during a satellite pass is fed directly into the computer memory to preprogrammed storage locations. The computer automatically interrogates the lock circuits of the receiver during this time and rejects as invalid any message interrupted by a loss of lock in the track. If a sequence of three, full two-minute satellite messages, is not received during a single satellite pass, the computer cannot compute a fix, and the printout will indicate (prior to manual entry of ship's data) that no fix is possible.

Satellite data is transmitted in BCDXS3 format. Any time that the printer of the control group is activated, the computer must operate through the decoder matrix of the receiver. Thus, all data injected into the computer via the receiver must also be in this format. As a 32 bit word is injected from the receiver, the computer is sequenced to accept each four bit series and shift its position to accept the next four bits. All computer data are in this serial binary form, with all numbers having a magnitude less than unity. The binary point is located between the 31st bit and the sign bit, which is in the 32nd position or the left-hand end of the printout. All numbers are stored as absolute value plus the sign bit.

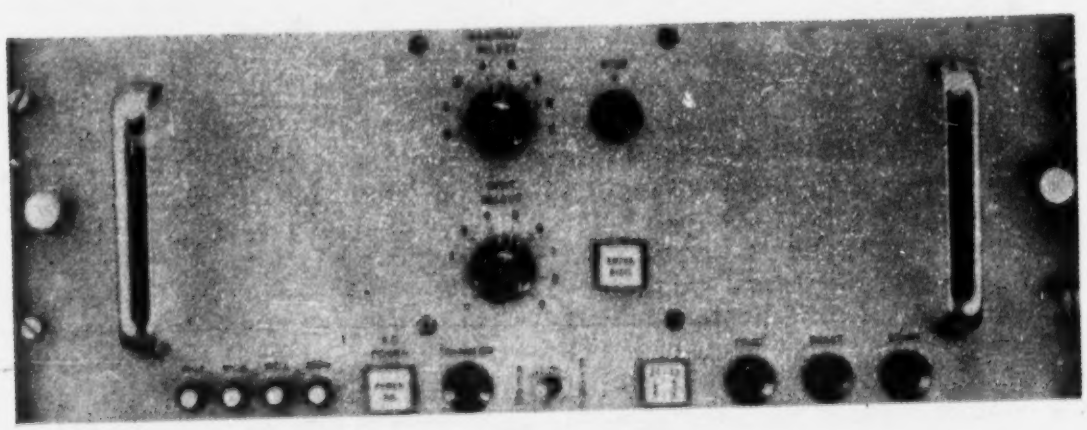

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Figure 15-19.—Drawer II, front view, showing control panel.

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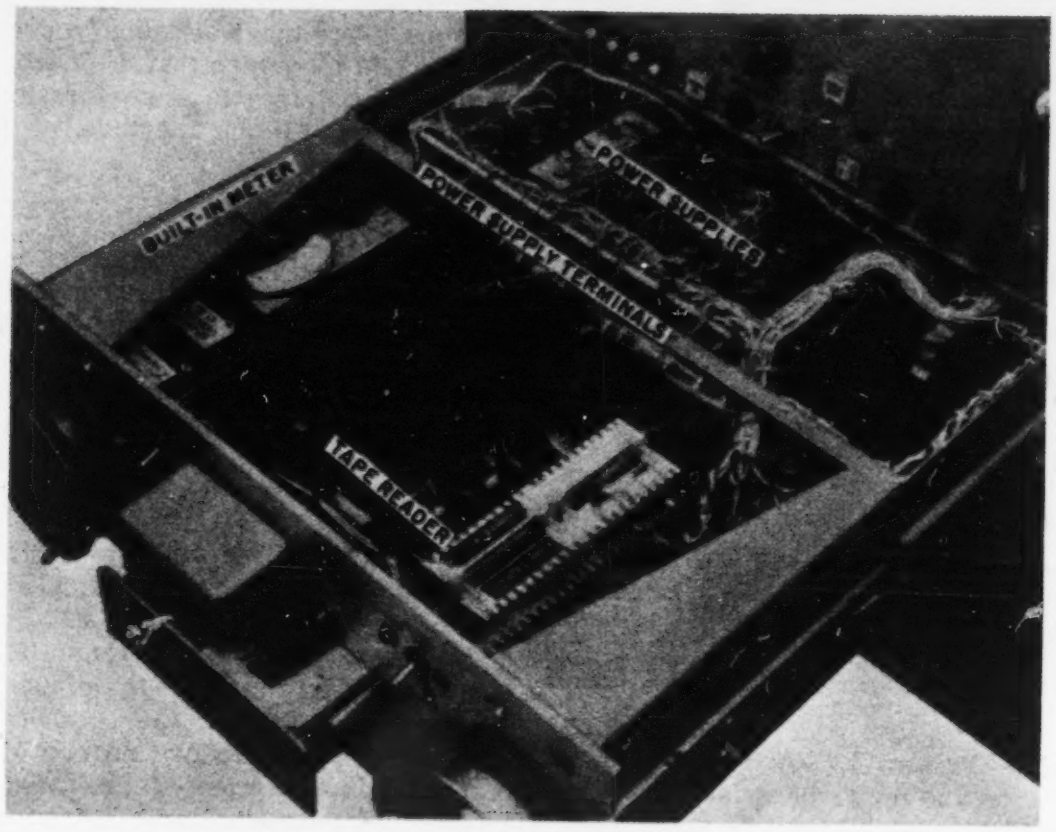

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Figure 15-20.—Drawer III, open view, showing interior tape reader and power supply sections.

Satellite data are arranged with the least significant bit in position 1 of the printout, or the right-hand end of the word. The receiver lines feeding the computer are arranged to inject each series of data correctly into bit positions with the most significant bit in position four, and then these are end-around shifted for the computer to accept the next four bits.

The conversion from BCDXS3 is made in the computer prior to the arithmetic operations to simplify the logic. However, output must be reconverted for printing, since the printer must again operate through the receiver's decoder matrix. The Z register, through which all data must pass either entering or leaving the computer, will therefore display its content in XS3 format on the Tester panel lights prior to printing. Likewise, manual entries made in decimal form from the computer panel will be displayed in XS3 form on the (Z-register) Tester lights, although the printout will be in the same decimal form as used for entering the digits.

Core Memory

The computer utilizes two identical ferrite core memories with storage capacities of 128 words of 32 bits each. Each memory consists of the ferrite storage cores arranged in a matrix which is subdivided into four quadrants of 32 X 32 bits. The cores are threaded by three wires to give an X drive, a Y drive, and a bias-digit drive. Each quadrant also has its own sense line feeding a single sense amplifier. The 32 X and the 32 Y drive lines pass through each of the four quadrants of a memory plane. For any given memory cycle, one of the four quadrant lines will be true while the other three are false. During this time, the cores of the three quadrants not selected receive bias current, while the selected quadrant cores receive no bias current. After application of bias current, drive current is applied to one of the X drive lines, in opposition to the bias current. The Y drive current is then applied and only the core at the intersection of the X and Y drive lines in the

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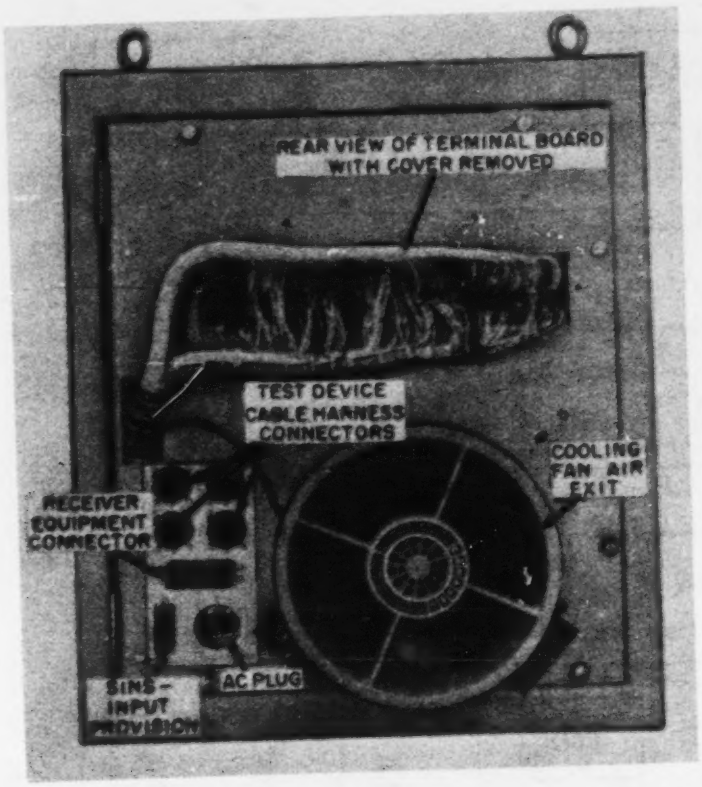

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Figure 15-21.—Rear door assembly showing connectors, cooling fan, and terminal board (with cover removed).

selected quadrant receives full current and is switched.

The current steering switch techniques employed provide simplicity for X and Y drive selection and are designed to minimize dissipation in the current stabilization circuits and to provide greater timing tolerance. Sense signals of approximately 45 millivolts occur for each one bit output. A memory cycle consists of two beats, a read or clear and a restore or write beat. Each beat requires 4 microseconds, providing memory cycles of 8 microseconds each.

Whenever the content of a memory cell is scanned, the contents are read without changing the values within the cell.

Instruction Codes

Instruction codes to program the computer may be generated either from the punched tape or from the internally stored program of the memory. Operation from the control panel by the operator can drive words into memory storage, transfer words from memory and obtain a printout. Whether the taped instructions are controlling the operation of the computer, or whether the manual controls are being used to enter data into the computer, the reset button of the computer must be pushed to generate a signal causing the proper sequence and logics to reset and wait for further instructions.

The start button then shifts the computer to a position where it awaits taped instruction. Four characters on the 8-channel tape define a 32 bit instruction. The first 8 bits of the instruction are used for the operation code. The second, third, and fourth groups of 8 bits each are used for the A, B, and C operands, since the CP-827 uses three address computer logic. The timing is based on the use of a stored program, and the variations of time with different instructions are due to the difference in time required for address decoding, according to the position in the memory which is being addressed. By placing the primary working storage in the small addresses of temporary storage registers, it is possible to keep the timing at a minimum for the bulk of a computing program. For this reason, eight special registers are set aside in the memory for use in performing the various arithmetic and logical operations, and to provide temporary storage of instructions.

Block Description

The organization of the computer is shown in block diagram form in fig. 15-22, and the front panel of the Test Device is shown in fig. 15-23.

Three types of input are shown in blocks A, B, and C, (fig. 15-22). These are the manual data entered at the control panel, the taped instructions at the tape reader, and the satellite data via the decoder matrix of the receiver. The output to the printer, Block E, is via the same decoder matrix of the receiver.

All information is time gated on passing to or from the Z register, Block 1. The Z register is the accumulator, the heart of the computer. All inputs and outputs pass through the Z register, which receives and sends signals from and to the adder.

The J register, Block 2, is the storage register for operational instructions. It controls the adder and the sequence of F states that are to be followed for each instruction.

After an operational code is sorted in the J register, the first two addresses are obtained, the operation is performed, and the results are stored. Then the third address is obtained and

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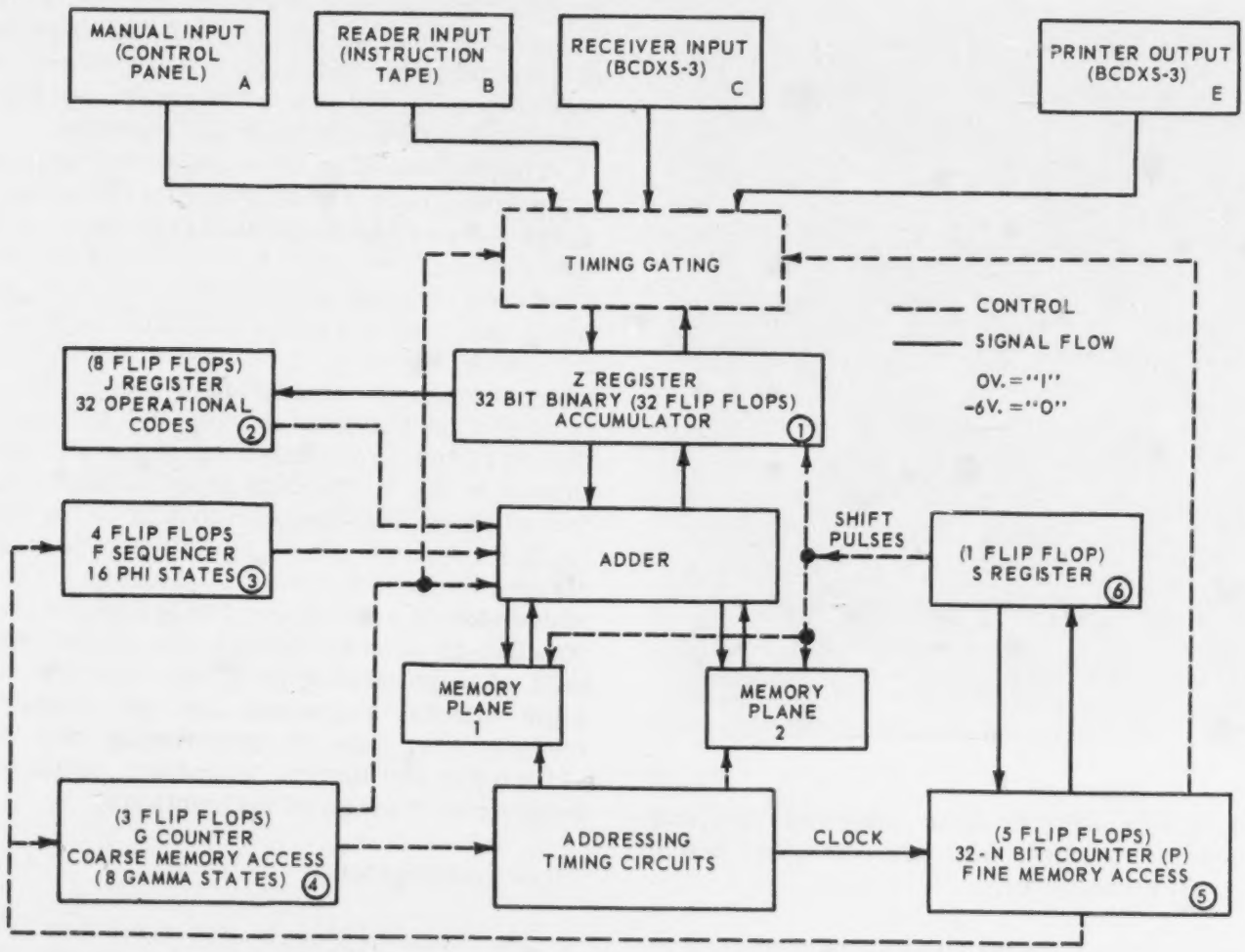

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Figure 15-22.—Block diagram of computer organization.

decoded to obtain the cell into which the results are to be placed.

The F-register, Block 3, is called the "sequencer" and is actually a coarse control to sequence the computer to perform the desired operation while other registers in the computer derive the discrete timing and control necessary for the operations.

The G-register, Block 4, consists of three flip-flops and is used in 11 of the 16 F sequencer states. The G register, called the gamma counter, is used to synchronize the computer with unclocked input data and it controls finer timing for memory access. The G counter sequences, in a particular F sequencer state, to enable word timing signals for setting the memory addresses to select a word and to relocate this word as desired. In the F sequencer states where the G counter is used, the counter will not sequence to a new F state until the G counter has sequenced properly. The eight states of the gamma counter are displayed on the Tester by the eight lights labeled γ.

Timing is provided in the computer by the clock system and the P counter. The basic clock pulse has a repetition rate of 125 kc and this rate is derived from a free running 1-mc oscillator. Elements of the P counter synchronize the clock pulse and also provide a means for inhibiting the clock. The five flip-flops of the P counter, Block 5, count a standard word length of 32 bits, as well as the 8-bit timing used in address manipulation and the 4-bit digit data.

Although the standard word is 32 bits, it may vary to a shorter word, as when tape data is to be entered or when four bit shifts are to occur. By setting the initial P counter state at the complement of the number to be counted, the P counter then acts as a down counter. For address manipulation, the complements of the address

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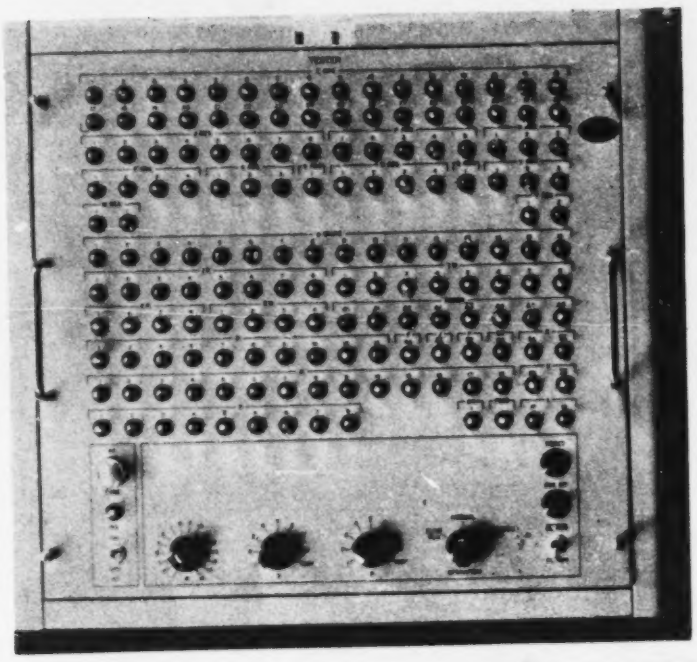

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Figure 15-23.—CP-827/SRN-9 test device.

are injected. When this counter overflows, it signals the computer that the correct word length has been counted and turns off the S flip-flop to inhibit any further manipulation at this time. The P counter remains in the 32nd bit time for two full bit times during which logical functions are performed for correct computer sequencing.

The S-register, Block 6, is the main timing flip-flop which transmits shift pulses to the Z-register and the memory planes, as controlled by the P counter. The S counter remains off for either one or two pulses, during which time the memory drive circuits are reset and the F and G counters are reset to new states. When the Z-register is to be shifted, the P counter controls the S-register action to cause the shift. When the P counter overflows, this causes the S-register to turn off. Therefore, the S-register is on for the number of bit times conditioned by the state of the P counter. The F- and G-registers do not change their states until after the S-register has been turned off, allowing at least one clock pulse for sampling the end result of all states. This S flip-flop controls the memory by inhibiting or enabling the drive circuitry. Since all memory outputs must pass through the Z-register via the adder, the Z-register must see the same shift pulses as the memory. These are the pulses that drive the memory.

The adder controls all access to the memory and performs various arithmetic operations required by the operation instructions.

The W register (front of control panel in fig. 15-17) consists of four flip-flops, W01 through W04 which are used to drive indicator lights. Their primary purpose is to give a visual indication to the operator entering the ship's data or manual data. At this time, the lights are set and reset in such a sequence that by reading the binary number shown by the W01 through W04 indicator lights, the operator can determine what has been entered manually in the navigational program.

AN/SRN-9 RF TEST SET

The AN/SRN-9 RF Test Set is designed to provide fault isolation in the AN/SRN-9 Electronics Group and to provide a means of checking the AN/SRN-9 Mast Group. The AN/SRN-9 RF Test Set provides simulated satellite signals on 400 mc and 150 mc. The 400-mc output is phase-modulated to produce a test message.

Physical Description

The RF Test Set (fig. 15-24) operates on 115 VAC, 60-cps power. It also operates on battery power when it is required to the check the Mast Group. It is composed of two major sections: One side of the set contains the Modulation Switch, the fuse holder and voltage indicator lamps, and three pushbutton switches for BIT, MSG, and WORD synchronization. The remaining jacks and phase delay adjustments are for use with other test equipment and may be disregarded for purposes of this discussion. The major r-f test hookup points, selection dials, and attenuators are contained in an r-f section which can readily be removed for battery operation when it is necessary to climb the mast to check the Mast Group.

The selection dials are as follows:

1. POWER—3 positions, for OFF, INTernal, or BATtery.
2. DOPPLER—INTernal OSCillator selects 32 kc and EXTernal OSCillator selects 26 kc or 52 kc.
3. ATTENUATORS—10 db steps for both the 150-mc and 400-mc outputs. A jumper cable is furnished to hook either output into the center attenuation

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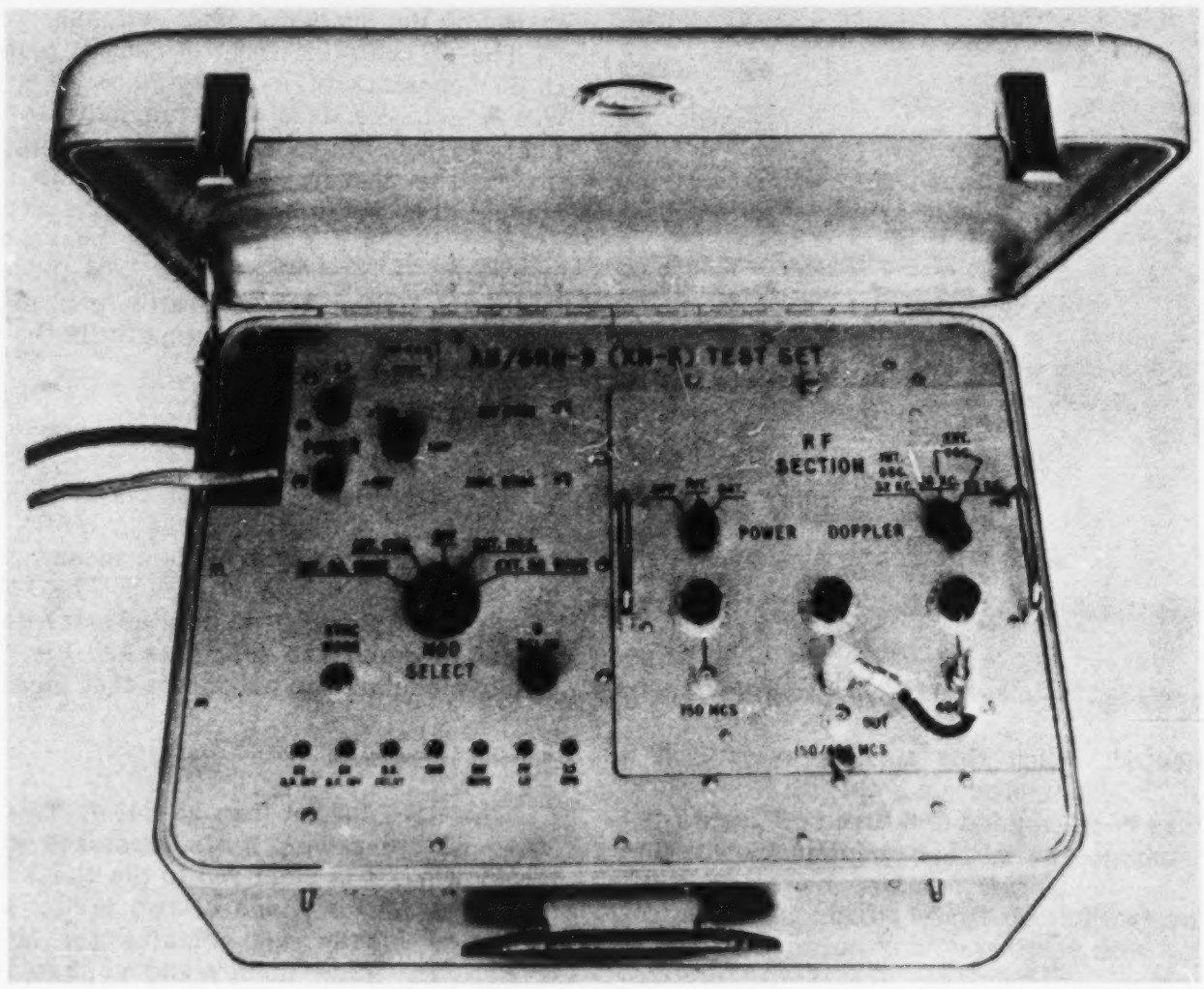

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Figure 15-24.—SRN-9 RF test set panel controls and switches.

3. ATTENUATORS Continued

selector which is in 1 db steps and thus permits finer selection of attenuation characteristics.

Four basic modes of test hookup can be used to isolate basic operational malfunctions. The sequence of these tests is as follows:

1. Readiness Check—prints a test message, variable doppler count.
2. Radiation Check—prints a test message, variable doppler count, varying AGC.
3. Mast Check—no test message, no doppler count.
4. Doppler Purity—prints test message and fixed doppler count.

Readiness Check

The purpose of this test is to check the ability of the Electronics Group to lock on a test signal and decode a test message. The RF Test Set will furnish a simulated satellite signal to the Navigation Set. Therefore, the procedure for acquisition and locking onto the signal is identical to that used for a satellite pass. The printout obtained from this check is a predetermined message of alternating words of zeros and nines, followed by a message of threes and sixes. Each two-minute message will consist of one of these combinations and will end with a doppler count which will not be stable for this check and may be disregarded. If, as a result of this check, all message printout is normal, it can be assumed that all sections of the

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Electronics Group are functioning properly and any loss of sensitivity will require a Mast or Radiation Check.

Radiation Check

The second check that can be performed is a radiation check. It renders a variable doppler count and varying AGC. This check isolates a completely malfunctioning Mast Group (Electronics Group not receiving any signal), without necessitating climbing the mast. The test set attenuation settings are at 0 db and the Modulation Section Switch on INT MSG. Using the normal AN/SRN-9 equipment setup with the Mast Group connected to the Electronics Group, if signal lock-on or proper message printout is not obtained, proceed to Check No. 3. If all indications are normal, proceed to Check No. 4.

Mast Check

If there is an improper message printout, or no test signal lock-on is obtained, climbing the mast is unavoidable. It is assumed that all connections of the Electronics Group, including a-c power, have been verified to be correct. For this test the RF section must be removed from the Test Set, and arrangements made for communications between the man on the mast and the operator monitoring the received signal at the Electronics Group of the Navigation Set. This test gives a sensitivity check of the Mast Group. A low sensitivity in the Mast Group would indicate the need for replacement.

Doppler Purity Test

The Doppler Purity Test provides a test message and a fixed doppler, although the message is of no consequence in determining the accuracy of results of a navigational fix. This test will reveal any power line noise which can cause doppler errors. If the Doppler Purity Check is not passed, the 115-VAC power must be checked for transients.

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APPENDIX I

TRAINING FILM LIST

Certain training films that are directly related to the information presented in this training course are listed below under appropriate chapter numbers and titles. Unless otherwise specified, all films listed are black and white with sound, and are unclassified. For a description of these and other training films that may be of interest, see the United States Navy Film Catalog, NavWeps 10-1-777.

Chapter 1

ADVANCEMENT

MN–10402	The Electronics Technician (13 min.–1967).

Chapter 2

MAINTENANCE

MN–10043A	Planned Maintenance System–Introduction (20 min.–Color–1964).
MN–10043B	Planned Maintenance System–Maintenance Data Collection (15 min.–Color–1965).
MN–8639	Safety on the Job at Sea (16 min.–1957).
MC–4597	For Safety's Sake (13 min–1945).
MN–8990	115 Volts–Deadly Shipmate (19 min.–Color–1960).
MN–6754	Safety Precautions for Electronics Personnel (15 min.–1951).

Chapter 7

MULTICOUPLERS AND DISTRIBUTION SYSTEM

MN–6836	Shipboard Radio Communication–Remote Control Transfer Switchboards (11 min.–1951).

Chapter 8

TELETYPE AND FACSIMILE TERMINAL EQUIPMENT

MN–8099A	Radio Teletype Systems Afloat–General Principles of of Operation. (15 min.–1956).
MN–8099B	Radio Teletype Systems Afloat–Tone Modulated System (11 min.–1956).

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Chapter 10

ELECTRONIC AIDS TO NAVIGATION, Part I

MN—5894A	Radio Direction Finders—Theory and Fundamentals (15 min.—1948).
MN—2731A	Loran—Basic Principles of Loran Operation (12 min.—1944).

Chapter 11

ELECTRONIC AIDS TO NAVIGATION, Part II

MN—6925C	Ground Aids to Air Navigation (Ship to Shore) (19 min.—1955).

Chapter 12

SEARCH RADAR

MA—6000A	Technical Principles of Radar—Part I—Introduction (22 min.—1945).
MA—9524	Theory of Moving Target Indicator Operation (20 min.—1960).

Chapter 14

SPECIAL PURPOSE EQUIPMENT

MN—6987A	Electronic Countermeasures—Introduction (13 min.—1953—Classified).
MN—9455B	The FBM Weapon System—The Navigation Subsystem (20 min.—Color—Classified—1963).

Chapter 15

SATELLITE NAVIGATION

MN—10186	The Navy's Navigation Satellite System (13 min.—1967).

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PUB DATE - ND 122p.

DESCRIPTORS - *CURRICULUM GUIDES; *HOUSING MANAGEMENT AIDES; *VOCATIONAL EDUCATION; MANAGEMENT EDUCATION; ECONOMICALLY DISADVANTAGED

ABSTRACT - Developed by the Rental Housing Association of the Greater Boston Real Estate Board, this training course includes all major categories of real estate management practice. Intended as a 2-week course, the lectures, discussion groups, and field trips are oriented toward socioeconomic and behavioral topics, particularly with regard to low income groups. Certificates are provided for persons completing the course. (BH)

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MASSACHUSETTS DEPARTMENT OF COMMUNI

DIVISION OF COMMUNITY SERVIC

OFFICE OF TRAINING

COMMUNITY DEVELOPMENT TRAINI

HOUSING MANAGEMENT TRAINING PR

Publication of This Document Approved by Alfred C. Holland, State
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MASSACHUSETTS DEPARTMENT OF COMMUNITY AFFAIRS

DIVISION OF COMMUNITY SERVICES

OFFICE OF TRAINING

COMMUNITY DEVELOPMENT TRAINING

HOUSING MANAGEMENT TRAINING PROGRAM.

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AUTHORITY

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This community development and training progra
Project No. CD-68-101.

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AUTHORITY

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ity development and training program has been designated as
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CONTENT OF COURSE

All major categories of standard real esta
cluded in the course content. Substantial emphas
and reasons for policy and modus operandi; yet,
insure inclusion of substantial practical detail
these principles.

Pertinent sociological problems prevalent
society at large are discussed clinically and ill
method in order to better understand the tenant a
socio-economic and behavioral topics.

Reference material is suggested for supple
yond that which the scope of the course permits.

7465

CONTENT OF COURSE

major categories of standard real estate management practice are in-
the course content. Substantial emphasis is programmed for the theory
s for policy and modus operandi; yet, great care has been exerted to
lusion of substantial practical detail for every-day application of
ciples.

tinent sociological problems prevalent in low income groups and our
large are discussed clinically and illustrated by the case history
order to better understand the tenant and his work. This will include
omic and behavioral topics.

erence material is suggested for supplementary study and research be-
which the scope of the course permits.

METHOD OF PRESENTATION

The course is designed so as to be most beneficial wh
week (ten-day) period. Some sessions will provide intense i
management led by experienced lecturers and managers from pu
ing. Training aids, current forms, and illustrations will b
are planned for discussion groups, further investigation of
trips, with the major emphasis centering around student part
tion.

Certificates of completion of the course will be issu
attending the full course. Tests or quizzes may be given at
the instructor to be used as a measure of progress and a tea
as a criteria for successful course completion. Such materi
seminars and workshop sessions shall be supplied by the cour

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METHOD OF PRESENTATION

urse is designed so as to be most beneficial when given over a two-
) period. Some sessions will provide intense inquiry into areas of
d by experienced lecturers and managers from public and private hous-
g aids, current forms, and illustrations will be used. Other sessions
or discussion groups, further investigation of subject matter, field
he major emphasis centering around student participation and contribu-

icates of completion of the course will be issued to those persons
full course. Tests or quizzes may be given at the discretion of
r to be used as a measure of progress and a teaching tool, but not
for successful course completion. Such materials as are needed for
workshop sessions shall be supplied by the course moderator.

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SESSION ONE: INTRODUCTIO

OBJECTIVE:

SUGG

To introduce the purpose of the course, its general format, class procedures, methods of presentations, group discussions, workshops, sensitivity training sessions and course scheduling.

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SESSION ONE: INTRODUCTION

	SUGGESTED MATERIALS:
urpose of the course,	Copy of course syllabus for each participant.
, class procedures,	
ations, group discus-	
sensitivity training	
e scheduling.	

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I. ON MANAGEMENT

Definition of management and the manager, popular and professional. Management's position as the middleman (owner-tenant). Manager's responsibility as a legal agent. "The manager works for ...

A. The owner of the property

What owner's motives are and how the manager operates to achieve them:

1. Private

2. Public

B. The community or societal purpose

1. The manager's responsibility operating as a non-profit budgetary manager. Efficiency not sacrificed.

2. Differences evident by entity ownership rather than private

a. Communication problem

NOTES

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as the
ponsibil-
s for ...

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ity

iency.

tity
vate

lem

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b. Policy change delays

c. Complaint discharge

d. Exterior considerations

i. Political

ii. Express and implied

iii. Tenant groups

iv. Tenant expectations

v. Citizens and neighbors

C. Tenant needs

1. Just wants

2. Fair play

3. Legitimate complaints

4. Good service

delays

NOTES

charge

derations

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and implied

groups

expectations

ns and neighbors

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II. THE COURSE

A. Origin of course

1. Department of Community Affairs, authorizing agent

2. Department of Housing and Urban Development, funds

3. Rental Housing Association of the Greater Boston Real Estate Board, author. and moderator

B. Instructors

1. Private - experts

2. Public - experts

3. Related subject - experts

C. Procedure

1. Times: 9:00 - 12:00 noon
   1:00 - 4:00 p.m.

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d Urban

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te Board,

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2. Format

a. Morning sessions chiefly lecture - variety of speakers

b. Afternoon sessions chiefly workshops, sensitivity training and application

3. Primary subjects to be covered

a. Tenant selection

b. Merchandising

c. Leasing

d. Moving day

e. Management policies and procedures

f. Tenant responsibility

g. Repairs and maintenance

CD-68-101

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h. Purchasing

i. Sociological aspects of low and moderate rental housing

j. Case history illustration

III. PUBLIC AND LOW INCOME HOUSING

A. Definition

1. Public housing

2. FHA 221(d)(3)

3. Housing for the elderly

4. Nursing homes

sing

NOTES

ogical aspects of
d moderate rental
g

istory illustration

NG

g

he elderly

IV. RESPONSIBILITIES TO OWNER AND TENANT

A. Over-all responsibility of carrying out the policy and wishes of owner, public or private

1. Profit motive

2. Budget considerations

3. Maintaining stability and durability

B. Responsibility to the tenant

1. Providing service

2. Protecting rights

a. Privacy

b. Quiet enjoyment

c. Articulation

d. Individual dignity

ND TENANT

NOTES

ity of carrying
ishes of owner,

erations

tability and durability

tenant

vice

ghts

njoyment

ation

ual dignity

C. The manager considers himself

1. Professionalism

2. Advancement

3. Increased responsibility and authority

4. Service of mankind

5. Challenging vocation

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NOTES

lity and

SESSION TWO: TENANT SELECTION

OBJECTIVE:	SUGGESTED
To explore the factors involved in proper tenant selection, ranging from initial inquiry to tenant placement or apartment unit assignment, keeping in mind that it is the tenant who is the sole reason for the existence of the housing at all, and the influences, direct and indirect, which will affect the nature and character of that tenancy.	Renta Bosto Discr Fair

SESSION TWO: TENANT SELECTION

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from initial in-
or apartment unit
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, which will
acter of that

SUGGESTED MATERIALS:

Rental Housing Association Application Form

Boston Housing Authority Application Form

Discrimination Act of 1868

Fair Housing Act of 1965

I. PROSPECTIVE TENANTS AND INQUIRIES

A. Determine type of tenant desired
(Idealize, then compromise)

1. Income description - set minimum acceptable, if applicable

2. Family size

3. Rental habits - pays on time

a. Importance

b. Value as indicator of attitude

4. Prior tenancy record

a. What information available

b. How to evaluate and sift fact

c. Questions to ask prior landlord

d. Care of premises

e. Term of tenancy, stability pattern

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on - set minimum accept-
ble

pays on time

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indicator of attitude

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rmation available

aluate and sift fact

to ask pricr landlord

remises

enancy, stability pattern

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B. Determine what it is you will be acquiring tenants for

1. Know your apartments

a. Room count and style

b. Amenities of tenancy

c. Location

2. Know your apartment relativity

a. How do you compare

i. Rent

ii. Amenities

iii. Location

ll be acquiring ten-

NOTES

d style

tenancy

relativity

mpare

les

on

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C. Determine information you will ask prospective tenant in order to satisfy your purposes

1. Strategy of question-asking

a. Make at ease

b. Indirect questions that do not give but indicate information indirectly

c. Direct questions

d. Provide adequate time - no rush

D. Plan strategy of which information is necessary to you at each stage of tenant interest

1. Initial inquiry

2. Formal application

3. Secondary investigation

4. Moving plans

nformation you will ask prospective
order to satisfy your purposes

NOTES

ategy of question-asking

a. Make at ease

b. Indirect questions that do not give but indicate information indirectly

c. Direct questions

d. Provide adequate time - no rush

gy of which information is necessary
ach stage of tenant interest

ial inquiry

al application

ndary investigation

ng plans

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E. The interview

1. Be professional

a. Be organized

b. Take charge

c. Execute your plan

d. Close promptly and conclusively

F. The records

1. Record facts, date, name, statistics

2. Record commitments made by you

3. Make notes, recommendations, impressions part of permanent record

4. Distribute duplicate records as your procedure requires

5. File - quick access system for you and your associates

NOTES

n

nd conclusively

e, statistics

by you

ons, impressions

ords as your

em for you and

G. Leave applicant with next step

II. THE APPLICATION FORM

Example: Rental Housing Association and Boston Housing Authority forms

A. Purpose of the application form

1. Information

2. Determine firm interest by applicant

3. Applicant often committed upon signing (see RHA application above signature)

4. Future uses by management

a. Determine whereabouts

b. Next of kin

c. Legal proceedings, attachments

d. Secondary investigation

h next step

NOTES

ssociation and Boston
y forms

ication form

rm interest by applicant

ten committed upon signing
lication above signature)

by management

mine whereabouts

of kin

proceedings, attachments

dary investigation

B. Completion instructions

1. Explain reasons for application

2. Show physically areas to be completed

3. Allow ample time

4. Review before terminating interview

C. Review application forms inserted in this lesson plan

III. ELIBIGILITY, INCOME

A. Verification

1. Income

2. Employment

3. Family size

4. Prior tenancy

5. Reason for prior tenancy termination

s NOTES

for application

areas to be completed

e

erminating interview

s inserted in this

r tenancy termination

B. Acceptability

1. Are our standards met

2. Is timing compatible for move-in/ move-out

IV. INVESTIGATION

A. Financial institutions - generally by mail

B. Credit agencies

1. Independent - review credentials of several

2. Rental housing associations

3. Prior landlord

C. Charge accounts

D. Credit references offered on application

NOTES

et

e for move-in/

enerally by mail

w credentials of

ciations

on application

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V. COMPATABILITY

A. Character of prospective tenant

1. Age

2. Family composition

3. Pets

4. Modus operandi

B. Placement of tenant types for compatability, if possible

1. Quiet enjoyment

2. Complementary neighbors

3. Tenant preferences

4. Preference of existing tenants

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tenant

for compatability,

hbors

ting tenants

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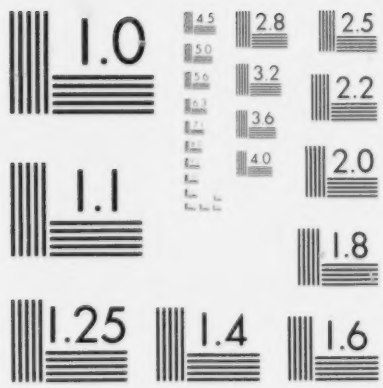

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

VI. DISCRIMINATION

A. Discrimination Act of 1868

B. Fair Housing Act of 1965

NOTES

Act of 1868

t of 1965

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SESSION THREE: MERCHANDISING AND SHOWING AP

OBJECTIVE:

To instruct a manager in the correct procedures of advertising, showing and renting apartments in the best and most professional manner possible.

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SESSION THREE: MERCHANDISING AND SHOWING APARTMENTS

SUGGESTED MATERIALS:

correct procedures

enting apartments

onal manner possible.

Assorted newspaper ads illustrating good and bad ads

A checklist for manager's use to personally inspect apartment before showing to first prospect

A checklist form for manager's use to explain rules and procedures covering moving day, trash collections, parking areas, snow removal, etc.

7506

505

I. PRICING THE APARTMENTS

A. Government Control

1. Income limits

B. Physical variations

C. Features

D. Advantages

1. List and evaluate for showing and presentation

E. Disadvantages

1. List and evaluate for showing and presentation

2. Explain clearly

3. "Tell the Truth" attractively

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NOTES

for showing and pre-

for showing and pre-

attractively

7508

F. Return on investment

1. The profit motive

2. The budget motive

3. The break-even motive

G. Competition

II. PROSPECTS

A. Private

1. Waiting lists

2. Neighborhood canvass

3. Church and civic groups

a. Soliciting cooperation

b. Presentations to

NOTES

s

eration

o

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4. Moving and storage companies

5. Institutions

6. Industrial companies

B. Public

1. Neighborhood community action (anti-poverty) agency offices and personnel

2. Present tenants

3. Health, social and welfare agencies

4. Public agencies displacing people (re-development authorities, condemnation)

5. Elected public officials

rage companies

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panies

mmunity action (anti-
offices and personnel

and welfare agencies

displacing people (re-
horities, condemnation)

officials

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III. ADVERTISING SOURCES
(Pertinent to private housing)

A. Newspapers

1. Local

2. Regional

3. Which paper to use

a. Determinants

b. Circulation

4. Special rates

a. Bulk

b. Format

5. Quality

a. Ad character

b. Format

NOTES

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to use

minants

lation

s

t

aracter

at

13

6. Quantity

   a. Size

   b. Content

7. White space

   a. "The sizzle to attract the steak-eater"

8. Display ads

   a. Mass attack

   b. Image building

9. Features

   a. Major subjects

   b. Minor subjects

NOTES

to attract the

ing

cts

cts

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10. Points of interest

    a. Aims at special interest buyers

11. Community interest or human interest news stories

12. Carelessness

    a. Sloppy arrangement

    b. Read proofs carefully

    c. Is all important information included

13. Records

14. Results

    a. Evaluate response

    b. Determine corrective improvement

NOTES

al interest buyers

r human interest

ement

arefully

ant information

onse

rrective improvement

B. Signs - on property

C. Billboards

1. Public

2. Private

D. Magazines

1. Local

2. Trade

E. Radio and television - when applicable

F. Bulletin boards

G. Direct mail

NOTES

en applicable

7520

H. Word-of-mouth

I. Brochures, floor plans, etc.

1. Include all information, including room size

IV. UNDERSTANDING PEOPLE

A. What people will do

1. Predict tenant reaction

2. Prepare response

B. What people will not do

1. Don't suggest trouble topics (Example: neighbors)

C. Motivation

1. Supply reasons why apartment is appealing to applicant

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:c.

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ble topics
rs)

apartment is
icant

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NOTES

s of disadvantages
s-greater privacy,

sms

vantages for

es of apartment

cant

ciation of

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I. Impressions

1. From guide - make tour narrative flexible to applicant's interests

2. From applicant - solicit comments and dissatisfaction

a. Reply, respond, explain, agree, whichever is called for

V. TELEPHONE TECHNIQUES

A. Smile

1. Prepare your attitude

2. Project enthusiasm

B. Making the call

1. Plan format

2. Follow format

NOTES

tour narrative
ant's interests

olicit comments
n

ond, explain,
never is called

ude

C. Receiving the call

1. Politeness

a. For pleasant response

b. For unpleasant response

2. Interruptions

a. To telephone for further contact

b. Directions to showing apartment

3. Noise levels

a. Background interference

b. Voice tone

NOTES

ponse

esponse

further

owing

ference

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VI. SELLING PROCESS

A. Enthusiasm

B. Aggressiveness

C. Overstatement of facts - never

D. Courtesy - always

E. Psychology

NOTES

never

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VII. INSPECTING AND SHOWING THE APARTMENT

A. Checklist

1. Cover all physical features

B. Condition

1. Determine

2. Plan necessary renovation

3. Note necessary repairs

C. Cleanliness

1. Schedule cleaning prior to showing

2. Remove trash and debris

3. Dust

ENT

NOTES

features

ovation

airs

prior to showing

ebris

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D. Lighting

1. In good repair

2. Available for after-dark showing

E. Furnishings

1. Remove

2. Repair

3. Replace if necessary

F. Dimensions

1. Physical measurements

a. For tenant's planning

b. For scheduled repairs and renovations

NOTES

rk showing

anning

epairs and

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VIII. CLOSING METHODS

A. Accent the positive

B. Talking too much - the art of listening

C. Ask for signatures

D. Forgotten item technique

IX. FAILURES

A. Lack of property knowledge - poor preparation

B. Lack of customer knowledge - bad initial qualifications and interview

C. Overstating - misrepresentation

NOTES

tening

preparation

initial quali-

336

D. Under-rating

1. Demeaning

2. Pointing out weaknesses in apartment

E. Rushing

1. Give customer breathing time

F. Accepting dismissal without a fight

1. The gracious exit

G. Rudeness

H. Ignorance of problem

NOTES

knesses in apartment

eathing time

hout a fight

t

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SESSION FOUR: LEASING

OBJECTIVE:

To explain the basic concepts of the leasing agreement to property managers and prospective property managers in order that they may better understand the landlord/tenant relationship and the rights and obligations thereto, and thus make the real estate property manager better equipped to carry out his management functions. Responsibilities are assumed by all parties to the lease contract. It is the purpose of these individual obligations and their interdependent relationship that we will observe.

SUGGESTED MAT

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SESSION FOUR: LEASING

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nagers and pros-
order that they
ndlord/tenant
and obligations
eal estate prop-
to carry out his
nsibilities are
e lease contract.
ndividual obliga-
nt relationship

SUGGESTED MATERIALS:

Rental Housing Association Lease Form

Boston Housing Authority Lease Form

I. THE LEASE: WHAT IS IT?

A. Estate in land

B. Possessory interest as distinguished from license

1. Mere license to use space is not lease. Example: laundry area or concessions

2. Contractual - lease or tenancy can't arise from trespass

3. Lodging houses - common law, occupants, licensees

a. Statute: G. L. Chap. 186, sec. 17. Three consecutive months are tenants-at-will

C. Consideration - money or kind

1. Leasing agreement must have consideration, usually rent

NOTES

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laundry area or

se or tenancy can't
ss

common law, occu-

G. L. Chap. 186, sec.
e consecutive months
s-at-will

kind

must have consider-
nt

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D. Distinguished from tenancy-at-will

1. Writing

2. Termination

a. For breach

b. Mutual - surrender and acceptance

E. Contract - contains covenants and agreements

1. Independent covenants

2. Dependent covenants

F. Term of lease

1. Automatic renewals

2. Notice

r and

nd agreements

G. Parties to lease

1. Who may be landlord - agents

2. Minors

3. Guarantors and sureties

4. Discrimination as to race, creed, etc.

II. ILLEGAL PROVISIONS AND PROHIBITED USES

A. Covenants prohibiting children
(G. L. Chap. 186, sec. 16)

B. Exoneration of landlord from negligence
(G. L. Chap. 186, sec. 15)

C. Illegal gaming, sale of alcoholic beverages, prostitution

1. Creates legal nuisance
(G. L. Chap. 139)

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gents

ce, creed, etc.

egligence

lic beverages,

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2. Landlord may elect to terminate lease

3. Duty of landlord to evict or be guilty himself

D. Provisions waiving tenant's rights under municipal or state codes - not void per se, but may be if specified in ordinance

III. LANDLORD'S OBLIGATIONS

A. Covenant of quiet enjoyment

B. Maintenance and repairs

1. Sanitary code and municipal codes

a. Conflict with lease

b. Financial responsibility by contract

2. Gratuitous repairs

3. Common areas

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NOTES

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t or be

ghts under
void per
ordinance

icipal codes

lease

onsibility

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C. Services as part of rental

1. Heat, light, elevator, etc. - anything not specifically agreed but area custom

a. See also G. L. Chap. 186, sec. 14, re willful failure by landlord to supply foregoing items. Criminal penalty.

b. Cannot shut off light, heat, etc., if tenant fails to pay rent

IV. TENANT'S OBLIGATIONS

A. Use premises in tenant-like manner

1. For lawful purposes only

2. Generally purpose specified to exclusion of other purposes

B. Not to commit waste

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r, etc. - anything
eed but area custom

. Chap. 186, sec.
l failure by land-
y foregoing items.
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ff light, heat,
nt fails to pay

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cified to
rposes

C. Cleanliness

1. Waste and rubbish disposal

2. Insects

D. Rent payments

1. Late charges and penalties (G. L. Chap. 186, sec. 15B)

2. When rent is payable - end of month, absent contract

3. Landlord has no lien for rent except innkeeper, hotel or lodging house manager

E. Abide by safety and other rules for the building promulgated from time to time

F. Pets

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of

nt ex-
dging

r the
time

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G. Allow access to landlord to inspect, make repairs

1. Absent provision in lease; landlord has no right to enter during term (now see G. L. Chap. 186, sec. 15B)

2. State sanitary code provides tenant must give landlord access to correct violations

H. Occupancy - limited to named lessees only

1. Number of occupants may be limited by local zoning

I. Yield-up at expiration of term

1. Very important. Hold-over tenants liable for all loss caused by holding over.

spect,

NOTES

se; landlord
uring term
6, sec. 15B)

vides tenant
ss to correct

essees only

be limited

ver tenants
sed by hold-

V. ASSIGNMENT AND SUB-LETTING

A. O.K. unless prohibited by lease covenants

B. Status of tenant and sub-tenant

1. Both liable for rent. Covenant to pay rent runs with the land

2. Other covenants in lease are personal and sub-tenant not bound unless he specifically assumed all tenant's obligations in the lease

C. Liability of landlord

1. Liable to tenant for breach of lease

NOTES

y lease covenants

-tenant

ent. Covenant
with the land

n lease are per-
ant not bound
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for breach of

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VI. SECURITY DEPOSITS

A. Security for performance of obligations of lease

1. Not prepaid rent

2. Amount of deposit

B. Refunding - no interest possible

1. No other rent owed

2. Prompt inspection for damages

3. Tenant has vacated - where to send check

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C. Keep tenant advised

1. Let tenant know before he moves that you intend to refund promptly if all is okay - tenant will be more cooperative

2. Return of keys

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VII. REMEDIES OF LANDLORD

A. Suit for breach

1. Landlord can sue each month as payments are due

B. Eviction

1. On breach of covenants, landlord can give proper notice as provided in lease to terminate lease. Can then follow up with court action to get order evicting tenant

a. In Massachusetts, landlord cannot enter premises for this purpose or lock out the tenant without court order (G. L. Chap. 186, sec. 15B)

b. Proper notice to terminate

i. State reason or reasons

ii. Indicate clearly the effective termination date

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iii. Serve it, in hand, to tenant or adult family member; or by certified mail; constable or sheriff, best method.

2. On termination, right to sue for balance of rent under lease is lost. Some tenants invite termination for this reason

a. Indemnity provision of lease. Tenant responsibility for all damages to end of term or til premises re-let, whichever occurs first

3. Caution! Accepting rent after giving eviction notice may waive the notice. If rent accepted, immediately reserve all rights by written letter.

VIII. REMEDIES OF TENANT

A. Rent deductions - no

1. Covenant to pay rent is independent. No right to offset rent for inconveniences, etc.

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B. Statutory rent withholding
(G. L. Chap. 239, sec. 8A)

1. Violations of sanitary code

2. Tenant gives notice of intent to withhold

3. Notice from public authority as to violation may be deemed to be notice from tenant (Chap. 355, Acts 1969)

C. Rent receivership
(G. L. Chap. 111, sec. 127A-K)

1. Tenants affected can petition court to appoint receiver to collect rents and run building. Pay rents into court. Landlord restrained from evicting, etc.

D. Stay of judgment

1. Where tenancy is terminated without fault of tenant, court may grant discretionary stay for hardship. In Massachusetts, presently the courts may give up to six months.

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E. "Constructive Eviction"

1. Dangerous for tenant, difficult to prove. Usually adjudicated only in cases of no heat for several days during winter. Must have serious deprivation by landlord of the use and enjoyment of premises.

2. Tenant must move out of premises

IX. RETALIATIONS

A. Prohibited in Massachusetts (G. L. Chap. 186, sec. 18)

B. Civil damage suit for three months' rent

C. No eviction if retaliatory

D. Under Massachusetts statute, if tenant has made complaint to health authority within six months of notice to quit, presumption of retaliation

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E. Absent statutes, only District of Columbia (lower court) has held retaliations to be illegal and against public policy (Edwards vs. Habib, 397 F.2 687, 1968)

X. EXECUTION OF LEASE

A. Representative capacity

1. Agent should designate he is agent for landlord. Otherwise might not bind landlord and may be personally liable.

B. Authority of agent

1. Varies - but agent should not make promises not contained in lease, which he has no authority to make

C. Signature of tenants

1. Best to have all tenants signing be present at same time

2. Landlord or agent should see them sign if possible

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public policy (Edwards
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3. Suspected minor - check identification if you have doubts

4. Guarantor's signature. Have him present

5. Initial changes in printed forms

D. Occupancy

1. Until leases are complete with all signatures, and you are satisfied as to genuineness, do not allow tenant to occupy premises

E. Alterations

1. Do not add or detract from lease after tenants sign

F. Delivery

1. Give tenant a signed copy of lease as soon as possible. Without delivery, a lease may not be effective and you may have only a tenant at will.

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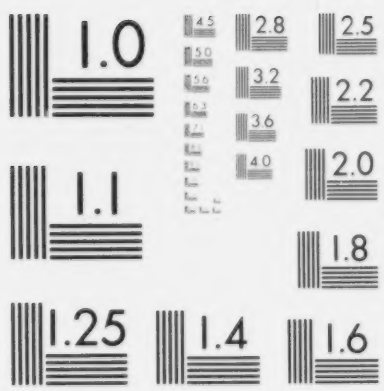

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SESSION FIVE: MOVING DAY

OBJECTIVE:

To illustrate the importance of proper scheduling and orientation of the new tenant on his moving day.

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SESSION FIVE: MOVING DAY

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SUGGESTED MATERIALS:

Letter to tenant - scheduling move-in date

Tenant form - receipt for keys, lease, etc.

Tenant form - "Welcome" letter

Tenant form - General information sheet

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I. SCHEDULE MOVE-INS

Make definite appointments so as not to congest elevator.

II. CLEAN APARTMENT

Make sure apartment is ready, clean, for scheduled move-in day.

III. PRE-MOVE-IN CHECK

The manager should personally inspect the apartment to insure it is ready.

IV. KEY CONTROL

Do not release keys to the apartment until you are ready to have the family take occupancy of the apartment. (Once you release keys, you release the apartment.)

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V. RECEIPT OF KEYS

Make sure you receive receipt for keys given to tenant. Also make sure you give keys to person who signed lease or authorized representative.

VI. INSPECTION OF APARTMENT WITH NEW TENANT

When keys are released, manager should escort tenant to new apartment as a form of welcome. Manager should note, in presence of tenant, any shortcomings in the apartment and make note of the items. (This precludes later claims by tenant that paint was bad, mirror missing, etc.)

Manager should also stress correct way to lock apartment (double bolt at all times) for security reasons.

Manager should give tenant "welcome" letter and "Information Sheet."

VII. TENANT VISIT

Manager should drop in to the apartment first evening, if possible, or soon thereafter, to see if everything is all right. Invaluable for showing the manager "cares" and tenant is appreciative of attention.

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SESSION SIX: MANAGEMENT RESPO

OBJECTIVE: SU

To illustrate and discuss the administrative responsibilities assumed by management as a result of its exercise of authority. Some of these are express, some implied, some direct, and some indirect. By opinion and expectation, tenants often impute leadership roles to management. The purpose of this session is to define some of these responsibilities and to evaluate them.

SESSION SIX: MANAGEMENT RESPONSIBILITIES

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SUGGESTED MATERIALS:

Zoning codes

Municipal ordinances

Building, wiring, plumbing codes

Board of Health directives

Tenant council by-laws

Tenant action case histories

I. TENANT RELATIONS

A. Causes of bad relationship

1. Misunderstanding

2. Poor fielding of complaints

3. Overlooking tenant rights

4. Maintenance policies

5. Etc.

B. Basis of good relationships

1. Review of policy

a. House rules

b. Rent collection

c. Maintenance

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d. Complaint procedure

e. Service requests

f. Etc.

C. Promoting respect

1. Initiate improvement programs

a. Care of premises

b. Encourage community activity and participation

c. Push "pride of occupancy"

2. Solicit tenant opinion

a. Be seen

b. Inspect and consult

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3. Encourage positive attitudes among

a. Staff

b. Work force

c. Tenant leaders

C. Roles of the manager imputed by tenant expectations

1. Judge and jury

2. Arbitrator

3. Welfare consultant

4. Political representative

5. Scapegoat

6. Law and order

sitive attitudes among

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II. TENANT COUNCILS

A. Organization and description

1. Purposes

2. Creation

3. Operating procedures

4. Action demands

5. Participants

B. Trends

1. Group representation

2. Collective bargaining

3. Rent strikers

4. Publicity pressure

5. Political pressure

6. Professional leadership and counsel

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C. Avoid, appease, or work with tenant groups?

1. The cooperative approach by management

2. The supportive approach by management

3. The non-cooperative approach by management

4. What to do as the storm approaches

III. NEIGHBORHOOD RELATIONS

A. Keep informed on neighborhood activities and trends

B. Play your part in the common effort of community living and approach

1. Trash

2. Snow

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3. Landscaping

4. Parking

5. Lighting

C. Set the pace for mutual benefit

1. Best-effort maintenance

2. Appearance - compatability

3. Conforming usage - code

D. Neighborhood improvement associations

1. Participation by management

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C. Building, repairs and maintenance

1. Familiarize yourself

2. Insist on licensed tradesmen

3. Bonded performance

4. Inspections

5. Implications of negligence

D. Lines of communication: purpose and use

1. Fire department

2. Police department

3. Public health department

4. Building department

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V. UPDATING MANAGEMENT TOOLS

A. Determine your scope of effectiveness

B. Determine weak points of operation

C. Isolate inefficiencies

D. Define corrective measures

E. Education of staff

1. Real estate boards

a. Contacts in industry

b. Research source

c. Bulletins, instructional materials

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2. Institute of Real Estate Management

   a. National information exchange

   b. Mark of professionalism

   c. Journals

   d. Experience exchange reports

3. Seminars, workshops and study groups

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ence exchange reports

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SESSION SEVEN: HOW TO ACHIEVE TENANT COOPER

OBJECTIVE:

To examine the relationship between the manager and residents. The subjects that the relationship and communication are about are those covered in other sections of the project.

A resident must be aware of the responsibilities assumed when he is part of a housing-group society. He must pay rent, get ride of trash, clean his home, respect the neighbors.

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EVEN: HOW TO ACHIEVE TENANT COOPERATION

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In order that such routines are understood, and, in order to avoid misunderstanding, the rules and procedures of a building must be clearly communicated and clearly understood <u>by both manager and resident</u>.

This session concerns itself with how the manager and tenant can achieve maximum cooperation.

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I. COMMUNICATIONS

A. Definition

B. Explanation

1. Two-way process

2. Clarity

3. Acquaintance of parties

C. Attitude

1. Receptive atmosphere

2. Availability of manager and agents

3. Procedures for emergencies and routine matters

4. Cordiality vs. "buddy system"

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D. Standard Communications

1. Written - posted

2. Notice of investigations - before and after

3. Routine policy communications by subordinates

E. Listening

1. Places to listen - privacy

2. Patience (often best solution to problem)

3. Be concerned

4. Sift facts, evaluate problem

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F. Talking

1. Dictatorship vs. management

2. Review facts before speaking

3. Firmness, aggression, domination

4. Patience, clarity, judgment

G. Written communications with tenants

1. Notices

a. Not used for trivia

b. Purpose clear and brief

c. Timely delivery

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sion, domination

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2. Distribution

a. Generally to all concerned simultaneously

b. Policy changes to all persons affected

c. Insure delivery established

H. Communications with management organization

1. Establish and promulgate lines of authority

2. Job descriptions: hours, wages, duties, prohibitions, use of manual

3. Work order slip system

4. Work review and comment

5. Encouragement, praise, correction

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I. Knowledge a tool of communication

1. Keeping informed

2. Anticipating encounters

II. HOUSE RULES

A. Composition

1. Format

2. Language

B. Subject matter

1. General application

2. Sanitary instructions

3. Emergencies

4. Where to get information

5. Description of ownership

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III. RENT COLLECTION

A. General rent procedure

1. When told to tenant

2. How to pay

3. Penalties for non-payment

4. Where to pay

B. Billing system

1. Purpose of billing

2. Duplicates and receipts

3. Partial systems - reminder billings

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C. Cash payments

1. Handling of cash

2. Receipts - importance

3. Security

4. Depositing procedures

5. Partial payments

6. Check cashing

D. Slow payments

1. Reminders - 5-10 days

2. Firm requests, eviction suggestions

3. Polite insistence

4. Fourteen-day notice

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E. Collection leniency

1. Subsistence, welfare checks

2. Illness, calamity

3. Late-payer vs. deadbeat

4. Hazards of arrearage

IV. TENANT REQUESTS

A. Availability of management

1. Emergencies

2. Routine

B. Complaint vs. requests

C. Promises with flexibility

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D. Fair and equal attention to all tenants

E. Follow through on repairs

F. Memos for tenant and maintenance records

V. DISTURBANCES

A. Evaluating complaints

1. Source evaluation

2. Substance evaluation

B. Type of disturbance

1. Noise

2. Physical damage

3. Water

4. Fire

11 tenants

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C. Response

1. Investigation

2. Police department

3. Fire department

4. Notification to other tenants

5. Evacuation

D. Records

1. For repeated disturbance

2. For tenant evaluation

a. Are repeated complaints justified

b. Nuisance tenants

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c. Over-reacting from other tenants

d. Anticipating trouble agitators

VI. INSPECTIONS AND DAMAGES

A. Regular inspections

1. Preventive maintenance

2. Checking tenant use and damage

3. Public relations and management image

B. Observing normal wear and tear

Paint shades, woodwork, floors, refrigerators, stove, door handles, etc.

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C. Determining damage

1. Holes in walls, excessive dirt, and grime, cracked or broken windows, nails, paint, unreported damage to equipment

D. Resident response to inspection

1. Refusal to admit - how to handle

2. Denial of cause or knowledge of damage

3. Re-affirm damage reporting procedure

4. Referral to initial apartment inspection for determination of damage

E. Assessing tenant for damage

1. Deduction from security deposit

2. Estimates

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3. Standard charges or actual

4. Official notice and explanation - written

5. Billing damages and rent to create arrearage threat

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SESSION EIGHT: OPERATING A MANAGEMENT OFFICE

OBJECTIVE:

To examine the internal functioning of the management office and its operation.

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IGHT: OPERATING A MANAGEMENT OFFICE

SUGGESTED MATERIALS:

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Record forms

Statement forms

Reporting forms

Work orders

Employment questionnaires

Employee records

Cost analysis sheets

Cross reference file

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I. SELECTING A SITE

A. Convenience to tenants

B. Prominent visibility for strangers

C. Close to service areas

D. Space requirements

1. Size of staff

2. Anticipated traffic volume

E. Decor

1. Make attractive but not gaudy

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II. PERSONNEL

A. General manager - last word - responsible

B. Receptionist - telephone operator

1. Most contact with outside - image builders

C. Bookkeeper

1. Need for detail extreme

D. Hours

1. Regular

2. Evenings/Saturdays

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III. EQUIPMENT

A. Basic office equipment
Desks, typewriter, files, adding machine

B. Phones, inventory

C. Reception/waiting room

IV. STAFFING

A. Sources

1. Parent organization

2. Employment agency

3. Direct advertising

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B. Procedures

1. Who hires whom

2. Test and performance ratings

3. Applications and investigations

C. Duties

1. Job descriptions

2. Chain of command

3. Collateral responsibilities

V. RECORDS - multi-facet business

A. Variety of functions

1. Public relations

2. Collection agency

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ratings

estigations

bilities

3. Rental agency

4. Construction company

5. Cleaning and maintenance company

B. Accurate records must be kept

C. Constant updating required

1. Relative to apartment unit

Listing - size - location - equipment - history of repairs - replacement and servicing - rental charges included with rent - services available for extra charges - condition of rental unit - reference of similarity with other units of size and location

2. Relative to tenant

History of credit - compatability with neighbors - housekeeping abilities in previous rental situations - present occupancy history - present credit standing - size of family - parking on location - number, type of complaints made - frequency of delinquencies - methods of communications used to reach tenant - copies of all communications sent and received

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3. Relative to the project

a. Land cost

i. Purchase of land

ii. Title insurance

iii. Preparation for construction

b. Building cost

i. Cost of completed structures - material, labor, architect, fees, etc.

ii. Cost of construction loans, commissions, etc.

iii. Carrying cost of land and building up to time of completing IC. R. E. taxes, insurance, assessments, advertising, mortgage payments to completion, etc.

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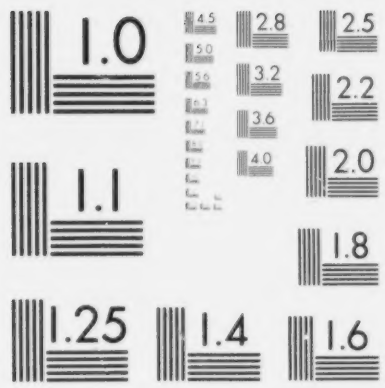

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

c. Furniture costs

i. Lobby

ii. Office

iii. Apartments

VI. METHODS OF KEEPING RECORDS (ACCOUNTING)

A. Apartment unit income

1. Ledger - maintain separate account for each apartment unit

2. Keep record within ledger of all costs which are chargeable to each apartment

3. Record rental due and date due - length of lease and date of termination

4. Record any and all notices, special billings made, dates of payments and manner in which claims were satisfied

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5. Record date units became vacant

6. Record previous tenant's name continuity

B. Filing system set up in apartment number sequence

1. Keep copies and all references to tenants in file

2. When new tenant takes over, separate section of apartment file should be set up to contain all information relative to that particular file

3. Keep report on condition of apartment prior to tenancy

4. Keep copy of lease

5. Sign-out sheet for file removal

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C. Index by alphabetical sequence of tenant - reference to apartment unit occupied

1. If more than one occupant with different name, a separate file reference should be made

D. Time of expiration of lease

1. File should be maintained to enable timely notices for re-write. Should contain name, apartment number and basic lease information, and if filed by date, the later expiration following the earlier.

E. Rental Receipts

1. Record and deposit as soon as possible

2. Amount of deposit is total receipts or income for month

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F. Total building expenditures

1. Accuracy of bills must be verified

2. Charge to correct type of expense

3. Use numerical code to simplify and speed record-keeping

4. Always try to pay bills to benefit from discounts

VII. MONTHLY SUMMARY

A. Need to assemble information for over-all look at operation

B. Income summary contains

1. Losses due to vacancies

2. Amounts collected for security deposits

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3. Payments made for other than rent

4. Payments made in advance

5. List of tenants unpaid at end of month (arrears)

6. Statement of petty cash

7. Statement of bank deposits

8. Statement of vacancies - to rate loss

   a. Number of vacancies at beginning of period

   b. Number of vacancies at end of period

   c. Number of new tenants during month

   d. New vacancies during month

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Number of vacancies at
beginning of period

Number of vacancies at
end of period

Number of new tenants
during month

New vacancies during
month

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e. Total rental days of all units during month (No. days of month x no. units)

f. Total rental days vacant during month

g. % of vacancies during month (f. divided by e.)

C. Expense summary contains

1. Check number
2. Date paid
3. Vendor
4. Account charged
5. Amount billed
6. Amount discount
7. Net paid
8. Total all expenses

days of all
month (No. days
. units)

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es during month
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D. Operation statement

1. Monthly, quarterly, annual

2. Summary of income statement and expense summary

3. Shows profit or loss of operation

4. Enables management to budget and control operations

VIII. COMPUTER OPERATIONS

A. Need must be determined

1. Speed

2. Cross analysis

3. Billing

4. Payroll

5. Statements

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B. Sources

1. Computer manufacturers

2. System analysts

3. Management consulting firms

4. Public accountants

C. Cost - relative to use and savings

1. Ownership

2. Rental

3. Time share

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SESSION NINE: REPAIRS, MAINTENANCE, PURCH

OBJECTIVE:

General preservation of the bricks, mortar and boards of real estate is an area where responsible management must give continuing attention. Tenant needs, property values and neighborhood considerations dictate such. This session will present categories of repairs and maintenance, review materials and supplies and explore budgeting, scheduling and purchasing.

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SSION NINE: REPAIRS, MAINTENANCE, PURCHASING

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SUGGESTED MATERIALS:

Maintenance forms

Inspection reports

Purchasing records and forms

Check lists

Specificiation and instruction sheets

Repair orders

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I. HOUSEKEEPING, JANITORIAL

A. Work force types

1. Live-in janitor

2. Regular maintenance staff

3. Contract

B. Choosing type of work force

1. Policy of owners toward cleaning

2. Contracting

a. Determine reliability

b. Written contract

c. Work clearly specified

d. Continual check-up

e. Liability and bonding

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Communicative Skills, Grade Ten.

Little Rock Public Schools, Ark.
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PUB DATE - ND 146p.

DESCRIPTORS - *VOCATIONAL EDUCATION; VOCATIONAL HIGH SCHOOLS; *RELEVANCE (EDUCATION); *COMMUNICATION SKILLS; *TEACHING GUIDES; STUDENT NEEDS; *ASSIGNMENTS; READING INSTRUCTION; SENTENCES; CAREER PLANNING; STUDENT ATTITUDES

ABSTRACT - This document includes both a teacher's manual and student exercises for a course in communications skills and was prepared to help the vocational student develop skills necessary for effective communications in the world of work. These materials have been tested in a tenth grade class and revised accordingly. The teacher's guide includes sections on (1) Becoming a Good Student, (2) Loosing Toward a Career, (3) Reading Newspapers, (4) Improvement of Reading, (5) Dialects, and (6) Kernel Sentences. Student assignments which correspond to these sections are included. (JS)

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COMMUNICATIVE SKILLS

GRADE TEN

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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LITTLE ROCK PUBLIC SCHOOLS

Little Rock, Arkansas

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COMMUNICATIVE SKILLS

GRADE TEN

INSTRUCTIONAL PACKETS DESIGNED TO IMPROVE
THE COMMUNICATIVE SKILLS OF TENTH GRADE STUDENTS
IN VOCATIONAL-TECHNICAL SCHOOLS

PACKET NO. ONE

ORIENTATION

PACKET NO. TWO

READING

PACKET NO. THREE

LANGUAGE

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FOREWORD

The Little Rock Public School System is pleased to make available a course of study in Communicative Skills - Grade Ten. The book consists of Student Exercises and a Teacher's Manual written by Mrs. Lela Willis, project director. Mrs. Willis worked under the general direction of Mr. John Fortenberry, assistant superintendent for instruction; Mrs. Josephine Feiock, supervisor of English; and Mr. Ernest L. Rush, director of industrial and vocational education.

Mr. Rush's concern for the vocational student who drops out of high school because he does not pass academic subjects caused him to seek answers. Mrs. Ruth Steele, an English teacher at Metropolitan High School, had experimented with ideas for lessons to make English relevant to her students' interests and needs. A Small Research Project Grant was received in 1968 and work on an innovative program in communicative skills was begun. Mrs. Willis was chosen as project director because of her interest in discovering methods that would reach terminal students. The lessons and teaching guide were used on an experimental basis by Mrs. Steele, the participating teacher, in her tenth grade classes. The lessons were revised and Mrs. Steele's tests and units that came from student suggestions are included in this book.

We feel that this project has been a step toward providing English materials relevant to the interests of vocational students who must be able to communicate effectively in a work world upon graduating from high school. The needs of a special group of students--those not college bound--are being met.

Floyd W. Parsons

Floyd W. Parsons
Superintendent of Schools

PREFACE

The lessons in this book have been a step toward providing English materials relevant to the interests of vocational students who must be able to communicate effectively in a work world upon graduation from high school. The materials have been designed to fit into a sequential plan with grades eleven and twelve but also may be used as an entity.

The lessons have a built-in inductive approach which provides for extensive student participation in the formation of concepts and ideas. It should be emphasized that although the lessons are carefully structured, Communicative Skills is not designed to teach itself. It is not a workbook. The teacher must play an active role in stimulating and guiding class discussion. The teaching manual should be studied in connection with the matching student exercises. The teacher should be alert to student comments when thought questions are discussed.

The communicative skills are reading, writing, listening, speaking, thinking, and social (getting along with others). A hidden value is the development of positive attitudes toward working and studying. Well-prepared and creative teachers can adapt the materials to fit the special needs of their students.

John Fortenberry
John Fortenberry
Assistant Superintendent - Instruction

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OVERVIEW

SCOPE

Becoming acquainted with high school environments, especially Metropolitan High School

Reviewing study skills

Getting along with others

Finding individual weaknesses in using language skills - reading, writing, speaking, listening, and thinking

Giving students opportunities to talk about themselves and to learn about others

OBJECTIVES

To provide group and individual activities through which the students develop a relaxed attitude towards fitting into the high school program

To maintain a relaxing atmosphere conducive to enjoyable learning and teaching

To practice techniques for studying

To help the student to grow in his attitudes toward learning

To help the student to gain an understanding of himself

To help the student look towards an occupation for himself

To help the student develop enjoyment and competence in reading

EXPECTED OUTCOMES

Development of a positive attitude towards learning

Recognition of the importance of communication on all levels

Recognition of the importance of setting a goal in life with tentative ideas about an education

Identification of a work world and its problems in communication

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TO THE TEACHER

The instructional packets of materials designed to improve the communication skills of students in vocational-technical schools have been devised on the premise that every student must succeed in some way before he can be motivated to learn even basic skills. Therefore, it is quite important that the teacher find the level of understanding of each student and begin instruction from that point. To do this the teacher needs to develop a permissive atmosphere in a disciplined or controlled classroom environment. The vocational student will respond to the resulting orderliness because he likes meaningful discipline. Students want reasons for what they are doing and should never be kept in the dark about reasons for assignments, for reading, and for any other plans of classwork. The student's slightest suggestions for class activities should be accepted and commented upon.

Probably the key to helping the student gain self-respect is to praise him often. No red marks should be put on papers for errors during the first weeks of a school term. Instead, use the red pencil to circle something that is a good idea. Give a mark of approval for whatever you can, and refrain from commenting on errors at first. Record the student errors in your notebook and devise exercises for all the students to help them correct errors in grammar, usage, and spelling.

Avoid frustrating the students with assignments that they cannot do or do not understand. The lesson numbers in the packets are used to indicate a sequence and not to indicate daily assignments.

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EXPLANATORY NOTES AND GLOSSARY

CLASS SETS:	Materials provided by the school for classroom use: desk dictionaries, a set of encyclopedias, an unabridged dictionary, Student Handbook, Julius Caesar (Globe Book Company), The Pearl by Steinbeck (Bantam Pathfinder Edition), pamphlets on How to Use the Readers' Guide (H. W. Wilson Company), The How in Parliamentary Procedure (The Interstate, Danville, Illinois), Impact Series: At Your Own Risk (Holt, Rinehart, Winston), Career booklets, (New York Life Insurance Company), Tactics for Perspectives (Scott, Foresman)
EXERCISES:	Single learning tasks provided for the student in response to a specific behavorial objective
FLEXIBILITY:	Even though the teaching modules are designed to be used in sequence, they are flexible so that the teacher may profitably use a single unit out of sequence. The lessons are also flexible so that the teacher may add materials that fit her students or omit those materials that are not appropriate and make a complete presentation.
FOLDERS:	One with staples for the Student Exercises; regular manila folders for filing
LESSONS:	Instructional parts of a module; a term used to indicate sequence of presentation and not a limited time
LOGS:	Student logs for three weeks each; teacher log on poster board for classroom display
PAGINATION:	T + number - Teacher's Manual S + number - Student Exercises
POST-TESTS:	A standard test; teacher-student planned tests; teacher-made tests; student evaluations
PRE-TESTS:	An inventory used at the beginning of a teaching module for student orientation to the subject
TEACHING MODULES:	Teaching units on a single subject

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INTRODUCTION

After reading the section directed "To the Teacher," some teachers may need to readjust their thinking about a philosophy of teaching. At no time in these lessons do we intend to forget the student by concentrating on merely a presentation of subject matter.

The teacher should become familiar with an entire teaching module so that she can blend her ideas and the students' ideas. Motivation is easier when there is teacher-student and student-teacher rapport. The teacher assumes the role of a leader, a participant, a listener, and an aide.

Class organization may begin by listing supplies the students will need. The list may be written on the blackboard, or presented on a transparency, or dittoed.

1. Dictionaries

   a. Pocket size
   b. Desk edition (A class set of these may be provided by the school.)

2. Loose-leaf notebook (six divisions)

   a. Assignments
   b. Language
   c. Literature
   d. Composition
   e. Miscellaneous
   f. Vocabulary and Spelling

3. Textbooks

   a. Literature Anthology
   b. Class sets of paperbacks
   c. Library books

4. Other needs

   a. Ink pen
   b. Pencil with eraser
   c. Loose-leaf paper

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NOTEBOOKS

Learning to keep a neat notebook is a step towards becoming a good organizer of materials and thoughts. There will be time to jot down class notes, and the students will find time to add interesting and worthwhile materials under the different headings in their notebooks.

1. Assignments

    a. Book reports
    b. Special projects

2. Language

    a. Language skills - note taking
    b. Communicative skills - reading, thinking, listening
    c. Special language problems
    d. Language history

3. Literature

    a. Reading techniques
    b. Discussion and note taking

4. Composition

    a. Rules for composing
    b. Mechanics of writing
        (1) Punctuation
        (2) Capitalization

5. Miscellaneous

    a. Interesting clippings
    b. Cartoons
    c. Student ideas
    d. Student comments
        (1) Dated
        (2) Titled

6. Vocabulary and Spelling

    a. Study the Official Spelling List - Little Rock Public Schools
    b. Write definitions of words according to the (NP_1 + VP + NP_2 + *Modifier*) sentence pattern
    c. Note new words that you hear and read

7712

KEEPING A LOG

Log sheets should be checked by the teacher at the end of each three-weeks period. At the end of a grading period (either six or nine weeks), the teacher may use the log as one criterion for evaluating the student. The student reports what was done in each day's English class and comments on what was done. The teacher may ask that the sentence definitions of the word "log" be handed in.

The teacher should prepare an enlarged copy of the individual logs with subject or topic headings for each day. This is an excellent way to teach the students that plans can be changed and at the same time an orderliness in recording can be maintained.

INTRODUCING THE LOG IDEA

We would like for everything we do in our classroom to be practical and meaningful to all of us. The purpose for our keeping the log is to measure our progress. Let's read together "Why we should keep a daily record." We do need to know exactly what a log is, or let's say we need a "working definition" of a log. (Decision by students and teacher)

Now that we have a definition we can think about an economical way to keep our daily record. You will notice that the space for daily notations is limited. You may want to make extra comments on these 3" X 5" cards. Encourage the students to be frank in their remarks. The logs are confidential. They are not graded. Honest, but positive, remarks may be written (not in red ink) to the student for the purpose of encouraging him to keep talking.

The teacher may note and write in her notebook the misspellings of common words (Note the Official Spelling List - Little Rock Public Schools.) and errors in composition. Time will be given for classwork drill to correct these errors. Do not single out students except to point out the progress one is making. Every student must feel that he is succeeding in some way.

THE COMMENT CARD

In a box in the classroom you will find 3" X 5" cards. From time to time you may feel the urge to comment on something that you have read in a newspaper or magazine, or that you have heard on TV or the radio, or that we are doing in class. Write your comments legibly on one of the cards. You do not need to sign your name. The cards will not be shared unless you write share on the card. Be sure to date the card.

SUGGESTED SEQUENTIAL PRESENTATION OF THE MODULES IN COMMUNICATIVE SKILLS 10

FIRST QUARTER		SECOND QUARTER		THIRD QUARTER		FOURTH QUARTER	
Skill Emphasis		Skill Emphasis		Skill Emphasis		Skill Emphasis	
Social Reading for Information	*Student Handbook*	Listening Speaking (Pronunciation) Reading (Basic Skills)	*Improvement of Reading*	Listening Speaking (Enunciation) Writing (Sentence Construction) Reading for Information	*Language Dialects Generative Grammar*	Speaking (Dramatic)	*Improvisations*
Social Reading for Information Thinking	*Becoming a Good Student*	Reading for Information & Enjoyment Listening	*Reading Newspapers*	Reading for Depth Study and Enjoyment of Language Speaking (Group Discussion, Exposition) Thinking	*The Pearl: A Study of the Author's Use of Language*	Reading for Depth Study and Appreciation Thinking Writing (Expository) Speaking (Fact and Opinion)	*Julius Caesar*
Speaking (Formal) Listening	*Practicing Parliamentary Procedure*	Listening Reading (Advanced Comprehension Skills) Speaking (Discussion Techniques)	*Reading Literature* Point of View Inferences Central Idea Imagery Relationships			Reading for Personal Understanding	*Impact: At Your Own Risk*
Thinking Social	*Improving Attitudes*					Writing (Creative)	*Autobiography*
Reading for Information Writing (Expository)	*Looking Toward a Career*	Thinking Speaking (Formal & Informal) Listening Reading for Information and Enjoyment	*Spaceways* (Student-Planned Unit)				

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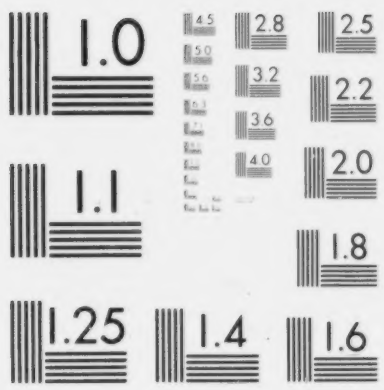

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

PRE-TEST

Read the questions with the students. Ask them to write answers to some of the questions, possibly the first eight. Allow a student to write, "I don't know," if he wants to, but encourage him to attempt an answer. Take the papers. Discuss with the students the questions that arise.

Questions 9, 10, 11, and 12 may be presented in the next class period. Ask the students to write their answers in complete sentences. Allow as much time as is needed for discussion of the meaning of each question before letting them write on their own. Place the pre-test answers in the students' individual folders for reference.

1. What are credits?

2. How many units are needed for graduation from Metropolitan High School?

3. What occupation would you like to pursue?

4. What courses will aid you in understanding the work world involved in this occupation?

5. What are "elective courses"? Of what value are they?

6. What are communication skills?

7. Are communication skills learned only in an English classroom? Explain your yes/no answer.

8. What speaking skills will you need after you graduate from high school?

9. What are <u>your</u> strong points as a student?

10. What do you consider your weaknesses to be?

11. Tell how attitudes are important for you as a student.

12. We are agreed that it is important that we get along with others. When will you be tested on how well you get along with others in school and out of school? Be specific in your answers.

NOTEBOOK ASSIGNMENT

From time to time list in your notebook any ideas you may have about other things you will need to know before you can become a good high school student. Title this page of your notebook "Becoming a Good Student."

Be sure you understand the meaning of the underlined words:

1. We need to develop positive <u>attitudes</u> towards life.
2. Sometimes <u>communication</u> is lost because one is a poor <u>listener</u>.
3. A student should take an <u>inventory</u> of his work <u>skills</u>.

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THE STUDENT HANDBOOK

Lesson One: Approach

Each of you has a Student Handbook. On page 10 you note our first topic is "Organization." The first thing we need to do is to orient ourselves. On the maps on pages 11 and 12, locate where we are. On page 11, which general building are we in? On page 12, specifically, which room are we in? Where is your home room? We know about home rooms, but let's read the material on page 10. Listening in home room will be our first step towards developing orderliness in our school day. (Discuss)

Two time schedules are given on page 13. One is for the days when we will have assemblies. Let's read on page 10 about assemblies. Do you have any questions? The word assembly may be added to your vocabulary list. What is a word that is a synonym for assembly? Probably someone will say convention or the word may be looked up in the dictionary. What do you know about conventions? What is the difference between a convention and an assembly? To be accurate you may want to check your dictionaries again.

Some of the students may want to prepare a map as suggested in the student assignments. One may want to prepare a larger map for the bulletin board - a good idea.

Lesson Two: Student Schedules

Let students feel free to discuss their schedules. Lead all of them into an understanding of elective courses, credits, and units.

Study page 25 with the students. Pause between the requirements listed to give the students a chance to take inventory.

Give the students specific directions for the writing assignment. If you have not done so, explain carefully how you want the papers identified. Keep the schedules in the students' individual folders. Discuss the writing of the schedules thoroughly before the students begin work. Do not accept a finished schedule until it is neatly done.

Lesson Three: Rules and Regulations

Check-test for the reading for comprehension assignment. Check only for meaning. The questions should be dittoed so each student has a copy.

1. For what excuses are blue readmittance slips given?

2. Where may you get a student identification card to allow you to ride the city buses at a reduced rate?

3. Give one rule for using the telephone.

4. What is the purpose of the early morning study hall?

5. How may a student leave school early?

6. How may one be admitted to the health room?

7. Why may you not want to wear a hat to school?

8. Who may eat lunch at home?

9. How may a student get his name on the honor roll?

10. Give two rules that must be obeyed if one brings a car to school.

11. Define tardiness according to the handbook.

12. What is the punishment for being truant a second time?

13. What must you do when you bring a visitor to school?

14. How is traffic in the halls controlled when classes are in session?

Discuss student questions and ideas that may come from their reading.

Let the students talk about discipline and self-discipline. Give the students time to write these words in their notebooks.

At the end of this class period or at the beginning of the next period, ask the students to write three to five sentences giving their ideas on "The Importance of Self-discipline."

Lesson Four: Club Activities

Read pages 36-40 carefully. Call on your own experiences in participating in club activities to indicate the advantages and the disadvantages in belonging to clubs. Emphasize that when a student becomes a member he must be a participating member. Give as much help as you think is needed in helping the students prepare their oral contributions. Since this is the first time the students have been asked to speak on their own, they may not want to stand before the group and make what to them is a formal speech. Try to insist on everyone's preparing something to say. Maybe a student would rather sit in the group while offering his contribution. Those who do not respond orally should hand in a written outline so you can check on the logic of their thinking.

New words that should be discussed are substantiate, specific, and extra-curricular activities. The word curriculum can be introduced at this time and related to course of study.

AN ENGLISH CLUB:

Try to lead the students into wanting some kind of English Club. Do not let the forming of such a club become cumbersome. The purposes would be to arouse student interest in initiating ideas for study; to help students to participate in group work; to inspire creative writing; to play roles

in drama; to teach parliamentary procedure by actually using it; to promote respect for the rights of others; to locate talents that might not be recognized in an always formal atmosphere; to develop a freedom in thought and movement in the classroom; to practice social skills.

If a club is formed, officers may be chosen each nine weeks so that more students can benefit from assuming responsibilities. Committees like program planning, bulletin board, nominating committees, etc., can give other students a chance to participate; and involving others in publicity, liaison, etc., will give everybody a chance to adjust to working together in a group.

Lesson Five: Service

Allow plenty of time for free discussion of the services a school offers and about schools as businesses.

Talk about listening manners before the guests, the principal, and the counselor come in to speak to the class. Let the students, with your guidance, formulate a set of rules for listening and write them in their notebooks.

If you feel that the students would like to, you may help them to write invitations to the speakers. This would be a good opportunity to point out why invitations should include specific information.

The students may be asked to take simple notes. If this is not feasible, review the speeches with the students and ask them to record the pertinent information.

NOTEBOOK ASSIGNMENT

The planning for a practical class routine should be the cooperative effort of the students and the teacher.

BECOMING A GOOD STUDENT

Cooperate with the students in trying to set a pattern for establishing a practical daily routine. This will require time, but it will be time well spent.

Give the students time to arrive at tentative definitions for habits and skills.

Lesson One: Developing Study Skills

Ask the students to answer the true/false questions quickly. Answers may be checked in class, and student questions and comments should be discussed and noted in the teacher's notebook.

Lesson Two: Textbooks as Tools

SUGGESTED TEACHER PRESENTATION

You may begin by saying that before you can do a good job of studying, you must become acquainted with available tools. I have named some of the tools on your list of supplies. First let's look at our textbooks. You should have bought your books and have them with you today.

First look at your Warriner's English Grammar and Composition or another English textbook.

The title page of a book is a right-hand page. Find the title page in your grammar book. What information do you find? (title, authors, contributors, publisher, place of publication) Let the students give the answers orally. Be sure everyone else can hear each student as he answers.

The back of the title page is called the copyright page. There are several dates after the word copyright (c). What do you think the dates refer to? (The year of copyright is the year in which the book was first published. If new matter were added later, or if the book were revised, there will be additional copyright dates referring to the years in which these changes first appeared.) Sometimes a supply of books is exhausted and a new printing is made. The date of the reprinting is also recorded on the copyright page. Ask the students this thought question: Why is the copyright date more important than the reprint date of a book? (Discuss the answers.) Tell the students why an author wants a copyright. Show them a copyright certificate, if one is available.

What is the title of the introductory page in your text? What other titles have you noted for introductory pages? (foreword, introduction) Turn to

page ____ (page number of the table of contents). What is the heading of this page? (contents) Of what use will this listing be to you?

Turn to page ____ (the index). What is the title for this page? How is this section of the book different from the contents page? How is it similar? Do you consider this a good index? Why? (Explain what a definitive index is. The students will note its usefulness.)

Check on the students as they fill in the blanks in Listening: Exercise Two and assist those who seem to be unsure of themselves.

Place the vocabulary words on the board. Some of the words are new: collate, blurb, glossary, and frontispiece. Explain that the new words will be used in your next lecture.

Lesson Three: Taking Care of Books

Sum up the discussion of rules for caring for books by giving the following lecture and demonstration. Tools for the demonstration: (1) A new book in its book jacket (2) A library book in which a blurb has been pasted (3) A book that has a frontispiece, a dedication, an acknowledgment

You may begin by saying, "If a book is handled intelligently, it will last a long time; if mishandled it will become dirty or torn, or come apart at its binding and lose its usefulness." A new book should be opened properly. First remove the book cover and lay it to one side. Place the book on a level surface on its back edge, and holding the pages upright, open both covers. With the index finger press down along the inside edge of each cover. Turn down about ten pages at the back of the book and press down as you did the covers; then turn down about ten pages at the front of the book and press down the inside edge with your forefinger. Continue this alternately with front pages and back pages until you reach the center of the book. After the demonstration, ask the students how opening the book in this manner will cause it to last longer. No book is useful unless it has all its pages in order. The process of checking to see if all the pages are all right and in order is called collating a book. We do this by turning the pages of the book one at a time. This is also a good time to clip pages apart that may not be cut. If the book is acceptable, then the material about the book (blurb) and/or author may be clipped from the book jacket and pasted or taped in the book. When you are ready to place the book on a shelf, put its back edge flush with the edge of the shelf. Do not crowd books. One should be able to remove a book from a shelf by grasping its back edge between the thumb and forefinger.

Some books have other parts that your grammar book or another textbook does not have - frontispiece, dedication, or acknowledgment. (Show the students the books that have these parts. They might also be interested in end papers.)

PRACTICE ACTIVITY

Some of the students may be interested in finding library materials on how a book is made. Encourage them in their efforts by helping them to find readable materials and aiding them in preparing illustrations and charts to help them to explain what they find to other members of the class.

Lesson Four: Introduction of Library Tools

Everybody should acquire the library habit. Today, when we have so much leisure time, visiting a library can be a most profitable pastime. We have talked about the worth of a single book and how we can use a book as a tool. A library is a storehouse for all kinds of books. If you learn the techniques for using one library, you can be at ease in any library. Check the list of library techniques on page 488 in Warriner's. Which ones are you acquainted with? Are there any that you feel you already handle skillfully?

How are fiction books arranged on the shelves in the library? After this we will use the word stacks to refer to shelves of books in a library. Do you know why they may be called stacks? (Tell the students how floors of shelves are placed on top of each other like the floors of storied buildings.)

Explain the Dewey Decimal System. Dictate these titles and let the students write the general number that classifies the book:

Fenner: Stories for Fun
Zinn: Alligators and Crocodiles
Bergere: Logging
Webster: Daddy Long-Legs
Lamb: Tales from Shakespeare
Clark: Thomas Alva Edison
Bulfinch: Mythology
Stevenson: A Child's Garden of Verses
Jones: Seeing Japan

Lesson Five: The Card Catalog

The card catalog is a file of cards showing you what books are in a library. There are at least two cards for each book - an author card and a title card. Why is there need for more than one card? Useful information about a book is written on each card. On page 491 in Warriner's what information did you note about a book? Sometimes there is a subject card. Of what use is the subject card? Quite often the subject is written in red to distinguish it as a subject card. Why is this important? Read on page 493 about cross-reference cards. What are they? Explain the difference between the two kinds. Are cross references the same in all libraries? Why?

Check page 494 in Warriner's and assign some of the exercises. Stagger the assignments so all the students will not be trying to work on the same problem in the same place at the same time.

PRACTICE EXERCISES

1. Ask the students to write catalog cards for the following book:

> E. B. White wrote a book of ninety-five pages on composition which he called Elements of the Language. It was published in 1959 by American Book Company of Chicago. Mr. White's Cutter number is 83. The book includes a bibliography.

AUTHOR CARD

```
 400
W83e        White, E. B.
                 Elements of the language.
            Chicago, American Book Company,
            1959.
                 95 pages
                 bibliography

            1. English language - composition
```

TITLE CARD

```
 400        Elements of the language
W83e        White, E. B.
                 Elements of the language.
            Chicago, American Book Company,
            1959.
                 95 pages
                 bibliography

            1. English language - composition
```

SUBJECT CARD

```
 400  English language - composition (in red)
W83e        White, E. B.
                 Elements of the language.
            Chicago, American Book Company,
            1959.
                 95 pages
                 bibliography

            1. English language - composition
```

2. Arrange these books in the order they would be shelved by numbering them from 1 to 10.

375 616c	371.6 619d	759 D56c	973.6 A33o	435.6 C96e
435.6 D19c	517 F86a	759.3 B16g	109 W32h	516.9 D75g

EVALUATION

Underline the correct answer to complete each statement.

1. The quickest way to find out whether the book entitled The Red Pony is in the library is to look in the card catalog drawer marked:

   (1) S - V
   (2) Q - S
   (3) O - Q

2. The classification number on the back of a book is the symbol of the

   (1) subject
   (2) title
   (3) author

3. The quickest way to find the page on which a certain topic appears in a book is through

   (1) the appendix
   (2) the index
   (3) the table of contents

4. To find the title of a book written by Henry Wadsworth Longfellow, look in the card catalog under

   (1) Henry
   (2) Biography
   (3) Longfellow

5. To find a biography of Henry Wadsworth Longfellow look in the card catalog under

   (1) Longfellow, Henry Wadsworth
   (2) Biography
   (3) Longfellow, Henry Wadsworth (in red type)

6. The table of contents is a list of chapters arranged

   (1) as they appear in the book
   (2) by no special arrangement
   (3) alphabetically by first word

7. Individual biography is arranged alphabetically by

   (1) person written about
   (2) title
   (3) author

8. The guide to the date of the content of books is called

   (1) imprint date
   (2) copyright date
   (3) publication date

9. Fiction is arranged alphabetically on the shelf by

   (1) author
   (2) subject
   (3) title

10. To find out what books the library has about China, one should first

    (1) look among the geography books
    (2) consult the card catalog
    (3) ask another student

11. The system in general use for classifying books is called

    (1) Dewey decimal system
    (2) expansive system
    (3) Library of Congress system

12. Nonfiction books in a library are grouped by

    (1) subject
    (2) size
    (3) title

Lesson Six
The Readers' Guide to Periodical Literature

A class set of free pamphlets entitled "How to Use the Readers' Guide to Periodical Literature" may be ordered from H. W.Wilson Company, 950 University Avenue, Bronx, New York, 19452. The teacher should study carefully the introductory materials on pages 1 to 5. Questions and problems are listed on pages 12 and 13. The teacher should adapt these to fit her class situations.

SUGGESTED ACTIVITIES

1. The students should make a list of the magazines in the high school library that are indexed in the Readers' Guide.

2. The students should be able to write the abbreviations for the months of the year.

3. Practice answering question 8 on page 12. Then ask the students to find a subject entry in the booklet that has at least three items. Copy the items and "translate" them into bibliographical form.

   Following is a subject entry:

   BICYCLES
   Look what's happening to bicycles. A. Wall.
   il Pop Sci 187:108-11 + Ag '65

   Following is a translation:

   Wall, A. "Look What's Happening to Bicycles," Popular Science, vol. 187 (August, 1965), pp. 108-111.

4. If arrangements can be made with the librarian, bring Readers' Guides into the classroom and let the students work in groups to prepare bibliographies of magazine articles on subjects they choose. Be sure each group uses more than one Readers' Guide in preparing the assignment.

NOTEBOOK ASSIGNMENT

Let the students decide in a class meeting the items from this assignment which they all will include in their notebooks. Of course, each student may add whatever he wants to his notebook assignments.

EVALUATION

1. Study the vocabulary words with the students so that all the students have accurate definitions for their notebooks.

2. Ask the students to write at least two sentences telling how he feels he will benefit from knowing how to use a Readers' Guide.

3. As a follow-up to this lesson the teacher may want to tell the students about the Vertical File.

4. A visit to the library for a question-answer period with the librarian would be appropriate now. The students have studied library skills so that they can ask questions and benefit from the answers.

Lesson Seven: Reference Books

The discussion of reference books can be done after a visit to the library because the students will have some knowledge of where the books are and how they are used. Arrangements should be made with the librarian so that the students will feel free to browse in the library while searching for answers to the questions.

The students and the teacher should make an annotated bibliography of the reference materials in the library. The annotations should include the place of the index in the reference books.

This would also be a good time for the students, in a club meeting, to formulate rules of behavior in using the library. Try to lead them into talking about understanding an assignment before going to the library; about asking questions of the librarian; about returning books as soon as they have finished using them. Remind them of the rules they formulated earlier for taking care of books.

Lesson Eight: Dictionaries

The questions that are used to motivate this lesson can be answered by using the "Popular Library Pocket Edition" of Webster's New World Dictionary of the American Language. If another dictionary is used, the teacher should check the answers before presenting the lesson.

The students will probably note the following items of information about a word that may be found in a dictionary: (Their wording may not be the same as yours, but you can insert the correct wording for their definitions and thus teach the vocabulary words.)

1. main entry or spelling in black type
2. pronunciation or respelling
3. part-of-speech label
4. irregular inflections (plurals, tense, participles, etc.)
5. definitions (Be sure to note the order of the meanings)
6. etymology, or origin of the word
7. derivations (words derived from the entry word by the addition of a suffix)
8. synonyms, antonyms and synonym studies
9. usage notes

The exercises that are used to practice the skills in using the dictionary could be worked out by the teacher and the students. Following are some suggestions the teacher may mention and the students may add to:

1. Writing sentences using homonyms, as fair, fare.
2. Writing the symbols for vowel sounds that may be spelled the same, as great, leave or hop, hope.
3. Writing the symbols which the dictionary gives for consonant sounds as in "change," "great"

4. Dividing words into syllables

5. Using words to illustrate their uses as different parts of speech

6. Practicing writing dictionary definitions in your own words

7. Dividing words into prefixes, stems, and suffixes.

8. Noting inflectional forms: comparison, plural, possessive, participle, tense

9. Noting derivations and their part-of-speech labels under main entries

10. Noting interesting etymologies of words.

If it is convenient, the attention of the class should be called to the differences between the unabridged and the abridged dictionaries. This should be done by demonstration with extra copies of unabridged dictionaries. This explanation would be useful in working out some of the exercises above.

SUGGESTED ACTIVITIES

1. Ask the students if they would like to prepare dictionaries of their own. Help them to recall that on their trip to the library the librarian pointed out different kinds of dictionaries based on subject matter, as Dictionary of Technical Terms, Dictionary of Slang, etc. You could tell them how language changes and how words get into dictionaries. For example point out definition No. 8 of the word square in Webster's New World Dictionary and then look at definition No. 8 in Webster's Seventh New Collegiate Dictionary. A slang word because of usage is now standard English. There are a number of subjects that the students will be interested in - cars, home, food, clothes, school - that they have their own language for. One example could be "Kinds of Dances." They could name dances that they know now or have heard of. They would have fun asking older members of their families the names of dances and then finding definitions of these dances in their dictionaries. These dances would include Waltz, Cha-Cha, Twist, Jitterbug. The names of the newer dances like Funky-funky Broadway, Frug, Skate, Watusi, Shing-a-ling, Flounder Stomp, Push, Jerk, etc. The students will write their own definitions of the new words. As writers of dictionaries, the students become lexicographers. In their groups they may appoint phonologists to write pronunciation, orthographers to spell the words correctly, tabulators to alphabetize, grammarians to suggest usage labels, inflectional forms and parts of speech, etymologists to give the origin of the word, illustrators to picture the words, researchers to check to see if the word is already in a dictionary, and clerks to make card files of the words. (All the cards in the class may be collected and a dictionary of teen-age language could be "published.") All the students should have a part in writing the definitions. The decisions of the subgroups on spelling pronunciation, etc., should be submitted to the group for acceptance. The booklets may be done by hand or if the project proves worthwhile, the material may be dittoed so each one may have a copy of his own. This could be a continuing project in that materials may be added anytime the students are studying language or vocabulary building.

2. Report orally on the unusual histories of some of the words they hear or meet in their individual reading.

3. Bring to class examples of familiar words used in unfamiliar contexts.

4. Clip unusual words or references to words in the comics in newspapers.

5. Rewrite phrases using different levels of usage.

6. Make a card index of "word families."

7. Find examples in their textbooks, trade manuals, or special interest magazines of words in general use that have specialized meanings in certain vocations or fields of interest.

8. Replace words in context with synonyms. This would be an excellent opportunity to introduce A Dictionary of Synonyms and Roget's Thesaurus.

9. Give the students practice in trying to decide the meaning of a word by its use in context and then checking their ideas with dictionary meanings.

VOCABULARY

A. Definitions

1. student: (a) a person who studies or investigates
(b) a person who is enrolled for study at a school or college

2. pupil: a person, especially a young person, who is being taught under the supervision of a teacher or tutor, as in school

3. scholar: a learned person; one trained in a special branch of learning, as literature, arts, etc.

4. knowledge: (a) acquaintance with facts; range of information, awareness, or understanding
(b) all that has been perceived or grasped by the mind; learning, enlightenment
(c) the body of facts accumulated by mankind

5. wisdom: (a) the power of judging rightly and following the soundest course of action based on knowledge, experience, understanding, etc.
(b) learning; knowledge; erudition

6. insight: the ability to see and understand clearly the inner nature of things

7. teach: (a) to show how to do something; to give instructions; to train
(b) to provide with knowledge, insight, etc.

8. train: to instruct so as to make qualified; as, nurses are trained at this hospital

9. educate: to give knowledge or training to; train or develop the knowledge, skill, mind, or character of, especially by formal schooling or study; teach; instruct

10. education: the process of training and developing the knowledge, skill, mind, character etc., especially by formal schooling, teaching, and training

11. vocation: (a) the function or career toward which one believes himself to be called
(b) the work in which a person is regularly employed

12. avocation: something one does in addition to his vocation or regular work, and usually for fun

B. Questions: Students may write the answers in their notebooks

1. What is the basic difference between a pupil and a student?

2. Can a student be a scholar? How do you know?

3. If you were referring to your knowledge, which of the three definitions would apply?

4. Can a person have knowledge but lack wisdom? How do you know?

5. Is it possible for a person to have more wisdom than knowledge?

6. Which is closest in meaning to "common sense," wisdom or knowledge?

7. Can a person have insight but lack knowledge? Can he have insight but lack wisdom?

8. Of the three definitions of the word teach, which one is most important in your opinion? Why? Which one is the easiest to carry out? Which would be the most difficult? Why?

9. What is the difference between train and teach? Which of the two diagrams below is a more accurate representation of the relationship between train and teach?

A

train	instruct	guide
show	help	lead

B

Teach	=	Train

10. Why do you think there is no mention of "wisdom" or "insight" in the definition of educate?

11. What do we mean by referring to a person as "self-educated"?

12. Why is education defined as a process?

13. Note definition of vocation: Is it possible for a person to work regularly at a specific job but yet feel no particular "calling" for it? What is the advantage of feeling "called" to do a certain type of work. What would be some indications that a person had been "called" to a special type job? Do you feel inclined or called to do a certain type of work?

14. Do you have an avocation? What is it? You may have several. List them below.

EVALUATION FOR STUDENTS AND TEACHER

1. If a word is spelled several ways, which is the right way?

2. Find alright and ain't in your dictionary. How do you account for their being in the dictionary?

3. When you ask someone how to spell a word, and he answers, "Look it up in the dictionary" why do you feel confused and helpless?

4. Why do people who read widely usually develop large vocabularies?

5. What is meant by "learning words by context"?

6. Give examples of words containing a schwa for different spellings as, circus, about.

7. How do words get into a dictionary?

8. Why do we need an unabridged dictionary in our classroom?

NOTEBOOK ASSIGNMENT

Check to see if the students are keeping their notebooks in an orderly manner. Let the students ask questions about the form they use in writing definitions of the vocabulary words. You may ask for sentences using the vocabulary words if you feel practice is needed for clarification of the meanings of some of the words.

PRACTICING PARLIAMENTARY PROCEDURE

An Approach to Teaching Parliamentary Procedure

Parliament comes from the French word parler, which means "to speak." Conducting meetings according to parliamentary law comes to us from England and can be traced back to Roman law. Parliamentary procedure is the code of rules for working together in groups.

Parliamentary rules have grown naturally out of certain basic ideas or principles, which are in harmony with our democratic ideals. Because we believe that power resides in the people of a nation, or of a club, or of a class, we determine majority opinion by vote and then abide by the rule of the majority. We try to make sure that everyone who wishes to do so has a chance to express his views in our meetings because we believe that our citizens are equal in rights, privileges, and duties. To carry out this principle, order must be preserved and members must be courteous. Although we abide by the rule of the majority, we still feel that the minority should express their views freely if they speak in order and one at a time. Decisions are made by allowing all participants to vote. The responsibility then rests on individual members who make up an organization. Therefore, one of the most important skills that we develop during our high school days is a knowledge of the importance of using parliamentary procedure.

The outline in the Student Lessons is a simple one. Drill exercises should be given frequently until all students are familiar with how a member secures the floor and makes a motion. (The wording of the main motion is further discussed in Lesson Two.)

An English Club should be formed so that a realistic situation exists. Under the guidance of the teacher, the students may practice making pertinent motions, asking for discussion, and putting the question. Subsidiary motions should be defined and illustrated during the periods for discussion. (These are discussed in Lesson Three in the Student Lessons.) Reading assignments should be made in the booklet, The How in Parliamentary Procedure, and class discussion should follow.

If there is time, each student should have an opportunity to preside, to read the minutes, or to make a committee report. The actual participation - making motions, discussing, and voting - should be done spontaneously.

Careful attention should be given to the understanding of the post-test on parliamentary procedure in Lesson Five in the Student Lessons. If the students can be motivated to write on "What America Means to Me Today," the written exercise can be profitable and the writings could be collected for a booklet of creative writings and kept on file for use in eleventh grade classes.

A discussion of VICA might be appropriate at this time. Membership in any club should be based on an individual's desire to participate and to develop leadership. Students enrolled in vocational classes are eligible for VICA and can through positive group participation develop ideals and set goals that go with them into the work world.

NOTE: Any unit on parliamentary procedure should be considered a continuing unit and practice in developing the skills of securing the floor, making a motion, and discussing the motion should be practiced in homeroom, classroom, and club activities.

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IMPROVING ATTITUDES

You may need to explain to the students the significance of the title of this unit. Try to do this inductively by letting the students recall times they have heard the word used. They probably have hazy ideas which you should be ready to crystallize for them. In some way lead the discussion to personal relationships. Help the students understand the discussion of the word persona from which the word person comes.

From the discussion of persona you can bring up individualism and the need for everybody's taking a personal inventory. Hopefully all the students will participate in the activity of describing their strengths and weaknesses. You may or may not look at the papers. You can decide on this as you see how the students are responding.

The following inventory sheets should be dittioed for the students. Probably some of the ideas need to be deleted and some ideas added.

Allow time for the discussion questions. This will probably be a serious discussion by the students if they have done the inventories thoughtfully. Some may express themselves awkwardly. Try to give all questions and answers your personal recognition.

1. Ask questions about the words you do not understand. Check (✓) those you think apply to you. Place a plus sign (+) by those traits you would like to acquire, and place a minus sign (-) by those that sometimes apply to you.

   I am

   1. cheerful
   2. sad
   3. inattentive
   4. often an absentee
   5. timid
   6. not above telling little white lies
   7. a mild gossiper
   8. a good listener
   9. late for many appointments
   10. sensible
   11. not a snob
   12. jealous of my friends
   13. contented with most things
   14. sick most of the time
   15. easy going
   16. a loner
   17. generous with my possessions
   18. a perfectionist
   19. agreeable

20. a safe driver
21. critical of my family
22. a borrower
23. a procrastinator
24. a pretender
25. friendly to new acquaintances
26. conscientious all the time

II. Under the proper headings record your reaction to these words:

	Like	Dislike	Fear	No Feeling
1. Dances				
2. Freedom				
3. Democracy				
4. Reading				
5. TV Commercials				
6. Fire				
7. War				
8. Football				
9. Foul language				
10. Deep water				
11. Dentist				
12. Poverty				
13. English				
14. Cancer				
15. Parents				
16. Camping				
17. Chores				
18. Country music				
19. Baseball				
20. Listening to the radio				
21. Travel				
22. Birthdays				
23. Christmas				
24. Police				
25. Parties				
26. Newspapers				
27. Being alone				
28. Modern art				
29. Gossip				
30. Indoor activities				
31. Sleeping				
32. Crowds				
33. School				
34. Books				
35. Teachers				
36. Manners				
37. Elections				
38. Vacations				
39. Elderly people				

LOOKING TOWARD A CAREER

This unit should grow gradually from a discussion of attitudes and personality. Quite often students begin to reveal their ideas in such a way that their philosophy of living is made known. A discussion of philosophy leads naturally into answering questions about what one wants out of life.

Lesson One: Recognizing Your Personality

The written assignment, which the children will probably be interested in because it is about themselves, could be used as a springboard for some careful instruction in composition and revision. Grade the papers carefully. Use the red pencil to mark the good ideas; use a student's pen for marking errors in coherence or whatever you decide especially to stress at this time. Keep the written materials and the revisions of such materials in the students' individual folders.

Lesson Two: Projecting Yourself into a Work Situation

Be as helpful as you can in guiding the students in selecting materials to read on the various occupations. Be sure the students understand that this is an assignment in exploring the possibilities of several careers. You could stress the importance of looking into the potential of several occupations before deciding on a job. The thought questions should provide interesting discussions. Some personal stories of misfits would emphasize the need for these lessons.

Lesson Three: Planning Your Career

This assignment may serve as a book report if such reports by students are required. The outline in the student manual is merely a suggestion and should be amended to fit your particular classroom situation.

Lesson Four: Identifying Yourself in a Work Situation

This assignment may also serve as a book report. The lesson is included here because of continuity of ideas on the importance of one's identifying himself with an occupation and working towards achieving success in the occupation.

You may have a student chairman for the oral discussions after you are sure the students understand the problems portrayed in the stories. If they can write good sentences identifying the problems, then they can communicate with their classmates in talking about the problems. (See the book list in the Supplement and the reading record in the Student Lessons.)

READING NEWSPAPERS

This teaching module should be considered merely as an introduction to the reading of a newspaper. The ideas of propaganda and separating fact from opinion should not be introduced unless the students ask questions. In the eleventh grade more sophisticated skills of understanding news media will be introduced. The teacher may want the students to work in groups to share materials and ideas. Some plan could be formulated for putting the assignments into the regular class notebooks or making separate booklets. During the evaluation period if there is enough interest exhibited by the students, a small class newspaper can be planned as a creative project. The finished project should be dittoed so that all the students have a copy.

Lesson One: The Front Page

Prepare for the handling of the materials - newspapers, scissors, paste - in a convenient way so that the students assume the responsibility each day for keeping the classroom neat.

After the discussion of the questions that are answered in the leads of stories, the teacher may write on the board the following:

A Newsman's Text

"I have six honest serving men.
They taught me all I know.
Their names are Where and When
And What and How and Why and Who."

-Rudyard Kipling

The following material may be used for a note-taking and listening exercise. The ideas should be rearranged to fit the results of the class discussion on leads. The lead is the summary of the story. The lead may be,and most often is,just the first sentence. In a long,complicated story the lead may run to two, three, or four paragraphs. The lead can make or break the story. It sets the tone of the story at once and puts the essential information quickly before the reader. Primarily the lead is written for the hurried reader. The lead itself is simple. All you have to do is answer Mr. Kipling's questions. To this list you will want to add one more question: Who says so? The lead is the briefest possible summary of the story.

Spend as much time as interest warrants on headlines and leads and front page news. You might ask this thought question: What is the meaning of the word important when it is related to a news story? Ask the students to recall Lesson One: The Student Handbook where the directions - north, east, west, and south - are in the reading material. They will note the initial letters - N E W S.

Lesson Two: The Editorial

The students will need guidance in understanding the ideas in the editorials. If there is time, the teacher in preparing for this unit could have noted some good editorials and cartoons for tenth-grade students to discuss. Clip from newspapers cartoons that do not have captions. Let the students suggest fitting captions. These could be used for bulletin board material.

Lesson Three: Other News Items

This lesson may be used as an oral discussion or as group work to conserve time.

Lesson Four: The Sports Story

The students may be interested in discussing sports newscast and televised sporting events in connection with reading sports stories in newspapers.

Lesson Five: Advertisements

Try to lead the students into reading some want ads that pertain to jobs they can do part time or in the summer or jobs that they will be interested in after high school. The students will probably be interested in the wording of other kinds of advertising in the classified section of the paper. Questions, answers, and sharing by reading aloud would be a relaxing break for them.

SUGGESTED QUESTIONS FOR STUDYING WANT ADS

1. What salary is noted in the ad?
2. What are the job benefits?
3. Is the title of the company given? Is it a reputable company?
4. Tell why you would or would not answer some of the ads.

Lesson Six: Summary and Evaluation

ACTIVITIES

Set up a dummy for the front page of a newspaper. Use the blackboard. Discuss and decide on seven or eight headlines that would serve as a springboard for current news items. The items could refer to local, state, and/or national news.

Prepare a vocabulary of words one should have in his speaking vocabulary when he is discussing newswriting. Practice using some of the words when you make oral reports on newspapers.

Ask Mr. Fred Graham, head of the journalism department, to talk to you about writing news stories and taking pictures that "tell" stories.

If it is convenient, this will be an opportune time for a visit to the print shop on our campus.

A visit to the Arkansas Territorial Restoration to see the first printing press used in Arkansas and then a visit to a local newspaper publishing company would be most interesting at this time.

The students will be interested in the comic strips. Some comic strips represent very careful writing.

If the teacher has a collection of news pictures from The Associated Press, or a comparable agency, she may ask the students to supply captions for the pictures and then write headlines and leads for appropriate news stories. The students may compose a story orally by suggesting sequential sentences. The story may be written on the board and then revised by the students so that it is more effective.

The preceding activity would be a good one to summarize testing the adequacy of a lead and the effectiveness of the vocabulary in the story.

The above activities may or may not fit into the teacher's schedule. A teacher-planned test may be needed at this time for evaluation purposes. The students should be involved in some kind of activity as an outgrowth of the learning experience. The students may enjoy attempting to make up a test for this unit.

APPLICATION: DISTINGUISHING BETWEEN FACT AND OPINION

Materials: The literature textbook, Perspectives, pp. 530-540
Guidebook for Perspectives, pp. 52-56
Tactics in Reading II, Cards 21, 22, 23, 24A, and 24B

Purpose: To help students discriminate between statements of fact and statements of opinion as an introduction to critical reading

Method: Follow the helpful suggestions given in the Guidebook for Perspectives, p. vii

IMPROVEMENT OF READING

The Division of Secondary Education of the Los Angles City School Districts gives its teachers an inventory sheet to help each teacher to understand that he or she is teaching reading. Most teachers have the idea that the teaching of reading involves drill and a formalized program of instruction. A check of the following inventory indicates that all teachers are teachers of reading.

In your teaching, do you help students learn through these experiences? Check those you develop.

___Listening

___Graphic and concrete experiences for understanding

___Oral use of new words

___Word recognition

___Vocabulary building

___Comprehension

___Selecting main points

___Using textbook aids

___Using supplementary books

___Alphabetizing

___Using the dictionary

___Selecting correct definitions

___Adjustment of reading rate to purpose

___Enjoyment of reading

___Accuracy in reading

___Following directions

___Reasoning

___Use new words in writing

___Fact recall

___Evaluation

___Critical analysis

___Integration of new ideas

___Forming sensory images

___Making comparisons

___Organizing ideas

___Making generalizations

___Summarizing

___Recreational reading

Reading of:

___Schematic diagrams

___Graphs

___Figures

___Charts

___Maps

___Pictures

___Cartoons

___Symbols

___Working drawings

If, in your classes students are learning some of the above,

YOU ARE TEACHING READING!

All teachers recognize that there is a need for teaching techniques for improvement of reading in most secondary schools. Although listening, reading, and speaking activities can be carried on in the regular classroom with the use of the tape recorder and the record player, it is difficult to conduct remedial work and many reading improvement exercises without interrupting the continuity and the rapport of the learning situation. On the other hand, we are agreed that there is a definite need to identify the weaknesses in the reading skills of tenth grade students who will go into the work world upon graduation from high school. In this curriculum which we are trying to build on the interests of the students, we are providing time for free reading periods. Paperback copies of books on many subjects and various magazines are available for browsing and reading. The students are not asked to make formal book reports but are given opportunities to discuss ideas that grow out of their reading. The vocational students have read and discussed easy materials that help them to project themselves into work situations. (See teaching module, "Looking Toward a Career.")

Tests may be given to help the teacher decide whether time should be allotted to concentrate on the improvement of those reading skills in which the students are deficient. Suggested tests to use are Gates Reading Test and the reading skills section of the Iowa Test of Educational Development. If it is at all possible, each student should be allowed to progress at his own rate in whatever program is chosen to develop improvement in reading skills.

Following is a suggested list of reading improvement programs. The titles marked by the asterisks are the materials that have been used for this project.

*1. Pooley, Robert C. and others. Perspectives. Glenview, Illinois: Scott, Foresman and Company, 1963.

Perspectives is the tenth grade literature anthology of the Galaxy series designed to improve reading. The teacher's Guidebook is very good and there is a Tactics box containing interesting individualized drill exercises to develop particular reading skills such as "making judgments." This is the adopted literature text for tenth graders in Metropolitan High School. Most publishers of literature anthologies provide a program similar to the Galaxy series for the basic learner.

2. Learning 100. Huntington, New York: Educational Laboratories, McGraw-Hill, 1967.

The complete program consists of various machines - Controlled Reader, Flash-X, Tach-X, and Aud X - that should be set up in a reading laboratory setting. Individual machines, such as Aud-X or the Controlled Reader, could be used in an English classroom to improve certain reading skills.

3. Reading Improvement Program. Camp Hill, Pennsylvania: Book-of-the-Month Club

   This program, sponsored by Rutgers University, is designed to help individuals to increase their reading speed and to improve retention of what they read. It is mentioned here because business and industrial companies are finding the program practical for individual improvement in reading.

4. Comprehensive Reading Program Through Visual Learning Systems. 6767 Southwest Avenue, St. Louis, Missouri 63143: Perceptional Developmental Laboratories.

5. Science Research Associates, Inc., 259 East Erie Street, Chicago, Illinois 60611

   Among the titles of the reading improvement programs are Reading in High Gear and Dimensions in Reading.

6. Sullivan Reading Program. Box 577, Palo Alto, California 94302: Behavioral Research Laboratories.

   This is a set of programmed textbooks for individual instruction.

*7. Guidebook to Better Reading. Oklahoma City, Oklahoma: The Economy Company.

   This program is designed to develop word-attack skills, to develop sight vocabulary, and to sharpen comprehension skills. The teaching manual is an adequate guide to achieving improvement of reading skills for the teacher who feels she is not a reading teacher.

*8. Holt's Impact. New York: Holt, Rinehart and Winston.

   This is a sequential series designed for the student whose progress in school has been impeded by his environment and not necessarily by a lack of intelligence. An attractive feature is a set of paperbacks, five copies of ten titles that are related to the subject of the book that is studied in depth by all the students. The experimental groups chose the title At Your Own Risk for their reading enjoyment.

9. The Reader's Digest: Reading Skill Builder. Pleasantville, New York: Reader's Digest Services.

   The Reading Skill Builder's series are designed to provide students with worthwhile basic or enrichment materials. The materials are high in interest appeal and are varied in form and matter. Provisions are made in the presentation of materials for individual materials.

READING DEEPLY FOR MEANING

Sometimes the teacher and the students will want to delve more into the meaning of a story they are all reading or that groups are reading. The students sometimes tire of discussing theme, plot, and setting as such. They like to relate their reading to themselves, and surely they need to if their reading is to be enjoyable and meaningful.

The following suggestions have been gleaned from experiences in teaching, sharing experiences with other teachers, and from Reading Ladders for Human Relations, edited by Muriel Crosby and published by American Council on Education.

I. Rather than a summary of the whole story, ask the students to think about the story and name and tell about incidents or situations that are clearest in their minds.

   A. Ask students to read aloud passages from the incident that give it meaning.

   B. The students may bring to class musical recordings that seem to be background music for the story.

   C. They may cut pictures from the papers that illustrate the story or they may draw their own illustrations.

   D. Through discussion, decide what the author is telling us in this incident. Could this be the theme of the story - the main idea that the author is presenting? Then when the class defines the theme, discuss how the author uses his tools - plot or action, characters, setting, and language - to present his main ideas.

II. If the teacher decides that the story is a good one for character study, the following questions may help:

   A. What does the character do in the story? Why did he do what he did?

   B. In what ways does the character show his feelings? Has there been a change in his feelings in some way?

   C. How do you feel about what the character did? How would you have felt if you had been in his situation?

III. Generalize about incidents that have the same emotional experiences that you have either read about or experienced. Discussion could begin with:

   A. Have you ever seen something like this happen? When? Where?

B. How were the incidents alike or different? Think before answering so you can be specific in your answers.

IV. Explore and question the consequences of certain behavior and/or feelings.

A. Identify the consequence.

B. What action or feeling led to the result?

C. How were other people affected by the consequences of one character's actions? Are they made happier or are they placed in more difficult situations?

WRITTEN ASSIGNMENT

If you could relive one of your own experiences, what would you do differently? Why? What would you do to make the situation different?

SUGGESTED BIBLIOGRAPHY FOR TEACHING READING IN THE ENGLISH CLASSROOM

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Spiegler, Charles G. "If Only Dickens Had Written About Hot Rods," April, 1965, pp. 275-279.

Tincher, Ethel. "Helping Slow Learners Achieve Success," April, 1965, pp. 289-294.

Wright, Gertrude S. "Some Reading Guidance Techniques," December, 1966, pp. 1183-1190.

OTHER SOURCES

American Association for Supervision and Curriculum Development, 1201 Sixteenth Street, N. W., Washington, D. C. 20036.

Globe Book Company, 175 Fifth Avenue, New York, N. Y. 10010. (Publishers of materials for the basic student - the slow learner)

Indiana University Press, Tenth and Morton Streets, Bloomington, Indiana 47401 (Publishers of the Indiana University English Curriculum Study Series)

International Reading Association, Newark, Delaware

National Council of Teachers of English, 508 South Sixth Street, Champaign, Illinois 61820. (The distributing agency for national and affiliate publications)

Scholastic Book Services, 904 Sylvan Avenue, Englewood Cliffs, New Jersey 07632

The World Publishing Company, 2231 West 110th Street, Cleveland, Ohio 44102 (Publishers of The Clifton Fadiman Lifetime Reading Plan)

READING LITERATURE: UNDERSTANDING POINTS OF VIEW

The discussion on distinguishing between fact and opinion has given the teacher an opportunity to introduce the students to a literature text called Perspectives. The Guidebook and Tactics II to accompany the textbook are valuable aids for the teacher. The sequence of presenting the materials in this unit is merely a suggestion. The different teaching modules may be altered to fit individual classroom needs.

The approach to literature should be social rather than literary. This is based upon the realization that all affective literature is related to life in the same way that a portrait is related to its subject. The aim in reading literature should be "to have one foot in literature and one foot in life."[1]

Lesson One: Understanding Differences in Points of View

ASSIGNMENT

The students should have read the story, "Without Words," in Perspectives, pages 92-100, before coming to class. The teacher may refer to the Guidebook, pages 31-36.

APPROACH

Judgments reflect differences in the viewpoints of readers. There are reasons why viewpoints change. Sometimes our viewpoints may be deliberately influenced by other people. Certainly our background experiences influence our thinking, our actions, and, consequently, our judgments.

NOTEBOOK ASSIGNMENT

Be sure to allow plenty of time for class discussion before asking the students to write their conclusions.

Lesson Two: Listening and Discussing

APPROACH

The students may read silently "A Man Who Had No Eyes" in Perspectives, pages 101-104. Answer as many of the questions as the students seem interested in. Ask the students to note the contrasts in the two men's appearance, actions, and attitudes and to decide whether conclusions may be reached on situations that can influence one's point of view. The conclusions may be added to those already recorded in the student notebooks.

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[1]Murray Bromberg. Making Literature Lessons Live. Prentice Hall, 1961, p. 9.

Read "Best-Hated Man in Town" on pages 104-108 aloud to the students. Read the first two paragraphs and stop to emphasize who is telling the story. (Note the briefness of the first paragraph and the parenthesis in the second paragraph.) Continue reading aloud with expressive emphasis on the examples of grouchiness exhibited by George Beebe and the reaction of the townspeople to his goading of them.

DISCUSSION

Relate the title "Best-Hated Man in Town" to the character traits of George Beebe.

Discuss the meaning of the one word "Best-Hated" as a combination of two antonyms: good and bad.

Lead students into a discussion of the influence of an individual in a community.

You may ask: If you were a George Beebe, what needed changes are you aware of in your community that you would like to mention?

Lesson Three: Time Changes Ideas

The poem "Sea Love" by Charlotte Mew on page 111 shows how time can change one's idea of love. "About Crows" by John Ciardi on page 118 emphasizes the differing of the opinions of the young and old. As one grows older his ideas change. The students can be led into discussions of how their ideas of vocations have changed and are still changing. The only thing we can be sure of about change is that there sill be change. Life does not stand still.

EVALUATION

The characters we have studied are individuals as all of us are. You have written two-sentence biographies of some of these characters: George Beebe, Jan, the two crows, Joe, Mr. Parsons, the peddler, and Mathieu. Now let us try to determine the attitudes that identify the characters by answering two questions: Which characters showed attitudes that were based on reasoning? Which characters based their opinions on their emotions? Be specific in your answers by citing examples from the stories and poems you have read.

These discussions should help the students to understand how difficult it is to separate fact from opinion, whether one is the writer, the speaker, or the listener.

READING LITERATURE: MAKING INFERENCES

APPROACH

The material in the textbook Perspectives on pages 562 and 563 may be used to help the students define inferences. Of course, we must understand an author's ideas that he states outright, but the good reader must become aware of ideas which the author suggests or implies.

Card 35 from Tactics II would be an apt follow-up of the pictured clues in Perspectives. If the teacher wants to relate the reading of literature to advertising in the mass media, she can ask the students to look at advertisements and listen to radio and TV commercials. These questions may be asked: To whom was a particular advertisement meant to appeal? How do you know? The Tactics Cards on inferences from what the author tells you, from conversation, and from actions could be presented before the study of characterization which is presented in the student lessons.

Lesson One: A Study of Contrasts

The students will easily understand that characters are people if they have learned to project themselves into what they read. Relate problems to people. Help the students decide on subject categories for identifying problems. Then if the discussion can be turned towards identifying human traits that may cause or be the result of personal problems, you will be leading the students towards their writing assignment for this lesson.

Take plenty of time to note the evidences of contrasts that can be useful in determining character traits that distinguish one person from another.

WRITTEN ASSIGNMENT

Try to help the students understand that they want to identify one main trait of the person they choose to write about. The mention of ideas about other traits should support the main idea. Help them to write descriptions, anecdotes, and conversation that delineate the trait. The story "Grandfather Tower" by Glenway Wescott is a good example of the writing described above. Grandfather Tower's impatience is pointed out in each section of the story which is also coherent because of the time sequence used to relate the story. Make your explanations to the students for the writing of the composition as clear and simple as possible. Then let the students write in class. They may begin by thinking about a person and jotting down all the ideas that come to mind as they think. Do not be too critical of the students' attempts. Try to help them devise ways to emphasize a single trait.

READING LITERATURE: FINDING THE CENTRAL IDEA

The teacher may easily relate the skill of finding the central idea when reading to the previous writing assignment. Sometimes one also has to read between the lines to understand an author's main idea.

The unit "Spaceways" in Perspectives because of its timeliness will appeal to the students. Use as much of the material available in the text and in the handbook as there is time for or there is indiciated interest. See the Guidebook for Perspectives, pages 103-126, for suggested methods.

The reading of the stories and articles will provoke discussion and curiosity. This will probably be a good time to give the students practice in using the tools for research which have been previously introduced. If there are any types of reports as a result of class interest, they should be brief. Insist that the students use exact terms in making their reports or giving information.

APPLICATION AND IMPLEMENTATION

Companies in business and industry publish attractive brochures containing descriptive materials about various tools, jobs, and machines. This material may be placed in the classroom for the students to browse through. Ask each student to select a job description or a tool description and explain it to the other class members. The purpose of this assignment is to impress on the students that when articles are known by particular names they should not be referred to in terms such as "thing-um-bob."

READING LITERATURE: IMAGERY AND FIGURATIVE LANGUAGE

Lesson One: Inanimate Objects as Images

The teacher should help the students relate what they read to their senses. You are helping them to read with meaning if you can convey to the students that words are meaningless and, in a sense dead, until a reader lifts them from a page and projects them into a world of relevancy.

Since the backgrounds and experiences of people are different, we do not all see the same sensory images when we look at the same objects. You can illustrate this by saying isolated words like car, chair, flower, city, etc., and asking the students to note the different responses.

Use as much of the material in Perspectives, pages 587-598, and the Guidebook, pages 176-177, as you can without losing the students' interest. Get suggestions from the students for some exercises and let them work with each other until they seem to understand imagery.

The story "Papa and the Bomb" is very interesting and the students should enjoy reading it under their own momentum.

The discussion on inanimate objects could be opened with the students' recognizing that we live in a world of things - some useful, some necessary, some unnecessary. The implications of inanimate objects are varied as the students will discover for themselves.

WRITTEN ASSIGNMENT

You may ask the students to write different messages that Papa could have placed in his "bomb." The writing will give you a clue to the depth of their thinking.

Lesson Two: Recognizing Figures of Speech

With the help of the students, probably the teacher should define figurative language. A dictionary definition is not adequate. Before using the exercises in the book on pages 540-549, ask some simple questions that require the students to describe a thing or an action such as the following: How fast did Billy run? How scared were you when you heard the explosion? How did you feel when you knew you were locked in the building? Require that the answers be given in complete sentences. The students will discover that they need to express themselves in terms understood by their listeners or that they must use examples of known actions to be understood.

Refer to pages 72-76 in the Guidebook and to Tactics in Reading II, Cards 25, 26, 27, and 28.

READING LITERATURE: RELATIONSHIPS

APPROACH

The material in Perspectives on pages 574-585 should be carefully discussed with the students so that they clearly understand four kinds of relationships: time order, comparison-contrast, cause-effect, and simple listing. The students should become so familiar with these relationships that they consciously use one kind of relationship or a combination of relationships in the organization of their oral and written compositions. Refer to the Guidebook, pages 152-154.

If more material is needed for drill work on relationships, the teacher may use Tactics in Reading II, Cards 39-43. These cards will be useful in refreshing the students' memories when they begin seriously practicing using different relationships in their writing later.

Lesson One: Relating Inferences and Relationships

ASSIGNMENT

Any anecdotes about O. Henry would be appropriate to introduce this story. Reading this story will give the students an opportunity to practice using the techniques for reading between the lines. Refer to pages 155-156 in the Guidebook.

Lesson Two: The Significance of Titles of Stories

APPROACH

Study the picture on page 351 with the students. Ask what inferences can be drawn from the headnote. Ask the students to read the story silently. Lead a general discussion of the story by letting the students talk freely among themselves and by raising questions. Lead them to the central idea of the story (a gamble against great odds). Then let them discuss the thought question in their exercises. Refer to pages 168-169 in the Guidebook.

Lesson Three: Relationships--Cause and Effect

"Frame-up" on pages 15-33 is a long short story that becomes a gripping detective story. Let the students define frame-up in their own language. Then begin reading the story aloud so that all understand the setting and situation of the story. Ask the students as they continue the reading to try to figure out what really happened on the highway and why it happened.

Lesson Four: Relationships--Comparison and Contrast

Carefully prepare the interpretative reading you will do for the students. Probably you should read the poem twice before letting them read silently for the deeper meaning. Many of them will understand the deeper meaning and should be given an opportunity to try to unearth the meaning.

Introduce "The Mate" by relating it to hunting. Hunting is an exciting and pleasurable sport for many. Read this poem for its meaning. The teacher may need to read the poem aloud to help the students to clarify the meaning. Ask which words forcibly bring out the contrasts of feeling as portrayed in the first and last parts of the poem. See pages 37 and 87 in the Guidebook.

INTRODUCTION TO LANGUAGE: DIALECTS

INTRODUCTION

An approach to the teaching of language to students may very well begin with an understanding of dialects. The definition of dialects in this teaching module is that a dialect is the language of a speech community. It is not a separate language; it simply differs in word choices, pronunciations, and grammatical construction from the same elements of language in another community. Dialects of people in the same community may differ if their backgrounds, environments, and traditions are different. A person's dialect may keep him from pronouncing words correctly, or shall we say in the usually accepted manner. Jenkinson says: "Each man's language differs slightly from that of his neighbors. His use of words, his grammatical constructions, and his pronunciation of some words are not exactly the same as his neighbors. Each man has an idiolect, i.e., each man has a speech pattern that sets him apart from his neighbors . . . . It's no disgrace to speak a dialect. Everyone does."[1]

APPROACH

The teacher will not relate the ideas listed above directly to the students. It will be better to let the students consciously listen for differences among the pronunciation and grammatical constructions of students and others. This teaching module should be presented to a class during a relaxed period of time. So often we English teachers feel that we must begin a school term with what we call a "good grammar review." We think that our students will write better compositions after we have corrected their grammatical errors. This is not necessarily true. The student improves his grammatical constructions as he succeeds in expressing himself about ideas that he has developed on his own.

If you can lead the student into believing that when he has something important to say, that he should want to express it in language that is understood by his audience, you are on the road toward leading him from using a substandard dialect to an acceptable dialect. When you recognize that the student has acquired the finesse of appropriateness of levels of usage, you know you have done an excellent job.

Lesson One: Listening for Dialect Differences

APPROACH

This will be a good time to give the students some relief from teacher-designed academic discussions by letting them discuss a topic of their own

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[1]Edward B. Jenkinson. What Is Language? Bloomington, Indiana: Indiana University Press, 1967, p. 153.

choosing. We find that when people are discussing literary topics, they often use an artificial, stilted language. The purpose of this lesson is to get the students to speak naturally on topics of their interest. You may suggest to the students during one of their club meetings that they plan for a "conversation day" on some subject agreed on by the group. They may spend some time in wording various discussion topics so that everyone is agreed on a general definition and limitation of the subject. You know from experience that no topic can evoke good discussion until all have clearly in mind what the topic for discussion really is. I would let this be a continued lesson if interest in the group warrants this.

PROCEDURE

The students, directed by the teacher, will set up a format for the conversation--chairman, seating arrangement, methods for allowing and encouraging all to speak, etc.

The teacher who is in the background during the conversation period should interfere only if an argument ensues. Quietly explain that this is a conversation group and not a debate group. No one is in the group to settle a controversal matter or solve problems. The discussion is for learning and encouraging thinking.

The teacher or a student will record the conversations for the study of the dialects of the persons involved in the conversation. Play the tapes, stopping to note differences in pronunciations and in syntactical structure. Let the students question and discuss on their own while the teacher points out good examples like different pronunciations for fog, dog, get, etc.

If there are available recordings of the speech of well-known people, they could be played to emphasize further the differences in the dialectal expressions of people from different backgrounds.

TEACHER OBJECTIVE

The teacher will note sentences that represent different sentence patterns. The students will of course use many transforms, but you will use only kernel sentences for the next lesson. You may need to make up some more sentences to clarify your explanations of sentence patterns. Keep the sentences on the students' level and on the subject of the conversation.

KERNEL SENTENCES: THE NOUN PHRASE

Lesson One: Proper Nouns, Personal and Indefinite Pronouns

Either use the overhead projector or write sentences representing various sentence patterns on the board. As the students pick out the subjects and predicates, draw a vertical line separating the two parts of the sentence. A list of sentences illustrating the kernel sentences may include:

1. Joe worked in his shop.
2. The girl has cut her finger.
3. The boss is cheerful today.
4. This answer seems best.
5. A monkey wrench is a tool.
6. She is here.
7. Someone will work in the cafeteria.

Write NP over the subjects and VP over the predicates as,

NP	VP
Joe	worked in his shop.

PROCEDURE

Discuss the vocabulary for transformational grammar with the students:

A. Kernel Sentence

$S \longrightarrow NP + VP$

S = *sentence*
$\longrightarrow$ = *may be written as*
NP = *noun phrase*
VP = *verb phrase*

NOTE: A phrase may be a single word or a group of words.

B. Noun Phrase

NP = *proper noun, personal pronoun, indefinite pronoun, or Det + n*

1. To introduce the NP you may use the following idea: You may ask the students to write their names. Some of the students may write their names on the board. Ask, "Why did you use capital letters?" (Be sure to include in the reasons the idea of avoiding confusion: We gave the book to Sue and The man will sue you.) One way to recognize the proper nouns is by their being capitalized. Ask the students to write other proper nouns that are not names of people. List them on the board. Call their attention to the built-in the in some words that is not capitalized: the Mississippi River, the ARKANSAS GAZETTE, the United States . . . .

2. Then say, "Let us talk with each other without addressing anyone by name. We may have to point or use gestures to be understood." To introduce a topic you may say, "I am pleased with the reading you have been doing. What have you learned that you wish to share with us?"

   When the conversation begins to lag, help the students to note that they have been using personal pronouns because they have been talking to and about certain people.

3. Ask the students to suggest words that they would use if they want to talk about people and things in general. Write on the board this list of words: every-, some-, any-, no-, -one, -body, -thing. Ask the students to make compound words using combinations of words in the list. Then say, "These are indefinite pronouns."

4. Now flash on the screen again the sentences listed at the beginning of Lesson One. Ask the students to pick out the proper nouns, the personal pronouns, and the indefinite pronouns in the noun phrases.

   Say aloud the noun phrases in sentences 2, 3, 4, and 5. Ask, "What do you note about them?" (The noun is preceded by another word that helps us to get the sentence started.) The word preceding the noun is called a determiner. A noun phrase like this is written as NP $\rightarrow$ Det + N.

ASSIGNMENT

Ask the students to write ten sentences. Direct them to draw a vertical line after the noun phrase. Over the noun phrase, write what kind it is Remember a phrase may be one word or more.

Lesson Two: The Noun in Det + N

APPROACH

Write these sentences on the board:

1. The boys will run the machine for us.
2. Boys can run fast.
3. Some boys do not like girls.

Ask the students with your help to pick out the determiner in each sentence. <u>The</u> is a definite article. (You may want to stop here to define an article in this sense.) <u>Some</u> is a nondefinite article. Name others. Sentence two has no determiner, but the word <u>boys</u> belongs in the category Det + N. The word <u>boys</u> is a count noun.

The word null may be a new word for the students. It is simply a term used to indicate the absence of a word. Refer to sentence two. The sign for null is Ø.

PROCEDURE

Ask the students to substitute a or an for the articles in the above sentences. What happens to the word boys? It becomes boy. With your help ask the students to note that one characteristic of a noun in Det + N is that it can be counted. Can all nouns be counted? No. Name some. (furniture, blood, sugar . . .)

Now we can indicate that nouns in Det + N are of two kinds:

N ⟶ count + plural
noncount

Use as much oral drill as is necessary to be sure everyone understands Det + count + plural nouns or Det + noncount nouns.

ASSIGNMENT

Ask the students to bring to class useful objects, like tools, that they can write and talk about. Discuss carefully with them the following outline that will help you in evaluating the organization of their oral and written compositions. Give them one grade on organization and one on subject-verb agreement. Ask them (1) to define the object by telling what it is made of and describing its features and then (2) to explain the usefulness or practicality of the object.

See Writing: Unit-Lessons in Composition, pages 73-75, for examples of definitions. Parts A and B contain suggestions for helping the students to prepare their compositions.

FOLLOW-UP ASSIGNMENTS

1. Evaluate the oral composition by the number of questions unanswered by the student in his report to the class.

2. Check the errors in agreement of the subject and verb and ask the students to rewrite these sentences for you.

Lesson Three: The Determiner in Det + N

Explain the part of the vocabulary in the student exercises pertaining to determiners. In an oral exercise ask the students to make sentences using different determiners. Talk about the meaning of the demonstratives. Explain that careful use of determiners helps one to be understood.

KERNEL SENTENCES: THE VERB PHRASE

APPROACH

Recall the formula S ⟶ NP + VP. Choose from some of the student compositions sentences to represent the different verb patterns. Use the overhead projector to show the students the sentences. Help the students to separate the noun phrase and the verb phrase in each sentence. Because there has been a written and oral composition lesson since the study of the noun phrase, ask them to identify the noun phrases as proper nouns, personal pronouns, indefinite pronouns, and Det + N.

Lesson One: The Verb be

PROCEDURE

A. The verb we use so often is the verb be. There are different forms of the verb be. See how many you recognize in these sentences.

1. The book is on my desk.
2. I am hungry.
3. Our coach is a hard-working person.
4. The teacher will be here.
5. The girls were scared.
6. Christmas is vacation time.
7. The children are happy.
8. Jane was late this morning.
9. The waiter had been unhappy.
10. The boys have been in the shop.

Separate the sentences with the vertical line drawn between the subject and the predicate so that the entire verb phrase is noticeable. Ask what question is answered by the word or phrase after each be form in the predicate. (Sentences 1 and 4 answer where. Sentences 3 and 7 answer who or what. In the other sentences the verb be is followed by a word that describes.) We can now write a rule stating that the verb be needs a completer which may be an adverb of place, a noun (NP), or an adjective:

The verb be must be followed by a NP, an adjective, or an adverb of place.

B. Write these sentences on the board:

1. The man is looking for you.
2. They were here yesterday.
3. Joe had been waiting for us.

4. The teacher is kind.
5. The teacher is talking to her class.

Read each sentence aloud. Ask the students to decide which sentences contain the verb be. Then ask "How do you account for the be forms in sentences 1, 3, and 5?" Hopefully you will get an answer that the word is helping the predicate in the sentence. Write the word auxiliary on the board and tell the students that there is an auxiliary in every verb phrase. Explain the following formula:

VP → Aux + be + *NP, adjective, or adverb of place*

or

Aux + verbal

The auxiliary carries the tense signal which comes first in the verb phrase. Every verb phrase must have a tense signal. The two tenses are past and present.

THE VERB PHRASE: THE VERBALS

INTRODUCTION

Before we go deeply into the study of tense, we must discuss carefully the word verbal in the above formula.

Lesson One: Transitive Verbs

PROCEDURE

The word verbal refers to all finite verbs except the verb be. There are different types of verbals which we will present one at a time.

A. Write these sentences on the board:

1. Mother broke the vase.
2. She dropped her purse.
3. Some people are studying their lessons.
4. James will tell the story.

Ask these questions:

1. Who or what is the actor in each sentence?
2. What action is named in each sentence?
3. Who or what is the receiver of the action in each case?

B. Ask the students to make the receiver of the action the subject of the sentence and note how the sentence sounds:

1. The vase was broken by Mother.
2. Her purse was dropped by her.

3. Their lessons are being studied by some people.
4. The story will be told by James.

Following is a suggested way for helping the students understand the transitive verb:

NP		VP
actor	+ action	+ receiver of action
Mother	+ broke	+ the vase

NP		VP	
receiver of action	+ action	+ by	+ actor
The vase	+ was broken	+ by	+ Mother

When there is a receiver of the action in the sentence, the verbal is a transitive verb hereafter referred to as V_t.

Lesson Two: Intransitive Verbs

Write these sentences on the board. These sentences contain intransitive verbs. Do they seem to be used in the same manner in all the sentences?

1. Babies cry loudly.
2. Some girls become secretaries.
3. People gossip.
4. The children were playing in the street.
5. The corn grew tall.
6. The candy smells good.
7. The boys became tired on the hike.

(1) In which of the sentences can we recognize sentence sense by just saying the subject and the verb proper? (Sentences 1, 3, 4) For sentences like these, we say the $VP \longrightarrow Aux + V_i$.

(2) Look at sentences 2, 5, and 7. Each has a form of the verb <u>become</u>. In sentences 2 and 5 <u>become</u> is followed by an adjective. For sentences like these we say the $VP \longrightarrow V_b$ + *NP* or *adjective*. In sentence 5, the verb is grew which has a semblance of the meaning of become.

(3) Look at sentence 6. One of the verbs indicating sense (smell) is followed by an adjective. For a sentence like this we say the $VP \longrightarrow Aux + V_s$ + *adjective*.

Lesson Three: The Verb <u>have</u>

Explain the difference between these two sentences:

1. James has a car.
2. James has broken the rules.

Put the test for a transitive verb to sentence 2: actor + action + receiver and receiver + action + by + actor. Now do the same for sentence 1. Because there is no receiver of the action named in sentence 1, we cannot say that has is a V_t. For the verb have we say the $VP \longrightarrow Aux + V_{mid} + NP$.

The teacher may summarize by asking the students to refer to the vocabulary included in their exercises in Introduction to Language.

THE VERB PHRASE: THE AUXILIARY

APPROACH

Let's discuss the meaning of the word morpheme. The root morph simply means form. A morpheme is a form that indicates the smallest unit of meaning. A morpheme may be a word or a part of a word. Man is the smallest unit of meaning in the three-lettered word, m-a-n. In the word manly there are two morphemes: man + ly. In the word manliness there are three morphemes: man + ly + ness. (Note how the spelling changes.)

Morphemes are important in the verb phrase because we must change the forms of the verb be and the verbals as we attempt to communicate accurately.

For our purposes in studying the auxiliary in verb phrases, let's think of the morpheme as the smallest unit of meaning that can change the form of the word to indicate the meaning we are conveying to our reader.

Lesson One: Present and Past Tense of the Verb be

It would be impossible for us to write all the tense forms of all the verbs that we use in our writing so we use morphemes: present tense --- Pres; past tense --- Pas. The grammatical concept tense has to do with form, not with meaning. We have noted earlier in the discussion of the verb phrase that either past or present tense is always indicated. A writer or speaker must have some method of indicating the relationship of the time of action and the time of the speaking or writing about the action in a sentence.

We are going to attack the verb be and the two tenses first because the verb be has many forms. Following is a table that you will write in your notebooks to refer to often:

be + Pres ⟶ am when the subject is I
be + Pres ⟶ is when the subject is he, she, it, a proper noun, an indefinite pronoun or a Det + N when N is not plural
be + Pres ⟶ are in all other cases
be + Pas ⟶ was when the subject is I, he, she, it, a proper noun, an indefinite pronoun, or a Det + N when N is not plural
be + Pas ⟶ were in all other cases

The table above may be referred to when the teacher is discussing subject-verb agreement.

Use the practice sentences in the student exercises for drill. Be sure every student has a chance to participate.

Recall that the noun in Det + N may be either a count or a noncount noun. If the noun is one that can be counted, we simply mean that it has a plural form. The morpheme for plural is s: boy + s = boys; man + s = men; sheep + s = sheep.

Some of the sentences in the exercises will contain the morpheme s in addition to the morphemes Pres and Pas. The symbol # stands as the marker of the beginning or end of a word.

Lesson Two: Other Elements in the Auxiliary

We must stress that every verb phrase has tense. The tense will either be present tense or past tense. Tense is a morpheme that usually affects the form of the first word in the verb phrase. To illustrate this point look at these sentences with the students.

1. The boys are here.
2. Someone is coming.
3. Jane has been ill.
4. She will be a teacher

Separate the noun phrase and the verb phrase in each sentence. Now let's concentrate on the verb phrase.

Aux $\longrightarrow$ tense + (modal) + (have + part) + (be + ing). The morphemes are tense, part, and ing because they change the form of a word. Tense is required in all verb phrases. The other elements in parentheses may or may not be used. If any of them are used, they must follow the sequence listed above. The modals are can, will, shall, may, must. Present tense does not change the form of these modals. Must is always written must + Pres. The past tense changes the following modals:

can + Pas $\longrightarrow$ could
shall + Pas $\longrightarrow$ should
will + Pas $\longrightarrow$ would
may + Pas $\longrightarrow$ might

If we use the past participle form of a word, we indicate that there is a have in the sentence by using the morpheme part after have. Be + ing in the sentence indicates that an ing verb is in the sentence. Now for fun let's see what verb phrases we can form by using the formulas we have studied.

Every verb phrase begins with tense. Any other one or all the elements in the auxiliary may be used in sequence.

We will use he as the noun phrase.

1. He + Pres + be + ing + choose + a + new + hat.
   He # is # choosing # a # new # hat.

2. He + Pas + call + me.
   He # called # me.

3. He + Pres + will + be + ing + come + soon.
   He # will # be # coming # soon.

Now let the students look at their formulas for the verb phrase and make some sentences. Everyone should use the same noun phrase in his sentences. You work at the board saying aloud that we begin with tense. Choose either past or present. Then choose from the other elements of the auxiliary what pleases them. Then choose the verb be or a verbal. Help them to do this correctly. Go slowly at first. You may work two or three problems on the board with the students speaking out. Then have a quiet time, and let the students work on their own while you check their papers at their desks. Practice on exercises a short time each day until all the students can handle the verb phrase easily.

ASSIGNMENT

After you feel that the students can work on their own, ask them to write in their notebooks the sentences on their exercise sheet, using the example preceding the sentences.

OUTGROWING LESSONS

When you hear an ungrammatical sentence, write the sentence on the board and with the students' help try to write the NP and the VP of the sentence. Maybe this exercise will help the students to see that learning the VP will help them to write and speak effectively.

KERNEL SENTENCES: QUESTIONS

Lesson One: Yes/No Questions

APPROACH

I believe you are beginning to see that language patterns are natural. We seem to have a built-in knowledge of sentence sense. Let's use this built-in knowledge to describe how we ask questions that can be answered with either yes or no.

PROCEDURE

Write sentences for these strings:

1. Sue + Pres + be + ing + wait
   (Sue is waiting.)

2. A woman + Pres + have + part + be + here
   (A woman has been here.)

3. The boy + Pres + can + run + fast
   (The boy can run fast.)

Now write each of the sentences as a yes/no question.

1. Is Sue waiting?
2. Has a woman been here?
3. Can the boy run fast?

Now let us look again at the string for the first sentence:

Sue + Pres + be + ing + wait

Write the string for the question.

Pres + be + Sue + ing + wait

Describe what you have done. (You moved the first two items in the auxiliary to the front of the sentence: Pres + be.) Continue with the exercise, letting the students note that in writing simple yes/no questions we move the tense + be, or tense + modal, or tense + have to the position in front of the NP or subject.

Lesson Two: Using do in yes/no questions

Change these sentences into yes/no questions:

1. Jane walked to school.

2. The boy runs fast.
3. Joe works after school.
4. The shop teacher guided his students in their work.

The students will spontaneously respond by adding the correct form of do at the beginning of the sentence:

1. Did Jane walk to school?
2. Does the boy run fast?
3. Does Joe work after school?
4. Did the shop teacher guide his students in their work?

Now ask the students to describe the questions they have made by writing the string for the sentence.

1. Pas + do + Jane + walk + to school
2. Pres + do + boy + run + fast
3. Pres + do + Joe + work + after school
4. Pas + do + shop teacher + guide + his students + in their work

Lesson Three: Wh- Questions

Change these sentences into appropriate questions. Your questions will not be answered by simply a yes or a no:

1. Mary is in her room.
   (Where is Mary?)

2. My sister is coming here at noon.
   (When is your sister coming here?)

3. Jack read the directions carefully.
   (How did Jack read the directions?)

4. Sue broke her new watch.
   (What did Sue break?)

5. Bill can run very fast.
   (How fast can Bill run?)

6. Jim stayed at home because he was ill.
   (Why did Jim stay at home?)

There might be other questions suggested for sentences like the second one: Who is coming here at noon? Where is your sister coming at noon? Whose sister is coming here at noon? This would be an opportune time to discuss the necessity of being specific in asking questions to evoke the answer one is looking for.

USING TRANSFORMS TO WRITE EFFECTIVE SENTENCES

We also have a built-in knowledge about transforms. Transforms are kernel sentences that have been expanded by modification, subordination, and coordination. We use transforms to be specific in what we are saying--to answer the anticipated questions of our audience.

Let's choose a plural noun and verb to illustrate what we mean.

1. Babies cry.
   (Which babies cry?)
2. All babies cry.
   (What kind of babies?)
3. All spoiled babies cry.
   (How spoiled are they?)
4. All very spoiled babies cry.
   (How do they cry?)
5. All very spoiled babies cry loudly.
   (When do they cry?)
6. All very spoiled babies cry loudly when their mothers are busy.

Let the students choose noun phrases and verb phrases and then ask questions to add to the sentences.

Choose sentences at random from the students' writing. Use the overhead projector to show the students the sentences. Discuss the sentences before asking for suggestions for rewriting the sentences.

Choose paragraphs that the students have written and present them with the overhead projector. Let the students combine some of the sentences by using coordination and subordination. You should receive a variety of suggestions for combining sentences. Probably all the suggestions will be grammatically correct, but some combinations will sound better than others. Let the students recognize the effective sentences without your prodding them.

NOTE: If you do not have appropriate examples from your students' writing, you may use sentences from their reading materials for the exercises. Be sure the sentences and paragraphs are studied orally. A student benefits more from hearing the language than from merely writing it for a grade. If he is trained to listen for good sentences, he may be helped to "hear" the sentences he himself writes.

See Writing: Unit Lessons in Composition pages 31 to 39 for practice exercises in writing effective sentences.

STEINBECK'S *THE PEARL*: A STUDY OF AN AUTHOR'S USE OF LANGUAGE

INTRODUCTION

The text used for this unit is a Bantam Pathfinder Edition (ED78) of The Pearl by John Steinbeck.

In The Sea of Cortez, Steinbeck has recorded the myth of a La Paz Indian boy who found the pearl. The teacher may or may not present this story before studying the novel. The English Journal, October 1963, contains a discussion of the relation of the myth to Steinbeck's story, The Pearl.

APPROACH

Steinbeck's stories are unforgettable because of the language and style he uses to weave a worthwhile story. The Pearl may be used as a study of the human characteristics of all of us regardless of where we live or who we are. We all have the same needs--food, shelter, clothing--and we are guided by traditional teachings. We experience the same feelings--jealousy, hate, anger, love, hopelessness--to which we respond in various ways. Steinbeck uses different songs in his story to indicate the fortunes and misfortunes of Kino and Juana and their fellow villagers in La Paz. The description of a song helps the reader to project himself into the story because he is made aware of the tone of the story.

PROCEDURE

Because the purpose of this unit is to study the uses of language, the teacher should read the story aloud so that the students hear the language.

Lesson One: Chapter One of The Pearl

Read chapter one without pausing. Then by calling attention to sentences and paragraphs, point out how the students may enjoy the story more if they read between the lines. Go slowly in your interpretations so as not to overwhelm students for whom the close reading of a story is new.

The first paragraph of any story is important and usually helps the reader to orient himself to the action, the setting, and possibly to the characterization in a story. The first paragraph of The Pearl is puzzling and will have no meaning until the student understands the whole story. In his introduction Steinbeck says, "And, as with all retold tales that are in people's hearts, there are only good and bad things and black and white things and good and evil things and no in-between anywhere." The first sentence in the story, "Kino awakened in the near dark," contains one of the contrasting ideas--darkness. Also there is in the first paragraph

a description of animals. Man is animal. How does man work to satisfy his needs? What do animals do for their needs?

On page 2 we have the first mention of the songs with the explanation that everything the people saw or thought or did or heard became a song. There are personal songs. Kino's first song is the Song of the Family. What are the sounds, sights, and actions that make up Kino's Song of the Family? On page 6 the Song of the Family becomes the Song of Evil. Why?

The story opens with the dawning of a day and the description of the full dawn continues.

-- "The stars still shone and the day had drawn only a pale wash of light in the lower sky to the east." (page 1)
-- Kino went outside to watch the dawn. "The dawn came quickly now, a wash, a glow, a lightness, and then an explosion of fire as the sun rose out of the Gulf." (page 2)
-- "The world was awake now . . . ." (page 5)

Folk beliefs and folkways are woven into most stories, and <u>The Pearl</u> is no exception.

-- "When Kino had finished, Juana came back to the fire and ate her breakfast." (page 5)
-- "He lowered his blanket from his nose, now, for the dark poisonous air was gone and the yellow sunlight fell on the house." (page 5)
-- "The thing had become a neighborhood affair." (page 10)
-- " . . . Juana repeated an ancient magic . . ." (page 6)

Sensory descriptions are used to stir the senses of the readers, to draw them into the story.

-- " . . . the sound of breakfast . . ." (page 4)
-- "They could hear the splashing water." (page 12)
-- "And they could smell the frying of good bacon." (page 12)
-- "Kino could see the green coolness . . . ." (page 13)

Other descriptive passages are noted:

-- A description of the doctor (pages 13 & 14)
-- A description of the procession (page 10)
-- Descriptions of the animals (page 5)
-- A description of the animals (page 3)
-- Description of the animals (page 1)

A good author will quite often describe an incident that causes the reader to recognize certain emotions. Sometimes the writer states the emotion to explain certain actions:

-- "Kino felt weak and afraid and angry at the same time. Rage and terror went together." (page 12)
-- "The doctor put his cup down gently before he let his anger rise." (p. 14)
-- "And now a wave of shame went over the whole procession." (page 15)

On page 16 there is an example of a bared emotion shown through the actions of Kino. Why does Kino strike the gate?

Steinbeck is a good story-teller. Let's note first a sentence on pages 2 and 3 that indicate simple movements (actions) without any embellishing: "Juana went to the fire pit and uncovered a coal and fanned it alive while she broke little pieces of brush over it." There are many sentences like this in the story. We call this moving the story by narration. On pages 6-8 we have a narration of an incident that brings tenseness to the story. The visit to the doctor in town, pages 13-15, is another incident that adds to the suspense of the story. How does the author in his use of language bring about a feeling of tenseness in the reader?

Inanimate objects are important in stories. The author quite often introduces an object early in the story and then refers to the object from time to time so that the role the object plays becomes a thread of the plot.

The inanimate object in the first chapter is Juana's shawl. On page 4 we are told how Juana "hammocked her child in her shawl." The shawl is mentioned again on page 10 when the family is preparing for the visit to the doctor.

Lesson Two: Preparing for Group Discussions

The students will probably be able to continue the analyzing begun with the study of the first chapter. They may want to work in groups so that each student does not have to concentrate on all the ideas. Then in the group discussions from time to time the students who have worked on a particular idea can contribute to the discussion. Probably the students will realize from their discussions how an author weaves a story by using the language purposefully. Following are some ideas that may serve as topics:

1. Bared emotions shown through the actions of characters
2. Folk beliefs and folkways
3. The different dawnings of new days
4. Songs and music
5. Sensory descriptions
6. Narrated incidents

Following is a list of references for each topic. The teacher and the students will find other references during their study:

1. Bared emotions

-- Juana dares to try to throw the pearl into the gulf. Kino is brutal. Why? He loves Juana. (page 76)
-- They must save themselves. (page 79)
-- Kino is not an evil man. (page 80)
-- He feels a surge of exhilaration. (page 81)
-- Kino is a killer. (page 113)
-- Triumph (page 26)
-- What brought on the emotions, fear and rage? (pages 47-48)

-- tension (page 50)
-- emotions bared by the man with a coin in his fingers (pages 62, 65)
-- afraid of the unknown (page 69)
-- Juan Tomas is afraid for Kino (page 70)

2. Folk beliefs and folkways

-- "It is not good to want a thing too much. It sometimes drives the luck away." (page 24)
-- "The Father is coming." (page 35)
-- "Gods do not love men's plans, and the gods do not love success" (page 38)
-- covered noses (page 44)
-- the way he wore his hat (page 57)
-- old ways of great-great grandfather (page 60)
-- idea of a canoe (page 80)
-- mourning (page 83)
-- evil night air (page 87)

3. The different dawnings of new days

-- after a murder (page 81)
-- the day the pearl is to be sold (pages 51 and 55)
-- The late moon arose before the first rooster crowed. (page 75)
-- "All night they walked, and the first dawn Kino searched the roadside for a covert to lie in during the day . . . . And then, in the first light he heard the creak of a wagon." (pages 91 and 92)

4. Songs and music

-- Song of the Pearl that might be (page 22)
-- secret melody of the maybe pearl (page 26)
-- music of the pearl merged with the music of the family (page 30)
-- music of the pearl: truimph (page 33)
-- the song changes. Why? (page 35)
-- Song of the Family (page 37)
-- Song of the Family (page 43)
-- Song of Evil (page 47)
-- Evil (page 66)
-- Song of the Family (page 72)
-- evil music (page 80)

5. Sensory descriptions

-- imagery (pages 46, 47)
-- news of the pearl (page 30)
-- the dark and the light (page 82)
-- metaphor (page 27)

Lesson Three: Ideas for Composition Following the Study of The Pearl

A. Some of the comparisons in the story may be studied. The techniques for writing comparison-contrast paragraphs should be discussed before the students are asked to write. For examples of writing comparison paragraphs see the two paragraphs on Imaginings on page 34 and the paragraph on page 30, beginning with "But Kino and Juana did not know these things." See also "Develop meaning through comparison," pages 86-90, in Writing: Unit-Lessons in Composition.

These are topics based on The Pearl that may be studied or outlined:

1. The doctor (pp. 11 and 14) and Kino (p. 4)
2. The village (p. 10) and the town (pp. 17 and 27)
3. People with things to sell and people with favors to ask (p. 29)
4. The incandescence of the pearl (pp. 31 and 51) and the darkness of the pearl (pp. 93, 94, and 117)
5. A family leaving (p. 89) and a family returning (p. 114)
6. Kino's visit to the doctor (pp. 13-15) and the doctor's visit to the village (p. 38)

B. Some of the students may want to choose an inanimate object in the story and explain how the author purposefully uses the object. Of course, the pearl is the most important inanimate object and a discussion of it could be divided into different phases. Other objects include: Juana's shawl (pp. 10, 11, 19, 20, 31, 34, 47, 57, 115)
Kino's canoe (pp. 19, 80)
a rifle (pp. 32, 93, 109, 113, 114, 115, 117)

Lesson Four: Review Questions

Following is a list of questions that the teacher may use as the book is being read to see if the students are understanding the story. Or the questions may be used for review and discussion at the end of the study.

Chapter One

1. What does a pearl commonly represent? What does it represent at the beginning of this novel?

2. What evidence is there in chapter one that Kino and Juana were poor? What evidence is there that they were superstitious?

Chapter Two

1. Why was Kino's boat extremely important to his way of life?

2. Describe in detail Kino's discovery of the pearl from the time he first saw the oyster until the time when he removed the pearl from the oyster.

Chapter Three

1. As news spread through the town about Kino's discovery, various people reacted differently. Explain how the priest, the shopkeepers, the doctor and the pearl buyers reacted when they heard the news. What do you think of their reactions?

2. Explain the meaning of the following two sentences:
"The essence of pearl mixed with essence of men and a curious dark residue was precipitated." (pages 29, 30)
"The news of the pearl stirred up something infinitely black and evil in the town . . . ." (page 30)

3. Why, after he discovered the pearl, did Kino become "every man's enemy"?

4. What were Kino's plans for his family now that he had discovered the pearl?

5. Why do you think the song of evil came into Kino's mind when the priest appeared?

6. Why does Kino begin to feel "alone and unprotected"? (page 37)

7. What was the doctor's real purpose in going to see about Kino's baby? How did he discover where Kino had hidden the pearl?

8. After Kino had attacked the intruder who tried to find the pearl, what did Juana want to do with it?

Chapter Four

1. Why did all the neighbors go with Kino and Juana to the pearl buyers?

2. What did the first buyer say about Kino's pearl? How much did he offer Kino for it? Why did Kino not accept the offer?

3. What were the two opinions among Kino's neighbors concerning his refusal to sell his pearl? Do you think he should have sold it? Why?

4. What did Juan Tomas mean when he said, "You have defied not the pearl buyers, but the whole structure, the whole way of life, and I am afraid for you"?

5. What did Kino decide tc do after he refused to sell his pearl?

6. Why does the author never reveal the identity of the persons who attacked Kino and tried to steal his pearl?

Chapter Five

1. What did Kino do to Juana when she tried to destroy the pearl? Why do you think he reacted in this way?

2. What made Juana realize that the old life was gone forever, and that the only thing they could do now was save themselves?

3. Why was the destruction of Kino's boat worse than killing a man? Why didn't Kino consider the possibility of stealing one of his neighbor's boats?

4. What happened to Kino's house?

5. How did Juan Tomas help Kino and his family escape?

6. Kino referred to the pearl as his misfortune, his life, and his soul. What do you think he meant?

Chapter Six

1. How did Kino reply to Juana's remark that perhaps the dealers were right and the pearl was valueless?

2. What did Kino want Juana and Coyotito to do after he discovered they were being trailed? Why do you think Juana refused?

3. What were some of the ways Kino attempted to make the trackers lose their path?

4. How did Kino Plan to attack the trackers? What were Juana and Coyotito supposed to do? What happened to Coyotito during the fight?

5. Why did Kino and Juana return to La Paz? Why do you think they walked side by side?

6. Why did Kino throw away the pearl? Why did Juana, at this point, refuse to do it? Why do you suppose Kino threw the pearl into the sea? Could he not have thrown it away in the mountains? Explain.

SHAKESPEARE'S USE OF LANGUAGE: JULIUS CAESAR

Lesson One: Improvisations

INTRODUCTION

Because Shakespeare is the best portrayer of human nature, everyone should have an opportunity to become acquainted with the language that Shakespeare uses to reveal a story through the human traits of his characters.

Through improvisations the students can recognize the feelings and actions of people caught in situations similar to those in Julius Caesar. Improvisations are natural for students when they become involved in trying to explain even a simple incident. Talk, gesture, and movement work together. The teacher, when she knows her class, can decide whether she wants to begin discussion with the entire class or whether she wants the students to work in groups, with each group pursuing a different idea.

We are including in this lesson some suggestions for improvisations that the students can relate to and then relate to their study of Julius Caesar. The copy of Julius Caesar that we refer to is Julius Caesar by William Shakespeare, adapted by Jack A. Wapen and Leroy S. Layton, Globe Book Company, 1952.

The students' reactions and feelings in these situations may not be the same as those described in the dialogue in Julius Caesar. The students will recognize the situations when Julius Caesar is read and the play becomes relevant to them. James Moffett writing in Drama: What is Happening? says that if a play works, communicates, it is because the same social forces that have installed voices in the author have also installed them in the spectator. Dr. Moffett is talking about the experience of seeing a play. Reading a play will not be as effective unless the listener and reader can identify with the characters. Improvisation is one method that helps the readers because they become involved in situations similar to those in Julius Caesar.

SUGGESTED SITUATIONS

1. A man is warned that he will have bad luck or even may be killed if he leaves his house. Someone, maybe his girl friend or wife, tries to persuade him to stay at home. Act I, ii, 22; Act II, ii, 8-10

2. Two friends meet. One acts a bit cool toward the other. Act I, ii, 30-75

3. A new hero appears on the scene, replacing one who has been quite popular. How would the crowd react? How would friends of the former hero react? How might a jealous "friend" react? Act I, i; ii, 89-129.

4. Make detailed plans of a plot to get even with somebody. Can you trust all the plotters? The plotters may have a disagreement. The leader will use persuasive tactics to convince others to follow the plan. Act I, iii, 120-160; Act IV, ii, 15-45

5. Suppose you do something that you shouldn't have. Someone questions you. How do you cover up your actions? Act II, i, 231-255

6. Discuss how you would react to being betrayed by your dearest friend. Through dialogue and pantomime construct scenes to portray your ideas. Act III, i, 79

7. A friend of a murdered man attempts to find the truth about the murder. How would he approach the murderers? What excuses would the murderers give for the killing? How do the murderers convince a mob of the reasons for killing? Act III, i, 130-150; Act III, ii, 14-60

8. A friend or friends of a murdered hero stirs the people to rioting. What kinds of speeches will be used? How will the crowd react? Act III, ii, 73-265

9. An innocent man is killed. Why? Act III, iii, 5-35

10. One is a boaster. How will his associates react? Will they try to show him up by giving him a dare? Act IV, ii, 75-96

Lesson Two: Reading the Play

The teacher may begin by reading the play aloud to the students until they are in tune with Shakespeare's language. Stop frequently to interpret so that the play has meaning for the students. Play a recording to let students hear the language. Filmstrips will also help to picture the various scenes in the story.

Lesson Three: Thinking About the Play

1. How do some people gain power?

2. What is a rabble-rouser? Is Brutus one?

3. Why is it that those who receive greatness and honor are often envied by others, sometimes their closest friends?

4. How does Antony use facts and opinions in Act II to influence the people? List the known facts. Which is more effective for his purpose, fact or opinion? See Writing: Unit Lessons in Composition, Unit 22.

5. Brutus' errors in judgment led to the failure of the conspirators' plan to overcome Caesar and his influence in Rome. What errors did he make?

NOTE:- There are good study questions in the student's textbook that may be used for discussion and writing.

WRITING AN AUTOBIOGRAPHY

Tenth grade students should write an autobiography that can be filed in their individual folders for reference later. Many of the students will have a misconception of what an autobiography is because they are familiar with biographies that are records of the lives of people. Tell them that you do not want a theme that sketches their lives from the day they were born to the present. Rather you would like to know about moments in their lives that have had an impact on some of their decisions or has helped them to develop a personality. Reading books from the Impact Series (Holt, Winston) will be a starting point for discussion. You may help the students recall that they have written some about themselves as they identified their personalities when they were discussing attitudes and careers. Then you may say, "I do not want you to try to tell the whole story of your life; I do want to know you better, and you are the only one who can tell me about yourself. A very wise man once said, 'I am a part of all that I have met.' To me this means that I am what I am because of the experiences I have had, the people I live with, the people I have met, the books I have read. Of course, I am also what I am naturally. My personality reflects my likes and dislikes, my disappointments and satisfactions, my joys and sorrows."

Tell the students that they should write about the things about themselves that are important to them. They should tell in detail those experiences which keep coming to mind as they think about themselves. They may like to forget some experiences, but these may be important to their autobiographies. They may tell about unusual hobbies or ideas, persons that have greatly influenced them (rightly or wrongly), recognitions they have had, or problems they have faced or are facing. The autobiographies should reveal the students' thinking about such things as schools, jobs, religion, politics, etc.

The teacher will need to help the students to limit their topics to a central idea. The paragraphs in the body of the theme will contain incidents or illustrations or examples that will each emphasize the central idea or add more information about the central idea.

Following are references that will be useful:

Brooks, Charlotte, editor. Holt's Impact Series. New York: Holt, Rinehart and Winston, 1968.

Wolfe, Don M. Creative Ways to Teach English. New York: Odyssey Press, 1966.

Wolfe, Don M. "Fruitful Long Paper: The Autobiography." English Journal, Vol. 45 (January, 1956), pp. 7-12.

A SUGGESTED READING LIST FOR VOCATIONAL STUDENTS

Art, Music, and Poetry

Glass, Paul and Louis C. Singer, Songs of Forest and River Folk
Glass, Paul and Louis C. Singer, Songs of Hill and Mountain Folk
Lytle, Ruby, What is the Moon?
Pflaum, George A., publisher, 40 + 1
Leisy, , Songs for Pickin' and Singin'
Scott, John Anthony, The Ballad of America
Silver, , The Pop Makers

Biography

Anderson, Marian, My Lord, What a Morning
Angell, Pauline, To the Top of the World
Baldwin, James, Notes of a Native Son
Bontemps, Arna, We Have Tomorrow
Burgess, Alan, The Inn of the Sixth Happiness
Burt, Olive, First Woman Editor Sarah J. Hale
Chevigny, Hector, My Eyes Have a Cold Nose
Chute, Marchette, Introduction to Shakespeare
Clark, Jim, Jim Clark at the Wheel
Cornel, Adam Lengyel, Presidents of the U.S.A., Profiles and Pictures
Dewey, Anne Perkins, Robert Goddard, Space Pioneer
Dooley, Tom, Before I Sleep
Dooley, Tom, Dr. Tom Dooley, My Story
Dooley, Tom, The Edge of Tomorrow
Frank, Anne, Diary of a Young Girl
Freedman, Nancy and Benedict, Mrs. Mike
Garst, Shannon and Warren, Ernest Thompson Seton, Naturalist
Gibson, Althea, I Always Wanted to be Somebody
Gunther, John, Death Be Not Proud
Hall, Gordon and Anne Pinchot, Jacqueline Kennedy
Hano, , Willie Mays
Hersey, John, Hiroshima
Hickok, Lorena A., The Touch of Magic
Horgan, Paul, Citizen of New Salem
Horne, Lena and Richard Schickel, Lena
Howarth, David, We Die Alone
Hubler, Richard, Lou Gehrig, Iron Horse of Baseball
Kayira, Legson, I Will Try
Keith, Agnes Newton, Three Came Home
Killilea, Marie, With Love from Karen
King, Martin Luther, Why We Can't Wait
Kugelmass, J. Alvin, Ralph J. Bunche: Fighter for Peace

Levine, I. E., Inventive Wizard, George Westinghouse
McPhee, John, A Sense of Where You Are
Malkus, , The Story of Winston Churchill
Mantle, Mickey, The Quality of Courage
Marshall, Catherine, A Man Called Peter
Martin, Betty and Evelyn Wells, Miracle at Carville
Mayerson, Charlotte, Two Blocks Apart
Patterson, Floyd, Victory over Myself
Peare, Catherine Owens, The FDR Story
Peare, Catherine Owens, Mary McLeod Bethune
Rankin, William H., The Man Who Rode the Thunder
Rich, Josephine, Pioneer Surgeon
Schary, Dore, Sunrise at Campobello
Strousse, Flora, John Fitzgerald Kennedy: Man of Courage
Sullivan, George, Wilt Chamberlain
Thorne, Alice, Story of Madame Curie
Twain, Mark, Life on the Mississippi
Twain, Mark, Roughing It
Washington, Booker T., Up from Slavery
White, Anne, George Washington Carver
Wilkerson, , The Cross and the Switchblade
Woodham-Smith, Cecil, Lonely Crusader: The Life of Florence Nightingale
Wright, Richard, Black Boy
Young, Desmond, Rommel, The Desert Fox

Drama

Gibson, William, The Miracle Worker
Hansberry, Lorraine, A Raisin in the Sun
Lawrence, Jerome, and Robert E. Lee, Inherit the Wind
Lerner, Alan Jay, My Fair Lady
Schulman, I., West Side Story

Family Life

Arnow, Harriette, The Dollmaker
Doss, Helen, The Family Nobody Wanted
Emery, Anne, Mountain Laurel
Forbes, Kathryn, Mama's Bank Account
Garst, Shannon, Wish on an Apple
Gates, Doris, Blue Willow
Gilbreth, Frank B., Cheaper by the Dozen
Hunt, Irene, Across Five Aprils
Lewiton, Mina, The Divided Heart
Lindsay, Howard, The Sound of Music
Meader, Stephen, Snow on Blueberry Mountain
Moody, Ralph, Little Britches
Moody, Ralph, Man of the Family
Petry, Ann, The Street
Pinkerton, Kathrene, Hidden Harbor
Rose, Anna Perrott, Room for One More
Saroyan, William, The Human Comedy

West, Jessamyn, The Friendly Persuasion
Gateway English Series (Macmillan), A Family is a Way of Feeling

General Interest

Colby, Vinita, Strangely Enough
Dresner, , Science World Book of Brainteasers
Hersey, John, Here to Stay
Hurlbut, , Hurlbut's Story of the Bible
Macdonald, , The Complete Buyer's Guide to 1968 Cars
Mead, Margaret, People and Places
Nader, Ralph, Unsafe at Any Speed

History, Government, and World Affairs

Armour, Richard, It All Started with Columbus
Dobler, Lavinia, Arrow Book of the United Nations
Fredericks, Pierce, The Yanks Are Coming
Griffin, Ella, Continent in a Hurry: The Challenge of Africa Today
Lincoln, C. Eric, The Negro Pilgrimage in America
Michener, James A., The Bridge at Andau
Tinkle, Lon, The Alamo

Historical Novels

Catton, Bruce, Banners at Shenandoah
Forbes, Esther, Johnny Tremain
Edmonds, Walter D., Drums Along the Mohawk
Moore, Brian, The Emperor of Ice Cream
Nolan, Jeannette Covert, Spy for the Confederacy
Richter, Conrad, The Lady
Richter, Conrad, Sea of Grass
Wallace, Lew, BenHur (adapted)

Hobbies and Crafts

Fernande, Garvin, The Art of French Cooking
Freedman, Edward H., How to Draw
Hay, Henry, The Amateur Magician's Handbook
Lehner, Ernst, Picture Book of Symbols
Mager, Robert, How to Work with Tools and Wood
Morgan, Dan, Playing the Guitar
Perkins, Wilma Lord, Fannie Farmer Jr. Cookbook
Sanderson, William B., Patent Your Invention and Make It Pay
Yates, Raymond, The Boys' Book of Tools

Humor

Eddy, Roger, Worldly Adventures of a Teen-Age Tycoon
Hyman, Mac, No Time for Sergeants
Johnston, William, Get Smart
Johnston, William, Sorry Chief
Merrill, Jean, The Pushcart War

Milne, A. A., Once on a Time
Schulz, Charles, Charlie Brown's All-Stars
Schulz, Charles, This Is Your Life, Charlie Brown
Schulz, Charles, Very Funny, Charlie Brown
Schulz, Charles, The Wonderful World of Peanuts
Scoggin, Margaret C., Chucklebait
Simon, Tony, Ripsnorters and Ribticklers
Smith, Robert, Where Did You Go? Out, What Did You Do? Nothing.
Wolfe, Tom, The Kandy-Kolored Tangerine - Flake Streamline Baby

Language

Chase, Stuart, The Tyranny of Words
Hudson, Peg, Words to the Wise
Moore, John, You English Words
Shipley, Joseph T., Dictionary of Word Origins
West, Fred, Breaking the Language Barrier

Leisure Reading for Young Adults

Adams, , Doomsday Creek
Annixter, Paul, Swiftwater
Armer, Alberta, Screwball
Ball, Dorothy Whitney, Hurricane, the Story of a Friendship
Barrett, William E., Lilies of the Field
Baudouy, Michel-Aime, More Than Courage
Benary-Isbert, Margot, The Ark
Bennett, Jack, Mister Fisherman
Bennett, Jack, Jamie
Benson, Sally, Meet Me in St. Louis
Borland, Hal, When the Legends Die
Boulle, Pierre, The Bridge Over the River Kwai
Boyle, Myrl C., Lookout Mountain
Bradbury, Ray, Dandelion Wine
Burnett, W. R., Winning of Mickey Free
Butters, Dorothy Gilman, Heartbreak Street
Castex, Pierre, Nightmare Rally
Cather, Willa, My Antonia
Clark, Walter Van Tilburg, The Ox-Bow Incident
Colman, Hila, Julie Builds Her Castle
Dormandy, Clara, The Doctors
Edmonds, Walter D., Chad Hanna
Felsen, Henry Gregor, Crash Club
Felsen, Henry Gregor, Road Rocket
Felsen, Henry Gregor, Street Rod
Finley, , Nurse Pro-tem
Frank, Pat, Alas Babylon
Graham, Lorenz, South Town
Haggard, Rider, King Solomon's Mines
Harte, Brete, Outcasts of Poker Flat
Humphries, Adelaide, Chesapeake Doctor
Hyatt, , Ivy Halls

Jackson, Caary, Stock Car Racer
Jarvis, Eloise, Sawdust in His Shoes
Johnston, William, The Littlest Rebels (Flying Nun Series)
Kipling, Rudyard, Captains Courageous
Kipling, Rudyard, Kim
Knight, Ruth Adams, Queen of Roses
Krumgold, Joseph, Onion John
Lacy, Ed, Sleep in Thunder
Lee, Harper, To Kill a Mockingbird
Lewiton, Mina, A Cup of Courage
Llewellyn, Richard, How Green Was My Valley
Loring, Emilie, Across the Years
Loring, Emilie, We Ride the Gale
Loring, Emilie, As Long as I Live
Loring, Emilie, With Banners
McCloskey, Robert, Homer Price
McDonald, Zillah, Roxanne, Industrial Nurse
McGraw, Eloise J., Crown Fire
Marshall, Catherine, Julie's Heritage
Martin, George Victor, The Bells of St. Mary's
Medearis, Mary, Big Doc's Girl
Murphy, Robert M., The Pond
Newell, Hope, A Cap for Mary Ellis
Papashvily, George and Helen, Anything Can Happen
Paton, Alan, Cry, the Beloved Country
Patton, Frances, Good Morning, Miss Dove
Peyton, K. M., The Maplin Bird
Phipson, Joan, The Family Conspiracy
Saint-Exupery, Antoine de, Night Flight
Sherburne, Zoa, Evening Star
Schaefer, Jack, Old Ramon
Sherburn, Zoa, Almost April
Shute, Nevil, On the Beach
Smith, Betty, A Tree Grows in Brooklyn
Stafford, Jean, Boston Adventure
Stevenson, Robert L., Kidnapped
Stuart, Jesse, The Thread That Runs So True
Summers, James L., Off the Beam
Summers, James L., Tougher than You Think
Tarkington, Booth, Penrod
Tarkington, Booth, Seventeen
Thompson, Mickey, Challenger
Trahey, Jane, The Trouble with Angels
Watson, Sally, To Build a Land
Steinbeck, John, East of Eden
Steinbeck, John, Of Mice and Men
Steinbeck, John, Travels with Charlie
Stoutenburg, Adrian, Four on the Road
West, Jessamyn, Cress Delahanty
Whitney, Phyllis A., A Long Time Coming
Wilson, Carolyn, The Scent of Lilacs
Wouk, Herman, City Boy
Wright, Harold Bell, The Shepherd of the Hills

Mystery and Adventure

Benson, Mildred, Dangerous Deadline
Burroughs, Edgar Rice, At the Earth's Core
Burroughs, Edgar Rice, Land of Terror
Burroughs, Edgar Rice, Tarzan at the Earth's Core
Colman, Hila, Dangerous Summer
Doyle, Sir Arthur Conan, The Hound of the Baskervilles
Freethy, Vernon T., Assignment in Danger
Heyerdahl, Thor, Kon-Tiki
Lansign, Alfred, Endurance
Lord, Walter, A Night to Remember
Nordhoff, Charles and James Norman Hall, Men Against the Sea
Seaman, Augusta, Mystery of the Empty Room
Sigurd, Senje, Escape
Wibberley, Leonard, The Epics of Everest

Myths, Legends, and Folklore

Graves, Robert, Greek Gods and Heroes
McGovern, Ann, Aesop's Fables
Pyle, Howard, Some Merry Adventures of Robin Hood
Pyle, Howard, Story of King Arthur and His Knights
Rouse, W. H. D., Gods, Heroes, and Men of Ancient Greece
White, T. H., The Once and Future King

Nature and Pets

Adamson, Joy, Born Free
Brower, David, Sierra Club Wilderness Handbook
Burnford, Sheila, The Incredible Journey
Caras, Roger A., The Custer Wolf
Carson, Rachel, Silent Spring
Dodd, Ed., Mark Trail's Book of Animals
Gipson, Fred, Old Yeller
Kantor, McKinley, Voice of Bugle Ann
Kjelgaard, Jim, The Black Fawn
London, Jack, Call of the Wild
London, Jack, White Fang
North, Sterling, Rascal
Rawlings, Marjorie Kinnan, The Yearling
Richardson, Anthony, One Man and His Dog
Shelton, Jess, Daktari
Street, James H., Good-bye, My Lady
Zim, Herbert, Snakes

Personal Grooming and Guidance

Bell, Susan, 250 Hairstyles
Bush, , The CBS National Drivers Test
Cain, Arthur H., Young People and Drinking: Use and Abuse of Alcohol
Carnegie, Dale, How to Win Friends and Influence People

Denman, Frank, The Law, It's On Your Side
Friedenborg, Edgar Z., The Vanishing Adolescent
Hefley, James C., Get the Facts
Harwood, Michael, The Student's Guide to Military Service
Juster, Harry, Clothes Make the Man
Keiffer, , McCall's Guide to Teen-Age Beauty and Glamor
Public Affairs Commission, Teen Love, Teen Marriage
Raymond, Jack, Your Military Obligations and Opportunities
Shefter, Harry, How to Get Higher Marks in School
Taylor, Norman, Narcotics: Nature's Dangerous Gifts
Unger, Arthur, What Girls Want to Know about Boys
Vanderbilt, Amy, Everyday Etiquette

Science Fiction

Asimov, Isaac, Fantastic Voyage
Boulle, Pierre, Planet of the Apes
Bradbury, Ray, The Martian Chronicles
Conklin, Groff, Invaders of Earth
Laumer, Keith, The Invaders
Serling, Rod, Twilight Zone
Serling, Rod, More Stories from the Twilight Zone
Wells, H. G., Invisible Man
Wells, H. G., Time Machine
Wells, H. G., War of the Worlds
White, T. H., The Master
Wyndham, John, Out of the Deeps

Short Stories

Berger, Eric, ed., For Boys Only
Bradbury, Ray, R Is for Rocket
Burton, Ardis Edwards and Joseph Mersand, Stories for Teenagers, I and II
Cerf, Bennett, The Unexpected
Daly, Maureen, Twelve Around the World
Ferris, Helen, Time of Starting Out
Jones, Evan, ed., High Gear
Knight, Ruth, It Might Be You
Nolan, William F., Men of Thunder
Nolan, William F., and Charles Beaumont, When Engines Roar
Paton, Alan, Tales from a Troubled Land
Poe, Edgar Allan, Great Tales of Horror
Schuman, Sylvie, For Girls Only
Sohn, David A., Ten Top Stories
Stolz, Mary, Beautiful Friend and Other Stories
Stuart, Jesse, A Jesse Stuart Harvest
Unger, Arthur, First Dates and Other Disasters
Unger, Arthur, Under Twenty

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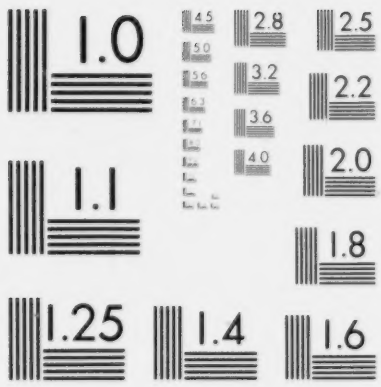

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Sports

Carson, John F., The Coach Nobody Liked
Carson, John F., Floor Burns
Douglas, Gilbert, Hardnose
Felsen, Henry Gregor, To My Son, The Teen-Age Driver
Felsen, Henry Gregor, A Teen-Ager's First Car
Ingles, James Wesley, Test of Valor
Knott, Bill, Junk Pitcher
Mays, Willie, Danger in Centerfield
Porter, Mark, "Keeper" Play
Ward, Roger, Ward's Guide to Good Driving

War

Chamberlain, William, Combat General
Chambliss, William C., The Silent Service
Congdon, Don, Combat: The Civil War
Congdon, Don, Combat: European Theater
Congdon, Don, Combat: Pacific Theater
Forester, C. S., Sink the Bismarck
Hersey, John, A Bell for Adano
Montagu, Ewen, The Man Who Never Was
Remarque, Erich Maria, All Quiet on the Western Front
Westheimer, David, Von Ryan's Express
White, Theodore H., Mountain Road

Vocations and Careers

Adler, Kenneth R., Job Resume and Letter of Application
Biegeleisen, J. I., Careers and Opportunities in Commercial Art
Brenner, Barbara, Careers and Opportunities in Fashion
Biegeleisen, J. I., Getting a Job with a Future
Carroll, John M., Careers and Opportunities in Electronics
Cooke, Donald E., Marvels of American Industry
Crowe, Lester and Alice, How to Study
Eskow, Seymour, Guide to the Two-Year Colleges
Feingold, S. Norman, Job Finder: It Pays to Advertise
Ferrari, Erma Paul, Careers for You
Gardiner, Glen L., Hou You Can Get the Job You Want
Kasper, Sydney H., Careers in the Building Trades
Kaufmann, William, 1001 Top Jobs for High School Graduates
Kitson, Harry and Edgar Stover, Vocations for Boys
Liebers, Arthur, How to Pass Employment Tests
McCausland, Elizabeth, Careers in the Arts
Mann, Roland, Careers in Business Management
Nourse, , So You Want to Be a Nurse
Paradis, , From High School to a Job
Perry, John, Seventeen Million Jobs
Perry, John, Your Career Opportunities in Journalism
Perry, John, Your Career Opportunities in Nursing
Perry, John, Your Career Opportunities in Printing

Strang, Ruth, Target: Tomorrow, an Educational and Vocational Guide for Teenagers
Splaver, , Your Career If You're Not Going to College
Frazier, Neta Lohnes, Something of My Own
Colby, Jean Poindexter, Tear Down to Build Up
Bugbee, Emma, Peggy Covers the News

Western

Grey, Zane, The U. P. Trail
Grey, Zane, The Last of the Plainsmen
Grey, Zane, Nevada
James, Will, Sand
James, Will, Smokey
Portis, Charles, True Grit
Schaefer, Jack, The Canyon
Schaefer, Jack, Shane
Short, Luke, Ride the Man Down
Short, Luke, Station West
Wister, Owen, The Virginian

AUDIO - VISUAL AIDS

I. Films (The numbers refer to the film library of the Little Rock Public Schools.)

A. Guidance and Personal Development

322 - "Belonging to the Group"	16 minutes	
251 - "Developing Self-Reliance" (Analyzes the steps in developing self-reliance)	11 minutes	
601 - "Improve Your Study Habits"	11 minutes	
311 - "Learning to Study" (Study in conscious learning)	14 minutes	Color
278 - "Let's Pronounce Well" (Listeners apply what they learn)	11 minutes	
323 - "How to Think"	13 minutes	
909 - "How to Read a Book" (Shows how to select a book for a particular purpose and how to use a book's reading aids)	11 minutes	Color
400 - "How to Succeed in School" (A discussion of attitudes)	11 minutes	

B. Library Tools

727 - "Magic Book" (Taking care of books)	10 minutes	Color
221 - "Making Books" (From author's manuscript to completed book)	11 minutes	
846 - "You'll Find It in the Library"	13 minutes	Color
468 - "Dictionary, Using the: Look It Up" (Designed to motivate the dictionary habit)	11 minutes	
154 - "It's Fun to Read Books"	10 minutes	
849 - "Libraries Are for Sharing" (Using the card catalog)	11 minutes	Color
134 - "Printing Through the Ages"	13 minutes	

C. Speaking and Listening

502 - "Effective Listening"	15 minutes	
278 - "Let's Pronounce Well"	15 minutes	
284 - "Fundamentals of Public Speaking" (The importance of public speaking in everyday life is presented in a typical school situation)	11 minutes	
180 - "Parliamentary Procedure" (Special emphasis on motions and amendments to motions)	11 minutes	
219 - "How to Conduct a Discussion" (Explains some of the basic principles of discussion methods)	17 minutes	
"Listening Skills: An Introduction"		Color
"Improve Your Oral Reports"		

II. Filmstrips

These may be ordered from: Society for Visual Education, Inc.
1345 Diversey Parkway
Chicago, Illinois 60614

Order No.		
125-S	"Your Dictionary and How to Use It" 6 color filmstrips	$27.00
123-S	"Words: Their Origin, Use, and Spelling" 6 color filmstrips	$27.00
V151-2	"Use Your Library for Better Grades and Fun,Too" Black & White	$ 6.00
C788-SR	"Vocational Decisions" 3 color filmstrips, 1 record	$24.75
778-SA	"Foundations for Occupational Planning" 5 color filmstrips	$22.50

III. Posters and Transparencies

These may be ordered from: Gene Swepston Company
2324 Durwood Road
Little Rock, Arkansas 72207

Order No.		
FA0150	"Using Your Library" 32 posters in color	$ 5.50
253-875	"How to Use a Library" 41 overhead transparencies	$175.00

IV. Free Booklets for Class Use

Career Series: New York Life Insurance Company
Box 51, Madison Square Station
New York 10, New York

Careers: General Motors Corporation
Educational Relations Section
General Motors Technical Center
Warren, Michigan

"How to use the Readers' Guide to Periodical Literature," The H. W. Wilson Company, 950 University Avenue, New York 52, New York.

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"SPACEWAYS"

A Student-Planned Unit

Toward the end of the second quarter, the teacher may wish to determine the degree to which students are able to make use of the communicative skills taught in the earlier modules. One method for evaluating their ability to use these skills is to design a unit in such a way that the students themselves can have a major part in planning and carrying out its activities.

The unit entitled "Spaceways" in the reading anthology Perspectives (Scott, Foresman, 1963) provides good source material for planning a unit such as the one described above. Students find the subject of space intriguing, and they will be particularly interested in reading the stories and articles contained in this section.

OBJECTIVES

Objectives can be outlined by the teacher at the beginning of the unit, or they can be established through mutual planning and discussion by both teacher and students. How the objectives are established must depend largely on the judgment of the teacher as to the ability of her students to participate in this phase of the planning. The objectives listed below set forth suggested goals a teacher might hope to accomplish through teaching the unit:

1. To provide practice in developing techniques for finding the central idea in reading

2. To provide opportunities for using the Readers' Guide, reference materials, and the card catalog to find library information on an assigned topic

3. To provide opportunities for students to use the written and oral language to express themselves knowledgeably on a topic or project of their choosing

4. To help students plan and produce a program for other students and teachers based on what they have learned about space.

ACTIVITIES AND PROJECTS

After the unit objectives are established, a suggested list of projects and activities should be given to the students. The teacher should discuss these with the students, allowing them to make additional suggestions. So far as possible both teacher and students should then decide upon the content, the sequence, and the activities of the unit. Again, the degree to which students can do this type of planning successfully will depend largely on their ability to make mature choices as well as their confidence in expressing their ideas. If the classroom atmosphere is not conducive to freedom of expression, the

teacher can expect very little participation from the students. If they do participate, however, the teacher is provided an excellent opportunity to see how well the students can put into use the speaking, reading, listening, writing, thinking and social skills taught in the earlier modules.

Given below are lists of activities and projects which might prove helpful in planning the content of the unit.

A. Textbook Activities

1. Read pictorial survey of space exploration in the textbook, pages 204-208.

2. Read and discuss "Astronaut Aweigh," pages 209-222. Complete related vocabulary and writing assignments, page 222.

3. Complete Exercises I-II, "The Central Idea," pages 550-559.

4. Read and discuss "Suited for Space," pages 228-233.

5. Read for enjoyment "The Prisoner," pages 234-244.

6. Complete Exercise III, "The Central Idea," pages 559-561.

7. Read "Before the Astronauts," page 246.

8. Complete cards 29-33 in Tactics II.

B. Library and Class Activities

1. Spend class periods in the library gathering information on projects and reports.

2. Confer with students individually to decide how to disseminate the information they have learned from their project.

3. Prepare bulletin boards, containing displays and information relating to space.

4. Prepare "comment cards" on science fiction stories to share with other students.

5. Locate central ideas from recent magazine articles relating to space.

6. A culminating activity might well be the development of a program or panel by the students to share some of the information they have learned with other students and invited guests. Committees can be formed to make selections concerning the participants and the content of the program. Again, this is a good way for students to participate actively in planning the unit work. In addition, the teacher can determine how well the students are assimilating the skills being taught. The following are two sample programs, both worked out by students from two different classes:

"The Last Frontier"	"A Decade of Space Exploration"
presented by	presented by
The Young Communicators	The Junior Parliament
Master of Ceremonies:	Master of Ceremonies:
EARLY SPACE PIONEERS Wan Hu Leonardo da Vinci Robert Goddard	EARLY SPACE DEVELOPMENTS Wan Hu, Leonardo da Vinci, Robert Goddard Development of the V-2 Rocket
MODERN ACHIEVEMENTS IN SPACE 1958-1964 1965-1967 1968-1969	SATELLITES Tiros - the weather satellite Explorer - the research satellite Telstar - the communications satellite
THE MOON - A MYSTERY UNCOVERED	MANNED SPACE PROGRAMS Mercury Gemini Apollo

C. Projects

The information below is printed as it was given to students who participated in planning a unit in "Spaceways". It can be adapted to fit various class needs and differences.

1. POSTERS, CHARTS, DIAGRAMS

a. Space Vocabulary: Prepare a list of words showing how they are used in space. Examples: NASA, LEM, chaff, chicken switch, capsule, etc. You would need to read a number of articles and books to locate interesting examples of words.

b. Diagrams of Rockets, Space Capsules, Firing Techniques, etc.: Several excellent diagrams are available in encyclopedias. See the Students Encyclopedia, Vol. 17 for a good example. You would need to prepare brief explanations of each part of the rockets or techniques you included. These explanations can be oral or written.

c. Milestones in Space Exploration: Show some of the outstanding developments in space exploration. Give the year, and then write a brief account of the event. Use pictures when possible.

d. A Decade of Space Exploration, 1960-1969: During this brief

period we have moved from the launching of unmanned spacecraft to a manned flight around the moon. Brief illustrations of some of the key events during this decade would be very interesting. Your purpose would be to show the tremendous strides which have been made in space exploration.

e. The Astronauts: Pictures, newspaper articles, illustrations, etc., of the astronauts would provide some very interesting poster displays. You can choose one astronaut if you wish and find out all you can about his background, his selection as an astronaut, his qualifications, etc.

f. The Balloon Flights: Include illustrations and drawings showing the first balloon flights. You can find much material on this subject in your textbook.

g. Flight Experiments of Leonardo da Vinci: Many of his sketches are available in encyclopedias. You will find that he invented many of the ideas we use today.

h. Cape Kennedy: You can obtain some material on this subject by writing to tourist centers in Florida. Try to find out exactly what goes on at the Cape.

i. N.A.S.A.: Try to determine the purpose and function of this group. What was its origin? What are its future plans?

j. Apollo Space Flights: Trace the plans and development of the Apollo program. Include a diagram of the flight plan of Apollo 8.

k. Telstar-Comsat: See what you can learn about the development of communications satellites and the impact they have had on world communications.

2. SCALE MODELS

Several hobby shops and ten-cent stores have scale models of rockets, space ships, early airplanes, fighter planes, etc. You can assemble one or more of these and prepare a brief oral or written report to accompany your model. You may wish to assemble several models and show the great progress made in air travel.

3. WRITTEN OR ORAL REPORTS

a. Growth of Commercial Air Travel

b. Development of Rockets in Russia

c. Robert Goddard

d. Jules Verne

e. Aerospace medicine

f. Wernher von Braun

g. UFO's

h. Explorations of Mars

i. Any of the current satellite systems (Tiros, Explorer, Echo, etc.)

4. CREATIVE WRITING

a. Short story or play based on information gained about space. This would be a "science fiction" story such as "Astronaut Aweigh" or "The Prisoner" in your text. Please note that such a story, though science fiction, would need much careful research and thinking to make the situation believable.

b. News articles about an imaginary landing on Mars. Include headlines, photographs, feature stories, etc.

5. UNIT PLAN

A unit plan such as the one outlined below can be worked out by students and teacher and placed on a master log sheet or on the blackboard. This will enable everyone to know what is happening on specific days within the time scheduled for the unit.

1	2	3	4	5
Introduction: Discuss 1)Objectives 2)Activities 3)Projects Complete text activity 1	Complete text activities 2 & 3. Work out bulletin board display	Library Work: on projects Complete text activity 4	Library Work: on projects Complete text activities 5 & 6	Library Work: Committees meet to decide on program format
Complete text activity 7	Library Work: Committees meet. Begin Tactics II Work Card #29	Reading Day: Individual conferences. Tactics II Work Cards #30-31	Rehearsal. Tactics II Work Cards #32-33	Program-
6	7	8	9	10

SUGGESTIONS FOR TEACHING JULIUS CAESAR

CLASSROOM ACTIVITIES

In order to vary the classroom approach to the reading of Julius Caesar, several methods can and should be used. Various suggestions and comments are listed below:

Student reading: Students can read the play aloud, taking turns. When questions arise it is easy to stop and discuss various points which are important to the students' understanding or the ideas which you think should be stressed.

Professional recordings: For preciseness in diction and expression, various professional recordings are excellent. We recommend them especially for sound effects and for accurate interpretation of important scenes.

Filmstrips and accompanying records: While these do not record the play in its entirety they do provide the "story" as well as an analysis of the play's structure and some insight into its meaning. The series entitled Selected Shakespearean Tragedies (A147-2SR) produced by the Society for Visual Education is helpful.

Student recordings: If time permits, students can record all or parts of the play on tape. These recordings can be used not only to "tell the story," but also as a point of departure for instruction concerning diction and expression. In addition, when students hear other students on tape, they can sometimes be motivated to make their own recordings of various scenes. By careful editing over the years you can build a collection of good student recordings.

Student acting: Students usually enjoy acting out parts of the play. If a movie camera is available, the acting can be filmed. This technique is quite good for motivational purposes.

Insofar as it is practical, the students should be allowed to participate in the decision making with regard to the type of oral reading that is done. They should also be reminded to look for situations in the play similar to their improvisations.

THINKING ABOUT THE PLAY

The study questions in the student packet may serve as the basis for class discussions or writing assignments. Their usefulness will depend upon the perception and insight of your students as well as your methods of teaching the play. You may want to use all the questions or some of them. You may decide to add questions of your own. These are included to guide the students' thinking. You should use only those which you think will contribute to their understanding.

Additional theme and project suggestions for individual and group work are listed below:

Analysis of Shakespeare's Language: Since an abridged, "modernized" version of the play is being used, you may wish to have students compare the modern rendering of various lines with the original. This would enable them to see how language has changed since Shakespeare's day and should provide interesting work in word origins and contrasts between twentieth century usage and the usage of the Elizabethan Age.

Julius Caesar and the Mass Media: Students can plan television and newspaper coverage of the assassination of Caesar. In groups and as individuals they can plan the content and format of various television programs and news articles relating to the assassination. Students can select various television news programs to use as patterns. They can also practice writing news articles, feature articles, etc. A project such as this could be expanded or shortened to correspond to the ability and interest of your class. The following topics could be adapted for use in planning programs and news articles:

1. News coverage of the assassination

2. Biographical details of the conspirators with news commentators' opinions concerning why they participated in the assassination

3. Television coverage of Antony's speech in the Forum

4. Television coverage of Caesar's funeral (This would require library research into Roman burial customs.)

5. Biographical programs concerning Mark Antony, Calpurnia, and Octavius Caesar

6. Program depicting the political rise of Caesar

7. Program entitled "The Future of the Roman Republic." Such a program would contain a panel of distinguished news commentators and would predict the future of the Roman republic

8. Interviews with outstanding Roman citizens, including Cicero and Publius

9. Interviews with "the man in the street" - the Roman citizen - and his reactions to Caesar's death and Antony's speech.

10. Interviews with Flavius and Marullus, the two banished tribunes

11. Special editions of the Roman Times, dated February 15, 44 B.C., and March 15, 44 B.C. Some interesting contrasts could be made in this project.

Architectural Development of the Elizabethan Theater: Students interested in architectural design may want to trace the changes in the style of the Elizabethan theaters. They may wish to draw floor plans and sketches of the exterior. To carry the project further, students may wish to contrast the theaters of Shakespeare's day with those of today to see how people's ideas of beauty and practicality have changed.

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STUDENT LESSONS

7800

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SUPPLEMENT

A Suggested Reading List

INTRODUCTION

You have received a packet of materials that have been devised with you in mind. This is your first year in a senior high school. You have chosen to attend Metropolitan High School and you will want to become a participating member of the student body. To help you to make a smooth transition from junior high school you have been given this packet of materials on orientation. The process of orientation is a study of adjusting to a new environment or to a similar environment where there are some new ideas and/or situations. The varied exercises are suggestions to help you to understand yourself as a student and your responsibilities as a student.

A pre-test is placed at the beginning of the series of lessons to orient and to stimulate your thinking.

You are in your English classroom with other students in English 10 and your teacher. The first topic we will discuss may be referred to as housekeeping chores. Wherever there are people working together there are housekeeping chores that we must all perform if we are to have uncluttered surroundings so that we can do orderly thinking. Everyone seems to feel safe and at ease when he knows exactly where he is heading and when he understands how he is to reach a destination. In other words he knows what is expected of him. Your teacher will explain to you the ideas that we will follow for the semester. She will also list the tools you will need in your activities. Keep the lists she gives you and refer to them from time to time.

Keeping a Log

We need to check on ourselves daily to see how we are progressing. This is a student-teacher project. We will all keep a "log." Are you familiar with this word in any way? Discuss your ideas with your classmates and with your teacher. Write your choice of a definition in a sentence beginning "A log is (noun) + (modifier)." Keeping a log will be an orderly way for each one of you to keep a record of his progress. As a student you are working to improve your skills. You are competing only with yourself.

In this packet there are three pages that make up your log for the first nine weeks of school. On a bulletin board your teacher has placed a copy of her log listing planned activities. Note briefly exactly what you did during the period. Ask yourself: What did I achieve? Could I have done better? Did I do a satisfactory job? Be frank in your day by day comments on what you feel you have accomplished and what you feel your shortcomings are. Listen carefully to the more specific directions that your teacher will give.

PRE-TEST

The teacher may ask you to write about some of the following questions. Even though the word test is used in the title, this is really an inventory. Note carefully the idea of keeping a notebook. Determine now to keep a neat, orderly record. Careful directions will be given from time to time about keeping a notebook. You should feel free to add materials that you are interested in. These are the questions for you to think about.

1. What are credits?

2. How many units are needed for graduation from Metropolitan High School?

3. What occupation would you like to pursue?

4. What courses will aid you in understanding the work world involved in this occupation?

5. What are "elective courses"? Of what value are they?

6. What are communication skills?

7. Are communication skills learned only in an English classroom? Explain your yes/no answer.

8. What speaking skills will you need after you graduate from high school?

9. What are your strong points as a student?

10. What do you consider your weaknesses to be?

11. Tell how attitudes are important for you as a student.

12. We are agreed that it is important that we get along with others. When will you be tested on how well you get along with others in school and out of school? Be specific in your answers.

NOTEBOOK ASSIGNMENT:

From time to time list in your notebook any ideas you may have about other things you will need to know before you can become a good high school student. Title this page of your notebook "Becoming a Good Student."

Be sure you understand the meaning of the underlined words:

1. We need to develop positive attitudes towards life.

2. Sometimes communication is lost because one is a poor listener.

3. A student should take an inventory of his work skills.

2. A time for unhurried meals

3. A time for recreation

4. A quiet time (at least 10 minutes per day)

5. A time for outside work or for chores at home

Hand in the finished schedule written as neatly and orderly as you can write.

Lesson Three

READING ASSIGNMENT: Pages 27-33

This is a silent reading assignment. Read as the teacher directs you and answer the thought questions she will give you. As you read, jot down questions you may want to ask or ideas you would like to have discussed in class.

This part of the handbook called "Rules and Regulations" has been devised to help each of you to fit into a school pattern. Wherever there are many people there is a need to identify the rules that help in carrying out daily activities. Some educators may call this a plan for discipline. Look up the word discipline to find its various meanings. What do you think would be the meaning of self-discipline? Why is self-discipline important?

Lesson Four

READING ASSIGNMENT: Pages 36-40

As a member of the student body, you have a voice in the Student Council. How? Discuss the Student Council with the teacher and your classmates until you thoroughly understand how the council works and what your responsibilities are.

What clubs and activities will sophomores be eligible for and most interested in? Your participation in extracurricular activities is a part of your permanent record. What is a permanent record? Answer this question by giving the meaning of permanent and of record.

SPEAKING ASSIGNMENT: Be prepared to talk on, "Why I plan to belong to a club or participate in another extracurricular activity." Give at least two reasons and then substantiate your ideas. Try to be specific. If you do not plan to participate in an extracurricular activity, insert the word not between plan and to in the title of the topic and proceed with the assignment. Your teacher will give more specific help in planning your talk.

Lesson Five

READING ASSIGNMENT: Pages 16-19

What is the general heading for this particular section of the student handbook? What are specific headings? Some of the specific headings name

people and some, things. How is each person or thing related to a school? Can we say that a school is a business? Why? Make a list of rules that are incorporated in this section of the handbook. Why are they included? Does a business establishment have rules? List some rules that you think are necessary in running a business. Check your rules. Are they stated positively or negatively? Let's read some aloud from both lists. Which ones are more easily understood - the positive or the negative? Which ones are more readily heeded - the positive or the negative? Why?

LISTENING:

1. Invite your principal in for a "Get-Acquainted" meeting. Ask him to talk to you.

2. Invite your counselor in to talk to you. Get into groups ahead of time and prepare pertinent questions for him to discuss with you in a question and answer period. Pertinent questions are those that are practical and that you need answers to now.

NOTEBOOK ASSIGNMENT:

If you recorded any notes from either of the talks of the visitors, copy them neatly in your notebooks.

On a separate page of your notebook write "Listening Skills." List the rules for listening. Word them carefully.

You may add ideas on listening to this section of your notebook from time to time.

Under the section of you notebook labeled Miscellaneous write "Classroom Organization," and with the teacher and other members of the class, write a plan for a practical class routine. Refer to this page in your notebook frequently during the first days of the school term when you are learning to be a good high school student.

BECOMING A GOOD STUDENT

Before beginning the specific lessons to develop study skills, do you have any questions about classroom routines? Attempt to follow the same daily routine in getting the class started. If you will do this each day, you will soon establish the habit of being in your place and ready for work as soon as possible.

THOUGHT QUESTION

Notice the two underlined words - habits, skills - in the introduction to this lesson. What is the difference in meaning between the two words?

Lesson One: Developing Study Skills

If you were asked, "Who is a student?" you would probably answer, "One who studies," and you would be right. A person may become a good student if he practices orderliness in his study habits. Let's see how this can be done. To make this a useful study, plan to apply the study exercises to your English materials. The teacher will give you guides to follow in your study and she will study with you. Before you actually delve into the techniques for studying, look at these true/false statements. They have been planned to help guide your thinking.

_____ 1. Good study skills are natural and do not need to be developed.

_____ 2. Habits and skills are synonymous.

_____ 3. There is no way to improve learning.

_____ 4. Planning to learn more than you will actually need to pass a test is a waste of time.

_____ 5. Interest is not necessarily an important factor in remembering.

_____ 6. You should try to have a regular time for studying.

_____ 7. A good student learns to plan ahead.

_____ 8. A good student "crams" before a test because test grades are important.

_____ 9. A good student studies all school subjects in the same manner.

____ 10. A good student takes a positive attitude towards learning and a positive approach to studying any subject that is in his course of study.

Lesson Two: Textbooks as Tools

LISTENING

Follow the directions of the teacher as she guides you in locating the parts of the textbook.

Use another one of your textbooks and answer the following by filling in the blanks. Write neatly and follow directions carefully.

1. Title _____
   (Underline the title of the book.)

2. Author _____
   (If there is more than one author, write the name of the first one listed.)

3. Publisher _____

4. The index begins on page _____.

5. Copyright date _____

6. Reprint date _____

7. Is the index a good one? Why? (Write your answer in a complete sentence.)

   _____

8. Why is there a period after the blank in item number 4? _____

   _____

VOCABULARY

1. Not all books have a frontispiece, a page of dedication, or a glossary.

2. Every book of information should have a table of contents and a definitive index.

3. No book should be accepted until it is collated.

4. Publishers read manuscripts submitted by many authors.

5. Some writers include much good material in the appendix of a book.

6. A blurb may be considered as a kind of advertisement.

Lesson Three: Taking Care of Books

With the other members of the class devise at least five rules for taking care of books. Think about how you have seen books being handled, and let this thinking be your guide in writing the rules. Are you stating the rules in a positive or negative manner?

NOTEBOOK ASSIGNMENT: Copy the rules neatly in your notebook.

Lesson Four: Introduction of Library Tools

A library is a storehouse of books. Before a person can use a library with ease, he needs to know some of the tools that are provided and how they can help in studying. Chapter 27, page 488, in Warriner's is called "Information in the Library." At the bottom of page 488 there is a list of skills which you should know. Read the list silently to check to see how many of these techniques you already know.

You should know, first of all, that all books are divided into two principal groups, fiction and nonfiction. Fiction includes novels and short stories. Nonfiction includes everything else from books on current events to deep scientific works. Fiction books are put into a section of the stacks separate from the nonfiction books. Read with your teacher on page 489 in Warriner's about "Fiction."

Nonfiction books are classified according to subjects; such as history, science, and art. The classification by numbers, which may seem difficult at first, is really quite simple. Read in Warriner's "Nonfiction: The Dewey Decimal System," on pages 489-90. You should become familiar with the Dewey Decimal System so that you can read the Dewey charts that are in all libraries.

Lesson Five: The Card Catalog

To help you find the books you want without going to the stacks, each library has a card catalog. You should know that the card catalog in a library is for that particular library. On your trip to your library you will want to locate the card catalog first.

The librarian has a way for helping you find a book in the card catalog. You may find a book if you know its subject, or author, or title. In Warriner's on page 491 read about the author card, the title card, and the subject card so that you can distinguish one from the other. Examples of catalog cards are on page 8 in your Student Lessons.

In the upper left-hand corner there is a number that is referred to as a catalog number because it gives the classification of the book. Sometimes it is called a call number because the number identifies a book in the stacks.

Study the catalog numbers and the explanation of each one on page 9. Even though school libraries rarely have a complete catalog number, it is good to know what the different letters and figures stand for.

CATALOG CARDS

AUTHOR CARD

```
400
W83e        White, E. B.
                Elements of the language.
            Chicago, American Book Company,
            1959.
                95 pages
                bibliography

            1. English language - composition
```

TITLE CARD

```
400         Elements of the language
W83e        White, E. B.
                Elements of the language.
            Chicago, American Book Company,
            1959.
                95 pages
                bibliography

            1. English language - composition
```

SUBJECT CARD

```
400  English language - composition (in red)
W83e        White, E. B.
                Elements of the language.
            Chicago, American Book Company,
            1959.
                95 pages
                bibliography

            1. English language - composition
```

F — Fiction

D 55 o

First letter of the author's last name — The author's Cutter number — First letter of the first important word in the title

Example: Oliver Twist by Charles Dickens

B — Biography

C 76 b

First letter of the subject's last name — The subject's Cutter number — First letter of the author's last name

Example: Frank Bell's Biography of Joseph Conrad

973 — Nonfiction (History)

B 19 a

First letter of the author's last name — The author's Cutter number — First letter of the first important word in the title

Example: Charles Beard's American History

The word Cutter in Cutter number is spelled with a capital letter because a man named C. A. Cutter invented a flexible table of numbers to go with initials of peoples' name for identification. Maybe your teacher will bring to class a Cutter table and show you how a librarian uses it.

PRACTICE EXERCISE:

Choose two books and with your teacher's help prepare three catalog cards for each book. Either use 3" X 5" cards or make 3" X 5" slips from your paper. Underline with a red pencil the word that is used as a guide for alphabetizing the six cards you have prepared. Hand the cards in in alphabetical order.

NOTEBOOK ASSIGNMENT:

After your teacher has checked the cards, paste or tape three of the cards of one book on a page in your notebook. Label each card as either author, title, or subject card.

VOCABULARY:

1. A student needs to know the classification of books to be at ease in the stacks of a library.

2. Some people read biographies for pastime.

3. Reading fiction is a good way to spend leisure time.

4. Using the Dewey Decimal System is a technique for classifying books.

5. Reference materials are usually read in a library.

6. Alphabetical listings help the flexibility in the use of library tools.

Lesson Six:
The Readers' Guide to Periodical Literature

You have a copy of "How to Use the Readers' Guide to Periodical Literature." This is a sample of the large Readers' Guides that are in your library. A Readers' Guide is an author and subject index to about one hundred thirty magazines. What do you think is the relationship between a magazine we read and the magazine of a gun? There are five or more meanings of the word "magazine" in your dictionary. Check them. As you become acquainted with the Readers' Guide, try to decide why everyone should know how to use this library tool.

NOTEBOOK ASSIGNMENT:

Keep a record of as many of the class exercises as you and your classmates decide will be useful to you later.

VOCABULARY:

1. Using cross references helps one to write a better bibliography.

2. Several issues of a magazine make up one volume.

3. A cumulative index aids one in finding the periodical he needs.

4. The captions of pictures are fun to read.

5. Many entries may be found in abridged editions of the READERS' GUIDE.

PRACTICE ACTIVITY:

Plan a visit to your school library. Decide ahead of time the questions you will want answered. Even though you have not studied about reference books yet, notice carefully the general encyclopedias and the special encyclopedias (sometimes called cyclopedias) that are in your library. Note the catalog numbers on the backs of the reference books. Ask the librarian about library rules for checking reference materials from the library.

Lesson Seven: Reference Books

Encyclopedias contain information on all subjects, including persons, places, things, and events. They are easy to use because all the subjects are arranged in alphabetical order. These reference books are in several volumes

and there is usually some kind of index to the set of books. What are the names of the encyclopedias in our library? How are they indexed? Your teacher will help you in answering these questions. Look in the card catalog under Cyclopedia and copy the titles you find.

ASSIGNMENT:

Look at the following questions. You can find answers to these questions and questions like them in reference materials. There may be other questions that you are interested in. Decide on two questions. Use the reference materials to answer the questions. Write the answers in sentences of your own. Do not copy the material word for word from the encyclopedia. Write on your paper the source of the information you used to answer each question. You may not find some of the answers in your school library. Choose another question for your assignment. Some time when you are in the public library, you could search for the answers to some of the questions.

1. Who is John Gunther?

2. Who was vice-president of the United States in 1888?

3. What is bauxite?

4. When and where did Rocky Marciano win the heavyweight title?

5. When it is noon in New York, what time is it in Calcutta, India?

6. How many pounds are there in a metric ton?

7. How is a pearl formed? What is a cultured pearl?

8. How does a cuttlefish conceal itself?

9. For what purpose did the Scotch use the "fiery cross"?

10. Today the World Series in baseball is won by the team that is victorious in four games. In 1903 and three other years the champion had to win five games. What were the three years?

11. List 8 precious or semiprecious stones. What other uses have they besides ornamentation?

12. Is the country of Israel in Africa or in Asia?

13. How is the date of Easter Sunday determined?

14. What is chloroform? What are its uses?

15. What are the most important ingredients of the earth's atmosphere?

16. Who are the executive officers of Arkansas?

17. What are driver ants?

18. How do crickets sing?

19. For what is ambergris used? Is it a valuable substance?

20. Who was Sister Kenny?

21. Who was Cecil Rhodes?

22. How many islands are there in the Hawaiian Island group?

23. How large is Alaska? When did she acquire statehood?

24. Where and what are the Tetons?

25. How does an electronic microscope work?

26. How many television sets were made in the United States in 1947? in 1962?

27. How did Buffalo Bill Cody spend the last half of his life?

28. Where and when was Dwight D. Eisenhower born?

29. Who are the U. S. Senators from Arkansas?

30. Who was Davy Crockett?

31. What was Mrs. J. F. Kennedy's maiden name?

32. Of what college was Robert E. Lee president?

33. Whom did George Washington marry?

34. What and where is Chimborazo?

35. Name four books written by Samuel Clemens.

VOCABULARY:

1. We do not copy material verbatim from a book unless we give credit to the author.

2. Several sources of information should be read before a subject is discussed.

3. We used the teacher's bibliography when we were studying reference materials.

Lesson Eight: Dictionaries

Think about this quote: "With words you think and speak and read and write. Imagine a wordless day - a wordless world!" Some people actually sit down and read dictionaries. They read to learn more of the things they know a little something about, to learn of things they know nothing about, and to be amused.

You have a paperback copy of Webster's New World Dictionary of the American Language. Following is a list of questions that can be answered by using your dictionary:

1. What is the grisly origin of the word bonfire?

2. How many square feet are in an acre?

3. Is the word news singular or plural?

4. What does i.e. mean?

5. To what besides a fruit might the word lemon be applied?

6. As what parts of speech may the word saw be used? Name three compound words containing the word saw.

7. Does believe drop or retain the -e when -able or -er is added?

8. What is the Roman numeral for the number ninety?

9. Does the name of the English river Thames rhyme with gems or games?

10. Is the spelling for the plural of the word tool in your dictionary? Do you know why?

Think about the information you have gleaned from the dictionary and make a list of the uses of a dictionary. Someone should write your ideas on the blackboard so all of you can check them. What other kinds of information do you think you will want to know about a word? Discuss your ideas.

Learning to use a dictionary should be approached as though this tool is a do-it-yourself kit. As in assembling a do-it-yourself kit, you take your chances when you do not read directions. If you did not know the answer to the last part of question 10, look at Section III on page vii in your dictionary. Then with your teacher and the other members of the class study carefully pages iv to vii. Different approaches are used in writing different kinds of dictionaries. Before your dictionary or any dictionary you are using can become a useful tool, you must become acquainted with the guide for using that particular dictionary. As you are studying the guide and as you browse through the dictionary, be ready to suggest words and exercises that you can all use for practice until everybody becomes quite familiar with the dictionary.

NOTEBOOK ASSIGNMENT:

Copy verbatim the information in the dictionary of these words: sophomore, shop, raw. Do not crowd your writing. Then label in red the items of information that are in each entry. Refer to this list: (1) spelling (2) pronunciation (3) parts of speech (4) inflections (5) definition (6) etymology (7) derivatives (8) synonym or antonym (9) usage label.

VOCABULARY:

1. Diacritical marks and accent marks are used to indicate the pronunciation of words.

2. The typist must know the syllables of words to be able to hyphenate a word.

3. The schwa is a symbol for unstressed vowels.

4. The formal writer is interested in the usage labels of words.

5. The grammarian is interested in the inflections of words.

6. Some words get into a dictionary through coinage; orthographers decide on the spellings of the words.

7. The user of an abridged or an unabridged dictionary may save time by using the guide words.

8. The meaning of a word, but not its etymology, may be discovered by seeing the word in context.

DEFINITIONS:

Use your dictionaries to find the meanings of the words below. Write the definition using the sentence pattern $NP_1 + VP + NP_2 + Modifier$ as you did when you defined the word log. What do you need to know before you can write a good sentence? What kind of modifier do you use and what does it modify?

student	knowledge	train	education
pupil	wisdom	educate	vocation
scholar	insight	teach	avocation

PRACTICING PARLIAMENTARY PROCEDURE

Lesson One: Introduction - The Main Motion

Parliamentary procedure is properly used wherever people are gathered together to formulate decisions. Parliamentary procedure is necessary if group action is to be accomplished so that the rights of the minority may be respected. When an individual in a group realizes that business is carried on by the will of the majority, he should use his voice to express his ideas.

To be able to express himself in a meeting, a person recognizes and practices some ground rules. Business is introduced and carried out by the proper use of the main motion. Following are three easy steps to follow:

A. Member secures the floor

1. Member rises
2. Member addresses the chair
3. Chair recognizes the member

B. Introducing business

1. Member makes a motion by saying, "I move that..."
2. Motion is seconded
3. Chair says, "The motion has been made and seconded that... Is there any discussion?" (Discussion follows with one person speaking at a time.)

C. Putting the question

1. Chair states the question and asks for the affirmative vote
2. Then the negative vote
3. Chair states the result. Only until then is the motion completed.

Lesson Two: Wording the Main Motion

The purpose of the main motion is to bring business before the assembly in a form in which it may be considered and voted upon. (See p. 17 of Russell's The How in Parliamentary Procedure.)

PRACTICE EXERCISES:

Pretend that you are having an English club meeting. Someone may volunteer to be chairman or the teacher may serve as chairman. Let each student go through the three steps for securing the floor.

The teacher will now write on the board the words, "I move that..." Remember that every motion begins with these three words. Write three motions that

would be pertinent to one of your club meetings. Read the motions aloud and check for this information: Does the wording of the motion begin with I move that? Is there only one idea expressed in the motion? (At this time you may be asked why the last question is necessary when testing a motion.)

Read number 4 on pages 18 and 19 in your book and answer this question: What is the purpose of the seconding of the motion? What happens to a motion if it receives no second?

Discuss with your teacher the importance of the discussion period that follows the seconding of a motion.

Lesson Three: Subsidiary Motions

Recall that all business begins with a main motion properly presented. During the discussion period it may be evident that the idea of the main motion is good, but the idea needs further clarification or limitations. Read pages 23-28 about how to improve the original or main motion. Your teacher will give you practice in amending a motion when you are participating in club meetings.

THOUGHT QUESTION:

Main Motion: I move that we buy new hair dryers for the Cosmetology Department. Is the following amendment proper for this motion? I move that we amend the motion by substituting "the Print Shop" for "the Cosmetology Department." Devise several amendments that would improve the main motion.

Lesson Four: Conducting Meetings

Look in the Table of Contents of your booklet, The How in Parliamentary Procedure, to decide the topics that will help you in this assignment. Choose different people from your class to discuss the topics.

Lesson Five: Testing Your Knowledge of Parliamentary Procedure

Can you answer these questions?

1. How does a member secure the floor?

2. How is new business introduced?

3. What is the purpose of seconding a motion?

4. Say the three words that should begin every main motion.

5. How can committees be a help in carrying on business?

6. Sometimes discussion of a motion will become tiresome. How can you as a member help to keep the meeting from being delayed?

7. Sometimes a motion should be voted on at another time. There are

three ways to delay a vote. Explain the consequences of each method.

8. What does a member mean when he stands and without being recognized says, "Mr. Chairman, I appeal from the decision of the chair"?

9. How can rules be legally violated in a meeting?

10. In writing your logs day by day you have, in a way, been writing minutes of a class activity. What are some guides to follow in writing the minutes of a meeting? Why should minutes of a club be saved during the lifetime of a club?

11. Parts of the table on pages 52 and 53 should be learned by practicing recalling the ideas from time to time.

12. Note the words majority and two-thirds under "Vote Required" and be able to explain the difference.

13. Do you participate in school elections? Why?

14. Next year in English classes you will study American literature with emphasis on the founders of our Nation. As we study the literature of our Country, we realize what our privileges and responsibilities of being an American citizen are.

WRITTEN ASSIGNMENT: Write briefly in prose or poetry on "What America Means to Me Today."

IMPROVING ATTITUDES

Each of us has a role we play. Each of us is a person, a human being. Look in your dictionaries for the etymology of the word person and you will find persona is the root, but there is no definition given of the original word. Persona is a word used for the masks the early actors wore. When we divide the word into its parts we have per and son. Per means "through" and son means "sound."

Actors in Roman and Greek dramas often had to take more than one part in a single performance and for each actor they portrayed they would wear a different mask. The name of such a mask in Latin is persona and since we are in a fashion all actors, the word persona came to mean the part that anyone plays in the world. Finally, it designated an individuality or, as of today, a person. By a similar figure of speech if we impersonate another, we put on a mask.

THOUGHT QUESTIONS:

Who am I behind the mask? How do I "sound through" to other people? What are my strengths? What are my weaknesses?

PRACTICE EXERCISE: THE INVENTORY

Let's begin with the last question: What are my strengths and weaknesses? To answer this question we may need to take a personal inventory. Divide a sheet of paper lengthwise by folding it. On one side list what you consider weaknesses that have affected your personality as a student. On the other side list the strengths that make up your personality. Do this exercise thoughtfully and carefully. Be bold in stating your feelings. Be consistent and positive in your thinking as you write.

Now look at the list the teacher gives you. Check (✓) the ones you think apply to you. Place a plus sign (+) by those traits you would like to acquire, and place a minus sign (-) by those that apply to you sometimes. The teacher will explain the directions that are written on the two other sheets of the inventory.

Now that you have completed various inventories of your attitudes, think about why we would talk about attitudes in an English class. Refer to the discussion on person at the beginning of this unit. The word personality is a derivative of person. Is personality a noun or an adjective? How do you know? What does the word mean? What is the relationship between the word personality and the word individuality? Think about this statement and apply it to yourself: I am the most important person that I know. Do you agree with this statement? Try your ideas out in a discussion with others in the class. See if you can reach a conclusion on whether the statement is true.

VOCABULARY:

1. A pessimist is an unhappy person.

2. An optimist can usually face a disappointing event with a smile.

3. Some people are introverts and some are extroverts.

QUESTIONS FOR DISCUSSION:

1. What is the difference between a positive and a negative attitude toward studying? toward working?

2. Which attitude will more often lead to success? Why?

3. Which attitude, the negative or the positive, toward life requires more courage? Why?

NOTEBOOK ASSIGNMENT:

Copy this poem in your notebook. Ask the teacher to read it aloud to you, and then you may read it several times to get the meaning. One interesting thing about reading poetry is that you probably will not get the same meaning from the poem each time you read it.

THREE KINDS OF COURAGE

There's the courage that nerves you in starting to climb
the mount of success rising sheer;
And when you've slipped back, there's the courage sublime,
that keeps you from shedding a tear.
These two kinds of courage, I give you my word, are worthy
of tribute - but then,
You'll not reach the summit unless you've the third - - -
the courage to try - it - again!

Roy Farrell Greene

THOUGHT QUESTION

Can you see any relationship between the poem about courage and your taking a personal inventory?

LOOKING TOWARD A CAREER

Our lives are gauged by our attitudes. Attitudes mirror our likes, dislikes, fears, and interests. Other people notice these things about us. For us to know ourselves we need to recognize our attitudes, our strengths, our limitations, and our goals. The unit on "Improving Attitudes" has been a step toward helping us to know ourselves. This new unit is called "Looking Toward a Career." Would "Choosing a Career" be a better title? Discuss the differences in the meanings of the two titles.

Lesson One: Recognizing Your Personality

What do you want most from a lifetime job - money? satisfaction? enjoyment? success?

What factors are involved in selecting a suitable career? Probably you have not given much thought to the future and its possibilities for you. Maybe you think that as sophomores you have plenty of time to decide about a vocation. Let us think about this. You have noted that our discussion of your schedules has indicated that we need to choose courses carefully to be sure that we are taking proper steps toward receiving a diploma. You have analyzed your strengths and weaknesses and have noted your attitudes in general.

WRITTEN ASSIGNMENT:

Think about yourself and write for your teacher a brief analysis of yourself. This is not an autobiography; it is an attempt on your part to identify your personality.

Lesson Two: Projecting Yourself into a Work Situation

We have in the room some books that contain discussions of different vocations. If there is a vocation that you are already interested in, then you may be ready to select a book now. Ask yourself these two questions to guide your thinking: What occupation am I fitted for? What kind of occupation would I like?

READING:

Begin your reading with the idea that you are exploring the possibilities and the potential of a career. Try to imagine yourself doing the job as it is described. This exercise is not designed for you to decide on a career today, but is designed to help you to guide yourself into choosing a career that will give you a great deal of personal satisfaction. Discussions in your other classes, especially the classes designed to help you develop work skills, will be quite useful in guiding you to a particular kind of job.

THOUGHT QUESTIONS:

Do you know a person who is in an unhappy work situation?

Is it too late, do you think, for him to change jobs? Why?

What seems to be his attitude toward other things in life besides his job?

Lesson Three: Planning Your Career

Following is an outline that may be used for an oral or a written report on your reading.

I. Why I think I would like this occupation

II. Nature of the work involved in this job

III. Qualifications

A. Physical requirements
B. Educational requirements
C. Psychological requirements
D. Duty requirements

IV. Future of the job

A. Salary
B. Advancement
C. Tenure
D. Working conditions

V. Why I think I would/would not like to pursue this job

A. Advantages
B. Disadvantages
C. Necessary attitudes

Lesson Four: Identifying Yourself in a Work Situation

There are on the bookshelves many stories of people who have achieved in some way. We can say that they are success stories. This brings to mind a question: "What do we mean by success in life"? One may very well ask also, "How is success measured"? Helga Sandburg has said that success is measured by oneself. The mentioning of oneself reminds us of our discussion of individualism and persona. Many people are able to wear a mask of success and hide a record of unsuccessful attempts. An understanding of oneself becomes even more important as a person advances in a career. As you read the stories of people who have succeeded easily and of those who have overcome adverse circumstances to achieve, think about this quote from Somerset Maugham: "The common idea that success spoils people by making them vain, egotistical, and self-complacent is erroneous; on the contrary, it makes them, for the most part, humble, tolerant, and kind. Failure makes people cruel and bitter."

READING, WRITING, AND LISTENING:

As you read the success stories, try to recognize the problems that these people face. Write about these problems in your own words. Share your writings with the others in the class. Be ready to comment on how the problem is solved. Try this: Read your identification of the problem. Then say to the other members of the class, "How would you have solved the problem?" Listen carefully to the comments by your classmates. As soon as the "ball quits bouncing" (the discussion lags), tell how the character in the story solves the problem. You and your classmates, if you identify yourselves with the people who have problems, will probably have some better solutions than those written in the stories.

SUPPLEMENTARY READING

Included with your lessons is a book list categorized according to subject matter. You should read the titles frequently so that you will recognize the books when you see them in a library or in a bookstore.

You will want to keep a record of what you have read. Following are some questions you may answer in keeping a reading record that can be shared with other students:

1. What idea was the writer attempting to impress upon his readers?

2. What is your own personal reaction to this book?

3. What further reading would you like to do as a result of this reading experience?

4. Would you recommend this book to a friend or classmate? Why?

READING NEWSPAPERS

Lesson One: The Front Page

Bring to class old newspapers that can be cut. You will need Sunday and daily editions. Your teacher may ask you to bring scissors and paste.

We are going to study the makeup of newspapers so that we can read them more easily and quickly. First let us look at the front page. What type news stories are there?

Read the first sentence of a story that attracts your attention. What questions are answered for the reader? What questions are unanswered?

Now look at this list and see how many of these questions are answered for you: Who? What? When? Where? How? Why? Who says so? If these questions are not answered in the first sentence, continue reading through the first paragraph. The part of the story that answers these questions, or most of them, is called "the lead."

LISTENING:

Listen to what your teacher says about the lead of a story. She will probably dictate some ideas about leads that she wants you to write in your notebook for future reference.

ASSIGNMENT:

Find on the front page of a newspaper a story that you understand. Cut it out and paste it on a sheet of your writing paper. Copy the questions that test the adequacy of a lead; use words from the lead sentence or paragraph for the answers.

Read the following test for the adequacy of a lead: Does it give in summary the bare outlines of the story - everything that the busy reader would want to know if he could read only the lead? Now write two or three sentences of your own, telling your decision about the adequacy of the lead of the story you are working with, or choose another one for practice. You may have decided to work in groups for this assignment so that you can share ideas about the leads in several stories. Make individual decisions about the adequacy of the lead of the article you choose for your assignment.

Re-read the article you have pasted on your paper. Underline colorful words. Note the extra details that are in the story. How necessary are these details to an understanding of the story? Comment on the structure of the sentences. Are the sentences effective? Why?

Lesson Two: The Editorial

Cut a brief editorial from the editorial page of a daily paper and paste it on a sheet of paper. What is the editorial about? What other materials are on the editorial page? Especially note the cartoon and its caption. Is it timely? Clip the title and copyright data found on the editorial page.

In a Sunday paper, where does one find editorials? This part of the paper is referred to as a section. Clip from the editorial section the following items. Paste them on sheets of paper and label each one. What part of the editorial section of the paper would some people probably want to save? Clip these:

1. An article on entertainment
2. An editorial of national source
3. An editorial of state source
4. A short book review
5. An entertainment advertisement
6. Table of best sellers
7. One feature story

Lesson Three: Other News Items

Clip and paste on sheets of paper one of each of the following. Label each clipping correctly.

1. An obituary
2. A notice of a meeting
3. An accident story
4. An announcement of a business personal promotion
5. A wedding announcement

Lesson Four: The Sports Story

Find a brief sports story. Clip it and paste it on a sheet of paper. Criticize the story for clarity, colorful words, and interest.

Lesson Five: Advertisements

Clip several want ads for employment that interest you. What items of information are found in the ads that interest you? Is the salary a good one? On what ideas are you basing your answer?

WRITTEN ASSIGNMENT:

Try writing a want ad in which you are advertising for employment. Use either the employer or the employee viewpoint.

Lesson Six: Summary and Evaluation

You may have suggestions for activities that you think you and your classmates will enjoy doing. Your teacher will have suggestions, too.

READING LITERATURE: UNDERSTANDING POINTS OF VIEW

Lesson One: Differences in Points of View

The story "Without Words" on pages 92-100 in your textbook is one about individual personalities. As you read the story, especially note their attitudes toward stealing and killing.

NOTEBOOK ASSIGNMENT

Label a section of your notebook "Reading Literature."

Write the title of the story you have read and the page on which it is found. From your analyzation of the two characters, Jan and Mathieu, try to draw conclusions about why their viewpoints are different. Record the reasons.

Lesson Two: Listening and Discussing

Read "A Man Who Had No Eyes" by MacKinlay Kantor on pages 101-103 in Perspectives. Then discuss with your classmates the idea that even though both men are blind, their achievements are different. How do you account for the differences?

LISTENING

Listen as the teacher reads a story about a grouchy man. Try to decide how there can be different ideas about grouchiness.

Lesson Three: Time Changes Ideas

You will remember reading a poem "Three Kinds of Courage" and being told that we have different points of view about poetry because we are individuals. With your teacher read and discuss two poems: "Sea Love" by Charlotte Mew page 111 in Perspectives and "About Crows" by John Ciardi page 118 in Perspectives.

NOTEBOOK ASSIGNMENT

1. Discuss further with other class members your ideas on why there are different points of view about the same subjects. Write in your own words what you have learned about differences in viewpoints. Be quite specific in naming causes.

2. To test your ability to determine basic reasons for differing points of view, make a list of characters we have studied in this unit and write two-sentence biographical sketches of each one.

READING LITERATURE: MAKING INFERENCES

Lesson One: A Study of Contrasts

Characters are people. They reveal themselves in the stories through what they say and do. A careful reader can learn to make inferences from what he reads in the stories and become aware of the human traits in characters. In other words, reading literature can become a living, practical art. We have learned in analyzing ourselves in this class that we all have problems that must be faced. As we go more deeply into our study of literature, we realize that the problems of people fall into identifiable categories.

Read the non-serious essay on pages 564-565 entitled "From a Boy's Point of View." Try reading between the lines and question your classmates as all of you discuss the questions in the text on page 565. Your questions may be worded, "Why do you answer in this way?" or "Which word clue did you use to arrive at your answer?"

"Stranger On the Night Train" on pages 267-271 is an intriguing story about war and the Czechoslovakian border. You may want to take turns reading the story aloud to each other.

Your teacher will guide you in noting some of the contrasts in the story. After discussing this particular story, you may want to talk about the significance of the expression "behind the Iron Curtain."

THOUGHT QUESTIONS

Do we have any "Iron Curtains" in America?

How free are we?

How free should we be?

Discuss freely this idea: Freedom carries responsibility.

WRITTEN ASSIGNMENT

Write a character sketch of someone you know quite well. Think carefully before you write about <u>one</u> outstanding trait that identifies the person as an individual. Be rather sly by relating anecdotes that reveal the actions of the person that give clues to his character. Placing the person in situations with other people and relating their conversations will be another way for revealing character traits.

READING LITERATURE: FINDING THE CENTRAL IDEA

There will be many times that you will want to read quickly for information. To do this you should learn to pick out the main ideas in paragraphs. In some of your textbooks, the headings of the paragraphs indicate the main idea. Most of your reading for information will be done in periodicals and not in planned textbooks. With practice you can learn to read informative materials rather rapidly. One key to reading of this kind is to avoid reading every word. Read by paragraphs for the central idea. On pages 550-561 in Perspectives there are interesting exercises to help you to develop the skill of recognizing the central idea. In your last writing assignment you were conscious of emphasizing one identifying trait of a person and then supporting your idea with appropriate details. This same plan may be followed in reading for information.

There is a section in Perspectives on pages 209-249 entitled "Spaceways." The stories are timely and exciting. Today we are all interested in outer space - the frontier of the twentieth century. You may want to collect materials on outer space that you can share with others. Too if there are ideas and terms that you read about that you would like to do research on, the teacher will give you time for extra study. Now that you know how to use the Readers' Guide to Periodical Literature, you can easily locate recent articles on topics related to outer space.

READING LITERATURE: IMAGERY AND FIGURATIVE LANGUAGE

Lesson One: Inanimate Objects as Images

One of the best stories in Perspectives is a story about a plan for peace, "Papa and the Bomb," on pages 411-420. The inanimate objects such as a ruler, a coffee can, a cake, a clock, bowling jackets and shoes, etc., serve as images that carry meanings for all of us. As you read the story, take time to enjoy the language used by the members of the family.

THOUGHT QUESTIONS

Papa objects to clocks and rulers and uses them as springboards to his criticisms of civilization. What are his criticisms? Do you agree with them?

Lesson Two: Recognizing Figures of Speech

Now that you have studied with your teacher about how figurative language is used for comparisons and you can distinguish between literal and figurative statements, you will enjoy reading "My Country" on pages 405-409. The teacher will read the introductory lines on page 404. The questions and the implied answers are clear. The situation, "Here lies an American soldier; he is dead," is also clear. Choose two good readers in the class to read "His Sister Speaks" and "His Teacher Speaks." Ask the teacher to read aloud the last part of the poem, beginning with line 70.

THOUGHT QUESTIONS

The first four questions on page 410 may be used as a guide for class discussion. The author seems to believe that the "secret of liberty" may be found in the graves of dead soldiers. What is this "secret" of freedom? To answer this question satisfactorily, you may need to paraphrase the last seventeen lines of the poem. Paraphrasing means to determine in your own words the meaning of each line of a poem. Locating the end marks of punctuation and recognizing the action words will help you to understand the meaning.

READING LITERATURE: RELATIONSHIPS

Lesson One: Relating Inferences and Relationships

The story "After Twenty Years" on pages 311-313 in Perspectives was written by O. Henry. Read the brief biographical sketch of him on page 313. Pause as you read the story; and, by drawing careful inferences from the actions of the policeman and the conversation of the man from the West, try to decide how the story will end.

THOUGHT QUESTIONS

What clues do you have about how the story will end? Answering the questions in the textbook on page 313 will aid your thinking.

What are some events or circumstances that can complicate decisions of policemen?

Lesson Two: The Significance of Titles of Stories

"The Long Shot" on pages 351-359 is the story of a policemen who faces a decision. This is a gripping, terrifying story; so read it without stopping.

THOUGHT QUESTIONS

The title "The Long Shot" literally refers to the shot which Officer Henderson must fire across the street. What is the deeper suggestion of the title?

Lesson Three: Relationships--Cause and Effect

"Frame-up" on pages 15-33 is in a sense a detective story. See if you can figure out before Jimmy does what really happened to cause the accident.

THOUGHT QUESTIONS

What causes Jimmy to be so determined to search for the witness? Why does he falter or almost give up? Discuss the family relationship in this story. Is it unusual?

Lesson Four: Relationships--Comparison and Contrast

Listen as the teacher reads "The Scrub Oak Tree" by Herbert Merrill on page 182. Then you read the poem as though it is a short short story paying attention to end marks of punctuation. After you think you know the meaning, answer all of question one. Now you are ready to enter into the class discussion on comparison-contrast.

Turn to page 109 and read "The Mate" by James Stokely. Your teacher will give you time to read and to think about the poem. Before entering into a class discussion of question four on page 110, ask your teacher to read the poem aloud. Her stresses on certain words and her interpretation of the poem will help you to clarify your thinking on the meaning of the poem.

THOUGHT QUESTIONS

Does the boy in "The Mate" seem younger than sixteen? Why? The poem, "The Scrub Oak Tree," really has two meanings. The author describes an acorn planted in rocky soil, but he is actually suggesting through an image a broader idea about life in general. What are some of the conclusions about life in general that you think the author wants you to draw?

INTRODUCTION TO LANGUAGE

Now that we have listened to recordings of the speech of different people, we recognize that nearly all of us pronounce our words a bit differently from other people. Our ability to speak words distinguishes us from lower animals. Let's think back: How did we learn to talk? Why did we learn to talk? Why did we decide that certain words refer to or are names for objects? Let's say a few words and then see if we all have the same picture in our minds when we hear the word. Think of these words and the suggest others for you and your classmates to use in this exercise: chair, car, dish. These are words for tangible objects with which you are all familiar. The reason we have different ideas about these words is that these are general words. We would have difficulty communicating if we went around saying just words. Suppose we said these words in this order: bought, man, the, car, a. In our recording we understood each other. Why? (The order in which words are said is important.) English is a language that is dependent on word-order in sentences to be understood. Look at these pairs of sentences and note the differences in meanings:

1. Joe hit Bill.
1. Bill hit Joe.
2. The pretty girls in the choir sing on Sunday.
2. The pretty girls sing in the choir on Sunday.

In our next lessons we are going to study word order in sentences beginning with what we call kernel sentences. To understand the lessons we will need a vocabulary which we are including here. The words and signs will seem a bit queer to you until you and your teacher use them. Then they will be fun to use because they are easy to remember.

A. Kernel Sentence

$S \longrightarrow NP + VP$

S = *sentence*
$\longrightarrow$ = *may be written as*
NP = *noun phrase*
VP = *verb phrase*

B. Noun Phrase

NP = *proper noun, personal pronoun, indefinite pronoun, or Det + N*

proper nouns = James, New York, the United States . . .
personal pronouns = I, he, she, it, we, you, they
indefinite pronouns = everyone, everybody, everything; someone, somebody, something; no one, nobody, nothing; anyone, anybody, anything

Det + *N*

Det = article ⟶ definite = the

or

nondefinite = a/an, some, or null

or

demonstrative ⟶ singular = this or that
or
plural = these or those

N = count + plural
or
noncount

C. The Verb Phrase

VP ⟶ Aux + be + *NP* / *adjective* / *or adverb*

or

Aux + verbal

Aux ⟶ *tense* + (*modal*) + (*have* +*part*) + (*be* + *ing*)

tense = *Pres* or *Pas*
modal = *can*, *will*, *shall*, *may*, or *must*

verbal ⟶ V_t + NP
V_i + *adv*
V_b + NP *or adjective*
V_s + *adjective*
or V_{mid} + NP

KERNEL SENTENCES: THE NOUN PHRASE

Look up the word kernel in your dictionary. Which definition do you think fits our idea of a kernel sentence? The kernel sentence contains the subject and predicate which are the core of any sentence.

Look at these sentences in which an action is named. Fill in the blanks with appropriate-sounding words:

The _____ walks.

A _____ walks.

Some _____ walk.

_____ walk.

That _____ can walk.

In each of the sentences you have named a person or animal that walks. Each name is a subject in a sentence. Your teacher is going to flash on the screen some kernel sentences which will give you practice in picking out subjects, which we shall call noun phrases, and predicates, which we call verb phrases. Refer to Section A of your vocabulary sheet. Copy this part in your notebooks, and write some kernel sentences to help you to understand that a sentence is a NP + VP.

Lesson One: Proper Nouns, Personal and Indefinite Pronouns

Discuss with your teacher Section B of the vocabulary Sheet. Help her to list different proper nouns, personal pronouns, and indefinite pronouns. You may want to test yourself when you are listing I, he, she, it, you, and they to see if you can name all the forms of first person I and use them in sentences. Then you could do the same for second person you and third person he, she, it.

ASSIGNMENT

Writing sentences of your own will help you to check yourselves to see if you understand subjects and predicates.

Lesson Two: The Noun in Det + N

Det is a sign for determiner. The word determiner is particularly useful since it is used as a label for those words that always signal that a noun is following. Certain words pattern with nouns and these words (determiners) are noun markers. Your teacher will discuss definite and indefinite articles with you in this lesson. Refer to Det in Section B

of your vocabulary sheet. Is the word demonstrative a new word for you? When you note that the demonstratives are this, that, these, those, you can decide for yourselves their use. Make some sentences using demonstratives as determiners and ask your teacher if they are right.

ORAL AND WRITTEN COMPOSITION

It should be easy to describe something that you are holding in your hand and that all the listeners can see. You can fall into a trap because when you have the object before you you may say, "This part here . . . ." The object of this lesson is to help you to be specific and call all items by their proper terms. You are really a "teacher" describing a tool and how it works so that your "students" can explain what they have learned to someone else. Your listeners may want to explain a tool which they do not have near them, and they will need exact terms for their descriptions.

KERNEL SENTENCES: THE VERB PHRASE

Lesson One: The Verb be

The verb phrase in Section C of the vocabulary sheet looks rather complicated. It really is not. Probably the verb we use most often is the verb be. This verb changes its form to indicate person, tense, and number. Following is a table that may help you. You need not memorize it, but be sure you understand its meaning. Proper nouns are usually used as third person as, John is here.

Present Tense

	Singular Number	Plural Number
1st person	I am	we are
2nd person	you are	you are
3rd person	he (she) (it) is	they are

Past Tense

	Singular Number	Plural Number
1st person	I am	we were
2nd person	you were	you were
3rd person	he (she) (it) was	they were

As the teacher goes through the lesson, check the formulas for the verb be in Section C on the vocabulary sheet. Be sure to ask questions so the teacher can re-explain the ideas she is teaching you.

The teacher will write these sentences on the board and ask you to decide which sentences contain the verb be. Remember the verb be must be followed by a NP, an adjective, or an adverb of place.

1. The man is looking for you.
2. They were here yesterday.
3. Joe had been waiting for us.
4. The teacher is kind.
5. The teacher is talking to her class.

Be sure you understand these sentences before the teacher begins the discussion on auxiliaries and verbals. All you need to know about the auxiliary at this point is that it is a helping word.

THE VERB PHRASE: THE VERBALS

Lesson One: Transitive Verbs

Look at these sentences. In each one there is an actor, an action, and a receiver named.

1. Mother broke the vase.
2. She dropped her purse.
3. Some people are studying their lessons.
4. James will tell the story.

If we divide these sentences into NP + VP, the lines would come after Mother, She, Some people, and James. Note that in the verb phrase there are an action and a receiver named. These verbals are referred to as V_t + NP (action + receiver). V_t = transitive verb.

Lesson Two: Intransitive Verbs

In the following sentences there are no receivers of action; however, there are differences in the make-up of the verb phrases. See if you can relate these different make-ups to the terms for verbals as listed in Section C of the vocabulary sheet.

Lesson Three: The Verb have

You have now noted all the verbals except one: V_{mid} + NP. To understand this one look at these two sentences:

1. James has a car.
2. James has broken the rules.

Test to see if the VP is V_t + NP by putting the receiver in the subject's place. Sentence 1 will not pass the test. We say that VP containing the verb have are V_{mid} + NP.

THE VERB PHRASE: THE AUXILIARY

The word morpheme will be new to some of you. It is a single unit of meaning. Morph means form, and a morpheme is the smallest word or part of a word that indicates meaning. The auxiliary in the verb phrases indicates the form of the verb be or of the verbal in the verb phrase. The first item in the auxiliary is tense which may be either present or past. Check this item in Section C of the vocabulary sheet and remember to choose either Pres or Pas for the first element in the VP. Also, remember that Pres or Pas is a morpheme that affects only the element immediately following it in the VP.

Lesson One: Present and Past Tense of the Verb be

The grammatical concept of tense has to do with form, not with meaning.

The verb be is an example of this idea; it changes its form to indicate tense. Tense indicates the relationship of the time of action and the time of the speaking or writing about the action in a sentence.

Copy the following material in your notebook. Remember Pres and Pas are morphemes that change the form of words to which they are added:

1. be + Pres = am when the NP is I
2. be + Pres = is when the NP is he, she, it, a proper noun, an indefinite pronoun, or a Det + N when N is not plural
3. be + Pres = are in all other cases
4. be + Pas = was when the NP is I, he, she, it, a proper noun, an indefinite pronoun, or a Det + N when N is not plural
5. be + Pas = were in all other cases

ASSIGNMENT (Oral)

Make sentences to illustrate the ideas above. Listen as others read their sentences above for errors. You are learning that a subject and verb must agree in person and number.

ASSIGNMENT (Written)

Remember that the noun in Det + N may be either a count or a noncount noun. If the noun can be counted, we simply mean that it has a plural form. The morpheme for plural is s: boy + s = boys; man + s = men; sheep + s = sheep. The symbol # stands as the marker of the beginning and end of a word. Write these sentences. Spell the words as the morphemes indicate they should be. Punctuate the sentences correctly.

1. # the # man + s # Pres + be # here #
2. # somebody + Ø # Pres + be # in the room #
3. # the # principal + Ø # Pas + be # worried #
4. # Jim # Pres + be # president # of our class #
5. # the # desk + s # Pres + be # in the hall #
6. # our # neighbor + s # Pres + be # kind #
7. # the # tool + s # Pas + be # in the shop # yesterday #

Write the sentences carefully. Either the teacher or you will correct your paper. Be sure you understand how you made errors, if you did make some.

Lesson Two: Other Elements in the Auxiliary

Looking at the vocabulary sheet we find that Aux ⟶ tense + (modal) + (have + part) + (be + ing). The word tense is not in parentheses because every verb phrase must include either present (Pres) or past tense (Pas). If there is a modal in the verb phrase, it will follow tense. The common modals are can, will, shall, may, must. Pres does not change the form of these modals. Must is always Pres + must. Pas changes the following modals:

can + Pas = could	will + Pas = would
shall + Pas = should	may + Pas = might

Next in order is (have + part) which may be used. Understanding this element in the auxiliary helps us to say I have taken the test, He had seen me earlier . . . . (Be + ing) may follow next in the order of the auxiliary. If the verbal has an ing it will be preceded by (be + ing); as, She is coming to our house, My mother was waiting for me.

ASSIGNMENT

Copy these sentences. Indicate the attaching of the morpheme to the word following it in the VP. (Remember the morphemes are Pres, Pas, part, and ing in verb phrases.) Then write the sentences punctuating them correctly. Example:

John + Pres + have + part + be + ing + study
John + has + been + studying
John has been studying. .

1. John + Pres + will + study + his lessons

2. John + Pas + run + to school

3. John + Pas + be + at home

4. John + Pres + be + ing + wait + for me

5. John + Pas + will + see + me

6. John + Pas + shall + be + ing + work + in the shop

7. John + Pas + have + a car

8. John + Pres + be + kind + to his mother

9. John + Pas + may + have + part + be + ing + listen + to the teacher

10. John + Pres + be + ing + play + the piano

STEINBECK'S *THE PEARL*: A STUDY OF AN AUTHOR'S USE OF LANGUAGE

INTRODUCTION

For class use you will each have a Bantam Pathfinder Edition (ED78) of The Pearl by John Steinbeck. Steinbeck is one of the best storytellers we have had in America. You may be interested in reading about him during a library period.

PROCEDURE

The teacher will read the first chapter to you and will point out some ideas in the story that you might not notice on a first reading of the story. After you have studied the first chapter, the teacher will ask you to choose some topic that you can concentrate on while you are reading the rest of the story. Try to look at your topic in two ways: (1) Relate the actions and feelings of the people to what you know about the actions of people today that express their feelings. (2) Especially note the language the author uses to help you to understand the story.

Here are some topics that you may want to discuss. You should feel free to suggest other topics as you continue the study:

1. Bared emotions shown throughout the actions of characters
2. Folk beliefs and folkways
3. The different dawnings of new days
4. Songs and music
5. Sensory descriptions
6. Narrated incidents

Anytime the class is having a discussion on some of the ideas listed above, you should offer your ideas freely.

THOUGHT QUESTION

There is not much conversation in the story, but the reader feels that there is communication among the characters. How do you account for this?

SHAKESPEARE'S USE OF LANGUAGE: JULIUS CAESAR

Lesson One: Improvisations

Your teacher will give you a list of various situations which you may use for enacting impromptu skits with your classmates. Read them carefully and decide how you would re-create the situations.

Lesson Two: Reading the Play

You are about to read a play about the assassination of Julius Caesar, a great Roman leader. The historical events in this play occurred during the years 44-42 B.C. However, this particular account was written by William Shakespeare in 1601. Julius Caesar is an exciting story. Murder, conspiracy, rioting, battles, and ghosts all have their place in a drama full of action and suspense and tragedy.

As you read, you will become well acquainted with some of the characters in the play. You will meet noble, gentle Brutus, whose motive for killing Caesar was honorable, and jealous, spiteful Cassius who wanted Caesar dead because he hated him. You will also meet Mark Antony, Caesar's trusted lieutenant, whose oratory stirred the citizens of Rome to rioting and murder and who later tried to cheat them out of money Caesar had left them in his will. You will meet the great leader himself, Julius Caesar, who is returning as the brilliant and triumphant dictator of Rome, but who possesses one overwhelming ambition--to be crowned emperor!

You will probably want to reflect upon and think seriously about some of the universal questions Shakespeare asks in the play. Does the end justify the means? Is murder ever right? What are the qualities of true leadership? Should a man be honorable at the expense of being practical? Or should he take a practical approach to life and forego honor? These are some of the questions which will occupy your thinking. They are often called universal because people in every age of history have had to answer them. You will be interested to see how Shakespeare's characters answer these and other questions.

You should decide with your teacher how you would like to read the play. Perhaps you would prefer to be assigned parts to read aloud in class or maybe you would prefer to listen to tape recordings by other students. Whatever you decide, keep in mind that the purpose of the reading is for you to receive maximum enjoyment and meaning from the play.

Lesson Three: Thinking About the Play

As you read the play Julius Caesar, several questions will probably come to your mind. Below are given some study aids to guide your thinking as you

read. Your teacher will assign them to you or use them for class discussions.

ACT I

1. Contrast the attitudes of Flavius and Marullus and the attitudes of the common people with regard to Julius Caesar.

2. Caesar is presented as a magnificent figure; yet he has certain defects. What are these defects and how does Shakespeare reveal them to us?

3. Why do you think Shakespeare had the Soothsayer appear when he did? Look up the word "foreshadowing" and relate its meaning to the above question.

4. Why is Cassius determined to have Brutus join the conspiracy against Caesar?

5. Why do you think Shakespeare included details of strange, supernatural happenings on the night of March 14?

ACT II

1. Brutus persuades himself to join the conspiracy against Caesar. By what reasoning does he decide to do this?

2. After reading the conversation between Brutus and Portia, write your impression of Portia.

3. Why does Cassius want Antony to be killed? Why does Brutus refuse to allow a second murder?

4. Caesar decides not to go to the capitol, then decides to go. Who and what are responsible for his change in plans? In answering this question do you find evidence of character traits in Caesar that could be dangerous?

5. Why do you think Shakespeare included Scene 3 in the play?

ACT III

1. In what way does Caesar reveal his pride and conceit at the beginning of Act III? How does he reveal his political power?

2. What does Caesar mean when he says, "Et tu, Brute?"

3. Following the assassination the conspirators smear themselves with Caesar's blood. Why? How can this be called a "symbolic" act?

4. Your teacher will help you analyze the speeches of Brutus and Antony. Can you determine why Antony's speech had more effect on

his listeners than Brutus'? Find as many contrasts as you can between the two speeches. Would a modern day crowd react the same or differently to both speeches? Explain your answer.

5. What does the killing of Cinna reveal about the effect of mob violence?

ACT IV

1. Relate the event which caused the quarrel between Brutus and Cassius.

2. Explain the battle plans of Brutus and Cassius. Which was more practical?

3. Why do you think Shakespeare included the ghost scene at this particular time?

4. In Act IV we receive glimpses of Brutus' warmth and compassion. How are these qualities illustrated?

ACT V

1. Describe as best you can the battle strategy followed by the armies.

2. Describe in detail the event which caused Cassius to kill himself.

3. How do we know that even Brutus' foes had deep respect for him?

WRITING AN AUTOBIOGRAPHY

Lesson One: Recalling the Personal Inventories

In the units "Improving Attitudes" and "Looking Toward a Career" each of you took an inventory of your strengths and weaknesses. All participated in interesting discussions about how attitudes are revealed in our relationship with other people and how each one of us plays a role in life. When we were studying about careers we understood that our attitudes mirror our likes, dislikes, fears, and interests and present us as individuals to other people. Each of you wrote a brief analysis of yourself. At this time read again what you wrote. As you read, ask these questions of yourselves: Is this me? Have I changed in anyway? What influences in my life have made me what I am?

Lesson Two: Choosing a Moment to Remember

Think of an incident or experience or a moment of thought that is vivid to you because you were affected by the experience so that it changed your course in life or your attitude toward something. As you write your thoughts, express yourself freely. Consciously try to picture your feelings in words that will help the reader visualize what you are saying.

Lesson Three: Expanding the Moment

Analyze the meaning of the paragraph you have written. What is its central idea? Is it centered around one person, one sport, one time (year, day, month)? Is its central idea one that describes a deep feeling like hatred, jealousy, respect, gratitude, shame, humbleness?

Lesson Four: Writing the Theme

Now try writing an introductory paragraph that will be a general discussion of your central idea. Following are some samples of introductory paragraphs[1] that other students have used for writing autobiographies.

Good Times in Our Jalopy

Our family has had some wonderful good times in our old jalopy which Dad bought for $50 five years ago. It is a 1941 Mercury. Dad and I worked on it together. He taught me how to take a motor apart. We painted it a fiery red. Then it was ready for family trips and good times which I shall never forget.

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[1]Don M. Wolfe, Creative Ways to Teach English, (New York: The Odyssey Press, 1966), p. 82.

My Hobby: Electric Trains

When I was eight years old, my father bought me a small electric train for Christmas. Since then my family has given me five other trains. From this hobby I have learned many things about railroads, electric motors, and railroading signals. In this theme I shall describe five moments when this hobby gave the greatest pleasure.

Discuss these opening paragraphs with your teacher and ask some questions about how you can introduce your central idea so that it can be expanded into four or five paragraphs.

EVALUATION

Revise and rewrite your theme so that your sentences are effective and are properly punctuated.

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Standard First Aid Training Course. Navy Training Course.

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ABSTRACT - Designed as a reference for both Naval officers and enlisted men, this manual may be used for individual or group instruction in shipboard first aid procedures. Chapters, containing information and illustrations, are: (1) General Instructions, (2) Hemorrhage, (3) Asphyxiation, (4) Shock, (5) Poisoning, (6) Wounds, (7) Injuries to Bones, Joints, and Muscles, (8) Injuries from Heat and Cold, (9) Defense against NBC Agents, and (10) Rescue and Transportation Procedures. A listing of common emergencies and actions to take is appended, and a subject index is included. (SB)

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STANDARD FIRST AID TRAINING COURSE

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BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10081-B

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PREFACE

This book is designed to serve as a basic reference in the field of first aid. Since all naval personnel are required to have a knowledge of the principles of first aid, it is expected that this book will be of value to both officers and enlisted men of the Navy. The course is designed for individual study, but may also be used as a basic text for group instruction in first aid procedures. Although the general principles of first aid are, of course, equally applicable on board ship and at shore activities, primary emphasis has been given in this book to shipboard first aid problems.

As one of the Navy Training Courses, this book was prepared by the Training Publications Division, Naval Personnel Program Support Activity, Washington, D. C., for the Bureau of Naval Personnel. Technical assistance was furnished by the Bureau of Medicine and Surgery.

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Revised 1962

Revised 1965

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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CHAPTER 1

GENERAL INSTRUCTIONS

First aid is the emergency care given sick or injured persons. Emergency care must not take the place of proper medical or surgical treatment, but should consist ONLY of furnishing temporary assistance until competent medical aid is available.

The purposes of first aid are: (1) to save life, (2) to prevent further injury, and (3) to preserve vitality and resistance to infection.

Everyone in the Navy must know when and how to apply first aid measures and be prepared to give competent assistance to persons injured in battle, collision, fire, and other accidents that may occur on land or at sea. A real knowledge of first aid and its purposes, when properly applied, may mean the difference between life and death, between rapid recovery and long hospitalization, between temporary disability and permanent injury.

In administering first aid, you have three primary tasks:

1. Stop severe bleeding.
2. Begin artificial respiration.
3. Prevent or reduce shock.

Work quickly, but don't rush around frantically. Don't waste time looking for readymade materials; do the best you can with whatever is at hand. Send for a medical officer as soon as possible.

GENERAL FIRST AID RULES

Although each case of injury or sickness presents its own special problems, there are some general rules that apply to practically all situations. You should have a thorough understanding of the following rules before going on to learn specific first aid treatment for various types of injuries:

1. Keep the victim lying down, his head level with his body, until you have found out what kind of injury he has and how serious it is. However, it should be quickly noted if the victim has one of the following problems that represent exceptions to this rule and require different positions (fig. 1-1):

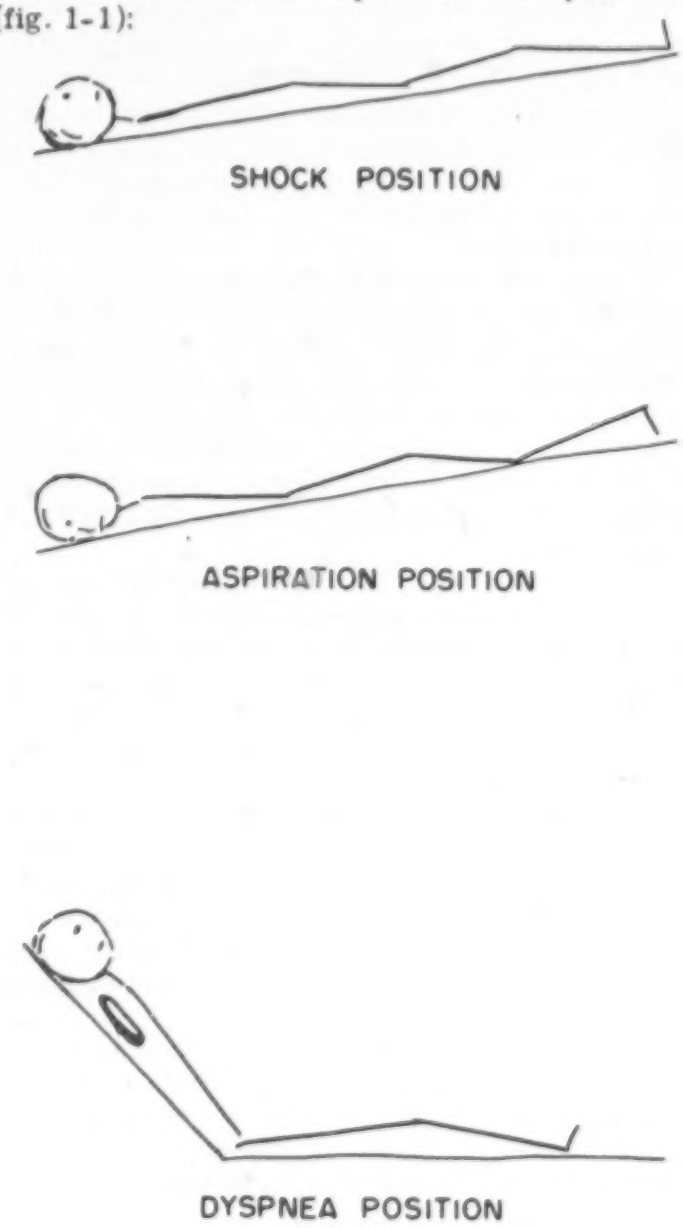

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Figure 1-1.—Positioning victim for specific injuries.

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Severe Shock.—If the victim is in severe shock, place him on his back with his head slightly lower than his feet.

Vomiting or Bleeding About the Mouth and Semiconscious.—If the victim is in danger of aspirating blood, vomited matter, or water, place him on his belly with his head, turned to one side, lower than his feet.

Shortness of Breath.—If the victim has a chest injury or respiratory obstruction, place him in a sitting or semisitting position.

2. Examine the victim for hemorrhage (serious bleeding), asphyxiation (suspended breathing), and shock, all of which require immediate treatment. Hemorrhage and stoppage of breathing are both of such great immediate importance that, whenever possible, one person should take care of one condition while another attends at once to the other.

If you are alone and the victim is bleeding severely and, at the same time, needs artificial respiration, the best course to follow would probably be to stop the bleeding. Artificial respiration usually requires some time to be effective and, once begun, should not be interrupted. You must decide if the bleeding is severe enough to warrant a delay in beginning artificial respiration.

3. In examining the victim, move him no more than is absolutely necessary. It may be necessary to remove some of his clothing in order to determine the extent of his injuries. Remove enough clothing to get a clear idea of the extent of the injury. It is preferable to rip the clothing along the seams, but the material may be cut if ripping it will disturb the victim greatly or aggravate an injury. Removing clothing in the usual way may do great harm, especially in fracture injuries. Do not remove so much clothing that the victim will become cold. Shoes may have to be cut off to avoid causing pain or increasing an injury.

4. Keep the victim reassured and as comfortable as possible. Often a restoration of confidence is very helpful. If pain is severe and the victim is not in deep shock and there is no respiratory or head injury, morphine may be given. (See ch. 4 for dosage.)

5. Avoid allowing the victim to see his injury. Assure him that his injuries are understood and that he will get medical attention as soon as possible.

6. Do not touch open wounds or burns with fingers or other objects, except when sterile compresses or bandages are not available and it is absolutely necessary to stop severe bleeding.

7. Do not try to give an unconscious person any solid or liquid substance by mouth. He may vomit and get some of the material into his lungs when he breathes, causing infection. It is also possible that his windpipe might be blocked causing strangulation. Death could result.

8. Do not move the victim unless it is absolutely necessary to do so. If a bone is broken, or you suspect that one is broken, do not move him until you have immobilized the injured part. This may prove lifesaving in cases of severe bone fractures, for the jagged bone may sever blood vessels, damage tissues, and increase shock. Of course, threat of fire, necessity to abandon ship, and other similar situations may require that the victim be moved. But the principle should always be kept firmly in mind and considered against other factors.

9. When transporting an injured person, always see that the litter is carried feet forward no matter what injuries he has. This will enable the rear bearer to observe the victim for any respiratory obstruction or stoppage of breathing.

10. Keep the injured person comfortably warm—warm enough to maintain normal body temperature.

In most situations you will not be called upon to do very much for an injured person. Very serious and mutilating injuries may require heroic first aid measures on your part; but by far the greater number of injuries will require a minimum of effort on your part and a maximum of judgment and self-control to prevent yourself and well-intentioned bystanders from trying to do too much.

In the following chapters, you will occasionally find information which will enable you to go somewhat beyond the usual limits of first aid treatment. This information has been included because it is recognized that situations might arise in which you and others would find yourselves isolated, temporarily surrounded by hostile forces, adrift at sea, or deprived of medical aid by the injury or death of your medical personnel; and in such situations some extra knowledge might enable you to ease a victim's suffering or help him to survive.

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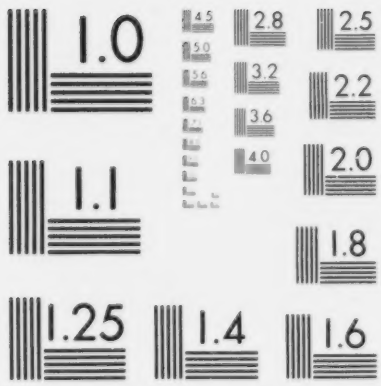

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CHAPTER 2

HEMORRHAGE

Blood is circulated throughout the body by means of three different kinds of blood vessels: arteries, veins, and capillaries. ARTERIES are large vessels which carry the blood away from the heart; VEINS are large vessels which carry the blood back to the heart; and CAPILLARIES form a connecting network of smaller vessels between the arteries and the veins.

Hemorrhage (escape of blood) occurs whenever there is a break in the wall of one or more blood vessels. In most small cuts, only capillaries are injured. Deeper wounds result in injury to veins or arteries. Bleeding which is severe enough to endanger life seldom occurs except when arteries or veins are cut. (You may have heard of people called "bleeders," who can bleed to death from a very small cut because their blood cannot form clots. This condition is so rare, however, that you are not likely to encounter it.)

The average adult body contains about 5 quarts of blood. One pint of blood can usually be lost without harmful effect—in fact, this is the amount usually given by blood donors. However, the loss of 2 pints (1 quart) will usually cause shock, and shock becomes greater and greater as the amount of blood loss increases. If half the blood in the body is lost death almost always results.

Capillary blood is usually brick red in color. If capillaries are cut, the blood oozes out slowly. Blood from the veins is dark red. If a vein is cut, the blood escapes in a steady, even flow. If an artery near the surface is cut, the blood will gush out in spurts which are synchronized with the heart beats; but if the cut artery is deeply buried, the bleeding will appear to be a steady stream. Arterial blood is usually bright red in color.

In actual practice, you might find it difficult to decide whether bleeding was venous or arterial, but the distinction is not usually important. A person can bleed to death quickly from a cut artery; prolonged bleeding from any large cut can, of course, have the same effect. The important thing to know is that ALL bleeding must be controlled as quickly as possible.

CONTROL OF HEMORRHAGE

The only way to stop serious bleeding is by the application of pressure. In practically all cases, bleeding can be stopped if pressure is applied DIRECTLY TO THE WOUND. If direct pressure does not stop the bleeding, pressure should be applied at the appropriate PRESSURE POINT. In those very rare cases where bleeding is so severe that it cannot be controlled by either of these methods, pressure can be applied by means of a tight constricting band called a TOURNIQUET. These three ways of using pressure to control hemorrhage are described below.

Direct Pressure

In almost every case, bleeding can be stopped by the application of pressure directly on the wound. If a sterile dressing is available, place it directly over the wound and fasten it in position with a bandage. If you do not have a sterile dressing, use the cleanest cloth available—a freshly laundered handkerchief, a towel, or some article or clothing. Fold it to form a wad, place it directly over the wound, and fasten it in position with a bandage.

If the bleeding does not stop, try applying direct pressure with your hand, over the wad of cloth (fig. 2-1).

In cases of severe hemorrhage, do not worry too much about the dangers of infection. The basic problem is to stop the flow of blood. If no material is available, simply thrust your hand into the wound. Remember, DIRECT PRESSURE is the first method to use when you are trying to control hemorrhage.

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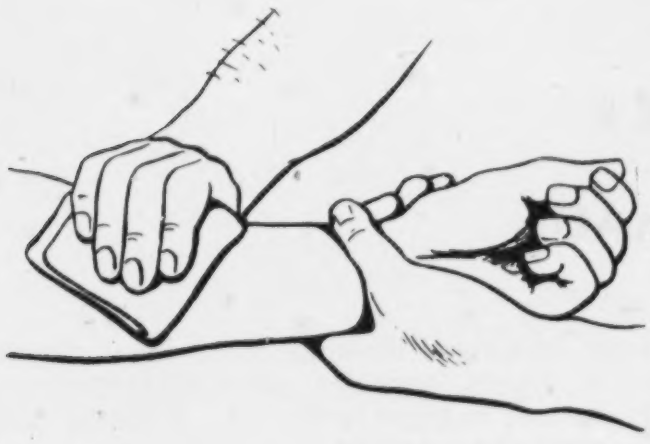

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Figure 2-1.—Controlling bleeding by direct pressure.

Pressure Points

Bleeding from a cut artery or vein may often be controlled by applying pressure to the appropriate pressure point. A PRESSURE POINT is a place where the main artery to the injured part lies near the skin surface and over a bone. Pressure at such a point is applied with the fingers (digital pressure) or with the hand; no first aid materials are required. The object of the pressure is to compress the artery against the bone, thus shutting off the blow of blood from the heart to the wound.

There are 11 principal points on each side of the body where hand or finger pressure can be used to stop hemorrhage. These points are shown in figure 2-2. Notice that arteries are shown in red and veins are shown in blue.

If bleeding occurs on the face below the level of the eyes, pressure should be applied to the point on the lower jawbone. This is shown in figure 2-2A. To find this pressure point, start at the angle of the jaw and run your finger forward along the lower edge of the jawbone until you feel a small notch. The pressure point is in this notch.

If bleeding is in the shoulder or in the upper part of the arm, apply pressure with the fingers in back of the collarbone. You can press down against the first rib or forward against the collarbone—either kind of pressure will stop the bleeding. This pressure point is shown in figure 2-2B.

Bleeding between the middle of the upper arm and the elbow should be controlled by applying digital pressure on the inner (body) side of the arm, about halfway between the shoulder and the elbow. This compresses the artery against the bone of the arm. The application of pressure at this point is shown in figure 2-2C.

Bleeding from the hand can be controlled by pressure at the wrist, as shown in figure 2-2D. If it is possible to hold the arm up in the air, the bleeding will be relatively easy to stop.

Figure 2-2E shows how to apply digital pressure in the middle of the groin, so as to control bleeding from the thigh. The artery at this point lies over a bone and quite close to the surface, so pressure with your fingers may be sufficient to stop the bleeding.

Figure 2-2F shows the proper position for controlling bleeding from the foot. As in the case of bleeding from the hand, elevation is very helpful in controlling this bleeding.

If bleeding is in the region of the temple or the scalp, use your finger to compress the main artery to the temple against the skull bone, at the pressure point just in front of the ear. Figure 2-2G shows the proper position.

If the neck is bleeding, apply pressure below the wound, just in front of the prominent neck muscle. Press inward and slightly backward, compressing the main artery of that side of the neck against the bones of the spinal column. The application of pressure at this point is shown in figure 2-2H.

Do not apply pressure at this point unless it is absolutely essential, since there is great danger of pressing on the windpipe and thus choking the victim.

Bleeding from the lower arm (forearm) can be controlled by applying pressure at the elbow, as shown in figure 2-2I.

As mentioned before, bleeding in the upper part of the thigh can sometimes be controlled by applying digital pressure in the middle of the groin, as shown in figure 2-2E. Sometimes, however, it is more effective to use the pressure point in the upper thigh, as shown in figure 2-2J. If you use this point, apply pressure with the closed fist of one hand and use the other hand to give additional pressure. The artery at this point is deeply buried in some of the heaviest muscle of the body, so a great deal of pressure must be exerted in order to compress the artery against the bone.

Bleeding between the knee and the foot may be controlled by firm pressure at the knee. If pressure at the side of the knee does not stop the bleeding, hold the front of the knee firmly with

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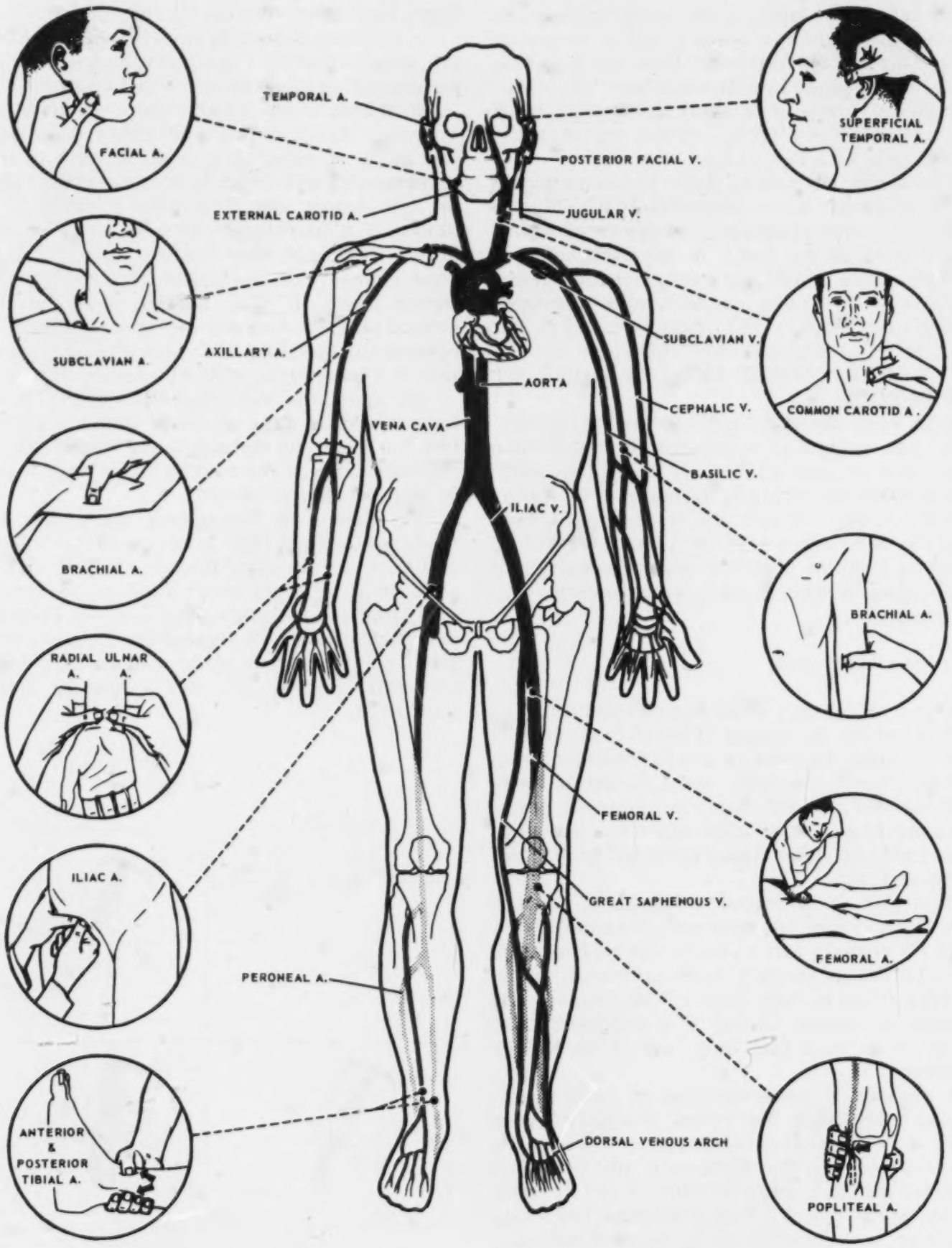

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Figure 2-2.—Pressure points for control of bleeding.

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one hand and thrust your fist hard against the artery behind the knee, as shown in figure 2-2K. If necessary, you can place a folded compress or bandage behind the knee, bend the leg back, and hold it in place by a firm bandage. This is a most effective way of controlling bleeding, but it is so uncomfortable for the victim that it should be used only as a last resort.

You should memorize these pressure points so that you will know immediately which point to use for controlling hemorrhage from a particular part of the body. In the discussion of these pressure points, did you notice the general principle by which you can determine the proper point to use? The correct pressure point is that which is (1) NEAREST THE WOUND, and (2) BETWEEN THE WOUND AND THE MAIN PART OF THE BODY.

It is very tiring to apply digital pressure, and it can seldom be maintained for more than 15 minutes. As soon as possible, therefore, some other method of continuing the control of bleeding must be found. Sometimes a compress, held securely over the wound by a bandage, will be enough to keep the bleeding under control; but if the bleeding is still severe you may have to apply a tourniquet.

Use of the Tourniquet

A tourniquet is a constricting band which is used to cut off the supply of blood to an injured limb. It cannot be used to control bleeding from the head, neck, or body, since its use in these positions would result in greater injury or death. A tourniquet should be used only if the control of hemorrhage by other means proves to be difficult or impossible.

Basically, a tourniquet consists of a pad, a band, and a device for tightening the band so that the blood vessels will be compressed. There are several different kinds of readymade tourniquets. The type found in Navy first aid kits consists of a length of rubber tubing or a web band 2 1/8 inches wide by 5 feet long, with a buckle for fastening.

A variety of materials can be used to improvise tourniquets. Any round, smooth pressure object may be used—a compress, a roller bandage, a stone, a rifle shell—and any long, flat material may be used as the band. It is important that the band be flat: belts, stockings, flat strips of rubber, or neckerchiefs can be used; but rope, wire, string, or very narrow pieces of cloth should not be used because they will cut into the flesh. A short stick may be used to twist the band, thus tightening the tourniquet.

A tourniquet must always be applied ABOVE the wound—that is, towards the body—and it must be applied as close to the wound as practicable.

It is best to use a pad, compress, or similar pressure object, if one is available. It goes under the band. It must be placed directly over the artery, or it will actually decrease the pressure on the artery and thus allow greater flow of blood. If a tourniquet placed over a pressure object does not stop the bleeding, there is a good chance that the pressure object is in the wrong place. If this occurs, shift the object around until the tourniquet, when tightened, will control the bleeding. If no suitable pressure object is available, use the tourniquet without it.

To apply the web tourniquet found in Navy first aid kits, wrap it once about the limb and run the free end through the slit in the felt pad and then through the buckle. Draw it tight enough to stop the flow of blood.

To apply an emergency tourniquet made from something like a neckerchief, wrap the material once around the limb and tie an overhand knot. Place a short stick on the overhand knot, and tie a square knot over it. Then twist the stick rapidly to tighten the tourniquet. The stick may be tied in place with another strip of material. Figure 2-3 shows how to apply a tourniquet.

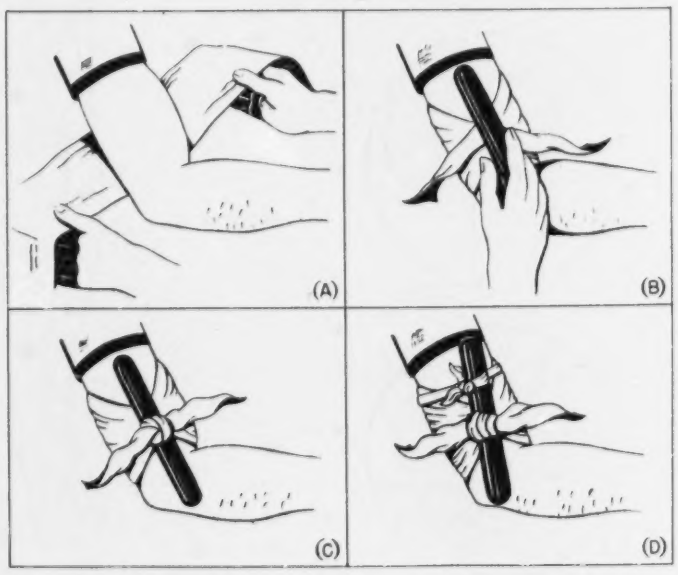

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Figure 2-3.—Applying a tourniquet.

In order to be effective, a tourniquet must be tight enough to stop the arterial blood flow to the limb. If the pressure from the tourniquet is less than the arterial pressure, arterial bleeding will continue. Also, insufficient tourniquet pressure may actually increase the amount of bleeding from the veins. So be sure to draw the tourniquet tight enough to stop the bleeding. However, do not make it any tighter than necessary.

If you have ever had any first aid training, you may have been told quite a lot about the dangers of using a tourniquet, and you may have been instructed to loosen it every 15 or 20 minutes in order to allow some blood to circulate through the injured limb. It is true that a tourniquet is dangerous, and that it can cause the loss of a limb if it is left on too long or if it is improperly applied. However, recent experience has shown that a tourniquet which is correctly applied may be allowed to remain in place for a considerable length of time, with very little risk to the limb. More important, it has been found that in any case where bleeding is severe enough to justify the application of a tourniquet, the danger to life involved in loosening the tourniquet is a much more urgent consideration than any possible risk to the limb. You must remember that a tourniquet is NEVER put on unless the hemorrhage is so severe that it cannot be controlled in any other way; by the time the tourniquet is put on, therefore, the victim has already lost a considerable amount of blood. THE ADDITIONAL LOSS RESULTING FROM LOOSENING THE TOURNIQUET MAY EASILY CAUSE DEATH. Once a tourniquet has been applied, therefore, it should be released only by medical personnel.

After you have brought the bleeding under control with the tourniquet, apply a sterile compress or dressing to the wound, and fasten it in position with a bandage.

Here are the points to remember about using a tourniquet:

- Don't use a tourniquet unless you can't control the bleeding by any other means.
- Don't use a tourniquet for bleeding from head, face, neck, or body. Use it only on the limbs.
- Always apply a tourniquet ABOVE THE WOUND, and as close to the wound as possible.
- Be sure you draw the tourniquet tight enough to stop the bleeding, but don't make it any tighter than necessary.
- Don't loosen a tourniquet after it has been applied, except in extreme emergency.
- Don't cover a tourniquet with a dressing. If it is necessary to cover the injured person in some way, MAKE SURE that all other people concerned with the case know about the tourniquet. Using crayon, skin pencil, or blood, mark a large "T" on the victim's forehead or on a medical tag attached to his wrist.

EMERGENCY SITUATIONS

Bleeding from most external wounds is fairly easy to control. When some of the larger arteries are cut, however, hemorrhage may be so rapid that death will result within a few minutes. Possible methods of controlling the flow of blood in some of these emergency situations are briefly described below.

Wounds of the neck are often caused by sharp objects such as knives, razors, and glass fragments. Sometimes the large artery is cut, sometimes the large vein, and sometimes both; in any event, the blood loss will be extremely rapid. It is sometimes possible to control the bleeding from these wounds by applying hand pressure above AND below the cut; such pressure must be maintained until a medical officer gives further instructions. It is a good idea to use cloth under your hands, if any is available, because the blood makes the neck very slippery and difficult to hold.

If the large artery in the leg is cut, the bleeding is very rapid. A tourniquet is usually necessary. At least partial (and perhaps complete) control of the hemorrhage can be and should be attained, however, by immediately applying extreme pressure directly over the wound. Cover your clenched fist with any clothing or other cloth which is available, and thrust your fist directly into the wound. (If no cloth is available, use your fist alone; but you will find it more difficult to control the bleeding in this way because your fist and the wound will both become very slippery.) Continue to apply direct pressure with your fist while the tourniquet is being applied.

Internal bleeding may be caused by deep wounds or by heavy blows which rupture internal blood vessels. The actual control of internal bleeding is beyond the scope of first aid, but the victim should always be treated for shock. (See ch. 4.)

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GENERAL FIRST AID MEASURES

In addition to knowing how to control serious bleeding by the application of pressure, you must know the following measures which are important in the first aid treatment of a person who has suffered severe bleeding. Any person who has lost a large amount of blood must be treated by a medical officer as soon as possible. In the meantime, however, you can greatly improve his chances for recovery by treating him for shock as soon as possible, and by keeping him quiet.

Shock is always present in persons who have lost a large amount of blood. If you don't see any symptoms of shock, treat the person for it anyway; since the measures used to prevent shock are the same as those used to treat it, you may prevent its occurrence or, at least, lessen its severity.

Keep the casualty quiet. Try to keep him from getting excited. Do not move him unnecessarily, and do not handle him roughly. Keeping him quiet will allow a clot to form in the wound, and will also help to prevent the occurrence of shock. In some cases raising the injured part may help stop the bleeding—but don't try to do this if there is any other injury, such as a fracture or a dislocation, which would be made worse by such treatment. Try in every way to be careful and gentle in handling the casualty, and do everything you can to make him as comfortable as possible under the circumstances.

SUMMARY

Hemorrhage is bleeding caused by a break in the wall of one or more blood vessels. If an artery is cut, the blood is bright red and may spurt rather than flow. If a vein is cut, the blood is dark red and flows steadily. In capillary bleeding, usually brick red in color, the blood oozes out slowly. Severe hemorrhage can cause death in a few minutes; it must be controlled as soon as possible.

Hemorrhage may be controlled in three ways—pressure directly over the wound, digital pressure at the appropriate pressure point, and pressure applied by a tourniquet. Direct pressure should be attempted first by applying a sterile compress fastened with a bandage, or by applying a wad of sterile cloth held firmly in place with your hand, directly over the wound. If bleeding cannot be controlled by direct pressure, use your fingers or hand to compress the artery against bone at the appropriate pressure point. A tourniquet should be used only if either direct pressure or digital pressure fails to control the bleeding. Mark a "T" on the injured person's forehead to indicate a tourniquet is in place. Once applied, a tourniquet should not normally be released.

A person suffering from hemorrhage should always be treated for shock. Keep him quiet, warm, and lying down, with his head lower than his feet. Always get medical assistance as soon as possible.

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CHAPTER 3

ASPHYXIATION

A person who has stopped breathing is not necessarily dead, but he is in immediate, critical danger. Life is dependent upon oxygen, which is breathed into the lungs and then carried by the blood to every body cell. Since body cells cannot store oxygen, and since the blood can hold only a limited amount (and that only for a short time), death will surely result from continued lack of breathing.

However, the heart may continue to beat for some time after breathing has stopped, and the blood may still be circulated to the body cells. Since the blood will, for a short time, contain a small supply of oxygen, the body cells will not die immediately. Thus, for a very few minutes, there is some chance that the person's life may be saved. A person who has stopped breathing but who is still alive is said to be in a state of ASPHYXIA.

The process by which a person can be saved after he has stopped breathing is called ARTIFICIAL RESPIRATION; it is described later in this chapter. But first let's look at some of the reasons why a person might stop breathing, and consider some of the accidents which commonly cause this condition.

CAUSES OF ASPHYXIATION

You won't always be able to tell what has caused a person to stop breathing, and it is not always necessary to know. The first aid treatment for asphyxiation is the same in all cases—that is, artificial respiration. However, since it is often necessary to deal with the causes of asphyxiation before beginning artificial respiration, determining the cause is frequently important. It is also important to know the kinds of accidents which are likely to cause asphyxiation.

Drowning, electric shock, and gas poisoning are the three most common accidents likely to result in asphyxiation. Asphyxiation also occurs from such accidents as choking, hanging, and burial in materials like grain, sand, or gravel. Excessive use of alcohol or drugs may also cause breathing to stop. Also, some illnesses, such as poliomyelitis (sometimes called polio or infantile paralysis) may result in asphyxiation.

In general, cases of asphyxiation may be classified as being due to one or more of the following causes:

- Blocked air passages
- Insufficient oxygen in the air
- Inability of the blood to carry oxygen
- Paralysis of the breathing center in the brain
- Compression of the body

Blocked Air Passages

Blocked air passages cause asphyxiation in cases of drowning, choking, and suffocation. In drowning, the air passages are blocked by water. In choking, they may be blocked by bones, large pieces of food, false teeth, chewing gum, or any other foreign object which becomes caught in the throat and cuts off the supply of air. Suffocation may occur as the result of a tight band around the neck, as in hanging or strangulation; as the result of mucous membrane swelling, from such causes as breathing live steam or certain chemical warfare gases; or because of a spasm of the air passages caused by smoke, ammonia, some chemical warfare gases, acid fumes, or similar agents.

Insufficient Oxygen in the Air

Even if the air passages are not blocked, asphyxia may occur because of insufficient oxygen in the air. For example, aviators and mountain climbers are sometimes asphyxiated because there is not enough oxygen in the air at

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high altitudes. The supply of oxygen in unventilated spaces aboard ship, such as voids, tanks, and double bottoms, is frequently too small to support life. Similarly, on shore, places which are not well ventilated—cisterns, sewers, old wells, unused basements, silos, abandoned mines—may be dangerously deficient in oxygen. (Another danger of such places is that they may contain poisonous or explosive gases. Before anyone is allowed to go down to work in places of this kind, the air must be tested to be sure that it is safe.) Another cause of poor oxygen supply may be that other gases take the place of the oxygen. For example, a fire in any closed space results in the formation of carbon dioxide and a consequent reduction in the amount of oxygen. (The amount of carbon dioxide is greatly increased, of course, if you use a carbon dioxide extinguisher to put out the fire.) If there is not enough oxygen available, unconsciousness will occur suddenly and breathing will stop.

Inability of the Blood to Carry Oxygen

Carbon monoxide poisoning is the primary example of asphyxiation due to an inability of the blood to carry oxygen. Carbon monoxide combines with certain blood cells very rapidly, in such a way as to prevent the blood from carrying oxygen. Thus the body cells (especially in the brain) suffer a lack of oxygen which causes death. Carbon monoxide is a colorless, odorless, and tasteless gas which gives no warning of its presence. Even a small amount of it can be very dangerous. Carbon monoxide is present in engine exhaust gases, manufactured gases used for cooking and heating, sewer gases, gases used for or resulting from industrial processes, and many other gases. It is produced by any fire, but particularly those in which coal, coke, oil, or gasoline are burned. It is also produced by decomposition; for example, food decaying in the hold of a ship may produce enough carbon monoxide to poison anyone who goes into the space. Carbon monoxide poisoning is a frequent cause of asphyxia.

Paralysis of the Breathing Center of the Brain

Breathing can also be stopped by paralysis of the breathing center in the brain. The most frequent causes of paralysis of the breathing center are electric shock; excessive amounts of alcohol, drugs, or anesthetics; and breathing too much carbon dioxide. Also, some frequently used solvents, such as carbon tetrachloride, affect the breathing center and cause breathing to stop.

Compression of the Body

Since breathing movements cannot be made against any great amount of pressure, compression of the body can easily stop a person's breathing. Accidental burial in dirt, sand, gravel, coal, cinders, or similar material is likely to cause asphyxiation because of body compression. In such cases death may occur even though the nose and mouth are uncovered.

In many cases of asphyxiation, it is necessary to rescue the victim before you can begin first aid treatment. Rescue procedures for some common emergencies are described in chapter 10. If you find it necessary to rescue a person from any dangerous situation, remember that the danger may still exist. Take all possible measures to protect yourself. Speed is important, but a careful evaluation of the situation is essential. A few moments' thought may make the difference between life and death—for you, as well as for the person you are trying to rescue.

ARTIFICAL RESPIRATION

The purpose of artificial respiration is to force air out of the lungs and into the lungs, in rhythmic alternation, until natural breathing is reestablished. Artificial respiration should be given only when natural breathing has been suspended; it must NOT be given to any person who is breathing naturally, on his own. Do not assume that a person's breathing has stopped merely because he is unconscious, or because he has been rescued from the water, from poisonous gas, or from contact with an electric wire. Remember: DO NOT GIVE ARTIFICIAL RESPIRATION TO A PERSON WHO IS BREATHING NATURALLY.

If you do not know whether a person is breathing, place your hands on his sides at the level of the lowest ribs. If he is breathing, you will usually be able to feel the movement.

If possible, send someone for a medical officer; but don't go yourself if you are alone with the victim. Speed in beginning artificial respiration is essential in any case in which breathing has stopped. Every moment's delay cuts down the victim's chance of survival. Do not take time to move the victim to a more satisfactory place, unless he is in such a dangerous

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position that he must be moved in order to save his life. If special circumstances make it necessary to move the victim before he has begun to breathe normally by himself, continue the artificial respiration while he is being moved.

If another person is present while artificial respiration is being given, he can be very helpful. Have him remove false teeth, chewing gum, seaweed, froth, mucus, mud, or other matter from the victim's mouth; at the same time he can bring the victim's tongue forward. He can also loosen the clothing around the victim's neck, waist and chest. If you are alone you will have to attend to these things before beginning artificial respiration.

- Do not attempt to remove water from the victim's lungs or stomach.
- Keep the victim sufficiently covered so that he will not suffer from exposure.
- Do not allow bystanders to crowd around the victim and interfere with the first aid treatment.
- Do not attempt to give the victim anything to drink while he is unconscious, or you may cause him to choke.
- Artificial respiration must be continued for at least 4 hours unless the natural breathing is restored before that time or a medical officer declares the person dead. Some people have been saved after as much as 8 hours of artificial respiration.
- Do not give up in less than 4 hours, even if the victim appears to be dead. All persons who have suffered an interruption of breathing do not have the same appearance. In some cases, the face is bluish black. In other cases it is pale and white. In cases of carbon monoxide poisoning the skin is often (although not always) a peculiar cherry red in color. In many cases of suspended breathing the pulse is so weak that it cannot be detected. Sometimes after electric shock the entire body becomes stiff and rigid—a condition which is occasionally mistaken for the rigidity of death. You can see, therefore, how difficult it is to judge whether a person in this condition is dead or alive, and the usual indications of death cannot be trusted in cases of asphyxiation.

METHODS OF ARTIFICIAL RESPIRATION

The standard methods of artificial respiration are the mouth-to-mouth method (with variations) and several manual methods (back-pressure, arm-lift; chest-pressure, arm-lift; back-pressure, hip-lift). Of these the mouth-to-mouth method is the one that is considered best. Although first advocated for infants and children, it is now the recognized method of choice for all age groups and body weights.

Mouth-to-Mouth Method (Mouth-to-Nose)

When administering mouth-to-mouth artificial respiration, use the following procedures:

1. Place the victim on his back immediately. Don't waste time moving to a better place, loosening clothing, or draining water from lungs.
2. Quickly clear his mouth and throat. Remove any dentures, mucus, food, and other obstructions.
3. Tilt the victim's head as far back as possible (fig. 3-1A). His head should be in a "chin-up" position and his neck stretched to ensure an open airway (fig. 3-1B).
4. Lift his lower jaw forward. Grasp the jaw by placing your thumb into the corner of his mouth (fig. 3-1C). Do not hold or depress his tongue.
5. Pinch his nose shut (or seal his mouth). Prevent any air leakage.
6. Open your mouth wide and blow. Take a deep breath and blow forcefully (except for babies) into his mouth or nose until you see his chest rise (fig. 3-1D).
7. Quickly remove your mouth when his chest rises. Listen for exhalation—if the victim makes snoring or gurgling sounds, his jaw is not high enough (fig. 3-1E).
8. Repeat (steps 6 and 7) 15 to 20 times per minute. Continue until the victim begins to breathe normally.
9. Remove air blown into the victim's stomach. Periodically, between breaths, if the stomach is distended, place your hand on his upper abdomen and gently but firmly press the air out of his stomach (fig. 3-1F).
10. For infants seal both mouth and nose with your mouth. Blow with small puffs of air from your cheeks.

Avoiding Mouth-to-Mouth Contact.—The mouth-to-mouth method may be objectionable to many as there is a hesitancy on the part of a

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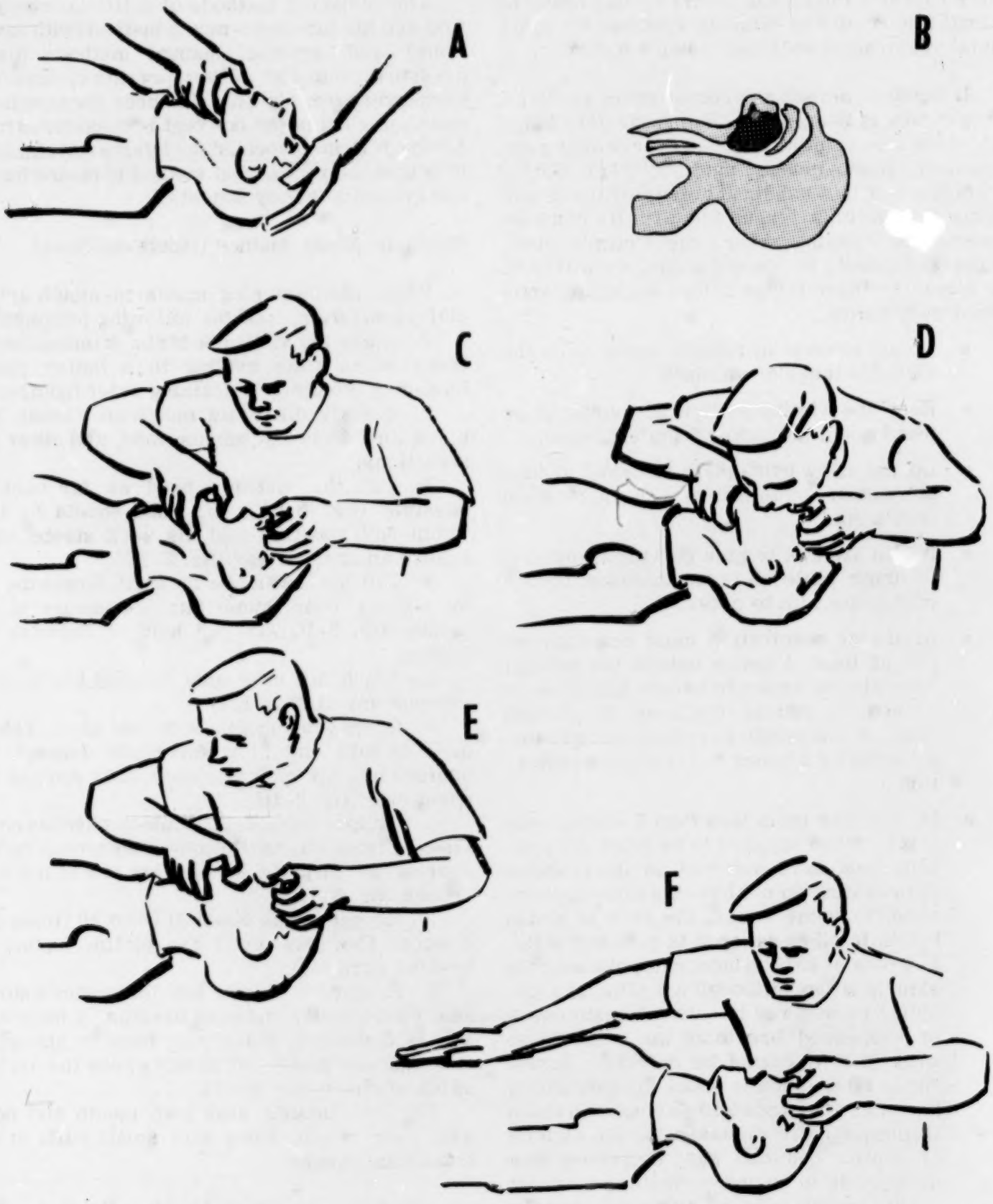

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Figure 3-1.—Mouth-mouth artificial respiration.

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rescuer to touch with his mouth the mouth of a person near death. Several solutions have been offered. The first one is to cover the victim's mouth with gauze or any clean, porous cloth before blowing into his mouth. (See fig. 3-2A). This will prevent the lip-to-lip contact that may be so repulsive.

Another means of avoiding lip-to-lip contact is to form a ring with the index finger and thumb of your hand holding the victim's chin. The victim's lips are then opened and the ring placed firmly about his mouth, thus holding his mouth open. The third and fourth fingers are placed under the victim's chin to maintain upward traction and the thumb seals off his nostrils (figs. 3-2B and C).

A device known as an oropharnygeal airway (figs. 3-2D and E) also eliminates lip-to-lip contact. Unfortunately, as with most first aid devices, an airway is often not at hand when needed. If this is the case, do not waste time looking for one, but proceed immediately to administer mouth-to-mouth artificial respiration. Hesitation may mean the difference between life and death.

Mouth-to-Airway Artificial Respiration

The oropharyngeal airway eliminates the physical-contact element from mouth-to-mouth artificial respiration. An S-shaped instrument, it has an airway at either end, one larger than the other. One half (the short half) serves as a mouthpiece for the rescuer; the other half is inserted into the victim's mouth.

In inserting the airway, you must be careful not to push the tongue back but to hold it forward. (In inserting the airway in small children and infants, the SHORT end of the airway should be inserted, and you should blow through the long or larger end of the S-tube.) When in position, the airtube delivers air blown from your lungs directly into the pharynx, trachea, and lungs of the victim.

After the airway has been properly placed, you should assume a position at the top of the victim's head, firmly grasp his lower jaw with both hands and pull forcefully upward. This position must be maintained throughout the procedure to maintain an open airway. Prevent leakage of air by blocking the victim's nose with your thumbs. (See fig. 3-2F for proper positioning of thumbs.)

Inflate the victim's lungs by blowing into the mouthpiece—FORCEFULLY WITH ADULTS, GENTLY WITH CHILDREN, ONLY "PUFFS" WITH INFANTS. You must watch the victim's chest constantly. When his chest rises, remove your mouth from the mouthpiece and let the victim exhale by the natural elastic recoil of his lungs and chest wall. Repeat this procedure 15 to 20 times per minute.

CAUTION: With the airway in place, the victim may gag and vomit when starting to respond to your efforts to revive him. At the first sign of revival, remove the airway.

Manual Methods of Artificial Respiration

Under certain circumstances, mouth-to-mouth resuscitation cannot be used. The gas mask worn in contaminated areas and facial injuries involving bleeding around the mouth and lips would prevent its being used. Under such conditions, the rescuer must use a manual method of artificial respiration. All too frequently, however, manual methods are not effective because of failure on the part of the rescuer to MAINTAIN A FREE AND UNOBSTRUCTED AIRWAY. (Even with the oropharyngeal airway in place, exchange of air is accomplished freely only if the head is properly positioned.) In using the manual methods discussed below, the first consideration must be proper positioning of the head to avoid airway obstruction.

Back-pressure, Arm-Lift Method.—Before the revival of mouth-to-mouth resuscitation, the back-pressure, arm-lift method was accepted on a nationwide basis as the method of choice. However, this method fails in an overwhelming majority of cases because the head drops as the arms are raised, and this action shuts off the airway. But, if an assistant is available to hold the victim's head up and thus maintain an open airway, the back-pressure, arm-lift method is effective and is the method of choice in those instances where drainage of fluids such as vomited matter is troublesome, or if facial bleeding or injury prevents the use of the mouth-to-mouth method.

The assistant should sit at one side of the victim's body facing toward his head, place his hand on the victim's forehead and, using the bony ridge of the brow to get a firm grasp, tilt the head backward. With his other arm, he supports his own body. The rescuer kneels at the victim's head on one or both knees, and faces toward his feet. (For proper positioning, see fig. 3-3.)

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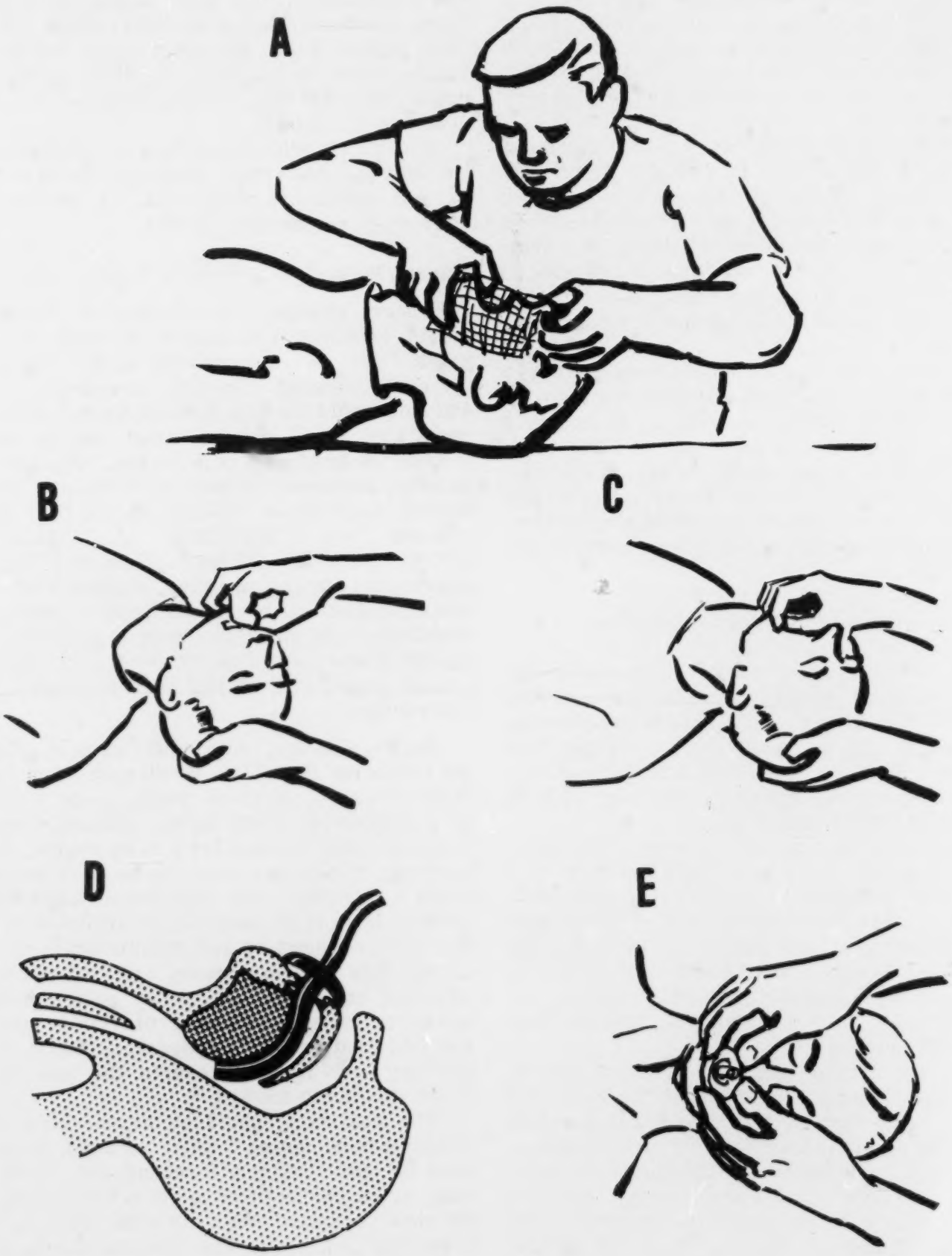

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Figure 3-2.—Methods of avoiding mouth-to-mouth contact; inserting the oropharyngeal airway.

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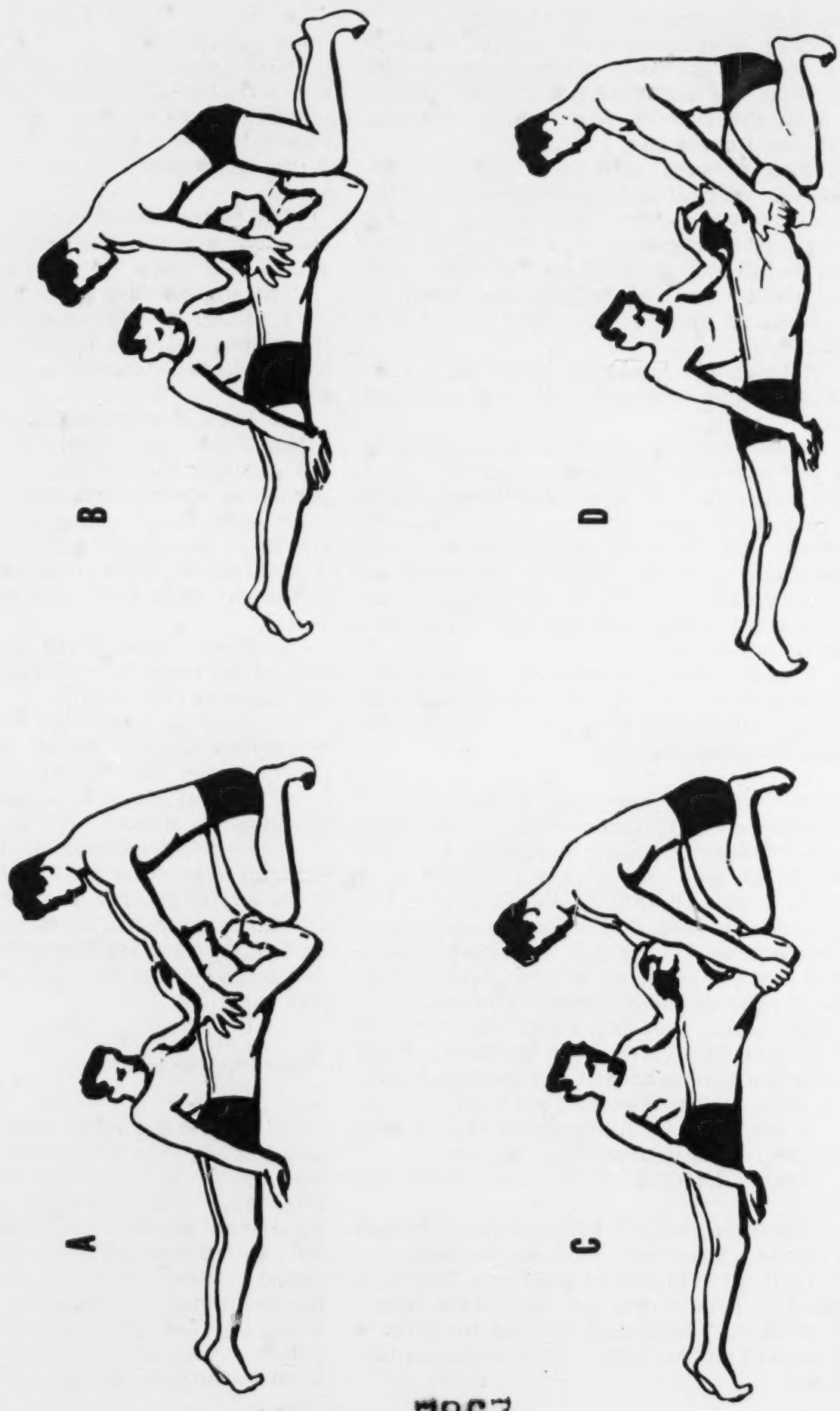

Figure 3-3.—Back-pressure, arm-lift method.

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The step-by-step procedure follows:

1. Place your hands on the victim's back in such a way that the heels of your hands lie just below a line running between the victim's armpits. With the tips of your thumbs touching, spread your fingers (fig. 3-3A).

2. Rock forward until your arms are approximately vertical and allow the weight of the upper part of your body to exert a slow, steady, even pressure downward on your hands. This forces the air out of the victim's lungs. Your elbows should be kept straight and pressure exerted almost directly downward on his back (fig. 3-3B).

3. Release the pressure, avoiding a final thrust downward, and begin to rock backward slowly.

4. As you rock backward, grasp the victim's arms just above his elbows and draw his arms upward and backward. Apply just enough lift to feel resistance and tension at the victim's shoulders. Do not bend your elbows, and with the backward rock the victim's arms will be drawn backward (fig. 3-3C and D). Then drop the victim's arms gently to the ground. This completes the full cycle.

5. Repeat steps 1 through 4 approximately 20 times per minute. As soon as the victim is breathing, adjust your timing to assist him. Do not fight his attempts to breathe.

Chest-pressure, Arm-Lift Method.—As in other methods of artificial respiration, the key to success in using the chest-pressure, arm-lift method is an open airway. Place the victim on his back. A blanket, pillow, folded coat or the like should be used to elevate his shoulders. This positioning lets the head drop back and extends the neck ensuring an open airway (fig. 3-4B). If none of these materials is available, you may place one foot under the victim's shoulder and thus elevate his shoulders. Then by tilting his head backward and pressing firmly with a knee against the top of his head, you can maintain his head in this position (fig. 3-4A).

The step-by-step procedure follows:

1. Grasp the victim's forearms above the wrists.

2. Place the victim's hands on his chest and rock forward. Exert only moderate pressure almost vertically downward until you feel firm resistance. This forces air out of his lungs.

3. Then rock backward, drawing the victim's arms upward and backward. This draws air into his lungs.

4. Repeat steps 2 and 3 approximately 20 times per minute.

Back-pressure, Hip-Lift Method.—The back-pressure, hip-lift method (fig. 3-5) may be used in cases where it is necessary to give artificial respiration to a person who has been injured in the upper part of his body—chest, shoulders, arms.

The victim should be placed face-down, with his elbows bent. Turn his face to one side and extend his neck to ensure an open airway.

The step-by-step procedure follows:

1. Kneel on either knee, straddling the victim at the level of his hips. The heel of your other foot should be directly opposite the kneeling knee.

2. Rock forward and place your hands on the middle of the victim's back, just below his shoulder blades (fig. 3-5A). Your fingers should be spread downward and outward, with your thumb tips touching at the spine. Allow the weight of the upper part of your body to exert a slow, steady, even pressure almost vertically downward until firm resistance is met (fig. 3-5B).

3. Rock backward and let your hands come to rest at the victim's hips. Slip your fingers under his hipbones (fig. 3-5C).

4. Keeping your arms straight, lift the victim's hips about 6 inches off the ground, then gently lower him to the ground (fig. 3-5D).

5. Repeat steps 2, 3, and 4 approximately 20 times per minute.

The back-pressure, hip-lift method is often difficult to perform for long periods, especially if the victim is large or heavy. It does have one advantage, however, in that each time the hips are raised, the body is pulled away from the head and this tends to keep the neck extended and the airway open.

Pole-Top Resuscitation

The work of construction linemen is hazardous, particularly in that they often work with or near "live" wires and may be shocked accidentally. When a man working on a pole receives an electric shock, he will usually need two first aid measures—artificial respiration and external cardiac massage, the first to restore his breathing, the second to restore his heartbeat. (Do not give external cardiac massage unless you have been trained in its use.) Under ideal conditions, a man can be lowered to the

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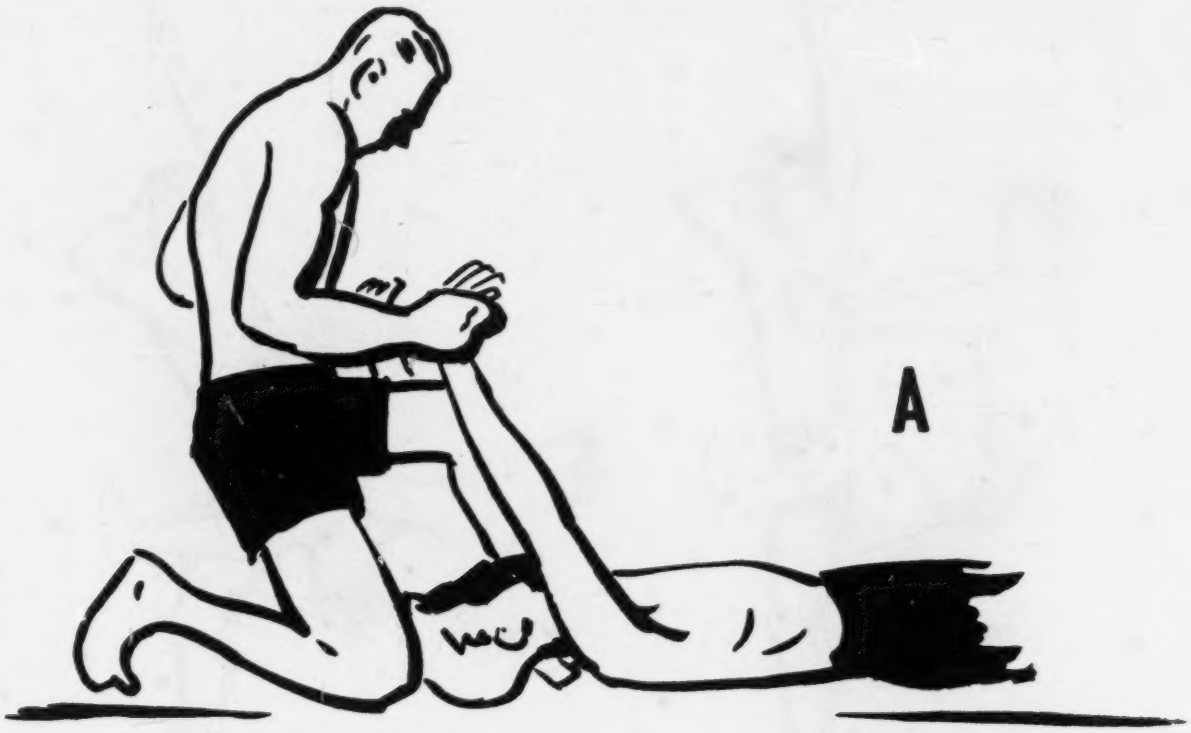

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Figure 3-4.—Chest-pressure, arm-lift method.

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Figure 3-5.—Back-pressure, hip-lift method.

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ground in less than 2 minutes. If he can be lowered after the initial shock within 2 minutes, he should be and mouth-to-mouth respiration and external cardiac massage (if necessary) should be begun immediately. Give the victim 3 to 5 respirations, then examine him quickly for a pulse. The best place to determine pulse is at the neck. Place the tips of your index and middle finger alongside the Adam's apple and press slightly against the neck in this area. Here you can feel the carotid artery. If a pulse exists, do not give external cardiac massage. Continue with artificial respiration until the victim is breathing normally.

Under field conditions, it may take 10 minutes or longer to lower the victim from the pole. Since a person cannot live more than a few minutes without oxygen and blood circulation, every moment lost decreases the victim's chances of survival. Resuscitation measures must, therefore, begin on the pole. Various procedures have been tried to cut down the interval between the time of electric shock and the time resuscitation begins. The method which has thus far proved most effective is known as "pole-top" resuscitation. Properly applied, pole-top resuscitation provides an adequate exchange of air to maintain life and additionally, with each cycle, the heart is compressed sufficiently to pump blood to the brain and other vital organs.

Pole-top resuscitation is performed as follows:

Climb to the victim and immediately disengage him from the power circuit. (CAUTION: Do not attempt to release the victim from energized lines or equipment unless you know how to do it and have the proper equipment.) Allow him to hang alongside the pole by his own safety belt. Take a position on the pole BELOW the victim, and work your way up the pole. Keep the victim between yourself and the pole, and keep the victim's legs spread apart so that he is straddling your safety belt. When you have worked your way up as high as you can, the weight of his body will be on your safety belt. The correct position is shown in figure 3-6. (Do not take the time to check for pulse. You may be wearing gloves and, at any rate, determining pulse at the top of a pole is difficult at best and has no bearing on the first aid measures to be given.)

Pull the victim's tongue forward, and clear his mouth of any foreign objects (false teeth, chewing gum). Lay his head back over your shoulder and keep it there during resuscitation. This will ensure an open airway.

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Figure 3-6.—Pole-top resuscitation.

Put your arms around the victim's waist (under his arms) and place your hands on his abdomen. Your fingertips should just touch in the middle of his abdomen, and your thumbs should be just below his lower ribs.

Use your arms and hands to compress the victim's abdomen and push it upward. By the end of the compression stroke, your hands will be cupped and your fingers will be depressing the victim's abdomen immediately under his ribs. Release the pressure quickly to complete the cycle. Repeat the cycle 30 to 40 times per minute.

Resuscitation should continue until the victim is revived or until he can be lowered to the ground. Do not interrupt resuscitation to attach a rigging to the victim; the rigging should be of a type that permits artificial respiration to continue while it is being attached to the victim. Once the rigging is attached, lower the victim to the ground and immediately begin MOUTH-TO-MOUTH resuscitation and, if necessary, perform external cardiac massage simultaneously.

MECHANICAL AIDS

Mechanical RESUSCITATORS are sometimes used as aids in restoring breathing. Because they

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are applied only to the victim's face, they are particularly useful in situations where physical manipulation of the body would be difficult or impossible—while a person is undergoing surgery, while he is trapped under debris or caught under an overturned vehicle, or while he is being transported to a place of safety. A resuscitator may often be used successfully on persons who have extensive burns, broken bones, or other serious injuries which make it impossible to use the manual methods of artificial respiration.

However, a resuscitator should never be used by anyone who is not entirely familiar with the correct method of operation. There are different kinds of resuscitators, so knowing how to operate one will not necessarily enable you to operate another type. Each mechanical resuscitator has a manufacturer's instruction book which gives specific operating directions, but you must have actual training and practice before using any resuscitator. Most of the older types involve the application of pressure, and are therefore very dangerous when used by unskilled persons.

The type of resuscitator which is now being distributed by the Navy is so designed that you cannot apply too much pressure. This type of resuscitator is much safer to operate, since only the amount of oxygen which the victim can use is allowed to pass through the respirator.

An INHALATOR is a device which supplies oxygen, or a mixture of oxygen and carbon dioxide, while artificial respiration is being performed by one of the manual methods previously described. Since the inhalator does not involve pressure, it is less dangerous to use than the mechanical resuscitator. Most mechanical resuscitators can be set up to operate as simple inhalators.

These mechanical aids may be very helpful in some situations, but they cannot be expected to take the place of the other methods of artificial respiration. For one thing, the mechanical devices are not always available at the scene of an accident; and, for another, they are worse than useless in the hands of untrained persons. You should know that devices of this type are available, and that they may sometimes be used to great advantage; but you must also recognize their limitations and dangers.

Treatment During Recovery

When a person is regaining his breath, the bluish or pale appearance of his skin may be succeeded by a distinct flush of color. Then his muscles may begin to twitch and his fingers to scratch and clutch. Swallowing movements are sometimes the first sign of natural respiration. Or the first attempt to breathe may be a faint catch of breath or a sigh. You must not fight the victim's efforts to breathe. If you are using the mouth-to-airway method, remove the airway when he begins to breathe; if you are using mouth-to-mouth (nose) or a manual method, adjust your efforts to assist him.

When the victim's breathing has become fairly regular, sit down near his head where you can watch him, in such a position that you can immediately begin artificial respiration again if his natural breathing fails. Do not move the victim immediately; let him rest for at least a few minutes. When you do move him, use a stretcher or something similar so that he can stay in a horizontal position. DO NOT LET HIM SIT OR STAND OR WALK. The slightest exertion at this point might easily cause death from heart failure. Sometimes people who have suffered an interruption of natural breathing go through a period of frenzied violence soon after they are revived. If this occurs, you must be prepared to keep the victim quiet in spite of his own efforts to the contrary.

A person whose breathing has been interrupted must always be treated for shock. (See ch. 4.) Keep him covered so that he can maintain body temperature, but do not overheat him. Keep him quiet, and get him under the care of a medical officer as soon as possible. NEVER give morphine to a person who has suffered an interruption of breathing.

SUMMARY

Asphyxiation is a condition in which there is a deficiency of oxygen and increased carbon dioxide in the blood and tissues. Some common causes of asphyxiation are drowning, electric shock, inhalation of poisonous gases, and lack of sufficient oxygen in the atmosphere.

Since asphyxiation can be fatal in a very short time, emergency treatment must begin as soon as possible. First aid for asphyxiation consists primarily of administering artificial respiration. Shock, nearly always a factor, must also be treated, along with other injuries. In some cases of asphyxiation, the heart may stop

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beating. External cardiac massage may be given to restore heartbeat, if you have been trained to use the technique.

In giving artificial respiration, the most important consideration is to maintain an open airway. The mouth and throat must be cleared of all obstructions, and the tongue brought forward. Extend the neck and position the head as recommended for the method of artificial respiration used.

Mouth-to-mouth artificial respiration is the preferred method as it is the most effective in introducing large volumes of air into the lungs. If it is not possible to give mouth-to-mouth respiration, use a manual method, paying particular attention to ensure an open airway.

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CHAPTER 4

SHOCK

Have you ever hit the end of your finger with a hammer, dropped a heavy weight on your foot, or caught your hand in a car door? Along with the immediate pain, did you experience a feeling of weakness, dizziness, and nausea? If so, this was SHOCK—a mild form of it.

Some degree of shock follows all injuries. It may be slight and almost unnoticed, lasting only a moment, or it may be severe enough to cause death. Shock is often the cause of death in cases of burns, hemorrhage, poisoning, fractures, and other serious injuries. It may occur immediately following the injury, or it may come on several hours later. Even if it does not occur immediately, it is a real danger. All injured persons should be treated for shock before being treated for the actual injuries, except in cases where there is severe hemorrhage or asphyxiation.

In order to be able to help an injured person, therefore, you must know what to do for shock. Instead of just trying to memorize the treatment, however, let's try to understand something about the nature of shock, what causes it, how you can recognize it, and how you can prevent it. The more you learn about shock, the more you will understand why certain measures are important in the first aid treatment of this condition.

WHAT IS SHOCK?

When you hit the end of your finger with a hammer, you get a response from your whole body. Since your finger hurts, you might think that it is the only part of you which is responding to the injury; but actually a great many changes are taking place in your body while you are concerned with the immediate pain. Your body AS A WHOLE is injured, and your body AS A WHOLE attempts to recover from the injury. A series of changes takes place, designed to restore the body to its [illegible] healthy condition.

Sometimes , however, the changes which occur may in themselves cause further damage to the body. To some extent this is what happens in shock. When a person is injured, the blood flow in his entire body is disturbed. To overcome this difficulty, the heart beats faster and the blood vessels near the skin and in the arms and legs contract, thus sending most of the available blood supply to the vital organs of the body and to the nerve centers in the brain which control all vital functions.

While this is going on, the other body cells do not receive enough blood, and therefore do not get enough oxygen or food. The blood vessels, like the rest of the body, suffer from this lack, and eventually they lose their ability to contract. When this happens, the vital organs and the brain do not receive enough blood, either, and the condition of shock becomes worse and worse. If this situation continues, the damage presently becomes so extensive that recovery is impossible. In less severe cases, prompt first aid treatment for shock may make the difference between life and death. In mild cases of shock, recovery usually occurs naturally and rather quickly.

Basically, then, shock is a condition in which the circulation of the blood is seriously disturbed. As we will see later, the measures used to combat shock are aimed at helping the body to recover from this disturbance of the blood flow.

CAUSES OF SHOCK

Serious shock occurs as a result of serious injury to any part of the body. Crush injuries, fractures, burns, poisoning, and prolonged bleeding are very likely to cause serious shock. An interruption of breathing, from whatever cause, is almost always followed by severe shock. Blast and concussion injuries, caused by pressure waves resulting from the

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Remember, EVERY SERIOUSLY INJURED PERSON IS LIKELY TO DEVELOP SERIOUS SHOCK.

PREVENTION AND TREATMENT OF SHOCK

In many emergency situations, the most helpful thing you can do for an injured person is to begin treatment for shock. If shock has not yet developed, the treatment may actually prevent its occurrence: if it has developed, you may be able to keep it from reaching a critical point. As we have seen, shock creates a vicious circle—the worse it is, the worse it gets. It is extremely important, therefore, that you begin the treatment at the first possible moment.

In order to give first aid treatment to a person in shock, you will need to know how warm he should be kept, what position is best for him, and what you may do to relieve pain.

A word of caution must be given here concerning the administration of liquids to a sick or injured person. Until recently, first aid books and training courses have emphasized the use of warm liquids (in particular, water, tea, and coffee) as a part of the first aid treatment for shock. However, it is now believed that the administration of liquids is not, as a rule, a necessary or even desirable part of first aid treatment. It is true that a person in shock is in need of liquid; but liquid given by mouth is not absorbed—and therefore does no good—except in very mild cases of shock. In moderate or deep shock, intravenous administration of liquids is necessary; but this is a medical procedure, and cannot under any circumstances be performed by a person giving first aid.

A further and even more important reason why you should not give liquids by mouth to an injured person is that this treatment is very likely to interfere with later administration of an anesthetic, should this be necessary.

As we have seen, a person in shock is often thirsty. No particular harm will be done if you allow the victim to moisten his mouth and lips with cool water, if it will make him more comfortable; but in general there is no need to give him anything to drink unless you are in a position where medical personnel will not be available for an excessively long period of time. In giving first aid treatment to a sick or injured person, you must of course use your own common sense and good judgment. It would not be reasonable, for example, to deprive a person of fluids for several days merely because he had been injured. The body needs 2 to 3 quarts of liquid daily. If an injured person is able to survive for some time in spite of his wounds, he should not be deprived of the normal amount of liquid which the body requires. If medical care will not be available for some time, you should give SMALL AMOUNTS of warm water, warm tea, or warm coffee, if he is conscious and able to swallow and if he has not suffered internal injuries.

As a general rule, then, liquids should NOT be given as a part of first aid treatment, but they may be given if circumstances make it necessary for you to go somewhat beyond the usual first aid measures in caring for an injured person.

In the case of burns, an exception must be made to the rule of not giving liquids. A seriously burned person has an overwhelming need for fluids. It is therefore a permissible and even desirable part of first aid treatment for burns to give water or other liquids. Sweet tea, fruit juices, or sugar water may be given, if the casualty is conscious and able to swallow, if he has no internal injuries, and if vomiting is no problem.

One final precaution must be given concerning the use of liquids: NEVER GIVE ALCOHOL TO A PERSON IN SHOCK OR WHO MAY GO INTO SHOCK. Alcohol increases the blood supply to surface vessels and so diminishes the blood supply to the brain and other vital organs.

Heat

Heat is important in the treatment of shock to the extent that the injured person's body heat must be conserved. Exposure to cold, with resulting loss of body heat, can cause shock to develop or to become worse. You will have to judge the amount of covering to use by considering the weather and the general circumstances of the accident. Often a light covering will be enough to keep the casualty comfortable. Wet clothing should be removed and dry covering provided, even on a hot day. Use blankets or any dry material to conserve body heat. Artificial means of warming (hot water bottles, heated bricks, heated sand) should not ordinarily be used. Artificial heat may cause loss of body fluids (by sweating) and it brings the blood closer to the surface, thus defeating the body's own efforts to supply blood to the vital organs and to the brain. Also, the warming agent may burn the victim.

KEEP AN INJURED PERSON WARM ENOUGH FOR COMFORT, BUT DO NOT OVERHEAT HIM.

Position

The best position to use for the prevention or treatment of shock is one which encourages the flow of blood to the brain. If it is possible to place the injured person on his back on a bed, cot, or stretcher, you can raise the lower end of the support about 12 inches so that his feet will be higher than his head (fig. 4-2). If the circumstances of the accident make it impossible to do this, it might still be possible for you to raise his feet and legs enough to help the blood flow to the brain. Sometimes it is possible to take advantage of a natural slope of ground and place the casualty so that his head is lower than his feet.

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Figure 4-2.—Position for treatment of shock.

In every case, of course, you will have to consider what type of injury is present before you can decide on the best position. For example, a person with a chest wound may have so much trouble breathing that you will have to raise his head slightly. If the face is flushed rather than pale, or if you have any reason to suspect a head injury, do not raise the feet; instead, you should keep the head level with, or slightly higher than, the feet. If the person has broken bones, you will have to judge what position would be best both for the fractures and for shock. So remember: THE BASIC POSITION FOR TREATING SHOCK IS ONE IN WHICH THE HEAD IS LOWER THAN THE FEET. Do the best you can, under the particular circumstances, to get the injured person into this position. In any case, never let a seriously injured person sit or stand or walk around.

Relief of Pain

A long accepted, but false generalization is that all extensive injuries are associated with severe pain and that the more extensive the injury, the worse the pain. In reality, severe and even fatal injuries may be considerably less painful than a mashed finger tip, which can cause agony.

Another generalization is that, with similar injuries, everyone experiences the same amount of pain. This, too, is incorrect. Some feel pain far more severely than others. Also, those who would not be in much pain from a wound when rested, relaxed, and confident might experience severe pain from the same wound if exhausted, tense, and fearful. Persons in shock tend to feel less pain. However, pain, unless relieved, may cause or increase shock.

Relief of pain can often be accomplished without the use of drugs. The injured man should be assured and made to realize that his injuries are understood and that he will get the best possible care. He should also be told of plans to get medical help or plans to move him to a place where medical assistance is available.

Support for an Injury.—Pain can often be relieved by furnishing adequate support for an injury. Fractures of bones in which the surrounding tissue swells rapidly are extremely painful when left unsupported. Adequate immobilization of fractures not only relieves pain but prevents further tissue damage and shock. Needless suffering can often be eliminated by unlacing or slitting a shoe or loosening tight clothing in the region of the injury. Often a simple adjustment of a bandage or splint will be of much benefit, especially when accompanied by a few encouraging words.

Use of Drugs.—Ordinarily, drugs are NOT to be administered by persons giving first aid treatment. Which drug to give and the dosage must depend on a number of conditions. Decisions such as these can be made only by medical personnel.

You may give one or two aspirin or APC (aspirin-phenacetin-caffeine) tablets for mild pain. Other drugs should be given only by medical personnel.

Morphine Administration.—In time of battle, shipboard disaster, or other extreme emergency, morphine syrettes are sometimes distributed to nonmedical personnel. Therefore, you must know when to use morphine and when not to use it, and how to use the morphine syrette.

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Morphine is the most effective of pain-relieving drugs. Properly administered, it will relieve severe pain and assist in the prevention of shock. The adult dose of morphine is 8 to 16 milligrams (1/8 to 1/4 grain) repeated not more than ONCE, if necessary, in not less than 4 hours. A morphine syrette may be given if the pain is very severe and IF THERE IS:

1. No head injury.
2. No chest injury, this to include non-sucking as well as sucking wounds.
3. No wound of the throat, nasal passages, mouth, or jaws from which blood might obstruct the airway.
4. No massive bleeding.
5. No respiratory obstruction or impairment, including chemical burns of airway. Any casualty breathing at a rate of less than 16 breaths per minute should not be given morphine.
6. No evidence of severe or deepening shock.
7. No loss of consciousness.

The morphine syrette (fig. 4-3) consists of a collapsible metal tube with a sterilized hypodermic needle attached. Syrettes now being supplied contain 16 milligrams (1/4 grain) of morphine. (Syrettes containing 1/2 grain of morphine may still be in use. If you have a syrette containing 1/2 grain, use no more than one-half of its contents and THROW THE REST AWAY.)

If it is necessary for you to give morphine to an injured person, use the following procedure:

1. Find a place where the morphine can be injected. The best place to inject morphine is usually on the outer surface of the upper arm, but it may be injected into the thigh if the arms are injured. In very cold climates, morphine is sometimes injected at the back of the neck in order to avoid undressing the victim any more than necessary.

CAUTION: If a tourniquet has been applied, the morphine must be injected ABOVE THE TOURNIQUET—that is, between the wound and the main part of the body.

2. Sterilize the skin, if time and facilities permit. You can do this by washing the skin with alcohol or any skin antiseptic. If no antiseptic is available, wash the area with soap and water or with plain tap water alone.
3. Remove the transparent plastic hood which is over the needle.
4. Grasp the wire loop and push the wire down into the tube, until the loop is stopped by the guard. When the wire is pushed into the tube, it pierces the inner seal.

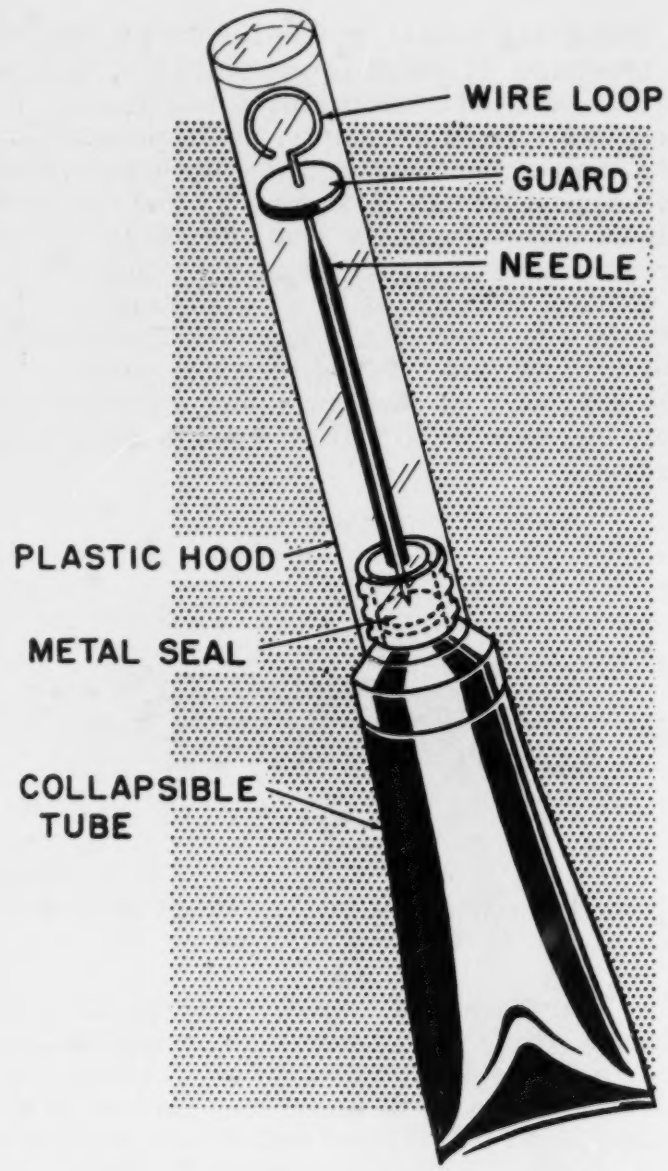

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Figure 4-3.—Morphine syrette.

5. Pull out the wire and throw it away. DO NOT TOUCH THE NEEDLE!
6. Thrust the needle through the skin. Push it in the full length of the needle.
7. When the needle is properly in place, inject the morphine solution by slowly squeezing the collapsible metal tube, beginning at the sealed end and working toward the needle. If the casualty is in shock or has severe burns, massage the injection site for a few minutes to help circulate the morphine.

Overdosage is an ever-present danger. For this reason every casualty who has received

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morphine should have it plainly noted. Write the letter "M" and the hour of injection on his forehead (e.g., M 0830). Use a skin pencil, colored antiseptic, ballpoint pen, crayon, or ink for this purpose. The empty syrette may be attached to his shirt collar or some other conspicuous area of clothing by a safety pin or other means to alert others that morphine has been given.

DO NOT GIVE REPEATED INJECTIONS OF MORPHINE. In general, do not give more than two injections, not less than 4 hours apart. Morphine is a dangerous drug; it must be used only with the greatest caution.

SUMMARY

Shock is a disturbance of the circulation of the blood and is caused by injury. Some degree of shock accompanies or follows all injuries. Severe shock usually occurs in cases of asphyxiation, hemorrhage, burns, large wounds, fractures, and other similar injuries.

Shock is characterized by the following symptoms: shallow, rapid, irregular breathing; weak, rapid pulse; cold, clammy skin; profuse sweating; usually a pale skin, but in some cases bluish, in others, slightly flushed; and pupils dialated or enlarged. The injured person may complain of thirst, weakness, faintness, and dizziness. He also may exhibit a lack of awareness and responsiveness. Unconsciousness may result in cases of severe shock.

In treating shock, act quickly. Keep the injured person warm, lying on his back, and lessen his pain. The basic position (head slightly lower than his feet) is altered for the following injuries: if he has a head injury or his face is flushed, raise his head slightly; if he has a chest injury or breathing difficulty, raise his head and shoulders; if he has facial injuries and is semiconscious, place him on his belly with his head, turned to one side, lower than his feet. Do not force an injured person into the position recommended if this would cause further injury or increase pain. Never let an injured person sit, stand, or walk,

As pain can produce shock or increase its severity, do all you can to relieve it. Providing adequate support for all injuries and loosening tight clothing will often relieve pain. Normally, drugs should not be given as a first aid measure. However, under certain conditions, morphine may be given if pain is severe and if there is no head injury, no chest injury or breathing difficulty, no massive bleeding, no evidence of severe or deepening shock, and no loss of consciousness. The adult dose is not more than 1/4 grain, repeated not more than once, in not less than 4 hours. Always indicate that morphine was given by writing the letter "M" and the time on the injured person's forehead. Attach the empty syrette to some conspicuous area of clothing.

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CHAPTER 5

POISONING

As we have seen, severe hemorrhage, asphyxiation and shock must be given first aid treatment immediately, if life is to be saved. In cases of poisoning, speed in giving aid is also essential—the sooner the poisonous substance can be removed or neutralized, the better will be the victim's chances for recovery.

CAUSES OF POISONING

Poisoning occurs in a variety of ways. Sometimes it is the result of attempted suicide or homicide. Frequently it is accidental—a person takes an overdose of medicine, or by mistake takes some poisonous substance such as lye, iodine, or arsenic. Poisoning may be caused by the continuous use of a substance which is not dangerous if taken for a short time, but which is cumulative in effect—that is, the poison is not eliminated from the body as quickly as it is absorbed. Poisoning occurs also from overexposure to industrial materials such as ammonia, gasoline (and, in fact, all petroleum products), lead salts, mercury, and many others; and from exposure to various toxic by-products of industrial processes. The venom of some snakes, spiders, and scorpions causes poisoning.

What is a Poison?

When you consider all the different ways in which poisoning can occur, you might begin to wonder: What is a poison? Basically, it is a substance which causes bodily disturbance, injury, or death, by chemical rather than mechanical means. It would be almost impossible to list all poisons, because a great many substances are harmless if used in the proper way but are poisonous if used in the wrong way or in the wrong amount. For instance, nearly all drugs and medicines are potentially both beneficial and poisonous; the effect is determined by the method of use and by the amount taken into the body. Such things as alcohol, coffee, and tobacco are actually poisonous substances for which the human body has certain tolerances; poisoning results if these tolerances are exceeded. Powdered glass, needles, metal splinters, and other foreign bodies are damaging when applied to or introduced into the body, but they are not classified as poisons because their action is mechanical rather than chemical.

Variations in Effects of Poisons

The action of a poison is dependent upon several factors. The action will be more severe if a large dose is taken, because more of the poison will be absorbed in a short period of time. (Remember, of course, that the toxicity of substances varies greatly—a few drops of one poison might be immediately fatal, while another poison might not be harmful unless taken by the tablespoonful.) The age and body weight of the victim should also be considered. Infants, young children, and very old people are more likely to be killed by small doses of poison. In general, the less a person weighs the smaller will be the fatal dose. Another factor which influences the action of poisons taken by mouth is the condition of the stomach; poisons taken on an empty stomach will act much more quickly (and therefore more violently) than those taken when the stomach is full.

The action of any poison is dependent, also, upon the tolerance which the individual has for the particular substance. Some people seem to have a natural resistance to the action of certain poisons; others are so highly sensitive to them that even a small amount, such as might be given in a medicine, produces toxic effects. Habit is sometimes a factor to consider—drug addicts can tolerate doses of the habit-forming drugs which might kill the average person. The effectiveness of a poison is also dependent upon the general health of the victim.

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The physical state of the poisonous substance also determines its effectiveness. Gases are absorbed more quickly than liquids, and liquids more quickly than solids. Related to this is the fact that the way in which a poison enters the body determines to some extent the speed and effectiveness with which it acts. In general, inhaled poisons are likely to work most quickly, injected poisons next, and poisons taken by mouth more slowly. Poisoning by skin contact usually occurs quite slowly over an extended period of time. It should be noted also that some substances are poisonous when taken in one way, but not when taken in another; for example, snake venom may cause death when injected (as by a snakebite), but may be relatively harmless if swallowed.

General Symptoms of Poisoning

It is often very difficult to recognize a case of poisoning. Most poisons do not give rise to symptoms which are sufficiently uniform or characteristic to provide a sure means of identification. Many poisons cause symptoms which are so similar to those of various diseases that they cannot be readily distinguished.

In addition to these difficulties, there is the fact that the symptoms vary according to the amount of poison taken and the length of time it has been in the system. There may be several fairly distinct degrees or stages of poisoning, and the symptoms may be different in each stage.

However, there are some general signs which might indicate that a person has been poisoned. Intense pain frequently follows poisoning. Nausea and vomiting may occur. The victim may become delirious, or he may collapse and become unconscious. Poisoning by caustic acids, alkalis, phenols, and metallic salts is likely to cause corrosion, swelling, and bleaching of the skin, mouth, and throat. Brown or black stains on the skin or mucous membranes may be indicative of iodine poisoning; yellow stains may be caused by nitric acid and picric acid. Some poisons turn the urine red, dark green, bright yellow, or black; any unusual color may be well an indication of poisoning. Many substances cause the victim's breath to have a peculiar odor.

In almost all cases of acute poisoning, the victim is likely to have considerable trouble in breathing. Some poisons characteristically cause paralysis; others cause convulsions. Some poisons cause the pupils of the eye to contract (become smaller), and others cause them to dilate (become larger). The skin may be flushed or pale, or perhaps bluish in color. Shock is always present in cases of acute poisoning.

As you can see, almost any sign of bodily distress or disturbance MIGHT be an indication of poisoning. If you find a person who seems to be sick, or who shows any signs similar to those described, you must keep in mind the possibility of some kind of poisoning. Many times, your best information will come from the general circumstances in which you find the victim. An empty poison bottle, for example, would provide an obvious clue. Most situations are not likely to be that clear, but you should always look around for external evidence of that kind—often it will help you to understand the nature of the trouble.

Obtaining Professional Help

The United States Public Health Service maintains a clearinghouse for information about the symptoms and the methods of treatment for all types of poisons. It also identifies the poisonous ingredients in all kinds of commercial products. This information is received from, and furnished to, poison control centers at various medical establishments throughout the United States.

Emergency treatment is usually required in poisoning cases because poisons act very rapidly. If more than one person is present, one should be delegated to obtain assistance while the other begins emergency treatment. If only one person is present, help should be sought as soon as the patient can safely be left alone for a time. Treatment by a physician or assistance from a poison control center should be obtained as soon as possible. This is important even when the symptoms of poisoning have disappeared completely before professional help can be obtained because the poison may have harmful effects that do not appear immediately.

FIRST AID TREATMENT FOR POISONING

The first aid treatment which is appropriate for any given case of poisoning depends partly upon the method by which the poison enters the body. The four ways in which poisoning is likely to occur are: (1) By ingestion—that is, taking the poison into the stomach by way of the mouth; (2) by inhalation—that is, breathing poisonous gases; (3) by skin contact; and (4) by injection

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into the bloodstream or into muscular tissue. First aid treatment for various common poisons which are absorbed into the body in one or more of these ways is given in the following sections.

Ingested Poisons

There are a great many substances that are poisonous, if swallowed. Because there are so many, it would be impossible to remember the detailed treatment for each kind of poison. However, most poisons may be assigned to one of several general classifications according to their effects on the body and the symptoms of poisoning. Generally, the proper FIRST AID TREATMENT may be determined by the general classification in which a certain poison falls.

Corrosives

Corrosives are substances that rapidly destroy or decompose the body tissues they contact. Corrosives may be ACIDS (hydrochloric, nitric, sulfuric); PHENOLS (carbolic acid, creosol (Lysol), creosote); or ALKALIES (lye, lime, ammonia). Iodine is also a corrosive.

General Symptoms.—When corrosives are swallowed, immediately there is burning pain in the mouth with severe burning pain in the esophagus and stomach. This is followed by retching and vomiting; the stomach contents are mixed with dark colored liquid and shreds of tissues that line the mouth, esophagus, and stomach. The inside of the mouth is eaten away and the lips are characteristically stained if an acid or iodine has been swallowed. Swallowing is very difficult, breathing is difficult, the abdomen is tender and distended with gas, body temperature is high, and the facial expression shows anxiety and great suffering.

Irritants

Irritants are substances that do not directly destroy the body tissues but cause inflammation in the area of contact. Some examples are potassium nitrate, zinc chloride, zinc sulfate, arsenic, iodine, and phosphorus.

General Symptoms.—When swallowed, the irritants cause faintness, nausea, vomiting, and diarrhea. The vomited matter and stools frequently contain blood. Also, there is pain, with cramps, in the abdomen.

Depressants

Depressants are substances that depress the nervous system. Some examples of depressants are the alkaloids (including atropine, and morphine and its derivatives), bromides, barbiturates, alcohol, and most local anesthetics.

General Symptoms.—When swallowed, depressants usually have an initial stimulative effect, so the symptoms may begin with a short period of excitement. This is soon followed by drowsiness and stupor; slow breathing, with snoring; cold, moist skin with the face and fingers a bluish color; relaxed muscles; and dilated or contracted pupils.

Excitants

Excitants are substances that stimulate the nervous system. Some examples are strychnine, camphor, and the fluorides.

General Symptoms.—When swallowed, excitants cause delirium (mental disturbance, physical restlessness, and incoherence); a feeling of suffocation and inability to breathe; hot, dry skin; rapid, weak pulse; convulsions or jerking muscles; and dilated or contracted pupils.

Emetics, Demulcents, and Antidotes

As with other common emergencies, it is likely that the materials necessary to treat a case of poisoning will not be available when needed. You will have to use what is available. Fortunately, some relatively common substances are effective emetics, demulcents, or antidotes.

Emetics.—An emetic is a substance that causes vomiting. Emetics are not very effective in cases of depressant poisoning because depressants inhibit the vomiting reflex. In such cases, vomiting may be brought on by tickling the throat. The following substances are effective emetics:

1. Powdered mustard—1 to 3 teaspoonfuls in a glass of warm water.
2. Salt (sodium chloride)—2 teaspoonfuls in a glass of warm water.
3. Warm water with soapsuds (not detergents). This emetic has an antidotal effect for a many metallic salts, especially mercuric chloride.
4. Large quantities of warm water.

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Demulcents.—A demulcent is a substance that will soothe the stomach and delay absorption of the poison. Periodically, after the victim has vomited, he should be given a demulcent. Raw egg whites, milk, or a thin paste of cooked starch or flour are effective.

Universal Antidote.—When the exact nature of the poison is known, the specific antidote should be used, but if it is not available, the best antidote available should be used rather than delay treatment until the specific antidote can be obtained.

A universal antidote has been devised for use when the nature of the poison is not known. It is especially effective against the irritants, the excitants, and the depressants. The universal antidote contains ingredients that either cause the poison in solution to form solid particles; combine with the poison to make it less harmful; or change it into a harmless chemical compound.

The universal antidote is prepared from the following ingredients:

Activated charcoal	2 parts(1/4 ounce)
Magnesium oxide	1 part (1/8 ounce)
Tannic acid	1 part (1/8 ounce)

The dose is 1/2 ounce in a half glass of water, given by mouth. It should be followed by an emetic, EXCEPT WHEN THE POISON IS A CORROSIVE. If these ingredients are not available, substitute burned toast or charred wood in place of activated charcoal; milk of magnesia for magnesium oxide; and strong tea for tannic acid.

Antidotes for Acids.—When poisonous acids are swallowed, the acids must be neutralized. Milk of magnesia, magnesium oxide, lime water, or soap given in large amounts of water are effective. This should be followed by a demulcent. DO NOT GIVE EMETICS WHEN THE POISON IS ACID.

Antidotes for Alkalies.—When poisonous alkalies are swallowed, the alkalies must be neutralized. Diluted vinegar, lemon juice, or grapefruit juice are effective. This should be followed by a demulcent. DO NOT GIVE EMETICS WHEN THE POISON IS ALKALI.

Treatment of Poisoning by Mouth

The basic procedures for treatment of poisoning by mouth are:

1. Identify the specific poison or the type of poison, if possible. Note the symptoms, the contents of glasses or bottles, and other related sources of information.

2. Remove the bulk of the poison from the stomach quickly. Use an emetic, EXCEPT WHEN THE POISON IS CORROSIVE.

3. Administer the antidote. Have the victim swallow large quantities of the antidote; then give emetics to promote vomiting. Repeat this treatment at intervals of 10 minutes for as long as it appears that some poison remains in the stomach.

4. Give demulcents. Periodically, after the victim has vomited, give him a thin paste of starch, two raw egg whites, or milk. Do not give milk if phosphorus has been swallowed. When the poison is a corrosive, demulcents should be given between doses of the antidote.

5. After the poison has been removed from the stomach, give the victim epsom salts (1/2 ounce in a half glass of water) followed by large quantities of water. This will speed passage of any portion of the poison that has passed into the intestines, and prevent its absorption. If it is certain that the poison is not phosphorus, phenol, or other oil-soluble poisons, castor oil (1/2 fluid ounce) may be used.

6. Treat the victim for the effects of the poison. No definite outline of treatment can be given for the effects of ingested poisons. The victim should be treated for shock and given artificial respiration, if necessary. Stimulants (strong coffee or tea) may be given in most cases. The notable exceptions are iodine and strychnine poisoning. Alcohol, as a stimulant, should not be used as a first aid measure. ALWAYS GET MEDICAL ASSISTANCE AS SOON AS POSSIBLE.

You must also take possession of all foods, medicines, vomited matter, feces, urine, and anything that may be of value in determining the identity of the poison and whether it was taken accidentally or intentionally, or whether it was criminally administered.

Unknown Poisons.—For the purpose of first aid treatment of unknown poisons, the case may be considered as one of two kinds:

1. It may be a case where the local effects of the poison have injured the tissues lining the

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mouth, esophagus, and stomach to an extent that an emetic cannot be used safely. Poisons classified as CORROSIVES generally produce conditions such as these. They have an injurious and even destructive effect on the lining of the mouth and stomach. In such conditions, vomiting may cause a rupture of the stomach, therefore, emetics should not be given.

2. It may be a case where the poison has had little or no effect on the tissues lining the mouth, esophagus, and stomach and therefore, emetics can be used safely. Generally, poisons classified as IRRITANTS, DEPRESSANTS, and EXCITANTS do not injure or damage the tissues lining the mouth or stomach, and emetics can be used without fear of injuring the victim.

Even when the exact nature of the poison is unknown, it usually is not difficult to determine whether the poison is corrosive. A corrosive leaves unmistakeable signs about the lips and mouth. When the local condition points to a corrosive poison, the evidence usually indicates also whether it is of the acid or alkali type.

ACIDS burn the lips, mouth, tongue, and throat and leave a characteristic stain (dark-brown or black by hydrochloric and sulfuric acid; yellowish green to orange by nitric acid; brownish by acetic or oxalic acid). Generally, the treatment of all cases of acid poisoning is the same: do not use emetics; give the antidote (magnesia, lime water, soap in large of amounts of water); give demulcents (egg whites, milk); give stimulants; treat for shock.

ALKALIES leave a strong soapy taste in the mouth, and also cause severe burning pain in the mouth, throat, and stomach. The tissues become swollen and white and the lips and tongue swell. The throat may become swollen making breathing difficult. (Phenols, which are acids, also cause similar symptoms. However, phenols leave an odor of wood tar or coal tar, and the soapy taste is absent.) Generally, the treatment of all cases of alkali poisoning is the same; do not use emetics; give large amounts of the antidote (diluted vinegar, lemon juice, grapefruit juice); give demulcents (milk, egg whites, or others); give stimulants; treat for shock.

In cases where there are no signs of injury to the lining of the mouth, the probabilities are that the poison is one of the irritants, depressants, or excitants. Generally, the treatment for all is the same: use emetics to promote vomiting; give large amounts of the antidote (universal antidote); give demulcents (milk, egg whites, or others); give simulants, EXCEPT FOR EXCITANTS; treat for shock.

Poisonous Fish

Some fish are extremely poisonous. It is not always easy to distinguish the edible fish from the poisonous varieties, but the two general points to consider are the LOCATION in which you find the fish, and the APPEARANCE of the fish. Almost all poisonous fish are found in muddy or sandy waters near shore, or in shallow waters near rock or coral reefs. Almost all poisonous fish have round or box-shaped bodies. Edible fish have scales, but most poisonous fish have skin (either smooth or rough) instead of scales. Many of them are covered with bristles or spines. Most poisonous fish have small, parrot-like mouths, small gill openings, and small belly fins; some have no belly fins at all. Some poisonous fish are shown in figure 5-1; as you can see, they are quite different in appearance from ordinary edible fish.

Do not eat sea eels or barracuda, except when prepared professionally. Although they do not fit the general pattern of appearance of poisonous fish, there is considerable evidence to indicate that they may be poisonous in certain areas.

The symptoms caused by eating poisonous fish include nausea, vomiting, diarrhea, itching, cramps, paralysis, and a metallic taste in the mouth. The symptoms are likely to occur suddenly, from 1 to 6 hours after the poisonous fish has been eaten. There is no known antidote for the poison contained in these fish. If symptoms of poisoning appear, induce vomiting repeatedly until the stomach is well washed out. (As you will remember, salt water is a good emetic. Drink sea water until vomiting is induced; repeat as many times as necessary to make sure that the stomach is emptied.)

INHALED POISONS

Toxic vapors and fumes are an ever-present hazard in many industrial operations. Sometimes they are essential to the processes, and sometimes they are merely unwanted by-products. In the Navy, a great many industrial processes are carried out, both on board ship and at shore establishments, and consequently the whole problem of poisoning by inhalation is one with which all naval personnel must be familiar. Many ships, for example, carry on such a wide

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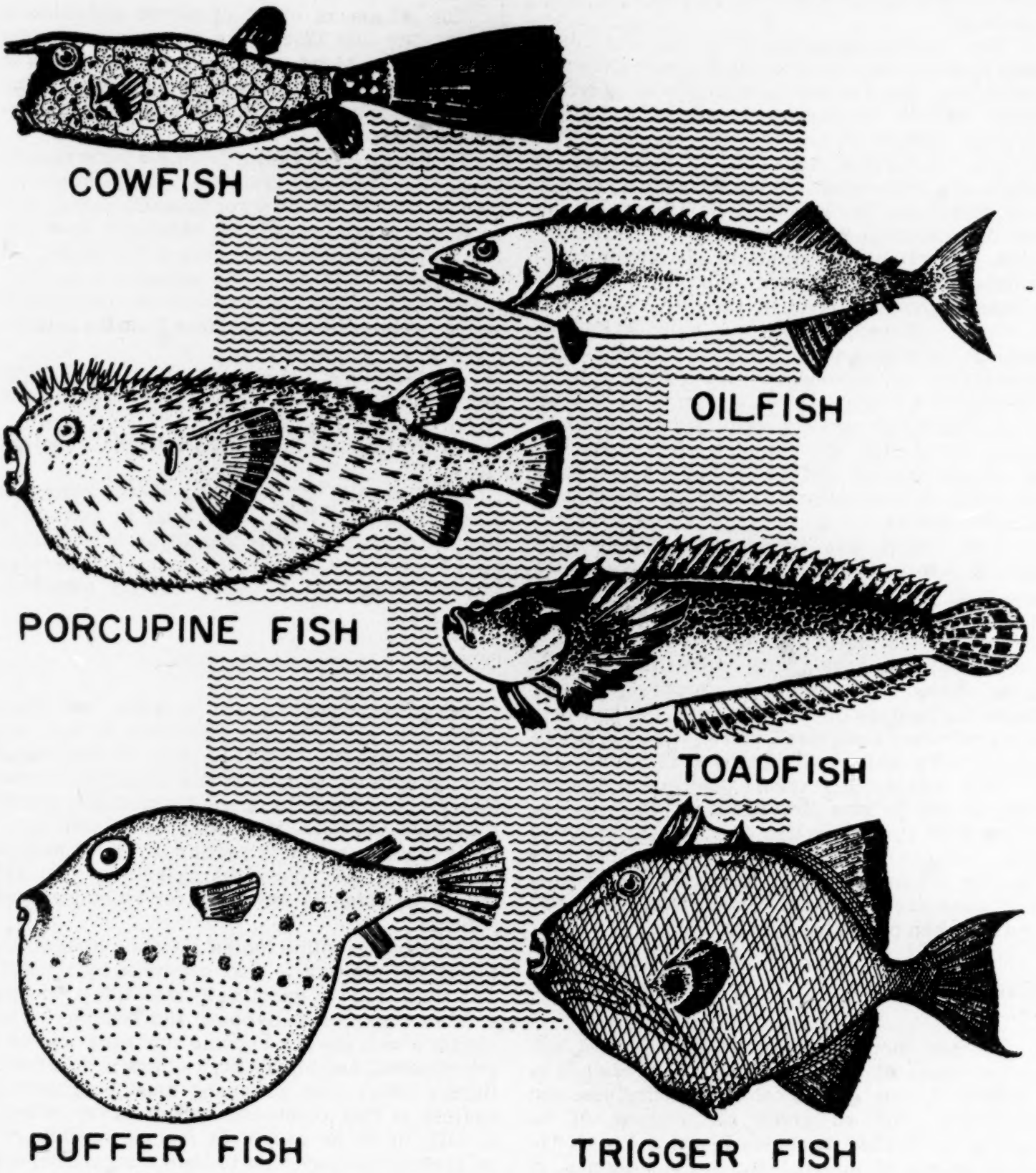

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Figure 5-1.—Poisonous fish.

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variety of industrial operations—casting, molding, welding, plating, casehardening, and many others—that they are in effect floating industrial plants.

The routine operation of maintenance of a ship requires the use of an enormous number of materials, some of which have toxic properties when inhaled. Refrigeration machinery, fire-fighting equipment, paints and solvents, photographic materials, and many other types of shipboard equipment involve the use of volatile and sometimes poisonous chemicals. Also, the handling of large quantities of petroleum products—fuel oil and gasoline, in particular—constitutes a special hazard, since all of these products give off poisonous vapors.

Other poisonous gases are found in the undesirable but unavoidable by-products of certain operations or processes—exhaust gases from internal-combustion engines; fumes or vapors from materials used in metallurgical processes; gases associated with bacterial decomposition in closed spaces; and gases which accumulate in voids, double bottoms, empty fuel tanks, and similar places.

You cannot give first aid treatment to a person who has been overcome by a poisonous gas until you get him out of the toxic atmosphere and into a well-ventilated space. You will have to rescue the victim quickly, because inhaled poisons usually have a very rapid effect upon the body. However, take care to protect yourself from the dangers of the situation. Use appropriate protective equipment, and observe the safety precautions which are discussed in chapter 10.

You will be in a better position to effect a rescue and to give first aid if you know something about the properties of various toxic fumes and vapors. Let's see what gases most frequently cause poisoning, what their properties and uses are, and what kind of first aid is required when poisoning occurs.

Carbon Monoxide

Carbon monoxide is probably the most frequent cause of gas poisoning. As mentioned in chapter 3, this gas is colorless, odorless, and tasteless, and so gives no warning of its presence. Carbon monoxide is present in all exhaust gases of internal-combustion engines, in sewer gas, and in manufactured gas used for heating and cooking. Since it is formed by partial or incomplete combustion, carbon monoxide is almost always present in dangerous concentrations in any poorly ventilated space in which a fire has occurred.

The poisonous effect of carbon monoxide is due to the fact that it combines very rapidly with certain blood cells, in such a way as to prevent those cells from carrying oxygen. The first aid treatment for carbon monoxide poisoning follows:

1. Remove the victim from the toxic atmosphere to a well-ventilated space. Note, however, that the victim should not be taken outside in cold weather. A good supply of oxygen is essential for the elimination of the carbon monoxide, but exposure to cold air could actually cause collapse. Try to find a place which is comfortably warm, well-ventilated, and free from the poisonous gas.
2. Administer oxygen or an oxygen-carbon dioxide mixture, if an inhalator is available and if you know how to use it.
3. If breathing fails, give artificial respiration.
4. Keep the victim lying down, keep him warm, and keep him quiet. Rest is extremely important. The victim should be hospitalized as soon as possible, for treatment of the serious effects which often follow carbon monoxide poisoning.

Gasoline, Benzine, and Naphtha

Gasoline, benzine, and naphtha, and other petroleum products are poisonous if they are ingested, inhaled, or if they come into prolonged contact with the skin. Gasoline vapor is heavier than air, and tends to flow downward. It is highly explosive and flammable when mixed with air.

If liquid gasoline is swallowed, as sometimes happens in the course of siphoning, first aid should be given as described for other ingested poisons.

Inhaling gasoline fumes causes a kind of intoxication similar to that produced by alcohol. The first stage of gasoline intoxication produces a false sense of well-being and security. The victim's movements become unsteady and uncoordinated, and his ability to think is impaired. (Injury other than poisoning must be guarded against at this point—the victim is very likely to fall, or to be caught in moving machinery; or perhaps he may want to light a cigarette, not realizing that he is a highly flammable object.) Later stages of gasoline intoxication result in unconsciousness and a serious depression of

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breathing, which may be followed by death from asphyxiation. First aid treatment for a person who has inhaled gasoline vapors consists of the following:

1. Remove the victim to a well-ventilated place. Take off his contaminated clothing.
2. Give oxygen or an oxygen-carbon dioxide mixture, if available.
3. If the victim is not breathing, give artificial respiration.
4. Keep the victim lying down, keep him warm, and keep him quiet. Keeping him quiet is important, but it may not be easy to do. As he begins to recover he may pass through stages in which he is extremely violent and almost uncontrollable. In these stages he may be self-destructive or he may cause injury to others, unless he is very carefully guarded.

CAUTION: Do not give morphine.

Chlorinated Hydrocarbons

Carbon tetrachloride and other chlorinated hydrocarbons such as methylene chloride, chloroform, dichloromethane, and tetrachloroethane are widely used as solvents. They are very effective agents for dissolving oils, fats, and waxes. They are commonly used for dry cleaning, for degreasing metal articles, for cleaning electrical and electronic equipment, and for a variety of purposes in various manufacturing processes. They are sold for home use under many different trade names. They are not flammable—in fact, carbon tetrachloride is used as the extinguishing agent in some fire extinguishers. (It should be noted, however, that acute carbon tetrachloride poisonings have occurred as a result of using these extinguishers. Furthermore, it is extremely dangerous to use carbon tetrachloride as a fire-extinguishing agent because it decomposes in the presence of heat and forms phosgene gas.)

On board ship the chlorinated hydrocarbons have been used to clean and degrease many kinds of machinery and equipment. However, their use is now being restricted because they are extremely poisonous if they are swallowed, if their vapors are inhaled, or if they are allowed to remain in prolonged contact with the skin. Acute poisoning is most likely to occur from inhalation of the vapors. The vapors cause extreme irritation of the eyes, nose, throat, and lungs. When the chlorinated hydrocarbons are absorbed into the body they damage the liver and other vital organs.

The symptoms of poisoning are often delayed. A person who has been exposed to a toxic concentration of these vapors may not realize his condition until he becomes dangerously ill, some hours later. General signs which should lead you to suspect poisoning from these materials include headache, nausea, mental confusion, and in some instances a kind of drunken behavior similar to that caused by alcohol.

A further danger involved in the use of the chlorinated hydrocarbons is that they break down into extremely toxic agents when they are exposed to high temperatures. In particular, they form phosgene gas—a gas so deadly that it is used as a chemical warfare agent.

There is no known antidote for poisoning by carbon tetrachloride and the other chlorinated hydrocarbons. However, if a person has inhaled any of these vapors, you should give him the following treatment:

1. Remove him from the toxic atmosphere. Remove his contaminated clothes.
2. Give artificial respiration if necessary.
3. Keep the victim lying down and keep him quiet. Be sure that he is comfortably warm.
4. DO NOT give any fats, oils, or alcohol. These substances increase the absorption of the chlorinated hydrocarbons.

CAUTION: When the use of chlorinated hydrocarbons is unavoidable, as in cleaning such things as electrical and electronics equipment, be very careful not to inhale the vapors and not to allow any prolonged contamination of the skin. Treatment for this kind of poisoning is difficult, and recovery is by no means certain. Even a small amount of vapor can be dangerous. In at least one instance, a person was hospitalized for weeks as a result of using carbon tetrachloride to clean the type on a typewriter. If the ventilation is poor, the vapor from one cupful of carbon tetrachloride can cause death. The Bureau of Medicine and Surgery has listed precautionary measures which MUST be observed by all personnel working with the chlorinated hydrocarbons. These measures include the following:

1. Chlorinated solvents shall be handled only by trained personnel and under competent supervision.
2. All hand operations in which chlorinated solvents are used must be performed in well-ventilated areas, preferably outdoors in the open air.
3. Impermeable gloves must be worn for handling these materials. If necessary, other

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impermeable garments—sleeves, aprons, etc.—must be worn.

4. Chlorinated solvents MUST NOT BE HEATED! The application of heat causes them to decompose and form PHOSGENE.

5. Hose (air-line) masks or organic-vapor respirators must be worn if adequate ventilation cannot be arranged.

6. Persons who are required to work with chlorinated solvents MUST NOT DRINK ALCOHOLIC BEVERAGES. The use of alcohol greatly increases susceptibility to this type of poisoning.

Freon

Freon is a colorless, odorless gas which is widely used as a refrigerant. Although it is generally classed as nonpoisonous, it is toxic in high concentrations. Dangerous conditions may be created by large leaks in a refrigeration plant, particularly in confined or unventilated spaces. First aid treatment for this type of poisoning is as follows:

1. Remove the victim from the toxic atmosphere.
2. In general, give the same treatment that you would give to a person who had been poisoned by one of the chlorinated hydrocarbons.
3. Attend to the victim's eyes. Freon is a powerful freezing agent, and even a very small amount can freeze the delicate tissue of the eye. Medical attention must be obtained as soon as possible, in order to avoid permanent damage to the eyes. In the meantime, put drops of clean olive oil, mineral oil, or other nonirritating oil in the eyes and make sure that the victim does not rub his eyes.

CAUTION: Freon is derived from carbon tetrachloride. Like carbon tetrachloride, it breaks down into PHOSGENE gas when it is heated.

Hydrogen Sulphide

Hydrogen sulphide is a colorless gas which smells like rotten eggs. However, its presence cannot always be detected by its odor because the gas paralyzes the sense of smell when it is present in high (and therefore toxic) concentrations. Hydrogen sulphide may be found in high concentrations in places where animal matter has been burned or has been allowed to decay. For example, a ship's compartment in which animal matter is rotting may contain a dangerous amount of this gas. Hydrogen sulphide is used in some industrial processes. It is flammable as well as poisonous.

The general signs of hydrogen sulphide poisoning are eye, nose, and throat irritation, and breathing difficulty. There is usually an abundant flow of tears. Breathing is at first deep, noisy, and gasping; later it is feeble and irregular. Death is caused by paralysis of the breathing center in the brain. First aid treatment for hydrogen sulphide poisoning follows:

1. Quickly remove the victim to a well-ventilated place.
2. Give artificial respiration, if necessary.
3. Give oxygen, if it is available.
4. Keep the victim as quiet as possible until medical help is obtained.

Ammonia

Ammonia is an industrial gas which is used in many different ways. One of its primary uses is as a refrigerant. (Most shipboard refrigeration plants now use Freon, but ammonia is still used in many shore establishments.) Ammonia is pungent, biting, and extremely irritating. Personnel cannot remain in an atmosphere which contains one-tenth of one percent ammonia. The irritation causes coughing and a spasm of the air passages. Death may occur from asphyxiation. (See ch. 3.) The first aid treatment for a person who has inhaled ammonia fumes is as follows:

1. Remove the victim to a well-ventilated space.
2. Give artificial respiration, if necessary.
3. Give oxygen, if it is available.
4. Hold vinegar or a weak solution of acetic acid close enough to the victim's face so that he can inhale the fumes; but discontinue this if it does not give the victim relief.
5. Keep the victim quiet until medical help is obtained.

If you look back over the discussion of poisoning by inhalation, you will see that there are certain GENERAL RULES you can follow in giving first aid treatment for almost any case of poisoning which occurs in this way. These general directions are:

1. Get the victim out of the toxic atmosphere, into a well-ventilated space. Remove his contaminated clothing.
2. Watch his breathing. Give artificial respiration if necessary.
3. Give oxygen, or an oxygen-carbon dioxide mixture, if it is available and if you know how to use it.

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4. Keep him lying down. Keep him quiet. Treat him for shock.
5. CALL A MEDICAL OFFICER AS SOON AS POSSIBLE.

First aid for gas poisoning caused by chemical warfare agents is discussed in chapter 9.

POISONING BY SKIN CONTACT

Poisoning which occurs as a result of skin contact is not ordinarily a first aid problem. It is usually chronic in nature, rather than acute. Poisoning which occurs in this way may be very serious—and, in fact, it frequently results in death—but it usually builds up rather slowly, over a long period of time. It is basically, therefore, a problem for the medical officer rather than for the first-aider.

However, you should know something about the substances which most commonly cause poisoning in this way, since you will probably have to handle them at one time or another. Some of them are used on board ship, and others are used in the more extensive industrial processes which are carried out at shore establishments. Knowing something about these materials may help you avoid the dangers which are involved in handling them.

GASOLINE, BENZINE, NAPHTHA, and other petroleum products cause chronic poisoning if they are allowed to remain on the skin for any length of time. High-octane gasoline, in particular, is dangerous because it contains tetraethyl lead, which is quite easily absorbed through the skin. Tetraethyl lead poisoning may result from such operations as cleaning fuel storage tanks and handling high-octane gasoline.

Other LEAD COMPOUNDS can also cause poisoning by absorption through the skin. People who are regularly exposed to lead compounds may develop chronic lead poisoning. (For example, many painters develop chronic lead poisoning, because some paints contain lead compounds.) Constant handling of MERCURY, ARSENIC, and certain other metals and metallic compounds may in the same way lead to chronic poisoning.

Among the most dangerous of the common substances, from the point of view of poisoning by skin absorption, are the CHLORINATED SOLVENTS such as CARBON TETRACHLORIDE. When absorbed through the skin, these chemicals cause serious damage to the liver, the kidneys, and other vital organs of the body. All safety precautions MUST be observed in handling the chlorinated hydrocarbons. These solvents must never be used for any purpose if a less toxic substitute can be found. Remember, THERE IS NO REAL CURE FOR THIS KIND OF POISONING.

Trinitrotoluene (TNT) is the most widely used of all military high explosives. Poisoning caused by handling TNT is fairly common, on board ship and in naval magazines ashore. Inhaling the fumes can also cause poisoning. If a person who has been handling TNT shows any toxic symptoms he should be moved away from the area immediately. The poison can be removed from the skin with a solution of sodium hyposulphite. Give the victim plenty of fresh air, and keep him absolutely quiet until medical aid is obtained.

Injected Poisons

Although there are a number of substances which are highly poisonous when injected into the human body, the only ones which are important from the point of view of first aid are those which are injected by the bites of spiders, scorpions, or snakes and fish stings.

Spiders and Scropions

SPIDERS and SCORPIONS are common in almost all parts of the world, and some of the more venomous varieties can cause serious poisoning. Adults rarely die from spider bites or scorpion stings, but they are often made seriously ill by them.

Tarantulas and black widows are probably the most common of the poisonous spiders. The bite of the black widow spider causes pain almost at once, and the pain spreads quickly from the region of the bite to the muscles of the back, shoulders, chest, abdomen, and limbs. The pain is usually accompanied by severe spasms of the abdominal muscles.

A bite from any other kind of poisonous spider is not likely to be so immediately painful. The bite itself may be felt as a sharp sting, but it is not usually accompanied by severe pain. About half an hour after the bite, the victim begins to feel painful muscle cramps. At first they are localized near the bite, but they soon spread to involve the other muscles of the body. Shock usually develops at about the same time, though it may be delayed for as much as an hour or two. The victim becomes restless and anxious. He may be very thirsty. Nausea and vomiting may occur.

Very often there is only slight visible evidence of a spider bite. Sometimes there is a slight local swelling which may or may not be accompanied by redness of the skin. The occurrence of these signs probably depends to some extent upon the location of the bite.

Scorpions sting, rather than bite; the stinger and the venon sac are located in the scorpion's tail. The sting causes immediate, intense pain. After a while, however, the area near the sting becomes numb and paralyzed. If the sting is on the arm or the leg, the paralysis may be so great that the limb will be useless for a time.

First aid measures for spider bites and scorpion stings are limited. Simply clean the wound and surrounding area with alcohol to rid them of bacteria. Treat the victim for shock; keep him lying down, quiet, and warm. Severe muscle cramps and pain may sometimes be relieved by warm-water baths. Do not apply suction and do not incise (cut) the wound in an attempt to remove the poison. These actions do no good.

Snakebite

Two kinds of poisonous snakes, the Crotalidae and the Elapidae, are present in the United States. The Crotalidae (frequently called the "pit viper" family) are abundant and include the true rattlesnakes, the pygmy rattlers, copperheads, and water moccasins. The family Elapidae has only one representative—the coral snake. The venom of the Crotalidae is hemotoxic (poisonous to the blood). The venom of the Elapidae (coral, cobra, kraits) contains a highly potent neurotoxin (poisonous to nerve tissues). In addition, some snake venom contains other toxins.

Antivenom.—The Armed Forces Medical Supply provides an antivenom kit which neutralizes the venom of hemotoxic snakes of North and South America, including the rattlesnake, cottonmouth, copperhead, fer-de-lance, and the bushmaster. Throughout the world, other antivenoms have been developed that neutralize the venoms of snakes peculiar to certain areas.

Administration of the antivenom should be accomplished by medical personnel. But if professional help is not available or is not going to be available, the antivenom should be given to save a life. Be certain you have properly identified the snake and have the right antivenom.

Identifying the Snake.—Identification of the snake should be established if at all possible. In some instances, recognition is not so easy. Identification characteristics vary with the locality; this is particularly true of coloration. In addition, much false information is circulated as, for example, "snakes which are poisonous all have triangular heads." Some snakes whose heads cannot be distinguished from their bodies are dangerously poisonous. In identifying the snake these points should be checked:

1. Arrangement of teeth. The presence of fangs immediately labels the snake as poisonous. In addition, the type of fang and its placement may provide a means of deciding its group. (See fig. 5-2).
2. Rattle. Presence of rattles immediately identifies the rattlesnake. However, rattles are often lost and their absence need not rule out this family of reptiles.
3. Sensory pits. Certain groups have a sensory organ between the nostrils and eyes placed in a "pit" and those with it are known as "pit vipers". All pit vipers are poisonous.
4. Color and pattern of coloration. Since color and pattern change with age and are dependent on other factors, they are not always reliable. However, they do help in identification and should be fixed in mind. One generalization can be made: longitudinally striped snakes (lengthwise along the body) are not poisonous. There is only one exception—a small, very rare type native to the Far East.

Symptoms.—The bite from the Crotalidae (pit vipers) may produce the following symptoms:

1. Tissue swelling at the site of the bite gradually spreading to surrounding areas. (Swelling occurs between 3 to 5 minutes following the bite, but may continue for as long as an hour and be so severe as to burst the skin.)
2. Severe pain at the site of the bite.
3. Escape of blood from the capillaries. (Accumulation of blood in the tissues may cause severe pain.)
4. Severe headache and thirst.
5. Bleeding from some of the internal organs into the intestines and excretory tracts may show as blood in urine and/or stool.

The bite from the Elapidae (coral, cobra, krait) may produce the following symptoms:

1. Irregular heartbeat, followed by generalized weakness and exhaustion, ending in shock.
2. Severe headache, dizziness, mental disturbances such as incoherent speech, stupor, mental confusion, and possibly unconsciousness. (Extreme pain is not characteristic.)

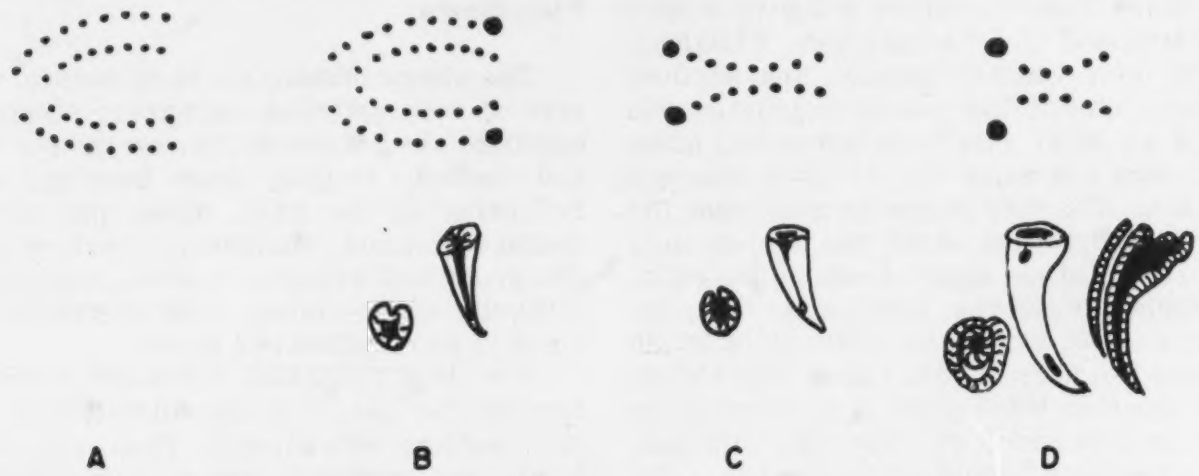

Identification of Snakes by Bite Impressions. A, nonpoisonous, no fangs, *family Colubridae* subfamily Colubrinae (U.S. garter snake, European ringed snake, black snake); B, poisonous, posterior fangs, fangs not hollow but grooved slightly, *family Colubridae* subfamily Boiginae (boomslang of Africa); C, poisonous, anterior fangs, fangs relatively short, deeply grooved, *family Elapidae* (kraits, mambas, water cobras, cobras, and coral snakes) and *family Hydrophidae* (sea snakes); D, poisonous, anterior fangs markedly separated from teeth, fangs long, relatively large, and completely hollow, *family Viperidae* (horned, sand, and tree vipers, puff adders), *family Crotalidae* (rattlesnakes, copperheads, water moccasins, fer-de-lance).

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Figure 5-2.—Identification of snakes by bite impressions.

3. Muscular incoordination such as inability to reach for and pick up an object or to move from place to place; sometimes muscle spasms and twitching.

4. Difficult or labored breathing and even respiratory paralysis.

5. Numbness and tingling of the skin particularly of the lips and soles of the feet and excessive sweating.

6. Chills and fever.

7. Nausea, vomiting, and diarrhea.

Treatment.—The first advice to give the snakebite victim is that he lie down and keep calm. Remind him that of those bitten, few die or are even disabled, if certain principals are followed. Since the identity of the snake is important in the selection of the antivenom, kill the snake (a sharp blow on the head is the best method) and, with a stick, examine the mouth for fangs. Fix the color and color pattern in mind and note the general appearance of the snake. (Unfortunately, most snakebites occur between twilight and daybreak when snakes are most active and identification most difficult. Identification in these situations can only be made by analyzing the symptoms.)

The following rules of first aid should be observed:

1. Immediately put the victim at rest and immobilize the affected part below the level of the heart. Keep him dry, warm, and quiet. Transportation should be by litter when possible.

2. When the bite is on the arm or leg, place a tourniquet 2 to 4 inches closer to the heart than the site of the bite. The tourniquet should be tight enough to stop the flow of blood in the veins but not in arteries. EXCEPTION: If the bite occurs in Africa, India, Burma, Thailand, or Australia where venoms that affect the nervous system are to be expected, or if the snake is positively identified as one possessing this type of venom, the tourniquet should be tight enough to restrict arterial flow and should be placed on the upper arm or upper leg where single bones make restriction possible. The tourniquet should be released for 30 seconds every 20 minutes to allow fresh blood to enter the extremity.

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3. If more than 1 hour is going to elapse before antivenom can be injected, TRAINED RESCUERS may employ incision and suction. With a sharp, sterile instrument (sterilized with a match if no other means is available) make two cuts, each not more than 1/2 inch long and 1/4 inch deep. The cuts should be made over the fang marks, lengthwise along the arm or leg. The incision must not injure tendons, muscles, blood vessels, or nerves. Suction may be performed by suction cup, if available, or by mouth and continued for at least 30 minutes. The sooner suction is started the better. If as much as an hour has passed since the bite was inflicted, incision and suction should not be used.

4. Antivenom should be given as soon as possible. This is best done by a physician because of difficulties that may arise from reactions to the serum. It should be administered as first aid only if medical assistance is not or will not be available and it is necessary to save the life of the victim.

5. Treat the victim for shock. Keep him lying down, make him as comfortable as possible, and keep him quiet. It may be necessary to give artificial respiration and cardiac massage. There are a number of cases on record where men have been kept alive as long as 2 hours after they became unconscious and have been saved by delayed injection of antivenom.

WHAT NOT TO DO: Morphine should not be given for pain when the venom is the type that affects the nervous system. Alcohol is forbidden—it speeds circulation. Ice packs and ice water should not be used—they have no proven value and may do considerable damage.

Self-aid for Snakebite.—The first point to keep in mind is that a nervous or frightened person is severely handicapped, so keep your emotions under control. If it is possible to kill the snake and look for fangs without a lot of excitement and activity, do so. If it is not, sit down at once, apply a tourniquet 2 to 4 inches above the site of the bite, incise the wound, and suck to remove the poison. Remain as quiet as possible and keep the wound lower than your heart.

If pain is great, if there is swelling, numbness, tingling, or continued oozing of blood at the bite site, you can be fairly sure that the snake is poisonous. Do not attempt to travel unless it is evident that no one is going to be coming for you—then walk slowly with a minimum of exertion for help.

Fish Stings

The stings of many sea creatures (portuguese man-of-war, jellyfish, stingray, scorpion fish, toadfish) are poisonous. The symptoms are many and varied, ranging from burning, stinging, reddening of the skin, hives, pus sores, abdominal cramps, numbness, dizziness, pain in the groin and armpits, nausea, muscular pain, difficulty of breathing, and constriction of the chest to prostration and shock.

For PORTUGUESE MEN-OF-WAR stings, remove the tentacles immediately and wash the skin surface with alcohol. Then apply calamine lotion or ammonia water. For JELLYFISH, treatment is about the same. Apply ammonia water, vinegar, or a soothing lotion. Artificial respiration is sometimes needed. Treat for shock.

The wound made by the stingray should be washed immediately with cold salt water. Much of the toxin will wash out, and the cold water causes blood vessels to constrict slowing circulation and acts as a mild pain-killing agent. The wound should then be immersed in hot water for 30 minutes to an hour. The water should be maintained at as high a temperature as the victim can stand without injury. (Hot compresses can be applied for wounds in areas that cannot be immersed.) A sterile dressing should be applied after the soak.

SUMMARY

Poisoning is the absorption of harmful chemical substances that cause illness, injury, or death. Absorption of poisons may occur through ingestion, inhalation, skin contact, and injection.

The symptoms of poisoning may vary greatly, depending on the type of poison, the amount and the length of time it has been in the system, and the physical condition of the victim. Also, some persons are more susceptible to certain poisons than others. A poison that may produce violent reactions in some may produce only mild reactions in others.

Ingested poisons may be grouped according to their effects on the body and the symptoms they produce. Specific first aid treatment is determined by the classification into which the poison falls—corrosives, irritants, depressants, or excitants. In treating cases of ingested poisoning, the basic procedures are to identify the poison; remove the bulk of the poison from the

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stomach; administer the antidote; give demulcents; hasten elimination of the remainder of the poison from the intestines; and treat the victim for the effects of the poison. Remember, emetics are not to be given for corrosives. If the specific antidote for the poison is known, use it; if not, use the best antidote available. The universal antidote may be given when the poison is unknown.

Gaseous poisons that are inhaled may destroy the oxygen-carrying ability of the blood and irritate or destroy the tissues of the lungs and the air passages. If poison is inhaled by a person, he should be removed immediately from the contaminated area. His lungs should then be ventilated by artificial respiration, and oxygen should be administered if necessary.

Some poisons have a damaging effect locally when they contact the skin and the tissues lining the mouth, nose, and throat; and some may be absorbed, entering circulation and causing damage elsewhere in the body. Poisons can be removed from accessible places by washing with water or, if the poison is not water soluble, with alcohol. A chemical antidote can be added to the water. Antidotes for acids are soap, baking soda, borax, or lime water; for alkalies, diluted vinegar or lemon juice.

Injected poisons cannot be removed from the body effectively using first aid measures. The use of a tourniquet will delay absorption of the poison and thereby lower the concentration in the circulatory system so that the body may be able to eliminate the poison without fatal effects. In giving aid to victims of snakebite, make every effort to identify the snake as this is very important to both the treatment and the antivenom to be used. Antivenom should not be administered as a first aid measure, except to save a life, nor should incision and suction be employed, except by trained personnel. Incision and suction should not be employed at all, if antivenom can be injected within 1 hour, or if 1 hour has elapsed since the bite was inflicted.

Treatment by medical personnel should be obtained in all cases of poisoning as soon as possible. Even when the symptoms of poisoning have disappeared completely the poison may have harmful effects that do not appear immediately.

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CHAPTER 6

WOUNDS

Any injury which causes a break in the skin or other body membranes or in the underlying tissues is known as a WOUND. The two main dangers involved in this type of injury are SERIOUS BLEEDING and INFECTION. Serious bleeding has been discussed in chapter 2. In this chapter we will take up the classification of wounds, the general treatment of fresh wounds, special problems which arise because of the location of the wounds, the general problem of infection, and the use of dressings and bandages in the first aid treatment of wounds.

CLASSIFICATION OF WOUNDS

Wounds may be classified according to their general condition, their size, their location, the manner in which the skin or tissue is broken, and the agent which caused the wound. It is usually necessary for you to consider some or all of these factors in order to determine what first aid treatment is appropriate for a wound.

General Condition of the Wound

If the wound is fresh, first aid treatment consists mainly of stopping the flow of blood, treating for shock, and preventing infection. If the wound is already infected, first aid consists of keeping the victim quiet, elevating the injured part, and applying warm wet dressing. If the wound contains foreign objects, first aid treatment may include removing them if they are not too deeply embedded.

Size of the Wound

In general, large wounds are more serious than small ones because they usually involve more severe bleeding, more damage to the underlying organs or tissues, and a greater degree of shock. However, small wounds are sometimes more dangerous than large ones because they may become infected more easily.

Location of the Wound

Since a wound may involve serious damage to deeper structures, as well as to the skin and the tissues immediately below it, the location of the wound is an important consideration. For example: A knife wound in the chest is likely to puncture a lung and cause serious interference with breathing. The same type of wound in the abdomen might cause peritonitis (a dangerous infection in the abdominal cavity), or it might actually puncture the intestines, the liver, the kidneys, or other vital organs. A knife wound to the head might cause brain damage. And the same kind of a wound in a less vital spot (as, perhaps, an arm or a leg) might be relatively unimportant.

How the Skin is Broken

When considered from the point of view of the manner in which the skin or tissue is broken, there are five general kinds of wounds: Abrasions, incisions, lacerations, punctures, and crushed wounds. Many wounds, of course, are combinations of two or more of these basic types.

Abrasions.—Abrasions are made when the skin is rubbed or scraped off. "Rope burns," "floor burns," and "skinned" knees or elbows are common examples of abrasions. This kind of wound becomes infected quite easily, because dirt and germs are usually ground into the tissues.

Incisions.-Incisions, commonly called CUTS, are wounds made by sharp cutting instruments such as knives, razors, broken glass, etc. Incisions tend to bleed very freely because the blood vessels are cut straight across. There is relatively little damage to the surrounding tissues. Of all classes of wounds, incisions are

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least likely to become infected, since the free flow of blood washes out many of the microorganisms (germs) which cause infection.

Lacerations.—Lacerations are wounds which are torn, rather than cut. They have ragged, irregular edges, and masses of torn tissue underneath. These wounds are usually made by blunt, rather than sharp, objects. A wound made by a DULL knife, for instance, is more likely to be a laceration than an incision. Bomb fragments often cause lacerations. Many of the wounds caused by accidents with machinery are lacerations, although they are often complicated by crushing of the tissues as well. Lacerations are frequently contaminated with dirt, grease, or other material which is ground into the tissues; they are therefore very likely to become infected.

Punctures.—Punctures are caused by objects which penetrate some distance into the tissues while leaving a relatively small surface opening. Wounds made by nails, needles, wire, knives, and bullets are usually punctures. As a rule, small puncture wounds do not bleed freely; however, large puncture wounds may cause severe internal bleeding. All puncture wounds are very dangerous from the point of view of infection.

Crushed Wounds.—Crushed wounds are particularly subject to infection because the microorganisms which cause infection grow and multiply rapidly in the body cells which are destroyed by the crushing. Crushing of the tissues frequently accompanies lacerated wounds.

Cause of the Wound

Although it is not always necessary to know what agent or object has caused a wound, it is frequently helpful. Knowing what has caused the wound may give you some idea of the probable size of the wound, its general nature, the extent to which it is likely to be contaminated with foreign matter, and what special dangers must be guarded against.

TREATMENT OF FRESH WOUNDS

As we have seen, there are several ways of classifying wounds, and there are various special problems which must be considered in treating different kinds of wounds. However, there are three basic rules to be followed in the treatment of practically all fresh wounds: Stop the flow of blood, treat the victim for shock, and do whatever you can to prevent infection. In addition, it is sometimes necessary to remove foreign objects from a wound, and it is sometimes necessary to immobilize the injured part in order to prevent further damage.

Stopping the Flow of Blood

The first aid methods which are used to stop serious bleeding (described in chapter 2) depend upon the application of pressure. Pressure may be applied in three ways: (1) Directly to the wound; (2) at key pressure points throughout the body; and (3) by means of a tourniquet. You will recall that DIRECT PRESSURE should be tried first, and the other two methods should be used ONLY if direct pressure fails to stop the flow of blood. For almost all minor wounds, a combination of direct pressure and elevation of the wounded part will be sufficient to stop the bleeding.

Treating for Shock

Shock is likely to be severe in a person who has lost a large amount of blood or suffered any serious wound. Keep the casualty lying down on his back, with his feet and legs somewhat elevated—unless, of course, his injuries are such as to prevent the use of this position. Be sure that he is comfortably warm, but do not overheat him. Morphine may be given for relief of severe pain, if there is no head injury, no chest injury, and if the casualty is not in deep shock.

Preventing Infection

Any break in the skin or other body membrane (such as the mucous membrane which lines the nasal passages) is dangerous because it allows microorganisms (germs) to enter the wound. Although infection may occur in any wound, it is a particular danger in wounds which do not bleed freely, wounds in which torn tissue or skin falls back into place and so prevents the entrance of air, and wounds which involve crushing of the tissues. Incisions, in which there is a free flow of blood and relatively little crushing of the tissues, are least likely to become infected.

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Minor wounds should be washed immediately with soap and clean water, dried, and painted with a mild, nonirritating antiseptic. Benzalkonium chloride tincture, which is now found in most Navy first aid kits, is a good skin antiseptic; it does not irritate the skin, but it effectively destroys many of the microorganisms which cause infection. (Benzalkonium chloride is commonly sold under the name of Zephiran, or Zephiran chloride.) Apply a dressing if necessary.

Larger wounds should be treated only by medical personnel. You should not make any attempt to wash or clean a large wound, and you must not apply any kind of antiseptic. Merely cover the wound with a dry sterile compress and fasten the compress in place with a bandage.

Remember that PUNCTURE WOUNDS are very likely to become infected. In particular, tetanus (sometimes called "lockjaw") is likely to develop from puncture wounds unless preventive treatment is given in time. Although the microorganism which causes tetanus is found almost everywhere—in the ground, in street dirt, in house dust—it cannot grow and multiply in the presence of air. However, when the organism is carried into a puncture wound, where it is not exposed to air, ideal conditions for its growth are set up. All puncture wounds are dangerous, and must be treated by a medical officer.

A special kind of infection which must be guarded against in the case of ANIMAL BITES is the possibility of rabies (sometimes called "hydrophobia"). This disease is caused by a virus which is present in the saliva of infected animals. The disease occurs most commonly in dogs, but has been found in cats, wolves, foxes, goats, sheep, horses, pigs, and other animals; in fact, it is probable that all mammals are susceptible to it. The virus which causes rabies is ordinarily transmitted by a bite, but it can be transmitted by the saliva of an infected animal coming in contact with a fresh wound or with the thin mucous membrane of the lips or nose. The virus does not penetrate normal unbroken skin.

If rabies once develops in man, it cannot be cured and is always fatal. A preventive treatment is available which is very effective if it is given within a few days after the bite; this treatment is known as the Pasteur vaccine treatment. Since the vaccine can be given only by medical personnel, any person bitten by an animal MUST receive medical attention at the earliest opportunity. The victim should be transferred to the nearest medical facility, and a complete report of the circumstances should be given. Remember, PREVENTION is of utmost importance; no cure is possible after the symptoms begin to develop.

Immediate local treatment of the wound should be given. Wash the wound and the surrounding area carefully, using sterile gauze, soap, and sterile water. Use sterile gauze to dry the wound, and then cover the wound with a sterile dressing. Do NOT use any chemical disinfectant. Do not attempt to cauterize the wound in any way.

You will recall that fresh wounds are not ordinarily washed. However, a wound made by an animal bite should be washed immediately and thoroughly; all of the animal's saliva must be removed from the victim's skin in order to prevent further contamination of the wound. (CAUTION: DO NOT allow the animal's saliva to come in contact with open sores or cuts on your hands.)

When a person has been bitten by an animal, every effort must be made to catch the animal to keep it confined for a period of about 2 weeks. DO NOT kill it if there is any possible chance of catching it alive. The symptoms of rabies are not always present in the animal at the time the bite occurs, but the saliva may nevertheless contain the rabies virus. It is essential, therefore, that the animal be kept under observation until a diagnosis can be made. The Pasteur treatment is given if the animal develops any definite symptoms, if it dies during the observation period, or if for any reason the animal cannot be kept under observation.

Remember that any animal bite is dangerous, and MUST be treated by medical personnel.

Removing Foreign Objects

Many wounds contain foreign objects. Wood or glass splinters, bullets, metal fragments, bits of wire, fishhooks, nails, tacks, cinders, and small particles from grinding wheels are examples of the variety of objects or materials which are sometimes found in wounds. In some cases, first aid treatment for wounds includes the removal of such objects when they are near the surface and exposed. However, first aid treatment does NOT include the removal of deeply embedded objects, nor the removal of powdered glass, emerywheel particles, or any widely-scattered material of this nature. You should never attempt to remove bullets, but you should

try to find out whether the bullet remains in the victim; look for both entrance and exit wounds. The general rule to remember is this: Remove foreign objects from a wound, when you can do so easily and without causing further damage; but NEVER HUNT FOR, OR ATTEMPT TO REMOVE, DEEPLY-BURIED OR WIDELY-SCATTERED OBJECTS OR MATERIALS.

The following procedure may be used to remove a small object from the skin or tissues, if the object is near the surface and clearly visible:

1. Sterilize the skin over and around the object by painting the area with benzalkonium chloride tincture.

2. If necessary, pierce the skin with a sharp instrument (a needle, a razor, or a sharp knife) which has been sterilized by passing it through a flame several times.

3. Grasping the object at the end, remove it. Tweezers, small pincers, or forceps (such as are contained in most Navy first aid kits) may be used for this purpose. Whatever instrument you use should first be sterilized by boiling for 15 minutes.

4. If the wound is superficial, apply gentle pressure to encourage bleeding.

5. Cover the wound with a dry sterile dressing.

If the foreign object is under a fingernail or toenail, you may have to cut a V-shaped notch in the nail so that the object can be grasped by the forceps. Do NOT try to dig the object out from under the nail with a knife or similar instrument.

A curved or barbed object such as a fishhook may present special problems. Figure 6-1 shows one method of removing a fishhook which has become embedded in the flesh. As you can see from figure 6-1 (A), the barb on the hook prevents its direct removal. However, if you push the hook forward through the skin, as shown in figure 6-1(B), you can clip off the barb with a wirecutter or similar tool, as shown in figure 6-1(C). The remainder of the fishhook can then be withdrawn in the manner indicated in figure 6-1(D).

Many eye wounds contain foreign objects. Dirt, coal, cinders, eyelashes, bits of metal, and a variety of other objects may become lodged in the eye. Since even a very small piece of dirt is intensely irritating to the eye, the removal of such objects is very important. However, the eye is very easily damaged. Impairment of vision (or even total loss of vision) can result from fumbling, inexpert attempts to remove foreign objects from the eye. The following precautions MUST be observed:

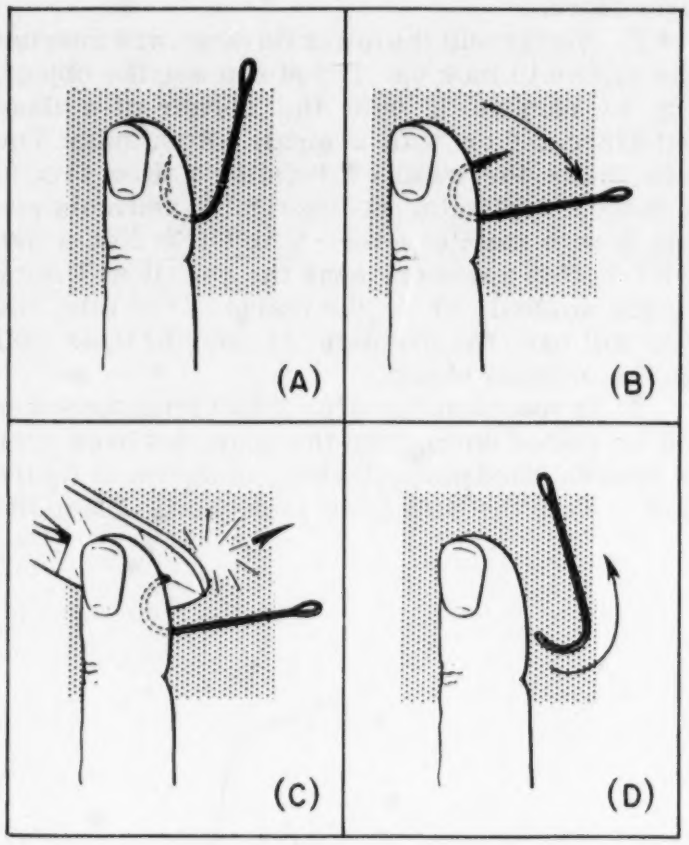

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Figure 6-1.—Removing a fishhook.

1. DO NOT allow the victim to rub the eye.

2. DO NOT press against the eye, or manipulate it in any way which might cause the object to become imbedded in the tissues of the eye. Be very gentle; roughness is almost sure to cause injury to the eye.

3. DO NOT use such things as knives, toothpicks, matchsticks, wires, etc., to remove the object.

4. DO NOT UNDER ANY CIRCUMSTANCES ATTEMPT TO REMOVE AN OBJECT WHICH IS EMBEDDED IN THE EYEBALL OR WHICH HAS PENETRATED THE EYE!. If you see a splinter or other object sticking out from the eyeball, leave it alone! Only specially-trained medical personnel can hope to save the victim's sight if an object has actually penetrated the eyeball.

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Small objects which are lodged on the surface of the eye or on the membrane lining the eyelids can usually be removed by the following procedures:

1. Gently pull the lower lid down, and instruct the victim to look up. If you can see the object, try to remove it with the corner of a clean handkerchief or with a small cotton swab. You can make the swab by twisting cotton around a wooden applicator, not too tightly, and moistening it with sterile water. CAUTION: Never use DRY cotton anywhere near the eye. It will stick to the eyeball, or to the inside of the lids, and you will have the problem of removing it, as well as the original object.

2. If you cannot see the object when the lower lid is pulled down, turn the upper lid back over a smooth wooden applicator, as shown in figure 6-2. Tell the victim to look down. Place the applicator lengthwise across the center of the upper lid. Grasp the lashes of the upper lid gently but firmly. Press very gently with the applicator, and immediately pull up on the eyelashes, thus turning the lid back over the applicator. If you can see the object, try to remove it with a moist cotton swab or with the corner of a clean handkerchief.

3. If you are not successful in removing the foreign object by either of these two methods, try to wash the eye gently with lukewarm sterile water. A sterile medicine dropper or a sterile syringe can be used for this purpose. Have the victim lie down, with his head turned slightly to one side as shown in figure 6-3. Hold his eyelids apart. Direct the flow of water to the INSIDE corner of his eye, and let it run down to the OUTSIDE corner. Do not use any greater force than is necessary to keep the water flowing

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Figure 6-2.—Turning the upper eyelid back over wooden applicator.

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Figure 6-3.—Washing a foreign object from the eye.

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across the eye. Do NOT let the water fall directly onto the eyeball.

4. If the foreign object cannot be removed by any of the above methods, YOU MUST NOT MAKE ANY FURTHER ATTEMPTS TO REMOVE IT. Instead, place a small, thick gauge dressing over the eye and hold it in place with a LOOSE bandage or eye shield. (A firm bandage might drive the foreign object deeper into the eye.)

5. Get medical help for the victim at the earliest opportunity.

Preventing Movement

In giving first aid treatment to a person who has suffered a large wound, you may find it necessary to immobilize the injured part, since movement of the wound might cause a recurrence of bleeding, an increase in the severity of shock, and a general enlargement of the injury. Some wounds can be sufficiently immobilized by the application of a firm bandage; others may require splints. Methods of splinting are discussed in chapter 7.

SPECIAL WOUNDS

As we have seen, the basic first aid treatment for all fresh wounds consists of stopping the flow of blood, treating the victim for shock preventing infection, and—when necessary—removing foreign objects and immobilizing the injured part. Now let's consider some particular wounds which, because of their location, may require special first aid measures.

Chest Wounds

Wounds in the chest may involve lung damage and serious interference with breathing. If a lung is actually punctured, the victim is likely to cough up frothy, bright red blood. The proper first aid treatment for a person with a serious chest wound is as follows:

1. Close the wound at once, using any materials which are available. If possible, place a dry sterile pad (large enough to cover the wound completely) over the wound. Then apply an airtight pressure bandage. Strips of adhesive tape about 2 1/2 inches wide can be used, as shown in figure 6-4. It is very important that the dressing be airtight; otherwise, it will not relieve the victim's breathing difficulties.

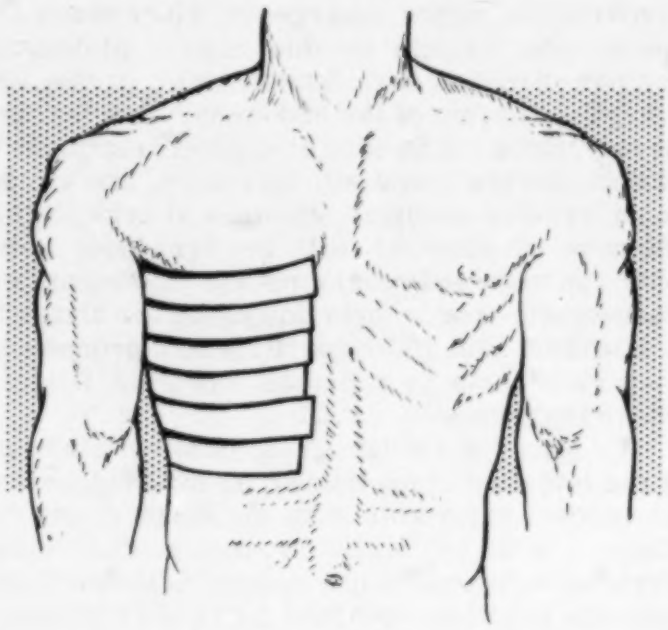

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Figure 6-4.—Airtight pressure bandage for chest wound.

If you do not have a large sterile compress and adhesive tape, you may be able to improvise a dressing which will hold the edges of the wound together. Clothing can be used to make the pad, or the bandage, or both. Use whatever materials you can find, and make the dressing as airtight as possible. If you can't find anything to use for a bandage, place one hand on each side of the wound and push the tissues together; hold the wound tightly closed until help arrives, or until you can improvise a better means of keeping the wound closed. Remember, you must keep the wound so tightly closed that air cannot go in and out by way of the wound.

2. Give oxygen, if the apparatus is available and if you know how to use it.

3. Treat for shock. Note, however, that it may be necessary to prop the victim up on pillows so that he will be able to breathe, in spite of the fact that this position is not ordinarily recommended for the treatment of shock. Keep the victim comfortably warm. As a rule, you should NOT give liquids to a person who has a chest wound, as he might choke on the liquid or get it into his lungs.

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Abdominal Wounds

A deep wound in the abdomen is likely to constitute a major emergency, since there are many vital organs in this area. Abdominal wounds usually cause intense pain, nausea and vomiting, spasm of the abdominal muscles, and severe shock. Immediate surgical treatment is almost always required; therefore, the victim must receive medical attention at once, or his chances of survival will be very poor. Give only the most essential first aid treatment, and concentrate your efforts on getting the victim to a hospital. The following first aid procedures may be of help to a person suffering from an abdominal wound:

1. Keep the victim lying down on his back. If the intestine is protruding or exposed, he may be more comfortable with his knees drawn up; place a coat, a pillow, or some other bulky cloth material under his knees to help him maintain this position. DO NOT ATTEMPT TO PUSH THE INTESTINE BACK IN, OR TO MANIPULATE IN ANY WAY!

2. If bleeding is severe, try to stop it by applying direct pressure.

3. Cover the wound with a dry sterile dressing, if the intestine is not exposed. If the intestine is exposed, apply a sterile compress moistened with sterile water. If no sterile water is available, clean seawater or any water which is fit to drink may be used to moisten the compress. Figure 6-5 shows an abdominal wound with the intestine protruding. As you can see from this illustration, the compress should be large enough to cover the entire wound and the surrounding skin. The compress should be held in place by a bandage. Fasten the bandage firmly, so that the compress will not slip around, but do not apply any more pressure than is necessary to hold the compress in position.

4. Give morphine for the relief of pain, unless the victim will receive medical attention very soon. Pain is likely to be severe, but this fact must be weighed against the consideration that medical diagnosis is much more difficult after the victim has been given morphine. Before giving morphine, therefore, try to estimate how long a time must elapse before medical aid can be obtained.

5. Treat for shock—but don't waste any time doing it. The victim must be transported to a hospital at the earliest possible opportunity. However, you can minimize the severity of shock by making sure that the victim is comfortably warm and by keeping him lying down on his back. DO NOT GIVE HIM ANYTHING TO DRINK. If he complains of great thirst, moisten his mouth with a small amount of water; but do not allow him to swallow any liquid.

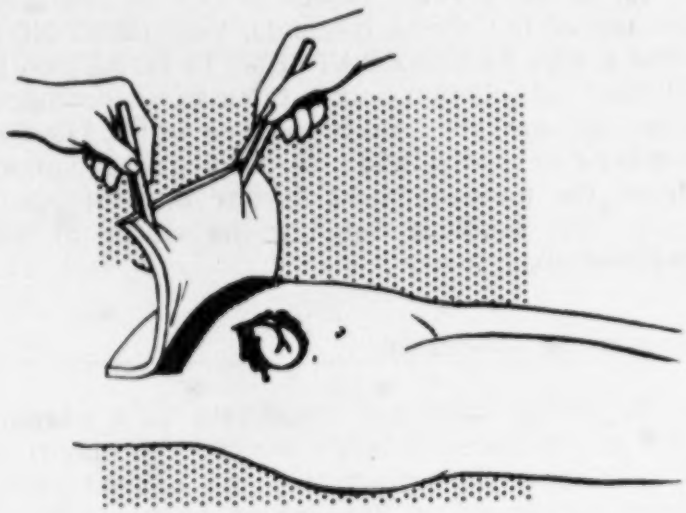

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Figure 6-5.—Abdominal wound with protruding intestine.

Head Wounds

Head wounds must be treated with particular care, since there is always the possibility of brain damage with injuries of this kind. The general treatment for head wounds is the same as that for other fresh wounds. However, certain special precautions must be observed if you are giving first aid to a person who has suffered a head wound:

1. NEVER GIVE MORPHINE.

2. Keep the victim lying flat, his head at the level of his body. Do not raise his feet. If his face is flushed, or if he is having trouble breathing, you may raise his head slightly.

3. If the wound is at the back of the head, turn the victim so that he is lying on his side.

Facial Wounds

Wounds of the face are treated, in general, like other fresh wounds. However, some kinds of face wounds present special problems. For example, if the lower jaw is shot away or seriously damaged, there is considerable danger that the

tongue may fall back into the throat and choke the victim. You can prevent this occurrence by running a safety pin or a thread through the middle of the tongue, pulling the tongue forward, and fastening the pin or thread to the victim's clothes.

A person with a serious face wound should ordinarily be kept lying face down, so that the blood from the wound will not clog his breathing passages or get into his lungs.

Facial wounds which involve the eyelids or the soft tissues around the eye must be handled very carefully in order to avoid further damage. If the injury does not involve the eyeball, apply a sterile compress and hold it in place with a FIRM bandage. If the eyeball appears to be injured, use a LOOSE bandage. (Remember that you must NEVER attempt to remove any object which is embedded in the eyeball, or which has penetrated it; just apply a dry sterile compress and hold it in place with a LOOSE bandage.)

Any person who has suffered a facial wound which involves the eye, the eyelids, or the tissues around the eye must receive medical attention as soon as possible. Be sure to keep him lying down; a stretcher must be used to transport him, so that he will not have to sit or stand.

Internal Wounds

External blows or impacts which do not break the skin frequently cause extensive internal damage. Internal injuries are not always thought of as wounds, because no blood shows on the surface of the body. However, if you remember the definition of a wound—any injury which causes a break in the skin or other body membranes or in the underlying tissues—you will see that many internal injuries are really wounds.

Internal wounds are frequently caused by pressure waves which result from the detonation of high explosives, either in the air or under water; if caused in this way, the wounds are usually referred to as BLAST or CONCUSSION injuries. Internal wounds may also be caused by any sudden forceful blow such as might occur in fights, in automobile accidents, or in accidents involving some kinds of machinery. Internal wounds of the lung sometimes occur when a broken rib punctures the lung.

In general, the organs which are most likely to be internally damaged by external blows or forces are the lungs and the intestines. If there is an internal wound of the lung the victim will cough up frothy, bright red blood; he will have difficulty in breathing, and may cough and gasp. If the injury is so severe that he cannot get enough oxygen, his face will be bluish in color. Internal wounds of the intestines usually cause severe pain and cramping, and immediate bowel movements; the stools are loose, and frequently tinged with blood.

Spontaneous internal bleeding, not caused by any external blow or force, sometimes occurs. Spontaneous bleeding from the LUNGS is most likely to be caused by tuberculosis. The blood which is coughed up is frothy and bright red; you will not generally be able to distinguish spontaneous bleeding from that which is caused by an external blow. Spontaneous bleeding from the STOMACH may be caused by ulcers. The blood is usually vomited up. It is dark brown or black in color; it is broken up into small clots, and so has somewhat the appearance of coffee grounds. However, if a person vomits blood which has this appearance, don't jump to the conclusion that he is suffering from stomach ulcers. Any blood which has been swallowed (as, for example, from bleeding of the mouth or nose) is dark and clotted when it is vomited up.

It is often difficult to recognize the presence of internal wounds. However, any person who is suffering from internal bleeding is likely to be restless, anxious, and thirsty, immediately after the injury; later these signs may be replaced by indications of more severe shock. In many cases of blast or concussion injury, signs of shock are the only indication of internal damage.

There is relatively little in the way of first aid that can be done for persons suffering from internal wounds. ALL INTERNAL INJURIES ARE SERIOUS. THEY REQUIRE IMMEDIATE MEDICAL ATTENTION. The first aid measures which are used in these cases have two purposes: (1) To minimize the severe shock which almost always accompanies internal injuries; and (2) to prevent further damage. First aid treatment should be given as follows:

1. Keep the victim lying down. If he has a chest wound, he will have difficulty in breathing and may have to be propped up. If he has an abdominal wound, he may be more comfortable with his knees drawn up; place some bulky material such as a coat or a pillow under his knees to help him maintain this position. If he has no breathing difficulty, and if he does not appear to be more comfortable with his knees drawn up, keep him lying flat on his back. Do not elevate his feet.

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2. Be sure that the victim is comfortably warm, but do not overheat him.

3. Keep him as quiet as possible, and do not move him unless it is absolutely necessary. If you must move him, keep him lying down and handle him with great care. Any movement will probably make the injury worse.

4. Give morphine for the relief of pain, if the victim is breathing normally, without difficulty.

5. Give oxygen to a person with an internal chest wound, if the apparatus is available and if you know how to use it.

CAUTION: DO NOT give a person anything to drink if you suspect that he has an internal wound. If he complains of great thirst, moisten his mouth with a small amount of water, but do not let him swallow any of it.

INFECTION

The treatment of infected wounds is ordinarily a problem for medical personnel. However, you must know something about infected wounds so that you will know what to do if medical help is not immediately available.

Infections are dangerous in any part of the body, but particularly so in the area around the nose and mouth. Figure 6-6 shows this danger zone. From this area, infections spread very easily into the bloodstream, causing septicemia (blood poisoning), and into the brain, causing abscesses and infections there. Boils, carbuncles, and infected hair follicles just inside the nostril are perhaps the most common infections which occur in this area.

Symptoms of Infection

You are probably familiar with the general symptoms of infection. Heat, redness, swelling, and pain occur around the wound. Pus is often (although not always) visible. If the infection is severe, there may be an increase of body temperature (fever) and swelling of the glands in the neck, armpit, or groin. The presence of any of these signs should be taken as a possible indication of infection.

Treatment of Infected Wounds

There are three things you can do for a person who has an infected wound, while you are waiting for the medical officer:

1. Keep the person at rest, preferably in bed. Physical activity spreads the infection throughout the whole body.

2. Elevate the injured part, if possible. This will tend to reduce pain.

3. Apply a warm wet dressing to the infected wound and to the surrounding area. A large bulky pad should be used for this purpose; it may be made from a bandage, a towel, gauze, or any other clean cloth. The pad should be large enough to extend 5 or 6 inches in every direction beyond the infected wound, and it should be at least 1 inch thick.

Wet the pad with a solution of table salt and warm water (one teaspoonful of salt to a pint of water) or a solution of epsom salts and warm water (as much epsom salts as will dissolve in the water). The wet pad may be held in place by a bandage, if necessary.

For the first 6 hours of treatment, you should apply warm wet dressings continuously. Then allow the wound to dry for an hour. Apply warm wet dressings for another hour, and let

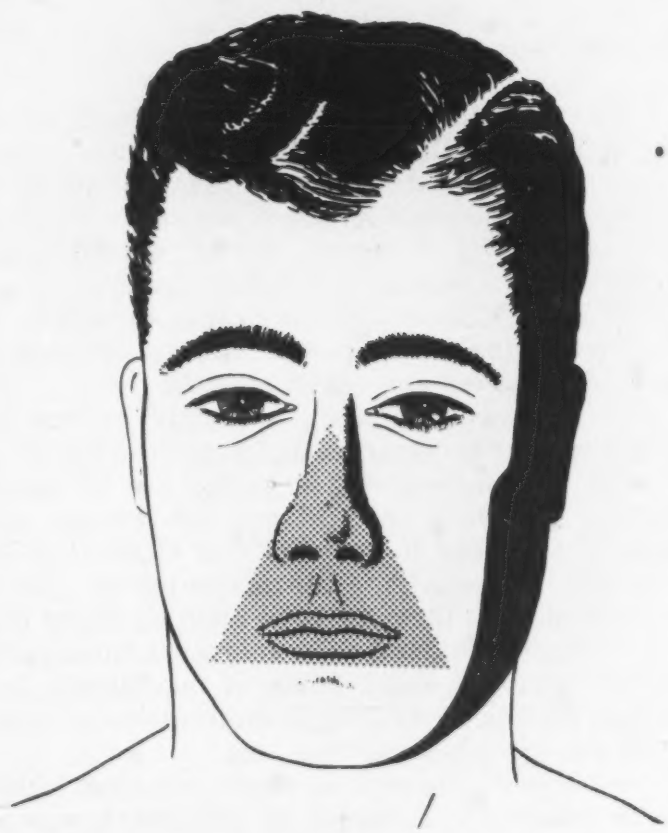

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Figure 6-6.—Danger zone for infection.

dry for an hour again. Continue this alternating wet-dry treatment until a medical officer takes charge of the case, or until the symptoms of infection disappear.

If the infected wound is on a hand or a foot, soaking may be more convenient than applying wet dressings. The injured part should be immersed for several hours in a solution of salt and warm water or epsom salts and warm water, allowed to dry for half an hour or an hour, and then soaked again. Continue this treatment until medical advice is available or until the symptoms of infection disappear.

CAUTION: Never cut or squeeze an infected wound; never attempt to open it in any way. The pus or matter which is usually present in an infected wound contains both live and dead microorganisms. If you try to open the wound, you will probably force some of the living organisms into the blood-stream, where they will be carried by the blood to every part of the body. Serious (sometimes fatal) general infections can result.

COMPRESSES, DRESSINGS, AND BANDAGES

In general, the term DRESSING is used to describe everything which is used to cover or dress a wound. The sterile pad which is put directly over the wound is called a COMPRESS. A BANDAGE is used to hold the compress in position. A combined compress and bandage, in which the sterile gauze pad is fastened to a gauze, muslin, or adhesive bandage, is usually referred to as a dressing. Most Navy first aid kits contain both large and small dressings of this kind.

Any part of a dressing which is to come in direct contact with a wound should be absolutely sterile—that is, it should be free from microorganisms. The dressings which you will find in first aid kits have been sterilized. However, if you touch them with your fingers, your clothes, or any other unsterile object, they are of course no longer sterile. If you drag a dressing across the victim's skin, or allow it to slip after it is in place, the dressing is no longer sterile. An improvised dressing can be made sterile by boiling it for 10 to 15 minutes.

Emergencies sometimes arise in which it is impossible to obtain a regular sterile compress, and equally impossible to boil a piece of cloth in order to sterilize it. In such a situation, use the cleanest cloth available. A freshly laundered handkerchief, towel, shirt, etc., may be used; unfold it carefully so that you will not touch the part which goes next to the wound.

A compress should be large enough to cover the entire area of the wound, and to extend at least 1 inch in every direction beyond the edges. If the compress is not large enough, the edges of the wound are almost sure to become contaminated.

Materials which are likely to stick to a wound or which may be difficult to remove should NEVER be used directly over a wound. Absorbent cotton, collodion, impregnated cloth, adhesive tape, electrician's tape, and friction tape are examples of materials which should not come in contact with a wound.

Bandages

The two basic types of bandages which are most commonly used are the ROLLER BANDAGE and the TRIANGULAR BANDAGE.

Roller Bandage.—The roller bandage, shown in figure 6-7, consists of a long strip of material

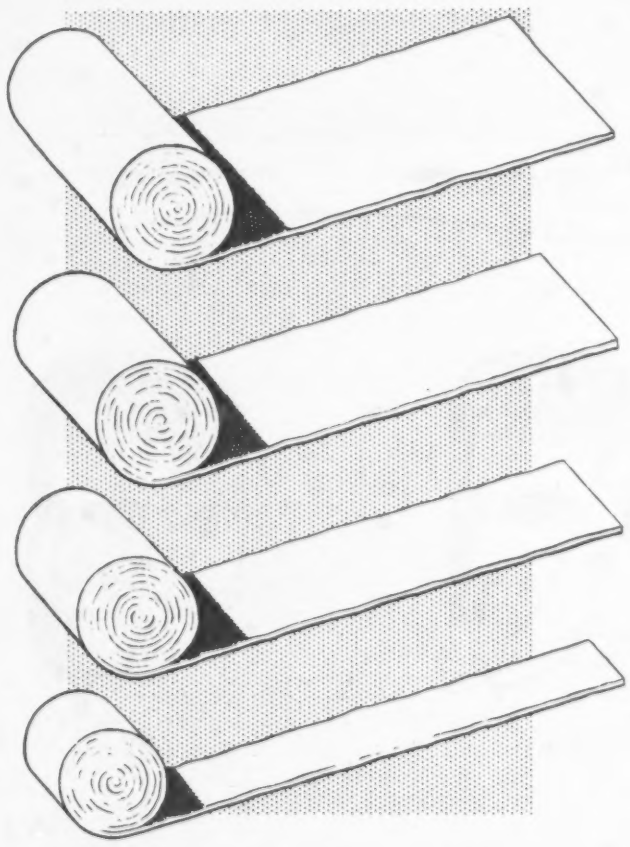

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Figure 6-7.—Roller bandages.

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(usually gauze or muslin) which is wound into a cylindrical shape. Roller bandages come in various widths and lengths. Most of the roller bandages found in first aid kits have been sterilized, so pieces may be cut off and used as compresses in direct contact with wounds. If you use a piece of roller bandage in this way, however, be very careful not to touch it with your hands or with any other unsterile object.

A piece of roller bandage may be used to make a FOUR-TAILED BANDAGE. This is done by splitting the cloth from each end, leaving as large a center area as necessary. Figure 6-8(A) shows a bandage of this kind. The four-tailed bandage is often used to hold a compress on the chin, as shown in figure 6-8 (B), or on the nose, as shown in figure 6-8 (C). It is particularly good for bandaging any protruding part of the body, because the center portion of the bandage forms a smoothly-fitting pocket when the tails are crossed over.

Triangular Bandages.—Triangular bandages are usually made of muslin. They are made by cutting a 36- to 40-inch square from a piece of cloth, and then cutting the square diagonally, thus making two triangular bandages. A smaller bandage of this kind may be made by folding a large handkerchief diagonally. The longest side of a triangular bandage is called the BASE; the corner directly opposite the middle of the base is called the POINT; and the other two corners are called ENDS. Figure 6-9 shows a triangular bandage with the base, point, and ends labeled. The triangular bandage is useful because it can be folded in a variety of ways to fit almost any part of the body.

The triangular bandage may be folded to form a CRAVAT BANDAGE, which is particularly useful in controlling bleeding from wounds of the scalp or forehead. To make the cravat, bring the point of the triangular bandage down to the base; then fold the bandage lengthwise along the middle. The cravat may then be used, or—if a narrower bandage is desired—it may be folded again along the middle. Figure 6-10 shows how to fold a triangular bandage into a cravat.

If specially prepared bandages are not available, use whatever material you can find. Remember that the basic purpose of a bandage is to hold the sterile compress in place. Any material and any method of application which does not cause further injury to the victim is adequate if it serves the purpose. Material used as a bandage does not have to be sterile, since it does not come in direct contact with the wound; it should, however, be as clean as possible.

Cloth bandages should be fastened by tying the ends with a SQUARE KNOT or by pinning the ends with strong safety pins. If you use a knot to fasten the bandage, be sure to use a square knot; as you know, this knot is easy to tie, does not slip, and can be untied quickly when

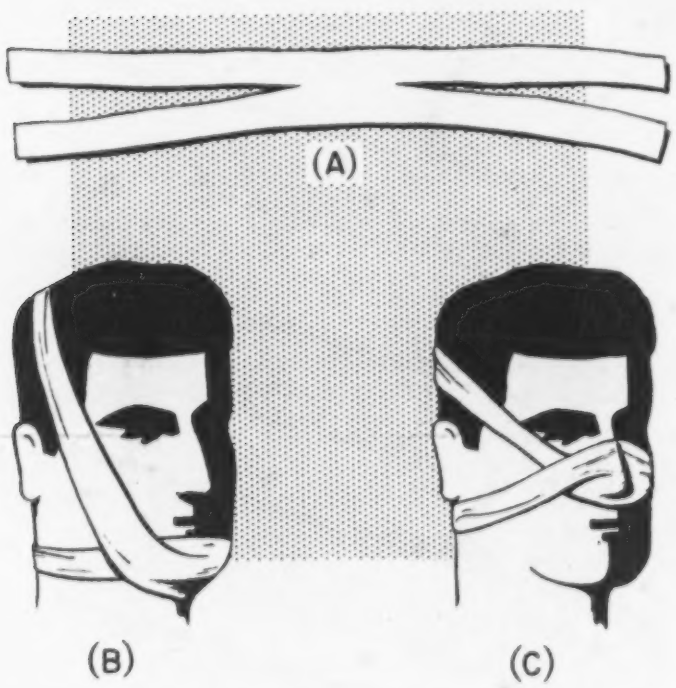

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Figure 6-8.—(A) Four-tailed bandage. (B) Four-tailed bandage applied to chin. (C) Four-tailed bandage applied to nose.

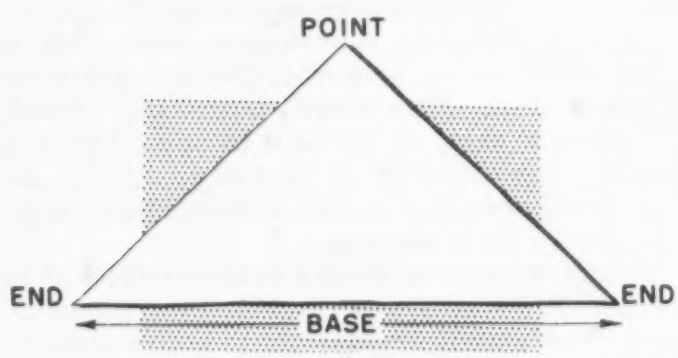

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Figure 6-9.—Triangular bandage.

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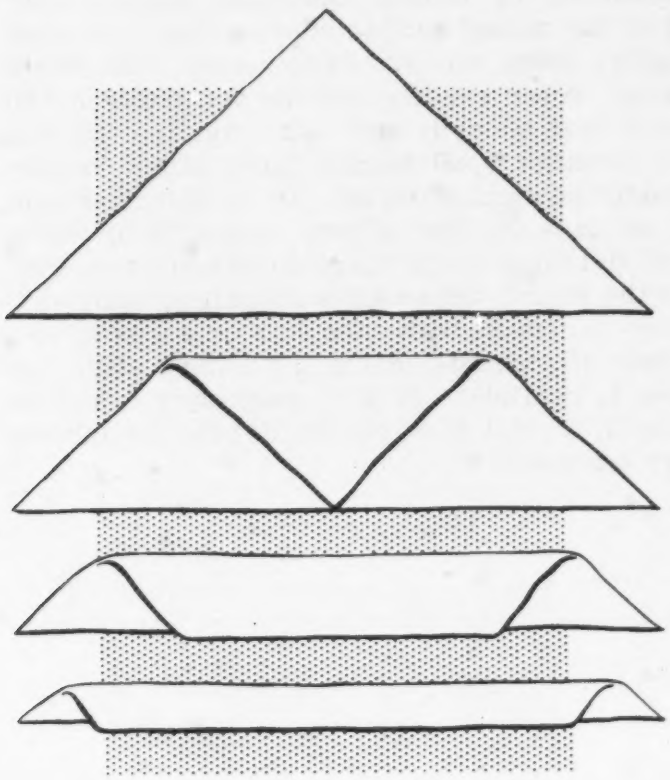

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Figure 6-10.—Cravat bandage.

necessary. Be sure, also, that you place the knot so as to cause the least possible discomfort to the victim, and that you place it where it can be removed easily and quickly.

As a general rule, bandages should be applied firmly but not tightly. A bandage which is too loose is likely to slip off the wound. A bandage which is too tight may cut off some of the blood supply to the injured part, and may cause severe damage to the blood vessels and to the tissues. When you fasten a bandage around an arm or a leg, leave the fingers or toes exposed; if they become blue or swollen you will know that the bandage is too tight and should be loosened.

SUMMARY

A wound is a break in the skin, other body membrane, or underlying tissue. Several factors that should be considered in treating wounds are the size of the wound, condition of the wound, location of the wound, type of wound, and cause of the wound. Any one or a combination of these factors may alter somewhat the first aid treatment that should be given.

Basically, the most important steps in treating all wounds are to stop the flow of blood, to treat for shock, and to dress the wound to reduce the possibility of infection. However, in addition to these steps, certain wounds require special treatment.

Chest wounds should be closed immediately, using an airtight bandage. When the wound causes breathing difficulty, oxygen should be given, if the apparatus is available and you can use it. In treating for shock, place the casulaty in a sitting or semisitting position to aid breathing. Do not give morphine, unless breathing is normal.

In abdominal wounds, direct pressure is the only way to control bleeding. Cover the wound with a dry sterile dressing. If intestines protrude, cover the wound with a sterile compress moistened with sterile water. Keep the injured person on his back, either flat or with knees drawn up, whichever position is more comfortable. Do not give morphine if he will receive medical attention in a short time. Do not give liquids or solids by mouth.

For head wounds, never give morphine. Keep the injured person lying flat; do not lower his head. If his face is flushed, or if he has difficulty breathing, raise his head slightly.

Facial wounds should be given the same general treatment as other wounds, except that in treating for shock, keep the injured person lying face down, head turned to one side, so that blood from the wound will not clog breathing passages.

Eye wounds must be treated with extreme care to avoid further injury. Never attempt to remove objects embedded in the eyeball. Apply a thick, dry, sterile compress and fasten it with a bandage. If the eyeball is injured, apply a loose bandage, without pressure against the eyeball. If the eyeball is not injured, use a firm bandage. A person with an eye injury should not be allowed to sit or stand; keep him lying down, flat on his back.

A foreign object in the eye, which has not penetrated the eyeball, may be removed by gently pulling away the upper or lower eyelid and using the corner of a clean handkerchief or a small cotton swab moistened with sterile water (never dry) to dislodge it. If the object cannot be dislodged in this manner, wash the eye gently with lukewarm sterile water. If neither method is successful, make no further attempt

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to remove it. Apply a loose bandage and get medical assistance immediately.

Internal wounds, caused by external blows or impacts that do not break the skin, require immediate attention by medical personnel. Do not give morphine if medical assistance will be available soon or if breathing is difficult. Keep the injured person lying flat, except that for internal chest injuries raise the head and shoulders. For abdominal wounds, he may be more comfortable with knees drawn up. Do not give liquids to a person with internal wounds.

Infected wounds should never be cut, squeezed, or opened. Apply warm, wet dressings, using a solution of salt or epsom salts and warm water. Keep the infected part elevated.

Animal bites are dangerous because of the possibility of rabies infection. Immediately, wash the wound and the surrounding area thoroughly, using sterilie gauze, soap, and sterile water. After washing, dry the wound with sterile gauge and cover it with a dry sterile compress and bandage. All animal bites should receive prompt medical attention. In treating the wound, do not use any type of skin antiseptic or chemical disinfectant and make no attempt to cauterize the wound. Do not allow the animal's saliva to come in contact with open cuts or sores on your hands. If possible, catch the animal alive, and keep it confined. If it is necessary to kill the animal, or if it dies, cut off the head for laboratory examination.

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CHAPTER 7

INJURIES TO BONES, JOINTS, AND MUSCLES

Many kinds of accidents cause injuries to bones, joints, or muscles. In giving first aid to an injured person, you must always look for signs of fractures (broken bones), dislocations, sprains, strains, and contusions.

An essential part of the first aid treatment for fractures consists of immobilizing the injured part with splints so that the sharp ends of broken bones will not move around and cause further damage to nerves, blood vessels, or vital organs. Splints are also used to immobilize severely injured joints or muscles, and to prevent the enlargement of extensive wounds. You must have a general understanding of the use of splints before going on to learn the detailed first aid treatment for injuries to bones, joints, and muscles.

USE OF SPLINTS

Some Navy first aid kits are supplied with basswood splints, which may be cut to the desired size; other kits contain wire mesh splints, which may be cut and then molded to the proper shape. These readymade splints are, of course, easier to apply than improvised splints; but in an emergency almost any firm object or material will serve the purpose. Such things as umbrellas, canes, swords, rifles, tent pegs, laths, sticks, oars, paddles, spars, wire, leather, boards, pillows, heavy clothing, corrugated cardboard, and folded newspapers can be used as splints. Adhesive tape is often used to splint a fractured rib. A fractured leg may sometimes be splinted by fastening it securely to the uninjured leg.

Splints, whether readymade or improvised, must fulfill certain requirements. They should be light in weight, but they must be strong and fairly rigid. They should be long enough to reach the joints above and below the fracture. Splints should be wide enough so that the bandages which are used to hold them in place will not pinch the injured part. Splints must be well padded on the sides which touch the body; if they are not properly padded, they will not fit well and will not adequately immobilize the injured part. If you have to improvise the padding for a splint, you can use articles of clothing, bandages, cotton, oakum, felt, blankets, or any other soft material. If the victim is wearing heavy clothes, you may be able to apply the splint on the outside, thus allowing the clothing to serve as at least part of the required padding.

To apply splints to an injured part, fasten them in place with bandages, strips of adhesive tape, pieces of rope, articles of clothing, or any other available material. If possible, one person should hold the splints in position while another person fastens them.

Although splints should be applied snugly, they should NEVER be tight enough to interfere with the circulation of the blood. When you are applying splints to an arm or a leg, try to leave the fingers or toes exposed. If the tips of the fingers or toes become blue or cold, or if the normal pink color does not quickly return when you press against the nails, you will know that the splints or bandages are too tight. You should examine a splinted part approximately every half hour, and loosen the fastenings if the circulation appears to be impaired. Remember that any injured part is likely to swell, and splints or bandages which are all right when applied may later be too tight.

INJURIES TO BONES

A break in a bone is called a FRACTURE. There are two main kinds of fractures. A SIMPLE FRACTURE is one in which the injury is entirely internal—that is, the bone is broken but there is no break in the skin. A COMPOUND FRACTURE is one in which there is an open

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wound in the soft tissues and the skin. Sometimes the open wound is made when a sharp end of the broken bone pushes out through the flesh; sometimes it is made by an object such as a bullet which penetrates from the outside. Figure 7-1 shows simple and compound fractures.

Compound fractures are more serious than simple fractures. They usually involve extensive damage to the tissues, and they are quite likely to become infected. Simple fractures are sometimes turned into compound fractures by rough or careless handling of the victim.

It is not always easy to recognize a fracture. All fractures, whether simple or compound, are likely to cause severe pain and shock; but the other symptoms may vary considerably. A broken bone sometimes causes the injured part to be deformed, or to assume an unnatural position; however, this is not always the case. Pain and swelling may be localized at the point of fracture, and there may be a kind of wobbly movement if the bone is broken clear through. It may be difficult or impossible for the victim to move the injured part; if he is able to move it, he may feel a kind of grating sensation as the ends of the broken bone rub against each other. However, if a bone is cracked rather than broken through, the victim may be able to move the injured part without much difficulty. A compound fracture is easy to recognize if an end of the broken bone protrudes through the flesh. If the bone does not protrude, however, you might see the external wound but fail to recognize the broken bone.

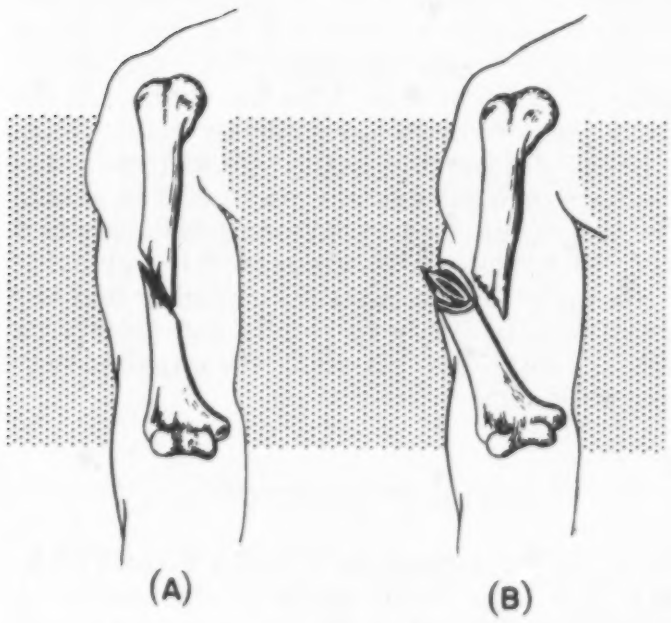

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Figure 7-1.—Types of fractures. (A) Simple fractures. (B) Compound fractures.

If you are required to give first aid to a person who has suffered a fracture, you should follow these general rules:

- If there is any possibility that a fracture has been sustained, treat the injury as a fracture.
- Get medical aid at the first possible opportunity. All fractures require medical treatment.
- Do not move the victim until the injured part has been splinted, unless you must move him in order to save his life or prevent further injury.
- Treat for shock. Give morphine for the relief of severe pain, unless there is evidence of head injury. Remember, never give morphine to a person who has suffered a head injury!
- Do not attempt to locate a fracture by grating the ends of the bone together.
- Do not attempt to set a broken bone.
- When a long bone in the arm or leg is fractured, the limb must be carefully straightened so that splints can be applied. Never attempt to straighten the limb by applying traction with any improvised windlass or other device. Pulling gently with your hands in the long axis of the limb is permissible, and may be all that is necessary to get the limb back into position. If protruding bone ends are covered with dirt or other foreign matter which can be EASILY wiped off, they should be very gently cleaned with sterile cloth before the limb is straightened.
- Apply splints. If the victim is to be transported only a short distance, or if he will be seen very soon by a medical officer, it is probably best to leave his clothing on and place emergency splinting over it. However, if the victim must be transported for some distance, or if a considerable period of time will elapse before he can be treated by a medical officer, it may be better to remove enough clothing so that you can apply well-padded splints directly to the injured part. If you decide to remove clothing over the injured part, cut the clothing or rip it along the seams. In any case, BE CAREFUL! Rough handling of the victim may convert a simple fracture into a compound fracture, increase the severity of shock, and cause extensive damage to the blood vessels, nerves,

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muscles, and other soft tissues around the broken bone.

• If the fracture is compound, you must take care of the wound before you can deal with the fracture. Bleeding from the wound may be quite serious; however, most bleeding can be stopped by direct pressure on the wound or by digital pressure at the appropriate point. If these methods are not successful, use a tourniquet. (Methods of stopping serious bleeding are described in ch. 2.) When you have stopped the bleeding, give whatever further treatment is necessary for the wound, according to the principles discussed in chapter 6. Then treat the fracture. If one of the long bones of the arm or the leg is broken, straighten the limb carefully (using GENTLE traction) before applying splints. If one end of the bone protrudes, straightening the limb may draw it back into place. HOWEVER, YOU MUST NEVER ATTEMPT TO FORCE THE END OF THE BONE BACK INTO THE WOUND!

Now that we have seen the general rules for treating fractures, let's take up the symptoms and emergency treatment of fractures of the forearm, upper arm, thigh, leg, kneecap, collarbone, rib, nose, jaw, skull, spine and pelvis.

Fracture of the Forearm

There are two large bones in the forearm. When both are broken the arm usually appears to be deformed. When only one bone is broken, however, the other acts as a splint and the arm therefore retains a more or less natural appearance. (When the fracture is low, near the wrist, the deformity may be very clear even if only one bone is broken.) Any fracture of the forearm is likely to result in pain, tenderness, inability to use the forearm, and a kind of wobbly motion at the point of injury. If the fracture is compound, there will of course be an open wound, through which the bone may show.

Treatment.—If the fracture is compound, stop the bleeding and treat the wound. Apply a sterile dressing over the wound.

Carefully straighten the forearm. (Remember that rough handling of a simple fracture may turn it into a compound fracture.)

Apply two well-padded splints to the forearm, one on the top and one on the bottom. Be sure that the splints are long enough to extend from the elbow to elbow the wrist. Use bandages to hold the splints in place.

Put the forearm across the chest. The palm of the hand should be turned in, with the thumb pointing upward. Support the forearm in this position by means of a wide sling, as shown in figure 7-2. The hand should be raised about 4 inches above the level of the elbow.

As in all cases of fracture, treat the victim for shock and get medical attention for him as soon as possible.

Fracture of the Upper Arm

The signs of fracture of the upper arm include pain, tenderness, swelling, and wobbly motion at the point of fracture. If the fracture is near the elbow, the arm is likely to be fully extended—that is, it will be straight, with no bend at the elbow.

Treatment.—If the fracture is compound, stop the bleeding and treat the wound before attempting to treat the fracture.

NOTICE THAT TREATMENT OF THE FRACTURE DEPENDS PARTLY UPON THE LOCATION OF THE BREAK.

If the fracture is in the upper part of the arm, near the shoulder, place a pad or folded towel in the armpit, bandage the arm securely to the body, and support the forearm in a narrow sling.

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Figure 7-2.—Sling used to support a fractured forearm.

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If the fracture is in the middle of the upper arm, you can use one well-padded splint on the outside of the arm. The splint should extend from the shoulder to the elbow. Fasten the splinted arm firmly to the body, and support the forearm in a narrow sling, as shown in figure 7-3.

Another way of treating a fracture in the middle of the upper arm is to fasten two wide splints, or four narrow ones, about the arm, and support the forearm in a narrow sling. If you use a splint between the arm and the body, be very careful that it does not extend too far up into the armpit; a splint in this position can cause a dangerous compression of the blood vessels, and may be extremely painful to the victim.

If the fracture is at or near the elbow, you may find the victim with his arm either bent or straightened out. NO matter what position you find the arm in, DO NOT ATTEMPT TO STRAIGHTEN IT OR TO MOVE IT IN ANY WAY. As carefully as possible, splint the arm in the position in which you find it.

Treat the victim for shock, and get him under the care of a medical officer as soon as possible.

Fracture of the Thigh

The thighbone is the long bone of the upper part of the leg, between the kneecap and the pelvis. When the thighbone is fractured, any attempt to move the limb results in a spasm of the muscles and causes excruciating pain. The leg has a wobbly motion, and there is complete loss of control below the fracture. The limb usually assumes an unnatural position, with the toes pointing outward. The fractured leg is shorter than the uninjured one, by actual measurement, due to the pull of the powerful thigh muscles. Serious damage to blood vessels and nerves often results from a fracture of the thighbone. Shock is likely to be severe.

Treatment.—If the fracture is compound, stop the bleeding and treat the wound before attempting to treat the fracture itself. Serious bleeding is a special danger in this type of injury, since the broken bone may tear or cut the large artery in the thigh.

Carefully straighten the leg. Apply two splints, one on the outside of the injured leg and one on the inside. The outside splint should reach from the armpit to the foot. The inside splint should reach from the crotch to the foot. The splints should be fastened in five places: (1) Around the ankle; (2) over the knee; (3) just below the hip; (4) around the pelvis; and (5) just below the armpit. Both legs should be tied together, in order to support the injured leg as firmly as possible.

It is essential that a fractured thigh be splinted before the victim is moved. Ready-made splints are best, but improvised splints may be used. Figure 7-4 shows how a rifle may be used as an emergency splint for a fractured thigh. Remember, DO NOT MOVE THE VICTIM UNTIL THE INJURED LEG HAS BEEN IMMOBILIZED!

Treat the victim for shock, and get medical care for him at the earliest possible opportunity.

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Figure 7-3.—Splint and sling for fractured upper arm.

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Figure 7-4.—Rifle used as emergency splint for fractured thigh.

Fracture of the Lower Leg

When both bones of the lower leg are broken, the usual signs of fracture are likely to be present. When only one bone is broken, the other one acts as a splint and thus to some extent prevents deformity of the leg. However, tenderness and swelling at the point of fracture are almost always present. A fracture just above the ankle is often mistaken for a sprain. If both bones of the lower leg are broken, a compound fracture is very likely to result.

Treatment.—If the fracture is compound, stop the bleeding and treat the wound. Carefully straighten the injured leg. Apply THREE splints—one on each side of the leg and one underneath. Be sure that the splints are well padded, particularly under the knee and at the bones on each side of the ankle.

A pillow and two side splints work very well for treatment of a fractured leg. Place the pillow beside the injured leg, then carefully lift the leg and place it in the middle of the pillow. Bring the edges of the pillow around to the front of the leg, and pin them together. Then place one splint on each side of the leg, over the pillow, and fasten them in place with strips of bandage or adhesive tape.

Treat the victim for shock, and get medical care for him as soon as possible.

Fracture of the Kneecap

The following first aid treatment should be given for a fractured kneecap:

Carefully straighten the injured limb Immobilize the fracture by placing a padded board under the injured limb. The board should be at least 4 inches wide, and should reach from the buttock to the heel. Place extra padding under the knee and just above the heel, as shown in figure 7-5. Use strips of bandage to fasten the leg to the board in four places: (1) Just below the knee; (2) just above the knee; (3) at the ankle; and (4) at the thigh. DO NOT COVER THE KNEE ITSELF! Swelling is likely to be very rapid, and any bandage or tie fastened over the knee would quickly become too tight.

Treat the victim for shock, and obtain medical aid as soon as possible.

Fracture of the Collarbone

A person with a fractured collarbone usually shows rather definite symptoms. When the victim stands, the injured shoulder is lower than the uninjured one. He is usually unable to raise his arm above the level of his shoulder. He may attempt to support the injured shoulder by holding the elbow of that side in his other hand—this is, in fact, a characteristic position assumed by a person with a broken collarbone. Since the collarbone lies very near the skin, you may be able to detect the point of fracture by deformity and localized pain and tenderness.

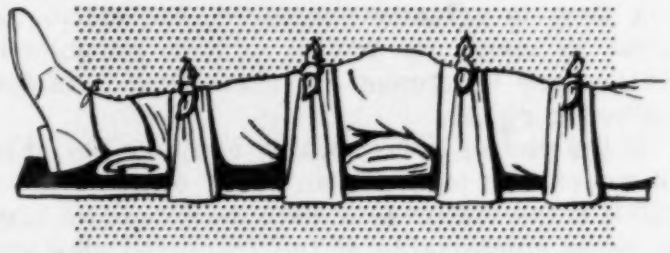

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Figure 7-5.—Immobilization of fractured kneecap.

Treatment.—If the fracture is compound, stop the flow of blood and treat the wound before attempting to treat the fracture.

Bend the victim's arm on his injured side, and place the forearm across his chest. The palm of his hand should be turned in, with the thumb point up. The hand should be raised about 4 inches above the level of the elbow. Support the forearm in this position by means of a wide sling.

Use a wide roller bandage (or any wide strip of cloth) to fasten the victim's arm to his body. The bandage should make several turns around the victim's body, and should go down over the hand so that the arm will be held close against the body.

Treat the victim for shock, and see that he receives medical attention as soon as possible.

Fracture of the Rib

A broken rib may cause severe pain at the point of fracture. Since the pain is greatly increased by the movements of coughing or deep breathing, the victim may breathe in a shallow, gasping way, and he may press his hands against his chest in an effort to prevent movement of the broken bone.

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The greatest danger from a fractured rib is that the broken ends may cause lung damage. If a lung is actually punctured, the victim is likely to cough up frothy, bright red blood. (Emergency treatment for chest wounds is described in ch. 6.)

If the victim is reasonably comfortable, it is not necessary to apply any kind of bandage or splint. If the victim is in pain, however, he may be more comfortable if the fractured ribs are immobilized to some extent. Figure 7-6 shows how three cravat bandages may be used for this purpose. The cravat bandages should be applied in the following way:

1. Place the first bandage around the upper part of the chest and tie it in a LOOSE knot on the victim's UNINJURED side.
2. Place the second and third bandages a little lower down, and tie loosely.
3. Place a compress or pad UNDER the knots, on the victim's UNINJURED side.
4. Tighten the three bandages, one at a time, beginning with the top one. Each one should be tightened immediately after the victim has breathed OUT.

Fracture of the Nose

A fracture of the nose usually causes localized pain and swelling, a noticeable deformity of the nose, and extensive nosebleed.

Treatment.—Stop the nosebleed. Have the victim sit quietly, with his head tipped slightly backward. Tell him to breathe through his mouth, and tell him not to blow his nose. If the bleeding does not stop within a few minutes, apply a cold compress or an ice bag over the nose.

Treat the victim for shock, and see that he receives medical attention as soon as possible. Permanent deformity of the nose may result if the fracture is not treated promptly.

Fracture of the Jaw

A person who has a fractured jaw may suffer a serious interference with breathing. He is likely to have great difficulty in talking, chewing, or swallowing. Any movement of the jaw causes pain. The teeth may be out of line, and there may be bleeding from the gums. Considerable swelling may develop.

Treatment.—If the fractured jaw interferes with breathing, pull the lower jaw and the tongue well FORWARD and keep them in that position.

Apply a four-tailed bandage, as shown in figure 7-7. Be sure that the bandage pulls the lower jaw FORWARD. Never apply any bandage which forces the jaw backward, since this might cause a serious interference with breathing. The bandage must be firm, so that it will support and immobilize the injured jaw, but it must not press against the victim's throat.

Treat the victim for shock, and get medical attention for him as soon as possible.

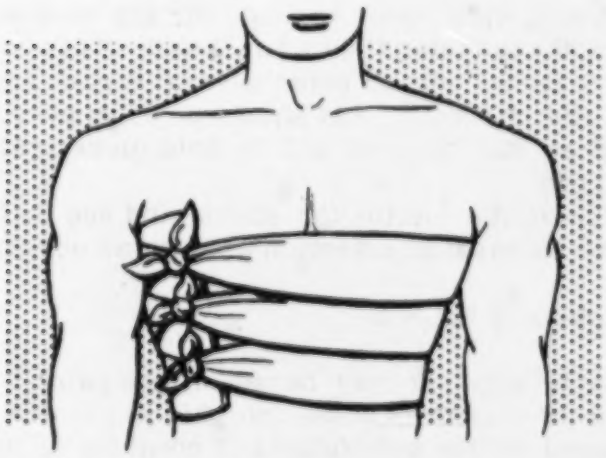

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Figure 7-6.—Cravat bandages used to splint fractured ribs.

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Figure 7-7.—Four-tailed bandage for a fractured jaw.

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Fracture of the Skull

When a person suffers a head injury, the greatest danger is that the brain may be severely damaged; whether or not the skull is fractured is a matter of secondary importance. In some cases, injuries which fracture the skull do not cause serious brain damage; but brain damage can—and frequently does—result from apparently slight injuries which do not cause damage to the skull itself.

It is often difficult to determine whether an injury has affected the brain, because the symptoms of brain damage vary greatly. Any person who has suffered a head injury of any sort must be handled very carefully and given immediate medical attention.

Some of the symptoms which may indicate brain damage are listed below. However, you must remember that these symptoms are not always present in any one case, and that the symptoms which do occur may be greatly delayed.

- Bruises or wounds of the scalp may indicate that the victim has sustained a blow to the head. Sometimes the skull is actually depressed ("caved in") at the point of impact. If the fracture is compound, you may find bullets, glass, shrapnel, or other objects actually penetrating the skull.
- The victim may be conscious or unconscious. If he is conscious, he may feel dizzy and weak, as though he were going to faint.
- Severe headache sometimes (but not always) accompanies head injuries.
- The pupils of the eyes may be unequal in size, and may not react normally to light.
- There may be bleeding from the ears, nose, or mouth.
- The victim may vomit.
- The victim may be restless, and perhaps confused and disoriented.
- The arms, legs, face, or other parts of the body may be partially paralyzed.
- The victim's face may be very pale, or it may be unusually flushed.
- The victim is very likely to be suffering from shock, but the symptoms of shock may be disguised by other symptoms.

It is not necessary to determine whether or not the skull is actually fractured, when you are giving first aid to a person who has suffered a head injury. The treatment is the same in either case, and the primary intent is to prevent further damage to the brain.

Treatment.—Keep the victim lying down. If his face is flushed, raise his head and shoulders slightly. If his face is pale, have him lie so that his head is level with, or slightly lower than, his body. Do NOT allow him to sit or stand.

If there is serious bleeding from the wound, try to control it by the application of direct pressure.

Be very careful about moving or handling the victim. Do not move him any more than necessary. If you must transport him, keep him lying down.

Be sure that the victim is kept comfortably warm, but do not overheat him.

Do NOT give the victim anything to drink.

NEVER GIVE MORPHINE TO A PERSON WHO HAS A HEAD INJURY!

See that the victim receives medical attention as soon as possible!

Fracture of the Spine

The spinal cord, which contains nerve fibers in direct connection with the brain, is enslosed and protected by a bony structure known as the SPINAL COLUMN, or BACKBONE. The spinal column is made up of a number of small bones called VERTEBRAE.

If the spine is fractured at any point, the spinal cord may be crushed, cut, or otherwise damaged so severely that death or paralysis will result. However, if the fracture occurs in such a way that the spinal cord is not seriously damaged, there is a very good chance of complete recovery—PROVIDED the victim is properly cared for. Any twisting or bending of the neck or back, whether occurring from the original injury or from careless handling later, is likely to cause irreparable damage to the spinal cord.

The primary symptoms of a fractured spine are pain, shock, and paralysis. PAIN is likely to be acute at the point of fracture. SHOCK is usually severe, but (as in all injuries) the symptoms may be delayed for some time. PARALYSIS occurs if the spinal cord is damaged. If the victim cannot move his legs, feet, or toes, the fracture is probably in the back; if he cannot move his fingers, the neck is probably broken. Remember, however, that a spinal fracture does not always injure the spinal cord, so the victim is not always paralyzed. Any person who has

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an acute pain in the back or the neck, following an injury, should be treated as though he has a fractured spine, even if he has no other symptoms.

First aid treatment for all spinal fractures, whether of the neck or of the back, has two primary purposes: (1) to minimize shock, and (2) to prevent further injury to the spinal cord.

You will remember that, in general, there are three things you can do to treat for shock (1) keep the victim comfortably warm; (2) keep him lying down, with his head slightly lower than the rest of his body; and (3) give morphine for the relief of severe pain. Now let's see which of these measures can be used in the case of a person with a fractured spine:

You must keep him comfortably warm.

You must not attempt to keep him in the position ordinarily used for the treatment of shock, because getting him into this position might cause further damage to the spinal cord. Just keep him lying flat, and do NOT attempt to lower his head.

You may give him morphine, if he is suffering severe pain.

In order to avoid further damage to the spinal cord, DO NOT MOVE THE VICTIM UNLESS IT IS ABSOLUTELY ESSENTIAL. If he is lying in a place where his life is in immediate danger, or if he must be transported to some other place in order to receive medical attention, then of course you must move him. If it necessary to move him, however, be very sure that you do it in a way which will cause the least possible damage. DO NOT BEND OR TWIST THE VICTIM's BODY. DO NOT MOVE THE HEAD FORWARD, BACKWARD, OR SIDEWAYS. DO NOT UNDER ANY CIRCUMSTANCES ALLOW THE VICTIM TO SIT UP.

If it is necessary to transport a person who has suffered a fracture of the spine, follow these general rules:

- If the spine is broken at the NECK, the victim must be transported lying on his back, FACE UP. Place pillows or sandbags beside his head so that it cannot turn to either side. Do NOT put pillows or padding under his neck or head.
- If the spine is broken lower down—that is, if the BACK is broken—the victim should be transported lying FACE DOWN. However, if he must be transported any great distance he will be much more comfortable lying on his back, FACE UP, and so should be carried in this position. If he is carried in the face-up position, put padding under the small of his back.
- If you suspect that the spine is fractured, but do not know the location of the break, treat the victim as though he had a broken neck—that is, keep him lying on his back, FACE UP. If both the neck and the back are broken, keep the victim on his back, FACE UP.
- No matter where the spine is broken, USE A FIRM SUPPORT IN TRANSPORTING THE VICTIM. Use a rigid stretcher, or a door, shutter, wide board, or a frame similar to that shown in figure 7-8. Pad the support carefully, and put blankets both under and over the victim. Use cravat bandages or strips of cloth to fasten the victim firmly to the support.
- Hold the victim by his clothing and slide or pull him onto the support. DO NOT ATTEMPT TO LIFT HIM UNLESS YOU HAVE ADEQUATE ASSISTANCE! Remember, any bending or twisting of the body is almost sure to cause serious damage to the spinal cord. If there are at least four (preferably six) men present to help lift the victim, they can probably accomplish the job without too much movement of the victim's body,

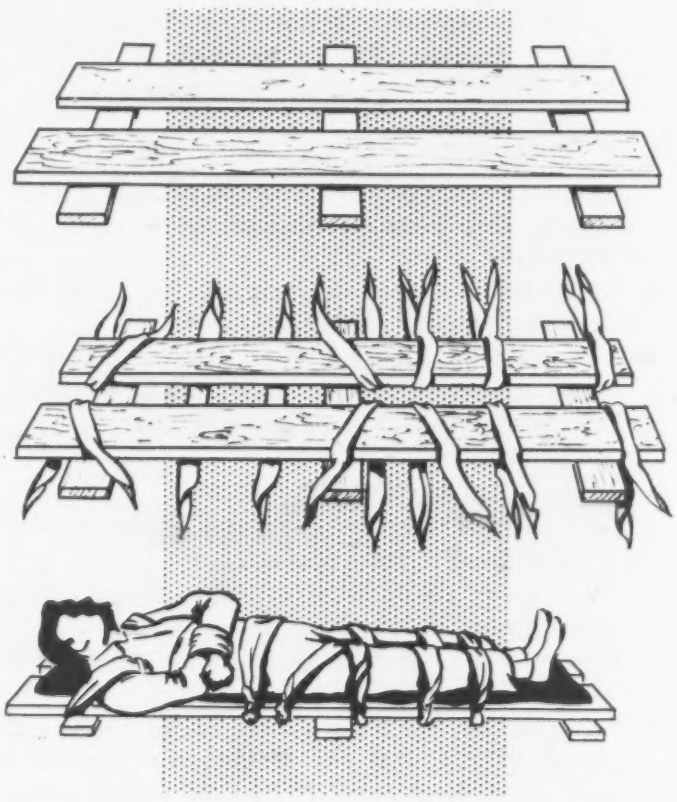

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Figure 7-8.—Improvised frame for transporting victim with fractured spine.

but a smaller number of men should NEVER attempt to lift the victim.

- Get medical help at once!

Fracture of the Pelvis

The large pelvic bones (sometimes called hipbones) and the lower bone of the spinal column together make up the bony structure which is known as the PELVIS. The joint between the thighbone (the long bone of the upper part of the leg) and the pelvic bone is called the HIP JOINT.

Fractures in the pelvic region often result from falls, heavy blows, and accidents which involve crushing. The great danger in any pelvic fracture is that the organs which are enclosed and protected by the pelvis may be seriously damaged when the bony structure is fractured. In particular, there is danger that the bladder will be ruptured. There is also danger of severe internal bleeding, because the large blood vessels in the pelvic region may be torn or cut by fragments of the broken bone.

The primary symptoms of a fractured pelvis are severe pain, shock, and loss of ability to use the lower part of the body. The victim is unable to sit or stand. If he is conscious, he may feel as though he is "coming apart." If the bladder is injured, the victim's urine may be bloody.

Treatment.—Do not move the victim unless ABSOLUTELY necessary!

Treat the victim for shock. Keep him comfortably warm, and give morphine for the relief of severe pain. (DO NOT attempt to move him into the position ordinarily used for the treatment of shock.)

If you must transport the victim to another place, handle him with the utmost care. Use a rigid stretcher or a padded door or wide board. Keep the victim lying on his back. In some cases he will be more comfortable if his legs are straight; in other cases he will be more comfortable with his knees bent and his legs drawn up. When you have placed him in the position in which he is most comfortable, immobilize him as shown in figure 7-9. Bandage his legs together at the ankles and at the knees. Then place a pillow beside each hip, and fasten the pillows in place with bandages or strips of cloth. Fasten the victim securely to the stretcher or improvised support.

Get medical help at once!

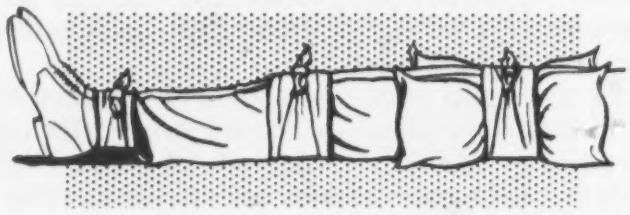

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Figure 7-9.—Method of immobilizing fractured pelvis. (Legs may be straight or bent at the knee.)

INJURIES TO JOINTS AND MUSCLES

Injuries to joints and muscles often occur together, and sometimes it is difficult to tell whether the primary injury is to a joint or to the muscles, tendons, blood vessels, and nerves near the joint. Sometimes, also, it is quite difficult to distinguish joint or muscle injuries from fractures. In case of doubt, ALWAYS treat any injury to a bone, joint, or muscle as though it were a fracture.

In general, joint and muscle injuries may be classified under four headings: (1) dislocations; (2) sprains; (3) strains; and (4) contusions (bruises). Now let's take up these four types of injuries, and see how to recognize them and how to treat them.

Dislocations

When a bone is forcibly displaced from its joint, the injury is known as a DISLOCATION. In some cases the bone slips back quickly into its normal position, but in other cases it becomes locked in the new position and remains dislocated until it is put back into place. Dislocations are usually caused by falls or blows, but are occasionally caused by violent muscular exertion. The joints which are most frequently dislocated are those of the shoulder, hip, finger, and jaw.

A dislocation is likely to bruise or tear the muscles, ligaments, blood vessels, tendons, and nerves near the joint. Rapid swelling and discoloration, loss of ability to use the joint, and severe pain and shock are characteristic symptoms of dislocations. The fact that the injured part is usually stiff and immobile, with marked deformation at the joint, will help you to distinguish a dislocation from a fracture. (In a

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fracture, you remember, there is deformity BETWEEN joints rather than AT joints, and there is generally a wobbly motion of the broken bone at the point of fracture.)

As a general rule, you should NOT attempt to "reduce a dislocation"—that is, put a dislocated bone back into place—unless you know that medical assistance cannot be obtained within 3 or 4 days. Unskilled attempts at reduction may cause great damage to nerves and blood vessels, or may actually fracture the bone. Except in great emergencies, therefore, you should leave this treatment to the medical officer, and concentrate your efforts on making the victim as comfortable as possible under the circumstances. The following first aid measures will be helpful:

- Loosen the clothing around the injured part.
- Place the victim in the most comfortable position possible.
- Support the injured part by means of a sling, pillows, bandages, splints, or any other device which will make the victim comfortable.
- Treat the victim for shock.
- Get medical help as soon as possible.

You should NEVER attempt to reduce the more serious dislocations, such as those of the shoulder or the hip. However, if it is probable that the victim cannot be treated by a medical officer within a reasonable time, you should make a careful effort to reduce minor dislocations, such as those of the jaw or the finger.

Dislocation of the Jaw.—When the lower jaw is dislocated, the victim cannot speak and cannot close his mouth. Dislocation of the jaw is usually caused by a blow on the mouth; sometimes it is caused by yawning or laughing. This type of dislocation is not always easy to reduce, and there is considerable danger that the operator's thumbs will be bitten in the process. For your own protection, therefore, you must wrap your thumbs with a handkerchief or bandage. Stand in front of the victim, facing him. Press your thumbs down just behind the victim's last lower molars and, at the same time, lift his chin up with your fingers. The jaw should snap into place at once; you will have to remove your thumbs quickly in order to avoid being bitten. No further treatment is required, but you should warn the victim not to open his mouth any more than necessary during the next few hours.

Figure 7-10 shows the position you must assume in order to reduce a dislocated jaw.

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Figure 7-10.—Position for reducing dislocated jaw.

Dislocation of the Finger.—The joints of the finger are particularly susceptible to injury, and even minor injuries may result in prolonged loss of function. Great care must be used in treating any injury of the finger.

To reduce a dislocation of the finger, grasp the finger firmly and pull it slowly into position. If it does not slip into position, try it once more; but if it does not go into position on the second attempt, DO NOT TRY AGAIN. In any case, whether or not the dislocation is reduced, the finger should be strapped or splinted until the victim can receive medical attention. Figure 7-11 shows how a dislocated finger can be immobilized by strapping it to a flat wooden stick, such as a tongue depressor.

Sprains

A SPRAIN is an injury to the ligaments which support a joint. A sprain usually involves a momentary dislocation, with the bone slipping back into place of its own accord. A sprain is caused by the violent wrenching or twisting of the joint beyond its normal limits of movement. Although any joint may be sprained, sprains of the ankle, wrist, knee, and finger are most common.

Tearing of the supporting ligaments is probably the most serious part of a sprain, but there is also a considerable amount of damage to the

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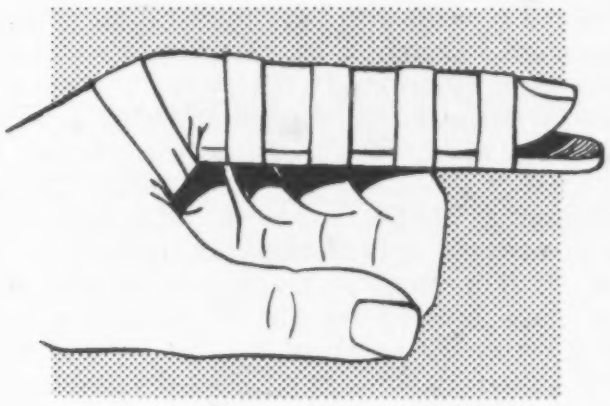

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Figure 7-11.—Immobilization of dislocated finger.

blood vessels and other soft tissues which surround the joint. When the blood vessels are damaged, quite a lot of blood escapes into the joint itself and into the tissues. This causes the severe pain and marked swelling which are characteristic of a sprain.

Treatment.—Immobilize the injured joint with some type of splint or with a snugly-fitting adhesive or elastic bandage, in order to put the injured ligaments at rest. (Be careful to loosen the bandage if it becomes so tight that it interferes with the circulation of the blood. Remember that the injured part may continue to swell, so a bandage which is loose enough when applied may soon be too tight.)

Elevate the injured part, if possible; this will help to reduce the pain and swelling.

Apply COLD cloths or an ice bag to the injured joint for the first 24 hours.

CAUTION: It is very difficult to tell the difference between a sprain and a fracture. If you are not sure which injury is present, always treat it as a fracture until the victim has been brought under the care of a medical officer or until improvement more or less rules out the possibility of fracture.

Strains

An injury caused by the forcible overstretching or tearing of a muscle or tendon is known as a STRAIN. Strains may be caused by lifting excessively heavy loads, by sudden or violent movements, or by any other action which pulls the muscles beyond their normal limits.

The chief symptoms of a strain are pain, lameness or stiffness (sometimes involving knotting of the muscles), moderate swelling at the place of injury, and discoloration due to the escape of blood from injured blood vessels into the tissues.

Treatment.—Rest the injured part. If the injured muscle is in an arm or leg, elevate the part. Apply COLD to the area by means of cold compresses or an ice bag.

Contusions

CONTUSIONS, commonly called BRUISES, are responsible for the discoloration which almost always accompanies injuries to bones, joints, and muscles. Contusions are caused by blows which damage bones, muscles, tendons, blood vessels, nerves, and other body tissues, although they do not necessarily break the skin.

The symptoms of a contusion, or bruise, are familiar to everyone. There is immediate pain when the blow is received. Swelling occurs because blood from the broken blood vessels oozes into the soft tissues under the skin. At first the injured place is reddened, due to local skin irritation from the blow; later the characteristic "black and blue" marks appear; and finally, perhaps several days later, the skin is yellowish or greenish in color. The bruised area is usually very tender.

Treatment.—As a rule, slight bruises do not require treatment. However, if the victim has severe bruises, treat him for shock.

Immobilize the injured part. Keep it at rest, and protect it from further injury. Sometimes the victim will be more comfortable if the bruised area is bandaged firmly with an elastic or gauze bandage.

If possible, elevate the injured part. A sling may be used for a bruised arm or hand. Pillows or folded blankets may be used to elevate a bruised leg.

Apply COLD cloths or an ice bag to a fresh bruise.

CAUTION: Extensive bruises may be very serious. In such cases, always get medical attention for the victim as soon as possible.

SUMMARY

Any number of accidents may cause injury to bones, joints, and muscles. Of the various

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types of injuries that may occur, fractures are the most serious. A fracture is a broken bone, but the break need not be complete. A simple fracture is one in which the skin is unbroken; a compound fracture is one that breaks the skin causing an open wound.

Most fractures should receive the same general treatment—control hemorrhage, splint the injured part, and treat for shock. If the fracture is compound, hemorrhage should be controlled before splinting. Splints should be strong, well-padded, and of the recommended length. Splints may be applied over clothing, if medical assistance will be available soon. Splints should not be applied so snugly that they interfere with blood circulation. In treating for shock, keep the injured person lying down, in the position recommended for the particular type of injury. Morphine may be given for severe pain, except when the type of injury or other considerations prohibit its use. As all fractures are serious, they must be treated by a medical officer as soon as possible.

In giving first aid treatment for fractures, do not move the injured person until the fracture is splinted. Handle him gently as simple fractures are easily converted to compound fractures. Do not attempt to locate a fracture by grating broken ends of bones. Do not try to set broken bones. Make no attempt to straighten the injured part, except when the long bone in the arm or leg is fractured. Never attempt to force the end of a broken bone back into a wound. Use extreme care in transporting the injured person.

Certain fractures require special care in treatment. Skull fractures, spinal fractures, and pelvic fractures should be treated with extreme care to prevent permanent injury or death. Injuries of this type are so serious that you should be absolutely sure of what you are doing before you proceed.

A person with a fractured skull should never be given morphine. Do not allow him to sit or stand; keep him lying down. If his face is flushed, raise his head and shoulders slightly; if pale, keep his head level with, or slightly lower than, his body. Do not give a person with a fractured skull anything to drink.

For a fractured spine, do not move the injured person unless it is absolutely necessary. Never bend or twist his body or move his head. Do not attempt to keep him in the position ordinarily used for treating shock; keep him lying flat.

When a person with a fractured spine must be transported, fasten him securely to a rigid stretcher or support. If the casualty's neck is broken, transport him lying on his back, face up. Immobilize his head with pillows, sandbags, or other means so that it will not turn. Do not put padding under his head or neck. If the casualty's back is broken, transport him lying face down. However, if he must be transported a long distance, have him lie on his back, face up. Put padding under the small of his back. If you suspect a spinal fracture but cannot determine the location of the break, treat the injured person as though he had a broken neck; if both the neck and back are broken, treat him as though he had a broken neck.

When the pelvis is fractured, do not move the injured person unless it is absolutely necessary. Do not attempt to move him into the position ordinarily used for treating shock. Keep him lying on his back with his legs straight or drawn up, whichever is more comfortable. Immobilize the casualty as soon as possible. Bandage his legs together at the ankle and at the knees. Place pillows beside each hip, and fasten them in place with bandages or strips of cloth. Fasten the casualty securely to a rigid stretcher.

Injuries to joints and muscles may be classified as dislocations, sprains, strains, and contusions.

A dislocation is an injury in which a bone is forcibly displaced from its joint, and is likely to bruise or tear the surrounding tissues. As a general rule, you should not attempt to put a dislocated bone back in place. Place the injured person in a comfortable position, loosen the clothes around the injured part, support the injured part, and treat for shock.

A sprain is an injury to the ligament that supports a joint, and usually involves a momentary dislocation, with the bone slipping back into place of its own accord. As it is difficult to tell the difference between a sprain and a fracture, treat the injury as a fracture. Immobilize the injured joint and elevate the injured part, if possible. Apply cold cloths or an ice bag to the injured joint.

Strains are caused by the forcible overstretching or tearing of a muscle or tendon. Lameness or stiffness usually results, with moderate swelling and discoloration. Rest and, if possible, elevate the injured part. Apply cold

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to the area by means of cold compresses or an ice bag.

Contusions are caused by blows that damage bones, muscles, tendons, blood vessels, and other body tissues. Treat the injured person for shock; immobilize and, if possible, elevate the injured part; and apply cold compresses or an ice bag.

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CHAPTER 8

INJURIES FROM HEAT AND COLD

Exposure to extremes of temperature—whether of heat or of cold—causes injury to skin, tissues, blood vessels, vital organs, and in some cases to the entire body. In this chapter we will take up the injuries which are caused by extremes of heat or cold, the first aid treatment which should be given for them, and some of the preventive measures which may be taken to avoid them.

HEAT INJURIES

Burns, heatstroke, heat exhaustion, and heat cramps are the injuries most commonly caused by exposure to extreme heat. "Burns" caused by contact with acids, alkalis, and other chemcals, are not, for the most part, true heat burns; however, they will be discussed here because many people think of them as burns and do not realize that they require special treatment.

Burns and Scalds

Burns and scalds are caused by exposure to intense heat, such as that generated by fire, bomb flash, sunlight, hot solids, hot gases, and hot liquids. Contact with electric current also causes burns, particularly if the skin is dry. (Dry skin offers about 20 times more resistance than moist skin to the passage of electric current; when the skin is dry, therefore, the local heating effects (burns) are greater, even though the total damage to the body is less than when the skin is wet.)

It should be noted that burns and scalds are essentially the same type of heat injury. When the injury is caused by dry heat, it is called a burn; when caused by moist heat, it is called a scald. Treatment is the same in both cases.

Classification of Burns.—Burns are classified in several ways—by the extent of the burned surface, by the depth of the burn, and by the cause of the burn. Of these, the extent of body surface burned is the most important factor in determining the seriousness of the burn and plays the greatest role in the casualty's chances for survival.

In calculating the extent of burned surface, the RULE OF NINES is used (fig. 8-1). These figures aid in determining the correct treatment for the burned person. Shock can be expected in adults with burns of over 15 percent or small children with burns of over 10 percent of body surface area. In adults, burns involving more than 20 percent endanger life, and 30 percent burns are usually fatal if adequate medical treatment is not received.

The depth of injury to the tissues is spoken of in degrees. FIRST DEGREE burns are the mildest, producing redness, increased warmth, tenderness, and mild pain. SECOND DEGREE burns redden and blister the skin and are characterized by severe pain. THIRD DEGREE burns destroy the skin and may destroy muscle tissue and bone in severe cases. Severe pain may be absent because nerve endings have been destroyed. The color may vary from white and lifeless (scalds) to black (charred from gasoline explosions). Figure 8-2 shows the appearance of first, second, and third degree burns.

It is important to remember that the size of the burned area may be far more important than the depth of the burn. A first degree or second degree burn that covers a very large area of the body is almost always more serious than a small third degree burn. A first degree sunburn, for example, can cause death if a very large area of the body is burned.

The causes of burns are generally classified as thermal (heat) or chemical, or as resulting from sunburn, electric shock, or radiation. Whatever the cause of the burn, shock always results if the burns are extensive.

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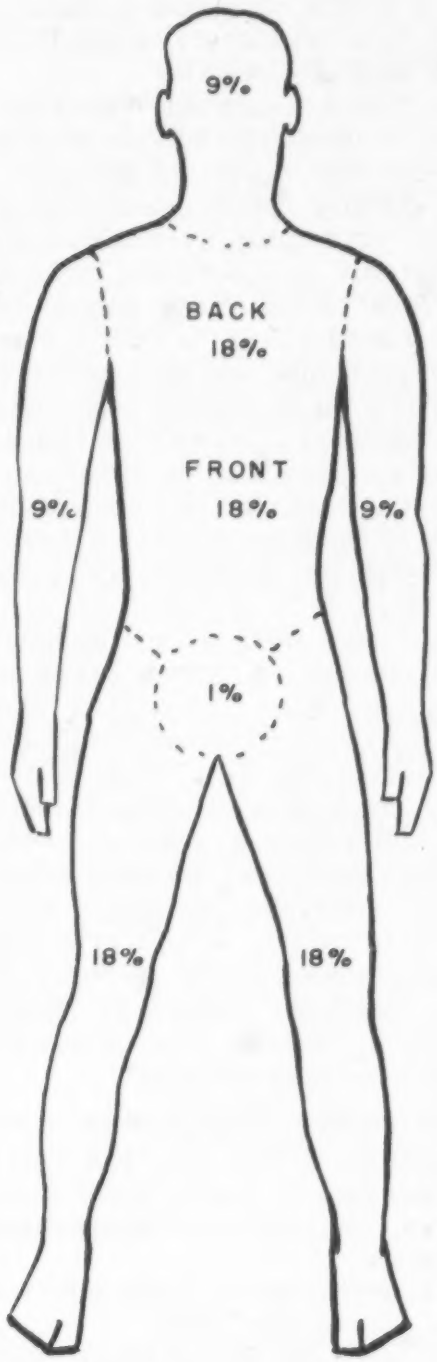

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Figure 8-1.—Rule of Nines for estimating percentage of burned area.

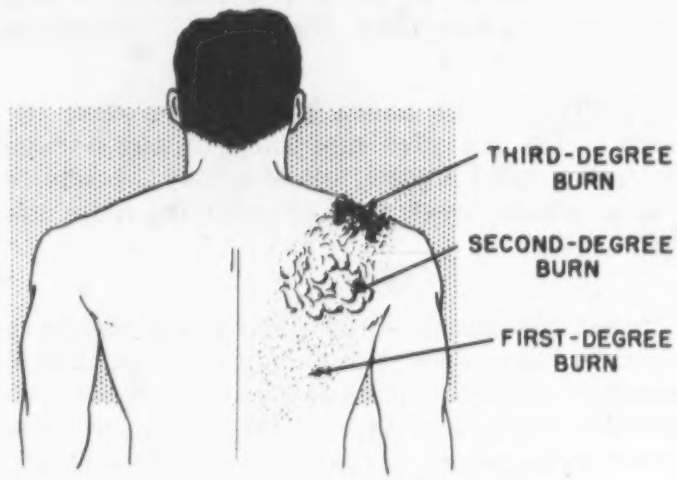

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Figure 8-2.—First, second, and third degree burns.

Treatment of Burns and Scalds

First aid for all burns involves the following main items:

1. Relieve pain.
2. Prevent or treat shock.
3. Prevent infection.

In electric shock, the burn may have to be temporarily ignored while resuscitative measures are carried out. (See Ch. 3, Asphyxiation.) Otherwise the treatment is the same as for heat burns. Also, local treatment for chemical burns varies, depending on the agent that caused the burns. Chemical burns are discussed more fully later in this chapter.

Ice Water Treatment.—It is recognized that clean water and ice are not always available, but when they are, as an emergency measure, ice water provides immediate relief from pain and also seems to lessen the damaging effects of burns. For burns involving less than 20 percent of the body, immerse the burned part in ice water or, where immersion is not practical, apply ice-cold moist towels repeatedly to the burned area. The treatment should be continued until no pain is felt when the burned area is withdrawn from the water. This may take from 30 minutes to as long as 5 hours. When available, hexachlorophene should be added to the water to destroy bacteria. After the ice water treatment, the regular treatment for burns should follow (see below).

Relief of Pain.—Simple, first degree burns that do not cover a large body area may require no more than one or two aspirin tablets to relieve discomfort. Severe burns cause extreme pain, and the pain contributes to the severity of shock. A person who has suffered extensive burns may be given not more than 1/4 grain of

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morphine to relieve the pain. The injection site should be massaged for a few minutes to help circulate the morphine. (See ch. 4, "Morphine Administration".)

CAUTION: The casualty may have other injuries. Do not give morphine to any person who has a head injury, chest injury, or who is in deep shock, even if he is suffering from extensive burns.

Treat for Shock.—Any person who has been seriously burned must be treated for shock immediately. Serious shock always accompanies an extensive burn, and is, in fact, the most dangerous consequence of the injury. Start the treatment for shock before making any attempt to treat the burn itself.

Relieving the casualty's pain is, of course, an important part of the treatment for shock. After this has been done, place him in a position so that his head is lower than his feet. Make sure that he is warm enough; do not remove his clothing immediately. Remember that exposure to cold will cause shock to become worse, but do not overheat him.

As mentioned in chapter 4, a seriously burned person has an overwhelming need for liquids; and the administration of liquids in such cases is an important part of the treatment for shock. Give small amounts of sweet tea, fruit juice, or sugar water, if the casualty is conscious and able to swallow and has no internal injuries.

Prevention of Infection.—Second and third degree burns are, in effect, open wounds and must be covered to reduce the possibility of infection. Every effort must be made to use a sterile covering, but makeshift wrappings such as sheets and freshly laundered towels may be used.

OINTMENTS AND OTHER MEDICINES SHOULD NOT BE PUT ON THE BURN WOUND. Using these agents may make later treatment by a physician difficult or impossible.

Do not allow unsterile objects or materials to come in contact with the burn wound. Do not open any blisters. Do not cough or sneeze near the casualty, and if possible, keep a piece of sterile gauze over your mouth and nose while you are working near the burn. Contamination by micro-organisms from the mouth and nose is a frequent cause of serious (and possibly fatal) burn infections.

Treatment.—If the casualty is to receive medical attention soon, do nothing more than relieve the pain, treat for shock, and cover the burn with a sterile wrapping or clean sheet or towel. DO NOT ATTEMPT TREATMENT OF THE BURN WOUND ITSELF.

If more than 3 hours will elapse before the services of a physician will be obtained, you should dress the burn. First remove the casualty's clothing from around and over the burned area, preferably by cutting it away. Be very careful not to cause further injury. If clothing sticks to the burn wound, DO NOT ATTEMPT TO PULL IT LOOSE. Merely cut around the part that sticks, and leave it in place. If any material such as wax, metal, dirt, grease, or tar sticks firmly to the burn, do not try to remove it. Do not allow absorbent cotton, powder, adhesive tape, or other substances that might stick to the burn to come in contact with the burn. Never put iodine or any other antiseptic on a burn.

When you have cleared away as much of the clothing as you can, you should dress the burn. Apply a single layer of sterile, fine-mesh petrolatum gauze over the burn wound, beginning at the outside of the burn wound and working toward the center in a circular manner. Next place bulky fluffs of gauze over the burn, with a large padded dressing as the outer layer. Wrap gauze strips smoothly and gently around the dressing. The bandage should give light even pressure and immobilize the injured part. Once the bandage has been applied, IT SHOULD BE LEFT ALONE. Leave it in place until the casualty receives medical care.

Burns of the Eye.—Burns of the eye require special attention. If they are true heat burns, caused by exposure to steam, bomb flash, welding arc, or any other source of intense heat, treat them as follows:

1. Put a few drops of clean mineral oil or olive oil into each eye.
2. Cover each eye with a small, thick compress, and fasten the compress in place with a bandage or an eyeshield.
3. Make sure that the casualty does not rub his eyes.
4. Get medical attention for the casualty as soon as possible.

Chemical Burns

When acids, alkalies, or other chemicals come in contact with the skin or other body

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membranes, they may cause injuries which are generally referred to as CHEMICAL BURNS. For the most part, these injuries are not caused by heat but by direct chemical destruction of the body tissues. Chemicals which often cause this kind of injury are acids, such as nitric acid, sulphuric acid, hydrochloric acid, etc., and CAUSTIC ALKALIES, such as potassium hydroxide (lye), sodium hydroxide (caustic soda, soda lye), and calcium oxide (quicklime). PHENOL, commonly called CARBOLIC ACID, also causes chemical burns. Strong concentrations of various bleaches and disinfectants cause chemical injuries to the skin. CHLORINE, AMMONIA, and other industrial gases (whether in liquid or vapor form) may cause serious chemical burns of the skin or of the eyes. WHITE PHOSPHOROUS, one of the substances used to develop screening smokes, causes a burn which is a combination of a true heat burn and a chemical injury.

First aid treatment for chemical burns consists of the following measures:

1. WASH OFF THE CHEMICAL WHICH IS CAUSING THE INJURY! This must be done IMMEDIATELY. Flood the affected areas with large amounts of water—preferably water which is clean, fresh, and cool. The best way to get rid of the chemical is to put the casualty under a shower and let the water run as long as necessary.

In order to make the washing process effective, you will of course have to remove all clothing which has come in contact with the chemical. Strip it off as quickly as possible; or, if shears are available, cut it off.

If it is not possible to put the casualty under running water, immerse the affected areas in the largest available amount of water, or pour great quantities of water over him.

It is important to use a large quantity of water, so that the chemical will be diluted and weakened; but you should not apply it forcefully. The skin and tissues which are injured by the action of the chemical will suffer additional damage if the water is applied with too much force.

2. Neutralize any chemical which remains on the skin, by the following applications: for ACID burns, apply a solution of sodium bicarbonate (baking soda) or some other mild alkali; for ALKALI burns, apply vinegar, lemon juice, or some other mild acid; and for PHENOL (carbolic acid) burns, wash the skin with alcohol. DO NOT ATTEMPT TO NEUTRALIZE ANY CHEMICAL UNLESS YOU ARE SURE THAT YOU KNOW WHAT IT IS AND WHAT SUBSTANCE WILL EFFECTIVELY NEUTRALIZE IT!

3. Wash the affected areas again with fresh water, and dry gently with sterile gauze. Be careful that you do not break the skin or open any blisters. Take all possible precautions to avoid infection.

4. Do whatever you can to relieve the casualty's pain and to treat him for shock. Extensive chemical burns, like extensive heat burns, cause extreme pain and shock.

From this point on, it is usually safe to treat a chemical burn as though it were a true burn, except that petrolatum gauze should not be applied unless you are certain all of the chemical has been removed. Get medical attention for the casualty as soon as possible.

Chemical Burns of the Eye.—Chemical burns of the eye should be treated as follows:

1. Flush the eye IMMEDIATELY with large quantities of fresh, clean water. A drinking fountain may be used to supply a steady stream of water; hold the casualty's head in position so that the water flows from the INSIDE corner of his eye toward the OUTSIDE corner. Do NOT let the water fall directly on the eyeball, and do NOT use any greater force than is necessary to keep the water flowing across the eye.

If you are not near a drinking fountain, have the casualty lie down with his head turned slightly to one side; then pour water into the INSIDE corner of his eye and let it flow across the eyeball to the OUTSIDE corner. Remember that the water must not fall directly upon the eyeball, and that it must not be poured with any greater force than is necessary to sustain the flow across the eyeball.

> NOTE: Because of the intense pain, the casualty may be unable to open his eyes. If this occurs, you must hold the eyelids apart so that the water can flow across the eyeball.

Another way to wash chemical substances from the eye is to have the casualty open and close his eyes several times while his face is immersed in a pan or bucket of fresh water.

2. Cover the eye with a small, thick compress; fasten the compress in place with a bandage or an eyeshield.

3. Get medical care for the casualty as soon as possible.

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CAUTION: Do not use anything except water in treating chemical burns of the eye. Do not attempt to neutralize the chemical which has caused the injury. Do not apply any ointment, grease, oil, or salve.

Heatstroke

Exposure to excessive heat may result in either heatstroke or heat exhaustion. Heatstroke and heat exhaustion are caused by the same external conditions—desert or jungle heat, exposure to direct rays of the sun, or heat of machinery spaces, foundries, bakeries, etc. Under similar circumstances, one person may develop heatstroke and another heat exhaustion.

Although the external cause of the two injuries is the same, there are important differences between them which must be clearly understood. Each condition represents a DIFFERENT bodily reaction to excessive heat, and for this reason the symptoms and treatment are also different.

HEATSTROKE (sometimes called SUNSTROKE) is a very serious condition which results from a failure of the heat-regulating mechanism of the body. The body becomes overheated, the temperature rises to between 105° and 110° F, but there is no sweating and therefore no cooling of the body. As you would expect, the casualty's skin is hot, dry, and red. Sometimes the casualty may have preliminary symptoms such as headache, nausea, dizziness, or weakness; but very often the first signs are sudden collapse and loss of consciousness. Breathing is likely to be deep and rapid. The pulse is strong and fast. Convulsions may occur. Heatstroke may cause death or permanent disability; at best, recovery is likely to be slow and complicated by relapses.

The longer the casualty remains overheated, the more likely he is to die. Therefore, all first aid measures are aimed at lowering the casualty's body temperature. The following steps should be taken:

1. Remove the casualty to the coolest possible place.
2. Take off the casualty's clothing.
3. Place him so that he is lying on his back, with his head and shoulders SLIGHTLY RAISED.
4. Cool the casualty. Sponge or spray his body with cold water, and then fan him so that the water will evaporate rapidly.
5. If the casualty regains consciousness, give him cool (but not cold) water to drink. DO NOT GIVE ANY STIMULANTS OR HOT DRINKS!
6. Get the casualty to a hospital or under the care of a medical officer as soon as possible. Cooling measures must be continued while the victim is being transported.

Heat Exhaustion and Heat Cramps

As we have seen, heatstroke is a condition in which the body becomes overheated because the heat-regulating mechanism fails to function. In HEAT EXHAUSTION, the bodily reaction to excessive heat is very different. There is no failure of the heat-regulating mechanism, but there is a serious disturbance of the blood flow, similar to the circulatory disturbance of shock. Through prolonged sweating, the body loses large quantities of salt and water; it is believed that this loss is responsible for the circulatory disturbance which occurs in heat exhaustion.

Heat exhaustion may begin with headache, dizziness, nausea, weakness, and profuse sweating. The casualty may collapse and lose consciousness, but he can usually be aroused rather easily. The body temperature is usually normal or even below normal; sometimes it may go down as low as 97° F. As in shock, the pupils of the eyes are usually dilated (enlarged); the pulse is weak and rapid; and the skin is pale, cool, and sweaty. Heat exhaustion is sometimes—although not always—accompanied by severe cramps in the muscles of the abdomen, legs, and arms. These cramps, known as HEAT CRAMPS, may also occur separately, without any other signs of heat exhaustion. Loss of salt is probably the basic cause of heat cramps.

First aid treatment for heat exhaustion is very much like first aid treatment for shock. The following measures should be taken:

1. Remove the casualty to a cool place, but be careful that you do not put him where he will be exposed to strong drafts or where he might become chilled.

2. Loosen his clothing and make him as comfortable as possible. Keep him quiet.

3. Keep the casualty lying down, with his feet and legs somewhat elevated. Be sure that he is kept comfortably warm. You may have to cover him with blankets, even if the air around him is quite warm.

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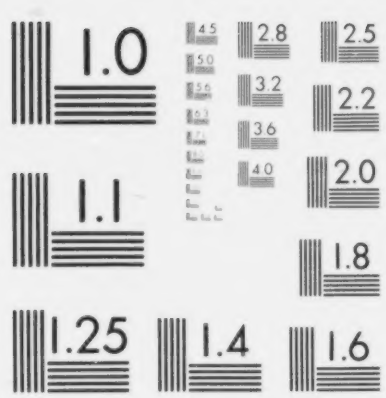

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4. If the casualty is suffering from severe heat cramps, the pain may be relieved by the application of heat to the affected muscles or by firm pressure of the hand against the muscles. If the cramps are exceedingly painful, it may be necessary to give morphine.

5. If the casualty is conscious and able to swallow, give him plenty of warm water to drink, adding 1/4 to 1/2 teaspoonful of salt to each glass. Note that this is probably the most important part of the treatment for most cases of heat exhaustion. Replacement of the salt and water which has been lost by sweating often brings about a rapid recovery.

6. Give the casualty hot coffee or hot tea; the caffeine contained in both coffee and tea stimulates the heart and thus decreases the circulatory disturbance.

7. If the casualty does not recover promptly, get medical attention for him as soon as possible.

PREVENTION of heat exhaustion and heat cramps may be accomplished by increasing the consumption of salt and water. All persons who are required to live or work in excessively hot places should add about one teaspoonful of salt (or two 10-grain salt tablets) to each quart of drinking water. It is better to dissolve the salt in the drinking water than to take salt tablets undissolved, since salt taken in concentrated form may cause nausea, vomiting, and diarrhea.

COLD INJURIES

Cold injury may be defined simply as tissue injury caused by exposure to cold. Traditionally, cold injuries are categorized as chilblains, immersion foot, trenchfoot, and frostbite (in order of ascending severity). However, these categories serve little purpose other than to describe the manner in which the injuries were acquired. Basically, there are two types of cold injuries—FREEZING and NONFREEZING. But, it is seldom that the injury will be totally of one type, with none of the other. Rather, a cold injury may range from frostbite of the exposed part to lesser degrees of nonfreezing as progress is made to less exposed parts.

General Precautions

The following factors are important in the treatment of all cold injuries:

- Cold injury should never be treated lightly because of the possibility of tissue loss and nerve damage. If a cold injury is suspected, the casualty should not be permitted to perform his regular duties until the severity of his injury can be determined.
- It is essential to get the casualty into a warm place as soon as possible. It is nearly impossible to give effective first aid treatment for cold injuries while the casualty remains exposed to cold.
- It may be necessary to treat other injuries BEFORE the casualty can be moved to a warmer place. Severe bleeding must be controlled, breathing must be restored if necessary, and fractures must be splinted (over clothing) before the casualty is moved. Treat the casualty for shock, insofar as possible.
- If it is necessary to give morphine for relief of severe pain, do not give more than the recommended dosage (see ch.4). The cold slows up the circulation of the blood, delaying absorption of the morphine. Massage the injection site repeatedly to hasten absorption of the morphine. Do not give a second injection in less than 4 hours.

Finding a place to inject morphine may be difficult if the casualty is wearing heavy clothing. The most accessible place where it is permissible to give morphine is likely to be at the muscular area at the base of the neck. Do not remove any more clothing than is necessary.

NOTE: In very cold weather, the morphine syrettes must be carried close to the body so that they will not freeze.

Treatment

First aid measures for cold injuries consist, in general, of giving mild stimulants such as tea or coffee, exercising care not to injure skin deadened by the cold when removing constrictive clothing, and exercising great care to prevent infection. Blisters should not be broken. Alcohol and tobacco are prohibited. Snow, ice water, grease, massage, or dry heat should not be applied to the affected parts. If the part has been frozen, it should be rapidly rewarmed in a controlled temperature bath.

Chilblains.—Chilblains (Pernio) are a mild cold injury caused by repeated exposure for several hours at a time to temperatures between 32° and 60° F. It is generally associated with high humidity.

Chilblains is characterized by redness and swelling; itching, burning skin inflammation;

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tingling and later a deep-seated ache. Very mild cold injuries such as chilblains require little in the way of specific treatment, except to warm the injured part and keep it dry. However, because of the difficulty of determining tissue damage accurately, care must be taken not to underestimate the cold injury. Get medical assistance as soon as possible.

Nonfreezing Injuries.—Nonfreezing injuries such as immersion foot and trenchfoot, although having different causes, have similar symptoms and should, in general, receive the same treatment.

Immersion foot is caused by exposure to cold water (50° F and below) for 12 hours or more; or to water of approximately 70° F for several days. Trenchfoot is caused by exposure to cold (32° F to 50° F), damp weather for a period of several hours to 14 days (average, 3 days). Inability to move about freely because of local conditions or wounds is also a contributing factor. These injuries are characterized by tingling and numbness; swelling legs and feet; bluish discoloration of the skin; blisters; and pain.

In treating nonfreezing injuries, get the casualty off his feet as soon as possible. Expose the affected parts to air; warm, dry air is the most beneficial. Blisters should not be ruptured, and salves and ointments should not be used. If the skin is not broken and loose, the injured part may be left exposed; however, if it is necessary to transport the casualty, the injured part should be covered with loosely wrapped, fluff bandages of sterile gauze.

When the skin is broken and tissue is loose, the extremity should be placed on a sterile sheet and covered with a sterile sheet draped over the injured extremity to protect the sensitive tissue from pressure and infection.

Freezing Injuries.—Frostbite is caused by brief exposure to extreme cold (-20° F and below), or exposure to near zero weather for several hours. At temperatures of -20° F to -60° F and below, exposed fingers and toes may rapidly become frozen, with the freezing extending up the arms and legs as exposure is prolonged.

The symptoms at first are burning, stinging, then numbness. Ice crystals in the skin cause a gray or white waxy color, but the skin will move over bony ridges. When the part is completely frozen, there are ice crystals in the entire thickness of the extremity, indicated by a pale, yellow, waxy color. The skin will not move over bony ridges. When the frozen part is thawed, it becomes red and swollen and large blisters develop.

The frostbitten or frozen extremity should be rapidly thawed in a water bath of 107° F to 109° F, provided the part is not going to be subjected to extreme cold again. (Refreezing a thawed extremity seals its fate. It is better to leave the part frozen until the casualty arrives at an installation equipped to care for it than to take a chance on its being refrozen.) If you have no thermometer with which to check the temperature, make sure that the water is comfortably warm. Warming should not continue beyond the time when thawing is complete. After warming, dry the casualty carefully. Place him in bed and keep him covered, with sterile sheets, if possible, but do not let the covers come in contact with the frostbitten parts. Keep the frostbitten parts dry. Sterile gauze or cloth pads should be placed between the toes or between the fingers. If possible, keep the frostbitten part slightly elevated.

All casualties whose legs or feet have been frostbitten or frozen must be treated as litter patients. No walking should be permitted.

The rapid thawing of a frostbitten or frozen extremity may cause intense pain. Morphine may be given if the casualty has no head injury, no chest injury, and is conscious. Do not give more than the recommended dosage.

Chemical "Burns".—Frostbite may be caused by contact with certain chemicals that have a rapid freezing action. Some of these chemicals such as liquid oxygen, carbon dioxide, Freon, and other industrial gases are widely used in the Navy. Although injuries caused by contact with these substances are often referred to as chemical "burns," the body tissue is actually frozen rather than burned.

Cold injuries caused by contact with chemicals tend to be superficial and, as a rule, not very serious—UNLESS the chemical comes in contact with the eyes. If the eye tissues are frozen, permanent impairment of vision may result. Any person who must work around Freon, methyl chloride, or other refrigerants must be particularly careful to protect his eyes. Safety goggles are provided for use in case of refrigeration system leakage. If any of these rapid-freezing chemicals come in contact with the eyes, get medical help for the person at

once. In the meantime, put drops of clean olive oil or mineral oil in the eyes and make sure that the casualty does not rub his eyes.

General Loss of Body Heat

The abnormal lowering of general body temperature is usually brought about by total immersion in cold water and by loss of consciousness (perhaps through injury, coma, or alcoholism) in winter weather with prolonged exposure without adequate clothing. The person appears pale and unconscious and may be taken for dead. Breathing is slow and shallow, and the pulse faint or unobtainable. Body tissues feel semirigid, and the extremities may be stiff.

First aid treatment consists mainly of bringing the body temperature to normal. This should be done by wrapping the person in warm blankets and placing him in a warm room. Hot drinks, massage, and other stimulants should not be given until after the person has regained consciousness. Get medical assistance as soon as possible.

SUMMARY

When exposed to extremes of temperature, the body may be seriously injured.

Extreme heat may cause burns, heatstroke, heat exhaustion, and heat cramps. Of these, only burns cause skin and tissue damage, and the extent of burned surface is the most important consideration in determining the seriousness of the burn. In treating burns, the main tasks are to relieve pain, prevent or treat shock, and prevent infection. As a rule, ointments, salves, and other medications should not be applied to the burned surface.

Heatstroke, heat exhaustion, and heat cramps may be classed as heat emergencies, of which heatstroke is the most serious. In treating heatstroke, characterized by hot, dry skin, all first aid measures must be aimed at lowering the casualty's body temperature. As recovery from heatstroke may be long and difficult, always get the casualty under medical care as soon as possible.

Heat exhaustion and heat cramps are caused by the loss of body salt and water due to profuse sweating. Recovery is generally rapid once salt and water are replaced.

Cold injuries are of two general types—freezing and nonfreezing. First aid measures generally consist of giving mild stimulants, preventing injury to deadened tissues, and preventing infection. Blisters should not be broken, nor should salves or ointments be used. If the injured part has been frozen, it should be rapidly thawed in a controlled temperature bath, if it is certain that the part will not be subjected to refreezing. As it is difficult to determine the extent of tissue damage in cold injuries, always get medical assistance as soon as possible.

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CHAPTER 9

DEFENSE AGAINST NBC AGENTS

It is common knowledge that any poison that gets into your body may result in sickness or death. When NBC (nuclear, biological, chemical) warfare agents are used, poisons are released and casualties are almost certain.

The purpose of NBC warfare is to produce casualties; it merits your respect. The agents used in NBC warfare may be strange to you, but means by which casualties are brought about are familiar enough.

Results similar to those occurring from chemical warfare (also called CW or gas warfare) can be seen in everyday events. Many automobile drivers have died from the effects of carbon monoxide gas. Firemen, also, have been overcome by deadly fumes. You have probably used chemicals such as fly spray to kill flies. The chemicals used in CW are more deadly and cover larger areas than fly spray—and they are aimed at you.

Next, consider biological warfare (called BW or germ warfare). A few harmful germs or organisms are present in everyday living and result in disease like colds or diarrhea. Most contagious diseases such as measles, mumps, chicken pox are due to certain germs getting into the body. Although only a small percentage of germs are so deadly that they can result in death, you may have had friends or relatives who got such germs and died. Germ warfare is a man-made attempt to use germs to produce disease or death in man, animals, and plants.

Finally, certain aspects of nuclear warfare (NW) are not new to you. The painful results of overexposure to strong sunrays are a common experience. Taking X-ray pictures or X-ray treatments must be carefully controlled. In the wrong hands X-ray machines can be very dangerous and can cause severe sickness or death. Any ray that is powerful enough to penetrate your skin and damage your body cells merits respect. In a nuclear explosion radiation is present in dangerous amounts, although the heat and blast present are much more deadly.

In brief, NBC agents are poisons in the form of gases, liquids, smokes, germs or germ products, and radioactive materials used in warfare to produce death, injury, or discomfort.

CHEMICAL AGENTS: WAR GASES

War gases are toxic (poisonous) chemicals which can produce death, injury, or irritating effects. Although commonly called gases, actually these agents may be found as solid particles, liquids, or gases.

War gases attack the body and produce specific damages according to the nature of the gas used. Shown below is a simple breakdown of the most common types:

1. Nerve gases
2. Blister gases
3. Psycho gases
4. Blood gases
5. Choking gases
6. Vomiting and tear gases

Nerve Gases

Of great importance because of their ACTION on your NERVOUS SYSTEM is a group of gases called "G-GASES." We will refer to them simply as nerve gases. They are quick killers. Very small amounts result in dimmed vision, headache, dizziness, and nausea. Upon entering your body through the nose, skin, or mouth, nerve gases interfere with breathing and may cause convulsions, paralysis, and death. The first effects are usually headache, difficulty in vision, and contraction of the eye pupils to pinpoint size. These effects are usually followed by a running nose, nausea, stomach cramps, rapid breathing, tightness of the chest, twitching muscles, and cessation of breathing. This is the most important group of killer gases.

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Right here it must be stressed that PROTECTION AGAINST NERVE GASES requires FOUR ACTIONS:

1. Speed in detection
2. Speed in giving the alarm
3. Speed in masking
4. Speed in self-aid and first aid

Blister Gases

As the name tells you, blister gases cause blisters on your skin. The result can be far worse than a severe case of sunburn. In either liquid or vapor form, these agents irritate and blister any part of your body that they touch. Blister gases can be effective in small amounts. A drop the size of a pinhead will produce a blister the size of a quarter. Blister gases are more effective in hot weather than in cold weather. They first affect the moist parts of the body (bend of arms and knees, armpits, and crotch). Men who are sweating are especially subject to severe burns. Blister gases are quick-acting, but their quick action is not apparent at first. If you are exposed to blister gas, nothing will happen immediately. One to several hours will go by before your skin starts to turn red. It will be hours or even days later before the blisters appear. However, the damage is done during the first few minutes of exposure. That is the reason why speed (stressed later in the section on self-aid) is so all-important.

Damage to the eyes may be worse than the effects on the skin. Gases—even liquids—may irritate the eyes only mildly at first, or there may be no pain at all. In a few hours, however, your eyes will smart, become inflamed, and be sensitive to light. Tears and great pain will follow, and permanent injury may result. Some blister gases will cause the eyes immediate pain.

If breathed into your lungs, blister gases will inflame the throat and windpipe and produce a harsh cough. In serious exposure this may result in pneumonia and death. Quick detection of blister gases plus prompt protection against entry into the eyes, lungs, or skin is vital in order to escape harm.

Psycho Gases

Psycho gases are something like marijuana—they produce mental symptoms and may also produce physical symptoms such as staggering gait, dizziness, and blurred vision. Some cause fainting spells, and some cause severe muscle weakness. The mental symptoms often resemble alcoholic drunkenness—men may act silly, giggle, or become angry and belligerent like a "fighting drunk." Sometimes psycho agents cause hallucinations. (Like alcoholic "DT's," victims may imagine they see snakes or enemy soldiers or imagine that colors have changed—some men think that trees are orange instead of green.) Many of these psycho gases prevent sleep, like benzedrine pills ("goof balls"). Some people may stay wide awake for 4 days and be mentally confused for the whole period. These gases are nonkillers and may become widely used. They do not kill but they make a man noneffective. Many of them do not produce effects until several hours after inhalation. These effects last from 8 hours to 4 days.

Blood Gases

Blood gases get their name because of the action they have on your blood. If you inhale blood gas, the blood cannot furnish oxygen to the body cells. As a result, the body tissues suffocate and die. Rapid breathing followed by violent convulsions are the main symptoms when a large amount of blood gas is inhaled. A mild exposure may produce headache, dizziness, and nausea. Blood gases either will cause a speedy death or complete recovery will take place within a few hours. Like nerve gases, blood gases are quick killers; therefore speed in masking is essential. Although they are cheap to make, it is very hard to build up effective concentrations in the air. It is thought that most countries will discontinue stocking them.

Choking Gases

Your lungs are the target for choking gases. If you can avoid breathing these gases, you are safe inasmuch as they do not harm your skin or digestive system. Choking gases will actually choke an unprotected person. If large amounts enter the lungs, the lungs will become filled with liquid, and death may result from lack of oxygen. Your protective mask gives you complete protection against all choking gases. The INSTANT you suspect the presence of a war gas, carry

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out these THREE ACTIONS as quickly as possible:

1. Stop breathing.
2. Put on your protective mask.
3. Clear your mask.

Protective mask drill will make you letter-perfect in these steps.

Choking gases will probably also be discontinued by most countries because of the more effective nerve gases.

Vomiting and Tear Gases
(Riot Control Agents)

Vomiting and tear gases produce unpleasant symptoms, usually only for a short time, and do not cause death when properly used. They are used to control riots, to force people out of buildings or caves, and sometimes, to capture enemy forces without injury. They are often used for training.

Vomiting Gases.—Inhaling vomiting gases makes you sick. A sense of fullness in the nose, a severe headache, intense burning in the throat, and tightness and pain in the chest are the general symptoms. These are followed by uncontrollable coughing, violent sneezing, nausea, and finally vomiting.

Remember that symptoms may be delayed several minutes. If you should inhale vomiting gas before you get your protective mask on, you might get sick after your mask is on. It would be natural, then, to think that the mask is leaking and to take it off. If you do so, however, you will be exposed to more gas. This would be disastrous if vomiting gases were combined with nerve, blister, or blood gases. It is quite possible that the enemy might do just this. The result would kill or seriously injure the man who took his mask off because he was sick.

YOU MUST WEAR YOUR PROTECTIVE MASK AS LONG AS GAS IS PRESENT. PULL IT AWAY FROM THE CHIN (DON'T TAKE IT OFF) DURING THE ACTUAL VOMITING. The protective mask offers adequate protection against vomiting gases. The undisciplined man, feeling terribly sick, will remove his mask and die, if poison gases are also present. But the disciplined man, with as great an urge to take off his mask, will keep it on and live. Effects of vomiting gases usually wear off in 20 minutes to 2 hours.

No chemical—even common table salt—is completely safe, and some men were killed when vomiting gas was used (against regulations) in very high concentration inside a barracks. This gas is often used as a training gas, but should only be used outdoors.

Tear Gases.—Tear gases are the least toxic of the six groups of war gases. They are discussed in this manual because you will encounter them during your training. They may also be used in civil riots to disperse the crowds or to squelch prison riots. The vapors of tear gases produce sharp, irritating pain in the eyes, resulting in an abundant flow of tears. There is usually no permanent damage to the eyes, however, and the effects wear off quickly. For a short time, though, you may not be able to see. The protective mask, put on before tear gases get into your eyes, will give complete protection. One of the purposes of the gas chamber exercise is to prove to you how effectively your protective mask protects against gases which attack you through the nose, mouth, or eyes. Some of the new tear gases also cause a running nose, severe chest pains, and sometimes, vomiting. Like regular tear gas, these effects also wear off quickly.

Self-Aid

Self-aid—personal decontamination—is your responsibility. If battle conditions at the time of exposure require you to keep fighting, you will decontaminate as soon as possible. In battle, it will be a tragic error for you to wait for someone else to give you first aid. The need for speed requires you to be your own aidman.

Time Limits

Since there are definite time limits after which self-aid becomes useless, immediate self-aid or personal decontamination is all-important if you are exposed to war gas. Decontamination either by neutralizing (making the chemical agent harmless) or by removing the agent, or both, should be done before serious injury occurs. If you have been contaminated with liquid nerve gases or blister gases, you must perform several self-aid measures as rapidly as possible.

Speed is essential in self-aid, and because you may not know whether you have been contaminated with liquid nerve gas or liquid blister

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gas, the following standard procedures must be observed to prevent injury from liquid agents:

1. Decontaminate eyes and face if necessary.
2. Mask.
3. Rinse contaminated areas with water. (Removes nerve gases.)
4. Throw away contaminated clothing (or cut away the contaminated part).
5. Blot off remaining liquid agent.
6. Apply protective ointment. (Remove blister gases.)
7. ONLY if effects of nerve gases begin, use atropine injection device.

The self-aid procedure for specific gases is given in the following paragraphs, and should be employed if the agent has been identified.

Protective Kit

The protective ointment kit is issued for your use in applying self-aid to reduce or avoid injury from war gases. It contains the following items:

1. Three tubes of protective ointment
2. One or more atropine injectors
3. Absorbent cloth or paper

Directions for using these items are printed on the containers. A new impregnated pad has been developed to replace the ointment and is used like a blotter.

Self-Aid for Nerve Gases

Mask at once if you notice any of the following symptoms:

1. A faint, sweetish, fruity odor. (This will be very rare, as most nerve gases are odorless.)
2. The pupils of someone else's eyes shrinking to pinpoint size.
3. Your sight blurring or dimming.
4. A painful sensation in your eyes.
5. Tightness in your chest and difficulty in breathing.

If you are told that your pupils are getting very small, or if you are having trouble breathing and your chest feels tight, take the atopine injector from your protective ointment kit. The directions for use are as follows:

1. Unscrew needle cover and remove. Be careful not to lose the wire loop!
2. Keeping needle end up, push wire loop down firmly until inner seal breaks, then pull wire out.
3. Jab needle into muscle (thigh, arm, etc.).
4. Squeeze tube slowly from sealed end until empty.

CAUTION: For use ONLY in NERVE GAS poisoning.

Another type of injector (automatic) may be issued to you. Complete directions for its use will be included with the injector.

Tips on the use of the atropine injector:

1. Inject the needle into a large muscle in the thigh or upper arm.
2. Place point of needle against skin, and then with firm pressure force the needle through the skin into the muscle all the way. You will feel little pain, only a slight pricking sensation.
3. The needle may be injected through the clothing.

PRECAUTIONS in applying self-aid for the nerve gases:

1. Do not take an injection of atropine until you are SURE you NEED it. Pinpointing of the eye pupils or blurred vision along with a tightness in the chest and a hard time breathing are signs that you need it. If you get excited and inject atropine when you have not been exposed to nerve gas, you may become ill, particularly in very hot weather. This would be a real danger in combat. However, if you really do inhale some nerve gas, atropine counteracts it and will make you feel better.

2. If you have inhaled a really large dose of nerve gas vapor, you may need more than one injection of atropine to relieve your symptoms. If nerve agent symptoms persist, you may give yourself up to two more injections for a total of three. More than three injections may be given under supervision of Medical Personnel, if available, or under direction of your NCO or officer in charge.

3. If you get good relief from the atropine and can breathe freely again, carry on with your duties. DRYNESS OF THE MOUTH IS A GOOD SIGN. It means that you have had enough atropine to overcome the dangerous effects of the nerve gas.

4. If you should get a drop or splash of liquid nerve gas in your eye, INSTANT ACTION is necessary to avoid serious injury. Get some water as fast as possible, tilt your head back so that your eyes look straight upward, and slowly pour water into the contaminated eye to flush it out. Hold the eye open with the fingers, if necessary. Pour the water slowly so that the irrigation will last not

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less than 30 seconds. This irrigation must be done in spite of the danger of breathing nerve gas vapor. Get your mask on quickly after completing the irrigation. Then if symptoms of nerve gases develop, give yourself atropine.

5. If liquid nerve gas gets on your skin or clothing, fast action is needed to get rid of it. Immediately flush the contaminated area with water. If there is no water, blot the liquid off your skin with one of the cloths from your protective ointment kit, your handkerchief, or a piece of cloth torn from your outer clothing. Do this by pinch-blotting in order not to spread the contamination. Next, quickly remove contaminated clothing. Blot off the contamination and decontaminate with soap and soapy water. Then carry on with your combat duties. Meanwhile, notice if there is any twitching of the muscles under the contaminated area. If none develops in the next half hour and you have no tightness in your chest, your decontamination was successful and you can forget it.

6. If twitching of the muscles under the area of contaminated skin does develop, do not wait for the appearance of other symptoms, but give yourself an injection of atropine AT ONCE. If no other symptoms develop, one injection of atropine is enough. The atropine does not relieve the local twitching of the muscles, but this twitching is not dangerous.

7. Avoid water and food that may be contaminated with nerve gases. Let the medics check food and water for safety before you use them. If you have swallowed contaminated food or water, and all of these symptoms occur—increased flow of saliva, nausea, pains in the stomach, and a tightness in the chest—take atropine.

First Aid for Nerve Gases

The most important things to do for a casualty who has been poisoned by nerve gas are:

1. If you suspect the gas is still present, put his mask on him.

2. Give him an atropine injection from his kit.

3. Give artificial respiration. Mouth-to-mouth is the best method, but if you are still masked, you must, of course, use another (manual) method. Some of the latest protective masks have a coupling and a hose so that you can connect up and give mouth-to-mouth artificial respiration while remaining masked.

4. Poisoning with nerve gases causes the mouth and throat to fill up with thick, sticky saliva. You may have to clear out the back part of the victim's mouth with a handkerchief, rag, or your fingers. Continue to check this as it may make artificial respiration difficult.

Many modern crop and garden sprays and bug killers are related to nerve gas. Every year many people are fatally poisoned from these chemicals. First aid is the same as for nerve gases.

Self-Aid for Blister Gases

Since mustard gas is a typical blister gas, knowledge of self-aid for mustard will be a basis for self-aid against all blister gases. For liquid mustard on the skin, take the following actions:

1. Blot it off, using a pinching motion to keep liquid from spreading.

2. Apply your protective ointment.

CAUTION: Do not apply protective ointment near the eyes.

3. Scrub your skin with soap and water followed by plenty of clear water. If there is no soap and water, blot off the first coat of protective ointment. When scrubbing, pay special attention to areas not covered by clothing (neck and ears), to the belt area, to hairy regions, and to the pubic (private) region.

4. Apply protective ointment again and let it remain.

For liquid mustard in the eyes, flush your eyes repeatedly with clear water.

For the Eyes.—If blister gas gets in your eyes, treat it instantly, as every second counts. THIS IS IMPORTANT. If there is no pain in your eyes, treat them with water only as described below. If there is pain in your eyes, flush eyes with water and seek medical aid immediately. If your eyes do hurt, a different type of blister gas is present, requiring immediate medical attention.

1. Flush the eye with water. The best way to do this is to tilt the head back so that the eyes look straight upward. Pull the lids apart with the fingers of one hand. With the other hand, pour water slowly into the eye. Try to regulate the flow of water so that the flushing lasts not less than 30 seconds and not more than 2 minutes.

2. SPEED in decontaminating the eye is ABSOLUTELY ESSENTIAL. Decontamination is very effective for mustard gas if applied within the first few seconds, but after 2 minutes it does very little good.

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For the Skin.—Pinch-blot liquid blister gas from the skin with the cloth that comes wrapped around the tube of protective ointment or with any other absorbent material at hand. Throw away the cloth or absorbent material used.

2. Break the tip off or tear off the bottom of a tube of protective ointment and apply ointment freely to the contaminated area. Rub it in well with the fingers and wipe off as much as can be removed readily with a fresh cloth or parts of the outer clothing. Apply a fresh layer of ointment and let it remain. An impregnated pad will soon replace the tube of ointment.

3. If the contamination is discovered late, when no liquid blister gas is visible and reddening of the skin has begun, wash contaminated area with soap and water. Protective ointment will not help at this stage; it will irritate the reddened skin.

4. Cut off hair which becomes contaminated with liquid blister gas. Decontaminate the exposed scalp with protective ointment, as described above.

5. Remove clothing which is contaminated with liquid blister gas. This applies to both ordinary clothing and to impregnated protective clothing. Decontaminate small areas with protective ointment or soap and water. It may be that the contamination is too great to handle with the equipment you have. In this case, cut out the contaminated parts or don't wear the clothes. When you are able, boil them with soap and water. This will make them safe to wear. The only exception to this is when the contaminating drops are very, very small (size of pinhead or smaller) and you are wearing both impregnated outer clothing and impregnated long underwear. The chemical in your impregnated clothes will take care of very small droplets.

Self Aid and First Aid for Psycho Gases

By the time a victim of psycho gas poisoning realizes something is wrong, he may be too confused mentally to do anything about it. He should be taken to a doctor immediately. If many people are affected, it may be necessary to confine them temporarily under guard to prevent accidents. They must not be allowed in critical or dangerous spaces until completely recovered as they are not responsible for their actions. Some of these gases prevent sweating and very much increase the danger of sunstroke on hot days.

There are effective antidotes for psycho gases, and one of these may be added to the self-aid kit in your protective mask carrier.

Self-Aid for Blood Gases

The first rule for the victim of blood gas is to get your mask on and avoid unnecessary movements. If you have received a large dose, you need an aidman. He will give you AMYL NITRITE to inhale and will administer artificial respiration if you need it. If blood gases are ever used again (unlikely), you may be issued amyl nitrite ampoules. In that event you can give the amyl nitrite to yourself. Just squeeze the ampoule until it pops. Insert two ampoules inside the facepiece of your mask under the eye lens. Repeat this at intervals of 3 or 4 minutes until normal breathing returns or until a total of eight ampoules are used.

Self-Aid for Choking Gases

Put on your protective mask IMMEDIATELY upon detecting any phosgene in the air. The odor is like new-mown hay or fresh-cut corn. Phosgene can also be detected by irritation of the eyes or by change in the taste of your cigarette (it may become tasteless or offensive in taste). Try not to breathe while masking. Even if you have inhaled some phosgene, continue with your combat duties. If, however, you have a very hard time breathing, feel nauseated, or vomit, take it easy. Avoid unnecessary movement.

Self-Aid for Vomiting Gases

Put on your protective mask and wear it in spite of coughing, sneezing, salivation, or nausea. Lift the mask from the face briefly, if necessary, to permit vomiting or to drain saliva from the facepiece. Clear your mask each time you adjust it to your face and before you resume breathing. CARRY ON YOUR DUTIES as VIGOROUSLY as possible; this will help LESSEN and SHORTEN the SYMPTOMS. Combat duties usually can be performed in spite of the effects of vomiting gases.

Self-Aid for Tear Gases

Put on your protective mask, cover the outlet valve, and blow hard to clear the mask. Keep your eyes open as much as possible. When vision

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clears, carry on your duties. When it is safe to remove your mask, blot away tears, but do not rub your eyes. If liquid or solid agent has entered your eye (rare occurrence), force your eye open and flush it with water.

DECONTAMINATION

Decontamination can be done by removing, neutralizing, or destroying the agent. The purpose of personal decontamination is to remove toxic agents from your body or personal equipment before serious injury occurs.

An example of REMOVING is pinch-blotting mustard gas from your skin.

Applying protective ointment to make the agent harmless is NEUTRALIZING.

DESTROYING is burning or burying a contaminated cloth which was used to blot off mustard gas.

Use Common Sense

Common sense and quick thinking play a big role in personal decontamination. You may have to rely on whatever you have on hand to remove war gases from your skin, eyes, or equipment. If liquid nerve or blister gases touch any part of your body, remove them as fast as you can. If you are caught without the best removers, like ointment or soap and water, then use anything that is available. It may be mud, gunoil, or even urine. A crude remover may get off only two-thirds of the agent, but it is better than nothing. You must keep in mind the fact that nerve and blister gases penetrate very fast. You CAN'T WAIT for help. GET THEM OFF!

Soap and Water

Always carry a bar of soap with you. Soap is excellent for removal of war gases. Cold water, while not as good as warm water, does dilute or weaken chemical agents. If plenty of cold water is available, it is very effective because you can pour it on for several minutes. Hot soapy water removes agents in a hurry. When you are removing any agent from your body with soap and water, scrub just as vigorously as a doctor scrubs his hands before an operation. Exposed regions and hairy regions should be given extra attention.

DEFENSE AGAINST BIOLOGICAL WARFARE

Biological warfare (BW) is the deliberate use of germs or their poisonous products to produce disease, injury, or death in man, animals, or plants. It is the intentional use of biological agents that makes BW new and dangerous.

You have been waging an individual fight against germs since you were born. The doctor who delivered you at birth made certain that your eyes were disinfected—free from dangerous germs. Your mother guarded you against disease by frequently bathing your body, sterilizing your milk bottle, and keeping you away from people with colds. Later you were vaccinated to protect you from smallpox. One of the first things you did on becoming a sailor was to take "shots" to protect you from diseases like typhoid fever. During World War II, naval personnel in tropical areas were careful to take atabrine to guard against malaria.

Any belief that biological warfare concerns a new or mysterious superweapon is NOT BASED ON FACT. Our fight against disease-producing germs has been going on for hundreds of years. BW is a manmade attempt to produce disease on a large scale.

Characteristics of BW Agents

Most germs are not harmful to man, animals, or plants. Many, in fact, are helpful. Yeast is used in the manufacture of bread and beer. Molds are used to ripen cheese. Only a few types of germs produce disease.

Since germs are alive, they behave as do other living things—they multiply, breathe, eat, grow, and die. They depend on moisture, food, and certain limits of temperature for life and growth. When their surroundings do not provide suitable conditions, they die. Most germs are killed by simple acts that you know about, such as boiling water, adding chlorine tablets to water, cooking food, exposure to sunlight, and use of soap and water.

How BW Agents Attack Your Body

BW agents or their poisonous products attack your body by the same routes as chemical agents—through your nose, mouth, or skin. Stop their entry into your body and you are safe from BW.

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Dangers of BW

In spite of the Navy's fine health program, BW does hold dangers that you must be prepared to meet. There is little to worry about from new kinds of diseases. The real danger to you is in new ways of spreading diseases already known.

When a person coughs or sneezes, tiny drops of moisture are blown from his mouth and nose into the air. If he is ill, the spray may carry harmful germs to others. Scientists working in laboratories have found that they are able to spread disease germs in much the same way—by floating the germs in fine sprays or mists called aerosols. Aerosols might be used for large BW attacks. They could be released from special sprayers carried by airplanes. When diseases are spread through the air in aerosols, anyone who breathes the mist is very likely to get a number of germs in his lungs. In that vital spot, germs can easily take hold and cause illness.

Protection Against BW

Defense against BW, like defense against CW, is neither simple nor easy. Individual protection against BW attack includes the use of protective equipment. Your protective equipment used for defense against gas warfare may be used for defense against BW. You will find that your first line of defense against BW is the natural resistance of your own body. Keep yourself in top physical condition. Every time you drill, engage in physical exercise or sports, hike, or eat good meals, you are preparing strong defenses against BW. A high standard of personal cleanliness and careful attention to sanitation are your best insurance against the spread of disease. Such steps are bolstered by the "shots" you get from time to time.

Inhaling airborne germs is a great danger in BW. Your protective mask, therefore, is an important item. A properly fitted mask which has been kept in good condition will greatly reduce the danger of your inhaling germs present in the air. Since you cannot detect the presence of biologic agents, you may be ordered to use your protective mask and protective equipment until the danger has passed. Your CO will base his decision upon information received from intelligence reports and the advice of his technical staff or higher headquarters. Several automatic alarm systems are under development.

Germs must actually get inside your body to cause disease. However, if a great many germs collect on your skin, they might get into your body in several ways, such as through your nose or mouth. Cuts or open sores are open doors to germs trying to enter your body. Be sure to keep cuts bandaged. Any type of clothing will give you some protection against BW. The degree of protection depends upon the size of the pores in the fabric and the number of layers of clothing worn. In order to keep out germs and disease-bearing insects such as mosquitoes, fleas, and ticks, it is important that the shirt and jacket collars be fastened, sleeves rolled down, cuffs buttoned, and all other clothes tied down to stop entry of germs which may be in the air or on the ground. The uniform you use for protection against chemical agents gives a higher degree of protection against BW agents than your ordinary clothing.

Treatment of BW Casualties

If you've ever had measles, you will remember that you had no idea when or where you were exposed. Several days after you were exposed to the germ you began to feel sick. Then the red rash appeared. Diseases caused by BW appear in this same way. THERE IS NO SELF-AID FOR BW CASUALTIES. The Navy gives you preventive "shots" for some diseases. If BW is ever used, additional "shots" have been developed which will be given to all hands. If you contract a disease from BW in spite of the "shots", the sickness will be mild, and you will get the best treatment that the medical men can give you.

Decontamination

If you are exposed to BW agents, scrub yourself thoroughly with soap and water as soon as the combat situation permits. Pay careful attention to your face and hands. A fingernail brush is a good item to have in order to remove dirt under your nails. Brush your teeth frequently—the roof of your mouth and tongue, as well as the gums and teeth. Take a bath or shower when it is possible. Change your clothes if they are contaminated. All washable clothes polluted with germs should be scrubbed clean at the first opportunity.

You should always be careful what you eat and drink in combat. If you are told that a BW

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attack has been made, you must be doubly careful. One of the easiest ways to get germs inside your body is to swallow them along with food and water. Don't forget that food and water are the natural homes of many disease producers. A few germs in your food will grow into millions in a very short time. Learn the commandments for defense against BW:

1. Remember the "BIO" sign; it means the area is contaminated with biologic agents.
2. Don't pick fruits or berries.
3. Don't chew grass or leaves.
4. Don't eat native food or drink native beverages. They may be contaminated intentionally or unintentionally.
5. Don't take souvenirs.
6. Eat only Navy food and drink only Navy beverages.
7. Don't bathe in lakes or ponds.
8. Don't touch animals.
9. Don't neglect preventive medicine.

Survival Tips for BW

Here are seven survival tips for biological warfare:

1. REPORT SICKNESS PROMPTLY. If you get sick, notify your unit medical personnel immediately.

2. KEEP YOURSELF AND YOUR LIVING QUARTERS CLEAN. Don't help germs by making things easy for them. Germs have trouble living in clean places. If you keep clean, the odds increase that you won't get sick.

3. DON'T NEGLECT PREVENTIVE MEDICINE. Take pills, "shots," or vaccinations when you are told to do so.

4. KEEP YOUR NOSE, MOUTH, AND SKIN COVERED. When BW agents are known to be present or are suspected of being present, use all of your protective equipment to keep them out of your body.

5. KEEP YOUR FOOD AND WATER PROTECTED. Bottled or canned foods are safe after a BW attack if the seals are not broken. Food in the open will be contaminated. If in doubt, boil the food for 10 minutes. That will kill most of the germs. Clean cans, packages, et cetera with soap and water before opening.

6. KEEP ALERT TO ANY SIGNS OF BW ATTACK. Any clues such as new or unusual types of shells or bombs, strange material sprayed by airplanes, smokes or mists of unknown nature, or other strange substances should be reported to your CO immediately.

WATCH OUT FOR BW "BOOBY TRAPS." The enemy may challenge your discipline and self-control by making available all sorts of tempting items of food. To eat or drink these contaminated items may mean death.

DEFENSE AGAINST NUCLEAR WARFARE

The explosion of a nuclear weapon like that of an ordinary bomb, causes damage by heat and blast. In addition, the nuclear explosion presents a third danger—nuclear radiation. You do not need to become an expert on the nuclear bomb, but there are some facts that you must understand to protect yourself from this weapon and nuclear radiation. Nuclear radiation is emitted at the time the bomb explodes, and also by particles called "fallout" which result from the bomb. These may cover large areas—many hundreds of square miles.

Effects of Nuclear Explosions

Although radiation is only one effect of a nuclear explosion, it has received much attention. To many, this effect has an air of mystery. Predictions were made that Hiroshima would never again be a safe place to live. Many rumors dealt with horrible injuries and sickness due to radiation. However, Hiroshima has been rebuilt. Crops grown in that area are safe to eat. The people are healthy and normal. The truth is that HEAT AND BLAST CAUSE MOST of the INJURIES.

Dangers of Radiation

You have already had contacts with radiation. In the form of cosmic rays from the sun, you have been bombarded by radiation every hour of your life. You know that too much exposure to the sun will result in severe sunburn. The effects of radioactivity may be compared to severe sunburn. You have also had X-rays taken of your chest. This was done by sending invisible, but powerful, rays into your body. You have heard of doctors using radium in the treatment of cancer. In receiving this treatment, the patient was exposed to powerful radiations. If you are an athlete, you may have taken infrared lamp treatments for a "charley horse." Like sun rays, X-rays, and

infrared rays, nuclear radiation is not a mysterious occurrence, but is easily understood by comparison with the above examples.

Rays, like BW agents, cannot be heard, seen, tasted, smelled, or felt. For example, when an X-ray is taken of your hand, you feel nothing. However, millions of X-rays have gone through your hand to the photographic plate. The light-shaded outline of your bones on the negative means that millions of X-rays have been stopped or absorbed by your bones. Too many X-rays will cause injury. They tend to tear down the body cells, especially the blood-forming cells. That is why a safety limit is set up. X-ray machine operators are allowed to absorb only a certain amount of radiation in a week. Likewise, service personnel working a radioactive or "hot" area will not be allowed to absorb radiation beyond a safe limit, which will be determined by their commander.

How Radiation Affects You

There are two ways you can acquire an overdose of radiation. You can be caught in the open when an nuclear bomb explodes nearby. If your distance from the point of explosion is great enough to protect you from blast and heat, gamma rays cannot reach you. However, if you are in the open within 800 to 1,000 yards of the burst, you will receive an overexposure to radiation because your clothes will not stop gamma rays. Overexposure occurs if you remain too long in an area which is radioactive from fallout. Your commander will tell you how long to stay in a radioactive area.

The first indication of an overdose of radiation probably will not show up for several hours. Then you most likely will get sick and begin to vomit. The time it takes you to get sick depends on how large a dose you get. The larger the dose, the quicker you get sick. For a few days you might continue to feel below par. But in spite of it all, you would still stand a better than even chance of complete recovery.

NW Protective Measures

In order to protect yourself against NW, you must know about the different kinds of nuclear explosions.

An AIR BURST is a nuclear explosion high in the air. This type of explosion does the greatest damage by blast and heat. The radiation from an air burst disappears fast and is called INITIAL RADIATION.

A GROUND OR WATER BURST is one which is low or on the surface. It produces less damage from blast and heat. It produces fallout radiation which lasts for quite a long time and is called RESIDUAL RADIATION.

Since an air burst does the greatest damage, that is the kind you can expect most often. With air bursts, the violent, upward surge of superhot gases and air sweeps radioactive ashes into the sky. Most of them are carried off in the drifting bomb clouds. Air explosions do not create "hot" areas. In fact, they leave almost no radiation on the ground. After a few minutes, your unit can move across the center of destruction with no danger from harmful rays.

Ground, underground, or water bursts leave a limited area "hot." Such bursts will limit the time that fighting forces can stay there.

Self-Protection

Air Bursts.—The important point to remember is that in a nuclear explosion, you do the same thing you would do in an ordinary bomb explosion. Speed in taking cover is vital. If you can protect yourself from heat and blast, you will also be protected from the dangerous initial gamma rays. Remember that residual radiation after an air burst is a very small danger. But initial gamma rays at the time of explosion are very dangerous. Fortunately, these initial rays are gone 10 seconds after the bomb explodes. If you take cover for a minute or two you should escape harm unless the explosion occurs very close to you. The type of cover you should take will depend upon your mission, location, whether or not you are warned, and many unforeseen factors. As with any explosion, the more material or distance between you and the burst, the safer you are. Falling flat and covering your face is better than standing. As is true with protection from all the dangers of war, you must make the most of what you have. Your training on protection against small arms or artillery fire is also good training for protection against nuclear bombs.

First Aid

In the case of an air burst, you may give first aid to casualties who received injuries from nuclear explosions without fear of becoming contaminated by the casualties. If the weapon has been detonated close to the ground, both you and

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the casualties may have some radioactive fallout on your skin and clothing. Your unit NBC personnel can tell you whether the amount is serious or not. Most of it can be removed by simply dusting and shaking of clothes. Treat for hemorrhage, shock, wounds, fractures, burns, and other injuries. These are by far the most important effects of the bomb. Men who have received radiation injury alone will need no first aid since the only symptoms they will show are vomiting and diarrhea, usually hours after the event.

Protective Equipment

Clothing.—Any type of clothing that covers you gives some protection against NW. In order to protect the clothes you are wearing from radioactive materials, extra covering is desirable. For example, if you are caught in the open, try to grab something to cover yourself when you fall to the ground. A board or some sheets of newspaper will help, but your raincoat is better. The object is, of course, to keep radioactive dust off your body and regular clothing.

Gloves And Mask.—When you enter a "hot" area, you must wear gloves to protect your hands. Touching radioactive material with bare hands may result in serious burns. Any kind of gloves will protect your hands. Later when you wash your hands, it will be easier to decontaminate them, especially your fingernails, if you have worn gloves. Your protective mask or dust respirator should be worn in a "hot" area to prevent inhalation of radioactive dust. Dust respirators may be used in place of the protective mask. The point to remember is never to inhale radioactive dust. Serious internal injury and radiation sickness may result. If there is no dust in the "hot" areas, it will probably be safe to enter without a mask. Your unit NBC personnel will check and advise the person in command whether a mask is needed.

Protecting Your Skin.—"Beta particles" (which are found in fallout), like blister gases may have a delayed action. Beta particles penetrate very far into your body, but they will damage your skin. Reddening of the skin may be an indication of this. Such damage, as with blister gas, may not appear until some time after exposure. You may not know you have received skin burns until it is too late. Play it safe by wearing any protective clothing you are issued in the manner that you are instructed to wear it.

Decontamination

If you suspect that you are contaminated, or, if detection equipment shows that you are, report to a personnel decontamination station as directed. Outer clothing will serve as a trap for most radioactive contamination. By taking off your clothes you may remove most of the contamination.

Upon reporting to the personnel decontamination station, follow the directions of the men operating the station. If none are posted at the station, necessary instructions will be posted on signs. Obey them to the letter.

The usual procedure at the personnel decontamination station is as follows: Discard clothing and equipment as directed. Enter shower and take a good bath, using plenty of soap and warm water. In washing, pay close attention to the hairy parts of your body and to your body creases. It is at these points that dirt, probably contaminated dirt, tends to gather. Do not forget your fingernails. After you have finished your shower, you will be directed to a monitor who will check you with a counter. If you are still contaminated, you will be sent back to take another shower. If you are free from contamination, you will go to the dressing room for a new issue of clothing and equipment.

Remember that bathing is the best way to remove radioactive contamination from your body. No special cleaning compound is necessary. Soap, brushes, and warm water will do the job.

Food and water can become contaminated. Avoid using uncovered food or water if they are in a radioactive area. Canned food and covered water may be used with safety. Rely on trained Navy men to check and declare harmless anything you take into your mouth.

Decontamination Expedients.—Since a shooting war will be going on, the situation may not permit you to go to a decontamination station. You must be able to remove most of the radioactive material with what you have on hand. Lingering radiation dies out quickly during the first few hours after a nuclear explosion, hence the little you may leave on after your "quickie"

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decontamination job probably will not harm you. If you become heavily contaminated—

1. Remove your outer garments. Shake them violently in the wind. This will remove most of the radioactive material, unless it is wet and muddy.
2. If it is too cold or wet to remove your outer clothing, brush or scrape them carefully.
3. This same procedure should be used to decontaminate your equipment.

SUMMARY

The use of chemical and biological agents and nuclear devices as potential weapons will remain a possibility as long as war exists. Therefore, all Navy personnel should familiarize themselves with the characteristics and effects of these weapons so that they may take measures to reduce their effectiveness.

The harmful effects of chemical and biological agents can be minimized if the protective devices supplied by the Navy are used promptly, and if self-protection measures are carried out by all hands. In self-aid and first aid, speed is the most important consideration—speed in masking, speed in removing the agents from the body, and speed in using protective ointments and injections.

The detonation of a nuclear device produces heat, blast, and radiation. Of these, the effects of radiation are most feared by those who don't know the facts. Actually most casualties are produced by heat and blast. Self-protection measures are similar to those taken for conventional explosive devices. The more material between you and the site of the blast, the better your chances of survival. Protective clothing provides some protection from nuclear contamination, and prompt decontamination by removal of outer clothing and by soap and water shower further reduces the effects of radiation.

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CHAPTER 10

RESCUE AND TRANSPORTATION PROCEDURES

It is a basic principle of first aid that an injured person must be given essential treatment BEFORE he is moved. However, it is obviously impossible to treat injuries while the casualty is in a position of immediate danger. If he is drowning, or if his life is endangered by fire, steam, electricity, poisonous or explosive gases, or other hazards, he must be rescued before first aid treatment can be given.

The life of an injured person may well depend upon the manner in which he is being transported to a medical officer. Rescue operations must be accomplished quickly, but unnecessary haste is both futile and dangerous. After rescue, and after essential first aid treatment has been given, further transportation must be accomplished in a manner which will not aggravate his injuries.

In this chapter we will consider the use of common types of protective equipment, ways of effecting rescue from dangerous situations, emergency methods of moving injured persons to safety, and procedures for transporting them after first aid has been given.

PROTECTIVE EQUIPMENT

The use of appropriate items of protective equipment will substantially increase your ability to resuce a person from a threatening situation. Protective equipment that is generally available on naval vessels and at some shore activities includes oxygen breathing apparatus; hose (air line) masks; protective (gas) masks; asbestos suits; steel-wire life lines; and devices for detecting oxygen insufficiency, explosive vapors, and some poisonous gases.

Oxygen Breathing Apparatus

Oxygen breathing apparatus is provided for emergency use in compartments containing toxic gases and in which there is insufficient oxygen to support life. There is no limitation as to the concentration of gas, smoke, dust, or deficiency of oxygen in which the apparatus will function effectively. The apparatus is particularly valuable for rescue purposes because it is a self-contained unit. The wearer is not dependent upon outside air or upon any type of air line, within the effective life of the canister.

There are several types of oxygen breathing apparatus, but they are all similar in operation. Independence of the outside atmosphere is achieved by having air within the apparatus circulated through a canister. Within the canister, the air is continuously replenished with oxygen and continuously freed of impurities. The effective life of the canister varies from 45 minutes to 20 minutes, depending on the particular apparatus and the type of work being done. One of the newer types of oxygen breathing apparatus, shown in figure 10-1, is designed so that you can change canisters without leaving the toxic atmosphere.

If you are to enter an extremely hazardous area, you should also wear a lifeline. The lifeline should be tended by two persons, one of whom is also wearing a breathing apparatus.

Never allow oil or grease to come in contact with any part of an oxygen breathing apparatus. Oxygen is violently explosive in the presence of oil or grease. If any parts of the apparatus become contaminated with oil or grease smudges, clean it before it is stowed.

Care should be taken to prevent oil or oily water from entering the canister between the time it is opened and the time of disposal.

Hose (Air Line) Masks

Hose masks are part of the allowance of all ships having repair party lockers. They are smaller than the oxygen breathing outfits, and can therefore be used by persons who must enter

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Figure 10-1.—Type A-2 oxygen breathing apparatus.

voids or other spaces which have very small access hatches. The hose or air line mask consists essentially of a gas mask facepiece with an adjustable head harness and a length of airhose. Note that the air line mask uses AIR, rather than pure oxygen. It must NEVER be connected to an oxygen bottle, oxygen cylinder, or other source of oxygen; even a small amount of oil or grease in the air line mask would combine rapidly with the oxygen and cause an explosion. When properly connected to a suitable source of AIR, such as the low-pressure ship's service air line, the hose mask can be worn safely even in spaces which contain a high concentration of oil or gasoline vapors; for this service, in fact, the air line mask is superior to the oxygen breathing apparatus.

Notice in figure 10-2 that the man wearing the air line mask is also wearing a separate safety belt fitted with shoulder straps, a pocket for the hose connection, and a D-ring. One of these safety belts is furnished with each air line mask, and MUST BE WORN. A lifeline must be fastened to the D-ring; and the lifeline should be loosely lashed to the airhose to reduce the possibility of fouling. The airhose and lifeline must be carefully tended at all times, so that they will not become fouled or cut. The person wearing the air line mask and the person tending the lines should maintain communication by means of standard divers' signals.

Protective (Gas) Masks

Protective (gas) masks provide respiratory protection against nuclear, biological, and chemical warfare agents. They do not provide protection from the effects of carbon monoxide,

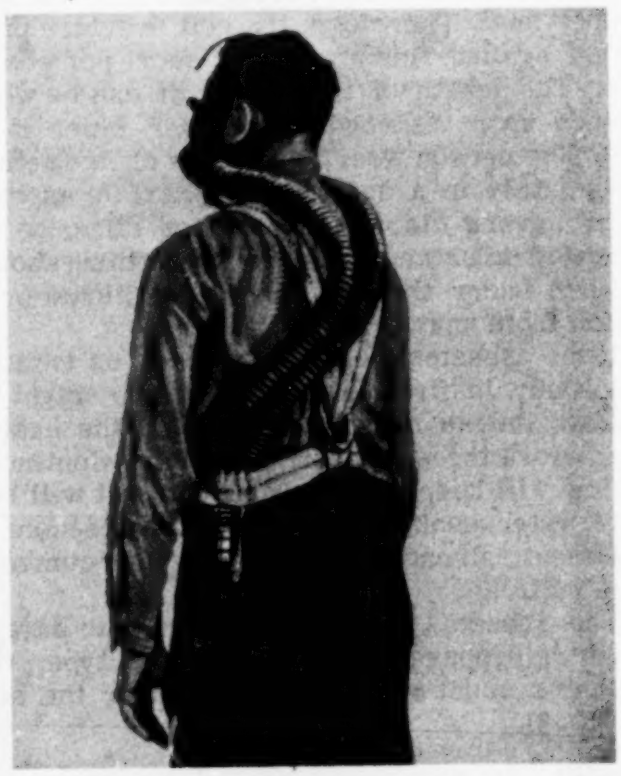

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Figure 10-2.—Hose (air line) mask.

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carbon dioxide, illuminating gas, gasoline vapors, ammonia, and many other industrial gases.

In emergencies, protective (gas) masks may be used for passage through a smoke-filled compartment or for entry into such a compartment to perform a job that can be done quickly, such as close a valve, secure a fan or deenergize a circuit. However, they provide only limited protection against smoke. The length of time you can remain in a smoke-filled compartment depends on the type of smoke and its concentration.

The most important thing to remember about protective (gas) masks is that they do not manufacture or supply oxygen. They merely filter the air as it passes through the canister. Therefore, the protective (gas) mask should not be used in air containing less than 16 percent oxygen or in air having a heavy concentration of smoke from oil fires, except for very short periods of time.

Asbestos Suit

The Navy asbestos suit is made in a single unit, is easy to get into, and provides complete cover for the wearer. With it on, a firefighter can move quickly through flame to effect a rescue or perform some other job that can be done quickly.

While asbestos will not burn, it will char and conduct heat. Therefore, the suit provides protection against flame only for short periods of time. The length of time the suit can be worn depends upon the conditions under which it is used. The person wearing the suit should return immediately to a safe, cool area if he experiences severe discomfort such as difficulty in breathing or extreme heat. Heavy clothing should be worn under the suit to give additional protection from heat.

If the asbestos suit becomes wet, as is more than likely in firefighting, the wearer might be scalded, unless he withdraws from the heated area before the water turns to steam. Continued wetting will keep him cool, but the suit will become water-soaked and reduce his freedom of movement, already restricted by the cumbersome suit.

The asbestos suit may be worn with oxygen breathing apparatus. Whatever the type, the apparatus must always be worn over the suit (fig. 10-3).

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Figure 10-3.—Asbestos suit (oxygen breathing apparatus worn outside).

Lifeline

The lifeline is a steel-wire cable, 50 feet long. (See fig. 10-4.) Each end is equipped with a strong hook that closes with a snap catch. The line is very pliable and will slide freely around obstructions.

Lifelines are used as a precautionary measure to aid in the rescue of persons wearing rescue breathing apparatus, hose masks, or similar equipment. Rescue, if necessary, should

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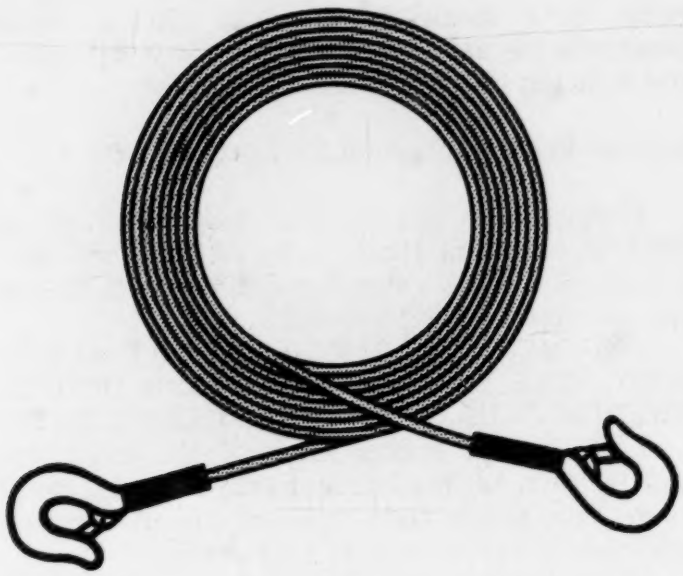

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Figure 10-4.—Steel-wire lifeline.

be accomplished by having another man or men equipped with breathing apparatus follow the lifeline to the person being rescued, rather than by attempting to drag him out. Attempts to drag a person from a space may very well result in fouling the lifeline on some obstruction or in parting his harness, in which case it would still be necessary to send a rescue man into the space.

An important precaution in the use of lifelines should be obvious, but it is stated here because in the excitement of fire or other emergency it may be forgotten. A stricken person must never be hauled up by a lifeline attached to his waist. He may be dragged along the deck a short distance, but his weight must never be suspended on a line attached to his waist. If he is not wearing a harness of some kind, the line must be passed around his chest under his armpits and made fast either front or back.

When tending a lifeline, you must wear gloves to be able to handle the line properly. Pay out the line carefully, so that it will not foul. Try to keep the lifeline in contact with grounded metal, and do not allow it to come in contact with any energized electrical equipment.

Detection Devices

The detection devices used to test the atmosphere in closed or poorly ventilated spaces include the FLAME SAFETY LAMP, for detecting oxygen deficiency; COMBUSTIBLE-GAS INDICATORS, for determining the concentration of explosive vapors; and TOXIC-GAS INDICATORS, such as the CARBON-MONOXIDE INDICATOR, for finding the concentration of certain poisonous gases. These devices are extremely valuable, and should be used whenever necessary; however, they MUST BE USED ONLY AS DIRECTED. Improper operation of these devices may lead to false assurances of safety; or, worse yet, to an increase in the actual danger of the situation. For example, the use of a flame safety lamp in a compartment filled with acetylene or hydrogen could cause an explosion so violent that you would have no further interest in determining the oxygen content of the atmosphere.

RESCUE PROCEDURES

If you are faced with the problem of rescuing a person threatened by fire, explosive or poisonous gases, or some other emergency, do not take any action until you have had time to determine the extent of the danger and your ability to cope with it. The large number of accidents in which the rescuer rushes in and becomes the second victim would seem to indicate that this advice is hard to follow. Do not take unnecessary chances! Do not attempt any rescue that needlessly endangers your own life! You cannot help anyone, even yourself, if you are seriously injured or killed.

Rescue From Fire

If you must go to the aid of a person whose clothing is on fire, try to smother the flames by wrapping him in a coat, a blanket, or a rug. Leave his head UNCOVERED. First beat out the flames around his head and shoulders, and then work downward toward his feet. If you have no material with which to smother the fire, roll him over—SLOWLY—and beat out the flames with your hands. If he tries to run, catch him and throw him down. Remember that he MUST lie down while you are trying to extinguish the fire. If he runs, his clothing will burn rapidly. If he sits or stands, he may be killed instantly by inhaling flames or hot air.

CAUTION: Inhaling flame or hot air can kill YOU, too. Don't get your face directly over the flames. Turn your face away from the flame when you inhale.

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If your own clothing catches fire, roll yourself up in a blanket, coat, or rug. KEEP YOUR HEAD UNCOVERED. If material to smother the fire is not available, lie down, roll over slowly, and beat at the flames with your hands.

If you are trying to escape from an upper floor of a burning building, be very cautious about opening doors into hallways or stairways. When a building is on fire, hot air often collects in halls and stairwells. Always feel a door before you open it; if it feels hot, don't open it if there is any other possible way out. Remember, also, that opening doors or windows will create a draft and make the fire worse; so don't open any door or window until you are actually ready to get out.

If you are faced with the problem of removing an injured person from an upper story of a burning building, you may be able to improvise a lifeline by tying sheets, blankets, curtains, or other materials together. (Use square knots.) Secure one end around some heavy object inside the building, and fasten the other end around the casualty under his arms. You can lower him to safety, and then let yourself down the line. Do not jump from an upper floor of a burning building, except as a last resort.

It is often said that the "best" air in a burning room or compartment is near the floor, but this is true only to a limited extent. There is less smoke and flame down low, near the floor, and the air may be cooler; but carbon monoxide and other deadly gases are just as likely to be present near the floor as near the ceiling. If possible use oxygen breathing apparatus or other protective breathing equipment when you go into a burning compartment. If protective equipment is not available, cover your mouth and nose with a wet cloth to reduce the danger of inhaling smoke, flame, or hot air. REMEMBER, HOWEVER, THAT A WET CLOTH GIVES YOU NO PROTECTION AGAINST POISONOUS GASES OR LACK OF OXYGEN!

Rescue From Steam-Filled Spaces

It is sometimes possible to rescue a person from a space in which there is a steam leak. Since steam rises, escape upward may not be possible. If the normal exit is blocked by escaping steam, move the casualty to the escape trunk or, if there is none, to the lowest level in the compartment.

The equipment which offers protection against fire does NOT protect you against steam. In particular, it should be mentioned that the asbestos suit absorbs water, and is therefore of no value in a steam-filled space. Steam would penetrate the asbestos very quickly and the person wearing the suit would be scalded.

Rescue From Electrical Contact

Rescuing a person who has received an electric shock is likely to be difficult and dangerous. Extreme caution must be used, or you may be electrocuted yourself.

YOU MUST NOT TOUCH THE CASUALTY's BODY, THE WIRE OR ANY OTHER OBJECT WHICH MAY BE CONDUCTING ELECTRICITY.

Look for the switch first of all, and if you find it, turn off the current immediately. Don't waste too much time hunting for the switch, however; every second is important.

If you cannot find the switch, you should try to remove the wire from the casualty with a DRY broom handle, branch, pole, oar, board, or similar NONCONDUCTING object. It may be possible to use DRY rope or DRY clothing to pull the wire away from him. You can also break the contact by cutting the wire with a WOODEN-HANDLED axe, but this is extremely dangerous because the cut ends of the wire are likely to curl and lash back at you before you have time to get out of the way. When you are trying to break an electrical contact, always stand on some nonconducting material such as a DRY board, DRY newspapers, or DRY clothing.

Rescue From Unventilated Compartments

Rescuing a person from a void, double bottom, gasoline or oil tank, or any closed compartment or unventilated space is generally a very hazardous operation. Aboard naval vessels and at naval shore activities, no person is permitted to enter any such space or compartment until the gas-free engineer (or some person designated by him) has indicated that the likelihood of suffocation, poisoning, and fire or explosion has been eliminated as far as possible. The rescue of a person from any closed space should, therefore, be performed under the supervision of the gas-free engineer, or in accordance with his instructions. In general, it is necessary to observe the following precautions when attempting to rescue a person from any closed or poor ventilated space:

- If possible, test the air for oxygen deficiency, poisonous gases, and explosive vapors.

Moving the Casualty to Safety

In an emergency, you may have to hoist, carry, or drag an injured person away from a position of danger. In some instances you will be able to do this by means of the Neil Robertson stretcher, or by the use of improvised lifelines; in other cases you will have to move the casualty by using the fireman's carry, the tied-hands crawl, the blanket drag, the pack-strap carry, the chair carry, or some type of arm carry. Sometimes it is necessary to move him with all possible speed, without regard to the severity of his injuries. Remember, however, that when you move an injured person you are taking a calculated risk: YOU MAY KILL HIM BY MOVING HIM! You are justified in taking such a risk only when it is evident that he will die if you do not move him.

Neil Robertson Stretcher.—The Neil Robertson stretcher is specially designed for the purpose of removing an injured person from engine-room spaces, holds, and other compartments where access hatches are too small to permit the use of regular stretchers.

The Neil Robertson stretcher is made of semirigid canvas. When firmly wrapped around the casualty mummy-fashion, it gives sufficient support so that he may be lifted vertically. (See fig. 10-5). Note that a guideline is tied to the casualty's ankles to keep him from swaying against bulkheads and hatchways while he is being lifted.

Stretchers of this type can be made on board ship, and kept in appropriate places ready for use. If a Neil Robertson stretcher is not available when needed, a piece of heavy canvas, wrapped firmly around the casualty, will serve somewhat the same purpose.

Emergency Rescue Lines.—As previously mentioned, the steel-wire lifeline can often be used to haul a person to safety. An emergency rescue line can also be made from any strong fiber line. Both should be used only in extreme emergencies, when an injured person must be moved and no other means is available.

Figure 10-6 shows an emergency rescue line which could be used to hoist a man from a void or small compartment. Notice that a running bowline is passed around the body, just below the hips, and a half hitch just under the arms. Notice also that a guideline is tied to the casualty's ankles to keep him from banging against bulkheads and hatchways.

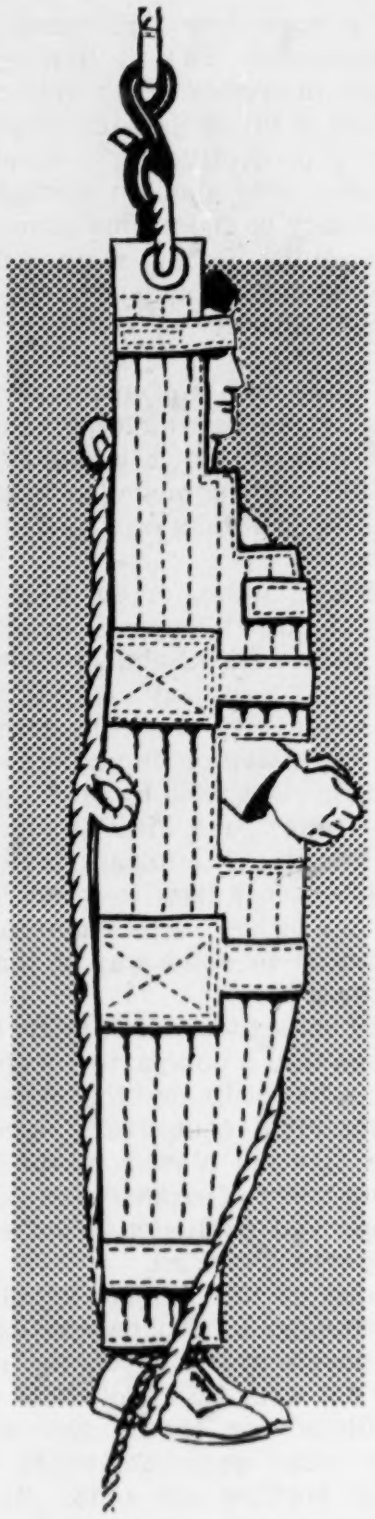

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Figure 10-5.—Neil Robertson stretcher.

Fireman's Carry.—One of the easiest ways to carry an unconscious person is by means of the fireman's carry. Figure 10-7 shows the procedure:

1. Turn the casualty so that he is lying flat, face down, as shown in figure 10-7 (A). Kneel on

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Figure 10-6.—Emergency rescue line (using running bowline and half hitch).

one knee at his head, facing him. Pass your hands under his armpits; then slide your hands down his sides and clasp them across his back.

2. Raise the casualty to his knees, as shown in figure 10-7 (B). Take a better hold across his back.

3. Raise the casualty to a standing position, and stick your right leg between his legs, as shown in figure 10-7 (C). Grasp his right wrist in your left hand and swing his arm around the back of your neck and down your left shoulder.

4. Stoop quickly and pull the casualty across your shoulders and, at the same time, put your right arm between his legs, as shown in figure 10-7 (D).

5. Grasp his right wrist with your right hand and straighten up, as shown in figure 10-7 (E).

The procedure for lowering the casualty to the deck is shown in parts (F) and (G) of figure 10-7.

Tied-Hands Crawl.—The tied-hands crawl, shown in figure 10-8 may be used to drag an unconscious person for a short distance; it is particularly useful when you must crawl underneath a low structure.

To carry a person by this method turn him so that he is lying flat on his back. Cross his wrists and tie them together. Kneel astride the casualty and lift his arms over your head so that his wrists are at the back of your neck. When you crawl forward, raise your shoulders high enough so that the casualty's head will not bump against the deck.

Blanket Drag.—The blanket drag, shown in figure 10-9, can be used to move a person who is so seriously injured that he should not be lifted or carried by one man alone. Place the casualty on his back on a blanket, and pull the blanket along the floor or deck. Always pull the casualty head first, with his head and shoulders slightly raised, so that his head will not bump against the deck.

Pack-strap Carry.—With the pack-strap carry, shown in figure 10-10, it is possible to carry a heavy person for some distance. Use the following procedures:

1. Place the casualty lying down, face up.

2. Lie down on your side along the casualty's uninjured or less injured side. Your shoulder should be next to his armpit.

3. Pull the casualty's far leg over your own, holding it there if necessary.

4. Grasp the casualty's far arm at the wrist and bring it over your upper shoulder as you roll and pull him onto your back.

5. Rise up on your knees, using your free arm for balance and support. Hold both of the casualty's wrists close against your chest with your other hand.

6. Lean forward as you rise to your feet, and keep both of your shoulders under the casualty's armpits.

Do not attempt to carry a seriously injured person by means of the pack-strap carry, especially if his arms, spine, neck, or ribs are fractured.

Chair Carry.—The chair carry can often be used to move a sick or injured person away from a position of danger. The casualty is seated on a chair, as shown in figure 10-11, and the chair is carried by two men. This is a particularly good method to use when you must carry a person up or down stairs or through narrow, winding passageways. It must NEVER be used to move a person who has an injured neck, back, or pelvis.

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Figure 10-7.—Fireman's carry.

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Figure 10-8.—Tied-hands crawl.

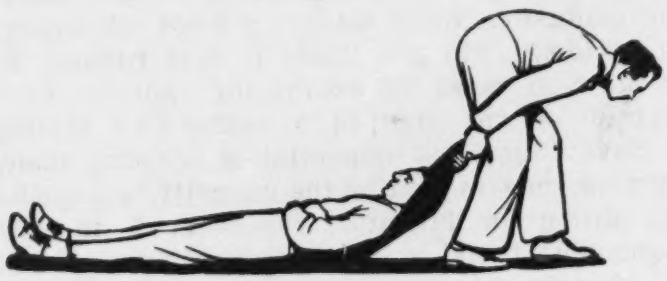

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Figure 10-9.—Blanket drag.

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Figure 10-10.—Pack-strap carry.

Arm Carries.—There are several kinds of arm carries which can be used, in emergency situations, to move an injured person to safety. Figure 10-12 shows how one person can carry the casualty alone. However, you should never try to carry a person this way if he is seriously injured. Unless he is considerably smaller than you are, you will not be able to carry him very far by this method.

The two-man arm carry, shown in figure 10-13, can be used in some cases to move an injured person. However, it should not be used to carry a person who has serious wounds or broken bones.

Another two-man carry which can be used in emergencies is shown in figure 10-14. Two men kneel beside the casualty about at the level of his hips, and carefully raise him to a sitting position. Each man puts one arm under his thighs; hands are clasped and arms are braced as shown in figure 10-14(A). Both men then rise slowly and steadily to a standing position, holding the casualty as shown in figure 10-14(B). This carry must not be used to move seriously injured persons.

TRANSPORTATION OF THE INJURED

Thus far in this chapter, we have dealt with EMERGENCY methods used to get an injured person out of danger, into a position where he can receive first aid. As we have seen, these emergency rescue procedures often involve substantial risk to the casualty and should be used ONLY when clearly necessary.

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Figure 10-11.—Chair carry.

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Figure 10-12.—One-man arm carry.

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Figure 10-13.—Two-man carry by arms and legs.

Once you have rescued the casualty from the immediate danger which threatened him, SLOW DOWN! From this point on, handle and transport him with every regard for the injuries which he has sustained. In the excitement and confusion which almost always accompany an accident, you are likely to feel rushed, as though you must do everything rapidly. To a certain extent, this is a reasonable feeling to have: Speed is essential in treating many injuries, and in getting the casualty to a medical officer or hospital. However, it is NOT reasonable to let yourself feel so hurried that you handle him roughly or carelessly, or transport him in a way which will aggravate his injuries.

General Precautions

The basic precautions which must be observed in transporting an injured person may be summarized as follows:

- Give necessary first aid BEFORE attempting to transport the casualty. Be sure that all injuries have been located. Treat serious bleeding, asphyxia, and shock. Immobilize all fractures, sprains, and dislocations. Do whatever you can to reduce the casualty's pain and to make him as comfortable as possible under the circumstances.
- Use a regular stretcher, if one is available; if you must use an improvised stretcher, be sure that it is strong enough. Be sure, also, that you have enough men to carry the stretcher, so that you will not run any risk of dropping the casualty.
- Whenever possible, bring the stretcher to the casualty instead of carrying him to the stretcher.

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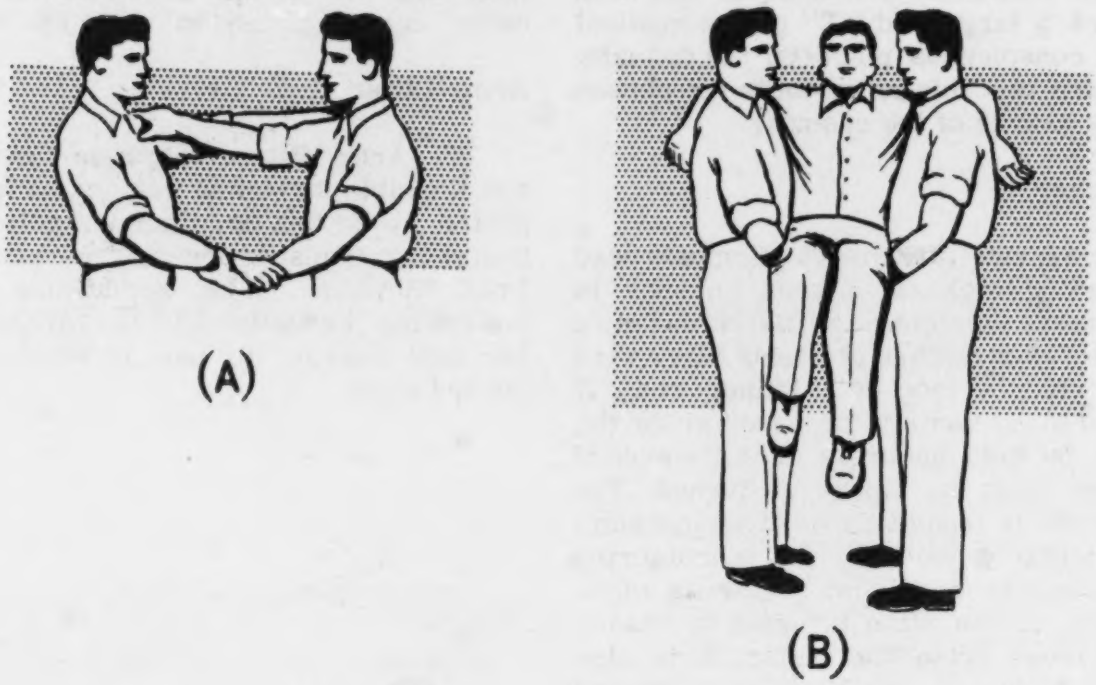

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Figure 10-14.—Two-man arm carry.

- Fasten the casualty to the stretcher so that he cannot slip, slide, or fall off. Tie his feet together, unless he has injuries which make this impracticable.
- Use blankets, garments, or other material to pad the stretcher and to protect the casualty from exposure.
- As a general rule, an injured person should be lying on his back while he is being moved. However, in some instances the type of injury or location of the injury will necessitate the use of another position. A person who is having difficulty in breathing because of a chest wound may be more comfortable if his head and shoulders are slightly raised. A person who has a broken bone should be moved very carefully, so that the injury will not be made worse. (Chapter 7 gives specific instructions concerning the transportation of persons who have suffered serious fractures.) If the casualty has received a severe injury to the back of the head, he should be kept lying on his side while he is being transported. In all cases, it is important to place him in the position which will best protect him from further injury.
- The stretcher should be carried in such a way that the casualty will be moved FEET FIRST.
- If you must use a motor vehicle to transport a seriously injured person, DO NOT USE A PASSENGER CAR EXCEPT IN EXTREME EMERGENCY! It is difficult to get an injured person into a car without causing further injury and pain; and it is almost impossible to keep him lying flat in a passenger car. The best means of transportation is, of course, an ambulance; if no ambulance is available, however, a truck or station wagon makes a fairly good substitute.

If it is absolutely necessary to use a passenger car to transport a seriously injured person, do not attempt to put him in the car until you have figured out the best place for him to be and the best way to fit him into it! An injured person is in no condition to be used as a measuring stick; don't put him anywhere in the car until you are sure that he can be fitted in without undue bending, twisting, or turning.

- Do not turn the casualty over to anyone without giving a complete account of the situation. Be sure that the person taking over knows what caused the injury and what first aid treatment has been given. If the casualty has received morphine, use a skin pencil, crayon, or blood to mark a large red "M" and the time

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on his forehead and attach the used morphine syrette to his collar. If a tourniquet has been applied, mark a large red "T" on the medical tag or on a conspicuous place on the casualty and make sure that this is known to the person who is taking charge of the casualty.

Stokes Stretcher

The Navy service litter most commonly used for transporting sick or injured persons is called the Stokes stretcher. As shown in figure 10-15, the Stokes stretcher is essentially a wire basket supported by iron or aluminum rods. It is adaptable to a variety of uses, since the casualty can be held securely in place even if the stretcher must be tipped or turned. The Stokes stretcher is frequently used aboard ship, and is particularly valuable for transferring injured persons to and from boats. As mentioned before, it can often be used to rescue injured survivors from the water. It is also used for direct ship-to-ship transfer of injured persons.

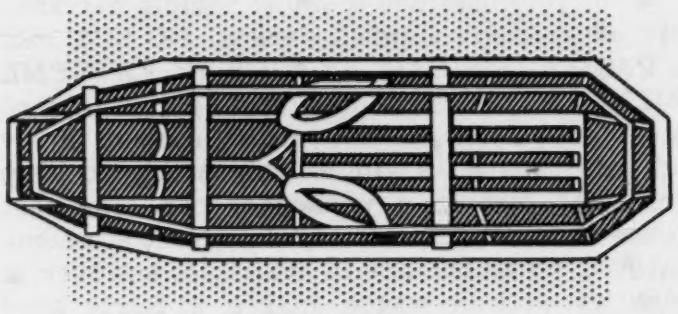

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Figure 10-15.—Stokes stretcher.

The Stokes stretcher should be padded with three blankets: two of them should be placed lengthwise, so that one will be under each of the casualty's legs, and the third should be folded in half and placed in the upper part of the stretcher to protect his head and shoulders. The casualty should be lowered gently into the stretcher, and made as comfortable as possible. His feet must be fastened to the end of the stretcher so that he will not slide up and down. Another blanket (or more, if necessary) should be used to cover him. The casualty must be fastened into the stretcher by means of the straps which go over his chest, hips, and knees. Note that the straps go OVER the blanket or other covering, and thus hold it in place.

Army Litter

The Army litter, shown in figure 10-16, is a collapsible stretcher made of canvas and supported by wooden or aluminum poles. It is very useful for transporting battle casualties in the field. However, it is sometimes difficult to fasten the casualty onto the Army litter; and for this reason its use is somewhat limited aboard ship.

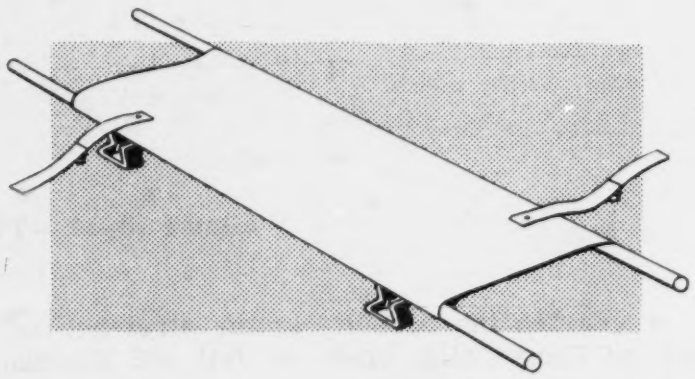

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Figure 10-16.—Army litter.

Improvised Stretchers

The Stokes stretcher or the Army litter should be used, if possible, whenever it is necessary to transport a seriously injured person. If neither of these stretchers is available, however, it may be necessary for you to improvise some way of carrying the seriously injured.

Shutters, doors, boards, and even ladders may be used as stretchers. All stretchers of this kind must, of course, be very well padded; and great care must be taken to see that the casualty is fastened securely in place.

Sometimes a blanket may be used as a stretcher, as shown in figure 10-17. The casualty is placed in the middle of the blanket on his back. Three or four men kneel on each side, and roll the edges of the blanket toward the casualty as shown in figure 10-17 (A). When the rolled edges are tight and large enough to grasp securely, the casualty should be lifted

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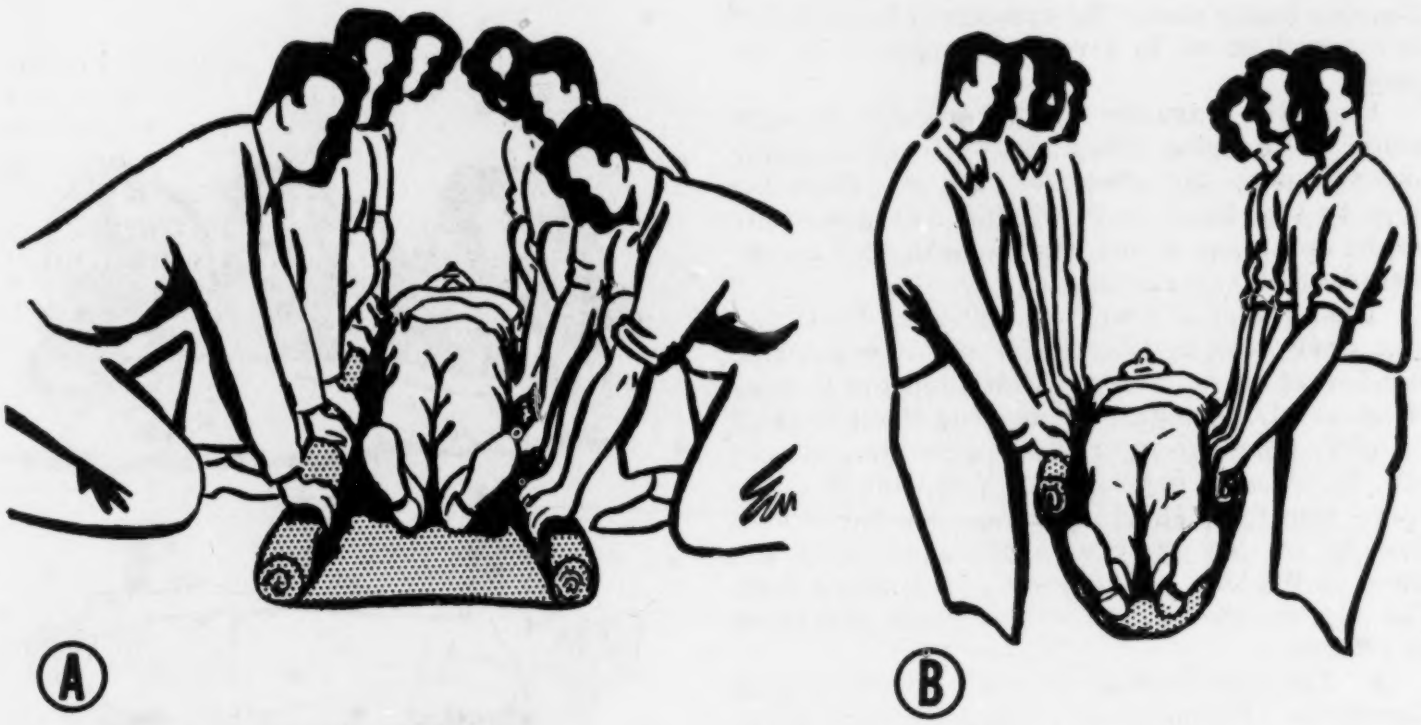

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Figure 10-17.—Blanket used as an improvised stretcher.

and carried, as shown in figure 10-17(B). CAUTION: This type of stretcher must not be used for seriously injured persons, particularly those with fractures.

Stretchers may also be improvised by using two long poles (about 7 feet long) and any strong cloth, such as a rug, a blanket, a sheet, a mattres cover, two or three gunny sacks, or two coats or jumpers. Figure 10-18 shows an improvided stretcher made from two poles and two jumpers.

CAUTION: Many improvised stretchers do not give sufficient support to be used in cases where there are fractures or extensive wounds of the body. They should be used only when the casualty is able to stand some sagging, bending, or twisting, without serious consequences.

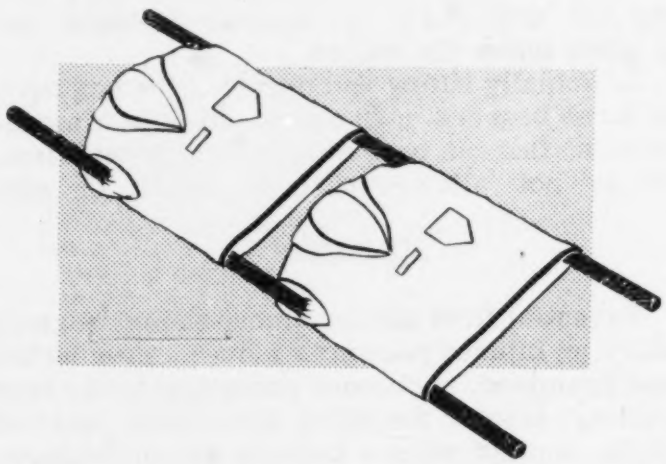

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Figure 10-18.—Stretcher made from poles and jumpers.

Loading a Stretcher

One of the best ways to lift an injured person onto a stretcher is by means of the EIGHT-MAN CARRY. This is the safest method to use when you must move a person who has a fractured neck, back, or pelvis.

The casualty is placed so that he is lying on his back. Four men kneel on each side of him, each man kneeling on the knee closest to the casualty's feet. Each man then works

his hands, wrists, and forearms underneath the casualty until the palms of the bearers' hands are directly under the midline of his head, neck, back, or legs. The bearers' hands are positioned alternately from the two sides. The two hands under the casualty's head should be clasped so as to give firm support for the head.

Keep the casualty lying perfectly straight while he is being lifted and while he is being lowered onto the stretcher. Do not allow his body to sag, bend, or twist. Lift and lower only on the command of one person, so that all movements will be synchronized.

The method of lifting described for the eight-man carry can be adapted for use by a smaller number of men, if appropriate support is provided at all essential points. The THREE-MAN CARRY, shown in figure 10-19, is often used to lift an injured person onto a stretcher or to carry him for a short distance. The three men line up on the same side of the casualty and kneel on the knee nearest to the casualty's feet. The bearers then position their hands and arms as follows:

- The bearer nearest the casualty's head places one arm under the casualty's head, neck, and shoulder, and the other under the upper part of his back.
- The middle bearer puts one arm under the small of the back, and the other under the thighs.
- The bearer nearest the casualty's feet puts one arm under the casualty's knees, and the other under his ankles.

In actually lifting and carrying the casualty, the three bearers must synchronize their movements so that his body is kept straight and firm, and is not allowed to bend, twist, or sag.

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Figure 10-19.—Three-man carry.

SUMMARY

Essential first aid treatment should be given before an injured person is moved. After he has been examined, positioned according to the type of injury, treated for shock if required, and had splints applied when a fracture is a consideration, the problem remaining is to move him to where he may be transported to a medical officer. However, at times it may be necessary to move a casualty without prior first aid treatment if his safety or life is threatened. In moving the casualty to safety, use the drag, carry, or hoist that does the least to aggravate or compound his injuries.

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Rescuing a person from certain situations presents dangers to the rescuer. Know the hazards and make use of the available protective equipment. Be sure that you know not only the uses of the protective equipment but also its limitations so that you yourself need not be rescued. Before you attempt to rescue a person, be sure that you can cope with the situation. You should be physically able to effect the rescue without unnecessarily endangering your own life. Obviously, a man who cannot swim should not jump into the water to rescue someone drowning, but it has happened. Often other means can do the job just as well, and with a greater margin of safety.

In transporting the casualty to a medical facility, use a stretcher, if one is available. If not, use an improvised stretcher that is strong enough to hold him. Place him on the stretcher in the position recommended for the particular type of injury. Transport the casualty feet first so that the rear bearer may continuously observe the casualty for breathing difficulty and hemorrhage.

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APPENDIX I

COMMON EMERGENCIES

Description	What To Do
UNCONSCIOUSNESS: Lack of awareness, lack of responsiveness. In deep states of unconsciousness, victim cannot be aroused. In partial unconsciousness, victim may show intermittent responsiveness but appear to be unaware of his surroundings. Unconsciousness is symptom of many different illnesses and injuries, including: Head injury Acute alcoholism Apoplexy Poisoning Asphyxiation Severe hemorrhage Convulsive seizures Shock Heart attack Heatstroke Heat exhaustion Prolonged exposure to cold	FOR UNCONSCIOUSNESS, WHEN CAUSE IS NOT KNOWN: 1. If victim is pale: Keep him lying down, head level with or slightly lower than feet. Keep him warm, but do not overheat him. 2. If victim is flushed: Keep him lying down, with head and shoulders slightly raised. Apply cold cloths to head. Cover victim only if he appears to be cold; be particularly careful not to overheat him. GENERAL PRECAUTIONS: Examine victim for signs of injury—hemorrhage, asphyxiation, poisoning, heatstroke, etc. In particular, be careful to observe victim's breathing. If breathing fails, give artificial respiration. However, do not give artificial respiration merely because victim is unconscious! Do not confuse unconsciousness with lack of breathing! Never attempt to give liquids to unconscious person. Never give morphine to unconscious person. Do not assume that person is drunk, merely because you find him unconscious, with odor of alcohol on his breath! If you make this assumption, you may cause unnecessary loss of life. Keep unconscious person lying down while you transport him. Get medical attention as soon as possible.

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Appendix I—COMMON EMERGENCIES

Description	What To Do
FAINTING: Brief period of unconsciousness, with spontaneous recovery. Contributing causes: Hunger Pain Exhaustion Emotional stress Symptoms: Nausea, weakness, dizziness Unconsciousness Excessive perspiration Pale, moist skin	FOR FAINTING: 1. Lower victim's head. If victim is unconscious, keep him lying down, head lower than his feet (shock position). If victim is weak, dizzy, etc., but has not yet become unconscious, have him lean over so that his head is lowered; or have him sit in chair, bend forward at waist until his head is between his knees. 2. Hold smelling salts or other ammonia inhalant under victim's nose. These stimulants are helpful in some cases. 3. If victim does not recover within few minutes, get medical care for him.
HEART ATTACK: Improper functioning of heart Symptoms: Symptoms vary greatly, depending upon basic cause. Symptoms may include: Violent, agonizing pain (present in many but not all cases of heart attack) Acute fear and anxiety Faintness Breathing difficulty Unconsciousness	FOR HEART ATTACK: 1. Keep victim quiet. If victim has trouble breathing, prop him up as much as necessary to ease his breathing. If he does not have breathing difficulty, keep him lying down. Do not let him move about. 2. Keep victim warm, but do not overheat him. 3. Reassure victim. Anxiety is likely to be intense, and may make victim's condition worse. If victim carries medicine prescribed for such attacks, help him to take it. 4. Get medical help at once.
APOPLEXY (sometimes called a stroke or a shock): Sudden collapse caused by rupture of blood vessel in brain. (Most likely to occur in persons past 50 years of age) Symptoms: Unconsciousness Paralysis of one side of body; mouth drawn to one side; one side of body more limp than other Face flushed, as a rule; but may be very pale Strong, slow pulse Pupils sometimes unequal in size	FOR APOPLEXY: 1. Keep victim lying on his back, head and shoulders slightly raised. 2. Apply cold cloths or ice bag to head. 3. Keep victim warm, but do not overheat him. 4. Get medical help at once. PRECAUTIONS: Do not move victim unless it is absolutely necessary to do so. Do not use stimulants (smelling salts, etc.) Keep victim absolutely quiet.

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Description	What To Do
CONVULSIVE SEIZURES May be caused by: Epilepsy Brain injury Poisoning Electric shock Fever, etc. Symptoms may include: Extreme restlessness and irritability Total or partial loss of consciousness Convulsive muscular movements (twitching, thrashing, jerking, biting, etc.) lasting from a minute or two to about half an hour Involuntary action of bowels and bladder. Quiet stupor or unconsciousness may follow symptoms listed above. Victim may then become conscious, or pass into deep sleep. Death rarely occurs from convulsion itself, but may occur as result of accident—victim may be drowned, burned, crushed by machinery, run over by car, etc., while unable to help himself.	FOR CONVULSIVE SEIZURES: 1. Protect victim from external injury. Move him away from dangerous place. 2. Prevent victim from injuring himself. Put folded cloth or pencil wrapped in cloth between victim's teeth to keep him from biting his tongue. Put pillow, coat, rug, etc. under victim's head to protect it from injury. Loosen all constricting clothing. Be sure victim's tongue does not fall back and prevent him from breathing. 3. Keep victim warm. 4. Watch victim's breathing. Breathing may stop as convulsive movements stop, or just before. Breathing usually begins again spontaneously. If it does NOT begin within 1 minute, start giving artificial respiration. 5. Do not disturb victim unnecessarily. Do not attempt to restrain victim's convulsive movements. Do not disturb victim during period of sleep or unconsciousness which usually follows convulsive seizure. 6. Get medical attention at once. Convulsions are sometimes (although not always) indication of serious illness.
ACUTE ALCOHOLISM: Poisoning caused by consumption of excessive amount of alcohol Symptoms: Shock, collapse, unconsciousness	FOR ACUTE ALCOHOLISM: 1. Keep victim quiet. Acute symptoms may disappear if victim is allowed to sleep quietly for several hours. 2. Keep victim warm. Cover victim, and apply external heat if necessary.

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Description	What To Do
Face flushed at first, then pale Pulse strong at first, then weak Pupils equal in size Odor of alcohol on breath CAUTION: Do not assume that victim is suffering from acute alcoholism merely because you find him unconscious, with odor of alcohol on his breath. Check him carefully for injuries and illnesses.	3. Give emetic, if victim is conscious and cooperative when you first discover him. (See chapter 5.) 4. Give liquids, when victim is conscious. Water and orange juice should be given in large quantities. Coffee may be helpful. 5. Watch victim's breathing. For greatly depressed breathing, give oxygen-carbon dioxide mixture, if apparatus is available and you know how to use it. If breathing fails, give artificial respiration.

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ABSTRACT - This primer may be used both as a basic introduction to the real estate field and as a supplementary reference or review source for applicants for a real estate salesman's license. Contents include sections on: (1) study tips, (2) licensing procedures, (3) real estate definitions and regulations, (4) land descriptions, (5) real property laws, (6) estates and interests, (7) landlord-tenant interaction, (8) mortgages, trust deeds, liens, contracts, and deeds and conveyances, (9) operation of the real estate office, (10) real property taxation, (11) water rights, plats, and subdivisions, (12) appraising, (13) real estate financing, (14) land abstracts, title, and title insurance, (15) real estate documents, (16) mathematics used in real estate, and (17) definitions of commonly used real estate words and phrases. Numbered questions similar to those in the real estate licensing examination are scattered throughout the text, and are keyed to an included answer key. Excerpts from Oregon real estate laws and rules and regulations of the Oregon Real Estate Board are also included as well as the Realtor's Code of Ethics. (AW)

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Real Estate Primer

A Basic Study Guide for the Applicant for a Real Estate Salesman's License

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PREFACE

This Primer is a basic introduction to the broad field of real estate. An applicant who will seriously apply himself to hard study of its contents should make a passing grade in the real estate examination.

It can also be an excellent supplement to the undergraduate study of real estate and as a basic review in post-licensing classes.

An applicant should realize that in preparing for the real estate examination he is in fact taking the first step toward a new mode of livelihood. If he is to be successful in this highly competitive and skilled vocation, he cannot afford to be lazy in his pursuit of knowledge.

Many fine schools and a great number of excellent texts on real estate subjects are available to him. Success in the examination and reward in practice will be measured by the extent of his use of these tools.

Throughout the text there are many numbered questions typical of those found in the examination. The best answers to these questions are found in the back of the Primer, beginning on Page 260.

When being used as a reference source, it is suggested that search first be made in the Definitions of Real Estate Words and Phrases, beginning on Page 195. A clue to information sought is often found here and, frequently, the question is fully answered.

William E. Healy
Editor

Fourth Edition - 1970

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HOW TO STUDY

Introduction

Our increasingly complex economy and society are daily making more technical demands upon us as citizens and workers. Higher levels of education and training are taken for granted in many vocations. Such trends are especially evident in the field of real estate, which is attempting to achieve higher professional standards. This is an age of the specialist. Specialized knowledge in such subjects as economics, marketing, selling, real property law, taxation, and valuation has now become a necessity. The required information may be acquired in a regular classroom or by independent study. However accomplished, the task will require study and the reading of technical works which many will find difficult.

It is the purpose of this brief presentation to sketch some of the main principles of effective study. Interestingly enough, the one course which is not taught in college is probably needed above all others. How to Study! It is taken for granted that the students know how to study; surely after 12 years of elementary and secondary education they would have acquired efficient and effective study habits. Yet it is painfully evident, as one surveys the many drop-outs and the high percentage on probation, that many of these students could have done much better with proper study habits. There are certain "tricks to the trade" in the learning process which can lead to a more satisfactory performance - often in less time. Improved study habits cannot make a genius out of a moron, but few people will fail to benefit from them.

The real estate practitioner can benefit even more than the students, for he has probably been out of school for a number of years and is rusty in his study habits. Studying will be a painful task, at best, for many. It is never too late to improve your study skills.

Your Study Schedule

For those persons taking a course or doing independent study in addition to their regular jobs, the problem of finding the time to study is not easily resolved. Ideally, one should be rested and refreshed before tackling a study period, especially if difficult reading is involved. This ideal can rarely be realized when study must be secondary to our job, but we can try to schedule our activities

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so that we establish a pattern of study at certain hours for certain periods of time. You may have to study during week-ends, or the early evening hours, or even early in the morning, during the week.

Don't study uninterruptedly for too long a time. Take a short break at least once an hour. If your attention span dwindles, it is time to take a break. It is not how long you study as how well you study. Staring dully at the book for hours on end is usually a waste of time.

The Study Setting

Selecting a proper place to study is a point which cannot be over-emphasized. Pick a spot which is as quiet as your office or home conditions allow. Those individuals who insist upon studying in front of a TV set, a blaring radio, or chattering family are only kidding themselves.

Try to reduce the elements that might distract to a minimum. Study is hard work, even under the best conditions. Anything which tends to take your mind off your work should be avoided. This includes such things as pictures or mementos on your desk which may interrupt your train of thought as you recall fond memories.

Frame of Mind

Motivation plays a major role in learning. It explains why some persons of ordinary intelligence outperform other persons of greater intelligence. Your attitude towards your work is an important element in how easily and successfully you gain a command of the material. Not every subject is of equal interest to each of us. This is reasonable. Some people, however, have a positive fear or dislike of subjects such as economics or math. Their negative attitude leads to further poor performances and a still more negative attitude.

We cannot be expected to like each topic or book equally well. It is important that we decide at the outset we will make the best of the situation. The "power of positive thinking" plays an important role here. It enables us to generate more interest in what at first seemed an otherwise dull topic. Try to capture some of the joy of learning the sense of power that comes with mastering a subject.

Four Steps to Learning

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1. Survey - A common error of many students involves plunging immediately into reading without first surveying the way the material has been organized. Consequently, they fail to grasp the main points which are usually found in the chapter titles and headings. They skip the preface - often a very important part of a book - and the table of contents. Step one, therefore, it to survey your reading; skim through it and get a good idea of its over-all structure and the main ideas. If you were actually writing a book, this would be your most important task - to organize and outline your presentation. This is the time to survey the forest before getting into the trees.

2. Reading - Experts advise at least three readings of an assignment. The first should be the skim-through which will give you an overview. The second should attempt to connect the main ideas and headings with the specific information. The third reading should concentrate on details and exact means. Don't expect to understand technical material on the first reading; otherwise, you become needlessly discouraged.

Don't real listlessly or passively. You must read actively and intently. Text books cannot be read like a novel; they must almost be grappled with as in combat. Note the lead sentences and headings and the illustrations. Many people pass these by without realizing their importance. Maps, graphs, tables, etc. may be the missing ingredient to better understanding. For especially difficult passages, some persons find it useful to read aloud as if giving a speech. They find that in trying to get across the material to a hypothetical audience they increase their own understanding. Have a dictionary handy to check the meaning of unfamiliar words.

3. Recitation - Many people read in a very passive manner, thinking they know the material. Later they find to their surprise how little they knew. They failed to check their understanding by constantly asking themselves questions about the material and attempting to explain in their own words the meaning of certain points. Recitation reveals areas of ignorance - give these special attention.

Don't think this is an unimportant rule. Recitation can make the difference in how much you remember. Stop at intervals and recite the substance of each major section of a chapter - without looking at the text! This is simply a means of doing your own tutoring.

4. Review - Almost everyone reviews before an examination but most people do not review enough and they do it at the wrong time. They wait until the last minute to do any reviewing and then try to cram the whole process into a short time. You should review the

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material at least a couple of times before the final review. (The first review is quite similar to recitation in the sense that it helps indicate those parts in which you need more work.)

Many students review by re-reading underlined passages in the text. Tests have indicated, however, that outlining the material in your own words is a superior method of summarization. A good outline is your best review device plus your class notes - if you are taking a class.

Conclusion

The suggestions and rules you have just read are based on years of educational research and tested on thousands of students. They will work if you give them a chance; but it should be emphasized that acquiring new study habits is not easy.

You will have to work hard at changing familiar - but sloppy - habits. A single hour spent on consciously improving your study habits, however, may save many more hours later in more efficient study. Above all, you should be able to improve your learning performance and become a more successful, respected member of your profession.

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LICENSE PROCEDURE

Most vocations require certain minimum qualifications for the beginner. Almost universally the standards and the method of ascertaining possession of these qualifications rests with some responsible authority.

Since 1939, applicants for an Oregon real estate license have been required to pass a written examination. The examination is prepared, conducted and graded under supervision of the Oregon Real Estate Board.

Application for a license is made upon a form supplied by the Commissioner, the payment of an examination fee of $10 and satisfactory proof of the necessary qualifications.

REQUIRED QUALIFICATIONS FOR ALL APPLICANTS

Satisfactory proof of honesty, truthfulness, and a good reputation.

At least 21 years of age, a citizen of the United States, and a resident of Oregon.

Pass an examination as to his knowledge of real estate as a vocation.

Q. What information is an individual applicant for a broker's license required to give with his application?

A. His name, address, the name under which, and the place or places where, the business is to be conducted; his previous experience in the real estate business and disclose in what occupation he was engaged for five years prior to the date of the application. Disclose whether or not he has ever been convicted or is under indictment for forgery, embezzlement, obtaining money under false pretenses, larceny, extortion, a crime involving moral turpitude, conspirancy to defraud or other like offenses; whether or not he has ever been refused a real estate broker's or salesman's license or any other occupational license and whether or not such a license has ever been revoked or suspended. The application must be accompanied by the recommendation of three resident citizens, not related to the applicant, who have owned real estate at least three

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years in the county where the applicant resides, certifying that the applicant bears a good reputation for honesty, truthfulness and fair dealing, and recommending that a license be granted.

Q. What information must a salesman submit with his application for a license?

A. The information is generally the same as that required of the broker applicant, and in addition must be accompanied by a special character-credit report from a credit reporting bureau.

Q. What subjects does the law require to be covered by the examination.

A. Reading, writing, spelling, arithmetic and computation, salesmanship, appraising, accounts, real estate ethics, real estate taxation, problems in real estate and a general knowledge of the provisions of the law.

Q. How may one prepare himself for the examination?

A. A thorough study of the Real Estate License Law, the Rules and Regulations of the Real Estate Board and Code of Ethics is recommended. A Real Estate Primer is available from the Real Estate Division at a nominal cost. There are a number of excellent private schools and courses available in many locations in the state. Most of the Community Colleges offer in-depth courses for the practitioner and the beginner, and most bookstores contain a "real estate shelf" which might be helpful.

Q. If an applicant has passed an examination and a license has been issued to him is it necessary for him to take a new examination with each annual renewal of the license?

A. No. Upon payment of the renewal fee the Commissioner will renew the license for a further period, expiring on the licensee's next birthday.

Q. Is it lawful for an applicant to engage in the real estate business as soon as he makes his application for a license and before the granting of the same?

A. No. The License must be issued and delivered.

Q. Must I find employment with a broker before taking the salesman's examination?

A. No. You have one year after passing the examination in which to activate your license.

FEES OF THE REAL ESTATE DIVISION

Each examination applied for	$10.00
Broker's license	25.00
Annual renewal thereof	25.00
License to member of firm or officer of corporation, other than person designated in application	25.00
Annual renewal thereof	25.00
Associate broker's license fee if broker's license fee has previously been paid	25.00
Annual renewal thereof	25.00
Salesman's license	15.00
Annual renewal thereof	15.00
Renewal of broker's inactive license	10.00
Renewal of salesman's inactive license	7.50
Reactivation of broker's inactive license	25.00
Reactivation of salesman's inactive license	15.00
Each additional place of business	5.00
Each change of location	5.00
Transfer of salesman's license	5.00
For each salesman, associate broker or branch office license reissued with change of name or change of location	1.00
Duplicate of broker's license	2.00
Duplicate of salesman's license	2.00
Duplicate of pocket card	1.00
Certified copies, certificate	2.00
Certified matter, per folio	.25
Uncertified copies, per folio	.25
Directory of licensees	1.00
The Oregon Manual, additional copies and to non-licensees	5.00
Real Estate Primer	
Educational pamphlets, per each	

PURPOSE AND SCOPE OF THE EXAMINATION

After meeting the minimum basic qualifications each applicant for a real estate license must demonstrate by written examination

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competence in the following:

(a) A basic knowledge of the English language, including reading, writing and spelling.
(b) An ability to compute mathematical problems related to normal real estate transactions.
(c) An understanding of the principles of real estate, which includes elementary real estate economics, transfer and conveyance of real property, deeds, mortgages, land contracts of sale, leases and appraisal.
(d) A general and fair understanding of the obligations between a principal and his agent, and the canons of business ethics.
(e) A thorough knowledge of the Oregon Real Estate Brokers' Law and the Rules and Regulations of the Real Estate Board.
(f) Familiarity with the principles of the Code of Ethics.

Examinations prepared by the Board consist of questions covering one or all of the above subjects. There also may be questions regarding the law or policy of other governmental agencies relating to real estate.

Ambiguous questions are avoided. The so-called "trick question" is never included.

The examinations are qualifying and not competitive.

Successful examination results are confidential as to grade scored.

The applicant failing to score a passing grade is notified of his grade. This is done to assist him in future study and preparation.

The law places no duty or responsibility on the Board or the Division to help in the study or preparation of an applicant for a license. This is the sole responsibility of the applicant.

The applicant can be assured of a passing grade if he meets the standards required in the examination.

The Real Estate Board emphasizes there is no quota on the number passing or failing. All examinees receiving a grade score of 75 or better will be issued a license, whereas scores below 75 will be graded as failures.

TIME IS OF THE ESSENCE

The Board recognizes the Division must have sufficient time to process applications and compile an accurate list of eligibles. This

list must be delivered to Board Members at least 5 days before the examination.

It is also recognized that each applicant is entitled to a reasonable time to complete and file his application with the Division.

Both needs are satisfied through the establishment of closing dates or "deadlines". Notice of closing dates appear in each issue of the Oregon Real Estate News, with information as to the examination to which they apply. Once the notice has been published the applicant assumes full responsibility for timely filing of his application. No machinery is available for the late filing of an application.

CLOSING DATES HAVE BEEN ESTABLISHED AS FOLLOWS:

July 15 for the August examination.
September 15 for the October examination.
November 15 for the December examination.
January 15 for the February examination.
March 15 for the April examination.
May 15 for the June examination.

NOTICE TO APPEAR FOR EXAMINATION - Salesman

Approximately 15 days before the examination an official notice to appear for examination is mailed to the applicant. The time and place at which the applicant will report is indicated.

The official notice to appear gives the applicant about 10 days for a final effort in his studies. Experience has shown at least 50 percent of all past failures have been due to inability to correctly answer the ten arithmetic questions in Section I of the examination.

To assist applicants for a license, a Real Estate Primer is available from the Real Estate Division at a nominal cost. The Primer can be used as study material in preparing for the examination.

While it is true that some examination questions may not be answered from material in the Primer, DO NOT BE ALARMED. The answers to approximately 90 percent of all questions will be found in the Primer.

THE DAY YOU APPEAR FOR YOUR EXAMINATION

Your notice for you to appear for your examination included the starting time. It will be to your advantage to arrive a few minutes

early. This will allow time for your materials to be assigned you and a few moments of relaxation.

You are again warned that you are not to perform any of the acts of a real estate salesman until after you have been notified that you received a passing grade and your salesman's license has been delivered to your broker.

The examinations are given in three Sections. Section I consists of mathematical problems typical of those confronting a real estate salesman in his daily work. The salesman's examination usually allows three points for each problem worked correctly. The number of points earned in this section has a strong bearing on the final grade.

Section II consists of questions on real estate law, real estate principles, practice and procedure, and definition of real estate terms used frequently. There are usually 50 questions of this type with credit of one point for each correct answer.

Section III requires the filling out of a Listing Agreement and an Earnest Money Receipt. In completing this section everything included in the problem must find a proper place in the document, but nothing is to be included that does not appear in the explanation.

The Board allows 18 points credit for a correct preparation of the Listing Agreement and the Earnest Money Receipt. Errors in either or both documents result in a reduction of points earned.

A two-point credit is given for excellence in spelling, writing and neatness.

The Board may change the format of the examination or the manner in which the examinations are conducted at any time when in its judgment the change is in the best interests of the Division, the licensee, or the general public.

EXAMINATION PROCEDURE

When you receive your examination papers, you will discover the only place your name appears is at the top right hand corner of the cover jacket. This portion of the jacket will be perforated and you will be instructed to remove prior to the time your completed papers are handed in. You will also observe a large red number on the cover jacket, which also appears on the first page of each section, and on the grade sheet. This number was assigned to your papers in the Salem office at the time the master eligible list was prepared. The master list is completed about ten days before the examination, and NEVER leaves the Salem office. With this system

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the applicant's identity, other than by number, is not revealed until the graded paper is returned to Salem. At that time the grades are transferred to the master list and you are then notified as to whether you passed or failed.

In the process of grading, all papers showing a grade of not less than 66 nor more than 74 are regraded by another Member of the Board. This is an extra precaution taken to avoid error.

A salesman applicant making a passing grade receives the necessary license application forms with the notification of his success. He must then procure the signature of his employer broker and return the forms to the Division with the necessary license fee. The license and pocket card will be immediately issued and forwarded to the employer broker.

If you did not pass the examination you will be promptly notified and will receive a written review of your grades by examination Sections.

If you receive a notice of failure we suggest, before you become too critical of the examination, the Board, or the Division, you review your own efforts in preparing for the examination. If you did not make a serious effort to study your grade may honestly reflect the amount of your effort. No advance information will be given by either the Portland or Salem office regarding your grade or whether or not the applicant failed or passed the examination. All such inquiries made either by letter, phone call or in person will be refused.

HOW MUCH TIME IS ALLOWED FOR THE EXAMINATION?

The time allowed to complete an examination has been pretty well established, but can vary as examination content and instruction may change.

At present all the examinations start promptly at 8:30 a.m. and must be completed at 3 p.m. As already pointed out, examinations consist of three sections. The time schedule by sections is 8:30 to 10:30 a.m.; 10:30 to 12:30 p.m.; one-half hour for lunch; 1 to 3 p.m.

Conversation is not permitted and the use of notes or references to texts is strictly forbidden. Dishonest practice of any kind will result in a non-passing grade, and may be grounds for denying future examinations.

QUESTIONS AND ANSWERS

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Some of the most frequently asked questions pertaining to examination procedures are answered here:

Q. If for any reason it is impossible for me to appear for my examination on the date I am eligible, will my name be placed on the list for the next examination?

A. Before your name can be placed on the list to take a succeeding examination, you must again file your application and remit a second examination fee of $10. The original fee was forfeited regardless of reason for failure to appear.

Q. I have been told if I fail two successive examinations I will not be permitted to take another examination for one year.

A. Your information is correct. The law provides that an applicant who fails two successive examinations shall be ineligible for another examination until the expiration of one year from the date of the last examination.

Q. If I fail my examination will I have an opportunity to review my papers with someone in the Division or with a Member of the Board?

A. No. Each applicant failing to make a passing grade receives a written review of his examination as soon as possible. The Members of the Board will not conduct personal reviews, and prohibit any member of the Division from doing so.

Q. I have been told there is a fund which the Commission may use for educational programs. Why isn't this money used to assist applicants in preparing for the examinations?

A. The law specifically provides this money can be expended for conducting educational meetings for the benefit of licensed real estate brokers and salesmen. An applicant has not qualified as a salesman until he has passed the examination and has been issued a salesman's license. The Commissioner has held, however, that applicants for a license may attend educational meetings if all of the available accommodations are not occupied by licensees.

Q. Will the Division forward to me copies of the examination papers which have been previously used?

A. No. Examination papers are confidential. The Board has ruled they be destroyed after each examination.

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Q. After I have completed the examination, may I work as a salesman until I have been notified that I either passed or failed?

A. No. The law provides that after passing the examination, neither a broker or salesman can work until he has received his license. It is suggested you review Rule 10-055 of the Rules and Regulations of the Real Estate Board.

Q. After I pass my examination, how long have I to pick up my license?

A. A successful broker or salesman examinee must pick up his license within one year from the date he wrote the examination. Failure to do so within the one year period will require the applicant to submit again to the written examination.

EXAMINATION QUESTIONS

Questions and arithmetic problems asked in the real estate examinations are typed on legal size sheets of white paper.

There are usually five questions on each single sheet, all of the sheets to each section being stapled together with side staples. Sufficient blank space is allowed below each question for the applicant to write in the answer. Pencils with erasers are supplied the applicants.

The arithmetic problems are typed on the examination sheets in the same manner. Usually two problems are shown on each sheet, although this may vary from time to time.

Below the typewritten problem, and to the right side of the page, a ruled box is provided for the answer to the problem. There is adequate blank space below each question for the necessary computation.

SAMPLE QUESTIONS AND PROBLEMS

A number of questions and problems similar to those used in examinations are found on the following pages of this Section. The questions and problems have been correctly answered, but the computation for the arithmetic problems is not shown. It could be excellent exercise to see if your computations produce the same answers.

QUESTIONS

Q. Is a charge for water furnished by the city a lien on real property?

A. No.

Q. A broker sells a $10,000 home on a contract of sale with a small down payment. Should the earnest money agreement provide for the furnishing of a purchaser's title insurance policy forthwith or at a later date when the buyer will have paid in a substantial amount on the purchase price?

A. Should be furnished at time of sale in order to protect both buyer and seller, no matter how small the down payment.

Q. What is a percentage lease?

A. A lease of property in which the rental is an amount equivalent to a stated portion of the receipts from the business conducted by the lessee.

Q. What is a party wall?

A. A dividing wall erected upon and over a line separating two adjoining properties and in which the owners of the respective parcels have common rights to its use.

Q. What is a life estate?

A. A freehold interest in land, the duration of which is confined to the life of one or more persons or contingent upon certain happenings.

Q. What is the maximum rate of interest that can be charged an individual on a real estate mortgage in the state of Oregon?

A. 10 percent.

Q. What is meant by the covenant of seizin?

A. A covenant of seizin is the grantor's guaranty that he is the owner of the property and has the power to convey title.

Q. What is meant by "curable depreciation"?

A. Any defect that can be cured. It is measured by the cost to cure.

Q. Is title by adverse possession just as valid as title by written instrument?

A. Yes.

Q. For what purpose is a deed recorded?

A. To give notice to the world.

Q. What is the legal rate of interest in Oregon?

A. 6 percent.

Q. If a purchaser assumes and agrees to pay a mortgage indebtedness, does that relieve the original mortgagor of the obligation? Explain.

A. No. He is liable for the debt until it is paid.

Q. A seller makes a counter offer which is refused by the purchaser. Can the seller then hold the purchaser to his original offer? Explain.

A. No. A counter offer cancels the original offer.

Q. A quit claim deed warrants and guarantees nothing. What is it used for?

A. To remove a partial or possible interest.

The questions in Section II of the examination consist of essay type, multiple-choice, or both. Samples of multiple-choice questions follow:

Q. The maximum rate of interest on a G. I. guaranteed loan is (a) 6%, (b) 8½%, (c) 7½%, (d) 4%.

Answer: b

Q. A quit claim deed is used to (a) bequeath property, (b) remove tenants, (c) pay assessments, (d) relinquish an interest.

Answer: d

PROBLEMS

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Q. On September 1, 1969, a house was insured against fire for 90% of its $24,000 value. The insurance rate was $.54 cents per $100 for a three year period. The house was sold February 1, 1971. What was the unearned premium to be charged the buyer?

Answer: $61.56

Q. What is the annual interest rate on an $8,000 loan when the interest payments are $80 per quarter on the full amount?

Answer: 4%

Q. A lot 65 feet wide and 150 feet deep sold for $7,670. What was the price per front foot?

Answer: $118

Q. The owner of a block of 14 building lots, each with a frontage of 75 feet, desires to realize $33,750 from the sale thereof, withholding, however, two lots for himself. What must be the sale price per front foot?

Answer: $37.50

Q. If John Doe purchased an apartment building for $40,000 and the total amount of the rents received was $6,000 annually, and the annual expenses totaled $2,000, what percent does his investment pay?

Answer: 10%

Q. A fire insurance policy was taken out for three years dated June 1, 1969, and premium paid for three years was $36.00. The property was sold January 1, 1971. How much would you prorate to the buyer?

Answer: $17.00

Q. The value of a frame house at the end of six years was estimated to be $7,650. What was the original cost of the house if the yearly rate of depreciation was 2½%?

Answer: $9,000

Q. What is the cost of a tract of land 264 feet wide by 660 feet deep at $800 per acre?

Answer: $3,200

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Q. If you contracted to sell the southwest quarter of the southwest quarter of the northwest quarter of a section of land, how many acres would be in the parcel sold? Assuming the larger square below to be one section of land, sketch in the location of the above parcel.

Answer: 10 acres

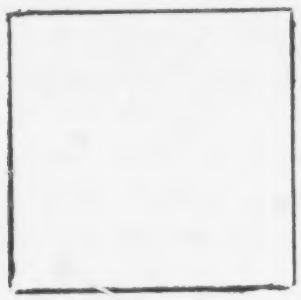

Q. 1 A property produced an 8% gross return on a $10,000 purchase price for a one-year period. The owner's only expense resulted from a 6% annual interest charge on a $9,000 lien against the property. What is the percentage of return the owner is realizing on his equity?

(A) 8%
(B) 10%
(C) 12%
(D) 26%

(Answer on Page 260)

REAL ESTATE - DEFINED AND REGULATED

Property is the right or interest of an individual in anything subject to ownership. Protection of this right or interest by society is a product of the free enterprise system.

Real Property is defined as the land, and generally, whatever is erected, growing upon, or affixed to the land.

Realty was formerly used to designate the land, but is now in common usage as a synonym for real property.

Personal Property is defined as everything that is the subject of ownership not coming under the domination of real estate. Personalty is frequently used to designate the thing itself.

The Legal Concept of Land is that it is not limited to surface boundaries, but that it extends upward to the sky and downward to the center of the earth.

Legal Rights arising in the ownership of real estate embrace possession, control, enjoyment, disposition, or right to do nothing at all.

Governmental Limitations on the ownership of real estate, enforced for the common welfare of the community, are police power, eminent domain, taxation and escheat.

Real Estate has two commonly accepted meanings as a result of commercial usage, although the words taken separately have historical origins in the ownership of property. The phrase is commonly employed interchangeably with realty and real property, and it is used to designate those persons engaged in commercial transaction or management of this commodity.

Administration of the Real Estate Division is under the supervision of the Real Estate Commissioner, who is appointed by the Director of the Department of Commerce and serves at his pleasure. He is charged with supervision of the activities of brokers and salesmen throughout the state, and has power to suspend or revoke licenses.

All correspondence relating to matters pertaining to the real estate division and the administration of the real estate law should be addressed to: REAL ESTATE COMMISSIONER, 158 12th Street NE,

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Salem, Oregon 97310.

The Oregon Real Estate Board consists of the commissioner and four experienced brokers appointed by the Director. Duties of the Board are: "to inquire into the needs of the real estate licensees of Oregon, the functions of the real estate division and the matter of the business policy thereof, to confer and advise with the Director as to how such division may best serve the state and the licensees, and to make recommendations and suggestions of policy to the real estate commissioner as said board shall deem beneficial and proper for the welfare and progress of the licensees and of the public and of the real estate business in Oregon." The Division is expressly authorized to make and enforce any and all reasonable rules and regulations deemed necessary to administer the provisions of the Act. Further, the Division may prepare and "circulate" among licensees such printed matter as it may deem helpful or educational.

In addition, the board is required to prepare questions for the examination of applicants for licenses, to conduct the examinations, grade the papers submitted by applicants and certify who have failed and who have passed.

Known as Chapter 696, Oregon Revised Statutes, Real Estate Brokers and Salesmen, the law has for its purpose:

To define the business of real estate brokers, associate brokers and real estate salesmen; to regulate and supervise the activities of all those engaged in real estate business as brokers, associate brokers and salesmen; to require those engaged in such business to have licenses; to provide methods for the suspension or revocation of such licenses in case of violation; to provide a real estate commissioner to administer the law and a real estate board to conduct the required examinations and act in an advisory capacity, all for the purpose of serving licensees, providing for their welfare and progress, with due regard for the welfare and interests of the public.

SOME EXPLANATIONS

Questions frequently asked of the Division pertaining to administration of the Act, together with the answers, follow:

Q. What is meant by the word "compensation" as used in the definition of real estate broker?

A. The word "compensation" means and includes any fee, commission, salary, money or valuable consideration for services rendered or to be rendered as well as the promise thereof and whether contingent or otherwise.

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Q. Does the term "valuable consideration" as used in the definition of a real estate broker, mean only a money consideration?

A. No. A valuable consideration may consist of property, the rendition of services, the granting of a favor, or anything which the parties themselves or the law deems to be of value; even slight value, will be enough to constitute "valuable consideration".

Q. Does the term "real estate" as used in the Act refer only to the land itself, without improvements?

A. No. The term "real estate" includes all buildings, fixtures and improvements attached to the land, and includes standing timber.

Q. What is meant by the term "associate real estate broker"?

A. An associate real estate broker is a person who has qualified as a real estate broker, who works for a designated broker and whose license states he is associated with a designated broker.

Q. What is meant by the term "real estate salesman"?

A. A real estate salesman means any person, who, for compensation or in the expectation or upon the promise thereof, is employed or engaged by a licensed real estate broker to do any act or deals in any transaction listed in the definition of a "real estate broker" for or on behalf of such licensed real estate broker.

Q. Does the word "person" as used in the Act include within its meaning individuals, firms, co-partnerships, associations and corporations?

A. Yes.

Q. How many acts as a real estate broker or as a real estate salesman will require a person engaged in such activity to take out a license?

A. One.

Q. Is it unlawful to carry on or hold one's self out as a real estate broker or salesman without having a license?

A. Yes. The Act prescribes severe penalties for the unlawful practice of real estate.

Q. What are the penalties for violating the provisions of the Real Estate Broker's License Act?

A. Upon conviction, for a first violation, a fine of not less that $200 nor more than $500 or by imprisonment for a term not exceeding ninety days or by both such fine and imprisonment; for a second or subsequent violation, a fine of not less than $500 nor more than $1,000 or by imprisonment for a term not exceeding two years or by both such fine and imprisonment. Such violation would be considered a misdemeanor.

Q. 2 The "legal concept of land" is that it is:

(A) capable of being inherited
(B) not limited to surface boundaries, but extends from the sky to the center of the earth
(C) heterogenous, incapable of being moved and limited in quantity
(D) a statement identifying location and boundaries

Q. 3 What does the term "improvements" mean in a real estate transaction?

(A) everything except the land
(B) additions to property since last sale
(C) fixtures and personal property
(D) streets, curbs, sidewalks and utilities

LAND DESCRIPTIONS

ORIGIN OF SURVEYS

Under the constitution of the United States, all real property located within the boundaries of the original Thirteen Colonies became the property of the state when the colony became a state. This left no public land within the boundaries of the original colonies.

All of the property of the Thirteen Colonies was described by "Metes and Bounds." This means that the legal description was by direction and measurement from some designated starting point. The starting point was called a "monument." Many of the early descriptions had as their starting point the foot of a mountain, the bank of a stream, or, in some cases, even a tree or stump. Later this often gave rise to disputes and difficulty in determining the boundaries of a property.

As additional land was acquired by the government it was necessary to prepare for settlement tracts which were known as "public lands." These public lands had to be divided up into suitable parcels for sale and homesteading.

In 1784 the Continental Congress appointed a committee to devise a system of land measurement. The first plan called for the dividing of the public lands into tracts that were 10 miles square. These tracts were further divided into 100 smaller parcels one mile square. The tracts were numberer from 1 to 100 beginning in the Northwest corner and numbering to the East then back West. This system was used to some extent in Virginia but did not meet with wide acceptance.

In 1785, Thomas Jefferson suggested to the Continental Congress that the unit of measurement be a block of land six miles square. These new units were called "Congressional Townships" but later became known as just townships. The units were further divided into sections one mile square. The sections were numbered beginning at the Southeast corner and numbered West and back to the East. This was later changed to begin the numbering at the Northeast corner and numbering West, then back East. This procedure has continued up to the present time.

THE RECTANGULAR SYSTEM

The present system known as the "Rectangular System" was adopted in 1805. This system was first used in the Northwest Territory. Most of the land west of the Mississippi River was surveyed in this way with the exception of Texas. The surveying of the public lands was done by the General Land Office of the Government.

In making any survey it is necessary to have a "starting point." By an act of congress in 1850, the Surveyor General of the territory of Oregon was required, on the order of the Secretary of the Interior, "to cause a base line and meridian to be surveyed, marked and established, in the usual manner, at or near the mouth of the Willamette River." Following this order the territorial Surveyor General established for the States of Oregon, Washington, and Idaho a north and south line called the Willamette meridian, and an east and west line called the base line. These lines intersect at a point in Multnomah County, Oregon, about three miles west and slightly north of the present county court house in that county. The Willamette meridian extends from the northern border of California to the southern boundary of Canada. The base line extends from the Pacific Ocean into the state of Idaho, but not completely through the state.

Lines are surveyed every six miles parallel to both the Willamette meridian and the base line. The lines parallel to the meridian mark off the land into strips 6 miles wide. These strips are known as "ranges" and are numbered east or west of the Willamette meridian. The lines parallel to the base line at six mile intervals cut the ranges into squares known as "townships." These townships are numbered beginning with 1 both north and south of the base line. A description of a township might read "township 5 north, range 2 west of the Willamette meridian and base line."

Because the earth is curved, the north and south lines become closer together as they proceed north. This means that the six mile blocks are not exactly square. Therefore, each township does not contain a full 36 square miles. This variation at the north end of each township is approximately three rods or 49½ feet narrower at the north end than at the south. In order to keep the meridian lines as near 6 miles apart as possible a "correction line" or jog is made every 24 miles as the line continues north. The survey is moved over so that the lines are again 6 miles apart.

After a township has been surveyed, the sections are numbered beginning at the northeast corner and numbering west and then back until all of the 36 sections are numbered. It is evident from the above discussion that not all of the sections would contain a full 640 acres. The survey is usually made north and south from the base line and east and west from the prime meridian, the tier of sections on the north side of a township, north of the base line, would be compressed to less than a full section. The same would be true of the tier on the west side of the township. Rather than make each section less than 640 acres all of the discrepancy is taken out of the eleven sections known as "fractional sections." (See illustration.) Each township is made up of 25 full sections and 11 fractional sections.

N

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Township

N

6	5	4	3	2	1
7					
18					
19					
30					
31					

Sections in a township in which fractional eighths appear. Namely Sec. No. 1-2-3-4-5-6-7-18-19-30-31

These fractional sections on the sides of a township are surveyed so that the sections from 1 to 6 of all sections north of the base line have a full 320 acres in the south half of the section. Then the north half is then divided so that the south one-half of the northeast quarter contains a full 80 acres. The same is true of the south half on the northwest quarter.

This leaves the N. ½ of the N. E. ¼ and the N. ½ of the N. W. ¼ as being the units that have less than a full 80 acres. In sections 6, 7, 18, 19, 30, and 31 the deficit is placed in the west half of the section instead of the north half. Since section 6 has two deficits levied against it, the result is that only the S. E. ¼ is a full quarter section unless the deficit is allocated in some other way. In practice surveyors attempt to establish as many full 80 acre tracts in a section as possible. The description of the deficit portions given above applies only to townships which are north of the base line and west of the Willamette meridian. Those east of the meridian and south of the base line would change according to their relation to the prime meridian and base line.

Since the numbering of the sections always begins at the northeast corner this section is always numbered 1. The numbering then proceeds to the west so that the last section in the tier is number 6 and the section directly below it is number 7 and the numbering proceeds back to the east, so that the last section in the southeast corner of a township is always number 36.

The sections can also be divided into halves, called the north and south halves or the east and west halves. The halves can be further divided into quarters called the northeast, northwest, southwest and southeast quarters. These quarters in turn can be divided as far as necessary.

The rectangular system therefore affords a comprehensive and complete system for the prompt location of any land in an area. It also makes it possible to divide up parcels or combine them at will.

SUBDIVISION OF SECTION
5,280 Feet

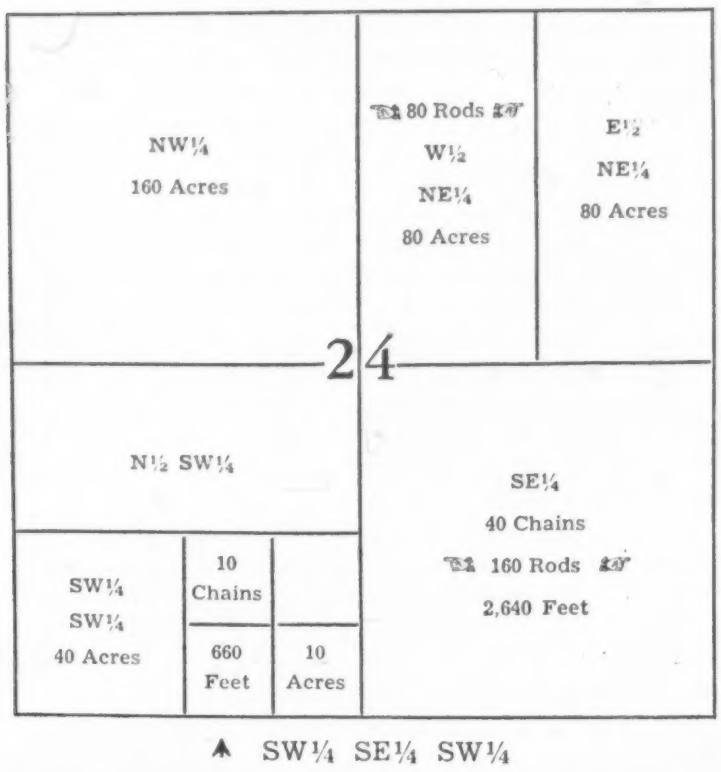

METES AND BOUNDS DESCRIPTION

In a metes and bounds description the piece of land is described by giving its boundaries. If natural objects such as trees, streams, or stone monuments are used to form the boundary no attempt is made at an accurate measurement as to distance and angles. This is called an informal survey. The same piece of land bounded by a description from accurate measurements made by surveying instruments is called a formal description.

The first requisite of a metes and bounds descriptions is a definite and stable starting point; for example, the intersection of the center lines of two streets. The boundary lines must be run continuously from one point to another, returning to the starting point, so as to produce a closed area. A description which fails to enclose a tract of land is fatally defective.

From the point of beginning the description recites the course or direction and the length of each succeeding boundary line. The course is stated by giving the bearing of the line. The bearing of a line is its angular deviation measured in degrees, minutes and seconds from, as a rule, a true north and south line. Visualize a circle, whose circumference contains 360 degrees, with each degree composed of 60 minutes of 60 seconds each. Divide the circle in four (4) equal parts by a line running north and south and a line running east and west through the center of the circle.

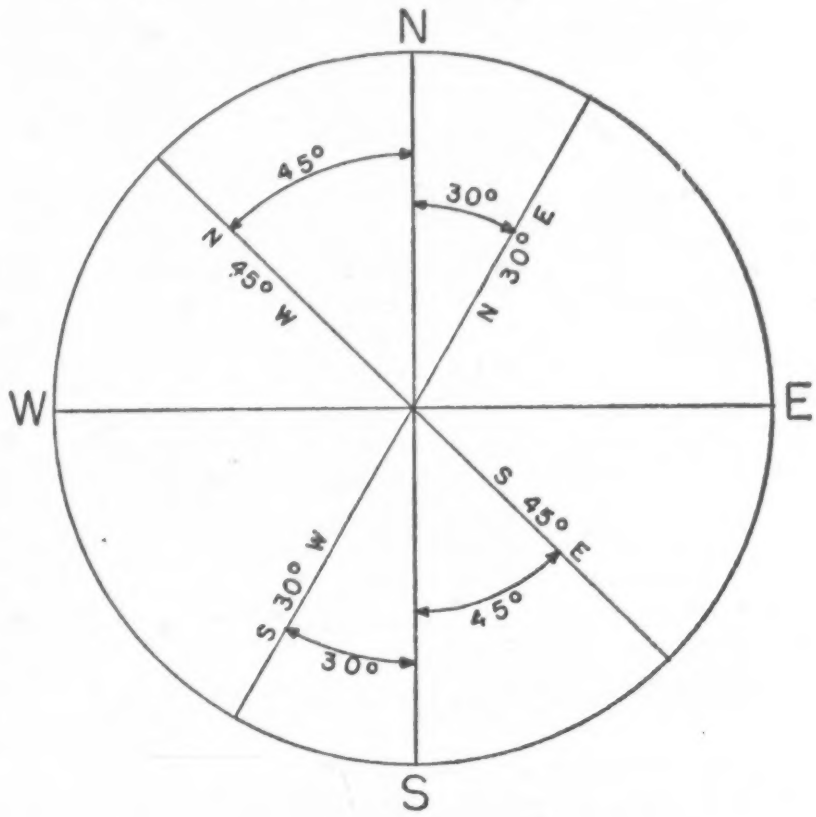

The north and south line has a bearing of 0 degrees, the east and west line bears 90 degrees. With the point of beginning at the intersection of the two lines, the bearing of the course is described by measuring easterly or westerly from the north and south

line to a maximum of 89°, 59′, 59″. Thus, if the direction of a line measures 30 degrees from north towards east, the bearing of the line is stated as "North 30 degrees East" or merely "N. 30° E." If the angular deviation is greater than 90°, the measurement is not given, for instance, as 135° but as 45° east of south or "S. 45° E."

The length of the line whose bearing has been given is then added and this completes the description for that particular line. This is repeated for each new line until the point of beginning is again reached and an enclosed area is described.

An example of a metes and bounds description is:

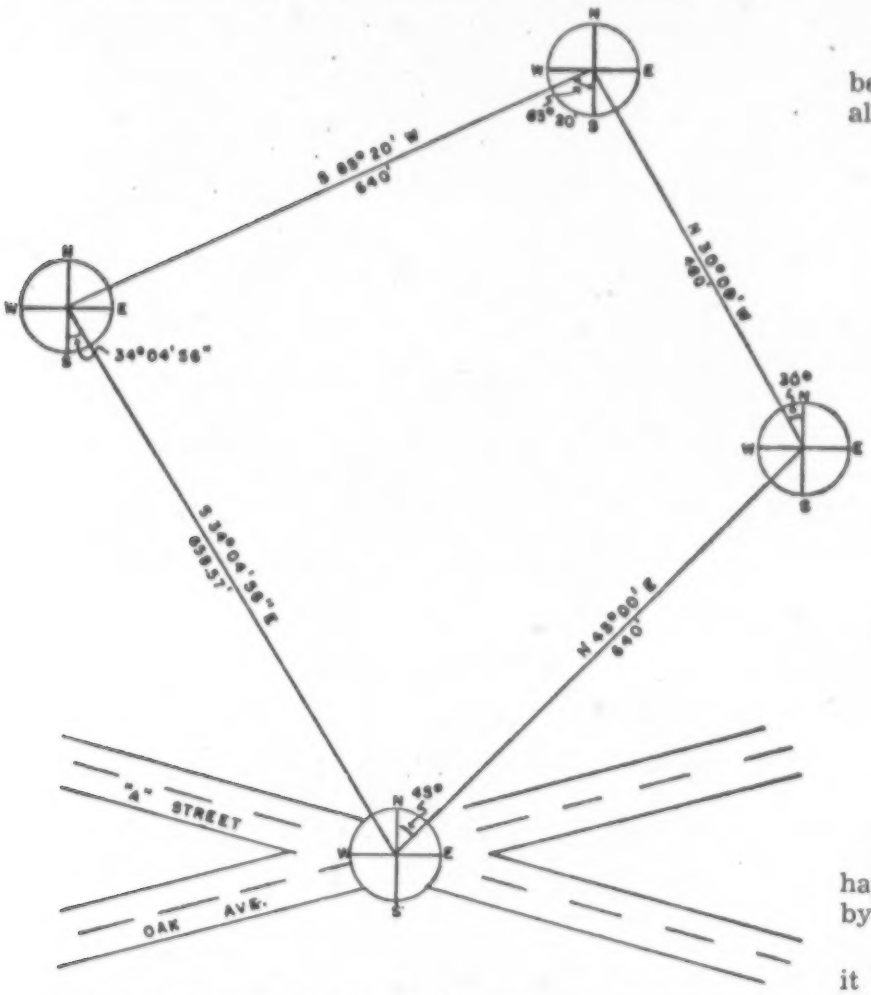

That portion of the SW¼ SW¼ of Section 32, Township 7 South, Range 3 West, Willamette Meridion in the County of Marion, State of Oregon.

Beginning at the intersection of the center lines of "A" Street and Oak Avenue, the real point of beginning; thence

North 45 degrees 00 minutes East (N. 45° 00′ E.) 640 feet to a point; thence

North 30 degrees 00 minutes West (N. 30° 00′ W.) 480 feet to a point; thence

South 65 degrees 20 minutes West (S. 65° 20′ W.) 640 feet to a point; thence

South 34 degrees 04 minutes 56 seconds East (S. 34° 04′ 56″ E.) 658.57 feet to the point of beginning.

To all metes and bounds descriptions, either formally or informally surveyed, should be added the name of the county and the city, if it is within the limits of a city.

RECORDED PLAT DESCRIPTIONS

Much agricultural land has been subdivided in recent years for building purposes. The requirements for such subdividing are given under the topic of Plats and Subdivisions. After a plat has been recorded it is only necessary for a legal description to refer to the recorded map and the name of the subdivision. Since the lots are numbered and the blocks numbered or named a legal description might read:

Lot 5, Block 1 of the Hilldale Tract, City of Portland, County of Multnomah.

In some cases a lot plus a part of another lot might be for sale, both parcels having an easement for an alley. The legal description for this sale might read:

All of Lot 5 except the northerly 15 feet, dedicated for alley purposes, and the easterly 10 feet of Lot 4, except the northerly 15 feet, dedicated for alley purposes, all in Block 1, Hilldale Tract, City of Portland, County of Multnomah.

Table of Land Measure

Linear Measure

1 link	=	7.92 inches
1 rod	=	25 links, 16½ feet, 5½ yards
1 chain	=	100 links, 66 feet, 4 rods
1 mile	=	5,280 feet, 320 rods, 80 chains

Square Measure

1 acre	=	160 sq. rods, 10 sq. chains
1 section	=	640 acres
1 sq. mile	=	640 acres
1 township	=	36 sq. miles

Legal Description of Land

How important is a legal description of land? Perhaps this question should be asked more frequently by those of us who deal in real property.

When land is purchased or sold it is necessary that it be accurately and clearly described. There can be no doubt in the minds of either the seller or purchaser as to the tract of land to be conveyed. Yet too often it is considered as merely a matter of filling out a printed form, especially in listing agreements or earnest money receipts.

Land is unlike any other commodity in that it is lacking in segmentation or natural divisions. It comes to us a mass of area upon which we must make artificial divisions or boundaries. Only when land is completely enclosed by such boundaries can it be properly described.

The sufficiency of the description is most important and upon its accuracy will depend the success or failure of a real estate transaction. There are of course the three basic methods of describing real property, namely—

1. Metes and bounds descriptions.
2. Government rectangular survey system.
3. Lot and block or recorded plat method.

In addition to the above basic methods of describing real property there are in use other types of descriptions, which when used may be sufficient but are fraught with danger. Many times reference is made by street number, tax lot number or some other method of describing a parcel in an informal manner. Each of these latter methods may describe the premises sufficiently to be good as between the parties but insufficient to properly indentify the boundaries with reference to adjacent lands.

The most common practice of describing the subject property in an informal manner is through the use of the street address. It is true that in many instances the property can be identified but not with certainty. In urban areas where street addresses are used with frequency many properties lie in two or more separate or distinct recorded plats.

Another situation which often occurs is that of a parcel of land which has been acquired by the owner by two or more purchases. The property being sold may consist of a main parcel to which has been added at a later date a garden tract or other parcel, perhaps containing valued improvements. In checking the assessor's records to ascertain the correct legal description it frequently happens that only a portion of the premises are identifiable from the street address. It should be remembered that street addresses are assigned on the basis of 50′ parcels and a given street address may only identify a portion of the premises. If it is necessary to use a street address then most definitely the dimensions of the tract should be specified. This will enable the title company to check the description with some degree of certainty.

The use of the tax lot number should also be approached with caution. A tax lot number is an assigned number principally for the convenience of the assessor which will enable his office to identify a particular parcel. This number is identified further on the records of the assessor by a metes and bounds description. Because it is a number for the assessor's convenience it at times changes, especially if a smaller tract is carved out of a larger area. For this reason the use of a tax lot number to identify the parcel should be combined with a reference to the particular year the tax lot number appears on the assessment roll. If this is not done the result may be a conveyance of an entirely different parcel of land than that which was intended to be conveyed.

At times reference is made in an earnest money receipt to all of the seller's land in a particular area. Such reference has been upheld by our courts if the land can be identified with certainty. It may require a lawsuit to do so and for this reason this type of description should not be used. An example of such a situation leading to confusion was the subject of an Oregon Supreme Court decision wherein the court refused to uphold an earnest money receipt which called for the sale of seven lots owned by the seller on a particular street. Because he owned eight lots on that street the court held there was no contract because the seven lots could not be identified with certainty.

A more recent decision, decided in May of 1964, involved an earnest money receipt which contained the following description:

"Residence and property belonging to Susan Lehman located at 3805 N. W. Saltzman Road, Portland 10, Oregon. Said property consists of approximately 39 acres and fronts on two sides of N. W. Thompson Road and one side by Saltzman Road. Legal description to follow."

The court had this to say:

"The seller's land at the location in question actually contained slightly more than 46 acres. The trial court could not discern from the agreement which 39 of those acres the parties intended to buy and sell. Neither can this court.

"The post office address (3805 N. W. Saltzman Road, Portland 10, Oregon) adds nothing to the description when the land to be sold a part of a larger tract generally sharing the same postal address. Three physical boundaries (N. W. Thompson Road on two sides, and Saltzman Road on one side), which ordinarily would be of some value in identifying the land to be sold, in this case apply as well to the entire tract. The approximate acreage is a clue to the intent of the parties, but in this case the question remains, what 39 acres?"

A reference to a recorded document such as a deed or mortgage which contains a correct legal description is an acceptable method of describing a particular parcel.

Every effort should be made to ascertain the correct legal description. If such description cannot be obtained at the time of listing a parcel for sale, most certainly it can be obtained in most cases before it becomes necessary to include the description in an earnest money receipt. The owner has his records and documents from which the description can be ascertained, or lacking this your title insurance company will be most happy to obtain the correct legal description—this extra precaution may save a deal or a lawsuit.

ENTRY ON LAND FOR U. S. EXPLORATIONS AND SURVEYS

Oregon law provides that "any person employed in the execution of any survey authorized by Congress may enter upon lands in Oregon for lawful objects, and may establish permanent station marks, and erect signals and temporary observatories."

This person must pay or tender compensation to the owner. If they cannot agree on the compensation the county court will assess the damages.

Q. 4 An area of 24 square miles is divided into how many townships?

BASIS OF REAL PROPERTY LAW

When we speak or think of "property" we usually have in mind the thing itself - an automobile or a parcel of land. Technically, and in a legal sense, however, the word does not mean the thing owned, but refers to the right or interest that a person has in the thing he owns. These rights include the right to possess, to use, to encumber, and to dispose.

It has often been said that there are as many interests in land as there are leaves on a tree. It is impossible to visualize the numerous and varied interests which can be held in the title to real property. Such interests are at times well defined and at other times are subject to much conjecture, and frequently do require the interpretation of our courts.

COMMON LAW EXPLAINED

Determination of rights in land in Oregon depends upon both the "Common Law" and "Statutory Law".

"Common Law" is contrasted with and opposed to "Statutory Law". As used in this state, "Common Law" comprises the body of those principles and rules of action relating to the government and security of persons and property which do not rest for their authority on any express and positive declarations of the will of the legislature. In other words, "Common Law" will prevail in Oregon unless such law has been abrogated by statutory law.

Interpretations of "rights", "interest" and "estates" in land is not only interesting, but also exacting. The rights acquired by single persons, married persons and groups of persons are referred to as fee simple estates, tenancies by the entirety, tenants in common, joint tenants, and tenants for life in common with the right of survivorship, and must be resolved beyond a reasonable doubt.

The extent of such rights depends upon an accurate interpretation of various legal documents in the "chain of title", such as deeds, wills, leases, suits, etc., in relation of either statutory or common law. For the real estate practitioner this service is usually performed by the title insurance company when it issues a policy insuring the ownership of an interest in real property.

ACTIONS AT LAW

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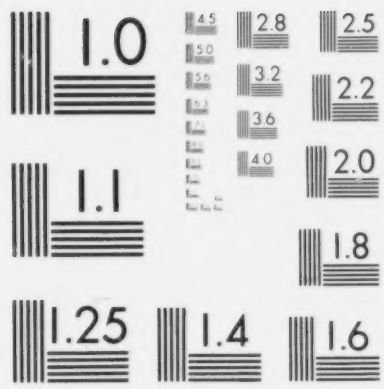

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Oregon law requires that actions shall be commenced and tried in the county in which the subject of the action, or some part, is situated if it is an action for the recovery of real property, or an estate or interest therein, or for injuries to real property; for the partition of real property; foreclosure of a lien or mortgage upon real property; for the determination of an adverse claim, estate or interest in real property, or the specific performance of an agreement in relation thereto.

SOME DEFINITIONS

Judgment is the final determination of the rights of the parties in an action or special proceeding.

Decree is the final determination of the rights of the parties to a suit.

Order is any intermediate determination.

Line and Partition Fences

Under Oregon law an owner of land who makes use of a line fence already erected by his neighbor to enclose his own property becomes liable to the neighbor for one-half the value of the partition fence. Both parties are then liable for the repair or rebuilding of the partition fence.

If either of the parties think it proper to vacate his part of the inclosure he is at liberty to do so by giving the other party six months written notice. The second party can prevent removal of the partition fence if, within two months, he pays a sum agreed upon by the parties or arrived at by arbitration.

When any person builds, by mistake and in good faith, a fence on the land of another, he may go upon the land of the other to remove the fence at any time within one year. The owner of the land on which the fence was mistakenly erected cannot remove or destroy the fence during the one year period.

Enforcement of Judgments and Decrees
Executions and Exemptions

EXECUTIONS

We are familiar with the fact that there are but two ways to transfer title to real property during the lifetime of an owner thereof. These are by voluntary and by involuntary sales, both of

which are discussed under other headings in this Primer. Involuntary sales are made pursuant to statutory or judicial authority and generally are without the co-operation or consent of the owner, hence the designation of "involuntary". Such sales are usually the result of disputes, neglect, financial reverses, or the incapacity of the owner to act.

An execution sale is made by an officer of the law pursuant to power conferred by the statute and differs from a judicial sale, which is made by the court or by an agent of the court.

A "writ of execution" may be construed as a command to execute the judgment of the court.

Present day writs of execution are issued by the clerk of the court and directed to the sheriff. Such writs require the sheriff to first satisfy the judgment "out of the personal property of the debtor or if sufficient personal property cannot be found, then out of the real property belonging to him on the day when the judgment was docketed in the county or at any time thereafter". A purchaser at such sale does not necessarily get a marketable title free from liens or encumbrances. The adequacy of the sale and the title which the purchaser receives depends upon the sufficiency of the judgment. A judgment is always the result of a law suit. In order to have a valid and binding judgment, it is necessary to procure proper jurisdiction over the defendant. That is, he must be properly served with summons in order that he be afforded the opportunity to defend the suit. He is entitled to his day in court.

Assuming that service is sufficient, that the defendant has had his opportunity to defend, then the purchaser will receive the title that the judgment debtor had. Such title may be free and clear or it may be subject to liens, encumbrances and defects. The purchaser will take title subject to all such prior liens against the premises.

The title in the purchaser is further subject to the right of redemption of the previous owner or judgment debtor. Also, the right of redemption of any junior lien holder whose lien may have been cut off by the execution sale. The right of redemption of the owner is for a period of one year from the date of sale. That of junior lien holders, sixty days from either the date of sale or from the date of the last redemption.

SECURED, UNSECURED JUDGMENTS AND ATTACHMENTS

In the foregoing we discussed execution sales in general. Such sales follow the entry of a judgment which is the result of suit either

for damages or for the recovery of a debt. Judgments fall into two groups, secured and unsecured.

Secured judgments are the result of the foreclosure of a mortgage or other lien or the final determination of an action wherein specific property has been attached. A decree of foreclosure of a mortgage or lien or the final judgment based upon an attachment will provide that the real property be sold to satisfy the debt.

Such execution sales are referred to as special executions simply because they are directed to a specific parcel of real property. Otherwise the procedure is the same as a sale under a general execution sale.

In the foreclosure of a mortgage or other lien, it is necessary to join all junior lien-holders who may claim a lien on the specific property. Jurisdiction must be procured over each of these defendants in order that they may have the right to contest the validity or priority of the lien being foreclosed. The decree is for a sum of money with a special direction that specific property be sold to satisfy the judgment. If the proceeds of sale are insufficient, then the remaining debt, or deficiency may be satisfied as a general and unsecured lien against other property owned by the defendant.

A judgment based upon a foreclosure of a lien or upon an attachment dates back to the date of recording the lien or the filing of the attachment, and has priority over any subsequent liens or encumbrances against the specific property. Otherwise the priority of a judgment is determined by the date of its entry in the judgment docket. A sale under execution will cut off the rights of subsequent or junior lien-holders, other than their statutory right of redemption, without notice.

MOBILE HOME EXEMPTION

Any mobile home which is the actual abode of a judgment debtor shall be exempt from execution in the amount of $3,000.

HOMESTEAD EXEMPTION

A homestead shall be exempt from sale or execution from the lien of every judgment and from liability in any form for the debts of the owner to the amount in value of $7,500. The property must be the actual abode of the debtor. The exemption extends to the proceeds of a sale to the value of $7,500, which may be held for one year with the intention to procure another homestead.

If located in a town or city the homestead shall not exceed

7997

one block, and if not in a city or town, not more than 160 acres. The claim of homestead may be made at any time prior to sale of the property. If the homestead cannot be blocked out, the property is sold and $7,500 turned over to the homestead claimant. The exemption does not apply to mechanics' liens, purchase money liens and mortgages lawfully executed.

Actions and Suits Involving Property Rights

Oregon law permits any person who has a legal estate in real property and a present right to the possession thereof, to recover possession of the property, with damages for withholding possession, by an action at law.

Examples of "unlawful holding by force" are a tenant in possession who fails or refuses to pay rent 10 days after it is due, or fails to deliver possession after being in default 10 days; or after a lease has expired; or a tenant holding from month to month, or year to year, and remaining in possession after notice to quit; or is holding contrary to a condition of the lease, or is holding without a written lease.

ABATING A NUISANCE

Any person whose property or personal enjoyment thereof is affected by a private nuisance, may maintain an action at law for damages therefor.

If an order is issued, the sheriff will be directed to abate the nuisance, and the expense will be levied against the property of the defendant.

Ten residents of a single precinct in a county of 50,000 or more inhabitants may petition the county commissioners to conduct a hearing relative to an alleged nuisance. If the plaintiffs' position is upheld, the county commissioners shall bring a suit for abatement.

SUIT TO ESTABLISH BOUNDARY

Where any dispute or controversy exists between owners of adjacent or contiguous lands in this state, concerning the boundary lines or the location of the line dividing such lands, either party may bring a suit in equity in the circuit court in the county where all or part of the lands are situated, for the purpose of having the boundary line or dividing line ascertained and marked by proper monuments.

The determination shall be made by three disinterested commissioners, one of whom shall be a practical surveyor.

INJURY BY CHANGE OF GRADE

Both the State Highway Commission and the county are liable under Oregon law for any legal damage or injury to any real property abutting upon a public road affected by a change of grade. Just and reasonable compensation shall be made in accordance with the rules of eminent domain. Such an action must commence within six months after the change of grade is completed and accepted.

ACTION FOR WASTE

If a guardian or tenant in severalty, or in common, for life or for years of real property commits waste thereon, any person injured thereby may maintain an action at law for damages against the guardian or tenant. In the action there may be judgment for treble damages.

If the waste was committed with malice, forfeiture and eviction can be given in favor of the person entitled to a reversion against the tenant in possession.

CUTTING TREES

In a very broad Oregon statute, any person who injures or removes from the lands of another, public or private, any produce, trees or shrubs is liable for treble the damages claimed. If this trespass was casual or involuntary, judgment shall be for double damages.

Partition of Real Property by Suit

One of the little known methods of involuntary sale of an interest in real property is through the medium of the partition suit.

Partition is by judicial proceedings at the instance of one or more of the co-tenants without regard to the wishes of the other co-tenants. It is a statutory procedure and the provisions of the code must be strictly complied with.

The method of sale or the elimination of an interest in real property through partition may be accomplished in several ways. Basically the complaint asks for partition of the premises; that is,

it asks for a physical partition setting off to the participants a portion of the premises in accordance with the quality and quantity of their respective interests, as determined by the referees appointed by the court.

If actual physical partition is had, it is accomplished by three referees, who are to determine the portions to be set off. They may employ the services of a surveyor to assist them.

If, in the opinion of the court, partition cannot be made without great prejudice to the owners, then the court may direct a sale of the whole or a part thereof. In the event a sale is directed, the court may appoint one or more referees to conduct the sale. All sales made by the referees shall be made at public auction to the highest bidder in the same manner required for the sale of real property on execution.

Any one of the parties to the suit, either the plaintiffs or defendents, may purchase the whole or part of the premises when sold. Only the referees or a guardian representing an infant in the suit are precluded from being a purchaser.

The act also provides a protection to those who object to either a partition or sale of the premises. If, in the opinion of the court, the property can neither be partitioned nor sold without great prejudice to the owners, the courts may receive evidence as to the value of the respective interests, fix the value thereof, and make an order permitting the owners objecting to the partition or sale, to borrow money on the property with which to pay off the claims, as so fixed, of the persons demanding a partition or sale.

Probate Sales of Real Property

To the uninitiated or uninformed, some of the methods of selling real property seem to be cumbersome and without merit. One of these procedures is that of the probate sale of real property in a decedent's estate. The right to sell such property is a statutory procedure; it can only be sold for the specific purpose provided for by statute. The sale is conducted by the executor or administrator and has some of the attributes of an involuntary sale, because the executor or administrator, who does not own the property, sells the interest of another in real property.

Title to real property vests immediately in the heirs or devisees upon the death of the decedent, subject, however, to the right of the executor or administrator to sell the property.

The right to sell is defined by Oregon statutes, and such sales may be made for the following purposes only:

1. For the purpose of paying the charges, expenses and claims against the estate.
2. When it shall appear to the satisfaction of the court that it would be for the best interest of the heirs, devisees and legatees that the property be sold for the purpose of distribution.

Bankruptcy and Real Property

The sale of real property by an executor or administrator has already been discussed. Another type of sale by an official of the court is a sale in bankruptcy.

The object and purpose of the bankruptcy law is two-fold: First, it is for the purpose of accomplishing a prorate distribution of the bankrupt's assets among his creditors; second, to secure to the bankrupt immunity from further liability for his debts by granting him a discharge which shall be a bar against any legal proceedings.

The right to adjudicate a person a bankrupt and to administer his assets is exclusively under the jurisdiction of the United States District Court for the District in which he resides.

PETITION FIRST STEP

The proceedings to declare one bankrupt are initiated by petition either voluntarily by the bankrupt or involuntarily upon petition by his creditors. After a hearing, if circumstances warrant, he is declared a bankrupt and an order adjudicating him as such is signed. After such adjudication a trustee is appointed to administer the assets. Immediately on his appointment, the trustee is vested by operation of law with title to all the property, wherever situated, owned by the bankrupt at the time of filing petition.

It is the duty of the trustee to collect the assets of the estate as quickly as possible and to dispose of them to the best possible advantage in order to realize an equity for the creditors. The trustee is under no obligation to accept property which would burden rather than benefit an estate. He may refuse to accept such property, subject to the approval of the bankruptcy court, and the effect of his rejection would be to revert title back in the bankrupt.

SALE PROCEDURE

The procedure for sale of real property is relatively simple and may vary somewhat in each jurisdiction. Usually the trustee obtains an order for sale. After notice to creditors, a hearing is had, after which the trustee makes his report of the sale and petitions

for an order of confirmation. Upon the confirmation being granted, the trustee executes a deed to the purchaser.

This is the procedure for sale, but the purchaser does not necessarily receive a valid title. Such a sale is subject to all liens, encumbrances and defects against the title.

LIENS NOT VOID

There are some mistaken theories as to the effect of bankruptcy upon judgment liens against the bankrupt. It is often said that a judgment lien obtained within four months of the petition for bankruptcy is void. A judgment lien obtained during this four month period is merely voidable and not void. The bankruptcy court may declare such a lien void if it finds that, at the time such lien was obtained, the bankrupt was insolvent, or if such lien was permitted in fraud.

The lien of the judgment is not extinguished by the bankruptcy but only the remedy. Therefore, if the bankrupt wishes to sell or mortgage at a later date, he must procure a release of the judgment or wait until the lien is extinguished by operation of law.

Secured lienholders, such as mortgagees, are not free to pursue their remedy of foreclosure against a bankrupt without first obtaining permission to do so from the bankruptcy court.

Limitations of Actions and Suits

STATUTE OF LIMITATIONS

Actions at law shall only be commenced within the periods prescribed, except when a different limitation is prescribed by statute.

An action shall be deemed commenced when the complaint is filed and a summons served.

SOME LIMITATIONS

An action for the determination of any right or claim to, or interest in, real property, or the recovery of possession of real property shall be commenced within 10 years.

No mortgage upon real property shall be a lien upon such property after the expiration of 10 years from the date of maturity. After 10 years the mortgage shall be presumed paid and discharged.

This limitation is voided when (1) any portion of the mortgage debt or interest has been voluntarily paid within 10 years of beginning of the suit (2) the original mortgagor still owns the mortgaged property (3) and no lien or right of a third person has attached to the property after the expiration of the 10 year period.

Actions on judgments or sealed instruments must be commenced within 10 years.

A judgment remains valid and a lien on real property for 10 years after entry. It may be renewed by the circuit court.

LAND CONTRACTS

Suit or action to enforce a contract for the sale of real property must be instituted in the county in which the real property is situated within 5 years from the date of maturity of the final payment provided for in the contract. After that period it ceases to be a lien, encumbrance or cloud on the title of the property.

OTHER LIMITATIONS

Actions for waste or trespass upon real property must be commenced within 6 years.

An action upon a contract, express or implied, excepting those listed herein - 6 years.

An action for taking, detaining or injuring personal property, including an action for the specific recovery thereof - 6 years.

An action upon a statute, except for penalty or forfeiture - 6 years.

An action upon a statute for penalty or forfeiture - 3 years.

An action for any injury to the person or rights of another, not arising on contract, and not especially enumerated - 2 years.

An action for libel or slander - 1 year.

For any felony, other than murder or manslaughter, within 3 years of its commission.

For any misdemeanor - within 2 years of its commission.

Uniform Commercial Code

8003 4008

Oregon statutes relating to "bulk sales", "conditional sales" and "chattel mortgages" were repealed on September 1, 1963, when the Uniform Commercial Code became effective.

The Code gave us a new set of terminology. Conditional sales and chattel mortgages have become "security agreements". Security agreements are used when it is intended to create a security interest in goods, documents, installments, chattel paper, accounts or contract rights.

Real estate practitioners have an interest in this section of the Code because security agreements will be used when "fixtures", "growing crops" or "standing timber" is used as security for a loan.

A person claiming security upon such goods must file a "financing statement" with either the County Clerk or Recorder. The parties to the financing statement are the "debtor" and the "second party".

The lien created by the filing, if for five years or less, is effective until the maturity date, and thereafter for a period of 60 days. If no maturity date is given, the lien is effective for a period of five years. The execution and filing of a "continuation statement" will extend the lien for an additional five-year period. Most transactions under the Code will be filed with the Secretary of State and the county in which the debtor resides.

Bulk Transfer Law

Most real estate brokers will have occasion to make sales which involve the sale of a going business. Those brokers who do this only occasionally are apt not to be familiar with the procedure required by the Bulk Transfer section of the Uniform Commercial Code.

The Bulk Transfer law provides that it is the duty of every person buying any commercial business or establishment, including restaurants and other food dispensing establishments, or of all, or substantially all, of the furniture, fixtures, supplies, or equipment of any such business or establishment, to demand the receive from the seller an affidavit containing the names and addresses of all of the creditors of the seller, together with the amount of the indebtedness due to each creditor. It is the duty of the seller to furnish such a statement.

The buyer must preserve the affidavit for six months following the sale and permit inspection by any creditor of the seller, or he may file the affidavit in the office of the county clerk in the county in which the seller's place of business is located.

The law further provides that after a purchaser receives the

affidavit, and at least 10 days before the closing of the sale, the purchaser must notify personally or by registered letter, each of the creditors of the seller named in the affidavit, of the proposed purchase. The contents of the notice are prescribed by law. The reason for this notice is to give to all such creditors listed the opportunity to attach the assets of the business prior to the consummation of the sale.

The law further provides that in any case where there is a purchase of personal property coming within the purview of the Act, without receiving such affidavit and without notifying the creditors listed in the affidavit, if any are listed, the purchase shall be ineffective as to any creditor who has not been notified. In other words, unless this procedure is followed as required by law, the purchaser does not acquire good title to the assets of the business, and the assets of the business are subject to being attached for the payment of debts owed by the seller.

The purpose of the Bulk Transfer law is to prevent fraud, to protect creditors, and to make the matter of the sale known to creditors. In the event of a violation the sale is presumed to be fraudulent and void as to existing creditors.

It is quite obvious that in the event any business establishment is being sold, regardless of the nature of the business which is being conducted, the law should be strictly complied with; and if a broker is closing a transaction, even though there is included in the transaction, in addition to the assets of the business, the real property on which the business is located, it is the duty of the broker to see to it that this law is strictly complied with.

No action shall be brought nor levy made under the Bulk Transfer law more than six months after the date on which the buyer took possession of the goods, unless the sale has been concealed. If the transfer has been concealed, actions may be brought or levies made within six months after its discovery.

If the intended sale is to be made at public auction, in addition to information required for ordinary bulk transfer, the notice must state that the sale is to be by auction, the name of the auctioneer, and the time and place of the auction.

In an auction sale, the responsibility for giving the statutory notice is the auctioneer's. A sale which violates the requirements does not render the transfer fraudulent and void, but the auctioneer becomes personally liable to the transferor's creditors.

Discrimination in Selling, Renting, or
Leasing Real Property Prohibited

An important Oregon law from the standpoint of the real estate licensee is ORS 659.033, which reads as follows:

(1) No person engaged in the business of selling real property shall solely because of race, color, religion or national origin of any person:

(a) Refuse to sell, lease or rent any real property to a purchaser.
(b) Expel a purchaser from any real property.
(c) Make any distinction, discrimination or restriction against a purchaser in the price, terms, conditions or privileges relating to the sale, rental, lease or occupancy of real property or in the furnishing of any facilities or services in connection therewith.
(d) Attempt to discourage the sale, rental or lease of any real property to a purchaser.

(2) No person shall publish, circulate, issue or display, or cause to be published, circulated, issued or displayed, any communication, notice, advertisement or sign of any kind relating to the sale, rental or leasing of real property which indicates any preference, limitation, specification or discrimination based on race, color, religion or national origin.

(3) No real estate broker or salesman shall accept or retain a listing of real property for sale, lease or rental with an understanding that a purchaser may be discriminated against with respect to the sale, rental or lease, thereof, solely because of race, color, religion or national origin.

(4) No person shall assist, induce, incite or coerce another person to commit an act or engage in a practice that violates this section.

Husband and Wife Property Rights Relationship

While many American women were picketing the White House in the early 20's, and others were parading to promote their cause for equal suffrage, the women of Oregon were going to the polls alongside their menfolk and casting ballots.

Oregon gave women the right to vote in the election of November 8, 1912, by a margin of above 5,000 to 3,000 votes.

Since that time this state has frequently taken steps to see to it that both members of a marital partnership enjoy equal benefits

under the law. In ORS 108.010 it provides: "All laws which impose or recognize civil disabilities upon a wife which are not imposed or recognized as existing as to the husband hereby are repealed; and all civil rights belonging to the husband not conferred upon the wife prior to June 14, 1941, or which she does not have at common law, hereby are conferred upon her."

The statute provides that a conveyance, transfer or lien executed by either husband or wife in favor of the other is valid; by an expressed intention either can convey a one-half undivided interest in property to the other and thus create an estate by the entirety; either can dissolve an estate by the entirety by conveying his or her interest in such an estate to the other; either may constitute the other his or her attorney in fact to control, sell and convey, or mortgage for their mutual benefit.

Courts are now authorized to restrain a husband or wife, or both, from encumbering or disposing of any real or personal property during pendency of a suit for divorce.

In 1943, Oregon joined its neighboring states in enacting a "community property law", but apparently the common law concept of the property of husband and wife was the more popular. The law was repealed and provision made to convert community property into property held as tenants in common, or by the entirety, or as the separate property of either.

Alteration

A broker must not overlook the rule of law pertaining to alterations in contracts after they are executed. An unauthorized material alteration of a contract after its execution, made by a party who is asserting his rights under the contract, works a destruction of the contract to such an extent that the party responsible for the alteration can assert no rights under the contract either in its altered or in its original form. As a general rule after such an unauthorized material alteration has been made the restoration of the contract to its original form will not validate the contract as to the person who has made the alteration. The purpose of this rule of law is to "impose the highest care upon the holder of the contract and to visit him with loss because of his negligent and fraudulent conduct."

This rule applies to any material change that is made in a contract which has already been signed by one of the parties thereto and even though that change consists solely of filling in a blank in a form that was not filled in at the time the contract was signed.

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Notary Public

The acknowledgment of the execution of most deeds is taken by a "notary public". A Notary Public is appointed by the Governor for a term of four years, based upon a written application filed by the applicant.

A Notary Public can become a "non-lucrative" office when the notary files a statement with the Secretary of State waiving his fees. The statutory fee for acknowledging a deed or other instrument in writing is $1.

The functions of a Notary Public are not considered "official duties" as prescribed in Article III, Sec. 1, of the Oregon Constitution. A notary pays an application fee of $5, a recording fee, and a bond of $500.

Written Agreements

One of the most important principles of law affecting the rights of real estate brokers is the rule which provides that a real estate broker cannot maintain an action for a commission for the sale of real property unless he has a written agreement promising to pay a commission. To be binding, this agreement must be signed by the party being sued or by his agent who has been authorized in writing to sign the agreement. The agreement must contain a description of the property sufficiently definite so that the property can be identified, must by its terms employ the broker to sell the property and must specify with reasonable certainty the amount of the commission. Unless the agreement complies with all of these provisions, it is void and cannot be enforced.

Land Under Water

Statewide enthusiasm for the efforts of the 1967 Legislature to protect the public interest in ocean beaches and treasure-trove, and by a major rewriting of ORS chapters 273 and 274, which control state lands, called attention to the wide ownership of land under water by the State of Oregon.

Title to underwater land has always been of prime concern to the professional title examiner. A knowledge of ownership identity in such lands can be of benefit to the real estate practitioner.

With admission to the Union the state gained ownership of all tidelands and the beds of all navigable streams up to high water mark. All navigable streams became common highways controllable by the state.

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Title to the beds of all navigable lakes was given to the state by the legislature.

Various sections of the law identify the state's ownership of land under water, as follows:

Submerged lands - lands lying below the line of ordinary low water of all navigable waters within the boundary of Oregon, whether such waters are tidal or non-tidal.

Submersible lands - lands lying between the line of ordinary high water and the line of ordinary low water of all navigable waters within the boundaries of Oregon, whether tidal or non-tidal.

Tide and Overflow lands - all lands over which the tide ebbs and flows from the line of ordinary high tide to the line of mean low tide, and all islands, shore lands and other such lands held by the state by virtue of her sovereignty.

Swamp lands - lands claimed by an Act of Congress approved in 1860. Generally, lands too wet and unfit for cultivation. Statutory provision exists for the draining of such lands.

Ocean shore - that part of the shore of the Pacific Ocean between ordinary high tide and extreme low tide, and from the state's borders with Washington on the north and California on the south. This has been declared a recreation area.

All these lands are under the management of the State Land Board, which may lease, sell or grant easements. Other lands managed by the Board are discussed in an article in the Finance section of this Primer.

State law permits any resident of Oregon over 18 years of age to purchase up to one section of swamp or tide and overflow lands.

It is interesting to note that on rare occasions a sandbar will "creep" downstream, forming an island to which the state holds title.

On non-navigable streams title to the bed is in private ownership and usually runs to the center of the stream.

Riparian owners own this underwater land on non-navigable streams, but his common law right to use the water is now regulated by statute as pointed out in the Water Rights section of this Primer.

The legislature solved the problem of "treasure-trove" on state-owned land by an amendment to existing law. Treasure-trove is defined as being "any money, bullion, precious stones, precious

metals or jewelry, found hidden, the owner of which is not known".

The Land Board has been directed to establish rules governing exploration and removal of treasure-trove, semiprecious stones and petrified wood from state-owned lands. Twenty-five percent of any treasure-trove will be retained by the Land Board. Removal of a reasonable non-commercial collection of petrified wood and semiprecious stones will be permitted.

Descriptions of property adjoining navigable streams usually describe the boundary as being the low water or high water mark, depending on the stream to which the premises are adjacent.

Where there is a slow change in the stream there will be "accretion" or "reliction", and little difficulty in determining boundary lines. If the change is sudden and violent, known as "avulsion", it can result in a loss of property and a new boundary line.

BEACH LAW

The problem of protection of public interest in ocean beaches has been temporarily solved by a new law relating to private development between extreme low tide and a point on the beach having an elevation of less than 16 feet.

Private development of this area can proceed only under a permit issued by the state highway department.

To Preserve Some Land

To provide for the preservation or maintenance of open areas and spaces the legislature has given to political bodies authority to acquire easements in such lands.

Chapter 318, Laws of 1967, permits the state or political subdivisions to purchase or acquire by agreement or donation, but not by the power of eminent domain, conservation or scenic easements in any area within its jurisdiction.

"Conservation or scenic easements" means an aggregation of easements, covenants or conditions running with the land, to preserve or maintain all or part of the natural or existing state of recreational, cultural, scenic, historic or other appropriate places of public significance.

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ESTATES AND INTERESTS IN REAL PROPERTY

There are two classes of real estate - freehold and leasehold.

Under Oregon law, in freehold estates we have possessory and concurrent estates. Interests in real property will be considered under the headings of "easements" and "restrictive covenants". Leasehold estates are discussed under the chapter on "Landlord and Tenant".

A freehold estate is divided into two types: "Fee simple" and "life estate". The fee simple estate can also be a fee simple qualified estate, which provides for reversion to the grantor upon the happening of certain events. Life estates are either conventional or legal.

FEE SIMPLE ESTATE

Fee simple estate, frequently referred to as a "fee simple absolute", is the highest or greatest estate a person can have in land. It is an estate having no qualifications in length of duration, alienability, or any other particular. A deed conveys the fee simple if the grantor possesses the same, unless there is an expressed interest to convey a lesser estate.

Fee simple upon special limitation, sometimes known as a "base fee", is an estate qualified or determinable by the happening of a certain contingency. The land may have been granted to a church. If it ceases to be used for that specific purpose the estate automatically terminates and the fee reverts to the grantor or his heirs.

Fee simple on condition subsequent, is an estate in which the qualifications upon the fee are prompted by the wish of the grantor to force compliance by the grantee with some condition. He may qualify with the provision that spirituous liquor not be sold. If this qualification is violated the grantor or his heirs have the right to re-enter. A qualified fee can be granted in a will where a testator leaves his land to his widow "so long as she does not re-marry".

Fee simple conditional, is an estate in which the grantor wishes to pass his estate to a particular heir. If and when such an heir is born the estate passes in fee simple absolute.

Generally, conveyance of a qualified fee simple estate is not

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popular with the courts.

LIFE ESTATE

A conventional life estate is an estate whose duration is limited by the life of some person. This person, or life tenant, has the right to the exclusive possession of the land until the end of his estate. This carries the primary right to possession, use, enjoyment, income and profits from the land during the existence of his estate.

A legal life estate is created by the operation of the law for the benefit of the surviving spouse when the owner of the land dies.

Oregon law contains two specific applications to the life estate:

A conveyance made by a tenant for life or years, purporting to grant a greater estate than he possesses or could lawfully convey, does not work a forfeiture of his estate, but passes to the grantee all the estate which the tenant could lawfully convey.

Where real property has been devised to a person for life, and in case of the death of the life tenant without leaving lawful issue born alive and living at the time of his death, then to other heirs of the testator, a conveyance from all reversioners or remaindermen and all issues of the life tenant as are in being, of all their interest in the real property, vests a fee simple estate in the life tenant.

JOINT TENANCY

Joint tenancies are abolished in Oregon by ORS 93.180, except as to executors or trustees. The so-called "grand incident" of joint tenancy is the right of survivorship. A life estate of survivorship can be created between two or more grantees by expressed intent. Once created it cannot be destroyed unless one tenant acquires the interest of the other life tenant. Upon the death of all but one of the life tenants the fee vests in the survivor.

SURVIVORSHIP ESTATE

Though "joint tenancy", as it was known at common law, is abolished in Oregon, an estate can be created, by express words, which would permit a type of joint tenancy and survivorship.

Any attempt to create an estate of survivorship would have to be clearly and affirmatively expressed in the deed. The deed construed in the leading Oregon case wherein a survivorship was established, conveyed title to two brothers and contained the following language:

"The grantees herein do not take the title in common but with the right of survivorship; that is, that the fee shall vest in the survivor of the grantees."

It was held that this was not a "joint tenancy" but was a "life estate to two tenants in common with a contingent remainder to the survivor" and that this language did not violate the Oregon statute.

TENANCY IN COMMON

The statute aboloshing joint tenancy provides that when two or more persons take title to the same property, and nothing else is said as to their holding, they take as tenants in common.

Such co-tenants have only one thing in common, that is the right of possession. Otherwise, the quantity of their respective estates may differ, the shares may be unequal and the mode of acquisition of title may be unlike, and they may hold for different tenures.

Each tenant owns an undivided fraction and each is entitled to an interest in every inch of the soil, but none is entitled to the exclusive possession of any particular part of the land, each being entitled to occupy the whole in common with the others, and to receive their share of the rents and profits.

TENANCY MAY BE SHARED

There is no limit to the number of persons who may own an undivided interest in real property. It is interesting to note that there can be a "tenancy by the entirety" owning a unit with an individual who owns with them as a tenant in common. An example of such ownership would be a deed to three persons, two of whom are husband and wife. If the deed is silent as to how title is to be held the husband and wife would own an undivided one-half interest as "tenants by the entirety" in common with the third person who would also own an undivided one-half interest.

ENTITY MAY OWN INTEREST

A legal entity, such as a corporation, can also own an undivided

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portion of the premises with an individual, or two or more corporations can be tenants in common, owning undivided interests in the real property.

A husband and wife may own title to real property as tenants in common. The deed to them must recite, however, that they take title as tenants in common, otherwise they would own as tenants by the entirety. At times, there are distinct advantages why a husband and wife should own certain types of real property as tenants in common, usually because of the impact of income and inheritance taxes. Before closing the sale of substantial properties it is wise to consult an attorney and plan the method of holding title.

NO RIGHT OF SURVIVORSHIP

There is no right of survivorship in the tenancy in common. The share of a tenant in common may be inherited, sold or pledged without regard to the rights of the other tenants in common. It is also subject to involuntary sales such as execution, bankruptcy and tax sales.

Even though a tenant in common is entitled to the possession of the premises, such possession is subject to the rights of the other tenants in common. The undivided interest of each tenant may be sold, mortgaged or devised without regard to the rights of the other co-tenants.

There is, however, an obligation which each tenant has to the others. Each is entitled to an accounting of rents and profits and each to a contribution and reimbursement of sums spent for necessary repairs, and for the payment of taxes, liens and insurance premiums.

RIGHTS OF TENANTS

One tenant cannot commit waste, such as the removal of timber or other products of the land to the detriment and exclusion of the others.

If there is a sale of the premises for delinquent taxes or liens, a redemption from such sale by one tenant is a redemption for all. In such cases the tenant in common who redeems from the sale, does so for the others and his act is construed as that of an agent for and on behalf of all the other owners. The same rule applies if there is a redemption from a mortgage foreclosure when such mortgage was a lien on the interest of all the co-tenants.

One tenant in common cannot go into possession of the premises

his interest to a third person. If for instance, the husband deeds to a third party, such grantee "steps into the shoes" of the husband and actually has the same rights as the wife. Thereafter the extent of the ownership of the grantee will depend upon whether or not the husband survives the wife. If he survives then his grantee takes all, but if he dies first, the grantee takes nothing and the wife is the owner free from any claim of the husband's grantee.

Creditors cannot destroy the entirety. The interest of one tenant by the entirety may be sold under execution to satisfy his debts. If this is done, then the rights of the purchaser will again depend upon survivorship. If the debtor dies first, then the purchaser takes nothing. If the debtor survives the other tenant, the purchaser will take all.

Divorce, which severs the unity of persons upon which the entirety depends, will also destroy and terminate the entirety. Thereafter each will own an undivided one-half interest as tenants in common.

A common law marriage, or a statement on the instrument "husband and wife", does not create a tenancy by the entirety. A lawful marriage does this automatically. In these other cases a tenancy in common is created. If the parties are lawfully married the tenancy by the entirety is created whether or not the marital status is shown on the deed.

As stated before, a husband and wife can take as tenants in common by an expressed statement. Tenancy by the entirety is a concurrent estate with indestructible rights of survivorship.

A tenancy by the entirety is dissolved only by death, divorce, conveyance of the property by both tenants, or by a conveyance of one to the other.

It has been pointed out that after a divorce they hold as tenants in common. If the property is awarded to one party by the decree that party receives the other's undivided one-half interest subject to liens and encumbrances existing at the time of the decree.

WHAT TYPE TENANCY?

Just how to hold title depends upon many factors. Consideration should be given to the type of property being acquired, the worth of the individuals and the impact of income and inheritance taxes.

Since 1959 tenancies by the entirety have been subject to state inheritance taxes to the extent of one-half of the value of the property. Federal inheritance taxes are based upon the entire value of the property. Other provisions of the inheritance tax laws covering joint ownership of property may not make it desirable to create a survivorship estate. For this reason competent legal advice should be sought upon the acquisition of title to real property, especially if it has substantial value.

Dower and Curtesy

The rights of married persons in the lands of their spouses vary in each state. In the Pacific Northwest, Oregon is unique and is an island surrounded by states which have an entirely different concept in their consideration of the rights of married persons.

Oregon is a "common law state" and retained the "dower" and "curtesy" theory, whereas our neighboring states are all "community property states". Dower and curtesy are based upon the "common law" with its origin in England, whereas "community property" stemmed from Germanic tribes, and through Spain to the Spanish colonies of North and South America. These differences sometimes lead to confusion and misunderstanding, especially to those persons who have resided in another state.

DOWER - CURTESY ABOLISHED

Effective July 1, 1970, the new Oregon Probate Code repealed the statutory property rights of dower and curtesy.

Dower arose as a result of the public's desire to provide for the support of the widow and her children after her husband's death. Curtesy is the corresponding right of a widower.

Under the old Oregon law, the dower interest included a life estate in one-half of all the equitable interest which had been owned by the husband at any time during their marriage. This dower interest would not become a complete or "vested" property right until the husband died. For this reason, that interest which the wife held in this real property before her husband's death, was known as "inchoate" dower, meaning incomplete.

This made it necessary for both husband and wife to sign every document attempting to convey an interest in real property. As a result of the change only the actual owner must sign a listing, earnest money receipt or deed.

Under the new Probate Code, the surviving spouse has a right to elect to take a one-fourth share of the deceased spouse's net estate instead of what is given her or him under the will.

Easements

An easement is defined as a non-revocable right to use the land of another for a specified purpose. To have a valid easement it is necessary that it be made clear in the instrument an intention to create servitude.

There are two types of easement. "Appurtenant" and "in gross". An easement is not a natural right, but one which must be created. It is an interest in land, but not an estate in land. It is both a non-possessory right and a restricted right.

An easement is created by express grant, or express reservation. It may be implied, or created by ways of necessity. To be valid it must spell out a description of the land it will occupy and the limits of the duration. The fact that it is non-revocable distinguishes it from a license.

EASEMENTS IN GROSS

An easement in gross is a mere personal right and interest in the real estate of another, which is not dependent upon the ownership of any adjoining property by the party who has the easement. A servient estate exists but there is no dominant estate. An example: The owners of other lots in a tract have an easement in gross, an enforceable easement, in the set-back lines reserved in the instrument filed for the tract.

EASEMENTS APPURTENANT

An easement appurtenant is the right belonging to a dominant estate to the use of a servient estate. It is created for the purpose of benefiting the land possessed by the owner of the easement. This easement is said to "run with the land", and passes with the estate to the grantee whether or not it is mentioned. Easements of this nature are most frequently for utility services.

If there is a mortgage on a tract of land, before it is encumbered with an easement, the consent of the mortgagee should be obtained and recorded.

The most common easement is a "right of way", but easements are obtained for light and air, lateral support, party wall, or

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encroaching wall.

PROFITS A PRENDRE

Closely akin to an easement is a "profit a prendre", a right to take from another's land a part of the soil, or the products of the soil. This right carries with it a profit, a right absent in an easement.

The grantee may remove sand or gravel, standing timber or crops, subject to legal restrictions. Oregon law treats the sale of standing timber as creating an estate on condition, subject to being defeated if the timber is not removed within the time specified in the contract. If "all the standing timber" is granted, an estate is created. If "the right to cut and remove timber" is specified, then a license has been given.

Restrictive Covenants

The words "conditions, covenants and restrictions" are a familiar phrase to those acquainted with real property law expressions. They call attention to the fact that a tract of real property is restricted in its use in some manner.

The established usage of these words to indicate in a broad way a particular fact, frequently causes the legal significance of each to be overlooked. A condition or a covenant in a deed of conveyance of land is a qualification or restriction that in case a particular event does or does not happen, or in case the grantor or grantee omits to do a particular act, an estate shall commence, be enlarged, or be defeated.

The most common use of these words is to make reference to the fact that a particular tract or area is restricted in its use, such as for residential purposes.

Conditions and covenants contained in real property documents can also restrict the land in other ways, or defeat a conveyance upon the happening of an event. The word "restriction" is used to convey the thought that the use of land is limited in some way. Reference may be made to a "restrictive condition" or "restrictive covenant". The line of distinction as to whether or not a restriction is a condition or a covenant is a fine one. A very important consideration in determining the nature of a provision as a covenant or a condition is the presence or absence of a forfeiture or reversionary clause in the event of a violation of such a provision. If for instance, the document which imposes a restriction also provides that upon a breach thereof title will revert to the grantor, then the restriction

is a condition. On the other hand, if the restriction provides that upon breach or violation the person imposing the restriction, or others may bring action for damages, it is a covenant. In common usage the distinction between a covenant and a condition is often overlooked, but could become very important in the event of a breach of the restriction.

OWNER HAS FREEDOM

An owner of land has the right to sell or convey his land as he sees fit. He can impose any condition, covenant or restriction he wishes, without regard to its effect or how ridiculous it may be or seem to be. The only restraint to which he must observe is that such condition or covenant does not impose either an impossible requirement or an unlawful condition which is contrary to public policy.

Restrictions can be imposed in a number of ways:

1. They may be made by a deed conveying a single tract of land.
2. By an agreement entered into between two or more owners of land.
3. By the conveyance of a single tract of land and then by later reference in other deeds of adjoining properties, to the restriction in the first deed.
4. By a declaration of conditions and restrictions imposed and established by a single document.

RESTRICTIONS A BENEFIT

The use of the word "restriction" would indicate that there is a restraint which would preclude the free use of the land. This is so, but does not necessarily mean that such restraint is detrimental to the value of real property. In many instances restrictions have increased the value of property because such restrictions have the effect of giving to property a higher and better use.

The intent of parties imposing restrictions and the interpretation thereof has led to many legal actions. Attorneys drawing such documents should use care to see that the intent is clearly expressed, because courts strictly construe the restriction and any doubts are resolved against the restraint.

If there is a general plan, then the restriction is for the benefit of all parties affected thereby. Regardless of the size of the subdivision all persons who are subject to the same

restriction have a right to the enforcement thereof. The fact that a complainant's tract is at some distance from the parcel upon which the violation occurs, would make no difference. The test is whether or not each is subject to the same restriction and whether such restriction is for the benefit of all.

RESTRICTIONS EXTINGUISHED

Restrictions are extinguished in a variety of ways. Some expire after a stated period of time; others only upon a mutual agreement by those affected. Sometimes the change in character of a neighborhood will result in the extinguishing of a general restrictive scheme. Such termination will depend, however, upon the actual facts as to such changes and usually can only be determined by a lawsuit. Also a person may be precluded from enforcing such restrictions or may be precluded from restraining a use because of laches. One cannot stand by and knowingly allow a violation to take place and then at a later date complain. This too, will usually result in a legal action.

Another form of restriction is through the use of zoning ordinances which are imposed by ogvernmental action and differ from restrictions imposed either by conditions or covenants. Each operate independently of each other and at times are inconsistent. A zoning ordinance may permit the use of the tract for commercial purposes, while a condition or covenant covering the same tract may restrict it to residential use. Neither will take priority over the other. Private restrictions will only yield to public restrictions when they require something to be done which is unlawful under the government regulations. Building setback lines, usually established under the police power of the municipality, will take priority over a private restriction if such private restriction would require a violation of such public restriction. If, however, a private restriction requires a greater setback than the public ordinance, then the private setback must be complied with. It is incumbent in construing restrictions on real property to examine and consider both the public and private restrictions. One cannot assume that the most beneficial requirement imposed will be the one which will prevail. This is an excellent situation for the aid of an attorney.

The proper remedy for enforcement of restrictions in Oregon is by injunction relief. For a restriction to run with the land it must:

1. It must be in writing.
2. The parties must express their intent that is shall run with the land.
3. It must relate to the real property or its enjoyment.

4. At law, there must be privity of estate (a simultaneous transfer of land or an easement); or in equity, a notice to the party burdened of the existence of the servitude.

Zoning Ordinances

To many persons who deal in real estate the effect of zoning ordinances at times seems unjust and without reason. To some, the changing of zones, especially after purchase of a property for a specific purpose, appears to be tantamount to taking property without just compensation.

The people themselves have relinquished to the State a certain control over their property. The control so relinquished is that which the State must have in order to protect the health, morals, peace, safety and welfare of the public. This is called "police power".

This right, to so regulate, has been passed on to cities and counties through enactment of permissive legislation which enables cities and counties to establish zones wherein a municipality can regulate, restrict and segregate the location of industries, businesses, apartments, multiple dwellings, single family dwellings, public and semi public buildings. Such rights also provide for the regulation of building heights and the determination of yards, courts and open spaces.

The first statute permitting the zoning of cities was passed by the Legislature of the State of Oregon in 1919. The voters of the City of Portland, on November 4, 1924, enacted by the initiative process an ordinance dividing the City into districts. This ordinance was almost immediately the subject of a lawsuit to test the constitutionality of the 1919 Act.

Perhaps the preamble of the 1919 Act best illustrates the purpose of zoning and also expresses the State's right under its police power to establish zoning districts. The first part of the Act reads as follows: "For the public interest, health, comfort, convenience, preservation of public peace, safety, morals, order and public welfare . . .".

It is generally recognized that it is highly desirable for a city to plan its development and growth. There is also a virtual unanimity of opinions holding that zoning is a legitimate exercise of police power. Federal decisions hold that general ordinances are valid, but individual restrictions and limitations imposed by the general ordinances must bear some substantial relation to the public health, safety and general welfare. Such general ordinances have been held not to deprive land owners of

their property or its use without due process of law. While there appears to be a deprivation of a use of property, such deprivation is with due process.

Existence of a zoning ordinance has a strong effect on "market value", but it is not an encumbrance on the real property.

Boundary Lines and Adverse Possession

A prolific cause of disputes between adjoining property owners is the determination of the location of the boundary line between their respective properties. Owners are at times surprised to learn that a portion of their premises is occupied by their neighbor, or that the boundary line is not where it was thought to be. Most times such disputes are resolved by an agreement between the parties or by the exchange of deeds.

The rights of the respective parties in such a situation depends upon the actual state of facts which pertain to the specific problem. If a fence is so constructed or located as to encroach upon the adjoining land, the result may be that the fence could, under certain circumstances, determine the boundary line between the tracts, even though legal title is otherwise.

One of the common methods of acquiring title to real property, other than through purchase and conveyance of title, is by adverse possession. Such acquisition is based upon possession and may apply to a whole tract of land or to only a part thereof. The principle covering acquisition of a whole tract and that which applies to boundary lines is practically the same. We are confined here to the determination of boundary lines only.

There is a common concept that occupancy of an area of land for a period of ten years will result in the acquisition of, and ripen into, a good title. This is not entirely true, because the circumstances under which the occupation occurs are a factor which will determine the situation.

NO ADVERSE STATUTE

There is no specific statute in Oregon which provides that occupancy for a given period of time will ripen into ownership because of adverse possession.

Adverse possession refers to a principle based upon and governed by the policy that limits the right and remedy for the possession of land to actions brought within a stated time. In other words it is a right to defend against an adverse claim, but

such right is extinguished if it is not exercised within the stated period. One cannot stand by and allow a stranger to a title, take possession and exercise the functions of complete ownership. Such acts must be defended against. This principle of defense is governed by the Statute of Limitations. The statute applies to other rights and limits actions at law for recovery or relief. As applied to real property the statute provides: "An action for the recovery of real property, or for the recovery of possession thereof, shall be commenced within ten years".

In order to prevail, the claimant must prove that he had been in actual, notorious and exclusive possession under a claim of ownership for the statutory period. The courts have given many definitions of adverse possession wherein they have attempted to define, "actual, notorious and exclusive possession". Such decisions seem to resolve the fact that the possession must be visible so that an owner of the legal title may have an opportunity to learn of the adverse claim and protect his rights. Actual knowledge of possession on the part of the true owner is not, however, necessary; it being sufficient that he could have learned thereof by the exercise of proper diligence.

BOUNDARY DISPUTES

Boundary disputes are usually the result of a mistaken belief of ownership. In the past some of the cases in Oregon have varied the rule of adverse possession as applied to boundary line disputes.

A recent Oregon case has done much to clarify these principles as applied to boundary disputes. In this case the court stated the following: "We think our law should now be clarified and we hold the possession under a mistaken ownership satisfies the element of hostility of adverseness in the application of the doctrine of adverse possession. The evidence must show a possession visible, notorious and exclusive under a claim of ownership, continuing ten years, and the owner must have knowledge of such possession and claim."

Many disputes concerning boundary lines can be prevented if a proper survey of the premises is made, either at time of purchase or before the construction of a fence. The mere fact that a fence exists near the boundary line will not in itself determine the boundary between adjoining parcels. Such fence must be recognized and accepted by the parties as the actual boundary line, but this in itself will not give title to the adverse claimant. The rights of the parties must be adjudicated through the medium of a lawsuit, and the facts concerning location of a fence, the period of time it has existed, and the nature of the possession are only evidence, for the purpose of determining if such possession is sufficient to

satisfy the elements of adverse possession and thereby acquire title.

CONTROLLED ACCESS TO PUBLIC HIGHWAYS

An exercise of "police power" by the State is exemplified by legislation to control access to public highways. Such control to our highways is comparatively new, the first such Act being passed by the Legislature in 1947.

Access to a road or highway is a private right enjoyed by the abutting property owner. It is an easement to said public road, but should be distinguished from the common concept and use of the word "easement". Normally, we use this word in a sense that it refers to the use of the land of another for a special purpose. The word "access" denotes the right vested in the owner of the land which adjoins a road or highway to go and return from his land to the highway without obstruction.

Adjoining owners have two distinct rights in a road or highway.

1. The kind he enjoys in common with others, a public right.
2. Private right, not common to the public, only to his contiguous ownership.

The private rights of owners of adjoining property which are common to the public are generally, the right of access, of view, of light and air, and of lateral support. These rights are subordinate to the right of passage of the public and are subject to reasonable regulation and restriction.

While public rights in a road or highway can be taken away by the governing bodies at any time, the loss of such public rights are not subject to the payment of compensation by reason of such loss. The public rights are usually lost through vacation or relocation of a road or highway. When this occurs the only obligation is to maintain to the adjoining property owner his right of access. In other words, payment is only made for the loss of private rights.

Access to and from a public road or highway is a property right and cannot be damaged or taken without just compensation. An owner, when access is taken, may sustain damage without suffering loss of physical property, but the loss of the right is sufficient to entitle him to compensation. If, however, he has free and convenient access to his property and the improvements thereon, and his means of ingress are not substantially interfered with by the public, even though he does not have access at all points in the boundary between his land and the highway, he has no cause of complaint.

LEGAL LIMIT ON ACCESS

The foregoing are general rules which have always applied to the rights of abutting property owners on a road or highway. This general rule has been changed through legislation and it is now possible to purchase property adjoining a highway and not be able to have free access to such highway.

The 1947 Legislature exercising its right under the "police power" of the State enacted legislation to authorize the Highway Commission to "lay out, locate, relocate, adopt, establish, construct, designate, maintain and supervise the use and operation of a new highway known as "throughways". This Act also authorizes the Commission under certain circumstances to change an existing road to a throughway and thereby control the access thereto.

Additional legislation has been enacted which also authorizes the State Highway Commission, with respect to state highways, other than throughways, and the County Court, or Board of County Commissioners, with respect to county roads, to adopt reasonable rules and regulations, and to issue permits for the construction or placing of approach roads to such highways or roads. Such rules and regulations may regulate the manner of construction and the width thereof, and may also require the removal of such approach if not constructed in accordance with said rules and regulations.

When purchasing the title to real property which abuts upon a major road or highway, inquiry should be made as to the right of access in order that proper use of the premises can be had consistent with its intended use.

CONDOMINIUM

A new concept of land ownership in Oregon was born with the passage of the "Unit Ownership Act" in 1963.

The condominium, known to the Romans as early as the sixth century, was legalized in Oregon to take advantage of FHA financing.

Closely related to a subdivision, the condominium in Oregon is specifically included in the Subdivision Control Law.

Unlike the "Stock-Lease Cooperative" and the "Co-ownership Cooperative", the owner of a condominium unit has the same rights he acquires when he purchases an individual house and lot in a subdivision. He may mortgage his unit separately, or he may lease, sell or devise the same without regard to the owners of other units.

The unit is taxed separately just the same as an individual home is taxed. Because of a 1967 amendment a lessee in a condominium is taxed in the same manner as an individual owner.

The unit owner must share in his prorate portion of the expenses of the maintenance of the common areas.

The Unit Ownership Law is part of another section of the Primer.

Q. 5 In tenancy in common, there is always a unity of:

(A) time
(B) title
(C) interest
(D) possession

Q. 6 On what theory of law is the "tenancy by the entirety" based?

Q. 7 What is the name given to the right to use of a portion of another's property without having title thereto or lease?

(A) encumbering easement
(B) appurtenant easement
(C) encroaching
(D) trespassing

Q. 8 A tenant for life is in possession of a parcel of real estate. Explain why he can or cannot enter into a valid lease, as lessor, of the property.

LANDLORD AND TENANT

LEASES

A lease is a written document through which the possession of real property is given by the owner to a second party for a specified time for a specified rent. During the past 20 years the leasing of real property in Oregon has very rapidly increased.

The lease of real property for a stated period of time made its appearance in our law as early as the reign of William the Conqueror (1066-1087).

Early leases were used primarily to raise a large sum of money immediately. They were made for long terms and payment of the entire gross rental for the period was paid at the beginning of the term.

For a great many years there existed a belief that 40 years was the maximum term of a lease. By 1270, however, leases for 100 years were being made, and today 99 year terms are common.

In the first years of the leasing of real property the rights of the lessee came from the Roman law based on a contractural right to use without ownership. The lessee had no rights in the land, merely the benefit of a contract to use of it.

Between 1200 and 1500 common law recognized the lessee as the owner of an interest in the land, protected against the lessor and third parties. The interest of the lessee came to be regarded as an estate in land—the lease was a conveyance rather than a contractural arrangement between the parties.

Today the lease has become a synthesis of conveyance notions and contract notions. A controversy rages among accountants, lawyers, economists, investment bankers and others as whether to charge to income rental as it becomes due or to capitalize the income stream for the entire period into present worth.

We will treat a lease of real property as a conveyance of an interest in the land to the tenant, recognizing, however, that leasehold estates are *chattels real.* They give to the tenant an interest or estate in real property, but are a form of personal property governed by the laws applicable to personal property.

In the execution of a lease of real property a landlord and tenant relationship is established. The landlord becomes the *lessor* and the tenant the *lessee.*

The lessor's interest in the contract is the right to receive rent and the right to the reversion (right to get the land back). The appraiser measures the present worth of a lease by capitalizing the rents plus the reversion.

The lessee's interest in a lease is known as a leasehold. The leasehold gives to the lessee the beneficial rights of use and occupancy, plus the right to receive any excess rent during the life of the lease.

"Excess rent" is defined as the surplus, if any, of economic rent over the contract rent called for in the instrument. Economic rent is what the property would bring in the open market if vacant and ready to be leased today.

Appraisers refer to a "negative leasehold" and a "positive leasehold." In the former the contract rent is found to be higher than the economic rent, while a positive leasehold is one in which the economic rent exceeds the contract.

A lease illustrates an operation of the "two property concept." Technically the owner has sold one of his rights. In the contract the lessor conveys one of his rights from his "bundle of rights"—the right of possession in exchange for rent. The lessee becomes the owner for the term, and, unless he commits waste, has the right of "quiet enjoyment." A breach of this right is an eviction (dispossession of tenant).

Rent can be money or something else, such as labor or a share of the crops.

The body of law concerning real property leases is what is called the "Law of Landlord and Tenant."

In Oregon a tenancy is deemed to exist when one has let real estate to another to hold of him as a landlord. We know that tenancies can be freehold estates, or estates of less than freehold. A freehold estate is defined as an "estate of indefinite duration", while an estate of less than freehold is an "estate of definite duration." A lease, therefore, is an estate of less than freehold.

TYPES OF TENANCY

The law of Landlord and Tenant classifies tenancies as tenancy at sufferance, tenancy at will, tenancy for years, tenancy from month to month, tenancy by curtesy, tenancy by entirety, and tenancy for life.

Definitions of the applicable tenancies are as follows:

TENANCY AT SUFFERANCE—One who comes into possession of the real estate of another lawfully, but who holds over by wrong after the termination of his term. No notice is required to terminate this tenancy.

TENANCY AT WILL—One who enters into the possession of real estate with the consent of the owner, under circumstances not showing an intention to create a freehold interest. When the rent reserved in the lease at will is payable at periods of less than three months, a notice to terminate the tenancy is sufficient if it is equal to the interval between the times of payment of rent.

TENANCY FROM YEAR TO YEAR—One who enters into possession of real estate with the consent of the owner, and no certain time is mentioned, but an annual rent is reserved. Notice to terminate is sufficient if given 60 days prior to the expiration of the period for which rents are paid.

TENANCY FROM MONTH TO MONTH—One who holds the lands or tenements of another, under the demise of the other, and no certain time has been mentioned, but a monthly rental has been reserved. Tenancy may only be terminated by either the landlord or tenant giving the other, at any time during the tenancy, not less than 30 days notice in writing.

When the terms of the lease fix the date of expiration of tenancy, no notice is required to render the holding of the tenant wrongful and by force after the expiration date.

Terms of a written lease may waive notice

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required. Notice must be in writing conspicuously posted on premises or left at residence.

PAYMENT OF RENT

Unless a different period is stipulated in the lease, the failure of a tenant to pay the rent called for by the terms of the lease for a period of 10 days after it becomes due and payable, operates to terminate his tenancy. No notice to quit or pay the rent is required to render the holding of such tenant thereafter wrongful. If the landlord, after such default, accepts payment the lease is reinstated for the full period fixed by its terms.

Unless expressly provided for by the terms of the lease all rents are due and payable in advance. The tenant shall pay or tender payment on or prior to the first day of the rent paying period, and no demand is necessary to render a tenant in default. (This is an example of statutory law prevailing over common law. In common law the rent was payable at the end of the term.)

Every person in possession of land out of which any rent is due, whether it was originally demised in fee, or for any estate of freehold, or for any term of years, is liable for the amount of the rent due.

Such rent may be recovered in an action at law, and the deed of demise, or other instrument in writing, if there is any, may be used in evidence by either party to prove the amount due.

FARM TENANT'S RIGHTS TO EMBLEMENTS

When the leasing or occupation is for the purpose of farming or agriculture, the tenant or person in possession shall, after the termination of the lease or occupancy, have free access to the premises to cultivate and harvest or gather any crop or produce of the soil planted or sown by him before the service of notice to quit.

USE FOR GAMBLING PROHIBITED

No person shall let or rent any real property knowing or having reason to believe it will be used for gambling purposes.

All such contracts are void.

An owner learning of such use can avoid or terminate such lease and recover immediate possession by an action of law brought before a justice of the peace.

An owner knowingly violating this law is liable to forfeiture of twice the amount of the rent for six months; the district attorney to institute the action in the name of the state.

ESSENTIALS OF A VALID LEASE

While no particular form or language is necessary to create a leasehold, it is essential that certain elements be present. These are:

1. The parties must have contractual capacity.
2. There must be an agreement to let and take.
3. The premises must be described.
4. The term or duration must be defined.
5. Amount of rent or consideration must be specified.
6. It must be duly executed.
7. There must be a voluntary delivery and acceptance.

STATUTE OF FRAUDS

A lease of real property for a period of more than one year, in order not to be void, must be in writing. A lease for a period of less than one year may or may not be in writing. A lease for exactly one year must be in writing if it is to take effect at some time subsequent to execution.

KINDS OF LEASES

Leases fall into two broad classes—"short term" lease and "long term" lease. Any lease running for more than 10 years is generally defined as a long term lease, while one for less than 10 years is a short term lease. Leases may or may not be recorded. It is recommended that all long term leases be duly recorded.

Among the many kinds of leases are the following:

MONTH TO MONTH—Such tenancy may or may not be under a written lease.

GROSS LEASE—Also referred to as a "fixed" or "flat" lease. The rent is stated as a sum to be paid the lessor monthly, quarterly or annually and is the only liability for payment by the lessee.

NET LEASE—This provides a net income to the lessor, the lessee agreeing to pay the normal costs of the property, such as taxes and insurance, in addition to the rent.

PERCENTAGE LEASE—A popular form of commercial lease in which the lessee pays a percentage of his gross sales or income. There is usually a minimum rent. This lease is most successful if the percentage agreed upon is what that type of business pays elsewhere. In a sense this lease makes the landlord a partner of the lessee. It is used because of what is known as "commercial income", the fixed ability of a merchant to pay, determined by the type of merchandise and amount of sales. The lessor under a percentage lease usually need not worry about getting his just return because most such leases contain a clause that voids the contract if dishonesty is discovered.

OIL AND GAS LEASE—Recently becoming popular in Oregon. Usually a flat sum is paid for the right to explore for oil or gas. If successful, the lessee agrees to pay a royalty which is quite commonly one-eighth of each barrel of oil.

GRADED LEASE—Also known as a "graduated lease." Usually a flat minimum or flat rent, stepped up or down after an initial period. Step-up helps the tenant get established (this can be a hardship if step-up comes during a recession). Step-down sometimes provides a tax advantage.

RENEWAL LEASE—Provides at time of negotiation for an extension. If the clause is an "option to renew" the option rests with the lessee. If an "automatic renewal" both parties retain the right to make a decision.

REVALUATION LEASE—The rental is revalued every so many years, usually on the basis of an appraisal. This is a hazardous type of lease because of its encouragement of quarrels.

LEASEBACK OR LEASE PURCHASE—Under this form the owner of a property sells to a buyer and then leases the property from the buyer as lessor, the seller becoming the lessee. This is usually a long term lease. Its advantages include the acquiring of capital in a business, and tax concessions earned by changing a fixed asset to a current asset. Companies that do not need the 100 per cent locations frequently erect the improvement, sell the property, and then enter into a long term lease. The yield to investors in such an arrangement is sometimes as low as 4½ per cent, but is said to be "as safe as a bond."

INDEX LEASE—A lease in which the amount of rent is tied to national indices, such as the cost of living or value of the dollar.

SANDWICH LEASE—Essentially the sub-letting of a leased property in which the lessee lets to another party and becomes both lessor and lessee. Unless prohibited by the terms of the instrument, a lessee may assign or sub-let his lease.

LEASE-OPTION—A lease containing an option to permit the lessor to purchase the property at a fixed price or a negotiated price, or a price to be established by neutral appraisers.

FARM LEASE—A lease used in rural areas. Usually provides for a flat annual rental, a share of the crops, or both.

ROOF TOP LEASE—A frequently used instrument to lease space for the erection of display or advertising signs.

The rental income from a business lease is frequently influenced by pedestrian traffic in the vicinity of the property. There are three kinds of pedestrian traffic, namely, structural, lane and shopping.

Structural traffic is comprised of persons employed in offices, shops and factories. Lane traffic refers to persons passing to and fro with a definite purpose in mind. Shopping traffic refers to women in particular and is, of course, the most desirable kind of traffic.

TERMINATION

A lease may be terminated for:

1. Breach of conditions.
2. Eminent Domain.
3. Destruction of premises.
4. Constructive eviction on the part of the landlord.

In the event of condemnation, misunderstandings may arise. To avoid these there should be a clause giving the lessee no part of the award, or a stated sum, in the event of an exercise of the power of eminent domain.

Unless stated otherwise in the lease the tenant has the responsibility of keeping the premises in repair.

The lease should also contain a clause clarifying future removal of trade fixtures.

Many leases contain a "distraint clause" which permits the lessor to levy upon the tenant's goods and chattels for rent in arrears.

In discussing leases we may hear the phrase "doctrine of anticipatory breach", which is a common law understanding that one party can sue on a breach without himself performing his own promises; or the "doctrine of frustration", which releases the tenant from the obligation to pay rent when some change, usually of a statutory nature, prevents him from enjoying the lease.

MORTGAGE ON A LEASE

A mortgage on a lease is employed when a business is sold in which part of the transaction involves the transfer or assignment of the lease. The seller obtains a mortgage on the lease in addition to promissory notes. Thus, in the event of default on the part of the purchaser, the mortgagee may foreclose the mortgage on the lease and in effect regain control of the business. Without this he could only sue for money judgment on the notes.

PERSONAL PROPERTY LEASES

The leasing of personal property is part of the law of bailments. This is strictly a contractual arrangement where a thing is hired, the hirer or bailee gaining temporary use thereof and the obligation to return the thing.

When a lease of real property is treated as a conveyance the lease is said to be an "executed" contract. The lease used for personal property is said to be a "executory" contract, one in which something remains to be done—the return of the thing hired.

The Federal bankruptcy law treats all leases as executory contracts. This law limits the lessor to damages in an unexpired lease to one year's rent.

Q. 9 How is a lease transferred by the lessor to a purchaser of the leased property?

Q.10 One who has the right to possession and use of real estate under an oral agreement is known as what?

MORTGAGES, TRUST DEEDS AND LIENS

Mortgages

With few exceptions, modern transactions involving the transfer of title to real property require some degree of financing. This financing is generally accomplished through use of the real property as security for the debt created by the necessity of borrowing.

The vehicle through which this financing is handled is either a "mortgage" or a trust deed.

A mortgage is commonly defined as a pledge of property as security for a debt. Mortgages are not always used to effect a transfer, but regardless of purpose, when a mortgage is used a debt has been created for payment of which the property becomes security.

"Mortgage" actually designates two writings or documents. The primary written instrument is a promissory note, which is evidence of the debt. The second is the mortgage document itself, which creates an interest in the described property as security for the debt evidenced by the note.

The two instruments, note and mortgage, are to be construed together. If, however, there is a conflict with respect to maturity of the debt, the provisions of the note control. If the mortgage contains an acceleration clause and the note does not the provisions of the mortgage control.

The note given in a mortgage is a negotiable instrument or a written promise to pay. Negotiable instruments are an indispensible factor in commerce —consider the common bank check. The "holder in due course" provision of the state law erects certain protections for the third party in the transfer of negotiable instruments, and when a note is transferred the transferor implies certain warranties. These are: that the instrument is genuine and what it purports to be; he, the transferor has a good title to the instrument; all parties had capacity to contract; he does not know any fact that would impair the validity of the instrument or make it valueless.

A mortgage is a contract, and to be valid must contain all of the elements of a contract. We know these to be (1) parties capable of contracting, (2) their consent, (3) a sufficient consideration, (4) a lawful object, (5) a proper writing.

The parties to the mortgage are the "mortgagor", who is the borrower, and the "mortgagee", who is the lender.

A mortgage in which real property is pledged to secure a debt is usually simply referred to as a "mortgage." When personal property is the security the instruments are identified as a "chattel mortgage."

CREATES A LIEN

Oregon law treats a mortgage as a lien against the property, the title remaining with the mortgagor. With the recording of the document the lien is publicly established. The priority of the lien is created by the time of its recording. In the absence of fraud, the document recorded first, regardless of date of execution, is the first lien or "first mortgage", and subsequent mortgages are "junior mortgages."

A minority of the states follow the "title theory" as opposed to the "lien law theory" in Oregon. Under the title theory the mortgagor passes title to the mortgagee. Upon payment of the debt the title reverts to the mortgagor.

The law of Oregon states that a mortgage of real property is not a conveyance so as to enable the owner of the mortgage to recover possession of the property without a foreclosure and sale.

Other provisions of Oregon law relative to mortgages state:

A mortgage does not imply a covenant for the payment of the sums secured. When there is no express covenant for such payment in the mortgage, and no note to secure such payment, the remedies of the mortgagee are in the lands mentioned.

All improvements are a part of the mortgaged property and are subject to the mortgage lien. If removed the mortgagee may regain possession or recover the value thereof.

When the mortgagor fails to pay taxes, assessments, interest on prior mortgages, insurance premiums, or other charges necessary for the protection of the lien, the mortgagee may pay any or all of the costs and add the amount to the mortgage debt. These additions will bear the same rate of interest as the original obligation.

Mortgages may be assigned by an instrument in writing, executed, acknowledged and recorded. The recording is not of itself notice to the mortgagor, so as to invalidate a payment made to the mortgagee.

A mortgage is discharged by the owner delivering a certificate of satisfaction to the county recording officer, or by an entry in the margin of the proper page of the official record, signed by the mortgagee. When there has been a transfer of the note by endorsement, and no formal assignment of the mortgage, the holder of the note executes the satisfaction.

If a mortgagee fails to discharge the mortgage lien within 30 days after being requested to do so, he is liable in the sum of $100 and for all actual damages occasioned by such failure.

THREE CLASSES

Real property mortgages are usually one of three classes—FHA insured mortgage, GI guaranteed mortgage, and the conventional mortgage. In Oregon we have an "in between" type in the mortgage used to secure a State Vet loan. This is essentially a conventional mortgage, but the loan is made directly by the state government.

Most popular form of mortgage, and one highly developed by the FHA, is the amortizing mortgage which retires the debt by a series of equal monthly payments of both principal and interest. A variation of this form includes in the monthly payments necessary amounts to cover taxes and/or fire insurance premiums.

There is also the "straight" mortgage which calls for the payment of interest only during the term of the note, and the "installment" mortgage which calls for periodic payments on the principal, such payments being separated from the interest payments.

Other forms of mortgages are the package mort-

gage, blanket mortgage, open end mortgage, lease mortgage, crop mortgage, and "purchase money" mortgage, all of which are defined in the "words and phrases" section of this Manual.

The purchase money mortgage is merely an extension of credit by the seller to the buyer. In the event of a default in payments under a purchase money mortgage the mortgagee can foreclose. The decree in such a case shall provide for the sale of the real property covered by such mortgage, but the mortgagee shall not be entitled to a deficiency judgment on account of the mortgage or note or obligation secured by the same. A deficiency judgment is usually sought in a mortgage foreclosure when the sale does not bring a sufficient amount to satisfy the debt. In the case of a purchase money mortgage no money was actually loaned.

The same prohibition against a deficiency judgment is found in the trust deed law, although in this case money was loaned.

As a general rule, all governmental liens become a first lien on the property. In some instances a purchase money mortgage or trust deed, subject to proper recording, takes precedence over all but government liens. The importance of recording is emphasized in the Oregon law stating that a conveyance of real property shall be void as against the lien of a judgment unless such conveyance be recorded at the time of docketing the judgment.

Chattel Mortgage

As is the case with a mortgage involving real property, in order that there be a valid chattel mortgage there must be a debt and evidence of the debt, and an instrument creating an interest in the property—in this case the interest is in personal property.

Legal requirements applying to chattel mortgages are found in the Uniform Commercial Code.

Oregon Trust Deed Act

Conveyances to a Trustee to secure a loan were in use in the later seventeenth century in England. In this country the use of Trust Deeds has been wide spread. Some twenty-two states had legislation authorizing Trust Deeds when the Trust Deed Act became effective in Oregon in its present form on August 9, 1961.

Trust Deeds are given to secure loans on real estate. They perform the same function as a real estate mortgage, but there are differences in the terms used, in the methods of handling, and in foreclosure.

Whereas a mortgage involves two parties, the mortgagor (borrower) and the mortgagee (lender), a Trust Deed involves three parties, the Grantor (borrower), the Trustee, to whom the property is conveyed as security for the note, and the Beneficiary (lender). The note which is secured by the Trust Deed is given by the Grantor to the Beneficiary (not to the Trustee) in the same manner as in a mortgage transaction. The loan is handled by the broker, the mortgage company or bank, and the title company in the same manner as a mortgage transaction, with certain exceptions.

The Trust Deed Act provides that only an attorney admitted to the Oregon State Bar, a bank, trust company, savings and loan association, or a title insurance company, its agents or affiliates, each of which is authorized by State law or Federal charter, can act as Trustee. In normal practice it is usually the title insurance company which writes the title insurance that will be named as Trustee in the Trust Deed. The Trustee and the Beneficiary must be two different persons or corporations and cannot be the same, since the purpose of the Trust Deed is to have an individual or company other than the lender or borrower control the security.

In filling out the Trust Deed the property owner and his wife will be named as "Grantor", a title insurance company or one of the other eligible parties would be named as "Trustee" and the lender (whether an individual, mortgage company, bank or savings and loan association) would be named as "Beneficiary."

The property description is filled in as in a mortgage. The Trust Deed Act limits the coverage of Trust Deeds to real property which does not exceed three acres. If the property is larger than three acres a mortgage must be used and not a Trust Deed.

The Trust Deed secures a promissory note made payable to the Beneficiary by the Grantor. The instrument is signed and acknowledged by the husband and wife, and delivered to the lender with the signed note as in a mortgage. The instrument is recorded in mortgage records, and the Grantor is indexed as the mortgagor and the Beneficiary as the mortgagee. The note and Trust Deed are held by the Beneficiary until: (1) the Trust Deed is assigned; (2) it is paid; (3) it becomes in default and must be foreclosed by Trustee's sale.

If the Trust Deed is assigned the printed form "Assignment of Trust Deed by Beneficiary" is used. This instrument is filled out, signed, acknowledged and recorded in the same manner as an assignment of mortgage. No notice to the Trustee is required other than by the recording of the assignment in mortgage records. The note is endorsed and delivered to the assignee with the Trust Deed.

If the indebtedness is paid, the Beneficiary (or assignee) completes and signs the "Request for Full Reconveyance", which appears on the trust deed form, and delivers the Trust Deed and the cancelled note or notes to the Trustee, with any other papers, such as fire insurance policies, which are to be returned to the borrowers. Upon payment of a nominal fee, five dollars , the Trustee will execute a "Trustee's Deed of Reconveyance", and deliver it to the parties named by the Beneficiary in the Request for Full Reconveyance. The recording of this Deed of Reconveyance in mortgage records will clear the title of the property from the lien of the Trust Deed. It is thus equivalent to a satisfaction of mortgage. Careful note must be made that the Trustee for its protection will retain the original cancelled note and Trust Deed in its file as its authority for executing the reconveyance to the borrowers. If Grantors desire copies they must procure them from the Trustee.

The principal difference between a Trust Deed and a mortgage is in the method of foreclosure. In

foreclosing a mortgage an attorney brings a court action to foreclose the mortgage, the necessary parties are served as in any legal proceeding, a decree of foreclosure is entered, the property is sold by the sheriff, and after one year from the sale (redemption period) a sheriff's deed is issued to the purchaser, if the property is not redeemed.

In the case of a Trust Deed, if a default occurs, the Beneficiary or assignee sends a request to the Trustee to foreclose the Trust Deed by Trustee's Sale, who executes a "Beneficiary's Notice of Default and Election to Sell." This notice includes a description of the Trust Deed and of the property, states that a default has occurred and that the Beneficiary has declared the entire obligation due and payable, and sets out the sums owing. It gives notice that the property will be sold by the Trustee at a time and place named in the notice. This Notice of Default must be recorded in mortgage records more than 120 days prior to the sale.

The Trustee must mail notice of sale to the proper parties at least 120 days before the sale, publish notice of sale for four weeks and have the notice personally served on the occupants of the property or posted on the property if it is unoccupied. The Trustee then at the time and place set sells the property to the highest bidder, and gives the buyer a "Trustee's Deed." In this sale there is no court proceeding, no period of redemption, and no deficiency judgment against the Grantors (borrowers).

However, the Beneficiary, but not the borrower, has the option of bringing a judicial foreclosure by a court proceeding, and in this case the borrower will have the same one year redemption period as in a mortgage foreclosure, but the lender Beneficiary cannot take a deficiency judgment.

Thus the foreclosure by Trustee's sale eliminates the court proceeding and allows the buyer to obtain a deed following the Trustee's sale without having to wait out a year's redemption. In the ordinary case the Trustee's sale should be completed in five months instead of the fifteen to eighteen months required for a mortgage foreclosure.

The Trust Deed Act allows the Grantor, or a subordinate lien holder, at any time between default and the sale, to pay the amount of the delinquency then due, plus the Beneficiary's costs and expenses, together with a Trustee's and attorney's fees not exceeding $50. If this is done the Trust Deed is reinstated.

Payments on the note are made by the Grantors to the Beneficiary, not to the Trustee. The Trustee is not obligated to execute a reconveyance unless requested to do so in writing by the Beneficiary or its assigns. Thus, under the Act, no active duty is imposed on the Trustee, except to execute a reconveyance upon written request of a Beneficiary or its assigns, unless there has been a default and the Trustee is requested to commence foreclosure.

Foreclosure of a Trust Deed by advertisement and sale or by judicial procedure shall be commenced within the time limits for mortgages.

Advantages of the Trust Deed:

To the lender—the principal benefit is the short foreclosure period.

To the borrower—an increase in available mortgage funds, elimination of possibility of a deficiency judgment, and the right to cure a default at any time before sale by payment of the delinquency plus nominal costs.

FEES FOR ACTING AS TRUSTEE UNDER TRUST DEEDS

1. Reconveyance Fee
   Full or partial reconveyance ..... $ 5.00
2. Fee for Trustee's Sale
   In addition to expenses actually incurred by the trustee for title search, recording, mailing, posting, service and publication of notice of sale, the following:

   a. For completed sale, trustee's fee computed as in ORS 86.795 as follows:
      - 3½% of any amount up to $1,000.00
      - 2% of all above $1,000.00 and not exceeding $10,000.00
      - 1½% of all above $10,000.00 and not exceeding $50,000.00

      Above fee shall be computed on the amount due on the obligation, both principal and interest, at the time of the trustee's sale.

   b. For cancellation prior to recording notice of default 25.00

   c. For cancellation after recording notice of default 50.00

It should be noted that the fee for cancellation of a default is that paid the Trustee. The law provides for a similar fee for attorney, plus necessary costs.

OPEN-END MORTGAGE

Depending upon the requirements of the lender and the needs of the borrower, mortgages and trust deeds vary in their terms.

The "open-end" provision is frequently used to assure the borrower of future monetary advances, the advances to be secured by the original obligation and security instrument.

A question immediately arises as to whether the advance will be a prior lien, as against a junior lien holder. The answer apparently rests on the terms of the contract—whether the lender is obligated to make advances, or whether he simply reserves the right to do so.

An Oregon court decision held as follows:

"(1) if a mortgagee is obligated to make advances to the extent of a sum stated in the mortgage, the lien of the mortgage is security for all such advances, whether made before or after notice of subsequent encumbrances;

"(2) If the mortgagee is not obligated to make the advances, the mortgage lien attaches only to such advances as are made before notice of the junior encumbrance."

In the latter case, lenders should have a title search to check for intervening liens before the advance is made.

PREPAYMENT PENALTY DISCLOSURE

New legislation now requires a full disclosure of any prepayment privilege penalty attached to any mortgage or trust deed securing a loan on real property for a period of more than three years.

The statute provides that the maximum penalty for the first year and each year thereafter be "expressly and clearly" stated on the loan agreement and promissory note.

"Loan agreement" is defined as a written document which sets forth the terms upon which the loan will be made. It does not mean a mortgage or trust deed which secures a promissory note. The statute, however, requires the disclosure on the note.

Violation of the statute makes the prepayment penalty provision void.

ASSUME OR SUBJECT TO

When purchasing or selling the title to real property, which is subject to either a mortgage or trust deed, it is important that the intent of the parties, with respect to such encumbrance, be clearly and definitely understood. Careless use of words in an earnest money agreement or in a deed of conveyance, will sometimes result in either the grantee assuming a liability which was not intended, or will result in no assumption of such liability, contrary to the intent of the parties.

When real property is subject to a mortgage or trust deed it is used as security for a debt. The debt is evidenced by a note, which is a negotiable instrument and is an obligation and promise to pay by the maker. If the title to the real property upon which the mortgage or trust deed is a lien is conveyed to someone else, such conveyance does not change the obligation of the original maker of the note. One who sells title to real property cannot assume that by such sale he will be relieved of the obligation to pay.

It is often agreed between a seller and buyer that the purchaser will assume and pay the obligation. Such an agreement between the parties will have the effect of subjecting the purchaser to personal liability for the debt but will not in itself relieve the original maker. Such agreement must be clearly expressed as to the intent of the parties.

Usually the express words which constitute the contract and subjects the purchaser to such liability are contained in the deed of conveyance. The mere fact that the purchaser continues to pay, or seeks an extension of the loan, will not in itself subject the purchaser to personal liability. The words must be express in that the intent must be manifested that the grantee will assume and agree to pay the debt.

Deeds of conveyance take on many forms, and a deed which merely "excepts" a lien of a mortgage or trust deed will not result in the assumption of personal liability. Also, a deed which makes exception of the lien and then adds "which the grantee agrees to pay", does not impart personal liability.

A deed which says "subject to a mortgage which grantee *assumes* and agrees to pay", will result in the assumption of the obligation.

Often, a purchaser will enter into an extension agreement with the holder of the mortgage or trust deed, to extend the obligation for another period of time. If a new note is not made and if the agreement is silent as to the assumption of the debt, then the agreement will not result in personal liability being assumed by such purchaser.

Such an extension agreement will have another effect, however, and that is, it will relieve the original maker from liability unless he consents to the extension. The original maker can also be relieved by an assumption agreement which is often entered into between the purchaser and holder of the note upon the sale of the title to real property.

A signed release to substitute a new mortgagor is not unusual, particularly under FHA insured financing.

WATER BILL NOT A LIEN

In the closing of real estate transactions it sometimes is necessary to determine if a charge for services is a lien on real property. A simple test is always applied—and that is, can the real property be sold to satisfy the charge?

A common example of such a charge is a water bill. A mistaken concept is that a water bill is a lien against the real property and can be enforced against the premises. This is not so, because no levy can be made against the property to sell the same to satisfy the charge. The service can, however, be cut off until such time as the charge is paid.

Because of this right to refuse water services, care should be exercised to ascertain if such bills have been paid. Inasmuch as a service charge is not enforceable against the real property and is not a lien thereon, a title search will not disclose a delinquency, if one exists.

Liens

Liens are special encumbrances which make real property security for the payment of a debt or obligation, such as mortgages, trust deeds, taxes and judgments. An encumbrance is anything which affects or limits the fee simple title to the property. To those listed under "liens" can be added easements or restrictions of any kind.

Liens created by law are known as "statutory liens." The lien created by mortgage is an "equitable lien." The latter is not a right in the land itself, but personal rights or obligations against the owner or grantor of the property.

Stated simply, encumbrances are those rights or interests against property which diminish the value of the owner's interest in the property, but generally do not restrict or impair his powers to convey the property subject to the encumbrances.

Generally, they may be grouped in two classes. First, those which limit the use of the land or grant certain rights to the use of the land to third parties; and, secondly, those representing a monetary charge or obligation owing by the owner and for the pay-

ment of which the property has been pledged or is otherwise obligated.

The first group of encumbrances referred to above include easements granted by the owner of the property to provide a right of way for access to adjoining property, or easements for utility lines and other similar purposes. Also in this classification would be the familiar form of building restrictions which limit the use that the owner may make of his property. It should be stated here that a zoning ordinance of itself is not an encumbrance against property.

We will not be concerned with encumbrances of this first general classification, but rather our consideration will be limited to encumbrances of the second group, that is those involving a monetary obligation. Encumbrances, or liens, of this latter classification may also be subdivided into two broad groups.

INVOLUNTARY LIENS—TAXES

The first of these groups is involuntary liens, that is those arising out of no voluntary or willful act of the property owner, but which result—oftentimes without the owner's consent, in a lien or charge against his real property. This lien may be specific as to a particular piece of real property or it may be general so as to include any real property owned by the person obligated to pay the money involved.

Under this heading is included most of the various tax obligations which may be charged against the property. The most common tax obligation is the regular year to year assessment of ad valorem (meaning by value) taxes which are levied by the assessors in the various counties of the state for the purpose of providing funds for local government.

In many states the tax levying divisions of local government levy and collect taxes separately. In Oregon these several districts prepare budgets and present them to the County Assessor whose duty it is to determine the total amount of tax to be levied against each parcel of property.

The annual tax roll includes the obligation of each property for all the various units of local government. This may include the county, a city if the property is within the city limits, a school district, a fire district, water district, flood or drainage district, sanitary district and any of several other special districts authorized by Oregon law and given the power to levy taxes for the support of their activities. It is apparent then, that in order to anticipate what the year to year taxes may be with respect to a particular property you should first know the various taxing districts within which it is situated and current budget plans.

ASSESSMENTS

In addition to this annual levy for ad valorem taxes many of the taxing districts in Oregon are authorized by law to levy special assessments for local improvements. These assessments are distinguished from general taxes in that general taxes are presumed to benefit all property within the taxing district equally, whereas the special assessments are levied only on particular pieces of property because of the peculiar benefit that the assessed property may derive from the contemplated improvement. The most common assessment of this type is the street assessment levied by the city government. There are many others, including sewer, water, diking and so forth. These assessments are specific in nature based upon the actual cost of the particular project and are distributed among the various affected properties, as nearly as possible in proportion to the benefit. Thus, in the case of street assessments, the total cost of the improvement is distributed on a front foot basis among the properties abutting the street. Similarly the installation of sewer facilities and the cost of the installation of water mains will frequently be assessed to the affected properties on a front foot basis.

BANCROFT ACT

In recent years the counties have been granted authority to improve county roads outside the corporate limits of cities or towns on an assessment basis and distribute the cost to property owners abutting the improvement. The Oregon law provides with respect to most of these assessments that the property owner may upon request be permitted to pay them on an installment basis. In the case of city assessments for streets and sewers, this is generally referred to as the Bancroft Act. At any given time you will be concerned to know what the unpaid balance owing on such an asssesment may be and whether the required installments have been kept up to date. In the event of the sale of property affected by one of these assessments, the unpaid balance can be paid out of the purchase price at the time of closing the sale, or the purchaser may assume the unpaid balance and pay off the installments as they come due. County road improvement assessments can also be paid in installments, but over a somewhat shorter period.

AUTHORITY TO FORECLOSE

In the event that the property owner fails to make payment of the amounts due either with respect to the ad valorem taxes or special assessments for local improvements, the law permits the levying body, county or city as the case may be, to institute a suit to foreclose the lien of such tax or assessment and cause the property to be sold to satisfy the obligation.

Oregon law affords to the delinquent taxpayer a variable period of time within which he may redeem from the foreclosure sale and re-acquire title to his property. In the event of his failure to redeem within the time provided the title will vest absolutely in the purchaser at the foreclosure sale, which is usually the taxing unit of government.

In fixing liability between a buyer and seller it is sometimes important to determine the time when a particular levy or assessment becomes a lien against the property. This time may vary depending upon the nature of the assessment. In Oregon, by statute, the tax year for a general ad valorem tax on real property is a fiscal year beginning on July 1st and ending June 30th of the succeeding year. By law the real property taxes for any given year become a lien against the property on July 1st of that year, although the tax statements may not be delivered to the property owner until sometime after the 15th of October of the sam[illegible] When taxes have been

paid in full it will cover the period up to June 30th of the succeeding year.

Assessments for special improvements are governed by the action of the body imposing the lien. In the case of city liens, the lien against the property for street improvements is usually imposed through an ordinance adopted by the city council and usually becomes a lien on the property on the day that a final ordinance fixing and determining the amount is finally approved by the council. The procedure on county road improvements is somewhat different. These assessments may become a lien against the property before the work has actually been performed. The law in this instance provides that after holding the necessary hearings, the county court may make an order directing that the improvement be made. The ultimate lien for the cost of such improvement attaches against the property as of the date of entry of the order to improve.

PERSONAL PROPERTY TAXES

Another classification of local taxes you will have occasion to deal with regularly in the conduct of your business is the tax on personal property. These taxes are assessed in substantially the same manner as general taxes on real property but the tax year is the calendar year from January 1 to December 31, although the bill usually comes out in October or November at the same time as the real property tax bill.

The law in Oregon provides two ways in which the tax collector may obtain a lien against real property to enforce collection of delinquent personal property taxes. First, the tax collector may issue a warrant for the delinquent personal property taxes and cause a copy of this warrant to be filed with the county clerk. When such a warrant is filed it has the effect of a judgment against the delinquent taxpayer and without further action becomes a lien against any real property the taxpayer may own within the county. The lien thus obtained will have a priority dating from the time of filing and collection may be enforced by the tax collector the same as any judgment creditor may proceed to collcet his judgment.

The second means by which the tax collector may obtain a lien on real property for delinquent personal property taxes is by a procedure known as "attaching" or "extending" the delinquent personal property taxes on the real property tax rolls. Oregon law authorizes the tax collector any time he deems it necessary to insure collection of delinquent personal property taxes to select any piece of real property within the county owned by the delinquent taxpayer and to extend upon the real property tax rolls the amount of the unpaid personal property taxes. From the date that such notation is made on the real property tax rolls the personal property taxes become a lien upon the particular parcel of real property thus selected. In this instance, if they continue unpaid, collection would be enforced as in any other case of foreclosure of delinquent taxes.

STATE AND FEDERAL TAX LIENS

In Oregon as in most other states the laws also provide a means whereby the state or federal government may obtain a lien against real property to enforce collection of unpaid tax obligations owing by the property to those branches of government.

The method provided both in the case of delinquent taxes owing the state of Oregon and in the case of delinquent taxes owing the United States is somewhat similar to the first procedure outlined above for the collection of delinquent personal property taxes, that is, the law provides for the issuance of a warrant or of a notice substantially similar to a warrant, and for the filing or recording of this warrant within the county in which the land is situated. The law provides that the claim of the taxing agency will become a lien against any property within the county owned by the delinquent taxpayer from the date of filing such claim or warrant.

This procedure to enforce collection of delinquent taxes has become a favorite method because of the virtual guaranty of collection that goes with it. Once a warrant has been filed within the county giving notice of a delinquent tax obligation owing by a property owner, it is virtually impossible for that taxpayer to sell or mortgage property without first satisfying the tax claim. In a great many instances claims for delinquent taxes are collected through the rather simple procedure of filing a warrant or notice and then waiting for a title insurance company to disclose the lien upon a title examination. Since to actually pursue the taxpayer and enforce collection by whatever procedure was available might be a slow and expensive process for the tax levying body, literally thousands of these warrants or notices are filed each year in the various counties throughout Oregon and in a great many instances they facilitate the collection of taxes which might otherwise go unpaid. The subject of tax liens is a large field but an important one and you will find an understanding of how these claims arise and how they may be discharged to be of great help to you in the day to day pursuit of your business.

JUDGMENTS

The subject of involuntary liens also includes money judgments.

Judgments are principally of two types and arise out of litigation wherein the property owner has been an unsuccessful party and which has resulted in a money claim against the property owner in favor of some other person. This judgment may be for a sum of money due either in a lump sum or in installments, or it may be for a nominal amount resulting from a situation where the property owner has been an unsuccessful plaintiff and in denying his claim the court has given a judgment in favor of the adverse party for the costs incurred. In any case the judgment, from the time it is docketed within the county, will be a lien against any real property which the judgment debtor owns or which he may subsequently acquire during the life of the judgment.

Lump sum judgments will frequently be the result of litigation between parties involving some contractual obligation of the property owner. In recent years another very common source of such judgments is litigation arising out of an automobile accident. Judgments payable in installments over an extended period of time, either for alimony or for child support

arising out of marital troubles have become a very considerable factor in the past few years. In addition to the lien of judgments arising out of litigation within the county in which the property is situated, the law also provides a means whereby a person obtaining a judgment in one county may have a transcript of that judgment prepared and filed in any other county within the state in which the judgment debtor obtains property, and thus obtain a lien against that property.

The lien of a judgment once obtained is usually good for a period of 10 years. Generally speaking the lien thus obtained against real property by the judgment debtor can be removed by payment and satisfaction, by expiration of the ten year period including its extension, if extended, or by obtaining a release from the judgment creditor whereby he releases all property or a particular piece of property from the effect of the judgment. In some instances, through appropriate proceedings, the lien of a judgment may be discharged as a result of bankruptcy of the judgment debtor.

PRIORITY OF JUDGMENT

Oregon law requires the clerk to note "the day, hour and minute" of the docketing of a judgment; and provides that the judgment is a lien from the "time" of docketing and not the "date" as was previously the case. The time of day a judgment is docketed will determine the priority of judgments entered on the same day.

MECHANIC'S LIENS

There is one further type of involuntary lien which is fairly common and with which you should be familiar.

The Oregon law provides that any person or firm supplying material or labor for the construction, improvement, alteration or repair of real property or structures thereon shall be entitled to a lien against that property to secure payment of the money due him for such material or services supplied. This law provides for the inclusion of almost every type of material or labor furnished in connection with the improvement of the real property or structures as long as the material becomes permanently affixed to the land. For an illustration of the distinctions which are made in this type of lien—materials or labor furnished for the structural parts of the building and all electrical and plumbing fixtures incorporated therein would properly be included in such lien.

Materials and labor used in the construction of portable fixtures moved onto the premises and not attached would not properly be included in this type of lien.

The law provides that such a supplier has a period of 60 days in the case of an original contractor, or 45 days in the case of any other supplier, from and after completion of the work within which to file a notice of his claim. When such a lien has been properly prepared and filed it becomes a charge against the property dating back to the time that work was commenced. It is universally recognized as having a very high priority. For example: You might have a situation where work on a new dwelling was commenced on July 1st; on August 1st the builder placed of record a mortgage; on September 1st work was completed and October 25th the general contractor, not having been paid, files a notice of lien. Assuming that the lien is properly prepared and filed and assuming that all of the parties have acted in complete good faith, in the event of foreclosure of the builder's lien his priority would date from July 1st, the date of commencmeent of the work and his claim would be prior to that of the holder of the mortgage recorded on August 1st.

The notice of mechanic's lien claim of this type is filed with the county clerk. The lien is good for a period of six months generally, within which period if the claim has not been paid the lien claimant must institute proceedings to foreclose the lien or his lien against the particular property will be lost. In certain special instances the time within which foreclosure may be commenced may be extended up to a maximum of two years. Liens of this sort, as in the case of other liens, may be discharged by payment and satisfaction, by release of all or part of the property, or, of course, would be extinguished in the event of an unsuccessful attempt to foreclose the lien.

A 1967 amendment to the law changed from 7 to 10 days the period in which any person furnishing materials or supplies to be used in the construction of an improvement must furnish notice to the owner or mortgagee of such delivery to a contractor. A person furnishing labor in addition to material does not have to give this notice.

Upon demand of an owner or mortgagee of the property, a supplier of materials must furnish a list to the owner or mortgagee of the materials delivered and the amount due. Failure to do so waives his statutory preference.

SOME UNUSUAL LIENS

Among statutory liens in Oregon are the following:

CROP LIEN—A lien on the first crop for cost of furnishing seed, commercial fertilizer, or chemical weed eradicator. The property is bound by this lien for 12 months.

INNKEEPER'S LIEN—A lien on baggage, clothing, jewelry or other property if the proper charges are not paid. The property can be sold 60 days after publication of notice.

LANDLORD'S LIEN—A lien on all personal property, except wearing apparel, if rent is not paid within 20 days after due date. The lienor can take possession of the property and sell after 90 days.

LIEN FOR PREPARING LAND FOR CULTIVATION OR CONSTRUCTION—must be filed within 60 days and can be foreclosed in the same manner as a mortgage.

NON-POSSESSORY LIEN—A lien for labor and material expended on personal property. Lienholder has a lien for reasonable worth of his expenditures for one year. Must file notice with recording officer within 60 days of delivery of chattel to the owner.

NURSERYMAN'S LIEN—A lien on the land planted if the value exceeds $25. Foreclosure same as a mortgage.

POSSESSORY LIEN—A lien for labor or material expended on personal property. Lienholder may retain possession and sell if charges not paid within 90 days.

VENDOR'S LIEN—A lien to which a seller is entitled when he has conveyed a parcel of real property to a vendee and has not been paid the full purchase price of the property. Enforceable by foreclosure.

VOLUNTARY LIENS—MORTGAGES

The customary type of voluntary lien against real property in Oregon is the mortgage. In your consideration of voluntary liens it is suggested that you review the "trust deed" portion of this section.

The normal mortgage transaction usually involves two parties, the borrower designated as the mortgagor and the lender designated as the mortgagee. In Oregon this is a traditional method of giving a lien upon real property to secure the payment of an obligation owing by one party to another.

The debt or obligation owing between the parties is expressed by a separate instrument, a promissory note. Because this note is a negotiable instrument and an assignable asset, it must contain an unconditional promise to pay; be in writing; be made by one person to another; be signed by the maker; engaging to pay on demand or at a fixed or determinable future time, a sum certain in money; to order or to bearer.

The mortgage is the instrument through which the lender obtains a lien on real property to secure the payment of the debt.

It is important that the mortgage accurately name the parties, both mortgagor and mortgagee, that it describe the debt with sufficient particularity to enable a person reading the record to determine the amount of money owing and the manner and time of payment. It also is important that the mortgage describe with exactness the particular piece of real property which is being pledged by the mortgagor to secure payment of the obligation. In order that the mortgage may be recorded so as to impart constructive notice to third persons dealing with the land, it is necessary that the mortgage be properly acknowledged by the mortgagors before a notary public or other officer authorized to take acknowledgments. The part of the mortgage that is "acknowledged" is the signature of the mortgagor.

Some clauses, desirable to one or other of the parties, are frequently found in the mortgage, such as the "fire insurance clause", which protects the mortgagee in the event the premises on which he has his mortgage are destroyed by fire; the "receiver clause", used in some jurisdictions to prevent dissipation of the asset that secures the loan, such as abandonment by the mortgagor or loss of good will or retention of profits from the property; the "prepayment", which permits the mortgagor to pay the entire or stated amounts of the principal any time he chooses before due date; the "acceleration clause", which permits the mortgagee to declare the remaining unpaid balance due and payable upon default in a payment; or the "partial release clause" used with a blanket mortgage to free from the lien individual parcels of real property upon payment of a stated sum.

Once the mortgage has been properly acknowledged and recorded in the mortgage records of the county in which the real property is situated, the mortgagee obtains a lien against that property which will continue until it is released by payment or by foreclosure sale, and the execution of a "satisfaction piece" by the mortgagee or the court; or until barred by the statute of limitations. In some instances a mortgagee can release the lien other than by payment, but the "satisfaction" must also be made a matter of record.

The lien of the mortgagee will be determined generally as of the date of recording the mortgage. In the event that the debt is not paid and it becomes necessary for the holder of the mortgage to foreclose his lien, his claim will be prior to that of any other person who has obtained a lien against the property subsequent in time to the date of recording his mortgage. Thus second or third mortgages may be eliminated in the event of a default on the first mortgage and a proper foreclosure by the holder of the first mortgage. Under the recording statute of Oregon the first person who records his mortgage has the first lien. Without this rule, there would be an open door to fraud.

As to federal tax liens, both the U. S. Supreme Court and the Oregon Supreme Court have held that a federal lien takes priority over an inchoate lien. An inchoate lien is one that is imperfect or unfinished. Such inchoate liens are exemplified by mechanics liens or attachments. Here the amount and the final determination of the lien is contingent upon the outcome of litigation.

Some liens, such as taxes and assessments, take priority over contractural and statutory liens regardless of the date of entry. These liens are always prior to other liens of record.

A mortgage is a contractural lien and even though it may be considered as inchoate, because in order to enforce it, it is necessary to foreclose the lien, by statute such a lien is given priority over federal tax liens.

The President on November 2, 1966, signed into law the Federal Tax Lien Act, which restores the priority of all obligations secured by a mortgage over federal tax liens filed after the mortgage is executed and recorded. The new law removes much confusion over priority of a federal tax lien.

Liens are released in various ways when they are secured by real property. Some expire after a certain length of time, such being determined by the statute which provides for the specific lien. And, of course, a lien is released upon the execution of a satisfaction or release by the holder.

FORECLOSURE SALE

The object of the foreclosure is to sell the right, title and interest in the property which the mortgagor had at the time of the execution of the mortgage. Parties whose claims are adverse or superior to that of the mortgagor are not affected by the decree, but good practice generally adopts the following sequence of events:

1. Title search is made so that any person having a possible interest in the property and who

might be adversely affected by the foreclosure may have their "day in court."

2. A lis pendens (notice of pendancy of action) is prepared and filed with the county clerk or recorder. At the same time a summons and complaint are served on the parties.
3. The court directs that the foreclosure sale be advertised (once a week for four consecutive weeks) and that at the expiration of this time the property be sold at public auction.
4. A writ of execution is then issued authorizing the sheriff to sell the property.
5. The property is sold and a certificate of sale is given by the sheriff to the purchaser.
6. Beginning of the redemption period. At any time within one year from the date of the sale, the mortgagor or others acting for him may redeem the property by paying the purchaser the purchase price, 6 per cent interest, the amount of taxes or other assessments paid by the purchaser, a reasonable sum for fire insurance, maintenance, upkeep or repair of any improvement, and 6 per cent interest on these costs.

Another lien creditor may also redeem the property within 60 days of the sale by paying the purchase price plus 10 per cent interest per annum, and the other costs with like interest.

In addition to the claim against the property to secure the payment of the debt, generally the mortgagor is also held personally liable for the full debt, whether or not the sale brought a sufficient amount (deficiency judgment).

It is quite common in Oregon for a purchaser of real property to "assume and agree to pay" an existing mortgage. In such cases the purchaser also will become personally liable for the payment of the debt. When a purchaser buys "subject to" an existing mortgage he is held to have only purchased the equity.

In the event that the indebtedness is not paid when due and foreclosure by the mortgagee results, the original mortgagor, and any subsequent owners of the property who have assumed and agreed to pay the debt, may be held personally liable in the event that a sale of the property does not produce sufficient funds to discharge the entire balance owing on the mortgage, including interest and costs of foreclosure.

In the case of a sale of property by "A" to "B" and a mortgage given by "B" back to "A" for the unpaid balance of the purchase price—a "purchase money mortgage"—Oregon law will not permit a deficiency judgment, but foreclosure proceedings are the same as those for the commonly used mortgage. The purchase money mortgage is merely an extension of credit by the seller to the buyer.

Deed in Lieu of Foreclosure

Under certain circumstances, mortgagors unable to continue mortgage payments may wipe out the debt and the possibility of a deficiency judgment by executing a "deed in lieu of foreclosure".

The deed, of course, gives the mortgagee only the title in the property of the mortgagor in default but is faster than a foreclosure and eliminates the statutory one year redemption period.

Such a deed states that the conveyance is made because the mortgagor is in default, that he can not make his payments and desires to discharge the indebtedness.

RIGHT OF REDEMPTION

As already pointed out, owners of real property are at times faced with the loss of title by reason of involuntary sale of their interest in the property.

When this happens there is usually protection and relief from such sales either in law or equity.

It is generally held that in the absence of contract, the right to allow redemption only extends to cases provided for by statute, though equity courts, in their effort to provide fair treatment to all parties, have sometimes allowed it in other cases.

Presently in Oregon there are three accepted methods of purchasing real property on credit. They are:

1. By contract of sale.
2. By mortgage.
3. By trust deed.

The contract of sale is subject to foreclosure; however, such foreclosure is not a legal action but an action in equity. Because of this there is no statutory right of redemption upon foreclosure but a court of equity will usually allow a reasonable time for the vendees to redeem.

It has been held in Oregon that "the time allowed for redemption in strict foreclosures must be determined from the facts in each case. It is largely a matter of discretion of the court." Periods of redemption have varied, but have usually been about 60 days, although some have been for as long as one year after the decree of foreclosure.

The rights to redeem under a mortgage foreclosure are specified by statute. The period fixed is one year after the date of sale. If a deficiency judgment has been procured against an original maker of the note, then such person has an additional 10 days after the expiration of the year in which to redeem.

The statute also provides for redemption by junior lien holders who may redeem from such sale. Such creditors must redeem within 60 days of the date of the sale, but if there are several junior lien holders, each may redeem within a 60 day period of each prior redemption. If a junior lien holder redeems he must pay off all prior liens against the property.

If the original maker of the note redeems, then all liens against the property are reinstated as of the date of foreclosure.

The statute which provides for financing through use of the trust deed does not provide for redemption in the event a foreclosure sale is conducted by the trustee. Such sale is a nonjudicial sale so there is no equitable relief which can be granted. There is, however, a waiting period under the trust deed foreclosure procedure which is tantamount to a redemption period. The law provides that a sale cannot be had until the expiration of at least 120 days after the notice of default is recorded.

The same rights of redemption apply where other creditors have effected a sale of the property, such as mechanics lien claimants and judgment creditors. The rights of such claimants are legal rights and therefore a "right of redemption" exists.

In tax foreclosures the owners may redeem as provided by statute, within one year of the date of the decree.

TITLE INSURANCE

The standard form title insurance policy in use in Oregon contains certain printed exceptions relieving the insurer of liability on account of liens of certain types that are not disclosed by the public records. Principally these exclusions cover claims arising out of material or labor liens no notice of which is of record at the time of the issuance of the policy, and street or other special assessments which have not yet been extended on the public records. Because of the fact that your buyer's title insurance policy will not afford him protection against these items, it is important that you make an inspection of the property and be in a position to advise the purchaser as to whether street or sidewalk work has recently been done, sewer facilities installed, or repairs, alterations or remodeling work done on the structures. If work is in progress at the time of the sale, it is particularly important that the purchaser be aware of the hazards that are involved in order that he can take the necessary steps to protect himself against loss on account of subsequent liens.

SUPPLEMENTARY REAL ESTATE INSTRUMENTS

Real estate transactions involve the use of a great many instruments or documents. The primary instruments are the mortgage, trust deed, contract, deed and the lease.

Frequently the real estate broker will handle one or more supplementary instruments in completing a transaction. Most of these supplementary instruments have to do directly with a disposition of the primary instruments. Examples are the assignment of mortgage or trust deed; the estoppel certificate, in which a mortgagor makes a signed declaration of the amount due on the mortgage and whether or not he has a defense to a foreclosure; and the very important instrument for recording the satisfaction of a mortgage. A power of attorney given in a situation involving real property is a supplemental instrument.

In the main, supplementary real estate instruments exist or come into being through clauses or specific statements in the primary instruments, although many are statutory.

Q. 11 What is the name given to a past due mortgage that is subject to foreclosure any time?

(A) first mortgage
(B) blanket mortgage
(C) open mortgage
(D) any of the above

Q. 12 The funds for a loan secured by a trust deed are supplied by:

(A) the grantor
(B) the escrow agent
(C) the trustee
(D) the beneficiary

CONTRACTS

To the businessman in general, and to the real estate broker and salesman in particular, the law of contracts and knowledge of the use of the contract as the basic legal instrument of trade and commerce is very important.

Throughout this Primer, reference is made in many sections to some phase of a "contract". Now, what is a contract? Very simply stated it is "a promise which the law enforces as binding".

A contract must contain certain essential elements, and so that these elements can be more easily identified we might define a contract, as many texts do, as "an exchange of promises or assents by two or more persons, for the breach of which the law gives a remedy, or the performance of which the law in some way recognizes as a duty".

When we use the shorter definition that a contract is a promise which the law enforces as binding, we recognize that a contract can be "expressed" or "implied". It can be written or oral. If a promise of one party is given in exchange for the promise of another party it is a "bilateral" contract. It is "unilateral" if one party promises something to induce the other to act, such as the promise to pay a reward for recovery of a lost dog.

When both parties have fully performed under a contract it is said to be "executed". When something remains to be done by either party it is "executory". A contract is "valid", "void", or "voidable". A contract binding and enforceable against both parties is valid. A void contract is simply a non-existent contract, and a voidable contract is one binding and enforceable on its face, but one in which one party usually has an option to void or validate as he chooses and subject to certain conditions. In real estate we usually encounter voidable contracts in transactions involving a minor.

ESSENTIAL ELEMENTS

In order that there be a contract there must be:

1. Competent parties.

2. Offer and acceptance.

3. A lawful object.

4. Valid consideration.

5. Be in writing and be executed by the parties to satisfy the Statute of Frauds. (This is a necessity only in real estate and certain other specific contracts.)

It is important in any contract that there be a "meeting of the minds". There must be actual offer and acceptance with all parties furnishing legal consideration.

Misrepresentation, if proven, is grounds for recission of a contract.

It is of additional importance to add that the parties must be identified, that the assent be genuine (not obtained under fraud or duress), that the subject matter be identified, and that the terms be definite and certain, and that the contract be dated.

Real Estate Contracts

In addition to the so-called "land contract", which will be discussed under that heading, there are three principal types of contracts commonly used in real estate brokerage. These are (1) the Listing Agreement and Employment Contract, which is the contract employing a broker to buy or sell real estate for compensation or commission, (a great many forms of this contract are available, such as residential, commercial, farms, exchanges, etc.); (2) the Earnest Money Receipt or Agreement, which, when properly prepared, is the contract for the sale of real property or of an interest therein, (this document actually becomes a contract between three parties - seller, buyer and broker); and (3) contracts for the lease of real estate for a period of more than one year.

As is the case with deeds, Oregon has no statutory contract forms. Real estate brokers and salesmen, however, use standardized printed forms as the principal documents of their daily business transactions.

THE CONTRACT OF SALE

An agreement for the sale of real property is within the Statute of Frauds and <u>must</u> be in writing in order that it not be void.

In order that it not be held void for lack of some essential,

it must be definite and certain in its necessary particulars. The contract must designate the parties, identify the subject matter with certainty, set forth the terms and conditions, express the consideration, and be signed by the parties to be charged.

All too frequently employment contracts are carefully drawn until the blank space for the commission percentage to be paid the broker is reached. Here the blank is not filled in. It has often been repeated that the courts will not attempt to "write a contract", and that in the absence of any single essential it is void.

It is of vital importance that everyone interested in a contract of sale of real property be designated with all possible certainty. All parties having an interest in the fee should be bound by the contract so that any decree for specific performance will affect all persons required to execute a deed sufficient to convey marketable title.

"Specific performance" under a contract refers to an order of the court to do specifically what a party to a contract promised to do.

An individual, other than the person holding the legal title, who has a life estate in the property should join in the contract of sale as one of the sellers.

CAPACITY AND AUTHORITY

The capacity and authority of the seller to execute the contract must be thoroughly determined and identified. Examples:

If the seller is a minor the contract must be executed by the duly appointed guardian. A minor has the option of declaring a contract valid or void when he reaches the age of maturity.

If the estate of an intestate descendant, it must be executed by an administrator.

If by a seller as a fiduciary named under a will, a trust or agency agreement must be shown.

DESCRIPTION

The principle that a contract for the sale of real property must be definite and certain applies to both the terms of the agreement and the legal description of the real property. An insufficient description may render the contract void under the Statute

of Frauds or other pertinent statutes.

The property should be described so that it is readily identifiable. Sometimes it is not possible to get a complete and accurate legal description. Oregon courts have been liberal in this essential, but as a minimum it should show clearly the quantity and location of the lands to be transferred. The courts have held a description to be sufficient if the property can be identified by a competent surveyor. When a legal description cannot immediately be had it is good practice to refer to a separate document, such as the public record, thereby making such a reference a part of the contract.

LAND CONTRACTS

As we have seen, contracts of sale are the basic legal instrument in almost every real estate sale transaction.

Through common usage, however, we have come to consider sales of real property, other than for cash, as being negotiated through the medium of either the mortgage, trust deed, or the "contract of sale".

During periods of so-called "tight money" the use of the contract of sale is increased. In this context, the contract of sale, frequently known as a "land contract", refers to the special situation in which the seller agrees to sell for a price payable in installments over a specified period of time, and to execute a deed only upon full performance by the buyer. Full performance may be payment of the full purchase price, or a stipulated proportion of the purchase price.

RECORDING

In the event both real and personal property are being sold by the contract of sale, the contract should also describe in detail the items of personal property which are being sold. This can be done by either listing the items in the body of the contract of sale or by referring to an inventory attached to the contract of sale.

The ordinary contract of sale covering only real property in which the seller retains title need not be recorded, but if personal property is included the law requires that the contract of sale be recorded in the Conditional Sales Contract Records in the county in which it is located.

CONSIDERATION AND MANNER OF PAYMENT

Any contract which does not show the true purchase price and the manner in which it is to be paid, expressed definitely and clearly, is a sorrowful reflection on its author and most likely void.

Very frequently where property is being sold on contract of sale there is in existence, as an encumbrance on the real property covered by the contract of sale, a mortgage upon the property. In this event it is necessary that the contract of sale recite that the property is subject to the mortgage, describing the mortgage sufficiently so as to be identified. The contract of sale should further make it clear as to whether the seller or the buyer is to make payments upon this mortgage while the contract is in force and effect.

Another situation is where, instead of the property being subject to a mortgage, the seller owes money upon an existing contract of sale upon the property.

Where this situation exists the contract of sale should provide that the interest of the seller in the property covered by the contract is represented by the ownership of a buyer's interest in a contract of sale. The contract should, further, describe this contract of sale by parties, by date, and by balance due. Provision should be made as to which of the parties is to make the payments upon the existing contract.

POSSESSION

In the absence of agreement between the seller and purchaser the right to possession follows the legal title. The contract should express and specify as to delivery of possession to the purchaser and should definitely fix the date of such possession.

FORECLOSURE

In a suit to foreclose a contract of sale the court makes an interlocutory decree which decrees the amount due on the contract, gives to the buyer a specified time to pay in full the amounts found to be due, and provides that in the event of the failure of the defendant to pay said amounts that the defendant be foreclosed of all right in the property covered by the contract. If the defendant fails to pay the amounts due within the time allowed in the interlocutory decree, the court makes a final decree, which completely forecloses out all of the interest of the buyer in the property. Thus it is seen that the buyer in a contract of sale has no right of redemption. It is therefore, obvious that it is

to the advantage of the seller of the property to sell it on contract of sale rather than deeding the property to the buyer and taking back a mortgage for the unpaid balance. Oregon's trust deed law has the same advantages, plus some additional benefits to the purchaser.

In the event of a default in the payments under a contract of sale the buyer does not automatically and by operation of law lose all of his right in the property, nor does the seller have the immediate right to go into possession of the property.

There is no way whatsoever to take from the buyer his rights in the property save and except to foreclose the contract of sale, or the securing of some sort of a release from the buyer of his interest in the property.

WAIVER OF STRICT PERFORMANCE

If the seller in a contract of sale accepts any payment upon the contract of sale, even one day late, or if the seller accepts any performance on the contract of sale after a default by the buyer in the failure to pay taxes, or the failure to pay insurance premiums, the seller is deemed to have received the strict performance of the contract.

JUDGMENT

It is quite generally recognized that where a buyer in a contract of sale has a judgment of record against him, he can make an assignment of the contract of sale and a transfer of his interest in the real property covered by the contract of sale, without having the judgment vested as a lien on the property.

It is not so well known that this is not true where there has been recorded a Federal tax lien against the buyer. These liens vest on any type of interest or ownership of property.

FORFEITURE CLAUSE

In the event of a default in payments on a contract of sale, the seller is limited in his remedies by the forfeiture clause of the contract.

Some contract forms contain what is known as a self executory clause. Under this clause the sole remedy of the seller is to foreclose the contract.

If this clause is not present the seller is given the option to

determine whether or not he desires to forfeit all of the right and interest of the buyer in the property, or whether he elects to sue the buyer and obtain personal judgment against the buyer for the payments upon the contract of sale as they accrue.

ENTIRETY SEVERED

A little understood point of law relative to contracts of sale is the change in the position of husband and wife upon signing of a contract of sale.

Prior to the time of entering into the contract they held title in an estate by the entirety. When they entered into a contract to sell the property the nature of their ownership of the property changed. For purposes of distribution in an estate, and for other purposes, their ownership of the legal title is personal property rather than real property, and that interest passes in an estate as personal property rather than real property.

EQUITABLE CONVERSION

The effect of the execution of a "land contract" upon the legal title and upon the rights of the parties thereto is interesting because of a fiction known as "equitable conversion". This doctrine is recognized in Oregon and applies to various situations where such a conversion is rendered necessary by the equities of a case. Here we will discuss only the conversion which is the result of the execution of an executory contract for the sale of real property.

Briefly, the doctrine of "equitable conversion" is the change of property from real to personal or from personal to real. Such conversion when the result of the execution of a contract is entirely fictional and not physical. Conversion in a physical sense is a change in nature of real or personal property resulting from either an actual severance from or an attachment to land. An example of physical severance from land would be the cutting of timber or other crops, which while growing are considered real property but when severed become personal property. Conversion by attachment would be best illustrated by the connection of personal property to real property, such as the construction of an improvement on real property or the addition of some item considered personal property but permanently attached to a building thereby making it real property.

As applied to a contract of sale, upon the execution thereof the contracting parties change places. The buyer's interest is "land" and the right and interest conferred by the contract upon

the seller is "personal property". The seller has the right to receive the money and he also is the owner of the real property as trustee for the benefit of the buyer, who is referred to as the "equitable owner". Because of this conversion the rights of the seller in a contract of sale are not as assumed by the parties.

In as much as the seller's right is personal property, if the seller should die while said contract is in existence it would be treated as personal property in his estate. If the seller died leaving a will his interest in the property would be distributed as personal property to his legatees and not to his devisees.

Validity of Contracts Executed on Sunday

In the colonial days most of the colonies had laws which have, through the years, become known as "Blue Laws", or sometimes as "Sunday Laws". These laws, as a general thing, forbade certain things being done on the Sabbath. Among these things was the transaction of business and the execution of contracts. A few of the states of the union have such laws. Oregon does not have such a statute, consequently, agreements executed on Sunday are as valid as though they were executed on any other day of the week.

If Oregon did have a law forbidding the execution of contracts on Sunday, the mere dating of the contract on a different date, say Monday, would not in any manner add to the validity of the contract, and might very likely defeat a remedy for breach.

The date affixed as the date of execution on a contract is only prima facie evidence as to the true date. The date the actual execution took place can be presented as evidence verbally. The misdating of a contract will not accomplish anything.

The Statute of Frauds

The "Statute of Frauds" is the name of that law which requires certain agreements to be in writing and provides that if such agreements are not in writing they are void.

The sufficiency of earnest money receipts and listing agreements covering the sale of real property has been the subject of innumerable law-suits. Most licensed real estate brokers and salesmen know that an agreement concerning the sale of real property has to be in writing - but there are some who will argue.

General usage of the printed listing agreement and earnest money receipt or agreement has eliminated many controversies

concerning the sufficiency of a contract for the sale of real property. It should be remembered that an agreement to employ a broker to sell real property can only be consummated and evidenced by a series of writings or notes.

The importance of properly drafting a listing agreement or an earnest money receipt cannot be overemphasized. First of all, such an agreement MUST be in writing, otherwise it is void and not merely voidable. Only the writing is allowed in evidence and no other evidence is admissible to change the terms of the document. When such an agreement is drawn it must stand alone. It would then appear that when selling real estate the most important document in the transaction is the earnest money receipt or agreement. The terms of the transaction are fixed beyond any alterations when the agreement is signed by all parties.

HISTORY

The Oregon Statute of Frauds, set forth in ORS 93.020 and ORS 41.580, was enacted in 1862 as a part of the Civil Code, and in the opinion of many attorneys is our most important statute in the sense that it probably affects a greater number of business transactions than any other existing law.

ORS 41.580

"In the following cases the agreement is void unless the same or some note or memorandum thereof, expressing the consideration, be in writing and subscribed by the party to be charged, or by his lawfully authorized agent; evidence therefor, of the agreement shall not be received other than the writing, or secondary evidence of its contents, in the cases prescribed by law:

"(5) An agreement for the leasing for a longer period than one year, or for the sale of real property, or of any interest therein.

"(6) An agreement concerning real property made by an agent of the party sought to be charged unless the authority of the agent be in writing.

"(7) An agreement entered into subsequent to the taking effect of this Act, authorizing or employing an agent or broker to sell or purchase real estate for compensation or commission; provided, however, that if the note or memorandum of such agreement be in writing and subscribed by the party to be charged, or by his lawfully authorized agent, and contains a description of the property sufficient for identification, and authorizes or employs the agent or broker named therein to sell such property, and expresses with reasonable certainty the amount of the commission or compensation to be paid such agent or broker, such agreement of authorization or

employment shall not be void for failure to state a consideration."

ORS 93.020

"No estate or interest in real property, other than a lease for a term not exceeding one year, nor any trust or power concerning such property, can be created, transferred, or declared otherwise than by operation of law, or by a conveyance or other instrument in writing, subscribed by the party creating, transferring, or declaring the same, or by his lawful agent, under written authority, and executed with such formalities as are required by law."

The Supreme Court has denied Oregon brokers any right of recovery of a commission where they have been employed orally to sell real property. After expressing sympathy with their efforts, the court stated, "without a lawful agreement to support the same, no labor, however valuable, by one for another will make the person performing it more than a mere volunteer not legally entitled to compensation."

THE RULE FOR PERSONAL PROPERTY

In order to maintain an action for commission for the sale of real property it is necessary to have a written agreement; this rule or principle of law does not apply to actions for commissions claimed for the sale of personal property.

Oral agreements may be relied upon in the recovery of a commission for the sale of personal property. In numerous instances sales are made which include both real and personal property. If any real property is included in the sale and if the sale cannot be severed as between the real and the personal property insofar as a consideration is concerned, a broker cannot recover a commission for such sale without having an agreement in writing. This is true even though the real property may in fact constitute only a minor part of the consideration in the sale.

Uniform Vendor and Purchaser Risk Act

Any contract made on or after August 3, 1955, in this state for the purchase and sale of realty shall be interpreted as including an agreement that the parties shall have the following rights and duties, unless the contract expressly provides otherwise:

If, when neither the legal title nor possession of the subject matter of the contract has been transferred, all or a material part thereof is destroyed without fault of the purchaser, or is taken by eminent domain, the vendor cannot enforce the contract,

and the purchaser is entitled to recover any portion of the price that he has paid.

If, when either the legal title or the possession of the subject matter of the contract has been transferred, all or any part thereof is destroyed without fault of the vendor, or is taken by eminent domain, the purchaser is not thereby relieved from a duty to pay the price, nor is he to recover any portion thereof that he has paid.

The purpose of the Act is supplying of an answer as to who takes the loss if, after a contract is made for the purchase and sale of real property, a fire or other disaster destroys or seriously damages the property.

Minors

Modern day teenagers will hardly approve, but in law the reference to a person as an "infant" means any person who has not attained the age of majority as prescribed by law. The age of majority is defined as "the age at which, by law, a person is entitled to the management of his own affairs and to the enjoyment of civic rights."

At common law the age of majority was twenty-one, but under statutory law the age of majority is a matter for legislative regulation.

The age of majority as designated by Oregon statute, for both sexes, is twenty-one. But if a minor is legally married, such minor "shall be deemed to have arrived at the age of majority according to law".

The age at which a male and female may consent to marriage differs - eighteen years of age for the male and fifteen years of age for the female, with parental consent. The age at which a marriage may be contracted without parental consent is twenty-one for a male and eighteen for a female.

Care should be exercised when dealing with persons who may not have attained their majority. A contract, except for necessities, is voidable by the infant within a reasonable time after he attains his majority.

Q. 13 Name three of the five essential elements of a valid contract.

DEEDS AND CONVEYANCES

Rights in real property are subject to sale, either voluntary or involuntary, and are also subject to being devised by will, or to descent by operation of law. Voluntary transfer of title during the lifetime of the owner is always accomplished by a written document known as a "deed".

Just when the use of a written document was first used to transfer title is unknown. In the study of English law we are taught that early transfer of title was accomplished by possession, and proof of transfer of title existed solely in the memory of the witnesses present when a change of possession occurred.

STICK CARRIED TITLE

The actual delivery of title was through a symbolic ceremony known as "livery of seisin". The parties with their witnesses went upon the land and the grantor gave to the grantee a stick, twig, piece of turf, or a handful of earth taken from the land.

Sometimes other items, such as a ring or a knife, were handed over as a token of delivery of title. At the same time the grantor used proper and technical words which were to show that he intended to transfer the land. By the use of such words the extent of the interest conveyed was also expressed.

The use of the written instrument gradually became more pronounced; however, such use remained optional until the passage in England in the year 1677 of the Statute of Frauds. The principles of this statute were adopted by the State of Oregon. In addition, we also have a statute which reads as follows:

"Conveyances of lands, or of any estate or interest therein, may be made by deed, signed by the person of lawful age from whom the estate or interest is intended to pass, or by his lawful agent or attorney, and acknowledged or proved, and recorded without any other act or ceremony."

CONTROLLED BY LAW

After a person becomes the owner of land he cannot transfer or part with title except by some form or manner prescribed by law. The law in Oregon is:

"No estate or interest in real property, other than a lease for a term not exceeding one year, nor any trust or power concerning such property, can be created, transferred or declared otherwise than by operation of law or by a conveyance or other instrument in writing, subscribed by the party creating, transferring or declaring it, or by his lawful agent under written authority, and executed with such formalities as are required by law."

WORDS SIGNIFICANT

At common law, words used in a deed were significant in that each word was capable of creating a different estate. Under present usage deeds still retain some of the early language, and also designate the estate or interest conveyed. In some states there are statutes setting forth certain short convenient forms of deeds and declaring the effect to be given to the clauses or provisions thereof.

These deeds are called "statutory deeds". Deeds used in Oregon are based upon the common law conveyances. Oregon, of course, does have statutory provisions relating to form and legal effects of conveyances, but has no statutory deeds.

ADVERSE POSSESSION

Oregon law provides that "No grant or conveyance of lands or interest therein is void for the reason that at the time of its execution the lands were in the actual possession of another claiming adversely."

NO IMPLIED COVENANTS

The law also provides, "No covenants shall be implied in any conveyance of real estate, whether it contains special covenants or not."

DEEDS

Three types of deeds are used in Oregon. These are the Warranty Deed, Bargain and Sale Deed, and the Quitclaim Deed. The Warranty Deed has two forms: General Warranty Deed and Special Warranty Deed.

Most textbooks on the subject say that a deed to be valid must contain the following: Competent grantor, a grantee, recital of consideration, words of conveyance, description of land, quantity of estate conveyed, exceptions or reservations, warranties of title, execution, delivery and acceptance.

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QUITCLAIM DEED

Oregon law says of the quitclaim deed: "A deed of quitclaim or release, of the form in common use, is sufficient to pass all the estate which the grantor could lawfully convey by a deed of bargain and sale."

The quitclaim deed does not "convey", nor does it purport to transfer the property - only the "right, title and interest, if any" in the property.

This deed is usually used as a release. It contains no covenants of warranty or otherwise. Because it conveys only the present interest, if any, it does not have the protection of the recording acts as against a prior unrecorded conveyance.

It cannot safely be used for passing title, but is used to release a cloud on a title, or surrender or release an interest back to the holder of the fee title.

Title insurance companies will not insure on a quitclaim deed. It is their position that the sufficiency of a deed, whether it be a bargain and sale deed or a warranty deed, always depends on whether or not the grantee is a bona fide purchaser. If the grantee has acquired title in good faith without deceit or fraud, either of the latter deeds will convey a good and sufficient title. Such deeds are accepted by an examiner of titles at face values as passing all of the title of the grantor, including any after acquired title of such grantor.

Unfortunately, this cannot be said of the quitclaim deed, which is too frequently used in an attempt to convey title to real estate.

The quitclaim deed is best used to clear a cloud on the title and in correcting title defects in marital situations.

BARGAIN AND SALE DEED

A deed frequently used in Oregon is the Bargain and Sale Deed.

This deed can be identified by its basic words, which are "bargain and sell". Modern usage has generally expanded the granting clause to read "grant, bargain, sell and convey". A deed which contains these words and no other covenants will convey a good and valid title and will also convey after acquired title of the grantor. This deed is next to the lowest form in order of obligation by the grantor and protection to the grantee.

WARRANTY DEED

The deed most frequently used to convey title to real property in Oregon is the Warranty Deed.

Basically the Warranty Deed is a Bargain and Sale Deed with covenants. Such covenants are an agreement by the grantor that something is either done or shall be done or stipulates for the truth of certain facts. The granting words in a warranty deed are identical with those in a bargain and sale deed, to-wit: "grant, bargain, sell and convey". In addition a warranty deed usually reads as follows: "the grantor - covenants to and with the grantee - that he is lawfully seized in fee simple - that the premises are free from all encumbrances - and that he shall warrant and forever defend the granted premises - against the lawful claims and demands of all persons whomsoever."

These words contain the covenant of seizin and the right to convey. Such covenant is that assurance of the grantor that he has the estate in quantity and quality that he purports to convey. He covenants that the premises are free from encumbrances, unless, of course, he expressly excepts specific liens. He also agrees that in the event his promises and assurances are not correct he will defend the title against "the lawful claims and demands of all persons whomsoever."

SPECIAL DEED DESCRIBED

Deeds which contain the aforementioned general warranties are called General Warranty Deeds. There is also a Special Warranty Deed in use which has all the attributes of a bargain and sale deed, contains the covenant of warranty, but limits the warranty to only those acts or deeds committed by the grantor. The special warranty deed can be recognized by the following language, to-wit: "shall warrant and defend against the lawful claims and demands of all persons claiming by, through or under the grantor."

GRANTEE PROTECTED

Before the use of title insurance, deeds which contained covenants of warranty were considered extremely important because, in the event of a defect in title the grantee ostensibly had someone to look to for reimbursement when there was a failure of title. Such reimbursements depended, of course, upon the availability of the grantor and also his ability to pay or defend. A warranty is a personal obligation and if the grantor is deceased or has removed himself beyond the jurisdiction of the courts, or if his financial fortunes have changed, then the possibility of

recovery by the grantee because of a breach by the grantor would be doubtful.

Fortunately, our modern method of insuring titles has alleviated to a certain extent the absolute necessity of insisting upon a warranty deed.

TEXT IMPORTANT

Today it is the custom to use printed documents which emblazon the type or form of deed. Such deeds should not be accepted at their face value without closer examination of the entire document. Courts today do not rely upon the granting words alone to determine the type of deed, but examine and consider the entire document. A change in the granting words may change completely the form of deed and by so doing the right and liabilities of the parties thereto.

Each of the three forms of deeds is designed for a different use for special objects and in particular situations.

SOME USES

The warranty deed is the highest form of instrument in terms of protection to the grantee.

The special warranty deed is most frequently used in a "contract of sale" or "land contract" transaction, because its only warranty of title is to encumbrances suffered by or placed upon the title by the grantor, and does not warrant against liens or encumbrances placed on the property by the grantee, or others, in the interim.

If title insurance is not to be furnished, a seller limits his obligations to a minimum through use of the bargain and sale deed.

GENERAL RULES

A transfer of real property to husband and wife usually creates a tenancy by the entirety, but there are cases where for tax purposes, or something else, a tenancy in common is indicated. The short form deed now used by many Oregon attorneys should result in greater working cooperation between the real estate practitioner and the lawyer.

Frequently in a discussion of conveyances we use the word "executed", which simply means that these instruments of real property transfer must be signed by the grantors. A deed without a date is

still valid, but a deed without a grantor's signature is a headache.

The signature of the grantors should be acknowledged before a notary public, but under Oregon law, if it is necessary, the acknowledgment can be accomplished by the signing of a subscribing witness.

The word "delivery" is universally understood to be the physical act of handing over, and the time is understood to be when something actually passes between the parties. Oregon decisions, however, define delivery of a property interest as the time the grantor manifests an intention to transfer his interest. Actual delivery to the grantee or delivery to an escrow agent is the normal procedure.

CONSIDERATION SHOWN ON
CONVEYING INSTRUMENT

All instruments conveying an interest in real estate must show on the face of the instrument the true and actual consideration paid, stated in terms of dollars.

"Consideration" includes the amount of cash and any lien, mortgage, contract, or other encumbrance existing against the property and agreed to be paid or assumed by the purchaser. The monetary value of personal property included in the sale need not be stated, but it must be shown as a part of the consideration.

The grantor has the prime responsibility for making the recital. If he is unable to act, the grantee takes responsibility. No conveyance will be accepted for recording unless it contains such a verifying statement.

The giving of a false statement is punishable by a fine up to $500.

Recordation and Its Effects

The recording system of Oregon, modeled after the system established by the original American Colonies, is strictly an American device for safeguarding the ownership of land.

Under the recording statutes, the first person who records his mortgage has the first lien. Without such a system, there would be an open door to fraud.

The recordation statutes provide a system by which evidence

of title or interest therein can be collected in a convenient and safe public place, to the end that those planning to purchase or otherwise deal with land may be more fully informed as to the ownership and condition of the title.

When an instrument is recorded, under Oregon statutes notice is given to the world of its existence. Real estate practitioners have an obligation to give the grantee in a conveyance the protection of the recording statute at once.

Under the growing popularity of the escrow method of closing, title insurance companies accept all the necessary documents to a transaction, check title records, examine the instrument, and see to the recording.

Normal procedure in Oregon is for the seller to pay the cost of title insurance and recording of any documents to clear title. The buyer pays the recording fee for his deed, and, of course, the fee for any mortgage he himself puts on the property.

The recordation statutes require the county clerk to provide separate books for the recording of deeds and mortgages; to certify the time of receipt of every conveyance; to keep an index; to accept recordings of leasehold interests; to record foreclosed mortgages; to accept notice of lis pendens; and to issue a subpoena to compel a witness to testify to execution of a deed.

Two sections of the Oregon recordation act are of importance to real estate practitioners. They are:

ORS 93.640. (1) Every conveyance affecting the title of real property within this state which is not recorded as provided by law is void as against any subsequent purchaser of the same real property, or any portion thereof, in good faith and for a valuable consideration whose conveyance is first filed for record, and as against the heirs and assigns of such purchaser.

(2) Every assignment of sheriff's certificate of sale of real property on execution or mortgage foreclosure which is not recorded in the records of deeds in the county where the land is situated within five days after its execution is void as against any subsequent purchaser of such certificate of sale, or the real property covered thereby, or any portion thereof, in good faith and for a valuable consideration whose assignment is first recorded.

ORS 93.650. The record of a conveyance duly recorded, or a transcript thereof certified by the county clerk in whose office it is recorded may be read in evidence in any court in the state, with the like effect as the original conveyance. However, the

effect of such evidence may be rebutted by other competent testimony.

ACKNOWLEDGMENT

In order to be protected under the recording act, a purchaser of title to real property must have a properly executed and acknowledged instrument which is entitled to be recorded.

The acknowledgment, usually before a notary public, does not validate the deed but the grantee cannot avail himself of the protection of the recording act unless this formality is followed.

If a grantee is in possession of a deed which has not been acknowledged, Oregon statute makes it possible to record by having the signature of a witness to the document acknowledged. If there are no witnesses it is still possible to prove the handwriting of the grantor in circuit court.

Q. 14 The title interest of the grantor passes to the grantee when a valid deed is:

(A) signed
(B) recorded
(C) delivered and accepted
(D) acknowledged

Q. 15 What is a "bargain and sale deed"?

Q. 16 Which of the following is a requirement in order for a deed to be valid and convey title?

(A) an acknowledgment
(B) execution on a day of the week other than Sunday
(C) a property description
(D) use of the phrase "to have and to hold"

OPERATING THE REAL ESTATE OFFICE

The Law of Agency in a publication dealing with a discussion of law would normally be found in the section on contracts, but in a Manual for real estate practitioners it is properly placed under operation of the real estate office.

"Agency" is defined as the relationship which exists when one person is employed to act for another.

There are three kinds of such contractural relationship: Principal and agent, master and servant, and employer and independent contractor.

Assuming that "principal", "master" and "employer" have generally similar rights and obligations, what of the second parties in each contractural relationship?

An "agent" is employed by his principal to bring the principal into new contractual obligations.

A "servant" represents his master in the performance of ministerial or mechanical acts or services.

As an "independent contractor" the employer has no control over the means or methods by which the work is accomplished.

The relationship between a real estate broker and the owner of property is that of principal and agent. Under certain circumstances in a real estate transaction the position of principal and agent exists between the broker and the buyer.

The real estate broker is a special agent—he has been employed to sell a particular parcel of land. He cannot delegate his authority. In other words, he cannot transfer the legal rights the principal has against him.

RIGHTS OF PRINCIPAL AGAINST AGENT

1. Right to have the agent render reasonable diligent and skillful services. (This is why we have educational programs.)
2. Right to have the agent act in obedience to instructions, and only within the limits of his authority.
3. Right to demand an accounting from the broker in financial dealings of the agent with third persons. (One of the principal reasons for a Closing Statement)
4. Right to expect fidelity and loyalty from the agent. The agent must inform the principal of such facts that come to his knowledge as would be likely to influence the principal's action. (A reason for giving a frank opinion of Market Value) The agent cannot take advantage of information to make a personal profit. (Purchase of the property by the broker without a full disclosure) The agent cannot accept side compensation. He cannot act for both parties. (Both must agree with full knowledge of the facts.)

RIGHTS OF AGENT AGAINST PRINCIPAL

1. Right to compensation agreed upon.
2. Right to reimbursement and indemnity. The principal is bound to pay all bills incurred, as long as the agent is acting rightfully and within his authority.

An agent warrants his authority and subjects himself to suit for damages for breach of his warranty. An agent is not a "partner." Partnership is defined as an association of two or more persons to carry on, as *co-owners,* a business for profit.

The relationship between the real estate broker and the real estate salesman has usually been considered as that of independent contractor, but some tax rules make it that of employer and employee.

A strict interpretation of the Real Estate Law would fix the relationship as employer and employee. The State Tax Commission so holds, requiring the broker to withhold state income taxes from the gross commission of the salesman. The State Compensation Department takes the same position.

The Federal government, on the other hand, accepts the statement of the broker that the arrangement is that of employer and independent contractor. It should be pointed out, however, that this relationship contemplates that the broker has no control of the means or methods used by the salesman in getting the work done.

It cannot be stressed to heavily that the broker is a trusted fiduciary agent of the seller.

The authority and trust placed in a real estate broker is closely akin to that of a lawyer and his client, a physician to his patient, or an accountant to his principal.

We owe the maximum in loyalty, honesty, trustworthiness, and our best efforts. When it is remembered that relations with the buyer are of immense concern to future reputation, it will be apparent that the stability of our progress will be measured by the degree to which we practice the Code of Ethics.

TERMINATION OF AGENCY

Ordinarily, the agency may be terminated by acts of the parties or by operation of law. The parties may agree to terminate it, or the agent may renounce the agency, or the principal may revoke it. An agency is also terminated by the expiration of its term, extinction of its subject, or the death or incapacity of either the principal or the agent.

Broker Owes Fidelity to Principal

Real estate brokers and the salesmen for whom they are responsible should frequently remind themselves of the duty which they owe to their principals of exercising the highest degree of fidelity toward them, and of making a full and complete disclosure of any and all natural facts involved in a transaction.

This principle may be well illustrated by reference to the case of Hanson et al vs. Johnson et ux, 143 Ore. 536. In this case the Plaintiffs, who were real estate brokers, brought an action against the Defendants upon a promissory note of $200.00. This promissory note had been given by the Defendants to the Plaintiffs in payment for the balance due upon a commission arising out of an exchange of property.

The Defendants filed a counter-claim asking for damages against the Plaintiffs based upon alleged fraud. The Defendants, upon the trial, obtained a judgment against the Plaintiffs for $1,500.00 and the Plaintiffs appealed the case to the Supreme Court. The evidence in the case disclosed that the Defendants had been residents of the State of California. They had been in communication with the Plaintiffs with the view of trading a parcel of property which they owned in California for a ranch in Oregon. After some correspondence between the Plaintiffs and the Defendants, the Defendants came to Oregon and called upon the Plaintiffs and made two visits to the Oregon ranch. Ultimately an exchange agreement was signed between the Defendants and the owners of the Oregon ranch, as a result of which the Defendants received the Oregon ranch.

The fraud alleged by the Defendants in their counter-claim had to do with the condition of the soil of the ranch which they obtained and some other details with respect to the ranch. The Plaintiffs contended, upon the appeal in the Supreme Court, that since the Defendants had visited the ranch on two different occasions, they had no right to rely upon anything which the Plaintiffs may have said with regard to the ranch. The Supreme Court, in passing upon this question, called attention to the fact that the Plaintiffs in the transaction were acting as agents for the Defendants as well as agents for the former owners of the Oregon ranch. The Supreme Court in its opinion, in pointing out the duty of the real estate broker to his principal, made the following pertinent statement:

"The Plaintiffs were Johnsons' agents, and it was their duty to make full and truthful disclosure of all material facts known to them. They could not lawfully misrepresent nor conceal."

If You Keep Good Records, Your Records Will Keep You

The Oregon real estate law requires that you keep copies of certain documents pertaining to a real estate transaction. These must be kept for six years.

Taxing authorities require the keeping of other records, and in our highly regulated society it is prudent to think twice before throwing anything away.

Complete records are often an unexpected protection for the broker. Copies of every letter, contract or agreement leaving the office should be properly filed.

The modern real estate office should have a property record file, set up by street names and street numbers. The value of this file showing property transfers, will increase with the years and become your own "valuation laboratory."

There should be a general file for correspondence, and a file for listings. The originals from both files should never leave the office.

A valuable aid in any office is what might be called a "people file." This is a record of everything you learn about individuals in your community and can be a real source of prospects.

In addition to the records required by law, every office should keep adequate and complete office operation records. There is nothing that will educate you faster than seeing where money was spent needlessly. Learn to question every expenditure and ask yourself if it was really necessary.

The really efficient office will require a signed contract between broker and salesman, which in its truest sense will be a procedure manual. Under such an arrangement all parties are fully aware of their rights and obligations toward each other.

A salesman is entitled to know office policy toward "walk-ins" and floor duty. He has a right to expect some system of advising him that "so-and-so" helped a certain individual while he was out of the office.

Salesmen will help in the important task of keeping an office neat and orderly if ground rules are spelled out. The simple little thing of keeping a telephone tied up with personal calls should be spelled out in a taboo list.

With so much discussion in the nation as to the danger or non-danger of smoking it is difficult to recommend on a "smoking rule", but a real safe bet would be a ban on smoking in the customer area by *all* personnel of the office.

Visits by Real Estate Division Examiners

Periodically every licensed broker is visited by a field examiner from the Oregon Real Estate Division. He has been assigned by the Real Estate Commissioner to make a routine office inspection. He is a civil service employee of the State of Oregon, who has passed a general fitness examination and been thoroughly trained on the job he is authorized to perform.

To the real estate broker interested in conducting his business in accordance with the real estate law and accepted business ethics, this visit can be very beneficial.

The broker and his sales people should feel free to ask any questions they desire of the field man, and free to discuss departmental business.

His authority and training is limited to the real estate law and the rules and regulations of the Real Estate Board. He should not be expected, and certainly will not, attempt to give advice on real estate problems outside his authority and training.

The field examiner will expect to examine all pending real estate transactions. He will determine amounts of earnest money received and disbursed, as well as the respective dates of such receipt or disbursement.

In the event of disbursement prior to closing, he will want to examine the authority for such disbursement. He will further, examine transactions closed since his last visit to determine that all documents are in proper order, and to match the closing statement items to the clients' trust account cancelled checks.

He will satisfy himself that pro-rates are prop and paid, and that title costs are also correct and paid. He will check to see that the broker's sign is placed as the law requires, and see that it corresponds with the license issued by the Commissioner.

You may expect him to examine salesman's business cards to satisfy himself that they comply with

the legal requirements, that such advertising must feature and identify the real estate firm rather than an individual salesman. He will contact the bank where the clients' trust account is located to determine the balance on hand, and audit the broker's account to see that the balance equals the liability.

Any violations noted will be called to the attention of the broker, be charged against the broker, and fully explained by the field examiner in his report to the Commissioner. Subsequent office inspections should show elimination of these violations of the real estate law or rule and regulation of the Board.

The field examiner has been carefully selected by the supervisory personnel in the Oregon Real Estate Division. He should be a welcome friend to all licensees, however, as the representative of the Commissioner, who is charged with the administration of the law and the rules and regulations, he will not tolerate any attempt to hide or evade information he believes relevant.

He has been trained to find errors accidental or otherwise, and is conversant with the law sufficiently to use it as the implement with which to do a good job for every licensee and the Commissioner.

Ignorance of the requirements of the real estate law and the rules and regulations of the Oregon Real Estate Board relative to the keeping of certain records is no excuse for the absence of such records.

Lack of complete records will be considered a serious violation by the field examiner, and one that certainly will prompt a more complete investigation by the Commissioner.

ORS 696.280 provides that records of all real estate transactions handled by or through the broker shall be kept. These include listings, earnest money receipts and closing statements showing all receipts, disbursements and adjustments.

The "Shall Nots"

The limited number of disciplinary actions taken by the Real Estate Commissioner each year is ample proof of the recognition of each licensee of the weight of the confidence and trust that accompanies the issuance of a real estate license.

Sufficient cause for the suspension or revocation of a license would be proof of any of the following:

1. Making any substantial misrepresentations.
2. Making false promises.
3. Unauthorized use of the word "Realtor."
4. Representing both parties to a transaction without the knowledge of both.
5. If a salesman, accepting compensation from one not his employer.
6. If a salesman, representing another broker without his employer's consent.
7. Failing to account for another's money or other property within a reasonable time.
8. Issuing an appraisal report on real property in which he has an interest unless the nature and extent of such interest is fully disclosed in the report.
9. Violating any provision of the brokers and salesmen law.
10. Publishing untruthful or misleading advertising.
11. Paying or receiving any rebate, profit or compensation in violation of the law.
12. Inducing, for personal gain, a party to breach a contract for the purpose of substituting a new contract in lieu thereof.
13. Conviction of forgery, embezzlement, obtaining money under false pretenses, larceny, extortion, conspiracy to defraud, moral turpitude, or any like offense.
14. Demonstrated want of integrity.
15. Guarantee of future profits on resale.
16. Placing "for sale" or "for rent" signs on property without the owner's consent.
17. Using "free lot" schemes, lotteries, contests or prizes to induce sales.
18. Any act which demonstrates bad faith, incompetency, untrustworthiness.
19. Failing to pay the registration or annual renewal fee within the time specified in the law.
20. Commingling of money or other property of his principal or client with his own.
21. Failing or refusing upon demand to produce any document, book or record in his possession concerning any real estate business transacted by him for inspection of the real estate Commissioner or his authorized representative.
22. Failing to maintain at all times in his principal place of business a complete record of every transaction which comes within the provisions of the law.
23. Violation of the law administered by the Labor Commissioner respecting discrimination on account of race, color, religion, or national origin.

Some Pertinent Questions

Q. Where a license is issued to a partnership or a corporation, is the person designated to act on behalf of the group authorized by the license to conduct a real estate business in his own name?

A. No. If he desires to conduct a real estate business in his own name, he must make a separate application for a license as an individual, pay a separate fee, and secure a separate license.

Q. May a partnership or a corporation be represented by members or officers other than the one designated in its application?

A. Yes. Should other members, *other than the one designated in the application,* desire to act on behalf of the group each such member is required to take out a separate broker's license and pay the required fees. Such a licensee is not authorized to transact real estate business in his own name.

Q. Can a salesman be a member of a partnership or an officer of a corporation?

A. No. The law provides that every member of a partnership or officer of a corporation who will perform any of the acts constituting the practice of real estate shall be licensed as a broker.

Q. If an application for license is made during the last half or the last quarter of the year, is the

applicant permitted to pay one-half or one-quarter of the annual license fee?

A. No. Irrespective of the date of the application, the full amount of the annual fee must be paid.

Q. How does a broker change the name under which he will operate?

A. Get from the division a form known as "Request for Real Estate Broker's Change of Name"; complete the form and return to the division with his license and pocket card, the licenses and pocket cards of his salesmen; and fees of $5.00 for himself and $1.00 for each salesman.

Q. How is a change made of location of a branch office?

A. Obtain from the division the form "Request for Real Estate Broker's Branch Office"; complete and return to the division with the fee of $5.00. A branch office license is not transferable.

Q. What are the requirements of the employer broker upon the termination of the salesman's employment?

A. The employer-broker shall immediately return the salesman's license to the division for cancellation. The broker shall, at the time of returning the salesman's license notify the salesman at his last known address of the return of his license to the Commissioner. A copy of such communication to the salesman shall accompany the license when mailed or delivered to the Commissioner.

Q. What is the effect of a salesman's failure to notify the Commissioner of a change of employer?

A. Failure to notify the Commissioner within ten days automatically cancels the salesman's license.

Q. How are salesmen affected by a revocation or suspension of the license of their employer broker?

A. Their licenses are immediately and automatically suspended pending a change of employer and a transfer of license. Should any of the salesmen enter the employ of another broker during the same year, a new license will be issued to the salesman without charge upon the surrender of his former license and pocket card.

Q. What is the effect upon the license of a partnership, or a corporation, of a revocation or suspension of the license issued to the member authorized to act on behalf of the partnership or corporation?

A. The license of the partnership or corporation shall be revoked unless, within a time to be fixed by the Commissioner, the offending member is discharged.

Q. Must a broker remove his sign when he moves his office?

A. Yes.

Q. May a real estate broker who is not a Realtor advertise or hold himself out as such?

A. No. The word is in effect a coined term and may only be used under certain conditions. Its unauthorized use may be enjoined by the courts and such a use is ground for revocation of a license.

Q. In case a real estate broker desires to change his place of business, what must he do?

A. He must notify the Commissioner on a form supplied by the division "Request for Real Estate Broker's License Transfer"; send in his license and pocket card and the licenses and pocket cards of all salesmen in his employ; and remit $5.00 for the reissuance of his license and $1 fee for reissuance of each salesman's license.

Q. In case a real estate salesman desires to change his employer, what must be done?

A. He should obtain from the division a form known as "Real Estate Salesman's License Transfer"; request the broker by whom he is employed to send to the Commissioner his license (the broker shall do so without delay) and obtain the signature of the broker on the transfer form; go to the broker whose employment he will enter and obtain his signature; mail the completed Real Estate Salesman's License Transfer, his pocket card and the $5.00 fee for transfer of license to the division.

Q. What are the legal requirements for branch offices?

A. Every additional office or place of business other than the principal place of business of a broker shall be licensed only with the approval of the real estate Commissioner after the broker has given satisfactory proof that this additional place of business will be so located as to receive the broker's personal supervision, or that it will be under the supervision of a duly licensed competent employee of the broker, approved by the Commissioner. Every such office shall be designated a BRANCH OFFICE by an appropriate sign displayed in the manner provided by the law.

Q. Does the law provide the qualification of a manager of a branch office?

A. Yes. Each branch office shall be in charge of an associate broker or a licensed salesman with at least two years experience as a salesman.

Q. Is a real estate broker required to post or erect a sign at his place of business?

A. Yes. Each place of business must be designated by a sign containing the name under which the broker is licensed, together with the words "Real Estate", or if a member of the National Association of Real Estate Boards, the word "Realtor." Each sign shall be written in letters not less than one inch in height and placed so that it can be easily observed and read by anyone entering the place of business.

Q. When a license expires at the end of the license year and an application to renew, together with the fee, is not made until ten days later, is the licensee permitted by law to engage in the real estate business during that ten day period?

A. No. The license is automatically suspended until the fee is paid. In such an instance the licensee was unlawfully engaged in real estate, and could be required to take another examination.

Q. Is it necessary for a real estate broker, associate broker or salesman to have his license on his person at all times?

A. No. All licenses are in the custody and control

of the broker and must be displayed at his principal place of business.

Q. Is the licensee furnished with any evidence showing his authority to transact business as a broker or salesman?

A. Yes. Pocket cards are furnished by the Commissioner for that purpose.

Q. How many places of business may a real estate broker maintain?

A. At least one is required. He may maintain as many branch offices as he desires so long as they comply with the law. Each place of business must be registered with the Real Estate Division and an annual fee of $5.00 is paid to cover each branch office licensed.

Q. Is the broker notified when a salesman in his employ makes application for a broker's license?

A. Yes. The applicant is obliged to have the broker complete the form "Verification of Salesman Experience Claim by Employer Broker."

Q. How may a real estate broker act as a salesman for another broker if he obtains an associate broker's license?

A. An associate broker's license may be obtained by a broker, without examination. He then executes the form "Associate Real Estate Broker Agreement" obtainable from the division. This is an agreement that he will not act as a broker other than as an employee of his employing broker. A copy of the agreement is filed with the Commissioner.

Q. What is the proper procedure to obtain an associate broker's license.

A. Complete form "Application for Associate Broker's License", obtainable from the division, return with present license and pocket card, and the fee of $5.00. The broker's license can be reinstated by the cancellation of the associate license.

Q. In what form will an associate broker's license and pocket card be issued?

A. Similar to those of a salesman, except that the words "associate broker" will replace "Real Estate Salesman."

Q. If a salesman's license has been surrendered as inactive, what is the cost of reactivating it during the current fiscal year?

A. The license will become inactive 10 calendar days after receipt in the Division if a transfer to another broker is not effected within that period. Reactivation of the license during the current fiscal year will require payment of the full license fee of $15. If the license is transferred during the 10-day period, the transfer fee of $5 applies.

Q. Does the same procedure apply to an associate broker?

A. Yes. Reissuance of the license after the 10-day period, either as an associate or a broker, will require the full fee of $25.

Q. Can a broker take advantage of a 10-day waiting period?

A. No. The license of a broker becomes inactive upon its surrender to the division for purposes other than a status change. In effect, a broker placing his license "on ice" one day may conceivably, a day or so later, decide to resume business. He would then be required to pay the full reactivation fee of $25.

Q. The Manual says a broker "cannot delegate his authority". Does he not do this when he appoints a branch office manager?

A. Under the law of agency a broker cannot transfer the legal rights his principal has against him. In appointing a branch office manager he is merely delegating limited responsibilities to the manager. It should also be kept in mind that this delegation does not mean abdication by the broker. A California court decision stated "a salesman is strictly an employee of the broker. He should not collect money from customers or actively take charge of the broker's office".

The Ninety-Day Clause

Most listing agreement forms in use in Oregon contain a clause which provides that the seller will pay the broker a commission if the broker places the owner in touch with a prospective buyer, who purchases the property within a limited period after expiration of the listing.

The period after expiration of the listing is 90 days in most areas of the state, and 60 days in the form used by the Portland Board of Realtors.

A few brokers are critical of this clause because its existence creates a possibility of the owner being liable to two different brokers for full commissions, upon the same transaction. Most brokers are in favor of this clause being in the listing agreements because of the fact that without it the owner and prospective purchaser can get together and agree to wait until the listing expires before making a deal and thus likely defeat the broker's right to recover his commission.

While it is true that this clause performs a useful service in protecting a broker and his efforts against a deliberate waiting out of a listing period by unscrupulous parties, it has frequently been used in a manner not originally intended.

The Commissioner and other members of the Real Estate Board have spoken very strongly against any use of the clause which would place an owner in danger of being liable for two commissions for a single sale.

In this connection every broker should be familiar with Rule 10-015, which reads as follows:

"10-015 Listings. (1) A broker or salesman who obtains a listing shall, at the time of securing such listing, give the person or persons signing such listing a true, legible carbon copy thereof.

"(2) Every listing agreement, exclusive or non-exclusive, shall state a definite expiration date; it shall contain no provision requiring a party signing the listing to notify the broker of his intention to cancel the listing after such definite expiration date; it shall contain no provision which would subject the owner of the property to the payment of two commissions for one sale in the event the owner lists the same property with a second or subsequent broker after the termination of the first or preceding listing.

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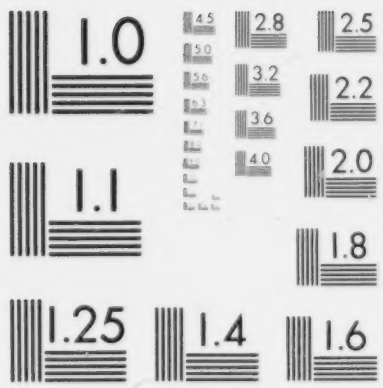

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

"(3) No broker or salesman shall conspire with anyone to deprive an original listing broker of a commission, utilizing the restrictions of sub-paragraph (2) above."

There is a question in the minds of some brokers as to whether or not a broker can recover a commission under this clause without proving that he was the procuring cause of the sale. This question was definitely answered a number of years ago by the Oregon Supreme Court in the case of McGuire vs. Sinnett. A salesman for the plaintiff took the prospective purchaser to the home of the defendant, at which time the salesman introduced the purchaser to the defendant. The salesman, the purchaser and the defendant then went to the house covered by the listing in order to show the house to the prospective purchaser. Upon arriving at the house they were unable to get inside of the house because it was occupied by a tenant and the tenant was not at home. The purchaser inspected the exterior of the house and the defendant promised to make arrangements with the tenant for admission to the house so that the purchaser would have an opportunity to thoroughly inspect it. These arrangements had not been made by the defendant and after a few days the purchaser read an advertisement of another broker which covered the same property. This broker took the purchaser to the property and was able to get into the house so that the purchaser had an opportunity to inspect the interior. About two weeks after the expiration of the original listing, the purchaser made an offer to purchase through this second broker and the deal was closed.

It was the contention of the defendant in the Supreme Court that the plaintiff was not entitled to recover since he was not the procuring cause of the sale because the plaintiff had not shown the purchaser through the property and had not obtained a deal and that the sale, in fact, was made by the second broker. It was the contention of the plaintiff that he was entitled to recover under this so-called ninety (90) day clause contained in the listing agreement even though he was not the procuring cause of the sale. The Supreme Court in upholding the contention of the plaintiff stated as follows, in its opinion:

"In the case before us, the broker is entitled to his commission in one of three following instances: (1) If he found a buyer ready and willing to enter into a contract with the defendant on terms and price agreed to by the defendant; (2) if he placed the defendant in touch with a buyer to whom the defendant sold the property during the life of the contract or within ninety days after the expiration thereof; or (3) if he was the procuring cause of the sale."

Therefore, there is no question but that if a broker is able to prove that he placed a purchaser in touch with the seller during the life of the listing and the purchaser consummated a deal prior to the expiration of ninety (90) days from the termination of the listing, the broker is entitled to a commission regardless of whether or not he was the procuring cause of the sale.

Q. When is a broker the procuring cause of a sale?

A. It frequently happens that an owner of real estate employs two or more brokers to effect a sale. Such employment is optional with the owner and, until he revokes the authority given, each broker has the right to find a purchaser. In such instances there is no implied contract to pay more than one commission, and the broker who first brings about a sale is the one who is to be compensated. When competing brokers approach the same prospect, who eventually buys the property, many nice questions arise as to which has earned the promised commission. In Scott vs. Lloyd, 19 Colo. 401, 35 Pac. 733, it is said that where property is openly put in the hands of more than one broker, each is aware that he is subject to the chance of competition and that if either finds a person who is likely to buy and quits him without having effected a sale, he must know that he runs the risk of such customer falling under the influence of his competitors and that in such case, if they effect a sale, his labor is lost. "This risk," said the court, "is an inevitable part of the business."

From a more recent court action in reference to the subject, we are quoting in part, from a decision of the Oregon Supreme Court, found in the case of Withers vs. Sohoweid, 198 Or 449 as follows:

"Not having found a buyer ready and willing to enter into a contract for the purchase price or such other price that the defendant was willing to accept and not having placed the defendant in touch with a buyer, the defendant sold the property, plaintiff was not entitled to have the case go to the jury and the court should have granted the defendant mentioned a direct verdict."

For brokers to become involved in such litigation further emphasizes the fallacy of not dealing entirely with exclusive listings.

Under the decisions in such cases, the law will award the commission to that one of the brokers who is the procuring cause of the sale. A broker is said to be the procuring cause of a sale when he originates or starts a series of events which without break in their continuity result in the accomplishment of an actual sale.

Cancellation of Non-Exclusive Listing

A serious problem arises where the owner of property has an out-standing non-exclusive listing and gives an exclusive listing to another broker.

Many brokers have the erroneous idea that the mere giving of the exclusive listing to another broker terminates or cancels the existing non-exclusive listing. This is not a fact. The mere giving of an exclusive listing to a second broker has no effect whatsoever upon the rights of the broker who has the non-exclusive listing. Therefore, an owner in this position must attempt to do what he can in order to protect himself. If the owner waits until the expiration date of the non-exclusive listing he can with safety then give to another broker an exclusive listing, except that even after the expiration of the non-exclusive listing there might potentially be some liability if a sale were made to a customer produced by the broker having the non-exclusive listing. The 90-day clause (60 days for the Portland Board of Realtors) gives the first broker certain legal claims under the contract even after its expiration.

The problem is also sometimes complicated by the fact that the non-exclusive listing does not contain a definite expiration date. In this event the listing is in force and effect a reasonable length of time. It is true that one of the rules and regulations of the Oregon Real Estate Board provides that a broker shall not take any listing except that it contain a definite expiration date. Although this rule and regulation may subject the broker to disciplinary procedures for its violation in the event the broker has a listing without an expiration date, this does not and cannot affect the legal rights which the broker has under the listing itself.

Where an owner wishes to give an exclusive listing to a new broker thought should be given to whether it is possible for the broker to cancel the non-exclusive listing. Unless the non-exclusive listing by its terms contains some provision with respect to its cancellation, an owner should proceed with caution in attempting to effect a cancellation. There are, in fact, some listings in use in Oregon that do contain a provision for cancellation.

It cannot be definitely said one way or the other under the law in this state whether or not the owner has the legal right to cancel a non-exclusive listing while it is still in force and effect. If thought is given to cancelling a non-exclusive listing while it is still in force and effect, care should be taken with respect to a sentence which appears in many of the listing agreements, which is to the effect that in the event the owner terminates the listing prior to its expiration date, that he agrees to pay a commission to the broker just as if a sale had been made; so if the non-exclusive listing in question contains this sentence, it is possible that an attempted cancellation of the listing by the owner might subject him to immediate liability under this clause of the listing agreement.

It would be well to mention the position in which an owner will find himself if he gives to another broker an exclusive listing while he has a non-exclusive listing outstanding. If the broker who has the non-exclusive listing finds a buyer ready, able, and willing to buy the property for the price and upon the terms of the listing, the owner becomes liable to that broker for the commission whether the owner sells the property to that buyer or not.

If the owner sells the property through the broker having the non-exclusive listing, or to his prospect, he will become liable to the broker having the non-exclusive listing for the full commission, and, of course, if the sale is consummated while the exclusive listing is still in force and effect, the owner will also be liable to the broker having the exclusive listing for the full amount of the commission.

In this discussion we have assumed that the action by which the owner gave both a non-exclusive and an exclusive listing was initiated by the owner. All ethical brokers frown on a situation where an owner is required to pay a full commission to two different brokers for the sale of one piece of property, and, as pointed out, this might very well happen in the situation being discussed here.

A real estate broker or real estate salesman has no right to inquire of owners concerning the expiration date and making other solicitation of existing listings. Such an action is considered unethical conduct under the national code of ethics.

In fairness to the owner, and in fairness to the above principles of ethical conduct, any broker taking an exclusive listing on property he learns to have already been obligated under a non-exclusive listing, should promptly amend his listing agreement to except the owner from liability as to prospective purchasers produced by the broker having the non-exclusive listing.

Situations of this kind, all too frequent for the welfare of the real estate vocation, could never arise if only exclusive listings are taken.

Questions They Ask

Q. What is the position of the real estate broker with reference to the attorneys of the buyers and seller?

A. In closing sales and leases, the broker should always recommend the employment of competent legal counsel; many misunderstandings arise out of the doubtless sincere but erroneous advice of those not skilled in the complexities of the law; "home-made" contracts frequently result in trouble and litigation, with a consequent loss to the broker of prestige and good will. The proper fees of the attorneys are paid by the buyer and the seller. When the broker fails to recommend legal counsel, he may be injuring not only himself, but those whose interests he is required to protect. A satisfied client is always potentially a "repeat customer" and an asset to any broker.

Q. Is it good policy for a broker to give a copy of the listing agreement to the owner who employs him?

A. The listing form is a contract and each party to the agreement is entitled to a copy. If the broker's employer is furnished with copies of all listings and other agreements, many future misunderstandings will be avoided. Rule 10-015 says the broker or salesman *shall* give the owner a true, legible carbon copy of the listing.

Q. May a real estate salesman be lawfully employed by or accept compensation from any broker other than the broker under whom he is licensed at the time?

A. No. Such employment is prohibited by ORS 696.290, which in its broadest sense would seem to make any other employment unlawful, referring directly to the so-called "part time" salesman.

Q. Where a real estate salesman employed by one broker is assisted in a transaction by a real estate salesman employed by another broker, under an arrangement whereby both salesmen are to have a part of the commission, is it lawful for the first to pay directly to the second salesman the latter's share of the commission?

A. No. Payment to the second salesman must be made through his employer broker.

Q. Assume that after a listing is taken, an earnest money receipt signed, or a contract executed, a slight change is made in the terms or conditions, and the broker, in the presence of the interested parties, alters the writing to conform to the new arrange-

ment; what precaution should the broker take to protect himself against future misunderstandings?

A. Always and without exception, he should have all parties to the contract place their signatures or initials in the margin opposite or nearest the alteration. A better practice is to have the document entirely rewritten.

Q. What may a licensed real estate broker lawfully do that licensed real estate salesman may not do lawfully?

A. Among other things, a salesman may not transact any phase of the real estate brokerage business in his own name, all must be transacted in the name of the broker by whom he is employed. These phases include: Opening and maintaining an office, employing salesmen, listing, advertising, soliciting, negotiating, taking deposits, issuing earnest money receipts, closing transaction, dividing commission, etc.

Q. Where a real estate broker who is employed to sell a particular property, buys it himself, but in the name of a "dummy", will the sale stand if attacked?

A. No. As agent for the seller, it is the broker's duty to get as much for the property as possible; as buyer, it is to the broker's interest to acquire the property as cheaply as possible; in such a situation there is a direct conflict between duty and self interest; therefore, it is well established that if a broker desires to purchase the property himself, he must, before so doing, advise the owner to the effect: if the owner then is willing to proceed, the sale is valid; if the broker does not make a full disclosure, the sale may be set aside. There is nothing inherently wrong in a broker buying his employer's property; the wrong lies in not advising the employer of the broker's true interest in the matter.

Q. A broker is employed by an owner to sell a particular property. He introduces a prospective purchaser to the owner, who, a short time later, cancels the contract of employment. Some time later the owner sells to this prospect. Is the broker entitled to his commission?

A. Yes, in all ordinary cases. The law of agency requires the owner to exercise towards the broker the same good faith as is required of the broker in his dealings with his employer.

Q. Is a real estate broker liable in law for frauds and misrepresentations of a salesman working out of his office, where the broker had no knowledge of the misrepresentations and did not participate in them?

A. Probably yes. If the fraud and misrepresentation were practiced in connection with real estate the broker had for sale.

Q. Is a real estate salesman liable to third persons for the misrepresentation of the broker with whom he is associated?

A. Not unless he participates therein.

Q. Why is it necessary that a contract employing a real estate broker to sell real estate for a commission be in writing?

A. The Statute of Frauds provides that unless such contracts, or some sufficient memo thereof, are in writing, signed by the employer, they are void.

Q. How is the Statute of Frauds usually interpreted by the courts.

A. Strictly against the broker. He has no standing in any court unless his contract of employment is in writing.

Q. What is the position of a broker, who accepts oral employment to sell real estate, and then finds a purchaser who buys the property and pays the owner his full asking price?

A. In view of the Statute of Frauds, the broker is helpless to recover compensation, wholly irrespective of the fact that the owner has derived a substantial benefit; the law regards the broker as a mere "volunteer" offering and giving his services gratuitously. See the next question for the proper procedure in a similar situation.

Q. Assume that a real estate broker is orally employed to sell real estate; he finds a purchaser to whom he gives a receipt for the earnest money; he then secures the owner's written approval of the sale and the latter's written agreement to pay a commission; is the broker then entitled to his commission?

A. Yes, provided that the papers sufficiently describe the property, name the parties, the amount of the commission, and either authorize or employ the broker named therein to sell the property, or ratify his employment.

Q. What is the difference between a contract giving a broker the exclusive right to sell and a contract giving him an exclusive agency listing with reference to real property?

A. In a contract for the exclusive right to sell real property, the owner is bound to pay a commission in case of a sale by any person, including himself; while in a contract providing for an exclusive agency listing, the owner merely agrees to employ no other broker in the sale of his property and the owner may sell the property himself without becoming liable for the commission.

Q. If a husband employs a real estate broker to sell real estate and the broker procures a purchaser ready, able and willing to buy on the husband's exact terms, and the wife then refuses to sign the deed so that the sale is never consummated, is the broker entitled to collect his commission, and if so, from whom?

A. Yes. From the husband.

Q. If one employs a broker to sell real estate in which he has no interest whatsoever and the broker finds a purchaser ready, willing and able to buy the real estate on the exact terms and for the exact price stated in the listing contract and then the employer, having no title, is unable to convey, is the broker entitled to his commission?

A. Yes. The broker has fully performed all that he agreed to do and is entitled to the agreed commission.

Q. What compensation can a broker recover for services in bringing about a sale of real estate where his contract of employment does not specify the amount thereof?

A. The Statute of Frauds provides in effect that a contract employing a broker to sell real estate must be in writing and if not in writing the contract is

void. It occasionally happens that such a contract, though written, fails to specify the amount or rate of compensation to be paid the broker.

It is well established in this state that if a broker would recover a commission, for services rendered in connection with the sale of real estate, he should see to it that the amount and the rate of his commission are clearly specified in writing in his contract with his principal; for, if the contract is silent on this point, he can recover nothing, even though his efforts have resulted in the sale of the property.

Now, it must be remembered that the final paragraph of an Earnest Money Agreement is a contract between broker and seller, and that extreme care should be used to see that the dollars and cents of commission to be paid is correctly entered.

In the employment contract the compensation is shown as a per cent of the selling price. In the earnest money agreement the percentage (actual amount) is shown. Do not get carried away and change the 6% of the employment contract to the decimal .06 in the earnest money—you might get just that—6 cents.

Q. Under what circumstances may a broker receive compensation from both parties to the same transaction? Can a broker represent both the seller and purchaser in a sale or exchange of real estate and collect a commission from both?

A. This question has been discussed by the Oregon Supreme Court upon several occasions and the circumstances outlined under which the broker's double employment is allowable. The rule is that if one employs a broker or accepts his services with knowledge of his employment by another the written agreement to pay commission can be enforced, if the transaction is otherwise fair and honorable.

The reason for the foregoing rule is based upon the fact that one cannot exercise his whole duty to two principals whose interests are conflicting, it being the duty of the agent for the seller to sell for the highest price and the duty of the agent for the buyer to buy for the lowest price.

Q. Where a real estate broker having no written contract for a commission brings about an exchange of properties and the parties to the exchange in their agreement with each other agree to pay a commission, may the broker recover the same?

A. No. This question was decided by our Supreme Court for the first time in the case of Rugh vs. Soleim, 94 Or. 329, 180 Pac. 830. The law governing the collection of real estate broker's commission requires that every commission contract be in writing, and provides that if the same is not in writing the contract is void and the commission is not collectible. In construing the Statute of Frauds, our Supreme Court has repeatedly held that it does not matter how efficient the broker may have been in bringing about a sale or how meritorius the services of the broker may have been, if the agreement to pay a commission is not embodied in writing, signed by the party to be charged, which shows the contracting parties, intelligently identifies the property involved, discloses the terms and conditions of the agreement, and expresses a consideration, the broker is helpless, legally, to collect the promised commission, notwithstanding that he brought about a sale accepted by the owner.

Q. Where an owner of real estate authorizes a broker to sell his property at a certain price, and the broker finds a purchaser who pays to the broker a deposit of earnest money to bind the sale, and the owner then refuses to convey, who is liable to the purchaser for the return of the earnest money, the broker or the owner?

A. In most of the cases where this question is involved, the broker is found trying to retain the earnest money on the theory that it is due him from the owner as a commission. Though recognizing that the broker has a valid claim against the owner, courts everywhere hold that the broker must look directly to the owner for his compensation, and that he cannot retain the deposit, thus, in effect, forcing the purchaser to pay the owner's debts.

Q. What is a sufficient description of real estate in a contract to buy or exchange the same? Must a correct legal description be given, or is it sufficient to refer to the land in general terms?

A. Quoting the Supreme Court: "A writing concerned with the sale of real property must identify the latter. It is common to say that the writing must describe the property, but, as indicated in Wigmore on Evidence, 3d ed., Sec. 2476, the connotation of the word "describe" exacts more than the Statute of Frauds requires. Parol evidence may be used for the purpose of supplying the description to the land, but it is never a valid substitute for missing description. . . . In the present instance, no part of the writing gives any indication whatever of the city, county or state in which the property is located; nor does it mention the place where the agreement was effected or the parties reside. As already indicated, no one with the paper in his hand would have any idea where to go in search of the property. In short, a material part of the description is missing and no part of the writing points to the source of evidence aliunde which will identify the property."

Q. Is it correct practice for a salesman to complete a sale and collect in his own name the commission and then give his broker-employer his share of the commission?

A. No. The salesman has no right to collect the commission; that right belongs exclusively to his employer; should the salesman receive the commission, he should deliver it immediately to his employer.

Q. When earnest money is received by a salesman, is he at liberty to make use of it for his personal account up to the amount of his share of the commission before the deal is closed? If not, what should he do with it?

A. No. Deposits of earnest money should be delivered by the salesman to his employer immediately; there are no exceptions to this rule.

Q. Is it legal for a broker to place a sign on property without the consent of the owner?

A. No.

Q. If a broker is assisted by his grocer in procuring a prospect or in closing a deal, is it lawful for the broker to pay the grocer for his services a fair and reasonable portion of his commission?

A. No.

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THE IMPACT OF TAXES

PROPERTY TAXES - GENERAL

All property taxes levied in Oregon are for local government use. They serve a variety of purposes. Some are general, as those for county-wide purposes of general government, support of county libraries, county hospitals, etc.

This type of tax is levied under the authority of the county governing body. Either the county court or the Board of Commissioners, depending upon the organization of the particular county.

Taxes for the various taxing districts, such as county, schools, fire, port, and many others, are based upon budgets approved by the respective governing bodies. In recent years, the levies for schools have constituted the biggest tax bite; some depend upon levies voted by the affected taxpayers.

All voter approved levies are those requiring approval because the levying body does not have the authority to make the particular levy, such as bonds, or a large levy for operating costs or capital improvements.

In addition to the regular ad valorem, or commonly termed "property taxes", many special districts created for limited purposes levy funds upon some basis other than value. Irrigation districts, for instance, may apportion their budget to those they serve at a uniform rate per acre. The resulting levy, in spite of this, will be reported to the county assessor who will enter it upon the assessment roll and certify it to the sheriff for collection, along with the ad valorem taxes imposed upon the same property.

LEVY

All counties, municipalities, districts, such as schools, fire, sanitary, and, at time some quasi-municipal corporations, are authorized to levy taxes which constitute a lien upon all of the taxable property lying within their respective geographical limits. A particular property may lie in several overlapping districts, in which case it will be subject to the levy of each district. In addition, all taxable property in the county is subject to any county-wide levy. The state of Oregon, itself, is presently prohibited from asserting any levy upon property in excess of that needed to satisfy debt service requirements. No state levy for even this limited purpose has been imposed for over 20 years.

All public bodies vested with the power of levying taxes shall make their levy in dollars and cents, and report the levy to the county assessor, who, in turn, computes the rate in dollars per thousand assessed value of levy by dividing the total assessed valuation for all taxable property within the particular taxing district into the amount of money proposed to be raised by taxation. The rate percent shall then be applied to the separate assessed value of each ownership for each taxing body within whose borders it lies. The aggregated taxes for each property will be the amount certified to the sheriff for collection with respect to the particular property. At this time, the assessment roll with the various levies spread upon it becomes the tax roll.

VALUATION

All taxable property is to be valued at TCV (true cash value). True cash value is market value unless the statutes provide otherwise. For exceptions see ORS 321.617 and 308.370. The assessor is charged with the duty of assessing each property in accordance with the best information he can obtain. The assessed values so determined are entered upon the assessment roll in accordance with the provisions of ORS 308.215. The roll consists of a listing of the names of all persons in his county owning real property, or having control, of taxable personal property; a description of each parcel of real estate, including its area, and the assessed value, separately, of the land, improvements, timber and personal property.

The Oregon procedures for obtaining market value (true cash value) for assessment purposes is shown in the Valuation and Appraising section of this Manual.

The 100 percent ratio (market value) was first used for the 1968 tax roll. The stating of the levy in dollars and cents per $1,000 of TCV was first done in respect to the 1967 roll. Both changes were the result of 1967 legislation. The use of terms in dollars and cents, rather than in millage, has found favor with Oregon taxpayers.

The reappraisal of real property was completed in 1966 and the Department of Revenue and county assessors are now engaged in a maintenance program. Assessors are obliged to reappraise each property at least once every 6 years "that equality of taxation according to law shall be secured".

FARM USE LAND

Owners of agricultural lands entitled to the farm use zone special assessment must make application with the county assessor

on or before April 1 of each year. If an owner does not re-apply for this special assessment, the assessor will notify him of his rights not later than April 10. He then has not later than May 1 to apply, but must pay a late filing fee of $10.

"Farm Use" means the current employment of land for the purpose of obtaining a profit in money by raising, harvesting, and selling farm products.

Farm use land shall not be regarded as being used for the purpose of obtaining a profit in money if the whole parcel has not produced a gross income from farm uses of $500 per year for 3 of the 5 calendar years immediately preceding assessment.

In using comparable sales to appraise agricultural land for farm use assessment the legislature stated, "It is the legislative intent that bona fide farm properties shall be assessed at a value that is exclusive of values attributable to urban influences or speculative purchases."

APPEALS

While the assessor is charged with making his assessment on the basis of the best information available to him, his determinations are not necessarily final.

If a taxpayer feels the assessor's true cash value of a particular property is out of line with comparable properties in the neighborhood, he should first request the assessor to review the appraisal. The assessor may make an adjustment as late as May 1.

If the taxpayer is still dissatisfied with the assessor's determination, he may appeal by petition to the County Board of Equalization. Forms for this purpose are available from the county clerk or county assessor.

From the Board, he may appeal directly to the Department of Revenue or, in certain cases, directly to the Oregon Tax Court's Small Claims Division.

The latter's jurisdiction covers real property whose true cash value for either the parcel of land or the total improvements thereon is not over $25,000, and personal property where the true cash value does not exceed $10,000.

If the taxpayer appeals directly to the Small Claims Division, the decision is final and no further review is permitted.

Decisions by the Department of Revenue may be appealed to the

Tax Court, and the Tax Court's decisions (except in the Small Claims Division) to the Oregon Supreme Court.

PERSONAL PROPERTY

All items of tangible personal property held by the owner for delivery or by a vendor to him, for his personal use, benefit or enjoyment are exempt from taxation.

The exeption does not apply to any such property held by the owner, wholly or partially for use or sale in the ordinary course of a trade or business or for the production of income, or solely for investment or to personal property required to be licensed or registered under the laws of the state.

Assessment procedures with respect to personal property are based upon the same TCV standards that are used for real property. They are also entered into the assessment roll in a similar manner, but there are some differences in methods. (1) The assessor may assess and collect the tax upon transient merchandise, upon discovery, at the rates established for the current year (2) the owner or the person having in his control taxable personal property shall make a return to the assessor of the county in which the property is situated before March 3 of each year. The return (which is confidential) shall set forth a complete listing of such property and a statement of its TCV. The same channels of relief from the assessor's findings are available that were previously described under "appeals" with respect to real property.

TIMBER TAXES

At present there is a distinction between the methods provided for the taxation of timber in Western Oregon (ad valorem) and Eastern Oregon (severance for timber and ad valorem for land). The dividing line runs from the northern boundary of Oregon along the western boundaries of Wasco, Jefferson, Deschutes and Klamath counties to the southern boundary of the State of Oregon. Western Oregon ad valorem values are based upon appraisals by the State Tax Commission, and made available to the county assessors and boards of equalization. Special provision is made for classified reforestation land. After approval and classification by the State Forester and the State Tax Commission, such classified lands are subject to an annual forest fee of ten cents per acre in Western Oregon and five cents per acre in Eastern Oregon, which will be charged in lieu of the prescribed ad valorem and severance taxes, respectively, during the period of classification as reforestation lands, plus a yield tax on all forest crops harvested from such lands.

CENTRALLY ASSESSED PROPERTY

Centrally assessed properties in Oregon consist of the properties of the so-called public utility group whose properties usually extend across county lines within the state, and frequently into other states as well. Valuation of such properties presents almost insurmountable difficulties as far as the county assessor is concerned. Because of this the State of Oregon has charged the State Tax Commission with the duty of valuing such properties within the state, and of apportioning those values among the counties, municipalities, and districts within which they operate or own property.

The values are certified by the State Tax Commission to the assessors of the various counties, who then enter the values upon the tax rolls. These properties are then subject to the various appropriate levies in the same manner as for properties which have been assessed by the assessor.

TAX YEAR AND PAYMENT

While property taxes are related to values as of January 1 of each year, the tax year in Oregon is actually the fiscal year ending on June 30. Taxes are due and payable on November 15 of each year, and if paid in full are subject to a discount.

Property taxes may, however, be paid without penalty in quarterly installments due on November 15, February 15, May 15 and August 15.

Prorations of property taxes between seller and buyer of real property are therefore made upon the basis of the twelve month period commencing on July 1 of one year and ending on June 30 of the following year.

The lien date also controls the assessment of taxes upon real property passing into or out of public or exempt ownership. In other words, if the property is subject to tax on July 1, it shall remain taxable for the ensuing fiscal year. If property exempt from taxation is transferred to non-exempt ownership, or use, between January 1 and June 30 of any year, it will be taxable for the fiscal year next ensuing.

Taxes normally attach to and become a lien upon the affected property as of what is commonly known as "tax day" -- the date to which the valuation is related. This is true in Oregon with regard to the tax upon personal property, but a statutory lien date of July 1 is provided with respect to taxes upon real property. This corresponds to the tax year for which the tax is assessed.

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TAX DISCOUNTS

Oregon statute provides for a discount for prepayment of real property taxes. If payment of the tax is made on or before November 15 a discount of 3% is allowed. If three-quarters of the tax is paid on or before this date the discount is 2%; if one-half is paid the discount is 1%.

TAX PENALTIES

The term "penalty" for non-payment of taxes on or before the due date is loosely used to describe the "interest" charged and collected on unpaid taxes.

Interest on unpaid taxes accumulates at the rate of two-thirds of 1% per month on each quarterly installment from its due date until paid. A fraction of a month is counted as a full month.

DELINQUENT TAXES

Real property taxes are "delinquent" on August 16 following the expiration of the fiscal year. Taxes for the current tax year beginning July 1, are delinquent if not paid by August 16 of next year.

Tax foreclosure proceedings against a parcel of real estate begin whenever three years have elapsed from the date of the earliest delinquency.

Where the total tax charged on any parcel of property amounts to $10, or more, a partial payment of $2.50, or more, may be made at any time, but this payment is first applied against any accrued interest.

INCOME TAXES

Every real estate transaction affects someone's income tax return. The tax effects of a transaction are inherent. Nothing that occurs later will affect it. Tax planning, therefore, should be an essential part of every transaction. All parties involved, particularly the vendors of real property, should be advised by their broker to seek competent counsel, that they may be advised in advance of what the tax consequences to them will be.

Many, if not most, real property transactions can be consummated in more than one manner. Usually, one will prove to be less costly taxwise than the alternatives. The tax consequences may hinge upon

such questions as whether or not certain liabilities should be assumed by the buyer; whether the FMV (fair market value) of third-party obligations, accepted as partial compensation, will adversely affect the right to installment reporting; and, countless other items which, although they appear harmless, are actually of major importance in determining the tax result.

The importance of tax counseling appears in its true light when we examine a few of the multitude of ways in which a tax return can be affected by everyday transactions in the real estate field.

INSTALLMENT SALES

It may be desirable to defer the tax on the gain attributable to a particular transaction into the years in which that gain is actually realized.

A lack of care in providing for the initial payment, which is not limited to the amounts paid to the seller at the time of the sale, but includes, in addition, all payments on principal received during the year of the sale, monies used to defray the cost of the sale, to pay back taxes, and to defray any obligations of the seller may nullify the intent to defer the tax. Differences between the FMV and the face value of third-party paper received as part of the initial payment may affect the right to report upon the installment basis, and further, may result in that difference being treated as ordinary income when received, thus sacrificing part of the capital gain treatment advantages.

EXCHANGES

Contrary to the popular impression, like-for-like exchanges, involuntary conversions, and similar transactions are not tax-free. Such transactions frequently produce a tax consequence, which is subject to deferral, but must be taken into consideration upon disposition of the replacement property. It should be noted that Oregon places some restrictions upon tax deferrals, which result in some distinctions between application for Oregon and Federal purposes. For example, Oregon law authorizes deferral of tax in the case of like-for-like exchange, in reinvestment of proceeds received under provisions of involuntary conversion section and reinvestment in a personal residence <u>only</u> if the replacement property is located with Oregon.

Mortgage assumption as a part of either a sale or an exchange may at times serve as a catalyst that will materially change the taxable nature of the transaction. Receipt of "boot", which may consist of money, property other than money, or assumption of liabilities,

may result in taxable gain to the extent of the boot in what would otherwise have been, at that time, a deferred tax transaction.

TWO INCOME TAXES

Taxpayers in Oregon are subject to two income taxes -- one imposed by the United States Government and one by the State of Oregon.

"The consequences of the two are generally similar with respect to a given transaction. For tax years beginning on or after January 1, 1969, the State of Oregon has adopted as a tax base the federal definition of taxable income. In general, the State of Oregon determines taxable income with reference to the federal taxable income with certain specific adjustments. Therefore, in most instances the tax consequences of a transaction will be the same for the State as it is for the federal. One notable exception to this is noted above under "exchanges" where the property acquired in an exchange, involuntary conversion, or in acquiring a personal residence is not located in Oregon. In such a case it is likely that all of the "potential" gain will be taxable for Oregon purposes.

We have noted previously that the State of Oregon is precluded from the imposition of a tax upon real property for general state purposes. This tax, used for the support of other political subdivisions of the state, is based on the theory that all property equally enjoys the benefits and protection of government; and, therefore, all property is required to bear its equal share, prorate, of local government expense.

The income tax, in addition to absorbing the cost of state government, is in turn funneled back in large amounts to relieve property taxes at the local level through what is known as the "Basic School Fund Act". This diversion has been in a constantly increasing amount in recent years. First, because of the steadily increasing number of children shown by the School Census, and, secondly, by a constantly accelerating amount per child.

All income tax returns are subject to audit. Determinations of the examining agents are subject to review by a higher authority upon proper protest, or appeal, by the taxpayer. While similar channels of relief are available to the taxpayers, under both Oregon and Federal law, some differences of methods apply under the respective laws. For that reason, a summarized approach is provided here with respect to the separate jurisdictions.

OREGON PRACTICE

(1) The State of Oregon Department of Revenue will transmit a

copy of the auditor's report, together with a notice which advises the taxpayer (a) that he may, if he does not agree with the examiner's findings, discuss the matter with the auditor in charge of the office that originated the notice, who has authority to modify or cancel the proposed assessment on the basis of failure of the examining auditor's determination to be in accord with the facts, or (b) a request for a conference may be filed with the Administrator of the Income Division, State of Oregon Department of Revenue within 30 days of the date of the notice. This may either follow or be without benefit of the discussion referred to in (a) above. The conferee has full authority to revise within the policy structure established by the Department of Revenue.

(2) Assuming that the conferee (Income Division of the Department of Revenue) sustains the auditor in whole or in part, a 30-day notice of assessment will be issued. Following the issuance of this notice, an appeal may be taken to the Director of the Department of Revenue. In the event the proposed tax for no one of the years involved exceeds $250, an appeal may be directed to the Small Claims Division of the Oregon Tax Court instead of to the Commission. This is a matter of choice as far as the taxpayer is concerned. Small claims decisions are not appealable, the determination of the Court being final.

Appeals directed to the Director of the Department of Revenue involve a semi-formal hearing before the Department, followed by the issuance of a Department of Revenue order and opinion. This Order may be appealed to the Regular Division of the Tax Court, and then on to the Supreme Court of the State of Oregon.

FEDERAL PRACTICE

(1) The examining agent will discuss any possible adjustment with the taxpayer, or his representative, and solicit his signature to an acceptance of his findings.

(2) If the taxpayer refuses to accept the agent's findings, he will receive a letter explaining the proposals and inviting him to an informal conference. The letter forms the basis for the conference.

(3) If the taxpayer still does not agree, he will receive a 30-day letter. This includes a copy of the examiner's report and a notice that if the contest is to be continued, that a protest must be filed within 30 days.

(4) The taxpayer has several choices at this point. He may (a) do nothing and await the issuance of a 90-day letter, or (b) he may by letter state that he does not agree, but waives an Appellate

Division hearing; (c) accept the examiner's finding; (d) submit a protest requesting that the case be referred to the Appellate Division for hearing and review.

(5) The last notice is a 90-day letter which is a formal notice of deficiency and may follow (4) (a) (b) or (d) above, and advises the taxpayer that he may petition the Tax Court for a review of the deficiency within the 90-day period. Further appeals may follow the Tax Court determination to the appropriate Circuit Court of Appeals, and, on occasion, to the U. S. Supreme Court.

VETERANS AND THEIR WIDOWS

Oregon has recognized the services of war veterans by providing for direct tax exemptions on real property which is the homestead of such persons.

The exemption amounts to $7,500 of the true cash value of the homestead of the person qualifying. The application must be filed each year between January 1 and April 1 with the county assessor of the county where the property is located. The county assessor furnishes the required application form. Any supporting evidence required by law should also be submitted before the deadline. Those entitled include:

1. Any war veteran with a 40 percent disability or more, as certified by the Veterans Administration or by a branch of the Armed Forces. The veteran receiving a total and permanent, non-service connected pension from the VA is entitled, the same as the veteran with a 40 percent service connected disability. There is no limit on the amount of income a veteran in this category may receive to be entitled. Recipients of the Armed Forces Expeditionary Medal and the Vietnam Service Medal qualify as war veterans under Oregon law.

2. The unremarried widow of a war veteran. She must submit proof of her husband's military service and copies of the marriage and death certificates if she had not done so previously. There is no limit on her income. Pensioned widows of Spanish-American War Veterans get an additional $2,000 exemption on their homesteads only, based on taxable value. Widows of Medal recipients cited above qualify.

3. Any honorably discharged veteran of the Spanish-American War, the Philippine Insurrection or the Boxer Rebellion, regardless of disability. No income limitation.

In a separate category is the veteran with a disability which cannot be certified by the VA or the Armed Forces. If his county

health officer and one other licensed physician in his county certify that he has a disability of 40 percent or more, he may receive the property tax exemption provided he has not received more than $2,500 total gross income during the last calendar year.

Veterans whose disabilities are certified by the VA can and should obtain a statement each year from the VA regional office to submit to the county assessor certifying to the existence of the disability.

Veterans whose disabilities are not on record with the VA, but rather with a branch of the Armed Forces, should obtain one statement -- preferably in triplicate -- every three years from that service branch. The statement should be to the effect that disability is current. One copy of this statement should be filed each year with the claim for tax exemption.

Veterans Over Age 65: Veterans no longer have to file the annual certificates of disability if they had once filed them after reaching age 65. They do have to continue to apply annually for the tax exemption.

Property Acquired After March 20: The veteran who acquires property after March 20, and before July 1, has 10 days following the date of acquisition to apply for the tax exemption. If he acquires the property on or after July 1, he cannot get the exemption for the current year.

Transfer of Exemption: If, after April 1, a person receiving the property tax exemption sells his property and purchases another property on or before June 30, he may transfer the tax exemption to the new property provided he applies for the transfer within 10 days of acquiring the new property.

If he sells his property after June 30 (and before October 15), then he may transfer his tax exemption only to property which he already owned or held under a recorded contract on or before June 30. He must submit proof to the county assessor of the ownership of the alternate property to which he wishes to transfer his exemption. If his property sale occurred after October 15, he loses the tax exemption for the current year.

Life Estate Clause: If a veteran enjoying the property tax exemption deeds his property over to his children by a deed reserving a "life estate" to the veteran -- that is, the deed contains a provision that he may continue to reside on the property so long as he lives -- he may continue to receive the property tax exemption if he actually uses the property as his homestead.

Wife Owner of Homestead: If a war veteran lives with his wife

in a house owned by her, the house is considered their homestead and the veteran can claim the exemption under ORS 307.270 which states: ". . . real property of the wife of any such veteran where they are living together and occupying the same as their homestead shall be deemed the homestead of the veteran."

MOBILE HOME EXEMPTIONS

An annual license fee reduction of up to $100 on the mobile homes in which they reside is provided the Oregon veterans.

The qualifications are the same whether a veteran lives in a mobile home or a house.

The reduction will not be allowed to veterans who in the current calendar year received a property tax exemption or who did not receive a reduction on another mobile home at anytime during the last 12 months.

SENIOR CITIZEN PROPERTY TAX EXEMPTION

Oregon law contains provision for property tax relief to individuals 65 years of age and over.

The relief granted is a percentage of the first $10,000 of the true cash value of the taxpayer's homestead, dependent upon the age of the taxpayer as of March 1 of the year in which claim for exemption is filed, as follows:

65 to 68 years.....	10%
69 to 71 years.....	30%
72 to 74 years.....	50%
75 to 77 years.....	70%
78 to 79 years.....	90%
80 and more years.....	100%

The exemption shall only apply if the household income of the taxpayer does not exceed the sum of $3,000 during the last preceding calendar year. Household income is defined under the statute and includes all incomes of residents of the homestead who are related to the claimant.

In order to gain the exemption the claimant must file with the assessor on or before April 1 of each year. If the property is acquired after March 20 and before July 1, the claim must be filed within 10 days of the date of acquisition.

The exemption is lost if the taxpayer ceases to reside permanently

on the property at any time before the assessment roll becomes the tax roll. If, however, he dies before that time the exemption will extend to his widow.

A war veteran cannot claim both the veteran exemption and the senior citizen exemption.

SENIOR CITIZEN PROPERTY TAX DEFERRAL

Although not an exemption, Oregon law provides a procedure to defer payment of taxes for individuals 65 years or over.

The deferral of the tax is applicable only to the homestead of the applicant, and the property must be non-income producing. The deferred taxes become a lien against the property.

Forms for such deferral must be filed with the county assessor and state treasurer on or before April 1 of each year. Payment of the deferred tax to the political subdivisions is made by the state treasurer from a special fund.

The deferred taxes, including accrued interest at 6 percent per year, becomes due when the claimant dies or the property is sold. A surviving spouse 60 years of age or older can elect to continue the deferral.

ONCE IN LIFETIME FEDERAL TAX BREAK

Under certain conditions an individual 65 years of age or over is given a one time only tax exemption under federal law.

This individual can sell his home at an "adjusted sale price" of $20,000 or less and pay no tax on any capital gain. Adjusted sale price means you deduct real estate commission, sales expense, and fixing up expense from the full sale price.

PERSONAL PROPERTY IN TRANSIT (Free Port)

Persons and firms seeking tax exemption on personal property in transit must file a written statement with the assessor on or before April 1 of each year.

Property eligible for exemption is goods, wares and merchandise destined for sale in the ordinary course of trade or business, manufactured or produced outside the state and brought into the state for transshipment to an out-of-state (other than county of origin), while being shipped or while held in public or private

storage awaiting further shipment.

Such property is not deprived of exemption because while in the warehouse the property is assembled, bound, joined, disassembled, divided, cut, broken in bulk, labeled, packaged, relabeled or repackaged.

COUNTY BOARD OF EQUALIZATION

In order to be of maximum assistance to clients every real estate licensee should be familiar with the functions of Oregon's 36 County Boards of Equalization.

Each Board consists of three members. One member of the Board is a member of the County Court of County Board of Commissioners. One is a member of the Budget Committee or the Tax Supervision and Conservation Commission. The third man is a free holder appointed by the above two. The County Court or Commission is <u>not</u> the appointing authority. See ORS 309.020.

The Board meets first in November to review assessment quality and levels. This meeting provides an opportunity for the board members to guide the assessor in his preparation of the assessment roll.

The Board meets again in April to review the assessor's progress. In May, the Board meets for a three-week period to equalize the assessment roll and to hear taxpayer appeals for reduction in assessed values.

UNIFORM FEDERAL TAX LIEN
REGISTRATION ACT

The Uniform Act, adopted by the 1967 legislature, requires that notices of liens upon real property for taxes payable to the federal government shall be filed in the office of the recorder or clerk of the county in which the real property is situated. The statute provides for a $1 filing fee.

Upon request the filing officer is required to issue his certificate showing whether there is on file in his office a federal tax lien. He will charge $1 for the certificate plus 50 cents for each lien of record.

BANCROFT BONDING ACT

A method permitting property owners to pay assessment costs for

city improvements of streets, sidewalks, street lights, sewer or water mains, or off-street parking facilities by installments.

The assessments are paid in semi-annual installments, bearing interest at the rate of 7 percent, and spread over a period not to exceed 10 years. The assessment is a lien against the real property benefitted by the improvement. This lien has priority over all others.

Immediate costs of the improvement are paid by the city through the issuance of general obligation bonds. The law limits the city to an issuance of such bonds to an amount not to exceed 15 percent of the assessed value of all real property.

TAX CALENDAR

January 1 - Assessment date for all property. Lien date for personal property taxes.

March 3 - Final date for filing personal property returns with county assessor.

On or before April 1 - Deadline for filing proof for exemption of commercial facilities under construction - county assessor.

February 15 - Second quarter property taxes due.

April 1 - Last day to file claims for exemption with county assessor. These include veterans' exemptions, senior citizen exemptions and special assessment of unzoned farm land, as well as institutions and organizations claiming exemption.

April 15 - Final day for filing income tax return.

May 1 - Assessor must notify property owner if valuation has been increased more than $400 or 5%, whichever is greater. The notice must be mailed out not later than the first Monday in May.

2nd Monday in May - County Board of Equalization meets to hear appeals.

Third Monday in May - Last day to file petition for assessment review. Third quarter property taxes due.

July 1 - Lien date for real property taxes.

August 15 - Fourth quarter taxes due.

October 15 - Last day for delivery of the assessment roll to the tax collector (sheriff) by the county assessor.

November 1 - Assessor mails tax statements prior to this date.

November 15 - First quarter taxes due and final date for full discount for full payment.

Q. 17 A property owner is preparing his Federal income tax return. He may be allowed to take a depreciation deduction on all of his following property, except:

(A) an apartment building
(B) a home he rents to a friend
(C) a vacant duplex
(D) land held for investment

Q. 18 An exchange of property of like kind frequently results in the postponement of tax on any gain realized. Which of the following would not qualify for a non-taxable exchange?

(A) an apartment house for a warehouse
(B) timberland for farm equipment
(C) an office building for a hotel
(D) a city lot for a ranch

Q. 19 Interest is charged for failure to pay real property taxes on or before the due date. What is the interest rate on an annual basis?

Q. 20 On what month and day of each year do real property taxes become a lien on the property?

Q. 21 What is the interest rate provided for in the Bancroft Act for the installment payment of local improvement assessments against real property?

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Upon proof made to the satisfaction of the State Engineer that an appropriation has been made under the terms of a permit, a certificate of water right is issued as conclusive evidence of the extent of the completed water right.

Neither the permit nor a certificate assures that water will be available at all times. It authorizes the use of water for beneficial purposes to the extent that it may be available in excess of the needs of prior rights.

Authority of the State Engineer does not extend to matters of property rights; therefore, acceptance of an application or the issuance of a permit should not be construed in any sense as granting a right of access to a stream or any right of way for construction or maintenance of works necessary to the use of water.

All rights of access and right of way must be obtained from the owner of the property involved.

ARE THERE WATER RIGHTS FOR THIS PROPERTY?

All legal established water rights, whether they may be incomplete rights under permits, undetermined claims through ground water registration statements, or completed and perfected rights evidenced by certificates of water right, are of record in the office of the State Engineer. Copies of the records pertinent to a watermaster district are also maintained in the offfice of the watermaster for the particular district. *To determine whether there is a legal right* of record for the appropriation of water for use upon a particular tract of real property or to divert water from a source within the property, you may *contact the office of the State Engineer,* 516 Public Service Building, Salem, Oregon 97310, *or the watermaster* for the district within which the property is located. The name and office address of the watermaster or watermasters concerned with your area will be furnished upon request.

It will be necessary for you to furnish a copy of the legal description of the property as it would appear on a deed *or a map* which shows the boundary of the property in relation to section lines and section subdivision lines. If the legal description describes the property as a portion of a platted and recorded subdivision, a copy of the recorded plat should accompany the legal description.

CHANGE OF OWNERSHIP

A *completed and perfected water right* as evidenced by a certificate of water right is appurtenant to the lands on which the right was established and passes with the land through change of ownership, unless specifically reserved in the articles of conveyance. There is no statutory provision for transferring or assigning a completed and perfected water right from one owner to another.

An *incomplete right* under a water right permit or a ground water registration statement can be conveyed to a new owner only through the recording of an assignment in the office of the State Engineer. Forms for this purpose are supplied upon request. If the assignment is not recorded it is not binding on anyone but the parties thereto and may result in cancellation of the water right.

HOW LONG DOES THE RIGHT LAST?

A completed and perfected water right as evidenced by a certificate of water right remains valid and in force so long as it is not lost through intentional abandonment or through non-use for a period of five successive years or more.

Q. 22 Underground water not confined to a known and well defined channel is known as percolating water. This water is:

(A) owned absolutely by the land owner
(B) owned by the county
(C) available for beneficial use by other landowners.
(D) available only to the first user.

Q. 23 What is meant by the words "water table"?

PLATS AND SUBDIVISIONS

Land development quite generally means the creation of a "subdivision." Since the 1963 Legislature, regulation of subdivisions by agencies of government extends into four fields.

Depending upon the progress of the subdivision or its nature, regulatory bodies are the city and county authorities in which it is located, the real estate commissioner, or the corporation commissioner.

The subdividing of land for many years has been regulated by the governing bodies of counties or cities, usually through a planning commission.

Under Chapter 92, Oregon Revised Statutes, county and city governments have sought to accomplish the orderly development of the land within the jurisdiction of such county or city, and to promote the public health, safety and general welfare of the county or city.

The 1963 Legislature passed what is known as the "Oregon Subdivision Control Law", intended to regulate the promotion and sale of subdivided lands.

This Act is intended to protect the public from fraud, deceit and misrepresentation in offerings of tracts of marginal or submarginal lands in this and other states. This Act is administered by the real estate commissioner.

In the absence of another name we will call Chapter 92 the "Plat and Map Act." The intent of both Legislative Acts is spelled out in the law itself, and appear to give the counties and cities prior jurisdiction in the creation of subdivisions, and the real estate commissioner authority over the sale of lots or parcels in such subdivisions.

While there is some slight difference in the definitions contained in each Act, those found in the "Plat and Map Act" are generally applicable to both.

"Plat" includes a final map, diagram, drawing, replat or other writing containing all the descriptions, locations, specifications, dedications, provisions and information concerning a subdivision.

"Subdivide land" means to partition a parcel of land into four or more parcels of less than five acres each for the purpose of transfer of ownership or building development, whether immediate or future, when such parcel exists as a unit or contiguous units under a single ownership as shown on the tax roll for the year preceding the partitioning.

This definition does not apply to the division of agricultural land into tracts of five or more acres if it is to be used for agricultural purposes, provided, such division does not involve any new roads or streets or the widening of any existing thoroughfare.

Note: The Oregon Subdivision Control Act does not include this latter exclusion of agricultural land. Nor does it make reference to the size of the divided parcels.

"Subdivision" means either an act of subdividing land or a tract of land subdivided or partitioned for the purpose of transfer of ownership or building development.

Before starting a land development program the prudent developer will first contact his county surveyor. Real estate practitioners should be familiar with an Oregon statute that reads "the county surveyor shall within 10 days, when called upon, survey any tract of land or town lot lying in his county, at the expense of the person demanding the same, if his legal fees are first tendered."

It may come as a surprise to many real estate practitioners to learn that "subdivision" also includes certain types of multi-family structures. Some types of apartments or adjoining single family dwellings are known in many parts of the nation as "vertical" or "horizontal" subdivisions, and under Oregon law require certain governmental approval. These are discussed following the requirements for approval under the "Plat and Map Act" and the "Oregon Subdivision Control Law."

Plat and Map Act

No person shall sell or offer for sale any lot or parcel of land in any subdivision until final approval has been obtained from the proper authorities.

Before any subdivision of land can be made the owner or his agent must make an application in writing to the nearest planning agency in the county or if there is no such agency to the county court. A tentative map of the proposed subdivision is submitted to the planning commission or to the governing body of the county. The approval of the tentative map, however, does not constitute a final approval of the plat for recording.

If the land being subdivided is within the jurisdiction of any city in Oregon which has a planning commission the plat for the subdivision must be approved by the planning commission. If there is no planning commission, then by the governing body of the city.

Where a county has no planning commission, land within six miles of the corporate limits of a city is under the jurisdiction of the city for the purpose of giving approval to plans or plats.

No sales or offers to sell shall be made until the approved plat has been recorded in the office of the appropriate county recording officer.

REQUIREMENTS OF SURVEY AND PLAT OF SUBDIVISION

The plat of a subdivision cannot be recorded until all the requirements for the survey and final map have been met. The requirements are as follows:

a. The survey for the plat of the subdivision must be of such accuracy that the error of closure does not exceed one foot in 4,000 feet.
b. That the survey and plat of the subdivision be made by a surveyor who is a registered engineer or a licensed land surveyor.
c. The plat of the subdivision must be of such a scale that survey and mathematical information and other details can be easily obtained from it. All of the streets must be named. Each block must be lettered or numbered and all the lots numbered. The length and width of all lots must be clearly shown.

OREGON SUBDIVISION CONTROL LAW

The subdivision control law does not apply to the sale or leasing of apartments, offices, stores or similar space within an apartment building, industrial building or commercial building.

It does not apply to subdivided lands in Oregon containing less than 20 separate lots or parcels, which are not in unit ownership created under ORS 91.505 to 91.675 but which are contained within a recorded subdivision plat which has met the requirements of ORS 92.020 to 92.160, or as an alternative have met the following conditions:

(A) Each lot is situated on a dedicated road or street constructed to the specifications of the county commissioners of the county or the governing body of the municipality which has accepted such road or street for maintenance; and

(B) The subdivision has drainage structures and fill necessary to prevent flooding, which structures and fill have been approved by the county commissioners of the county or the governing body of the municipality; and

(C) Electric power is available at or near each lot; and

(D) Domestic water supply and sanitary sewage disposal are available at or near each lot, meeting the requirements of the State Board of Health, the Sanitary Authority of the State of Oregon and, in the case of septic tanks, the local health department of the county in which the land is situated.

NOTICE OF INTENTION

Before any subdivided lands in another state are offered for sale or lease in Oregon, or before any subdivided lands within the state are offered for sale or lease, the subdivider or his agent must notify the Real Estate Commissioner in writing of his intention. The notice is known as a "Preliminary Notice of Intention".

This notice must contain:

(1) The name and address of the subdivider.
(2) The names and addresses of all members of his sales force.

(3) The legal description and area of the lands, the proposed plat, or a certified copy of the subdivision plat recorded in the city or county records, and a map showing the proposed layout and its relation to existing streets or roads and utilities.

(4) A brief but comprehensive statement describing land and location.

(5) A statement of the condition of the title to the land.

(6) A statement of the provisions that have been made for legal access, sewage disposal and public utilities in the proposed subdivision, including water, electricity, gas and telephone facilities.

(7) A statement of the intended use of the property.

(8) A statement of any restrictions limiting use or occupancy of the parcels.

A preliminary notice of intention shall be accompanied by a filing fee of $10.

REQUEST FOR FURTHER INFORMATION

After an examination of the preliminary notice, the commissioner may require further information. This information will include:

(1) Terms and conditions on which it is intended to transfer ownership, together with copies of any contract, conveyance, lease, assignment or other instrument.

(2) Copies of sales pamphlets and literature to be used in the sales.

(3) Any other information the subdivider cares to present.

In his reply to a request for further information the subdivider shall give proof of his financial ability to complete improvements and facilities which are required by the appropriate state, city and county authorities, and those promised to prospective purchasers.

FEES FOR ADMINISTRATION

The subdivider's reply to the first request for further information requested by the Commissioner under subsection (1) of this section shall

be accompanied by a fee as follows:

(a) For subdivisions containing 10 lots or parcels, or less, $40;

(b) For subdivisions containing over 10 but not more than 25 lots or parcels, $90;

(c) For subdivisions containing over 25 but not more than 50 lots or parcels, $190;

(d) For subdivisions containing over 50 but not more than 100 lots or parcels, $290;

(e) For subdivisions containing over 100 lots or parcels, $490, and $2 for each additional lot or parcel over 100 up to a total maximum of $1,000.

EXAMINATION AND PUBLIC REPORT

For the purpose of obtaining information necessary to compile a public report for the guidance of investors or purchasers, the commissioner may make an examination of the subdivision.

USE OF PUBLIC REPORT

The selling or leasing of any lot or parcel in a subdivision prior to issuance of the public report is prohibited. The public report is intended to be given to each prospective purchaser, and the commissioner may require the subdivider to take and keep a receipt of delivery of such report.

Use of the public report, other than in its entirety and without alteration, for advertising purposes is prohibited.

FEES FOR EXAMINATION

Whenever an examination is made of subdivided lands, no matter where located, the following fees shall be paid in advance by the subdivider:

An amount equivalent to 10 cents a mile for each mile to be traveled in going to and returning from the location; and an amount estimated to be necessary to cover the additional expense not to exceed $100 a day for each day consumed in the inspection.

Under this plan an association is formed of members, each issued a share of stock in the enterprise and given the right to occupy a particular dwelling erected on the tract. After certain conditions are met, the title is distributed to members covering the homes or apartments they individually occupy.

Completion of such projects depends upon the sale of a certain percentage of the stock, which means that a certain number of potential home purchasers must be obtained before such a project can be closed.

Any type of such a corporation must first be approved by the Corporation Commissioner, and it is advisable that any plans for such a co-operative project be first submitted to the Corporation Commissioner for study and advice.

Unit Ownership Act

Continued popularity of the "condominium", or multiple-unit building or buildings in which each unit is owned in fee simple absolute by a person who also holds an undivided interest in the common elements, led to passage of the "Unit Ownership Act" by the 1963 Legislature.

The law requires the owner of any property qualifying under the terms of the Act to file a declaration in the office of the recording officer in the county in which the property is located.

Before a declaration may be recorded it must be approved by the county assessor and the tax collector of the county. No declaration shall be approved if the property bears a name that is the same or similar to the name of another property in the same county, or until all taxes and assessments due and payable have been paid.

EXCLUSIVE OWNERSHIP AND POSSESSION

The law provides that each unit owner shall be entitled to the exclusive ownership and possession of his unit. A unit in the building may be individually conveyed and encumbered and may be the subject of ownership, possession or sale as if it were sole and entirely independent of the other units in the building, and individual titles and interests shall be recordable.

The undivided interest in the common elements shall not be separated from the unit to which it appertains and shall be conveyed or encumbered with the unit even though such interest is not expressly mentioned or described in the conveyance or other

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instrument.

At the time of recording the declaration a copy of the by-laws adopted by the unit owners governing the administration of the property must also be recorded.

The by-laws shall provide for the election of a board of directors from among the unit owners; a chairman, secretary and treasurer; provision for maintenance, upkeep and repair of the common elements; and the manner of collecting from the unit owners their share of the common expense.

FEDERAL LAW

Under certain conditions, developers of tracts containing 50 or more lots are subject to the Interstate Land Sales Full Disclosure Act.

This law is administered by the Office of Interstate Land Sales Registration in Washington, D. C.

Q. 24 What is the "police power" of the state?

Q. 25 What is a "plat"?

Q. 26 An owner of land, planning to sell smaller units comes within the jurisdiction of Oregon's subdividion control law when he partitions the tract into how many lots or parcels?

Q. 27 What is "marginal land"?

VALUATION AND APPRAISING

It has been said that a professional appraiser is not a first-class salesman. If true, it only endorses a much older truism that "a servant can not serve two masters."

Inversely, experience has taught that a good salesman is a better salesman if he has a working knowledge of the principles and fundamentals of appraising.

The good appraiser, conscious always that "people make value", is a better appraiser if he has first-hand knowledge of the fundamentals of selling.

The recognition of the amenities offered by a particular property, plus a knowledge of selling techniques, separate the successful from the mediocre in real estate.

An Oregon real estate license gives to the holder the right to make fee appraisals. Without such a real estate license appraising for a fee is unlawful.

Various governmental agencies and lending institutions have staff appraisers, who usually are not licensed to practice real estate. The successful applicants for a civil service job as an appraiser are certified as available for employment, and recently have come to be known as "certified appraisers."

The liberal provision of the real estate license law could, and may sometimes, be abused to the detriment of the public. The necessity of ability, skill, perfection and intellectual honesty in the fee appraiser may soon lead to special licensing requirements for such individuals. A qualified salesman can do fee appraising but only with the knowledge and approval of the employer-broker.

In Oregon state and local government appraisers have their own organization known as the Society of Certified Appraisers. Tax appraisers can also qualify for membership as a Certified Assessment Evaluator (CAE), which is under the jurisdiction of the International Association of Assessing Officers in Chicago. Fee appraisers are eligible for membership in the National Association of Independent Fee Appraisers, headquartered in Arizona.

The real estate licensed appraiser has two professional affiliations open to him if he can meet the rigid requirements of the sponsoring organizations. These are membership in the American Institute of Real Estate Appraisers, an affiliate of the National Association of Real Estate Boards; and the Society of Real Estate Appraisers. Members of these professional groups are permitted to use the letters MAI and/or SRA after their names.

The real estate practitioner every day has occasion to use the practical approach to value in determining the proper market price for property listed for sale. The practical approach is the market place, that rough and tough arena in which his experience and judgment qualify him to arrive at an opinion of what people will pay.

Competence in arriving at an opinion of value is vital to the real estate practitioner. The law of agency fixes an obligation on him to the property owner, by whom he is employed. For the Realtor, there is no alternative. His Realtor's Code of Ethics requires him to inform the owner *honestly* and *intelligently* regarding the fair market value of property listed with him for sale.

All you have to offer the seller is honesty. You may arrive at your estimate of market value through application of appraisal techniques, or through a practical approach based on experience. All you know is that in your honest, well-considered opinion the property will attract a buyer, as is and as of today, at a certain price.

Knowledge and understanding of the "economic principles of valuation" give to the real estate broker and salesman the best available guide-lines in the listing and selling of real property.

Appraising is not an exact science. It is a "judgment science"—an application of checks and balances. The three approaches to an appraisal—Market Data, Cost, and Income are not used to arrive at three different values. The result of each is weighed and studied, *not averaged*, and a final opinion of value determined.

Normally, the goal of an appraisal is "market value." If you do not know market value of a property, rest assured your potential buyer is concerned with it, and usually has a rather accurate opinion of what it is. The loss of a single sale because the merchandise you are showing is overpriced may or may not be too important, but the question in the mind of the prospect as to your intelligence or integrity will do irreparable harm to your future in real estate.

In appraising a property before listing you visualize the tumult of the market place, asking, "who is going to buy it, how much will they pay for it, and how can they pay for it?".

Definitions and Terminology

An appraisal is an opinion. It is an estimate of value of an adequately described property at a specified date, supported by presentation and analysis of factual and relevant data.

Valuation is a procedure applied in estimating value.

Opinion is an exercise of experience and judgment.

Judgment is the faculty of judging wise and well, and based on facts.

The fundamental *purpose* of an appraisal is to estimate value. In preparing to make an appraisal the "why?" is first determined. Is it to learn market value, insurable value, going concern value, liquidation, or assessed value?

The *function* of an appraisal is to provide a guide for taking an action or establishing a policy, so the second step for the appraiser is to ask "what?". Is the final result to be used in connection with the transfer of ownership; for financing and credit; just compensation in condemnation; or as a basis for taxes?

Value is the relationship between a thing desired and a potential purchaser; a measure of the present worth of future rights and benefits to the typical buyer.

Objective value is created in the object itself. It is found in the cost approach where emphasis is placed on the cost of production, plus the land.

Subjective value is created in the minds of men. It is what people will pay, regardless of cost. It is found in the market data and income approaches.

Market value is the highest price estimated in terms of money which a property will bring if exposed for sale in the open market, allowing a reasonable time to find a purchaser, who buys with knowledge of all the uses to which it is adapted and for which it is capable of being used.

Cost is that which is expanded to create or acquire; cost does not necessarily equal value; cost and value are the same if construction is new, there is no depreciation, and the land is developed to its highest and best use.

Price is the amount asked, or the amount paid.

True cash value is the goal of appraisals made for ad valorem tax purposes. It is defined by Oregon statute as "true cash value of all property, real and personal, means market value as of the assessment date. True cash value in all cases shall be determined by methods and procedures in accordance with rules and regulations promulgated by the State Tax Commission. (If the property has no market value, true cash value shall be the amount of money that would justly compensate the owner for the loss of his property)".

The above definition points up the difference between the words "appraise" and "assess". Appraise means to estimate market value; assess means to fix tax value. The figures are usually different.

The real estate practitioner must always remember that PEOPLE MAKE VALUE. Land acquires value only when desired by people; normally, people will pay no more than the going price on the current market.

The mere existence of a parcel of real estate is not the reason it has a particular value. That value is related to someone willing to pay that much for the right of ownership.

Economic Principles of Valuation

The real estate broker or salesman who will make a serious effort to understand, and apply, the economic principles of real property valuation will find new success in the listing and selling of real estate.

PRINCIPLE OF ANTICIPATION

Affirms that value is created by anticipated benefits to be derived in the future. Examples are the anticipation of profit, or the satisfaction of social ambition by a home in a prestige neighborhood.

PRINCIPLE OF BALANCE

Value is created and maintained in proportion to the equilibrium in the amount and location of essential uses of real estate. Balance maintains value; imbalance destroys value. Examples: ratio of land to buildings; use of the right kind of materials; room size and arrangement.

HIGHEST AND BEST USE

That use which at the time of the appraisal is most likely to produce the greatest net return to the land and/or the building over a given period of time.

In considering "highest and best use" it must be remembered that "net return" does not necessarily mean money. The "amenities" offered by the particular property must be considered.

An "amenity" is frequently defined as a condition of agreeable living or a beneficial influence arising from the location. A house has "intrinsic value" in addition to physical features.

PRINCIPLE OF CHANGE

No material thing remains static. It is affected by the past, the present and the future. No one can predict the future, but it is the future to a large degree that establishes value. A change in the income relationship in a neighborhood, change in zoning, or an encroachment can affect values; people moving up.

PRINCIPLE OF COMPETITION

Points out that profit tends to breed competition which can dissipate all or part of the profit. Example: the success of a drug store causes another drug store to locate in the next block.

PRINCIPLE OF CONFORMITY

Holds that maximum value is realized when there is a reasonable degree of uniformity—social as well as economic.

Values tend to be higher and more stable in a neighborhood of like structures with similar uses. A house in a decreasing area gains nothing from aluminum storm windows; and an $8,000 home buyer does not expect a full tiled bath.

PRINCIPLE OF CONTRIBUTION

Affirms that the value of an item in production is measured by its net return to the enterprise. Has he spent too much to modernize? Two full baths in a two bedroom home. An elevator that will not increase income sufficiently to cover its cost. Sometimes an expenditure is made to assure continuation of present income, which otherwise would decrease.

SUPPLY AND DEMAND

Affirms the economic doctrine of scarcity, desire, and ability to purchase. Different income and social groups concentrate on property best suited to their needs and finances. They generally choose the property that fits their needs, satisfies a desire, and within reach of their pocketbook. People buy real property for one of three reasons—use and occupancy, for investment, or for speculation.

PRINCIPLE OF SUBSTITUTION

No reasonable man would pay more for a product than that for which he could buy a reasonable duplicate, allowing for no undue delay. Consider the situation of two similar properties being offered by two different sellers at different prices. One of two things will happen—the higher priced will be reduced to compete with the lower, or it will not be sold.

PRINCIPLE OF UTILITY

The ability to provide usefulness or profit. Appraisers usually consider "utility" and "desire" as one and the same thing.

PRINCIPLE OF INTEGRATION AND DISINTEGRATION

Affirms that all existence is characterized by three stages—integration, equilibrium, and disintegration. This is the life cycle of a neighborhood. Is it on the way up, holding its own, or on the way down?

SURPLUS PRODUCTIVITY

Defined as the net income remaining after the costs of labor, management and capital have been paid. The capitalization of this income tends to fix the value of the land.

INCREASING AND DECREASING RETURNS

Affirms that larger and larger amounts of the agents of production (labor, management and capital) will continue to produce a greater net return to a point.

PRINCIPLE OF REGRESSION

Maintains that the worth of better properties will be adversely affected by the presence of lesser. Evil destroys good, but good rarely lifts evil. A $10,000 home in an area of $25,000 homes will adversely affect the adjoining property. A low income group moving in will lower value.

Forces in Real Property Valuation

In recent years the appraiser has come to recognize that the accuracy of his opinion of market value of a particular property is tied directly to the extent of his knowledge of three great forces in real estate.

These forces are Social, Economic and Political. The movement of these forces can be followed by "trends", which are defined as a series of related events. Recognition of these trends will influence the appraiser in his valuation process.

Trends under the Social force include population growth and decline, shifts in population density, mobility, personal instincts and desires.

Some sets of trends influenced by the Economic force are natural resources, commercial and industrial tracts, availability of money and credit, employment and wage levels, interest rates, tax burden, purchasing power.

Trends directed by the Political force include zoning, building codes, police and fire regulations, rent controls, national defense, allocation and credit controls, government housing, guaranteed loans.

Analyzing the Neighborhood

The final estimate of value of a particular property will attach to the physical property, but because "value is in the minds of men" the final conclusion of value will have been strongly influenced by things outside the physical.

We have already considered the great forces that influence the neighborhood. In studying the neighborhood consider the following:

PHYSICAL—Streets, transportation, schools, stores, parks, churches, climate, utilities.

SOCIAL—Social and economic homogeneity, prestige, attitude toward law, family size and age.

ECONOMIC—Thrift, income, vacancy rate, attitude of lenders, changing use.

GOVERNMENTAL—Tax burden, zoning, assessments.

Site Analysis

In the analysis of the site we generally are not seeking to value the land, but to determine its contribution to the valuation of the entire property.

Facts to consider in analyzing a site are:

Is it employed to its highest and best use?

The title and public record data: Are there public or private restrictions?

Physical data: Topography, frontage, depth, shape, utilities, landscape.

Relation to land pattern: Corner, climatic (light and air), advertising advantage, street width, curbs, traffic load.

Some of the amenities attached to a site are whether it is a name location, its spaciousness, location of schools and parks.

If your chore is the valuation of the land, the very best method is by comparison with similar properties (the Market Data approach).

Land should always be valued to its highest and best use. If a building on the land is no asset the demolition cost should be deducted. The ad valorem tax values land and buildings separately, and the law permits no depreciation of land for tax purposes.

Styles and Functional Utility

In an analysis of the improvements first attention is given to the architecture and functional utility.

Is the architecture related to the site? What is its relative marketability?

Functional utility is defined as the sum of the property's attractiveness and usefulness. How about the planning? No waste space? A large living room, small efficient kitchen, adequate dining area, one large or master bedroom, linen closet, medicine closet, attic storage?

Consider whether the property is a so-called "competition house" or one with gimmicks that add nothing to utility. The "competition house" loses value by thin butt shingles on the roof, non-miter corners on door and window casings, two door hinges where there should be three, no sub-floor, cheap electric fixtures.

The property will be desirable to the degree it will serve its occupants. Fads and personal nicknacks are not enjoyed by all persons to the same degree or at the same time.

It is in your inspection of the property that you will apply many of your economic principles of valuation. Does it conform? Has the principle of balance been adhered to in room size and arrangement?

Construction Survey

An understanding of local conditions of climate, sources of materials, popularity of planning, types

and variations in equipment is necessary in forming an opinion on construction.

A check list for a construction survey should direct your attention to the foundation, frame, termite damage, exterior wall, floors, interior walls, doors, windows, hardware, roof, fireplace, chimneys and flues, gutters and downspouts, mechanical equipment, heating system, plumbing, electric wiring.

Building Costs Estimates

An accurate, but costly and time consuming, method of estimating cost of a building is known as the "quantity survey." The kind and amount of every material used is tabulated and the total cost of each item is added to labor and overhead to arrive at your estimate.

Another method is known as "unit in place" in which the installed prices of units of construction are estimated on a square foot basis.

Best method is the "comparative" in which you compare the subject property on a square foot or cubic foot basis with similar buildings whose cost is known to you.

Because cost and value are so seldom related, the average real estate practitioner will rarely be concerned with costs of a property.

It is well to know, however, that costs are both direct and indirect.

Direct costs are the costs of materials delivered on the job and the cost of labor to assemble the materials into the finished structure.

Indirect costs are the contractor's overhead and profit, and the general overhead, such as architect and legal fees, taxes, insurance, administrative expense, and interest during construction.

Direct costs attributable to land are the price of the land, title examination, recording fees, and legal fees.

Depreciation

The MAI definition of "depreciation" is "depreciation always has been, is now, and probably always will be a loss of value from all causes, but modern thinking says it is the difference between the reproduction cost new and the present value."

There are three types of depreciation:

PHYSICAL: A loss of value from all causes of age and action of the elements.

FUNCTIONAL: A loss of value from all causes within the building. These could include structural or something such as four bedrooms with a single bathroom.

ECONOMIC: A loss of value from all causes outside the property. Anything present that violates the principle of balance, such as an over or under improvement, close to a nuisance, or some government regulation.

Expressing depreciation in dollars is better than percentage. A $10,000 property 50% depreciated has a depreciation of $5,000. A 60% depreciation would be $6,000. The difference between the percent figures is 10%, while the difference in the dollar amounts is 20%, a possible source of confusion.

The depreciation in real property is normally very slow, and an almost unbroken trend of social, economic, and political tensions have tended to wipe out this natural wearing away of value. The almost unbroken phenomena of many years of profit in the resale of real estate has practically eliminated any idea of the "cost of enjoyment" from the minds of owners. But, depreciation is there, regardless of the great external forces, and if you are to be successful you must be able to support your determination of realistic value with facts and logic.

In expressing an opinion of value you are simply carrying out one of the important phases of the daily task of making a living. Under our commission system we could make more money if buyers would buy at the prices asked by eager sellers.

Market Data Approach

Of the three techniques employed in the appraisal process, the Market Data approach is the most common, most easily understood by people, given the greatest weight by courts, is one of the oldest, and is solidly based on the truism that "value is in the minds of men."

It is the technique employed daily by the real estate practitioner. It is well to remember that the mechanics of this technique, the use of comparables, is also basic in both the Cost and Income approaches to value.

Experience comes from working in the hustle-bustle of the market place, while knowledge comes in the quiet of the study.

In testing the market we must think as the average buyer thinks, and look at a property through the eyes of the average buyer. The mere fact that a friend sold a similar property at a pleasing profit is not reason enough to overprice a particular property. The friend may have sold to a father who bought the property for a daughter, thus assuring himself that his grandchildren would be nearby.

Market value is not determined by "similar" properties, but by "comparable" properties. As we have seen, many things outside the structure and outside the lot lines must be considered in selecting comparables. It is well to remember that market data must include the effect of the down payment. The market may give you an opinion of value, but the price will have been influenced by the terms of the sale.

THE PROCESS

The market data approach is a process of making comparisons, and is very accurately described as "the use of the judgment factor."

Before attempting to arrive at a conclusion of value of any parcel of real estate the broker should have supplied his office with check lists and some form of rating grids, similar to those shown in this section.

Comparisons must be made with prices paid for similar properties, prices now asked by owners, offers made by interested purchasers, willing and able to buy, rentals and leases, like utility, comparable location, time required to sell. At the same time an analy-

sis should be made of the social and economic factors affecting the marketability of the subject property.

The comparisons are made under four general headings—price, date sold, location, and physical characteristics. When you offer an estimate of market value of a particular property, a well documented record of sales of comparable properties makes your opinion convincing.

A single sale of a comparable property will rarely give sufficient data for an opinion of value. If possible, a minimum of four sales should be used for comparison. As no two properties are exactly alike an adjustment must be made for differences.

It is well known that the motive that prompts a sale has a bearing on the selling price. Discover, if you can, what stimulated the sale. Perhaps a threat of foreclosure, gift to a relative, need of expansion, a tax advantage. Are the buyer and seller informed people? Are they typical?

A group of brokers and salesmen interested in acquiring a particular property requested an estimate of its market value from a committee of their own members.

The subject property was a residence of English type architecture, built in 1926 on a 50′ x 100′ lot, and containing 1060 square feet of living area.

The FHA had made a conditional commitment of $13,950. An inspection of the property itself seemed to indicate that the commitment was in line with current market value.

The committee then set about its important task of comparing. A similar property directly across the street, sometime before appraised at $12,500, had sold six months ago for $10,500. A residence in the neighborhood, listed for $10,750, had sold on contract for $9,500 with a $700 down payment. Another similar property sold three years ago for $12,500, but recently re-sold for $8,500. Three lots in the area had once been appraised for $12,700, but were now offered for $10,500.

A check at the tax collector's office showed the last tax bill against the subject property to have been $240.30. The tax was based on the assessor's market value of $9,200.

After an analysis of this data and neighborhood data, the committee concluded that social and economic forces, and the life cycle experienced by every neighborhood were sharply changing [illegible]. The committee's estimate of market value of [illegible] subject property was $11,500.

In this actual appraisal of a subject property the appraisers use as comparables listings, offers to sell, and actual sales.

Listings tend to set the ceiling of market price. The number of listings in a particular area is a good indicator of a trend. Offers to purchase tend to set the floor of market price.

Too much emphasis can not be placed on the importance of using a check list and a rating grid in making comparisons of similar properties. A "property record" file, if carefully worked at, can become your own "appraisal laboratory." Into the file should go all the information you can get, see or hear about properties in your area. The information from this file, with the courthouse records and your own field work, will make your job easier and the end result more accurate. The file should list the properties by street number and street name, show sales and listing prices, time to sell, conditions of sale, etc.

If it is necessary to go outside the neighborhood of the subject property for a comparison make adjustments for differences in neighborhood and inhabitants, transportation, schools, parks, playgrounds, traffic hazards, nearby shopping.

Samples of rating grids, adjustment grids, and comparison grids are shown in this section. In each you determine whether the subject property is equal, superior, or inferior to the comparable. Although rating is usually done on a percentage basis, the final adjustment should be expressed in dollars. People understand dollars.

Verification of comparable sales should be made through the title company.

It is not anticipated, nor intended, that this appraisal discussion will, by itself, qualify the reader as a professional appraiser. The material presented here is intended to be of assistance to the real estate practitioner in his day by day routine.

The Market Data approach will be the technique used most frequently by real estate brokers and salesmen to arrive at an honest estimate of market value in the listing and selling of real property.

The Cost and Income approaches will be discussed only briefly. Attendance at classes offered by the American Institute of Real Estate Appraisers and the Society of Real Estate Appraisers for the individual interested in advanced or professional training in appraising is highly recommended.

Cost Approach

Use of the Cost approach to arrive at an opinion of market value requires a higher degree of training and experience than does the Market Data. Because of the ease of error in estimating depreciation this approach is used more frequently in estimating value of a newly constructed property.

THE PROCESS

There are six steps to the Cost approach.
They are:

1. Estimate land value.
2. Estimate reproduction cost new today.
3. Estimate depreciation (physical, functional, economic).
4. Deduct depreciation from building cost.
5. Add value of land to result of No. 4.
6. Result—indicated value of building and land today.

In the above process we used the word "reproduction" cost. Reproduction cost new is generally accepted as meaning the cost that would be incurred if the property was reproduced as an exact replica. To do this might well involve materials and construction practices not practical to apply today. Unless the appraisal is being made to determine insurance value, the second step should be to estimate "replacement" cost, which would be the cost of replacing the building with one of the same utility and amenities.

Since people ordinarily will not pay more for a property than it would cost to replace within a reason-

able time (principle of substitution), the Cost approach tends to set the upper limit of value.

METHOD

The estimated land value is obtained by comparison with similar properties. It is always market value of the land, considered as vacant and available for improvement to its highest and best use. The "cost" of the land is *not* its market value.

The building cost new today is usually obtained by one of three methods:

1. Quantity survey method: the kind and amount of everything in the structure, including both labor and materials is priced.
2. Unit in place method: how much to put in a square foot of floor, wall, roof, etc.
3. Comparison: obtain the square foot or cubic foot building costs from a local contractor for similar structures.

The comparison method is the easiest and fastest. It requires no technical construction knowledge, but it is not as accurate as the other methods.

Treatment of Depreciation

In arriving at an opinion of value via the Cost approach, the appraiser must carefully consider each of the three types of depreciation, namely, physical, functional, and economic. These were defined earlier in this section.

Depreciation can best be estimated by personal inspection and comparisons of the subject property with a hypothetically new or 100% property. This is known as the "observed condition method" and is given the greatest weight by the courts.

The most commonly used method is "straight-line" depreciation. In this method depreciation estimates are tied to a fixed rate applied to the age of the structure, such as 2% per year. While widely used, there is little justification in assuming that improvements depreciate at a rate corresponding to their age.

While the application of the Cost approach is not a simple task, it is essential on complicated, single purpose, and industrial properties.

Before leaving the Cost approach, attention of licensees interested in appraising should be called to the book, Cost Factors for Residential Buildings, which is available at reasonable cost from the State Tax Commission.

The book is designed to aid rapid application of the Cost approach to estimate current market value in mass appraisal projects. It can be of help to the licensee in general brokerage.

Income Approach

The Income approach is concerned with the definition "Value of a property is the present worth of the net income it will produce during the remainder of its productive life."

The Income approach teaches that rent measures value because it measures the intensity of the desire of the prospective user of the property; and that there is always a fixed relationship between rents paid in a neighborhood and the prices at which properties are selling.

The Income approach is particularly important in the valuation of income-producing property, but almost invariably the careful appraiser will use the other two approaches to value as a check on this single technique.

This approach is usually based on the use of the "net" income because the properties thus appraised are purchased for money income or for investment. In the appraisal of one or two family residential properties an appraisal tool, the "gross rent multiplier" is frequently used.

GROSS RENT MULTIPLIER

The "gross rent multiplier" expresses a relationship between the gross monthly rent and the estimated market value of a property.

This must not be confused with another well-known rule of thumb, which proclaims that the monthly rent multiplied by 100 equals value.

To get the gross rent multiplier the appraiser selects properties that are comparable to the subject property. He then divides the known sales price of the comparable property by its gross monthly rent to get the monthly gross rent multiplier. The gross rent multiplier can then be multiplied by the gross rent of similar or comparable properties to arrive at an estimate of market value. In many areas assessors are making use of the gross rent multiplier for taxation purposes.

AN EXAMPLE:

The appraiser finds a comparable property now rented for $150 a month, and which recently sold for $24,000. He divides $24,000 by $150 and arrives at a gross rent multiplier of 160. The subject property has a monthly rental income of $175 a month. He then multiplies $175 by 160 and estimates the value of the subject property to be $28,000.

In the above example we could have capitalized the gross annual rent to arrive at an indication of value, but this is seldom done.

If our potential buyer expected a return of 5½% on the gross rent we could select a rate to recapture his investment over a period of 50 years. This rate would be 2%. Adding the two together we have a capitalization rate of 7½%.

The income of $175 per month amounts to $2,100 a year. Dividing $2,100 by the capitalization rate of .075 we would get an estimated value of $28,000.

A "gross income multiplier" can be used with annual income in a similar manner. The comparable property sold for $24,000 and had an annual income of $1,800. Dividing $24,000 by $1,800 we get a gross income multiplier of 13.3. Multiplying the $2,100 annual income of the subject property gives us an estimated value of $27,930, which would be rounded to $28,000.

CAPITALIZATION PROCESS

As already stated, in the normal Income approach the appraiser works with "net" income. Actually, he begins with "effective gross income." This figure is obtained by deducting from the "gross" income of the

property an estimate of vacancy and credit losses. In arriving at the "gross income" he used the "economic rent", which is what the facility would bring on the open market today if 100% occupied.

From effective gross income he deducts fixed expenses, such as taxes and insurance; actual operating expenses and repairs; a reserve for replacements, such as short-lived items of equipment; and other expenses, such as mortgage interest, income tax, or depreciation reserves. He now has "net income."

His next step is the most difficult and requires a high degree of training and experience. This is the selection of the "capitalization rate." This rate is the sum of an interest rate and rate to recapture capital. The investor wants a return "on" his investment and a return "of" his investment.

The appraiser must go to the market place to find the interest rate that will attract an investor. What interest do investors demand from a "safe" investment, such as government or utility bonds? What penalty do they demand for the "risk" in real property? The sum of the two will be the interest rate.

The next step is to find the recapture rate, which is the rate that will return the investment, including depreciation over a period of years. The sum of the interest rate and recapture rate becomes the Capitalization Rate.

When the net income and the capitalization rate have been determined the final step is to capitalize the income.

This can be a simple mathematical calculation as shown below if the income is considered to be a perpetuity, or a more involved use of formulaes and annuity tables.

In the advanced use of the Income approach there are three techniques of capitalization. They are "land residual", "building residual" and "property residual." Four methods of capitalization are "straight line", "annuity", "sinking fund" and "increasing and declining annuity."

As an example of a simple mathematical calculation of value via the Income approach consider the same property we discussed in the use of a gross rent multiplier.

In this case the appraiser determined the "net" income to be $125 a month, or $1,500 a year. He learned that investors would demand a capitalization rate of 8% on such an investment. He then divides .08 into $1,500 and arrives at an estimate of value of $18,750 for the property valued at $28,000 via the use of a gross rent multiplier.

The valuation arrived at in the above example was reached by charging $600 in expense items against the gross income, reducing net income to $1,500. This demonstrates the importance of arriving at accurate gross income and expense estimates.

It is well to point out that if he had determined the proper capitalization rate to have been 8½% his final estimate of value via this approach would have been approximately $17,645. Thus, the more risk the less an income stream is worth and the higher the interest rate.

Careful selection of the capitalization rate is the secret of the Income approach. As already stated, gross income is used as the starting point in residential properties, and net income is used for strictly income or investment properties.

As the property used in the above examples was a residential property the appraiser would have used the gross income, and had he arrived at a capitalization rate of 7½% he would have reported an indicated value of $28,000, the same as that via the gross rent multiplier. Although other methods are used to arrive at the safe and risk components of the capitalization rate, the most reliable source is the market place.

The capitalization rate then depends upon the return investors will demand for an investment in such a risk. This rate must take into consideration the return *of* the invested capital and a return *on* the investment.

When thinking of capitalization rates, remember the equation:

Income divided by rate equals value:

$I \div R = V$; or $I \div V = R$; or $V \times R = I$. It may be easier to keep a picture in your mind, such as

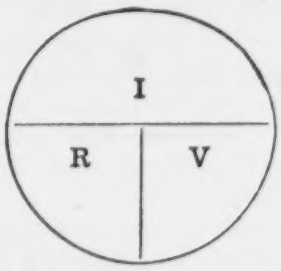

Both are expressions of an algebraic equation, if any two of the parts are known the third can be determined.

From the formula, it is evident that "capitalization" is the process of arriving at the value of a property through the use of a rate. The rate is believed to represent the proper relationship between the real property and the net income it produces.

The rate is obtained from the market. What does the typical investor expect from such an investment compared to that from other sources seeking capital?

SUMMARY

What, briefly, are the good and bad features of each approach?

Market Data—Good: One of the oldest, its mechanics are used in all approaches, best on residential property, easiest to understand, accepted by people, accepted by courts. Bad: No two properties are identical, adequate data not always available, retrospective in character.

Cost—Good: The oldest, popular with buyers, ascertains location, time and reason for depreciation, accepted by most courts, can be an accurate indication of value. Bad: Costs never estimated exactly, chance of error in depreciation, some buyers do not depend upon it, requires time and considerable skill.

Income—Good: Excellent check on conclusions of other approaches, one of best on land with no improvements, desired by large investors, may be only guide available. Bad: Everything is an estimate, accurate data difficult to collect, not understood by small investors, courts and juries.

FINANCING

Research into the field of finance and the implement of barter indicates that had it not been for man's discovery of metal we might today buy or lease real property by exchanging an indeterminate number of cows for the right to possession and enjoyment of the real estate.

According to historians, coins were first used about 700 B.C., and paper money came into being during the 14th century. Whether we barter in butter, coins or paper money, real property transfers today are seldom for cash.

A very high percentage of all real estate transactions require financing, extending over a period of years. Real estate brokers and salesmen can gauge their hopes of success by the extent of their knowledge of the sources of financing and the requirements of the individual lenders.

Prior to the 1934 National Housing Act, mortgage loans were quite generally short term, non-amortizing, and bearing high interest rates.

Low ratios of loan-to-value led to a considerable volume of junior financing, while the lack of a system for checking tax records resulted in many tax delinquencies. Lending practices were characterized by an inadequate credit analysis and inadequate construction requirements.

The National Housing Act and the Servicemen's Readjustment Act of 1944 contributed much to better lending policies and practices.

Real estate loans are generally classified as residential, residential income, commercial, shopping center, industrial, office buildings, lease and leasehold, tract and subdivision, and special purpose.

The rank in volume of non-farm mortgages of non-government lenders is probably in the following order: Savings and loan associations, life insurance companies, commercial banks, mutual banks, mortgage bankers, individuals, pension funds, colleges and universities, credit unions, cemetery endowment funds, trusts, etc.

TYPICAL TYPES OF LENDING

Each of the various types of lending institutions follows a lending policy quite general to its class. These are:

Savings and Loan Associations—Single family residences, substantial amounts of construction lending, relatively high loan-to-value ratios, slightly higher rates than other institutions, medium maturities, properties located relatively close to association.

Life Insurance Companies—Long-term lending, large size loans or packets of loans, considerable amount of commercial and industrial lending, few construction loans, loans on property leased by large concerns, many loans through correspondents.

Commercial Banks—Short-term lending, considerable number of small size loans, large number of highly liquid loans, properties located relatively close to bank, loans associated with relationships with customers, considerable amount of interim lending.

Mutual Savings Banks—Predominantly residential lending, properties near bank if conventional loan, if property is distant from bank loan is FHA or VA, or handled through correspondent, small size loans.

MORTGAGE BANKERS

The mortgage banker is playing a constantly increasing role of importance in real property financing.

As a correspondent for the large institutional lender, the mortgage banker is constantly on the alert for suitable outlets for the funds of his principal. It is his task to do the preliminary processing of the loan applications, submit them to his principal, and service the completed mortgage.

Most mortgage bankers perform a general real estate brokerage business in addition to their lending activities. Most also represent themselves or other individuals in providing real estate financing. In such cases they close the loan and then sell the instrument to the permanent lender.

Mortgage bankers are a major source of construction loans.

BROKER'S PLACE IN FINANCING

Good business practice places a duty upon the real estate practitioner to render assistance to a client in arranging for his financing.

To minimize the time of processing, to avoid embarrassment and the disappointment of a prospective applicant for a loan the real estate practitioner must keep his knowledge of local lending policies up-to-date.

He must remember that the lender of today will look both to the property as collateral and to the repayment potential of the borrower. The three "C's" of credit pretty generally govern a lender's decision: "Capital, capacity, and character."

The broker should be familiar with the sources, and mechanics of each source in approving a loan.

He should be familiar with the basic contents of each form of application. He can help by a preliminary screening of the applicant, by advising the applicant as to justifiable amounts and terms to request, by clarifying for the applicant the technical aspects of the application, by advising his client as to the desirable amounts of supplemental information to include, by checking the application for accuracy and adequacy, and by aiding in the presentation of the application to the lender.

It was recently pointed out that while FHA will insure a loan made to a person whose liabilities were removed by bankruptcy, few lending institutions will make the loan.

A knowledge of lending policies and practices plays a major role in the success of the real estate brokerage business because of the importance of credit in making transfer of title possible.

The commodity sold by the broker is actually the equity of the seller, or to explain it another way, selling real estate is usually selling down payment and terms of credit.

Brokers and salesmen must know the source of credit and be able to expedite loan placement. In the money market they must be flexible—seek and have many sources and arrangements.

RULES OF THUMB

While "rules of thumb" are nothing more than uncertain guide lines, some reliance can be placed on them in estimating the credit capacity of an individual. A couple of these are "a new home should cost no more than 2 to 3 times the annual income", or "housing costs should not be greater than 20 to 25 per cent of 'effective income' ", which is explained in the FHA section of this Manual.

QUALITIES OF A GOOD INVESTMENT

1. Safety
2. Certainty of yield
3. Liquidity (saleable in the market)
4. Acceptable denominations (of a size typical investor can handle)
5. Value as collateral (can it be used as security for a loan)
6. Acceptable duration (some want long term, other short)
7. Freedom of care (people do not want to manage their investments)
8. Potential appreciation (will it be a hedge against a change in purchasing power)

JUNIOR MORTGAGE

A junior mortgage is one subordinate to the claims of the first mortgage. The first mortgage has first lien on the property revenues, and once foreclosed wipes out the claims of the junior mortgage holder against the property. Foreclosure of the second mortgage does not disturb the position of the prior mortgage holder.

When used the second mortgage commands a higher interest rate because of the greater risk. If it can be sold the second mortgage has a high discount rate. Use of the second mortgage has largely been replaced by the land contract, which permits a low down payment when a buyer is unable to qualify for other financing.

If a second mortgage is used it is usually taken back by the seller, because neither party is in a position to add the amount to a new first mortgage. Second mortgage funds come from private sources, and are usually drawn for a five year period.

Bank Real Estate Loans

National banks and state banks are permitted to make real estate loans on improved property, such as residential, farm, commercial, and industrial.

Laws governing national bank real estate loans are regulated by the congress of the United States, while real estate loans made by the state banks are regulated by our state legislature. Usually these laws are identical.

National banks and state banks are permitted to make what they term conventional real estate loans as follows:

Type	*Term*	*Payments*	*% to Appraised Value*
Conventional			
Residential	Up to 25 years.	In amount sufficient to amortize loan over the loan period.	80% of bank appraisal.
Farm	Up to 25 years.	In amount sufficient to amortize loan over the loan period.	80% of bank appraisal.
Commercial	Up to 25 years.	In amount sufficient to amortize loan over the loan period.	80% of bank appraisal.
Industrial	Up to 25 years.	In amount sufficient to amortize loan over the loan period.	80% of bank appraisal.
Improved public parking lots	Up to 25 years.	In amount sufficient to amortize loan over the loan period.	80% of bank appraisal.

The Federal Housing Administration value and maximum mortgage amounts for one and two family residences are as follows:

Type	*Term*	*Payments*	*% to Appraised Value*
FHA (Federal Housing Administration)	Up to 40 years.	In amounts sufficient to amortize loan over the loan period.	In accordance with FHA regulations.

The down payment on Federal Housing Administration loans depends on the size of the loan, and the age of the house that is being purchased.

At the time the Primer went to press, Congress was moving favorably on legislation to permit national banks to make fully amortized conventional mortgage loans with a loan to value ratio of 90% for terms of 30 years.

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Savings and Loan Associations

1. Savings and loan associations are the largest single source of residential mortgage financing. Nationally, the savings and loan associations account for approximately 45 percent of all non-farm mortgage recordings.
2. These associations are specifically chartered under the laws of the State of Oregon or the laws of the United States. Those chartered under the laws of Oregon are supervised by the State Savings and Loan Supervisor and in conjunction with supervision under the direction of the Federal Home Loan Bank Board. The associations chartered under the laws of the United States are supervised by the Federal Home Loan Bank Board of Washington, D. C.
3. The charter of the associations under state supervision provide that "they are to encourage thrift, industry, frugality and home building", and those chartered under the federal law are organized to "promote thrift and home ownership". Each association is a separate entity and is locally operated. Branch offices are under the jurisdiction of the home office of the parent organization.
4. On the side of thrift, savings and loan associations accept savings accounts and savings certificates from individuals, partnerships and corporations and pay interest earnings either semi-annually or quarterly on such accounts. Most state

chartered associations are members of the Federal Home Loan Bank System and of the Federal Savings and Loan Insurance Corporation. All Federally chartered associations are members of the two organizations. The Federal Savings and Loan Insurance Corporation insures the saver in all institutions under its system against loss of savings up to $20,000. Historically, savings and loan associations have paid a somewhat higher return to the investor or saver than do other financial institutions.

5. Most of the investments of savings and loan associations have to be confined to first mortgage loans upon improved real property, although they do have additional authority to invest in state and municipal bonds.

6. Both State and Federal savings and loan associations must live within the same framework and abide by the same regulations if they are to qualify as a "Domestic Savings and Loan Association". These regulations require that most loans must be made on 1 to 4 family dwellings, with loans also permitted on commercial property and apartments. Commercial and apartment loans cannot exceed 36% of total loans for any association. Further, not more than 18% can be represented by commercial loans. In practice most associations carry from 70% to 85% of all loans in residential properties. These provisions make savings and loan associations the only supervised lender whose operations are concentrated in the residential field.

7. There are 32 Oregon savings and loan associations, and two

out-of-state associations have branches in the state. There are 18 Federally chartered and 14 State chartered associations. Total Oregon savings and loan associations' mortgage loans outstanding December 31, 1969, exceeded $1 billion 400 million. The 32 associations, either by home office or by branches, now have offices in most of the cities of Oregon and can provide residential financing for most of the outlying areas.

LOAN RATIO

8. The rules and regulations under which Federal associations operate provide ability to grant conventional loans to 80 percent of association's appraised value, (under certain circumstances 90 percent), and any loan approved by the Federal Housing Administration or the Federal Veterans' Administration.

Rules covering the making of 90 percent loans were liberalized in 1967, permitting 90 percent conventional mortgage loans up to $31,500. This means a top purchase price for a home (or a combination of home and business property) of $35,000. This applies to both new and existing homes.

9. State chartered associations have the authority to grant up to 80 percent of appraised value on an installment mortgage loan or a 66 2/3 percent straight loan. In making loans in excess of 80 percent, but not to exceed 90 percent, state associations must establish either an excess reserve account amounting to 10 percent of the balance due on all excess reserve loans or

the 10 percent excess must be guaranteed by mortgage guaranty insurance.

10. The rules for Federal associations will also permit an association to lend a relatively small percentage of their total loans outstanding on apartments and commercial property.

11. In general, most of the loans made by the savings and loan associations are "conventional loans", that is, loans made without any government insurance or guarantee, such as Federal Housing Administration insurance, or the guaranteed Veterans' Administration loans.

12. While savings and loan associations are permitted to make the insured or guaranteed loan, only about 8 percent of Oregon Associations; outstanding loans are in this field. Actually, throughout the nation, less than 30 percent of all mortgages recorded are either FHA insured or VA guaranteed.

13. While lending rates and lending percentages may vary from association to association, and from time to time as the money market fluctuates, the savings and loan associations, as local lenders on residential real property, are always able to make a mortgage commitment to a good purchaser on a good residence.

14. Briefly speaking, the business of savings and loan associations is confined to two avenues: one, receiving of savings of people in order to, two, loan out money to deserving people who desire to build, purchase or remodel a home.

FEDERAL HOUSING ADMINISTRATION

The Federal Housing Administration has been in business since 1934. It was established under the provisions of the National Housing Act approved June 27, 1934, and now functions as a part of the Department of Housing and Urban Development.

The preamble to the National Housing Act states that the purpose of the Act is "to encourage improvement in housing standards and conditions, to provide a system of mutual mortgage insurance, and for other purposes". The FHA operates under authority of Titles I, II, VII, VIII, IX, X, and XI of the Act. These titles provide for FHA insurance against loss on loans for alterations, repairs, and improvements to homes and other real property; insurance of mortgages on homes; insurance of mortgages on multifamily rental projects; insurance of loans for land development and new communities; and insurance of group practice facilities.

The FHA works in cooperation with private industry to make better housing available to the American people. About 40 million families have benefited through FHA-insured loans.

Through the insurance programs of the FHA, the average family is enabled to finance homes on reasonable terms.

Owners of homes and other properties can borrow money needed for repairs and improvements. Cooperative and condominium groups can take advantage of the economies and other benefits of housing acquired through joint effort. Families in urban renewal areas can improve their housing conditions, and those providing facilities for housing of senior citizens, for mobile courts, and for nursing homes may qualify for desirable financing with FHA mortgage insurance. The supply of other multifamily housing at reasonable rents is increased, and essential housing for the Armed Forces is provided. The construction of group practice facilities is also encouraged. These facilities can be used for the practice of medicine, optometry, or dentistry.

The FHA operates without cost to taxpayers except for the rent supplement and payment subsidy programs. Its income from fees, premiums, and interest on investments has been sufficient to pay its operating costs, insurance losses, and related expenses, and to build up substantial reserves.

The mutual mortgage insurance system, with provision for minimum property standards, low down payments, and amortization of the debt by monthly payments suited to the borrower's income grew out of recognition of the need for a sound method of home financing. It has brought home ownership within the reach of many families who could not otherwise afford it, and at the same time has helped industry to maintain a high level of home construction.

Besides playing an influential part in the revision of mortgage lending practices, the mutual mortgage insurance system has other accomplishments to its credit. By providing a standardized mortgage instrument, it has made possible the purchase and sa[redacted]ured mortgages on a [redacted]ional scale. It has

also contributed materially to improvement in housing standards through the establishment of minimum property standards, careful architectural analysis, construction inspection, and the establishment of methods of planning and developing subdivisions. Moreover, FHA analysis of local housing markets has helped to avert overbuilding in specific areas and price ranges.

Another activity that is extremely important to the success of the FHA's mortgage insurance business is the study and evaluation of new materials, new combinations of old materials, and new or improved methods of construction and land development. FHA cannot sanction experimentation with the homeowner's money by accepting unproved materials or methods. On the other hand, it does not want to block progress by rejecting products or ideas only because they are too new to reflect long experience. The technical studies program, set up by FHA, provides a procedure for identifying, analyzing, and studying construction and materials problems without duplicating research work performed by others, and involves the assistance of industry, Government agencies, educational institutions, and various research organizations in solving these problems.

FHA insures lenders against loss in connection with more than 25 different segments of the various titles. Title I of the Act authorizes the FHA to insure lending institutions against loss on loans made to finance alterations, repairs, and improvements to existing structures and the building of new structures for non-residential use. About 20 billion dollars have been advanced to property owners under the Title I program. FHA liability is limited to 90 percent of the loss on an individual loan and to 10 percent of the total amount of Title I loans made by the institution. The loans are made, without FHA processing, by approved lending institutions to borrowers with satisfactory incomes and credit records. The borrower must have a fee title or life estate interest in the property, or a lease expiring not less than six months beyond the maturity of the loan, or be purchasing the property on contract.

A loan to improve a single-family home, or to build a new non-residential, non-agricultural structure may be in any amount up to $5,000. It may be repaid in equal monthly installments over a period from six months up to seven years. A loan to repair or convert a multifamily structure which is not owned by a corporation may be as much as $15,000, or an average of $2,500 per family unit, whichever is less, and may have a maturity up to seven years. A loan to build a new structure for agricultural use may be as much as $5,000 and may be repaid over a period of seven years or up to 15 years if the loan is secured by a first lien. A loan of $5,000, repayable in seven years, may be had to build a new commercial structure. FHA may insure loans, up to the maximum amount of $10,000, to be repaid in 12 years and 32 days, financing the retail sale of mobile home units.

Under the Title I program, loans are usually personal type rather than loans where collateral is pledged. FHA specifies the broad lending policies used by lenders in processing and making improvement loans.

Pursuant to the requirements of prudent business practice and the legal requirements of the National Housing Act, and in the interests of impartiality, uniformity, and consistency, the Federal Housing Administration has formulated a system of mortgage risk rating. A mortgage risk rating is the act of analyzing the elements which produce mortgage risk and ascribing a rating, based on the risk characteristics of individual mortgages. The purpose of the system is to determine whether or not a particular mortgage transaction has a reasonable promise of success. The rating thus derived, in the FHA risk-rating system, is called Rating of Mortgagor.

One of the requirements dealing with the insurance of mortgages under Section 203(b), which is the principal activity of FHA, is that "no mortgage shall be accepted for insurance under this section unless the Commissioner finds that the project with respect to which the mortgage is executed is economically sound". Economic soundness is lacking if the mortgagor is not an acceptable credit risk, even though the property is adequate security for the mortgage and, contrawise, it is lacking if the mortgagor is an acceptable credit risk but the property is not adequate security for the loan. Loss to the mortgagee can occur only in the event the mortgagor is unable or unwilling to meet his obligations to the mortgagee and the mortgaged property cannot be sold in a reasonable time for an amount sufficient to discharge the mortgagor's total obligation under the mortgage, including the expenses and carrying charges incurred by the mortgagee up to the date of the sale. Obviously, then, the aim of mortgage lending policy and practice should be to avoid, if possible, recourse to forcing a sale of the mortgaged property in order to satisfy the debt of a defaulted mortgagor. Since this contingency can occur only upon default by the mortgagor, good practice and economic soundness demand not only that the mortgagor be an acceptable credit risk but also that the mortgaged property be adequate security for the loan. Therefore, the degree if risk characterizing any mortgage loan depends upon relationships between the present and prospective characteristics of the borrower and property and the amount and term of the loan.

The FHA risk-rating system provides a method by which the economic soundness of any particular mortgage transaction can be rated by analyzing its relative degree of risk. Analysis in mortgage credit leads to a conclusion as to the borrower's past, present, and probable future willingness and ability to meet his obligations. Analysis of the real estate elements, which relate to the property and its location, leads to conclusions as to the value of the property at the time of the mortgage transaction and as to the probable future marketability of the property should its sale become necessary to discharge the outstanding obligation of the borrower to the mortgagee. The third group of elements analyzed are the amount, repayment plan, and term of the loan.

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The FHA risk-rating system is not a formula. It is a guide to judgment which is intended to bring about a maximum possible degree of accuracy and consistency in evaluating risk in mortgage transactions.

The architectural analysis relates to the building improvements of a property submitted for mortgage insurance. This analysis is made to determine the eligibility and acceptability of the physical security for insurance. It also provides conclusions essential to the determination of the value of the real estate through analysis of the physical elements of the property from the viewpoint of its quality as mortgage security. Inspections of construction are made by FHA in its own interest in order to determine whether construction of the physical security for the mortgage to be insured is in acceptable compliance with the terms of the insurance commitment and sound construction practices.

In the FHA system valuation estimates are required to assist in making decisions with respect to the eligibility of loans for mortgage insurance. A percentage of the estimate of value establishes:

(a) The maximum amount beyond which the National Housing Act does not permit a loan to be insured.

(b) The minimum amount of cash investment required of the mortgagor; and

(c) The ratio of loan to value used in risk rating.

Valuation estimates are used in FHA's mortgage insurance operations to disclose the capability of the property to secure the loan. There are two ways in which real properties constitute security for a mortgage. The first is the borrower's desire to retain ownership of a property because of the future usefulness and benefits to be derived. The second is the amount obtainable at a sale if the mortgage is foreclosed and the property sold.

The word "value" is defined as: "The price which typical buyers would be warranted in paying for the property for long-term use or investment, if they were well informed, acted intelligently, voluntarily, and without necessity." The National Housing Act requires that the value FHA ascribes to a property be made known to any purchaser who will use FHA mortgage insurance to finance the purchase. Where FHA value was not furnished the purchaser prior to the signing of an agreement to purchase, such agreements must be amended to place the purchaser in the same position he was in prior to entering into the agreement.

Analysis of value includes not only the physical improvements but also the manner in which value is affected by reason of its location. Further steps in the valuation analysis include an estimate of replacement cost of the property, estimate of available market price, estimate of capitalized income

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and finally an estimate of value. The benefits, or returns, derived from ownership of a dwelling property may be in the form of amenities or satisfactions, or in the form of money. The valuation analysis gives consideration to these returns by a prescribed method of capitalization of income. A capitalization of rental-income method is used when the anticipated returns are primarily monetary.

The mortgage credit risk in a mortgage loan transaction is the probability of the failure of the mortgagor to fulfill his promise of future payments in accordance with the terms of the mortgage transaction. The purpose of mortgage credit analysis is to determine the degree of mortgage credit risk in mortgage transactions to be insured and to limit the probabilities of foreclosure or collection difficulties through the application of predetermined standards with respect to acceptable risks. Mortgage credit analysis does not contemplate forced sale of the mortgage security to accomplish liquidation or to avoid loss. In some transactions there may be sufficient assurance that loss to the mortgagee or to FHA can be avoided through forced sale of the mortgage security, but to predicate the making of mortgage loans on this basis would not be in the best interests of mortgagors. A mortgage lending policy, to be sound from all points of view, must be based upon the probability that the mortgagors will be able and willing to protect their ownership of mortgaged properties.

Giving proper weight to the prospective homeowner's ability to meet the terms of his mortgage is a highly important part of the FHA insured mortgage system. It is a vital factor in the economic soundness of the transaction from the point of view of the government's insurance risk. It is an important aspect of the homeowner's enjoyment and satisfaction with his purchase. It is a stabilizing influence on the whole home building and allied industries.

To gauge the risk introduced into a mortgage transaction by the borrower's ability to meet monthly payments, three estimates must be made. The first is an estimate of the prospective mortgagor's dependable, continuing income, termed "effective income" by FHA. The second is an estimate of the cost of occupancy of the property which FHA calls "prospective monthly housing expense". Third, all debts, living costs and other financial demands are considered. All these factors are then related to judge the feasibility of the loan.

It is seldom possible to make a really reliable estimate of an individual's anticipated income over a period of 15 to 30 years. However, the first years of a mortgage loan are the period of greatest risk, and a forecast of a prospective borrower's income during this early period can be made with some degree of certainty. For practical purposes, this early period of risk may be assumed to be approximately one-third the term of the mortgage.

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In making a realistic estimate of dependable income, FHA screens out all except that of a continuing nature. Dependable, stable, continuing income after deducting federal income tax is called "net effective income" by FHA. It represents the amount of money with which the borrower can confidently expect to meet his household and other expenses. A person's income from overtime work, employment of members of the family other than a steadily employed wife if the family pattern has been established as including her employment, return of a capital investment, the renting of a room or the rendering of occasional personal services cannot be viewed realistically as dependable continuing income.

In estimating the prospective monthly housing expense, the following are taken into consideration: mortgage principal and interest, mortgage insurance premium, hazard insurance premium, taxes, special assessments, maintenance, repairs, heat, and utilities. The estimate of prospective housing expense is then compared with the housing expense the borrower is accustomed to paying. If the prospective expense is greater than that previously paid, and if the applicant has been unable to build up a financial reserve while paying the lesser amount, the greater degree of risk must be recognized. When the housing expense is increased without a corresponding increase in income, downward adjustments in other living standards are difficult to make. Charts portraying the relationship between prospective housing expense and net effective income are available at FHA insuring offices.

Other analyses are made to determine that past credit experience with the applicant has been acceptable, that the prospective mortgagor's income is stable and that he has the funds necessary to make the down payment and the deposits to reserves without resorting to unacceptable secondary financing. In connection with the latter, prior to mortgage insurance endorsement, mortgagors must certify that they will not have outstanding any other unpaid obligations contracted in connection with the mortgage transaction or purchase of the property except obligations which are secured by property or collateral owned by the mortgagors independently of the mortgaged property. FHA does not feel that furniture, trade tools, or automobiles which an applicant uses in his employment or business would be acceptable security for loans to supplement the insured mortgage.

An FHA insured mortgage can be paid in full, without an adjusted premium becoming due, under the following circumstances: (a) no more than 15 percent of the original amount is prepaid on the principal in any calendar year; (b) the loan is refinanced with another FHA loan; (c) the loan is retired by payments as originally scheduled; or (d) prepayment takes place on or after the 120th scheduled payment. The adjusted premium charge is a maximum of one percent of the original amount of the mortgage or the amount of mortgage insurance premiums which would be paid through the 120th scheduled payment.

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The chart following contains information on those home mortgage segments of the National Housing Act in which there is most activity. Similar information for project mortgages is not included here but may be obtained at your local FHA insuring office.

All of the above are as of February 1, 1970, and are subject to change. It is not meant to be a complete resume of all requirements, but merely sets forth certain pertinent points. The maximum interest rate is 8-1/2 percent. The Mortgage Insurance Premium is one-half of one percent, except for Title X. The term of the mortgages, for the most part, may not exceed three-fourths of FHA estimate of remaining economic life, or 30 years (35 years where proposed construction is involved and the purchaser cannot qualify with a 30-year term) except that certain mortgages under Section 221 may be for 40 years. The FHA examination fee is $45 for proposed construction cases and $35 for existing or under construction properties.

ORS 86.610 specifically permits Oregon financial institutions and lenders to make loans secured by real property or leasehold for which the Federal Housing Administration insures or makes a commitment to insure, and may obtain such insurance.

Other lesser known sources of real property financing programs are the Federal Home Loan Bank Board, the Department of Agriculture, and the Small Business Administration.

Federally insured mortgages may be purchased by the Federal National Mortgage Association or the Government National Mortgage Association.

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Section	Purpose	Number of Units	Amount Insurable	Loan-Value Ratio
203b	Finance proposed or existing dwellings.	Owner-occupant borrower 1 2 3 4	 $33,000 $35,750 $35,750 $41,250	Owner-occupant (a) Properties approved for insurance prior to beginning of construction or completed one year or more: 97% of the first $15,000 of FHA valuation; plus 90% of next $10,000 of FHA valuation; plus 80% of all valuation over $25,000. (b) Properties not approved for insurance prior to beginning of construction and construction completed less than one year: 90% of the first $20,000 of FHA value; plus 80% of all value over $20,000. Non-owner occupant 85% of the amount computed for an owner-occupant.
		Non-owner-occupant borrower 1 2 3 4	 $28,050 $30,350 $30,350 $35,050	
		If escrow commitment procedure (trade-in) is used: Same as for occupant mortgagor, subject to 15% escrow pending sale to an acceptable owner-occupant within 18 months.		
203b	Finance proposed or existing dwellings for Veterans who have not used their Federal GI home loan benefits and who obtain VA Form No. 26-8261 executed by Veterans Administration.	1	$33,000	100% of first $15,000 of FHA value or the sum of (1) value not in excess of $15,000 and (2) items of prepaid expense, less $200, whichever lesser, plus 90% of value between $15,000 and $25,000, plus 85% of value in excess of $25,000.

Section	Purpose	Number of Units	Amount Insurable	Loan-Value Ratio
221	Finance low-cost homes.	Owner-occupant borrower Displaced family 1 ..... 2 ..... 3 ..... 4 ..... Non-displaced family 1 ..... Operative-builder 1	 $18,000 $24,000 $32,400 $39,600 $18,000 $15,300	Owner-occupant 100% of FHA valuation if proposed construction or if completed more than one year. 90% of FHA valuation if under construction or not completed one year. Rehabilitation: (1) estimated cost of repair and rehabilitation; (2) estimated cost of repair and rehabilitation plus amount required to refinance outstanding debt against property. Operative-builder 85% of appraised valuation.
222	Finance proposed or existing dwellings for mortgagors certified as servicemen.	Owner-occupant borrower 1	 $33,000	Same as Section 203b.
Title X	Finance purchase and development of raw land.	Maximum loan of $10,000,000. Maximum term of 7 years except term may be longer where case includes privately owned water or sewerage systems. (Mortgage premium for term of 7 years or less is 2% for first 3 years and 1/12 of 1% for each additional month. Other percentages apply where term more than 7 years.		The lesser of (a) 75% of FHA value or (b) 50% of FHA value before development, plus 90% of FHA estimate of cost of development.

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Section	Purpose	Number of Units	Amount Insurable	Loan-Value Ratio
203h	Disaster housing. Finance dwellings for owner-occupant borrowers.	1.....	$14,400	100% of FHA valuation.
203i	Finance proposed on existing dwellings. Non-farm or farm of 5 or more acres adjacent to highway.	Owner-occupant borrower 1..... Operative-builder 1.....	 $16,200 $14,300	Owner-occupant 97% of the first $15,000 of FHA valuation; plus 90% of next $5,000 of FHA valuation; plus 80% of all valuation over $20,000. Operative-builder Proposed construction only: 85% of FHA valuation.
203k	Alteration, repair and improvement of existing structures outside urban renewal areas.	$16,000 per family unit. (May not exceed $41,250 on a 4-family structure)		Amount of loan plus any outstanding debt related to the property cannot exceed amount and ratio insurable under Section 203b.
220h	Alteration, repair and improvement of existing structures in urban renewal areas	$12,000 per family unit. (May not exceed $41,250 on a 4-family structure)		Amount of loan plus any outstanding debt related to the property cannot exceed the amount and ratio insurable under Section 203b.

Section	Purpose	Number of Units	Amount Insurable	Loan-Value Ratio
234	Condomium Housing. Finance the purchase of individual units in multifamily housing projects on an ownerships, rather than on a rental basis.	1	$33,000	Owner-occupant. Same as 203(b) Non-owner-occupant Same as 203(b)
235	Interest subsidy on Home Mortgages. Finance the purchase of a home or a membership in a cooperative housing project by low-income families. Assistance is in the form of monthly payments by HUD to the mortgagee to reduce interest costs on a market rate home mortgage insured by FHA to as low as 1 percent if the homeowner cannot afford the mortgage payment with 20 percent of income.	1 ..... 1 (5 or more and for home containing 4 or more bedrooms) 2	$18,000 $21,000 $24,000	100% of FHA valuation with a minimum of $200 down which can apply to reserves.
237	Mortgage Credit Assistance for Homeownership. Provide mortgage insurance to finance homeownership for low-and moderate-income families whose credit history does not qualify them for insurance under normal standards. (This program is not operative as of February 1, 1970).	1	$18,000	Same as the section of the Act pursuant to 237.
Title I	(Mobile Home Loan Insurance) Finance the retail sale of mobile home units to owner-occupants.	1	$10,000	Maximum term up to 12 years and 32 days at interest rates determined according to Title I discount rates.

State of Oregon

Veterans' Farm and Home Loans

PURPOSE OF THE LOAN

The State of Oregon provides loans to eligible war veterans, upon security consisting of real property located in Oregon, for the acquisition of homes and farms. The program is administered by the State Department of Veterans' Affairs.

It must be the applicant's intent to occupy the property as his own home. The term "acquisition" for purposes of the loan means:

1. The purchase of real property and its improvement.

2. To pay off a purchase contract, a purchase-money mortgage, or a mortgage in the nature thereof, and the improvement of property so acquired.

3. For the construction of a home.

ELIGIBILITY

To be entitled to the loan, the applicant must be either:

1. A veteran of World War II who served on active duty in the armed forces of the United States for not less than 90 days, any part between September 15, 1940 and July 25, 1947, who was honorably discharged and who was a resident of Oregon at time of entry to active duty or a resident of Oregon at least two years between the date of discharge and December 31, 1950; or

2. A veteran of the Korean emergency who served on active duty for not less than 90 days, any part between June 25, 1950 and January 31, 1955, was honorably discharged and was a resident of Oregon at time of entry to active duty or a resident of Oregon for at least two years between the date of discharge and December 31, 1960; or

3. A veteran of the post-Korean period who has served on active duty in the United States armed forces not less than 210 days, any part after January 31, 1955, unless he was discharged for service-connected injury or illness before

completing such period of service. He must have been honorably discharged, and have been a resident of Oregon at time of entry to active duty.

DEADLINES

The deadline for World War II veterans to apply for loans is January 31, 1980. The deadline for Korean veterans to apply is January 31, 1988. The deadline for post-Korean veterans to apply is 20 years following discharge.

LOAN TERMS

The veteran may borrow up to $21,500 for the acquisition of a home or up to $80,000 to acquire a farm. In no event, however, may the loan exceed 85 percent of the mortgage loan value of the property.

The interest rate on a home loan is 4 percent up to $18,500. On the amount borrowed over $18,500 the rate goes to ½ percent above the price of the latest bond sale, but to not less than 4½ percent.

The interest rate on a farm loan is 4 percent up to $50,000. On the amount borrowed over $50,000 the rate goes to ½ percent above the price of the latest bond sale, but to not less than 5 percent.

The maximum term for repayment under the law is 25 years for homes and 30 years for farms, but it may be less, depending on the age, quality and location of the property, and other factors.

Repayment of the loan will be on a monthly basis when the security consists of city or suburban property, acreage, or a complete farm unit having a monthly income. In other cases involving complete farm units, payments may be arranged on a quarterly, semiannual or annual basis.

There is no penalty for paying off the loan in advance.

Included in the borrower's monthly or other periodic payments to the department will be an amount sufficient to meet the annual property tax requirements. The borrower is required to keep the property insured against fire loss.

DOWN PAYMENT

The applicant is required to have an equity in the property.

Generally, the amount of equity required will be in excess of 10 percent of the amount of the loan granted, and in some cases might be for the full amount of the difference between the state loan and purchase price. The department will approve secondary financing in those instances where the minimum equity requirement is met and the veteran's ability to repay is satisfactory.

MORTGAGE CANCELLATION LIFE INSURANCE

The Department of Veterans' Affairs has provided a low-cost mortgage cancellation life insurance plan whereby any qualified borrower may obtain life insurance in the amount of the unpaid balance of his loan. In the event of the veteran's death, the insurance will pay the balance on the loan and the state's mortgage will be released. The insurance plan does not increase the borrower's monthly payments because the cost of the insurance is taken care of by extending the customary loan repayment period. The premium rate, effective March 1, 1970, was 37 cents per month per $1,000 of insurance. The rate is subject to change annually.

TO APPLY FOR A LOAN

The loan applicant fills out and submits an eligibility form (DVA-1) to the Department of Veterans' Affairs, along with a full-size photostatic or certified copy of his honorable discharge and his notice of separation. He should do this in advance of his actual need for the loan, where possible.

He then completes the loan application form and submits it to the department, along with a copy of the earnest money receipt or agreement to purchase. Applications may be filed in any of the three department offices. The addresses are:

Department of Veterans' Affairs
General Services Building
1225 Ferry Street SE
Salem, Oregon 97310
Phone: 378-4624

Department of Veterans' Affairs
State Office Building
1400 SW Fifth Avenue
Portland, Oregon 97201
Phone:

Department of Veterans' Affairs
338 W. 11th Street
Eugene, Oregon 97401
Phone:

8119

Veterans living in counties employing county service officers may obtain assistance in such offices.

After the veteran's eligibility has been established and his loan application submitted, the department will appraise the property and will check such things as the veteran's employment record and credit standing. The veteran will then be advised as to whether the security and his standing are sufficient for the required loan.

LOAN COSTS

When a veteran's loan is completed he will pay a service charge, which will be used by the department to pay the costs of appraisal and loan closing. The service charge is based on the type and location of the property and the amount of the loan. The service charge for homes will range from $56 to $87, and for farm loans from $56 to $280. The charge may exceed these limits if more than one parcel of real estate is offered as security.

SOURCE OF LOAN FUNDS

The Department of Veterans' Affairs is the lender under the Oregon veterans' farm and home loan program; the loan funds come from the department, and go direct to the veteran borrower.

The department obtains its loan funds primarily from the sale of self-liquidating bonds, and it also makes loans from the funds derived from veterans' loan repayments.

The Oregon veterans' loan program is a self-sustaining operation, and has built up a net operating revenue of more than $26 million since the program started in 1945, of which nearly $14 million has been turned over to the State General Fund.

TIPS FOR BROKERS

1. A veteran who has not used his full entitlement to a loan may receive the difference to purchase another home or to make improvements to his present home. In certain cases involving the loss of his home through no fault of his own, he may have his entire loan entitlement restored.

2. A state veterans' loan may be assumed by another person. The interest rate goes to 1½ percent above the price of the last bond sale unless the new purchaser is the spouse, former

spouse, parent, child or stepchild of the veteran giving up the property.

3. The interest rate may change each time the property is transferred. Therefore, agents assisting a person in acquiring a state-mortgaged property should contact the Department of Veterans' Affairs to determine what the interest rate will be at that time. On transferred loans, the new interest rate will take effect on the date of the instrument of transfer.

4. When a person assumes a state veterans' loan, he should send the Department of Veterans' Affairs a copy of the instrument conveying the property and give the new owner's name and address. The deed or contract must contain a clause stating that the purchaser assumes and agrees to pay the balance on the state's mortgage, or the instrument will be invalid by law. If the buyer is entitled to the interest rate being paid on the original loan, he should request the department's approval.

5. When a portion of a property under a state veterans' loan is sold, the department should be contacted prior to the completion of the transaction to arrange for a partial release of mortgage.

VETERANS ADMINISTRATION

1. Eligibility for Veterans Administration home and farm loans.

   a. A World War II veteran who served at any time between September 16, 1940, and July 25, 1947, and was discharged under conditions other than dishonorable after at least 90 days active service (or for service incurred disability in less than 90 days).

   b. A Korean Conflict veteran who served at any time between June 27, 1950, and January 31, 1955, inclusive, and was discharged under conditions other than dishonorable after at least 90 days active service (or for service incurred disability in less than 90 days).

   c. Post-Korean veteran who served on active duty for 181 days or more, any part of which occurred after January 31, 1955, and who was discharged or released from active duty after such date for a service-connected disability. Servicemen who served at least 2 years in active duty status, even though not discharged, while their service continues without a break.

d. Unremarried widows of the above-described eligible persons who died as the result of service.

e. Women members of the Armed Forces in qualifying services.

2. The terminal date for loan guaranty benefits for each World War II, Korean conflict and post-Korean veteran is computed by the use of a special formula which provides that each veteran has 10 years of basic eligibility from date of discharge or release from his last period of active duty, any part of which occurred during wartime or the post-Korean period plus 1 year of eligibility for each 3 months of active wartime or post-Korean military duty plus 4 days for each additional day of active duty, but not to exceed the maximum terminal date for each class of veteran. The eligibility of servicemen is available so long as they remain on active duty. If they are discharged or released from active duty before using their entitlement, a new determination of their eligibility must be made, based on the discharge received. The dates used in computing active wartime military service for World War II veterans are from September 16, 1940 through July 25, 1947; and, for veterans of the Korean conflict are from June 27, 1950, through January 31, 1955. The beginning date for post-Korean veterans is February 1, 1955. The law does not specify an ending date for post-Korean veterans. The minimum and maximum terminal dates for loan benefits for each class of veterans are:

a. World War II veterans -- from July 25, 1962, through July 25, 1970.

b. Korean conflict veterans -- from January 31, 1965, through January 31, 1975.

c. Post-Korean veterans -- March 3, 1976, is the minimum terminal date. The maximum terminal date is 20 years from the date of discharge or release from the last period of active duty. If eligibility is based on 2 years' active duty, entitlement is available so long as the serviceman remains on active duty without a break.

3. If the veteran does not have a current Certificate of Eligibility he may request a VA Form 4-1880, "Request for Determination of Eligibility and Available Loan Guaranty Entitlement: from the Portland VA Regional Office or from a lender, such as a bank, savings and loan association, mortgage broker, etc., or County Service Officer. The completed form should be sent to the VA Office together with all service and separation papers which will be returned to the veteran after the eligibility determination is made.

4. It is important that the veteran obtain a Certificate of

Eligibility so that if he is applying to a lender for a guaranteed loan, the lender will know he is eligible and also make sure that the loan application will be submitted timely to the VA. In cases involving direct loans made by the VA, it is required that the application be received by the VA and a commitment issued to the veteran for a loan before the terminal date of his eligibility for loan benefits.

5. If the veteran sells his house for a compelling reason and the loan has been paid in full, his eligibility may be restored.

GUARANTEED HOME LOANS

1. With respect to GUARANTEED LOANS, there is no limitation on the amount of a loan eligible for guaranty. The limitation is upon the amount of guaranty that can be issued upon the loan. The maximum guaranty is $12,500 and the VA will guaranty 60% of the loan or $12,500 whichever is less. The VA does not require a down payment by the borrower.

2. Loan is made by a lending institution such as a bank, savings and loan association, insurance company, mortgage company, public and private lending agencies or individuals who are in a position to look after the loan properly. If the veteran qualifies, the VA guarantees the loan up to a certain amount, so the lender will probably not suffer any loss in case of failure to repay the loan.

   a. Obtain earnest money receipt or land sales contract if existing property; have three sets of plans and specifications on proposed new construction, also firm bid on construction cost and earnest money receipt if land is purchased separately.

   b. Locate lender who will make GI loan at a rate of interest not in excess of the maximum rate which is now 8½%.

   c. Ask lender to send in VA Form 4-1805, Request for Determination of Reasonable Value.

   d. The lender and VA will process the case from here on.

DIRECT HOME LOANS

1. The VA Portland Regional Office makes direct loans to veterans for housing in housing credit shortage areas in the State of Oregon designated by the Administrator. These areas are generally rural areas and small cities and towns not near the metropolitan

area of large cities. The currently eligible direct loan designated areas can be obtained from the VA Regional Office.

a. Obtain earnest money receipt or three sets of plans and specifications as in guaranteed loans.

b. Have veteran write to VA Regional Office, 426 SW Stark Street, Portland, Oregon 97204, requesting direct loan, giving brief description of property, its selling price and amount of loan desired to finance the purchase or construction, including land, if any, to be purchased.

c. Send Certificate of Eligibility with request for direct loan application. If certificate not available, complete VA Form 4-1880 and forward same to the Regional Office along with discharge or separation papers which show dates of entry into and discharge from active service. Direct loan application will be sent if veteran is eligible.

d. Veteran should be alerted to be ready to send in $50.00 with his loan application as instructed when he receives blank application form from VA and to be ready to pay certain closing costs assessed to him, plus tax and insurance reserves at the time of loan closing. The VA charges on origination fee of $50.00 or 1 percent of the loan whichever is greater (2 percent if the direct loan is used to finance the construction of the home and if stage payments are necessary - 1 percent if stage payments are not required). The credit report, appraisal fee, and the loan closers fee are paid out of this origination fee.

e. VA will process from here on. If the veteran and realtor express written desire, all letters and forms may be mailed to the veteran in care of his realtor.

2. The maximum direct loan which the VA can make the veteran if he has not used any of his entitlement, is $21,000, including funding fee, if any.

GENERAL

1. In both types of loans, guaranteed and direct, the parties should draw up earnest money receipt in such manner as to expressly provide for return of deposit and cancellation of earnest money receipt if for any reason the type of loan desired cannot be advanced.

2. To qualify for a loan, the law requires that the contemplated

8125

terms of payment of the loan bear a proper relation to the veteran's present and anticipated income and expenses and that he be a satisfactory credit risk. He must have sufficient income to repay the loan, all other obligations and have enough remaining for his family support.

3. The present interest rate on guaranteed and direct loans is 8½%.

4. A fee of one-half of 1 percent of the loan amount must be paid to VA in the case of loans for post-Korean veterans and servicemen. This is a one-time payment fee. The fee will not be required if the veteran, at the time of loan application was also eligible for loan based on World War II or Korean conflict service. The loan fee may be added to the loan amount.

5. The law requires that the amount of the GI guaranteed or direct loan may not exceed the reasonable value of the property, as determined by the VA. If the price the veteran agrees to pay for the home is more than such reasonable value, the veteran must pay the difference in cash from his own resources. The loan may exceed the reasonable value by the amount of the one-half of 1 percent payment made by post-Korean veterans if it was included in the loan.

6. The veteran must certify in his loan application that he now occupies or will occupy the property as his home within a reasonable period of time after completion of the loan.

7. When a veteran is selling his home, he should be counseled that he remains liable on his VA loan but can make application to the VA for release of personal liability. This release will be granted by the VA i the purchaser assumes all of the veteran's liability and it is determined that he qualifies as a good credit risk.

8. Farm loans to purchase a farm and farm residence which is to be occupied by the veteran personally as his home are eligible for guaranty when made by a lender. These loans which are not limited in amount not exceeding the established reasonable value of the property, may be guaranteed up to a maximum of $12,500. Real estate loans for farm purposes only, and not for residential occupancy by the veteran, although not limited in amount may be guaranteed up to a maximum of $4,000.

9. Direct loans are available only for housing and includes purchase of a farm on which there is a farm residence to be owned and occupied by the veteran as his home. Direct loans are also available to build on land owned by the veteran a farm residence to be occupied by him as his home.

10. A guaranteed or direct loan may be partially or fully prepaid at any time without penalty premium or fee.

11. The VA Regional Office in Portland, Oregon, will answer any questions regarding the Veterans Administration program. The office address is:

Veterans Administration
Regional Office
426 SW Stark Street
Portland, Oregon 97204

Q. 28 Briefly define "amortization".

Q. 29 Which of the following statements relating to real estate loans is not true?

(A) conventional loans include straight loans
(B) conventional loans include amortizing loans
(C) conventional loans are two-party transactions
(D) conventional loans are three-party transactions

Q. 30 Which of the following does not belong in a list of sources of home purchase financing?

(A) land contracts
(B) conventional bank mortgages
(C) G. I. guaranteed loans
(D) F.H.A. title I loans

Q. 31 Most commercial transactions involving computation of interest are based on:

(A) the banker's year
(B) government year
(C) individual selection
(D) some other method

Q. 32 What is "usury"?

Q. 33 What is the maximum "contract rate" of interest in Oregon in the purchase of a home?

SUGGESTED WAYS TO FINANCE

1. Cash.
2. Conventional loans (savings and loan associations, insurance companies - 75%, 80%, 90%; 25 and 30 years).
3. Insured 90% loans, (maximum loan is $31,500.00).
4. First Mortgage (held by seller).
5. Land Contract (try to make a marketable contract).
6. Second Mortgage (monthly payments or short term due date).
7. F. H. A.
8. Federal V. A.
9. Combination F. H. A. and V. A.
10. Collateral Savings Accounts as additional security for a loan (they draw interest).
11. Assumption of loan (be sure to check for a change in interest rate).
12. Rent with Option to Buy (try for high monthly payments).
13. Blanket Loan-check equity. (Putting more than one property under one loan.)
14. Personal Loan (finance company, bank or credit union).
15. Short term loan on life insurance.
16. Pledge (stocks or bonds).
17. Broker-Purchase, re-sell on land contract, or first and second mortgage, Trust Deed.
18. Trade-either as principal or as agent. Also, guarantee or direct exchange.
19. Owner (re-finance, then sell on terms). Seller best source of financing.
20. State V. A.

Reminder:

The money market changes every month and current interest rates are constantly changing. It is necessary to keep up on this at ALL times. Be certain to find out just how much down payment a buyer has and how much he can pay per month and whether or not monthly amount is to include taxes and insurance. It is absolutely necessary to have this information and refer to it often.

Remember to try a "delayed closing" - anything is better than a contingency.

Q. 34 What is a conventional loan?

Q. 35 What is a "discount" as applied to mortgage loan financing?

Q. 36 What is the current FHA mortgage insurance charge?

Q. 37 What is the prepayment penalty rate for an FHA insured mortgage?

Q. 38 What is the maximum dollar loan available under FHA insurance coverage for a single residential unit?

Q. 39 The minimum down payment on a VA loan for residential property is:

(A) 2½%
(B) 10%
(C) depends on age of dwelling
(D) none of the above

Q. 40 The VA in guaranteeing the loan of an eligible veteran requires that any escrow fee be paid by the:

(A) seller
(B) buyer
(C) seller and buyer equally
(D) mortgagee

Assumption vs. Refinancing

Many factors make assumption of an existing mortgage generally more favorable than a refinancing of the loan.

A new loan fee usually runs from 1% to 2% of the loan. There is quite probably a prepayment penalty clause in the old mortgage. Prepayment penalties on FHA insured loans are 1% of the original amount. Many mortgages contain clauses establishing penalties of up to six months interest on the existing balance. Such penalties can run from $150 to $500.

An assumption can avoid expenditure of a few dollars in reconveyance fees. Frequently the interest rate on an old mortgage is lower than the current rate. This, of course, could be upset with the exercising of an acceleration clause which could force refinancing at a higher rate.

On the other side of the coin, some institutions charge as much for an assumption fee as a new loan —this makes assumption not so attractive.

Assumption fees on FHA and VA mortgages range from $25 to $40, and interest rates cannot be raised regardless of the market.

Assumption is most favorable on FHA, VA, and conventional bank loans.

Prepayment Penalty Shown

As part of a "truth in lending" package, Chapter 336, Laws of 1967, requires a full disclosure of prepayment penalties attaching to a real estate loan.

The law requires that any person making a loan having a loan period of more than three years secured by a mortgage or trust deed shall expressly and clearly state on the loan agreement and promissory note any maximum prepayment privilege penalty during the first year of the loan period and for each year thereafter.

A violation makes any prepayment privilege penalty in the loan agreement or promissory note void. (See "loan agreement" in Words and Phrases section)

Why a Contract Sale?

Sale of real property on contract frequently offers a number of advantages. Some of these are:

1. Saves the mortgage discount. Assuming the discount to be 4% a seller saves $400 on a $10,000 mortgage.
2. A higher price. Experience has demonstrated that the lower the down payment the higher the price.
3. An excellent investment for the owner. The seller gets a fair return on his actual investment in the property plus the same return on the normal equity appreciation due to inflation. In many cases he receives the difference between a lower existing mortgage interest rate and his contract rate.
4. Tax savings. For higher income tax bracket sellers the contract is very meaningful.
5. Use contract as collateral. The contract can be pledged as security for a loan, or can be used to acquire other property.
6. A fast, completed transaction.

Sales Price Disclosure

Primarily as an assist to county assessors in the establishment of comparable sales data, Chapter 462, Laws of 1967, prohibits the recording of any instrument conveying real estate or an interest therein unless the actual consideration is shown.

The law requires that the actual consideration paid for such a transfer be stated in terms of dollars on the face of the instrument.

"Consideration" includes the amount of cash and any lien, mortgage, contract, indebtedness or other encumbrance existing against the property and agreed to be paid or assumed by the purchaser.

Primary responsibility for attaching the information is that of the grantor, but if he cannot act then the recital shall be made by the grantee. There must be a signed verification of the recital.

The giving of a false statement as to true and actual consideration is punishable by a fine of up to $500. The law was made effective January 1, 1968, the effective date of repeal of the federal documentary tax on real estate transactions.

Usury

Usury simply means charging more than the lawful rate for the use of money. Each of the 50 states has a usury law. The law in each of the states differs.

In each state there are two lawful rates—a legal rate and a contract rate.

The *legal rate* is that sought to be charged when two individuals—a lender and a borrower—engage in a loan with no contract or understanding as to rate. This is rare.

The *contract rate* is that agreed upon either verbally or by written document. This is the kind of credit we grant or accept every day.

In Oregon the *legal rate* is 6 percent. The *contract rate* is 10 percent.

There are some exceptions. The law itself provides that a commercial corporation may agree to pay not to exceed 12 percent interest. Pressures on the legislature have given us a Motor Vehicle Loan Law, an Industrial Loan Law, and a Small Loan Law—all of which permits interest rates beyond the usury statute.

TITLE, LAND ABSTRACTS, TITLE INSURANCE AND ESCROW AGENTS

What Is "Title"?

The word "title" represents to the real estate broker and salesman, as well as the title insurance man, the commodity with which he deals.

It is idiomatic for the average person to state that he has bought or sold "real estate." Newspapers advertise "real estate" for sale, yet it is only the "title" to real estate which can be bought.

WORD HAS MANY DEFINITIONS

It is interesting to explore the meaning of the word "title" as applied to real property law. Some dictionaries define the word as meaning the right to or ownership of property; others that it be the evidence of right which a person has to the possession of property.

Still another definition as applied to real property is the investigation of titles as one of the principal branches of conveyancing, and in that sense the word "title" has acquired the sense of "history." Therefore, we refer to searching the title, investigating the title, opinion of title, and title insurance.

Regardless of the numerous definitions of the word "title", it should be remembered that the word is synonymous with the words "right", "interest" and "estate." Such words are used to denote the degree, quantity, nature and extent of the interest a person may have in real estate.

There are many and varied interests in real estate which the words "title" and "estate" define when coupled with other words, such as "fee simple estate."

Such a designation of ownership means that the owner has the largest estate in land known to the law. His title when so designated means that he has the greatest use and enjoyment of the land.

Other designations of ownership may disclose limitations of ownership. It is well to remember that a person may have "title" to real property and not be entitled to the possession thereof, and conversely, a person may have possession of real property without benefit of "title."

POSSESSION NOT "TITLE"

As an example: A lessee, a tenant from month to month, or a life tenant may, within the provisions of the tenancy, enjoy the possession of real property and never have "title." Also one may purchase or inherit "title" but may be precluded from gaining possession thereof because of the existence of a lease or a life tenancy. In order to ascertain the extent of the "Title" it is necessary to search the title.

Land Abstracts and Title Insurance

The record of the ownership of land is as old as the written history of man. In the clay tablets of the Assyrians and Babylonians are records of land transactions and mortgages. However, our form of title records and of title evidence may be considered as beginning with the year 1066, when King William the Conqueror and his Norman Nobles conquered the Anglo-Saxons and began the long line of Norman Kings of England. This marks the beginning of the feudal system in England which, in the common law of England, became the foundation of our law of land titles and real property.

Many of our present concepts of the law of real property originated with the feudal system, from which we take the word "fee." When an owner of property dies without leaving heirs and without having made a will the property escheats to the State in the same manner as property returned to the King. All our real estate titles originate by patent or grant from the sovereign government. Similarly, in the same manner as the English kings controlled the descent of property under the feudal system the State regulates the manner in which property descends upon the death of the owner.

However, our present forms of deeds and mortgages are much more recent than the beginning of the feudal system. In feudal times a transfer of title was effected by a symbolic ceremony known as livery of seisin, in which the parties with their witnesses went upon the land and the seller gave the buyer a stick or twig or some other object as a token of delivery. Until the passage of the Statute of Frauds in England in 1677 the use of a written instrument in real estate transactions was optional. Even today in England many titles are evidenced by possession of the property and by exhibition of the original title deeds, and one of the principal activities of many English solicitors is the safeguarding of the original deeds which they keep in their possession. In the Thirteen Colonies, probably because it was newly settled land and there was much travel between settlements, a system of recording land transactions was adopted, and after the Revolution the new country took over the recording system then in effect. Originally the recorded documents were copied into record books in longhand by pen and ink. Later typewritten records were substituted for hand copying, and today much of the recording is done by photography.

Originally attorneys examined the county records of land transactions and issued their opinions of title based upon their own examination of the title records. In the course of time it became ncessary for the attorneys to prepare abstracts of the records containing copies of the various instruments and court proceedings which they examined to write their opinions. In some parts of the United States the attorneys still make their own abstracts. However, today abstracts are usually prepared by qualified companies which specialize in this work. The preparation of abstracts by abstract companies and the examination of them by attorneys is still the pattern in some parts of the United States.

LAND ABSTRACTS

The title to any parcel of real estate is contained in and controlled by the recorded and filed documents in the public records of the county in which the land is situated.

Under provisions of the recording acts, the public has constructive notice of all property recorded and of all filed papers. That is, one is presumed to know the existence and legal effect of every paper affecting title to land which has been properly recorded or filed in the county.

In order that one may examine the title to a parcel of land, to determine ownership and condition of the title, it is necessary that a search be made of these public records. Further, to know the contents of all the instruments disclosed by such search. This implies the reading of all of these records in their entirety.

Abstracting is the "briefing" or "digesting" of the particular records affecting a given parcel of land. An Abstract of Title contains a digest of every instrument or event brought out by the search, arranged in chronological order, to enable an examiner to determine the ownership and condition of title. Every fact and element in the records bearing in any way on the title to such parcel of land must be included in an Abstract of Title.

An Abstract of Title is often referred to as a "History of Title." It must necessarily show each transfer of ownership, whether by deed, descent, devise, or foreclosure; also any mortgage, lien, encumbrance, or other matter in any way affecting the title. Consequently, most Abstracts of Title are voluminous. This "book" or "history" called an Abstract of Title must be carefully preserved by the owner, presenting a difficult storage problem in many cases.

It must be stressed that an Abstract of Title is merely the history of happenings to a particular parcel of land, as shown by the records. Thus, one may have a perfectly good abstract and a very poor title. The Abstractor's certificate covers only the completeness of his work in showing a digest of the records. An Abstract of Title must be thoroughly examined by a competent attorney familiar with real estate law, in order that the persons interested in the land may know the ownership and condition of the record title. Of course, no Abstract of Title can cover unseen hazards such as missing heirs, forged deeds, transactions by a minor or incompetent, etc.

The voluminous procedure necessary in the use of Abstracts of Title in the closing of real estate transactions has practically eliminated their acceptance by money lenders and most buyers of real estate. Other inadequacies of an Abstract of Title, such as limitation of liability, additional examination costs, with consequent delay in closing of a transaction, and the duplication when land is divided, have resulted in the Abstract of Title becoming obsolete in most areas of this State.

DEVELOPMENT OF THE TITLE INSURANCE COMPANY

In order that the title to property might be transferred more freely, the idea of a title insurance policy was conceived. The first policy was issued in Philadelphia in 1875. The growth of the title insurance business has been very rapid. In most parts of the United States it is the only method by which title is evidenced. It is a well-known fact that in no country in the world today is the transfer of real property so free of delay, red tape and hazard as in the United States.

The first title insurance policies in Oregon were issued in 1911. Today, almost all real property transactions in Oregon involve the use of a title insurance policy.

Generally speaking, title insurance is a statement of who owns, and what other interests there are in, and what charges exist against, a parcel of land; with certain agreements written into a policy for the protection of those insured. The policy is an insured statement of the condition of the title.

The title insurance company keeps a complete and up-to-date history of every parcel of land in the county, in order to tell an owner about his title. In Oregon these records go back to the original settler's patent—in many cases these records cover a period of over 100 years. Daily the thousands of entries on the public records of the courthouses of Oregon are noted by the searchers of the title insurance companies and entered in their records. Accurate ownership maps are kept up to date. Title examiners constantly review court decisions and new statutes which affect ownership in land. When an order for title insurance is received, a searcher makes a list of all the documents, legal action, judgments, tax liens, taxes, deaths, divorces, and other items that affect the particular tract of land, and a title examiner examines this, and a title report is made listing the owner of the property, how the title is held, the correct legal description, and any exceptions, any outstanding rights owned or claimed by others. When the transaction is closed, a title insurance policy is issued.

POLICY COVERAGE, EXCEPTIONS AND STIPULATIONS

The title insurance policy insures against losses which might be suffered:

—if any document in the series of record by which ownership was acquired was improperly drawn, signed or delivered;

—if any of the deeds and other documents were signed by minors, incompetent or insane persons, or other persons suffering from disabilities which might invalidate their acts;

—if any of the documents in the series of records are forged, in which case they are void;

—if any past legal proceedings essential to establish title are defective;

—if unknown or undiscovered heirs of any deceased owner whose estate had been distributed, attempt to set aside the distribution and claim an interest in the property;

—if someone who has executed a document essential to the title has acted in excess of his authority;

—if a husband or wife claims curtesy or dower in a parcel of land by reason of their failure to join in deeds conveying the tract;

—if there are any unpaid county or city taxes or liens on record which are not shown in the policy;

—if certain records, disclose any easements, conditions, covenants, restrictions, reservations, exception, mechanic's liens, mortgages, leases, attachments, judgments, executions, contracts of sale, or any other city liens or encumbrances which are not shown in the title insurance policy.

In general, the things not insured in a policy are called "exception." The printed exceptions are stated in the policy and are, in the main, things which do not appear on public records in the county, and which can be ascertained by inquiry or examination of the

premises by the insured. If these exceptions were eliminated from the policy, a substantially higher premium would be charged; for the title insurance company would have to make a search of these off-the-record items.

The title insurance policy does not insure against the following items:

—defects, liens, claims, encumbrances, or other matters existing at the date of the policy and known to the insured, unless disclosed to the title insurance company;

—easements, liens, or encumbrances, including material or labor liens, which are not shown by the public records—such as—an unrecorded easement for public utility purposes; liens for labor or materials used in constructing or repairing a building, which, in Oregon, can in some cases be filed up to 60 days after the work is completed;

—mining claims, reservations in patents, water rights, claims of title to water—patent reservations are contained in the original patent and cannot be eliminated. Mining claims and water rights cannot be ascertained by searching the county records—water right records are kept by the State Engineer in the State Capital;

—rights or claims of persons in possession, or claiming to be in possession—such as—tenants in possession under an unrecorded lease, a squatter claiming title by adverse possession, or an owner occupying a tract of land who has not recorded his deed—all items that cannot be ascertained by an inspection of the land;

—any state of facts which an accurate survey and inspection of said land would show—such as—shortages or excesses in boundaries; or buildings of others improperly placed on the tract insured, or buildings on the tract insured being partially on adjoining land;

—assessments which are not shown as existing liens by the public records; taxes not yet payable; pending proceedings for vacating, opening or changing of streets or highways preceding entry of the ordinance or order therefor—again items that cannot be ascertained by an inspection of the county records and items that the owner can readily discover by inquiry;

—zoning ordinances and similar regulations on the use of land.

TITLE INSURANCE RATES

Just as the issuance of title insurance has been the outgrowth of earlier searching and abstract methods so, too, have the fees now charged for title insurance evolved out of the charges that were made under the earlier methods of furnishing title evidence. As a matter of fact, the initial title insurance policies were issued only after the title records had been searched, an abstract of such records been prepared, an examination of such abstract made by an attorney, and an opinion rendered to the company issuing the title insurance based upon which the title insurance policy was issued. A separate charge for each phase of the process was made by the one performing the service. In some small communities where real estate activity is not great enough to support a title office this method is still employed.

As title insurance became more and more popular as the medium for evidencing title and as the real estate transactions became more numerous and complicated, this method proved impractical and inefficient and as a result the present practice of doing all the work in the title company developed.

With the institution of the practice of title insurance being issued by the insuring company based upon its own searching and examinations the method of charging for the service changed and a single premium charge covering the cost of the various operations required in preparing title insurance developed.

The present rates are based upon several considerations among which are the cost of maintaining a title plant adequate to afford safe, expedient title information; the employment of competent title examiners; the establishment of adequate reserves and deposits to protect the policyholders; the competitive nature of the business; and a fair return on investment to the owners or stockholders. As will be mentioned in the section having to do with Deposits with the State Treasurer and Regulation of Title Industry by State Insurance Commissioner, these rates must be filed with the Commissioner.

Almost everyone who deals with real estate is familiar with the printed rate tables which have been issued by the respective title companies and which set out the basic rates applicable for title insurance. These tables are only intended as a general guide and are not to be taken as a definite quotation of the fees chargeable for all title insurance for a certain amount. There are numerous other factors which may affect the title insurance premium in any specific area. For example, the issuance of a policy may involve the examination of several tracts of land which are being consolidated. In such a situation it may be that the ownership of the individual tracts being consolidated are derived under unrelated chains of title so that a separate search and examination of each tract is required in the same manner as though a separate policy had been issued to each tract. Again, the title to the property under consideration may have been involved in a great deal of litigation or other court proceedings, the examination of which requires a great amount of the examiner's time; a special form of policy may be required or special endorsements included in the policy. Any one of these situations and many others which might arise, would involve an adjustment in the fee charged for that particular policy.

For these reasons it is not a wise policy for the broker or salesman to make any definite commitment as to the charge in a specific case, but, rather it is good practice to consult the title company, which will issue the policy, for a quotation of the fee chargeable.

In addition to the basic fees shown in the printed schedules, there are many special fee arrangements which may be applicable in a given situation, such as in cases where combination policies, equity policies, or mortgage reissue policies, may be involved. In these cases the policies may be issued at rates less than the basic rates in the printed table, but the issuance of policies under these circumstances is subject to certain conditions and it would be well that all parties involved be made fully aware of these condi-

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tions. Again, discuss the matter with the title company.

It is most difficult to establish rates which are equitable in all cases, but the rate schedules do result in an equitable fee for the service rendered in by far the most cases. To attempt to meet the unusual case with special rates would result in both confusion and misunderstanding, and consequently is not desirable.

DEPOSITS WITH STATE TREASURER AND REGULATION OF TITLE INDUSTRY BY STATE INSURANCE COMMISSIONER

The first Oregon title insurance law was enacted in 1909. This act provided that each title insurance company must have a paid up capital stock of at least $100,000, of which $50,000 should be deposited with the State Treasurer as a guarantee fund. Thereafter every title insurance company was required to deposit each year 10 per cent of its premiums received until the guarantee fund amounted to $100,000.

In 1919 the act was amended to permit companies doing business in counties of 50,000 or less to deposit $10,000—with a guarantee fund of double that amount. Larger deposits were required for companies whose place of business was in the more populous counties.

In 1955, under the sponsorship of the State Insurance Commissioner, a new title insurance law was enacted, which substantially amended and expanded the former law. The former deposit requirements were not increased, but the act provided that deposit and guarantee fund requirements be met for all the counties in which a company does business. A company may be a statewide business if it has a guarantee fund of $100,000.

In addition to the guarantee fund, each title insurance company must maintain a Title Insurance Unearned Premium Reserve Fund, into which must be paid each year 3 per cent of the gross premium received during the year. Fifteen years of such reserves must be maintained at all times. At the end of 15 years the reserves so required to be set aside constitute a very sizable amount of money in the case of the larger companies.

The act provides that title insurance companies shall be subject to and comply with all the laws applicable to insurance companies generally and to the rules and regulations of the State Insurance Commissioner.

Title insurance companies are thus subject to audit by the department and their reserves and investments are subject to the same type of supervision and regulations as are those of other insurance companies.

The act requires that title insurance companies file with the Insurance Commissioner their rate schedules and their policy forms. It specifically provides that no deviation from the filed rates or forms of policy is permitted. Rebates and discounts to customers are prohibited.

In addition to the foregoing safeguards, the act requires that each title insurance company own and maintain a title plant with a general index, adequate maps and tract indexes for the lands of the county.

All of the foregoing requirements of the law for deposits with the State Treasurer, statutory reserves, filing of rates, supervision and control by the State Insurance Commissioner are provided for the protection of holders of title insurance policies. The industry cooperates wholeheartedly with the Insurance Department and the legislature in the enactment of the far reaching legislation contained in the 1955 act. The industry feels that such legislation and the control and supervision it provides for the industry will benefit not only the public, but also the Title Insurance business it regulates and controls.

QUESTIONS ON TITLE INSURANCE

What is Title Insurance?

Basically, title insurance is the opinion of the ownership and marketability of title to a particular parcel of real property; this opinion is backed by the promise of the title company to indemnify an insured in the event of a loss by reason of a defect or a flaw in title prior to the date of the policy.

What is a "title plant"?

A title plant is a private collection of public records meeting the minimum rules of the title insurance laws of Oregon. It is the stock in trade of a title company.

Escrow Agents

In its original concept, the escrow agent was little more than a stakeholder, accepting money or property from one party for delivery to another upon the payment of the consideration or delivery of the property which was to be accepted in return. The duties and responsibilities of the escrow agent in modern real estate practice are much broader.

The escrow agent's duties arise in the first instance from the written agreement between the parties stating the terms of the transaction, and are more fully defined and described in such written instructions as he may be given by the parties; and by the terms of such documents relating to the transaction as may be deposited. The primary source of the escrow agent's duties and responsibilities is the written instructions of the parties. These instructions are usually incorporated in printed forms supplied by the escrow agent and completed to express the details of the particular transaction. Apart from securing the necessary legal documents required to complete the transaction in accordance with the written instructions and the agreement of the parties, one of the essential functions of the escrow agent is to assemble the necessary data from which the required financial adjustments between the parties can be made. This extremely important part of the escrow closing is essentially a matter of accounting detail and includes such matters as obtaining all pertinent information on mortgage balances, interest accruals, commissions and other charges payable by the various parties; tax and insurance information, rental data and a host of allied details. As this information is assembled it is incorporated in a work sheet with adjustments made to the agreed or probable closing date. This information is then transferred to a settlement sheet for presentation to the parties in order that they may better visualize the financial results of the transaction.

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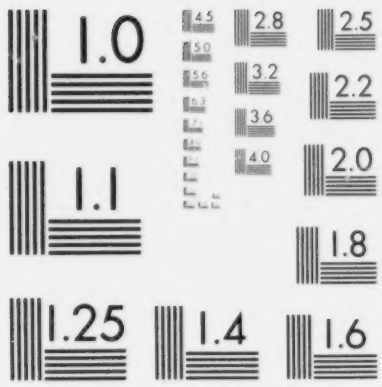

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

When all necessary funds and documents have been deposited with the escrow agent and the transaction is ready to close, the escrow agent will set in motion the process of recording all documents which are to be recorded, secure the necessary assignments of fire insurance, transfer mortgages and loan reserves, and cause the necessary final title search to be made. Instructions will have authorized the escrow agent to disburse the funds at the proper time to the persons entitled thereto. After recording has been completed and the funds disbursed a simple statement must be prepared which will disclose to each party in detail the exact result of the transaction. This statement should be as simple as the details of the transaction will permit and should briefly identify each item entered therein. After closing it is the duty of the escrow agent to see that all documents described in the instructions are delivered to the party properly entitled thereto.

In a real estate transaction the function of the escrow agent will necessarily be very closely related to the title insurance company. The purchaser will usually be furnished with a preliminary report showing the condition of the title to the lands in question prior to the time the funds are deposited and the purchaser's instructions will usually enumerate the exceptions or encumbrances which will be permitted to remain on closing. In order to insure compliance with the purchaser's instructions the escrow agent will find it necessary to cause the records to be reexamined at the time of closing and after closing to deliver the necessary title insurance policies provided for in the instructions.

LICENSE REQUIRED

The 1963 Legislature created a new provision in the real estate law to require the licensing of escrow agents.

The license provisions do not apply to the following:

1. Any person doing business under the laws of this state or the United States relating to banks, mutual savings banks, trust companies, savings and loan associations, common and consumer finance companies, industrial loan companies, or insurance companies.
2. An attorney at law rendering services in the performance of his duties as attorney at law.
3. Any person whose principal business is that of preparing abstracts or making searches of title which are used as a basis for the insurance of titles by a company doing business under ORS 748.010 to 748.090.
4. Any firm or corporation lending money on real or personal property and which firm or corporation is subject to licensing, supervision or auditing by a federal or state agency.
5. Any person doing any of the acts specified in the definition of "escrow" under order of any court.

At the time of filing an application with the Commissioner for an escrow agent's license, the applicant must deposit a corporate surety bond in the amount of $25,000.

Fees for an original license and each annual renewal are set at $100 for the principal office and $35 for each branch office. At the time of making application for a renewal of license, the applicant must submit a satisfactory independent audit by a certified public accountant.

The Commissioner is given broad authority upon which to base a denial of license, or a suspension.

Q. 41 When a title company issues an ALTA policy, it customarily extends the risks normally insured against under the standard policy to include all but which one of the following:

(A) rights of parties in possession
(B) unrecorded physical easements
(C) the effect of zoning regulations
(D) unrecorded mechanics' liens

Q. 42 A lender of money on real property should know that his mortgage is an enforceable lien. He can best accomplish this by:

(A) recordation
(B) a mortgagee's title insurance policy
(C) providing for an acceleration clause
(D) a physical inspection of the property

THE USE OF REAL ESTATE DOCUMENTS

To comply with the Statute of Frauds, the completion of a real estate transaction depends upon the proper preparation of the listing agreement and the earnest money receipt. The listing agreement is your employment contract in writing, employing you to sell and, in turn, obligates your employer to pay compensation for your services.

The earnest money receipt is first an offer to purchase. When accepted and signed by your employer it becomes a contract binding all parties to the transaction. A well prepared listing agreement and earnest money receipt is your best insurance for a satisfactory closing. When carelessly prepared and not complete these documents become the source of most of your difficulties and complaints.

A thorough knowledge of the three documents in general use in all real estate transactions marks the competent and successful real estate practitioner. An error or uncertainty on the part of the broker or salesman may cause the transaction to collapse.

No matter how the title closing is conducted—by the broker, or in escrow by a title insurance company, or by an attorney—knowledge of the mechanics of the Closing Statement can often avoid losing a hard-earned commission.

A frequent review of the material in this Section is highly recommended.

Listing Contracts

A listing contract is a contract between a real estate broker and the owner or seller of a parcel of real estate. This contract, in order to be valid, is signed by the seller and by the real estate broker. This contract, therefore, is binding only upon the seller and the real estate broker. In some instances, a real estate broker authorizes his salesmen to accept or sign a listing contract as the agent of said broker. This act by the salesman, however, is a permissive act specifically authorized by the real estate broker. It does not change the meaning or force and effect of this contract. In a normal listing contract, a real estate broker obligates himself to use his best efforts to find a purchaser for the property involved. In consideration for this promise, the seller agrees to pay the broker a specified commission and in some instances may also grant to the broker the exclusive right to sell said real estate. In other words, in an exclusive contract the seller is permitting this broker to work on the sale of this property alone and bars all other brokers from working on the sale of this property. The seller can, however, make provisions in his listing contract to provide that a commission shall not be paid if the property is sold to certain specific individuals or, in some cases, if the property is sold by the seller himself.

In addition, the listing contract places certain other responsibilities and duties upon the real estate broker, such as retaining monies in a trust account and places certain duties upon the seller, such as furnishing abstract of title or title insurance and marketable title. Since this contract consists of mutual consideration between the broker and seller, this contract is a personal contract between these two parties and does not become the property of a third person. In other words, a salesman who solicits and receives a listing contract does so as an agent of the broker and the listing contract in no way becomes the property of the salesman but is strictly the property of the broker. Under the contract the real estate salesman does not incur any obligations to perform the advertising or selling of this property and does not sign this contract except as the agent of the broker. The broker, on the other hand, is obligated to use his best efforts to advertise and attempt to sell the real estate involved. His failure to perform under this contract could result in his being sued for damages, if damages were incurred by the seller by reason of the broker's failure to perform under the contract. Consequently, the practice of securing numerous listing contracts to tie up real estate and a failure to use the best efforts available to find a purchaser might constitute a dangerous practice for the broker to follow. It has always been advocated that a broker carefully select the listings that he signs and review these listings paying particular attention to the listing price to determine that it is in line with the current market price for that particular type of real estate.

A salesman, when he secures a listing contract, is securing this contract for his broker. Listing contracts constitute the stock and trade of a real estate broker and, therefore, are a valuable asset. When a salesman leaves the employ of a broker, the listing contract remains with the broker and is the property of the broker. If the broker dies or is in some other way unable to perform under his listing contract, the contract either becomes null and void in the case of death or the seller may rescind the contract on the basis that the broker is unable to perform his mutual promise and obligation under the contract. It is generally advocated that brokers establish very definite written rules with respect to the payment of any fees to salesmen in connection with listing contracts or commissions payable on the sale of real estate.

It is also strongly suggested that these written rules be printed and a copy furnished to each salesman employed by a broker.

Employment Contract or Listing Agreement

As a licensed real estate broker or salesman, your listings represent your stock in trade. The value of this contract to the broker depends upon its accuracy and completeness.

Good listings, properly prepared, represent salable stock. If the asking price is too high, or the property is not in a salable condition, you are wasting your time and the time of the owner by taking the listing. If the listing is not properly prepared you are creating a source of complaint and risking loss of good will, the broker's most valued possession.

The listing agreement is not a contract for sale of real estate. It is a contract for services.

Never take a listing over the telephone. You are aware that this contract must be signed, and that the seller has a right to the benefit of the broker's knowledge, which might influence the owner's action.

Make clear what fixtures or improvements the seller wishes included in the sale, and those he intends to withhold. A prospective buyer will rely upon your statement in this matter and an error here can lose the sale and result in loss of confidence.

Too much care can not be shown in arriving at a complete understanding of price and terms of payment. The experienced broker or salesman is aware that there is a difference between the cash price for a property and the price of the same property with a low down payment. The typical buyer is less apt to argue about purchase price if he has the down payment. Recheck your figures. How much down? How much a month?

In arriving at the selling price of a property the owner has a right to the benefit of your opinion of "market value", and frankness in a sales plan.

An example of such a discussion might sound like this: After arriving at his opinion of market value, the broker said, "I think your home will sell for a figure between $16,500 and $17,000 to someone who has about $5,000 for a down payment. We should get a first mortgage for $8,500 which means that you will be required to take back a second mortgage for approximately $3,000. If you insist on all cash, it will take longer to sell and you might have to reduce your price to $15,500. If you like, you can sell the second mortgage, but the current rate is 50% of face value."

THINGS TO LOOK FOR

Sometimes the cost of repair or renovation to place a property in condition to place it on the market can become a tax deductible expense item. The lister should be familiar with this rule.

In accepting the property as saleable merchandise, the successful lister will make a record of little things that might cause later embarrassment when showing the property.

Is the furnace working? Is the hot water heater sound? Is the electric stove, the garbage disposal, and all electric outlets in usable condition? Should some minor painting or cleaning up be suggested?

Some very successful listers are keenly aware that an empty house accentuates defects. They seriously look into the possibility of putting in some furnishings which will be included in the sale price.

HELP FROM TRADE-IN PROGRAM

Offices using a guaranteed trade-in program have a valuable tool in obtaining listings.

The trade-in program guarantees the seller he will not be paying the expenses of two properties at the same time, and that he can have his equity in cash when he needs it. It can also be used to get listings by showing to the seller that a potential buyer with another home to sell can be sure of having cash for the new purchase.

One beneficial side effect of the trade-in program is the fact that the lister or his office is risking his own money, and cannot afford the luxury of unrealistic listings. The result is an important ingredient to a successful sale—a merchantable listing.

Careful use of the program results in lower sales costs, greater profits, many referrals and repeats, and captive buyers.

If you are knowledgeable of the facts of the real estate market, it is entirely possible that a property owner who answers "no" to a question as to whether he would consider selling is really saying "tell me more".

FORM OF CONTRACTS

In Oregon there are four working arrangements in general use by the brokers. Standard printed forms are available for "Exclusive Right-to-Sell" and "Non-Exclusive" employment contracts. The infrequent use of "Exclusive Agency" and "Net Listings" contracts does not justify the issuance of printed employment contracts.

All Broker's Employment Contracts have three things in common.

(1) The agreement must be in writing.
(2) All contracts of employment must contain a definite termination date.
(3) A legible copy of the signed listing must be supplied to the seller.

"EXCLUSIVE RIGHT-TO-SELL" EMPLOYMENT CONTRACT

Grants to the listing broker an absolute, sole and exclusive right to sell or exchange the described property, and some contracts provide that in the event of any sale made by the seller or any other person, exchange or conveyance of the property, or any part thereof, during the term of the broker's employment, or in case the broker's authority is withdrawn prior to the expiration date, the seller agrees to pay a commission to the broker just the same as if the broker had actually consummated a sale. (See comment under Excerpt 14, this section.)

This type of employment is the most desirable as it enables the broker to freely advertise and show the property. Upon procuring such a listing the broker is duty bound to exert his every effort through advertising, posting and showing, in an endeavor to consummate a sale for his principal.

"EXCLUSIVE AGENCY" EMPLOYMENT CONTRACT

The seller grants to listing broker the right to sell the property for a specified period of time, to the exclusion of any one other than the seller. If the seller consummates a direct sale without the assistance of the listing broker—no commission is payable.

"NON-EXCLUSIVE" EMPLOYMENT CONTRACT

The seller reserves the right to sell or list the property with any other broker. Also known as an "open listing."

"NET LISTING"

Not in general use, resorted to only when the seller insists he wants a stipulated net amount. The contract specifies the net price the seller is to receive, and any amount obtained over and above the seller's net price is the broker's commission. "Net listings" are prohibited by law in several states and where used frequently are the cause of disputes and law suits.

OPTIONS

Option agreements with right of assignment, or irrevocable options, are sometimes used by brokers in lieu of "net listings." It is required that the broker in taking such options, disclose to the seller that he is taking the option as a broker, with the intent of subsequently selling and assigning the option to a third person for profit. There are many dangers in this type of listing or option arrangement and the use of same is not recommended by the Board.

USE OF ESPECIALLY DESIGNED FORMS OF LISTINGS

Oregon brokers and salesmen are fortunate in having available standard printed forms for almost all types of listings.

The Oregon Real Estate Board does not recommend the forms of any particular publisher, however, it does recommend to you the use of good standard printed forms which have been especially designed for the listing of various types of property. The selection and use of the proper type of listing will assist in calling to your attention important financial and physical features of the property which might otherwise be overlooked.

STUDY OF THE DOCUMENTS

The following text breaks down each real estate document by paragraph and term, with an explanation as to how and why they apply. Stevens-Ness forms are used because of their wide use throughout the state and are the forms used in the Real Estate Examinations.

A problem is presented regarding a real estate transaction similar to those used in the examination. The problem is carried forward to the illustrated forms as they apply. On the left hand side in the text is an "excerpt number." You will also find this excerpt number in the same position in the problem and on the illustrated documents. If you will follow each excerpt number from the problem to the text to the illustrated form there appears to be no reason why you should not be able, in an actual real estate transaction, to complete these forms in a satisfactory manner.

For study purposes the sample form of "Real Estate Broker's Employment Contract" appearing in this section has been divided into 19 parts by marginal numbers which will indicate where the excerpt under discussion is located.

DESCRIPTION

EXCERPT 1.

"REAL ESTATE BROKER'S
EMPLOYMENT CONTRACT"
Residential Property

"Description: Lot 6, Block 10, Yew Park Addition, Marion County, 280 Yew Park Drive, City of Salem, State of Oregon; for better description see owner's title deed on record, now made a part hereof. For personal property, if any to be included in property offered for sale for price next mentioned, see below or see signed inventory, to be attached."

If possible, insert the legal description of the property. Such description can be procured from an inspection of the owner's deed, deed records at the County Court House or from your local Title Insurance Company.

On city property the designation by street address and the size or approximate size of the lot will, under most circumstances, prove sufficient provided of course that the names of the City and State wherein the property is located are properly shown.

One of the problems oft times encountered is where the seller is disposing of his home together with an adjacent lot. In such cases the broker or salesman can describe the property by giving the street address of the house and then adding a description of the vacant property adjacent thereto. The Oregon Supreme Court in an early decision laid down the rule that a sufficient description was one whereby:

> A surveyor, with a deed or other written instrument before him, can locate the property and establish the boundaries (6 Oregon 175).

The words "for better description see owner's title deed on record, now made a part hereof", incorporate into the listing the deed records in the County Court House. Were the test, as laid down by our Supreme Court, to be applied to an incomplete or faulty description—such a reference would enable the surveyor to consider the description shown on the deed records. The clause will not cure all incomplete or faulty descriptions—it may assist in curing some.

SELLING PRICE AND TERMS

EXCERPT 2. "Selling price, free of encumbrances: **$15,500.00;**

Terms: **Mortgage may be assumed by purchaser and credited on purchase price.**

(a) The words "free of encumbrances: **$15,500.00**" does not necessarily indicate that the property is unencumbered by mortgage, contract balance or lien. It does mean that the broker's ultimate commission is to be based not upon the interest that the seller **may have** in the property, but upon the full sale price **just as if** the property were "free of encumbrances" at the time of listing.

(b) The "terms" should be explicit. If the seller is wanting cash for his equity with the buyer assuming encumbrances, it should be so stated. It might be weeks or months before a buyer is secured and the equity might be changing from month to month. If the seller will sell for $500 or $1,000 cash and definite terms on the balance, it should be clearly stated.

INVENTORY OF CHATTELS

EXCERPT 3. "Is signed inventory attached as part hereof? Yes .....; No .....; to be attached as part hereof? Yes .....; No ....."

If chattels are too numerous to list in Item 9 below, complete in duplicate an inventory of the chattels to be included. Attach one copy of the inventory (signed by the seller) to the broker's and seller's copies of the Employment Contract. Indicate at this point that

such an inventory has been supplied and by reference becomes a part of the contract. If items of personal property to be included in the sale are of material value that value should be stated on account of U. S. Revenue Stamps to be attached to the deed, fire insurance and perhaps other reasons.

NAME OF BROKER

EXCERPT 4. "To .....,
Real Estate Broker

....., ..., ..., 19 ....."
City State Date

The name to be filled in above the words "Real Estate Broker" does not necessarily mean the name of the broker. It should be the name under which the broker has his Real Estate License. This is to be followed by city, state and date of contract.

COMMISSION AND PERCENTAGE

EXCERPT 5. "FOR VALUE RECEIVED, you hereby are employed to sell or exchange the property described hereon at the selling price and on the terms noted. You hereby are authorized to accept a deposit on the purchase price. You may, if desired, secure the cooperation of any other broker, or group of brokers, in procuring a sale of said property. In the event that you, or any other brokers cooperating with you, shall find a buyer ready and willing to enter into a deal for said price and terms, or such other terms and price as I may accept, or that during your employment you place me in contact with a buyer to or through whom at any time within 90 days after the termination of said employment I may sell or convey said property, I hereby agree to pay you in cash for your services a commission equal in amount to .....% of said selling price."

In the foregoing excerpt we find several phases of contract law—as well as a recitation of certain conditions which will entitle the listing broker to his commission:

(a) Recites "valuable consideration" necessary in all contracts

(b) Specifies purpose for which broker is employed

(c) Authorizes broker to accept a deposit on the purchase price

(d) Authorizes listing broker to cooperate with any other broker

(e) Seller agrees to pay a "cash" commission in the event that the listing broker:

(1) Procures a buyer at the **exact price and terms** specified by the seller

(2) Procures a buyer at any other price and on terms acceptable to the seller, and

(3) Places prospective purchaser "in contact" with the seller, during the lifetime of the employment contract, to whom the seller may sell or convey at any time within the 90-day period following the termination of the listing.

In this connection all licensees should review Rule 10-015.

The matter of "placing in touch", or similar wording, indicates more than a mere showing of the property prior to the expiration date.

The general trend of Court decisions on the 90-day protection clause has been aptly expressed as follows:

"If a broker, after introducing a prospective customer to his employer to no purpose, abandons his employment entirely or if, after procuring a person who proves to be unwilling to accept the terms of his principal, he merely ceases to make further endeavors to negotiate a deal with that particular individual and all negotiations in that direction are completely broken off and terminated, he will not be entitled to his commission if his employer subsequently renews negotiations with the same person, either directly or through the medium of another agent and thus effects a sale without further effort on the part of the broker first employed. The question as to when the broker will be deemed to have abandoned his efforts to sell depends upon the facts in the individual case. The mere fact that some time elapses after the broker has discontinued his efforts to make a sale, before the sale is made in fact by the owner, is not evidence of itself that there has been a complete abandonment of the negotiations." BROKERS SECTION 144 AMERICAN JURISPRUDENCE.

(f) The percentage figure to be inserted in ".....% of said selling price" is a matter to be determined by agreement between the seller and broker.

DEEDS, EVIDENCE OF TITLE, PRO RATING

EXCERPT 6. "I agree to convey said real estate to the purchaser by a good and sufficient deed, to transfer and deliver said personal property, if any, by good and sufficient bill of sale and to furnish either title insurance insuring or a complete abstract showing marketable title to said real estate and good right to convey. I hereby warrant that the information shown hereon below is true, that I am the owner of said property, that my title thereto is a good and marketable title, that the same is free of encumbrances, except as shown hereafter under "Financial Details" and except taxes levied on said property for the current tax year which are to be pro rated between the seller and buyer."

(a) Seller agrees to convey real property "by good and sufficient deed", meaning that he may at his option supply:

(1) Warranty Deed,

(2) Special Warranty Deed, or

(3) Bargain and Sale Deed.

The increased use of "title insurance" has materially reduced the importance of the buyer procuring a "Warranty Deed" to the exclusion of other types of conveyance, for the reason that title insurance protects the purchaser against loss (in an amount equal to the purchase price) regardless of what type of deed is supplied by the seller.

(b) Seller agrees to convey title to the personal property, if any included, by "Bill of Sale."

(c) Seller agrees to furnish, in the event of sale, evidence of marketable title by supplying:
(1) Title insurance, or
(2) Abstract of record.
If Title Insurance is to be furnished, the word "either" and the words "or a complete abstract showing" should be stricken.
At the time of taking the listing, ascertain what type of evidence of title the seller will supply. Such information will be needed when preparing the Earnest Money Receipt.

(d) Seller asserts that:
(1) He has good title and right to convey.
(2) That the information which he has supplied regarding the property is true (See Items 7 and 8).
(3) That the property is free of encumbrances except as shown under Financial Details (See Item 17).

(e) Seller agrees to pro rate current year's taxes.

EXCHANGE AUTHORIZATION

EXCERPT 7. "In case of an exchange, I have no objection to your representing and accepting compensation from the other party to the exchange as well as myself."

The sale price and terms as stipulated by the seller will not ordinarily permit the broker to attempt negotiations for sale of the property for any consideration other than cash. With the inclusion in the contract of the "exchange clause" the broker may also attempt negotiations for the sale of the property on an exchange basis—and if successful—he is authorized by the seller to divide his allegiance between the seller and the other party to the exchange.

The negotiation of exchange transactions is one of the few sets of circumstances wherein, provided his employment contract so provides, the broker may render simultantous allegiance to any one other than the seller who first employed him.

SHOWING PREMISES—INFORMATIVE DATA

EXCERPT 8. "I hereby authorize you and your customers to enter any part of said property at any reasonable time to show same. Also, I authorize you, at any time, to fill in and complete all or any part of the 'Informative Data' below, except financial details."

(a) On occasions the property listed for sale will be occupied by renters who are reluctant to permit the broker and his prospects to visit and inspect the property. In such instances the seller, under the foregoing "show" clause, assumes the responsibility of settling such difficulties with the tenants.

(b) In the majority of instances, complete information relating to both physical and financial features of the property are entered on the broker's employment contract **prior** to the procurement of seller's signature. Occasionally, however, the seller's signature will be procured when only the property description, price, terms and financial data have been noted. This leaves the broker in the position of making a subsequent inspection of the property and entering on his copy of the contract the property's physical features.

The latter part of the foregoing excerpt is designed to avert the possibility of the seller subsequently alleging that the broker, through the insertion of such information, after the affixing of seller's signature, has rendered the contract "void."

It will be noted that the broker's authority has been limited to the subsequent filling in of "Information Data." See Item 18, which relates, for the most part, to the property's physical features—available from an inspection of the premises. No authorization is given to the broker to subsequently fill in—on his own initiative—"financial information." (See Item 17.)

CHATTELS

EXCERPT 9. "The following items are to be left upon the premises as part of the property purchased: All irrigation fixtures and equipment, plumbing and heating fixtures and equipment (including stoker and oil tanks but excluding fireplace fixtures and equipment), water heaters, electric light fixtures, light bulbs and fluorescent lamps, bathroom fixtures, venetian blinds, window and door screens, storm doors and windows, attached linoleum, all shrubs and trees and all fixtures except **three patented rose bushes.** The following personal property is also included as a part of the property to be offered for sale for said price: **one G. E. automatic washer** (or see signed inventory, if any, attached)."

It is a wise broker indeed who definitely settles with the seller at the time of the taking of the listing, what chattels are or are not to be included with the sale. Particular notice should be given to chattels such as curtain rods, traverse rods and drapes, ranges, refrigerators, washing machines, deep freeze units, etc., which have not been included in the foregoing printed list. This identical clause appears in the Earnest Money Receipt Item 9, and any exceptions or additions shown in the Employment Contract must be also noted when making out the Earnest Money Receipt.

EXPIRATION DATE AND TIME TO CLOSE

EXCERPT 10. "This agreement expires at midnight on **April 6, 1968,** but I further allow you a reasonable time thereafter to close any deal on which earnest money is then deposited."

(a) As previously stated, Regulations require that every listing must contain a definite termination date. The broker's employment expires at midnight on whatever date is inserted here —however, the period of employment may be subsequently extended by the seller to a new date by using the "extension clause" (See Items 13 and 16).

(b) Occasionally sellers who have listed their property for sale will change their minds about selling, and even after a broker has

advertised and procured a buyer at seller's exact price and terms, the seller may attempt to evade the deal as well as avoid the payment of broker's commission.

In an Oregon case involving a "cash net listing" the broker's employment contract provided a definite termination date but made no provision for a reasonable time, after the termination of the broker's employment, in which to close any transaction that might be consummated prior to the termination date.

On the last effective day of the employment contract the broker was successful in procuring a buyer at the seller's exact price and terms. Broker tendered seller an earnest money receipt and deposit. The seller refused to accept the deposit and specified that he was ready and willing to tender to the buyer both a deed and abstract of title—provided the full amount of the cash purchase price ($47,500.00) was paid immediately, and he would not allow the purchaser an extension of time, following the termination date of the broker's employment contract, in which to ascertain the marketability of the title.

The purchaser rightfully refused to pay the full purchase price without an opportunity to examine the title. The broker's claim for damages was refused by the Court for the reason that he had procured a buyer "ready", "able", but not "willing" to purchase under the conditions imposed by the seller.

EXCLUSIVE RIGHT-TO-SELL OR NON-EXCLUSIVE CONTRACT

EXCERPT 11. "Any sale, exchange or conveyance of the property or any part thereof by me prior to the said expiration date or through another broker or third person without your assistance shall be construed as a withdrawal of your authority to sell the above described property."

The Broker's Employment Contract, from which these excerpts have been taken, is designed to serve as an "exclusive Right-to-Sell" employment contract. By deletion of Item 14, the broker's employment can be amended to a "non-exclusive" listing.

(a) The excerpt quoted above, when read as a part of an "exclusive right-to-sell" listing, provides certain acts that "shall be construed as a withdrawal of your (broker's) authority to sell" and must be read in conjunction with excerpt 14 below wherein it provides that if seller, prior to the contract's termination date, **withdraws the broker's authority** the seller will be liable for payment of broker's commission.

(b) If the contract is to be used as a "non-exclusive" listing and excerpt 14 is stricken, this paragraph must stand by itself and provide the conditions which shall be construed as terminating broker's "non-exclusive" listing.

EXCERPT 14. "THIS LISTING IS AN EXCLUSIVE LISTING and you hereby are granted the absolute, sole and exclusive right to sell or exchange the said described property. In the event of any sale, by me or any other person, exchange or conveyance of said property, or any part thereof, during the term of your employment, or in case I withdraw the authority hereby given prior to said expiration date, I agree to pay you the said commission just the same as if a sale had actually been consummated by you."

To eliminate possible misinterpretation, the acts of selling, exchanging, etc., recited in Excerpt 11 have been again restated.

Appendix

The weight of authority of Courts Decisions is to the effect that the seller theoretically reserves the right to cancel a broker's exclusive right-to-sell privilege at any time prior to the expiration date. Such cancellation may be either by owner's notice to broker or by sale of the property by the owner to a purchaser not procured by the listing broker.

The question then arises as to the liability of the seller and the amount of damages, if any, to which the broker is entitled where the broker has not, prior to cancellation, expended any monies, exerted any effort or procured a buyer ready, willing and able to purchase.

A survey of Supreme Court Cases discloses that in the majority of instances that the broker's employment contracts were silent regarding the broker's rights and the seller's liability in the event of cancellation. In these cases the courts were rather consistent in holding that all the broker was entitled to recover was the amount which he had expended in the seller's behalf prior to the cancellation.

By contrast however the Courts held that broker's using employment contracts which provided that the broker would be entitled to his full commission "in the event of any sale prior to the expiration date" were able to recover their full commissions, rather than sum equal to their expenditures. (See American Law Reports vol. 64, page 416.)

The contract shown in Excerpt 14, goes further and provides: "or in case I withdraw the authority hereby given prior to said expiration date, I agree to pay, etc."

This is new verbiage and as yet there have been few, if any cases, carried to the Supreme Courts. The trend thus far seems to indicate that where the wording is clear in its intent that notice of cancellation will entitle the broker to his full commission "just the same as if a sale had actually been consummated."

One of the primary and determining factors running through all cases was the question as to whether the broker had in fact exerted time, effort and expended monies in the seller's behalf.

EXCERPT 12. "In case of suit or action on this contract, I agree to pay such additional sum as the Court may adjudge reasonable as Plaintiff's attorney fees."

This is a common clause found in most contracts. No attorneys fees are collectible except where actions are adjudicated in Courts of Law and fee is approved by trial Judge.

The mere filing of an action for breach of contract will not be sufficient to make this clause enforceable.

EXTENSION OF EMPLOYMENT DATE

EXCERPT 13. "It is further agreed that my signature affixed to the renewal clause below shall have the effect of renewing and extending your employment to a new date to be fixed by me on the same terms and all with the same effect as if the said new date had been fixed above as the expiration date of your employment."

Excerpt 10 provided that every listing must contain a definite termination date but could be subsequently extended to a new date by procuring seller's signed approval (See Excerpt 16).

EXCERPT 16.

Accepted: **January 6, 1968**
A. Broker

JOHN SELLER (SEAL)
MARY SELLER (SEAL)
owner

Owner's Address **280 Yew Park Drive** City **Salem** State **Oregon** Phone **363-8442.**

The date of acceptance in most cases is the same as the listing and should be signed by the broker or a salesman may sign the acceptance thus: A. Broker by Roy Hart.

FOR VALUE RECEIVED, the above broker's employment hereby is renewed and extended to and including ....., 19.....

Accepted: ....., 19.....

.....
Broker

.....(SEAL)
.....(SEAL)
Owner

DELIVERY OF COPY OF LISTING TO SELLER

EXCERPT 15. "I HEREBY CERTIFY THAT I HAVE RECEIVED A CARBON COPY OF THIS CONTRACT."

Board Rules and Regulations provide:

"A broker or salesman who obtains a listing, at the time of securing such listing, shall give the person or persons signing such listing a true copy thereof."

FINANCIAL DATA

EXCERPT 17. This should be as complete as possible. Price and terms as stated above. Space is provided to indicate if the payment includes principal, interest, taxes, insurance and the interest on deferred payments. The next item is the amount of fire insurance and the fire insurance premium. If the premium is for 3 years, cross out the word "annual" and write "3 years."

The next item is "Taxes last year." This is misleading. Taxes are on a fiscal year basis. Cross out the word "last" and show the fiscal year, viz. 1967-68, and the amount.

The next space is for Federal Housing Administration Commitment if there is one.

The next spaces are for encumbrances, or indebtedness which the owner owes or which must be paid if the owner was to give a clear title to the property. This can be in the form of mortgages, trust deed, taxes, municipal liens such as paving, etc., or it might be the owner is buying on a Contract of Sale. Under the item "delinquent taxes", you should remember that taxes owing for the fiscal year in which you take the listing may be past due, but do not become delinquent until August 16 following the fiscal year.

INFORMATIVE DATA

EXCERPT 18. That portion of the form used for Informative Data has not been completed in the sample form illustrated, but an accurate and complete filling in of this part is what makes a good listing. "B" means basement, "1F" first floor, "2F" second floor, "A" attic. These spaces should be as complete as possible. Use numerals and the words "yes" and "no", rather than an "X" or a check mark. For example: Bedrooms: first floor 1, second floor 3; comment large closets; Basement full—yes.

Space is provided for important information which includes street number of the house situated on the lot in the block described in the listing.

If all spaces are filled in you have a valuable listing.

If you secure additional information for which no space is provided, place it under the heading "Remarks."

Notation should be made if you are permitted to put up a sign. The name of the party who inspected the property should be shown.

EXCLUSIVE RIGHT-TO-SELL OR NON-EXCLUSIVE

EXCERPT 19. "*TO MAKE NON-EXCLUSIVE—Strike complete Paragraph following (*) in Employment Contract and have owner initial the deletion." For discussion see Excerpt 11.

Listing Agreement Problem

Compare this information with the text and the illustrated form.

4 A. Broker, 1020 A Street, Salem, Oregon, ob-
14 tains a three-months exclusive right to sell the hereafter described property.

16 **Owners:** John Seller and Mary Seller, husband and wife, 280 Yew Park Drive, Salem, Oregon, Phone 364-8442.

Date of Listing: January 6, 1968.

Terms of Listing: Expires April 6, 1968.

Listing Accepted: January 6, 1968.

6 **Commission:** 6%

1 **Legal Description:** Lot 6, Block 10, Yew Park Addition to the City of Salem, Marion County, Oregon.

Property Address: 280 Yew Park Drive, Salem, Oregon.

2 **Listing Price:** $15,500.00.

2 **Terms:** Cash for equity, buyer to assume mortgage.

17 **Taxes:** The taxes for 1967-68 on the property were $192.00. Paid in full.

RESIDENCE PROPERTY

FORM No. 674 COPYRIGHT BY STEVENS-NESS LAW PUB. CO., PORTLAND, OREGON

REAL ESTATE BROKER'S EMPLOYMENT CONTRACT

1 DESCRIPTION: Lot 6, Block 10, Yew Park Addition, 280 Yew Park Drive

City of Salem, County of Marion, State of Oregon; for better description see owner's title deed on record, now made a part hereof. For personal property, if any to be included in property offered for sale for price next mentioned, see below or see signed inventory, to be attached.

2 Selling price, free of encumbrances: $ 15,500.00; Terms Cash for equity, buyer to assume and agree to pay mortgage of record payable $85 per month including interest at 6%

3 Is signed inventory attached as part hereof? Yes ____; No X; to be attached as part hereof? Yes ____; No ____

4 To A. Broker, 1020 A Street (Real Estate Broker), Salem (City), Oregon (State), January 6, 19 68

5 FOR VALUE RECEIVED, you hereby are employed to sell or exchange the property described hereon at the selling price and on the terms noted. You hereby are authorized to accept a deposit on the purchase price. You may, if desired, secure the cooperation of any other broker, or group of brokers, in procuring a sale of said property. In the event that you, or any other brokers cooperating with you, shall find a buyer ready and willing to enter into a deal for said price and terms, or such other terms and price as I may accept, or that during your employment you place me in contact

6 with a buyer to or through whom at any time within 90 days after the termination of said employment I may sell or convey said property, I hereby agree to pay you in cash for your services a commission equal in amount to 6 % of said selling price. I agree to convey said real estate to the purchaser by a good and sufficient deed, to transfer and deliver said personal property,

7 if any, by good and sufficient bill of sale and to furnish [redacted] title insurance insuring [redacted] marketable title to said real estate and good right to convey. I hereby warrant that the information shown hereon below is true, that I am the owner of said property, that my title thereto is a good and marketable title, that the same is free of encumbrances except as shown

8 hereafter under "Financial Details" and except taxes levied on said property for the current tax year which are to be pro rated between the seller and buyer. In case of an exchange, I have no objection to your representing and accepting compensation from the other party to the exchange as well as myself. I hereby authorize you and your customers to enter any part of said property

9 at any reasonable time to show same. Also, I authorize you, at any time, to fill in and complete all or any part of the "Informative Data" below, except financial details. The following items are to be left upon the premises as part of the property purchased: All irrigation fixtures and equipment, plumbing and heating fixtures and equipment (including stoker and oil tanks but excluding fire place fixtures and equipment), water heaters, electric light fixtures, light bulbs and fluorescent lamps, bathroom fixtures, venetian blinds, window and door screens, storm doors and windows,

attached linoleum, attached television antenna, all shrubs and trees and all fixtures except 3 patented rose bushes. The following personal property is also included as a part of the property to be offered for sale for said price: 1 G.E. automatic washer

10 ____ (or see signed inventory, if any, attached). This agreement expires at midnight on April 6, 19 68, but I further

11 allow you a reasonable time thereafter to close any deal on which earnest money is then deposited. Any sale, exchange or conveyance of the property or any part thereof by me prior to the said

12 expiration date or through another broker or third person without your assistance shall be construed as a withdrawal of your authority to sell the above described property. In case of suit or action on this contract, I agree to pay such additional sum as the court may adjudge reasonable as plaintiff's attorneys fees. It is further agreed that my signature affixed to the renewal clause below shall

13 have the effect of renewing and extending your employment to a new date to be fixed by me on the same terms and all with the same effect as if the said new date had been fixed above as the expiration date of your employment.

14 *THIS LISTING IS AN EXCLUSIVE LISTING and you hereby are granted the absolute, sole and exclusive right to sell or exchange the said described property. In the event of any sale, by me or any other person, exchange or conveyance of said property, or any part thereof, during the term of your employment, or in case I withdraw the authority hereby given prior to said expiration date, I agree to pay you the said commission just the same as if a sale had actually been consummated by you.

15 I HEREBY CERTIFY THAT I HAVE RECEIVED A CARBON COPY OF THIS CONTRACT.

16 Accepted: January 6, 19 68 — John Seller (SEAL)

A. Broker (Broker) — Mary Seller (SEAL) (Owner)

Owner's Address 280 Yew Park Drive City Salem State Oregon Phone 364-8442

FOR VALUE RECEIVED, the above broker's employment hereby is renewed and extended to and including ____, 19____

Accepted: ____, 19____ — ____ (SEAL)

Broker — Owner (SEAL)

FOLD ON DOTTED LINE FOR INSERTION IN RING BINDER

17 FINANCIAL DETAILS

Selling price (free of encumbrances) $15,500.00 Terms: $5,300.00 cash, assume $10,200.00 mortgage balance.

Payments include: Prin. X Int. X Taxes. ___ ins. ___ (Check items to be included in payments)

Interest on deferred payments 6 %

Fire ins. $ 12,000 Ann'l prem. $ 24.00

Taxes [redacted] year $ 1967-68 $192.00

F.H.A. commitment $

ENCUMBRANCES		Payable
1st mtg. $ 10,200.00	Int. 6 %	$85
2nd mtg. $	Int. %	
Mtg. held by		
Contr. bal. $	Int. %	

Delinquent taxes $ none

Municipal liens $ 284.00

18

	B	1F	2F	A	Comment
Living rm.					
Dining rm.					
Kitchen					
Brkft. nk.					
Bedrooms					
Slpng. pch.					
Bath					
Den					
Party rm.					
Utility rm.					
Hallway					

Attic: Fin. Unfin.

RESIDENCE PROPERTY INFORMATIVE DATA

Office Listing No. ____

Address ____ Bet. ____ & ____ District ____

Lot ____ Block ____ Addition ____ Facing N S E W

Dimension of lot ____ x ____ Dimension of house ____ x ____ No. rooms ____ No. Stories ____ Attic ____

Owner has: Abstract ____ Title Insurance ____ Cert. of Title ____ Contract ____ Deed ____

Occupied by: Owner ____ Vacant ____ Renter ____ Renter's name ____ Tel. ____ Rent $ ____

Owner's name ____ Tel. ____

May we use pass key ____ Key at ____

Possession may be had ____

Type of house ____

Type of construction ____ Type of roof ____

Condition: roof ____ paint exterior ____ paint interior ____

Utilities: Electricity ____ Gas ____ Phone ____ Water ____ Garbage service ____

For details as to chattels included in sale: See employment contract ____ See signed inventory ____

FEATURES & FINISH	HEATING	OUTSIDE	DISTANCE TO
Sink	House	Garage: Sgle. ____ Dbl. ____	Bus or carline
L. trays		Lawn	Name of line
Shower		Garden	Grade school
		Shrubbery	High school
Hdwd. floor			Pub. park
Fir floor			Grocery store
Plaster ceil.			MISCELLANEOUS
Beam ceil.	Water		Sewer
Rms. papered		STREETS	Cesspool
Rms. tinted	BASEMENT	Paved	Septic tank
En. finish	Full ____ Part ____	Macadam	Outdoor frplce.
Nat. finish	Fin. ____ Unfin. ____	Graded	Walks
	Floor drain	Ungraded	Weatherstripping
		Sidewalk	Insulation
		Alley	Wired elect. stove

Remarks: ____

Listed by ____

Signs permitted ____

Inspected by ____

Will consider exchange for ____

19 * TO MAKE NON-EXCLUSIVE — Strike complete paragraph following asterisk (*) in Employment Contract and have owner initial deletion.

FOR INSTRUCTION AND EXAMINATION PURPOSES - NOT FOR COMMERCIAL USE.

17 **Encumbrances:** Mortgage balance is $10,200.00 payable $85 per month including interest at 6% per annum. Paving assessment balance $284.00.

17 **Insurance:** The improvements are insured for fire loss in the amount of $12,000.00 written for a three year period effective December 1, 1967. Three year premium paid in advance was $72.00.

9 **Inclusions:** G. E. Automatic washer.

9 **Exclusions:** Three patented rose bushes.
Owner to Furnish Title Insurance.

18 Informational Data is not included in this problem because such information is not always required in an examination.

Notice to Brokers and Salesmen

The most important document that will be prepared in your office is the Earnest Money Receipt. A large percentage of all complaints filed with this division, and many lost sales, are the results of these forms being improperly prepared. Every licensed employee in a broker's office should have the ability to prepare one properly before he is permitted to sell. Lack of this ability may result in disciplinary action by this division, loss of commission on the transaction, and last but not least, loss of public acceptance of the real estate practitioner.

The Earnest Money Contract is the foundation on which a sale of real estate is constructed. (You may look upon the listing contract as such, but that is only the employment contract wherein you were employed to secure a purchaser. *It is not an agreement to sell.*)

The entire transaction will be firm or shaky depending on the foundation you lay in the Earnest Money Contract.

The seller or buyer have the right to expect that a transaction will be completed exactly on the terms and conditions to which they have agreed—NO MORE and NO LESS. They also have the right to expect that, if necessary, they can maintain a legal action to enforce the contract.

The professional real estate practitioner makes certain that the Earnest Money Contract is legally correct as to contents; that all things to which each party has AGREED AND IS COMMITTED are contained in the contract, that it is properly signed by all parties with any changes, modifications, or alterations, being properly initialled, and promptly delivers executed copies to all parties. He leaves no little "surprises" to be brought up for the first time at the closing, such as fuel oil adjustment, prepayment penalties, mortgage discounts, appraisal fees, taxes, or pending assessments.

Nothing reflects more adversely on the real estate practitioner than the misspelling of commonly used words, or an excessive use of abbreviation.

Are *you* a professional or a non-professional? You don't really need to answer—your Earnest Money Contract will speak for you.

If you will carefully review the text in this section and observe the following suggestions, the licensee should not have further difficulty in this most important part of his business.

(a) Your relation with your principal always demands absolute fidelity.
(b) You should always endeavor to collect earnest money substantially in excess of your commission.
(c) The earnest money receipt must be prepared in quadruplicate. A copy of the earnest money receipt signed by all parties must be delivered to both the purchaser and the seller at once if the offer is accepted. One of the copies provides a receipt for the purchaser at the time he makes his offer and earnest money deposit. The original copy is to be retained in the broker's file.
(d) A salesman must promptly turn over to his broker all client's funds entrusted to his care.
(e) A broker, as provided by law, must establish a trust account as a depository for all client's funds in his possession.
(f) Check carefully your description of the property involved.
(g) Ascertain that all signatures, including your own, are affixed in the space provided.
(h) Have no oral understandings. Make sure that every understanding on the part of either party is a part of the written agreement.
(i) Any change of the earnest money receipt after the signatures have been affixed, which is agreed to by the parties, must be added as a part of the agreement and be initialed by all parties. It is well to include the date and hour such a change was made.

An earnest money receipt becomes a contract and as such must contain certain essentials. Here is a check list:

Be in writing.
Competent parties.
Identify the parties.
Obligation to sell and to buy.
Description of the land.
Price and terms of payment.
Nature of the title (good and marketable).
Instrument of conveyance (type of deed).
Time for performance (closing).
Prorating interest, taxes, insurance, rents.
Your commission in dollars and cents.

Status of Earnest Money

What is the status of earnest money held by a real estate broker?

When the purchaser pays the earnest money, the broker becomes a trustee for the purchaser, as it is the duty of the broker to account to the purchaser for the earnest money up to the time that the broker has secured from the seller a binding acceptance of the transaction. When the broker does secure a binding acceptance from the seller, he then becomes a trustee for both the buyer and seller. It may become his duty to account to the buyer in the event the seller is unable to make good title to his property or defaults on the contract, and it will be necessary for the broker to account to the seller in the event of a forfeiture of

the earnest money or in the event the parties consummate the transaction.

Brokers must keep in mind the fact that they are holding this earnest money as trustees and as such are obligated to all of the parties concerned to keep the earnest money intact, so that the broker will be in a position to account for the same. In other words, a broker should not pay any of this earnest money to the seller or to any one else, until and unless the transaction is closed or the earnest money forfeited. Also, by all means, the broker should not pay himself his commission out of this earnest money until the transaction is consummated or the earnest money forfeited.

DESCRIPTION OF PROPERTY IN EARNEST MONEY RECEIPTS

There is a tendency of real estate brokers to be careless in the describing of property in earnest money receipts and listing agreements. Unless the property being sold is so described in the instrument that the requirements of the law are fully met, it is not an enforceable agreement.

We find a good illustration of this in the decision of the Supreme Court of the State of Oregon in the case of Hertel v. Woodard, 183 Or. 99. The earnest money receipt in question read substantially as follows:

"May 10, 1947

Received from Lucky Hertel $80.00 Eighty Dollars earnest money on lot & house number 960 Union Street. Price $5,000.00 Five Thousand and—balance of $4,920.00 to be paid when papers and title insurance are completed. It is understood this deal would be closed and house vacated on or before June the 10th. All furniture except personal belongings included in this transaction."

An examination of this earnest money receipt discloses that there is no mention made of the city, county or state in which the property is located. It appeared from the pleadings and in the trial of the case that the earnest money receipt was signed while all of the parties thereto were in the house which was covered by the earnest money receipt, and it was contended that because of this that there could be no room for misunderstanding between the parties as to the location of the property.

The Supreme Court held that because of the failure of the earnest money receipt to state the location of the property in that there was not contained therein the name of the town or state in which the property was located, that the earnest money receipt was void and unenforceable.

A good test to be applied to determine the sufficiency of the description of property is whether a stranger to the instrument, having no knowledge whatsoever with respect to the location of the property, could take the instrument and from the information given therein locate the property. It must be kept in mind in determining the sufficiency of the description that it makes no difference that the parties themselves were fully agreed as to the property which the scrivener of the instrument intended to describe. The instrument must stand on its own feet and if the description contained therein is insufficient to enable a stranger to the intsrument, who has no knowledge of the transaction, to locate the exact property, this description will be held insufficient to comply with the requirements of the Statute of Frauds.

Earnest Money Receipt

The term "earnest money" refers to the money paid by the prospective purchaser at the time of making his offer to purchase. This actual deposit will hereafter be referred to as "hand money" for the purpose of distinguishing the actual deposit from the "Earnest Money Receipt", which is sometimes referred to as "Earnest Money Receipt and Argeement to Purchase" or "Earnest Money Contract", and much more frequently as "Earnest Money Agreement."

The actual "hand money" placed on deposit with the broker or salesman, is promptly deposited by the broker in his trust account where he holds it subject to the owner's acceptance of the purchaser's offer.

The factors that make the "Earnest Money Receipt" form so important are that it is: (1) a receipt for the "hand money" deposited; (2) it must contain a written understanding of all of the basic factors which are to be included in the subsequent contract of sale or purchase money mortgage arrangement; (3) it serves as a contract of sale on cash transactions up to and until the date of closing; (4) it must contain a complete understanding as between the purchaser, owner and broker as to return of the hand money deposit in the event of the refusal of the seller to accept the offer; and (5) forfeiture of the hand money in the event that the purchaser fails or neglects to go forward with the transaction following the seller's acceptance.

LAWYER COOPERATION

Frequently a real estate transaction is closed by an attorney. If he is a competent lawyer he will probably use a check list in drawing up the final contract. Respect for your ability will be furthered if the probable items on this check list are included in the earnest money receipt or supplied as an addenda. His check list will probably include these items: consideration and manner of payment, payment of balance of purchase price, interest provisions, prepayment privileges, taxes, insurance, possession, improvements, alteration and repairs, title insurance, covenants of title, escrow, delivery of deed, risk of loss, default provisions, representations (purchaser certifies he has examined property), waivers, assignments, successor interests, closing.

STUDY OF THE EARNEST MONEY AGREEMENT

The sample form of the earnest money receipt shown in this section is a one-time carbon manufactured in quadruplicate (original and three copies); one copy is delivered to the purchaser at the time he signs the "Agreement to Purchase" portion of the Earnest Money form and tenders his hand money deposit; another copy is delivered to the seller at the time he accepts the offer; the third copy showing "Seller's Acceptance" is delivered forthwith back to the purchaser (this delivery can be made either manually or by registered mail with request for postal

return receipt to broker); and the original copy, as shown, is retained by the broker and contains all the terms, conditions, signatures of the buyer and seller, as well as a showing of the manner in which the broker elected to use in returning the "acceptance" copy to the buyer. The delivery of this "acceptance" copy places the buyer upon actual notice that his offer to purchase has been accepted.

For study purposes the sample form, as shown, has been divided by marginal numbers into 16 component parts. These numbers compare with those assigned to the following discussion:

(1) Entry of correct place and date(s) is of utmost importance, for it is from these controlling dates that time limits will be determined for the happening of the successive chain of events requisite in every real estate transaction.

(2) Enter name(s) of only the person(s) who will sign the "Agreement to Purchase." If the husband is the one who inspects the property and pays you the earnest money and his wife is not present to confirm the offer, only the husband's name should be used.

(3) The amount of earnest money should be filled out both in spelling and numbers, (One Thousand & no/100 Dollars and $1,000.00) just as you would write a check, and state if said sum is in the form of cash, check or draft, or note.

(4) After filling in the name of the City, County and State you should enter the complete legal description of the property to be sold. If space is insufficient on the form to include a metes and bounds description, it is advisable to write on the face of the Earnest Money form the words "see legal description attached hereto marked 'Exhibit A' and by reference made a part hereof" and then affix a rider containing a complete property description marked "Exhibit A" to all four copies of the form. The complete property description may be written on the reverse or blank side of the form and the cross reference words written on the face "for complete property description see reverse hereof." It is recommended that all four copies of the attached rider or description appearing on the back of the forms be initialed or signed by both buyer and seller.

Another method of handling a long legal description is to identify the property "as described on Page ....., Volume ....., Deed Records, ... County, Oregon"; or "as recorded ..... day ..... year, Reel ....., Clerk's Filing No. ....., ... County, Oregon, Deed Records."

Correct legal descriptions are available from the Deed Records in the County Court House or from your local title insurance company. Some brokers who have failed or neglected to procure in advance the correct legal description and insert the words "legal description to be added later" are inviting disaster.

(5) The purchase price and terms of sale must be complete in all details. The line "(on ....., * (on owner's acceptance) 19..... as additional earnest money, the sum of $....." is used only in instances where the broker accepts a partial hand money payment at the time of procuring the buyer's offer and then arranges for additional hand money to be paid on a certain date, or upon the owner's acceptance. Later on in this discussion we will find provision is made for the forfeiture of the "earnest money" in the event that the purchaser fails or neglects to go forward with the transaction. The only money required to be forfeited is the money designated as "earnest money" and any money paid down and not so designated may be construed as a down payment made on the purchase price, which under the terms of the contract, is not forfeitable.

In this same part of the form we show how the balance of the purchase price is to be paid. If an existent contract or mortgage is to be assumed as a part of the purchase price we show the balance payable, terms of payment and whether the interest, taxes and insurance are included as a part of the monthly payment, which is also shown.

It is quite possible there may have been several other conditions in the offer and no space on the Earnest Money Receipt for them. When this occurs, they should be written in full on the back of the form and initialed by the buyer and seller or listed separately and made a part of the agreement.

(6) If title insurance is to be furnished, the entire sentence regarding abstract of title should be deleted. Delivery of evidence of title by the owner to the broker does not constitute delivery to the purchaser. It is therefore necessary that the broker promptly, upon receipt of the seller's evidence of title, deliver it "forthwith" to the purchaser for his examination.

(7) Here we find a most important clause of the Earnest Money form, for it provides that the purchaser shall have a reasonable time in which to examine the seller's evidence of title and the seller shall have 30 days in which to clear any "clouds" upon the title in order to make the title marketable. The paragraph also contains provisions as to return or forfeiture of the earnest money deposit.

(8) Provides that the seller is to convey the property by good and sufficient deed free and clear of all encumbrances, except for certain enumerated items that shall not be considered as encumbrances on the title. Space is then provided for the insertion of any balances on liens, mortgages or taxes which are due and owing and which are to be assumed and paid by the purchaser.

In this blank space should be filled in those items of indebtedness which are a lien on the property at the time of the sale and are not being removed by the sale, but are to be paid by the buyer in the future and are to be listed on the Deed which the buyer will receive as an indebtedness against the property. It should clearly state whether the buyer is taking title "Subject" to the indebtedness, or if the buyer is "Assuming" the indebtedness.

(9) The first space is for the chattels that are excepted from the sale, and the following space for inclusions. Particular care should be taken in inserting into the Earnest Money receipt any exceptions or additions shown in the original signed listing.

(10) Seller and Purchaser agree to the pro-rating of taxes, rents and existing insurance and provide that any encumbrances now existent upon the property and payable by the seller on or before closing may be paid out of the purchase money at the date of closing.

(11) Insert the date when the purchaser may

take actual possession of the premises. The accuracy of the date is usually determined by checking the Broker's Employment Contract and ascertaining how much time the seller specified at the time of listing would be required to vacate the premises in event of subsequent sale. The accuracy of the date which you place in the Earnest Money form will, to a large measure, determine what commitments the purchaser will make regarding the premises which he is leaving or as to how soon he will have to give his landlord notice—or promise occupancy to a third party buyer of his present home. The form then goes on to provide that time is of the essence of the contract and that the purchaser's rights are not assignable.

(12) Enter name of broker on top line in the same manner in which it is shown on the Real Estate License Division records. This eliminates the possibility of subsequent contention that the Earnest Money form failed to show the proper party having a real estate broker's license. On the next line following the word "By" enter the name of the broker or salesman who prepared the Earnest Money form.

(1–13) Enter date on which purchaser's signature is procured, also the full purchase price and number of days which the purchaser agrees to grant the broker for the procuring of the seller's acceptance, during which time he (the purchaser) agrees not to withdraw or revoke his offer. Under the General Law of Contracts and our trend of decisions by the Supreme Courts, it has been held that the purchaser may withdraw his offer at any time prior to the seller's acceptance and procure back his deposit. The number of days entered here also refers back to Item 7 in the Earnest Money form wherein it states "within the period allowed broker below in which to secure seller's acceptance."

The broker should by all means exert every effort to procure the seller's acceptance at the earliest possible date and not dilatorily wait out the time limit or hold the original offer pending in the hope of procuring a subsequent offer from a third party at a higher price or on better terms.

Next is entered the name(s) of the person(s) to appear in the Deed or in the contract as purchaser(s), and have the agreement to purchase signed by the same person(s) as appear in Item 2 of the Earnest Money form. Upon procuring signatures and hand money deposit, the broker or salesman delivers to the purchaser(s) a copy of the Earnest Money form, completed up to this point and prepares to seek the seller's acceptance of the offer.

(1–14) Agreement to Sell: Enter here the date on which seller's signature is procured. The accuracy of this date will control the forfeiture of the entire hand money deposit in the event that the purchaser should subsequently elect to withdraw his offer (see Items 7 and 13). If the sellers are husband and wife, even though the property is held in the individual name of one of the parties, be sure to procure both signatures—for by so doing they bind themselves to subsequently execute the deed as provided for in the contract. Failure to procure both spouses' signatures has resulted in one spouse subsequently defeating the transaction by refusing to sign the deed and thereby convey their respective dower or curtesy interest.

(15) Agreement to pay Commission: Enter the amount of your commission in dollars and cents. Do not enter "6% of selling price" for if it should subsequently develop that your seller is unable to supply marketable title, the hand money would be returned to the buyer and the broker's efforts would result in "no sale." Simple mathematics will show that 6% of "no sale" will equal no commission. By inserting the amount of commission in dollars and cents there can be no misunderstanding as to amount of money which the seller has obligated himself to pay for broker's services; payable even though the owner is subsequently unable to deliver marketable title.

The following forfeiture clause refers back to the forfeiture mentioned in Item 7 of the Earnest Money form, and provides that the broker shall retain out of the hand money forfeited to the seller, the full extent of his agreed upon commission with residue, if any, over to the seller as liquidated damages.

Procure here signatures of all parties named as "sellers" (Item 14). As previously stated, the "Closing Instructions and Agreement to pay Commission" portion of the Earnest Money agreement appears only on the owner's copy and the broker's original.

Completed contract copy of the Earnest Money form can now be delivered to seller.

(16) It is requisite that under Board rulings the broker deliver back to the purchaser a completed copy of the agreement showing seller's acceptance. This delivery can be made either manually and acknowledged by the purchaser or can be delivered by registered mail with return receipt attached.

The remaining original should be filed in the broker's Closing Statement Deal Envelope or Deal Folder for safekeeping and subsequent reference pending the closing of the transaction and the compiling and submitting of Broker's Closing Statement to the buyer and seller.

EXCHANGE CONTRACTS

Provide for dual commission and are sometimes quite difficult to handle on one or more earnest money receipt forms. Special forms of "Exchange Contracts" are available and are recommended for use in exchange transactions.

Earnest Money Receipt and Agreement to Purchase Problem

1 On February 1, 1968 Robert Buyer and Sally
2 Buyer, husband and wife, offer to purchase the property belonging to John Seller and Mary Seller as listed on January 6, 1968.

The following data is for your guidance. Compare this information with the text and the illustrated form.

1–13 **Offer to Purchase By:** Robert Buyer and Sally Buyer, husband and wife, 421 Mountainview Drive, Salem, Oregon, Phone 364-4658.

5 **Offer:** $15,000.00. Purchaser agrees to assume and pay existing mortgage with balance to be adjusted to closing date. Remainder due on

Form No. 871
Copyright 1944, KO
Stevens-Ness Law Publishing Co.
Portland, Oregon

EARNEST MONEY RECEIPT

City Salem State Oregon February 1, 1968

RECEIVED FROM Robert Buyer and Sally Buyer, husband and wife (hereinafter called "purchaser")

the sum of One Thousand and no/100 ..... Dollars ($ 1,000.00)

in the form of Check (CASH, CHECK, DRAFT) as earnest money and in part payment for the purchase of the following described real estate situated in the City of Salem, County of Marion, State of Oregon to-wit:

Lot 6, Block 10, Yew Park Addition, also known as 280 Yew Park Drive

which we have this day sold to said purchaser

for the sum of Fifteen Thousand and no/100 ..... Dollars ($15,000.00)

on the following terms, to-wit: The sum, hereinabove receipted for, of One Thousand and no/100 Dollars ($ 1,000.00);

* {On ..... 19 ....., as additional earnest money, the sum of Three Thousand Eight Hundred Dollars ($ 3,800.00);
{On owners acceptance,

Upon acceptance of title and delivery of * {deed, [redacted] the sum of ..... Dollars ($ .....);

Balance of Ten Thousand Two Hundred and no/100 ..... Dollars ($10,200.00)

payable as follows: Assume and agree to pay balance of existing mortgage adjusted to date of closing, balance in cash. Balance on mortgage as of January 1, 1968, $10,200.00 payable $85 per month including interest at 6% per annum. Seller to pay paving assessment balance of $284.00 plus accumulated interest at 6% paid to March 1, 1967. (See exhibit A attached and by reference made a part hereof.)

A title insurance policy from a reliable company insuring marketable title in seller is to be furnished purchaser in due course at seller's expense; preliminary to closing, seller may furnish a title insurance company's title report showing its willingness to issue title insurance, which shall be conclusive evidence as to seller's title; [redacted]

It is agreed that if seller does not approve this sale within the period allowed broker below in which to secure seller's acceptance, or if the title to the said premises is not insurable or marketable, or cannot be made so within thirty days after notice containing a written statement of defects is delivered to seller, the said earnest money shall be refunded. But if said sale is approved by seller and title to the said premises is insurable or marketable and purchaser neglects or refuses to comply with any of said conditions within ten days after the said evidence of title is furnished and to make payments promptly, as hereinabove set forth, then the earnest money herein receipted for shall be forfeited to seller as liquidated damages and this contract thereupon shall be of no further binding effect.

The property is to be conveyed by good and sufficient deed free and clear of all liens and encumbrances except zoning ordinances, building and use restrictions, reservations in Federal patents, easements of record and, Existing mortgage of record as described above.

All irrigation, plumbing and heating fixtures and equipment (including stoker and oil tanks but excluding fire place fixtures and equipment), water heaters, electric light fixtures, light bulbs and fluorescent lamps, bathroom fixtures, venetian blinds, drapery and curtain rods, window and door screens, storm doors and windows, attached linoleum, attached television antenna, all shrubs and trees and all fixtures except 3 patented rose bushes.

are to be left upon the premises as part of the property purchased. The following personal property is also included as a part of the property for said purchase price: 1 G.E. automatic washer

Seller and purchaser agree to pro rate the taxes which are due and payable for the current tax year. Rents, interest, premiums for existing insurance and other matters shall be pro rated on a calendar year basis. Adjustments are to be made as of the date of the consummation of said sale or delivery of possession, whichever first occurs. Encumbrances to be discharged by seller may be paid at his option out of purchase money at date of closing.

Possession of said premises is to be delivered to purchaser on or before March 1, 19 68, or as soon thereafter as existing laws and regulations will permit removal of tenants, if any. Time is the essence of this contract. The purchaser's rights herein are not assignable without written consent of seller.

Address 1020 A Street, Salem, Oregon A. Broker, Broker

Phone 364-4362 By .....

AGREEMENT TO PURCHASE

I hereby agree to purchase the above property and to pay the price of $15,000.00, as set forth above and grant to said agent a period of 5 days hereafter to secure seller's acceptance hereof, during which period my offer shall not be subject to revocation. Said deed or contract to be in name of February 1, 19 68

Robert Buyer and Sally Buyer, husband and wife.

Address 421 Mountainview Drive Purchaser Robert Buyer (SEAL)

Phone 364-4658 Sally Buyer (SEAL)

AGREEMENT TO SELL

I hereby approve and accept the sale of above described property and the price and conditions as set forth in above contract, and agree to furnish evidence of title as above provided; also the said deed when stated. 2:30 p.m., February 2, 19 68

Address 280 Yew Park Drive Seller John Seller (SEAL)

Phone 364-8442 Mary Seller (SEAL)

The PURCHASER'S COPY SHOWING SELLER'S ACCEPTANCE should be promptly delivered to purchaser either manually or forwarded to him by U. S. Registered mail with request for return receipt. Prepare for mailing and seal in presence of witness.

February 3, 19 68

The undersigned purchaser acknowledges receipt of the foregoing earnest money receipt bearing his signature and that of the seller showing acceptance.

Purchaser Robert Buyer

PURCHASER'S COPY BEARING COPY OF SELLER'S SIGNED ACCEPTANCE prepared for mailing and sealed in presence of .....

Sent by U. S. Registered mail on ....., 19....

Receipt card received and attached to Broker's copy ....., 19....

SELLER'S CLOSING INSTRUCTIONS

February 2, 19 68

I agree to pay forthwith to the above named broker a commission amounting to $900.00 for services rendered in this transaction. In the event of a forfeiture of the deposit as above provided, the said deposit shall be paid to or retained by the broker to the extent of the agreed upon commission with residue to the seller. I authorize said broker to pay out of the cash proceeds of sale the expense of furnishing evidence of title, of recording fees and revenue stamps, if any, as well as any incumbrances on said premises payable by me at/or before closing. I acknowledge receipt of a copy of this earnest money receipt bearing my signature(s) and that of the purchaser named above.

NOTE: IF ANY BLANK SPACES ARE INSUFFICIENT, USE S-N No. 810 "HANDY PAD", TO BE SEPARATELY SIGNED BY BUYER AND SELLER.

Seller John Seller (SEAL)

Mary Seller (SEAL)

Cr. 556

BROKER'S COPY - FILE IN DEAL ENVELOPE

* STRIKE WHICHEVER PHRASE NOT APPLICABLE

FOR INSTRUCTION AND EXAMINATION PURPOSES - NOT FOR COMMERCIAL USE.

property will be paid in cash at time of closing. Offer good for 5 days.

14 **Acceptance:** February 2, 1968, at 2:30 p.m.

3 **Earnest Money Deposited:** $1,000 check on Commercial Bank, Salem, Oregon.

5–8 **Encumbrances:** Purchaser assumes and agrees to pay first mortgage. Payable not less than $85.00 per month including interest at 6% per annum. Balance due on mortgage was $10,-200.00 as of January 1, 1968. Balance to be assumed by purchaser, is to be computed as of the date of possession.

11 **Possession:** March 1, 1968. Purchaser to complete and close the deal as of that date.

L17 **Taxes:** The 1967-68 tax assessed on the property is $192.00, paid in advance by the seller.

L17 **Insurance:** The improvements are covered by fire insurance in the amount of $12,000.00 written for a three year period effective December 1, 1967, and the three year premium paid in advance was $72.00.

5 **Assessments:** The property is subject to an outstanding balance of municipal assessments in the sum of $284.00 to be paid by seller on closing. Interest at 6% paid to March 1, 1967.

9 **Exclusions:** Three patented rose bushes.

9 **Inclusions:** G. E. Automatic washer.

16 Purchaser's copy of Earnest Money Receipt was delivered to him in person February 3, 1968.

Exhibit A

CLOSING: Purchaser to complete and close the transaction as of March 1, 1968.

Taxes: The 1967-68 tax assessed on the property is $192.00, paid in advance by the seller.

Insurance: The improvements are covered by fire insurance in the amount of $12,000.00 written for a three year period effective December 1, 1967, and the three year premium paid in advance was $72.00.

John Seller
Mary Seller

Robert Buyer
Sally Buyer

(**Note:** The Earnest Money Receipt is a complete contract. Frequently the blank spaces are insufficient and all of the pertinent data is not included. The buyer is entitled to know what costs he will be obliged to pay at closing. Information that can not be placed in the blanks of the Earnest Money Receipt should be made a part of the contract by either the use of the back of the form or an attachment. Stevens-Ness offers a blank form for this purpose, or a sheet of paper marked and identified as a part of the contract can be attached.)

Closing Statement

The terms of the listing agreement make no provision obligating a broker to close a real estate transaction. A broker has completed his employment and earned his commission when he finds a buyer whose offer meets the terms of the listing, or any other terms acceptable to the seller. (See excerpt 5.)

If a broker does not assume the responsibility for closing a transaction, he has only the following duties to perform:

(a) If a transaction is being closed by a title insurance company, escrow agent or attorney, he must immediately pay all earnest money which he has received in the transaction to that third party to disburse, or deposit the earnest money in his trust account as required by Rule 10-025 of the Real Estate Board and hold this earnest money in readiness to be disbursed upon the closing of the transaction.

(b) He must see to it that both the buyer and the seller receive complete closing statements and that he has a true copy thereof in his own files. (See 10-030.)

If a broker takes the responsibility of closing a transaction he owes the following responsibilities to the parties:

(a) The transaction must not be closed by a salesman except under authority and supervision of the broker. He is responsible for all of the acts of the salesman or of an employee if he delegates this job.

(b) He must deposit all monies received in the transaction, immediately upon their receipt, in a separate bank account maintained by him for that purpose. This money must be retained in this bank account until the transaction is closed. In depositing the money he must indicate on his deposit slip the names of all parties involved in the transaction. He must keep a complete record in his office showing all amounts received and disbursed in the transaction. This record must be kept available for the inspection of the Real Estate Commissioner's office.

(c) He must give to both the buyer and the seller a complete, detailed closing statement showing all receipts and disbursements handled by him and must retain a copy thereof in his files.

(d) If the broker assumes the responsibility of computing the various adjustments in the transaction, he must be sure that he has obtained all of the pertinent facts in relation thereto and that his computations are correct. He is, in this situation, personally liable for all errors in his computation and for any negligence in his failure to determine the facts with relation to the adjustments.

The growing popularity of escrow closing, with the parties dividing the escrow fee, will eliminate many misunderstandings and complaints common to many small offices doing their own closing.

On the other hand, every broker should be familiar with closing techniques in order to be able to clearly explain the charges and credits shown in a closing statement.

No broker should assume to pass upon the validity or necessity of the legal documents used in closing a transaction.

LITTLE THINGS THAT CAUSE TROUBLE

Most loans have prepayment penalties, and these vary widely on conventional loans. Some lenders charge additional interest on FHA loans in addition to the allowable prepayment penalty.

Many assumable loans have assumption fees, which vary considerably.

Some conventional loans have acceleration clauses, which can cause the interest on an assumed loan to rise. Sometimes a loan brokerage fee is asked on an assumed loan. Drawing and recording of documents add to closing costs. A brokerage fee on a new loan could be an added cost.

Buyers are sometimes shocked to learn that the estimated closing costs did not include the assumption of the reserve account.

On the plus side, an alert broker, transferring title to a property having secondary financing, earns respect if he explores the possibility of a discount for cash.

KEEP IT SIMPLE

The closing statement has always been a real problem in the real estate industry.

There are two very acceptable types of closing statements. One is set up on a "debit" and "credit" basis. In bookkeeping or accounting this is known as a "T" account; it is so called because debits are entered on the left side of "T" and credits on the right side with the total of each column being equal.

This type of closing statement is extremely professional and is very fine IF the broker is knowledgeable of accounting methods and so are both the seller and buyer; or if either buyer or seller is not, the broker is willing and able to take the time at a closing to explain the statement in a manner that the person completely understands.

However, it is not sufficient to merely state that a certain item is a "debit" or "credit", with an attitude or tone of voice that suggests a person of course knows what a credit or debit is. And if not, he is obviously stupid. Another hazard of this type of closing statement is that the same particular item may be EITHER a "debit" or a "credit", depending on to whose account it is posted.

The second type of statement is that commonly referred to as "single entry". This type of statement does not have the professional accounting appearance of the double entry type statement. However, it is easily understood by all parties to a transaction even if they have no knowledge of accounting terminology.

It is recommended that you use whichever type of closing statement you find most comfortable and convenient for yourself and your clients, but if in doubt, use the second type. Most of the standard closing forms combine a little of each type.

STANDARDIZED CLOSING STATEMENTS

Lack of uniformity in the preparation of closing statements always has been a thorn in the side of real estate practitioners.

The closing statement in a real estate transaction deals primarily with figures, and all these figures affect the accounts of both the buyer and the seller. These statements can have a direct bearing on the individual's financial statement or income tax.

Nothing destroys confidence faster than for the buyer at the time of the closing to find out that he owes additional money. To prevent such a situation the broker should know or make a reasonable estimate as to taxes, insurance, tenant's rent and water bills long before the closing date.

There are so many things to remember while collecting the necessary items for the closing statement that some successful offices use a check list. The more printed forms, reminders and tables you acquire and use the easier and more accurate is the closing.

Here is where you make future sales—follow through—make certain there has been an examination of title, that there has been a transfer of insurance policies, that prorating of taxes and other charges are correct, that all documents (deed, mortgage, chattel mortgage and leases) have been recorded, that utilities services have been transferred and leases assigned.

The apportionment of income and expense items will be more readily followed if computed according to some uniform pattern. In the absence of an official custom in Oregon it is suggested that the following rules be followed:

1. All adjustments of interest, rents, taxes, water rates and insurance premiums shall be made to the day on which title is closed.
2. Interest, rents, taxes, water rates and insurance shall be computed by the 360-day method, each month representing 1/12th of the annual charge and each day 1/30th of the monthly charge.
3. Where the period for which the computation of interest, rents, taxes, water rates and insurance is to be made is more than one month, the elapsed time shall be computed by full months and by the actual number of days in excess of such full months.
4. Where the period for which the computation of interest, rents, taxes, water rates and insurance is to be made is less than one month, the actual number of days shall be counted, excluding the first day and including the last.

NOTE: These rules mean that the seller shall be charged with interest, taxes, water rates and insurance to and including the day immediately preceding the day on which title is closed and that the purchaser shall bear these items from the day on which title is closed and receive the rents from that day.

HOW TO PRORATE

The above rules are desirable because they create uniformity and thus reduce the always present danger of misunderstandings.

It must be remembered, however, that the rules can always be altered or resolved by agreement between the parties. The most important rule is that there be agreement and full understanding on the part of each party to a transaction.

In arriving at what period of time taxes, insurance and interest are to be charged, the simplest and most accurate method is the year, month and day subtraction.

If a transaction closed March 1, 1968, and the seller paid the 1967-68 taxes in advance we will

find the period of time for which the buyer must be charged as follows:

68– 7–1 taxes paid to

68– 3–1 prorated to

4 months taxes to be paid by buyer

The improvements on the property are covered under a three-year fire insurance policy issued December 1, 1967. The seller had paid the three-year premium in advance. Our proration is as follows:

70–12–1 premium paid to

68– 3–1 prorated to

2– 9–0 buyer owes for 2 years, 9 months of unearned insurance premium

A balance is still due on a paving lien, plus interest at 6% from March 1, 1967, both of which the seller will pay. We compute as follows:

68– 3–1 interest due to

67– 3–1 interest paid to

1 buyer must pay interest for one year.

Proration rules and the mechanics of computation are found in the mathematics section of the Manual.

STUDY OF THE CLOSING STATEMENT

The information required for the final closing is shown in the listing agreement and Earnest Money Receipt problem and illustration. Check each item through to the final distribution of funds as shown on the closing statement.

The members of the Real Estate Board place considerable weight in the points allowed for preparing the closing statement in the brokers' examination. For those who are preparing for this examination we suggest that after you have thoroughly studied this problem that you prepare similar problems, using standard forms. Also our files reveal that some brokers already licensed could spend some time which would prove very valuable to them if they would carefully review this section.

STEVENS-NESS FORM NO. 669

The use of this form will not be so complicated if you will keep 4 things in mind.

1. The purchaser's debits are those items which the purchaser must pay, including the price of the property.
2. The purchaser's credits are those items which the buyer will pay in the future, the rent which may have been collected in advance by the seller and the money which has been paid by the buyer as earnest money, an additional payment if any and the cash paid on closing.
3. The seller's credit is an itemized list of the moneys shown in the purchaser's credits. This is the cash which the broker has in his Clients' Trust Account.
4. Charges against seller is an itemized list of the obligations of the seller which are being paid by the broker. After these have been paid by the broker from the funds of this sale in the Client's Trust Account, the balance will be paid to the seller.

Every broker and salesman should be able to prorate taxes, fire insurance premiums and rents and compute interests on mortgages, taxes and city liens. Keep in mind the recording fees to be paid by the purchaser and seller.

IMPORTANT NOTICE

Frequently in the real estate examination, the printed Closing Statement form is not used. The applicant is supplied with plain white sheets of paper on which to prepare the closing statement for the seller and the closing statement for the buyer. Examples are found in this section.

Closing Statement Problem

As of March 1, 1968 we are ready to prepare the Closing Statement in accordance with the terms as shown on the Earnest Money Receipt.

1 **Seller:** John Seller and Mary Seller, husband and wife.

2 **Buyer:** Robert Buyer and Sally Buyer, husband and wife.

3 **Description of Property:** Lot 6, Block 10, Yew Park Addition to Salem, Marion County, Oregon.

4 **Purchase Price:** $15,000.00.

5 **Date of Closing:** March 1, 1968.

6 **Earnest Money Receipt:** $1,000.00. Check Commercial Bank, Salem, Oregon.

7 **Mortgage Assumed:** Buyer is to assume balance of mortgage of $10,131.83 as of March 1, 1968. (The principal amount of $10,200.00 owing on January 1, 1968 has been reduced by payments made by the seller.)

8 **Taxes:** The 1967-68 taxes assessed on the property are $192.00, paid in advance by the seller.

9 **Insurance:** The improvements are insured by fire insurance in the amount of $12,000.00 written for a three year period effective December 1, 1967, and the three year premium paid in advance was $72.00.

10 **Utilities:** The estimated water bill to date of closing is $4.50. To be assumed.

11 **Title Insurance:** To be paid by seller, $91.25.

12 **Assessments:** A balance of $284.00 plus interest is still due on a paving lien. Interest paid to March 1, 1967.

13 **Recording Fee:** A deed recording fee of $1.50 is to be paid by purchaser.

Form No. 669
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STEVENS-NESS LAW PUBLISHING CO.
Portland, Oregon

REAL ESTATE BROKER'S CLOSING STATEMENT

USE COMPANION FORM NO. 670, REAL ESTATE BROKER'S DEAL ENVELOPE, OR 670F (Letter Size) or 670FL (Legal Size) BROKER'S DEAL FOLDER, IN COMPILING THIS INFORMATION.

5 Deal No. 1301 City Salem, State Oregon, March 1, 1968

1 Property of: John Seller and Mary Seller, husband and wife Seller

2 Sold to: Robert Buyer & Sally Buyer, husband & wife, by A. Broker Broker

3 Description: Lot 6, Block 10, Yew Park Addition, Street address 280 Yew Park Drive

City of Salem County of Marion State of Oregon

7 Selling price and terms: Purchaser assumes and agrees to pay mortgage and pays equity in cash. Taxes and insurance premiums to be prorated to March 1, 1968. Paving assessment to be paid by seller. Price $15,000.00.

PURCHASER'S STATEMENT

4

PURCHASER'S DEBITS (In items 1 to 11 below, show all sums to be paid or assumed by purchaser.)

Item		
1. Purchase price	$15,000.00	
9 2. Pro rata taxes paid in adv. by seller	64.00	
3. Unearned insurance premium, fire	66.00	
4. Unearned insurance premium, liability		
5. City liens, paid in advance by seller		
6. Rents adjusted		
13 7. Recording fees payable by purchaser	1.50	
8. Purchaser's share of expenses: Atty. $ Bank $		
Escrow fee $ Survey $ (see item 40)		
9.		
10.		
11.		
12. TOTAL DEBITS (Items 1 to 11 incl.)	$15,131.50	

(ITEM 12 AND ITEM 24 SHOULD TALLY)

PURCHASER'S CREDITS (In items 13 to 23 below, show all cash paid, credits for mortgages and contract balances, given or assumed by purchaser and all other credits available to him.)

Item		
13. Earnest Money deposited	$1,000.00	6
14. Buyer's unpaid balance on contract		
15. Mortgage given to seller		
16. Mortg., premises conveyed subject to	10,131.83	
17. Taxes, assumed		
18. City liens (if included in sales price)		
19. Rents, collected in advance by seller		
20. Unpaid water rents, assumed	4.50	10
21.		
22.		
23. *CASH PAID ON CLOSING	3,995.17	
*(Total items 13-22 incl. and deduct from item 12)		
24. TOTAL CREDITS (Items 13 to 23 incl.)	$15,131.50	

Has all insurance been transferred? Yes X No

Will buyer let us handle insurance renewal at time of expiration?

Abstract ( ) Title insurance (X) delivered to Buyer

Title insured by Policy No.

The foregoing statement is hereby certified to be correct. A. Broker Broker

Receipt of foregoing Purchasers Statement acknowledged 3/1/1968

Robert Buyer Purchaser

Sally Buyer Purchaser

→ Purchaser is entitled only to above information. After filling out both statements detach and destroy this portion before obtaining purchaser's signature. ←

SETTLEMENT WITH SELLER

RECEIPTS TO SELLER'S CREDIT (In items 25 to 33 below, list only actual cash received by broker in transaction.)

Item		
25. Earnest money, (see item 13)	$1,000.00	
26. Cash paid on closing (see item 23)	3,995.17	
27.		
28.		
29.		
30.		
31.		
32.		
33.		
34. TOTAL RECEIVED (Items 25 to 33 incl.)	$4,995.17	

(ITEM 34 AND ITEM 43 SHOULD TALLY)

CHARGES AGAINST SELLER (In items 35 to 42 below, list only the commission and the broker's actual cash disbursements.)

Item		
35. Abstract or title insurance	$ 91.25	11
36. Revenue stamps		
37. Recording fees payable by seller		
38. Broker's Commission	900.00	
39. Recording fees paid by purchaser (see item 7)	1.50	13
40. Purchaser's share of expenses (see item 8)		
41. Seller's share of expenses: Atty. $ Bank $		
Escrow fee $ Survey $		
City Lien	284.00	12
Interest on lien Mar. 1, 1967		
to Mar. 1, 1968	17.04	12
42. *CHECK NO. ATTACHED		
BALANCE DUE SELLER	$3,701.38	
*(Total items 35-41 incl. and deduct from item 34)		
43. TOTAL DISBURSED (Item 35 to 42 incl.)	$ 4,995.17	

The foregoing statement is hereby certified to be correct.

A. Broker Broker

Receipt of $ 3,701.38 is hereby acknowledged in full settlement of the proceeds of the above sale, also a true copy of the foregoing statement.

March 1, 1968

John Seller Seller

Mary Seller Seller

FOR INSTRUCTION AND EXAMINATION PURPOSES - NOT FOR COMMERCIAL USE

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Closing Statement
Purchaser's Copy

Deal No. 1301 March 1, 1968 Salem, Oregon

Property of John Seller and Mary Seller, husband and wife, sold to Robert Buyer and Sally Buyer, husband and wife, by A. Broker, a real estate broker.

Description: Lot 6, Block 10, Yew Park Addition to the City of Salem, Marion County, Oregon.

Selling price and terms: $15,000.00. Purchaser assumes and agrees to pay mortgage balance of $10,131.83 and pays equity in cash. Taxes and insurance premium prorated to this date. Purchaser given credit for assuming unpaid water bill. Paving assessment and accumulated interest paid by seller.

Paid or Assumed by Purchaser		Purchaser's Credits	
Purchase price	$15,000.00	Earnest money paid 2/1/68	$ 1,000.00
Prorate 1967-68 tax	64.00	Mortgage balance assumed	10,131.83
Prorate insurance premium	66.00	Unpaid water bill assumed	4.50
Recording of deed	1.50		
TOTAL OBLIGATIONS	$15,131.50	TOTAL CREDITS	$11,136.33

CASH PAID ON CLOSING $3,995.17

The foregoing statement is hereby certified to be correct.

A. Broker *Broker*

Receipt of foregoing Purchaser's Statement acknowledged March 1, 1968.

Robert Buyer *Purchaser*

Sally Buyer *Purchaser*

Closing Statement
Seller's Copy

Deal No. 1301 March 1, 1968 Salem, Oregon

Property of John Seller and Mary Seller, husband and wife, sold to Robert Buyer and Sally Buyer, husband and wife, by A. Broker, a real estate broker.

Description: Lot 6, Block 10, Yew Park Addition to the City of Salem, Marion County, Oregon.

Selling price and terms: $15,000.00. Purchaser assumes and agrees to pay mortgage balance of $10,131.83 and pays equity in cash. Taxes and insurance premium prorated to this date. Purchaser given credit for assuming unpaid water bill. Paving assessment and accumulated interest paid by seller.

Purchase price	$15,000.00		
Prorate 1967-68 tax	64.00		
Prorate insurance premium	66.00		
Recording of deed	1.50		
Total obligation of purchaser		$15,131.50	
Earnest money paid 2/1/68	1,000.00		
Mortgage balance assumed	10,131.83		
Unpaid water bill assumed	4.50		
Total credits to purchaser		11,136.33	
CASH PAID ON CLOSING			$3,995.17
Charges against seller:			
Title insurance policy	91.25		
Broker's commission	900.00		
Recording fee paid by purchaser	1.50		
City lien and interest	301.04		
Total charges against seller		1,293.79	
BALANCE DUE SELLER			3,701.38
Total Cash Received	$4,995.17		
Total Disbursed	$4,995.17		

The foregoing statement is hereby certified to be correct.

A. Broker *Broker*

March 1, 1968

Receipt of $3,701.38 is hereby acknowledged in full settlement of the proceeds of the above sale, also a true copy of the foregoing statement.

John Seller *Seller*

Mary Seller *Seller*

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REAL ESTATE MATHEMATICS

INTRODUCTION

The Real Estate profession is faced with the problems inherent in any profession which is trying to upgrade the quality of its service to the public. The results of examinations given to real estate licensee applicants has proved that the area of arithmetic is in definite need of improvement. Far too many applicants fail the examination for broker as well as salesman because of an inability to be facile in the handling of numbers. The use of numbers in the communication process is growing more rapidly than the use of words. The automated processes of the age rely on precise skill in the use of numbers. The average citizen is faced with increasing number problems when he uses his telephone, mails a letter, applies for a position, or uses his credit card.

This section of the Manual is not intended to be a complete review of all the problem areas that will confront the salesman, but it is a hope that proper study of the text material and a working of the problems will help review the applicant on the basic computational areas. There is a short bibliography of currently published Business Mathematics and Business Arithmetic texts at the end of the section, should you desire or need to review in depth some of the arithmetic subjects that are indistinct in your memory.

Computation of Areas

AREAS OF FLAT SURFACES

When you wish to find the area, or amount of surface, you use square units of measure. In order to understand these units and their relationship to each other, you will need to review certain facts about the rectangle and the square. A *rectangle* is a four-sided figure whose opposite sides are equal and whose angles are right angles. A *square* is a rectangle all of whose side are equal.

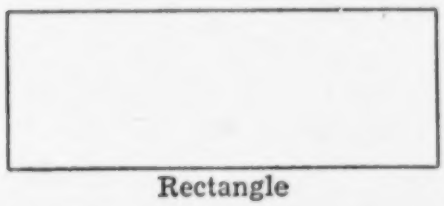

Rectangle

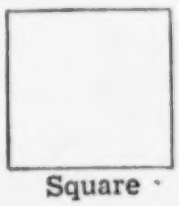

Square

The area of a rectangle is found by multiplying its length by its width when the two dimensions are expressed in terms of the same linear unit. The short way of writing a rule is called a formula. The formula for the area of a rectangle is:

$$A = l \times w \qquad \text{or} \qquad A = lw$$

where A is the area, l the length, and w the width.

Since the square is a particular kind of a rectangle, we find its area in the same way as the area of a rectangle.

From the diagrams below you can see that the area of a triangle, or three-sided figure, is half the area of the rectangle. The height of a triangle is called its *altitude;* the side upon which the triangle seems to rest is called its *base*. The *area of a triangle is equal to half the product of its base and its altitude* when these two dimensions are expressed in terms of the same linear unit. The formula for the area of a triangle may be written as:

$$A = \tfrac{1}{2} \times b \times h \qquad \text{or} \qquad A = \tfrac{1}{2}bh$$

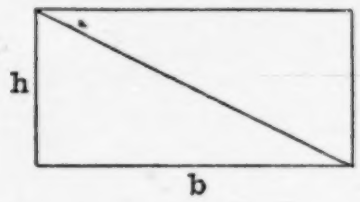

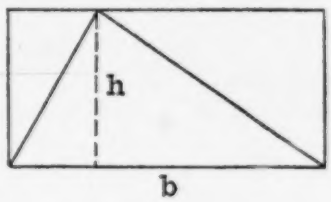

UNITS OF AREA

The units of area are all squares. The square inch is a square one inch on each side. A square foot is a square one foot on each side. You will be able to visualize a square foot if you lay four rulers, each one foot iong, so that they form a four-sided figure whose corners are right angles. The square yard is a square which is one yard on each side. Other units of square measure are the square rod, the acre, and the square mile.

Table of Square Measure

12 × 12 or 144 sq. in.	= 1 sq. ft.
3 × 3 or 9 sq. ft.	= 1 sq. yd.
5½ × 5½ or 30¼ sq. yd.	= 1 sq. rd.
160 sq. rd.	= 1 acre (A)
640 A	= 1 sq. mile

MEASUREMENT OF A CIRCLE

To find the circumference (distance around) of a circle, multiply the diameter (distance across) by 3.1416 (Pi).

To find the diameter divide the circumference by 3.1416.

To find the area of a circle, multiply the circumference by ½ the radius (distance from center to circumference); or multiply diameter × diameter × .7854 (¼ Pi); or multiply radius × radius × 3.1416. The result will be in square units.

MEASUREMENT OF A CYLINDER OR BUCKET

To find the volume of a cylinder first find the area of one base (a circle) and multiply it by the length.

To find the volume of a bucket, with different size ends, find the area of each end (both circles) and add them together, then divide this sum by 2 and multiply by the height of the bucket.

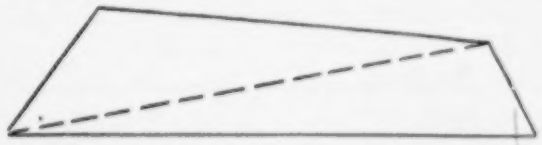

A "trapezium" has 4 sides, of which no sides are parallel. To find the area draw a dividing line forming two triangles. Multiply the length of the base × ½ the height of each, and add the two for the total area.

called the straight-line depreciation rate. This system is the easiest to understand because once the rate is established the calculation is the same each year regardless of the actual wear and tear on the property.

The present tax laws recognize the straight-line method as well as the declining balance method and the sum of the years-digits method. Discussion of each of the alternative methods will not be presented here but the methods should be studied *thoroughly* before advice is given to an income property owner regarding the particular method he should use in his tax preparation.

STRAIGHT-LINE METHOD

The average annual depreciation is often expressed as a per cent of the original cost under the straight-line method of spreading the total depreciation. The average annual depreciation therefore represents part; and the original cost represents the base, or whole, with which the part is compared. The formula would be as follows:

$$\text{Rate of Depreciation} = \frac{\text{Average Annual Depreciation}}{\text{Original Cost}}$$

Another way of saying the same thing, is to take the total original cost of a building and divide that number by the number of years that the property will have a useful life. The result will be the amount of the annual depreciation. Thus,

$$\text{Annual Depreciation} = \frac{\text{Original Cost}}{\text{Length of Life of the Property}}$$

In the calculation of depreciation, the cost of the land is always *excluded*. Land does not depreciate and hence should not be involved in the cost computation.

The calculation of depreciation becomes more involved when an older building or a home is being sold. Assuming that the annual rate of depreciation has been determined it is then possible to estimate the present value of the structure after knowing how many years the building has been standing. For example, if a ten year old building has been depreciating at the rate of 2% per year, what then is the present value quoted in terms of a percentage of its original value? Since the building has been depreciating 2% per year for 10 years, then 20% of its value must have been used leaving 80% still to be depreciated.

PROBLEMS:

1. The value of a house at the end of four years was estimated to be $8,725. What was the original cost of the dwelling if the annual rate of depreciation was 4¼%?

Steps: a. If the house depreciated 4¼% each year and it is four years old, then it must have depreciated 17% over the period. (4¼% × 4 years)

b. If the value has been reduced by 17% from original value, which is always stated in terms of 100%, then the current undepreciated value of the house would be 83%.

c. If the house is worth $8,725 after four years of use, then this figure is equal to 83% of the original cost.

d. To find original value of the house, divide $8,725 by 83%, or $8,725 divided by .83 and the result of the division would reveal that the original estimated value was $10,512.04.

2. The value of a house at the end of six years was estimated to be $7,650. What was the original cost of the dwelling if the annual rate of depreciation was 2½%?
3. In purchasing an eight year old house, an appraiser estimated present value at $23,400. If the rate of depreciation is 2¾% a year (straight-line) from the original value, what was the original value?

PRORATION RULES

Prorating means adjusting taxes, insurance, rents and interest to determine two things:

1. Whom to charge and for what period of time.
2. Amount of money to charge.

In determining whom to charge and for what period of time you need only the closing date and the date to which the item has been paid.

Remember, if the item is paid beyond the closing date there is a charge against the buyer. If the item was paid short of the closing date there is a charge against the seller.

To determine the time period for the charge use the "year, month and day" method of subtraction.

Taxes

Closing date, December 1, 1967.

1967-68 taxes paid to July 1, 1968.

Year	Month	Day
68	7	1
67	12	1
—	—	—
0	7	0

In this example the buyer is charged for taxes for 7 months.

You will notice that under the month column we were unable to subtract 12 from 7 so we borrowed a year, 12 months, from the year 1968 and subtracted 12 from 19.

Closing date December 15, 1967

Taxes paid to July 1, 1968

Year	Month	Day
68	7	1
67	12	15
—	—	—
0	6	16

Because we can not subtract 15 from 1 under the day column we borrowed one month, 30 days, from the 7 in the month column, and then borrowed a year, 12 months, from the year column. This made our problem look like this:

Year	Month	Day
67	18	31
67	12	15
—	—	—
0	6	16

Buyer is charged with 6 months and 16 days.

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Insurance

Policy period from June 1, 1966, to June 1, 1969.
Closing date: February 1, 1968.

Year	Month	Day
69	6	1
68	2	1
1	4	0

Buyer's share = 1 year and 4 months.
Policy period from June 1, 1966, to June 1, 1969.
Closing date: March 12, 1968.

Year	Month	Day
69	6	1
68	3	12
1	2	19

Rents

Apartment unit paid from July 10, 1968, to August 10, 1968.
Closing date: July 19, 1968.

Year	Month	Day
68	8	10
68	7	19
0	0	21

Buyer receives credit for 21 days.

Interest

Last payment on a mortgage was October 1, 1968.
Next payment is due November 1, 1968.
Closing date: October 20, 1968.

Year	Month	Day
68	10	20
68	10	1
0	0	19

19 days charged to seller.

Note: Since interest paid on October 1, 1968, is really the interest charge for the month of September, 1968, the November 1, 1968 payment will pay the interest for all of October, 1968.

The *buyer* will make the payment for the October, 1968 interest on November 1, 1968. Since the buyer will have to pay this, the buyer is entitled to a credit for 19 days, which is the seller's share of the October interest.

These rules mean:

The buyer is charged for day of closing for interest, taxes, and insurance.

The buyer receives the rent for the day of closing.

DETERMINING AMOUNT OF MONEY TO CHARGE

1. *Taxes and Interest:* Divide annual amount by 12 to find monthly amount.
   Divide monthly rate by 30 to find daily amount.
2. *Insurance:* If 3 year policy, divide by 36 to find monthly amount. Divide monthly rate by 30 to find daily amount.
3. *Rents:* Divide monthly rent by 30 regardless of number of days in month.

In your division problem carry the result to three places to the right of the decimal.
The solution to your proration problem is arrived at by multiplying the period of time you found by subtraction by the amount of money found by division.

PROBLEMS:

1. The property tax on a parcel of real estate is $180 per year. The taxes are due and payable on or before November 15 of the fiscal year. The buyer is to pay the taxes when due. How much would you charge the seller and credit the buyer if the taxes were prorated as of October 1st?

Year	Month	Day	
?	10	1	Closing date
?	7	1	Lien date
	3 months		

$180.00 ÷ 12 = $15.00 per month

3 months × $15.00 = $45.00

2. The buyer has agreed to purchase a piece of property on which the current taxes are still unpaid, amounting to $375.00 and the insurance premium for a three year period amounted to $90.00, which has been paid by the seller. The closing date is September 1, 1968. The insurance policy is from 9/1/66 to 9/1/69. How would you prorate the allowable expenses for each party?

INTEREST ON TAXES:

You must remember to account for interest on real property taxes not paid on the quarterly due dates.

Confusion exists in this area only because a person fails to keep in mind that interest is charged from the *DUE DATE* of each quarter *UNTIL PAID*, rather than from the beginning of the tax year or some other date.

Tax due dates are November 15, February 15, May 15, and August 15.

Remember that interest is due on each quarter after the passing of the quarterly due date. The buyer is given no credit for a discount taken by a seller for prepayment of taxes.

To determine an interest credit: 1. find the difference between the due date of the tax quarter in question and the closing date. (Use year, month and day method); 2. multiply the interest rate of 2/3 of 1% times tax for quarter; multiply interest per month times number of months delinquent to find taxes for that quarter.

EXAMPLE:

Taxes for 1967-68 tax year were $480. The closing date was May 1, 1968; none of the taxes are paid.

What is the interest for the first quarter?

Year	Month	Day	
68	5	1	taxes paid
67	11	15	1st quarter due
—	—	—	
	5	16	

(The interest rate on taxes is 2/3 of 1% per month or FRACTION thereof; therefore 1 day equals one month in interest)

In the above example the first quarter is delinquent 6 months.

¼ of $480 = tax due per quarter.
.00667 (2/3 of 1%) × $120 = .80040 or 80 cents interest per month.
.80 × 6 months = $4.80 interest 1st quarter.

Investments in Real Estate

GROSS INCOME VS. NET INCOME CONCEPTS

The broker or salesman is often approached by persons interested in learning about the value of an investment in real estate. Great care and caution must be given to questions of this type since the profession of real estate selling is being held to a high degree of accountability for the advice given.

The rent that a property owner receives from a tenant represents his *gross* income from the property. The *net* income is the amount remaining after deducting the ownership expenses from the gross income. The income and expenses are usually figured on an annual basis. The expenses should include all properly chargeable items such as taxes, insurance, repairs and upkeep, and interest on the mortgage if there is a mortgage on the property. These expenses are called cash expenses since they represent the amount of money that has been spent. The other type of expense for which there must be an allowance in the calculation of net income is depreciation. The decrease in the value of the property must be recognized as an expense just the same as an expense for which cash may have been spent.

DETERMINATION OF NET INCOME AND RATE OF INCOME

The annual net income on an investment in real estate is the amount remaining ofter deducting total annual expense from the annual total or gross income received from rent. The relationship can be expressed by formula as:

$$\begin{array}{l}\text{Annual Rental Income}\\ \text{minus Annual Expenses}\end{array} = \text{Annual Net Income}$$

To determine the rate of income from a real estate investment it is necessary to find out the amount of the owner's cash investment in the property and dividing the annual net income by the cash investment. Expressed by formula as:

$$\text{Rate of Income} = \frac{\text{Annual Net Income}}{\text{Cash Investment}}$$

FACTORS AFFECTING YIELD AND TOTAL INVESTMENT

The property owner may desire information as to the amount of rent to be charged to yield a certain rate of return on the investment. If the owner desires a stated rate of return on his investment, then the annual rental income must be sufficient to cover all annual expenses plus the amount of the net income desired. It might be stated in this manner:

$$\text{Annual Rental Income} = \begin{array}{c}\text{Annual Expenses}\\ \text{plus Annual Net Income}\end{array}$$

The monthly rent that should be charged can then be found by dividing the required annual rental income by 12.

When the problem arises of learning what total investment is necessary to provide an annual net income of a certain figure and the rate of income is known, the amount of the cash investment in the property can be found by dividing the annual net income by the rate of return. Thus:

$$\text{Cash Investment} = \frac{\text{Annual Net Income}}{\text{Rate of Return}}$$

PROBLEMS:

1. M. E. Cowan bought a two-family house for $11,000, paying $4,500 in cash and giving a 4½% mortgage for the remainder. The lot was valued at $1,500 and the building at $9,500. During the first year, he received $57.50 a month for rent of each apartment. In addition to the interest on the mortgage, he paid $239.50 for taxes, $27.00 for insurance, $175.00 for repairs and miscellaneous expenses, and allowed 2% of the value of the house for depreciation. What was the amount of the net income for the year?
2. L. M. Sisson purchased a house and lot as an investment for $6,000, paying $2,000 in cash and giving a 6% mortgage for the balance. The house rents for $55 a month. Besides interest on the mortgage, other annual expenses including depreciation amount to $320. What is Mr. Sisson's annual net income from the investment? Mr. Sisson's annual net income is what per cent of his *cash* investment?
3. A four-family house is purchased for $22,000, subject to a $15,000 mortgage at 5%. The annual expenses, in addition to interest on the mortgage, include $735 for taxes, $55 for insurance, $325 for repairs, and $600 for depreciation. What monthly rental to the nearest dollar must be charged each family in order that a net income of 6% may be realized on the investment.
4. Mr. Smith's annual net income from an apartment house is $1,995, which is 5% of his investment in the property. What is the amount of his investment?
5. An apartment house had a gross income of $1,250 per month with annual expenses of $5,900, including depreciation. What price would a buyer pay for the property to show a net return of 6¾% per annum on his investment computing the answer to the nearest cent?

FIGURING THE RATE OF CAPITALIZATION

This is repetition of the preceding explanation but many think of investments in real estate on the basis of "capitalization rates."

When thinking of capitalization rates, consider the equation: income divided by rate equals the value.

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Thus: I ÷ R = V. Because this is an algebraic equation if any 2 parts are known the third can be determined:

as above I ÷ R = V; or I ÷ V = R; or V × R = I

From the formula, it is evident that "capitalization" is the process of ascertaining the magnitude or worth or value of a capital good through the use of a rate. The rate is believed to represent the proper relationship between the capital good or property, and the net income it produces.

Q. A man has a sum of money on deposit in a savings bank which pays 2% interest on the deposit. The amount of his deposit in the bank is sufficient to give him an annual income of $1,000. How much money does he have in the bank?

A. Step 1. There are 3 different things to consider: the income, the interest rate, and the deposit. The first 2 are known: $1,000 and 2%. The third is unknown.

Step 2. As the rate expresses the income and the deposit, we can say that $1,000 is 2% of the deposit, or $1,000 ÷ .02 (I ÷ R) = $50,000 (V).

Q. A man owns an apartment building. His net income (after depreciation) from the property is $12,000. The rate of return expected by investors from this type of property in the area is 6%. What is the amount of capital in the property?

A. Step 1. Two things are known: the amount of the income, $12,000, and the rate which expresses the fixed relationship between the income and the value, 6%.

Step 2. If $12,000 is 6% of the figure which represents the value of the property, it is evident that the property is worth: $12,000 (I) ÷ .06 (R) = $200,000 (V). Thus the man has $200,000 capital in the property.

Calculation of Interest

INTEREST DEFINED

Real estate transactions usually involve the calculation of interest. Briefly defined *interest is the rent of money*. The landlord charges rent for the use of his property by the renter. Likewise, a lender makes a charge for the use of his funds by the borrower. In the latter case the money is rented. The interest charge is computed on the basis of an interest rate. Like most other rates, it is expressed as a per cent of value, such as 6%. This rate, unless otherwise stated, is considered to be the annual rate and referred to as per annum or for the year, and is that rate on each unit of $100 that is borrowed. Thus, the term "with interest at 6%" means that, if the borrower should hold the money for an entire year, the interest charge would be $6 for each $100 borrowed.

FINDING EXACT INTEREST

Although the 360-day year is used in most commercial transactions that involve interest, the United States Government, in interest computations, always uses 365 as the number of days in a year. The 365-day year, therefore is called a government year. The 365-day year is also referred to as an exact year, since it contains the actual number of days in the year. When interest is found by this method, it is called exact or accurate interest. For example, Mr. Gibbons borrowed $640 at 6% for 85 days. To find the exact interest on this principal you would substitute those facts known into the general interest formula: I = PRT

$$I = \$640 \times 6\% \times 85 \text{ days}$$
$$I = \$640 \times {}^{6}/_{100} \times {}^{85}/_{365}$$
$$I = \$8.94$$

This method is not used commonly in business transactions however, it is well to know how to perform the calculation as you may have a business deal with a unit of government.

When trying to figure the interest rate on a given amount of money due, consider the formula: Principal × Rate × Time = Interest (PRT = I).

Q. The amount of a note is $1,000 and the annual rate of interest on the note is 3%. How much interest will be paid on the note in one year?

A. Applying the formula, Principal ($1,000) × Rate (3%) × Time (1 yr.) = Interest ($30.00).

Q. If the interest rate is 4½% and the monthly interest payment is $21.25, what is the principal sum due?

A. *Step 1.* If the monthly interest payment is $21.25, then 12 times that amount would give the amount of interest paid in 1 year. Thus 12 × $21.25 = $255.

Step 2. Our formula now appears as: Principal (?) × Rate (4½%) × Time (1 yr.) = Interest ($255).

Step 3. To solve for the principal, state the formula as P = I ÷ RT. The interest ($255) divided by the rate (.045) times the time (1 yr.) gives us the answer of $5,666.66 for the principal.

COMPUTATION OF INTEREST USING 6%, 60 DAY METHOD

For years the business world has been using the 360-day year in the calculation of interest. This method was developed long before the day of the computer and the automatic calculators and is still used because of the speed with which the answer can be obtained in comparison with the exact method. The 360-day year is called by different names, the most commonly used being bank or banker's year, commercial year, business year, or ordinary year.

For example, $720 was borrowed at 6% for 90 days and you are asked to compute the interest to be charged on this loan. Using the formula, I = Prt, you can easily determine that $720 multiplied by 6% would yield the interest for one year. This would amount to $43.20. The problem stated that the money was borrowed for only 90 days. Since 90/360 of a year is ¼ of a year, the interest charged the borrower will be ¼ of $43.20 or $10.80.

The use of the 6%, 60 day method, will shorten the calculation process still further. The base or formula will always begin with 6% for the rate and 60 days for the time. In that case the last two fractions in the formula ${}^{6}/_{100}$ and ${}^{60}/_{360}$ and the product of these two fractions will always be ${}^{1}/_{100}$. Therefore, no matter what the principal is, it must be multiplied by ${}^{1}/_{100}$. This is another way of saying that the principal must be divided by 100. The quickest way to accom-

plish this is to move the decimal point in the principal two places to the left. For example, What is the interest on a $575 loan at 6% for 60 days.

$I = Prt \quad I = \$575 \times 6\% \times 60$ days

$I = \$575 \times {}^{6}/_{100} \times {}^{60}/_{360} = \$575 \times {}^{1}/_{100} = {}^{\$575}/_{100}$

$I = \$5.75$

The rule is therefore, *that the interest on a loan that was made for a period of 60 days at an interest rate of 6% can be found by moving the decimal point two places to the left of its original position in the principal.*

PROBLEMS:

1. Assume in the following problems that the interest rate was 6% and the time was for 60 days. (You will note the answers in the parentheses)

a. $325	(3.25)	c. $854.30	(8.54)
b. $476	(4.76)	d. $3,425.50	(34.26)

If the time in the preceding problems had been 120 days rather than for 60 days, the interest would be found by doubling the interest for a 60 day period of time. Conversely, if the time had been for only 30 days, the interest would have been exactly one-half of the cost for the 60 day period of time. As can be seen from the above, that the number of days whether more or less than the number of days in the formula, can be used in ascertaining the interest for the number of days in the problem.

2. What is the interest on $840 at 6% for 96 days?

   Steps: a. $8.40 = 60 days' interest at 6% on $840
   b. $4.20 = 30 days' interest (½ of 60 days)
   c. .84 = 6 days' interest (1/10 of 60 days or move decimal point one place)

3. Assume the interest is at 6% on each of the following loans.

a. $900 for 80 days	($12.00)
b. $800 for 90 days	($12.00)
c. $400 for 33 days	($2.20)
d. $375 for 49 days	($3.06)

4. The banker's 60-day method can be applied to combinations of days other than those that have been presented briefly. The time and effort involved in finding these combinations may be greater than if you used the general formula, I = Prt. Similarly, this method may be used where the rate of interest is other than 6%, however, the interest may be obtainable with greater ease with the general formula than the 60-day method. The more that you practice this method, the easier it will be for you to work. For example, compute the following:

   a. Find the interest on $600 at 3% for 54 days.
   Steps: I.

   $6.00 = 60 days' interest at 6% on $600
   —.60 = 6 days' interest ($^1/_{10}$ of 60 days)

   5.40 = 54 days' interest at 6% on $600
   2.70 = 54 days' interest at 3% on $600

   b. Find the interest on $750 at 2% for 129 days.
   Steps: I.

   $ 7.50 = 60 days' interest on $750
   .75 = 6 days' interest ($^1/_{10}$ of 60 days)
   .375 = 3 days' interest (½ of 6 days)

   16.125 = 129 days' interest at 6% on $750
   5.375 = 129 days' interest at 2% on $750
   (2% is 1/3 of $16.125)

The conclusion that may be drawn from this very brief introduction of interest problems is that the latter method is far too complicated to use. This conclusion would be valid if you did not use it often and master the method as well as you have the general formula, I = Prt. You may want to study a wide variety of problems available in any of the current texts listed in the bibliography for more examples of this method of computation.

PROBLEMS:

1. If the rate of interest is 7.8% per annum and the monthly interest payment is $65 on what principal are you paying?
2. You interest a prospective purchaser in a property for sale at $7,000.00. $1,000.00 is to be paid as a down payment and the balance in monthly installments of $50.00 each, plus taxes and interest at 5% per annum on the deferred balance. The prospect inquires, "How long will it take to retire the full purchase price?" Assuming that all interest and taxes were paid promptly when due, compute your answer.

Computation of Commission

INCOME FROM COMMISSIONS

In many lines of business including real estate, a salesman is paid on a commission basis; that is, instead of being paid a fixed salary, he is paid in proportion to the value of quantity of the goods or service that he sells. Commission on sales may be in the form of a certain uniform amount for each article sold or it may be a certain uniform per cent of the salesman's total sales. When a salesman's entire earnings are in this form, he is said to be paid a *straight commission.*

When the rate of commission is expressed as a per cent, the per cent is always based on the amount, or value, of the sales. Since the amount of sales is the base, this amount is multiplied by the per cent, or the rate of commission, to find the amount of the salesman's commission. The formula would be:

Rate of Commission × Sales = Commission

The conversion of per cents to decimal equivalent may cause some difficulty at this point. Remember that when the commission rate is quoted, say 6%, you must remove the per cent sign and move the decimal point two places to the left before proceeding further. The use of the per cent sign means hundredths and you think automatically—two places. For example: 65% would be .65; or 2% would be .02; or 6% = .06.

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PROBLEMS:

1. A broker is to receive a 6% commission on a $15,000 sale. How much commission will he earn?
   Steps: a. Translate the per cent, 6%, into decimal form or .06.
   b. Multiply the sale price, $15,000 by .06 and it would equal $900.00.
2. Albert Timmers, a real estate salesman for the Smith Realty Co., sold 5 building lots at $675.00 each, 9 at $850.00 each, and 7 at $1,075 each. If his commission rate was 6%, what was his total commission?
3. It is agreed that all commission collected by the office on sales made by a salesman are to be divided as follows: 10% to the sales manager and the balance to be divided equally between the broker and the salesman. The salesman closes a deal on which the sales price is $9,500 and the office collects a 6% commission on the sales price. What amount of commission is due the salesman?

ANSWERS TO PROBLEMS

Computation of Areas
2. $1,169.53 (by fraction $1,169.47)
3. $240
4. 80 acres
5. $96.12

Computation of Taxes
2. $500
3. $261.12
4. $377

Calculation of Depreciation
2. $9,000
3. $30,000

Pro-Ration of Insurance and Taxes
2. Seller to pay $62.50 of the taxes. Buyer to pay seller $30 of the insurance premium and pay taxes of $312.50.

Investments in Real Estate
1. $456
2. $100; 5%
3. $79
4. $39,900
5. $134,814.81

Calculation of Interest
1. $10,000
2. 10 years

Computation of Commission
2. $1,113
3. $256.50

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Arithmetic Review

Nearly all of the mathematical problems encountered in real estate deal with decimal or percentage numbers. A brief review of the fundamentals involved in such problems follows:

I. Fractions appear in different forms depending upon the use that is made of them.

A. Fractions such as ½, ⅓, ⅔, and ⅝ are known as *common fractions.* They are for everyday common use. For example, a person buys ½ of an acre of land, or measures a board to sixteenths of an inch.

B. Fractions in the decimal form, as .8 or .07 or .135 are known as *decimals.* They are for precise measurement.

C. Fractions in the *percent form* are the fractions of business and are very much like decimal fractions. The sign for this way of writing hundredths is %. Thus, we can use the sign that means hundredths in place of the decimal that shows hundredths. 7/100 = .07 = 7%. Because a percent is a decimal whose denominator is 100, we can write a decimal as a percent; or we can write a percent as a decimal. Also we can write a percent as a common fraction. And we can write a common fraction as a percent, provided we can express it with 100 as the denominator.

1. To *change a decimal to a percent,* we think: If our decimal is hundredths, we can show this with the percentage sign in place of the decimal point. .25 = 25% .09 = 9% Thus the rule for changing a decimal to a percent: move the decimal two places to the right, and write the sign (%) for percent.
2. To *change a percent to a decimal,* we leave off the percent sign and write the number as hundredths by moving the point two places to the left. 65% = .65 2% = .02 If a percent contains a fraction, let us see how to write it as a decimal.
   (if 1% = 1/100 or 10/1000, then ½% = 5/1000 or .005)
   16½% = .16½ = .165
   10¼% = .10¼ = .1025
   3⅓% = .03⅓ = .0333
   17⅛% = .17⅛ = .172
3. To change a fraction to a percent, simply change the fraction to hundredths. The point is dropped and the sign (%) is annexed. ½ = .5 = 50%
   If you do not know the decimal equivalent, figure it out. Let us take ⅛ as an example.
   .12½ = .125 = 12.5%
   8) 1.00

II. The procedure for placing the decimal is different for multiplying and dividing.

A. When multiplying decimal numbers, there are two steps to follow in determining where the decimal point will be.

1. Count the total places to the right of the decimal point in both the multiplier and the multiplicand.
2. Start at the right and point off in the product (answer) as many decimal places as there are in both the multiplier and multiplicand. For example:

multiplicand	.16	(2 places)
multiplier	× .7	(1 place)
	.112	(3 places)

B. When *dividing*, the place of the decimal will depend on if the divisor is a whole number or a decimal.

1. To divide a decimal by a *whole number*, place the point in the quotient above the point in the dividend. Divide as with whole numbers. An example would be:

.7 (quotient)
(divisor) 6) 4.2 (dividend)

2. When dividing by a decimal, change the decimal in the divisor to a whole number by multiplying it by 10, 100, or 1,000 (using the minimum to make the divisor a whole number), as well as multiplying the dividend by the same number. Doing these operations to both divisor and dividend does not change the answer: Example:

Divide 96 by .16

600. (quotient)
(divisor) 16) 9600. (dividend)

II. The application of these fundamentals is not difficult.

A. To find the percent of a number, change the percent to hundredths and multiply the number by the hundredths or decimal.

Example: Mr. X saves 15% of his salary, which is $3,600 per year. How much does he save each year?

$3,600
× .15
$ 540.

B. To find what part one number is to another, we make a fraction. The number asked about is the numerator. Or we divide. Then the number asked about is the dividend. The quotient may be expressed as a decimal or as a percent.

Example: Mr. Y had 20 acres, but then sold 5. What part of the acreage did he sell?

5/20 = ¼ = .25 = 25%

C. To find what percent one number is of another, the number asked about is the dividend (numerator) of the division problem.

Example: 20 is what percent of 25. We put the 20, the number asked about, in the dividend. We then divide 20 by 25 = .80 or 80%.

To find the percent of each item to a total, divide I by the total, then multiply each item by the answer.

IV. Here is a "tying together" formula which will help you.

A. When the fraction is expressed as a percent, these terms are called: the base (b); the rate percent, or the rate (r); and the percentage (p).

B. The terms can be fit into a formula in one of three ways, each capable of describing a solution for one of the three types of percent problems.

1. Problems of the first kind: Find 25% of 48. We know the base (48) and rate (.25), and we are to find the percentage. To find the percentage, this formula is used.

Percentage = rate × base, or p = rb;

48 (b)
× .25 (r)
12 (p)

2. Problems of the second kind: 12 is what percent of 48? The base and the percentage are known, and we are to find the rate. To find the rate:

Rate = percentage ÷ base, or r = p ÷ b, or $r = \frac{p}{b}$

$$\frac{12\ (p)}{48\ (b)} = 25\%\ (r)$$

3. Problems of the third kind: What is the number if 25% of it is 12? The example gives us the rate (25%) and the percentage (12), and asks us to find the base. To find the base:

Base = percentage ÷ rate, or b = p ÷ r, or $b = \frac{p}{r}$

$$\frac{12\ (p)}{25\%\ (r)} = 25\overline{)\ 1{,}200}\ \ 48.$$

4. A problem using all three of the above illustrations:

Mr. A owned 2,400 acres of timber last year, but recently sold 75% of it. How many acres did he sell?

Base is 2,400 (Base—percentage—rate)

The rate is 75% (Rate—percentage—base)

The percentage is 1,800 (Percentage—base × rate).

"TRUE" ANNUAL INTEREST ON CERTAIN INSTALLMENT LOANS

Certain installment loans have a way of working "magic" on the interest rate figured on the loan's declining balance.

There are two types of such loans: 1. The "add-on" loan in which the interest is added to the original amount for division into monthly payments and, 2. the "discount" loan in which the interest is subtracted from the amount the borrower gets.

Stated Rate	"True" annual rate on money borrowed for:			
On an "add-on" loan	12 months	18 months	24 months	36 months
4%	7.4%	7.6%	7.7%	7.8%
5%	9.2%	9.5%	9.6%	9.7%
6%	11.1%	11.4%	11.5%	11.7%
8%	14.8%	15.2%	15.4%	15.6%
On a "discount" loan				
4%	7.7%	8.1%	8.3%	8.8%
5%	9.7%	10.2%	10.7%	11.4%
6%	11.8%	12.5%	13.1%	14.2%
8%	16.1%	17.2%	18.3%	20.5%

Linear and Spacial Measurements Used In Appraising and Land Descriptions

COMMON LINEAR MEASURE (LONG)

12 inches = 1 foot
3 feet = 36 inches = 1 yard
5½ yards = 16½ feet = 1 rod
40 rods = 1 furlong
8 furlongs = 320 rods = 1760 Yards = 5280 feet = 1 mile
3 miles = 1 league

CHAIN MEASURE

7.92 inches = 1 link
100 links = 66 feet = 1 chain
10 chains = 1 furlong
80 chains = 1 mile

(These are old surveyors' measurements. Modern surveyors use a steel tape or what is called an engineer's chain which is 100 feet long with links of one foot. Thus, a mile measure with a modern steel tape chain is 52.8)

SURVEYORS' MEASURE (AREA)

625 sq. links = 1 sq. pole
16 sq. poles = 1 sq. chain
10 sq. chains = 160 sq. rods = 43,560 sq. feet = 1 acre
640 acres = 1 sq. mile = 1 section
36 sections = 36 sq. miles = 1 township
¼ section = 160 acres

Area of a square or rectangle = length × width in unit of linear measurement used.

Area of a triangle = base × ½ altitude.

(An acre is an odd and inconsistent measurement. It is supposed to have been the amount of land that a farmer could plow in a day with an oxen and the old wooden plow. As a square it is approximately 208.71 feet on a side. To convert square feet to acres multiply by .000023.)

SQUARE MEASURE (AREA = LENGTH × WIDTH)

144 sq. inches = 1 sq. foot
9 sq. feet = 1 sq. yard
30¼ sq. yards = 1 sq. rod = 272¼ sq. feet
160 sq. rods = 4840 sq. yards = 43,560 sq. feet = 1 acre

CUBIC MEASURE (VOLUME = LENGTH × WIDTH × HEIGHT)

1728 cubic inches = 1 cubic foot
27 cubic feet = 1 cubic yard
128 cubic feet = 1 cord of wood (a pile 8′ × 4′ × 4′)
1 cubic yard of earth = 1 load
1 cubic foot of water = 7½ gallons = weighs 62½ pounds (avoirdupois)

CIRCULAR MEASURE

360 degrees in a circle
60 minutes = 1 degree
60 seconds = 1 minute

MISCELLANEOUS MEASURE

1 hair's breadth = 1/48th of 1 inch
1 hand = 4 inches
1 span = 9 inches
1 space = 3 feet
1 furlong = 660 feet
1 knot (nautical mile) U.S. = 6,080.2 feet
1 board foot = 144 cubic inches (12 × 12 × 1)
1 cord foot = 16 cubic feet (4 × 4 × 1)
31½ gallons = 1 barrel = 126 quarts
2 barrels = 1 hogshead = 63 gallons = 252 quarts
1 bushel = 4 pecks = 2150.42 cubic inches

The unit in measuring land is the acre, except for a city lot.

A square used in roofing is 100 square feet.

The unit used in measuring surfaces other than land is the square yard.

DEFINITION OF REAL ESTATE WORDS AND PHRASES IN COMMON USE

ABATEMENT - To reduce in amount; to lift; a tax rebate.

ABSTRACT OF TITLE - The history of the chain of title of a specific property.

ACCELERATION CLAUSE - Clause in a mortgage giving lender right to call all sums owing him to be immediately due and payable upon the happening of a certain event, normally a default.

ACCEPTANCE - Act of the seller or agent's principal in agreeing to the terms of the agreement of sale and approval of the negotiations on the part of the agent and acknowledges receipt of the deposit in subscribing to the agreement of sale; the act of accepting an offer which results in a binding contract.

ACCESS RIGHT - The right of an owner to have ingress and egress to and from his property.

ACCESSION - The process whereby property, belonging to one person becomes the property of another by reason of its being added to or incorporated with the property of the latter.

ACCRETION - Addition to the land through natural causes; a slow build up of lands by natural forces such as wind, wave or water.

ACCRUED DEPRECIATION - The difference between the cost of replacement new as of the date of the appraisal and the present appraised value. A fundamental of the cost approach. The highest courts have repeatedly held that the "observed condition" method of estimating accrued depreciation should be accorded the greatest weight.

ACKNOWLEDGMENT - A formal declaration before a duly authorized officer by a person who has executed an instrument that such execution is his act and deed; necessary for recording of an instrument.

ACQUISITION - The act or process by which a person procures property.

ACRE - A measure of land equaling 160 square rods, or 4,840 square yards, or 43,560 square feet, or a tract about 208.71 feet square.

ACRE FOOT - A unit of water measure. The volume of water required to cover an acre of land one foot deep, or 43,560 cubic feet of water, or 325,851 gallons.

ACTION - A proceeding in a court of justice for the enforcement or

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protection of a right, the redress or prevention of a wrong or the punishment of a public offense; a case at law.

ACTIONABLE - A term used to describe incidents or circumstances that are grounds for instituting legal action or lawsuit.

ACTUAL AGE - Chronological age of a structure.

AD VALOREM TAX - Literally means according to value and is an assessment of taxes against a property.

ADJACENT - Lying near or close by; neighboring; boundaries of two properties may or may not touch.

ADJOINING - Contiguous; touching; in actual contact with.

ADJUDGE - To pass on judicially; to decide, settle or decree by court decision; to sentence or condemn.

ADMINISTRATION OF AN ESTATE - The management and settlement of the estate of a deceased person.

ADMINISTRATOR - A person appointed by a court to administer the estate of a deceased person who left no will, that is, who died intestate; also chief officer of a governmental department, such as the Real Estate Commissioner.

ADULT - One who has attained the age of majority or full responsibility.

ADVANCE FEE - Payment of compensation ahead of performance; sometimes a "racket" in which an owner pays a fee in the seldom realized expectation that vaguely described services will result in the sale of his property; a frequently attempted method to circumvent license law.

ADVERSE POSSESSION - The right of an occupant of land to acquire title against the real owner where possession has been actual, continuous, hostile, visible and distinct for the statutory period. (10 years in Oregon)

AFFIANT - A person who has made an affidavit.

AFFIDAVIT - A written statement respecting anything under the sun, signed and sworn to by the affiant before any officer authorized by law to administer oaths.

AFFIRM - To confirm, to aver, to ratify, to verify, to testify.

AGENCY - The relationship between principal and agent which arises out of a contract, either expressed or implied, written or oral, wherein the agent is employed by the principal to do certain acts in dealing with a third party.

AGENT - One who represents another from whom he has derived authority, such as a broker in regards to his principal, and a salesman in regards to his broker.

AGRARIAN - Pertaining to fields or lands, or their tenure.

AGREEMENT OF SALE - A written agreement whereby the purchaser agrees to buy certain real estate and seller agrees to sell upon terms and conditions set forth therein.

AIR RIGHTS - The ownership of the right to use, control or occupy the air space over a designated property.

ALIEN - A person who resides in one country and owes allegiance to another; a person born outside the jurisdiction of the United States who has not been naturalized under the Constitution and laws of this country.

ALIENATION - The transfer of property to another; the transfer of property and possession of lands, or other things, from one person to another.

ALIMONY - Allowance made by order of the court to a woman for her support, out of her husband's estate, in an action for divorce, separation or annulment, payable in periodic installments or lump sum.

ALLUVION - Soil deposited by accretion. Increase of earth on a shore or bank of a river. Usually considered as belonging to the owner of the land to which it is added.

AMENITIES - The satisfaction of enjoyable living to be derived from a home, or profit from income property; conditions of agreeable living or a beneficial influence arising from the location.

AMORTIZATION - A gradual extinction of a monetary obligation by periodic contributions to extinguish the debt together with the payment of interest thereon; recovery over a period of cost or value; or orderly process of recovery or liquidation.

ANIMAL UNIT - A grown beef or dairy animal or its equivalent. A calf is rated a half unit; 5 sheep are one unit.

ANIMAL UNIT MONTH - The amount of pasture required to graze an animal

unit for one month. Frequently expressed as "AUM". If 50 animal units could graze for 4 months, the pasture would be rated 200 AUM's.

ANNUITY - An annual income, or a series of regular, level periodic and sure payments; a sum of money or its equivalent that constitutes one of a series of equal periodic payments.

ANTICIPATION - An appraisal principal which affirms that value is created by anticipated benefits to be derived in the future; the taking or alienation, as by assignment, of the income of a trust estate before it is due.

APPEAL - The review of a case by a court of superior jurisdiction.

APPELATE COURT - A court having jurisdiction of appeals and reviews.

APPRAISAL - An estimate and opinion of value. The process through which conclusions of property value or property facts are obtained; also commonly the report setting forth such estimate and conclusion.

APPRAISAL APPROACH - The appraisal methods or avenues used in estimating market value. There are three: Market Data, Cost and Income.

APPRAISAL PROCESS - An orderly program for estimating the value of real estate; an orderly process to define the problem, the work necessary to solve the problem is planned, the date involved is acquired, classified, analyzed and interpreted into an estimate of value.

APPRAISER - One qualified by education, training and experience to estimate the value of real property; one who practices a judgment science.

APPRECIATION - An increase in value of property due to economic or related causes which may prove to be temporary or permanent.

APPURTENANCE - That which passes with the land incidentally to the sale of the property, such as a right of way.

ARBITRATION - The investigation and settlement of a matter of contention between opposite parties by a person or organization chosen by the parties.

ARCHITECTURE - An expert combination of mass, materials, openings and details.

ARSON - The intentional and malicious burning of a dwelling house or other building, or causing one to be burned.

ASSESSED VALUATION - The full cash value as defined by statute or a percentage thereof of real property.

ASSESSED VALUE RATIO - An appraisal method which considers the assessed value of the land as a percentage of the assessed value of improvements.

ASSESSMENT - A charge against real estate made by a unit of government to cover the proportionate cost of an improvement; also the valuation of property for the purpose of levying a tax.

ASSESSOR - The official who has the responsibility of determining assessed values.

ASSETS - All the property one possesses that may be made available for the payment of debts.

ASSIGN, ASSIGNEE - He who receives property from another by assignment, conveyance, devise, descent or act of law.

ASSIGNEE, ASSIGN - The person to whom an assignment of interest is made; also assigns.

ASSIGNMENT - A transfer in writing of an interest in real estate from one person to another.

ASSIGNOR - One who has the right and authority to assign and/or gives to another an assignment.

ASSUMPTION AGREEMENT - An agreement which provides for a third party to assume the mortgage of the mortgagor defaulting in his mortgage payments.

ASSUMPTION FEE - A charge made by the lender for correcting his records to show assumption of the liability by a third party.

ASSUMPTION LETTER - A statement of the status of all charges against the security for the loan at the time of the assumption by a third party.

ASSUMPTION OF MORTGAGE - The taking of title to a property by a grantee, wherein he assumes liability for payment of an existing note secured by a mortgage or deed of trust against the property; becoming a co-guarantor for the payment of a mortgage or deed of trust note.

ASSURED - A person indemnified by an insurance company against the loss described in the policy; the insured.

A.T.A. TITLE POLICY; Also known as ALTA - A type of title insurance policy issued by title insurance companies which expands the risks normally insured against under the standard type policy to include unrecorded mechanic's liens, unrecorded physical easements, facts a physical survey would show, water and mineral rights, and rights of parties in possession, such as tenants and buyers under unrecorded instruments.

ATTACHMENT - The act of taking or seizing property by court order, thus bringing it into the custody of the law during the process of an action.

ATTEST - To affirm to be true or genuine, an official act establishing authenticity.

ATTORNEY IN FACT - One who is authorized to perform certain acts for another under a power of attorney; power of attorney may be limited to a specific act or acts or be general.

ATTORNEYS LIEN - A lien or charge given by law upon a judgment or upon lands in those cases where an attorney has procured an award on behalf of his client.

AUTHENTICATION - The performance of certain acts upon or with reference to a written instrument, for the purpose of rendering it admissible in evidence as being what it purports to be, without other proof that it is such.

AVULSION - The sudden tearing away or removal of land by action of water flowing over or through it.

AWARD - A judgment, sentence or final decree.

BACKFILL - The replacement of excavated earth into a hole or against a structure.

BAILEE - Party who has possession during bailment.

BAILMENT - Transfer of personal property by one party to another for some specific purpose, to be returned at a stated time or upon completion of purpose for which transferred.

BAILOR - Party who transfers property in bailment.

BALANCE - An appraisal principle which affirms that balance maintains

value while imbalance destroys value. Value is created and maintained when there is proper equilibrium among the amount and location of essential uses.

BALLOON PAYMENT - Where the final installment payment on a note is greater than the preceding installment payments and pays the note in full.

BALLROOM APPRAISAL - See DUAL CONTRACTS.

BANKRUPTCY - Proceedings taken under the bankruptcy statute to have the assets of the bankrupt divided among his creditors.

BARGAIN AND SALE DEED - Deed which conveys the land described therein, but without any warranties whatsoever.

BASE AND MERIDIAN - Imaginary lines used by surveyors to find and describe the location of private or public lands.

BASE MOLDING - Molding used at top of baseboard.

BASE SHOE - Molding used at junction of baseboard and floor; commonly called a carpet strip.

BASEBOARD - A board placed against the wall around a room next to the floor.

BASELINE - A part of the "Rectangular System" for the states of Oregon, Washington and Idaho. The east and west survey line intersecting the Willamette Meridian. The line runs from the Pacific Ocean into the State of Idaho. Lines surveyed every 6 miles parallel to the base line help form the boundaries of townships.

BATTEN - Narrow strips of wood or metal used to cover joints, interiorly or exteriorly; also used for decoration effect.

BEAM - A structural member transversely supporting a load.

BEARING WALL OR PARTITION - A wall or partition supporting any vertical load in addition to its own weight.

BENCH MARKS - A location indicated on a durable marker by surveyors.

BENEFICIAL RIGHTS - The rights of occupancy of a tenant.

BENEFICIARY - One entitled to the benefit of a trust; the lender on the security of a note and trust deed.

BEQUEATH - To give personal property to another by will; distinguished from devise, which relates to real property.

BEQUEST - Transfer of personal property under a will; distinguish from devise, which relates to real property.

BETTERMENT - An improvement in a property which is considered to add to the investment of capital cost - as distinguished from repairs or replacements where the original character or cost is unchanged.

BILL OF SALE - A written instrument transferring to a buyer the title to personal property.

BINDER - A written agreement to cover a down payment for the purchase of real estate as evidence of good faith on the part of the purchaser.

BLACKTOP - Asphalt paving used in streets and driveways.

BLANKET MORTGAGE - A single mortgage on two or more parcels or real estate as security for a single loan.

BLIGHTED AREA - A declining area in which real property values are seriously affected by destructive economic forces, such as encroaching inharmonious property usages, infiltration of lower social and economic classes of inhabitants, and/or rapidly depreciating buildings.

BLUE RIBBON JURY - A jury chosen for its outstanding qualifications, and used to consider cases of special importance.

BOARD FOOT - Unit of measurement of lumber; one foot wide, one foot long, one inch thick; 144 cubic inches.

BONA FIDE - In good faith, without fraud; genuine.

BONA FIDE HOLDER FOR VALUE - One who takes a negotiable instrument in good faith for a valuable consideration in the ordinary course of business before it is due.

BONA FIDE PURCHASER - One who buys for a valuable consideration with the belief that the seller has a right to sell and with no knowledge of any impediments to the transfer.

BOND - Any obligation under seal; a real estate bond is a written obligation, usually issued on security of a mortgage or a trust deed.

BRACING - Framing lumber nailed at an angle in order to provide rigidity.

BRANCH OFFICE - A licensed real estate office, other than the principal place of business, of a licensed real estate broker. The "branch office license" must be displayed at the branch office. Licenses of associated brokers or salesmen, in charge of or working from the branch office, must be displayed at the broker's main place of business.

BREACH - The breaking of a law, or failure of a duty, either by commission or omission.

BRIDGING - Small wood or metal pieces used to brace floor joists.

B.T.U. - British thermal unit. The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

BROKER - One employed by another, for a commission or other compensation, to carry on any of the activities listed in the Oregon real estate license law definition of the word.

BUDGET MORTGAGE - A variation of the amortizing mortgage, which includes in the monthly payments of principal and interest other costs, such as taxes and fire insurance.

BUILDING CODE - Regulates the construction of buildings within a municipality by ordinance or law.

BUILDING LINE - A line fixed by law at a certain distance from the boundaries of a lot, beyond which no buildings can project.

BUILDING PAPER - A heavy waterproofed paper used as sheathing in wall or roof construction as a protection against air passage and moisture.

BUILT-IN CABINETS - Cabinets or similar features built as part of the house.

BULK SALES LAW - An Oregon law requiring the purchaser of any commercial business to demand and receive from the seller an affidavit containing the names and addresses of all creditors of the seller. The purchaser then, at least 10 days before closing, is obliged to notify the creditors of the proposed purchase. Its purpose is to protect the purchaser. (Now part of Uniform Commercial Code)

BUNDLE OF RIGHTS - The theory holding that ownership of real property may be compared to a bundle of sticks, each stick representing a distinct and separate right or privilege. They are the right to use, to sell, to lease, to enter, to give away, or right to refuse to take action.

BUYING BY ASSUMING AND AGREEING TO PAY - Assuming personal liability.

BUYING SUBJECT TO - No personal liability assumed.

CAPITAL - Wealth; the cost of interest on and recapture of an investment.

CAPITAL ASSETS - The term "capital assets" has a special meaning in income tax law. Generally, it is distinguishable from "inventory" which comprises assets held for sale to customers in the ordinary course of the taxpayer's trade or business. "Capital gains" - gains from sale or exchange of capital assets - are taxed at not more than 25% after being offset by capital losses.

CAPITAL GAINS - Capital gains are gains from sale or exchange or "capital assets" as that term is defined above. "Long-term capital gains" are subject to a special alternative tax of 25% of the amount of such capital gains if, and only if, that tax would be lower than a tax computed by including such capital gains in the taxable income taxed at the regular income rates. Depreciable assets and certain other noncapital assets held for more that 6 months are treated as if they were capital assets if their sale or exchange collectively results in a net gain.

CAPITAL LOSSES - Capital losses are losses from sales of capital assets. A corporation may deduct capital losses of any taxable year in that year only to the extent of capital gains. The excess may be carried over to succeeding years for five years but only as an offset against capital gains of such later years. If there are no such capital gains, the deduction is lost. Individuals are treated similarly, except that each year, including the year of the loss and the next five years, they may deduct capital losses against their taxable income (computed without regard to capital gains and losses and without regard to the personal exemptions) up to $1,000 each year.

CAPITAL STOCK - The sum of money raised by the subscriptions of stockholders and divided into shares.

CAPITALIZATION - A process whereby we convert income into value; the act or process of converting future incomes into current equivalent capital value; also the amount so determined. Income

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divided by rate equals value.

CAPITALIZATION RATE - Percent figure used to evaluate an income flow and convert it into a capital amount; the product of an interest rate on an investment and the recapture rate for return of an investment.

CAPITALIZATION RECAPTURE - The return of an investment.

CASE - A general term for actions or suits at law or in equity.

CASEMENT WINDOW - Frames of wood or metal which swing outward.

CAUSE OF ACTION - The ground on which a lawsuit can be sustained.

CAVEAT EMPTOR - Let the buyer beware. The buyer must examine the goods or property and buy at his own risk.

CAVEAT WARNING - Let him beware.

CERTIFICATE OF SALE - Document issued to the highest bidder at a foreclosure sale.

C.P.E. - Certified Property Exchanger.

C.P.M. - Certified Property Manager; a member of the Institute of Real Property Management of the National Association of Real Estate Boards.

CERTIORARI - A proceeding to review in a competent court the action of an inferior tribunal, board or officer exercising judicial functions, when such action is alleged to be without jurisdiction, or otherwise illegal.

CHAIN - A term of land measurement being 66 feet in length.

CHAIN OF TITLE - A history of conveyance and encumbrances affecting the title from the time the original patent was granted, or as far back as records are available.

CHANGE - An appraisal principle which affirms that all existence is characterized by three stages - integration, equilibrium and degeneration.

CHATTEL - Personal property, such as household goods, stock or equipment.

CHATTEL MORTGAGE - A pledge of personal property as security for the

performance of an act or payment of an obligation; now known as a "security agreement" under the Uniform Commercial Code.

CHATTEL REAL - An estate related to real estate, such as a lease on real estate.

CIRCUIT BREAKER - An electrical device which automatically intercepts an electric circuit when an overload occurs; may be used instead of a fuse to protect each circuit and can be reset.

CIRCUMSTANTIAL EVIDENCE - Facts that establish a condition or circumstances from which the principal fact is a possible conclusion.

CITATION - A writ commanding a person to appear before a named judicial tribunal or officer on a day named.

CITIZEN - One who under the Constitution and laws of the United States, by virtue of birth or naturalization, owes allegiance to his country and is entitled to the enjoyment of full civil rights in the United States.

CIVIL RIGHTS - Rights of a non-political nature, secured by the Thirteenth and Fourteenth Amendments to the Constitution of the United States or by various state or federal statutes.

CLAPBOARD - Boards usually thicker at one edge used for siding.

CLEAR TITLE - A title free and clear of all encumbrances.

CLOSING STATEMENT - An accounting of funds made by the broker to the seller and buyer separately, and required by law to be made at the completion of every real estate transaction. An exact copy must be retained by the broker.

CLOUD ON THE TITLE - An outstanding claim or encumbrance which, if valid, would affect or impair the owner's title, such as a judgment, dower interest; some irregularity such as would cast a doubt on validity of title; usually removable by quit claim deed or court action.

CODICIL - A supplement to a will; becomes a part of original.

COLLAR BEAM - A beam that connects the pairs of opposite roof rafters above the attic floor.

COLLATERAL SECURITY - A separate obligation attached to a contract to guarantee its performance; the transfer of property or of other

contracts or valuables to insure the performance of a principal agreement.

COLLUSION - An agreement between two or more persons to perpetrate a fraud.

COLOR OF TITLE - That which appears to be good title but which is not title in fact.

CO-MAKER - A person who signs or endorses the promissory note of another before delivery of the note to the payee.

COMBED PLYWOOD - A grooved building material used primarily for interior finish.

COMMERCIAL ACRE - A term applied to the remainder of an acre of newly subdivided land after the area devoted to streets, sidewalks, curbs, etc., has been deducted from the acre.

COMMERCIAL PAPER - Bills of exchange used in commercial trade.

COMMINGLE - To mingle or mix, such as a deposit of client's funds in the broker's personal account.

COMMISSION - An agent's payment for the performance of specific duties, as the percentage of sales price paid for selling a property. An administrative and regulatory body of real estate license laws.

COMMITMENT - A pledge or a promise; a firm agreement.

COMMITTEE OF INCOMPETENT - Person or persons invested by order of court with the guardianship of the person or estate of one adjudged an incompetent or lunatic.

COMMON LAW - The body of law that grew from customs and practices developed and used in England. It is contrasted with and opposed to "Statutory Law". "Common Law" will prevail in Oregon unless such law has been abrogated by statutory law.

COMMUNITY PROPERTY - Property accumulated through joint efforts of husband and wife living together. This interest does not exist in Oregon.

COMPACTION - Whenever soil is added to a lot to fill in low places or to raise the level of the lot the added soil is often too loose and soft to sustain the weight of buildings. It is then necessary to compact the added soil.

COMPANY - An association of persons, whether incorporated or not, for the purpose of carrying on some business.

COMPETITION - An appraisal principle which holds that profit tends to create competition, which can dissipate all or part of the profit.

COMPLAINANT - One who applies to the courts for legal redress.

COMPOUND INTEREST - Interest paid on the original principal and also on the accrued and unpaid interest which has accumulated.

COMPOUND SUM - Amount of an obligation at maturity, including principal and unpaid interest compounded.

COMPROMISE - An agreement made either in or out of the courts for a settlement of a dispute.

CONDEMNATION - Taking private property for public use, with compensation to the owner, under eminent domain.

CONDITION OR CONDITIONS - A proviso in a Deed or Will that upon the happening or failure to happen of a certain event, the title of the purchaser or devisee will be limited, enlarged, changed or terminated.

CONDITIONAL COMMITMENT - A commitment of a definite loan amount for some future unknown purchaser of satisfactory credit standing.

CONDITIONAL SALE CONTRACT - A contract for the sale of property providing for delivery to the buyer, but title remaining vested in the seller until the conditions of the contract have been fulfilled.

CONDOMINIUM - The individual ownership of a single unit in a multi-unit development with common ownership of halls, stairs, elevators, driveways, parks, etc. Each owner is responsible for his own taxes and mortgage payments on his unit and a proportionate share of taxes and expenses on common elements.

CONDUIT - Usually a metal pipe in which electrical wiring is installed.

CONFESSION OF JUDGMENT - An entry of judgment upon the debtor's voluntary admission or confession.

CONFORMITY - An appraisal principle which holds that the maximum of value is realized when there is reasonable uniformity, social as well as economic.

CONSERVATOR - A person appointed by the court to protect and preserve the lands and property of an individual physically incapacitated or otherwise not able to handle his own affairs.

CONSIDERATION - Anything of value given to induce entering into a contract; it may be money, personal service, or even love and affection.

CONSTANT - The cash flow requirement to liquidate a mortgage.

CONSTRUCTIVE NOTICE - Notice given by the public records.

CONTEMPT - A willful disregard of the authority of a court of justice or legislative body or disobedience of its lawful order.

CONTIGUOUS - An area touching upon another; properties having a common boundary.

CONTRACT - A legally enforceable agreement, either written or oral, to do or not to do certain things. All contracts pertaining to real property must be in writing.

CONTRACT MILKING - Representing that the contract or note secured by trust deed can only be sold for big discount, selling it for lower discount, and pocketing the difference.

CONTRACT OF SALE - See AGREEMENT OF SALE.

CONTRACT RENT - Rent stipulated in a lease, usually for a long term, or a series or renewable short term leases.

CONTRIBUTION - An appraisal principle which affirms that the value of an item in production is measured by its contribution to the net return of the enterprise.

CONVENTIONAL LOAN - A "tailored" flexible mortgage contract developed by savings and loan associations; a loan not insured or guaranteed by the federal government.

CONVERSION - Change from one character or use to another; change of real property or personal property.

CONVERT - To assume or exercise the right of ownership over another's goods.

CONVEYANCE - The means or medium by which title to real estate is transferred, another term for deed.

CONVEYANCING - The art or science of transferring, by written instrument, the title to real estate from one person to another.

COOPERATIVE - A type of ownership of real property where ownership of a portion of the building equity entitles the owner-tenant to a long-term lease on the apartment.

COORDINATION - The cost of management and overhead.

CORPORATION - A group or body of persons established and treated by law as an individual or unit with rights and liabilities or both, distinct and apart from those of the persons composing it.

CORPOREAL - Pertains to a right or group of rights of a visible and tangible nature.

CORRECTION DEED - A writing correcting an error, frequently typographical, in a recorded deed - Example: "This deed has been corrected and initialled by the parties thereto and is re-recorded to show correction of a typographical error in the middle initial of the grantee, Mary D. Smith."

CORRELATION - Co-relating facts and data, and bringing them together.

COST - That which is expended to create or acquire.

COST APPROACH - One of three appraisal methods of estimating value. The value estimate is obtained by estimating value of land as if vacant, and adding to estimated current cost of reproducing the existing improvements, less the estimated depreciation from all causes; usually held to fix the upper limit of value.

COST OF REPRODUCTION NEW - The normal cost of exact duplication of a property with the same or closely similar materials as of a certain date or period.

COUNSEL - In the language of the law, means legal advice; also a lawyer or lawyers engaged to give such advice, or to conduct a cause in court.

COUNTERFLASHING - Flashing used on chimneys at roofline to cover shingle flashing and to prevent moisture entry.

COVENANT - An agreement written into deeds and other instruments promising performance or nonperformance of certain acts, or stipulating certain uses or non-uses of the property.

COVENANT FOR QUIET ENJOYMENT - The right of an owner to the use of property without interference of possession.

COVERTURE - The legal condition or state of a married woman at common law.

CRAWL HOLE - Exterior or interior opening permitting access underneath building, as required by building codes.

CREDITOR - A person to whom a debt is owed by another person who is called the debtor.

CUBIC FOOT - The volume contained in a cube measuring one foot wide, one foot long, and one foot high; equals 7.4805 gallons of water.

CUL-DE-SAC - A street or lane open at one end only and usually having a "turn-around" at the closed end.

CURABLE DEPRECIATION - Any defect that can be cured. It is measured by the cost to cure.

CURB RIDER - Nomadic licensee operating with only nominal or no office location.

CURTAIL SCHEDULE - A listing of the amounts by which the principal sum of an obligation is to be reduced by partial payments and of the dates when each payment will become payable.

CURTESY - A life estate in an undivided one-half interest in the lands of his deceased wife which the law of Oregon gives to a widower.

DAMAGES - The indemnity recoverable by a person who has sustained an injury, either in his person, property, or relative rights, through the act or default of another.

DEBTOR - A person who owes money or something else of value.

DECEDENT - One who is dead.

DECIDUOUS TREES - Lose their leaves in the autumn and winter.

DECISION - The judgment or decree of a court.

DECK - Usually an open porch on the roof of a ground or lower floor, porch or wing.

DECREE - Final determination of the rights of the parties to a suit.

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DECREE OF FORECLOSURE - Decree by a court on the completion of foreclosure of a mortgage, contract or lien.

DECREMENT - Quantity lost by gradual diminution or waste.

DEDICATION - An appropriation of land by an owner to some public use together with acceptance for such use by or on behalf of the public.

DEED - An instrument in writing which when executed by the grantors and delivered to the grantee conveys the described real estate from the one to the other.

DEED, BARGAIN AND SALE - A deed which conveys the land described therein, but without any warranties whatsoever.

DEED, GENERAL WARRANTY - A deed which not only conveys the lands described therein, but in which the grantor makes certain "warranties", usually to the effect that he has good right to convey, that the land is free of encumbrances, except as stated, and that he will defend the title against the lawful claims of all persons.

DEED, QUITCLAIM - A deed that releases or quitclaims all of the right, title and interest, if any, of the grantor in the land described therein.

DEED, SHERIFF'S - Document given to holder of Sheriff's Certificate at conclusion of period of redemption.

DEED, SPECIAL WARRANTY - A deed in which the grantor warrants only against his own acts and the claims of persons claiming by, through or under him.

DEFAULT - Failure to fulfill a duty or promise or to discharge an obligation; omission or failure to perform an act.

DEFEASANCE - The fulfillment of a condition in a legal document which has the result of nullification of that document.

DEFENDANT - The party sued in an action at law.

DEFERRED MAINTENANCE - Existing but unfulfilled requirements for repairs and rehabilitation.

DEFERRED PAYMENTS - Money payments to be made at some future date.

DEFICIENCY JUDGMENT - A judgment of the court against the defaulting

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mortgagor for the difference between the indebtedness sued upon and the sale price or market value of the real estate at the foreclosure sale.

DELINQUENCY - Failure, omission or violation of duty, as a delinquency in regard to the monthly payment on a mortgage loan.

DELIVERY - The final and absolute transfer of a deed from seller to buyer in such a manner that it cannot be recalled by the seller. A necessary requisite to the transfer of title.

DEMAND LETTER - See FORWARDING FEE.

DEMISE - The transfer of an estate to another for years, for life, or at will; or by lease.

DEPRECIATED VALUE - The value of a property after deducting depreciation.

DEPRECIATION - Loss in value brought about by deterioration through ordinary wear and tear, action of the elements, or functional or economic obsolescence; a loss in value from any cause.

DEPRECIATION BASE - Cost (or other value) of base to be amortized annually.

DEPTH TABLE - One of a number of "rule of thumb" used by assessors and others in making adjustments for variations in lot shapes, depths and location in the block. The theory that land varies directly with the depth, but that each succeeding unit of depth adds less value than the preceding unit. The 4-3-2-1 theory.

DESCENT - In law, the passage of real estate, upon the death of the owner, to his heirs at law.

DETERIORATION - Impairment of condition. One of the causes of depreciation and reflecting the loss in value brought about by wear and tear, disintegration, use in service, and the action of the elements.

DEVISE - A gift of real property by last will and testament.

DEVISEE - One who receives a bequest made by a will.

DEVISOR - One who bequeaths by will.

DIRECT REDUCTION LOAN - A loan repayable in consecutive equal monthly payments of interest and principal sufficient to retire the debt within a definite period. "Direct" actually means that

after the monthly interest payment has been taken out of the payment, the balance of the loan payment is applied directly to the reduction of the principal of the loan.

DIRECTIONAL GROWTH - The location or direction toward which the residential sections of a city are destined or determined to grow.

DISCHARGE IN BANKRUPTCY - The release of the bankrupt from the obligations of his debts which were, or might have been, proved in bankruptcy proceedings.

DISCOUNT - In financing, the discount is an amount discounted from the loan by the lending agency, usually paid by the seller as a bonus to the lending institution, and usually figured as a certain percentage of the amount to be repaid; varies according to the character of the current money market and the amount of risk involved.

DISCRETION - Freedom in the exercise of judgment.

DISCRIMINATION - An unfair or injurious treatment; (sometimes unlawful).

DISPOSSESS - To deprive one of the use of real estate.

DIVEST - To dispossess.

DOCKETED JUDGMENT - A judgment listed in the formal records of a court or county records.

DOCUMENTARY EVIDENCE - Evidence in the form of written or printed papers.

DOCUMENTARY STAMP - A revenue stamp issued for the payment of a tax on documents, such as deeds, checks or wills.

DOMICILE - The place where one has his true, fixed and permanent home, and to which he has the intention of returning whenever he is absent.

DLC, DONATION LAND CLAIM - The land allocated to an Oregon settler under a federal law of 1850. The allocations were for 320 or 640 acres.

DONEE - One to whom property is given.

DONOR - The giver of property.

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DOUBLE ESCROW - See DUAL CONTRACTS.

DOUBLE INDEMNITY - The provision in an insurance policy that under certain conditions the insurance company will pay to the beneficiary under the policy twice the face amount of the policy.

DOWER - A life estate in an undivided one-half interest in the lands of her deceased husband which the law of Oregon gives to a widow.

DROP-RATE - Reduction of interest rate at regular intervals provided under the Savings and Loan Mortgage Plan.

DUAL CONTRACTS - Term used to characterize misrepresentation of purchase price and/or down payment through a spurious deposit receipt, to obtain loan or higher loan from lender.

DUE PROCESS OF LAW - The law in its regular course of administration through the courts of justice.

DURESS - Unlawful constraint exercised upon a person whereby he is forced to do some act against his will.

EARNEST MONEY - Down payment made by a purchaser of real estate as evidence of good faith.

EARNEST MONEY RECEIPT OR AGREEMENT - The most important document in a real estate office. It serves as a receipt for a down payment or "hand money", an offer to purchase, as a contract of sale or a contract to sell, sets forth the time and method of closing, contains instructions to the broker, provides for disposition of the "hand money" in the event of forfeiture, and fixes the broker's compensation.

EASEMENT - The right, privilege or interest which one party has in the land of another; an encumbrance or limitation on property. It is extinguished by release, abandonment, or when the necessity no longer exists.

EASEMENT, APPURTENANT - Something held in connection with an easement.

EASEMENT, DOMINANT - The land benefitting by an easement.

EASEMENT, ENGROSS - Not connected.

EASEMENT, PERSONAL - Similar to a license.

EASEMENT, SERVIENT - The land upon which the easement is given.

EAVES - The lower part of a roof projecting over the wall.

ECONOMIC DEPRECIATION - Loss of value from all causes outside the property. (Too heavy traffic, a new service station in a residential area, one-way traffic.)

ECONOMIC LIFE - That period for which a property is good for its present or intended use; the period over which a property will yield a return on the investment, over and above the economic or ground rent due to land.

ECONOMIC OBSOLESCENCE - Loss of value due to economic causes. These are changes external to the property, such as social changes, property taxes, or legislation.

ECONOMIC RENT - The rent a property can command in the open market if it is vacant and ready to be leased today. Also see GROUND RENT.

ECONOMIC SIZE - Buildings of the proper size, no over or under improvement.

EFFECTIVE AGE - The age a property appears to be when compared to one that is known.

EFFECTIVE GROSS INCOME - The income remaining after the deduction from gross income of vacancy and credit losses.

EGRESS - The right to leave a tract of land. Often used interchangeably with access.

EJECTMENT - The name of an action wherein the plaintiff seeks to recover from the defendant the possession of real property, with damages for the unlawful detention of the same.

EMBLEMENTS - Right of tenant farmer to go on the land to harvest his crops.

EMINENT DOMAIN - The authority of the government, local, state or federal, in which private property may be taken for public use, and under which the owner is paid a just compensation.

EMPLOYMENT CONTRACT - The vital portion of what is commonly known as a "listing". A written agreement employing a real estate broker, for value received, to perform certain specified services and fixing the amount of his compensation. All of the essentials of

a contract are necessary in this document. In order to establish a claim for a commission there must be an employment contract in writing.

ENCROACHMENT - A building, part of a building or obstruction which intrudes upon or invades or trespasses upon property of another; displacement of an existing use.

ENCUMBER - To burden a parcel of land with a lien or charge such as a mortgage.

ENCUMBRANCE - A claim, lien, charge, or liability attached to and binding upon real property, such as a judgment, unpaid taxes, or a right of way.

ENDORSEMENT - The act of signing one's name on the back of a check or note, with or without further qualification.

ENTIRETY - An estate in land held by husband and wife resulting in sole ownership by the survivor upon the death of one or the other. See ESTATE.

EQUITEER - See MORTGAGE CLIPPING.

EQUITY - The dollar interest one has in real estate above the encumbrance; a system of law that grew side by side with the English common law, and provided relief when no legal remedies were available. Oregon administers both in the same court, with separate law and equity dockets.

EQUITY OF REDEMPTION - Right of original owner to reclaim property sold through foreclosure proceedings by payment of debt, interest and costs.

EROSION - The wearing away of land through processes of nature, such as by streams and winds.

ESCALATOR CLAUSE - A clause in a contract providing upward or downward adjustment of certain items to cover contingencies.

ESCHEAT - Reversion of property to the state by reason of failure of persons legally entitled to hold, or lack of heirs.

ESCROW - A deposit of instruments and funds with written instructions to a neutral third party to carry out the provisions of an agreement or contract; an escrow presupposes the existence of a valid contract, with sufficient parties, a proper matter, and a consideration.

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ESCROW AGENT - Any person engaged in the business of receiving escrows for deposit or delivery for compensation.

ESTATE - A right in property. An estate in land is the degree, nature or extent of interest which a person has in it.

ESTATE IN SUFFERANCE - The wrongful occupation of lands and tenements by a tenant after his rightful possession has expired.

ESTATE FOR LIFE - A freehold estate, not of inheritance, but which is held by the tenant for his own life, or the life or lives of one or more other persons, or for an indefinite period which may endure for the life or lives of persons in being and beyond the period of life.

ESTATE FOR YEARS - An interest in lands by virtue of a contract for the possession of the property for a definite and limited time. A lease may be said to be an estate for years.

ESTATE IN REVERSION - The residue of an estate left in grantor to commence in possession after termination of some specific estate granted by him. In a lease, the lessor has the estate in reversion after the lease is terminated.

ESTATE OF INHERITANCE - An estate which may descend to heirs. All freehold estates are estate of inheritance, except estates for life.

ESTATE OF WILL - The occupation of land and tenements by a tenant for an indefinite period, terminable by one or both parties.

ESTOPPEL - A bar to one's asserting or denying a fact because of one's own previous action, by which the contrary has been admitted, implied, or determined.

ESTOPPEL CERTIFICATE - A document used in the assignment of a mortgage in which the owner certifies that the mortgage is a lien for the amount stated and that there are no defenses to the mortgage.

ET UX - Means - and wife; ET AL - means - and others.

ETHICS - That branch of moral science, idealism, justness, and fairness, which treats of the duties which a member of a profession or craft owes to the public, to his clients or patrons, and to his professional brethren or members.

EVICTION - Usually a process instituted to oust a person from possession of real estate.

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EVIDENCE - That which tends to prove or disprove any matter in question.

EX OFFICIO - By virtue of his office.

EXAMINER - A title company employee charged with the duty of interpreting and passing upon the validity of documents dealing with real property. Sometimes designated as a title officer.

EXCEPTION - In legal descriptions that portion of lands to be excluded or deleted. The term is often used in a different sense to mean an objection to title or encumbrance on title.

EXCESS RENT - The amount being paid over and above the economic rent. The difference between contract rent and economic rent.

EXCHANGE - An exchange of one property for another. A special contract for exchange should be used by the broker in bringing about this transaction.

EXCLUSIVE AGENCY LISTING - A written instrument giving one broker the right to sell property for a specified time, but reserving the right of the owner to sell the property himself without the payment of a commission.

EXECUTE - To complete, to make, to perform, to do, to follow out, to execute a deed, to make a deed, including especially the signing, sealing and delivery; to execute a contract is to perform the contract, to follow out to the end, to complete all its terms.

EXECUTED CONTRACT - All of the terms and conditions have been fulfilled.

EXECUTION - A writ issued to a sheriff or law enforcement officer requiring the execution of a judgment of the court.

EXECUTOR - A person named in a will to carry out its provisions.

EXECUTORY CONTRACT - Something remains to be done.

EXECUTRIX - A woman appointed to perform the duties of an executor.

EXEMPT - Free from burden or liability.

EXPANSIBLE HOUSE - Home designed for further expansion and additions in the future.

EXPANSION JOINT - A bituminous fiber strip used to separate units of concrete to prevent cracking due to expansion as a result of temperature changes.

FACADE - Front of a building.

FALSE PRETENSE - False representations and statements made with the design of obtaining something of value, with intent to cheat.

FALSE REPRESENTATION - An untrue representation willfully made to deceive another to his loss.

F.H.A. - Federal Housing Administration. An agency of the United States Government that insures real estate loans.

F.N.M.A. - Federal National Mortgage Association; buys and sells FHA insured and VA guaranteed mortgages; known as Fanny Mae.

FSLIC - Federal Savings and Loan Insurance Corporation; an instrumentality of the federal government which insures up to $10,000 a savings account in an institution which is a member of the Corporation.

FEE - An estate of inheritance in real property.

FEE SIMPLE - In modern usage the terms "fee" and "fee simple" are substantially synonymous.

FEE SIMPLE ABSOLUTE - An estate in real property by which the owner has the greatest power over the title possible to have under our system of law. He may dispose of it by sale, or trade, or will, as he chooses. It is the best title one can have. Complete ownership.

FEE TAIL - An estate of inheritance limited to a class of heirs.

FIDUCIARY - A person in a position of trust and confidence, as between owner and broker; broker as fiduciary owes certain loyalty which cannot be breached under rules of agency.

FINANCE - To find or to provide capital.

FINANCING STATEMENT - A document prepared for filing with the County Clerk or Secretary of State indicating that personal property or fixtures is encumbered with a debt; required by the Uniform Commercial Code; brief notice of existence of a security agreement (chattel mortgage or conditional sales contract) filed with

County Recorder where real estate mortgages are filed.

FIRE STOP - A solid, tight enclosure of a concealed space, placed to prevent the spread of fire and smoke through such space.

FIRM COMMITMENT - A commitment by the F.H.A. to insure a mortgage on specified property with a specified mortgagor.

FIRST MORTGAGE - A mortgage which has priority as a lien over all other mortgages.

FIXED CHARGES - Real Estate taxes and insurance.

FIXTURES - Tangible personal property attached to the land or improvements, which usually cannot be removed without agreement as they become real property. Examples: plumbing fixtures and store fixtures built into the property.

FLASHING - Sheet metal or other material used to protect a building from seepage of water.

FLOOR AREA - Total area of all stories or floors finished as living accommodations; does not include space in garages, carports, attics; measurements are taken to outside of exterior wall.

FLOOR PLAN - Drawing of a house, as though seen from above with roof off, showing rooms, partitions, windows, doors, stairs.

FOOTING - The base or bottom of a foundation wall, pier or column.

FORCIBLE ENTRY AND DETAINER - The name of an action for the prompt recovery of the possession of real property in certain cases.

FORECLOSURE - A legal remedy to collect a debt or lien secured by real property. Property is sold to pay the debt in event of default in payments or terms.

FORESHORE - Land between high and low water marks.

FORFEITURE - Loss of money or anything of value due to failure to perform, such as under a contract for the sale of property.

FORGERY - Falsely making or materially altering any writing with intent to defraud.

FORTHWITH - At once, immediately, promptly.

FORWARDING FEE - Charge made by lender for a letter to the title

company stating the exact amount necessary to pay off the loan on a given date. (Beneficiary statement.)

FOUNDATION - The supporting portion of a structure below the first floor construction, or below grade, including the footings.

FOUR AGENTS IN PRODUCTION - Labor, Coordination, Capital and Land.

FRAUD - The intentional and successful employment of any cunning, deception, collusion, or artifice as a means of circumventing, cheating or deceiving another person, whereby that person acts upon such means to his own loss.

FREEHOLD - A tenure of land held in "Absolute Fee Simple" or "Limited Fee Simple", as distinguished from a leasehold. In feudal society of medieval England it described an owner not subject to certain servile incidents or demands of his overlord.

FREEHOLDER - A record owner of real property or the purchaser under a duly recorded contract of purchase of real property, but does not include the vendor under a duly recorded contract of purchase of real property.

FRONT FOOT - Property measurement for sale, lease or valuation purposes. The property measures by the front foot on its street line, each front foot extending the depth of the lot.

FROST LINE - The depth of frost penetration in the soil; varies in different parts of the country; footings should be placed below this depth to prevent movement.

FUNCTIONAL DEPRECIATION - Loss of value from all causes within the property. (One bathroom for 4 bedroom home, lack of closet or storage space, bathroom off the kitchen, no rear entrance.)

FUNCTIONAL OBSOLESCENCE - Impairment of functional capacity or efficiency. It is evidenced by conditions within the property such as poor plan, inadequacy or over-adequacy due to size, style, age or otherwise.

FUNCTIONAL UTILITY - The sum of a property's attractiveness and usefulness.

FURRING - Strips of wood or metal applied to a wall or other surface to even it, to form an air space, or to give the wall an appearance of greater thickness.

GABLE ROOF - A pitched roof with sloping sides.

GAMBREL ROOF - A curb roof, having a steep lower slope with a flatter upper slope above.

GARNISHMENT - A notice to a person holding another's property (for example, a bank account) to give the court an accounting of it and not to yield it to the one who holds title to it; a notice to present oneself in court.

GENERAL WARRANTY - A covenant in a deed whereby the grantor agrees to protect the grantee against any claimant.

G.I. LOAN - Loans guaranteed by the U. S. Veterans Administration under Servicemen's Readjustment Act of 1944; only honorably discharged veterans and their widows are eligible; sometimes used to identify loans of the Oregon Department of Veterans' Affairs.

GIFT DEED - A deed for which the consideration is love and affection, and where no material consideration was involved.

GIRDER - A large beam used to support beams, joists and partitions.

GOVERNMENT LOTS - Quarter sections along north and west boundaries of townships, made irregular in shape by curvature of earth; also caused by meanderable bodies of water, government donations, reservations, and other variables existing prior to the Government Survey.

GOVERNMENT SURVEY - Rectangular system of land survey which divides a district into 24 mile square tracts from the Meridian (north-south line) and the Baseline (east-west line); and tracts are divided into 6 mile square parts called Townships, which are in turn divided into 36 tracts one mile square known as Sections.

GRADE - Ground level at the foundation.

GRADE, FINISH - Final elevation of lawns, walks, drives, etc., after backfilling has been completed.

GRADE, NATURAL - Undisturbed natural surface of the ground before construction begins.

GRADIENT - Slope, or rate of increase or decrease in elevation of surface, road or pipe; usually expressed in percentages.

GRADUATED LEASE - Either a short term or long term lease in which the flat rent or minimum rent will be stepped up or down after an initial period. Frequently rent is based upon periodic appraisals or gross income. Usually used to assist a tenant get started, but

sometimes desired by the lessor for tax reasons.

GRAND INCIDENT - Right of survivorship in tenancy by the entirety.

GRANT - A technical term made use of in deeds of conveyance of lands to indicate a transfer.

GRANTEE - A person to whom real estate is conveyed; a buyer.

GRANTOR - A person who conveys real estate by deed; a seller; the borrower in a trust deed transaction.

GRID MAP - Subdivision map drawn without reference to topography - usually straight lines without contours.

GROSS INCOME - Total income from property before any expenses are deducted.

GROSS LEASE - A lease in which the lessee pays only the stipulated rent, all other charges against the property, such as taxes and insurance, are paid by the lessor.

GROSS RENT MULTIPLIER - A factor used in a "rule of thumb" method of arriving at an indication of value. The gross rental income is multiplied by the factor. The factor is obtained by dividing known sales prices of comparable properties by the rental income of those properties.

GROUND LEASE - An agreement for the use of the land only, sometimes secured by improvements placed on the land by the user.

GROUND RENT - Earnings of improved property credited to earnings of the ground (land) itself after allowance is made for earnings of improvements; often termed "economic rent".

GUARANTEED SALE - Broker guarantees that listings will be sold within listing period or he will buy it. Frequently unenforceable.

GUARANTY - A warranty, given by a third party, for the payment of a debt or other obligation or for the performance of some act.

GUARDIAN - One appointed by the court to administer the affairs of an individual not capable of administering his own affairs.

HABEAS CORPUS - A writ or order commanding a person detaining another to produce him and submit to a decision on the legality of the detention.

HABENDUM CLAUSE - That clause in a deed in which the quantity of the estate taken in indicated and means the affirmation of the principle of the private ownership of property; known as the "To have and to hold" Clause.

HARBOR LINE - An arbitrary line set by authorities on navigable rivers beyond which wharves and other structures may not be built.

HEADER - A beam placed perpendicular to joists and to which joists are nailed in framing for chimney, stairway, or other opening.

HEIR - One who might inherit or succeed to an interest in lands under rules of law applicable where an individual dies without leaving a will.

HEIRS AND ASSIGNS - Terminology used in deeds and wills to provide that the recipient receives a "fee simple estate" in lands rather than a lesser interest.

HEREDITAMENTS - Any property which may be inherited whether real, personal, corporeal or incorporeal.

HIATUS - A gap or space unintentionally left between when attempting to describe adjacent parcels of land.

HIGHEST AND BEST USE - An appraisal phrase meaning that use which at the time of appraisal is most likely to produce the greatest net return to the land and/or buildings over a given period of time; that use which will produce the greatest amount of amenities or profit. This is the starting point of an appraisal.

HIP ROOF - A pitched roof with sloping sides and ends.

HOLDER IN DUE COURSE - One who has taken a note, check or bill of exchange in due course: (1) before it was overdue, (2) in good faith and for value, (3) without knowledge that it has been previously dishonored and without notice of any defect at the time it was negotiated to him.

HOLDOVER TENANT - Tenant who remains in possession of leased property after the expiration of the lease term.

HOLOGRAPHIC WILL - A will written by its maker (the lestator) entirely in his own handwriting.

HOME IMPROVEMENT LOANS - Non-insured, unsecured loans for property alternation, repair or improvement made by lending institutions.

HOMESTEAD - A home upon which the owner or owners have recorded a Declaration of Homestead as provided by Oregon statutes; protects home against judgments up to specified amounts.

HORIZONTAL PROPERTY REGIMES - See CONDOMINIUM.

HHFA - Housing and Home Finance Agency; a permanent federal agency started in 1947 and charged with carrying out the principal government housing and home financing aids which Congress enacts.

HUNDRED PER CENT LOCATION - The location or site in a city which is best adapted to carrying on a given type of business.

HYPOTHECATE - To give a thing as security without the necessity of giving up possession of it.

ILLEGITIMATE - That which is contrary to law.

IMPROVED VALUE - The market value of land and improvements.

IMPROVEMENTS - Those additions to raw lands tending to increase value, such as buildings, streets, sewers, etc.

INCHOATE - Recently or just begun; unfinished, something begun but not completed, such as the dower or curtesy rights of living husband and wife.

INCOME - The money return or other material benefit arising from the use of a capital good.

INCOME APPROACH - One of the three appraisal methods used in arriving at the indicated market value of real property; based on the theory that value of a property is the present worth of the net income it will produce during the remainder of its productive life.

INCOMPETENT - One who is incapable of managing his affairs because mentally deficient or undeveloped.

INCREMENT - An increase. Most frequently used to refer to the increase in the value of land that accompanies population growth and increasing wealth in the community. The term unearned increment is used in this connection since values are supposed to have increased without effort on the part of the owner.

INCUMBRANCE - Any right to or interest in property which diminishes its value in the hands of the owner, and yet does not deprive

him of the title thereto or use thereof, nor of the power to convey or transfer the same.

INCURABLE DEPRECIATION - A defect that cannot be or is not practical to cure. A defect in the "bone structure" of a building. It is measured by age-life or life expectancy.

INDEMNIFY - To secure against loss or damage; to make reimbursement to one for a loss already suffered.

INDENTURE - A written agreement made between two or more persons having different interests.

INDEPENDENT CONTRACTOR - A person self-employed, or one employed by another who has no right of control over the employee except as to final results. Although tax laws differ as to the classification of a real estate salesman, the Oregon license law contemplates that salesmen are employed by brokers who exercise reasonable supervision and are responsible for the acts of their salesmen.

INFANCY - The state of a person under the age of legal majority; minority.

INFILTRATION - Displacement by persons of a lower economic status.

INGRESS - The right to enter a tract of land. Often used interchangeably with access.

INJUNCTION - A writ or order issued under the seal of a court to restrain one or more parties to a suit or proceeding from doing an act which is deemed to be inequitable or unjust in regard to the rights of some other party or parties in the suit or proceeding.

INSTALLMENT NOTE - A note which provides that payments of a specified sum or amount be paid on dates specified in the instrument.

INSTRUMENT - A written legal document, created to effect the rights and liabilities of the parties.

INSURABLE TITLE - A title which can be insured by a title insurance company.

INTANGIBLE VALUE - Good will.

INTEREST - Money paid for the use of money; rent for the use of money;

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the return on an investment.

INTEREST RATE - A percentage of the amount of a loan paid for the use of the money and covering a specified period, usually one year. In the income approach to value that rate of return necessary to attract capital to the particular type of investment at the particular time.

INTERIM FINANCING - Financing used during construction to be superceded by take-out financing after construction.

INTESTATE - A person who dies having made no will, or one which is defective in form, in which case his estate descends to his heirs at law or next of kin.

INTIMIDATION - A contract procured by intimidation is void.

INVESTMENT VALUE - Long term value, always based on market value.

INVOLUNTARY LIEN - A lien imposed against property without consent of an owner. Example: taxes, special assessments, federal income taxes.

IRREVOCABLE - Incapable of being recalled or revoked; unchangeable.

IRRIGATION DISTRICT - Quasi-political district created under special laws to provide for water services to property owners in that district.

JAMB - The side post or lining of a doorway, window or other opening.

JEOPARDY - Peril; danger.

JOINT - The space between the adjacent surfaces of two components joined and held together by nails, glue, cement, or mortar.

JOINT NOTE - A note signed by two or more persons who have equal liability for payment.

JOINT TENANCY - A joint holding of property by two or more persons, who, as co-tenants, enjoy the property equally throughout their lives with right of survivorship to the other grantees. Not applicable to a husband and wife. Abolished in Oregon by ORS 93.180. All persons having an undivided interest in real property, except tenants by the entirety, are to be deemed and considered tenants in common.

JUDGMENT - Is a general lien which attaches to all the lands of the

judgment debtor when docketed; the final determination of the rights of the parties in an action, or special proceeding.

JUDGMENT CREDITOR - One who has received a decree or judgment of court for money due for any cause.

JUDGMENT DEBTOR - One against whom a judgment has been issued by a court for money owed.

JUDGMENT LIEN - The charge upon the lands of a debtor resulting from the decree of a court properly entered in the judgment docket.

JUNIOR MORTGAGE - A mortgage second in lien to a previous mortgage; having a mortgage ahead.

JURAT - That part of an affidavit in which the officer certifies that the same was sworn to before him.

JURISDICTION - The power and authority to hear and determine a cause.

JURY - A body of persons temporarily selected from the qualified inhabitants of a particular district, and invested with power (1) to present or indict a person for a public offense; or (2) to try a question of fact.

LABOR - The cost of wages.

LACHES - Delay or negligence in asserting one's legal rights.

LAND - Property of the immovable class; the residue or value into perpetuity.

LAND CLAIM - A claim to a piece of land based on conformity to the legal requirements for settlement and title.

LAND CONTRACT - Sometimes referred to as an "installment land contract". A contract ordinarily used in connection with the sale of property in cases where the seller does not wish to convey title until all or a certain part of the purchase price is paid by the buyer; usually used for long-range financing and permitting a small down payment. Frequently provides that when a stipulated amount has been paid the deed is transferred and the balance financed by a note and mortgage.

LAND GRANT - Government land granted to a railroad, educational institution, etc.

LAND PLANNING - A technique influencing the form and nature of new

subdivisions; the first step in the process of dividing land in such a way that the life of a whole community will be benefited.

LAND, TENEMENTS AND HEREDITAMENTS - A phrase used in early English law. Its present use denotes real estate with all fixed improvements thereon.

LANDMARK - A fixed object serving as a boundard mark to a tract of land.

LATH - A building material of wood, metal, gypsum, or insulating board fastened to the frame of a building to act as a plaster base.

LEASE - A written legal document in which possession of a property is given by the owner to a second party for a specified time and for a specified rent, and setting forth the conditions upon which the tenant may use and occupy the property.

LEASE - GROUND - An agreement for use of land for a specified term usually secured by the improvements placed thereon by the lessee.

LEASE INTEREST - The rights of each party in a leasehold. Under the two property concept the owner has sold one right to the lessee. The same theory holds true in the case of the sale of mineral rights.

LEASE - PERCENTAGE - A lease of property in which the rental for its use is measured by or dependent upon the business transacted by the lessee. The usual method is payment to the lessor of an agreed upon percentage of the gross receipts of the lessee.

LEASED FEE - The fee of a property subject to a lease.

LEASEHOLD - A property held under tenure of lease; a property consisting of the right of use and occupancy by virtue of a lease agreement; the lessee's (tenants) interest in a lease.

LEGACY - A gift of personal property by will.

LEGAL DESCRIPTION - The legal identification of real property by either (1) the rectangular survey, (2) metes and bounds, (3) recorded plat, which a court will compel one to give or accept.

LEGAL RATE OF INTEREST - The rate of interest that may be charged

is governed by state law. The legal rate is the rate charged in the absence of an express contract between the parties. The contract rate is the highest rate upon which the parties may agree. In Oregon the legal rate is 6% and the contract rate is 10%.

LEGATEE - A person who takes personal property under a will.

LESSEE - One who possesses the right to possession and use of a property under a written or oral agreement.

LESSEE'S INTEREST - The right to use plus the right to receive any excess rent during the life of the lease.

LESSOR - A title holder who grants the right to use and occupy a property under a written or oral agreement.

LESSOR'S INTEREST - The right to receive rent and the right to the reversion (right to get the property back).

LIABILITY - The condition of being bound in law and justice to do something which may be enforced in the courts.

LICENSE - A privilege or right granted by the state to an individual to operate as a real estate broker or salesman.

LICENSEE - One who has a license to perform a specified task or business; one who holds a real estate license.

LIEN - A special encumbrance; a charge against property whereby the property is made security for the payment of a debt or charges such as a judgment, a mortgage or taxes; a lien is an asset and therefore may be assigned.

LIEN - FIRST PARAMOUNT - Having priority over any other lien.

LIEN - JUNIOR - One that is secondary to the lien recorded ahead of it.

LIFE ESTATE - A (freehold) interest in land, the duration of which is confined to the life of one or more persons or contingent upon certain happenings.

LINK - A term of land measurement being 1/100th of a chain of 66/100th of a foot.

LINTEL - A horizontal board that supports the load over an opening such as a door or window.

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LIS PENDENS - Suit pending. Usually recorded so as to give constructive notice of pending litigation.

LISTING - A written employment contract between principal and agent authorizing agent to perform services for the principal involving the latter's property; a record of property for sale by a broker who has been authorized by the owner to sell; the property so listed.

LITIGATION - The act of carrying on a lawsuit.

LITTORAL - That which belongs to the shore of a sea or large lake. A coastal region.

LOAN AGREEMENT - A written document issued in connection with a particular loan which sets forth the terms upon which the loan will be made; does not include a mortgage or trust deed which secures a promissory note.

LOAN CLOSING - All of the actions and procedures incident to the establishment of a valid prior lien on the subject property; legal consummation of the mortgage loan transaction.

LOAN FEE - A charge made by a lender when granting a loan; usually considered the amount necessary to process and complete the documents.

LOCK-IN - Mortgage or trust deed without provision for prepayment with or without interest. May require full interest payment to maturity to refinance.

L.S. - The abbreviation for the Latin phrase "locur sigilli"; the place occupied by the seal on a written instrument, as the seal of a public officer, such as a notary. Private persons seldom use a seal today, though legal documents often provide a place for one.

LOT BOOK REPORT - A non-liability letter issued by title companies showing the last owner of record and encumbrances thereafter; not a title report.

LOT LINE - Line bounding lot as described in the title to the property.

LOTTERIES - Schemes for distributing prized by chance.

LOUVER - An opening with a series of horizontal slats set at an angle to permit ventilation without admitting rain, sunlight, or vision.

M.A.I. - Designates a person who is a member of the American Institute of Real Estate Appraisers of the National Association of Real Estate Boards.

MAIN OFFICE - The place of business of a licensed real estate broker. The place of business of the broker is designated in his license, and must be identified by a sign containing the name under which he conducts his business; the words "Real Estate", or "Realtor" if a member of the National Association of Real Estate Boards; and in which he must display his license and the licenses of all salesmen employed by him.

MAJORITY - In Oregon an individual reaches majority at the age of 21 years. All persons are deemed to have arrived at majority upon their being married according to law. See MINOR.

MANDATORY - Requiring strict conformity or obedience.

MARGINAL LAND - That land which barely pays the cost of working or using; land whereon the costs of operating approximately equal the gross income.

MARKET DATE APPROACH - One of three appraisal methods used in valuation. An estimate of value of a property is obtained by comparing it with similar properties in the same type and class which have been sold recently or are currently offered for sale in the same or competing areas.

MARKET PRICE - The price paid for a property; the amount of money that must be given or which can be obtained at the market in exchange under the immediate conditions existing at a certain date. To be distinguished from "Market Value".

MARKET VALUE - The highest price which a buyer, willing but not compelled to buy, would pay, and the lowest price a seller, willing but not compelled to sell, would accept; F.H.A. - The price which typical buyers would be warranted in paying for the property for long time use or investment if they were well informed, acted voluntarily and without necessity; M.A.I. - As defined by the courts, is the highest price estimated in terms of money which a property will bring if exposed for sale in the open market allowing a reasonable time to find a purchaser who buys with knowledge of all the uses to which it is adapted and of which it is capable of being used.

MARKETABLE TITLE - Merchantable title, clear title and good title are synonymous, and mean that the land is free from encumbrances or is title that a court would compel a purchaser to accept.

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MATERIAL FACT - A fact is material if it is one which the agent should realize would be likely to affect the judgment of the principal in giving his consent to the agent to enter into the particular transaction on the specified terms.

MECHANIC'S LIEN - A lien created by state law in favor of persons who have performed work or furnished materials in the erection or repair of a building.

MEETING OF MINDS - A mutual intention of two persons to enter into a contract affecting their legal status and based on agreed upon terms; a complete understanding between the interested parties.

MEGALOPOLIS - A very large city; an area containing a series of cities.

MERCHANTABLE - Salable in the ordinary way; fit for the ordinary uses to which it is put.

METES AND BOUNDS DESCRIPTION - A legal description of a parcel of real estate that describes the boundaries by direction and measurement from a designated starting point called a monument; METES are measure of length such as inches, feet, years or rods; BOUNDS are boundaries, both natural and artificial, such as streams, streets or roads.

MILL - One-tenth of one cent; the measure used to state the property tax rate; a tax rate of one mill on the dollar is the same as a rate of one-tenth of one percent of the assessed value of the property.

MINOR - All persons under 21 years of age, except that any person lawfully married who is 18 years or over is deemed an adult person for the purpose of entering into any engagement or transaction respecting real property.

MINOR LIENS - Criminal surety bonds, property taxes and federal taxes; (a surety bond is a pledge of property in lieu of bail money for a person accused of a crime).

MODERNIZATION - The replacement in modern style of outmoded parts of the structure and/or equipment.

MODIFICATION AGREEMENT - Extension of the term of a conventional loan in arrears.

MOLDING - Usually patterned strips used to provide ornamental variation of outline or contour, such as cornices, bases, window and door jambs.

MONUMENT - A fixed object and point established by surveyors to establish land locations.

MORAL TURPITUDE - Want of integrity; lack of honesty and uprightness.

MORATORIUM - The temporary suspension, usually by statute, of the enforcement of liability for debt.

MORE OR LESS - These words, when used in a conveyance of land, after a statement of the number of acres therein, are intended to cover only a reasonable excess or deficit.

MORTGAGE - A written instrument recognized by law by which real property is pledged to secure a debt or obligation; a lien on real property.

MORTGAGE CLIPPING - Acquisition of distressed property for income to be derived without payment to mortgagee.

MORTGAGE CORRESPONDENT - One who represents a lender of money on the security of real property; one who represents a potential mortgagee.

MORTGAGE GUARANTY INSURANCE - Insurance against financial loss available to mortgage lenders from Mortgage Guaranty Insurance Corporation, a private company organized in 1956.

MORTGAGE MILKING - See MORTGAGE CLIPPING.

MORTGAGEE - The party who advances the capital for a mortgage loan and in whose favor the property serving as security is mortgaged.

MORTGAGOR - The party who borrows money or mortgage security and mortgages property owned by him as security for a loan.

MULTIPLE LISTING - A listing, usually an exclusive right to sell, taken by a member of an organization composed of real estate brokers, with the provision that all members will have the opportunity to find a purchaser; a cooperative listing with a prearranged division of commission between the listing broker and the selling broker, with a small percentage going to the board or exchange.

NAREB - Abbreviation for National Association of Real Estate Boards.

NATIONAL HOUSING ACT - A series of related laws called "Titles", each of which covers a different part of the government's mortgage insurance program.

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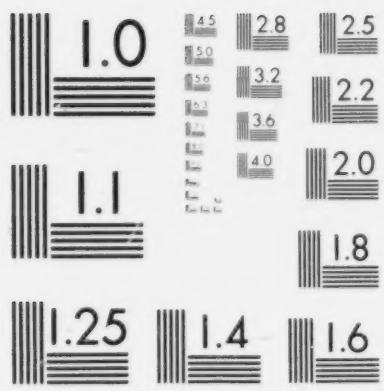

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

NEGATIVE LEASEHOLD - Where the contract rent exceeds the economic rent.

NEGOTIABLE - Capable of being negotiated; assignable or transferrable in the ordinary course of business.

NEGOTIABLE INSTRUMENT - A written promise or order to pay money - promissory note is first; bank check second.

NEIGHBORHOOD - An area in which people of relatively similar habits and tastes carry on their living or business activity. Property is an integral part of a neighborhood.

NET INCOME - Income from property or business after expenses have been deducted; effective gross income less operating expenses.

NET LEASE - A lease where, in addition to the rent stipulated, the lessee assumes payment of all property charges such as taxes, insurance and maintenance.

NET LISTING - A price, which must be expressly agreed upon, below which the owner will not sell the property and at which price the broker will not receive a commission; the broker receives the excess over and above the net listing as his commission.

NON-CONFORMING USE - Use made of property before zoning which does not conform to the zone uses; it is usually permitted to continue under certain stipulation.

NONCUPATIVE WILL - An oral will or a will made by a word-of-mouth declaration.

NON-RESIDENT - Persons who do not reside within the state.

NOTARY PUBLIC - A public officer, appointed by the Governor, who attests or certifies deeds and other instruments to make the execution authentic.

NOTE - A written instrument which acknowledges the debt and promises to pay.

NOTICE TO QUIT - Notice to a tenant to vacate rented property.

OAREB - Abbreviation for Oregon Association of Real Estate Boards.

OBJECTIVE VALUE - Created in the object itself. Found in the cost approach to appraising where emphasis is placed on the cost of production, plus the land.

OBSOLESCENCE - As applied to real estate it is a loss in value due to structural, economic or social change. Its effect is depreciation.

OCEAN SHORE - That part of the Pacific Ocean between ordinary high tide and extreme low tide, and from the state's borders with Washington on the north and California on the south; owned by the state and declared a recreation area.

OFFICE IN HAT - See CURB RIDER.

OFFSET STATEMENT - Statement by owner of property or owner of lien against the property setting forth the present status of liens against the property.

OPEN END CLAUSE - A clause in a mortgage to provide a method of advancing the note after partial payment. To meet new obligations the debt can be quickly restored to its original amount.

OPEN LISTING - A listing which is non-exclusive; may be given to any number of brokers without liability to compensate any except the one who first secures a buyer ready, willing and able to meet the terms of the listing, or secures acceptance by the seller of a satisfactory offer. Quite generally held to be the source of many misunderstandings.

OPINION - An exercise of experience and judgment.

OPTION - A written agreement granting the exclusive right, during a stated period of time, without creating an obligation on the grantee, to buy, or control the use of property.

ORAL CONTRACT - A verbal agreement which is not reduced to writing.

ORDER - Any intermediate determination, as distinguished from a judgment or decree.

OREGON REAL ESTATE BOARD - A statutory body consisting of the real estate commissioner and four members appointed by the Director, Department of Commerce, charged with responsibility for the examining of applicants for a license, making and enforcing rules and regulations; advise on matters to best serve the state and the licensees, and in the conduct of an educational program.

ORGANIC LAW - The Constitution of the United States and the Constitution of the State of Oregon.

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ORIENTATION - Placing a house on its lot with regard to its exposure to the rays of the sun, prevailing winds, privacy from the street and protection from outside noises.

OVER IMPROVEMENT - An improvement which is not the highest and best use for the site on which it is placed by reason of excess in size or cost.

OVERALL INTEREST RATE - The rate that includes interest on the land, interest on the building, and a recapture of capital.

OVERHANG - The part of the roof extending beyond the walls to shade buildings and cover walks.

PACKAGE MORTGAGE - Popular form of mortgage used with new residential sales. The debt includes the cost of certain mechanical or electrical equipment. Equal monthly payments take care of interest, principal, taxes, fire insurance and equipment.

PAR VALUE - Market value, nominal value.

PARCEL MAP - Final map pertaining to lot splits not constituting subdivision per Map Act.

PARKING RATIO - The ratio of square foot of parking area to gross area of the building served by the parking area.

PAROL EVIDENCE RULE - Provides that the courts will prohibit introduction of any oral testimony in a court proceeding which may be necessary to establish the meaning of a real estate contract.

PARQUET FLOOR - Hardwood flooring laid in squares or patterns.

PARTIAL RELEASE CLAUSE - See RELEASE CLAUSE.

PARTITION - A division made of real property between those who own it in undivided shares.

PARTNERSHIP - A contract of two or more persons to unite their property, labor or skill, or some of them, in prosecution of some joint and lawful business, and to share the profits in certain proportions.

PARTY WALL - A wall common to buildings on two adjoining properties.

PATENT - Conveyance of title to government land.

PAWN - Goods entrusted to a creditor as security for a loan, a pledge

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or a hypothecation.

PENNY - The term, as applied to nails, serves as a measure of nail length and is abbreviated by the letter "d".

PER CAPITA - By heads, that is, by individuals. Persons taking equal shares, each in his own right, in the distribution of a decedent's estate; in contradistinction to a share for an entire class which is termed "per stirpes".

PER STIRPES - Taking property by right of representation is called "succession per stirpes", in opposition to taking in one's own right or as a principal, which is termed "per capita"; distribution of shares by classes of kindred relations.

PERCENTAGE LEASE - A lease of property in which the rental is an amount equivalent to a stated portion of the receipts from the business conducted by the lessee; frequently expressed as a percentage of the gross revenues.

PERCOLATION TEST - A test to determine the capacity of a soil to absorb water.

PERIMETER HEATING - Baseboard heating, or any system in which the heat registers are located along the outside wals of a room, especially under the window.

PERSONAL LIABILITY - Responsibility of one who is bound in law and justice to do something which may be legally enforced.

PERSONAL PROPERTY - Any property which is not real property. In event of question three tests are applied. They are: (1) real or constructive annexation of the article to the realty, (2) adaptation of the article to the use or purpose of that part of the realty with which it is connected, (3) intention of the party making the annexation to make the article a permanent part of the real property.

PERSONALTY - Used broadly means personal property; everything not real property.

PHYSICAL DEPRECIATION - The loss of value from all causes of age and action of the elements. Example: broken window, hole in plaster, collapsed porch railing.

PIER - A column of masonry, usually rectangular in horizontal cross section, used to support other structural members.

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PITCH - The incline or rise of a roof.

PLAT - A plan or map of a certain piece or pieces of land.

PLAT BOOK - A public record of various recorded plans in a stated area.

PLATE - A horizontal board placed on a wall or supported on posts or studs to carry the trusses of a roof or rafters directly; a shoe, or base member as of a partition or other frame; a small board on or in a wall to support girders, rafters, etc.

PLEDGE - The depositing of personal property by a debtor with a creditor as security for a debt or engagement.

PLOT - Parcel of land consisting of one or more lots or portions thereof; usually described by reference to a recorded plat.

PLOTTAGE INCREMENT - The appreciation in unit value created by joining smaller ownerships into one large single ownership.

POCKET LICENSE CARD - Evidence of possession of real estate license issued to each broker and salesman by the Real Estate Division; to be carried at all times, and presented when requested by any person with whom the licensee is dealing in regard to real estate.

POINTS - Loan fee exacted by lender from seller at time loan is made. Sometimes paid by buyer.

POLICE POWER - The right of the state, county or city as a constitutional authority to enact laws and enforce them for the order, safety, health, morals and general welfare of the public.

POSITIVE LEASEHOLD - Where the contract rent is lower than the economic rent.

POWER OF ATTORNEY - An instrument authorizing a person to act as the agent of the person granting it. A general power authorizes the agent to act generally in behalf of his principal; a special power limits the agent to a specific or particular act.

PREPAYMENT CLAUSE - A clause in a mortgage permitting partial or full payment prior to due date. Many of these clauses contain a provision that a penalty must be paid if the benefit of the clause is exercised.

PREPAYMENT YIELD - Percent return on obligation paid prior to maturity.

PRESCRIPTION - The securing of title to property by adverse possession; by occupying it for the period determined by law barring action for recovery.

PRESENT VALUE - Value at the present of an amount to be recorded in the future.

PRESENT VALUE OF AN ANNUITY - Value at present of receiving a set of equal payments in the future.

PRICE - The amount asked or the amount paid.

PRICE KITING - See DUAL CONTRACTS.

PRIMA FACIE - Presumptive on its face.

PRINCIPAL - The employer of an agent; the person ordinarily liable primarily; the amount of a debt.

PRINCIPAL NOTE - The promissory note which is secured by the mortgage or trust deed.

PRIORITY - Legal preference.

PRIVITY - Mutual relationship to the same rights of property; contractual relationship.

PROBATE COURT - A court having jurisdiction of the proof of wills, the settlement of estates, and, usually, of guardianships. In this state it is in the Circuit Court.

PROPER INTEREST RATE - The rate that will attract capital.

PROPERTY - The right or interest which an individual has in lands and chattels to the exclusion of all others; the rights we gain from the ownership of wealth.

PROPERTY LINE - Recorded boundary of a plot.

PRO-RATE - To allocate between seller and buyer their proportionate share of an obligation paid or due; for example, a pro-rate of real property taxes or insurance.

PRORATION OF TAXES - To divide or pro-rate the taxes equally or proportionately to the time of use of the property.

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PROSPECTUS - A printed folder describing a specific property.

PROXIMATE CAUSE - The proximate cause of an event is that which, in a natural and continuous sequence, unbroken by any new cause, produced that event, and without which that event would not have happened.

PUBLIC POLICY - The law considers the conservation and promotion of the public welfare to be the first and highest duty of government, and it will not countenance any transaction which contravenes a sound public policy.

PUNITIVE DAMAGES - Damages by way of punishment.

PURCHASE MONEY MORTGAGE - A mortgage given by the buyer to the seller as part or all of the purchase price of property. In the event of foreclosure of such a mortgage the mortgagee is not entitled to a deficiency judgment.

QUALITIES OF VALUE - Utility, scarcity, desire, ability to buy.

QUARTER ROUND - A molding that presents a profile of a quarter circle.

QUIET ENJOYMENT - The right of an owner to the use of property without interference of possession.

QUIET TITLE - A court action brought to establish title; to remove a cloud on a title.

QUITCLAIM DEED - Deed given when the grantee already has, or claims, complete or partial title to the premises and grantor has a possible interest that otherwise would constitute a cloud upon the title. (not used for conveyance purposes)

RADIANT HEATING - A method of heating, usually consisting of coils or pipes placed in the floor, wall or ceiling.

RAFTER - One of a series of boards of a roof designed to support roof loads; the rafters of a flat roof are sometimes called "roof joists".

RANGE - A strip of land six miles wide determined by government survey, running in a north-south direction.

RANGE LINES - Lines parallel to the Meridian marking off the land into 6 mile strips known as ranges; they are numbered east or west of the Willamette Meridian.

RATE - A fixed relationship between two magnitudes (two items).

REAL ESTATE - Land, tenements and other hereditaments or rights therein, and whatever is made part of or is attached to it by nature or man; the land and all the improvements thereon.

REAL ESTATE BOARD - An organization whose members consist primarily of real estate brokers and salesmen in a particular political subdivision. (Not to be confused with Oregon Real Estate Board, created by statute, whose members are appointed by the Director, Department of Commerce.)

REAL ESTATE COMMISSIONER - The chief administrative officer of the Real Estate Division and chairman of the Oregon Real Estate Board. Appointed by the Director, Department of Commerce.

REAL PROPERTY - The rights to use of real estate; also used interchangeably with real estate; the three classes of estates are fee simple, for life, for years, the land and everything attached to it by man or nature.

REALTOR - A professional in real estate who subscribes to a strict Code of Ethics as a member of the local and state boards and of the National Association of Real Estate Boards.

REALTY - A collective term used to designate real estate; lands and buildings.

RECAPTURE RATE - The rate of interest necessary to provide for the return of an investment. Not to be confused with interest rate, which is the rate of interest on an investment.

RECEIVER CLAUSE - In a mortgage, to prevent dissipation of the asset that secures the loan. Receiver takes over a residential property abandoned by the mortgagor, rents and maintains it. If a business, prevent mortgagor from destroying good will, or retaining profits from the property.

RECONVEYANCE - The transfer of the title of land from one person to the immediate preceding owner. Used in Oregon with the trust deed.

RECORDING - Act of entering in a book of public record to give notice to the world. The grantee pays the fee for recording a deed; examination of public records determines a party's interest in land. Failure to record a deed will operate to divest a grantee of his title as against a subsequent purchaser from the grantor.

REDEEM - Literally "to buy back"; the act of buying back lands after a mortgage foreclosure, tax foreclosure, or other execution sale.

REDEMPTION - The right of a mortgagor to redeem the property by paying the debt after the expiration date; the right of an owner to reclaim his property after a sale for taxes; buying back one's property after a judicial sale.

REDUCTION CERTIFICATE - An instrument signed by the mortgagee stating the balance due on the mortgage, thus advising a purchaser of the true extent of the obligations on the property.

REFORMATION - An action to correct a mistake in a deed or other document.

REGRESSION - An appraisal principle that maintains the worth of better properties will be adversely affected by the presence of lessor. Evil destroys good, but good rarely lifts evil.

REHABILITATION - Restoration to satisfactory condition without changing plan, form or style. Its cost would be the cost of curable deterioration and obsolescence.

RELEASE - The relinquishment of some right or benefit to a person who already has some interest in the property.

RELEASE CLAUSE - A stipulation that upon the payment of a specific sum of money to the holder of a trust deed or mortgage that the lien of the instrument as to a specifically described lot or area shall be removed from the blanket lien on the whole area involved.

RELEASE OF LIEN - The discharge of a certain property from the lien of a judgment, mortgage or claim.

RELICTION - Gradual subsidence of waters leaving dry land.

REMAINDER - An estate which vests after the termination of the prior estate, such as a life estate.

REMISE - To remit or give up.

REMODELING - Changing the plan, form or shape to correct functional or economic deficiencies.

RENOVATION - A combination of two or more of "rehabilitation", "modernization", and "remodeling".

RENT - The compensation paid for the use of real estate.

REPAYMENT CLAUSE - A provision that the mortgagor may pay the entire or stated amounts on the principal at any time he chooses prior to the due date.

REPLACEMENT COST - The cost of erecting a building to take the place of or serve the functions of a previous structure.

REPRESENTATION - The principle by which the descendants of a deceased person inherit the share of an estate which the deceased person would have inherited if he had lived; the taking or inheritance per stirpes.

REPRODUCE - A replica.

REPRODUCTION COST - The cost of reproducing a new replica on the basis of current prices with the same or closely similar materials. Normal cost of exact duplication of a property as of a certain date.

RESCISSION OF CONTRACT - The abrogation or annulling of a contract by the mutual consent of the parties, or for cause by either party to the contract.

RESERVATION - A right retained by a grantor out of that property which he has conveyed.

RESERVE FUND - In multi-family properties an amount set aside from income to replace short-lived items, such as furniture and equipment; the distinctive feature of a budget mortgage loan on residential property, the monthly payments contain sufficient sums, which are impounded or reserved, to pay taxes and insurance when due.

RESIDENCE - Personal presence in a place with no present intention of removing therefrom.

RESIDUAL - That which remains; an appraisal technique to estimate the amount of net annual income attributed to the land, the building, or both; what is left after deduction; the rest of the income.

RESTRICTION COVENANT - A clause in a deed limiting the use of the property conveyed for a certain period of time, or a device in a deed for controlling the use of the land for the benefit of the land.

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REVERSION - The right of a lessor to recover possession of leased property upon the termination of the lease with all the subsequent right to use and enjoyment of the property.

REVERSIONARY INTEREST - The interest which a person has in lands or other property upon the termination of the preceding estate.

REVOCATION - Recall or cancellation of an authority previously vested; voiding of a written document.

RIDGE - The horizontal line at the junction of the top edges of two sloping roof surfaces; the rafters at both slopes are nailed at the ridge.

RIDGE BOARD - The board placed on edge at the ridge of the roof to support the upper ends of the rafters; also called roof tree, ridge piece, ridge plate and ridgepole.

RIGHT OF REDEMPTION - The right to free property from a claim or lien by payment of what is due with interest, costs, etc.

RIGHT OF SURVIVORSHIP - Right to acquire the interest of a deceased joint owner; the distinguishing feature of tenancy by the entireties.

RIGHT OF WAY - An easement over another's land.

RIGHTS OF OWNERSHIP - Ownership of real estate carries with it the right to possession, enjoyment, control and disposition.

RIPARIAN RIGHTS - The rights of a landowner to water on, under or adjacent to his land. These rights vary and depend upon local legal regulations.

RISK RATE - A penalty for risk.

RULES OF THUMB - Sometimes used to assist in the estimating of value of a property. Some are gross rent multiplier, price per front foot, price per square foot, cost per apartment unit, cost per room.

RUNNING WITH THE LAND - Affecting the land and the successive owners thereof; usually spoken of as a covenant or an easement.

S.R.A. - Designates a person who is a Senior Residential Appraiser member of the Society of Real Estate Appraisers.

SAFE RATE - Interest rate on government bonds, utility bonds, bank savings.

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SALES CONTRACT - A contract by which a buyer and seller agree to terms of a sale.

SALESMAN - Any person who, for compensation or the expectation or promise thereof, is employed or becomes associated with a licensed real estate broker to deal in real estate or do any of the acts enumerated in the Oregon law defining real estate broker. Such a person is required to be licensed as a real estate salesman; the individual who makes the wheels of the American economy go round and round.

SALVAGE VALUE - Value of the whole as it is right now.

SANDWICH LEASE - A leasehold interest which lies between the primary lease and the operating lease.

SASH - Wood or metal frames containing one or more window panes.

SATISFACTION OF A MORTGAGE - A written instrument which describes the mortgage and states that the debt has been paid, and the mortgage has been satisfied. If mortgagee fails to do this within 30 days after requested he is liable to mortgagor for $100 damages, plus actual damages occasioned by such failure.

SATISFACTION PIECE - An instrument of writing whereby satisfaction of a lien is acknowledged.

SCENIC EASEMENT - A "servitude" devised to permit land to remain in private ownership while at the same time being subject to control over its future uses to insure preservation of scenic beauty.

SCRIBING - Fitting woodwork to an irregular surface.

SEAL - A particular sign made to attest in the most formal manner the execution of an instrument. The seal affixed to a writing is primary evidence of a consideration.

SECOND MORTGAGE - The second lien on property.

SECRET INTEREST - Hidden or concealed from public knowledge.

SECTION - A section of land established by government survey and containing 640 acres.

SECURITY AGREEMENT - Document used to mortgage articles of personal property under Uniform Commercial Code; replaces chattel mortgage and conditional sales contract; in a chattel mortgage

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ownership of the article is transferred to the buyer; under a conditional sales contract ownership of the article remains with the seller. There is no difference under the Code.

SEPARATE PROPERTY - Property acquired by either spouse prior to marriage or by gift or devise after marriage. Property owned by a single person.

SERVICING CONTRACT - A document which enumerates specific servicing requirements and legally binds the servicing institution to perform them.

SETBACK - The distance from the curb, street or other established line within which no building may be erected.

SEVERALTY OWNERSHIP - Owned by one person only; sole ownership.

SHAKE - A hand-split shingle, usually edge grained.

SHEATHING - Structural covering, usually boards, plywood or wallboard, placed over exterior studding or rafters of a house.

SHERIFF'S CERTIFICATE - Document given purchaser at sheriff's sale under foreclosure of a mortgage.

SHERIFF'S SALE - A sale of real or personal property made by a sheriff or other like ministerial officer, in obedience to an execution or other similar mandate of the court.

SIEZEN - also SEISEN - The possession of real property by a person entitled to possess it; possession of a freehold estate in land by one having title thereto; seised of the freehold; a medieval term describing the method by which ceremonial conveyance of land was made; the actual physical moving onto the land.

SILL - The lowest part of the frame of a house resting on the foundation and supporting the uprights of the frame; the board or metal forming the lower side of an opening, as a door sill, window sill, etc.

SIMPLE INTEREST - Interest computed on the original principal.

SINKING FUND - Fund set aside from the income of property which, with accrued interest, will eventually pay for replacement of the improvements.

SKIP PAYMENT - A privilege provided in the savings and loan mortgage

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plan which allows the borrower to skip a monthly payment when necessary if his payment total is running ahead of contract schedule.

SKYLEASE - A lease for a long period of time of space above a piece of real estate; upper stories of a building to be erected by the tenant; upon the termination of the lease the improvements belong to the lessor.

SLANDER - The malicious speaking of false and defamatory words concerning another, whereby he is injured.

SLANDER OF TITLE - Words spoken, written or printed and published, tending to deny or diminish one's title in property.

SOIL PIPE - Pipe carrying waste out from the house to the main sewer line.

SOLE or SOLE PLATE - A member, usually 2 x 4, on which wall and partition studs rest.

SPAN - The distance between structural supports, such as walls, columns, piers, beams, girders, and trusses.

SPECIAL ASSESSMENT - Legal charge against real estate by a public authority to pay cost of public improvements such as: street lights, sidewalks, street improvements, etc.

SPECIAL PURPOSE PROPERTIES - Built for a special or single purpose and therefore have a limited demand in the market.

SPECIAL WARRANTY DEED - A deed in which the grantor limits his liability to the grantee to anyone claiming by, from, through, or under him - the grantor.

SPECIFIC PERFORMANCE - A legal action in which the court is asked to direct either the buyer or seller, whichever the case may be, to perform the terms of the contract when he has refused to fulfill his obligations; an order of the court to do specifically what was promised on a contract.

SPLIT RATE - A different rate of interest on land and buildings.

STANDARD METROPOLITAN AREA - Defined by the Bureau of the Census as a county, or a group of contiguous counties, containing a city of 50,000 population of more.

STATE VET'S LOAN - A loan at 4 percent interest to eligible war

veterans upon security of real property located in Oregon, for the acquisition of homes and farms. The program is administered by the State Department of Veteran's Affairs.

STATUS - Legal standing, condition or relation. Relative position or rank.

STATUTE - A law established by an Act of the legislature.

STATUTE OF FRAUDS - State law which provides that certain contracts must be in writing in order to be enforceable at law. Examples: real property lease for more than one year, broker's authorization to sell real estate.

STATUTE OF LIMITATIONS - A certain statutory period after which a claimant is barred from enforcing his claim by suit.

STIPULATION - A material provision in an agreement.

STRAIGHT LINE DEPRECIATION - The setting aside of equal annual amounts to recover or recapture within a period of years the present value of a building or improvement; most accurately referred to as "recapture". Example: depreciating a property 2 percent per year.

STRING, STRINGER - A timber or other support for cross members; in stairs the support on which the stair treads rest.

STUDS OR STUDDING - Vertical supporting timbers in the walls and partitions.

SUBDIVISION - Generally a tract of land divided into lots suitable for home building purposes; under Oregon law the dividing up or partitioning into four or more units of less than 5 acres each any tract or registered plot of land that was shown on the last tax roll as one unit or contiguous units, for the purpose of transferring the ownership of the land or for the improvement by building at the present or at a future time.

SUBJECT TO MORTGAGE - When a grantee takes title to real property subject to mortgage he is not responsible to the holder of the promissory note for the payment of any portion of the amount due. The most he can lose in the event of foreclosure is his equity in the property. See also "Assumption of Mortgage" in this section. In neither case is the original maker of the note released from his responsibility.

SUBJECTIVE VALUE - Created in the mind of men. It is what people will

pay regardless of cost. In appraising it is found in the income and market data approaches.

SUBLEASE - An agreement conveying the right to use and occupancy of a property in which the lessor is the lessee in a prior lease.

SUBMERGED LANDS - Those lands which lie below the line of ordinary low water of the navigable water of this state whether such waters be tidal or nontidal.

SUBMERSIBLE LANDS - Those lands which lie between the line of ordinary high water and the line of ordinary low water of the navigable waters of this state whether such waters be tidal or nontidal.

SUBORDINATION - The act of making an encumbrance secondary or junior to another lien.

SUBORDINATION CLAUSE - A clause in a second or junior lien permitting retention or priority for prior liens.

SUBPOENA - A writ commanding the designated person to attend court under penalty for failure.

SUBPOENA DUCE TECUM - A subpoena requiring a witness to bring with him certain books or documents in his possession.

SUBROGATION - The substitution of another person in place of the creditor, to whose rights he succeeds in relation to the debt. The doctrine is used very often where one person agrees to stand by another person.

SUBSTITUTION - One of the basic economic principles of valuation. Affirms that no sensible purchaser will pay more for a property than the cost of acquiring an equally desirable substitute property providing the substitute property can be obtained without undue delay. The value of the substitute property tends to indicate the value of the subject property.

SUMMATION - An appraisal method of selecting an interest rate; an indicated value arrived at by estimating the reproduction cost, subtracting depreciation, and adding the value of the land. One method of the cost approach.

SUPPLEMENTARY PROCEEDING - A method used to determine whether a judgment debtor has any assets which can be seized by the judgment creditor for payment of the debt.

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SUPPLY AND DEMAND - An important principle in economics and appraising which affirms the doctrine or scarcity, desire and purchasing power.

SURETY - One who guarantees the performance of another, a guarantor.

SURPLUS PRODUCTIVITY - An appraisal theory defined as the net income remaining after the costs of labor, coordination and capital have been paid. This tends to fix the value of the land.

SURVEY - The process by which a parcel of land is measured and its area is ascertained.

SURVIVORSHIP TENANCY - A method of drafting a deed to provide for survivorship rights, other than by tenancy by the entirety.

SWAMP LANDS - Lands claimed by the state under an act of Congress approved in 1860. Generally, too wet and unfit for cultivation. Statutory provision exists for the draining of such lands.

SWEAT EQUITY - Owner-built construction lending.

TAX - A charge, usually pecuniary, laid upon persons or property for public purposes. The Constitution of the State of Oregon requires that taxes be uniform as applied to any class of property.

TAX DEED - A deed given by the tax collector to the county and terminates all rights of redemption.

TAX ROLL - A record of all taxable property with amount of tax at the millage rate applicable as of the compilation date of closing for any tax year.

TAX SALE - Sale of property after a period of nonpayment of taxes.

TAX SALE CERTIFICATE - A certificate given to one who purchases land at a tax sale.

TAX TITLE - The title by which one holds lands purchased at a tax sale.

TAXATION - A means of raising revenue by assessments on property for federal, state and municipal purposes, and one of the four constitutional limitations on property. They are eminent domain, escheat, police power and ad valorem taxes.

TENANCY AT WILL - A license to use or occupy lands and tenements at the will of the owner.

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TENANCY BY THE ENTIRETY - Is an estate which exists only between husband and wife, with equal rights of possession and enjoyment during their joint lives, and with the right of survivorship.

TENANCY IN COMMON - Ownership by two or more persons who hold undivided interest without right of survivorship; interests need not be equal.

TENANCY OF SUFFERANCE - A tenancy which arises when a tenant holds over after expiration of his lease.

TENANT - One who holds or possesses real estate by any kind of title, either in fee, for life, for years or at will. In a more limited and popular sense, a tenant is one who has the temporary use of real estate which belongs to another.

TENEMENTS - Everything of a permanent nature; anything attached to the soil.

TENTATIVE MAP - The map which must accompany the original written application to a planning commission or governing body for permission to launch a subdivision.

TENURE IN LAND - The mode or manner by which a man holds an estate in lands.

TERMITE SHIELD - A shield, usually of noncorrodible metal, placed on top of the foundation wall or around pipes to prevent passage of termites.

TERMITES - Ant-like insects which destroy lumber used in buildings.

TERMS - Conditions and arrangements (on a mortgage or contract for example).

TESTAMENT - Another term for a will; commonly referred to as "last will and testament".

TESTATOR - A man who makes a will.

TESTATRIX - A woman who makes a will.

3 x 3's - Dividing acreage into three parcels, and transferees re-dividing each parcel into three parcels, to avoid application of the subdivision law.

THRESHOLD - A strip of wood or metal beveled on each edge and used above the finished floor under outside doors.

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TIDE AND OVERFLOW LANDS - All lands over which the tide ebbs and flows from the line of ordinary high tide to the line of mean low tide, all islands, shore lands and other such lands held by the state by virtue of her sovereignty.

TIME IS THE ESSENCE - One of the essential requirements to forming a building contract; contemplates a punctual performance when used in any contract.

TITLE - Evidence of ownership which refers to the quality of the estate; the right, interest or estate in real property.

TITLE, DEEDS - The successive deeds upon which title rests. The owner of the land is properly entitled to these. They go with the land.

TITLE INSURANCE - An insurance policy of indemnification protecting the title holder against flaws and defects in title insofar as these have been revealed by the public record and subject to certain printed exceptions.

TITLE REPORT - A report which discloses condition of the title, made by a licensed title insurance company preliminary to issuance of title insurance.

TOPOGRAPHY - Nature of the surface of the land; topography may be level, rolling, mountainous.

TORRENS CERTIFICATE OF TITLE - The evidence of ownership given a landowner by the State of Oregon; a system of land records provided by state law, a certificate is issued by the circuit court and entered in the register of titles by the county recorder.

TORRENS LAW - A state law made necessary by the time and cost of searching titles. Enabled a party to ask for a court decree that confirmed his title to land free and clear of all outstanding claims. Generally supplanted by faster, cheaper title insurance policy.

TORRENS PROPERTY - Real property to which a certificate of title has been issued by the circuit court under the Torrens system of registration. Most of the early Torrens properties have been removed from this registration.

TORT - A wrongful act; wrong, injury; violation of a legal right, such as fraud or deceit; tort of fraud or deceit has five elements: a false representation made to the plaintiff by the

defendant, knowledge that the representation was false, representation made with the intention that the plaintiff should act upon it, belief by the plaintiff in the truth of the defendant's statement, action by the plaintiff upon the statement to the plaintiff's damage.

TOWNSHIP - A territorial subdivision six miles long, six miles wide and containing 36 sections, each one mile square. Created by lines parallel to the base line at six mile intervals.

TRADE-IN - An increasingly popular method of guaranteeing an owner a minimum amount of cash from his present property to permit him to purchase another. If the property is not sold within a specified time at the listed price the broker agrees to arrange financing to purchase the property at an agreed upon discount.

TRADE-IN-FEE - A fee charged by a broker to compensate for his risk in guaranteeing an owner of a home his equity in cash by a specified date.

TRADES - Used interchangeably with "exchange". Transaction in which owners transfer rights in a particular property for rights in another. Requires its own form of transfer document. Highly developed by members of the Internation Trader's Club.

TRANSFER BOOKS - Books required to be kept by the county auditor, showing all transfers of real estate within the county.

TRANSITION - Change.

TREASURE TROVE - Money, gold, silver or bullion found hidden, the owner of which is unknown.

TREND - A series of related events.

TRESPASS - An entry on the ground of another without lawful authority.

TRIM - The finish materials in a building, such as moldings, applied around openings or at the floor and ceiling.

TRUST - A right of property held by one for the benefit of another.

TRUST ACCOUNT - A bank account separate and apart and physically segregated from broker's own funds, in which broker is required by state law to deposit all moneys collected for clients.

TRUST DEED - A conveyance of real estate to a third person to be

USURY - Charging more than the lawful rate of interest for the use of money.

VALID - Having force of building force; legally sufficient and authorized by law.

VALLEY - The internal angle formed by the junction of two sloping sides of a roof.

VALUATION - Estimated worth or price; the act of valuing by appraisal; a professional process of estimation.

VALUE - The present worth of all the rights to future benefits arising from ownership; the quantity of one thing that will be given in exchange for another thing - the relationship between a thing desired and a potential purchaser, or the present worth of future rights and benefits to the typical buyer; people make value; value is in the minds of men.

VENDEE - A purchaser; buyer.

VENEER - Thin sheets of wood.

VENDOR - A seller; one who disposes of a thing in consideration of money.

VENDOR'S LIEN - An equitable lien which the vendor of land has thereon for the unpaid purchase - money.

VENT - A pipe installed to provide a flow of air to or from a drainage system to protect trap seals from siphonage or back pressure.

VERBAL - This word, when used with reference to a contract, or to evidence, means spoken, not written.

VERIFICATION - Sworn statement before a duly qualified officer to correctness of contents of an instrument.

VESTED - Bestowed upon someone; secured by someone, such as title to property.

VOID - To have no force or effect; that which is unenforceable.

VOIDABLE - That which is capable of being adjudged void, but is not void unless action is taken to make it so.

VOLUNTARY LIEN - Any lien placed on property with consent of, or as a result of, the voluntary act of the owner. A mortgage.

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WAINSCOTING - Wood lining of an interior wall; lower section of a wall when finished differently from the upper part.

WAIVER - Voluntary relinquishment or abandonment of an enforceable promise.

WARRANTY - A representation or promise in a contract.

WARRANTY DEED - One that contains a covenant that the grantor will protect the grantee against any claimant; contains covenants of title, against encumbrances, and of quiet enjoyment.

WATER TABLE - Distance from surface of ground to a depth at which natural ground water is found.

WEALTH - All things subject to man's ownership; all the useful things owned by man.

WILL - A legal declaration or testament of a person's wishes for the disposition of his property after death.

WILLAMETTE MERIDIAN - The north-south line extending from the northern border of California to the southern boundary of Canada, intersecting with the base line at a point in Multnomah County, Oregon, about 3 miles west and slightly north of the present county courthouse in that county.

WITHOUT RECOURSE - Words used in endorsing a note or bill to denote that the future holder is not to look to the endorser in the event of nonpayment.

WRIT OF EXECUTION - A writ which authorizes and directs the proper officer of the court to carry into effect the judgment or decree of the court.

ZONE - An area set off by proper authorities for specific uses, subject to certain restrictions or restraints. (Residential zone, commercial zone, industrial zone, light manufacturing zone, etc.)

ZONING ORDINANCE - Exercise of police power of a municipality in regulating and controlling the character and use of property.

ANSWERS TO NUMBERED QUESTIONS FOUND THROUGHOUT THE TEXT

Q. 1 - 26%
Q. 2 - (B)
Q. 3 - (A)
Q. 4 - 16
Q. 5 - (D)
Q. 6 - That husband and wife are one.
Q. 7 - (B)
Q. 8 - He can enter into a valid lease, but it cannot extend beyond the term of his own life.
Q. 9 - By assignment
Q. 10 - Renter
Q. 11 - (D)
Q. 12 - (D)
Q. 13 - (1) competent parties, (2) offer and acceptance, (3) a lawful object, (4) valid consideration, (5) be in writing and executed by the parties.
Q. 14 - (C)
Q. 15 - A deed conveying the described lands, but without any warranties.
Q. 16 - (C)
Q. 17 - (D)
Q. 18 - (B)
Q. 19 - 8 percent
Q. 20 - On the first day of July of each year.
Q. 21 - 7 percent
Q. 22 - (C)
Q. 23 - Distance from surface of ground to a depth at which natural ground water is found.
Q. 24 - The right of the state to enact laws and enforce them for the order, safety, health, morals, and general welfare of the public.
Q. 25 - A plan or map of a certain piece or pieces of land.
Q. 26 - Four
Q. 27 - Land that barely pays the cost of working or using.
Q. 28 - Liquidation of a debt by regular and equal payments.
Q. 29 - (D)
Q. 30 - (D)
Q. 31 - (A)
Q. 32 - Charging more than the lawful rate of interest for the use of money.
Q. 33 - 10 percent
Q. 34 - Any loan which is not insured or guaranteed by a government agency.
Q. 35 - A fee paid to the lender to induce him to make the loan.
Q. 36 - ½ of 1 percent
Q. 37 - 1% of the original mortgage
Q. 38 - $33,000.00
Q. 39 - (D)
Q. 40 - (A)
Q. 41 - (C)
Q. 42 - (B)

DEFINITIONS

696.005 [1963 c.580 §39; repealed by 1965 c.617 §8]

696.010 Definitions. As used in ORS 696.010 to 696.490 and 696.610 to 696.730, unless the context requires otherwise:

(1) "Associate real estate broker" is a person who has qualified as a real estate broker and who works with a designated broker and whose license states that he is associated with a designated broker.

(2) "Board" means the Real Estate Board.

(3) "Commissioner" means the Real Estate Commissioner.

(4) "Compensation" means any fee, commission, salary, money or valuable consideration for services rendered or to be rendered as well as the promise thereof and whether contingent or otherwise.

(5) "Division" means the Real Estate Division of the Department of Commerce.

(6) "Inactive license" means a license which has been returned to the commissioner and is being held by the commissioner on an inactive status.

(7) "Real estate" includes leaseholds as well as any and every interest or estate in land, whether corporeal or incorporeal, whether freehold or nonfreehold and whether the land is situated in this state or elsewhere.

(8) "Real estate broker" means any person who, for another and for compensation or with the intention or in the expectation or upon the promise of receiving or collecting compensation:

(a) Sells, exchanges, purchases, rents or leases real estate.

(b) Offers to sell, exchange, purchase, rent or lease real estate.

(c) Negotiates, offers, attempts or agrees to negotiate the sale, exchange, purchase, rental or leasing of real estate.

(d) Lists, offers, attempts or agrees to list real estate for sale.

(e) Appraises, offers, attempts or agrees to appraise real estate.

(f) Auctions, offers, attempts or agrees to auction real estate.

(g) Buys, sells, offers to buy or sell or otherwise deals in options on real estate.

(h) Collects, offers, attempts or agrees to collect rental for the use of real estate.

(i) Advertises or holds himself out as being engaged in the business of buying, selling, exchanging, renting or leasing real estate.

(j) Assists or directs in the procuring of prospects, calculated to result in the sale, exchange, leasing or rental of real estate.

(k) Assists or directs in the negotiation or closing of any transaction calculated or intended to result in the sale, exchange, leasing or rental of real estate.

(9) "Real estate broker" also means any person employed by or on behalf of the owner of real estate at a stated salary or upon a commission or upon a salary and commission basis or other compensation to sell, exchange or offer for sale such real estate, or any part thereof, and who shall sell or exchange, or offer or attempt or agree to negotiate the sale or exchange of any lot or parcel of real estate.

(10) "Real estate salesman" means any person, who, for compensation or in the expectation or upon the promise thereof, is employed or engaged by a licensed real estate broker to do any act or deals in any transaction set out in subsection (8) of this section for or on behalf of such licensed real estate broker.

[Amended by 1953 c.166 §5; 1955 c.322 §6; 1965 c.617 §1]

REAL ESTATE BROKERS AND SALESMEN

696.020 Real estate brokers and salesmen required to be licensed. (1) No person shall engage in or carry on or advertise or hold himself out as engaging in or carrying on the business, or act in the capacity of, a real estate broker or a real estate salesman within this state without first obtaining a license as a real estate broker or a real estate salesman as provided for in this chapter.

(2) A person who is licensed as a real estate broker or real estate salesman shall be bound by and subject to the requirements of ORS 696.010 to 696.490, 696.610 to 696.730 and 696.990 in doing any of the acts specified by subsection (8) or (9) of ORS 696.010:

(a) While acting for another; and

(b) While acting in his own behalf.

[Amended by 1969 c.674 §1]

696.030 Certain persons exempted. ORS 696.010 to 696.375, 696.395 to 696.490, 696.710 to 696.730 and 696.990 do not apply to, and the terms "real estate broker" and "real estate salesman" do not include:

(1) Any person, partnership, association or corporation who, as owner, lessor or lessee, performs any acts with reference to property owned or leased by him or it; or any regular employe of any person, partnership, association or corporation who performs any acts with reference to property owned or leased by such person, partnership, association or corporation which are incidental to other principal activities or business of a nonreal estate nature of the employer.

(2) Any person acting as attorney in fact under a duly executed power of attorney from the owner authorizing the final consummation by performance of any contract for the sale, leasing or exchanging of real estate, if the power of attorney is recorded in the office of the recording officer for the county in which the property to be sold, leased or exchanged is located.

(3) Any attorney at law rendering services in the performance of his duties as an attorney at law.

(4) While acting as such, any receiver, trustee in bankruptcy, administrator or executor; or any trustee, or the regular salaried employes thereof, acting under a trust agreement, deed of trust or will.

(5) Any person doing any of the acts specified in subsection (8) or (9) of ORS 696.010 under order of any court.

(6) Any person employed by and acting for a single non-licensed corporation, partnership, association or individual in the management, but not sale, of commercial properties.

(7) Any registered professional engineer or architect appraising, offering, attempting or agreeing to appraise real estate where such appraisal primarily involves the utilization of the specialized knowledge of such registered professional engineer or architect and is not made for the purpose of establishing the sale value of the property.

(8) Any person employed by a single corporation, partnership, association or individual acting for the unit owner of a condominium as defined in ORS 91.505 to 91.675 in the rental and management of such unit as a hotel or motel guest accommodation.

[Amended by 1955 c.322 §7; 1963 c.593 §1; 1967 c.277 §1; 1969 c.674 §2]

696.040 Single act sufficient to constitute actor broker or salesman. One act or transaction in consideration of compensation, by fee, commission, salary or otherwise, or with the intention or in the expectation or upon the promise of receiving or collecting a fee of the kind or nature described in the definition of a real estate broker in subsection (8) or (9) of ORS 696.010, whether the act is an incidental part of a transaction, or the entire transaction, shall constitute the person offering or attempting to perform the act or transaction a real estate broker or a real estate salesman within the meaning of this chapter.

[Amended by 1955 c.322 §8]

696.050 Qualifications of applicants for licenses. (1) Licenses shall be granted only to persons who are trustworthy and competent to transact the business of a real estate broker or real estate salesman in such manner as to safeguard the interests of the public and only after satisfactory proof has been presented to the commissioner. Every applicant for a license as a real estate broker or salesman shall:

(a) Be of the age of 21 years or over;

(b) Be a citizen of the United States;

(c) Have established his residence in Oregon prior to filing his application, with the exception that a licensed broker or salesman who is currently licensed by a state, and who is a resident of that state, may file his application for a broker's or salesman's license as a nonresident licensee, providing that the state by which he is currently licensed has a law which meets the requirements of ORS 696.250; and

(d) Possess a high school diploma or have passed an equivalency examination in lieu thereof, or show satisfactory evidence of completion of a course in real estate practice and theory of at least 20 hours duration in a school licensed or approved by the Department of Education, or a similar course of instruction of like duration in a community college or area education district. Any person licensed prior to July 1, 1974, shall not be required to meet this standard.

(2) In order to qualify for a broker's license, the applicant must also furnish proof satisfactory to the commissioner that:

(a) He was actively engaged in business and duly licensed as a real estate salesman for a period of at least three years prior to the date of his application; or

(b) He has taken and successfully completed a course of instruction in real estate principles, practices and procedures, which in the opinion of the commissioner is the equivalent of three years' experience as a real estate salesman; or

(c) At the discretion of the board, he has had other experience in the selling, appraising or management of real estate equivalent to three years' experience as a real estate salesman, and evidences such experience by detailed explanatory affidavit to establish the nature of such experience; or

(d) He has a combination of partial fulfillment of the qualifications described by paragraphs (a), (b) and (c) of this subsection which in the opinion of the board or commissioner, or both as the case may be, is the equivalent of three years' experience as a real estate salesman.

(3) If an applicant qualifies with only appraisal experience, his license shall be restricted to appraisal activity.

(4) Brokers licensed under the laws of the state on August 22, 1969, are not required to meet the requirement of subsection (2) of this section.

(5) No broker's license shall be issued to a partnership, association or corporation unless all the members of the partnership, association or corporation who will actively engage in the real estate business and all the officers and directors of the corporation who will actively engage in the business of real estate are 21 years of age or over and citizens of the United States. The commissioner, at his discretion, may issue a license to any person not a citizen of the United States who may be eligible for a license if due proof is made to the commissioner that he has declared his intention to become a citizen of the United States.

(6) If an applicant has been convicted of any crime enumerated in paragraph (m) of subsection (1) of ORS 696.300, such conviction may be accepted as conclusive evidence of the untrustworthiness of the applicant, and such conviction may, in and of itself, be sufficient grounds for refusal of license.

[Amended by 1955 c.322 §9; 1961 c.471 §1; 1963 c.412 §1; 1969 c.515 §1; 1969 c.674 §3]

696.060 Form and contents of application for real estate broker's license. Every applicant for a real estate broker's license shall apply therefor in writing upon blanks prepared or furnished by the division. The application for a broker's license shall be verified by the applicant. If the application is made by a partnership or an association, it shall be verified by at least two members thereof. If the application is by a corporation, it shall be verified by the president and secretary thereof. The application shall be in such form as the commissioner may prescribe and shall set forth:

(1) The name and address of the applicant. If the applicant is a partnership or an association, the name and address of each member shall be set forth. If the applicant is a corporation, the name and address of each officer and director shall be set forth.

(2) The name under which the business is to be conducted.

(3) The place or places, including the street number, town, village or city, and county where the business is to be conducted.

(4) The business or occupation theretofore engaged in by the applicant for a period of at least two years immediately preceding the date of such application, and the location thereof; if the applicant is a partnership or an association, by each member thereof, or if a corporation by each officer thereof.

(5) The time and place of the applicant's previous experience in the real estate business, as broker or salesman; if the applicant is a partnership or an association, by each member thereof, or if a corporation, by each officer thereof.

(6) Whether the applicant has ever been convicted of or is under indictment for forgery, embezzlement, obtaining money under false pretense, larceny, extortion, a crime involving moral turpitude, conspiracy to defraud or other like offense or offenses or has been disbarred from the practice of law; if the applicant is a partnership or an association, whether any member thereof has been so convicted, indicted or disbarred; if the applicant is a corporation, whether any officer or director has been so convicted, indicted or disbarred.

(7) Whether the applicant has been refused a real estate broker's or salesman's license or any other occupational or professional license in any other state or whether his license as a broker or salesman or in any other occupational or professional capacity has been revoked or suspended in any other state; if the applicant is a partnership or an association, whether any member thereof has had a license as a broker or salesman or in any other occupational or professional capacity which has been revoked or suspended in any other state; if the applicant is a partnership or an association, whether any member thereof has had a license as a broker or a salesman or in

any other occupational or professional capacity refused, suspended or revoked in any other state; if the applicant is a corporation, whether any officer thereof has had a license as a broker or a salesman or in any other occupational or professional capacity refused, suspended or revoked in any other state.

(8) If the applicant is a partnership, association or corporation, the name of the designated member or officer thereof who is to receive his license by virtue of the issuing of a license to the partnership, association or corporation as is provided for in ORS 696.080.

(9) If the applicant is a member of a partnership or association, or an officer of a corporation, the name and office address of the partnership, or association, or corporation of which the applicant is a member or officer.

696.070 Recommendations to accompany application. The application for a real estate broker's or salesman's license shall be accompanied by the recommendation of at least three resident citizens, not related to the applicant, who have owned real estate for a period of three years or more in the county in which the applicant resides or has or intends to establish his place of business, and who have known the applicant for a period of three years or more. The recommendation shall certify that the applicant bears a good reputation for honesty, truthfulness, fair dealing and competency, and shall recommend that a license be granted to the applicant. If the applicant cannot procure such recommendations for the reason that he has not resided within the county for a period of three years, he may furnish similar recommendations from three persons with like qualifications from any locality within or without the state where the applicant has resided within the three years prior to the filing of his application.
[Amended by 1963 c.412 §2]

696.080 Partnerships, associations and corporations; designating person to make application and pass examination. Every partnership and association, in its application for a license, shall designate and appoint one of its members, and every corporation in its application for a license shall designate and appoint one of its officers to submit an application for a broker's license. The application of the partnership, association or corporation, and the application of member or officer so designated, shall be filed with the commissioner together. No license shall be issued to any partnership, association or corporation unless and until the person or officer so designated by the partnership, association or corporation submits to and passes the examination required by ORS 696.010 to 696.490 and 696.610 to 696.730, on behalf of the partnership, association or corporation. Upon such member's or officer's successfully passing the examination and upon compliance with all other requirements of law by the partnership, association or corporation, as well as by the designated member or officer, the commissioner shall issue a broker's license to the partnership, association or corporation, which shall bear the name of such member or officer, and, thereupon, the member or officer so designated shall act as a real estate broker only as officer or agent of the partnership, association, or corporation, and not on his own behalf. If, in any case, the person so designated is refused a license by the commissioner or in case the person ceases to be connected with such partnership, association or corporation, the partnership, association or corporation shall have the right to designate another person who shall make application and qualify as in the first instance.

696.090 Certain firm members required to obtain broker's license. Each and every member or officer of a partnership, association or corporation who will perform or engage in any of the acts specified in subsection (8) of ORS 696.010, other than the designated member or officer of the partnership, association or corporation in the manner provided in ORS 696.080, shall be required to make application for and take out a separate broker's license in his own name individually; but the license issued to any such member or officer of a partnership, association or corporation shall entitle such member or officer to act as real estate broker only as officer or agent of the partnership, association or corporation, and not on his own behalf.
[Amended by 1955 c.322 §10]

696.100 Application for salesman's license. Every application for a salesman's license shall be made in writing upon a form prescribed by the commissioner and shall contain such information as is required in a broker's application, and also shall set forth

the period of time, if any, during which the applicant has been engaged in the real estate business, stating the name and address of his last employer. Every application for a salesman's license shall be verified by the applicant.
[Amended by 1963 c.412 §3]

696.110 Application and examination fee. (1) Every application for a license and any examination under ORS 696.010 to 696.490 and 696.610 to 696.730 shall be accompanied by the examination fee prescribed in ORS 696.270. The fee for all licenses issued shall, at all periods of the year, be the same as prescribed in ORS 696.270.

(2) No other license or fee shall be required of such licensee by any city, county, town or other political subdivision thereof.
[Amended by 1955 c.322 §11; 1961 c.309 §3; 1965 c.617 §2]

696.120 Commissioner may require additional information from applicants; rules and regulations. (1) Applications for a broker's or salesman's license shall contain such other information as to the applicant, in addition to that described in ORS 696.060 to 696.100, as the commissioner shall require. The commissioner may require such other proof, through the application, or otherwise, as he shall deem desirable, with due regard to the paramount interests of the public, as to the honesty, truthfulness, integrity and competency of the applicant.

(2) The commissioner expressly is vested with the power and authority to make and enforce any and all such reasonable rules and regulations connected with the application for any license as shall be deemed necessary to administer and enforce the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730.

696.130 Examination of applicants; issuance of salesman's license upon revocation of broker's license. (1) In addition to proof of honesty, truthfulness and good reputation of any applicant for a license, the applicant shall be required to pass a written examination to be conducted by the Real Estate Board. The examination shall include reading, writing, spelling, arithmetic and computation, salesmanship, appraising, accounts, real estate ethics, real estate taxation, problems in real estate and a general knowledge of the provisions of ORS 696.010 to 696.375, 696.395 to 696.490, 696.710 to 696.730 and 696.990.

(2) The board shall hold examinations at such times and places as it may determine, except that the board shall hold the examinations no less frequently than every 60 days. The examination for a broker's license shall differ from the examination for a salesman's license in that it shall be of a more exacting nature and require higher standards of knowledge of real estate. If the license of any real estate broker or salesman is revoked by the commissioner, no new license shall be issued to such person until he complies with the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730 unless at the time a broker's license is revoked the order authorizes the issuance of a salesman's license.
[Amended by 1955 c.322 §12; 1969 c.674 §4]

696.140 Reexamination. Any individual who fails to pass an examination conducted by the board pursuant to ORS 696.130 is ineligible for a similar examination until after the expiration of 60 days from the time he took the last examination, and then only upon making application and payment of the examination fee. An applicant who has failed two successive examinations shall be ineligible to take another examination until the expiration of one year from the date of the last examination taken. Any person who fails to take or pass the examination shall not be entitled to the return of any examination fees previously paid.
[Amended by 1961 c.471 §2; 1963 c.412 §4]

696.150 Examination where applicant is a partnership, association or corporation. If the applicant is a partnership, association or corporation, the examination shall be submitted to on behalf of the partnership, association or corporation by the member or officer thereof who is designated in the application as the person to receive a license by virtue of the issuing of a license to the partnership, or association, or corporation, as provided for in ORS 696.080.

696.160 Issuance of broker's or salesman's licenses. Upon satisfactorily passing the examination and upon complying with all other provisions of law and conditions of ORS 696.010 to 696.490 and 696.610 to 696.730, a license shall thereupon be granted by the commissioner to the successful applicant therefor as a real estate broker or a real estate salesman. The applicant, upon receiving his license, is authorized to conduct the business of a real estate broker or real estate salesman, as the case may be, between the

date of his license and the renewal date of his license, unless sooner revoked or suspended. Not more than one license shall be issued and outstanding to or in favor of any licensee at any one time.
[Amended by 1969 c.674 §5]

696.165 Issuance of associate broker's license and pocket card; application of chapter to associate brokers. (1) A real estate broker may act as a salesman for another broker if he obtains an associate broker's license. An associate broker's license may be obtained by a broker, without examination, by subscribing to an agreement that he will not engage in any act in the capacity of a broker other than as an employe of the employing broker, while associated with the employing broker. The form of this agreement is subject to the approval of the commissioner. Signed copies of the agreement shall be filed with the employing broker and the commissioner. Before an associate broker's license may be issued, the applicant must also surrender to the commissioner his real estate broker's license and pocket card for inactivation, which license and card shall remain inactive as long as his associate broker's license is outstanding and effective, and shall be reissued upon inactivation of his associate broker's license and compliance with the other provisions of ORS 696.010 to 696.490 and 696.610 to 696.730 relating to brokers.

(2) Upon approval of the agreement mentioned in this section, and the tender of the broker's license and pocket card to the commissioner, the commissioner shall issue, in the applicant's name, an associate broker's license and pocket card, the license to be delivered by the commissioner to the employing broker in accordance with ORS 696.180. The license shall designate the applicant as an associate real estate broker and he shall be known by that title. The pocket card shall be the same as that provided in ORS 696.190 for salesmen except that the designation "associate real estate broker" shall be substituted for "real estate salesman." The provisions of ORS 696.010 to 696.490 and 696.610 to 696.730, other than ORS 696.130 to 696.150 that relate to and govern real estate salesmen shall also apply to and govern associate real estate brokers.
[1953 c.166 §4; 1969 c.674 §6]

696.170 [Amended by 1955 c.322 §13; repealed by 1969 c.674 §20]

Note: ORS 696.170 is repealed effective July 1, 1970. Until that time, ORS 696.170 (1967 Replacement Part) remains in effect.

696.172 License renewal period. There is established a staggered renewal period to coincide with the last day of the month of the birthdate of each licensee. A new license or renewal issued on July 1, 1970, shall be for the term of one year plus the additional calendar months up to and including the month in which the birthdate of the licensee occurs. On July 1, 1970, all licensees shall pay:

(1) The annual fee; and

(2) A sum for the additional months up to and including the month in which the birthdate of the licensee occurs. Such sum shall be computed as one-twelfth the annual fee for each month.
[1969 c.674 §9]

Note: ORS 696.172 to 696.176 take effect July 1, 1970. See 1969 c.674 §7.

696.174 License renewal date; effect of failure to make timely renewal. (1) Each license as a real estate broker, or real estate salesman may be renewed by the commissioner upon the payment by the licensee of the registration or renewal fee specified in ORS 696.270 if that fee is paid on or before the first day of the month following the month of the birthdate of the licensee.

(2) If the licensee fails to pay the registration or renewal fee on or before the first day of this month, the commissioner may accept a later payment, subject to such conditions as he may require; but between this last day of the month of his birthdate and the date of renewal of the license the rights of the licensee under such license shall be suspended, and during such suspension it is unlawful for any licensee to do or attempt or offer to do any of the acts of the kind and nature described in the definition of a real estate broker in subsection (8) of ORS 696.010 in consideration of compensation of any kind or expectation thereof.
[1969 c. 674 §11]

Note: See note under 696.172.

696.176 Terms of licenses. (1) A new license or renewal issued after July 1, 1970, shall be for the term of the months up to and including the month of the birthdate of the licensee. These licensees shall pay the annual fee for such license.

(2) Corporations, partnerships and associations shall have established as the equivalent of a birthdate, that date upon which the license is issued.

(3) Branch offices shall have established as the equivalent of a birthdate, the birthdate

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of the real estate broker or the agency establishing the branch office.
[1969 c.674 §10]

Note: See note under 696.172.

696.180 Form and content of license. The commissioner shall issue to each licensee a license in such form and size as shall be prescribed by the commissioner. The license shall show the name and address of the licensee and, in case of a real estate salesman's license, shall show the name of the real estate broker by whom he is employed. Each license shall have imprinted thereon the seal of the division and shall contain such other matter as shall be prescribed by the commissioner. The license of each real estate salesman shall be delivered or mailed to the real estate broker by whom such real estate salesman is employed and shall be kept in the custody and control of such broker.

696.190 Pocket cards to be issued. The commissioner shall prepare and deliver to each licensee a pocket card, which card, among other things, shall contain an imprint of the seal of the division and shall certify that the person whose name appears thereon is a licensed real estate broker or real estate salesman, as the case may be. If it is a real estate salesman's card it shall also contain the name and address of his employer. The matter to be printed on such pocket card, except as above set forth in this section, shall be prescribed by the commissioner.

696.200 Real estate broker to maintain place of business; branch offices; removal from state; change of business location. (1) Except for nonresident brokers licensed pursuant to ORS 696.250 and associate brokers licensed pursuant to ORS 696.165, every real estate broker shall maintain in this state a place of business to be designated as his main office and designate such place of business by a sign which shall contain the name under which he conducts his business, together with the words "Real Estate," or if a member of the National Association of Real Estate Boards he may use the word "Realtor." Such sign shall be written in letters not less than one inch in height and placed so that it can easily be observed and read by anyone entering the place of business.

(2) The place of business shall be specified in the application for license, and designated in the license. No license issued under ORS 696.010 to 696.490 and 696.610 to 696.730 authorizes the licensee to transact business from any office other than that designated in the license, unless notice in writing is given to the commissioner prior to any such change of business location, designating the new location of such office, at which time the broker shall send in his license and pocket card and the licenses and pocket cards of the salesmen in his employ with the fee required by ORS 696.270 for each new license. The commissioner forthwith shall issue a new license for the new location for the unexpired period. The change of a business location without notification to the commissioner is grounds for cancellation of licenses previously issued.

(3) If a broker desires to establish one or more branch offices, he shall notify the commissioner, giving the location thereof, and pay the fee required by ORS 696.270 for each branch office to be established, whereupon the commissioner may issue a license therefor. The branch office license shall be issued in the same name that the main office license is issued, and the license must be posted in such place of business. Branch office signs shall conform with the provisions of subsection (1) of this section and the designation "Branch Office" shall be included. Each branch office shall be under the management of an associate real estate broker or of a licensed real estate salesman with at least two years' experience as a duly licensed real estate salesman immediately preceding the management of the branch office. The license of such broker or salesman shall state that he is associated with or employed by, as the case may be, the broker licensed to establish the branch office.

(4) Except for nonresident brokers licensed pursuant to ORS 696.250, when a broker currently licensed in Oregon terminates his Oregon residence he shall immediately surrender his broker's license to the commissioner. The commissioner shall hold the license as inactive until residency is reestablished by the broker or the license expires. Failure to surrender the license to the commissioner upon the termination of residency is grounds for cancellation of the license. All salesman's licenses in the custody of the broker at the time his residency is terminated shall be surrendered to the commissioner to be held as an inactive license or may be transferred to a qualified broker upon

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the payment of the fee specified in ORS 696.270. Absence from the state for a period in excess of 90 days is to be considered prima facie evidence of a termination of residency for the purpose of this section unless evidence satisfactory to the commissioner is furnished that such broker has not, in fact, changed his residence, and that such absence from the state is temporary only.

(5) Upon removal from any location it shall be his duty to see that his name or the name under which he has operated is removed from the location which he has vacated. A broker shall not display any name as such at the designated places of business named in his license or licenses other than the name under which he is licensed.

[Amended by 1955 c.322 §14; 1961 c.471 §3; 1965 c.367 §1]

696.210 Display of licenses at place of business. Each real estate broker shall display prominently in his principal place of business his own license as well as the licenses of all real estate salesmen employed by him therein or in connection therewith.

696.220 [Repealed by 1955 c.322 §15]

696.221 Return of salesman's license to commissioner. (1) A real estate broker at any time may, and at the request of the salesman shall without delay, return the license of a real estate salesman to the commissioner. When, and only when, the license of a salesman is returned to the commissioner, the relationship of the broker returning the license and the salesman whose license is returned, is, for the purposes of ORS 696.010 to 696.490 and 696.610 to 696.730, terminated. Before the broker returns the license of a salesman to the commissioner he shall make a reasonable attempt to give the salesman notice of his intent so to do.

(2) After the license of a salesman has been returned to the commissioner under subsection (1) of this section by the employing broker it may:

(a) Become an inactive license.

(b) Be reissued to the same broker.

(c) Be reissued to a different broker.

[1955 c.322 §4; 1969 c.674 §12]

696.224 Inactive real estate salesman's license. (1) The license of a real estate salesman becomes an inactive license if it is not reissued, revoked or suspended within 10 days after his employment with a broker is terminated.

(2) The license of a real estate salesman shall be reissued to the same or a different broker when, within 10 days after termination of his employment with a broker:

(a) Notice of his employment by the broker and the name of the employing broker is given to the commissioner by the real estate salesman; and

(b) The fee prescribed by ORS 696.270 for the transfer of licenses has been paid to the commissioner.

[1955 c.322 §5; 1969 c.674 §13]

696.226 Surrender of broker's license to commissioner; inactive licensee not to engage in business; renewal, reactivation, revocation or suspension of inactive licenses. (1) When a broker ceases to maintain a place of business he shall surrender his license to the commissioner, who shall keep such license on record as an inactive license. The license of a salesman becomes inactive as provided in subsection (1) of ORS 696.224.

(2) While his license is being held by the commissioner as an inactive license, the licensee shall not engage in, or carry on, or advertise or hold himself out as engaging in or carrying on the business of a real estate broker or a real estate salesman within this state.

(3) Inactive licenses may be:

(a) Renewed upon the payment of the renewal fee specified in ORS 696.270.

(b) Reactivated upon application to the commissioner and the payment of the reactivation fee specified in ORS 696.270.

(c) Revoked or suspended by the commissioner when conditions exist under which the commissioner would have been authorized to revoke or suspend the license if it were active.

[1955 c322 §2]

696.228 Surrender of associate broker's license; inactive licensee not to engage in business; renewal, reactivation, revocation or suspension of inactive license. (1) When an associate real estate broker ceases to act as a salesman for another broker he shall surrender his associate broker's license to the commissioner who shall keep such license on record as an inactive license.

(2) While his associate broker's license is being held by the commissioner as an inactive license, the licensee shall not engage in, or carry on, or advertise or hold himself out as a salesman for another broker.

(3) Inactive licenses may be:

(a) Renewed upon the payment of the renewal fee specified in ORS 696.270.

(b) Reactivated upon application to the commissioner and the payment of the reactivation fee specified in ORS 696.270.

(c) Revoked or suspended by the commissioner when conditions exist under which the commissioner would have been authorized to revoke or suspend the license if it were active. [1969 c.674 §8]

Note: ORS 696.228 takes effect on July 1, 1970. See 1969 c.674 §7.

696.230 [Repealed by 1969 c.674 §21]

696.240 Disposition of funds received by brokers. Every person, partnership or corporation licensed as a real estate broker, who does not immediately place all funds entrusted to him in his capacity as a real estate broker by his principal or others in a neutral escrow depository in this state, shall maintain a trust fund account with some bank or recognized depository located in this state and place all such entrusted funds therein upon receipt. The Real Estate Division shall establish rules and regulations to provide for records to be maintained and the manner in which such deposits shall be made.
[Amended by 1957 c.383 §1; 1963 c.580 §49]

696.250 Licensing of nonresidents. (1) A nonresident of this state who is a licensed broker in another state may obtain a license as a broker in this state by complying with all provisions of ORS 696.010 to 696.490 and 696.610 to 696.730, provided that the nonresident broker is regularly engaged in the real estate business and maintains a place of business in the [illegible] state, and provided that that state offers the same privileges to the licensed broker [illegible] this state. Such nonresident licensee may not maintain a place of business within this state. The commissioner may license such nonresident broker without examination, provided that he has qualified for a broker's license in the state in which he resides by written examination, and also that his state of residence permits licenses to be issued without written examination to brokers resident in and licensed by this state. The commissioner may, in his discretion, refuse to issue a broker's license to an applicant who is not a resident of this state.

(2) The commissioner may issue a nonresident salesman's license to the salesman of a licensed nonresident broker.

(3) When a nonresident broker no longer regularly engages in the real estate business or maintains a place of business in the state of his resident real estate broker's license, his nonresident broker's license and the nonresident salesman's licenses of salesmen in his employ shall be surrendered to the commissioner.
[Amended by 1953 c.202 §2; 1961 c.675 §1; 1965 c.367 §2; 1969 c.674 §14]

696.260 Acceptance of license by nonresident as appointment of commissioner as agent for service; service of process on nonresident broker. The acceptance, by a nonresident, of a license as a real estate broker under this section and ORS 696.250, shall be deemed equivalent to an appointment by such nonresident of the Real Estate Commissioner of this state as his true and lawful attorney, upon whom may be served any lawful summons, process or pleading in any action or suit against him, in any court of this state, arising out of any business done by him as a real estate broker in this state, and such acceptance shall be deemed equivalent to an agreement by such nonresident that any summons, process or pleading so served shall be of the same legal force and validity as if served on him personally in this state. If it appears by the certificate of the sheriff of the county in which an action or suit has been filed against such a nonresident broker, that the defendant cannot be found in this state, service of any summons, process or pleading in the action or suit may be made by leaving a copy thereof, with a fee of $2, in the hands of the commissioner or in his office. Such service shall be sufficient and valid personal service upon the defendant; provided that notice of such service and a copy of the summons, process or pleading is sent forthwith by registered mail by the plaintiff or his attorney to the defendant, at the most recent address furnished to the commissioner by the nonresident broker or to his last-known address, and the affidavit of the plaintiff or his attorney of such mailing is appended to the summons, process or pleading and entered as a part of the return thereof. However, personal service outside of the state in accordance with the statutes relating to personal service of summons outside of the state shall relieve the plaintiff from such mailing requirement. Any summons served as provided in this section shall require the defendant to appear and answer the complaint within four weeks after receipt thereof by the commissioner. The court in which

the action or suit is brought may order such continuances as may be necessary to afford the defendant reasonable opportunity to defend the action. The fee of $2 paid by the plaintiff to the commissioner shall be taxed as costs in favor of the plaintiff if he prevails in the action. The commissioner shall keep a record of each summons, process or pleading served upon him under this section, showing the day and hour of service.

696.270 Fees. The following fees shall be charged by and paid to the Real Estate Division:

(1) For each examination applied for, $10.

(2) For each real estate broker's license, $25; and for each annual registration or renewal of a real estate broker's license thereafter, $25.

(3) For each license as real estate broker issued to a member of a partnership, association, or officer of a corporation other than the member of the partnership or association, or officer of the corporation named in the license issued to such partnership, association or corporation, $25; and for each annual registration or renewal of such license thereafter, $25.

(4) For each associate broker's license a fee of $25 and for each annual registration or renewal a fee of $25.

(5) For each real estate salesman's license, $15; and for each annual registration or renewal of such license thereafter, $15.

(6) For each additional office or place of business, an annual fee of $5.

(7) For each change of name or address of a broker on the records of the department, $5.

(8) For each duplicate license, where the original license is lost or destroyed and affidavit made thereof, $2.

(9) For each salesman's or associate broker's license issued when change of business location or change of name, $1.

(10) For each transfer of salesman's license, $5.

(11) For each duplicate registration, where the original card is lost or destroyed and affidavit made thereof, $1.

(12) For certified copies of any record in the office of the commissioner, $2 for each certificate, and 25 cents per folio for matter certified; for uncertified copies, 25 cents per folio.

(13) For the renewal of a broker's inactive license, $10.

(14) For the renewal of a salesman's inactive license, $7.50.

(15) For the reactivation of a broker's inactive license, $25, for the reactivation of an associate broker's inactive license, $25, and for the reactivation of a salesman's inactive license, $15.

(16) In addition to the annual renewal or registration fee, for late renewal or late annual registration, $10.

[Amended by 1953 c.166 §5; 1955 c.457 §1; subsections (13), (14) and (15) enacted as 1955 c.322 §3; 1957 c.383 §2; 1961 c.670 §1; 1965 c.617 §3; 1969 c.674 §15]

696.280 Real estate brokers to keep records. Every person licensed as a real estate broker shall keep records of all real estate transactions handled by or through him, which records shall include copies of earnest money receipts and closing statements showing all receipts, disbursements and adjustments, also copies of listing contracts, if any. Such records shall at all times be open for inspection by the commissioner or his duly authorized representatives. The records of each transaction shall be kept by the broker for a period of not less than six years after the date of the transaction. Violation by a real estate broker of any of the provisions of this section is grounds for revocation or suspension of licenses issued to such broker.

696.290 Sharing commission with unlicensed person prohibited. No licensed broker or salesman shall offer, promise, allow, give, pay or rebate, directly or indirectly, any part or share of his commission or compensation arising or accruing from any real estate transaction to any person who is not a licensed broker or licensed real estate salesman licensed under ORS 696.010 to 696.490 and 696.610 to 696.730. However, a licensed broker may pay a finder's fee or a share of his commission on a cooperative sale where such payment is made to a licensed broker in another state provided that the state in which he is licensed has a law permitting brokers to cooperate with brokers in this state and that such nonresident broker does not conduct in this state any of the negotiations for which a fee, compensation or commission is paid. No real estate salesman shall be employed by, or accept compensation from, any person other than the broker under whom he is licensed at the time, and no broker shall

make payment to the salesman of another broker except through the salesman's employing broker. Nothing in this section prevents payment of a commission or fee earned by such salesman while licensed, because of change of employment or inactivation of his license.

[Amended by 1953 c.42 §2; 1961 c.670 §2; 1969 c.674 §16]

696.300 Grounds for revocation or suspension of licenses. (1) The commissioner may, upon his own motion, and shall upon the verified complaint in writing of any person, provided such complaint, or such complaint together with evidence, documentary or otherwise, presented in connection therewith, shall make a prima facie case, investigate the actions of any real estate broker or real estate salesman, or any unlicensed person who assumes to act in either such capacity within this state, and has the power to suspend or revoke any license issued under ORS 696.010 to 696.490 and 696.610 to 696.730 at any time where the licensee has by false or fraudulent representation obtained a license, or where the licensee, in performing or attempting to perform any of the acts mentioned in ORS 696.010 to 696.490 and 696.610 to 696.730 is deemed to be guilty of:

(a) Making any substantial misrepresentations.

(b) Making any false promises of a character likely to influence, persuade or induce.

(c) Pursuing a continued and flagrant course of misrepresentation, or making of false promises through agents or salesmen or advertising or otherwise.

(d) Using the term "Realtor" by one not a member of the National Association of Real Estate Boards, or using any other trade name or insignia of membership in any real estate organization of which the licensee is not a member.

(e) Acting for more than one party in the transaction without the knowledge of all parties for whom he acts.

(f) Accepting a commission or valuable consideration as a real estate salesman for the performance of any of the acts specified in ORS 696.010 to 696.490 and 696.610 to 696.730, from any person, except his employer, who must be a licensed real estate broker.

(g) Representing or attempting to represent a real estate broker other than the employer, without the express knowledge and consent of the employer.

(h) Failing, within a reasonable time, to account for or to remit any moneys or to surrender to the rightful owner any documents or other valuable property coming into his possession which belong to others; or issuing an appraisal report on real property in which he has an interest, unless the nature and extent of such interest is fully disclosed in the report.

(i) Disregarding or violating any provisions of ORS 696.010 to 696.490 and 696.610 to 696.730.

(j) Making, printing, distributing or in any manner publishing misleading or untruthful advertising, descriptions or promises, of such character as reasonably to induce any person to act to his damage or injury.

(k) Paying or receiving any rebate, profit, compensation or commission in violation of ORS 696.010 to 696.490 and 696.610 to 696.730.

(L) Inducing any party to a contract, sale or lease to break such contract, for the purpose of substituting in lieu thereof a new contract with the same principal or a different principal, where such substitution is motivated by the personal gain of the licensee.

(m) Forgery, embezzlement, obtaining money under false pretenses, larceny, extortion, conspiracy to defraud, a crime of moral turpitude, or other like offense or offenses, and who had been convicted thereof in a court of competent jurisdiction of this or any other state.

(n) Guaranteeing or having authorized or permitted any person to guarantee future profits which may result from the resale of real property.

(o) Placing a sign on any property offering it for sale or for rent without the authority of the owner or his authorized agent.

(p) Soliciting, selling or offering for sale real property by offering "free lots," or conducting lotteries or contests, or offering prizes for the purpose of influencing a purchaser or prospective purchaser of real property.

(q) Any act or conduct, whether of the same or a different character than specified above in this section, which constitutes or demonstrates bad faith, incompetency or untrustworthiness, or dishonest, fraudulent or improper dealings.

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(r) Failing for any reason to pay to the commissioner the annual registration or renewal fee as specified in ORS 696.270 promptly and before the time specified in that section.

(s) Commingling the money or other property of his principal or client with his own.

(t) Failing or refusing upon demand to produce any document, book or record in his possession concerning any real estate business transacted by him, for inspection of the Real Estate Commissioner or his authorized representative.

(u) Failing to maintain at all times in his principal place of business a complete record of every transaction which comes within the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730.

(v) Violating ORS 659.033.

(2) The commissioner shall, in addition, have power to revoke or suspend any license issued under the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730, at any time, where the licensee performs any act or offers, attempts or agrees to do any act, for which the commissioner lawfully may refuse to issue a license to any applicant.

[Amended by 1959 c.585 §1; 1961 c.670 §3; 1969 c.674 §17]

696.310 Effect of revocation on licensed associates. Any unlawful act or violation of any of the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730 by any licensee is not cause for the suspension or revocation of a license of any employer, employe, salesman, partner, member or officer associated with or employed by such licensee, unless it appears to the satisfaction of the commissioner that such employer, employe, salesman, partner, member or officer, had guilty knowledge thereof. A course of dealing shown to have been persistently and consistently followed by any real estate salesman, employe, partner, associate or officer shall constitute prima facie evidence of such knowledge upon the part of the employer, partner, associate or officer. In the event of the revocation or suspension of the license issued to any member of a partnership or to any officer of an association or corporation, the license issued to such partnership, association or corporation shall be revoked by the commissioner, unless, within a time fixed by the commissioner, where a partnership, the connection therewith of the member whose license has been revoked is severed and his interests in the partnership and his share in its activities brought to an end, or, where an association or corporation, the offending officer is discharged and has no further participation in its activities. However, the discharged or withdrawing member or officer of such partnership, association or corporation may reassume his connection with, or be reengaged by such partnership, association or corporation upon termination of the suspension or reinstatement of his license.

696.320 Effect of suspension or revocation of employing broker's license on salesman. The suspension or revocation of a broker's license shall suspend automatically every salesman's license pending a change of employer or the issuance of a new license. Such new license shall be issued without charge, if granted during the same year in which the original license was granted, upon the receipt of the salesman's original license and pocket card.

[Amended by 1969 c.674 §18]

696.330 Hearing by commissioner prior to refusing, suspending or revoking license. The commissioner shall, before denying the application for a license or before suspending or revoking any license, set the matter down for a hearing and, at least 20 days prior to the date set for the hearing, shall notify the applicant or licensee in writing, which notice shall contain an exact statement of the charges made and the date and place of the hearing and shall afford the applicant or licensee an opportunity to be heard in person or by attorney in reference thereto. The written notice may be served by delivering it personally to the applicant or licensee, or by mailing it by registered mail to the last-known business address of the applicant or licensee. If the applicant or licensee is a salesman the commissioner also shall notify the broker employing him or in whose employ he is about to enter by mailing notice by registered mail to the broker's last-known business address. The hearing on such charges shall be held before the commissioner at such time and place as the commissioner shall prescribe, and the hearing may be continued from time to time.

[Amended by 1967 c.206 §1]

696.340 Powers of commissioner in relation to hearings. The commissioner shall have the power:

(1) To administer oaths.

(2) To certify to all official acts.

(3) To subpena and bring before him any person in the state as witness.

(4) To require the production of books and papers.

(5) To swear witnesses.

(6) To take testimony of any person by deposition.

696.350 Subpenas and witnesses; decision of commissioner. Subpenas issued pursuant to the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730 shall be served in the same manner as subpenas may be served in any civil action in this state and the same fees and mileage shall be allowed in all such cases as are allowed by law in the trial of civil cases in a justice court. Any party to any such hearing shall have the right to the attendance of witnesses in his behalf at such hearing, upon making request therefor to the commissioner, designating the person sought to be subpenaed and advancing the witness fees and mileage for each such witness, and shall have the right to examine and cross-examine witnesses for and against him, either in person or by legal counsel. In all cases where the commissioner deems it necessary and proper to subpena witnesses at the expense of the division, he may do so, and such fees and expenses of any hearing may be paid out of the funds specified in ORS 696.490. The circuit court in the county in which the hearing may be held shall have the power to compel the attendance of witnesses, the giving of testimony and the production of books and papers as required by any subpena issued by the commissioner. In case of the refusal of any witness to attend or testify or produce any books or papers required by such subpena, the commissioner may report to the circuit court in the county in which the hearing is pending by petition, setting forth that due notice has been given of the time and place of attendance of the witness or the production of books and papers and that the witness has been summoned in the manner prescribed in the subpena or has refused to answer questions propounded to him in the course of such hearing, and ask an order of the court compelling the witness to attend and testify or produce the books or papers before the commissioner in charge of any such hearing. The court thereupon shall enter an order directing the witness to appear before the court at a time and place to be fixed by the court in such order, and then and there to show cause why he has not attended or testified or produced the books and papers at the hearing. A copy of the order shall be served upon the witness. If it appears to the court that the subpena was regularly issued the court thereupon shall enter an order that the witness appear before the commissioner at the time and place fixed in the order and testify or produce the required books and papers, and, upon the failure to obey the order, the witness shall be dealt with as for contempt of court. In each case a decision shall be rendered by the commissioner in writing and filed in the proceeding. If, after the hearing, the commissioner determines that an applicant is not qualified to receive a license, a license shall not be granted to the applicant, and, if the commissioner determines that any licensee is guilty of a violation of any of the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730, his license shall be canceled or revoked.

696.360 Appeal from commissioner's decision. In case of the refusal, revocation or suspension of a license by the commissioner under the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730, the applicant whose application is so refused, and the licensee whose license is revoked or suspended by the commissioner, shall have the right to appeal from the decision of the commissioner so refusing, revoking or suspending such license within 60 days after the filing of the decision in the office of the commissioner in the manner provided by ORS 183.480.
[Amended by 1967 c.206 §2]

ADMINISTRATION

696.375 Real Estate Division; Real Estate Commissioner; salary and bond of commissioner. (1) The Real Estate Division is established within the Department of Commerce.

(2) The Real Estate Division shall be under the supervision and control of an administrator who shall be known as the Real Estate Commissioner. The Director of Commerce shall, with the approval of the Governor, appoint the Real Estate Commissioner who shall have been, before the date of his appointment, for five years a real estate broker actively engaged in business as such in this state or actively connected with the administration of the Real Estate Division or

its predecessor, the Oregon Real Estate Department. The commissioner shall hold his office at the pleasure of the Director of Commerce and shall be responsible for the performance of the duties imposed upon the division. The Real Estate Commissioner shall receive such salary as may be provided by law.

(3) Twenty percent of the annual salary of the Real Estate Commissioner shall be paid from the Collection Agency Account, to be paid monthly out of the State Treasury upon warrant from the Secretary of State.

(4) Before entering upon the duties of his office the commissioner shall give to the state a fidelity bond with one or more corporate sureties authorized to do business in this state in the sum fixed by the Director of Commerce. The premium for the bond shall be paid by the division.

[1963 c.580 §§40, 41]

696.380 [Repealed by 1963 c.580 §103]

696.385 Power of division. The Real Estate Division shall have the power to:

(1) Adopt a seal by which it shall authenticate its proceedings.

(2) From time to time, prepare and cause to be printed and circulated among the real estate licensees of Oregon such printed matter as it may deem helpful or educational or proper for the guidance and welfare of such licensees.

(3) Make and enforce any and all such reasonable rules and regulations as shall be deemed necessary to administer and enforce the provisions of, and enforce and discharge the duties defined in, any law with the administration or enforcement of which the division is charged.

[1963 c.580 §48; 1965 c.617 §5]

696.390 [Repealed by 1963 c.580 §103]

696.395 Power of commissioner. The Real Estate Commissioner shall have the power to:

(1) For the purpose of administration, with the approval of the Director of Commerce, organize and reorganize, as necessary, the division in the manner that he deems necessary to properly conduct the work of the division.

(2) Appoint all subordinate officers and employes of the division and prescribe their duties and fix their compensation, subject to the applicable provisions of the State Merit System Law. Subject to any other applicable law regulating travel expenses, the officers and employes of the division shall be allowed such reasonable and necessary travel and other expenses as may be incurred in the performance of their duties.

(3) Require a fidelity bond of any officer or employe of the division who has charge of, handles or has access to any state money or property, and who is not otherwise required by law to give a bond. The amounts of the bonds shall be fixed by the commissioner, except as otherwise provided by law, and the sureties shall be approved by him. The division shall pay the premium on the bonds.

[1963 c.580 §42]

696.400 [Repealed by 1963 c.580 §103]

696.405 Real Estate Board; appointment; term; qualifications; compensation; expenses. (1) The Real Estate Board is established within the Department of Commerce. The board shall consist of five members, one of whom shall be the Real Estate Commissioner, and the other four members shall be appointed by the Director of Commerce with the approval of the Governor to hold office for a period of four years, but to serve at the pleasure of the Director of Commerce. The members of the board must have been, before the date of their appointment, for five years real estate brokers actively engaged in business as such in this state or actively connected with the administration of the Real Estate Division or its predecessor, the Oregon Real Estate Department. In case of a vacancy for any cause the Director of Commerce, with the approval of the Governor, shall make an appointment to become immediately effective for the unexpired term.

(2) A member of the Real Estate Board is entitled to compensation or expenses as provided in ORS 292.495.

[1963 c.580 §43; 1969 c.314 §97]

696.410 [Repealed by 1963 c.580 §103]

696.415 Officers; meetings; quorum. (1) The Real Estate Board shall annually select one of its members as chairman, who shall preside at the meetings of the board. In the absence of the chairman some other member of the board may serve as chairman. The board shall meet at such times and places as determined by the board and may also meet upon call of the chairman.

(2) A majority of the board shall constitute a quorum for the transaction of business. A vacancy on the board shall not impair the right of the remaining members to

perform all the duties and exercise all the functions and authority of the board.
[1963 c.580 §45]

696.420 [Repealed by 1963 c.580 §103]

696.425 Powers and duties of board. (1) The Real Estate Board is authorized to inquire into the needs of the real estate licensees of Oregon, the functions of the Real Estate Division and the matter of the business policy thereof, to confer with and advise the Director of Commerce as to how the division may best serve the state and the licensees, and to make recommendations and suggestions of policy to the Real Estate Division as the board may deem beneficial and proper for the welfare and progress of the licensees and of the public and of the real estate business in Oregon.

(2) The board shall conduct all examinations for applicants for both broker's and salesman's licenses, prepare or cause to be prepared the questions to be asked in the examinations and grade or cause to be graded the papers of each applicant after the completion of the examination and file a written report with the Real Estate Division as to applicants taking the examination who have passed and who have failed to pass the examination. The board shall provide the manner and methods for conducting examinations.

(3) The expenses of the Real Estate Board shall be paid from moneys available to the Real Estate Division for payment of administrative expenses relating to the real estate and business broker activities of the division.
[1963 c.580 §46; 1969 c.674 §19]

696.430 Records of commissioner as evidence; records open to inspection. Copies of all records and papers in the office of the commissioner duly certified and authenticated by the seal of the commissioner shall be received in evidence in all courts equally and with like effect as the original. All records kept in the office of the commissioner under authority of ORS 696.010 to 696.490 and 696.610 to 696.730 shall be open to public inspection under such reasonable rules and regulations as shall be prescribed by the commissioner.

696.435 Printed matter to be furnished licensees. Single copies of matter printed and circulated as authorized by ORS 696.385, except replacement pages or parts therefor, may be furnished free of charge to each licensee. Additional copies and any replacement pages or parts furnished to licensees or any copy furnished to any other person, except one required by law to be furnished, are to be sold for a charge set by the commissioner. The charge is to be set at a level reasonably estimated to be sufficient to recover the cost of printing and distributing copies to be sold.
[1963 c.546 §5; 1965 c.617 §6]

696.440 [Repealed by 1963 c.580 §103]

696.450 [Repealed by 1963 c.580 §103]

696.460 [Repealed by 1963 c.580 §103]

696.470 [Repealed by 1963 c.580 §103]

696.480 Publication of directory by commissioner. (1) The commissioner shall, at least annually, publish a directory or a list of the names and addresses of all currently licensed brokers and salesmen and all applicants whose licenses have been refused, and licensees whose licenses have been suspended or revoked within one year, a copy of the provisions of ORS 696.010 to 696.375, 696.395 to 696.490, 696.710 to 696.730 and 696.990, the code of ethics as adopted by the National Association of Real Estate Boards and a list of all local real estate boards, their officers and directors.

(2) The directory shall contain a financial statement of the receipts and disbursements of the department for the previous fiscal year and shall also contain a general report of its activities. One such directory shall be mailed without charge to each licensed broker. One such directory shall be mailed to the county clerk in each county of the state and shall be held by the county clerk as a public record. One directory also shall be mailed to the district attorney in each county of the state for his files, and one copy shall be mailed or furnished to any person upon request and the payment of $1 therefor except that copies requested may be furnished without charge to any state department.

696.490 Disposition of receipts; Real Estate Educational Account. (1) Except as provided in subsection (2) of this section, the net amount of all fees and charges collected under this chapter shall be paid by the division, at least once each month, into the State Treasury and after deduction of refunds be deposited to the credit of the General Fund and become available for general governmental expenses.

(2) All charges collected pursuant to

ORS 696.435 and one-fourth of the amount of each license fee collected under subsections (2), (3), (4), (5) and (15) of ORS 696.270 shall be deposited by the division in the General Fund in the State Treasury to the credit of an account to be known as the Real Estate Educational Account. The moneys in the Real Estate Educational Account hereby are appropriated continuously to the division, and may be expended by the division for the purpose of advancing education and research in real estate, including distributing printed matter of an educational nature, and conducting educational meetings for the benefit of licensed real estate brokers and salesmen.

[Amended by 1955 c.457 §2; 1961 c.309 §4; 1963 c.440 §16; 1963 c.580 §50; 1965 c.617 §7]

696.500 [Amended by 1959 c.27 §1; repealed by 1961 c.309 §5]

ESCROWS AND ESCROW AGENTS

696.505 Definitions for ORS 696.505 to 696.580. As used in ORS 696.505 to 696.580, unless the context requires otherwise:

(1) "Commissioner" means the Real Estate Commissioner.

(2) "Escrow" means any transaction wherein any written instrument, money, evidence of title to real or personal property or other thing of value is delivered to a person not otherwise having any right, title or interest therein for the purpose of effecting the sale, transfer, encumbrance or lease of real or personal property, to be held by that person until the happening of a specified event or the performance of a prescribed condition, when it is then to be delivered by such person to a grantee, grantor, promisee, promisor, obligee, obligor, bailee, bailor, or any agent or employe of any of them.

(3) "Escrow agent" means any person engaged in the business of receiving escrows for deposit or delivery for compensation.

[1963 c.440 §1]

696.510 [Repealed by 1961 c.309 §6]

696.511 License required; application; issuance. (1) No person shall engage in or carry on, or hold himself out as engaging in or carrying on the business or act in the capacity of an escrow agent without first obtaining a license as an escrow agent under the provisions of ORS 696.505 to 696.580.

(2) Every escrow agency before engaging in the escrow business shall file in the office of the commissioner an application for a license, in writing, verified by oath and in the form prescribed by the commissioner. It shall state the location of the agent's principal office and all branch offices in this state, the name or style of doing business, the names, resident and business addresses of all persons interested in the business as principals, partners, officers, trustees and directors, specifying as to each his capacity and title, the general plan and character of business and the length of time the agent has been engaged in business.

(3) The commissioner may require additional information he considers necessary in connection with any application for a license under this section.

(4) The commissioner shall examine the application for a license and if he is satisfied that the applicant should not be refused a license under ORS 696.535, he shall issue the license.

(5) No person shall engage in business as an escrow agent without holding a license required by ORS 696.505 to 696.580.

[1963 c.440 §§4, 17]

696.515 Foreign corporations required to have certificate of authority to act as escrow agents. No foreign corporation without a valid certificate of authority under ORS 57.655 to 57.745 shall transact any escrow business in this state.

[1963 c.440 §3]

696.520 Application of ORS 696.505 to 696.580. The provisions of ORS 696.505 to 696.580 do not apply to and the term "escrow agent" does not include:

(1) Any person doing business under the laws of this state or the United States relating to banks, mutual savings banks, trust companies, savings and loan associations, common and consumer finance companies, industrial loan companies, or insurance companies.

(2) An attorney at law rendering services in the performance of his duties as attorney at law.

(3) Any person whose principal business is that of preparing abstracts or making searches of title which are used as a basis for the insurance of titles by a title insurance company authorized to do business in this state.

(4) Any firm or corporation lending money on real or personal property and which firm or corporation is subject to licensing, supervision or auditing by a federal or state agency.

(5) Any person doing any of the acts specified in subsection (2) of ORS 696.505 under order of any court.
[1963 c.440 §2; 1967 c.359 §701]

696.525 Bond for escrow agents. (1) At the time of filing an application for an escrow agent's license, the applicant shall deposit with the commissioner a corporate surety bond running to the State of Oregon, executed by a surety company satisfactory to the commissioner, in the sum of $25,000, the provisions to be in the form substantially as follows:

Know All Men by These Presents, That we, ———————— as principal, and ————————, a corporation, qualified and authorized to do business in the State of Oregon as surety, are held and firmly bound unto the State of Oregon for the use and benefit of any interested person, in the sum of $25,000, lawful money of the United States of America, to be paid to the State of Oregon for the use and benefit aforesaid, for which payment well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

The condition of the above obligation is such that: Whereas the above-named principal has made application to the Real Estate Commissioner of the State of Oregon for registration as an escrow agent within the meaning of ORS 696.505 to 696.580 and is required by the provisions of ORS 696.505 to 696.580 to furnish a bond in the sum above named, conditioned as herein set forth:

Now, therefore, if the principal, his agents and employes, shall strictly, honestly and faithfully comply with the provisions of ORS 696.505 to 696.580, and shall pay all damages suffered by any person by reason of the violation of any of the provisions of ORS 696.505 to 696.580, now or hereafter enacted, or by reason of any fraud, dishonesty, misrepresentation or concealment of material facts growing out of any transaction governed by the provisions of ORS 696.505 to 696.580, then this obligation shall be void; otherwise to remain in full force and effect.

This bond shall become effective on the———— day of————————, 19——, and shall remain in force until the surety is released from liability by the Real Estate Commissioner, or until this bond is canceled by the surety. The surety may cancel this bond and be relieved of further liability hereunder by giving 30 days' written notice to the principal and to the Real Estate Commissioner of the State of Oregon.

This bond shall be one continuing obligation, and the liability of the surety for the aggregate of any and all claims which may arise hereunder shall in no event exceed the amount of the penalty hereof.

In witness whereof, the seal and signature of the principal hereto is affixed, and the corporate seal and the name of the surety hereto is affixed and attested by its duly authorized officers at ————————, Oregon, this —— day of————————, 19——.

———————————— (Seal)
Principal

———————————— (Seal)
Surety

By————————————

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(2) The commissioner may at any time require an escrow agent to deposit with the commissioner an additional bond when in the commissioner's opinion any bond then in force is insufficient to protect the public interest.
[1963 c.440 §5]

696.530 Renewal of license; fees. (1) The escrow agent's license shall expire June 30 next after the date of issuance if it is not renewed by July 1 of such year. A license may be renewed by filing a renewal application, submitting a satisfactory independent audit by a certified public accountant and paying the annual license fee for the next succeeding fiscal year.

(2) The filing fees shall be:

(a) For filing an original or a renewal application, $100 for the principal office and $35 for each branch office.

(b) For filing an application for a duplicate copy of any license, upon satisfactory showing of such loss, $10.
[1963 c.440 §6]

696.535 Refusal, suspension or revocation of licenses; records and reports. (1) The commissioner may refuse to license any escrow agent, or may suspend any license, by entering an order to that effect, with his findings in respect thereto, if upon examination into the affairs of the applicant or licensee, either in the performance of routine duties, or upon field examination, or upon hearing, it is determined that the applicant or licensee:

(a) Is insolvent; or

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(b) Is of bad business repute or has demonstrated his unworthiness to transact the business of agent; or

(c) Does not conduct his business in accordance with law, or has violated any provisions of ORS 696.505 to 696.580; or

(d) Is in such financial condition that he cannot continue in business with safety to his customers; or

(e) Has been guilty of fraud in connection with any transaction governed by ORS 696.505 to 696.580; or

(f) Has made any misrepresentations or false statement to, or concealed any essential or material fact from, any person in the course of the escrow business; or

(g) Has knowingly made or caused to be made to the commissioner any false representation of a material fact, or has suppressed or withheld from the commissioner any information which the applicant or licensee possesses, and which if submitted by him would have rendered the applicant or licensee incompetent to be licensed under ORS 696.505 to 696.580; or

(h) Has failed to account to persons interested for all escrows received; or

(i) Has not delivered, after a reasonable time, to persons entitled thereto, escrows held or agreed to be delivered by the licensee, as and when paid for and due to be delivered; or

(j) Has refused to permit an examination by the commissioner of his books and affairs, or has refused or failed, within a reasonable time, to furnish any information or make any report that may be required by the commissioner under the provisions of ORS 696.505 to 696.580; or

(k) Has been convicted of a felony or any misdemeanor of which an essential is fraud.

(2) It is sufficient cause for refusal or revocation of a license in case of a partnership or corporation or any unincorporated association, if any member of a partnership or any officer or director of the corporation or association has been guilty of any act or omission which would be cause for refusing or revoking the registration of an individual agent.

(3) All escrow agents shall keep and maintain at all times in their principal places of business, complete and suitable records of all escrow transactions made by them, together with books, papers and data clearly reflecting the financial condition of the business of such agents. Every agent shall, at the times required by the commissioner, make and file in the office of the commissioner a true and correct statement, in the form and containing the data the commissioner may require, of the business of the agent.

(4) Notice of the entry of any order of suspension or of refusing a license to any agent shall be given in writing, served personally or sent by certified mail or by telegraph to the agent affected. The agent shall, upon application, be entitled to a hearing; but if no such application is made within 20 days after the entry of an order of suspension or of refusing a license of any agent, the commissioner shall enter a final order in either case.

[1963 c.440 §7]

696.540 Authority of Real Estate Commissioner over escrow agents. (1) The commissioner shall have general supervision and control over all escrow agents residing in and doing business in this state. Subject to ORS chapter 183, the commissioner may adopt such rules and regulations as are reasonable and necessary for the enforcement of ORS 696.505 to 696.580. All such agents shall be subject to examination by the commissioner, or his authorized deputies, at any time he considers advisable. The provisions of this section and any other section relating to the examination of the affairs of an agent shall extend to an agent whose license has expired or been revoked or suspended, if in the judgment of the commissioner, such agent has violated any condition of his license or any provision of ORS 696.505 to 696.580 or has committed a fraud or is insolvent. The commissioner may collect from each agent the actual expenses incurred in that examination.

(2) No person shall neglect or refuse to attend and testify or answer any lawful inquiry or to produce books, papers, accounts, records, contracts or documents, if in his power so to do, in obedience to the subpena of the commissioner.

[1963 c.440 §8]

696.545 Investigation; injunction; jurisdiction. (1) The commissioner may investigate either upon complaint or otherwise whenever it appears that an escrow agent is

conducting his business in an unsafe and injurious manner or that any person is engaging in the escrow business without being licensed under the provisions of ORS 696.505 to 696.580.

(2) If upon investigation it appears that such agent is so conducting his business or an unlicensed person is engaged in the escrow business the commissioner may, in addition to any other remedies, bring suit in the name and on behalf of the State of Oregon against such person and any other person or persons concerned in or in any way participating in or about to participate in such unsafe or injurious practices or acting in violation of ORS 696.505 to 696.580, to enjoin such person and such other person or persons from continuing such practices or engaging therein or doing any act or acts in furtherance thereof or in violation of ORS 696.505 to 696.580.

(3) The circuit court of any county of this state hereby is vested with jurisdiction in equity to restrain unsafe, injurious or illegal practice or transactions and may grant injunctions to prevent and restrain such illegal practices or transactions, in addition to the penalties and other remedies provided in ORS 696.505 to 696.580. The court shall have power, during the pendency of the proceedings before it to issue such preliminary restraining orders as may appear to be just and proper; and the findings of the commissioner shall be deemed to be prima facie evidence and sufficient ground, in the discretion of the court, for the issue ex parte of a preliminary restraining order.

(4) In any such court proceedings the commissioner may apply for and on due showing be entitled to have issued the court's subpena requiring forthwith the appearance of any defendant and his employes and the production of documents, books and records as may appear necessary for the hearing of such petition, to testify and give evidence concerning the acts or conduct or things complained of in such application for injunction.
[1963 c.440 §9]

696.550 Appeal procedure. (1) An appeal may be taken by any person interested from any final order of the commissioner to the circuit court of Marion County by serving upon the commissioner within 20 days after notice of the entry of the order a written notice of the appeal, stating the grounds upon which a reversal of the final order is sought and accompanied by a demand in writing for a certified transcript of the record and of all papers on file in his office affecting or relating to the order and by executing a bond in the penal sum of $500 to the State of Oregon, with sufficient surety, to be approved by the court, conditioned upon the faithful prosecution of the appeal to final judgment and the payment of all costs adjudged against the appellant. Thereupon the commissioner shall within 10 days make, certify and deliver to the appellant the transcript, or in lieu thereof the original papers if the court so orders. The appellant shall within five days thereafter file the same and a copy of the notice of appeal with the clerk of the court, which notice of appeal shall stand as appellant's complaint. Thereupon the cause shall be entered on the trial calendar of the court for trial de novo and shall be given precedence by the court over other matters pending. The court shall receive and consider any pertinent evidence, oral or documentary, concerning the order of the commissioner from whom the appeal is taken.

(2) If the order of the commissioner is reversed the court shall by its mandate specifically direct the commissioner as to his further action in the matter, including the making and entering of any order in connection therewith, and the conditions, limitations or restrictions to be therein contained, provided that the commissioner shall not thereby be barred from thereafter revoking or altering the order for any proper cause which may thereafter accrue or be discovered. If the order is affirmed, the appellant shall not be barred after 30 days from filing a new application provided the application is not otherwise barred or limited. The appeal shall not in anywise suspend the operation of the order appealed from during the pendency of the appeal unless upon proper order of the court. An appeal may be taken from the judgment of the circuit court on any such appeal on the same terms and conditions as an appeal is taken in civil actions. An appeal from an order of the commissioner shall be considered as a proceeding in equity. Any order of the commissioner which finally limits, or adversely determines, the rights of any interested person, shall be a final order as to such interested person, and be subject to appeal under this section and ORS 696.555.
[1963 c.440 §10(1), (2)]

696.555 Commissioner to take possession of property and assets of escrow agent when assets or capital impaired; receiver may be appointed. (1) When the commissioner ascertains by examination or otherwise that the assets or capital of any agent are impaired, or that the agent's affairs are in an unsafe condition, he may in either case immediately take possession of all the property, business and assets of the agent which are located in this state and retain possession of them pending the further proceedings specified in this section and ORS 696.550. Should the board of directors or any officer or person in charge of the offices of such agent refuse to permit the commissioner to take possession as aforesaid, the commissioner shall communicate such fact to the Attorney General, whereupon it shall become the duty of the Attorney General at once to institute such proceedings as may be necessary to place the commissioner in immediate possession of the property of the agent. The commissioner thereupon shall make or have made an inventory of the assets and known liabilities of the agent. The commissioner shall file one copy of the inventory in his office and one copy in the office of the clerk of the circuit court of the county in which the principal office of the agent is located, and shall mail one copy to each stockholder of the agent at his last-known address, if by the exercise of reasonable diligence it can be determined. The clerk of the court with whom the copy of the inventory is filed shall file it as any other case or proceeding pending in the court and shall give it a docket number.

(2) The officers, directors or stockholders of the agent may have 60 days from the date when the commissioner takes possession of the property, business and assets, to make good any deficit which may exist or to remedy the unsafe condition of its affairs. At the expiration of this time, if the deficiency in assets or capital has not been made good or the unsafe condition remedied, the commissioner may apply to the court to be appointed receiver and proceed to liquidate the assets of the agent which are located in this state in the same manner as now provided by law for liquidation of a private corporation in receivership. No other individual shall be appointed receiver by any court without first giving the commissioner ample notice thereof. The inventory made by the commissioner and all claims filed by creditors shall be open at all reasonable times for inspection and any action taken by the receiver upon any of the claims shall be subject to the approval of the court before whom the cause is pending. The expenses of the receiver and compensation of counsel, as well as all expenditures required in the liquidation proceedings, shall be fixed by the commissioner, subject to the approval of the court, and, upon certification of the commissioner, shall be paid out of the funds in his hands as such receiver.
[1963 c.440 §10(3),(4)]

696.560 Deposit and designation of money held in escrow. All money deposited in escrow to be delivered upon the close of the escrow or upon any other contingency shall be deposited in a bank and kept separate, distinct and apart from funds belonging to the escrow agent. Such funds, when deposited, are to be designated as "trust funds," "escrow accounts," or under some other appropriate name indicating that the funds are not the funds of the escrow agent.
[1963 c.440 §11]

696.565 Funds exempt from execution or attachment; designation of funds. (1) Escrow or trust funds are not subject to execution or attachment on any claim against the escrow agent.

(2) No person shall knowingly keep or cause to be kept any funds or money in any bank under the heading of "trust funds" or "escrow accounts" or any other name designating such funds or money as belonging to the clients of any escrow agency, except actual escrow or trust funds deposited with such agency.
[1963 c.440 §12]

696.570 Hearings procedure under ORS 696.505 to 696.580; subpena; witness fees; depositions. (1) All hearings before the commissioner or his authorized representative conducted under the authority of ORS 696.505 to 696.580 shall be conducted in accordance with the provisions of ORS chapter 183 and such rules and regulations made in conformity therewith as the commissioner shall consider necessary.

(2) The commissioner, or anyone authorized by him, shall have the power to subpena witnesses and administer oaths in connection with the administration of ORS 696.505 to 690.580. Each witness who appears before the commissioner and who was subpenaed in his behalf shall receive for his attendance

the fees and mileage provided for witnesses in civil cases in the court of record in the county where the hearing is held. The commissioner or any party may, in any investigation, cause the depositions of witnesses residing within or without the state to be taken in the manner prescribed for depositions in civil actions in circuit courts.
[1963 c.440 §13]

696.575 Civil or criminal actions not limited by ORS 696.505 to 696.580. Nothing in ORS 696.505 to 696.580 shall limit any statutory or common law right of any person to bring any action in any court for any act involved in the transaction of the escrow business or the right of the state to punish any person for any violation of any law.
[1963 c.440 §14]

696.580 Documents filed with commissioner as public records; exception. All papers, documents, reports and other written instruments filed with the commissioner under ORS 696.505 to 696.580 shall be open to public inspection, except that the commissioner may withhold from public inspection for such time as he considers necessary any information which in his judgment the public welfare or the welfare of any escrow agent requires to be so withheld.
[1963 c.440 §15]

BUSINESS CHANCE BROKERS

696.610 "Business chance broker" defined. As used in this chapter, "business chance broker" means and includes all persons, firms, corporations and associations that engage directly or indirectly in the business of buying, selling or dealing in any established business or business opportunity or good will or any interest therein, or who, for profit, compensation or commission engage in the business of offering to establish others in business or who declare to the public that they are engaged in the business of buying, selling or dealing in established businesses or business opportunities.

696.620 Real estate broker's or salesman's license required. No person shall engage in the business of a business chance broker without having a real estate broker's license or a real estate salesman's license as provided in this chapter.

696.630 Powers and duties of commissioner in relation to business chance brokers. The Real Estate Commissioner shall enforce the provisions of ORS 696.610 to 696.640, and he shall have full power to issue, deny, suspend and revoke licenses in the manner and under the terms and conditions as provided in ORS 696.010 to 696.490 and 696.610 to 696.730.

696.640 Law applicable to business chance brokers. Any person who engages in the business of a business chance broker is bound by and subject to all the provisions of ORS 696.010 to 696.490 and 696.610 to 696.730, except subsection (2) of ORS 696.110.

ACTIONS AND REMEDIES

696.710 Necessity of alleging license in action to collect compensation. No person engaged in the business of, or acting in the capacity of, a real estate broker within this state shall bring or maintain any action in the courts for the collection of compensation without alleging and proving that such person was a duly licensed real estate broker at the time the alleged cause of action arose.

696.720 Remedies are concurrent. The remedies provided for in ORS 696.010 to 696.490 and 696.610 to 696.730 are in addition to and not exclusive of any other remedies provided by law.

696.730 Jurisdiction of courts for violations; revoking license upon conviction. Any court of competent jurisdiction, including justices of the peace, has full power to try any violation of ORS 696.010 to 696.490 and 696.610 to 696.730, and, upon conviction, the court may, at its discretion and in addition to the other penalties imposed, revoke the license of the person or persons convicted.

PENALTIES

696.990 Penalties. (1) Violation of any provision of ORS 696.010 to 696.165, 696.180 to 696.226, 696.240 to 696.375, 696.395 to 696.490 and 696.610 to 696.730 is punishable, upon conviction of a first violation thereof, by a fine of not less than $200 nor more than $500 or by imprisonment for a term not to exceed 90 days, or by both, and, upon conviction of a second or subsequent violation, by a fine of not less than $500 nor more than $1,000 or by imprisonment for a term not to exceed two years, or by both.

(2) Any officer or agent of a corporation, or member or agent of a partnership or association, who personally participates in or is an accessory to any violation of ORS 696.010 to 696.165, 696.180 to 696.226 696.240 to 696.375, 696.395 to 696.490 and 696.610 to 696.730 by the partnership, association or corporation, is subject to the penalties prescribed in subsection (1) of this section.

(3) A violation of any one of the provisions of 696.505 to 696.580 is a misdemeanor.

REAL ESTATE DIVISION

[ED. NOTE: Unless otherwise specified, Sections 10-010 through 10-125 of this Chapter of the Oregon Administrative Rules Compilation were adopted by the Real Estate Board July 20, 1959, and filed with the Secretary of State, August 27, 1959 as Administrative Order REC 10.]

Statutory Authority: ORS 696.385 (3) and ORS 696.240

Real Estate Brokers and Salesmen

10-010 Advertising. (1) A broker shall not advertise by liner advertisements, or otherwise, to sell, buy, exchange, rent or lease property in a manner indicating that the offer to sell, buy, exchange, rent or lease such property is being made by a private party not engaged in the business of a real estate broker, except as provided in subsection (3).

(2) All advertising must be under the direct supervision and in the name of the employer-broker on all display signs as well as other types of advertising and the name of the broker must be prominently displayed and the name of the salesman must not be featured. Every salesman is prohibited from advertising under his own name.

(3) The advertising for rent of licensee owned property is exempted from the provisions of (1) and (2) above.

Hist: Amended 7-3-69 by REC 23. Eff.: 9-1-69

10-015 Listings. (1) A broker or salesman who obtains a listing shall, at the time of securing such listing, give the person or persons signing such listing a true, legible carbon copy thereof.

(2) Every listing agreement, exclusive or non-exclusive, shall state a definite expiration date; it shall contain no provision requiring the party signing the listing to notify the broker of his intention to cancel the listing after such definite expiration date; it shall contain no provision which would subject the owner of the property to the payment of two commissions for one sale in the event the owner lists the same property with a second or subsequent broker after the termination of the first or preceding listing.

(3) No broker or salesman shall conspire with anyone to deprive an original listing broker of a commission, utilizing the restrictions of sub-paragraph (2) above.

Hist: Filed 5-5-65 as REC 20. Eff.: 7-1-65

10-020 Offers to Purchase. A broker or salesman shall promptly tender to the seller every written offer to purchase obtained on the property involved and, upon obtaining a proper acceptance of the offer to purchase, shall promptly deliver true executed copies of same, signed by the seller and purchaser, to both purchaser and seller; all brokers and salesmen shall make certain that all of the terms and conditions of the real estate transaction are included in the offer to purchase, especially that portion referring to evidence of title or absence of the requirement thereof, should that right have been waived by the prospective purchaser. An earnest money receipt, when signed by the prospective purchaser, shall be deemed in all respects, an offer to purchase.

10-025 Deposits. (1) All moneys of whatever kind and nature pertaining to real estate transactions as defined in ORS 696.010 belonging to others and accepted by the broker while acting in his capacity as a broker, shall be deposited in a neutral escrow depository or in a separate bank account to be entitled CLIENT'S TRUST ACCOUNT, maintained by the broker as a depository for clients' funds and shall be retained in this bank account until the transaction involved is consummated or terminated, at which time the broker shall account for the full amounts received. However, a broker, in his discretion, may pay to any seller or to the seller's authorized agent, the whole or any portion of such special deposits provided that such broker shall, nevertheless, be held personally responsible for such deposits at all times.

(2) Every salesman shall, promptly upon receipt by him of any money on any transaction in which he is engaged on behalf of his employer broker, pay over the amount to his employer.

(3) Under no circumstances shall a broker permit any advance payment of funds belonging to others to be deposited in the broker's personal account or be commingled with funds he may have on deposit.

(4) Every deposit made in accordance with the provisions of ORS 696.240, shall be made with a deposit slip which will identify each transaction. This deposit slip shall state in addition to the amount of the deposit, the names of all parties involved in the transaction.

(5) A complete record must be maintained in the broker's office of all moneys received on all real estate transactions. This record shall show from whom the money was received, the date of the receipt, the place of deposit, and the date it was deposited, and when the deal has been completed the final disposition of the funds.

(6) All earnest money deposits wherein a broker or salesman has a purchaser's interest, shall be placed in a neutral escrow in this state.

(7) The Commissioner shall be provided upon his request continuing authorization to verify the actual balance in any "CLIENT'S TRUST ACCOUNT". Such authorization to be placed on file with the bank in which the acount is maintained.

Hist: Amended 7-3-69 by REC 23. Eff.: 9-1-69

10-030 Closing Statements. (1) In any real estate transaction where he acts as a real estate broker, any broker shall deliver to the seller at the time the transaction is consummated, a complete detailed closing statement showing all of the receipts and disbursements handled by him.

(2) He shall also deliver to the buyer a complete statement showing all moneys received in the transaction from the buyer and how they were disbursed.

(3) The broker shall retain true copies of these statements in his file including evidence of delivery.

Hist: Amended 7-3-69 by REC 23. Eff.: 9-1-69

10-035 Earnest Money. The type of earnest money received in any real estate transaction, whether it be cash, check or promissory note, shall be specifically stated in the earnest money receipt.

10-040 Method of Filing. All real estate deals or transactions shall be numbered consecutively. All listing agreements and all earnest money receipts shall be approved in writing on the document by the broker within five (5) days of the date thereof. The above documents shall be kept in the main office and copies thereof may be retained in the branch office.

Hist: Filed 4-11-63 as REC 18

10-043 Brokers. A broker shall not permit the use of his license to enable salesmen licensed through him to in fact establish and carry on a real estate brokerage business wherein the brokers only interest is the receipt of a fee for use of his license by others, the broker having no or only nominal control of the affairs of the business conducted under his license.

Hist: Filed 3-1-63 as REC 17

10-045 Broker's Personal Interest. (1) A broker shall not either directly or indirectly buy for himself, property listed with him or as to which he has been approached by the owner to act as broker, nor shall he acquire interest in any other property therein either directly or indirectly, without first making his true position clearly known to the owner. Satisfactory written proof of this fact must be produced by the broker upon request of the Commissioner.

(2) A broker shall not take an option to himself, either directly or indirectly, upon property for the sale of which he has been approached by the owner to act as a broker, without first making his true position clearly known that he is now acting as a prospective buyer and is no longer acting as a broker or agent for the owner. Satisfactory proof of this must be produced by the broker upon request of the Commissioner.

(3) A salesman shall not buy for himself, either directly or indirectly, property listed with his employer-broker, nor shall he acquire interest in any other property, either directly or indirectly, without first making his true position clearly known to the owner, nor shall he take an option unto himself from any such owner or to anyone on his behalf upon any property without first making his position known. Satisfactory written proof of these facts must be produced by the salesman on request of the Commissioner.

Hist: Amended 7-3-69 by REC 23. Eff.: 9-1-69

10-050 Associate Real Estate Brokers. The contract provided for in ORS 696.165 as a prerequisite for a broker to have his license transferred to that of an associate broker shall read substantially as follows:

Agreement For Associate Broker

_____, Oregon _____, 19____.

For and in consideration of the issuance to me of a license as an Associate Real Estate Broker by the Real Estate Commissioner of the State of Oregon, I do hereby undertake and agree that I will not, during the time that I retain my license as an Associate Real Estate Broker, engage in any act or acts whatsoever in the capacity of a Broker other than as an employe of my employing broker. This agreement is executed in conformance with ORS 696.165, and is for the benefit of my employing broker.

10-055 Salesmen. Every salesman shall be licensed under a broker; he cannot be licensed with more than one broker during the same period of time. A salesman shall not commence work until he receives a pocket card from his employer-broker, either an original application or transfer. Brokers and salesman shall carry their pocket cards with them at all times. Duplicate cards will be issued upon submission of satisfactory proof of the loss of the originals. Immediately on the issuance of a duplicate card the original shall cease to have any effect.

10-060 Salesman Closing. A salesman shall not handle the closing of any real estate transaction (unless authorized by his employer-broker) except under the direct supervision of the broker, a licensed officer, or a licensed partner of the corporation or partnership under whom the salesman is licensed. Authorization of a salesman to make closing must be in writing, and a copy of the authorization bearing the employer-broker's signature must be filed with the Real Estate Division.

Hist: Filed 8-5-64 as REC 19

10-065 Application for Real Estate License: (1) Any person desiring to take an examination for real estate broker or salesman must file with the Real Estate Division a completed application together with the application fee no later than the fifteenth day of the month immediately preceding the month in which the examination is scheduled.

(2) In addition to that information and those documents required by ORS 696, every applicant shall as an integral part of the completed application furnish at his own expense a current credit report from an established credit reporting agency acceptable to the Real Estate Commissioner.

Hist: Amended 7-3-69 by REC 23. Eff.: 9-1-69

10-070 Assumed Business Names. (1) A broker shall not conduct his business under any name other

than the one in which his license is issued. A broker desiring to operate under an assumed name shall forward a copy of the registration of assumed name furnished and verified by the Corporation Commissioner to the Real Estate Commissioner with his application for a broker's license and said name shall be shown on the broker's license and pocket card.

(2) An "Assumed Business Name" of a real estate broker may not contain as part of that name the surname of a real estate salesman licensed with that broker. The name of a corporation, partnership or association may not contain as part of that name, the surname of a real estate salesman licensed with that corporation, partnership or association. The Commissioner may, at his discretion, however, allow the use of such surname where the circumstances are unusual or coincidental.

(3) Use of an "Assumed Business Name" which is misleading or is the name of a person whose license has been suspended or revoked is grounds for refusal by the Commissioner to issue a license in such name.

Hist: Filed 8-5-64 as REC 19
Amended 7-3-69 by REC 23. Eff.: 9-1-69

10-075 Branch Offices. Any additional office or places of business other than the principal place of business of a broker shall be licensed only with the approval of the Real Estate Commissioner after the broker has given satisfactory proof that his additional place of business will be so located as to receive the broker's personal supervision or that it will be under the supervision of the duly licensed salesman or associate broker of the broker, approved by the Commissioner. Every such office will be designated as a BRANCH OFFICE by an appropriate sign displayed in the manner provided for signs in ORS 696.200.

10-080 [Repealed 8-5-64 by REC 19]

10-085 Licenses and Licensees. (1) A broker or salesman, upon surrendering his license or upon notice of suspension or revocation of his license, shall forward the license, together with his pocket card, at once to the Commissioner. A broker shall also forward to the Commissioner with his broker's license and pocket card all salesman's licenses and pocket cards in his possession or in his office and shall be responsible for all missing licenses of his salesmen. No refund will be made upon licenses when surrendered, suspended or revoked.

(2) At the time of renewing his license, a broker or salesman who does not intend to perform any of the acts as defined in ORS 696.010, may renew his license on an inactive basis. The fee of $7.50 for an inactive salesman's license or the fee of $10.00 for an inactive broker's license shall accompany the application.

(3) To reactivate an inactive license, the salesman's license fee of $15.00 or the broker's license fee of $25.00 must be submitted with the application, and no credit for fees previously paid will be allowed.

(4) A broker or salesman who has renewed his license as inactive or who surrendered his active license during the fiscal year and has applied for an inactive license, must, in order to remain in good standing, pay the annual renewal fee each year that the license is inactive.

(5) It is unlawful for any broker or salesman who holds an inactive license to perform any acts defined in ORS 696.010.

(6) Any real estate broker, associate broker or real estate salesman whose license has not been renewed for a period exceeding one year shall not be eligible for renewal of such license without again submitting to the real estate examination for such license.

(7) Any person who has passed the examination for real estate broker or real estate salesman, must become licensed within one year from the date of such examination in order to become eligible for such license. Failure to comply with this provision will necessitate the submission to and passing of another examination.

Hist: Filed 7-5-67 as REC 21
Amended 7-3-69 by REC 23. Eff.: 9-1-69

10-090 Attorneys. A broker should not discourage any party to a real estate transaction from seeking the advice of an attorney.

10-095 Penalties. Any real estate broker or salesman who fails or neglects to abide by sections 10-010 to 10-115 shall be deemed prima facie, to be guilty of improper dealings, and may be subject to a hearing before the Commissioner.

10-100 Hearings. The Commissioner may refuse to accept jurisdiction of any dispute presented or complaint filed in his office not involving fraud on the part of a broker or salesman or may dismiss any such matter without prejudice at any stage of the proceeding when it develops or appears that the complaining party or other disputes may obtain adequate relief through the courts. In any case in which a broker is charged with fraud or the improper handling of money, and where the Commissioner becomes satisfied that there is no sufficient basis for such charge, the Commissioner may dismiss the matter, leaving the parties to their respective court remedies.

10-105 Recording to Hearings. At any hearing before the Commissioner as provided by ORS 696.330, the testimony of witnesses may be recorded by a mechanical, electrical or electronic device.

10-110 Amendments. These rules may be amended by the Oregon Real Estate Division at any time without notice; provided, however, that in the event of any such amendment, or in the event of the adoption by the Division of additional rules a copy shall be mailed by the Commissioner to each licensed broker within the state at his most recent address registered in the real estate division. Failure on the part of any licensee to receive any such copy shall be no defense.

Hist: Filed 8-5-64 as REC 19.

PROCEDURE

10-115 Rules of Procedure in Contested Cases. (1) The rules of procedure in contested cases of the Real

Estate Board (agency) shall be the Model Rules of Procedure as promulgated by the Attorney General of the State of Oregon and filed with the Secretary of State on October 3, 1959 with the exception of Rule 3A (3) (c) and Rule 3B (2) (b) which are a part of the model rules and are not adopted by this agency.

(2) The Division shall require an original and two copies of the petition provided for in Rule 3A (4) of the Model Rules.

(3) The Division shall require two copies of any amended petition provided for in Rule 3A (8) of the Model Rules.

Hist: Filed 8-5-64 as REC 19

10-120 Brokers and Salesmen: Every licensee shall, within ten days, notify the Real Estate Commissioner of any adverse decision of any court of competent jurisdiction as the result of any suit or judgment, civil or criminal, in which the licensee appeared as the defendant, and in which the subject matter involved any real estate or business-chance transaction to which he was a party.

Hist: Filed 7-3-69 as REC 23. Eff.: 9-1-69

10-125 Payment of Commission. Upon receipt by a real estate broker of an earned commission as a disbursement from his "CLIENT'S TRUST ACCOUNT" or from a neutral escrow account, he shall within a reasonable time pay to his salesman or salesmen, as the case may be, the agreed share or shares of such salesman's commission. Failure to so pay the salesman within 30 days after receipt of a commission by a broker shall be deemed prima facie evidence of violation of this section.

Hist: Filed 7-3-69 as REC 23. Eff.: 9-1-69

10-126 to 10-195 [Reserved for Expansion]

8253

CODE OF ETHICS

NATIONAL ASSOCIATION OF REAL ESTATE BOARDS

Preamble

Under all is the land. Upon its wise utilization and widespread ownership depend the advancement of national well-being and the perpetuation of the free institutions that go to make the American way of life.

The Realtor has husbanded and developed the land resource of the nation and, with his help, ownership has attained its widest distribution—a distinguishing mark that differentiates this from other civilizations and provides the real safeguard against radical impenetrations.

The Realtor is a creator of homes, both urban and rural, and by his activities helps mold the form of his future community, not only in the living of its people, but in its commercial and industrial aspects.

Such functions impose obligations beyond those of ordinary business; they impose grave social responsibilities which the Realtor can meet only by diligent preparation and by dedicating himself as a civic duty to their fulfillment.

The Realtor therefore must be zealous to maintain and continually improve the professional standards of his calling. He shares with his fellow-Realtors a common responsibility for the integrity and honor of that calling. In the interpretation of his obligations, he can take no safer guide than that which has been handed down through twenty centuries, embodied in the Golden Rule, in substance:

"Whatsoever ye would that men should do to you, do ye even so to them."

Accepting this standard as his own, every Realtor pledges himself to observe its spirit in all his dealings and to conduct his business in acordance with the following Code of Ethics, adopted by the National Association of Real Estate Boards:

PART I

Relation to the Public

Article 1. The Realtor should keep himself informed as to movements affecting real estate in his community, state, and the nation, so that he may be able to contribute to public thinking on matters of taxation, legislation, land use, city planning, and other questions affecting property interests.

Article 2. It is the duty of the Realtor to be well informed on current market conditions in order to be in a position to advise his clients as to the fair market price.

Article 3. It is the duty of the Realtor to protect the public against fraud, misrepresentation or unethical practices in the real estate field.

He should endeavor to help stamp out or prevent arising in his community, any practices which could be damaging to the public or to the dignity and integrity of the real estate profession. If there be a board or commission in the state, charged with the duty of regulating the practices of brokers and salesmen, the Realtor should lend every help to such body, cooperate with it, and report violation of proper practice.

Article 4. The Realtor should ascertain all pertinent facts concerning every property for which he accepts the agency, so that he may fulfill his obligation to avoid error, exaggeration, misrepresentation, or concealment of pertinent facts.

Article 5. The Realtor should not be instrumental in introducing into a neighborhood a character of property or use which will clearly be detrimental to property values in that neighborhood.

Article 6. The Realtor should not be a party to the naming of a false consideration in a deed, unless it be the naming of an obviously nominal consideration.

Article 7. The Realtor should not engage in activities that constitute the practice of law and should recommend that title be examined and legal counsel be obtained when the interest of either party requires it.

Article 8. The Realtor should keep in a special bank account, separated from his own funds, monies coming into his hands in trust for other persons, such as escrows, trust funds, client's monies and other like items.

Article 9. The Realtor in his advertising should be especially careful to present a true picture and should not advertise without disclosing his name or his firm name, nor permit his salesmen to use individual names or telephone numbers, unless the salesman's connection with the Realtor is obvious in the advertisement.

Article 10. The Realtor, for the protection of all parties with whom he deals, should see that financial obligations and commitments regarding real estate transactions are in writing, expressing the exact agreement of the parties; and that copies of such agreements, at the time they are executed, are placed in the hands of all parties involved.

PART II

Relations to the Client

Article 11. In accepting employment as an agent, the Realtor pledges himself to protect and promote the interests of the client. This obligation of absolute fidelity to the client's interest is primary, and does not relieve the Realtor from the obligation of dealing fairly with all parties to the transaction.

Article 12. In justice to those who place their interests in his hands, the Realtor should endeavor always to be informed regarding the law, proposed legislation, legal orders issued and other essential facts and public policies which affect those interests.

Article 13. Since the Realtor is representing one or another party to a transaction, he should not ac-

cept compensation from more than one party without the full knowledge of all parties to the transaction.

Article 14. The Realtor should not acquire an interest in or buy for himself, his firm or any member thereof, or a corporation in which he has an interest, property listed with him, or his company or firm, without making his true position known to the listing owner. In selling property owned by him, or in which he has some ownership interest, the exact facts should be revealed to the purchaser.

Article 15. The exclusive listing of property should be urged and practiced by the Realtor as a means of preventing dissension and misunderstanding and of assuring better service to the owner.

Article 16. When acting as agent in the management of property, the Realtor should not accept any commission, rebate or profit on expenditures made for an owner, without the owner's knowledge and consent.

Article 17. The Realtor should charge for his services only such fees as are fair and reasonable, and in accordance with local practice in similar transactions.

Article 18. When asked to make a formal appraisal of real property, the Realtor should not render an opinion without careful and thorough analysis and interpretation of all factors affecting the value of the property. His counsel constitutes a professional service for which he should make a fair charge.

The Realtor should not undertake to make an appraisal or render an opinion of value on any proprty where he has a present or contemplated interest unless such interest is specifically disclosed in the appraisal report. Under no circumstances should he undertake to make a formal appraisal when his employment or fee is contingent upon the amount of his appraisal.

The Realtor should not undertake to make an appraisal that is outside the field of his experience unless he obtains the assistance of a Realtor or appraiser familiar with such types of property, or unless the facts are fully disclosed to the client.

Article 19. The Realtor should not submit or advertise property without authority and in any offering, the price quoted should not be other than that agreed upon with the owners as the offering price.

Article 20. In the event that more than one formal offer on a specific property is made before the owner has accepted a proposal, all written offers should be presented to the owner for his decision.

PART III

Relations to His Fellow-Realtor

Article 21. The Realtor should seek no unfair advantage over his fellow-Realtors and should willingly share with them the lessons of his experience and study.

Article 22. The Realtor should so conduct his business as to avoid controversies with his fellow-Realtors; but, in the event of a controversy between Realtors who are members of the same real estate board, such controversy should be submitted for arbitration in accordance with regulations of their board and not to a suit at law. The decisions in such arbitration should be accepted as final and binding.

Article 23. Controversies between Realtors who are not members of the same real estate board should be submitted to an arbitration board consisting of one arbitrator chosen by each Realtor from the real estate board to which he belongs. One other member, or a sufficient number of members to make an odd number, should be selected by the arbitrators thus chosen.

Article 24. When the Realtor is charged with unethical practice, he should voluntarily place all pertinent facts before the proper tribunal of the real estate board of which he is a member, for investigation and judgment.

Article 25. The Realtor should never publicly criticize a competitor, nor volunteer an opinion of a competitor's transaction. If his opinion is sought it should be rendered with strict professional integrity and courtesy.

Article 26. When the Realtor accepts a listing from another broker, the agency of the broker who offers the listing should be respected until it has expired and the property has come to the attention of the accepting Realtor from a different source, or until the owner, without solicitation, offers to list with the accepting Realtor unless contrary to the rules of the local real estate board; furthermore, such a listing should not be passed on to a third broker without the consent of the listing broker.

Article 27. The Realtor should cooperate with other Realtors on property listed, sharing commissions on an agreed basis. Negotiations concerning property listed exclusively with one Realtor should be carried on with the listing broker, not with the owner, except with the consent of the listing Realtor.

Article 28. The Realtor should not solicit the services of an employee or salesman in the organization of a fellow-Realtor without the knowledge of the employer.

Article 29. Signs giving notice of property for sale, rent, lease or exchange should not be placed on any property by more than one Realtor, and then only if authorized by the owner, except as the property is listed with and authorization given to more than one Realtor.

Article 30. In the best interest of society, of his associates and of his own business, the Realtor should be loyal to the real estate board of his community and active in its work.

Conclusion

The term Realtor has come to connote competence, fair dealing and high integrity resulting from adherence to a lofty ideal of moral conduct in business relations. No inducement of profit and no instructions from clients ever can justify departure from this ideal, or from the injunctions of this Code.

VT 012 734
Airframe Maintenance Technician Curriculum. An Experimental Program for Vocational and Technical High Schools.

New York City Board of Education, Brooklyn, N.Y. Bureau of Curriculum Development.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - Jul69 91p.

DESCRIPTORS - *CURRICULUM GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *AVIATION MECHANICS; *AVIATION TECHNOLOGY; VOCATIONAL EDUCATION; TEACHING GUIDES; MAINTENANCE; ENGINES; SECONDARY GRADES; VOCATIONAL HIGH SCHOOLS; CERTIFICATION; EDUCATIONAL FACILITIES

ABSTRACT - Developed by the Bureau of Curriculum Development in cooperation with the Bureau of Trade and Technical Education of the New York City Board of Education, this curriculum guide is for instructor use in an experimental airframe maintenance technician program in vocational and technical high schools. The objectives are to provide over a 3-year period (1,518 hours), the technical knowledge and skill to students interested in qualifying for an FAA Maintenance Technician Certificate of Competency with the Airframe, Powerplant, or combined Airframe and Powerplant ratings. A topical outline, time allotments, curriculum pattern, teacher requirements, and facilities and equipment information are presented. The majority of the material is concentrated on the airframe maintenance technician curriculum, with assignments and necessary information given for each topic. (GEB)

VT 012 734

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CURRICULUM PROJECT REPORT

Limited Distribution

AIRFRAME MAINTENANCE TECHNICIAN CURRICULUM

An Experimental Program

For

Vocational and Technical High Schools

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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Project No. 7515

These experimental curriculum materials were prepared as part of the Curriculum Workshop Program of the Bureau of Curriculum Development in cooperation with the Bureau of Trade and Technical Education.

July 1969

BUREAU OF CURRICULUM DEVELOPMENT
BOARD OF EDUCATION • CITY OF NEW YORK
131 Livingston St., Brooklyn, New York 11201

VT012734

8257 16M-69

_____ School Name

_____ Date

_____ Principal

Airframe Maintenance Technician Curriculum

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Amended Curriculum
F.A.R. Part 147.7

8258

1. Introduction

The New York City Board of Education Curriculum Development Bureau submits the amended curriculums for Airframe, Powerplant and Airframe and Powerplant Maintenance Technician Ratings to the Department of Transportation, Federal Aviation Administration for approval in accordance with the revised F.A.R. Part 147. The individual curriculum projects are identified as follows:

1. Airframe Maintenance Technician Project 7515
2. Powerplant Maintenance Technician Project 7516
3. Airframe and Powerplant Maintenance Technician Project 7515A

These curriculums will be put to use in those Vocational and Technical High Schools that wish to provide the educational opportunities necessary for teaching the technologies and skills required by interested and motivated students in order to qualify for an F.A.A. Maintenenace Technician Certificate of Competency with the Airframe, Powerplant or combined Airframe and Powerplant ratings.

The New York City school system has the following schools teaching F.A.A. Approved Maintenance Technician Curriculums:

1. Aviation High School
   Mr. Frank Woehr, Principal
   Queens Blvd. and 36 Street
   Long Island City, N.Y. 11101

   a) Airframe Maintenance Technician

   b) Powerplant Maintenance Technician

   c) Airframe and Powerplant Maintenance Technician

2. East New York Vocational and
   Technical High School
   Mr. Solomon Kantowitz, Principal
   1 Wells Street
   Brooklyn, N. Y. 11208

   a) Powerplant Maintenance Technician

Approval of these curriculums and the issuance of amended F.A.A. Maintenance Technician School Ratings for Aviation High School and East New York Vocational and Technical High School is hereby applied for:

_____
Principal

_____
School

_____
Date

School _____ Date _____

Principal _____

2. Topical Outline

Airframe Maintenance Technician Curriculum

Topical Outline, Year Levels and Time Allotment in Hours

10th, 11th, 12th Year Shops and Related Technology

I. General Curriculum Subjects

	YEAR LEVEL				
	10	11	12	RT	TOTAL
A. Basic Electricity	70	70	30	40	210
B. Aircraft Drawings	5	5	10	25	45
C. Weight and Balance			10	25	35
D. Fluid Lines and Fittings		5	5		10
E. Materials and Processes	5		5	40	50
F. Ground Operation and Servicing			10	5	15
G. Cleaning & Corrosion Control	5			15	20
H. Mathematics				20	20
I. Maintenance Forms & Records			5	10	15
J. Basic Physics				15	15
K. Maintenance Publications			5	5	10
L. Mechanic Privileges & Limitations			5		5
	85	80	85	200	450

Name of School _____ Date _____

Principal _____

Airframe Curriculum Subjects

II. Airframe Structures

	YEAR LEVEL				
	10	11	12	RT	TOTAL
A. Wood Structures	60		15	10	85
B. Aircraft Covering	10		20	5	35
C. Aircraft Finishes	10		20	10	40
D. Sheet Metal Structures	90		40	53	183
E. Welding		55	10	20	85
F. Assembly and Rigging	5		45	20	70
G. Airframe Inspection	5		45	5	55
Sub Total Hours	180	55	195	123	553

III. Airframe Systems & Components

	10	11	12	RT	TOTAL
A. Aircraft Landing Gear Systems		15	25		40
B. Hydraulics & Pneumatic Power Systems		60	40	25	125
C. Cabin Atmospheric Control Systems			25	20	45
D. Aircraft Instrument Systems			20	15	35
E. Communication & Navigation Systems			15	10	25
F. Aircraft Fuel Systems			45	10	55
G. Aircraft Electrical Systems	5	60	45	20	130
H. Position & Warning Systems			15	5	20
I. Ice and Rain Control Systems			15	5	20
J. Fire Protection Systems			15	5	20
Sub Total Hours	5	135	260	115	515
Airframe Course Total Hours	270	270	540	433	1518

8262

School _____ Date _____

Principal _____

3. CURRICULUM PATTERN

All students enrolled in the FAA approved school curriculum (Airframe or Power Plant) follow the same course of instruction during the 10th and 11th school years.

The course content includes those subjects of common interest and importance to both the airframe and power plant ratings. This pattern allows the students to acquire training and experience in both areas of the maintenance technician curriculum. Specialization for either the airframe or power plant maintenance technician curriculum takes place in the 12th year.

The FAA approved airframe or power plant maintenance technician curriculum of the school provides 1518 hours of training and instruction for each course. The minimum hours of instruction required for either the Airframe or Power plant approved curriculum as listed in F.A.R. 147.21 is 1150 hours.

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4. STUDENT HOURS OF INSTRUCTION

1. Students daily instruction time - 6.75 Hours.

	Daily	Term	Year
* Shop	3.00	270	540
* Related Technology	.45	67.5	135
** Math Science Drawing	.45	67.5	135
Academic	1.30	135	270
Lunch	.45		

* 3 hours and 45 minutes per day for the FAA program during the 11th and 12th year

** An additional 45 minutes of Math, Science and Drawing added to the FAA program in the 10th year

2. School Term: 90 days 18 weeks - 5 days per week

3. School Year: 180 days 36 weeks - 5 days per week

4. FAA Curriculum Hours:

* 10th Year - Shop Rel. Tech. Math Science Drawing	438
* 11th Year - Shop and Rel. Tech.	405
12th Year - Shop and Rel. Tech.	675
Total Hours	1518

The maximum number of students enrolled at any one time is 900.d

School Date

Principal

5. GENERAL NOTES

A. Federal Air Regulations contained in Volumes I, II, III, IV, V, VI and IX and Parts 1, 11, 13, 21, 23, 25, 27, 29, 33, 35, 37, 39, 41, 43, 45, 47, 49, 65 91 and 145 will be covered and taught throughout the Airframe, Powerplant, Airframe and Powerplant and the General Curriculum wherever they are deemed applicable.

B. The use and care of tools, equipment, materials, instruments and essential safety instructions will be taught at the appropriate time in conjunction with the demonstration and information lessons throughout the 10th, 11th and 12th year shops.

C. The basic references recommended and to be followed for the instructional and training program will include: AC65-2A - Airframe & Powerplant Mechanics Certification Guide, The General, Airframe and Powerplant Study Text Books now being prepared for sale by the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, and any other suitable text book that the individual teacher deems satisfactory. There will be no attempt to restrict or limit the use of texts, instruction sheets, job sheets, information sheets, assignment sheets, audio, visual or animated instructional aids.

_____ School _____ Date

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D. The instructional levels to be maintained are clearly defined in AC 65-2A as follows:

Level 1. Know - basic facts and principles

Be able to - find information, follow directions and written instructions

Knowledge of general principles but limited practical application with no development of manipulative skill

Instruction by lecture, demonstration and discussion

Level 2. Know and understand - principles, theories and concepts

Be able to - find and interpret information and perform basic operations

A high level of skill is not required

Instruction by lecture, demonstration, discussion and limited practical application

Level 3. Know, understand and apply - facts, principles, theories and concepts, Understand how to relate to the total operation and maintenance of aircraft

Be able to - make independent and accurate judgements, perform all operations to a return to service standard

Practical application of general principles to a high degree and development of a sufficient manipulative skill to accomplish return to service

Instruction by lecture, demonstration, discussion and degree of practical application

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E. Testing of each student's technical knowledge and competence in performing manipulative skills will be conducted by a series of written exams and practical performance projects. This testing and evaluation is indicated at the end of each section for each subject area in the curriculum. This program will consist of the following:

All level 1 learning - a written examination

All level 2 learning - a written examination and a practical project

All level 3 learning - a written examination and a practical work project that must meet "return to service standard"

The curriculum lists the practical work projects that will be used to conduct the performance demonstrations.

A record of the examination grades and performance scores earned by each student, the practical projects completed by each student, will be kept by the school and made a part of each student's accumulative record.

A work progress card will be maintained by the shop teacher who will hold an FAA Maintenance Technicians Certificate of Competency for each student that will show:

(a) each completed practical project

(b) grade earned for each project

(c) score earned for each written examination

(d) attendance and punctuality record

(e) character and personality ratings

_____ School _____ Date

_____ Principal

F. The school will expect each student who satisfactorily completes the FAA Technician Certification Courses, Airframe or Powerplant, to score 70% or higher in the school-administered Final Qualifying Examination to be given at the very end of the completed course of study. Failure to meet this standard will prevent a student from receiving the school FAA course completion graduation certificate. Provisions for continued education and training will be made available during the summer period so that interested and motivated students will be helped to meet the requirements for the FAA school course completion graduation certificate.

School _____ Date _____

Principal _____

6. AIRFRAME MAINTENANCE TECHNICIAN CURRICULUM

I. GENERAL CURRICULUM SUBJECTS

A. BASIC ELECTRICITY (10th, 11th, 12th Year and RT)

1. Measure capacitance and inductance (level 1)

a) The effect of inductive reactance in an electrical circuit.

b) The interrelationship of capacitive and inductive reactance.

c) The term that describes the combined resistive forces in an A.C. electrical circuit.

d) The unit of measurement for capacitance and inductance.

A written examination appropriate to the above subject will be used to determine the degree of learning by the students.

2. Calculate and measure conductivity and electrical power (Level 2)

a) Determine the power furnished by a generator to an electrical system consisting of various electrical units having specific load ratings.

b) Determine the power required by an electric motor that is operating at a specified efficiency and load.

A written examination required and practical projects.

1) Find the power required of a generator supplying various units in an electric circuit

2) Find the power required by an electric motor in an existing circuit under various load conditions.

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3. Measure voltage, current, resistance, continuity, and leakage (Level 3)

   a) Use an ohmeter to check for open or short circuits.

   b) The test instruments used to check continuity.

   c) The basic operating principles of D.C. electrical instruments.

   d) The basic operating principles of a galvonometer.

   e) Connect voltmeters and ammeters into an electrical circuit.

   f) The purpose of a shunt resistor when used with an ammeter.

   g) The meaning of prefixes such as micro, mega, kilo, and milli as used in expressing electrical quantities.

   A written examination required and practical projects.

      1) Use an ohmeter to check for short and open circuits in an existing electrical circuit.

      2) Connect an ammeter and a voltmeter in an existing electrical circuit. Use an ammeter requiring an external shunt.

4. Determine the relationship of voltage, current, and resistance in electrical circuits (Level 3)

   a) Determine the current flow in an electrical circuit using variable resistance and voltage valves.

   b) Determine the power requirements of an electrical circuit when the voltage and resistance valves are specified.

   c) The current relationship in an electrical parallel circuit.

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d) The unit of measurement used to express electrical power.

e) The principles of electromagnetic induction.

f) The characteristics of magnets and magnetic lines of force.

g) The factors that effect the voltage drop in an electrical conductor.

h) Determine the resistance of an electrical device from the wattage and voltage values specified.

i) Calculate the voltage drop across a resistor.

A written examination required and practical projects.

1) Determine the needs of, select, install, operate and test an electrical circuit using a ZAV supply consisting of the following units: bus, circuit breaker, switch, relay, lamps, and rheostat.

The above project should reflect both series and parallel lamp circuits.

5. Read and interpret electrical circuit diagrams (Level 3)

a) Trace electrical circuits using aircraft wiring diagrams.

b) Identify electrical system malfunctions by reference to circuit diagrams.

c) Identify the commonly used aircraft electrical symbols.

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A written examination required and practical projects.

1) Wire an aircraft navigation and lighting system mock-up using an aircraft wiring diagram. Incorporate the following units into the lighting system: bus bar, circuit protecting devices, switches, lamps in parallel, variable resistance in series with cabin lamps.

6. Inspect and service batteries (Level 3)

a) Remove spilled electrolyte and treat all adjacent surfaces.

b) Remove and install a battery in the aircraft with a single wire electrical system.

c) Connect batteries to a constant current battery charger.

d) Determine the specific gravity of the battery electrolyte.

e) Perform a high-rate discharge condition test of batteries.

f) The design factors that affect battery voltage and capacity.

g) The factors that determine battery charging rate on a constant voltage source.

h) The indications of a shorted battery cell.

i) The significance of battery capacity ratings.

j) The effects of increased internal resistance on battery operation.

k) The effects of connecting battery cells in series or parallel.

l) The relative advantages of lead-acid and nickel-cadmium batteries for use in aircraft.

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m) The principles of battery construction.

n) Check battery electrolyte level.

o) The relationship between battery state of charge and the temperature at which the electrolyte will freeze.

p) The purpose of and requirements for ventilating batteries and battery compartments in civil aircraft.

q) The effect of excessive charging rates on batteries.

A written examination required and practical projects.

1) Remove, clean, service, charge and install batteries in an aircraft. (Use constant current and constant potential charger)

2) Clean and protect battery compartment in an aircraft and service spill-jar.

B. AIRCRAFT DRAWINGS (10th, 11th, 12th Year and RT)

1. Use drawings, symbols, and schematic diagrams (Level 2)

a) Interpret the various types of lines employed in blueprints and schematics.

b) Use schematic diagrams to analyze system malfunctions.

c) Extract a specific electrical circuit from a system drawing.

d) Know why dimensions are used and how they are shown on aircraft drawings.

e) Use installation diagrams to locate and identify components.

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A written examination required and practical projects.

1) Install a rotating beacon on an aircraft using blueprints and wire chart as references.

2) Install wiring for a generating system using schematics, charts, and graphs.

3) Using wiring diagram of an aircraft engine instrument system, isolate a particular system, i.e. fuel pressure system, and proceed to correct fuel pressure system malfunction.

4) Rig a centersection on a biplane using specifications shown on a blueprint.

5) Layout a drawing to specifications. Transfer layout information to a piece of flat stock. Fabricate fitting.

2. Draw sketches of repairs and alterations (Level 3)

a) Illustrate a major repair or alteration.

b) Use dividers, compass, ruler, T-Square, etc., in the development of sketches of repairs and alterations.

c) Use standard drafting procedures.

A written examination required and practical projects.

1) Recover a control surface, fill out form 337 and appropriate records.

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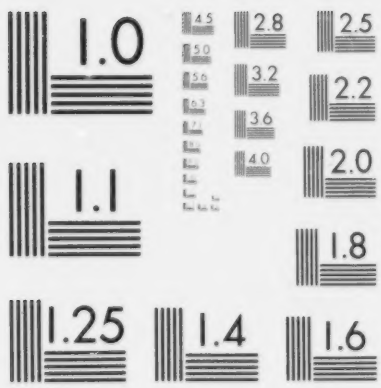

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

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2) Repair damage to stressed skin area of fuselage, fill out form 337 and appropriate records.

3) Install an oil cooler on an engine other than that shown on data sheet, fill out form 337 and appropriate records.

3. Use blueprint information (Level 3)

a) The information presented in blueprint title blocks

b) The common symbols used on aircraft blueprints

c) Install and modify component parts by reference to blueprints

d) Identify the changes made to a blueprint

A written examination required and practical projects.

1) The drafting department curriculum provides adequate time and practice in areas a, b, and d above

2) Modify a stringer installation by reference to blueprints.

3) Install an electrical oil pressure gauge using installation prints and specifications.

4. Use graphs and charts (Level 3)

a) Determine electric cable size and current carrying capacity

b) Determine engine power requirements

A written examination required and practical projects.

1) By referring to the electrical cable chart in AC 43 13-1 determine the size of an aluminum cable to replace a copper cable for the inverter.

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2) During ground run use the manufacturer's manual to determine if the engine meets manufacturer's requirements.

C. WEIGHT AND BALANCE (12th Year and RT)

1. Weigh aircraft (Level 2)

a) Use aircraft specifications for weighing purposes.

b) Locate jacks and scales in the correct position.

c) Prepare aircraft for weighing.

A written examination required and practical projects.

1) Weigh an aircraft and record the scale readings.

2. Perform complete weight and balance check and record data (Level 3)

a) Determine that the foreward or rearward center of gravity (C.G.) limit is not exceeded on a specified aircraft.

b) The point of reference for all weight and balance measurements.

c) The procedure for computing "minimum fuel."

d) Locate the information that should be known to compute weight and balance.

e) The method of expressing additions or removals of equipment for weight and balance purposes.

f) Determine the fully loaded center of gravity of an aircraft.

g) Determine the "maximum authorized weight" of an aircraft.

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h) The method of determining aircraft empty weight, when engine oil and hydraulic fluid are contained in supply tanks.

i) The effect on weight and balance of replacing a component with another of different weight and location.

j) Calculate the maximum cargo or baggage weight that can be carried by an aircraft.

k) The record requirements for weight and balance data.

l) The hazards of exceeding aircraft fore and aft center of gravity limits.

m) The critical conditions of helicopter load and balance.

n) Determine aircraft empty weight and empty weight center of gravity.

o) Define maximum gross weight.

p) Determine the moment of an item of equipment.

q) Account for tare weight when weighing an aircraft.

A written examination required and practical projects.

1) Compute new empty weight, empty weight center of gravity, and useful load. Complete appropriate record requirements.

2) Change or remove equipment from an aircraft, such as propeller, seats, gas tanks, etc. Compute new weight and balance, reflecting a corrected empty weight, empty weight center of gravity, useful load, fore and aft check and correction where necessary. This project must utilize such specifications and references as "Data Sheets" "A.CA 65. 13-1" and equipment list.

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D. FLUID LINES AND FITTINGS (11th, 12th Year and RT)

1. Fabricate and install rigid and flexible fluid lines and fittings (Level 3)

a) Single and double-flare tubing.

b) Install military standard (MS) flareless fittings

c) The significance of the identification stripes that appear on aircraft hose

d) Fabricate and install beaded tubing

e) Use lubricants and sealants in the assembly of lines and fittings

f) Identify flexible hydraulic lines

g) Install hose clamps

h) Determine the bend radii for rigid tubing

i) Fabricate aluminum tubing using standard AN flared tube fittings

j) Route fluid lines in entryways and passenger, crew, or baggage compartments.

k) Repair metal tube lines

l) Route fluid lines adjacent to electrical power cables.

m) Install rigid tubing.

n) Select tube flaring tools

o) Identify AN fitting materials from color designators

p) The maximum reduction in original outside diameter allowed when bending aluminum alloy hydraulic lines.

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q) The procedure to follow if scratches are detected on an aluminum alloy tube.

r) The storage requirements for hydraulic hose.

s) Install flexible hydraulic hose.

t) The lubricant used when assembling oxygen fittings.

A written examination required and practical projects.

1) Make up a replacement fluid line (rigid and flexible) and install the line in an aircraft or system mock-up. Use both AN and MS fittings.

2) Repair a rigid or a flexible fluid line using a union or repair a high pressure line using a replacement section.

E. MATERIALS AND PROCESSES (10th, 11th, 12th Year and RT)

1. Identify and select appropriate nondestructive testing methods (Level 1)

a) The use of radiography in aircraft and component inspection

b) The use of ultrasonic inspection methods for detecting cracks.

c) The applicability of magnetic particle inspection methods to engine crankshafts.

d) The method for detecting surface cracks in aluminum castings and forgings.

e) The technique for locating cracks in materials when only one side of the material is accessible.

A written examination appropriate to the above subject will be used to determine the degree of learning by the students.

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2. Perform penetrant, chemical etching, and matnetic particle inspections. (Level 2)

   a) The general procedure for performing magnetic particle inspection.

   b) Demagnetize steel parts after magnetic particle inspection.

   c) Clean parts in preparation for penetrant inspection.

   d) The visual indications of a subsurface flaw or fracture during magnetic particle inspection.

   e) Locate cracks and blowholes in welded assemblies.

   f) The procedure for using dye penetrants.

   g) Distinguish between heat-treated and non-heat-treated aluminum alloys when the identification marks are not on the material.

A written examination required and practical projects.

1) Using dye-penetrant method of inspection examine suspected areas of an aircraft engine power section.

2) Using the magnetic particle type of inspection equipment inspect various engine parts, piston pin, connecting rod, crankshaft, and welded assembly.

3) Using acceptable trade practices distinguish between a heat treated and a non-heat treated piece of aluminum alloy.

4) Inspect an aluminum propeller blade using the caustic soda etching method.

5) Inspect a landing gear component by use of magnetic particle equipment.

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6) Inspect an aircraft and/or powerplant aluminum alloy part using the "Zyglo" method of inspection.

3. Perform basic heat-treating processes (Level 2)

a) The types of aluminum alloys considered to be heat treatable.

b) Anneal copper tubing.

c) The steps in heat treatment of aluminum alloys.

d) The effects of various forms of heat treatment.

e) The effect of incorrect heat treatment on the corrosion-resistant properties of aluminum alloys.

f) Identify the degree of temper for aluminum alloy products from code designators.

g) The effect of heating a metal slightly above its critical temperature, and then rapidly cooling it.

h) The effect of strain hardening on the tensile strength of aluminum alloy.

i) The relationship between tensile strength and metal hardness.

j) Anneal a welded steel part.

A written examination required and practical projects.

1) Remove a copper primer line, anneal, and reinstall.

2) Anneal a welded steel tubing joint or cluster.

3) Heat treat and form an aluminum alloy rib.

4) Heat treat a new machined center punch.

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4. Identify and select aircraft hardware and materials (Level 3)

   a) Identify aluminum alloys from code designators.

   b) Identify steel from code designators.

   c) The identification markings of AN standard steel bolts.

   d) Identify aircraft cable.

   e) The characteristics of a material that affect its ability to be hammered, rolled, or pressed into various shapes.

   f) The SAE system of identifying steel.

   g) Determine wrought aluminum alloy composition and condition by referring to aluminum codes.

   h) Install self locking nuts.

   i) Determine the correct length bolt to use.

   j) Determine correct torque values for tightening aircraft nut and bolts.

   k) Determine rivet composition, condition, shape, and dimension by referring to Rivet Code.

   l) Identify materials suitable for use for firewalls and exhaust shrouds.

   m) Install castle nuts.

   n) The strength characteristics of type "A" rivets.

   o) The characteristic of aluminum alloy rivet material that causes some rivets to require several days to reach their ultimate strength.

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p) Determine that materials used in aircraft maintenance and repair are of the proper type and conform to the sppropriate standards.

q) The characteristics of aluminum - clad sheet aluminum alloy.

A written examination required and practical projects.

1) Fabricate an aluminum alloy control surface.
2) During engine overhaul assemble sylinders and torque to proper value.
3) Install an aircraft control surface using castellated nuts.
4) During engine overhaul install connecting rods using castellated nuts.
5) Replace an aircraft control cable in an aircraft.
6) Replace a propeller governor control cable.
7) Install bolts using self locking nuts during engine overhaul.
8) Install bolts using self locking nuts during replacement of components on aircraft.
9) Select steel and aluminum alloy using code designators in fabricating aircraft fittings and brackets.
10) Make stressed skin repair.

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5. Inspect and check welds (Level 3)

a) The characteristics of a good weld.

b) The types of stress that welded joints can withstand.

c) The effect of welding over a previously brazed or soldered joint.

A written examination required and practical projects.

1) Weld a steel tubing cluster.

2) Inspect a welded tube structure, i.e., welded tube engine mount, welded tube fuselage structure.

6. Perform precision measurements (Level 3)

a) Use a micrometer and a caliper to make precision measurements.

b) Measure a small hole using micrometer and a hole gauge.

c) Read and interpret a vernier micrometer scale.

d) Use a dial indicator, V blocks, and a surface plate to check the alignment of a shaft.

A written examination required and practical projects.

1) During engine overhaul inspect various parts for wear and proper clearance.

2) During engine overhaul inspect a camshaft and/or crankshaft for runout.

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F. GROUND OPERATION AND SERVICING (12th Year and RT)

1. Start, ground operate, move, service and secure aircraft (Level 2)

a) The procedure for extinguishing fires in the engine induction system during starting.

b) Use hand signals to direct aircraft movement.

c) Select and use external auxiliary power units for engine starting.

d) Tie down and secure aircraft for outside storage.

e) Protect aircraft fuel system from contamination during fueling operations.

f) Connect and operate an external source of hydraulic power.

g) Start and operate an engine equipped with a float type carburetor.

h) Check a reciprocating engine for liquid lock.

i) Operate hand and electrical priming systems during engine starting.

j) Start and operate an engine equipped with a pressure injection carburetor.

k) Start and operate an engine equipped with an internal supercharger.

A written examination required and practical projects.

1) Move, tie-down, and store aircraft on hangar apron and in hangar.

2) Pre-start check a reciprocating engine including a check for liquid lock.

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3) Start an aircraft engine using an A.P.U.

4) Start and run an aircraft engine with an internal supercharger.

5) Start and run an aircraft engine with a pressure injection carburetor.

6) Start and run an aircraft engine with a float type carburetor.

7) Service an aircraft engine with fuel and oil.

8) Operate aircraft actuating mechanisms with an external source of hydraulic power.

2. Identify and select fuels (Level 2)

a) The effect of ethylene dibromide added to aviation gasoline.

b) The identifying color of various grades of aviation gasoline.

c) The characteristic of a fuel that affects its tendency to "vapor lock."

d) The significance of the numbers used to designate various grades of aviation gasoline.

e) The relative advantages of gasoline and kerosine for use as fuel for turbine engines.

f) Determine the types of fuel to be used with a specific aircraft.

g) The factors affecting the antiknock characteristics of fuel.

A written examination required and practical projects.

1) Refuel various aircraft requiring several grades of fuel.

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G. CLEANING AND CORROSION CONTROL (10th, 11th, 12th Year and RT)

1. Identify and select cleaning materials (Level 3)

a) The effect of caustic cleaning products on aluminum structures.

b) The characteristics and use of chemical cleaners.

c) Clean aluminum and steel engine parts.

d) The type cleaner for use on high strength metals.

e) The methods for cleaning turbine engine compressor blades.

A written examination required and practical projects.

1) Clean an engine in preparation for PIS assembly.

2) Clean engine parts in preparation for inspection.

3) Clean an aircraft structure in preparation for painting.

4) Clean engine exhaust systems.

2. Perform aircraft cleaning and corrosion control (Level 3)

a) Protect tires and other rubber products from the deteriorating effects of cleaning materials.

b) The cause and corrective procedures for fretting corrosion.

c) Identify and control intergranular corrosion of heat treated aluminum alloy.

d) Protect structure against dissimilar metal corrosion.

e) Prevent and remove rust.

f) The effect of oily, dirty surfaces on the operation of high performance aircraft.

g) Protect interior surfaces of closed steel and aluminum tubing against corrosion.

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h) The methods of protecting aluminum alloy parts against corrosion.

i) Clean and protect battery compartments and adjacent areas.

j) Remove corrosion products such as metal flake, scale powder and salt deposits from aluminum.

k) Clean corrosion resistant parts by blast cleaning methods.

l) Use paints and similar organic coatings for corrosion protection purposes.

A written examination required and practical projects.

1) Clean and protect a battery compartment on an aircraft.

2) Clean exhaust collectors and shrouds.

3) Cover tires of stored aircraft against oil and solvent drippings.

4) Remove rust from the exterior of spark plugs and paint.

5) Wash down aircraft.

6) Clean, zinc chromate, and paint aircraft fittings and brackets before installing.

7) Use par-al-ketone to protect exterior surfaces of engines in storage.

8) During fabrication of a control surface (Aileron) use proper corrosion protection between dissimilar metals.

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_____ Principal

H. MATHEMATICS (10th, 11th, 12th Year and RT)

1. Extract roots and raise numbers to a given power (Level 1)
2. Determine areas and volumes of various geometrical shapes (Level 2)
3. Solve ratio and proportion and percentage problems (Level 3)
4. Perform algebraic operations involving addition, subtraction, multiplication, and division of positive and negative numbers (Level 3)

Students will demonstrate competency with this subject while performing practical projects and written examinations at appropriate times throughout the curriculum. Selected projects would include: weight and balance computations, flat pattern layout development, electric circuit computations, and calculating gear ratios and engine displacement.

I. MAINTENANCE FORMS AND RECORDS (11th, 12th Year and RT)

1. Write descriptions of aircraft condition and work performed (Level 3)
   a) Describe the repairs made to an aircraft structure.
   b) State aircraft condition based upon inspection.

   A written examination required and practical projects.

   1) Make a log book entry describing repairs made to an aircraft and/or powerplant.
   2) Perform a 100 hour inspection to an aircraft and/or powerplant and submit a completed inspection report and discrepancy list.

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2. Complete required maintenance forms, records, and inspection reports (Level 3)

   a) Enter the required information in the permanent maintenance records when a minor repair has been performed.

   b) Prepare and properly dispose of FAA Form 337.

   c) The minimum information required to be entered in the maintenance records after maintenance or alteration of aircraft.

   d) Make record entries to indicate compliance with airworthiness directives.

   e) The definition of "Time In Service" with respect to maintenance records.

   f) The record requirements for returning aircraft to service after 100 hour inspection.

   g) The requirement for maintaining a permanent record of aircraft maintenance.

   h) The definition of "Repair" as related to aircraft maintenance.

   i) The requirements for a permanent maintenance record.

A written examination required and practical projects.

   1) Make a log book entry reflecting a major repair made to an aircraft and/or powerplant and execute an FAA Form 337.

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2) Make a log book entry reflecting compliance with an airworthiness directive.

3) Make a log book entry reflecting return to service after completing a 100 hour inspection.

J. BASIC PHYSICS (10th, 11th, 12th Year and RT)

1. Use the principles of simple machines; sound, fluid, and heat dynamics. (Level 2)

The course content includes classroom and laboratory experiments and demonstrations in the theory and application of the laws of physics as applied to aviation in the performance and operation of aircraft and powerplants and the functioning of its support systems.

Examples: Charles Law, Boyles Law, Pascals Law, Bernoulli Theorum, Newtons Laws, Otto Cycle, Braden Cycle are examples of the basic concepts incorporated in the curriculum.

K. MAINTENANCE PUBLICATIONS (10th, 11th, 12th Year and RT)

1. Select and use FAA and manufacturer's aircraft maintenance specifications, data sheets, manuals, and publications, and related Federal Aviation Regulations (Level 3).

a) Determining the suitability of a propeller for use with a particular engine - airplane combination.

b) Determine the minimum diameter of a propeller type and model when used with a particular engine.

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c) Locate aircraft leveline and weighing information.

d) Determine engine/propeller speed ratios.

e) The instrument markings required on a specified type and model aircraft.

f) The purpose and applicability of technical standard orders.

g) The purpose and applicability of supplemental type certificates.

h) Identify the useful load and empty weight C.G. of an aircraft by reference to data.

i) Use FAA specifications and type certificate data sheets.

j) The applicability and requirements for aircraft airworthiness certificates.

k) Determine the control surface movement limits of a specified aircraft.

l) Determine seat locations of an aircraft using aircraft specifications.

m) Use aircraft listing to find information about aircraft of limited production.

n) The purpose and applicability of FAA airworthiness directives.

o) Use "Table of Limits" to determine condition of parts.

A written examination is required and practical projects.

1) During the performance of a 100 hour inspection, determine from the aircraft data sheet that the powerplant/propeller combination is correct and that the diameter of the propeller is within limits.

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2) During the weighting of an aircraft make use of the aircraft data sheets to determine the identification of, and location of the leveling means, seat location, and gross weight.

3) Check instrument marking and placards using aircraft and powerplant data sheets.

4) During engine overhaul make use of manufacturers instruction manuals and table of limits.

5) Determine the airworthiness of various pieces of equipment by referring to technical standard orders.

6) During the performance of a 100 hour inspection refer to summary of airworthiness directives for mandatory adherence data sheets for control surface travel.

2. Read technical data (Level 3)

a) Find specified information in technical reports and manuals.

L. MECHANIC PRIVILEGES AND LIMITATIONS.(12th Year)

1. Exercise mechanic privileges within the limitations prescribed by FAR 65 (Level 3)

a) The criteria for determining the classification (major, minor, or preventive maintenance) of airframe repairs and alterations.

b) The criteria for determining the classification (major, minor or preventive maintenance) of powerplant repairs and alterations.

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c) The criteria for determining the classification (major, minor, or preventive maintenance) of propeller repairs and alteration.

d) Return an aircraft to service after installation of an engine type other than that for which the aircraft was originally certificated.

e) The minimum age requirement for issuance of a mechanic certificate.

f) The privileges of a mechanic in relation to 100-Hour and annual inspections.

g) The requirements for reporting change of address.

h) The duration or effective period of a mechanic certificate.

i) The requirements an applicant must meet for issuance of a mechanic certificate.

j) Determine the maintenance classification (major repair, minor repair, preventive maintenance) of Landing Gear tire removal, installation, and repair.

k) Determine the maintenance classification (major repair, minor repair, preventive maintenance) of servicing Landing Gear shock struts.

l) Determine the repair classification (major repair, minor repair, preventive maintenance) of repairs to steel tubing structures by welding.

m) Determine the repair classification (major repair, minor repair, preventive maintenance) of replacing the fabric on fabric - covered parts such as wings, fuselages, stabilizers, and control surfaces.

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3. Repair a damaged steel tubing structure and/or overhaul a cylinder. Establish authority to do the work necessary. Refer to Part 65, and classify the work required as to a major repair, minor repair or preventive maintenance. Refer to Part 43.

4. Recover a control surface and/or remove and service a set of spark plugs. Establish authority to do the work necessary. Refer to Part 65, and classify the work required as to a major repair, minor repair or preventive maintenance. Refer to Part 43.

5. Replace a Landing Gear shock strut and/or a rebuilt generator. Establish authority to do the work necessary. Refer to Part 65 and classify the work required as to a major repair, minor repair or preventive maintenance. Refer to Part 43.

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II. AIRFRAME STRUCTURES

A. WOOD STRUCTURES (10th, 12th Year, General Science)

1. Service and repair wood structures (Level 1)

a) The general requirements of scarf splice joints.

b) The repair procedure for elongated holes in wood spars.

c) The permissible wood substitutes for use in making repairs to wood structures.

d) The procedures for repairing wood rib capstrips.

e) The characteristics of glue used in aircraft construction and repair.

f) The procedures for sealing the inner surfaces of wooden structure that is to be assembled by gluing.

g) The general characteristics of wood commonly used in Aircraft construction.

A written examination appropriate to the above subjects will be used to determine the degree of learning by the students.

2. Identify wood defects (Level 2)

a) Recognize acceptable and nonacceptable wood defects.

A written examination required. Practical Projects.

1) Inspect a wood spar for acceptable defects.

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3. Inspect wood structures (Level 2)

   a) The effect of moisture content on wood size and strength.

   b) The strength characteristics of wood structures.

   c) The characteristics of plywood and laminated wood.

   A written test is required. Practical Project.

   1) Students will inspect a sample wood aircraft structure.

B. AIRCRAFT COVERING (10th, 12th Year, RT)

1. Select and apply fabric and fiberglass covering materials (Level 1)

   a) The factors to consider in selecting aircraft fabric.

   b) The types of seams commonly used in aircraft fabric coverings.

   c) The general requirements for making doped and lapped seams.

   d) The meaning of the term "warp" as used in reference to aircraft textile products.

   e) The precautions to observe when installing surface tape on control surfaces.

   A written examination appropriate to the above subject will be administered to determine the degree of learning by the student.

2. Inspect, test and repair fabric and fiberglass (Level 3)

   a) Determine the condition of aircraft fabric.

   b) Apply a doped-on patch to aircraft fabric.

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c) Make a sewed repair to a fabric-covered surface.

d) The areas on a fabric-covered aircraft most susceptible to corrosion.

A written examination required and practical projects.

1) Cover an aircraft structure with aircraft fabric.

2) Test and repair fabric covered aircraft structure.

C. AIRCRAFT FINISHES (10th, 12th Year, General Science)

1. Apply trim, letters and touch-up paint (Level 1)

a) The requirements for registration markings.

b) The relative proportions of identification markings.

c) The use of color and ornamentation when applying registration markings.

A written examination appropriate to the above subject will be used to determine the degree of learning by the students.

2. Identify and select aircraft finishing materials (Level 2)

a) The characteristics of butyrate and acetate dopes.

b) The types of thinners used with various types of paint and dope.

c) The characteristics of fabric rejuvenators.

d) The types of priming paints generally used on aircraft.

e) The type of paint used to coat the insides of battery compartments.

A written examination appropriate to the above subject will be used to determine the degree of learning by the students and the practical projects will consist of:

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1) Apply clear dope to a fabric covered aircraft surface.

2) Apply primer to a metal aircraft surface.

3. Apply paint and dope (Level 2)

a) The purpose of fungicidal dope in aircraft finishing.

b) The application of rejuvenator to repair an aged dope finish.

c) The products and methods used to dopeproof airframe structures.

d) The effect of atmospheric conditions on dope during its application.

e) Sand and rub aircraft finishes.

f) Apply primer to aluminum alloy parts.

g) Use and maintain a paint spray gun.

h) The purpose of brushing the first coat of dope instead of spraying.

Written examination required and practical projects.

1) Spray pigmented dope on aircraft fabric.

2) Spray paint on a metal aircraft surface.

4. Inspect finishes and identify defects (Level 2)

a) The type of painting defect caused by moving the spray gun in an arc instead of a straight line.

b) The cause of runs and sags in aircraft finishes.

Written examination required and practical projects:

1) Student to demonstrate proper spraying technique.

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D. SHEET METAL STRUCTURES (10th, 12th Year and RT)

1. Install special rivets and fasteners (Level 2)

a) Determine correct rivet length and diameter.

b) Install a Hi-Shear rivet.

c) The precautions concerning rivet fit.

d) Install Deicer boot fasteners.

e) Install blind type rivets.

f) The stresses that a rivet is designed to resist.

A written test is required. The practical projects are:

1) Assemble two aluminum alloy plates utilizing conventional rivets, Hi-Shear rivets, cherry rivets and riv-nuts.

2. Inspect bonded structures (Level 2)

a) The reason for using metal sandwich panels in high-speed aircraft construction.

b) The use of the metallic "ring" test to inspect for delamination damage of bonded structures.

c) Evaluate the extent of damage to a bonded structure and determine the type of repair needed.

A written test is required. The practical projects are:

1) Student to make a visual inspection of a sample bonded aircraft structure.

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3. Inspect and repair plastics, honey-comb, and laminated structures (Level 2)

   a) Distinguish between transparent plastic and plate-glass enclosures.

   b) Protect plastics during handling and repair operations.

   c) Remove scratches and surface crazing from plastic enclosures.

   d) Drill shallow or medium depth holes in plastics materials.

   e) The effect of moisture entrapped in honey-comb structures.

   f) Use a router to remove damaged area from honey-comb panels.

   g) Clean honey-comb panels prior to patching.

   A written test is required. Practical Project.

   1) Clean and polish plastic canopy and windshield enclosures.

4. Inspect, check, service, and repair windows, doors and interior furnishings (Level 2)

   a) Clean transparent plastic window and windshield materials.

   b) Inspection procedures and airworthiness requirements for safety belts.

   c) The characteristics of acrylic plastic enclosure materials.

   d) Maintain safety belts.

   e) Secure transparent plastic enclosure material to aircraft structure.

   f) Protect transparent plastic enclosure material during handling and storage.

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g) The physical characteristics of transparent plastic enclosure materials.

h) Form and shape acrylic plastic.

i) Repair shallow surfaces scratches in transparent plastic enclosures.

A written test is required;the practical projects are:

1) Make an airworthiness inspection of seat belts and their installation.

5. Inspect and repair sheet-metal structures (Level 3)

a) Select and use twist drills.

b) Select and use a hand file for soft metals.

c) Prepare dissimilar metals for assembly.

d) Determine the type, size and number of rivets for use in structural repairs.

e) Repair sheet metal flight control surfaces.

f) The loads acting on a semimonocoque fuselage.

g) The construction characteristics of monocoque and semimonocoque fuselage.

h) The construction characteristics of canti-lever wing structures.

i) The types of loads carried by wing spars.

j) Drill holes in stainless steel.

k) Define shear failure.

l) Repair a hole in a stressed skin metal wing.

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m) Repair a section of damaged skin using a single-lap sheet splice.

n) Construct a watertight joint.

o) Countersink a hole.

p) Perform dimpling process.

q) Select the correct rivet to accomplish a repair using a specified material.

r) Repair or splice stringers on the lower surface of a stressed-skin metal wing.

s) Determine the correct rivet layout and spacing for a specified repair.

t) Use proper riveting techniques.

u) Stop drill cracks in sheet metal.

v) Repair a slightly oversize hole.

w) Repair structural units, such as spars, engine supports, etc. that have been built from sheet metal.

x) Repair shallow scratches in sheet metal.

y) Determine the condition of a stressed-skin metal structure that is known to have been critically loaded.

z) Use a reamer.

A written test is required. The practical projects are:

1) Construct and assemble a metal control surface.

2) Make a stressed skin repair. *

3) Make a stringer repair. *

* In conformance with AC-43.13-1

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6. Install conventional rivets (Level 3)

   a) Prepare sheet metal for installation of flush rivets.

   b) Identify and select rivets.

   c) Determine the correct rivet length and diameter.

   d) Select and use the correct rivet set for specified rivet head styles.

   e) Select and use bucking bars.

   f) Remove rivets.

   g) Determine the condition of a driven rivet.

   h) Determine the circumstances under which 2117 rivets may be used to replace 2017 and 2024 rivets.

   i) Define rivet tipping.

   j) Determine the correct number of rivets to be used in making a structural sheet metal repair.

   k) Handle and install rivets that require heat treatment prior to use.

   l) Adjust and use an air operated riveting gun.

   m) The circumstances under which type "A" rivets may be used in aircraft.

   n) The mechanical properties of heat-treated rivets.

A written test is required. The practical projects are:

   1) Make a fuselage frame splice using several different alloy rivets (AD, D, DD) and incorporate some oversize rivets.

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7. Hand form, layout, and bend sheet metal (Level 3)

a) Make a joggle or offset bend.

b) Bend sheet metal that requires the use of a large radius.

c) Determine the neutral axis of a bend.

d) Define bend radius.

e) Determine the amount of material required to make a specified bend.

f) Bend sheetmetal to a specified angle.

g) Lay out and bend a piece of sheet metal using minimum radius for the type and thickness of material specified.

h) Lay out a bend in relationship to metal "grain" to minimize the possibility of cracking.

i) Determine the flat layout dimensions of a component part to be formed by bending.

j) Form metal by bumping.

A written test is required. The practical projects are:

1) Make a "U" channel aircraft spar section.

2) Form metal rib for the metal control surface.

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WELDING (11th, 12th Year and RT)

1. Weld magnesium and titanium (Level 1)

   a) The method of cleaning magnesium in preparation for welding.

   b) The main function of a flux while welding magnesium.

   c) The types of gases to use when gas welding magnesium.

   d) The use of butt joints when gas-welding magnesium.

   Written examination required.

2. Solder Stainless Steel (Level 1)

   a) The use of silver soldering as a method of bonding metals.

   b) The preparation of stainless steel for soldering.

   c) The methods of cleaning material after soldering.

   Written examination required.

3. Fabricate tubular structures (Level 1)

   a) The types of tubing splices.

   b) The proper welding sequence to use when welding - fuselage tubes.

   c) The characteristics of a welded tubing joint.

   d) The protection of the interior of tubular steel that is to be closed by welding.

   e) The methods used to control distortion of steel tube structures during welding repairs.

   f) The preparation of tube ends for welding.

   Written examination required.

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4. Solder, braze, gas, and arc-weld steel (Level 2)

   a) Use cleaning operations to prepare sheet steel for welding.

   b) Adjust oxyacetylene welding torch to produce the type flame needed to weld a specified material.

   c) Select and use filler rod.

   d) The effect of excessive heat on metal.

   e) Operate a portable welding set.

   f) Select the correct size welding torch tip.

   g) The precautions regarding welding over a previously brazed or soldered joint.

   h) Solder a wire or cable to an electrical component.

   i) Sweat solder a lap joint.

   j) Normalize a steel part after welding.

   k) Identify steel parts considered to be repairable by welding.

   l) The preheating required prior to welding.

   Written examination required and practical project.

      1) Gas weld a steel tubular "T" joint.

      2) Weld a steel tube to a plate.

5. Weld aluminum and stainless steel. (Level 2)

   a) Use a filler rod when welding aluminum with oxyacetylene.

   b) Use flux when welding aluminum.

   c) The purpose and effect of using inert gas to shield the arc in certain types of welding.

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Written examination required and practical projects.

1) Butt weld two pieces of sheet aluminum using the inert gas method.

2) Butt weld two pieces of stainless steel using the inert gas method.

F. ASSEMBLY AND RIGGING (10th, 12th Year and RT)

1. Rig rotary-wing aircraft (Level 1)

a) The condition of flight that a properly rigged aircraft should maintain.

b) The relationship of thrust and drag of an aircraft during level unaccelerating flight.

c) The relationship of lift and weight of an aircraft during level unaccelerating flight.

d) The meaning of the term "angle of attack" of an airfoil.

e) The type of control movement used to induce forward flight in a helicopter.

f) The method of controlling vertical flight of a helicopter.

g) The movement of an aircraft about its axes during normal flight maneuvers.

h) The factors affecting stability of an aircraft abouts its axes.

i) The methods of maintaining directional control of a helicopter.

j) The cause and effect of rotor blade stall in helicopters operating at high speeds.

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k) The cause of vertical vibration in a two-blade helicopter rotor system.

l) The preparations required prior to rigging.

m) The method of tracking helicopter main rotor blades.

Written examination required.

2. Rig fixed-wing aircraft (Level 2)

a) The condition of flight that a properly rigged aircraft should maintain.

b) The factors to consider when rigging vertical stabilizer of single-engine, propeller-driven aircraft.

c) The relationship of thrust and drag of an aircraft during level unaccelerating flight.

d) The effect of incorrect wing incidence angle.

e) The effect of dihedral on aircraft stability.

f) Use wing "wash-in" and "wash-out" to correct aircraft rigging.

g) The relationship of lift and weight of an aircraft during level unaccelerating flight.

h) The meaning of the term "angle of attack" of an airfoil.

i) The effect of flaps on aircraft landing speed and approach angle.

j) The meaning of the term "incidence angle" of an airfoil.

k) The movement of an aircraft about its axes during normal flight maneuvers.

l) The relationship between the center of pressure of a wing and its angle of attack.

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m) The factors affecting stability of an aircraft about its axes.

n) The usual location of aircraft c.g. in relationship to center of lift.

o) The changes in lift and drag of the wings when an aircraft is rolled about its longitudinal axis.

p) The procedure for establishing wing angle of incidence prior to repairing wing attachment fittings.

Written examination required and the practical projects.

1) Level aircraft laterally and longitudinally.

2) Assemble and rig a high wing strut braced monoplane.

3. Check alignment of structures (Level 2)

a) Prepare fuselage for alignment check.

b) Check alignment of internally braced wing structure.

c) The significance and method of expressing reference positions.

d) Check alignment of assembled aircraft.

Written examination required and the practical projects.

1) Check the alignment of an internally braced wing.

2) Check the alignment of a tubular fuselage.

3) Check the alignment of a semi-monocoque fuselage.

4. Assemble Aircraft (Level 3)

a) The methods of safetying aircraft screws, bolts and nuts.

b) Assemble, adjust and safety cable turnbuckles.

c) The correct method of inserting bolts in aircraft fittings.

d) Install and inspect swaged cable terminals and fittings.

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Written examination required and the practical projects are:

1) Install attaching hardware on a control surface installation.

2) Make up a control cable using swaged terminals.

3) Install and safety an aircraft control cable.

5. Balance and rig movable surfaces (Level 3)

a) The inspection requirements for cable-operated primary flight control systems.

b) Handle and make up control cables.

c) The corrosion protection requirements of control cables.

d) The effect of overtightening control cables.

e) The relationship between specified movements of the cockpit controls and the control surfaces.

f) The relationship between specified control movements during flight and the movement of the aircraft about its axes.

g) The movement of the controls, control surfaces, and the aircraft about its axes during normal flight maneuvers.

h) Balance control surfaces after repair.

i) The relationship between specified movements of the trim tab operating device and the trim tab.

j) Secure the cockpit flight controls in preparation for control surface rigging.

k) The effect of a worn pulley in a cable-operated control system.

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l) The means used to reduce or prevent control surface flutter.

m) The purpose and operation of control surface locks.

n) The purpose and operation of differential controls.

o) The purpose and applicability of fairleads in a cable operated control system.

p) Install and rig the cables in a flight control system.

q) Splice control cables using Nicopress sleeves.

r) The probable causes of control surface flutter.

s) The maintenance requirements of control surface trim tab systems.

t) The purpose of counterweights incorporated into the leading edges of some primary control surfaces.

u) The purpose and function of "spring tabs" and "servo tabs."

v) Measure control surface movement and adjust control stops.

w) The effect of temperature changes on control system cable tension.

x) Assemble, adjust, inspect and safety push-pull type flight control systems.

Written examination required and the practical projects.

1) Check, balance and install a cable operated aircraft control surface to manufacturer's specifications including trim tabs.

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2) Check, balance and install a push-pull tube operated aircraft control surface to manufacturer's specifications, including trim tabs.

3) Make up and splice aircraft control cable using Nicopress sleeves.

6. Jack aircraft (Level 3)

a) Determine maximum allowable jacking weight.

b) The use of correct capacity jacks.

c) Protect aircraft from damage during lifting and lowering operations.

d) Use ballast when jacking aircraft with engine removed.

e) The effects of wind when jacking aircraft.

Written examination required and the practical projects:

1) Jack an aircraft observing all necessary precautions for:

(a) rigging

(b) landing gear "swing" check.

G. Airframe Inspection (10th, 12th Year and RT)

1. Perform airframe conformity and airworthiness inspections (Level 3)

a) The maximum period of time an aircraft can be flown before an annual inspection is required.

b) Determine the condition of airframes, airframe systems, and components.

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c) The primary purpose of inspection.

d) The maximum time an aircraft that carries passengers for hire or is used in flight instruction can be flown before being inspected.

e) Determine that an aircraft is in conformity with FAA Specifications.

f) Determine that applicable Airworthiness Directives have been complied with.

g) Conduct a thorough and detailed inspection of an aircraft.

Written examination required and practical project.

1) A 100 hour inspection of the airframe in accordance with appropriate federal air regulations.

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III. AIRFRAME SYSTEMS AND COMPONENTS

A. Aircraft Landing Gear Systems (11th, 12th Year)

1. Inspect, check, service and repair landing gear, retraction systems, shock struts, brakes, wheels, tires, and steering systems (Level 3)

a) Determine aircraft tire inflation pressures.

b) The factors affecting the retreading of aircraft tires.

c) Adjust landing gear toe-in.

d) Install and remove aircraft wheel and brake assemblies.

e) Install tubes and tires.

f) Protect aircraft tires from hydraulic fluids.

g) Service brake boosters.

h) Service landing gear shock struts.

i) The effects of increasing temperature on "parked" brakes.

j) Determine the cause of an oleo strut bottoming during taxi operations.

k) The pressure source for actuating power brakes.

l) Select and install air valves in oleo shock struts.

m) Observe safety precautions when demounting tire and wheel assemblies.

n) Determine if a brake system requires bleeding; perform brake system bleeding.

o) Inspect and adjust multiple-disc brakes.

p) Install new linings in hydraulically operated single-disc brakes.

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q) Determine the cause of spongy brake action.

r) Inspect and service aircraft tires and tubes.

s) Determine the reason for "dragging" brakes.

t) The method of equalizing braking pressure on both sides of the rotating disc of a single-disc brake.

u) Operate and check retractable landing gear.

v) Determine the cause of fading brakes.

w) Replace actuating cylinders.

x) Install brake blocks in an expander-tube brake assembly.

y) Inspect brake drums.

z) The purpose and function of metering pins in oleo shock struts.

aa) Determine the cause of excessive brake pedal travel.

bb) The operating principles of oleo shock struts during landing.

cc) The storage requirements for aircraft tires and tubes.

dd) The effect of a broken return spring in a brake master cylinder.

ee) Determine the cause of grabbing brakes.

ff) The purpose and operation of a debooster in a hydraulic power brake system.

gg) Detect internal leakage in a brake master cylinder.

hh) The operating principles of servo, expander-tube, multiple-disc, and single disc aircraft brakes.

ii) The purpose and operating principles of brake master cylinders.

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Written examination required and practical project.

1) A complete brake system overhaul, installed on aircraft.

2) Perform a tire change and service.

3) A landing gear retraction check, including system inspection and adjustment.

4) Overhaul and service an oleo shock strut assembly.

5) Check and service a power brake system in accordance with manufacturer's specifications.

B. HYDRAULIC AND PNEUMATIC POWER SYSTEMS (11th, 12th Year and RT)

1. Repair hydraulic and pneumatic power system components (Level 2)

a) Install packing seals and rings on hydraulic components.

b) Determine the correct seal type to use with ester-base, petroleum-base and vegetable base fluids.

c) Remove and install hydraulic selector valves.

d) Remove and install a spool-type or balanced-type pressure regulator.

e) Determine the cause of excessive oil in an aircraft pneumatic system.

f) The operating principles of a pneumatic power system multi-stage reciprocating compressor.

g) Identify hydraulic seals and packing.

h) Protect packing rings or seals against thread damage during installation.

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A written test is required. The practical projects are:

1) Remove, disassemble, inspect and reassemble various types of hydraulic units and reinstall in system.

2. Identify and select hydraulic fluids (Level 3)

a) Determine the fluid type for use in a specified aircraft hydraulic system.

b) The method of measuring the viscosity of a liquid.

c) Identify ester-base, petroleum-base, and vegetable-base fluids.

A written test is required. The practical project is:

1) Service aircraft hydraulic system with fluid in accordance with maintenance manual.(Students will identify the type of fluid used on a specific aircraft or mock up)

3. Inspect, check, service, trouble shoot and repair hydraulic and pneumatic power systems (Level 3)

a) Determine the air pressure in a hydraulic accumulator.

b) The location and use of quick-disconnect fittings in hydraulic and pneumatic systems.

c) The mounting position of diaphragm and bladder type hydraulic accumulators.

d) Service hydraulic reservoirs.

e) Determine the causes of incorrect system pressure.

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f) Service porous paper and micronic filter elements.

g) Adjust the pressure setting of the main system relief valve.

h) Purge air from the hydraulic system.

i) The term used to indicate force per unit area.

j) Identify the types of hydraulic power systems.

k) The purpose, location, and operation of a hydraulic fuse.

l) Protect a hydraulic system against contamination during a component replacement.

m) Inspect a hydraulic system for water and metal contamination.

n) Service a pneumatic system moisture separator.

o) The purpose, location and operation of an orifice check valve in the wing flap actuating system.

p) The purpose, location, and operation of a wing flap overload valve.

q) The purpose, location, and operation of a hydraulic system pressure regulator.

r) The purpose, location and operation of a sequence valve.

s) The purpose, location and operation of a cross flow valve.

t) The purpose, location and operation of a hydraulic system accumulator.

u) The purpose, location and operation of a shuttle valve.

v) The purpose, location and operation of a check valve.

w) Install and remove hydraulic engine driven pumps.

x) The indications of a worn or damaged hydraulic pump shaft.

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y) The operating principles of hydraulic hand pumps.

z) The cause of hydraulic pump chatter during operation.

aa) The operating principles of a constant displacement hydraulic pump.

bb) The operating principles of a variable displacement hydraulic pump.

cc) The purpose of the shear section on the shaft of an engine-driven hydraulic power pump.

dd) The purpose and operation of a hydraulic actuating cylinder.

ee) Determine the cause if a constant pressure hydraulic system with no external leakage will not hold pressure when the power pump is not operating.

ff) Determine the cause if an engine driven power pump will not maintain system pressure during the actuation of a unit in the system.

gg) The general features and operating principles of aircraft pneumatic power systems.

hh) The purpose of pressurized reservoirs in some hydraulic systems.

ii) The purpose and location of a stand pipe in some hydraulic systems.

jj) The cause of too frequent cycling of a constant-pressure hydraulic system.

kk) Operate and check a hydraulically operated flap system.

ll) The operating mechanism of most hydraulic pressure gauges.

mm) The indications of a low fluid supply during system operation.

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A written test is required. The practical projects are:

1) Connect a hydraulic A.P.U. to the aircraft hydraulic system. Check operation.
2) Adjust hydraulic system pressures on a constant pressure type system.
3) Adjust hydraulic system pressures on an open center hydraulic system.
4) Install and service hydraulic system accumulators.
5) Trouble shoot a malfunction in a hydraulic system or component.
6) Inspect and service hydraulic filters and reservoirs.
7) Install and remove various hydraulic system components such as engine driven pumps, hand pumps, actuators, check valves, filters, selector valves and pressure gauges.

C. CABIN ATMOSPHERE CONTROL SYSTEMS (12th Year and RT)

1. Repair heating, cooling, air-conditioning, pressurization, and oxygen system components (Level 1)
   a) The usual reasons a surface combustion heater fails to operate.
   b) The effects of cracks or holes in an exhaust-type heat exchanger.
   c) The usual sources of contamination of a freon system.
   d) The method of protecting a freon system from contamination during replacement of a component.

Written examination required.

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2. Inspect, check, troubleshoot, service, and repair heating, cooling, air conditioning, and pressurization systems. (Level 1)

   a) The operating principles of a thermostatically controlled surface combustion heater.

   b) The methods used to control cabin pressure of a pressurized aircraft.

   c) The protective features included in the control circuits of surface combustion heaters.

   d) The purpose and operation of check valves in the delivery air ducts of a pressurization system.

   e) The basic principles of providing and controlling aircraft pressurization.

   f) The inspection requirements of cabin heating systems that utilize and exhaust heat exchanger as a source of heated air.

   g) The method of checking a combustion heater fuel system for leaks.

   h) The function of the condenser in a freon cooling system.

   i) The function of the evaporator in a freon cooling system.

   j) The function of an expansion valve in a freon cooling system.

   k) The location, in relationship to each other, of the units in a freon cooling system.

   l) The method of determining the liquid level in a vapor-cycle cooling system.

   m) The procedure for servicing a vapor-cycle air conditioning system that has lost all its freon charge.

   n) The basic operating principles of an air-cycle cooling system.

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o) The function of a jet pump in a pressurization and air-conditioning system.

p) The function of a mixing valve in an air-conditioning system.

q) The function of the negative pressure relief valve in a pressurization system.

r) The function of the outflow valve in a pressurization system.

s) The function and principles of operation of an automatic cabin rate-of-climb control system.

Written examination required.

3. Inspect, check, troubleshoot, service and repair oxygen systems (Level 2)

a) Check oxygen system for leakage.

b) Service oxygen system with breathing oxygen.

c) Inspect a breathing oxygen system for contamination.

Written examination required and the practical project:

1) Check an oxygen system for leakage and service the system.

D. AIRCRAFT INSTRUMENT SYSTEMS (12th Year, RT)

1. Install instruments (Level 1)

a) The installation and connection of shock-mounted vacuum instruments to their power system.

b) The types of hardware used to install instruments.

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c) The application of operation markings to the glass face of an aircraft instrument.

d) The protection of instruments during handling.

e) The installation practices necessary to prevent damaging an instrument.

f) The installation practices used in making hose or tubing connections to the instruments.

Written test required.

2. Inspect, check, service, troubleshoot, and repair heading, speed, altitude, time, attitude, temperature, pressure and position indicating systems. (Level 1)

a) The procedure for "swinging" an aircraft magnetic compass.

b) The methods used to test a static air system for leakage.

c) The significance of various types of marks on the face of an instrument.

d) The operating principles of a thermo-couple temperature-indicating circuit.

e) The service requirements of instrument system filters.

f) The effect of a ruptured or disconnected static pressure line located inside a pressurized cabin.

A written test required.

School _____ Date _____

Principal _____

E. COMMUNICATION AND NAVIGATION SYSTEMS (12th Year and RT)

1. Inspect, check and service auto pilot and approach control systems (Level 1)

   a) The operating principles of the sensing device used in an autopilot system.

   b) The purpose and operation of the autopilot.

   c) The purpose of a servomotor in an autopilot system.

   d) The installation requirements for autopilot units.

   e) The function of a position transmitter in an autopilot system.

   Written examination required.

2. Inspect, check, and service aircraft electronic communication and navigation systems. (Level 1)

   a) The FCC regulations pertaining to the operation of two-way radio.

   b) The principal conditions which must be considered in the installation of radio.

   c) The protection of radio equipment from shock and vibration.

   d) The methods of reducing engine noise in radio receivers.

   Written examination required.

3. Inspect and repair antenna and electronic equipment installations (Level 2)

   a) The preferred location and methods of mounting external antennas.

   b) The procedure for returning an aircraft to service after a radio installation has been made in accordance with approved installation data.

_____ School _____ Date

_____ Principal

c) The preferred location for the VOR localizer receiver antenna on a small aircraft.

Written examination required and the practical projects.

1) Install a LF antenna on aircraft.

2) Install a VHF antenna to mast.

3) Inspect the installation of radio equipment and racks in aircraft for conformance with approved installation data.

F. AIRCRAFT FUEL SYSTEMS (12th Year, RT)

1. Check and service fuel dump systems (Level 1)

a) The reasons for requiring fuel dump systems.

b) The methods used to control the operation of fuel dump chutes and valves.

c) The principal safety requirements for a fuel dump system.

d) The purpose of jettison pumps in fuel dump systems.

Written test required.

2. Perform fuel management, transfer, and defueling (Level 1)

a) The precautions required when defueling an aircraft.

b) The tank-to-engine combinations possible with a crossfeed system.

School Date

Principal

c) The method of maintaining C.G. limits using fuel transfer technique.

d) The arrangement of fuel system controls, indicators, and warning lights.

Written test required.

3. Inspect, check, and repair pressure fueling systems (Level 1)

a) The method of controlling fuel level during pressure fueling operations.

b) The methods used to operate fueling valves.

c) The protection of inegral tanks against overpressure during pressure fueling operations.

d) The arrangement of fueling system controls, indicators, and warning lights.

e) The precautions required when fueling an aircraft.

f) The purpose and operation of pilot valves.

Written test required.

4. Repair aircraft fuel system components (Level 2)

a) Repair and seal fuel tanks.

b) Pressure test fuel tanks.

c) Remove and clean fuel strainers.

d) The precautions to follow when routing fuel lines.

e) The method of regulating fuel system pressure.

Written test required. Practical project included in Item 7.

School _____ Date _____

Principal _____

5. Inspect and repair fluid quantity indicating systems (Level 2)

   a) The methods used to determine the level of fluid in a tank.

   b) The purpose of remote-reading electrical gauges.

   c) Calibrate liquidometer-type fluid quantity indicating systems.

   d) The effect of aircraft attitude on fluid level measuring devices.

   Written test required. Practical project included in Item 7.

6. Troubleshoot, service, and repair fluid pressure and temperature warming systems (Level 2)

   a) Determine and adjust the pressure or temperature at which warning systems operate.

   b) Determine the cause of incorrect warning system indications and make corrections.

   Written test required. The practical projects are:

   1) Correct malfunction in fuel pressure warning system.

7. Inspect, check, service, trouble shoot, and repair aircraft fuel systems (Level 3)

   a) The fuel system inspection requirements for aircraft operating in areas of high humidity or wide temperature ranges.

   b) The design and installation requirements for aircraft fuel tanks.

   c) The maintenance requirements of fuel tank sumps.

   d) The marking requirements for fuel filler openings.

School Date

Principal

e) The purpose of potassium dichromate in a fuel system.

f) The reason for using booster pumps with engine-driven pumps.

g) The purpose of baffle plates in fuel tanks.

h) The installation and operation requirements of fuel valves.

i) The venting requirements of interconnected fuel tanks.

A written test is required. The practical projects are:

1) Repair and check fuel tank strainers.

2) Install a fuel pump, pressure check fuel lines and adjust pressure.

3) Check and service fuel quantity indicators installed in aircraft, in accordance with maintenance manual.

4) Perform a daily inspection of a fuel system.

5) Replace and check firewall shut-off valve, selector values, linkages and handles.

6) Install and check a fuel booster pump.

7) Check, service and trouble shoot a fuel tank vent system.

8) Service aircraft fuel system with proper grade of fuel.

G. AIRCRAFT ELECTRICAL SYSTEMS (10th, 11th, 12th Year and RT)

1. Repair aircraft electrical system components (Level 2)

a) Use a "growler" in generator and motor armature inspection and repair.

b) Check the condition of shunt and compound generator field circuits.

School

Principal

c) Locate and use overhaul information for electrical equipment.

d) The procedures for correcting generator brush arcing.

e) Dress or turn the commutator surface of a motor or generator armature.

f) Flash a generator field.

g) The effect of changes in speed and load on generator output.

h) The function of a commutator in a direct current electric motor.

i) Seat new or replacement generator brushes.

j) The effect of incorrect generator brush spring tension on generator operation.

k) The methods of reducing armature reaction in aircraft generators.

l) The operating principles of carbon-pile voltage regulations.

m) The design factors that determine the number of cycles-per-revolution an alternating current generator will produce.

n) Determine the speed (r.p.m.) of an electric motor.

o) The basic principles of generators.

p) The factors that affect the torque produced by an electric motor.

q) The methods used to protect armature shafts from overloads.

r) The speed and load characteristics of series-, compound-, and shunt-wound motors.

s) The means employed to control current and voltage output of aircraft generators.

t) The methods used to control output frequency and voltage of alternating current generators.

School Date

Principal

u) The general operating characteristics of vibrator-type current and voltage regulators.

v) The purpose and operation of reverse-current cutout relays in generator control circuits.

w) The basic internal electrical circuits of series-, compound-, and shunt-wound generators.

x) The operating principles of magnetic clutches and brakes commonly used with electric motors.

y) The purpose and operation of reversible electric motors.

Written examination required and the practical projects:

1) Disassemble, inspect, repair as necessary, assemble and test an aircraft D.C. generator.

2) Service a D.C. generator regulating system.

3) Disassemble, inspect, repair as necessary, assemble and test an aircraft D.C. motor which incorporates a "brake" system.

2. Install, check, and service airframe electrical wiring, controls, switches, indicators, and protective devices (Level 3)

a) The purpose, applicability, and operation of electrical fuses and circuit breakers.

b) The types and operation of electrical switches.

c) Install and wire electrical switches.

d) Splice wiring in aircraft electrical systems.

e) The characteristics of high tension and low tension electrical wiring.

School

Principal

f) The purpose, applicability, and use of electrical wiring terminal strips.

g) The criteria for selecting aluminum and copper electrical cables.

h) Replace terminals on aircraft aluminum and copper electrical cables.

i) Determine the current-carrying capacity of an electrical circuit.

j) The installation and maintenance of open wiring electrical systems.

k) Install electrical wiring in conduits.

l) The method of protecting electrically operated emergency systems from accidental actuation.

m) The strength requirements for electrical cable terminals.

n) Select and install electrical bonding jumpers.

o) The installation requirements for electrical junction boxes.

p) The characteristics of single-wire electrical systems.

q) The special requirements an electrical bonding jumper must meet if it is required to carry a ground load for a unit of electrical equipment.

r) The purpose of shielding electrical wiring and equipment.

s) The use of quick-disconnect electrical plugs and sockets.

t) The purpose of static wicks or dischargers.

u) The American Wire Gage (A.W.G.) system of designating electrical wire sizes.

_____ School _____ Date

_____ Principal

Written examination required and the practical projects:

1) Install a single-wire navigation light system.

2) Install a two-wire aircraft landing light system.

3) Install electrical wiring in a conduit and junction box using a quick disconnect plug.

4) Set the limit switches that control the position or limits of motion of electrically operated flaps, landing gear retraction, or similar systems.

5) Inspect and test bonding system connections with ohmmeter including static wicks.

3. Inspect, check, troubleshoot, service and repair alternating current and direct current electrical systems (Level 3)

   a) The results of short or open circuits in a generator control circuit.

   b) The effect of sticking points in a reverse-current cutout relay.

   c) The cause and effect of solenoid switch chatter.

   d) The installation and circuit requirements for anticollision light systems.

   e) The installation and circuit requirements for position lights.

   f) The method of providing direct current for battery charging on aircraft that operate only alternating current generators.

   g) The common methods of controlling output current and voltage of compound direct current generators.

   h) The operating principles and characteristics of inverters.

School _____ Date _____

Principal _____

i) Determine the output frequency of an alternating current generator.

j) The operating principles and characteristics of rectifiers.

k) The method of providing alternating current in aircraft that operate only direct current generators.

l) The electrical device usually used to convert alternating current to a lower or higher voltage without a change in frequency.

m) The operating principles and characteristics of electrical induction coils.

n) The operating principles and characteristics of transformers.

o) The advantages of using alternating current in aircraft.

Written examination required and the practical projects:

1) Locate and correct a malfunction in a D.C. electrical system.

2) Locate and correct a malfunction in an A.C. electrical system.

3) Check reverse current relay settings.

4) Check and correct malfunction in a battery charging system.

5) Check the output of generator-operated electrical system.

School _____ Date _____

Principal _____

H. POSITION AND WARNING SYSTEMS (11th, 12th Year and RT)

1. Inspect, check and service speed and take off warning systems, electrical brake controls and antiskid systems (Level 1)

   a) The general requirements for installing skid detectors.

   b) The operating principles of hydraulic brake antiskid systems.

   A written test is required.

2. Inspect, check, trouble shoot, service and repair landing gear position indicating and warning system (Level 3)

   a) Determine the cause of a gear unsafe warning signal.

   b) The effect of various electrical faults in the operation of the landing gear warning system.

   A written test is required. The practical projects are:

   1) Locate defective micro switch in landing gear position indicating system.

   2) Correct inoperative warning horn in gear position indicating system.

I. ICE AND RAIN CONTROL SYSTEMS (12th Year and RT)

1. Inspect, check troubleshoot, service, and repair airframe ice and rain control systems (Level 2)

   a) Install deicer boots.

   b) The operating principles of anti-icing systems that utilize heated air in the leading edges of airfoils and intake ducts.

School _____ Date _____

Principal _____

c) The operating principles of electrically operated anti-icing systems.

d) Protect de-icer boots from deterioration.

A written test is required. Practical projects:

1) Check pilot tube heater.

2) Check the installation and operation of installed de-icer boots.

3) Inspect and service the air/oil separator in a vacuum system.

J. FIRE PROTECTION SYSTEMS (12th Year and RT)

1. Inspect, check and service smoke and carbon monoxide detection systems (Level 1)

a) The operating principles of smoke and carbon monoxide detection systems.

A written test is required.

2. Inspect, check, service, trouble shoot, and repair aircraft fire detection and extinguishing systems (Level 3)

a) The type of fire extinguishing agent most suitable for use with electrical fires.

b) The fire extinguishing agent normally used with built-in aircraft fire extinguishing systems.

c) Check fire extinguisher container pressure.

d) Check continuity and resistance of the electrical circuit.

School Date

Principal

e) Determine the cause for the system failing function.

f) Check fire warning sensors or detectors for open or short circuits.

A written test is required. The practical projects are:

1) Locate and replace a defective thermal sensor.

2) Check quantity of fire extinguishing agent available in the system.

3) Make operational check of circuits used to actuate a built-in fire extinguishing system.

School Date

Principal

AIRFRAME MAINTENANCE TECHNICIAN INSTRUCTIONAL FACILITIES

The following is a brief description of the airframe facilities.

All shops are equipped with suitable arrangements for the storing of materials, tools, and equipment. Suitable and separate space is provided for wash tanks, de greasing, air pressure and other cleaning equipment. In addition, other specialized equipment applicable to the subject being taught is provided. All of the facilities are properly heated, lighted, and ventilated.

10TH YEAR

COMPOSITE AIRFRAME SHOPS

Room 510	Square Feet of Space	1620
610		1620
611		1620
615		521
613		800

BASIC ELECTRICAL SHOPS

608	Square Feet of Space	1620
612		1620
	Total Square Feet of Space Composite Airframe and Electrical Shops	9421

School _____ Date _____

Principal _____

SHEET METAL SHOPS

Room 208	Square Feet of Space	1620
210		1620
212		1620
308		1620
Total Square Feet of Space Sheet Metal Shops		6480

AVIATION MACHINE SHOPS

Room 311	Square Feet of Space	1620
315		1620
313		600
Total Square Feet of Space Aviation Machine Shops		3840

11TH YEAR

WELDING SHOPS

Room 511	Square Feet of Space	1620
515		1620
Total Square Feet Welding Shops		3240

ELECTRICAL SHOPS

Room 211	Square Feet of Space	1620
215		1620
Total Square Feet Electrical Shops		3240

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School _____ Date _____

Principal _____

HYDRAULIC SHOPS

Room 110	Square feet of space	1620
112		1620
Total Square Feet Hydraulic Shops		3240

12TH YEAR

Room 104	Square feet of space	1620
310		1620
		3240
Room B-2	Hangar Square Feet	15000
Hangar Apron		15000
Total for A.M. Curriculum		62701

Mechanical Drawing, Science Laboratory and Related Technology

Room 634	Square feet of space	1400
636		1400
638		1400
534		1400
536		1400
538		1400
10 Related Technology Class Rooms Separate enclosed rooms other than Shop 1400 square feet each		14000
	Total square feet	32400

SCHOOL

PRINCIPAL.

MATERIAL, TOOLS AND SHOP EQUIPMENT.

SUMMARY OF SHOP EQUIPMENT AND LOCATION

EQUIPMENT	570	610	611	615	613	608	612	208	210	212	308	311	315	313	511	515	211	215	110	112	310	104	[illegible]
DRILL PRESSES	3	3	3	3		3	3	4	4	4	4	3	3	2	3	3	1	1	1	1	4		3
BELT SANDER	1	1	1	1		1	1	1	1	1	1										1		1
DISC SANDER																							1
JOINTER	1	1	1	1		1	1																
JIG SAW	1	1	1	1		1	1																
BAND SAW CONTOUR	1	1	1	1		1	1	1	1	1	1										1		1
RADIAL SAW	1	1	1	1		1	1																1
BENDING SHEARS	1	1	1	1		1	1	1	1	1	1										1		1
GRINDERS, PEDESTAL	1	1	1	1		1	1	1	1	1	1	1	1	1							1		2
BENCH SHEARS	1	1	1	1		1	1	1	1	1	1				1	1					1		1
HYDRAULIC PRESS								1	1	1	1										1		1
SINKING SHEARS	1	1	1	1		1	1																1
FABRIC TESTER		1																					2
MOISTURE METER		1																					
CASCADE SPRAY BOOTH				1																			
LUMBER RACKS					2																		
SETTIFIER						1	1										1	1				1	4
PORTABLE STORAGE CABINET	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
JIGSAW SAW	1	1	1	1																			1
SHINGLING HAMMER								1	1	1	1												1

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121 OF 327

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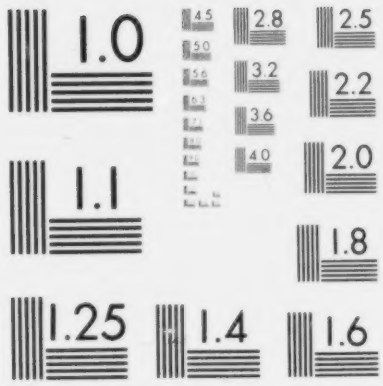

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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ENGINE STANDS																							3
TAIL STANDS																							1
VACUUM CLEANERS																							1
PORTABLE PAINT SPRAY EQUIPMENT. 1																							1
ELECTRONIC SCALES																							16
MECHANICAL SCALES																							4
SHIPPING SCALE.																							1
POSTAL SCALE																							1
D.C. HARNESS TEST.																							2
CABLE SWAGING EQUIPT.																							2
PRESS. LUBE EQUIPMENT																							1
SPARK PLUG CLEANER																							1
SCOBB COMPRESSION TESTER																							1
FIRST AID TRIPOD																							1
RIVETING EQUIPMENT																							20
PORTABLE MAGNAFLUX EQUIPT.																							1
HYDRO EQUIPMENT																							1
ZYC PENETRANT EQUIPT.																							1
PORTABLE TENSIONMETERS																							10
PRECISION MEASURING TOOLS																							x
D.C. FIELD TEST UNIT																							1
PRECISION ELEC'L TESTERS						4	4	4										4	4		4	4	
REFRIGERATOR								1	1	1	1												
BOWLER																		1	1		1	1	
5T DIMPLE MACHINE								1	1	1	1												
OAK BENCHES (WOOD)	12	12	12			12	12																
STEEL BENCH MACHINIST								12	12	12	12	12	12	2						12	12	12	
PORTABLE CABINET.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	12	

School _____ Date _____

Principal _____

INSTRUCTIONAL EQUIPMENT

The Airframe curriculum provides the following instructional equipment consisting of training aids, visual aids, and mock-ups appropriate to the course.

1. Hydraulic Training Aids:
   a) Aileron boost systems.
   b) Landing gear actuating system.
   c) Various types of brake systems.
   d) Open and closed center systems.

2. Electrical Mock-ups
   a) D.C. generator and generator control systems.
   b) A.C alternator system.
   c) Junction mock-up.
   d) F-84 electrical system mock-up.

3. Various types of wing sections, fuselages, control surfaces and tab systems.

4. Aircraft (complete)
   a) 7 North American (SNJ-AT6)
   b) 1 Sikorsky S-51 Helicoptor
   c) 1 Stearman (Boeing PT-17)
   d) 2 Beechcraft (D-18, CAS)
   e) 1 Lockheed (T-33, TV-2)
   f) 1 Aeronca (K)

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_____ Principal

9. Teachers

There will be at least one teacher for 25 students in each shop or laboratory. The teachers of shop subjects will hold the appropriate mechanic certificates and ratings issued by the F.A.A.

Specialized teachers, who are not certificated mechanics, can be used to teach mathematics, science and mechanical drawing as called for in the new curriculums.

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ABSTRACT - Developed by drafting instructors in the Milwaukee Public Schools in cooperation with a curriculum advisory committee, this curriculum supplement is a collection of individual resource units including bibliographies for use in junior high and high schools. The publication, designed to assist instructors of drafting, presents current industrial practices which include: (1) Levels of Drafting Occupations, (2) Kinds of Drafting Activities, (3) Standards, (4) Documentation, (5) Engineering Drawing Changes, (6) Dimensioning, (7) Drawing Media, and (8) Microfilming. For the convenience of instructors who might experience difficulty in securing prints from industry, various industrial prints are appended. (LM)

VT 012 748

EDO 56238

AN INSTRUCTIONAL RESOURCE FOR STAFF

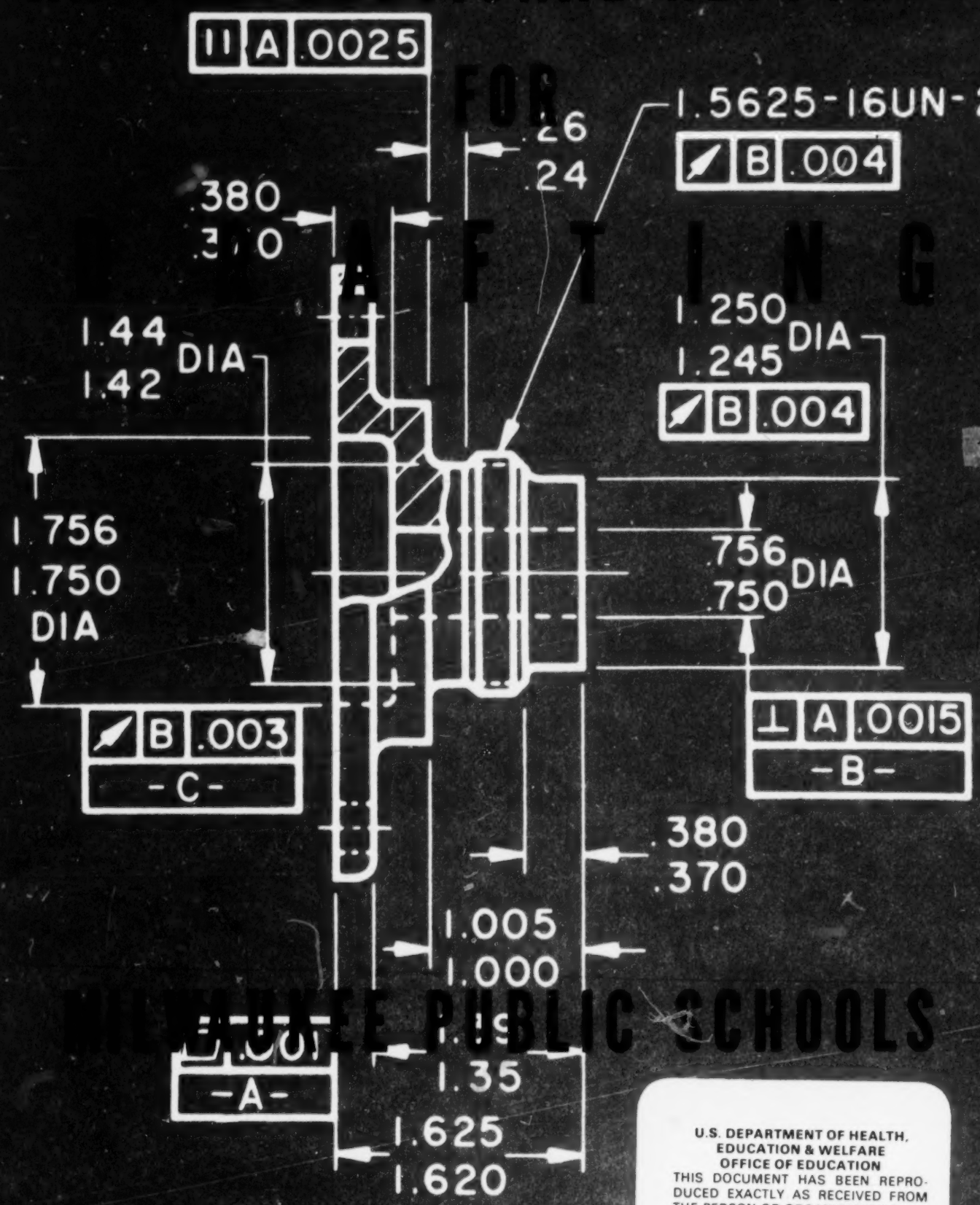

MILWAUKEE PUBLIC SCHOOLS

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VT012703

D R A F T I N G

(INSTRUCTIONAL SUPPLEMENT)

Department of Elementary and Secondary Education

Division of Curriculum and Instruction

Milwaukee Public Schools

1969

8350

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The material covered in this publication has been selected in cooperation with the Curriculum Advisory Committee for Drafting, and the content of this and other identified resources has been developed with their assistance.

The writing has been accomplished as a joint effort by Agner Andersen, Gerald DeLeeuw, Rowland Morrison, and Donald Strube--all of whom are instructors of drafting in the Milwaukee Public Schools.

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INTRODUCTION

This material has been developed in an effort to assist instructors of drafting within the Milwaukee Public Schools in areas of current drafting-room practice for which their individual backgrounds and/or coverage in texts is inadequate to provide for meaningful instruction. This is a supplement to the existing curriculum guide and is not intended for student use. Since this is not intended as a text, but rather as a series of individual resource units in one binding, individual bibliographies are incorporated as a part of each unit rather than as a part of the total publication.

Current industrial practice is presented in a concise, authoritative way. At the same time, attention is called to as many resource materials as can be identified in each subject area which will, in turn, facilitate the development of an expanded resource library.

Proficiency in all of these areas is not necessarily the objective. In many cases, no more is desired than a sense of awareness that a given activity is currently being used in industry.

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LEVELS OF DRAFTING OCCUPATIONS

Every industry has its own set of job titles, and each individual industry may assign different activities to persons holding the same or similar titles. In view of these facts, it is not possible to set forth a firm list of job titles or the kinds of activities in which persons having a particular responsibility are engaged. The descriptions outlined below are no more than examples of what might be. Individual instructors are encouraged to invite resource persons from several industries into their classes to discuss the table of organization, job description, employment requisites, etc., typical of their companies.

The Draftsman Trainee

The trainee works under the close guidance and direction of other draftsmen or supervisory personnel. His assignments are selected and varied according to individual competence so as to develop his skills in the acquisition and application of drafting techniques.

The trainee acquires basic knowledge and skill through assignments in a short, formalized training program and/or by working directly on assignments in a specific department. He learns and applies fundamentals of drafting under immediate supervision. Included are dimensioning, development of detailed views, cross-sections of major units, and preparation of tables and production drawings. The major portion of a trainee's time is spent effecting changes on existing documents, as this permits him to adapt to company standards and familiarizes him with the product.

Qualifications for training programs usually specify a high school diploma or its equivalent, with specialization in drafting, mathematics, and science.

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The Draftsman

Work as a detailer may be the first opportunity a draftsman has to make decisions relative to design. His primary function is to prepare detail drawings for manufacture. This would include:

- -- Preparing parts drawings
- -- Working from layout drawings
- -- Working from explicit instructions by engineer or layout draftsmen
- -- Revising drawings - bills of material
- -- Incorporating revisions of design
- -- Preparing bills of material

The draftsman utilizes the best practical language for communicating an engineer's, designer's, or architect's ideas to the workmen who, in turn, transform them into reality. His work requires skill in applying drafting techniques along with a practical knowledge of engineering and production procedures.

The Layout Draftsman

The layout draftsman proves out the product design on drawings using prior layouts, sketches, models, and verbal instructions. As a layout draftsman, he also supervises and aids detail draftsmen and works with designers on new and special products.

The Designer or Senior Draftsman

The designer or senior draftsman typifies the peak of the producing draftsman. Not only does he use skills acquired over the years and contribute to the design of the finished product, but he exercises personal leadership in directing those working under him.

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Checkers

Checkers are experienced draftsmen who verify and examine all finished drawings to insure accuracy, completeness, and manufacturing efficiency. They must certify the correctness of documents before they may be released. To qualify, checkers must:

-- Be familiar with manufacturing practices in the industry

-- Be well trained in drafting and manufacturing standards

-- Have experience similar to that required for senior draftsmen or designers

-- Be able to suggest modifications to correct errors in design and recommend changes which will facilitate production

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KINDS OF DRAFTING ACTIVITIES

Engineering Drafting

Engineering is an applied science involving the complete and accurate communication of physical facts. Quantitative relationships may be expressed mathematically, while the written word completes many descriptions. But whenever machines and structures are designed, described, and built, graphic representation is necessary. Although the works of artists (or photography and other methods of reproduction) provide pictorial representation, they cannot serve as engineering descriptions.

Engineering drawings express pure engineering intent but do not show how manufacturing is to be accomplished. Shaded pictorial drawings and photographs are used for special purposes, but the great bulk of engineering drawings are made in line only, with separate views arranged in a logical system of projection. Drawings which specify operations and other directions for manufacture are process drawings and are often produced in a production engineering department. This is the language of engineering drawing, which can be defined as the graphic representation of physical objects and relationships.

Electrical Drafting

Drawings for electrical machines, details, fixtures, apparatus, and related construction are based upon the same basic principles of orthographic projection and dimensioning as for all other drafting. However, electrical and electronic drafting has to do with drawings which show circuits or wiring diagrams. These circuits must be planned by the electrical design engineer. Sketches form an important part of the design studies from which draftsmen work.

Various types of diagrams and a great number of graphic symbols are used to show the different parts or components of a system--where they are located and how they are connected to serve the required purpose.

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Electrical drafting requires a basic knowledge and understanding of circuitry in addition to the ability to make drawings. Therefore, one should seek to learn about circuitry and how it behaves as well as about the materials, tools, and processes used in electrical work.

Architectural Drafting

The general principles of drawing are the same for all kinds of technical work. However, architectural drawings usually reveal a more spontaneous approach to drawing problems than that shown in other fields of engineering. The preparation of preliminary studies, presentation drawings, building models, and architectural working drawings requires various techniques and drawing skills. Thus, an architect--even more than his fellow engineers--must be able to draw both freehand and with instruments, using all the materials and techniques at a draftsman's disposal.

The combined art and science of building structures, especially the art of building houses, churches, bridges, and the like, is properly placed (professionally) between engineering and the fine arts. Architectural designing is that phase of architecture based primarily upon study of the fine arts, but architects must understand structural engineering requirements.

Structural Drafting

Structural drafting has to do with the drawings made for the framework and supporting members of structures such as columns, floor members, roof trusses, bridge trusses, and the great variety of construction work made from structural-steel shapes and plates. The design of structures requires a knowledge of the many subjects included in structural engineering, such as mathematics, stresses, mechanics, properties of materials, methods of fabricating, and methods of erection.

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Map Drafting

Maps are essentially one-view drawings of a part of the earth's surface. Some maps having to do with the ownership of property, such as city plats, must be extremely accurate--particularly as to data noted on the map. The scale is relatively large (50 to 200 feet to the inch). Geographic maps of states or countries which show boundary lines, streams, lakes, coastlines, and relative locations may use a scale of several miles to the inch.

These represent only a portion of the types of drawings. Many others are in common usage in industry and should be understood by the student of drafting. Included would be piping diagrams, interface control drawings, matched parts, inseparable assembly, and purchase part drawings. An excellent single source for definitions is MIL-STD-100A, as noted in the bibliography for this unit.

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TYPE AND LENGTH OF TRAINING PROGRAMS FOR DRAFTSMEN

(As Developed by Typical Milwaukee Companies)

Company	Type of Training
Allen-Bradley	Four-Year Apprenticeship
Bucyrus-Erie	Three-Year Apprenticeship
Chain Belt	Three-Year Apprenticeship
City of Milwaukee Civil Service Commission	Draftsman I - Two Years (Or less if able to pass promotional examination)
	Draftsman II - Two Years (Or less if able to pass promotional examination)
	Draftsman III
Cutler-Hammer	Trainee
Evinrude	Four-Year Apprenticeship
Falk	Three-Year Apprenticeship
Globe-Union	Three-Year-Apprenticeship
Harnischfeger	Two-Year Apprenticeship
Johnson Service	Three-Year Apprenticeship
Kearney and Trecker	Three-Year Apprenticeship
Ladish	Three-Year Apprenticeship

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770 South Adams
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Washington, D. C. 20402

DICTIONARY OF OCCUPATIONAL TITLES
MIL-STD-100A ENGINEERING DRAWING PRACTICES, Chapter 2

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STANDARDS

What are standards? Webster says they are ". . . established by authority or general consent; that which is proper and adequate for a given purpose."

Standards relate to people as well as things. Requirements for teacher certification are a form of standard, as are eligibility requirements for the athlete and graduation requirements for the student. Many technical jobs screen applicants by carefully-written job specifications. Standards define a product, process, or procedure with reference to nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing, and the service for which designed.

Standards serve the needs of designers and control variety. They cover materials, engineering practices, processes, codes, symbols, nomenclature, and include some phases of marketing. Inadequate standardization could result in complications in procurement and production, as well as in significantly greater costs. Today's standards become obsolete as old problems are solved, as new ones arise, and as new products and processes come into use. Thus, a continual process of reappraisal, rejection, and modification is required.

Perhaps the most universal standard deals with measurement. Scientists throughout the world use the metric system of weights and measures. Many American industries employ both systems, the inch and the meter, because of the demands of customers or the nature of their product. For this reason students must have an accurate understanding of the metric system of weights and measures. A more complete discussion of metrics will be found in the unit on dimensioning.

Because of the fact that common fractions do not lend themselves to the degree of accuracy which is demanded of our industrial society and, because they cannot be converted to meters, industry has ceased using them and has adopted decimals. The facts that most nations of the world measure in meters,

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and that industry measures with decimals clearly indicate that students must learn to think in terms of and work with decimals.

As students progress through their learning experiences in mathematics, they acquire an understanding of fractional parts, or what the layman thinks of as common and decimal fractions. Because it is necessary for the student to learn to think in terms of decimals, rather than thinking common fractions and converting to decimals, it would appear desirable to talk in terms of "decimals" rather than "decimal fractions," even though the latter term is correct mathematically. It is interesting to note that teachers of mathematics find students, particularly those who are less capable, able to more effectively apply concepts developed around decimals than those oriented to common fractions.

It is unnecessary for the student of drafting to know a great amount of detail about many kinds of standards, but he must understand that no one in the broad field of drafting works with complete freedom. He should, however, know where and how to research standards and understand their place in the profession.

Equipment standardization is usually limited to features which insure interchangeability, compatability, operational characteristics, and the use of standard parts. Consequently, these will not necessarily result in items identical in appearance or design, but only in conformation to space allocation, interchangeability, common operational characteristics, etc.

Are standards really necessary? Couldn't we get along without them? Consider that, less than one hundred years ago, every community established its own time, as did each railroad system. Imagine the chaos encountered in attempting to plan a trip which might involve a change from one railroad to another, compounded by meetings in cities along the way. Yet, it took twenty years for the American Railway Association to adopt the standard time zones of today, and even longer for the communities in the country to follow this lead.

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Industry agrees that the savings which standards make possible far outweigh the cost of developing them. One estimate indicates that every dollar spent on standards will effect at least a three-dollar saving in design and production. Imagine the cost in man-hours alone if each automobile manufacturer had to carefully spell out the composition of each piece of steel, cast iron, aluminum, glass, rubber, plastic, wire, and fabric used. Compound this with specifics of sizes, tolerances, and cost considerations for tooling and limited production runs.

Every manufacturer in the United States knows that a tap made in the East will thread a hole to accept a screw cut in the West; that a nut produced in the South will fit, within the prescribed tolerances, a matching bolt made in the North. He knows that a given grade of steel, regardless of the producer, will have certain characteristics, and that the ingredients used in alloying the steel will also have been produced under and will have met prescribed standards.

What kinds of standards are there?

COMPANY STANDARDS are those adopted by any corporation for its own use. These may, of course, include many things. Restricting examples to the drafting room, company standards might include the sizes of sheets, the numbering system, the style and height of lettering, design data, and the number of details on a single sheet.

INDUSTRY STANDARDS, as the name implies, are those adopted for use within an industry. These are most often the outgrowth of activities within a trade association, and these standards are oftentimes incorporated, in whole or in part, into national standards. Typical of groups developing industry standards are: American Concrete Institute, American Institute of Architects, American Petroleum Institute, American Welding Society, and the Society of Automotive Engineers.

NATIONAL STANDARDS are usually developed as the result of the cooperative efforts of several groups under the coordination of the USASI (United States

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United States of America Standards Institute
10 East 40 Street
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<u>USASI Drafting Manuals</u>

Y1	Series for Abbreviations
Y10	Series for Letter Symbols
Y14	Series for Drafting
Y32	Series for Graphical Symbols

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DOCUMENTATION

A document is, by definition, any instrument which conveys information, and documentation is the information itself. For the purposes of the draftsman, the word documentation refers to the actual drawing as well as supporting parts lists, bills of materials, standard hardware lists, and all other supporting materials. Documentation can further be defined as configuration management which is: 1) identification (product definition); 2) control; and 3) processing and verification. The engineering documentation is that which supports the drawing, such as specifications, bills of material, or parts lists which identify the design. The manufacturing documentation is the paper work supporting the drawings involved in the manufacture of the product. Data process runs, manufacturing drawings, test runs, process sheets, operation sheets, etc., would be included in this definition.

The two areas having a somewhat different definition of documentation also have somewhat different uses. Engineering concerns itself with the design and development of a product, while manufacturing documents indicate the specifics related to manufacture.

Manufacturing may require a change in the document so that parts may be produced or purchased in a more economical way. Parts may be altered or change orders issued which will make the document more adaptable to the use of computerized or data-controlled processes. Computerized bills of material, parts lists, etc., are used by almost all commercial industries. Even smaller and commercially-oriented (not just the large military contract type) industries use computer-developed information in the preparation of drawings. The cost of computer and data processing equipment is lessened through time-sharing. This is a system which permits several companies to share in the use of and derive the benefits from a computer. None of these individual companies would have enough work to keep the computer busy and, therefore,

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could not justify the expense involved. These new processes have the effect of taking much data off the drawing itself and putting it onto supporting documents.

The commonly accepted practice is to put as few notes on a drawing as possible and to use more symbols--the language of the newer method--thus reducing the need for notes. Notes can be typed on supporting documents quickly and are easier to revise; symbols require less time to comprehend, are less likely to be misinterpreted, and require less time for revision. Typical examples are to be found on pages 45-52.

Hardware catalogs, manufacturing specification sheets, and material supply catalogs are a source of reference for the student. He should become acquainted with them and their use by the draftsman. The general types of detail drawings such as electrical, mechanical, welding, structural, manufacturing, purchased parts, schematics, and assembly should be shown by example and with problems in all of these areas. Multi-detail drawings are used primarily for single- or low-production runs whereas mono-detail drawings are now commonly used in industry for high production. Size of the component is not significant. Anticipated production is the determining factor.

Types of Drawings

There must be as many different types of drawings as there are things to be drawn. The two largest fields involved with particular types of drawings are construction drawings for the construction industries and product drawings for the manufacturing industries.

CONSTRUCTION DRAWINGS are used in the design of buildings, structures, and their related construction and are normally associated with architectural or civil engineering operations. Construction drawings include plan drawings, elevation drawings, erection drawings, and plot (plat) plan drawings. They do not normally include sketches, perspectives, and presentation drawings.

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Plan drawings depict horizontal projection of a building or structure showing the layout of the foundation, floors or specific levels, and roof. The plan drawing shall show shapes, sizes, and materials; the relationship between the different plan drawings and the location of walls, bulkheads, stanchions, columns, openings, stairs, skylights, ventilators, parapet walls, drainage, etc. It may include or require separate drawings for services depicting individual layouts for heating, plumbing, air conditioning, electrical, and other utility systems. These, again, are individual types of drawings.

Elevation drawings depict vertical projections of a building or structure, showing the profile. Other requirements of plan drawings also apply to elevation drawings.

Erection drawings depict procedure and operation sequence for the erection or assembly of a structure. An erection drawing shows--for each part of the structure--the location, identification markings, types of fastening required, controlling dimensions and any other information that would contribute to the erection of the structure.

Plot (plat) plan drawings depict areas on which structures are clearly indicated with detail information regarding their relationship to other structures, existing and proposed utilities, topography, boundary lines, fences, railroad sidings, roads, walks, etc. A plot (plat) plan drawing shows necessary property lines, building lines, location of structures to be constructed, existing buildings, existing and new utilities, approaches, finish grades, shrubbery, and other pertinent data.

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PRODUCT DRAWINGS are used to manufacture and maintain a particular product. Product drawings include detail drawings, inseparable assembly drawings, assembly drawings, control drawings, and diagnostic drawings. Product drawings do not include sketches or layout drawings, although they may be used in the process of creating them.

Detail drawings depict total requirements for a particular part delineated on a drawing. A detail drawing defines all features of a part including configuration, dimensions, tolerances, materials, mandatory processes, surface finishes, protective coatings, etc. Detail drawings can be subdivided into drawing types dependent on the method of fabrication, such as: machined parts, sheet metal parts, gears, castings, forgings, purchased part drawing, etc.

Inseparable assembly drawings depict parts that are fabricated individually and are permanently joined together to form an integral part, such as weldments, etc. The inseparable assembly drawing fully defines the integral part as assembled.

Assembly drawings depict the assembled relationship of two or more parts, a combination of parts and subassemblies, or two or more subassemblies. An assembly drawing contains sufficient views to show the relationship between each part or subassembly that comprises the assembly. Parts on subassemblies shall not be reidentified on the assembly drawing. Assembly drawings contain references to related diagrams and associated lists.

Control drawings depict configuration, requirements, weight limitations, and necessary mounting and connecting attachments to enable the item to be developed or procured on the commercial

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market, meeting the stated requirements. Control drawings can be further defined as envelope, specification control, source control, interface control, or installation control drawings.

Diagramatic drawings depict features and relationship of parts forming an assembly or system by means of symbols and lines. A diagramatic drawing is a graphic explanation of the manner by which an installation, assembly, or system performs its intended function. Diagramatic drawings can be further subdivided as electrical or electronic schematic diagram, mechanical or gear schematic diagram, hydraulic schematic diagram, pneumatic schematic diagram, interconnection diagram, piping diagrams, logic diagram, etc.

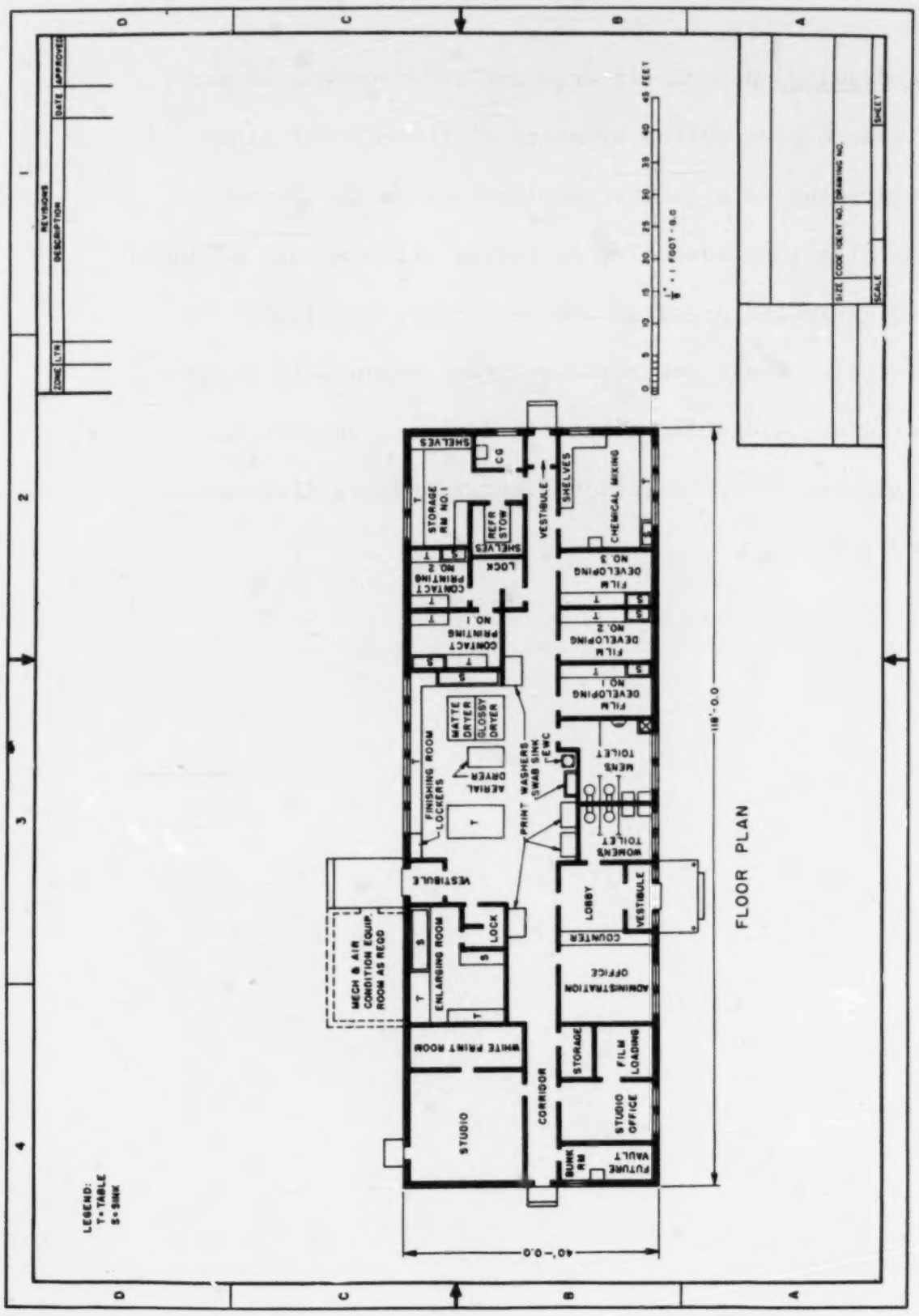

FIGURE 28. **Plan drawing**

This sample drawing shall be construed as informational only. It is complete to the degree necessary to illustrate a condition. Actual drawings shall conform to textual requirements set forth in this standard.

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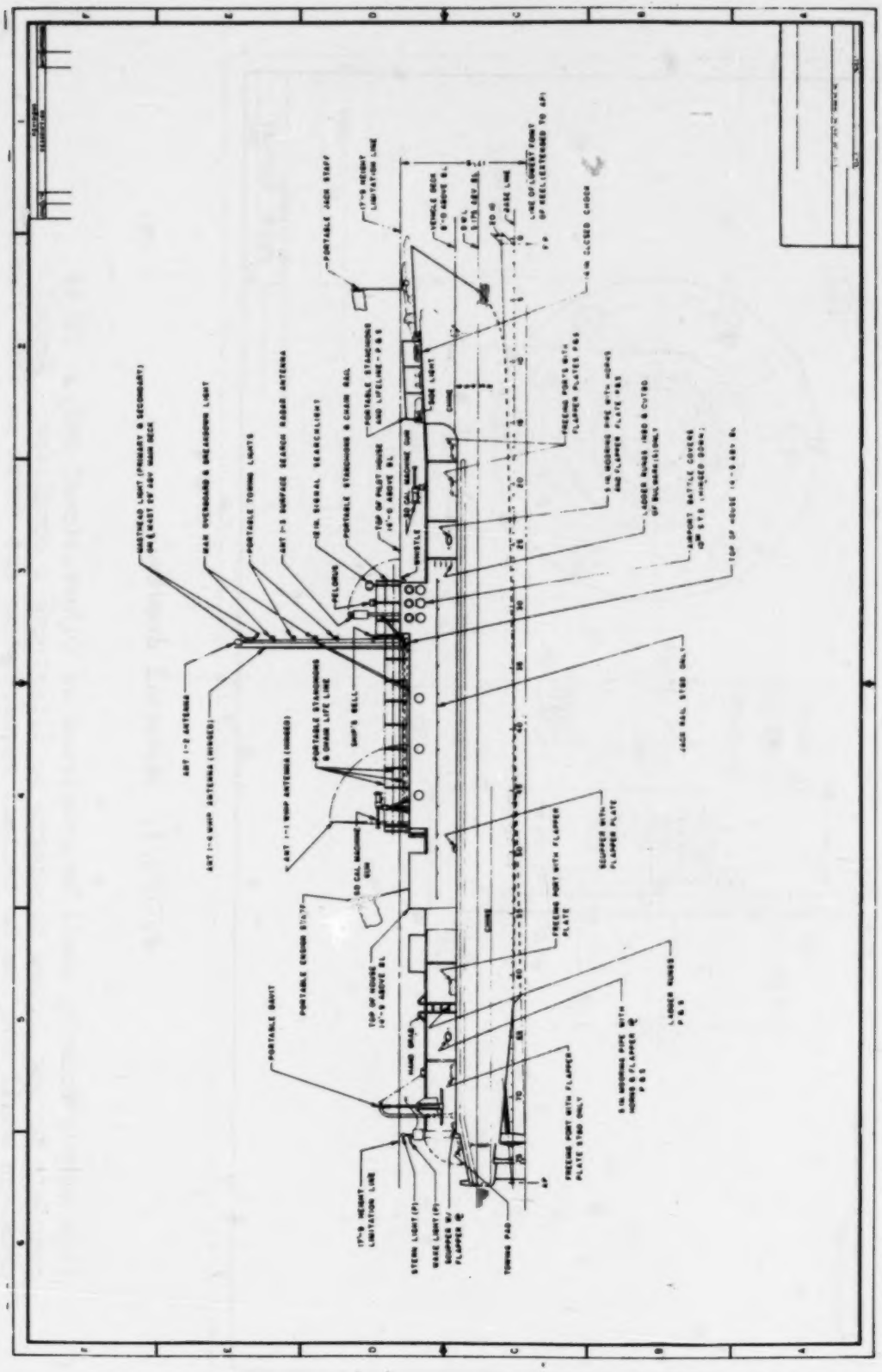

FIGURE 20. Elevation drawing

This sample drawing shall be construed as informational only. It is complete to the degree necessary to illustrate a condition. Actual drawings shall conform to textual requirements set forth in this standard.

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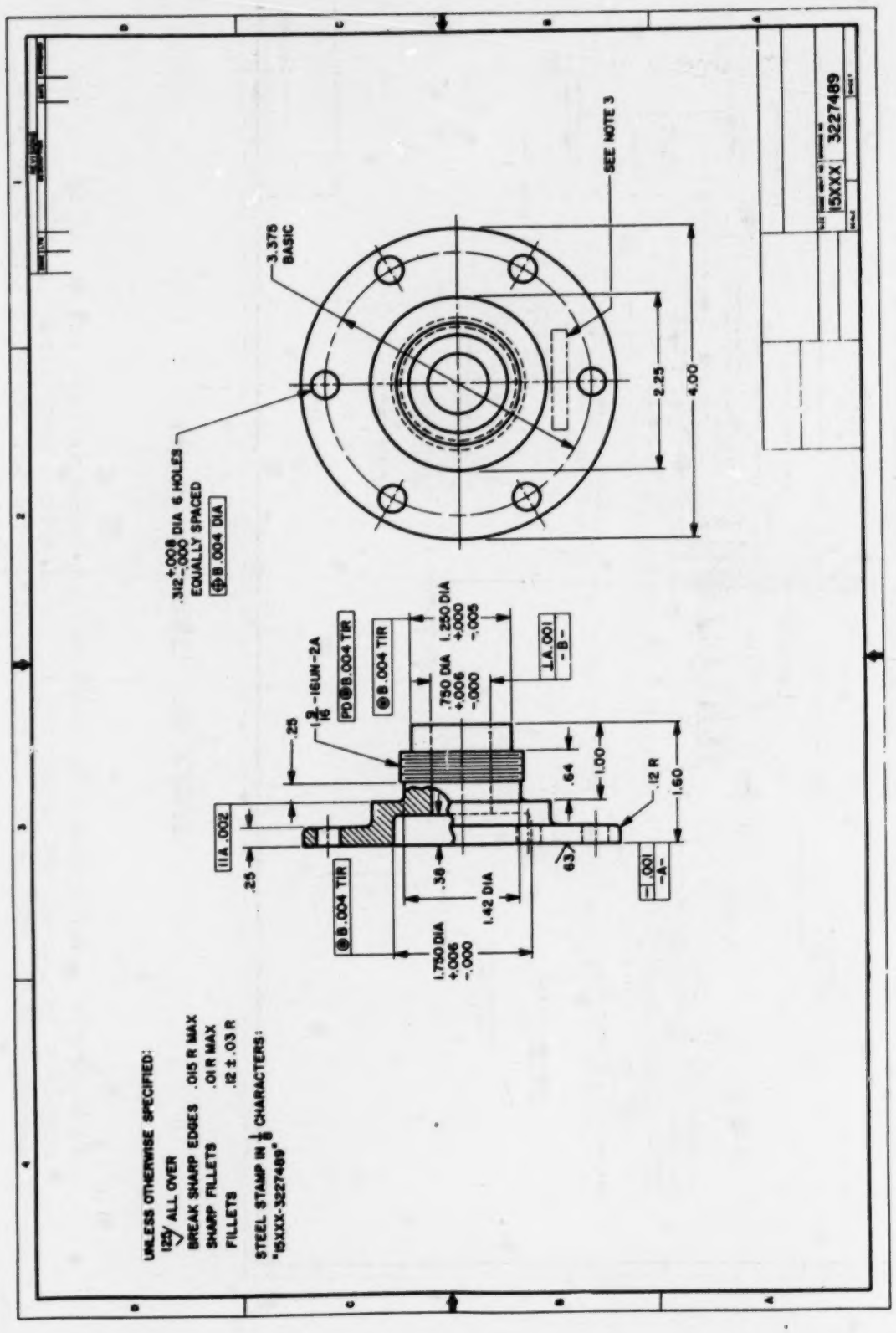

FIGURE 1. **Monotail drawing**

This sample drawing shall be construed as informational only. It is complete to the degree necessary to illustrate a condition. Actual drawings shall conform to textual requirements set forth in this standard.

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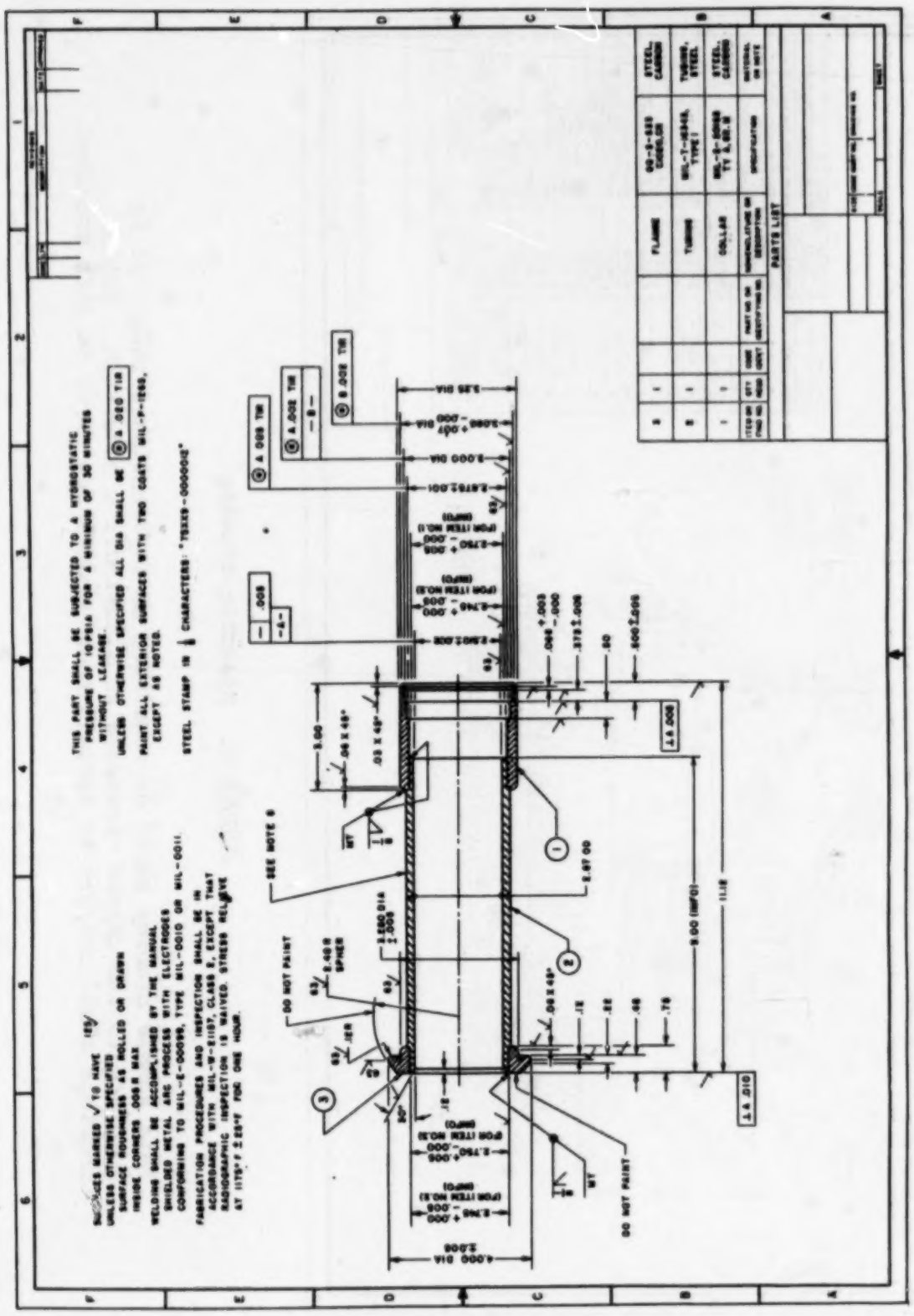

Inseparable assembly drawing

FIGURE 10. *This sample drawing shall be construed as informational only. It is complete to the degree necessary to illustrate a condition. Actual drawings shall conform to textual requirements set forth in this standard.*

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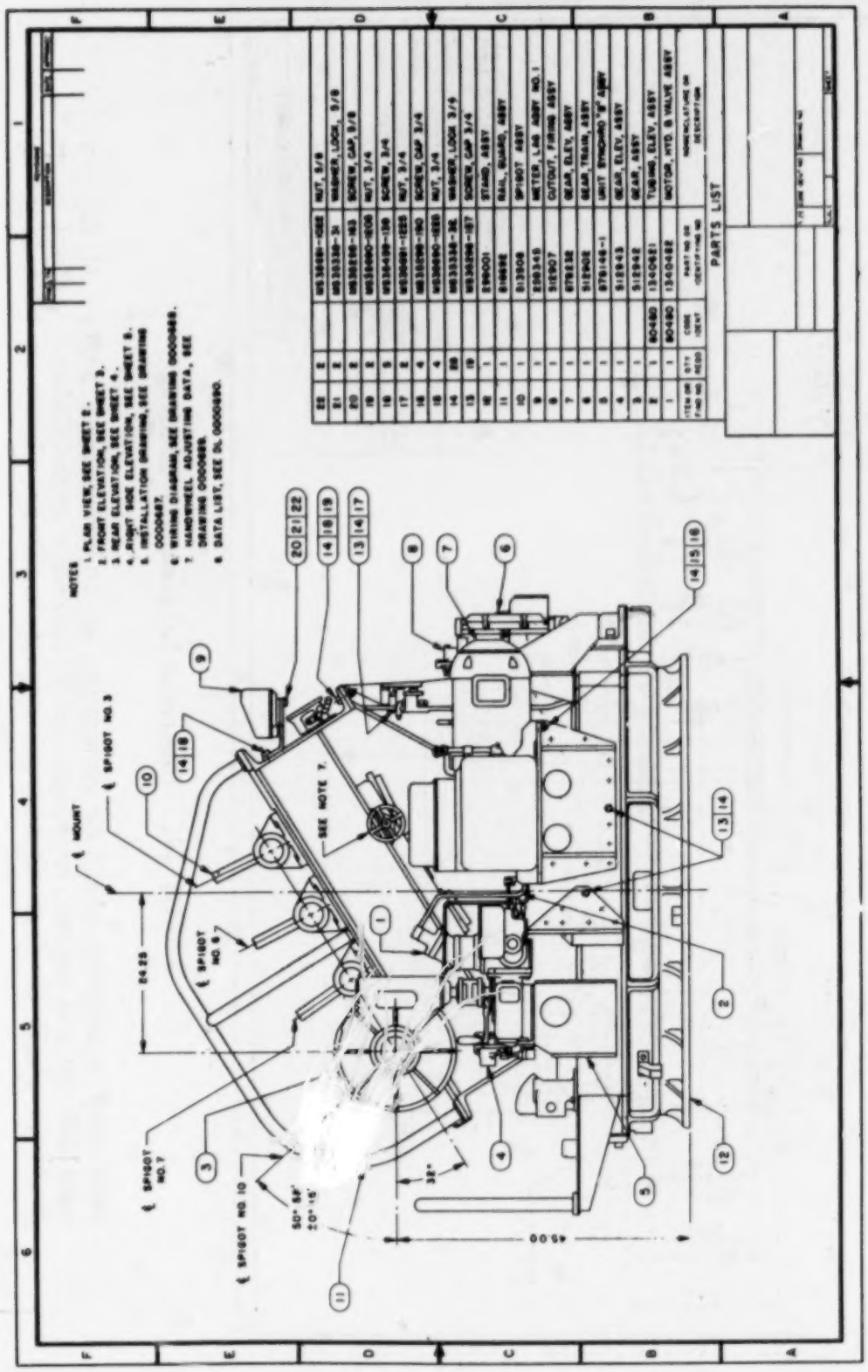

FIGURE 6. **Assembly drawing**

This sample drawing shall be construed as informational only. It is complete to the degree necessary to illustrate a condition. Actual drawings shall conform to textual requirements set forth in this standard.

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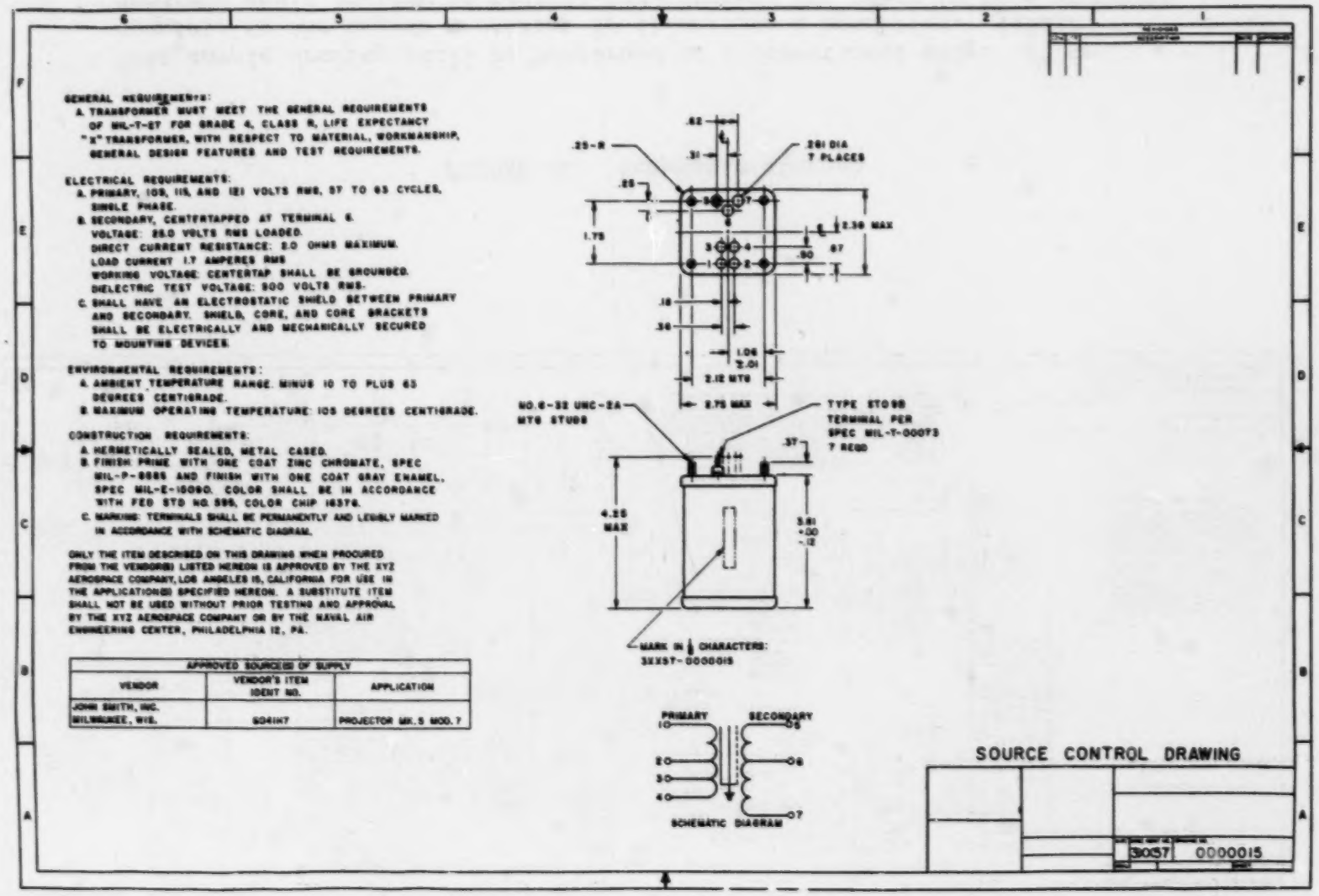

FIGURE 14. **Source control drawing**

This sample drawing shall be construed as informational only. It is complete to the degree necessary to illustrate a condition. Actual drawings shall conform to textual requirements set forth in this standard.

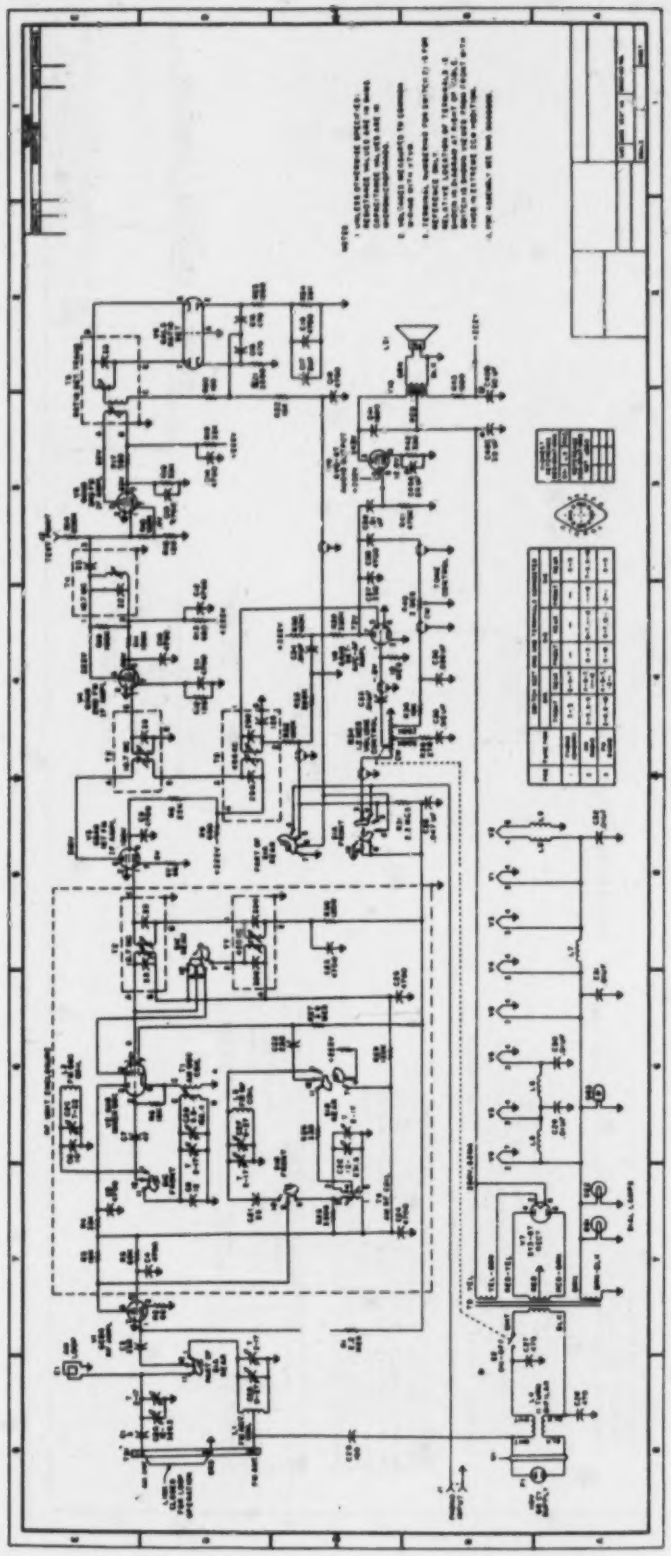

FIGURE 21. Schematic diagram

This sample drawing shall be construed as informational only. It is complete to the degree necessary to illustrate a condition. Actual drawings shall conform to textual requirements set forth in this standard.

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Satellite Documents (Completing a Set of Engineering Drawings)

A satellite document is any separate document--such as a specification, parts list, process, etc., called out on the drawing by a separate number--required to support the manufacture and maintenance of the item depicted.

In thinking of engineering drawings used to manufacture an item, many persons think of just the drawings. If a bolt is going to be manufactured, visualize a single drawing containing all the information necessary to identify its requirements on the single document--its material, finish requirements, the dimensions, and all other data required to completely identify its parameters.

The same illusion is created when thinking of an assembly drawing--a self-contained document that would call out the necessary assembly instructions plus identify the individual parts, by number, that are in the assembly.

To understand a drawing and what it is used for, this approach and thinking is all right. But, in reality, this is not the way major industries prepare their drawings or define a product.

Drawings are prepared for many purposes other than manufacturing. Some of the other purposes would be design evaluation, logistics support, installation, maintenance, etc. (See Types of Drawings, page 16.)

To completely define an item to be manufactured and supported, many additional documents are prepared. These documents are called satellite documents and are referenced on the individual engineering drawings. Once referenced on the drawing the same rules of control, quality, and maintenance apply to them as to the engineering drawing.

Another reason for preparing a satellite document would be because the information to be placed on the drawing is of such a magnitude that it would be more logical to be on a separate document or because the information to be placed on a drawing is the same information that would be common to many

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drawings. Again, this information placed on separate documents and called out on the drawings has the same importance and serves the same purposes as that of a self-contained drawing.

A few examples would help illustrate the above information. Complete descriptions of materials, test instructions, or material finishes are many times too voluminous to call out in their entirety on the face of the engineering drawing, or the material (as an example) is common to many parts and repeating the voluminous information would be time consuming and expensive. In these cases, separate documents would be prepared.

In many companies these separate documents are called "specifications." They, like the drawing, have standards controlling not only the preparation but also the size of the document, format, change block, etc.

Another satellite document commonly prepared by most companies in industry is the parts list or, as some call it, the bill of material. With most companies now using computers to support their operations, preparation of the parts lists by this means is very economical, timesaving, and easy to maintain.

Again, when prepared separately from the assembly drawing this document has a controlled procedure for preparation, format, and change. As stated previously, a complete set of drawings is only complete when all satellite documents called out on the drawings are included in the drawing package and are maintained through a controlled change system the same as the drawing.

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MIL-D-1000 ENGINEERING DRAWINGS AND ASSOCIATED LISTS

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ENGINEERING DRAWING CHANGES

The great majority of all drafting room activity is devoted to revisions of existing documents. Such documents include layout, detail, and assembly drawings as well as parts lists, master templates, diagrams, and other documents. Change orders may come about as a result of requests by the customer, manufacturing, purchasing, or engineering. Any of these groups may call for revision even before manufacturing has started.

Management's decision to "stop the presses" must be a wise one. Customer acceptance, product reliability, manufacturing, inventories, service policies, instruction manuals, and other existing items of cost must be considered.

The decision to change a product triggers a review in many areas. Customer interface drawings (documents which affect the design or operation of co-functioning items are used as design control documents for the purpose of establishing and maintaining compatability between planes having a common boundary) of mechanical or electrical requirements might be needed. Such a change might require a layout revision, stress analysis, materials review, and other engineering studies.

After the decision to change has been approved, the change must be controlled. A history of the original design should be kept. This can be done on microfilm before the drawing is changed. An engineering order authorizes the drafting department to incorporate the change. The order is kept as part of the change history.

Management's decision to authorize a change is transmitted to responsible groups by an engineering change order (ECO). Copies are distributed to all groups concerned. Dealer information concerning changes is sometimes distributed by newsletter for information on future sales and service.

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During the review of the required changes, all drawing structures for the assemblies in which a part is used are studied. The record of usage is reviewed to determine whether a change will affect an assembly not under consideration. Also, during this review, drawings such as schematic diagrams, electrical wiring drawings, test specifications, and other related data are studied and the necessary changes written. "Related changes" can increase the ECO and drafting work effort by a significant margin. Other documents such as parts lists must also be changed.

When an article must be removed from the shipping line or altered in the field, a retrofit or modification drawing is made. These documents delineate the instructions, parts list, and other necessary information for modifying parts or assemblies to meet new specifications.

At the time of writing an ECO, a person familiar with drafting policies and procedures might review the change order. This action prevents an ECO from describing a change which adversely affects any step in the change procedure.

The drawing of a part is sometimes retained in its original form and a new model or assembly number created. This allows stock and dealer parts to be used, followed by the new model. The new part drawing could be a reproduction of the original part with the required drawing and identification changes incorporated. The process is fast and economical.

When the original drawing is changed, the ECO requirements must be closely followed. Revisions are made by erasure or chemical eradication. History of the change is indicated by a revision statement or ECO number recorded in the revision area of the drawing.

Because the status of change is important to many groups, the time of acceptance is important. The change status of a drawing is identified by a revision letter and date.

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New design requirements are distributed to responsible groups through the revised drawings and associated lists. New tooling, parts, and materials are ordered where necessary. If changes require it, time studies and product costs are revised. Assembly procedures must show the new part numbers, tooling setups, and techniques. If required, a break-in point can be part of the ECO. In this case a given quantity or serial number is manufactured using the requirements before the change. After this point the changed part or assembly is made.

From the above information, it is apparent that there is more to an engineering change than simply revising the document. A good, knowledgeable draftsman will not only make the required change as directed by the engineering order but, knowing the impact of a change on his facility, will look for such items as inter-assemblies, etc. Change activity is a very important part of a draftsman's job. Its importance should not be minimized.

In keeping with the amount of time draftsmen devote to this practice, students must have experience making revisions on documents. Since the primary concern is with drawings as opposed to supporting documents, instruction may be accomplished by developing a set of revision and change-order assignments supplementing the required problems. A column should be provided on the drawing for noting revision data.

Specific guidelines for effecting changes on documents prepared for DOD contracts are indicated in MIL-STD-100A. Since many companies hold government contracts this is an excellent reference.

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MIL-STD-100A ENGINEERING DRAWING PRACTICES
Chapter 1, Section 5

DIMENSIONING*

Decimal Dimensioning

History and Purpose

The use of decimal notation is inherent to the 10-base numerical system used throughout the civilized world and is employed in the majority of the world's coinage systems. Decimalization is a fundamental practice in the metric system of weights and measures. The decimalized foot was used in land surveying in the United States prior to 1856.

The ability to fabricate parts to a high degree of precision evolved during the industrial revolution of the nineteenth century. It brought about the need for expression of subdivisions of the inch in increments smaller than the 1/64 fraction previously considered to be the smallest practical subdivision of the inch. About the time of the American Civil War, mechanical measurements began to be expressed in terms of thousandths of an inch and this practice was followed closely by the gage maker's need for even smaller increments of one ten-thousandth of an inch. Today, manufacturers are able to produce to accuracies in terms of millionths of an inch.

The use of thousandths and ten-thousandths in combination with the common fractions, however, has created awkward dimensioning and measuring practices which may be overcome by dispensing with the common fractions and going to complete decimalization.

Trend in Industry

A major breakthrough occurred when a decimal inch system for linear measurements was adopted by the Ford Motor Company in 1930. The expanding

*Portions of this unit have been extracted from USA STANDARD DRAFTING PRACTICES, DIMENSIONING AND TOLERANCING FOR ENGINEERING DRAWINGS (USASI Y14.5 - 1966), with the permission of the publisher, The American Society for Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.

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aircraft industry in the United States was quick to see the advantages of decimalization. By 1940 many aeronautical manufacturers were using the decimal inch exclusively for product dimensioning. In 1946, the SAE Aeronautical Drafting Manual was published, which included a description of a complete decimal inch dimensioning system.

During the period 1946 to 1961, many leading companies in the automotive, electrical, defense, and allied mechanical industries converted to the decimal inch using the two-place decimal as the basic increment. The majority of industrial firms are currently using the decimal dimensioning system, which makes it almost mandatory for the schools to familiarize prospective draftsmen and machine operators with this system. Industry has found it necessary to change to this system due to its compatability with computers and for programming for numerical control machine tools.

Utilization

The scales used and conversion practices followed will vary with some firms, from merely converting fractions to decimal equivalents to adoption of the "complete decimal inch system."

Drawing textbooks currently available still use fractional dimensions for most assignments. It is suggested that a system of converting fractions to decimal equivalents be used at the beginning levels, following conversion tables available in most texts. This will make it easier for the students to understand and accept decimals but, at the same time, they should be learning to think in terms of decimals--not to think common fractions and convert.

Advanced students familiar with the above practice could be introduced to the "complete decimal inch system," which would require the use of scales graduated in tenths and fiftieths--on which the smallest graduation is 0.02 inch. The complete decimal inch system uses increments of 0.02 inch or multiples thereof, such as 0.04, 0.24, 5.20, etc. Two-place decimal

8388

dimensions in other than 0.02 inch increments should be used where necessary to satisfy design requirements or where required to comply with standard commercial sizes of stock or tools.

For greater precision, three, four, or more decimal places may be used. Where less precision allows, one or no decimal place may be used. Decimal points should be bold, be given a full letter space, and placed in line with the bottom of the digits.

The number of places to which a decimal dimension is carried out will reflect the implied tolerance. An example is shown at the right.

UNLESS OTHERWISE SPECIFIED
1 - PLACE DEC ±.060 2 - PLACE DEC ±.030 3 - PLACE DEC ±.010 ANGULAR ± 2°

This implied tolerance may vary with different companies and should be specified in the title block area of the drawing.

The use of implied tolerances is a labor-saving device and not an inherent part of decimal dimensioning. Their use eliminates the need for specifying tolerance except where it differs from the implied.

A decimal dimension may be given as a UNILATERAL dimension: $1.878\ ^{+.000}_{-.003}$ which means that the permissible variation from the design size is shown in one direction. BILATERAL tolerancing permits variations in both directions, as $1.876\ ^{+.002}_{-.001}$

Another common practice is to apply the tolerance as a limit dimension. The relative position of the high and low limit is based upon the direction of material removal.

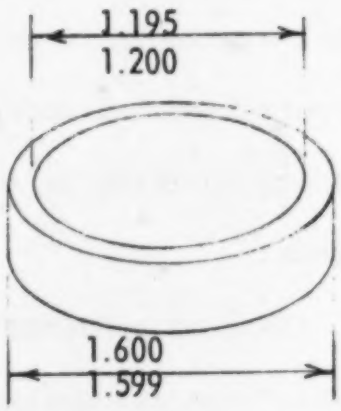

8389

The Metric System

Of the two major systems of weights and measures used in the world today, the United States uses the oldest one, which is based upon the inch and the pound. The other system, presently used by over 90 percent of the world's population, is the metric system, with the meter and kilogram as its base.

The metric system originated in France nearly 200 years ago, and the value of metric measurements as used by the French soon became so apparent to residents in adjoining countries that they gradually adopted metric weights and measures. A steady progression of metric usage in the majority of the world's countries followed, and now the internationally-understood language of measurements based on the metric system is called the International System of Units or SI.

Early in United States history, efforts were made to abandon the complicated inch-pound system in favor of the metric system. These efforts led to enactment of legislation by Congress in 1866 that made the metric system the only legal system of weights and measures in the United States. The law, however, did not state that use of metric measurements was compulsory.

Since that time, consistent but unsuccessful attempts have been made to pass a law making the metric system the only legal system in the United States. Starting in 1960, an almost annual attempt has been made to get Congress to approve a comprehensive study on advantages and disadvantages of the United States adopting the International System of Units.

The United States has drifted toward metrics and now uses a mixture of inch-pound/metric measurements, with the inch-pound system predominating. The SI has become the language of science in America. A number of groups (optical, pharmaceutical, chemical, etc.) have converted to the SI within their own industries.

1668 8390

Positional Dimensioning

True position dimensioning is the establishment of the theoretically exact location of a feature by means of basic dimensions. It provides for a tolerance zone uniformly distributed about this basic location and specifies the acceptable limits of deviation. True position tolerances are calculated to allow the maximum permissible deviation that will still guarantee assembly and interchangeability of parts. In many cases a bonus tolerance can be realized as a feature departs from its maximum material condition. The true position system may be used with coordinate or other methods in combinations that best suit the application. Examples of both the coordinate and true position systems of dimensioning are shown on pages 39 and 41.

Datums

Just as each of us depends on a road map when traveling in strange territory, a machinist depends on a drawing for specific directions when making a new part. Directions on a map or on a drawing have meaning only if the starting point is known and can be found with little difficulty. The machinist's starting point is called a datum. The following concepts are fundamental to specified or implied datum interpretation and use.

The term datum means something real or assumed which is used as a beginning for calculation or measurement. As "called out" or implied on drawings, datums are points, lines, planes, etc., assumed to be exact for purposes of computation and from which the location or geometric relationship (form) of other features of a part may be established. The word datum is used as an adjective with the applicable feature element.

As applied in manufacturing and inspection, datum references are established by relationship to the planes existing in the machine tool, jig, fixture, surface plate, gauge, or other setup or checking device. They may be either finished surfaces approximating true planes or planes developed by coordinate movements of the equipment.

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All manufactured parts contain datums, which may be specified on the drawing or implied by the dimensioning. Each feature requires a starting point from which its location and relationship to other features is established.

Unless otherwise specified, "maximum material condition" applies to datum references used to control true position tolerances. "Regardless of feature size" applies to datum references used to control positional and form tolerances. Datum surfaces and datum features that are single planes have no size and, therefore, result in an RFS application, regardless of intent.

An implied datum is one that is evident by the method of dimensioning. On most drawings, datums are not specified as such. However, dimensions referenced to a common surface or center line imply a datum. On the part shown below, the near or far side and the left and lower edges are implied datums by dimensional arrangement.

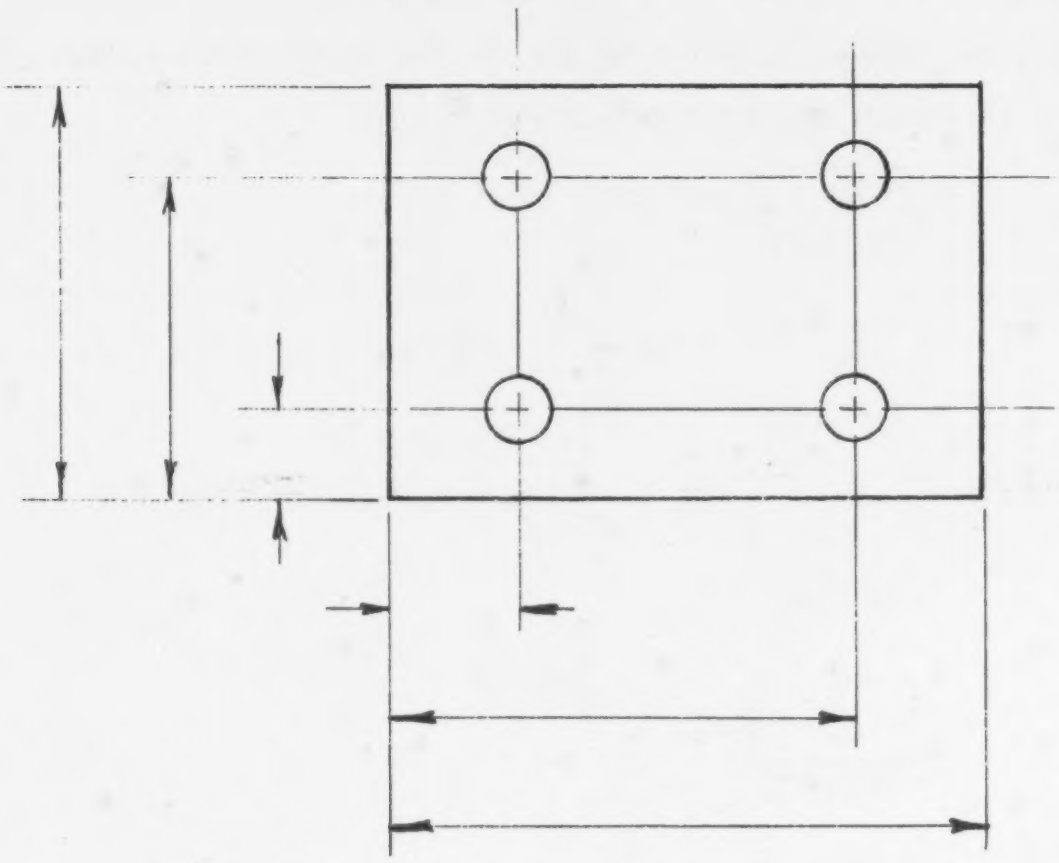

For production and inspection purposes either the near or far side could be used as the primary plane and the left and lower edges as secondary or third planes.

8392

Symmetrical parts sometimes require a point "P" to be marked on the part to identify the datums used in manufacture, thus avoiding conflict between manufacturing and inspection.

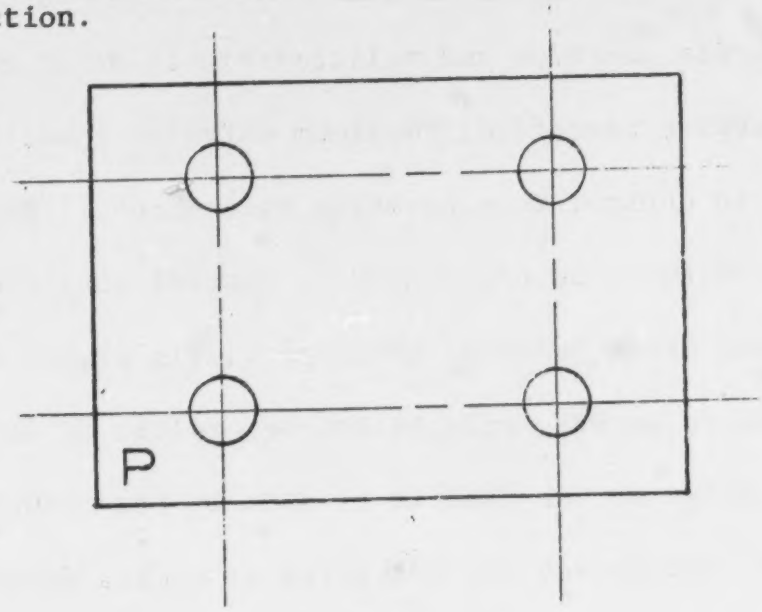

A specified datum is one that is identified by a symbol or note. The datum identity symbol consists of an identity letter preceded and followed by a dash within a rectangular frame. The symbol will be identified with the applicable line, plane, or point by one of the means shown below. Use of a datum surface is always preferable to a datum line.

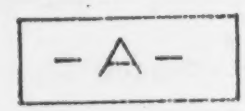

Specified Datum Symbol

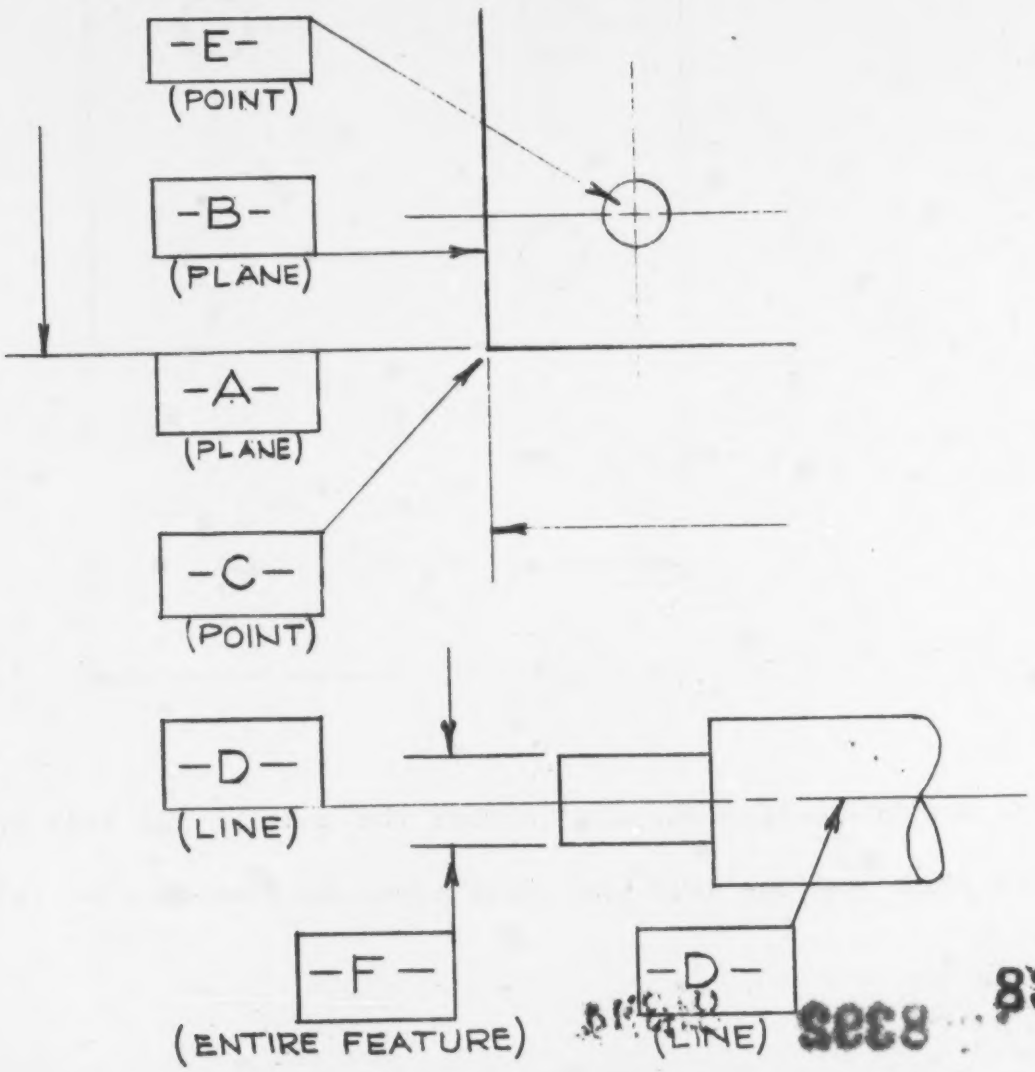

8393

Used as a reference, the specified datum identity letter is included in the feature control symbol without the dashes.

Where reference is made to two or more datums used to control positional or form tolerances of a feature, the primary datum letter is first; second datum letter is second, etc. Datum reference letters are placed in order of importance with respect to establishing location, form or position of other features, and will not necessarily be in alphabetical order, as applied.

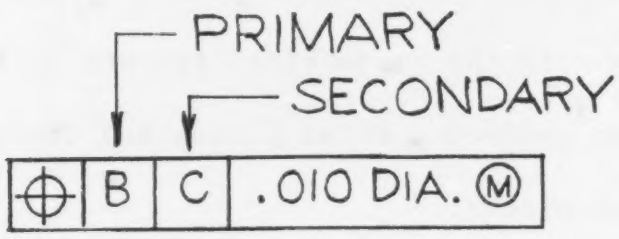

Where a datum feature is controlled by a positional or form tolerance, the feature control symbol and the datum identification symbol are combined, as shown.

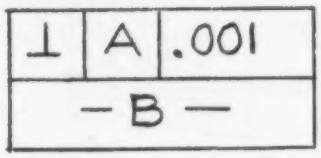

Three-Plane Concept

When a part is related to reference planes, it should be visualized in three dimensions. Datum features are specified or chosen in logical sequence to orient the part in relation to a set of three mutually perpendicular planes.

CYLINDRICAL DATUM FEATURES

Two datum planes are represented on the drawing by center lines intersecting, at right angles, the center of cylindrical datum features. Thus, one cylindrical datum feature is associated with two datum planes, and the intersection of these planes is called the datum axis. If the cylindrical feature is first in the specified datum sequence, these planes are the primary and secondary datum planes.

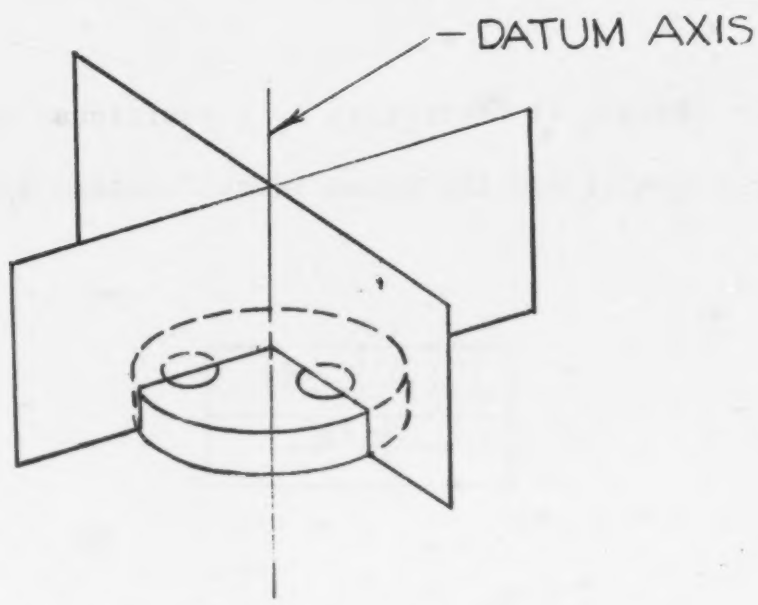

RECTANGULAR PARTS

The primary datum feature relates the part initially to the primary datum plane of the three-plane reference framework, as shown on the next page. Secondary and tertiary datum features relate the part to corresponding secondary and tertiary datum planes. For rectangular parts, the three planes are easily visualized, since flat surfaces of parts resemble datum planes.

8395

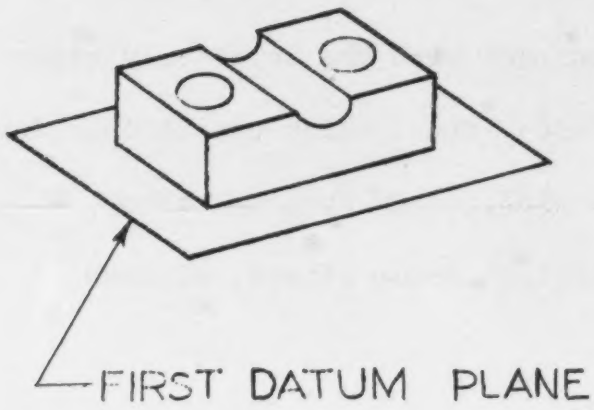

⌒	.005
— A —	

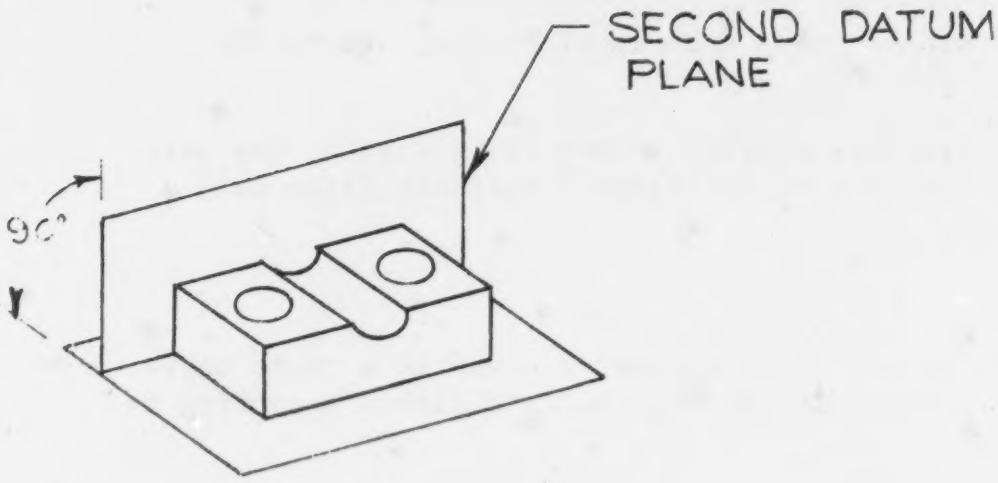

B	⊥A .005

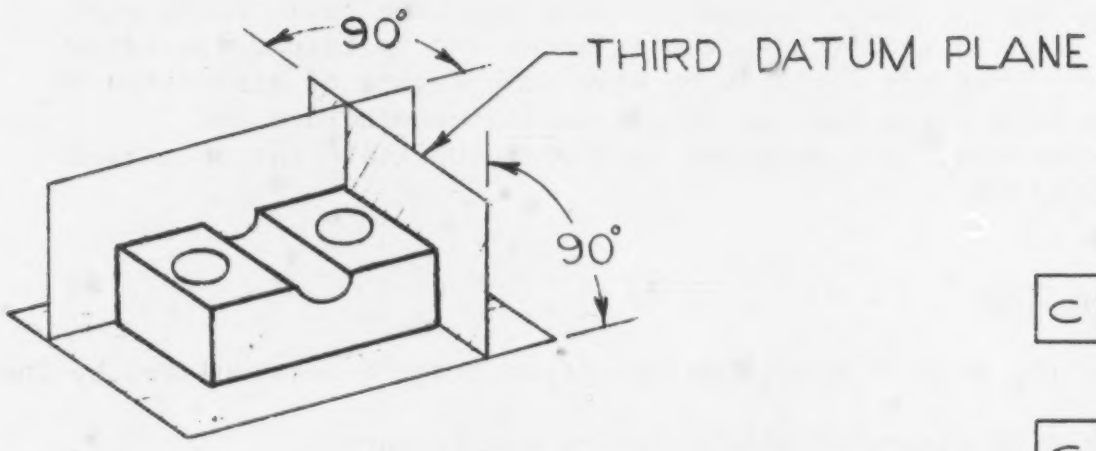

C	⊥A .005

OR:

C	⊥B .005

8396

Establishing Datum Planes

Since perfectly flat planes do not exist in either parts or machines, datum planes must be established by making contact with the relatively high-quality surfaces of machine tables, angle plates, etc., which can be considered to simulate perfect planes. Surfaces of the part, rough by comparison, actually touch at only a few points. To establish datum planes, minimum contact requirements are:

Primary Plane

- -- The three highest points by which the piece will rest without rocking
- -- If concave, the points along the edge upon which the part will rest in its free state (evenly shimmed where necessary)
- -- If convex, the center point plus equal spacing around the periphery
- -- If none of the previous conditions are satisfactory, the part shall be rough finished to establish a suitable datum with a minimum cut

Secondary Plane

- -- The two highest points which contact a plane at a right angle to the primary plane (It may also be established according to (b) or (c) above.)

Tertiary Plane

- -- The one highest point of contact with the tertiary datum plane at right angles to both primary and secondary planes

Since actual surfaces and features used to establish datums include all their irregularities, the same basic rules must be used in both manufacturing setup and in inspection setup. Parts that are flexible or have some degree of distortion in the free state must be fixed, during manufacture and inspection, in a position that will duplicate the assembled condition.

Establishing Datum Axes

In practice, the axis of a cylindrical datum feature is simulated by the axis of the processing equipment which centers the feature.

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Tolerance of Form

FUNCTION

Form tolerances state how far the actual part may deviate from the perfect shape implied by the drawing. They control the conditions of straightness, flatness, roundness, cylindricity, angularity, parallelism, perpendicularity, profile, and runout. Although primarily position controls, symmetry and concentricity tolerances are included. Normal shop practice limits and size tolerances provide adequate form control for average conditions. However, when more restrictive control is required, it should be specified. Symbols and modifiers are used to define these special conditions.

GEOMETRIC CHARACTERISTIC SYMBOLS			
	Characteristic		Symbol
Form Tolerances	For Single Feature	FLATNESS	▱
		STRAIGHTNESS	—
		ROUNDNESS (CIRCULARITY)	○
		CYLINDRICITY	⌭
		PROFILE (CONTOUR)	⌓
	For Related Features	PARALLELISM	∥
		PERPENDICULARITY (SQUARENESS)	⊥
		ANGULARITY	∠
		RUNOUT	↗
Positional Tolerances		TRUE POSITION	⊕
		CONCENTRICITY	◎
		SYMMETRY	⌯

FEATURE CONTROL SYMBOL

The basic control system consists of the characteristic symbol and the tolerance value within a rectangular frame. Datum references and modifiers are added when required. The following symbols are used extensively by industry and agree with U.S.A. standard Y14.5. Each has a definite meaning and can be quickly drawn. Use of these symbols on the drawing will save drafting time and make the drawing easier to read and more universally understood. Last, but far from least, they will eliminate the ambiguous and confusing drawing notes that have been used in the past.

8398

Flatness

When the flatness symbol is indicated, the surface can deviate within two parallel planes which are as far apart as the noted tolerance. The example shows a flatness tolerance of .002 over the surface. It should be understood that this symbol controls only flatness--not squareness or parallelism in any relation to any other surface.

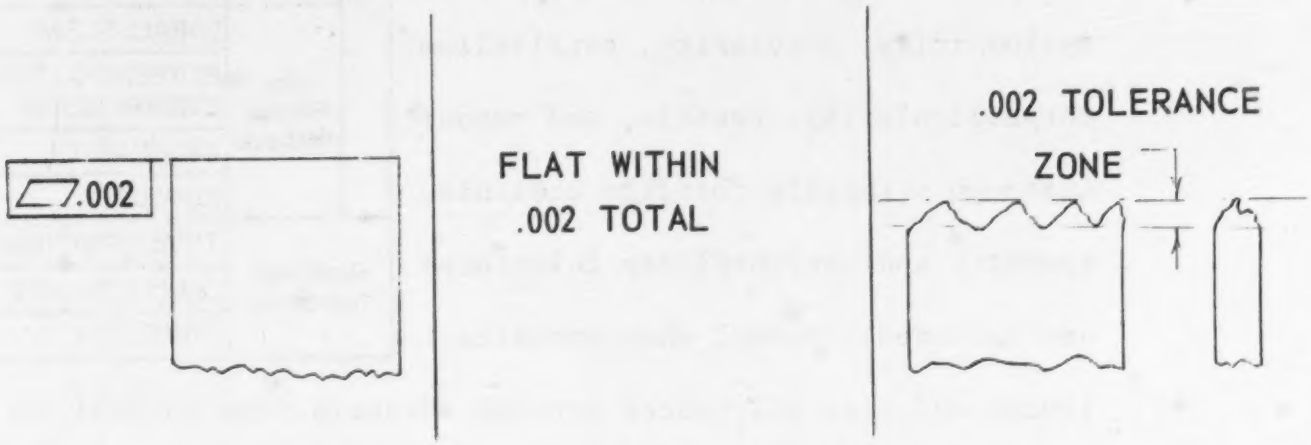

Straightness

Straightness is the condition in which an element of a surface is a straight line, where the characteristics of flatness are common to a surface having one element in one plane. Straightness may be applied to cylindrical or conical surfaces.

8399

Roundness (Circularity)

Although related, separate symbols have been assigned to roundness and cylindricity. A roundness tolerance applied to a surface means that every point in any cross-section perpendicular to a reference access, or through the center of a ball, must lie between two concentric circles separated by a distance equal to the specified tolerance.

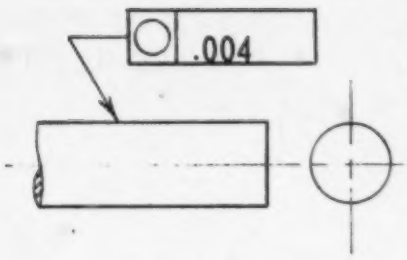

ROUND WITHIN .004

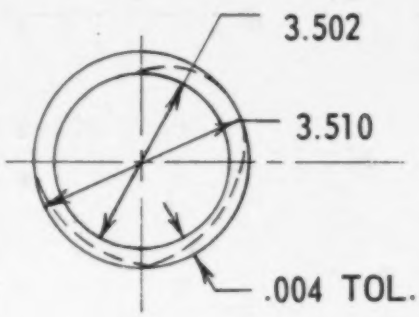

Cylindricity

A cylindricity tolerance applied to a surface means that the entire surface must lie between two coaxial cylinders separated by a distance equal to the tolerance specified. As in the case of roundness, cylindricity is measured with respect to itself, and a datum feature reference is not necessary.

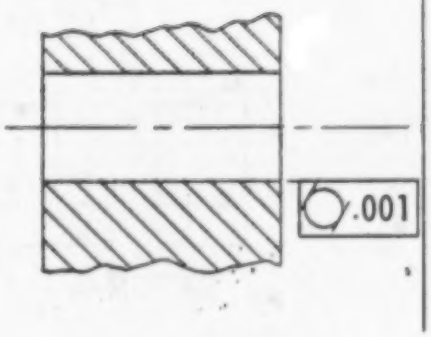

CYLINDRICAL WITHIN .001

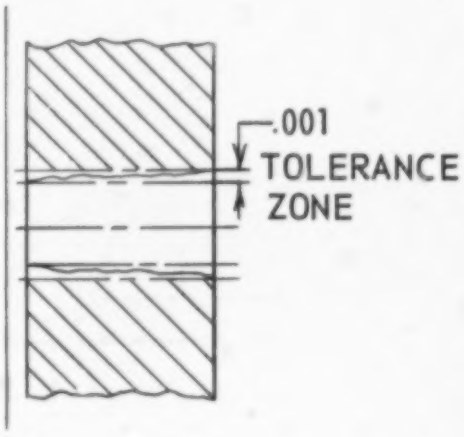

Profile (Contour)

Contour control is the means of controlling either a portion or the total outline of a part in which a uniform variation can be permitted from the basic untoleranced size dimensions.

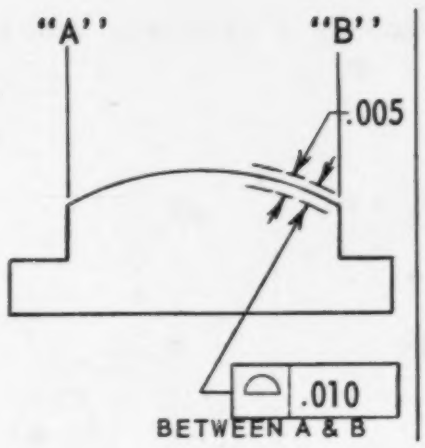

TOLERANCE AT ALL POINTS WITHIN .010

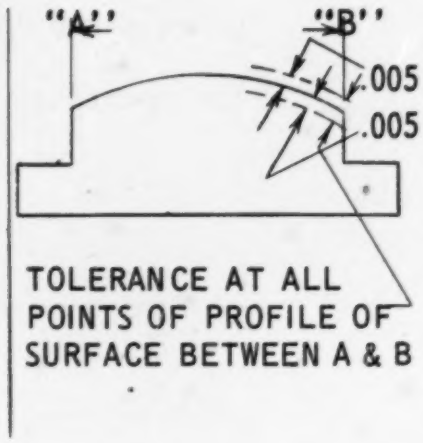

Parallelism

Parallelism is the condition in which a plane is an equal distance from its datum throughout its entire length. The tolerance is the distance between two planes within which the surface must lie. These planes are parallel to the datum plane. In this example the surface is held parallel over its total area to datum A within .002.

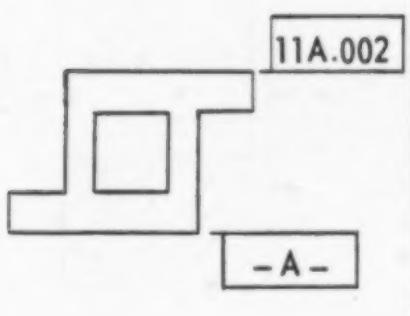

PARALLEL TO A WITHIN .002 TOTAL

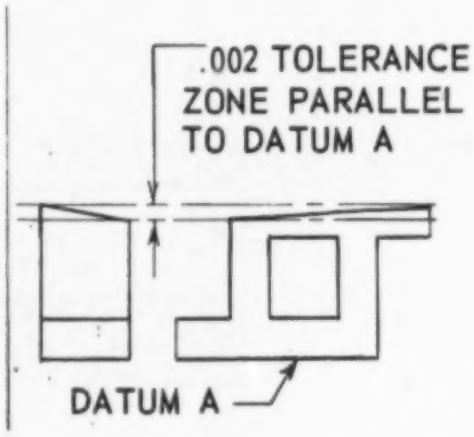

0049 8401

Perpendicularity (Squareness)

Perpendicularity is the condition of a feature which is at right angles to a datum or another feature.

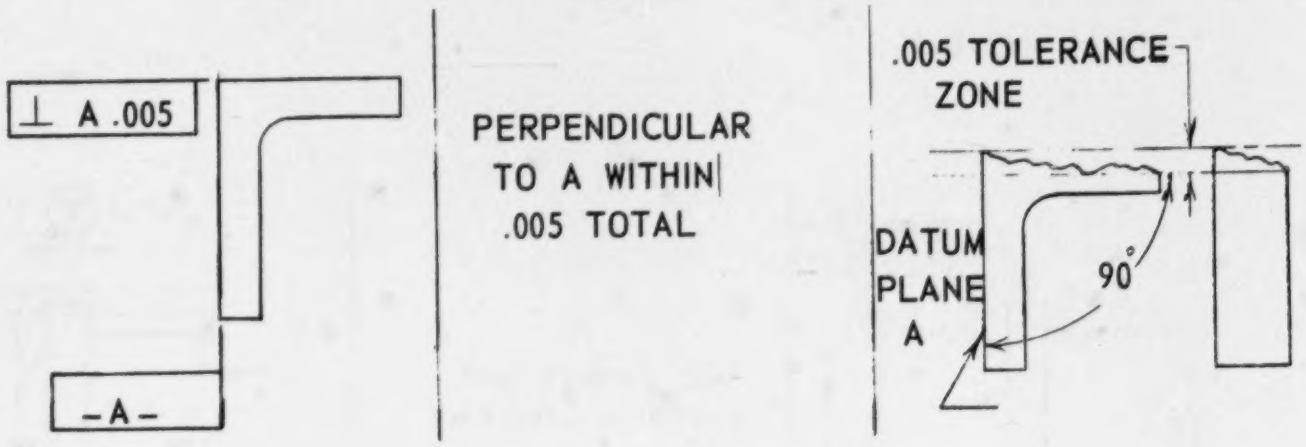

Angularity

The angularity tolerance is the permissible variation from a specific angle. There are two basic ways that angularity control can be defined. One is in degrees, with an angular tolerance; the second is with a uniform tolerance zone between two parallel planes--within which the entire tolerance surface must lie. The planes are inclined from the datum at the exact nominal angle. In the illustration, the two sides of the tolerance zone are parallel. The acceptable tolerance is .003, the width of the tolerance zone.

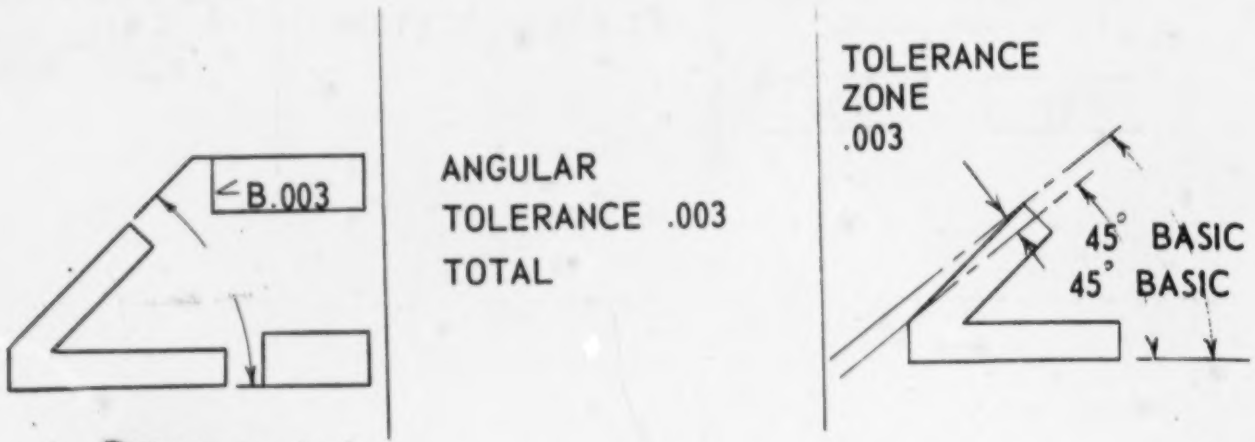

Runout

Runout establishes control of features having a common axis, with measurements taken under a single setup. It is, therefore, necessary to establish a datum axis about which the features are to be related.

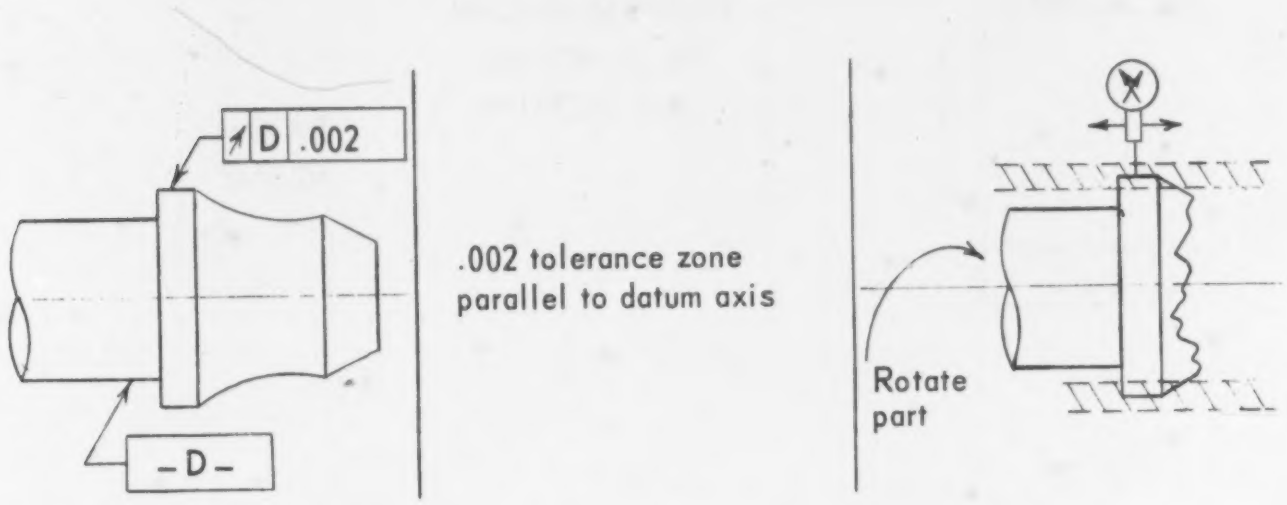

True Position

True position is the theoretically exact position for a feature.

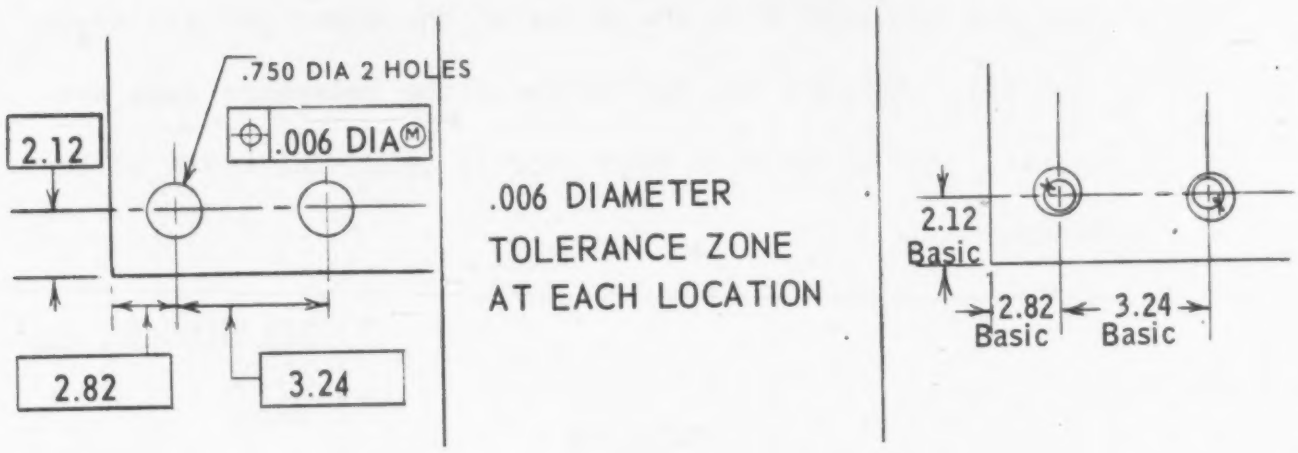

DUP. 8403

Concentricity

It should be emphasized that concentricity is primarily a tolerance of position relating one axis to another. Therefore, it is preferable to use the concentricity symbol only when a definite control of axis is needed, regardless of feature size.

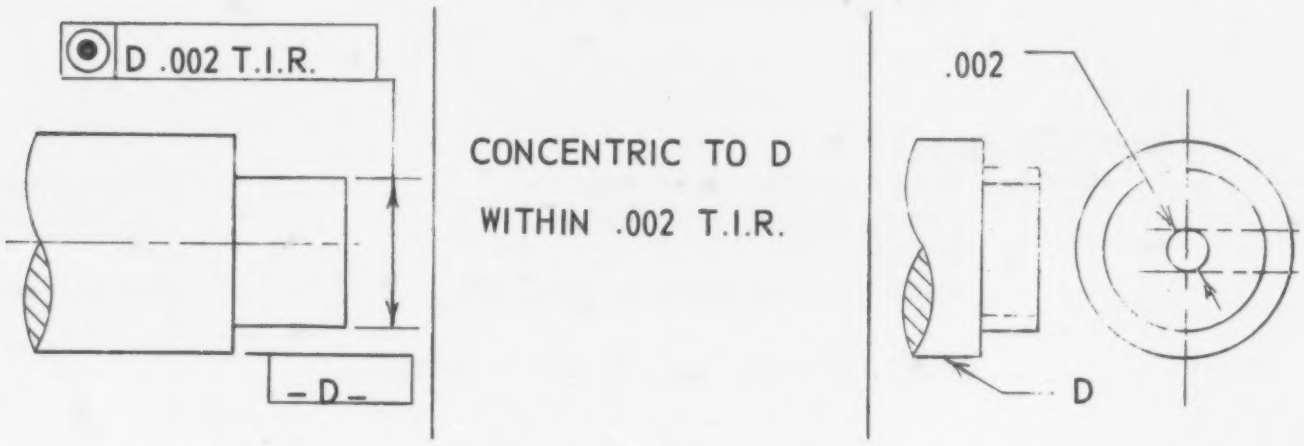

Symmetry

This is the condition in which the part or the feature has the same contour and size on each side of a central plane.

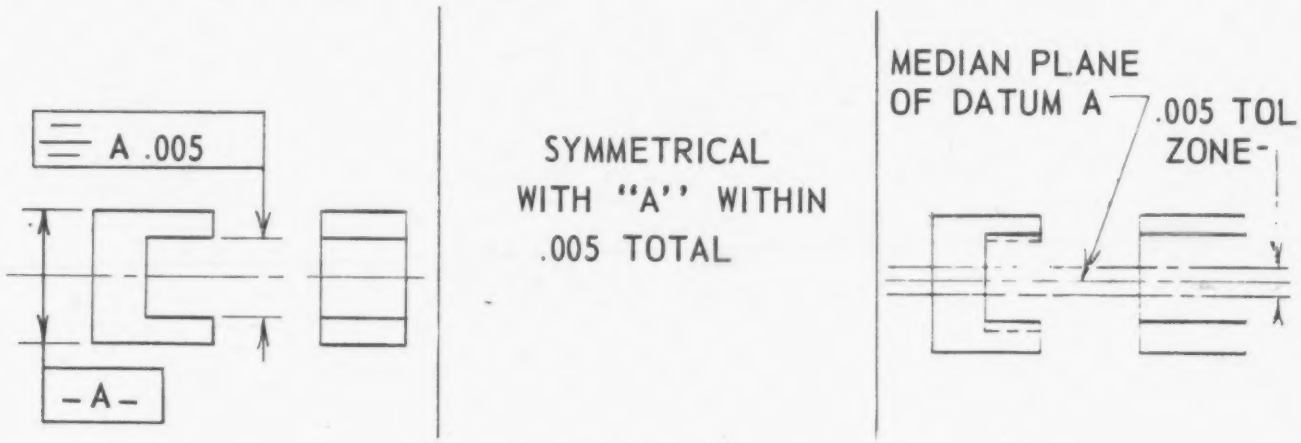

8404

The complete symbol should be read from left to right and top to bottom.

<u>Basic Symbol</u>

Means: This surface must be flat within .004 total.

▱	.004

<u>Modified Symbol</u>

Means: This feature must be perpendicular to datum A within .006 total at MMC.

⊥	A	.006 Ⓜ

<u>Modified Symbol</u>

Means: This feature must be perpendicular to datum A within .015 total RFS and must be flat within .004 RFS.

This feature then becomes datum C.

⊥	A	.015
▱	.004	
– C –		

8405

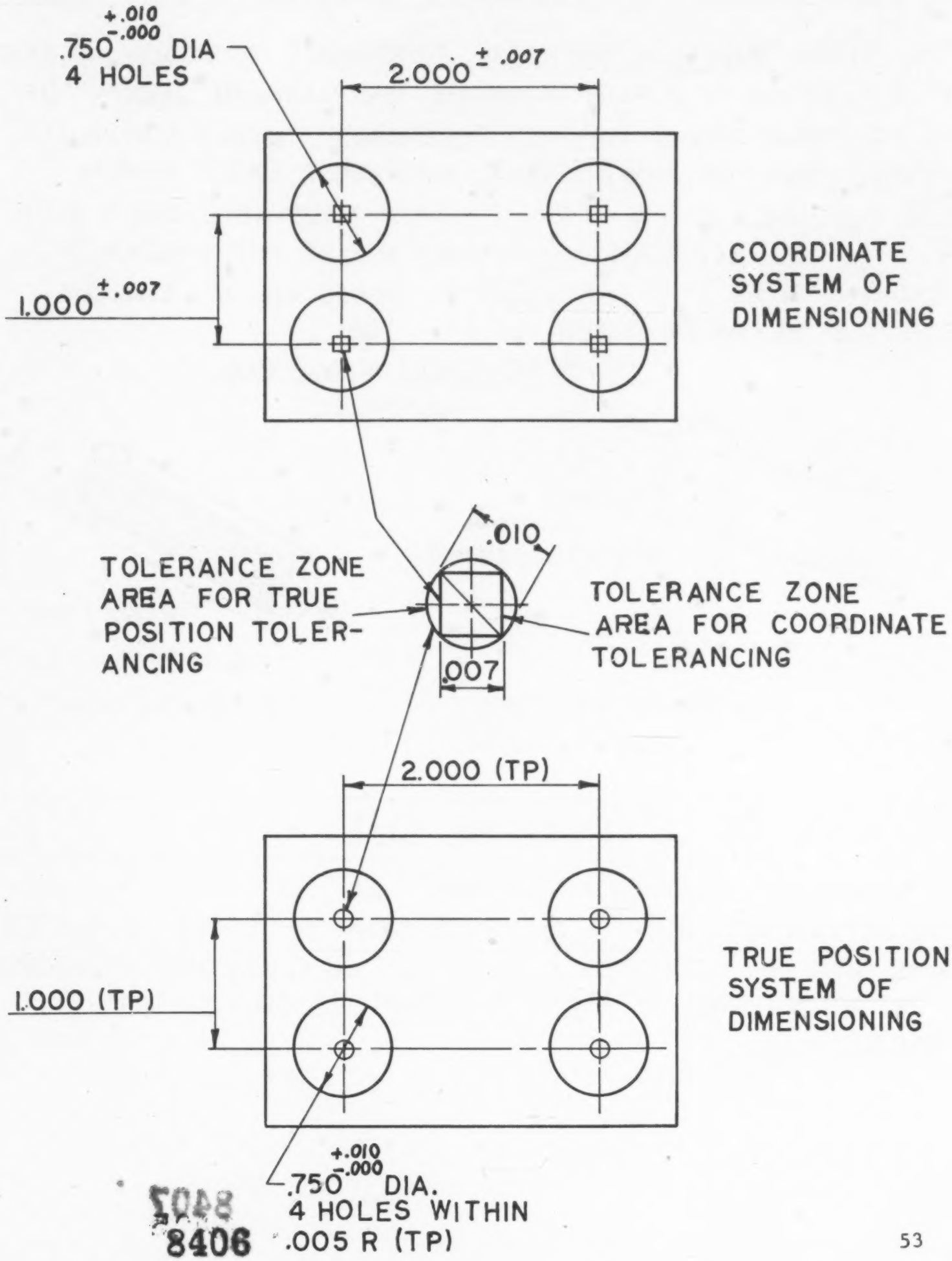
.750 +.010 -.000 DIA
4 HOLES
2.000 ± .007
1.000 ± .007
COORDINATE SYSTEM OF DIMENSIONING
.010
TOLERANCE ZONE AREA FOR TRUE POSITION TOLERANCING
TOLERANCE ZONE AREA FOR COORDINATE TOLERANCING
.007
2.000 (TP)
1.000 (TP)
TRUE POSITION SYSTEM OF DIMENSIONING
.750 +.010 -.000 DIA.
4 HOLES WITHIN
.005 R (TP)

8406

MAXIMUM MATERIAL CONDITION

THE TERM "MAXIMUM MATERIAL CONDITION" BASICALLY MEANS THAT A FEATURE OF A PART CONTAINS THE MAXIMUM AMOUNT OF MATERIAL PERMITTED BY ITS SIZE TOLERANCE. THAT IS, MAXIMUM MATERIAL CONDITION FOR INTERNAL FEATURES EXIST WHEN THESE FEATURES ARE AT THEIR MINIMUM ALLOWABLE SIZES AND FOR EXTERNAL FEATURES WHEN THEY ARE AT THEIR MAXIMUM ALLOWABLE SIZES. IT IS THE CONDITION RESULTING IN A MINIMUM CLEARANCE BETWEEN MATING PARTS. Ⓜ

(MMC) MAXIMUM MATERIAL CONDITION

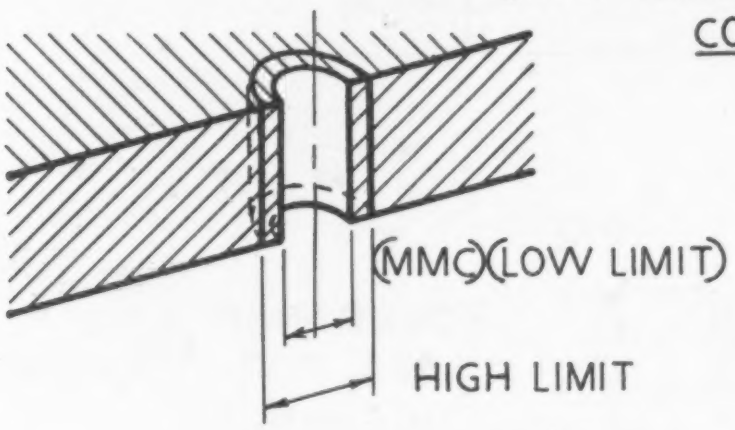

INTERNAL FEATURE (HOLE)

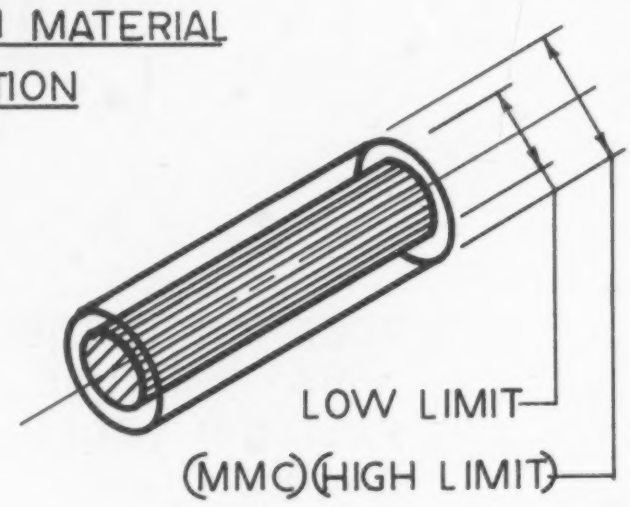

EXTERNAL FEATURE

REGARDLESS OF FEATURE SIZE

REGARDLESS OF FEATURE SIZE "RFS" Ⓢ

THE APPLICATION OF (RFS) TO A POSITIONAL OR FORM TOLERANCE MEANS THAT THIS TOLERANCE MUST NOT BE EXCEEDED REGARDLESS OF THE ACTUAL SIZE TO WHICH THE FEATURE OR FEATURES ARE PRODUCED.

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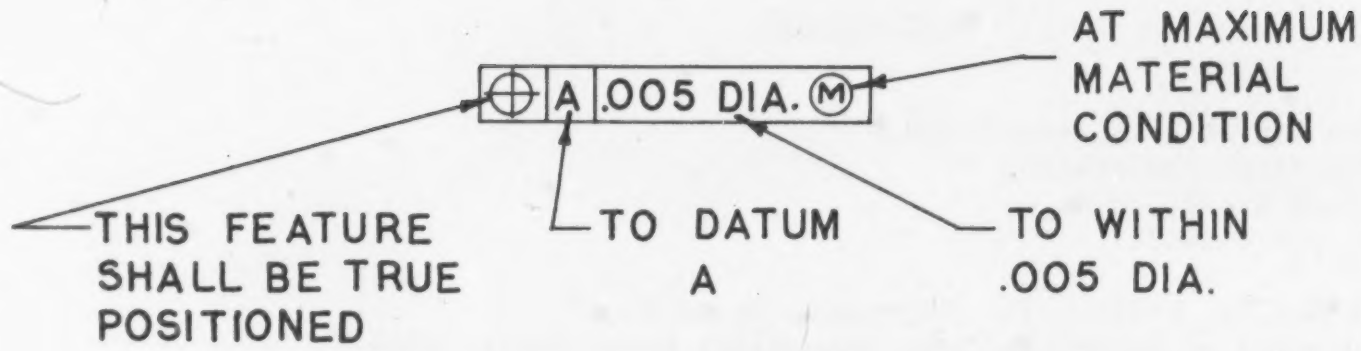

SYMBOL EXAMPLES OF CIRCULAR OR CYLINDRICAL TOLERANCE ZONE

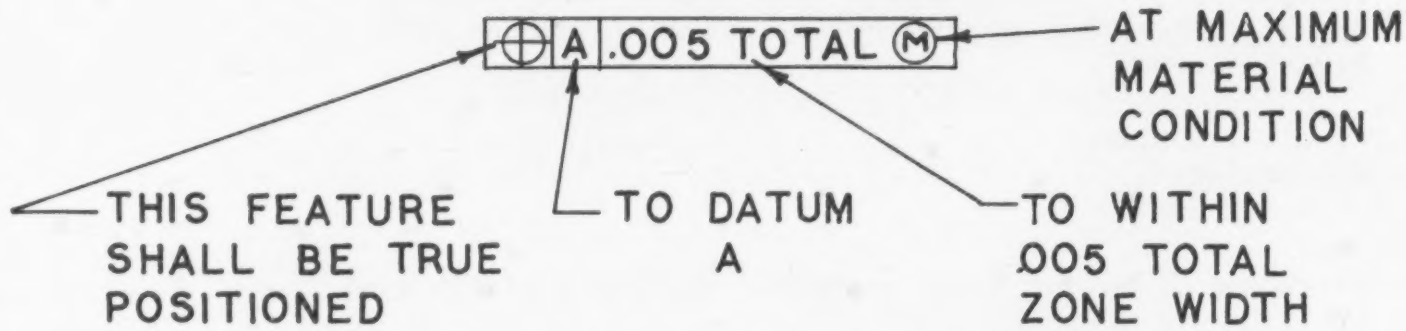

SYMBOL EXAMPLE OF NONCYLINDRICAL TOLERANCE ZONE

NOTE: ALL TOLERANCE OF CYLINDRICAL FEATURES SHALL BE EXPRESSED IN TERMS OF DIAMETER.

- THE ACTUAL HOLE CENTER MUST LIE WITHIN THE POSITIONAL TOLERANCE ZONE AS IN THE FIGURE BELOW.

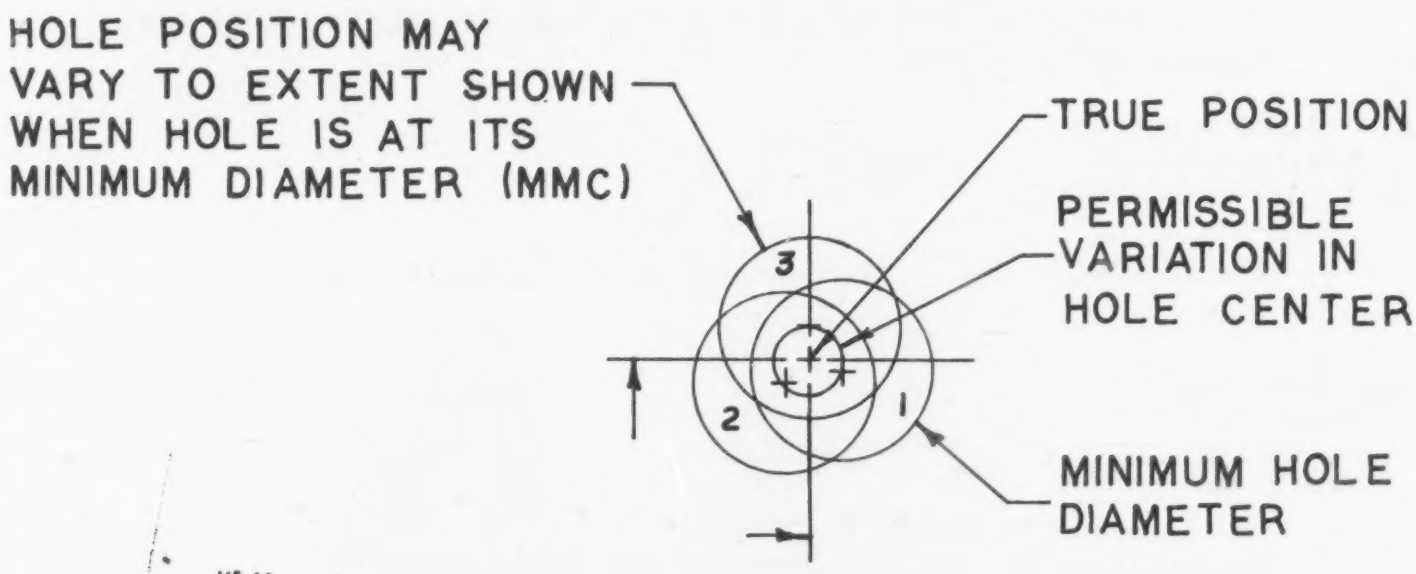

POSSIBLE HOLE LOCATIONS WITHIN TOLERANCE

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DRAWING MEDIA

Drawing paper and drafting techniques have changed and improved with the passage of time. Formerly, most engineering and technical drawings were rendered in pencil or ink on a relatively opaque sheet from which an ink tracing was made on a translucent sheet in order to obtain a reproduction.

Today, drawings are commonly rendered in pencil directly on a translucent sheet. Relatively opaque drawing papers are still produced and used; however, the term "tracing paper" has come to mean the translucent drawing paper on which most drawings are rendered, even though the "tracing" operation generally is outmoded.

Tracing Papers

The selection of satisfactory tracing paper is the first requirement for successful reproduction.

There are two primary types of tracing paper. "Natural paper" has natural translucency as it comes from the mill. "Prepared" papers, frequently called vellum, are of a similar basic paper stock, but have been treated to secure additional transparency so that prints may be made at a faster speed than with natural paper.

Translucency

Translucency--the characteristic of permitting the passage of light and, in printmaking, particularly the ultraviolet rays--is very desirable in paper used for making drawings, as it contributes substantially to good reproduction. Quite often one paper may appear more translucent than another, yet it may actually permit less ultraviolet transmission due to a yellowish tint to the paper which impedes the passage of the actinic rays of the printing machine. Therefore, a good tracing paper should be white or only slightly bluish in tint, since the blue tint is only a slight obstacle to the passage of ultraviolet light.

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Thinness also contributes to the translucency of paper, but because of other considerations--mainly that of strength--tracing papers are rarely made in basis weights lighter than 12 pounds. ("Basis weight" is defined as the weight of 500 sheets of 17" x 22" paper.)

Another important consideration in selecting tracing paper is uniformity of thickness, since variations in thickness will result in variations in translucency and unsatisfactory prints.

Surface Quality and Tooth

The softer grades of drawing pencils deposit more graphite on paper and hence produce more opaque lines. However, many draftsmen continue to use the harder grades because they produce sharper lines and do not smudge as readily under drafting instruments and perspiring arms and hands. If harder pencil grades are to be used, the drawing paper must have sufficient surface roughness, called "tooth," to wear away sufficient graphite to give a uniform line of consistent opacity. A smooth surface paper takes a more uniform deposit of graphite than one with "tooth." However, the graphite on the smooth paper will smear more easily than the line on the paper with "tooth." The harder leads should not be used, for they tend to engrave and emboss the paper, making successful erasures difficult.

A graphite or pencil line, under magnification, is not a continuous line but a chain of graphite particles with spaces or voids between them. The fewer open spaces in the graphite line the better, as light passing through the voids weakens the image on the reproduction.

Surface finish of the paper also is important when ink is used, for it must not absorb the ink excessively and neither repel nor "feather" it. The surface must take the ink exactly as the ruling or lettering pen delivers it. The ink must adhere to the paper surface so that it will not flake off after drying, but it must not penetrate so deeply that it cannot be erased with reasonable ease. Also, paper must not pucker due to the wetting action of

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the ink. Puckering, also called "cockling," "cockle," or waviness, may also be produced by perspiration from hands or arms and may interfere with the contact between the original and the reproduction paper during printing exposure, resulting in "fuzzy" prints.

Erasability

It is inevitable that engineering drawings will be changed or revised. This imposes a requirement that tracing paper withstand repeated erasures. Erasures should be made with extreme care, and the draftsman should be encouraged to use the type of eraser recommended for the drawing medium on which he is working.

A good tracing paper must be capable of withstanding not just one but several erasures in the same spot and should leave no "ghost" to show on the reproduction. Even after repeated erasures, the paper should permit the draftsman to draw clearly and sharply over the erased area without feathering the line.

Although pencil drawings are now predominant, occasionally an ink drawing must be made, or the draftsman may wish to use ink on some portion of his pencil drawing. Good erasing quality in the paper is a critical requirement in pencil drawings but is obviously much more important when ink is used.

Paper Strength - Aging Qualities

After the drawing has been completed and checked for accuracy, it goes to the graphic reproduction center to obtain the required number of prints.

Some mutilation, smudging, wrinkling, or other quality deterioration invariably results when the operator picks up the drawing as it emerges from the printer, and then feeds it back on the sensitized paper. The principal danger in such handling is the risk of tearing a drawing which represents a sizable expenditure of engineering and drafting time. Consequently, another important characteristic of tracing paper is high resistance to tearing.

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In the printing or reproduction machines, the drawing is subjected to intense ultraviolet light and high temperatures. Therefore, it must also resist curling, shrinking, stretching, and embrittlement. A good paper must resist "yellowing" with age, as this characteristic effectively filters the printing light, thus requiring greater printing time.

Paper must also have uniform "formation" or texture, otherwise fiber-clusters, foreign matter, or other blemishes such as watermarks, dirt, specks, or oil spots are likely to be reproduced in the prints.

The required characteristics of tracing paper are usually best met by carefully made 100% rag paper--preferably made from strong, uniform, new cotton rags, such as white shirt cuttings. There are no qualities in rag paper which may not eventually be achieved by wood fiber papers but, at the present, rag papers are superior.

Pencil Tracing Cloth

Pencil tracing cloth is used where greater durability and permanence are desired than can be obtained with paper. Such cloths are more expensive than paper and most of them permit the use of both pencil and ink.

One type of pencil tracing cloth is processed to make it quite impervious to moisture--whether from accidental wetting or the perspiration of the draftsman.

Other Drawing Media

Polyester film, acetate film, glass cloth, and other materials are being used in increasing amounts as drawing media. A distinctive characteristic of these materials is improved dimensional stability.

Polyester film appeared on the market early in 1958. Its popularity as a drafting room drawing media soared. Today it is perhaps the leading media, crowding out the old standbys such as vellum and cloth.

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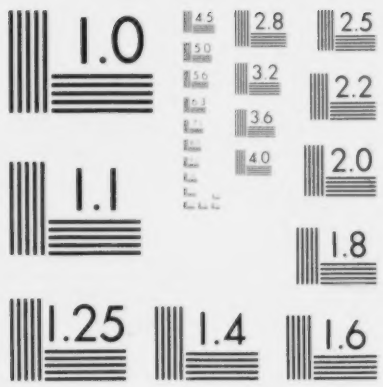

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

The reasons for its popularity are many, such as:

-- Toughness. This media offers almost complete immunity to tearing.

-- Stability. It is relatively unaffected by temperature and humidity; as a result it will not buckle or curl and always lies flat on the drawing board.

-- Permanence. Even after long periods in storage, drafting films will not become brittle and will not fade, age, yellow, crack, rip, peel, or wrinkle.

-- Erasability. Using a soft pencil eraser, preferably of the plastic type, lines can be removed easily without leaving "ghosts."

-- Printability. Due to its high degree of transparency it gives faster reproductions--a very important consideration in reducing print-back costs. Since stored drawings produced on mylar do not pick up opaquing properties, such as commonly happens with vellum and cloth, reproduction printing speeds are not slowed up and the user is assured of obtaining good first, second, or third generation sepia intermediates.

However, the same considerations in the care and preparation of drawings rendered on tracing paper and cloth generally apply in the use of these new materials.

Grades of Pencils

The quality and grade of the pencil used is important in the preparation and reproduction of technical drawings. Since wood drawing pencils and mechanical pencil leads are available in many degrees of hardness, the grade selected should be compatible with the type of drawing medium to be used. Careful selection, after adequate tests, will be well worthwhile. Avoid the use of regular writing pencils, since they tend to produce gray lines which do not print well.

The selection of the grade of pencil or lead, under a given set of conditions, is determined by a number of factors, such as:

-- Quality and texture of the drawing medium
-- Atmospheric conditions such as humidity and their effects on the drawing medium
-- Type of work being done
-- Method of reproduction
-- Draftsman's personal preference

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Before a particular brand of drawing pencil or lead is selected, it is suggested that it be tested for the following characteristics:

-- Uniformity of grading and labeling
-- Smoothness
-- Point strength
-- Wear
-- Wood clinching
-- Straightness
-- Smudging
-- Lead centering
-- Erasability

Graphite pencils are not recommended for use with mylar drafting film, as a certain amount of graphite flaking will occur which tends to smudge the drawing. Special plastic lead pencils have been developed especially for this drafting media.

As important as media and leads are to the production of quality documents, correct drafting techniques are equally essential in the making of good prints. Thin or light pencil lines "burn out" during the reproduction process and require retouching before acceptable reproductions can be obtained.

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Washington, D. C. 20402

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UU-P-561	Paper, Tracing
CCC-C-531	Cloth, Tracing
TT-I-528 TT-I-532 TT-I-533	Ink, Drawing
L-P-519	Plastic Sheet, Tracing, Glazed and Matte Finish
SS-P-212	Pencils and Leads, Art and Drafting

MICROFILMING

Microfilming is a photographic process by which documents such as engineering drawings are reduced to a small fraction of their original size.

In its early days, microfilming was valued as insurance against disaster or for its space-saving features. It became apparent that existing methods of handling active engineering information were not adequate to satisfy the demands imposed by industry which was becoming more and more automated. A new application for microfilming emerged. Combining the potentials of microfilm and the EAM (Electric Accounting Machine) card, by mounting a micro-image of an engineering drawing in an apertured EAM card, resulted in a new approach to the handling of engineering information.

The use of unitized microfilm provides a radically new medium with potential far beyond that of a single print. It is not just a new technique for making prints. It is a new working tool around which a fully integrated system can be built.

Some of the more important features of microfilming as related to the function of providing an improved and more economical means of handling engineering information are:

-- It is a compact medium for information storage. Its ability to concentrate large amounts of information in a small package provides for a more efficient system.

-- Drawings are reduced to a uniform size and mounted in EAM cards which, in turn, permits the introduction of automated functions.

-- The original microfilm may be duplicated, and all copies of the film may be used to produce enlarged prints, or the film can be viewed in a reader without printing.

-- It simplifies the maintenance of a complete and up-to-date drawing file.

-- Files become more efficient, more compact, and more easily controlled. Satellite and archival files become feasible and financially practical.

-- Costs--such as reproduction, handling, and mailing--are reduced.

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There are many variations in microfilm systems, depending on the characteristics of equipment produced by each manufacturer. However, regardless of the specifics of a system, the above benefits result from conversion to a microfilm system.

The following equipment is required to produce microfilm:

-- Camera - for exposing the microfilm

-- Processor - for developing the microfilm

-- Inspection equipment - for checking film quality

-- Electric accounting machines - for entering the visible identification information on aperture cards

-- Mounter - for cutting frames of microfilm and mounting each into an aperture card

-- Microfilm printers - for making film copies required for distribution

In the process of making microfilm, documents are prepared for photographing and taken to the camera. A microphotograph is made with a precision camera using high-resolution film, which is developed in a processor capable of controlling development within very close limits. The processed film is inspected to assure that the camera and processor have produced the desired quality of microfilm.

After inspection, the film is ready for mounting in aperture EAM cards. These must have identification information printed on them by EAM equipment, as the micro-image on the film is too small to be read without magnification.

The mounting operation permanently seats the micro-image of the drawing accurately in the center of the aperture.

The microfilm is now ready for use. It may go directly into the engineering file or it may be used as a master to make additional copies for distribution.

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The following equipment is required to use microfilm:

-- File equipment

-- Manual or automated card-to-card printers

-- Readers

-- Enlarger-printers (reader-printers)

A card-to-card printer is a device capable of making an exact copy of a microfilm in a few seconds. Blank sensitized film mounted in a "copy card" is used to make the copy. It may be exposed and developed in a normally lighted room.

A reader is a projection device which enlarges a micro-image sufficiently for normal reading. A large reader is used when it is essential that the whole image be viewed at the same time. The small reader provided with a scanning device is finding wide use as a desk-top reader.

Enlarger-printers make enlarged prints (hard copy) and reproducibles from microfilm. Some models have facilities for both viewing the image and making enlargements. These are called reader-printers.

It should be emphasized that microfilm is not a panacea for all reproduction problems. There are situations where it fits, and there are others where it does not fit.

Let us take as an example a design engineer who uses a few drawings at a time. He may spend a great deal of time studying them while he is considering a design change. It may be necessary for two or three people to gather around these drawings to study and discuss them. Obviously, it would be difficult to work entirely from a reader. A situation like this suggests the need for prints.

This situation may be contrasted with that of engineers who are engineering new jobs from existing drawings. They may require many drawings, each providing information which must be taken off and entered as part of the data necessary to engineer the new job. Often, a drawing is referred to only

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to obtain a single number, while at other times substantial information must be taken from the drawing. For this type of usage, a reader would serve very well, although this same engineer--as the job progresses--may find it necessary to have prints or reproducibles to mark and transmit to others.

It is apparent that, if a system is built totally around readers without regard for the need for prints, it would not be a well-engineered application. At the same time, if the system is built totally around printmaking, the advantages and economies of using readers would not have been given proper consideration.

Engineering personnel who travel or who work at some point remote from central engineering information sources are always at a disadvantage when prints are needed. Because the compactness of microfilm permits large numbers of drawings to be carried conveniently and economically, the problem is rather simply resolved.

By virtue of the characteristics of microfilm, engineering personnel have easy access to all of the information needed. This assures them of the most important element in getting their job done; that is, to be able to get information immediately and to see the job to a conclusion with fewer starts, stops, and delays which result from lack of complete information.

While there are some conditions where quality seems to improve in the microfilming process, the general rule is that there is always some loss, however small, in making any kind of copy by any reproduction process. This, then, gives emphasis to the fact that best results will be obtained with strict observance to certain rules and guides in the preparation, changing, handling, and storing of drawings.

Since the quality of the original document is so important to an effective microfilm system, it is necessary to consider the role which the draftsman plays in the development of an effective system.

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It is imperative to remember that a drawing is a tool. Its function is to convey information to the production and assembly floor employees for the manufacture of an item of functional hardware. These people get all of their information for processing and fabricating from a copy of the original drawing. Each component and the finished product is inspected with the aid of a drawing copy. The product is shipped to the consumer who installs, inspects, integrates into a system, and maintains it through the use of a drawing copy. These copies may, of course, take many forms, but the emphasis here is on microfilm.

One common drawing size, 34" x 44", will be reduced to a piece of film 1-1/4" x 1-3/4", with a maximum image area of 1.197 x 1.615. This is a reduction of 30 times. A 3/8" high letter reduced 30 times will become 1/80 of an inch; smaller than a period. A closed 5 or 3, or any letter not properly made, will become illegible in the reproduction process. If the man in the shop or in the field attempts to interpret these figures and guesses wrong, untold loss in terms of scrap and time will result, and schedules will not be met. Hardware can be fabricated economically and accurately only with clear, concise drawing copies. These can be made only from clear, concise, well-drawn and well-organized originals. It is often necessary to make new originals from copies and the resulting "original" may be, in part, a third or fourth generation from the initial original.

Typical house standards as they affect a draftsman's work might be these:

-- The minimum size numeral to be used for the drawing number should not be less than .40 of an inch in height.

-- Dependent on the size of the drawing paper, the following are minimum heights of letters and figures to be used for titles, dimensions, and notes:

8.5 x 11 -- .10 minimum	22 x 34 -- .12 minimum
11 x 17 -- .10 minimum	34 x 44 -- .20 minimum
17 x 22 -- .10 minimum	34 x 60 -- .30 minimum

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-- Lines of lettering should be spaced approximately .12 inches apart.

-- A minimum space of .04 should be maintained between letters, symbols, numerals, dashes, and decimal points.

-- Dashes used in notes should be approximately .10 inches long and cleanly broken.

-- Letters and numerals such as A-N-M-Y-V-W-4 must have a clean, sharp, and full opening at each vertex.

-- Numerals 3-5-6-8-9 must have full round loops.

-- Decimal points must be uniform, dense, and large to be clearly visible on reduced-size prints. Decimal points should be placed in line with the bottom of the associated digits and be given adequate space.

Specific examples of poor drafting techniques which result in poor prints by a reproduction operation include: poor erasures, crowded dimensions, use of hard pencils, improper letter size, crowded lines, lack of uniformity in line density, failure to restore accidental erasures, poor planning, paper clips and cleaning materials left rolled in the drawing, and poorly affixed stick-on's.

The foundation for quality reproductions is built by the draftsman. He must be aware of what happens to his drawing once it is completed. A good legible copy cannot be made without a good original. Unless the draftsman concerns himself and avails himself of all of the aids at his disposal, his effort is for naught.

It should be kept in mind, also, that most engineering-drawing microfilm systems provide enlarged blowbacks which are smaller than the original. This places even greater emphasis on the establishment of adequate drafting standards. It leaves little doubt as to the important part the draftsman plays in a successful microfilm program.

The advantages of microfilm systems have, here, been oriented to engineering personnel. These advantages hold true for all users of microfilm, including tool engineers, production, purchasing, sales, and quality control personnel.

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To gain these advantages one must be able to obtain a quality microfilm. The military, as well as industry, has written standards and specifications related to inspection of microfilm. One of the military specifications requires the capacity for a completely legible copy from a fourth generation microfilm. This means that five copies must be made, one from the other, and reemphasizes the quality which the initial document must possess. Also, as previously stated, blowbacks (reproductions) from microfilm are not to the full, original size. This reaffirms the need for lettering and dimensions to be larger, so as to compensate for this reduction and for sharp, clear letters and figures. Line weight (width) and density are very important so as to provide good contrast.

To sum up the draftsman's role as it relates to microfilm is very simple. Quality microfilm starts with a quality document. This is the drawing. Quality, or a better term--workmanship--must, in the eyes of the draftsman, be considered as important as the technical content of the drawing. What good is a drawing that is 100% technically correct but cannot be used to make copies in reproduction systems such as microfilm because of poor workmanship?

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APPENDIX

The preceding materials have been prepared as a means of assisting instructors of drafting in their efforts to present instruction which closely parallels current industrial practice. Since some may experience difficulty in securing prints from industries, the following are included as prints typical of industry and have been solicited from several sources.

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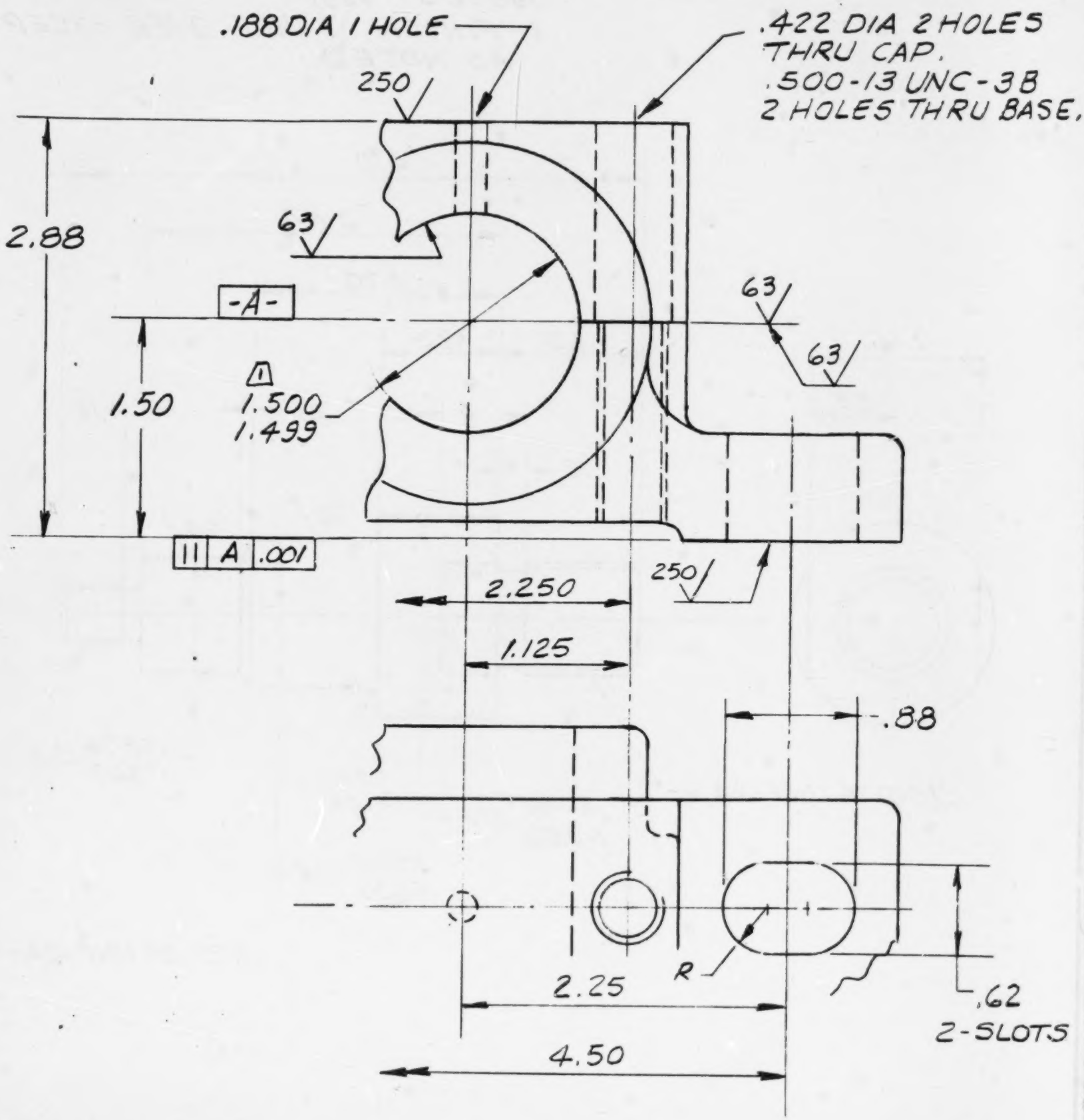

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1 (D-3) WAS 1.460 1.459			
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		FOR TOLERANCES NOT SPECIFIED SEE 500-SERIES SHOP PRACTICE STANDARDS	MATL REF C1-60 WT R F
		DR CA 5-20-68	SIMILAR TO 50-123-455
		CH	GPH NO.
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			PART NO. 50-123-457-001

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NOTES:
1-FINISH 125/ ALL OVER EXCEPT AS NOTED.

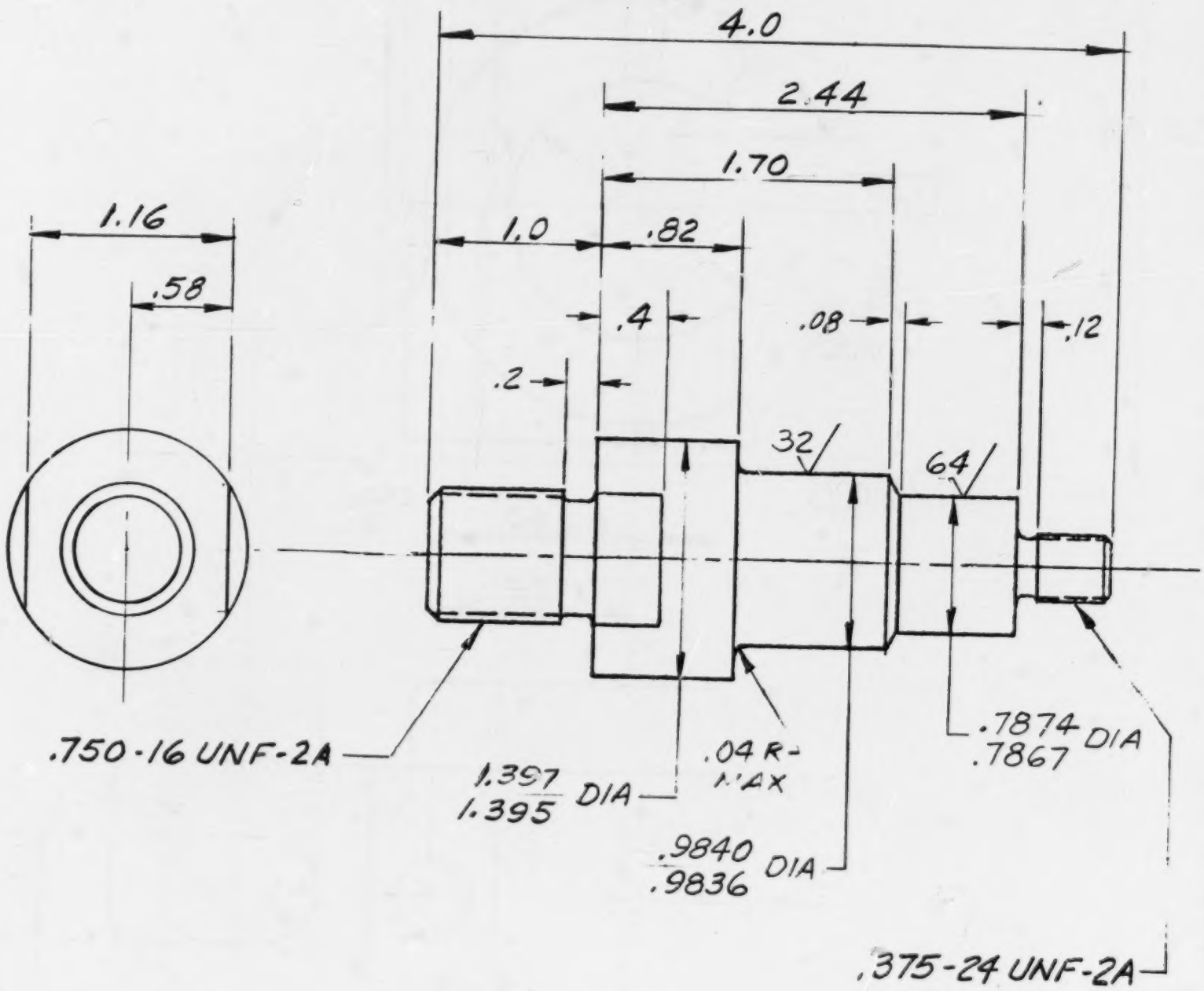

01	5-15-68 CA		NAME: SHAFT, FAN
		UNLESS OTHERWISE SPECIFIED: 1-PLACE DEC ± .020; 2-PLACE DEC ± .010; 3-PLACE DEC ± —; ANGULAR ±; FOR TOLERANCES NOT SPECIFIED SEE 500-SERIES SHOP PRACTICE STANDARDS; MACHINED SURFACE TEXTURE ✓	MATL: 1.5 X 4 BARROUN
			SAE 1045 CD; WT R 2 #; F —
		DR CA 5-15-68; CH; AP; SIMILAR TO NONE	8429; GPH NO.
		SCALE 1:1; SHEET 1	PART NO. 50-123-456-001

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327.
2. ALL PART NUMBERS ARE FOR REFENCE ONLY.
3. REFERENCE DESIGNATIONS NOT INCLUDED IN PARTS TABLE ARE FOR REFERENCE ONLY.
4. DRAWINGS FOR REFERENCE:
   7885572 ASSEMBLY DRAWING

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD

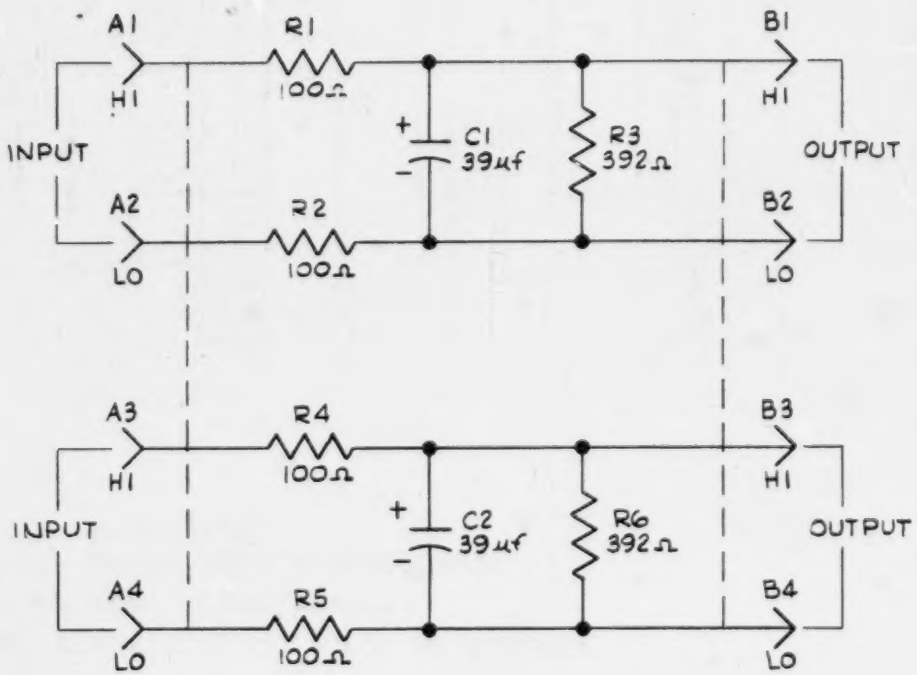

REF DES.	PART NO.	DESCRIPTION	SCHEMATIC DIAG. OR VALUE, TOL RATING
C1	8596448-013	CAPACITOR, TANTALUM	39 μf - ±10% - 10VDC
C2	8596448-013	CAPACITOR, TANTALUM	39 μf - ±10% - 10VDC
R1	8596449-101	RESISTOR	100Ω - ±1% - 1/20 WATT
R2	8596449-101	RESISTOR	100Ω - ±1% - 1/20 WATT
R3	8596449-158	RESISTOR	392Ω - ±1% - 1/20 WATT
R4	8596449-101	RESISTOR	100Ω - ±1% - 1/20 WATT
R5	8596449-101	RESISTOR	100Ω - ±1% - 1/20 WATT
R6	8596449-158	RESISTOR	392Ω - ±1% - 1/20 WATT

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DECIMALS ± — 3 PLACE DECIMALS ± — ANGLES ± —

MATERIAL —

APPROVAL

REFERENCE (ACSK ONLY) D.O. 70754

DRAFTSMAN [signature] 6-FEB 68 (DAY MO YR)
CHECKER Bert R. Walker 6 FEB 68
ENGINEER [signature]
APPROVAL [signature]
CONTRACT F04695-67-C-0054
DESIGN ACTIVITY APPROVAL
OTHER APPROVAL

SCHEMATIC DIAGRAM, ELECTRICAL - HIGH GAIN DC AMPLIFIER CIRCUIT CARD ASSEMBLY

SIZE C | CODE IDENT NO. 99974 | 7885577

SCALE — | SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327.
2. MATERIAL: ALUMINUM ALLOY 2024-T351 PER QQ-A-250/4, TEMPER T351 ES2104-001).
3. FINISH: ELECTRICAL INSULATING COATING, HEAT CONDUCTIVE PER ES2620-001. SURFACE Z TO BE FREE FROM COATING.
4. UNLESS OTHERWISE SPECIFIED:
   A. SURFACE ROUGHNESS MUST NOT EXCEED 125√.
   B. ALL CORNERS TO BE .010 R OR CHAMFER.
5. MUST BE FREE FROM BURRS.
6. IDENTIFY USING PART NUMBER PER MIL-STD-130 (ES267).

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD

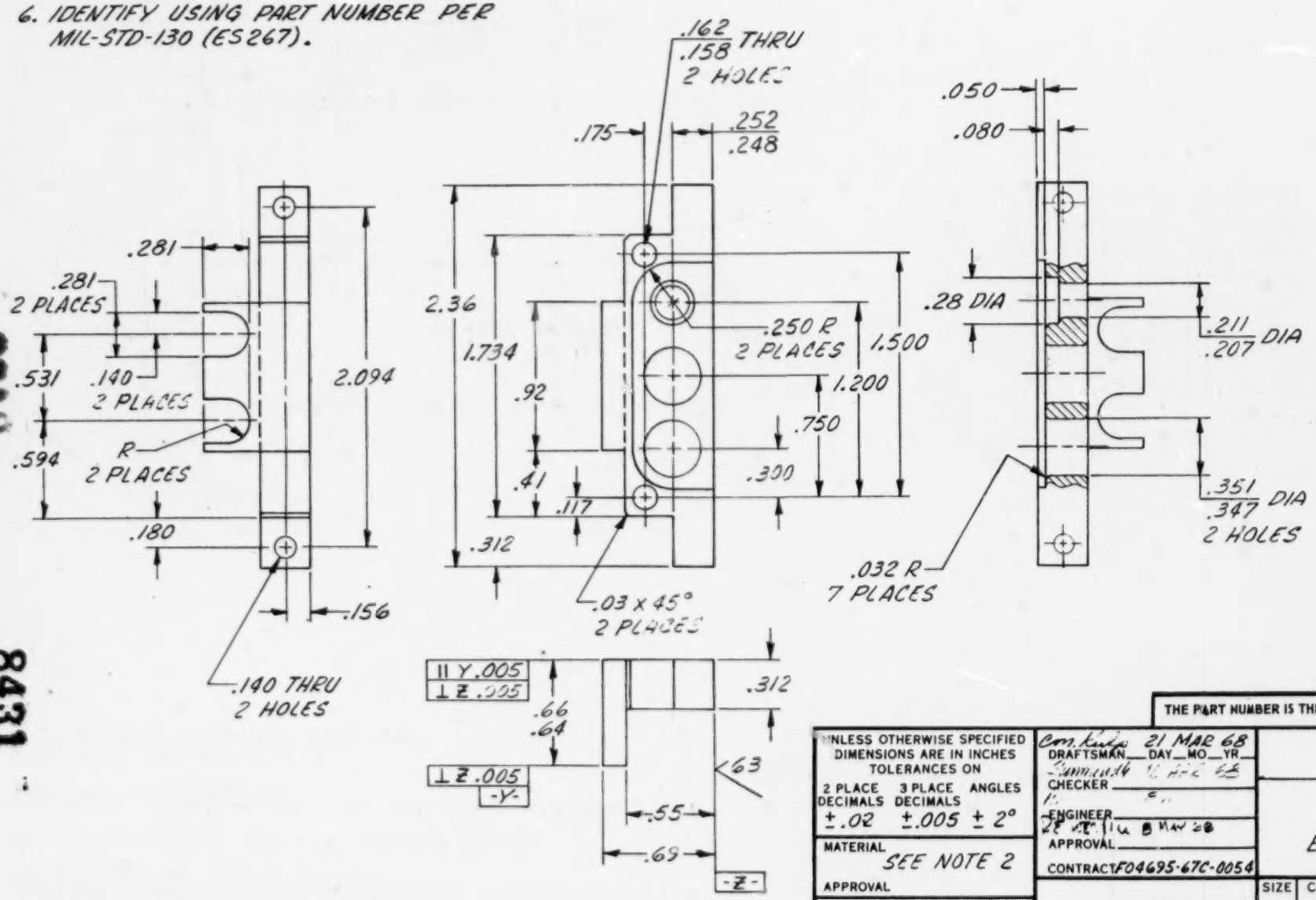

SHEET NUMBER	ZONE	DASH NUMBER
		001

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON

2 PLACE DECIMALS	3 PLACE DECIMALS	ANGLES
±.02	±.005	± 2°

MATERIAL: SEE NOTE 2

APPROVAL

REFERENCE (ACSK ONLY): DO 70783

DRAFTSMAN: Con. Kulp DAY 21 MO MAR YR 68
CHECKER: [illegible] 12 APR 68
ENGINEER: [illegible] 8 MAY 68
APPROVAL
CONTRACT: F04695-67C-0054
DESIGN ACTIVITY APPROVAL
OTHER APPROVAL

HEAT SINK, ELECTRONIC COMPONENT

SIZE	CODE IDENT NO.	
C	99974	7885664

SCALE 2:1 SHEET 1 OF 1

0628
8431

NOTES:
1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000.
2. MATERIAL: QQ-C-533 COND 1/4 HARD (ES2108 BERYLLIUM COPPER).
3. UNLESS OTHERWISE SPECIFIED:
   A. ALL INSIDE BEND RADII TO BE .02 MAX R.
4. MUST BE FREE FROM BURRS AND SHARP CORNERS.
5. IDENTIFY USING PART NUMBER PER MIL-STD-130 (ES267).

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD

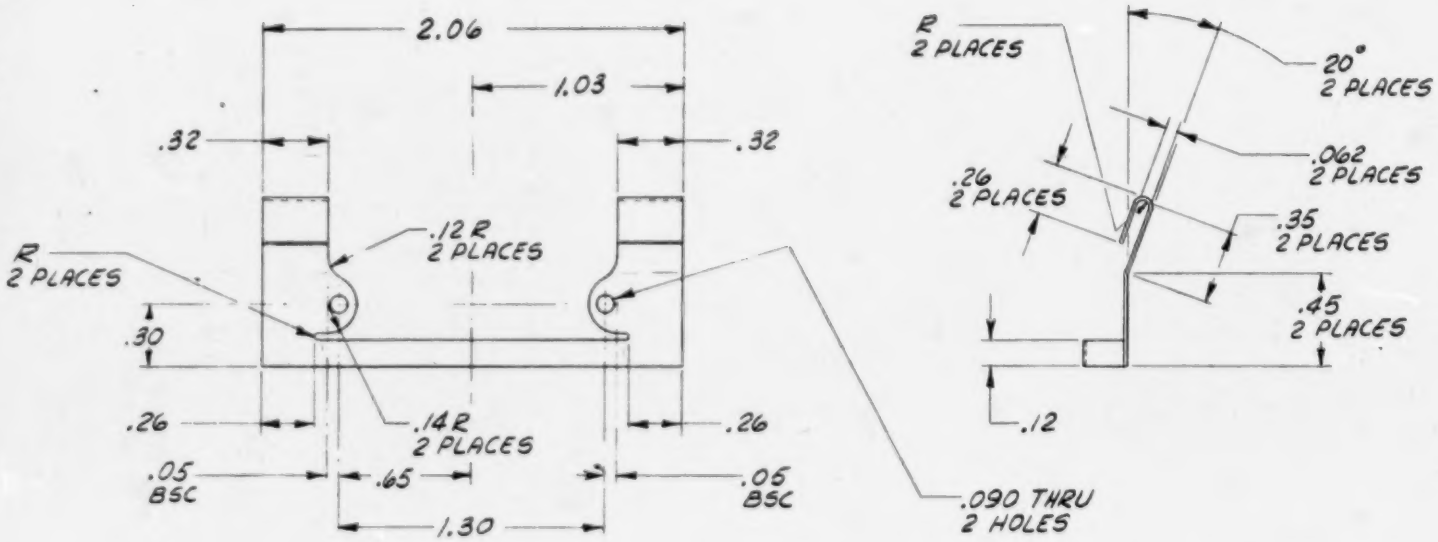

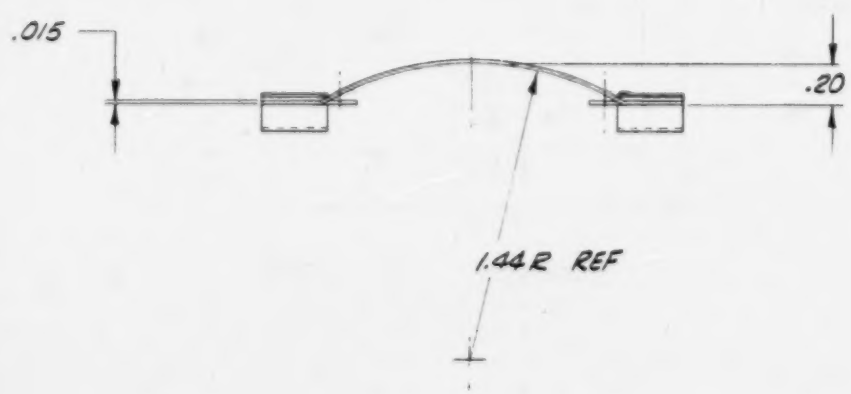

SHEET NUMBER	ZONE	DASH NUMBER
		001

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

2 PLACE DECIMALS	3 PLACE DECIMALS	ANGLES
±.01	±.005	±1°

MATERIAL: SEE NOTE 2

APPROVAL

REFERENCE (ACSK ONLY): D.O. 68237

DRAFTSMAN: J.A. Kendrick DAY 18 MO APR YR 68

CHECKER: [illegible] 19 APR. 68

ENGINEER: E. Pewlick 19 APR. '68

APPROVAL: [illegible]

CONTRACT

DESIGN ACTIVITY APPROVAL

OTHER APPROVAL

STRAP RETAINING - OUTER ROLL GIMBAL

SIZE	CODE IDENT NO.	
C	99974	7884586

SCALE 2:1 SHEET 1 OF 1

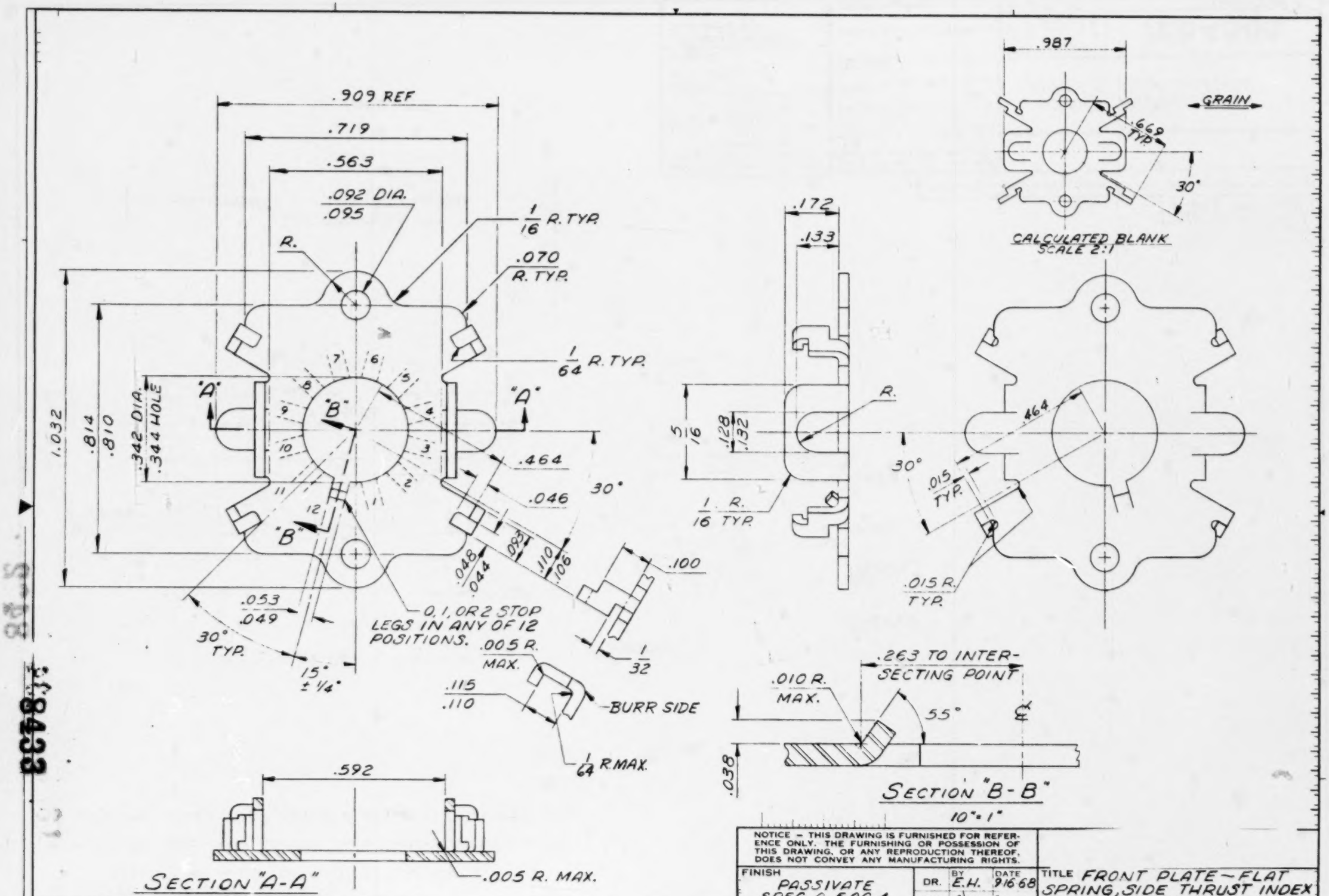

NOTICE – THIS DRAWING IS FURNISHED FOR REFERENCE ONLY. THE FURNISHING OR POSSESSION OF THIS DRAWING, OR ANY REPRODUCTION THEREOF, DOES NOT CONVEY ANY MANUFACTURING RIGHTS.

FINISH: PASSIVATE SPEC. 0-5AC-4	DR.	E.H.	9-16-68
MATERIAL: .035±.001 x 18-8 STAINLESS STEEL, TYPE 302, 2B FIN, ANNEALED, RB-75-90	CHK.	[illegible]	9-17-68
	ENG.	[illegible]	9-19-68
	ENG.		
	APPD.		
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES. TOLERANCE ON DECIMALS ±.005 FRACTIONS ±.0 ANGLES ±½°	PRINT CODE		

TITLE: FRONT PLATE – FLAT SPRING, SIDE THRUST INDEX SUBMIN. SWITCH

PART NO. DvP12-69

ASSY. DWG.

CODE IDENT. NO.	DWG. NO.	SIZE	ISSUE
	DvP12-69	C	01

SCALE 5" = 1" SHEET OF

REVISIONS

01	9-16-68 EH						

S-88
8423

NOTE:
PART SYMMETRICAL ABOUT VERTICAL ℄.

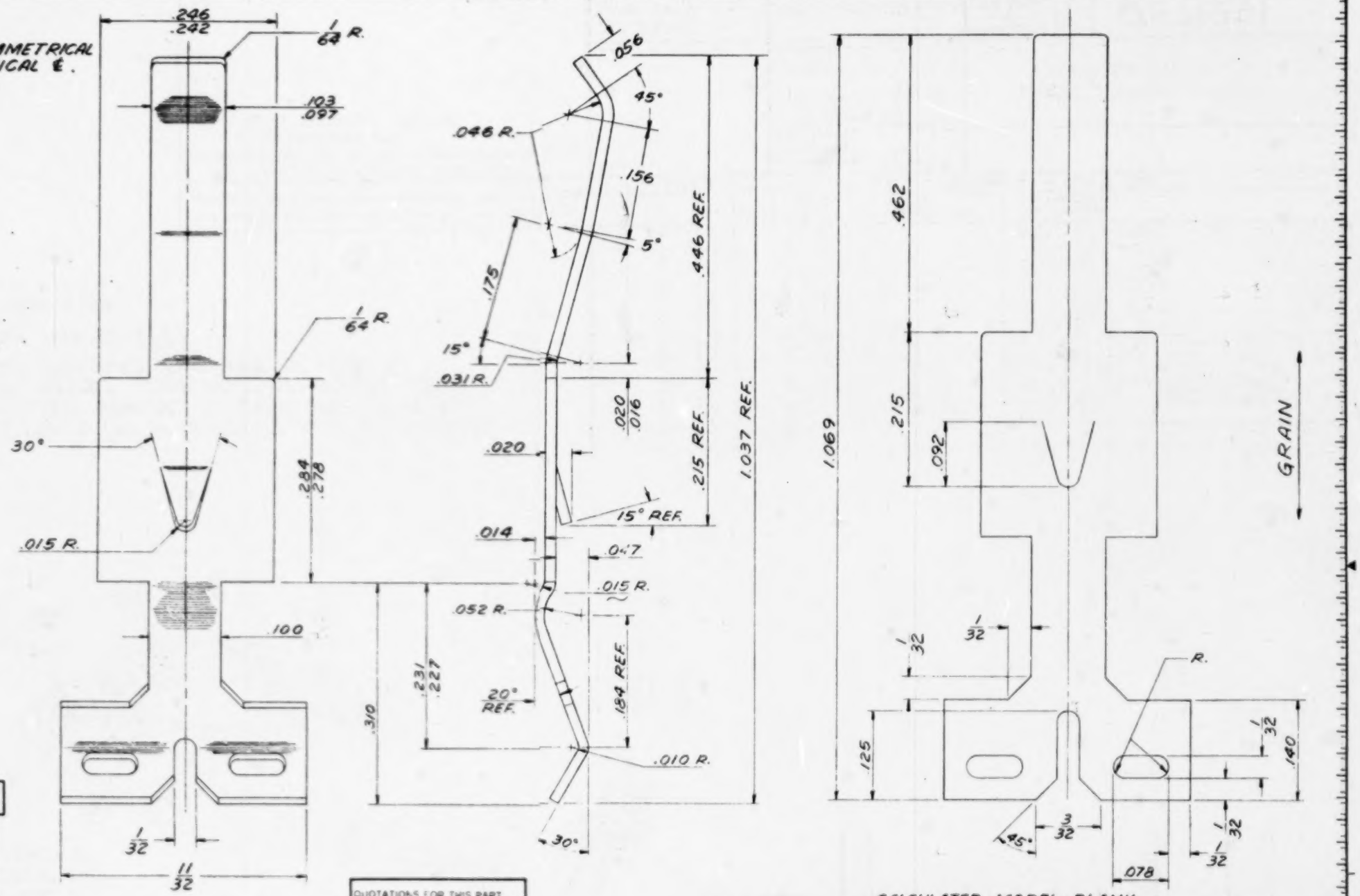

CALCULATED MODEL BLANK

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE BEFORE PLATING

QUALITY STANDARDS

DIMENSION	AQL
.231 .227	1.0
.246 .242	1.0
.215	1.0
.047	1.0
.020	2.5

QUOTATIONS FOR THIS PART ARE RECEIVED WITH THE UNDERSTANDING THAT QUALITY WILL BE SUCH TO MEET THESE STANDARDS. DIMENSIONS OTHER THAN THESE SPECIFIED ARE INSPECTED TO 4.0 AQL
REF MIL STD 105

REVISIONS

REVISED & REDRAWN 03 1-28-69 JAV						

NOTICE – THIS DRAWING IS FURNISHED FOR REFERENCE ONLY. THE FURNISHING OR POSSESSION OF THIS DRAWING, OR ANY REPRODUCTION THEREOF, DOES NOT CONVEY ANY MANUFACTURING RIGHTS.

	BY	DATE
DR.	JAV	1-28-69
CHK.		
ENG.		
ENG.		
APPD.		

FINISH: LEAD TIN PLATE SPEC. O-SAR-4

MATERIAL: .0159 ± .001 X BRASS CABRA 260 SPRING TEMPER

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES. TOLERANCE ON DECIMALS ± .005 FRACTIONS ± .010 ANGLES ± 1°

PRINT CODE

TITLE: RIGHT & LEFT CONTACT LIGHTED BUTTON ISOSTAT SWITCH

PART NO. DvP 70-27

ASSY. DWG. DvP 70-91 & 92 B

CODE IDENT. NO. | DWG. NO. DvP70-27 | SIZE C | ISSUE 03

SCALE 10 X | SHEET | OF

8432 . 4284

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000.
2. MATERIAL: AL ALY 6061-T6 PER QQ-A-250/11 TEMPER T6.
3. MUST BE FREE FROM BURRS AND SHARP EDGES.
4. FINISH: CHEMICAL TREATMENT PER MIL-C-5541, CLASS I.
5. IDENTIFY USING PART NUMBER PER MIL-STD-130.

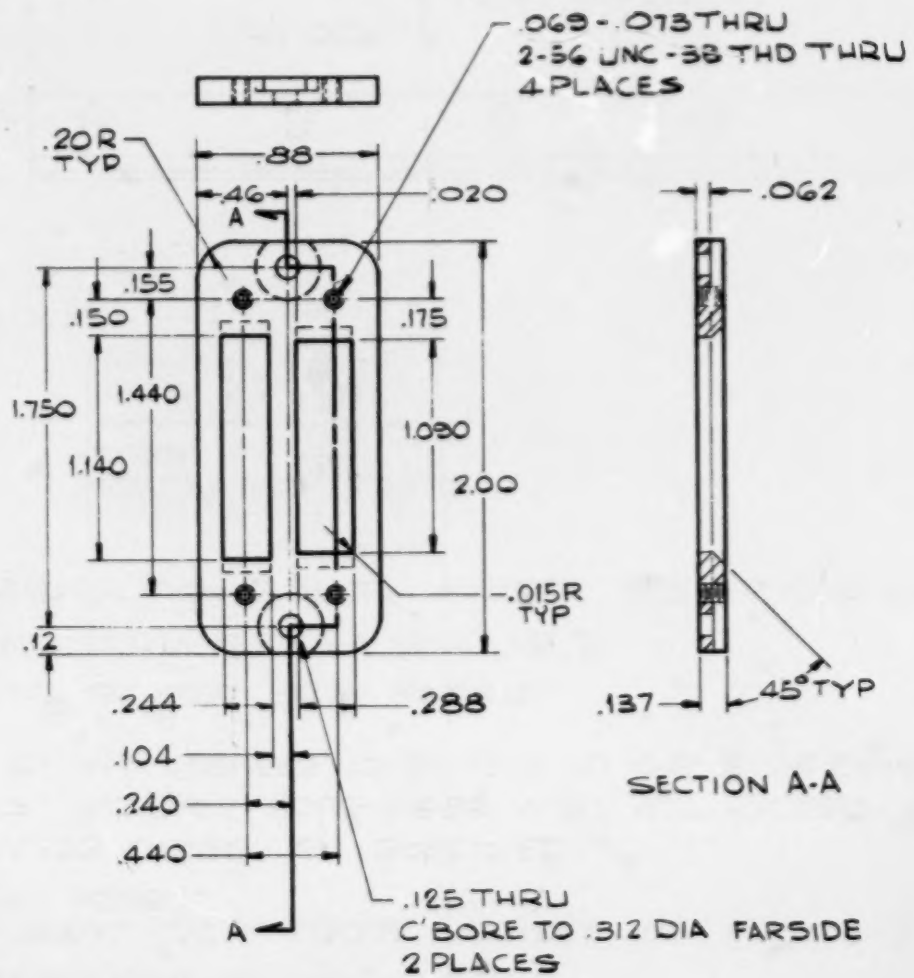

SHEET NUMBER	ZONE	DASH NUMBER
		001

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DECIMALS ±.02 3 PLACE DECIMALS ±.005 ANGLES ±2°

MATERIAL: SEE NOTE 2
APPROVAL

REFERENCE (ACSK ONLY): DO. G5815, LM 7275-B

DRAFTSMAN: 17-NOV-67 (DAY MO YR)
CHECKER: 6 DEC 67
ENGINEER
APPROVAL: 7 DEC 67
CONTRACT
DESIGN ACTIVITY APPROVAL
OTHER APPROVAL

PLATE, MOUNTING, ELECTRICAL CONNECTOR

SIZE	CODE IDENT NO.	
C	99974	7884223

SCALE 2:1 SHEET 1 OF 1

8436

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000
2. MATERIAL - QQ-A-200/9 TEMPER T5 (ES2149-2 AL ALY TYPE 6063).
3. UNLESS OTHERWISE SPECIFIED:
   A. SURFACE ROUGHNESS MUST NOT EXCEED 125/.
   B. ALL CORNERS TO BE .005 TO .015 R OR CHAMFER.
4. MUST BE FREE FROM BURRS.
5. FINISH: ANODIZE PER MIL-A-8625, TYPE II.
6. IDENTIFY USING PART NUMBER PER MIL-STD-130 (ES267).

DASH NO	DIMENSION A
-001	.066 / .058
-002	.086 / .078

REVISIONS

ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD
	A	① DELETED .066/.058, & ADDED TABLE, ZONE C-4, ② DELETED -001, SHT NO, & ZONE BLOCK, ZONE A-1.	MXC 226151	5 SEP 67	JRK
	B	REVISED	MXC 229081	11 DEC 67	JRK JRK

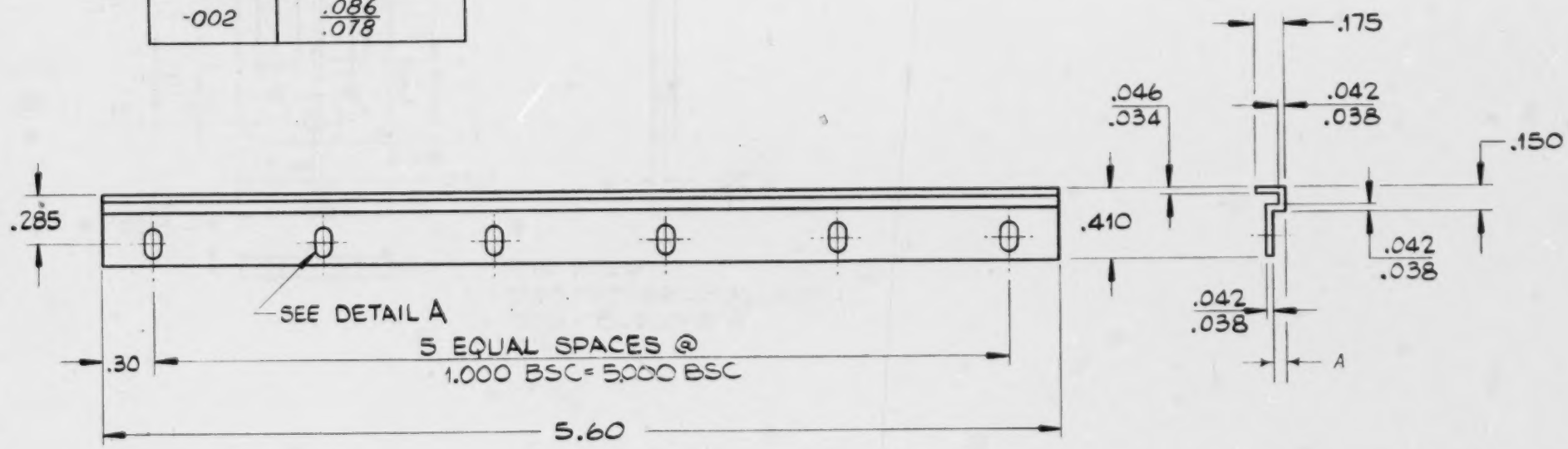

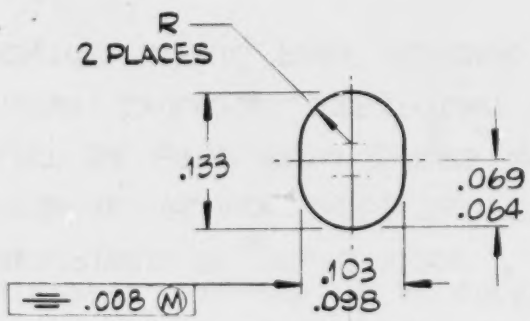

DETAIL A
SCALE 10:1
6 PLACES

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DECIMALS ±.01 3 PLACE DECIMALS ±.005 ANGLES ±

MATERIAL SEE NOTE 2

APPROVAL

REFERENCE (ACSK ONLY) DO 65617

DRAFTSMAN 20 JUL 67 DAY MO YR

CHECKER 26 JUL 67

ENGINEER

APPROVAL

CONTRACT

DESIGN ACTIVITY APPROVAL

OTHER APPROVAL

BRACKET, CIRCUIT CARD

SIZE C | CODE IDENT NO. 99974 | 7883997

SCALE 2:1 | SHEET 1 OF 1

8138

8437

7901862 D

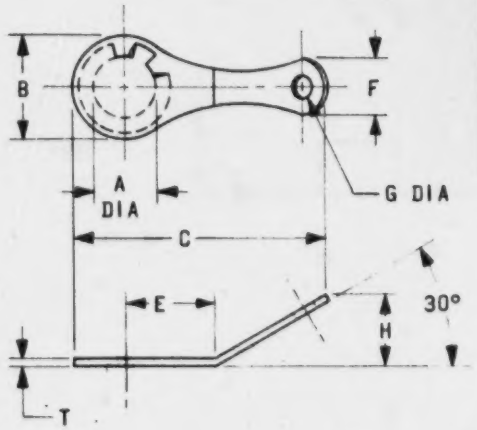

REQUIREMENTS:

MANUFACTURER'S CATALOG ITEM IN TABLE PER DATA SOURCE NOTED.

1 MATERIAL: BRONZE

2 FINSIH: HOT SOLDER DIP

REVISIONS

SYM	DESCRIPTION	CHG NO.	DATE	APPD.
D1	D1 REDRAWN, ADDED -006, -008 AND ASSOCIATED INFORMATION	CCM 193151	26-DEC-63	J.B. / VM.

AC SPARK PLUG DASH NO.	SCREW SIZE (REF)	A DIA MAX	A DIA MIN	B	C	E	F	G DIA	H	T THICKNESS	MANUFACTURER'S PART NUMBER
-004	NO. 4	.123	.116	5/16	13/16	17/64	11/64	3/32	15/64	.018	2103-04-00
-006	NO. 6	.150	.142	5/16	13/16	17/64	11/64	3/32	15/64	.018	2103-06-00
-008	NO. 8	.176	.168	5/16	13/16	17/64	11/64	3/32	15/64	.018	2103-08-00
-010	NO. 10	.204	.195	11/32	53/64	17/64	11/64	3/32	15/64	.018	2103-10-00

DATA SOURCE:
SHAKEPROOF CATALOG (1957), PAGE 9.

SUPPLIER DATA:
SHAKEPROOF DIVISION OF ILLINOIS TOOL WORKS
ELGIN, ILLINOIS (78189)

THE PART NUMBER IS THE DRAWING NUMBER PLUS THE APPLICABLE DASH NUMBER

SPEC CONTROL DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN THE INTERNATIONAL INCH
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
+ 1/64 + .005 + 2°
— 1/64 — .005 — 2°
√ MEANS √

MATERIAL 1
FINISH 2
MATL APPD

J. BERGE 7-APR-59 DRAFTSMAN (DAY MO YR)
CHECKER M. MANNING
ENGINEER J. PEDDICORD
APPROVAL D. FLEMING
APPROVAL

TERMINAL - LUG
(SOLDER, 30° ANGLE)

7253 M.E.CO.
REFERENCE ACSP ONLY

DESIGN ACTIVITY APPROVAL
OTHER APPROVAL

CODE IDENT NO. 99974 | SIZE C | 7901862
SCALE NONE | SHEET

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327.
2. MATERIAL: QQ-A-250/8, TEMPER H32 (AL ALY 5052-H32, ES2105-1).
3. FINISH: MIL-A-8625, TYPE I ANODIZE (ES385).
4. MUST BE FREE FROM BURRS & SHARP EDGES.
5. ALL INSIDE BEND RADII .12.
6. IDENTIFY USING PART NUMBER PER MIL-STD-130 (ES 267).

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD

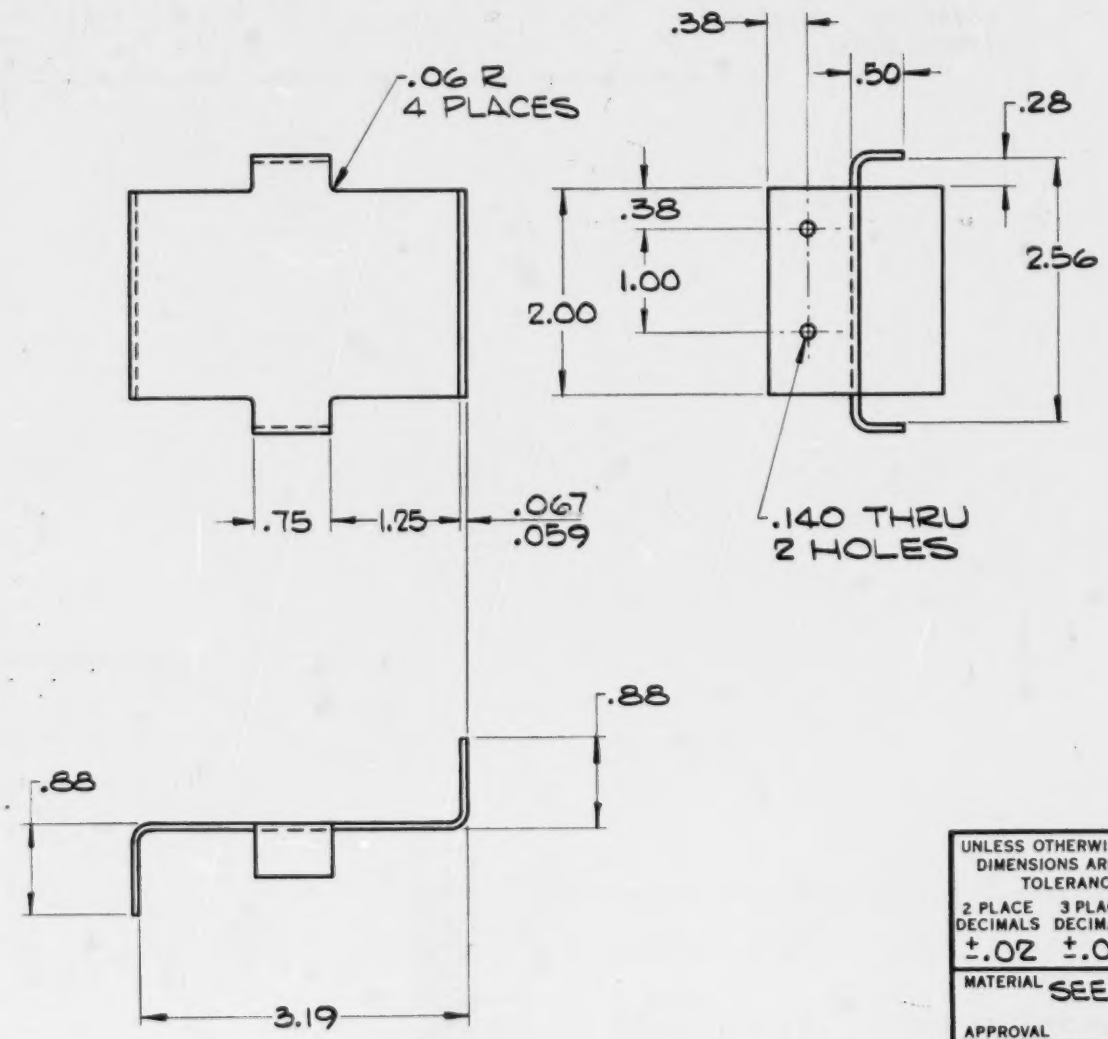

		001
SHEET NUMBER	ZONE	DASH NUMBER

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON 2 PLACE DECIMALS ±.02 3 PLACE DECIMALS ±.005 ANGLES ± —	DRAFTSMAN Goodman DAY 27 MO JUN YR 67	BRACKET, DOUBLE ANGLE
MATERIAL SEE NOTE 2	CHECKER	
	ENGINEER	
	APPROVAL	
APPROVAL	CONTRACT	
REFERENCE (ACSK ONLY) D.O. 70470	DESIGN ACTIVITY APPROVAL	SIZE C / CODE IDENT NO. 99974 / 7885110
	OTHER APPROVAL	SCALE 1/1 / SHEET 1 OF 1

8439 0220 0000

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327.
2. MATERIAL: SST PER QQ-S-766 CLASS 302, COND A.
3. FINISH: PASSIVATE PER MIL-F-14072 (SIG. C) FIN E 300
4. MUST BE FREE FROM BURRS AND SHARP EDGES.
5. IDENTIFY USING PART NUMBER PER MIL-STD-130.

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD

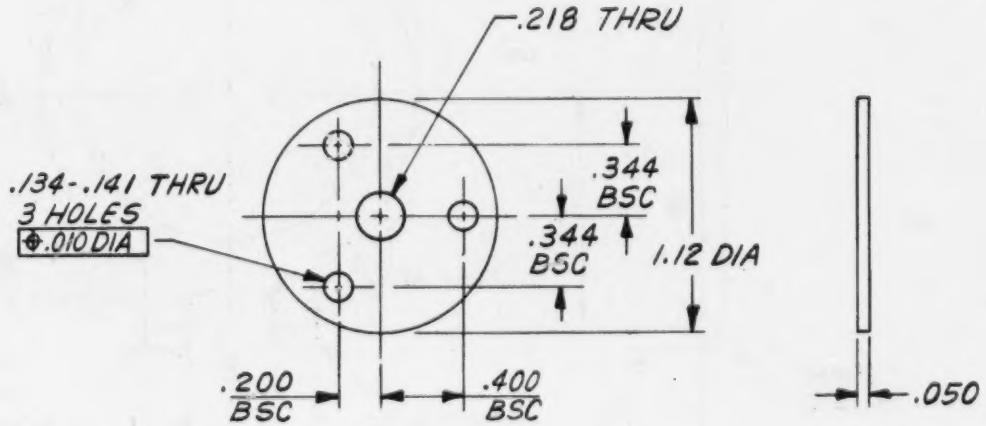

SHEET NUMBER	ZONE	DASH NUMBER
		001

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON

2 PLACE DECIMALS	3 PLACE DECIMALS	ANGLES
±.02	±.005	±2°

MATERIAL: SEE NOTE 2

APPROVAL

REFERENCE (ACSK ONLY): 30 7SEE4, LM6659

DRAFTSMAN: Hetchler 16 NOV 67 (DAY MO YR)

CHECKER

ENGINEER

APPROVAL

CONTRACT AF04(695)282

DESIGN ACTIVITY APPROVAL

OTHER APPROVAL

PLATE, RETAINING

SIZE	CODE IDENT NO.	
C	99974	7885336

SCALE 2:1 SHEET 1 OF 1

844 0

NOTE !!

1.) PART TO BE MADE WITH EITHER LEG #1 OR LEG #2, SEE CHART.

2.) PART TO BE FLAT WITHIN .003.

PART NO.	LEG NO.
DvP26-2	1
DvP26-2.1	2

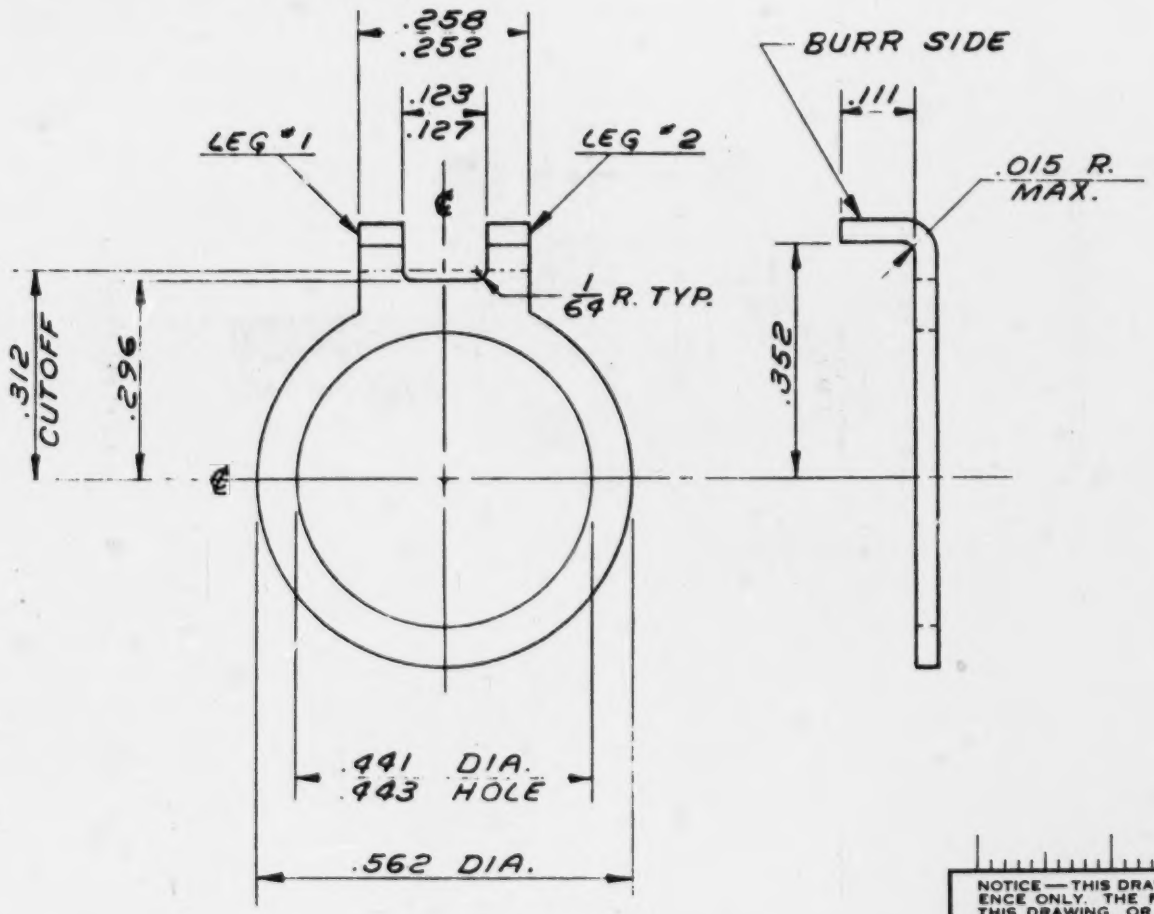

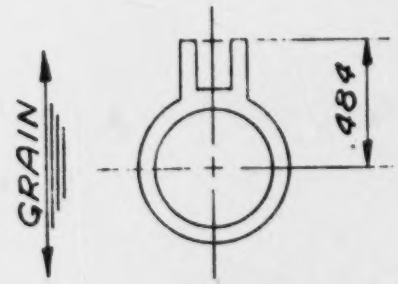

CALCULATED MODEL BLANK (2X SIZE)

NOTICE — THIS DRAWING IS FURNISHED FOR REFERENCE ONLY. THE FURNISHING OR POSSESSION OF THIS DRAWING, OR ANY REPRODUCTION THEREOF, DOES NOT CONVEY ANY MANUFACTURING RIGHTS.

FINISH: CADMIUM PLATE SPEC. O-5AR-3, CL. 1

MATERIAL: .035 ±.0015 C.R. STEEL #2 TEMPER

UNLESS OTHERWISE SPECIFIED. ALL DIMENSIONS ARE IN INCHES. TOLERANCE ON DECIMALS ±.005 FRACTIONS ±.010 ANGLES ±

	BY	DATE
DR.	RJT	10 30 67
CHK.	E.H.	10-30-67
ENG.		
ENG.		
APPD.		

PRINT CODE

TITLE: SPRING DRIVER 080 INDEX REDESIGN

PART NO.: SEE CHART

ASSY. DWG.

CODE IDENT. NO.	DWG. NO.	SIZE	ISSUE
	DvP26-2	B	01

SCALE 5X & NOTED SHEET OF

REVISIONS

01	10-30-67 RJT			

0080 8441

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD
	A	REVISED PER XC228912		18 DEC 67	RWH
	B	REVISED PER XC231727		28 MAR 68	

NOTES

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327.
2. MATERIAL: QQ-A-225/8 TEMPER T651 (ES 2106-1 AL ALY 6061-T651).
3. FINISH: ANODIZE PER MIL-A-8526 TYPE 2 CLEAR (ES 383).
4. MUST BE FREE FROM BURRS.
5. UNLESS OTHERWISE SPECIFIED:
   SURFACE ROUGHNESS MUST NOT EXCEED 125/.
   ALL CORNERS TO BE .005 TO .015 R OR CHAMFER.
6. IDENTIFY USING PART NUMBER PER MIL-STD-130 (ES 267).
7. DIMENSION TO BE AS SPECIFIED AFTER ANODIZE.

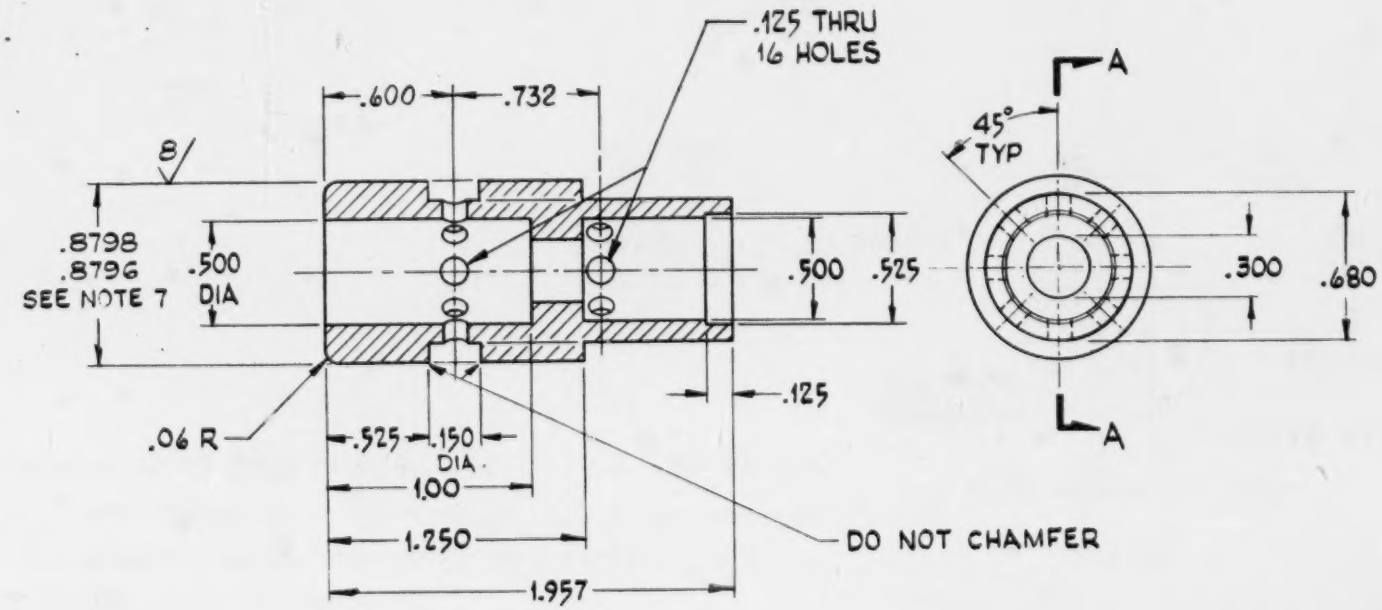

SECTION A-A

SHEET NUMBER	ZONE	DASH NUMBER
		001

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DECIMALS ± .02
3 PLACE DECIMALS ± .005
ANGLES ± 2°

MATERIAL SEE NOTE 2

APPROVAL

REFERENCE (ACSK ONLY) LM 6648 DO 70429

DRAFTSMAN Kosmatka 27 JUN 67 (DAY MO YR)

CHECKER

ENGINEER

APPROVAL 13 JUL 67

CONTRACT AF 04(695)-282

DESIGN ACTIVITY APPROVAL

OTHER APPROVAL

RESTRICTOR, FLUID FLOW

SIZE	CODE IDENT NO.	
C	99974	7885091

SCALE 2:1 SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-70327.
2. MATERIAL: QQ-S-763, CLASS 303 COND A, CF (ES 380-1).
3. FINISH: MIL-F-14072 FIN. E300 PASSIVATE (ES 585).
4. MUST BE FREE FROM BURRS.
5. UNLESS OTHERWISE SPECIFIED:
   SURFACE ROUGHNESS MUST NOT EXCEED 125√.
   ALL CORNERS TO BE .005 TO .015 R OR CHAMFER.
6. IDENTIFY USING PART NUMBER PER MIL-STD-130 (ES 267)

REVISIONS

ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	APPD
B-2 C-3 B-2	A	① .180 DIA. WAS .18 DIA & .540 DIA. WAS .54 DIA ② ADDED PITCH DIA. IS -B- ③ ADDED ⊙ B.002 TO .726/.719 DIA	XC 225152	23 OCT 67	JJJ / CP
	B	① DIM .35 WAS .55 ② DIM .40 WAS .60 ③ DIM .690 WAS .890 ④ DIM .90 WAS 1.10	XC 226436 MC-1	7 NOV 67	DL / [illegible]
	C	REVISED PER XC 228913	MC-2	18 DEC 67	dw / RWH

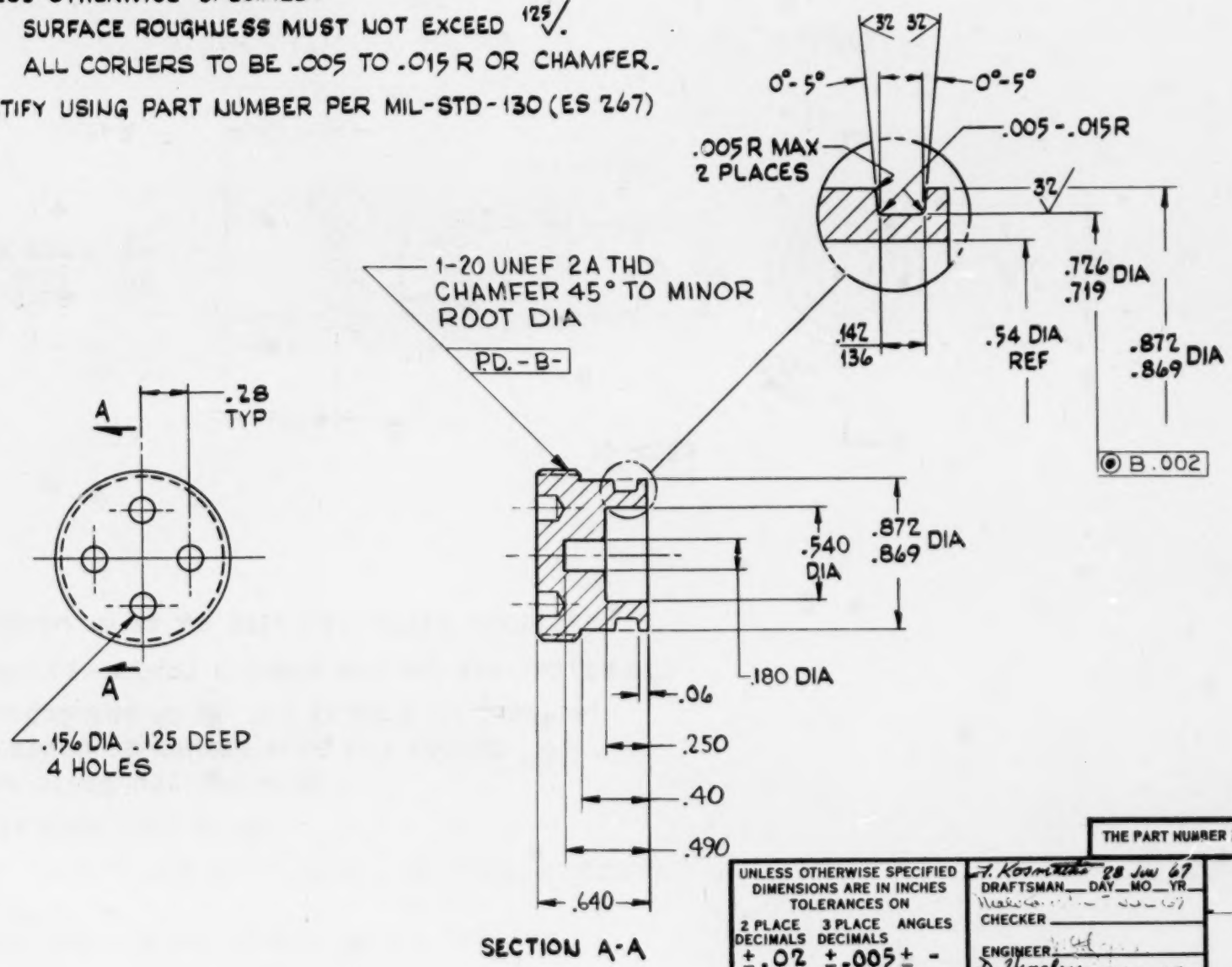

SHEET NUMBER	ZONE	DASH NUMBER
		001

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
2 PLACE DECIMALS ±.02 3 PLACE DECIMALS ±.005 ANGLES ±-

MATERIAL SEE NOTE 2
APPROVAL

REFERENCE (ACSI. ONLY)
LM 6648
DO 70429

DRAFTSMAN J. Kosmicki 28 Jun 67 (DAY MO YR)
CHECKER
ENGINEER D. Hinsley
APPROVAL 13 JUL 67
CONTRACT 4FC4(695)-282
DESIGN ACTIVITY APPROVAL
OTHER APPROVAL

PLUG, ADJUSTING, RESTRICTOR

SIZE	CODE IDENT NO.	
C	99974	7885093

SCALE 2:1 SHEET 1 OF 1

SAAR

8443

REVISIONS					
01	6-8-66 EH.				

FOR ALL OTHER DIMS & SPECS SEE DRAWING NO. DvB19-5A

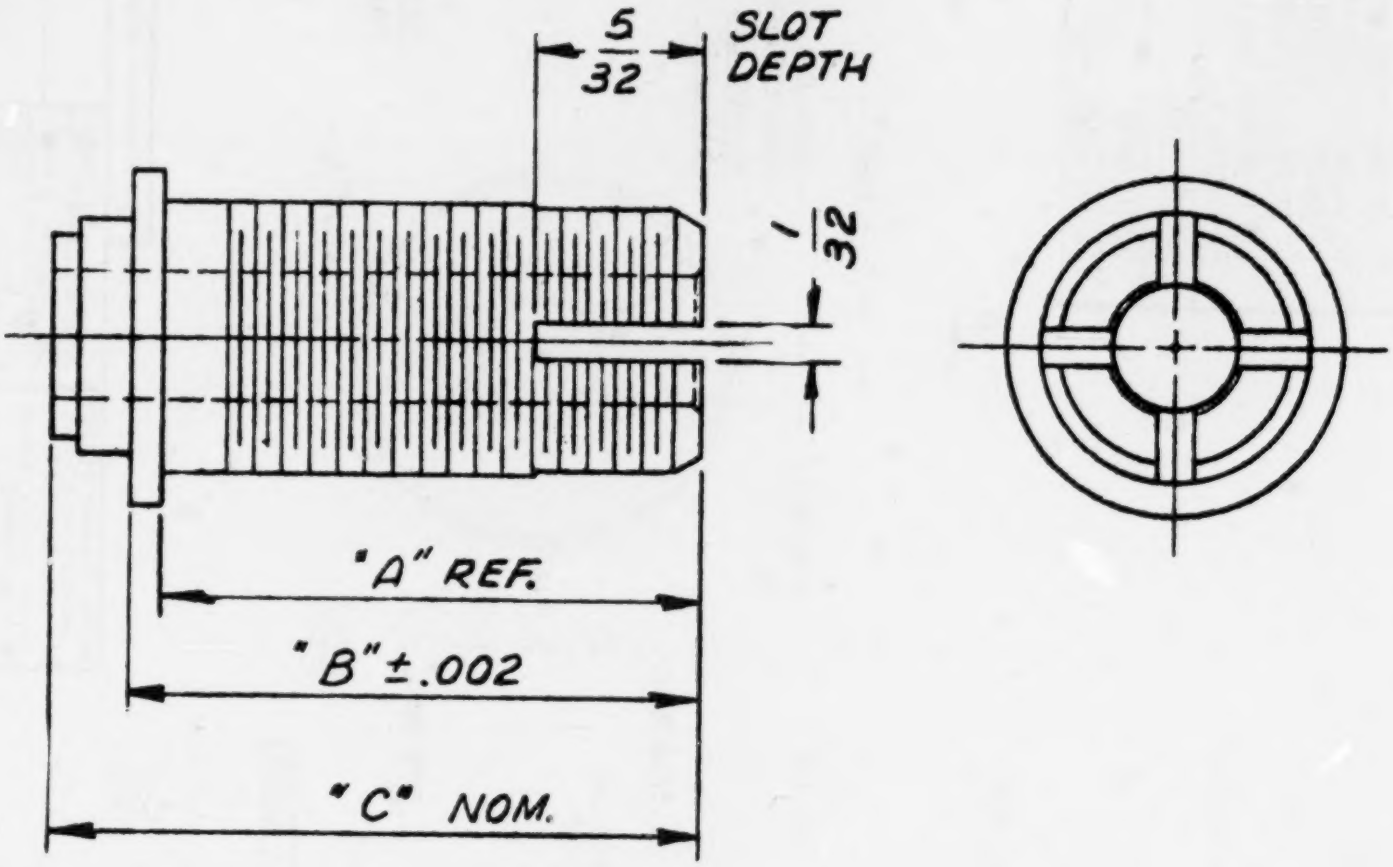

PART NO.	"A"	"B"	"C"
DvB19-6-2	.625	.655	.732
DvB19-6-1	.500	.530	.607
DvB19-6	.375	.405	.482

NOTICE — THIS DRAWING IS FURNISHED FOR REFERENCE ONLY. THE FURNISHING OR POSSESSION OF THIS DRAWING, OR ANY REPRODUCTION THEREOF, DOES NOT CONVEY ANY MANUFACTURING RIGHTS.

FINISH: NICKEL PLATE SPEC. O-SAR-1, CL.1

MATERIAL: 5/16 DIA. BRASS ROD

SEE SPECS 7443-A

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES TOLERANCE ON DECIMALS ± FRACTIONS ±.010 ANGLES ±

	BY	DATE
DR.	E.H.	6-8-66
CHK.	WP	8-19-66
ENG.		
ENG.		
APPD.		

PRINT CODE

TITLE: BUSHING ~ LOCKING TYPE 1/2" DIA. UNIVERSAL HMP

PART NO.: SEE CHT.

ASSY. DWG.: DvB19-23B

CODE IDENT. NO.	DWG. NO.	SIZE	ISSUE
	DvB19-6	A	01

SCALE: 5" = 1" SHEET OF

8444

NOTES:

1. INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS PRESCRIBED BY MIL-D-1000.
2. MATERIAL: QQ-A-225/9 TEMPER T651 (ES 2177 -1), ALUM ALY 7075 - T651.
3. FINISH: ES402 TYPE I (DIA. Z AND GEAR TEETH AND SURFACES INDICATED TO BE FREE FROM ANODIZE).
4. MUST BE FREE FROM BURRS.
5. UNLESS OTHERWISE SPECIFIED:
   A. ALL CORNERS TO BE .005 TO .015 R OR CHAMFER.
   B. SURFACE ROUGHNESS NOT TO EXCEED 125√.
6. IDENTIFY USING PART NUMBER PER MIL-STD-130 (ES267).
7. *FINISH APPLIES AFTER ANODIZING.*

REVISIONS					
ZONE	LTR	DESCRIPTION	CHG. NO.	DATE	
	A	① NOTE 2. WAS "QQ-A-225/6 TEMPER T351 (ES 2104-1), ALUM ALY 2024-T351" ② NOTE 3. WAS "FINISH ES 402 TYPE I (ANODIZE PRIOR TO FINISHING DIA. Z AND GEAR TEETH"	MXC 220879	26 APR 67	DJW
	B	REVISED	MXC 229077	11 DEC 67	JRK
	C	REVISED	ECM 231824	20 MAR 68	JRK
	D	REVISED -001	CM 232066	16 MAY 68	KCH

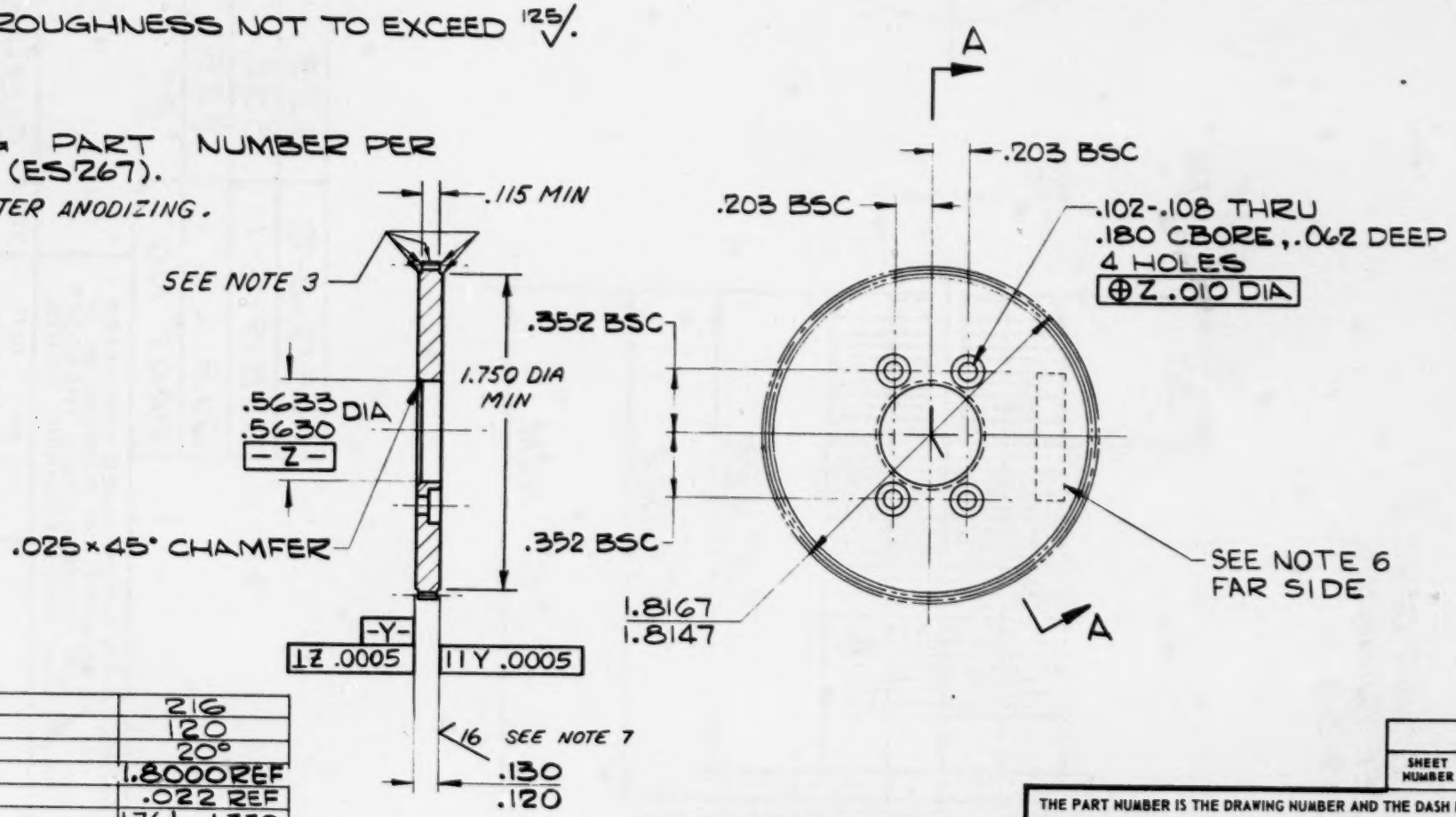

SECTION AA

NUMBER OF TEETH	216
DIAMETRAL PITCH	120
BASIC PRESSURE ANGLE	20°
BASIC PITCH DIAMETER	1.8000 REF
WHOLE TOOTH DEPTH	.022 REF
ROOT DIAMETER	1.761 - 1.778
MAXIMUM ROUGHNESS - WORKING SURFACE OF TEETH	32√
CENTER DISTANCE WHEN MESHED WITH STANDARD INSPECTION MASTER - AS REFERRED TO CENTER OF DIAMETER Z	1.4000 +.0000 -.0010
TOTAL COMPOSITE ERROR	.00025
BASIC PITCH DIAMETER OF MASTER	1.0000
CHECKING PRESSURE	4 OZ
RUNOUT (TIR)	—
TOOTH TO TOOTH COMPOSITE ERROR	.0002 MAX

SHEET NUMBER	ZONE	DASH NUMBER
		001

THE PART NUMBER IS THE DRAWING NUMBER AND THE DASH NUMBER THAT APPLIES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
2 PLACE DECIMALS ± —
3 PLACE DECIMALS ±.005
ANGLES ± 2°

MATERIAL: SEE NOTE 2
APPROVAL
REFERENCE (ACSK ONLY): D.O. 65190

DRAFTSMAN 30 MAR 67 (DAY MO YR)
CHECKER 31 MAR 67
ENGINEER 3 APRIL 67
APPROVAL 4 APR 67
CONTRACT
DESIGN ACTIVITY APPROVAL
OTHER APPROVAL

GEAR, SPUR

SIZE	CODE IDENT NO.	
C	99974	7883461

SCALE 2/1 SHEET 1 OF 1

8445

DIE NO. -8350 PER DWG C-4499
FORG. CO. MILWAUKEE FORGE & MACHINE CO.
FINISH MACHINING ALLOWANCE 3/32
THICKNESS TOLERANCE +.078 -.026
DIE WEAR TOLERANCE +.062
DIE SHIFT TOLERANCE ±.027
DIAMETER TOLERANCE +.089 -.021

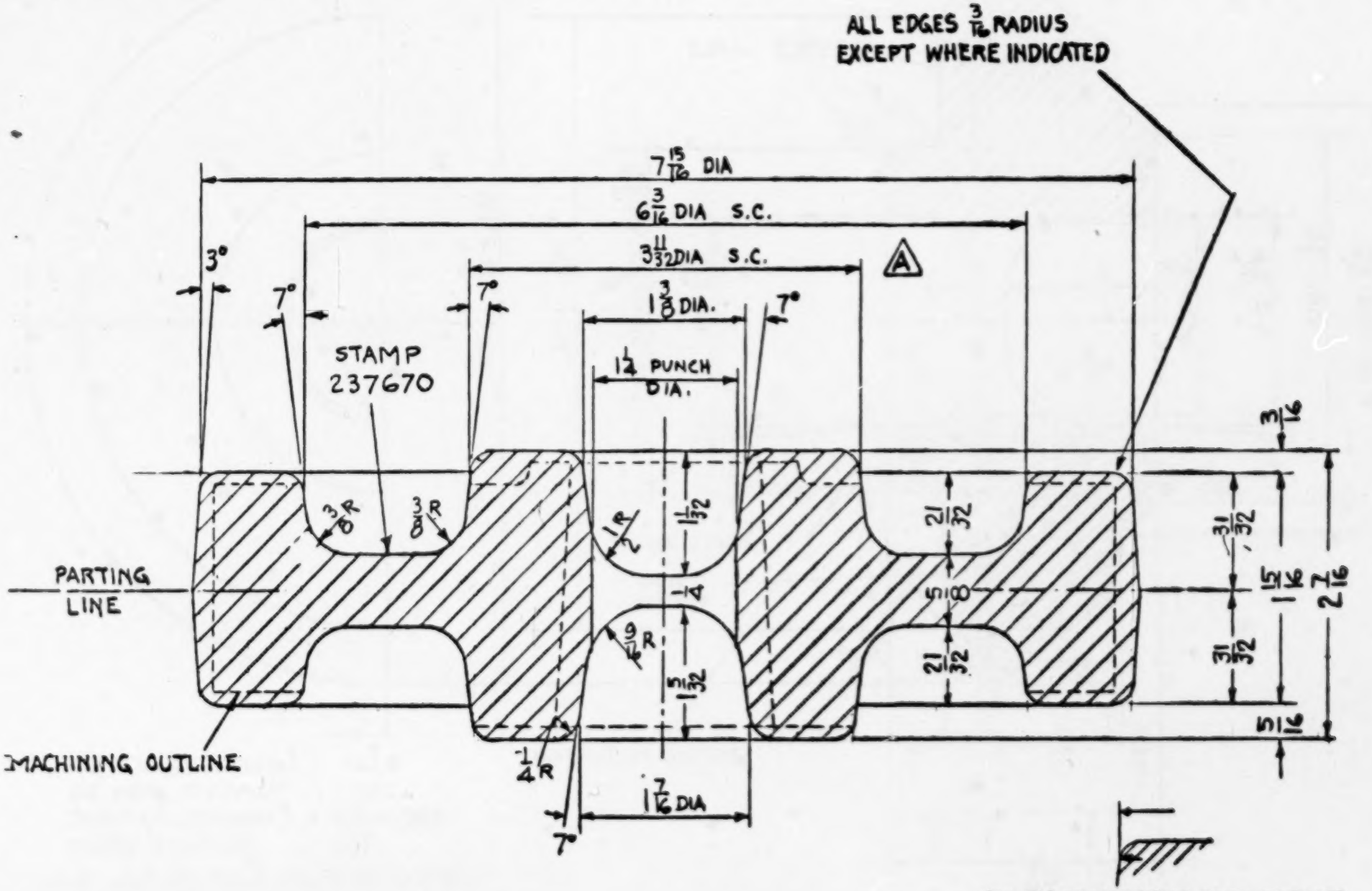

SECTION THRU CIRCULAR FORGING

8446

DIE NO. 8099

FORG. MFG: MILN. FORGE & MACH. CO. - DWG. No. C-4241

FINISH ALLOWANCE	3/32
THICKNESS TOLERANCE	+.078 -.026
DIE WEAR TOLERANCE	.053
DIE MISMATCH TOLERANCE	.024

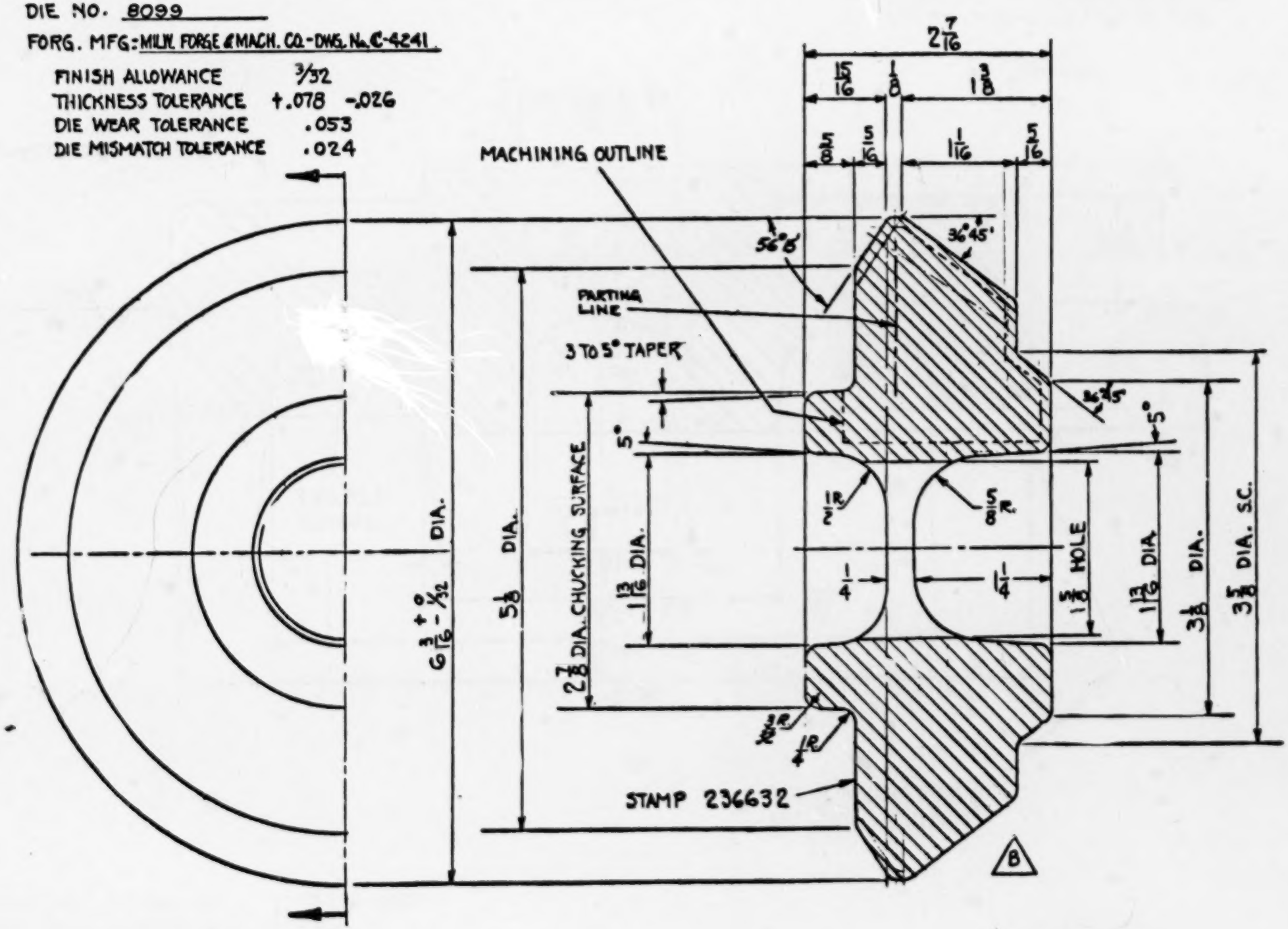

ALL DIAMETER DIMENSIONS GIVEN AT POINT OF TANGENCY UNLESS OTHERWISE SPECIFIED

D

ALL EDGES $\frac{3}{16}$ RADIUS EXCEPT WHERE INDICATED

8447

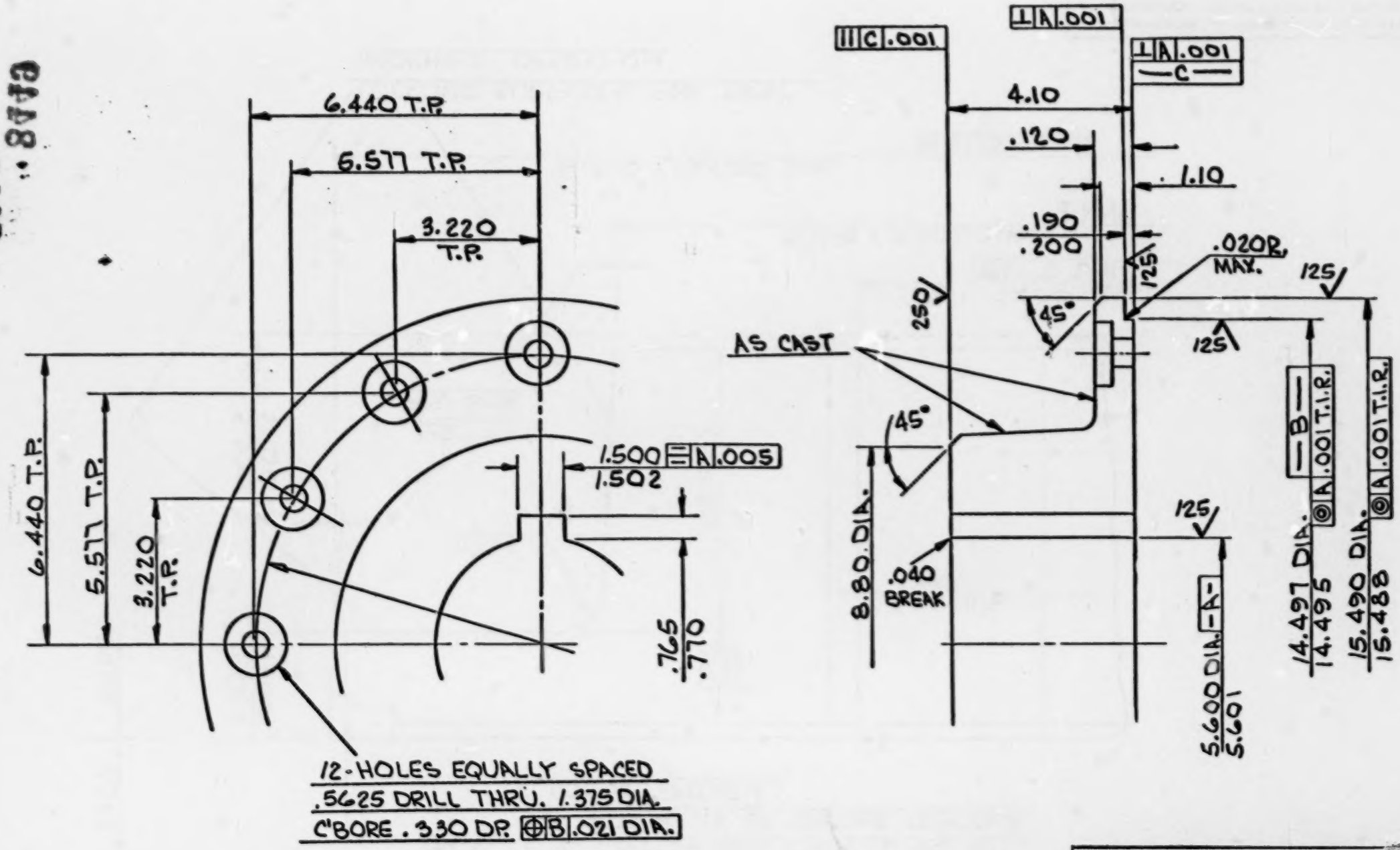

TOLERANCES ON DIMENSIONS TO MACHINED SURFACES, UNLESS OTHERWISE SPECIFIED.			
1 PL. DEC.	2 PL. DEC.	3 PL. DEC.	ANGLES
± .060	± .030	± .010	± 1°

8448

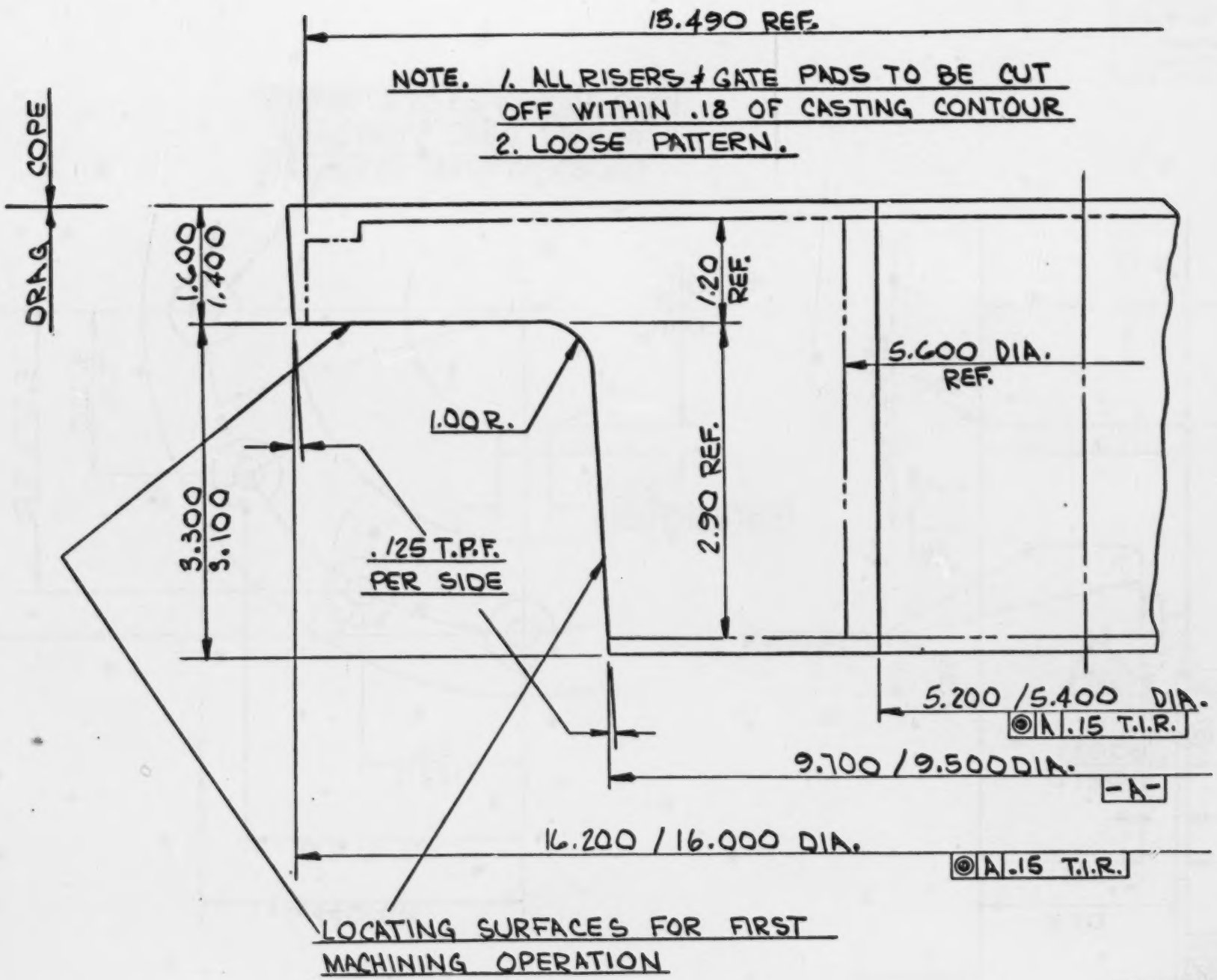

TOLERANCES ON DIMENSIONS TO MACHINED SURFACES, UNLESS OTHERWISE SPECIFIED.			
1 PL. DEC.	2 PL. DEC.	3 PL. DEC.	ANGLES
± .060	± .030	± .010	± 1°

8449

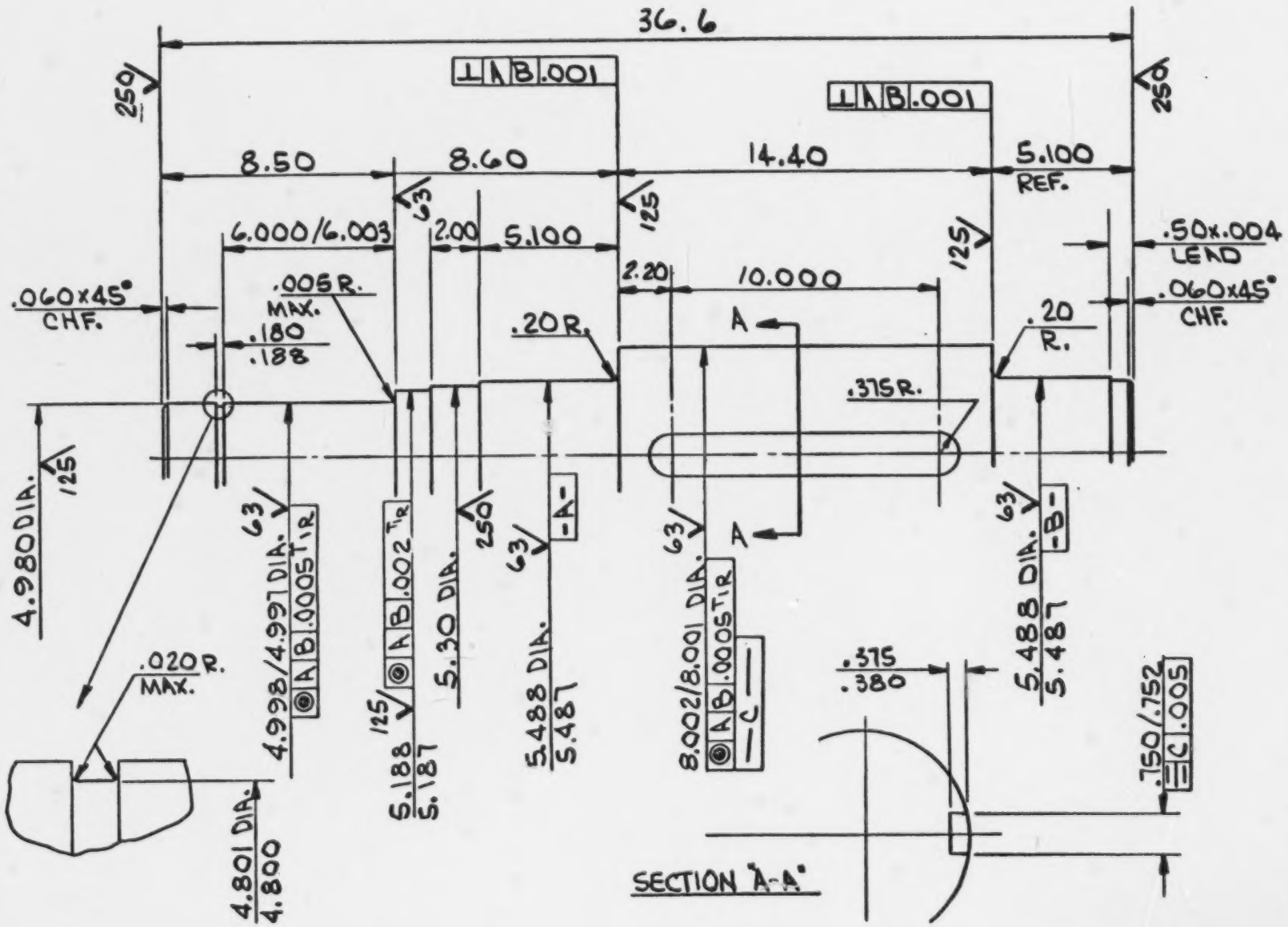

TOLERANCES ON DIMENSIONS TO MACHINED SURFACES, UNLESS OTHERWISE SPECIFIED.			
1 PL. DEC.	2 PL. DEC.	3 PL. DEC.	ANGLES
± .060	± .030	± .010	± 1°

8450

VT 012 750
Commissaryman 3 and 2. Navy Training Course.

Department of the Navy, Washington, D.C.
Bureau of Naval Personnel.
MF AVAILABLE IN VT-ERIC SET.
NAVPERS 10279-D
PUB DATE - 66 223p.

DESCRIPTORS - *FOOD SERVICE WORKERS; *MILITARY PERSONNEL; MILITARY TRAINING; *STUDY GUIDES; FOODS INSTRUCTION; FOOD STANDARDS; FOOD HANDLING FACILITIES; SANITATION; ILLUSTRATIONS; NUTRITION INSTRUCTION

ABSTRACT - Developed for the Bureau of Naval Personnel, this training manual is to be used by Naval and Naval Reserve Personnel who are studying for advancement to the rates of Commissaryman 3 and 2. Chapters are (1) Advancement to Petty Officer, (2) The Food Service Division, (3) Inspecting Subsistence Items, (4) Storage and Care of Subsistance Items, (5) Galley and Meat Cutting Equipment, (6) Nutrition and Menu Planning, (7) Expenditure of Subsistence Items, (8) Sanitation in the General Mess, (9) Meat, (10) Food Preparation, (11) Baking, (12) Food Service, and (13) Landing Party. Illustrations, photographs, and charts augment the text. A list of training films is appended, and a subject index is included. (Author/SB)

VT 012 750

8451.

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EDUCATION & WELFARE
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ED0 56238

COMMISSARYMAN 3 & 2

VT012750

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10279-D

PREFACE

This book was prepared by the Training Publications Division, Naval Personnel Program Support Activity, Washington, D.C., for the Bureau of Naval Personnel. Technical assistance was provided by the Bureau of Supplies and Accounts, Washington, D.C.; by the U.S. Navy Subsistence Office, Washington, D.C.,; and the U.S. Naval Schools Command, U.S. Naval Station, Newport, Rhode Island.

Original edition 1948
Revised 1958
Revised 1963
Revised 1966

8453

THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

NAVY PUBLICATIONS

Food Operations Reference Manual, NavSandA Publication 421

Manual of Naval Preventive Medicine, NavMed P-5010, Chapter 1, Food Sanitation

Navy-Marine Corps Recipe Service, NavSandA Publication 7

Battle Stations in Food Service, NavSandA Publication 338

USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your Information and Education Officer.* A list of those courses applicable to your rate follows:

Self Teaching

Number	Title
MB 150	Review Arithmetic
MB 507	Hygiene

Correspondence

CB 150	Review Arithmetic
CB 507	Hygiene

*"Members of the United States Armed Forces Reserve components when on active duty are eligible to enroll for USAFI courses, services, and materials if the orders calling them to active duty for a period of 120 days or more regardless of the time specified in the active duty orders."

CHAPTER 1

ADVANCEMENT TO PETTY OFFICER

This training course has been prepared for men of the Navy and of the Naval Reserve who are studying for advancement to the rates of Commissaryman 3 and Commissaryman 2.

The Commissaryman qualifications which were used as a guide in the preparation of this training course are those contained in the Manual of Qualifications for Advancement in Rating, NavPers 18068-B. Changes occurring after revision 18068-B are not reflected in this text.

Chapters 2 through 13 of this training course deal with the professional (technical) matter of the Commissaryman rating. Chapter 2 provides detailed information about the organization of the general mess within the Supply Department, and the duties of the men who work in the Food Service Division.

Succeeding chapters discuss inspection of foods, their storage and care, the equipment used in food preparation, nutrition and menu planning, expenditure of subsistence items, sanitation in the general mess, food conservation, meats, general instructions for food preparation, baking, food service, and food preparation under emergency conditions.

The remainder of this chapter gives information on the enlisted rating structure, the Commissaryman rating, requirements and procedures for advancement in rating, and references that will help you both in working for advancement and in performing your duties as a Commissaryman. This chapter includes information on how to make the best use of Navy Training Courses. Therefore, it is strongly recommended that you study this chapter carefully before beginning intensive study of the remainder of this training course.

THE ENLISTED RATING STRUCTURE

The two main types of ratings in the present enlisted rating structure are general ratings and service ratings.

GENERAL RATINGS identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

SERVICE RATINGS identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

THE COMMISSARYMAN RATING

The Commissaryman rating is a general rating; there are no service ratings. Commissarymen operate the general mess for enlisted men in the Navy. They serve as cooks and bakers on ships and shore stations. In this capacity Commissarymen prepare food, assist in ordering subsistence items, check deliveries for quantity, and inspect for quality, stow subsistence items, and maintain cleanliness and sanitation of the galley and related spaces.

To learn about the Commissaryman rating, study the qualifications for advancement in rating.

To qualify for Commissaryman 3 you must have acquired a broad knowledge of the Food Service Division's activities as a whole and a detailed knowledge of those activities of the Division that you will be required to perform.

You will be expected to know how the general mess is organized, who is in charge, and the daily routine that is followed.

You must be able to take your place in a galley watch, which includes knowing how to operate, secure, and clean the galley equipment such as food mixers, meat grinders, ovens, and ranges.

You should know what to do to keep foods wholesome from the time of their arrival aboard ship until they are prepared and served. This includes knowing how to care for refrigerators,

vegetable lockers, and other storage facilities. It also includes a knowledge of the basic causes of food poisoning and the special care required to prevent food spoilage.

You also must know how to determine the quantities of subsistence necessary to prepare the number of servings required in your mess and the regulations for drawing them from the storerooms.

You should be able to cook and bake as required in the Qualifications for Advancement in Rating. You must be familiar with and know how to use the recipes and guides to food preparation provided in the Navy-Marine Corps Recipe Service, NavSandA Publication 7/MCO-P10110.16; Navy Food Service; and Food Operations Reference Manual, NavSandA Publication 421.

To advance to Commissaryman 2, you must know more about the operation of the Food Service Division, and be able to perform more complicated duties than you did when you passed your third class examinations.

By this time, you will have to know the functions of vitamins and minerals in the diet and their sources in various foods. You will have to know the names and the proper uses of the various standard cuts of beef, veal, lamb, and pork, and the location of each cut on the meat carcass. Also, a knowledge of the proper ways to carve meat and poultry for serving will be required.

Morale is a word having a great deal of significance in the Navy. You as a Commissaryman, can contribute much toward the morale of your ship by serving high quality food in the general mess.

As you prepare for advancement to CS3 and then to CS2, you will hear a good deal about your increasing responsibilities in connection with General Order No. 21 and the naval leadership program. In addition to the general leadership required of all petty officers, there are applications of leadership to the duties of your rating.

Basically, your responsibilities for technical leadership arise from the very nature of your work. Keeping the ship's galley operating and the cooking and serving of the foods as desired by all hands is a tremendous task.

Technical leadership is more than just giving orders. In fact, you can demonstrate some of the most important aspects of technical leadership even if you are not required to tell anyone else what to do about anything. As a CS3 or CS2, you demonstrate technical leadership when you follow orders exactly, when you observe safety precautions, when you accept responsibility, when you continue to increase your knowledge of the Commissaryman's job, and when you perform every detail of your work with complete integrity and reliability.

Integrity of work is really a key factor in technical leadership, and all other factors relate to it in some way. Integrity of work refers to big things and to little things—the way you stand a galley watch, your concern for cleanliness, the way you cut meat, the way you supervise the mess line, the way you receive and issue subsistence items, and the way you bake bread. When you perform every job as efficiently as you can, and when you are constantly working to increase your skill and broaden your knowledge, you are demonstrating integrity of work in a concrete, practical, everyday sort of way. When your work has integrity, you are demonstrating technical leadership.

ADVANCEMENT IN RATING

Some of the rewards of advancement in rating are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

But the advantages of advancing in rating are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating, you increase your value to the Navy in two ways. First, you become more valuable as a technical specialist in your own rating. And second, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy.

How to Qualify for Advancement

What must you do to qualify for advancement in rating? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and professional training courses.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NavPers 760.
4. Be recommended by your commanding officer, after the petty officers and officers

8458

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	†E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6.	36 mos. as E-7. 8 of 11 years total service must be enlisted. Must be permanent appointment.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3, AME 3, HM 3			Class B for AGCA, MUCA, MNCA.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 760, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.	Counts toward performance factor credit in advancement multiple.						
EXAMINATIONS	Locally prepared tests.		Navy-wide examinations required for all PO advancements.				Navy-wide, selection board, and physical.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		
	TARS attached to the air program are advanced to fill vacancies and must be approved by CNARESTRA.							

* All advancements require commanding officer's recommendation.
† 2 years obligated service required.

Figure 1-1.—Active duty advancement requirements.

0028 8459

supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.

5. Demonstrate your KNOWLEDGE by passing a written examination on (a) military requirements and (b) professional qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your division officer or training officer to be sure that you know the most recent requirements.

Advancement in rating is not automatic. After you have met all the requirements, you are ELIGIBLE for advancement. You will actually be advanced in rating only if you meet all the requirements (including making a high enough score on the written examination) and if the quotas for your rating permit your advancement.

How to Prepare for Advancement

What must you do to prepare for advancement in rating? You must study the qualifications for advancement, work on the practical factors, study the required Navy Training Courses, and study other material that is required for advancement in your rating. To prepare for advancement, you will need to be familiar with (1) the Quals Manual, (2) the Record of Practical Factors, NavPers 760, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052, and (4) applicable Navy Training Courses. Figure 1-3 illustrates these materials; the following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

The Quals Manual

The Manual of Qualifications for Advancement in Rating, NavPers 18068-B, gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals Manual," and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications.

MILITARY REQUIREMENTS apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

PROFESSIONAL QUALIFICATIONS are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

The written examination for advancement in rating will contain questions relating to the practical factors and the knowledge factors of both the military requirements and the professional qualifications. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as second class qualifications.

The Quals Manual is kept current by means of changes. The professional qualifications in your rating which are covered in this training course were current at the time the course was printed. By the time you are studying this course, however, the quals for your rating may have been changed. Never trust any set of quals until you have checked the change number against an UP-TO-DATE copy of the Quals Manual.

Record of Practical Factors

Before you can take the servicewide examination for advancement in rating, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional qualifications. A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 760, is used to keep a record of your practical factor qualifications. This form is available for each rating. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement in Rating, and revised forms of NavPers 760 are provided when necessary. Extra space is allowed on the

REQUIREMENTS *		E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
	FOR THESE DRILLS PER YEAR								
TOTAL TIME IN GRADE	48	6 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
	24	9 mos.	9 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
	NON-DRILLING	12 mos.	24 mos.	24 mos.	36 mos.	48 mos.	48 mos.		
TOTAL TRAINING DUTY IN GRADE †	48	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
	24	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
	NON-DRILLING	None	None	14 days	14 days	28 days	28 days		
PERFORMANCE TESTS				Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION		Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)		Record of Practical Factors, NavPers 760, must be completea for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Completion of applicable course or courses must be entered in service record.							
EXAMINATION		Standard exams are used where available, otherwise locally prepared exams are used.						Standard EXAM, Selection Board, and Physical.	
AUTHORIZATION		District commandant or CNARESTRA					Bureau of Naval Personnel		

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-2.—Inactive duty advancement requirements.

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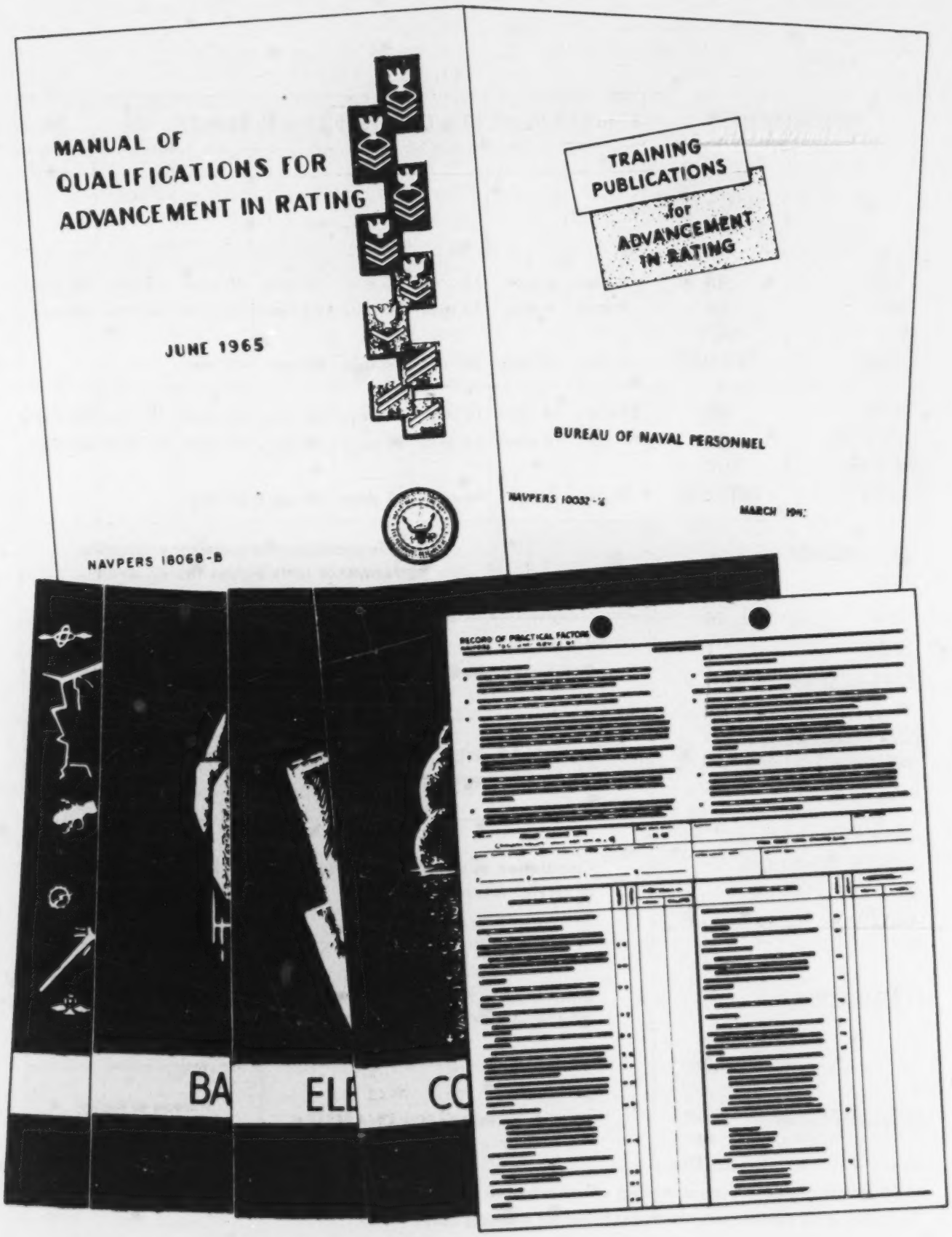

Figure 1-3.—Materials used in preparing for advancement.

Record of Practical Factors for entering additional factors as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 760 form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

NavPers 10052

Training Publications for Advancement in Rating, NavPers 10052 (revised), is a very important publication for anyone preparing for advancement in rating. This bibliography lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052 for your rating.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Navy Training Courses are marked with an asterisk (*). Any course marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you can be eligible to take the servicewide examination for advancement in rating. Each mandatory course may be completed by (1) passing the appropriate enlisted correspondence course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the training course; or (3) in some cases, successfully completing an appropriate Class A school.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military requirements for advancement. Personnel of ALL ratings must complete the mandatory military requirements training course for the appropriate rate level before they can be eligible to advance in rating.

The references in NavPers 10052 which are recommended but not mandatory should also be studied carefully. ALL references listed in NavPers 10052 may be used as source material for the written examinations, at the appropriate rate levels.

Navy Training Courses

There are two general types of Navy Training Courses. RATING COURSES (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the professional qualifications of ONE rating. SUBJECT MATTER COURSES or BASIC COURSES give information that applies to more than one rating.

Navy Training Courses are revised from time to time to keep up to date technically. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether any particular copy of a Navy Training Course is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists all current training courses and correspondence courses; you will find this catalog useful in planning your study program.)

Navy Training Courses are designed to help you prepare for advancement in rating. The following suggestions may help you to make the

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best use of this course and other Navy training publications when you are preparing for advancement in rating.

1. Study the military requirements and the professional qualifications for your rating before you study the training course. Remember, you are studying the training course primarily in order to meet these quals.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too may interruptions or distractions.

3. Before you begin to study any part of the training course intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training course in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the qualifications for advancement in rating?

5. When you have a general idea of what is in the training course and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training course, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Navy Training Courses or on other appropriate texts. As mentioned before, completion of a mandatory Navy Training Course can be accomplished by passing an Enlisted Correspondence Course based on the Navy Training Course. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master the information given in the training course, and also helps you see how much you have learned.

10. Think of your future as you study Navy Training Courses. You are working for advancement to third class or second class right now, but some day you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCES OF INFORMATION

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional qualifications of your rating.

Some of the publications described here are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you to do your work or to

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advance in rating; it is likely to be a waste of time, and may even be seriously misleading.

In addition to this training course, there are handbooks that provide specific and practical information for your rating. You are required to study them in order to attain your required professional qualifications. These handbooks are:

Publication	Applicable Rating
Food Operations Reference Manual NavSand P-421	CS3
Manual of Naval Preventive Medicine NavMed P-5010, Chapter 1, Food Sanitation	CS3
Navy-Marine Corps Recipe Service NavSandA P-7/MCO-P10110.16	CS3
Battle Stations in Food Service NavSandA P-338	CS2

A list of training films that may be useful to you is given in appendix I of this training course. Other films that may be of interest are listed in the United States Navy Film Catalog, NavWeps 10-1-777. This catalog, published in 1966, supersedes three earlier publications: the former catalog with the same title but numbered NP 10000-A; the Supplement, NavWeps 10-1-772; and Navy Classified Film Catalog, NP 10001-A.

As this book goes to press, the Navy is undergoing a major reorganization, in which certain bureaus will be redesignated as Systems Commands. The Bureau of Supplies and Accounts will be known as the Supply Systems Command.

Check Instructions and Notices for further information concerning this change.

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CHAPTER 2

THE FOOD SERVICE DIVISION

One of the first tasks of a trainee is to become acquainted with the organization in which he works and with the functions of that organization. This chapter will help you to see the general mess as a part of the supply department and to understand the lines of authority and the duties of the various personnel in carrying out its mission.

"The purpose of the general mess," as defines in the Bureau of Supplies and Accounts Manual, "is to provide Navy and Marine Corps enlisted personnel with a well balanced diet by proper preparation and service of the daily food allowances as authorized by the Navy Ration Law." In earlier years, each department had its own individual mess, and there was a wide variance in the food service. Today, on most ships and stations Navy men eat in one central mess hall, where modern cafeteria style equipment is provided to keep all items on the menu at the proper temperatures until they are served. An adequate supply of nutritious and appetizing foods is made available through compliance with the NAVY RATION LAW. Enacted by Congress, this ration law specifies the allowance of quantities of food to be issued daily by the general mess to each enlisted man of the Navy and the Marine Corps. The quality of the subsistence obtained, use of modern galley equipment, and strict adherence to the tested recipes of Navy-Marine Corps Recipe Service, (NavSandA Publication 7/MCO-P10110.16A) are important factors in maintaining the high standard of meals served throughout the Navy. Even more important than those factors, however, are the skills of the cooks, bakers, meat cutters, strikers, and other food service personnel. Also of major importance is the manner in which the duties and responsibilities of general mess personnel are organized—the extent to which that organization ensures smooth and efficient operation.

Although the general mess is a part of the supply department aboard all ships and stations, mess organization differs somewhat from ship to ship because of variations in the numbers of men to be fed and in facilities available. You should keep this in mind as you compare the organization and responsibilities described in this training course with those in effect aboard your ship or station.

OFFICER RESPONSIBILITIES

The commanding officer, executive officer, and medical officer, as well as the supply and food service officers, have certain responsibilities regarding the operation of the general mess. Their duties are outlined in the following paragraphs.

Command Responsibility

Your COMMANDING OFFICER has overall responsibility for the entire ship or station. He is responsible for taking all proper steps to preserve the health of the crew and consults the medical officer regarding sanitary measures to be adopted. The commanding officer establishes the hours for messing, according to the routine of the ship and the recommendations of the supply officer. In emergency conditions, the officer of the deck has authority to recommend changes in the messing hours. When messing changes are approved by the commanding officer, the officer of the deck notifies the supply officer and the food service officer. In the discharge of his responsibility to provide appetizing and wholesome food for his crew, the commanding officer approves, with his recommendations if any, the weekly menu which is prepared by the senior Commissaryman and forwarded through the supply department. He will designate an officer to be present and to sample each meal and to report if there is any cause for complaint on the quantity, quality, or service of the food.

The commanding officer makes periodic inspections of the mess hall and general mess spaces. In addition to those times, you will

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probably see the commanding officer when you least expect it, because many COs have a habit of stopping by the galley now and then to see how things are going. You can be glad if your CO takes interest in your work because it will indicate the importance he places on it in the ship's activities.

The EXECUTIVE OFFICER is a direct assistant to the commanding officer. His responsibilities to the general mess include:

1. Assigning, to the supply officer, from departments other than the supply department, mess hall master at arms.

2. Detailing messmen for duty in the general mess.

3. Notifying the supply officer daily, in writing, of the estimated number of personnel to be fed and thereafter notifying the supply officer of any changes in such number, including the number of personnel hospitalized or absent with or without leave. He notifies the SO as far in advance of the meal hour as possible, of the number of personnel that will be absent during meal hours, including men on liberty and on working parties. Information regarding the number of rations to be reserved for personnel working parties or on special detail will accompany the original notification.

4. Preparation and submission of the Personnel Recapitulation and Mess Ration Credit (S. and A. Form 27) daily, monthly, and upon relief of the supply officer.

Medical Department Responsibility

The MEDICAL OFFICER, under the commanding officer, is responsible for the health and physical welfare of the ship's crew. He will inspect FOR QUALITY any fresh subsistence items brought aboard for the general mess and, when required, will inspect foods that have been prepared and are ready for service to determine if they are fit for consumption. At frequent intervals, established by the local command, he checks the preparation of meals, and reports to the commanding officer upon the sanitary condition of the mess. He examines all food-service personnel to determine if they are free from communicable disease, before they are assigned food service duties. In addition, a weekly "surprise" physical inspection is made by the medical officer of all food handlers in order to detect acute and chronic illnesses of a communicable nature. Another Medical Department responsibility for the general mess is the weekly inspection of all subsistence items in the storerooms and of the sanitary conditions prevalent in storage spaces and in the scullery.

Supply Department Responsibility

The mission of a ship's supply department, of which the food service division is a part, has been said to be "furnishing the maximum supply services possible for the command, the ship, and the crew, to the end that a significant contribution to the attainment and maintenance of the ship's maximum fighting efficiency has been made." In fulfilling this mission, the supply department provides the various other departments with the materials and services necessary for the accomplishment of their assigned functions, maintains prescribed records, renders pertinent reports and returns, pays the personnel aboard, and SUBSISTS ENLISTED PERSONNEL IN THE GENERAL MESS.

Ships With Supply Corps Officers.—When a Supply Corps officer is attached to a ship, the SUPPLY OFFICER under the commanding officer has overall responsibility for the operation of the general mess. This includes the following, (see fig. 2-1).

1. Preparation and service of food and supervision of these operations.

2. Supervision of Commissarymen, master at arms, messmen, and all other men assigned to general mess duties in the supply department and "on-the-job" training programs.

3. Cleanliness and good condition of all places where food is stored, prepared, and served, such as the galley, bake shop, and issueroom.

4. Ensuring that adequate supplies of subsistence items are on board at all times in sufficient quantities to meet normal requirements and any emergencies which may arise.

5. Assigning of personnel to duties in the general mess for which they are best suited by reason of their ability, training, and personality.

6. Reviewing inventories, actual issues, and such records as considered necessary so that timely action may be taken to ensure the continued availability of balanced stocks and to prevent the accumulation of excesses.

7. Inspecting, to ensure that subsistence items are stored in such a manner that the oldest pack, either export or domestic, will be issued first, except when the condition of a newer pack requires that immediate issue be made in order to avoid a loss.

On active fleet ships, when two or more supply officers are assigned, the supply officer

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can assign an officer assistant, as the food service officer to take charge of the general mess. Such officer will be held responsible for the overall operation of the general mess and for its financial accountability including signing the General Mess Operating Statement (S. and A. Form 45).

Ships Without Supply Corps Officers.—When a Supply Corps officer is NOT attached, the commanding officer is responsible for the administration of the general mess. The commanding officer may delegate operation of the general mess to any line officer in his command. The officer so delegated is designated as the supply officer but the commanding officer is responsible for the operation of the general mess and signing the S. and A. Form 45.

The designated supply officer ensures that the command, at all times, is supplied with items of subsistence in sufficient quantities to meet normal requirements and any emergencies which may arise. He is responsible for:

1. Original determination of requirements.
2. Receipt, inspection, and stowage of subsistence items.
3. Supervision of stock upkeep.
4. Inventory subsistence items when directed in writing by the commanding officer.

General Messes Ashore.—When one Supply Corps officer is assigned at shore activities operating a general mess, the supply officer performs both supply and food service duties. At activities requiring both supply and food service officers, the supply officer designates as officer assistant as the food service officer. Listed below are the duties normally performed by the supply officer and the food service officer:

Supply officer—is responsible for the following:

1. Procurement of subsistence items.
2. Custody of bulk subsistence stocks.
3. Sales and transfers of subsistence items.
4. Accountability of bulk subsistence stocks.
5. Submission of Navy Stock Account returns for subsistence.
6. Exercising general supervision over general mess activities.

Food service officer—is responsible for the following, (see fig. 2-2).

1. Operation of the general mess.
2. Issues of subsistence items made to the general mess by the supply officer and for the accountability thereof, including the preparation and submission of the subsistence returns.

Food Service Officer

In this training course, for the purpose of uniformity and simplicity, the term "food service officer" will be used to refer to any officer who is in direct charge of the general mess, afloat or ashore.

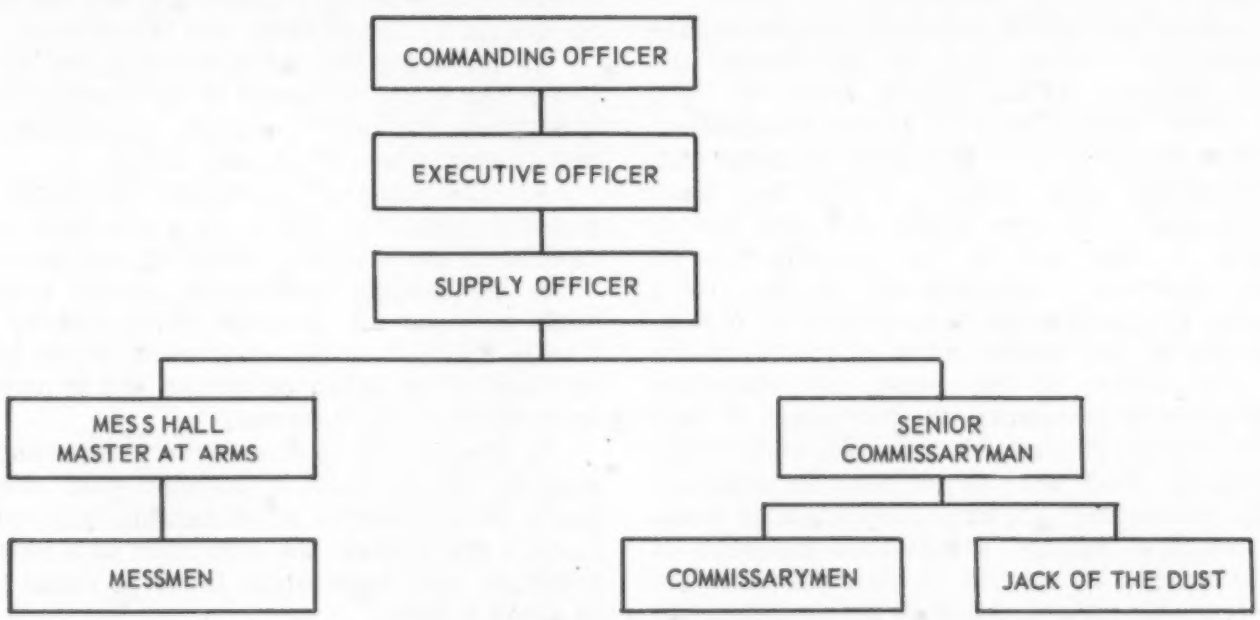

48.1

Figure 2-1.—Standard organization chart for a food service division afloat.

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48.2

Figure 2-2.—Standard organization chart for a food service division ashore.

The food service officer has custody of all subsistence items transferred to him for use in the general mess and is responsible for the performance of the men under him. He must see that his ship or station is at all times adequately supplied with subsistence items to meet both normal requirements and emergencies that may arise. He is responsible for making an original determination of normal and emergency subsistence items requirements, constant supervision of stock upkeep, proper receipt and inspection of subsistence items, proper stowage and storage practice, proper preparation and service of food in the general mess, and the preparation and submission of the subsistence returns.

Written orders are prepared by the food service officer defining the duties and responsibilities of each billet in his division. These orders are reviewed by the supply officer, where there is a food service officer as well as a supply officer, and are submitted to the commanding officer for his approval. After approval by the commanding officer, the orders are issued in the form of SUPPLY DEPARTMENT INSTRUCTIONS. Additional detailed instructions may be written by the food service officer, approved by the supply officer, and promulgated as Food Service Division Instructions. When a man is assigned to the food service division, or to a new job within the division, he is required to read that part of the instructions which apply to his job and to sign a statement that in the performance of his duties he will comply with the orders he has read. Whenever you are given such instructions to read, study them carefully, and be sure you understand them. Ask any questions that may occur to you. This is an opportunity for you to get a clear picture of your duties and responsibilities.

ENLISTED RESPONSIBILITIES

Enlisted personnel play a very important role in the actual operation of the general mess. In addition to Commissarymen, Commissarymen strikers, and Storekeepers you will find petty officers of other ratings, and nonrated men, assigned to certain duties in food service and related spaces. In most cases, these men will be serving as masters at arms or messmen. Detailed duties of these men are outlined in the following paragraphs.

Master at Arms

Mess hall masters at arms are detailed by the executive officer to the supply department for duty in the general mess. A mess hall master at arms reports to the supply and/or food service officer and coordinates his work with the senior Commissaryman and watch captains. The supply officer assigns the following detailed duties to the mess hall master at arms:

1. Responsibility for all spaces and equipment on the mess deck, serving line, and scullery.
2. Assigning messmen to cleaning stations, duty sections, and work details.
3. Mustering messmen daily and thoroughly inspecting them for personal neatness and cleanliness.
4. Maintaining order and discipline in the mess deck and mess lines.
5. Supervising the cleaning of the mess deck, serving line, scullery, and mess gear.
6. Ensuring that the scullery is operating in accordance with current and approved instructions.
7. Inventorying and maintaining adequate mess gear to ensure sufficient quantity will be available throughout serving periods.

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8. Administering a training program for messmen, including sanitation, scullery operation, and food handling.

Messmen.—Messmen are the enlisted men detailed for food service duty in the general mess, including the actual serving of food, the maintenance of cleanliness and sanitation of the mess hall spaces and equipment, the operation of the scullery, and the handling and disposal of garbage. In addition, messmen may be detailed to work in the vegetable preparation room, and to wash cooking and baking utensils in the galley and bake shop. Messmen are under the supervision of the mess hall master at arms. Petty officers are not detailed as messmen, except when nonrated men are not available.

Records Section Personnel

The records section of the food service division is under the supervision of the food service officer. Normally, the enlisted men assigned to that section are Storekeepers or Storekeeper strikers. Although Commissarymen seldom have specific record keeping duties in the office, you should be aware of what records are kept, because they relate to your own duties and to the functions of the food service division as a whole. Working directly under the food service officer, the records section Storekeepers maintain all of the records, log books, and files of the division, including the subsistence survey log, subsistence ledger, inventory records, stock records, record of receipts and expenditure, general mess control record, correspondence files, and other local records.

Storage Space Personnel

In addition to the records section, there are two other food service spaces where you might find a Storkeeper at work. One is the subsistence issueroom, where the man in charge is traditionally called the JACK-OF-THE-DUST. The other is the cold storage room. In each of these spaces EITHER a Storekeeper or a Commissaryman may be assigned. On small ships, one man (the jack-of-the-dust) may be assigned to both spaces.

The COLD STORAGE MAN is the Storekeeper or Commissaryman in charge of the cold storage

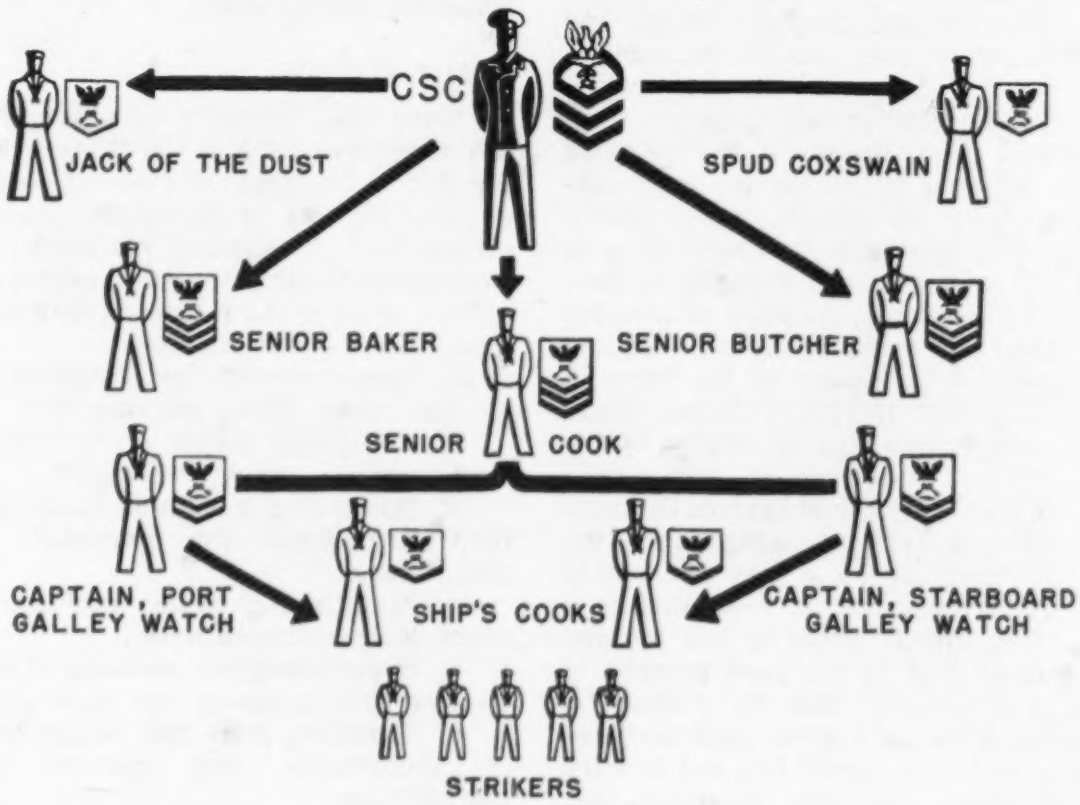

48.3

Figure 2-3.—Organization of a general mess under Chief Commissaryman.

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spaces. He is responsible for the stowage condition, and issue of refrigerated and frozen subsistence items. Twice daily, or more frequently if required, he logs temperature readings of all the thermometers in refrigerated spaces. This log is submitted daily to the senior Commissaryman. Whenever a temperature reading exceeds the maximum of safety for food preparation, the cold storage man must immediately notify the food service officer through the senior Commissaryman. On small ships or stations, the jack-of-the-dust often is in charge of refrigerated spaces in addition to his issueroom duties, and a cold storage man is not assigned.

Commissarymen

The assignment of duties and responsibilities to individual Commissarymen and strikers is influenced by the personnel complement or allowance of the division. The size of the division is, in turn, determined by the size and mission of the ship. On large ships the duties of individual billets tend to be quite specialized. On smaller ships the duties of each billet usually cover a broader scope of activities. For example: On most of the larger ships and stations there are billets for a Chief Commissaryman and a galley captain, watch captains, spud coxswains, meat cutters, and bakers. When fewer men are available, the duties of some of these billets are combined. On very small ships, one Commissaryman may do all the cooking and baking, and be the meat cutter as well. In the latter case, one man assumes the responsibilities of all billets. You should keep these facts in mind as you study the duties and responsibilities of the billets described.

Senior Commissaryman.—The Chief Commissaryman, or the senior Commissaryman if there is no Chief aboard, is the supervising petty officer in charge of the general mess. By regulation, due to principles of accountability, he is prohibited from having either custody or control over the original records of subsistence items received and from preparing public vouchers for subsistence items. His main duties are confined to the galley, bake shop, and such other spaces assigned to him by the food service officer and the work directly connected therewith, including preparation and signing of the weekly General Mess Menu (S. and A. Form 1080) for submission to the commanding officer via the supply officer. The Chief Commissaryman or senior Commissaryman performs the following duties: (See fig. 2-3.)

1. Supervises the galley and associated spaces.
2. Sees that all equipment, fitting, cooking utensils, and other galley gear, are kept at maximum efficiency.
3. Reports to the supply officer, for corrective action, any needed repairs or alterations.
4. Supervises all personnel assigned to the galley and associated spaces.
5. Makes suggestions to the supply officer relative to the men making up the several watches.
6. Musters the personnel of the galley and associated spaces each morning, conducts an inspection of all personnel for cleanliness of person and clothing, and makes a report to the supply officer of his inspection findings, and also of absentees.
7. Supervises issues and preparation of food; instructs all personnel, so that food is prepared in the most economical, attractive, and appetizing manner possible within the allowed NAVY ration, using the NAVY-MARINE CORPS RECIPE SERVICE when possible.
8. Ensures that food is prepared or cooked as near serving time as practicable.
9. Ensures that every precaution is taken to prevent contamination of food, and carefully inspects all food before it is prepared or served.
10. If there is any doubt as to the quality of the food, reports same to the supply officer, who in turn may have proper determination made by the medical officer concerning fitness of the food for human consumption.
11. Prepares for the supply officer the WEEKLY GENERAL MESS MENU.
12. Submits to the supply officer each morning a report of all subsistence items issued to the general mess the previous day.
13. At his discretion, keeps such duplicate records concerning the receipt, inventory, and expenditure of subsistence items as may be necessary to schedule menus, ensure economy, and establish usage data necessary to the proper performance of his duties.

When there is no Supply Corps officer aboard a ship or station, the senior Commissaryman is the ranking specialist in the food service division.

Galley Supervisor.—On large ships, a senior Commissaryman other than the chief is often given special duties as the GALLEY SUPERVISOR. As directed by his supervisor (usually the Chief Commissaryman), he is responsible for planning and coordinating the various operations in the galley. It is his duty to be present before, during,

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and immediately after each meal. He observes food preparation procedures, the service of food, and cleanup operations in the galley. He gives advice and instructions, as necessary, to improve procedures, prevent waste, and to train personnel. The galley supervisor directs both watches, each of which is under the immediate supervision of a watch captain, and on many ships and stations he is responsible for drawing up the watch bill.

Watch Captain.—Whether or not the size of a ship warrants the assignment of a galley supervisor, the senior Commissaryman on each watch is traditionally given responsibility as WATCH CAPTAIN. Under the supervision of the Chief Commissaryman (or the galley supervisor), the WATCH CAPTAIN is responsible for carrying out the routine of meal preparation as outlined in the Food Preparation Worksheet (NavSandA Form 1090), and for the proper maintenance and security of the galley and related food preparation spaces. He also supervises the preparation of vegetables by the spud coxswain. He must see that all subsistence items and supplies in the galley are kept in shipshape order, with proper consideration for food preservation and sanitation, and that subsistence items are not diverted from their intended use.

The galley supervisor or the WATCH CAPTAIN gives on-the-job training to galley personnel on his watch, including instructions about the care and operation of equipment and the observance of safety regulations. He ensures that the men on his watch report for muster in clean uniforms, aprons, and hats and that they are personally clean and neat, with hair trimmed and nails short and clean.

It is also his duty to ensure that the receipes of the NAVY-MARINE CORPS RECIPE SERVICE are available and FOLLOWED at all times, and that all necessary precautions are enforced to prevent the use of spoiled, or otherwise unwholesome food. He personally supervises the preparation, cooking, and issuing of food to the messmen in the serving line, assigns a Commissaryman to supervise the messmen in the replenishment of foods on the serving line, and, before turning the galley over to the relieving watch, sees that all waste and scraps have been disposed of and that the galley is in a clean and neat condition.

Spud Coxswain.—The SPUD COXSWAIN is the Commissaryman, or striker, who is detailed by the captain of the watch for duty in charge of the vegetable preparation room and is responsible for its efficient operation. When the workload warrants, messmen are detailed to assist the spud coxswain in his duties.

Senior Meat Cutter.—The SENIOR MEAT CUTTER is the senior Commissaryman detailed for duty in the meat cutting shop. He cuts and issues meat for the galley and for special messes. Under the supervision of the senior Commissaryman, he is responsible for the cleanliness of the meat cutting shop and for the proper preservation of meats in cold storage. Except when subsistence items are being stowed or broken out, or during cleaning operations, no one is authorized to enter the meat refrigerating room other than the senior meat cutter or his Commissarymen assistants. On small ships, meat cutting duties are sometimes combined with those of the watch captain.

Senior Baker.—The SENIOR BAKER is the Commissaryman who is responsible for the efficient operation of the bake shop. He mixes, bakes, and finishes all types of bakery products, including baked desserts. As required, he prepares, mixes, and freezes ice cream. He requisitions supplies from the storerooms, maintains a tally of subsistence items used and on hand, inspects and stores supplies in the bake shop in a manner to protect them from deterioration, and cleans and maintains sanitary conditions in the bake shop. On large ships, the senior baker supervises those Commissarymen and strikers who are assigned to assist him in the bake shop. On smaller ships, in contrast, his duties may be combined with those of senior cook, and possibly even those of senior meat cutter.

WATCHES

Commissarymen work long hours—they must remain on the job until everything is secured after supper and be up early in the morning to prepare breakfast. Their work has many compensations, however—it is interesting and satisfying, and a watch system is established to give them sufficient time off at one stretch to balance the long periods when they are on duty.

Here is how the system works. The men are divided into two watches—port and starboard—which relieve each other at 1300 (or any designated midday hour) when everything has been secured after dinner. Ordinarily, each watch has the duty

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for 24 hours at a stretch. For example, the starboard watch goes on duty at 1300 Monday, prepares supper on Monday and prepares breakfast and dinner on Tuesday before being relieved by the port watch. The cycle is 24 hours on duty—and then 24 hours off. Some ships use a system of watches giving the men even more continuous time off. Of course, this does not mean that you work continuously for 24 hours when you are on duty. Between periods of preparing for meals and other related duties, men can be secured for rest and relaxation. There must, however, be at least one man on duty at all times during regular working periods.

INSTRUCTIONS AND SAFETY PRECAUTIONS

You probably have noticed a set of INSTRUCTIONS AND SAFETY PRECAUTIONS posted on the bulkhead of your galley. This is required aboard all ships and stations. In general, all cover the same basic matters, but they may vary somewhat in application according to the size and mission of the activity, the nature of equipment in use, the daily routine followed, or other considerations. You should study and learn the instructions for your galley and make it a habit to follow the ones that apply to your work. In fact, you will WANT to follow them, because

Galley Instructions

The following instructions are issued for the operation of the galley. The senior Commissaryman on watch will, under supervision of the Chief Commissaryman, be in charge of the galley during the period of the watch, and will be referred to as the "Captain of the Watch." He will comply with these instructions, require compliance by all personnel under his supervision, and during the period of his watch he will be responsible for ensuring that:

1. All subsistence items, supplies, and equipment in his custody are maintained in a neat and orderly condition and that subsistence items delivered to his custody for use in preparation of meals for the general mess are not diverted to other uses.

2. The menu is strictly adhered to and that the preparation, cooking, and serving of food is effected in a proper and appetizing manner.

3. Personnel do not smoke or use tobacco in any form in spaces utilized in the preparation of food.

4. Unauthorized personnel do not enter the galley spaces.

5. No "hand-outs" are made to anyone.

6. Personal clothing is not washed or hung to dry in the galley, and that no personal gear is stowed therein.

7. Personnel under his supervision are instructed and indoctrinated concerning the performance of their assigned duties, in the care and operation of all cooking equipment, and that prescribed safety precautions are strictly adhered to.

8. Extreme caution is exercised to prevent the issue of spoiled food and that all doubtful food is referred to the medical officer before it is used in the preparation of meals.

9. Personnel on watch remain scrupulously clean and neat, that their hair is trimmed and kept combed, that fingernails are kept short and clean at all times, and that they wear the prescribed uniform while on watch.

10. A copy of the NAVY-MARINE CORPS RECIPE SERVICE is maintained in the galley at all times and that recipes and instructions contained therein are adhered to in the preparation of items on the MENU.

11. Hash or cream-filled pastries on the menu are prepared immediately before serving.

12. All waste and scraps are properly and promptly disposed of.

13. All equipment and utensils are kept scrupulously clean and that the entire galley is in proper condition before it is turned over to the relieving watch.

14. All personnel on watch thoroughly understand and comply with pertinent instructions contained in supply department instructions regarding security measures.

15. Security of the galley, its related spaces, and all its equipment is maintained.

16. Any additional instructions of the food service officer are complied with.

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Figure 2-4.—A typical set of instructions for posting in a ship's galley.

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you will see that they make sense. They are concerned with maintaining the galley as a clean, orderly workspace, keeping the equipment in tiptop shape, conserving Navy supplies, preparing first-class nutritious meals, and maintaining safety on the job, the security of the ship, and the health and welfare of all your shipmates.

You will find, too, that the instructions will make certain aspects of your job easier because they clearly point out some of the things that are not allowed, such as giving "hand outs" of food, or allowing unauthorized personnel to loiter around the galley. It is easier to say "No" to your friends when you can add, "It's against regulations."

Figure 2-4 is a typical set of instructions for posting in a ship's galley.

INDIVIDUAL RESPONSIBILITIES

As you studied this chapter, and learned about the functions of the food service division and the responsibilities attached to the individual jobs that are necessary to the operation of the general mess, you probably noticed how frequently the word "cleanliness" and its partner "sanitation" were mentioned. In fact, you probably came to the conclusion that in the food service division—CLEANLINESS AND SANITATION ARE EACH MAN'S RESPONSIBILITY—and that conclusion is correct! Foods and beverages that are not handled, prepared, and served in clean sanitary surroundings, by clean people, can become sources of disease and even death. Supplying clean, safe food is not only a responsibility that each Commissaryman and striker shares for the welfare of his shipmates, but it is essential to the attainment of maximum fighting efficiency for the entire ship.

Listed below are some of the daily health habits that, if followed, will protect your own health and that of your shipmates.

1. Take a bath or show daily to:
   a. Remove dirt, perspiration, and bacteria.
   b. Improve circulation, appearance, and health.
2. Wash hands with soap and water.
   a. FREQUENTLY while handling and washing dishes and utensils used by others. This protects you.
   b. ALWAYS after visiting the toilet, blowing nose, sneezing, etc.
   c. ALWAYS after handling garbage.
   d. ALWAYS after scrubbing the deck, cleaning the galley, etc.
3. Keep fingernails clean and short. This too, reduces transmission of disease and filth.
4. Keep hair confined and wash it frequently.
   a. Always wear a cap.
5. Keep teeth clean by brushing at least once daily, but preferably after each meal to:
   a. Inhibit tooth decay.
   b. Check unpleasant breath.
   c. Decrease chance of food infection from mouths of food service personnel.
6. Wear only clean inner and outer garments to:
   a. Reduce changes of transmitting disease and filth.
   b. Contribute to improvement of health and well-being.
   c. Help in eliminating offensive odors.
   d. Increase your self-respect.
7. Check yourself frequently for appearance and habits.
8. Report exposures to diseases and symptoms of illness to the medical department.

CHAPTER 3

INSPECTING SUBSISTENCE ITEMS

Before you buy an article for your own use you look it over. If you were buying several hundred, or several thousand, of the same article you would be even more particular. It isn't difficult then, to see why the Navy has set up a detailed inspection procedure to make certain that the millions of dollars worth of subsistence items it purchases each year meet Navy's standards as to quality and quantity.

RESPONSIBILITY FOR FOOD INSPECTION

In most instances, subsistence items will have been certified as to quality before they are delivered aboard your ship. However, there is always a chance for occasional error. Food products are highly perishable and may have deteriorated after they were inspected on the beach. There is also the possibility that some of the subsistence items, if purchased in an out-of-the-way place, may not have been inspected at all. In such a case you may be called upon to inspect them for quality. You can see how essential it is for you to know how to inspect subsistence items and what standards should be met. You will be guarding Uncle Sam's pocketbook, and—more important—ensuring that the Navy, and your shipmates, receive food that can safely be eaten.

Where Subsistence Items Come From

The ships of the Navy, for the most part, receive subsistence items from a Navy shore supply activity or a supply ship. Receipts from purchase and from other Government departments comprise a very small portion of the total volume of subsistence items. Before leaving port, a ship tops off with canned goods, flour, breakfast cereals, coffee, tea, sugar, frozen meats, and other items.

Perishable subsistence—meats, dairy and poultry products, fresh fruits, and vegetables—are obtained, while in port within the United States, either from a Navy shore supply activity or from dealers. Purchase contracts are made with dealers by field purchasing activities ashore. Information concerning these contracts is sent to all ships and stations in the area by means of a contract bulletin. This bulletin gives you the names and addresses of dealers from whom various types of subsistence items can be bought. Prices, descriptions, and inspection facilities are also indicated.

Nonperishable subsistence items are normally procured from a Navy shore supply activity or a supply ship.

Who Inspects for What?

Most subsistence items are inspected by a representative of the Department of Agriculture before being delivered to the ship. Aboard ship, the commanding officer requires a qualified representative of the medical department to inspect all subsistence items received from the local market or under contracts which require inspection at destination. The receipt document showing that a fitness-for-human-consumption inspection has been performed must be signed by the medical department representative. Items about which there is any doubt as to fitness should be rejected. Receipts from Navy sources and other Government departments have been inspected and additional inspection by the medical department is not required. Inspections required on receipts from these sources are performed by supply department personnel. If there is any doubt as to fitness for general mess use, the medical department representative should be contacted immediately.

Receipts From Naval Sources and Other Governmental Agencies.—Under ordinary circumstances, nonperishable subsistence items received from Navy sources and other governmental agencies in standard packages are presumed to be in the same condition as when

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they were originally certified. This condition is confirmed by the Navy inspection marks or other inspection stamps on the standard packages. However, the condition of the perishable subsistence items must be examined when they are received. Subsistence items found to be in an off condition or damaged, and for which the Government is liable, are reconditioned and used promptly if possible. Any loss or portion unsuitable for use is surveyed. The net weights marked on standard packages received from the Navy or other Government departments are accepted.

Receipts From Contractors.—Subsistence items received from contractors must be inspected to ensure compliance with the provisions of the purchase document. The inspection certificate is signed in the appropriate space on the Order and Inspection Report (NavSandA Form 48) by the person responsible for the quantity inspection and by the person responsible for the quality inspection. When partial deliveries are received, the food service officer indicates the quantities received and places his initials opposite the quantities indicated as having been received.

The medical officer or his representative inspects all subsistence items received from contractors to assure their fitness for human consumption. The food service officer retains the signed copies of all NavSandA Forms 48 under lock and key until the bills are forwarded for payment.

Storerooms and Galley Inspections

Daily and weekly inspections in the subsistence storage spaces must be made to determine the condition of stored foods. Checks must be made to ensure proper temperature and humidity in storage spaces, to determine condition of the items stored, and to guard against such intruders as bacteria, molds, rodents, and insects. Sanitary conditions must be kept at a high standard and temperature and storage charts should be maintained as required.

Although all foods that come into the galley have been inspected, you still have the responsibility of giving one last check before preparation. The medical officer should be called in to judge any doubtful subsistence items. Besides his periodic inspection of the food service spaces, he is always available to decide on any food that you may question. Don't hesitate to call on him. You can not afford to risk food posioning.

DO YOU KNOW GOOD FOOD?

Occasionally your ship may purchase subsistence items that have not been inspected by a Navy, or any other United States Government inspector. The next few pages give you some criteria by which to judge various foodstuffs. You will find this a handy reference for determining quality when you are called upon to assist in the purchasing and inspecting of subsistence items.

PURCHASED BREAD

The crust of good bakery bread is uniformly golden brown in color, with no light or dark spots. The loaf has good volume and is symmetrically shaped—neither low on one end and high on the other, nor bulging in the middle. The taste must be pleasing, and the aroma should be pleasingly sweet—not sour, musty, or moldy.

The desirable color for the inside portion, or crumb, is a creamy white. Remove a few slices and hold them to the light; they should have a healthy-looking gloss. Examine the grain of the bread. A close, even, uniform grain is desired. No open or coarse grains or large holes should show.

Be on the lookout for ROPE or MOLD. Rope is an undesirable condition caused by bacteria. Soft, sticky brown or yellow spots form in the bread crumb. Usually, the rope disease is not apparent during the first 18 hours after baking, but it develops rapidly after that time if the infection is serious and moist and warm conditions prevail. Temperatures of 85°F and above, particularly temperatures of 95°F to 105°F promote the development of rope.

Molds are microorganisms, visible to the eye as a furry growth. The most common color is bluish green. Molds grow best in an environment that is humid, preferably in the dark or in dim light and, usually, molds prefer warmth but not high heat. The best way to prevent these growths is to keep baked bread in a dry, sanitary place.

For further information on rope and mold, as well as other characteristics of bread, see the chapter in this text on baking.

INSPECTION OF MEATS

All meats procured for the Armed Forces are inspected. The Defense Subsistence Supply Center has the responsibility for implementing and carrying out the technical procurement

inspection programs. Such inspections are conducted by Army Veterinary Corps personnel, Defense Supply Agency Procurement Support Office personnel, and U.S. Department of Agriculture inspectors. The Defense Subsistence Supply Center requires inspection at place of origin to determine compliance with contracts. Receiving activities are responsible for destination inspections. This type of inspection is limited to identity, count, and condition. In some instances, meats are inspected at both origin and destination to verify compliance with contracts.

All major meatpacking centers, from which meat for the Armed Forces is procured, have Veterinary Corps personnel on duty to perform inspections. In many instances inspections are made in addition to those of Federal inspectors. The object of the military inspection is to: (1) protect the health of the Armed Forces against diseases transmitted through spoiled, damaged, or contaminated food, and (2) determine if the foods of animal origin are of the quality indicated in the purchasing document.

After products are inspected, stamps are imprinted on the meat to designate compliance with Federal meat inspection laws and that they meet the requirements of Federal specifications. Subsistence personnel should become thoroughly familiar with these stamps. See figure 3-1.

Beef

Both fresh and frozen beef are procured for the Navy in two styles, carcass or standard wholesale market cuts.

Carcass beef specifications call for steer or heifer beef carcasses. The grades specified are those used largely in the shipping trade and by hotels and restaurants. Carcasses are characterized by superior conformation throughout. Conformation means the shape, thickness, or amount of meat on the carcass. Carcasses in the "good" grade (C) are characterized by superior conformation as shown by short, thick necks and shanks, and by well developed ribs, loins, and rounds. Quality is evidenced by a bright, cherry-red color, lean that is fine-textured, plus a lacy-like mixture of fat, within the lean, called marbling. Top grade carcasses are finished with a creamy white hard fat evenly distributed over the thicker parts of the carcass. Therefore, the three things you would look

DEPARTMENT OF AGRICULTURE INSPECTION STAMPS

These stamps indicate that meat and meat food products are prepared in plants operating under Federal meat inspection regulations of the USDA.

DEPARTMENT OF AGRICULTURE (MEAT INSPECTION DIVISION)

This stamp indicates compliance with Federal specifications for military procurements of meat and meat food products.

DEPARTMENT OF DEFENSE INSPECTION STAMPS

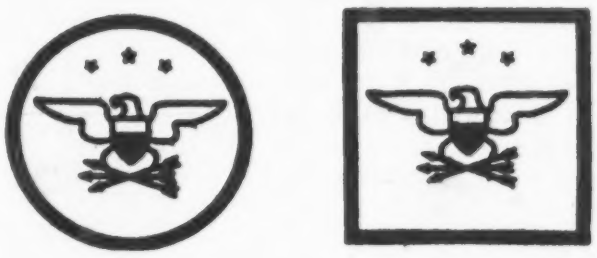

These stamps indicate that meat and meat food products have been inspected by Veterinary Corps personnel.

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Figure 3-1.—Meat inspection stamps appearing on meat or packages of meat.

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for in grading beef are quality, finish, and conformation. Standard wholesale market cuts include the rib and the round. The cuts are prepared and handled according to the specifications for each respective style, class, grade, state of refrigeration, and weight range.

Frozen boneless beef, procured under current specifications, is obtained from forequarters and hindquarters. It is labeled "Beef, boneless, frozen, fabricated, 6-way." Delivery from the packers is in complete units consisting of the following: portion-cut grilled steaks 13.50%; oven roasts 16.50%; portion-cut swiss steaks 11.00%; pot roast 15.00%; diced beef 10.00%; and ground beef 34.00%.

Veal

Veal is procured for the Navy as frozen semiboneless (chops, roasts, stews) and frozen boneless fabricated (slices — cutlet type and flaked steaks). Typical veal carcasses have grayish pink lean that is smooth and velvety in texture.

Lamb

Frozen lamb carcasses and frozen wholesale market cuts (leg and loin) are procured for the Navy. Lamb carcasses always have break joints on their shanks and generally have narrow rib bones, a rather regular contour, and a light red color and fine texture of lean. Carcass lamb must weigh not less than 30 pounds and not more than 55 pounds.

Frozen telescoped lamb which is procured for the Navy is dressed lamb. The carcasses are cut in the following manner: lower foreshanks are cut at the knee. Hind legs are cut squarely from the carcass. Lower hind legs are removed. Removed legs are placed inside the chest cavity. The carcass is then tied so that the long cut front touches the back cut legs, and the flanks are stitched.

Pork

The Navy procures fresh and cured wholesale cuts of pork. The fresh cuts, which may be delivered chilled or frozen are: pork butts; short shanks; pork hams; bladeless pork loins; string tied pork loins; partially boned pork loins; pork spareribs; and pork tenderloins. Fresh lean cuts should be well-developed and fine grained. The fat should be white and firm.

Cured wholesale cuts of pork are chilled or frozen smoked ham and frozen boneless cooked smoked ham. They are prepared and handled according to specifications and must meet the Navy requirements for weight.

Rabbit

Rabbit, frozen, ready-to-cook, cut-up is procured for the Navy according to Navy specifications.

Meat Products

All of the following meat products which are procured for use by the Navy are also prepared and handled according to Navy specification for the style, class, grade, state of refrigeration, and weight range for each specific item:

- Bacon, procures as slab, sliced or pre-cooked
- Beef, corned, brisket
- Beef, liver
- Bologna
- Cervelat
- Frankfurters
- Liver sausage
- Luncheon loaf, pickle and pimiento
- New England style sausage
- Pork sausage, mold style and unlinked style
- Salami, cooked and dried

POULTRY

The high quality, eviscerated poultry (frozen chicken, broiler-fryers and fowl, duck, and turkey) which is procured for the Navy must meet Federal specifications. It should be inspected for deformities, cuts, bruises, and plenty of firm, well-bled flesh.

The following types of poultry items are procured for Navy-wide use:

1. Chicken, frozen, broiler-fryers, ready to cook, cutup, without backs, necks, or giblets, grade A.
2. Chicken, frozen, fowl (hen) ready to cook, whole, grade A.
3. Duck, frozen, ready to cook, whole, grade A.
4. Turkey, frozen, ready to cook, whole, grade A.

FISH AND SHELLFISH

Fish and shellfish, both fresh and frozen are procured for Navy use. Frozen fish fillets (cod, flounder, haddock, mackeral, perch, rockfish,

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and whiting) and frozen fish steaks (halibut, salmon, snapper, and swordfish) are prepared and handled according to Federal specifications. Also frozen shellfish, such as shucked clams, crawfish, shucked oysters, scallops, shrimp, lobster, and fresh crawfish and lobster are procured. Requisition the type and form (fillets or steaks) by the correct Federal stock number to ensure receipt of the item desired. Check the fish carefully. Do not use refrozen fish; that is, fish that has been frozen, thawed, and then frozen again. Fish that has been refrozen will have soft, flabby flesh, a sour odor, and an off color. The wrapping paper may become moist, slimy, or discolored. The bottom of the box as positioned in the freezer, may contain a layer of ice, and the box may be distorted.

FRESH VEGETABLES

Standard grades for vegetables were developed by the United States Department of Agriculture, and the Navy bases its inspection on those standards. When deliveries are made, inspections must be conducted to find out if specifications have been met. Because of their perishability, fresh vegetables must be handled with care. Do not pinch, squeeze, or touch them unnecessarily for bruishing leads to decay and results in early spoilage. The vegetables listed below are procured for the Navy. The quality characteristics to look for when inspecting are included also.

ASPARAGUS.—Look for straight, fresh appearing stalks, crisp and tender, with compact pointed ends and only 1 inch or so of tough woody base to cut off.

BEANS.—Green or waxy yellow (wax beans)-should have long, straight pods, crisp enough to snap easily between your fingers. When the beans start to ridge and bulge the pods, they usually are old, tough, and leathery.

BEETS.—Look for good, globular shape with smooth firm flesh. Medium sized beets are less likely to be tough than very large ones.

BROCCOLI.—Look for plenty of green color in the heads as well as the leaves and stems. Stalks should be tender and firm with compact dark green or purplish-green buds in the head.

BRUSSELS SPROUTS.—Good "sprouts" are hard, compact, and of an attractive green color, while puffiness, wilted appearance, or yellow color all indicate poor quality.

CABBAGE.—Look for well-trimmed, solid heads that are heavy for their size and show no discolored veins.

CARROTS.—Check for bright colored carrots that are well shaped and medium sized. Carrots about $1^1/_2$ inches in diameter are usually a fine quality.

CAULIFLOWER.—A jacket of bright green denotes freshness. The head should be white or creamy white, clean, and solidly formed. If the flower clusters are spread or open, the vegetable will be of poor quality.

CELERY.—Quality characteristics for both the bleached and the green celery are the same. Leaf stems or stalks should be brittle enough to snap easily and of medium length and thickness. The inside of the stem should be smooth. If it feels rough or puffy to your fingers, the celery is likely to be pithy.

CORN.—May be either white or yellow. The husk is a fresh green color, while the kernels are tender, milky, and sufficiently large to leave no space between the rows. Ears generally should be filled to the tips, with no rows of missing kernels.

CUCUMBERS.—The best cucumbers are firm in texture and bright green in color. The older ones tend to be a deep black-green or sometimes yellow. Cucumbers of less than 7 inches in length and about 2 inches in diameter are best.

EGGPLANT.—Purple eggplants should be of a clear, dark, glossy color that covers the entire surface. Heaviness and firmness of flesh are important. Choose pear-shaped eggplant from 3 to 6 inches in diameter. Decay shows up in dark brown spots. Wilted, soft, or flabby eggplants should be discarded.

ENDIVE.—Curly endive grows in a bunched head with narrow, ragged-edged leaves which curl at the ends. The center of the head is a yellowish white and has a mild taste while the dark green outer leaves have a bitter taste.

ESCAROLE.—Escarole is a variety of endive. The leaves are broad and do not curl at the end. Crispness, freshness, and tenderness are the essential factors of quality.

GREENS.—Collards, kale, mustard, spinach, and turnip tops are the greens authorized for general mess use. Good quality greens must be fresh, young, green, and tender. Poorly developed, dry, or yellow leaves or insect-eaten leaves are not good. Coarse stems indicate poor quality.

LETTUCE.—"Iceberg" lettuce, usually purchased for the Navy is tightly headed lettuce, medium green on the outside with a very pale green heart. Discolored areas on the leaves indicate decay. Soft rot sometimes penetrates to the center of the head.

ONIONS.—Spanish and American types of onions, both grown in the United States, are

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used by the Navy. Dry onions should be bright, clean, hard, well-shaped, and dark-skinned. Moisture around the neck indicates decay.

ONIONS, GREEN.—Should be fresh in appearance, should have fresh green tops and medium-sized necks which are blanched for at least 2 or 3 inches from the roots, and young, crisp, and tender. Bruised, yellow, wilted tops indicate poor quality and may indicate poor quality necks. The condition can be ascertained by puncturing with the thumbnail and twisting.

PARSNIPS.—Young parsnips, $1\frac{1}{2}$ to 2 inches in thickness and free from rust spots, are the best. Withered parsnips are old, tough, and have a strong flavor.

PEPPERS.—Should be well shaped, thick walled, and firm, with a uniform glossy color. Pale color and soft seeds are signs of immaturity while sunken, blister-like spots on the surface indicate that decay may set in rather quickly.

POTATOES.—Good quality white potatoes are generally clean, firm, and free from cuts, growth cracks, and other knobs or surface defects. Watch for frost-damaged potatoes which generally have a watery appearance or show a black ring near the surface when cut across.

SWEET POTATOES.—Thick, chunky, medium-sized sweet potatoes which taper toward the end are the best. Avoid those with any sign of decay, as such deterioration spreads rapidly, affecting the taste of the entire potato, even in portions not immediately adjacent to the decayed area.

RADISHES.—Good quality is indicated by the root which should be smooth, crisp, and firm, never soft or spongy.

RHUBARB.—Fresh, large, crisp, and straight stalks of red or cherry color are best. Condition of the leaves is a reliable guide in judging the freshness of the vegetable.

RUTABAGAS.—Good quality rutabagas should be smooth-skinned, firm, and heavy for their size.

SQUASH.—Avoid hard rinds on the following:

Buttercup—shaped somewhat drum-like with sides slightly tapered near the apex.

Zucchini—cylindrical straight, with fairly square ends, skin color moderately dark green over a ground color of pale yellow.

Yellow straight-necked or crooked-necked—very brilliant light yellow color. Hard tough rinds are desirable however on the following as soft rinds are apt to have a watery flesh which is flat to the taste:

Acorn—acorn-shaped and very dull, blackish green with dull orange interior.

Hubbard—medium to large size best.

TOMATOES.—Look for tomatoes that are firm, plump, fairly well formed, of good color, (green out of season and bright red in season) and free from blemishes. They are one of the tenderest products and must be handled with care. Misshapen, angular, ribbed or scarred tomatoes are of poor quality.

TURNIPS.—Smooth skin, firmness, and good weight for their size are qualities to look for.

FRESH FRUITS

Inspections of fresh fruits are based upon standards of the United States Department of Agriculture. Due allowances, however, are made for differences in these grades or standards, but minimum requirements are defined for the various grades.

Generally speaking, the choice of any particular fruit is influenced by appearance and quality. However, you should consider the following factors in inspecting fruits: APPEARANCE (absence of blemishes), SIZE, and TASTE. Appearance is an indication of quality but must not be used as the sole standard in inspecting. Blemishes indicate poor quality or the beginning of decay. The larger the fruit, the more woody and coarse it usually is. Taste, however, is the best indicator of quality. Occasionally, fruits may have surface blemishes and the quality still may be high. Only by tasting can this quality be determined.

Standards for inspecting fruits are applied in the following descriptions.

APPLES.—The best grades of apples are firm and have good color (bright and unspotted) and a pleasant flavor. Immature apples have a poor color, lack flavor, and shrivel after storage. Tart apples are best for most purposes. Soft, mealy, or overripe apples should be avoided.

BANANAS.—The color and condition of the peel are good indications of the use that should be made of bananas. When the skin is all yellow, the banana is firm enough and ripe enough to be eaten. If the peel is yellow but flecked with brown, the banana is fully ripe and should be used immediately. Fruit with a moldy skin that has turned black is of poor quality, although some bananas with a dark skin are very ripe but still good eating.

CANTALOUPES.—There should be no trace of a stem at the blossom end. If the netting covers the cantaloupe thickly and stands out like a whipcord, the melon is generally good. An apparent softness at the blossom end is no sure indication of maturity, as repeated pressure from handling will produce this condition. Fully

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ripe cantaloupe will have a delicate aroma, while an audible rattling of the seeds in a melon, when shaken, is another sign of maturity. The skin beneath the netting usually has a yellow tinge. Too deep a yellow indicates overripeness.

CHERRIES.—High quality is denoted by plumpness with a bright appearance and good color.

GRAPEFRUIT.—Fine juicy grapefruits are well rounded in shape and heavy for their size. They are firm, but springy, to the touch; not soft wilted or flabby. When grapefruits have a course skin or are puffy and spongy it indicates lack of juice and taste.

GRAPES.—Color is a good guide to ripeness. The darker varieties should be free of a green tinge, while the white grapes should have a decided amber coloring. The fruit is plump and each grape is firmly fastened to the stem. A wet condition, or the presence of mold, indicates decay.

HONEY BALL MELON.—Prime-quality honey ball melons have a thick green-colored, sweet, fine-flavored flesh with a distinct, pleasant aroma. The rind has a light-yellowish color and yields slightly to pressure. Decay is generally indicated by mold or dark, sunken, watery areas.

LEMONS.—The best lemons have a greenish-yellow color with a smooth, fine-textured skin, and are heavy for their size. Mold or soft spots at the end indicate decay. If too springy, they may be decayed in the center.

NECTARINES.—Nectarines look and taste like small peaches except that they do not have "peach fuzz." They are red, white or yellow fleshed in color and are chosen for their plumpness and firmness.

ORANGES.—The skins of good oranges should be yellowish orange, smooth, and fine-textured. Avoid those that have badly creased skins or a puffy spongy condition and are light in weight for their size. When inspecting for quality, be sure that the crate does not contain decayed fruit.

PEACHES.—Quality in peaches is indicated by the general appearance and firmness of the flesh. They should be smooth skinned and well filled out. The color on the underside should be creamy white or yellow blushed with red. Overripeness is indicated by deeper reddish brown color and softness of the fruit.

PEARS.—Good quality pears are firm and shiny. Pears are packed and shipped green because it is characteristic that they develop a fine flavor and smoother texture when ripened off the tree. They should be full ripe for fresh use. If they are hard and unyielding to the touch at time of receipt, allow them to stand at ordinary room temperature until the flesh responds readily to a gentle pressure of the hand. They are then in prime condition for eating.

PINEAPPLE.—Fully ripe pineapples are slightly soft to the touch, golden yellow in color, and have a "piney" aroma. Fruit that is too green may not ripen well. Overmaturity is shown by slight decay at the base or on the sides by dark, soft, watery spots.

PLUMS.—Good plums should be full-colored and soft enough to yield to slight pressure. Some varieties are fully ripe when the color is yellowish green; others when the color is purplish blue or black. If hard, poor in color and flavor, the fruit is immature. Overripe fruit is soft and usually leaky.

STRAWBERRIES.—Quality in strawberries is indicated by the general appearance. They should be firm, plump, and bright red in color. Overripe berries are leaky, dull in color, and should not be used. Mold at the surface indicates decay.

TANGERINES.—Tangerines are small yellowish red oranges with easily removable skins and loosely adhering sections. Quality is based mainly on weight for size and deep yellow or orange color of the skin.

WATERMELONS.—A fully ripe watermelon has a thin outer skin that peels easily when scraped with the fingernail. The underside changes from white to yellow tinge with maturity. The safest way to determine watermelon quality is by "plugging."

CANNED PRODUCTS

In the event you are assigned to the inspection of canned products, such as meats, fish, poultry, vegetables, fruits, and juices, you should take into consideration the following:

CAN SIZE.—Make sure cans are the size requisitioned.

CAN LABELS.—Check the information stamped on the end of each can, and be sure that contents and date of pack are indicated.

CAN EXTERIOR.—Examine the exterior of the can for general appearance, dents, swelling, rust, and pinholes. Dents, unless so severe as to cause leakage, do not indicate that the contents are in an unsatisfactory condition. Rust does not injure the food unless it penetrates the can. Pinholes are found only by careful inspections.

CAN INTERIOR.—Remove the contents and check the inside of a sample can very carefully. It may be necessary to rinse the can thoroughly and then refill with water to detect very small pinholes.

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CONTENTS OF CAN.—Odor and taste indicate the condition of food. Fading of color, loss of flavor, and softening of contents are due to chemical action and natural aging processes. Discoloration is another defect caused by a chemical action found usually in products containing sulphur compounds; that is, corn, peas, and meat products.

Unsatisfactory Cans

Except for coffee, which is discussed later, foods contained in the following types of cans are found to be unsatisfactory and should be surveyed. Canned food that is abnormal in appearance or odor should never be eaten or EVEN TASTED.

PINHOLE CANS.—These are cans with tiny holes caused by the action of acid in the food.

SWELLS.—These are also called "swellers." Both ends of this type of can bulge out and remain that way. This condition is caused by chemical action of bacteria (microorganisms) in the foods which results in the freeing of a gas (hydrogen sulphide). This gas cannot escape and gains room only by bulging out the end of the can.

SPRINGERS.—The ends of this type of can are also bulged out, but they will yield to pressure of the fingers or thumb. When the pressure is relieved, the ends bulge out again. This condition may be caused by overfilling the can or by chemical or bacterial action on the food freeing gas which causes the swelling condition.

FLIPPERS.—This term describes a can, the ends of which are flat. However, one end may be forced into a convex condition when the other end of the can is brought down sharply on a flat surface. It indicates a loss of vacuum in the can from formulation of gas by bacteria or by chemical action on the metal of the can. Regardless of the cause, the contents should not be used.

Coffee

Coffee is an exception to the above. Care must be taken NOT to reject cans of roasted and ground coffee showing swell or springer characteristics. Swellers that develop in coffee are usually an indication of a properly sealed container that has retained its natural gases. The gas, replacing the original vacuum created in the can, expands.

When coffee in any sweller or springer can is of uncertain quality, report it to the commissary officer via the senior Commissaryman.

DRY STORES

DRY STORES, aside from canned goods, are such foods as cereals, sugar, dried fruits, vegetables, flour, and meal. They must be stored under controlled conditions of temperature, humidity, and air circulation.

Insects can cause great damage to stored food; attacking both natural and manufactured food. Food stored at temperatures between 60° and 90°F are especially attractive to insects.

In inspecting dry stores, remember that United States Department of Agriculture standards were followed at the time of purchase. The main things for you to check are the following: (1) OUTWARD APPEARANCE of the food, or food containers; and (2) CONDITION OF THE FOOD ITSELF. Flour and meal bags, for example, may be torn and the food exposed to bacteria. Rolled oats or other cereal containers may be broken and the food contaminated. Dried vegetables may be damp and moldy.

DAIRY PRODUCTS

Dairy products spoil quickly under improper storage conditions. The method of handling and the storage temperature must be correct. It is necessary that you check them carefully upon delivery, and frequently thereafter until they are consumed.

MILK AND CREAM.—Dairy products are purchased in accordance with Government standards. They are shipped in cans, or approved fiber containers. When delivered to you, check the containers for visible foreign matter, cleanliness, and leaks, and ensure that the medical representative has inspected them. Temperature of milk delivered to naval establishments should never exceed 50°F. In hot weather, taste the milk for freshness. It is important that you make a daily check on the temperature of the boxes in which milk and cream are kept. The temperature should be close to freezing, 32°F.

BUTTER.—Butter should reach you in clean, unbroken cases. The inspection stamped on the case should indicate the weight and the grade of the butter. For quality, it is best to taste samples for sweetness and freshness. The color should be uniform and the texture firm. No specks or foreign substance should be present.

CHEESE.—Check the rind, color, flavor, and texture of cheese. It may be delivered to you in either natural or processed form. The rind should be clean, and free from molds or wrinkles. The color should be evenly distributed through good

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cheddar cheese. You can tell this by holding a thin slice in front of a light. The flavor of good cheese is clean and "nutty," and the texture compact and solid. There should be no breaks or holes in the surface of the cheese.

EGGS.—Eggs are purchased in accordance with Navy specifications. When eggs meet specifications the containers are marked at the time of delivery by the inspector to show their grade and the date of inspection. Various types are procured to meet all kinds of conditions, temperatures, and uses.

Fresh eggs not over 30 days old are the preferred type. They have never been in cold storage, and have been held at a temperature between 40° and 50°F. Storage eggs have been stored at temperatures of about 29 - 31°F.

Dried, whole eggs have many advantages over fresh shell eggs. Such eggs occupy less space, effect a considerable saving in weight, and are ready for instant use without laborious inspection and separation from the shell.

Processed cold storage eggs have been preserved by dipping them in hot mineral oil at 200°F for 6 seconds. The hot oil seals the pores of the eggs, retards shrinkage by evaporation, and destroys molds and bacteria, thus prolonging the life of the egg. Processed eggs keep longer and retain their original flavor better than untreated eggs.

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CHAPTER 4

STORAGE AND CARE OF SUBSISTENCE ITEMS

Storage of subsistence items is important to a Commissaryman because conservation of foods and their availability for use are both dependent to a great extent on proper storage procedures. Correct storage is also an important aspect of the sanitary precautions that are so necessary to prevent foodborne illness.

Three factors of major importance in all storage, no matter what material, are safety, accessibility, and orderliness. This chapter defines standards of acceptability on each of these factors for the various types of subsistence items and discusses how such standards should be maintained.

SAFETY.—Materials must be stored so as to prevent injury to the ship and the crew and to prevent damage to the material itself. Articles stored overhead and upon the tops of bins must be secured with particular care because the lashings or other means of securing are subjected to heavy strains while the ship is underway. This means of securing should be inspected frequently and renewed upon the first sign of wearing.

Other very important factors that contribute to the actual SAFETY of the material are TEMPERATURE, AIR CIRCULATION, and HUMIDITY. These factors are discussed throughout the chapter. Tables given with the various kinds of commodities specify temperature, relative humidity, and safe-keeping time of individual perishable and nonperishable subsistence items.

ACCESSIBILITY.—Supplies must be arranged in stowage so as to facilitate breakout. Articles that are issued most frequently should be stored nearest the breakout area. Whenever practicable, avoid stowing an item on top of or behind an item of a different kind. (Failure to observe this rule causes slow breakouts and slow and inaccurate inventories.) Items must be stored so that, under ordinary conditions, the oldest stock will be the first issued.

ORDERLINESS.—Case goods should be stacked neatly in their storage area so that they can be counted by sight without being moved.

These three factors are closely inter-related and must be considered together. For instance, if, for the sake of accessibility, you leave cases of canned goods stacked in the passageway, or if you do not secure them properly, you will violate rules of safety and orderliness. If such a practice were carried to an extreme, you would eventually have such confusion that accessibility would suffer also. Because the factors are so closely linked, they are considered together throughout the chapter.

This chapter is organized according to types of subsistence items and considers the rules of storage applicable to each.

NONPERISHABLE SUBSISTENCE

The term "nonperishable subsistence" refers to food items that are canned, dried, dehydrated, or otherwise processed to the extent that such items may, under normal conditions, be stored in nonrefrigerated spaces. While nonperishable subsistence is not nearly so prone to spoilage as fresh subsistence, spoilage can and will occur if the items are mishandled, improperly stored, or stored too long. Always remember that the length of storage should be based on the packing date of the product and not the date of receipt.

Storage Principles

When possible, store nonperishable subsistence items in clean, cool, dry, well-ventilated storerooms. Check all items at regular intervals for signs of damage. Keep your storerooms clean to prevent the contamination of bagged foods by dirt and dust.

Segregate and clearly mark shipments so that the oldest lots — as packed, not as received — are issued first. However, if newer lots show signs of deterioration or spoilage, issue them first.

Methods of storage depend on the size and the contents of the container, and the bursting or breaking strength of the bottom layers. Care

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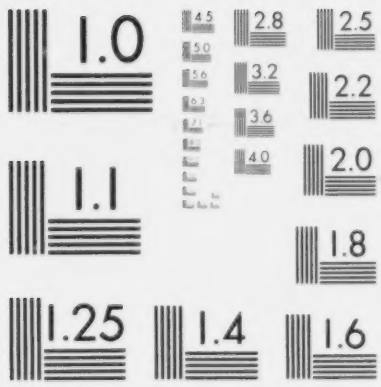

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must be taken not to stack items too high. This will cause a bursting or crushing of the bottom layers.

Do not stack items near steam or other heated pipes. Use pallets to raise the subsistence items off the deck and stack individual lots so as to permit proper circulation of air around the lots.

Bagged items and those requiring fumigation and insect control should not be stored in large masses in corners of the storeroom or directly against the bulkhead; this type of storage will not permit sufficient room for cleaning and inspecting. Whenever practicable, palletized storage should be used to ease the handling of the stores and reduce losses through breakage in handling. Cross stack items to keep the stack solid and prevent it from toppling.

The safe storage period for nonperishable subsistence items varies greatly, depending on such elements as temperature, humidity, care in handling, protection from the weather, quality of the food when received, and the packing. Subsistence that has been on hand beyond the safe storage limit should be inspected for spoilage, leakage, or other damage. If such items are in good condition, use them as promptly as practicable. Survey all items unfit for human consumption.

Causes of Spoilage

Age, bacteria, yeasts, molds, insects, rodents, and environmental factors contribute to the deterioration of all foodstuffs.

Age is one of the contributing factors in food spoilage. This factor compels an observance of the basic principle of storage that the oldest lots of the item should always be used first, except when the condition of the newer item is such that it must be given priority.

Bacteria, yeasts, and molds are the primary causes of food spoilage. Canned foods may be spoiled by bacteria which have survived the canning process or by bacteria which have gained access to the can through imperfections in or damage to the containers. Spoilage is evidenced by the development of gas and in most cases by a foul odor or bad taste. Yeast growth creates damage, particularly at temperatures between 77° and 95°F, to products with a sugar content, such as honey, sirup, dried fruits, sweet beverages, fruit concentrates, and canned fruits.

Molds produce visible threadlike filaments, musty odors, and off-flavors in the product in which they are growing. Surface molds on firm textured foods such as meats and meat products are not necessarily harmful. You can remove such molds by brushing with a stiff bristled brush and then wiping with a clean cloth moistened with a vinegar or salt-water solution. Heavy mold may be removed by trimming with a knife.

Insects can and do cause great damage to stored food, attacking both natural and manufactured food. Roaches and flies not only contaminate the foods but may spread disease. Foods stored at temperature between 60° and 90°F are especially attractive to insects. When supplies are not too heavily infested with some insects they may be reconditioned for use. Use insect repellents carefully so as not to contaminate the food or cause damage by absorption of the fumigant or insecticide flavor into the food.

Rodents (rats and mice) not only physically destroy food by feeding, chewing, and cutting the bags for nests or nesting material, but also contaminate food with their excreta and hairs. They are carriers of filth and disease. The most effective method of control is to prevent the entry of these animals into the storerooms.

Physical environmental factors that contribute to the spoilage of nonperishable subsistence include freezing, heat, moisture, lack of ventilation, and exposure to light. Dry products such as grains, flour, sugar, starch, cereals, and dehydrated foods, ordinarily are not injured by freezing. If canned foods containing large amounts of water are frozen accidently, the usefulness and taste of the products will not be harmed. However, the physical appearance may suffer by softening. Emulsions such as canned cheese and butter, prepared mustard, and mayonnaise will separate and appear unpalatable, although the food is not spoiled.

A high storage temperature over long periods of time is very detrimental to most food products. It encourages bacterial growth, mold growth, and insect infestation. Flour and associated products (barley, cereals, corn meal, cornstarch, crackers and biscuits, hominy, noodles, oats, rice, spaghetti and macaroni, tapioca, and uncooked wheat) are made more subject to insect infestation by heat. When storing flour and cereals, keep them away from materials which give off distinctive odors. Store any items that are not sealed in metal containers away from moisture and odor producing materials.

Moisture hastens the growth of insects, bacteria, and molds, and sometimes causes mustiness in flour, rice, and similar foods. Check your dried vegetables and fruits at frequent intervals to determine if this condition exists.

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Dehydrated products are perishable and should not be handled or stored carelessly. They are subject to moisture absorption, insect infestation, and mold. Loss of flavor and discoloration (darkening) will occur with age; this action is progressive, and is hastened at high temperature.

Improper ventilation and too much light can also add to the deterioration of foods. Where you have sharply fluctuating temperature and high humidity, the lack of proper ventilation may cause very high temperatures. Proper ventilation is one of the most important factors in protecting foods, particularly in tropical areas.

Damage from light is restricted to products that are packed in glass or transparent containers. Exposure to light causes color changes and may affect the flavor of foods containing, or composed of, edible oils and fats.

TABLES OF SAFE-KEEPING TIME AND STORAGE DATA FOR NONPERISHABLE SUBSISTENCE ITEMS

Information listed in the following pages is your guide in determining the average storage life of the listed items under existing conditions. Because of day-to-day changes in conditions of temperature and relative humidity, it will be necessary to consider both the average and the extreme to which products have been exposed. The type of packaging protection must also be considered.

When a product reaches the maximum age specified for a given temperature, it is not necessarily spoiled. It has merely reached the age at which experience has shown that a product of this type, under the specified conditions, should be suspected of deterioration. If a product exceeds the maximum storage age shown on the table, and you have any doubt concerning its condition, have a representative from the medical department inspect it to determine its fitness for human consumption.

Meat, Poultry, and Fish

Canned meat, poultry, and seafood products; and canned dehydrated meat, poultry, and seafood products will deteriorate to some extent at very high or very low temperature, and the container is subject to damage from high humidity combined with changing temperature. When storing the above products, place them on racks or dunnage in a moderately cool, dry place. The best storage temperatures are 30°F to 80°F, and a relative humidity of 60 percent. Always rotate your stocks to ensure that they are used well in advance of the recommended safe-storage periods. Refer to table 4-1 when storing canned meat, poultry, and fish.

Table 4-1.—Storage Data for Canned Meat, Poultry, and Fish

48.77.1

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Canned meat, poultry, and fish						
Meat					Temperatures above 90°F hasten deterioration	Deterioration resulting from age is evidenced by rancidity, softening of the meats, fading of color, and loss of flavor.
Beef						
Beef, corned	Can	60	36-48	30		
Beef with gravy	Can	60	36-48	30		
Hamburgers without gravy	Can	60	36-48	30		

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Table 4-1.—Storage Data for Canned Meat, Poultry, and Fish—Continued

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Meat—Continued						
Pork						
Bacon, sliced	Can	48	18	12		Sliced bacon in hermetically sealed cans may develop old flavors, rancidity, and the fat may become yellow in color. Slices may show a tendency to fall apart due to breakdown of the fat.
Bacon, sliced prefried	Can	48	30	12		
Ham, chunks	Can	60	48	30		
Luncheon meat	Can	60	36	24		
Pork sausage	Can	60	36	24		
Pork and beef combinations					Temperatures above 90°F hasten deterioration	
Frankfurters	Can	60	48	30		
Luncheon meat	Can	60	36	24		
Vienna sausage	Can	48	24-30	12-18		
Poultry					Do not store above 90° F	
Chicken	Can	60	36-48	30		
Turkey	Can	60	36-48	30		
Fish						Leaky cans, swells, flippers, springers, flat sours, pinholing, or discoloration are signs of deterioration of product. Occasionally sharp glass-like crystals may be discovered in canned fish items. Invariably these crystals are a formation of a substance known as struvite which occurs in storage, and is not harmful.
Clams	Can	48	12-24	6-12		
Salmon	Can	60	30	12		
Sardines	Can	48	12-24	6-12		
Tunafish	Can	60	30	12		

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Dairy Foods and Eggs

Most of the items listed in table 4-2 are classified as nonperishable and are packaged in rigid containers where moisture and infestation are not problems. However, items packaged in containers which are not closed to moisture, should be stored away from moisture. Observe storage temperature shown on the shipping containers. Products stored in containers which are not air tight should be given special attention. They should be stored in cool dry areas away from odorous items.

Table 4-2.—Storage Data for Dairy Foods and Eggs

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Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Dairy foods						
Cheese						
Cheddar, processed	Can	60	30-36	12		Deterioration indicated by blown cheese, excessive mold, oiling off, drying out, cracked cheese and off-flavor.
Grated Parmesan or Parmesan and Romano	Container		6	3		
Ice cream mixes						
Paste	Can	24	7-12	4	Do not store above 70°F	Rancid, tallow, fruity, and stale flavors, darkening, lumping, and poor solubility may occur in the mixes.
Powder	Can	24-36	12	4		
Milk and cream						
Milk						
Dry, nonfat, instantized	Can	36-60	12-24	9-12		May develop stale flavor.
Dry, nonfat, regular	Can	36-60	12-24	9-12		May develop stale flavor and caking when not adequately protected from moisture; color tends to darken. Should then be used only for baking.
Dry, whole	Can	24-36	10-12	5-6		May darken in color and develop stale flavor, rancidity or tallowness. If it becomes rancid, it may be used for baking.
Evaporated	Can	24-36	12	6	Do not store above 100°F or below 33°F	Cases should be turned every 30 to 60 days to prevent separation of butterfat, but separation and grainy sediments are not cause for condemning stock as the milk can be used for cooking purposes.

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Table 4-2.—Storage Data for Dairy Foods and Eggs—Continued

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Milk product, dry cocoa flavored	Heat sealed envelope	60	24	12	High humidity	Stale flavor and caking indicate deterioration.
Cream						
Dry, coffee type	Can	60	36	8	Do not store at 100°F or above	Deterioration indicated by stale or tallow flavor.
Dry, coffee type	Envelope	48	24	6		
Dry, whipping	Can	8	6	4	Do not store above 70°F	Deterioration indicated by stale or tallow flavor.
Eggs, whole, dried, powdered	Can	60	24-36	12-18	Do not store at 90°F or above	Deterioration indicated by darkening in color, loss of solubility, mealy texture, scorched flavor and off-odor when prepared.

Fruits and Vegetables

Store canned fruits and vegetables at most favorable conditions with storage temperatures not to exceed 100°F. Storage above 100°F may cause chemical and bacterial spoilage as well as loss of color and taste. Dehydrated canned fruits and vegetables should be kept at approximately 70°F or lower. Table 4-3 lists the best possible storage conditions for canned fruits and vegetables and dehydrated fruits and vegetables packaged in foil or fiber.

Table 4-3.—Storage Data for Fruits and Vegetables

48.79.1

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Fruits						
Canned					Over 100° F. Lower than 25° F	Musty flavor and darkening indicate deterioration.

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Table 4-3.—Storage Data for Fruits and Vegetables — Continued

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Fruits						
Canned—Continued						
Berries	Can	36	6-12	2-6		
Cherries, sour	Can	36	6-12	2-6		
Citrus	Can	36	6-12	2-6		
All other canned fruit	Can	48-60	24-36	12-18	Over 100°F. Lower than 25°F.	Spoilage occuring before the termination of safe-storage periods is evidenced by ruptured, leaky, or pinholed containers, flippers, springers, or swells, or off-color, odor, or flavor. Deterioration resulting from age is indicated by softening of fruit, fading of color, loss of flavor and pinholing of highly acid products.
Dehydrated					High temperatures	
Apples, pie style	Can	36-48	7-12	3-6		Deterioration indicated by darkening.
Applesauce, instant	Can	36	24	12		Deterioration indicated by browning and caking.
Apricots	Can	24	12	5		Deterioration indicated by darkening.
Fruit cocktail mix (dessert type)	Can	24	12	5		Deterioration indicated by darkening.
Peaches, slices	Can	24	12	6		Deterioration indicated by darkening.
Prunes, pitted	Can	24	12	9		Deterioration indicated by darkening.

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Table 4-3.—Storage Data for Fruits and Vegetables—Continued

48.79.2

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Fruits						
Dried—Continued					High temperatures and humidities below 70%	Loss of color and palatability increase with increase of temperature. As soon as a package is opened, it is immediately subject to infestation by insects. Insect activity virtually ceases at 40°F or below. Loosely sealed containers are not moisture-proof and are not readily accessible to insects. Dried fruit is very responsive to changes in humidity, and if humidity is less than 70%, the exposed fruit will become hard and dry.
Apricots	Carton	36	2-5	1		
Currants	Carton	36	12-15	6-9		
Peaches	Carton	36	7-12	3-4		
Prunes	Can	48-60	12-24	9-15		
Prunes	Carton	36	12-15	6-9		
Raisins	Can	48-60	12-24	9-15		
Raisins	Carton	36	12-15	6-9		
Juices						
Powdered, natural						Flavor and stability depend on use. Entire contents of can must be used at once, otherwise product absorbs moisture and cakes.
Grapefruit	Can	60	36	18		
Orange	Can	60	36	12		
Single strength						
Grape	Can	24	12	6		
Apple, pineapple	Can	36	24	10		
Grapefruit, orange blended grapefruit and orange	Can	48	36	18		
Miscellaneous						
Cherries, Maraschino	Jar	36	30	12	Below 0°F	Freezing will destroy texture. Deterioration, indicated by darkening.
Vegetables					Above 100°F below 25°F	
Canned						
Sauerkraut	Can	48	18	9		

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Bakery and Cereal Products

Bakery and cereal products are subject to deterioration or damage from moisture, high temperatures, infestation and absorption from other products. Store these items on racks or dunnage in a moderately cool, dry place at an approximate temperature of 70°F and a relative humidity of 60 percent. Protect them from heat, moisture, vermin, and such odorous items as paint, oil, soap, and spices. The approximate keeping time of bakery and cereal products under certain conditions is listed in table 4-4.

Table 4-4.—Storage Data for Bakery and Cereal Products

48.80.1

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Bakery products						
Mixes						
Biscuit						
Bread and roll						Deterioration indicated by rancid odor, mold, loss of baking quality.
Cake						Deterioration indicated by rancid odor, mold, loss of baking quality.
Doughnut	Bag or carton	12	6	3		Deterioration indicated by rancid odor and mold.
Frymix breading and batter	Can	48	24	12-18		Deterioration indicated by rancid odor and mold.
Pancake						Deterioration indicated by rancid odor and mold.
Pie crust						Deterioration indicated by rancid odor and mold.
Sweet dough						
Products and ingredients						
Cornstarch	Carton	36-60	24-36	12-24		
Cookies	Carton	4-12	1-6	1 week to 3 months		Deterioration indicated by staleness, mustiness, off-odors, and flavors.
Crackers, soda and graham	Carton	4-12	1-6	1 week to 3 months		Deterioration indicated by staleness, mustiness, off-odors, and flavors.

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Table 4-4.—Storage Data for Bakery and Cereal Products — Continued

48.80.2

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Bakery Products						
Mixes — Continued						
Crackers, soda 12% minimum fat	Carton	36	12	6		
Tapioca	Carton	36-60	24-36	12-24	High humidity	Deterioration indicated by mustiness, insect infestation, and rodent contamination.
Wheat base	Bag	60	36	18	Above 90° F	Refrigerated storage is desirable.
Cereals						
Barley	Carton	36-60	24-36	12-24		
Cereal, quick-cooking	Carton	36	24	18		Deterioration indicated by rancidity, mustiness, infestation, and rodent contamination.
Cereal, quick-cooking	Can	36-48	24-36	18-24		
Cereal, ready-to-eat	Carton	36	12	6	Above 50% humidity	
Cereal, ready-to-eat, sugar coated	Carton	12	12	6		
Corn meal	Carton	36	24	18		
Corn meal	Can	36-48	24-36	18-24	Above 60% humidity	
Hominy grits	Carton	24-36	12	6		
Hominy, whole	Can	48	36	6		
Rice, parboiled	Bag	24	12	6		
Flour						
Rye	Bag	4-6	2-4	1-2	Above 70% humidity	Keeping times are based on a relative humidity of 60%.
Wheat, hard or soft	Bag	24	9-12	3-4	Above 70% humidity	
Wheat, hard, vacuum	Can	60	24	12-18	Above 70% humidity	
Macaroni Products						
Macaroni, spaghetti, and vermicelli	Carton	36-48	24	9		
Noodles, chow mein	Can	6	2	1		
Noodles, egg	Carton	36	24	9		

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Sugar, Confectionery, and Nuts

All the items in table 4-5 are subject to deterioration or damage from moisture, high humidity, and odor absorption from other products. For variances in storage requirements for individual items, see the REMARKS column in the table.

Table 4-5.—Storage Data for Sugar, Confectionery, and Nuts 48.81.1

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Confectionery						
Almond paste	Can	36	9	3		
Candy, caramel	Box	24-36	9-18	4-6	Above 60% RH	
Candy, coated	Can	60	30	12		
Candy, coated	Box	24-36	9-18	4-6	Above 60% RH	
Candy, hard	Can	60	24-36	12-18	Above 90°F	Deterioration indicated by loss of hardness; becomes opaque and soft.
Chewing gum	Carton	9	4	2		Deterioration indicated by brittleness, lack of flavor.
Chocolate, cooking unsweetened	Paper wrapper	24-36	6-12	3-6	Above 80°F	Do not store near other material capable of imparting odor to the chocolate. Deterioration indicated by melting, mustiness, and mold.
Chocolate, sirup beverage, stabilized	Can	60	24	12		Deterioration indicated by off-flavor and color, change in consistency.
Chocolate sirup, topping, unstabilized	Can	60	24	12-18		
Coconut, dessicated for baking	Bag	24	12	6	High humidity and temperature	Deterioration indicated by off-odor, browning. Rancid soap taste develops at high temperature.
Coconut, prepared, sweetened	Can	30-36	18-30	12	Above 100°F	Deterioration indicated by yellowing, browning, soapy taste, and mold.
Fruit, candied, cherry and pineapple	Cartons	12	6	3	High temperature	Deterioration indicated by stickiness.
Fruit, candied, mixed pieces	Can	12	6	3	High temperature	Deterioration indicated by stickiness.

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Table 4-5.—Storage Data for Sugar, Confectionery, and Nuts—Continued 48.81.2

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Honey, extracted	Glass	36	24	12	Freezing temperature	Deterioration indicated by mold in crystal growth. Heating reverses crystallization.
Marshmallows	Box	36	12	6	Below 60% RH	
Sirup and molasses	Glass and can	60	18-24	10-12	Above 85°F, below 40°F	Deterioration indicated by crystallization and fermentation. Fermented product is not safe to use.
Nuts, shelled, vacuum pack	Can	60	24	12		
Sugar						
Brown	Carton	36	18	6-9	Above 90° F, below 35°F	Tends to cake.
Confectioner's	Carton	36	18	6-9	Above 90° F, below 32°F	Tends to cake.
Granulated	Bag	Indefinite	Indefinite	Indefinite		
Granulated	Can	Indefinite	Indefinite	Indefinite		

Jams, Jellies, and Preserves

Jams, jellies, and preserves listed in table 4-6 are procured in glass and metal containers and can be stored under available storage conditions. Generally, only the container will be subject to deterioration.

Soups

Soups stored at high temperatures for too long a period may deteriorate and become unacceptable. Long storage may cause some of the ingredients to form a ball or cake. When this happens it is difficult to make the soup go back to its original form. Refer to table 4-7 for the best possible storage information.

Special Dietary Foods and Food Specialty Preparations

For variance in storage requirements for individual items, see the REMARKS column in table 4-8.

Fats

Fats are subject to deterioration mainly from high storage temperatures. When you store these products, place them in cool areas where the humidity is low enough to prevent rusting of the containers. For the best results, these products should be stored at temperatures of 72°F or less. See table 4-9.

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Table 4-6.—Storage Data for Jams, Jellies, and Preserves

48.82

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Jams, jellies, and preserves						
Apple butter	Can or glass	36-48	12-24	10-12	Above 90°F	Deterioration indicated by carmelization, off-flavor, dark color, and crystallization. This does not render the product unsuitable for human consumption but does destroy the natural appeal.
Jams	Can or glass	48-60	18-24	10-12		
Jellies	Can or glass	48-60	18-24	10-12		
Marmalade	Glass	48-60	18-24	10-12		
Peanut butter	Can or glass	48-60	24-48	18-24		Separation of oil from peanut butter can be corrected by mixing.

Table 4-7.—Storage Data for Soups

48.83

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Soups						
Condensed	Can	36-48	12-48	6-8	Freezing temperatures	Cream-style soups break down on freezing but are not spoiled. Vegetable soup components become mushy.
Dehydrated						
Chicken noodle	Can	36-48	12-24	7-9		
Green pea	Can	60	30	12		
Onion	Can	60	24	9		
Tomato-vegetable	Can	24	12	6		Deterioration indicated by strong, hay-like aroma.
Ready-to-serve	Can	60	36	18	Freezing	Tomato spoils more rapidly than other varieties.

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Table 4-8.—Storage Data for Dietary Foods and Food Specialty Preparations

48.84.1

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40°F	70°F	90°F		
Chili Con Carne	Can	48	36	24		
Dessert powder, gelatin base	Fiber cans with metal ends, cans, cartons	60	12-24	6	High temperature, high humidity	Highly susceptible to damage by moisture and will deteriorate rapidly. Once opened, will tend to lose flavor and develop turpentine odor or flavor. Opened cans should be used as soon as possible.
		36	12	6		
Dessert powder, starch base	Can	60	24-36	10-12	High temperature, high humidity	
	Carton	36	12	6		
Gelatin, plain, edible	Moisture-proof carton	48-60	24-36	18-24	High temperature, high humidity	High humidity may cause damage to cans. Product has a tendency to cake.
Malted cereal, sirup, dry	Bag and carton	24	12	9	High humidity	Deterioration indicated by sticky, fermentation odor.
Malted cereal, sirup, liquid	Can	12	3-4	1-2	Temperature above 40°F	Deterioration indicated by darkening, gas formation due to fermentation.
Meringue powder	Package	48	24	12-18	Above 70°F high humidity.	Deterioration indicated by discoloration, off-color, off-odors, loss of baking qualities.
Mincemeat	Can	36	18	9		
Popcorn, unpopped	Can	96	36	36		
Potato chips	Cellophane bags and cartons	3	1	1 week		Deterioration indicated by rancidity, off-flavor, off-odors, loss of crispness.
Potato sticks	Can	36	24	12	Above 60°F	

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Table 4-8.—Storage Data for Dietary Foods and Food Specialty Preparations—Continued 48.84.2

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Soup and gravy base, dehydrated	Can	48	24	12	Freezing temperature	Deterioration indicated by caking, separation of ingredients, and oxidation, off-flavors and odors. Recommend that soup and gravy base, dehydrated, chicken be stored at 40°F.

Table 4-9.—Storage Data for Fats 48.85

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Fats						
Lard	Carton	16	5	No		Lard should be stored away from direct sunlight which accelerates rancidity. Cartons afford adequate protection only when the temperature is kept below soft point (approximately 85°F).
Margarine	Can	60	24	3-12	Above 90°F	
Salad oil	Can	24	9	4-6	Above 90°F	Deterioration indicated by rancid odor, taste or change in appearance (tends to lose its clarity and brilliance). Salad oil held for a long period below 32°F will show solid materials present which are harmless and disappear on warming.
Shortening compound	Can	36-60	18-24	12-15		Deterioration indicated by rancidity, off-flavors and odors. If held above 90°F, may induce changes in texture unfavorable to the normal creaming properties of shortening.

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Condiments and Related Products

It is recommended that condiments and related products be stored at 70°F or 40°F. The lower temperature is better. For additional information, refer to table 4-10.

Cocoa, Coffee, and Tea

When storing individual items of cocoa, coffee, and tea, see the REMARKS column of table 4-11 for variance in requirements.

Table 4-10.—Storage Data for Condiments and Related Products

48.86.1

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Antioxident compound, food service	Carton	Indefinite	Indefinite	Indefinite	High humidity	
Baking powder	Can	Indefinite	Indefinite	Indefinite		
Baking soda	Carton	Indefinite	Indefinite	Indefinite		
Catsup and chili sauce	Can	24-36	12	6		Deterioration indicated by blackening, raw pungent odor. Excessive long storage will result in pinholing of cans.
Cream of tartar	Carton	Indefinite	Indefinite	Indefinite		
Flavoring, imitation maple, vanilla	Glass	Indefinite	Indefinite	Indefinite	Store away from light	Deterioration indicated by loss of flavor and color and settling of material at bottom of bottle.
Flavoring, nonalcoholic, lemon, orange	Glass	24	18	6-9	Store away from light	Deterioration indicated by sharp off-flavor
Flavoring tablets, imitation vanilla, and maple	Carton	Indefinite	Indefinite	Indefinite	Above 80% relative humidity	Deterioration indicated by stickiness, gumminess evidence of mold and yeast growth.
Food coloring	Glass or can	Indefinite	Indefinite	Indefinite	Light	Tends to fade and lose strength.

Table 4-10.—Storage Data for Condiments and Related Products—Continued

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Garlic, dry, bulb	Carton	6-12	3-4	1		
Horseradish, dehydrated	Glass	36	24	6		Deterioration indicated by loss of flavor, lack of pungency.
Mayonnaise	Can	24	6	3	Above 90° F, below 35°F	Deterioration indicated by swollen cans.
Mineral yeast food	Bag or carton	Indefinite	Indefinite	Indefinite		
Monosodium glutamate	Can	Indefinite	Indefinite	Indefinite	High humidity	Deterioration indicated by caking and absorbed odors. Not recommended for export or underway replenishment.
	Fiberboard container	Indefinite	Indefinite	Indefinite	High humidity	
Mustard, prepared	Can and jar	24-36	18	12	Above 90° F, exposure to light	Deterioration indicated by gas bubbles in cans and offensive sulphur-like odor. Brown surface indicates oxidation which can be removed and the remainder is edible. If off-odors are present, the product should be discarded.
Olives, pickles, and relishes	Can	24	12	6-9	Alternate freezing and thawing	Deterioration indicated by mushy texture, pinholing, leakage, discoloration, and off-odors
Olives, pickles, and relishes	Glass	36	24-30	9-15		
Salad dressing	Glass or can	24	6	3	High temperature	Deterioration indicated by swollen cans, gas pockets. Do not freeze.
Salt, celery, garlic, onion	Shaker containers	60	36	6-12	Above 90° F	If unsealed, storage life at 100°F is limited to six months. Deterioration indicated by softening, caking.

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Table 4-10.—Storage Data for Condiments and Related Products—Continued

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Salt, table	Cloth or paper bag	Indefinite	Indefinite	Indefinite	High humidity	Relative humidity above 80% will cause caking unless package is moisture resistant. Caked salt is still usable.
Sauces, hot, kitchen, meat, soy and worcestershire	Glass	36-48	24	12	Freezing temperature. Long exposure to light will cause color changes	Deterioration indicated by off-odors and flavors. Excessive separation of ingredients or curdiness.
Spices and herbs	Fiberboard container and can	48-60	24	6-9	Above 100°F. Excessive heat or moisture; prolonged exposure to air	At temperatures above 100°F there is a complete loss of flavor in less than 6 months. Whole spices retain their strength longer than ground spices. Keep containers tightly closed when not in use.
Vinegar, cider	Glass	36-48	24-30	12-18	Below 32°F	Strained-out vinegar which contained eel, mother, or fruit fly at time of delivery is suitable for use but should be used as soon as possible.
Vinegar, dry, synthetic	Flexible package	24	12	6	High humidity	Deterioration indicated by vinegar odor outside container; caking.
Yeast, active, dry	Can	8	6-8	2-3		High temperature and moisture activate the yeast cells. This item also is listed in perishable subsistence storage table as chill storage is most desirable if available.

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Table 4-11.—Storage Data for Cocoa, Coffee, and Tea

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Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Cocoa	Can	48-60	24	18	Humidity above 60%	Will absorb off-odors and flavors. Open cans may become infested with insects and should be carefully checked before using. Cocoa stored at high temperature becomes gray or white on top. This is known as blooming and is harmless.
Coffee						
Instant, powdered	Can or glass	60	36	24		The approximate keeping time applies when the product is stored below 85% relative humidity or is packaged in sealed cans. If left in uncovered container, this product absorbs moisture, cakes, and is less soluble.
Roasted, ground	Can	12-18	7-12	5-6	Dampness, high temperature	Deteriorates rapidly after opening. Should be used promptly.
Tea						
Individual bags	Can or carton	36-48	12-18	12		Do not store tea packed in cartons below 50% or above 80% humidity, especially at temperature above 90°F.
Loose	Can	36-48	12-18	12	Above 75% humidity and high temperature	Absorbs strong odors if stored in open containers. Loses volatility if stored at high temperatures.

Beverages

It is recommended that liquid and powdered beverage bases be stored at 70°F or 40°F. THE LOWER TEMPERATURE IS PREFERABLE. Deterioration by loss of flavor results when these products are stored for a long time at a high temperature. See table 4-12.

Composite Food Packages

Composite food packages are designed to give their contents maximum protection against their contents maximum protection against the hazards of storage and transit. Moisture and high temperatures may cause gradual deterioration or more immediate damage. Vermin may infest the

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packages, fouling and destroying the contents. Store these products in a cool dry place at a temperature of 70°F and a relative humidity of 50 percent. For detailed information regarding deterioration, see the REMARKS column on table 4-13.

Table 4-12.—Storage Data for Beverages, Liquid and Powdered 48.88

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Beverages, non-alcoholic						
Beverage base Liquid (Type II)	Glass	36-60	9	6		Deterioration indicated by loss of flavor.
Powder	Can	60	24	12		Deterioration indicated by loss of flavor. Will cake if cans are opened for any length of time.
Cocoa beverage powder	Can	60	24	12	Dampness	Deterioration indicated by caking
Water, drinking	Can	Indefinite	Indefinite	Indefinite	Above 90°F	

Table 4-13.—Storage Data for Composite Food Packages 48.89.1

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Food Packet						
Abandon ship, individual	Carton	60	36-48	18-24	Above 120° F	Designed for use in survival at sea; is stored on all types of life saving craft; carried aboard ship. The components, jelly bars, sugar, tablets, chewing gum, and matches are packed in a waterproof bag. Cigaretts are also part of this ration. It is designed to withstand extreme temperature changes. Deterioration indicated by hardening and loss of color and flavor in starch jelly bars.

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Table 4-13.—Storage Data for Composite Food Packages—Continued

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Food Packet—Continued						
In flight, individual	Packet	60	24	12	Above 90° F	Designed to be eaten cold; however, it is more acceptable when some of the components are heated. Ten different menus are assembled in the different packets. The meal consists of 4 cans containing meat, fruit, bread, and dessert. An accessory packet which provides soluble beverage, sugar, chewing gum, can opener, etc. Deterioration indicated by swollen can, off-flavors and odors and caking of coffee and tea, separation of fat in candy.
Life raft, aircraft, individual	Packet	60	48	24		A tablet packet for use of survivors in emergencies involving Navy aircraft. It is stored aboard life rafts on the aircraft. Sucrose tablets of varying flavors, vitamin tablets, and candy-coated gum in a waterproof bag with a length of twine and instruction sheet are sealed in a small key-opening oblong can resembling a sardine can. The packet is designed for use when the supply of water may be critically limited.
Survival, arctic, individual	Packet	60	24	12	Above 90° F	A packet designed for survival kits carried aboard aircraft operating over arctic regions; packaged in flat, rectangular cans for ease in carrying; consists of a variety of concentrated

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Table 4-13.—Storage Data for Composite Food Packages—Continued

Product	Packaging	Months-approximate keeping time			Dangerous storage conditions	Remarks
		40° F	70° F	90° F		
Food Packet						
Survival, arctic, individual—Continued						and compressed food bars including cereal, chocolate, jelly, fruitcake, and cheese along with accessory items. Designed for use with a minimum of water; is not thirst provoking. Deterioration indicated by off-odors and flavor (rancidity); caking of soluble coffee, tea or cream beverages.
Combat Meals						
Meal, combat, individual	Can and packets	60	24	12	Above 90° F	Designed for use either in individual units as a meal packet, or in multiples of 3 as a complete ration. Twelve meal cartons and 2 accessory cartons (each holding 2 accessory packets) are packed in each container. Packaged by individual meal, offering a variety of canned meat, fish or poultry, canned vegetable, canned fruits, desserts, beverage. Deterioration indicated by rancidity and caking of soluble beverages. Small holes in flexible packages indicate insect infestation. For long storage, keep in cool place.
Ration, survival, individual	Can	60	49	36		Designed to be eaten cold; but consists mainly of meat and cereal-type food bars, fruitcake bars, and soluble beverages. Seasonings are included to provide flavoring. Having good stability, it lends itself well to emergencies. It is necessary that adequate water be consumed with this ration.

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RATION-DENSE FOODS

Concentrated, prefabricated, and dehydrated foods are described as RATION-DENSE. They are compact to stow and increase a ship's cruising endurance. The supply officer sees to it that all authorized ration-dense foods are stocked regularly.

Ration-dense foods eliminate waste, reduce bulk, and where possible, eliminate the need for refrigerated storage.

For comparison, examples of six standard and six space-saving food items for 100 men for 30 days are given below:

High-Use Standard	Space-Saving
Bacon, smoked, slab	Bacon, prefried, canned
Coffee, R and G	Coffee, instant
Eggs, fresh, shell	Eggs, dried, whole
Milk, fresh, whole	Milk, dry, nonfat
Onions, fresh	Onions, sliced, dehydrated
Potatoes, fresh	Potatoes, diced, dehydrated
Total Weight 3332 lbs	Total Weight 531.75 lbs
Total Space 220.5 cu ft	Total Space 33.9 cu ft

From the information above, and from figure 4-1, you can readily see that ration-dense foods save storage space, do not require refrigeration, and are convenient to use.

FRESH AND FROZEN SUBSISTENCE ITEMS

Fresh and frozen subsistence items include dairy products, eggs, fish, fruits, meat and meat products, poultry, and vegetables. The following paragraphs will give you a general idea of how to prevent deterioration of these types of subsistence.

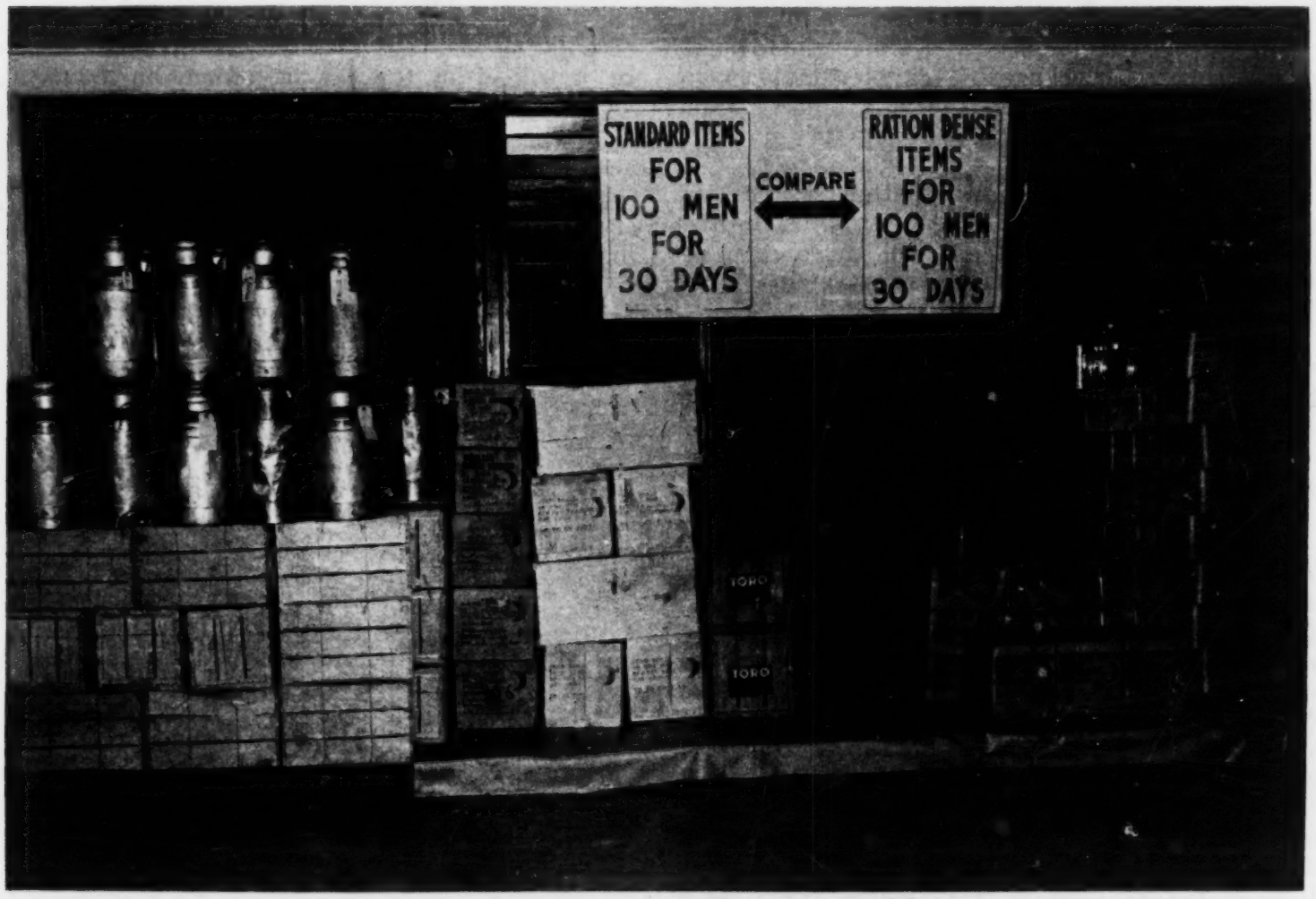

Figure 4-1.—Ration-dense foods are space savers.

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Prevention of Deterioration

All fresh and frozen subsistence items are highly perishable and subject to rapid deterioration when improperly stored. They require temperatures that are neither too high nor too low, favorable conditions of humidity and of air circulation, and special care in keeping the storage space sanitary. Failure to maintain any one of these conditions will result in rapid spoilage and eventual loss. Most spoilage in fresh and frozen subsistence is caused by micro-organisms, particularly certain species of bacteria and fungi; the infection spreads rapidly from the decayed items to the surrounding sound subsistence.

As a Commissaryman, you may be assigned as the cold storage man. When such is the case, your duties regarding storage and care of fresh and frozen subsistence items are as follows:

1. Making frequent inspections in storage, sorting and removing any decayed items or portions. This will keep the items in top condition and will keep losses and surveys to a minimum.
2. Segregating and marking shipments to make clear their relative ages. This facilitates issue of the oldest first unless there is some reason in the condition of a newer lot for giving it priority.
3. Preventing the accumulation of old lots of fresh and frozen subsistence items in the storage rooms. Issue them promptly or recommend for survey those items which are not fit for human consumption.
4. Except as otherwise indicated in chapter 3, refusing to accept frozen products that have thawed even a little. After items have been defrosted do NOT refreeze.

Fresh Fruits and Vegetables

When storing fresh fruits and vegetables, raise the containers off the deck with pallets, and stack individual lots in such a way as to permit free circulation of air. Also, stack the containers properly—put the pressure on the container, not on the contents (fig. 4-2). In some cases it may be desirable to maintain proper circulation in all parts of the room by a fan, perhaps with a duct system. Make certain that the room is safe for work. When fresh fruits and vegetables are stored in a tight compartment at temperatures of 40°F or higher, the concentration of carbon dioxide produced by respiration may reach such a danger point that it is unsafe for work. One good way to check the amount of carbon dioxide present in a room is to light a match or a candle. If the light is extinguished do not work in the room until fresh air has been introduced.

Meat, Meat Products, and Poultry

Proper circulation of air is the prime factor in keeping the desired temperature in all parts of the meat storage space. Do not store meat on the deck; place pallets on the deck to allow free circulation of air under all items stored in the space. Generally, when the recommended temperature in all parts of the refrigerated space is uniform and is maintained within the stacks in the freezer space, the circulation of air is considered adequate.

Dairy Products and Eggs

Keep the cold storage room for dairy products and eggs fresh by keeping it clean and by circulating the air slowly. Air circulation can be provided by the use of pallets on the floor, and by proper stacking of the various lots.

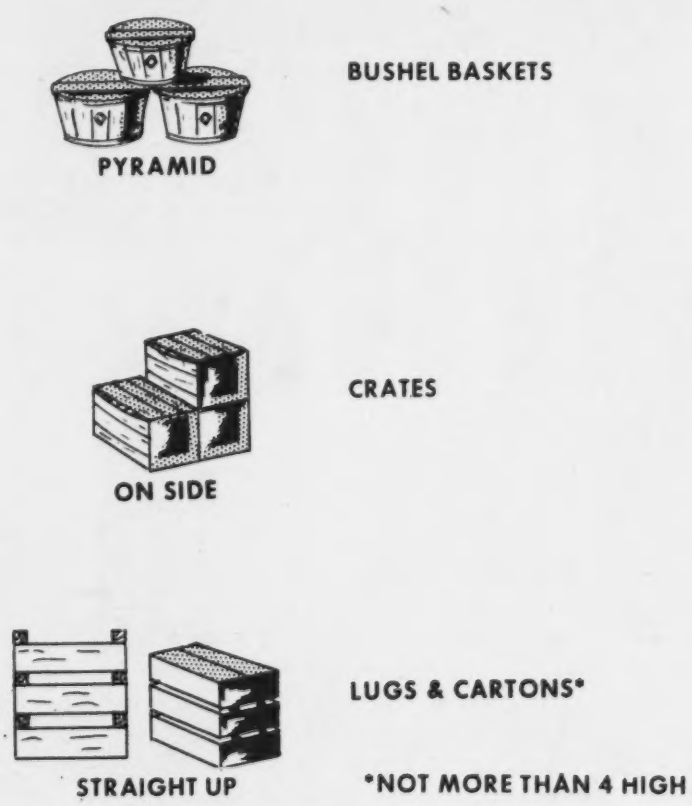

Figure 4-2.—Storage of fresh produce.

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Frozen Fruits and Vegetables

Frozen fruits and vegetables are highly perishable unless properly stored. Upon delivery, they must be transferred promptly to a low temperature storage space. Check the temperature of the load upon arrival, by taking temperature readings of cartons selected from top layers inside of shipping cases.

When the temperature is found to be higher than that of the freezer room, scatter the shipping cases loosely about the room on handtrucks or on the deck with adequate space between individual cases to permit rapid lowering of the product temperature to freezer room temperature. Use of a portable fan to create an air current over the item will speed up temperature equalization. When the temperature of the item has been lowered sufficiently, stack the cases compactly. If the item temperature upon delivery is the same as or below the temperature of the freezer room, cases should be stacked compactly at once. Stack from the bulkhead toward the center of the room, starting about 4 inches from the bulkhead or bulkhead coils. Stack the cases on pallets to permit circulation of air under them. Using pallets will keep the cases more sanitary. In rooms where cold air is expelled directly from blower units at the ends of the rooms, stack the cases low enough to permit air circulation. Allow at least 2 feet between the top of the stack and the overhead or air ducts.

REFRIGERATED STORAGE OF PERISHABLE SUBSISTENCE

Table 4-14 is for your guidance, afloat and ashore, in computing the maximum recommended storage periods for fresh and frozen subsistence under various storage or holding temperatures. The table lists temperatures and humidities which are considered to be the most favorable. The storage periods are based on the assumption that the products have been processed and procured in accordance with current specifications and delivered in good condition.

The information listed in table 4-14, when used intelligently, will provide adequate refrigerated storage information about the product named. Actually, it is a general guide and requires common sense application. The "approximate" storage life is just that—APPROXIMATE. There are exceptions to this list. Date of pack (season) or date of oldest inspection stamp on the product, as well as date of receipt must be used to compute the terminal date of the maximum possible storage period.

REFRIGERATION COILS AND UNITS

Three factors affect the rate at which frost and ice accumulate on refrigerator coils: (1) door traffic; (2) excessive temperature difference between the coils and the box; and (3) moisture from the stowed materials. In each case the build-up can be reduced by planning and care. Measures discussed in the following paragraphs may be used to prevent excessive icing of coils.

Door Traffic

Breakouts should be planned for a full day's requirements. All messes should draw their frozen subsistence items at a predetermined time, usually in the morning. Any items withdrawn at this single daily breakout from the freeze box, if not intended for immediate use, should be stowed temporarily in the chill box.

This "one breakout" per day should be strictly enforced. With a little planning on the part of the various messes, it should not be too difficult. In this way, the reefer temperature will remain constant and excessive icing from too much door traffic will be kept at the minimum.

Temperature Controls

Difference in the temperature of the refrigerated spaces and the coils will cause vapors that will ice the coil rapidly until the temperatures coincide.

The temperatures are likely to differ most during the period when the freeze box is being restowed. Higher temperature of the subsistence items being stowed will cause a rise in temperature in the refrigerated space and produce vapors. Vapors are also caused by the admittance of warm outside air into the reefers when the door is open. There is no way to prevent this condition, since the work of stowing must go on. However, once the stowage has been completed, the box should remain closed until the normal temperature level has been reached.

Air-Circulation

Moisture, humidity, and vapors which cause icing under conditions other than those cited above are usually the result of improper circulation of air within the box, or more generally are the result of improper stowage. Continuous circulation by electric blowers is necessary at all times. Stowage arrangements should be such as to allow free circulation of air throughout the box.

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Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items 48.90.1

Product	Description	Estimated freezing point (F°)	Best storage temperature (F°)	Preferred relative humidity (%)	Approximate storage life
Meat, poultry, and fish					
Meat					
Bacon, slab	Chilled	----------	30-40	--------	3 months
Bacon, slab	Frozen	----------	0 or below[1]	--------	12 months
Bacon, sliced	Frozen	----------	0 or below[1]	--------	2 months
Beef, boneless	Frozen	----------	0 or below[1]	--------	12 months
Beef, carcass or wholesale cuts	Chilled	----------	30-34	85-95	10-14 days
Beef, carcass or wholesale cuts	Frozen	----------	0 or below[1]	--------	12 months
Beef, corned	Chilled	----------	30-40	--------	10 days
Beef, corned	Frozen	----------	0 or below[1]	--------	6 months
Beef, dried, sliced	Frozen	----------	0 or below[1]	--------	12 months
Beef liver	Frozen	----------	0 or below[1]	--------	4-6 months
Bologna	Chilled	----------	30-40	--------	2 weeks
Bologna	Frozen	----------	0 or below[1]	--------	3 months
Bologna (high beef)	Frozen	----------	0 or below[1]	--------	6 months
Cervelat, dry	Chilled	----------	30-33	90-95	2 months
Cervelat, dry	Frozen	----------	0 or below[1]	--------	6 months
Cervelat, soft	Chilled	----------	30-33	90-95	1-2 months
Cervelat, soft	Frozen	----------	0 or below[1]	--------	6 months
Frankfurters	Chilled	----------	30-40	--------	2 weeks
Frankfurters	Frozen	----------	0 or below[1]	--------	3 months
Frankfurters (high beef)	Frozen	----------	0 or below[1]	--------	6 months
Ham, boneless, casing type, precooked	Frozen	----------	0 or below[1]	--------	6-9 months
Ham, canned, whole[2]	Chilled	----------	30-40	--------	6-8 months
Ham, smoked	Chilled	----------	30-40	--------	4 months
Ham, smoked	Frozen	----------	0 or below[1]	--------	6 months
Lamb, carcass and wholesale cuts	Frozen	----------	0 or below[1]	--------	8-10 months
Liver sausage	Chilled	----------	30-33	90-95	2-3 weeks
Liver sausage	Frozen	----------	0 or below[1]	--------	3 months
Luncheon meat, pimiento/pickle	Chilled	----------	30-33	--------	1-3 weeks
Luncheon meat, pimiento/pickle	Frozen	----------	0 or below[1]	--------	2-3 months
New England style sausage	Chilled	----------	30-40	--------	1-2 weeks
New England style sausage	Frozen	----------	0 or below[1]	--------	3-4 months
Pork jowls	Frozen	----------	0 or below[1]	--------	1-6 months
Pork sausage	Chilled	----------	30-40	--------	3-7 days
Pork sausage	Frozen	----------	0 or below[1]	--------	2-3 months
Pork, wholesale cuts	Chilled	----------	30-40	--------	5-7 days

See footnotes at end of table

Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items—Continued

48.90.2

Product	Description	Estimated freezing point (F°)	Best storage temperature (F°)	Preferred relative humidity (%)	Approximate storage life
Meat, poultry, and fish—Continued					
Meat—Continued					
Pork, wholesale cuts --	Frozen	----------	0 or below[1]	--------	1-6 months
Pork and beef sausage, precooked ----------	Frozen	----------	0 or below[1]	--------	3 months
Rabbit ----------	Frozen	----------	0 or below[1]	--------	4-6 months
Salami, cooked --------	Chilled	----------	30-33	90-95	1-2 weeks
Salami, cooked --------	Frozen	----------	0 or below[1]	--------	3-4 months
Salami, dry ----------	Chilled	----------	30-40	--------	1-3 months
Salami, dry ----------	Frozen	----------	0 or below[1]	--------	6 months
Veal, wholesale cuts ---	Chilled	----------	30-34	90-95	5-10 days
Veal, wholesale cuts ---	Frozen	----------	0 or below[1]	--------	4-6 months
Poultry					
Chicken or duck -------	Frozen	----------	0 or below[1]	--------	8-10 months
Turkey, boneless, cooked ----------	Frozen	----------	0 or below[1]	--------	9 months
Turkey, boneless, raw	Frozen	----------	0 or below[1]	--------	6-8 months
Turkey, ready-to-cook	Frozen	----------	0 or below[1]	--------	8-10 months
Fish					
Clams, oysters, and scallops ----------	Frozen	----------	0 or below[1]	--------	3-4 months
Crawfish (lobster tail)--	Chilled	----------	32-40	90-95	1 week
Crawfish (lobster tail)--	Frozen	----------	0 or below[1]	--------	6 months
Fish, fillets----------	Frozen	----------	0 or below[1]	--------	6-10 months
Fish, steaks ----------	Chilled	----------	33-40	90-95	8-10 months
Fish, steaks ----------	Frozen	----------	0 or below[1]	--------	6-10 months
Lobster ----------	Chilled	----------	33-50	90-95	See note[3]
Shrimp ----------	Chilled	----------	30-35 in ice	90-95	7-10 days
Shrimp ----------	Frozen	----------	0 or below[1]	--------	6-8 months
Shrimp, breaded-------	Frozen	----------	0 or below[1]	--------	10 months
Dairy foods					
Butter ----------	Frozen	28	-5 or below	Below 80	12-18 months
Butter ----------	Chilled	----------	32-26	80-85	2 months
Buttermilk ----------	Chilled	29	32-34	85	1 week
Chocolate milk, sterilized, canned----------	Chilled	30	32-40	--------	18-24 months
Cream, whipping type, 30% milk fat ----------	Stabilized	30	30-35	--------	6 months
Ice cream and sherbet---	Frozen	----------	10 or below	--------	6-9 months
Milk					
Concentrated, whole ---	Fresh	30	33-38	--------	3 weeks
Reconstituted----------	Pasteurized	29-30	33-35	--------	3-4 days
Sterilized, canned -----	Chilled	----------	32-50	--------	12 months[4]

See footnotes at end of table

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Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items — Continued

48.90.3

Product	Description	Estimated freezing point (F°)	Best storage temperature (F°)	Preferred relative humidity (%)	Approximat storage life
Dairy foods—Continued					
Milk—Continued					
Whole	Fresh	31	32	85-90	1 week
Whole	Frozen	----------	-10 or below	--------	2-4 months
Cheese[2]					
American, processed, sliced	Chilled	16	35-40	70-75	8-12 months
Blue-veined, natural	Chilled	----------	33-38	80-85	2-3 months
Cheddar, natural	Chilled	9	30-34	70-75	8-12 months
Cheddar, processed	Chilled	16	35-40	70-75	18-24 months
Cottage	Chilled	30	32-34	--------	1-3 weeks
Cottage	Frozen	----------	0 or below[1]	--------	3-4 months
Pimiento, processed, sliced	Chilled	----------	40-45	70-75	8-12 months
Swiss, natural	Chilled	9	30-34	70-75	8-12 months
Swiss, processed	Chilled	17	40-45	70-75	18-24 months
Eggs					
Shell, fresh	Processed	----------	29-31	--------	6-9 months
Shell, fresh	Unprocessed	----------	29-31	--------	3 months
Whites	Frozen	----------	0 or below[1]	--------	12-15 months
Whole, baking type	Frozen	----------	0 or below[1]	--------	9-12 months
Whole, table type	Frozen	----------	-10	--------	9-12 months
Yolks	Frozen	----------	0 or below[1]	--------	12 months
Fruits and vegetables					
Fresh					
Apples	----------	28	30-36	85-90	See note[5]
Apricots[6]	----------	30	31-32	85-90	1-2 weeks
Asparagus[6]	----------	30	32	85-90	3-4 weeks
Avocados	----------	27-30	40-45	85-90	4 weeks
Bananas, ripe[7]	----------	26	56-60	85-90	3-5 days
Beans, green or wax[6]	----------	30	40-45	85-90	7-10 days
Beans, lima, unshelled[6]	----------	31	35-45	85-90	1-2 weeks
Beets, topped	----------	29	32	95-98	1-3 months
Blackberries[6]	----------	29	31-32	85-90	7 days
Blueberries[6]	----------	30	31-32	80-85	2-3 weeks
Broccoli[6]	----------	29	32-35	90-95	7-10 days
Brussels sprouts[6]	----------	30	32-35	90-95	3-4 weeks
Cabbage	Summer types	31	32	90-95	3-6 weeks
Cabbage	Winter types	31	32-35	90-95	3-4 months
Cantaloupe[8]	----------	29	40-50	75-80	1-2 weeks
Carrots, topped	----------	29	32	90-95	4-5 months
Casaba melons[8]	----------	----------	40-50	75-85	4-6 weeks
Cauliflower	----------	30	32	85-90	2-3 weeks
Celery	----------	30	32-35	90-95	2-4 months

See footnotes at end of table

Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items—Continued

48.90.4

Product	Description	Estimated freezing point (F°)	Best storage temperature (F°)	Preferred relative humidity (%)	Approximate storage life
Fruits and vegetables—Continued					
Fresh—Continued					
Cherries[6]	----------	25-28	31-32	80-85	10-14 days
Chicory[6]	----------	30	32-34	85-90	10-30 days
Chives, potted[6]	----------	32	35-45	90-95	2 weeks
Collards[6]	----------	30	32	90-95	10-14 days
Corn on the cob[6]	----------	30	31-32	85-90	4-8 days
Cranberries	----------	28	35-40	85-90	1-4 months
Cucumbers	----------	30	45-50	85-90	2-3 weeks
Dates	----------	----------	32	--------	6 months
Eggplant[6]	----------	30	45-50	85-95	10-14 days
Endive[6]	----------	31	32	90-95	2-3 weeks
Escarole[6]	----------	31	32	90-95	2-3 weeks
Grapefruit[9]	----------	28	32-34	85-90	4 weeks
Grapes	American types[10]	28	31-32	80-85	3-8 weeks
Grapes	European types	25-26	31-32	85-90	3-6 months
Greens, mustard and turnip[6]	----------	30	32	90-95	10-14 days
Honeyball, honeydew melons[8]	----------	----------	40-50	75-85	2-4 weeks
Kale[6]	----------	30	32	90-95	10-14 days
Lemons	----------	29	50-55	85-90	6-8 weeks
Lettuce[11]	----------	29	32-35	90-95	2-3 weeks
Limes	----------	29	45-50	85-90	6-8 weeks
Nectarines[6]	----------	29	31-32	80-85	2-4 weeks
Okra[6]	----------	30	50	85-95	2-3 weeks
Onions, dry[12]	----------	30	32	70-75	6-8 months
Onions, green[6]	----------	29	32	90-95	1 week
Oranges[13] (except temple oranges)	Treated against decay	28	30-37	85-90	8-12 weeks
Oranges, temple	----------	28	32-36	85-90	1-2 weeks
Parsley[6]	----------	----------	32	90-95	10-14 days
Parsnips	----------	30	32	90-95	2-4 months
Peaches[6]	----------	29	31-32	80-85	2-4 weeks
Pears[6]	----------	28	30-31	90-95	See note[14]
Peas[6]	----------	30	32	85-90	8-10 days
Peppers, sweet[6]	----------	30	45-50	85-95	8-10 days
Persian melons[8]	----------	30	40-50	75-85	1-4 weeks
Pineapple[6]	Ripe	29	40-45	85-90	2-4 weeks
Plums	----------	29	32-48	85-90	4-8 weeks
Potatoes, sweet[15]	----------	29	55-60	80-85	4-6 months

See footnotes at end of table

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Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items — Continued

48.90.5

Product	Description	Estimated freezing point (F°)	Best storage temperature (F°)	Preferred relative humidity (%)	Approximate storage life
Fruits and vegetables—Continued					
Fresh—Continued					
Potatoes, white	----------	29	50[16]	85-90	6-8 weeks
Radishes[6]	----------	30	32	90-95	10-14 days
Rhubarb[6]	----------	30	32	90-95	2-3 weeks
Romaine[6]	----------	31	32	90-95	2-3 weeks
Rutabagas	----------	29	32	90-95	2-4 months
Spinach[6]	----------	31	32	90-95	10-14 days
Squash	Summer types	30	45-50	85-95	10-20 days
Squash	Winter types	29	50-55	70-75	4-6 months
Strawberries[6]	----------	30	31-32	85-90	7-10 days
Tangerines	----------	30	31-36	90-95	1-3 months
Tomatoes[17]	Green	31	55-65	85-90	3-5 weeks
Tomatoes[17]	Ripe	30	40-50	85-90	7-10 days
Turnips	----------	29	32	90-95	4-5 months
Watermelon	----------	30	36-40	85-90	2-3 weeks
Frozen					
Fruits, all kinds	----------	----------	0 or below[1]	--------	8-18 months
Juices, fruit, concentrated	----------	----------	0 or below[1]	--------	2 years
Vegetables, all kinds	----------	----------	0 or below[1]	--------	8-24 months
Vegetables, dehydrofrozen					
Peas	----------	----------	-10	--------	2 years
Bakery products					
Bread	Fresh	----------	75-95	80-85	2-3 days
Bread	Frozen	----------	0 or below[18]	--------	3-4 weeks
Cake, coffee and loaf	Fresh	----------	35-40	80-85	1 week
Fruitcake in corrugated paper box	Fresh	----------	30-34	80-85	8-10 months
Pie, fruit	Fresh	----------	35-40	80-85	1 week
Rolls	Brown and serve	----------	35-50	75-80	1 week
Rolls	Fresh	----------	75-95	60-80	1 day
Nuts, mixed	Unshelled	20-24	32-40	60-70	12 months
Jams, jellies	Individual serving	28	32-38	--------	3 months
Topping, dessert and bakery	Frozen	----------	0 or below[1]	--------	8 months
Fats					
Lard	Carton	----------	32	80-85	6-12 months
Shortening compound, hydrogenated	Carton	----------	32	80-85	6-8 months

See footnotes at end of table

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Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items—Continued

48.90.6

Product	Description	Estimated freezing point (F°)	Best storage temperature (F°)	Preferred relative humidity (%)	Approximate storage life
Condiments and related products					
Catsup, tomato	Individual serving	25	32-28	--------	3 months
Garlic, dry	Carton	26	32	70-75	6-8 months
Horseradish, prepared	Jar	30	32-38	--------	3 months
Mustard, prepared	Individual serving	28	32-38	--------	3 months
Salad dressing	Individual serving	----------	32-38	--------	3 months
Yeast, baker's	Compressed	----------	35-45	80-85	10-15 days
Yeast, baker's	Active dry	----------	31-32[19]	--------	1 year when vacuum packed

Notes on Perishable Table

[1] 0° or below represents the desired optimum to be maintained within the limitations of refrigeration equipment.

[2] Do not freeze.

[3] Quality lobster cannot be obtained after any period of storage; it should be purchased as a live product and it will remain satisfactory as long as it is alive and the flesh is not shrunken.

[4] If this item is to be held for periods of 3 months or less it may be carried in dry storage at moderate temperature.

[5] The length of time apples can be held successfully in cold storage will vary with the variety, district where grown, and their condition when harvested. The following data show the normal and maximum storage periods for different varieties when grown in regions to which they are adapted, picked at proper maturity, and stored immediately at 32°F. Storage life is considerably shorter at high temperatures. Ripening and deterioration is about twice as fast at 40°F as at 32°F and twice as fast again at 50° F as at 40° F. Apples should be issued while still in good condition.

Variety	Storage period (months)		Variety	Storage period (months)	
	Normal	Maximum		Normal	Maximum
Jonathan	2 to 3	4	Baldwin	4 to 5	6 to 7
Grimes Golden	2 to 3	4	Stayman Winesap	4 to 5	5 to 6
McIntosh	2 to 4	4 to 5	York Imperial	4 to 5	5 to 6
Golden Delicious	3 to 4	6	Arkansas (Black Twig)	4 to 5	6
Cortland	3 to 4	5	Northern Spy	4 to 5	6
Delicious	3 to 4	6	Rome Beauty	4 to 5	6 to 7
Rhode Island greening	3 to 4	6	Ben Davis	4 to 5	8
Yellow Newton	5 to 6	8	Winesap	5 to 7	8

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Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items—Continued

48.90.7

[6] Commodity not recommended for export but is suitable for immediate use by shore activities and by ships in port or shortly after sailing.

[7] Fully ripe bananas may be held at 40° F for several days with only slight discoloration of the peel and without any flavor change.

[8] Damage will result if item is stored at lower temperature than indicated.

[9] Storage temperatures of either 32° to 34° F or 50° to 55° F are recommended to avoid serious rind pittings. This defect is more severe at about 38° to 45° F than at higher or lower temperatures. A temperature of 50° to 55° F is best for control of pitting, but decay may become severe. Grapefruit may be held satisfactorily at near 32° F for about 4 weeks.

[10] Not recommended for export since the European type of grape from California with better keeping quality is available during the same period.

[11] The storage life of closely trimmed heads of lettuce packaged individually in polyethylene bags and stored at a 33° F temperature is extended much beyond the indicated 2 to 3 week period.

[12] Onions keep best at a storage temperature of about 32° F. This commodity should not be stored with items such as apples and grapefruit or an onion taste will be acquired by such items. Compartments should be kept dark.

[13] Florida type oranges keep best at 30° to 32° F. California type keep best at 35° to 37° F.

[14] The length of time fall and winter pears may be safely stored depends on the variety, when the fruit is picked, and on whether it is shipped before or after storage. Pears should be ripened for several days at 65° F before being issued for table use. Pears usually fail to soften if held at 75° to 80° F. Bartlett, Bosc, Anjou, and Comice lose their capacity to ripen normally if held in storage too long. Loss of ripening capacity occurs sooner at 36° F than at 30° F. The following data show the safe storage period for different varieties when stored at 30° or 31° F at shipping point and after shipment to market, and the approximate end of the storage season.

Storage treatment and variety	Length of storage period	End of storage period
Stored immediately after harvest:	Months	
Hardy	2 to 3	September to November
Comice	2 to 3	November to December
Bosc	3 to 3½	November to December
Kieffer	2 to 3	September to November
Anjou	5 to 6	March
Winter Nelis	6 to 7	March to May
Easter Beurre	5 to 7	March to May
Stored after 12-day transit period (precooled):		
Anjou	4 to 5	March
Hardy	2 to 3	September to November
Comice	2 to 3	November to December
Bosc	2 to 3	November to December
Winter Nelis	6 to 7	March to May

[15] Sweet potatoes are very perishable under the best conditions. Exposure to temperatures below 50° F even for a few weeks causes chilling injury and increases decay. The chilling injury causes the interior of the sweet potato to turn gray, brown, or nearly black, depending on how low the temperature is and the length of exposure.

Table 4-14.—Safe Keeping Time and Storage Data for Perishable Subsistence Items—Continued

48.90.8

[16] Potatoes will keep in good condition at 50° F for 6 to 8 weeks or longer if they are in good condition when received and if they are handled carefully during loading and stowing so as to avoid bruises and other damage. Potatoes which have been chilled prior to receipt and are then stowed in dry protected areas where temperatures do not exceed 70° F may keep for 4 to 5 weeks. Decay and sprouting is more likely to occur at higher temperatures. Potatoes stowed at temperatures of 40° to 45° F will have a storage life up to 5 months. At lower temperatures potatoes have a tendency to become undesirably sweet. A few days in 55° to 70° F storage should restore taste. Potatoes should be stored in the dark. Exposure to either natural or artificial light causes the potatoes to turn green, this green portion is bitter and unpleasant to taste and must be discarded. If temperatures below freezing are anticipated, do not store potatoes topside.

[17] Mature green tomatoes will become well colored and firm ripe in about 2 weeks at 65° F. If they are transferred at 32° F or 38° F after ripening, they may be kept another 3 weeks with little or no spoilage. Tomatoes ripened at 55° F do not keep as well as those ripened at 65° F.

[18] For several weeks storage, a rapid freezing and holding at 0° F or lower is recommended. Rapid staling occurs between 75° F and 0° F. If the bread is not to be frozen, the best storage temperature is 75° to 95° F, providing the bread is wrapped in a good quality waxed paper and efficiently sealed. Relative humidity is immaterial if the bread is wrapped and sealed properly as moisture transfer will be negligible. In the case of opened or broken wrappers, the relative humidity should be in the 80 to 85% range.

[19] Yeast, active dry is a semiperishable item and also is listed in the Nonperishable Subsistence Table.

Good stowage principles require that adequate aisles and overhead space be left clear as much as possible for the free circulation of air from the blowers. Inspect blowers to see that they are operating properly each day. Whenever one burns out, it should be reported for immediate repairs.

Defrosting Refrigerators

The refrigeration coils and units in cold storage spaces should be defrosted as often as practicable. A layer of frost or ice 1 inch or more in thickness will reduce the efficiency of the refrigeration system and may result in overloading the compressors. Bureau of Ships Technical Manual recommends defrosting before the average frost thickness reaches $^3/_{16}$ inch in the average cold storage refrigerating plant installation. Always consult the engineer officer regarding the defrosting of the refrigeration systems.

Some refrigeration units are so equipped that hot gas can be run through the cooling coil to melt the ice. Then the bulkheads, the overhead, and the deck remain cold because of the speed with which the coils are defrosted and there is no necessity for moving the food. This method of defrosting should be employed on all ships equipped with such a unit, since refrigeration in not interrupted. Check with the ship's engineer officer to see if your cold storage plant is of this type.

If your unit is not of this type, it will be necessary to remove all but the frozen items, and store them in another box. Frozen foods will not thaw in a normal defrosting period. The engineer officer will direct that the supply of refrigerant be secured to the box and the door be left open. The frost and ice will melt or they may be easily brushed off. Never use an ice pick or sharp tool to pick ice from the coils.

Once defrosting is completed, scrub and wash the box thoroughly with hot soapy water. Rinse, dry, and air the box, and return the food to its place.

SANITATION IN STORAGE SPACES

Constant attention to sanitation in provision storerooms and refrigerated spaces keeps down the number of insects and harmful bacteria, prevents waste through spoilage, and makes the storeroom an easier, more pleasant place in which to work.

You will find the following suggestions helpful in doing the job of cleaning correctly:

1. Plan your cleaning with regard to order of work and time.

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2. Sweep all decks of storerooms and storage boxes.

3. Remove all deck racks and scrub them with hot soapy water.

4. Add salt to water to help bleach the racks.

5. Clean decks and bulkheads with scrub brushes, a paint work rag, and hot soapy water.

6. Use a hot water hose on deck racks, wherever possible, to kill bacteria.

Additional care must be exercised in cleaning the refrigerators. Here is a suggested procedure:

1. Wait until the box is nearly empty, if possible. Then have the refrigeration cut off.

2. Remove remaining food to another refrigerated space.

3. Clean decks and deck racks. A suggested cleaning agent is baking soda and hot water, as this removes odors.

4. Leave doors open for several hours, if possible, to ventilate box.

5. If steam or water is used, be careful not to wet electrical connections or motors.

6. When the box is thoroughly aired, turn on refrigeration and replace food.

GUIDELINES FOR PROPER STORAGE

1. Inspect fresh fruits and vegetables frequently. Sort and remove decayed items.

2. Maintain the proper temperatures in the refrigerated spaces. Freeze box—0°F or lower; dairy box—30° to 32°F; chill or thaw box—36° to 38°F.

3. Maintain the proper relative humidity in the refrigerated spaces.

4. Keep fresh fruits and vegetables separated from other items which seem to absorb foreign odors.

5. Always expedite the stowing and handling of items going into the refrigerated spaces in order to conserve refrigeration and keep the products in as firm a condition as possible.

6. Consolidate breakouts so that the reefers are opened infrequently.

7. Ensure the highest standards of sanitation.

8. Maintain proper air circulation in all spaces.

9. Keep nonperishable subsistence items in dry, clean, cool spaces.

10. Inspect all storerooms frequently to discover damage or spoilage of subsistence items.

11. Avoid stacking nonperishable subsistence so high as to cause a bursting or crushing of the bottom layers.

12. Keep subsistence items away from steam or other heated pipes.

13. Use dunnage wherever possible.

14. Cross-stack to keep stacks solid and prevent toppling.

15. Keep stacks away from bulkheads and corners in order to allow for cleaning and inspections.

16. Where there are indications of rats, arrange to have appropriate rodent control.

17. Use insect repellents where the presence of insects is detected.

18. Keep products that are packed in glass or transparent containers from being exposed to light.

19. USE OLDEST STOCK FIRST (unless newer stock clearly must be used to avoid spoilage).

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CHAPTER 5

GALLEY AND MEAT CUTTING EQUIPMENT

The food preparation and service equipment located in galley and mess spaces at naval shore stations and aboard Navy ships is designed specifically for quantity food service. To ensure safe, sanitary, and efficient operation, it is important to maintain the equipment in proper working order and to use it correctly.

GALLEY EQUIPMENT

Galley equipment is used for the final cooking and preparation of food for use in the general mess. This equipment consists of ranges, ovens, griddles, deep-fat fryers, mixing machines, meat slicing machine, cube steak machine, coffee urns, toasters, steam-jacketed kettles, steamers, steam tables, scales, refrigerators, and cooking utensils.

Although the machine driven potato peelers, food cutters, and french fry cutters, are normally located in the vegetable preparation room, they are also discussed here.

Electric Ranges

Electric ranges used in the Navy are of the following types: (1) Type A. Three surface units and one oven; (2) Type B. One surface unit and one oven; (3) Type C. Two surface units and one oven; and (4) Type S. Griddle, three-section hotplate, and a two-compartment oven. See figure 5-1 for a type S range.

Each of the above type ranges is equipped with an oven. For instructions in operation and maintenance, see electric roasting ovens.

Type A Ranges.—Surface units of older models have one of the following arrangements:

1. Three hotplates, each controlled by one three-heat switch or two single-heat switches.
2. Three griddles, each controlled by a three-heat switch and a thermostat.
3. Combinations of hot plates and griddles.

The newer models of type A ranges are equipped with three combination griddle-hotplates, each controlled by one thermostatic switch having a temperature range from 250° F to 850° F.

Type B Ranges.—Older models of type B ranges have a combination griddle-hotplate which is controlled either by one three-heat switch or by two single-heat switches.

The newer models of type B ranges are equipped with one thermostatic switch having a temperature range from 250° F to 850° F.

Type C Ranges.—The type C range has two combination griddle-hotplates. On the older models the surface units are controlled by either one or two three-heat switches.

On the newer models the surface units are controlled by one thermostatic switch having a temperature range from 250° F to 850° F.

Type S Ranges.—The type S range was developed for submarine galley use and is replacing the type B range. All the cooking, except deep-fat frying and coffee making, can be accomplished on one type S range. One of these ranges occupies the same amount of deck space as two type B ranges. The food production capacity of one type S range, however, is considerably more than twice that of the two type B ranges. The type S range permits faster and more uniform cooking and enables several sections to be used interchangeably.

A compact galley unit, the type S range consists of three separate cooking sections. The top has a griddle on the left side and a three section hotplate area on the right. A two-compartment oven section, one above the other compartment, makes up the body of the range. Dial temperature control switches are mounted on the body directly adjacent to each section. A separately mounted panel (usually bulkhead

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NOMENCLATURE

1 SPLASH GUARD FOR GRIDDLE
2 GRIDDLE
3 GREASE RECEPTACLE; GRIDDLE
4 DRIP PANS, GRIDDLE; HOTPLATE AREA
5 THERMOSTATIC CONTROL DIAL, LEFT SIDE, GRIDDLE
6 " " " RIGHT SIDE, GRIDDLE
7 THERMOSTATIC CONTROL, LARGE HOTPLATE
8 SMALL HOTPLATE, FRONT
9 SMALL HOTPLATE, REAR
10 LARGE HOTPLATE
11 TOP OVEN
12 BOTTOM OVEN
13 THERMOSTAT DIAL CONTROL FOR TOP OVEN
14 THERMOSTAT DIAL CONTROL FOR BOTTOM OVEN
15 OVEN VENT
16 DAMPER CONTROL, TOP OVEN VENT
17 " " BOTTOM " "
18 OVEN DOOR RELEASE
19 SEA RAIL SUPPORT
20 SEA RAIL

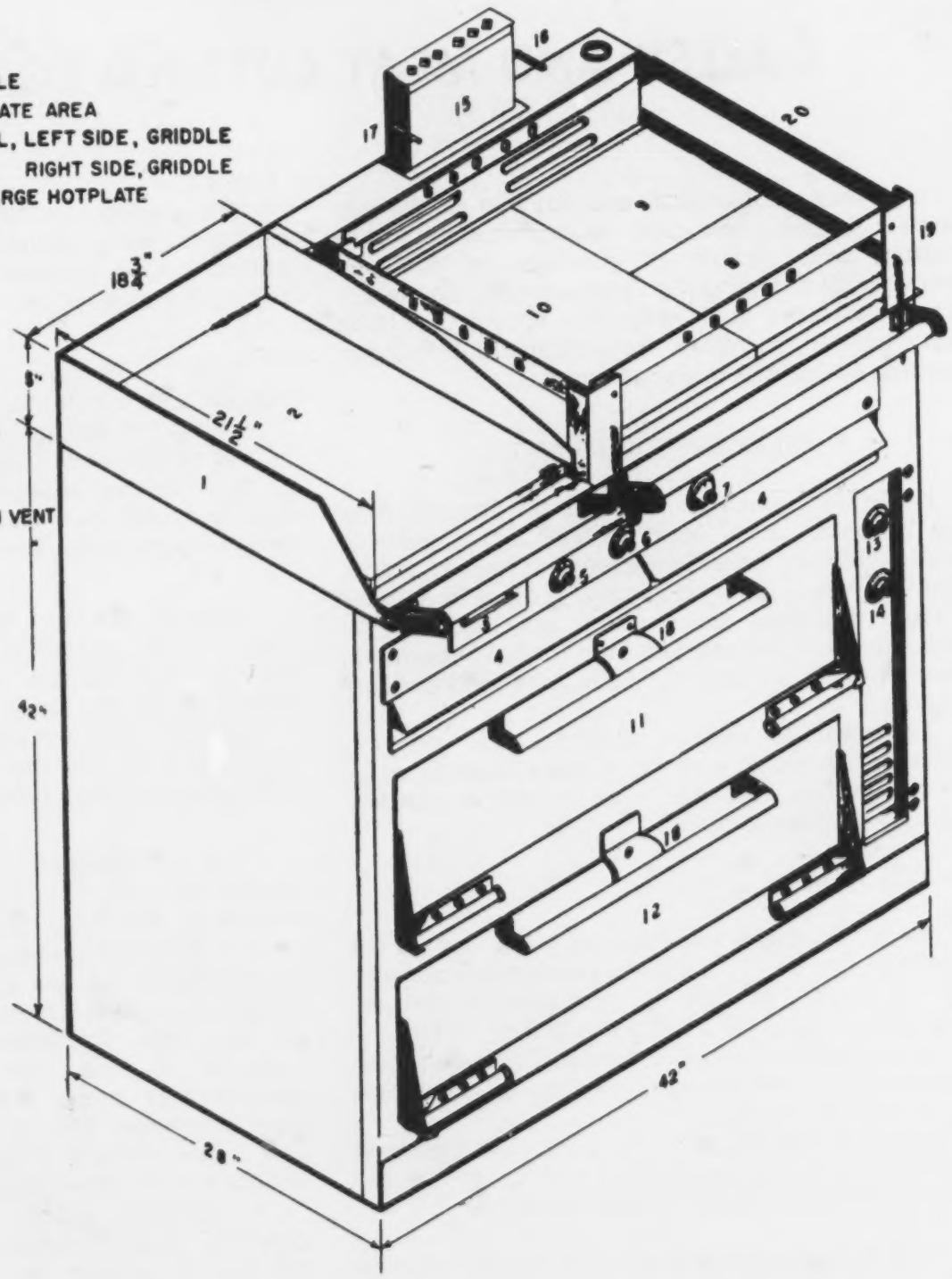

Figure 5-1.—Type S. electric range.

mounted) contains additional three-heat switches for use in operating the ovens and the small hotplates.

The overall dimensions of the range are 42 inches wide (including the guard rail), 28 inches deep, and 42 inches high (to the top of the heating surfaces).

Operation of Surface Units.—Use the switch or thermostat setting at maximum heat only to heat food to cooking temperature or to bring water to boil, then reduce the switch or thermostat setting to the heat required by the food being cooked. Using more heat than necessary is not only a waste of power but produces inferior food. DO NOT leave the surface units turned on when not in use. When steaming food, keep utensils covered. The food will stick and burn if left uncovered and power will be wasted.

Care and Cleaning.—Keep the range surface units clean, and avoid spilling grease under edges of hotplates. The spaces around the surface units should be scraped clean. Remove and clean drip pans daily. Clean the range thoroughly once a week or more often if possible. The griddle hotplate type surface units can be satisfactorily cleaned by using pumice stone blocks. Use only soap and water on enameled surfaces. Although soap and water are preferable, powdered cleansers may be used on polished steel areas.

Grease filters and hoods located over galley ranges should be kept free from an excessive amount of grease. Wash the filters at least once a week. The hoods should be wiped and washed as necessary.

Wash the filters in hot soapy water in the deep sink to remove most of the grease. Then, rewash in the dishwashing machine. The preliminary washing in the deep sink will avoid an accumulation of residue in the dishwashing machine.

Electric Roasting Oven

The Navy uses four sizes of electric ovens (see fig. 5-2 for a typical oven) as indicated in the following table.

Oven Type	No. of Compartments	Capacity (lbs of meat)
60	2	120
60	3	180
125	2	250
125	3	375

Each oven section is provided with two heating units, one located at the top of the compartment and the other underneath the deck. Each heating unit is controlled by a separate three-heat switch, and the temperature of each section is regulated by a thermostat.

Operating Instructions.—Ovens should be turned on for preheating before use. To preheat, both upper and lower units of the compartment should be turned to "high" until the desired temperature is reached. Then, the thermostat control will automatically cut off the current and will supply only enough to keep the temperature constant. After heating, set the two three-heat oven switches for the proper "top" and "bottom" heat to suit the product to be baked. In roasting meat, avoid spilling grease on heating elements or thermostats, as damage to this equipment may result.

Care of Roasting Ovens.—To prevent the accumulation of foreign material, you should clean the oven thoroughly at least once a week

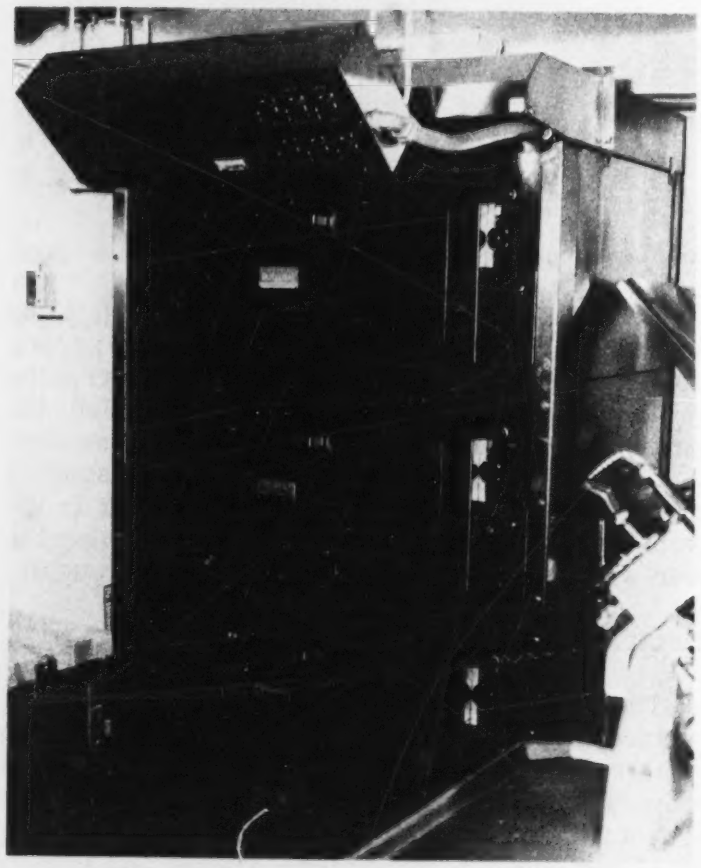

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Figure 5-2.—Electric oven.

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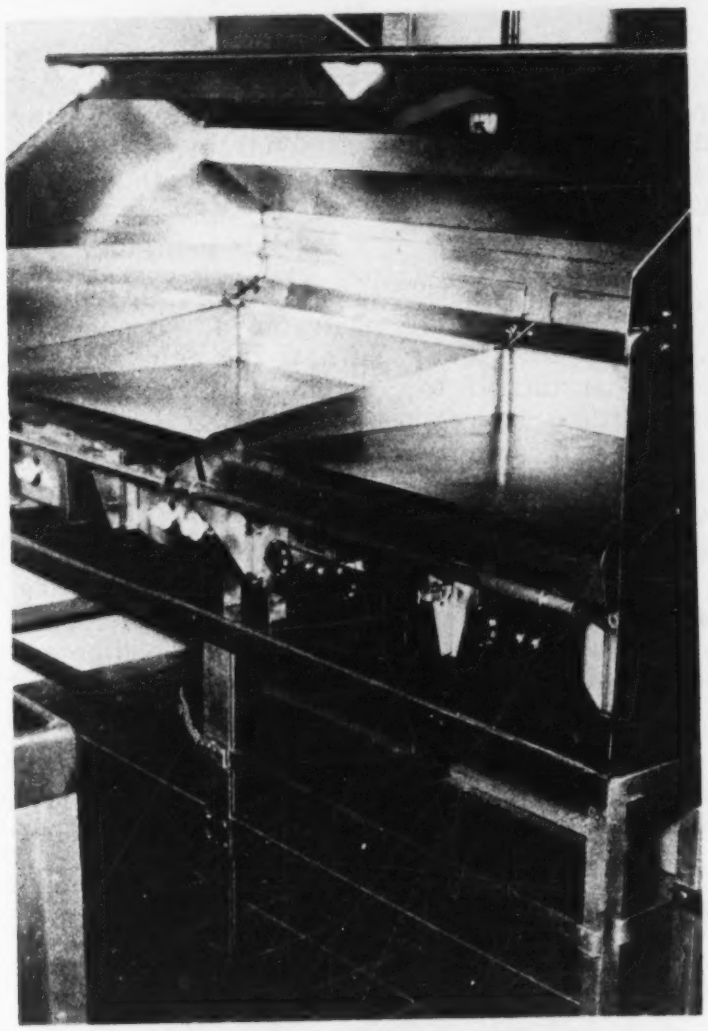

Figure 5-3.—Electric griddle. 48.10

in addition to the normal daily cleaning. Keep door edges clean. Crusty deposits prevent proper closing of doors causing loss of heat and corrosion by the escape of steam and fumes. Use the damper lever (located above the thermostat) to prevent smoke and steam from escaping around the oven door. Do not throw water in the oven to cool it or to wash it. When cleaning the oven with a wet rag, wring the rag out thoroughly.

Electric Griddles

The griddle (fig. 5-3) consists of a cooking surface approximately 34" by 18" surrounded by a grease receptacle, supported on an enclosed body. The body is mounted on a four-leg stand with an undershelf. A griddle guard, consisting of a rectangular bottomless frame and cover, is furnished for certain types of frying such as the preparation of home fried potatoes.

The heating element of the griddle is divided into two sections. On the older models, the heating element is controlled by a three-heat switch, and on the newer model, each heating element section is controlled by a thermostatic switch.

Operation.—To operate an electric griddle, turn the control switch to high heat for 15 minutes, then to medium heat or low heat as necessary. Use the griddle guard when necessary to keep food from sliding off the cooking surface. For satisfactory operation of the griddles, you should not place frozen meat or fish on the cooking surface.

Care and Cleaning.—Keep the cooking surface scraped and wiped clean at all times. The grease gutters should always be kept clean to facilitate draining off excess grease and thereby reducing smoke. The grease receptable should be emptied frequently and thoroughly cleaned at the end of the working day.

The cooking surface can be satisfactorily cleaned with a pumice stone block. If pumice stone is not available, periodically place a cloth dampened with ordinary household ammonia on the surface when the plate is cold and allow it to remain from 4 to 5 hours. The ammonia will soften the carbon so that it is easily removed with a cloth. Care must be observed in this operation to prevent the ammonia from entering sections containing electric wiring or other electric parts, as it will destroy insulating materials. All traces of ammonia odor will disappear as the grids are heated.

Deep-Fat Fryers

The Navy now uses four sizes of deep-fat fryers. They are the types 23, 35, 51, and 90. Type 35 is obsolescent and will be discontinued when stocks are depleted. The type numbers represent the approximate number of pounds of french fried potatoes which may be prepared per hour.

Deep-fat fryers (see fig. 5-4) are heated by the immersion of electric heaters located at such a level that the portion of the fat below the heater remains comparatively cool. This allows all the sediment from the frying food to settle to the bottom of the fat container without being burned. Heating elements are controlled by a magnetic contactor and a thermostat to maintain the fat at the desired temperature.

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Operation of Deep-Fat Fryers.—Before you use a deep-fat fryer, make sure that the drain valve is closed tightly. When filling the fryer with fat, use the amount specified in the technical manual furnished with the fryer. Fats should be kept at least 2 inches below the fryer top. If possible, the fat should be heated and melted before placing it in the fry kettle. Cold solid fat may have moisture pockets which will explode, casting hot melted fat over a wide area. Also, if the cold fat is not uniformly distributed around the heating element, the bare portions may heat up to a point where a sudden splash of fat on the overheated element will cause the fat to burn. The fat should cover the uppermost coil at all times when the deep-fat fryer is in operation. After the fat has been added, operate the deep-fat fryer as follows:

1. Set the thermostat at the cooking temperature prescribed in the Navy-Marine Corps Recipe Service for the recipe you are using.

2. Check the temperature of the fat with the dial or hand thermometer at least once a day. The temperature should never, under any circumstances, go above 400°F.

3. Have foods as free from moisture as possible before frying. Excess moisture causes the fat to foam, sputter, and boil over. It also causes some fats to break down and shorten their useful life.

4. Do not fry bacon in the deep-fat fryer, as the fat from the bacon causes the fat level to rise above the safe level. It also contains salt which will shorten the life of the fat.

5. Follow instructions furnished with the fryer. Do not exceed the capacity of the fryer indicated on the instruction plate.

6. Deep-fat fryers must never be operated near unguarded electric sockets, sparks, or flames.

7. Guard against fire. If a fire should occur in the deep-fat fryer, notify the damage control officer immediately. UNDER NO CIRCUMSTANCES SHOULD WATER BE THROWN ON A FAT FIRE. Smother the fire with foam and place a metal cover over the deep-fat fryer as soon as possible. Keep the cover on the fryer until the fat has cooled below the ignition temperature.

8. Always turn the line switch to "OFF" when the fryer is not in use.

Figure 5-4.—Deep-fat fryer. 48.11

Cleaning of Deep-Fat Fryers.—Each fryer should be cleaned every day, if it has been in use. Before cleaning, turn off the heating element and allow the fat to cool to about 150°F. Drain the fat out of the fryer (before returning, wash if necessary). Then, remove the basket support screen, scrape off oxidized fat from the sides of the kettle with a knife, and flush down the sediment with a small amount of fat. If the kettle has become very dirty, fill it to the fat level with hot water containing dishwashing machine detergent or vinegar. Turn on the heating element and allow the water to come to a boil. Boil the water for at least 5 to 10 minutes, turn off the heating element, drain, rinse thoroughly, and dry the fry well. Clean the outside of the fry kettle with a grease solvent. DO NOT leave heating elements turned on when the deep-fat fryer is empty. This may burn out the heating element.

Electric Food Mixer

Electric food mixers are used for an infinite number of applications including beating batters

for cakes, mixing bread doughs, beating eggs, mashing and whipping potatoes, and many other uses.

Food mixing machines (fig. 5-5) are furnished in 12, 60, and 80-quart sizes with the necessary attachments, paddles and beaters (fig. 5-6). The wire beater is used for eggs, cream, and light-weight mixing; the flat beater for cake batters and medium weight mixing; the hook beater for mixing bread doughs; and the beater for medium stiff doughs.

One part of the machine revolves through the use of a set of transmission and differential gears. Various shaped paddles and mixers (fig. 5-6) can be attached to this revolving unit.

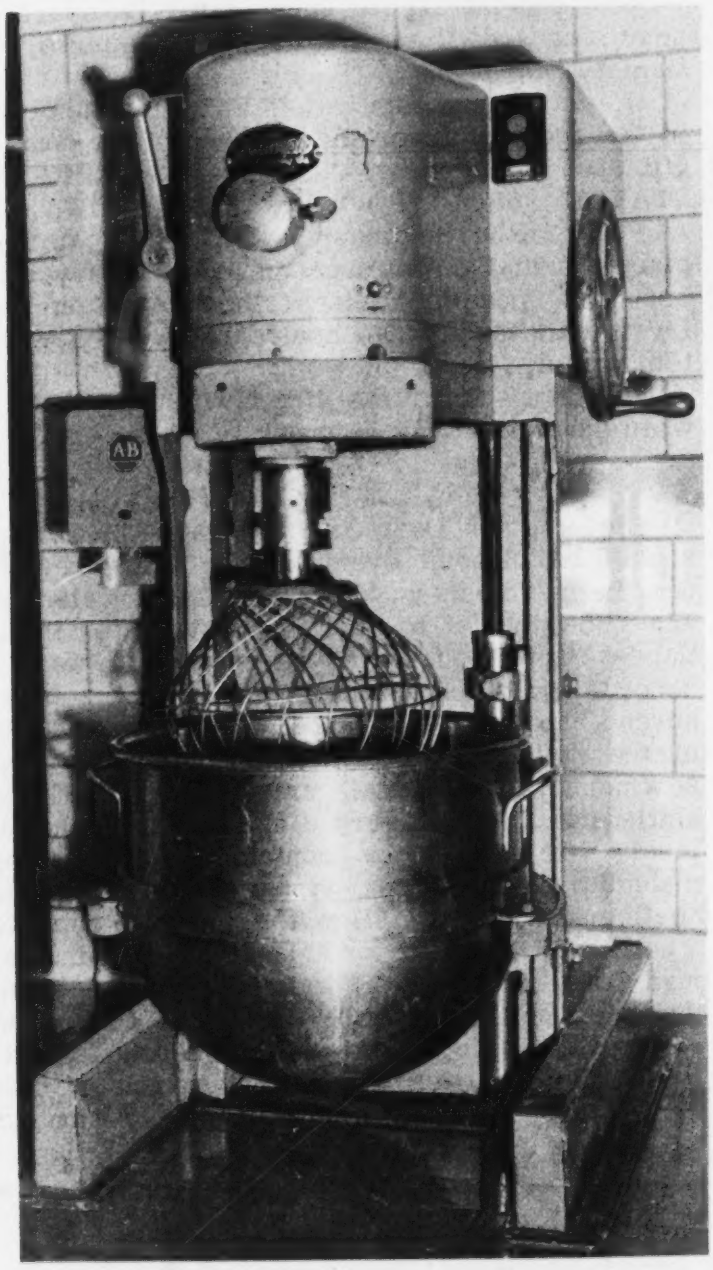

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Figure 5-5.—Electric mixer.

The lower part of the mixer contains two extended adjustable arms. A bowl, containing the foods to be mixed, is placed on these arms and the arms are then moved up so the paddles will revolve through the mixture. The machines have either 3 or 4 speeds. Usually they have an attachment socket that can be used for a vegetable slicer, juicer, and meat grinder.

Operation of Electric Mixer.—Before operating the machine make sure that the bowl, paddles and/or beaters are thoroughly clean. If necessary, wash them in hot soapy water and rinse with 180°F water.

Place the ingredients in the bowl as specified on the Navy-Marine Corps standardized recipe card. Do not fill the bowl more than half full. Place the bowl in a castered dolly and move to the mixer. Do not drag the bowl across the deck. Insert the bowl in the mixing machine, making sure that the bowl ears are on the supporting pins and both sides are locked in place.

Select the proper attachment and place it in the machine. The "L"-shaped notch in the beater is to be inserted over the pin in the shaft. On the smaller models the shaft will be grooved; the attachment is inserted into these grooves and slipped into the lock. Raise the bowl to the proper height by turning the wheel or crank.

Start the motor at NO LOAD and with clutch released shift to LOW SPEED; release the clutch each time the speed is changed. The speed to be used is indicated on the recipe card and on the instructions furnished by the manufacturer. If no clutch is provided, stop the machine each time the speed is changed.

Watch mixing time and mixing speeds carefully; often blended ingredients revert to separate ingredients if mixed too long or at an improper speed. If, during the process of mixing, some of the batter has piled up on the sides of the bowl, stop the machine. Using a long handled spoon or spatula, scrape down the sides of the bowl. NEVER put spoons, spatulas, or your hands into the bowl while the machine is in operation.

When the mixing is completed, move the control switch to the OFF position and stop the motor. Lower the bowl by the lever with which you raised it, remove the beater by turning the sleeve to the left. Remove any food left on the beater with a spatula. Then, place the bowl on the castered dolly and move it to the place of use.

Some electric food mixing machines are provided with bowls of two sizes. The 20-quart

machine with both 12- and 20-quart bowls; the 60-quart machine with both 30- and 60-quart bowls and the 80-quart with 30- and 80-quart bowls. When using a smaller bowl on a large machine, an adapter must be used as well as the correct beater and/or paddle for the different size bowl. At no time should the beater or paddle scrape the bottom of the bowl.

Care and Cleaning.—The electric mixer, beaters, whips, and bowls all require care. Beaters, paddles, and bowls should be washed immediately after use. Use hot soapy water and rinse with water 180°F. Hang beaters and paddles upside down to air dry. Clean the body of the machine after each meal. Use a damp cloth or wash with water as necessary for proper sanitation. Be sure that the beater shaft is free of all dirt and food particles.

The motor and mechanical parts of the mixer are inspected and maintained by the engineering department once a week.

Coffee Urns

Coffee urns (fig. 5-7) used in Navy general messes are of the combination type, consisting of an inner compartment or tank for coffee and and outer pressure-tight tank for water. The two tanks are separated by an air space to avoid rapid temperature changes of coffee when cold water is added to the water tank. A siphon pipe

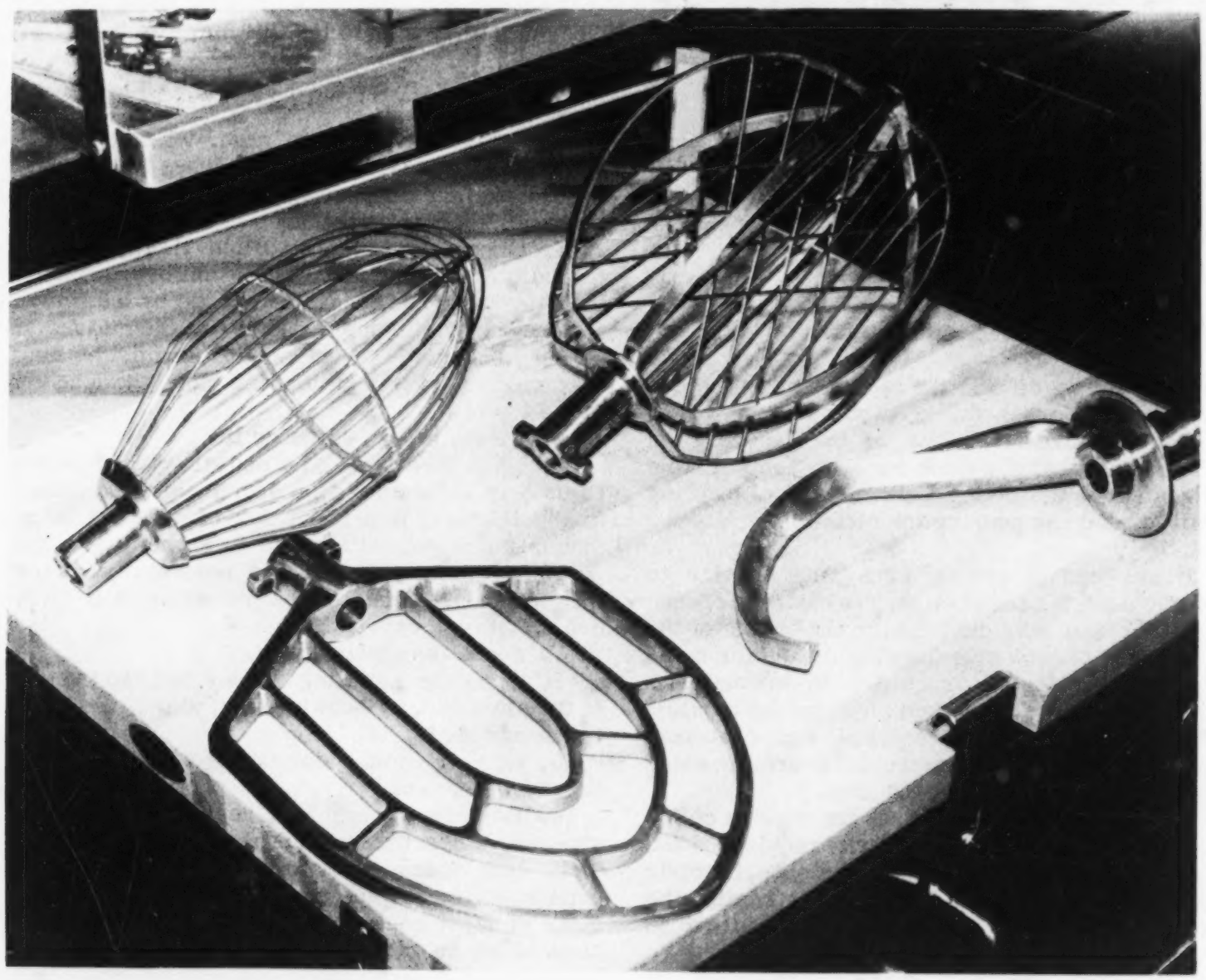

Figure 5-6.—Electric mixer attachments. 48.13

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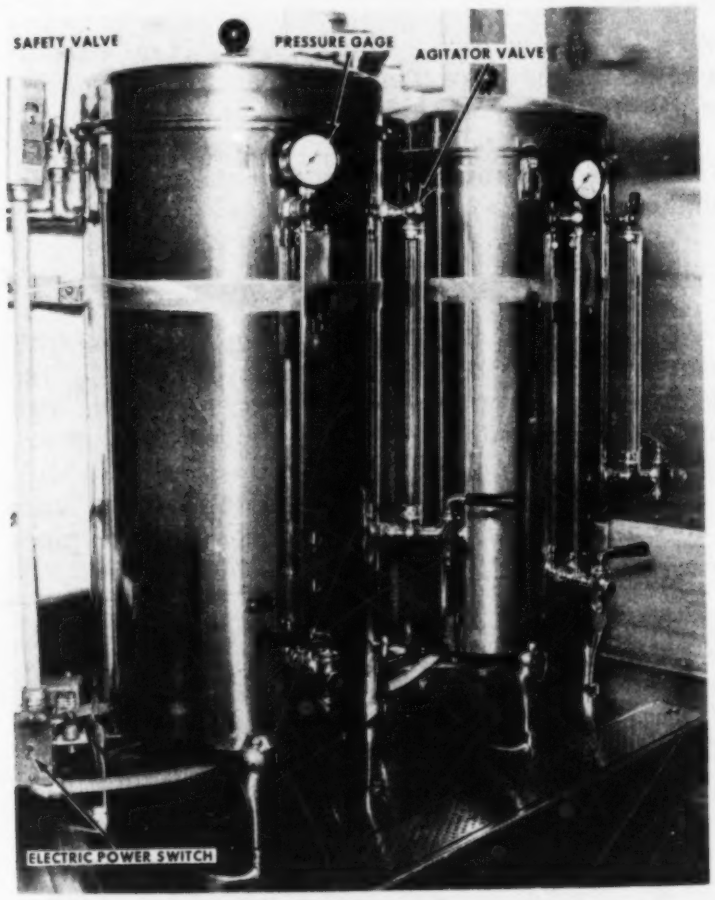

Figure 5-7.—Electric coffee urns. 48.14

between the water and the spray head in the urn cover or lid forces the hot water up and sprays it over the ground coffee in the leacher. An agitating valve is provided for thoroughly mixing the coffee in the coffee tank instead of drawing it off by hand and pouring the coffee back into the urn.

Steam heated coffee urns are similar to electric urns in construction. The basic difference is that a steam coil, installed in the bottom of the water tank, provides the heating means for these urns. Electricity is required to operate the pressure type controls used on all but the 1-gallon urn to maintain the required temperatures. Operating and cleaning instructions are the same as for the electrically heated urns.

Urns are furnished in sizes for making coffee in 1-gallon (nonautomatic urn requires hand pouring), 2-gallon, and 4-gallon batches. Electric immersion heaters are installed for heating the urns, and pressure type controls are provided for automatic temperature control.

Urn bags (leacher cloths) are made of unbleached muslin. When manufactured they are treated with sizing (mainly starch). Before a new urn bag is used, it should be soaked in hot water and wrung out to remove as much sizing as possible. If this is not done, the hot water poured over the grounds will release the sizing into the coffee brew and give it an unpleasant taste.

Operation.—Inspect coffee urns inside and out before each use. Examine gage glasses, valves, and faucets for leaks, and have faults corrected before using the urns. Check the urn bags; they should be in good repair and free of coffee grounds and other agents that might make the coffee unhealthy to drink or spoil its flavor. When the inspection has been completed, you are ready to operate the urn as follows:

1. Open the cold water filling valve and fill the urn with water to the full mark on the water gage.
2. Turn the electric power switch to the "ON" position.
3. Check the pressure gage. When the indicator or the pressure gage reaches $2^1/_2$ pounds (or the premarked operating position), the urn is ready for making coffee.
4. Clamp the leacher cloth firmly on the leacher, spread ground coffee uniformly inside the leacher in the quantity required by the Navy-Marine Corps Recipe Service for the gallons of coffee to be made (quantity of ground coffee may be varied to suit the taste), and place the leacher in the top of the urn.
5. Close the urn cover or lid.
6. Open the siphon valve and allow the required volume of water to siphon over the ground coffee in the leacher. If a full batch of coffee is being made, the water will cease to siphon when the correct volume of water has been sprayed over the coffee grounds, and heavy steam will show around the urn cover.
7. Close the siphon valve.
8. Open the agitating valve slowly to the end of the stem and, without pausing, slowly close the agitating valve.
9. Open the cold water filling valve and again fill the water tank.
10. Remove the leacher, remove used coffee grounds, rinse the leacher and leacher cloth in clean cold water, and store in clean cold water until required for use again. Replace the leacher cloth at least once a week. Discoloration of the cloth does not affect its utility provided it has been properly cared for.
11. Draw the coffee as required.

12. Time the preparation of coffee so that it does not stand longer than 30 minutes before serving.

In the larger urns where automatic agitators are provided, the question of repouring coffee is never considered. However, it is necessary to mix coffee prepared in an urn because the coffee at the bottom is extracted strong, the coffee in the center is of average strength, and the coffee at the top, weak and bitter. The brew must be mixed thoroughly before it is served. To do this properly when the older type of urn is being used, remove the spent grounds after brewing and then draw off 1 gallon of brewed coffee for each pound of coffee used. Pour it back as rapidly as possible into the urn to ensure thorough mixing. NEVER pour coffee over spent grounds.

Cleaning.—When you are cleaning electrically heated coffee urns, follow the instructions listed below:

1. Heat clean water in the urn water tank by turning electric power switch on, until the pressure gage indicates $2^1/_2$ pounds, or operating pressure.

2. Close the urn cover, then open the siphon valve and siphon enough hot water to half fill the coffee tank.

3. Wash the inside of the coffee tank, top, rim, and cover, using a clean cloth. Do not use a brush or mop for washing urns having a glass-lined coffee tank. Clean the faucet, gage glass, and draw-off pipe after each use with a wet brush and with destaining compound.

4. Drain the water off by opening the coffee faucet.

5. Close the urn cover and open the siphon valve and siphon approximately 1 gallon of hot water into the coffee tank. Open the coffee faucet and then open the agitating valve for about 1 minute to sterilize the dispensing route and coffee faucet.

6. Close the coffee faucet.

7. Siphon the coffee tank half full of hot water. If the urn is being shut down for the night, allow the water to stand over night. Drain it off in the morning before use.

Clean the urn in accordance with the above instructions at the end of each day. Twice weekly, sweeten the urn by using a solution of 1 cup of baking soda to 1 gallon of hot water. Keep the baking soda solution in the urn about 15 minutes. Then agitate by opening the agitating valve for 1 minute; drain and flush thoroughly with hot water. DO NOT use cold water on glass-lined urns; always use hot water by operating the siphon valve.

Vegetable Peeler

Vegetable peelers (fig. 5-8A) have capacities of either 10-15, 30, or 50 pounds, and have a cylindrical hopper with abrasive covered wall and an abrasive covered rotary disk in the bottom. The disk has a wavy surface to agitate the vegetables in a manner that will continually present new surfaces for action by the abrasive material.

Operation.—Before loading the machine, sort the potatoes so that those in any one load are of the same size and free of stones, sticks, and other hard objects. The machine should be started and the water turned into it before any vegetables are added. Do not overload the machine. The quantity of vegetables loaded should not exceed approximately 66 percent of the total hopper capacity. A larger quantity will not be thoroughly agitated.

If the abrasive surfaces of the machine are kept reasonably clean, a charge of potatoes should

Figure 5-8.—A. Vegetable peeler, B. Vegetable cutter. 48.15

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be satisfactorily peeled in about 1 minute. Deep eyes or depressions in potatoes should be removed and the peeling finished with a hand peeler or small knife. It is wasteful to allow vegetables to remain in the machine longer than necessary.

Cleaning.—At the end of each day's peeling, dismantle the machine. Lift the cover off and take out the abrasive disks; remove the peel trap and strainers; wash the removed parts and the interior and exterior of the machine with hot soapy water, and rinse with water 180° F. Be sure all food particles are washed out. Reassemble the unit to be ready for use and leave the cover open for air.

Electric Vegetable Cutter

Vegetable cutters (fig. 5-8B) are electrically operated machines which, without the use of attachments or removable parts, make three classes of cuts of vegetables — shredded, sliced, and grated. A dial control on the side of the machine allows instant changing of the thickness of the cut, even while the machine is in operation.

Cleaning.—The entire front of the machine swings open to provide complete access to the interior for cleaning and blade changing. The machine should be washed with hot water immediately after use. The knurled knob holds the front securely when the machine is in operation.

Clean and scrub the knives and bowl with hot, soapy water and a very stiff brush. RINSE well with 180° F water and allow to air dry thoroughly before reassembling.

Cutter, French Fry

The cutter (see fig. 5-9) is used for cutting vegetables into cubes, slices, and french-fry shapes.

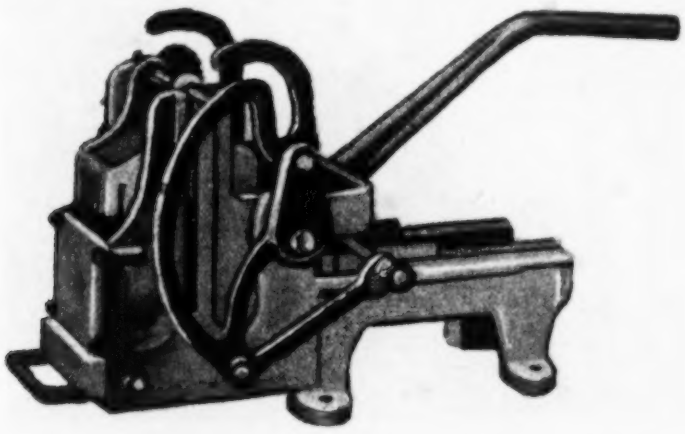

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Figure 5-9.—Cutter, french fry.

By means of a hand-operated lever, the vegetables are pushed through a die containing knives that cut them into parts one-half inch thick. Different kinds of dies may be used to give cubes or slices.

When operating the cutter, make sure the dies are properly set. Keep the dies absolutely clean and dry. Clean and oil the machine after each use.

Electric Toasters

Electric toasters which you may have occasion to use are the intermittent and the continuous

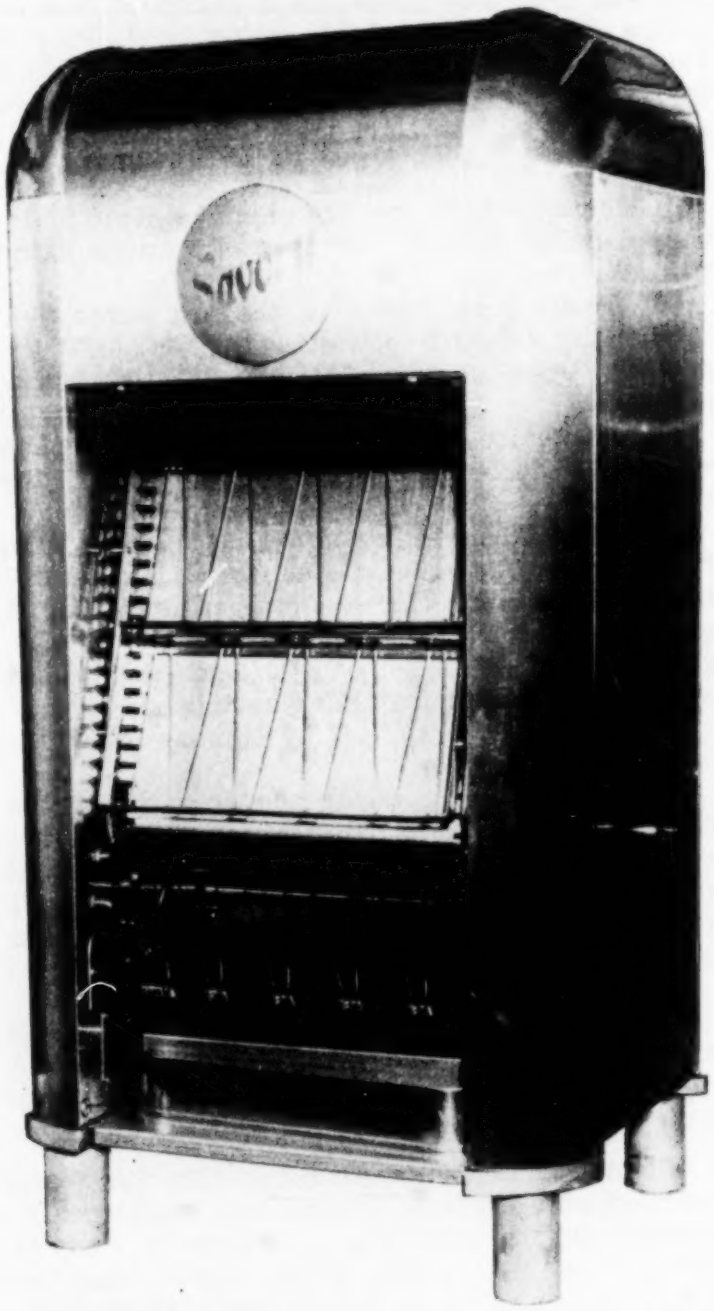

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Figure 5-10.—Electric toaster.

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type. (See fig. 5-10.) The intermittent type is composed of chrome-plated steel and has a vertical oven with from 2 to 12 top openings for inserting the bread slices. The continuous type has a chrome-plated heavy duty conveyor with motor driven revolving trays for the toast.

The accumulation of crumbs and food particles in these toasters, besides being unsanitary, may cause trouble to the heating elements. Before cleaning a toaster, be certain that the electric power is off. Then brush crumbs and charred food particles out of the heating element. If the toaster is a continuous type, the conveyor must also be cleaned. Clean metal surfaces of the toasters with a silver-dip solution at least once a week in order to keep them bright.

Steam-Jacketed Kettles

Steam-Jacketed kettles are used for cooking vegetables, boiling liquids, and making coffee. (See fig. 5-11.) They vary in size from 20 to 80 gallons. Approximately, the lower two-thirds of the kettle is surrounded by a jacket which is offset from the main kettle body to provide space for steam to circulate and heat the contents of the kettle. The kettles are stationary, mounted on three legs, and have a hinged lid or cover. They also have a tube at the bottom of the hemispherical body of the kettle, with a faucet at the outer end for drawing liquids in lieu of dipping them out, a steam inlet connection, a steam outlet connection, and a safety valve.

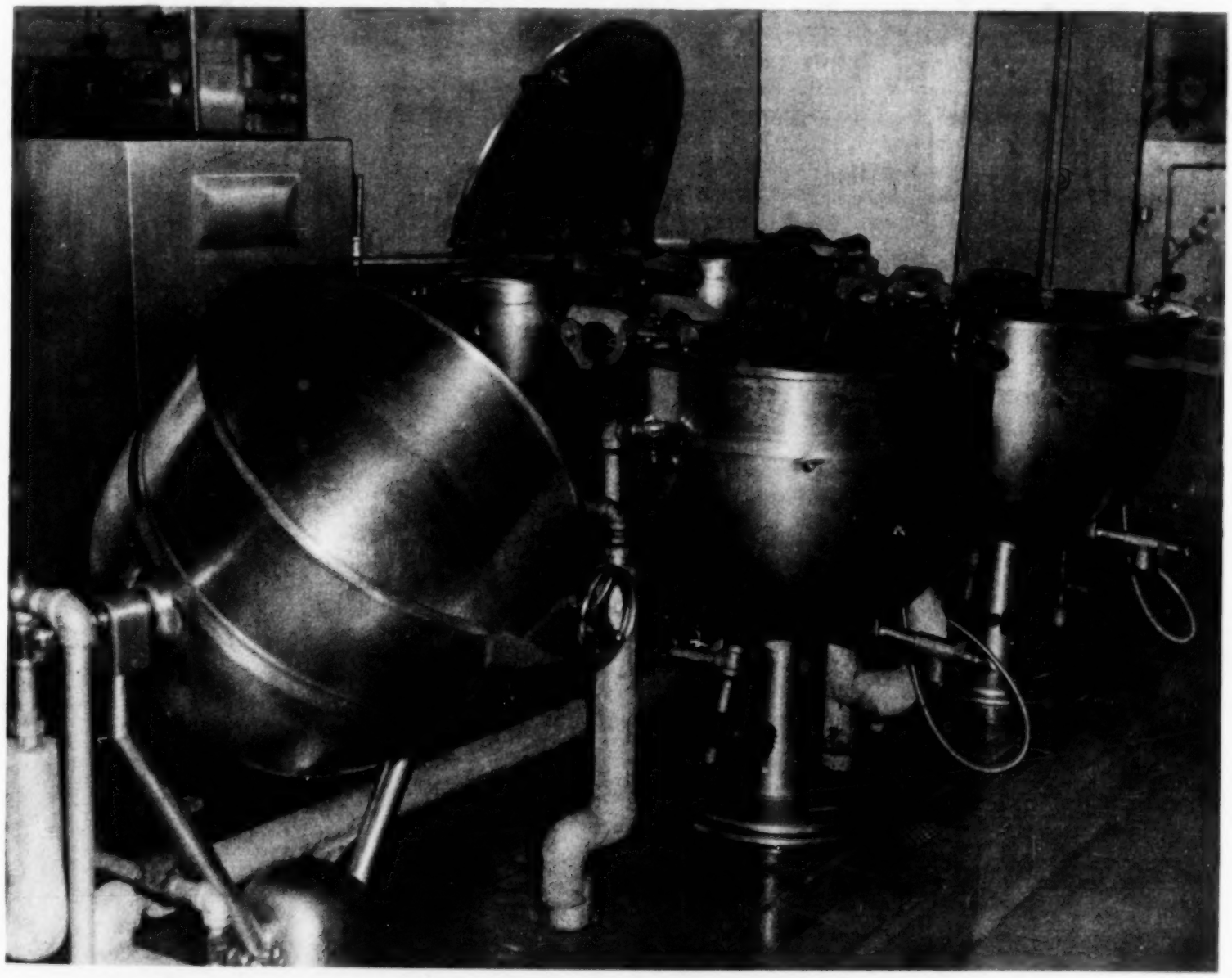

Figure 5-11.—Steam-jacketed kettles.

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Kettles now in use are of three types of material—corrosion-resisting steel, aluminum, and single clad corrosion-resisting steel.

Never fill the kettle completely full. If it is necessary to stir the contents, use a metal paddle, but never leave the paddle in the kettle while cooking. Rest it across the top.

Operation.—The kettles are constructed to operate on a maximum steam pressure of 45 psi. When the pressure in the galley steam line is in excess of 45 psi, a pressure regulating valve is installed in the steam line leading to the kettles. The safety valve is adjusted to blow off at 45 pounds pressure. Do not tamper with the safety valve or tie it closed. It is there to prevent the kettle from exploding. When you heat a cold kettle, turn the steam on gradually, thus allowing the shells to become thoroughly warm before full pressure is applied. After the shells have become warm, and before applying full pressure, open the safety valve by pulling the lever. Opening the safety valve while the pressure is within the shell removes air from within the jacket, and prevents the kettle from becoming air bound.

Cleaning.—The kettles should be cleaned thoroughly after being used. Before use they should be given a rinse with hot water. The draw-off tube and fittings should be cleaned with a round brush, having a flexible wire handle and with hot water. When you clean the draw-off tube, remove the plug from the faucet. (CAUTION: Do not change plugs from one kettle to another. Each plug is machined to match its own faucet, therefore, interchanged plugs may

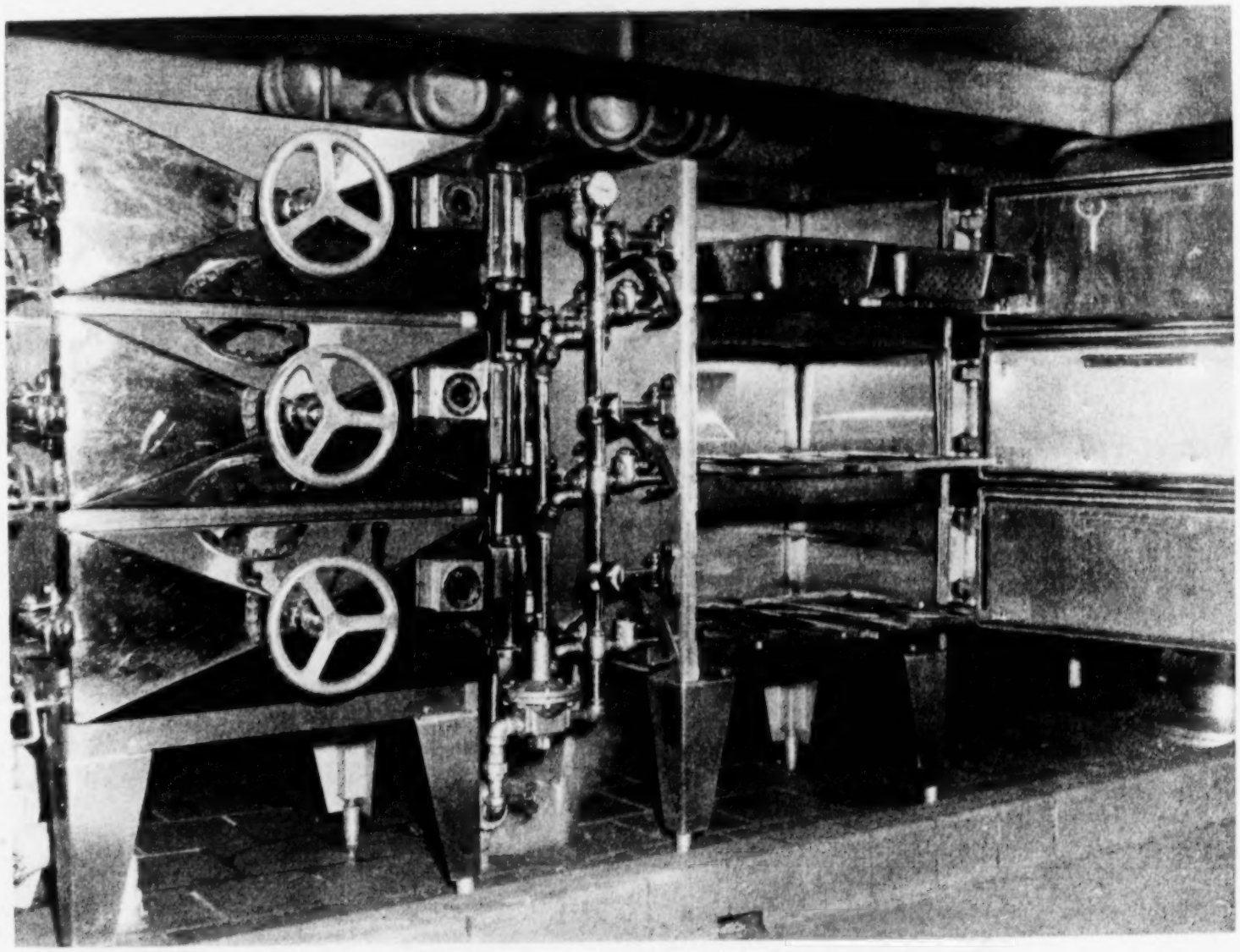

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Figure 5-12.—Steamer.

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cause leakage.) Run the cleaning brush back and forth through the tube while a small stream of hot water is running through the tube. DO NOT use caustic cleaners on the kettles. The draw-off tube of older kettles is made up of several pieces, which are threaded for screwing together. To clean this type, remove the plug or cap at the back end of the draw-off, so that the cleaning brush can be run back and forth through the tube. All of the old type draw-off fittings should be removed and thoroughly cleaned at least once a week.

Steamers

Steamers (fig. 5-12) are used for steaming fish, fruit, meat, poultry, and vegetables. Most steamers used in the Navy consist of a three-door, three-compartment unit. Each unit has one or two perforated pans or baskets.

Operation.—When operating steamers you are not limited to the use of pans and baskets furnished with them. On occasions when juices are to be saved, you should cook in leakproof solid pans of a suitable size. Pans should not be overloaded; steam circulates best when pans are about three-fourths full. Different foods may be cooked in the same steam compartment without mixing unlike flavors or affecting food taste. Onions and pudding placed in individual pans may be cooked in the same steam compartment without transfer of flavor.

After the food has been placed in the steamer, close the compartment door securely. (The door latch is linked with the steam supply on most steamers, and the final movement of the lever locks the door and turns on the steam at the same time. Unlocking the door and lever turns off the steam before the door can be opened.)

If the steam supply is controlled separately, open the steam valve slowly by turning the valve wheel counterclockwise after the door is latched. Then observe the pointer on the steamer gage, which should be in the range of 5 to 7 psi. Turn the valve wheel clockwise to reduce steam pressure if it is above 7 psi.

Watch your cooking time closely and avoid spoiling food by overcooking. Less time is required for steam pressure cooking than for boiling food in water; temperature of 7 psi steam is 233°F, and boiling temperature of water is 212°F.

After cooking has been completed, turn off the steam supply by turning the valve wheel clockwise on separately controlled units, or by unlatching the compartment door of the latch-controlled steam supply. You can relieve steam pressure by operating the lever of the safety valve, if provided; otherwise, wait 2 minutes before opening the door to full open position.

Care and Cleaning.—Occasionally, when you examine the drainpipe for steam-condensate drip, none will appear after a few minutes of steamer operation. When this is the case, turn off the steam supply by unlatching the door or closing the valve, as necessary. The fault normally is stoppage in the trap, strainer, or drainpipe. To eliminate this condition; close the steam valve, remove the steam-trap strainer basket, and clean by scraping out the solids and washing the basket until the mesh or perforations are open and clear. Clean the pipe connection in the steamer compartment; reassemble the strainer and repeat the pressure cooking. If there is still no drip, the steam trap is at fault, so report this to the engineer officer via the chain of command.

After each meal, the steamer should be brush-scrubbed, washed clean with hot soapy water, and rinsed with water 180°F. Allow to air dry.

Steamtable

Steamtables (fig. 5-13) are used for serving hot foods. There are several types such as those (a) with water compartments heated by steam coils 40 psi pressure or less, (b) with steam heated water compartments and dishwarmers, (c) with water compartments heated by immersion-electric heating elements, (d) with electric heating elements, and dishwarmers, (e) with water compartments heated by gas burners, and (f) with water compartments heated by oil burners.

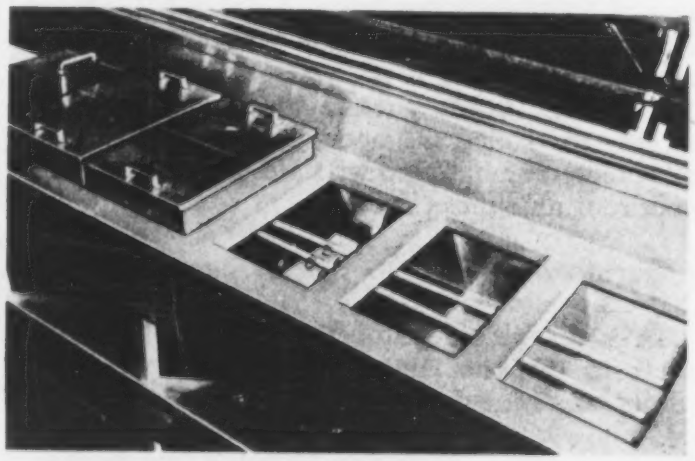

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Figure 5-13.—Steamtable.

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Operation.—When the steamtable is in use, steam condensation should drip to drain. If no condensation appears after 2 minutes of operation, turn off the steam valve and clean the strainer basket of the trap.

Do not overload food pans. An excessive amount of food makes it difficult to maintain the correct water compartment temperature, between 180°F and 200°F. If, on the other hand, water in the steamtable is allowed to become hotter than 200°F, the food will dry rapidly and continue cooking from the excess heat. You can correct this by adding more water to reduce the heat. Because food tastes best if served within 30 minutes (preferably within 15 minutes) after being placed in the steamtable, do not place food pans in the steamtable too early.

Care and Cleaning.—Wash pans in the pot sink by hand, using cleaning brushes, scouring powder, and hot soapy water; and rinse with hot fresh water at 180°F. Only fiber sponges should be used in cleaning pans of copper, copper-nickel, or corrosion-resistant steel.

After each meal, drain the steamtable, wash the tanks with hot soapy water, and rinse with very hot fresh water of at least 180°F. Wash the top and front of the steamtable to make it bright, clean, and sterile; then wipe it dry with a clean cloth.

Steamtables should be maintained in a sanitary, steamtight, and safe operating condition at all times. Metal parts should be kept free of corrosion by removing rust with solvents and by applying vegetable oil to bare spots.

Scales

The set of scale is one of the most important pieces of equipment you have. A scale will assist you in conserving food. When a recipe calls for a certain amount of food, you should weigh out that amount. Don't guess. This will make it possible to keep an accurate record of the subsistence on hand, and will aid you in preparing the correct amount of food.

Refrigerators

The Navy refrigerator used in the galley is similar to the one illustrated in figure 5-14. It consists of an insulated, stainless steel compartment, and rustproof, acid-resistant shelves. The refrigerator may be 16 or 30 cubic feet in size, and is designed for storing foods for short periods of time. Most refrigerators installed aboard ship have movable bars which fit in front of each shelf to keep the contents of the refrigerator from moving or falling out when the door is opened. At sea, food must be stowed in such a way that it will not move around when the ship rolls. To keep a refrigerator operating at top efficiency, three things are important:

KEEP IT CLEAN
DO NOT OVERLOAD IT
DEFROST IT REGULARLY AND PROPERLY

Washing the Refrigerator.—A refrigerator that is not thoroughly clean will quickly develop a bad odor, and the foods in it will spoil. Cleanliness retards the growth of mold and bacteria which often cause food poisoning. A refrigerator should be cleaned at least once a week and after each defrosting. Never hose down a refrigerator with running water. The fluid may seep into the insulation and cause permanent damage. The proper cleaning procedures are outlined as follows:

1. Wipe the gaskets around the door of the refrigerator to remove any oil or grease.
2. Wash the inside surfaces and food shelves with soap and warm water.
3. Rinse with a warm solution of baking soda, using 1 tablespoon of soda to 4 quarts of water.
4. Dry all surfaces thoroughly after flushing out the drain with hot water.
5. Clean the outside with warm water, rinse it, and dry it.

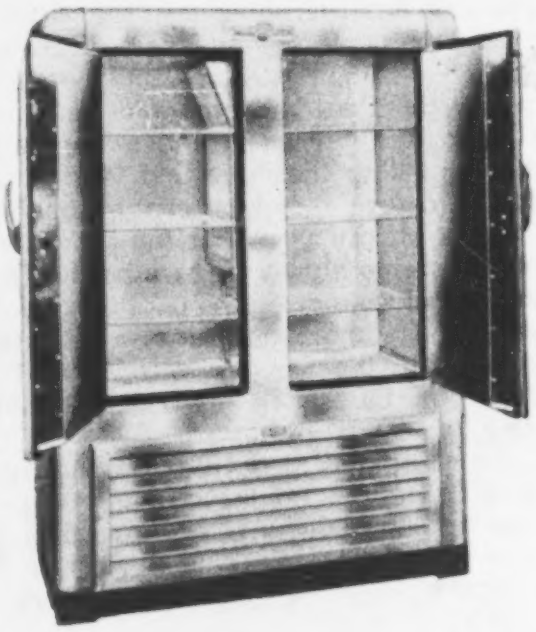

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Figure 5-14.—Refrigerator.

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Avoidance of Overloading.—Never overload a refrigerator. An overloaded refrigerator is hard to clean because food odors spread more rapidly, and the cooling unit frosts more quickly. To prevent overloading, limit the amount of food you draw from bulk storage at any one time. When you draw food that must be kept in the refrigerator, don't ask for more than you can store.

Defrosting.—Defrost a refrigerator at appropriate intervals. The number of times that a refrigerator requires defrosting depends, of course, on the rate at which frost builds up on the cooling unit. Ice formations should never be one-half inch thick, because ice and frost act as insulators and reduce efficiency. Don't try to speed up the defrosting by scraping, chipping, or sticking the frost with an ice pick. Don't pour hot water on the cooling unit. Defrosting, however, may be speeded up by placing pans of hot water in the refrigerator.

MEAT CUTTING EQUIPMENT

The meat cutting room, commonly known as the butcher shop, is where meats, fish, and poultry, drawn from refrigerated storerooms, are prepared for cooking. The equipment normally found in this area consists of meat cutting blocks, meat grinding machines, power driven meat cutting saw, slicing machines, steak cubing machines, knives and other hand cutting tools, and hooks for hanging meats.

Meat Block

Meat blocks are made of hard maple. Depending on the tonnage displacement of a ship or whether she has a meat cutting room, they are furnished in the following sizes:

1. 24 by 24 by 16 on destroyers and ships under 2000 tons displacement
2. 30 by 30 by 16 on ships having a 2000 tons or more displacement
3. 35 by 50 by 16 on ships that have a meat cutting room

Care and Cleaning.—Clean the meat block (fig. 5-15) with a scraper and a wire brush after each use. Do not wash the cutting surfaces of the meat block. Moisture softens and expands the wood and weakens the glued joints which, when dried, contract and form cracks to collect food particles. Do not salt the block. Salt is not a bacteria destroying agent and may interfere with drying, or may conceal an unclean surface. Listed below are some of the rules that you should follow in order to keep the cutting surface of the meat block in good physical and sanitary condition.

1. Use a wide-bladed steel scraper and a wide-bristle wire brush to clean the cutting surface after each use. DO NOT use wash water on the cutting surface. Water should be used on the sides only.
2. Keep the cutting head of the block dry.
3. Turn the block regularly so that the cutting surface will wear down evenly. When the blocks become pitted, rough, and uneven, they are impossible to maintain in a satisfactory condition and should be trimmed by sanding or by other approved methods.
4. Use a special cutting board, and never the block when cleaning or cutting poultry, liver, hot meats, fish, fruits, and vegetables. Unhealthy organisms when present may contaminate the block, and the moisture and juices in these products make cleaning difficult.

Meat and Vegetable Chopper, Electric

The electric meat and vegetable chopper (fig. 5-16) is used to chop (or grind) all meats (cooked or raw) and to prepare bread crumbs from leftover bread and toast. The meat and vegetable chopper is portable and may be placed where most needed. It should be placed on a sturdy stand within easy reach of an electric outlet.

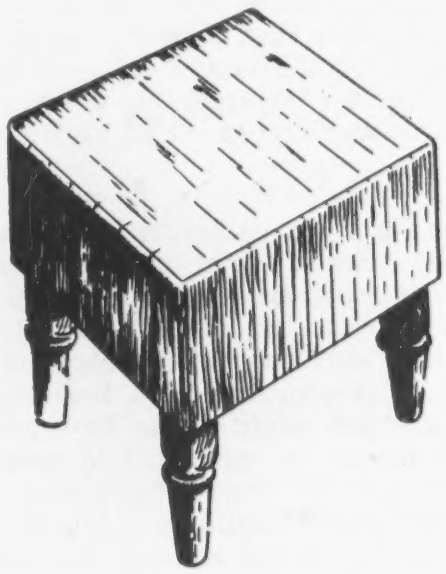

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Figure 5-15.—Meat block.

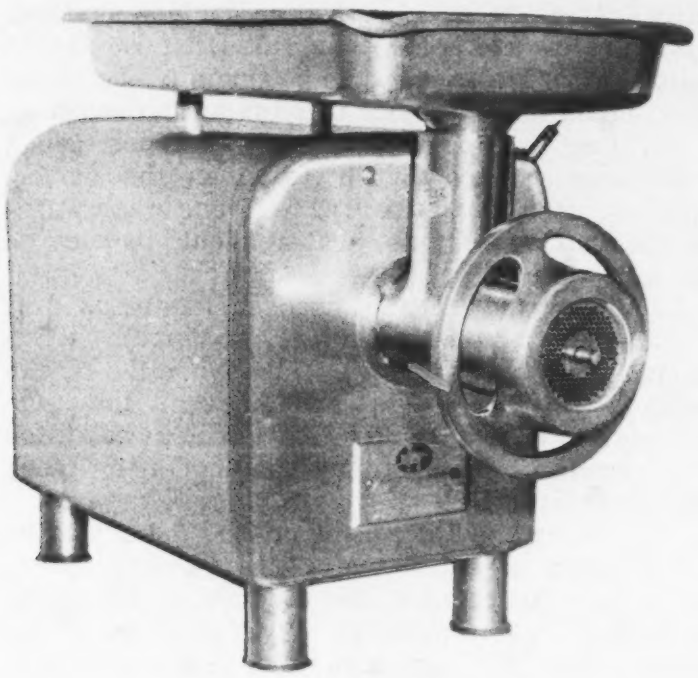

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Figure 5-16.—Meat and vegetable cutter.

Operation.—Usually a three-eights inch plate is used for grinding meat. The use of a three-sixteenths inch plate for such grinding puts too much pressure on the grinder. The coarser plates are for chopping vegetables. The cutting edge of the knife must go next to the plate. Never forcibly tighten the adjustment ring on the chopping end; tighten the adjustment ring on the chopping end; tighten it snugly. Excess pressure will wear the chopper parts.

Start the motor, then feed the material into the chopper. Turn the motor off when material is ground. Feed the material into the machine by means of a wooden stomper—NEVER WITH YOUR HANDS.

Care and Cleaning.—After meat has been chopped, take the grinder apart and wash each part thoroughly with soap and water, rinse with water 180°F, and allow to air dry. Do not allow food to dry on the surfaces of the chopper before washing it. A grinder can be a breeding place for bacteria which might cause food poisoning. Great care should be exercised in keeping the parts of the grinder free from contamination.

Knives and plates should be sharpened before they get dull, but do not attempt this yourself. The engineering department should be consulted. It is a good idea to keep the same knife and plate together as they wear to fit each other. Tie them together with a cord after use so they will not get mislaid.

Keep the motor dry. Don't grind juicy foods such as onions, for the juice is forced back into the gear housing, causing loss of oil and consequent wearing of gears.

If you are grinding foods such as crackers, grind a very small amount at a time or the machine will jam. When the chopper is hot, do not run raw meat through it. Remember that bits of bones can break worm gears and knives.

Motor-Operated Meat Saw

Electric sawing machines (fig. 5-17) are used mainly for cutting chilled, frozen, and smoked meats into steaks and chops. It is well to bear

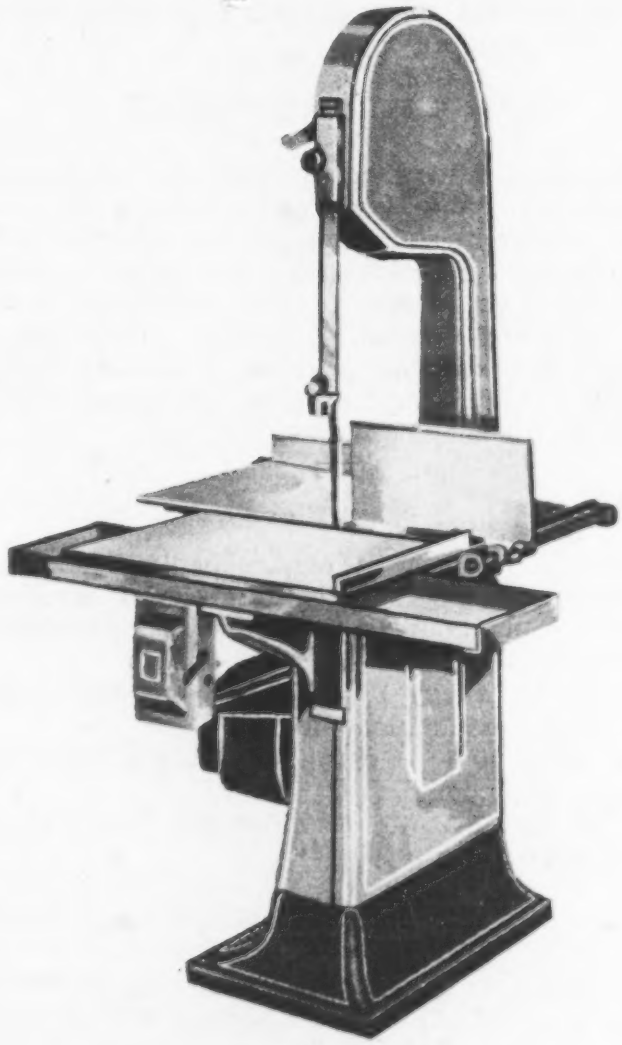

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Figure 5-17.—Electric meat cutter or sawing machine.

in mind that meat can be cut more uniformly by machine when there is still some frost in the boneless piece.

The saw is made to revolve by a mechanical arrangement of two wheels and an electric motor. The table on which the meat is laid is constructed so that you can cut the meat to any desired size. The saw blades themselves are five-eights inch wide and about 10 feet long.

Operating the Saw.—Before operating the saw, tighten the blade, using only one hand. Put only enough tension on it to keep it from skipping. Feed the meat through the straight, giving the blade a chance to cut. Use only sharp blades. Dull blades may heat up, twist, and break. DO NOT FORCE.

The electric meat cutter is a dangerous piece of equipment. A great deal of care is necessary to avoid injury when operating this machine. There are five safety precautions which should be observed whenever you operate the meat saw:

1. Before cutting meat, see that the right amount of tension is on the saw blade. There should be no flexibility whatsoever. The feel of the saw blade will be solid when the right amount of tension is applied.
2. Meat being sawed should be placed firmly against the sliding tray guide with enough pressure to maintain a uniform thickness of the slices.
3. Never use unnecessary force when cutting (sawing) meat. It is possible to break the blade and cause serious injury to yourself or others from flying pieces of metal.
4. Always make sure the guide is securely tightened after the adjustment for the thickness of the meat slices has been determined. Set the guide blade 2 inches above the meat.
5. Always keep your hands on the part of the meat which is most distant from the saw blade.

Care and Cleaning.—The revolving wheels have grease chambers. Pack them frequently. Keep the machine clean. Oil at least once a week. Always wash and sanitize machine properly after each use or after every 4 hours of continued use.

When washing, use hot soapy water, and rinse with water of 180°F. Do not drip water on the electric motor.

Meat Slicer

Meat slicing machines (fig. 5-18) are either hand operated or motor operated and are used for slicing hard or soft foods such as: roasts, cheese, bacon, luncheon meat, various kinds of sausages, and ham.

The machine has a carriage on which the meat is placed. A swiftly revolving disk knife slices the meat as the carriage is moved across the face of the revolving knife.

Operating the Meat Slicer.—To use the slicer, place the meat on the carriage and adjust the clamp to hold the meat firmly. This clamp also furnishes protection for your hand. Next, set the dial for the desired thickness of the slices. Then turn on the switch to make the disk knife

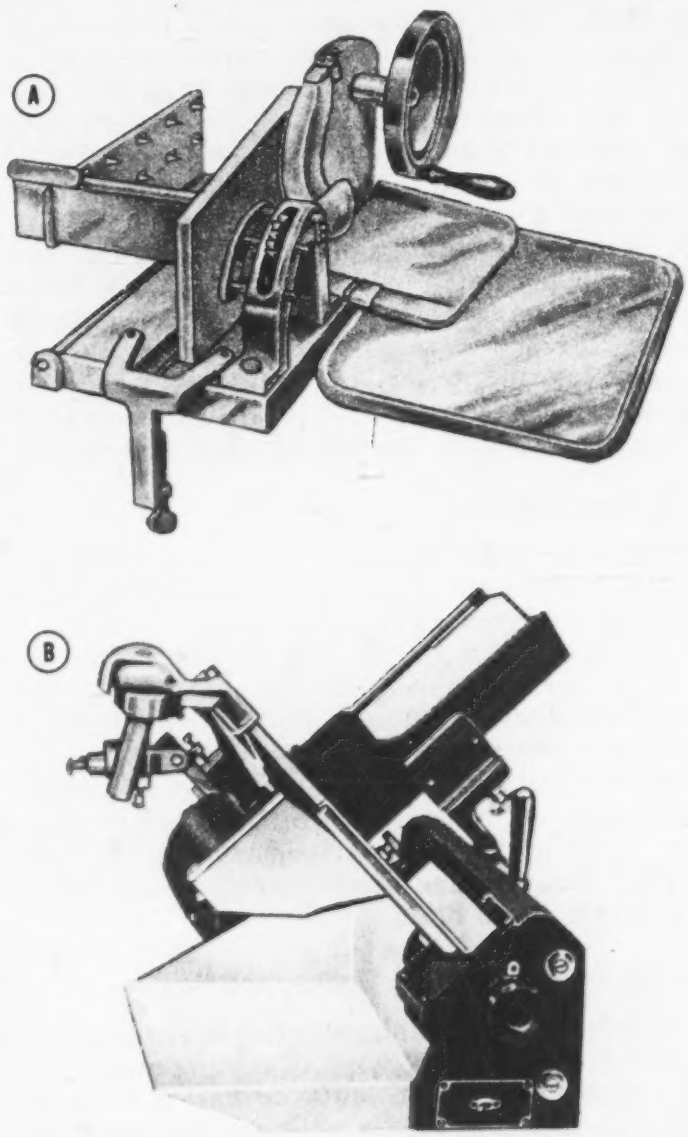

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Figure 5-18.—A. Hand operated meat slicer, B. Electric meat slicing machine.

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disk knife revolve. Move the carriage back and forth with the hand lever. WARNING: KEEP YOUR HANDS AWAY FROM THE REVOLVING KNIFE.

The meat slicing machine can be a dangerous instrument if your aren't careful. Never use it when the blade guard is off. Don't leave the plug in the electrical socket when the slicer is not in use. Never put your hands under the guard, and don't operate the machine with wet hands.

Care and Cleaning.—The meat slicing machine should be cleaned thoroughly after use. This is done by removing all cutting and meat handling attachments. Before dismantling an electric machine, turn the switch off and unplug. Clean the slicer knife with a damp cloth, wipe it with a dry cloth, and cover the blade with a thin coating of salad oil to prevent rust. Never use a knife or other hard substance to scrape food particles from the slicer knife. Wash attachments with soap and hot water; rinse with water of 180°F and allow to air dry. Wash the machine with hot water and a stiff brush, taking care not to let any water get into the motor. (Do not use extremely hot water or steam to clean; too much heat may destroy lubricants.) Dry the machine thoroughly with a cloth after cleaning. Clean the counter top under the slicer. Reassemble the slicer immediately so that the bare knife will not be exposed. Replace all guards securely.

Cube Steak Machine

The cube steak machine is used to tenderize all sorts of tough meats. The machine is about 20 inches long and about 1 foot wide.

To operate, turn the motor on, insert the meat to be tenderized into the opening at the top of the machine. The meat will pass through two sets of revolving rollers (which contain many small blades) and will be made tender. If further tenderizing is required, insert the meat again after first giving it a one-quarter turn (90°).

Take the machine apart and clean after each use. Oil the parts often.

Knives, Cleavers, Meat Hooks, and Saws

Different sizes and shapes of tools are required for the many different ways of cutting meat. You must understand which knife or saw is used for each job and be sure that they are used for purposes for which they are intended. Be particularly careful with the bladed tools (knives and cleavers), for if they are improperly used their edges will be ruined. For example, you would never use the long thin-bladed knife that is designed for carving cooked meats to bone a roast. It is easier, quicker, and more efficient, to use the boning knife which has a stiff, narrow, short blade designed to cut close around bones. The knives with the long, wide blade are used to cut steaks and roasts before they are cooked.

To get the most use out of the knives in the galley, they must be sharp. A dull knife is a hazard and makes extra work for you. A boning knife has a comparatively narrow bevel and will stand more hard use than a steak knife which has a wide bevel and a thin edge. But no matter what tool you use, you can't do a good job unless it is sharp. The butcher's steel is used only to keep the edges of knives straight and not to sharpen them. Nor should you sharpen knives on a power or hand driven stone, since this removes the temper from the cutting edge. The best things to use for sharpening are a water stone and a carborundum oilstone. If you are careful to use the entire stone when sharpening tools the stone will not "hollow out" at any one point. Draw the full blade, from heel to tip, across the length of the stone and then turn the knife over and pull it back from the opposite end of the stone. This sharpens the knife evenly and smoothly and causes the stone to wear uniformly. Always clean the blade and handle thoroughly after sharpening.

In steeling there is a definite technique and definite types of steel to be used to true the edge. Never use a rough steel. A smooth steel is important in keeping the blade in perfect condition and maintaining a keen edge. The steel should have good magnetism in order to hold steel particles. The following is the easiest and most effective method of steeling a knife:

1. Hold the steel firmly in the left hand, thumb on top of the handle, with the point upward and slightly away from the body.
2. Place the heel of the blade against the side of the tip of the steel. The steel and the blade should meet at an angle of about 25°.
3. With a quick swinging motion bring the blade down across the steel toward the left hand. This should pass the entire edge lightly over the steel.
4. Bring the knife into position again but with the blade against the top side of the steel, and repeat the same motion of passing the blade over the steel.
5. Alternating the knife from side to side, a dozen strokes will true the edge. Steel your knives as often as necessary to keep their edges straight.

Keep your knives in good condition. Don't let tools with wooden handles stand in water. Hot water soaks into the wood causing it to expand. As the wood dries it shrinks. The handles become loose, the seams are enlarged, and a knife has been ruined. Besides, enlarged seams are unsanitary.

Never throw knives into a drawer with other cutlery or tools. It is a good idea to have a knife rack fastened to some convenient place in the galley or meat cutting shop. If you keep knives in a drawer, secure a wood strip to the bottom of the drawer with slots wide enough for the blade of a knife. This sort of rack keeps unused knives out of the way, and keeps the blades in good condition.

The meat cleaver should be used as little as possible. Unless it is kept very sharp and used properly, it will shatter the bone and drive bone splinters into the surrounding meat. These splinters can be dangerous as well as inconvenient.

The meat hook is a very great aid in boning meat. It saves time and enables the man doing the cutting to get a firm grip on a slippery piece of meat. It also lessens the risk of cutting fingers while boning a piece of meat.

For every meat saw in the galley, there should be at least three blades. If there are always two blades, properly set and sharpened, in addition to the one in use, considerable time and effort will be saved. When a blade loses its edge and set, it can be immediately replaced.

FOR YOUR SAFETY

To prevent accidents, use the safety devices on galley and meat cutting equipment as directed. Keep your equipment operative at all times. Report defects promptly, via chain of command, to the engineering department.

Of course, all manner of safety devices will not guard against food contamination. Complete cleanliness at all times is necessary. This requires, among other things, diligent care of equipment. When food preparation equipment and utensils are systematically and thoroughly cleaned after each use, the possibility of food contamination and bacterial growth is greatly reduced.

HELP PREVENT FIRE

There is always the danger of a fire breaking out on a fighting ship, with consequent damage to equipment as well as serious injury to personnel aboard. But fires do not occur in war alone. Many shipboard fires have occurred in peacetime. The best way to fight fires is to prevent them.

Warn your men about the kind of matches they bring aboard. Navy regulations say that safety matches ONLY are allowed. Require your men to observe the NO SMOKING sign in galley spaces. The sign is placed there for two reasons—one is for sanitation and the other is for fire prevention.

Clean the canopy over the ranges daily—especially when grilled meats have been prepared. Flames that may reach the canopy from the range won't spread if there is no grease and dirt for them to feed on. Have exhaust fans and ducts over the ranges cleaned at least once a week—oftener if necessary.

Keep galley spaces free of waste materials. Waste paper and rubbish should be deposited in proper receptacles and disposed of promptly.

Do not allow trash to accumulate around electric motors or machines, against steam pipes, or within 10 feet of any range, oven, or fryer, or in places where flammable products (grease) are used or stored.

Inspect regularly fire extinguishers located in galley spaces to see that they are in good working condition. Report those that are faulty to your superior, who will consult with the damage control division concerning their repair or replacement. It is too late to inspect fire extinguishers after a fire starts.

Your men should know how to give the alarm for fires and where firefighting equipment is located, how it is operated, and the principles behind its operation. They should know how to extinguish fires which may occur in galley spaces.

Fires are classified by the Navy into three general kinds, A, B, and C. Your military training courses describe these classes in detail and give appropriate methods for fighting each.

CHAPTER 6

NUTRITION AND MENU PLANNING

Because of the effect of food on morale and welfare, the preparation of adequate, balanced menus is very important. For this reason, the men who prepare the menus in the Navy must know the major nutritive constituents that a man needs to consume and the kinds and quantities of foods that must be served to enable each man to maintain good health. It is the responsibility of the menu planner to provide the right kinds of foods, and foods that men will enjoy eating. Unless eating is a pleasure, men may not eat enough of the foods that will keep them healthy.

As a Commissaryman, it is your job to learn which foods the crew on your ship like and which they do not like. Keep a weather eye out and record which foods bring requests for second helpings and which are rejected on the serving line, and listen to the comments of the crew.

In this chapter you will learn about the major nutrients that are found in the foods that your menus should offer. Knowing the important functions of these nutrients in maintaining health, you will have a better understanding of the need for planning menus that offer good combinations of certain key foods. You will not need to know the quantities of each nutrient furnished by individual foods. Nutritionists have simplified this task for you by grouping all foods according to the functions of the nutrients which they furnish. This chapter will also teach you how to use the "food groups plan" in developing nutritious menus for your crew.

FOOD CONTENT AND HEALTH

Over a period of time everyone should eat many different kinds of foods—not only because a change of menu is pleasant but because different foods make different contributions to health. Nutrients in food act in the body to supply (1) energy, (2) material for growth, (3) material to regulate body functions.

Calories

Food produces energy for the body as fuel produces energy to keep an engine running. The unit used to measure the energy produced by food is called a calorie, which is the amount of heat required to raise the temperature of 1 kilogram of water 1 centigrade or 1 pound of water 4° Fahrenheit. The number of calories a person needs depends upon the amount and kind of work he does, his age and weight, and the climate. The larger a person is, the more calories he will require. A large active boy of 15 may need as much as 5000 calories. An adult man weighing 154 pounds, who does very little physical work, as at a desk job, will need about 2500 calories a day. The same man doing moderately active physical work, as in performing active shipboard duties, will need about 3000 calories. If he is in boot training, he may need 4000 or more. Young men up to 20 years of age generally need about 3800 calories per day. Young sailors should get enough calories to show normal growth. Lack of calories will result in loss of weight, whereas too many calories will cause a person to gain weight.

The adjustment in calories required for tropical, temperate, or frigid areas is made by eating more or less food. No great changes in a GOOD diet need be made, except to increase or decrease the total quantity of food served. When the temperature is low and a sailor is exposed to the weather, his caloric requirements might easily be increased 25 percent or more.

Energy Foods

Proteins, fats, and carbohydrates are known as energy foods.

Proteins.—The most important nutritive elements required by man are proteins. They are body building materials. They build new tissues,

repair old tissues, and regenerate the blood. Certain proteins in the blood give us the means of developing resistance, and sometimes immunity, to disease. Milk, meats, fish, eggs, poultry, legumes (kidney beans, lima beans, lentils, peanuts), cereals, and vegetables are sources of protein and should be included in the daily meal pattern.

Fats.—The fats are the most concentrated source of energy. They are divided into two main groups, vegetable and animal fats. Butter, milk, cream, meat fats, oily or dark colored fish, and egg yolks belong to the animal fat group. The seed and vegetable oils are vegetable fats. Butter, oil, and shortening are readily recognized as fat foods. Fat however, is also blended, incorporated, or absorbed in other foods as for example the fat content of avocados, olives, and nuts. The addition of fat to a meal makes the meal more palatable and satisfying.

Carbohydrates.—The primary source of energy, the most readily digestible, the least expensive, and the most quickly available, are the carbohydrates. Cereals and cereal products, starchy vegetables, sugars, and fruits, are sources of carbohydrates.

Minerals

Minerals are the inorganic constituents of the diet and function in three ways. They are constituents of teeth and bones, giving rigidity and permanence to their structure; they are constituents of all soft tissues; and they influence the irritability of muscles and nerves. Although all minerals are important there are four which must be included daily.

Calcium.—The builder of bones and teeth is calcium. This mineral also contributes to the clotting of blood and regulates or controls normal heart rhythm. It is necessary for normal muscle contraction and nerve irritability. Sources of calcium are milk, cheese, clams, egg yolks, nuts, broccoli, cabbage, cauliflower, mustard greens, and turnip greens.

Milk is the best calcium source. It is almost impossible to supply the amounts of calcium needed unless milk in some form is used daily and cheese and other milk containing products are eaten frequently. Use 1 pint of fresh milk or its equivalent per person per day. If the diet is low in calcium, it is also likely to be low in riboflavin, the B_2 vitamin.

Phosphorus.—Also necessary for building bones and teeth is phosphorus. Milk, cheese, eggs, meat, legumes, nuts, whole grain cereals, and vegetables are good sources of this mineral.

Iron.—Iron is a component of bone and of hemoglobin, which gives the blood its color and which carries oxygen to the tissues. The best source of iron is liver. Liver is "meat deluxe" from the standpoint of nutrition. Other good sources of iron are lean meats, egg yolks, dried legumes, green leafy vegetables, enriched breads and cereals, and molasses.

Iodine.—The human body must have a small but steady amount of iodine to help the thyroid gland work properly. Seafoods are especially rich in this mineral and the salt the Navy buys has enough iodine in it to take care of some of the body's requirements.

Salt is needed by everyone. The need for salt and water is closely related. A person needs about 1 level teaspoon of salt per day and more when he perspires a great deal. The average intake of salt is from 2 to 3 teaspoons daily, which is enough for a person drinking up to about 4 quarts of water. A person who is not getting enough salt will become weak.

Water

Water is not a food but it can be far more important than food. A person can live several weeks without food but will die within a few days without water. About three-fourths of the body is made up of water. Much of this water is lost through perspiration and must be replaced frequently.

The average adult needs about two and one-half quarts of water daily. A large part of this amount is taken in with food, as a large percentage of most foods is water. When a man is working or during hot weather, he may need from 5 to 12 quarts of water daily. Water should be taken into the body as it is desired, since thirst usually serves as an adequate guide to intake, except during illness. When large amounts of water are taken daily, it may be desirable to take extra salt in the form of salt tablets.

Cellulose

Cellulose does not have the function of a food, which is to produce energy; cellulose aids in body activity. It is that woody, fibrous, or semifibrous substance contained in many foods, as for example bran or the soft hemicellulose which is found in fruits and vegetables. Cellulose has been

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called the broom of the human body because by its own mass it shoves along food and body waste which otherwise might become stagnant in the intestines.

Vitamins

Vitamins occur naturally in foods in very minute quantities. They are odorless, tasteless, and invisible to the naked eye. They supply no heat to the body and no body-building elements, but they are indispensable to health and normal body functions.

Some vitamins can be stored in the human body; others cannot and must be supplied every day. Vitamins are usually grouped according to whether they are soluble in water or in fat. The water soluble vitamins, B and C, can be leached out of food that is cooked in water and will be lost unless the water is reserved for use in stews, soups, and sauces. These vitamins cannot be stored in the body and must be supplied every day. The fat soluble vitamins are A, D, E, and K.

B Vitamin Complex.—The B vitamin family has been broken down into at least ten parts. The whole group is called the vitamin B complex. Three vitamins of the complex are emphasized.

THIAMINE (B_1) promotes growth, creates a feeling of well-being, counteracts fatigue, and steadies the nerves. Good sources of thiamine are: lean meat (particularly pork), liver, whole-grain breads and cereals, enriched breads and cereals, legumes, peanuts, and milk.

RIBOFLAVIN (B_2) promotes growth and health. Generally it keeps the eyes, skin, and hair healthy. Good sources are: milk, liver, green leafy vegetables, whole-grain breads and cereals, and enriched breads and cereals.

NIACIN (Nicotinic acid) prevents a disease known as pellagra. It aids in digestion and the health of the skin. The best sources are liver and peanut butter. Lean meats, legumes (peas and beans), whole-grain breads and cereals, enriched breads and cereals.

Vitamin C.—The first vitamin separated from food was vitamin C. It is known as ascorbic acid. This nutrient helps to keep body tissues in good condition. Though not known at the time, a lack of this vitamin in the diet of seamen in the early days of the Navy caused the disease known as scurvy. In time, the Navy found that it could successfully fight the disease with lemon, lime, or orange juice. Tender and bleeding gums, hurting and swelling joints and weakened muscles are usually caused by a lack of vitamin C.

Vitamin C is necessary for the regulation of the heart muscle and muscle tone generally. It is also an important element in the cement substance which holds cells together and properly set in the body.

Since only a very limited amount of ascorbic acid (vitamin C) can be stored in the body, it is essential that you supply generous amounts in the daily diet. All of the familiar citrus fruits are excellent sources, as are various other fruits.

Other good sources of this vitamin are tomatoes, cantaloupes, raw green foods, fresh strawberries, and even potatoes if cooked in their jackets.

Vitamin A.—Milk, butter, cream, cheese, liver, egg yolk, leafy green and yellow vegetables, yellow fruits, cod liver oils, and other fish liver oils contain vitamin A.

Vitamins help to protect the body against infection and vitamin A's guard duty is to help keep the skin and the lining of the nose, mouth, eyes, and inner organs in good condition. A lack of vitamin A may cause the mucuous membranes around the eyes to become diseased, and a shortage of this vitamin may cause injury to the respiratory, digestive, or excretory systems.

Shortage of vitamin A in the diet may cause night blindness. Experiments with diets of high vitamin A content for aviators and automobile drivers have proved that the increased amount of vitamin A reduces accidents at night. Industry has also found similar results with workers. As you know, the Navy must constantly be on the alert for night blindness in personnel, particularly those required to stand watch duty. Many naval battles of the past have been started at night because the enemy desired to take advantage of the light conditions and the greater difficulties with vision at that time of day.

Vitamin D.—The direct rays of the sun or suitable ultraviolet rays change substance in the skin to vitamin D, so it is known as the "sunshine vitamin." The exact needs of adults for this vitamin are not known, but a certain amount is necessary for continued maintenance of the structure of the body. Bones are weakened by a lack of vitamin D.

Significant amounts of vitamin D are found in only a few natural foods. Fish liver oils, such as cod, are among the richest sources. Salmon, mackerel, tuna, sardines, beef liver, lamb and pork liver, eggs, butter, cream, and whole milk furnish small amounts.

Vitamin E.—Essential to growth, vitamin E is found in meat, milk, butter, grains, and vegetables.

Vitamin K.—A key element in the clotting of blood is vitamin K. Spinach and leafy vegetables such as cauliflower and turnip greens are good sources of this vitamin.

Figure 6-1 presents summary information about vitamins. This information will be valuable to you in making and analyzing menus, and also in conserving vitamins during cooking. The "stability," as used in the illustration, refers to the ability of the various substances to withstand destruction under the conditions mentioned.

THE NAVY RATION LAW

The first Navy Ration Law is found in an Act of Congress passed in 1794 which provided for a daily fixed allowance of food items for each day of the week. A typical day's ration was one pound of hard bread, one and one-half pounds of salt beef and one-half pint of rice. Included with this ration was a half-pint of distilled spirits or one quart of beer.

In 1842 the fixed allowance for each day of the week, as provided for in the 1794 Ration Law, was discarded in favor of a more flexible allowance of specified items and permitted substitution.

In 1862, the spirits ration was discontinued. This action was compensated for by a five-cents-a-day pay raise. Fresh meat and dried vegetables and fruit were added to the ration which by that time already included coffee, tea, and sugar. By 1902, the management of the general messes had been assigned to the supply officers of the Navy and it was in this year that the first Navy Cook Book was published.

Chemical Name	A	C	D	Vitamin B Complex		
	Carotene	Ascorbic Acid	Calciferol	Thiamine (B_1)	Riboflavin (B_2)	Niacin
Important food sources	Liver Egg yolk Vegetables Green Yellow Butter Cream Fish-liver oil	Citrus fruits Cabbage Tomatoes Cantaloupes Strawberries Potatoes in jackets	Fish-liver oil Butter Egg yolk Liver	Pork Liver Organ meats Nuts Legumes Whole wheat Whole grains	Liver Meats Eggs Milk Enriched bread Vegetables Green Leafy	Meat Fish Poultry Liver Green peas
Stability: cooking drying light	Gradual destruction by exposure to heat and drying at high temperature.	Unstable to heat and oxidation, except in acids. Destroyed by drying and aging.	Stable to heating, aging and storing.	Unstable to heat and oxidation.	Stable to heat in cooking, to acids and oxidation. Unstable to light.	Stable to heat, light and oxidation, acids and alkalis.
Lack of this vitamin causes	Night blindness; glare blindness Rough, dry skin Dry mucous membrane	Scurvy Sore mouth Stiff joints Sore and bleeding gums Weak-walled capillaries	Rickets Soft bones Bowed legs Poor teeth Skeletal deformities	Beriberi (man) Poor appetite Constipation Fatigue	Eye sensitivity Cataract	Pellagra

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Figure 6-1.—Summary of information on vitamins.

One hundred years after the establishment of the first Navy Ration Law, the great improvements are illustrated by the following:

SEA ROUTINE BILL OF FARE,
U.S.S PORTSMOUTH, 1894

	Breakfast	Dinner	Supper
Monday	Beans	Bean soup	Canned mutton
Wednesday	Coffee	Salt port*	Dried apples
Saturday	Hardtack Black molasses	Hardtack Coffee	Tea Hardtack

*Wednesdays at dinner yellow pea soup was served for a change.

Tuesday	Cracker hash Coffee Hardtack	Salt horse Corn pone Hardtack Coffee	Scouse Molasses Hardtack Tea
Thursday	Prunes Hardtack Molasses Coffee	Plum duff Salt horse Hardtack Coffee Molasses	Cracker hash Tea Hardtack Molasses
Friday	Cracker hash Hardtack Coffee Molasses	Salt horse Corn bread Hardtack Molasses Coffee	Scouse Hardtack Molasses Tea
Sunday	Cooked dried apples Hardtack Coffee Molasses	Plum duff Salt horse Coffee Hardtack Molasses	Cracker mutton Hash Tea Hardtack Molasses

The molasses was of the old-fashioned black strap kind, thick and heavy. The hardtack was really HARD. The coffee was weak enough to prevent the crew from getting nervous. (The bottom of the coffee pot was always to be seen when it was full.) The salt horse and pork came in large barrels and when opened (to leeward) the smell was hot. It generally was put in small cargo nets and towed overboard to get the rock salt and smell out of it. (Sharks never disturbed it.) On bean and pea soup days, enough was generally made to have enough for soaking hardtack to make scouse. When in port the crew generally fared pretty well, as they could get fresh food and vegetables but never cake and rarely butter. Meals generally consisted of stews, soups, meats, and potatoes. Fruit had to be bought from bumboats by the crew as it was rarely served in the mess. The ration was approximately $9 a month per man. The sea ration was all they had on the trip from Newport, R.I., to Queenstown, Ireland, 16 days; and 42 days from Funchal, Madeira to Newport; fresh vegetables and meats could not be carried beyond 2 or 3 days.

In 1933, the present Navy Ration Law became effective. It increased the allowance of vegetables, milk, and fruit while decreasing the allowance of meat. This ration law has remained unchanged to the present time except for the addition of vegetables and fruit juices and enrichment of flour with vitamin B_1, niacin, iron and enriched yeast.

The present Navy Ration Law is authorized by the Congressional Act of 2 March 1933 (47 stat. 1423), as amended (34 U.S. Code 902a). The Navy Ration is a quantity allowance of food. Each person, so entitled, may be served the following quantities of food each day:

- 8 ounces biscuit, or 12 ounces soft bread, or 12 ounces flour
- 12 ounces preserved meat, or 14 ounces salt or smoked meat, or 20 ounces fresh meat or fresh fish or poultry
- 12 ounces dried vegetables, or 18 ounces canned vegetables, or 44 ounces fresh vegetables
- 4 ounces dried fruit, or 10 ounces canned fruit, or 6 ounces preserved fruit, or 16 ounces fresh fruit, or 6 ounces canned fruit or vegetable juices or 1 ounce of powdered fruit juices or $^{6}/_{10}$ of an ounce of concentrated fruit juices
- 2 ounces cocoa, or 2 ounces coffee or $^{1}/_{2}$ ounce tea
- 4 ounces evaporated milk, or 1 ounce powdered milk, or $^{1}/_{2}$ pint fresh milk
- 1.6 ounces butter
- 1.6 ounces cereals, or rice, or starch foods
- $^{1}/_{2}$ ounce cheese
- 1.2 eggs
- 1.6 ounces lard or lard substitutes
- $^{2}/_{5}$ gill oils, or sauces, or vinegar
- 5 ounces sugar
- Baking powder, and soda, flavoring extracts, mustard, pepper, pickles, salt, sirup, spices, and yeast as required.

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DAILY FOOD REQUIREMENTS

The food we eat each day must supply the proteins, minerals, vitamins, carbohydrates, and fats needed to maintain the body in a healthy state. Most foods contain more than one nutrient, but no single food furnishes all the nutrients in proper quantities. To make it easier to plan menus that will have adequate quantities of all the necessary nutrients, foods are grouped together according to the substances they provide.

The BASIC FOUR foods, as outlined in the plan which follows, designate the minimum number of servings of each group which meet the needs of the body and form the foundation for a good diet (see fig. 6-2). To round out meals and to satisfy the appetite, more of these foods are used, and foods not specifically mentioned may be used—butter, other fats, oils, sugars, and unenriched grain products. These other foods are frequently combined with suggested foods in mixed dishes, baked goods, desserts, and other recipe dishes. Fats, oils, and sugars, are also added to many foods during preparation, and when served, enhance flavor and improve appetite appeal.

Each of the food groups listed has a special job to do in helping toward an adequate diet. In the number of servings specified and with the choices indicated, these foods grouped together furnish all, or a major share, of the calcium, protein, iron, vitamins A and C, and the B vitamins recommended. Other minerals and vitamins as well as fats and carbohydrates are also provided.

The Basic Four

The Basic Four groups are:

- Group I —Milk
- Group II —Meat
- Group III—Vegetables and fruit
- Group IV—Bread-cereals

Three of the four food groups furnish one key food value each plus additional value.

The milk in Group I furnishes calcium plus proteins and vitamins. The meat in Group II furnishes protein plus minerals and vitamins. The vegetables and fruits in Group III furnish vitamins A and C and some of most other food values. The fourth group, bread-cereals, furnishes many of the B vitamins plus protein, iron, and calories. Additional amounts of food values and needed calories are supplied by other foods.

Group I: Milk.—Milk is used in many forms—fluid, whole, evaporated, skim, dry, buttermilk, and all types of cheese (cottage, cream, cheddar-type, natural or processed). Two or more cups of milk a day are the basic requirement. Cheese and ice cream may replace part of the milk. The amount of milk is figured on the basis of calcium content. Common portions of various kinds of cheese and ice cream, and their milk equivalents in calcium are:

1 inch cube cheddar type cheese	= $^2/_3$ cup of milk
$^1/_2$ cup cottage cheese	= $^1/_3$ cup of milk
2 tablespoons cream	= 1 tablespoon of milk
$^1/_2$ cup ice cream	= $^1/_4$ cup of milk

Group II: Meat.—Included in the meat group are beef, pork, veal, lamb, rabbit, and meat products, fish, shellfish, eggs, and as alternates, dried beans, peas, nuts, peanuts and peanut butter. Two or more servings are required every day. You may count as a serving, 2 to 3 ounces of lean cooked meat, poultry or fish, or 2 eggs or 1 cup of cooked dry beans or 4 tablespoons of peanut butter.

Group III: Vegetables and Fruits.—Included in this group are all vegetables and fruits. The Basic Four guide emphasizes those that are valuable as sources of vitamin C and vitamin A. Sources of vitamin C are divided into groups, Good Sources and Fair Sources.

Good Sources	Fair Sources
Grapefruit or grapefruit juice	Honeydew melon
Orange or orange juice	Tangerines
Cantaloupes	Watermelon
Mangoes	Asparagus
Papaya	Brussels sprouts
Raw strawberries	Raw cabbage
Broccoli	Collards
Green peppers	Garden cress
Sweet red peppers	Kale
	Kohlrabi
	Mustard greens
	Potatoes and sweet potatoes cooked in jacket
	Spinach
	Tomatoes or tomato juice
	Turnip greens

Sources of vitamin A are dark-green and deep-yellow vegetables and a few fruits, namely:

Apricots	Kale
Broccoli	Mangoes
Cantaloupes	Pumpkin
Carrots	Spinach
Chard	Sweet potatoes
Collards	Turnip greens and other deep green leaves
Cress	Winter squash

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FOOD FOR FITNESS

A Daily Food Guide

MILK GROUP

SOME MILK FOR EVERYONE

CHILDREN UNDER 9 . 2 TO 3 CUPS
CHILDREN 9 TO 12 . . 3 OR MORE CUPS
TEENAGERS. . . . . 4 OR MORE CUPS
ADULTS. . . . . 2 OR MORE CUPS

MEAT GROUP

2 OR MORE SERVINGS

BEEF, VEAL, PORK, LAMB, POULTRY, FISH, EGGS

AS ALTERNATES–
DRY BEANS, DRY PEAS, NUTS

VEGETABLE FRUIT GROUP

4 OR MORE SERVINGS

INCLUDE–
A CITRUS FRUIT OR OTHER FRUIT OR VEGETABLE IMPORTANT FOR VITAMIN C
A DARK-GREEN OR DEEP-YELLOW VEGETABLE FOR VITAMIN A–AT LEAST EVERY OTHER DAY
OTHER VEGETABLES AND FRUITS, INCLUDING POTATOES

BREAD CEREAL GROUP

4 OR MORE SERVINGS

WHOLE GRAIN, ENRICHED, OR RESTORED

PLUS OTHER FOODS AS NEEDED TO COMPLETE MEALS AND TO PROVIDE ADDITIONAL FOOD ENERGY AND OTHER FOOD VALUES

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Figure 6-2.—Basic Four Food Groups.

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Plan to include 4 or more servings every day including:

1 serving of a good source of vitamin C or 2 servings of a fair source

1 serving, at least every other day, of a good source of vitamin A.

The remaining 1 to 3 or more servings may be any vegetable or fruit, including those that are valuable for vitamin C and vitamin A.

Group IV: Bread and Cereal.—Foods included in this group are breads and cereals that are whole grained, enriched, or restored. Specifically, this group includes: breads, cooked cereals, ready-to-eat cereals, cornmeal, crackers, flour, grits, macaroni, spaghetti, noodles, rice, rolled oats, and quick breads and other baked goods if made with whole grain or enriched flour.

Plan to include 4 servings or more each day, and if no cereals are to be served, allow an extra serving of bread or baked goods which will make at least 5 servings for this group daily.

You may count as a serving, 1 slice of bread or 1 package of ready-to-eat cereal or $^1/_2$ to $^3/_4$ cup cooked cereal, cornmeal, grits, macaroni, noodles, rice, or spaghetti.

MENU PLANNING

As you advance, you will be assigned more responsibility for planning menus for the general mess. A well-planned menu is the first step in assisting the cook in preparing and serving meals which, in addition to being well balanced and nutritious, also appeal to the appetite. Foods appeal to the appetite through color, flavor, texture, and variety of form. Good tasty meals are taken for granted by the men and they will expect to get them.

Any cook may on occasion serve a meal that isn't popular but the good cook will determine what is wrong, and not make the same mistake again. Careful planning will help eliminate unpopular meals.

Planning Attractive Menus

Color contrasts are important. Too many foods of the same color in any one meal make that meal uninteresting. Salads made of fresh vegetables, fruit, or a combination of fruits and vegetables, provide good color contrast. Carrots or yams will provide good color contrast with a meat course and a green vegetable or salad, but avoid carrots and yams together. Serve cauliflower when other dishes are colorful, not with creamed chicken and mashed potatoes.

Flavor is also important and again contrasts are necessary. Foods that have contrasting flavor tempt the appetite. The use of sour or sweet pickles, condiments (mustard, catsup, chile sauce, etc.), spices, and seasonings helps to provide these contrasts. Flavor and aroma are so closely linked in our minds that if food smells good it also tastes good. The aroma of meat cooking, eggs frying or coffee brewing puts men in the right mood for eating. Do everything you can to make the odor of the food agreeable.

Contrasts in the form and texture of food make it more appetizing. For instance, with creamed sea food over rice, you might serve broccoli or green beans, providing contrast in texture, form, and color.

Variety is the spice of life, and very important in cooking. Anyone gets tired of eating the same kind of food over and over no matter how good that food tasted the first time. Try to avoid repeating a menu too frequently.

The season of the year also affects the menu, both in the type of food available and the best types of food to eat.

Using Ration-Dense Foods

Another consideration for the menu planner is the use of ration-dense foods. These are concentrated, prefabricated, compressed, precooked, and frozen foods from which waste and replaceable substance have been removed. Their work-saving, time-saving features are important assets when developing a menu.

Standard Menu Format

In planning a menu you should use the following standard format:

Breakfast	Dinner and Supper
Fruit	Soup
Cereal	Meat
Milk	Gravy, sauce, or condiments
Eggs or substitute	Potatoes or substitute
Sweet rolls and/or toast	Other cooked vegetables
Butter—jam or jelly	Salad or relishes
Coffee	Bread or rolls
	Butter
	Dessert
	Beverages

You will note that there is a standard sequence in which food items are listed at each meal.

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MENU DRAFT

NAV. S. AND A. FORM 1092 (REV. 8-59)

	MONDAY	RECIPE	TUESDAY	RECIPE	WEDNESDAY	RECIPE	THURSDAY
BREAKFAST	CHILLED ORANGE JUICE (F)		CHILLED GRAPEFRUIT JC (INST)		CHILLED FRESH NECTARINE		CHILLED ORANGE JUICE (INST)
	Assorted ready-to-eat cereal		Assorted ready-to-eat cereal		Assorted ready-to-eat cereal		Assorted ready-to-eat cereal
			OR OATMEAL	E			
	Fresh milk		Fresh milk				
	SCRAMBLED EGGS	F14	CREAMED DRIED BEEF	J		F17	EGGS, ANY STYLE, TO-ORDER
	CRISP BACON SLICES	J1	ON CRISP TOAST POINTS			Q56	CRISP BACON SLICES
	GLAZED YEAST RAISED		HOT TOAST		QUICK COFFEE CAKE	C9	HOT CRACKED WHEAT TOAST OR
	DOUGHNUTS	C35, 18	BUTTER		W/STREUSEL TOPPING	I26	HOT PLAIN TOAST
	HOT						BUTTER
	BUTT						
	Jelly		Jam				Jelly
	Coffee		Coffee		Coffee		Coffee
DINNER	CHICKEN NOODLE SOUP (DEHYD)		OVEN ROAST OF BEEF, AU JUS	J4	SAUERBRATEN CUBES	J12	ONION SOUP (DEHYD)
	TOAST STICKS	C41	FRANCONIA POTATOES	Q46	SAUERBRATEN NATURAL GRAVY		PARMESAN CROUTONS
	BRAISED PORK CHOPS	J94	BUTTERED BROCCOLI (F) OR	Q12	HOT GERMAN POTATO GRIDDLE		CHICKEN TETRAZINNI (CN)
	BROWN PORK GRAVY	O7	BUTTERED CREAM STYLE CORN (CN)	Q-01	CAKES	C34	SOUTHERN STYLE WAX BEANS (CN)
	BAKED POTATO PUFF	Q50	OLD FASHIONED LETTUCE SALAD	M21	BUTTERED FRESH CARROTS	Q18	TOSSED VEGETABLE SALAD
	BUTTERED MIXED VEGETABLES (F)	Q80	ASSORTED BREADS	C15, 16	FRUIT SALAD ON LETTUCE	M2	W/GARLIC FRENCH DRESSING
	PEACH SLICES (CN) W/COTTAGE		BUTTER		W/FRUIT FRENCH DRESSING	M53	FRENCH BREAD
	CHEESE ON LETTUCE				BROWN AND SERVE POPPY		BUTTER
					SEED ROLLS	C22	
					CRACKED WHEAT BREAD	C15	
					BUTTER		
			CHILLED SWEET CHERRIES (CN)		MARBLE CAKE	D2	
	Assorted breads	C15, 16					
	Butter						
	STRAWBERRY (F) SHORTCAKE	D2	PEANUT BUTTER COOKIES	D49	W/VANILLA CREAM ICING	I3	BLUEBERRY PIE
	W/WHIPPED TOPPING (DEHYD)		ICED FRUIT BEVERAGE		CHILLED MOCHA MILK	H12	ICED FRUIT BEVERAGE
	Coffee — Tea —		Coffee — Tea — Milk		Coffee — ICED TEA	B4	Coffee — Tea —
SUPPER	CHILI CON CARNE	J37	VEGETABLE SOUP	P8	CHILLED FRUIT JC COCKTAIL	B9	POT ROAST OF BEEF
	W/STEAMED RICE	E1	CRACKERS		ITALIAN VEAL STEAK OR	J115	BROWN BEEF GRAVY
	BUTTERED ASPARAGUS (F) OR	Q1	ASSORTED COLD CUTS:		SWISS STEAK	J15	MASHED POTATOES
	BUTTERED SUMMER SQUASH	Q71	THIN SLICED CORNED BEEF	J26	PARSLEY BUTTERED POTATOES	Q43	CHILLED PICKLED BEETS OR
	SLICED CUCUMBERS AND ONIONS		LIVER SAUSAGE, SWISS CHEESE		HERB BUTTERED PEAS (F)	Q39	BUTTERED MIXED VEGETABLES (F)
	IN SOUR CREAM		FRENCH FRIED POTATOES	Q47	CHEF'S SALAD	M15	SLICED TOMATO SALAD
			CHILLED SAUERKRAUT (CN) OR		W/BLUE CHEESE DRESSING	M49	W/PIQUANT DRESSING
			BUTTERED GREEN BEANS (F)	Q2			
			DILL PICKLE SLICES - RADISHES				
			ASSORTED OLIVES				
			SANDWICH ROLLS	C22			
	CRACKERS		RYE BREAD	C16			
	Assorted Breads	C15, 16			Assorted Breads	C15, 16	Assorted Breads
	Butter		Butter		Butter		Butter
	REVEL ICE CREAM	G35	APPLE (DEHYD) PIE	K7	VANILLA ICE CREAM	G35	PEACH CRISP
	FRUIT BARS	D39			CRY BABY COOKIES	D37	
	Coffee — — Milk ICED TEA	B4	Coffee — ICED TEA	B4	Coffee — Tea —		Coffee — — Milk ICED TEA

STEP 1.
MAIN DISHES, GRAVIES, & SAUCES

STEP 2.
POTATOES, SUBSTITUTES, & VEGETABLES

STEP 3.
SALADS & DRESSING

STEP 4.
BREAKFAST FRUITS & CEREALS

STEP 5.
DESSERTS

Figure 6-3.—Menu Draft.

Week beginning 1ST WEEK OF SUMMER CYCLE MENU

RECIPE	FRIDAY	RECIPE	SATURDAY	RECIPE	SUNDAY	RECIPE
	CHILLED GRAPEFRUIT SEGMENTS (CN)		CHILLED APPLESAUCE (INST)		CHILLED GRAPE JUICE (F)	
	Assorted ready-to-eat cereal		Assorted ready-to-eat cereal		Assorted ready-to-eat cereal OR	
	OR WHOLE WHEAT MEAL	E3			FARINA	E3
	Fresh milk		Fresh milk		Fresh milk	
	HOT FRENCH TOAST	F19	MINCED BEEF	J43	FRIED EGGS, TO-ORDER	F12
J1	W/HOT MAPLE FLAVORED SIRUP		ON CRISP TOAST POINTS		GRILLED THIN HAM SLICES(CN)	J78
C15	BAKED PORK SAUSAGE PATTIES	J100	COTTAGE FRIED POTATOES	Q46	HOT TOAST	
	HOT TOAST		ICE CHAIN TWISTS	C28, I8	BUTTER	
	BUTTER		HOT TOAST			
			BUTTER			
	Jelly				Jelly	
	Coffee		Coffee		Coffee	
	FRENCH FRIED SHRIMP W/	H18	PORK AND NOODLE CASSEROLE	J87	MARYLAND STYLE FRIED	L2
C41	SEAFOOD COCKTAIL SAUCE	C14	OR GRILLED BEEF LIVER	J52	CHICKEN	
L20	HUSH PUPPIES OR	C8	W/CRISP BACON SLICES	J1	CREAM GRAVY	O7
Q2	SWEDISH MEAT BALLS	J48	DUCHESS POTATOES (DEHYD)	Q57	BREAD DRESSING	L22
M33	HASHED BROWNED POTATOES		FRENCH FRIED ONIONS OR	Q34	MASHED POTATOES	Q49
M52	(DEHYD)	Q56	BUTTERED WHOLE GRAIN CORN(F)	Q24	HERB BUTTERED PEAS (F)	Q39
C18	BUTTERED BABY LIMAS (CN)	Q4	CHILLED PICKLED GREEN BEANS	M11	JELLIED SPRING SALAD	
	SWEET GHERKIN PICKLES -				ON LETTUCE	M35
	CARROT STICKS - RIPE OLIVES				W/SALAD DRESSING	
	ASSORTED BREADS	C15,			HOT BISCUITS	C1
	BUTTER					
	ORANGE FRUIT GELATI					
				C15, 16	Assorted breads	C15, 16
			Butter		Butter HONEY	
K12	W/SUNSHINE WHIPPED TOPPING		BANANA SPLIT W/ASSORTED	G35	CHILLED FRUIT CUP	G28
	(DEHYD)		SAUCES	G33, 23, 25	BUTTERSCOTCH BROWNIES	D29
	Coffee — — Milk ICED TEA	B4	Coffee — Tea —		Coffee — — Milk ICED TEA	B4
J9	BOSTON STYLE CLAM CHOWDER	F10	BRAISED BEEF STEAK	J13	GRILLED CHEESEBURGERS	J39
O7	CRACKERS		BROWN BEEF GRAVY	O7	ON TOASTED HAMBURGER BUNS	C22
Q49	GRILLED FRANKFURTERS	J61	HOME FRIED POTATOES	Q46	PARSLEY BUTTERED POTATOES	Q43
Q11	MUSTARD BUTTERED POTATOES	Q43	BUTTERED FRESH CARROTS	Q18	BUTTERED BROCCOLI (F) OR	Q12
Q80	BAVARIAN CABBAGE (DEHYD) OR	Q15	LETTUCE SALAD	M20	BUTTERED MIXED VEGETABLES (F)	Q80
M30	STEWED TOMATOES	Q77	W/CHIFFONADE DRESSING	M50	TOMATO WEDGES - PICKLE	
M57	GARDEN SALAD	M29			RELISH - GREEN OLIVES	
	W/ZESTY FRENCH DRESSING	M52			RYE BREAD	C16
	HOT WIENER ROLLS	C22			BUTTER	
	RYE BREAD	C16				
					BOSTON CREAM PIE	D2
C15, 16			Assorted Breads	C15, 16		
	Butter		Butter			
Q30	PINEAPPLE UPSIDE DOWN CAKE	D18	BLACKBERRY (F) PIE	K11	W/INSTANT VANILLA PUDDING	
					CHILLED LEMONADE	B7
B4	Coffee — Tea —		Coffee — — Milk ICED TEA	B4	Coffee — Tea —	

STEP 6.
BREADS, SPREADS, & BREAKFAST PASTRIES

STEP 7.
SOUPS & BEVERAGES

The Menu Draft

The menu draft form (see fig. 6-3) allows for a 7-day menu plan. It is better management, however, to plan menus for 2 weeks or more.

There is no single way and no definite sequence of steps to be followed by all menu planners. Most meals are planned around the meat as the main dish, and other food items are selected to go along with the main dish. The step method listed below is suggested. Each step is followed across the draft form horizontally.

STEP 1. Main dishes, gravies, sauces, and accompaniments
STEP 2. Potatoes, potato substitutes, and vegetables
STEP 3. Salads and dressings
STEP 4. Breakfast fruits and cereals
STEP 5. Desserts
STEP 6. Breads, spreads, and breakfast pastries
STEP 7. Soups and beverages

At this point you will recognize that the daily menu is a plan for the day. With this in mind, the drafted menu should be reviewed and analyzed, asking these questions: Did you use authorized and available subsistence items? Did you include the proper amounts of Basic Four foods each day? Can the items be prepared using the equipment in your galley and the number of men on watch to do the work? Can all the foods be ready at the right time? What foods require last minute preparation? Does any meal show items that require a hot and a slow oven at the same time? Is the menu attractive in color, flavor, and texture contrast? Is there sufficient variation from previous menus to avoid monotony?

When you have decided what foods you will serve, list opposite each item the recipe card number in the Navy-Marine Corps Recipe Service (or your own locally approved recipe). BuSandA Manual requires that you do this, and you will find that the listing helps in several ways. Chiefly, it makes clear to everyone concerned exactly what you plan to serve and thus avoids misunderstandings. From these listings the jack-of-the-dust can conveniently assemble the recipe cards which will be his guide in planning breakouts.

When you understand the "hows" and "whys" involved in planning the menu, you will appreciate the important role that it plays in promoting efficient mess operations. Food Operations Reference Manual, NavSandA Publication 421, discusses in detail all aspects of writing menus. The publication Navy Food Service, which is mailed to all food service officers each month, includes a suggested menu. Both of these publications should be carefully studied by every Commissaryman. Navy Food Service, in addition to the suggested menu, publishes pertinent instructive information and guides concerning subsistence items, food preparation, and serving hints.

CHAPTER 7

EXPENDITURE OF SUBSISTENCE ITEMS

In chapter 4 of this text you learned about storage and care of subsistence items. Now let us see how all these subsistence items are moved from their storage spaces to the galley where they are used.

The nonperishable items are issued by the Storekeeper or a Commissaryman in charge of the bulk storeroom to the jack-of-the-dust in charge of the issueroom. The jack-of-the-dust then issues the nonperishable items to the galley as needed.

The senior butcher prepares and issues the meats to the galley directly from the cold storage compartment. The spud coxswain supplies the galley with fresh and frozen fruits and vegetables. Figure 7-1 shows how this system operates. On larger ships and stations a Commissaryman or Storekeeper is in charge of the refrigerated spaces and issues subsistence items to the butcher shop, galley, vegetable preparation room, and bake shop as required.

HOW MUCH SHALL BE ORDERED?

How does the cook in the galley know what and how much to order? The kind of subsistence items ordered is based on the menu for the day, as set up in the General Mess Menu (S. and A. Form 1080).

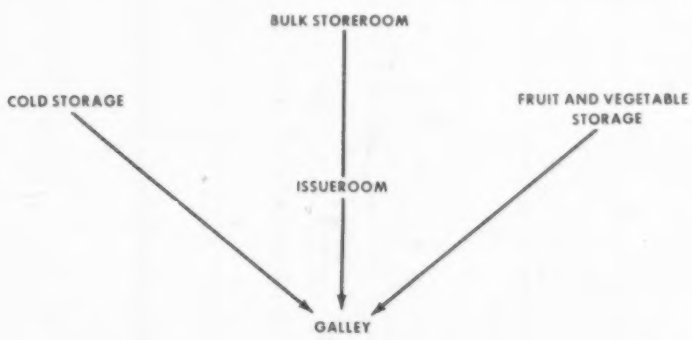

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Figure 7-1.—How subsistence items get to the galley.

The amount ordered depends on the number of men to be fed in the general mess. This number is estimated from the Personnel Recapitulation and Mess Ration Credit (S. and A. Form 27), submitted by the executive officer or personnel officer. (See fig. 7-2.)

Suppose the menu calls for Salisbury steaks. First look up the recipe for Salisbury steak in your Navy-Marine Corps Recipe Service. Recipe card J-45 states that you need 29 pounds of ground beef to feed 100 men. Suppose you're feeding 60 men. You need $^{60}/_{100}$ or six-tenths of 29 pounds of ground beef.

$$^{6}/_{10} \times 29 = {}^{174}/_{10} = 17.4 \text{ lbs}$$

Ration of your mess to 100 men

Pounds needed per 100 men

Pounds needed for your mess

Suppose 89 men eat in your general mess. What then? When the number cannot be changed to a simple, easy to handle fraction, do the problem this way: multiply the number of men to be fed by the recipe AMOUNT.

$$89 \times 29 = 2581$$

Number of men

Pounds needed per 100 men

Pounds needed, uncorrected as to decimal place

Then place a decimal point in front of the second number from the right and you get 25.81. You make it 26 pounds of ground beef on your order.

If you have difficulty in working out the amounts that are needed, you will do well to get a copy

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PERSONNEL RECAPITULATION AND MESS RATION CREDIT
NAV. S. AND A. FORM 27 (REV. 1-62)

[X] DAILY [ ] MONTHLY

BUSANDA 4061-6

ACTIVITY (Name and location): U. S.S. DUARTE (DD 901)

ACCT'G NO.:

DATE OR PERIOD: 1 March 19—

TYPE PERSONNEL	PERSONNEL RECAPITULATION: ALLOWANCE	PLUS SUPER-NUMERARIES	LESS COMMUTED	LESS LEAVE	LESS OTHER*	NET RATIONS ALLOWED	GENERAL MESS RATION CREDITS: NUMBER MEALS SERVED: BREAKFAST	DINNER	SUPPER	CONVERSION FACTOR	RATION CREDIT	TOTAL CREDIT
NAVY	240		6	4		230						
NAVAL RESERVE†												
MARINE CORPS												
MARCORPS RESERVE (Inactive)												
COAST GUARD												
ARMY‡												
AIR FORCE‡												
‡												
TOTALS	240					230						

NUMBER OF RATIONS SOLD FOR CASH

GRAND TOTAL

VALUE OF STOCKS RECEIVED — — — — — — — — — — — — ‡

* Specify
† Specify type as Enlisted, NROTC, or ROC (Newport, R.I. only)
‡ A separate monthly S. and A. 27 will be prepared for this type personnel and the CERTIFICATION, on the reverse side, will be completed.

J. A. Smith
J. A. SMITH, LT, USN
EXECUTIVE OR PERSONNEL OFFICER (Signature)

COMMISSARY OFFICER (Signature)

EXECUTIVE OFFICER (Signature required on monthly report only)

66.30

Figure 7-2.—Personnel Recapitulation and Mess Ration Credit (NavSandA Form 27).

COMMISSARYMAN 3 & 2

DATE 8 8 9 4
0550

of the Navy Training Course, Mathematics, volume 1, NavPers 10069-B, and review those sections that deal with fractions and decimals.

Another Example

The menu calls for grilled steaks or chops. There are 1778 men to be fed. How much meat, boneless (steaks or chops), is needed? According to the recipe card J-5, 47 pounds are needed for 100 men. So, you multiply:

1778 x 47 = 83,566

Number of men

Number of pounds needed for 100 men

Pounds needed, uncorrected as to decimal place

Now place a decimal point in front of the second number from the right, and you get 835.66. You should request 836 pounds of steaks or chops.

ISSUEROOM RECORDS

The general mess issueroom is maintained as a current supply storeroom containing small lots of subsistence items drawn from the bulk storeroom and/or partial (broken) cases of subsistence items for issue to meet the demands of the menu.

A record kept on a stock tally card system may be used to account for stocks on hand in the issueroom.

If you are serving as jack-of-the-dust, you can use these stock tally cards to keep tab on the stock available for daily galley issues, to record breakouts of subsistence items cleared through the issueroom, and to aid in the quarterly inventory. It is recommended that a permanent, individual set of stock tally cards be maintained for all subsistence items in each bulk storeroom.

When you place requisitions for subsistence items, you should make reference to the Federal Stock Numbers listed in the Federal Supply Catalog, Federal Supply Classification Group 89, Subsistence. Subsistence items are usually requisitioned from Navy Supply Centers, depots, and other Navy ships on a DOD Single Line Item Requisition System Document (Manual) (DD Form 1348). See figure 7-3. Some commands may require the use of a Requisition and Invoice/Shipping Document (DD Form 1149) for the requisitioning of perishable subsistence items.

A Stock Tally is shown in figure 7-4. Notice that the description of the article is complete. After the supply officer establishes HIGH and LOW limits for an item of stock, enter the limits on the stock tally card. Thereafter, check these limits frequently to determine when replenishment action is necessary. In making your decision about replenishment action, take into consideration LEAD TIME—the probable time BETWEEN THE

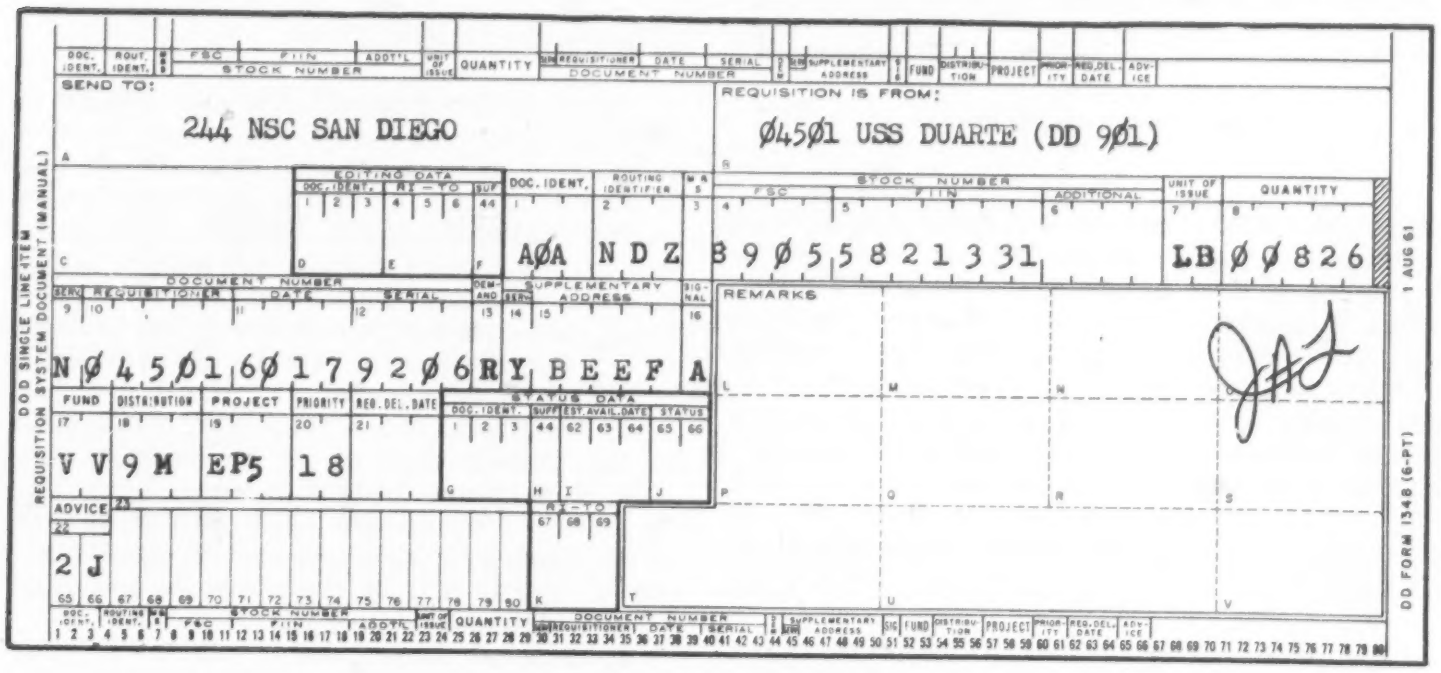

Figure 7-3.—DD Form 1348.

43.24

8915-221-0361 (Stock Number) | Can (Unit)

DESCRIPTION: TOMATOES, Canned, No. 303 size can | UNIT PRICE: .10

LOCATION: A-40

REMARKS:

HIGH LIMIT: 2250

LOW LIMIT: 744

DATE	REC'D	ISSUED	BALANCE	DATE	REC'D	ISSUED	BALANCE
7/1	1200		1200				
7/6	1082		2282				
7/6		48	2184				
7/13		96	2088				
7/18		72	2016				
7/26	240		2256				

STOCK TALLY—NAV. S. AND A. FORM 209 (REV. 6-51)

Figure 7-4.—Stock Tally. 24.22

DATE OF ORDER and the DATE OF RECEIPT of material. If you do not do this, occasionally you will come up short on essential subsistence items. When subsistence items are received, indicate the amount received in the "received" column and add this amount to the previous balance to get the new balance. When subsistence items are issued, indicate the amount issued in the "issued" column and subtract this amount from the last balance to get the new balance. Receipts and expenditures should be posted immediately as they occur.

TYPES OF EXPENDITURES

Expenditures of subsistence items normally are made by breakouts, issues to the general mess, transfers, sales to authorized messes, or surveys. The following paragraphs give a general idea how this is accomplished.

Breakouts

Breakouts of subsistence items should not be made from the bulk storeroom, issueroom, or the consolidated bulk-and-issue storeroom without prior written approval of the food service officer or other person designated by the food service officer.

Requests for breakouts from the above spaces are made on a Request for Issue or Turn-in (DD Form 1150) or a Subsistence Report (S. and A. Form 1059-1), prepared in triplicate. (See fig. 7-5.) The accomplished form must be signed by both the bulk storeroom or consolidated bulk and issueroom Storekeeper or the person to whom the issues are made.

After the form has been properly signed, distribute the original and two copies as follows:

1. Return the original to the supply office, where it is retained under lock and key by the food service officer.
2. Retain the duplicate in the bulk storeroom or consolidated bulk and issueroom for posting to the appropriate Stock Tally (S. and A. Form 209).
3. The triplicate is retained by the issueroom Storekeeper (jack-of-the-dust) for posting to the appropriate S. and A. Form 209, or it is retained by the senior Commissaryman for reporting issues to the general mess.

Issues to the General Mess

Issues to the general mess are authorized by the food service officer or other person designated to perform such duties. All of the issues should be supervised by the senior Commissaryman or another enlisted person designated to perform such duties. Every morning the senior Commissaryman submits a Subsistence Report (S. and A. Form 1059-1) to the food service officer, reporting all issues to the general mess for the previous day.

Issues to the general mess are posted to the:

1. Issueroom Stock Tally (S. and A. Form 209) by the jack-of-the-dust as transactions occur.
2. Subsistence Ledger (S. and A. Form 335) by the office Storekeeper as transactions occur.
3. Record of Receipts and Expenditures (S. and A. Form 367) by the office Storekeeper at the end of the accounting period only.
4. General Mess Control Record (S. and A. Form 338). Using a fixed price list established by the Navy Subsistence Office, the office

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SUBSISTENCE REPORT
NAV. S. AND A. FORM 1059-1 (Rev. 4-63)

CHECK APPROPRIATE BOX: ☐ GENERAL MESS ISSUES REPORT ☐ INVENTORY ☒ BREAKOUTS TO (Specify) ISSUE ROOM ON (Date) 1/12/—

ACTIVITY: U.S.S. QUARTE | ACCOUNTING NO.: Ø4981 | PERIOD COVERED: TO | DATE:

ITEM	U	C/T	QUANTITY	UNIT PRICE	VALUE
MEAT, POULTRY, AND FISH					
Bacon, slab	lb	01			
Bacon, sliced, prefried, 22 oz can	cn	02			
Bacon, sliced, frozen	lb	03	25		
Beef, boneless, 6-way	lb	04	84		
Beef, corned, 6 lb can	cn	05			
Beef, corned, chilled or frozen	lb	06			
Beef, dried, fzn, sliced	lb	07			
Beef, liver, sliced, preformed	lb	08			
Beef, liver, unsliced	lb	09			
Beef, w/gravy, 29 oz can	cn	10			
Bologna, chilled or frozen	lb	11			
Cervelat, chilled or frozen	lb	12			
Chicken, boned, 29 oz can	cn	13			
Chicken, deby., #10 can	cn	14			
Chicken, broiler-fryer, cut-up	lb	15			
Chicken, broiler-fryer, whole	lb	16			
Chicken, hen, whole	lb	17			
Clams, cnd, minced	lb	18			
Clams, frozen	lb	19			
Cod, fillets	lb	20			
Duck, whole	lb	21			
Flounder, fillets	lb	22			
Frankfurters, 22 oz can	cn	23			
Frankfurters, chill/frozen	lb	24			
Haddock, fillets	lb	25			
Halibut, steaks	lb	26			
Ham, chunks, 30 oz can	cn	27			

ITEM	U	C/T	QUANTITY	UNIT PRICE	VALUE
DAIRY FOODS AND EGGS					
Butter, prints, regular	lb	01			
Butter, prints, donated	lb	02			
Butter, patties, regular	lb	03	5		
Butter, patties, donated	lb	04			
Buttermilk, fresh	gl	05			
Cheese, blue-veined, natural	lb	06			
Cheese, cheddar, natural	lb	07	5		
Cheese, cheddar, processed, 5 lb loaf	lb	08			
Cheese, cheddar, processed, #10 can	cn	09			
Cheese, cottage, plain or creamed	lb	10	5		
Cheese, grated, Parmesan & Romano, 3 oz	co	11			
Cheese, Swiss, natural	lb	12			
Cheese, Swiss, processed, 5 lb loaf	lb	13			
Chocolate milk, past.	gl	14			
Chocolate milk, ster. #10 can	cn	15			
Cream, dry, coffee/table size 24% – 4 oz	cn	16			
Cream, fresh, past., whipping	gl	17			
Cream, stab. ster. whipping, qt	co	18			
Eggs, whole, dried, pwd., #2½ can	cn	19			
Eggs, whole, dried, pwd., #10 can	cn	20			
Eggs, whole fzn, bakery type, 30 lb can	lb	21			
Eggs, whole fzn, table type, 10 lb can	lb	22			
Eggs, shell, fresh	dz	23			
Egg white, frozen, 30 lb can	lb	24			
Egg yolk, frozen, 30 lb can	lb	25			
Ice cream, RTE	gl	26			
Ice cream, deby. #10 can	cn	27			

ITEM	U	C/T	QUANTITY	UNIT PRICE	VALUE
Pickles, cuc. small, dill, #10 can	cn	49			
Pickles, cuc. dill, 1 gal jar	jr	50			
Pickles, cuc. sweet, #10 can	cn	51			
Pickles, cuc. sweet, 1 gal jar	jr	52			
Pickles, mixed, sweet, #10 can	cn	53			
Pickles, mixed, sweet, 1 gal jar	jr	54			
Poppy seed, 3 – 4 oz cont.	co	55			
Poultry seasoning, 3 – 4 oz cont.	co	56			
Relish, pickle, sweet, #10 can	cn	57			
Relish, pickle, sweet, 1 gal jar	jr	58			
Salad dressing, #2½ can	cn	59			
Salt, table, 5 lb bag	lb	60			
Sesame seed, 3 – 4 oz cont.	co	61			
Soy sauce, 4 – 5 oz bottle	bt	62			
Thyme, ground, 1 – 2 oz cont.	co	63			
Vinegar, cider, 1 qt bottle	bt	64	12		
Vinegar, dry syn. 4 oz flex pkg	pg	65			
Worcestershire sauce, 5 – 6 oz bot.	bt	66	5		
TOTAL					

TOTAL	
Less: Surplus Dairy Products	
Galley Produced Bakery Products Sold	
GRAND TOTAL	

BREAKOUTS
REQUISITIONED BY (Signature, rate, title): B. J. Black CS2
APPROVED BY (Signature, rank, title): J. H. Jacks, LT(JG) SC USN
RECEIVED BY (Signature, rate, title): B. J. Black CS2
ISSUED BY (Signature, rate, title): M. S. Smith CS3

I HEREBY CERTIFY the foregoing to be a true statement of: (Check appropriate box)
☐ INVENTORY ☐ ISSUES TO THE GENERAL MESS
(Signature, rank, title)

NAV. S. AND A. FORM 1059-1 (REV. 4-63) PAGE 4 OF 4 C-1858

Figure 7-5.—Breakouts from bulk storerooms to issueroom.

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Storekeeper posts the total value of issues to the general mess, less the value of galley-produced bakery products sold to private messes.

Familiarize yourself with the S. and A. Form 338. It provides an accurate, cumulative account of the financial status of the general mess. Overissues are immediately visible and can usually be eliminated prior to the end of the accounting period. (See fig. 7-6.)

The S. and A. Form 338 is posted as follows:

Column	Explanation of Entry
1	Day of the month.
2	Number of daily rations allowed. The number of daily rations allowed is taken from the effective Personnel Recapitulation and Mess Ration Credit (NavSandA Form 27).
3	Cumulative total of column 2 for accounting period.
4	Value of subsistence items issued to the general mess. This figure is posted daily from the subsistence reports reflecting actual issues to the general mess. DO NOT include dairy products and the products and the value of sales of galley produced bakery products.
5	Cumulative totals of column 4. This figure reflects the cumulative value of subsistence items issued to the general mess for the accounting period.
6	This is the quotient of column 5 divided by column 3. Here is where you can determine the financial condition of the general mess. Column 6 is another cumulative figure since it reflects the average ration cost as of the current posting. If, for example, your ration allowance is $1.07 and column 6 in figure 7-6 shows an average ration cost of $1.0472 on the 31st of the month, then the general mess is underissued by

GENERAL MESS CONTROL RECORD
NAV. S. AND A. FORM 338
(Revised May 1944)

NAME OF SHIP OR STATION: U. S. S. Duarte (DD 901)
MONTH: March, 19 –

DATE (1)	RATIONS DAILY (2)	RATIONS TOTAL (3)	RATION COST DAILY (4)	RATION COST TOTAL (5)	RATION COST AVERAGE (6)	ALLOWANCE DAILY (7)	ALLOWANCE TOTAL (8)
1	230	13,630	230.80	14,225.10	1.0436	246.10	14,584.10
27							
28	225	19,950	228.80	20,870.30	1.0461	240.75	21,346.50
29	225	20,175	220.25	21,090.55	1.0453	240.75	21,587.25
30	225	20,400	255.40	21,345.95	1.0463	240.75	21,828.00
31	225	20,625	252.60	21,598.55	1.0472	240.75	22,068.75

THE FOOD SERVICE OFFICER WILL DESIGNATE THE NUMBER OF DECIMAL PLACES THIS FIGURE IS TO BE COMPUTED

☆ U. S. GOVERNMENT PRINTING OFFICE : 1944 16—23649-1

10.60

Figure 7-6.—General Mess Control Record.

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124 OF 327

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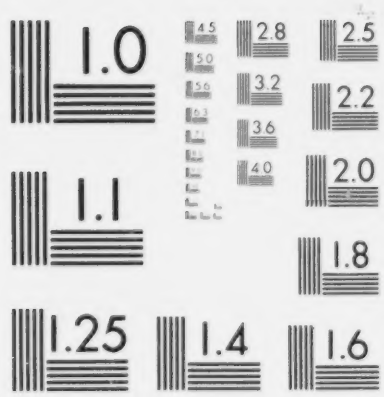

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

Column	Explanation of Entry
6—Continued	
	$.0228 per ration. Now multiply $.0228 by 20,625 (total allowed rations) and you find that the general mess is $470.25 underissued.
7	Column 7 shows the daily monetary allowance. Assuming that the ration allowance is $1.07, multiply $1.07 by column 2. By comparing column 7 with column 4, you can determine the amount of overissue or underissue for any one particular day.
8	This column is the cumulative monetary allowance. Compare column 8 with column 5 and you can determine the net cumulative overissue or underissue.

Notice that while the NavSandA Form 338 is designed to cover only a 31-day period, it is maintained over a quarterly period. All cumulative figures, therefore, run through the end of the quarter and not monthly as the form may imply.

Transfers

Transfers are those expenditure transactions by which the custody of subsistence items passes from one accountable officer to another accountable officer.

Authority to break out subsistence items for transfer to other supply officers from the bulk or consolidated bulk and issue storerooms is a properly approved DOD Single Line Item Requisition System Document (Manual) DD Form 1348, or Requisition and Invoice/Shipping Document (DD Form 1149). Such expenditures must be posted to the Stock Records: S. and A. Form 209 by the bulk storeroom Storekeeper or the jack-of-the-dust, as appropriate; Subsistence Ledger (S. and A. Form 335) by the office Storekeeper; and Record of Receipts and Expenditure (S. and A. Form 367) by the office Storekeeper.

Sales to Authorized Messes

Subsistence items may be sold to private messes when, in the opinion of the food service officer, the sale will not unduly deplete the quantity available for issue to the general mess.

Subsistence items may be sold to the following messes:

1. Flag mess
2. Cabin mess
3. Wardroom mess
4. Warrant officers' mess
5. Chief petty officers' mess

Sales Procedure.—The authorized representative of the private mess prepares, in quadruplicate, a Request for Issue or Turn-In (DD Form 1150) or a Subsistence Report (S. and A. Form 1059-1), as applicable.

All requisitions should bear a serial number. A separate block of numbers may be assigned to each mess so that all requisitions from a mess will be numbered consecutively. The various blocks will comprise one numbering series for the entire ship.

The breakout form must be approved by the mess treasurer or his authorized representative who retains the No. 4 copy. If a person other than the mess treasurer is authorized to approve requests for breakouts, such authority is furnished the food service officer in writing.

After the breakout form has been approved by the food service officer or his authorized representative, the office Storekeeper prices each item with the last receipt unit price at the time of issue. This unit price is used to bill the private mess. Upon receipt of the subsistence items, the mess representative signs the original and two copies of the DD Form 1150 or the S. and A. Form 1059-1, as applicable, which are then distributed as follows:

1. The signed original is returned to the supply officer where it is retained under lock and key by the food service officer until the monthly billing.
2. The signed duplicate is returned to the mess treasurer.
3. The signed triplicate is used for posting to the Stock Tally (S. and A. Form 209) and forwarded to the supply office for posting to the Subsistence Ledger (S. and A. Form 335) and then retained for the record.

Sale of Galley-Produced Bakery Products.—A separate issue document, DD Form 1150, is used by messes to procure galley-produced bakery products from the general mess.

The DD Form 1150 is submitted in triplicate, listing the items and quantities required, and must be approved by the mess treasurer or his designated representative prior to issue approval by the officer accountable for the general mess.

The issue document is priced in the supply or food service office by the office Storekeeper from a price list furnished by the Navy Subsistence Office (see fig. 7-7).

The cost of galley-produced bakery products, which do not appear in the price list, is established

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ITEM	UNIT OF ISSUE	PRICE
Baking powder biscuits	Dozen	$ .09
Bread	Pound	.06
Cake, 3-layer, 10" diameter, iced	Each	.63
Cake, 2-layer, 10" diameter, iced	Each	.44
Cake, 18" x 26" sheet, iced	Each	1.40
Cake, 18" x 26" sheet, iced (cut 50 servings per sheet)	Serving	.03
Cookies	Dozen	.15
Doughnuts, iced	Dozen	.21
Pies, cream, with whipped cream	Each	.38
Pies, fruit, two crust	Each	.42
Rolls and sandwich buns	Dozen	.10
Rolls, sweet, iced	Dozen	.21

48.30

Figure 7-7.—Price list of galley-produced bakery products.

at the local level, using the last receipt invoice price for the basic ingredients.

The distribution of the original and two copies of the DD Form 1150 is the same as for ordinary sales to messes.

Sale of Meat.—As far as possible, fresh meats should be sold in the units in which they are received aboard—beef in quarters or in complete units; veal, semiboneless; and mutton in carcasses. A complete unit is a group of cuts which includes all regular cuts from a carcass. When it is necessary to sell meat in market and small cuts, each special mess should be charged with the appropriate percent of the average cost price. This percent is found in Volumes III, IV, and VIII of the BuSandA Manual.

The following percentages of the issue price apply to sales of portion-cut beef, boneless, frozen, 6-way, effective when this text was written:

	Percent of Unit	Percent of Unit Price
Portion-cut grill steaks	13.50	170
Oven roasts	16.50	130
Portion-cut swiss steaks	11.00	120
Pot roasts	15.00	100
Diced	10.00	90
Ground	34.00	60

For example, if the last receipt unit price of portion-cut beef, boneless, frozen, 6-way is $0.59 per pound, sale of grill steaks is made at 170 percent of $0.59 (1.70 x $0.59) or $1.003 per pound. Rounded off to the nearest cent, the price is $1. If diced beef is sold, the unit price is 90 percent of $0.59 (.90 x $0.59) or $0.5310. Rounded off to the nearest cent, the price is $0.53 per pound.

Payment for Sales to Private Messes.—Monthly, a money value DD Form 1149 is prepared by the food service officer for each mess covering sales of subsistence items. The DD Form 1149 is submitted to the cognizant mess treasurer not later than the twelfth day of the month following the period covered. The applicable issue documents should be listed by document number (fig. 7-8) on the DD Form 1149. You will also notice the money value of galley-produced bakery products is shown separately, listing the appropriate issue documents.

The food service officer collects from the mess treasurer the total amount shown on the invoice. This money is later deposited with the disbursing officer. The disbursing officer acknowledges receipt of the funds on the original invoice and other required copies. The original of the DD Form 1149 is retained by the food service officer for submission with the appropriate returns.

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Surveys

When you come upon spoiled subsistence items or items about which you are doubtful, put them aside immediately so that they will not be used. It may be advisable to tag them. Then notify your food service officer via the senior Commissaryman. If he agrees that the subsistence items are not suitable, he will see that a request for "survey" is made.

What Is a Survey?—In Navy Regulations and the BuSandA Manuals, a survey is regarded as a means of establishing the reason for deterioration or loss of Government property. In the supply department, a survey is most frequently used as a means of accounting for subsistence items which have become unfit for human consumption. No matter what the circumstances may be, the end result of a survey is to provide a method of expending unusable subsistence items from the books.

If subsistence items are missing, a survey is a means of finding out what happened to them. If subsistence items are unfit for human consumption, a survey is for the purpose of investigating how the damage or deterioration occurred, who was responsible, and what should be done with the subsistence items. In either case, the survey is basically a MEANS OF EXPENDITURE.

Types of Surveys.—Surveys may be formal or informal. A FORMAL survey (fig. 7-9) is made by

SHIPPING CONTAINER TALLY → 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

REQUISITION AND INVOICE/SHIPPING DOCUMENT

SHEET NO. 1 | NO. OF SHEETS 1 | 5. REQUISITION DATE | 6. REQUISITION NUMBER

1. FROM: (4501) USS DUARTE (DD 901)

7. DATE MATERIEL REQUIRED | 8. PRIORITY

2. TO:

9. AUTHORITY OR PURPOSE: BuSandA Manual, par. 37415

10. SIGNATURE | 11a. VOUCHER NUMBER AND DATE: N04501/6090/9239

3. SHIP TO - MARK FOR: Cash sale of subsistence items to the wardroom mess

12. DATE SHIPPED | b. 31 March 19—

13. MODE OF SHIPMENT | 14. BILL OF LADING NUMBER

15. AIR MOVEMENT DESIGNATOR OR PORT REFERENCE NO.

4. APPROPRIATION SYMBOL AND SUBHEAD	OBJECT CLASS	EXPENDITURE ACCOUNT (From)	(To)	CHARGEABLE ACTIVITY	BUREAU CONTROL ACTIVITY NO.	BUREAU CONTROL NO.	AMOUNT
1761453.3140		73170	73170	4501	62380		

ITEM NO. (a)	FEDERAL STOCK NUMBER, DESCRIPTION, AND CODING OF MATERIEL AND/OR SERVICES (b)	UNIT OF ISSUE (c)	QUANTITY REQUESTED (d)	SUPPLY ACTION (e)	TYPE CONTAINER (f)	CONTAINER NOS. (g)	UNIT PRICE (h)	TOTAL COST (i)
	Value of galley produced bakery products sold to the wardroom mess during the month of March 1966.		Issue documents 60669201 60779206	60809210				14.50
	Value of other subsistence items sold to the wardroom mess during the month of March 1966.		60609189 60619195 60639200 60659203 60669207 60689209 60709212 60739214 60759216 60779218 60809220 60839223	60859225 60869226 60879228 60887229 60897231 60907233				426.10
	I certify that subsistence items in the amount of $440.60 were sold to the wardroom mess during the month of March 19—. J. A. LASKO, LTJG), SC, USN Food Service Officer							
	I certify that I have received the sum of four hundred forty dollars and sixty cents ($440.60) which amount will be taken up in my statement of accountability for the period 1-31 March 19—. J. A. LASKO, LTJG), SC, USN Disbursing Officer						TOTAL	440.60

16. TRANSPORTATION VIA MAYS OR MSTS CHARGEABLE TO | 17. SPECIAL HANDLING

18. RECAPITULATION OF SHIPMENT: ISSUED BY | CHECKED BY | PACKED BY

TOTAL NO. CONTAINERS	TYPE CONTAINER	DESCRIPTION	TOTAL WEIGHT	TOTAL CUBE
	Symbol 7148 4/4/—			
		← TOTAL →		

19. RECEIPT: CONTAINERS RECEIVED EXCEPT AS NOTED | DATE | BY | SHEET TOTAL
QUANTITIES RECEIVED EXCEPT AS NOTED | DATE | BY | GRAND TOTAL
POSTED | DATE | BY | 20. RECEIVER'S VOUCHER NO.

DD FORM 1 MAR 66 1149 (11 PT) 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

REPLACES EDITION OF 1 MAY 58 WHICH MAY BE USED

ORIGINAL

Figure 7-8.—Billing subsistence items sold to a private mess. 43.3

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SURVEY REQUEST, REPORT AND EXPENDITURE
NAV. S. AND A. FORM 154 (REV. 8-58)

DATE: 2/28/—
NUMBER: N04501/6059/9185

ACTIVITY: (4501) U.S.S. DUARTE (DD 901)

ORIGINATOR (Signature and title): J. A. Lasko
J. A. LASKO, LTJG, SC, USN

REQUEST FOR SURVEY

ITEM	STOCK NO. AND DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL VALUE
1.	MF8910-171-1563 CHEESE, Parmesan (lb)	72	.77	55.44
2.	MF8920-125-9423 FLOUR, Wheat, Hard (100 lb Bag)	2	6.80	13.60
3.	MF8920-125-9459 FLOUR, Wheat, Soft (100 lb Bag)	1	6.80	6.80
4.	MF8920-132-7782 CEREAL, Assorted, Dry (CT)	7	2.25	15.75
5.	MF8920-530-2185 RICE, Parboiled (lb)	180	.11	19.80
6.	MF8925-127-7325 SURGAR, Brown (lb)	48	.13	6.24
			TOTAL	$117.63

REASON FOR SURVEY: NOT FIT FOR HUMAN CONSUMPTION

ACCOUNT IN WHICH CARRIED (AFA, NSA, etc. or nonstores): 73170

OTHER DATA (Source, date of receipt, etc.): Received 2/3/—

ACTION BY COMMANDING OFFICER OR DELEGATE (DATE) 2/28/—

TYPE OF SURVEY: [X] FORMAL [ ] INFORMAL

SURVEY TO BE MADE BY:
1. L. D. Jones
L. D. JONES, LT., USN
2.
3.

SIGNATURE (C. O. or delegate): D. W. Cooper
D. W. COOPER, CDR, USN

SURVEY REPORT AND RECOMMENDATION

CONDITION: WATER DAMAGED

CAUSE: FLOODING AND EXCESSIVE MOISTURE IN DRY STOREROOM

RESPONSIBILITY: NONE

RECOMMENDATIONS: [X] EXP. FROM RECORDS [ ] TRANSFER TO B-270 [ ] TRANSFER TO MAT'L COND. CODE ($_____) (Est. repair cost) [X] TH[illegible] BOARD

ITEM(S) SURVEYED IN ACCORDANCE WITH NAVY REGULATIONS BY: [Signature(s)]
(1) L. D. Jones
L. D. JONES, LT, USN
(2)
(3)

REVIEW OF SURVEY REPORT

[X] APPROVED [ ] DISAPPROVED

SIGNATURE (C. O. or delegate): D. W. Cooper
D. W. COOPER, CDR, USN

DATE: 2/28/—

FORWARD TO (Bureau):

ACCOUNTING DATA

APPROPRIATION: 1761453.3140

EXPEND. ACCOUNT: 99002

BUREAU APPROVAL

DISPOSED OF AS INDICATED

SIGNATURE: J. A. Lasko
(Rank and title) J. A. LASKO, LTJG, USN, SUPPLY OFFICER

DATE: 2/28/—

U. S. GOVERNMENT PRINTING OFFICE: 1958 O—474416

Figure 7-9.—Formal survey - (S. and A. Form 154).

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a commissioned officer appointed by the commanding officer, or by a survey board appointed by the commanding officer. The board consists of three officers, one of whom, and as many as practicable, must be commissioned. Formal surveys are required for certain classes of material or articles designated by the bureau or office concerned. In the absence of instructions by higher authority, the commanding officer determines the type of survey required. When it

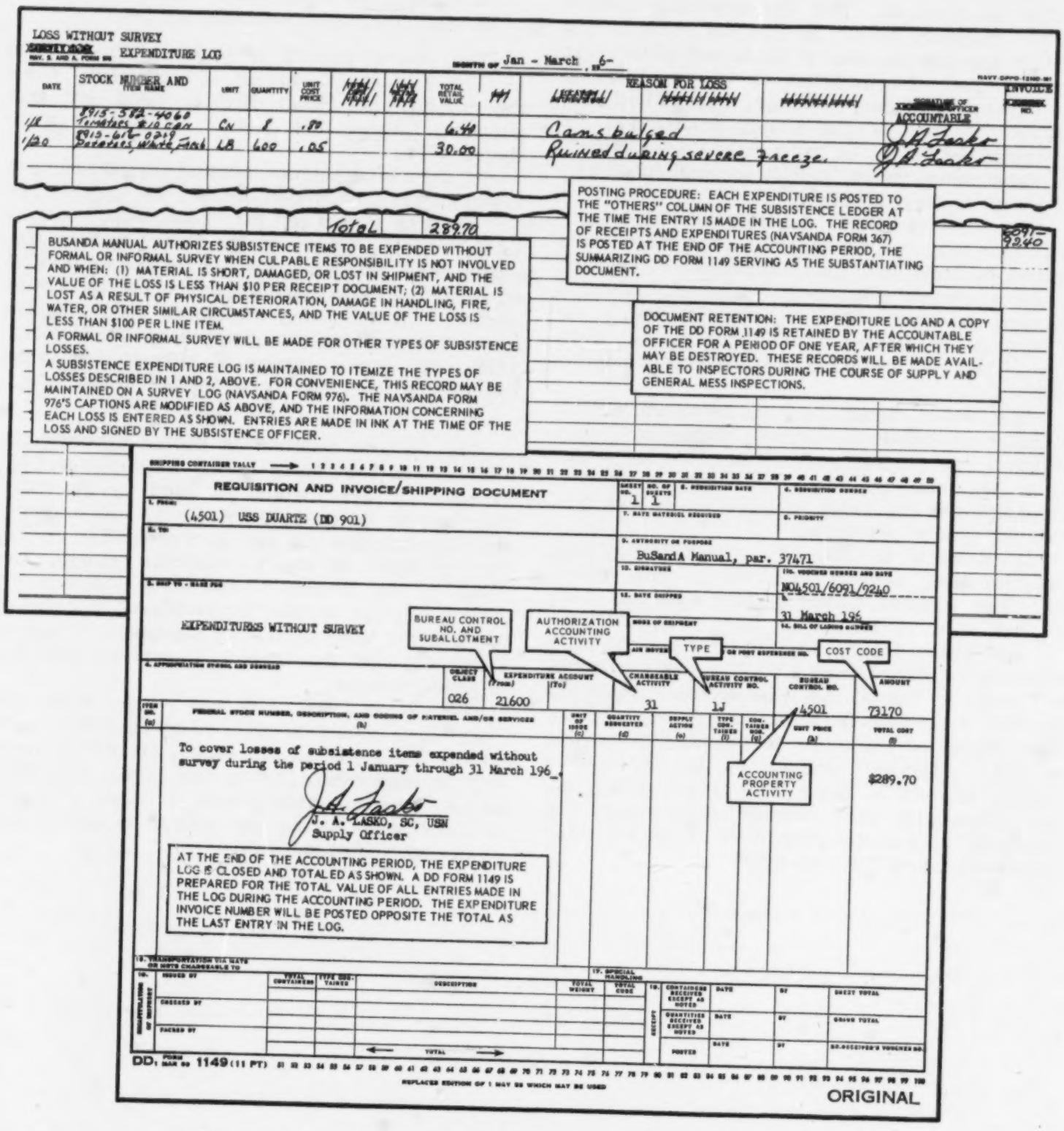

Figure 7-10.—Expending subsistence items without survey.

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appears that responsibility for lost or damaged material may be placed on a person or persons in the naval service, a formal survey is required at all times.

An INFORMAL survey is held for routine matters where it appears that no disciplinary action is required. The distinguishing feature of the informal survey is that the commanding officer appoints the head of the department having custody over the material to be surveyed as the surveying officer. However, a special officer, not a member of the supply department, is appointed by the CO as permanent survey officer for subsistence items, usually the medical officer or junior medical officer.

The medical officer makes a careful inspection, then indicates whether the subsistence items should be destroyed. He recommends disposition of the surveyed subsistence items and indicates whether the items have any salvage value, and if salvage is practical and economical. When sale of items is a possibility, this recommendation is made.

Subsistence items may be expended without formal or informal survey procedure when culpable responsibility is not involved and when:

1. Material is short, damaged or lost in shipment and the value of the loss is less than $10 per receipt document.

2. Material is lost as a result of physical deterioration, damage in handling, fire, water, or other similar circumstances and the value of the loss is less than $100 per line item.

The above losses should be itemized on a subsistence Expenditure Log. The entries should be made in ink at the time of loss and signed by the accountable officer. Each expenditure also should be posted by the officer Storekeeper to the "OTHERS" column of the Subsistence Ledger (S. and A. Form 335) as occurring, and the balance on hand reduced accordingly. The following information should be recorded in the Expenditure Log for each loss.

1. Date
2. Stock number
3. Item name
4. Quantity and unit of issue
5. Unit price
6. Total value
7. Reason for expenditure
8. Signature of accountable officer

The above record may be maintained on a Survey Log (S. and A. Form 976). When the S. and A. Form 976 is used for this purpose, change the form as annotated in figure 7-10.

At the end of each accounting period and upon relief of the accountable officer, the Expenditure Log must be closed and the "Total Value" column totaled. One "Money Value Only" Invoice (DD Form 1149) is then prepared for the total value of all entries made in the Log during the accounting period. The following statement signed by the accountable officer should appear on the DD Form 1149: "To cover losses of subsistence items expended without survey during the period _____ _____," see figure 7-10.

The invoice number is posted opposite the total as the last entry in the Expenditure Log. A copy of the invoice is used by the office Storekeeper to post to the Record of Receipts and Expenditures (S. and A. Form 367), and is then retained by the accountable officer. The value of the invoice should be included in the survey caption in the "expenditure" section of the General Mess Operation Statement (S. and A. Form 45) and the invoice forwarded with the required returns.

The Expenditure Log and a copy of the DD Form 1149 should be retained by the accountable officer for a period of 1 year, after which they may be destroyed. During the 1-year retention period, these records should be made available to inspectors during the course of supply and general mess inspections.

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CHAPTER 8

SANITATION IN THE GENERAL MESS

Outbreaks of food-borne illness continue to be one of the problems encountered in mass feeding operations. Most outbreaks are preventable, since the most common causes are failure of food service personnel to practice good personal hygiene habits and sanitary techniques.

In addition to the hazards of accidental contamination with which mess personnel have always contended, modern warfare has added others. Nuclear, biological, and chemical agents may be used in any future war. Protection of the food supply and decontamination measures in the galley and mess would be vital to defense of the ship or station.

FOOD-BORNE ILLNESSES

There are two main types of food-borne illness. In one type, the food actually contains poison. This poison may be introduced into the food naturally, as in the case of poisonous mushrooms and certain tropical fish. It may be introduced accidentally, as in the case of food cooked in utensils that introduce harmful chemicals, or bacteria may grow in the food and produce toxin (poison) before it is eaten. This type is considered not an infection but an intoxication, or poisoning.

The second main type of food-borne illness is caused by food that serves merely as a carrier of bacteria or animal parasites. After the food is eaten these plant or animal parasites multiply in the person's body and cause an infection.

A third type of illness produced by food is that which may be caused by a wide variety of allergies, transmitted by specific foods eaten by individuals allergic to those foods. These illnesses are not caused by lack of sanitation, and there is little or nothing that food service personnel can do about them. If an individual becomes ill from eating a food that others eat without ill effects, he should consult the medical officer about the possibility of an allergy.

Bacteria

An understanding of bacteria is valuable to all personnel and essential for those who work with food in any way. Bacteria are one-celled plants so small they are visible only under a microscope. They are widely distributed in the air, water, soil, and animal and plant tissues. Bacteria are classified by shape. Those round in shape are called COCCI; the rod-shaped, BACILLI; and the spiral shaped, SPIRILLA.

The fact that bacteria cannot be seen makes careful adherence to sanitation principles necessary. Bacteria can move of their own accord only in liquids and cannot leave a fluid surface unless transported as "passengers" by other agents such as dust, food, dishes, silverware, cooking utensils, dirty fingers or fingernails, a common drinking cup, a hand towel, moving air or water, insects, or rodents.

Bacteria reproduce themselves by simply dividing in half. On the average, each germ, under favorable conditions, will divide and become two germs every 20 minutes. The multiplication or growth of bacteria is affected by heat and cold. Boiling temperature will kill all bacteria and freezing will retard their multiplication. Some bacteria will continue to grow at refrigeration temperatures, while others can withstand high temperatures. When refrigeration is used to prevent the growth of bacteria, the temperature must be cold enough to accomplish its purpose. Cold—even freezing—will not kill bacteria. When thawed they become active again.

Not all bacteria are harmful or disease producing. Some are simply undesirable, causing putrefaction. Others are beneficial; for example, the bacteria used in the culture of cheese and sauerkraut. Some are benign, neither harmful nor beneficial.

Bacterial Food Poisoning

Certain types of bacteria, if allowed to grow and multiply, produce TOXINS or poisons. If

these bacteria are present in food, the toxins cause illness.

Staphylococcus.—The most common of all food poisonings is caused by the staphylococcus germ. It is found in the throat, on the skin as a causative agent of pimples and boils, and in great abundance in the postnasal drip of people recovering from colds. Food-service personnel with colds, sore throats, infected cuts, or other wounds or sores may be responsible. The germs are transmitted to food by food-service workers who cough or sneeze into food, or by one who rubs pimples on his face and then handles food or the business end of utensils. Men with any of these ailments should not be allowed to handle food.

Staphylococcus bacteria must have a suitable medium or food in order to grow. Tenderized ham, cream filled pastries, salads, chopped foods, and cured meats are most often responsible for staphylococcus food poisoning. Foods can contain sufficient toxin to cause food poisoning and yet have no odor of spoilage and no abnormal taste. Once the toxin has been allowed to form in food, cooking will not make the food safe. Refrigeration prevents the bacteria from producing toxin but will not destroy it once it is formed. Even when food has been properly refrigerated, it can become contaminated by germs while being prepared or while standing in the galley before being served.

Botulism.—Botulism is a second type of food intoxication. This disease, usually fatal, is caused by the toxin produced by the rod-shaped bacterium called clostridium botulinum. Botulism germs are found in the soil and gain access to foods through contact with soil and dust and possibly water. The foods most often responsible are either canned or fermented. The preserving process has not been properly performed and has not succeeded in destroying the bacteria in the food. The botulinum grows and multiplies in an airtight container. Commercially canned foods are considered safe. However, when cans are damaged, leak, bulge, or are sprung, the contents are presumed to be unsafe.

The botulinum organism sometimes produces a gas and a cheesy odor in food, but the absence of these signs does not necessarily mean the bacteria are not present.

Bacterial Food Infections

Certain types of bacteria that cause gastrointestional diseases are transmitted through foods. The general symptoms are sudden onset of a gastrointestinal disturbance usually 6-72 hours after eating.

Food infections usually are transmitted by foods infected and allowed to remain at room temperature for a length of time. Foods most commonly involved are: custards, milk, cream, ice cream, sea foods, meats, eggs, meat products, shellfish, salads, mayonnaise, salad dressings, poultry dressings, bread puddings, cream pies, eclairs, and filled pastry.

The chain of infection is from a person who is presick, sick, and/or a carrier; by droplets falling directly into the food or hands touching it; and sometimes from utensils that have been contaminated.

Salmonellosis.—Salmonella bacteria must be present to produce infection. This illness usually is contracted from undercooked, semi-cooked, or raw foods, or from foods infected after cooking by persons who are harboring the germs and giving them off in intestinal discharge.

Since salmonella bacilli leave the body through the intestinal tract, the main source of salmonella infection is the person who does not wash his hands after leaving the head and who consequently contaminates all the food he handles.

Mice, rats, and cockroaches may contaminate food by the mechanical means of dragging filth over food and food utensils, or by intestinal deposits brushed off into food or containers.

While no specific food may be said to be responsible for salmonellosis, the most dangerous foods probably are: (1) those that are usually eaten raw, such as salads and greens; (2) cooked foods that are not reheated thoroughly, such as turkey dressings, fish, and poultry; (3) foods that are undercooked, especially poultry and uninspected meats; and (4) infected eggs that are eaten raw or undercooked.

Streptococcus.—Infections such as septic sore throat and scarlet fever are transmitted by contaminated milk and by certain other foods, including meat, meat products, and dressings. A type of this infection also causes gastrointestinal disturbance. Floor dust is one of the modes of transmission.

Typhoid Fever.—Typhoid fever is transmitted by milk, shellfish, or water supplies that have become polluted with the urine or feces of a person harboring the organism of this disease. It is also spread by carriers and by flies which transport the typhoid germ from soiled articles to foods, dishes, and cooking utensils.

Bacillus Dysentery.--Bacillus dysentery is transmitted by contaminated foods or water, by carriers, or by flies. The bacilli of this disease are found in the bowel discharges of infected persons.

Other Types of Cell Life

Other types of cell life which may or may not be harmful are molds and yeasts.

Molds.—Composed of many cells, molds may be very small or large enough to cover an entire wall. They grow best in dark, damp places, where temperatures are favorable. Some molds are valuable in the production of medicines such as penicillin; other molds may cause certain infections in human beings.

Molds spoil the taste of food and eventually destroy it. Mold may be removed and the remainder of the food used. If in doubt about using foods that have molded, consult the medical officer.

Yeast.—Like bacteria, yeasts are single-celled. They reproduce by budding. When a bud becomes sufficiently large, it is pinched from the original cell and becomes an independent cell. Certain yeasts are used in bread making, vinegar fermentation, and the manufacture of beverages.

Illnesses From Animal Parasites

Animal parasites sometimes enter the body in food and produce infections. Some of these forms of animal life are one-celled; all are so tiny they are not visible when the food is being prepared.

Amoebic Dysentery.—This illness is caused by a one-celled animal, the amoeba. These organisms eat the red blood corpuscles of the body and also the cells which line the intestines. The dysentery producing amoebae are transmitted by foods served cold and moist, such as celery, lettuce, and other fresh vegetables, or fresh berries. These foods may be infected by human carriers, by flies, or by having been grown in fields where excreta were used as fertilizer.

Trichinosis.—Eating infected pork that has not been cooked enough to kill the trichinella worm causes trichinosis. Since there is no sure way of knowing whether this parasite is present, pork must ALWAYS be thoroughly cooked.

Pork Tapeworm Infection.—Similar to trichinosis, the pork tapeworm is an infestation transmitted by eating infected pork that has not been cooked long enough to kill the cysts of the worm, and also by accidentally ingesting pork tapeworm eggs.

Beef Tapeworm Infection.—Beef tapeworms are transmitted by eating infected beef that has not been cooked enough to kill the encysted larvae. In order to prevent ingesting the beef tapeworm, use Government-inspected beef only. If it is necessary to use beef that has NOT been inspected, freeze it at 14°F or below for 5 days or longer, or pickle it in 20-25 percent salt solution for 5 days or longer. Cook it well done and never serve it rare.

Fish Tapeworm Infection.—Fish tapeworm comes from infested fish that is not thoroughly cooked. The symptoms consist of nervous disorders, digestive disturbances, abdominal pains, anemia, and symptoms of peptic ulcers. They appear after an incubation period of 8 to 12 weeks.

For safety, always see that fish is thoroughly cooked, and that it is never tasted raw.

Poisonous Plants and Animals

In your tours of duty as a Commissaryman in the Navy, you will learn of many new foods that are not common to the United States.

Every effort is made to keep poisonous plants and animals off the ship. But sometimes they do get aboard. Toadstools, hemlock, mussels such as those found on the west coast during the summer, tropical fish such as toadfish, puffin fish, certain members of the jack fish family, and, in tropical waters, barracuda at certain seasons of the year can cause poisoning and death. The symptoms are predominantly of a nervous nature including weakness or paralysis, numbness, tingling of the ears, and apprehension.

Some types of mushrooms contain natural poisons. Only an expert can decide whether or not a certain mushroom is fit to eat.

The safest rule is never use strange plants and animals for food unless your medical officer approves their use.

Chemical Food Poisonings

Some food-borne illnesses are caused by chemical poisons, but usually chemical poisoning is rare compared to bacterial food poisoning.

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ONLY THE COOKING UTENSILS OFFICIALLY FURNISHED BY THE NAVY SHOULD BE USED. IF IT IS EVER NECESSARY TO USE OTHERS, SEE THAT THEY ARE NOT OF THE TYPES DISCUSSED IN THE FOLLOWING PARAGRAPHS.

ANTIMONY POISONING has been caused by eating food cooked in poorly coated or chipped gray enameled cooking utensils.

CADMIUM POISONING may take place if chilled acid foods or drinks are allowed to stand in cadmium-plated metal containers before they are served. Illness may strike 10 to 15 minutes after the food is eaten. Lemonade, fruit punch, tomatoes, raspberry gelatin dessert, and tea which contains lemon juice can be contaminated by cadmium. Ice trays and metal pitchers plated with cadmium have caused chemical poisoning when filled with cold acid foods.

Both antimony and cadmium poisoning cause vomiting, cramps, and diarrhea about one-half hour after the contaminated food is eaten.

TIN POISONING is practically unknown. It is now thought that reported outbreaks of tin poisoning were due to other causes. It is not true that food spoils more quickly when standing in an open tin can than when removed from the tin can and stored in a dish. Spoilage comes from bacteria growing in the food, not from the tin can. In fact, contamination by bacteria is less likely to take place if the food is left in the sterile (free from bacteria) can than if it is placed in a dish that has not been properly washed. The precaution to remember is that leftover food must be refrigerated.

ZINC POISONING in food is rare. It may occur when acid foods are cooked in galvanized iron kettles. Outbreaks have occurred when apples have been cooked in this type of kettle.

LEAD and ARSENIC sometimes used to spray fresh vegetables may cause these foods to become poisonous. Be sure all fresh fruits and vegetables are thoroughly washed before you cook them. LEAD POISONING may also result from the ingestion of food or water which has been in contact with lead pipes, lead-plated equipment, and lead-soldered pots and pans. Lead is a cumulative poison, and small doses accumulating in the body will eventually cause chronic lead poisoning.

FLUORIDE POISONING is caused by sodium fluoride—a substance often used to get rid of waterbugs or cockroaches. It is a white powder that can easily be mistaken for baking powder. Keep all containers for such poisons out of the galley and bakeshop.

METHYL CHLORIDE POISONING is caused by leaking mechanical refrigerators. Check your equipment for such leaks.

METHODS OF PRESERVING FOOD

Although bacteria have been discussed as the cause of food-borne illnesses, they also cause food spoilage either by actually eating the foods and leaving their waste products in them, or by producing toxins inside the foods.

Foods are protected from bacteria spoilage by several methods employing heat—pasteurization, cooking, dehydrating, and smoking. They are also protected within limitations, by refrigeration.

Effects of Heat

There is a definite relation between the temperature and the length of time required to kill bacteria; the higher the temperature, the less time required. This is known as the thermal death rate of bacteria. Below a certain temperature (140°F), however, the bacteria are not killed no matter how long they are kept hot.

Pasteurization.—Destruction of all harmful bacteria in certain foods, notably milk and milk products, is accomplished without actually cooking the foods. There are two methods of pasteurization:

1. Holding method, in which milk is held at a temperature of 143°F for not less than 30 minutes.
2. Short-time high temperature (flash) method, in which the milk is held at 160°F for not less than 15 seconds.

Since acid, or sour-tasting foods, are generally capable of destroying bacteria at a lower temperature, such foods as fruit juices, pickles, and sauerkraut, frequently are pasteurized rather than subjected to high temperatures.

Cooking.—Cooking is the most important operation for destroying all harmful and most food spoiling bacteria. Cooking cannot, however, be considered a sterilization process because some heat-loving bacteria are not destroyed by it. These heat-resistant bacteria fortunately, do not affect canned food since conditions are unfavorable to their development.

Dehydrating.—Dry heat is sometimes used to dehydrate fruits and vegetables in order to preserve them. In this case, however, the heat does not destroy the bacteria but simply removes one of the conditions essential for their growth—MOISTURE. Should any dried food come in contact accidentally with water during storage, the food will quickly deteriorate due to bacterial activity.

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Many little unconscious habits are highly unsanitary. For example, putting the fingers in the mouth, scratching the head, or rubbing the ear. It is important to become aware of these habits and to control them as much as possible. In any case, remember always to wash your hands before touching food or utensils.

Another unsanitary practice is sticking fingers into food for tasting purposes. The proper way to taste food is to use two spoons—usually the soup spoon size. Use one to dip out a tasting sample; transfer it to the second spoon for tasting. Always use two spoons. Never use the spoon used initially to prepare the food. When one spoon is used, there is the temptation to use it to dip another taste sample.

Bathing daily and wearing clean work clothes and hat are other important personal hygiene habits.

PRECAUTIONS IN FOOD PREPARATION

Study of the previous pages should make it increasingly evident that the food service worker is the most important link in the transmission of disease through foods. His health, personal habits, and methods of preparing and serving food are of concern not only to himself but to his shipmates as well.

Most food-borne disease outbreaks are due to three things: (1) preparation of food too far in advance; (2) poor refrigeration; and (3) careless handling.

The following precautions should be observed in preparing and serving food:

1. Prompt service or refrigeration—Food should be served promptly after it is prepared. Otherwise, it should be refrigerated or kept hot. This is the general rule. How this rule applies to specific foods is explained in items 2 through 7.

2. Handling cooked foods—Protein foods which are not served immediately after cooking should be either chilled to temperatures of 40°F or lower (but not frozen) or held at 140°F or higher. Protein foods include meats, fish, poultry, gravies, meat stocks, soups, eggs, custards, cream fillings, and milk. Growth of harmful bacteria and the development of toxins (poisons) formed by the bacteria occur rapidly in cooked protein foods during holding at temperatures between 40°F and 140°F. Cooked protein foods that have been held at temperatures between 40°F and 140°F for more than 3 hours should be considered unsafe for consumption and must be destroyed.

This principle is known as the 3-HOUR RULE. If the product is refrigerated at intervals and then permitted to warm up, the total time of the various periods between 40°F and 140°F must not be more than 3 hours. Protein foods composed of ingredients which are hand-peeled, hand-sliced, or hand-diced after cooking should never be used as leftovers; the 3-hour limit between temperatures of 40°F and 140°F is usually taken in preparing, chilling, and serving the food. These foods include potato salad, chicken salad, macaroni salad, shrimp salad, egg salad, and similar items. Hand preparation not only increases the chance of contamination, but generally increases the length of time that these foods are held at room temperatures. It is also dangerous to return opened jars or bowls of mayonnaise and cooked salad dressing from salad bars to refrigerators for reuse at a later meal. Because of the danger of miscalculation of total elapsed time that these salad dressings have been held at temperatures between 40°F and 140°F, mayonnaise and cooked salad dressings should be placed on the salad bar in small quantities and must not be returned from the salad bar for reuse as leftovers.

3. Handling leftovers—When leftovers or warm foods are chilled, care should be taken to assure prompt and thorough chilling (40°F or below) to the center of the food mass. Foods that are to be refrigerated should be placed in shallow pans to a depth of not more than 3 inches and should be covered with lids or waxed paper. Such foods should not be put in large deep pans as chilling may take so long to get to the center of the food mass that sufficient time is allowed for the growth of harmful bacteria and the development of toxins. Guard against any procedure that might delay cooling. Food to be chilled should be placed in the chill box immediately. Leftover food should not be saved for more than 36 hours. Freezing leftovers is prohibited.

4. Handling ground food—Food that has been ground or chopped and is to be cooked later or incorporated in a made-dish should be refrigerated immediately. Such ground or chopped food should be refrigerated in shallow pans filled to a depth of not more than 3 inches and should be covered until cooked. When food is ground, an increase in the area of contamination and growth of harmful bacteria results. When chilled foods are ground, the grinding process warms the food to the point where bacterial growth may start.

5. Meats that are cut, sliced, or diced should be placed in shallow containers, covered with lids or with waxed paper, and refrigerated

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immediately. The temperature of the meat cutting room should be maintained at 50°F to 60°F. Improper handling of meats can result in souring as well as disease transmission.

6. Frozen foods should be thawed in the refrigerator. Freezing breaks down tissue and because of it foods can be invaded by germs more rapidly. Foods once frozen then thawed should not be refrozen. If not eaten, store under 40°F.

7. Keep milk and milk products under refrigeration at all times. This means keeping them chilled on the serving line.

8. All pork should be thoroughly cooked; raw and rare pork always should be avoided. Masses of food like spaghetti should be stirred thoroughly during cooking so that the cooking will be complete to the center of the mass.

9. Fresh fruits and vegetables should be washed thoroughly under running water to remove any particles of filth, or to remove poisonous insect sprays. Green vegetables of uncertain origin should be suspected as being contaminated with pathogenic organisms and chemically sanitized by immersion for at least 15 minutes in a 100 ppm (parts per million) available chlorine solution or 30 minutes in a 50 ppm available chlorine solution (or other approved methods) and thoroughly rinsed with potable water before being cooked or served. Head items such as lettuce, cabbage, celery, etc., must be broken apart before sanitizing.

10. Food in storage or left standing in the galley needs to be protected from contamination from flies, dust, coughs, and sneezes. Keep food covered.

11. Store food off the deck.

12. Preparation tables and work tables should be kept clean.

13. Kitchen utensils, meat grinders, and other similar equipment should be kept clean and handled properly. Food that comes in contact with equipment that is contaminated becomes contaminated.

14. Wash your hands before preparing food.

15. Don't cough, sneeze, or talk over food while it is being prepared or served. It can be contaminated with unseen droplets.

16. Don't smoke while preparing food. Saliva can be dropped on foods very easily when smoking.

17. Keep fingers away from mouth, lips, face, and soiled surfaces.

18. Foods should be handled as little as possible.

19. Use tongs to handle butter, doughnuts, bread, and other similar items of food. Do not use your hands.

KEEPING UTENSILS AND EQUIPMENT CLEAN

All phases of sanitation in a general mess are important. However, one of the most obvious is the proper cleaning and sanitation of equipment used for preparing, handling, cooking, and serving food and the proper cleaning and sanitizing of trays, dishes, and mess gear.

Dishes may be washed by hand or by machine. Whatever the method, the final results may be either excellent or poor, depending upon your knowledge, skill, and conscientiousness as a dishwasher combined with the equipment and materials provided for your use. Unless you operate a machine properly, it is worthless. The best equipment and detergents are not complete answers to good dishwashing.

Types of Soil

Unless galley and mess equipment and utensils are thoroughly cleansed, food particles in which bacteria may grow will remain on them. These food soils are divided into several distinct types:

1. Freshly deposited soil—the soil that remains immediately after use of the equipment or utensil.

2. Thin film—the soil that remains as the result of ineffective cleaning, or following a flushing with plain water. Thin films are easily seen, and they are capable of sustaining germs.

3. Built-up deposits—the result of ineffective cleaning methods which permit a day by day accumulation of soil.

4. Dried deposits—accumulations that result from drying action and frequent formation of a heavy crusty deposit.

5. Baked deposits—deposits that have been baked onto equipment and have become difficult to remove.

6. Burned deposits—materials burned into equipment surfaces by high heat. These are the most difficult to remove.

Removing Stubborn Soils

The Navy procures the correct type of detergent to be used in washing food preparation utensils and equipment. Hot water also provides temperatures that increase the chemical activities of the various ingredients in properly compounded detergents. Friction is an important part of cleaning. The required friction may be applied by brushing with approved brushes or by strong flushing, as in dishwashing machines. Hard abrasives should never be used on any metal

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surface. They result in scratches which provide lodging places for soil. It is recommended that pots and pans, cooking utensils, and other such items be presoaked to loosen any food clinging to the utensil. Then, using the proper detergent compound and hot water, wash the utensils, pots, and pans. A detergent increases the effectiveness of the water as a cleaning agent, and the washed pots and pans must be rinsed with hot water at 125°F then sanitized for one minute in hot water of 180°F. Once washed and sanitized, the clean pots and pans should be stored, bottoms up, in clean racks. Otherwise, the effort spent in washing and sanitizing is wasted.

See figure 8-2. This figure illustrates the temperatures necessary for the proper cleaning and sanitizing of food service equipment and utensils.

Hand Dishwashing

The equipment for manual dishwashing varies from one-compartment sink to the preferred three-compartment sink. A booster heater should be installed under the final rinse compartment, plus remote dial thermometers. Regardless of the type of sink on board your ship or station, follow the correct procedure for dishwashing as outlined below:

1. You should have the following: hot water, detergent, bacterial agent (chlorine or other), scraper, garbage can, and long-handled baskets.
2. Scrape gross food residue from all mess gear.
3. Sort and stack mess gear by type. Chipped or cracked glasses or dishes should be discarded at this point.
4. Preflush all mess gear with warm water to get rid of gravy, sauces, and other surface food residue.
5. Wash the mess gear in hot (110° to 125°F) water with the amount of detergent recommended for use when dishwashing by hand.
6. Place each item in basket; prerinse in hot (120° to 125°F) water. (Use separate baskets for dishes, cups, and glasses.)
7. Rinse and sanitize mess gear in hot (1[illegible]°F) water for 1 minute or at least 2 minutes at 170°F or in chlorine solution containing not less than 50 parts per million residual chlorine for 2 minutes.
8. Lift the basket out of the hot water; place it on the drainboard and air dry.

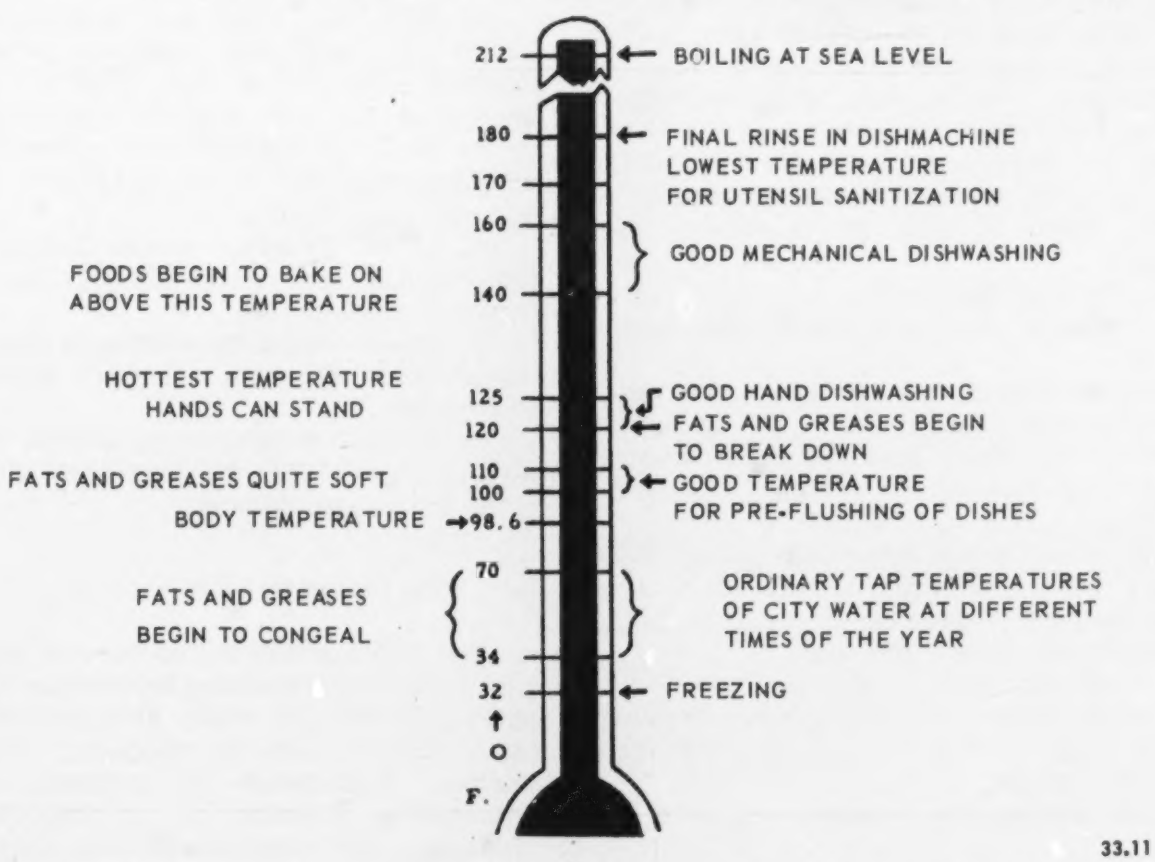

Figure 8-2.—Temperatures necessary for the proper sanitizing of food service equipment and utensils.

After the dishes have been washed and sanitized, the residual heat left in them aids in rapid air-drying. DO NOT DRY MESS GEAR (OR KITCHEN EQUIPMENT) WITH A TOWEL, since many bacteria may be added to a utensil by an unclean dish towel.

Soaps are prohibited in hand or machine dishwashing.

Machine Dishwashing

Dishwashing machine used in the Navy are classified as one-tank, two-tank, or three-tank machines. The three-tank machine is a fully automatic, continuous racking machine which scrapes, brushes, and provides two rinses. It is used at major recruit installations and other large activities.

Single-tank Model.—Single-tank machines (fig. 8-3) are used only on small ships where, because of space and weight considerations, larger models are not feasible.

In order to control the bacteria to a satisfactory minimum in single-tank machines, it is necessary

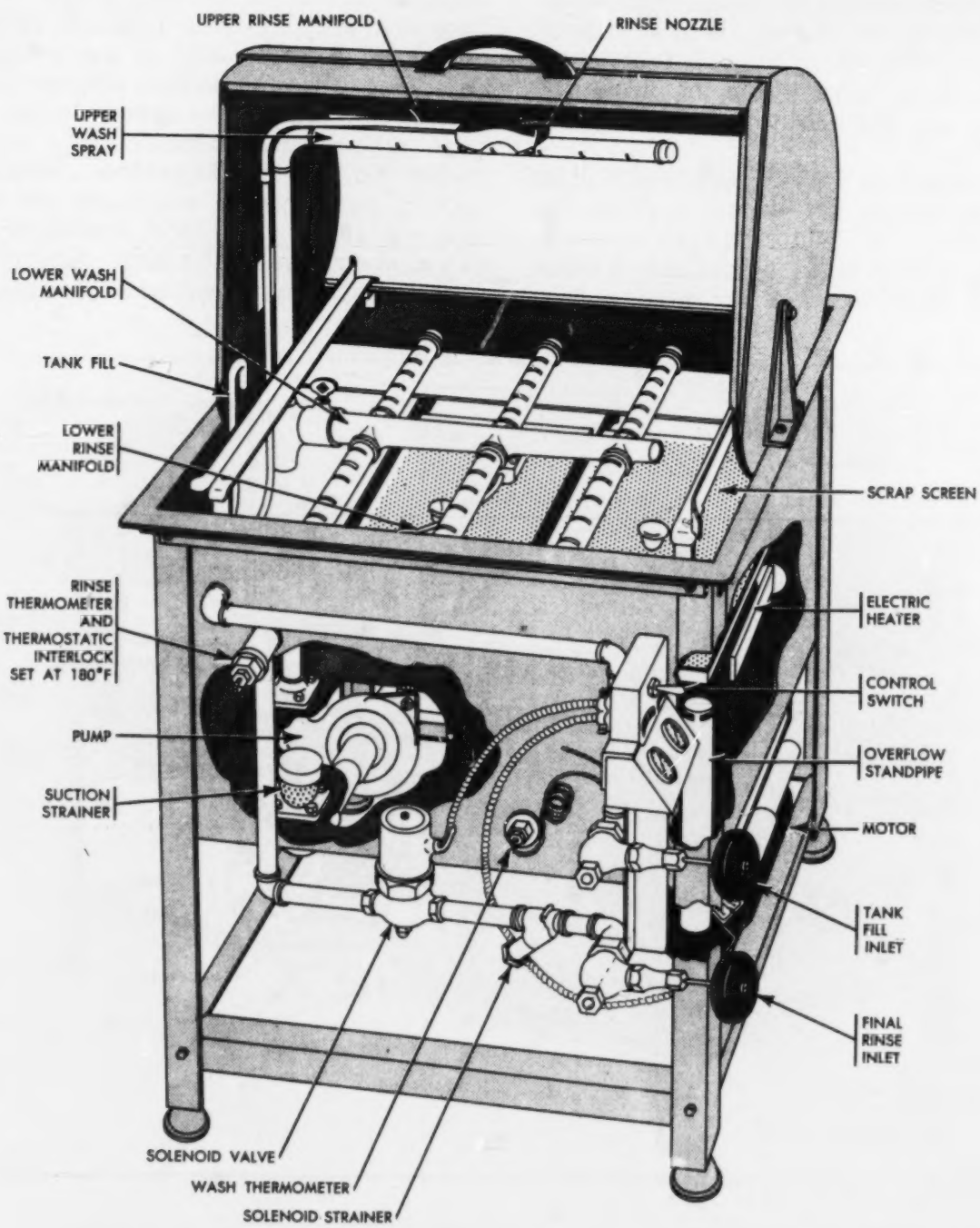

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Figure 8-3.—Typical semiautomatic single-tank dishwashing machine.

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that the temperature of the wash water in the tank be 140° to 160°F. Consequently, a thermostat is provided in the automatic machines to prevent operation when the temperature of the wash water is below 140°F. This higher operating temperature results in less efficient removal of food particles when certain starchy and albuminous foods are served. Therefore, the washing time is extended in the automatic machines to 40 seconds. For best results, soiled dishes should be prewashed by hand in warm water containing detergent before placing them in single-tank washers.

Rinsing is accomplished by means of hot water which is sprayed on the dishes from an outside source, and is controlled by an adjustable automatic steam-mixing valve which maintains the temperature of the rinse water between 180°F and 195°F.

In order to conserve fresh water, which must come from the ship's hot water system, the rinse time interval is limited to 10 seconds. When the water supply is not a problem, a rinse of 20 seconds is recommended.

Wash and rinse sprays are separately controlled by automatic, self-opening and closing valves in the automatic machine, or by handles in the manually operated machine. The automatic machine provides for a 40-second wash and a 10-second rinse; for manually operated machines, wash and rinse intervals are controlled by the operator who should allow this same time for washing and rinsing.

Double-tank Method.—Double-tank machines (fig. 8-4) are available with several different capacities and are used when more than 150 persons are to be served. These machines are provided with separate wash and rinse tanks and also have a final rinse of hot water sprayed on the dishes from an outside source and controlled by a self-closing valve opened by the racks which pass through the machine. The final rinse is controlled by an adjustable automatic steam mixing valve which maintains the temperature between 180°F and 195°F. Double-tank machines are also equipped with a thermostatically operated switch in the rinse tank which prevents operation

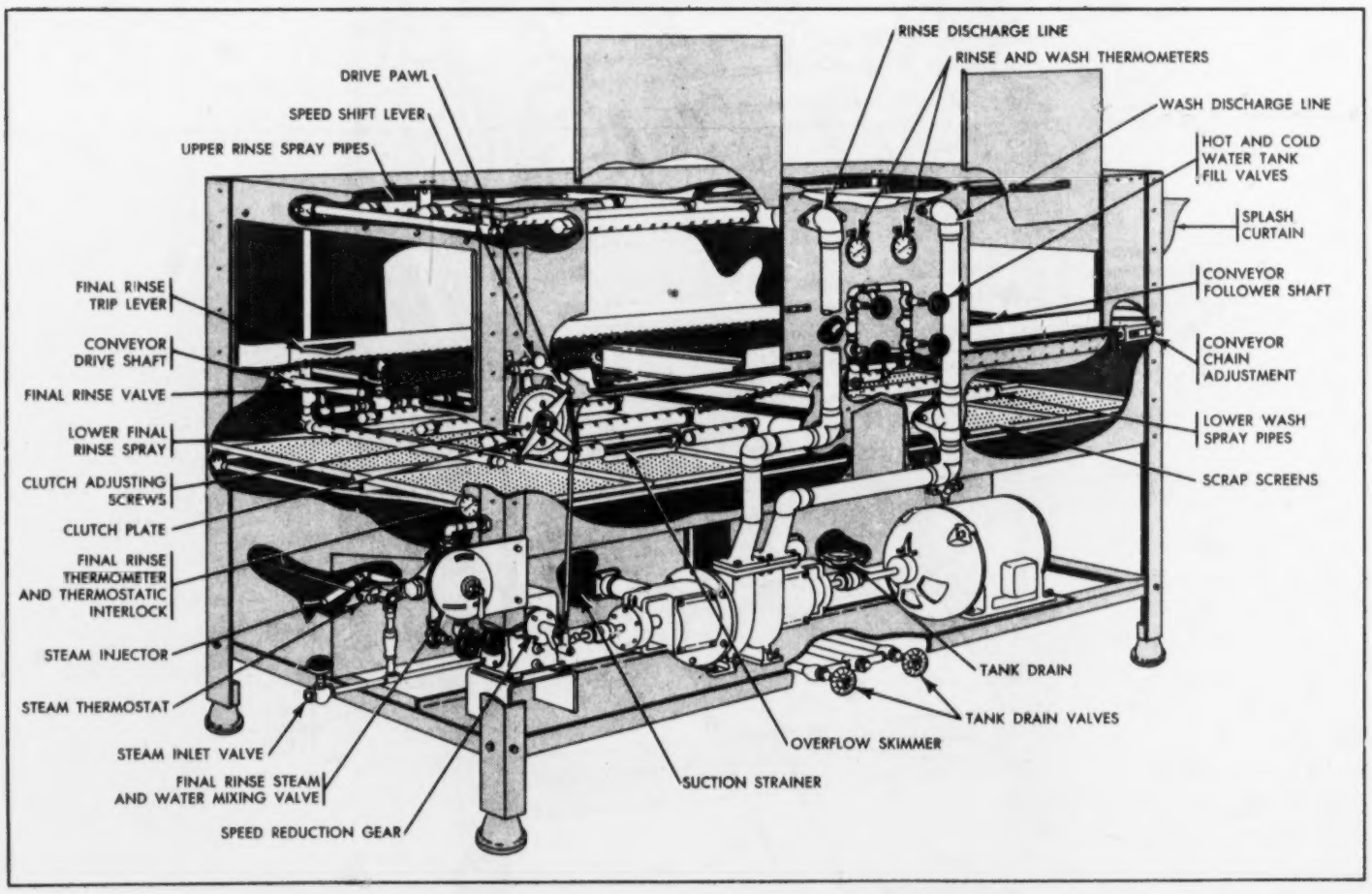

Figure 8-4.—Typical automatic double-tank dishwashing machine.

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of the machine if the temperature of the rinse water falls below 180°F. The racks pass through the machine automatically by means of conveyor chains. The two-tank dishwashing machine should be timed so that the utensils are exposed to the machine sprays for not less than 40 seconds (20-second wash, 20-second rinse).

Operating Dishwasher

The first thing you should do is to read and become familiar with the operating instructions included on the instruction plate which is mounted on the hood of the machine you are operating. Always follow these instructions, or you may damage the equipment or injure yourself and others.

The following detailed instructions are given for double-tank machines since most machines in service are of this type. These directions are also generally applicable to single-tank units, except for wash and rinse time intervals and temperatures.

1. Inspect the machine to see that the wash tank is clean and all spray openings are free from food particles, strings, and other obstructions.
2. Close the drain valves on both tanks.
3. Open the water valves and fill both tanks to the level marked on each or up to the overflow line. When tanks are filled, close the water valves tight.
4. Open the steam valve and heat the rinse tank water to 180°F or higher (not to reach vaporization point). Leave the steam valve on the rinse tank open so that the temperature does not fall below 180°F during operation of the machine. Machines are provided with a valve so that the final rinse temperature is 180°F or above. This adjustment must be made with the final rinse valve open.
5. On conveyor type machines, set the conveyor speed so that the dishes receive a minimum wash of 20 seconds and a minimum rinse of 20 seconds.
6. Add detergent. See Operation and Maintenance of Dishwashing Machines (NavShips 250-522) for the amount of detergent required for the wash tank size and the type of water being used.
7. Push the start button to start the pumps and conveyor. The rinse tank is fitted with a thermostat which, if properly set, will prevent the motor from starting until the temperature of the rinse tank has reached 180°F or higher.
8. Operate the machine for 1 or 2 minutes during which time the heat from the rinse spray should cause the temperature in the wash tank to increase gradually to 140°F.

At this point you are ready to start the washing procedure. However, it is important that dishes be thoroughly scraped free of solid food residues before being washed. Pre-cleaning will extend the useful life of the detergent in the machine, will prevent clogging of the pump and spray jets, and generally will result in improved cleaning performance. The dishes should be held over a conveniently located garbage can and scraped with an approved all plastic brush. Prewash all mess gear in the scullery sink prior to processing the dishwashing machine. Place scraped dishes in dish racks; cups, glasses, and containers should be placed upside down in appropriate racks so they are not filled with wash solution which cannot be washed away. Mess gear should never be nested since this prevents efficient washing and rinsing. Do not stack cutlery more than 1 inch deep in the rack.

9. Push the loaded dish racks into the machine on the conveyor until it comes up against the conveyor lug. With manually operated "push through" machines, be careful not to push the racks along too quickly since this practice will result in unsatisfactory cleansing. A minimum of 20 seconds should be allowed for each rack.
10. Maintain the temperature of the wash solution at 140° - 160°F. Higher temperatures will result in baking of egg and other protein solids onto the dishes.
11. Add $^1/_4$ of the original amount of detergent every ten minutes to compensate for the dilution and the increasing food particle load in the wash water.
12. Observe that as the first rack is discharged from the machine, the thermometer on the final rinse shows a temperature between 180° and 195°F.
13. Eating utensils should remain in the rack for approximately 1 minute for drying. When silverware racks are discharged from the machine, shake the rack slightly to get rid of entrapped water in the bowls of spoons and from the surfaces of all utensils.

Store dishes in a clean closed area to avoid recontamination, after being properly washed and cleaned.

The washing of silverware is often unsatisfactory because too much is placed in the rack for effective washing. A method of washing that avoids this difficulty is to sort the silver and place it in cylinder shapped compartments and run through the dishwashing machine. When the wash-rinse cycle is complete, the sanitized silver is inverted in like cylinder shaped

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compartments, thereby accomplishing the washing and sanitizing without hands touching the utensils.

Cleaning and Maintenance of Dishwashing Machines

Clean and rinse the interior of the machine, spray arms, and strainer pans after each period of use (see fig. 8-5).

Brushes are provided for cleaning the removable spray arms which, after cleaning, should be replaced in the machine so that the spray is directed vertically and not against the sides of the machine. Check the machine for leaky valves and report leaks to the commissary officer immediately. Have all moving parts lubricated at regular intervals.

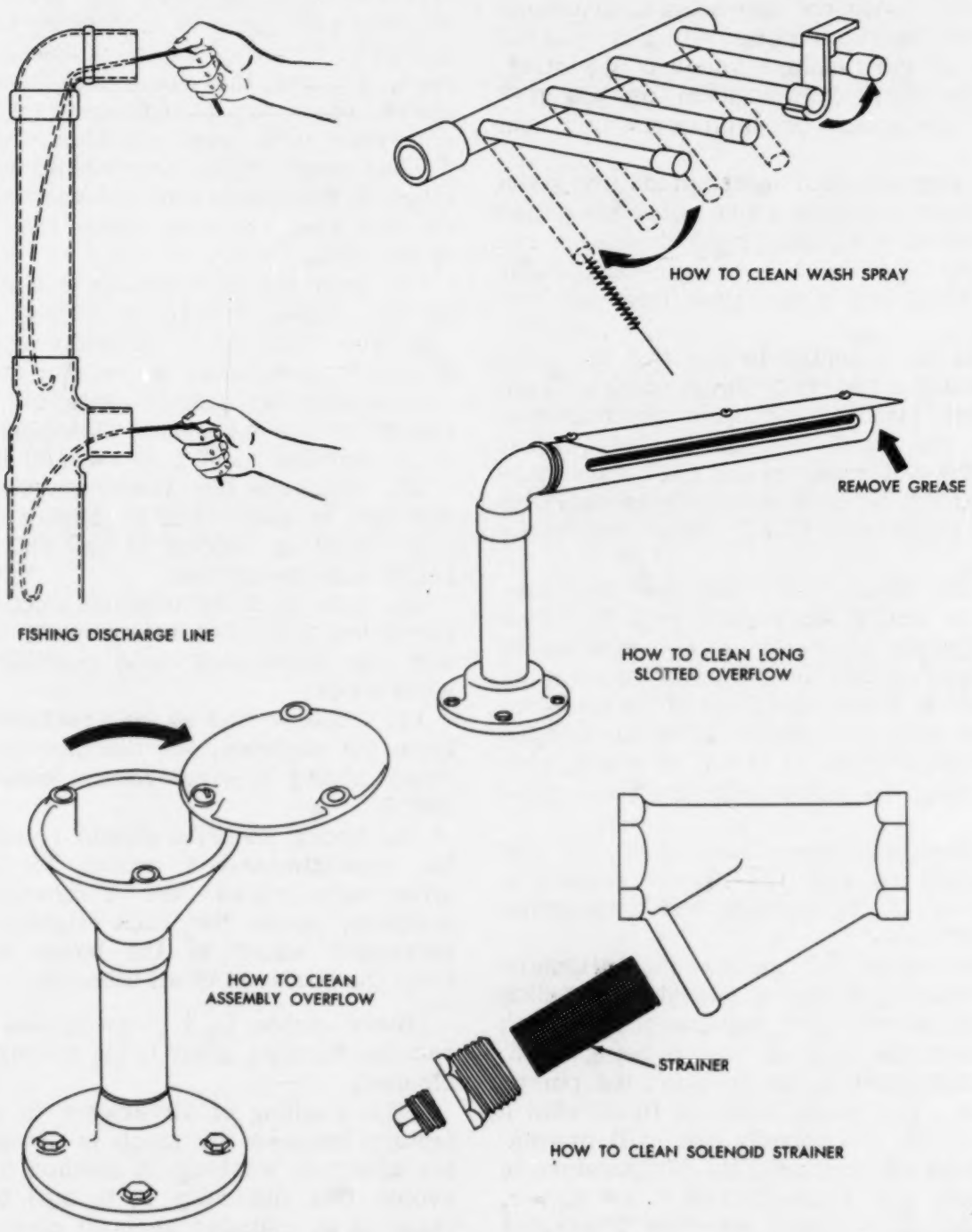

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Figure 8-5.—Cleaning sprays, drains, and strainers of dishwashing machines.

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Descaling Dishwashers

The accumulation of scale deposits in dishwashing machines is of public health significance for at least two reasons. FIRST—excessive scale deposit on the inside of piping and pumps clogs them and interferes with the efficient performance of the machine by reducing the volume of water that comes in contact with the utensil in the washing and sanitizing process. SECOND—scale deposits may provide a haven for dangerous bacteria.

The supplies needed for descaling are available through Navy supply channels. See the supply list below:

Stock Number	Description of Material
9G6810-264-6722	Orthophosphoric acid 85%, technical, 7-lb bottle
9G7930-282-9702	Detergent, general purpose, 1 qt bottle
9G7930-282-9699	Detergent, general purpose, 1 gal can
9G7930-282-9701	Detergent, general purpose, 5 gal drum

It is necessary to know the capacity of the dishwashing machine tanks. This may be determined by measuring (in inches) the inside dimensions of each tank, applying the following formula: length x width x depth (to water line) ÷ 231 = capacity in gallons.

Steps and key points are as follows:

1. Fill the tanks halfway to overflow level with hot clean water.

   If tanks are not fitted with water level indicators, remove a section of the scrap tray in each tank so that the overflow pipe can be seen.

2. Add the required amounts of acid and wetting agent to prepare the cleaning solution.

   Measure amounts carefully. Use 7 fluid ounces of orthophosphoric acid 85 percent plus $^1/_2$ fluid ounce detergent, general purpose, for each gallon capacity of the tank when filled to overflow level.

3. Complete filling tanks.

   Fill to the overflow level.

4. Put scrap trays, spray, and curtains in place.

   Scale deposits on all attachments must be removed.

5. Turn on machine.

   Operate the machine at the highest possible temperature for 30 minutes.

6. Turn off the machine and drain.

   Open the drain valves and allow all the cleaning solution to drain from the tanks.

7. Refill.

   Use fresh hot water.

8. Turn on the machine.

   Operate the machine at the highest temperature for 5 minutes.

Repeat steps 7 and 8 several times. The entire method should be repeated at such intervals as may be required to assure freedom from interference with efficient operation of the dishwashing machine.

RADIOLOGICAL WARFARE DEFENSE

Radiological defense includes all such measures as are taken to minimize personnel and material damage from radioactivity. The basic responsibility for this function resides with the damage control organization of the ship. Your basic guidance in radiological defense matters will be derived therefrom. Supply department personnel are normally assigned appropriate duties in accordance with the damage control plan. You should be aware of the plans and procedures to be followed on board your ship or station. Familiarize yourself with the appropriate portions of the following publications:

Disaster Control (Ashore and Afloat)
NavPers 10899-A
Basic Military Requirements
NavPers 10054-A

Emergency operations are those that immediately follow the blast. During this period, a realistic evaluation of the disaster is made, and initial steps toward recovery are taken. Protective clothing, monitoring equipment, and decontamination gear will be needed.

Radiological Contamination

Blast damage and thermal radiation may result in partial or in complete destruction of messing facilities and of subsistence items. The physical destruction of these facilities is important to the extent that food preparation and messing facilities are disrupted. Radioactivity is important for its effect on the human body.

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Because of its ability to penetrate matter deeply, gamma radiation is usually considered the most hazardous from the standpoint of external radiation. Since the principal source of alpha particles would be the unfissioned nuclear material of the weapon, the probability of significant alpha contamination from nuclear detonation is small. Beta particles likewise have poor penetrating ability (ordinary clothing will stop beta particles), entering the skin to a depth of about $^1/_5$ inch, but their ionizing power is about 100 times that of gamma rays. Ingested with food, inhaled, or entering through cuts within the body, beta particles meet no barriers and become particularly destructive when retained in the body for some time. Therefore, in food preparation and service, all forms of radioactivity should be regarded as hazardous.

Radioactivity may be induced in exposed materials close to the burst. Such items as soap, table salt, copper, or brass may become radioactive as a result of induced radiation (the action of neutrons). Radioactivity also may be carried by blast residues, the principal one being dust particles. A person contaminated by radioactive materials can easily contaminate an otherwise safe object or area. If he handles foods, the foods likewise can become contaminated. Radioactivity cannot be destroyed by cooking or sterilization, or neutralized by chemical treatment. It must be removed as completely as possible to a limit of radioactivity set by command authority in the light of existing circumstances.

Radioactive materials can only be removed by physical means. The extent of radioactivity existing in any commissary or messing space should be determined by survey with radiac monitoring equipment. This includes the galley, utensils, food for preparation, mess gear, the scullery, and all personnel involved in food preparation and service. If the survey so indicates, it may be necessary to reestablish the general mess in another area designated by the commanding officer as safe.

The supply officer is responsible for taking necessary precautions to ensure that the food served is free from radioactive contamination. Galleys and other food preparation spaces, food equipment, utensils, mess gear, and personnel engaged in the food service operation should be carefully monitored by qualified persons with appropriate monitoring equipment to ascertain the presence and the extent of radioactive contamination.

Decontamination operations should be carried out as required. Subsistence items in glass or metal containers or sealed in barrier-wrap packages will be the least likely to be contaminated. These should, nevertheless, be monitored, and care should be exercised upon opening such packages to avoid contamination. The fresh water supply should be monitored. Subsistence items should be monitored in their dry state because dilution with water will substantially lower the beta readings and the presence of alpha particles may not even show up on radiac instruments. All subsistence items, when they have been monitored, must be clearly marked as "contaminated" or "safe for use." All subsistence items should be cleared for use after monitoring if found to be within acceptable limits established by the local command in accordance with Radiation Health Protection Manual (NavMed P-5055).

Radiological Decontamination

There are various methods of removing contamination. They differ in effectiveness in removing the contaminant, in applicability to given surfaces, and in rate of operation. These, in general, fall into two classes, gross or rough decontamination and detailed decontamination. Gross decontamination consists of a rapid washing down with large quantities of water from a firehose or nozzle system. This class is generally not suitable for use in galley and messing spaces except for decks. Detailed decontamination procedures are characterized by more thoroughness. These procedures are costly in time, manpower, and material, but they are more effective. Detailed decontamination will be necessary in galley and messing spaces. Efforts to decontaminate with heavily contaminated water will obviously be ineffective; however, water contaminated to a less degree than the surface contamination to be removed may still be used to good effect. Water used for decontamination must be allowed to drain freely from contaminated areas. Water from tightly covered storage tanks should be safe and potable, provided the circulating system is tight. Water from open reservoirs cannot be relied upon as being free from contamination. Sea water in the neighborhood of an aerial burst to windward will be contaminated at the surface. A subsurface burst will heavily contaminate sea water in the vicinity. General knowledge of the local situation and a monitor survey should provide data on which a decision regarding the water supply will be based.

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When materials (cleaning agents) specifically designed for the removal of radioactive contaminants are available, they should be used in accordance with instructions. When they are not available, the following are suggested for general cleaning of galley surfaces:

Formula 1

Detergent, general purpose, liquid, water soluble, Type I...1/2 pound. Military specification MIL-D-16791

Sodium phosphate, tribasic, technical (trisodium phosphate)...1/2 pound. Federal specification O-S-642, Type II

Water, hot...(12 gallons)...100 pounds

Directions: The sodium phosphate should be completely dissolved by stirring into hot water. The sirupy liquid detergent should be added and stirred until thoroughly dispersed.

Formula 2

Dishwashing compound, machine, granular, free flowing. Federal specification P-D-425a (specify whether hard or soft water will be used).

Directions: The compound should be dissolved in hot water to make a 0.5 percent (approximate) solution (1 pound per 25 gallons of water). The solution should be used hot.

Formula 3

Citric acid, monohydrate, granular form. Military specification MIL-A-11029 (Cml) Change No. 3223

Directions: Citric acid should be dissolved by stirring to make a 3 percent (approximate) solution (3 pounds in 12 gallons of water). In use, utensils should be immersed and metal surfaces should be sprayed.

Except for citric acid, the above materials are commonly used and are readily available. The suggested formulas are not intended to take the place of agents specified in existing decontamination instructions. They constitute the bare minimum as substitutes and should serve to meet immediate emergency requirements. All chemical cleaning agents function most efficiently when hot. The choice of method and cleaning agent to be used should depend upon the nature of the surface to be decontaminated, the kind and degree of contamination, and the time, manpower, and materials to do the work.

Monitoring and Decontaminating Foods

All foodstuffs should be carefully monitored. Foods in metal or glass packages may be safe. Contamination is best removed from the external surfaces by washing. Food items in sealed dustproof packages may also be safe, provided the wrapper is not broken. To remove the contamination from these packages, vacuum them and carefully remove the outer wrap. Some vegetables can also be decontaminated if carefully washed, dried, monitored, and peeled, if monitoring shows contamination is not above specified limits. When surface contamination cannot be physically removed, the food should be condemned. All foods must be inspected and approved by the medical officer.

Decontaminating Spaces and Equipment

Thorough cleaning of all surfaces is a must. Work should be commenced overhead and continued downward in the direction of liquid flow. When feasible, the first step should consist of flushing the surfaces with clean water. DO NOT get water on electrical controls that are not waterproofed. The second step involves systematic scrubbing with chemical cleaning agents. Piping, duct work, stanchions, bulkheads, coamings, and decks should be repeatedly scrubbed until monitoring indicates that a safe condition exists. Bare metal surfaces should be given an initial scrubbing with alkaline detergents to remove grease film. When available, citric acid solution should then be applied and allowed to remain for a minimum period of 10 minutes. Rinse the surface with clean fresh water, allow to dry, and monitor. In the absence of citric acid, vinegar may be used, but is less effective.

Decontaminating Utensils and Mess Gear

Treat metal utensils and mess gear such as mess trays, metal tableware, and cutlery in the same manner as other metal surfaces. Wash with a detergent followed by an acid treatment. When possible, immerse utensils and mess gear in the acid solution. Crockery and glass present no particular cleaning problem, provided the glazed surfaces are without scratches and foreign deposits such as stains or hard water scale. Plasticware may present some difficulty because of the relatively porous character of the surface, scratches, and the presence of foreign deposits. Both glass and plasticware should be machine-washed, rinsed, dried, and each item monitored. Those that do not pass should be inspected for cracks and surface defects. Cracked and badly scratched items should be disposed of immediately. The other items still showing contamination should be

given repeated washings until safe, or they should be segregated to await natural decay of contamination or disposal of the item.

Protection of Personnel

When engaged in decontamination, wear protective clothing as prescribed by the ship's Damage Control Bill. If protective clothing is not available, similar garments may be substituted. Care must be taken that substitute clothing adequately prevents radioactive particles from coming in contact with the skin or gaining entry to the body by ingestion, inhalation, or through breaks in the skin. Masks should be worn. In the absence of regulation masks, goggles or glasses to protect the eyes and a filter improvised from several layers of turkish toweling worn over the nose and mouth to protect the lungs may be used.

Entrance into uncontaminated general mess spaces of any contaminated personnel and material should be prohibited. All personnel and material should be monitored and cleared before entering spaces requiring decontamination. Cleaning gear, items of protective clothing, et cetera, used in decontamination procedures should be segregated and disposed of as contaminated, according to their level of contamination.

To familiarize yourself with protective clothing and equipment, and with adapting regular issue clothing for NBC warfare protection, see Basic Military Requirements, NavPers 10054-A.

Avoidance of Recontamination

Contaminated items brought accidentally into general mess spaces should be removed and, pending decontamination of the affected areas, these areas should be roped off. Personnel who may have walked through these areas or who may have otherwise come in contact with radioactive particles should be sent to the decontamination station.

BIOLOGICAL WARFARE DEFENSE

Biological warfare is defined as the use of living agents, or their toxic products, to produce disease or cause the death of personnel, animals, or plants.

The chief objective of biological warfare is mass infection resulting in the incapacitation or death of large numbers of individuals or in the destruction of their sources of food, both animal and plant, or perhaps in both. The weapons of biological warfare, unlike most other weapons, act on living matter only and are limited in use to these objectives.

In case of a biological warfare attack, there are certain instructions that should be carried out for the protection and decontamination of eating, drinking, and galley utensils; galley and mess equipment; and messing spaces in an area contaminated by biological warfare agents.

Good sanitary and hygienic practices are the best defenses against many aspects of biological warfare. A close examination of the cleanliness of the general mess and strict adherence to the applicable instructions will improve biological warfare defense greatly.

The problems of biological warfare differ from ordinary military hygiene problems only in that hardier types of organisms may be present in other than their normal environment and in higher levels of contamination.

Biological Contamination

In treating the problem of biological warfare attack, it is assumed that there could be contamination of personnel, of all exposed surfaces, and of circulating air. Because of the current difficulty in rapidly detecting biological warfare agents, knowledge of contamination might (although not necessarily) be based on the occurrence of widespread or unusual sickness. This sickness could be caused by contamination that had occurred several days or weeks before. A situation could exist also whereby extensive employment of biological warfare would require additional precautions in the operation of all general messes. These instructions are intended for use in the event of suspected or known biological warfare attack. The problem is to decontaminate and prevent recontamination.

Decontamination Methods and Materials

Formalin vaporized by an insecticide fog applicator is an effective decontaminant and should be used under most circumstances for decontamination of galley and messing spaces. It is somewhat corrosive and leaves a disagreeable formaldehyde odor which is difficult to remove. Formalin vapor limitations are:

1. It is toxic to man.
2. It must remain 16 to 24 hours to be effective.
3. It damages delicate instruments.
4. Spaces must be aired for 24 hours after its use.
5. Masks, protective clothing, and rubber gloves must be worn.

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Ethylene oxide gas also is an effective decontaminant. It leaves no objectionable odors and is noncorrosive. It is, however, practicable only for small spaces, requires considerable preparation, and is not always available. It is used primarily to decontaminate equipment. Ethylene oxide gas limitations are:

1. It is highly explosive.
2. It is toxic.
3. Masks, protective clothing, and gloves must be worn.

If neither formalin nor ethylene oxide is available or if their use as fumigants is not feasible, the interior surfaces of the contaminated spaces should be scrubbed down with an effective detergent solution (discussed in the Radiological Decontamination section earlier in this chapter) to remove dust, grease, et cetera; next, hosed with clean, fresh, safe water to remove residual soil and detergent solution; then sprayed or scrubbed with water to which has been added 200 ppm (parts per million) available chlorine. Iodophors solution, phenolic solutions, or formalin solutions, although they are less desirable than chlorine, may be used if prepared as advised by the medical department.

Large equipment (those items too large to be immersed in sinks or run through dishwashing machines) should be washed, rinsed, and decontaminated in the same manner as prescribed for interior surfaces of messing spaces. Small items of equipment which will not suffer damage by immersion should be washed, rinsed, and sanitized in the dishwashing machine or by hand dishwashing as described earlier in this chapter.

Before eating and drinking utensils are brought to the scullery for decontamination, the interior bulkheads, all working surfaces (tables, dishcarts, and sinks), the interior and exterior of the dishwashing machine, and all other equipment used in the washing and sanitizing of eating and drinking utensils should be thoroughly washed, rinsed, and decontaminated as appropriate with formalin, ethylene oxide, or a detergent solution. Remember, both formalin and ethylene oxide are toxic to man, and therefore their use must be followed with thorough rinsing in safe water.

Eating and drinking utensils should be decontaminated by machine or hand dishwashing. A person who has handled contaminated utensils should not handle decontaminated utensils until he has been decontaminated. Decontaminated articles should not be placed in contact with any surface which has been exposed to contamination. If possible, use baskets or containers designed to hold silverware in a vertical position, handle down, during the washing and sanitizing processes, and additional containers of similar construction into which the silverware may be inverted without being handled by workers. If such containers are not available, lay the silverware flat in the racks with the handles extending in the same direction. Do not exceed a depth of two utensils. Take care when removing utensils from the racks after decontamination to prevent recontamination.

Sterilization by hypochlorite solution should be used only when dishwashing machines do not operate correctly. The utensils should be soaked, while still in the washrack, for one full minute at 100° - 140°F in a solution of one part hypochlorite and 50 parts water in a single-tank machine, or one part hypochlorite and 500 parts water in a double-tank machine; one-fifth of 1 percent of a detergent must be added to either solution. This solution may be mixed from nonionic detergent, FSN 9G6850-282-9699 through 9702, or solid nacconal detergent with any one of several chlorine containing compounds such as calcium hypochlorite, sodium hypochlorite (javelle water), or chlorinated lime.

In storage, compounds containing chlorine have been known to deteriorate. In this respect it will be necessary to have a qualified person from the ship's company to analyze the soaking solution for chlorine content to ensure that the proper concentration of available chlorine is attained and continued at sufficient strength.

After the sterilization soak and water rinse, cover the washracks containing the utensils with a cloth that has been sterilized by boiling. Do not transfer utensils to another rack. Ensure that personnel in the mess line pickup utensils from the washracks by touching only the handles.

Large equipment may be decontaminated by the use of hypochlorites. Hypochlorites are corrosive to all metals that will rust and should not be allowed to come in contact with motors and other electrical equipment from which such hypochlorites could not be thoroughly wiped off. After decontamination, cover as much of the equipment as possible with sterile cloths.

Avoidance of Recontamination

Recontamination may be caused by secondary aerosols which resettle organisms on surfaces or contaminate the air that is breathed. Secondary aerosols are clouds formed from particles (bacteria or other organisms) which, having been deposited on a surface, are stirred up into the air again by scuffing, shaking, or other mechanical

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action. Secondary aerosols may be suppressed by wetting surfaces with oil or water.

It is important to ensure that, before entering the mess spaces, Commissarymen and all personnel eating in the mess spaces are as free as possible from contamination. The medical officer should be consulted on the decontamination of food service personnel. In cold weather, personnel in the mess lines should be required to remove outer garments and leave them outside the mess spaces prior to entering the messing area. It has been found that removing clothing will shake off organisms which have come in contact with the surfaces, thereby setting up secondary aerosols. Do not permit unauthorized personnel in mess spaces.

Decontaminating Subsistence Items

The advice of the medical officer must be sought before any attempt is made to decontaminate food suspected of biological warfare contamination.

Dry Subsistence.—Food packed in containers that are resistant to the passage of biological agents (sealed containers made of metal, plastic, glass, or porcelain) requires only that proper exterior decontamination be performed. Paper labels and paper covers must be removed from the container and one of the following methods of decontamination should be used:

1. Immerse the containers for 15 minutes in a solution of water to which 200 ppm (parts per million) available chlorine has been added; the containers are then rinsed with potable water.
2. Soak the containers for a minimum of 15 minutes in effective detergent solution as an expedient method to reduce contamination to a safe level (see formula 1 discussed under the heading "Radiological Decontamination"); the containers are then rinsed with potable water.
3. The exterior surfaces of stacks of food packed in impermeable packages can be sterilized by vapor disinfectant, such as formalin or ethylene oxide.

Food packages which will not stand immersion must be wiped off with a solution of water to which 200 ppm (parts per million) available chlorine has been added and the food thoroughly cooked before eating.

Food packaged in sacks or other permeable containers can be decontaminated with ethylene oxide, but because of the limited availability of this product it is recommended that such foods be thoroughly cooked before eating.

Fresh or Chill Items.—Foods that can be peeled or pared may be decontaminated by soaking for 15 minutes in water to which 200 ppm available chlorine has been added. The food is then peeled or pared and rinsed well with potable water. This method has been applied satisfactorily to apples, potatoes, and eggs.

For other fresh or chill items the use of heat is the most practicable means of decontaminating contaminated foods. Thorough cooking will reduce contamination to a safe level so that food can be consumed. Specific methods to be followed in this form of decontamination are discussed later under the heading "Food Preparation Guidelines."

Frozen Items.—Food items stowed in freeze space in impermeable containers (canned frozen strawberries, for example) may be decontaminated by immersing the containers for 15 minutes in a solution of water to which 200 ppm available chlorine has been added; the containers are then rinsed with potable water.

Food items stowed in freeze space in permeable containers (frozen vegetables) may be decontaminated as outlined earlier for food packaged in sacks or other permeable containers.

Food items stowed in freeze space but not contained in outer packaging (meat, for example) must be completely thawed and thoroughly cooked before eating.

Additional Precautions.—Hands should be free of contamination during the opening operations to ensure that the contents are not contaminated. Opened cans of fruit, jam, jelly, or similar foods must be destroyed. Opened cans of vegetables may be decontaminated by boiling the vegetables for a minimum of 15 minutes in a steam jacketed kettle.

Food Preparation Guidelines

The use of heat is the most practicable means of decontaminating contaminated foods. In no case should decontaminated food be consumed until it is pronounced safe by a designated medical officer. It is recommended that, insofar as possible, only foods contained in impermeable packages (cans, bottles, jars) be decontaminated and used for meal preparation.

Food items which are not packaged or those that are packaged in permeable containers may be cooked by either of the following methods:

1. In a pressure type cooker at 15 pounds pressure at 250°F (121°C) for 15 minutes.
2. Boiling for a minimum of 15 minutes.

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Certain contaminated items may be decontaminated by baking. Only those recipes listed in the Navy-Marine Corps Recipe Service which specify an oven temperature of 400°F and above, for a cooking period of 30 minutes or longer, should be used to prepare baked items using contaminated ingredients.

All meats except those contained in decontaminated impermeable containers (canned meat items) must be cooked to the well done stage. Guidance cards in the Navy-Marine Corps Recipe Service include information on internal temperature indicating the well done stage.

Decontamination of Water

The detection of water contamination and the laboratory analyses are responsibilities of the medical department. Biological warfare decontamination of water is not difficult when regular water treatment facilities exist. However, more chlorine probably will need to be added during the ordinary processing of the water. If no water treatment facilities are available, water can be decontaminated by any of the following methods:

1. Boiling for 20 minutes.
2. By distillation, if equipment is available.
3. By using iodine tablets coupled with boiling.

A medical officer should pass on the method and the completeness of the decontamination process before water is used for drinking purposes. Water that has been decontaminated must be protected against further contamination.

CHEMICAL WARFARE DEFENSE

In chemical warfare, death, injury, or irritating effects are produced by toxic chemical agents. Although commonly called gases, actually these agents may be found also as solid particles or liquids. The term "chemical warfare agent" is a general expression applied to any chemical which, by its own action, can produce powerful casualty, harassing, screening, or incendiary effects.

Chemical Agents

Chemical warfare agents, like the biological warfare agents, are used chiefly for their effects on personnel, although some agents will have a corrosive effect on specific materials, and incendiaries will burn most materials. These agents produce a harmful physiological reaction when applied to the body externally, when breathed, or when taken internally. Most CW agents cause disorganization of the functioning of the body.

Descriptions of potential chemical warfare agents; methods of detection and identification of the various agents; material, equipment, and clothing to be used by decontamination personnel; and the methods of decontamination to be employed in the recovery of various areas, spaces, materials, and objects are published in Chapter 12 of NWIP-50-1.

The following paragraphs prescribe the methods of decontaminating eating, drinking, and galley utensils; galley and mess equipment; and messing spaces in an area contaminated by chemical warfare agents.

Decontamination

The contamination of general mess spaces and equipment depends on the chemical warfare agent used and the factors involved, such as method of delivery, the weather, and the various degrees of contamination (vapor, light liquid, and heavy liquid).

Vapor Contamination.—After the surrounding areas have been decontaminated, the general mess spaces should be aerated thoroughly and the entire messing space washed down inside and out with clean water. All equipment and utensils used in the preparation and service of food should be washed carefully using normal procedures. Spaces, utensils, and equipment then should be tested with the chemical agent detector kit and, if necessary, any of the prescribed procedures should be repeated.

Light Liquid Contamination.—The messing spaces, inside and out, should be washed with hot water. You may add an alkaline detergent, such as a standard dishwashing compound, and if applied at high pressure, it will increase the water's effectiveness. As an alternative method for mustards, you may apply a bleach slurry to all surfaces. After washing down, aerate the messing spaces. If slight contamination remains, the messing spaces should be heated to as high a temperature as possible for about 1 to 2 hours. Then the spaces should be opened and ventilated for 15 minutes. Repeat the procedure as necessary, testing at intervals with a chemical agent detector kit. Porous objects, such as meat blocks and wooden benches, will absorb liquid contamination to the extent that it probably will be necessary to destroy them. Metal, glass, or china utensils or any equipment which is not damaged by water should be immersed for 30 minutes in actively boiling water. Add 1 cupful of alkaline detergent to each 5 gallons of water.

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Upon completion of the boiling process, normal dishwashing procedures should be followed. Plastics generally cannot withstand boiling water and should be destroyed.

Heavy Liquid Contamination.—Heavy liquid contamination is unlikely, except from a direct hit, in which case recovery of the space and contents will be a major undertaking. However, when such is the case, the following procedures are recommended.

Spaces should be roped off or abandoned as unsalvageable, as no amount of washing or scrubbing of a porous surface which is heavily contaminated by a liquid chemical warfare agent (particularly mustard) is likely to do much good.

Metal, glass, or china utensils or any equipment which is not damaged by water, should be decontaminated in the same manner as prescribed in light liquid contamination discussed earlier.

Large equipment unsuited for immersion in boiling water should be scrubbed vigorously with DS2 solution or hot water and an alkaline detergent, rinsed, disassembled, and scrubbed again with particular attention to parts not reached by the first washing. The equipment then should be rinsed, dried, oiled, greased, and reassembled. Wooden items should be removed and destroyed.

On electrical equipment, unless the electrical unit is enclosed in a watertight seal, water must not be used in the decontamination process. Electrical equipment should be cleaned with trichloroethane, technical (methyl) chloroform, or DS2 solution. All greases must be removed, bearings cleaned, and the equipment regreased.

DS2 is flammable and irritating to the skin. Protective clothing and masks should be worn when it is used.

Careful inspection must be made of the general situation before large quantities of food or water suspected of chemical agent contamination are destroyed. Contaminated food and water must be destroyed in some cases; in other cases, they may be salvaged by special decontamination procedures. In any event, the responsibility belongs to the medical department to determine whether food or water contaminated by chemical agents should be decontaminated or destroyed. Decontamination should be accomplished in accordance with procedures in Disaster Control (Ashore and Afloat), NavPers 10899-A, chapter 7.

INSECT AND RODENT CONTROL

There are many kinds of galley pests, but the most common are flies, roaches, and mice (rarely rats). Great losses result from insect and rodent damage to subsistence and many other items of property in the absence of effective control programs.

Your commanding officer will set up such programs for the entire activity, but this does not relieve you of the responsibility for seeing that precautions are carried out for insect and rodent control in galley spaces. The best control measures for insects and rodents are proper cleaning of galley spaces and the proper collection and disposal of all garbage. Mice will not live where they cannot get food. Roaches also are and indication of insanitary conditions. Such insects will come aboard in crates of food, so that continual high sanitation standards must be maintained.

To make certain none of the commonly known insects and rodents contaminate food, utensils, and dishes, you must maintain constant vigilance and also observe the following rules:

1. Keep all galley spaces clean.
2. Clean up spilled foods immediately.
3. Be sure to thaw meat in the thaw box—never in the passageway or on the meat block.
4. Cover all foods that are not actually being prepared.
5. Leave no food exposed overnight.
6. Keep equipment clean and germ-free.
7. Remove all crumbs and food particles at the end of each meal.
8. Dispose of all garbage, rubbish, and litter promptly.
9. Keep garbage cans covered tightly; empty, wash, and scald them regularly.
10. Kill flies and roaches with sprays and powders.
11. Use traps for catching rats and mice.

When routine sanitary measures are not effective to control or eliminate insects and rodents, notify your medical officer or Medical Department representative immediately. He will advise you concerning the use of more drastic, corrective action.

If you are given insect poisons to use in your galley spaces, you must take every precaution, if they cannot be used immediately, to stow them so that they will not be mistaken for baking powder or other food items. Poison baits are often recommended to supplement rat and mouse trapping and other programs. They are effective in rodent control, but they must be used with all recommended safeguards, since they are also poisonous to human beings.

CHAPTER 9

MEAT

Meat appears on the Navy menu in some form, and in generaous quantity, each day. It is the focal point of every meal, often dictating what other dishes will be served. Meat affords excellent nutritional benefits, supplying calories, high-quality protein, iron, phosphorus, and essential vitamins, especially those of the "B" group. Correctly cooked and served, meat is indicative of a well informed and skillful Commissaryman.

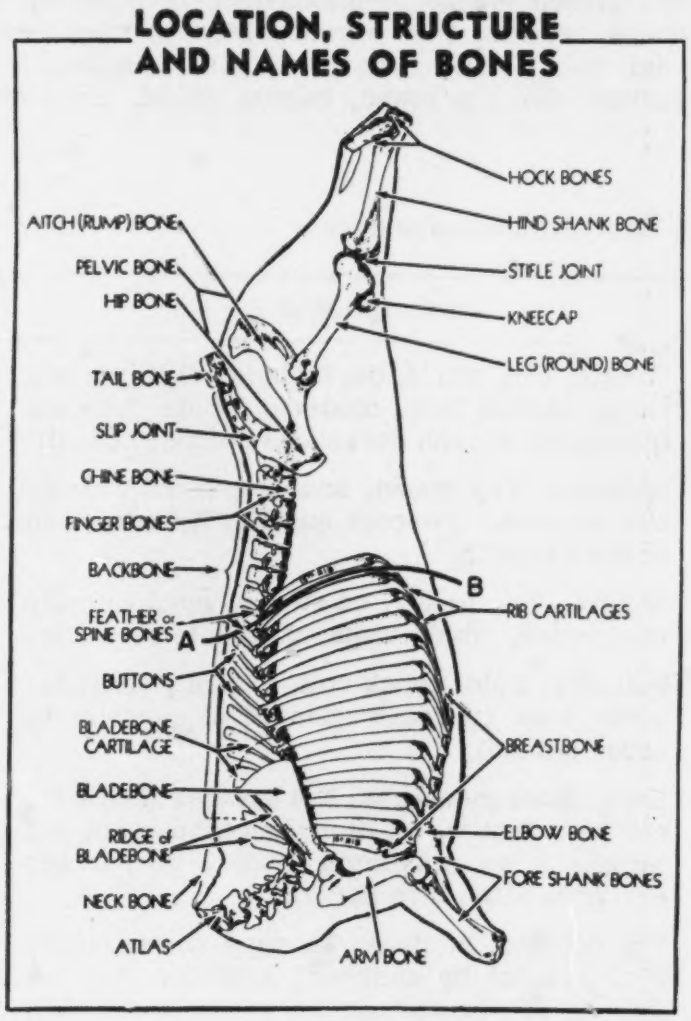

Figure 9-1.—Beef chart.

CARCASS BEEF

Beef is the most frequently used of all meats. By carefully studying the beef chart (fig. 9-1), you will become familiar with the locations, structure, and names of bones. The line A—B shows where the side is divided.

Figure 9-2 shows a hindquarter divided into various sections which you should be able to recognize. Dotted lines indicate pieces that are cut from the opposite side of the quarter. Cuts numbered 4 through 9 are used for roasts and steaks; cuts numbered 1, 2, 3, and 10 are used for braising, stewing, or grinding.

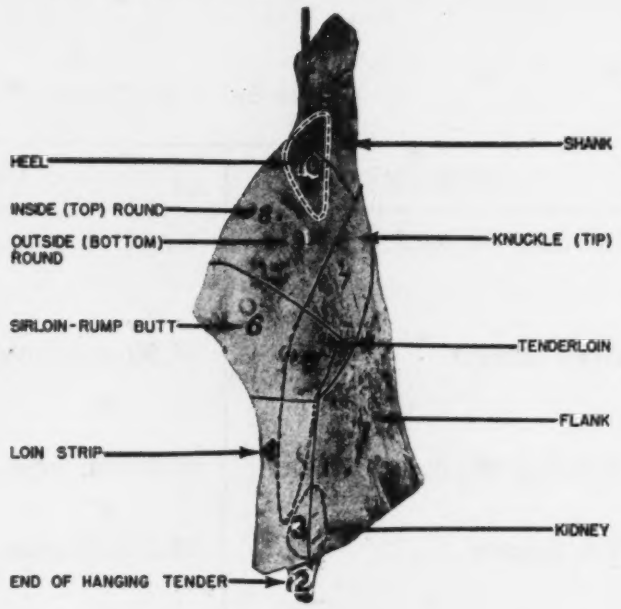

Figure 9-2.—Beef hindquarter.

Figure 9-3 shows the names and locations of the cuts that are made from the beef forequarter. Cuts numbered 1, 3, 4, 7, and 8 are used for roasts and steaks. Cuts numbered 2, 5, 6, and 9 are used for braising, stewing, or grinding.

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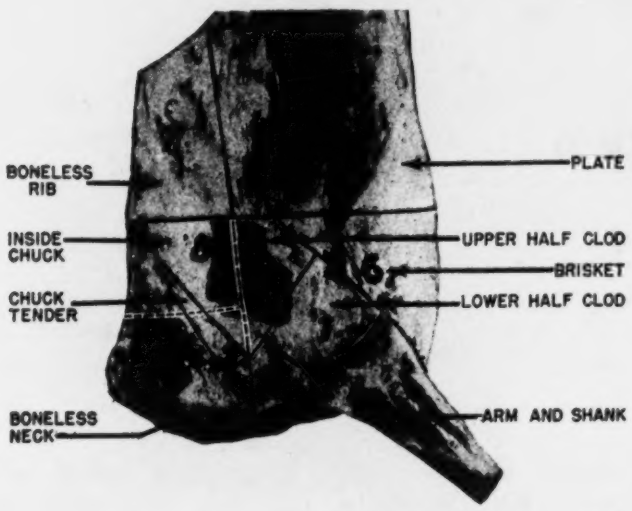

Figure 9-3.—Beef forequarter. 48.39

BONELESS BEEF

Boneless beef is carcass beef cut according to specifications for the Armed Forces. The meat is cut, wrapped, and packed in fiberboard boxes, then frozen. The boxes of beef weigh approximately 50 pounds. Bones, excess fat, gristle, and tendons are removed in the processing plants. The beef is issued in six categories as shown in table 9-1.

VEAL

Veal is best defined as immature beef or calves of less than 1 year of age. Most of the veal or calves slaughtered for meat are dairy cattle. The younger animals of other cattle breeds are allowed to mature for beef. The bone structure is identical to beef, although bone sizes are quite different, the animal for veal being much smaller.

Veal is cut from veal sides in the order shown in figure 9-4. One of the most popular uses of veal is for cutlets. Roasts may be used for this purpose, including the beal boneless or bone-in, illustrated in figure 9-5.

Navy general messes use fabricated veal categories and cuts in semiboneless and boneless form. Boneless consists of two categories, cutlets and flaked steaks. Semiboneless is made up of chops, roasts, and stews. Chops are cut from veal back, tenderloin butt, and knuckle. For roasts, the top round, buttom round, clod, and

Table 9-1.—Portion-cut Six-way Beef Categories and Cuts

Category	Percent of Unit	Description of Cut
Portion-cut Grill Steaks	13.50 minimum	Weight: $6\frac{1}{4}$ to $7\frac{1}{2}$ oz. Includes: Ribeye, loin strip, sirloin butt, tenderloin cuts (percent quantities of each decreases in order named).
Oven Roasts	16.50 minimum	Includes: Top round, knuckle, sirloin rump, eye of round (percent quantity decreases in order named).
Portion-cut Swiss Steaks	10.0 minimum	Weight: $5\frac{1}{4}$ to $6\frac{3}{4}$ oz steaks, mechanically tenderized, whole units of less tender cuts.
Pot Roasts	15.0 minimum	Includes: Cold, chuck roll, brisket, heel, plus other cuts (percent quantity decreases in order named).
Diced Meat	11.0 maximum or 9.0 minimum	Each piece measures: Not greater than 3 in. nor less than $\frac{1}{2}$ in. along longest surface and weighs 2 oz maximum (with a 10 percent deviation allowance per lot).
Ground Meat	34.0 maximum	Fat content: A single lot may contain up to 25.0 percent by analysis, provided that the average for the contract (on weight basis) does not exceed 22.0 percent fat by analysis.

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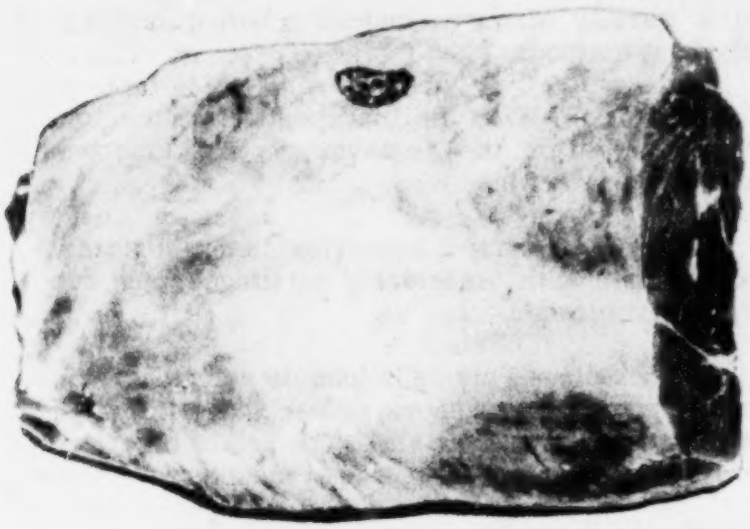

OUTSIDE (BOTTOM) LEG

VEAL KNUCKLE

48.91

SIRLOIN-RUMP BUTT

SHANK HALF OF LEG

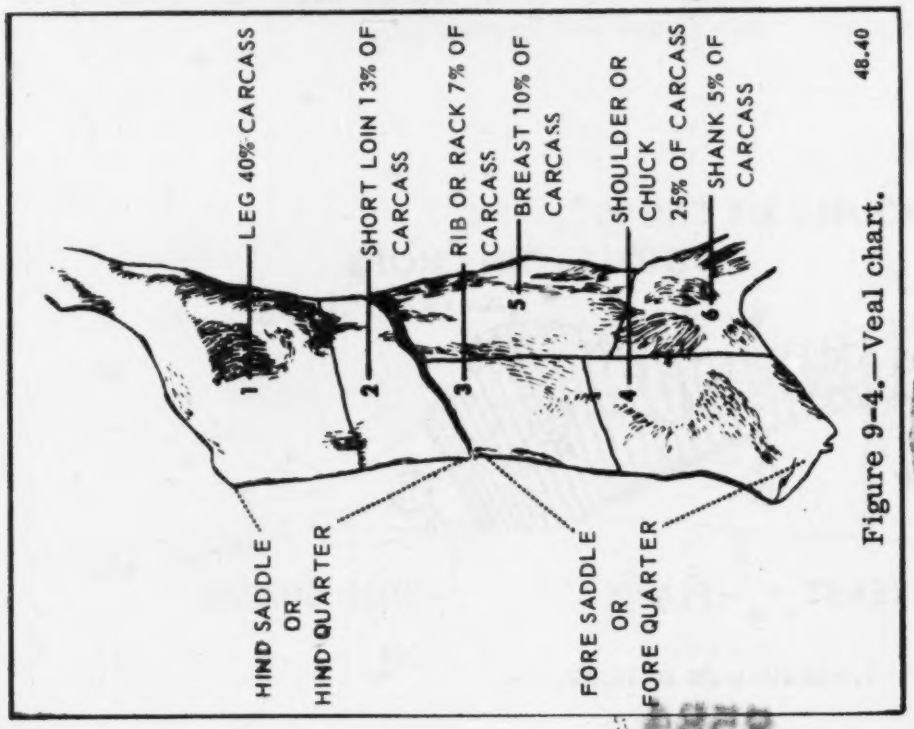

Figure 9-4.—Veal chart.

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INSIDE (TOP) LEG

Figure 9-5.—Cuts from veal hindsaddle used for cutlets.

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sirloin-rump butt are used. The shoulder, neck, and brisket are used for stews.

LAMB

Lamb is issued to the Navy general messes as frozen carcass, leg frozen, or frozen telescope. Carcasses are divided into primal cuts for the retail trade as shown in figure 9-6.

The major use of lamb in the Navy general mess is for chops. See figure 9-7.

PORK

Pork used by the Navy is in the forms of boston butt, loin (bladeless, boneless, string tied, tenderloin), spareribs, hams, and bacon. Pork cuts are procured both in the fresh and the cured state. Figure 9-8 shows the names and locations of the bones of a pork carcass.

Boston Butt

The boston butt cut is that portion of the skinned pork shoulder remaining after the picnic ham has been removed. See figure 9-9. This cut has the major portion of the bladebone still remaining, but the underlying excess of fat has been removed. This form of pork cut is not cured or smoked, but is used for preparing a number of meat dishes where moist heat is employed.

Loin

Loins are the choicest cuts of pork. They are used for roast pork and for chops prepared in a variety of ways, including both moist and dry heat methods.

Bladeless.—This is that portion of the loin remaining after the removal of the bladebone and related cartilage.

Boneless, String-Tied.—This is a completely boned item with tenderloin, cartilages, and rib figures removed.

Tenderloin.—This is a muscle removed from the loin section of pork sides. The tenderloin is relatively small in size. The use of this item is limited to a very few general messes.

Cutting the Loin

The steps necessary to complete boning of a pork loin from which the bladebone has been removed are shown in figure 9-10 on page 132.

Whole pork loins may be used for roasting if divided into two pieces of equal lengths; the pieces boned and string tied, or kept separate for roasting. See figure 9-11 on page 133.

The loin is used for roasting or is cut into pork chops with bones or without bones as illustrated in figures 9-12 and 9-13 on pages 134 and 135.

Spare Ribs

Spareribs are a bony but flavorful section of a pork side, made by separating the rib bones closely from the backbone and loin strip. See figure 9-9 on page 131.

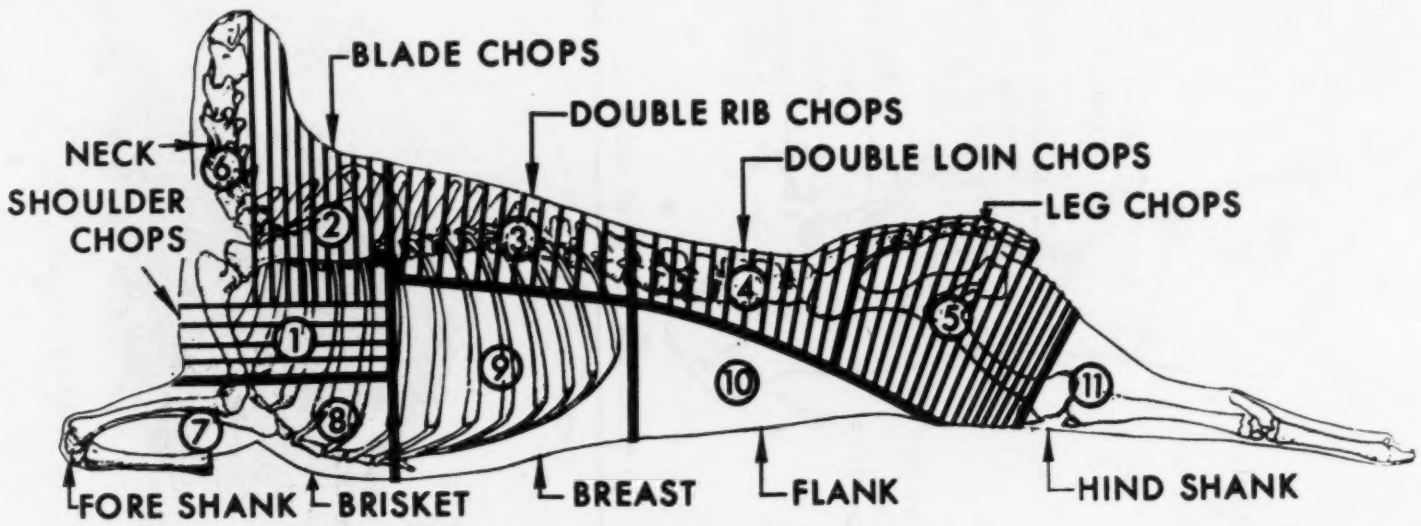

Figure 9-6.—Main cuts of lamb.

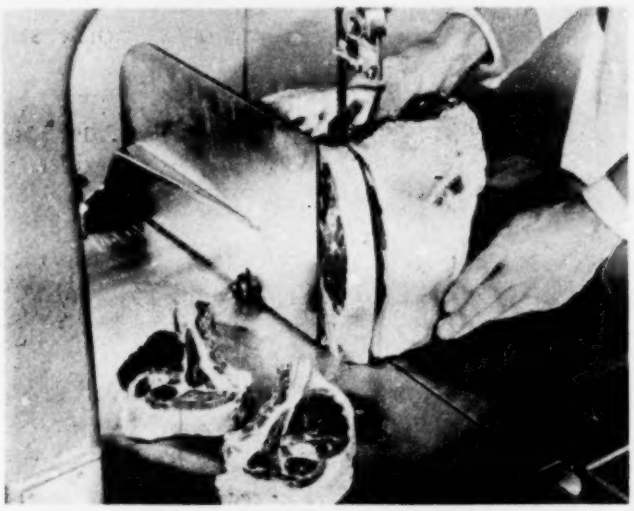

1 - ARM CHOPS. CUT UNSPLIT SHOULDERS AS SHOWN.

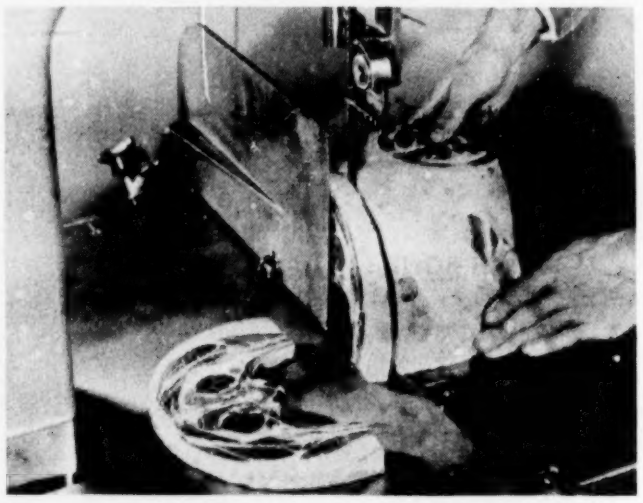

2 - BLADE CHOPS. CUT FROM UNSPLIT SHOULDERS AND THEN DIVIDE EACH CHOP INTO TWO PIECES. REMOVE CHINE AND FEATHER BONES.

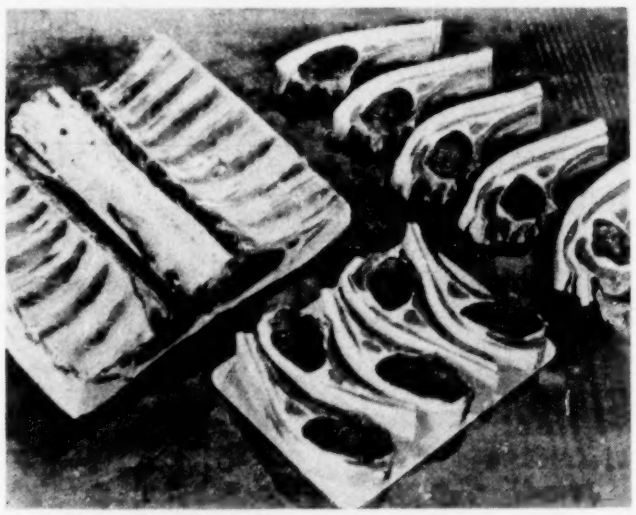

3 - RIB CHOPS FROM LAMB RACKS (SPLIT). REMOVE BACKBONE AS SHOWN AT LEFT. LOWER RIGHT--RIB CHOPS WITH FELL; UPPER RIGHT-FRENCHED RIB CHOPS.

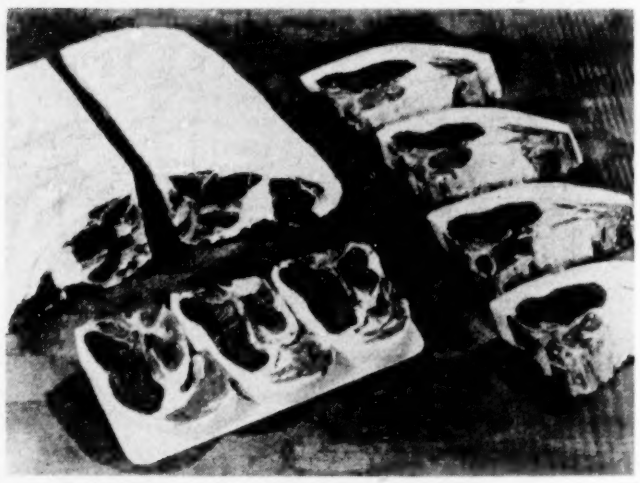

4 - LOIN CHOPS. SPLIT LOIN AS SHOWN UPPER LEFT, AFTER REMOVING FLANK, FELL, AND EXCESS FAT. LEAVE LOIN UNSPLIT FOR DOUBLE CHOPS.

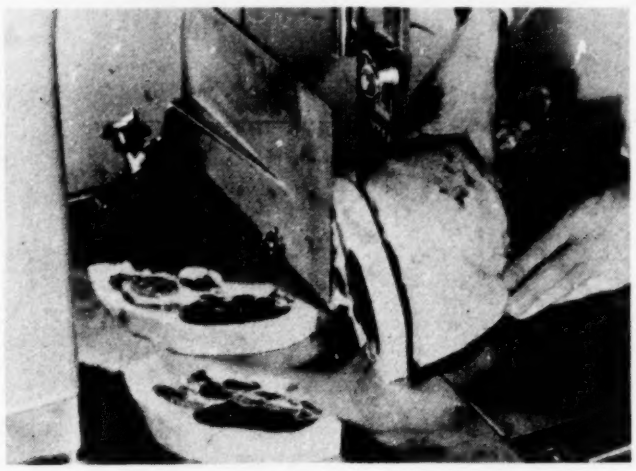

5 - SIRLOIN CHOPS. CUT LEG (SIRLOIN SECTION) AS SHOWN.

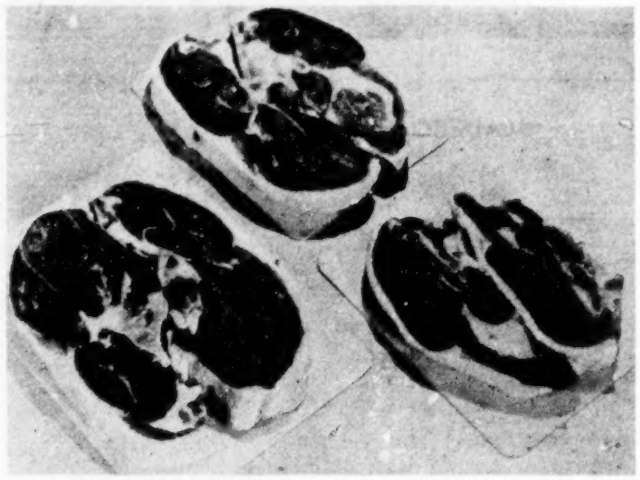

6 - TYPES OF CHOPS FROM LEG. LEFT-LEG; CENTER-SIRLOIN; RIGHT-PINBONE.

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Figure 9-7.—How to divide lamb carcass into chops.

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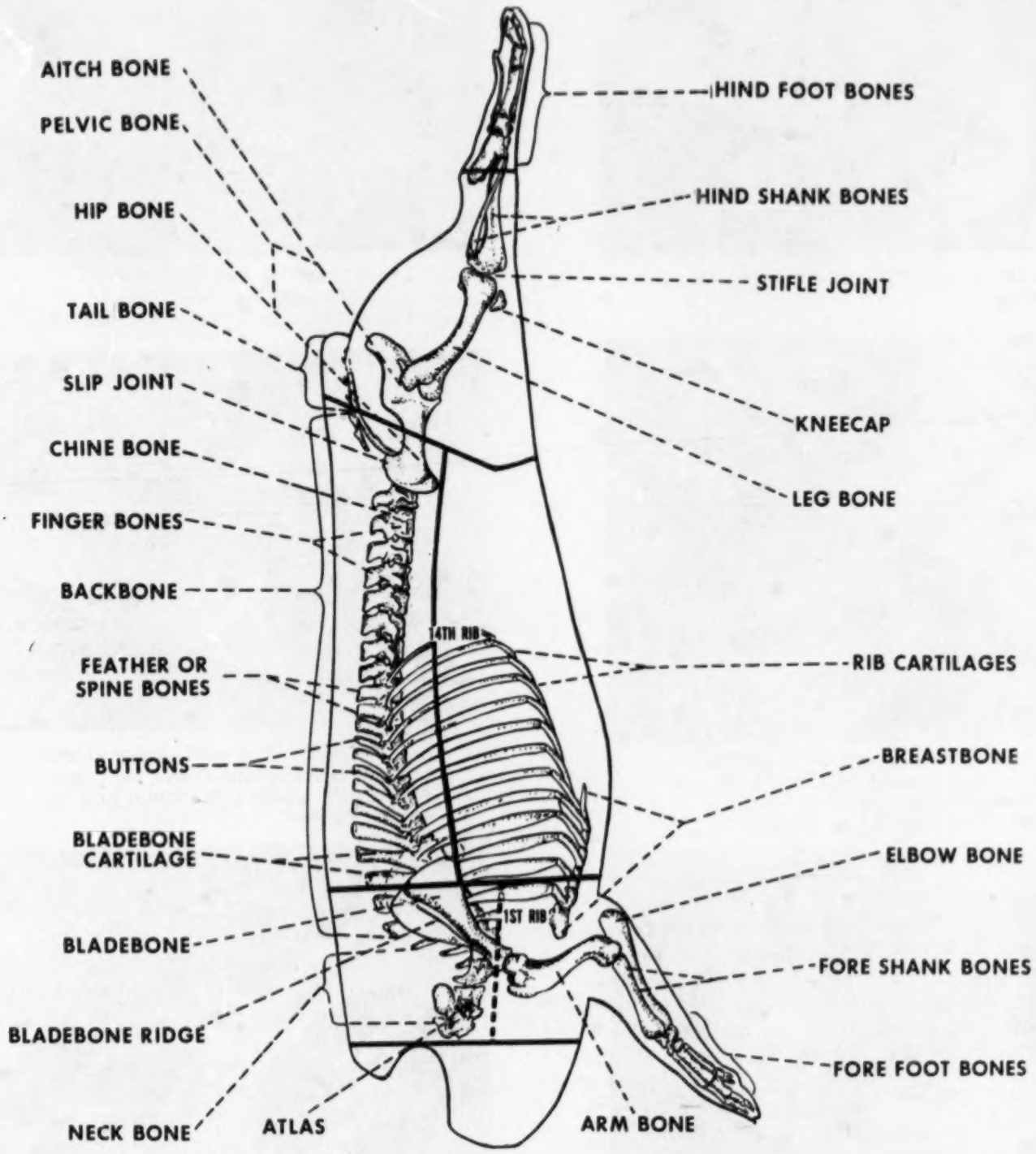

Figure 9-8.—Pork chart.

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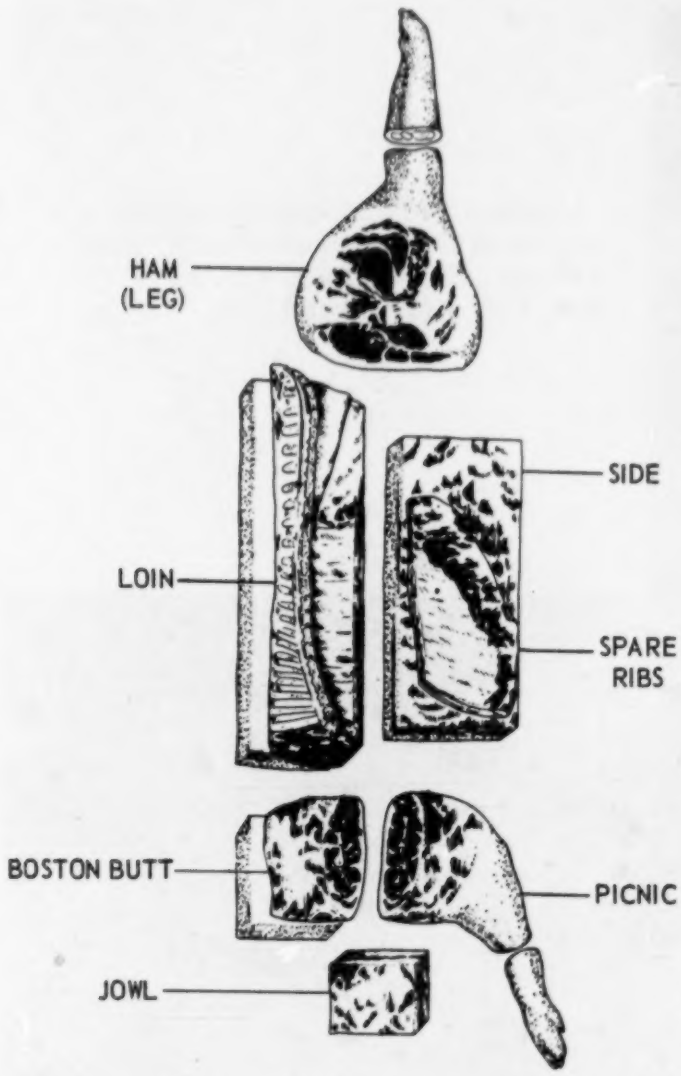

Figure 9-9.—Wholesale cuts of pork. 48.94

Bacon

Bacon is available for general mess use in several forms. The type of cure used on slab sliced and canned bacon varies according to the packer contract. For example, one type of cure is dry sugar-box or dry box cured. With process dry salt, sugar (an optional ingredient), nitrates, nitrites, and the spices are rubbed into the bacon. If sugar is used, the cure is referred to as dry sugar-box cure. The slices are packed in a box covered with a slatted lid so it can cure, hence the expression "box cure." The curing period covers 3 to 4 weeks, during which time moisture is withdrawn from the bacon as the salt is applied.

Ham

Canned whole ham and boneless frozen ham are used in Navy general messes.

Pear-shaped canned whole boneless ham (whole or partial) is perishable and must be stowed under refrigeration to maintain flavor and quality. It is precooked, but a thorough heating and glazing will enrich its flavor. Precooked, frozen boneless casing type hams average 9 pounds each and can vary from 8 to 12 pounds each. These hams are heated to an internal temperature of at least 150°F. The precooked frozen boneless hams are SMOKED, a treatment used on most cured meats to add color and flavor. An 18-hour smoke period is required for precooked hams.

Slicing Canned Ham

Whole cooked hams, packed in pear-shaped cans have high yield, ease of use, and economy. The full measure of these benefits is never reaped, however, if canned ham is improperly sliced. Uneven portions are wasteful and costly, besides being unattractive to serve.

The following machine slicing technique is recommended to obtain the maximum number of usable slices from either whole canned ham after baking or as it comes from the can for grilling.

As shown in figure 9-14 on page 135, the whole ham is first divided into three sections. The upper third section is cut straight across the butt end, and the remaining portion is halved into two even pieces lengthwise.

The slices are cut lengthwise across the butt section as well as the other sections as shown. Cutting with the grain of the butt section, as illustrated, is contrary to the general rule of meat carving: that is, meat should be carved across the grain to shorten lengthy muscle fibers and tenderize. Canned hams, however, are already tender products because of the process used; hence, they become another exception to the cross-grain carving rule. Cut the canned ham as directed to get the highest yield per ham.

THAWING METHODS FOR FROZEN MEATS

Frozen meat may be thawed in several ways. The preferred method is slow thawing because there is less drip loss in the meat. Meat thawed slowly yields a juicier and more palatable cooked product. An alternate method is recommended under circumstances where slow thawing is not practicable, such as on small ships with limited chill space, or whenever time is limited between meat issue and meat time. Once meat

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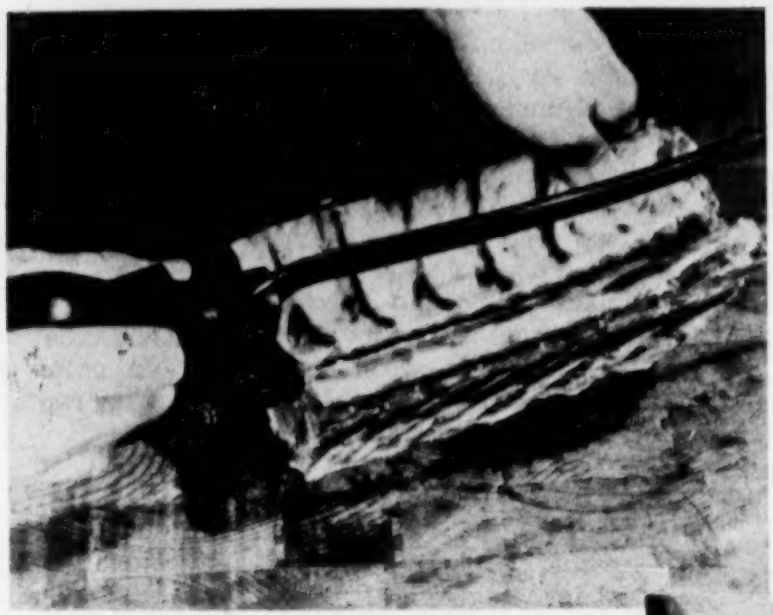

1 - LOOSEN THE BACKBONE BY SAWING ACROSS BASE OF RIBS AT A SLIGHT ANGLE SO THAT THE SAW BLADE WILL NOT CUT INTO THE "EYE" OF THE LOIN.

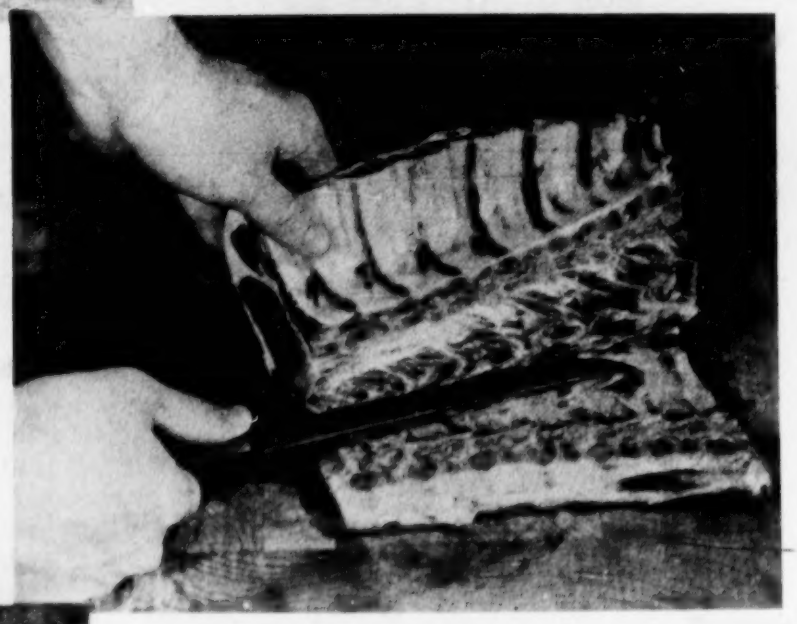

2 - REMOVE BACKBONE, LEAVING NO MORE MEAT THAN NECESSARY ON THIS BONE.

3 - LIFT BACKRIBS FROM MEAT. THE BONELESS BLADE LOIN IS USED FOR (1) ROAST AS INDIVIDUAL LOINS OR TWO TIED TOGETHER AS A BONELESS ROLL; AND (2) CHOPS AS SINGLE SLICES, OR BUTTERFLY CUTS.

Figure 9-10.—Steps in boning bladeless pork loin.

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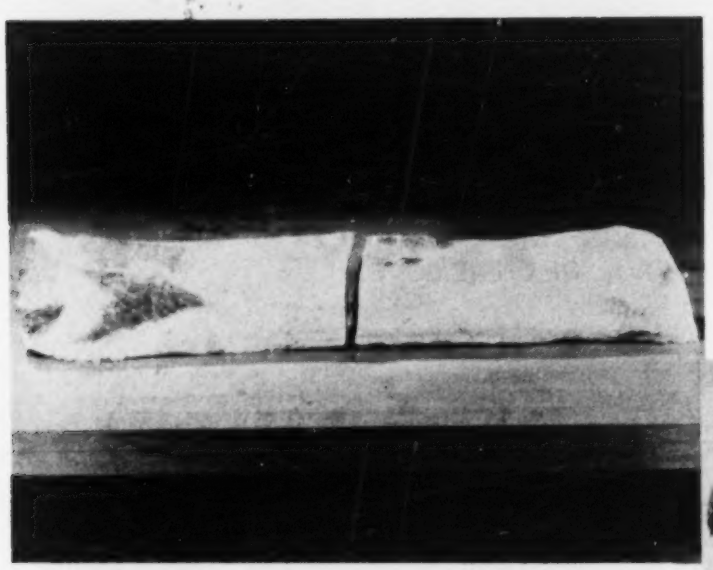

1 - PORK LOIN CUT INTO TWO EQUAL LENGTHS. SHOULDER OR LOIN END AT LEFT. RIB HALF OF THE LOIN AT RIGHT.

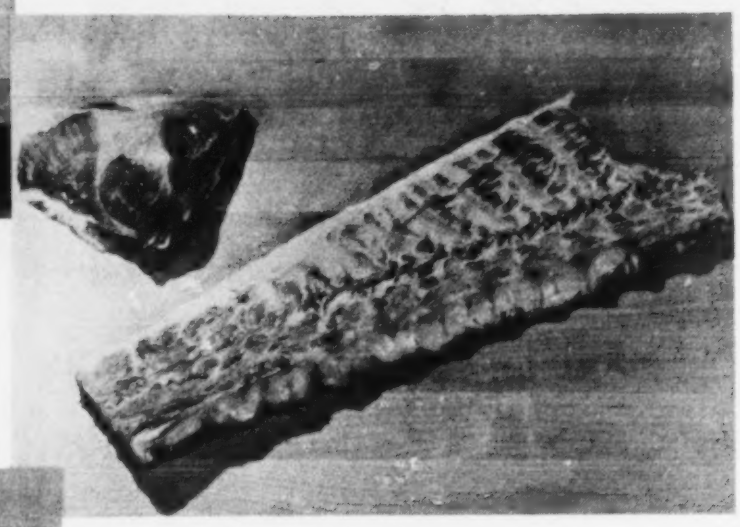

2 - PARTS REMOVED FROM RIB HALF OF PARTIALLY BONED PORK LOINS. BLADE PIECE, UPER LEFT, BACKBONE, LOWER.

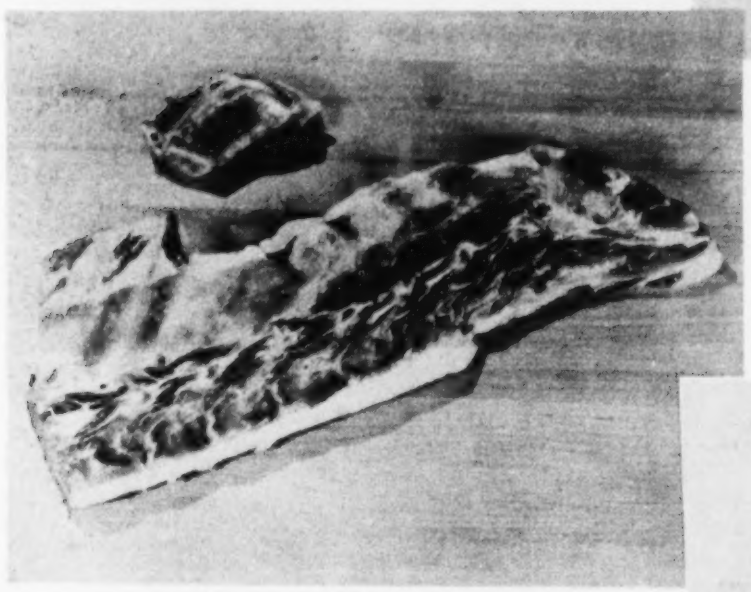

3 - PARTS REMOVED FROM LOIN HALF OF PARTICALLY BONED PORK LOINS. HIP BONE, UPPER LEFT, BACKBONE, LOWER.

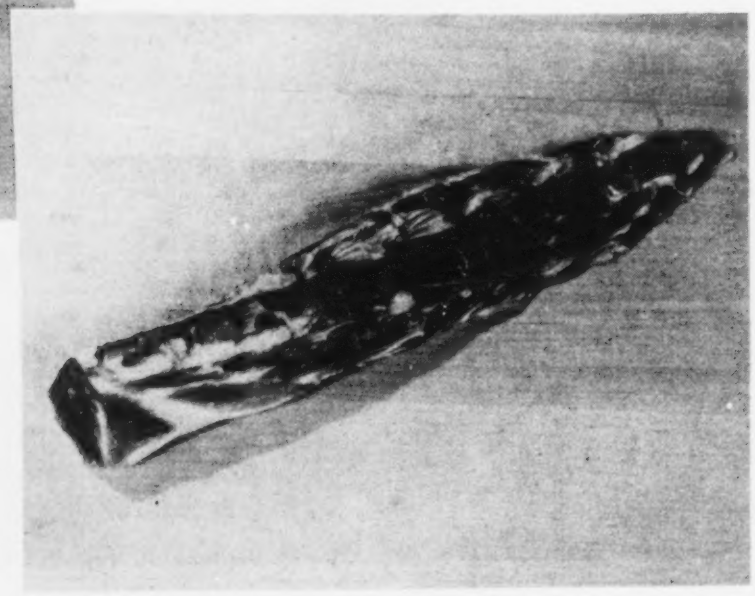

4 - PARTS REMOVED FROM LOIN HALF OF PARTIALLY BONED PORK LOINS. TENDERLOIN.

Figure 9-11.—Partially boned pork loin.

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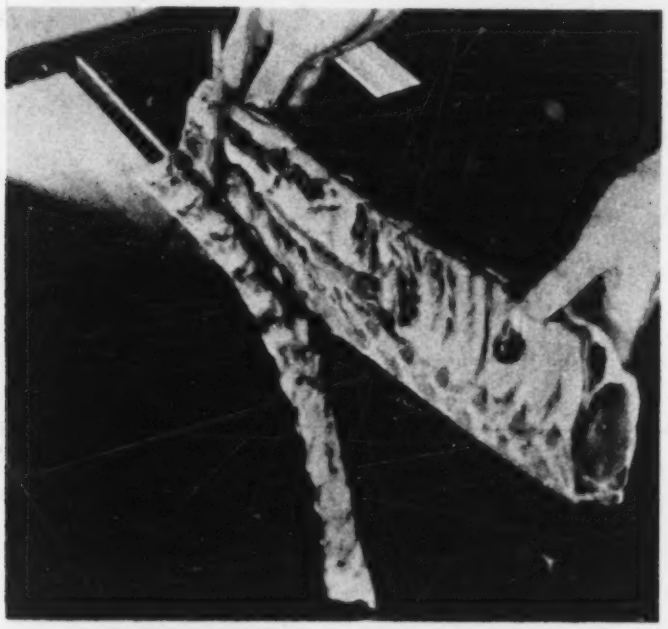

1 – REMOVE THE CHINE BONE FROM THE CENTER SECTION OF THE PORK LOIN. IF HAND SAW IS USED, CUT LOIN IN TWO PIECES TO FACILITATE REMOVAL OF CHINE BONE.

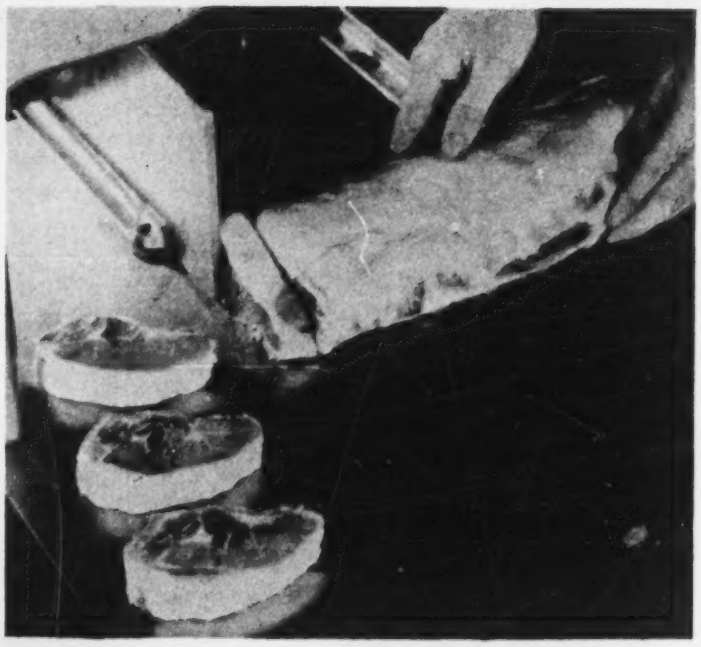

2 – CUT CENTER SECTION INTO CHOPS WITH POWER SAW. CUTTING CHOPS WITH A CLEAVER IS NOT RECOMMENDED.

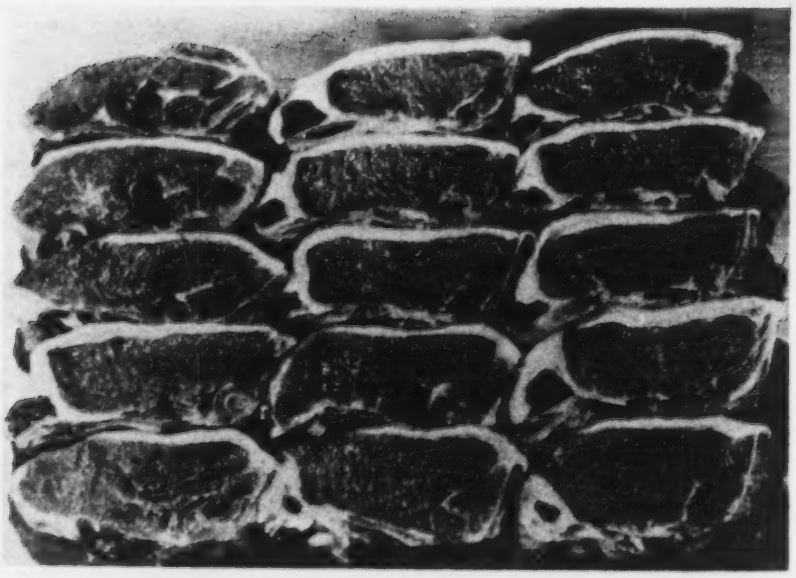

3 – CHOPS CUT OF UNIFORM THICKNESS.

Figure 9-12.—Steps in cutting bone in pork chops from the rib half of the loin (machine operation). 48.97

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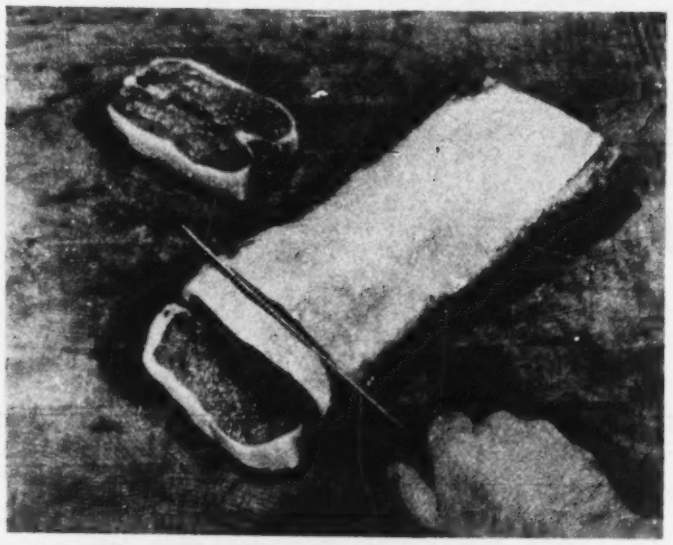

1 - CUT BONELESS LOIN (RIBS REMOVED) INTO CHOPS BY LEAVING ONE SIDE OF EACH DOUBLE CHOP HINGED TOGETHER WITH A THIN LAYER OF MEAT.

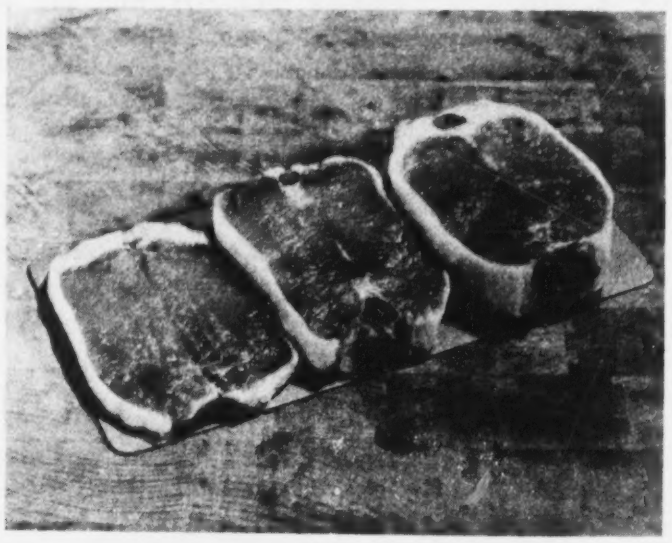

2 - BUTTERFLY CHOPS.

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Figure 9-13.—How to cut butterfly pork chops from loin (hand operation).

has been defrosted or thawed, it should be used as soon as possible, and not refrozen. Breakouts should not exceed the amount to be served.

Preferred Thawing Procedure

Break out the quantity of meat required. Remove from shipping container, but leave inside wrappings on the meat. Thaw slowly at reefer temperatures (36°-38°F) until almost completely thawed. The thawing period will vary according to:

1. Size of the meat cut. The larger the size, the longer time required.
2. Bone-in or boneless state. Bone-in meat takes less time to thaw.
3. Air temperature and circulation in chill space. Moving air accelerates thawing.
4. Quantity of meat being thawed in a given area. A large amount will lower the temperature of the room and deter thawing action. Spread the cuts out. Do not stack them.

It is almost impossible to predict exact time required to thaw meat unless there is a perfectly controlled set of circumstances. Frozen wholesale beef cuts and frozen boneless beef may require up to 48 hours to thaw at 36°-38°F temperatures; however, veal sides and telescope lamb may thaw in about 36 hours at this temperature range. Cuts from pork, veal, and lamb would probably thaw in about 24 hours under refrigerator temperatures.

Alternate Thawing Procedure

If it is necessary to thaw the frozen meat quickly, thaw it in the original sealed container at room temperature (72°F or above) for a period of several hours. Then, open the box. If the meat is not completely thawed, it will become so rapidly. The important point to remember is that unsealed boxes of the various six-way beef components, for example, will be the equivalent of a refrigerator, allowing meat to thaw slowly. The thawing continues inwardly toward the center of the package. Meanwhile, the outside thawed pieces will remain sufficiently cold to prevent spoilage while the center is thawing.

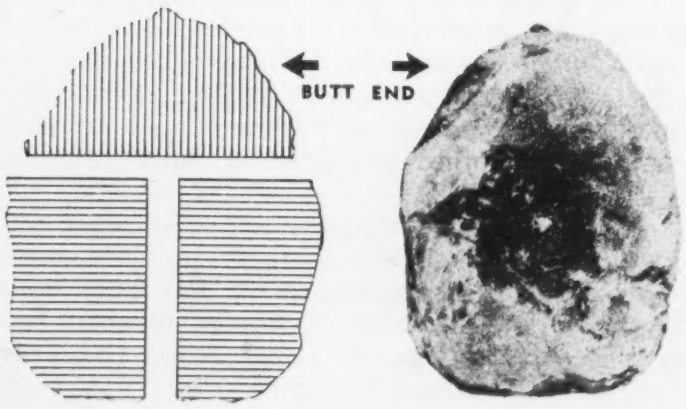

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Figure 9-14.—Slicing boneless ham.

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CHAPTER 10

FOOD PREPARATION

Food is your business. This chapter covers some of the what, how, why, and when of food preparation.

There is a short phrase that expresses the vital importance of your job as Commissaryman—men must eat to live. How the men of your ship will eat depends on you. Remember that the desired end result of all your functions as a Commissaryman is for the food to be accepted by the men on the mess line. To achieve this, you must continually strive for perfection in providing palatable, wholesome, and attractive food. You can get a great deal of satisfaction from serving an excellent meal, and your diligence, zeal, and attention to detail in preparing food can do much to keep the morale high and the crew happy.

To ensure efficient day-to-day operations of the general mess, the senior Commissaryman uses management tools which provide guidance for the men assigned to the galley. These tools are explained so that you will have a clear understanding of why they are used and how they serve to promote efficiency in the galley.

FOOD PREPARATION WORKSHEET

The Food Preparation Worksheet (NavSandA Form 1090) is an important part of food preparation. When posted in the galley, it becomes a written directive—a medium for passing information from supervisory personnel to watch captains and other key general mess personnel. See figure 10-1.

Study the Food Preparation Worksheet when you are on watch; it provides pertinent information concerning the preparation of the daily menu. The menu item column is copied directly from the approved General Mess Menu (NavSandA Form 1080). Observe figure 10-1; notice that space is provided for the Navy-Marine Corps Recipe Card number to be used and the portions to be prepared. Space is also provided for any additional instructions from the senior Commissaryman regarding the preparation and serving of a menu item.

The Food Preparation Worksheet is a valuable record of the menu for the day. Meaningful information which is a "must know" for any person supervising a general mess operation can be posted on it. Such information includes the number of persons actually fed and the acceptability of specific menu items. All this information is beneficial when the senior Commissaryman prepares future Food Preparation Worksheets.

STANDARDIZED RECIPES

All food for the general mess should be prepared according to the recipes published in the Navy-Marine Corps Recipe Service or recipes which have been approved by the commanding officer.

The Navy-Marine Corps Recipe Service consists of over 700 recipes which have been developed specifically for use in the general mess. The recipes are standardized to yield 100 portions and have been pretested in Navy test galleys as well as aboard ship, and reviewed by the Food Advisory Committee of the National Security Industrial Association.

The use of standardized recipes ensures quality food preparation by allowing more time for skill and finesse in preparing, serving, and merchandizing food. Variations in quality and quantity do not occur because guesswork is eliminated. Exact amounts of the various subsistence items required by a menu and accurate yields prevent leftovers and promote food cost control. Subsistence items for the day's menu can be drawn from the issueroom and accurately posted to the daily S. and A. Form 1059-1.

Recipes in the Navy-Marine Corps Recipe Service are printed on 5" by 8" cards. The yield for each recipe is given in weight and

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amount or both in the upper left corner. The size of the individual portion appears in the upper right corner. The ingredients are designated in weights, measures, or both. The measure specified for each ingredient is comparable to its weight. More accurate results can be expected when the ingredients are weighed instead of measured.

The amounts (measures) of ingredients are designated in teaspoons, tablespoons, cups, pints, quarts, and gallons. Listed below are the abbreviations used on the recipe cards; equivalents of weights and measures; and sizes of scoops or dippers:

Abbreviations Used on Recipe Cards

A.P.	= as purchased
E.P.	= edible portion
t or tsp	= teaspoon
T or tbsp	= tablespoon
C	= cup
pt	= pint
qt	= quart
gal	= gallon
oz	= ounce
lb	= pound

Equivalents of Weights and Measures

3 teaspoons	= 1 tablespoon
16 tablespoons	= 1 cup
1 cup	= $^1/_2$ pint
2 cups	= 1 pint
2 pints	= 1 quart
4 quarts	= 1 gallon
8 quarts dry	= 1 peck
4 pecks	= 1 bushel
16 ounces	= 1 pound
32 fluid ounces	= 1 fluid quart

Sizes of Scoops or Dippers

No. Per Quart	Measure	Approximate Weight
30	$^1/_8$ cup (2 tbsp)	1 ounce
16	$^1/_4$ cup (4 tbsp)	2 ounces
12	$^1/_3$ cup (5 tbsp)	$2^1/_2$ ounces
10	$^2/_5$ cup ($6^2/_3$ tbsp)	$3^1/_2$ to 4 ounces
8	$^1/_2$ cup (8 tbsp)	4 ounces

Steps in Using Standardized Recipes

There are five steps which you must follow when you are using standardized recipes, if an acceptable, uniform end-product is to be prepared. These steps are as follows:

1. Know the number of servings you are to prepare. Refer to the Food Preparation Worksheet for this information.

2. Read the recipe all the way through. By carefully reading the recipe, you will know what ingredients are needed, the quantity of each, and the method to be followed in preparation.

3. Adjust the recipe, which will yield 100 servings, to the number of servings you are to prepare. Let us assume that the Food Preparation Worksheet calls for 348 servings.

You will need a working factor—and this factor is obtained by dividing the number of servings needed by 100. In this instance, 348 divided by 100 equals a 3.48 working factor. The quantity of each ingredient in the recipe is multiplied by the working factor.

If, for example, you are going to adjust the recipe for beef loaf J-42 (fig. 10-2) to yield 348 servings, the quantity of bread, onion, and green pepper listed would be changed as follows:

a. The weight of each ingredient as listed on the recipe is multiplied by the working factor.

Bread, dry	Green Peppers
4 lb	.50 lb
x 3.48	x 3.48
13.92 lb	1.7400 lb

Onions

```
  1.25 lb
x 3.48
  1000
  500
 375
4.3500 lb
```

b. The part of a pound, as the .92 pound of bread, dry; .35 pound of onions; or .74 pound of green peppers, is converted to ounces by multiplying 16 by the decimal.

```
   16                16 ounces
 .92 lb bread        .35 lb onions
   32                80
 144                 48
14.72                5.60 ounces
```


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FOOD-PREPARATION WORKSHEET
NAV. SUP. FORM 1090 (Rev. 3-66)

DAY	DATE
TUESDAY	8 MARCH 1966

MEAL	ALLOWED	PREDICTED	ACTUAL
BREAKFAST	100	80	80
DINNER	100	95	95
SUPPER	100	95	50 ([illegible])

ACTIVITY	PREPARED BY (SENIOR COMMISSARYMAN)	PORT WATCH CAPTAIN (SIGNATURE)	STARBOARD WATCH CAPTAIN (SIGNATURE)
MELVILLE GALLEY NEWPORT, R.I.	J. H. Beaver CSC	R.C. Jones CS1	R. White CS1

	RECIPE CARD	MENU ITEM	PORTIONS TO PREPARE	INSTRUCTIONS	START PREP-ARATION	START COOKING	NO. OF BATCHES	PORTIONS LEFT-OVER	COMMENTS (acceptability, use of leftovers, reasons)
BREAKFAST		Chilled Grapefruit Halves	100	See reverse side	0615		As needed	40	Return to chill space
		Assorted Dry Cereal		Open as needed	0615		As needed		
	E-3	Hot Oatmeal	25	Leave slack - will thicken	0600	0615	2	10	Discard. Fair acceptability
	F-17	Plain Omelet	100	Follow Note 1 on Recipe. Use size 1 ladle	0600	0625	As needed	–	Excellent indiv omelets
	J-100	Baked Pork Sausage Links	100	Drain at least twice during baking	0600	0625	2	–	Very good
	C-36	Sugared Doughnuts	100	See reverse side				–	Slightly greasy
		Hot toast		Toast 12 slices at a time	0615	0625	4		
	L-G-7	Roast Turkey	100	Turkey completely thawed - 350 oven	1145	1145			
DINNER	J-5	Grilled Beef Steaks to order	100	Watch timing. Have some "rare" at all times	1100	1125	To order	–	Steaks tender
	Q-47	French Fried Potatoes	100	Follow Note 3 on recipe. Check temperature	1100	1125	6	–	Very acceptable
	Q-24	Buttered Whole Grain Corn	100	Measure the water carefully	1115	1120	4	10	Acceptable. Chill space
	Q-77	Stewed Tomatoes	80	Use dehydrated onions in Step 2	1045	1110	3	–	Acceptable. Bread chilled today.
	M-41	Cottage Cheese Salad	75	See reverse side. Use dehy. cottage cheese					
		Assorted salad bar		See reverse side					Return to chill space
	C-40	Toasted Garlic Bread		Use dehydrated garlic in Step 1					
	C-15	White Bread		See reverse side					
	D-2	Banana Filled Cake	100	See reverse side					
	I-15	Marshmallow Frosting	100	See reverse side				–	Very acceptable
SUPPER	P-2	Beef Noodle Soup	80	Use Soup & Gravy Base, beef. Break noodles	1615	1630	1	20+	Discard
	L-G-7	Hot Sliced Turkey Sandwich	100	Let cooked turkey set 30 min. Machine slice	1615		1	10	Turkey tender and moist - 2 not sliced - in chill space
	O-7	Brown turkey gravy	100	Taste for seasoning. Not too much pepper	1600	1615	2	–	
	O-57	Mashed Potatoes	100	Do not over-beat	1545	1600	4	20	Acceptable - chill space
	Q-12	Buttered Broccoli	60	Add 2 tsp oregano to butter in Step 3	1600	1605	4	10	Acceptable - chill space
	Q-80	Buttered Mixed Vegetables	60	Watch timing carefully	1600	1610	4	10	Acceptable - chill space
	M-20	Lettuce Salad	75	See reverse side				25	Chill space
		Salad Bar		See reverse side					
		Assorted Breads		See reverse side					
	G-27	Cranberry Crunch w/whipped topping	100	See reverse side				35	Good. Serve wed. non-serve

PORT WATCH CAPTAIN R.C. Jones, CS1 STBD. WATCH CAPTAIN R. White CS1

COMMISSARYMAN 3 & 2

GUIDELINES FOR PREPARATION AND USE OF FOOD PREPARATION WORKSHEET

The senior Commissaryman prepares the Food Preparation Worksheet; watch captains review and sign the worksheet before it is posted to indicate understanding and concurrence.

It is suggested that the format be posted on clipboard (7520-254-4610 measuring 9 by 15 inches). When posted on this clipboard and hung in the galley, the form is readily available for reference by Commissaryman when he is making his "check rounds."

The worksheet may be filed in legal-size manilla folders (9 x $14^{3}/_{4}$ inches).

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RECIPE CARD

Standard Navy-Marine Corps Recipe Card number or locally approved recipe.

MENU ITEM

List the menu items to be prepared indicating any leftover foods that are to be served with the meal. Do not include such items as crackers, assorted breads, jelly, jam, milk, coffee, etc. A pattern for service of these items should be developed at each activity and posted in the galley or serving counter area.

PORTIONS TO PREPARE

The number of portions is determined by the predicted number to be fed or the acceptability of the menu item.

INSTRUCTIONS

Special instructions regarding the preparation and/or service of menu items and the service of leftover food to be served with the meal are to be entered. To say "follow the recipe card" is not necessary; the recipe card number in the first column indicates that the recipe will be followed. An example of an instruction would be "use dehydrated onions in Step 3" or "slice meat loaf on the line."

START PREPARATION

Quality food preparation requires time and attention to detail. Menu items to be prepared, sanitary precautions, and the number of men to do the work, determine the time for precooking preparation.

START COOKING

The length of time required to cook a menu item (first batch), and the scheduled meal hour, determine the time actual cooking should begin. It should be timed so that the menu item can be transferred to the serving counter for immediate service.

NUMBER OF BATCHES

Every effort should be made to practice small-batch or progressive cookery. The number of batches, and quantity per batch, is determined by the total number of portions to prepare, the length of the serving hour, and peak periods.

Figure 10-1.—Food Preparation Worksheet. 48.99.2

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COMMISSARYMAN 3 & 2

XXXX	VEGETABLE PREPARATION ROOM			BAKE SHOP			MEAT PREPARATION ROOM		
	ITEM	QUANTITY	INSTRUCTIONS	ITEM	QUANTITY	INSTRUCTIONS	ITEM	QUANTITY	INSTRUCTIONS
BREAKFAST	Grapefruit	50	Wash. Cut as needed. Have on line at 0625	Cake Doughnuts	100	Follow Note 2 on recipe card	Link Sausage	25 lb	
	Celery	1½ lb	Chopped by 1000				Beef, boneless, grilled steak	47 lb	Break out of chill space at 1000
	Potatoes	58 lb	French Fry Cut - by 1000						
	For Salad Bar - ready for line at 1100						Boneless, string-turkey	45 lb	Break out of chill space at 1115
	Salad								
	Cucumbers	3 lb	Unpeeled diced						
	Radishes	3/4 lb	Chopped						
	Green Onions	1 cup	Chop fine	White bread		Slice as needed			
	Green peppers	3/4 lb	Chop fine						
DINNER	Cottage Cheese	8 lb	Reconstitute per instructions	Banana Filled cake	100	Sheet cake - not as layer cake	Bacon	15 lb	Break out for Wed. breakfast. Slice, pan and return to chill space.
	Lettuce	6 heads	Separate into cups						
	Pickles, sweet	1-No.10cn		Marshmallow Frosting					
	Olives, ripe	1-No.10cn							
							Beef, boneless, pot roast	38 lb	Put in chill space to thaw - on menu Thurs. Supper.
				Assorted Breads		Slice as needed			
SUPPER	Lettuce	13 heads	Cut each head into 6 wedges	Cranberry Crunch	100	Cut 6 by 9			
				Whipped Topping		Use dehy. topping - a scant #30 scoop per serving	Pork loin	45 lb	Cut into 3 oz chops. Pan. Put in chill space. Wed. dinner.
	For Salad Bar								
	Tomatoes	5 lb	Cut 4 slices per tomato						
	Carrots	3 lb	Cut julienne						
	Dill pickles	1-No.10cn	Cut 6 sticks per pickle						
							Beef, boneless, diced	26 lb	do any necessary trimming and cutting. Wed.supper
	P. Smith CS 2 (Signature)			J. Bay CS2 (Signature)			D. Peters, CS2 (Signature)		

48.99.3

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GUIDELINES FOR PREPARATION AND USE OF FOOD PREPARATION WORKSHEET—
Continued

VEGETABLE PREPARATION

The vegetable, quantity, method of preparation (diced, sliced, etc.), and the hour the preparation should be accomplished should be entered. Any additional quantities used should also be entered by the spud coxswain. At the end of the day, the spud coxswain should sign to indicate all has been accomplished per instructions.

BAKE SHOP

The number of portions of any dessert item and hot breads should be entered. Note any special instructions for time, portion size, garnish, cutting and serving. Any additional items issued to serving line or for use in bake shop should be entered, and any leftover dessert items returned after a meal serving hour. At the end of the day the baker should sign to indicate that all has been accomplished per instructions.

MEAT ROOM

List the meat items, quantity, and any specific instructions for the Commissaryman assigned to the meat room or for the watch captain. Weekly menu should be reviewed when this section is being completed so that frozen meat items scheduled for meals 2 or 3 days in the future, can be removed from the freeze space to chill space to allow for proper thawing. Quantities of meat items needed during a serving period, in addition to those listed, should be noted. Responsible Commissaryman or watch captain should sign at end of day's work.

AFTER THE MEAL HAS BEEN SERVED

Watch captain:

1. Posts the number of persons actually fed (obtain this information from MAA).
2. Completes the "Portions Leftover" column.

SENIOR COMMISSARYMAN AND/OR WATCH CAPTAIN

Completes the "Comments" column indicating the acceptability of new items and the course of action to be taken in regard to leftover food, noting reason for portions short, or for preparation in excess; acceptability of menu items.

Figure 10-1.—Food Preparation Worksheet—Continued.

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BEEF LOAF

J. MEAT No. 42

YIELD: 100 Portions (8 Loaves) — EACH PORTION: 1 Slice

INGREDIENTS	WEIGHTS	MEASURES	PORTIONS	METHOD
Bread, dry	4 lb	2 gal		1. Moisten bread with water; press out and discard excess water.
Water		To moisten		
Onions, finely chopped	1¼ lb	1 qt		2. Sauté vegetables in hot, melted shortening until light brown.
Peppers, green, finely chopped	½ lb	¼ qt		
Celery, finely chopped	1 lb	¾ qt		
Shortening	7 oz	1 cup		
Beef, boneless, ground	29 lb			3. Combine moistened bread, sautéed vegetables, ground beef, eggs, salt, and pepper. Mix thoroughly but lightly. Avoid overmixing, if using a mixer.
Eggs, whole, beaten	1 lb 3 oz	12 eggs (1¼ pt)		
Salt	6 oz	10 tbsp		
Pepper	½ oz	2 tbsp		
Water (variable)		3 cups		4. Add water only if necessary. 5. Shape into 5¼ lb loaves in lightly greased roasting pans (18 by 24 inches). 6. Bake at 325° F until done, approximately 1½ hours. Drain off excess fat.

NOTE: 1. Cut 13 slices per loaf.

2. Dehydrated sliced onions and dehydrated green peppers may be used in Step 2. Reconstitute according to instructions on Recipe Cards A–11 and A–12.

VARIATIONS

1. VEAL LOAF: Omit green peppers; use 20 lb of ground veal and 10 lb of ground beef.
2. PORK LOAF: Omit green peppers; use 15 lb ground lean pork and 15 lb of ground beef.
3. VEGETABLE MEAT LOAF: Add 1 lb of carrots to vegetables, and 2 cups of catsup to meat mixture. Pour 1½ qt tomato juice over meat loaf before baking.

48.47.1

Figure 10-2.—Recipe for beef loaf.

16 ounces
.74 lb green peppers
64
112
11.84

c. After the part of a pound has been converted to ounces, use the following scale to ROUND them off.

.01 to .12 = 0.

.13 to .37 = 0.25 or $^1/_4$ ounce

.38 to .67 = 0.50 or $^1/_2$ ounce

.68 to .87 = 0.75 or $^3/_4$ ounce

.88 to .99 = 0.99 or 1 ounce

According to the scale,

14.72 ounces of bread will be rounded to $14^3/_4$ ounces

5.60 ounces of onions will be rounded to $5^1/_2$ ounces

11.84 ounces of green peppers will be rounded to $11^3/_4$ ounces.

Going back to the original calculation: 13.92 pounds of bread, dry, will be 13 pounds $14^3/_4$ ounces; 4.35 pounds of onions will be 4 pounds $5^1/_2$ ounces; and 1.74 pounds of green peppers will be 1 pound $11^3/_4$ ounces.

If you decide to use the volume measures which are listed on each recipe, instead of the weights, the same procedure is used; 3.75 cups of onions times 3.48 equals 13.05 cups. The part of the cup must be changed to teaspoons or tablespoons so you multiply 16 tbsp per cup times .05 and you get .80 or $^3/_4$ tablespoon.

On occasions you may have to adjust the recipe on the basis of the amount of ingredients available rather than for the number of servings. When you increase the quantity of each ingredient in the recipe to yield 348 servings, you will need 100.92 pounds (29 pounds times 3.48) of beef. But you have been issued 99 pounds and are instructed to use that amount of meat. Knowing that the proportion of all ingredients in the recipe must be in balance to ensure an acceptable end-product, you again calculate a working factor. This is done by dividing the pounds you have to use by the pounds required to yield 100 servings.

For example, 99 pounds divided by 29 (pounds per 100 servings) equals a 3.41 working factor. The quantity of each item in the recipe will be multiplied by 3.41.

4. Before you start to prepare the recipe, assemble all of the necessary ingredients, the measures or scale, the mixing spoons or beaters, the right size pan, and the number of pans you will need.

5. Place the recipe so that as you work, you can follow each step as it is written on the recipe card. Then carefully and accurately do each step. Remember, there are no shortcuts.

SANITARY ASPECTS OF FOOD PREPARATION

Every precaution should be taken to handle food under proper sanitary conditions to prevent contamination.

The following paragraphs discuss certain procedures that should be followed when you are preparing food.

Safe Holding Temperatures for Cooked Foods

Protein foods which are not served immediately after cooking should be either chilled to temperatures of 40°F or lower (but not frozen) or held at 140°F or higher. Protein foods include meats, fish, poultry, gravies, meat stocks, soups, eggs, custards, cream fillings, and milk.

Cooked protein foods which have been held at temperatures between 40°F and 140°F for more than 3 hours should be considered unsafe for consumption and destroyed. If foods are refrigerated at intervals and then permitted to warm up, the total time of the various periods between 40°F and 140°F should not exceed 3 hours. Protein foods that are composed of ingredients which are hand-peeled, hand-sliced, or hand-diced after cooking should never be used as leftovers; the 3-hour limit between temperatures of 40°F and 140°F is usually taken in preparing, chilling, and serving the food. Hand preparation not only increases the chance of contamination, but generally increases the length of time that these foods are held at room temperatures.

You should not return opened jars or bowls of mayonnaise and cooked salad dressing from salad bars to refrigerators for re-use at a later meal, because of the danger of miscalculation of total lapsed time that these salad dressings have been held at temperatures between 40°F and 140°F. Instead, mayonnaise and cooked salad dressings should be placed on the salad bar in small quantities, and should not be returned from the salad bar for re-use.

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Leftovers to be Chilled

When leftovers or warm foods are chilled, care should be taken to assure prompt and thorough chilling (40°F or below) to the center of the food mass. Foods that are to be refrigerated should be placed in shallow pans to a depth of not more than 3 inches and should be covered with lids or waxed paper. Such foods should not be put in large deep pans, as chilling may take so long to get to the center of the food mass that sufficient time is allowed for growth of harmful bacteria and the development of toxin. Guard against any other procedures which may delay the cooling of the food. Place food to be chilled in the refrigerator immediately. Do not save leftovers for more than 36 hours. Freezing leftovers is prohibited.

Ground Food

Refrigerate immediately food which has been ground or chopped if it is going to be cooked later or incorporated in a made-dish. Such ground or chopped food should be refrigerated in shallow pans filled to a depth of not more than 3 inches. Cover the food until it is ready for cooking.

Meats

Meats which are cut, sliced, or diced should be placed in shallow containers, covered with lids or waxed paper, and refrigerated immediately. The temperature of the meat cutting room should be maintained at 50°F to 60°F, if possible.

Reconstituted Dehydrated Foods

Foods such as reconstituted dried eggs and vegetables, are as susceptible to spoilage after reconstitution as the fresh items. After dehydrated foods have been reconstituted, they should not be allowed to remain at room temperature more than 3 hours from the time the water is added.

SOUPS

Soup is a tasty, popular food. It is nutritious and wholesome and stimulates the appetite. Soup should be served at least once a day in cold weather, if practicable, and at least every few days regardless of the weather.

Kinds of Soups

Soups are basically of two kinds; thin or clear soups (light) and thick or hearty soups (heavy). The thin or clear soup is usually served before a heavy meal. The heavy soup is served with a light meal and may be sufficiently heavy to constitute the main dish of such a meal.

Broth and consomme are examples of light soups and are made from basic soup stock. Broth is made from stock using only one type of meat, and consomme is made from a very strong, clear stock from one or more types of meat, plus vegetables. Vegetable soup, celery soup, onion soup, and rice soup are other examples of light soups. No thickening agent is added to the light soup.

The hearty or heavy soups are: (1) those that are thickened with flour or cereals such as barley, rice, or macaroni; (2) cream soups and chowders made from either a stock base to which hot milk is added or from a thin white sauce, and (3) purees, made from cooked peas, beans, or cooked fresh vegetables which are put through a sieve and then added to a seasoned stock.

Soup Stock

Meat stock is made by using bones (beef, ham, veal, or lamb) which have been sawed not over 6 inches in length. The sawed bones, small pieces of less tender cuts of meat, and vegetables are placed in a steam-jacketed kettle, covered with cold water (liquids from canned cooked vegetables may be used), and allowed to simmer slowly for 6 hours. The stock is then strained from the solids and is ready to form the basis of whatever type of soup is to be prepared.

During the simmering period, the bones and meat should be kept submerged in liquid. In this period, the meat gives off fat which rises to the surface. When the stock is thoroughly cooked the fat may be removed by: (1) placing a lettuce leaf in the hot stock—to be removed when the leaf has absorbed the fat; or (2) placing the stock in the refrigerator to chill. The fat forms a thin layer on top of the stock and is easily removed with a skimmer.

The P (soups) section of the Navy-Marine Corps Recipe Service contains recipes for various kinds of meat and chicken stock. The ration dense items, instant beef soup and gravy base, and instant chicken soup and gravy base, may be reconstituted for use in any soup recipe.

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These powdered bases are seasoned and when reconstituted in boiling water have the characteristic flavor of beef broth or chicken broth. The proportions to be used when reconstituting these bases are included in the A (miscellaneous) section of the recipe service.

Soup stock spoils easily—HANDLE IT CAREFULLY. It should be placed in a clean container, covered securely with the container lid, and stored in the refrigerator until ready to use. Make it fresh every day.

Vegetables for Soup

The vegetables most commonly used for soups are celery, carrots, beans, peas, green peppers, onions, tomatoes, and okra. Cut the vegetables into small cubes, or into match like strips called julienne; cook each vegetable separately until it is tender, using as little water as possible. Then add both the solids and the cooking liquids to the stock. This cooking liquid contains valuable vitamins as well as some of the flavor of the vegetable.

The dehydrated vegetables such as parsley, onions, and potatoes may be used in soups. It is not necessary to reconstitute them first; they may be added directly to the soup stock.

Ration-Dense Soups

The canned dehydrated soups and condensed soups are not only easy to prepare but they are timesavers and space savers.

Dehydrated soups such as chicken-noodle, green pea, and tomato-vegetable are prepared by adding the required amount of the dehydrated soup to a proportionate quantity of boiling water. The mixture is covered and allowed to simmer for the length of time specified on the container. The product closely approximates in appearance and flavor the same type of soup made from raw food items.

The canned condensed soups are reconstituted by using an equal volume of cold water, which is stirred in slowly. A wire whip is a good utensil to use for stirring this mixture. The soup is brought to a boil and is then ready to serve. Condensed soups have the characteristic good body, aroma, flavor, color, and consistency of the particular style and type of soup.

Seasoning Soups

The individual recipe in the soup section specifies the types and amounts of seasonings to be used. When making meat or chicken stock, the flavor from the ingredients used concentrates; therefore, accurate measures of spices or herbs to be added are essential. Just before the soup is to be served, check it again for proper seasoning. It is better to add more seasoning, of suitable types, to the stock or soup a short time before serving, rather than have a soup so highly seasoned it is unpalatable. If the taste-check indicates that the soup is too salty, add a few slices of raw potatoes, bring the soup to a simmer for a few minutes, then remove the potatoes.

MEAT COOKERY

Meat is by far the most popular food in the mess, and it is the most expensive. Because of its nutritional excellence in food values, notably protein, it is not surprising that meat in some variety and form appears in the menu, and in generous quantity, almost every meal. Meat, correctly cooked and served, indicates that it was prepared by a well-informed and skillful Commissaryman.

Cooking Methods

Meat cuts are cooked by (1) dry heat, (2) moist heat, and (3) frying. The tender cuts of meat are cooked by dry heat because they contain little connective tissue. Moist heat is required to make tender those cuts which contain much connective muscle tissue. Various treatments before cooking have been recommended for tenderizing meat. Grinding, cubing, slicing, and pounding break up the muscle and connective tissue and make meat tender.

The dry heat methods are (1) roasting, (2) broiling, (3) pan-broiling or griddle-broiling. The moist heat methods are (1) braising and (2) cooking in liquid. The frying methods are (1) panfrying or sauteeing and (2) deep-fat frying.

Dry Heat Methods

The dry heat methods most frequently used in Navy general messes for cooking the tender cuts of meat are roasting and griddle-broiling.

ROASTING is synonymous with "baking," but baking is seldom used when speaking of meat cookery, except in the case of ham. Roasting may be defined as cooking by dry heat in the oven.

The following rules of roasting apply to beef, veal, pork, and lamb. Included with each rule is the "why."

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1. A moderately low oven temperature (250° F to 350° F) should be used because at this temperature (1) the roast is uniformly done throughout; (2) the cooking losses are moderate; (3) the meat is more palatable; and (4) the roast is plump and full. High temperatures cause excessive shrinkage, uneven cooking, and decreased juiciness. (See fig. 10-3.)

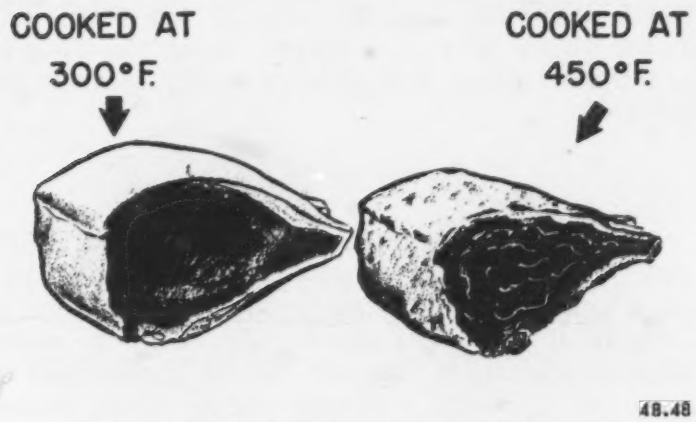

Figure 10-3.—High temperature vs low temperature roasting.

2. Searing does not keep in juices but actually increases the cooking losses. Searing causes loss of fat and contributes to excessive shrinkage.

3. Meat should be roasted fat side up, thus eliminating basting. Place the roast fat side up in the pan because as the meat cooks, it will baste itself with the melting fat.

4. A roast may be salted before or after cooking. Salt penetrates less than half an inch below the surface and any salt added before cooking adds flavoring to the drippings.

5. A roast should never be covered. Cook uncovered. If the roasting pan is covered, the moisture escaping from the meat will surround it and the meat will be cooked by moist heat.

6. Water should not be added. Roasts cooked without added water are juicer and more flavorful. The only reason for adding water would be to keep the drippings from becoming overly brown which does not happen when low oven temperatures are used.

7. Flouring a roast is not necessary. Drippings from a floured roast may be a more attractive brown, but the same results are obtained by browning flour in the drippings when making gravy.

8. A meat thermometer is the only accurate means of telling when a roast is done. The length of cooking time depends on the temperature of the oven, the weight and shape of the roast, and the kind of meat. See figure 10-4.

The thermometer should be inserted into the center of the main muscle (the thickest meat part) so that the tip is away from the bone and fat. As the heat from the oven penetrates the meat, the temperature at the center gradually rises and this rise is registered on the thermometer. When the thermometer registers the internal temperature which indicates doneness for that particular kind of meat, the roast is ready to be removed from the oven. The guidance card in the J (meat) section of the recipe service J-G-1 indicates the correct internal temperature which should be reached when roasting the various types of meat.

Boneless meat will require somewhat longer cooking than meat with bones. A smaller roast requires more minutes per pound than a large

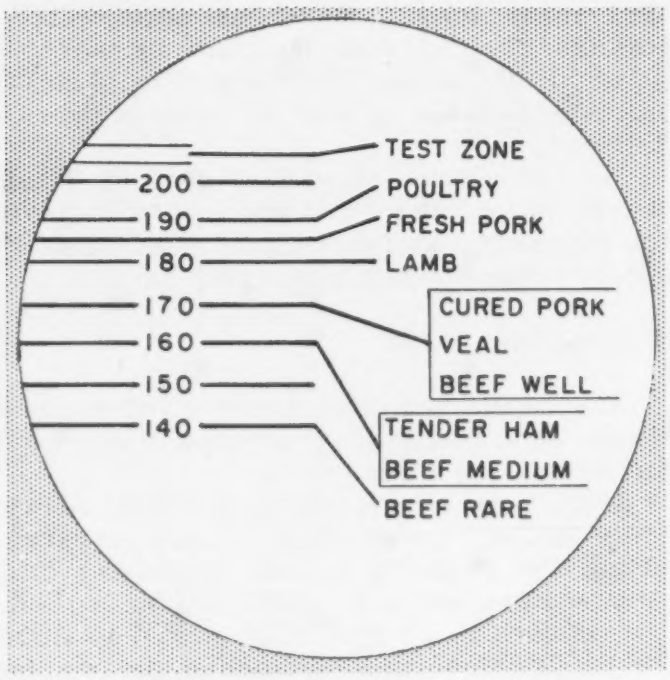

CAUTION: Using thermometer in oven above 400° F is not recommended.

1. The roasting temperatures indicated on the thermometer are approved by the National Live Stock and Meat Board and Poultry and Egg Board (National).

2. Insert thermometer at least 2 1/2 inches into thickest part of meat at an angle such that dial is easily readable when door is opened. The point should be in the center of the largest muscle, away from contact with bone, gristle or fat.

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Figure 10-4.—Dial type roast meat thermometer.

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one. A lean roast requires less time than a fat one. The cuts of meat which may be roasted are listed in table 10-1.

In GRIDDLE-BROILING the heat is transmitted to the meat from the hot metal of the griddle. The meat is placed on an ungreased griddle and a moderate temperature is maintained which prevents the meat from overbrowning. Enough fat cooks out to keep the meat from sticking. Surplus fat should be removed as it collects, to prevent the meat from frying. The meat is turned occasionally to ensure even cooking. Tongs or a broad turner should be used,to turn the meat. Puncturing the meat with the tines of a fork allows the juices to escape with a resultant dry, coarse end-product.

The cuts of beef, lamb, and pork which may be griddle-broiled are listed in table 10-2. Pork chops and pork steaks, although tender, are never griddle-broiled. Pork requires thorough cooking to bring out its full flavor. Braised pork chops are more desirable from the standpoint of aroma, texture, tenderness, and flavor of the lean. Veal is not griddle-broiled because it is a lean meat and because of the abundance of connective tissue which requires long slow cooking.

When griddle-broiling meat, season one surface of the meat after it is browned, then the other side when you turn the meat.

Moist Heat Methods

Cooking meat by moist heat is done by two methods—braising and stewing. Each method is discussed in the following paragraphs.

Braising is used in the preparation of those cuts containing considerable connective tissue. To braise means to brown meat in a small amount of added fat, then to cover and cook slowly in juices from the meat or in a small amount of added liquid. The liquid may be water, stock, vegetable juices, thin sauces, or a combination of these liquids. The amount of liquid used is just enough to start the natural juices in meat. Only a small amount is added at a time as the color and appearance of both the meat and gravy are better if the liquid is kept to a minimum. Pot roast and swiss steak are examples of this method of moist heat cooking.

Cooking the less tender cuts long enough to make them tender causes some loss of meat flavor. Flavor is developed by dredging the pieces of meat in seasoned flour; then browning in a small amount of fat or by marinating the meat in a well-seasoned mixture of vinegar,

Table 10-1.—Meat Cuts Suitable For Oven Roasting (Dry Heat)

[1]BEEF	VEAL
Carcass Spencer roll (or rib eye Sirloin tip Tenderloin Boneless Sirloin	Carcass Leg Loin Rib Shoulder (boned) Semi- and Boneless Roasts Top round Bottom round Clod Sirloin rump butt Chuck
PORK	LAMB
Hams Fresh Smoked Loin	Carcass Leg Loin Rack Shoulder

[1]The following beef cuts are roasted or used for pot roast:

Carcass—inside round, knuckle
Boneless—top round, knuckle tip, rump, eye of round.

Table 10-2.—Meat Cuts Suitable For Griddle Broiling

BEEF	HAM
Carcass Sirloin Rib Club Tenderloin Ground beef Boneless Portion-Cut Steaks Rib eye Loin strip Sirloin butt Tenderloin cuts Ground Meat Beef Liver	Smoked Ham slices Bacon Sausage LAMB Carcass Leg chops Shoulder chops Loin chops Semi-Boneless Rib chops Loin chops Leg chops

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vegetables, and spices. Sauerbraten, is an example of a less tender cut of meat that is marinated in a vinegar-spice mixture. The acid of the vinegar has a tenderizing effect on the connective tissue and the spice adds flavor. There is a theory that browning the meat develops flavor and aroma, and a rich brown color is typical of well-prepared braised dishes. Less tender cuts of meat may be scored (cutting the fibers) or pounded to break the connective tissue.

After the meat has been browned, the temperature is reduced, and cooking is continued at a low temperature so that the liquid will not boil. Braising may be done in the oven, on top of the range in a deep pot, or in the steam-jacketed kettle. Whichever means is used, the container must be tightly covered. The aim of braising is to produce a piece of meat which is evenly browned on the exterior, tender, juicy, and evenly cooked throughout, with no stringiness. Meat cuts which are braised are always cooked to the well-done stage.

The cuts of meat which may be braised are listed in table 10-3.

Cooking in Liquid

The second method of moist heat cooking is cooking in liquid. It is the method used in preparing the least tender cuts of meat. Small pieces of meat cooked in water are said to be STEWED; large pieces are said to be SIMMERED. In each case, the meat is covered with water and kept at a simmering temperature (185°F - 208°F). It is never boiled. Boiling the meat for the length of time required to tenderize it, would dissolve the connective tissue completely and the meat would fall apart, become stringy and dry.

Vegetables may or may not be added to the stew. If they are added, they are cooked to the just tender point, retaining their color and other characteristics. The gravy is light and smooth and of the typical flavor of the meat used in the stew. The pieces of meat may be dredged in seasoned flour and browned in a small amount of fat, or they may be browned, unfloured, before the liquid is added. The gravy will be a rich brown in color if the meat is browned first. Stews are made in a deep kettle which has a tight fitting lid and are held at the simmering temperature until the meat is done, usually $1\frac{1}{2}$ to 2 hours.

The cuts of meat used for stews are listed in table 10-4.

Cooking in liquid is used in the preparation of cured pork and beef cuts rather than fresh

Table 10-3.—Meat Cuts Cooked By Braising

BEEF	PORK
Boneless Roasts Shoulder clod Inside chuck Rump Bottom round Sirloin tip Chuck tender Boneless Beefsteaks Shoulder clod Bottom (outside) round Inside chuck Bottom sirloin butt Chuck tender Carcass Beef Roasts and Steaks Chuck (all cuts) Brisket Plate Flank Outside (bottom) round Heel of round Rump butt Variety Meats Liver	Loin Chops Spareribs Fresh Ham Steaks Tenderloin **VEAL** Boneless Roasts Top round Bottom round Clod Sirloin rump butt Chops Back Tenderloin Butt Knuckle

Table 10-4.—Meat Cuts Used For Stews

BEEF	LAMB
Carcass Heel of round Flank Shank Neck Plate Brisket Trimmings Blade Boneless Shank Heel of round Blade roll Neck Plate	Carcass Breast Shank Shoulder **VEAL** Carcass Breast Neck Shoulder Flank Semiboneless and Boneless Neck Shoulder Brisket

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cuts. Fresh beef, if cooked in liquid, is more often braised because better flavor is developed and a more attractive appearance is obtained. Meat cooked in liquid is tender and juicy and holds its shape when sliced. Usually the steam-jacketed kettle is used so that the meat can be completely submerged in the liquid at all times.

The large cuts that are cooked in liquid are:

BEEF	PORK	VEAL
Fresh Neck Shank Plate Heel of round Brisket Shortribs Cured or corned Rump Brisket	Cured Whole ham Half ham Shoulder Picnic shoulder Boston butt Spareribs Fresh Spareribs	Neck Shank

Frying

SHALLOW FRYING is accomplished in a pan or on a griddle. This method of cooking is often called sauteing. Be sure the fat is hot before placing the meat in it, otherwise the meat will absorb too much of the fat and will be unappetizing. The terms "fry," "pan or griddle broil," and "braise" are frequently used interchangeably, or at least the distinction is not drawn finely. There is an inclination to say of any meat cooked in a frying pan or on a griddle that it is fried. For example, it is a common practice to brown certain cuts in a small amount of fat, then cover the pan, and continue to cook until the meat is tender, and call it frying. This of course is not frying at all, but braising, because when the pan is covered, the meat is surrounded by steam and the process is exactly the same as that used in cooking a pot-roast. In shallow frying, the meat is sometimes floured or breaded.

DEEP-FAT FRYING involves the complete covering of the meat with hot fat. Meat prepared in this manner should be breaded. To obtain the best results, the correct temperature of the fat must be known to prevent excess fat absorption or excessive browning of the exterior before the interior is cooked done. The only accurate means of knowing the temperature of the fat is to use a deep-fat thermometer.

Place just enough meat in the basket to cover the bottom of the basket, and lower it into the hot fat. The pieces to be fried should be of uniform size. Small pieces should usually be fried at a high temperature.

Cooking Frozen Meat

Most of the meat used in Navy general messes is procured as frozen meat and with the exception of a few cuts may be cooked in the frozen state. Hamburger, diced meat, and pork chops must be completely thawed before cooking.

In the frozen state, roasts will require approximately $^1/_3$ to $^1/_2$ additional cooking time. Seasoning, as well as flavoring, must be delayed until the outside is some what thawed and the surface is sufficiently moist to retain salt, pepper, and flour. The insertion of the meat thermometer can be delayed until the roasts are partially thawed.

Beef, veal, and lamb chops may be grilled in the frozen state. Pork chops MUST BE THAWED to ensure complete doneness. The lengthly periods required to cook any of these meats completely done from the frozen state make it less practical because it ties up the cook's time, as well as griddle space.

Grilling or deep-fat frying of slices of frozen liver of $^3/_8$ to $^1/_2$ inch thickness is recommended. Liver cooked without thawing is more moist and, therefore, more palatable than partially thawed cooked liver, and slices are more uniform and attractive in appearance.

POULTRY

Navy procurements of poultry are limited to ready-to-cook (eviscerated). This style greatly reduces storage space requirements.

Poultry is typed also according to its state of refrigeration: fresh, chilled, and frozen.

Thawing

Frozen chicken, turkeys, and ducks must be thawed before being prepared for cooking. Unlike thawing meat, no choice should be permitted in poultry thawing methods. All poultry must be thawed at refrigerator (36°F to 38°F) or chill temperatures. This rule applies to all market forms of frozen poultry: cut-up, quarters, halves, whole birds, or turkey rolls. Large turkeys (14 to 24 pounds or more) will require from 24 to 48 hours or more to thaw, depending upon the exact refrigerator or chill box temperature to which it is exposed and the amount of circulating air. DO NOT THAW POULTRY IN WATER.

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Most whole turkeys and chickens come bagged in paper or plastic materials, and these may serve as wrappers to protect the poultry. Remove whole birds from the outer shipping containers and spread out for more rapid thawing. Loosen the inner bag, or wrapping material, to accelerate thawing, but do not remove it.

Layer-packs of cut-up chicken should be removed from the carton and spread out, but be sure to leave the inside sheets of wax paper (or other material that may be used for separating layers), to protect the surface of the chicken while thawing.

Frozen poultry that has been thawed should never be refrozen.

Use thawed frozen poultry as soon as possible. Do not hold in refrigeration (36°F - 38°F) over 24 hours. Poultry meat held in excess of 24 hours will not only have lowered quality but risks spoilage. Bacteria thrive on wet or moist surfaces and grow especially well in poultry.

Cleaning

Inspect all poultry after thawing for the presence of any spongy red lung tissue inside the back, loose membrane, pinfeathers, or skin defects; remove these, if present. Carcass turkeys, chickens, and ducks have necks and giblets wrapped and packed in the body cavity. Remove these, inspect, and rinse. Wash poultry inside and out under cold running water and drain.

Cooking Poultry

The fundamentals of cooking poultry do not differ from those applied to other meats. Dry-heat methods (frying, or roasting) are applicable to young, tender birds. Moist-heat methods (fricasseeing, simmering, steaming, or stewing) or a combination of moist and dry heat must be applied to older less-tender birds in order to make them tender and palatable. In moist-heat methods the water should simmer rather than boil to avoid the toughening effect of high temperature on the fibers. Depending upon the cooking method used, temperatures will vary, but slow to moderate temperatures are used at all times to develop maximum flavor, tenderness, color, and juiciness. Intense heat will harden and toughen the protein, shrink the muscles, and drive out the juices, thus producing a less palatable product.

All poultry should be cooked well done. To ensure this, each container of prepared chicken or turkey should be double checked.

Cooking losses will vary with the temperature and method of cooking and with the degree of fatness. Ducks have a lower yield of cooked meat and more fat than turkeys and chickens roasted at the same temperature. The yield of meat from chicken and turkey compares favorably with that from beef, pork, and lamb cuts with bone in.

When ROASTING poultry, precautions must be taken to prevent the poultry skin from becoming too hard and dry. An open pan should be used and a low oven temperature applied (250° to 350°F). A cloth moistened with melted fat is one means of preventing undesirable drying and toughening of the skin. As the cloth become dry, additional fat may be poured over it. The skin will then be brown and crisp but will carve well.

For even cooking, roast poultry with the breast side down through most of the cooking period, just turning it once, when about three-fourths done to develop the color of the breast. To turn the turkey, insert a meat fork into the neck cavity and a second meat fork into the body cavity. Then, lift the turkey and turn it breast side up. Roasting turkey in this manner ensures uniform cooking, and moist, flavorful meat. Pan drippings should be used for basting occasionally during the cooking period.

Turkey, being larger than most poultry, is more difficult to cook to the well-done stage without overdoing it. Care must be taken to cook it no longer than necessary; overcooking will result in loss of juices and stringy, dry meat. The meat thermometer inserted in the thickest part of the thigh muscle ensures proper roasting of the turkey. When the thermometer registers an internal temperature of 190°F, the turkey has reached the required stage of doneness. (See fig. 10-5 for the timetable for roasting unstuffed turkeys).

For PAN FRYING poultry, wipe the pieces dry. Then season them with salt and pepper and roll them in flour. For a heavier coating, the pieces may be dipped in batter or milk and egg mixture and rolled in soft bread crumbs. Preheat a heavy frying pan to a temperature of about 360° to 365°F, using approximately $^1/_2$ inch of frying fat. Turn the pieces frequently. To avoid piercing the muscle fibers, permitting the juices to escape, tongs or two spoons may be used to turn the pieces. Cook until well done.

The steps in preparation for DEEP-FAT FRYING are similar to those used for pan frying. The difference is that in deep-fat frying enough fat is used to cover the pieces to be cooked. Preheat the fat to 365°F, then carefully lower

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the pieces into the fat. (The use of a deep-fat frying thermometer is recommended. Do not crowd the pieces. The chicken may be cooked until done, or it can be browned in deep-fat, and the cooking can then be completed in an oven. ALWAYS allow the deep-fat to regain heat before re-loading.

STEWING is the method used for cooking the larger, least tender types of poultry. Long, slow cooking at a simmering temperature is required to soften the tissues and make them tender. The utensil or kettle should be tightly covered to allow the steam to accumulate. The combination of the steam and the long, slow cooking tenderizes the tissues. Remember—simmer, do not boil. The cooking water is used for soups, sauces, gravies, or bread dressings.

FRICASSEEING or BRAISING is another method of cooking chicken. The chicken is first cut into serving portions. Then, it may be dredged in seasoned flour and browned, or simply browned in a small amount of fat, or not browned at all depending on the recipe. The chicken is placed in a deep utensil or kettle, covered with cold water; vegetables and/or seasonings are added according to the recipe being used. The kettle is covered tightly and the chicken is simmered until tender. The cooked chicken is removed from the stock; the chicken fat is skimmed off and blended with flour to make a roux. The stock is added to the roux to make a sauce, and then the cooked chicken is returned to the sauce and is ready to be served.

Boneless Turkey

The Navy procures boneless, frozen, string-tied raw turkey, and boneless cooked turkey. These boneless turkeys consist of light and dark meat. Instructions for preparing and slicing each type are included with the specific turkey and in the L (poultry) section of the recipe service. Boneless turkey is a tasty, timesaving item that ensures portion control and ease of preparation.

Dressing

Recipes in the L (poultry) section of the recipe service include basic bread dressing recipes and many variations which may be served with chicken or turkey.

Preparing and Cooking Giblets

The giblets (gizzard, heart, and liver) that come with the eviscerated poultry need little preparation other than ordinary washing in cold water prior to cooking. One precaution to be observed during the washing of the liver is to inspect it closely to see if the bile sack that was attached to the liver could have been accidently broken. If it has been broken, it is always easily recognized by the greenish-brown or yellow coloring that it will leave on whatever parts of the meat it touches, rendering those parts inedible. After washing in cold water, place the giblets in

TIMETABLE FOR ROASTING TURKEY L-G POULTRY No. 5

Turkey is done when meat thermometer inserted in thigh muscle reads 190° F. If no thermometer is available, move the leg by grasping the end bone; if the joint moves easily, the ligaments are tender and the meat is done.

ROASTING TURKEYS UNSTUFFED

Weight of Turkey	Oven Temperature	Minutes Per Pound	Cooking Time Hours Per Bird
8 to 10 lb	250° F	25 to 30	3 to 3½
10 to 14 lb	250° F	18 to 20	3½ to 4
14 to 18 lb	250° F	15 to 18	4 to 4½
20 to 30 lb	250° F	12 to 15	5 to 6

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Figure 10-5.—Timetable for roasting turkey.

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just enough cold salted water to cover, bring to the boiling point, reduce the heat to a simmer, and cook approximately 1 hour or until the giblets are tender. Save the stock for gravy or dressing. Chop the giblets (do not grind) and use for the gravy or dressing.

FISH

Like meat and poultry, fish is an excellent protein food. Fish steaks and fillets are served in Navy general messes. Steaks are slices cut crosswise from large fish; fillets are lengthwise pieces taken from fish and free from bone. Fish is delicate in structure as well as in flavor and the flesh is tender and moist. Handle fish carefully. Recipes for preparing fish are in the H (fish) section of the recipe service.

The Navy also procures shellfish such as frozen shucked clams, frozen scallops, frozen shucked oysters, and frozen shrimp, to name a few. Recipes for preparing shell-fish are included in the H (fish) section of the recipe service.

Thawing Frozen Fish

Frozen fish, usually received on board in the form of boneless fillets, are wrapped and packaged in uniform-sized containers. Frozen fish should be thawed in the unopened package at a temperature of 36°F to 38°F. Thawing for mess use should never be accomplished by exposure to excessive heat or by soaking in warm water. However, it may be thawed at the prevailing room temperature, if cooked while still chilled.

Cooking Fish

Fish must be cooked through but not overcooked. Seafood prepared too far in advance, even though properly cooked, becomes dry and hard and loses flavor and succulence. When baking, temperatures should be in the moderate to moderately hot range (375°F). Fish is done when it flakes easily with a fork. Further cooking makes it dry and tough.

Use of Fat

Practically all fish varieties delivered to the mess, whether light-flesh or dark-flesh, require additional fat or oil while cooking. Fat aids in keeping the fish moist while it is browning, and makes it more palatable. A solid fat, such as butter or shortening may be "dotted" over fish. Melted fat or oil is brushed on. Fat meats, such as sliced bacon or thinly sliced salt pork, may be laid over fish. Fat may be supplied by pan frying or deep-fat frying. Fat (preferably butter fat or oil) may be added in the form of a sauce served with the fish.

Since there are no tough cuts of fish, as there are of meat, cooking fish in a large amount of water is only done when a soup, fish stew, or chowder-type dish is prepared. Usually, the water or stock is seasoned or flavored and is used in the finished food.

Seasoning

Simple seasoning is best for most fish. Salt and pepper are needed in moderation; monosodium glutamate is desirable for pointing up and holding flavor. Lemon juice and the milder herbs, such as parsley and chives are good seasonings. Seasonings are put on the surface of the fish or around it in a baking pan or they may be incorporated into a sauce, or a basting liquid that creates steam and helps to keep fish moist and flavorsome. When fish is cooked in liquid or sauce, season the fish lightly and also season the sauce.

GRAVIES AND SAUCES

Any gravy or sauce served as an accompaniment to a food is intended to complement or enhance that particular food. It is not to stand as something apart with no relationship to the food, nor is it to mask the food. It is important to consider the suitability of a gravy or sauce for its particular purpose.

The O (sauce) section of the recipe service contains many recipes for gravies to be served with meats and poultry, sauces to be served with fish and vegetables, and sweet sauce to be served with desserts.

Recipes for gravies and sauces often include a statement about making or using a "roux." The roux is the melted fat and starch base that is used mainly for thickening sauces, gravies, and soups. This is the key step in making a successful gravy or sauce. The roux is cooked over extremely low heat for 10 to 15 minutes. An important thing to remember is that flour alone must never be put into hot liquids for it will cook promptly into hard lumps that cannot be cooked or stirred smooth. The darker the roux, the darker and more highly seasoned the sauce in which it is used. Stock or vegetable juices are used with the dark roux. The light roux is the combination of butter and flour that is blended

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together over extremely low heat, but is not allowed to brown. Milk is used as the liquid for cream or white sauce. The roux, in either type, must be thoroughly cooked so that no taste of starch remains. When starch is cooked in liquid, the granules burst or rupture and take up moisture. Cooking must be sufficient to burst all the starch granules or the taste of raw starch remains, and the gravy or sauce is insufficiently thickened.

Sweet sauces or dessert sauces give the delightful finishing touches that raise dessert dishes above the average, and enable the cook to be clever in offering many surprises in serving puddings, cake, fruit, and ice cream. Many dessert sauces are named for the chief flavoring ingredient, such as butterscotch, lemon, nutmeg, orange, and vanilla sauces. These sauces are made principally from corn starch, sugar, water, butter, salt, and the flavoring agent indicated by the name. Occasionally, milk and eggs are used in the preparation.

VEGETABLES

Vegetables of all types are nutritional necessities in a well-balanced diet. In addition to the contribution of important minerals and vitamins, vegetables add color, flavor, and interest to meals. All too frequently, vegetables are rejected or left uneaten when they are poorly cooked and, therefore, not pleasing in appearance or flavor. A vegetable can become unpopular simply from being overcooked, watery, or poorly seasoned. Furthermore, food values are lost or diminished by improper handling and cooking.

Vegetables are bought by the Navy in the following forms: canned, dehydrated, frozen, and fresh.

Canned Vegetables

Vegetables that are canned have been cooked in the container and need only to be brought to boiling temperature just before they are served. Never boil a canned vegetable; always avoid overheating or overcooking. Save the liquid from canned vegetables to use in soups, sauces, and gravies. See figure 10-6, guide for heating canned vegetables.

Dehydrated Vegetables

Dehydrated vegetables are increasing in popularity in Navy general messes. Their small weight and volume make them convenient to store. They are easy to prepare; all the precooking tasks associated with raw vegetables have been done for you. They are peeled, diced, sliced, or chopped, and ready to use. They ensure portion-control.

The aim in dehydrating is to remove most of the water from the food—sometimes 99 percent of it—without damaging the product. The atmospheric (hot air) method is used for vegetables. The vegetable is cut into small pieces and spread out on trays which have slats or wire bottoms. The hot air is passed over and under the trays to dry the vegetables. In-package desiccation sometimes is used to remove the last small amount of water from dehydrated foods. A small envelope containing a chemical (activated lime) is put into the final package. It absorbs water from the food during storage.

Precooked potato granules, sliced raw potatoes, raw cabbage, sliced onions, and green peppers are some of the dehydrated vegetables used by the Navy. They are reconstituted by adding a measured quantity of the vegetable to a measured volume of water. The temperature of the water will vary with the specific dehydrated vegetable being reconstituted as will the length of time required in the reconstituting process. It may vary from 15 to 30 minutes in time and the water may be either lukewarm or cool. Recipes in the Q (vegetable) section of the recipe service give more detailed instruction for reconstituting dehydrated vegetables.

Frozen Vegetables

Frozen vegetables have the appearance and flavor of fresh vegetables, and like the dehydrated vegetables discussed previously are easy to prepare; the precooking tasks have been done. Frozen vegetables have been cleaned and trimmed and are ready to use.

Quality, palatability, and sanitary aspects of frozen vegetables require that they be handled carefully. They must be kept at 0°F until ready for use. Partial thawing is detrimental to the quality, and once partially or fully thawed, they must be used immediately and not allowed to refreeze.

The guidance card, (Q-G, vegetables, No. 2) in the Q section of the recipe service prescribes the method and timing for cooking frozen vegetables. Some may be added directly to boiling water in their frozen state; others should be partially thawed. When the guidance card specifies that a vegetable, spinach for example, should be partially thawed prior to cooking, the frozen spinach is removed from the freezer and placed

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Q-G. VEGETABLES No. 1 (1)

GUIDE FOR HEATING CANNED VEGETABLES

YIELD: 100 Portions (Approximately 22 Pounds)

EACH PORTION: 1 Heaping Serving Spoon (Approximately 3½ Ounces)

INGREDIENTS	WEIGHTS	MEASURES	APPROX. AM'T OF LIQUID PER CAN	METHOD
Asparagus, spears or cut up	36¼ lb.	40–No. 300 can	¾ cup	1. Pour off half the liquid; save for use in making soups, sauces, and gravies.
Beans, green or wax	25¼ lb.	4–No. 10 can	1¼ qt	2. Place vegetable and remaining liquid in steam-jacketed kettle.
Beets	26 lb.	4–No. 10 can	1 qt	3. Bring to serving temperature, approximately 10 minutes; stir gently occasionally while heating. Do not allow to boil.
Carrots	26¼ lb.	4–No. 10 can	1 qt	
Corn, whole grain	25½ lb.	4–No. 10 can	1 qt	4. Season and garnish as desired.
Okra	28 lb.	28–No. 303 can	½ cup	
Peas	26¼ lb.	4–No. 10 can	1 qt	
Spinach	30½ lb.	5–No. 10 can	1 qt	
Tomatoes	25½ lb.	4–No. 10 can	1 qt	

NOTE: 1. Prepare vegetables in small batches (determined by service rate) to prevent breaking up, discoloration, and overcooking.

2. Asparagus and spinach may be heated directly on the steam table in serving pans to prevent breaking up.

Q-G. VEGETABLES No. 1 (2)

Beans, lima	26¼ lb.	4–No. 10 can	¾ qt	1. Place entire contents of cans in steam-jacketed kettle.
Corn, cream style	24 lb.	24–No. 303 can	.....	2. Bring to serving temperature, approximately 10 minutes; stir gently occasionally while heating. Do not allow to boil.
Peas, black-eyed	24 lb.	24–No. 303 can	¼ cup	
Peas, field	24 lb.	24–No. 303 can	¼ cup	3. Season and garnish as desired.
Sauerkraut	25 lb.	4–No. 10 can	½ qt	

NOTE: 1. Prepare vegetables in small batches (determined by service rate) to prevent discolora- and overcookina.

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Figure 10-6.—Guide for heating canned vegetables.

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in the chill box in its original container, until touch-test indicates that partial thawing has been accomplished.

Preparing Vegetables for Cooking

Most raw fresh vegetables have waste or portions which are not edible. When you peel, scrape, brush, trim, or cut these vegetables, it is important that you not destroy or damage edible portions and, especially, that you not lose the valuable nutritional elements which are contained, usually, close to the outer skin or peel. Select vegetables about equal in size, or cut them into pieces of equal size. Then all the pieces will be cooked uniformly in the same length of time. Plan for cooking vegetables with the peel on whenever possible, especially potatoes. If potatoes must be peeled, do it very carefully so as to make thin peelings. Much of the food value in a potato lies close to the skin. WASH ALL FRESH VEGETABLES THOROUGHLY. Use a brush to clean celery, carrots, beets, potatoes, turnips, parsnips, or any vegetable that is pulled or dug from the soil.

Tightly-grown blossoms, heads, or stem-type vegetables, such as asparagus, broccoli, cabbage, cauliflower, and brussels sprouts, will harbor worms and insects which may not be dislodged by casual washing. Soak vegetables of this type in SALTED COLD WATER (1 tablespoon salt to 1 quart of water) $^1/_2$ to 1 hour, and then rinse them. Turn cauliflower blossoms end down in the soaking water; cut cabbages in halves or quarters and remove the cores.

Wash the leaf-type vegetables such as spinach, chard, kale, and turnip greens in several changes of cold water to remove dirt and sand particles. Lift these vegetables from the water instead of draining the water off. The dirt and grit will remain in the washing pan or sink. If this water is drained or poured off, the dirt will remain on the vegetables.

After vegetables have been washed clean, keep them in a cool storage place until you are ready to prepare them for cooking.

Wilted vegetables can be freshened by placing them in ice-cold water or between layers of crushed ice. When they are freshened, the vegetables should be covered with a clean, damp cloth and placed in a cool storage room until you are ready to use them.

Keep the time between preparation and cooking as short as possible. Valuable vitamins are lost when vegetables are soaked too long or are allowed to remain at warm temperatures for several hours.

Cooking Vegetables

Vegetables may be baked or sauteed; they may be boiled or steamed; they may be served with butter or covered with an appropriate sauce; or, after being boiled or steamed, they may be creamed, mashed, or sauteed.

The basic methods of cooking vegetables are baking, steaming, and boiling. BAKING means to cook in dry heat in an oven with the addition of little or no water. Dry baking is usually limited to potatoes and squash.

STEAMING means to place the vegetables in a perforated kettle. The only water that comes in contact with the vegetables is the small quantity formed by condensation.

BOILING means to add the vegetables to boiling water and to bring the cooking water back to boiling temperature as soon as possible.

Cook only a small amount of vegetables at a time. Vegetables must be cooked in the shortest possible time, and in the least amount of water. NEVER USE BAKING SODA to preserve color. Overcooking, cooking in too much water, or using soda in the water, destroys the very elements you are trying to conserve.

In fact, undercook rather than overcook vegetables. This is especially applicable when you know the cooked vegetable is to be placed on the steam table or is to have a second heating or cooking period, such as creaming, scalloping or baking. Cover all vegetables while they are cooking, except cauliflower, turnips and those of the cabbage family, including brussels sprouts.

To test to see if the vegetable is done, press pieces between the thumb and forefinger and taste the sample. The vegetable should be tender but have a definite bite quality.

Ways to make vegetables more delicious are:

1. Cook them in soup stock (clean and free from fat).
2. Cook ham or pork bones with the vegetables, in which case do not use much of the pork fat.
3. Serve them with a garnish that has a contrasting flavor, such as minced onion, diced crisp bacon, chopped parsley or chives, a cheese sauce, chopped egg sauce, or fresh lemon.

Cooking Legumes

There are several types of dried beans that are used in the Navy mess. Legumes may be used in place of meat, as a substitute or alternate for potatoes, or as a side dish. Among the most popular are navy beans and pea beans. The cooking qualities of beans differ. Therefore,

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cook only one variety, not a mixture, at one time. If large navy beans are mixed with small pea beans, the small beans will be overcooked and the large beans undercooked. See figure 10-7, guide for soaking and cooking dry beans.

FRUIT

Fruit is procured by the Navy in the fresh state, frozen, canned, dehydrated, and dried. Fresh and processed fruits may be combined to vary the flavor and texture.

Every daily menu should include some fruit. It adds color, variety, food value, and a refreshing flavor to any meal. Among the least expensive and the most nutritious of all foods, fruit has the distinction of being the most versatile.

Fruit fits into all three of your daily meals. At breakfast fruit can be served alone or in combination with cereal. It can be prepared as appetizers, salads, main dishes, soups, relishes, desserts, or snacks. It is excellent as garnishes and sometimes acts as seasoning. Fruit is an active partner in many meat dishes. Baked ham and pineapple are often teamed together, as are pork and applesauce, or turkey and cranberry sauce.

Q-G. VEGETABLES No. 3

GUIDE FOR SOAKING AND COOKING DRY VEGETABLES

YIELD: 100 Portions (Approximately 3¼ Gallons) — EACH PORTION: 1 Heaping Serving Spoon, ½ Cup (Approximately 3½ Ounces)

INGREDIENTS	WEIGHTS	MEASURES	APPROX. AMOUNT OF WATER	APPROX. COOKING TIME	METHOD
Peas, black-eyed, dry	9 lb	1½ gal	4 gal	40 min	1. Pick over beans or peas, removing any foreign matter. Wash thoroughly in cold water.
Beans, kidney, dry	9 lb	1¼ gal	4½ gal	1¼ hr	
Beans, lima, dry	9 lb	1¼ gal	7 gal	1½ hr	2. Cover with indicated amount of cold, clear water.
Beans, pinto, dry	9 lb	1½ gal	6 gal	1¼ hr	
Beans, white dry	9 lb	1¼ gal	6 gal	1¼ hr	3. Bring water to a boil; boil 2 minutes. Turn off heat. 4. Cover and let stand 1 hour.
Bacon, diced	2 lb	1¼ qt			5. Add bacon and seasonings (if desired) and bring water back to a boil.
Salt (optional)	2¼ oz	¼ cup			
Pepper (optional)	¼ oz	1 tbsp			6. Simmer for indicated time or until beans or peas are tender but not mushy. Add boiling water if beans or peas become dry.

NOTE: 1. Beans may be soaked according to Steps 1 through 4, then cooked as indicated in any particular recipe.

2. Meat stock may be substituted for water.

3. Avoid overmixing in order not to mash beans.

4. Cooking time and amount of water will depend on size, age, and variety of beans.

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Figure 10-7.—Guide for soaking and cooking dry vegetables.

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Preparing Fresh Fruit

Before using fresh fruits, wash them thoroughly to remove any insect spray which may be present. If possible, pare fresh fruits immediately before using. When pared and left in contact with the air, some fresh fruits become discolored. Discoloration may be partially prevented by covering the fruit with a thin sirup of lemon juice until you are ready to use it. Peeled fruit may also be dipped in a solution of antioxidant and water to prevent discoloration. Follow the directions printed on the antioxidant containers.

APPLES may be served raw and whole for breakfast; sliced and cubed in salads or fruit cocktails; and baked, stewed, or cooked as applesauce for breakfast or dessert. Applesauce or baked apples may be used with pork roast and chops. If the skin of a raw apple is tender, leave it on.

BANANAS may be served whole for breakfast, or sliced for breakfast, desserts, salads, or fruit cocktails. Peel and slice bananas as short a time as possible before using them in order to prevent discoloration.

BERRIES should be washed and drained. Handle them carefully to avoid crushing them. Serve them raw for breakfast or dessert, raw or cooked over shortcake, and cooked in cobblers or pies.

DATES should be washed and seeded. Serve them on cereals or in cakes, cookies, or puddings.

GRAPES should be washed. Serve them raw in bunches. If they are firm, slice, seed, and serve them in salads or fruit cocktails.

GRAPEFRUIT may be served raw for breakfast or dessert and baked or broiled at low temperature with sugar for dessert. Cut them into halves crosswise and cut around the rind with a knife to loosen the pulp from each section. For salads, pare and remove each section of pulp by cutting carefully between membranes, which are very bitter.

LEMONS may be cut into halves and the juice squeezed for use in fruit drinks, pies, or puddings. For use on fish or in tea, slice or cut them lengthwise into eights.

MELONS should be cut into halves or quarters and the seeds removed. They may then be served for breakfast or as desserts. For salads or fruit cocktails, remove the pulp with a spoon and shape it into balls.

ORANGES may be served whole, cut into halves, or pared, sliced, and segmented for breakfast, desserts, salads, or fruit cocktails. Also they may be cut into halves and the juice squeezed for use in fruit drinks or desserts.

PEACHES may be served raw and whole or peeled, stoned, and sliced for breakfast or dessert. They may be cooked in shortcake, cobblers, or pies. When you peel and slice peaches, do it as near as possible to the time you plan to use them in order to prevent discoloration.

PEARS may be served raw and whole or pared, cored, and sliced for breakfast or dessert, or they may be stewed with sugar, cinnamon, cloves, or lemon.

PINEAPPLE may be served for breakfast, desserts, salads, or fruit cocktail. Pare pineapple with a long, sharp knife, beginning at the top and cutting down.

PLUMS may be served raw and whole for breakfast or desserts, or stewed with sugar for sauce or pies.

Preparing Frozen Fruit

The Navy procures frozen fruits such as berries (strawberries, boysenberries), cherries, peaches, and rhubarb. Frozen fruits are closest to the fresh counterpart in flavor and appearance. They may be thawed by placing the unopened can in the chill space 24 hours before the anticipated use. This allows the frozen fruit to thaw completely and more evenly throughout.

Preparing Dehydrated Fruits

Dehydrated fruits, such as instant applesauce, perforated apple slices, and diced apricots, are readily reconstituted by adding a proportionate volume of water to a specified weight of the particular dehydrated fruit. Like the dehydrated vegetables discussed earlier, dehydrated fruits, because of their small weight and volume, are convenient to store. Dehydrated fruits may be used for dessert in puddings, pies, and cakes, or they may be reconstituted and served at any meal.

Preparing Dried Fruit

Wash dried fruits thoroughly before using them. They may be soaked to reduce cooking time, but avoid a long soaking period because it produces a watery, tasteless fruit. Cook raisins and dates without soaking. If sugar is to be added, it should be at the end of the cooking period. If it is added at the beginning, it interferes with the absorption of water.

SALADS

Salads have an important place on the menu. They add something both nutritious and refreshing to the dinner or supper meal.

Fruit and vegetable salads are the most popular. They are also one of the best means of introducing valuable vitamins, necessary minerals, and color into the meal.

Best of all—salads can be made quickly and easily if a few simple rules are followed, and this is equally true for individual salads which often seem more appetizing and receive greater acceptance than a large dish of salad.

Salad Greens

Select you salad greens carefully. You have a wide choice of greens suitable for a salad foundation — lettuce, endive, escarole, young spinach, and cabbage. These may also be used as one of the main ingredients of the salad itself. Parsley and the inner tender leaves of curly endive are good for a garnish.

Sort, trim, wash, and crisp the greens before making the salad. Wash them carefully to free them of sand and earth particles. Drain them well. Hand cut the lettuce and cabbage into strips or pieces.

Place the prepared greens in pans. Cover them with waxpaper, if available, and then with a clean, damp cloth. Put them in a refrigerator to chill and crisp before using. They should be free of excess water. And they should be one of the very last parts of the meal to be prepared.

Vegetables for Salads

Fresh, canned, or dehydrated vegetables may be used for salads. Select the fresh vegetables with care. Wash them thoroughly. Trim and peel them if necessary and cut them into uniform sizes. Cook those which need cooking. When canned vegetables are to be used in a salad, the liquid drained from the cans should be reserved for the stock pot. The canned vegetables may be marinated in french dressing prior to being used in a salad. Dehydrated cabbage, green peppers, onions, and string beans may be reconstituted for use in salads.

The salad made from dehydrated vegetables is a welcome addition to the menu aboard ships on long endurance voyages. Whether you use fresh, canned, or dehydrated vegetables for your salad, the prepared material should be covered with waxed paper and placed in the refrigerator to be chilled. Do this before combining it with the salad greens and dressings.

Main Course Salads

Salads used for the main course for dinner or supper should be substantial and provide the food values comparable to any other main dish. These salads must include an adequate serving of high protein food, such as meat, fish, poultry, cheese, eggs, legumes (dried beans and peas), or peanuts, combined with crisp salad greens or other vegetables. Potato salad, cold or hot, may be an accompaniment to cold meats on a dinner or supper plate. Used in a salad, the starchy potato functions as it does in any other potato dish. Portions for main dish salads are comparatively large, and mayonnaise or a mayonnaise-type dressing, rather than a french dressing, is usually served with the salad.

Mixing the Salad

Mix the salad carefully JUST BEFORE SERVING. Combine the prepared, chilled ingredients in small amounts at a time. Mix or toss them lightly together. USE A LARGE FORK to distribute the ingredients and dressing.

Use of Salad Dressing

The salad dressing is an important as the salad itself. Each type of dressing can take on a new flavor by the addition of different seasonings and herbs.

As a rule, add the dressing to a fruit or raw vegetable salad the very last thing—not more than a few minutes before you are ready to serve the salad. If you are preparing salads to be set out on the salad bar, and you are placing the various types of salad dressings in separate containers so that each man may choose his own, remember to use a small size container. Any salad dressing that is left over after the meal has been served should be discarded and not kept to be used at another meal.

Serving the Salad

After care has been used to produce a crisp, refreshing and attractive salad, it must be served so that none of this attractiveness is lost. Select as cool a place as possible for assembling and serving. Bring individual salads from the refrigerator, a few at a time, so that they will lose none of their crispness.

RELISHES

Relishes are good to use in place of, or with, a salad. Raw carrots sliced lengthwise, celery,

radishes, cauliflower flowerets, strips of green pepper, olives, and pickles make excellent relishes, have high food value, and increase the attractiveness of a meal. Before serving, all raw vegetables, except leafy varieties, should be refrigerated in cold water for an hour or more to become crisp and tender.

DESSERTS

Dessert adds the finishing touch to a meal. A dessert should not be considered a sweet extra, but rather should be a part of the meal which is as important as the main course.

Rules for good meal planning demand that all foods in the meal blend together with pleasing harmony and contrasts of color, texture, temperature, shape, and flavor. All of these points must be considered when you plan the dessert. Any dessert should harmonize with the food which preceded it. With a light meal, the dessert may be a hearty one, while with a hearty meal a light dessert is in order. With a meal which has been rich and highly seasoned, a simple mild-flavored dessert is best. In this way, the dessert balances the meal.

The flavor of the dessert should blend with the other courses. To repeat much of the same flavor in a meal is monotonous. Too many sweet-tasting foods with no tart food or too many tart foods without some sweet-tasting food is not satisfying. Therefore, a tart fruit dessert seems the perfect finishing touch for a roast pork dinner, and a raisin rice pudding is a good dessert after fish served with lemon.

COFFEE

Coffee is delicate and perishable. Ground coffee loses its flavor and aroma rapidly if it is exposed to the air. Coffee deliveries are made in airtight containers, so see that these containers are kept tightly sealed.

You won't have any trouble making excellent coffee if you follow a few simple rules. Use the recipes given in the B (beverage) section of the Navy-Marine Corps Recipe Service. Always measure both the coffee and the water. Use fresh coffee at all times, and keep the coffee covered while it is brewing. Never allow coffee to remain in contact with boiling water, as the flavor and aroma will boil off. Remove the grounds as soon as the coffee is made. Seepage from the grounds will ruin the flavor of the best coffee.

Most important of all, keep the COFFEE MAKING EQUIPMENT absolutely clean. Wash the urn with clear, hot water immediately after you have used it, and at the end of the day with hot water and urn powder. Rinse thoroughly with clear water. Never use soap or soap powder. When the equipment is not in use, leave 1 or 2 gallons of clear water in the urn. Drain it before making fresh coffee.

Remove the urn faucet once a day and scrub it with hot water, baking soda, and a brush. Use a tablespoon of baking soda for each quart of water. BE SURE TO RINSE THOROUGHLY.

Clean the glass gages at least twice a week with a brush, hot water, and baking soda.

Rinse the urn bag in clear, cold water after each use. When not in use, keep the bag in cold water. Renew the cloth bag frequently.

TEA

Normally, two forms of tea are used; bulk tea and teabags. However, instant, powdered tea also has special uses in the military services.

The quality of brewed tea depends upon how fast the boiling water extracts flavor and color from the tea leaves; it is the tannin present in the leaves that gives tea a bitter taste. Improper temperatures, times of brewing, and holding for service will bring out this bitterness and the pungency characteristics of extracted tannin.

The proper quantities of both water and tea should be measured carefully. Never guess at the amounts. A rule of thumb ration to remember is $^3/_4$ to $1^1/_2$ ounces of tea to 1 gallon of fresh boiling water for hot tea. Eight ounces of tea is a sufficient amount for $6^1/_2$ gallons of water. This amount of tea is sufficient for 100 eight ounce servings of hot tea. Some important points to remember when preparing hot tea follow:

1. If loose tea, not enclosed in a cloth bag, is placed in the urn or kettle, strain tea after it has steeped for 5 minutes.
2. Tea should be made just before serving.
3. Tea should never be boiled as this imparts a bitter flavor.
4. Schedule preparation of tea so that not more than 15 minutes will elapse between its preparation and service; hold finished tea at temperatures 175°F to 185°F for service.

The following are some of the important points to remember when preparing iced tea:

1. Do not add cold water to the concentrate; this may produce a cloudy tea infusion.
2. The tea may be presweetened by dissolving 2 pounds 10 ounces ($1^1/_2$ quarts) of sugar in the hot concentrate before diluting with cold water.

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3. If desired, cut $3\frac{1}{4}$ pounds of lemons (13 lemons) into eights to serve with the tea.

OTHER DRINKS

The B (beverage) section of the recipe service contains many recipes for various fruit drinks and milk drinks that may be prepared and served with either dinner or supper. When preparing fruit drinks such as lemonade or grapeade, it is important to remember to make the drink early enough to allow time for thorough chilling in the refrigerator. Ice should never be added to these beverages for chilling.

SANDWICHES

Sandwiches make satisfying meals and are especially convenient for emergency use. This is true under battle feeding conditions when groups of men are isolated from regular mess facilities, or under similar emergency circumstances. When sandwiches are prepared, it must be remembered that they will probably be the primary item of that particular mean and should be substantial. Where possible, sandwiches should be served with a beverage, fruit or fruit juice, and raw vegetables to be eaten from the hand. There is no limit to the interesting and tasty food combinations that can be used for filling sandwiches. Many good recipes are listed in your Navy-Marine Corps Recipe Service.

Preparing Sandwiches

Sandwiches may be made with any kind of bread. Varying the bread helps to avoid monotony. The kind of bread used should be appropriate for the type and flavor of the filling to be used; there is no set rule for such combinations, for the choice is determined by individual taste. Sandwiches may be served hot or cold.

Use slightly firm bread when making sandwiches because it is more easily handled than freshly baked bread. Bread requires special handling to deter further staling. To prevent moisture loss or absorption, observe the tips listed below on wrapping and storing bread and rolls.

1. Retain in a moistureproof wrapper.
2. Do not store bread in chill spaces; if properly wrapped, bread stays fresher at moderate temperatures (ideally 75° to 95°F). Immediate freezing of cooled, freshly baked bread will prevent staling.
3. Maintain a dry, clean storage spot for the bread and rolls; separate from other stores to prevent absorption of odors and flavors.

The primary rule in sandwich making is MAKE TO ORDER. Advance preparation hastens food spoilage and possible infection. The timing of sandwich making is extremely important. Not more than 3 hours, cumulative time, from preparation to consumption, should elapse without refrigeration.

Handle the bread and fillings as little as possible, avoiding the use of your hands in direct contact with foods if tools or equipment can do the job efficiently. Make prepared fillings only in such quantities as will be used during on serving period. Keep filled sandwiches at a temperature of 40°F or lower if possible.

Avoid leftovers. Do not use any foods for sandwich fillings, including leftover meat and eggs, that have been held at 40°F or over for more than a few minutes. The bacteria grow more rapidly in some foods than in others. The use of pickle relish or slightly soured mayonnaise in sandwiches is of no practical value in the control of pathogens or toxins.

Fillings should not be exposed to room temperature for long periods of time, since food poisoning bacteria grow rapidly in many sandwich fillings and even in the bread itself when it is moistened by mayonnaise or salad dressing, and, especially, those fillings containing eggs, moist lettuce, tomatoes, or similar foods.

Immediately following preparation, wrap each sandwich separately, if possible, and refrigerate. Never use a dampened cloth or towel to keep bread or sandwiches moist. Avoid stacking sandwiches in large numbers or placing them in cardboard boxes. These methods of care actually insulate the food and prevent it from reaching the desired cool temperature as quickly as it should.

Sanitary Precautions

Always prepare sandwiches under conditions where the least contamination possible can occur. Such conditions are affected by installations, equipment, quality of ingredients, and the health and cleanliness of workers. Strict observance of the rules and regulations promulgated by the Medical Department is a must, and such sanitation standards will ensure consumer confidence.

The following rules and regulations should be observed in sandwich production:

1. Keep sandwich counter and equipment clean and sanitary by thorough daily care.

2. Requisition and prepare refrigerated foods in such quantities as will guarantee top-quality sandwiches, a rapid turnover, and reduce spoilage. Avoid leftovers.

3. To keep mold and undesirable odors to a minimum, clean the chill boxes and accessories regularly.

4. Handle bread and fillings as little as possible during all production processes, avoiding the use of hands in direct contact with foods if tools or equipment can do the job efficiently.

CEREALS

Cereals are foods made from grains of wheat, oats, corn, rice, rye, and barley. Cereals are often referred to as breakfast foods, but are not limited to the breakfast meal. Cereals can be used in many types of recipes.

Cereals are usually classed as carbohydrates and thus are known as energy foods. Some cereals have a great amount of protein and are body-building foods.

Cereals are divided into two main classifications—those which are TO-BE-COOKED and those which are READY-TO-EAT.

The to-be-cooked cereals have two classifications: (1) those which are prepared by QUICK-COOKING; and (2) those that require a longer cooking period (sometimes called REGULAR or OLD-FASHIONED).

Quick-cooking cereals have been manufactured to cook completely in a few minutes. In these cereals the pieces of grain are cut finer and rolled thinner than those in the longer-cooking class.

Longer-cooking, or old-fashioned, cereals must be cooked for a longer period of time so that the starch is completely changed and made easy to digest.

Cooked cereal should be free from lumps; cooked to the proper consistency; not too thick nor too thin; and well flavored. Cooked cereals taste best when served piping hot. The cooking develops the flavor and changes the cereal starch, making it soft and more easily digestible. Since cereal grains contain a large proportion of starch, the grains increase in bulk and become thicker while being cooked. The starch in cereal cooks quickly, and long, slow cooking is not necessary. So that cooked cereal will retain its full flavor and not become too thick, it is best to cook it shortly before serving.

Flaked cereals such as rolled oats and whole wheat cereal are cooked by sprinkling them into boiling, salted water. Granular cereals such as farina and cornmeal are made into a paste, using cold water, and then added to boiling, salted water. The water should continue to boil while the cereal is being added. Vigorous stirring or beating of cereal while it cooks tends to make it sticky and gummy.

EGGS

Eggs are valuable foods which contain protein for building and repairing muscles, plus minerals and vitamins for good health. Eggs are easily digested, and, if properly cared for and prepared, are delicate in flavor.

There are literally hundreds of ways in which eggs can be used in food preparation. Below are special uses with other foods:

1. Thicken custards, puddings, and sauces.
2. Leaven cakes and cookies.
3. Add color, richness, and flavor to any dish in which they are used.
4. Help provide a coating on breaded meats, fish, or croquettes.
5. Serve as colorful, good-tasting garnish for salads, soups, or cold meat platters.
6. Bind ingredients together as in meat or fish loaves, croquettes, and patties.
7. Emulsify (help keep the right consistency of) salad dressings.

The Navy procures fresh shell eggs, frozen whole table-type eggs, frozen egg whites, frozen egg yolks, and dried whole eggs.

When several fresh eggs are to be used, break each one separately into a small dish. Thus any egg which may have a strong odor or poor appearance can be discarded without spoiling the others.

Frozen whole table-type eggs are to be used for scrambled eggs and omelets. The bakery-type, frozen egg yolks, and frozen egg whites are to be used only in baking.

Whole dried eggs may be used in cooking and baking or they may be scrambled. Instructions are included on the recipe cards for using whole dried eggs in baking.

When you are using whole dried eggs as scrambled eggs, prepare no more than 25 portions at one time and prepare them less than 10 minutes before serving; they toughen if allowed to stand. Reconstitute whole dried eggs carefully with cool water using the instructions included with the product. Once reconstituted, the eggs must be used within 1 hour. Diced cooked bacon, ham, sausage, luncheon meat, or cheese may be added to the eggs. Whole dried eggs, reconstituted with water, are used in the same way as fresh eggs, and should

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be treated with the same care as fresh eggs removed from the shell. Dried eggs should be sifted before measuring or weighing for reconstituting. If a sifter is not available, the powder should be stirred with a fork or a wire whip to make it light and fluffy.

Dried whole eggs will absorb moisture if they are exposed to air; consequently, they should be stored in a cool, dry place in tightly covered containers. If they are properly stored at refrigerator temperature, whole dried eggs will be satisfactory for at least a year. Whole dried eggs, left uncovered near strong-flavored foods such as onions, lemons, or cheese, will absorb odors and flavors as readily as do fresh eggs.

Eggs which are stored at room temperature or allowed to remain at room temperature for a number of hours, rapidly deteriorate in quality.

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CHAPTER 11

BAKING

Although procurement of bread, pies, cakes, and simple pastries is authorized, you will be expected to know how to make them. This is particularly true on small ships and at smaller shore stations, where conditions will permit serving hot breads and baked dessert items.

To produce high quality bakery products, you should learn certain general facts about each type of product. Eash has a basic recipe which may be varied to some extent, but which must remain essentially the same to produce a satisfactory result. You should understand this recipe and the interaction of its ingredients which causes the dough or batter to rise and produces other effects necessary to the final product.

The different kinds of dough and batter are handled and panned in specific ways to produce best results, and for each type there are instructions about baking time and temperature. Also, certain precautions must be observed to protect the products from spoilage.

BAKESHOP EQUIPMENT

Any discussion of baking is incomplete without a discussion of the equipment used and its operation. The electric mixer is discussed in chapter 5. On smaller ships, you will use a machine similar to this to mix bread and cakes, as well as other foods. On larger ships, where there is space for a separate bakeshop, you will use a BREAD-DOUGH MIXER. Bread-dough mixers should not be confused with food mixing machines.

Bread-Dough Mixer

If you are to use the dough mixer wisely, without danger of overloading, it is important that you know the capacity of the particular machine in your shop. This capacity is expressed in barrels. When dough mixers were first made, flour was packed in barrels, and the size of the mixers was designated by the number of barrels of flour they could mix. Since 1 barrel of flour weighed 196 pounds, a 1 barrel machine was designed to mix a dough containing 196 pounds of flour (a 360 pound dough).

Where speed is concerned, there are two types of dough mixers, no matter what their capacity. The low speed mixer which is used aboard ship operates at 26 rpm. The high speed mixer used for shore activities has a combination of 2 speeds and can be operated at low speed, 33 rpm, or high speed, 65 rpm. The baker must determine the exact time needed to mix a dough properly in the particular mixer in his shop. It takes longer to mix the dough in a mixer which operates at a low speed than in one that operates at a higher speed.

Also, the amount of friction heat developed by the high speed mixer will be greater than that developed by the low speed mixer. Since this amount of heat will affect the development of the dough, it will be necessary for you to determine the exact temperature rise from mixing on a particular machine. The temperature of the dough can be maintained at the desired level by controlling the temperature of the water used in mixing the ingredients.

Safety Precautions.—There are certain safety precautions for operating mixing machines. First, of course, the machine should always be properly cleaned to protect the product. For your own protection, never reach inside the machine when it is running; don't get water on any of the electrical parts or the motor; and always be sure that the power is switched OFF before cleaning.

Care and Cleaning.—The bread mixer should be cleaned after each use, unless doughs are being mixed one after the other. In this case, the machine should be cleaned immediately after

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the last dough is out. You should take care to remove all particles of dough and ingredients from all parts of the machine, particularly the places that are not visible, such as the underside of the cover.

Like any other machine, the dough mixer requires grease or oil, and sometimes both. The mixing machine should be properly lubricated to do the job. However, it is the responsibility of the baker to request lubrication service as often as necessary to keep the mixer in good operating condition. The mixer is a rugged piece of machinery and is not likely to break down if it is kept lubricated and is not overloaded.

Dough Trough

A dough trough is the container in which dough is placed during the fermentation period. It is an oblong box-like trough of steel construction (see fig. 11-1), equipped with 4 casters to permit easy movement in the bake shop area.

Dough troughs are of various lengths, and are designed to hold approximately 90 pounds of dough to a foot of length or 50 pounds of flour to a foot. If the trough is too long for the amount of dough to be fermented properly, dam boards may be inserted so that the correct amount of space is available.

It is important that the dough trough be thoroughly cleaned after each use. After cleaning, rub the inside with oil to prevent rusting.

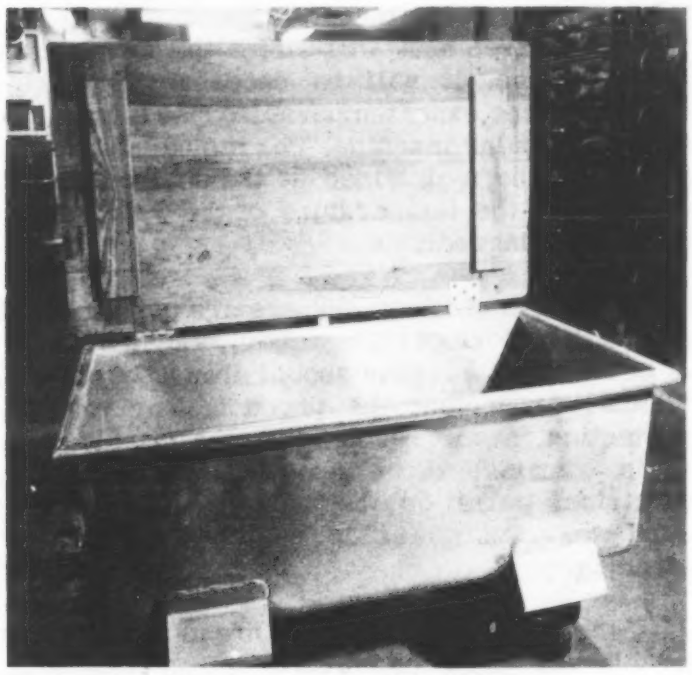

Figure 11-1.—Dough trough. 48.50

Dough Proofers

Dough proofers or fermentation rooms are used for conditioning dough and cooling baked bread. The air temperature and air moisture (humidity) in a dough proofer are kept at preset levels by automatic controls. Dough proofers are thermally insulated enclosures and vary in size from a small box with shelving to a room with space for many portable bread racks. Heating of dough proofers is done by steam coils or electric heating elements inside the enclosure, or by self-contained air conditioning units connected with the proofer by air ducts. For shipboard use, steam heated dough proofers (fig. 11-2) are furnished in various sizes; the number and size of the proofers depend on the capacity of the bake ovens installed on board ship.

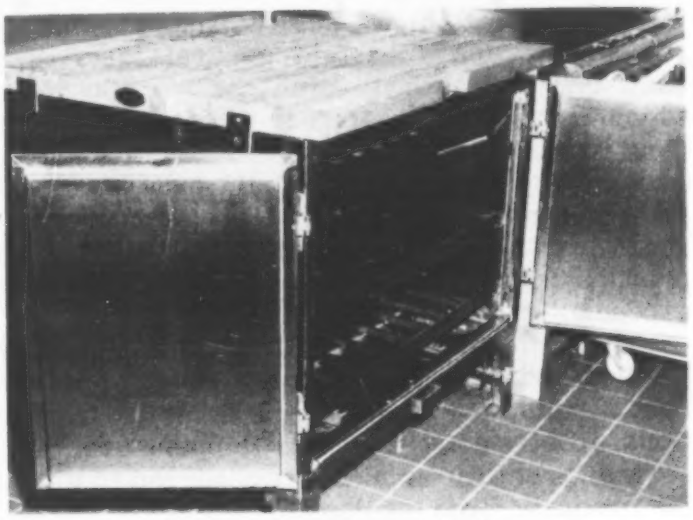

Figure 11-2.—Dough proofer. 48.51

Operation.—Regardless of the size, the operation of dough proofers is basically similar. Air within a proofer should be kept at a preset temperature and moisture level. Dough proofers require not less than 1 hour to attain proper atmosphere; the unit should be started well in advance of anticipated use.

For proofing Navy bread dough, the time and temperature in the proofer should be that specified on the recipe card being used. Turn the steam valve on full and open the pet cock to provide the necessary amount of steam for humidity. Adjust the steam inlet valve to obtain the desired temperature. When the temperature and humidity are correct, place the pans of dough within the proofer and close the door.

Watch the time closely, and test the dough periodically by pressing fingers into it. If the depression is filled by rising dough, fermentation is progressing properly. To reduce fermentation, cover the bread pans with cloths and reduce the proofer temperature. At no time should there be more than 35 pounds of steam pressure allowed to pass through the steam coils of the proofer. Drain the condensation from the drip pan at regular intervals by opening the pet cock.

Care and Cleaning.—Proofers should be maintained in a safe, sanitary, dustfree, rustfree, nonleaking, and economical operating condition. The enclosures and accessories should be kept free of flies, ants, cockroaches, mice, and rats.

At the end of each day, proofers should be swept clean; shelves and racks removed and scrubbed with hot soapy water and rinsed with 180°F water. When practicable the inside of the proofer should be scrubbed daily with hot soapy water, rinsed with 180°F water, and dried immediately.

Bake Ovens

Bake ovens (fig. 11-3) are furnished the Navy in four types: types 4, 6, 12, and 18. Types 4 and 6 are the older type ovens having 4 and 6 compartments, respectively. In those ovens the heating elements are located at the bottom of each compartment and at the top of the upper compartment. Each heating element is controlled by three-heat switches. Each baking compartment is equipped with a temperature indicator. The bake oven is also provided with means to prevent overheating by limiting the maximum temperature attainable in any compartment to 500° or 550°F under any operating condition.

The type 12 (2 compartments) and type 18 (3 compartments) are the newer design of bake ovens. These ovens have the same available oven space as the type 4 and type 6, respectively. Each oven compartment of the newer type is heat insulated from the others and is controlled separately by an adjustable thermostatic switch. Top and bottom heating elements in each section are controlled separately by three-heat switches.

Operation.—When ready for use, the oven should be preheated to the desired temperature with all switches on "high" position, then turned to "low" or "medium" as desired. Make every effort to avoid excessive opening of doors. Steam should not escape around the doors. Avoid direct air currents on ovens. Keep dampers as nearly closed as possible.

Load the decks evenly, distributing products uniformly over the deck area not closer than 3 inches to the door. Load the pans in rows from rear to front of the oven along the right wall. Follow this procedure until the oven is full. Start unloading with first row on the right; this procedure gives even baking for each pan.

Care and Cleaning.—Keep the inside of the oven and decks scraped clean to avoid spotty heating, particularly around doors and edges. If dirt accumulates, the doors will not close tightly, and poor baking will result.

Cool the compartments by opening the vents, using the control rod at the front of the oven. DO NOT throw water in the oven to cool the oven decks or to wash them. When you use a wet rag to swab or clean the decks, wring it out thoroughly before using.

Dough Thermometer

A dough thermometer is an essential instrument in any shop that is producing bread. It is

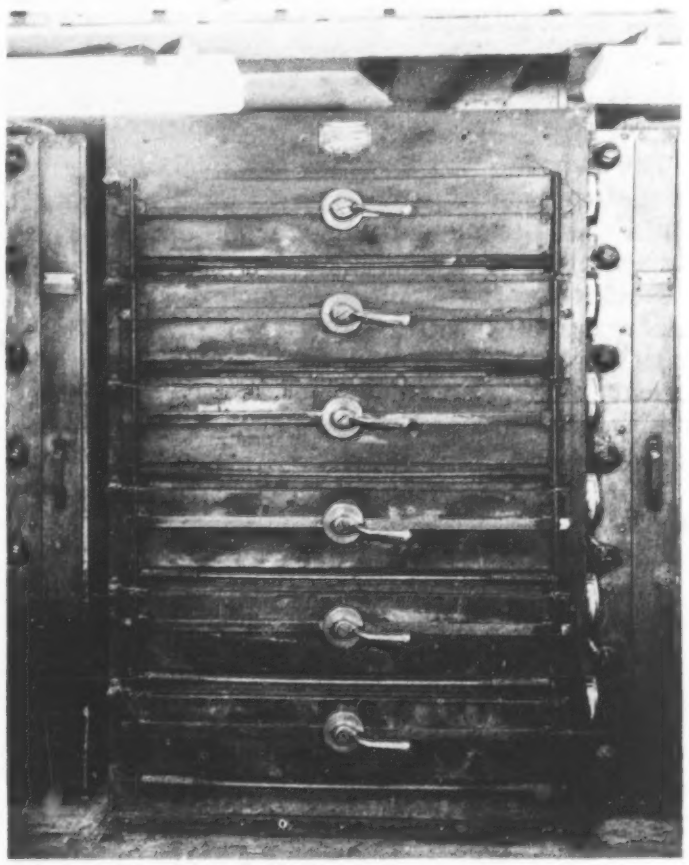

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Figure 11-3.—Bake ovens.

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used for determining the temperature of the room and of the flour and water used in the bread dough and, after the dough is mixed, the temperature of the dough. In order for the yeast to function uniformly and at a proper speed, the dough must be at the correct temperature. The temperature of the ingredients added to the dough and that of the room in which it is mixed, as well as the heat generated in mixing, will affect the final temperature. Without a thermometer, you will not be able to determine any of these temperatures accurately. The highest reading of the dough thermometer is 120°F. Keep it out of extremely hot water.

Bread Racks

Bread racks should be used for cooling or for proofing bread. The rack may be filled with pans of molded (shaped) loaves of bread and put in the proof box for the time required for proofing. In the cooling process, after the bread has been baked, the bread should be placed on the trays from the top down and about 1 inch apart.

Bread racks should be washed at frequent intervals to prevent dirt, crumbs, and foreign matter from falling on the bread.

Work Bench

The wooden work bench is used primarily for the makeup of handmade baked products. It should be permanently secured to avoid its being moved to a position where it may cause an accident. It should be checked for wood splinters which could get into the bread or injure the baker. It should never be used like a meat block, but instead should be protected from nicks and cracks, and scrubbed after each day's use.

Scales

Scales take the guess work out of measuring. They save time and are the most accurate way of measuring ingredients. Scales are usually on the ship's allowance, and it may be that only one pair is available on the ship. This means that great care must be exercised in handling them. They should be checked often to make sure that they are working properly. Scales are of two general types: the spring type and the balance type. These scales weigh to the nearest $^1/_4$ oz.

Pans

Pans for bread, rolls, cake, and pie constitute a major investment in every bakery operation. A knowledge of the care and maintenance of these pans is essential if they are to remain usable for the maximum time.

Pans are made of tinplate (the most commonly used), aluminum, and aluminized steel.

Maintenance.—All baking pans should be kept clean. Dirty pans affect the baking quality, are unsanitary, and often will impart objectionable odors or taste to the finished product. Pans may be washed by three methods: hand washing, tank washing, or with a pan washing machine. For each washing method, it is important that the proper pan cleaning material be selected. The cleaner must be powerful enough to remove the carbon and dirt and yet not harm the surface coating of the pan. The proper solution as recommended by the compound cleaner manufacturer must be followed in each case. The wrong solution can result in the complete ruin of the pan. After the pans are cleaned, they should be immediately and thoroughly dried by allowing them to air dry. Pie pans may be dried by separately placing them in a 380°F oven for about 15 minutes.

Storage and Handling.—Pans should always be stocked neatly, upon a clean pan truck or skid, to a safe height to allow the average person to remove the top pans easily. Pans should be stacked inverted to prevent contamination and to facilitate handling. If the pans are to be stored for a considerable time, they should be thoroughly cleaned to remove the pan grease and then covered with a fitted canvas duck or wrapped with kraft paper. The first day of storage should be marked on a obvious part of the wrapping surface. The purpose of dating the covering is so that the baker can schedule inspections of the stored pans and so that the covering will be replaced frequently enough to avoid dust and contamination accumulating on the covering and pans.

When pans are stored they should not be exposed to outside weather because corrosion may occur. The pan temperature also can be lowered enough to cause condensation to form during proofing. Low pan temperature also affects the quality of the proof, and the moisture from condensation can cause serious sticking problems at the pan dumping area.

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Do not bang and slam the pans. This distorts them and causes excessive strain on the strappings, leading to premature deterioration. Dented and bent pans cause poorly baked products, lead to malformed baked goods, and frequently are the cause of poor release qualities.

Bread Pans

Bread pans are made of steel and coated with tin. New pans should be treated before they are used so that the tin will be harder and less porous. This will help keep the bread from sticking. The process of treating the new pans is known as BLUEING OR BURNING OUT pans.

To burn out pans, follow these steps:

1. Thoroughly clean the pans.
2. Place pans in the oven and raise the temperature to 410°F.
3. Keep temperature of 410°F until the pan takes on a blue color.
4. Turn off oven and lower the temperature to below 275°F.
5. Remove the pans and grease them lightly while they are still warm.
6. Place pans in the oven and keep them warm for 1 hour.
7. Remove the pans from the oven; grease them prior to use when they are cold.

NOTE that it is very important for you to control the temperature of the oven to prevent melting the tin coating on the pans. Remember also that sliding pans on the hot oven deck may cause the tin coating to rub off the bottom.

Bread pans which are being used daily should be lightly greased to prevent sticking. Normally, sufficient fat is used in the dough so that it is not necessary to grease the bread pans after each use. The amount of grease used in a bread pan should be just enough to prevent the loaf from sticking to the pan.

All pans should be kept clean and dry to avoid rusting.

Pie Pans

Pie pans are round pans, the sizes being designated by the width (diameter) of the pan in inches. There are several good rules to observe in order to keep pie pans in good condition and to ensure a longer life.

1. Clean pans after use, and dry thoroughly (in the oven not above 380°F).
2. When you cut pies, avoid cutting or scratching the pan.

Muffin Tins

A unit in a muffin tin is approximately $1\frac{1}{2}$ inches in diameter, but the units vary in depth. The average pan has 12 units. The importance of keeping these pans well greased and clean cannot be overemphasized. If the pans are dirty, it will affect the finished product.

Avoid letting rancid grease accumulate in the crevices and corners of these pans. A good procedure to follow in caring for the pans is as follows:

1. Grease pans prior to use. Use a plastic grease.
2. Flour pans after greasing to avoid having cakes or muffins stick to the pans. Paper liners are now available for muffin tins. Your supply officer can order them for you.
3. Clean and dry pans after use. Do not grease.

BAKING INGREDIENTS

Many of the characteristics of bread are brought about because certain changes take place in the dough before it is baked. A knowledge of ingredients must include an understanding of the effects of time and the conditions to which the dough is subjected. As you read this discussion, refer to figures 11-4 and 11-5, which show the Navy-Marine Corps Recipe Service recipes for white bread, regular and short time, respectively.

The flavor of bread results partly from the blending of the ingredients in the dough and partly from changes that take place before and dough is baked. The color of the crust results from the sugar caramelizing in the presence of heat. The volume of the loaf is a result of the combined action of flour and yeast in the presence of water.

The basic ingredients of bread are flour, water, salt, and yeast. Additional ingredients will add to the normal characteristics of the bread, such as improving the flavor, color and volume, and contributing to the food value. Common among such enriching ingredients are sugar, shortening, and milk (milk solids).

Flour

There are four grains that are commonly milled into flour. These are wheat, corn, barley, and rye. Of these, wheat is the only one that contains properties that make it possible to produce a raised bread. The wheat contains protein which when combined with water forms

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WHITE BREAD — C. BREADS No. 13 (1)

YIELD: 30 Loaves (47½ Pounds of Bread) — DAILY RATION: 6 Slices

INGREDIENTS	WEIGHTS	MEASURES	% ON FLOUR BASIS	METHOD
Yeast, active, dry	5 oz	1 cup	1.11	1. Sprinkle yeast on top of water. Let stand 5 minutes, then stir. Add sugar, stir until dissolved. Let stand 10 minutes longer, then stir again.
Water, warm (110° F)	.....	1½ pt	.....	
Sugar	2 oz	4½ tbsp	.....	
Water (68° F) variable	.....	2⅛ gal (variable)	65.49 (Total)	2. Place water in mixer bowl. Add salt, sugar, and milk; mix on low speed to break up any lumps.
Salt	11 oz	1¼ cups	2.43	
Sugar	1 lb 13 oz	1 qt	6.86 (Total)	
Milk, nonfat, dry	1¾ lb	5¾ cups	6.19	
Flour, hard wheat, sifted	28¼ lb	28¼ qt	100.00	3. Add flour, yeast suspension, and shortening; mix until dough is smooth and elastic, (approximately 15 minutes, on medium speed).
Shortening, soft	1 lb 6 oz	3¼ cups	4.87	4. FERMENT: Set in warm place (78° to 80° F), free from drafts, until double in bulk (approximately 2 hours). 5. PUNCH: Let stand 30 to 45 minutes. 6. MAKE UP: Scale loaves at 28 oz, round up and let rest 10 minutes. Mold and place one loaf into each bread pan (11 by 5¼ inches). 7. PROOF: Place in a warm place until double in bulk, approximately 1¼ hours. 8. BAKE: 425° F approximately 35 to 40 minutes.

C. BREADS No. 13 (2)

NOTE: 1. A ½-inch bread slicer will yield 20 slices (plus 2 end slices); a 7/16-inch slicer will yield 23 slices (plus 2 end slices).

2. 10 oz of compressed yeast may be substituted for active dry yeast.

3. Temper water to yield a dough temperature of 80° F.

VARIATIONS

1. CINNAMON BREAD: In Step 6, after dough has been divided and scaled, roll each piece into a rectangular sheet. Brush with melted butter, sprinkle generously with Cinnamon Sugar Mix (Recipe Card I-24). Brush bottom edge of each piece of rolled dough with water then roll as for jelly roll. Seal on bottom and place one roll in each greased bread pan (11 by 5¼ inches). Sprinkle top of each roll with Cinnamon Sugar Mix. Proceed with Steps 7 and 8.

2. CRACKED WHEAT BREAD: Use 3 lb wheat base (approximately 10%) and 25 lb sifted hard wheat flour in Step 3.

3. RAISIN BREAD: Add 4 lb of raisins during the last 2 minutes of mixing in Step 3.

Figure 11-4.—Recipe for white bread.

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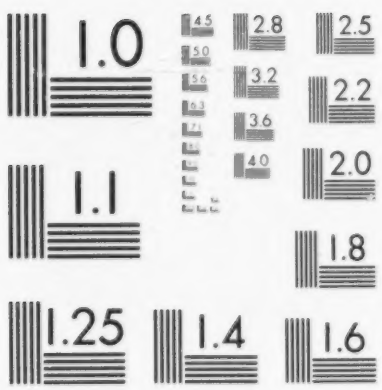

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BAYONNE BREAD C. BREADS No. 15 (1)

(short-time, white bread formula)

(NAVSUPRANDFAC, Bayonne, N. J.)

YIELD: 30 Loaves (47½ Pounds of Bread) DAILY RATION: 6 Slices

INGREDIENTS	WEIGHTS	MEASURES	% ON FLOUR BASIS	METHOD
Yeast, active, dry	8½ oz	1⅔ cups	1.82	1. Sprinkle yeast on top of water. Let stand 5 minutes, then stir. Add sugar, stir until dissolved. Let stand 10 minutes longer, then stir again.
Water, warm (110° F)	.....	5 cups	.....	
Sugar	3 oz	6¾ tbsp	.....	
Water (65° F) variable	.....	2 gal (variable)	63.25 (Total)	2. Place water in mixer bowl. Add milk, sugar, and dough conditioner. Mix on low speed to break up any lumps.
Milk, nonfat, dry	1½ lb	4¾ cups	5.13	
Sugar	14 oz	2 cups	3.63 (Total)	
Dough conditioner (optional)	2½ oz	4½ tbsp	.53	
Flour, hard wheat, sifted	22 lb	5½ gal	100.00 (Total)	3. Add flour and start mixer on low speed; add shortening and yeast suspension. Mix until flour is thoroughly moistened.
Shortening, soft	1 lb 6 oz	3⅛ cups	4.70	4. Mix on medium speed 10 minutes.
				5. Let rise in mixer bowl 20 minutes.
Flour, hard wheat, sifted	7¼ lb	7¼ qt	.....	6. Mix and sift flour, salt, and cornstarch; add and mix on medium speed 10 minutes or until dough is smooth and elastic.
Salt	8½ oz	1 cup	1.82	
Cornstarch	5 oz	1 cup	1.07	
				7. FERMENT: 30 minutes at a dough temperature of 88° to 90° F.
				8. MAKE UP: Scale 28 oz of dough into each bread pan (11 by 5¼ inches).
				9. PROOF: 25 to 30 minutes at 90° F or until double in bulk.
				10. BAKE: Preheat oven to 450° F. Bake 5 minutes. Reduce temperature to 375° F. Bake 25 to 30 minutes.

C. BREADS No. 15 (2)

NOTE: 1. A ½-inch bread slicer will yield 20 slices (plus 2 end slices); a ⅞-inch slicer will yield 23 slices.

2. 1 lb 1 oz of compressed yeast may be substituted for active dry yeast.

3. Water temperature and fermentation are based on a final dough temperature of 90° F.

4. Loaf units do not necessarily require molding. Roll scaled dough to pan size and place directly in pan.

VARIATIONS

1. RAISIN AND MOLASSES BREAD: Use 3 oz brown sugar in place of sugar in Step 1. Use 14 oz brown sugar in place of sugar and add 4 oz (1 cup) cinnamon in Step 2. In Step 6, omit corn starch and add 1 qt molasses. During the last 2 minutes of mixing in Step 6, add 4 lb raisins which have been "puffed" (See Recipe Card C–12). In Step 7, ferment for 1 hour. Proceed with Steps 8 and 9. Bake: at 350° F for 35 minutes.

2. WHEAT-TYPE BREAD: In Step 6, use 3¼ lb wheat base and 4 lb (4 qt) sifted hard wheat flour. Proceed with Steps 7, 8, 9, and 10.

Figure 11-5.—Recipe for making bayonne bread. 48.47.6

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the elastic substance GLUTEN, which gives the dough expansion qualities.

Wheat flour is divided into hard and soft varieties, depending on the type of wheat from which it is milled. Hard flour contains more protein and is used for making yeast bread and rolls, while soft flour is used for cakes, pastries, and, when blended with hard wheat flour, for quick breads. A hard wheat flour containing a good quality gluten is called a "strong flour." A low protein of soft wheat flour forms less of the gluten and a less tough type so that sufficient structural material will be provided for cakes and similar products, without causing them to be too tough.

Flour contains various food elements besides the protein. These are fat, carbohydrates, water, minerals, and vitamins, the content varying with the type, grade, and storage period of the flour. It is little wonder that bread made from such ingredients is called "the staff of life".

Although the FAT content of flour is very low, this fat will become rancid if flour is stored for long periods under unfavorable conditions.

CARBOHYDRATES in flour are usually in the form of STARCH, which absorbs water and helps give bulk to the dough. Flour especially made for cakes and pastries is rich in carbohydrates.

MINERALS are contained in the bran coat and the germ of wheat, and most of the minerals are lost when wheat is made into white flour. These minerals have been returned to enriched flour.

DIASTASE and PROTEASE are the most important enzymes found in flour. An enzyme is a very minute substance produced by a living plant, which, by its mere presence, brings about certain changes in the composition of a material. Diastase converts starch to sugar, and the yeast acts upon the sugar to produce carbon dioxide and other fermentation products. Protease softens the gluten, and when this enzyme is lacking, the dough will not be elastic.

All flour is aged chemically and no additional aging or blending is required.

Water

Water is one of the basic ingredients of bread. In many bakery products, including bread, the amount of water used is second only to the amount of flour. Water contains minerals. The amount and kind vary in different parts of the world. These variations affect the properties of dough and the finished bread.

Functions in Baking.—Water is necessary to form gluten from the protein of flour; this gives dough its elastic and gas retaining properties. Gluten absorbs twice its own weight of water. The amount of water used determines the consistency of the dough temperature after mixing. Water dissolves salt and sugar and aids in distributing these materials uniformly through the dough. Water makes its possible for the enzymes to act on flour, and for the yeast to cause fermentation.

Leavening Agents

Leavening agents are gases that cause dough to rise. They are produced by chemical action or introduced by the mixing process, which forces air into the dough. The common types of leavening agents are steam, air, and carbon dioxide gas.

Air is introduced into dough by blending (creaming) fat and sugar together, by sifting flour, or by folding in beaten egg whites which already contain air. Steam is used to leaven popovers and cream puffs. Carbon dioxide gas is created by using yeast, baking powder, or soda in the dough.

YEAST is a microscopic, one-celled plant which when conditions are favorable, will multiply by budding or by the division of a cell into two cells. In this process of reproduction, the yeast plant uses available food (sugars) to produce carbon dioxide gas and alcohol. This is known as fermentation.

Two kinds of yeast common in the Navy are COMPRESSED YEAST and ACTIVE DRY YEAST. By weight, active dry yeast is considered to be twice as strong as compressed yeast.

Compressed yeast should be broken up and suspended in a part of the water ingredient. The amount of water used will have an influence on the degree and ease with which the yeast can be distributed through the dough. Never use less than 1 quart of water to a pound of compressed yeast. For best results, allow yeast to remain in water for 5 to 10 minutes before adding it to the dough.

The water should be approximately 80°F. If the yeast is cold, warmer water (never over 95°F) will be required to activate it. Before adding the yeast water to the dough, distribute the salt of the formula thoroughly through the other ingredients.

Active dry yeast should be suspended in about four times its weight of water at 105°F to 110°F for 5 to 10 minutes before use. Colder water results in slower fermentation, while water which is much warmer may harm the yeast.

Complete distribution of the yeast cells throughout the dough is very important whether the yeast used is compressed or active dry. The total cells in the finished loaf of bread are limited to the total number of active yeast cells in the piece of dough at the time the loaf was being pan proofed.

BAKING POWDER is a leavening agent which contains carefully measured amounts of baking soda and a material which forms an acid when it is mixed with water. To keep these active ingredients separated, and prevent the moisture in the air from causing them to act with each other, they are mixed with a large amount of starch. It is required that they produce not less than 12 percent carbon dioxide. There are several types of baking powder, the type determined by the chemical which is used to form the acid. The Navy uses a combination type baking powder, S.A.S., which contains 2 acid ingredients: sodium aluminum sulphate and orthophosphate. This type of baking powder is moderately fast acting; one constituent acts in the batter, while the other does not act until it is heated in the oven.

Carbon dioxide may also be produced by combining baking soda with sour milk or molasses. It is difficult, however, to determine beforehand the amount of gas that these mixtures will produce, so it is difficult to obtain standard results. Baking powder recipes generally are more reliable.

Salt

Very little salt is used in bread making, but the amount used is essential, for it performs a very important function. Without salt, fermentation in dough is too rapid, and the baked product is too coarse, while too much salt will slow fermentation and the bread will be soggy. Salt strengthens gluten and helps it to expand, improves the color of baked products, and enhances the flavor.

Never use more than 3 peroent salt, or you will have salty bread. More than 5 percent will kill the action of the yeast. Most bread recipes call for $1\frac{1}{2}$ percent to $2\frac{1}{2}$ percent of the weight of the flour in the recipe. Use more salt to strengthen a weak gluten and for rich doughs. If you wish to reduce the speed of the fermentation, you can accomplish this by the use of more salt. The salt in the loaf makes it less likely to become moldy.

Sugar

In a bread dough, sugar is added to give the yeast an energy food as a source of carbon dioxide gas. Most of the sugar in breads, however, is converted from the starch by enzymes in the dough.

This sugar in the bread contributes to the color of the crust, the taste of the baked loaf, the toasting qualities of the bread, texture, moisture retaining qualities, and the nutritional value. Sugar is also a tenderizer.

All sugars do not have the same degree of sweetness, since sweetness depends upon the refining process through which the sugar has passed. Brown sugar, for example, is less highly refined than white sugar, and therefore is not so sweet. Brown sugar lends a pleasant taste to cooked or baked products, and sirups can be used for cakes and cookies. Sugar sirup is often used as a substitute for regular sugar. Corn sirup, honey, or molasses improves the flavor of cookies and helps them retain their moisture.

Shortening

Shortening is any edible fat used in baking. If the shortening is solid at room temperature, it is a fat. If it is a liquid at room temperature, it is an oil. The fat type shortening is more desirable for use in bread dough, because it can be more thoroughly distributed through the dough. The reason for this is that it will not saturate the flour with which it comes in contact. The oil type of shortening can be used effectively, provided the dough is well formed before the oil is added.

Butter is thought of as shortening when it is used in baking. Actually it is not a pure shortening because it contains milk solids, salt, and moisture. When butter is used as a shortening, you should adjust your recipe so that the total milk, salt, and moisture content is not adversely increased, and the total fat content is not adversely decreased.

Some of the common types of shortening are given in the following paragraphs.

LARD is rendered fat of sound healthy hogs.

SHORTENING COMPOUNDS are composed of animal and vegetable fats mechanically blended to give a final product of acceptable plasticity and satisfactory baking quality.

HYDROGENATED SHORTENING is a combination of vegetable oils that has been transformed from oil into a solid fat, white in color and tasteless. This is a high grade shortening that has excellent baking qualities.

SHORTENING with EMULSIFIER is hydrogenated shortening to which an emulsifying agent has been added. This gives the shortening exceptional ability to blend with other ingredients.

VEGETABLE OILS are obtained commercially from cotton seed, soy beans, corn, sunflowers, and peanuts.

Shortening produces tenderness in baked products, adds flavor and richness, helps produce better grain and texture, and makes the products stay fresh longer.

Milk

Milk is one of the almost complete foods. Nonfat dry milk contains all the food qualities of milk except fat. It is most acceptable for bread production because it is almost 100 percent nonfat milk solids. Dry milk can be added by mixing or sifting the milk and flour together, or it can be reconstituted with part of the water in the bread recipe and added to the dough. In either event, it is important that there be no lumps of milk powder in the dough.

The amount of milk used in the dough can be as high as 6 percent nonfat dry milk based on the weight of the flour. Inclusion of more than 6 percent in the bread dough is detrimental to fermentation. Milk improves the texture, flavor, and keeping quality of bread.

Eggs

In baked products, eggs supply a high protein, mineral, and vitamin content. The yolks add color, the whites help bind other ingredients, and both combine to add flavor and moisture.

Fresh eggs should be removed from the refrigerator and warmed to room temperature before being used in dough. Frozen eggs should be completely defrosted before being added to the dough, and should be well mixed. Dried whole eggs may be sifted with the dry ingredients in some baked products containing a high percentage of dry ingredients; the water needed to reconstitute the eggs is added to the required liquid. In cake batters, however, best results are obtained when the dried whole eggs are reconstituted prior to using the recipe. Reconstituted eggs should be used within 1 hour unless refrigerated. Do not hold them overnight.

BAKING TERMS

In addition to learning how to use the tools of your trade, you will need a speaking and working knowledge of the terminology that bakers use. The following terms will help you understand baking directions and recipes, and will enable you to know what other bakers are talking about when they use them.

ABSORPTION OF FLOUR is a commonly used term which refers to the ability of flour to absorb and hold liquid. Different flours vary in their ability to absorb liquid, and therefore there is a variation in the amount of water necessary to produce dough of normal consistency from a definite amount of flour. Absorption is expressed in percentages. For example, flour that will absorb 60 pounds of liquid for every 100 pounds of flour has an absorption power of 60 percent. The quality of flour is indicated by the amount of liquid it will absorb. Navy issue flour absorbs from 60 to 75 percent, which is very high.

When you don't know how much liquid a certain type of flour will absorb, you can take 1 pound of flour, add water to make the type of dough you want, weigh the dough, subtract 1 pound, and the remaining weight will be the amount of liquid absorbed. Use this weight to determine how much liquid you will need for your entire batch of flour.

FERMENTATION is the chemical change that takes place when yeast (or other leavening agent) in the bread releases carbon dioxide gas, causing it to rise. The fermentation period is the time which elapses between the mixing of the dough and the time the yeast is killed by the oven heat (140°F).

DIVIDING means cutting the dough into suitable size for scaling.

SCALING is the weighing of each piece of dough after it has been divided, to make sure each is the same size. An accurate set of scales is necessary for scaling bread.

ROUNDING UP, or BALLING UP, means rolling the divided pieces of dough into balls to close up the cut sides of the dough.

MOLDING, or MAKEUP, of dough means to form the dough into loaf shapes for proofing. The round ball of dough is rolled and flattened, and at the same time, lengthened until it is long enough to fold over its own length. Fold the dough and press it firmly with the heels of your hands to press out the gas. Roll it tight, compact, and free from air pockets.

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PUNCHING, CUTTING OVER, and TURNING all refer to the same operation, which takes place after the dough has risen the first time. The dough is punched to release the gas and is folded over. Then the dough is allowed to rise again and ripen.

PROOFING or PANPROOFING is the process by which the fermentation of the dough is completed in a proofing cabinet, where the temperature and humidity are controlled. This will take about 1 hour under normal conditions.

PANNING means to place the molded loaves in pans.

BREAD

Bread is the most important food produced by the baker. He prepares it in greater quantity than any other baked product. High quality and excellent taste must be maintained, regardless of the amount of bread you are required to bake.

After you select and weigh or measure the necessary ingredients, the next important step is mixing. Dough must be mixed thoroughly to make it smooth, to distribute the ingredients evenly, and to develop the gluten fully. Dough may be mixed by hand, but an electric mixer or a bread-dough machine will make your job easier. Time and speed of mixing vary with the type of mixer used, the kind of dough being prepared, and the strength of the flour.

Fermentation

Fermentation commences as soon as the dough is mixed, and continues until the yeast is killed by the heat of the oven. The correct temperature for the dough during fermentation is indicated on the Recipe Service recipe card. A higher temperature will cause growth of undesirable bacteria (wild yeast) and excessive acidity, which result in a coarse-grained bread of poor flavor.

The length of the fermentation period depends upon the amount of yeast used, strength of the flour, and temperature during fermentation. More yeast and higher temperatures cause the dough to rise faster. Weak flours require a shorter fermentation period than strong ones. Insufficiently fermented or conditioned dough is called "young dough," while that which has fermented too long is known as "old dough."

Punching

Punching the dough after it rises develops the gluten, and also redistributes the yeast cells. The temperature of the dough is equalized, and some of the carbon dioxide gas is forced out. Straight dough must be punched or worked down as soon as it has doubled in size, the rising time for dough made with 2 percent yeast being about 2 hours at 80°F.

To test the dough to see if it is ready for punching, insert your open hand into the top of the dough about 3 or 4 inches. If the impression that is made in the dough recedes slightly, the dough is ready to be punched or folded. If the impression closes up immediately, the dough is not ready. The length of time the dough remains in the dough trough should be calculated by using a definite fermentation ratio as shown in Chapter 3 of the Baking Handbook.

Makeup

The first step in making up a dough is to divide it into small uniform portions. When dough is divided by machine, you won't have a worry about size; but when you divide it by hand, it must be scaled to make sure each piece is the same size. When dividing dough, allow for loss in the baking process. This baking loss is approximately 10 percent of the total weight before baking.

After the dough has been divided, it must be rounded into balls to prevent escape of carbon dioxide gas through the cut edges of the dough.

A period of intermediate proofing follows the rounding process. During this time, the dough is allowed to rest and recover from being divided and rounded. It becomes loose enough so that it can be easily handled. The length of time of the intermediate proofing period is indicated on the recipe card.

Use as little dusting flour as possible, and follow these steps:

1. Place each piece of dough on the board, top side down.
2. Press gas out of dough (see fig. 11-6, upper left), and pull lengthwise carefully, shaping the dough into an oblong about the length of a finished loaf of bread.
3. Flatten dough with your hands or with a rolling pin.
4. Shape the dough by folding in the ends to form a rectangle. (See fig. 11-6, upper center.)
5. Fold lengthwise (fig. 11-6, upper right) to the center and seal (fig. 11-6, lower left) by firm finger pressure.
6. Fold over the other half of the dough (fig. 11-6, lower center) and press for additional seal.

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7. Roll dough (fig. 11-6, lower right) to complete sealing and molding of the loaf.

After the dough is molded into a loaf, place it in a lightly greased baking pan. Each loaf should be placed so that the molding seam is on the bottom, and the loaf should be long enough to reach the ends of the pan.

Proofing

Letting the dough rise at this stage is known as pan proofing. Since most of the gas was expelled from the dough in the molding process, the loaves will rise again to the proper degree of lightness.

Bread should be proofed until it doubles in size which will normally take 1 hour. Make sure the dough rises sufficiently, or you will have small loaves of heavy bread. Excessive proofing, on the other hand may cause a loaf to fall, be irregular in shape, and be coarse in texture. The temperature to be maintained during this period of proofing is indicated on the recipe card.

Baking and Cooling

Baking time for breads and pastries varies with the size of the pan and the amount of dough scaled into each pan. When the oven is fully loaded, the bread will not bake as rapidly as in

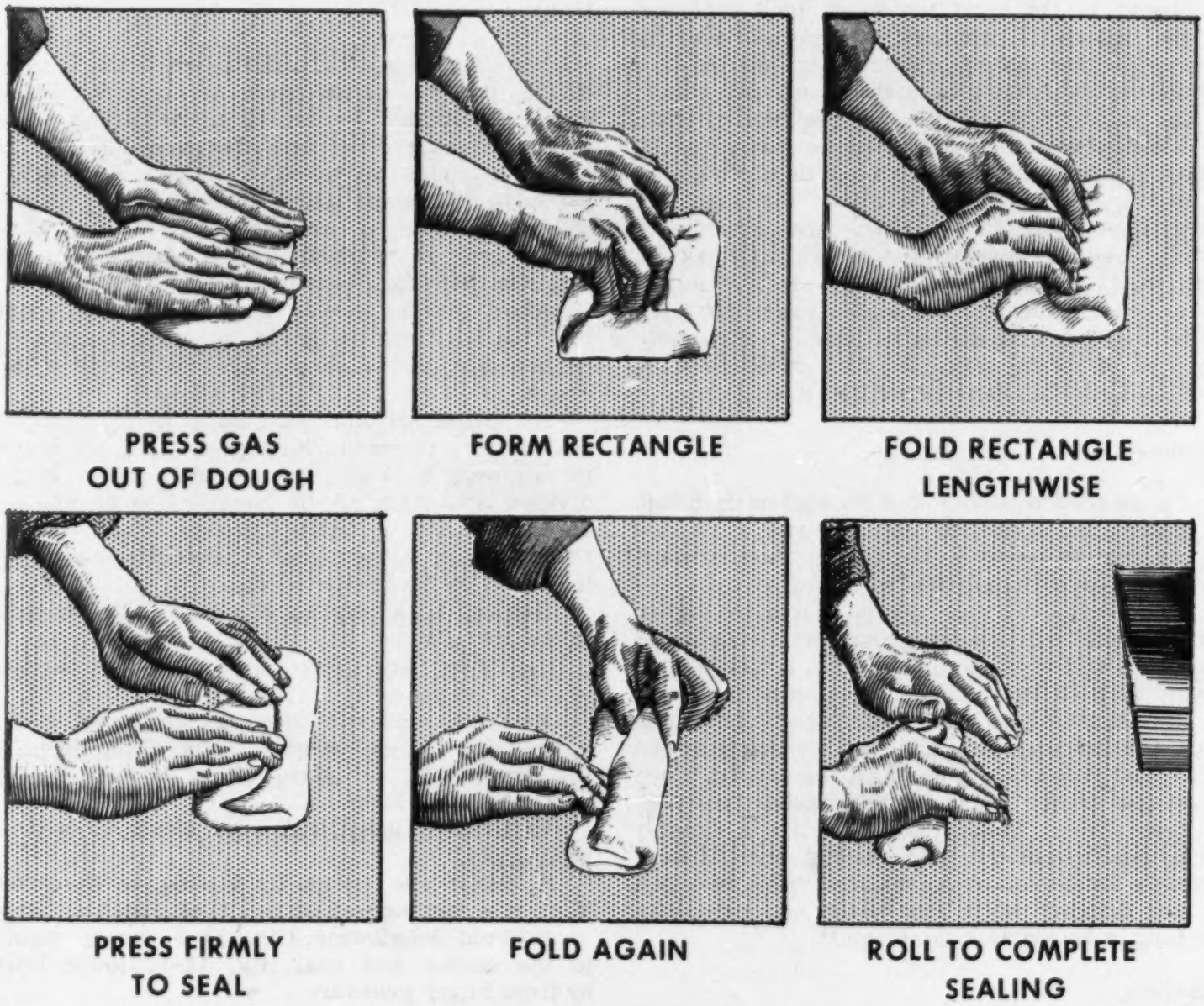

Figure 11-6.—Making up bread dough.

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a lightly loaded oven. Correct oven temperatures must be maintained if you expect your products to be baked properly.

Place the pans of dough in the oven carefully, because a jolt will affect the body of the dough. Remember the order in which the pans were placed in the oven; the first placed in should be the first to be removed. Make sure all pans are properly spaced so that the bread can be baked on all sides.

When it is necessary to bake the bread before it has risen sufficiently, the temperature of the oven should be lowered for a brief period to allow it to rise while the baking is in progress. During the first few minutes in the oven, the dough will rise rapidly; such a rise is known as "oven spring."

When the bread is done, remove from the pans, and place on racks to cool, making sure there is at least a 1-inch space between loaves. Cooling usually takes from $1\frac{1}{2}$ to 2 hours. Bread should not be covered while it is warm.

Rope and Mold

ROPE is an undesirable condition of bread caused by bacteria. The crumb of the loaf deteriorates, darkens, and becomes sticky and wet. If the loaf is pulled apart, long, wet strands will appear as it separates. Rope has an odor similar to overripe cantalope.

The rope spores that are formed from the active rope bacteria cells are highly resistant to heat, and any that may be near the center of the loaf are not killed during the baking. Therefore, only the proper conditions and sufficient time are necessary for their activation and appearance in the baked bread.

Temperatures of 86°F and above, particularly temperatures of 95°F to 105°F, promote the development of rope. When the climatic condition is such that the shop temperature is high, rope could develop in doughs that are even lower than 85°F. In the Tropics, high humidity often accompanies high temperature. This increases the danger of rope developing in the bread. Also doughs that are not sufficiently acid are highly subject to rope infection. Since acidity is normally increased through fermentation, an overly warm dough may not have time to become sufficiently acid to retard the development of rope.

When the weather or climate is hot and humid, you should keep a sharp lookout for the appearance of rope, and do everything in your power to prevent its development. By controlling the temperature of the doughs, you can make them cold enough to retard the development of rope.

Keeping equipment scrupulously clean and seeing that no pieces of previous doughs are allowed to remain in the shop, will also help prevent rope. The shop and all equipment should be thoroughly cleaned as soon after use as possible.

Ingredients should not be kept in the shop longer than necessary, and those that are kept should be arranged to allow free circulation of air around them. The bread baking schedule should be planned so that bread is not overstocked and allowed to become old in the shop or in the storage room. Bread that has accumulated and has become stale may be used for croutons and crumbs. All bread should be thoroughly cooled before being stored.

Vinegar may be used in the dough to increase its acidity and help prevent rope. Normally a proportion of 1 percent of 45 grain vinegar, to the weight of the flour, is sufficient. This amount may be increased up to 2 percent if it is felt that the danger of rope is a real hazard. The vinegar should be added during step 1 of the Navy-Marine Corps Recipe Service recipe for white bread, shown in figure 11-4. The dough may be made slightly stiffer by using less water. The amount of yeast used in the dough should be increased so that fermentation will progress at a vigorous rate, even with the dough temperature lowered, and the dough stiff.

In the event that rope does develop in your shop, it will be necessary to kill all the rope bacteria there before you do any more baking. Dispose of all baked products and ingredients in the shop, and thoroughly clean the shop and all the equipment. This means washing the bulkheads, decks, and overhead with hot soapy water and rinsing; removing all foreign matter from all equipment and tools and from the cracks and seams in the oven; sterilizing the work bench and all small equipment; and rinsing down everything a second time with a strong vinegar and water solution. When the production of bread is started again, use 2 percent vinegar in the doughs.

MOLD is composed of tiny plants visible to the naked eye. There are many types of mold which vary in form and color. They form velvety, colored spots on the bread and create a musty odor. Mold spores are present in the air and will become visible on almost any food substance if they are given sufficient time under proper conditions. Mold will multiply in a warm, humid atmosphere or on moist food. The absence of

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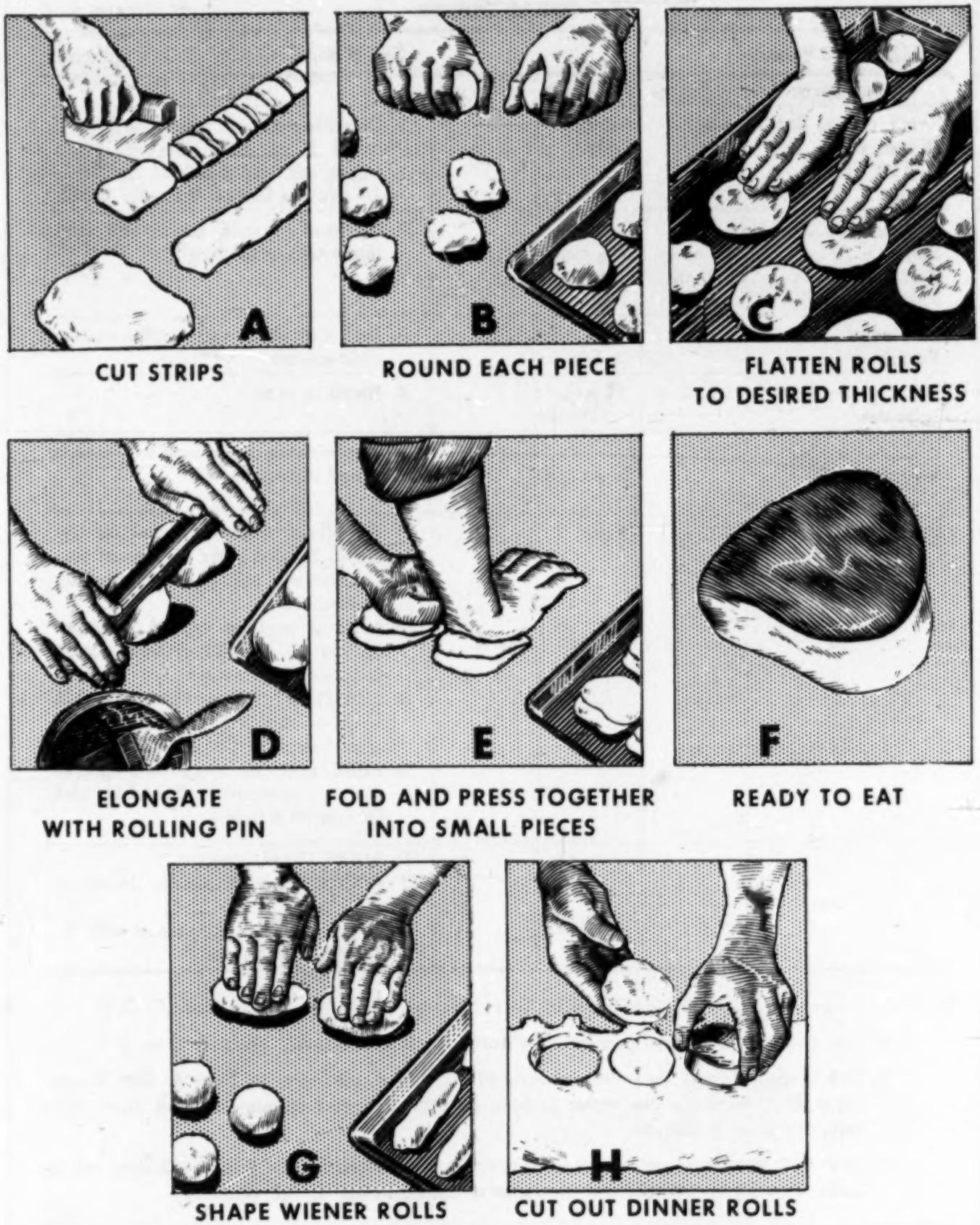

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Figure 11-8.—Rolls.

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SWEET DOUGH C. BREADS No. 28 (1)

YIELD: 100 Portions EACH PORTION: 1 Roll (2 Ounces)

INGREDIENTS	WEIGHTS	MEASURES	PORTIONS	METHOD
Yeast, active, dry Water, warm (110° F) Sugar	3 oz ..... 1 oz	10 tbsp 3/4 qt 2 1/4 tbsp	....	1. Sprinkle yeast on top of water. Let stand 5 minutes, then stir. Add sugar, stir until dissolved. Let stand 10 minutes longer, then stir again.
Milk, nonfat, dry Sugar Salt Mace (optional)	4 3/4 oz 15 oz 1 1/2 oz	1 cup 2 1/8 cups 3 tbsp 1 tsp	....	2. Mix and sift milk, sugar, salt, and mace into mixer bowl.
Shortening Vanilla	1 lb 2 oz	3/4 qt 1/2 tsp	....	3. Add shortening and vanilla, cream until smooth.
Eggs, whole, slightly beaten	1 lb 2 oz	11 eggs (1 1/8 pt)	.....	4. Blend in eggs.
Water (68° F) variable	.....	5 1/4 cups	.....	5. Blend in water.
Flour, hard wheat, sifted	6 lb	6 qt	.....	6. Add flour and start mixer on low speed. Immediately add yeast suspension, mix until flour is thoroughly moistened. 7. Mix on medium speed approximately 15 minutes or until dough is smooth and elastic. 8. FERMENT: Approximately 1 3/4 hours or until almost double in bulk at a dough temperature of 80° F. 9. PUNCH: Divide dough into desired working-size pieces. Round up and let rest 15 minutes.
				10. MAKE UP: As desired. 11. PROOF: Until pieces are double in size. 12. BAKE: 10 to 15 minutes at 425° F. 13. FINISH: As desired.

NOTE: 1. To perform Step 10, see Guide for Sweet Dough Make Up, Recipe Card C–G–2.

2. 6 oz compressed yeast may be substituted for the active dry yeast in Step 1.

3. Dried whole eggs may be substituted for the whole eggs in Step 4. See Recipe Card A–5. Increase the water in Step 5 to the required amount; sift the dried eggs with the flour in Step 6.

4. In Step 6, 3 lb 10 oz soft wheat flour may be substituted for the 6 lb sifted hard wheat flour. This 60/40 ratio of flour produces a lighter sweet dough product.

Figure 11-9.—Recipe for sweet dough. 48.47.8

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light and sufficient time also contribute. Mold first appears on the side of a loaf.

Mold is not resistant to heat, and therefore mold that may be present in ingredients will probably be killed during baking. This means that any mold on bread is a result of improper handling of the baked loaf.

Mold can easily be prevented in the bakeshop. The shop should keep clean and dry. Proper circulation of air should be ensured. Dark areas should be lighted. The loaf should be thoroughly baked and properly cooled before storing. Always avoid handling it with wet or damp hands. See that it is not necessary to keep bread for any length of time, since bread molds very quickly in storage.

Rolls

The recipe in the Navy-Marine Corps Recipe Service which applies to most types of hot rolls is shown in figure 11-7 (page 176). A number of types of hot rolls can be made from this basic recipe.

The method of making rolls is the same as that used for making bread. However, less mixing is required and the dough is much softer. Careful handling of the dough and developing skill in handling it will ensure light, tender rolls.

In make-up, the dough is divided into 3 or 4 pound pieces. Each piece of dough is then rolled into a strip $1\frac{1}{2}$ inches in diameter. The strips of dough are cut into pieces weighing approximately 2 ounces each (fig. 11-8A). These pieces are then rounded into balls by rolling them with a circular motion on the work bench (fig. 11-8B). When these basic steps are performed, you are ready to shape the dough into sandwich rolls (fig. 11-8C), parker house rolls (fig. 11-8D, E, and F), weiner rolls (fig. 11-8G), and dinner rolls (fig. 11-8H).

Sweet Rolls

A wide variety of sweet rolls can also be made from the simple basic sweet dough recipe. After you have mastered the basic mix, you are well on your way to becoming a good baker.

The basic recipe for sweet dough from the Navy-Marine Corps Recipe Service is shown in figure 11-9. The dough should be smoother than bread dough, but it should not stick to your hands.

Among the types of sweet rolls that can be made from this basic recipe are cinnamon buns, butterfly rolls, double-leaf rolls, pecan rolls, twists, chain twists, braids, bear claws, crullers, snails, crescents, raisin buns, hot cross buns, plain coffee cake, small coffee cakes, and Swedish tea rings. Specific instructions for making each of these types of sweet rolls from the basic dough recipe are given in the Navy-Marine Corps Recipe Service. Some of these rolls are illustrated in figures 11-10, 11-11, and 11-12.

Much of the attractiveness of sweet rolls is furnished by the glazes and fillings used. You will find the recipes for these glazes and fillings in the Navy-Marine Corps Recipe Service—Frostings and Fillings.

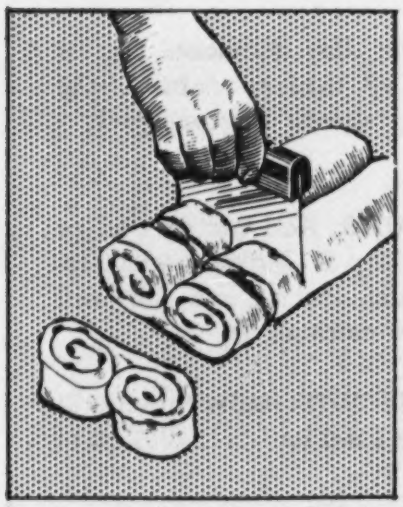

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Figure 11-10.—
Double cinnamon buns.

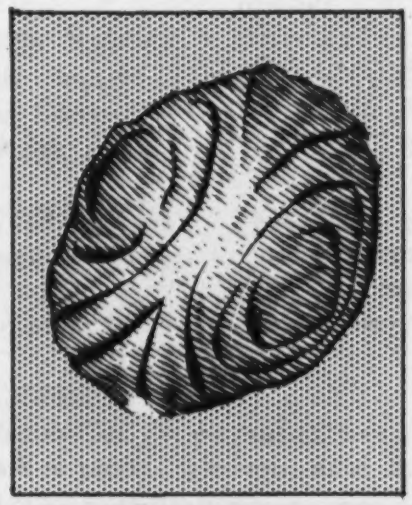

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Figure 11-11.—
Baked butterfly roll.

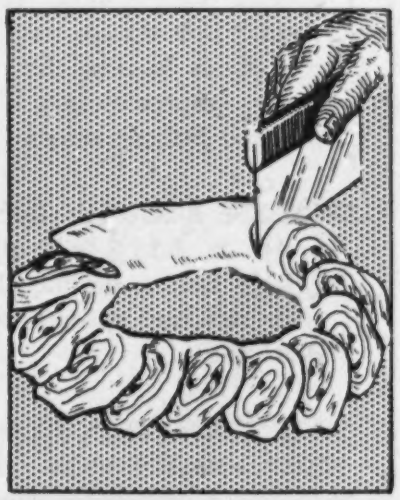

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Figure 11-12.—
Swedish tea ring.

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BAKING POWDER BISCUITS C. BREADS No. 1 (1)

YIELD: 100 Portions EACH PORTION: 2 Biscuits (2¼ Ounces Each)

INGREDIENTS	WEIGHTS	MEASURES	PORTIONS	METHOD
Flour, hard wheat, sifted	13 lb	3¼ gal		1. Mix and sift flour, milk, baking powder, and salt into mixer bowl.
Milk, nonfat, dry	2½ lb	2 qt		
Baking powder	10 oz	1½ cups		
Salt	¼ lb	7 tbsp		
Shortening	5 lb	3 qt		2. Add shortening. Mix on low speed approximately 1 minute or until mixture resembles coarse corn meal.
Water		4¼ qt		3. Gradually add water and mix on low speed approximately ½ minute or until dough is just formed. DO NOT OVER-MIX. 4. Place portion of dough onto lightly floured board. Knead lightly approximately 1 minute or until dough is smooth. 5. Roll out to a uniform ½ inch thickness. 6. Cut with a 2½ inch floured cutter. 7. Arrange biscuits close together on lightly greased baking sheets (18 by 26 inches). 8. Bake at 425° F 12 to 15 minutes.

NOTE: If time and space are limited, the dough may be cut in squares. This will eliminate re-rolling dough.

VARIATIONS C. BREADS No. 1 (2)

1. BUTTERSCOTCH BISCUITS: Roll dough into a rectangular sheet ⅓ inch thick. Spread with melted butter and brown sugar. Roll dough as for jelly roll. Cut into slices ¾ inch thick. Place cut side down, approximately 1 inch apart, on greased baking sheets (18 by 26 inches).

2. CHEESE BISCUITS: Decrease shortening to 4½ lb. Add 2 lb (2 qt) grated cheddar cheese before adding the water. Brush with milk and sprinkle with grated cheddar cheese.

3. CINNAMON BISCUITS: Proceed as for Butterscotch Biscuits. Spread with approximately 4 qt Cinnamon Sugar Mix. (See Recipe Card I-24.)

4. DROP BISCUITS: Use additional cup of water. Drop by tablespoonfuls onto greased baking sheets, approximately 1 inch apart.

5. ORANGE BISCUITS: Add grated rind of 12 oranges in Step 3. Make a small indentation in each biscuit and top with ½ tsp of orange marmalade.

6. CORN MEAL BISCUITS: Substitute 3½ lb (10½ cups) corn meal for 3½ lb (3½ qt) of flour in Step 1.

48.47.9

Figure 11-13.—Recipe for baking powder biscuits.

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Quick Breads

Quick breads include griddle cakes, waffles, popovers, muffins, and biscuits. They are called quick breads because a quick-acting leavening agent, baking powder or baking soda, is used, and a comparatively short time is required to mix and bake them.

There are two kinds of batters, soft or muffin batter, and roll-out or biscuit dough. If the product is to be muffins, griddle cakes, popovers, or waffles, the recipe will make a soft batter that may be spooned or poured. If the batter is to be rolled or cut for baking powder biscuits, the mix will require a lower proportion of liquid. The mixing of the batter is always kept to the very minimum when the leavening is produced by baking powder or baking soda.

The basic Navy-Marine Corps recipe for baking powder biscuits is given in figure 11-13. Note that if time and space are limited, the dough may be cut into squares instead of circles (see fig. 11-14). This eliminates re-rolling. Also, in order to plan work, biscuits may be panned and placed in the refrigerator 1 hour or more before baking time. This does nct mean, of course, that they can be held indefinitely before baking.

Recipes in the Navy-Marine Corps Recipe Service outline, step by step, the method for mixing quick bread batters.

CAKES

Two main types of cakes you will most likely be called upon to bake are batter and foam, the difference between them being that foam cake is made without shortening. The two main types are often combined to give you a third type, chiffon. In this type, the batter part and the foam part are mixed separately and then the batter is folded into the foam (or vice versa) to form the finished batter or mixture called "CHIFFON."

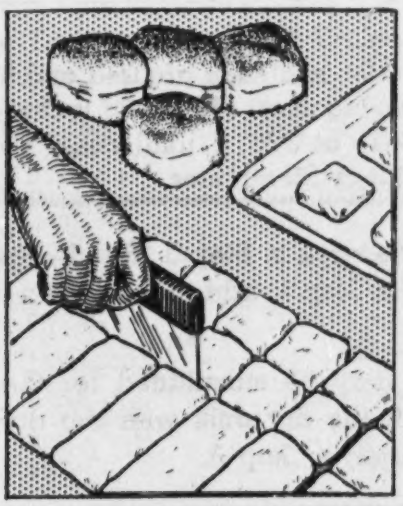

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Figure 11-14.—Cutting biscuits.

Each ingredient in a basic recipe has a specific function.

FLOUR furnishes structure and is used to hold the other materials together in making cake and should be soft wheat flour.

SUGARS, used chiefly as sweeteners, have tenderizing effects resulting from their ability to soften flour protein and starches. By lowering the caramelization point of the batter, sugars allow the cake crust to color at a lower temperature. Sugars also help to retain moisture in the baked cake, thereby keeping the cake moist and edible for several days.

SHORTENING carries the air incorporated in the finished cake batter; this air has a tenderizing action on the cake by virture of its leavening action. Shortening makes the baked product tender and must be considered to be a tenderizing agent.

EGGS furnish structure, moisture, flavor, and color. Egg whites for whipping must be free from grease or traces of egg yolk — as little as one-tenth of one percent will adversely affect whipping quality.

MILK, water, fruit juice, or coffee can be used as liquid in cake. Liquid is needed to combine and activate all other ingredients. It controls the consistency of the finished cake batter.

SALT brings out the flavor of the other ingredients used in the cake.

LEAVENING is accomplished in three ways: incorporation of air during mixing, chemically leavening, and vaporization of liquids in the dough by the heat of the oven. The manner of leavening depends upon the type of cake being made in regard to richness of formula, consistency of batter, and baking temperature.

In addition to the proper selection of ingredients, accurate measuring, and thorough mixing, three factors influence the finished baked products:

PANNING is the amount of batter used in a pan of given diameter and depth. It helps to determine whether the cake is moist or dry. The batter should be divided evenly by scaling or by use of a measure, then spread evenly in the pan with a spatula. Do not rap the pan on the work table to level the batter.

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BAKING TEMPERATURE is of the utmost important for it determines the texture of the baked product. The oven temperature and baking time vary with the type of product to be baked. The recipes in the Navy-Marine Corps Recipe Service note the correct oven temperature and baking time for the various types of baked products.

COOLING of the cakes before removing from the pan or icing is important. The time will vary with the thickness of the cake and the room temperature, but a minimum of 30 minutes should be allowed.

The Navy-Marine Corps Recipe Service recipe for a plain cake made with shortening is shown in figure 11-15. Variations of this cake may be made by adding fillings, frostings, or sauces. Recipes for the variations are included in the Recipe Service.

Frostings.—Frostings make a cake more tasty, increase eye appeal, and add food value. The terms

BASIC PLAIN CAKE D. CAKES AND COOKIES No. 1

YIELD: 100 Portions EACH PORTION: Cut Each Pan 6 by 9

INGREDIENTS	WEIGHTS	MEASURES	PORTIONS	METHOD
Flour, soft wheat, sifted	4 lb	4¾ qt		1. Sift together flour, sugar, baking powder, and salt into a mixer bowl.
Sugar	4 lb	2¼ qt		
Baking powder	3 oz	½ cup		
Salt	1½ oz	3 tbsp		
Shortening	1½ lb	¾ qt		2. Blend in shortening on low speed for 1 minute.
Eggs, whole, beaten	1½ lb	15 eggs (1½ pt)		3. Mix together eggs, milk, and vanilla. Add ⅓ of the mixture, mix on medium speed for 3 minutes; add another ⅓ of mixture, mix on medium speed for 3 minutes. Then add the remaining ⅓ of mixture, mix on medium speed for another 3 minutes. Scrape sides of bowl well after each addition.
Milk, liquid, whole		6½ cups		
Vanilla		2 tbsp		
				4. Scale 7 lb (approximately 1 gal) of batter into each greased and floured baking sheet (18 by 26 inches).
				5. Bake at 375° F until done, approximately 25 minutes.

NOTE: 1. Dried whole eggs may be substituted for the whole eggs in Step 3. See Recipe Card A-5. Sift the dried eggs with the dry ingredients in Step 1; add the required amount of water in Step 3.

2. Evaporated milk, dry whole or dry nonfat milk may be substituted for the liquid whole milk in Step 3. See Recipe Card A-4. Sift the dry milk with the dry ingredients in Step 1; add the required amount of water in Step 3.

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Figure 11-15.—Recipe for a plain cake.

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FROSTING and ICING are used interchangeably. Some frostings are used also for fillings, but often fillings are an entirely different substance.

Don't try to be too artistic when it comes to frostings. Rich cakes require simple frostings, while plain cakes may be more elaborately iced. Frostings may be cooked or uncooked, depending on the texture of your cake. Remember it is unsanitary to get your hands in a frosting, especially an uncooked one.

The Navy-Marine Corps recipe for vanilla cream icing, which is uncooked, is given in figure 11-16. Butter cream is the richest of all frostings. The Navy recipe for cooked frosting is given in figure 11-17.

COOKIES

Cookies are a popular dessert. Unlike most other desserts they can be stored a day or more and used as needed. Successful cookies depend upon proper mixing of ingredients; clean, dry baking pans; and correct baking temperature.

Cookies are of five types; rolled, dropped, ice box, sheet, and bar. Cookie dough should be mixed just enough to incorporate the ingredients thoroughly.

The dough for rolled cookies usually is as soft as can be handled. It may be more easily rolled if it is chilled before being used. Rolling a small part of the dough at one time facilitates handling and lessens the amount of rerolling. The dough is usually rolled to a thickness of $^1/_4$ inch and cut with a 2-inch floured cutter. The side of the spatula should be used for removing cookies from the board to the baking sheets.

Dropped cookies are made from a soft dough. The consistency determines whether the cookies will be rough and flat or hold their shape. Dough is dropped on greased floured baking sheets.

When making ice box cookies, cut the dough into 10-ounce pieces and shape into rolls as for bars. Each roll is wrapped in waxed paper, placed in a pan, and chilled or refrigerated overnight. To make ready for baking, chilled rolls are sliced with a knife or electric slicer.

Bar cookies are made of dough rolled into a strip 22 inches in length or to fit the sheet pan. Fold the two ends of the strip toward the center in order to move to the baking sheet. Allow space between strips. Use your fingers to shape the dough in uniform $^3/_4$-inch strips. Brush with egg wash, if desired. After bars are baked and cooled, cut them diagonally into pieces about two inches in width.

When making sheet cookies spread batter into shallow greased pans. Bake in a moderate oven. Cut into squares or strips while still warm. Coat with powdered sugar if desired. Recipes in the Recipe Service outline step by step methods for preparing all types of cookies.

The pans used for baking cookies should be clean, dry, and smooth. They should be greased and floured for cookie dough high in moisture, greased for average rich dough, and left ungreased for dough rich in shortening. Examine

VANILLA CREAM ICING — I. FROSTINGS AND FILLINGS No. 3

YIELD: 2 Quarts or 100 Portions — EACH PORTION: 1 Quart Per Sheet Cake

INGREDIENTS	WEIGHTS	MEASURES	PORTIONS	METHOD
Butter or shortening	10 oz	1¼ cups		1. Cream butter or shortening and vanilla until light and creamy.
Vanilla		2 tbsp		
Sugar, confectioner's, sifted	2½ lb	2½ qt		2. Gradually add confectioner's sugar, salt, and evaporated milk.
Salt	¼ oz	1½ tsp		3. On high speed, whip for approximately 5 minutes or until mixture is fluffy and smooth.
Milk, evaporated		1 cup		

NOTE: The volume of icing will vary depending upon the amount of creaming.

VARIATIONS

1. CHOCOLATE CREAM ICING: Add 4½ oz of cocoa sifted with the sugar. Increase evaporated milk by 3 tablespoons.
2. LEMON CREAM ICING: Omit vanilla. Use ¼ cup of lemon juice for ¼ cup of milk, and add ½ oz (1½ tbsp) of grated lemon rind.
3. ORANGE CREAM ICING: Omit vanilla. Use 6 tablespoons of orange juice for 6 tablespoons of evaporated milk, and add 1 oz (2 tbsp) of grated orange rind.

Figure 11-16.—Recipe for vanilla cream icing. 48.47.11

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COOKED FROSTING — I. FROSTINGS AND FILLINGS No. 1

YIELD: 100 Portions (2 Quarts) — EACH PORTION: 1 Quart Per Sheet Cake

INGREDIENTS	WEIGHTS	MEASURES	PORTIONS	METHOD
Sugar Salt Cream of tartar Water	3/4 lb	1 3/4 cups 1/8 tsp 1/4 tsp 1 cup		1. Combine sugar, salt, cream of tartar, and water. Cover, bring mixture to a boil. 2. Remove cover and cook until sirup spins a 2 inch thread (234° F). DO NOT STIR.
Egg whites (room temperature)	7 oz	8 egg whites		3. Beat egg whites until foamy.
Sugar, confectioner's sifted	5 oz	1 1/4 cups		4. Gradually add 1/2 of the confectioner's sugar, beat until whites "peak." 5. Slowly pour the hot sirup over the stiffly beaten egg whites, while beating on high speed. DO NOT SCRAPE the sirup kettle.
Vanilla		1 tbsp		6. Add vanilla and remaining confectioner's sugar. Beat thoroughly.

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Figure 11-17.—Recipe for cooked frosting.

the pans carefully before using them to avoid trouble later with sticking or uneven baking.

Baking at the correct temperature for the correct length of time is very important. Most cookies are baked at temperatures between 350°F and 400°F. Cookies should be on the soft side when taken from the oven, for the dough will bake a trifle during the cooling period.

PIES

The success of any pie depends first on the crust. A tender pie crust depends on the ingredients used and on careful mixing.

SOFT WHEAT FLOUR makes a tender crust that crumbles easily.

Fats vary in their ability to produce flaky pastry. LARD and HYDROGENATED FATS are 100 percent fat and make the tenderest pastry.

WATER acts as a binder to the other ingredients. The amount of water required will vary with the kind and temperature of ingredients and the extent to which the fat and flour are blended. Dough that contains too much water is well bound and the baked crust will not be tender. Dough that contains too little water is not sufficiently bound and the baked crust will be crumbly.

SALT has a desirable binding effect upon the dough. It develops and enhances the flavor of the other ingredients.

The fat should be mixed with the flour until the mixture resembles coarse corn meal with small particles of fat distributed evenly through the mixture. This may be done on the electric mixer with a pastry knife attachment or by mixing lightly with the fingers. The extent to which the fat and flour are blended largely determines the quality of the crust. Overmixing at this stage will make a paste of the fat and flour, and it will be impossible to add the water required to bind the ingredients together. Excessive mixing after the water has been added will result in a tough crust.

When the dough has been mixed, it should be set aside for a few hours in a cool place. This gives the flour time to hydrate properly and allows the dough to cool. Dough should be given the minimum amount of handling during makeup.

DIRECTIONS FOR MAKING A TWO-CRUST PIE K-G. PASTRY AND PIES No. 2

1. DIVIDE DOUGH:
   Divide dough into pieces of a size easily handled and place on a lightly floured board. Roll each piece into a cylinder approximately 3 inches in diameter, handling as little as possible. Cut into 8 ounce pieces for the bottom crust and 7 ounce pieces for the top crust.

2. ROLL DOUGH:
   Sprinkle each piece of dough lightly with flour; flatten gently. Using a floured rolling pin, roll lightly from center out to edge, in all directions, forming a circle approximately 1 inch larger than pie tin and approximately ⅛ inch thick. Shift or turn dough occasionally to prevent sticking to board.

3. BOTTOM CRUST:
   Fold pastry circle in half; lift onto ungreased pie pan, with fold at center; unfold and fit carefully to eliminate air pockets; bounce lightly on board to help free trapped air.

4. FILL CRUST:
   Arrange approximately 3½ cups of prepared filling in lined pie pan.
5. TOP CRUST:
   Roll top crust in the same manner as bottom crust. Fold in half; with knife, make several slits near center fold to allow steam to escape during baking. Brush outer rim of bottom crust with water. Lay top crust over filling, with fold at center; unfold and press edges of two crusts together lightly.
6. REMOVE EXCESS DOUGH:
   Trim the overhanging edges of dough by pressing hands against rim of pie pan. There should be little excess dough if skill is used in gauging portions and rolling. Use dough trimmings for bottom crust only.
7. SEAL PIE:
   Press edges firmly together or finish crust with a fluted edge. To help prevent juice from overflowing around edges of pie, lift sealed edges of pie with edge of a knife.
8. GLAZE TOP:
   If a glazed top is desired, brush top with water, milk, melted butter or Egg and Milk Wash (Recipe Card K-4). Allow glaze to dry on pie before placing it in oven. This eliminates dark spots.
9. BAKE:
   Bake at 425° F approximately 45 minutes or until crust is nicely browned. The exact time will vary with the filling used in the pie. The pie is done when the juice just begins to boil out of the perforations.

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Figure 11-18.—Directions for making a two-crust pie.

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DIRECTIONS FOR MAKING A ONE CRUST PIE — K-G. PASTRY AND PIES No. 1

BAKED PIE SHELL:

1. See Recipe Card K– Make up half the recipe; divide dough into pieces of a size easily handled and place on a lightly floured board. Roll each piece into a cylinder approximately 3 inches in diameter, handling as little as possible. Cut each roll into 7½ ounce pieces.
2. ROLL DOUGH:
   Sprinkle each piece of dough lightly with flour; flatten gently. Using a floured rolling pin, roll lightly from center out to edge, in all directions, forming a circle 1 inch larger than pie pan and approximately ⅛ inch thick. Shift or turn dough occasionally to prevent sticking to board. If edges split, pinch cracks together.
3. PLACE CRUST:
   Fold rolled dough in half and carefully place into ungreased pie pan. Unfold and ease into pie pan, being careful not to leave any air spaces between pan and dough. A light bounce on the board will help to eliminate trapped air.
4. REMOVE EXCESS DOUGH:
   Trim ragged edges approximately ½ inch beyond edge of pan. Fold extra dough back and under, and crimp with the thumb and forefinger to make a high fluted edge. Dock or prick dough on bottom and sides to prevent puffing.
5. BAKE:
   Bake at 450° F approximately 10 minutes or until golden brown. If available, place an empty pie pan inside of shell before baking to help prevent shrinking and puffing.

UNBAKED PIE SHELL:

1. Follow Steps 1 through 4, omitting docking of dough.
2. Fill and bake in accordance with specified recipe.

48.47.14

Figure 11-19.—Directions for making a one-crust pie.

The dough can be used for double crust pies, for custard-type using an unbaked shell, or for prebaked shell type. The Recipe Service includes guidance cards which outline directions for making a two-crust and a one-crust pie. See figures 11-18 and 11-19.

The standard pie crust, properly made, has outstanding characteristics. In appearance, it is golden brown with a rough surface that appears blistered. The texture may be flaky or mealy depending upon the method used to combine the ingredients. It should be tender enough to cut easily, but not so tender that it breaks or crumbles. The flavor should be delicate and pleasing.

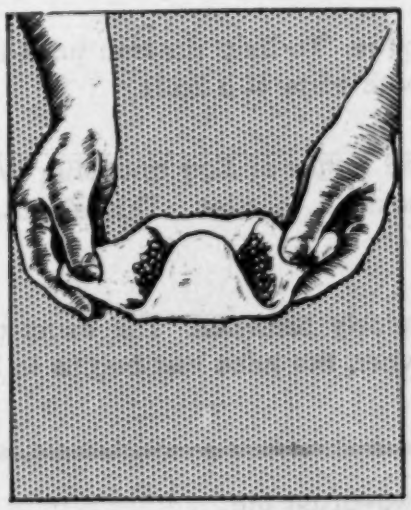

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Figure 11-20.—Shaping the turnover.

Turnovers

Turnovers can be made from pie crust dough, following these steps:

1. Roll dough into a rectangular sheet $^1/_8$ inch thick.
2. Cut into 5- or 6-inch squares.
3. Place 3 tablespoons of thick fruit filling in the center of each square.
4. Brush edge with water and shape turnovers as follows:
   a. Fold to form a triangle and seal edges, or,
   b. Fold opposite four corners to center, and seal by crimping edge, as shown in figure 11-20.

Meringue

Meringue will add to the attractiveness of a one-crust pie. The Navy-Marine Corps recipe for meringue is shown in figure 11-21. Beat the meringue mixture until it is light, and spread it evenly over the top of the pie, so that it touches

MERINGUE K. PASTRY AND PIES No. 5

YIELD: 100 Portions (Topping for 17 (9 inch) Pies) EACH PORTION: 2 Cups per Pie

INGREDIENTS	WEIGHTS	MEASURES	PORTIONS	METHOD
Egg whites, room temperature	2¼ lb	42 egg whites (4½ cups)		1. Beat egg whites, salt, and vanilla until foamy, using high speed, approximately 1 minute.
Salt	¼ oz	1½ tsp		
Vanilla	½ oz	1 tbsp		
Sugar	2¼ lb	1¼ qt		2. On medium speed add sugar, a little at a time. Beat well after each addition. Beat until egg whites just hold their shape, approximately 6 minutes.
				3. Spread meringue to edge of crust so top of pie is completely covered. Leave meringue somewhat rough on top.
				4. Bake at 350° F for 16 to 20 minutes.

NOTE: 1. For an equivalent yield, mix 6 ounces of meringue powder with 1 quart of cold water. Whip on high speed until stiff. Gradually add 3 pounds (1¾ qt) sugar and continue whipping for one minute.

2. To prevent shrinkage, spread meringue so that it touches inner edge of crust all around.

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Figure 11-21.—Recipe for meringue.

the crust on all sides. It usually takes about 5½ ounces of meringue to cover a 9-inch pie. Dip your knife in warm water before cutting a meringue pie, to prevent the meringue from sticking to the knife.

REFERENCE MATERIAL

Refer to the Food Operations Reference Manual (NavSandA Publication 421) for detailed coverage of all phases of baking.

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CHAPTER 12

FOOD SERVICE

Any meal, however plain, is improved by good service, and the best meal in the world can be ruined by failure to serve it properly. When you have to interest the same group of men in three meals a day, every day of the year, it is especially important to make each meal as attractive as possible. Fortunately, many of the procedures that promote sanitary and efficient service also help to keep the food attractive.

Sanitary and efficient food service begins in the galley when the food is prepared. Attractive food comes out of the galley looking and smelling good. It is brought to the serving line in appropriate containers. It is served neatly and in attractive portions by messmen who are neat and clean. The serving lines and all the serving operations are arranged to enable the hot food to be eaten hot, the cold food cold, and all foods while they are fresh and most palatable.

PREPARATIONS IN THE GALLEY

Food should always look attractive, both on the serving line and as an individual portion. This does not justify expenditure of time and materials on elaborate decoration. It does require thoughtful planning of the combination and garnishing of food, judicious selection of the most suitable serving containers, and careful serving.

Garnishes

Though garnishing is just one step in presenting food attractively, it is a very important one. A garnish is described as an ornament and also as something added for flavor or relish. Some garnishes are merely a decoration; others are planned to complement the flavor and texture of the dish as well as add "eye appeal." You should not spend the Navy ration dollar on decorations; therefore, any garnish used should be edible and should be such an integral part of the food that it will not be picked off and left on the plate.

If you were to plan a garnish for every food it would be quite a job, but fortunately, all food does not need this help. Even the plainest of foods combined in a well planned menu can get by with a minimum of garnish. For example, a meal consisting of pot roast of beef, mashed potatoes, brown gravy, buttered frozen peas, celery sticks and sweet pickles, hot rolls and butter, and blueberry pie need nothing in the way of added garnish to make it attractive. The natural colors, textures, and flavor combined in this meal provide enough variety to make the meal inviting to the eye and tempting to the taste.

Many of the Navy recipes have a "built in" garnish. Good examples of these are: (1) beef stew with vegetables; (2) tossed vegetable salads; (3) crusty browned casseroles; and (4) desserts such as cakes iced with frosting that complements the color and flavor of the cake.

Always refer to the food preparation worksheet for information regarding the garnishing of various foods on the menu.

Listed below are some practical guides to effective food garnishing:

1. Use restraint in garnishing. Keep a picture of the whole meal in mind. Too many garnished dishes in one meal will spoil the effect. Select a suitable garnish, if needed, and use it sparingly.
2. Vary food garnishes. Do not let garnishes become monotonous. (Use a section of orange or a slice of peach on top of a pudding sometimes; not always a maraschino cherry.)
3. Plan garnishes ahead and show the messman how garnished food should be served. (Should each portion have a sprig of parsley or just a few pieces be placed in the serving container?)
4. Plan simple garnishes. Do not sacrifice timely preparation for the sake of garnishing.
5. Take advantage of natural color contrasts in combining foods. Do not rely frequently on food coloring to supply color contrast.

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Containers

To ensure that an appetizing appearance is maintained, use shallow inserts for serving vegetables such as creamed potatoes, broccoli, and cauliflower, and for such items as breaded veal cutlets, baked pork chops, and meat in spaghetti sauce. For example, when french fried eggplant is stacked in a deep well, the first few men served will receive acceptable portions; everyone else will be served a soggy portion. If the eggplant is sent to the steamtable spread loosely in a shallow insert, you will know that all of the men served will receive as good a serving as the first man.

PREPARATIONS ON THE MESS DECK

A well-arranged serving line operates smoothly and rapidly. Each man should be able to select the servings that he wants and be able to get them to the table with the hot dishes hot and the cold dishes cold. Accomplishing these things requires planning and supervision on the part of the Commissaryman in charge.

Serving Time

The commanding officer and the supply officer establish the hours for the serving of food. The time published must be strictly adhered to; the day's work schedule in the galley must be organized to conform to the established meal-serving hours. The mess deck and the serving personnel should be ready to begin on time, and advance planning should have been done to ensure prompt and efficient service.

Posting the Menu

Service is speeded up when a person knows what foods are being served before he reaches the serving line. A good practice is to post the current menu, in full view, near the beginning of the mess line. It may be in the form of a small blackboard or typed menu. Another form is a menu board. This is a board with grooves that will hold cards bearing the names of various dishes for the meal. Any method is acceptable that gives the individual time to decide which foods he desires, or to refuse a food that he does not eat.

Preparing the Serving Line

Trays, cups, bowls, and silver, may be located at the head of the mess line, or trays cups, and bowls may be at the head of the line and the other items at the end. All items of mess gear should be inspected to see that they are spotlessly clean and should be supplied in sufficient number to last the entire serving period.

The serving counter and steamtable should be checked for cleanliness before any food is placed on them. The clean steamtable is filled with hot water and the steam turned on so that a temperature of 180°-200°F may be maintained. Always remember, the purpose of a steamtable is to keep food hot but not to cook it. Food should not remain on the steamtable for too long a time. It should be brought to the serving line in moderate quantities and replenished frequently from the main supply in the galley by the designated messman. The required temperature is difficult to maintain when the steamtable is overloaded.

Hot foods are most acceptable when eaten within the following temperature ranges:

Soups	145°-150°F
Potatoes and vegetables	140°-145°F
Entrees	140°-145°F

These foods may be held on the steamtable at temperatures higher than the 140°-150°F range to make up for the quick loss of heat while they are being carried to the table. Because whole meats retain heat longer than sliced meats, roasts should be carved on the serving line. Instructions for carving roasts are outlined later in this chapter.

Keeping cold foods, such as salads, properly chilled also requires advance preparation. Salads add so much both to balanced diet and to the general attractiveness of a menu that preparations for serving them deserve special attention. Because self-service salad bars, apart from the the hot food line, are used increasingly in the general mess, this method of serving salads is treated in a separate section later in this chapter.

The Messmen

The men who serve the food have an important effect on its attractiveness and—even more important—on its sanitary condition. Every man assigned to the serving line must be clean and look clean. That requires a fresh shave every day and hands washed many times during the day. Uniforms, hats, and aprons must be clean. When jumpers are worn, the sleeves should be rolled up to keep them from touching any food.

Messmen should not only be clean and neat; they should be trained to serve food properly,

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for serving techniques also effect both sanitation and attractiveness.

SERVING THE FOOD

Sending food to the steamtable in the proper container is not the only answer to good food service. What happens to the food at the steamtable, and especially how it is served, are also very important.

Serving Techniques

You as a Commissaryman or a Commissaryman striker may be placed in charge of one of the serving lines. When this is the case, you should instruct the messmen on the order of items on the serving line, how each item is to be served, and where each item is to be placed on the mess tray. Correct serving techniques should be taught for serving each item.

Soups and Similar Foods.—Soup is sent to the steamtable in deep well inserts; use the 6-ounce ladle and serve as follows. Key serving points follow each step.

1. Pick up the soup ladle.
   Hold the ladle with the right hand, about half way down the handle, grasping it between the thumb and forefinger. This is a firm hold that makes it easier to balance a full ladle.
2. Stir the soup.
   Stirring distributes the solid particles and the temperature evenly.
3. Dip from the bottom.
   Solids settle to the bottom, and the soup at the bottom of the pot is the hottest. Dip while solid particles are in motion.
4. Raise the ladle above the level of the soup bowl.
   The man in line has extended his tray and soup bowl toward you. As you raise the ladle, the liquid it contains will settle so that it is easier to pour and it will not spill over the sides.
5. Serve.
   Tip the ladle slightly and pour slowly. Direct the pouring into the center of the soup bowl.

Whenever you serve stew, chili con carne, or chow mein or any item that is similar, you should use the same technique—stirring to distribute the solid particles and the liquid evenly—then dip from the bottom.

The two points—stir and dip from the bottom are important techniques that are used when serving other menu items like creamed carrots or string beans. Each time you put your serving utensil into the container to dish up a serving—remember—stir and dip from the bottom. But, this is the ONLY TIME you should stir these items. When there is a lull and you are waiting for the next man to come through the line, do not stand and idly stir the vegetables. The least amount of handling helps maintain their appetizing appearance.

Solid Foods. As you serve items that are in shallow inserts, like macaroni and cheese or lyonnaise potatoes, serve the food from the back of the pan towards the front in an orderly system across the pan. A uniform way of serving helps maintain the fresh appearance of the food and prevents the "hashed up" look.

Carving

Carving plays an important role in serving meats in an appetizing manner. The appearance, texture, and portion size can be controlled by carving. For this reason, it is essential that Commissarymen develop the skill of carving. This can be done more readily by knowing the principles involved in carving. They are: knowledge of animal structure, the location of bones and joints, and the proper method of using the slicing knife and cutting board.

The direction of meat grain decides the carver's course of slicing action. All meats should be cut across the grain. Cross-grain slicing shortens the meat fibers and gives a neat slice. If the carver is not familiar with, or cannot identify the cut of meat, a safe rule is to slice parallel to the cut surface.

Carving Roast Meats.—Roast meats should be allowed to stand about 30 minutes in a warm place before being carved. This period allows for absorption of juices. The meat becomes more firm and can be sliced with greater ease and efficiency. Slicing should be done on a wooden surface because metal will turn the cutting edge of the knife. To conserve the drippings, place the meat on a carving board in a sheet pan. Then remove any string or cord which may have been used for tying the roast. Now with a sharp, long-bladed knife and a two-tined fork in hand, you are ready to carve the roast as follows.

1. Slice across the top of the roast from left to right so that carved portions are on the right side and can be easily lifted to the plate or tray.

2. Hold the roast in place by pressing the fork (which is in the left hand) firmly into the top and near the right side.

3. Carve across the grain of the meat. This cuts the long fibers and makes it seem more tender.

4. Cut thin, even slices.

Because it is important to carve a roast into uniform pieces, it is suggested that a few servings be sliced in the galley and weighed. This will help you to determine the serving size at the serving counter.

Carving and Serving Roasted Poultry

Roasted poultry should be allowed to rest 30 minutes in a warm place after removal from the oven prior to carving. This will allow a time lapse necessary for the "post-oven" rise in temperature. This rise in temperature always happens in meats or poultry after roasting in the oven. It will also allow the flesh of poultry time to firm up for better slicing.

When cooled, poultry can be carved in the galley, placed in insert pans, and served on the line. One roasted turkey, garnished and decorated, could be used on the mess line for eye appeal. Galley carving not only expedites service on the line, but greatly facilitates portion control by more careful, even slicing. To carve the turkey in the galley proceed as follows:

1. Place the cooked turkey on a cutting board.

2. Hold the wing with the left hand. Using a sharp boning knife, make a circular cut around the bone socket.

3. Twist the wing in the socket and cut the tendons at the joint. Place the wing on the cutting board.

4. Cut through the skin between the thigh and the body, pull the leg out and over to free the hip joint.

5. Use the tip of the knife to loosen the thigh meat and cut the skin along the back. Place the drumstick and thigh on the cutting board.

6. Slide the knife along one side of the keel bone from tip to the wish bone area. Cut to the shoulder joint following the curve of the wish bone. From underside of the wing socket joint continue cutting over the rib back to the beginning, the tip of the keel. The breast may be removed in one piece by inserting the knife along the rib cage and cutting along the rib bones or by inserting one's fingers into the cut along the keel bone and gently easing the breast meat outward to lift it away from the bone structure in one piece.

The second side of the turkey is carved in the same manner, then separate the drumstick and thighs, and cut the bone away from the thigh meat.

Use the slicing machine to cut the turkey breasts in nice even slices or use a sharp knife and slice by hand. Turn the chunky pieces to obtain the largest possible slices. Place the sliced turkey in a shallow insert and cover with waxed paper to prevent loss of moisture.

There are two advantages to this method of carving. It ensures portion control and makes it possible to use all other meat on the carcass in the best manner to avoid waste. That meat that is on the carcass is removed with a small knife and used for entrees such as "Turkey a la king or Creamed Turkey."

On special occasions roasted whole turkey may be carved on the serving line. This allows everyone to see and share in the festivity which a holiday bird symbolizes. This method for carving roasted whole turkey is illustrated in figure 12-1.

Be sure to store all unused portions properly. Sliced meat can be placed on a tray and covered loosely with waxed paper before placing in the refrigerator. Trimmings and other edible parts should likewise be placed in the refrigerator if they are not to be used immediately.

Carving Boneless Turkey

Machine slicing of boneless, string-tied turkey is preferred to hand slicing, if feasible.

The following method is recommended. Remove the strings and cut the boneless turkey into two equal parts lengthwise. Then place half the turkey, skin side up, against the slicing blade on the slicing machine. Cut in slices about $^1/_4$ inch thick. Place the cut slices in a shallow insert and cover with waxed paper.

If an electric slicing machine is not available, follow the same procedure using a sharp knife.

The Precooked Turkey Roll is divided in thirds, then sliced in even slices. The slices are placed in a shallow insert, covered with chicken stock, and preheated for service.

Serving Utensils

Using proper serving equipment simplifies food service and controls waste. Use a food turner for lifting such things as portions of steak, scrambled eggs, or grilled tomatoes.

1. CARVING POSITION – FIRST MOVE TURKEY COMFORTABLY CLOSE AND TURN IT ON ITS SIDE, BREAST AWAY FROM CARVER.

2. REMOVE WING – NEXT RAISE WING AND CUT IT OFF AT THE SECOND JOINT. SET WING ASIDE FOR OTHER DISHES.

3. BARE THIGH BONE – SLICE DARK MEAT OFF DRUMSTICK AND THIGH UNTIL THIGH BONE IS EXPOSED.

4. REMOVE DRUMSTICK – LIFT DRUMSTICK WITH NAPKIN AND CUT OFF AT THIGH JOINT, LEAVING THIGH ON BIRD.

5. MEAT FROM DRUMSTICK–SLICE AWAY DARK MEAT FROM DRUMSTICK.

6. CUT AWAY THIGH BONE–CUT AROUND THIGH BONE WITH KNIFE AND REMOVE FROM BIRD, AS PICTURED HERE.

7. SLICING DARK MEAT – SLICE DARK MEAT AWAY FROM TURKEY JUST ABOVE REMOVED THIGH BONE. ARRANGE NEATLY ON PLATTER.

8. BASE CUT–MAKE DEEP VERTICAL CUT IN BREAST JUST IN FRONT OF WING JOINT TO SERVE AS BASE FOR ALL BREAST SLICES.

9. BREAST SLICES–START FROM CENTER OF BREAST AND CUT TOWARD YOU, REMOVING SLICES ONE BY ONE AS SHOWN.

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Figure 12-1.—Galley carving procedure for roasted turkey.

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For mashed potatoes or items of similar consistency, use a serving spoon or ice cream dipper. A basting spoon or other shallow spoon is appropriate for dipping sauce or gravy from a shallow pan, but use a ladle if serving from a deep well. Some foods, such as peas and boiled cabbage, should be served with a straining spoon, so that the liquid drains back into the serving pan. Serving forks are needed for some meats. Fried chicken, asparagus, broccoli, and corn on the cob are handled best with tongs.

Portions

The Commissaryman assigned to supervise the serving line has two responsibilities regarding portion control. One is to see that servings are equitable, and the other is to assure that the amounts served are not more than the individual wants.

Portion sizes of some items can be regulated on the serving line through the use of standard ladles and spoons. When you serve meat, guesswork on correct portion sizes can be eliminated by using ounce scales to check one or two slices before proceeding to cut up the entire batch. Some meat items now purchased for Navy use are precut in individual portions.

Save food, time, and confusion by asking each man if he wants a portion of the food you are serving. Not all have the same appetite. Some may not want any; some may want a medium-sized portion; and some may want a more generous serving.

Replenishing

Don't wait until you are completely out of an item before you notify the runner. Give the cooks time to get the next container ready. When you know you have about 15 servings left and you can see that there are more than that number of men in line, tell the runner so that the second container will be ready when you need it.

Empty containers should be kept off the deck and serving tables. Send them back to the galley.

SALAD BAR

Self-service salad bars (fig. 12-2 on page 194) have become very popular in the operation of the general mess. The Bureau of Medicine and Surgery authorizes placing salad bars APART from the hot food serving line, and this speeds up food service.

When you are deciding where to put the salad bar, elements such as ease of access and continuous movement of traffic should be considered. If at all possible, salad bars should be situated to permit the crew to serve themselves from the salad bar before approaching the hot food serving line. This will eliminate the stop at the salad bar enroute to the mess tables and will enable the men to eat the hot food on their mess trays while it is hot.

Coordinate salad bar menus with the salad bar space available. Overcrowding items on the salad bar detracts from the presentation of the food, hinders easy self-service, and slows the speed of service. Careful attention should be given to arrangement of the salad items to eliminate the necessity of reaching over one container of food to get to another. This is not only unsanitary but also means that particles of food are often dropped from one container to another creating, to say the least, an unappetizing array.

The master at arms can prevent this reaching-over maneuver by directing the flow of traffic around the salad bar if the bar is accessible from all sides. When the traffic passes only one side of a salad bar, arrange all containers of food side by side along the bar rather than a front-to-back arrangement.

Refrigeration of Ingredients

For proper refrigeration of ingredients, place all salad bar items in pans or in trays on a bed of ice, or on an electrically refrigerated salad bar unit. Proper drainage is essential if salad bar items are set in ice.

When the use of ice is not possible, the salad bar should be large enough to accommodate shallow pans or trays of salad bar items which are taken directly from the refrigerated spaces. Because of the high temperawure of most dining areas, easily contaminated food (salad mixtures containing meat, fish, poultry, eggs, cooked salad dressing, and mayonnaise) should be placed on the salad bar in small quantities and replenished as needed. Mayonnaise or cooked salad dressing remaining on the salad bar after serving is finished should be disposed of and NEVER mixed with other containers of these foods remaining in the refrigerated spaces.

These rules about refrigeration apply equally, of course, whether you have a separate salad bar or not.

Serving Utensils for Salads

An adequate number and the proper kinds of serving utensils for the salad bar will promote

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good sanitary practices and keep the salad bar in neat order during self-service. Following are the most useful utensils and the foods with which they can be used:

TONGS—for relishes and green salads—carrot sticks, celery, pickles, olives, chefs salad, garden salad, and lettuce.

STRAINING SPOONS—for salads mixed with thin dressings—cole slaw, fruit salad, and cucumber and onion salad.

BASTING SPOONS—for compact salad mixtures—potato salad, ham salad, and fish salads.

DESSERT SPOONS OR TABLESPOONS—for thickened salad dressings served on the salad bar.

SMALL LADLES—for thin salad dressings.

FOOD TURNERS—for individual salads.

POLICING MESSING AREA

Sanitary practices before serving and those connected with serving operations have been discussed. It is equally important to maintain the general sanitation and neatness of the messing area during the meal and to clean up carefully when serving is finished.

The tabletops from which the men eat should always be kept clean. They should be cleaned with a sponge and sanitizing solution after every

Figure 12-2.—Self-service salad bar.

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use, because utensils such as knives, forks, and spoons and even foods such as bread and rolls often are placed directly on the table surface. A standard stock germicide and fungicide, chlorine solution, or other acceptable sanitizing solutions are the most efficient. Sponges are preferred and are considered more economical and sanitary than rags. Change the sanitizing solution as frequently as necessary to ensure a clean solution.

Salt, pepper, and condiment containers should be washed and refilled after each meal. These containers should be arranged in uniform order on all tables. One method is to place the taller containers in the center and arrange the others in graduated order.

Messmen should be instructed to police the dining area during a meal serving period, to wipe up any spilled food immediately, and to refill any condiment containers if necessary.

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CHAPTER 13

LANDING PARTY

In the previous chapters, you have learned what is expected of you, as a Commissaryman 3 or 2, in the preparation of a meal aboard ship or at a shore station, but this knowledge does not cover all of your duties. It is possible that you may have to go ashore with a landing party and prepare meals under emergency conditions.

In that case, before you can do any cooking, you will have some important duties to perform. You may have to lend a hand with the stretcher bearers or give medical assistance to the wounded. After this, you will have to prepare meals for exhausted and hungry men, and under battle conditions in the open air.

WATER

Safe water for drinking, cooking and washing is one of the prime concerns of those in command of landing operations.

No unit can function long without water. Personnel in even the smallest units, in the most temporary operations, must have drinkable water with them—plus the means for getting more when their supply runs out.

All water in the field should be regarded as unsafe until approved by a medical officer or his designated representative.

The choice of a water source is influenced by the quantity, quality, ease of procurement and ease of purification. A water reconnaissance should be made to find and look over available sources and to select the one that appears to be the most desirable. Some considerations of quality that should be used in the selection are freedom from:

1. Contamination by sewage, other wastes, and from pollution by chemical, biological, or radiological warfare agents.
2. Turbidity, color, and taste.
3. Excessive amounts of organic and mineral substances.

Purifying Water

Water which is from an unapproved source must be chemically treated or boiled. Receptacles used to store or carry water should be cleaned daily with boiling water. A solution of chlorinated lime (a ration of 1 part chlorinated lime to 1000 parts of water) may be used for sanitizing cans. New cans and carts in which water is to be transported should be thoroughly steamed to remove the protective coating, then super chlorinated and rinsed before being filled with water for drinking purposes.

SUPERCHLORINATION may be accomplished by the following methods:

1. One pound of grade A hypochlorite (HTH of perchloron ®) in 800 gallons or in 100 cu ft of water gives a chlorine dose of about 100 ppm (parts per million).
2. Calcium hypochlorite (chloride of lime) is less easily used and contains only about one-half as much available chlorine per unit weight of compound; therefore, 2 pounds of chloride of lime must be used in 800 gallons of water to obtain about 110 ppm chlorine.

LYSTER BAGS, which are 36-gallon canvas containers with a lid, are commonly used in the field to purify water. They usually are issued on the basis of 1 for every 100 men. When untreated water must be put in these bags, immediate treatment is necessary. A chemical kit is furnished for this purpose. It contains the following: 100 tubes, each containing $^1/_2$ gram calcium hypochlorite; 2 chlorination test kits, each with 50 orthotolidine tablets and a plastic testing tube; and 100 sodium sulphite tablets. This chemical kit will usually treat 25 bags of water. Always follow the directions that appear on the kit.

To sterilize a canteen of water use "Tablets, Water Purification, Individual, Iodine for Treating Water in Canteens, 50 tablets per bottle" and follow direction on the container. If the iodine

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tablets are not available, two drops of tincture of iodine can be used—waiting 30 minutes before using the water.

In very cold regions fresh water ice or snow may be melted to secure water. The ice or snow water source must be protected to prevent contamination by man or animals. When this type of water is used for drinking purposes it must be boiled or chemically treated.

REMEMBER: Winter or summer, purify water from ponds, lakes, or streams by boiling or by chemical treatment.

Storing Water

Purified water should be protected against recontamination by proper storage in a covered tank or container. If possible, seal all containers in which purified water is stored. Store water off the ground and in locations away from garbage and toilet areas.

Storage containers for purified water should be cleaned and disinfected before initial use. This can be done by washing the inside walls and the bottom with detergent, rinsing with clear water, and then rinsing with a strong chlorine solution. Use 1 teaspoonful of bleach to 1 gallon of water for the disinfection solution.

FIELD COOKING RANGES

Special cooking ranges designed for field use are usually available. These ranges consist of the M1937 field range and the field cooking outfit, small detachment. The ranges are discussed in the following paragraphs.

M1937 Field Range

The M1937 field range (fig. 13-1) is the most satisfactory equipment available for preparing meals in the field. It consists of a cabinet with necessary cooking utensils and a gasoline-burning fire unit. The range is portable and can be operated while in transit. (See fig. 13-2 for a M1937 gasoline field range outfit.)

Each range is a basic self-contained unit that may be used singly to serve up to 50 men. With additional units, the ratio of the men who can be served increases. The range can be used for boiling, roasting, frying, and griddle cooking. Also, it can be adapted as a bake oven (fig. 13-3 on page 199). Be sure you get the instruction book pertaining to the operation and maintenance of the M1937 field range.

Field Cooking Outfit, Small Detachment

The field cooking outfit is another special range designed for cooking in the field. It consists of a stove, figure 13-4 (page 200); and the necessary attachments and utensils (see figs. 13-5; 13-6; and 13-7 on pages 201, 202, and 203) required to prepare rations for 15 to 40 men. The outfit is designed primarily for out-of-door use by isolated detachments.

The Army manual, Field Cooking Outfit, Small Detachment, TM-10-7360-203-15 (Feb. 1961), contains information on the operation and maintenance of the outfit as well as a description of major components. Tools, repair parts, and supplies for use with the small detachment cooking outfit should be requisitioned by Federal stock number.

IMPROVISED COOKING UNITS

There are a variety of cooking units that may be improvised, ranging from simple grills to

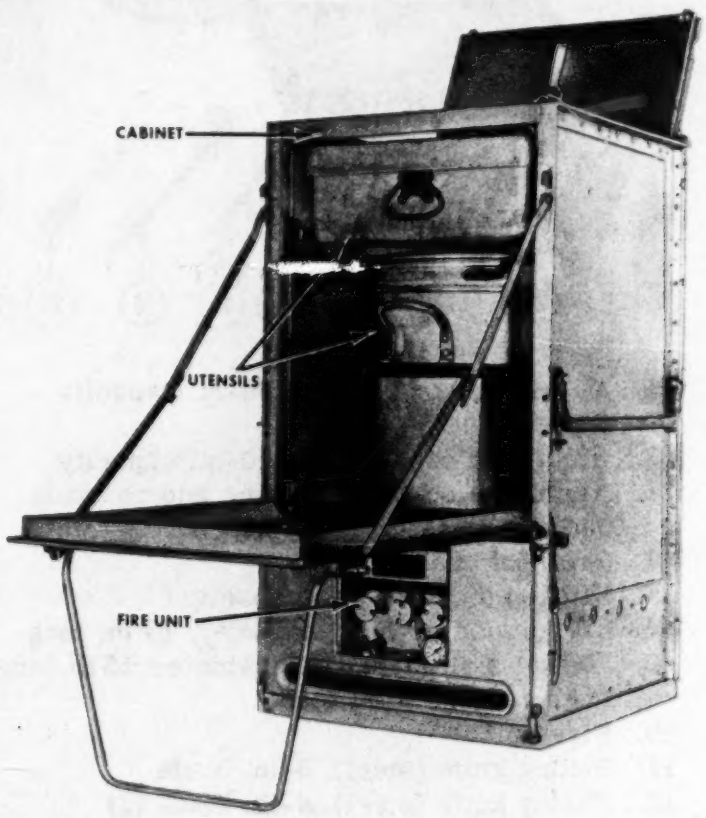

Figure 13-1.—M1937 field range with utensils and fire unit.

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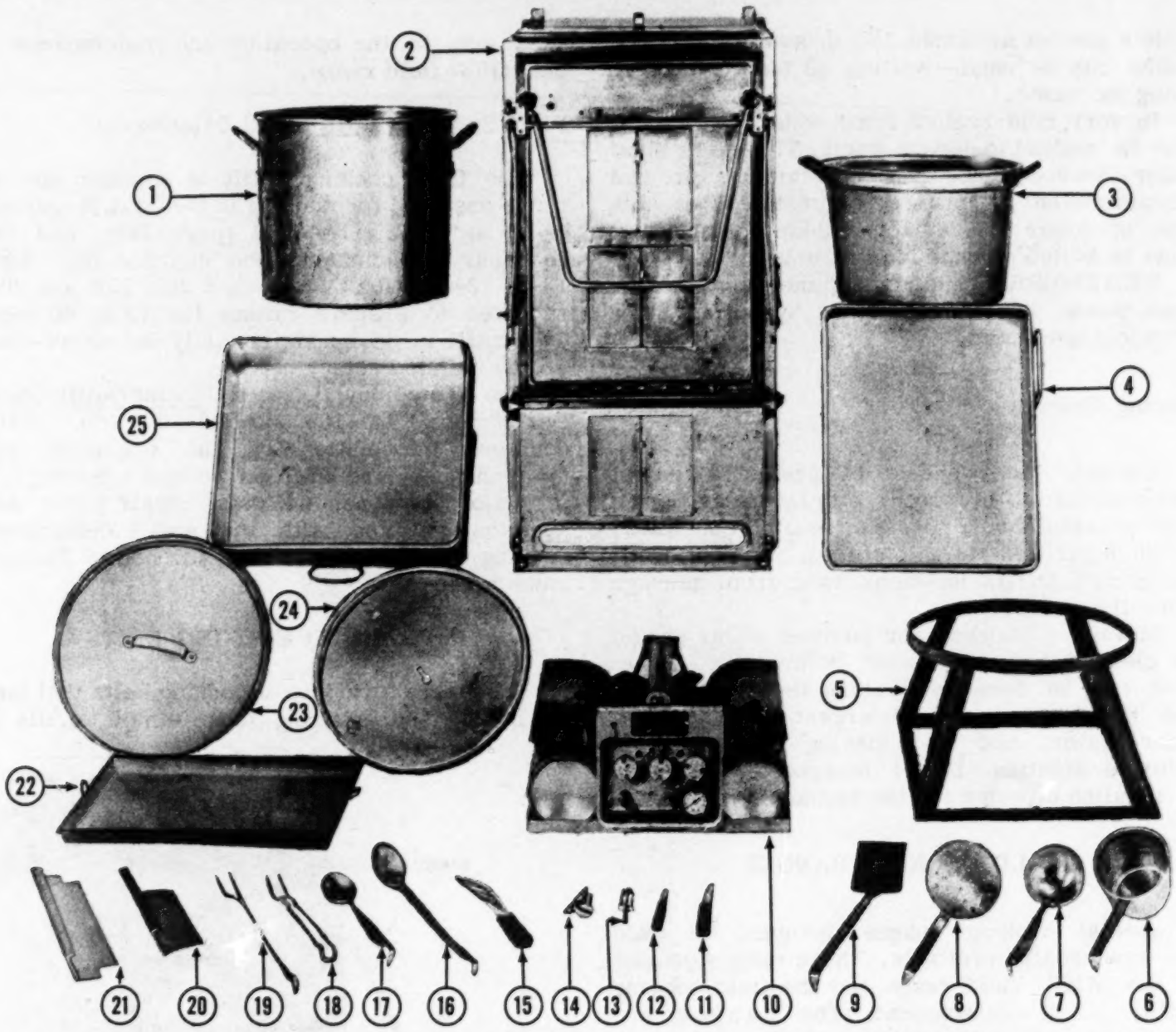

1. Aluminum cooking pot, 60-qt. capacity
2. Cabinet
3. Aluminum cooking pot, 40-qt. capacity
4. Aluminum cover for baking and roasting pan
5. Cook pot cradle
6. Kitchen dipper, 1-qt. capacity
7. Kitchen ladle, 8-oz. capacity, 15 in. long
8. Kitchen skimmer, 5 in., diameter, 15 in. long
9. Cake turner, solid blade
10. Fire unit
11. Boning knife (steel), 6-in. blade
12. Paring knife (steel), 4-in. blade (2)
13. Potato peeler (steel) (3)
14. Measuring set, 4 spoons
15. *Butcher's knife, (steel) 10 in. blade
16. Food service spoon, 21-in. long
17. Food service spoon, 15-in. long
18. Food preparation fork, 15-in. long
19. Food preparation fork, 21-in. long
20. Arm protector, short
21. Arm protector, long
22. Aluminum baking pan
23. Aluminum cooking pot cover (2)
24. Splash plate
25. Baking and roasting pan

*To be replaced by knife, steak, scimitar, 10-in. blade, pending standardization action.

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Figure 13-2.—M1937 gasoline field range outfit.

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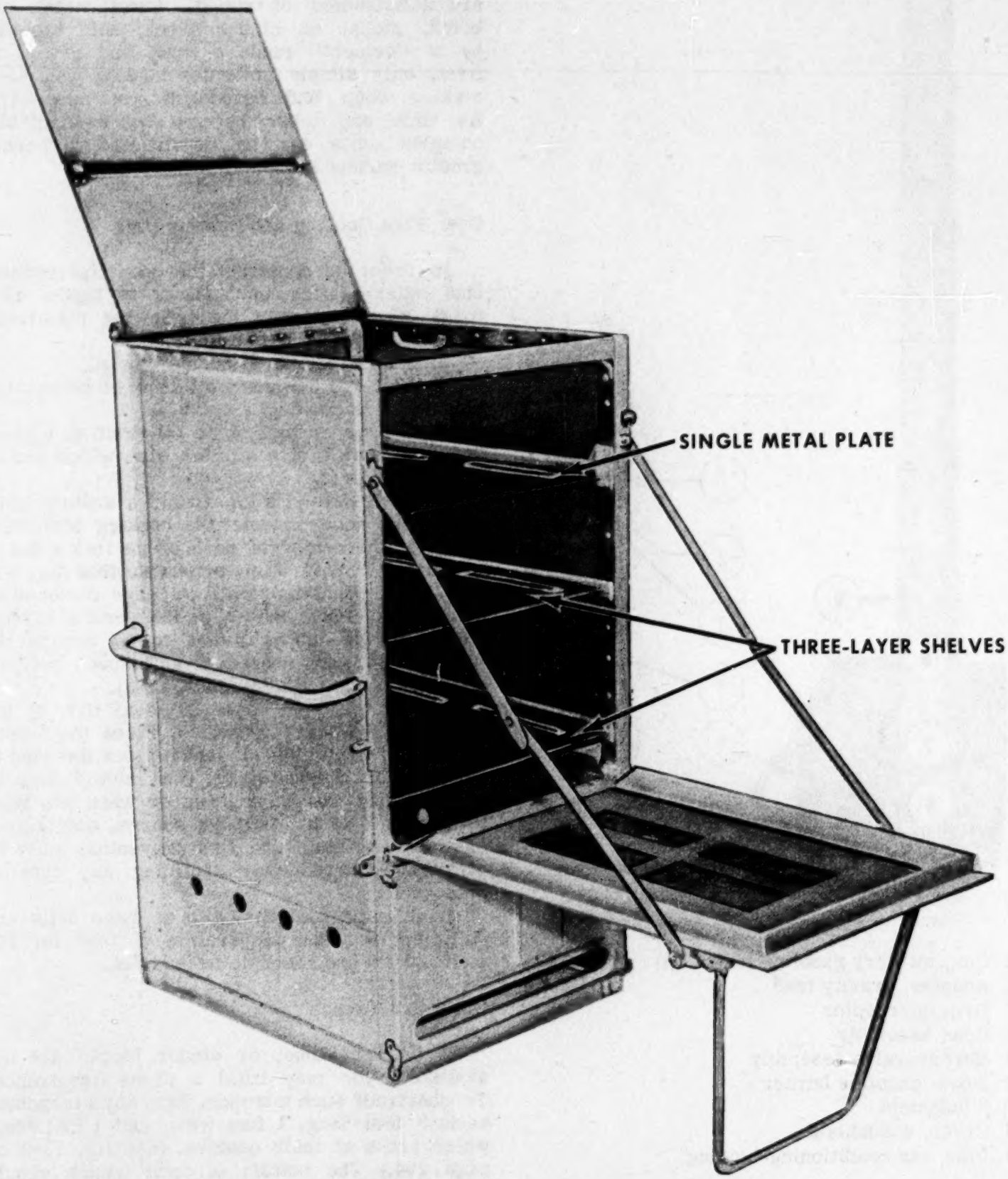

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Figure 13-3.—Field range, adapted for baking bread.

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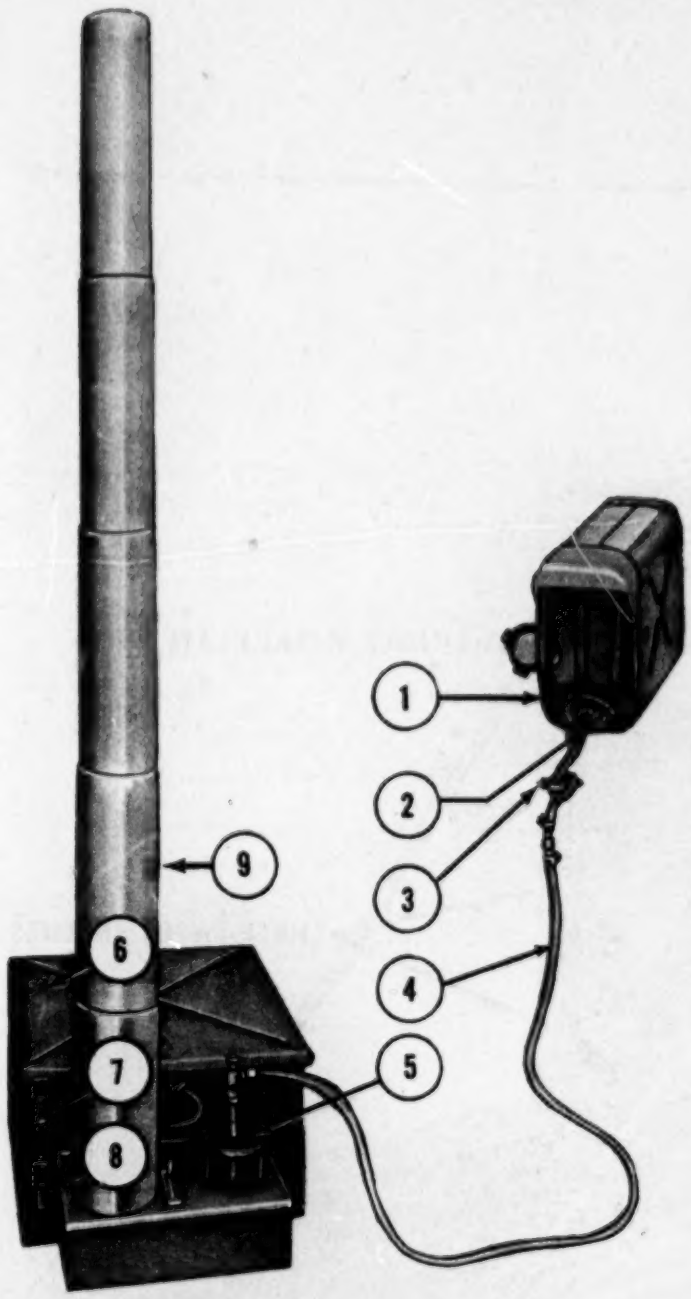

1 Can, military gasoline (5-gallon)
2 Adapter, gravity feed
3 Drip interceptor
4 Hose assembly
5 Burner-valve assembly
6 Stove, gasoline burner
7 Windshield
8 Cover, windshield
9 Pipe, air conditioning-heating

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Figure 13-4.—Cooking outfit, field, small detachment.

the more complex ovens. Some of these units are constructed of rubble, sheet metal, and brick, stone, or cinder block, held together by a "cement" made of mud and grass. At first, only simple units for heating water and making soup and beverages are necessary. As time and labor become more available, complex units can be constructed to permit greater variety in meals.

Open Fire Cooking and Heating Unit

In order to construct the open fire cooking and water-heating unit shown in figure 13-8 (page 204) you need the following materials:

1. Twelve brick or flat stones.
2. Four cinder or concrete blocks.
3. Half of a 55-gallon oil drum or other large container for cooking.
4. The upper half of an oil drum or a piece of sheet metal of a similar size which can be used as a shield.

On the selected site, outline a square large enough to accommodate the cooking container. Then, at the center of each of the four sides of the square, stack three bricks so that they will support the container with its edge contered on each stack. Place the pot on the stack of bricks, and bend the sheet metal to fit around the bricks, but leave about a 6-inch space between the ends of the metal (see fig. 13-8).

Finally, build a wood or coal fire at the center of the stack of bricks. Place the 6-inch opening of the shield so that it faces the wind to provide for a good draft. The shield may be moved when the wind shifts or when you wish to add fuel to the fire. Of course, safety precautions pertaining to fire prevention must be strictly observed when building any type of outdoor fire.

It is estimated that two of these units are sufficient for the preparation of food for 100 men and six are adequate to feed 500.

Crossfire Trench

If bricks, stone, or cinder blocks are not available, you may build a cross fire trench. To construct such a trench, first dig 2 trenches, each 8 feet long, 1 foot wide, and 1 foot deep, which cross at their centers. (See fig. 13-9 on page 204.) The bottom of each trench should taper up to the level of the ground toward the end, as shown in the illustration. Place scrap iron over the intersection of the trenches to make a grate. Approximately 10 pieces of scrap

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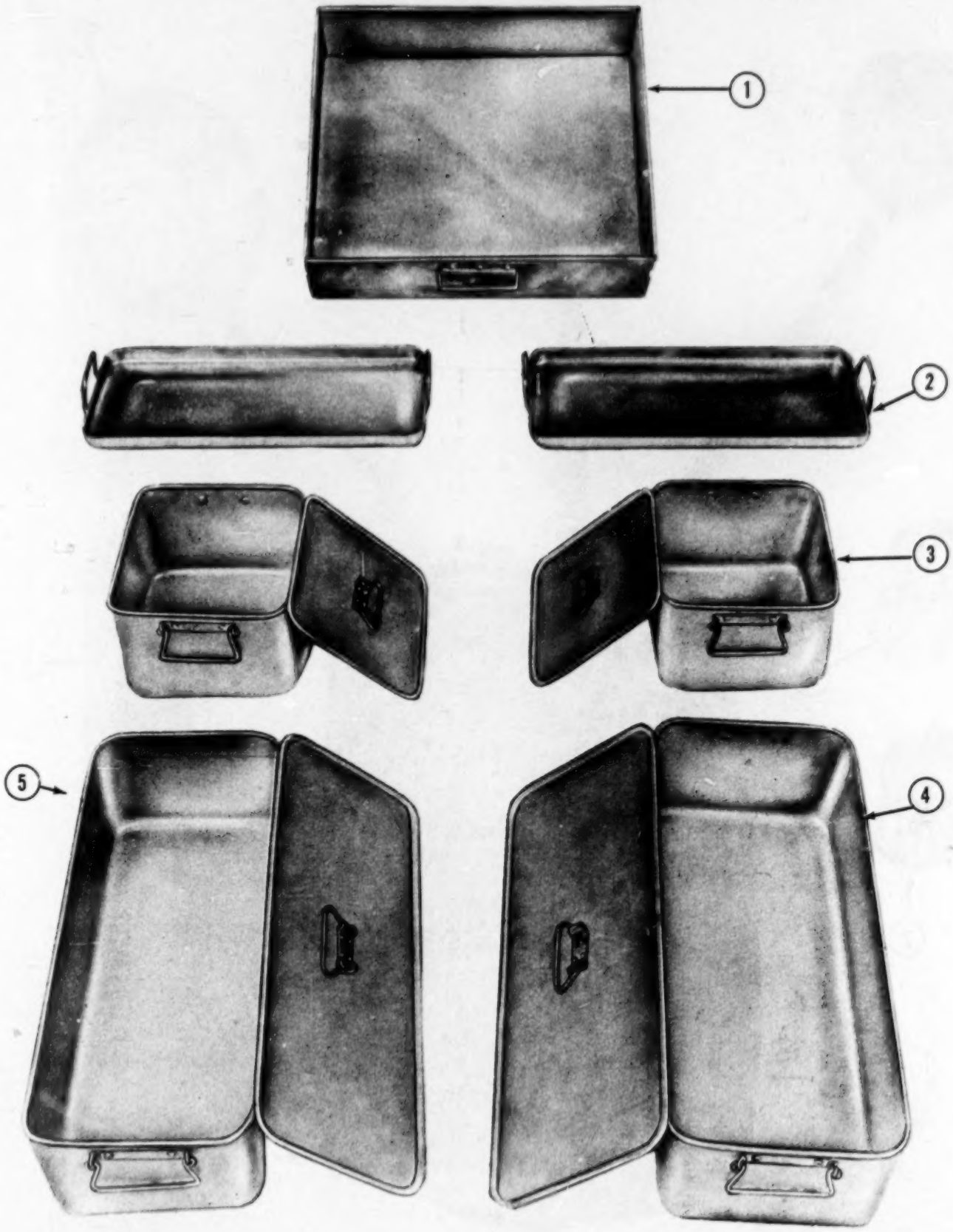

1 Pan, sterilizing
2 Pan, frying, outfit, cooking, small detachment
3 Pot with cover, cooking, 6-quart
4 Pot with cover, cooking, 13-1/2-quart
5 Pot with cover, cooking, 11-quart

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Figure 13-5.—Pots and pans.

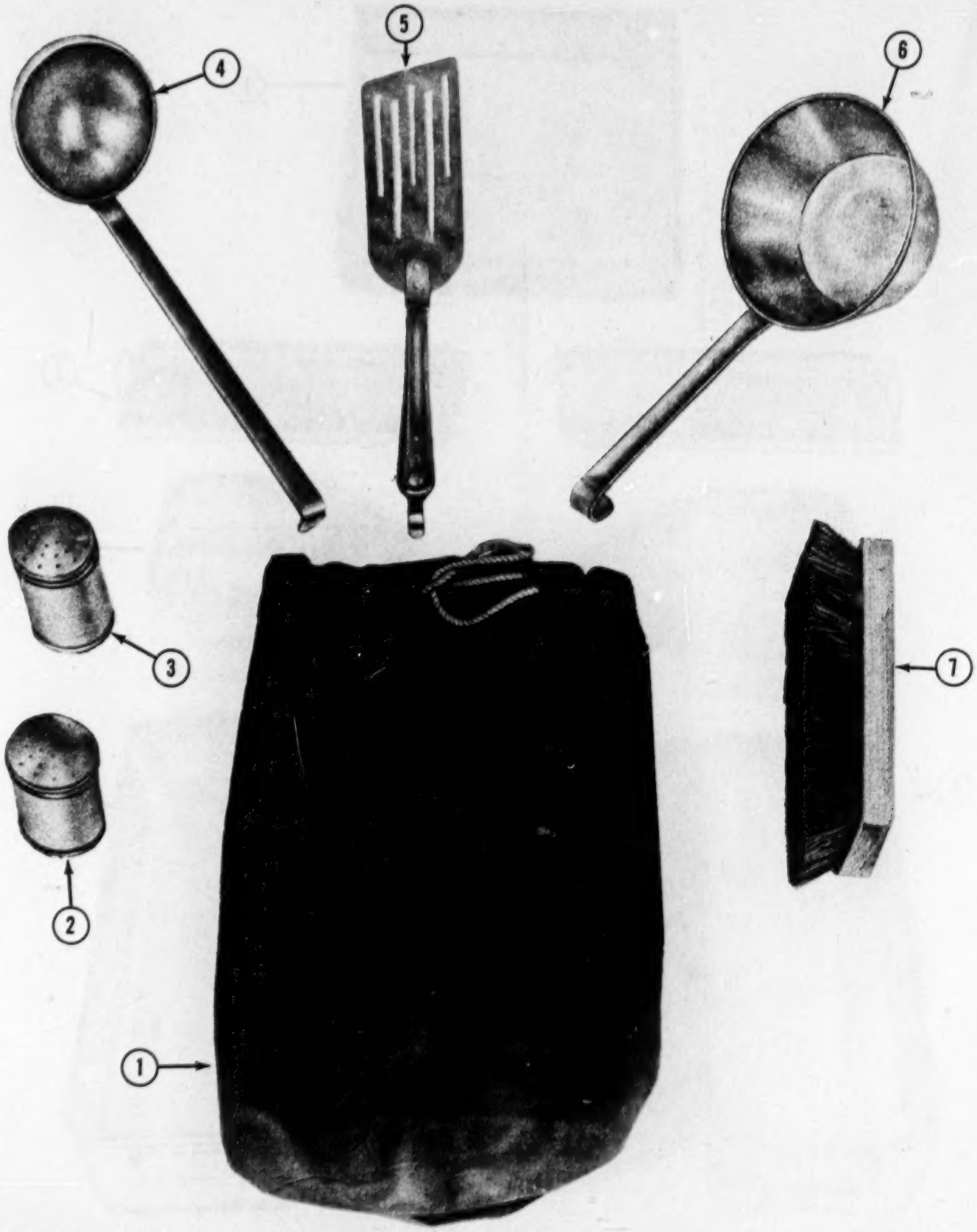

1 Bag, cotton duck, 7-inch diameter, 18-1/2 inches long
2 Pepper shaker
3 Salt shaker
4 Ladle, kitchen, 8-ounce capacity
5 Food turner
6 Dipper, kitchen, 1-quart capacity
7 Brush, scrub

Figure 13-6.—Components of cutlery bag. 48.65

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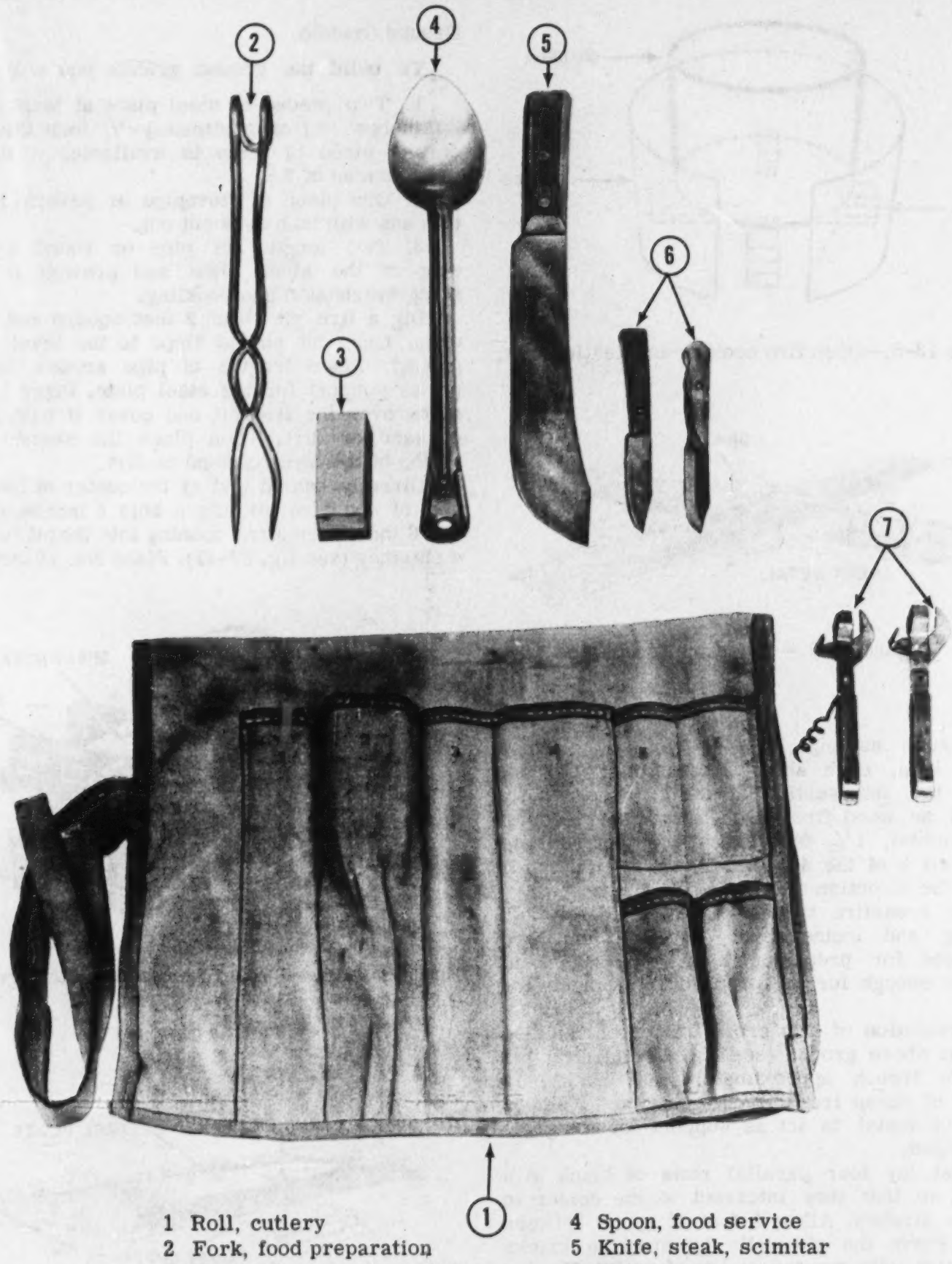

1 Roll, cutlery
2 Fork, food preparation
3 Stone, sharpening, pocket
4 Spoon, food service
5 Knife, steak, scimitar
6 Knife, paring
7 Opener, can, hand

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Figure 13-7.—Components of cutlery roll.

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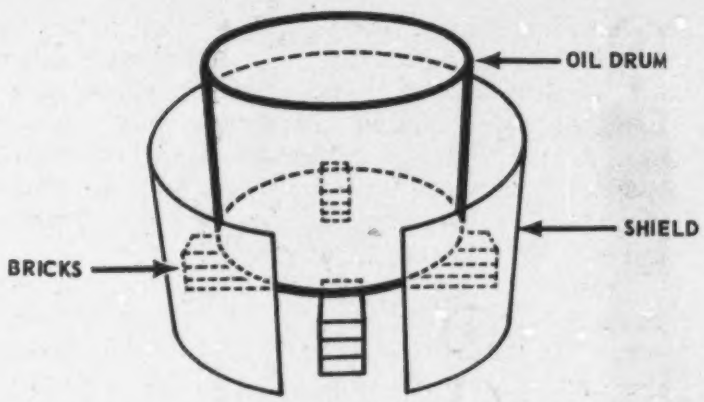

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Figure 13-8.—Open fire cooking and heating unit.

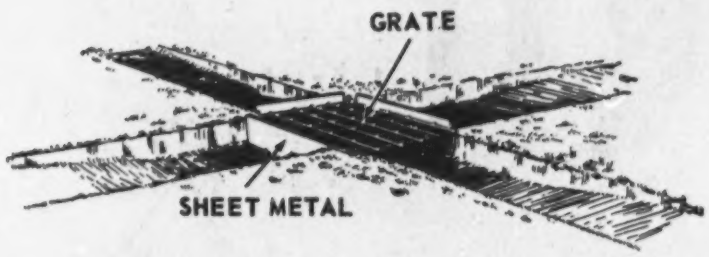

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Figure 13-9.—Crossfire trench.

iron, such as pipe, angle iron, or $^1/_2$-inch round iron, each about 2 feet long, will do.

At the intersection of the trenches, build a coal or wood fire. Then use three pieces of sheet metal, $1^1/_2$ feet long by 1 foot wide, to block off 3 of the 4 sides. Leave open the side facing the direction of the wind.

The crossfire trench can be used for both cooking and incinerating. Two of them are sufficient for preparing meals for 100 men; six are enough for the preparation of meals for 500.

A variation of this crossfire trench can also be built above ground (see fig. 13-10). For this type of trench approximately 100 bricks, 10 pieces of scrap iron for the grate, and 2 pieces of sheet metal to act as support for the grate are needed.

First lay four parallel rows of brick in a cross, so that they intersect at the center to form a firebox. Allow 1 foot of space between rows. Form the sidewalls by stacking bricks three high with mortar in between. Finally, lay the sheet metal at the intersection and place the scrap iron over the sheet metal to make the grate.

Ground Griddle

To build the ground griddle you will need:

1. Two pieces of steel plate at least 30 by 30 inches and approximately $^1/_4$ inch thick. (If only 1 piece of plate is available, it may be used instead of 2.)

2. One piece of stovepipe or several No. 10 tin cans with both ends cut out.

3. Two lengths of pipe or round iron to support the steel plate and prevent it from being overheated and buckling.

Dig a fire pit about 2 feet square and 1 foot deep. One end should slope to the level of the ground. Place lengths of pipe across the fire pit as support for the steel plate. Place 1 steel plate over the fire pit and cover it with 1 inch of sand or dirt. Then place the second plate on top of the layer of sand or dirt.

Directly behind and at the center of the deep end of the fire pit, dig a hole 6 inches square and 6 inches deep and opening into the pit to form a chimney (see fig. 13-11). Place No. 10 cans one

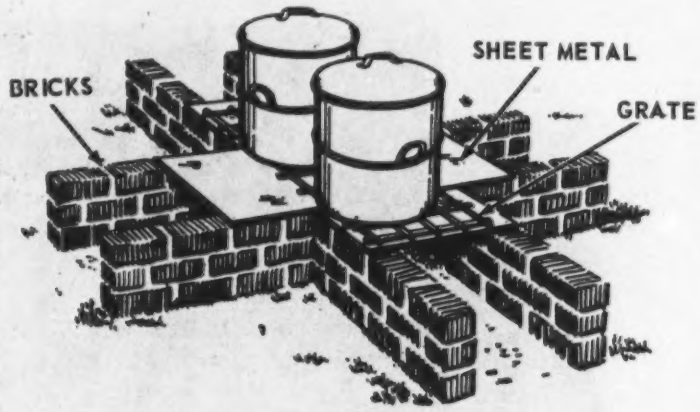

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Figure 13-10.—Crossfire trench above ground.

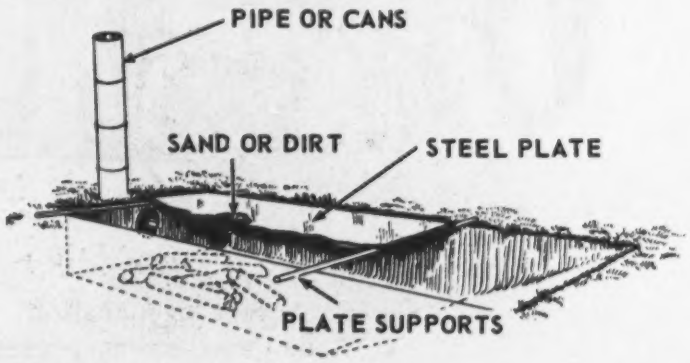

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Figure 13-11.—Ground griddle.

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on top of the other to fit over the hole in the ground and form the chimney stack. A tighter chimney may be made by cutting several inch-wide sections around the bottom edge of each can so that it fits over the rim of the connecting can. Use bricks to hold the chimney in place.

The ground griddle may also be used as a quick bread oven by covering dough placed on the steel plates with a tin can. And in the same way, it may be used as a food warmer.

It is estimated that you will need 2 ground griddles if you are to feed 100 men and 6 if you are to feed 500.

Roaster

To build a good improvised roaster, you will need:

1. One large can with a tight-fitting cover. (An institutional-size lard or shortening can is preferable.)
2. Bricks, cinder block, or stones to construct the sidewalls of the fire pit.
3. A length of steel rod, round iron, or heavy wire to be used as a spit.
4. A length of fine strong wire to tie the meat to the spit.

The improvised roaster is shown in figure 13-12. To form the brick fire pit, it is necessary only to place the bricks in a ring. Build your fire around the inside of this fire pit, allowing space in the center for the cooking container to rest on the ground.

Punch a hole for the spit on each side of the can several inches below the rim. Then wrap fine wire several times around the meat which you wish to roast, or run the wire through the center of the meat, leaving ends of wire long enough to make a strong loop. Run the spit through one hole in the can. Slip the wire loops on the roast over the spit so that the meat will hang suspended in the can. Then run the spit through the other hole.

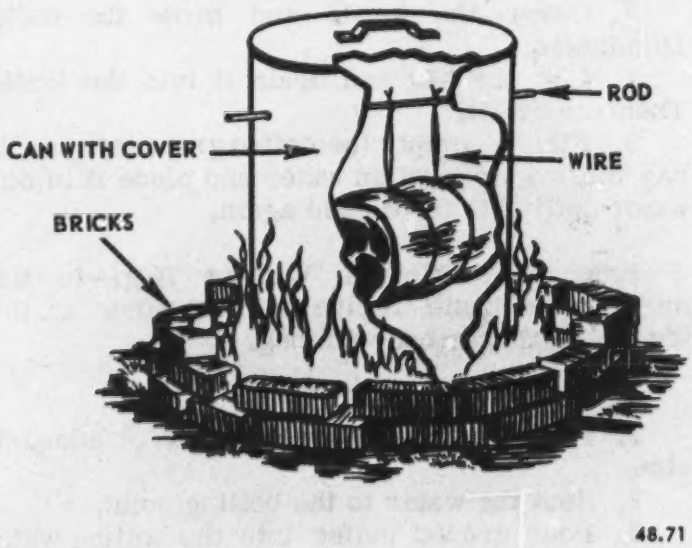

Figure 13-12.—Improvised roaster.

Put the cover on the can and place it on the ground within the fire pit, with a weight on the cover to hold it securely. Do not put water in the can. The meat should cook in its own steam. And remember that meat cooks more quickly in this type of pressurized container. For example, a 20- to 25-pound chuck of roast beef will cook in 2 to $2^1/_2$ hours.

COOKING CONTAINERS

Before you use any containers, such as salvage oil drums, they must be cleaned, scoured, and sterilized. If there is a choice, choose containers in the following order of preference:

1. Those in which fuels, oils, and lubricants were stored.
2. Those in which chemicals and fertilizers were stored.
3. Those in which paints were stored.

When you cleanse these containers, use the following procedure:

1. Cut 55-gallon oil drums in half.
2. Wip out oil and foreign matter.
3. Fill the containers with water, add detergents, and boil the water.
4. Empty the soiled water. Use an ordinary household abrasive to scour the container thoroughly. If such an abrasive is not available, make a mixture of sand, fine gravel, and water. Remove any foreign matter deposited in crevices or under rolled rims.
5. Rinse thoroughly with hot water several times.
6. Repeat the above procedures if necessary.
7. To ensure the cleanliness and safety of a container which is to be used as a cooking vessel, you may finally BLUE it.

Bluing Emergency Containers

The purpose of bluing is to prevent rust. Aluminum and tin utensils should never be blued, because the high heat necessary to blue a utensil will melt them. To blue utensils, use the following steps.

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1. Wash and dry the utensil thoroughly. Place it over a wood fire that has both flames and live coals. This burns out any remaining residue and opens the tiny pores of the metal.

2. Plunge the utensil in hot water and again scour and dry it thoroughly.

3. Coat the utensil inside and out with a thin film of lard or some other cooking grease. Do not use bacon or ham grease or any other grease which contains salt that will corrode the metal.

4. Place the utensil upside down over glowing coals, being careful not to burn away the grease.

The metal will slowly turn blue as the heat does its work. The spread of color is a guide in judging the progress of the bluing. This heat treatment melts the grease into the surface, closes the pores of the metal, and gives the utensil a smooth, glazed surface that resists rust.

BATTLE RATIONS

The armed services are equipped with battle rations that are prepared so that the necessary food values are provided in a form that can be used under battle conditions. The following paragraphs discuss some of these rations.

B Operational Ration

B rations are designed for large group feedings in situations when it is impossible to provide perishable foods because of lack of refrigeration facilities but when, nevertheless, kitchen and cooking facilities are available.

The B ration may include canned meats, cereals and cereal products, canned fruits, canned milk products, canned vegetables and legumes, dehydrated fruits and vegetables, dry milk products and dried eggs.

Meal, Combat, Individual

Field ration (meal, combat, individual) was designed for use either in individual units as a meal packet, or in multiples of 3 as a complete ration. It may be eaten either hot or cold, and is packaged so that it can be carried by the individual.

Packaged by individual meal, the ration offers a variety of canned meat, fish, or poultry, canned vegetables, canned fruits, desserts, and beverages.

Emergency Coffee

Emergency coffee can be made by the kettle method with bag or without bag. Each method is discussed in the following paragraphs.

Kettle Method With Bag.—Unbleached muslin, layers of cheesecloth, or sugar sacks are suitable for making bags. NEVER use burlap sacking or other material that has been sized or otherwise treated.

The basic recipe for making coffee in a 10-gallon kettle consists of 3 pounds of coffee to $7\frac{1}{2}$ gallons of boiling water. The yield will be $7\frac{1}{2}$ gallons of coffee, 30 quarts, or 160 six-ounce portions.

The following directions should be followed to make coffee by the kettle method with a bag:

1. Place ground coffee in a cloth bag large enough to permit the circulation of water and expansion of the coffee. Allow for expansion of as much as 2 or 3 times the amount of coffee used. Fifteen pounds of coffee is the maximum per bag for best results and convenient handling.

2. Tie the bag securely near the top with strong cord or string with one end long enough to fasten to the handle of the container. This makes it possible to remove the bag easily from the hot brew.

3. Pour water (freshly drawn if possible) into a large kettle and bring it to a boil.

4. Place the coffee bag in the boiling water; tie the cord to the handle or make it secure otherwise. Reduce the heat to keep the water at just below boiling AT ALL TIMES.

5. Submerge the bag with a paddle or stick, pushing up and down gently to force water through the grounds.

6. Cover the kettle and brew the coffee 10 minutes.

7. Lift the bag and drain it into the kettle. Then remove it.

8. Finally, empty the coffee grounds; wash the bag thoroughly in plain water and place it in cold water until it is to be used again.

Emergency Method Without Bag.—In this method the basic recipe is the same as that for the kettle method with bag.

Follow these directions:

1. Pour water into a container of adequate size.

2. Heat the water to the boiling point.

3. Pour ground coffee into the boiling water and stir.

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4. Reduce the heat to just below the boiling point.

5. Brew the coffee 10 to 12 minutes, being careful not to boil or overcook it.

6. Settle the grounds by sprinkling in a small amount of cold water. To avoid stirring up the grounds, carefully pour or ladle the coffee into another container.

HANDWASHING FACILITY

The handwashing facility illustrated in figure 13-13, has the advantage of being both simple and sanitary. In order to construct it, you will need:

1. Two No. 10 tin cans or other metal containers for water, with bails and tilt handles.

2. One length of iron rod, pipe, or wood from which to suspend the cans.

3. Six lengths of wood to form tripods, with cord or wire for typing.

First erect the tripods. Then put bails and tilt handles on the cans as shown in figure 13-13. Suspend the cans on the pole and tie them to it. Finally, place the pole on the tripods. (The area below the cans should be filled with sand or gravel so that the water from the cans will drain off and not form a mud puddle.)

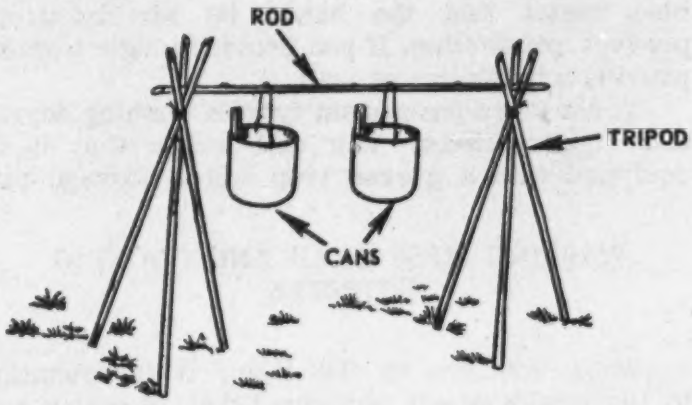

Figure 13-13.—Handwashing facility.

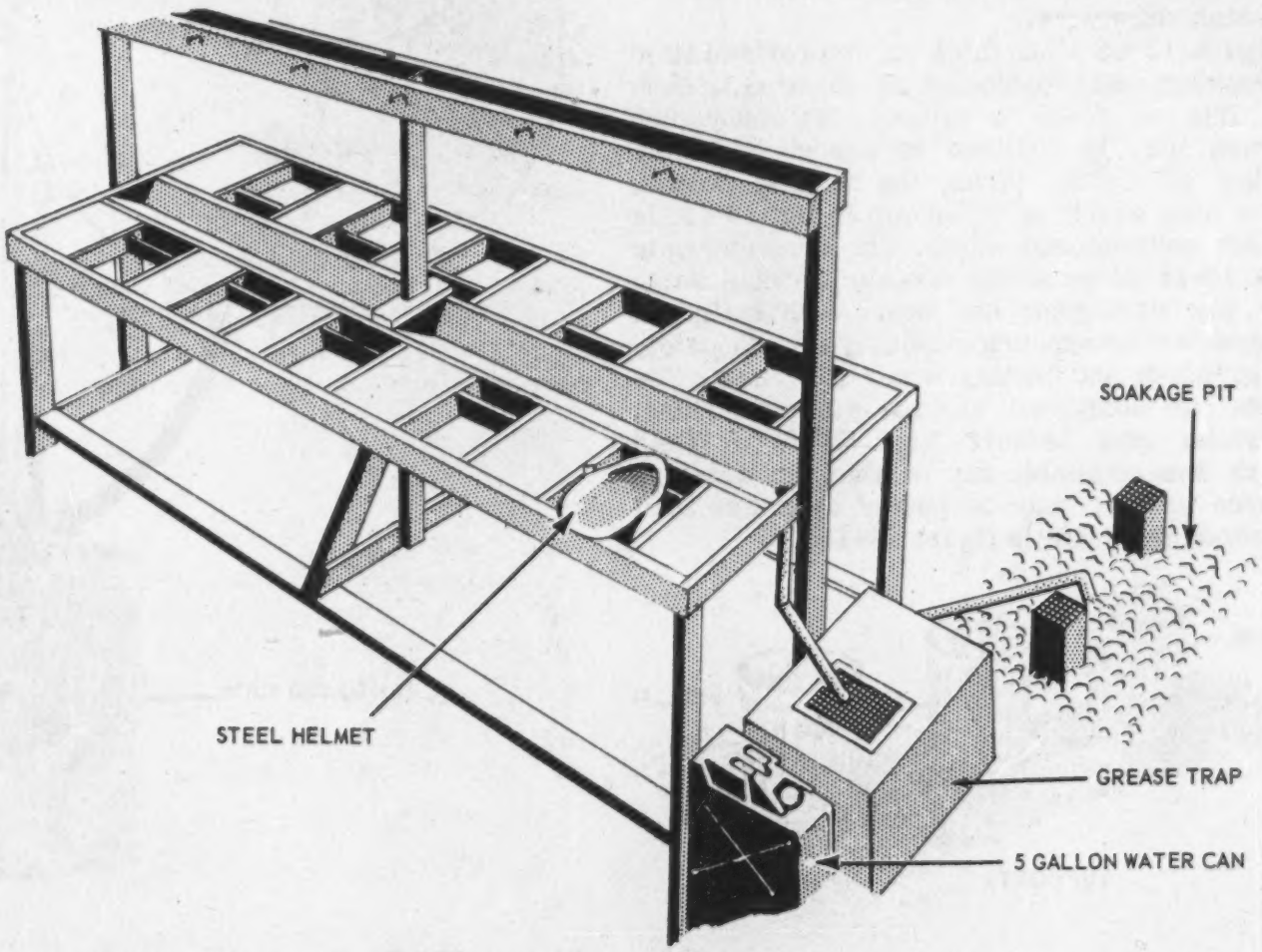

Figure 13-14.—Washing device with soakage pit.

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When you are ready to use the unit, fill 1 can with soapy water and the other with a disinfecting solution consisting of 1 ounce of any ordinary household laundry bleach to 2 gallons of water. Each man using it may first pour the soapy water over his hands and then rinse them with the disinfecting solution. You should provide single-service paper towels for each person or else insist that the hands be air dried, to prevent reinfection. If you provide single towels, provide a trash can as well.

For a more permanent type of washing device see figure 13-14. You will notice that it is equipped with a grease trap and a soakage pit.

WASHING MESS GEAR AND COOKING UTENSILS

When you are in the field, it is essential to the health of all personnel that all eating and drinking utensils, as well as equipment used to prepare, cook, and serve food, be properly washed and sanitized. This duty will require close supervision. One mistake could result in many sick shipmates.

Figure 13-15 illustrates an improvised field dishwashing unit consisting of three G.I. cans in a line to form a battery. As many such batteries may be utilized as needed to handle the flow of traffic during the feeding period.

One can, which is not shown in fig. 13-15, is used for garbage and waste. The cans shown in figure 13-15 respectively contain prewash warm water and detergent; hot water with sufficient detergent so that washing is quickly and adequately accomplished; and boiling water for rinse. You can use an additional can for a second rinse. Immersion type heaters (fig. 13-16) or field burners are available for heating the water in the cans or they may be heated over fire built in a trench as shown in figure 13-15.

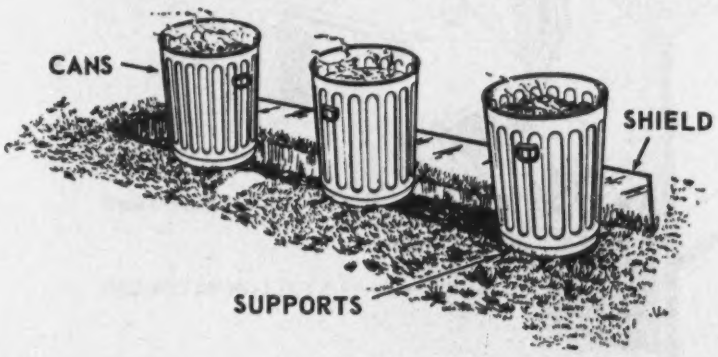

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Figure 13-15.—Emergency dishwashing facility.

Dishwashing Procedure

Long-handled brushes should be attached to the wash cans for use in prewashing. When scraps are discarded, prewash utensils to remove food particles and grease. Then wash in hot water 110° to 130°F and detergent before immersing in the sanitizing (boiling) rinse. The utensils

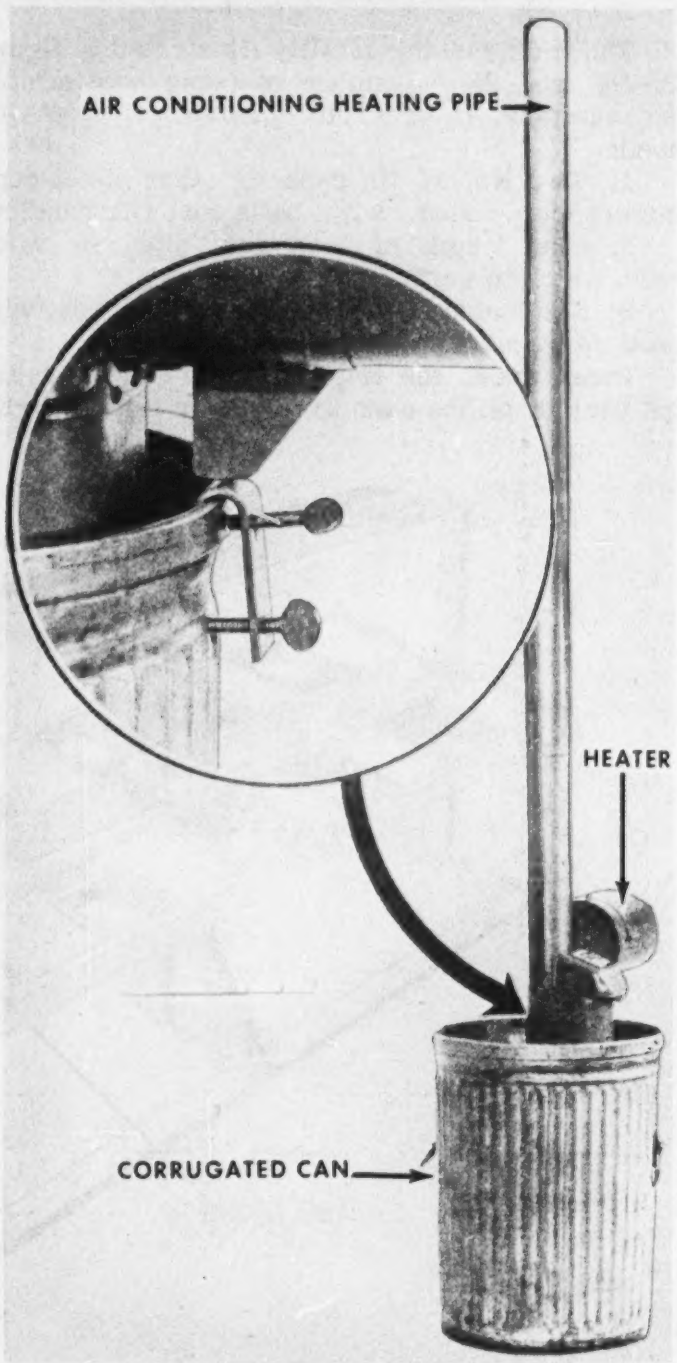

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Figure 13-16.—Immersion heater mounted in a corrugated can.

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should remain in the wash and rinse water for about 30 seconds. After immersion in the boiling water, the utensils should be allowed to air dry. NEVER dry them with towels.

The prewash water should be changed as frequently as necessary to prevent carryover of grease and food particles into the rest of the system.

After the battery has been secured, the cans should be emptied, thoroughly scrubbed, flushed, and inverted to permit complete draining and drying. Mark each can for its designated use, "garbage," "prewash," "wash," and "rinse." This should aid in restricting the use of each can for the one purpose for which it is intended.

DISPOSING OF WASTE

One of your biggest jobs will be the disposal of garbage, trash, and liquid wastes from the galley. Garbage is best disposed of by burying or burning.

To bury GARBAGE, dig a trench or pit 4 or more feet deep, dump the garbage in the pit, pack it down in layers and cover the exposed layer with a few inches of dirt at the end of each day. When the pit is filled, cover it with earth and pack it down well by tamping or running over it with a crawler tractor. When you abandon a garbage site, cover it with at least 2 feet of mounded earth.

When you incinerate garbage, all excess moisture must first be removed. Then start a good fire before adding the garbage. Add it to the fire in small amounts and add fuel as needed to keep a good fire going. The unburned residue must then be buried and covered with at least 2 feet of mounded earth.

To dispose of CANS, either wash them and use them as substitutes for cooking and eating utensils, or open both ends, flatten them, and bury them with the garbage.

GLASS JARS also can sometimes be used as substitutes for eating utensils. Otherwise, break them and bury them with the garbage. Breaking them will reduce the volume and save work in digging and covering.

Bury other noncombustible wastes with the garbage, and burn the combustible wastes.

LIQUID WASTES such as grease, except any usable grease or waste fat which can be used for cooking, may be burned or buried with the garbage. Dispose of other liquid wastes in a soakage pit. This pit should be located at a minimum of 25 feet from the kitchen area.

To build a soakage pit like that shown in figure 13-17, you will need:

1. Lumber to construct a box approximately 12 inches square and 2 feet high, open at both ends.
2. Enough 1- by 4-inch lumber to construct reinforcing strips to brace the top of the box and also strips inside the box for the wire basket to rest on.
3. Two 1-inch layers of wood, with the lower layer recessed, to construct a cover to fit the top of the box.
4. A layer of wire screen, matting, gunny sacking, tar paper, or a heavy layer of newspaper to retain the earth mound above the rocks.
5. Enough rocks or rubble to fill a pit 5 feet in diameter and 5 feet deep.
6. A wire basket of approximately $^1/_2$-inch mesh hardware cloth, resting on the 1- by 4-inch wood inner strips.
7. Earth to make a mound approximately 6 inches high over the rocks.

Locate the soakage pit in well-drained ground which is suitable for good soakage, preferably sand or gravel soil. Dig a pit 5 feet in diameter and 5 feet deep. Fill the pit with rocks or rubble to within 1 foot of the ground surface. Insert the box as shown in figure 13-17. Then add enough rubble to fill the pit to the ground surface around the box. Cover the rubble with screen wire or any other material that will serve as a separator between the rubble and the earth topping, and mound dirt over the pit.

The wire basket serves to catch any large pieces of solid matter floating in the liquid. These might prevent good drainage if they were dumped into the pit. The basket may be removed and emptied as necessary.

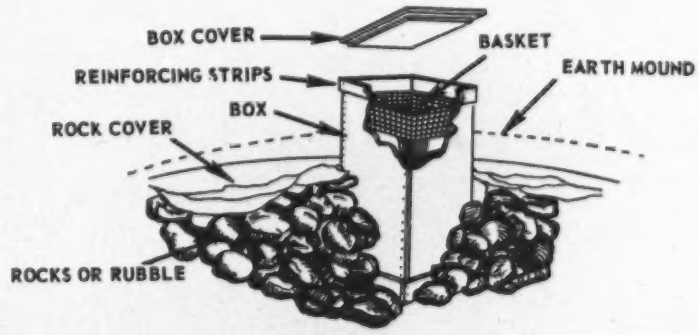

Figure 13-17.—Soakage pit.

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INSECT CONTROL

Flies breed in manure and decayed matter, so keep flies out of the galley. Screen the galley if possible. Keep the food in covered or screened containers where flies can't get at it. Mosquito netting is a good material to use.

Use traps and fly swatters freely. Sticky fly paper can be made by heating castor oil (5 parts by weight) and powdered resin (8 parts) until the resin is dissolved. Don't boil this solution. Apply it to glazed paper while it is still hot or paint it on iron hoops or wire strands. Wires so painted should be cleaned and recoated every 2 or 3 days.

DDT—made especially for the Armed Forces—is the most effective means of fighting flies and other insects. Spray it around as often as necessary, but don't let it come in contact with food or utensils.

Other pests such as ants, mice, and rats can present problems which may require special controls such as those mentioned in Chapter 8, Sanitation in the General Mess.

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APPENDIX I

TRAINING FILM LIST

Certain training films that are directly related to the information presented in this training course are listed below under appropriate chapter numbers and titles. Unless otherwise specified, all films listed are black and white with sound, and are unclassified. For a description of these and other training films that may be of interest, see the United States Navy Film Catalog, NavWeps 10-1-777.

Chapter 4

STORAGE AND CARE OF SUBSISTENCE ITEMS

SG-8470H Refrigerated Food Storage—Principles (12 min.—62 frames—1951)

MN-8238C Shipboard Inspection by Medical Department Personnel—Food Storage (13 min.—1958)

Chapter 10

FOOD PREPARATION

MN-9831 Preparing Ration-Dense Foods (17 min.—Color--1963)

MN-9995 Basic Meat Cookery (25 min.—Color—1964)

MN-10161 Poultry Cookery (25 min.—Color—1965)

Chapter 12

FOOD SERVICE

MN-8238E Shipboard Inspection by Medical Personnel—Food Serving (13 min.—1958)

Chapter 13

LANDING PARTY

MN-9695 Cooking Outfit for Small Detachments (22 min.—1961)

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ABSTRACT - Developed by the Division of Curriculum and Instruction of the Milwaukee Public Schools, this curriculum guide is for instructor use in teaching the trade and industrial fundamentals of machine shop in the secondary schools. Specific objectives include development of skills necessary in the machine industry, an understanding of the importance of the metalworking industry, and an appreciation of related information. The course outline covers 20 major units, encompassing 73 sub-units, which are presented in a seven-column format. Sixty detailed prints for projects, references, a list of films and filmstrips, and a bibliography are included. (GEB)

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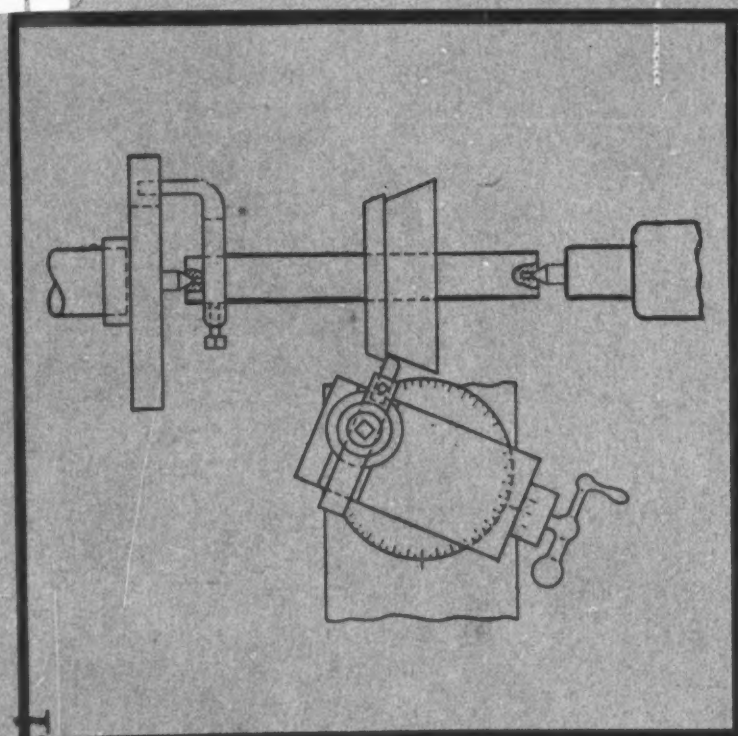

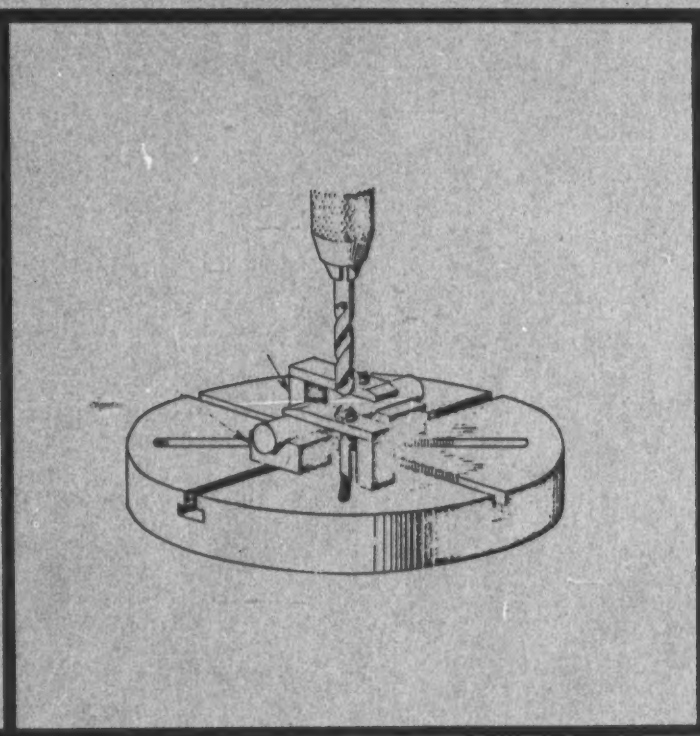

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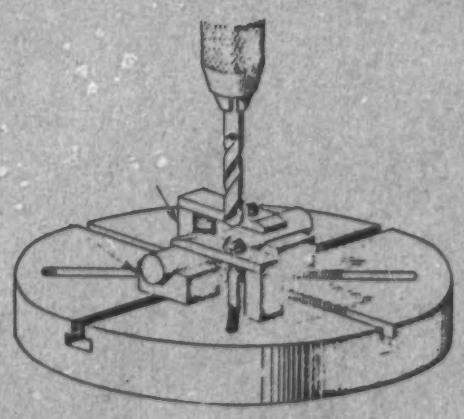

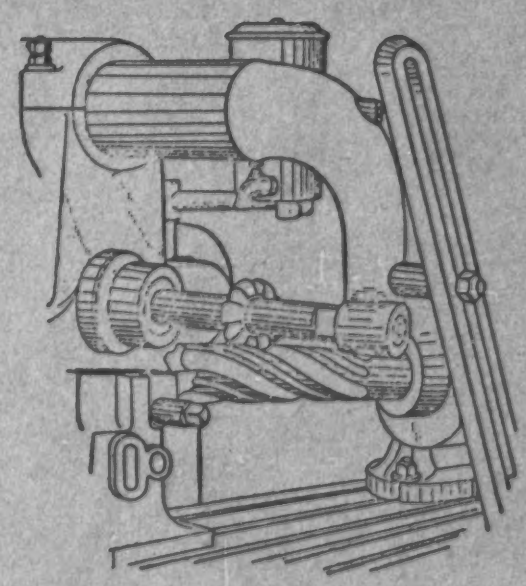

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MILWAUKEE PUBLIC SCHOOLS

1966

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INTRODUCTION

The curriculum guide for machine shop has been planned as an aid to the practical course which involves all levels of bench and machine work, from t The use of the curriculum guide will vary according to the equipment and tim concerned. Therefore, no sequence of instruction has been built into the gu will adapt it to make maximum use of their time and equipment.

In the presentation of this material, a concise seven-column guide has

-- Column one contains the title of the unit to be presented and the te used to cover this material. The code numbers assigned to each refe in the section entitled Bibliography, page 19.
Example: 1 - pp.101-106 lists the book GENERAL-INDUSTRIAL MACHINE S 101 to 106 as the source of information for the unit.

-- Column two lists the instructional information to be taught in this assumed that the instructor will use the listing as it best fits the which he is teaching.

-- Column three lists the suggested teaching methods that may be used the unit.

-- Column four contains a listing of films, filmstrips, charts, and par will aid in the presentation of the unit. All film numbers are pre letter F. Films are listed on page 29. Charts and pamphlets are li Supplementary Aids, page 21.

-- Column five lists drawings of various exercises and projects to be teaching the materials in the various units. The drawings themselv as the last section of this guide and are organized by drawing numb

-- Column six lists the suggested student textbook assignment to be us to the content of the unit.

-- Column seven may be used for the instructor's notes and comments--t as the unit is covered.

The purpose of this course is to prepare the high school graduate to e allied industries as an apprentice or knowledgeable production employee. S intentions, as such, to be eligible for this training. It is further inten graduation, plan to continue their education in a technical school or junio

INTRODUCTION

e for machine shop has been planned as an aid to the instructor teaching this
nvolves all levels of bench and machine work, from the beginning to the advanced.
m guide will vary according to the equipment and time limitations of each school
o sequence of instruction has been built into the guide; the teachers involved
ximum use of their time and equipment.

of this material, a concise seven-column guide has been used.

ins the title of the unit to be presented and the textbook references
is material. The code numbers assigned to each reference are listed
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.101-106 lists the book GENERAL-INDUSTRIAL MACHINE SHOP, with pages
106 as the source of information for the unit.

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f the unit.

be used for the instructor's notes and comments--to be inserted
overed.

course is to prepare the high school graduate to enter the metalworking and/or
apprentice or knowledgeable production employee. Students must state their
be eligible for this training. It is further intended for those who, upon
inue their education in a technical school or junior college.

AIMS AND OBJECTIVES

-- To develop the personality traits and abilities necessary

-- To develop an awareness of accident causes and the habit o

-- To develop abilities in the use of common tools, machines
industries

-- To develop an understanding of the social and economic ro
living

-- To emphasize the importance of English, mathematics, and

-- To develop the practice of careful planning and good work

-- To develop a program that will meet the needs of those wi
aptitudes, desires, and interests; also, to show students
applied successfully in industrial and technical fields

-- To train the student in skilled processes involving the u
which, together with his high school academic work, will
machine industry

-- To develop skill and accuracy in the manipulation and car
in the machinist trade

-- To teach and develop the ability to gauge and measure qui

-- To stimulate independent thinking in order to strengthen

-- To develop an understanding of metals, their machinabilit

-- To develop an understanding of related information, such
practices, patternmaking, shop mathematics, on-the-job tr
pay scales, employee and employer attitudes and responsib

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AIMS AND OBJECTIVES

- the personality traits and abilities necessary for the machinist trade
- an awareness of accident causes and the habit of safe practices
- abilities in the use of common tools, machines, and materials as used in the metalworking s
- an understanding of the social and economic role of the metalworking industry in everyday

ize the importance of English, mathematics, and science in industrial occupations

p the practice of careful planning and good workmanship

p a program that will meet the needs of those with varying abilities, potentialities, , desires, and interests; also, to show students where these characteristics can be uccessfully in industrial and technical fields

the student in skilled processes involving the use of modern tools, machines, and materials gether with his high school academic work, will prepare him for future employment in the ndustry

p skill and accuracy in the manipulation and care of essential hand and machine tools used chinist trade

and develop the ability to gauge and measure quickly and accurately

ate independent thinking in order to strengthen the student's problem-solving ability

p an understanding of metals, their machinability, and heat treatment

p an understanding of related information, such as blueprint drawing and reading, foundry , patternmaking, shop mathematics, on-the-job training, apprenticeship training, unions, s, employee and employer attitudes and responsibilities, etc.

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DESCRIPTION OF THE MACHINE SHOP COURS

This machine shop course has been geared toward the vocational tr entrance into the field of metalworking and other allied industries, e production worker with on-the-job training.

The course, as taught, will require a minimum time of one period eleventh and twelfth grades, except Boys' Technical High School which periods a day for seven semesters from the ninth through twlefth grade offered for the course--per period, per semester.

The prerequisites for taking the course are an indication of abi through aptitude tests and the Kuder Interest Inventory, plus the rec staff. Students should be between the ages of fourteen and nineteen. class enrollment is twenty students.

DESCRIPTION OF THE MACHINE SHOP COURSE

ne shop course has been geared toward the vocational training of young people for he field of metalworking and other allied industries, either as an apprentice or er with on-the-job training.

, as taught, will require a minimum time of one period a day for four semesters in the elfth grades, except Boys' Technical High School which schedules machine shop two or seven semesters from the ninth through twlefth grades. One-half credit will be course--per period, per semester.

uisites for taking the course are an indication of ability and interest as expressed e tests and the Kuder Interest Inventory, plus the recommendation of the guidance s should be between the ages of fourteen and nineteen. The recommended individual t is twenty students.

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MACHINE SHOP

UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	
1. Aims of Course and Shop Organization	Description of course Shop organization Shop conduct in school and industry Tardiness Absences Accident procedures Grading system Clean-up rules	Shop tour Duplicated materials Lecture		The d
2. History of Machinist Trade and Present Opportunities	Background and development of hand and/or machine tools Interchangeability of parts and mass production Important role of present-day machinist Changing job outlook caused by automation and other reasons	Public museum Pamphlets Lecture Duplicated materials	F - 14 11-3 17-1 17-2 18-1 23-5	The
3. General Shop Safety	Machine maintenance Proper dress Eye protection Working areas Floor condition Safety guards Electricity Flammable liquids Machine safety	Lecture Films Charts Posters Constant emphasis	F-1	Th

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MACHINE SHOP

SIC MATERIAL VERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
tion of course ganization nduct in school industry ess es nt procedures g system up rules	Shop tour Duplicated materials Lecture		Theory and discussion		
ound and develop- f hand and/or e tools hangeability of and mass tion ant role of t-day machinist ng job outlook by automation her reasons	Public museum Pamphlets Lecture Duplicated materials	F - 14 11-3 17-1 17-2 18-1 23-5	Theory	1 - pp. 2-3	
e maintenance dress otection g areas condition guards icity ble liquids e safety	Lecture Films Charts Posters Constant emphasis	F-1	Theory and discussion		

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS
4. Occupations in Machining Industries	Apprenticeships Earnings On-the-job training Working conditions Skilled and semi-skilled technicians	Film Charts Lecture Textbook	F-14 F-2 11-3 17-1 17-2 18-1 23-5
5. Using Bench Tools	Safety procedures Non-edge tools Striking tools Chisels Saws Pliers Clamping devices Wrenches Screwdrivers Files Taps and dies	Films Charts Lecture Textbook	F-5 F-10 F-30 F-31 F-32 19-1
6. Measuring			
6-1. Non-precision Measuring Instruments	Rules Calipers Dividers Trammel Surface gauge Protractor Combination square Parallels	Demonstration Textbooks Starret charts Films	F-27 23-4 24-2
6-2. Precision Measuring Instruments 3 - pp. 20-45 4 - pp. 421-430 6 - pp. 102-115 8 - pp. 33-57	Micrometers Verniers Indicators Gauge blocks Sine bars Fixed gauges Optics	Charts Films Pamphlets Tool catalogs	F-19 F-8 F-13 F-23 6-1 11-2 14-1 14-2 24-1 24-4

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BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
enticeships ings he-job training ing conditions led and semi-skilled chnicians	Film Charts Lecture Textbook	F-14 F-2 11-3 17-1 17-2 18-1 23-5	Theory and discussion	1 - pp. 40-46 2 - Unit 50 pp. 1-8	
ty procedures edge tools king tools els rs ping devices ches wdrivers s and dies	Films Charts Lecture Textbook	F-5 F-10 F-30 F-31 F-32 19-1	M-170 Tool gauge M-177 Parallel clamp screws	1 - pp. 10-30 2 - Units 7, 8, 9-12, 13-15, 16, 17	
s pers ders mel ace gauge ractor ination square llels	Demonstration Textbooks Starret charts Films	F-27 23-4 24-2	M-170 Tool gauge M-172 Caliper exercise M-177 Parallel clamp screw	1 - pp. 70-86 2 - Unit 4, pp. 1-4 Unit 5, pp. 1-2 Unit 6, pp. 1-10	
ometers iers cators e blocks bars d gauges cs	Charts Films Pamphlets Tool catalogs	F-19 F-8 F-13 F-23 6-1 11-2 14-1 14-2 24-1 24-4	M-171 Micrometer exercise M-182 Brass hammer M-206 Depth gauge	1 - pp. 87-98 2 - Unit 4, pp. 4-26	

UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDE ACTIVI
7. Layout Work and Tools Refer to Non-precision Measuring Instruments, Unit 6, page 2	Scribers Hammers Layout die Rules Dividers Center punch Prick punch Surface gauge and plate	Demonstration Charts Textbooks		M-170 Tool M-177 Para clamp sc M-206 Dept
8. Power Saws Hack Band (Contour) 3 - pp. 72-75 5 - pp. 62-68	Safety rules Blade section Pressure feeds Types of stock Types of saws Saw speeds Stock clamping Coolants	Textbooks Demonstration Film Saw charts	F-29 1-1	M-173 C-c M-175 Par clamp M-177 Par clamp M-206 Dep M-188 Gea M-199 V-b M-207 Too vise
9. Drills, Drilling, and Drilling Machines 3 - pp. 88-125 4 - pp. 197-220 5 - 69-114	Safety rules Types of machines Nomenclature Clamping devices Lubricants Speeds and feeds Materials Drill sharpening Types of drills Coolants	Demonstration Pamphlets Textbook	1-1 8-1 23-1 23-7 26-1 26-2	M-170 Too gauge M-174 Tap M-175 Par clamp M-177 Par clamp
10. Reamers and Reaming 3 - pp. 120-122 4 - pp. 221-224 5 - pp. 104-109 6 - pp. 90-92	Safety rules Types of reamers Speeds and feeds Nomenclature Lubricants Sharpening	Demonstration Films Charts Textbook	F-25 8-1	M-174 Sha M-190 Ben M-181 Ball hammer

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IAL UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
d plate	Demonstration Charts Textbooks		M-170 Tool gauge M-177 Parallel clamp screw M-206 Depth gauge		
	Textbooks Demonstration Film Saw charts	F-29 1-1	M-173 C-clamp M-175 Parallel clamp M-177 Parallel clamp M-206 Depth gauge M-188 Gear puller M-199 V-block M-207 Toolmaker's vise	1 - pp. 101-106 2 - Unit 35 4 - pp. 93-98	
s	Demonstration Pamphlets Textbook	1-1 8-1 23-1 23-7 26-1 26-2	M-170 Tool grinding gauge M-174 Tap exercise M-175 Parallel clamp M-177 Parallel clamp	1 - pp. 187-213 2 - Unit 34	
	Demonstration Films Charts Textbook	F-25 8-1	M-174 Shaper block M-190 Bench vise M-181 Ball peen hammer	1 - pp. 313-315 2 - Unit 34, pp. 18-19	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDEN ACTIVIT
11. Countersink Counterbore Spotfacing	Safety rules Types Speeds and feeds Nomenclature Lubricants Proper use	Demonstration Charts Textbook		M-174 Shape M-187 Cast C-clamp M-190 Bench M-207 Toolm vise
12. Fasteners 6 - pp. 92-98 4 - pp. 269-275	Nomenclature Uses Types Threading methods Glues	Charts Illustration Textbook		Theory and discussio
13. Lathe 13-1. History and Lathe Development 7 - pp. 3-5	History and development	Textbook Encyclopedia		Theory
13-2. Parts and Functions 3 - pp. 125-136 4 - pp. 433-436 5 - pp. 116-132 6 - pp. 149-157 7 - pp. 5-14	Nomenclature Function Proper use Sizes	Textbook Films Charts Pamphlets	F-18 23-2 23-6	Theory Discussion Illustratio
13-3. Safety and Care of Lathe	Safety Proper use Oiling	Textbook Charts Demonstration Duplicating material	23-2	Theory and discussio

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IC MATERIAL ERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
rules and feeds ature nts use	Demonstration Charts Textbook		M-174 Shaper block M-187 Cast C-clamp M-190 Bench vise M-207 Toolmaker's vise	1 - pp. 216-218 2 - Unit 34, pp. 19-20	
ature ng methods	Charts Illustration Textbook		Theory and discussion	1 - pp. 30-33 2 - Unit 18, pp. 1-8	
and development	Textbook Encyclopedia		Theory	1 - pp. 108-109	
ature n use	Textbook Films Charts Pamphlets	F-18 23-2 23-6	Theory Discussion Illustration	1 - pp. 112-118 2 - Unit 36, pp. 1-8	
use	Textbook Charts Demonstration Duplicating material	23-2	Theory and discussion	1 - pp. 119-121 2 - Unit 36, pp. 5-9	

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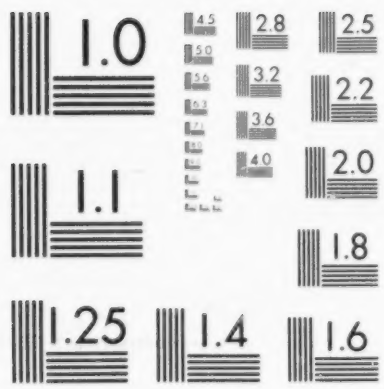

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

SIC MATERIAL VERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
safety ature der tion s	Films Demonstration Charts Textbook	F-11 1-1 3-1 16-1 23-2	M-170 Tool grinding gauge M-183 Threading tool	1 - pp. 121-128 2 - Unit 36, pp. 9-13 2 - Unit 33, pp. 1-4	
ion s tion to machinable s f cutting-tool ials	Textbooks Duplicated materials	1-1 23-2	Discussion and theory	1 - pp. 129-131 2 - Unit 36, pp. 13-15	
rules of locating rs nd sizes of center s of drilling and incorrect r holes	Charts Duplicated materials Textbooks	23-2	M-171 Micrometer exercise M-175 Parallel clamps M-184 V-THRD exercise M-185 Tap wrench	1 - pp. 131-136 2 - Unit 36, p. 16	
tion ent f centers nt of correcting rs	Demonstration Films Textbook and reference books	F-18 1-1 23-2	Theory and discussion	1 - pp. 136-139 2 - Unit 36, p. 17	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMEN AIDS
13-8. Facing 3 - pp. 165-167 4 - p. 441 5 - pp. 173-180 6 - pp. 186-189 7 - p. 49	Safety rules Methods -- Chuck -- Between centers Reasons for facing Speeds and feeds Tool setup	Demonstration Textbooks and reference books	F-18 1-1 23-2
13-9. Rough and Finish Turning on Centers 3 - pp. 167-171 4 - pp. 444-446 5 - pp. 145-148 6 - pp. 188-195 7 - pp. 47-51	Safety rules Dogs Proper setup Kinds of operations -- Facing -- Straight Speeds and feeds Tool setup	Demonstration Film Reference books	F-22 1-1 23-2
13-10. Under-cutting, Recessing, Shoulder Turning 3 - pp. 171-172 5 - pp. 180-187 6 - p. 195 7 - p. 52	Safety rules Types of shoulders -- Square -- Radius -- Angular Proper location Tool setup Cutting tools	Demonstration Charts Pamphlets Reference books Textbook	23-2
13-11. Chucks and Chuck Work 3 - pp. 148-151, 159-163 4 - pp. 437-438 5 - pp. 193-198 6 - pp. 196-203 7 - pp. 53-58	Safety rules Kinds -- Universal -- Independent -- Collet chuck -- Drill chuck -- Combination Operations Setup and uses Proper use Mounting and removal	Textbooks Reference books	23-2

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ASIC MATERIAL OVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
rules s huck etween centers s for facing and feeds etup	Demonstration Textbooks and reference books	F-18 1-1 23-2	M-171 Micrometer exercise M-172 Caliper exercise M-189 Boring exercise	1 - pp. 139, 151-152 2 - Unit 36, pp. 18, 19, 23-24	
rules setup of operations acing traight and feeds etup	Demonstration Film Reference books	F-22 1-1 23-2	M-171 Micrometer exercise M-172 Caliper exercise M-175 Parallel clamp M-184 V-THRD exercise	1 - pp. 136-143 2 - Unit 36, pp. 18, 19, 20	
rules of shoulders quare adius ngular location etup g tools	Demonstration Charts Pamphlets Reference books Textbook	23-2	M-172 Caliper exercise M-175 Parallel clamp M-178 Small jack screw M-184 V-THRD exercise M-185 Tap wrench	1 - pp. 143-146 2 - Unit 36, p. 20	
rules niversal ndependent ollet chuck rill chuck ombination ions and uses use ng and removal	Textbooks Reference books	23-2	M-178 Small jack screw M-185 Tap wrench M-189 Boring	1 - pp. 146-152 2 - Unit 36, pp. 20-24	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDE ACTIVI
13-12. Drilling and Reaming 3 - pp. 213-215 4 - pp. 446-447 5 - pp. 207-213 6 - pp. 204-211 7 - pp. 65-68	Safety rules Refer to Units 9 and 10 Holders Speed and feeds Lubricants Coolants Setups	Demonstration Textbooks Reference books	23-2	M-178 Smal screw M-181 Ball hammer M-182 Bras M-192 Layo M-193 Scre
13-13. Boring 3 - pp. 215-220 4 - p. 447 5 - pp. 214-218 6 - pp. 208-210	Safety rules Tool setups Boring toolholders Speeds and feeds Tool grinding Methods of measurement Reasons for boring	Textbook Reference books Charts	23-2	M-186 Dies M-189 Bori exercise
13-4. Tapering 3 - pp. 201-211 4 - pp. 445-446 5 - pp. 218-247 6 - pp. 218-227 7 - pp. 59-64 8 - pp. 213-225	Safety rules Kinds of tapers Setups Computations Measurement	Films Textbook	F-4 23-2	M-178 Smal screw M-179 Body M-181 Ball hammer M-185 Tap M-186 Dies
13-15. Threading 3 - pp. 180-201, p. 220 5 - pp. 284-286 6 - pp. 229-243 7 - pp. 69-86	Safety rules Terminology Kinds of THRD forms Cutting tools Measurement Setup THRD fits Uses	Charts Pamphlets Textbooks Reference books	23-2	M-204 Squa M-171 Mic M-172 Cali exercise M-178 Smal screw M-184 V TH exercise M-185 Tap M-187 Cast M-188 Gear M-190 Benc

IC MATERIAL ERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
ıles Units 9 and 10 d feeds ts	Demonstration Textbooks Reference books	23-2	M-178 Small jack screw M-181 Ball peen hammer M-182 Brass hammer M-192 Layout punch M-193 Screw jack	1 - pp. 152-154, 157-159 2 - Unit 36, pp. 35-36	
ıles ıps ɔolholders nd feeds nding ɔf measurement for boring	Textbook Reference books Charts	23-2	M-186 Diestock M-189 Boring exercise	1 - pp. 154-157 2 - Unit 36, p. 34	
ıles tapers ions ent	Films Textbook	F-4 23-2	M-178 Small jack screw M-179 Body hammer M-181 Ball peen hammer M-185 Tap wrench M-186 Diestock	1 - pp. 166-174 2 - Unit 36, pp. 25-29 Practical problems	
ıles ɔgy THRD forms tools ent s	Charts Pamphlets Textbooks Reference books	23-2	M-204 Square thread M-171 Mic exercise M-172 Caliper exercise M-178 Small jack screw M-184 V THRD exercise M-185 Tap wrench M-187 Cast C-clamp M-188 Gear puller M-190 Bench vise	1 - pp. 175-184 2 - Unit 36, pp. 29-34	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMEN AIDS
13-16. Knurling 3 - pp. 172-174 5 - pp. 187-190 6 - pp. 215-216 7 - p. 87	Safety rules Types of knurls Holders Speeds and feed Lubricants Uses of knurls	Demonstration Textbooks Reference books	23-2
13-17. Tapping in Lathe 3 - pp. 223-224 7 - p. 68, p. 86	Safety rules Setup Speed and feed Tap selection	Demonstration	23-2
13-18. Filing and Polishing 3 - pp. 175-178 5 - pp. 190-192 6 - pp. 216-218 7 - p. 89	Safety rules File selection Speeds and feeds Lubricants Types of emery cloth Selection Types of surfaces Finish Correct setup	Demonstration Textbook Reference book	23-2
13-19. Additional Accessories A. Steady Rest and Follower Rest	Safety rules Setup Use and purpose	Demonstration	23-2
B. Grinders 3 - p. 178 7 - pp. 100-101 1 - pp. 310-311	Safety rules Setup Machine protection Wheel selection Internal and external	Demonstration	23-2

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BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
fety rules pes of knurls lders eeds and feed bricants es of knurls	Demonstration Textbooks Reference books	23-2	M-175 Parallel clamp M-177 4" parallel clamp M-181 Ball peen hammer M-185 Tap wrench M-186 Diestock M-192 Cast C-clamp	1 - pp. 161-162 2 - Unit 36, pp. 36-37	
fety rules tup eed and feed p selection	Demonstration	23-2	M-178 Small jack screw M-192 Layout punch M-193 Screw jack		
fety rules le selection eeds and feeds bricants pes of emery cloth lection pes of surfaces nish rrect setup	Demonstration Textbook Reference book	23-2	M-178 Small jack screw M-179 Body hammer M-180 Ball peen hammer M-181 Ball peen hammer M-182 Brass hammer M-186 Diestock	1 - pp. 162-163 2 - Unit 36, pp. 37-38	
fety rules tup e and purpose	Demonstration	23-2		1 - pp. 164-165	
fety rules tup chine protection eel selection ternal and external	Demonstration	23-2		2 - Unit 36, p. 39	

UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	
C. Mandrels 5 - pp. 200-202 6 - pp. 213-214 7 - pp. 90, 102	Materials Kinds Safety rules Arbor press Purpose	Demonstration	23-2	M-1 s M-2
D. Faceplate 3 - p. 151 5 - pp. 198-200 7 - p. 88	Safety rules Setup Purpose Speeds and feeds	Demonstration	23-2	
E. Parting and Cutoff Tools 3 - pp. 174-175 5 - pp. 205-206 7 - p. 33	Safety rules Setup Speed and feed Lubricant Types of tools	Demonstration	23-2	M-1 h
14. Shaper 3 - pp. 226-268 5 - pp. 287-330 6 - pp. 244-273 9 - Delmar Shaper Book Note: The value of the shaper has been deemphasized. Time should be held to a minimum in teaching this unit.	Safety rules Nomenclature Types Tools Mounting Speeds and feeds Adjustments Shaper setups Vises Special setups	Textbooks Reference book Demonstration	1-1 23-3	M-1 c M-1 c M-1 M-2 M-2

IC MATERIAL ERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
s ules ess	Demonstration	23-2	M-178 Small jack screw M-205 Mandrels	1 - pp. 159-160 2 - Unit 36, p. 38	
ules nd feeds	Demonstration	23-2			
ules l feed tools	Demonstration	23-2	M-181 Ball peen hammer	1 - pp. 124-125 2 - Unit 36, pp. 24-25	
ules ture nd feeds nts etups setups	Textbooks Reference book Demonstration	1-1 23-3	M-175 Parallel clamp M-177 4" parallel clamp M-199 V-block #1 M-200 V-block #2 M-201 V-block #3	1 - pp. 220-251 2 - Unit 3, pp. 1-16	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	
15. Milling Machine Types 5 - pp. 331-336 6 - p. 276 10 - Delmar Mill Book	General safety rules Column and knee -- Plain horizontal -- Universal horizontal -- Vertical Bed type -- Manufacture mill -- Planer mill Nomenclature	Film Charts Textbook Reference books Pamphlets	F-20 9-2	T
15-1. Milling Machine Work-holding Devices	Safety rules Setups and use Vise -- Plain -- Universal -- Squaring Use of dividing head and footstock Bolts and clamps Jacks Angle plates Step blocks, riser blocks, V-blocks, rotary table	Textbooks Reference books Demonstration	9-2 13-1 13-2	T
15-2. Milling Machine Cutters 3 - pp. 277-284 5 - pp. 343-351 6 - pp. 285-290 10 - pp. 102-120	Handling safety Shapes and sizes Kinds and types Uses	Film Charts Textbook Catalogs Reference books Demonstration	F-21 1-1 9-2 13-1 13-2	I

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BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
ral safety rules mn and knee Plain horizontal Universal horizontal Vertical type Manufacture mill Planer mill nclature	Film Charts Textbook Reference books Pamphlets	F-20 9-2	Theory and discussion	1 - pp. 254-258 2 - Unit 38, pp. 1-4	
ty rules ps and use Plain Universal Squaring of dividing head d footstock s and clamps s e plates blocks, riser blocks, blocks, rotary table	Textbooks Reference books Demonstration	9-2 13-1 13-2	Theory and discussion	1 - pp. 258-260 2 - Unit 38, pp. 19-21	
ling safety es and sizes s and types	Film Charts Textbook Catalogs Reference books Demonstration	F-21 1-1 9-2 13-1 13-2	Examples, theory, and discussion	1 - pp. 263-268 2 - Unit 38, pp. 5-12	

UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES
15-3. Milling Machine Cutter-holding Devices 3 - pp. 284-288 5 - pp. 343-352 6 - pp. 190-192 10 - pp. 68-84	Safety rules Arbors Sleeves Collets Adapters	Textbook Reference books Catalogs Charts Pamphlets	13-1 13-2	Theory and discussion
15-4. Milling Machine Speeds and Feeds 3 - pp. 341-348 5 - pp. 337-342 6 - pp. 293-296 8 - pp. 197-198 10 - pp. 141-153	Safety rules Formulas Application to machinable metals Lubricants Conventional and climb milling	Textbook Reference books Charts Demonstration	1-1 13-1 13-2	Theory and discussion
15-5. Milling Machine Plain Milling 3 - pp. 304-306 5 - pp. 343-348 6 - pp. 299-303 10 - pp. 180-183	Safety rules Setup and operation Mounting Selection of cutter Speeds and feeds Lubricants	Demonstration Textbook Reference books	13-1 13-2	M-175 5" paral clamp M-177 4" paral clamp M-185 Tap wren M-200 V-block M-201 V-block M-206 Depth ga
15-6. Milling Machine Face Milling 3 - pp. 307-308 5 - pp. 349-351 6 - pp. 303-305	Safety rules Setup and operation Cutter selection Speeds and feeds Lubricants Procedures	Textbook Reference books Demonstration	13-1 13-2	

TERIAL IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
	Textbook Reference books Catalogs Charts Pamphlets	13-1 13-2	Theory and discussion	1 - pp. 261-263 2 - Unit 38, pp. 14-15	
metals and climb	Textbook Reference books Charts Demonstration	1-1 13-1 13-2	Theory and discussion	1 - pp. 272-274 2 - Unit 38, pp. 16-18	
ration cutter eds	Demonstration Textbook Reference books	13-1 13-2	M-175 5" parallel clamp M-177 4" parallel clamp M-185 Tap wrench M-200 V-block #2 M-201 V-block #3 M-206 Depth gauge	1 - pp. 274-277 2 - Unit 38, pp. 22-24	
ration ion eds	Textbook Reference books Demonstration	13-1 13-2		1 - pp. 277-278 2 - Unit 38, p. 35	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS
15-7. Milling Machine Side Milling 3 - pp. 310-312 5 - pp. 351-354 6 - pp. 305-309	Safety rules Setup and operation Cutter selection Speeds and feeds Lubricants	Textbook Reference books Demonstration	13-1 13-2
15-8. Milling Machine Slitting, Slotting, Sawing 3 - pp. 315-317 5 - pp. 360-363, pp. 377-378 6 - pp. 309-312	Safety rules Cutter selection Speeds and feeds Lubricants	Textbook Reference books Demonstration	13-1 13-2
15-9. Milling Machine Straddle Milling Gang Milling 3 - pp. 311-318 5 - pp. 357-359, pp. 369-370 6 - pp. 311-312 10 - Gen. ref.	Safety rules Setup and operation Cutter selection Speeds and feeds Lubricants	Textbook Reference books Demonstration	13-1 13-2

SIC MATERIAL VERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
rules nd operation selection and feeds nts	Textbook Reference books Demonstration	13-1 13-2	M-187 Cast C-clamp M-191 Machinist swivel vise M-194 Pipe vise M-199 V-block #1 M-200 V-block #2 M-201 V-block #3 M-207 Toolmaker's vise	1 - pp. 278-279 2 - Unit 38, pp. 25-27	
rules selection and feeds nts	Textbook Reference books Demonstration	13-1 13-2	M-199 V-block #1 M-200 V-block #2 M-201 V-block #3 M-207 Toolmaker's vise M-188 Gear puller	1 - pp. 278-282 2 - Unit 38, pp. 27-29	
rules nd operation selection and feeds nts	Textbook Reference books Demonstration	13-1 13-2	M-196 Pen holder M-191 Machinist swivel vise	1 - pp. 278-282 2 - Unit 38, p. 25	

UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	S AC
15-10. Milling Machine Drilling and Boring 6 - p. 312 10 - Gen. ref.	Safety rules Setup and operation Cutter selection Speeds and feeds Lubricants	Textbook Reference books Demonstration	13-1 13-2	
15-11. Milling Machine T-slot and Key-seat Milling 5 - pp. 367-369 6 - pp. 310-311 10 - Gen. ref.	Safety rules Setup and operation Cutter selection Speeds and feeds Lubricants	Textbook Reference books Demonstration		
15-12. Milling Machine Angular and Form Milling 5 - pp. 370-371 6 - pp. 314-317 10 - Ref. Book	Safety rules Setup and operation Cutter selection Speeds and feeds Lubricants	Textbook Reference books Demonstration	13-2	M-175 cla M-200 M-201
15-13. Milling Machine End Milling 3 - pp. 308-310 5 - pp. 363-366 6 - pp. 312-317 10 - Ref. Book	Safety rules Setup and operation Cutter selection Speeds and feeds Lubricants	Reference books Textbook Demonstration	13-1 13-2	M-175 cla M-200 M-208 vis M-177 cla

MATERIAL D IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
s peration ction feeds	Textbook Reference books Demonstration	13-1 13-2		1 - pp. 290-291 2 - Unit 38, p. 29	
s peration ction feeds	Textbook Reference books Demonstration			1 - p. 293 2 - Unit 38, pp. 32-33	
s peration ction feeds	Textbook Reference books Demonstration	13-2	M-175 5" parallel clamp M-200 V-block #2 M-201 V-block #3	1 - p. 292 2 - Unit 38, p. 32	
s peration ction feeds	Reference books Textbook Demonstration	13-1 13-2	M-175 5" parallel clamp M-200 V-block #2 M-208 Machinist vise M-177 4" parallel clamp	1 - pp. 281-282 2 - Unit 38, pp. 31-34	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS
15-14. Milling Machine A. Direct B. Simple C. Compound D. Helical E. Differential 3 - pp. 291-298 5 - pp. 379-406 6 - pp. 297-298 8 - pp. 284-290	Safety rules Formulas Cutter selection Setup Checking setup Operation Speeds and feeds Lubricants	Reference books Textbooks Demonstration	13-2
15-15. Milling Machine Gear and Gear Cutting 3 - pp. 318-341 5 - pp. 407-424	Safety rules Formulas Setup Checking setups Involute cutters Speeds and feeds Lubricants	Reference books Textbook Demonstration	13-3
16. Abrasives A. Wheels B. Cloth C. Stones D. Buffing Compound E. Lapping Compound 4 - pp. 397-399 5 - pp. 442-455 6 - pp. 76-78, pp. 329-332	Types of abrasives -- Natural -- Commercial Wheel markings Cloth use and selection Standard abrasive stones and sizes Correct selection of lapping and buffing compounds Surface finishing	Lecture Pamphlets Illustrations Charts	4-1 5-1, 5-2 5-3 10-1 12-1, 12-2 12-3, 12-4 12-9, 12-10 15-1 20-1 20-3, 20-4 20-5

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IC MATERIAL VERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
rules s selection g setup on and feeds nts	Reference books Textbooks Demonstration	13-2	M-196 Pen holder M-197 Tap wrench M-198 Photo tripod M-209 Tap wrench	1 - pp. 283-286 2 - Unit 38, pp. 19-21	
rules s g setups e cutters and feeds nts	Reference books Textbook Demonstration	13-3	M-214 Spur gear M-226 Bevel gear		
f abrasives tural mmercial arkings se and selection d abrasive stones izes selection of ng and buffing unds finishing	Lecture Pamphlets Illustrations Charts	4-1 5-1, 5-2 5-3 10-1 12-1, 12-2 12-3, 12-4 12-9, 12-10 15-1 20-1 20-3, 20-4 20-5	Theory and discussion Display	1 - pp. 33-34, pp. 311-313 2 - Unit 32, pp. 1-6 2 - Unit 33, pp. 10-14	

UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	ST ACT
17. Grinding Machine 17-1. Bench and Floor Grinders 4 - pp. 385-399 6 - pp. 178-180	Safety rules Wheel care and selection Wheel dressing	Demonstration Illustration Charts Textbook Reference books	9-1 12-1 12-5 12-6 12-8 12-10 15-1 20-1 20-2	M-170A grind #2 M-183 V M-204 S
17-2. Grinding Machine Surface Grinder 3 - pp. 349-356 5 - pp. 432-435 6 - pp. 333-334	Safety rules Wheel selection Types of surface grinders Setup and operation Speeds and feeds Types, use, and setup of wheel dressers Coolants Lubricants	Demonstration Illustration Charts Textbook Reference books Pamphlets	1-1	M-174 S M-199 V M-200 V M-206 D M-207 T vise M-201 V
17-3. Grinding Machine Cylindrical Grinder 3 - pp. 356-374 5 - pp. 435-440	Safety rules Grinding wheel selection Speeds and feeds Type, use, and setup of wheel dressers Coolant Lubrication	Demonstration Charts Textbook Reference books Pamphlets	12-7	M-205 M
17-4. Grinding Machine Tool and Cutter Grinder 3 - pp. 374-382 5 - pp. 440-442	Safety rules Wheel selection Work setup Types, use, and setup of wheel dressers Cutter clearance angles	Charts Pamphlets Operator's instruction books Textbook Reference books		M-228 W cutte

T	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
ction	Demonstration Illustration Charts Textbook Reference books	9-1 12-1 12-5 12-6 12-8 12-10 15-1 20-1 20-2	M-170A Tool grinding gauge #2 M-183 V-thread tool M-204 Square thread	2 - Unit 33, pp. 1-4	
up	Demonstration Illustration Charts Textbook Reference books Pamphlets	1-1	M-174 Shaper block M-199 V-block #1 M-200 V-block #2 M-206 Depth gauge M-207 Toolmaker's vise M-201 V-block #3	1 - pp. 298-299 2 - Unit 33, pp. 7-10	
ction p of	Demonstration Charts Textbook Reference books Pamphlets	12-7	M-205 Mandrels	1 - pp. 300-306 2 - Unit 33, pp. 4-6	
up of gles	Charts Pamphlets Operator's instruction books Textbook Reference books		M-228 Woodwork cutter	1 - pp. 306-310 2 - Unit 33, p. 7	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS
18. Metallurgy 18-1. Ferrous Metals 4 - pp. 145-152 5 - pp. 460-469 6 - pp. 344-348	Historical scope Physical properties Applications of ferrous metals Shapes Alloys Identification Testing methods Manufacturing methods	Pamphlets Demonstration Textbook Reference books Charts Models	F-16 F-28 F-7 F-26 2-1, 2-2 2-3, 2-4 22-1 25-1, 25-2 25-3 25-8 25-10
18-2. Metallurgy Non-ferrous Metals 4 - pp. 153-161 5 - pp. 469-470 6 - pp. 348-350	Historical scope Physical properties Application of non-ferrous materials Shapes Alloys Identification Testing methods Manufacturing methods	Pamphlets Charts Textbook Reference books Illustrations Models	1-1 21-1 22-1
18-3. Metallurgy Heat Treatment 3 - pp. 407-423 4 - pp. 349-352 5 - pp. 470-480 6 - pp. 338-343	Historical scope Heat treating process Safety precautions Quenching mediums Heat treatment terminology Chemistry of metals	Pamphlets Charts Films Textbook Reference books Illustrations Models	F-17 F-12 F-6
18-4. Metallurgy Hardness Testing 3 - pp. 424-427 5 - pp. 473-474 6 - pp. 343-344	Testing data Types of testers Methods of testing	Charts Pamphlets Textbook Demonstration Reference books	

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BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
Historical scope Physical properties Applications of ferrous metals Shapes Alloys Identification Testing methods Manufacturing methods	Pamphlets Demonstration Textbook Reference books Charts Models	F-16 F-28 F-7 F-26 2-1, 2-2 2-3, 2-4 22-1 25-1, 25-2 25-3 25-8 25-10	Theory and discussion Display Examples	1 - pp. 57-68 2 - Unit 1, pp. 7-18	
Historical scope Physical properties Application of non-ferrous materials Shapes Alloys Identification Testing methods Manufacturing methods	Pamphlets Charts Textbook Reference books Illustrations Models	1-1 21-1 22-1	Theory and discussion Display Examples	2 - Unit 1, pp. 7-18	
Historical scope Heat treating process Safety precautions Quenching mediums Heat treatment terminology Chemistry of metals	Pamphlets Charts Films Textbook Reference books Illustrations Models	F-17 F-12 F-6	M-175 5" parallel clamp M-176 Cold chisel M-192 Layout punch M-200 V-block #2 M-209 Tap wrench M-180 Ball peen hammer M-181 Ball peen hammer	1 - pp. 331-335 2 - Unit 31, pp. 1-7	
Testing data Types of testers Methods of testing	Charts Pamphlets Textbook Demonstration Reference books		M-205 Mandrels	1 - pp. 335-336 2 - Unit 31, pp. 7-9	

UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDE ACTIVI
18-5. Metallurgy Casting and Moulding 4 - pp. 355-376	Processes Materials Applications of castings Historical scope	Demonstration Textbook Reference books Models Illustrations	F-9 F-6	Discussio theory
19. Related Information 19-1. Limits, Tolerances, and Fits 4 - pp. 249-251 5 - pp. 156-157 6 - pp. 26-27	Terminology Classes of fits Uses Testing	Charts Reference books Textbook Models Illustrations		Discussio theory
19-2. Related Information Inspection and Assembly 4 - pp. 421-430 6 - pp. 113-115 2 - Unit 49	Gauges Fasteners Tolerances Fits Quality control	Textbook Reference books Charts Models	F-8 F-13 F-23	Discussio theory

AL NIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
astings	Demonstration Textbook Reference books Models Illustrations	F-9 F-6	Discussion and theory	2 - Unit 21, Sand Casting 2 - Unit 22, Plaster Mould 2 - Unit 23, Die Casting 2 - Unit 24, Permanent Mold Casting 2 - Unit 25, Investment Casting 2 - Unit 26, Shell Molding 2 - Unit 28, Forging	
	Charts Reference books Textbook Models Illustrations		Discussion and theory	2 - Unit 18, pp. 6-7 2 - Unit 2, pp. 2-3	
	Textbook Reference books Charts Models	F-8 F-13 F-23	Discussion and theory	1 - pp. 325-331	

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UNIT TITLE AND REFERENCES	BASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	S Ac
20. Related Industrial Processes 20-1. Automation 6 - pp. 354-356	Numerical Controlled machines Mass production	Pamphlets Reference books Catalogs Films	F-3 F-24	Discus the
20-2. Electrical Discharge Machining	Process Purposes	Reference books Catalogs Textbook		Discu the
20-3. Chemical Milling	Process Purpose	Reference books Catalogs Textbook		Discu the
20-4. Explosive Forming	Process Purpose	Reference books Catalogs		Discu the
20-5. Flame Spraying	Process Metals	Pamphlets Catalogs Textbook Magazines		Discu the
20-6. Powder Metallurgy	Process Purpose	Pamphlets Magazines Catalogs Textbook		Discu the
20-7. Cold Forming	Process Materials Purpose	Catalogs Pamphlets Textbook Magazines		Discu the
20-8. Extrusion	Process Materials Purpose Methods	Catalogs Pamphlet Textbook Magazines		Discu the

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ASIC MATERIAL COVERED IN UNIT	METHODS OF PRESENTING MATERIAL	SUPPLEMENTARY AIDS	STUDENT ACTIVITIES	STUDENT ASSIGNMENTS	INSTRUCTOR NOTES
ical olled machines production	Pamphlets Reference books Catalogs Films	F-3 F-24	Discussion and theory	1 - pp. 339-343 2 - Unit 48	
ss ses	Reference books Catalogs Textbook		Discussion and theory	2 - Unit 43	
ss se	Reference books Catalogs Textbook		Discussion and theory	2 - Unit 45	
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2 Walker, John R. MODERN METALWORKING. Goodheart-Wilcox,

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UNITED STATES STEEL CORPORATION
Chicago Film Distribution Center
208 S. LaSalle Street
Chicago, Illinois 60690

UNIVERSITY OF WISCONSIN EXTENSION DIVISION
Bureau of Audio-visual Instruction
1312 W. Johnson Street
Madison, Wisconsin 53706

FILMS

Film No.		
1	77531	ACCIDENTS DON'T HAPPEN: MACHINES. 8 minutes
2	1713	THE APPRENTICE. 11 minutes Milwaukee Public S
3	3473	AUTOMATION AND ROBOT MACHINES (THE SEARCH). 27 Wisconsin Extension Division
4	1876	CUTTING A TAPER. 11 minutes Milwaukee Public
5	8542	CUTTING THREAD WITH TAPS AND DIES. 20 minutes
6	Series	Doing It with Plastics. Association Films, Inc.
	S941	COMPRESSION MOLDING, Part 1. 10 minutes
	S942	COMPRESSION MOLDING, Part 2. 10 minutes
	S946	FINISHED MOLDED PARTS. 20 minutes
	S944	INJECTION MOLDING, Part 1. 20 minutes
	S945	INJECTION MOLDING, Part 2. 10 minutes
	S940	ORIGIN AND SYNTHESIS OF PLASTIC MATERIALS.
	S943	SEMIAUTOMATIC AND HAND MOLDING OF INTRICATE PA
	S947	TRANSFER MOLDING AND MOLDING A PART WITH INSE
7	8551	DRAMA OF STEEL. 34 minutes Milwaukee Public
8	7007	FIXED GAUGES. 18 minutes Milwaukee Public Sc
9	1150	FORGING IN CLOSED DIES. 22 minutes Roa's Fil
10	8537	FUNDAMENTALS OF FILING. 11 minutes Milwaukee
11	1889	GRINDING AND THE USE OF BASIC LATHE TOOL CUTTER Milwaukee Public Museum

8744

FILMS

CCIDENTS DON'T HAPPEN: MACHINES. 8 minutes Milwaukee Public Museum

HE APPRENTICE. 11 minutes Milwaukee Public Schools

UTOMATION AND ROBOT MACHINES (THE SEARCH). 27 minutes University of
isconsin Extension Division

CUTTING A TAPER. 11 minutes Milwaukee Public Schools

CUTTING THREAD WITH TAPS AND DIES. 20 minutes Milwaukee Public Museum

Doing It with Plastics. Association Films, Inc.

COMPRESSION MOLDING, Part 1. 10 minutes

COMPRESSION MOLDING, Part 2. 10 minutes

FINISHED MOLDED PARTS. 20 minutes

INJECTION MOLDING, Part 1. 20 minutes

INJECTION MOLDING, Part 2. 10 minutes

ORIGIN AND SYNTHESIS OF PLASTIC MATERIALS. 20 minutes

SEMIAUTOMATIC AND HAND MOLDING OF INTRICATE PARTS. 20 minutes

TRANSFER MOLDING AND MOLDING A PART WITH INSERTS. 10 minutes

DRAMA OF STEEL. 34 minutes Milwaukee Public Museum

FIXED GAUGES. 18 minutes Milwaukee Public Schools

FORGING IN CLOSED DIES. 22 minutes Roa's Films

FUNDAMENTALS OF FILING. 11 minutes Milwaukee Public Schools

GRINDING AND THE USE OF BASIC LATHE TOOL CUTTER BITS. 20 minutes
Milwaukee Public Museum

8745 8478

Film No.		
12	7010	HEAT TREATMENT OF STEEL: ELEMENTS OF HARI Public Schools
13	7009	HEIGHT GAUGES AND TEST INDICATORS. 13 m
14	7019	MACHINE MAKER. 11 minutes Milwaukee Pu
15	SU975	THE MAKING, SHAPING, AND TREATING OF STEE 50 minutes United States Steel Corporat
16	515	METALLURGY PLUS. 14 minutes Roa's Fil
17	8603	METAL MAGIC. 12 minutes Milwaukee Pub
18	1887	METALWORKING LATHE (How to Run a Lathe). Museum
19	1836	MICROMETER. 16 minutes Milwaukee Publ
20	7015	MILLING MACHINE. 8 minutes Milwaukee
21	8200	MILLING PRACTICE. 20 minutes Roa's Fi
22	1888	PLAIN TURNING (How to Run a Lathe). 20 m Schools
23	7014	PRECISION GAUGE BLOCKS. 18 minutes Mi
24	1794	QUALITY CONTROL. 10 minutes Universit
25	7008	REAMING WITH STRAIGHT HAND REAMERS. 20
26	SU635	RESEARCH IN STEEL. 26 minutes United
27	1835	STEEL RULE. 14 minutes Milwaukee Publ
28	516	STORY OF STAINLESS STEEL. 27 minutes
29	1906	USE OF SERVICE HAND TOOLS: HACK SAWS.
30	1908	USE OF SERVICE HAND TOOLS: HAMMERS. 1
31	1905	USE OF SERVICE HAND TOOLS: PLIERS AND S Milwaukee Public Schools
32	1904	USE OF SERVICE HAND TOOLS: PUNCHES, DRI Milwaukee Public Schools

8746

No.		
2	7010	HEAT TREATMENT OF STEEL: ELEMENTS OF HARDENING. 20 minutes Milwaukee Public Schools
3	7009	HEIGHT GAUGES AND TEST INDICATORS. 13 minutes Milwaukee Public Schools
4	7019	MACHINE MAKER. 11 minutes Milwaukee Public Museum
5	SU975	THE MAKING, SHAPING, AND TREATING OF STEEL (A Series of 6 Films). 50 minutes United States Steel Corporation
6	515	METALLURGY PLUS. 14 minutes Roa's Films
7	8603	METAL MAGIC. 12 minutes Milwaukee Public Museum
8	1887	METALWORKING LATHE (How to Run a Lathe). 20 minutes Milwaukee Public Museum
9	1836	MICROMETER. 16 minutes Milwaukee Public Museum
0	7015	MILLING MACHINE. 8 minutes Milwaukee Public Schools
1	8200	MILLING PRACTICE. 20 minutes Roa's Films
2	1888	PLAIN TURNING (How to Run a Lathe). 20 minutes Milwaukee Public Schools
3	7014	PRECISION GAUGE BLOCKS. 18 minutes Milwaukee Public Schools
4	1794	QUALITY CONTROL. 10 minutes University of Wisconsin Extension Division
5	7008	REAMING WITH STRAIGHT HAND REAMERS. 20 minutes Milwaukee Public Schools
6	SU635	RESEARCH IN STEEL. 26 minutes United States Steel Corporation
7	1835	STEEL RULE. 14 minutes Milwaukee Public Museum
8	516	STORY OF STAINLESS STEEL. 27 minutes Roa's Films
9	1906	USE OF SERVICE HAND TOOLS: HACK SAWS. 20 minutes Milwaukee Public Schools
0	1908	USE OF SERVICE HAND TOOLS: HAMMERS. 11 minutes Milwaukee Public Schools
1	1905	USE OF SERVICE HAND TOOLS: PLIERS AND SCREWDRIVERS. 14 minutes Milwaukee Public Schools
2	1904	USE OF SERVICE HAND TOOLS: PUNCHES, DRIFTS, AND BARS. 14 minutes Milwaukee Public Schools

8746

8747

A LIST OF PRINTS FOR PROJECTS

WHICH MAY BE USED IN THE INSTRUCTIONAL PROGRAM

M-122 Wood Vise
M-170 Tool Grinding Gauge
M-171 Micrometer Exercise
M-172 Caliper Exercise
M-173 C-clamp
M-174 Shaper Block
M-175 Parallel Clamp
M-176 Cold Chisel
M-177 4" Parallel Clamp
M-178 Small Jack Screw
M-179 Auto Body Hammers
M-180 Ball Peen Hammer
M-181 Ball Peen Hammer
M-182 Brass Hammer
M-183 V-thread Cutting Tool
M-184 V-thread Exercise
M-185 Tap Wrench
M-186 Diestock
M-187 Cast C-clamp
M-188 Gear Puller
M-189 Boring Exercise
M-190 Bench Vise - Metal
M-191 Machinist Swivel Vise
M-192 Layout Punch
M-193 Screw Jack
M-194 Pipe Vise
M-195 Wheel Puller
M-196 Pen Holder
M-197 Tap Wrench
M-198 Photo Tripod

M-199 V-bl
M-200 V-bl
M-201 V-bl
M-202 Port
M-203 Wood
M-204 Squa
M-205 Mand
M-206 Dep
M-207 Too
M-208 Mac
M-209 Tap
M-210 Dri
M-211 Dri
M-212 Sur
M-213 Mor
M-214 Bla
M-215 Han
M-216 Jig
M-217 Cap
M-218 Ben
M-219 Sta
M-220 Thr
M-221 Bor
M-222 Acm
M-223 Mor
M-224 Chu
M-225 Wor
M-226 Bev
M-227 Sta
M-228 Woo

A LIST OF PRINTS FOR PROJECTS

WHICH MAY BE USED IN THE INSTRUCTIONAL PROGRAM

ing Gauge
Exercise
ercise

ck
lamp
l
l Clamp
Screw
Hammers
Hammer
Hammer
er
utting Tool
xercise

mp
r
rcise
- Metal
Swivel Vise
ch

er

od

M-199 V-block I
M-200 V-block II
M-201 V-block III
M-202 Portable Drill Press
M-203 Wood Lathes
M-204 Square Thread
M-205 Mandrels
M-206 Depth Gauge
M-207 Toolmaker's Vise
M-208 Machinist Vise
M-209 Tap Wrench
M-210 Drill Gauge
M-211 Drill Press
M-212 Surface Gauge
M-213 Morse Tapers
M-214 Blank Spur Gear
M-215 Hand Vise
M-216 Jig Borer Exercise
M-217 Cap Screw
M-218 Bench Vise
M-219 Standard Parallels
M-220 Thread Dog
M-221 Boring Bar
M-222 Acme Thread
M-223 Morse Taper Exercise
M-224 Chuck Key
M-225 Worm and Worm Wheel
M-226 Bevel Gear
M-227 Standard Reference Disks
M-228 Woodwork Cutter

8749

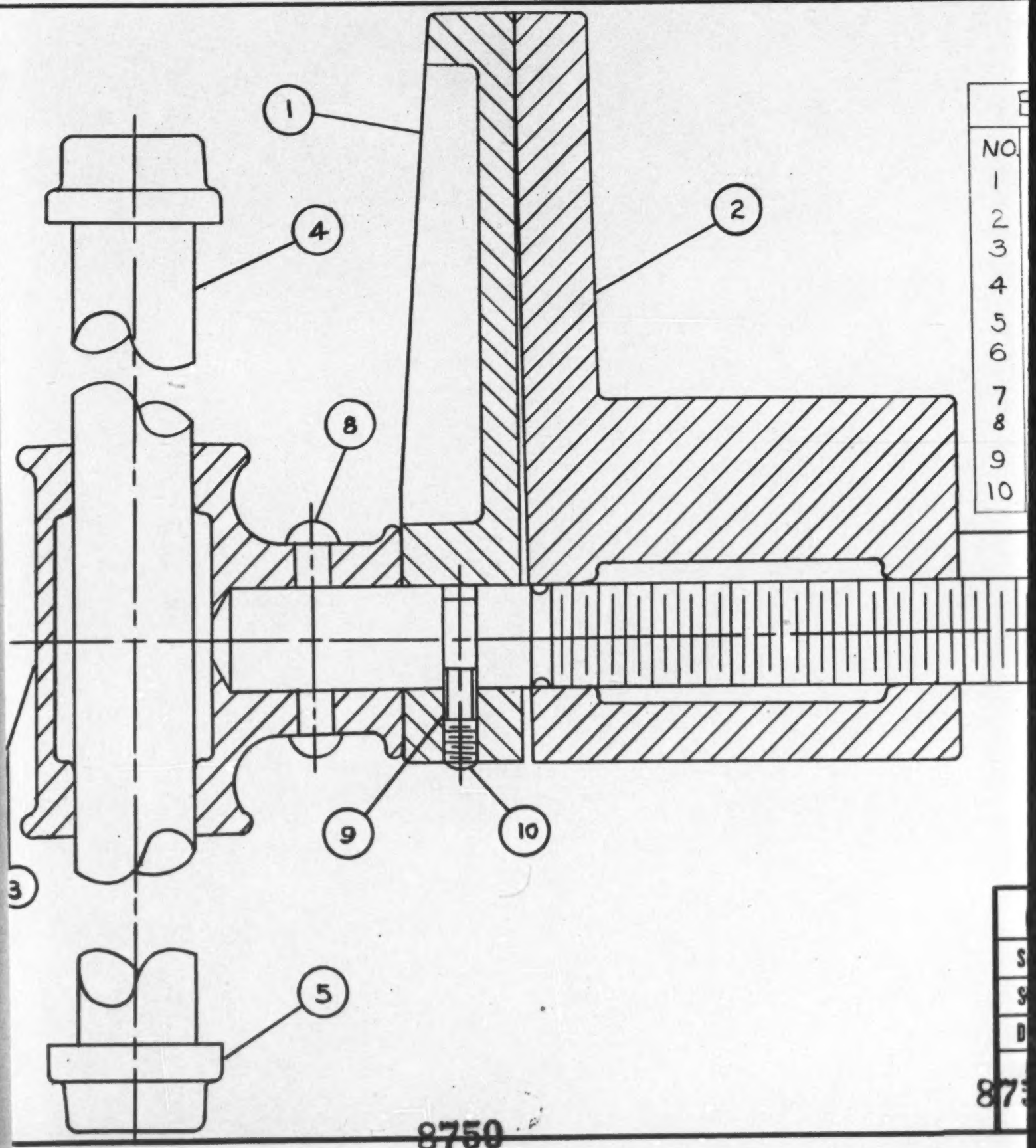
1
2
3
4
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9
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NO.
1
2
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8750

M-122

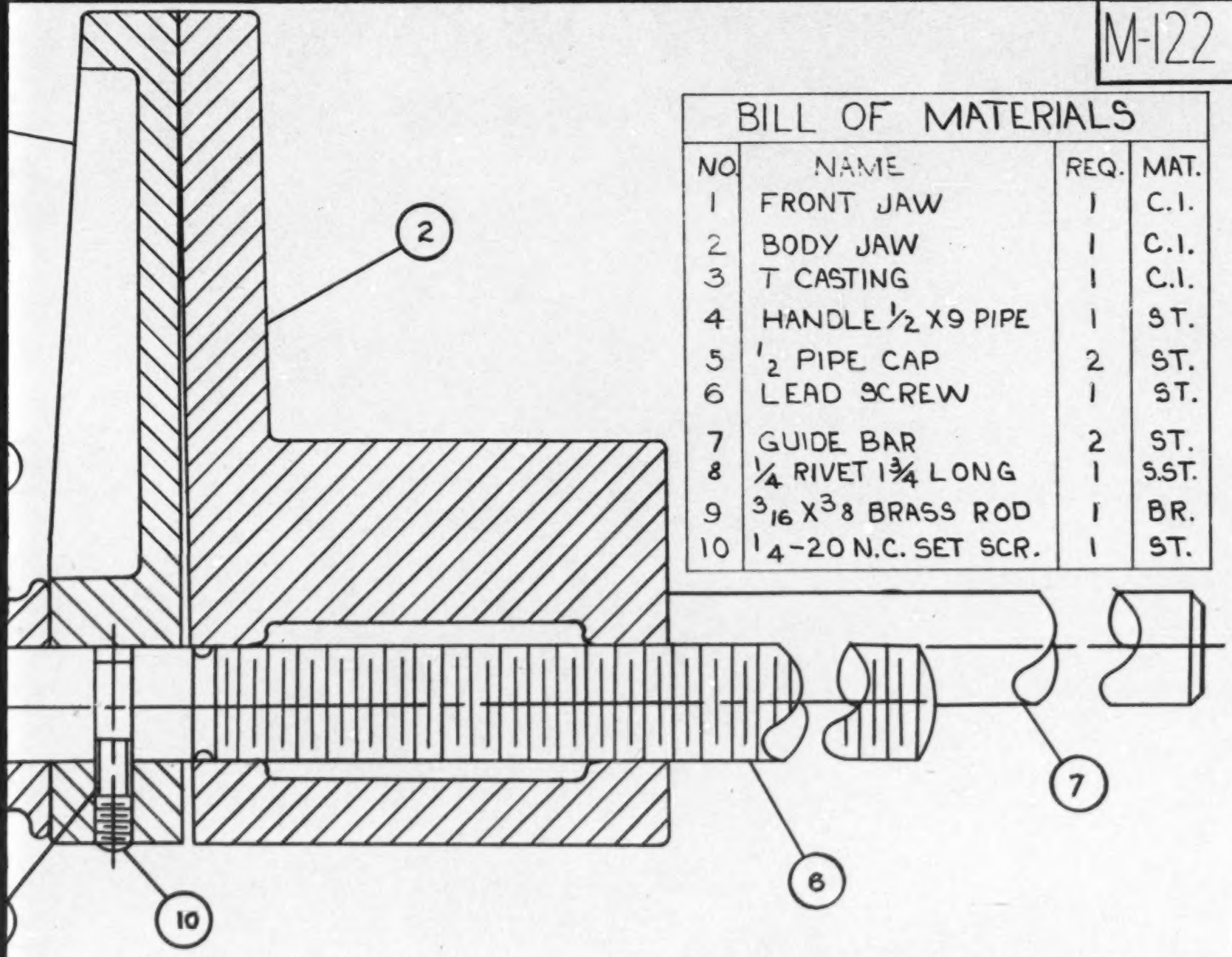

BILL OF MATERIALS

NO.	NAME	REQ.	MAT.
1	FRONT JAW	1	C.I.
2	BODY JAW	1	C.I.
3	T CASTING	1	C.I.
4	HANDLE 1/2 X 9 PIPE	1	ST.
5	1/2 PIPE CAP	2	ST.
6	LEAD SCREW	1	ST.
7	GUIDE BAR	2	ST.
8	1/4 RIVET 1 3/4 LONG	1	S.ST.
9	3/16 X 3/8 BRASS ROD	1	BR.
10	1/4-20 N.C. SET SCR.	1	ST.

WOOD VISE

SUGGESTED BY:

SCALE: 12"=1'0" | DATE: 6-29-66

DRAWN BY [illegible] | CHECKED BY [illegible]

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

8751

8750

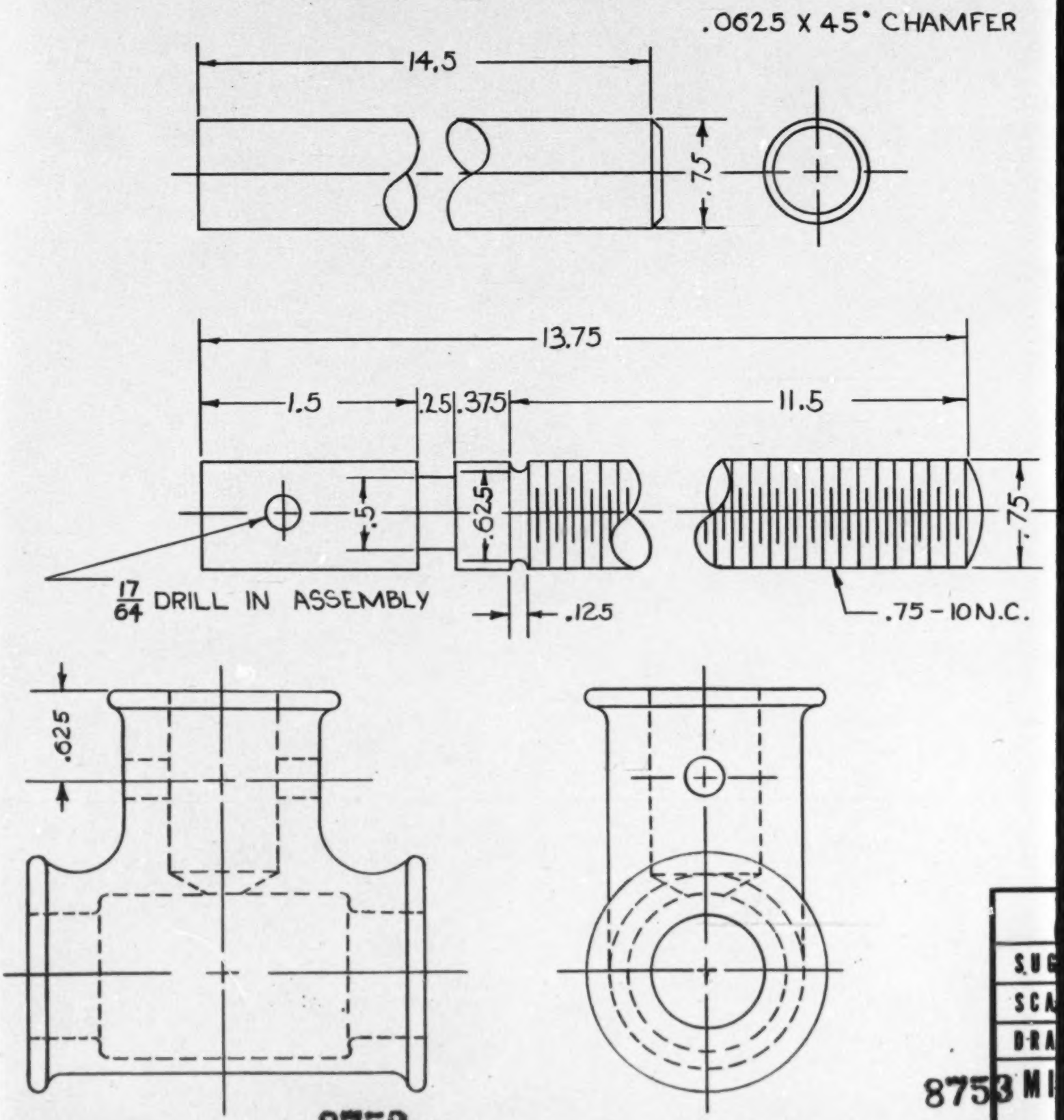
.0625 X 45° CHAMFER
14.5
.75
13.75
1.5
.25
.375
11.5
.5
.625
.75
17/64 DRILL IN ASSEMBLY
.125
.75-10N.C.
.625

8752

8753

M-122A

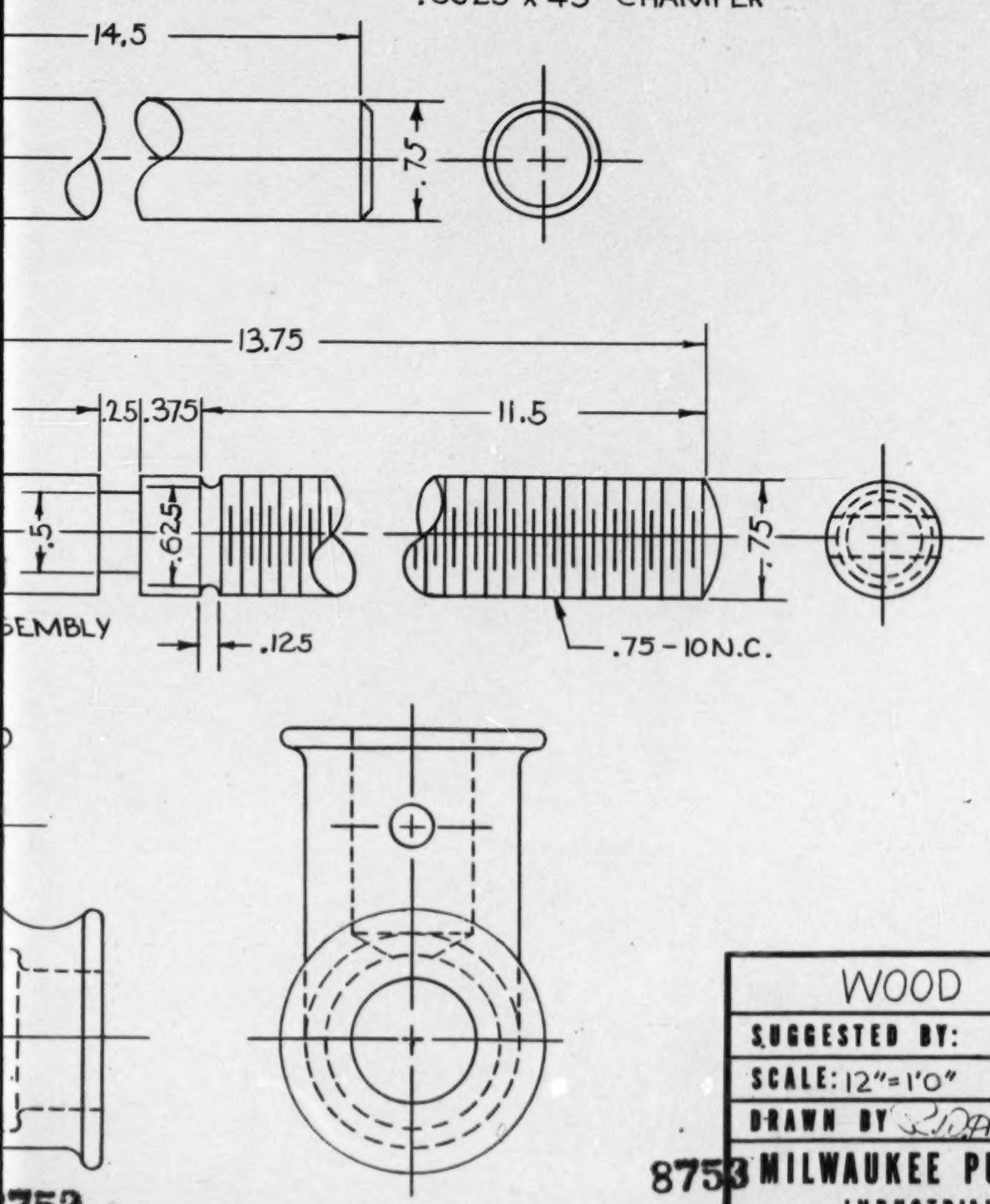

WOOD VISE DETAILS	
SUGGESTED BY:	
SCALE: 12"=1'0"	DATE: 6-29-66
DRAWN BY	CHECKED BY

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

8752

8753

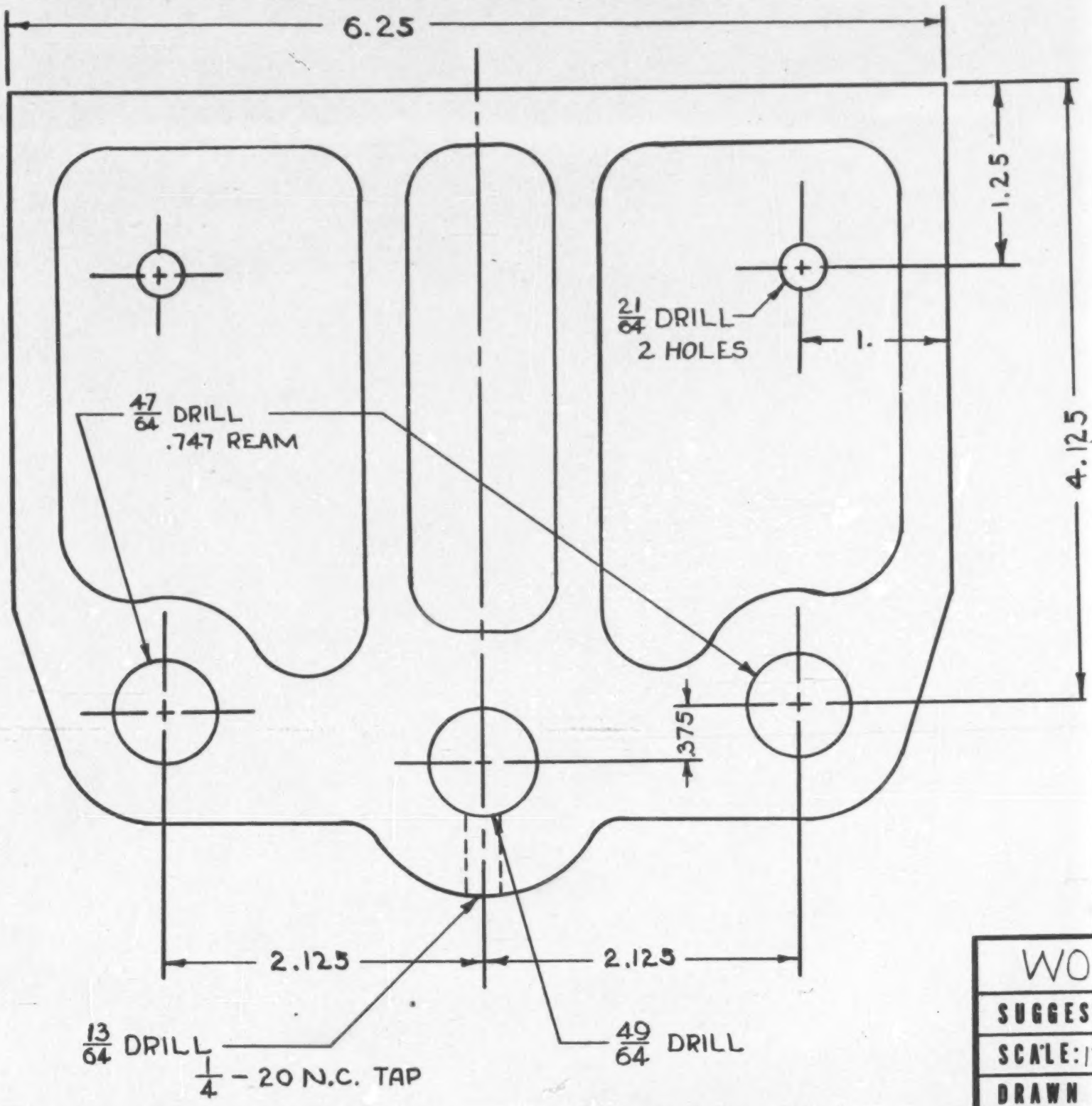

NOTE: GRIND AND POLISH SIDES OF CASTING

8754

8755

WO

SUGGES

SCALE:1

DRAWN

MILWA

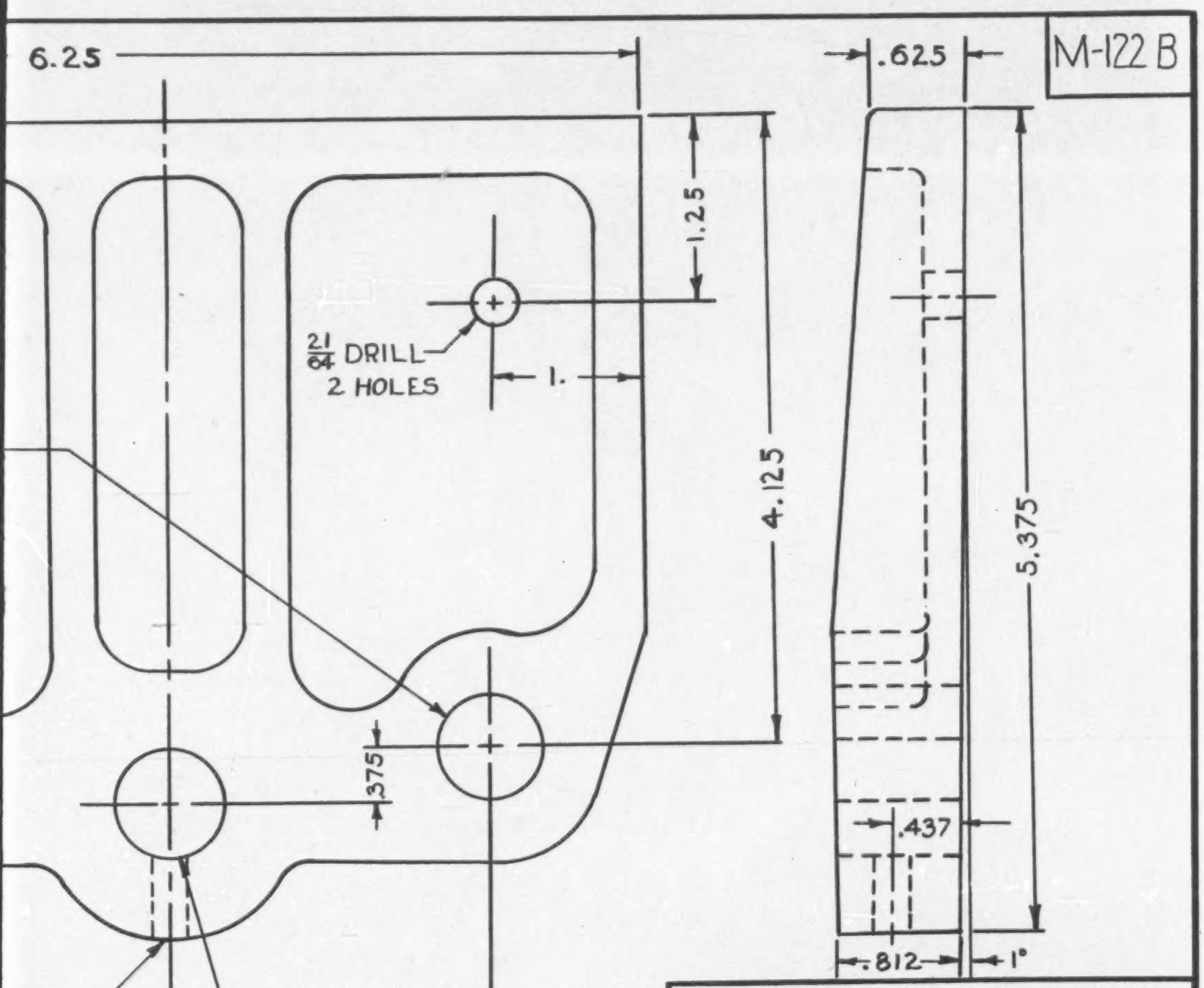

NOTE: GRIND AND POLISH SIDES OF CASTING

WOOD VISE DETAILS	
SUGGESTED BY:	
SCALE: 12"=1'0"	DATE: 6-29-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

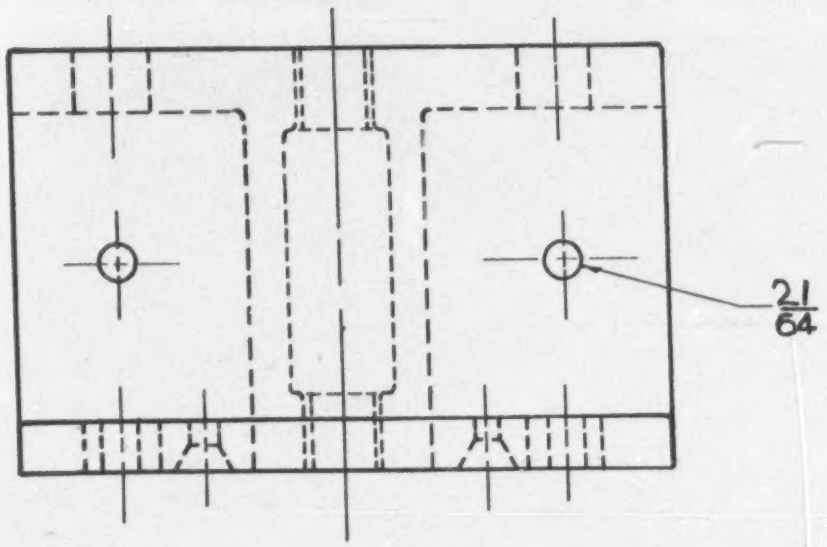
21/64 DRILL
2 HOLES

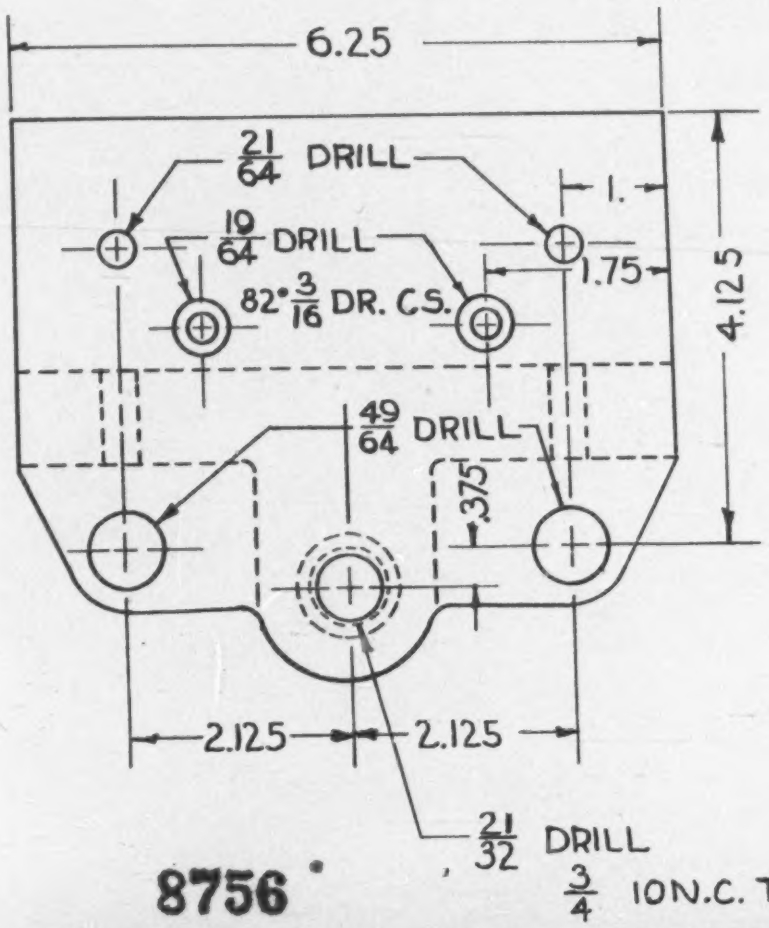
6.25
21/64 DRILL
19/64 DRILL
82° 3/16 DR. C.S.
1.
1.75
4.125
49/64 DRILL
.375
2.125
2.125
21/32 DRILL
3/4 10N.C. TAP

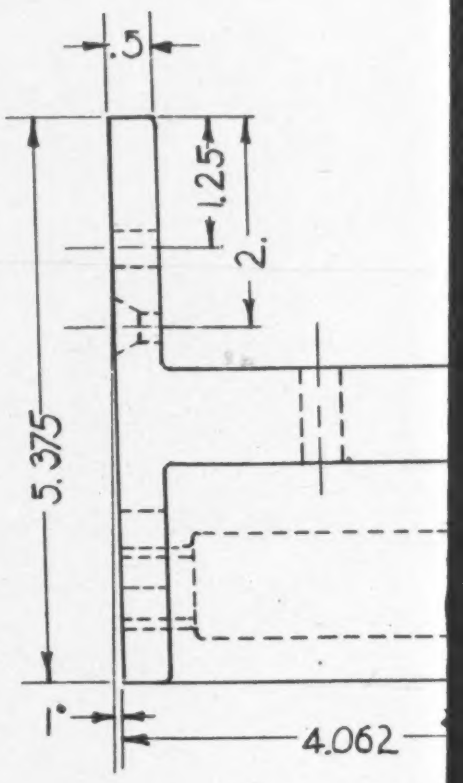
.5
1.25
2.
5.375
1°
4.062

8756

875

M-122C

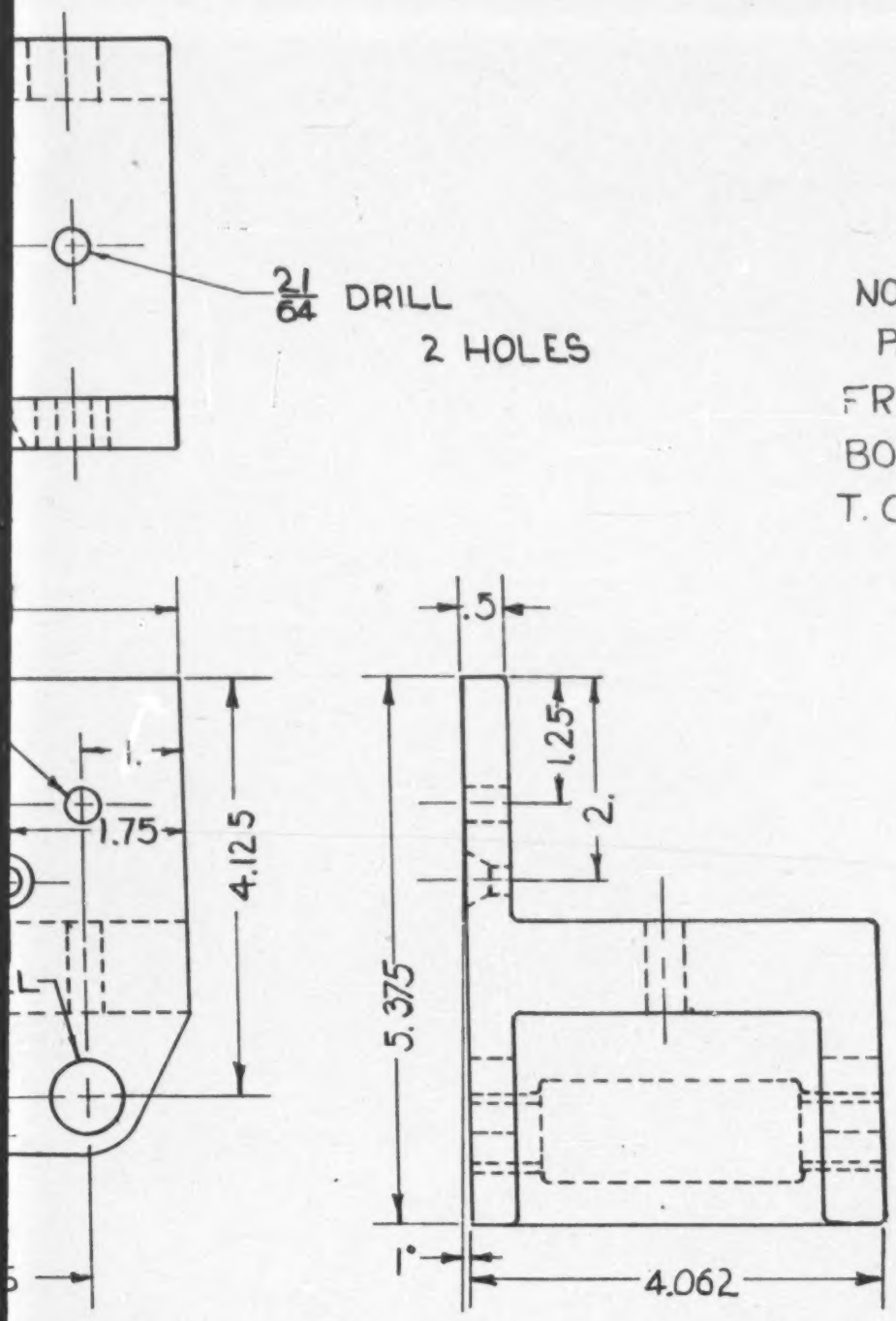

NOTE:

PATTERN	NO.
FRONT JAW	B.S.D. 35
BODY JAW	B.S.D. 34
T. CASTING	B.S.D. 33

8757

WOOD VISE DETAILS	
SUGGESTED BY:	
SCALE: 1"=2"	DATE: 6-29-66
DRAWN BY R.W.H.	CHECKED BY RCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

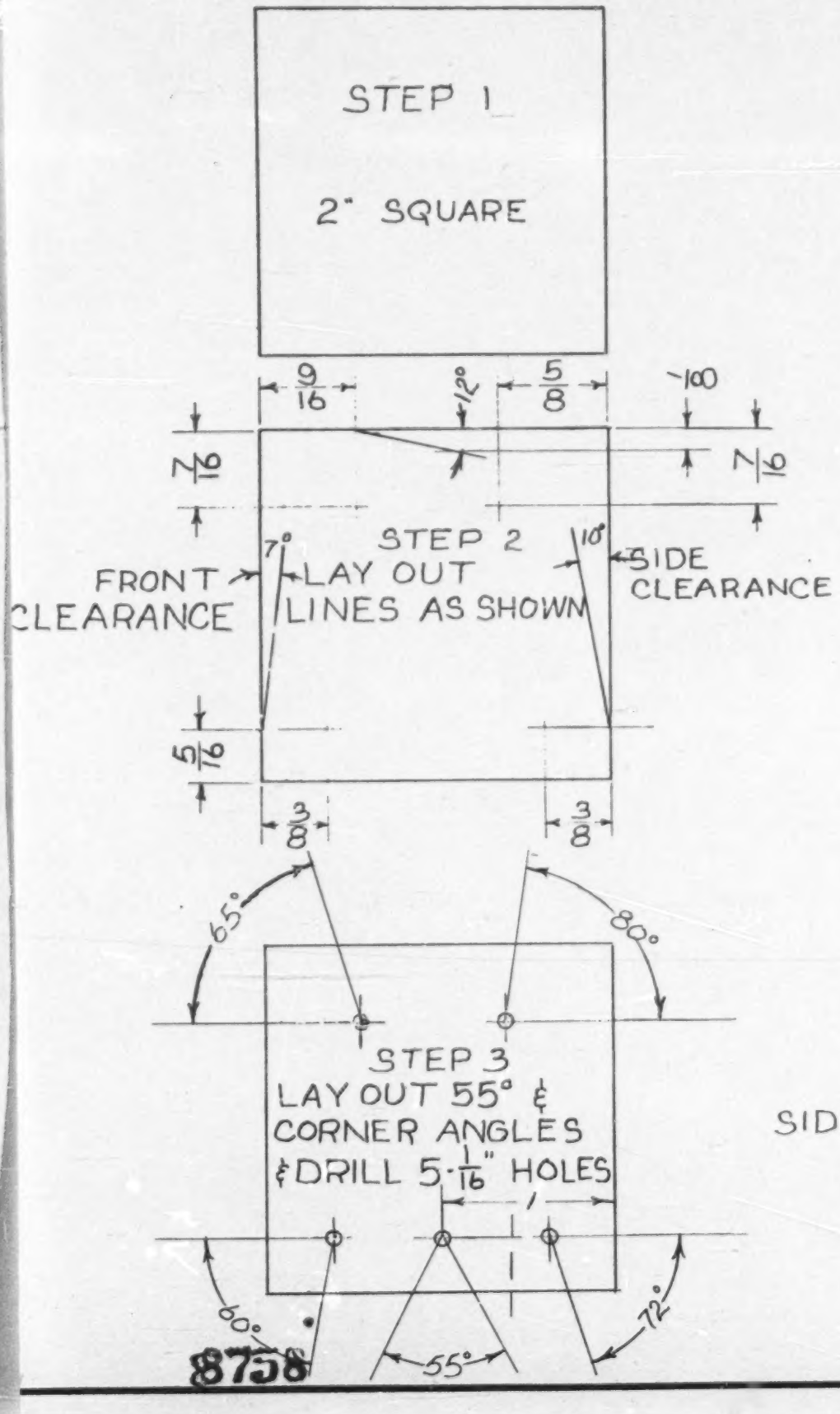
STEP 1
2" SQUARE
9/16
12°
5/8
100
7/16
7/16
STEP 2
7°
10°
FRONT CLEARANCE
LAY OUT LINES AS SHOWN
SIDE CLEARANCE
5/16
3/8
3/8
65°
80°
STEP 3
LAY OUT 55° & CORNER ANGLES & DRILL 5-1/16" HOLES
1
60°
72°
55°

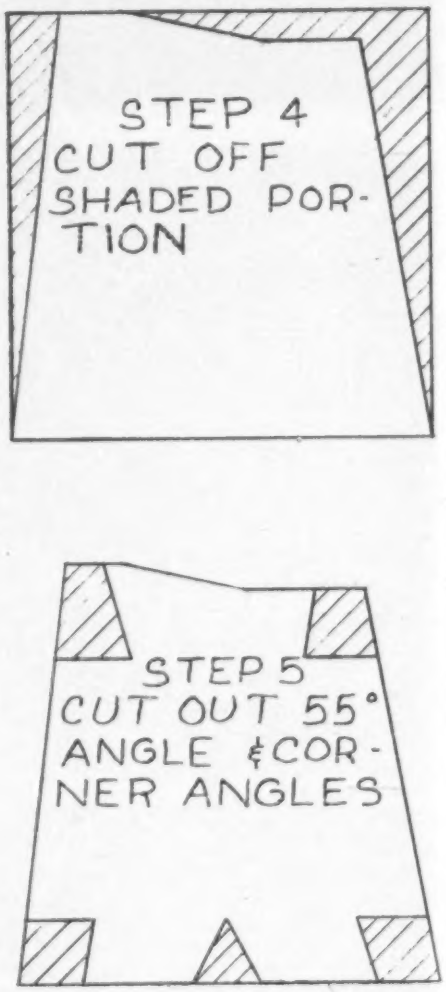
STEP 4
CUT OFF SHADED PORTION
STEP 5
CUT OUT 55° ANGLE & CORNER ANGLES

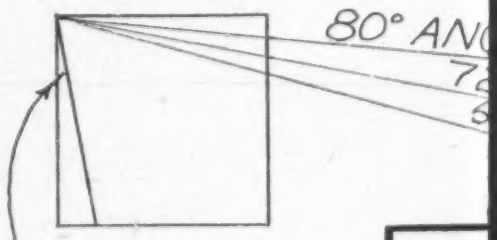
80° ANG
SIDE CLEARANCE 10°

8758

8759

M-170

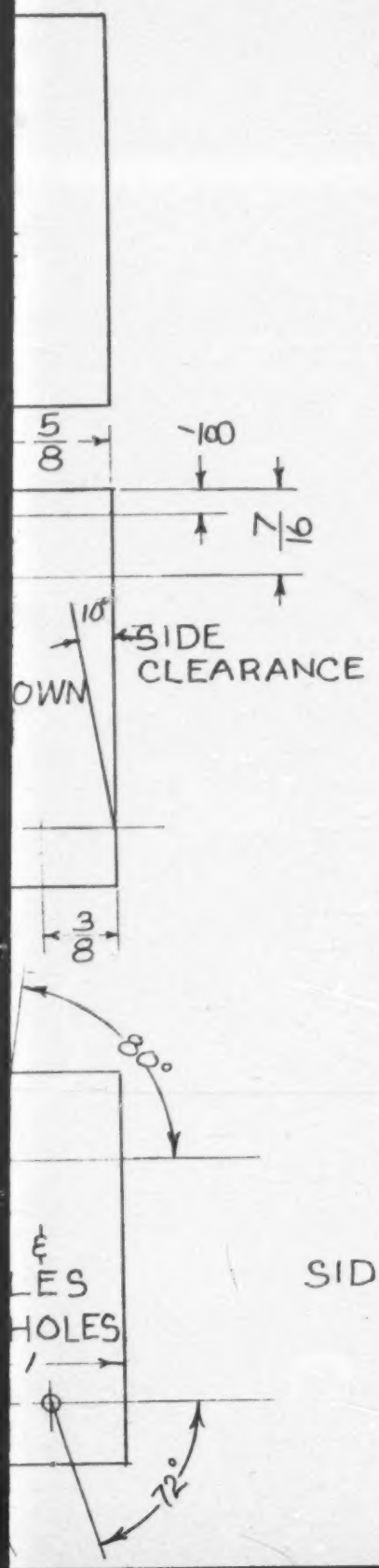

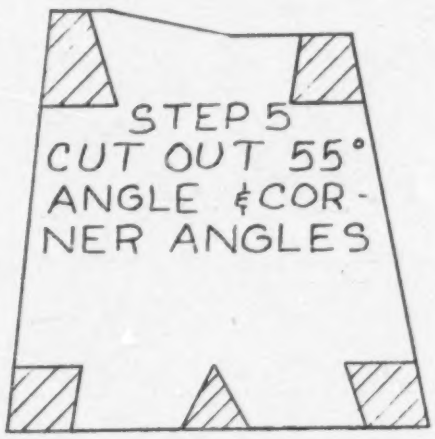

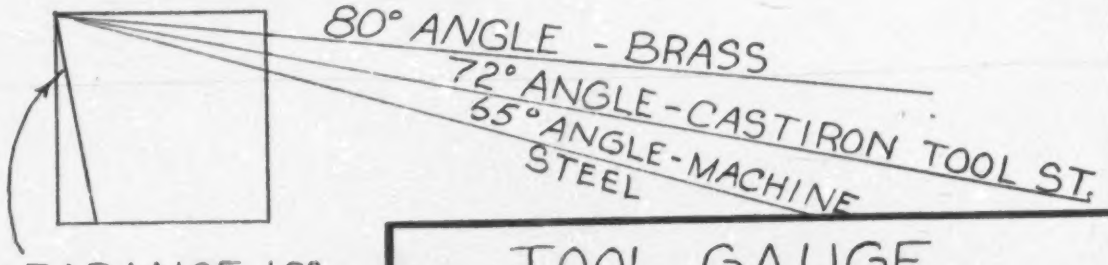

TOOL GAUGE	
SUGGESTED BY: BOY'S TECH.	
SCALE: 12" = 1'	DATE: 6-20-66
DRAWN BY R.T.	CHECKED BY NCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8759

1. GRIND LEADING SIDE OF RIGHT HAND TOOL

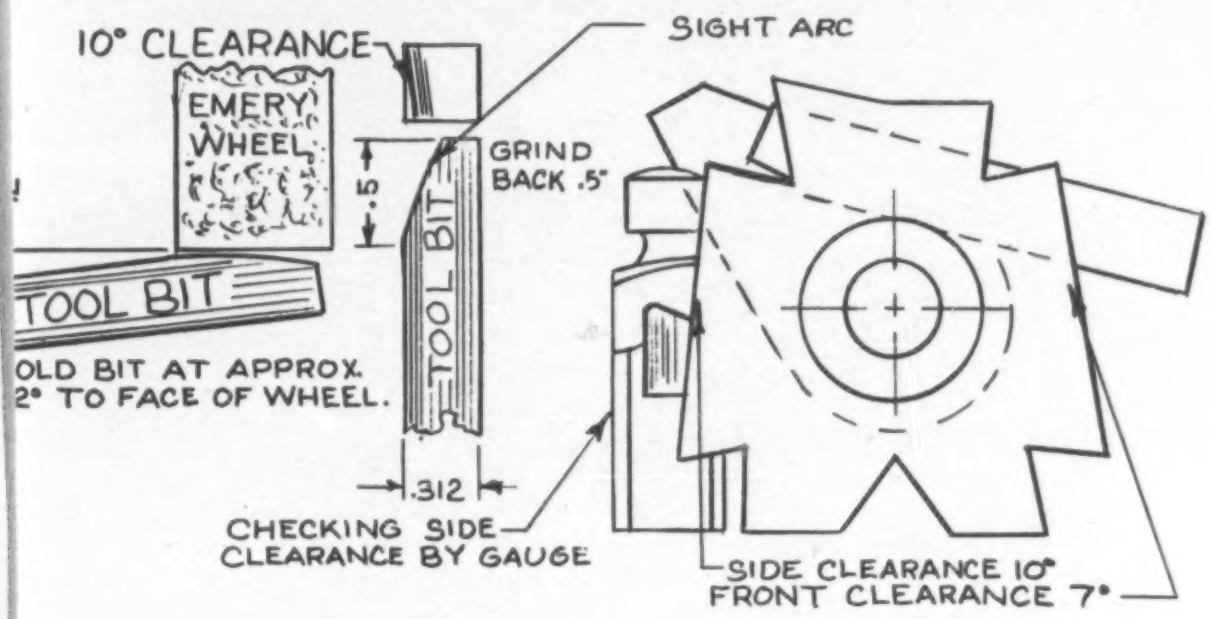

3. GRIND RA
TOOL.

2. GRIND FRONT CLEARANCE OF RIGHT HAND TOOL.

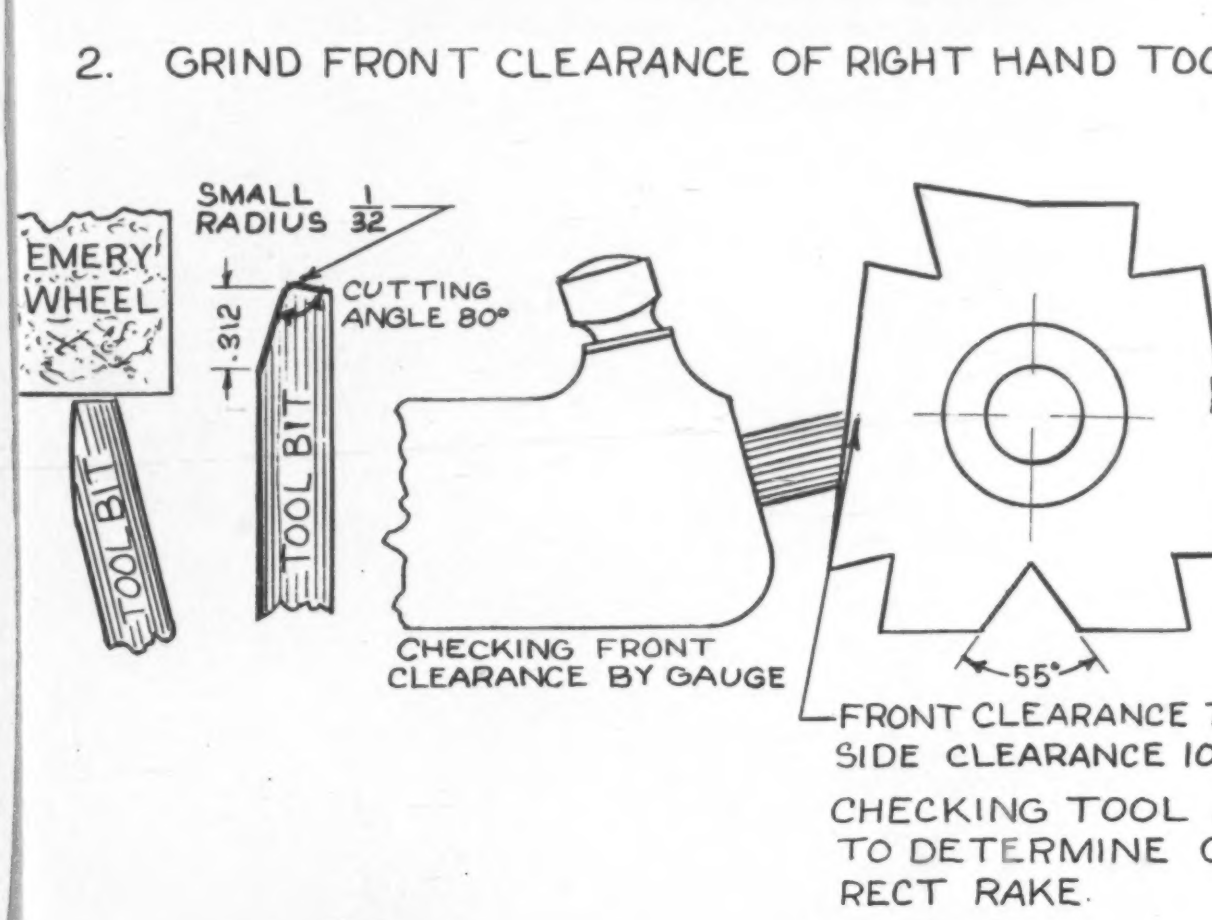

8760

8761

SIDE OF RIGHT HAND TOOL

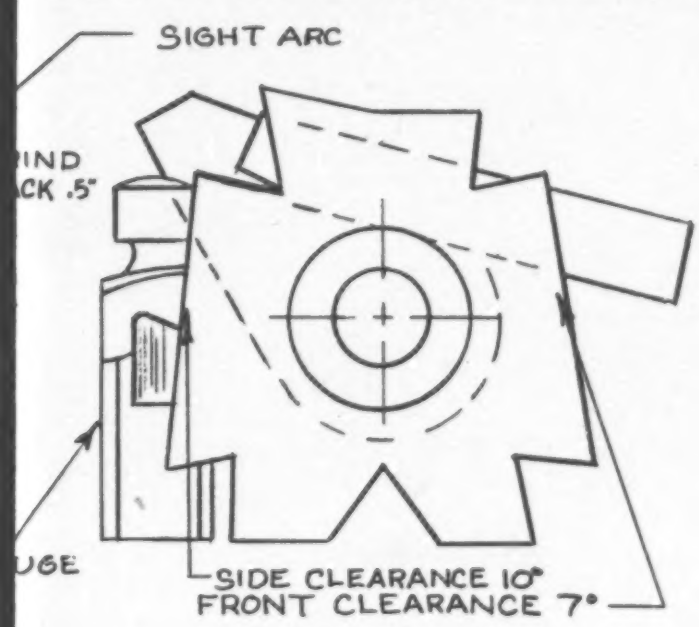

3. GRIND RAKE ANGLE OF RIGHT HAND TOOL.

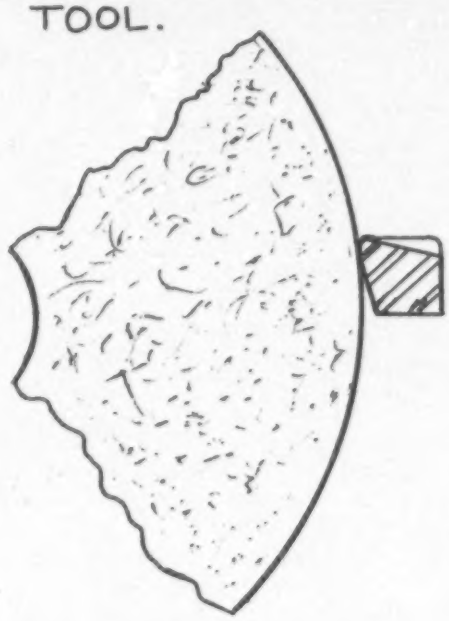

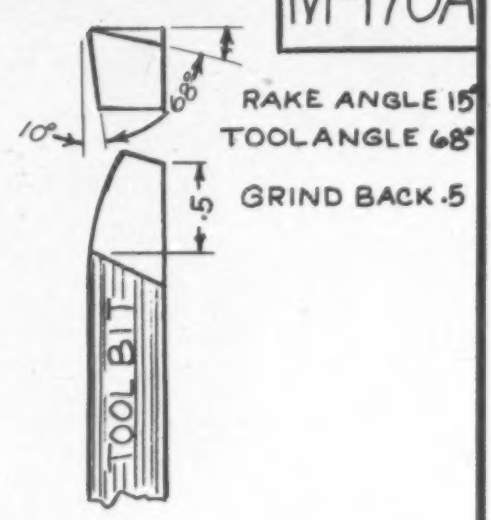

M-170A

LEARANCE OF RIGHT HAND TOOL.

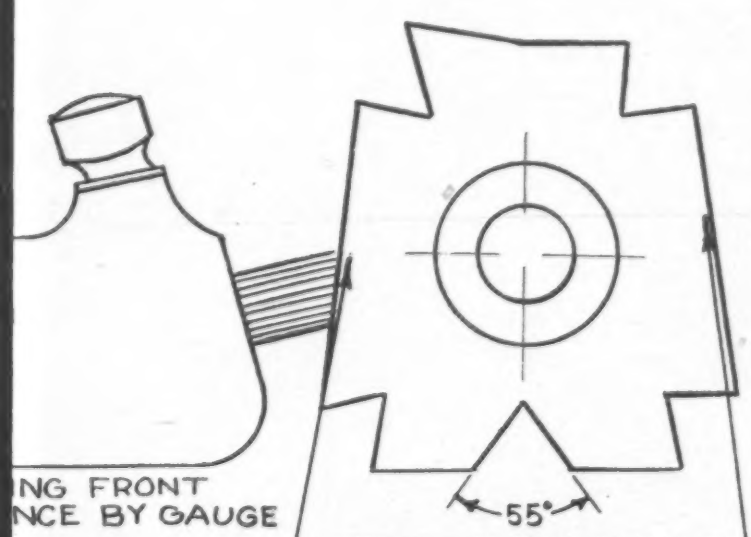

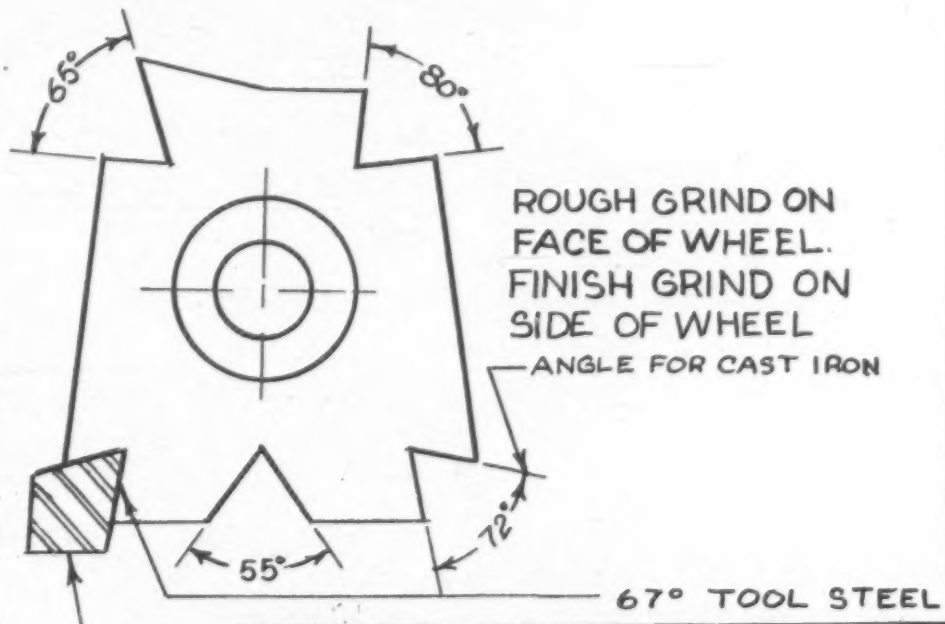

CHECKING TOOL ANGLE TO DETERMINE CORRECT RAKE.

8761

TOOL GAUGE	
SUGGESTED BY: BOYS' TECH.	
SCALE: 12" = 1'0"	DATE: 6-20-66
DRAWN BY R.O.T.	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

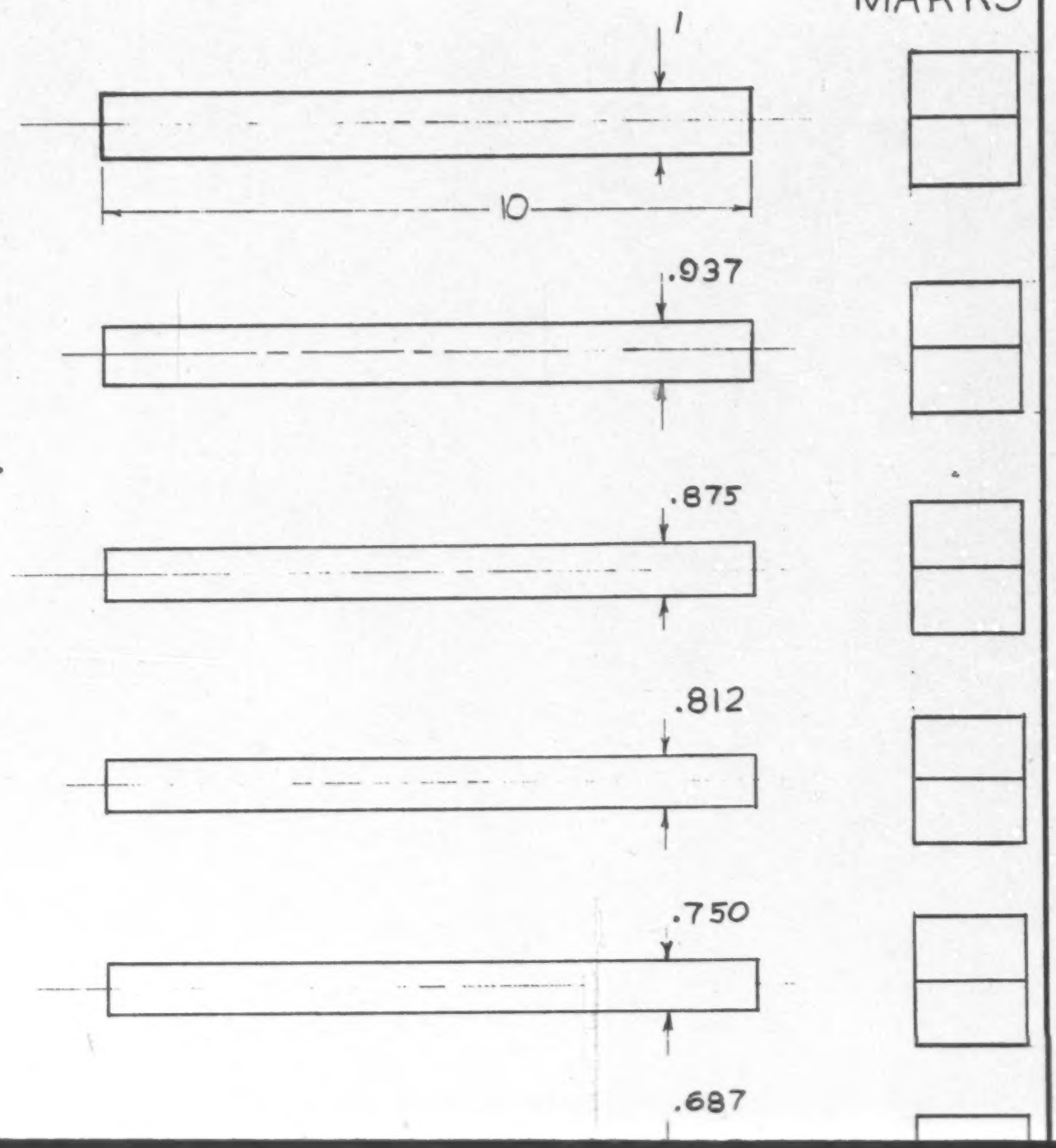

8762

M-171

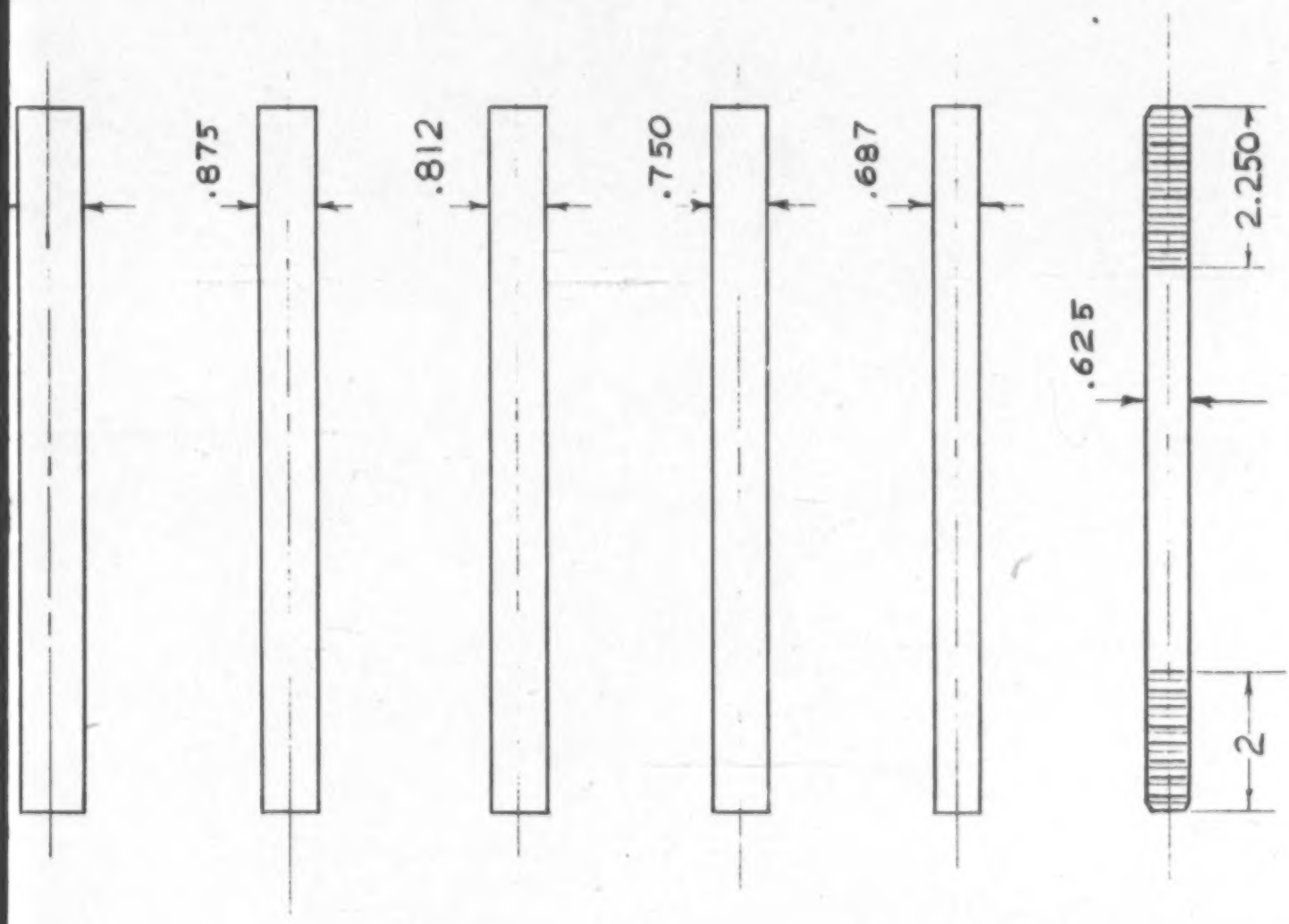

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

TOOL REST CLAMP STUD	
SUGGESTED BY:	
SCALE: 3/8":1"	DATE: 6-20-66
DRAWN BY T.S.S.	CHECKED BY DCE
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8763

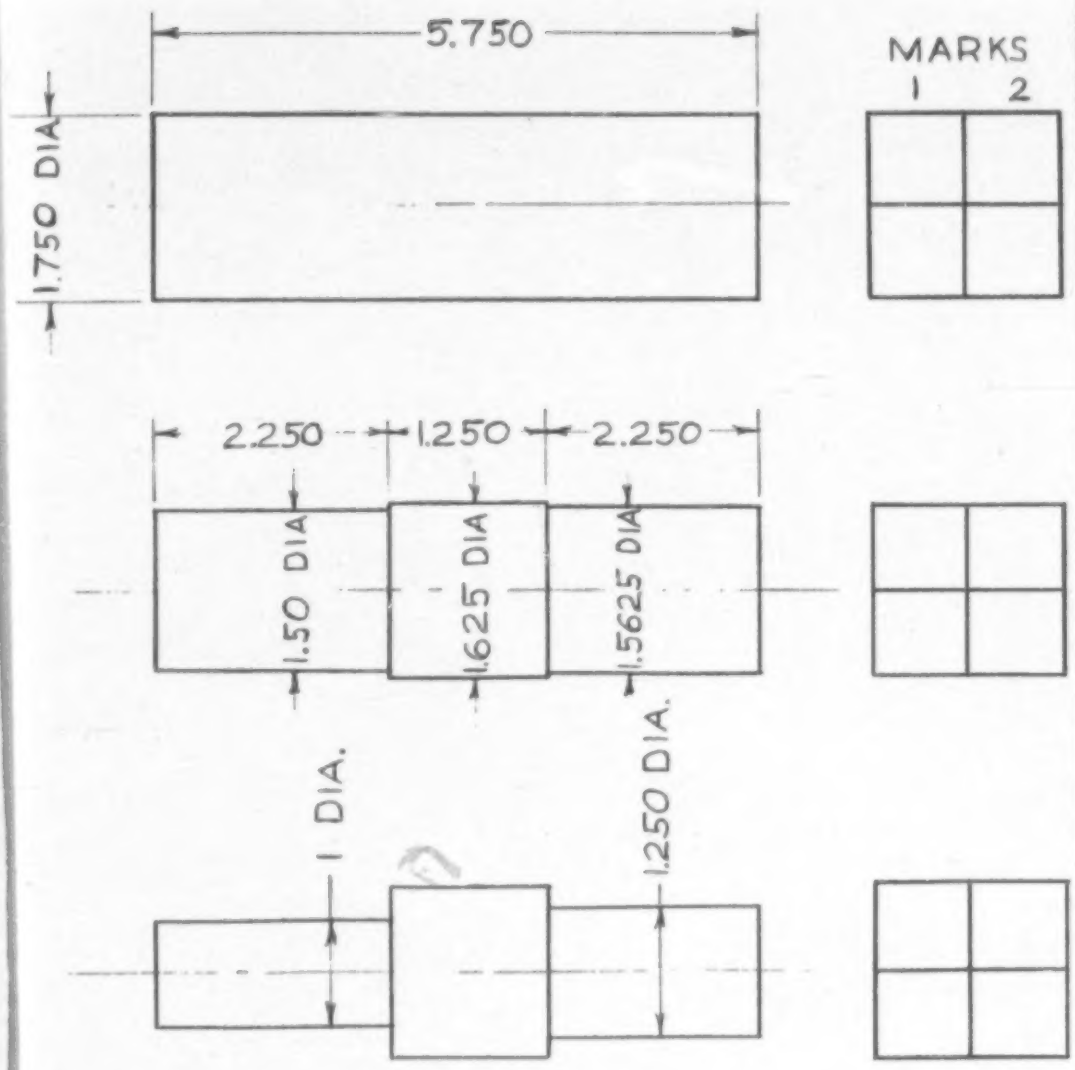
5.750
1.750 DIA
MARKS
1
2
2.250
1.250
2.250
1.50 DIA
1.625 DIA
1.5625 DIA
1 DIA.
1.250 DIA.

8764

127 OF 327

ED

056 238

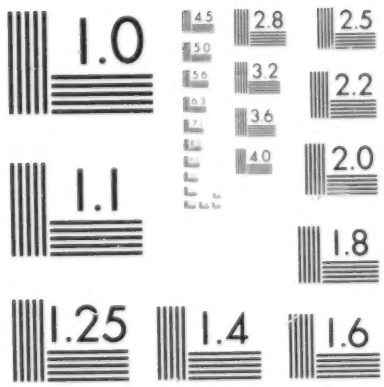

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

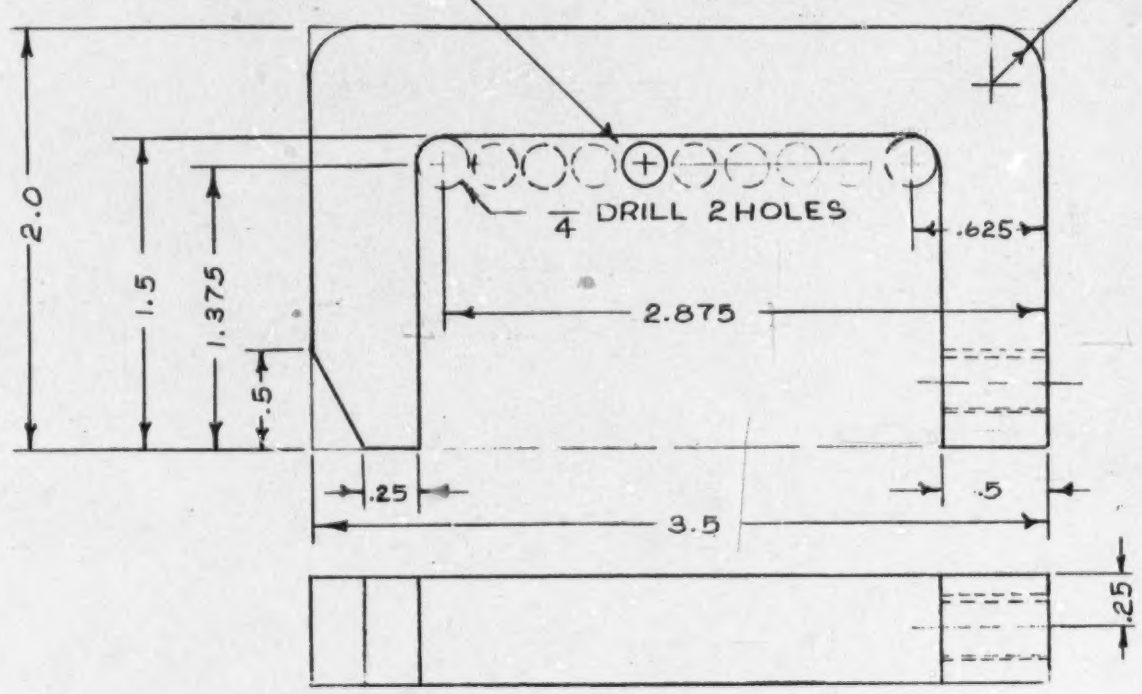

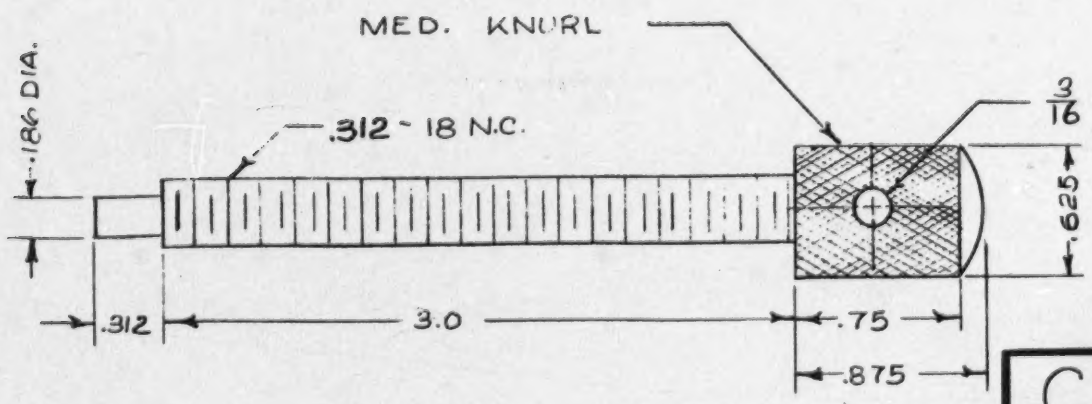

SCREW

8766

8767

TOLERA .005
UNLESS OTHERWISE STATED

C-

SUGG

SCALE

DRAW

MIL

M-173

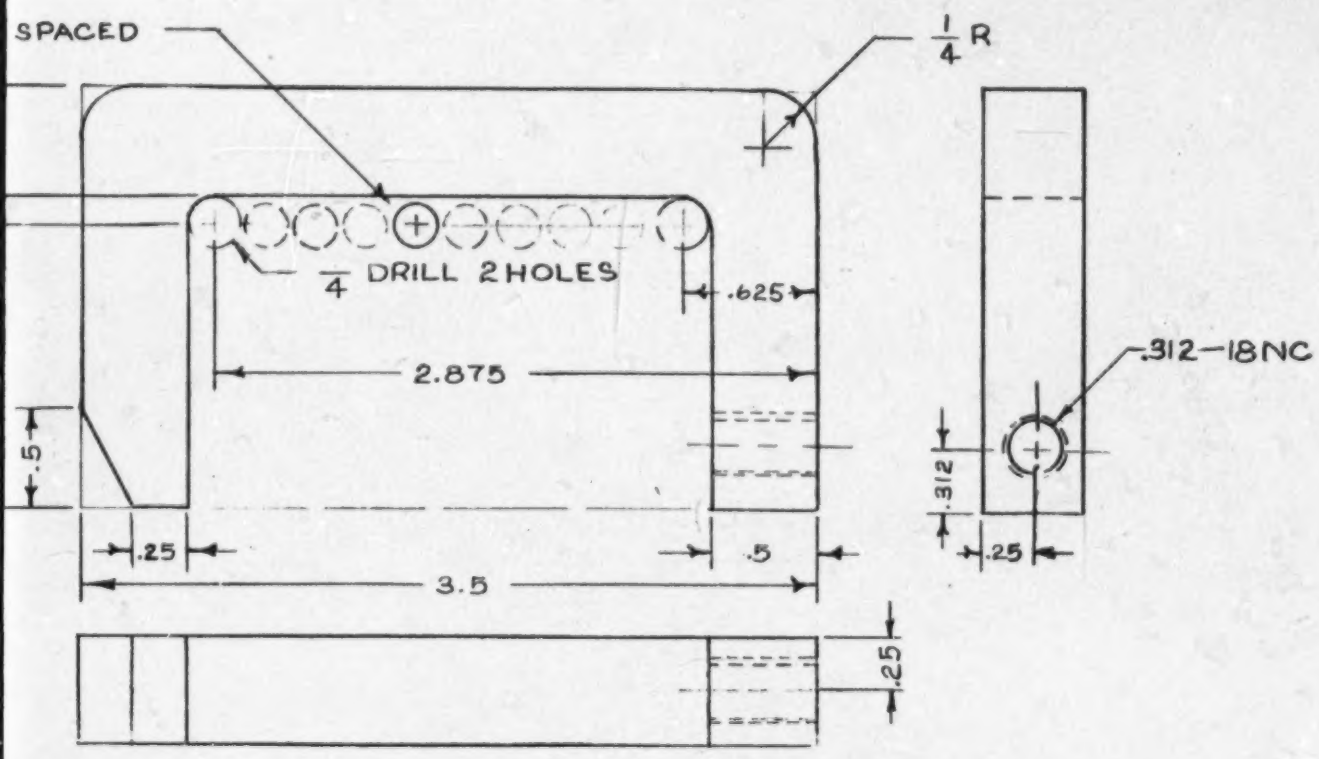

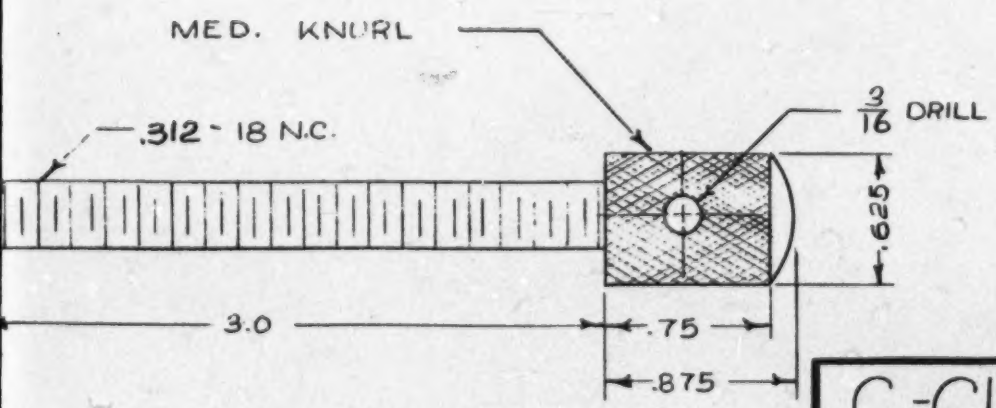

SCREW

TOLERANCE .005
UNLESS OTHERWISE STATED

8767

C-CLAMP & SCREW	
SUGGESTED BY:	
SCALE: 12" = 1'0"	DATE: 6-21-66
DRAWN BY R.T.	CHECKED BY NCG
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

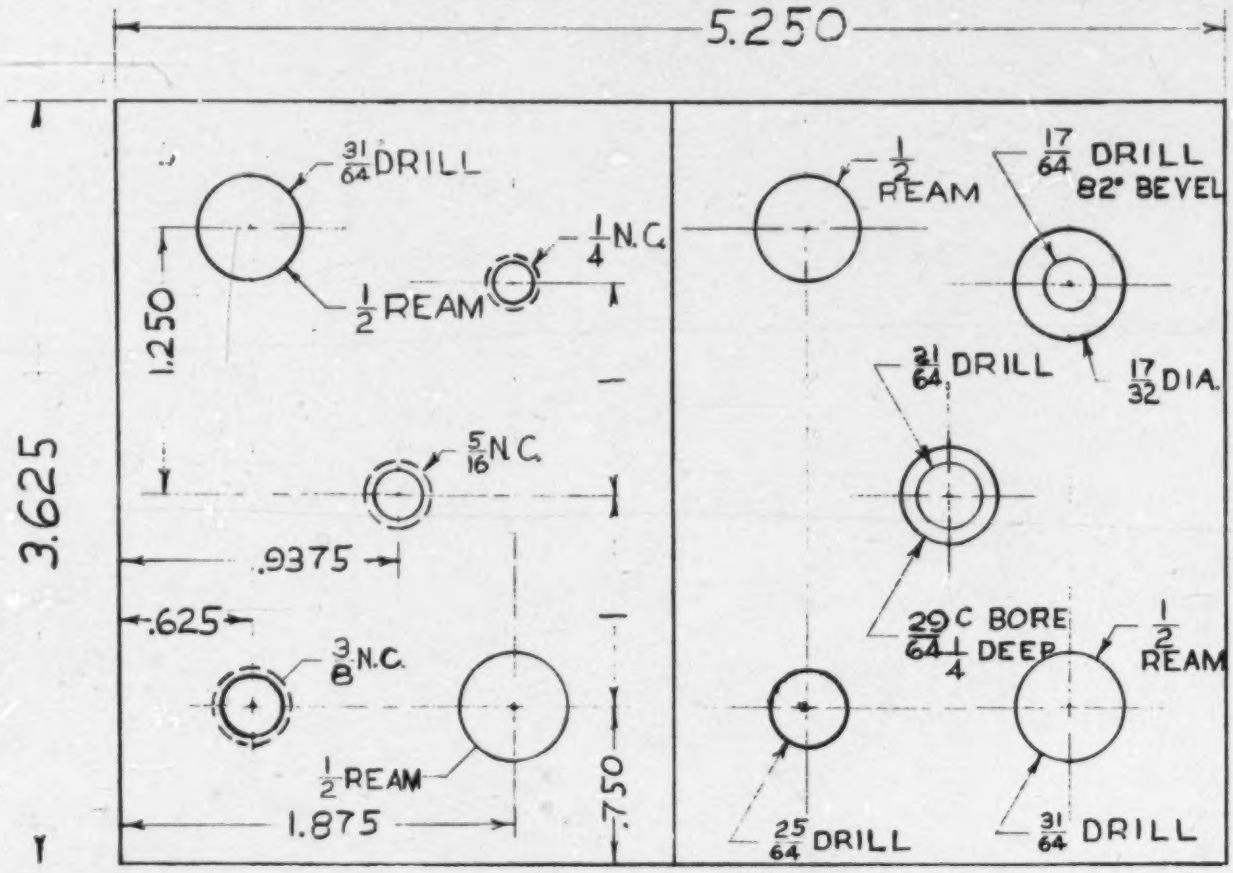

OPERATIONS

SHAPE BLOCK

A. SHAPE FACE SIDE
B. SHAPE SIDES ∥
C. SHAPE OPPOSITE FACE
D. SHAPE ENDS
E. HOLD SIZE .005 TO .01 +

LAYOUT

A. CLEAN FACE OR GRIND
B. APPLY BLUE VITRIOL
C. DRAW ALL ∥ & ⊥ LINES
D. CENTER PUNCH LIGHTLY
E. DRAW GIVEN CIRCLES 1/32" LARGER & SMALLER IN RADIUS
F. ENLARGE PUNCH MARKS

3. DRILL

A. SPOT HOLES
B. DRILL-USING CLAMPS OR VICE

4. COUNTERSINK

A. 1/32" BEVEL ALL HOLES

5. REAM

A. REAM ONE SIDE DRY AND ONE WET

6. COUNTER BORE

A. SIZE & DEPTH

7. T

A.
B. T

8. P

A.

9. C

A. U

SH
SUGG
SCAL
DRAW
MIL

M-174

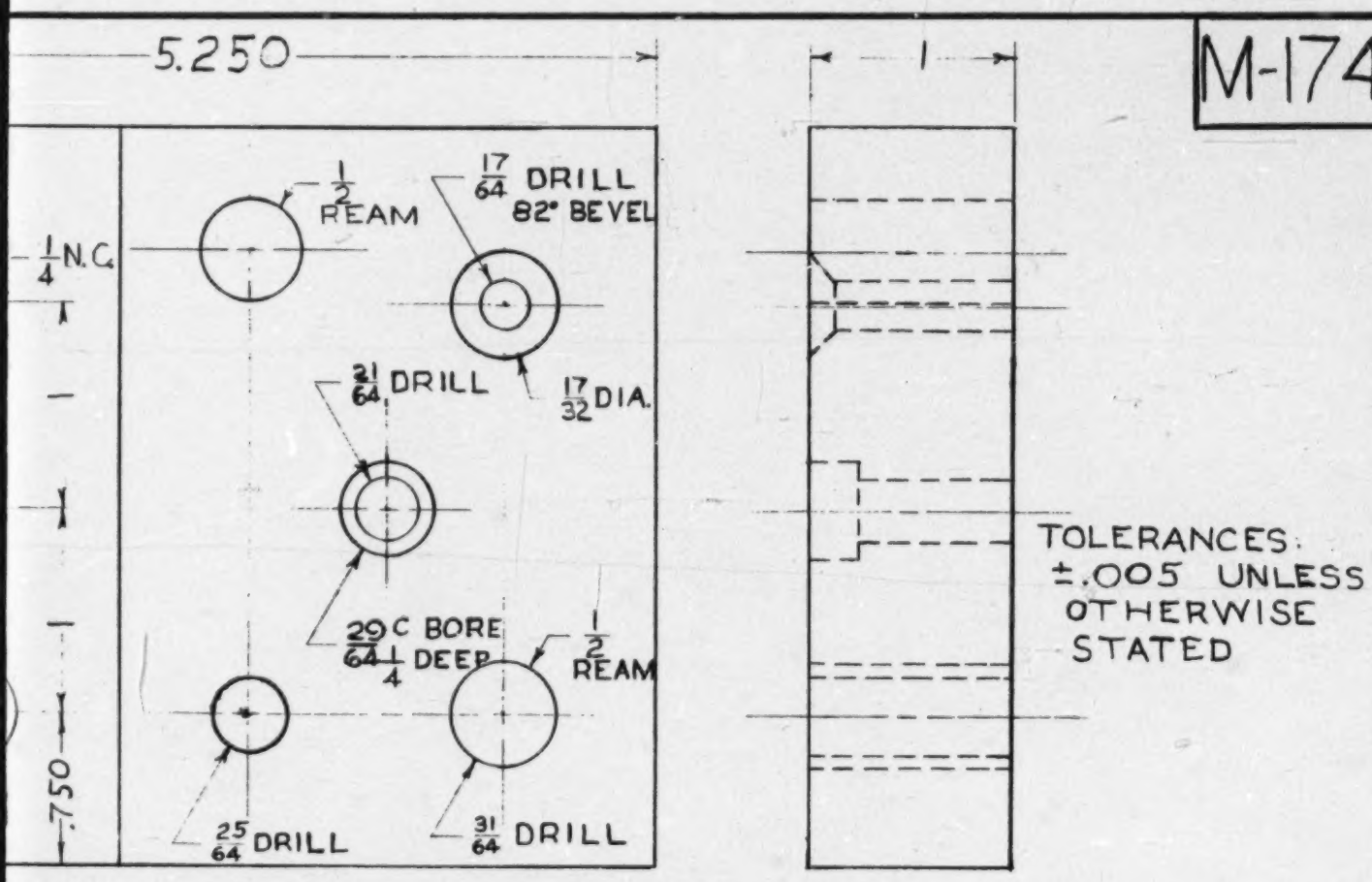

OPERATIONS

IN RADIUS

F. ENLARGE PUNCH MARKS

DRILL

A. SPOT HOLES

B. DRILL-USING CLAMPS OR VICE

COUNTERSINK

A. 1/32" BEVEL ALL HOLES

REAM

A. REAM ONE SIDE DRY AND ONE WET

COUNTER BORE

A. SIZE & DEPTH

7. TAP

A. CHECK TAP SIZE

B. TAP ⊥ TO FACE

8. PART

A. USE POWER SAW

9. CHECK

A. USE SCREWS & 1/2" PINS

SHAPER BLOCK	
SUGGESTED BY: BOYS' TECH	
SCALE: 1":1"	DATE: 6-21-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8769

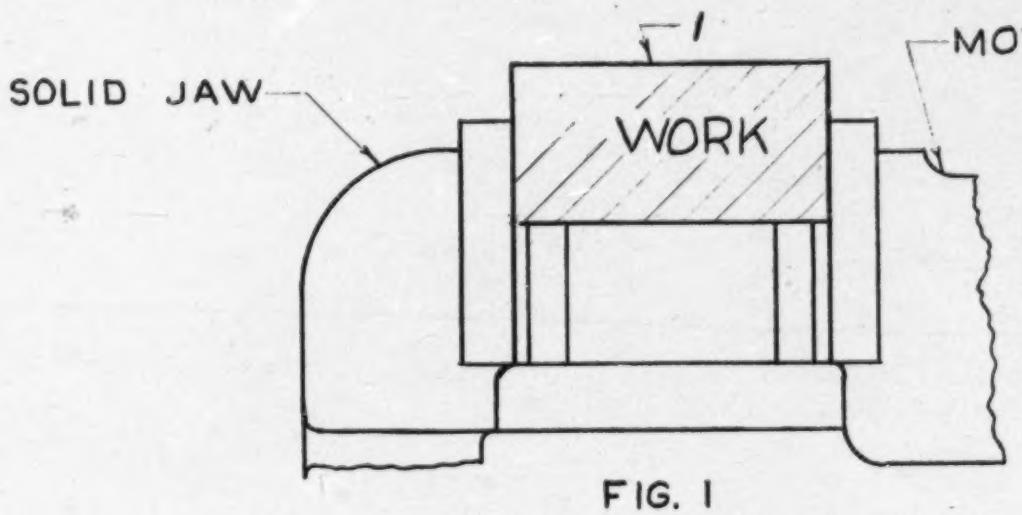

FIG. 1

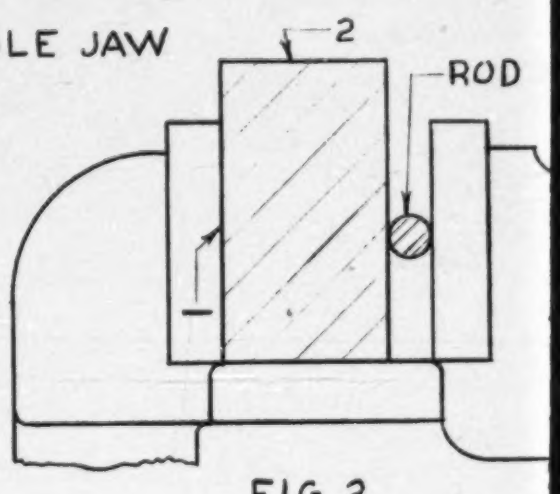

FIG. 2

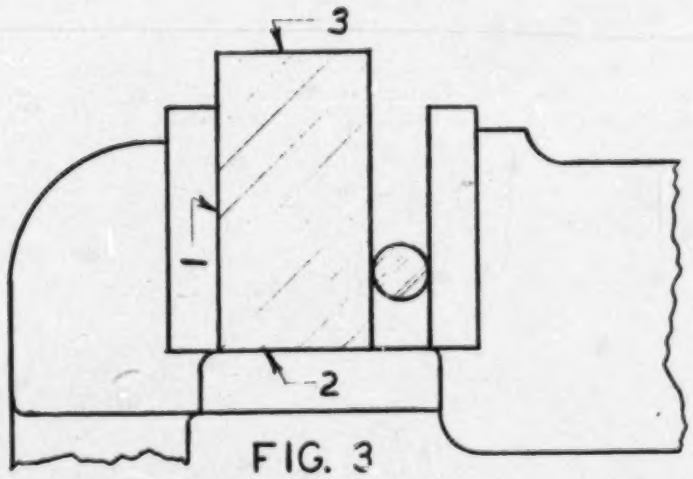

FIG. 3

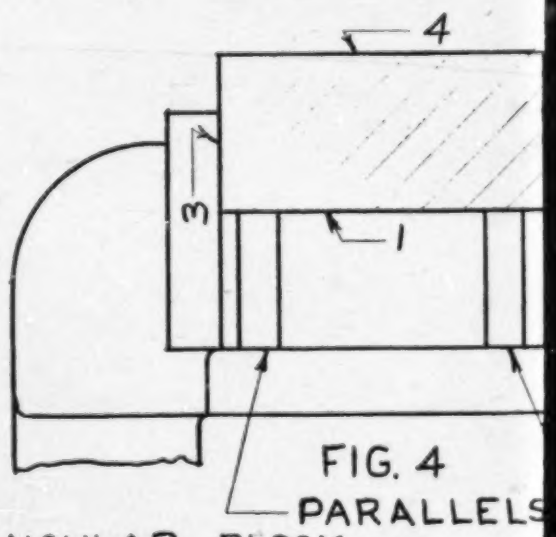

FIG. 4

FOUR SUCCESSIVE STEPS IN SHAPING A RECTANGULAR BLOCK

1. SHAPE ONE SIDE PREFERABLY A LARGE SURFACE #1 - FIG. 1
2. SHAPE ADJACENT SIDE OR LONG NARROW EDGE #2 - FIG. 2
3. SHAPE OPPOSITE SIDE OR OPPOSITE EDGE #3 - FIG. 3
4. SHAPE OPPOSITE SURFACE #4 - FIG. 4
5. USE PARALLELS FIGURES 1 & 4
6. USE COPPER JAWS FOR ROUGH CASTINGS
7. FINISHED THICKNESS TO BE 1.000 + (.005 TO .010)
8. FINISHED WIDTH TO BE 3.625
9. FINISHED LENGTH TO BE 5.250

SHA
SUGGESTE
SCALE: NO
DRAWN BY
MILWAU
IND

8770 8.71

M-174A

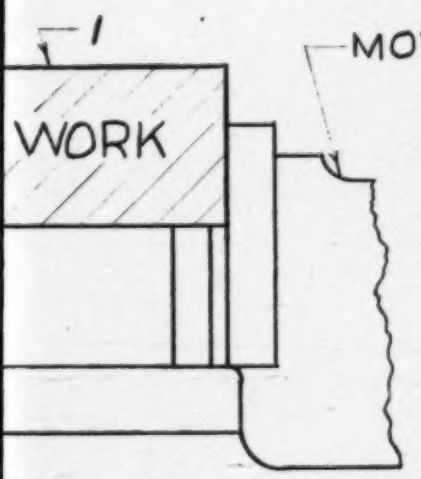

FIG. 1

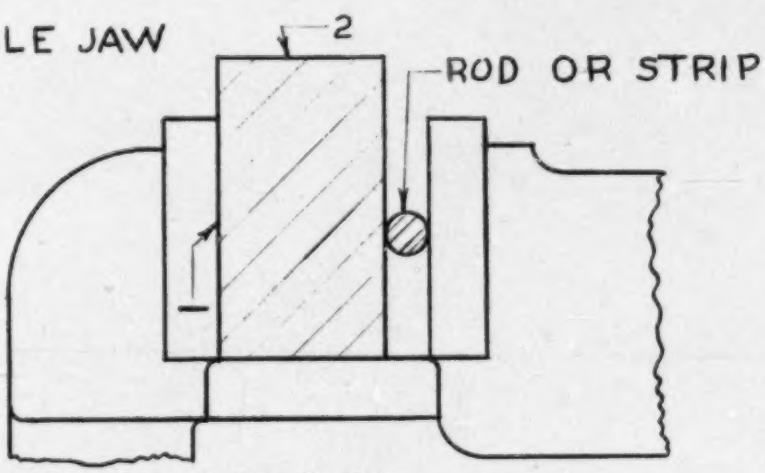

FIG. 2

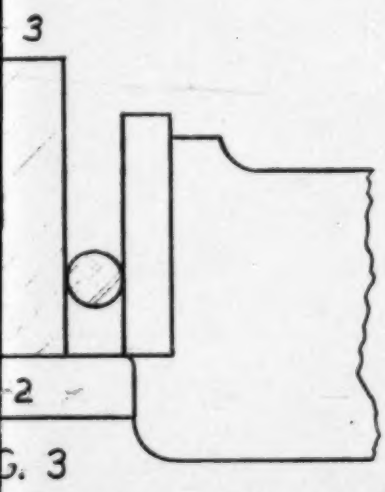

G. 3

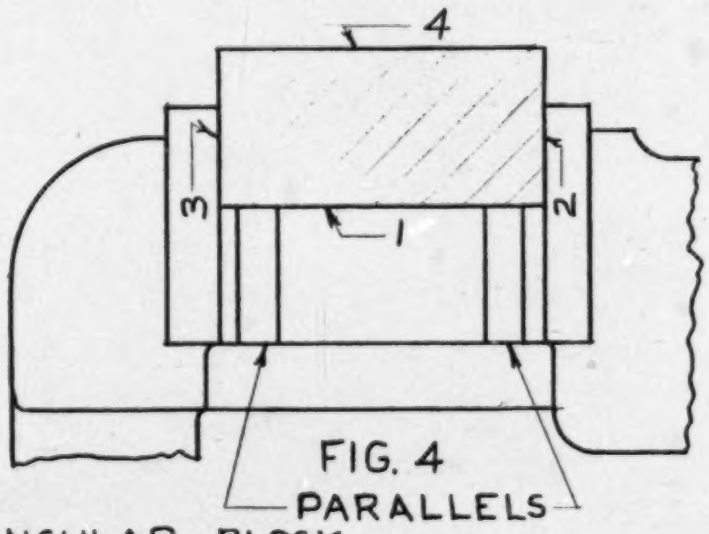

FIG. 4

IN SHAPING A RECTANGULAR BLOCK
ABLY A LARGE SURFACE #1 - FIG. 1
R LONG NARROW EDGE #2 - FIG. 2
R OPPOSITE EDGE #3 - FIG. 3
E #4 - FIG. 4
ES 1 & 4
R ROUGH CASTINGS
BE 1.000 + (.005 TO .010)
3.625
BE 5.250

SHAPER BLOCK	
SUGGESTED BY: BOYS' TECH	
SCALE: NONE	DATE: 6-21-66
DRAWN BY T.S.S.	CHECKED BY HCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8.71

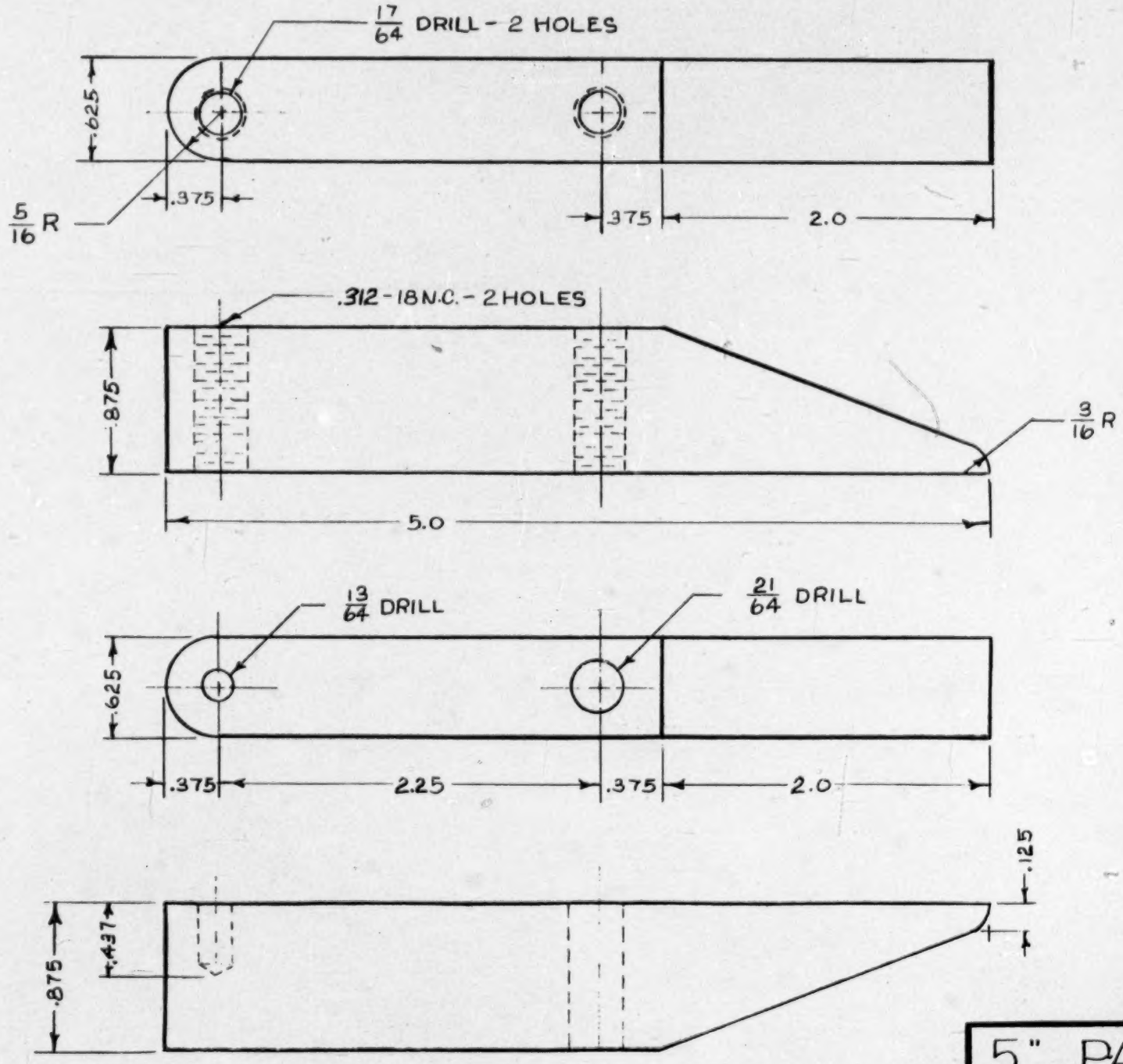

5" PAR

SUGGESTED

SCALE: 12" = 1'

DRAWN BY

MILWAUKE

INDU

TOLERANCE ±.005
UNLESS OTHERWISE STATED

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8773

M-175

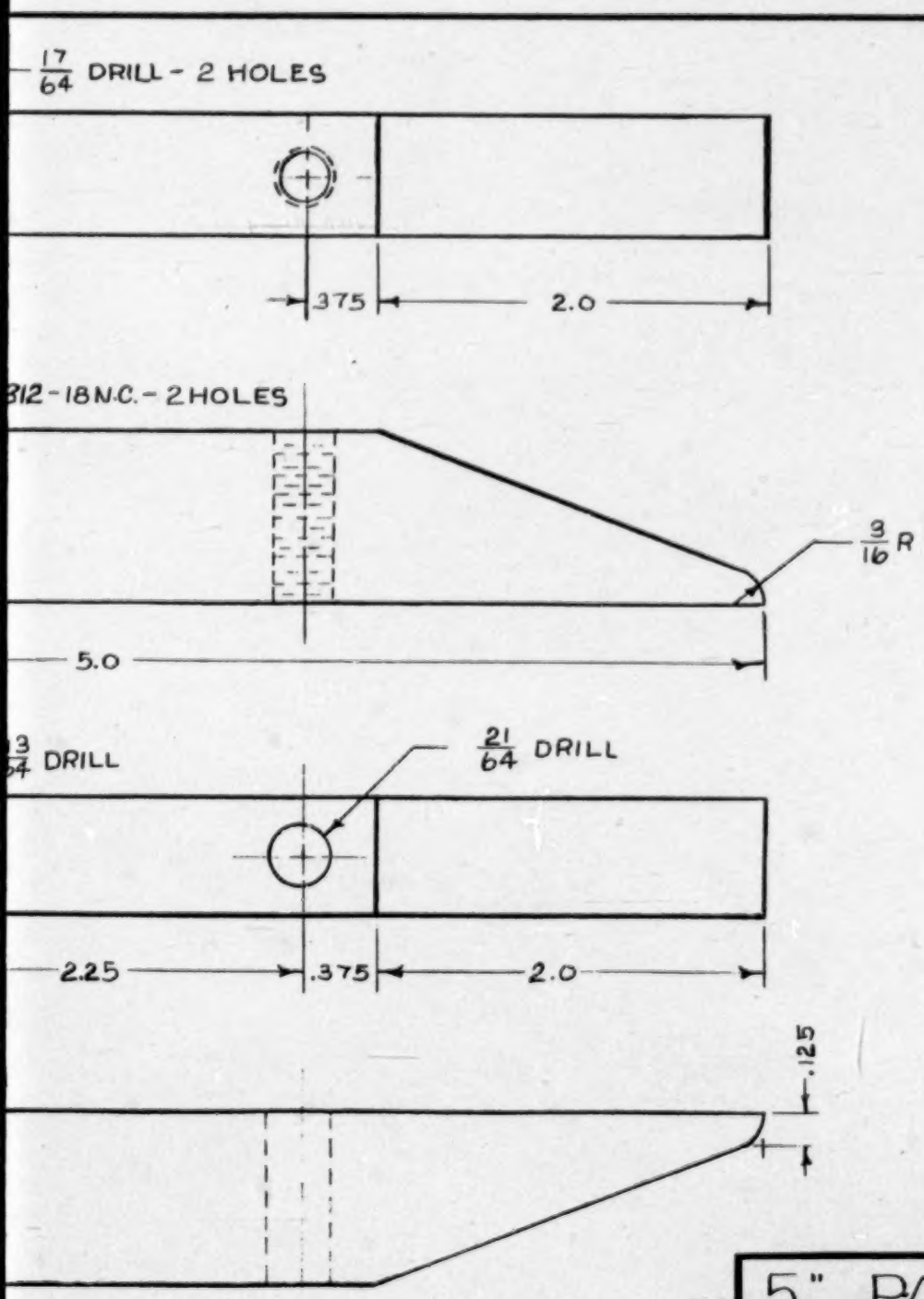

5" PARALLEL CLAMP	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'0"	DATE: 6-22-66
DRAWN BY R.T.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

TOLERANCE ±.005
UNLESS OTHERWISE STATED

8773

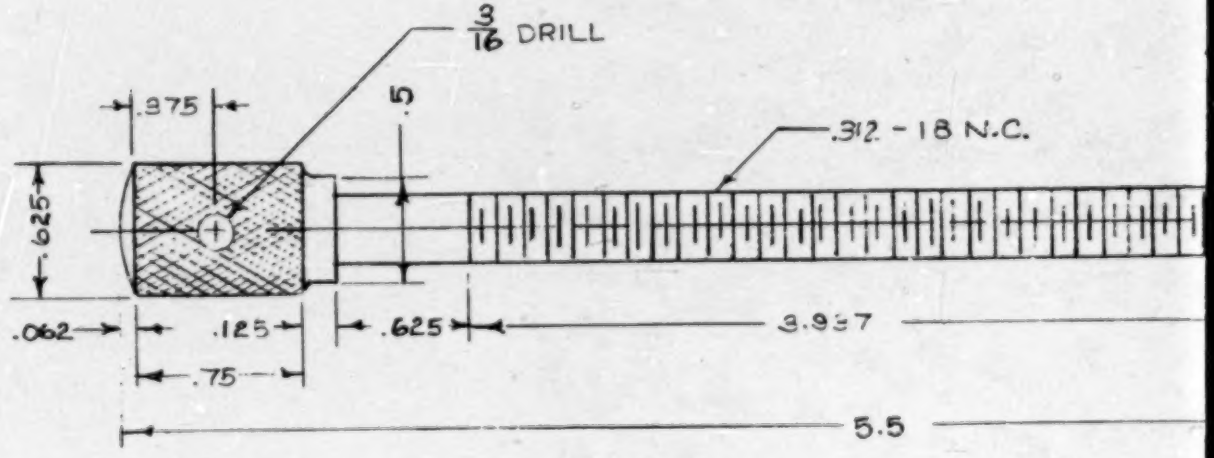

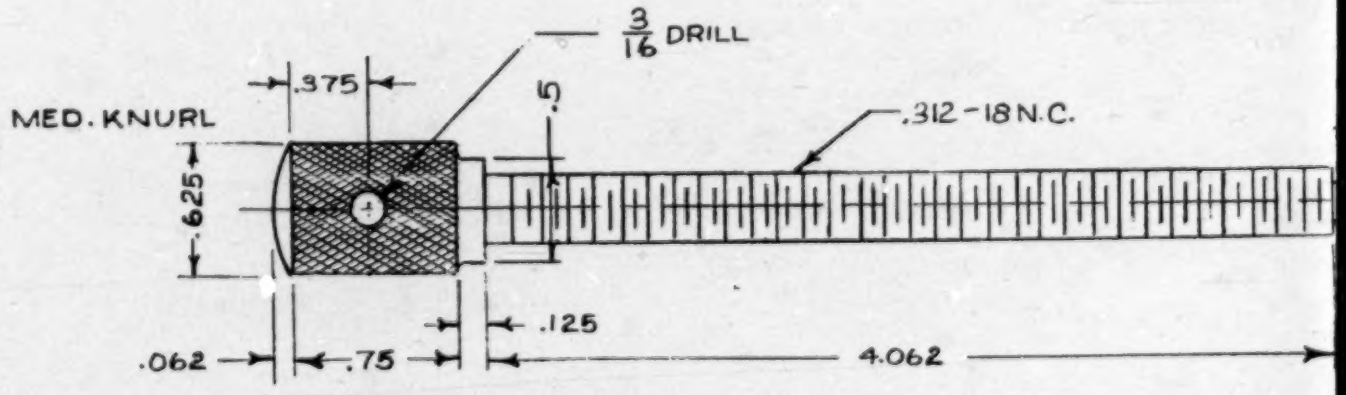

ONE OF EACH WANTED —
COLD ROLLED STEEL.

5"
SUG
SCA
DRA
MI

8774

8775

M-175A

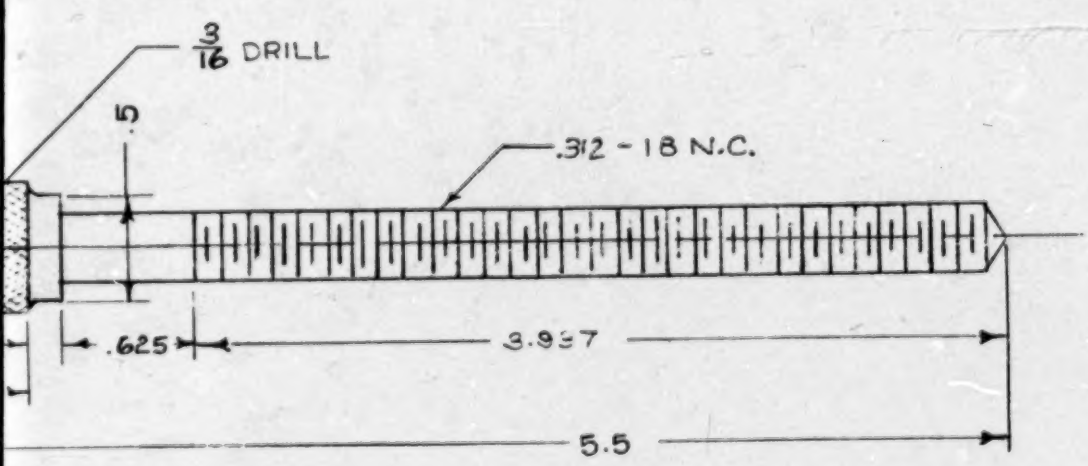

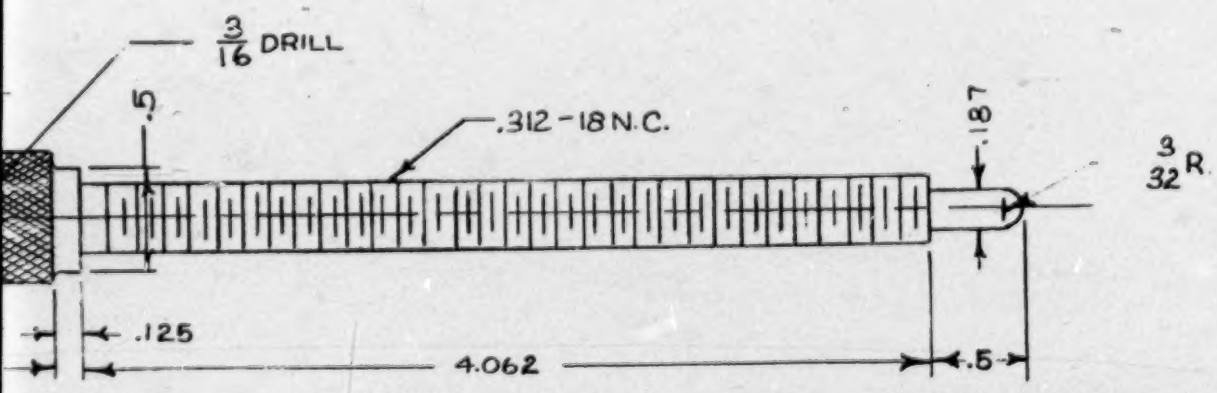

E OF EACH WANTED —
OLD ROLLED STEEL.

5" PARALLEL CLAMP	
SUGGESTED BY: BOYS' TECH.	
SCALE: 12" = 1'0"	DATE: 6-22-66
DRAWN BY R.G.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

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SIDES OF
PARALLEL
WIDER TH

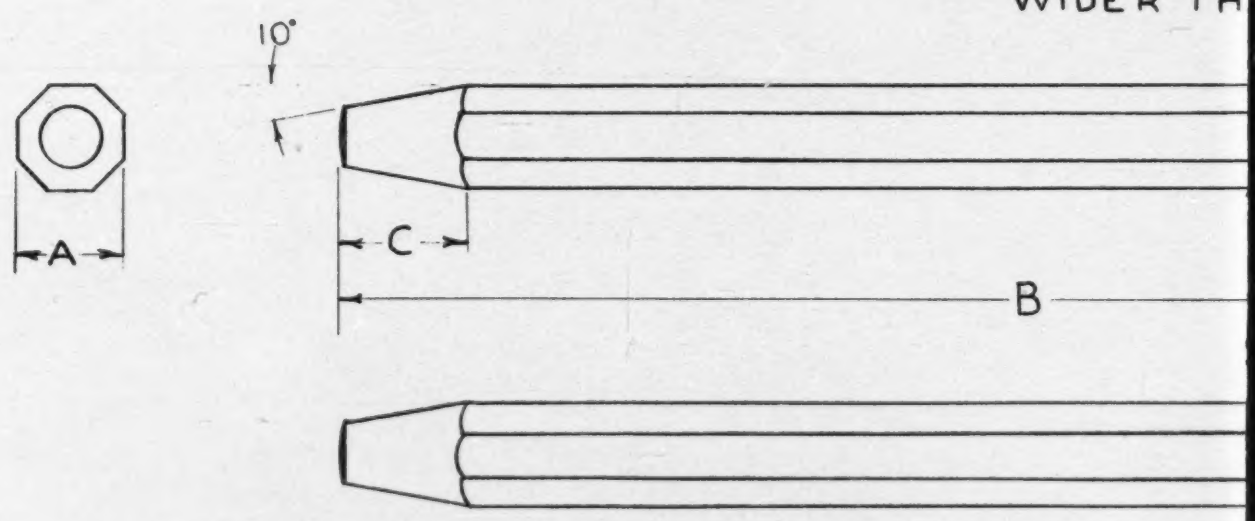

TABLE OF SIZES

A	B	C
$\frac{1}{2}$	$6\frac{1}{4}$	$\frac{5}{8}$
$\frac{5}{8}$	$7\frac{1}{4}$	$\frac{3}{4}$
$\frac{3}{4}$	$7\frac{3}{4}$	$\frac{7}{8}$

8776

8777

M-176

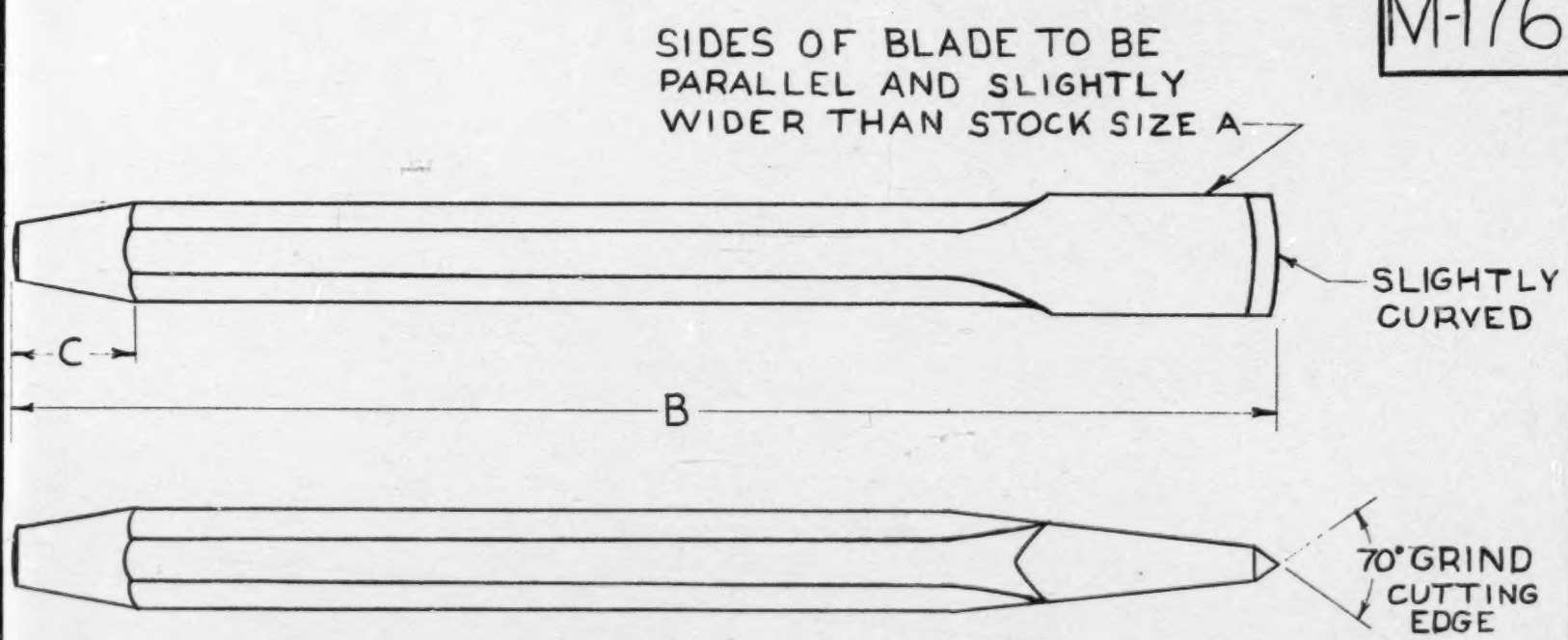

TABLE OF SIZES

A	B	C
$\frac{1}{2}$	$6\frac{1}{4}$	$\frac{5}{8}$
$\frac{5}{8}$	$7\frac{1}{4}$	$\frac{3}{4}$
$\frac{3}{4}$	$7\frac{3}{4}$	$\frac{7}{8}$

8777

COLD CHISEL	
SUGGESTED BY:	
SCALE: NONE	DATE: 6-21-66
DRAWN BY T.S.S.	CHECKED BY MCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

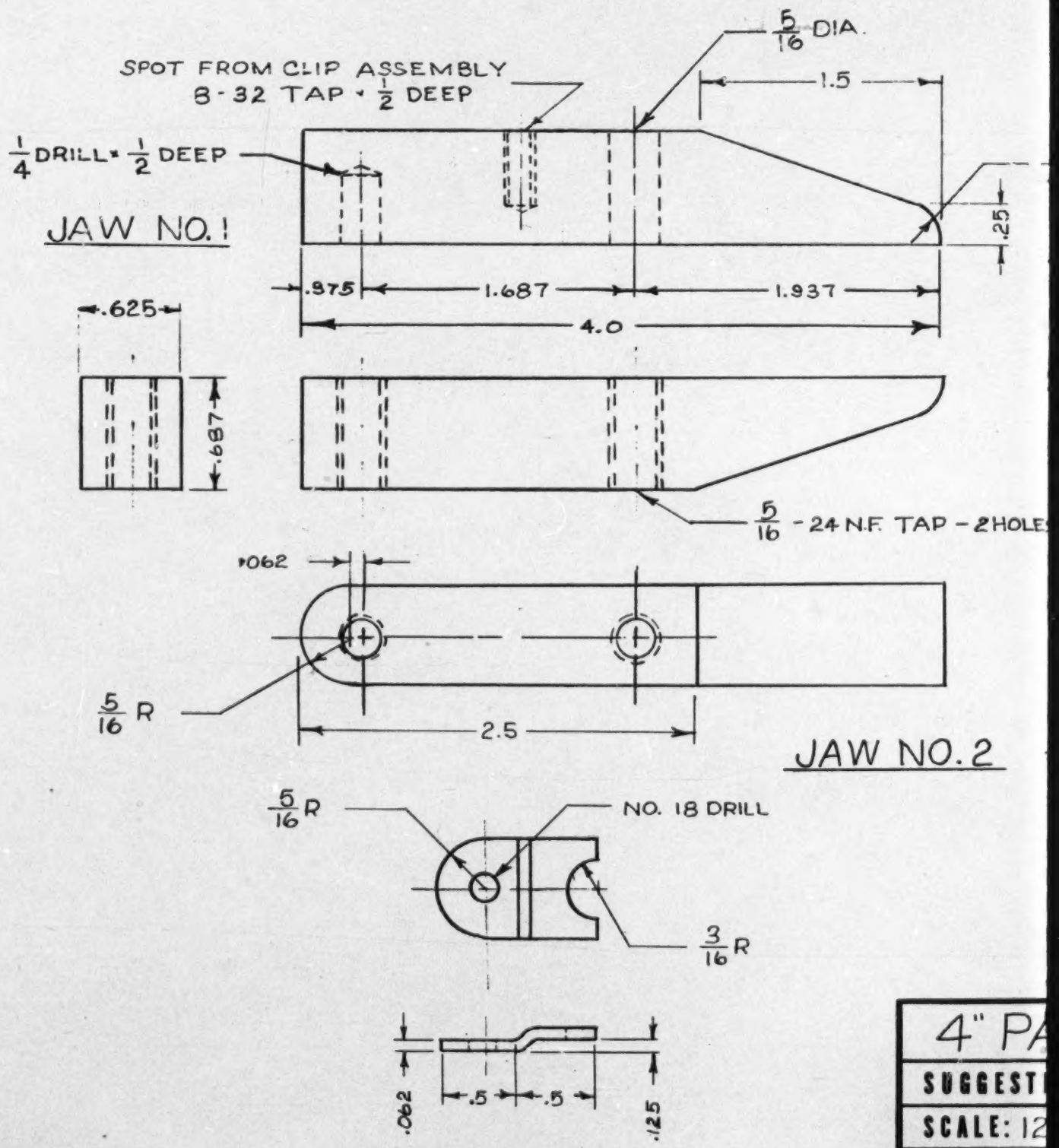
5/16 DIA.
SPOT FROM CLIP ASSEMBLY
8-32 TAP × 1/2 DEEP
1.5
1/4 DRILL × 1/2 DEEP
JAW NO. 1
.25
.975
1.687
1.937
4.0
.625
.687
5/16 - 24 N.F. TAP - 2 HOLES
.062
5/16 R
2.5
JAW NO. 2
5/16 R
NO. 18 DRILL
3/16 R
.062
.5
.5
.125
CLIP
8778
8779
TOLERANCE ± .005
UNLESS OTHERWISE STATED
4" PA
SUGGESTI
SCALE: 12
DRAWN B
MILWAU
IN

M-177

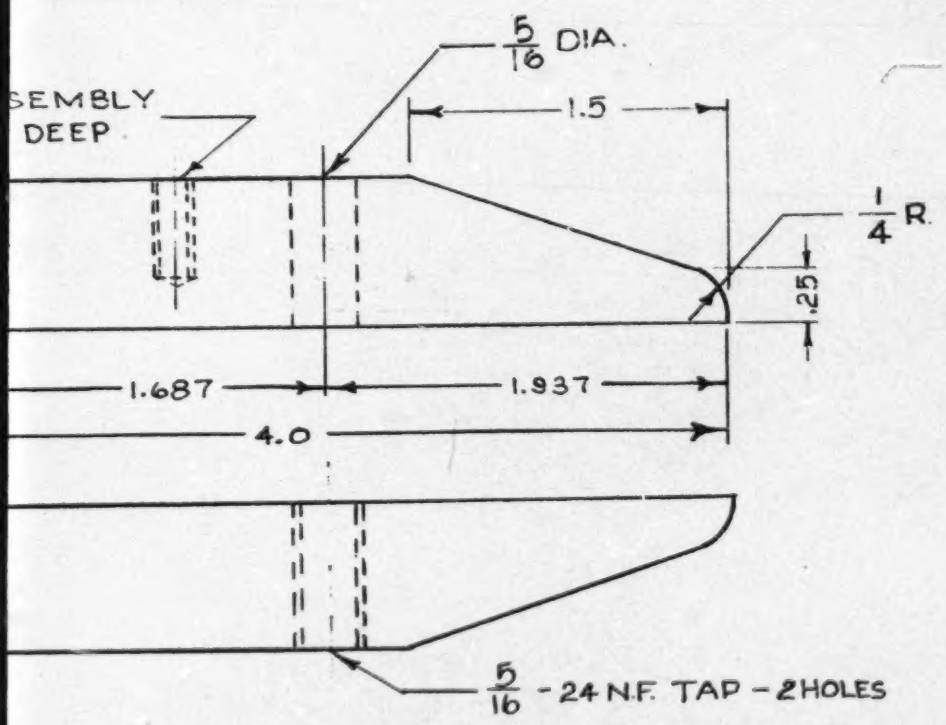

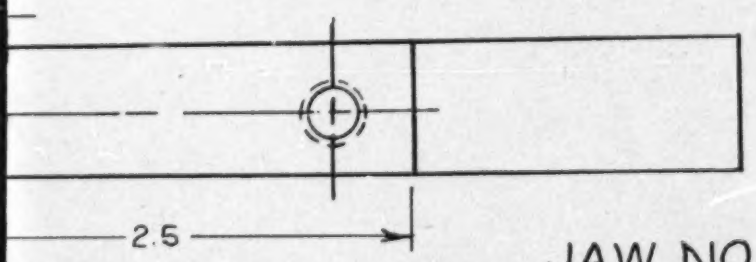

JAW NO. 2

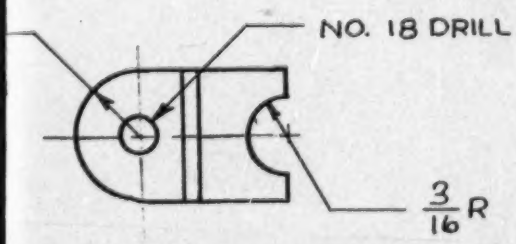

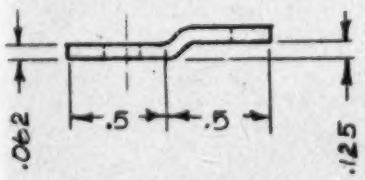

CLIP

8779

TOLERANCE ± .005
UNLESS OTHERWISE STATED

4" PARALLEL CLAMP	
SUGGESTED BY:	
SCALE: 12" = 1'0"	DATE: 6-22-66
DRAWN BY RCT	CHECKED BY RC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

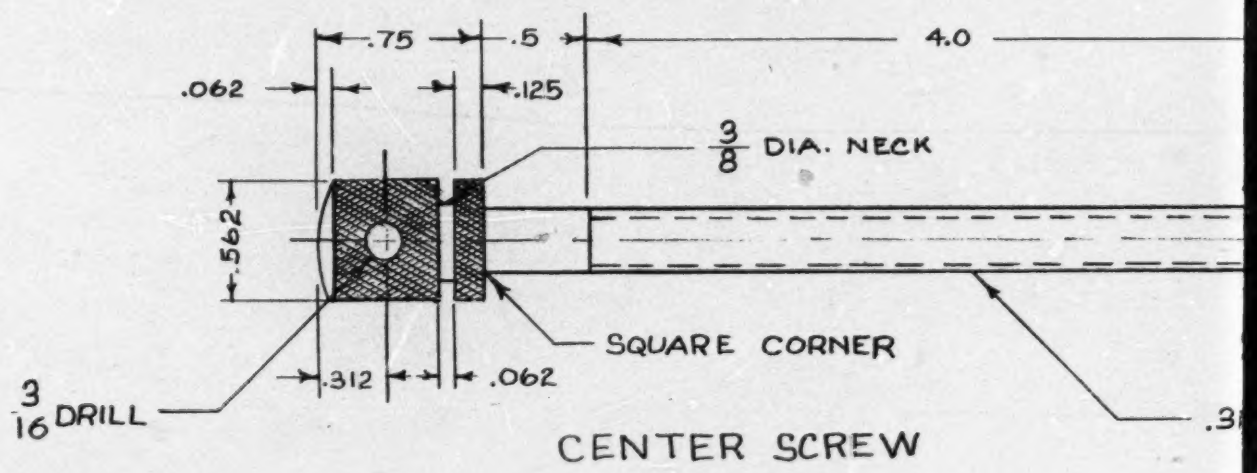

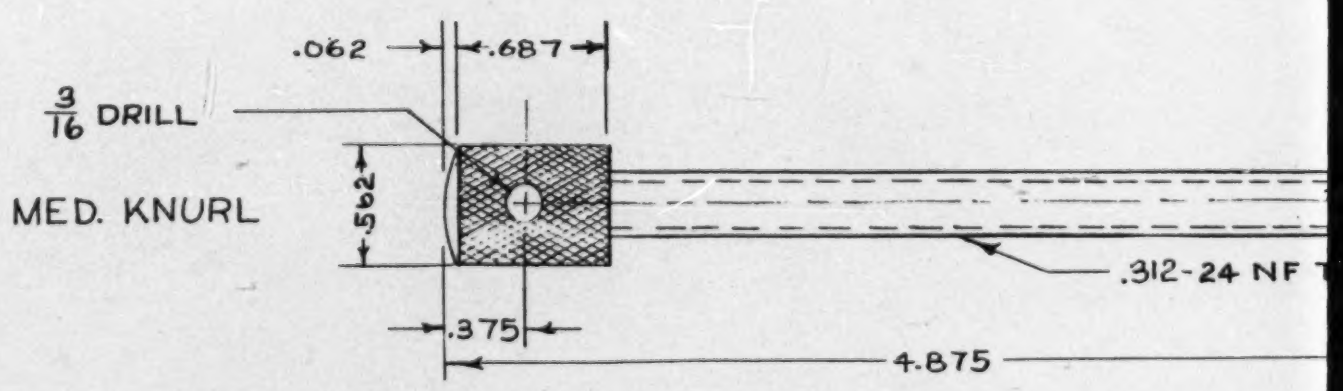

END SCREW

8780

8781

M-177A

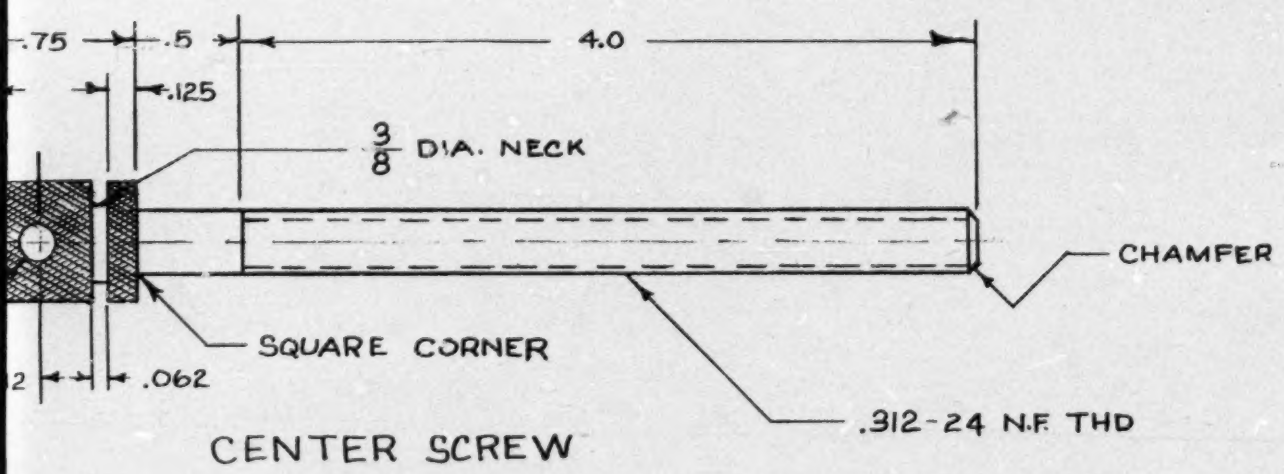

CENTER SCREW

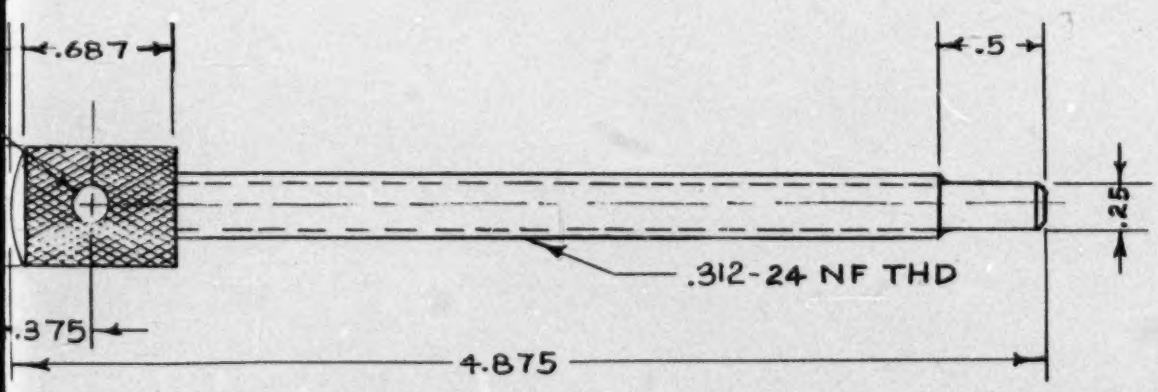

END SCREW

4" PARALLEL CLAMP	
SUGGESTED BY:	
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DRAWN BY R.T.	CHECKED BY NCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8781

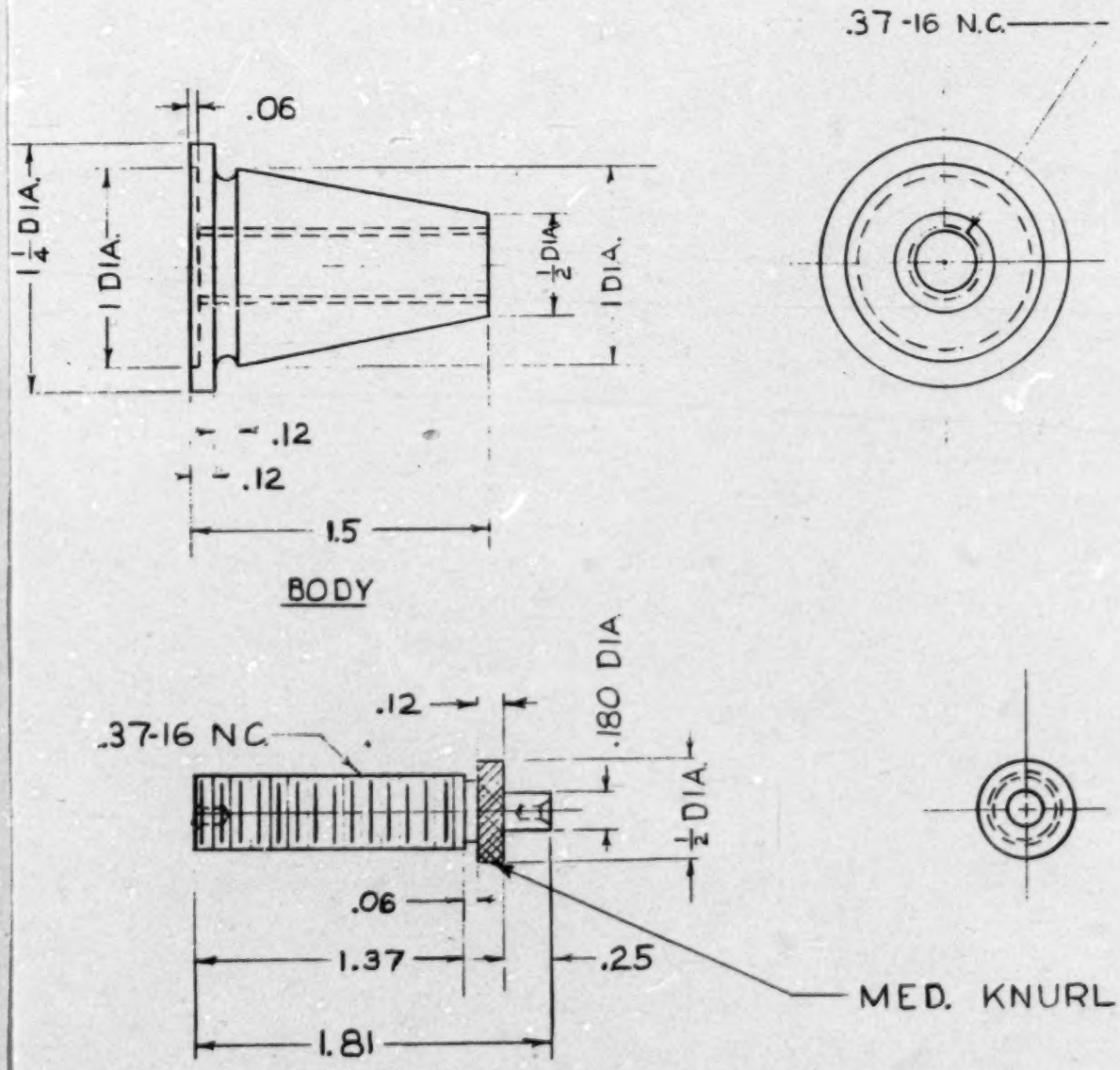
.37-16 N.C.
.06
1 1/4 DIA.
1 DIA.
1/2 DIA.
1 DIA.
.12
.12
1.5
BODY
.12
.180 DIA
.37-16 N.C.
1/2 DIA.
.06
1.37
.25
1.81
MED. KNURL

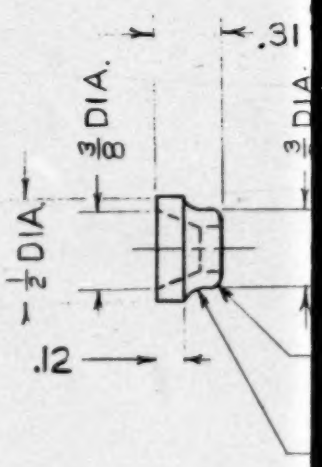
.31
3/8 DIA.
1/2 DIA.
.12

8782

8783

M-178

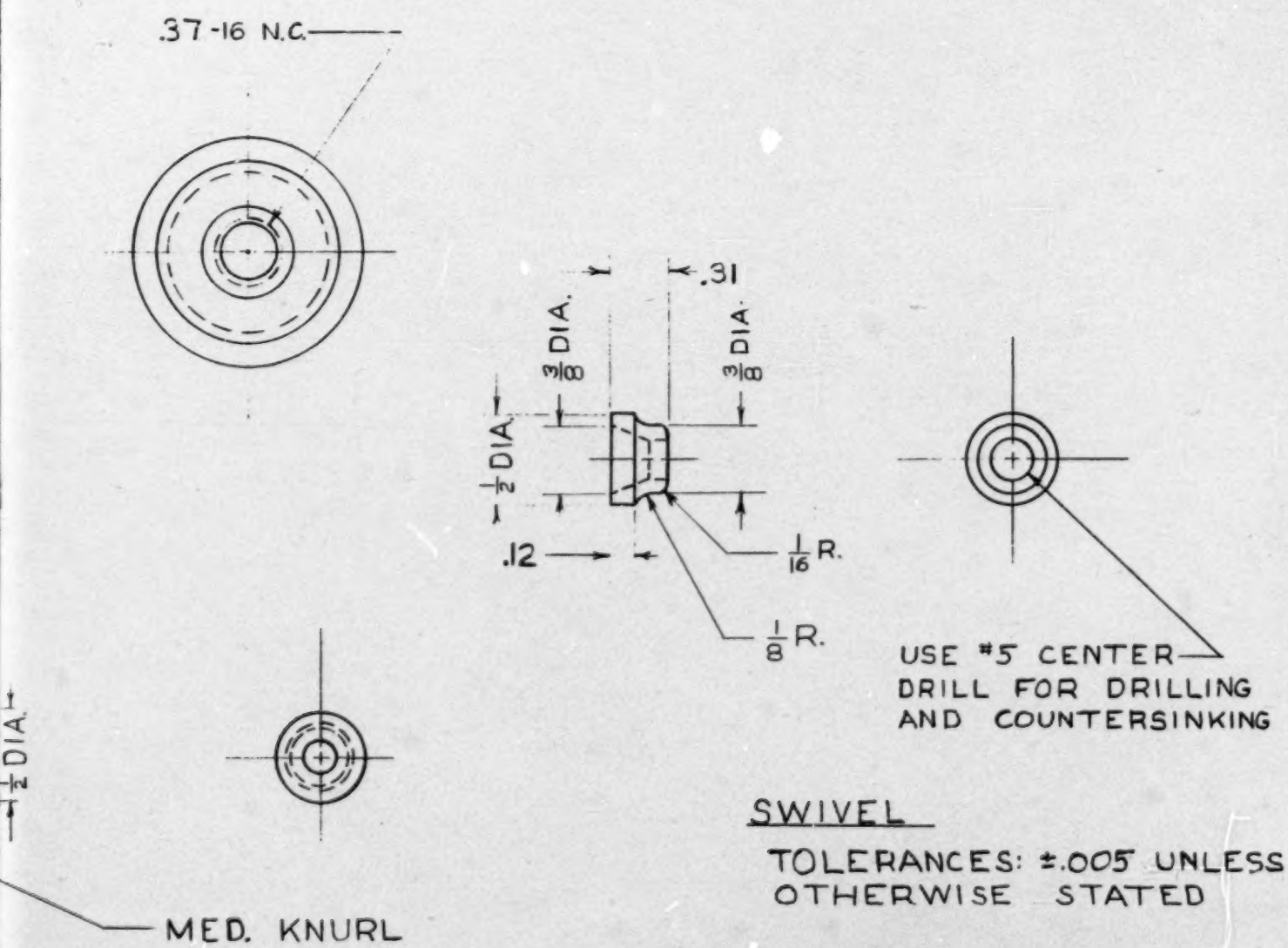

SWIVEL

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

SMALL JACK SCREW DETAILS	
SUGGESTED BY:	
SCALE: 1":1"	DATE: 6-22-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8783

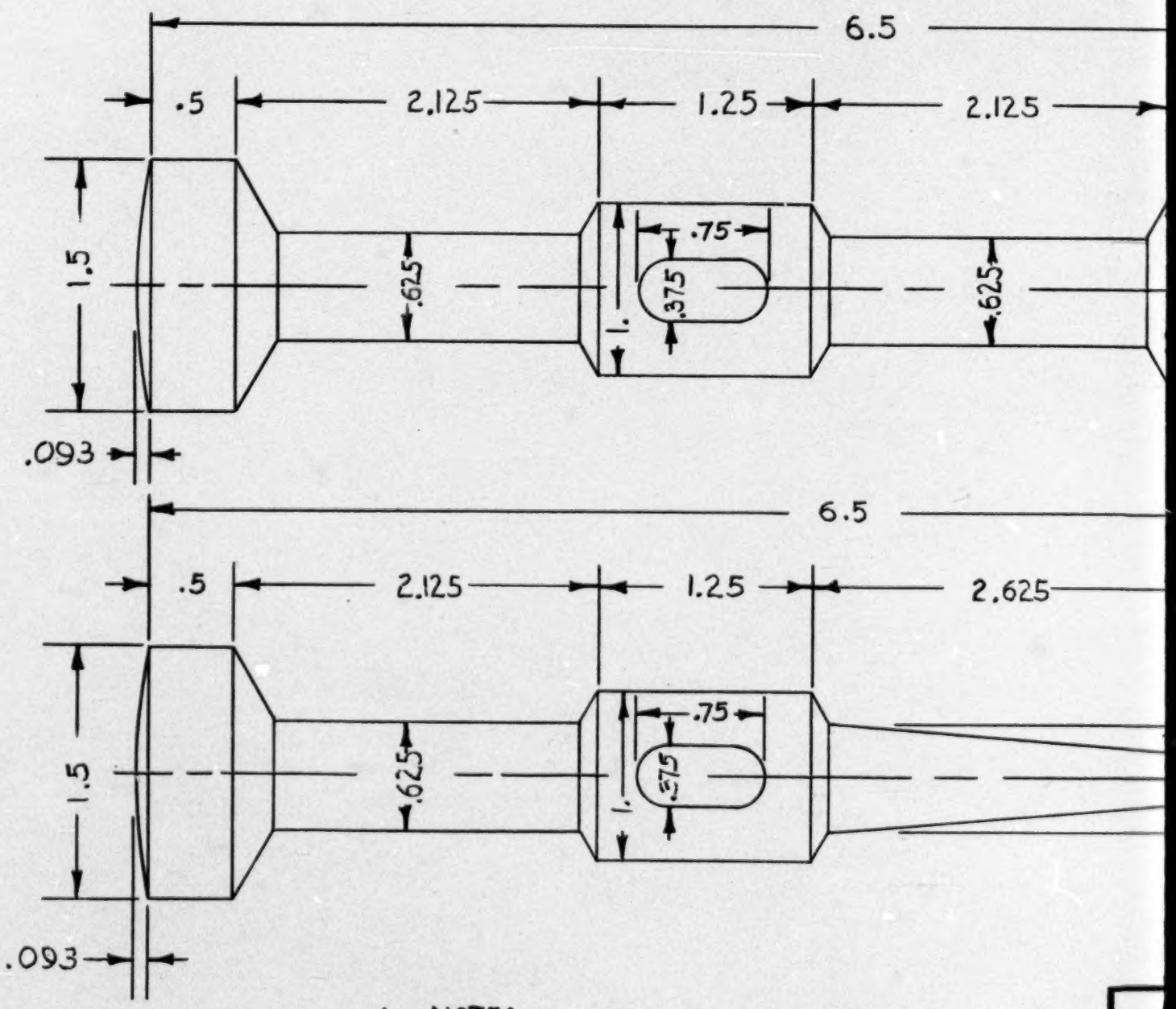

NOTE:
ALL CHAMFERS 60°

8784

8785

M-179

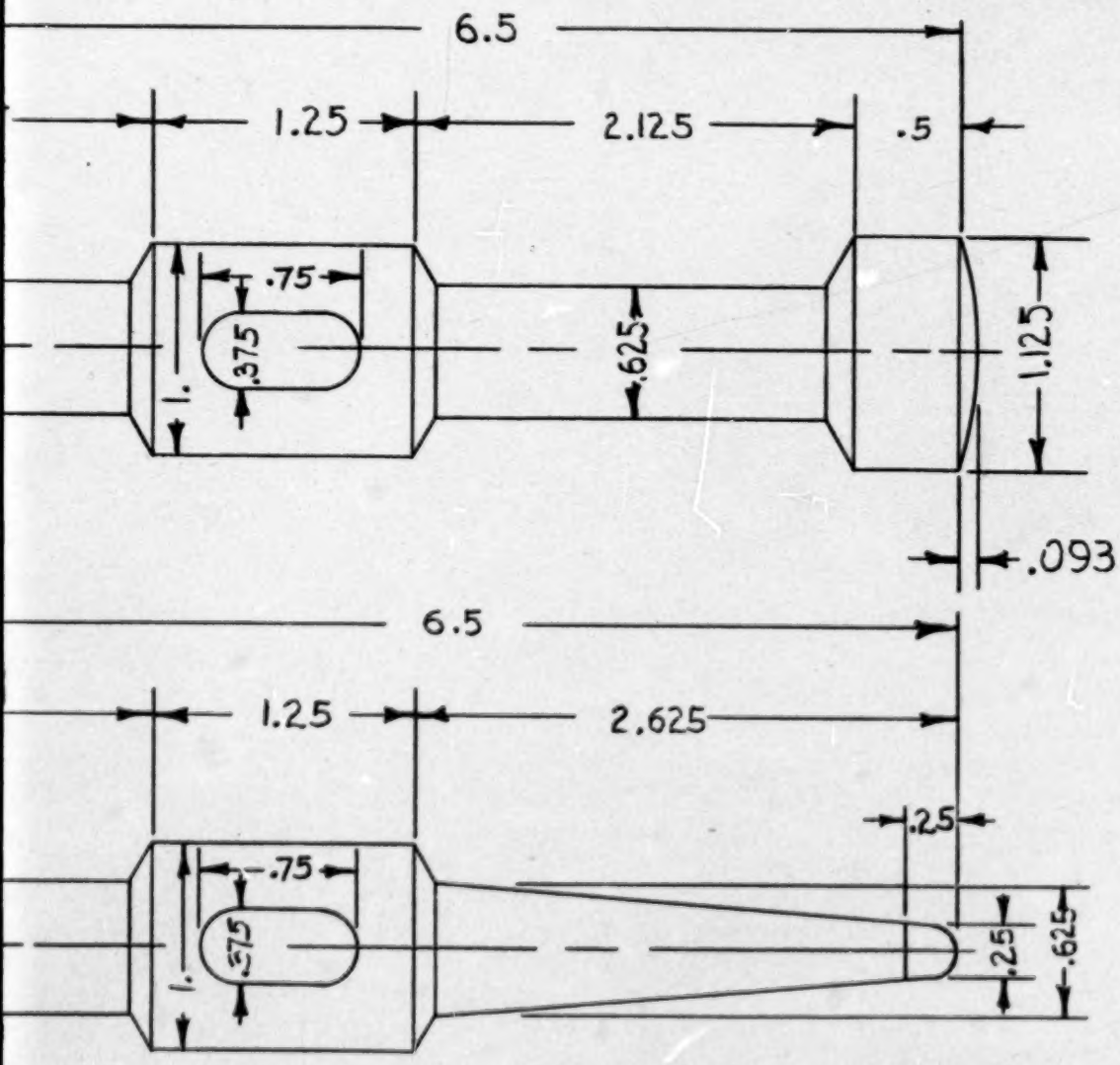

TE:
ALL CHAMFERS 60°

8785

BODY HAMMERS	
SUGGESTED BY:	
SCALE: 12"=1'	DATE: 6-22-66
DRAWN BY R.W.H.	CHECKED BY MC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

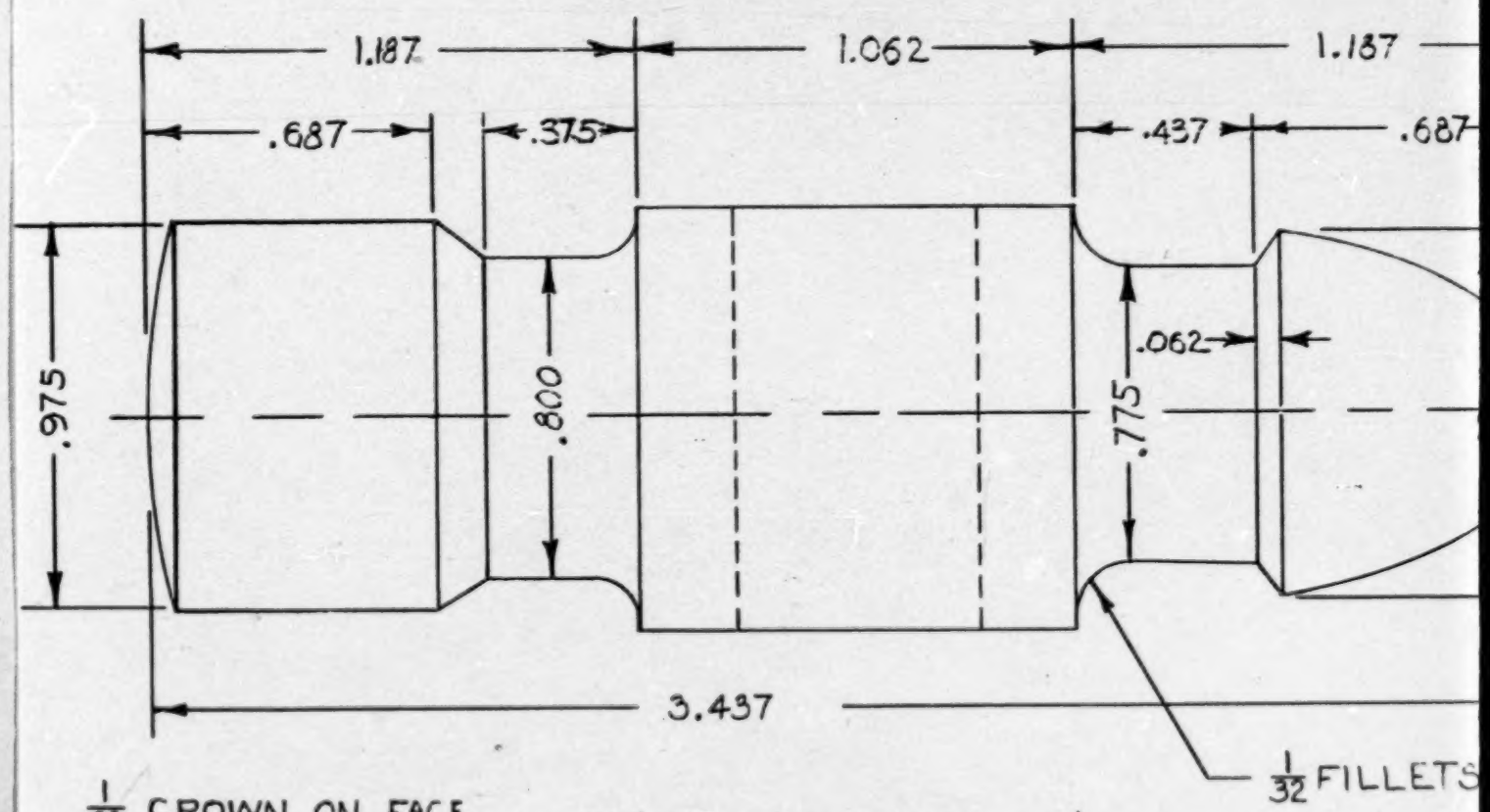

1/32 CROWN ON FACE

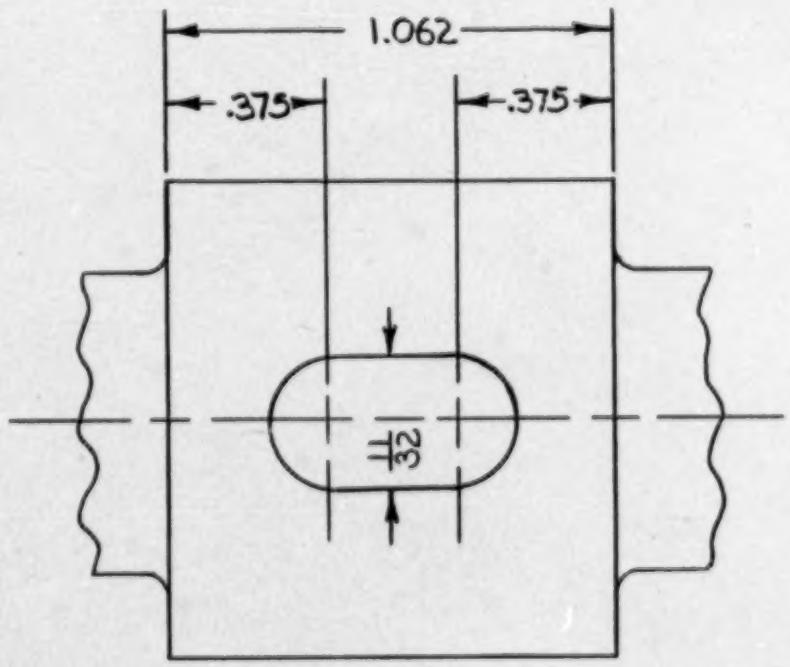

8786

8787

M-180

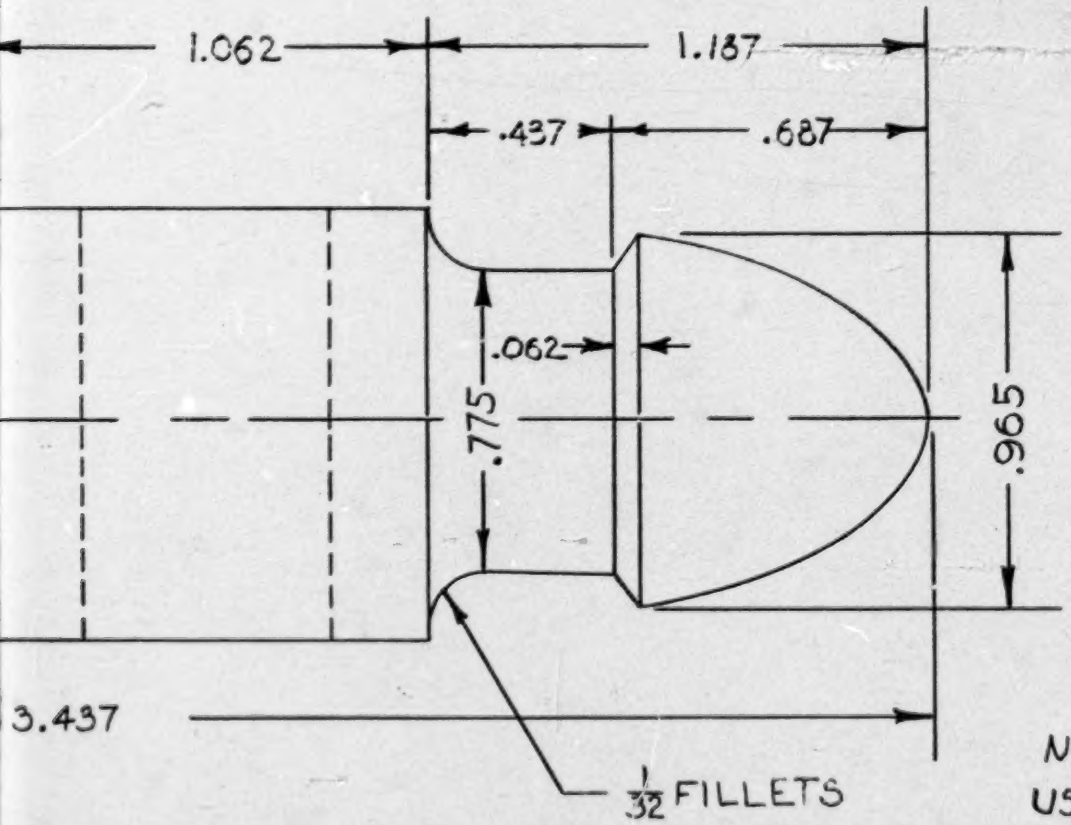

NOTE:
USE 1" STOCK
CUT $3\frac{7}{8}$" LONG
ALL DECIMAL DIMENSIONS $^{+.005}_{-.005}$

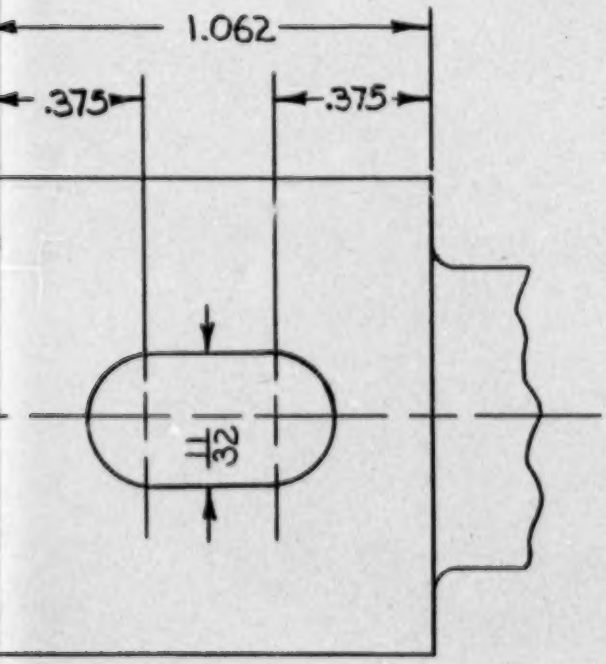

BALL PEEN HAMMER	
SUGGESTED BY: PULASKI HIGH	
SCALE: 2"=1"	DATE: 6-22-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8787

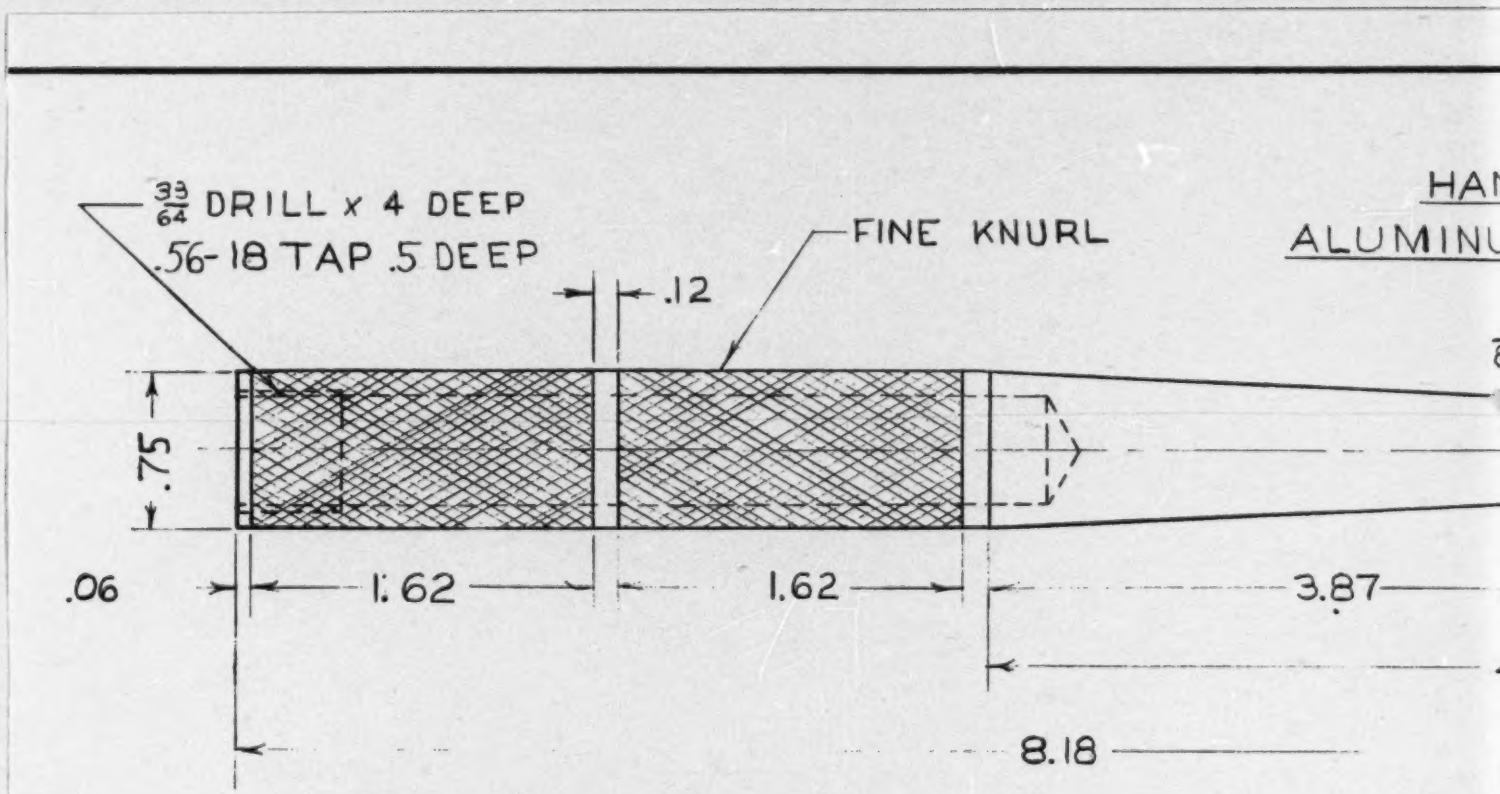

HA
ALUMINU

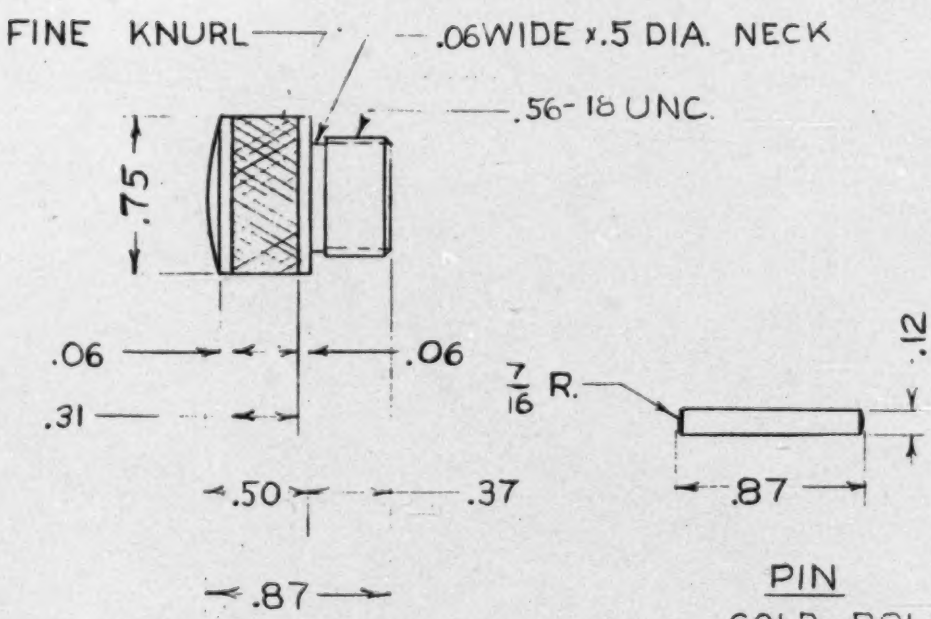

CAP
ALUMINUM - 1 REQ.

PIN
COLD-ROLLED
STEEL - 1 REQ.

HE
TOOL S

TOLERANCES ±.005
UNLESS OTHERWISE STATED

8788

8789

M-181

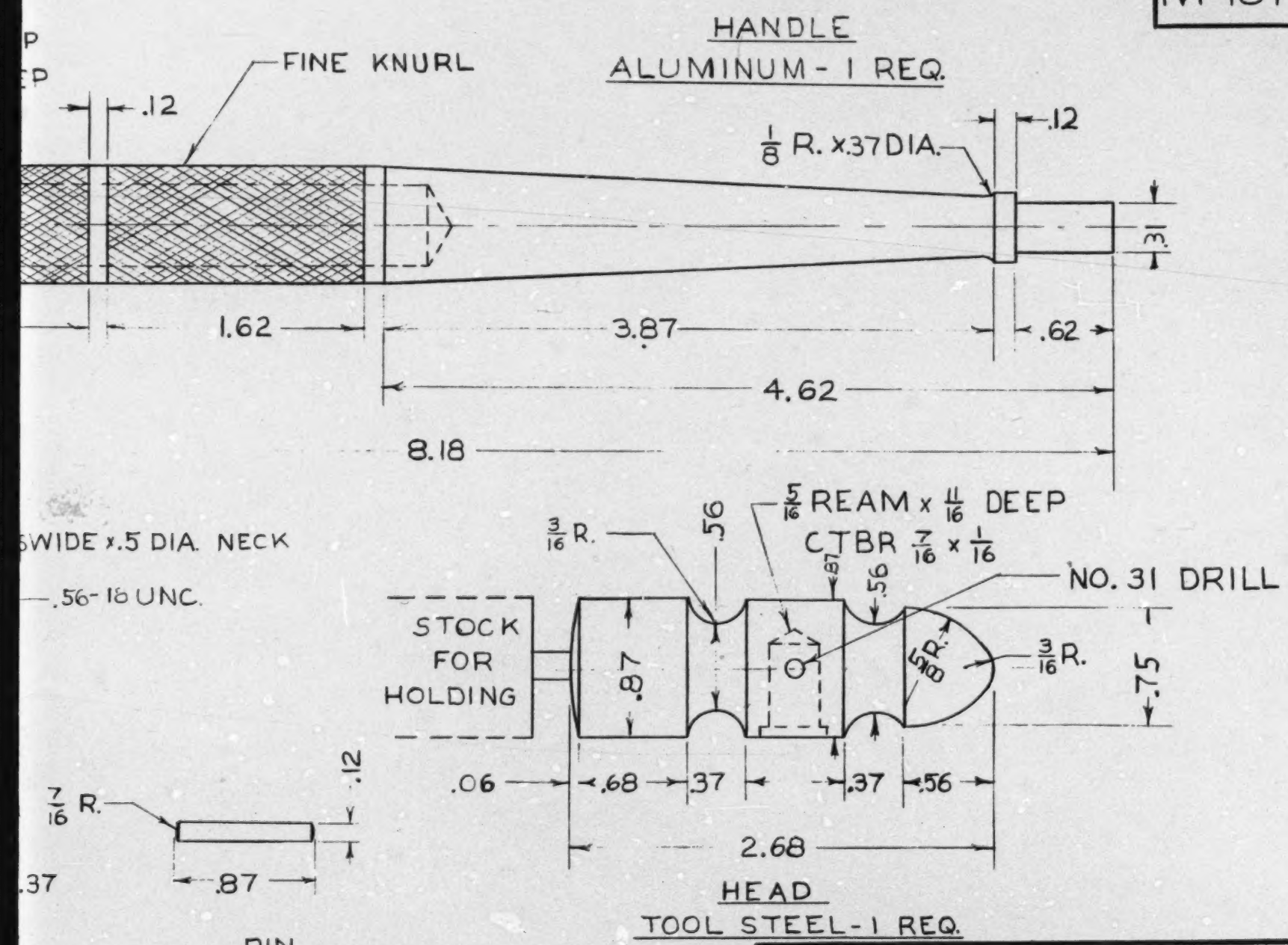

BALL-PEEN HAMMER	
SUGGESTED BY:	
SCALE: 12" = 1'-0"	DATE: 6-22-66
DRAWN BY T.S.S.	CHECKED BY NC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

TOLERANCES ±.005
UNLESS OTHERWISE STATED

8789

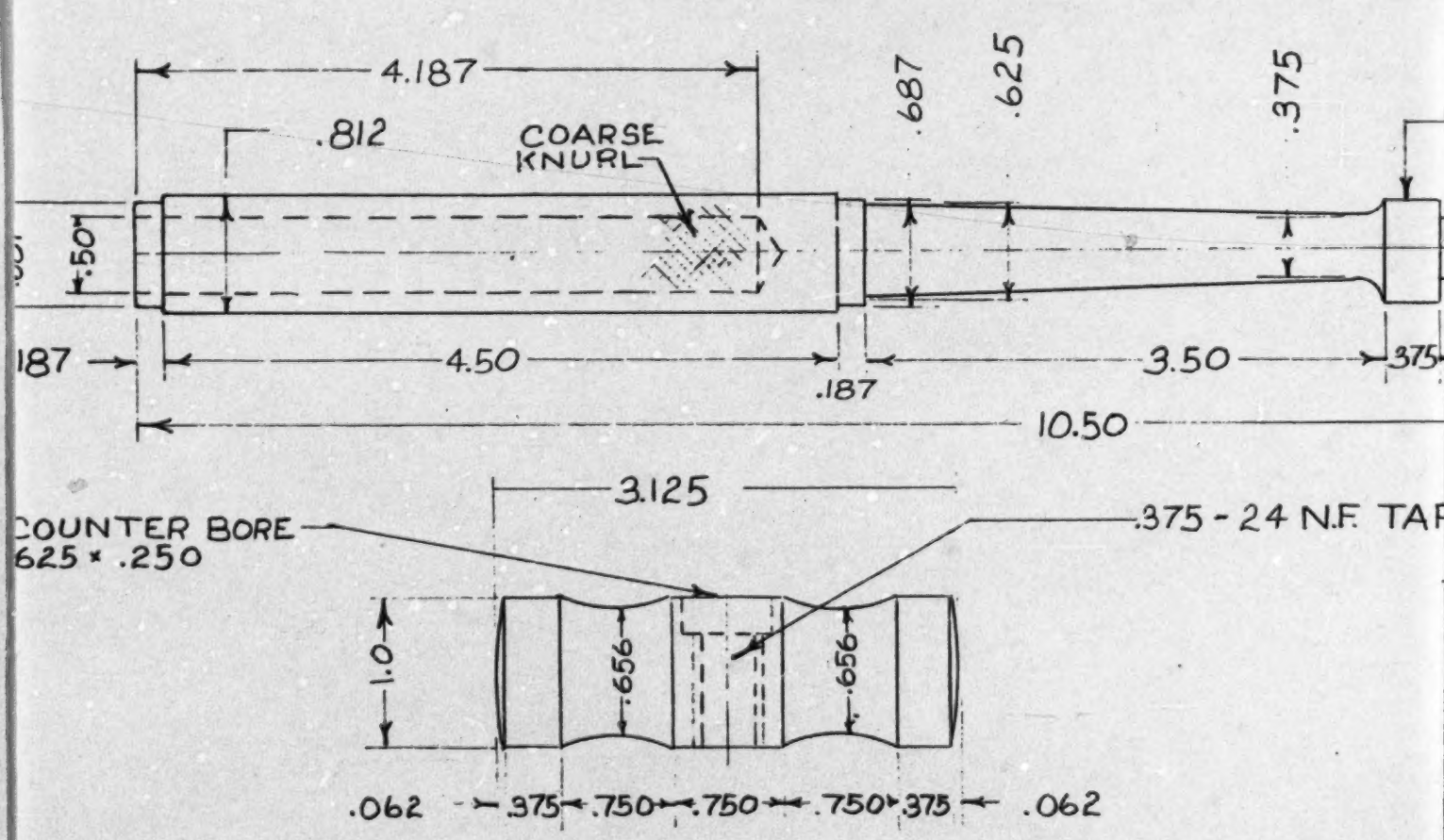

8790

TOLERANCE ±.005
UNLESS OTHERWISE STATED

8791

M-182

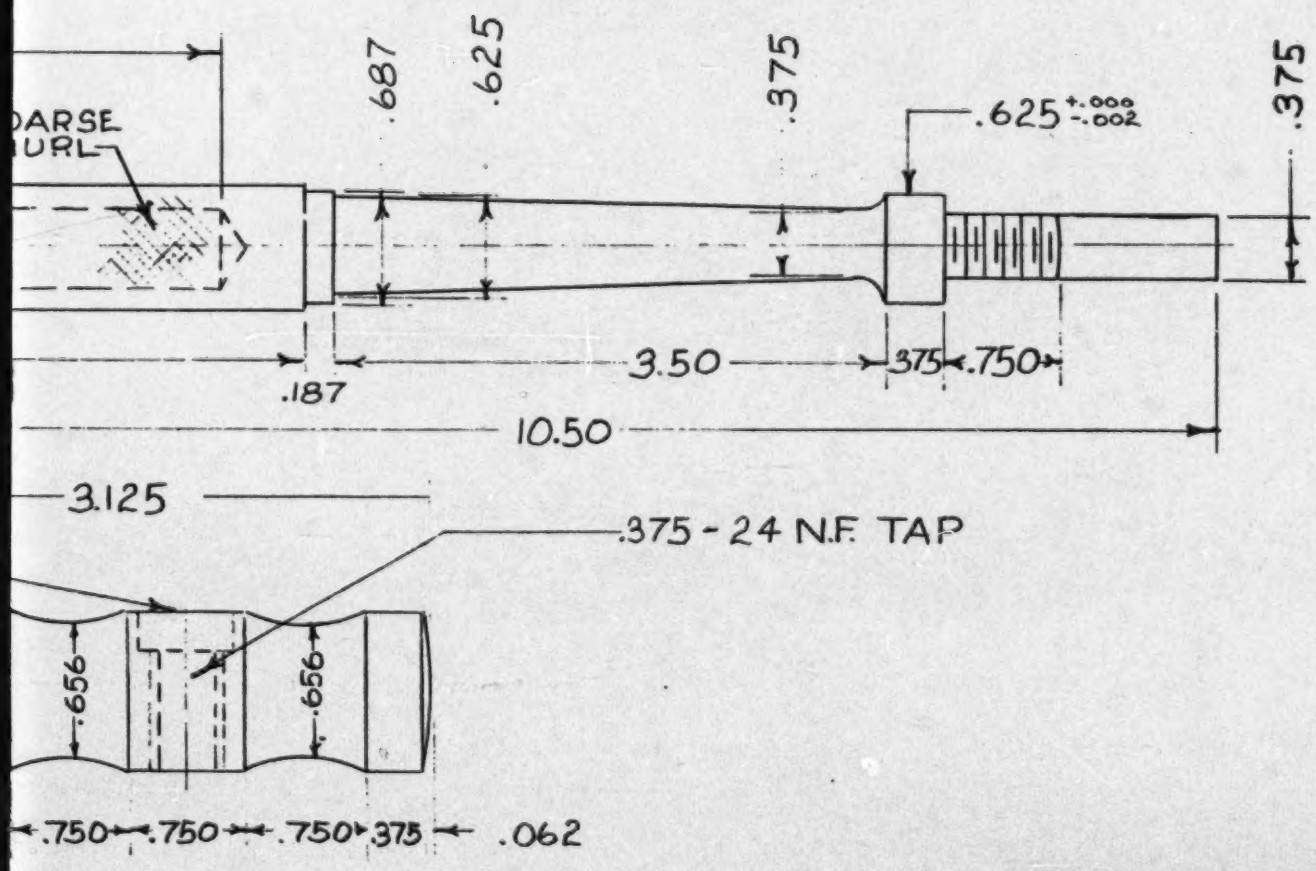

BRASS HAMMER	
SUGGESTED BY:	
SCALE: 9" = 1'0"	DATE: 6-22-66
DRAWN BY R.T.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

TOLERANCE ±.005
UNLESS OTHERWISE STATED

OPERATION #1

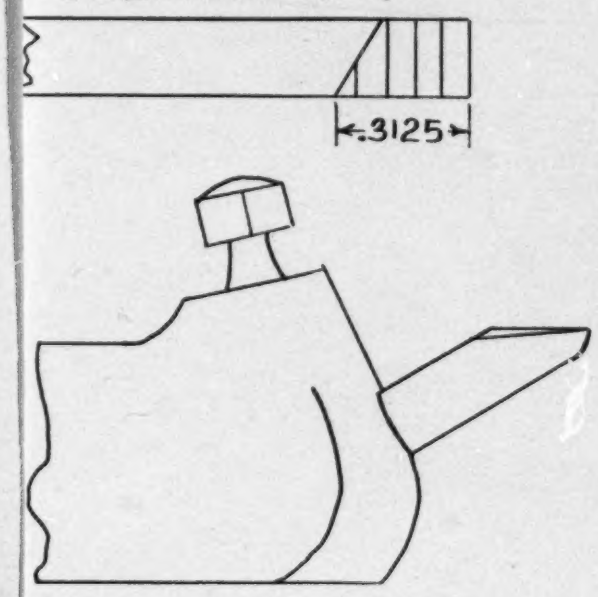

GRIND TOP OF TOOL

1. GRIND PARALLEL TO TOP OF TOOL HOLDER.
2. 4° – SIDE RAKE
3. HOLD PERPENDICULAR TO CENTER LINE OF WHEEL WHEN GRINDING.
4. ONE CLEAN CUT

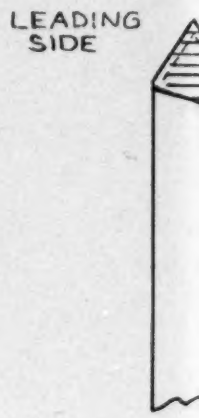

OPERATION #2

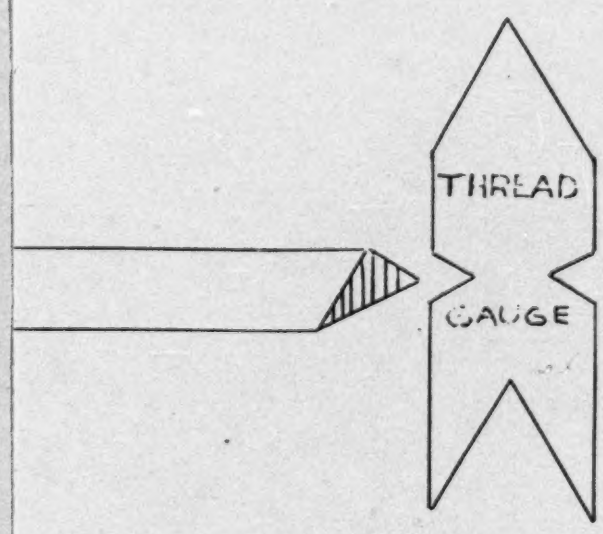

GRIND TOOL TO FIT GAUGE

1. ROUGH TOOL TO FIT GAUGE
2. HOLD CUTTING EDGE PERPENDICULAR TO CENTERLINE OF WHEEL.
3. ONE CLEAN CUT.

8792

8793

GRIND TOP OF TOOL
GRIND PARALLEL TO
TOP OF TOOL HOLDER.
4° – SIDE RAKE
HOLD PERPENDICULAR
TO CENTER LINE OF
WHEEL WHEN GRINDING.
ONE CLEAN CUT

OPERATION #3

M-183

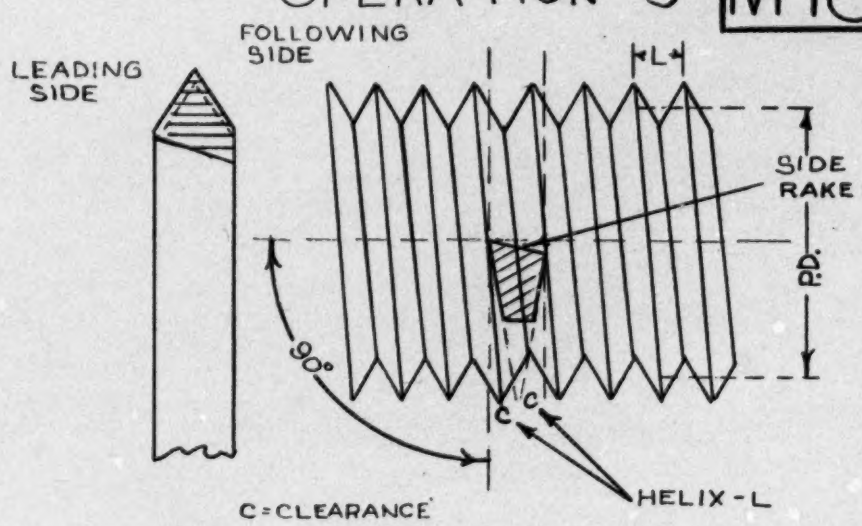

FINISH GRIND CUTTING EDGE
1. LEADING SIDE, CLEARANCE + HELIX ANGLE
2 FOLLOWING SIDE, CLEARANCE – HELIX ANGLE
3. GRIND LEADING SIDE WITH PROPER CLFARANCE AND STRAIGH EDGE.
4. GRIND FOLLOWING SIDE WITH PROPER CLEARANCE AND PERFECT FIT TO GAUGE.
5. ONE CLEAN CUT

GRIND TOOL TO FIT GAUGE
1. ROUGH TOOL TO FIT GAUGE
2. HOLD CUTTING EDGE PERPENDICULAR TO CENTERLINE OF WHEEL.
3 ONE CLEAN CUT.

V THREAD TOOL	
SUGGESTED BY: M.P.S.	
SCALE: NONE	DATE: 6-23-66
DRAWN BY R.T.	CHECKED BY NCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8793

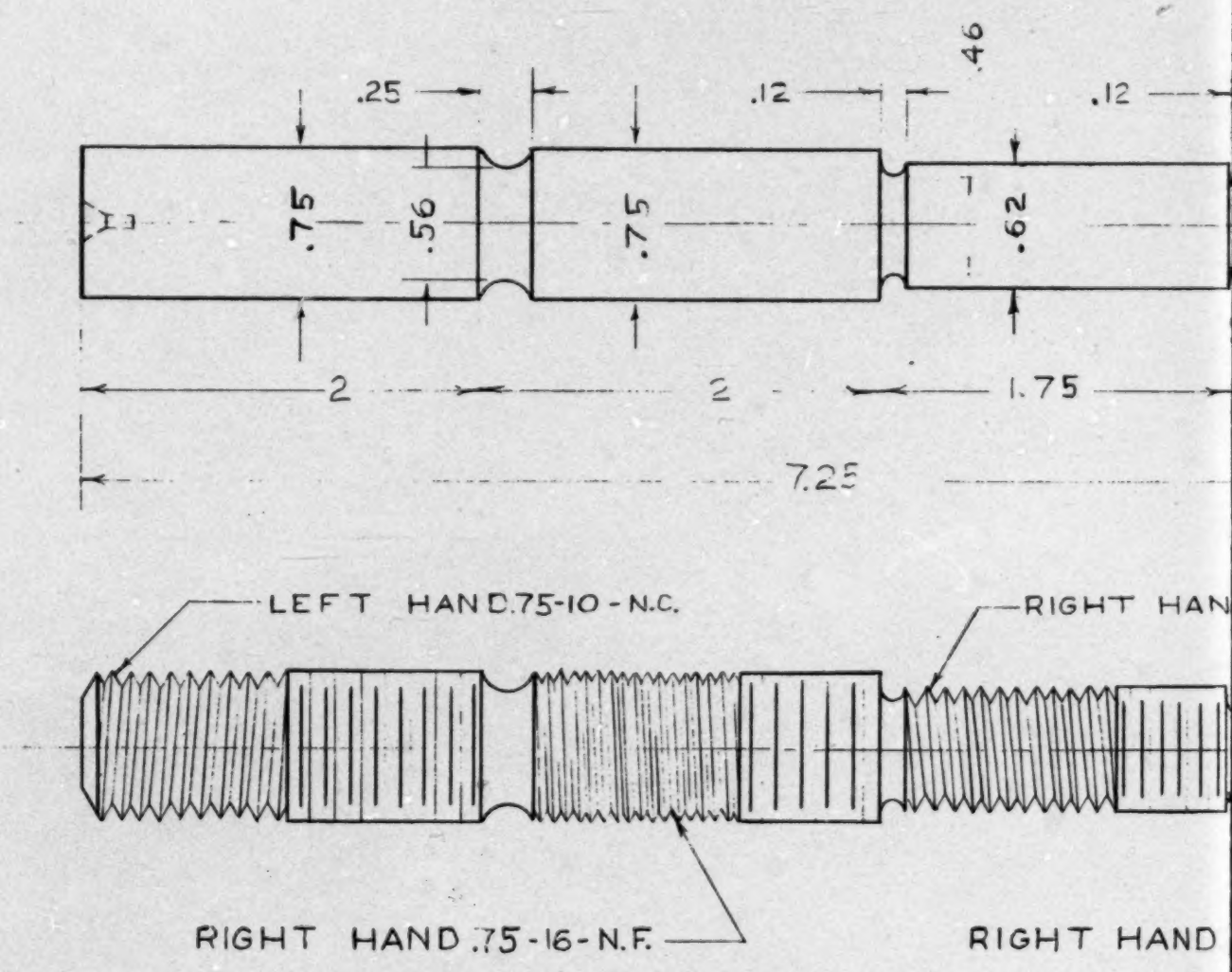

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8794

8795

M-184

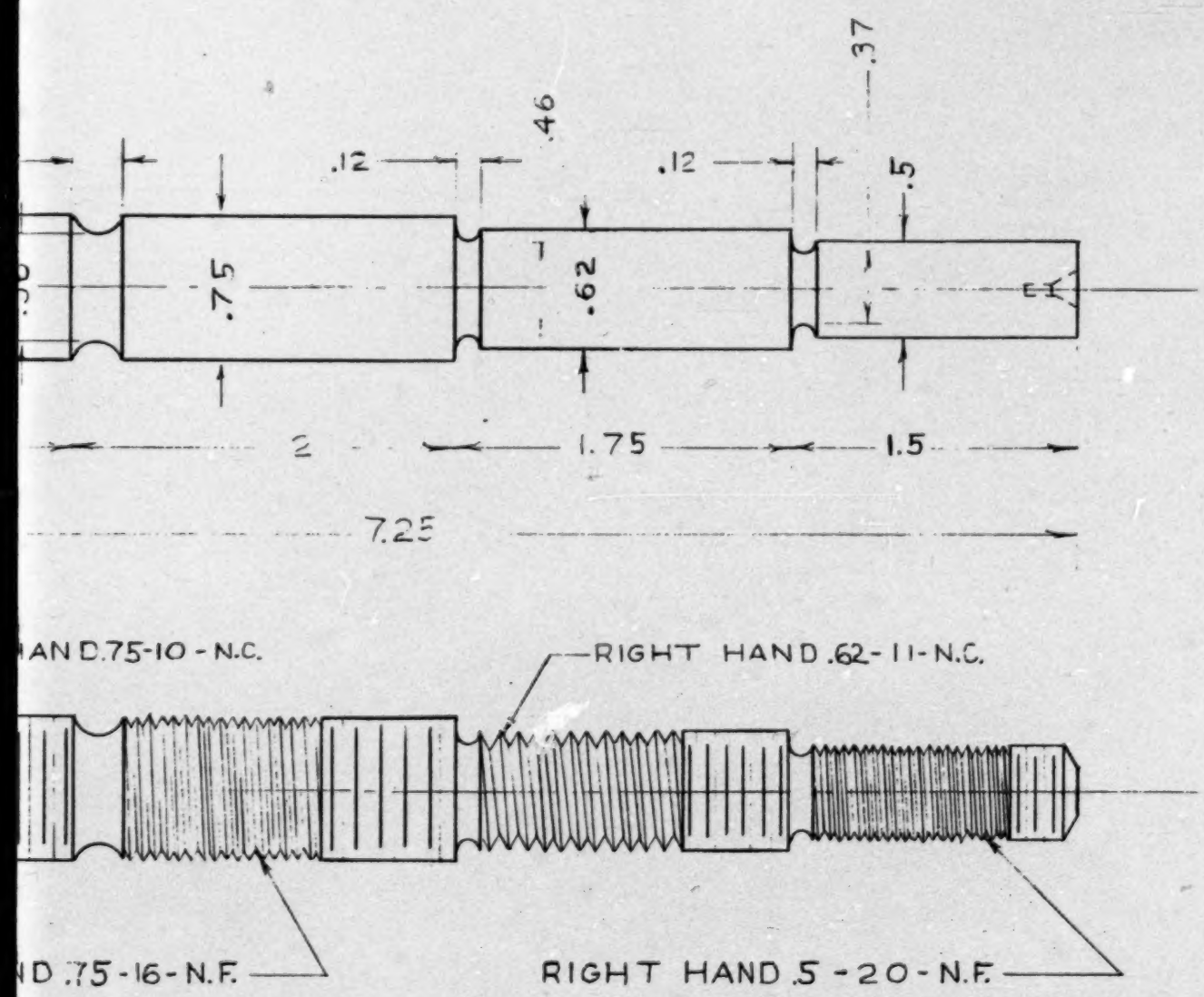

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8795

V-THREAD EXERCISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 6-23-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

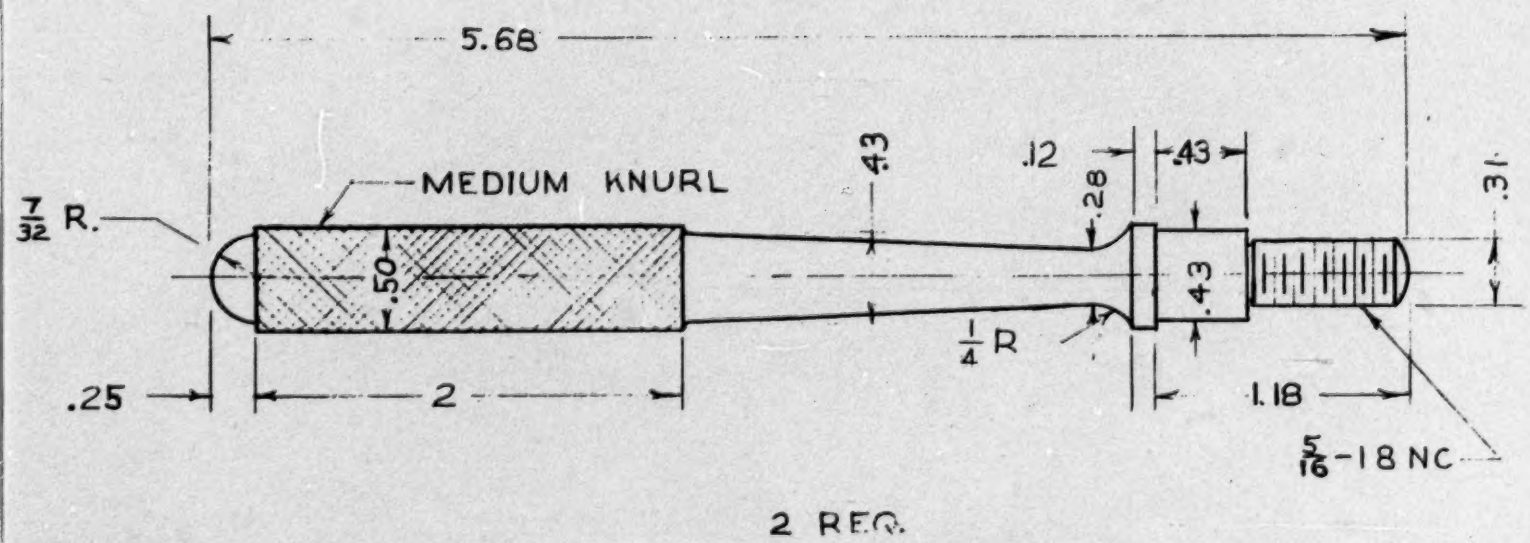

8796

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8797

SUG
SCA
DRA
MI

M-185

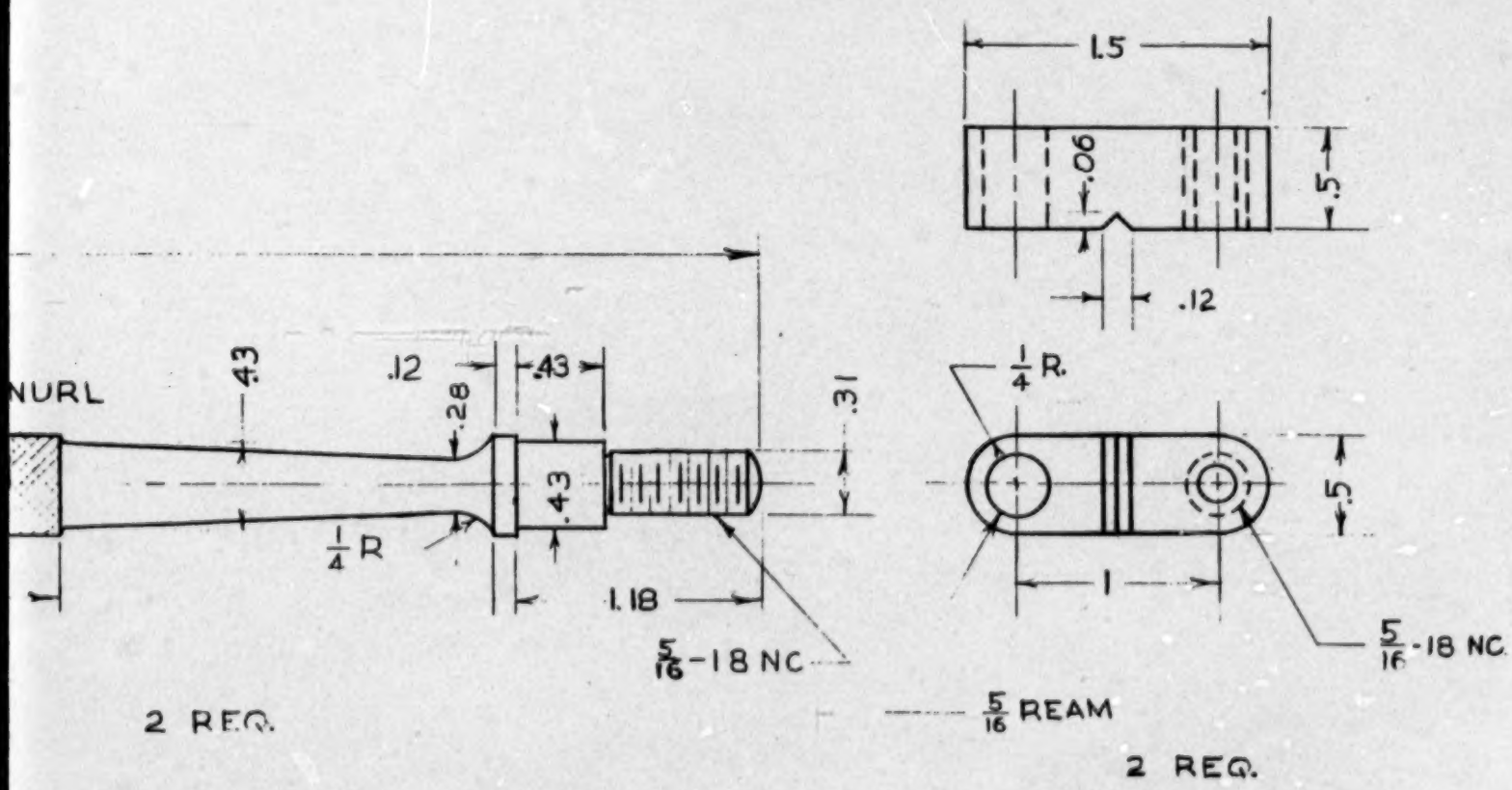

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8797

TAP WRENCH	
SUGGESTED BY:	
SCALE: 12 = 1'-0"	DATE: 6-24-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

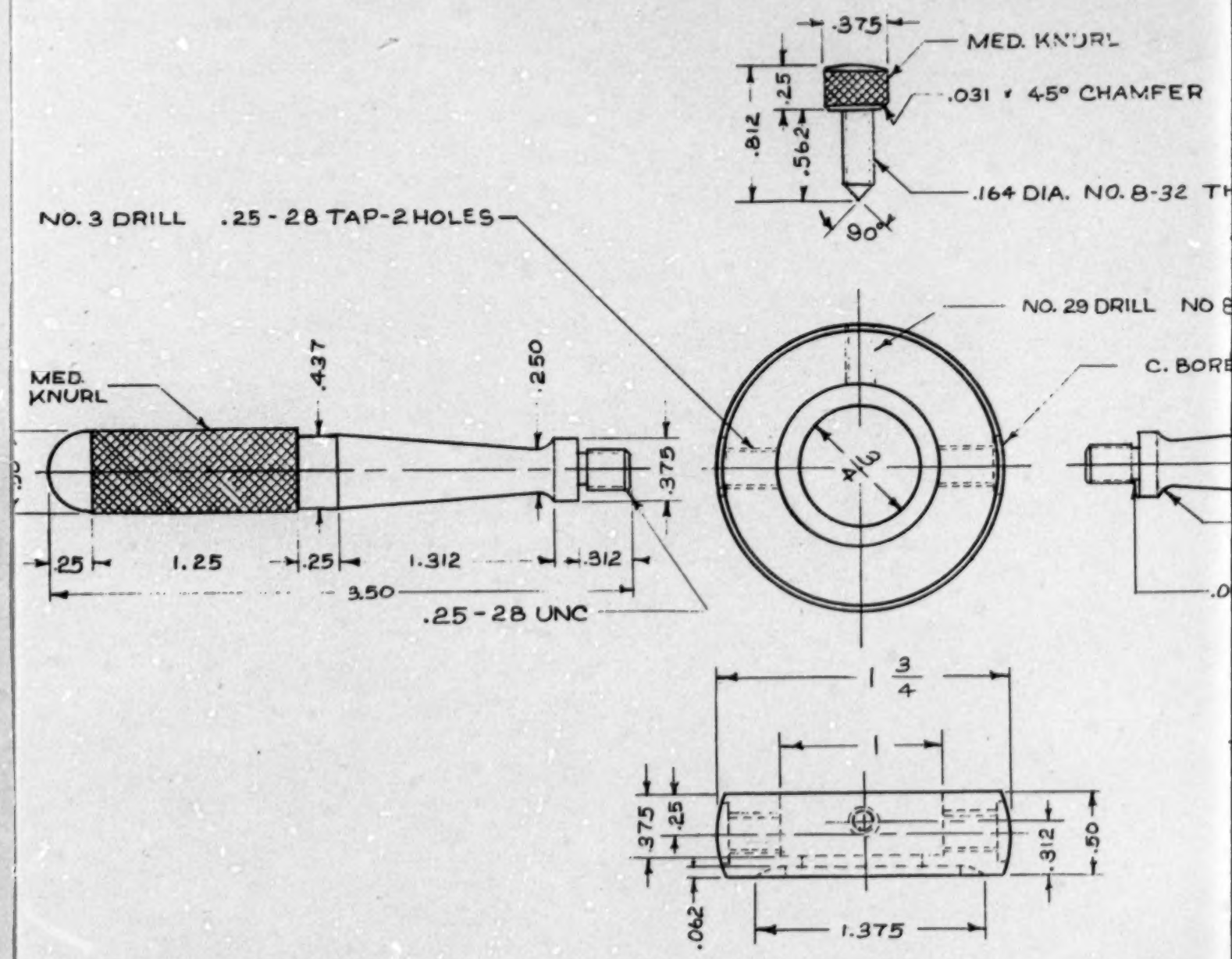

8798

TOLERANCE ±.005
UNLESS OTHERWISE STATED

8799

M-186

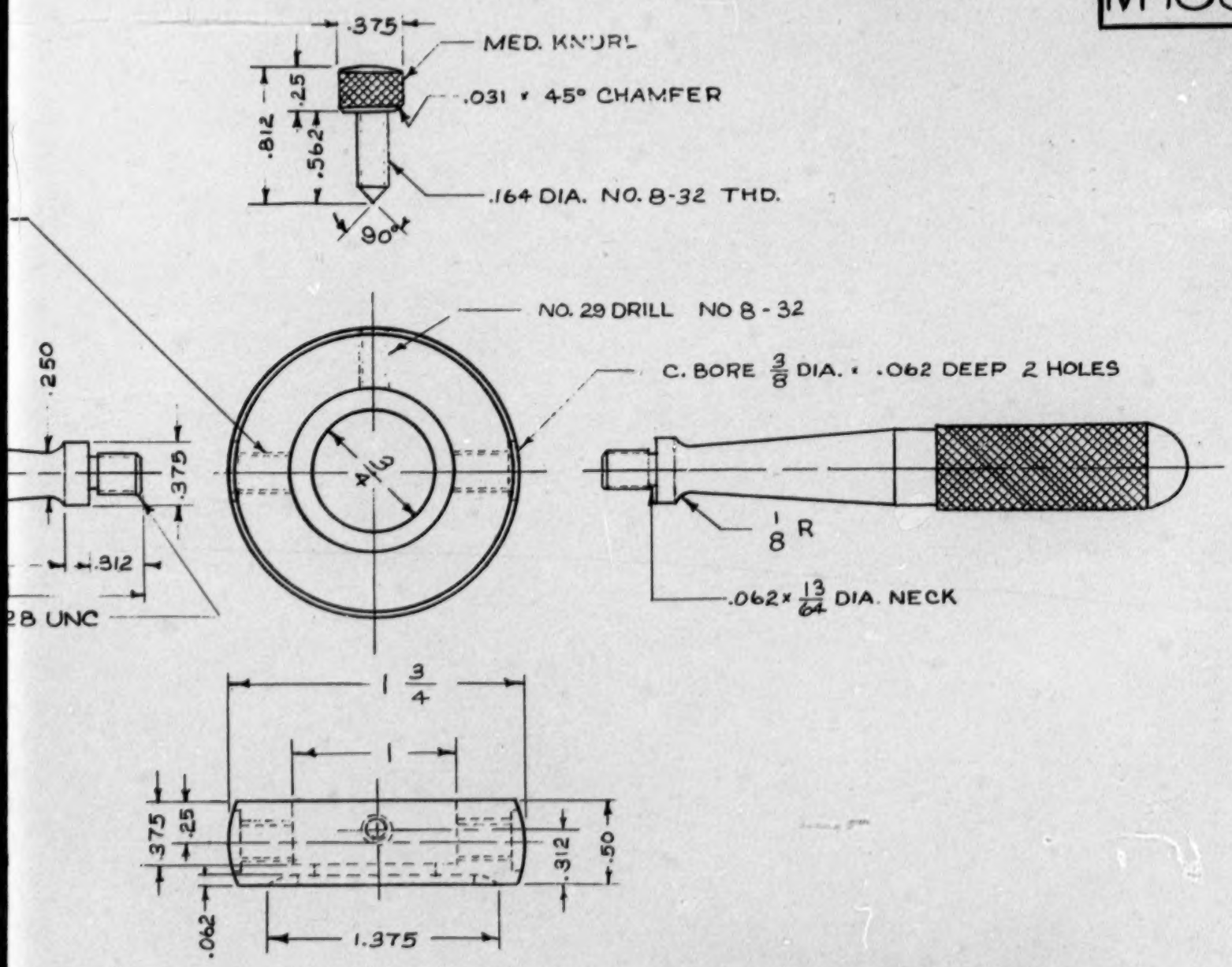

TOLERANCE ±.005
UNLESS OTHERWISE STATED

DIESTOCK	
SUGGESTED BY:	
SCALE: 12" = 1'0"	DATE: 6-24-66
DRAWN BY R.T.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

CASTINGS FROM CASTING SPECIALTIES, CEDARBURG,

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	R	S	T
3	9/16	5 3/8	3/4	4 5/8	1/4	.215	3/8	1/4	.434	7/16-14	5/8	3/8	3/32	7/16	7/32	5/16	1/4	3	3/8
4	.718	7 1/4	1	6 1/4	5/16	.309	7/16	5/16	.622	5/8-11	7/8	7/16	1/8	5/8	5/16	1/2	5/16	4	17/32
5	.781	9 3/8	1 1/4	8 1/8	3/8	.372	1/2	3/8	.685	11/16-11	1	1/2	3/16	11/16	3/8	9/16	3/8	4 1/4	19/32
3	.843	9 1/2	1 1/4	8 1/4	7/16	.372	1/2	3/8	.747	3/4-10	1 1/8	9/16	3/16	3/4	3/8	9/16	3/8	5	21/32

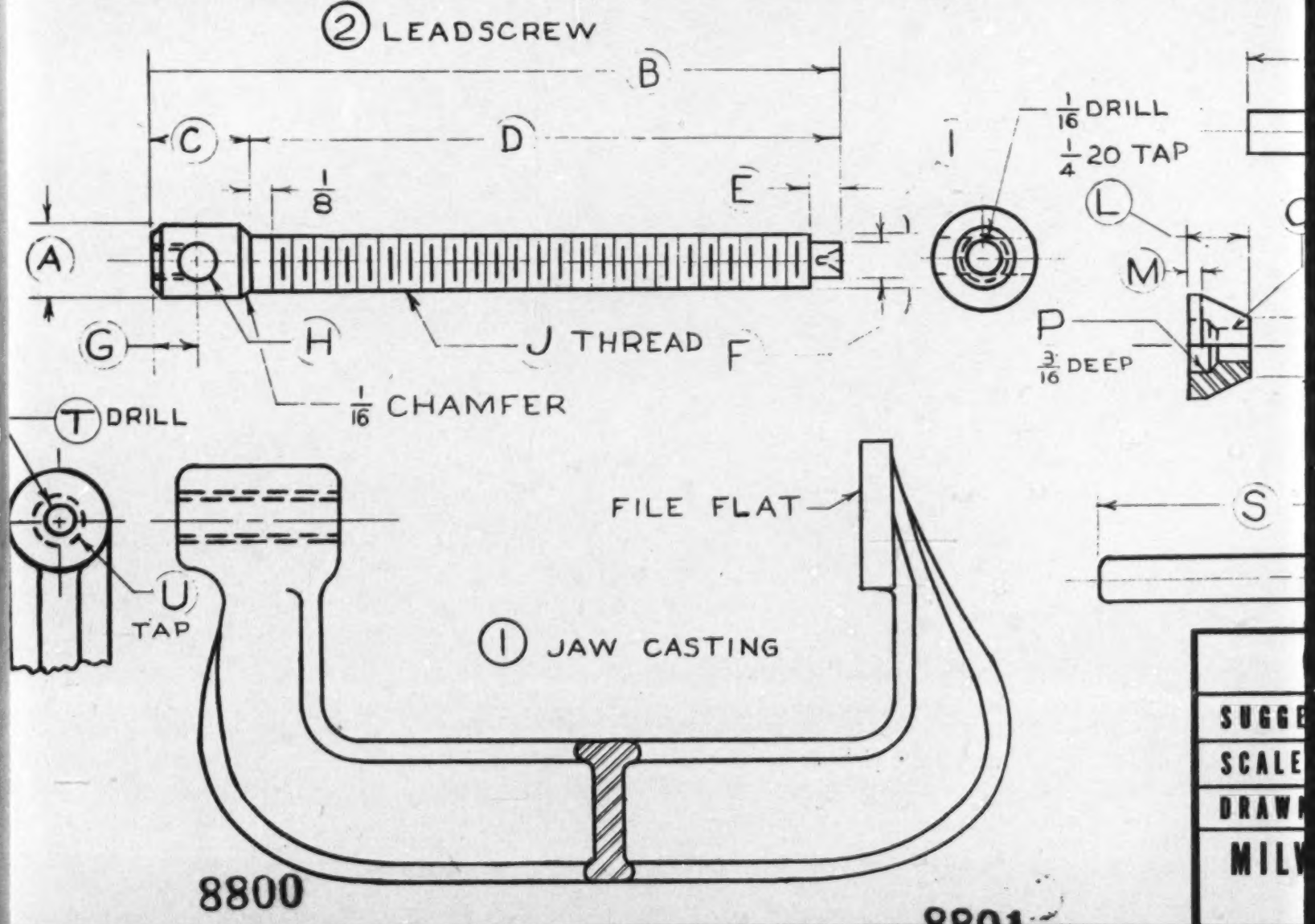

8800

8801

CASTING SPECIALTIES, CEDARBURG, WISCONSIN

M-187

H	I	J	K	L	M	N	O	P	R	S	T	U	V
1/4	.434	7/16-14	5/8	3/8	3/32	7/16	7/32	5/16	1/4	3	3/8	7/16-14	1/4
5/16	.622	5/8-11	7/8	7/16	1/8	5/8	5/16	1/2	5/16	4	17/32	5/8-11	7/16
3/8	.685	11/16-11	1	1/2	3/16	11/16	3/8	9/16	3/8	4 1/4	19/32	11/16-11	1/2
3/8	.747	3/4-10	1 1/8	9/16	3/16	3/4	3/8	9/16	3/8	5	21/32	3/4-10	1/2

TOLERANCES ± .005 UNLESS OTHERWISE STATED

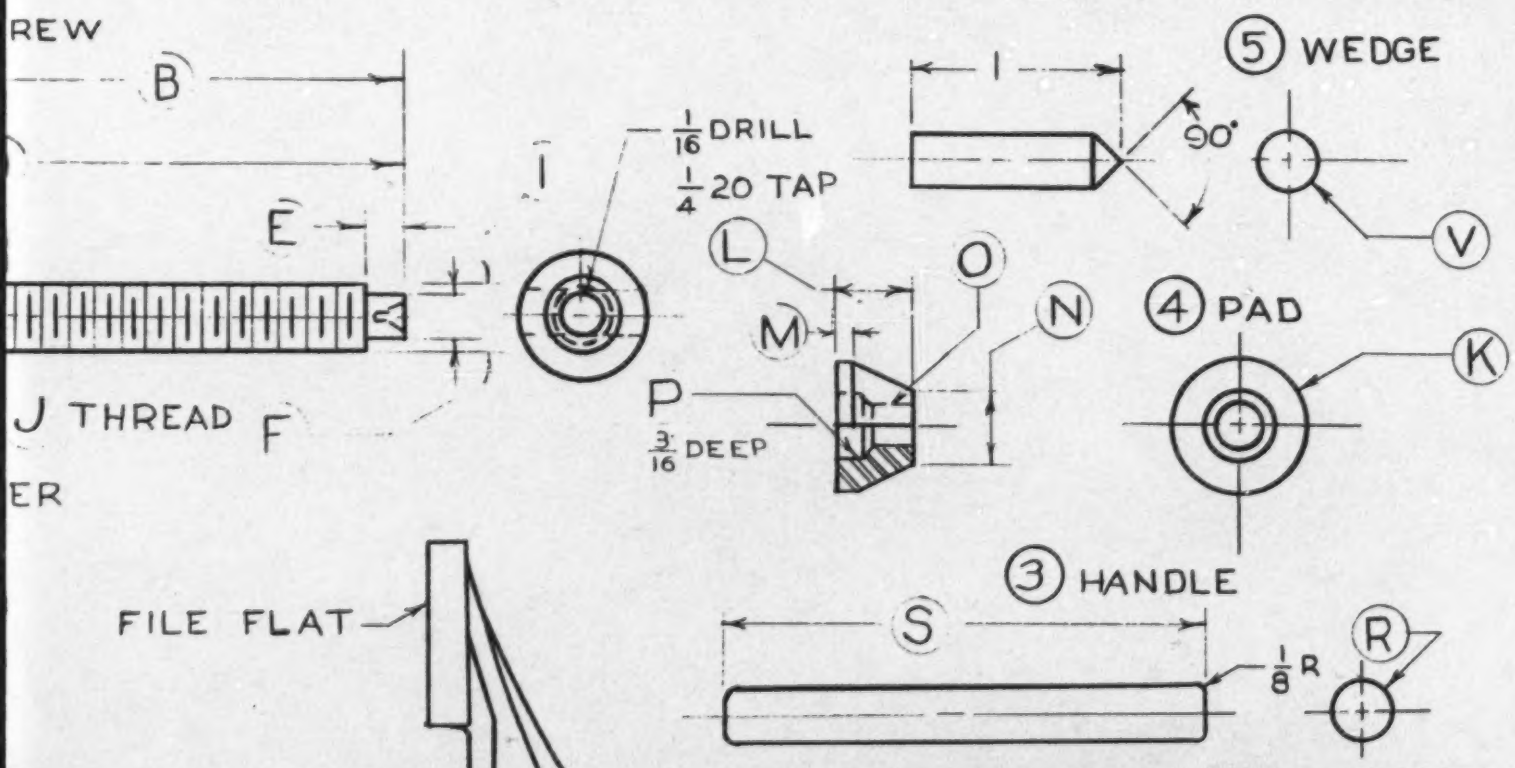

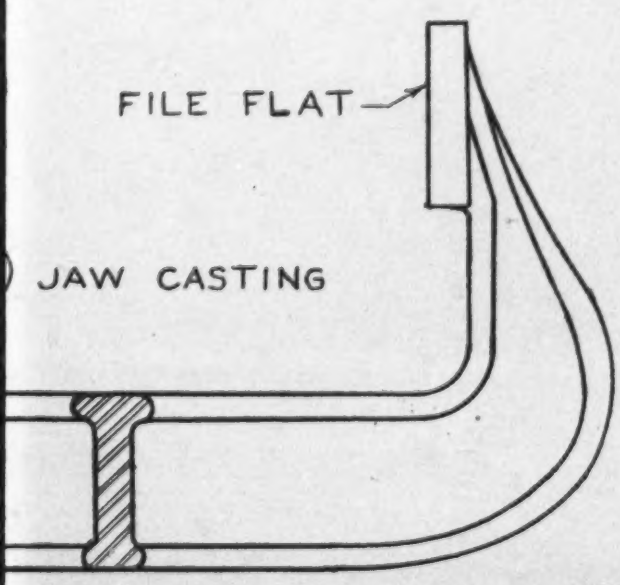

C-CLAMP	
SUGGESTED BY:	
SCALE: NONE	DATE: 6-27-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8801

SCREW - MAT. C.R.S.

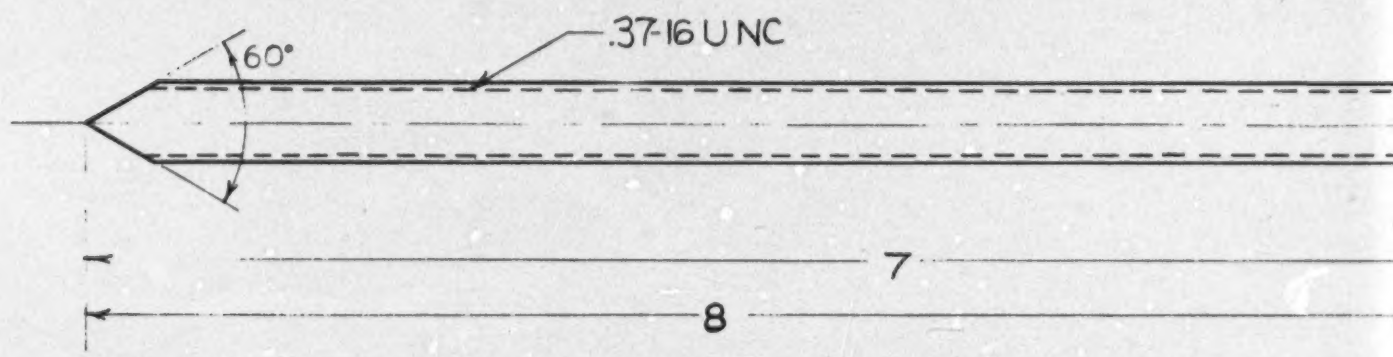

HOOK - 2 REQ.
MAT. MILD STEEL

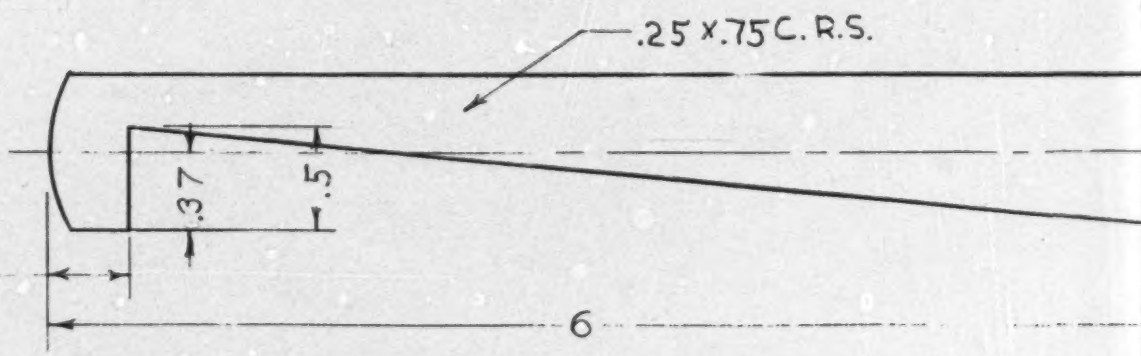

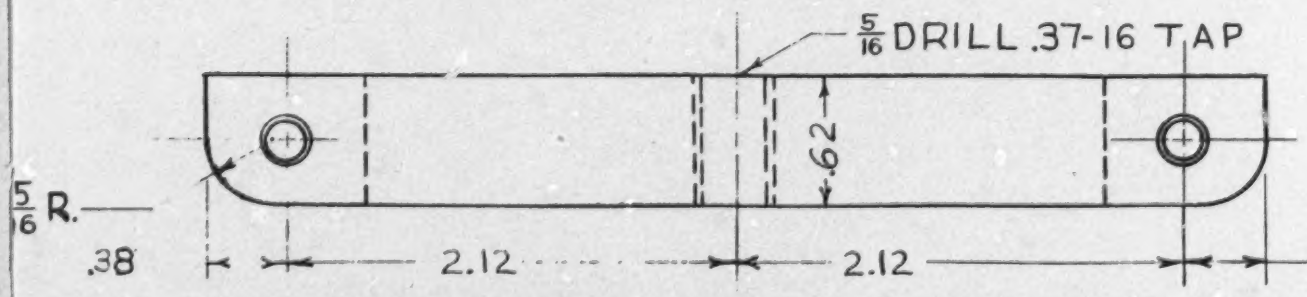

CROSS ARM - MAT. H.R.S.

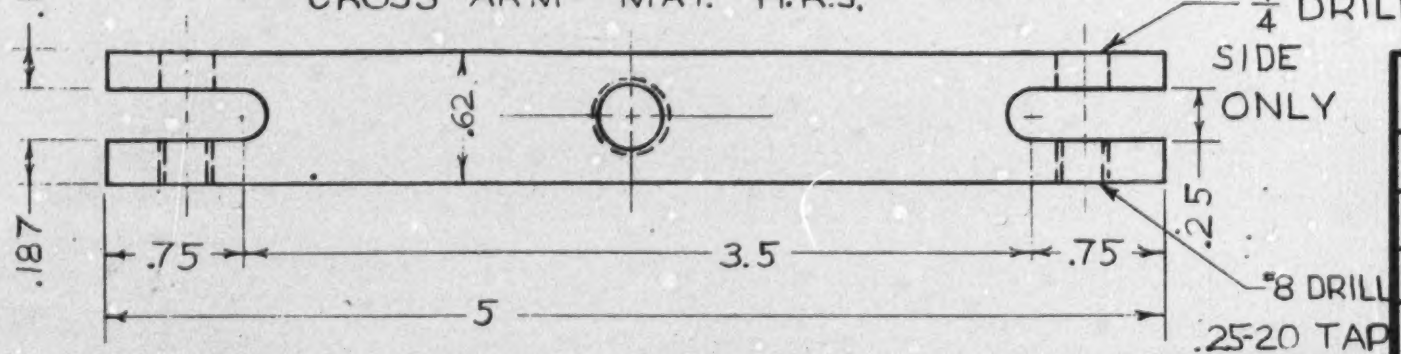

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8802

8803

M-188

SCREW - MAT. C.R.S.

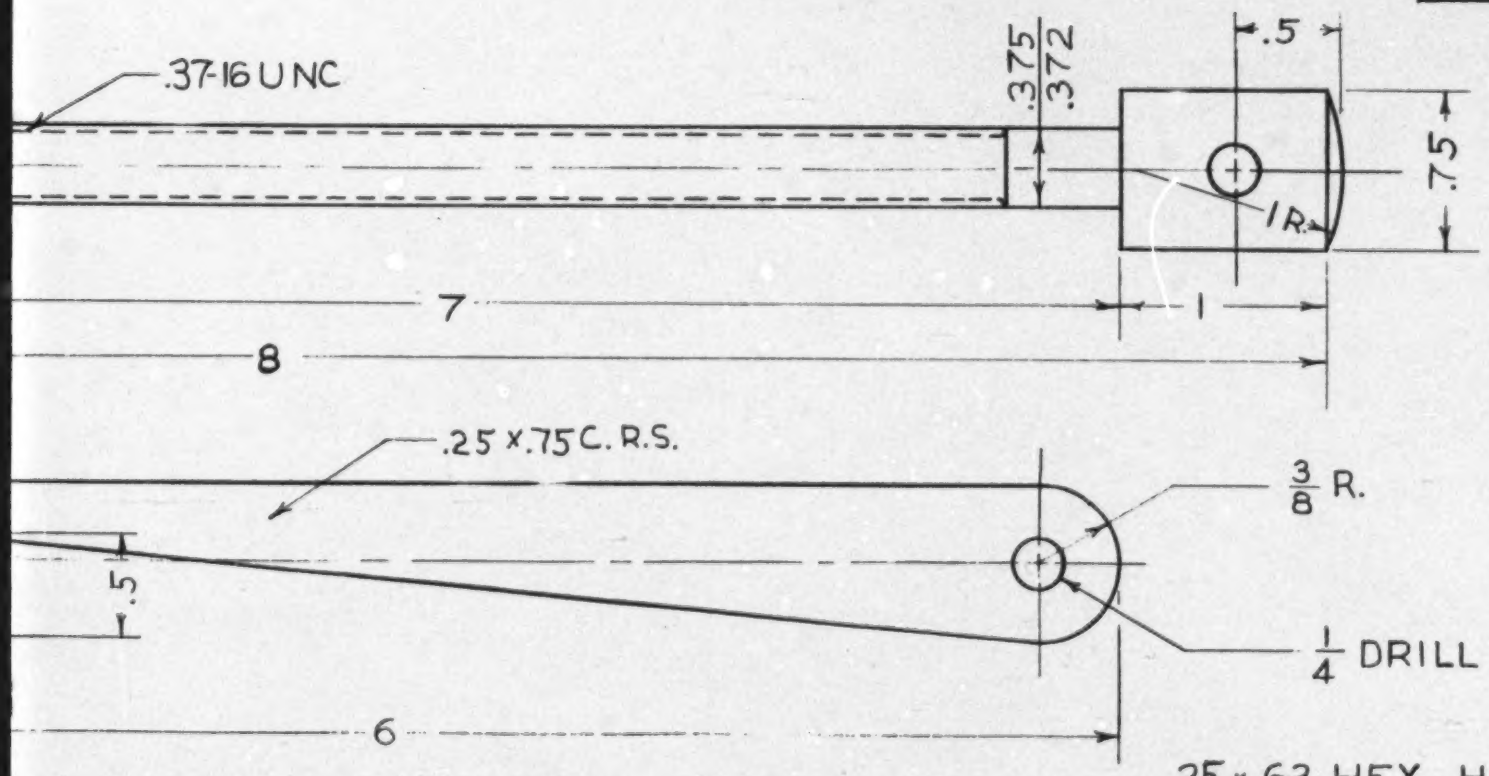

.25 x .62 HEX. HD.
CAP SCRS. - 2 REQ.

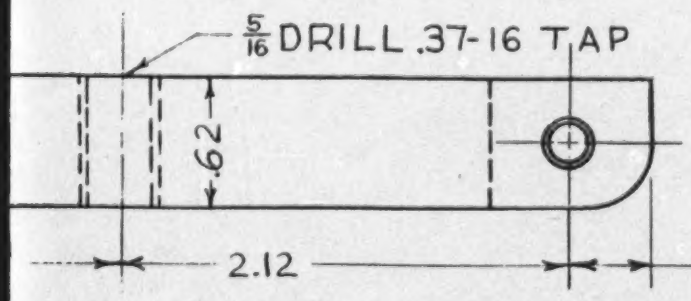

HANDLE .25 DIA x 3

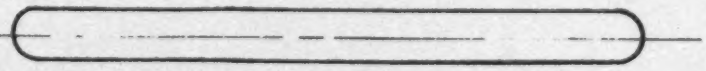

M- MAT. H.R.S.

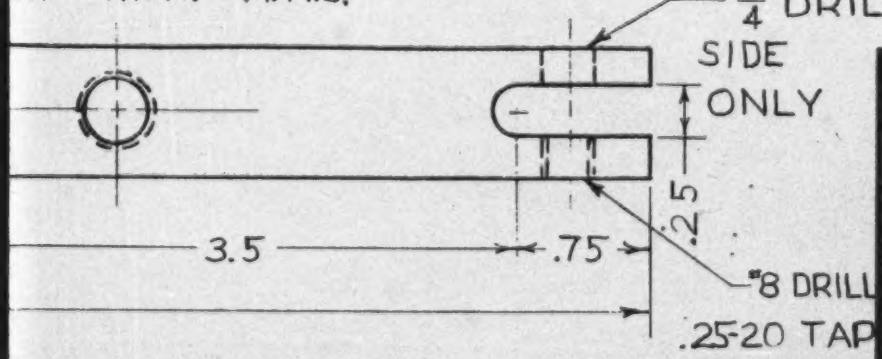

S OTHERWISE STATED

GEAR PULLER	
SUGGESTED BY:	
SCALE: 12" = 1'0"	DATE: 6-27-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8803

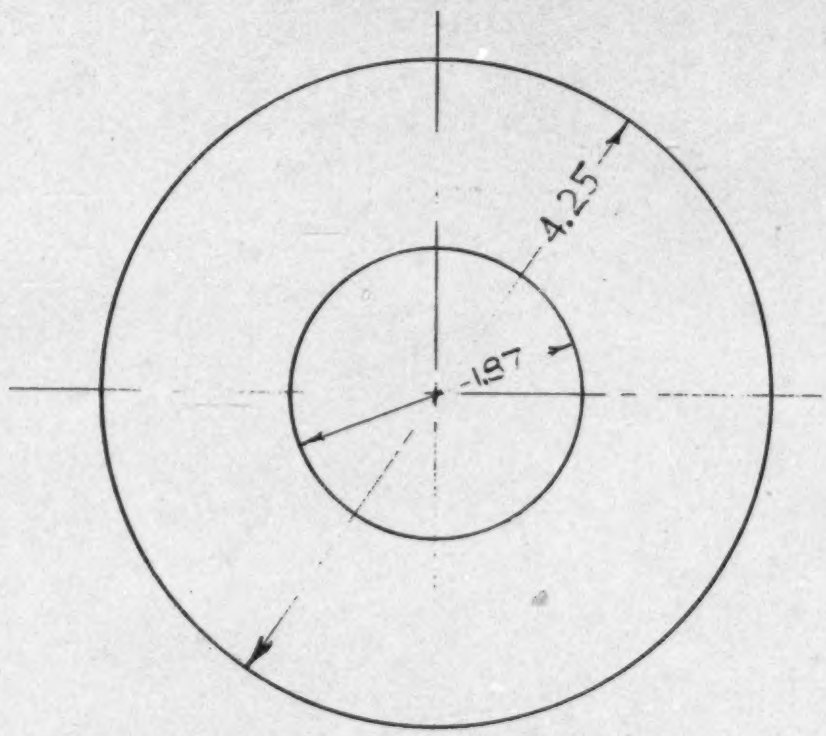

	SIZE	GRADE
1	$1\frac{15}{16}$	
2	2	
3	$2\frac{1}{16}$	
4	$2\frac{1}{8}$	
5	$2\frac{3}{16}$	
6	$2\frac{1}{4}$	
7	$2\frac{5}{16}$	
		AVE.

	SIZE	GRADE
8	$2\frac{3}{8}$	
9	$2\frac{7}{16}$	
10	$2\frac{1}{2}$	
11	$2\frac{9}{16}$	
12	$2\frac{5}{8}$	
13	$2\frac{11}{16}$	
14	$2\frac{3}{4}$	
		AVE.

	SIZE	GRADE
15	$2\frac{13}{16}$	
16	$2\frac{7}{8}$	
17	$2\frac{15}{16}$	
18	3	
19	$3\frac{1}{16}$	
20	$3\frac{1}{8}$	
		AVE.

BOR

SUGGES

SCALE:

DRAWN

MILWA

8804

8805

M-189

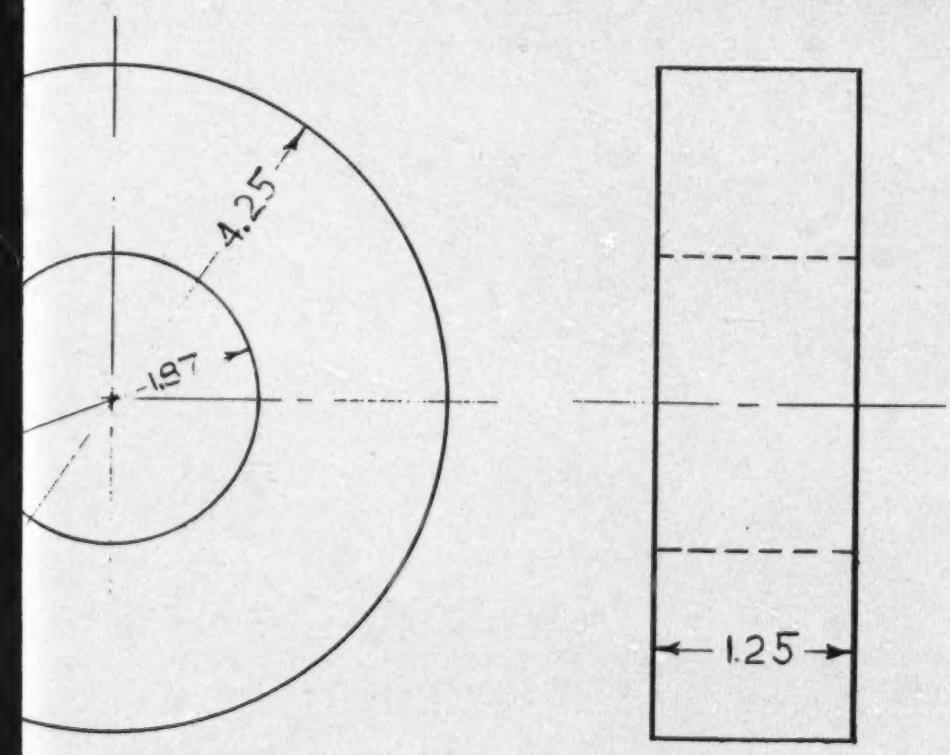

E	GRADE		SIZE	GRADE
3/8		15	2 13/16	
7/16		16	2 7/8	
1/2		17	2 15/16	
9/16		18	3	
5/8		19	3 1/16	
11/16		20	3 1/8	
3/4				
	AVE.			AVE.

BORING EXERCISE

SUGGESTED BY: BOYS' TECH

SCALE: 9" = 1'-0" | DATE: 6-27-66

DRAWN BY T.S.S | CHECKED BY

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

8805

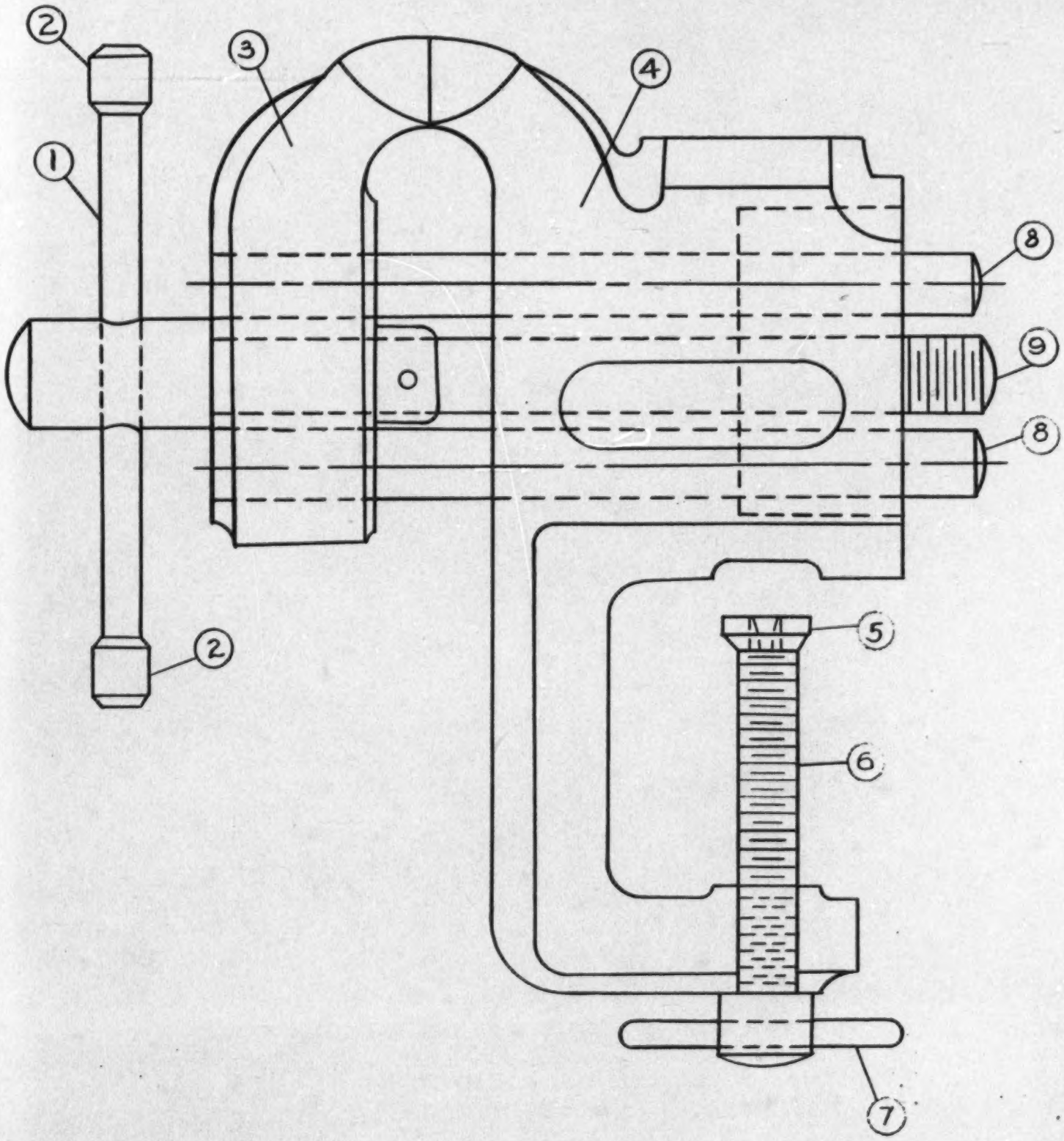

1
2
3
4
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B

SUGGEST

SCALE: 1

DRAWN

MILWA

1

8806

8807

M-190

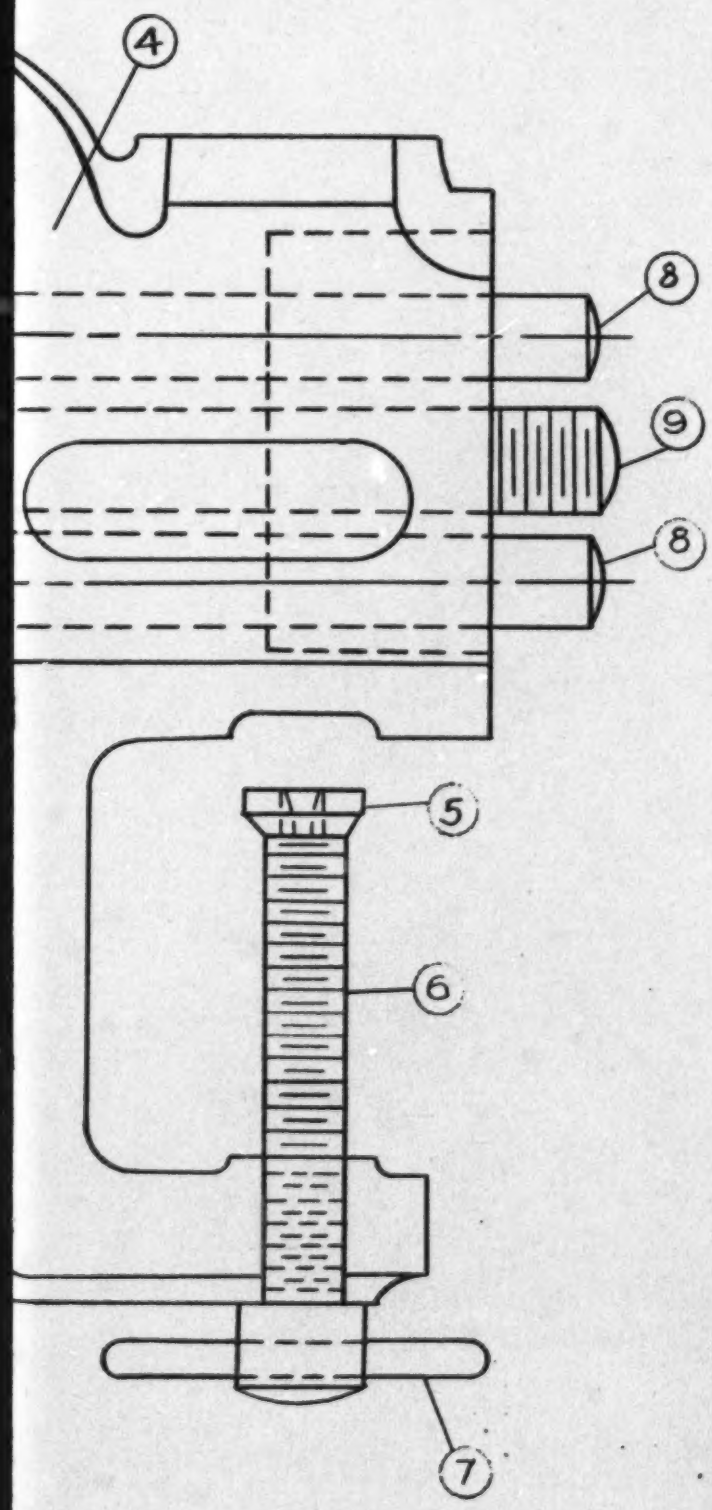

1 SCREW HANDLE
2 BUTTONS FOR HANDLE
3 VISE JAW
4 VISE BODY
5 CLAMPING SCREW BUTTON
6 CLAMPING SCREW
7 CLAMPING SCREWPIN
8 GUIDE BARS
9 VISE SCREW

BENCH VISE	
SUGGESTED BY: PULASKI HIGH	
SCALE: 12"= 1'-0"	DATE: 6-24-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

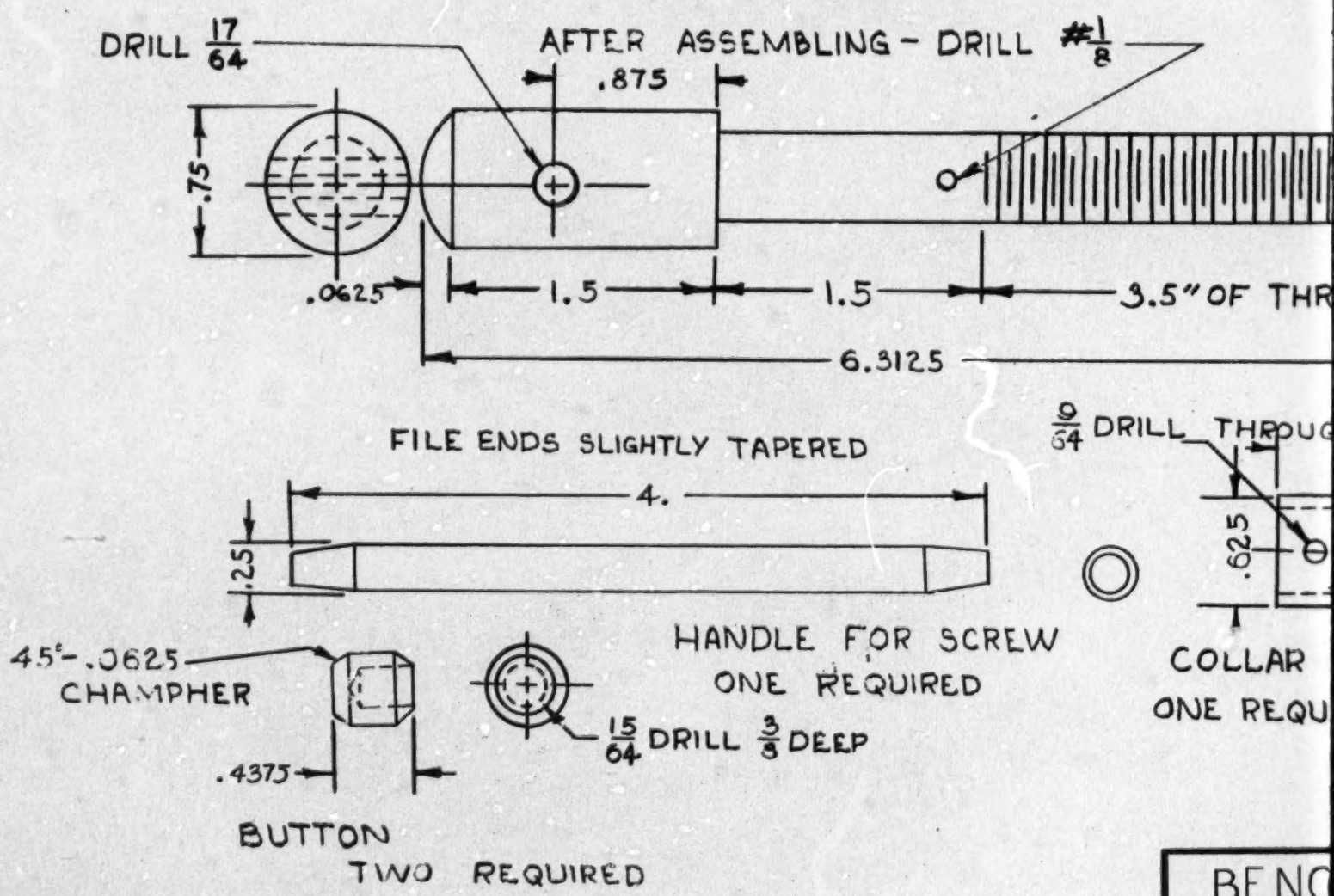

37/64 DRILL - 3 HOLES IN JAW AND VISE BODY. DRILL IN JIG. 7/16 REAM IN BODY. HOLES FOR GUIDE BARS.

BENC
SUGGEST
SCALE: 12
DRAWN B
MILWAU
IN

MH90A

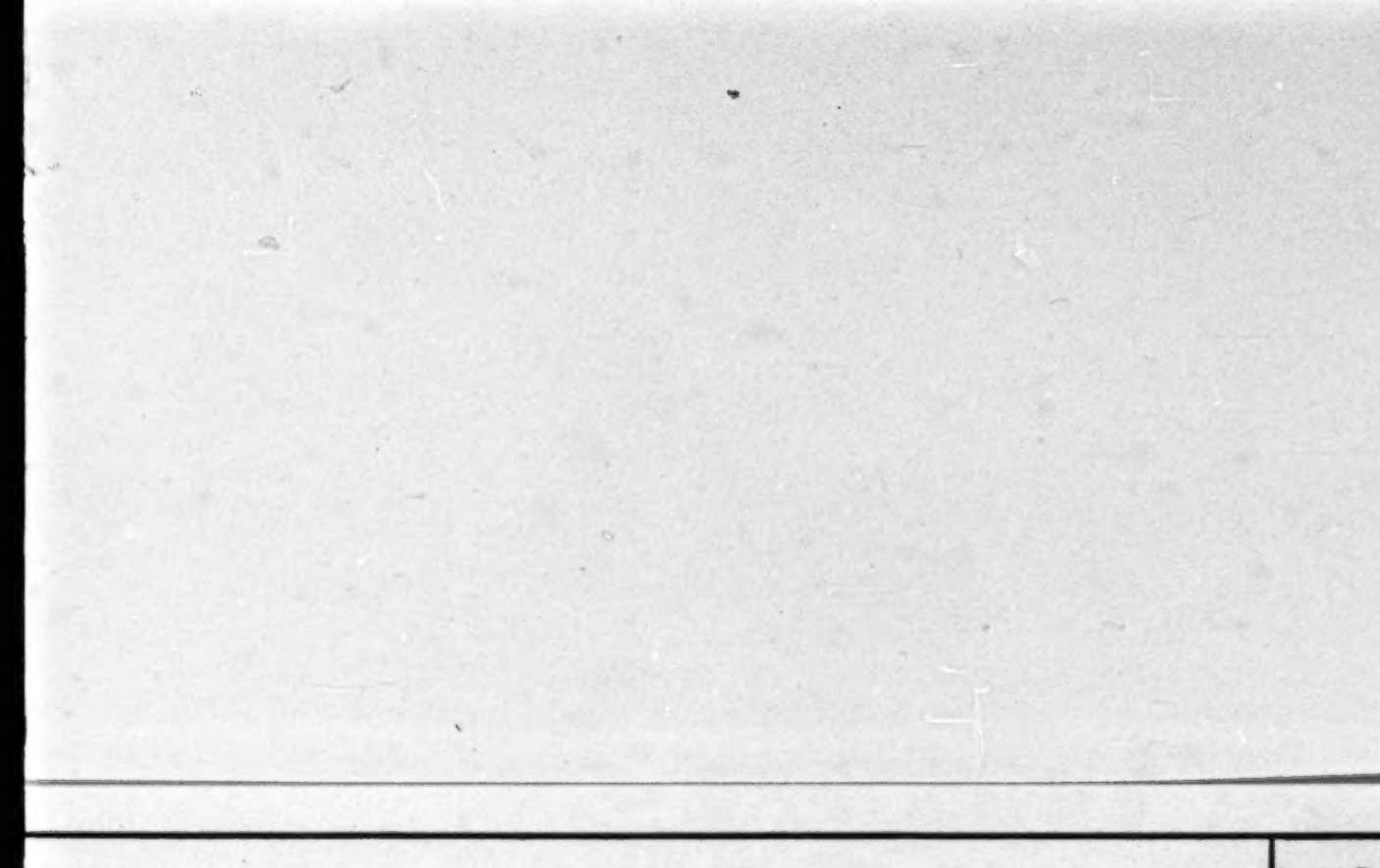

QUIRED

AND VISE BODY. DRILL
HOLES FOR GUIDE BARS.

BENCH VISE DETAILS	
SUGGESTED BY:	
SCALE: 12"=1'-0"	DATE: 6-24-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8809

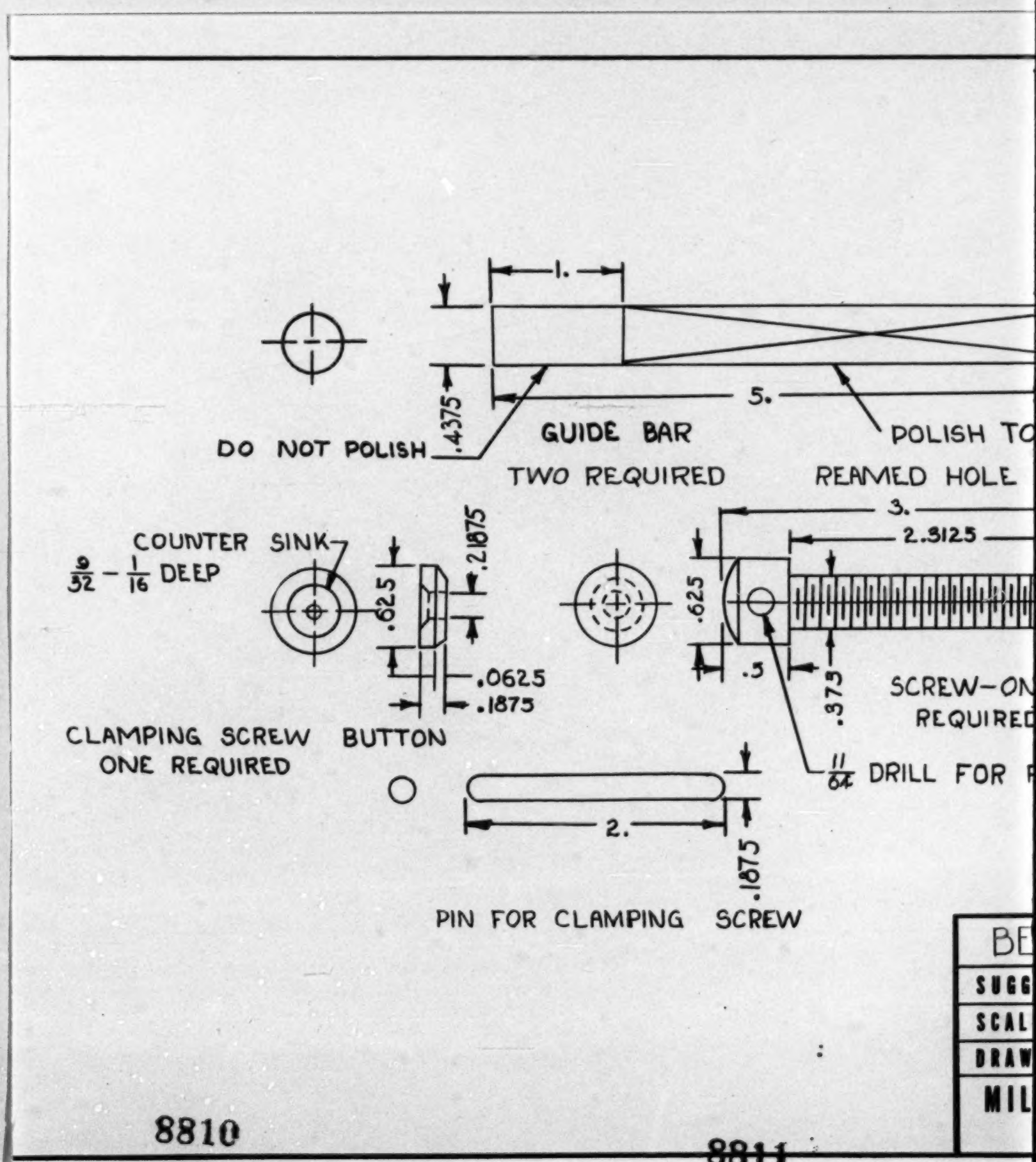
1.
.4375
5.
DO NOT POLISH
GUIDE BAR
TWO REQUIRED
POLISH TO
REAMED HOLE
3.
2.3125
COUNTER SINK
9/32 - 1/16 DEEP
.2187
.625
.0625
.1875
CLAMPING SCREW BUTTON
ONE REQUIRED
.625
.5
.373
SCREW-ON
REQUIRED
11/64 DRILL FOR
2.
.1875
PIN FOR CLAMPING SCREW
BE
SUGG
SCAL
DRAW
MIL

8810

8811

M190B

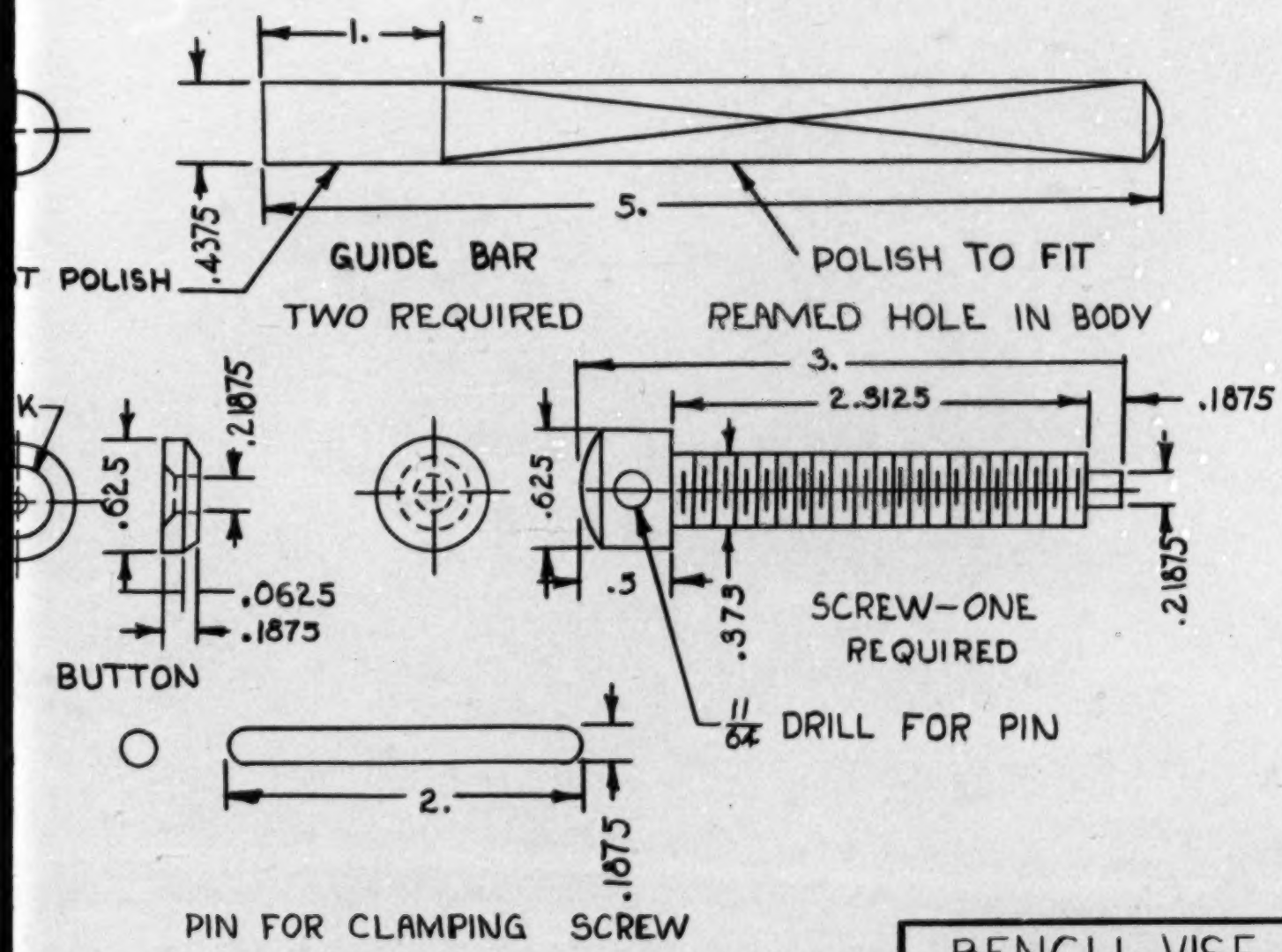

BENCH VISE DETAILS	
SUGGESTED BY:	
SCALE: 12"=1'0"	DATE: 6-24-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

CASTINGS FROM CASTING SPECIALTIES, CEDARBURG, W

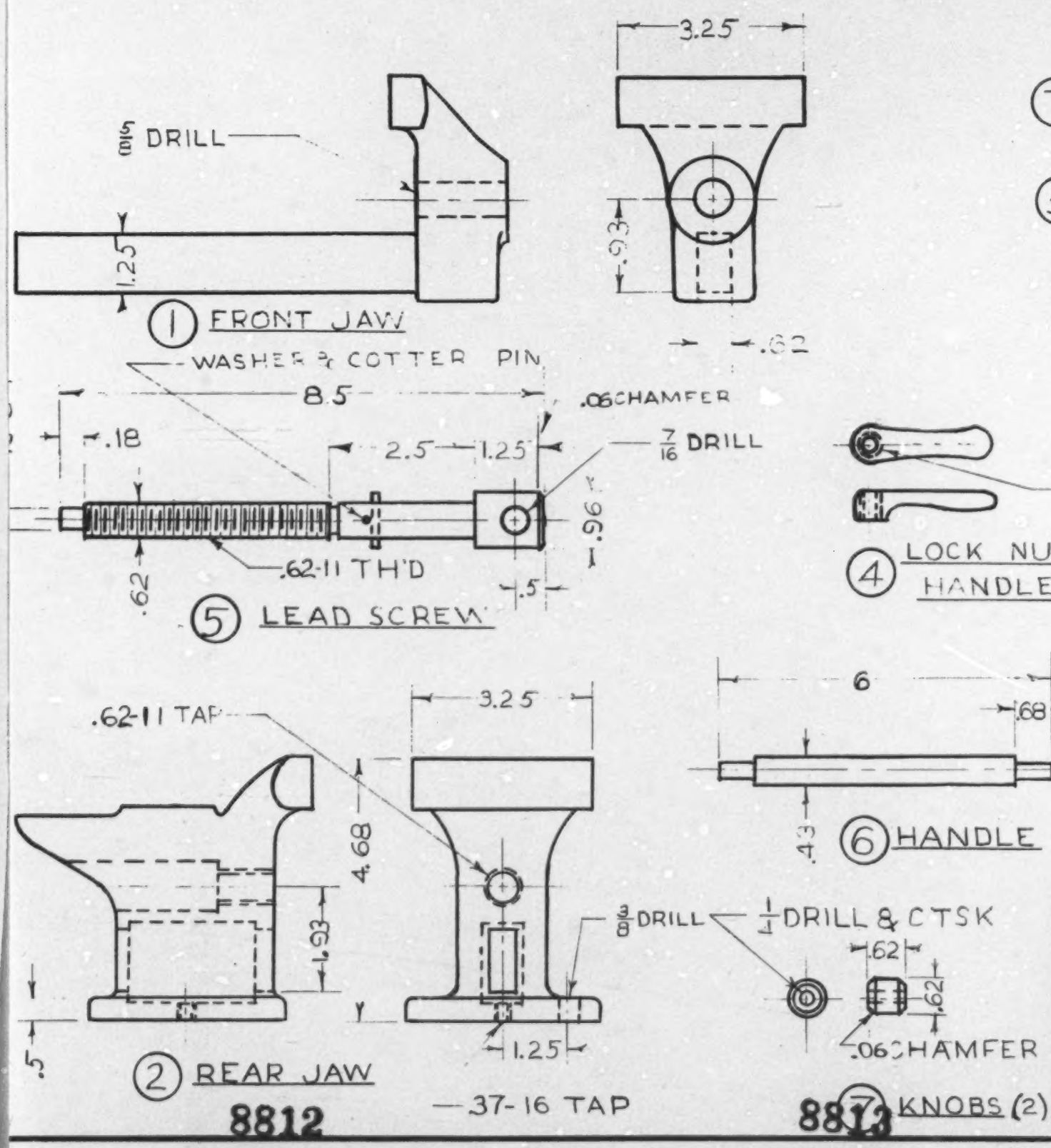

8812

8813

NG SPECIALTIES , CEDARBURG, WISCONSIN

M-191

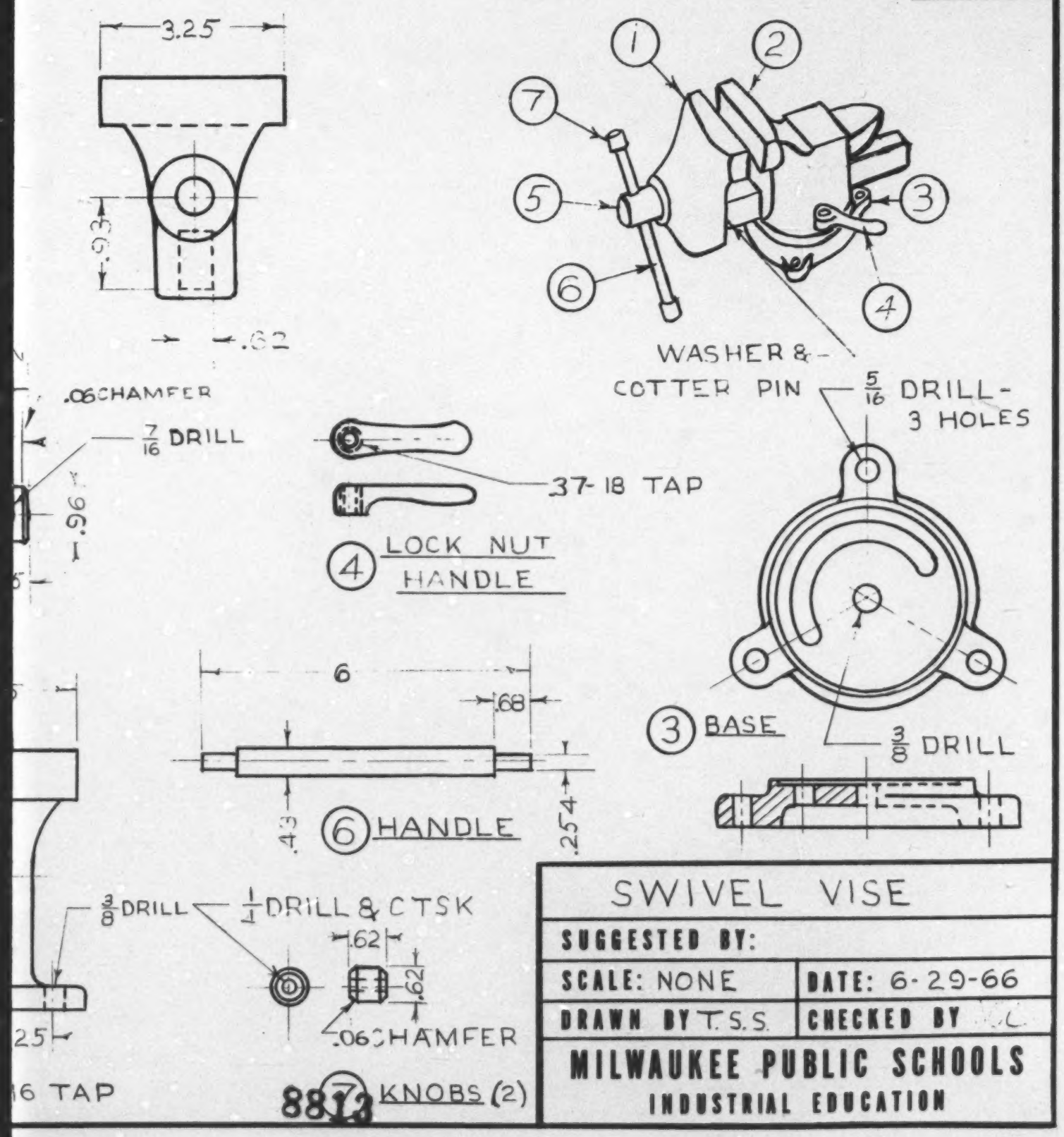

SWIVEL VISE	
SUGGESTED BY:	
SCALE: NONE	DATE: 6-29-66
DRAWN BY T.S.S.	CHECKED BY

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

8813

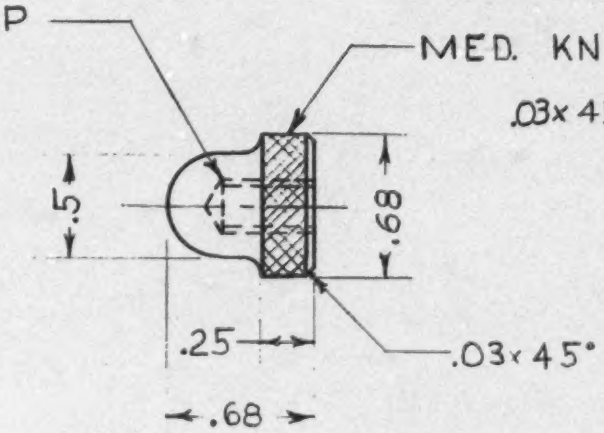

CAP

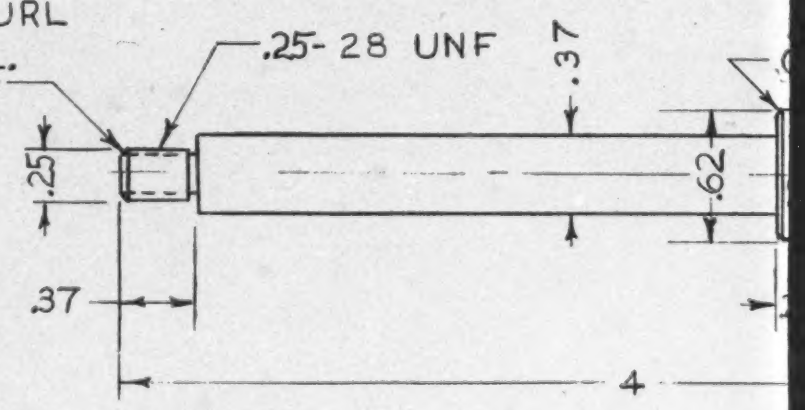

SHANK

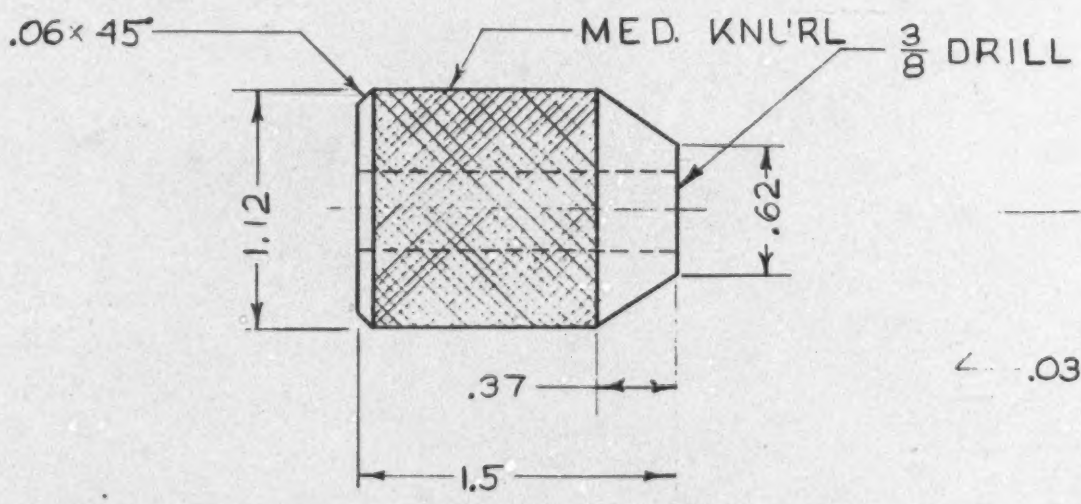

WEIGHT

TOLERANCES ±.005
UNLESS OTHERWISE
STATED

LA
SUGGE
SCALE
DRAW
MILW

8814

8815

M-192

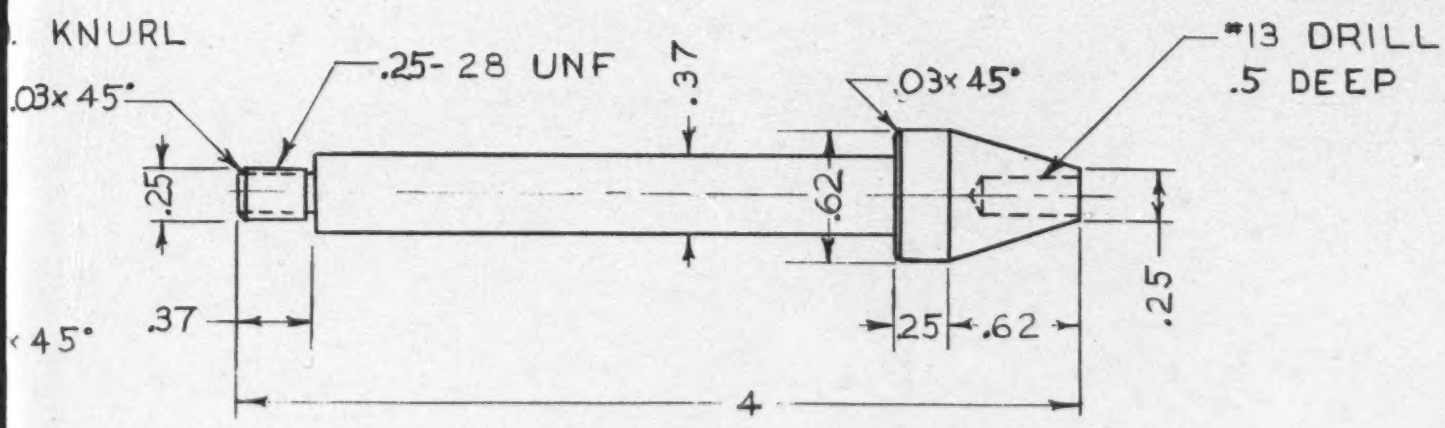

SHANK

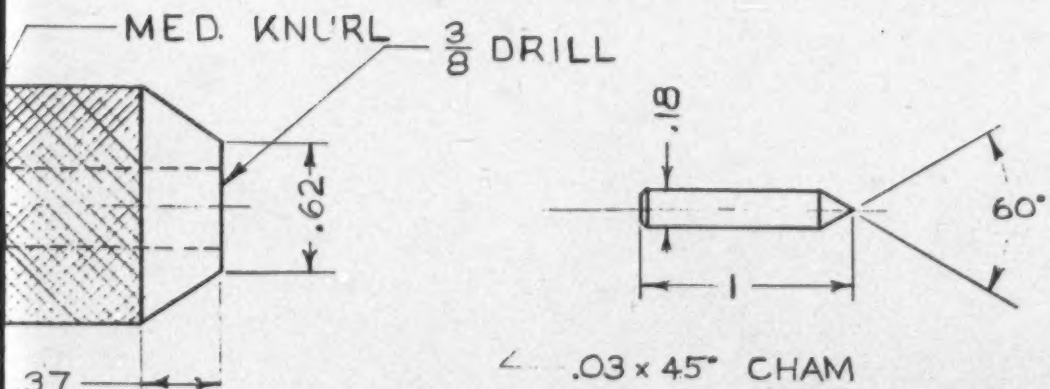

POINT - DRILL
ROD - HARDEN

EIGHT

TOLERANCES ±.005
UNLESS OTHERWISE
STATED

LAYOUT PUNCH	
SUGGESTED BY:	
SCALE: 12" = 1'0"	DATE: 6-28-66
DRAWN BY T.S.S.	CHECKED BY JCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8815

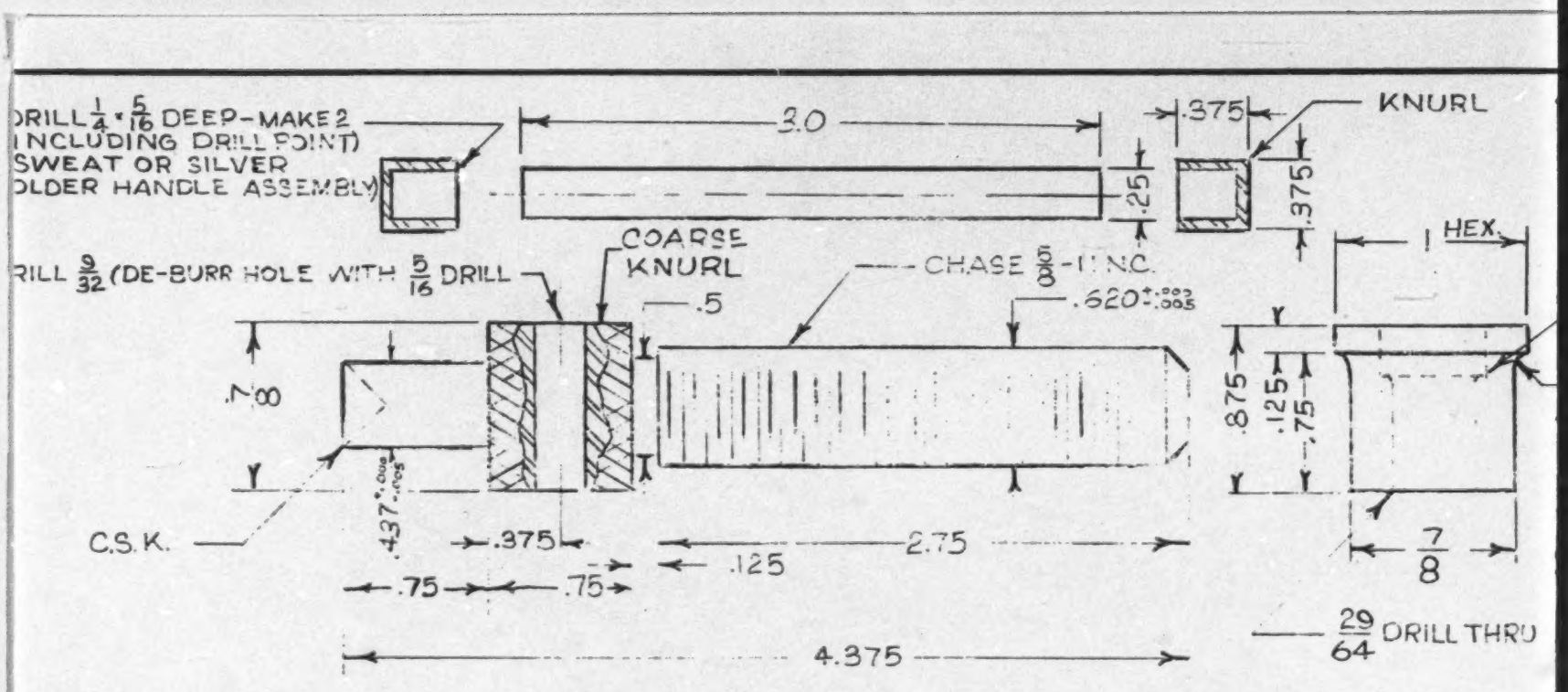

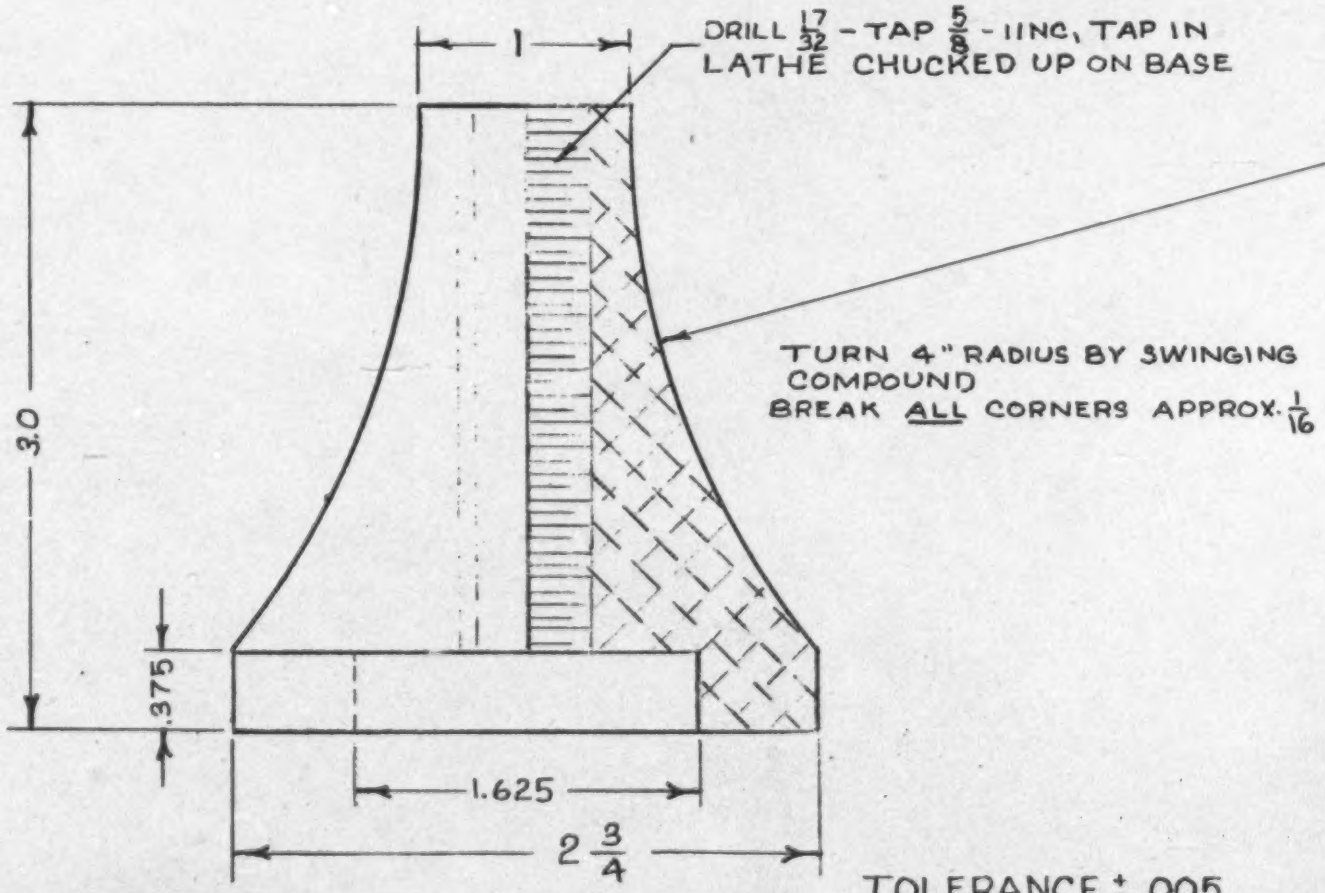

~ BIL
BASE
SCREW
HEAD
HANDL
CAPS

SC
SUGGESTE
SCALE: 12
DRAWN B
MILWAU
IN

TOLERANCE ±.005
UNLESS OTHERWISE STATED

8816

8817

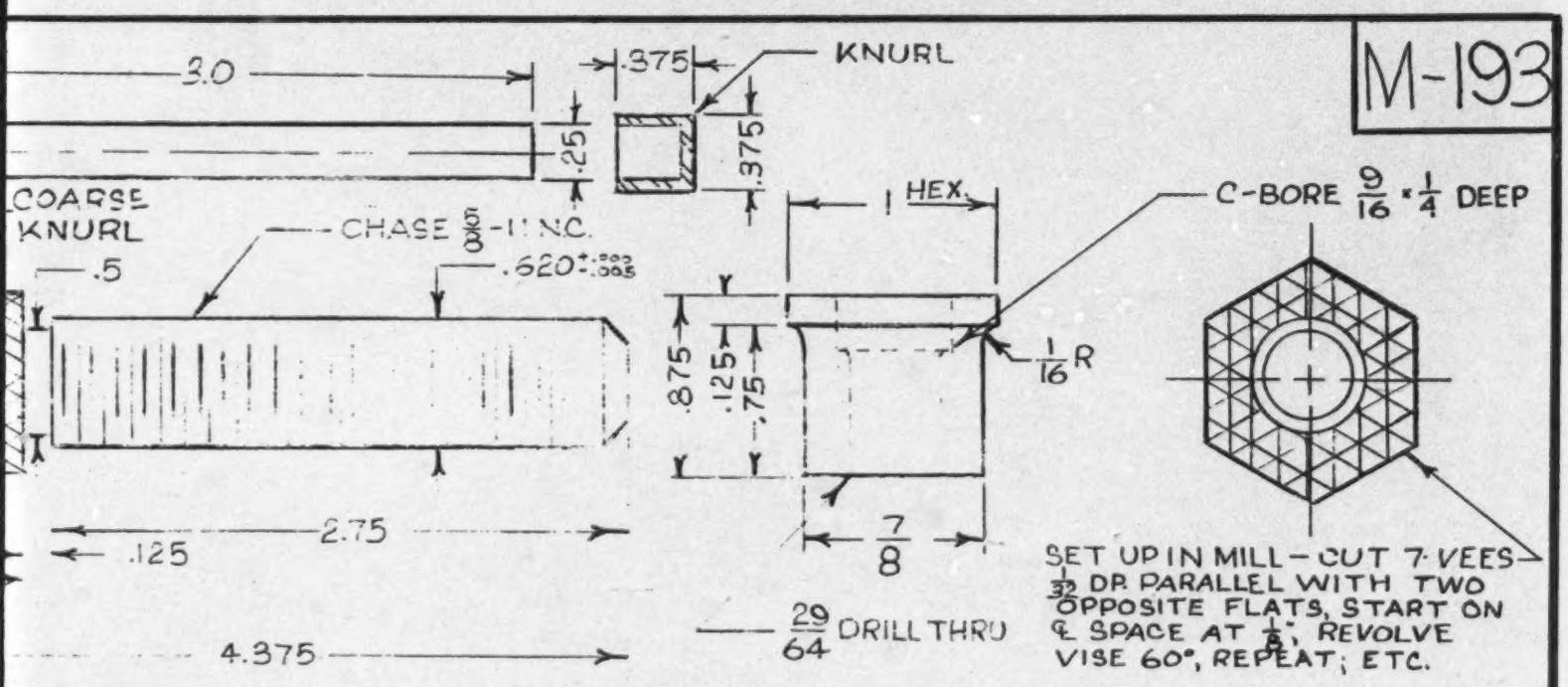

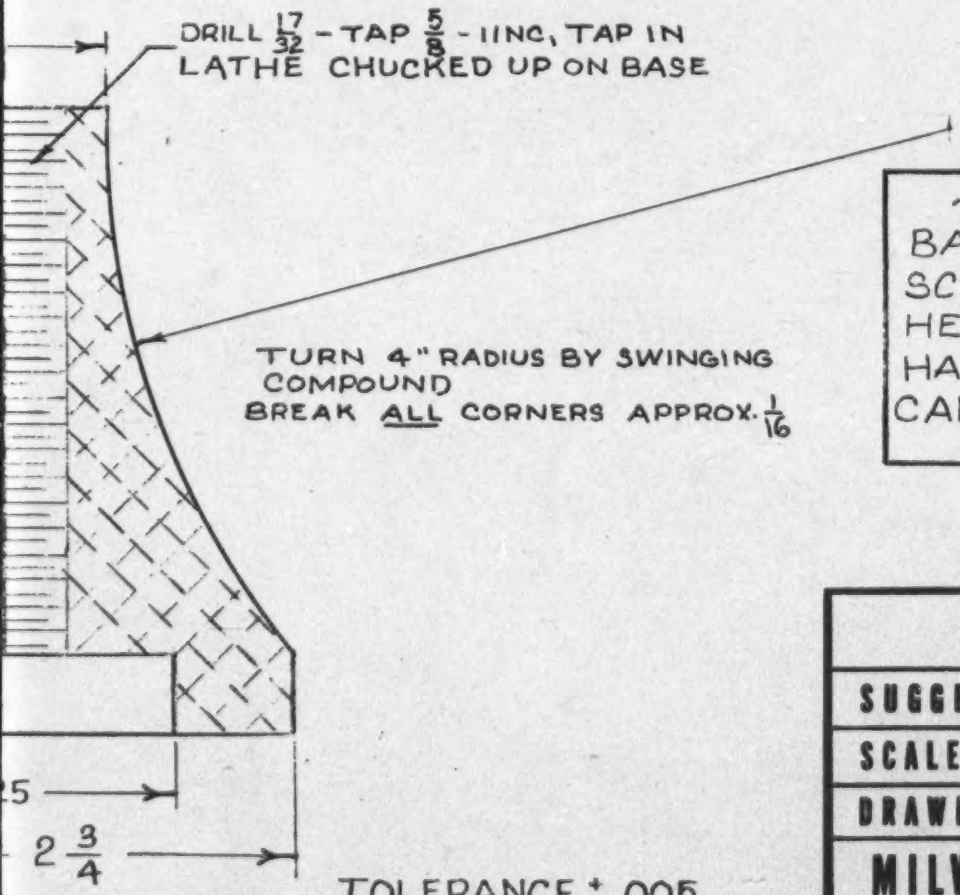

~BILL OF MATERIAL~
BASE - CAST ALUMINUM
SCREW - C.R.S. - 1" DIA. × 4 11/16
HEAD - 1" HEX. C.D.S. (RANDOM)
HANDLE - C.R.S. BAR 1/4 DIA × 3
CAPS - 3/8 DIA. C.R.S. (RANDOM)

TOLERANCE ±.005
UNLESS OTHERWISE STATED

SCREW JACK	
SUGGESTED BY:	
SCALE: 12" = 1'0"	DATE: 6-30-66
DRAWN BY R.T.	CHECKED BY MC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8817

CASTINGS FROM CASTING SPECIALTIES CEDARBURG W

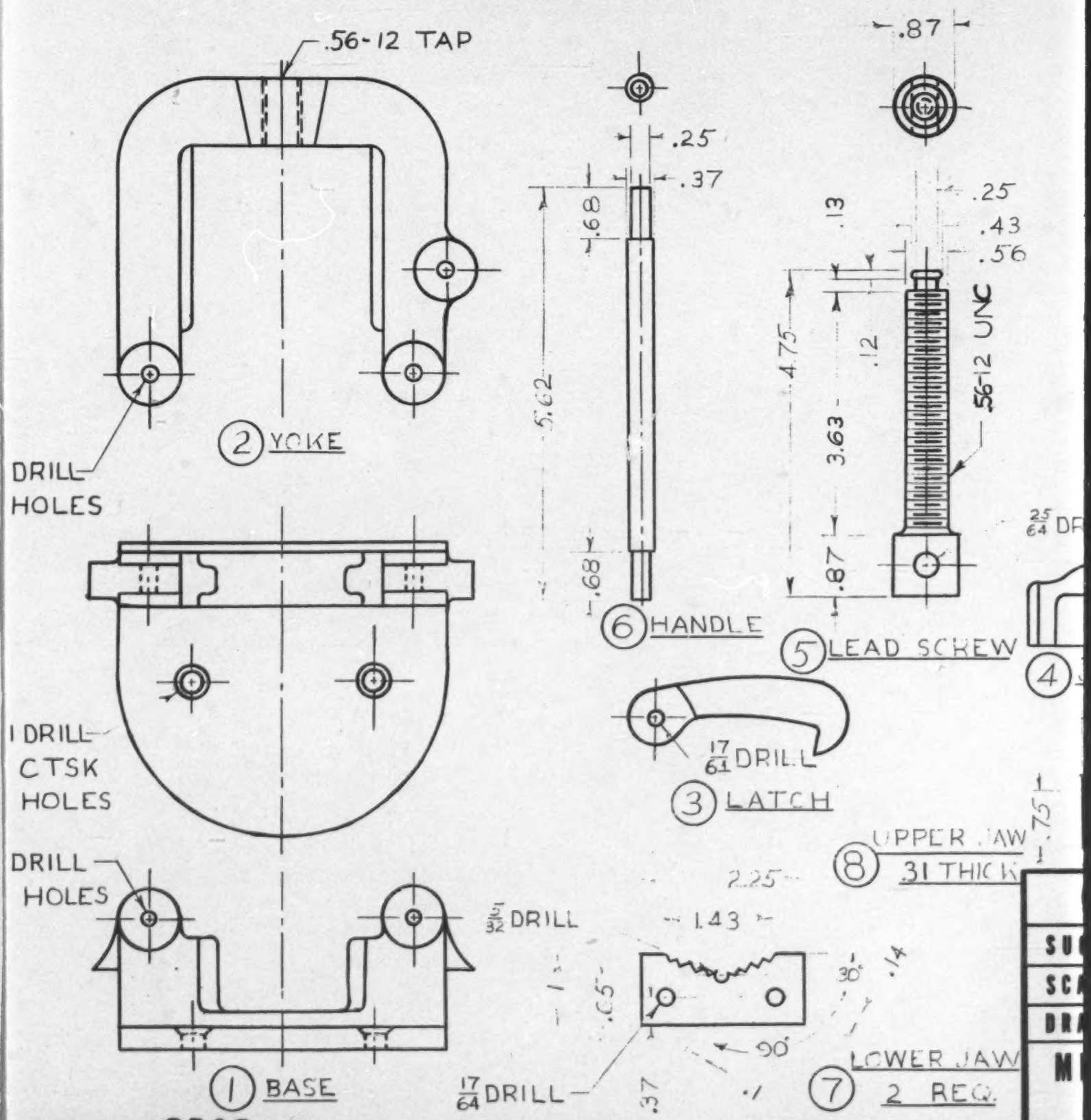

8818

TING SPECIALTIES CEDARBURG WISCONSIN

M-194

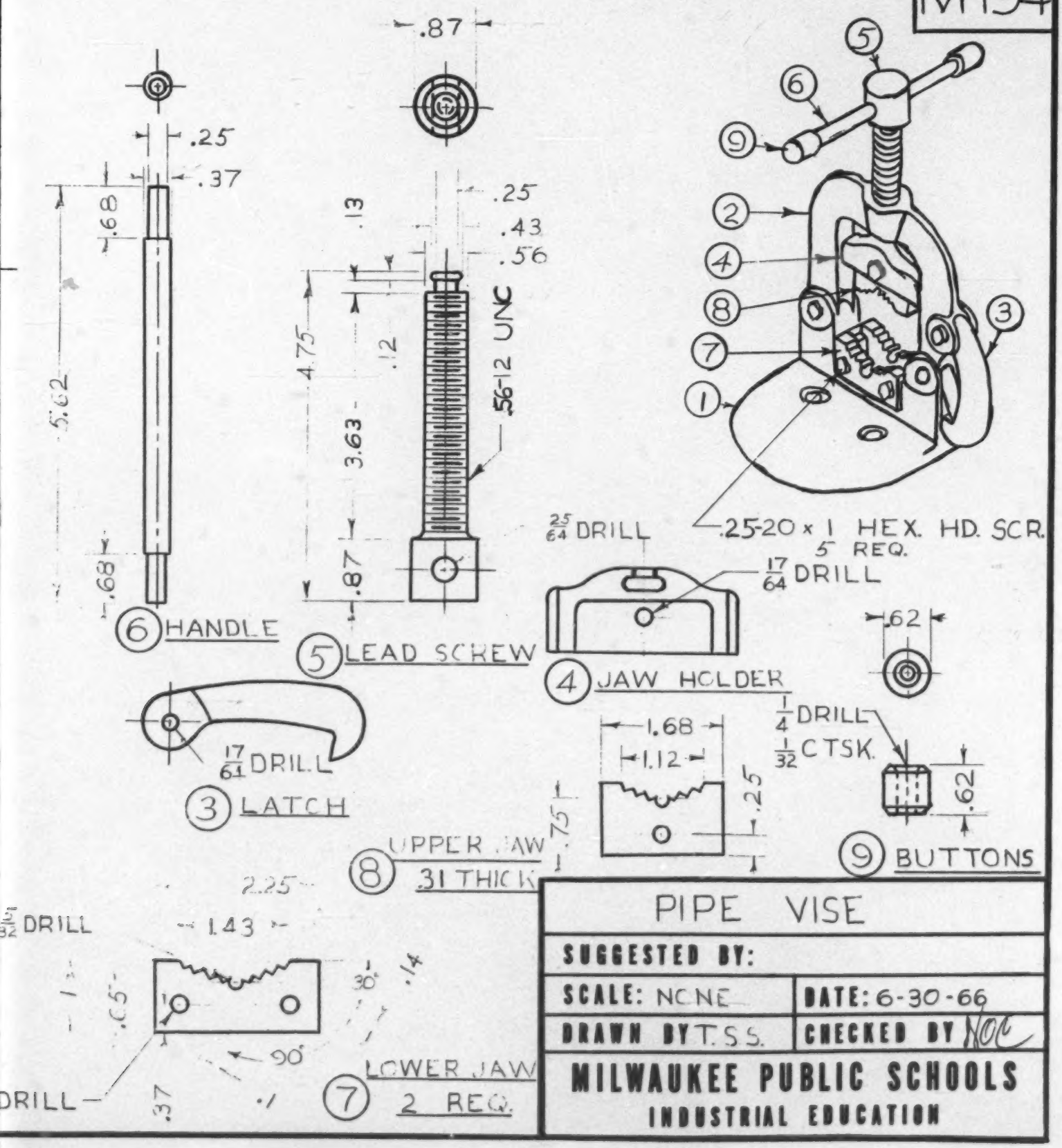

PIPE VISE	
SUGGESTED BY:	
SCALE: NONE	DATE: 6-30-66
DRAWN BY T.S.S.	CHECKED BY HOC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

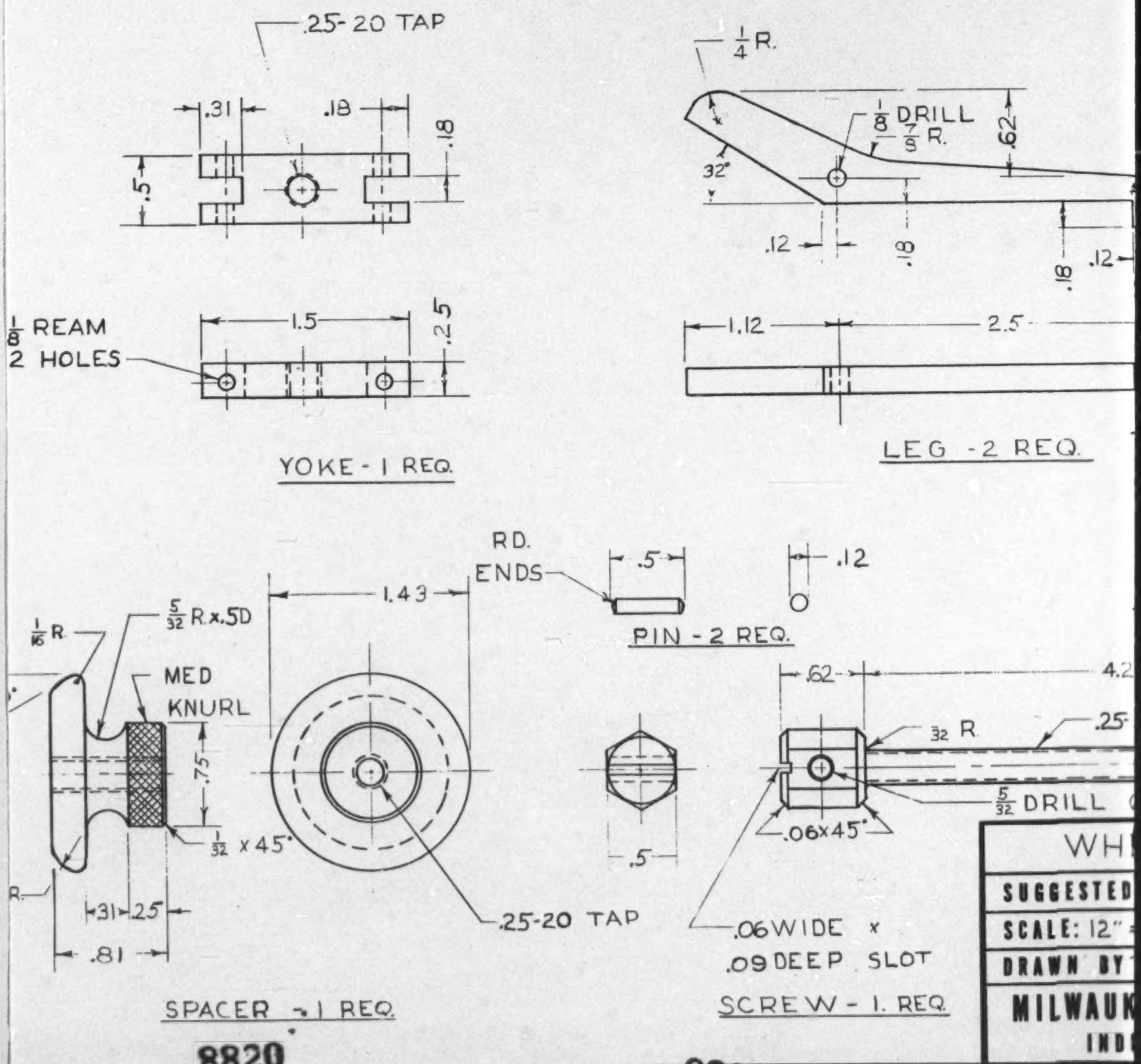
.25-20 TAP
.31
.18
.18
.5
1/8 REAM
2 HOLES
1.5
.25
YOKE - 1 REQ.
1/4 R.
1/8 DRILL
7/8 R.
.62
32°
.12
.18
.18
.12
1.12
2.5
LEG - 2 REQ.
RD.
ENDS
.5
.12
PIN - 2 REQ.
1/16 R.
5/32 R. x .5D
MED
KNURL
1.43
.75
1/32 x 45°
.31
.25
.81
.25-20 TAP
.5
.62
4.2
32 R.
.25
5/32 DRILL
.06x45°
.06 WIDE x
.09 DEEP SLOT
SPACER - 1 REQ.
SCREW - 1. REQ.
WH
SUGGESTED
SCALE: 12"
DRAWN BY
MILWAUK
IND

M-195

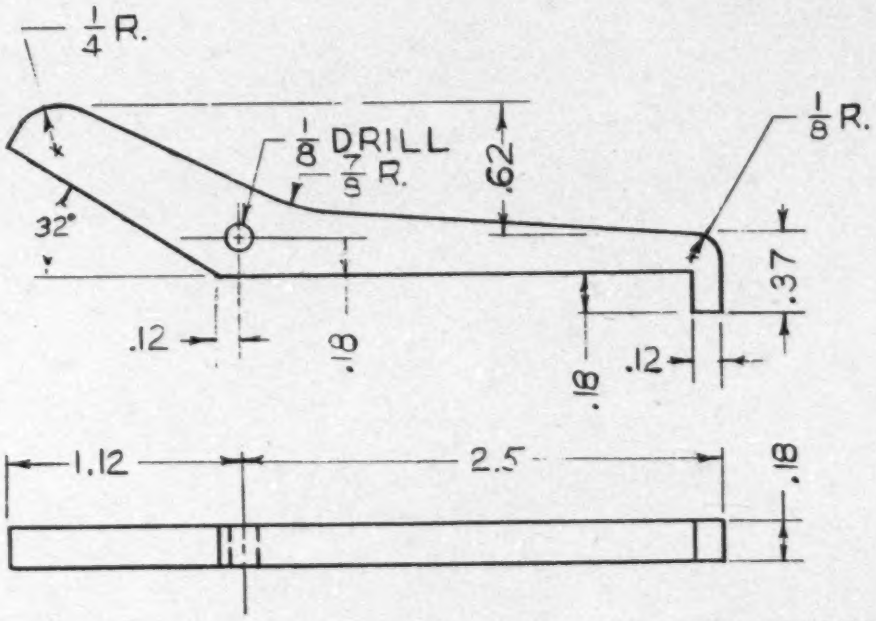

LEG - 2 REQ.

TOLERANCES: ±.005
UNLESS OTHERWISE
STATED

PIN - 2 REQ.

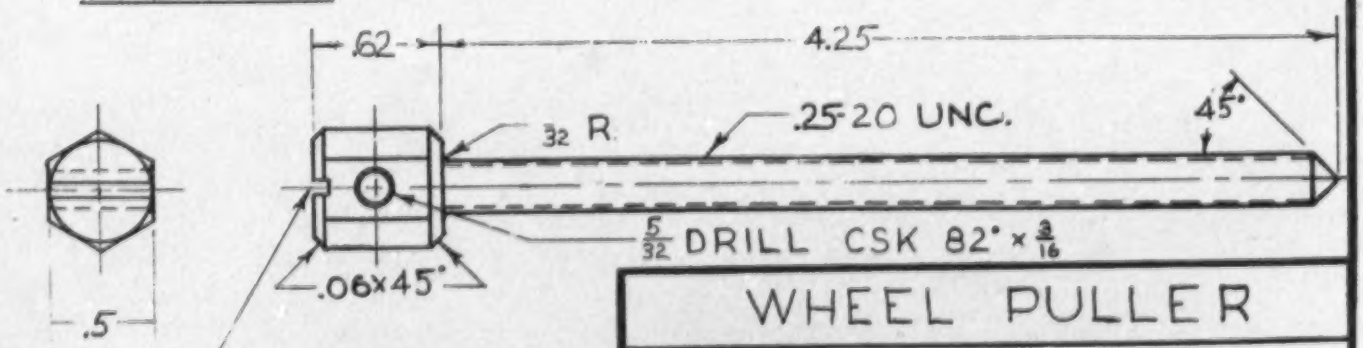

SCREW - 1. REQ.

WHEEL PULLER	
SUGGESTED BY:	
SCALE: 12" = 1'-0"	DATE: 6-29-66
DRAWN BY T.S.S.	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

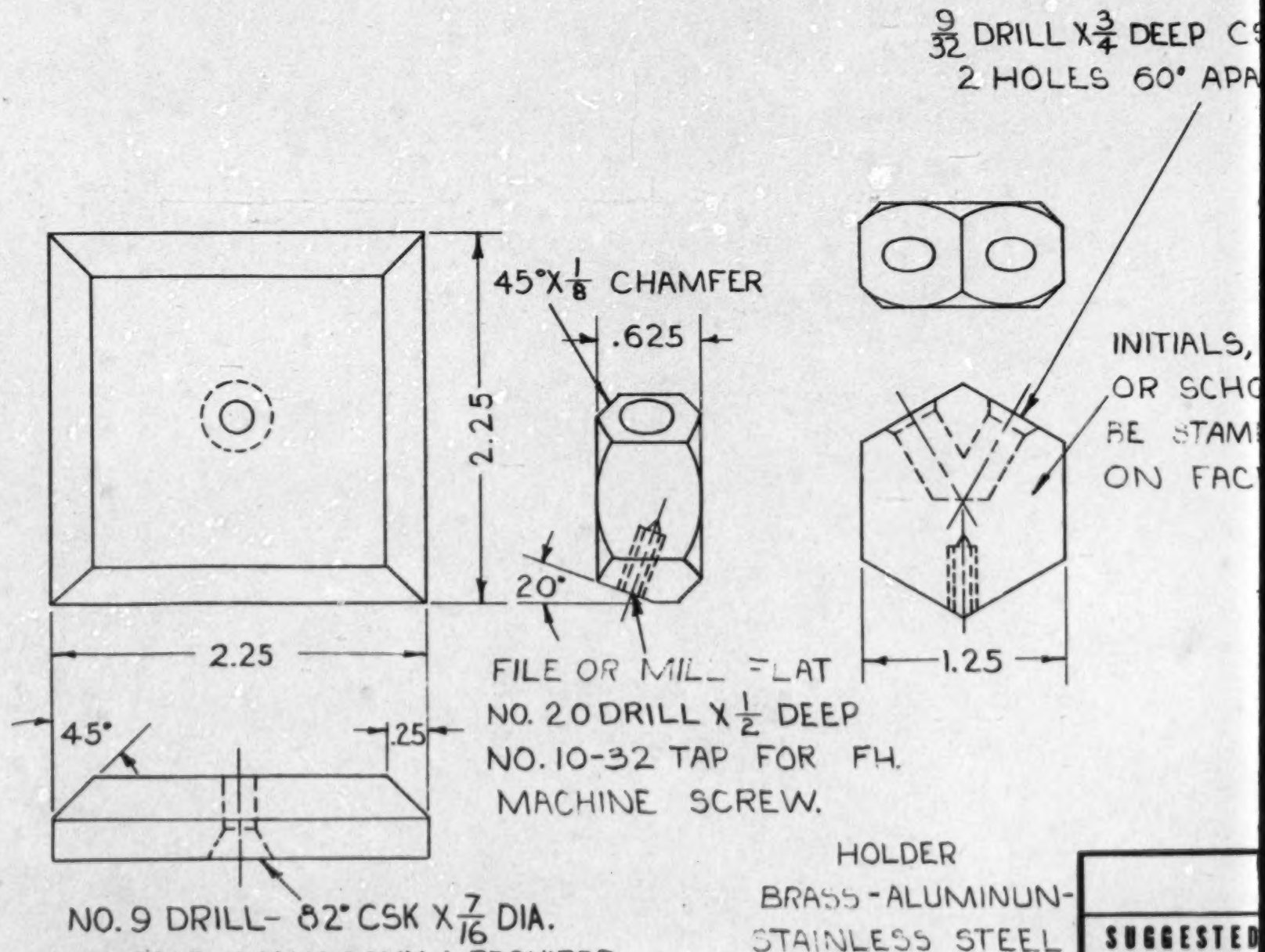
9/32 DRILL X 3/4 DEEP CS
2 HOLES 60° APA
45°X 1/8 CHAMFER
.625
2.25
20°
FILE OR MILL FLAT
NO. 20 DRILL X 1/2 DEEP
NO. 10-32 TAP FOR FH.
MACHINE SCREW.
INITIALS,
OR SCHO
BE STAM
ON FAC
1.25
2.25
45°
.25
NO. 9 DRILL- 82° CSK X 7/16 DIA.
WOOD BASE- MAHOGONY 1 REQUIRED
STAIN AND VARNISH
GLUE FELT TO BOTTOM AFTER ASSEMBLY
HOLDER
BRASS - ALUMINUN-
STAINLESS STEEL
1 REQUIRED
SUGGESTED
SCALE: 12"=
DRAWN BY
MILWAUK
IND

8822

8823

M-196

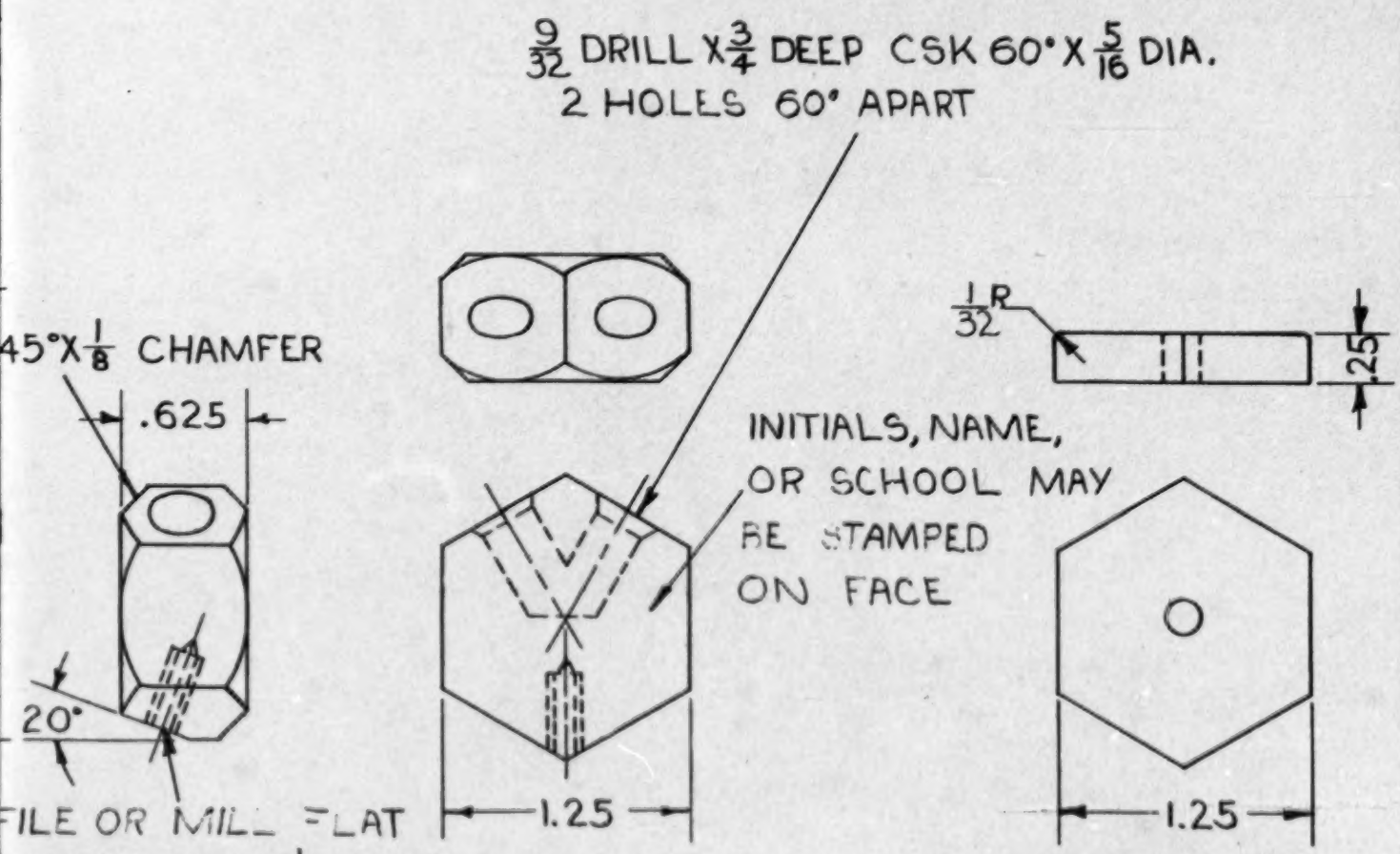

METAL BASE
BRASS-ALUMINUN-
STAINLESS STEEL

HOLDER
BRASS-ALUMINUN-
STAINLESS STEEL
1 REQUIRED

DIA.
QUIRED

FTER ASSEMBLY

PENHOLDER	
SUGGESTED BY:	
SCALE: 12"=1'0"	DATE: 6-30-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

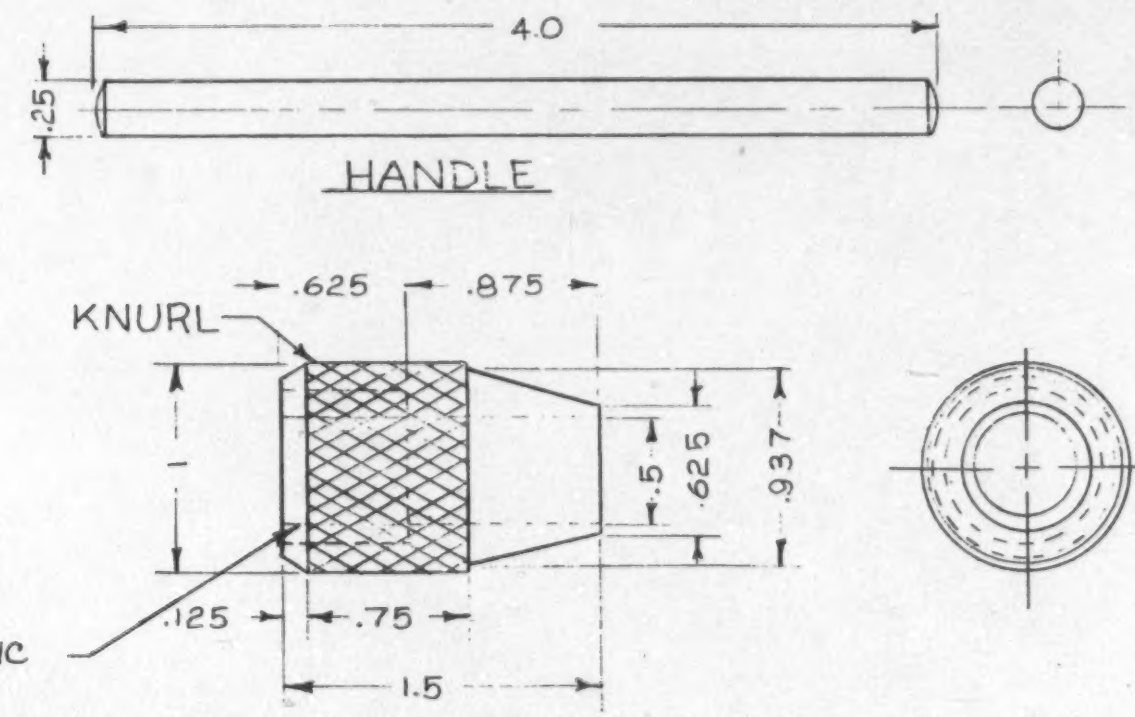

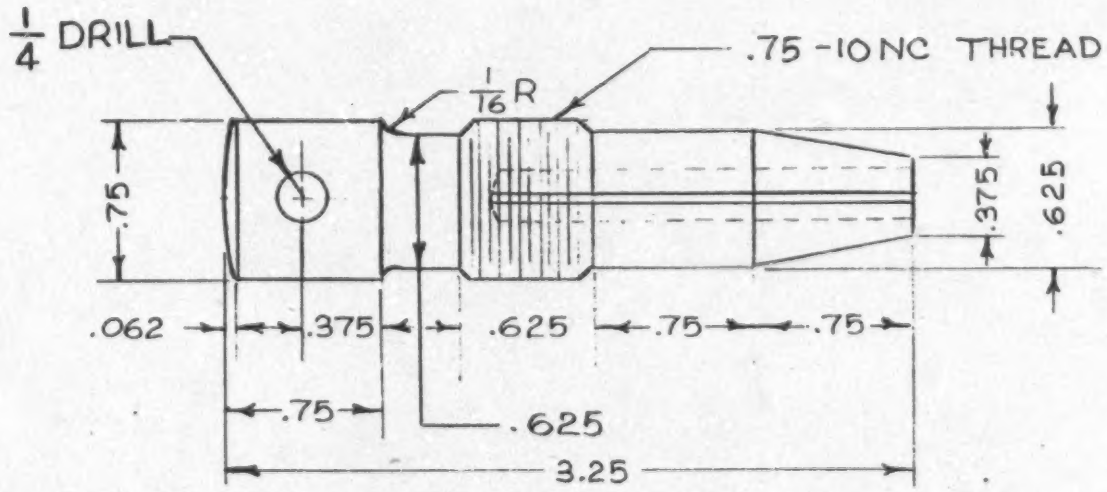

BODY

4 EQUALLY SPACED SAW SLITS 2" LONG

TOLERANCE ±.005
UNLESS OTHERWISE STATED.

8824

8825

SUGGE
SCALE
DRAWN
MILW

M-197

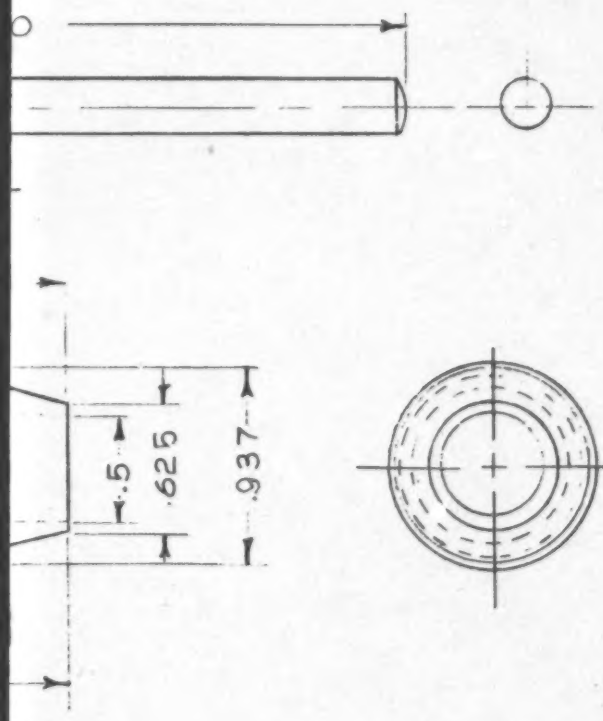

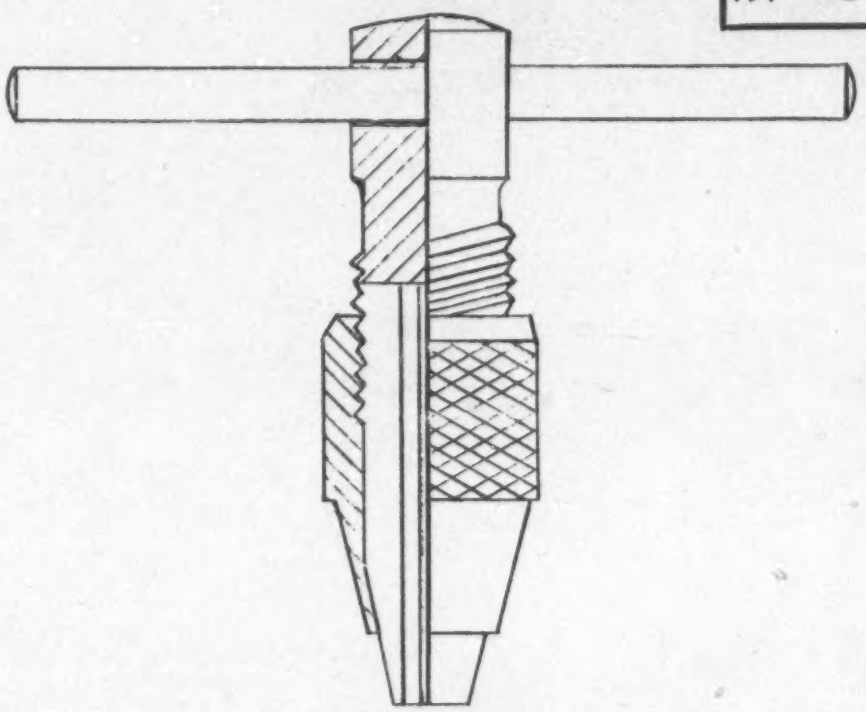

ASSEMBLY

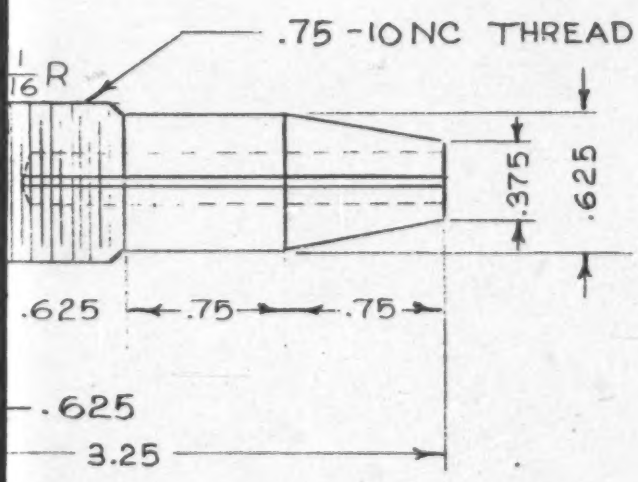

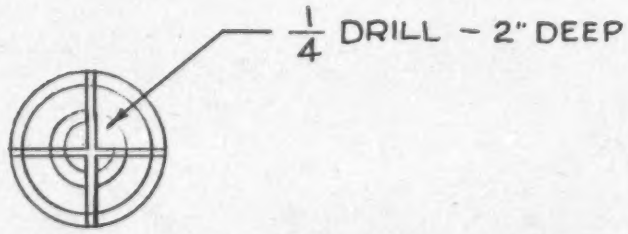

Y SPACED SAW SLITS 2" LONG

TOLERANCE ±.005

UNLESS OTHERWISE STATED.

TAP WRENCH	
SUGGESTED BY: PULASKI H.S.	
SCALE: 12" = 1'0"	DATE: 6-30-66
DRAWN BY RT	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

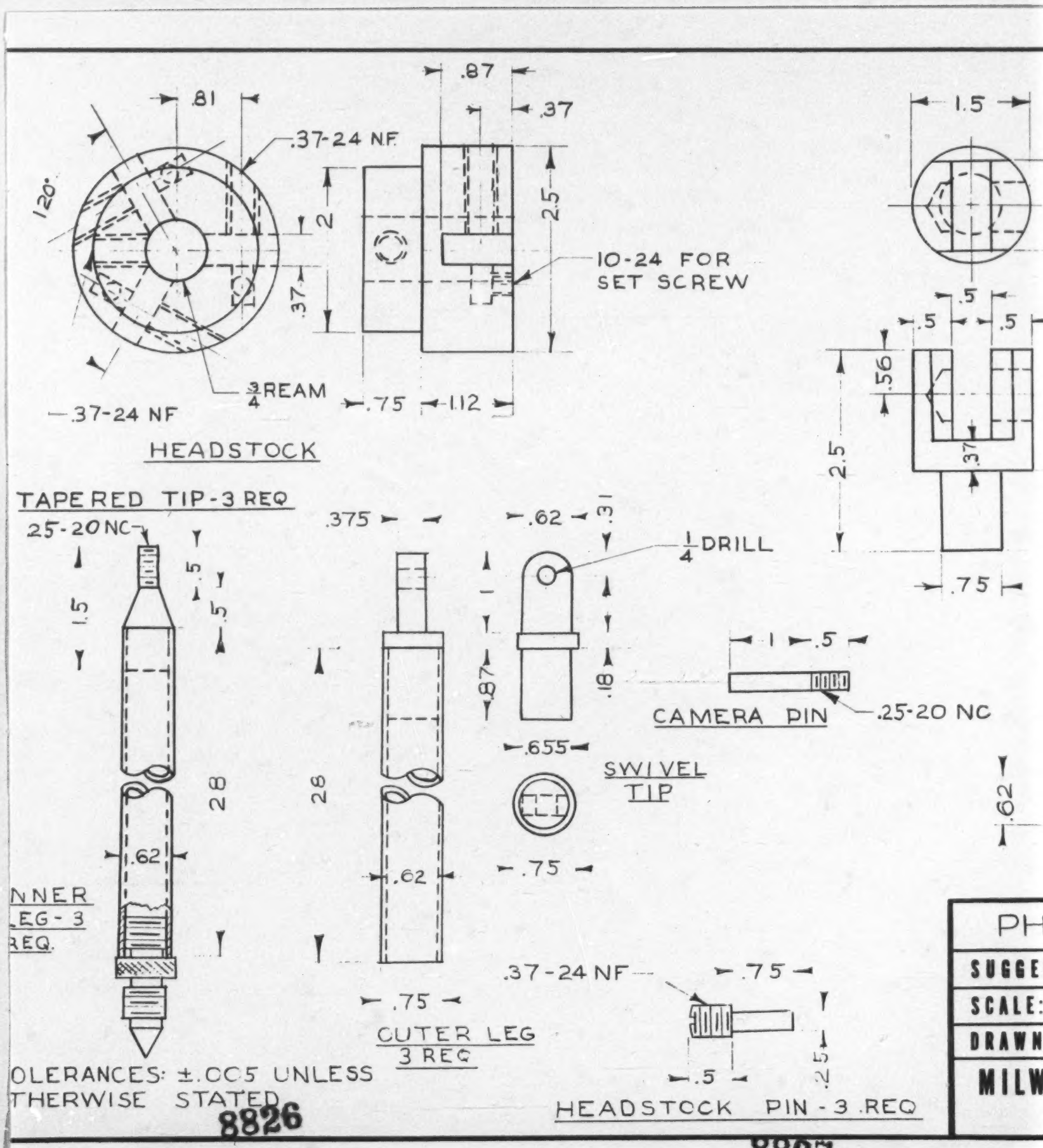
.87
.81
.37
.37-24 N.F.
120°
2
2.5
.37
10-24 FOR
SET SCREW
3/4 REAM
.75
1.12
.37-24 NF
HEADSTOCK
1.5
.5
.5
.56
2.5
.37
.75
TAPERED TIP-3 REQ
25-20 NC
.375
.62
.31
1/4 DRILL
1.5
.5
.5
1
.87
.18
1
.5
CAMERA PIN
.25-20 NC
.655
SWIVEL
TIP
28
28
.62
.62
.75
.62
INNER
LEG-3
REQ.
.37-24 NF
.75
.75
OUTER LEG
3 REQ
.5
.25
HEADSTOCK PIN - 3 REQ
TOLERANCES: ±.005 UNLESS
OTHERWISE STATED
PH
SUGGE
SCALE:
DRAWN
MILW

8826

8827

M-198

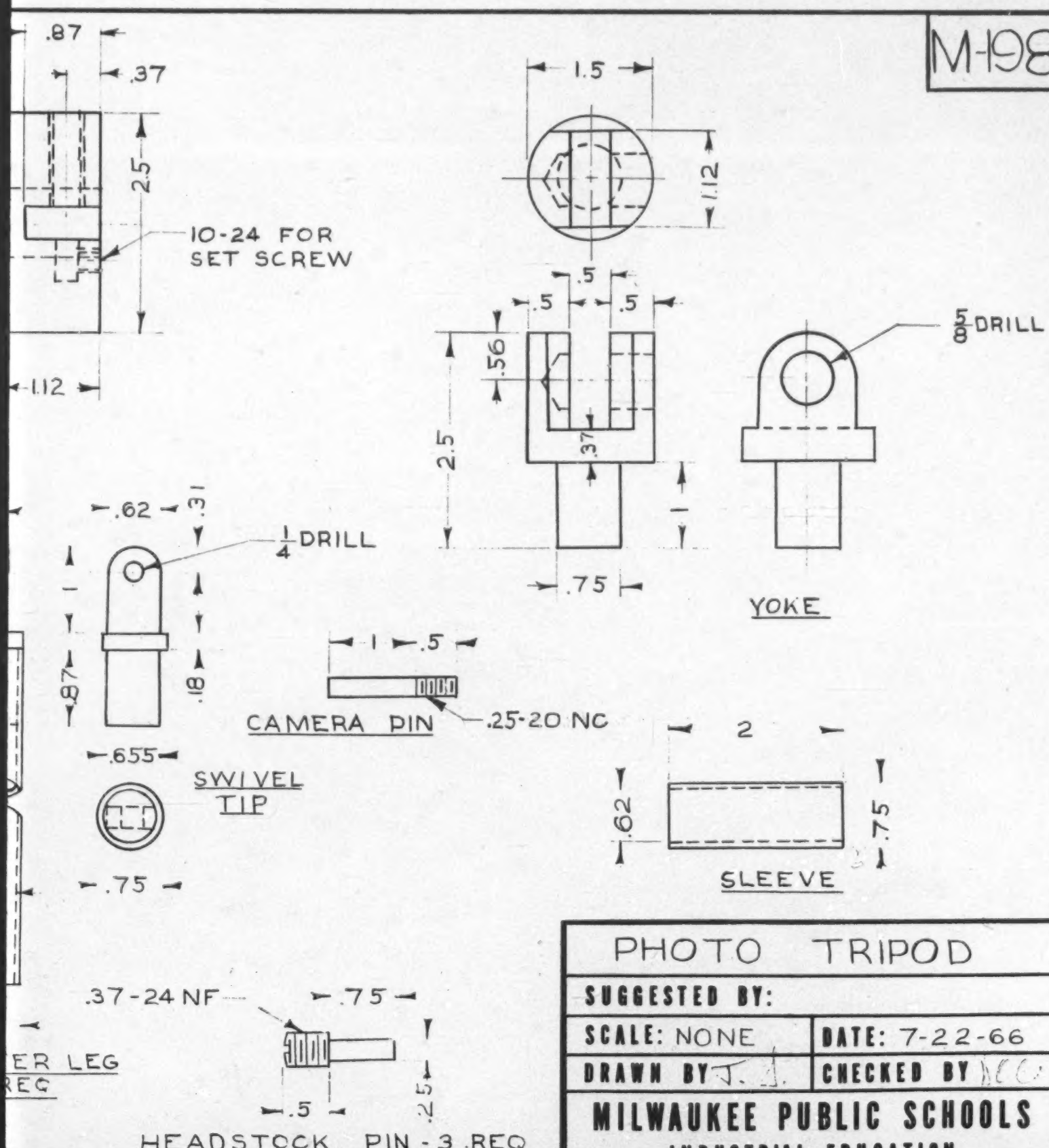

PHOTO TRIPOD	
SUGGESTED BY:	
SCALE: NONE	DATE: 7-22-66
DRAWN BY J. J.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8827

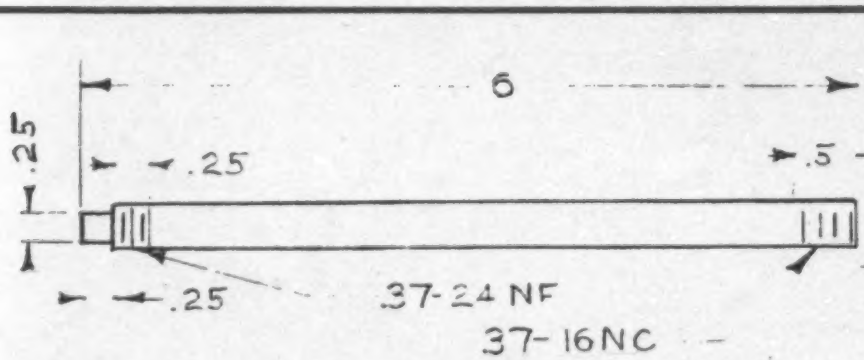

YOKE LOCK HANDLE

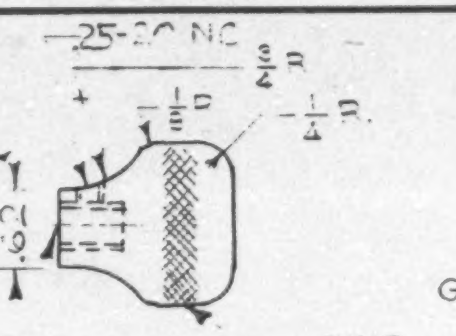

KNOB

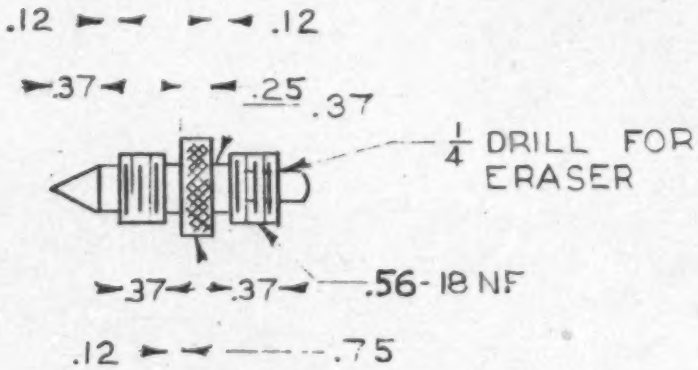

REVERSIBLE TIP - 3 REQ

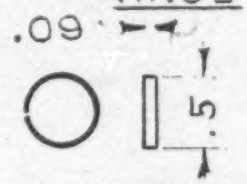

LOCK SPRING
3 REQ

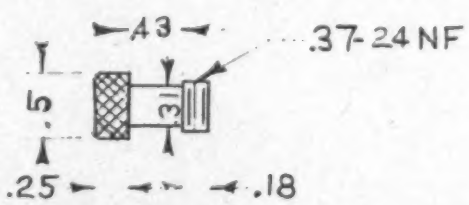

RISER POST
ADJUSTMENT SCREW

SWEDG
EX
LO

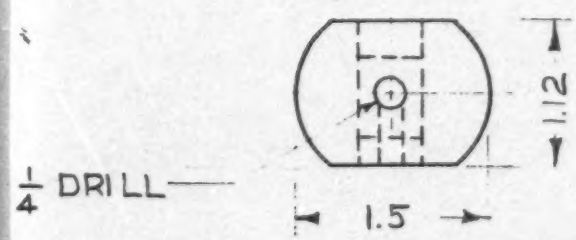

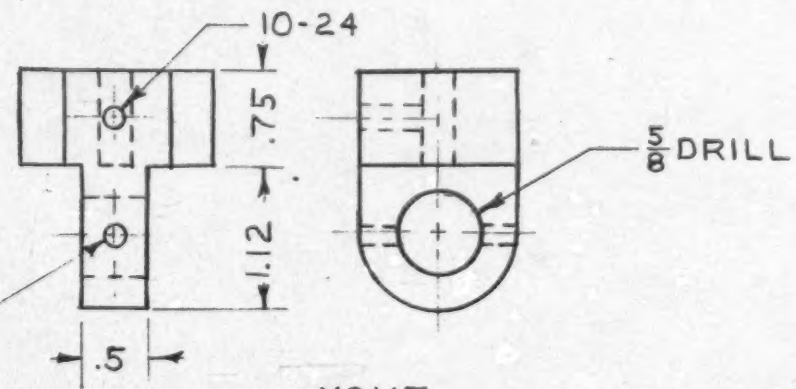

YOKE
SWIVEL

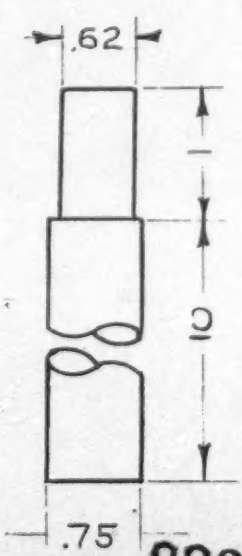

RISER
POST

EXPANDI
YOKE L

SUGGES
SCALE:
DRAWN
MILWA

8828

8829

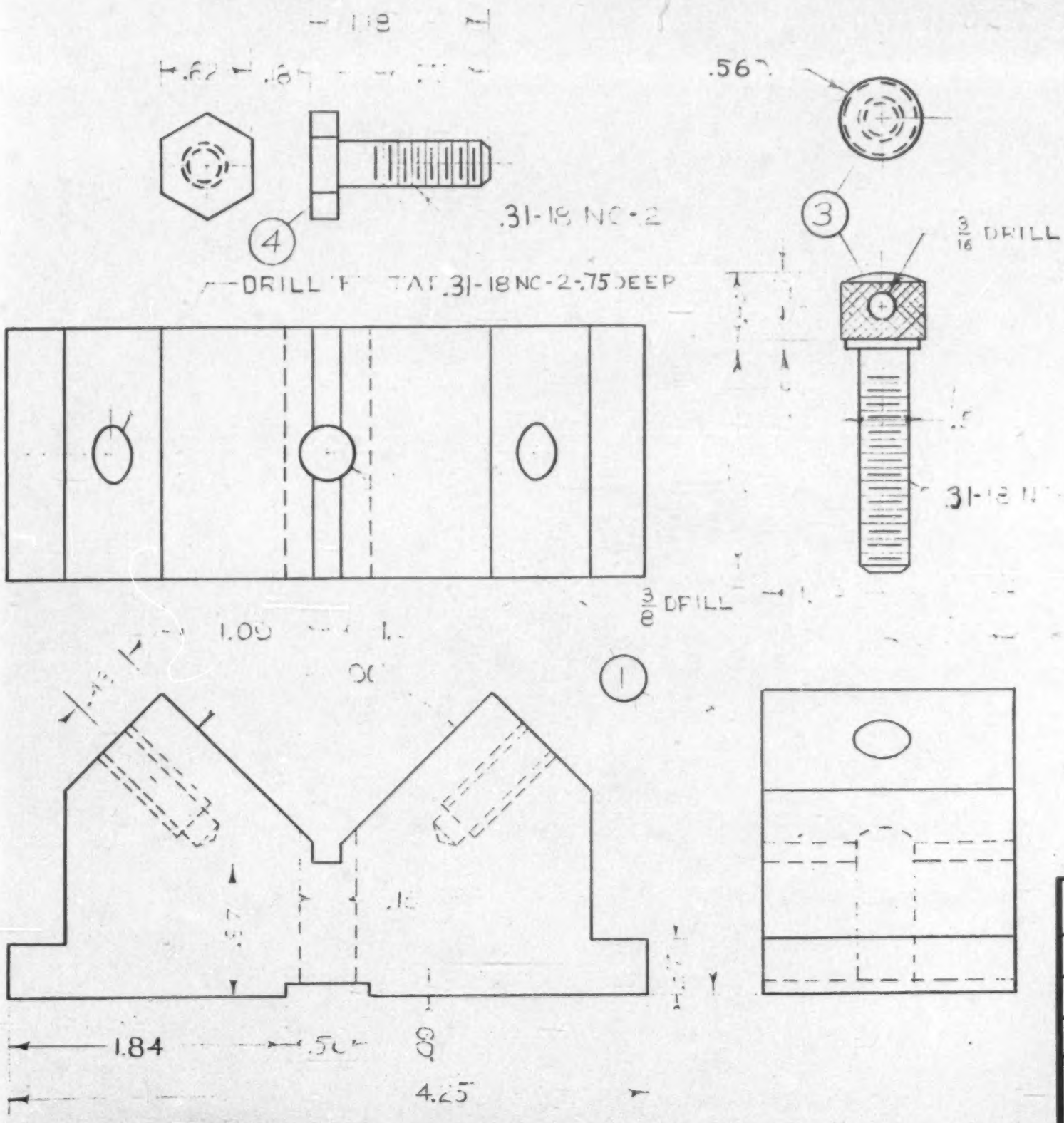

BILL	
NO.	NA
1	BASE
2	CLAM
3	CLAM
4	CAP

8830

M-199

BILL OF MATERIAL			
NO.	NAME	REQ	MAT
1	BASE	1	CI
2	CLAMP	2	ST
3	CLAMP SCREW	2	ST
4	CAP SCREW	2	ST

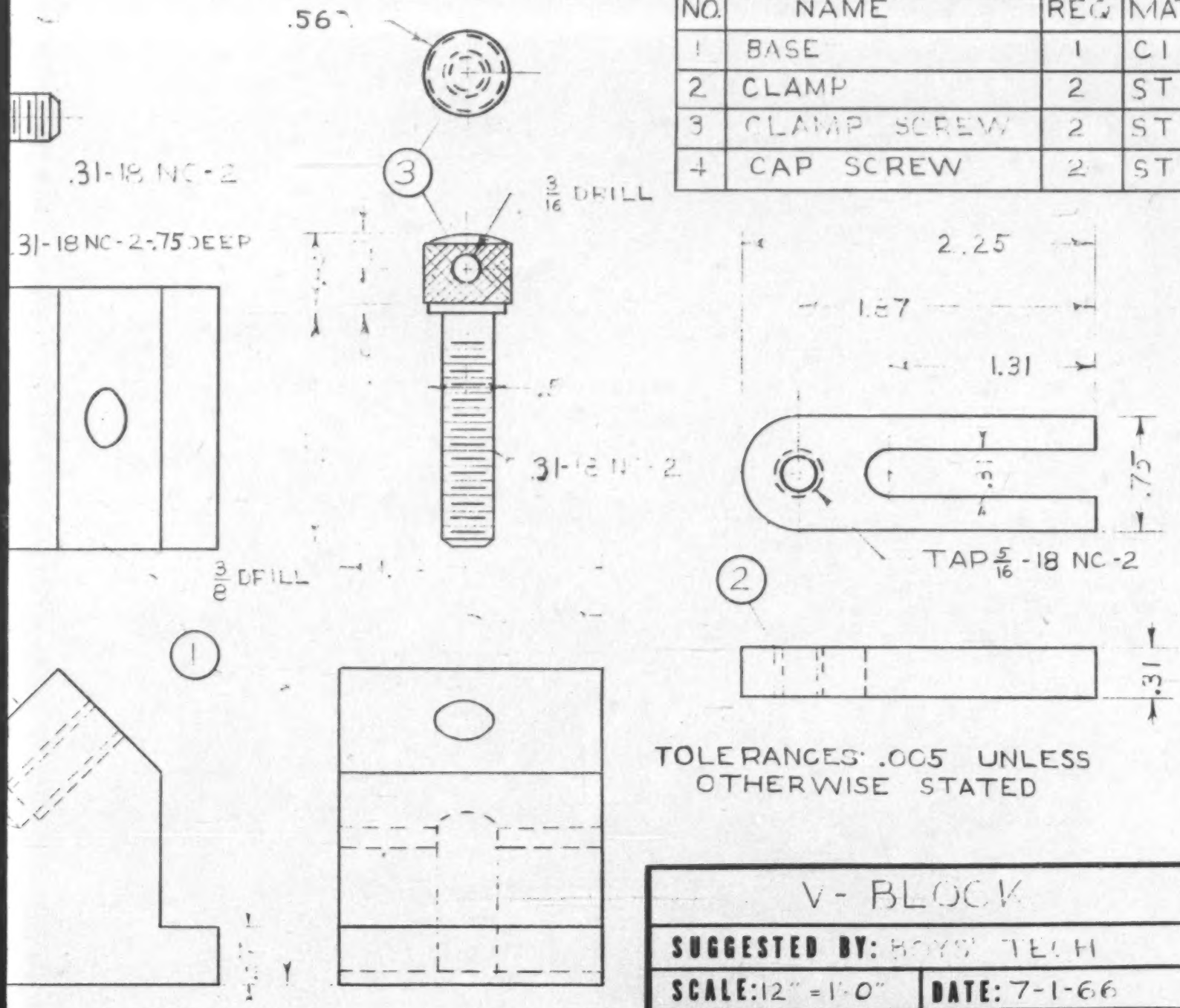

TOLERANCES: .005 UNLESS OTHERWISE STATED

V-BLOCK

SUGGESTED BY: BOYS TECH

SCALE: 12" = 1'-0" | DATE: 7-1-66

DRAWN BY T.S.S. | CHECKED BY

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

LEAVE .010 OVERSIZE FOR GRINDI

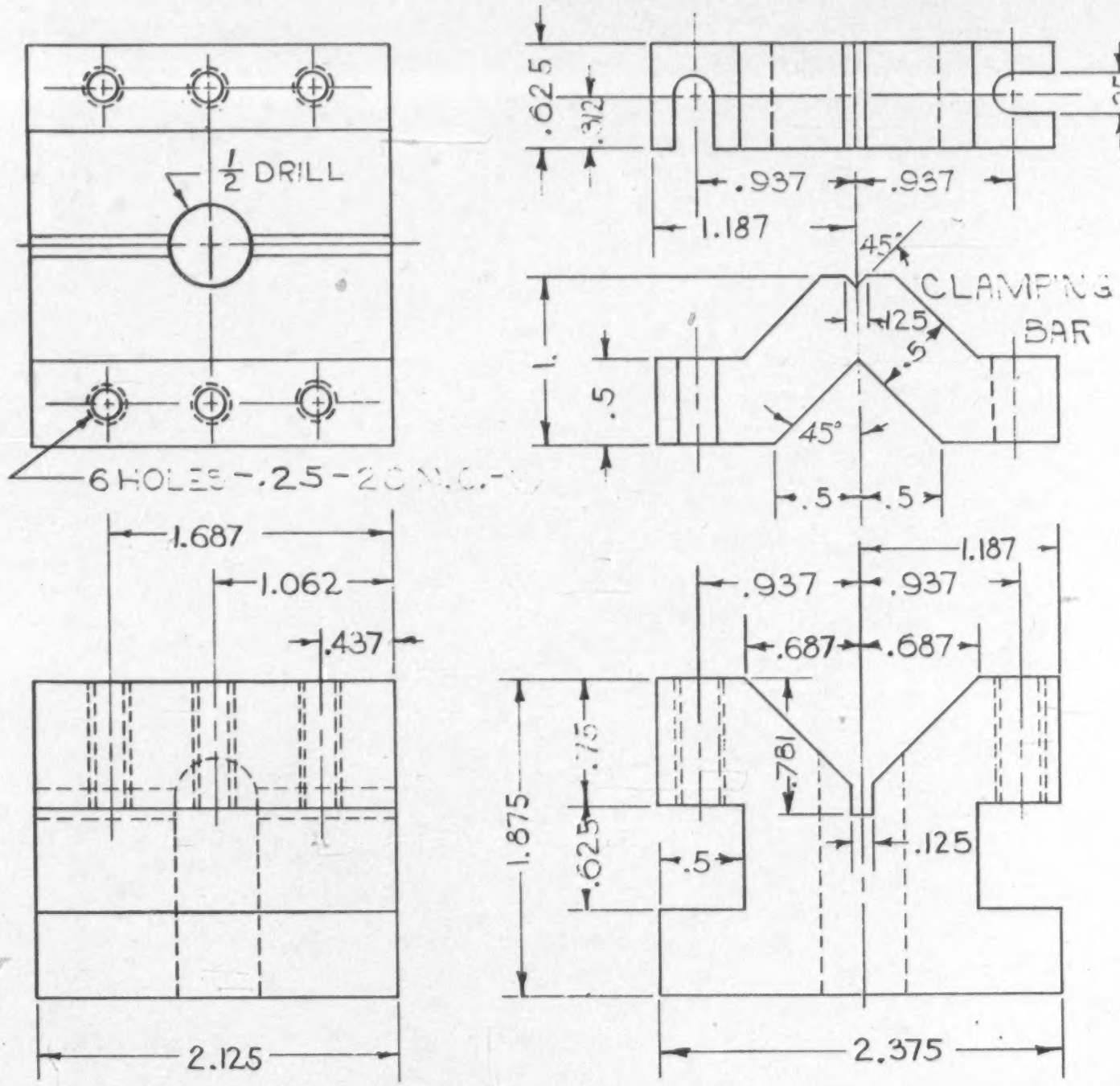

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8832

LEAVE .010 OVERSIZE FOR GRINDING

M-200

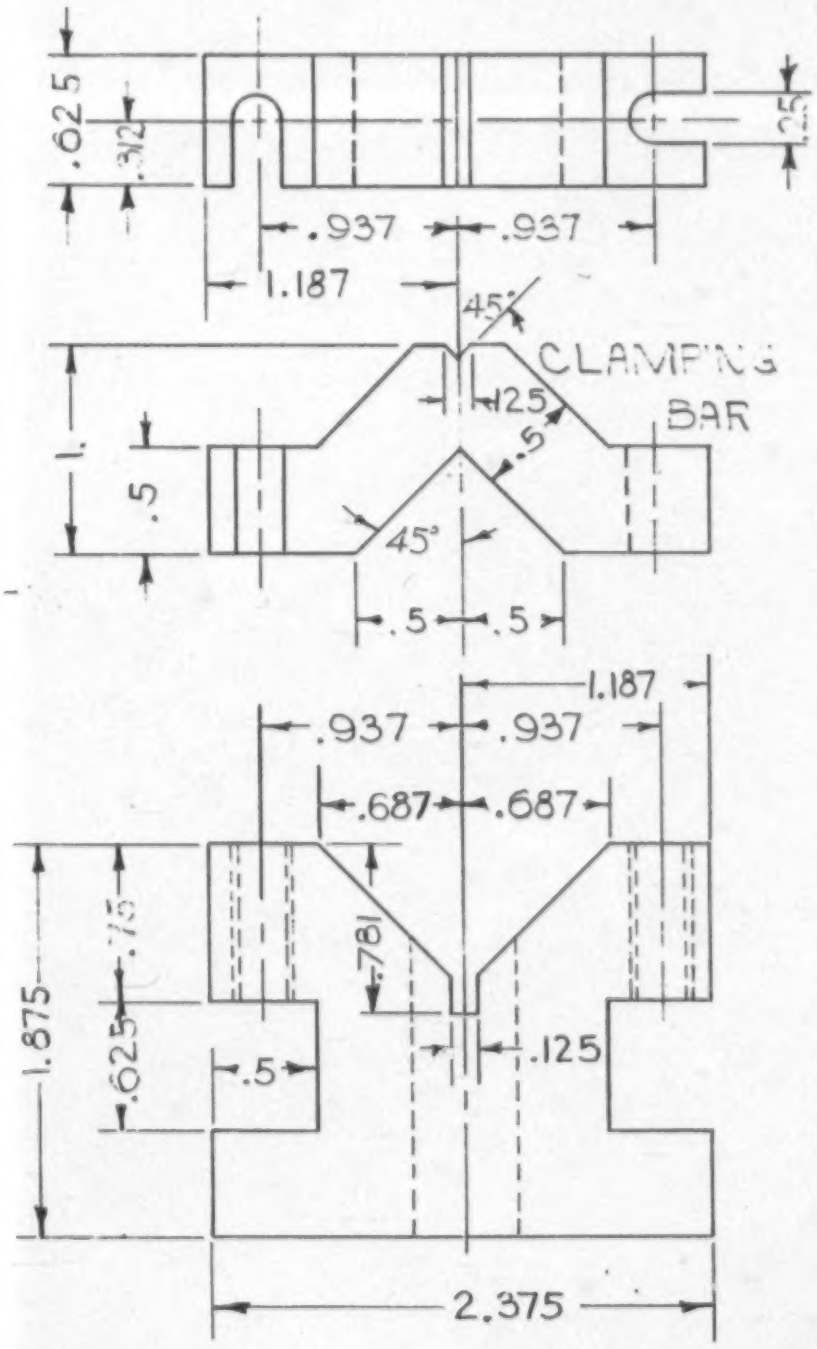

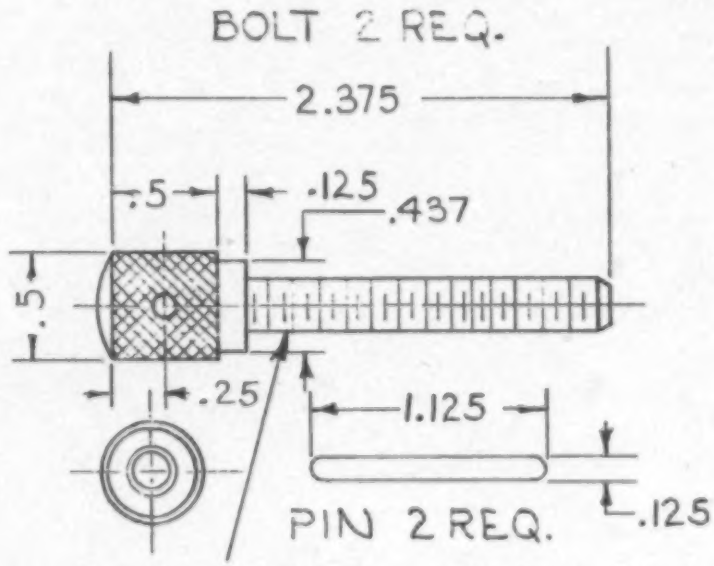

.25-20 N.C.-2 BOLT 2 REQ.

SAE 1020 STEEL

ROUND ALL CORNERS

APPROX. $\frac{1}{32}$

ALL PARTS TO BE FINISHED ALL OVER.

V-BLOCK	
SUGGESTED BY: BOYS' TECH	
SCALE: 12"=1'0"	DATE: 6-30-66
DRAWN BY [illegible]	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8833

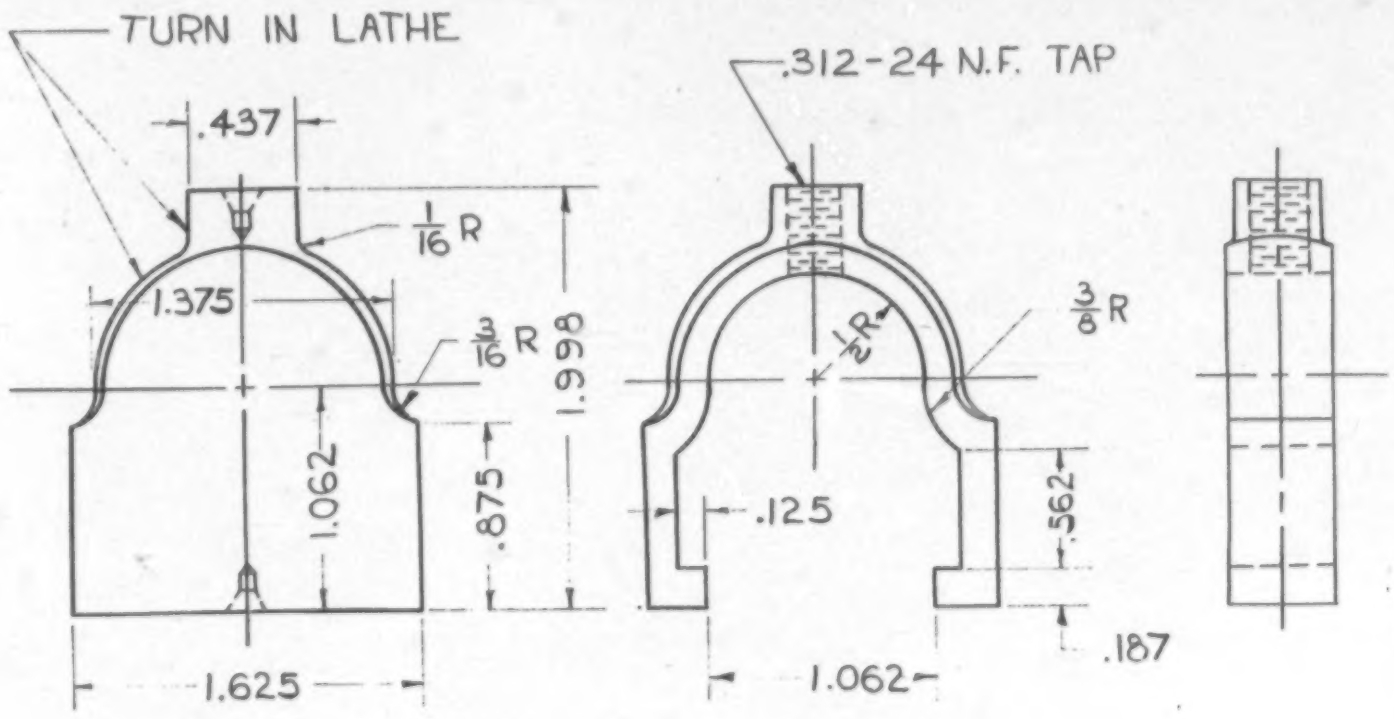

CLAMP
MILD STEEL

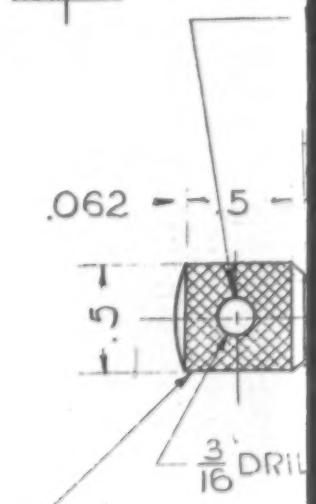

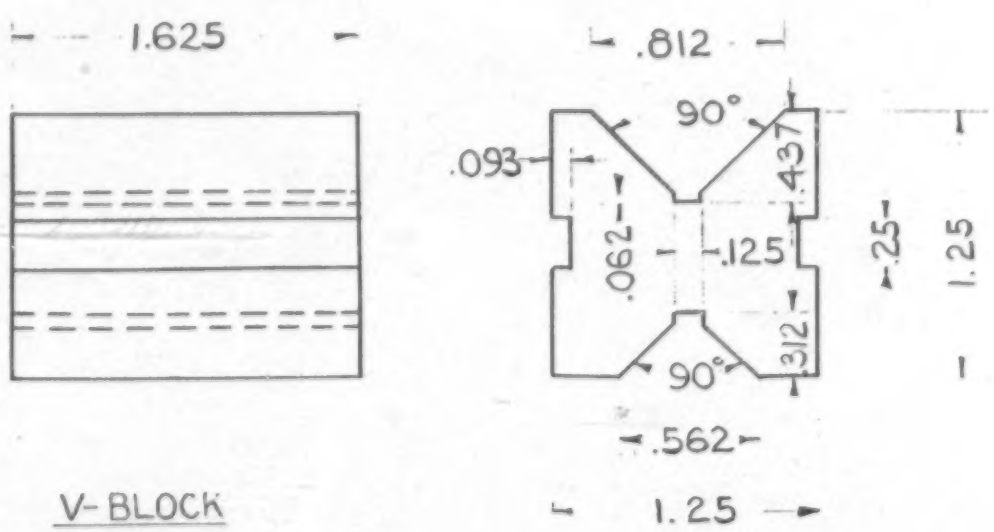

V-BLOCK
CAST IRON

8834

8835

SUG
SCA
DRA
MI

M-201

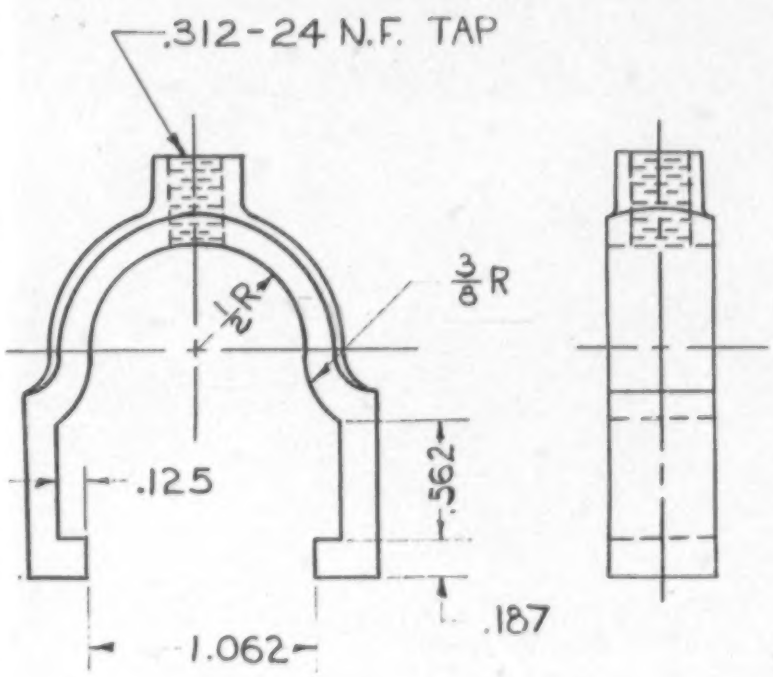

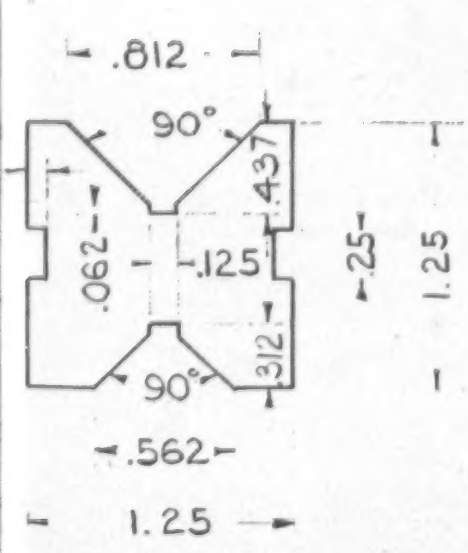

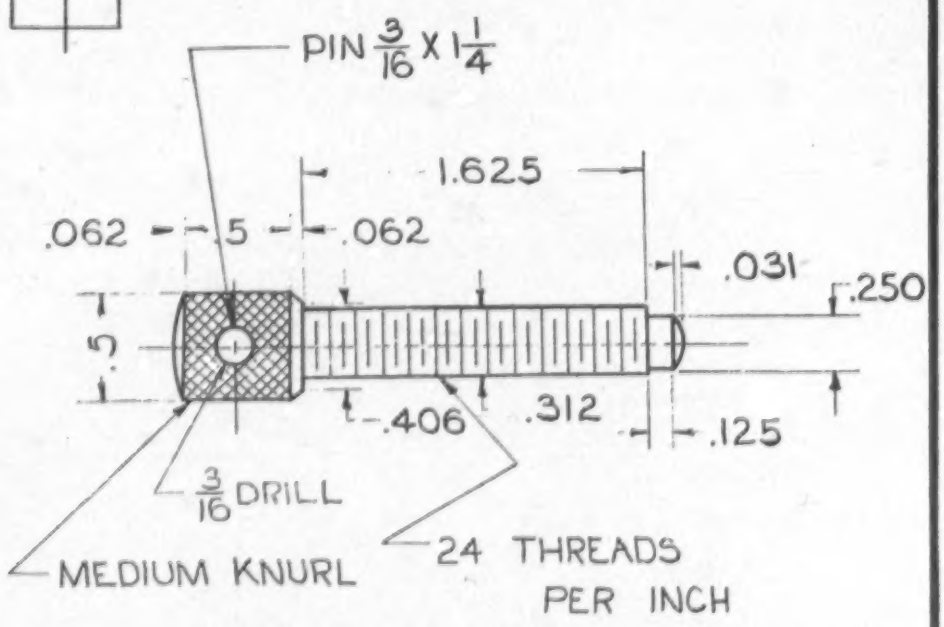

SCREW MILD STEEL

V-BLOCK III	
SUGGESTED BY: BOYS' TECH	
SCALE: 12"=1'0"	DATE: 7-21-66
DRAWN BY R.H.	CHECKED BY NCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8835

128 OF 327

ED

056 238

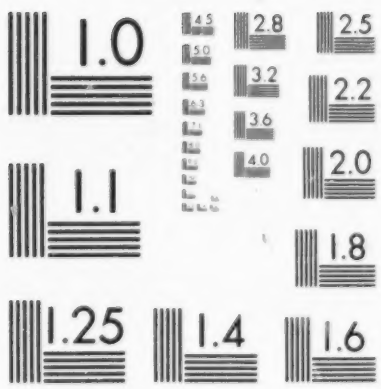

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CASTINGS FROM CASTING SPECIATIES CEDAREURG, WI

BILL OF MATERIAL				
NO.	NAME	REQ	MAT.	REMARKS
1	BASE	1	C. I.	
2	DRILL HOLDER FRAME	1	C. I.	
2 A	PIN	1	C.R.S.	1/4 D X 1.12
3	CLAMP	2	C. I.	
4	GUIDE PIN	1	C.R.S	9/16 D X 5
5	COLUMN	1	C.R.S	7/8 D X 18
6	HANDLE	1	C.R.S	1/8 x 3/4 X 11 7/8
7	SPRING 15/16 ID x 1 3/16 OD x 5 1/2	1		2 1/2 COILS PER INCH
8	RUBBER TUBE GRIP	1		4 LONG
9	ADAPTOR PLATE	1	C.R.S	5/16 X 2 X 3
10	HEADLESS SET SCR.			1/4 - 20 X 1/4
11	3/4 HEX. HD. CAP SCR.	1		3/8 - 16 X 2
12	WING NUT	1		5/8 - 16
13	WASHER	1	W. I.	5/16
14	COTTER PIN	1	W. I.	1/16
15	1/2 HEX HD. CAP SCR.	2		3/8 - 16 X 1
16	HEX. HD. CAP SCR.	2		1/4 - 20 X 3/4

TOLE
OTH

SUG
SCA
DRA
MI

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8837

FROM CASTING SPECIATIES CEDAREURG, WISCONSIN

M-202

OF MATERIAL			
	REQ	MAT.	REMARKS
	1	C.I.	
AME	1	C.I.	
	1	C.R.S.	1/4 D X 1.12
	2	C.I.	
	1	C.R.S	3/8 D X 5
	1	C.R.S	7/8 D X 18
	1	C.R.S	1/8 x 3/4 X 11 7/8
D x 5 1/2	1		2 1/2 COILS PER INCH
RIP	1		4 LONG
TE	1	C.R.S	3/16 X 2 X 3
SCR.			1/4 - 20 X 1/4
CR.	1		3/8 - 16 X 2
	1		3/8 - 16
	1	W.I.	3/16
	1	W.I.	1/16
SCR.	2		3/8 - 16 X 1
CR.	2		1/4 - 20 X 3/4

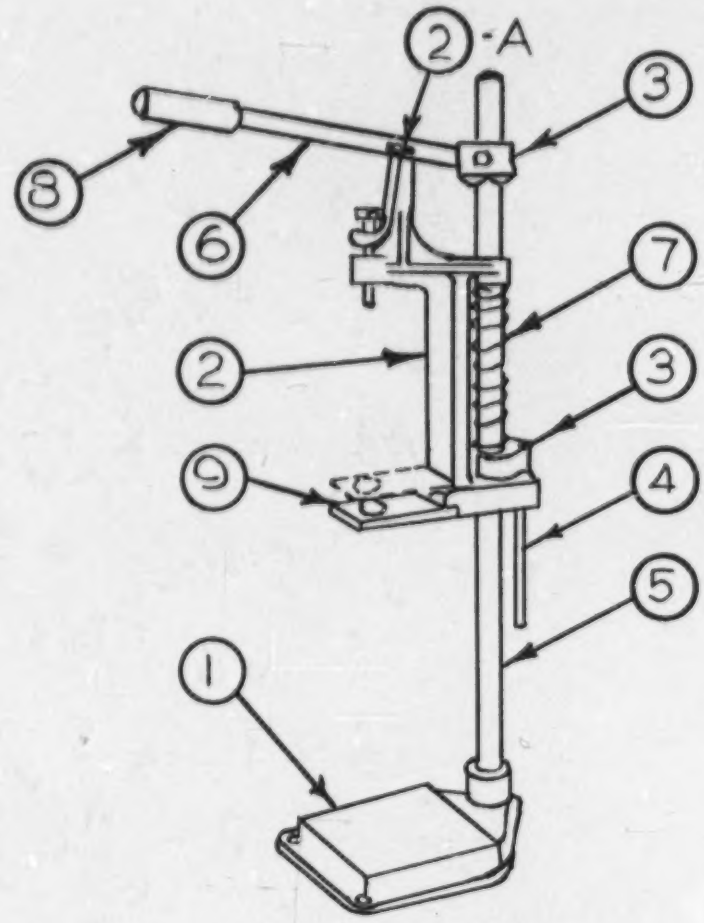

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

DRILL PRESS	
SUGGESTED BY:	
SCALE: NONE	DATE: 7-14-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8837

CASTINGS FROM CASTING SPECIALTIES, CEDARBU

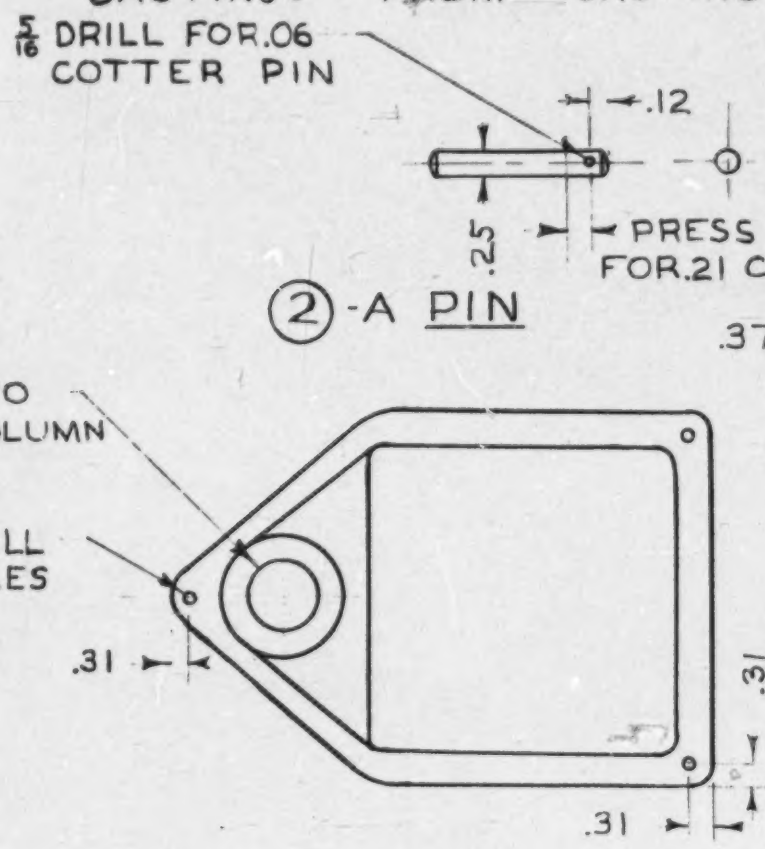

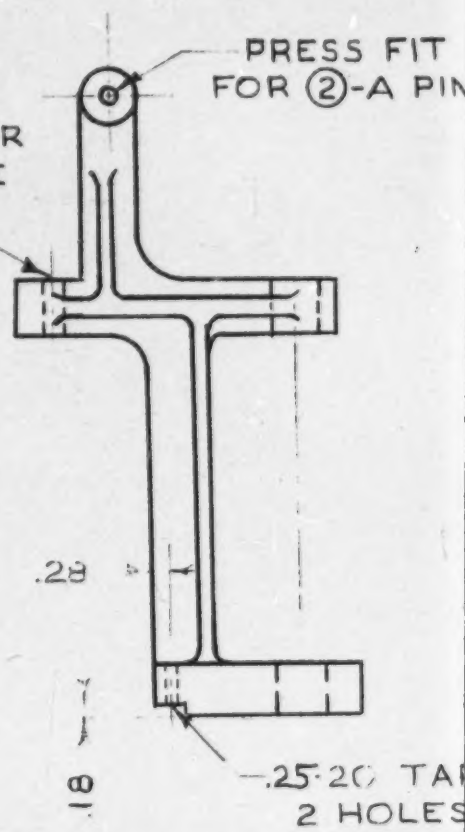

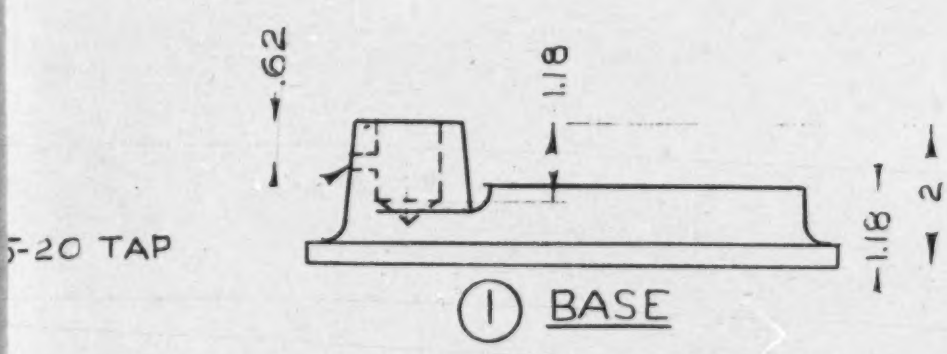

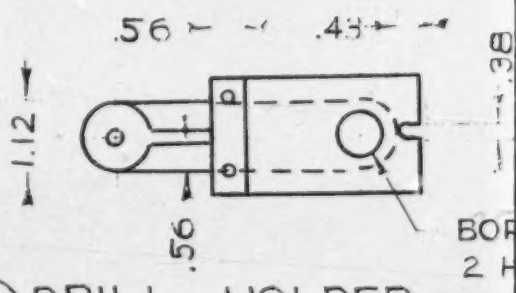

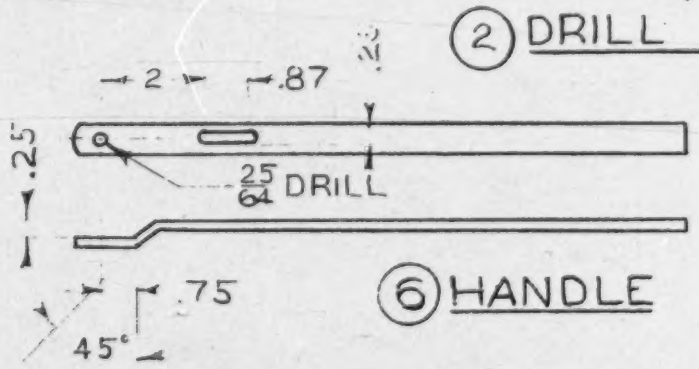

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SU	
SC	
DR	
M	

CASTING SPECIALTIES, CEDARBURG, WISCONSIN

M-202A

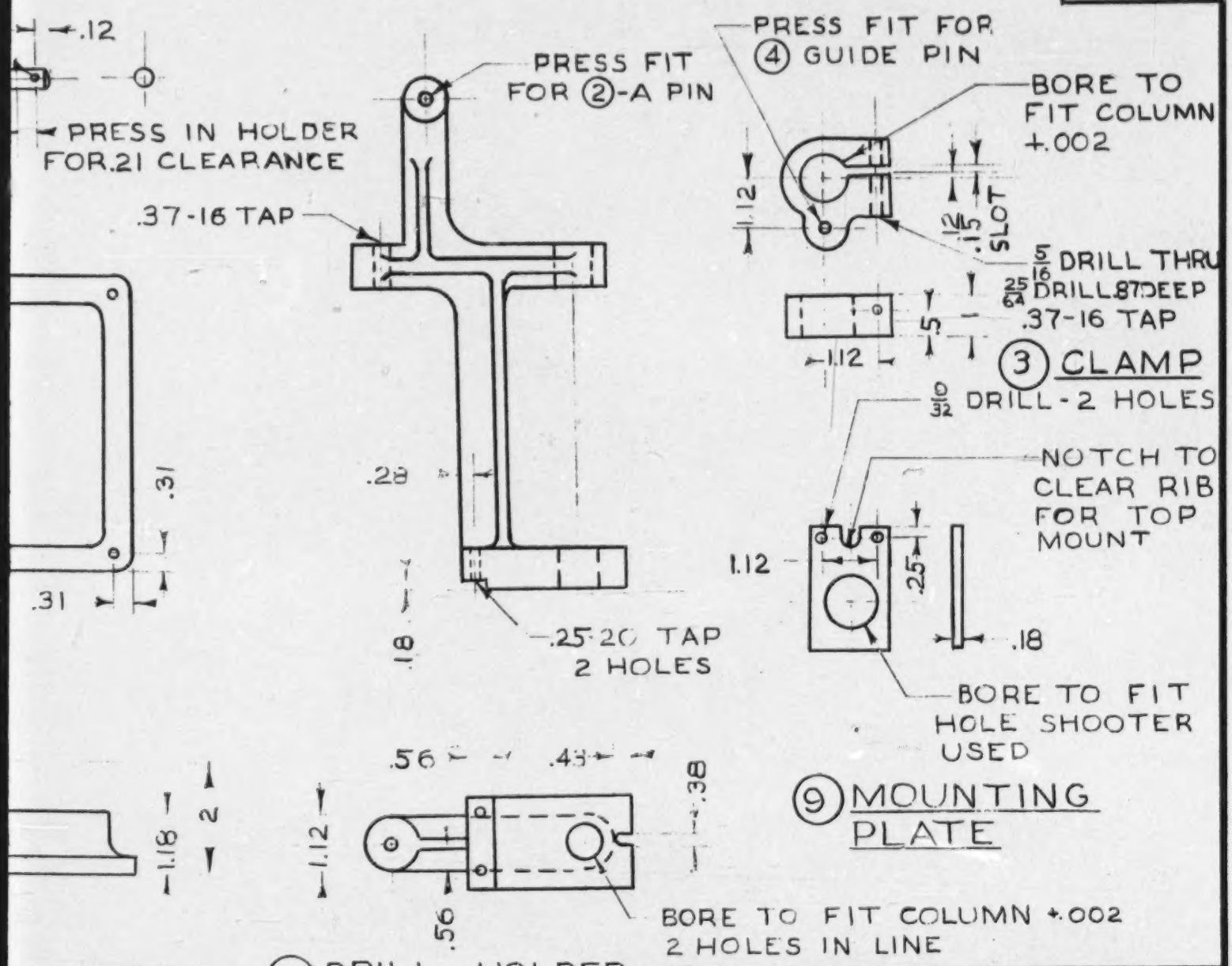

DRILL PRESS	
SUGGESTED BY:	
SCALE: NONE	DATE: 7-15-66
DRAWN BY T.S.S.	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8839

CASTING FROM CASTING SPECIALTIES CEDARE

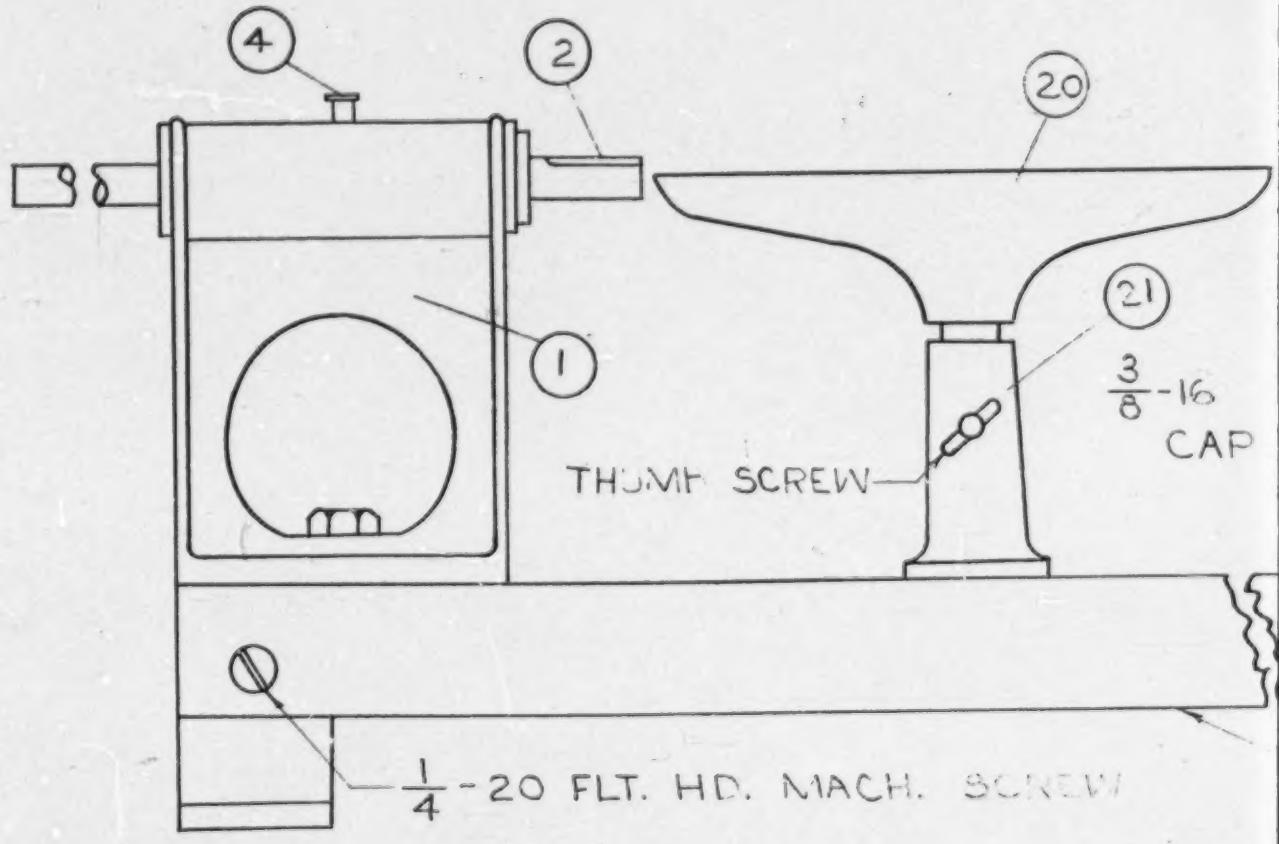

1 1/2 X

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FROM CASTING SPECIALTIES CEDARBURG, WISCONSIN

M-203

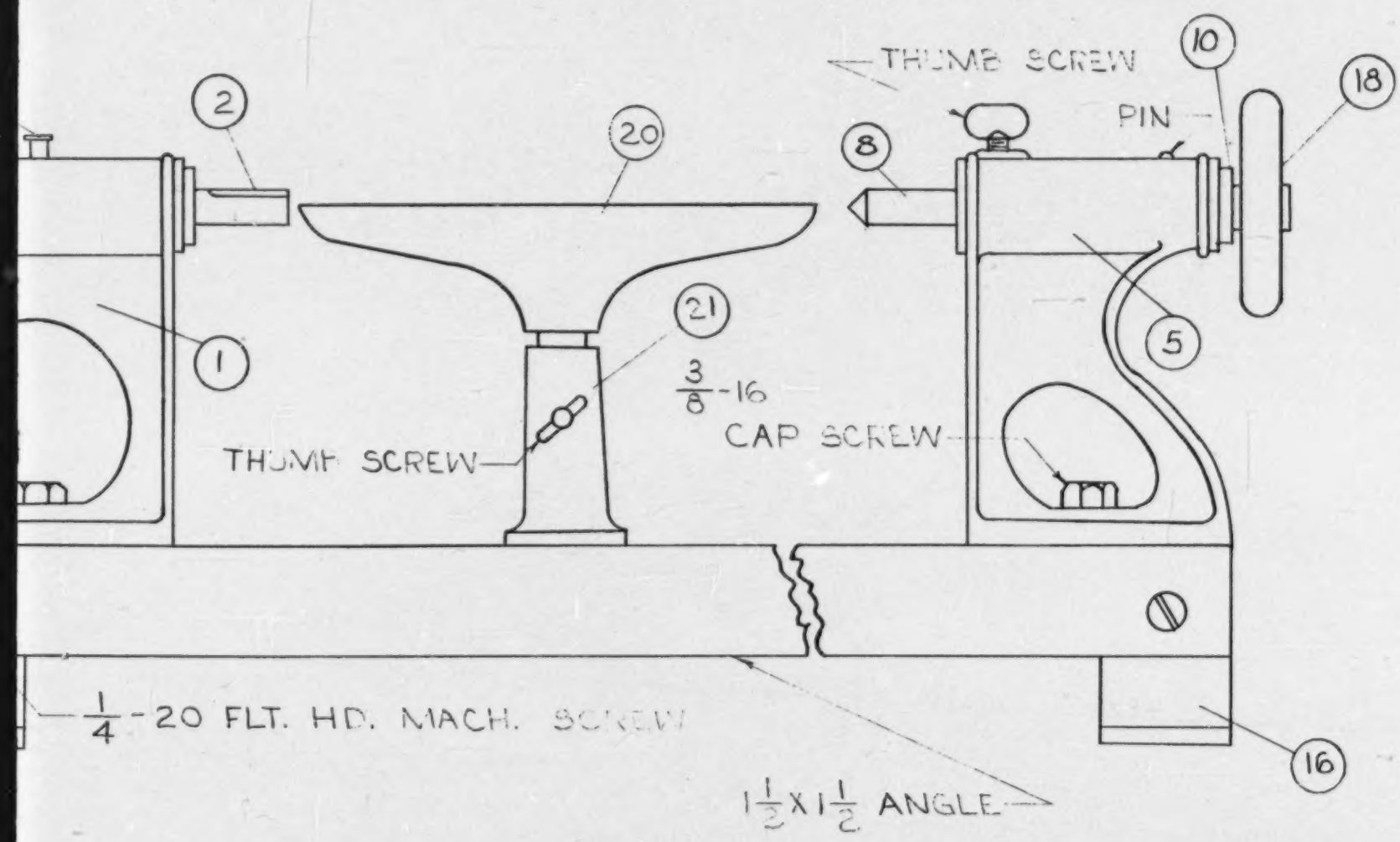

WOOD LATHE	
SUGGESTED BY:	
SCALE: NTS	DATE: 7-27-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8841

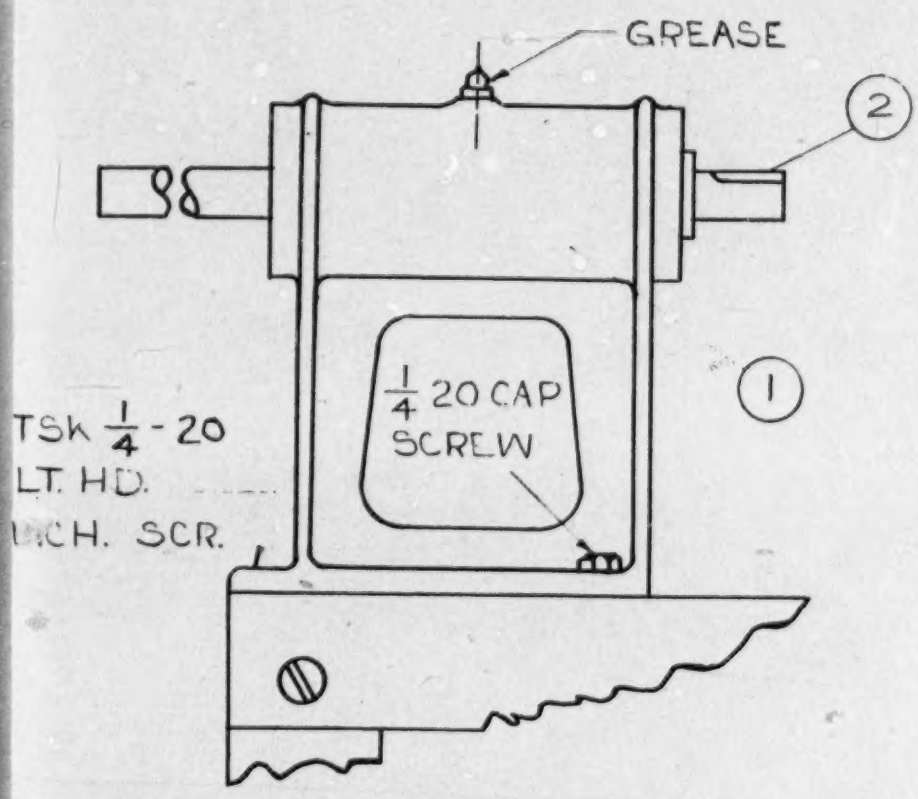

8842

8843

M-203A

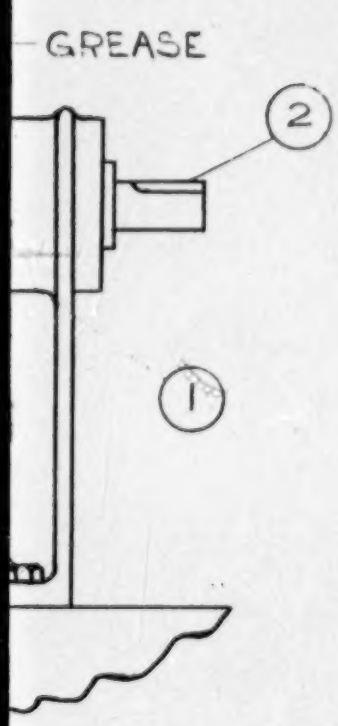

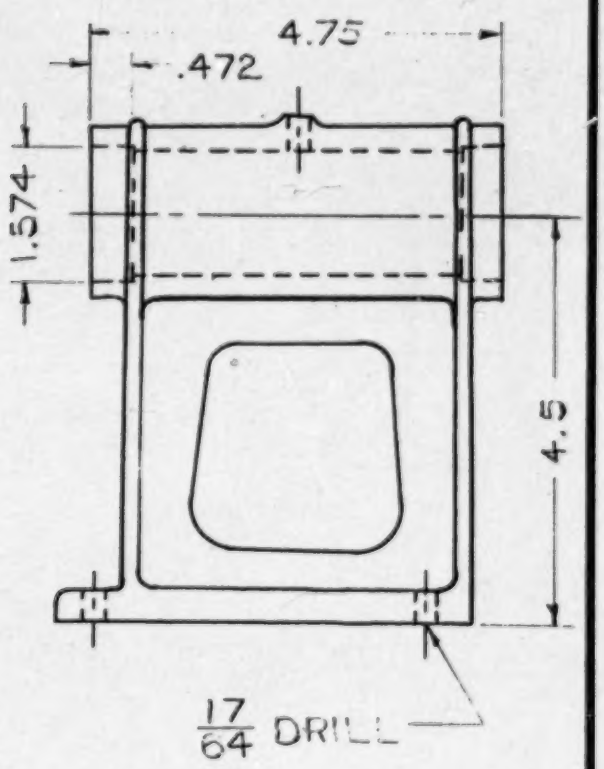

WOOD LATHE DETAILS	
SUGGESTED BY:	
SCALE: NTS	DATE: 7-27-66
DRAWN BY [illegible]	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

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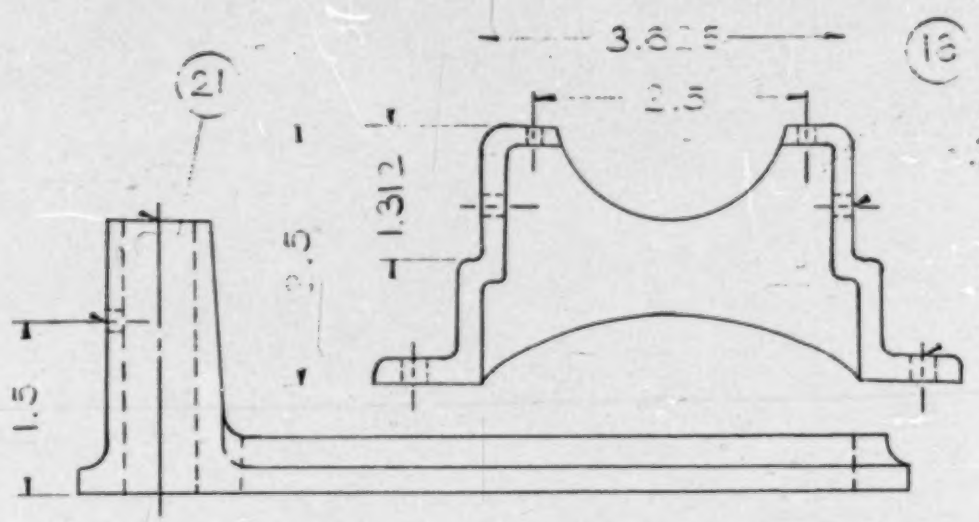

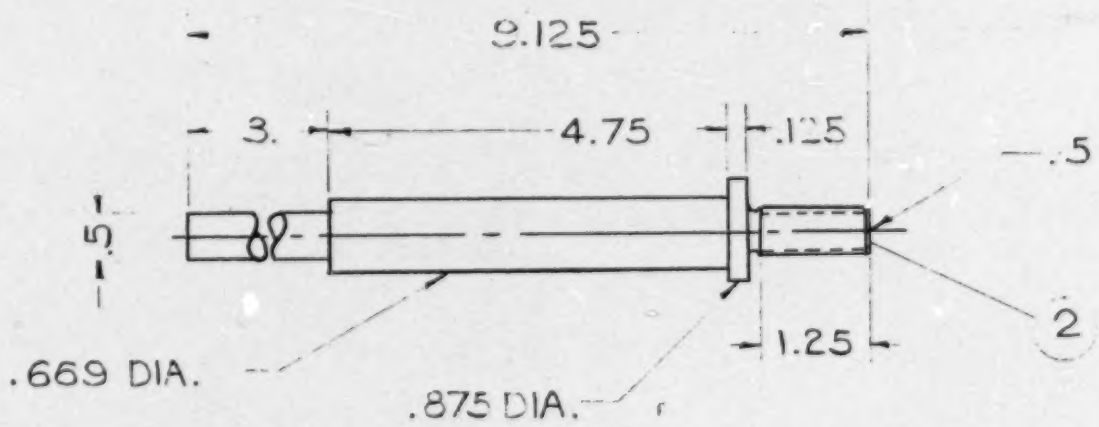

CASTINGS FROM CASTING SPECIALTIES CEDARBURG, WISCONSIN

M-203B

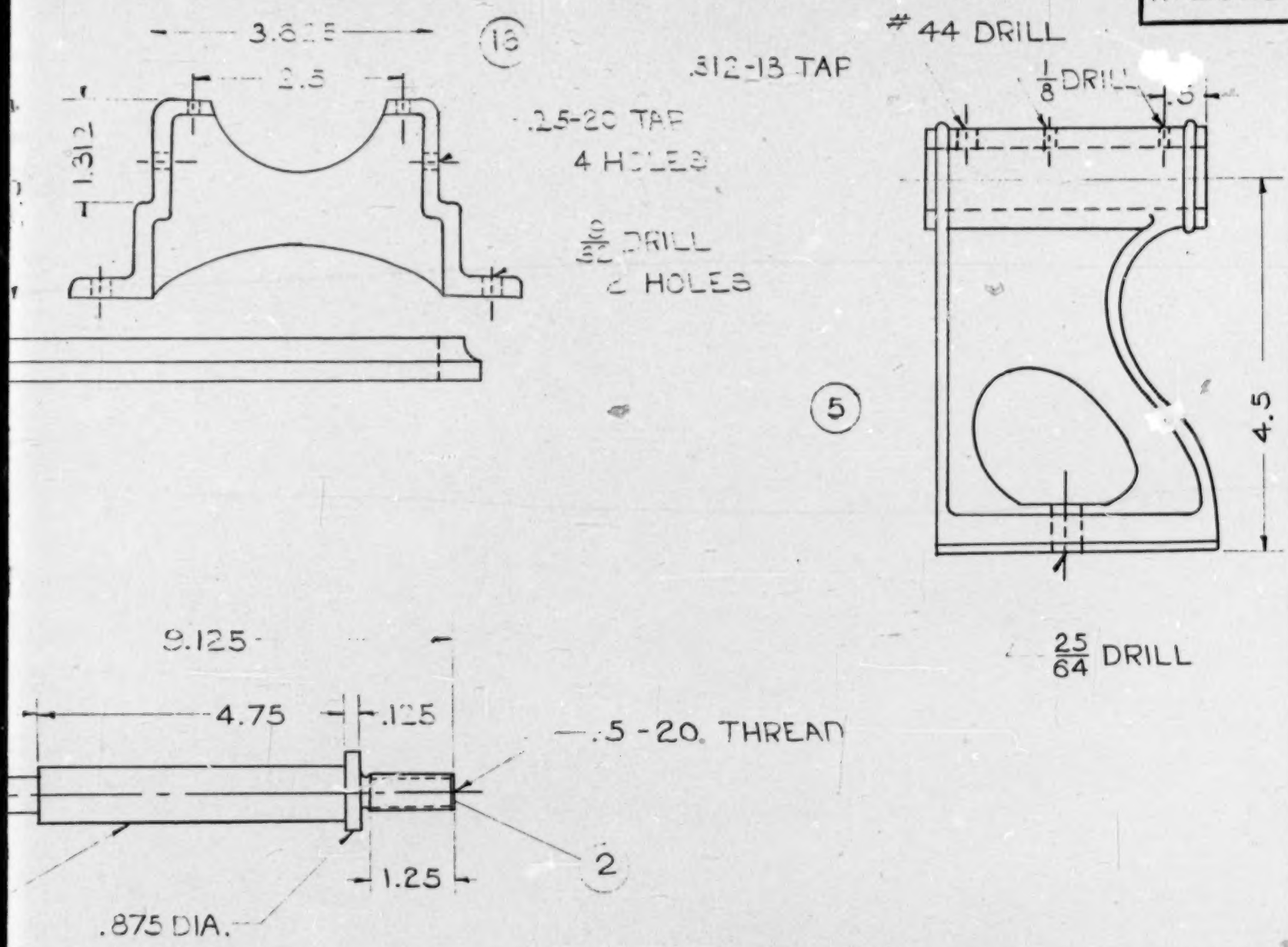

WOOD LATHE DETAILS	
SUGGESTED BY:	
SCALE: NTS	DATE: 7-27-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

NG SPECIALTIES CEDARBURG, WISCONSIN

8845

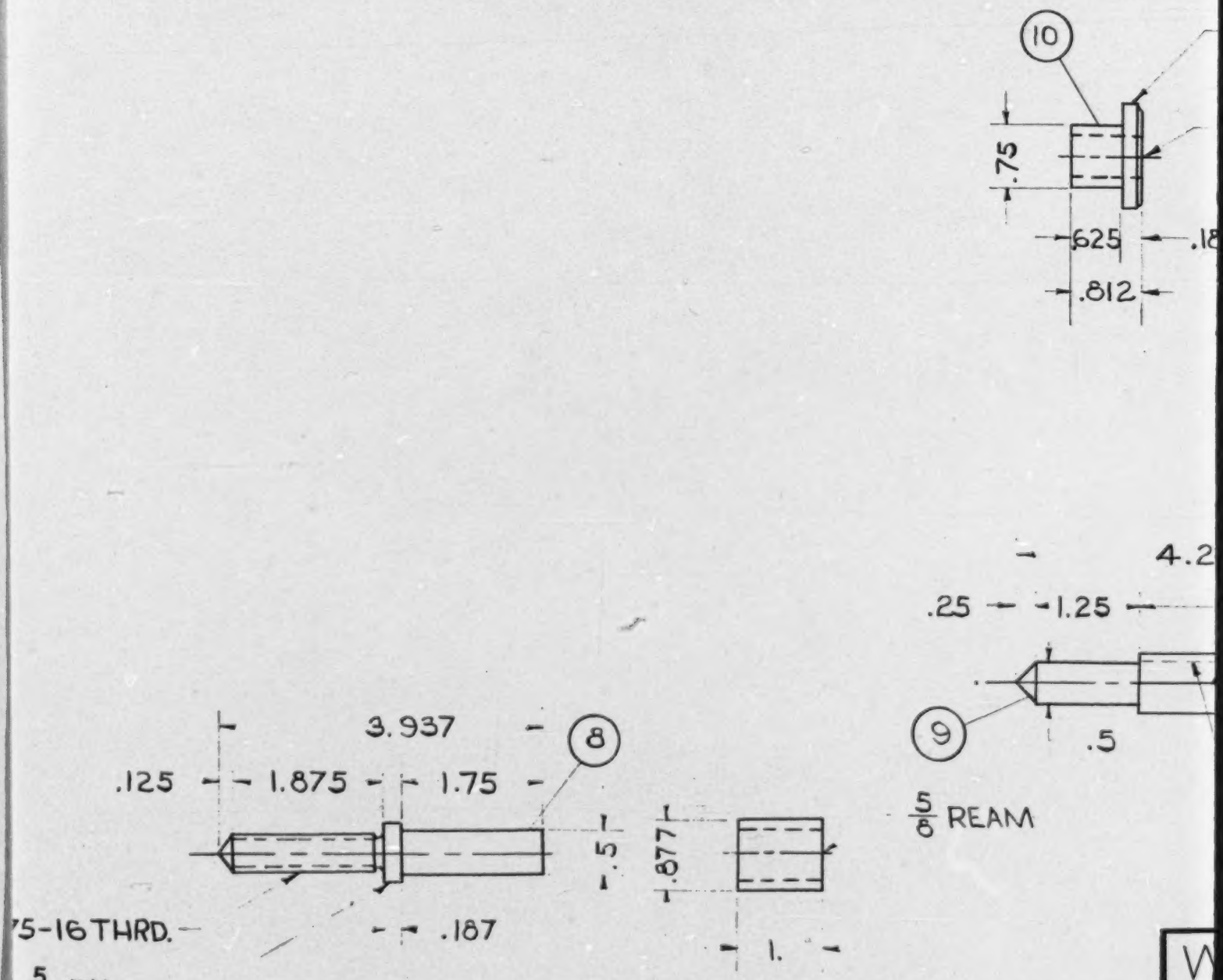
10
.75
.625
.812
4.2
.25
1.25
9
.5
5/8 REAM
3.937
8
.125
1.875
1.75
.5
.877
75-16 THRD.
.187
5/8 DIA.
1.
BRONZE BUSHING
PRESS FIT EACH
END OF HEADSTOCK

8846

8847

M-203C

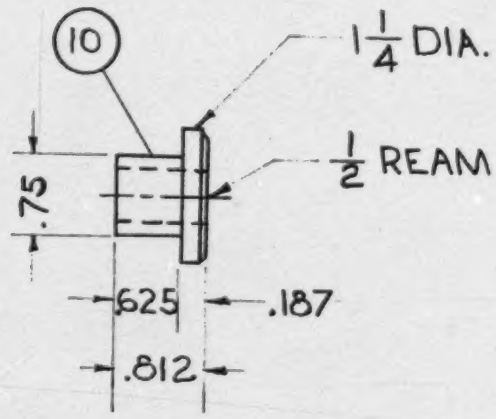

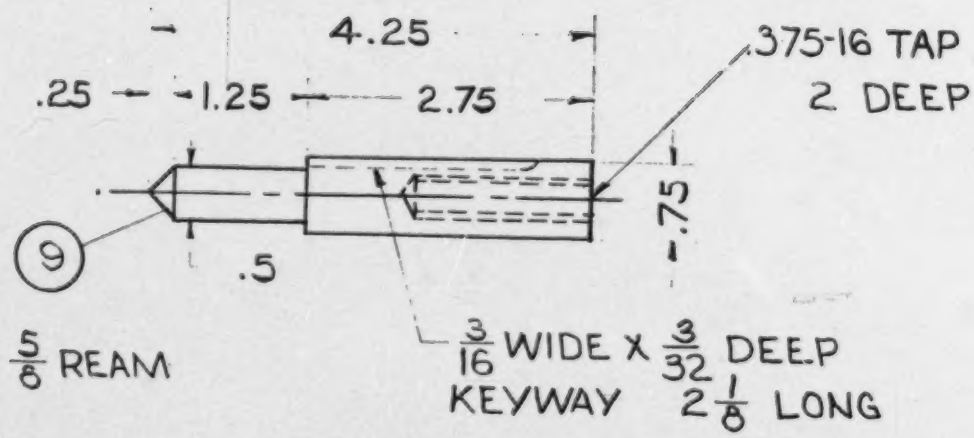

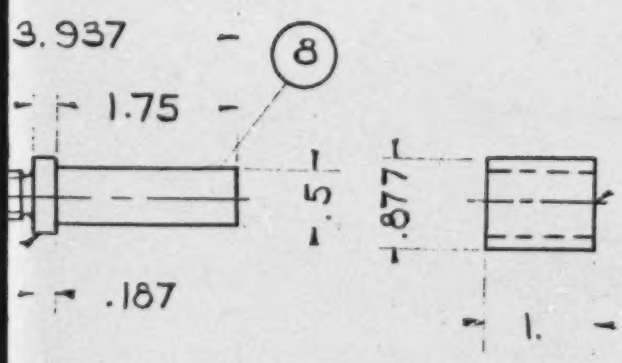

BRONZE BUSHING
PRESS FIT EACH
END OF HEADSTOCK

WOOD LATHE DETAILS	
SUGGESTED BY:	
SCALE: 6" = 1' 0"	DATE: 7-27-66
DRAWN BY R.W.H.	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8847

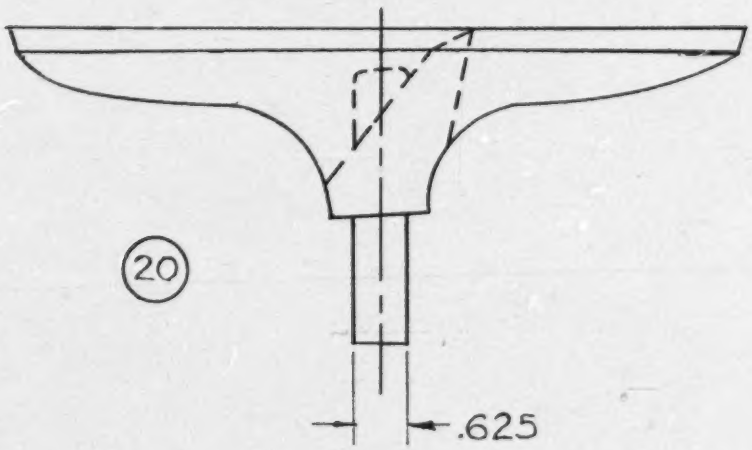
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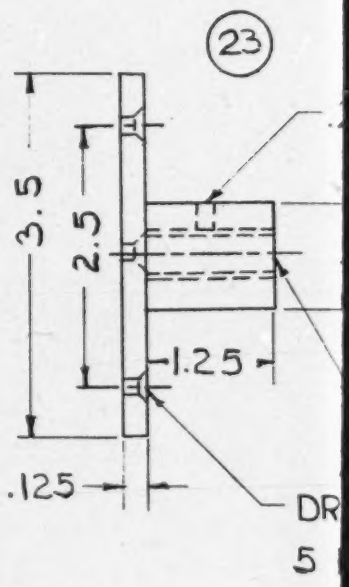
23
3.5
2.5
1.25
.125
DR
5

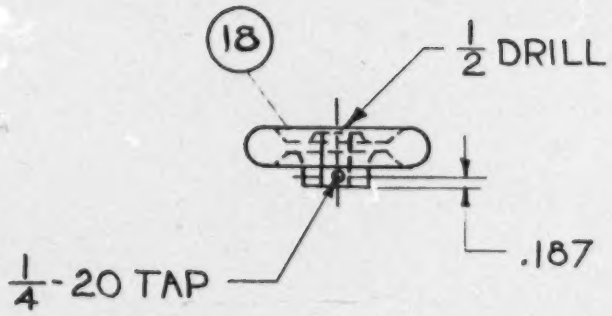
18
1/2 DRILL
.187
1/4-20 TAP

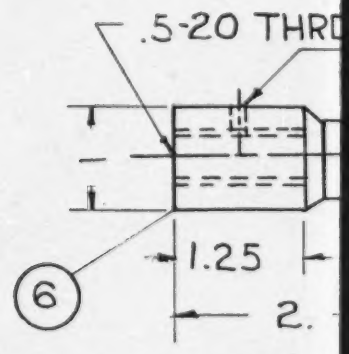
.5-20 THRD
6
1.25
2.

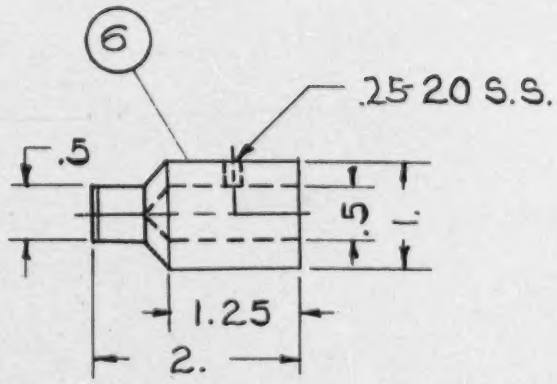
6
.25-20 S.S.
.5
.5
1.25
2.

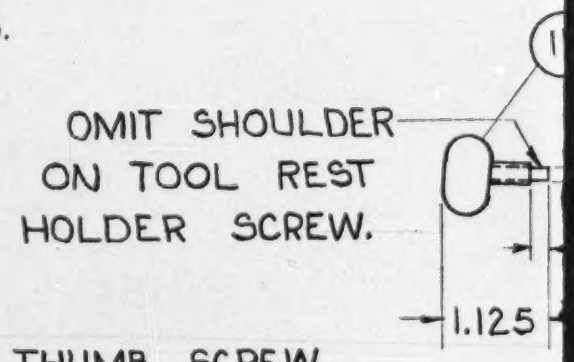
OMIT SHOULDER
ON TOOL REST
HOLDER SCREW.
1.125
THUMB SCREW

8848

8849

M-203D

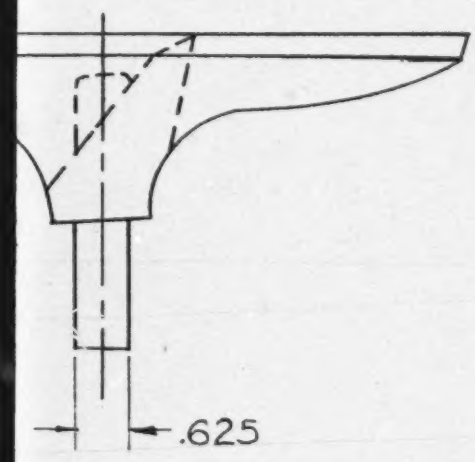

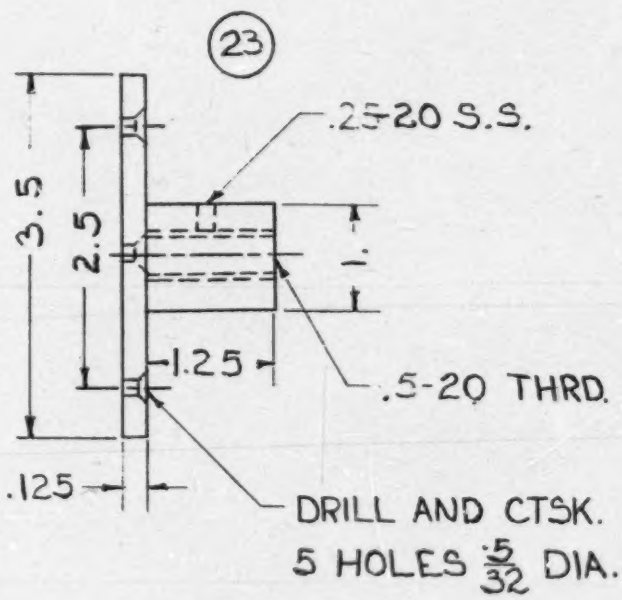

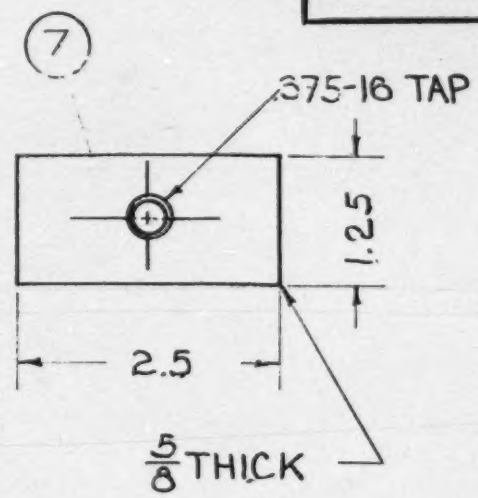

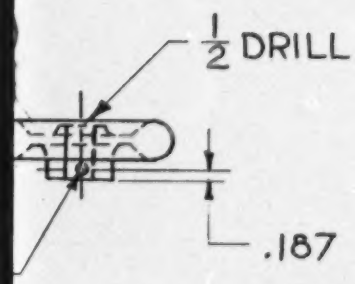

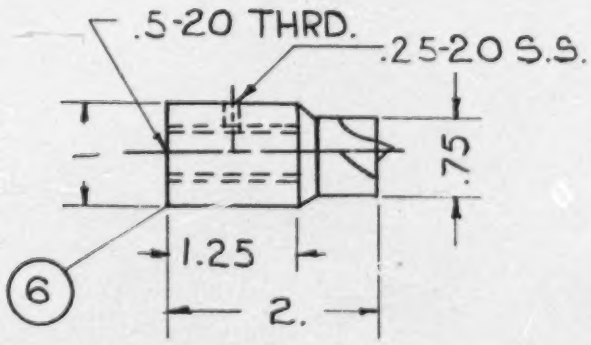

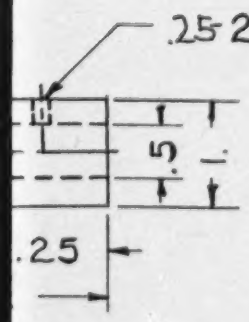

OMIT SHOULDER ON TOOL REST HOLDER SCREW.

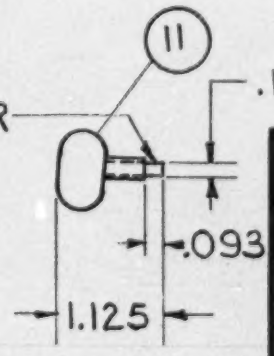

THUMB SCREW

WOOD LATHE DETAILS	
SUGGESTED BY:	
SCALE: 6" = 1'-0"	DATE: 7-26-66
DRAWN BY R.W.H.	CHECKED BY W.C.C.
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

MATERIALS FOR WOOD LATHE

NO.	PART	REQ	COMMENTS
1	HEADSTOCK	1	CAST. SPEC. PART #L113-1B
2	SPINDLE	1	7/8 X 9 3/16 CRS
3	HEX HD. CAP SCREWS	2	1/4-20 X 3/4
4	GREASE FITTING	1	
5	TAILSTOCK	1	CAST. SPEC. PART #L113-2
6	SPUR AND CUP CENTER	2	1 DIA. X 2-1/16 CRS
7	CLAMP BLOCK	2	5/8 X 1-1/4 X 2-1/2 CRS
8	SPINDLE	1	5/8 DIA. X 4 CRS
9	RAM	1	3/4 DIA. X 4-3/8 CRS
10	COLLAR	1	1-1/4 DIA. X 7/8 CRS
11	THUMBSCREW	2	5/16-18
12	DRIVE PIN	1	#2 PARKER-KALON
13	HEX HD. CAP SCREW	2	3/8-16 X 1
14	WASHER	2	5/16 W.I.
15	ANGLE IRON BED	1	3/16 X 1-1/2 X 1-1/2
16	FOOT	2	CAST. SPEC. PART #L113-3
17	FLAT HD. MACH. SCR.	8	1/4-20 X 1
18	HANDWHEEL CP 170-4	1	CAST. SPEC. PART #L113-4
19	HEADLESS SET SCR.	4	1/4-20 X 1/4
20	TOOLREST	1	CAST. SPEC. PART #L113-5
21	TOOLREST HOLDER	1	CAST. SPEC. PART #L113-6
22	CLAMP	1	CAST. SPEC. PART #113-7
23	FACEPLATE	1	CAST. SPEC. PART # L19-9

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7	CLAMP BLOCK	2	5/8 X 1-1/4 X 2-1/2 CRS
8	SPINDLE	1	5/8 DIA. X 4 CRS
9	RAM	1	3/4 DIA. X 4-3/8 CRS
10	COLLAR	1	1-1/4 DIA. X 7/8 CRS
11	THUMBSCREW	2	5/16 - 18
12	DRIVE PIN	1	#2 PARKER-KALON
13	HEX HD. CAP SCREW	2	3/8 - 16 X 1
14	WASHER	2	5/16 W.I.
15	ANGLE IRON BED	1	3/16 X 1-1/2 X 1-1/2
16	FOOT	2	CAST. SPEC. PART # L113-3
17	FLAT HD. MACH. SCR.	8	1/4 - 20 X 1
18	HANDWHEEL CP 170-4	1	CAST. SPEC. PART # L113-4
19	HEADLESS SET SCR.	4	1/4 - 20 X 1/4
20	TOOLREST	1	CAST. SPEC. PART # L113-5
21	TOOLREST HOLDER	1	CAST. SPEC. PART # L113-6
22	CLAMP	1	CAST. SPEC. PART # 113-7
23	FACEPLATE	1	CAST. SPEC. PART # L19-9

M-203E

WOOD LATHE

SUGGESTED BY:

SCALE:

DATE: 7-28-66

DRAWN BY

CHECKED BY

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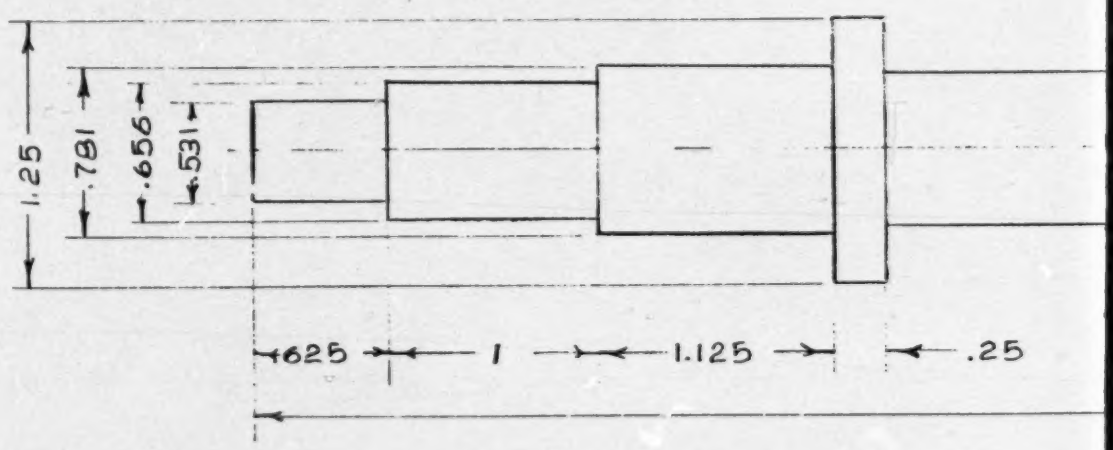

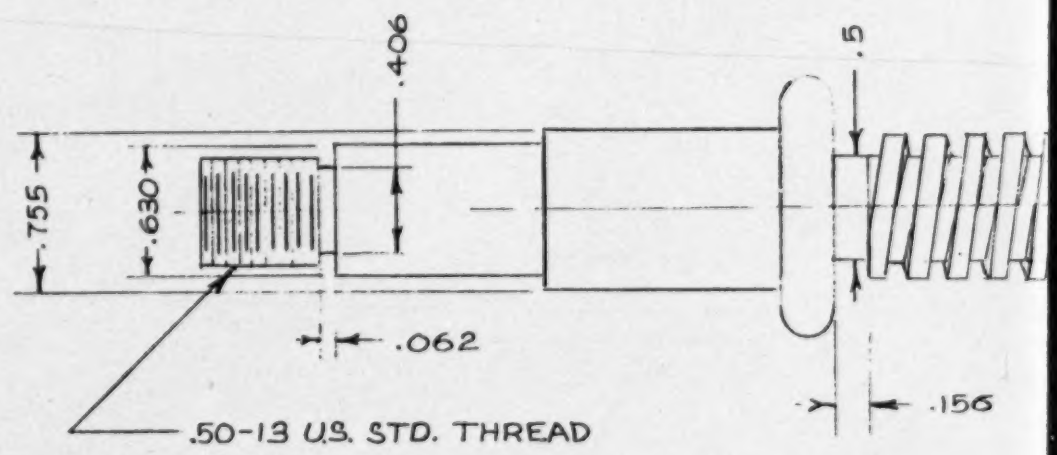

TOLERANC
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M-204

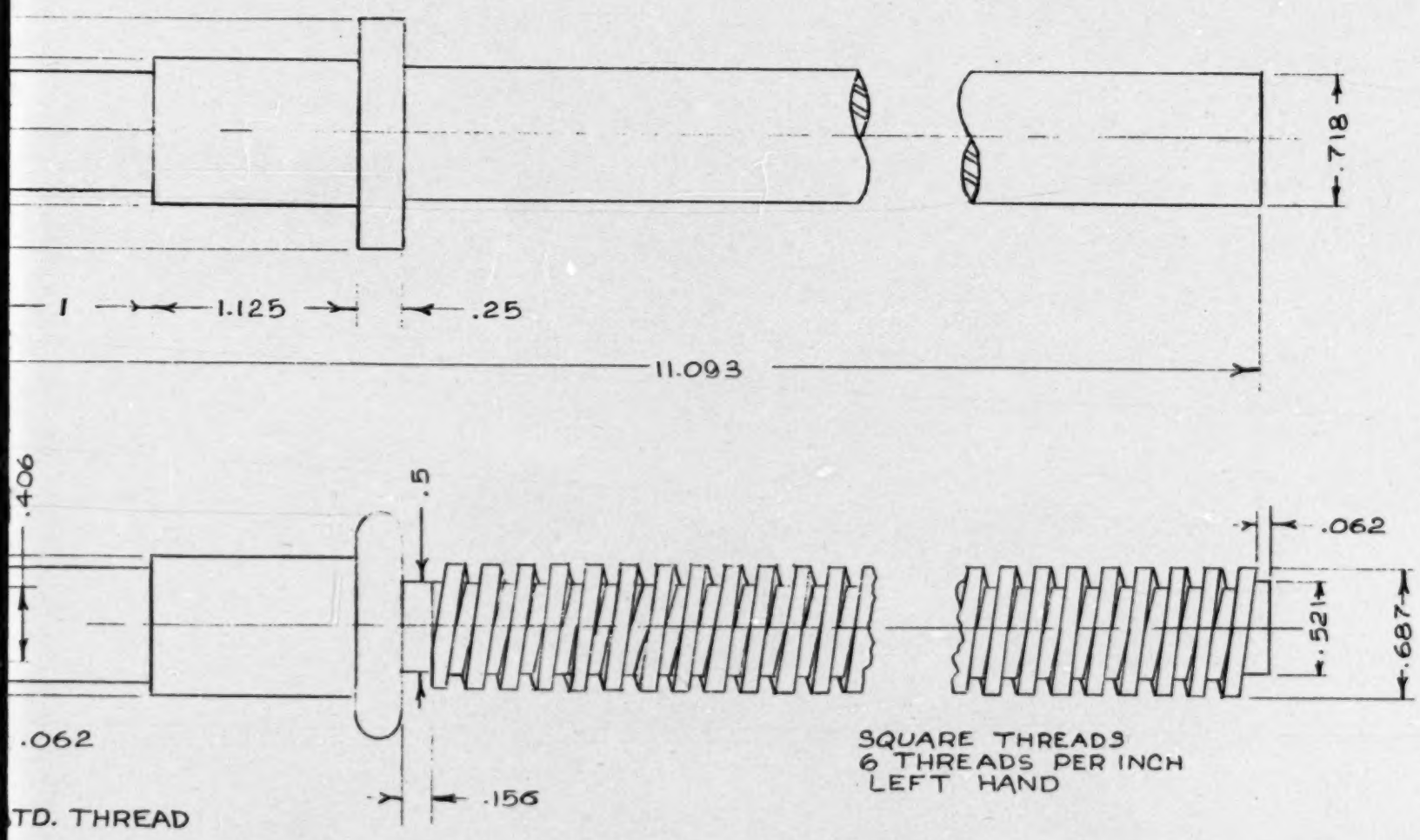

TOLERANCE ±.005
UNLESS OTHERWISE STATED.

THREAD EXERCISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'0"	DATE: 7-6-66
DRAWN BY RJT	CHECKED BY JCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

D	A	B	C	E	F	G	H	K	WIDTH OF FLATS
1/4	3 3/4	2 [illegible]	1/16	15/64	5/8	3/64 C. DR PILOT	1/8	1/8	7/64
5/16	4	[illegible]	7/16	9/32	43/64	3/64 C. DR. PILOT	5/32	3/16	1/8
3/8	4 1/4	[illegible]	1/2	[illegible]	23/32	1/16 C. DR. PILOT	3/16	1/4	5/32
7/16	4 1/2	[illegible] 1/8	9/16	13/32	49/64	1/16 C. DR. PILOT	7/32	9/32	1/4
1/2	5	[illegible]	5/8	15/32	13/16	3/32 C. DR PILOT	1/4	5/16	1/4
[illegible]	5 1/4	[illegible]	5/8	[illegible]	[illegible]	3/32 C. DR PILOT	9/32	5/16	1/4
[illegible]	5 1/2	[illegible]	3/4	19/32	27/32	3/32 C. DR. PILOT	5/16	3/8	1/4
[illegible]	5 3/4	4 1/4	3/4	5/8	15/16	3/32 C. DR PILOT	11/32	3/8	5/16
[illegible]	6	4 3/8	[illegible]	11/16	1	1/8 C. DR. PILOT	3/8	3/8	5/16
13/16	6 1/4	4 1/2	[illegible]	3/4	1 3/64	1/8 C. DR. PILOT	13/32	3/8	7/16
7/8	6 1/2	4 3/4	7/8	13/16	1 3/32	1/8 C. DR. PILOT	7/16	3/8	7/16
15/16	6 3/4	[illegible]	[illegible]	7/8	1 9/64	1/8 C. DR. PILOT	15/32	3/8	1/2
1	7	[illegible]	[illegible]	15/16	1 3/16	5/32 C. DR. PILOT	1/2	1/2	1/2
1 1/16	7 1/4	5 1/4	1	1	1 1/4	5/32 C. DR. PILOT	17/32	1/2	1/2
1 1/8	7 1/2	5 1/2	1	1 1/16	1 5/16	5/32 C. DR. PILOT	9/16	1/2	1/2
1 3/16	7 3/4	5 3/4	1	1 1/8	1 3/8	5/32 C. DR. PILOT	19/32	1/2	1/2
1 1/4	8	6	1	1 3/16	1 7/16	3/16 C. DR PILOT	5/8	5/8	1/2
1 1/2	9	6 1/2	[illegible]	1 7/16	1 9/16	7/32 C. DR. PILOT	3/4	5/8	5/8

MAN
SUGGOS
SCALE
DRAWN
MILL

88C4

8886

[illegible]	5 1/2	4	3/4	19/32	27/32	3/32 C. DR. PILOT	5/16	3/8	1/4
[illegible]	5 [illegible]	4 1/4	3/4	5/8	13/16	3/32 C. DR. PILOT	11/32	3/8	5/16
5/8	6	4 5/8	13/16	11/16	1	1/8 C. DR. PILOT	3/8	3/8	5/16
13/16	6 1/4	4 1/2	[illegible]	3/4	1 3/64	1/8 C. DR. PILOT	13/32	3/8	7/16
7/8	6 1/2	4 3/4	7/8	13/16	1 3/32	1/8 C. DR. PILOT	7/16	3/8	7/16
15/16	6 3/4	[illegible]	[illegible]	7/8	1 9/64	1/8 C. DR. PILOT	15/32	3/8	1/2
1	7	[illegible]	[illegible]	15/16	1 3/16	5/32 C. DR. PILOT	1/2	1/2	1/2
1 1/16	7 1/4	5 1/4	1	1	1 1/4	5/32 C. DR. PILOT	17/32	1/2	1/2
1 1/8	7 1/2	5 1/2	1	1 1/16	1 5/16	5/32 C. DR. PILOT	9/16	1/2	1/2
1 3/16	7 3/4	5 3/4	1	1 1/8	1 3/8	5/32 C. DR. PILOT	19/32	1/2	1/2
1 1/4	8	6	1	1 3/16	1 7/16	3/16 C. DR. PILOT	5/8	5/8	1/2
1 1/2	9	6 1/2	1 1/4	1 7/16	1 9/16	7/32 C. DR. PILOT	3/4	5/8	5/8

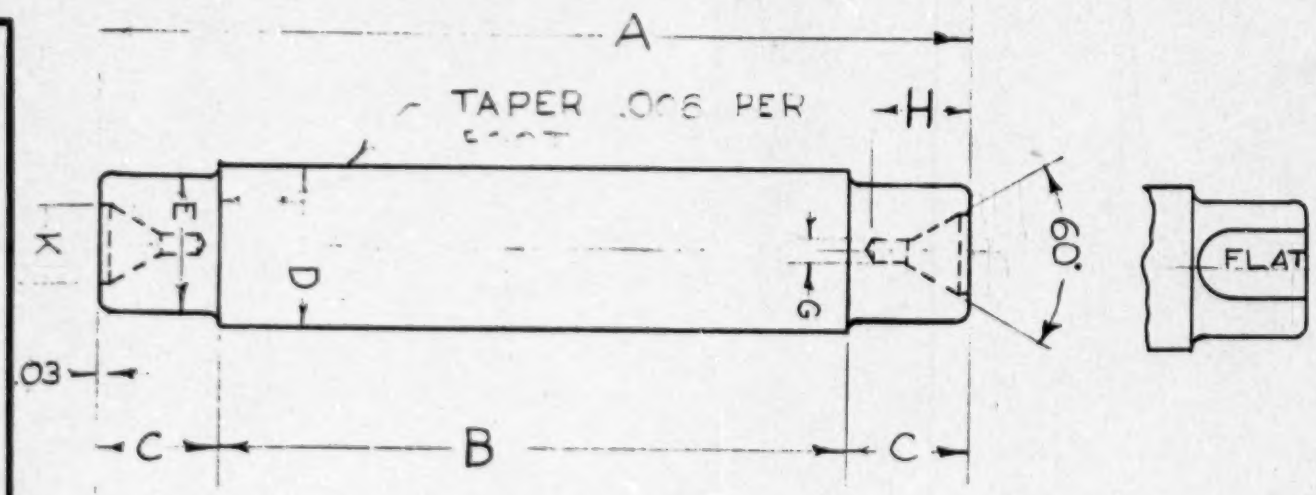

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

M-205

MANDREL DIMENSIONS

SUGGESTED BY: BOYS' TECH

SCALE: NONE | DATE: 7-5-66

DRAWN BY T.S.S. | CHECKED BY [illegible]

MILWAUKEE PUBLIC SCHOOLS

INDUSTRIAL EDUCATION

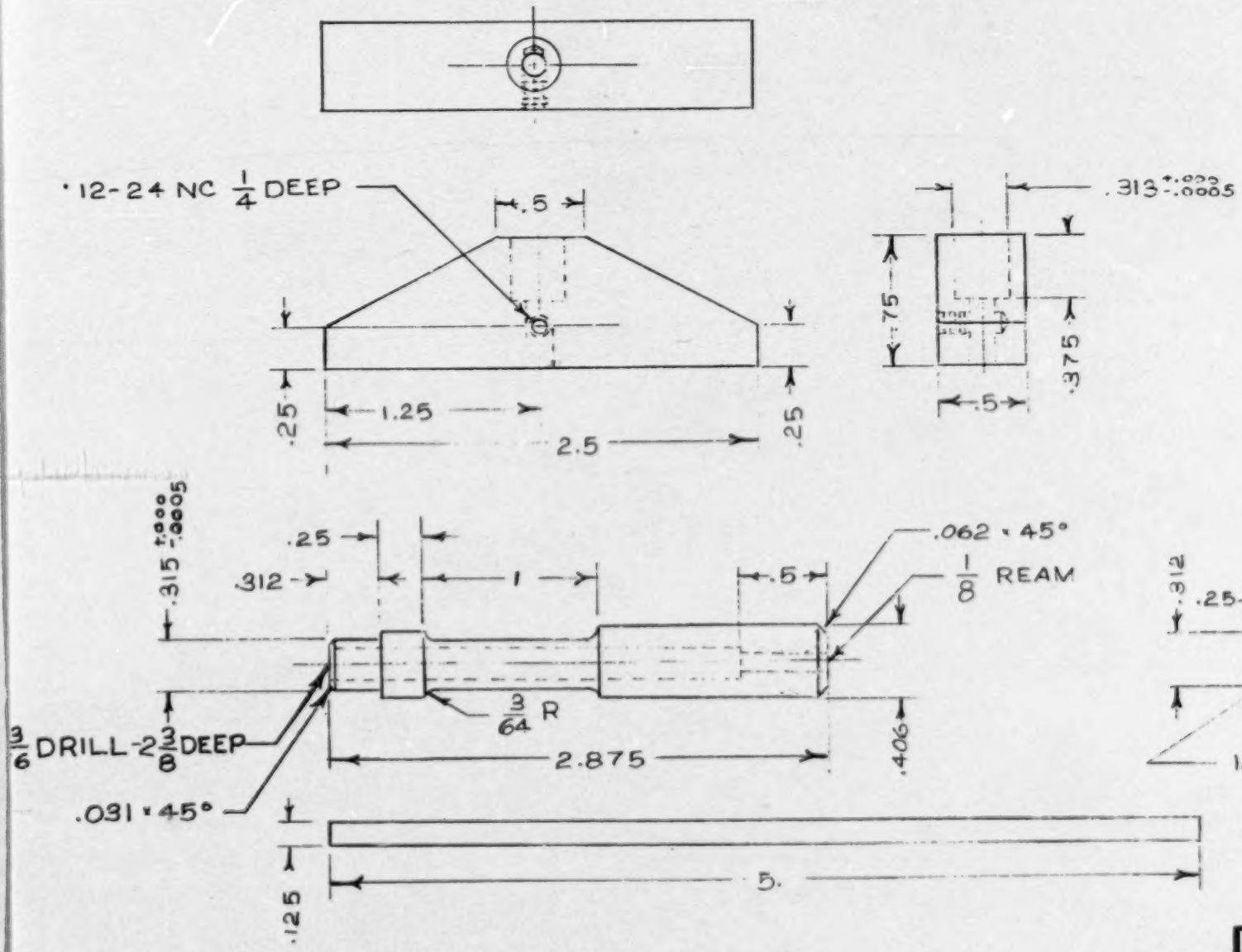

DE
SUGGES
SCALE:
DRAWN
MILWA

TOLERANCE ± .005
UNLESS OTHERWISE STATED.

8856

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M-206

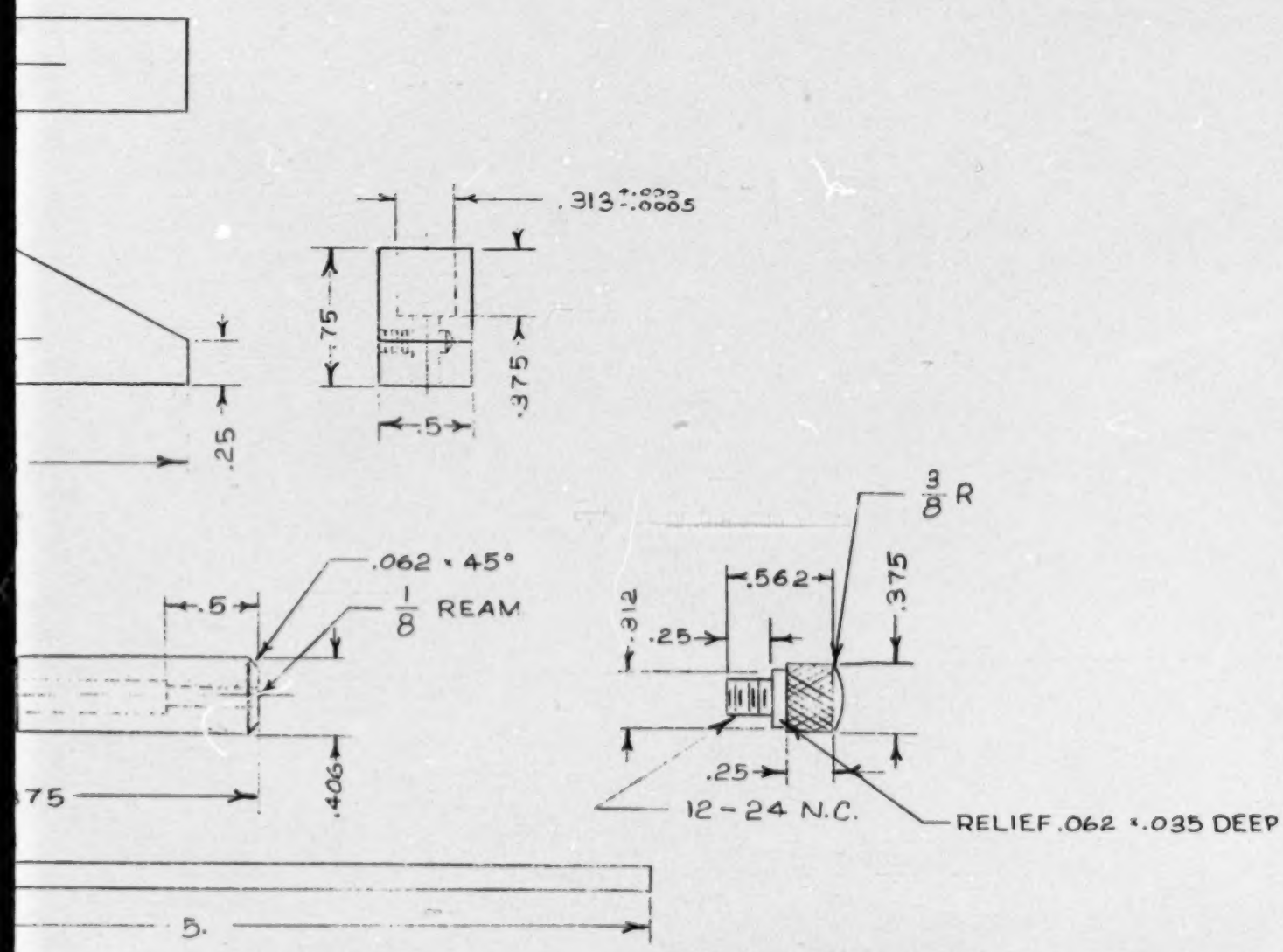

DEPTH GAUGE	
SUGGESTED BY:	
SCALE: 12" = 1'0"	DATE: 7-5-66
DRAWN BY [illegible]	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

TOLERANCE ± .005
UNLESS OTHERWISE STATED.

8857

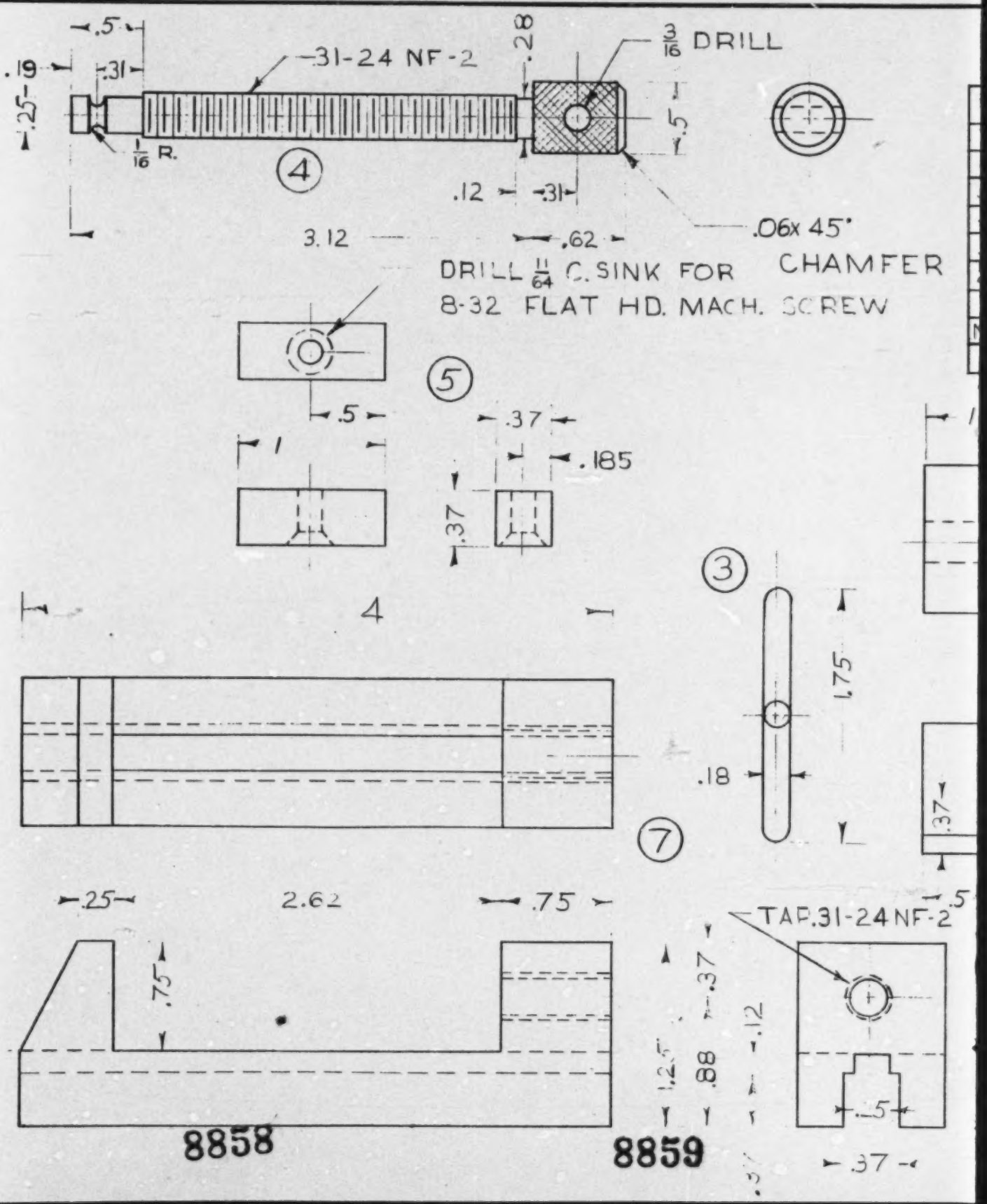
.5
.19
.31
.25
-31-24 NF-2
.28
3/16 DRILL
.5
1/16 R.
4
.12
.31
3.12
.62
.06x 45°
CHAMFER
DRILL 11/64 C. SINK FOR
8-32 FLAT HD. MACH. SCREW
5
.5
.37
1
.185
.37
3
4
1.75
.18
7
.25
2.62
.75
.75
TAP.31-24NF-2
.37
.88
.12
.5
.37
8858
8859

M-207

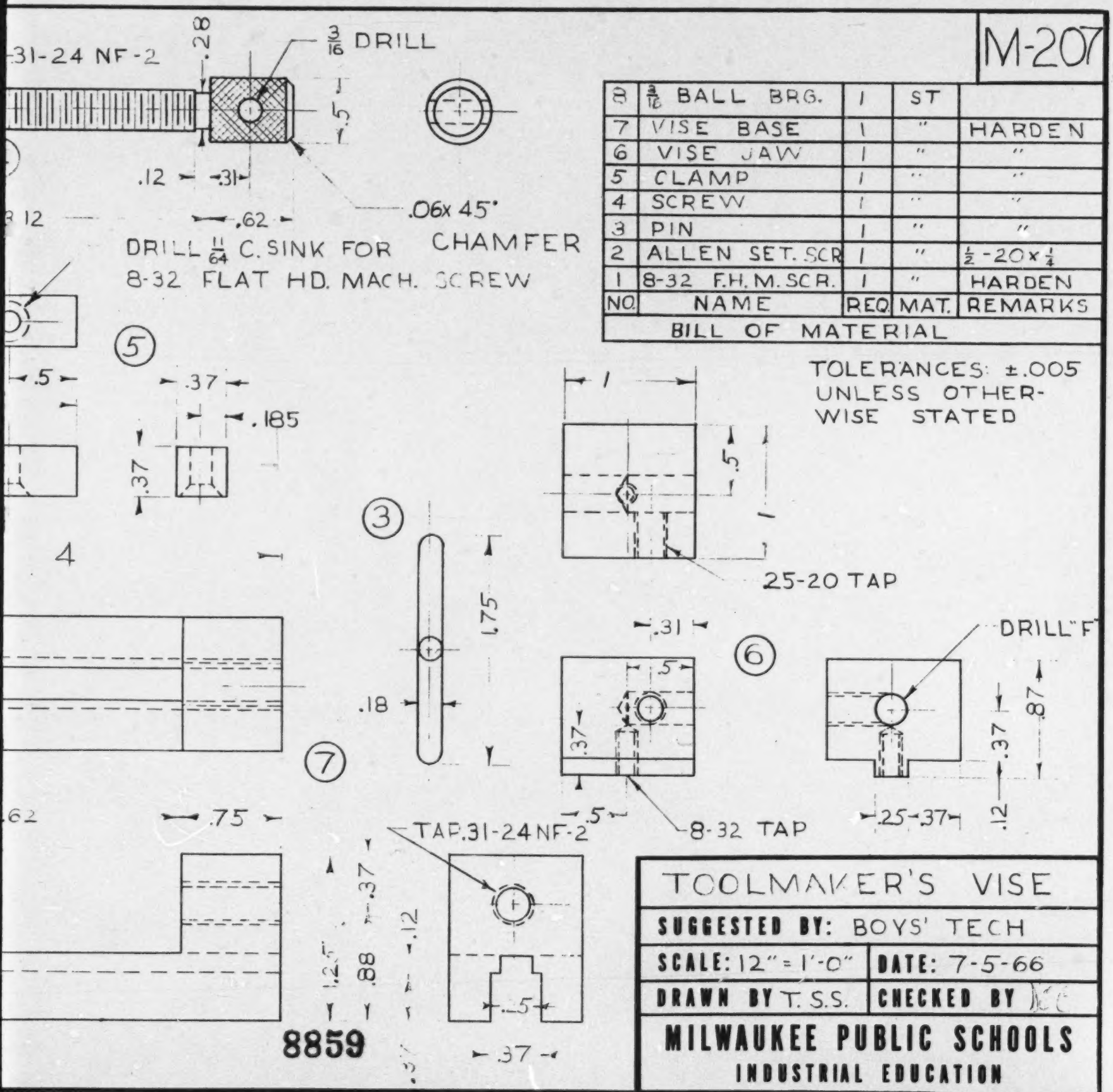

NO.	NAME	REQ.	MAT.	REMARKS
8	3/16 BALL BRG.	1	ST	
7	VISE BASE	1	"	HARDEN
6	VISE JAW	1	"	"
5	CLAMP	1	"	"
4	SCREW	1	"	"
3	PIN	1	"	"
2	ALLEN SET. SCR	1	"	1/2-20 x 1/4
1	8-32 F.H.M.SCR.	1	"	HARDEN

BILL OF MATERIAL

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

TOOLMAKER'S VISE

SUGGESTED BY: BOYS' TECH

SCALE: 12" = 1'-0" | DATE: 7-5-66

DRAWN BY T.S.S. | CHECKED BY

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

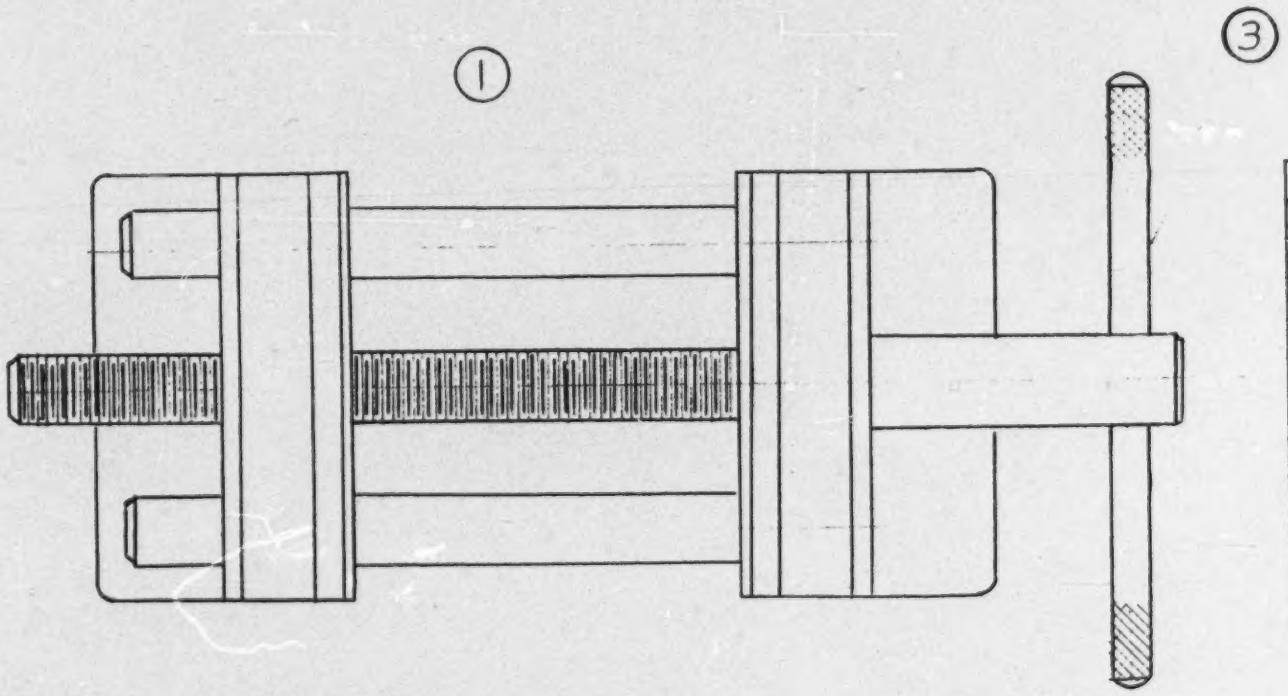

NO.	
1	GU
2	SC
3	H
4	C
5	M
6	JA
7	JA
8	ST
9	JA
10	D

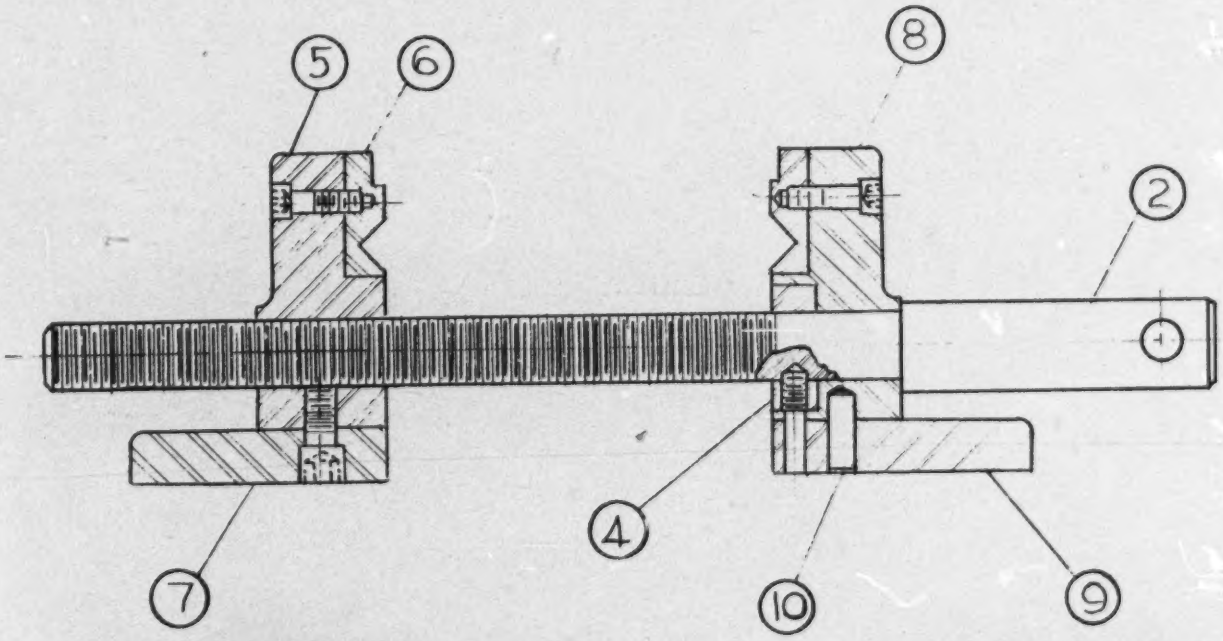

8860

8861

M-208

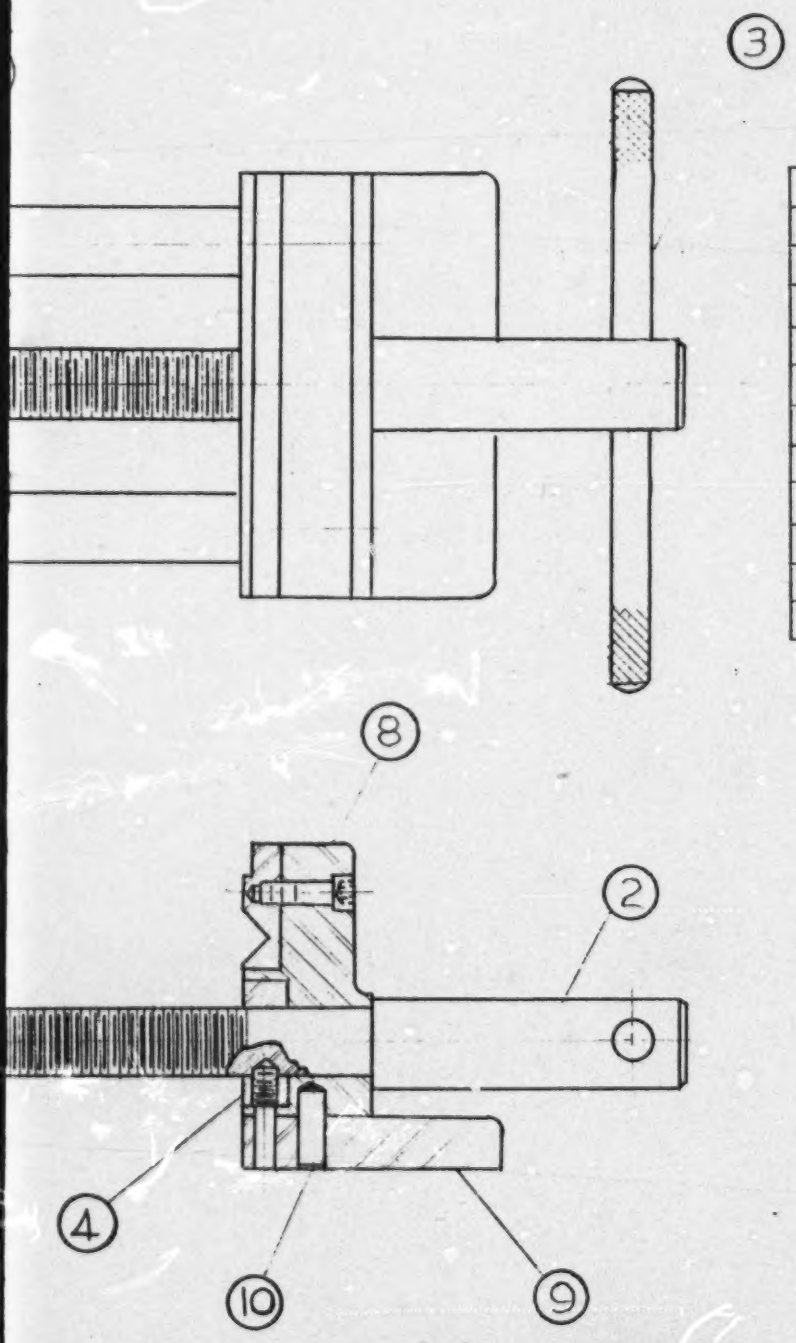

BILL OF MATERIAL			
NO.	NAME	REQ.	MAT.
1	GUIDE PIN	2	MACH. ST.
2	SCREW	1	" "
3	HANDLE	1	C.R.S
4	COLLAR	1	"
5	MOVABLE JAW	1	MACH. ST.
6	JAW LINING	2	" "
7	JAW BASE	1	" "
8	STATIONARY JAW	1	" "
9	JAW BASE (STA.)	1	" "
10	DOWEL PIN	4	" "

TOLERANCES ±.005 UNLESS OTHERWISE STATED

MACHINIST'S VISE	
SUGGESTED BY:	
SCALE: NONE	DATE: 7-28-66
DRAWN BY J. J	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8861

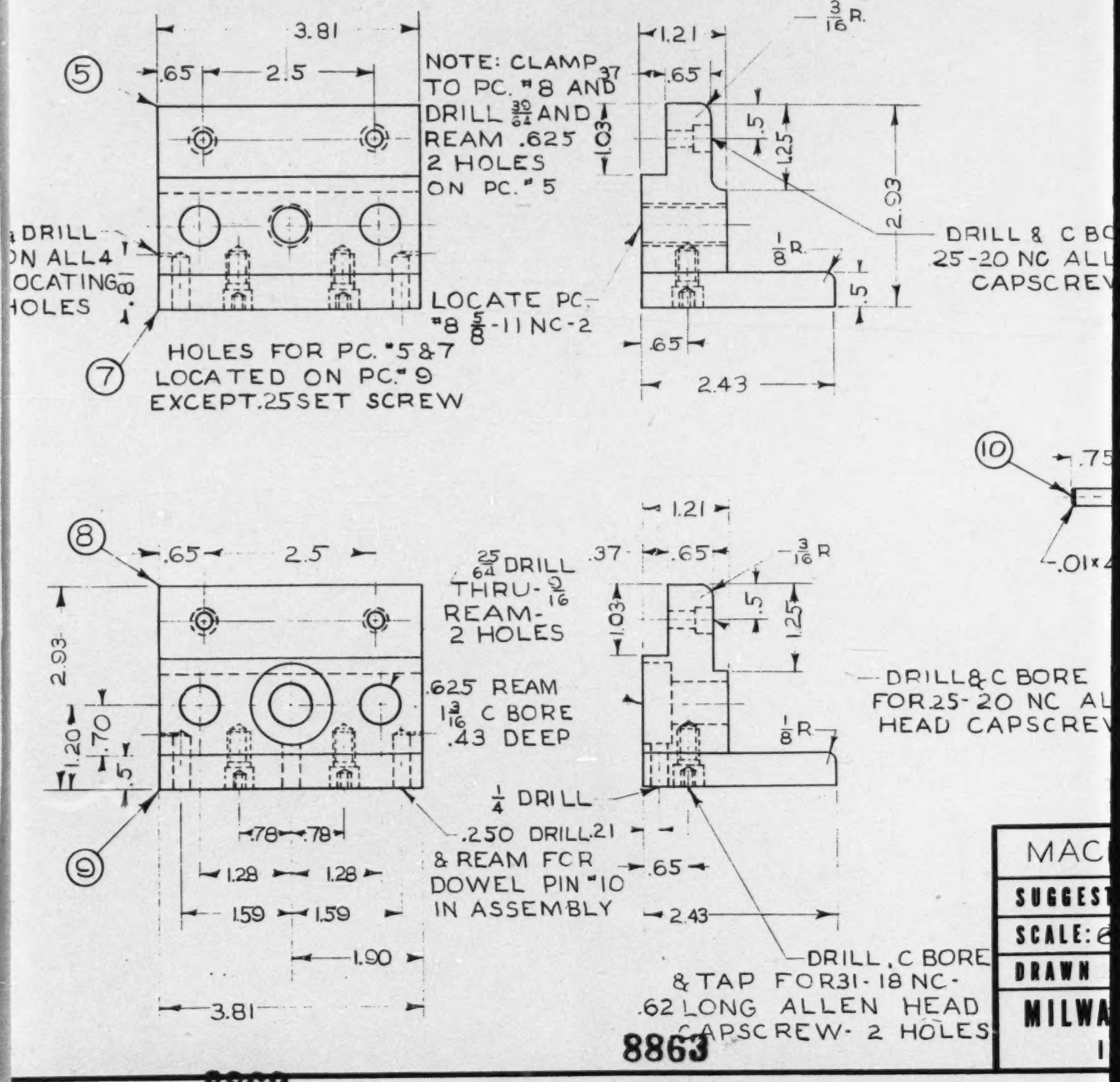
5
3.81
.65
2.5
NOTE: CLAMP TO PC. #8 AND DRILL 39/64 AND REAM .625 2 HOLES ON PC. #5
.37
1.03
1.21
3/16 R.
.5
1.25
2.93
DRILL & C BO
25-20 NC ALL
CAPSCREV
1/8 R.
.5
DRILL ON ALL 4 LOCATING HOLES
LOCATE PC. #8 5/8-11 NC-2
.65
2.43
7
HOLES FOR PC. #5 & 7 LOCATED ON PC. #9 EXCEPT .25 SET SCREW
10
.75
.01 x 4
8
.65
2.5
25/64 DRILL THRU-9/16 REAM-2 HOLES
.37
.65
3/16 R
1.21
1.03
.5
1.25
2.93
.625 REAM
1 3/16 C BORE
.43 DEEP
DRILL & C BORE
FOR .25-20 NC AL
HEAD CAPSCREV
1/8 R
1.20
.70
.5
1/4 DRILL
9
.78
.78
.250 DRILL
& REAM FOR DOWEL PIN #10 IN ASSEMBLY
.21
.65
1.28
1.28
1.59
1.59
2.43
1.90
3.81
DRILL, C BORE & TAP FOR .31-18 NC-.62 LONG ALLEN HEAD CAPSCREW-2 HOLES
MAC
SUGGEST
SCALE: 6
DRAWN
MILWA
1
8863
8862

M-208A

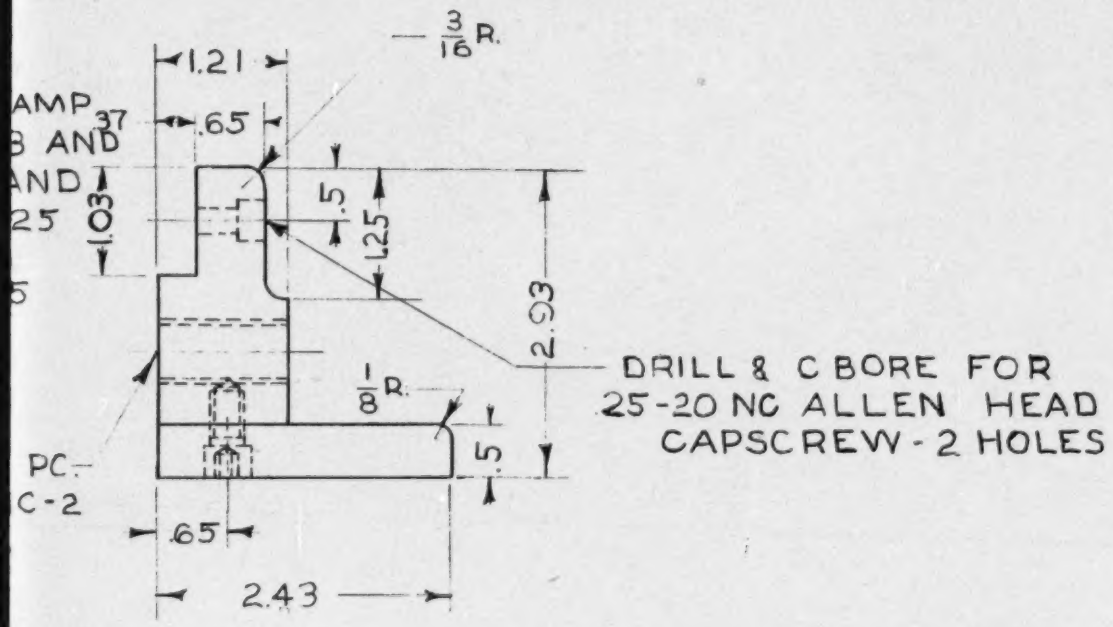

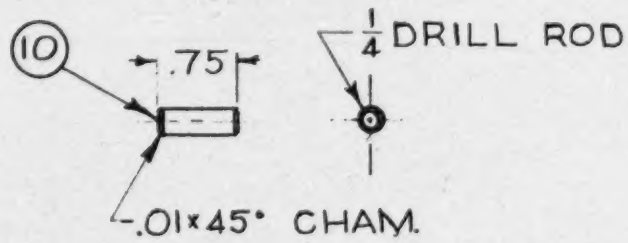

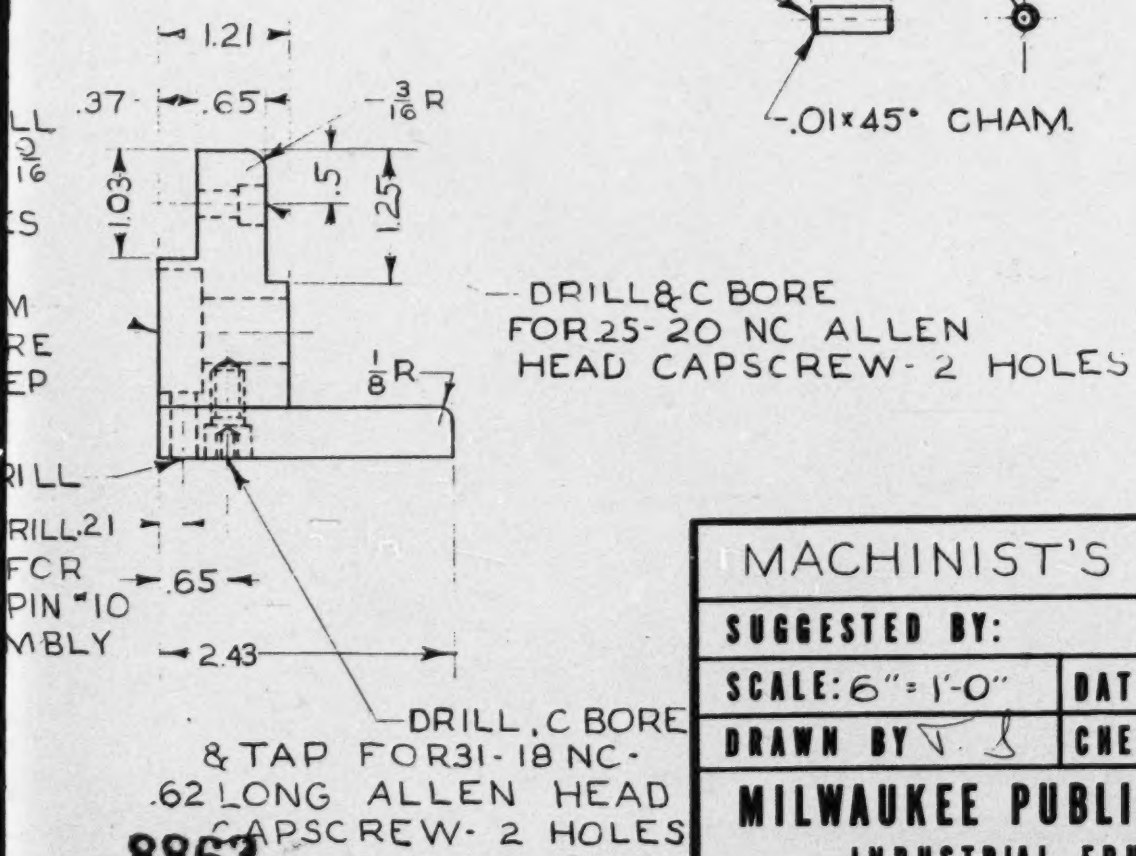

MACHINIST'S VISE	
SUGGESTED BY:	
SCALE: 6" = 1'-0"	DATE: 7-26-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8863

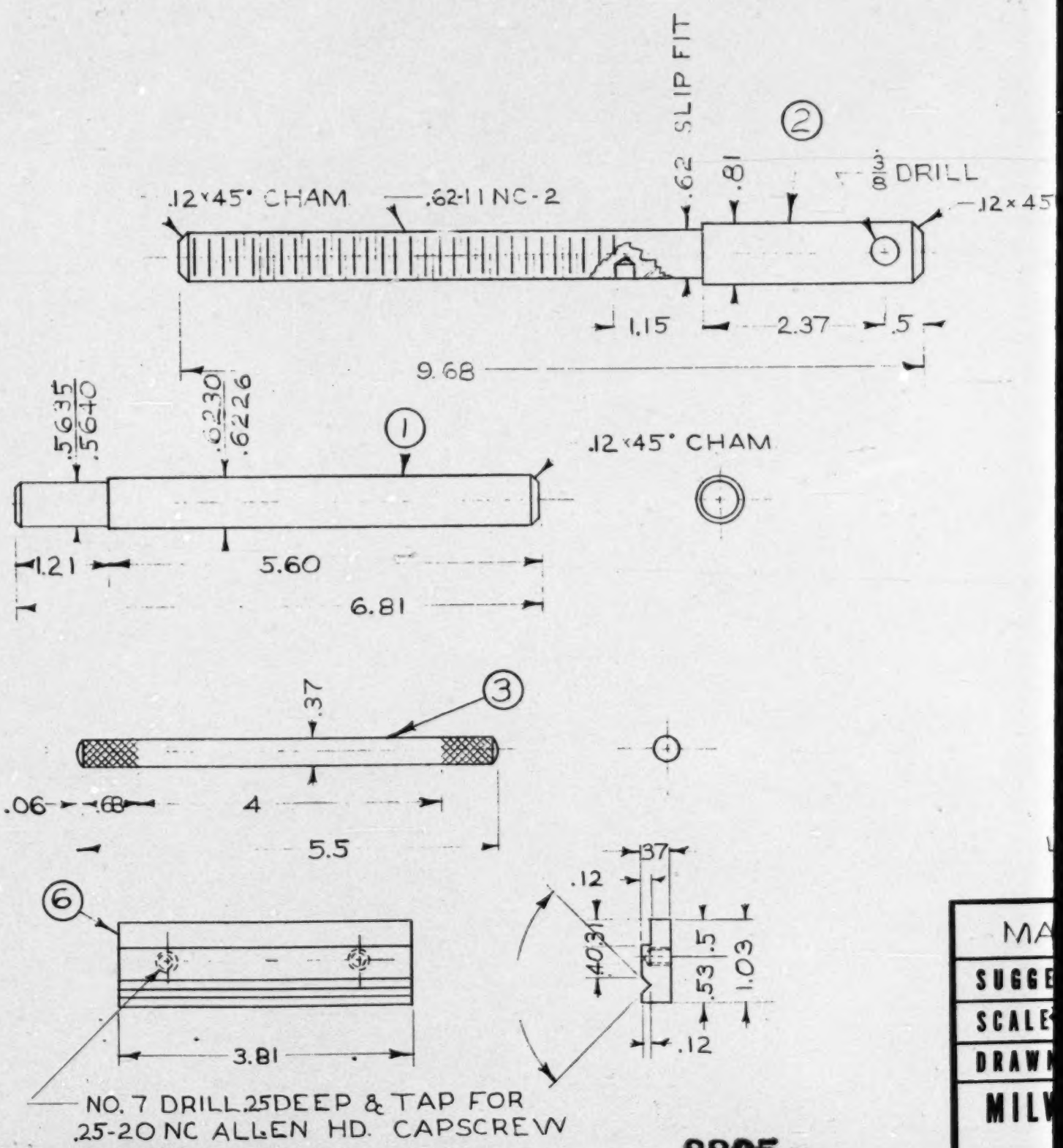

MA
SUGGE
SCALE
DRAW
MILW

M-208B

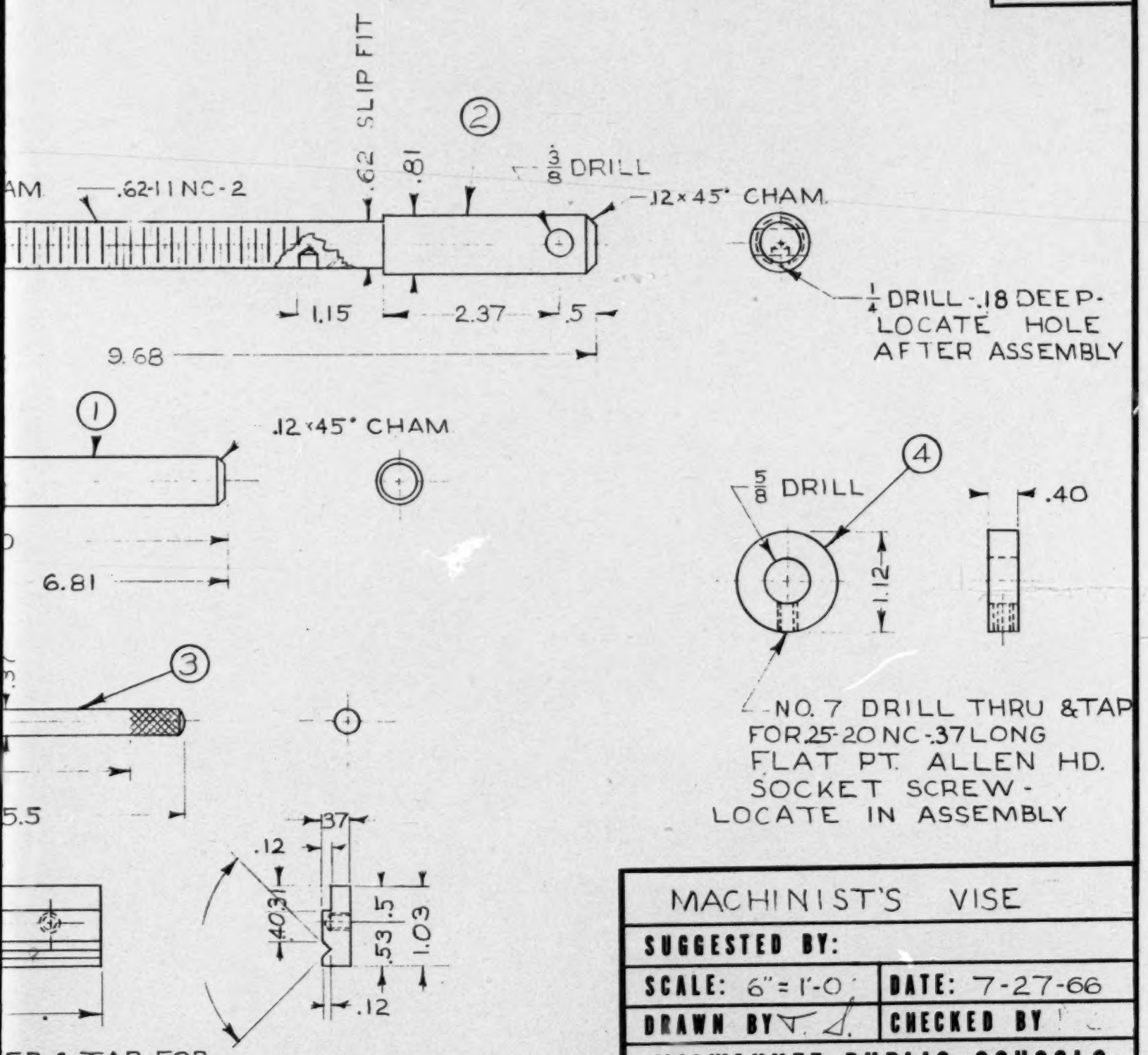

MACHINIST'S VISE	
SUGGESTED BY:	
SCALE: 6" = 1'-0"	DATE: 7-27-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8865

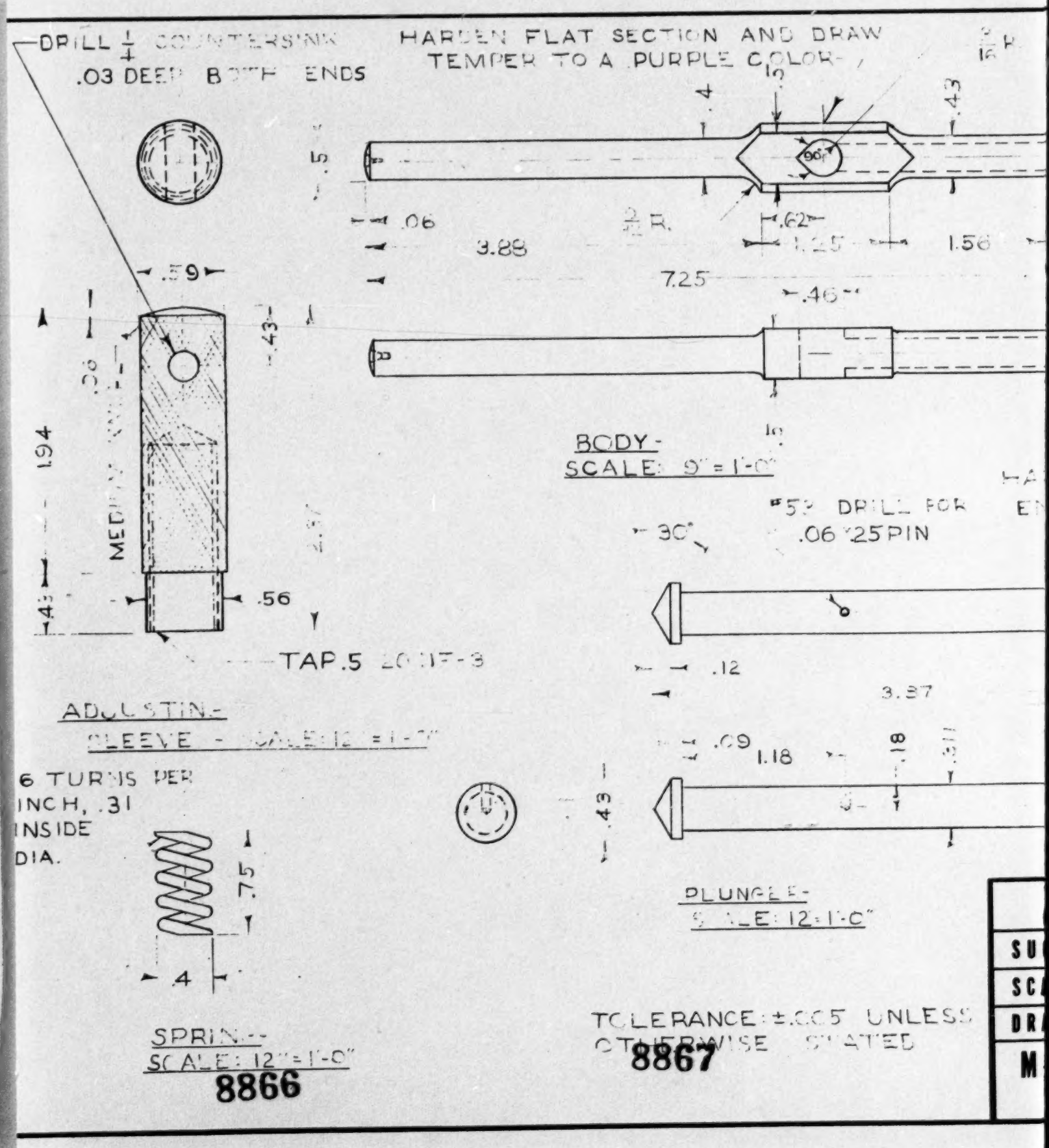
DRILL 1/4 COUNTERSINK
.03 DEEP BOTH ENDS
HARDEN FLAT SECTION AND DRAW
TEMPER TO A PURPLE COLOR
.59
1.94
.43
.56
TAP .5 20 NF-3
ADJUSTING-
SLEEVE - SCALE: 12" = 1'-0"
6 TURNS PER
INCH, .31
INSIDE
DIA.
.75
.4
SPRING-
SCALE: 12" = 1'-0"
8866
.5
.06
3.88
7.25
.62
1.25
1.56
.46
.43
BODY-
SCALE: 9" = 1'-0"
#52 DRILL FOR
.06 X .25 PIN
30°
.12
3.37
.09
1.18
.18
.31
.43
PLUNGER-
SCALE: 12" = 1'-0"
TOLERANCE: ±.005 UNLESS
OTHERWISE STATED
8867

M-209

HARDEN FLAT SECTION AND DRAW TEMPER TO A PURPLE COLOR

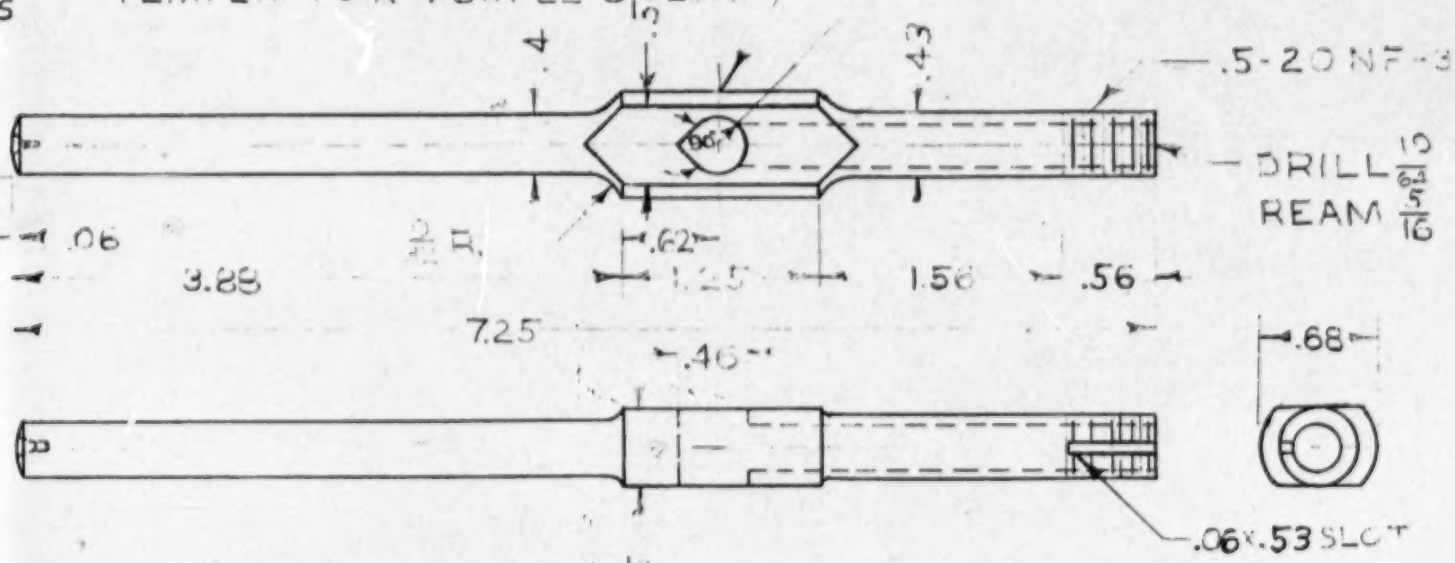

BODY-
SCALE: 9" = 1'-0"

#53 DRILL FOR .06×.25 PIN

HARDEN ½ BACK FROM END AND DRAW TEMPER TO A PURPLE COLOR

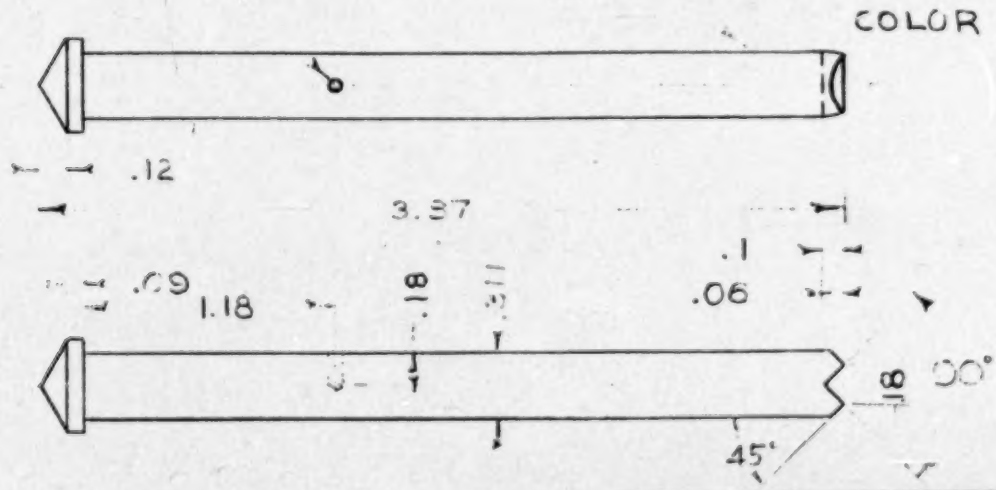

PLUNGER-
SCALE: 12" = 1'-0"

TOLERANCE: ±.005 UNLESS OTHERWISE STATED

8867

TAP WRENCH	
SUGGESTED BY:	
SCALE: AS SHOWN	DATE: 7-8-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

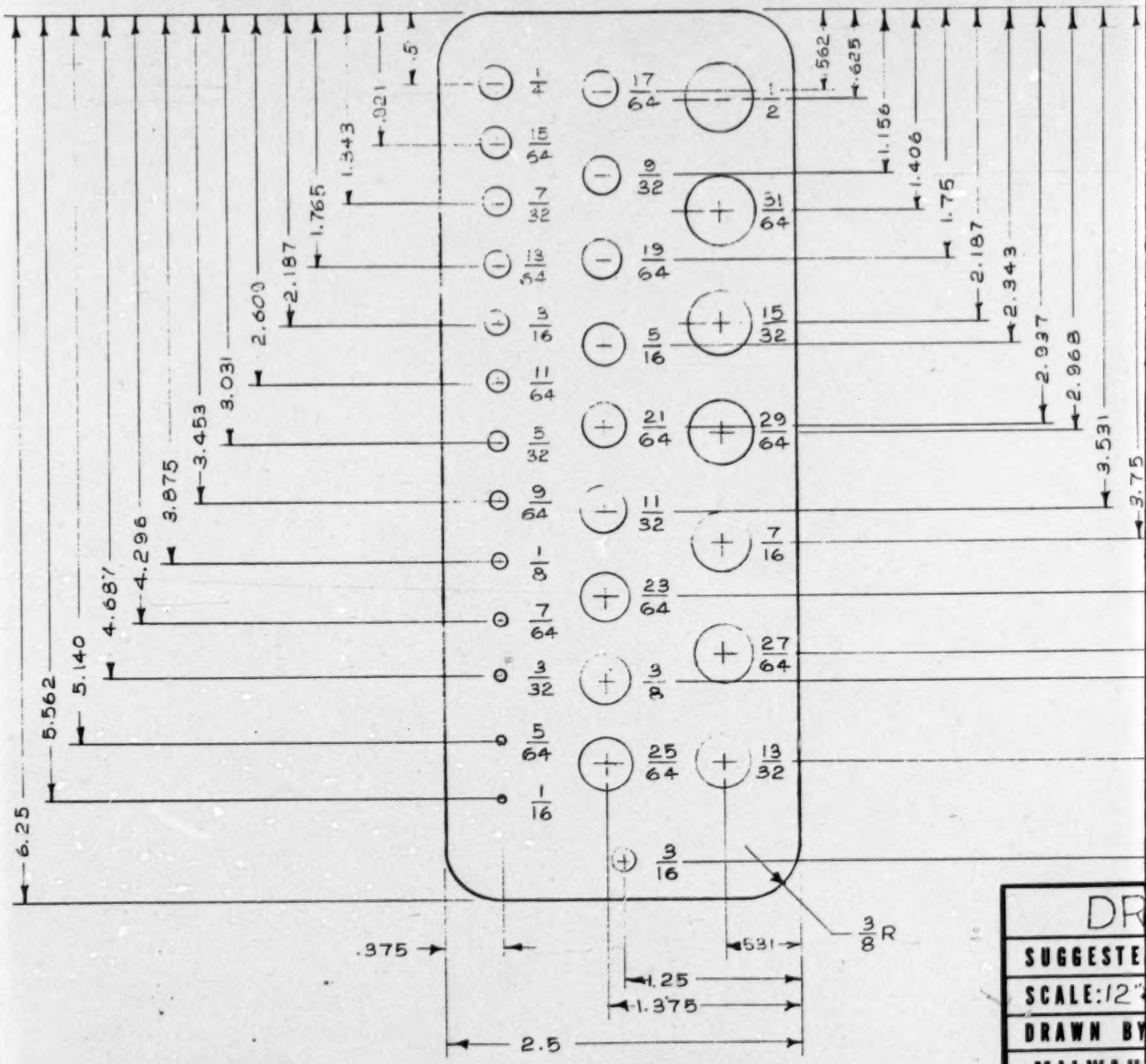
6.25
5.562
5.140
4.687
4.296
3.875
3.453
3.031
2.609
2.187
1.765
1.343
.921
.5
1/16
5/64
3/32
7/64
1/8
9/64
5/32
11/64
3/16
13/64
7/32
15/64
1/4
17/64
9/32
19/64
5/16
21/64
11/32
23/64
3/8
25/64
3/16
.562
.625
1.156
1.406
1.75
2.187
2.343
2.937
2.968
3.531
3.75
2
29/64
7/16
27/64
13/32
3/8 R
.375
.531
1.25
1.375
2.5
TOLERANCE ±.005
UNLESS OTHERWISE STATED
DR
SUGGESTE
SCALE: 12"
DRAWN BY
MILWAU
IND

8868

8869

M-210

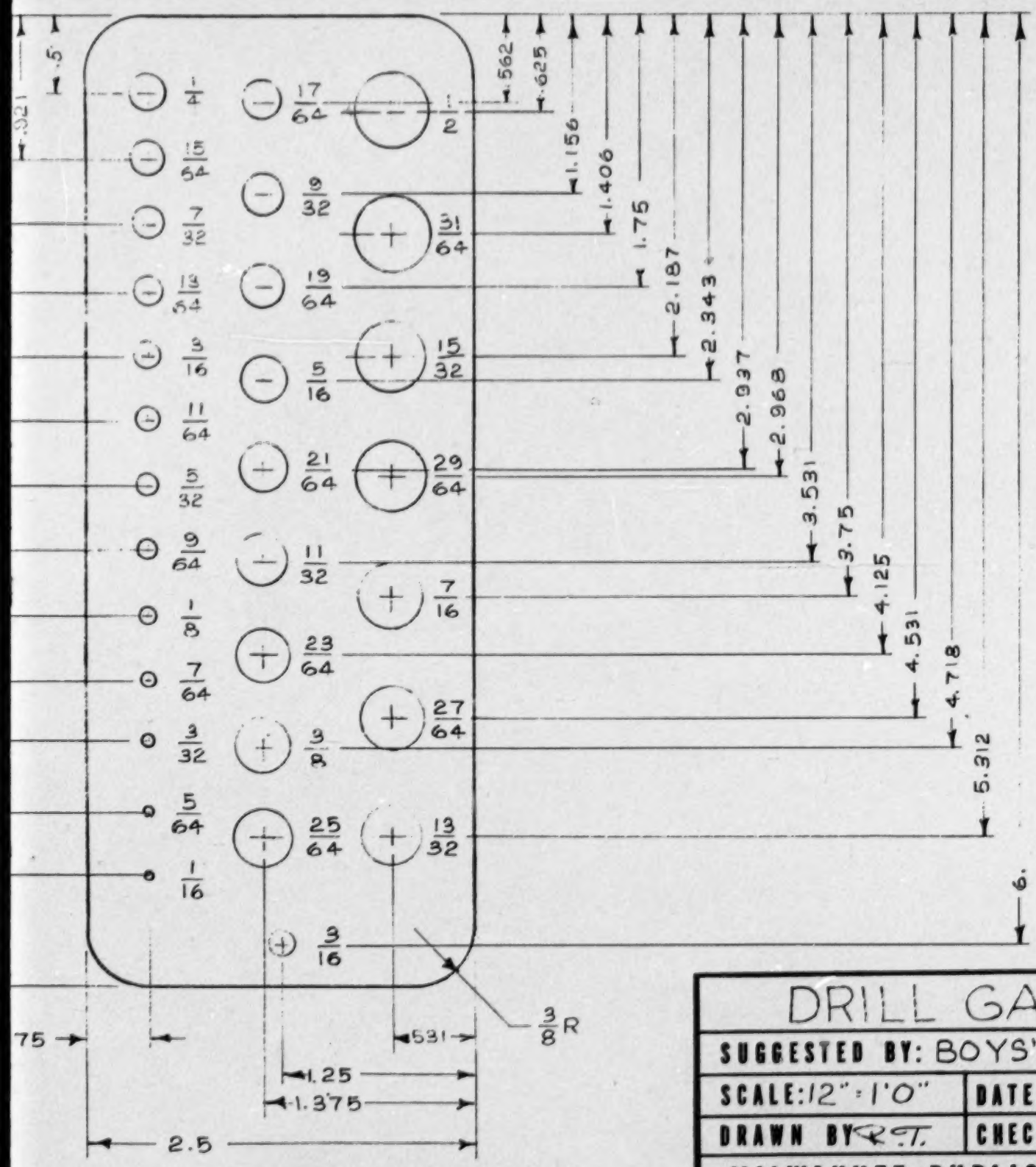

TOLERANCE ±.005
UNLESS OTHERWISE STATED

DRILL GAUGE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'0"	DATE: 7-7-66
DRAWN BY R.T.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

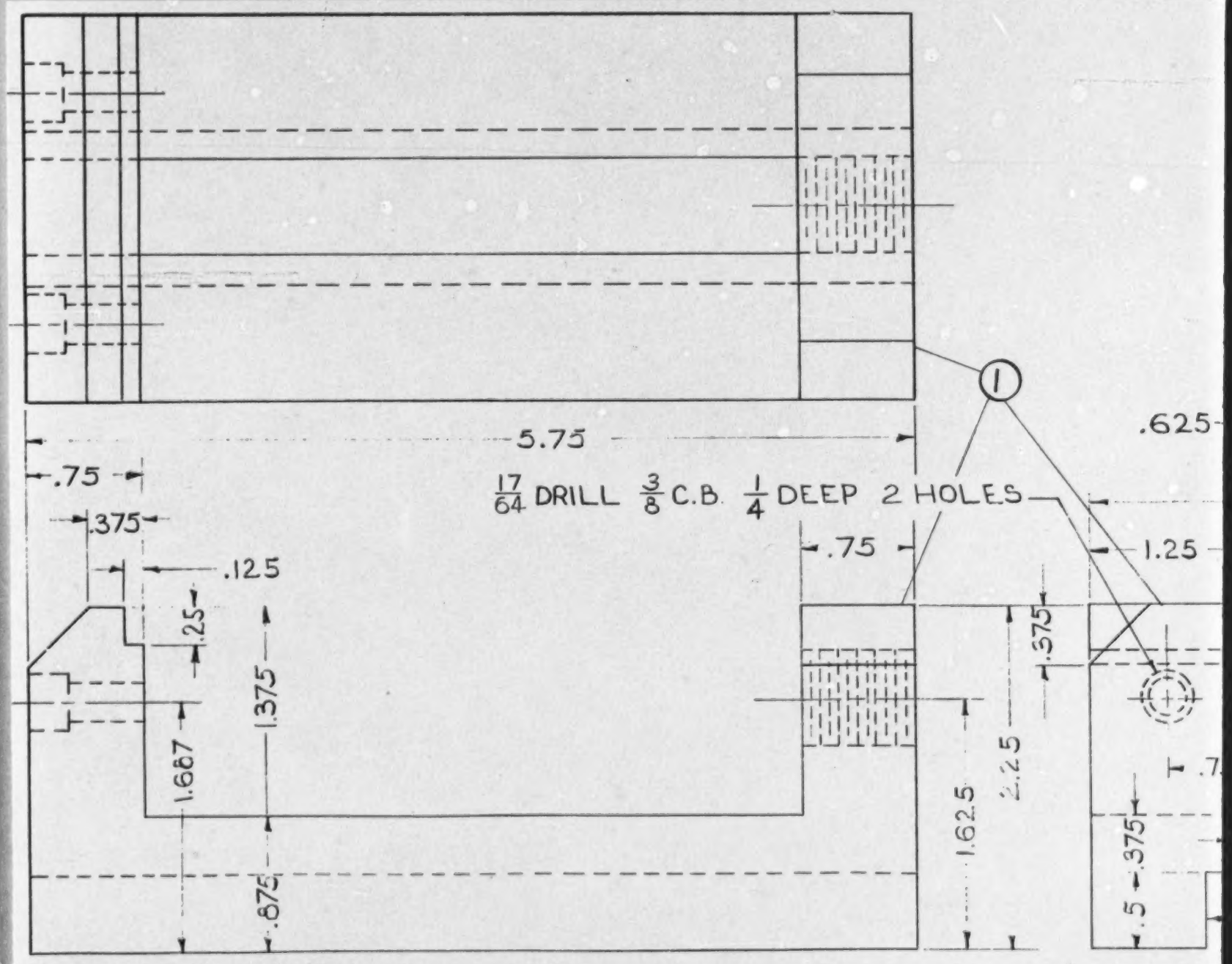
5.75
.75
.375
.125
.25
1.375
1.667
.875
17/64 DRILL 3/8 C.B. 1/4 DEEP 2 HOLES
1
.75
1.625
2.25
.375
.625
1.25
.375
.5
SUGGES
SCALE:
DRAWN
MILWA

8870

8871

M-211

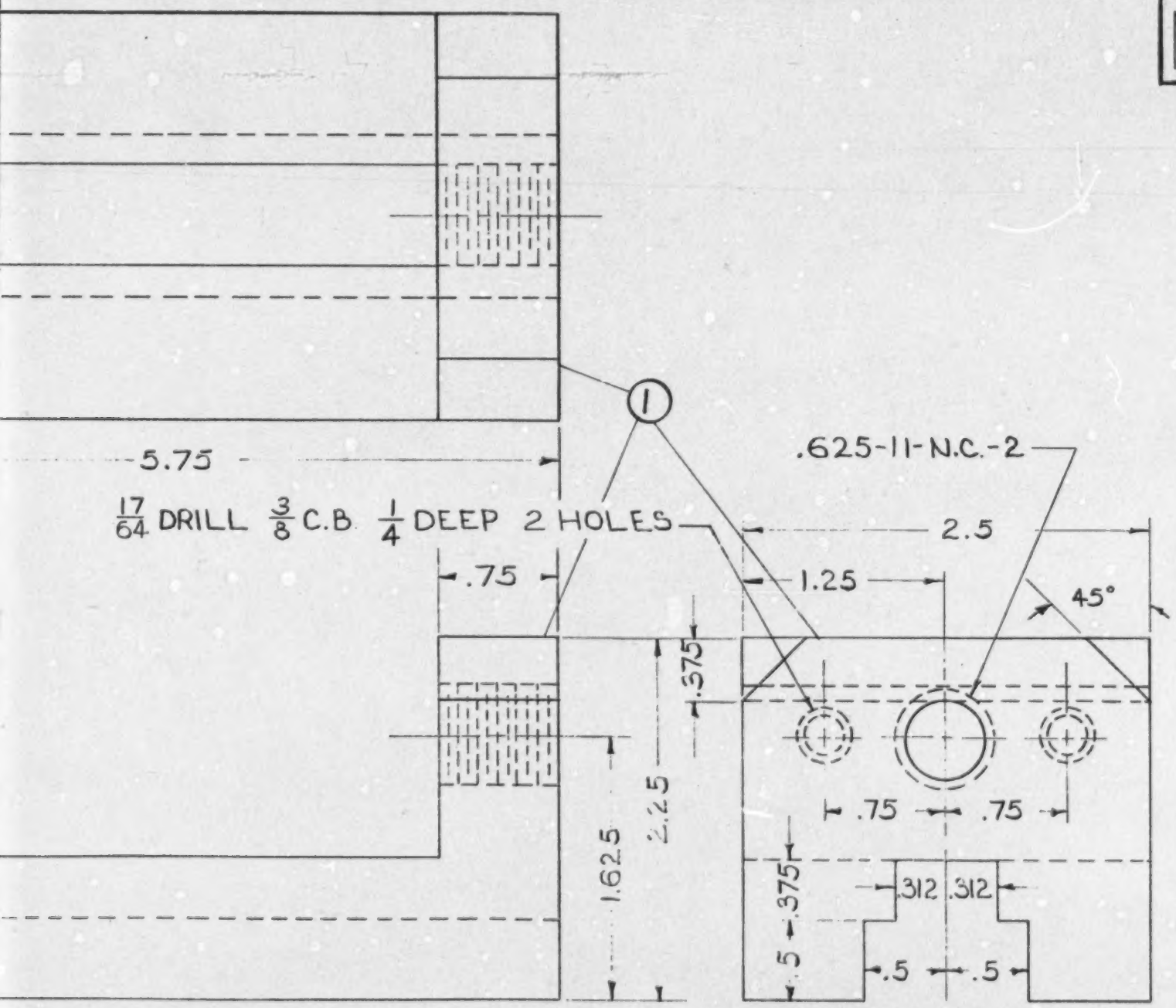

DRILL PRESS VISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'0"	DATE: 7-15-66
DRAWN BY [illegible]	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8871

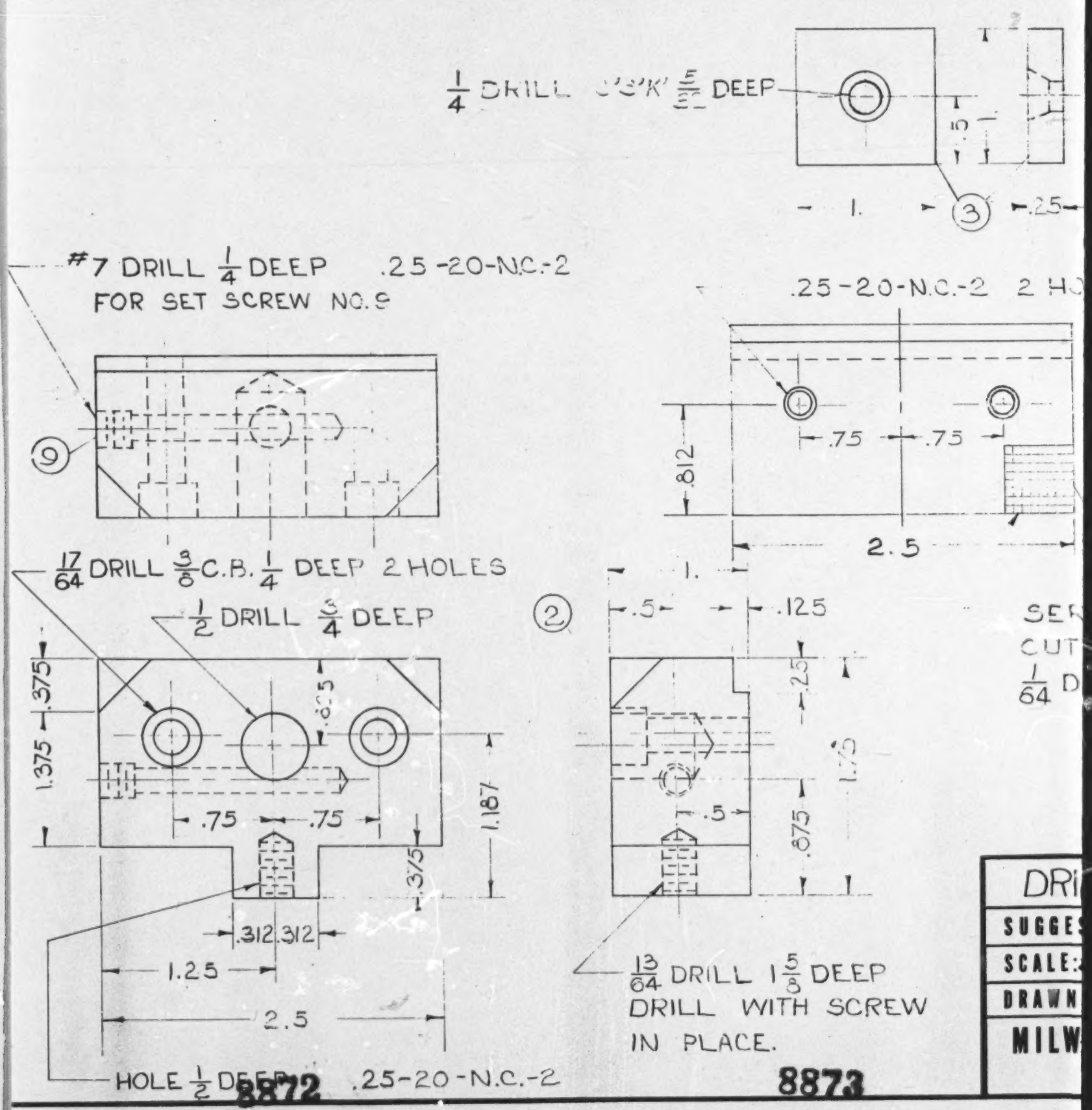
1/4 DRILL C'S'K' 5/32 DEEP
.5
1.
3
.25
#7 DRILL 1/4 DEEP .25-20-N.C.-2
FOR SET SCREW NO. 9
.25-20-N.C.-2 2 HO
.75
.75
.812
2.5
1.
.5
.125
17/64 DRILL 3/8 C.B. 1/4 DEEP 2 HOLES
1/2 DRILL 3/4 DEEP
2
SER
CUT
1/64 D
.375
1.375
.625
.75
.75
1.187
.375
.312 .312
1.25
2.5
.25
1.75
.5
.875
13/64 DRILL 1 5/8 DEEP
DRILL WITH SCREW
IN PLACE.
HOLE 1/2 DEEP .25-20-N.C.-2
8872
8873
DRI
SUGGES
SCALE:
DRAWN
MILW

M-211A

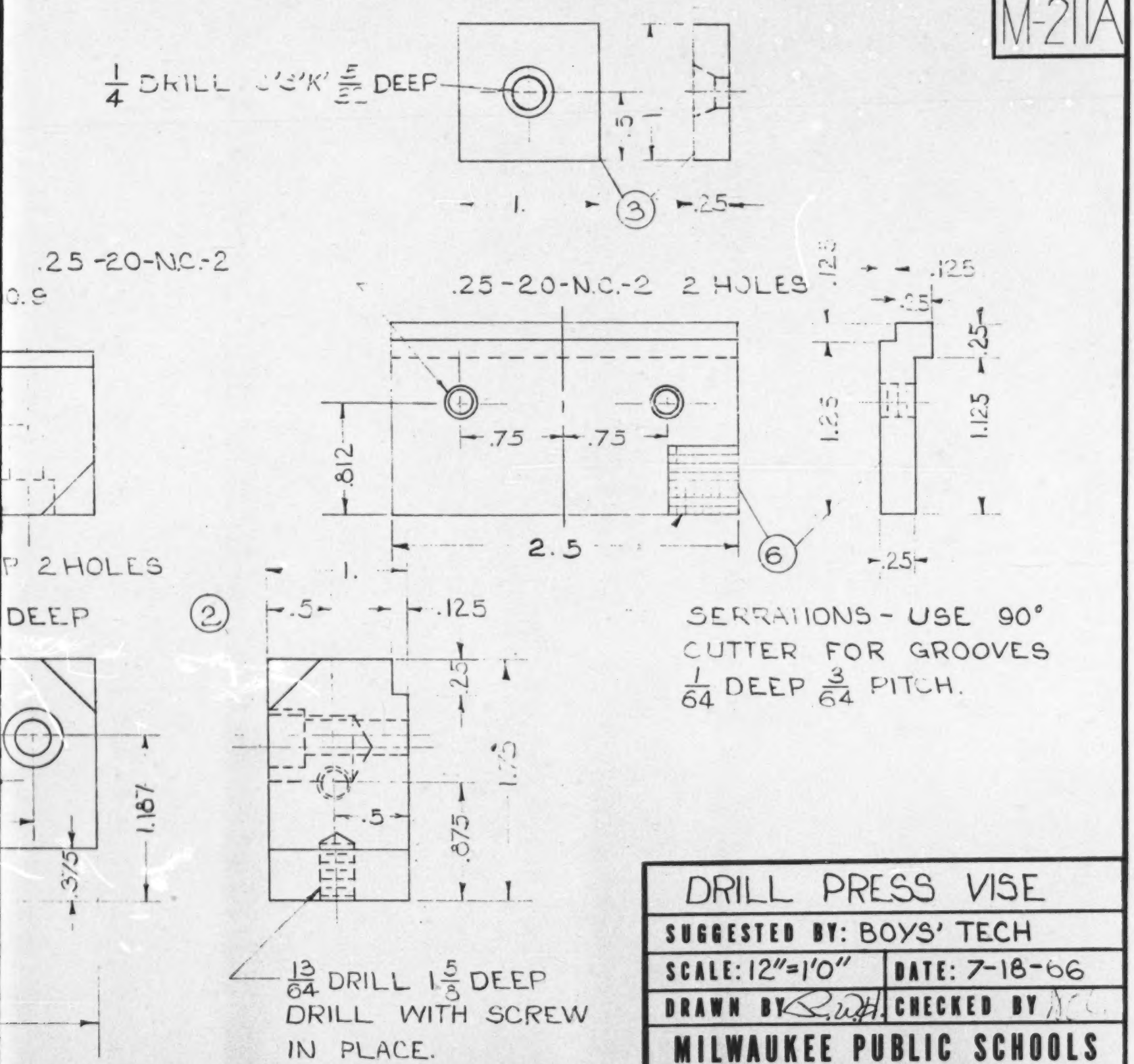

DRILL PRESS VISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12"=1'0"	DATE: 7-18-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8873

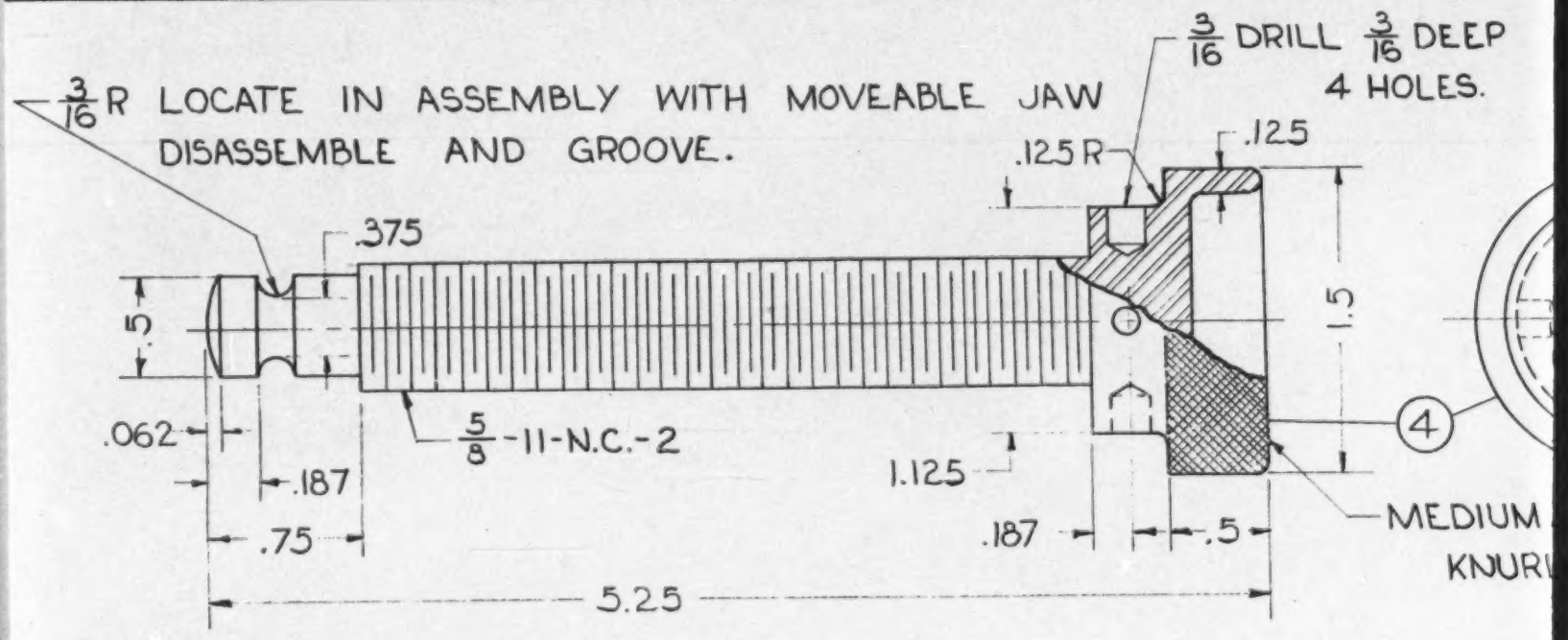

	SPECIFICATIONS			
NO.	NAME	MAT.	REMARKS	PCS.
1	BASE	ST.	1020 STEEL F.A.O.	1
2	MOVEABLE JAW	ST.	1020 STEEL F.A.O.	1
3	JAW GIB	ST.	1020 STEEL F.A.O.	1
4	SCREW	ST.	1020 STEEL F.A.O.	1
5	PIN	ST.	3/16 X 1 3/8 DRILL ROD F.A.O.	1
6	SERRATED JAW PLATE	ST.	TOOL STEEL F.A.O.	2
7	SOCKET HEAD CAP SCREW	ST.	1/4 X 1 STK. FOR JAW PL.	4
8	FLAT HEAD MACH. SCREW	ST.	1/4 X 1 STK. FOR JAW GIB	1
9	ALLEN HEAD SCREW	ST.	1/4 X 1/4 STOCK	1

D
SUG
SCA
DRA
MI

8874 8875

M-211B

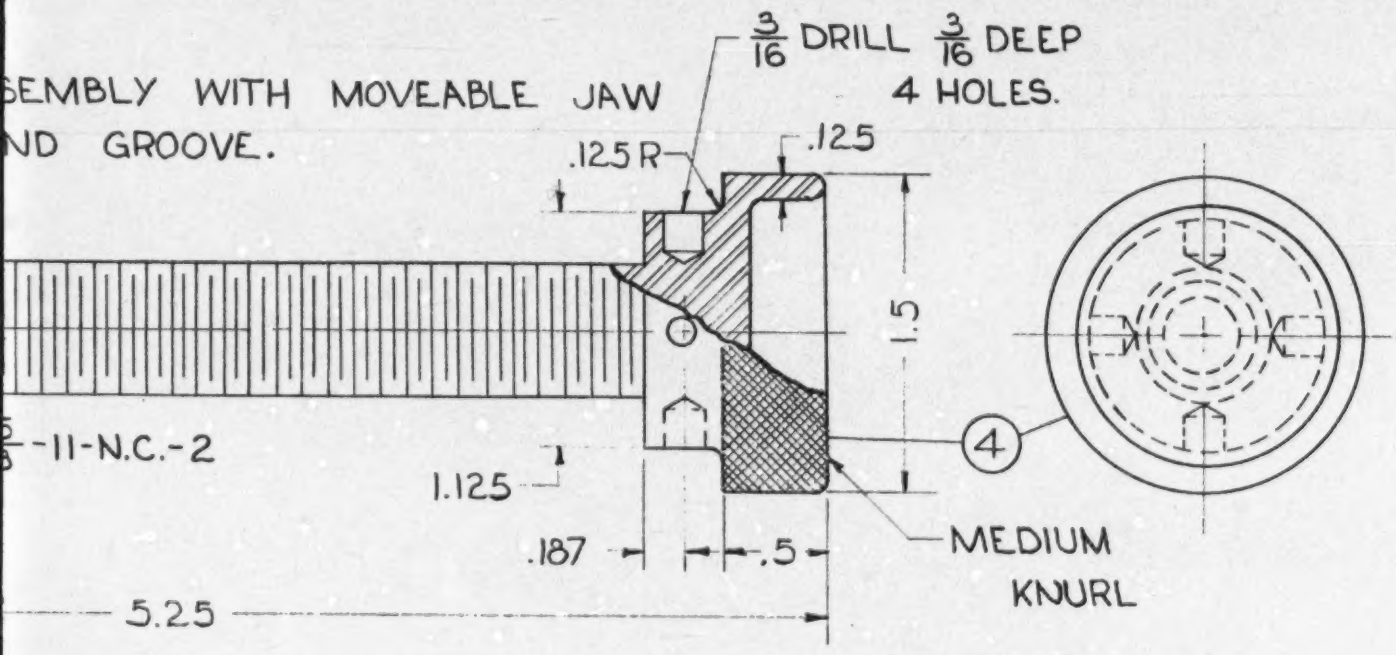

SPECIFICATIONS			
	MAT.	REMARKS	PCS.
	ST.	1020 STEEL F.A.O.	1
	ST.	1020 STEEL F.A.O.	1
	ST.	1020 STEEL F.A.O.	1
	ST.	1020 STEEL F.A.O.	1
	ST.	3/16X1 3/8 DRILL ROD F.A.O.	1
PLATE	ST.	TOOL STEEL F.A.O.	2
P SCREW	ST.	1/4X1 STK. FOR JAW PL.	4
H. SCREW	ST.	1/4X1 STK. FOR JAW GIB	1
CREW	ST.	1/4 X 1/4 STOCK	1

DRILL PRESS VISE

SUGGESTED BY: BOYS' TECH

SCALE: 12"=1'0" | DATE: 7-19-66

DRAWN BY Q.W.H. | CHECKED BY JCC

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

8875

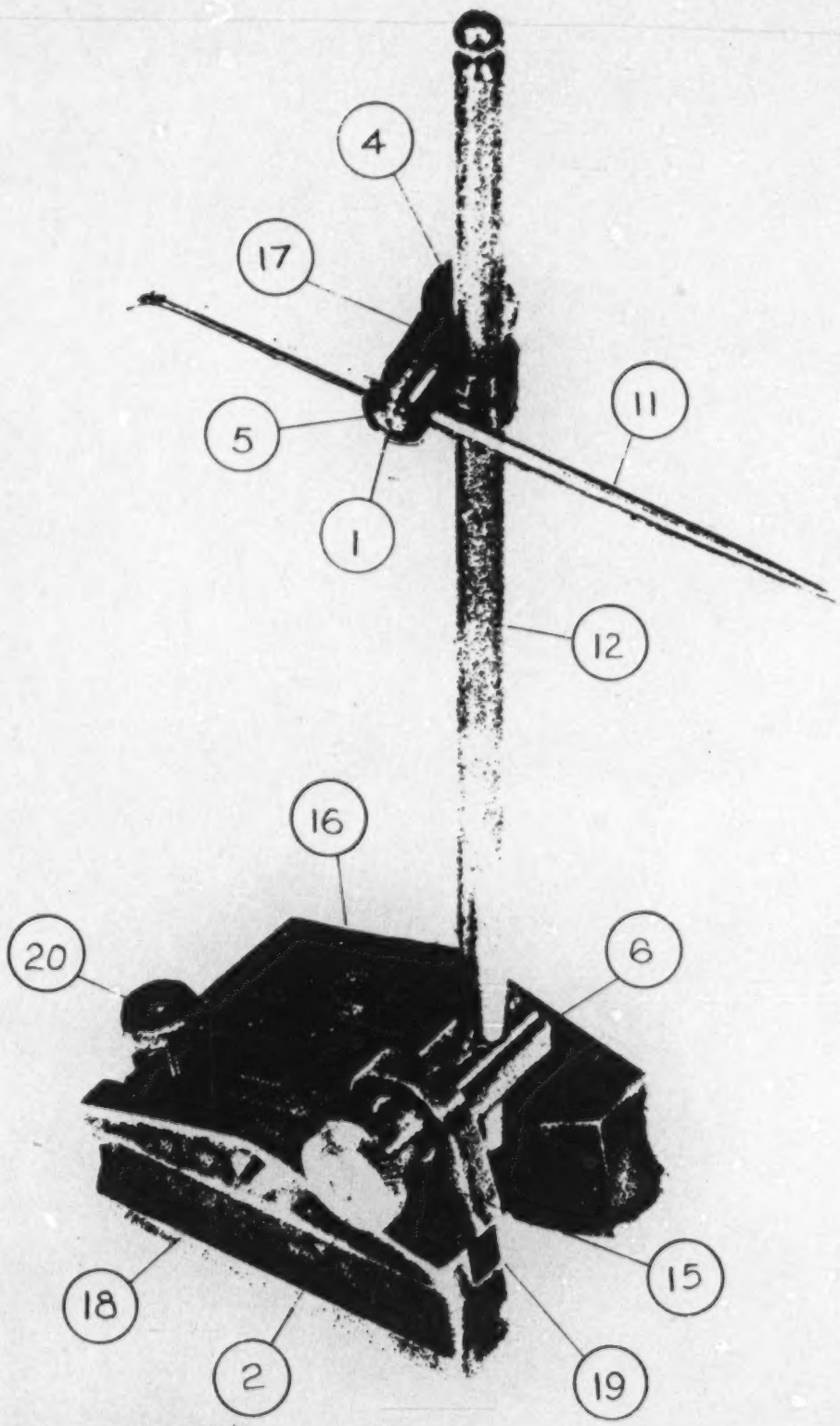

8876

NO	PART
1	CLAMP SCREW
2	POST CLAMP NUT
3	POST END SCREW
4	SCRIBER CLAMP NUT
5	CLAMP BUSHING
6	POST CLAMP BUSHING
7	SCRIBER CLAMP WASHER
8	POST CLAMP SCREW WASHER
9	POST CLAMP WASHER
10	POST END SCRIBER
11	SCRIBER
12	POST
13	SPRING
14	CLAMP NUT SPRING
15	ADJUSTER
16	BASE
17	SCRIBER CLAMP
18	SET SCREW
19	POST CLAMP SCREW
20	ADJUSTING SCREW

8877

SUGGES
SCALE:
DRAWN
MILW

M-212

NO	PART	REQ	MATERIAL
1	CLAMP SCREW	1	S.A.E. 1020 STEEL
2	POST CLAMP NUT	1	S.A.E. 1020 STEEL
3	POST END SCREW	1	S.A.E. 1020 STEEL
4	SCRIBER CLAMP NUT	1	S.A.E. 1020 STEEL
5	CLAMP BUSHING	1	S.A.E. 1020 STEEL
6	POST CLAMP BUSHING	1	S.A.E. 1020 STEEL
7	SCRIBER CLAMP WASHER	1	S.A.E. 1020 STEEL
8	POST CLAMP SCREW WASHER	1	S.A.E. 1020 STEEL
9	POST CLAMP WASHER	1	BRASS
10	POST END SCRIBER	1	S.A.E. 1020 STEEL
11	SCRIBER	1	S.A.E. 1020 STEEL
12	POST	1	1020 STEEL
13	SPRING	1	S.A.E. 1020 STEEL
14	CLAMP NUT SPRING	1	S.A.E. 1020 STEEL WIRE
15	ADJUSTER	1	S.A.E. 1020 STEEL
16	BASE	1	S.A.E. 1020 STEEL
17	SCRIBER CLAMP	1	S.A.E. 1020 STEEL
18	SET SCREW	1	S.A.E. 1020 STEEL
19	POST CLAMP SCREW	1	S.A.E. 1020 STEEL
20	ADJUSTING SCREW	1	S.A.E. 1020 STEEL

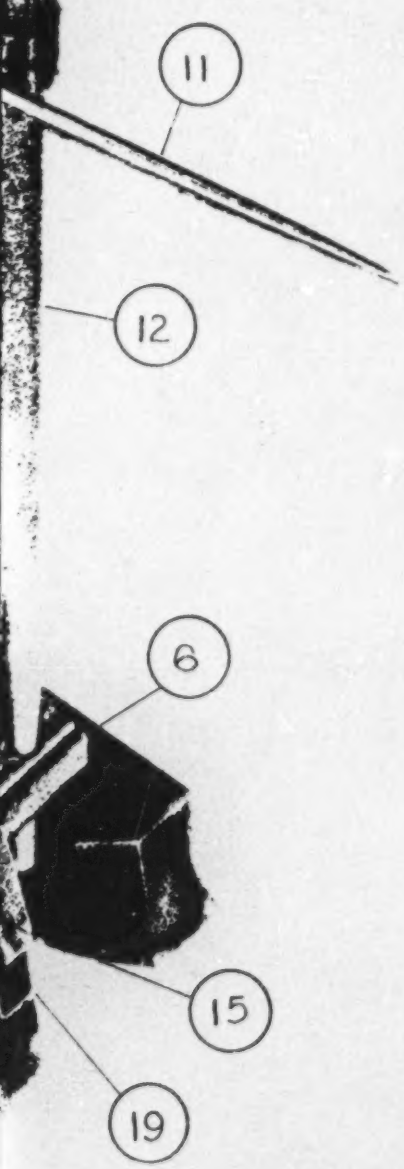

SURFACE GAUGE	
SUGGESTED BY: BOYS' TECH	
SCALE:	DATE: 10-17-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8877

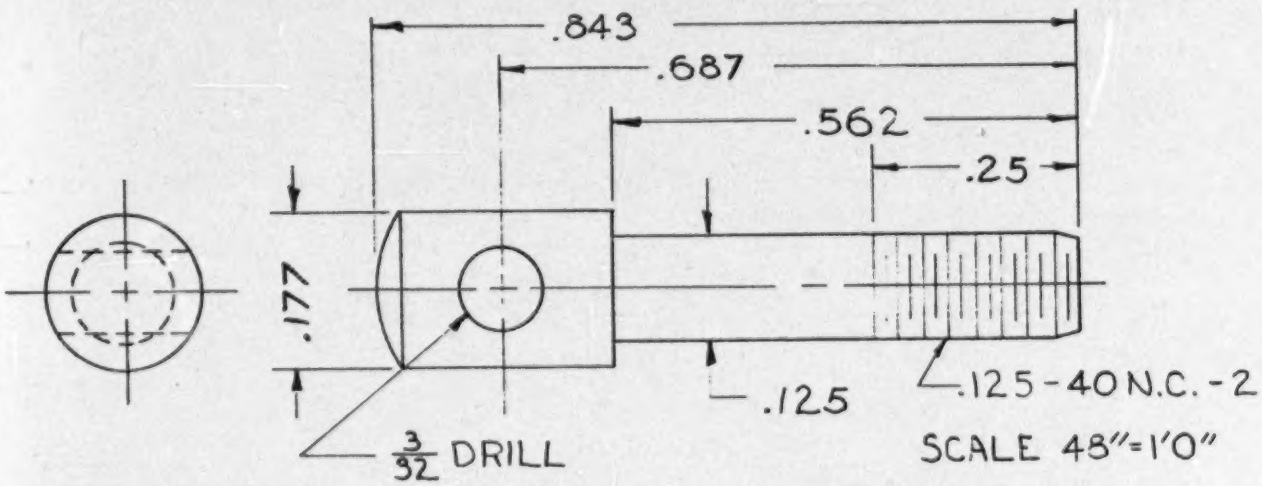

CLAMP SCREW

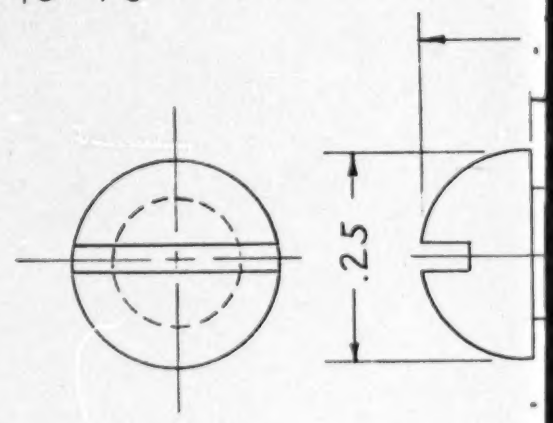

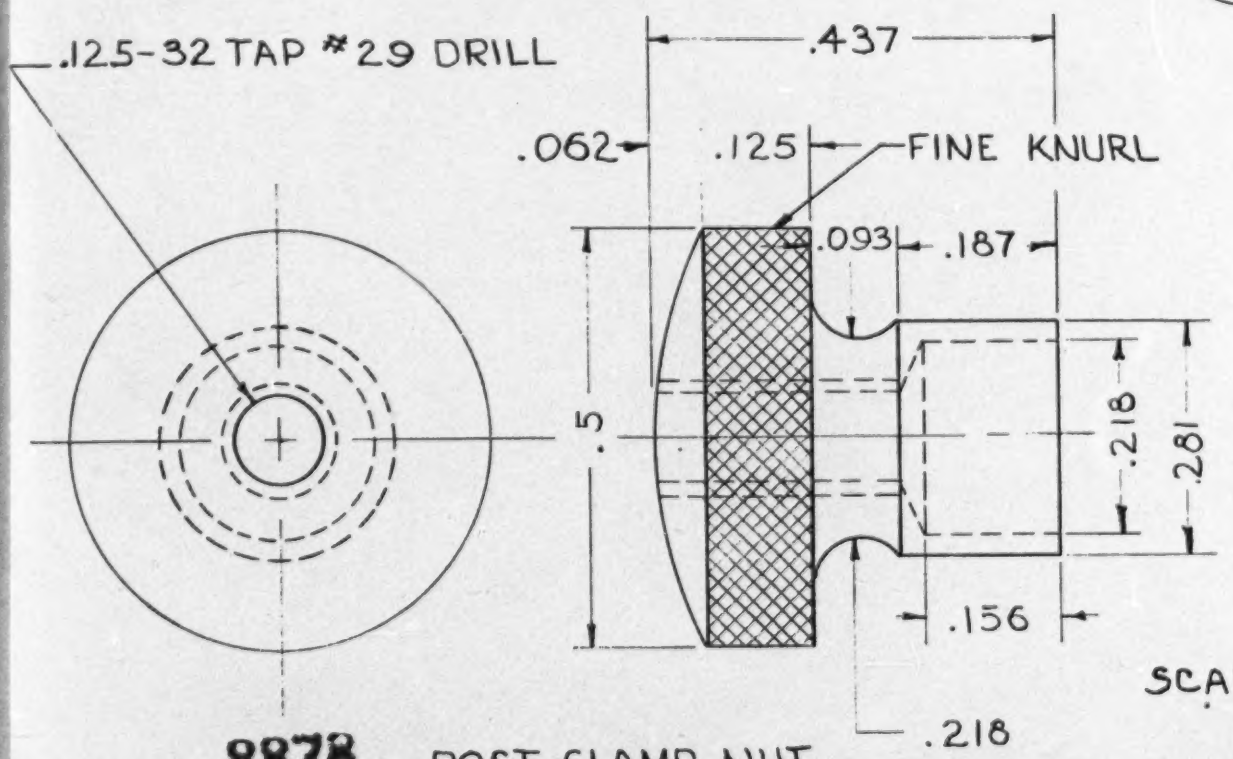

SCALE 48"=1'0"

8878 POST CLAMP NUT 8879

M-212A

1 EACH REQUIRED
ALL S.A.E. STEEL

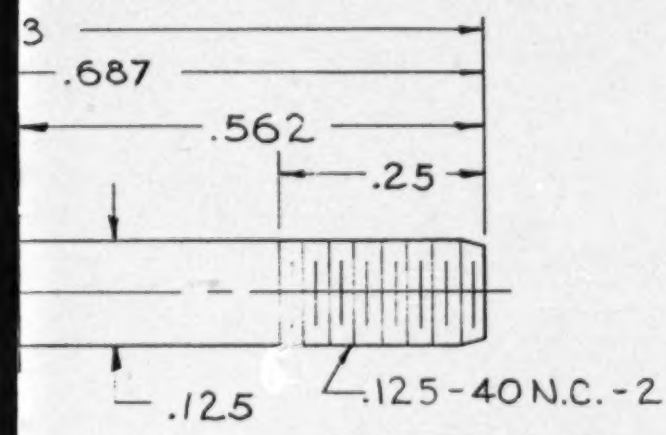

SCALE 48"=1'0"

LAMP SCREW

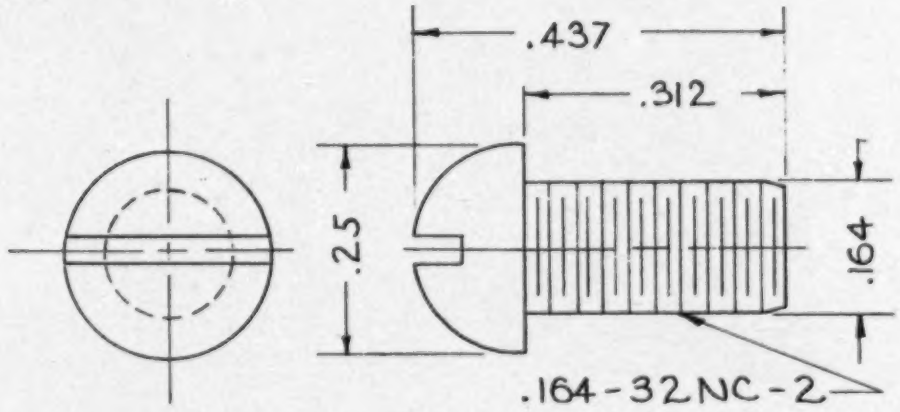

SCALE 48"=1'0"
POST END SCREW

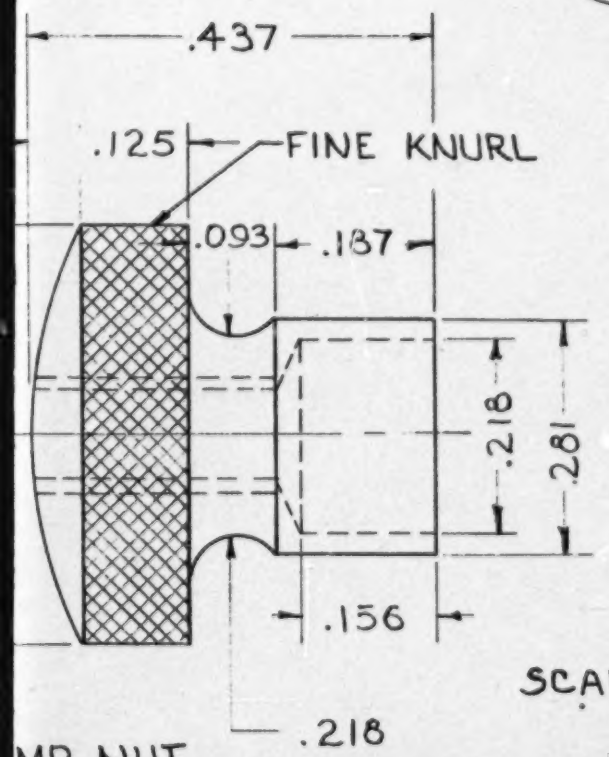

SCALE 48"=1'0"

MP NUT

8879

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

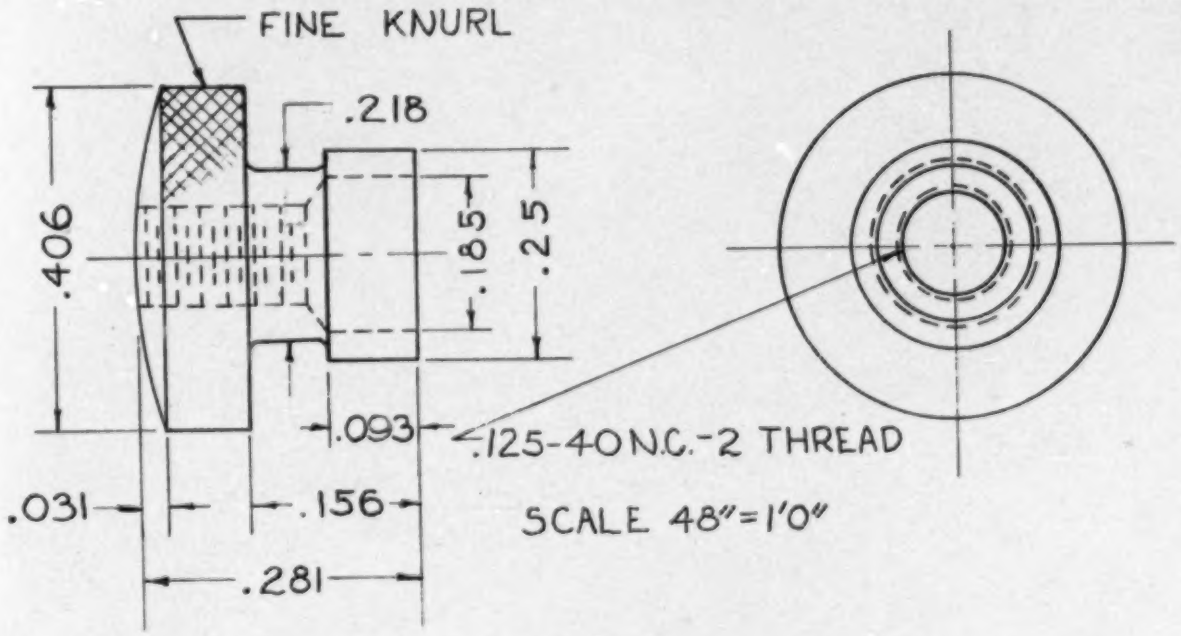

SCRIBER NUT CLAMP

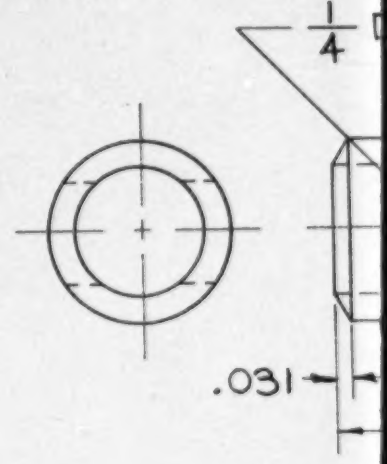

NOTE
DRIL
ASSE
SC
POS

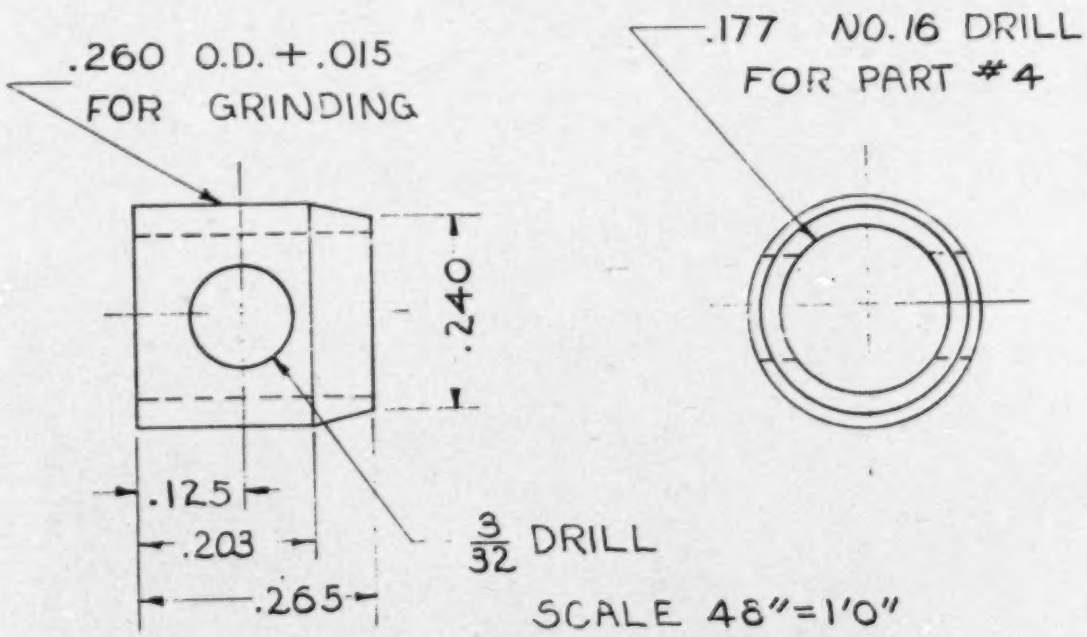

CLAMP BUSHING

I EACH
ALL SA

SURF
SUGGES
SCALE:
DRAWN
MILW

8880

8881

M-212B

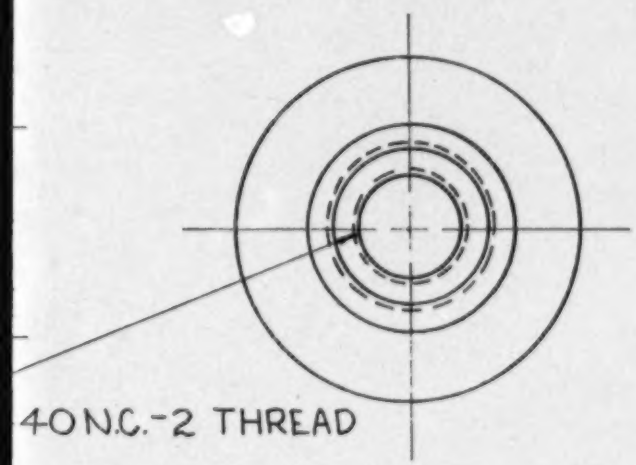

CALE 48"=1'0"

R NUT CLAMP

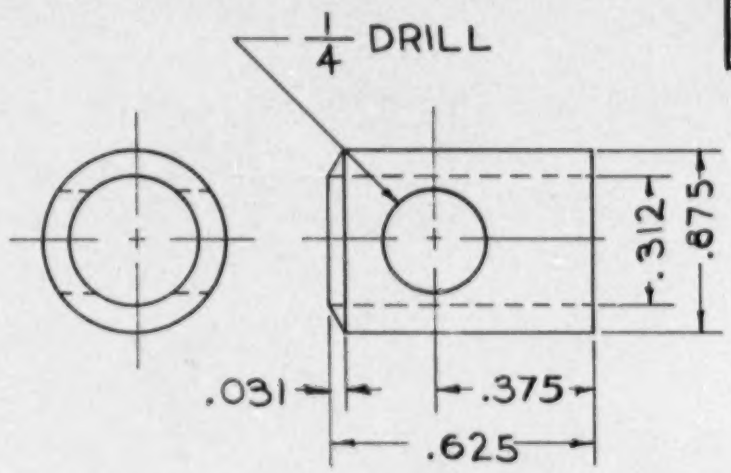

NOTE: 1/4 HOLE TO BE DRILLED WHEN ASSEMBLED WITH PART 12.
SCALE 24"=1'0"
POST CLAMP BUSHING

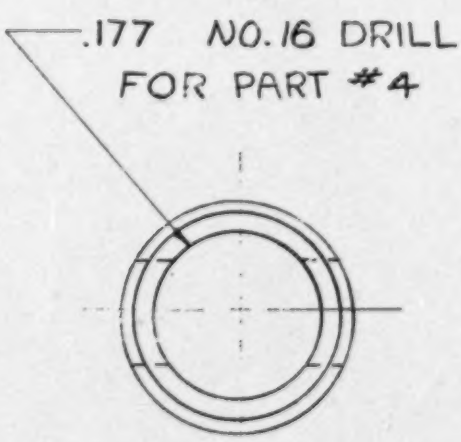

1 EACH REQUIRED
ALL S.A.E. STEEL

RILL

CALE 48"=1'0"

LAMP BUSHING

8881

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

1 REQUIRED
1020 STEEL

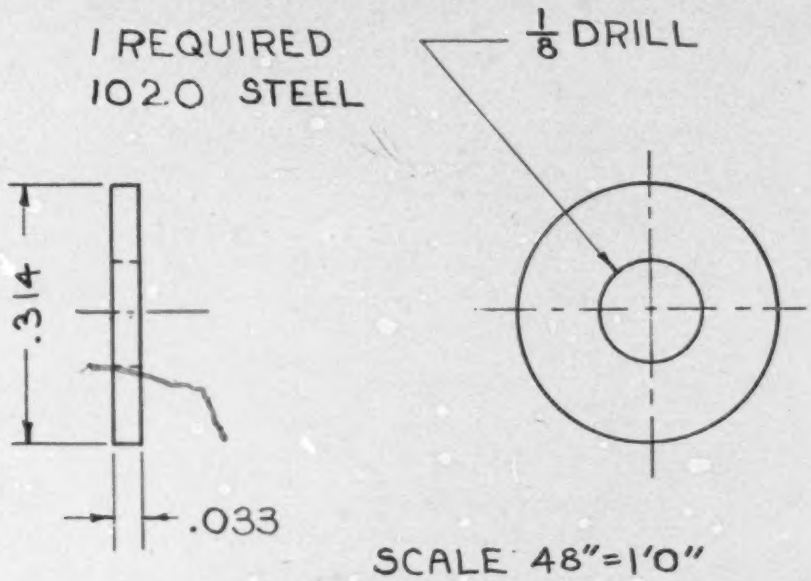

SCALE 48"=1'0"

SCRIBER CLAMP WASHER

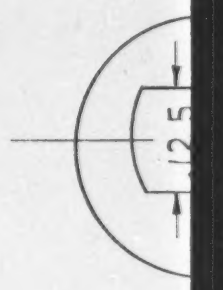

1 RE
BR

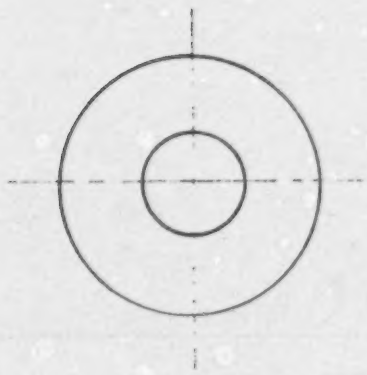

1 REQUIRED
S.A.E. 1020 STEEL.

SCA
POST

SCALE 48"=1'0"

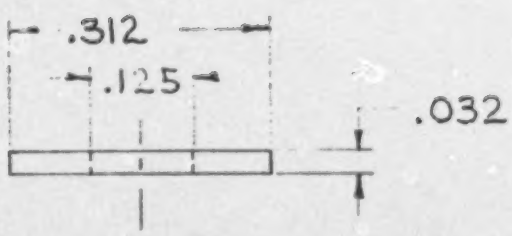

POST CLAMP SCREW WASHER

SURFA
SUGGEST
SCALE: A
DRAWN
MILWA
1

8882

8883

M-212C

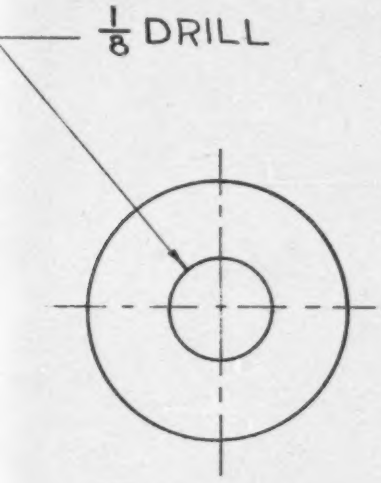

ALE 48"=1'0"

BER CLAMP WASHER

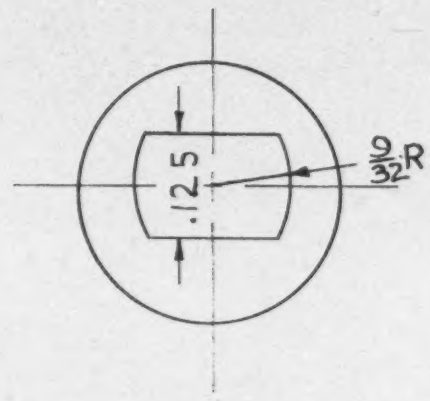

1 REQUIRED
BRASS

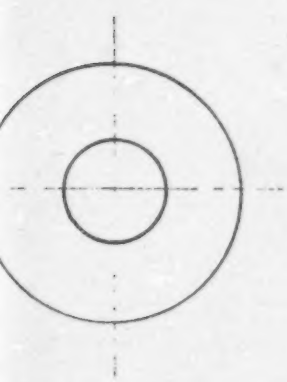

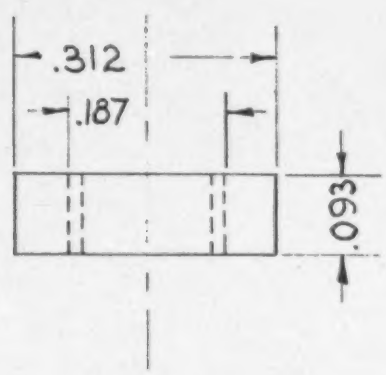

SCALE 48"=1'0"

POST CLAMP WASHER

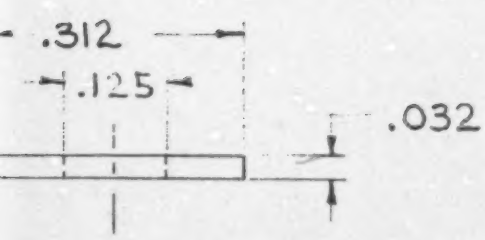

POST CLAMP SCREW WASHER

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY Q. W.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8883

1 REQUIRED
S.A.E. 1020 STEEL

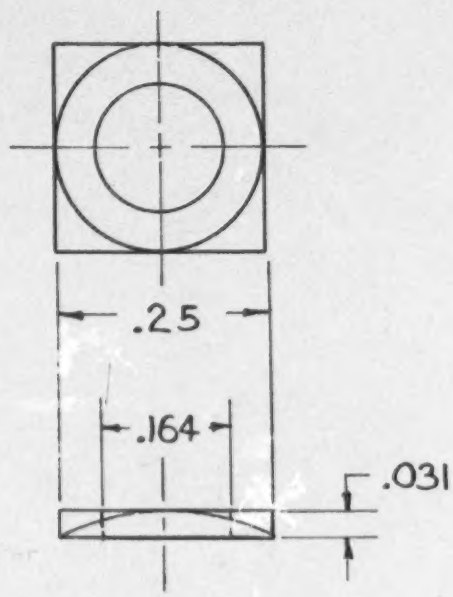

SCALE 48"=1'0"
POST END SCRIBER

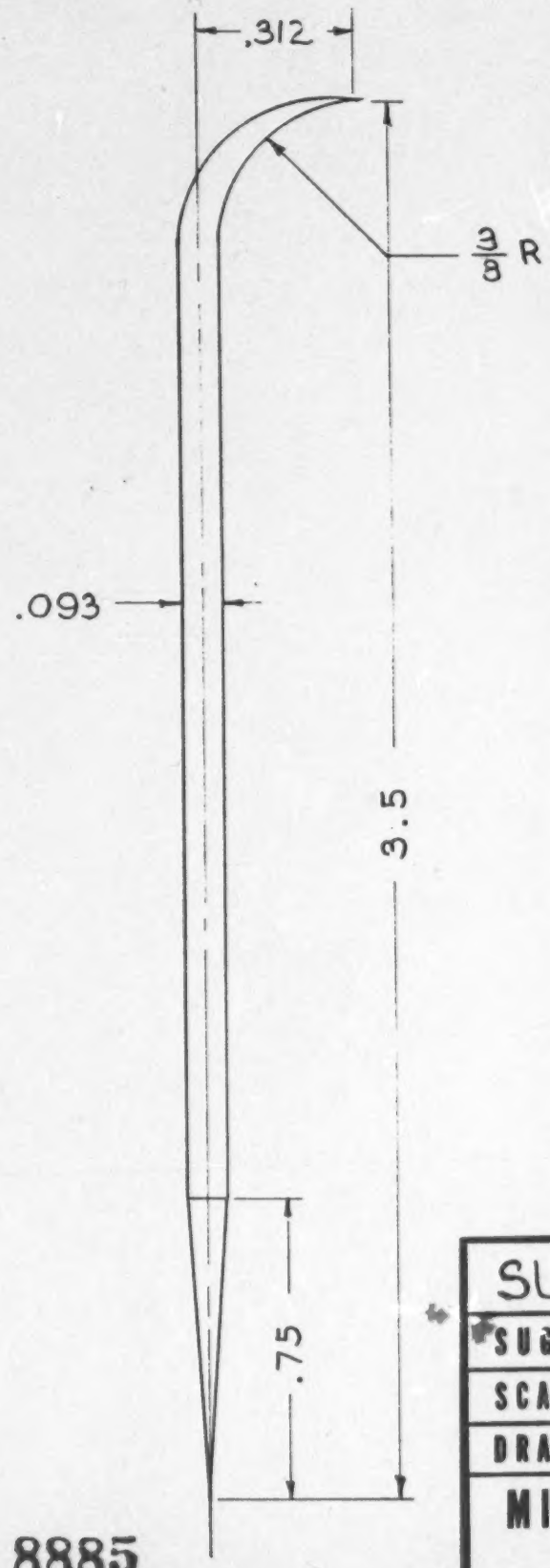

8884

8885

M-212D

EQUIRED
E. 1020 STEEL

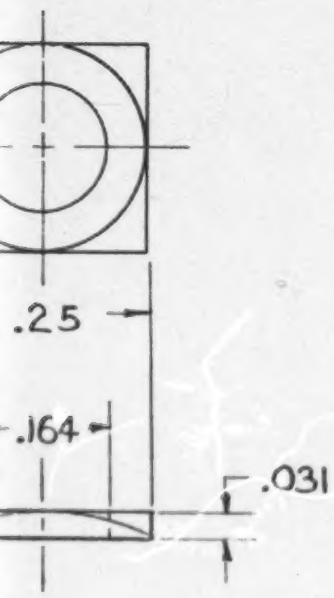

48"=1'0"
D SCRIBER

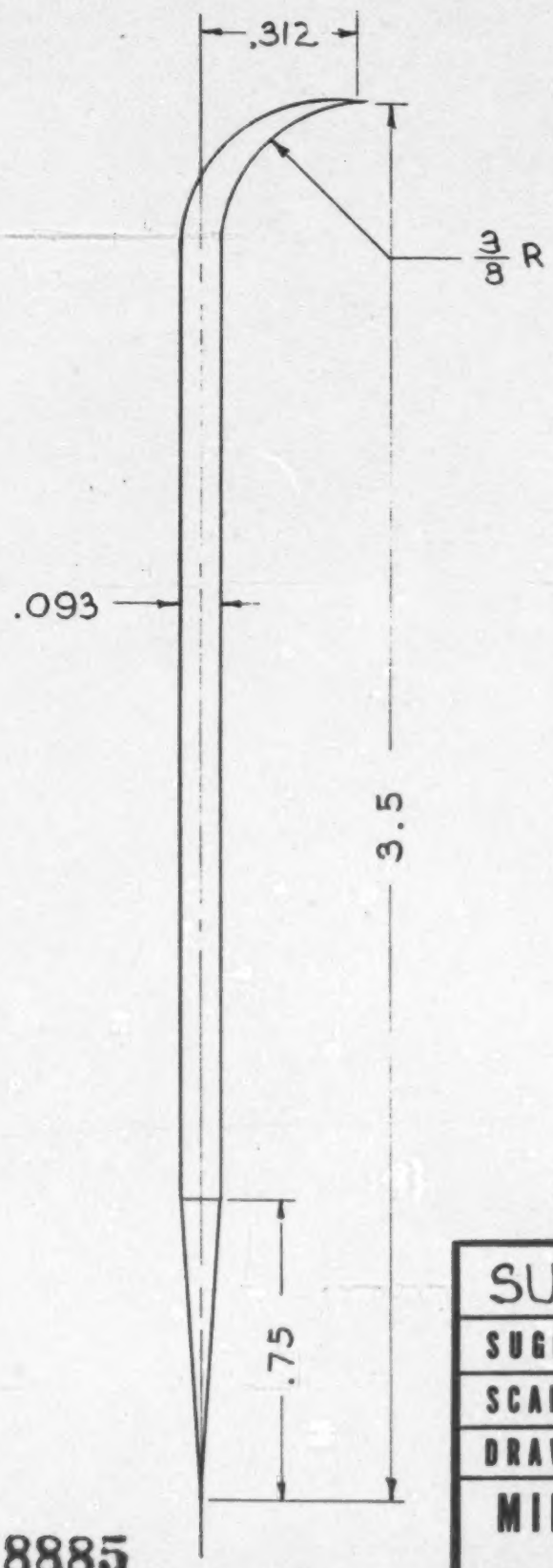

DRILL ROD
1 REQUIRED
SCALE 24"=1'0"

SCRIBER

8885

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY RWA	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

1 REQUIRED
1020 STEEL

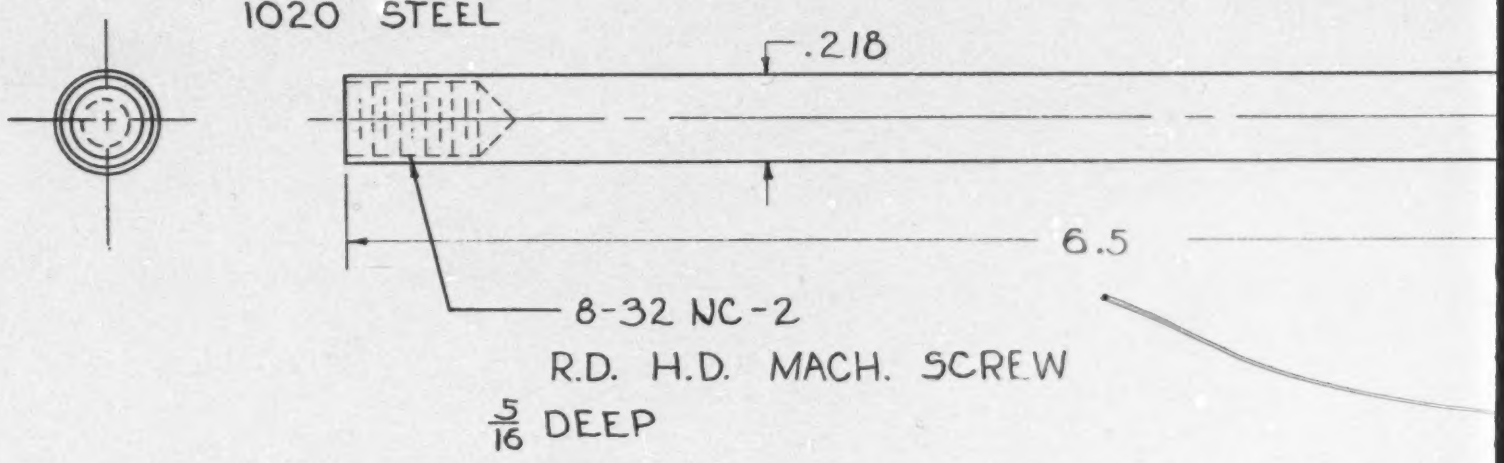

SCALE 24"=1'0"
POST

2 REQUIRED
28 GAUGE S.A.E. 1020
STEEL WIRE

1 REQUIRED
S.A.E. 1020
STEEL

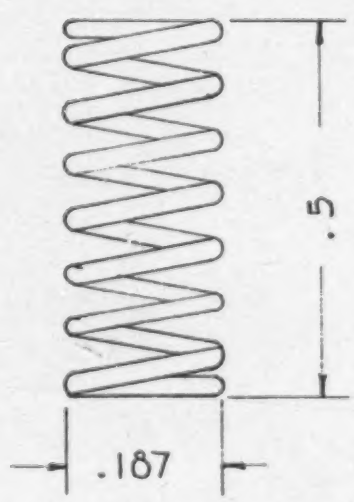

SCALE 48"=1'0"
SPRING

8886

8887

M-212E

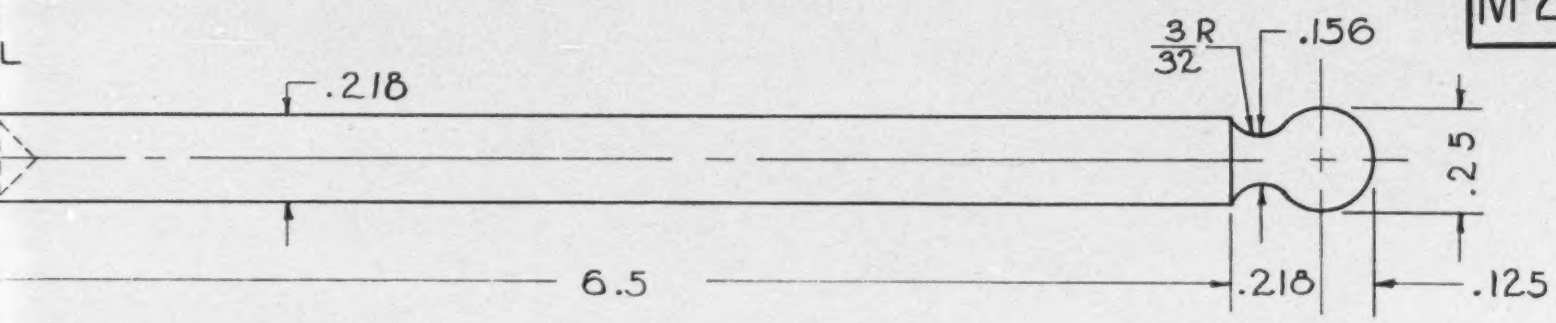

8-32 NC-2
R.D. H.D. MACH. SCREW
$\frac{5}{16}$ DEEP

SCALE 24"=1'0"
POST

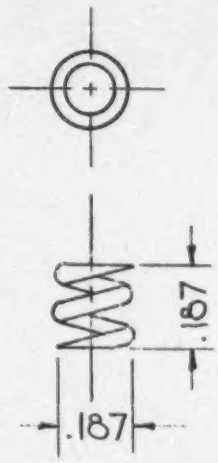

2 REQUIRED
28 GAUGE S.A.E. 1020
STEEL WIRE

SCALE 24"=1'0"
CLAMP NUT SPRING

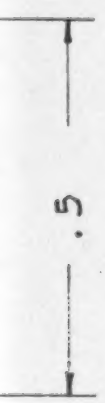

SCALE 48"=1'0"
SPRING

8887

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

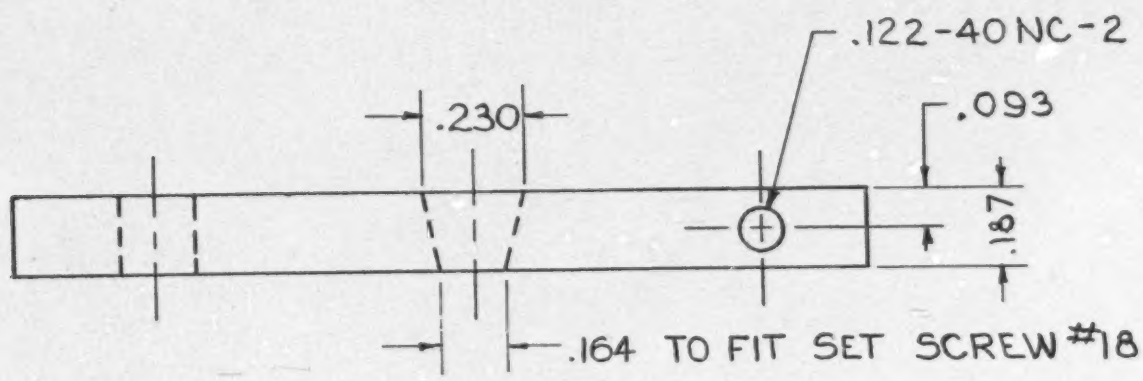

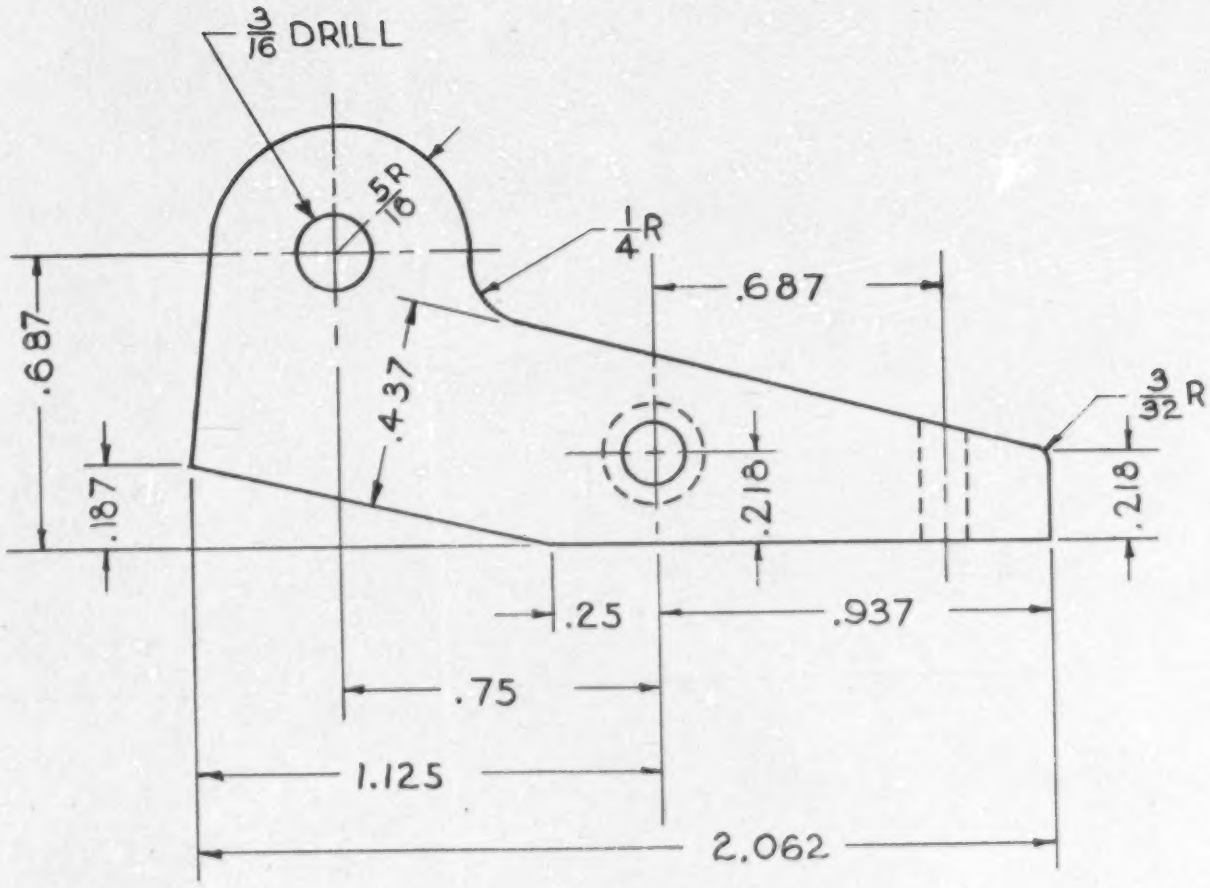

8888

8889

SUP
SUGG
SCAL
DRAW
MIL

M-212F

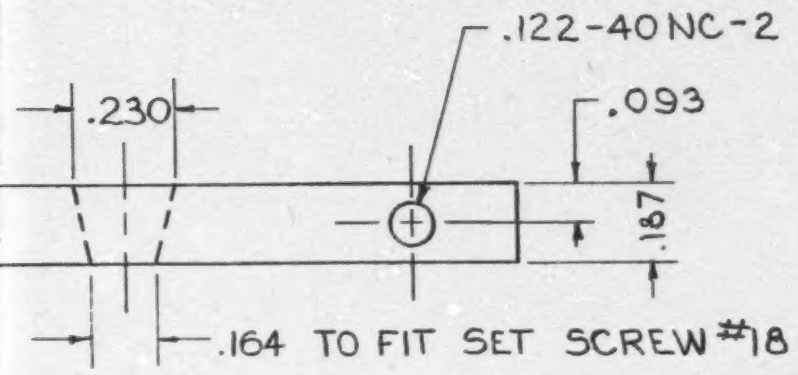

1 REQUIRED
S.A.E. 1020 STEEL

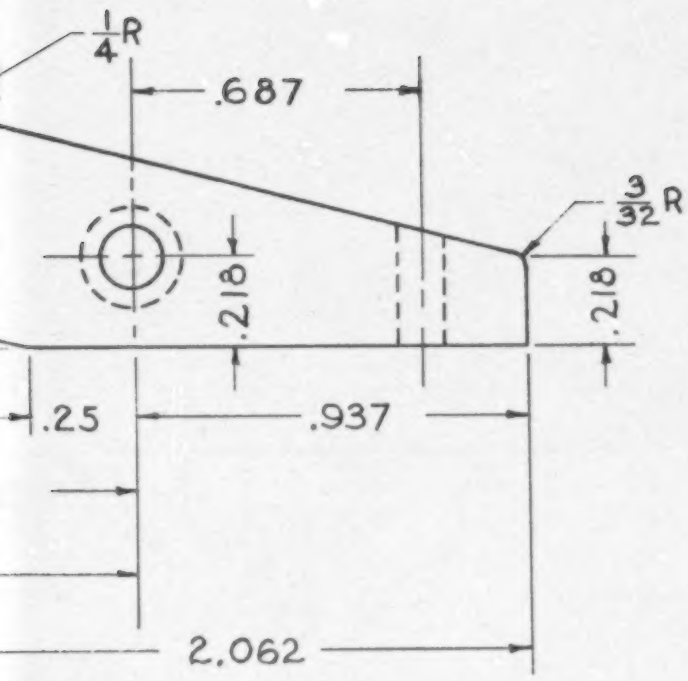

ADJUSTER
SCALE 24" = 1'0"

8889

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

SCALE 24 -16

SUR

SUGGE

SCALE

DRAW

MILW

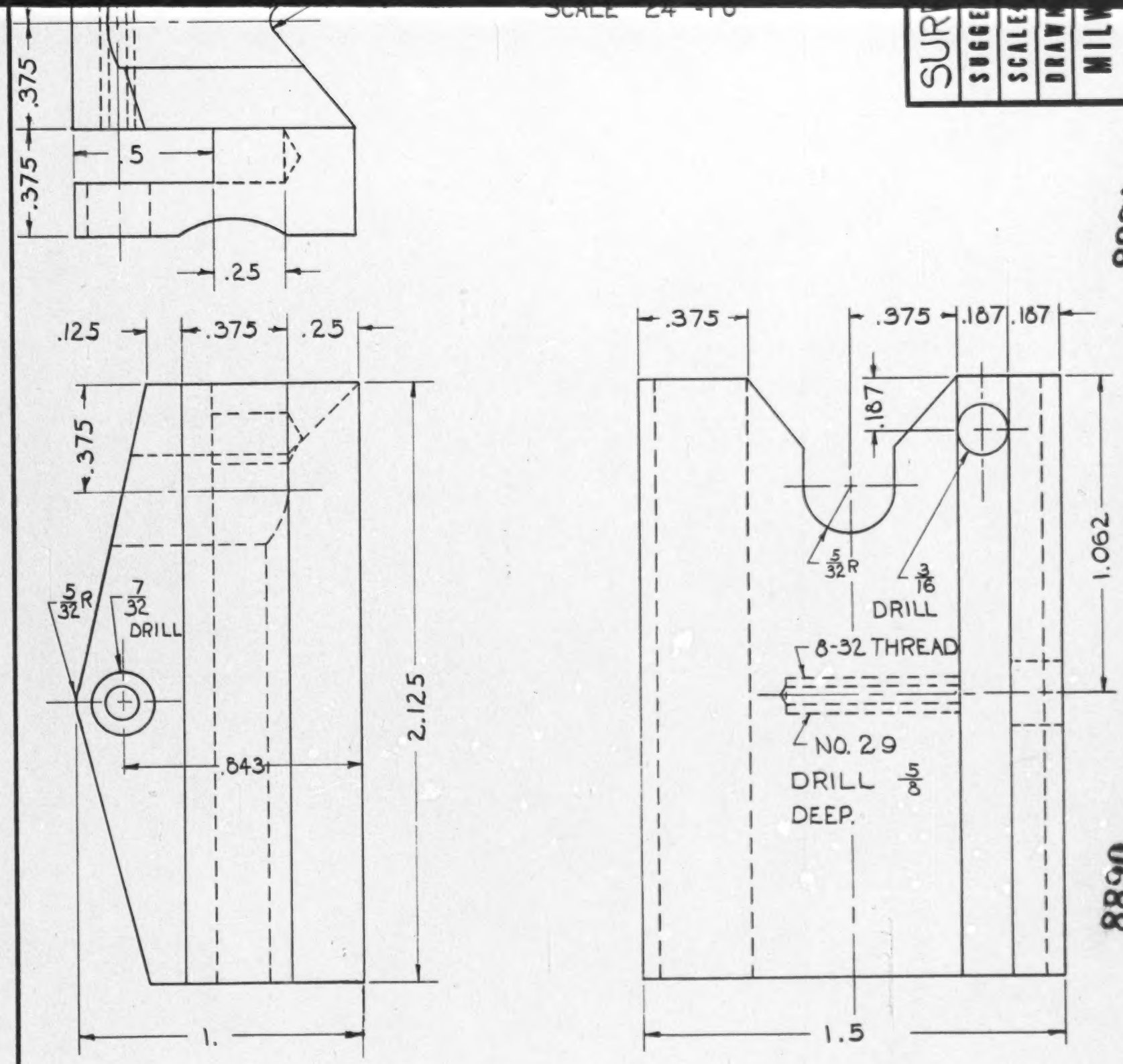

8891

8890

M-212G

1 REQUIRED
S.A.E. 1020 STEEL

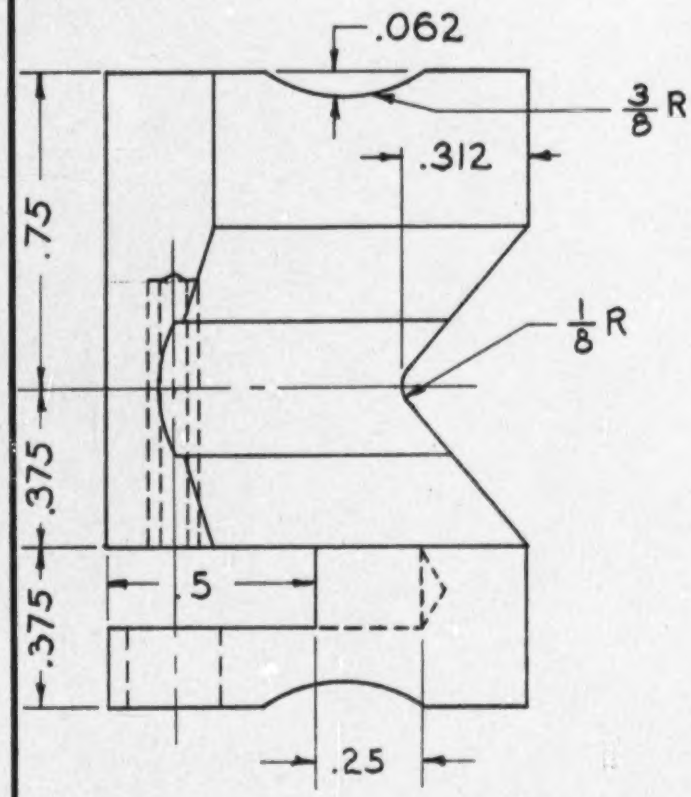

BASE
SCALE 24"=1'0"

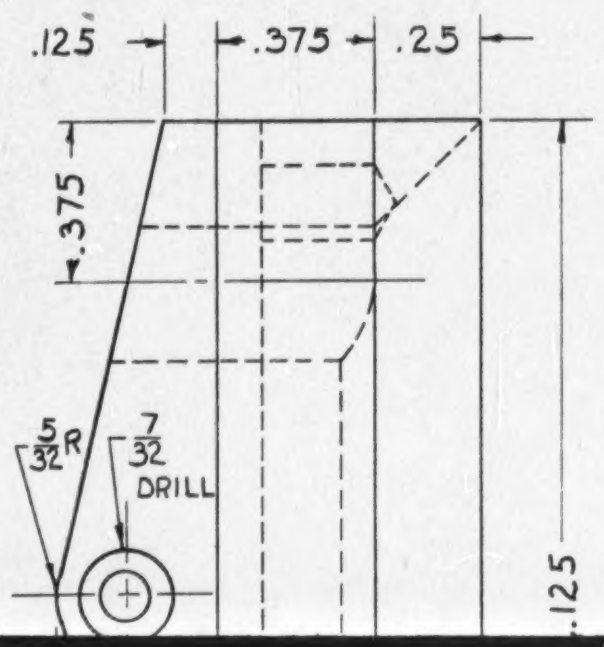

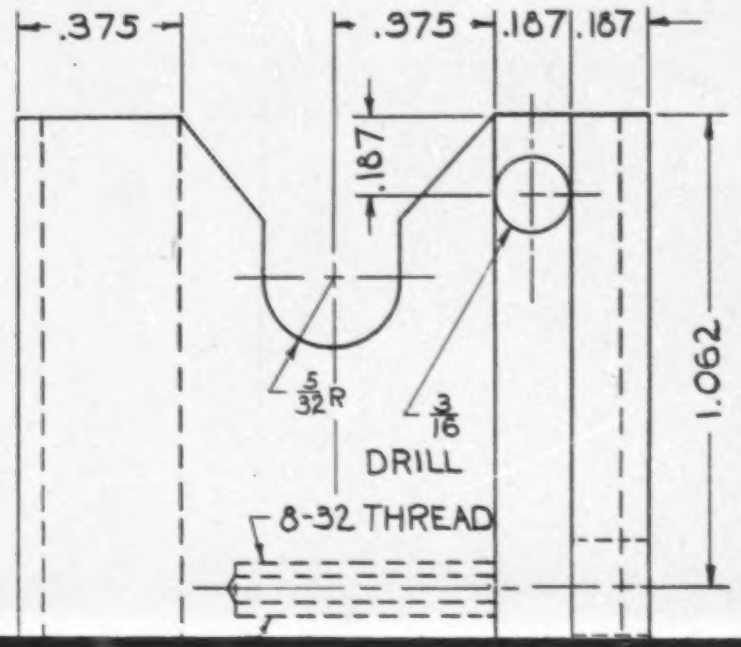

SURFACE GAUGE DETAILS

SUGGESTED BY: BOYS' TECH

SCALE: AS SHOWN | DATE: 7-12-66

DRAWN BY | CHECKED BY

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

8891

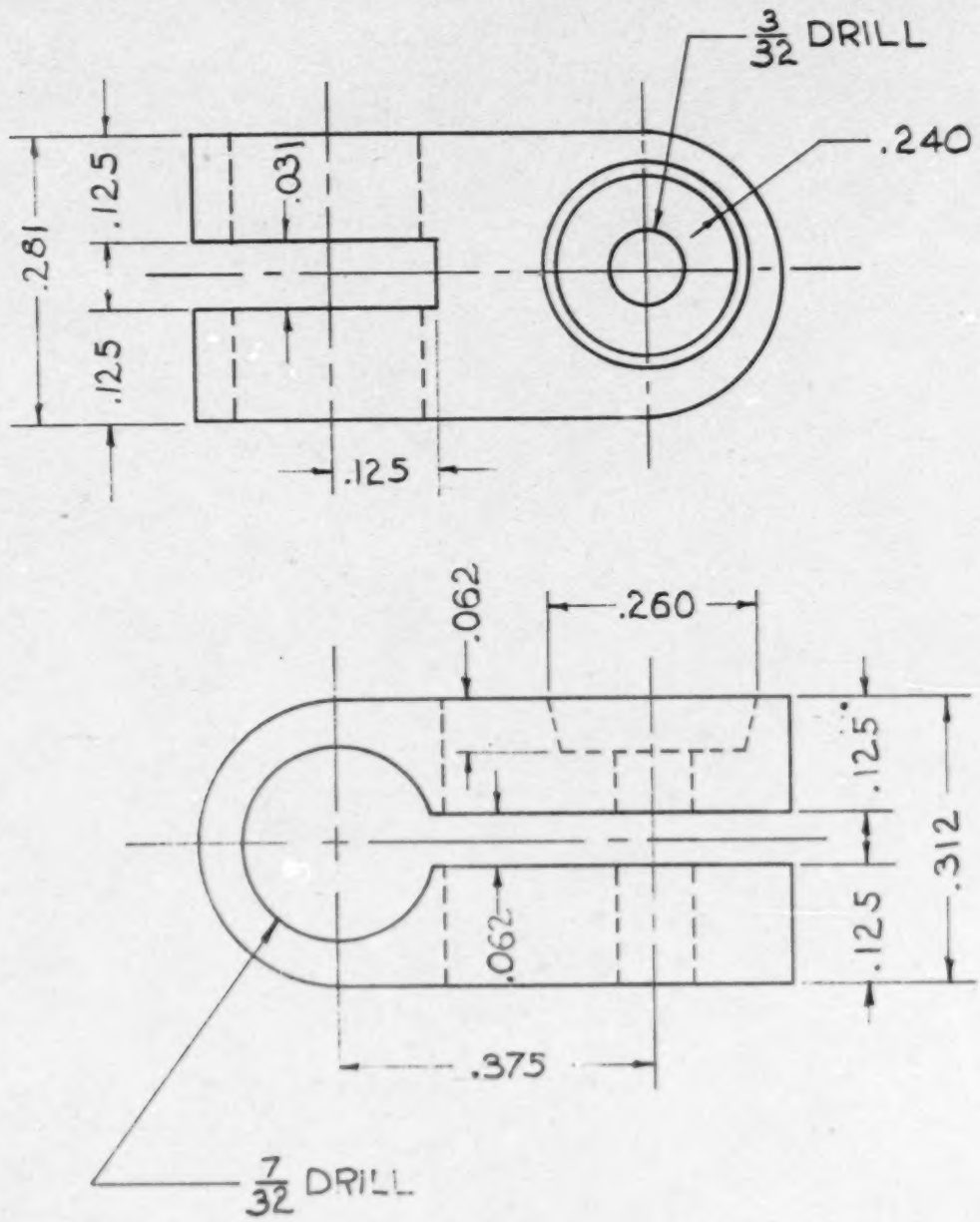

8892

8893

S.A
1 F

SUP
SUGG
SCAL
DRAW
MIL

M-212H

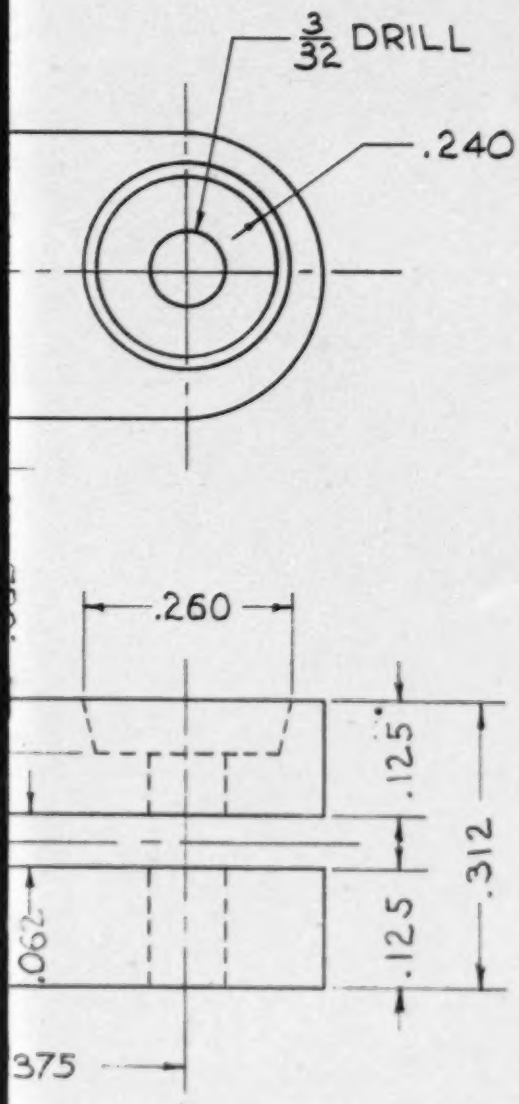

S.A.E. 1020 STEEL
1 REQUIRED

SCRIBER CLAMP
SCALE 4S"=1'0"

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8893

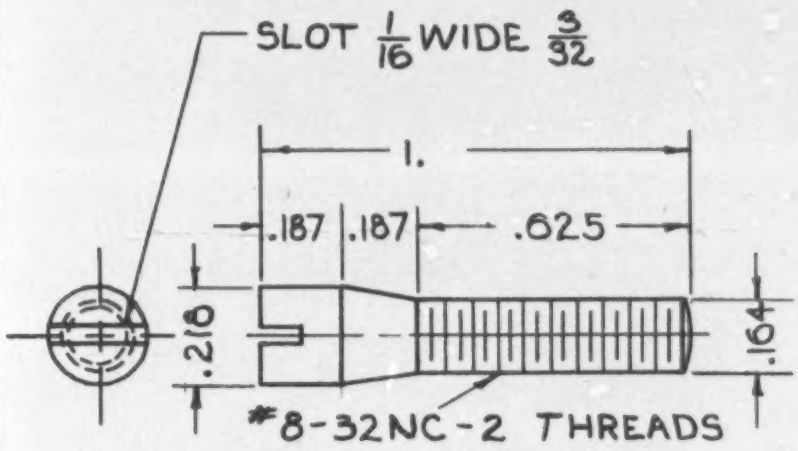

SCALE 24"=1'0"

SET SCREW

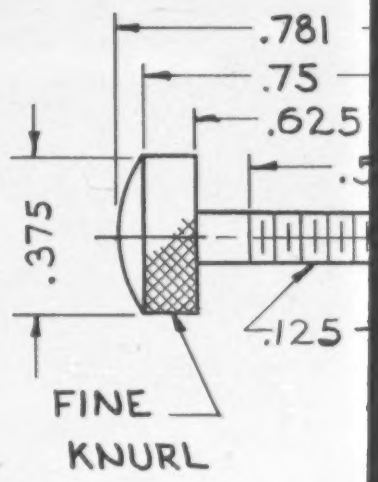

A

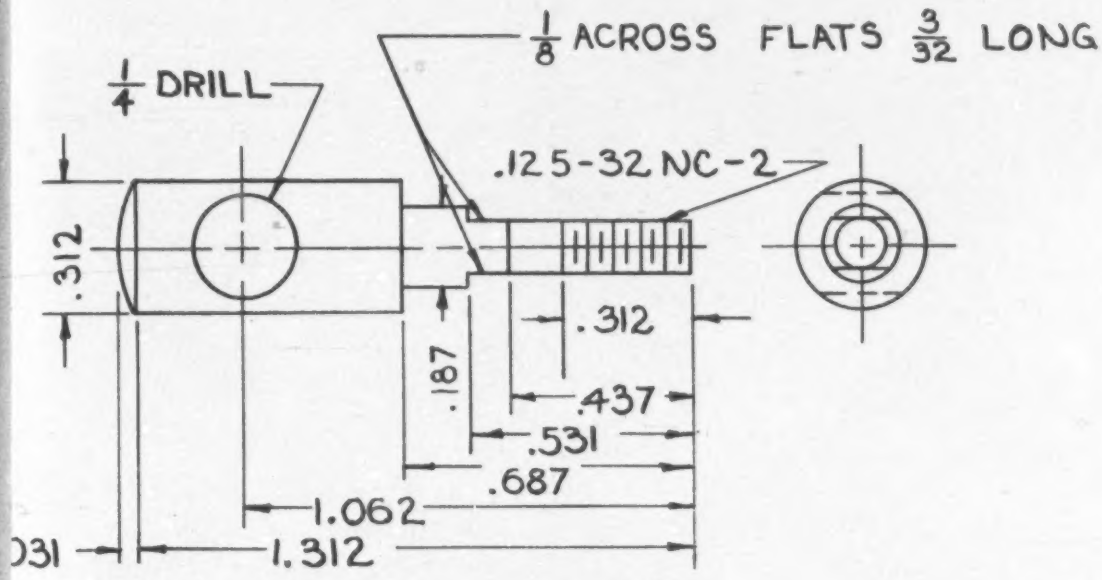

SCALE 24"=1'0"

POST CLAMP SCREW

1 EACH R
ALL S.A

SU
SUGG
SCAL
DRAW
MI

8894

8895

M-212-1

VIDE $\frac{3}{32}$

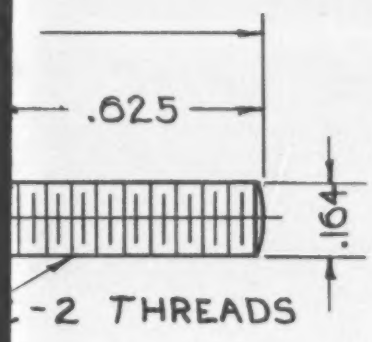

4"=1'0"

SCREW

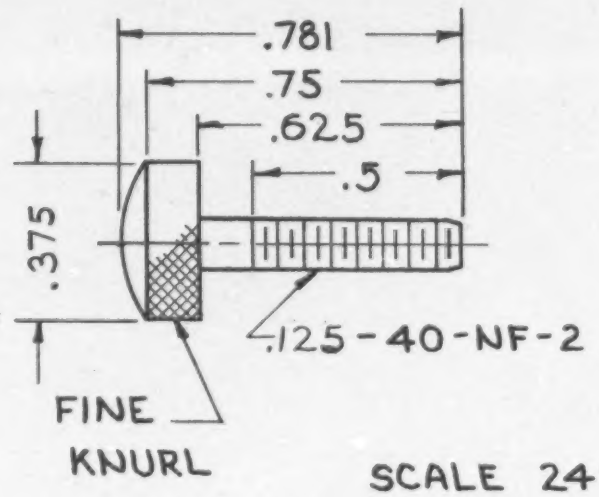

SCALE 24"=1'0"

ADJUSTING SCREW

$\frac{1}{8}$ ACROSS FLATS $\frac{3}{32}$ LONG

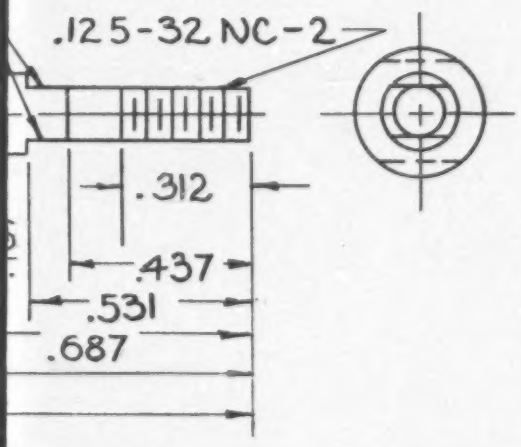

1 EACH REQUIRED
ALL S.A.E. 1020 STEEL

ALE 24"=1'0"

POST CLAMP SCREW

SURFACE GAUGE DETAILS	
SUGGESTED BY: BOYS' TECH	
SCALE: AS SHOWN	DATE: 7-12-66
DRAWN BY R.W.H.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8895

M-213

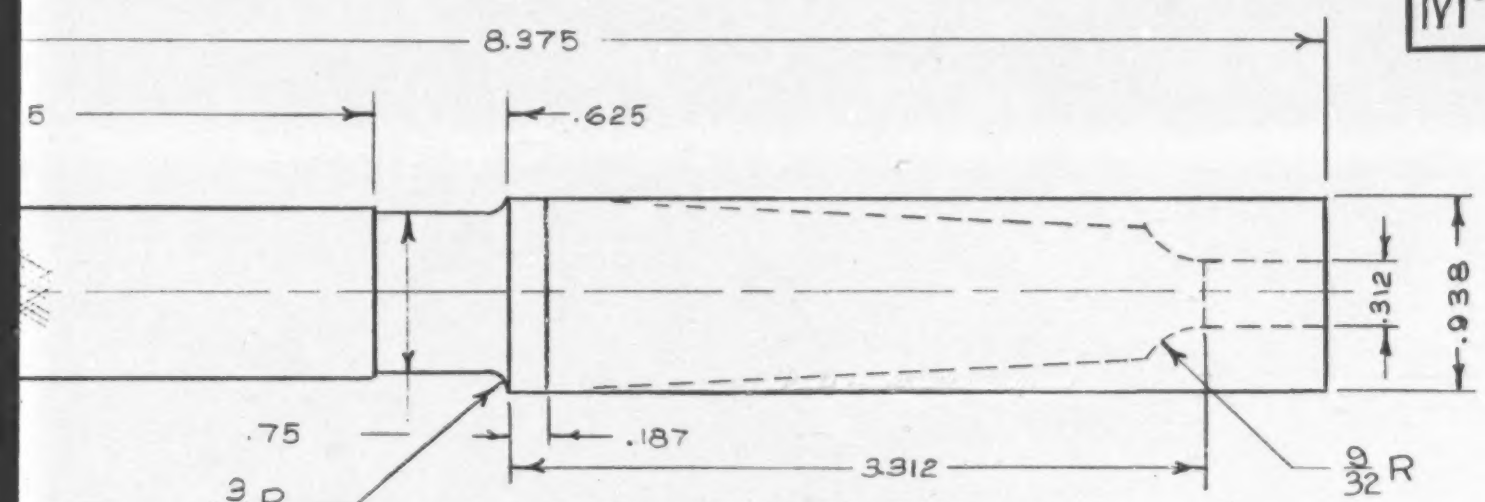

NO. 3 MORSE TAPER

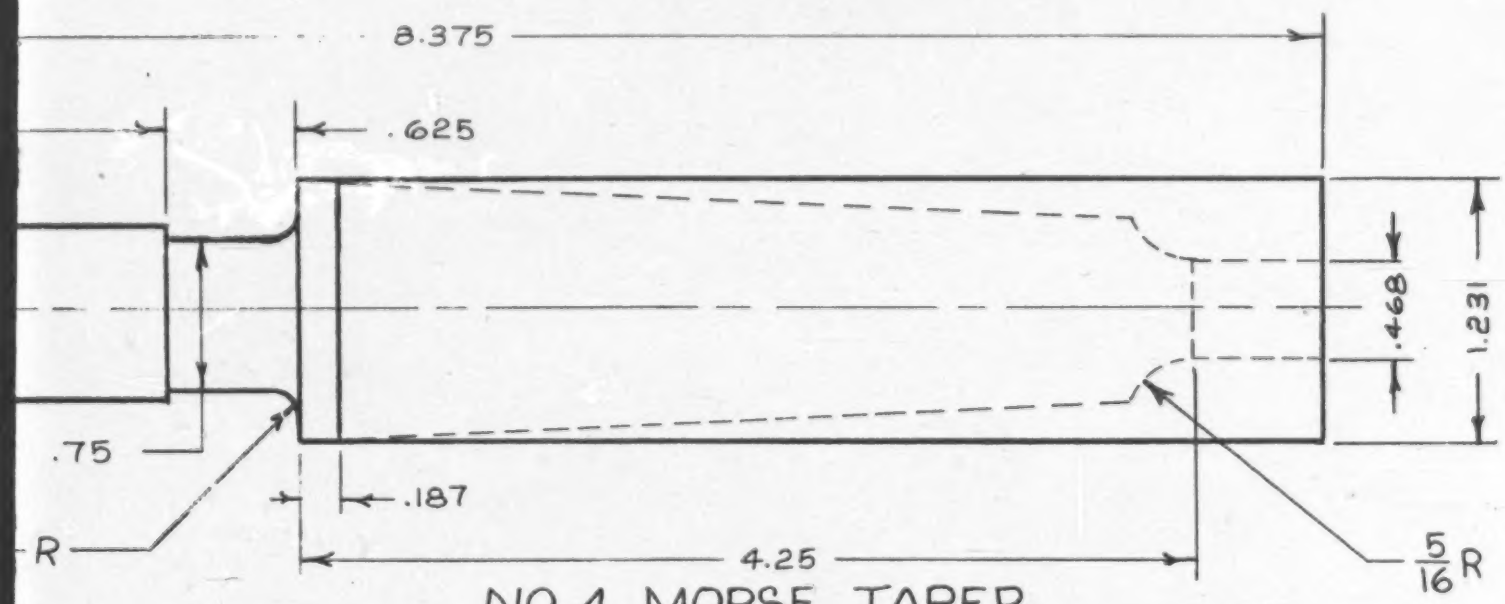

NO. 4 MORSE TAPER

ER FIRST, SO
ED NO. 4's CAN
WN TO LONG

TOLERANCE ± .005
UNLESS OTHERWISE STATED.

TAPER EXERCISE	
SUGGESTED BY: M.P.S.	
SCALE: 12" = 1'-0"	DATE: 7-8-66
DRAWN BY R.T.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8897

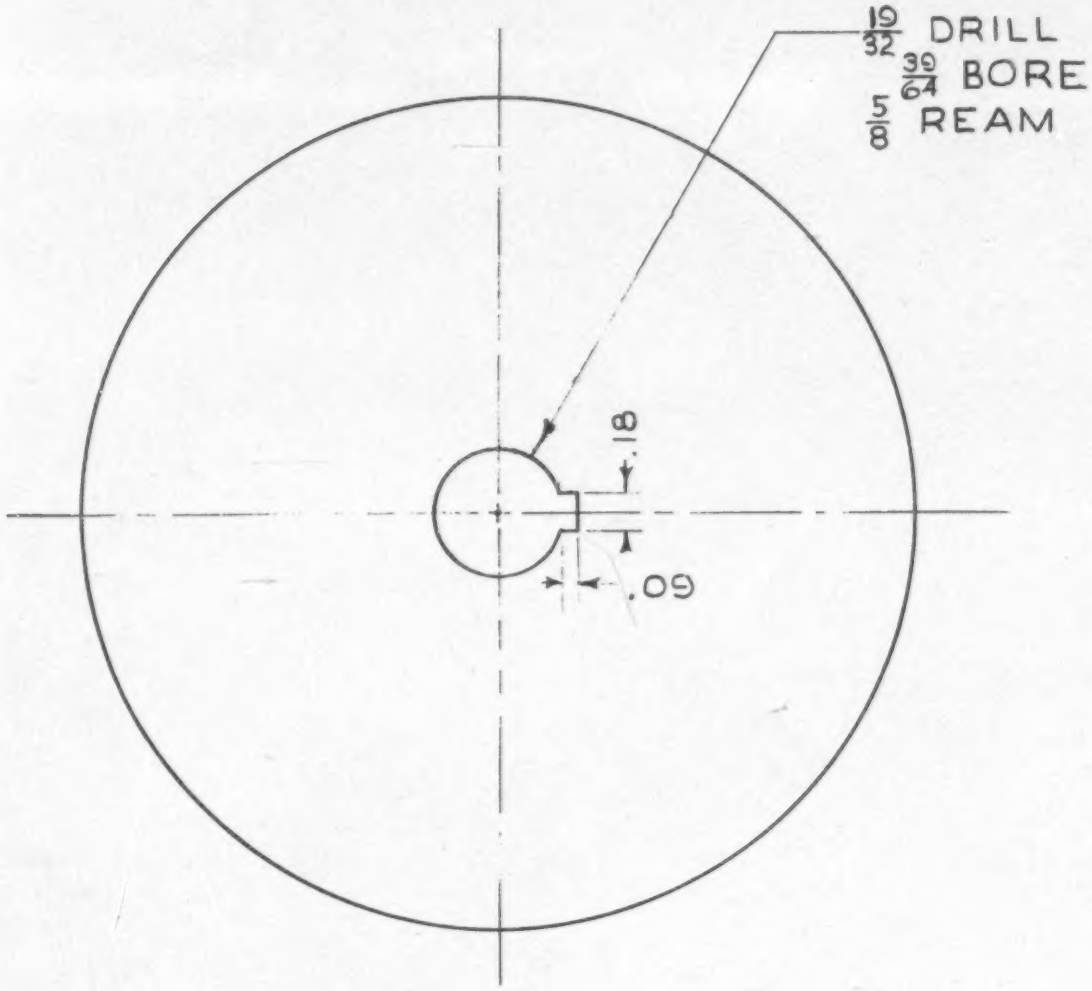

GEAR	NUMBER OF TEETH	DIA. PITCH	OUTSIDE DIAMETER
A	16	16	
B	32	16	
C	40	16	
D	44	16	
E	46	16	

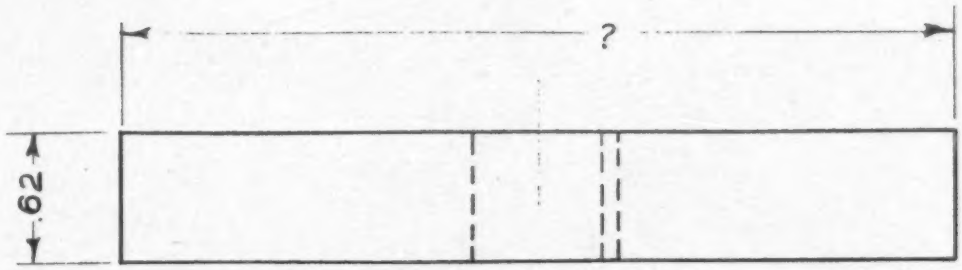

8898

8899

SPUR

SUGGESTED

SCALE: NO

DRAWN BY

MILWAUK

INDU

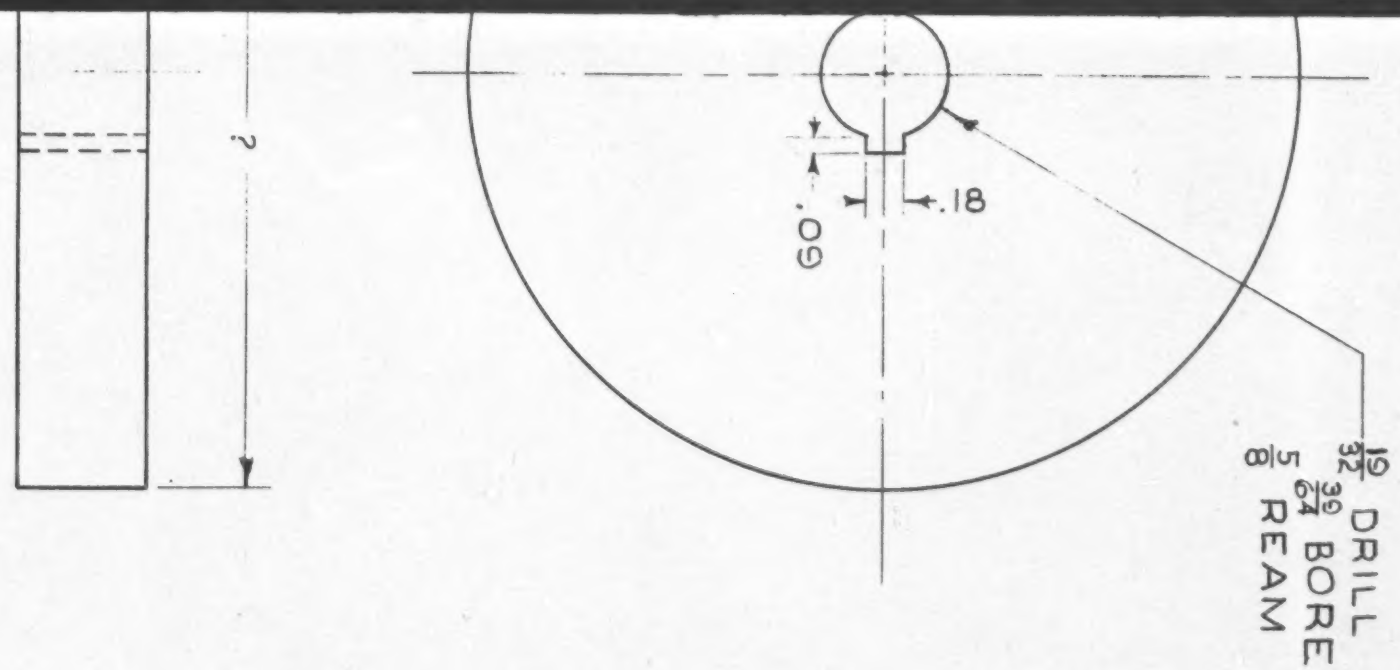

GEAR	NUMBER OF TEETH	DIA. PITCH	OUTSIDE DIAMETER
A	16	16	
B	32	16	
C	40	16	
D	44	16	
E	46	16	
F	48	16	
G	52	16	
H	64	16	

O.D = NO. OF TEETH +2 ÷ DIA. PITCH

CAST IRON

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

M-214

SPUR GEAR BLANK

SUGGESTED BY: BOYS' TECH

SCALE: NONE

DATE: 7-7-66

DRAWN BY T.S.S.

CHECKED BY MC

MILWAUKEE PUBLIC SCHOOLS

INDUSTRIAL EDUCATION

6688

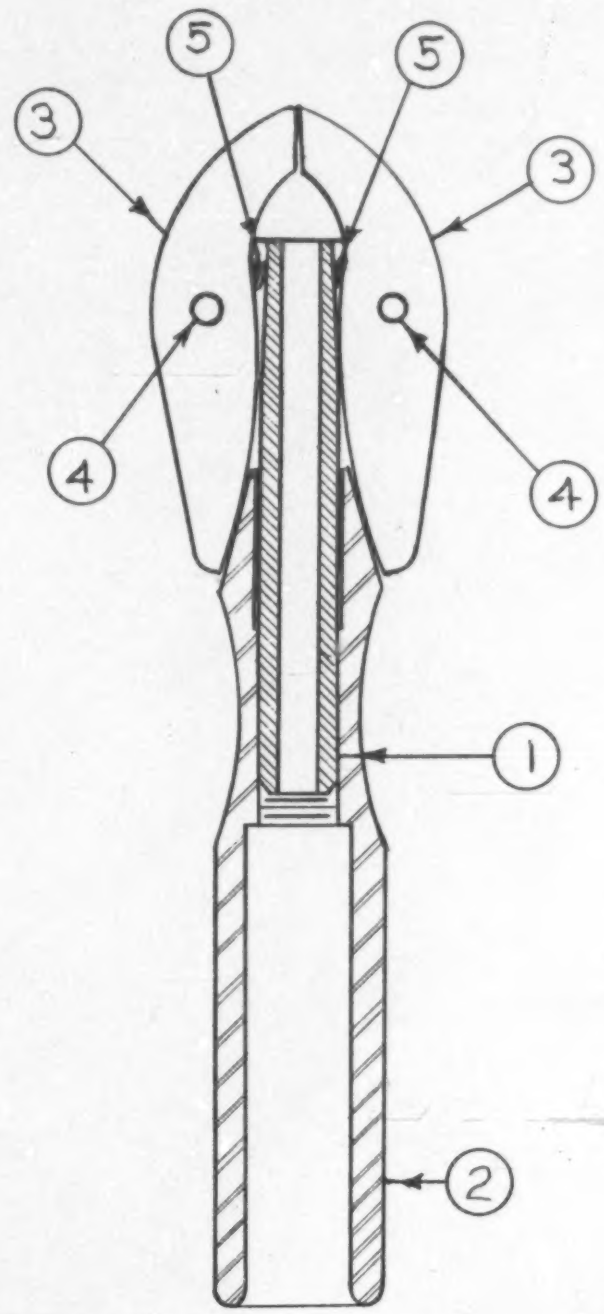

NO.	
1	C
2	H
3	J
4	P
5	S

T
O

8900

8901

M-215

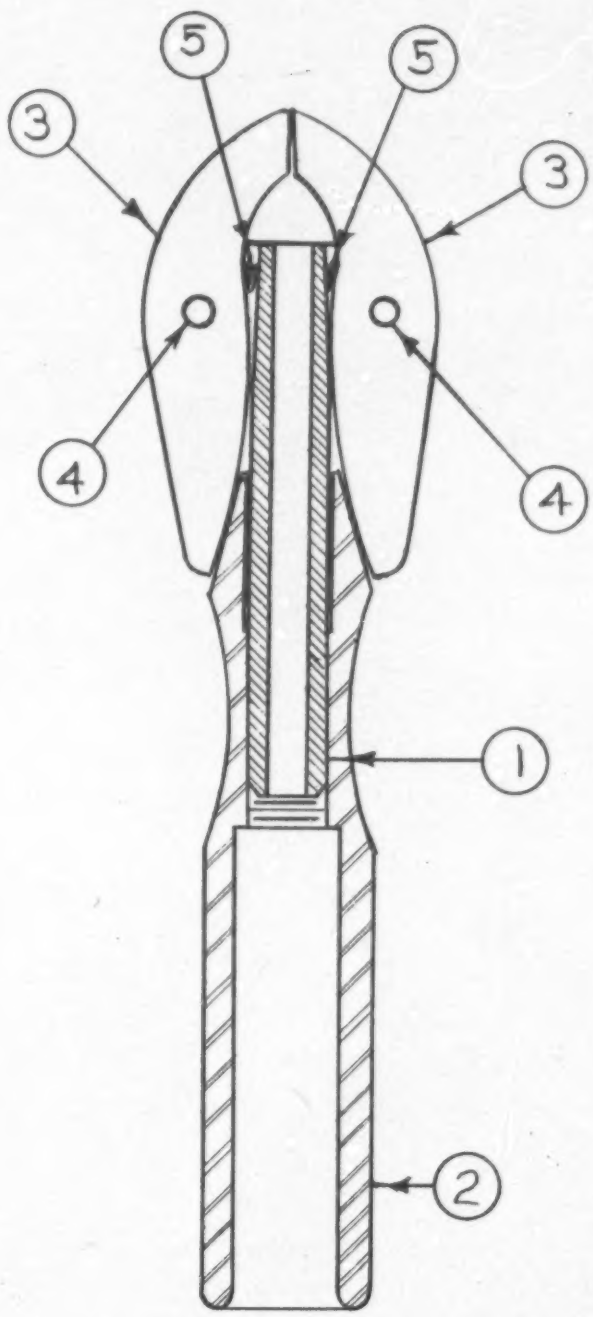

BILL OF MATERIAL			
NO.	NAME	REQ	REMARKS
1	CLAMP SCREW	1	
2	HANDLE	1	
3	JAWS	2	
4	PIN	2	5/32 x 3/4
5	SPRING	2	5/32 x 3/8

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8901

HAND VISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-15-66
DRAWN BY T.S.S.	CHECKED BY WCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

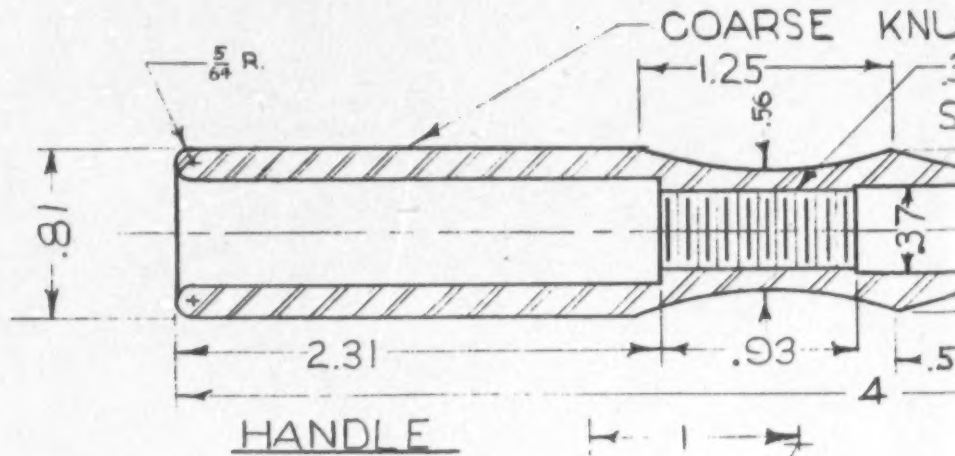

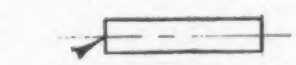

.15 x .75 DRILL ROD

PIN - 2 REQ

8902

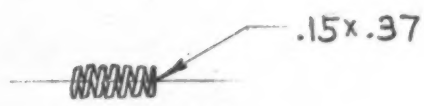

SPRING - 2 REQ

8903

M-215A

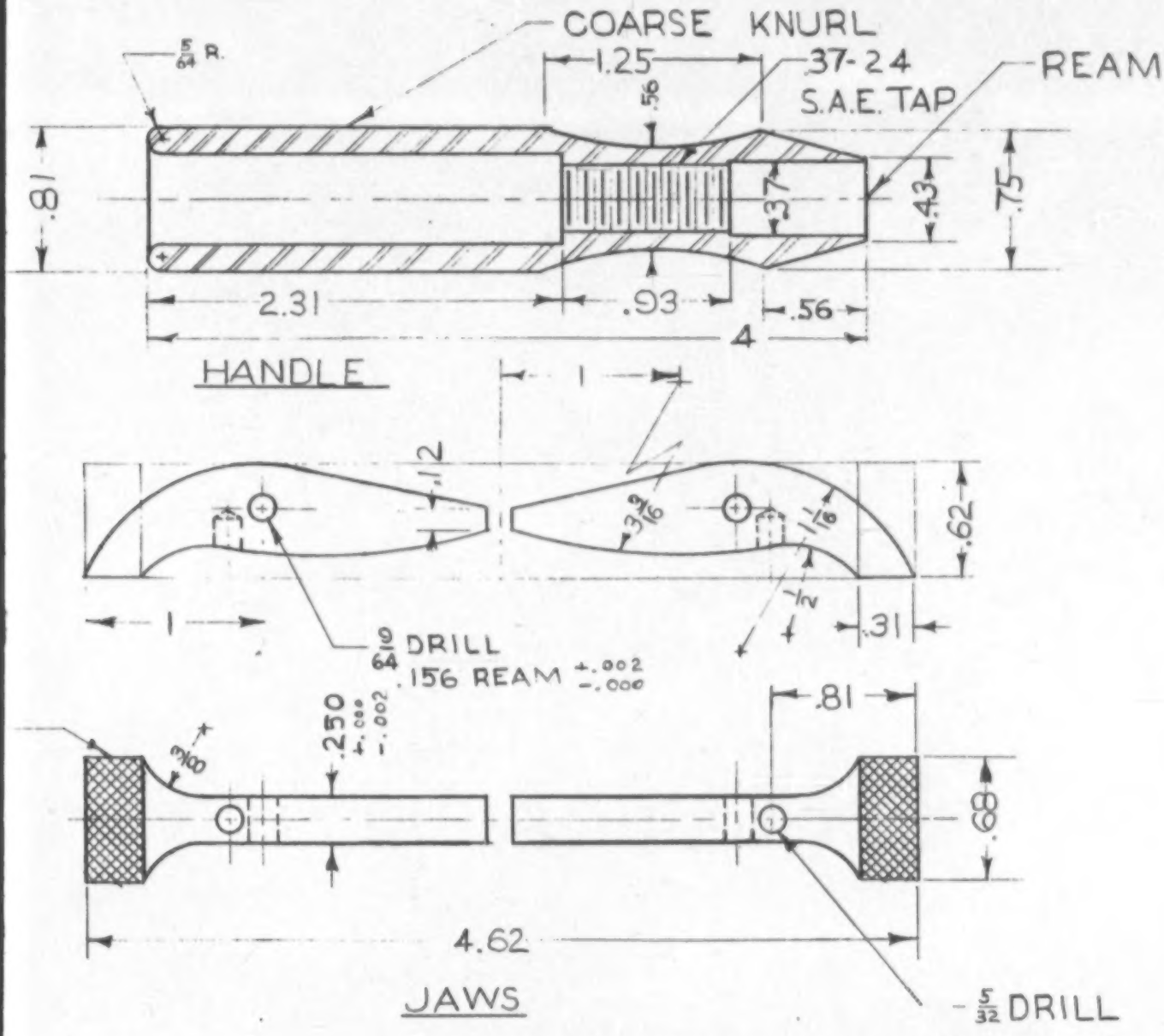

SPRING - 2 REQ.

ROD

8902

8903

HAND VISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-13-66
DRAWN BY T.S.S	CHECKED BY HOC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

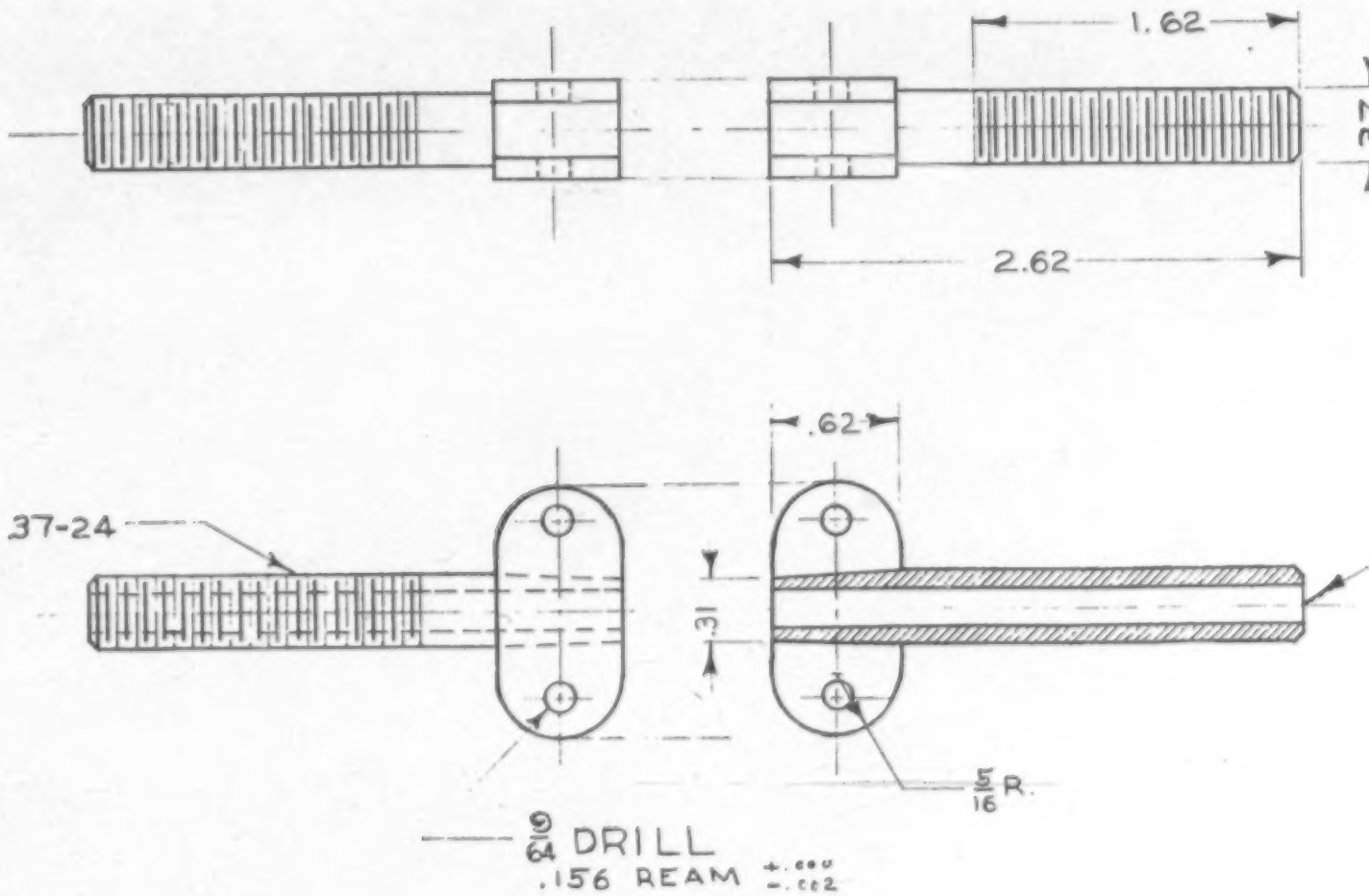

CLAMP SCREW

8905

8904

M-215B

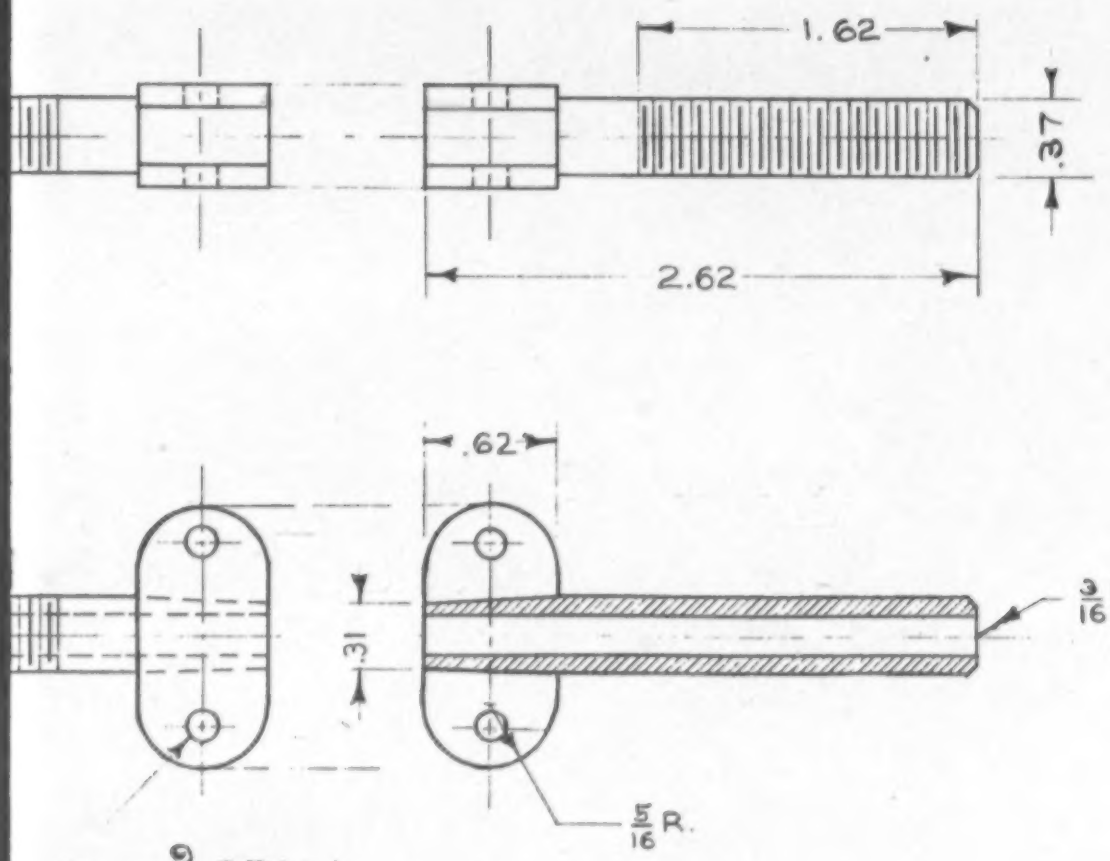

CLAMP SCREW

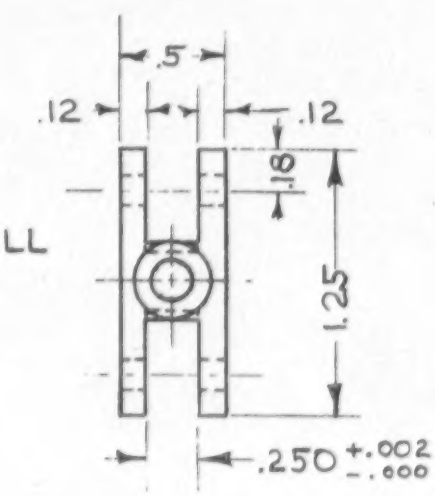

HAND VISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-13-66
DRAWN BY T.S.S	CHECKED BY MC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8905

129 OF 327

ED

056 238

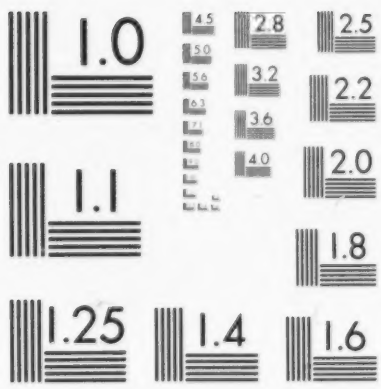

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

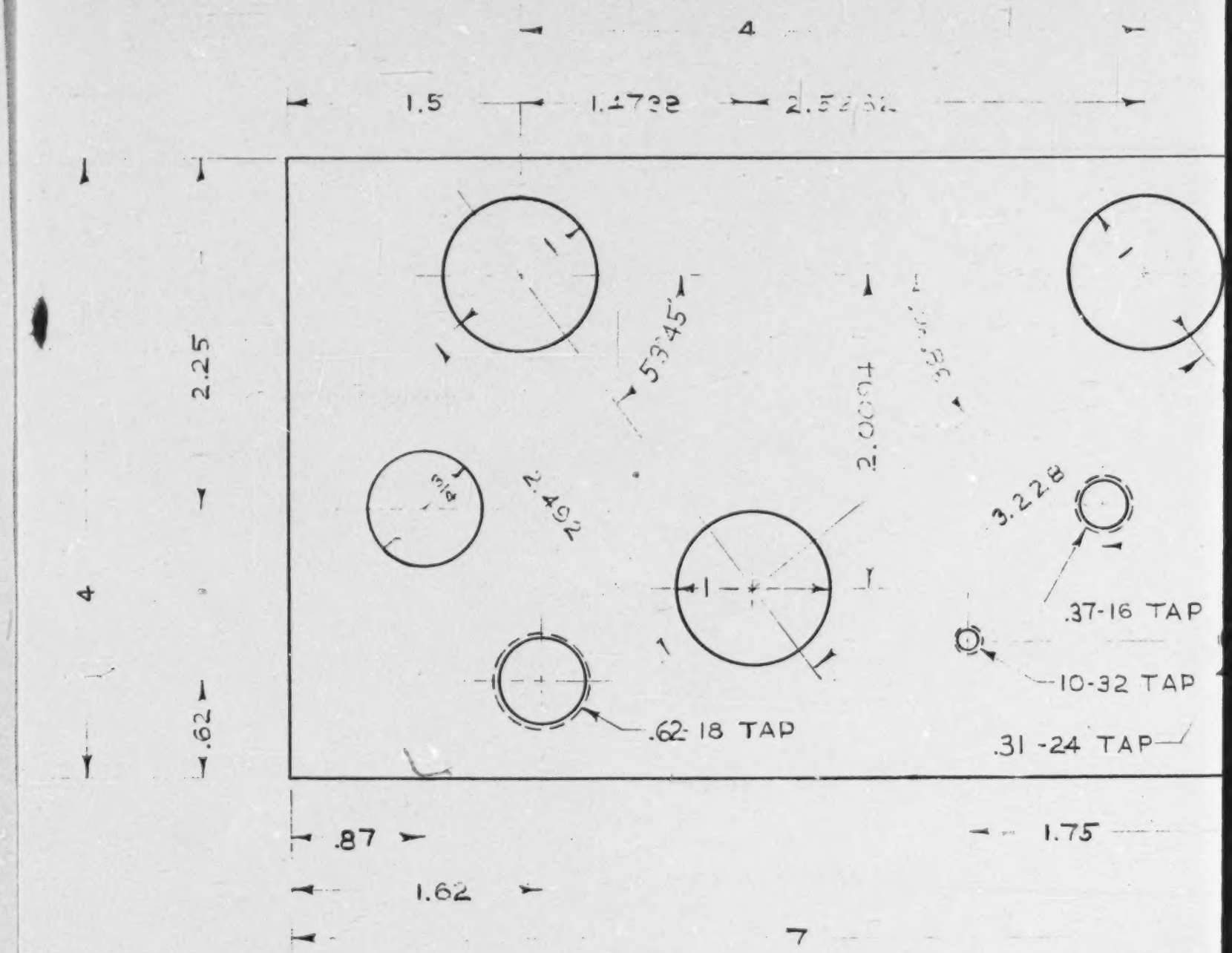

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

JIG	
SUGG	
SCALE	
DRAW	
MIL	

8906

8907

229

M-216

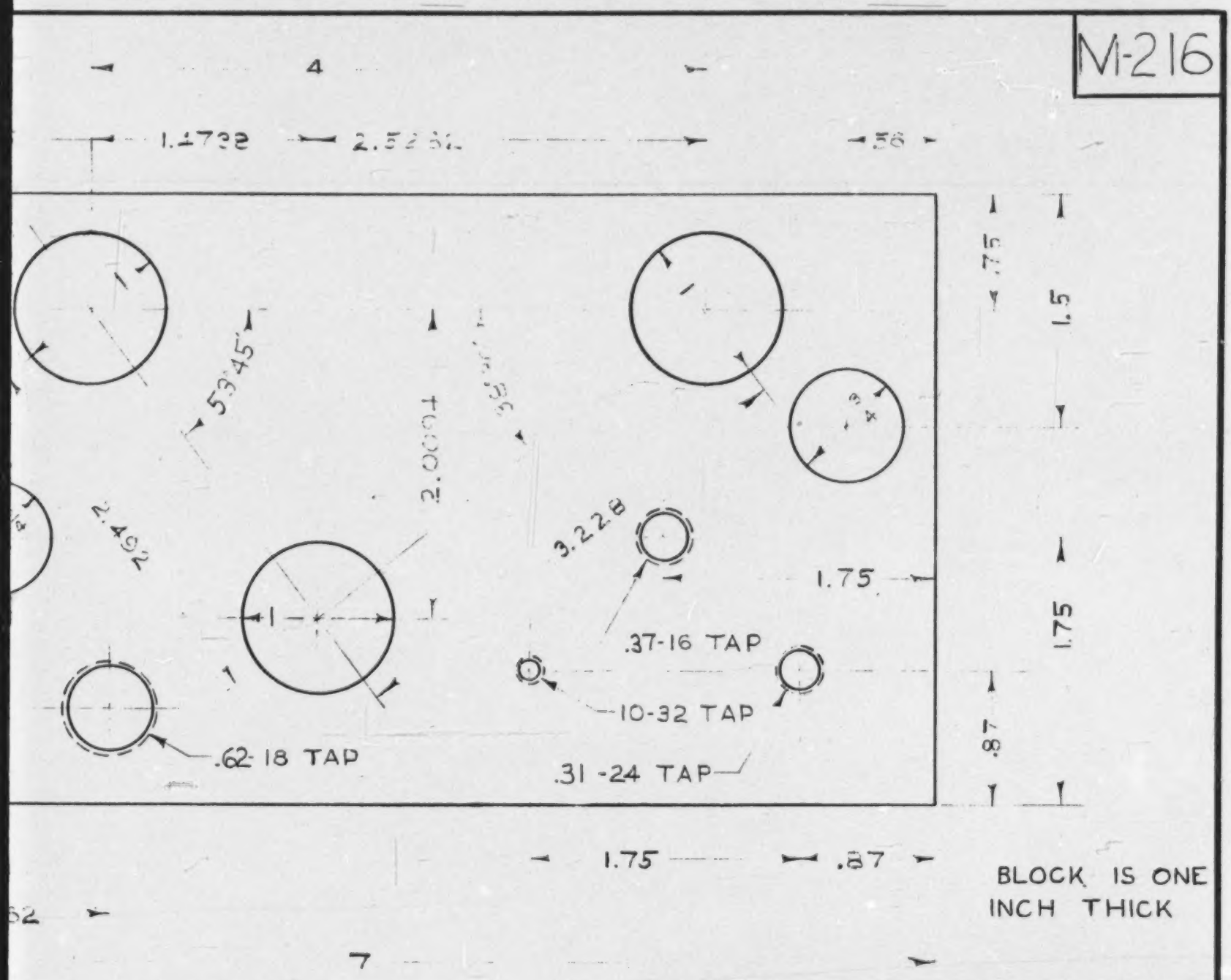

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8907

JIG BORER EXERCISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-8-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

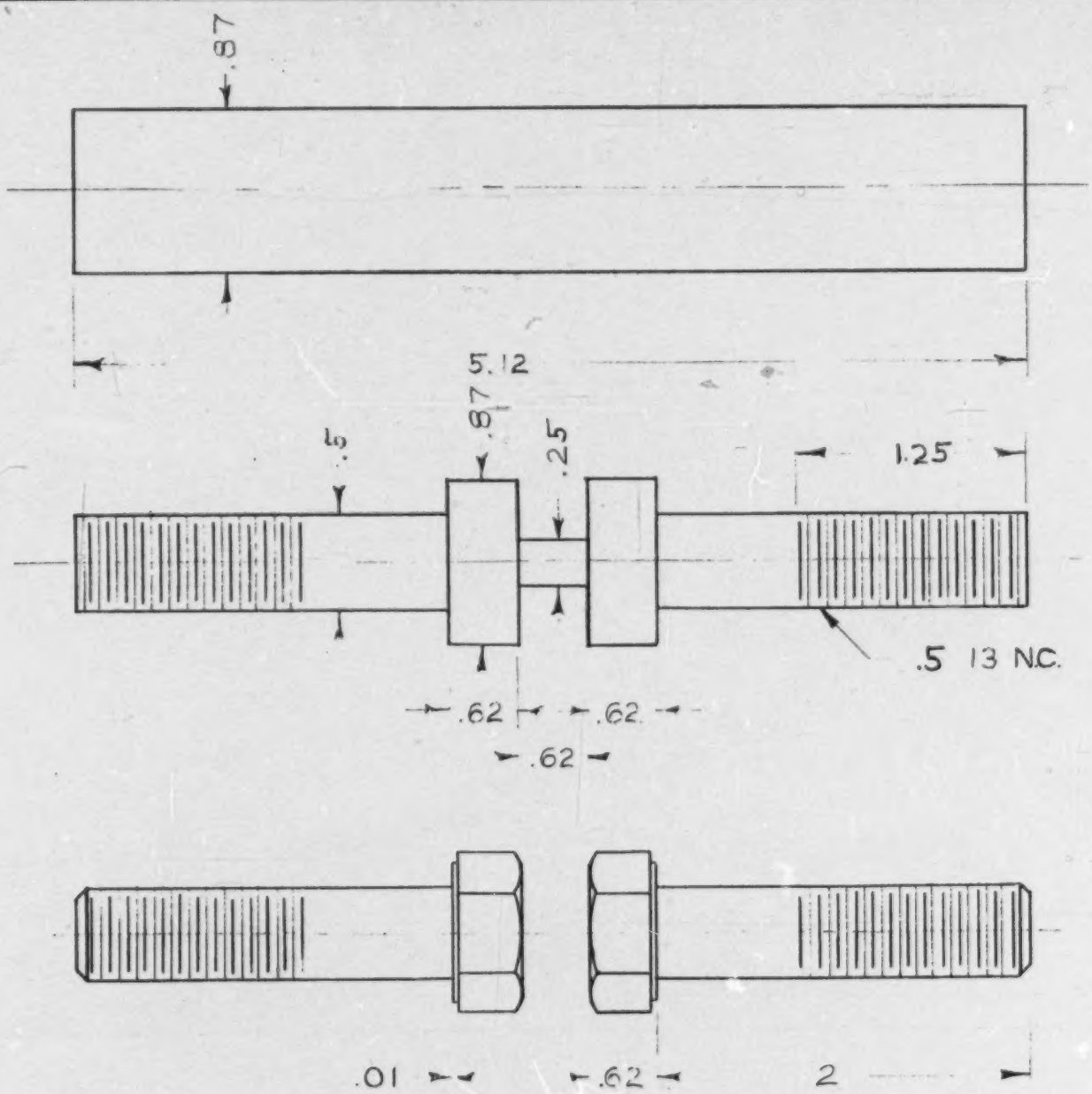

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8908

8909

$\frac{1}{2} \times 2$
SUGGES
SCALE:
DRAWN
MILW

M-217

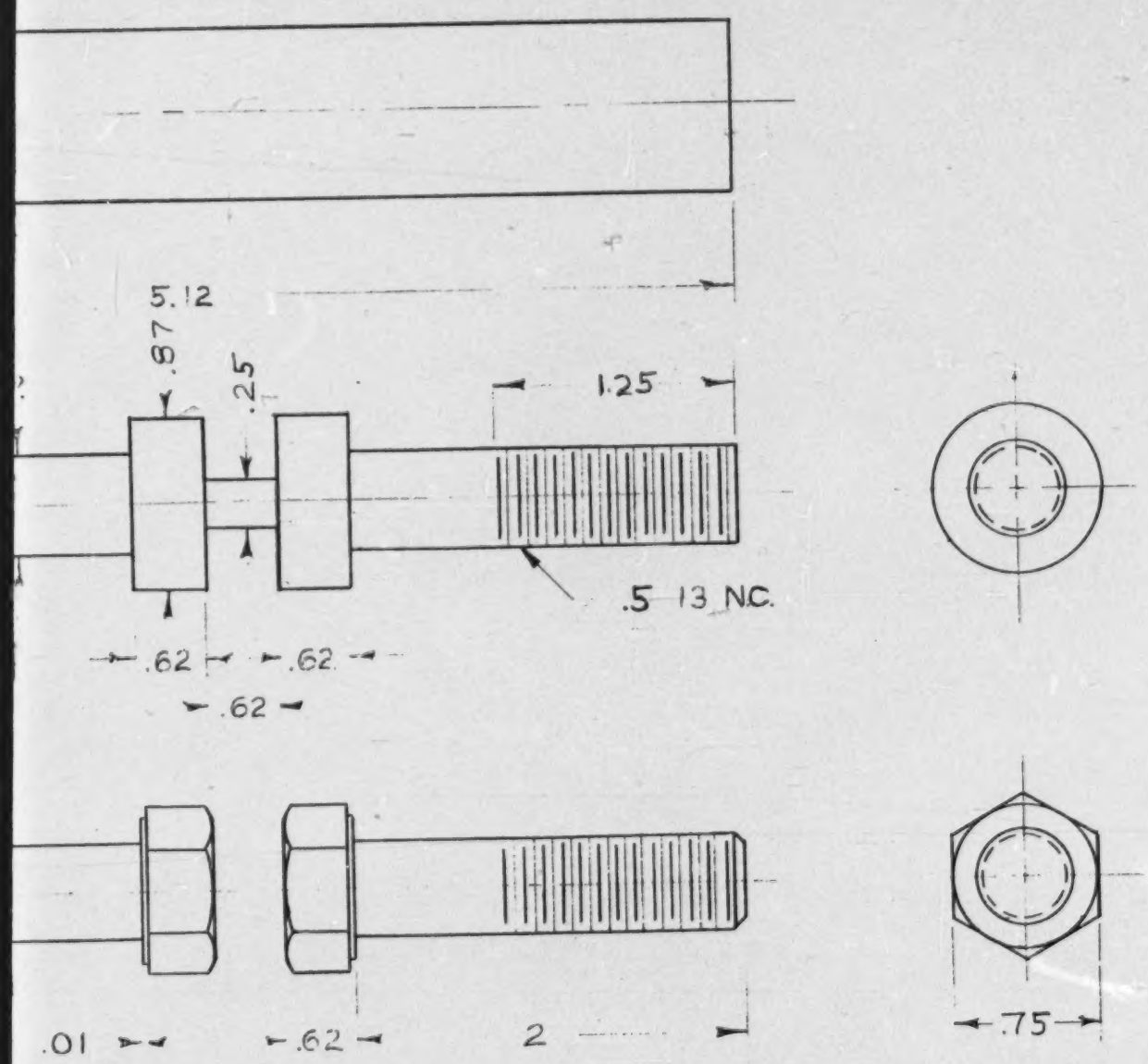

$\frac{1}{2}$ × 2 ST'D. CAP SCREW	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-8-66
DRAWN BY T.S.S.	CHECKED BY MC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8909

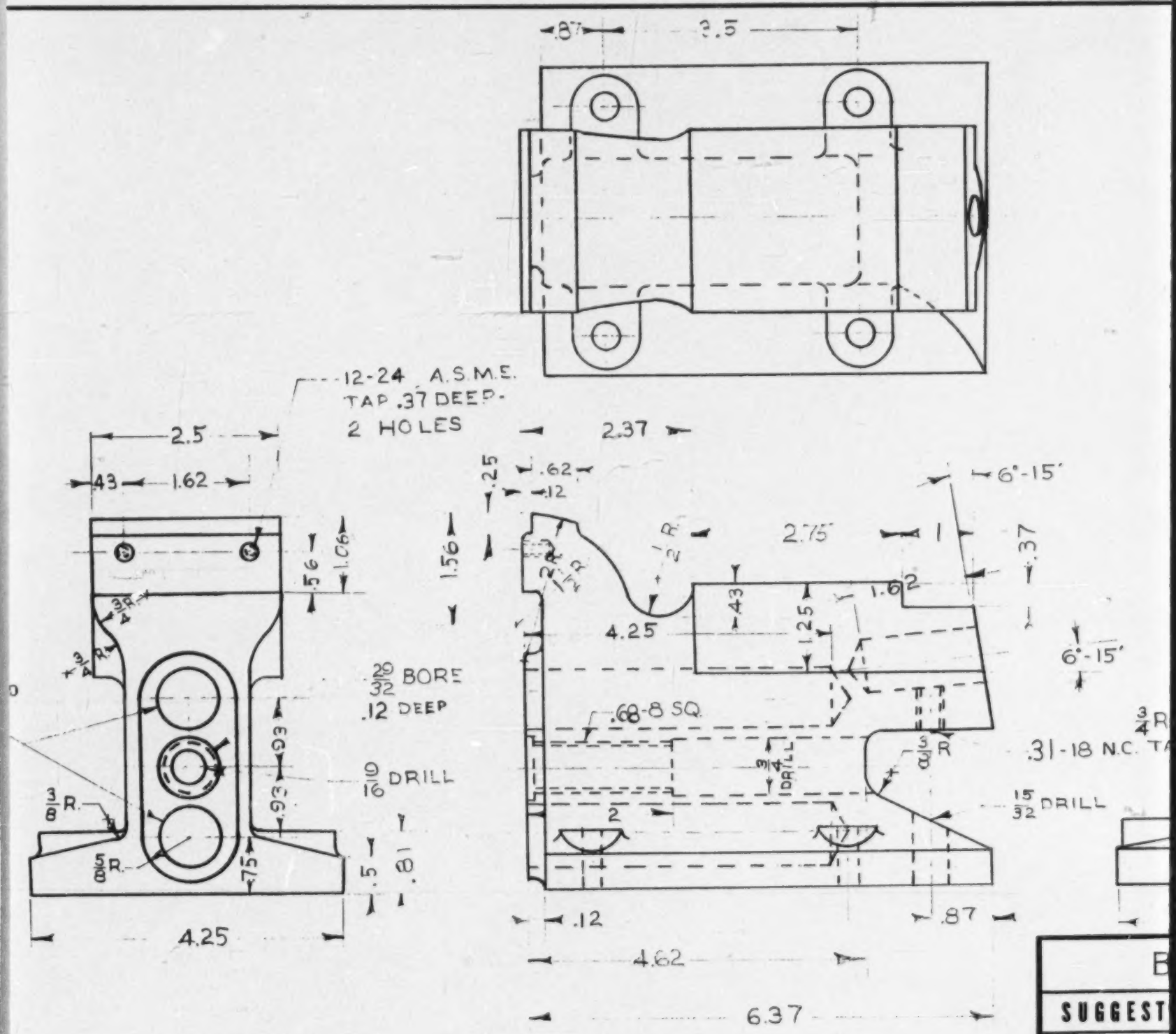
.87
2.5
12-24 A.S.M.E.
TAP .37 DEEP-
2 HOLES
2.37
2.5
.43
1.62
.25
.62
.12
6°-15'
1.56
1.06
.56
2.75
1
.37
1.62
.43
4.25
1.25
6°-15'
29/32 BORE
.12 DEEP
.68-8 SQ.
.93
.93
3/4 DRILL
5/8 R
.31-18 N.C. TA
15/32 DRILL
3/8 R.
5/8 R.
.75
.5
.81
4.25
.12
.87
4.62
6.37
TOLERANCE: ±.005 UNLESS
OTHERWISE STATED
B
SUGGEST
SCALE: 6
DRAWN
MILWA
IN

8910

8911

M-218

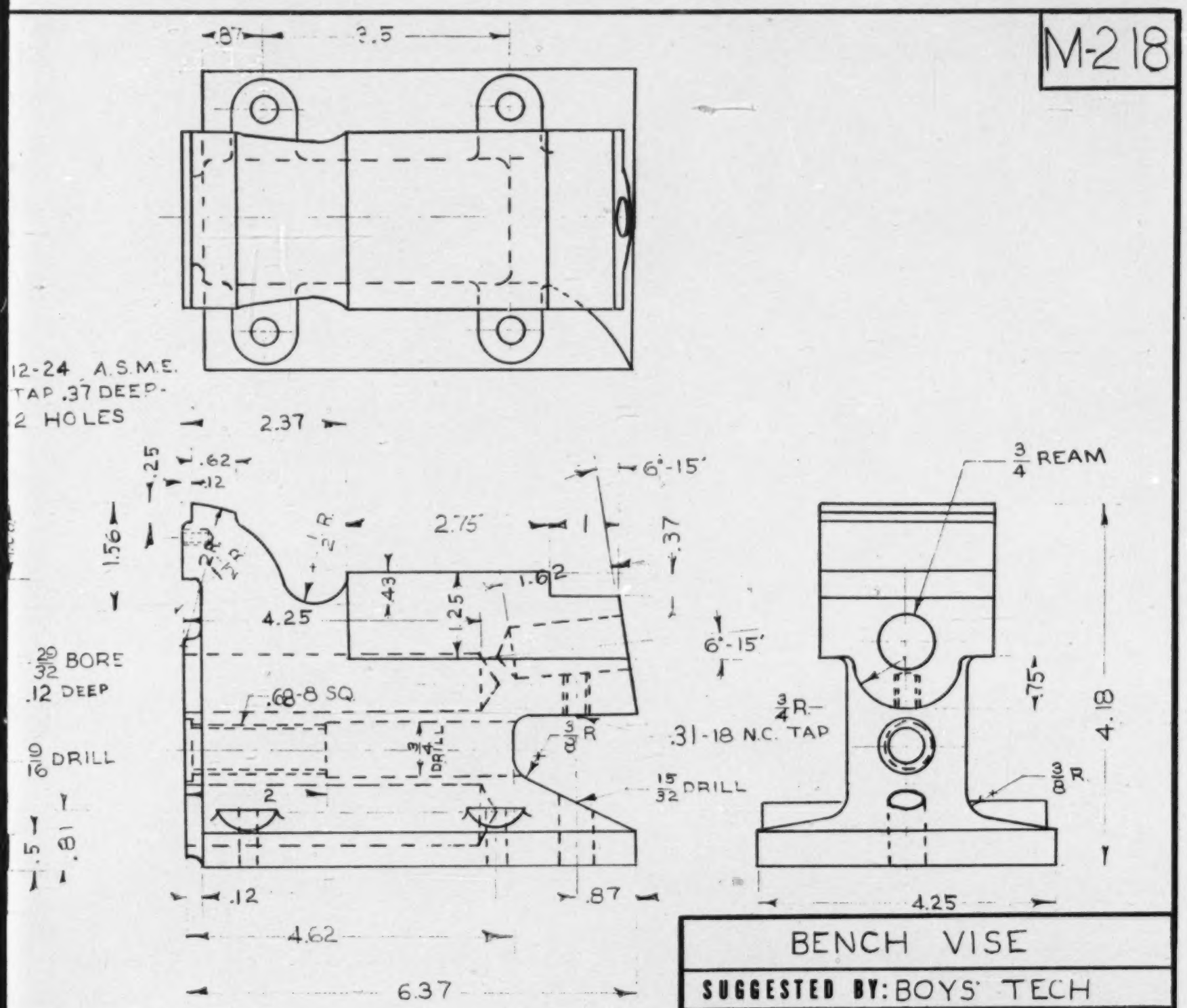

TOLERANCE: ±.005 UNLESS OTHERWISE STATED

BENCH VISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 6" = 1'-0"	DATE: 7-18-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8911

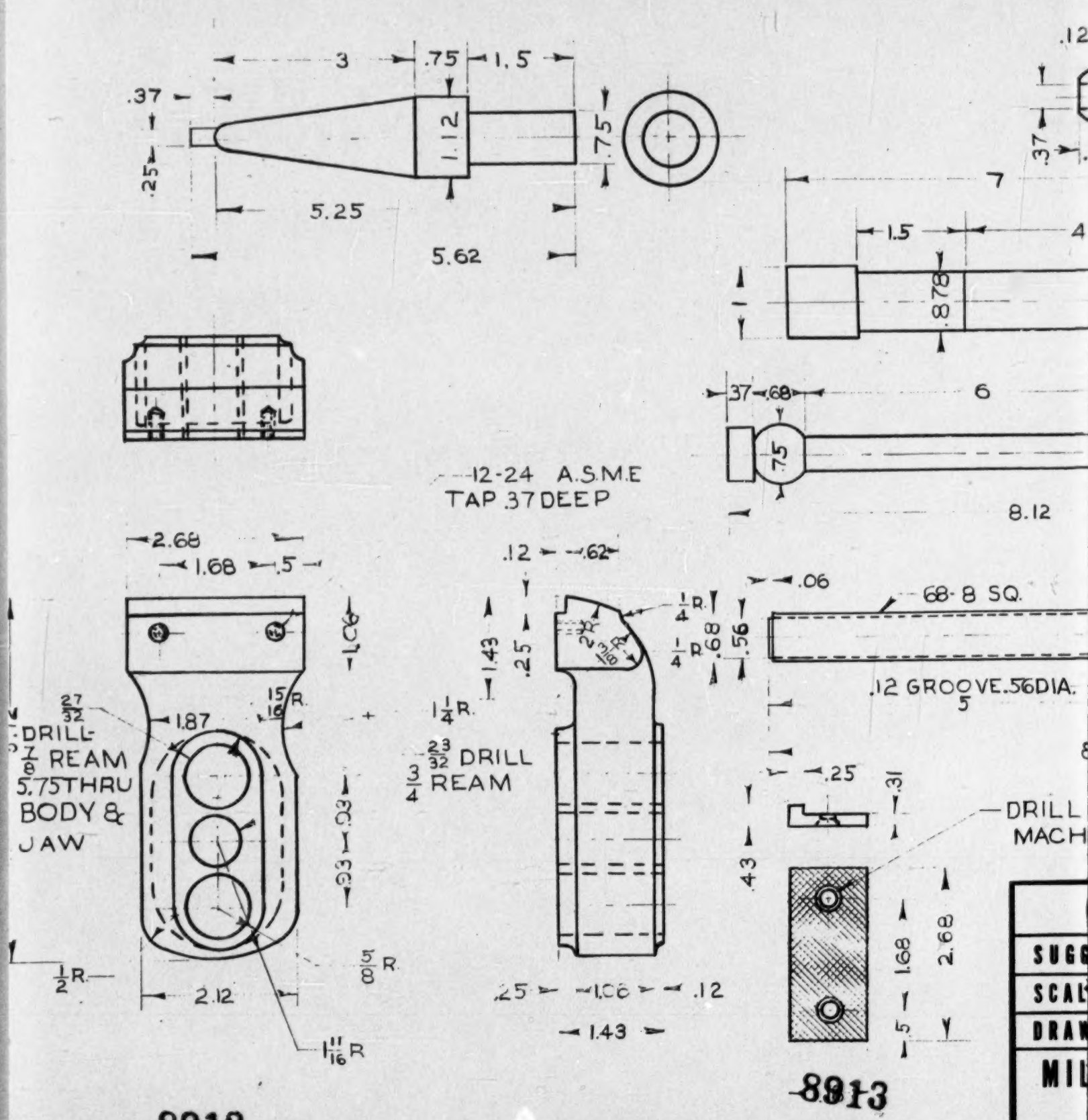
3
.75
1.5
.37
.25
1.12
.75
5.25
5.62
.12
.37
7
1.5
4
.878
.37
.68
6
.75
12-24 A.S.M.E
TAP .37 DEEP
8.12
2.68
1.68
.5
.12
.62
.06
68-8 SQ.
1.06
1.43
.25
1/4 R.
.68
.56
.12 GROOVE .56 DIA.
5
27/32
1.87
15/16 R.
DRILL
7/8 REAM
5.75 THRU
BODY &
JAW
1 1/4 R.
23/32 DRILL
3/4 REAM
.25
.31
DRILL
MACH
.43
.93
.93
1/2 R.
2.12
5/8 R.
.25
1.06
.12
1.43
1.68
2.68
.5
1 11/16 R
SUGG
SCAL
DRAW
MIL
8912
8913

M-218A

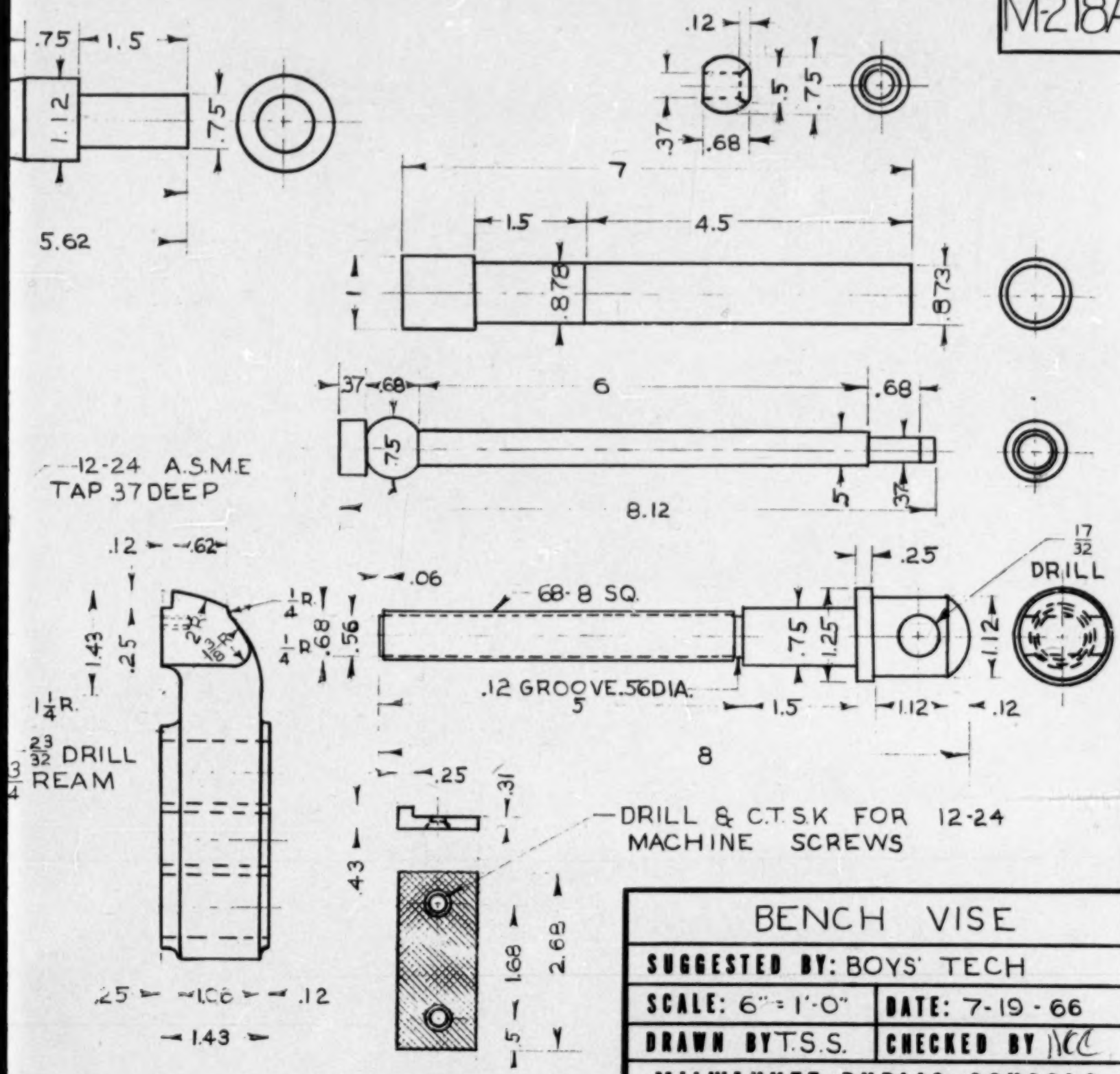

BENCH VISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 6" = 1'-0"	DATE: 7-19-66
DRAWN BY T.S.S.	CHECKED BY MCC
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8913

SMALL			MEDIUM			LARGE		
A	B	C	A	B	C	A	B	C
.25	.50	6	.50	.875	6	1	1.75	8
.25	.375	6	.50	1	6	1	1.875	8
.25	.50	6	.625	.625	6	1	2	8
.25	.625	6	.625	.75	6	1.25	1.25	12
.25	.75	6	.625	.875	6	1.25	1.50	12
.25	.875	6	.625	1	6	1.25	1.625	12
.25	1	6	.75	.562	6	1.25	1.75	12
.375	.375	6	.75	.75	6	1.25	1.875	12
.375	.50	6	.75	.875	6	1.25	2	12
.375	.625	6	.75	1	6	1.50	1.50	12
.375	.75	6	.875	.875	6	1.50	1.625	12
.375	.875	6	.875	1	6	1.50	1.75	12
.375	1	6	1	1	8	1.50	1.875	12
.50	.50	6	1	1.25	8	1.50	2	12
.50	.625	6	1	1.375	8	1.50	2.50	12
.50	.75	6	1	1.50	8	1.50	3	12

8914

STA
SUG
SCA
DRA
MI
8915

.25	1	6	.75	.562	6	1.25	1.75	12
.375	.375	6	.75	.75	6	1.25	1.875	12
.375	.50	6	.75	.875	6	1.25	2	12
.375	.625	6	.75	1	6	1.50	1.50	12
.375	.75	6	.875	.875	6	1.50	1.625	12
.375	.875	6	.875	1	6	1.50	1.75	12
.375	1	6	1	1	8	1.50	1.875	12
.50	.50	6	1	1.25	8	1.50	2	12
.50	.625	6	1	1.375	8	1.50	2.50	12
.50	.75	6	1	1.50	8	1.50	3	12

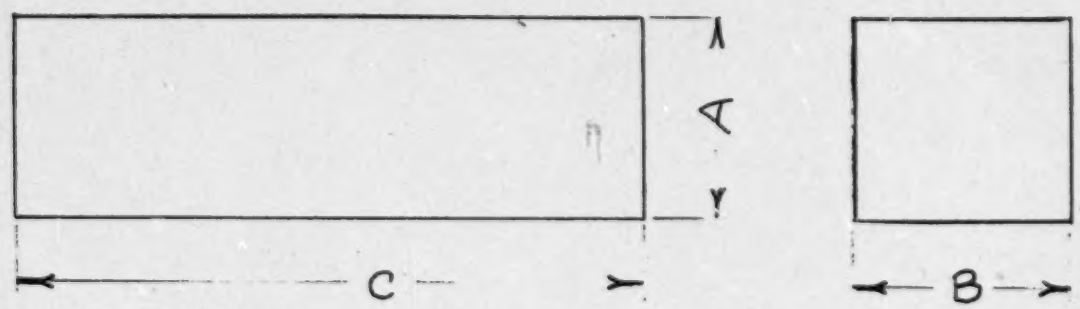

M-219

STANDARD PARALLELS

SUGGESTED BY: BOYS' TECH

SCALE: NONE | DATE: 7-8-66

DRAWN BY RCT. | CHECKED BY WCC

MILWAUKEE PUBLIC SCHOOLS

8915 INDUSTRIAL EDUCATION

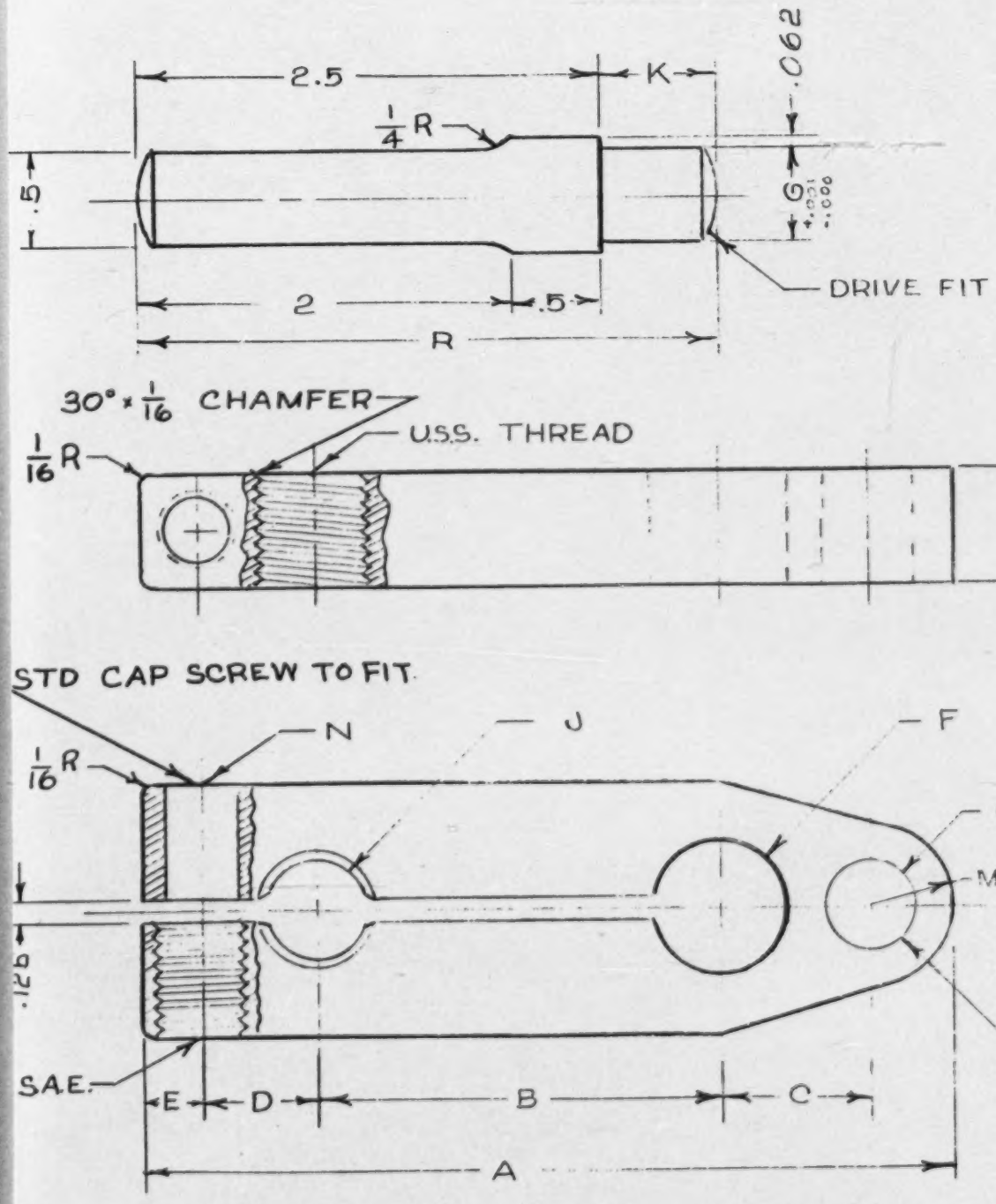

A	4.375	4.375	4.375
B	2.187	2.187	2.187
C	.812	.812	.812
D	.625	.625	.625
E	.312	.312	.312
F	.75	.75	.687
G	.500	.500	.437
H	1.375	1.312	1.25
J	.562	.50	.437
K	.625	.562	.50
L	.375	.375	.312
M	.437	.437	.437
N	.39	.39	.328
R	3.125	3.062	3.

T
SUGG
SCALE
DRAW
MIL

8916

TOLERANCE ± .005
UNLESS OTHERWISE STATED

8917

M-220

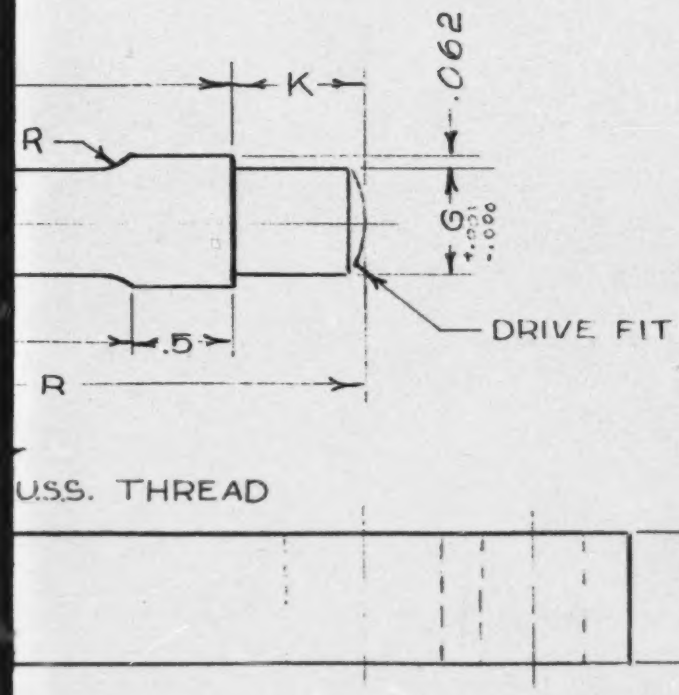

A	4.375	4.375	4.375	4.375	4.375	4.375
B	2.187	2.187	2.187	2.187	2.187	2.187
C	.812	.812	.812	.812	.812	.812
D	.625	.625	.625	.625	.625	.625
E	.312	.312	.312	.312	.312	.312
F	.75	.75	.687	.625	.625	.812
G	.500	.500	.437	.375	.375	.562
H	1.375	1.312	1.25	1.125	1.125	1.50
J	.562	.50	.437	.375	.312	.75
K	.625	.562	.50	.50	.437	.75
L	.375	.375	.312	.312	.25	.437
M	.437	.437	.437	.437	.437	.437
N	.39	.39	.328	.328	.328	.468
R	3.125	3.062	3.	3.	2.937	3.25

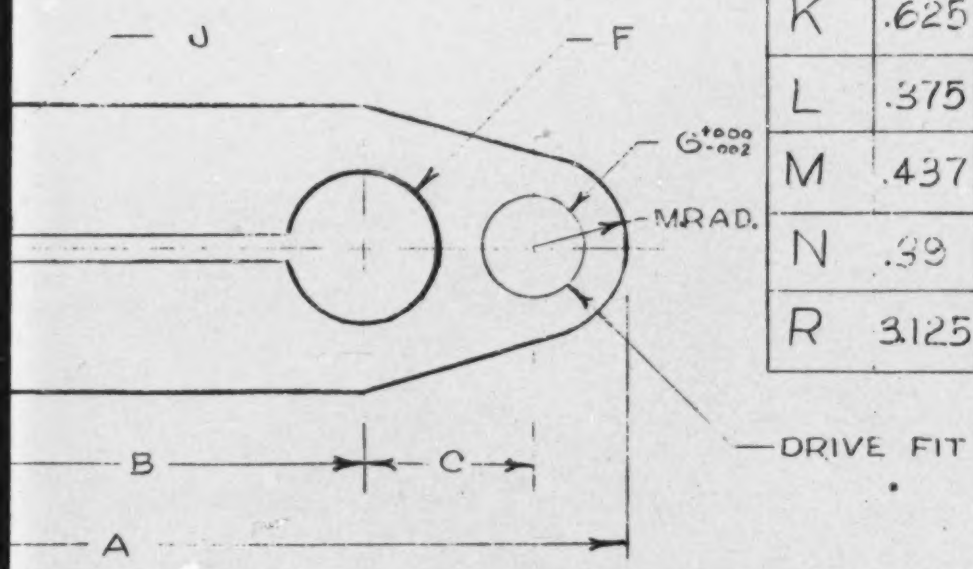

TOLERANCE ± .005
UNLESS OTHERWISE STATED

THREAD DOG	
SUGGESTED BY:	
SCALE: 12" = 1'-0"	DATE: 7-11-66
DRAWN BY R.T.	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8917

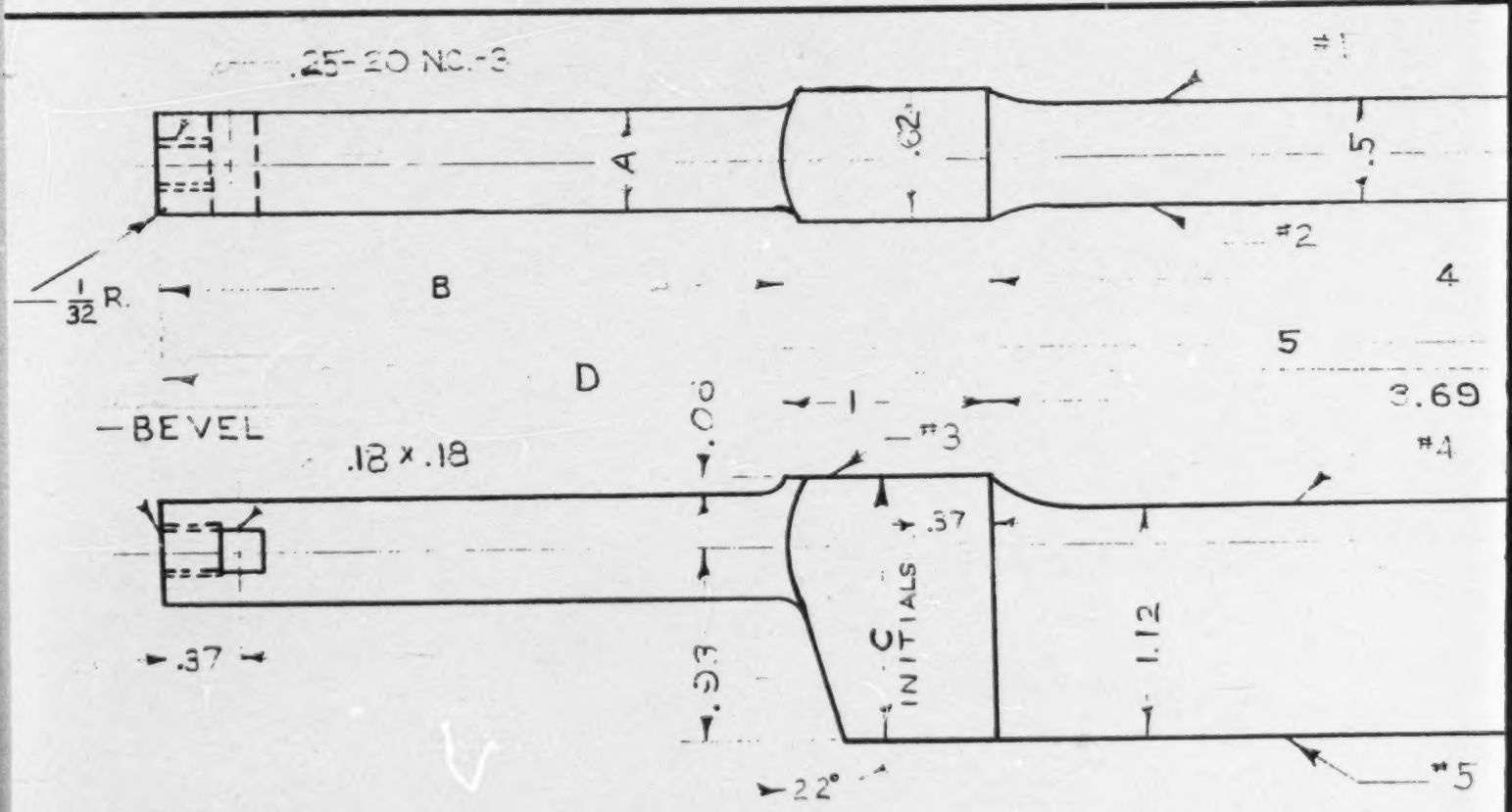

1. LOCATE CENTERS
   A. 31/32 FROM BASE
   B. CENTER DRILL
2. MILL SHANK (USE INDEX HEAD & FOOT STOCK)
   A. ROUGH #1 & 2 SIZE
   B. ROUGH #3 SIZE
   C. ROUGH #4 SIZE
   D. ROUGH #5 SIZE
3. MILL SHANK
   A. FINISH #1-2-3-4-5 TO SIZE
4. ROUGH TURN BAR END
5. FINISH TURN
6. LAYOUT, DRILL, & FILE SQUARE HOLE
7. DRILL & TAP FOR SET SCREW
8. MILL OR SHAPE SHANK END
9. BEVEL CORNERS ON SHANK
10. STAMP & CHECK

TOLERANCES: ±.005
UNLESS OTHERWISE
STATED

8918

8919

M-221

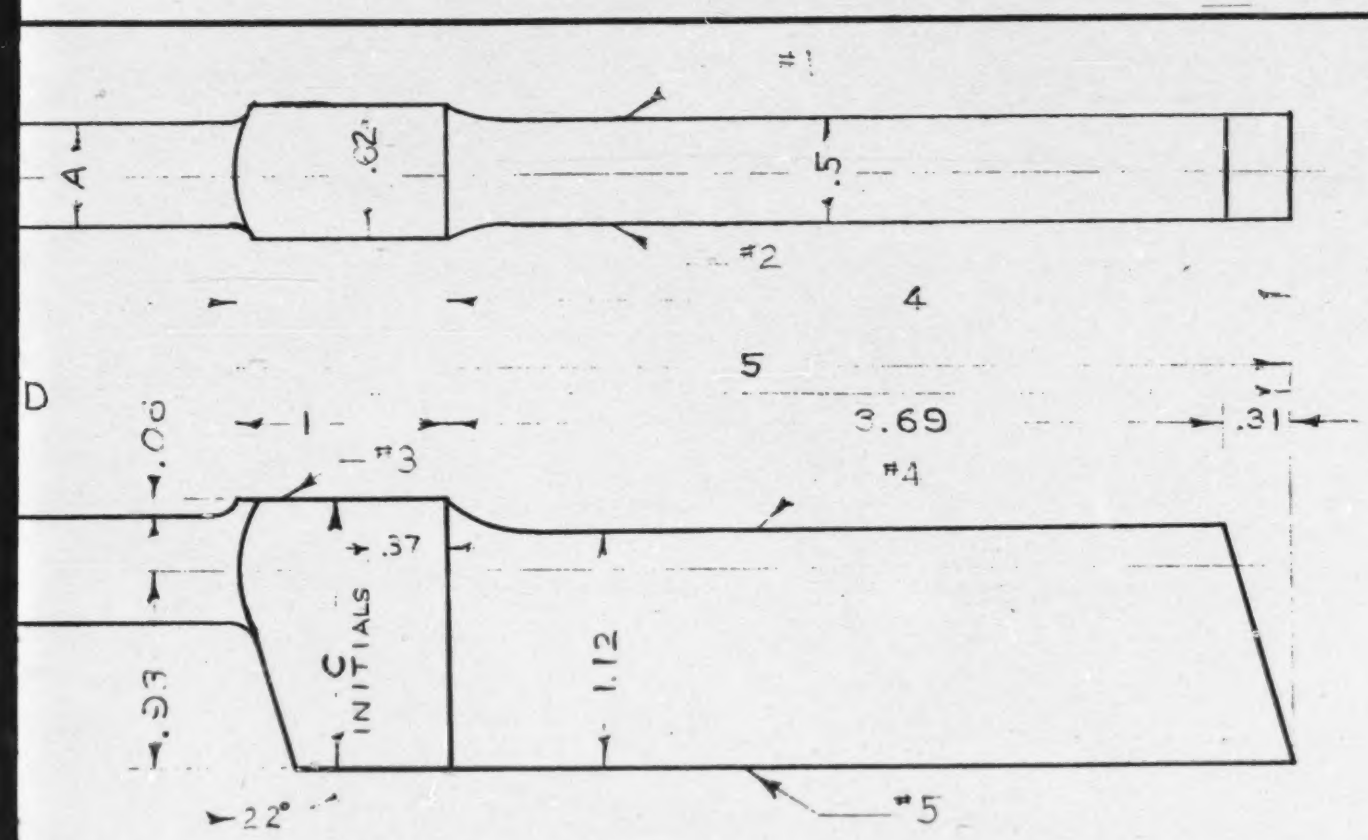

S

DEX HEAD & FOOT STOCK)
E

5 TO SIZE
R END

ILE SQUARE HOLE
T SCREW
ANK END
SHANK

A	B	C	D
$\frac{1}{2}$	2	1.25	7
$\frac{9}{16}$	3	1.28	8
$\frac{5}{8}$	4	1.31	9
$\frac{5}{8}$	5	1.31	10
$\frac{5}{8}$	6	1.31	11

TOLERANCES: ±.005
UNLESS OTHERWISE
STATED

8919

BORING BAR

SUGGESTED BY: BOYS' TECH

SCALE: 12" = 1'-0" | DATE: 7-12-66

DRAWN BY T.S.S. | CHECKED BY

MILWAUKEE PUBLIC SCHOOLS
INDUSTRIAL EDUCATION

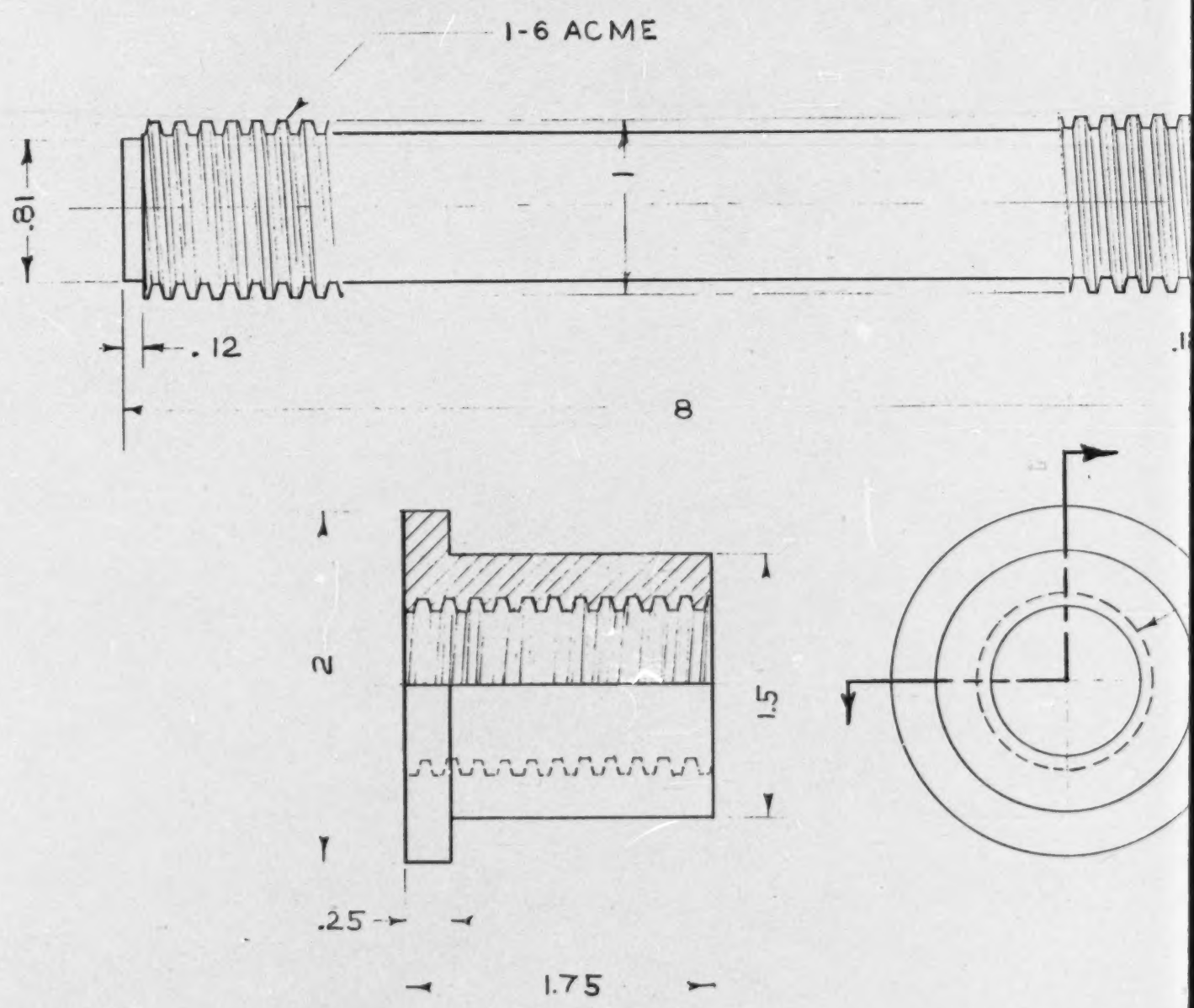

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8920

8921

M-222

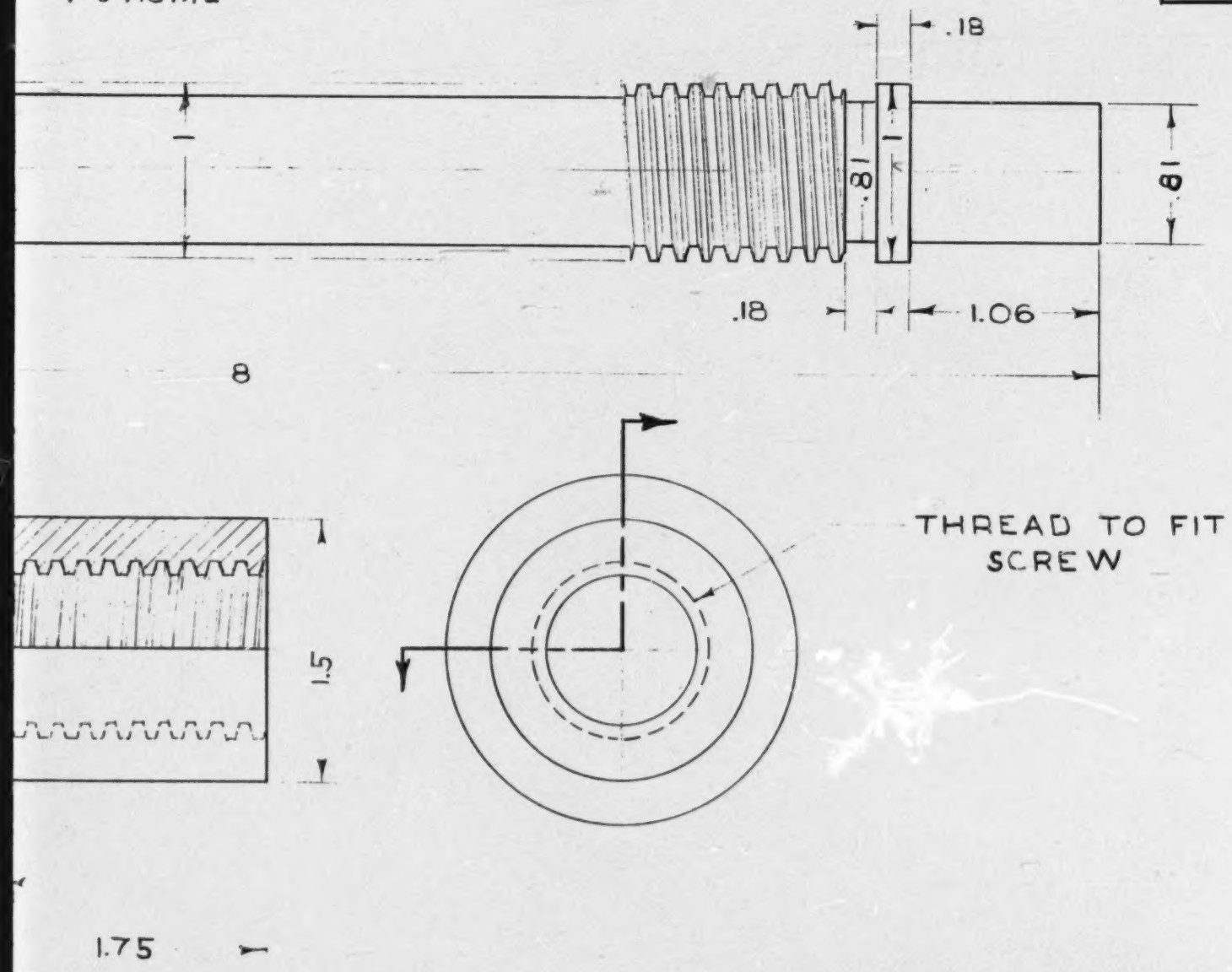

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

NUT AND SCREW FOR REVOLVING STOOL	
SUGGESTED BY:	
SCALE: 12" = 1'-0"	DATE: 7-11-66
DRAWN BY T.S.S	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8921

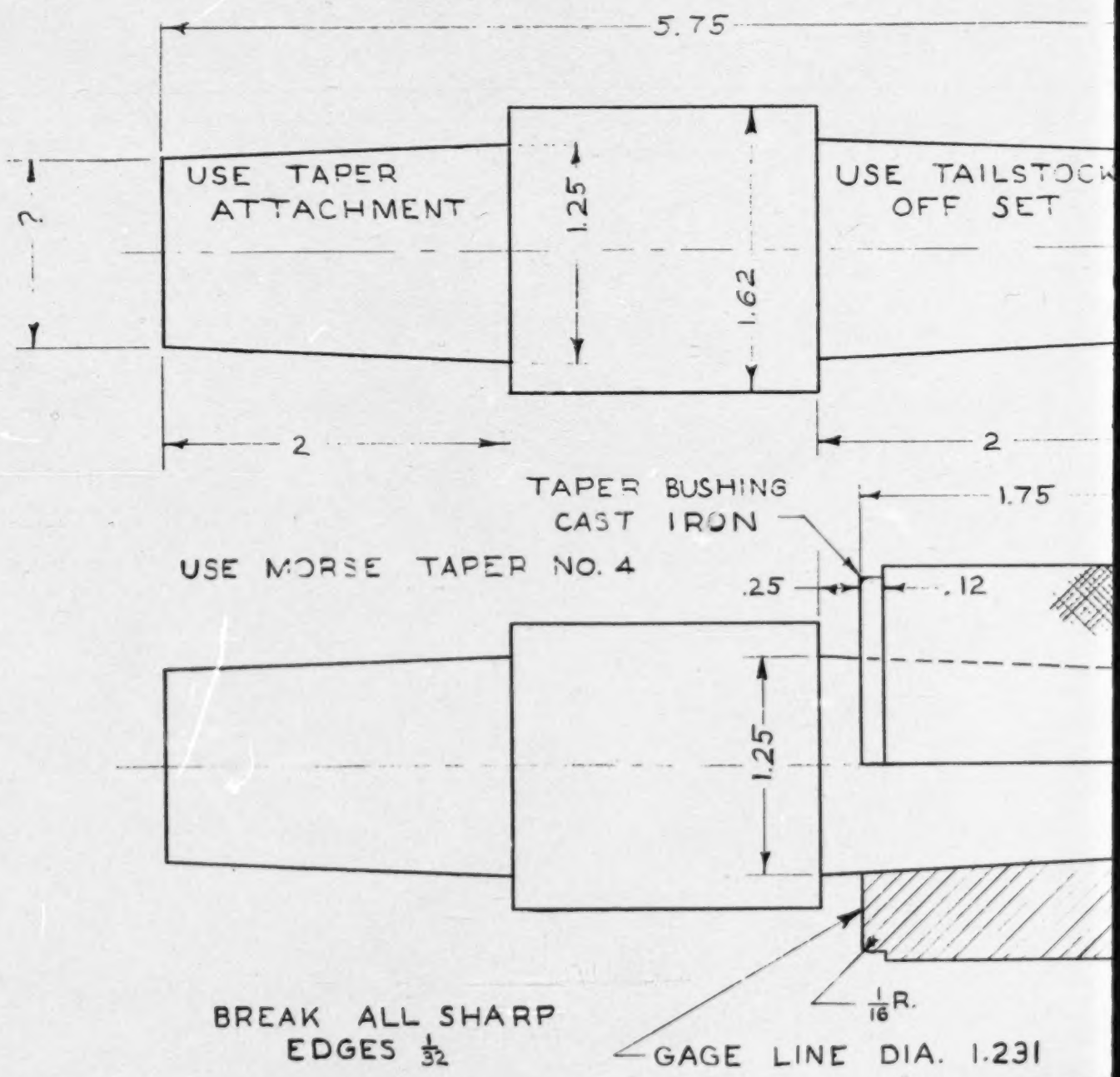

MATERIAL: C.R.S.

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8922

8923

MO
SUGG
SCAL
DRAW
MIL

M-223

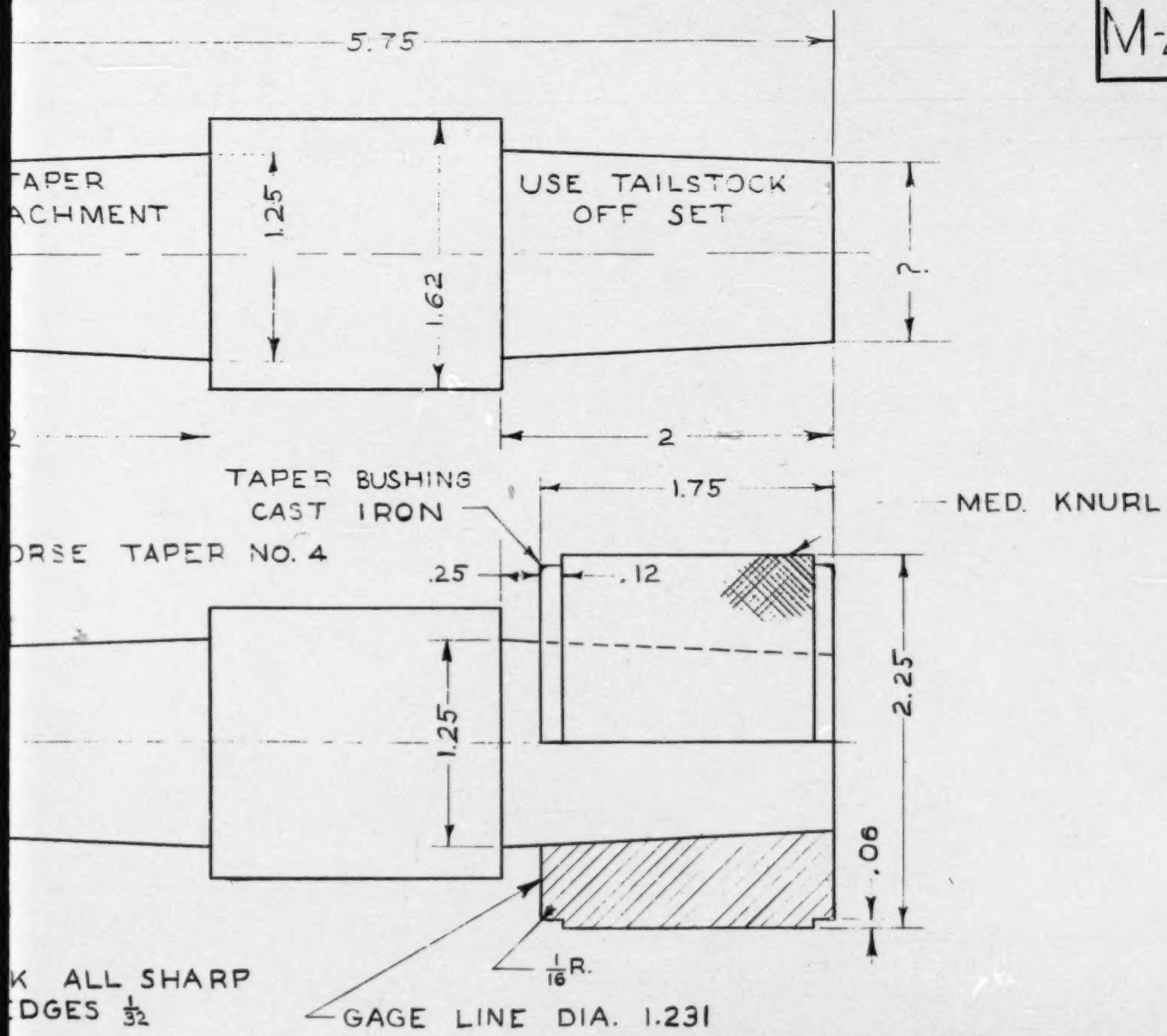

ERIAL: C.R.S.

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

8923

MORSE TAPER EXERCISE	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-11-66
DRAWN BY T.S.S.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

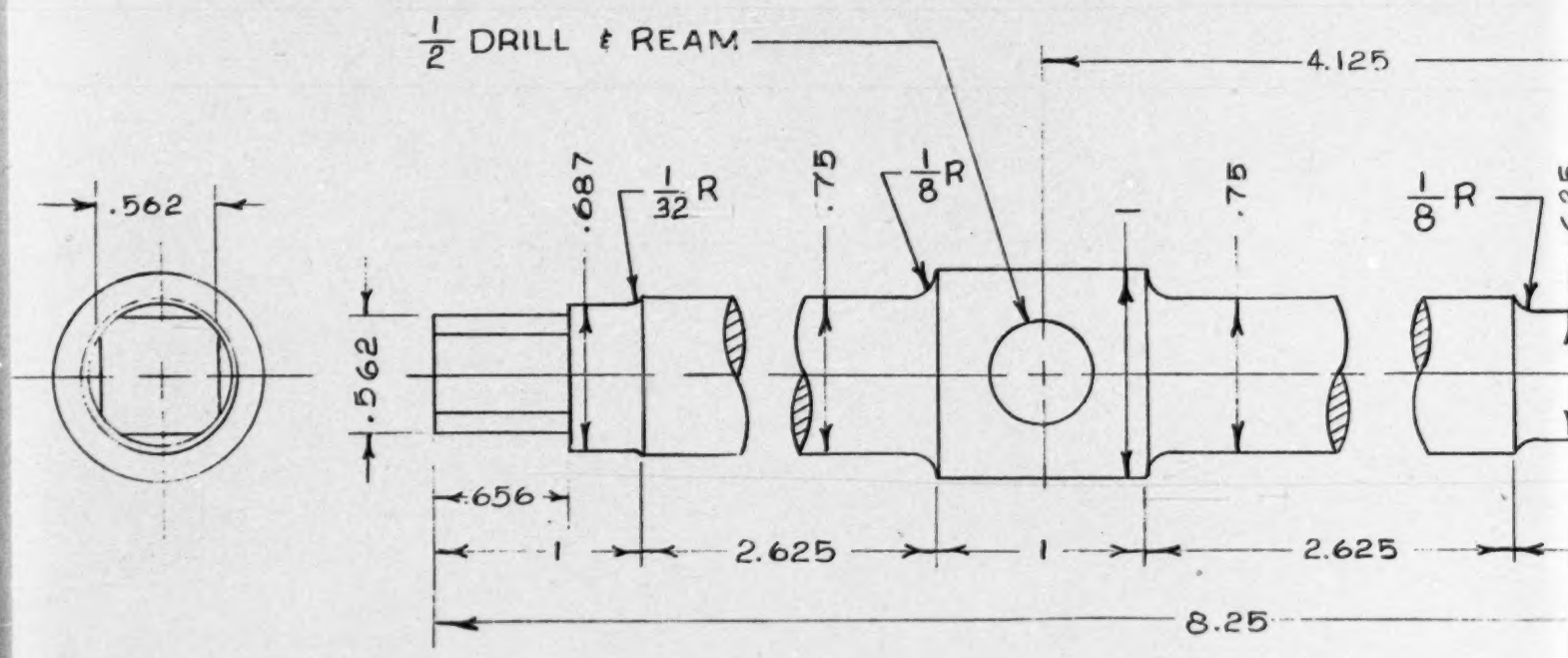

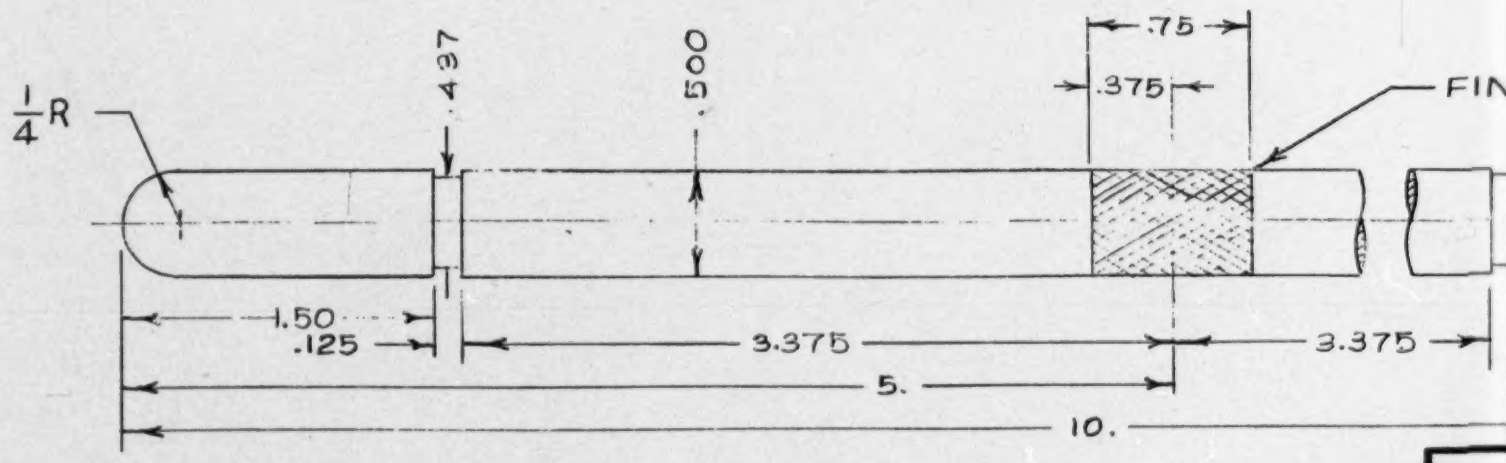

8924

8925

TOLERANCE ±.005
UNLESS OTHERWISE STATED

SU
SC
DR
M

M-224

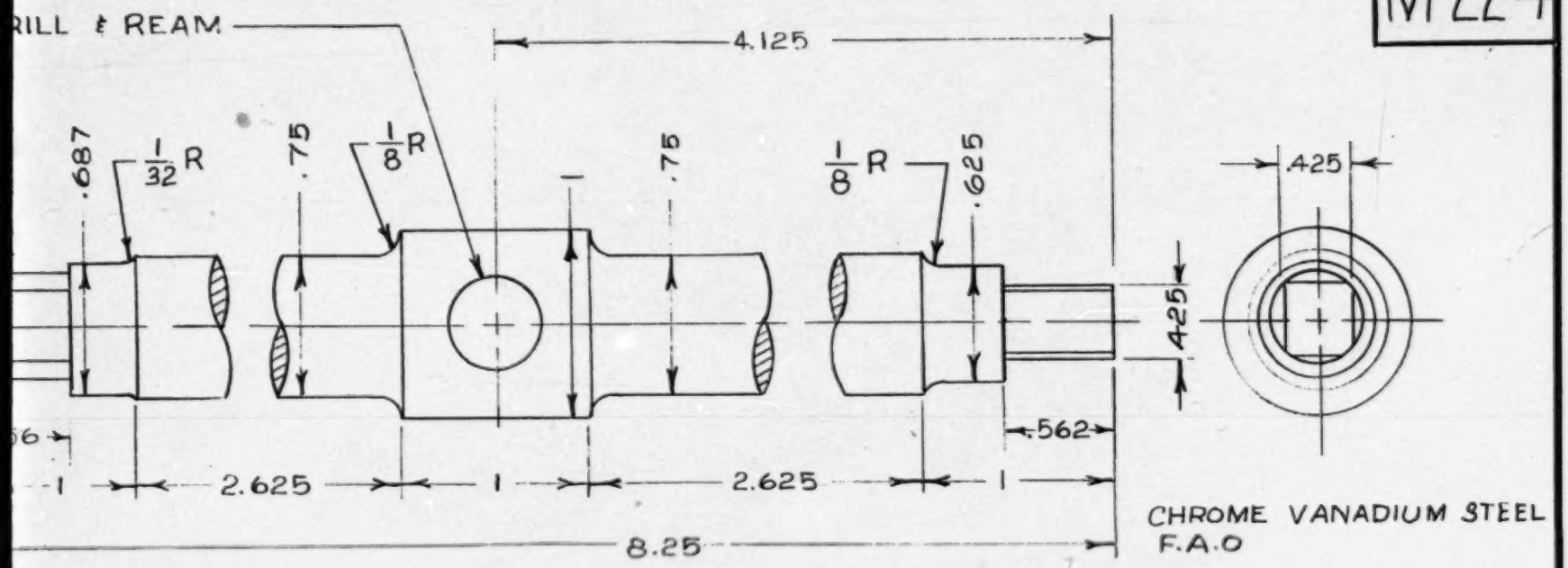

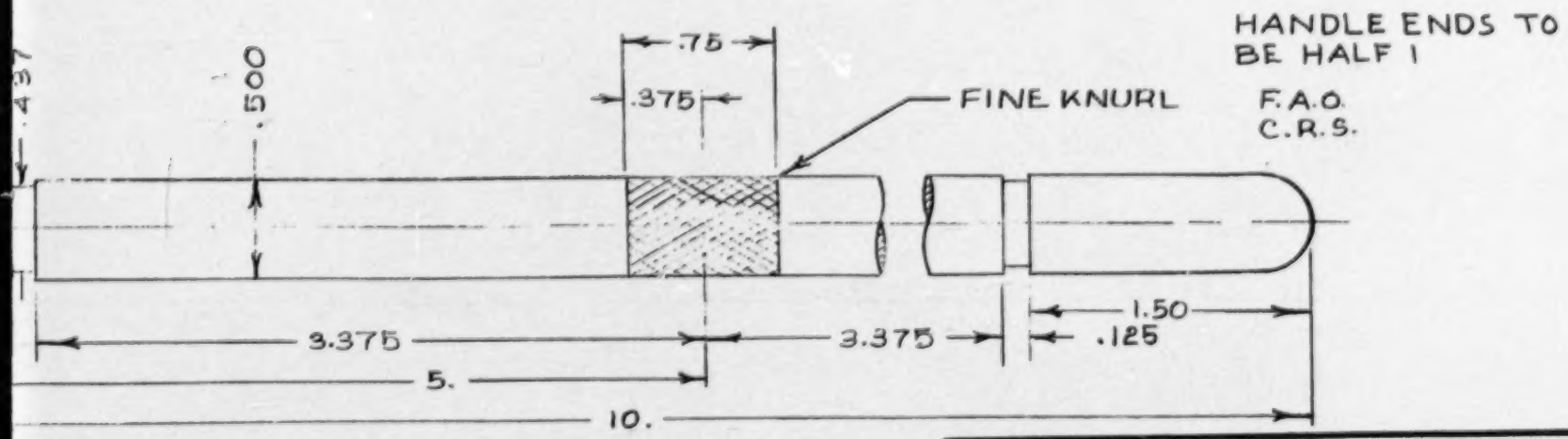

CHUCK KEY	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-12-66
DRAWN BY KRT.	CHECKED BY ICL
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

TOLERANCE ±.0625
UNLESS OTHERWISE STATED

8925

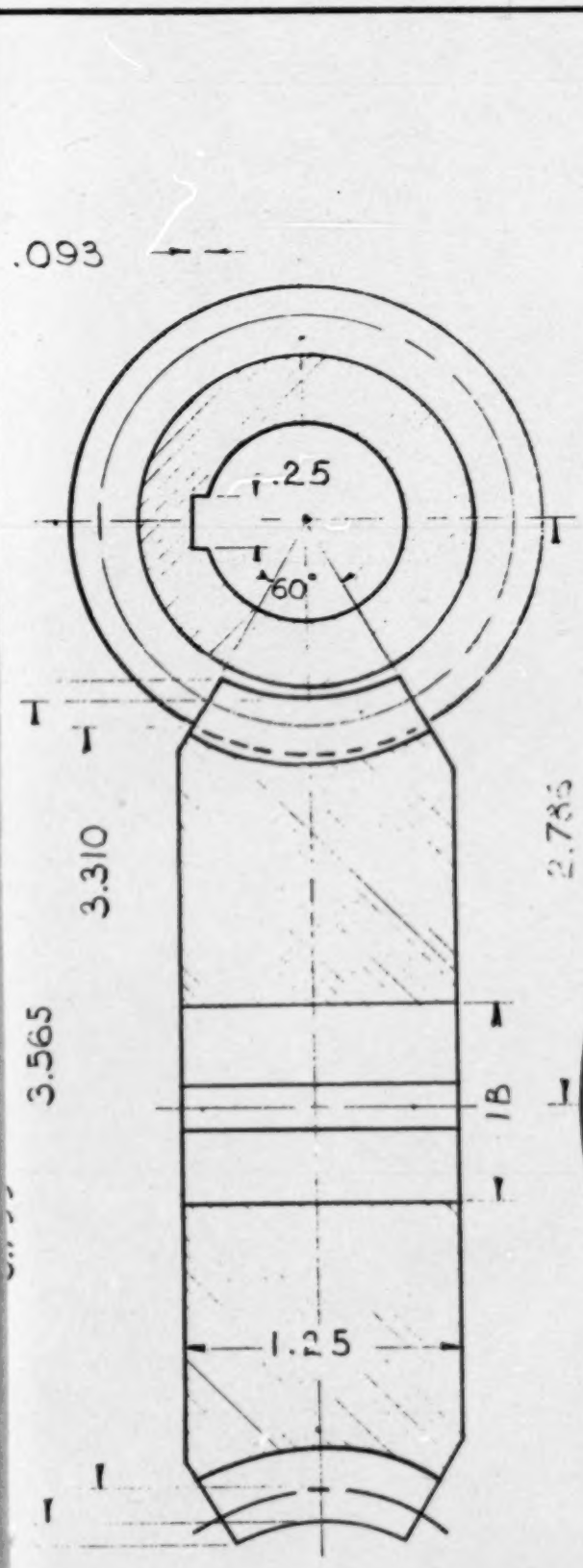

8926

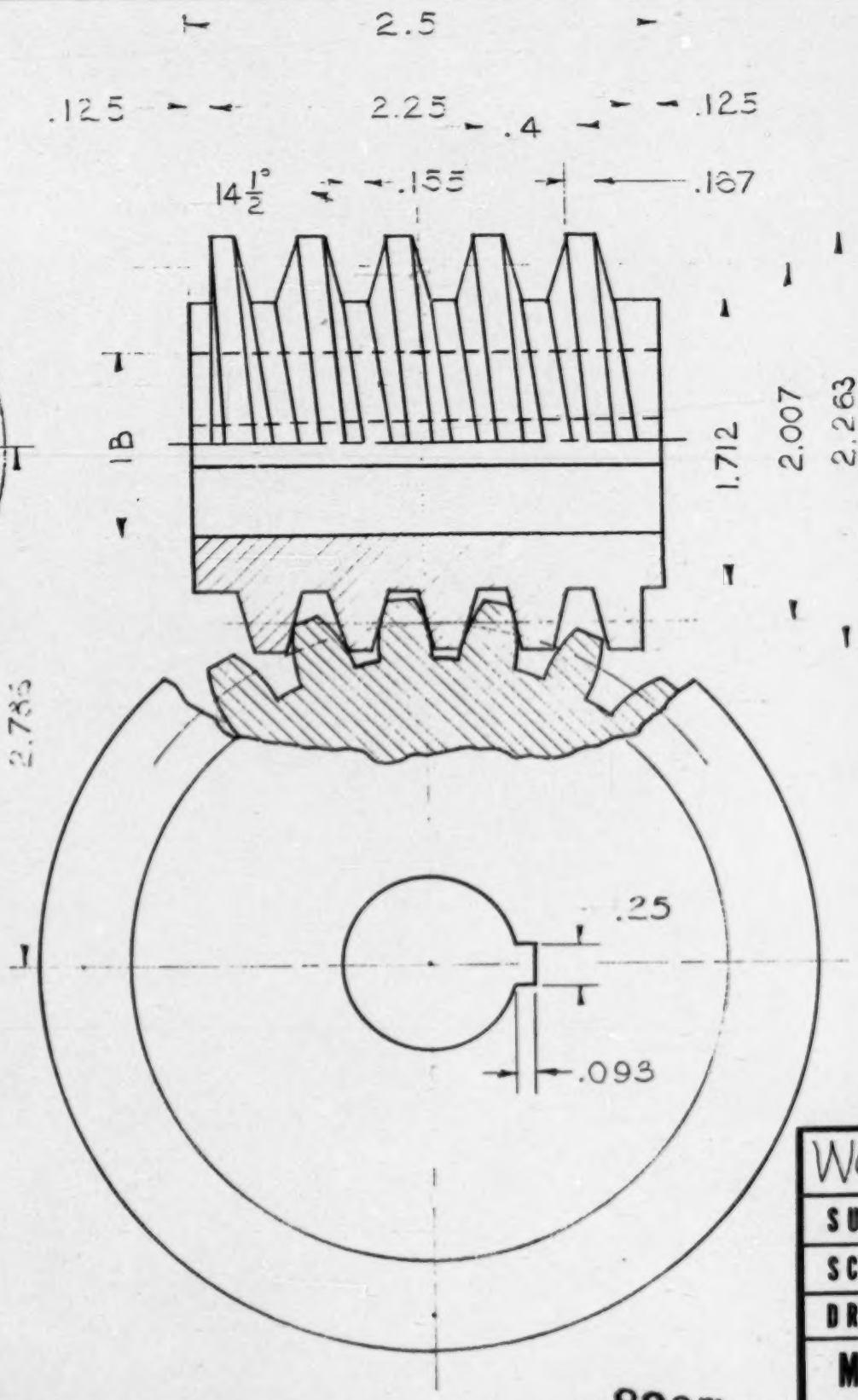

8927

WO
SUG
SCA
DRA
MI

M-225

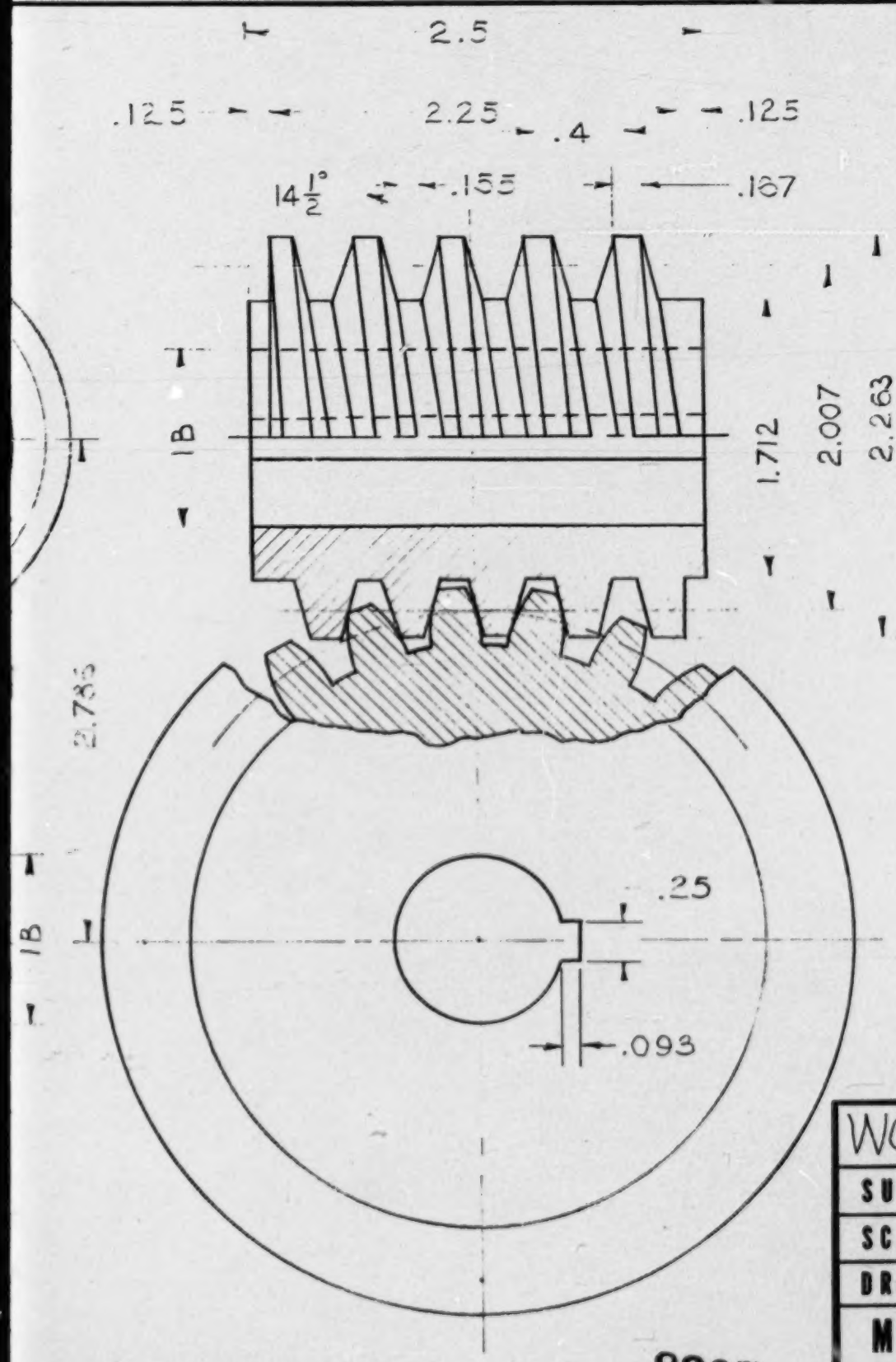

WORM

2 1/2 THREADS PER INCH

SINGLE R.H.

LINEAR PITCH .4"

HELIX ANGLE 3°-38'

FINISH ALL OVER

WORM WHEEL

26 TEETH

C. PITCH 400"

FACE ANGLE 60°

FINISH ALL OVER

WORM & WORM WHEEL	
SUGGESTED BY: BOYS' TECH	
SCALE: 12"=1'0"	DATE: 7-14-66
DRAWN BY [illegible]	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8927

926

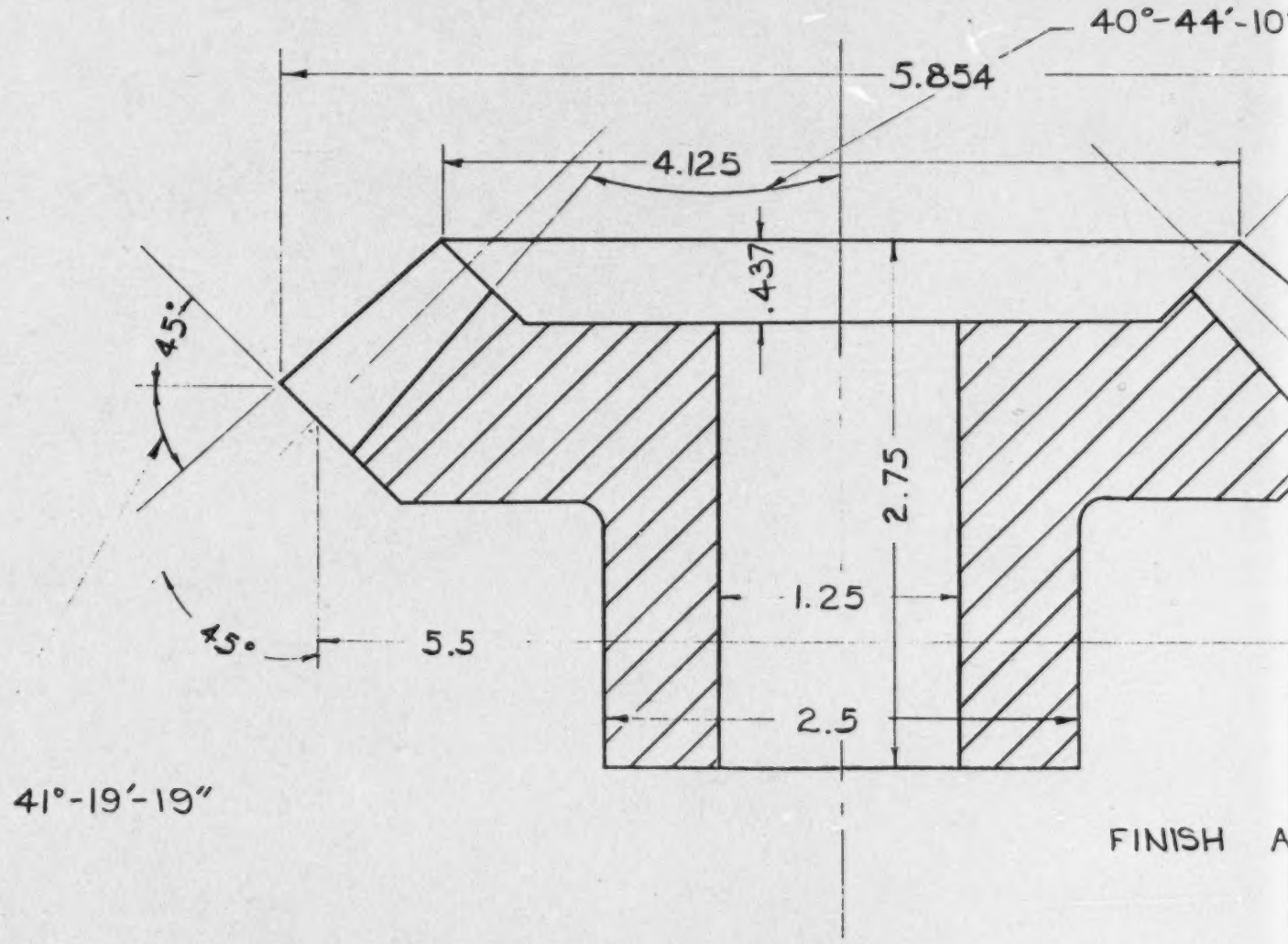

4 DIA. PITCH 22 TEETH - USE #4 CUTTER

SUGG
SCAL
DRAW
MIL

8928

8929

M-226

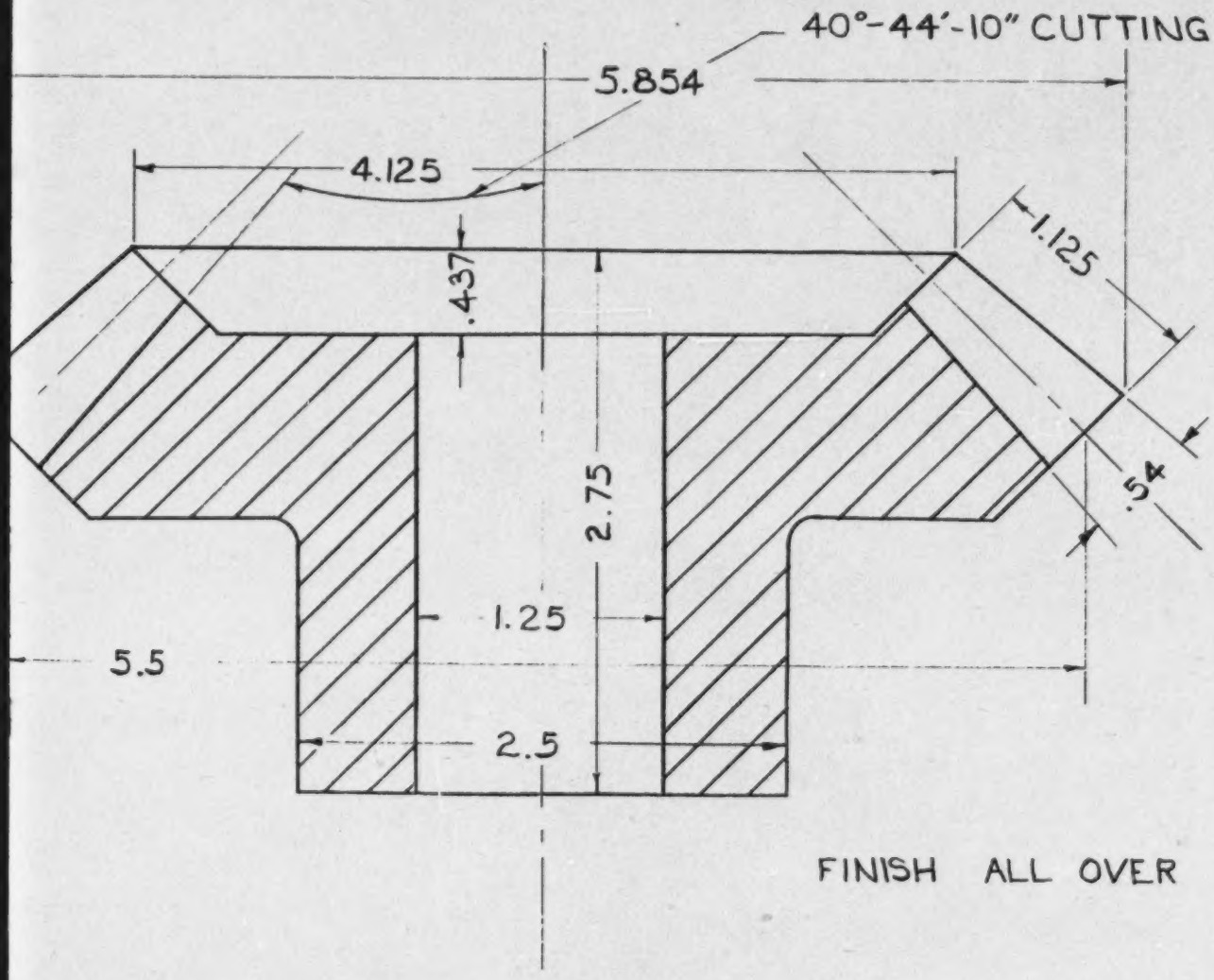

4 DIA. PITCH 22 TEETH - USE #4 CUTTER

MITRE GEAR	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-20-66
DRAWN BY L.w.p.	CHECKED BY
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

8929

O.D.	I.D.	O.D.	I.D.	O.D.	I.D.
$\frac{1}{2}$	$\frac{5}{16}$	$1\frac{1}{2}$	$\frac{9}{16}$	$2\frac{7}{16}$	$\frac{3}{4}$
$\frac{9}{16}$	$\frac{5}{16}$	$1\frac{5}{8}$	$\frac{9}{16}$	$2\frac{1}{2}$	$\frac{3}{4}$
$\frac{5}{8}$	$\frac{5}{16}$	$1\frac{3}{4}$	$\frac{9}{16}$	$2\frac{9}{16}$	$\frac{3}{4}$
$\frac{11}{16}$	$\frac{5}{16}$	$1\frac{7}{8}$	$\frac{3}{4}$	$2\frac{5}{8}$	$\frac{3}{4}$
$\frac{3}{4}$	$\frac{5}{16}$	$1\frac{15}{16}$	$\frac{3}{4}$	$2\frac{11}{16}$	$\frac{3}{4}$
$\frac{13}{16}$	$\frac{5}{16}$	2	$\frac{3}{4}$	$2\frac{3}{4}$	$\frac{3}{4}$
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$1\frac{1}{4}$	$\frac{9}{16}$	$2\frac{5}{16}$	$\frac{3}{4}$	$3\frac{1}{16}$	$\frac{3}{4}$
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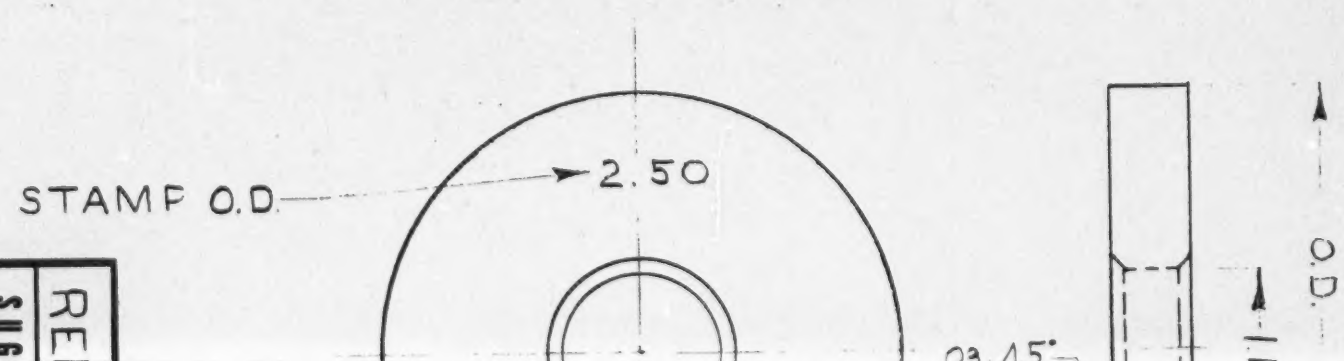

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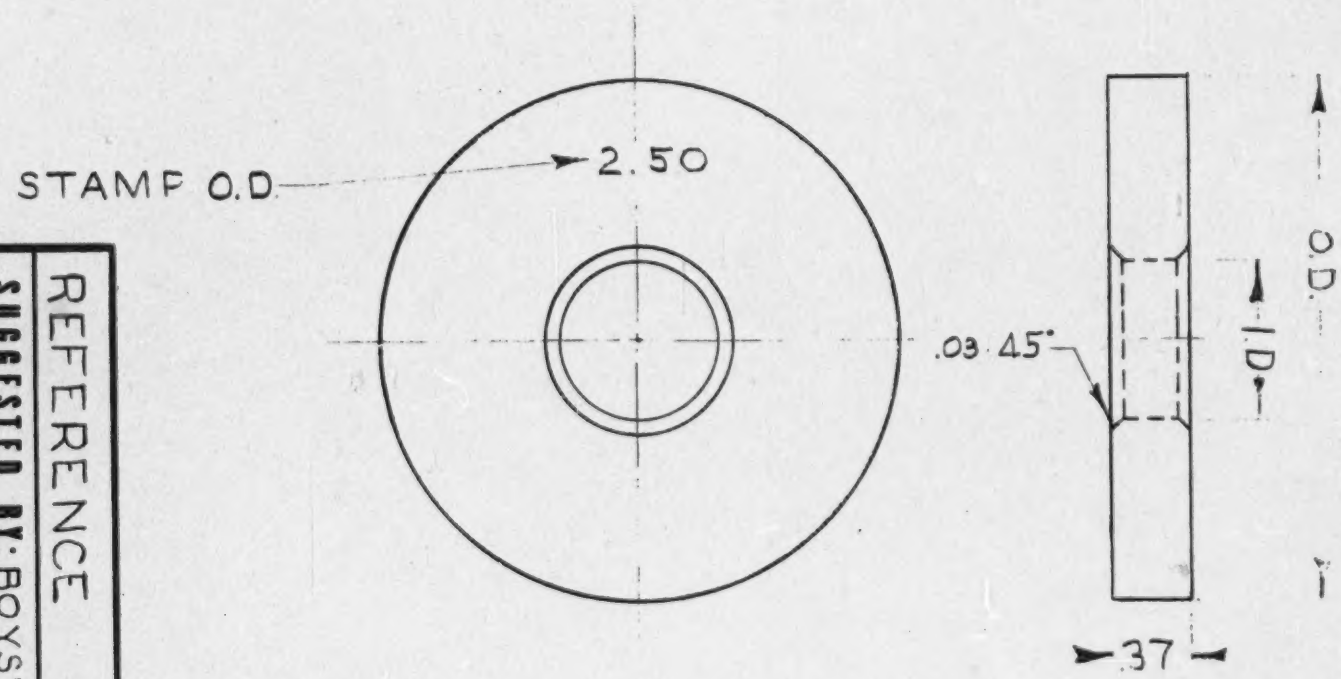

WATER HARD TOOL STEEL
LEAVE .015 FOR GRINDING O.D.
LEAVE .008 FOR GRINDING I.D.

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

M-227

REFERENCE DISKS

SUGGESTED BY: BOYS' TECH

SCALE: 12" = 1'-0" | DATE: 7-20-66

DRAWN BY T.S.S. | CHECKED BY

MILWAUKEE PUBLIC SCHOOLS

INDUSTRIAL EDUCATION

	A	B	C	D	E	F	G	H	J	K	L	M	N
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1. LEAVE
   NORMA
2. NORM
3. BORE T
4. MACHI
5. LEAVE
6. CUT
7. MILL
8. HARDE
9. GRIND
10. GRIND

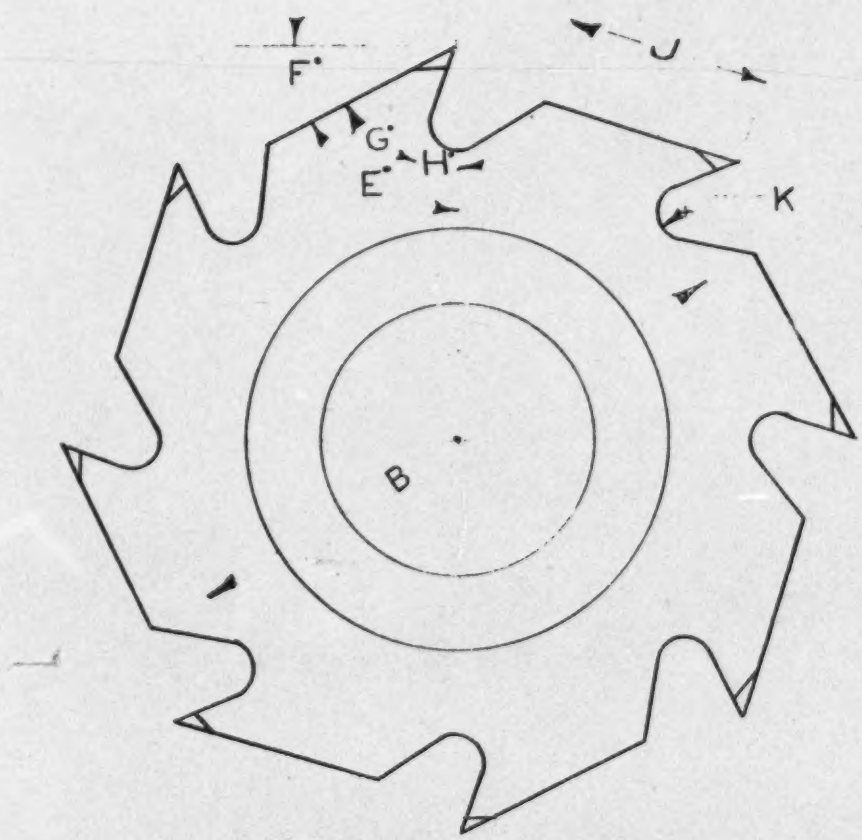

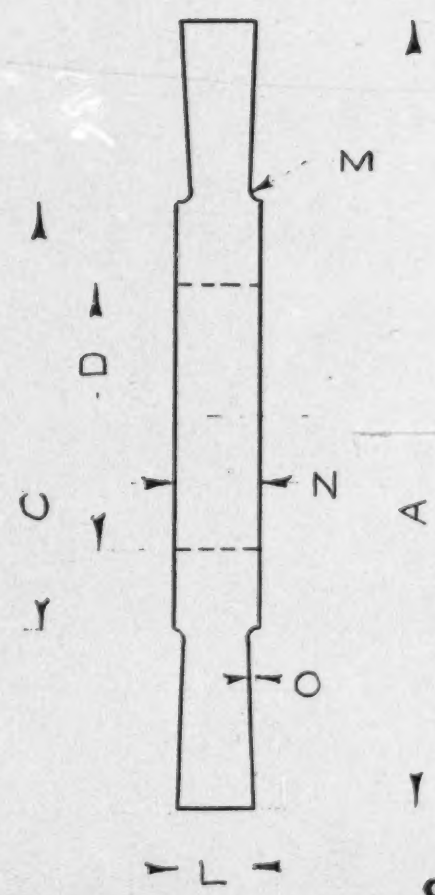

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D	E	F	G	H	J	K	L	M	N	O
$1\frac{1}{4}$	63°	27°	48°	15°	1	$\frac{1}{8}$R.	$\frac{1}{4}$	$\frac{1}{32}$R.	$\frac{11}{32}$	2°
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1. LEAVE $\frac{1}{16}$ OVERSIZE FOR NORMALIZING
2. NORMALIZE
3. BORE TO .010 UNDERSIZE
4. MACHINE TO SIZE O.D
5. LEAVE .015 ON WIDTH
6. CUT TAPER ON SIDES
7. MILL TEETH
8. HARDEN
9. GRIND BORE
10. GRIND WIDTH

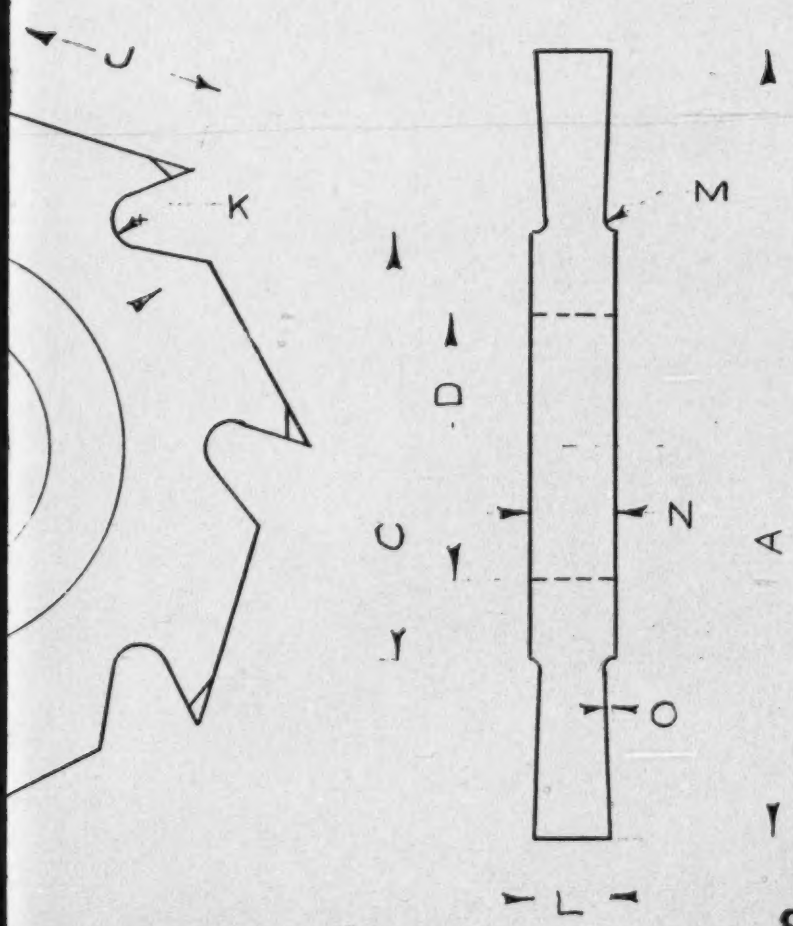

TOLERANCES: ±.005 UNLESS OTHERWISE STATED

WOODWORK CUTTER	
SUGGESTED BY: BOYS' TECH	
SCALE: 12" = 1'-0"	DATE: 7-21-66
DRAWN BY J.S.	CHECKED BY [illegible]
MILWAUKEE PUBLIC SCHOOLS INDUSTRIAL EDUCATION	

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VT 012 753
Davenport, Howard; Disch, Ronald
Power and Transportation 1-6 and Automotive Engine Tune-Up 1-2.

Milwaukee Public Schools, Wis. Dept. of Secondary Curriculum and Instruction.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - 66 82p.

DESCRIPTORS - *CURRICULUM GUIDES; *TRADE AND INDUSTRIAL EDUCATION; *POWER MECHANICS; *TRANSPORTATION; *AUTO MECHANICS; INDUSTRIAL ARTS; TEACHING GUIDES; SECONDARY GRADES; COURSE ORGANIZATION; AUTO MECHANICS (OCCUPATION); SKILLED OCCUPATIONS; BIBLIOGRAPHIES

ABSTRACT - Developed by the Division of Curriculum and Instruction of the Milwaukee Public Schools, this curriculum guide is for instructor use in teaching the vocational aspects of power and transportation and in teaching the principles of automotive engine tune-up in the secondary schools. The material is designed to cover a period of four school years and is broken into four basic parts. The first part is an introduction to power and transportation, the second is a more in-depth study, the third includes the theory and testing of systems, and the fourth part places emphasis on actual diagnosing and solving automobile engine problems with the use of test instruments. A 5-column format is used to present the material to best advantage. Objectives include the teaching of skills in the use of tools and equipment, development of an awareness of the industry, and acquaintance with products in the power and transportation field. An extensive list of supplementary aids, and a bibliography are included. (GEB)

VT 012 753

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POWER AND TRANSPORT
AND
AUTOMOTIVE ENGINE TU

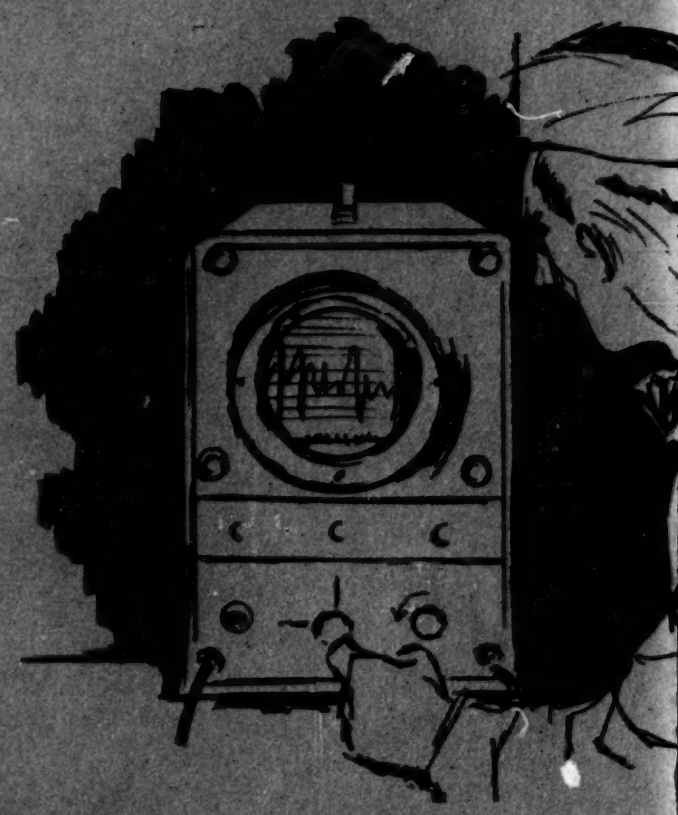

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MILWAUKEE PUBLIC
1966

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POWER AND TRANSPORTATION 1-6
AND
AUTOMOTIVE ENGINE TUNE-UP 1-2

MILWAUKEE PUBLIC SCHOOLS

1966

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1966

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OWER AND TRANSPORTATION 1-6
AND
UTOMOTIVE ENGINE TUNE-UP 1-2

SECONDARY DEPARTMENT

DIVISION OF CURRICULUM AND INSTRUCTION

MILWAUKEE PUBLIC SCHOOLS

1966

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ACKNOWLEDGMENT

Appreciation is expressed to the Advisory Committee for Power and Transportation whose suggestions and contributions helped to make the writing of this guide possible. The actual organizing, compiling, and writing of the material was done by Howard Davenport and Ronald Disch.

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Industrial Education

Frisby D. Smith, Executive Director
Secondary Curriculum and Instruction

Dwight Teel, Assistant Superintendent
Division of Curriculum and Instruction

Harold S. Vincent, Superintendent of Schools

AIMS AND OBJECTIVES

-- To develop an awareness of the industrial complexes related t
tion field

-- To train the student to be a responsible working member of an
laboratory or industrial activities

-- To acquire skills in using the tools and equipment of the pow
field

-- To present the student with vocational information and guidan
and transportation

-- To become acquainted with the various products of the power

-- To become acquainted with various methods of manufacturing i
transportation industry

-- To become aware of the technological advancements in the pow
field

AIMS AND OBJECTIVES

lop an awareness of the industrial complexes related to the power and transporta-
eld

n the student to be a responsible working member of any group involved in
ory or industrial activities

ire skills in using the tools and equipment of the power and transportation

ent the student with vocational information and guidance in the area of power
nsportation

me acquainted with the various products of the power and transportation field

me acquainted with various methods of manufacturing in the power and
ortation industry

me aware of the technological advancements in the power and transportation

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INTRODUCTION

This curriculum guide for power and transportation has that a varied program can be offered in all of the area high guide may be enlarged upon if shop facilities permit. Shop aids will determine depth of content and the amount of time therefore, this guide does not include a suggested timetable correlate classroom theory and practical shop application in possible, related shop skills should be developed. Instruct administered at the conclusion of the various units of work teacher.

In presenting the material, a concise, five-column form

-- The first column lists the areas emphasized in prese

-- Column two lists the exercises and activities by whi emphasis listed in the preceding column are presente

-- References to textbooks and jobs are made in the thi letter preceding the indicated pages or job number r letter preceding the book title as listed in the bib

-- Films, filmstrips, booklets, etc., are listed by cod column four. Titles will be found in the section en Aids on page 66.

-- In the last column, space is provided for the instru of lectures and demonstrations, time spent on variou instruction, and other information for his personal

INTRODUCTION

culum guide for power and transportation has been planned in such a way
rogram can be offered in all of the area high schools. Sections of this
larged upon if shop facilities permit. Shop facilities and supplementary
mine depth of content and the amount of time spent in any one area;
guide does not include a suggested timetable. It is not feasible to
room theory and practical shop application in all areas. However, when
ed shop skills should be developed. Instructor-made tests may be
the conclusion of the various units of work or at the discretion of the

ing the material, a concise, five-column format has been used:

st column lists the areas emphasized in presenting the course.

two lists the exercises and activities by which the areas of
s listed in the preceding column are presented to the student.

ces to textbooks and jobs are made in the third column. The
preceding the indicated pages or job number relates to the
preceding the book title as listed in the bibliography.

filmstrips, booklets, etc., are listed by code numbers in
four. Titles will be found in the section entitled Supplementary
page 66.

last column, space is provided for the instructor to note dates
ures and demonstrations, time spent on various units of
tion, and other information for his personal use.

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Power and Transportation 3 and 4. . . . . .

Course Outline -- Power and Transportation 3 . . . . . .
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Power and Transportation 5 and 6. . . . . .

Course Outline -- Power and Transportation 5 . . . . . .
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Automotive Engine Tune-up 1 and 2 . . . . . .

Course Outline -- Automotive Engine Tune-up 1. . . . . .
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POWER AND TRANSPORTATION 1 AN

This introductory course deals with the source, genera utilization of power as developed by the internal combustio aircraft, automotive, marine, and small engines. In the fi student should be instructed primarily on engines and engi semester work is centered around the small gasoline engine. practical experience in disassembly, cleaning, and servicin auxiliary systems. In Power and Transportation 2, the stud experience on a complete engine.

The experiences of the first two semesters are designe appreciation of the value, service, and place of the intern nation's economy.

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POWER AND TRANSPORTATION 1 AND 2

ductory course deals with the source, generation, transmission, and
power as developed by the internal combustion engine. The course includes
otive, marine, and small engines. In the first semester of work the
be instructed primarily on engines and engine systems. The second
s centered around the small gasoline engine. In Power and Transportation 1,
ience in disassembly, cleaning, and servicing is restricted to the
ns. In Power and Transportation 2, the student is exposed to practical
complete engine.

ences of the first two semesters are designed to help the student gain an
the value, service, and place of the internal combustion engine in our
y.

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COURSE OUTLINE -- POWER AND TRANSPOR

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES
<u>Student Orientation</u>	
A. Student Conduct	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School
B. Course Content	Present anticipated program in terms of: -- What student should know -- What student should be able to do
C. Class Management	Explain classroom and shop: -- Policy -- Procedures
<u>Introduction to Power</u>	
A. Historical Development	Discuss methods of travel: -- Land -- Air -- Sea
B. Simple Machines	Discuss uses: -- Early versions -- Present applications
C. Power Pioneers	Discuss leaders: -- Famous names -- Early inventors
D. Uses of Power	Discuss areas of power consumption: -- Home -- Industrial -- Transportation

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COURSE OUTLINE -- POWER AND TRANSPORTATION 1

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School			
	Present anticipated program in terms of: -- What student should know -- What student should be able to do			
	Explain classroom and shop: -- Policy -- Procedures			
	Discuss methods of travel: -- Land -- Air -- Sea	A - pp. 26-41 C - pp. 1-10	13-2 4-1 11-2 15-8 2-7 8-1	
	Discuss uses: -- Early versions -- Present applications			
	Discuss leaders: -- Famous names -- Early inventors	A - pp. 1-25		
	Discuss areas of power consumption: -- Home -- Industrial -- Transportation		28-6	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	
E. Economic Implications	Discuss needs of: -- Manufacturers -- Merchandisers -- Retail suppliers -- Service and repair firms	
F. Consumer Knowledge	Discuss advantages of knowledge of how to: -- Purchase -- Maintain -- Operate -- Repair	N -
<u>Source of Power</u>		
A. Energy Conversion	Discuss energy forms: -- Light -- Nuclear -- Heat -- Chemical -- Electrical -- Mechanical	N C
B. Energy from Fuel	Discuss potential energy of: -- Gasoline -- Diesel fuel -- Liquified petroleum	
C. Heat for Useful Work	Discuss heat applications on: -- Land -- Air -- Sea	L
<u>Types of Engines</u>		
A. External Combustion	Discuss uses in past: -- Steam	N K
B. Internal Combustion 1. Otto Cycle 2. Brayton Cycle 3. Two-cycle	Discuss present uses: -- Piston -- Turbine -- Thrust	K I A N J

S	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss needs of: -- Manufacturers -- Merchandisers -- Retail suppliers -- Service and repair firms		14-6	
	Discuss advantages of knowledge of how to: -- Purchase -- Maintain -- Operate -- Repair	N - pp. 223-266	4-1 14-5	
	Discuss energy forms: -- Light -- Nuclear -- Heat -- Chemical -- Electrical -- Mechanical	N - pp. 97-104 C - pp. 38-98	4-1 15-8 14-2	
	Discuss potential energy of: -- Gasoline -- Diesel fuel -- Liquified petroleum			
	Discuss heat applications on: -- Land -- Air -- Sea	L - pp. 139-181	28-5	
	Discuss uses in past: -- Steam	N - pp. 9-12 K - pp. 6-59 K - pp. 3-15	13-1 4-1 15-2	
	Discuss present uses: -- Piston -- Turbine -- Thrust	I - pp. 10-31 A - pp. 140-155 N - pp. 9-28 J - pp. 2-4	5-2 16-1 8-2 14-3	

8951 8952

AREA OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES
	Discuss future uses of: -- Rotary engines -- Fuel cells -- Solar batteries -- Reactors
<u>Fundamentals of the Internal Combustion Engine</u>	
Two- and Four-stroke Operation 1. Small engines 2. Automotive 3. Diesel 4. Aircraft	Present and discuss in general terms: -- Combustion chambers -- Valve and port operation -- Piston stroke -- Fuel systems -- Ignition systems -- Cooling systems -- Lubrication systems -- Block design
<u>Introduction to Safety</u>	
A. General Safety	Identify need for good grooming and proper clothing.
B. Shop Safety 1. Personal 2. Tool 3. Machine	Discuss reasons for wearing goggles and apron. Demonstrate the use and proper care of: -- Kinds and sizes of tools -- Power tools -- Machines -- Equipment
<u>Introduction to Proper Assembly and Disassembly Techniques</u>	
A. Fasteners	Observe types in general use.

8953

n 1

S	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss future uses of: -- Rotary engines -- Fuel cells -- Solar batteries -- Reactors		15-2 2-7	
ernal				
eration	Present and discuss in general terms: -- Combustion chambers -- Valve and port operation -- Piston stroke -- Fuel systems -- Ignition systems -- Cooling systems -- Lubrication systems -- Block design	A - pp. 140-155 I - pp. 47-68, 122-167 N - pp. 105-112 I - pp. 32-46 N - pp. 2-19 J - pp. 60-86	13-1 4-1 6-1 5-2 16-1 12-16 12-17 17-1 17-3 21-1 21-2 28-5	
	Identify need for good grooming and proper clothing.	I - pp. 451-463	4-1 15-2	
	Discuss reasons for wearing goggles and apron.	I - pp. 464-472	17-5 17-6 17-7	
	Demonstrate the use and proper care of: -- Kinds and sizes of tools -- Power tools -- Machines -- Equipment		15-2	
ly				
	Observe types in general use.			

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
B. Pins	Present facts on proper use.	
C. Washers	Identify different materials and types of construction.	B - pp A - pp
D. Materials and Construction		A - pp 3
<u>Fundamentals of Engine Systems</u> (Small Auto, Aircraft, and Diesel)		
A. Cooling	Study and observe types in general use.	
	Present and discuss information on: -- Types of systems -- Parts and function -- Heat transfer -- Coolant -- Additives -- Minor problems	A - pp I - pp N - pp J - pp
B. Lubrication	Study and observe types in general use.	I - pp N - pp K - pp
	Present and discuss information on: -- Types of systems -- Parts and function -- Lubricants and additives -- Filters and systems -- Ventilating systems -- Minor problems	J - p C - p C - p
C. Valves and Ports	Study and observe types in general use.	I - p N - p
	Present and discuss information on: -- Types of systems -- Parts and function -- Timing -- Minor problems	J - p C - p

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SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Present facts on proper use.			
Identify different materials and types of construction.	B - pp. 1-39 A - pp. 42-60 A - pp. 79-93, 389-401		
Study and observe types in general use.		13-1 4-1 6-1	
Present and discuss information on: -- Types of systems -- Parts and function -- Heat transfer -- Coolant -- Additives -- Minor problems	A - pp. 223-230 I - pp. 32-46 N - pp. 97-104 J - pp. 2-32	10-1 5-2 5-3 12-39 14-4	
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Present and discuss information on: -- Types of systems -- Parts and function -- Lubricants and additives -- Filters and systems -- Ventilating systems -- Minor problems	J - pp. 2-32 C - pp. 172-188 C - pp. 342-347	4-1 28-1 28-3 28-4	
Study and observe types in general use.	I - pp. 69-92 N - pp. 80-96	13-1 4-1 5-9 16-1	
Present and discuss information on: -- Types of systems -- Parts and function -- Timing -- Minor problems	J - pp. 2-32 C - pp. 113-126		

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AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	
D. Piston, Rings, Crankshaft, and Connecting Rods	Study and observe types in general use. Present and discuss information on: -- Construction of parts -- Function of parts -- Balance and motion -- Bearings and tolerances -- Minor problems	I - N - J -
E. Fuel	Study and observe types in general use. Present and discuss information on: -- Theory of operation -- Principles of carburetion -- Fuel pump operation -- Fuels and mixtures -- Injector operation -- Minor problems	I - N - K - J -
F. Ignition	Study and observe types in general use. Present and discuss information on: -- Electron theory -- Battery ignition -- Magneto ignition -- Compression ignition -- Timing -- Advance mechanisms -- Minor problems	I - N - J -
G. Governors 1. Onspeed 2. Underspeed 3. Overspeed	Study and observe types in general use. Present and discuss information on: -- Theory of operation -- Reason for governing -- Types of governors -- Function of parts -- Minor problems	N -

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SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Study and observe types in general use. Present and discuss information on: -- Construction of parts -- Function of parts -- Balance and motion -- Bearings and tolerances -- Minor problems	I - pp. 93-121 N - pp. 47-79 J - pp. 2-32	13-1 4-1 5-10 16-1 20-1	
Study and observe types in general use. Present and discuss information on: -- Theory of operation -- Principles of carburetion -- Fuel pump operation -- Fuels and mixtures -- Injector operation -- Minor problems	I - pp. 122-170 N - pp. 137-151 K - pp. 87-96 J - pp. 2-32	13-1 4-1 5-7 16-1 12-40	
Study and observe types in general use. Present and discuss information on: -- Electron theory -- Battery ignition -- Magneto ignition -- Compression ignition -- Timing -- Advance mechanisms -- Minor problems	I - pp. 171-193 N - pp. 182-209 J - pp. 2-32	13-1 4-1 5-7 16-1 12-51	
Study and observe types in general use. Present and discuss information on: -- Theory of operation -- Reason for governing -- Types of governors -- Function of parts -- Minor problems	N - pp. 113-114	4-1 5-6 16-1 12-54	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
H. Charging and Starting Mechanisms	Study and observe types in general use. Present and discuss information on: -- Electricity -- Generators -- Alternators -- Regulators -- Starters -- Solenoids -- Relays -- Minor problems	I - pp N - pp J - pp
<u>End of Semester</u>		
A. Review	If time permits, review the following: -- Areas needing more work -- Areas of great interest	
B. Evaluation	Prepare students for next semester.	
C. Closing	Discuss student progress and ways to improve. Turn in all work, keys, etc. Clean shop. Administer final exam.	

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
tudy and observe types in general se. resent and discuss information on: -- Electricity -- Generators -- Alternators -- Regulators -- Starters -- Solenoids -- Relays -- Minor problems	I - pp. 223-247 N - pp. 179-181 J - pp. 2-32	4-1 16-1 12-45 12-46 12-47	
If time permits, review the following: -- Areas needing more work -- Areas of great interest			
Prepare students for next semester.			
Discuss student progress and ways to improve.			
Turn in all work, keys, etc.			
Clean shop.			
Administer final exam.			

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COURSE OUTLINE -- POWER AND TRANSPORTATIO

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REF
<u>Student Orientation</u>		
A. Student Conduct	Review responsibilities: -- Individual -- Group -- Classroom -- Shop -- School	
B. Course Content	Present anticipated program in terms of: -- Student knowledge -- Student skills	
C. Classroom Management	Review classroom and shop: -- Policy -- Procedures	
<u>Necessary Knowledge</u>		
A. Safety 1. General 2. Hand Tools 3. Special Tools 4. Power Tools	Review safety rules. Present demonstration on safe use of tools. Discuss rules and demonstration.	I - pp O - pp
B. Threads 1. Standards	Introduce nomenclature. Examine thread construction. Introduce standards: -- N.C. -- N.F. -- S.A.E. -- N.P.T. Use standard charts. Use screw pitch gauge.	O - pp

0961

COURSE OUTLINE -- POWER AND TRANSPORTATION 2

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Review responsibilities: -- Individual -- Group -- Classroom -- Shop -- School			
	Present anticipated program in terms of: -- Student knowledge -- Student skills			
	Review classroom and shop: -- Policy -- Procedures			
	Review safety rules.	I - pp. 451-472 O - pp. 3-1	4-1 15-2	
	Present demonstration on safe use of tools.		5-4 17-7	
	Discuss rules and demonstration.			
	Introduce nomenclature.	O - pp. 11-1		
	Examine thread construction.			
	Introduce standards: -- N.C. -- N.F. -- S.A.E. -- N.P.T.			
	Use standard charts.			
	Use screw pitch gauge.			

8962

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
2. Taps	Examine taps: -- Taper -- Plug -- Bottoming Observe demonstration.	O - pp
3. Dies	Examine dies: -- Solid -- Split -- Two-piece Observe demonstration. Use tap and die.	O - pp
C. Fasteners 1. Bolts	Observe and identify various types of bolts: -- Square head -- Hex head -- Hex head shoulder -- Carriage	O - 11
2. Screws	Observe and identify various types of screws: -- Cap screw -- Oval head -- Fillister -- Flat -- Round -- Phillips -- Reed and prince -- Clutch -- Internal hex -- Headless -- Self-tapping	

8963

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
xamine taps: -- Taper -- Plug -- Bottoming	O - pp. 11-1 to 8		
bserve demonstration.			
xamine dies: -- Solid -- Split -- Two-piece	O - pp. 11-1 to 8		
bserve demonstration.			
se tap and die.			
bserve and identify various types f bolts: -- Square head -- Hex head -- Hex head shoulder -- Carriage	O - 11-1 to 8	15-2	
bserve and identify various types f screws: -- Cap screw -- Oval head -- Fillister -- Flat -- Round -- Phillips -- Reed and prince -- Clutch -- Internal hex -- Headless -- Self-tapping			

896908

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFEREN
3. Nuts	Observe and identify various types of nuts: -- Square -- Hex regular -- Hex check -- Castle -- Stop nuts	
4. Washers	Observe and identify various types of washers: -- Flat washer -- Standard lock washer -- External tooth lock washer	
5. Pins	Observe and identify various types of pins: -- Cotter -- Clevis -- Straight	
6. Rivets	Observe and identify various types of rivets: -- Solid -- Tubular	
7. Keys, Keyways, and Splines	Observe and identify: -- Woodruff -- Sunk -- Gib-head	
	Discuss and inspect application of fasteners on the small engine.	
D. Review of Parts and Theory		
1. Two-stroke cycle	Discuss two-stroke cycle.	N - pp. 9- J - p. 3
	Inspect parts and discuss function.	K - pp. 97 N - pp. 9-
	Compare cross port and loop scavenge.	

8965

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
serve and identify various types nuts: -- Square -- Hex regular -- Hex check -- Castle -- Stop nuts			
serve and identify various types washers: -- Flat washer -- Standard lock washer -- External tooth lock washer			
serve and identify various types pins: -- Cotter -- Clevis -- Straight			
serve and identify various types rivets: -- Solid -- Tubular			
serve and identify: -- Woodruff -- Sunk -- Gib-head			
scuss and inspect application of steners on the small engine.			
scuss two-stroke cycle.	N - pp. 9-19	13-1	
spect parts and discuss function.	J - p. 3 K - pp. 97-114 N - pp. 9-19	4-1 20-6 15-2	
mpare cross port and loop scavenge.		5-2.	

8966

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPL A
2. Four-stroke cycle	Discuss four-stroke cycle.	J - p. 4	16-1 5-1
	Inspect parts and discuss function.		11-1 16-1
	Compare two- and four-stroke cycle.		
E. Diagnostic Procedure Prior to Disassembly	Perform test: -- Ignition -- Compression -- Carburetion	N - pp. 122-126	5-7
F. Measurement 1. Steel scale 2. Micrometer 3. Telescoping gauge 4. Cylinder gauge 5. Plug gauge 6. Dial indicator	Review fractions.	O - pp. 4-1 to 25	4-1
	Work assignment sheets.		
	Observe demonstrations.		
	Use various gauges.		
<u>Engine Disassembly Diagnosis, Cleaning, and Inspection</u>	Demonstrate use of special tools.		4-1
A. Starting Systems	Disassemble, clean, and inspect with respect to weak springs, worn ropes, and pawls: -- Rope starter -- Recoil starter -- Impulse starter	N - p. 239 J - pp. 40-62	20-6 15-2 5-6 16-1 20-6
B. Fuel System	Demonstrate use of special tools.		
	Disassemble, clean, and inspect for leakage, stoppage, and warpage: -- Tank -- Lines -- Filter and screens -- Carburetor -- Manifold	N - pp. 137-151 J - pp. 29-30 K - pp. 115-135	5-3 16-1 26-1 29-1

078967

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
ss four-stroke cycle.	J - p. 4	16-1 5-1	
ct parts and discuss function.		11-1 16-1	
re two- and four-stroke cycle.			
rm test: Ignition Compression Carburetion	N - pp. 122-126	5-7	
w fractions.	O - pp. 4-1 to 25	4-1	
assignment sheets.			
ve demonstrations.			
arious gauges.			
strate use of special tools.		4-1 20-6	
semble, clean, and inspect with ct to weak springs, worn ropes, awls:		15-2 5-6 16-1	
Rope starter Recoil starter Impulse starter	N - p. 239 J - pp. 40-62	20-6	
strate use of special tools.			
semble, clean, and inspect for ge, stoppage, and warpage: Tank Lines Filter and screens Carburetor Manifold	N - pp. 137-151 J - pp. 29-30 K - pp. 115-135	5-3 16-1 26-1 29-1	

8968

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFE
C. Governing System	Demonstrate use of special tools. Remove, clean, and inspect for: -- Worn linkage and springs -- Broken vane -- Damaged flyweight	N - pp. J - pp.
D. Ignition System	Demonstrate use of special tools. Remove, clean, and inspect for: -- Sheared key -- Cracked flywheel -- Strength of magnets -- Shorted coil -- Worn armature -- Pitted points -- Ignition lead continuity -- Spark plug	N - pp. J - pp.
E. Lubrication System	Disassemble, clean, and inspect for: -- Broken gear teeth -- Worn piston -- Broken dipper -- Broken slinger	N - pp. J - pp.
F. Cooling System	Clean cooling fins and inspect for cracks. On marine engine, clean passages and inspect impeller pump.	N - pp. J - pp. H - p.
G. Power Takeoff	Remove, clean, and inspect for: -- Wear on belts and pulleys -- Clutch slippage -- Propeller nicks and cracks	H - pp. J - p.

8968 8969

S	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Demonstrate use of special tools.	N - pp. 113-114 J - pp. 325-326	4-1 20-6	
	Remove, clean, and inspect for: -- Worn linkage and springs -- Broken vane -- Damaged flyweight		15-2 5-6 16-1	
	Demonstrate use of special tools.			
	Remove, clean, and inspect for: -- Sheared key -- Cracked flywheel -- Strength of magnets -- Shorted coil -- Worn armature -- Pitted points -- Ignition lead continuity -- Spark plug	N - pp. 182-210 J - pp. 24-25		
	Disassemble, clean, and inspect for: -- Broken gear teeth -- Worn piston -- Broken dipper -- Broken slinger	N - pp. 101-104 J - pp. 80-81	5-10 16-1	
	Clean cooling fins and inspect for cracks.	N - pp. 97-101 J - pp. 2-32 H - p. 10	5-7 16-1	
	On marine engine, clean passages and inspect impeller pump.			
	Remove, clean, and inspect for: -- Wear on belts and pulleys -- Clutch slippage -- Propeller nicks and cracks	H - pp. 10-12 J - p. 133	13-2 11-3 16-1	

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
ew measurement techniques.		20-6 11-3	
ent and discuss examples of ification charts and tables.		5-4 16-1	
ss: - Reject sizes - Tolerances			
uss reasons for and practical ects of reconditioning: - Cost of parts versus value of engine		4-1 11-3 5-4 5-6 16-1	
onstrate and discuss: - Replacing spring - Replacing rope - Replacing pawls		26-1 29-1	
onstrate and discuss: - Patch tank - Flange lines - Rebuild carburetor - Lap warped surfaces - Service air cleaner	N - pp. 137-151 J - pp. 29-30		
onstrate and discuss: - Straightening linkage - Constructing linkage - Varying tension on spring	N - pp. 113-114		
onstrate and discuss: - Coil test - Condenser test - High tension test - Resurfacing points - Testing and adjusting spark plugs - Proper cleaning of plugs	N - pp. 182-210 J - pp. 24-27		

8972

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERE
E. Compression System 1. Cylinder Head	Demonstrate and discuss: -- Lap head -- Rethreading spark plug hole	N - pp. 12 N - pp. 39
2. Cylinder Block	Demonstrate and discuss: -- Lap mating surface -- Repairing hole in block -- Oversize cylinder -- Deglazing cylinder -- Measuring bore -- Measuring valve guide -- Measuring main bearing	N - pp. 39
3. Valve Seat	Demonstrate and discuss: -- Grinding valve seat -- Measuring concentricity -- Replacing valve seat	N - pp. 3
4. Valves	Demonstrate and discuss: -- Grinding valve face -- Resurfacing valve butt -- Chamfering valve stem -- Measuring stem -- Checking reed valve	
5. Camshaft	Measure bearings.	
6. Piston	Demonstrate and discuss: -- Use of special ring groove cleaner -- Measuring piston -- Measuring piston pin -- Measuring ring grooves	
7. Piston Rings	Measure gap and replace if necessary.	
8. Connecting Rod and Crankshaft	Measure crankshaft end. Align connecting rod. Measure journals. Polish journals.	

8973

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Demonstrate and discuss: -- Lap head -- Rethreading spark plug hole	N - pp. 127-136 N - pp. 39-96	5-9	
	Demonstrate and discuss: -- Lap mating surface -- Repairing hole in block -- Oversize cylinder -- Deglazing cylinder -- Measuring bore -- Measuring valve guide -- Measuring main bearing	N - pp. 39-96	4-1 5-8	
	Demonstrate and discuss: -- Grinding valve seat -- Measuring concentricity -- Replacing valve seat	N - pp. 39-96	5-9	
	Demonstrate and discuss: -- Grinding valve face -- Resurfacing valve butt -- Chamfering valve stem -- Measuring stem -- Checking reed valve			
	Measure bearings.			
	Demonstrate and discuss: -- Use of special ring groove cleaner -- Measuring piston -- Measuring piston pin -- Measuring ring grooves		5-6	
	Measure gap and replace if necessary.			
	Measure crankshaft end.		5-7	
	Align connecting rod.			
	Measure journals.			
	Polish journals.			

8974 1708

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES
F. Lubrication System	Demonstrate and discuss the replacement of broken and worn parts.
G. Cooling System	Demonstrate and discuss the replacement of worn parts.
H. Power Takeoff	Demonstrate and discuss the replacement of: -- Broken and worn pins and keys -- Worn and frayed belts -- Broken and worn bevel gears
<u>Assembly of Small Engine</u>	Review: -- Special tools -- Proper use of fasteners -- Ignition timing -- Valve timing
A. Prior to Assembly	Observe and discuss: -- Pre-oiling of bearings -- Proper installation of gaskets -- Alignment of mating parts
B. Assembly	Assemble in a logical order: -- Piston and rings into cylinder -- Crankshaft, oil dipper, and rod -- Tappets -- Camshaft -- Oil slinger or oil pump -- Sump -- Valves and springs -- Cylinder head -- Magneto -- Flywheel -- Starter and retainer -- Governor and linkage -- Blower housing -- Carburetor -- Fuel tank -- Carburetor Add oil and fuel.

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Demonstrate and discuss the replacement of broken and worn parts.	N - pp. 97-104	4-1 5-6	
Demonstrate and discuss the replacement of worn parts.	N - pp. 97-104		
Demonstrate and discuss the replacement of: -- Broken and worn pins and keys -- Worn and frayed belts -- Broken and worn bevel gears	N - pp. 248-266		
Review: -- Special tools -- Proper use of fasteners -- Ignition timing -- Valve timing		4-1 11-3 5-4 5-6 26-1 29-1	
Observe and discuss: -- Pre-oiling of bearings -- Proper installation of gaskets -- Alignment of mating parts			
Assemble in a logical order: -- Piston and rings into cylinder -- Crankshaft, oil dipper, and rod -- Tappets -- Camshaft -- Oil slinger or oil pump -- Sump -- Valves and springs -- Cylinder head -- Magneto -- Flywheel -- Starter and retainer -- Governor and linkage -- Blower housing -- Carburetor -- Fuel tank -- Carburetor			
Add oil and fuel.			

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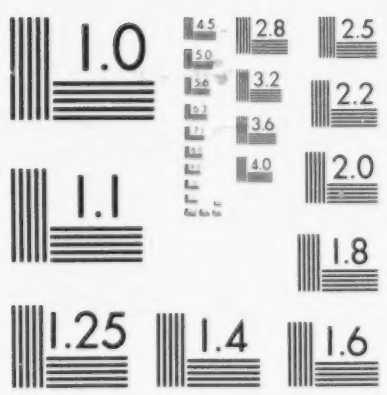

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REF
Adjustment, Testing, Starting, and Storage		
A. Prior to Starting	Tests prior to starting: -- Ignition -- Compression -- Carburetion Compare and discuss results of tests with those prior to reconditioning.	N - pp
B. Starting Procedure	Discuss and demonstrate starting procedure: -- Secure engine. -- Vent exhaust. -- Start engine. -- Adjust carburetor.	
C. Storage	Discuss storage: -- Winter -- Summer Write an evaluation of the reconditioning consisting of: -- Manufacture of engine -- Model, serial, and type number -- Application of engine -- Step-by-step list of procedure followed -- Results of reconditioning	
Basic Hydraulics		
A. Student Orientation	Introduce and discuss: -- Objectives -- Student responsibility -- Safety	M - S

8977

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	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
g,				
	Tests prior to starting: -- Ignition -- Compression -- Carburetion	N - pp. 137-151	4-1 15-2 11-3 5-11 5-5	
	Compare and discuss results of tests with those prior to reconditioning.		26-1 29-1	
	Discuss and demonstrate starting procedure: -- Secure engine. -- Vent exhaust. -- Start engine. -- Adjust carburetor.			
	Discuss storage: -- Winter -- Summer			
	Write an evaluation of the reconditioning consisting of: -- Manufacture of engine -- Model, serial, and type number -- Application of engine -- Step-by-step list of procedure followed -- Results of reconditioning			
	Introduce and discuss: -- Objectives -- Student responsibility -- Safety	M - Sec. 1	19-1 21-1	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERE
B. Basic Mathematics	Review: -- Whole numbers -- Fractions -- Decimals -- Formulas and measurement	M - Sec. 4
C. Basic Hydraulics Principles	Present and discuss: -- Symbols -- Diagrams -- Fundamentals -- Simple application	M - Sec. 6 Sec. 7
D. Applied Hydraulics	Observe and identify basic components: -- Controls -- Pumps -- Conductor Design a basic system.	M - Sec.
E. Troubles and Problems	Present and discuss: -- Isolating cause of trouble -- Testing -- Correction of problem	M - Sec.
F. Fluid	Observe and discuss: -- Characteristics -- Handling -- Filtration	M - Sec.
<u>End of Semester</u>		
A. Review	If time permits, review the following: -- Areas of weakness -- Areas of great interest Prepare students for next semester.	
B. Evaluation	Discuss students' progress.	
C. Close	Administer final exam.	

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Review: -- Whole numbers -- Fractions -- Decimals -- Formulas and measurement	M - Sec. 4		
les	Present and discuss: -- Symbols -- Diagrams -- Fundamentals -- Simple application	M - Sec. 6 Sec. 7	1-1 12-2 12-3 12-4 12-9 12-29 12-30 12-31 12-32	
	Observe and identify basic components: -- Controls -- Pumps -- Conductor	M - Sec. 20		
	Design a basic system.			
	Present and discuss: -- Isolating cause of trouble -- Testing -- Correction of problem	M - Sec. 21		
	Observe and discuss: -- Characteristics -- Handling -- Filtration	M - Sec. 15		
	If time permits, review the following: -- Areas of weakness -- Areas of great interest			
	Prepare students for next semester.			
	Discuss students' progress.			
	Administer final exam.			

8980

POWER AND TRANSPORTATION 3 AND 4

In the advanced semesters of power and transportation, the instruct more complex. In Power and Transportation 3, instruction is organized a projects with related classroom theory, following a step-by-step procedu and Transportation 4, the student is introduced in a detailed manner to electrical systems. In the electrical section, related shop experiences provided. Theory is also presented on clutches, transmissions, drive me chassis, but all of the area high school shops will not necessarily be e include practical experiences in these areas.

Students enrolling in this course will probably be interested in th opportunities of power and transportation.

8981 1868

POWER AND TRANSPORTATION 3 AND 4

semesters of power and transportation, the instructional units become
er and Transportation 3, instruction is organized around individual
classroom theory, following a step-by-step procedure. In Power
the student is introduced in a detailed manner to automotive
In the electrical section, related shop experiences should be
also presented on clutches, transmissions, drive mechanisms, and
he area high school shops will not necessarily be equipped to
eriences in these areas.

ng in this course will probably be interested in the vocational
r and transportation.

8982

COURSE OUTLINE -- POWER AND TRANSPORTATION

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFE
Student Orientation		
A. Conduct	Review student attitudes and responsibilities.	
B. Course Content	Present anticipated program in terms of: -- What student should know -- What student should be able to do	
C. Class Management	Explain classroom and shop: -- Policy -- Procedures	
D. Safety	Review safety rules to be followed in the shop: -- Personal -- Tool -- Machine	
Necessary Knowledge		
A. Automotive Engine Theory	Study and observe types in general use.	
	Present and discuss information on: -- Four-stroke cycle -- Two-stroke cycle -- Engine breathing -- Mechanical efficiency -- Thermal efficiency -- Volumetric efficiency -- Horsepower and measurement	N - pp. I - pp.

8983

COURSE OUTLINE -- POWER AND TRANSPORTATION 3

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
eview student attitudes and esponsibilities.			
resent anticipated program in terms f: -- What student should know -- What student should be able to do			
xplain classroom and shop: -- Policy -- Procedures			
eview safety rules to be followed n the shop: -- Personal -- Tool -- Machine			
Study and observe types in general use.			
Present and discuss information on: -- Four-stroke cycle -- Two-stroke cycle -- Engine breathing -- Mechanical efficiency -- Thermal efficiency -- Volumetric efficiency -- Horsepower and measurement	N - pp. 16-38 I - pp. 10-31	15-2 7-1 6-1 7-2 12-18 12-19 14-7 17-2	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
B. Arrangement of Cylinders	Study and observe types in general use.	
	Present and discuss information on: -- "I" type engine -- "V" type engine -- Opposed types -- Other types	N - pp. 39-47
C. Arrangement of Valves	Study and observe types in general use.	
	Present and discuss information on: -- "L" head -- "I" head -- "F" head -- "T" head -- Others	I - pp. 69-92 N - pp. 80-96 C - pp. 272-29
D. Nomenclature of Engine Parts	Study and observe types in general use.	
	Present and discuss information on: -- Cylinder heads -- Valves -- Pistons -- Rings -- Piston pins -- Crankshafts -- Connecting rods -- Bearings -- Camshafts	N - pp. 39-96 I - pp. 93-12
E. Cleaning of Parts	Study and observe types in general use.	
	Present safety measures and discuss information on: -- Alkaline cleaners -- Emulsifiable cleaners -- Solvent cleaners -- Petroleum spirits -- Acid cleaners	

8985 8988

EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
observe types in general			
d discuss information on: ype engine ype engine ed types types	N - pp. 39-47	15-2 7-1 6-1	
observe types in general			
d discuss information on: ead ead ead ead s	I - pp. 69-92 N - pp. 80-96 C - pp. 272-299		
observe types in general			
nd discuss information on: nder heads es ons s on pins kshafts ecting rods ings hafts	N - pp. 39-96 I - pp. 93-121		
observe types in general			
afety measures and discuss on on: line cleaners sifiable cleaners vent cleaners oleum spirits l cleaners			

8986

8987

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RI
Disassembly and Diagnosis		
A. Diagnosis of Engine Before Disassembly	Study and observe engine in operation.	N - p
	Present information on and check for: -- Oil loss -- Oil burning -- Compression loss -- Excessive noise -- Faulty parts	
B. Accessory Removal	*Remove and clean accessories in a logical sequence such as follows:* -- Air cleaner -- Carburetor -- Manifolds -- Generator -- Fan assembly -- Fuel pump -- Wires and plugs -- Distributor -- Oil filter -- Starter	
	Present related information on storing parts and proper disassembly.	
C. Engine Disassembly, Diagnosis, and Cleaning	Demonstrate proper procedure and use of special tools.	
1. Hoses, Pump, Tubes, and Water Jackets	Remove hoses and check for cracks and separation.	
	Remove pump and check bearings and impeller for wear, leaks, and damage.	
	Check distribution tubes for deterioration.	
	Inspect water jackets in block and head for scale, deposits, and cracks.	
	Clean, repair, and replace as necessary.	

8987

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
fore	Study and observe engine in operation.	N - pp. 115-121	20-3 7-1	
	Present information on and check for: -- Oil loss -- Oil burning -- Compression loss -- Excessive noise -- Faulty parts		6-1 2-2 7-2 18-1 20-2 20-3 20-4	
	Remove and clean accessories in a logical sequence such as follows: -- Air cleaner -- Carburetor -- Manifolds -- Generator -- Fan assembly -- Fuel pump -- Wires and plugs -- Distributor -- Oil filter -- Starter		20-5 20-3	
	Present related information on storing parts and proper disassembly.			
g	Demonstrate proper procedure and use of special tools.		20-3 15-2 7-1	
s,	Remove hoses and check for cracks and separation.		6-1 7-2 10-1	
	Remove pump and check bearings and impeller for wear, leaks, and damage.		12-20 12-21 12-22	
	Check distribution tubes for deterioration.		12-23 18-1	
	Inspect water jackets in block and head for scale, deposits, and cracks.			
	Clean, repair, and replace as necessary.			

8988

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES
2. Heads, Valves, Springs, and Guides	Demonstrate proper procedure and use of special tools. Remove heads, inspect for deposits and cracks, and clean as necessary. Remove valves; clean and inspect for wear--dished, necked, burned, or cracked. Inspect keepers, seals, springs, and guides for wear and other defects.
3. Oil Pan and Pump	Remove oil pan and inspect deposits for metal and other contaminants, indicating trouble. Inspect and clean pan. Remove pump and inspect for wear and defects. Clean as necessary.
4. Piston, Pins, Rings, Connecting Rods, and Bearings	Demonstrate proper procedure and use of the ridge reamer and other specia tools. Remove piston assembly; clean and inspect for wear, cracks, and other defects.
5. Vibration Damper, Timing Cover, Chain, and Gears	Demonstrate use of damper pullers. Remove, clean, and inspect damper ar cover. Check gears and chain for wear and defects.

8989 8993

IS	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Springs,	Demonstrate proper procedure and use of special tools.	I - pp. 69-92		
	Remove heads, inspect for deposits and cracks, and clean as necessary.			
	Remove valves; clean and inspect for wear--dished, necked, burned, or cracked.			
	Inspect keepers, seals, springs, and guides for wear and other defects.			
	Remove oil pan and inspect deposits for metal and other contaminants, indicating trouble.	I - pp. 47-68 C - pp. 83-99		
	Inspect and clean pan.			
	Remove pump and inspect for wear and defects.			
	Clean as necessary.			
ings, , and	Demonstrate proper procedure and use of the ridge reamer and other special tools.	I - pp. 93-121 C - pp. 100-112 C - pp. 300-318		
	Remove piston assembly; clean and inspect for wear, cracks, and other defects.			
r, hain,	Demonstrate use of damper pullers.	I - pp. 89-91	20-3 15-2	
	Remove, clean, and inspect damper and cover.		7-1	
	Check gears and chain for wear and defects.			

8990

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
6. Bell Housing and Flywheel or Converter	Remove bell and flywheel.	I - pp
	Clean and inspect as necessary.	
7. Crankshaft	Remove main bearings and mark order.	
	Remove crankshaft and make a visual inspection for wear, weakness, and other deterioration.	
	Clean as necessary.	
8. Camshaft and Lifters	Remove camshaft and lifters.	I - pp
	Make a visual inspection for defects and excessive wear.	
	Clean as necessary.	
	Demonstrate the use of the camshaft bearing puller.	
9. Engine Block	Remove freeze plugs and oil gallery plugs.	C - pp C - pp
	Completely clean and inspect all internal parts in preparation for reconditioning.	
D. Engine Reconditioning and Assembly	Present and discuss general reconditioning techniques.	I - pp
1. Measurements	Demonstrate measuring and proper use of charts and tables.	
	Discuss tolerances and reject sizes.	

8991

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Remove bell and flywheel.	I - pp. 279-290		
Clean and inspect as necessary.			
Remove main bearings and mark order.			
Remove crankshaft and make a visual inspection for wear, weakness, and other deterioration.			
Clean as necessary.			
Remove camshaft and lifters.	I - pp. 112-120		
Make a visual inspection for defects and excessive wear.			
Clean as necessary.			
Demonstrate the use of the camshaft bearing puller.			
Remove freeze plugs and oil gallery plugs.	C - pp. 83-99 C - pp. 189-199		
Completely clean and inspect all internal parts in preparation for reconditioning.			
Present and discuss general reconditioning techniques.	I - pp. 279-290	15-2, pp. 3-1 to 3-5 20-3 7-2 18-1	
Demonstrate measuring and proper use of charts and tables.			
Discuss tolerances and reject sizes.			

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFE
2. Engine Block	Demonstrate and discuss proper reconditioning procedures for: -- Boring cylinders -- Honing cylinders -- Fitting pistons -- Proper cleaning -- Pre-oiling engine parts -- Installing plugs Observe, study, and practice proper overhaul and assembly techniques.	
3. Crankshaft and Camshaft Assemblies	Demonstrate and discuss proper reconditioning procedures for: -- Grinding shafts -- Using undersize bearings -- Using bearing shims -- Using plastigage -- Installing bearings -- Checking clearances -- Timing valves -- Using torque wrench Observe, study, and practice proper overhaul and assembly techniques.	I - pp.
4. Pistons, Pins, Rings, and Connecting Rods	Demonstrate and discuss proper reconditioning procedures for: -- Using manulathe -- Knurling pistons -- Fitting rings -- Fitting pins -- Straightening rods -- Ring compressors -- Checking clearance -- Use of torque wrench Observe, study, and practice proper overhaul and assembly techniques.	I - pp.

8993

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Demonstrate and discuss proper reconditioning procedures for: -- Boring cylinders -- Honing cylinders -- Fitting pistons -- Proper cleaning -- Pre-oiling engine parts -- Installing plugs		15-2 20-3 7-1 6-1	
Observe, study, and practice proper overhaul and assembly techniques.			
Demonstrate and discuss proper reconditioning procedures for: -- Grinding shafts -- Using undersize bearings -- Using bearing shims -- Using plastigage -- Installing bearings -- Checking clearances -- Timing valves -- Using torque wrench	I - pp. 93-121	15-2 20-3	
Observe, study, and practice proper overhaul and assembly techniques.			
Demonstrate and discuss proper reconditioning procedures for: -- Using manulathe -- Knurling pistons -- Fitting rings -- Fitting pins -- Straightening rods -- Ring compressors -- Checking clearance -- Use of torque wrench	I - pp. 93-121	20-3 15-2	
Observe, study, and practice proper overhaul and assembly techniques.			

8994

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
5. Oil Pump and Pan	Demonstrate and discuss proper use of: -- Sealers -- Seals -- Gaskets	I - pp. 47-68
	Observe, study, and practice correct procedures.	
6. Valve Train	Demonstrate and discuss proper reconditioning procedures for: -- Using valve grinder -- Using valve seat grinder -- Replacing guides -- Reaming guides -- Knurling guides -- Installing seals -- Checking springs -- Servicing rocker arms and lifters -- Adjusting valve lash	I - pp. 69-92
	Observe, study, and practice proper overhaul and assembly techniques.	
7. Accessory Replacement	Demonstrate and discuss proper assembly procedures.	
	Present information on replacing: -- Starter -- Filter -- Distributor -- Wires and plugs -- Fuel pump -- Fan and water pump -- Generator -- Manifolds -- Carburetor -- Air cleaner	

8995

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
monstrate and discuss proper use of: -- Sealers -- Seals -- Gaskets	I - pp. 47-68	15-2 20-3 7-1 6-1	
serve, study, and practice correct ocedures.			
monstrate and discuss proper conditioning procedures for: -- Using valve grinder -- Using valve seat grinder -- Replacing guides -- Reaming guides -- Knurling guides -- Installing seals -- Checking springs -- Servicing rocker arms and lifters -- Adjusting valve lash	I - pp. 69-92	15-2	
bserve, study, and practice proper verhaul and assembly techniques.			
emonstrate and discuss proper ssembly procedures.			
resent information on replacing: -- Starter -- Filter -- Distributor -- Wires and plugs -- Fuel pump -- Fan and water pump -- Generator -- Manifolds -- Carburetor -- Air cleaner			

8996

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
E. Starting, Adjusting, and Testing	Place clean oil and water in a clean engine. Perform final sequence as follows: -- Wire engine. -- Start engine. -- Time engine. -- Adjust carburetor. -- Observe readings. -- Check for leaks. Observe, study, and practice proper break-in procedure.	
<u>End of Semester</u>		
A. Review	If time permits, review the following: -- Areas of weakness -- Areas of great interest Prepare students for next semester.	
B. Evaluation	Discuss student progress and ways to improve.	
C. Close	Turn in all work, keys, etc. Administer final exam.	

8997

0008

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
lace clean oil and water in a clean ngine.		15-2 20-3 7-1	
erform final sequence as follows: -- Wire engine. -- Start engine. -- Time engine. -- Adjust carburetor. -- Observe readings. -- Check for leaks.		6-1 2-1 7-2 18-1	
bserve, study, and practice proper reak-in procedure.			
f time permits, review the ollowing: -- Areas of weakness -- Areas of great interest			
repare students for next semester.			
iscuss student progress and ways to mprove.			
urn in all work, keys, etc.			
dminister final exam.			

COURSE OUTLINE -- POWER AND TRANSPORTATION 4

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
Student Orientation		
A. Conduct	Review student attitudes and responsibilities.	
B. Course Content	Present anticipated program in terms of: -- What student should know -- What student should be able to do	
C. Class Management	Explain classroom and shop: -- Policy -- Procedures	
D. Safety	Review safety rules to be followed in the shop: -- Personal -- Tool -- Machine	
Fundamentals of Automotive Electrical Systems		
A. Basic Electricity	Review and discuss electron theory. Stress the following: -- Atom construction -- Insulators -- Conductors -- Volts, amperes, and ohms -- Ohm's law -- Magnetism -- Types of circuits -- Voltage drop	I - pp. 171-193 N - pp. 152-222

8999

COURSE OUTLINE -- POWER AND TRANSPORTATION 4

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Review student attitudes and responsibilities. Present anticipated program in terms of: -- What student should know -- What student should be able to do Explain classroom and shop: -- Policy -- Procedures Review safety rules to be followed in the shop: -- Personal -- Tool -- Machine			
Review and discuss electron theory. Stress the following: -- Atom construction -- Insulators -- Conductors -- Volts, amperes, and ohms -- Ohm's law -- Magnetism -- Types of circuits -- Voltage drop	I - pp. 171-193 N - pp. 152-222	15-2 7-1 6-1 2-3 9-1 9-2 9-5 9-8 12-57 12-58 12-59 12-60 12-61 17-3	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCE
B. Ignition Systems	Review basic functions of: -- Battery -- Switches -- Coil -- Plugs -- Condenser -- Points -- Advance mechanisms -- Primary and secondary circuits Demonstrate and discuss: -- Cleaning and adjusting plugs -- Testing coil -- Testing condenser -- Installation of points -- Adjusting points -- Setting timing -- Adjusting advance -- Testing for continuity -- Analyzing engine Study, observe, and practice as many ignition exercises as possible using testing equipment.	I - pp. 248-2 N - pp. 152-2
C. Charging Systems	Review basic functions of: -- Electricity -- Generators -- Regulators -- Alternators -- Rectifiers -- Diodes Demonstrate and discuss: -- Replacing brushes -- Turning commutators -- Servicing slip rings -- Testing armatures -- Testing rotors -- Testing fields -- Testing diodes	I - pp. 223- N - pp. 152- C - pp. 215- C - pp. 271-

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Review basic functions of:	I - pp. 248-278	15-2	
-- Battery	N - pp. 152-222	7-1	
-- Switches		6-1	
-- Coil		2-3	
-- Plugs		9-2	
-- Condenser		9-5	
-- Points		9-6	
-- Advance mechanisms		9-9	
-- Primary and secondary circuits		9-12	
		9-13	
Demonstrate and discuss:		12-53	
-- Cleaning and adjusting plugs			
-- Testing coil			
-- Testing condenser			
-- Installation of points			
-- Adjusting points			
-- Setting timing			
-- Adjusting advance			
-- Testing for continuity			
-- Analyzing engine			
Study, observe, and practice as many ignition exercises as possible using testing equipment.			
Review basic functions of:	I - pp. 223-247	2-4	
-- Electricity	N - pp. 152-222	9-3	
-- Generators	C - pp. 215-232	9-7	
-- Regulators	C - pp. 271-283	9-10	
-- Alternators		9-14	
-- Rectifiers		9-15	
-- Diodes		12-48	
		12-49	
Demonstrate and discuss:			
-- Replacing brushes			
-- Turning commutators			
-- Servicing slip rings			
-- Testing armatures			
-- Testing rotors			
-- Testing fields			
-- Testing diodes			

9002

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENC
	-- Setting and servicing regulators -- Polarizing and cycling Study, observe, and practice as many practical exercises as facilities permit.	
D. Starting Systems	Review basic functions of: -- Starters -- Solenoids -- Relays Demonstrate and discuss: -- Testing for open circuits, shorts, and grounds -- Generator service that relates to starters -- Checking current draw -- Servicing drive mechanisms Study, observe, and practice using the test instruments.	I - pp. 223 N - pp. 152 C - pp. 200
<u>Fundamentals of Fuel Systems</u>		
A. Fuel Delivery System	Review basic functions of: -- Tank -- Lines -- Filters -- Pumps Demonstrate and discuss: -- Part replacement -- Test system for vacuum, pressure, and capacity -- Making a fuel line Use a fuel pump tester to analyze delivery system.	I - pp. 122 N - pp. 137

900300

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
-- Setting and servicing regulators -- Polarizing and cycling		15-2 7-1 6-1	
udy, observe, and practice as many actical exercises as facilities rmit.			
eview basic functions of: -- Starters -- Solenoids -- Relays	I - pp. 223-247 N - pp. 152-222 C - pp. 200-214	9-4 9-11 12-50	
emonstrate and discuss: -- Testing for open circuits, shorts, and grounds -- Generator service that relates to starters -- Checking current draw -- Servicing drive mechanisms			
tudy, observe, and practice using he test instruments.			
eview basic functions of: -- Tank -- Lines -- Filters -- Pumps	I - pp. 122-125 N - pp. 137-151	2-3 14-1 18-1 27-1	
emonstrate and discuss: -- Part replacement -- Test system for vacuum, pressure, and capacity -- Making a fuel line			
Use a fuel pump tester to analyze delivery system.			

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERE
B. Fuel Mixing System	Review basic functions of: -- Air cleaner -- Carburetion -- Carburetor systems -- Manifolds Demonstrate and discuss: -- Replacement -- Repair -- Testing -- Adjusting Use a vacuum gauge, tachometer, and exhaust gas analyzer to analyze system.	I - pp. 12 N - pp. 13
<u>Power Train</u>		
A. Clutch	Present and discuss information on need, construction, and operation of clutches. Study and observe types in general use. Students should develop an understanding of: -- Adjustment -- Rebuilding -- Troubleshooting	A - pp. 14 I - pp. 27 C - pp. 39 C - pp. 40 D - pp. 1-
B. Transmissions	Present and discuss information on: -- Standard transmissions -- Planetary gear set -- Overdrive -- Automatic transmissions -- Torque converter Study and observe basic parts.	I - pp. 2 C - pp. 4

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Review basic functions of: -- Air cleaner -- Carburetion -- Carburetor systems -- Manifolds Demonstrate and discuss: -- Replacement -- Repair -- Testing -- Adjusting Use a vacuum gauge, tachometer, and exhaust gas analyzer to analyze system.	I - pp. 122-170 N - pp. 135-151	15-2 7-1 6-1 2-3 12-41 12-42 12-43 12-44	
Present and discuss information on need, construction, and operation of clutches. Study and observe types in general use. Students should develop an understanding of: -- Adjustment -- Rebuilding -- Troubleshooting	A - pp. 140-155 I - pp. 279-291 C - pp. 391-400 C - pp. 401-405 D - pp. 1-100	13-2 7-1 12-24 12-25 12-27 18-1	
Present and discuss information on: -- Standard transmissions -- Planetary gear set -- Overdrive -- Automatic transmissions -- Torque converter Study and observe basic parts.	I - pp. 292-332 C - pp. 406-427	13-2 12-26 12-29 12-30 12-31 12-32 12-33 12-34 12-35 12-36 12-37 12-38	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
	Students should develop an understanding of: -- Power flow -- Hydraulics -- Servicing -- Overhaul -- Troubleshooting	
C. Drive Mechanisms	Present and discuss information on: -- Drive shaft -- Universal joints -- Rear end Study and observe types in general use. Develop an understanding of: -- Torque tube -- Hotchkiss -- Backlash -- Preload -- Hunting -- Partial nonhunting -- Nonhunting -- Tooth patterns -- Hypoid -- Full floating -- Three-quarter floating -- Semi-floating -- Service -- Troubleshooting	I - pp. 333-356 C - pp. 502-508
<u>Chassis Work</u>		
A. Steering	Present and discuss information on: -- Steering gears -- Power steering -- Front-end geometry Study and observe types in general use.	I - pp. 357-388 C - pp. 533-560 D - pp. 1-100

9007

9008

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Students should develop an understanding of: -- Power flow -- Hydraulics -- Servicing -- Overhaul -- Troubleshooting		15-2	
Present and discuss information on: -- Drive shaft -- Universal joints -- Rear end	I - pp. 333-356 C - pp. 502-508	13-2 7-1 6-1 12-13 12-14 12-15 18-1	
Study and observe types in general use.			
Develop an understanding of: -- Torque tube -- Hotchkiss -- Backlash -- Preload -- Hunting -- Partial nonhunting -- Nonhunting -- Tooth patterns -- Hypoid -- Full floating -- Three-quarter floating -- Semi-floating -- Service -- Troubleshooting			
Present and discuss information on: -- Steering gears -- Power steering -- Front-end geometry	I - pp. 357-388 C - pp. 533-560 D - pp. 1-100	3-1 22-1 15-2 7-1 6-1	
Study and observe types in general use.			

9008

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REF
	Students should develop an understanding of: -- Rack and pinion -- Worm and sector -- Screw and nut -- Integral and auxiliary power steering -- Camber -- Caster -- Toe-in -- Toe-out -- Steering balance	
B. Suspension	Present and discuss information on: -- Frames -- Axles -- Springs -- Shocks Study and observe types in general use. Students should develop an understanding of: -- Leaf springs -- Coil springs -- Torsion bars -- Independent suspension -- Solid axle suspension -- Direct acting shocks -- Single-acting shocks	I - pp.
C. Wheels and Tires	Present and discuss information on: -- Tire and wheel construction -- Tire repair -- Balancing Study and observe types in general use.	I - pp C - pp

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Students should develop an understanding of: -- Rack and pinion -- Worm and sector -- Screw and nut -- Integral and auxiliary power steering -- Camber -- Caster -- Toe-in -- Toe-out -- Steering balance		12-6 12-7 12-8 12-9 18-1	
	Present and discuss information on: -- Frames -- Axles -- Springs -- Shocks	I - pp. 389-401	3-1 2-6 12-5 18-1	
	Study and observe types in general use.			
	Students should develop an understanding of: -- Leaf springs -- Coil springs -- Torsion bars -- Independent suspension -- Solid axle suspension -- Direct acting shocks -- Single-acting shocks			
	Present and discuss information on: -- Tire and wheel construction -- Tire repair -- Balancing	I - pp. 402-421 C - pp. 595-601	3-1 15-2 7-1 6-1 12-10 18-1	
	Study and observe types in general use.			

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCE
	Students should develop an understanding of: -- Tube and tubeless -- Demountable rims -- Drop-center wheels -- Static balance -- Dynamic balance -- Wheel hubs -- Bearing and spindles	
D. Brakes	Present and discuss information on: -- Actuating brakes -- Servicing brakes -- Power brakes Study and observe types in general use. Develop an understanding of: -- Kinetic energy -- Coefficient of friction -- Brake and tire friction -- Hydraulic brake operation -- Fitting shoes -- Turning drums -- Booster operation -- Bleeding brakes -- Adjustment	I - pp. 422-4 C - pp. 571-5
<u>End of Semester</u>		
A. Review	If time permits, review the following: -- Areas of weakness -- Areas of greatest interest Prepare students for next semester.	
B. Evaluation	Discuss student progress and ways to improve.	
C. Close	Turn in all work, keys, etc. Administer final exam.	

9011

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Students should develop an understanding of: -- Tube and tubeless -- Demountable rims -- Drop-center wheels -- Static balance -- Dynamic balance -- Wheel hubs -- Bearing and spindles			
Present and discuss information on: -- Actuating brakes -- Servicing brakes -- Power brakes	I - pp. 422-450 C - pp. 571-586	1-1 1-2 2-6 12-2 12-3 12-4 18-1	
Study and observe types in general use.			
Develop an understanding of: -- Kinetic energy -- Coefficient of friction -- Brake and tire friction -- Hydraulic brake operation -- Fitting shoes -- Turning drums -- Booster operation -- Bleeding brakes -- Adjustment			
If time permits, review the following: -- Areas of weakness -- Areas of greatest interest			
Prepare students for next semester.			
Discuss student progress and ways to improve.			
Turn in all work, keys, etc.			
Administer final exam.			

9012
9003
9012

The third year of power and transportation includes the fuel system and ignition system.

A variety of test instruments and special tools will be student.

The suspension and steering system will also be stressed whenever possible.

Vocational guidance is included to help prepare the stud employment.

9013 a10e

POWER AND TRANSPORTATION 5 AND 6

ear of power and transportation includes the theory and testing of the
ignition system.

f test instruments and special tools will be used and serviced by the

ion and steering system will also be stressed, with laboratory experience
e.

guidance is included to help prepare the student for future

9014

COURSE OUTLINE -- POWER AND TRANSPORTATI

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
<u>Student Orientation</u>		
A. Student Conduct	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School	
B. Course Content	Present anticipated program in terms of: -- Student knowledge -- Student skills	
C. Classroom Management	Explain classroom and shop: -- Policy -- Procedure	
<u>Theory of Fuel</u>		
A. Types of Fuel	Discuss various types of fuel in general use: -- Gasoline -- Natural -- Artificial -- Benzol -- Propane -- Butane -- Diesel -- L.P. fuel -- Sewer gas	K - p G - p
B. Composition and Characteristics of Gasoline	Discuss terms: -- Color -- Order -- Volatility -- Hydrogen carbon compound -- Octane rating	

019015

COURSE OUTLINE -- POWER AND TRANSPORTATION 5

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School			
	Present anticipated program in terms of: -- Student knowledge -- Student skills			
	Explain classroom and shop: -- Policy -- Procedure			
	Discuss various types of fuel in general use: -- Gasoline -- Natural -- Artificial -- Benzol -- Propane -- Butane -- Diesel -- L.P. fuel -- Sewer gas	K - pp. 136-174 G - pp. 1-75	2-2 15-2 7-1 6-1	
	Discuss terms: -- Color -- Order -- Volatility -- Hydrogen carbon compound -- Octane rating		2-2 2-3	

3013 9106

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REF
C. Refining of Petroleum	Present and discuss charts and drawings of refining processes. Basic processes: -- Still -- Fractionating tower -- Condenser Other processes: -- Thermal cracking -- Catalytic cracking -- Reforming -- Polymerization -- Others	
D. Combustion of Gasoline	Present and discuss elements of combustion: -- Air-fuel mixture -- Flame speed -- Pressure -- Detonation -- Preignition	K - pp
E. Methods of Rating Octane	Present and discuss methods: -- C.F.R. engine -- Research Prepare chart on octane rating of popular brands.	
F. Gasoline Additives	Present and discuss additives and their purpose: -- Tetraethyl lead -- Metal deactivators -- Phosphorus compounds -- Anti-icers	
G. Diesel Fuel and Turbine Fuel	Discuss and compare diesel and automotive fuel with respect to: -- Heat value -- Operating efficiency	

9017

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Present and discuss charts and drawings of refining processes.		2-2 15-2 7-1 6-1	
Basic processes: -- Still -- Fractionating tower -- Condenser			
Other processes: -- Thermal cracking -- Catalytic cracking -- Reforming -- Polymerization -- Others			
Present and discuss elements of combustion: -- Air-fuel mixture -- Flame speed -- Pressure -- Detonation -- Preignition	K - pp. 136-174	2-2	
Present and discuss methods: -- C.F.R. engine -- Research		2-2	
Prepare chart on octane rating of popular brands.			
Present and discuss additives and their purpose: -- Tetraethyl lead -- Metal deactivators -- Phosphorus compounds -- Anti-icers		2-2	
Discuss and compare diesel and automotive fuel with respect to: -- Heat value -- Operating efficiency		2-2	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES
H. Liquified Petroleum Gas	Present and discuss uses and characteristics: -- Butane -- Propane
<u>Components of Fuel System</u>	Review components of fuel system with respect to function and types: -- Fuel tank -- Fuel gauge -- Fuel filter -- Fuel lines -- Air cleaner -- Intake manifold -- Heat control valve -- Fuel pump -- Carburetor
<u>Testing and Troubleshooting of Fuel System</u>	
A. Fuel Pump Gauge	Demonstrate proper use of various instruments and record all measurements: -- Test pressure and volume of fuel pump. -- Test for leaky intake. -- Carburetor adjustment -- Idle mixture adjustments
B. Vacuum Gauge	Discuss the theoretical aspects of fuel pump guage, vacuum gauge, and related mathematics problems.
C. Combustion Analyzer	Demonstrate and discuss theory of analyzer; record amount of carbon dioxide in exhaust.
<u>Theory of Ignition</u>	
A. Electrical Theory	Review basic electrical theory and terms: -- Analyzing basic circuits -- Using Ohm's law -- Solving electrical problems

9019

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Present and discuss uses and characteristics: -- Butane -- Propane		2-2	
	Review components of fuel system with respect to function and types: -- Fuel tank -- Fuel gauge -- Fuel filter -- Fuel lines -- Air cleaner -- Intake manifold -- Heat control valve -- Fuel pump -- Carburetor	I - pp. 122-168 C - pp. 127-164	2-2 15-2 7-1 6-1	
	Demonstrate proper use of various instruments and record all measurements: -- Test pressure and volume of fuel pump. -- Test for leaky intake. -- Carburetor adjustment -- Idle mixture adjustments	I - pp. 122-168 C - pp. 333-341 F - pp. 1-150	2-2 15-2 2-3 18-1	
	Discuss the theoretical aspects of fuel pump guage, vacuum gauge, and related mathematics problems.			
	Demonstrate and discuss theory of analyzer; record amount of carbon dioxide in exhaust.	C - pp. 745-746		
	Review basic electrical theory and terms: -- Analyzing basic circuits -- Using Ohm's law -- Solving electrical problems	I - pp. 171-193 K - pp. 200-231 C - pp. 200-214	2-2 15-2 7-1 6-1 9-1	

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AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFE
B. Primary Circuit	Discuss and observe parts of primary circuit with respect to construction and function: -- Ignition switch -- Resistance unit in ignition coil -- Primary winding -- Distributor contact points -- Capacitors -- Low-voltage wiring	C - pp. C - pp. C - pp. E - pp.
C. Secondary Circuit	Discuss and observe parts of secondary circuits with respect to construction, function, and theory: -- Secondary winding -- Coil-to-distributor high tension wire -- Ignition cables -- Distributor rotor -- Spark plugs	
D. Battery Ifnition Components	Discuss and observe entire ignition system. View schematic.	C - pp. C - pp.
<u>Testing and Troubleshooting of Ignition System</u>		
A. Ignition Test Instruments	Demonstrate use of various testing instruments. Discuss theoretical aspects and record findings: -- Compression tester -- Voltmeter -- Ammeter -- Coil and condenser tester -- Engine scope -- Tach and dwell -- Timing light -- Engine analyzer	I - pp. C - pp. E - pp.

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
scuss and observe parts of primary rcuit with respect to construction d function: -- Ignition switch -- Resistance unit in ignition coil -- Primary winding -- Distributor contact points -- Capacitors -- Low-voltage wiring	C - pp. 233-247 C - pp. 384-390 C - pp. 233-237 E - pp. 1-44	2-2 2-3 9-6 9-12 9-13 12-51 18-1 23-1 23-2	
scuss and observe parts of secondary rcuits with respect to construction, nction, and theory: -- Secondary winding -- Coil-to-distributor high tension wire -- Ignition cables -- Distributor rotor -- Spark plugs		2-2	
iscuss and observe entire ignition ystem.	C - pp. 200-214 C - pp. 233-247	2-2	
iew schematic.			
emonstrate use of various testing nstruments.	I - pp. 194-222 C - pp. 384-390 E - pp. 429-441	15-2 7-1 6-1	
iscuss theoretical aspects and ecord findings: -- Compression tester -- Voltmeter -- Ammeter -- Coil and condenser tester -- Engine scope -- Tach and dwell -- Timing light -- Engine analyzer		2-3 9-9 9-15 12-53 24-1 24-2 24-3 24-4	

9022

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENC
<u>Materials Research</u> A. Materials Used in the Power and Transportation Field	This unit involves materials used in the power and transportation field. Using school stationery, the instructor may write to various companies and gather information on the following manufacturing processes: -- Iron and steel -- Aluminum -- Glass -- Plastics -- Paint	B - pp. 40-6
<u>Manufacturing Methods</u>	Discuss and identify various methods of manufacturing: -- Casting -- Stamping -- Extrusion -- Welding -- Forging -- Drawing -- Swaging (rotary) -- Rolling -- Machining -- Powdered metallurgy -- Explosive forming Organize a field trip to a local plant.	B - pp. 77-6
<u>Automotive Careers</u> A. Factors in Job Planning	Discuss the following points to help interested students investigate job possibilities: -- Interest -- Aptitude -- Training -- Job openings -- Job security -- Benefits -- Salary -- Retirement	

9023

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ASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
the Power Field	This unit involves materials used in the power and transportation field. Using school stationery, the instructor may write to various companies and gather information on the following manufacturing processes: -- Iron and steel -- Aluminum -- Glass -- Plastics -- Paint	B - pp. 40-64		
	Discuss and identify various methods of manufacturing: -- Casting -- Stamping -- Extrusion -- Welding -- Forging -- Drawing -- Swaging (rotary) -- Rolling -- Machining -- Powdered metallurgy -- Explosive forming	B - pp. 77-616		
	Organize a field trip to a local plant.			
nning	Discuss the following points to help interested students investigate job possibilities: -- Interest -- Aptitude -- Training -- Job openings -- Job security -- Benefits -- Salary -- Retirement			

9024

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AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES
B. Applying for a Job	Discuss and plan: -- First interview -- Application
<u>Close of Semester</u>	
A. Review	If time permits, review the following: -- Areas of weakness -- Areas of greatest interest Prepare students for next semester.
B. Evaluation	Discuss progress and ways to improve.
C. Close	Turn in all work, keys, etc. Administer final exam.

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Discuss and plan: -- First interview -- Application			
If time permits, review the following: -- Areas of weakness -- Areas of greatest interest			
Prepare students for next semester.			
Discuss progress and ways to improve.			
Turn in all work, keys, etc.			
Administer final exam.			

COURSE OUTLINE -- POWER AND TRANSPORTATIO

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
<u>Student Orientation</u>		
A. Student Conduct	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School	
B. Course Content	Present anticipated program in terms of: -- What student should learn -- What student should be able to do	
C. Class Management	Explain classroom and shop: -- Policy -- Procedures	
D. Safety	Review safety rules to be followed in the shop: -- Personal -- Tool -- Machine	
<u>Fluid Power</u>		
A. Basic Hydraulics	Review operation and mathematics of applied hydraulics.	
	Discuss fluid power in the automobile: -- Brakes -- Power steering -- Shock absorbers -- Automatic transmissions -- Convertible tops	M - S
	Using basic scientific principles, develop an understanding in the mechanics of energy, work, and power.	

9027

COURSE OUTLINE -- POWER AND TRANSPORTATION 6

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School			
	Present anticipated program in terms of: -- What student should learn -- What student should be able to do			
	Explain classroom and shop: -- Policy -- Procedures			
	Review safety rules to be followed in the shop: -- Personal -- Tool -- Machine			
	Review operation and mathematics of applied hydraulics.			
	Discuss fluid power in the automobile: -- Brakes -- Power steering -- Shock absorbers -- Automatic transmissions -- Convertible tops	M - Sec. 1	19-1 25-1	
	Using basic scientific principles, develop an understanding in the mechanics of energy, work, and power.			

9028

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES
B. Components	Observe, study, and practice using various: -- Pumps -- Conductors -- Couplings -- Fittings -- Motors -- Cylinders -- Valves
C. Circuits	Demonstrate and discuss circuit construction from the component viewpoint with special emphasis on: -- Reservoirs -- Strainers -- Filters -- Intensifiers -- Fluids Students should develop an understanding of: -- Terms -- Laws -- Mensuration -- Controls -- Instruments -- Troubleshooting -- Tests -- Application
<u>Automotive Suspension</u>	
A. Principles	Review front-end terminology and discuss the need for suspension.
B. Frames	Discuss the purpose of the frame and stress its importance in suspension. Have students do research on frame materials and construction. Study methods of measuring squareness. Discuss and observe frame-straighteni equipment.

9029

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Observe, study, and practice using various: -- Pumps -- Conductors -- Couplings -- Fittings -- Motors -- Cylinders -- Valves	M - Sec. 12 Sec. 17	19-1 25-1	
Demonstrate and discuss circuit construction from the component viewpoint with special emphasis on: -- Reservoirs -- Strainers -- Filters -- Intensifiers -- Fluids	M - Sec. 12 Sec. 21		
Students should develop an understanding of: -- Terms -- Laws -- Mensuration -- Controls -- Instruments -- Troubleshooting -- Tests -- Application			
Review front-end terminology and discuss the need for suspension. Discuss the purpose of the frame and stress its importance in suspension. Have students do research on frame materials and construction. Study methods of measuring squareness. Discuss and observe frame-straightening equipment.	I - pp. 389-401	3-1 22-1 15-2 7-1 6-1 2-6 12-11 18-1	9030

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	R
C. Shackles	Discuss methods used to attach springs to frame. Students should observe and identify various: -- Hangers -- Bushings -- Shackles -- U-bolts	I - p
D. Springs	Review springs and air cushion. Discuss helper or booster springs. Study spring construction with detail given to: -- Spring inserts -- Spring lubrication -- Rebound clips -- Measuring height -- Safety when servicing	I - p
<u>Automotive Steering</u>	Present nomenclature of automotive steering.	
A. Arms, Links, and Rods	Students should observe and recognize such parts as: -- Steering knuckle arm -- Drag link -- Pitman arm -- Tie rod -- Steering arm -- Steering knuckle -- Sway bar -- Stabilizer bars -- Control arms -- Ball joints	I -

9031

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss methods used to attach springs to frame. Students should observe and identify various: -- Hangers -- Bushings -- Shackles -- U-bolts	I - pp. 389-401	3-1 15-2 7-1 6-1	
	Review springs and air cushion. Discuss helper or booster springs. Study spring construction with detail given to: -- Spring inserts -- Spring lubrication -- Rebound clips -- Measuring height -- Safety when servicing	I - pp. 389-401	3-1 12-11	
	Present nomenclature of automotive steering. Students should observe and recognize such parts as: -- Steering knuckle arm -- Drag link -- Pitman arm -- Tie rod -- Steering arm -- Steering knuckle -- Sway bar -- Stabilizer bars -- Control arms -- Ball joints	I - pp. 357-388	3-1 7-1 6-1 2-6 12-12 18-1	

0032

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
B. Geometry	Review terminology of steering: -- Caster -- Camber -- Kingpin inclination -- Steering axis inclination -- Included angle -- Toe-in -- Toe-out -- Scrub radius -- Slip angles	I - pp. 357-388
C. Adjustment and Service	Develop an understanding of: -- Preliminary inspection -- Checking ball joints -- Checking frames -- Adjustment procedures If possible, student should observe front end and suspension repair.	I - pp. 357-388
<u>Advanced Engine Testing and Research</u>		
A. Testing	Review engine testing and tune-up. Students should be given an opportunity to use and operate the latest testing and tune-up equipment. Students must use their background of knowledge and experience to study engine design and operation, with emphasis on the scientific and mathematical procedures.	
B. Research	Library reports should be assigned. Students should survey: -- Vehicle manufacturers -- Testing equipment manufacturers -- Petroleum industries -- Allied fields In this way, the latest and most current information can be obtained.	

9033

OP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
terminology of steering: ster nber gpin inclination ering axis inclination luded angle -in -out ub radius p angles	I - pp. 357-388	3-1 12-1 12-8	
an understanding of: liminary inspection cking ball joints cking frames ustment procedures	I - pp. 357-388	3-1 12-1 12-8	
ble, student should observe d and suspension repair.			
ngine testing and tune-up.		15-2	
should be given an oppor- o use and operate the latest and tune-up equipment.		7-1 6-1 2-3 2-4 2-5	
must use their background of e and experience to study esign and operation, with on the scientific and ical procedures.		18-1	
reports should be assigned. should survey: icle manufacturers ting equipment manufacturers roleum industries ied fields way, the latest and most current ion can be obtained.			

9034

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Individual tours should be encouraged. Field trips should be arranged to broaden understandings. Present information on how to fill out an application. Discuss the personal interview and stress good grooming. Discuss individual and group testing used by industry. Discuss desirable characteristics that make a person a valuable employee. Discuss the responsibility of the employee to: -- Himself -- The management -- The business -- The community Discuss: -- Attitudes -- Interests -- Goals The above should be used to develop greater insight into: -- Advancement -- Security -- Salary -- Benefits -- Retirement			

9036

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
<u>End of Semester</u>		
A. Review	If time permits, review the following: -- Areas of weakness -- Areas of greatest interest	
B. Evaluation	Discuss student progress and ways to improve.	
C. Close	Turn in all work, keys, etc. Administer final exam.	

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
If time permits, review the following: -- Areas of weakness -- Areas of greatest interest Discuss student progress and ways to improve. Turn in all work, keys, etc. Administer final exam.			

9038

AUTOMOTIVE ENGINE TUNE-UP 1 AND 2

Three semesters of power and transportation are required befo
enroll in Automotive Engine Tune-up 1 and 2.

Emphasis is placed on the actual diagnosing and solving of pr
involving the automobile engine.

The student will use various test instruments and will become
testing all engine systems.

The proper consultation procedures between customer and serv

The student will become familiar with identifying the year a
vehicle.

Current servicing procedures will be utilized according to e
specifications.

9039

AUTOMOTIVE ENGINE TUNE-UP 1 AND 2

Three semesters of power and transportation are required before a student can
in Automotive Engine Tune-up 1 and 2.

Emphasis is placed on the actual diagnosing and solving of practical problems
ving the automobile engine.

The student will use various test instruments and will become familiar with
ng all engine systems.

The proper consultation procedures between customer and serviceman will be stressed.

The student will become familiar with identifying the year and make of a specific
le.

Current servicing procedures will be utilized according to each manufacturer's
fications.

9039

9040

COURSE OUTLINE -- AUTOMOTIVE ENGINE T

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	
Student Orientation		
A. Student Conduct	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School	
B. Course Content	Present anticipated program in terms of: -- Student knowledge -- Student skills	
C. Class Management	Explain classroom and shop: -- Policy -- Procedures	
D. Vocational Planning	Discuss the following points to help students prepare for a job: -- Interest -- Attitude -- Goals -- Aptitude -- Training -- Job openings -- Job security -- Benefits -- Salary -- Retirement -- Customer relations	C
E. Safety	Review safety rules to be followed in the shop: -- Personal -- Tool -- Machine	I I C

OLOC
9041

COURSE OUTLINE -- AUTOMOTIVE ENGINE TUNE-UP 1

ASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss responsibility: -- Individual -- Group -- Classroom -- Shop -- School			
	Present anticipated program in terms of: -- Student knowledge -- Student skills			
	Explain classroom and shop: -- Policy -- Procedures			
ng	Discuss the following points to help students prepare for a job: -- Interest -- Attitude -- Goals -- Aptitude -- Training -- Job openings -- Job security -- Benefits -- Salary -- Retirement -- Customer relations	C - p. 10	2-2	
	Review safety rules to be followed in the shop: -- Personal -- Tool -- Machine	I - pp. 451-463 I - pp. 464-472 C - pp. 11-36		

9041

9042

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
Factors Affecting Engine Tune-up		
A. Identification	Present information on how to identify: -- Year -- Model -- Engine -- Accessory parts Students should observe and practice using: -- Service manuals -- Patent plate symbols -- Engine numbers -- Identification numbers -- Specifications -- Parts books Students should learn to apply information and specifications to vehicle.	
B. Mechanical Condition	Discuss common checks and inspections. Observe and identify: -- Various leaks -- Sources of trouble -- Correct repair procedures -- Worn parts Demonstrate common vehicle noises. Students should be able to recognize and identify all engine troubles. Have students practice diagnostic work and make repair recommendations.	C - pp. 258-272

9043e

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
ent information on how to tify: Year Model Engine Accessory parts		2-3 24-4	
ents should observe and practice g: Service manuals Patent plate symbols Engine numbers Identification numbers Specifications Parts books			
ents should learn to apply rmation and specifications to cle.			
uss common checks and inspections.	C - pp. 258-272		
rve and identify: Various leaks Sources of trouble Correct repair procedures Worn parts			
nstrate common vehicle noises.			
ents should be able to recognize identify all engine troubles.			
students practice diagnostic and make repair recommendations.			

9044

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	
C. Background Information	Discuss the need to get information about vehicle's past service from: -- Owner's comments -- Owner's record -- Shop record Have students volunteer to visit dealerships and report back to class. A field trip would also work in nicely at this time. Invite a guest speaker to give supplementary background information. Assign a project of compiling a service record for the family car.	
<u>Electrical Systems</u>		
A. Basic Electrical Application	Discuss application of Ohm's Law to the electrical system of the vehicle. Identify and learn to service: -- Series circuits -- Parallel circuits -- Combination circuits Discuss and explain proper use of electrical terms and electrical symbols. Study and use electrical pictorial diagrams and electrical schematic diagrams. Observe and practice wiring various engine electrical circuits.	C - E -

9045

-up 1

SIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
ion	Discuss the need to get information about vehicle's past service from: -- Owner's comments -- Owner's record -- Shop record Have students volunteer to visit dealerships and report back to class. A field trip would also work in nicely at this time. Invite a guest speaker to give supplementary background information. Assign a project of compiling a service record for the family car.			
	Discuss application of Ohm's Law to the electrical system of the vehicle. Identify and learn to service: -- Series circuits -- Parallel circuits -- Combination circuits Discuss and explain proper use of electrical terms and electrical symbols. Study and use electrical pictorial diagrams and electrical schematic diagrams. Observe and practice wiring various engine electrical circuits.	C - pp. 200-258 E - pp. 1-45	2-1 2-5 9-1 9-8 24-1	

9648e

131 OF 327

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056 238

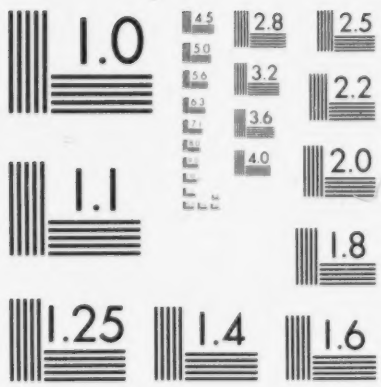

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUP A
	Develop an understanding of the application of: -- Permanent magnets -- Electromagnets -- Residual magnetism -- Short circuit -- Open circuit -- Grounded circuit		
B. Battery	The battery should be studied by itself because it is the source of power or foundation for all electrical systems.	C - pp. 200-215 E - pp. 45-100	12-
	Study and discuss: -- Manufacturer's coding -- Dealer's coding -- S.A.E. ratings -- Size and capacity -- Effects of temperature -- Composition and construction -- Use of hydrometer -- Use of voltmeter		
	Observe and study effects of operating condition of battery materials.		
C. Ignition System	Review and discuss conventional: -- Six-volt system -- Twelve-volt system -- By-pass system	C - pp. 233-248 C - pp. 384-391 E - pp. 397-478	2- 9- 9- 12- 12-
1. Resistors	Locate and identify: -- Ballast resistor -- Resistance coil -- Resistance wire		28- 23- 24-

9047

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
evelop an understanding of the pplication of: -- Permanent magnets -- Electromagnets -- Residual magnetism -- Short circuit -- Open circuit -- Grounded circuit			
e battery should be studied by tself because it is the source of ower or foundation for all lectrical systems.	C - pp. 200-215 E - pp. 45-100	12-45	
tudy and discuss: -- Manufacturer's coding -- Dealer's coding -- S.A.E. ratings -- Size and capacity -- Effects of temperature -- Composition and construction -- Use of hydrometer -- Use of voltmeter			
bserve and study effects of operating ondition of battery materials.			
eview and discuss conventional: -- Six-volt system -- Twelve-volt system -- By-pass system	C - pp. 233-248 C - pp. 384-391 E - pp. 397-478	2-3 9-6 9-13 12-51 12-53	
ocate and identify: -- Ballast resistor -- Resistance coil -- Resistance wire		28-1 23-2 24-2	

0048

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCE
2. Distributors	Demonstrate proper removal and inspection of various distributors. Remove, repair, and replace: -- Single contacts -- Double contacts -- Centrifugal advance units -- Vacuum advance units -- Primary wiring -- Condenser -- Rotors -- Distributor caps	
3. Coils	Present information on and discuss: -- Construction -- Windings -- Types of coils -- Coil polarity	
4. Spark plugs	Discuss and explain: -- Heat range -- Reach -- Design -- Thread size Students should practice: -- Removal -- Cleaning -- Adjusting gap -- Installation	E - pp. 465-
5. Transistorized ignition	Present and discuss information on contact and magnetic impulse type: -- Operation -- Parts identification -- Service and repair	

9049

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
emonstrate proper removal and ispection of various distributors.			
emove, repair, and replace: -- Single contacts -- Double contacts -- Centrifugal advance units -- Vacuum advance units -- Primary wiring -- Condenser -- Rotors -- Distributor caps			
resent information on and discuss: -- Construction -- Windings -- Types of coils -- Coil polarity		9-5 9-6 9-12	
iscuss and explain: -- Heat range -- Reach -- Design -- Thread size	E - pp. 465-466		
tudents should practice: -- Removal -- Cleaning -- Adjusting gap -- Installation			
resent and discuss information on ontact and magnetic impulse type: -- Operation -- Parts identification -- Service and repair		12-52	

9050 1406

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
D. Charging System		
1. Generators and Alternators	Have students: -- Remove -- Disassemble -- Service -- Repair -- Replace -- Test	C - pp. 215-233 C - pp. 371-384 E - pp. 197-226
2. Controls	Present information on, discuss, and have students become familiar with: -- Cutouts -- Voltage limiters -- Current limiters -- Indicators -- Adjusting and testing	
E. Cranking Systems		
1. Starters	Present and discuss starter motor circuits. Demonstrate and observe: -- Stall test -- Load test -- Armature and field tests	C - pp. 356-37 C - pp. 200-21 E - pp. 160-19
2. Starter Drives	Observe types in general use. Discuss and practice proper servicing.	
3. Controls	Present and discuss solenoids and relays with reference to: -- Identification -- Removal -- Disassembly -- Servicing -- Testing -- Replacement	

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Have students: -- Remove -- Disassemble -- Service -- Repair -- Replace -- Test	C - pp. 215-233 C - pp. 371-384 E - pp. 197-226	6-1 9-3 9-10 9-14 12-46 12-47 12-48 12-49	
Present information on, discuss, and have students become familiar with: -- Cutouts -- Voltage limiters -- Current limiters -- Indicators -- Adjusting and testing			
Present and discuss starter motor circuits.	C - pp. 356-371 C - pp. 200-215 E - pp. 160-197	9-4 9-11 12-50	
Demonstrate and observe: -- Stall test -- Load test -- Armature and field tests			
Observe types in general use.			
Discuss and practice proper servicing.			
Present and discuss solenoids and relays with reference to: -- Identification -- Removal -- Disassembly -- Servicing -- Testing -- Replacement			

9052

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFEREN
F. Lights and Accessories	Identify and inspect various: -- Fuses -- Circuit breakers -- Warning lights -- Control systems -- Air conditioners -- Electric windows -- Others	E - pp. 478
<u>Fuel Supply System</u>		
A. Carburetors	Identify and observe carburetor types and operation. Review basic systems and discuss: -- Disassembly -- Servicing -- Assembly -- Troubleshooting -- Adjustment	C - pp. 33
B. Fuel Pump	Present and discuss pump testing: -- Pressure -- Volume -- Vacuum Practice removal and installation.	
C. Tanks and Lines	Present and discuss information on: -- Repair -- Cleaning -- Checking -- Making new lines	
<u>Other Related Systems</u>		
A. Ventilating	Discuss repair and servicing of: -- Road draft system -- Positive type system	C - pp. 34

SCOE 9053

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Identify and inspect various: -- Fuses -- Circuit breakers -- Warning lights -- Control systems -- Air conditioners -- Electric windows -- Others	E - pp. 478-508		
	Identify and observe carburetor types and operation.	C - pp. 333-342	12-40 12-41 12-42 12-43 12-44	
	Review basic systems and discuss: -- Disassembly -- Servicing -- Assembly -- Troubleshooting -- Adjustment			
	Present and discuss pump testing: -- Pressure -- Volume -- Vacuum			
	Practice removal and installation.			
	Present and discuss information on: -- Repair -- Cleaning -- Checking -- Making new lines			
	Discuss repair and servicing of: -- Road draft system -- Positive type system	C - pp. 342-356	15-2	

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
B. Breathing	Discuss manifolds and air cleaners with reference to good tune-up procedures.	
C. Cooling and Lubricating	Discuss importance of a properly-working system. Cover transmission cooling.	
<u>Tune-up Procedures</u>		
A. Safety	Stress importance of knowing how to: -- Service live circuits -- Charge batteries -- Handle inflammables -- Use extinguisher Practice vehicle protection by having students use fender and seat covers.	C - pp. 248-272
B. Tools and Equipment	Students should apply manufacturer's specifications to behicle by using: -- Hand tools -- Power tools -- Oscilloscope -- Compression gauge -- Cylinder leak tester -- Vacuum gauge -- Fuel pump tester -- Tach-dwell meter -- Ignition timing light -- Ammeter -- Voltmeter -- Ohmmeter -- Battery-starter tester -- Generator, alternator, and regulator tester -- Combustion analyzer -- Condenser tester -- Ignition coil tester -- Armature tester -- Others	

9055

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
scuss manifolds and air cleaners th reference to good tune-up ocedures.			
scuss importance of a properly- rking system.			
ver transmission cooling.			
ress importance of knowing how to:	C - pp. 248-272	7-1	
-- Service live circuits		15-2	
-- Charge batteries		24-2	
-- Handle inflammables		24-3	
-- Use extinguisher		24-4	
actice vehicle protection by having udents use fender and seat covers.			
udents should apply manufacturer's ecifications to behicle by using:			
-- Hand tools			
-- Power tools			
-- Oscilloscope			
-- Compression gauge			
-- Cylinder leak tester			
-- Vacuum gauge			
-- Fuel pump tester			
-- Tach-dwell meter			
-- Ignition timing light			
-- Ammeter			
-- Voltmeter			
-- Ohmmeter			
-- Battery-starter tester			
-- Generator, alternator, and regulator tester			
-- Combustion analyzer			
-- Condenser tester			
-- Ignition coil tester			
-- Armature tester			
-- Others			

9056

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
<u>End of Semester</u>		
A. Review	If time permits, review the following: -- Areas of weakness -- Areas of greatest interest	
	Prepare students for second semester.	
B. Evaluation	Discuss student progress and ways to improve.	
C. Close	Turn in all work, keys, etc.	
	Clean shop.	
	Administer final exam.	

9057

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	If time permits, review the following: -- Areas of weakness -- Areas of greatest interest Prepare students for second semester. Discuss student progress and ways to improve. Turn in all work, keys, etc. Clean shop. Administer final exam.			

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFEREN
<u>Student Orientation</u>		
A. Student Conduct	Discuss responsibility: -- Individual -- Classroom -- Shop -- School	
B. Course Content	Present anticipated program in terms of: -- What student should know -- What student should be able to do	
C. Class Management	Explain classroom and shop: -- Policy -- Procedures	
<u>Preliminary Inspecting and Checking</u>		
A. Visual	Demonstrate and discuss proper methods of visual inspection: -- Oil leaks -- Water leaks -- Fuel leaks -- Fatigue wear	N - pp. 11
B. Audio	Demonstrate and discuss proper methods of audio inspection: -- Rod bearing -- Main bearing -- Piston slap -- Piston pin -- Valve train hydraulic -- Fuel pump linkage -- Generator or alternator -- Water pump -- Distributor -- Ignition leakage	N - pp. 11

9059

COURSE OUTLINE -- AUTOMOTIVE ENGINE TUNE-UP 2

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
iscuss responsibility: -- Individual -- Classroom -- Shop -- School			
resent anticipated program in terms f: -- What student should know -- What student should be able to do			
xplain classroom and shop: -- Policy -- Procedures			
emonstrate and discuss proper ethods of visual inspection: -- Oil leaks -- Water leaks -- Fuel leaks -- Fatigue wear	N - pp. 115-116	2-2	
emonstrate and discuss proper ethods of audio inspection: -- Rod bearing -- Main bearing -- Piston slap -- Piston pin -- Valve train hydraulic -- Fuel pump linkage -- Generator or alternator -- Water pump -- Distributor -- Ignition leakage	N - pp. 118-121	2-2 10-1	

9060

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	RE
	-- Accessory units -- Torque convertor -- Automatic clutch -- Automatic transmission -- Clutch -- Others	
C. Testing Prior to Tune-up	Discuss and demonstrate a compression test and determine: -- Valve condition -- Ring condition	C - p
	Discuss and demonstrate cylinder leakage test and determine: -- Valve condition -- Ring condition	C - p
D. Engine Related Accessory	Demonstrate and discuss the proper procedures for checking and servicing: -- Cooling system -- Lubrication system -- Heater and air conditioning -- Tires -- Safety devices	N - p
<u>Safety</u>		
A. General B. Hand Tools C. Special Tools D. Power Tools	Discuss safety rules. Observe demonstrations.	
<u>Testing Electrical System</u>		
A. Battery and Cables	Demonstrate and discuss visual inspection and cleaning: -- Cables -- Clamps -- Connections -- Mounting -- Hold-down -- Battery for leakage	C - C -

9061

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	-- Accessory units -- Torque convertor -- Automatic clutch -- Automatic transmission -- Clutch -- Others			
	Discuss and demonstrate a compression test and determine: -- Valve condition -- Ring condition	C - pp. 248-249		
	Discuss and demonstrate cylinder leakage test and determine: -- Valve condition -- Ring condition	C - p. 250		
	Demonstrate and discuss the proper procedures for checking and servicing: -- Cooling system -- Lubrication system -- Heater and air conditioning -- Tires -- Safety devices	N - pp. 116-117	2-2 2-4 10-1	
	Discuss safety rules.			
	Observe demonstrations.			
	Demonstrate and discuss visual inspection and cleaning: -- Cables -- Clamps -- Connections -- Mounting -- Hold-down -- Battery for leakage	C - pp. 200-204 C - pp. 359-363	2-3 9-1 12-45	

9062

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
	Demonstrate and discuss servicing and testing: -- Check level of electrolyte. -- Use voltmeter and hydrometer. -- Perform the cell test. -- Perform the sight load test and the battery capacity test. -- Use the battery-starter tester. -- Use the voltmeter to check cables and connections for voltage drop.	
B. Ignition System 1. Spark Plugs	Demonstrate and discuss proper procedure: -- Remove and replace spark plugs. -- Visually inspect. -- Operate cleaner and tester. -- Adjust and replace.	C - pp. 386-38
2. Coil	Demonstrate and discuss: -- Visual inspection of coil -- Use of coil tester both off and on car -- Use of oscilloscope	C - p. 384
3. Distributor	Demonstrate and discuss: -- Removal of distributor -- Visual inspection of cap and rotor -- Check contact points and service or replace -- Testing condenser and advance mechanism -- Using distributor tester machine -- Using oscilloscope -- Using voltmeter, ohmmeter, and oscilloscope to test primary wiring circuits -- Using oscilloscope to test secondary wiring circuit	C - p. 384

9063

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Demonstrate and discuss servicing and testing: -- Check level of electrolyte. -- Use voltmeter and hydrometer. -- Perform the cell test. -- Perform the sight load test and the battery capacity test. -- Use the battery-starter tester. -- Use the voltmeter to check cables and connections for voltage drop.			
	Demonstrate and discuss proper procedure: -- Remove and replace spark plugs. -- Visually inspect. -- Operate cleaner and tester. -- Adjust and replace.	C - pp. 386-389	2-3 9-5 9-12 12-51	
	Demonstrate and discuss: -- Visual inspection of coil -- Use of coil tester both off and on car -- Use of oscilloscope	C - p. 384	2-2 2-3	
	Demonstrate and discuss: -- Removal of distributor -- Visual inspection of cap and rotor -- Check contact points and service or replace -- Testing condenser and advance mechanism -- Using distributor tester machine -- Using oscilloscope -- Using voltmeter, ohmmeter, and oscilloscope to test primary wiring circuits -- Using oscilloscope to test secondary wiring circuit	C - p. 384	2-3 9-13	

9064

AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
4. Adjusting Ignition System	Demonstrate and discuss proper procedure for adjusting ignition: -- Timing light -- Test lamp -- Tach-dwell meter -- Oscilloscope	
5. Transistorized Ignition System	Demonstrate and discuss proper procedure for inspecting, servicing, adjusting, and testing: -- Conventional contact type -- Magnetic pulse type	C - pp. 233-23
C. Cranking System	Demonstrate and discuss proper use of: -- Battery-starter tester -- Remote starter switch -- Transmission safety switch -- Voltmeter to test insulated circuit -- Voltmeter to test ground circuit -- Voltmeter to test solenoid circuit for resistance -- Voltmeter to test cranking voltage at ignition coil	C - pp. 365-36
D. Charging System	Demonstrate and discuss proper inspection, adjusting, servicing, and testing: -- Generator output -- Voltage regulators -- Alternators -- Wiring and circuits Demonstrate use of: -- Voltampere tester -- Generator-regulator test bench -- Adjusting-charging rate	C - pp. 371-3

9065

	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Demonstrate and discuss proper procedure for adjusting ignition: -- Timing light -- Test lamp -- Tach-dwell meter -- Oscilloscope		9-2 9-9 9-6 9-13 12-53	
on	Demonstrate and discuss proper procedure for inspecting, servicing, adjusting, and testing: -- Conventional contact type -- Magnetic pulse type	C - pp. 233-237	12-52 2-2 2-3	
	Demonstrate and discuss proper use of: -- Battery-starter tester -- Remote starter switch -- Transmission safety switch -- Voltmeter to test insulated circuit -- Voltmeter to test ground circuit -- Voltmeter to test solenoid circuit for resistance -- Voltmeter to test cranking voltage at ignition coil	C - pp. 365-369	2-1 2-2 2-3 9-4 9-11	
	Demonstrate and discuss proper inspection, adjusting, servicing, and testing: -- Generator output -- Voltage regulators -- Alternators -- Wiring and circuits	C - pp. 371-383	2-3 9-3 9-7 9-11 9-14	
	Demonstrate use of: -- Voltampere tester -- Generator-regulator test bench -- Adjusting-charging rate			

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AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
<u>Fuel System</u>		
A. Manifold and Crankcase Ventilating	Demonstrate and discuss inspection, service, adjusting, testing: -- Manifold heat central valve -- Crankcase ventilating system -- Filters	C - pp. 334-335 C - pp. 336-337 C - p. 333
B. Fuel Pump	Demonstrate and discuss proper inspection, servicing, adjusting, and testing: -- Condition (visual inspection) -- Vacuum test -- Pressure test -- Capacity	
C. Carburetor	Demonstrate and discuss proper inspection, servicing, adjusting, and testing: -- Visual - leaks, cracks, looseness -- Adjusting idle mixture -- Adjusting idle speed -- Choke -- Linkage -- Carburetor rebuilding -- Recalibrating of parts -- Using vacuum gauge -- Using Tach-dwell meter -- Using combustion analyzer	C - p. 248
<u>Performance Testing</u>	Demonstrate and discuss proper starting and final adjustment: -- Dynamometer test	
<u>Vocational Guidance</u>		
A. Application for Employment	Present information on how to fill out an application. Discuss personal interview and stress good grooming.	

SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
Demonstrate and discuss inspection, service, adjusting, testing: -- Manifold heat central valve -- Crankcase ventilating system -- Filters	C - pp. 334-335 C - pp. 336-337 C - p. 333	2-2 2-3	
Demonstrate and discuss proper inspection, servicing, adjusting, and testing: -- Condition (visual inspection) -- Vacuum test -- Pressure test -- Capacity			
Demonstrate and discuss proper inspection, servicing, adjusting, and testing: -- Visual - leaks, cracks, looseness -- Adjusting idle mixture -- Adjusting idle speed -- Choke -- Linkage -- Carburetor rebuilding -- Recalibrating of parts -- Using vacuum gauge -- Using Tach-dwell meter -- Using combustion analyzer	C - p. 248	2-2 2-3 12-40 12-41 12-42	
Demonstrate and discuss proper starting and final adjustment: -- Dynamometer test			
Present information on how to fill out an application.			
Discuss personal interview and stress good grooming.			

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AREAS OF EMPHASIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES
	Discuss individual and group testing used by industry.	
B. Beginning Work	Discuss desirable characteristics that make a person a valuable employee.	
	Discuss responsibility of employee to: -- Himself -- Management -- The business -- The community	
C. Future Planning	Discuss: -- Attitudes -- Goals	
	The above should be used to develop greater insights into: -- Advancement -- Security -- Salary -- Benefits -- Retirement	
<u>End of Semester</u>		
A. Review	If time permits, review the following: -- Areas of weakness -- Areas of greatest interest	
B. Evaluation	Discuss student progress and ways to improve.	
C. Close	Turn in all work, keys, etc.	
	Administer final exam.	

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SIS	SHOP EXERCISES AND ACTIVITIES	REFERENCES	SUPPLEMENTARY AIDS	INSTRUCTOR NOTES
	Discuss individual and group testing used by industry. Discuss desirable characteristics that make a person a valuable employee. Discuss responsibility of employee to: -- Himself -- Management -- The business -- The community Discuss: -- Attitudes -- Goals The above should be used to develop greater insights into: -- Advancement -- Security -- Salary -- Benefits -- Retirement If time permits, review the following: -- Areas of weakness -- Areas of greatest interest Discuss student progress and ways to improve. Turn in all work, keys, etc. Administer final exam.			

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DESCRIPTORS - *VOCATIONAL EDUCATION; *STUDY GUIDES; *HAND TOOLS; WOODWORKING; *ENLISTED MEN; *SHOP CURRICULUM; SCHOOL SHOPS; ILLUSTRATIONS; FILMS

ABSTRACT - Designed to present the basic operations using handtools required for the performance of a wide variety of jobs, this book was developed by the Department of Navy. The text is divided into two parts: (1) descriptions, illustrations, general uses, and approved maintenance procedures for handtools and portable power tools, and (2) a description of the way in which the tools are used in specific operations. Topics are: (1) Common handtools, (2) Common power tools, (3) Fastening devices, (4) Measuring, (5) Laying out, (6) Testing, checking, and setting, (7) Woodcutting operations, (8) Grinding and filing operations, (9) Metal cutting operations, and (10) Miscellaneous skills. A training film list, tables of information, and electrical safety precautions are appended and a tool and operations index are provided. (GB)

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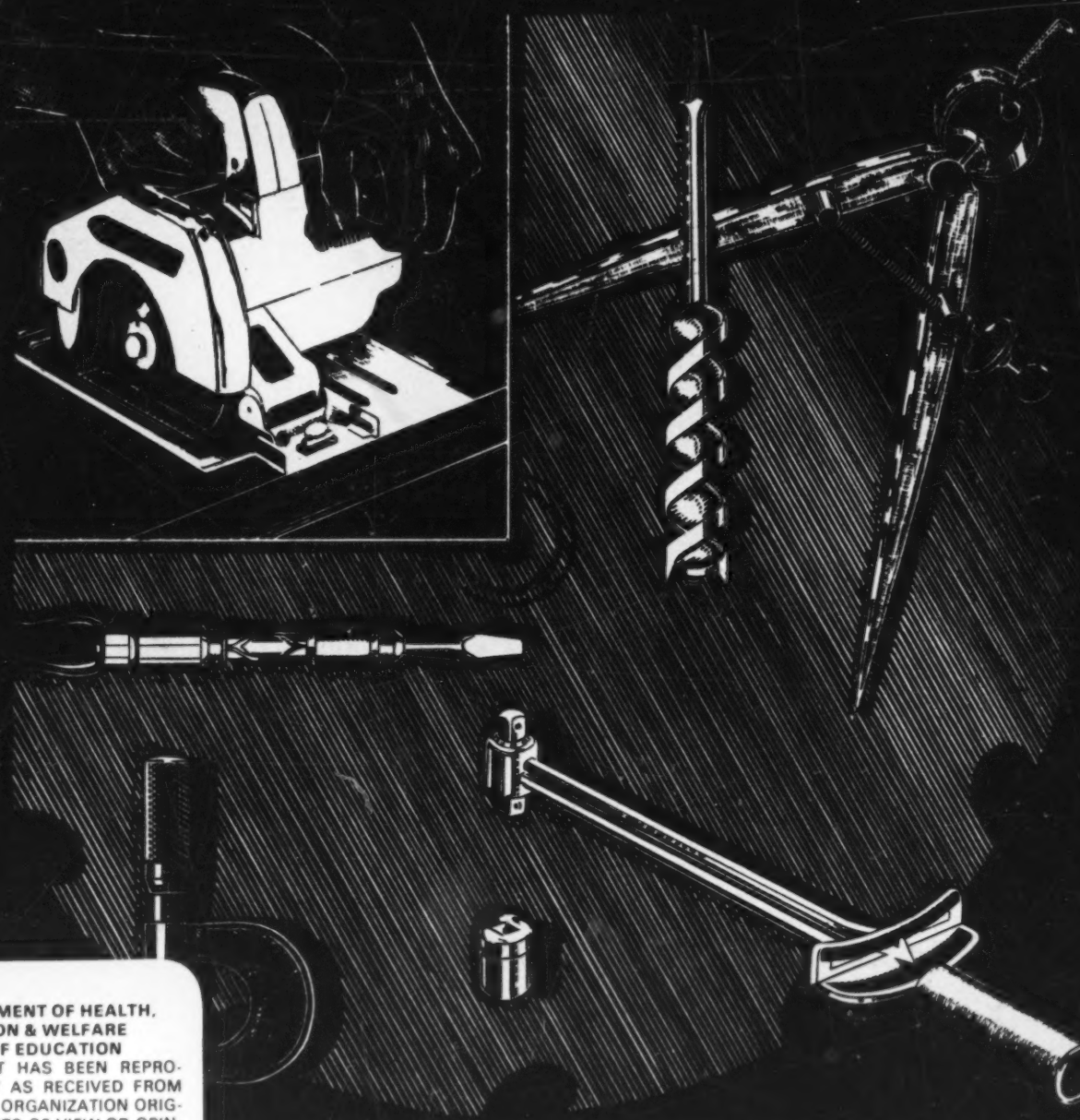

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BASIC HAND TOOLS

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BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10085-A

PREFACE

Use of handtools and of portable power tools is basic to almost every rating in the Navy. This book is designed to present, in a concise form, the basic operations required for the performance of a wide variety of jobs. Few jobs consist of a single operation; but when the separate operations are properly learned, it will be a fairly simple matter to combine separate operations so as to meet the requirements of specific jobs.

For example, such jobs as replacing a wooden shelf, crating a piece of machinery, or shoring up a damaged bulkhead, require the knowledge of several operations—measuring, job layout, sawing to size, planing, and finishing. The Navy man who has learned to do the individual operations should have no trouble with the various combinations of operations necessary to perform the overall job.

The individual operations described in this text cover the following broad areas: measuring skills; layout skills, testing, checking, and setting; woodcutting skills; grinding and filing; and metal cutting skills.

A description of how this text may be used to the best advantage is included immediately after this preface. Everyone should read the description, and should familiarize himself with the index of operations, the tool index, and the appendixes, at the back of this book. The indexes simplify the problem of locating the information concerning a specific work operation, or a special tool. The appendixes include tables of useful information that may be helpful in doing specific work operations.

This manual has been prepared by the Navy Training Publications Center, for the Bureau of Naval Personnel. Special assistance has been rendered by various Navy personnel specially cognizant of the handtools and portable power tools used, and the work operations in which they are chiefly employed.

First printing 1954
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HOW TO USE THIS BOOK

This current revision of Basic Handtools brings the information in the original text (Basic Hand Tool Skills) up to date with current practice, eliminating some material now adequately covered in other Navy training manuals, and expanding the text, especially in the areas of grinding and cutting skills.

The present text is divided into two parts: (1) a description of the tools themselves, and (2) a description of the way in which the tools are used in specific operations.

In part I, therefore, you will find descriptions, illustrations, general uses, and approved maintenance procedures for those handtools and portable power tools commonly used in the Navy. It provides all the information necessary to enable you to identify tools and fastening devices by their correct names; to understand the specific purposes and uses of each tool; and to learn the care and maintenance required to keep the tools in proper operating condition.

However, the real need of Navy men is to learn the use of the tools in performing the duties listed in the qualifications of their respective ratings. Part I of this text provides the required basic information concerning the tools; but part II teaches the reader how to use these tools in practical application. It emphasizes the operations performed in doing typical Navy jobs. After these operations have been learned, there must be sufficient practice to develop that skill in performance which is certainly as necessary as the knowledge of how the operations should be performed.

The following suggestions are given both for the performing of a specific job, and for the developing of specific skills even when no specific job is assigned:

1. When you are assigned a job that involves the use of handtools, use the operations index of this training manual to locate the major operation in part II.
2. Study the text material relating to the operation, and study the illustrations.
3. If the operation requires the use of any tool which you have not previously studied, use the tool index to locate the tool in part I. Study the description, illustration, general uses, and maintenance procedures for the tool.
4. If possible, practice each operation for a few times, before starting the job.
5. Check the text again, to ensure that you have a correct understanding of the order of the operations.
6. Perform the job.
7. If no specific job is involved, have an experienced man check your performance after you have practiced each operation.
8. Keep track of your proficiencies until you have successfully covered all operations involving the use of handtools and portable power tools.

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Always keep in mind that a knowledge of the tools and their uses is a fundamental requirement, the preliminary step in mastering basic hand-tool skills. The next step is careful practice, until you have mastered the various skills involved. The end result must be that you become capable of performing required operations, and of meeting the standards established in your rating qualifications. To accomplish this final result, you must first STUDY the tools and skills; then you must PRACTICE the skills; and finally you must DEMONSTRATE the skills.

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0103

THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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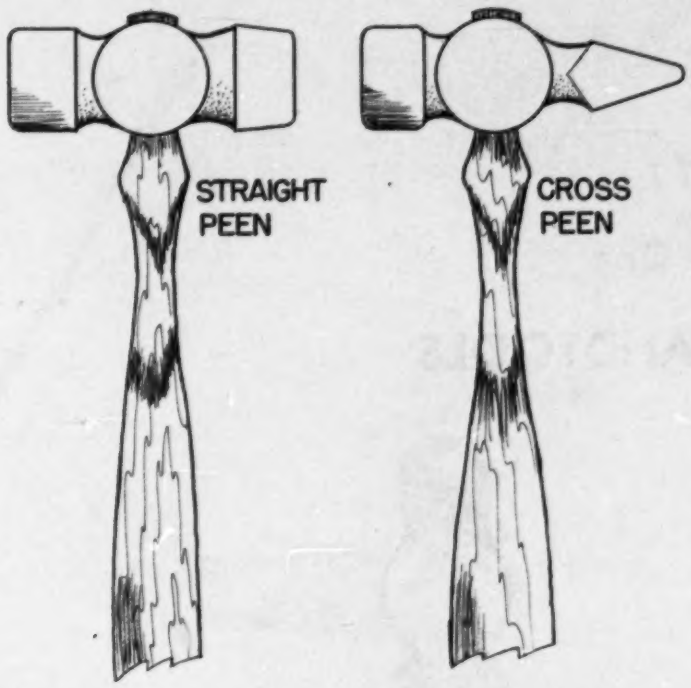

Figure 1-1-2.—Variations of the ball-peen hammer.

Simple as the hammer is, there is a right and wrong way of using it. (See fig. 1-1-4.) The most common fault is holding the handle too close to the head. This is known as choking the hammer, and reduces the force of the blow. It also makes it harder to hold the head in an upright position. Except for light blows, hold the handle close to the end to increase the lever arm and produce a more effective blow. Try to hit the object with the full face of the hammer. Hold the hammer at such an angle that the face of the hammer and the surface of the object being hit will be parallel. This distributes the force of the blow over the full face and prevents damage to both the surface being struck and the face of the hammer.

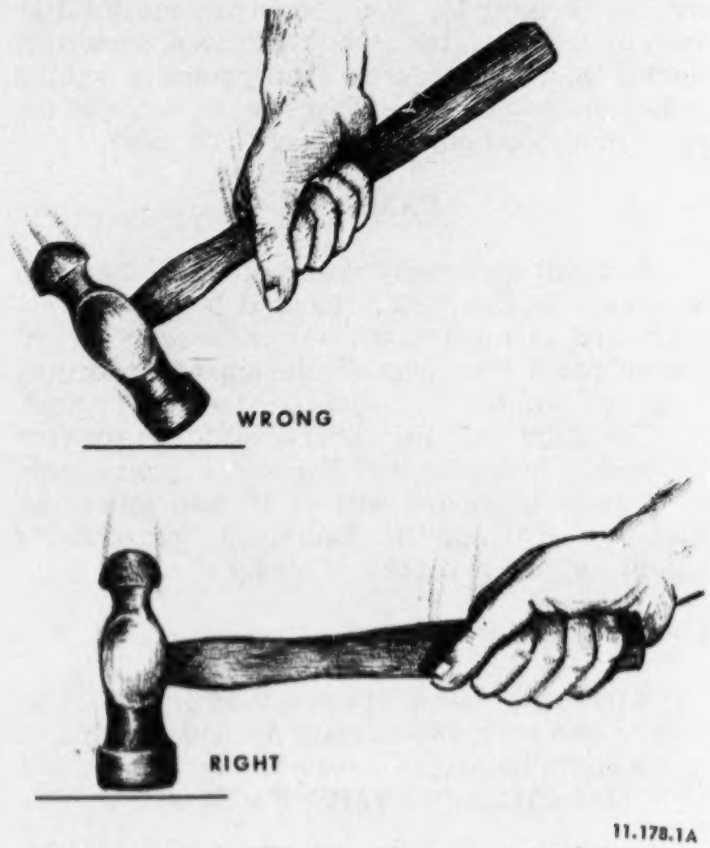

Figure 1-1-4.—Right and wrong way to use a ball-peen hammer.

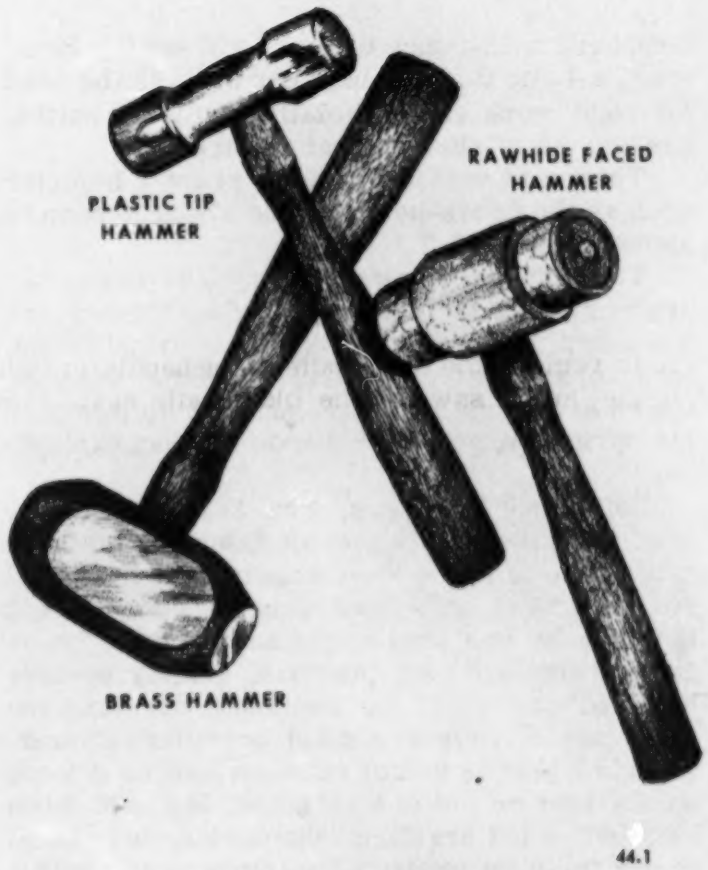

Figure 1-1-3.—Soft face hammers.

CARPENTER'S HAMMER

The carpenter's hammer is either a curved-claw or straight-claw hammer. The face may be either a bell-faced or plain faced. (See fig. 1-1-5.) The carpenter's hammer generally used in the Navy is the curved claw, bell-faced hammer. The hammers may have either a steel or wooden handle; however the wooden handle is

most common. The primary use of the carpenter's hammer is to drive or draw (pull) nails.

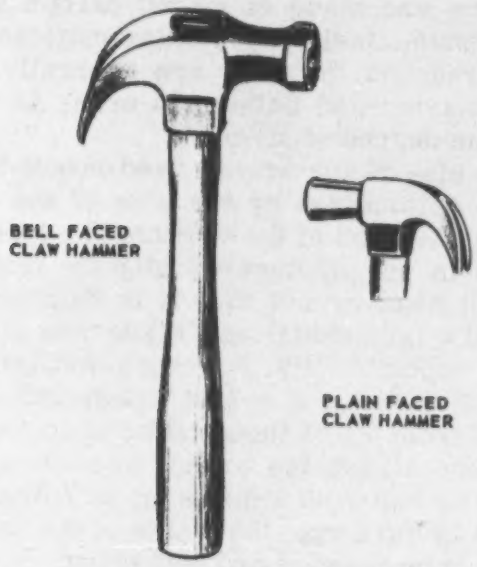

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Figure 1-1-5.—Bell-faced and plain faced claw hammers.

MALLETS AND SLEDGES

The mallet is a short-handled tool used to drive wooden-handled chisels, gouges, wooden pins, or small stakes. It is also used to form or shape sheet metal where hard-faced hammers would mar or injure the finished work. For example a rubber-faced mallet is used for knocking out dents in an automobile. Its heads are made from a soft material, usually wood, rawhide, or rubber. It is cylindrically shaped with two flat driving faces that are reinforced with iron bands. (See fig. 1-1-6.) The mallet and hammer are used in the same way. Never use a mallet to drive nails, screws, or any object that may cause damage to the face.

The sledge is a steel headed, heavy duty driving tool that can be used for a number of purposes. Short-handled sledges are used to drive bolts, driftpins, and large nails, and to strike cold chisels and small hand rock drills. Long-handled sledges are used to break rock and concrete, to drive spikes, bolts, or stakes, and to strike rock drills and chisels.

The head of a sledge is generally made of a high carbon steel and may weigh from 6 to 16 lb. The shape of the head will vary according to the job for which the sledge is designed.

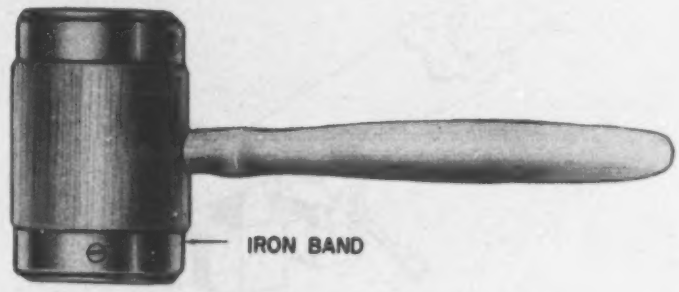

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Figure 1-1-6.—Steel reinforced wooden mallet.

MAINTENANCE OF STRIKING TOOLS

Hammers, sledges, or mallets should be cleaned and repaired if necessary before they are stored. Hammer and sledge faces should be free from oil or other material that would cause the tool to glance off nails, spikes, or stakes. The hammer heads should be dressed to remove any battered edges. Inspect the handles of striking tools and make sure they are secure to the head and do not have any cracks or splinters.

Never leave a wooden or rawhide mallet in the sun, as it will dry out and may cause the head to crack. A light film of oil should be left on the mallet to maintain a little moisture in the head.

Replace Hammer Handle

When a hammer handle becomes damaged or loose in the hammerhead, it should be replaced before the hammer is used. A serious injury to yourself or a shipmate can result from using a hammer that has a bad handle.

The first step in replacing a hammer handle is to remove the old handle. If the handle is tight in the head, saw off the old handle next to the head. (See fig. 1-1-7.) Do not saw the handle off so close to the head that the saw teeth will touch the head while sawing, thus damaging the set of the saw. A hacksaw may also be used for this purpose.

Place the head of the hammer in a vise and drill a hole in the part of the handle that remains in the head. Remove the rest of the handle by driving it from the head.

The new handle should fit snugly in the hammerhead. Use a wood rasp to shape the handle to fit the head. Check the fit of the head on the handle occasionally, and make sure you do not remove too much material from the new handle. After the correct fit has been attained, seat the

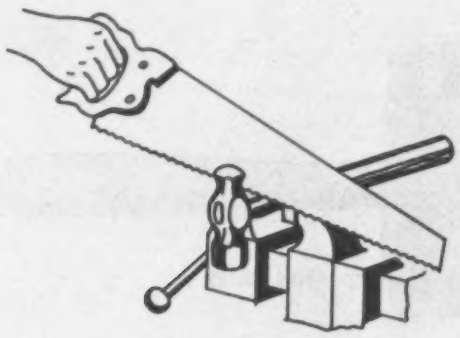

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Figure 1-1-7.—Removing old hammer handle.

handle firmly in the head by hitting the end of the handle with a mallet. (See fig. 1-1-8.) Saw off the projecting portion of the handle, and use a small wood chisel to cut slits for the wedges if wooden wedges are used. Either wooden or metal wedges may be utilized. When the wedges have been driven in the handle, grind the end of the handle even with the head.

COMMON MISUSES

Never strike a hardened steel surface with a hammer. This misuse is a serious safety hazard. Small pieces of sharp, hardened steel may break from the hammer and also from the hardened steel. Besides causing damage to the work and/or the hammer, a serious eye injury may result.

Do not use a hammer handle for bumping parts in assembly, and never use as a pry bar. Such abuses will cause the handle to split, and a split handle can produce bad cuts or pinches. When a handle splits or cracks, do not try to repair it by binding with string or wire. REPLACE IT.

WRENCHES

A wrench is a basic tool that is used to exert a twisting force on bolt heads, nuts, and studs. The special wrenches designed to do certain jobs are in most cases variations of the basic wrenches that will be described in this section.

Some ratings will naturally have more use for wrenches in doing their jobs than other ratings; however, practically all ratings, including clerical, will have occasion, from time to time, to use wrenches. It is necessary, therefore, that all hands have a basic understanding of the description and uses of wrenches.

The best wrenches are made of CHROME-VANADIUM STEEL. Wrenches made of this material are light in weight and almost unbreakable. This is an expensive material, however, so the most common wrenches found in the Navy are made of forged carbon steel or molybdenum steel. These latter materials make good wrenches, but they are generally built a little heavier and bulkier in order to achieve the same degree of strength.

The size of any wrench used on bolt-heads or nuts is determined by the size of the opening between the jaws of the wrench. The opening of a wrench is manufacturered slightly larger than the bolt head or nut that it is designed to fit. Hex-nuts (six-sided) and heads are measured across opposite flats. A wrench that is designed to fit a 3/8-inch nut or bolt usually has a clearance of from 5 to 8 thousandths of an inch. This clearance allows the wrench to slide on and off the nut or bolt with a minimum of "play." If the wrench is too large, the points of the nut or bolt head will be rounded and destroyed.

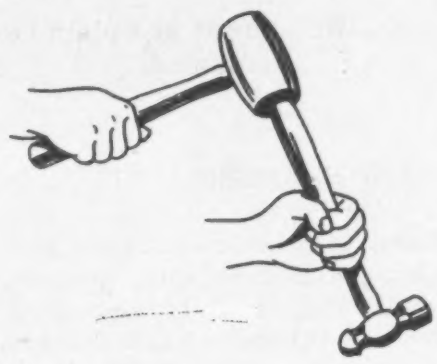

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Figure 1-1-8.—Seating hammer handle in head.

OPEN-END WRENCHES

Solid, nonadjustable wrenches with openings in one or both ends are called open-end wrenches. (See fig. 1-1-9.) Usually they come in sets of from 6 to 10 wrenches ranging from 5/16 to 1 inch. Wrenches with small openings are usually shorter than wrenches with large openings. This proportions the lever advantage of the wrench to the bolt or stud and helps prevent wrench breakage or damage to the bolt or stud.

Open-end wrenches may have their jaws parallel to the handle or at angles anywhere up to 90 degrees. The average is about 15 degrees. Handles are usually straight, but may be curved. Those with curved handles are called S-wrenches. Other open-end wrenches may have offset handles, to reach nut or bolt heads that are sunk below the surface.

One of the wrenches shown in figure 1-1-9 has jaws that are set on a 15-degree angle to the handle and one that is on a 90-degree angle. The reason why the jaws are placed at an angle becomes obvious when you have to work in close places.

There are special open-end wrenches, called TAPPET WRENCHES, which are very thin and have extra long handles. They are used to adjust the tappets of engine valves. These tappet wrenches are of light construction and the jaws of the wrench will spread easily, therefore, they should never be used for any purpose other than that for which they are intended.

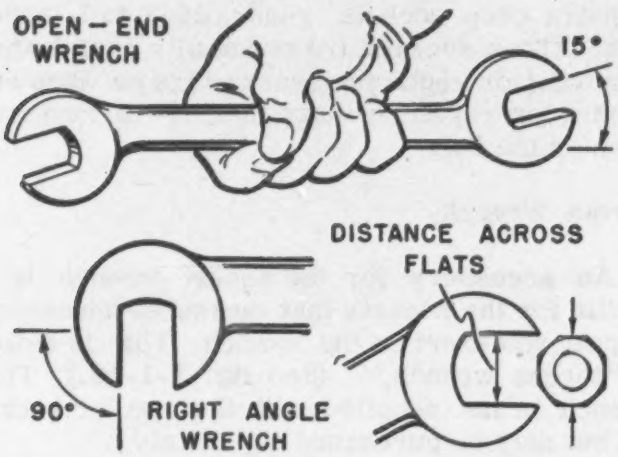

Figure 1-1-9.—Open-end wrenches. 1.16.1

BOX-END WRENCHES

Box-end wrenches have either 6, 8, 12, or 16 points inside the head. (See fig. 1-1-10.) The number of points determine the strength of the head. Six and eight point wrenches are used for heavy duty, 12 for medium duty and 16 for light duty work. The 12 point box-end wrench is the most common and can be used with a minimum swing of 30 degrees.

There is little chance of the box-end wrench slipping off the nut when the proper size wrench is used. Because the sides of the "box" opening are so thin, this wrench is suitable for turning nuts which are hard to get at with an open-end wrench. The offset box-end wrench (fig. 1-1-11) is especially useful in this respect.

There is one disadvantage to using box-end wrenches. You lose time if you use it to turn the nut all the way off the bolt once it is broken loose. You must lift the wrench completely off the nut after each pull, then place it back on in

1.16.2
Figure 1-1-10.—12-point box-end wrench.

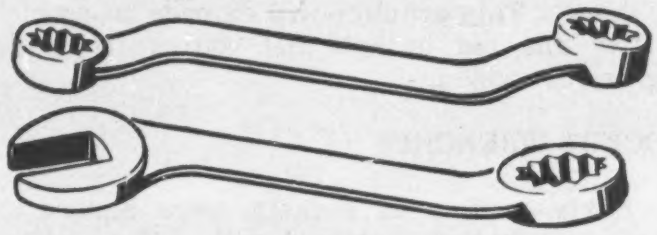

1.16.3
Figure 1-1-11.—Box-end and combination wrenches.

another position. The only time this procedure is not necessary is when there is room to spin the wrench in a complete circle.

After a tight nut is broken loose, it can be unscrewed much more quickly with an open-end wrench than with a box wrench. This is where a combination box-open end wrench comes in handy. (See fig. 1-1-11.) You can use the box-end for breaking nuts loose or for snugging them down, and the open end for faster turning.

For heavy-duty work, there are long-handled, single box-end wrenches. They are made only in the larger sizes, and you can apply all the pressure you need.

The correct use of open-end and box-end wrenches can be summed up in a few simple rules, most important of which is to be sure that the wrench properly fits the nut or bolt head.

When you have to pull hard on the wrench, as in loosening a tight nut, make sure the wrench is seated squarely on the flats of the nut.

PULL on the wrench—DO NOT PUSH. Pushing a wrench is a good way to skin your knuckles if the wrench slips or the nut breaks loose unexpectedly. If it is impossible to pull the wrench, and you must push, do it with the palm of your hand and hold your palm open.

Only actual practice will tell you if you are using the right amount of force on the wrench. The best way to tighten a nut is to turn it until the wrench has a firm, solid "feel." This will turn the nut to proper tightness without stripping the threads or twisting off the bolt. This "feel" is developed by experience alone. Practice until you have mastered the "feel."

Hammering on wrenches is strictly taboo—with one exception. There is a special type of box wrench, made strong and heavy so that you can hammer on it. The handle is short and has a steel pad on which the hammer blows are struck. This wrench is known as a "slugging" or "striking" wrench. Never place a piece of pipe over the handle of a wrench to increase leverage. This practice will damage the wrench and/or the nut or bolt that you are trying to tighten or loosen.

SOCKET WRENCHES

Early models of sockets were square or hexagonal sockets integral with a T or offset handle. (See fig. 1-1-12.) This type wrench is still in use but is generally made in large sizes. Socket sets presently used contain an assortment of individual sockets made to fit different handles. There are several types of handles and extensions (fig. 1-1-13), such as the T-handle, ratchet handle, screwdriver grip handle, and a "speed" handle. These handles and sockets can be assembled in combinations that will do most any job quickly and easily.

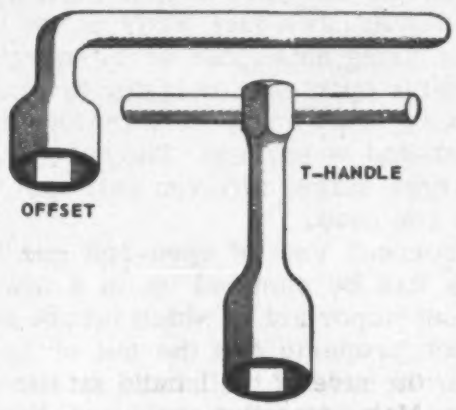

Figure 1-1-12.—Socket wrenches.[29.7A]

The nut opening of the socket is usually 8 or 12 points similar to the box-end wrench. Six-point sockets are still used for extra heavy-duty sockets or for large sockets. The end of the socket opposite the nut opening (fig. 1-1-14) has a square hole into which the handle fits. The size of the socket set is designated by the size of the square on the drive end of the handle. A spring loaded ball on the handle snaps into a groove in the socket to prevent it from falling off.

Sockets are usually furnished in sets for a range of different size nuts. The standard sizes are 3/8-, 7/16-, 1/2- and 3/4-inch drive. The larger sizes have sockets that are designed for heavier work and larger size nuts. For extra-heavy-duty jobs larger size sets are available.

Sockets with thin walls may be obtained for use in extremely close quarters, but their use is not recommended for general work.

A universal joint (fig. 1-1-15) frequently comes in handy when working on nuts in places where a straight wrench cannot be used. The universal is placed between the handle and the socket and enables you to work the wrench handle at an angle to the socket. This comes in very handy when working in close places.

Large socket wrench sets also contain a set of extra deep sockets, generally 3 to 5 inches long. These sockets are especially useful when removing or replacing spark plugs or when removing or replacing nuts that are a long way down on the bolt.

Torque Wrench

An accessory for the socket wrench is a handle for the sockets that measures the amount of pull you exert on the wrench. This is called a "torque wrench." (See fig. 1-1-16.) This wrench is not supplied with the regular socket set but may be purchased separately.

Most modern-day machinery is assembled with close clearances, therefore it is important that the correct amount of pressure be put on the nuts and bolts that hold it together. Manufacturers' manuals generally specify the amount of torque that is to be applied to the nuts. A torque wrench enables you to tell when these specifications have been met.

The accuracy of torque-measuring depends a lot on how accurately the threads are cut, and the cleanliness of the threads. Make sure you inspect and lubricate threads in order to get the most accurate torque reading possible.

ADJUSTABLE WRENCHES

A handy all-round wrench that is generally included in every toolbox is the adjustable open-end wrench. (See fig. 1-1-17.) This wrench is not intended to take the place of the regular solid open-end wrench for steady, hard service. One jaw of the adjustable open-end wrench is fixed; the other jaw is moved along a slide by a screw adjustment. The angle between the jaw opening and the handle is 22 1/2 degrees. The wrenches are available in varying sizes ranging from 4 to 18 inches in length.

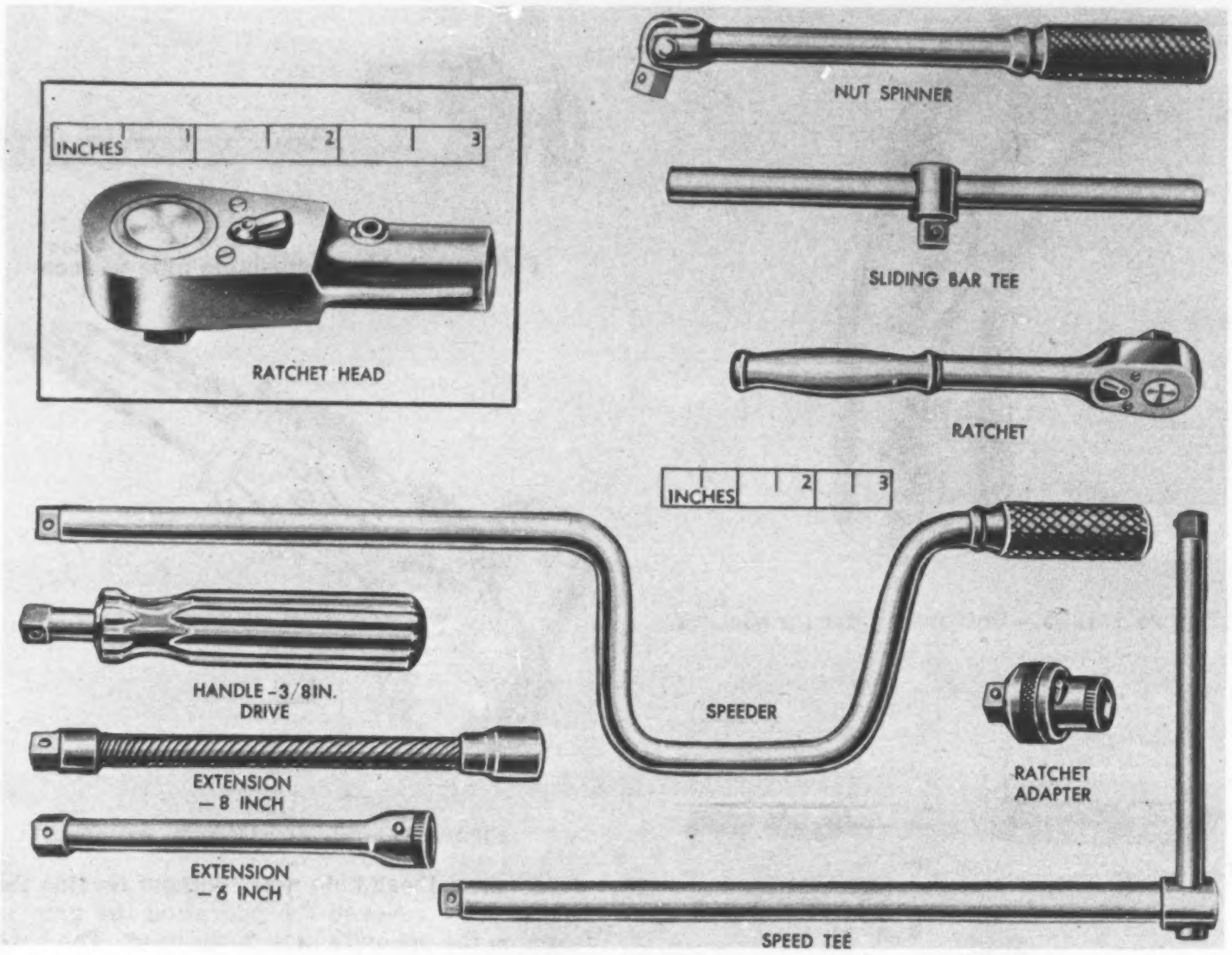

Figure 1-1-13.—Socket wrench ratchets, handles and extensions.[44.3]

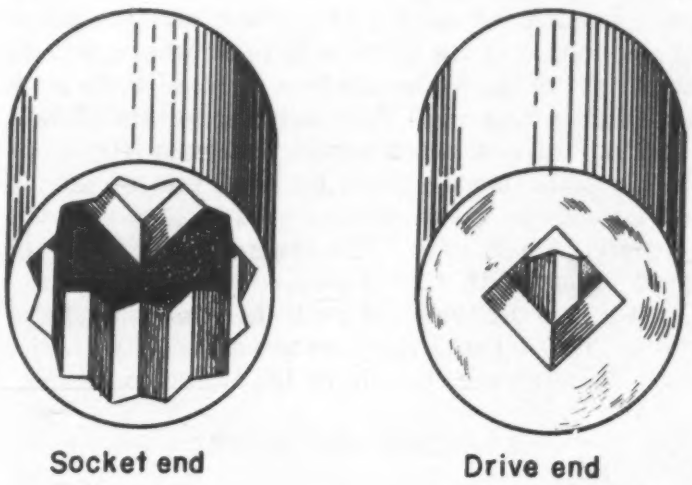

Figure 1-1-14.—12-point sockets.[44.4]

When using the adjustable end wrench be sure to pull on the side of the handle attached to the fixed jaw. Make sure the jaws of the wrench are adjusted to closely fit the nut. A loose fit on the nut will tend to round off the corners of the nut.

When rotating round work an adjustable pipe wrench (Stillson) may be used. (See fig. 1-1-18.) The movable jaw on a pipe wrench is pivoted to permit a gripping action on the work. These tools must be used with discretion, as the jaws are serrated and always make marks on the work. The jaws should be adjusted so the bite on the work will be taken at about the center of the jaws.

A different type pipe wrench, used mostly on large sizes of pipe, is the chain pipe wrench. (See fig. 1-1-19.) This tool works in one direction only, but can be backed partly around the

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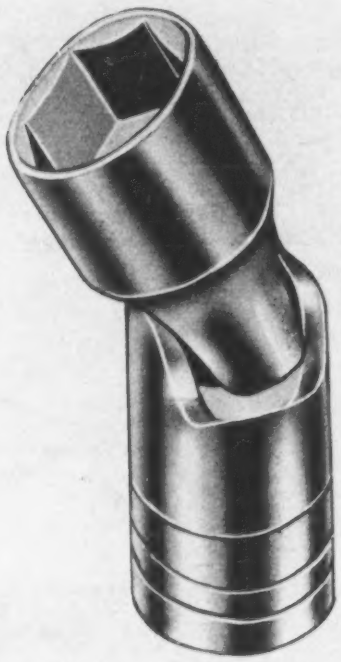

Figure 1-1-15.—Universal joint for sockets. 44.5

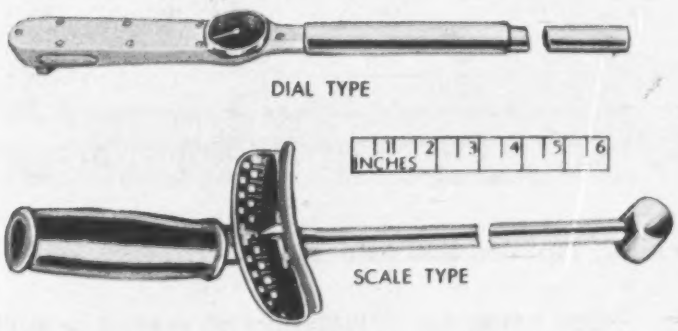

Figure 1-1-16.—Torque wrenches for use with sockets. 5.9(44)

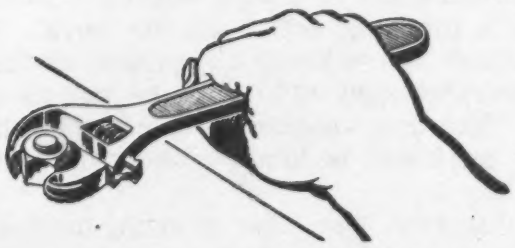

Figure 1-1-17.—Adjustable open-end wrench. 29.7(44)

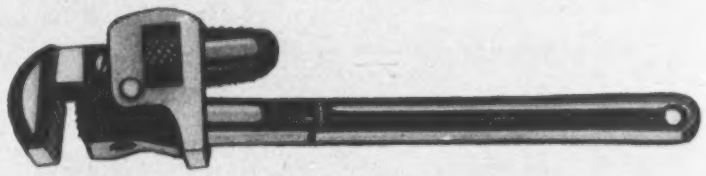

Figure 1-1-18.—Adjustable pipe wrench. 44.6

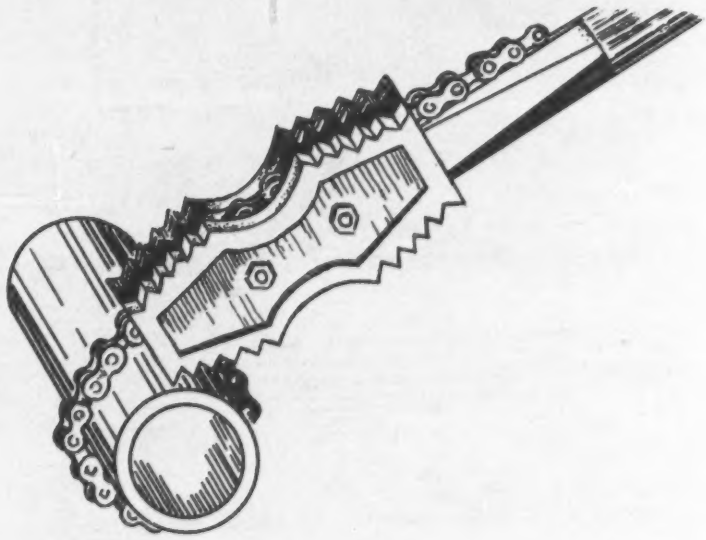

Figure 1-1-19.—Chain pipe wrench. 44.7

work and a fresh hold taken without freeing the chain. To reverse the operation the grip is taken on the opposite side of the head. The head is double ended and can be reversed when the teeth on one end are worn out.

The strap type pipe wrench is sometimes used for turning pipe. It is similar to the chain pipe wrench but uses a heavy web strap in place of the chain. This wrench is used where you do not want to mar the surface of the work such as fittings and pipe that are chromium plated.

The old fashioned monkey wrench (fig. 1-1-20) is still used a little by Navy personnel. It works well on large square nuts, but is too bulky for most small jobs. The jaws make an angle of 90 degrees with the handle, and should always point in the direction of pull. In some models of the monkey wrench the jaws are adjusted by turning a knurled nut, in others the handle is turned.

SPANNER WRENCHES

Spanner wrenches are wrenches that are used on special nuts. They are not generally included in a toolkit but are kept in a central

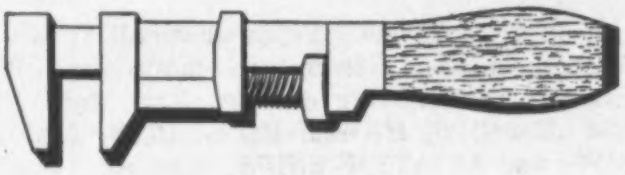

1.17.5

Figure 1-1-20.—Monkey wrench.

tool crib. They can be drawn out for use when the need arises. There are a number of types of spanner wrenches. The HOOK SPANNER (fig. 1-1-21) works on a round nut which has a series of notches cut in its outer surface. The hook (lug) is placed in one of these notches and the handle turned to loosen or tighten the nut. Fig 1-1-22 shows an adjustable type of spanner. The hook end of the wrench is hinged so that it will fit various sizes of nuts.

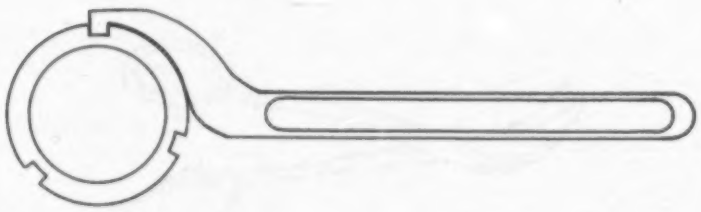

1.17.3

Figure 1-1-21.—Hook Spanner wrench.

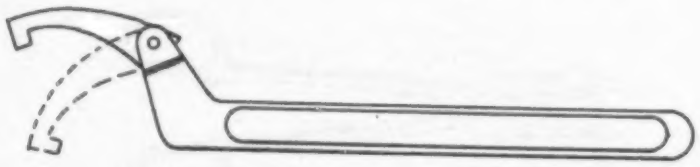

44.8

Figure 1-1-22.—Adjustable hook spanner wrench.

HEX-WRENCHES (ALLEN)

In some places it is desirable to use recessed heads on setscrews and capscrews. This type screw is used extensively on office machines and in machine shops.

Recessed head screws usually have a hex-shaped (six-sided) recess. To remove or tighten this type screw requires a special wrench that will fit in the recess. This wrench is called an Allen-type wrench. Allen-type wrenches are made from hexagonal L-shaped bars of tool steel. They range in size from 1/8 to 3/4 inch. When using the Allen-type wrench make sure you use the correct size to prevent rounding or spreading the head of the screw.

NONSPARKING WRENCHES

Nonsparking wrenches are wrenches that will not cause sparks to be generated when working with steel nuts and bolts. They are generally made from a copper alloy (bronze). However, they may be made from other nonsparking materials.

Nonsparking wrenches must be used in areas where flammable materials are present. These tools are used extensively when working around gasoline-carrying vehicles and when working around aircraft.

RULES FOR WRENCHES

There are a few basic rules that you should keep in mind when using wrenches. They are:

1. Always use a wrench that fits the nut properly.
2. Keep wrenches clean and free from oil. Otherwise they may slip, resulting in possible serious injury to you or damage to the work.
3. Do not increase the leverage of a wrench by placing a pipe over the handle. Increased leverage may damage the wrench or the work.
4. Provide some sort of kit or case for all wrenches. Return them to it at the completion of each job. This saves time and trouble and facilitates selection of tools for the next job. Most important, it eliminates the possibility of leaving them where they can cause injury or damage to men or equipment.
5. Determine which way a nut should be turned before trying to loosen it. Most nuts are turned counterclockwise for removal. This may seem obvious, but even experienced men have been observed straining at the wrench in the tightening direction when they wanted to loosen it.
6. Learn to select your wrenches to fit the type of work you are doing. If you are not familiar with these wrenches, make arrangements to visit a shop that has most of them and get acquainted.

METAL CUTTING TOOLS

There are many types of metal cutting tools used by skilled mechanics of all ratings. As you

become better acquainted with your rating, you will probably discover many tools that you use for cutting metal that are not described in this text. In this text, only the basic hand metal cutting tools will be considered. No matter how technical your work is you will find that certain jobs are done better and quicker with the basic handtool. The "how to do" certain jobs will be explained in a later section of this text.

SNIPS

One of the handiest tools for cutting light sheet metal is the hand snip (tin snips). The STRAIGHT HAND SNIPS shown in fig. 1-1-23 have blades that are straight and cutting edges that are sharpened to an 85-degree angle. Snips like this can be obtained in different sizes ranging from the small 6-inch snip to the large 14-inch. They are designed to cut sheet metal up to one-sixteenth inch in thickness. They will also work on slightly heavier gages of soft metals such as aluminum alloys.

Snips will not remove any metal when a cut is made. There is danger, though, of causing minute metal fractures along the edges of the metal during the shearing process. For this reason it is better not to cut exactly on the layout line in an attempt to avoid too much finish work.

Cutting extremely heavy gage metal always presents an opportunity to spring the blades. Once the blades are sprung, hand snips are useless. Use the rear portion of the blades only, when cutting heavy material. This not only avoids the possibility of springing the blades but also gives you greater cutting leverage.

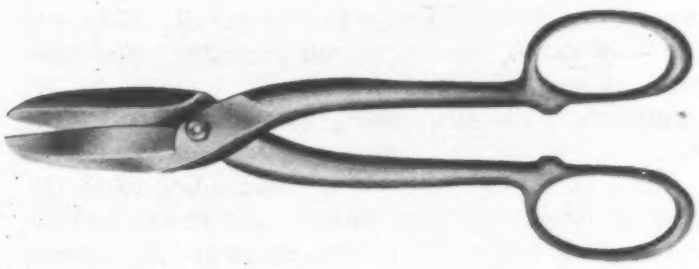

44.9

Figure 1-1-23.—Straight hand snips.

Never use tin snips to cut hardened steel wire or other similar objects. Such use will dent or nick the cutting edges of the blades.

It is hard to cut circles or small arcs with straight snips. There are snips expecially designed for circular cutting. They are called CIRCLE SNIPS, HAWKS-BILL SNIPS, TROJAN SNIPS, and AVIATION SNIPS. (See fig. 1-1-24.) Use these snips in the same manner as you would use straight snips and observe the same precautions. Like straight snips they come in many different sizes.

Many snips have small serrations (notches) on the cutting edges of the blades. This tends to

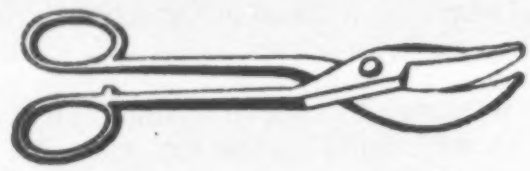

CIRCLE SNIPS

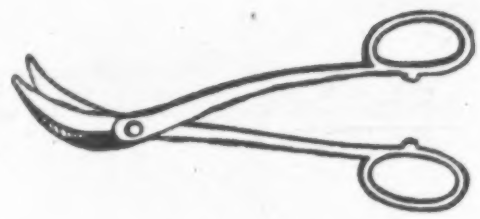

HAWKS-BILL SNIPS

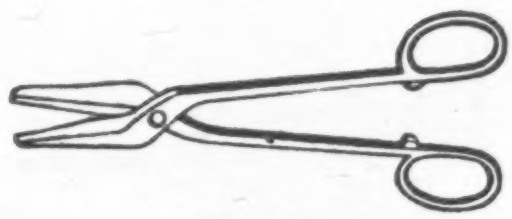

TROJAN SNIPS

AVIATION SNIPS

44.10

Figure 1-1-24.—Snips for cutting circles and arcs.

prevent them from slipping backwards when a cut is being made. Although this feature does make the actual cutting much easier, it mars the edges of the metal slightly. You can remove these small cutting marks if you allow proper clearance for dressing the metal to size. There are many other types of hand snips used for special jobs. The snips discussed here can be used for almost any common type of work.

Learn to use snips properly. They should always be oiled and adjusted to permit ease of cutting and to produce a surface that is free from burrs. If the blades bind, or if they are too far apart, the snips should be adjusted.

Never use snips as screwdrivers, hammers, or pry bars. They break easily. Do not attempt to cut heavier materials than the snips are designed for. Never toss snips in a toolbox where the cutting edges can come into contact with other tools. This dulls the cutting edges and may even break the blades. When snips are not in use, hang them on hooks or lay them on an uncrowded shelf or bench.

HACKSAWS

Hacksaws are used to cut metal that is too heavy for snips. Such things as bolts and metal bar stock can be cut with hacksaws. There are two parts to a hacksaw; the frame and the blade. Common hacksaws have either an adjustable or solid frame. (See fig.1-1-25.) Since hacksaw blades are made in different lengths, most hacksaws found in the Navy are of the adjustable frame type. Adjustable frames can be made to hold blades from 8 to 16 inches long, while those with solid frames take only the length blade for which they are made. This length is the distance between the two pins that hold the blade in place.

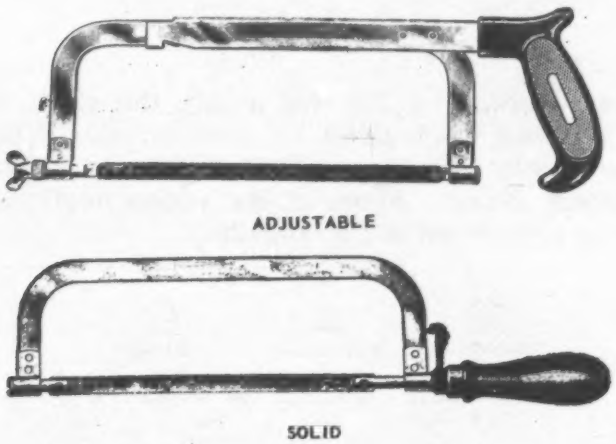

Figure 1-1-25.—Hacksaws. 1.19(44)

Hacksaw blades are made of high-grade tool steel, hardened and tempered. There are two types, the all-hard and the flexible. All-hard blades are hardened throughout, whereas only the teeth of the flexible blades are hardened. Hacksaw blades are about one-half inch wide, have from 14 to 32 teeth per inch, and are from 8 to 16 inches long. The blades have a hole at each end which hooks to a pin in the frame. All hacksaw frames which hold the blades either parallel or at right angles to the frame are provided with a wingnut or screw to permit tightening or removing the blade.

The SET in a saw refers to how much the teeth are pushed out in opposite directions from the sides of the blade. The four different kinds of set are ALTERNATE set, DOUBLE ALTERNATE set, RAKER set, and WAVE set. Three of these are shown in figure 1-1-26.

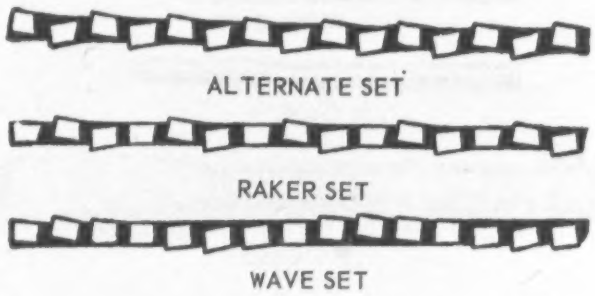

Figure 1-1-26.—"Set" of hacksaw blade teeth. 28.40(44)

The teeth in the alternate set are staggered, one to the left and one to the right throughout the length of the blade. On the double alternate set blade, two adjoining teeth are staggered to the right, two to the left, and so on. On the raker set blade, every third tooth remains straight and the other two are set alternately. On the wave (undulated) set blade, short sections of teeth are bent in opposite directions.

The main danger in using hacksaws is injury to your hand if the blade breaks. The blade will break if too much pressure is applied, when the saw is twisted, or when the cutting speed is too fast. If the work is not tight in the vise, it will sometimes slip, twisting the blade enough to break it.

Selecting the proper blade for certain jobs and more on how to use the hacksaw can be found in part II, section 6 of this text.

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CHISELS

Chisels are tools that can be used for chipping or cutting metal. They are made from a good grade tool steel with a hardened cutting edge and a beveled head. They will cut any metal that is softer than materials of which they are made. When it is skillfully used, the chisel can be made to do most any job that a milling machine can do, although it is perhaps less accurate and requires greater time and energy.

Usually the bar stock from which a chisel is forged is octagonal (eight-sided). Cold chisels are classified according to the shape of their points, and the width of the cutting edge denotes their size. The most common shapes of chisels are flat (cold chisel), cape, round nose, and diamond point. (See fig. 1-1-27.)

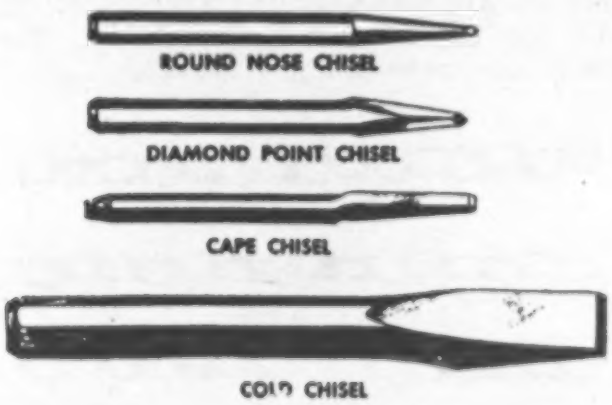

Figure 1-1-27.—Metal-working chisels. 29.9(44)

The type chisel most commonly used is the flat cold chisel, which serves to cut rivets, split nuts, chip castings, and cut thin metal sheets. Also used for special jobs is the cape chisel for cutting keyways, narrow grooves and square corners, the round-nose chisel for semicircular grooves and for chipping inside corners with a fillet, and the diamond-point for cutting V-grooves and sharp corners.

As with other tools there is a correct technique for using a chisel. Select a chisel that is large enough for the job. Be sure to use a hammer that matches the chisel; that is, the larger the chisel, the heavier the hammer. A heavy chisel will absorb the blows of a light hammer and will do virtually no cutting.

As a general rule, hold the chisel in the left hand with the thumb and first finger about 1 inch from the top. It should be held steadily but not tightly. The finger muscles should be relaxed, so if the hammer strikes the hand it will slide down the tool and lessen the effect of the blow. Keep the eyes on the cutting edge of the chisel, not on the head, and swing the hammer in the same plane as the body of the chisel. If you have a lot of chiseling to do, slide a piece of rubber hose over the chisel. This will lessen the shock to your hand.

When using a chisel for chipping, always wear goggles to protect your eyes. If other men are working close by, see that they are protected from flying chips by erecting a screen or shield to contain the chips. Remember that the time to take these precautions is before you start the job.

FILES

A toolkit for nearly every rating in the Navy is not complete unless it contains an assortment of files. There are a number of different types of files in common use, and each type may range in length from 3 to 18 inches. They are graded according to the degree of fineness, and according to whether they are single- or double-cut.

The length of a file is the distance from the tip to the heel, and does not include the tang. (See fig. 1-1-28.)

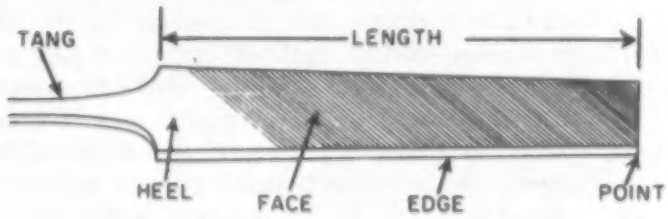

Figure 1-1-28.—File nomenclature. 1.20.1

In selecting a file for a job, the shape of the finished work must be considered. Files come in different shapes, both outline and cross sectional shape. Some of the cross sectional shapes are shown in fig. 1-1-29.

Figure 1-1-29.—Cross-sectional shapes of files. 1.20.2

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TRIANGULAR files are tapered (longitudinally) on all three sides. They are used to file acute internal angles, and to clear out square corners. Special triangular files are used to file saw teeth.

MILL files are tapered in both width and thickness. One edge has no teeth and is known as a SAFE EDGE. Mill files are used for smoothing lathe work, drawfiling, and other fine, precision work. Mill files are always single-cut.

FLAT files are general-purpose files and may be either single- or double-cut. They are tapered in width and thickness. HARD files, not shown, are somewhat thicker than flat files. They taper slightly in thickness, but their edges are parallel.

SQUARE files are tapered on all four sides and are used to enlarge rectangular-shaped holes and slots. ROUND files serve the same purpose for round openings. Small round files are often called "rattail" files.

The HALF ROUND file is a general-purpose tool. The rounded side is used for curved surfaces and the flat face on flat surfaces. When you file an inside curve, use a round or half-round file whose curve most nearly matches the curve of the work.

Kits of small files, often called "Swiss Pattern" or "Jewelers" files, are used to fit parts of delicate mechanisms, and for filing work on instruments. Handle these small files carefully because they break easily.

Cuts and grades of files vary greatly. As mentioned before, they have either single-cut or double-cut teeth. The difference is apparent when you compare the files in fig. 1-1-30.

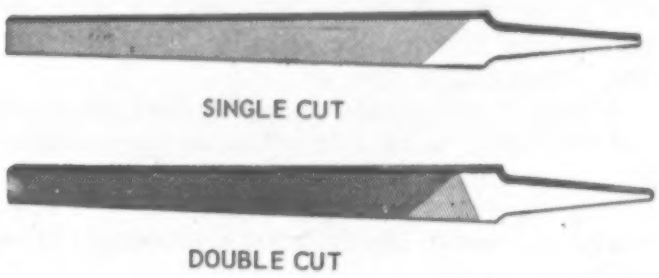

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Figure 1-1-30.—Single and double-cut files.

Single-cut files have rows of teeth cut parallel to each other. These teeth are set at an angle of about 65 degrees with the centerline. You will use single-cut files for sharpening tools, finish filing, and drawfiling. They are also the best tools for smoothing the edges of sheet metal.

Files with crisscrossed rows of teeth are double-cut files. The double cut forms teeth that are diamond-shaped and fast cutting. You will use double-cut files for quick removal of metal, and for rough work.

Files are also graded according to the spacing and size of their teeth, or their coarseness and fineness. Some of these grades are pictured in fig. 1-1-31. In addition to the three grades shown, you may use some DEAD SMOOTH files, which have very fine teeth, and some ROUGH files with very coarse teeth. The fineness or coarseness of file teeth is also influenced by the length of the file. When you have a chance, compare the actual size of the teeth of a 6-inch, single-cut smooth file and a 12-inch, single-cut smooth file; you will notice the 6-inch file has more teeth per inch than the 12-inch file.

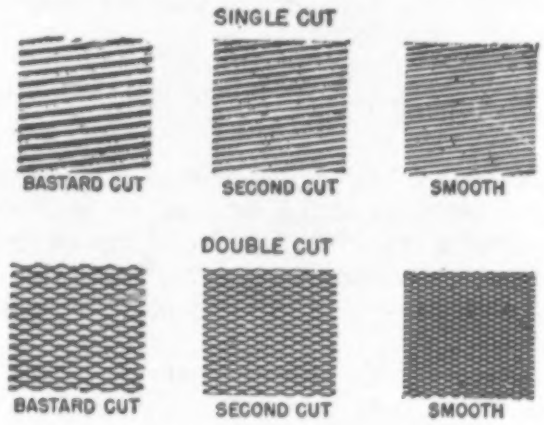

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Figure 1-1-31.—Grades of file teeth.

The flat or hand files most often used are the double-cut second cut file for rough work and the single-cut, smooth file for finish work.

For smoothing soft metals, such as aluminum and bearing metal, you may be supplied with a FLOAT-CUT file. It has large curved teeth and is worked with a planing action.

Never use a file unless it is equipped with a tight-fitting handle. If you use a file without the handle and it bumps something or jams to a sudden stop, the tang may be driven into your hand. To put a handle on a file tang, drill a hole in the handle, slightly smaller than the tang. Insert the tang end, and then tap the end of the handle to seat it firmly. Make sure you get the handle on straight.

As you file, the teeth of the file may "clog up" with some of the metal filings and scratch your work. This condition is known as PINNING. You can prevent pinning by keeping the file teeth clean. Rubbing chalk between the teeth will help prevent pinning, too, but the best method is to clean the file frequently with a FILE CARD or brush. A file card (fig. 1-1-32) has fine wire bristles. Brush with a pulling motion, holding the card parallel to the rows of teeth.

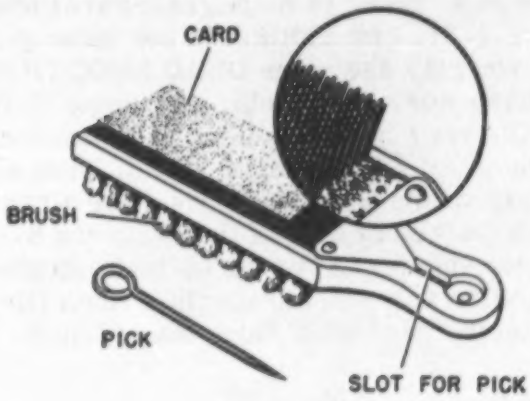

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Figure 1-1-32.—File cleaner.

A new file should be broken in carefully by using it first on brass, bronze, or smooth cast iron. Just a few of the teeth will cut at first, so use a light pressure to prevent tooth breakage. Do not break in a new file by using it first on a narrow surface.

Protect the file teeth by hanging your files in a rack when they are not in use, or by placing them in drawers with wooden partitions. Your files should not be allowed to rust—keep them away from water and moisture. Avoid getting the files oily. Oil causes a file to slide across the work and prevents fast, clean cutting. Files that you keep in your toolbox should be wrapped in paper or cloth to protect their teeth and prevent damage to other tools.

Never use a file for prying or pounding. The tang is soft and bends easily. The body is hard and extremely brittle. Even a slight bend or a fall to the deck may cause a file to snap in two. Do not strike a file against the bench or vise to clean it—use a file card.

TWIST DRILLS

Making a hole in a piece of metal is generally a simple operation, but in most cases is an important and a precise job. A large number of different tools and machines have been designed so that holes may be made speedily, economically, and accurately in all kinds of material.

In order to be able to use these tools efficiently, it is well to become acquainted with them. The most common tool for making holes in metal is the twist drill. It consists of a cylindrical piece of steel with spiral grooves. One end of the cylinder is pointed while the other end is shaped so that it may be attached to a drilling machine. The grooves, usually called FLUTES, may be cut into the steel cylinder, or the flutes may be formed by twisting a flat piece of steel into a cylindrical shape.

The principal parts of a twist drill are the body, the shank, and the point. (See fig. 1-1-33.) The dead center of a drill is the sharp edge at the extreme tip end of the drill. It is formed by the intersection of the cone-shaped surfaces of the point and should always be in the exact center of the axis of the drill. The point of the drill should not be confused with the dead center. The point is the entire cone-shaped surface at the end of the drill.

The lip or cutting edge of a drill is that part of the point that actually cuts away the metal when drilling a hole. It is ordinarily as sharp as the edge of a knife. There is a cutting edge for each flute of the drill.

The lip clearance of a drill is the surface of the point that is ground away or relieved just back of the cutting edge of the drill. The strip along the inner edge of the body is called the margin. It is the greatest diameter of the drill and extends the entire length of the flute. The diameter of the margin at the shank end of the drill is smaller than the diameter at the point. This allows the drill to revolve without binding when drilling deep holes.

A tang is found only on tapered-shank drills. It is designed to fit into a slot in the socket or spindle of a machine. It may bear a portion of the driving torque, but its principal use is to make it easy to remove the drill from the socket of the driving machine.

The maintenance of twist drills and more about how to use them on specific jobs are discussed in a later section of this text.

REAMERS

Reamers are used to enlarge and true a hole. The reamer consists of three parts—the body, the shank, and the blades. The shank has a square

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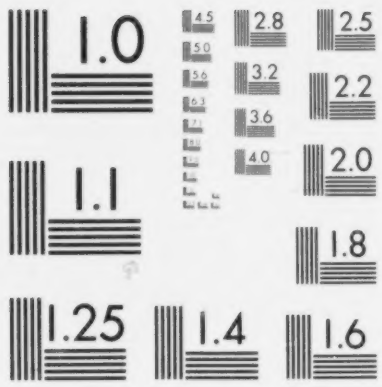

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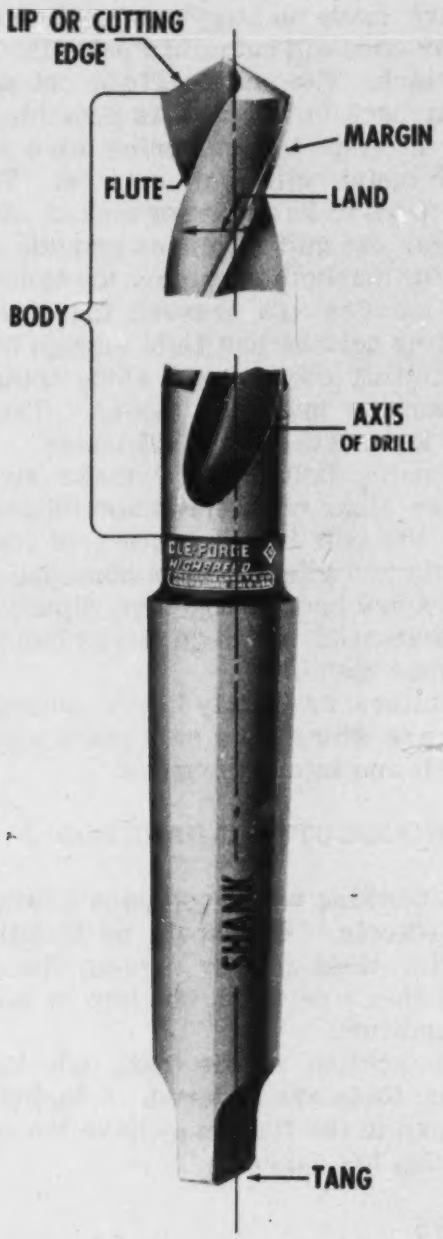

Figure 1-1-33.—Twist drill nomenclature.

tang to allow the reamer to be held with a wrench for turning. The main purpose of the body is to support the blades.

The blades on a reamer are made of steel and hardened to such an extent that they are brittle. For this reason you must be careful when using and storing the reamer to protect the blades from chipping. When you are reaming a hole, turn the reamer in the CUTTING DIRECTION ONLY. This will prevent chipping or dulling of the blades. Great care should be used to assure even, steady turning. Otherwise, the reamer will "chatter," causing the hole to become marked or scored. To prevent damage to the reamer while not in use, wrap it in an oily cloth and keep it in a box.

Reamers of the types shown in figure 1-1-34 are available in any standard size. They are also available in size variations of .001" for special work. Use a solid straight flute reamer when reaming a number of holes of the same size. This type lasts longer and is less expensive than the expansion reamer.

The solid spiral flute reamer is used where many similar holes are to be reamed. Many mechanics prefer it because it is less likely to chatter. The spiral reamer costs slightly more than the straight flute reamer.

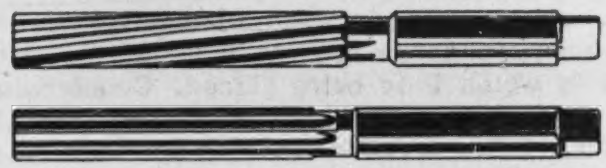

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Figure 1-1-34.—Above—solid spiral flute reamer.
Below—solid straight flute reamer.

For general purposes, an expansion reamer (fig. 1-1-35) is the most practical. This reamer can usually be obtained in standard sizes from 1/4 of an inch to 1 inch, by 32nds. It is designed to allow the blades to expand 1/32 of an inch. For example, the 1/4-inch expansion reamer will ream a 1/4-inch to a 9/32-inch hole. A 9/32-inch reamer will enlarge the hole from 9/32 of an inch to 5/16 of an inch. This range of adjustment allows a few reamers to cover sizes up to 1 inch.

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Figure 1-1-35.—Expansion reamer.

Reamers are made of carbon steel and high-speed steel. In general, the cutting blades of a high-speed reamer lose their keenness more quickly than a carbon steel reamer. However, after that keenness is gone, it will last longer than the carbon reamer.

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COUNTERSINKS

Countersinking is the operation of beveling the mouth of a hole with a rotary tool called a countersink. (See fig. 1-1-36.) The construction of the countersink is similar to the twist drill. There are four cutting edges, which are taper ground, to the angle marked on the body.

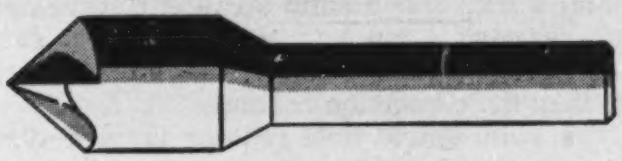

Figure 1-1-36.—Countersink. 28.59(44)

A countersink is used primarily to set the head of a screw or rivet flush with the material in which it is being placed. Countersinks are made in a number of sizes. One size usually takes care of holes of several different sizes. That is, the same countersink can be used for holes from 1/4 inch to 1/2 inch in diameter. Remove only enough metal to set the screw or rivet head flush with the material. If you remove too much material the hole will enlarge and weaken the work.

Select the countersink with the correct lip angle to correspond with the screw or rivet head being used. These countersinks can be turned by any machine that will turn a twist drill.

BOLT CUTTERS

Bolt cutters (fig. 1-1-37) are giant shears with very short blades and long handles. The handles are hinged at one end. The cutters are at the ends of extensions which are jointed in such a way that the inside joint is forced outwards when the handles are closed, thus forcing the cutting edges together with great force. Bolt cutters are made in lengths of 18 to 36 inches. The larger ones will cut mild steel bolts and rods up to 1/2 inch. The material to be cut should be kept as far back in the jaws as possible.

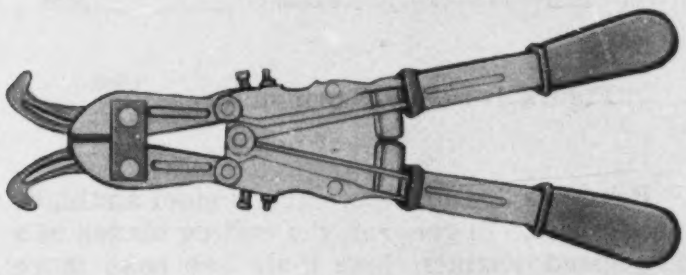

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Figure 1-1-37.—Bolt cutters.

Never attempt to cut spring wire or other tempered metal with bolt cutters. This will cause the jaws to be sprung or nicked. Adjusting screws near the middle hinges provide a means for ensuring that both jaws move the same amount when the handles are pressed together. Keep the adjusting screws just tight enough to ensure that the cutting edges meet along their entire length when the jaws are closed. The hinges should be kept well oiled at all times.

When using bolt cutters make sure your fingers are clear of the jaws and hinges. Take care that the bolt head or piece of rod cut off does not fly and injure you or someone else. If the cutters are brought together rapidly, sometimes a bolt-head or piece of rod being cut off will fly some distance.

Bolt cutters are fairly heavy, so make sure that they are stored in a safe place where they will not fall and injure someone.

WOODCUTTING HANDTOOLS

A man working with wood uses a large variety of handtools. He should be familiar with these tools, their proper names, the purpose for which they are used, and how to keep them in good condition.

In this section of the text, only the basic woodcutting tools are covered. It includes tools that any man in the Navy may have the occasion to use during his career.

HANDSAWS

The most common carpenter's handsaw consists of a steel blade with a handle at one end. The blade is narrower at the end opposite the handle. This end of the blade is called the "point" or "toe." The end of the blade nearest the handle is called the "heel" (fig. 1-1-38.) One edge of the blade has teeth, which act as two rows of cutters. When the saw is used, these teeth cut two parallel grooves close together. The chips (sawdust) are pushed out from between the grooves (kerf) by the beveled part of the teeth. The teeth are bent alternately to one side or the other, to make the kerf wider than the thickness of the blade. This bending is called the "set" of the teeth. (See fig. 1-1-39.) The

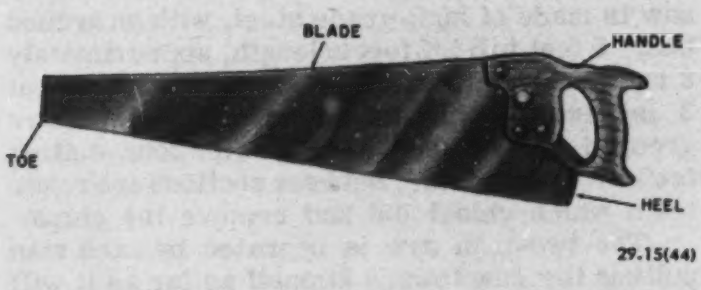

Figure 1-1-38.—Nomenclature of a handsaw.

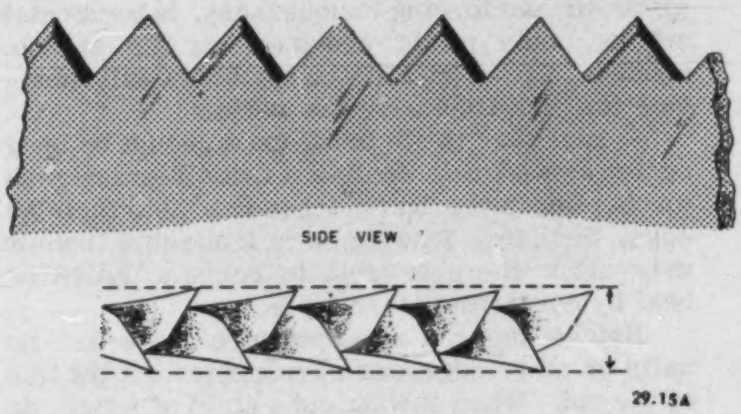

Figure 1-1-39.—"Set" of hand saw teeth.

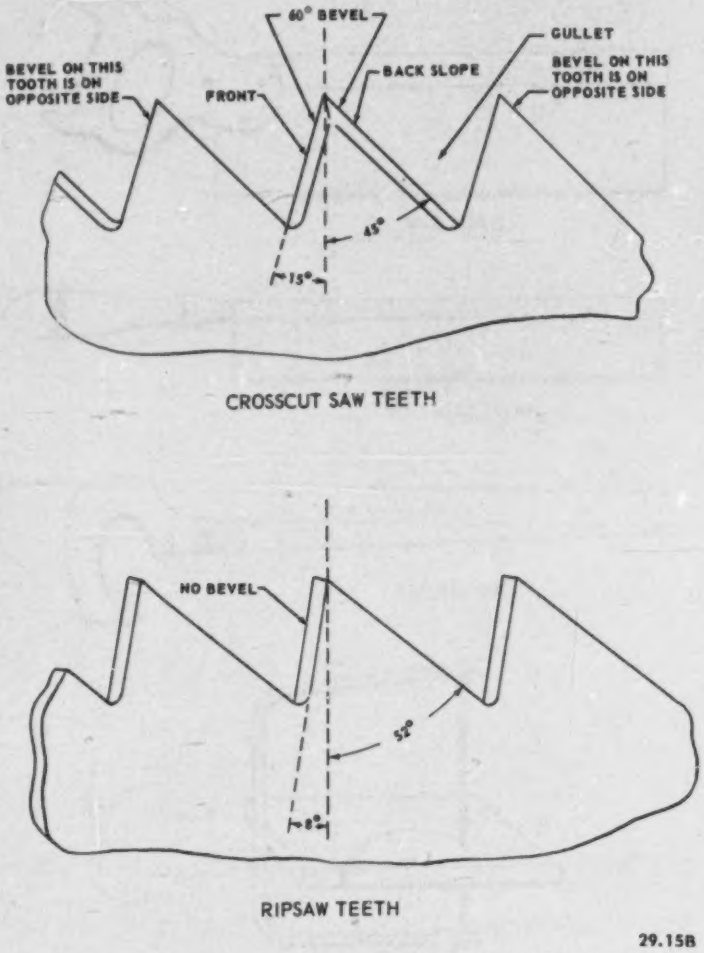

Figure 1-1-40.—Crosscut saw and ripsaw teeth.

number of teeth per inch, the size and shape of the teeth, and the amount of set depend on the use to be made of the saw and the material to be cut. Carpenter's handsaws are described by the number of points per inch. There is always one more point then there are teeth per inch. A number stamped near the handle gives the number of points of the saw.

Woodworking handsaws consist of RIPSAWS and CROSSCUT saws designed for general cutting. Ripsaws are used for cutting with the grain and crosscut saws are for cutting across the grain. A variety of other hand-operated saws, designed to serve special purposes, are designated by particular names, such as BACKSAW, DOVETAIL SAW, COPING SAW, and so on.

The major difference between a ripsaw and a crosscut saw is the shape of the teeth. A tooth with a square-faced chisel-type cutting edge, like the ripsaw tooth shown in figure 1-1-40, does a good job of cutting with the grain (called ripping), but a poor job of cutting across the grain (called crosscutting). A tooth with a beveled, knifetype cutting edge, like the crosscut saw tooth shown in the same figure, does a good job of cutting across the grain, but a poor job of cutting with the grain.

The more common types of saws used for special purposes are shown in figure 1-1-40. The BACKSAW is a crosscut saw designed for sawing a perfectly straight line across the face of a piece of stock. A heavy steel BACKING along the top of the blade keeps the blade perfectly straight.

The DOVETAIL saw is a special type of backsaw with a thin, narrow blade and a chisel-type handle.

The COMPASS saw is a long, narrow, tapering ripsaw designed for cutting out circular or other nonrectangular sections from within the margins of a board or panel. A hole is bored near the cutting line to start the saw. A KEYHOLE saw is simply a finer, narrower compass saw.

The COPING saw is used to cut along curved lines as shown in the figure.

The TWO-MAN CROSSCUT saw (fig. 1-1-42) is a double-handled saw used for heavy work, such as felling trees, cutting large trees into

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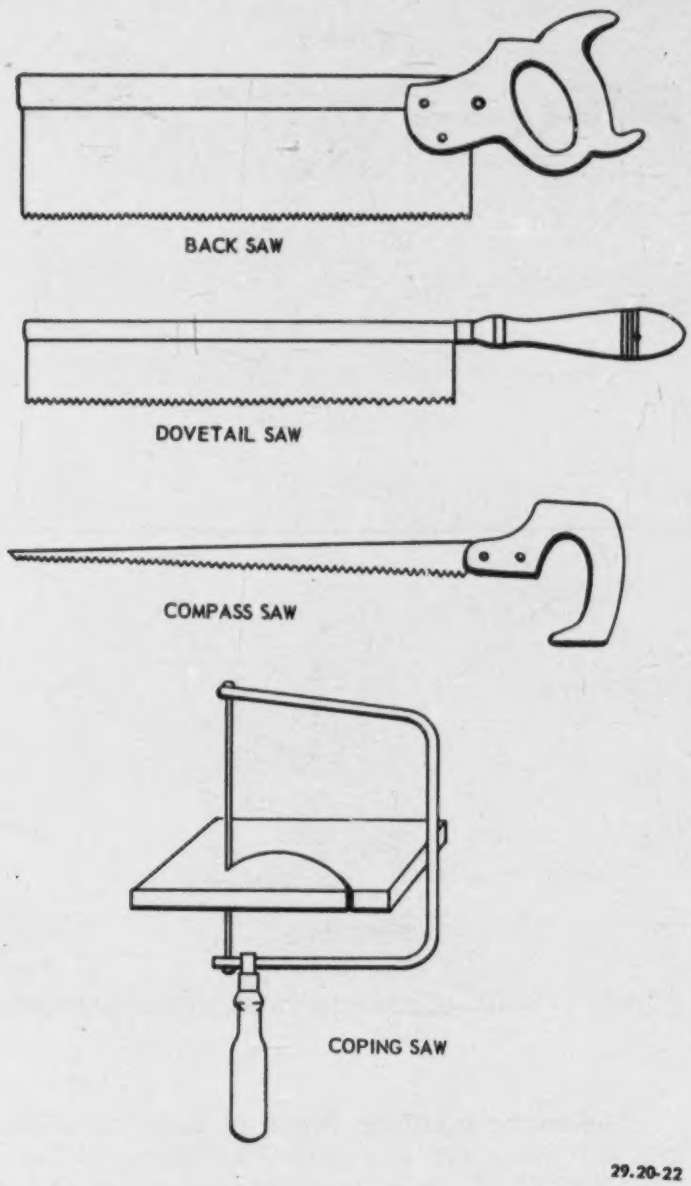

Figure 1-1-41.—Special saws.

logs, or sawing heavy bridge timbers. This saw is made of high-grade steel, with an arched blade 5 feet to 6 1/2 feet in length, approximately 8 inches wide at the middle and tapering to about 3 inches at each end. The cutting teeth are grouped in sections, usually with four cutting teeth to the section. Between sections are raker teeth which chisel out and remove the chips.

The two-man saw is operated by each man pulling the saw toward himself as far as it will go and then stopping, only guiding the saw as the other pulls it back. In vertical cutting, the weight of the saw creates enough pressure to make further forcing unnecessary. In horizontal cutting, only slight pressure on the saw is needed. Oil or paraffin on the blade will lubricate the blade and ease the work.

A saw that is not being used should be hung up or stowed in a toolbox. A toolbox designed for holding saws has notches that hold them on edge, teeth up. Stowing saws loose in a toolbox may allow the saw teeth to become dulled or bent by contacting other tools.

Before using a saw, be sure there are no nails or other edge-destroying objects in the line of the cut. When sawing out a strip of waste, do not break out the strip by twisting the saw blade. This dulls the saw, and may spring or break the blade.

Be sure that the saw will go through the full stroke without striking the floor or some other object. If the work cannot be raised high enough to obtain full clearance for the saw, you must carefully limit the length of each stroke.

Some right and wrong methods of using and caring for a saw are shown in figure 1-1-43.

PLANES

The plane is the most extensively used of the hand shaving tools. Most of the lumber handled

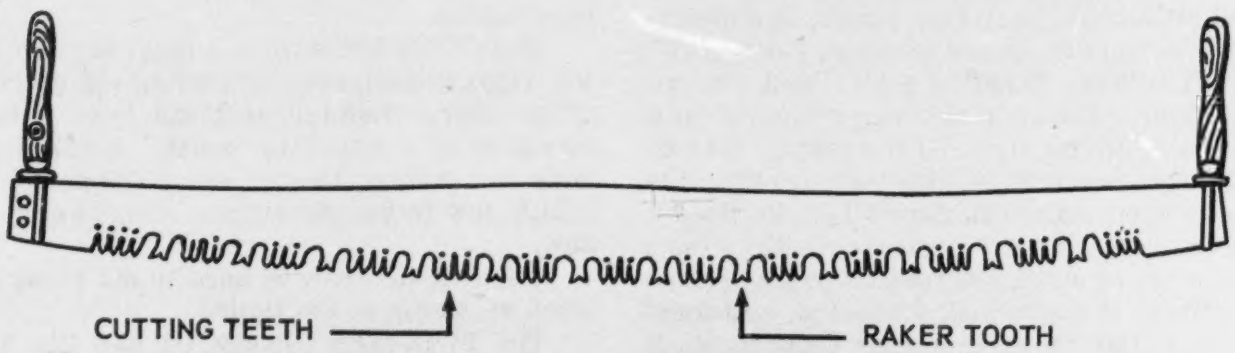

Figure 1-1-42.—Two-man crosscut saw.

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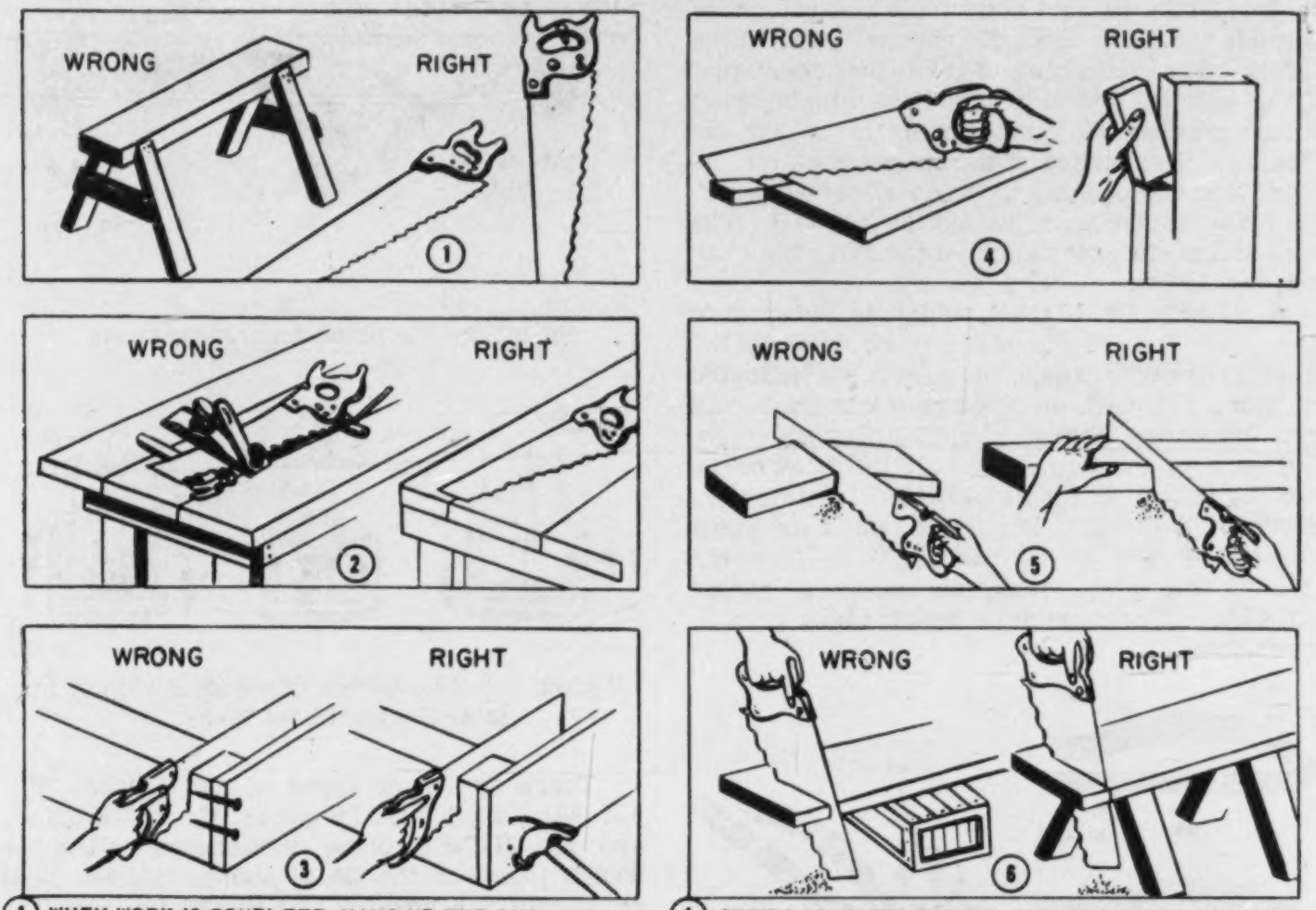

1. WHEN WORK IS COMPLETE, HANG UP THE SAW.
2. DO NOT PILE TOOLS ON TOP OF THE BENCH SO AS TO DISTORT BLADE
3. LOOK CAREFULLY OVER REPAIR OR ALTERATION WORK; SEE THAT ALL NAILS ARE REMOVED TO AVOID CUTTING INTO METAL
4. STRIPS OF WASTE SHOULD NOT BE TWISTED OFF WITH BLADE, BUT BROKEN OFF WITH HAND OR MALLET.
5. SUPPORTING THE WASTE SIDE OF WORK WILL PREVENT SPLITTING OFF.
6. RAISE THE WORK TO A HEIGHT SUFFICIENT TO KEEP THE BLADE FROM STRIKING THE FLOOR. IF THE WORK CANNOT BE RAISED, LIMIT THE STROKE.

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Figure 1-1-43.—Care of handsaws.

by anyone working with wood is dressed on all four sides, but when performing jobs such as fitting doors and sash, and interior trim work, planes must be used.

The large family of planes includes BENCH and BLOCK PLANES, designed for general surface smoothing and squaring, and other planes designed for special types of surface work.

The principal parts of a BENCH PLANE and the manner in which they are assembled, are shown in figure 1-1-44. The part at the rear that you grasp to push the plane ahead is called

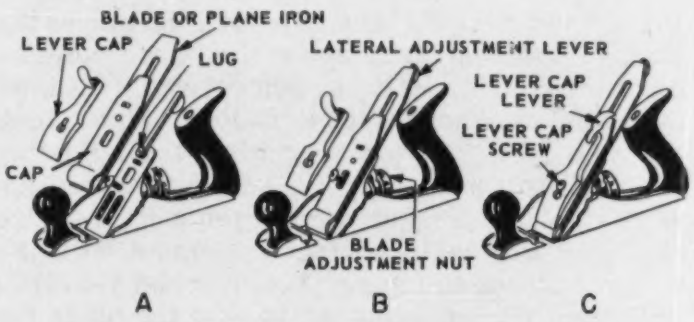

Figure 1-1-44.—Parts of a bench plane. 29.12A

the HANDLE; the part at the front that you grasp to guide the plane along its course is called the KNOB. The main body of the plane, consisting of the bottom, the sides, and the sloping part which carries the plane iron, is called the FRAME. The bottom of the frame is called the SOLE, and the opening in the sole, through which the blade emerges, is called the MOUTH. The front end of the sole is called the TOE; the rear end, the HEEL.

A PLANE IRON CAP, which is screwed to the upper face of the plane iron, deflects the shaving upward through the mouth, as indicated in figure 1-1-45C, and thus prevents the mouth from becoming choked with jammed shavings. The edge of the cap should fit the back of the iron as shown in figure 1-1-45A, not as shown in figure 1-1-45B. The lower end of the plane iron cap should be set back 1/32 in. from the edge of the plane iron, as shown in figure 1-1-45A. The iron in a bench plane goes in bevel-down.

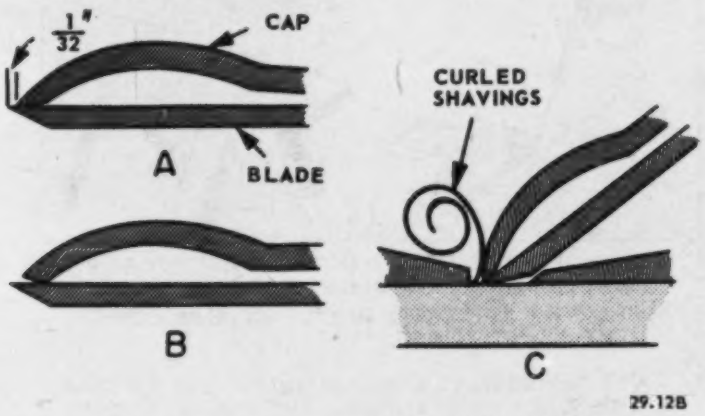

Figure 1-1-45.—Plane iron and plane iron cap.

The edge of the plane iron is brought into correct cutting position by the manipulation of first the ADJUSTING NUT and next the LATERAL ADJUSTMENT LEVER, as shown in figures 1-1-46 and 1-1-47. The adjusting nut moves the edge of the iron up or down; the lateral adjustment lever cants it to the right or left. To adjust the plane you hold it upside-down, sight along the sole from the toe, and work the adjusting nut until the edge of the blade appears. Then work the lateral adjustment lever until the edge of the blade is in perfect alinement with the sole, as shown in figures 1-1-46B and 1-1-46C. Then use the adjusting nut to give the blade the amount of protrusion you want. This amount will depend, of course, upon the depth of the cut you intend to make.

Figure 1-1-46.—Manipulation of the adjusting nut moves the plane iron up or down.

Figure 1-1-47.—Effect of manipulation of the lateral adjustment lever.

There are three types of bench planes (fig. 1-1-48): the SMOOTH plane, the JACK plane, and the JOINER plane (sometimes called the FORE plane or the GAGE plane). All are used primarily for shaving and smoothing with the grain; the chief difference is the length of the sole. The sole of the smooth plane is about 9 in. long, the sole of the jack plane about 14 in. long, and the sole of the jointer plane from 20 to 24 in. long.

The longer the sole of the plane is, the more uniformly flat and true the planed surface will be. Consequently, which bench plane you should use depends upon the requirements with regard to surface trueness. The smooth plane is, in general, smoother only; it will plane a smooth, but not an especially true surface in a short time. It is also used for cross-grain smoothing and squaring of end-stock.

The jack plane is the general "jack-of-all-work" of the bench plane group. It can take a deeper cut and plane a truer surface than the smooth plane. The joiner plane is used when the planed surface must meet the highest requirements with regard to trueness.

A BLOCK PLANE and the names of its parts are shown in figure 1-1-49. Note that the plane iron in a block plane does not have a plane iron cap, and also that, unlike the iron in a bench plane, the iron in a block plane goes in bevel-up.

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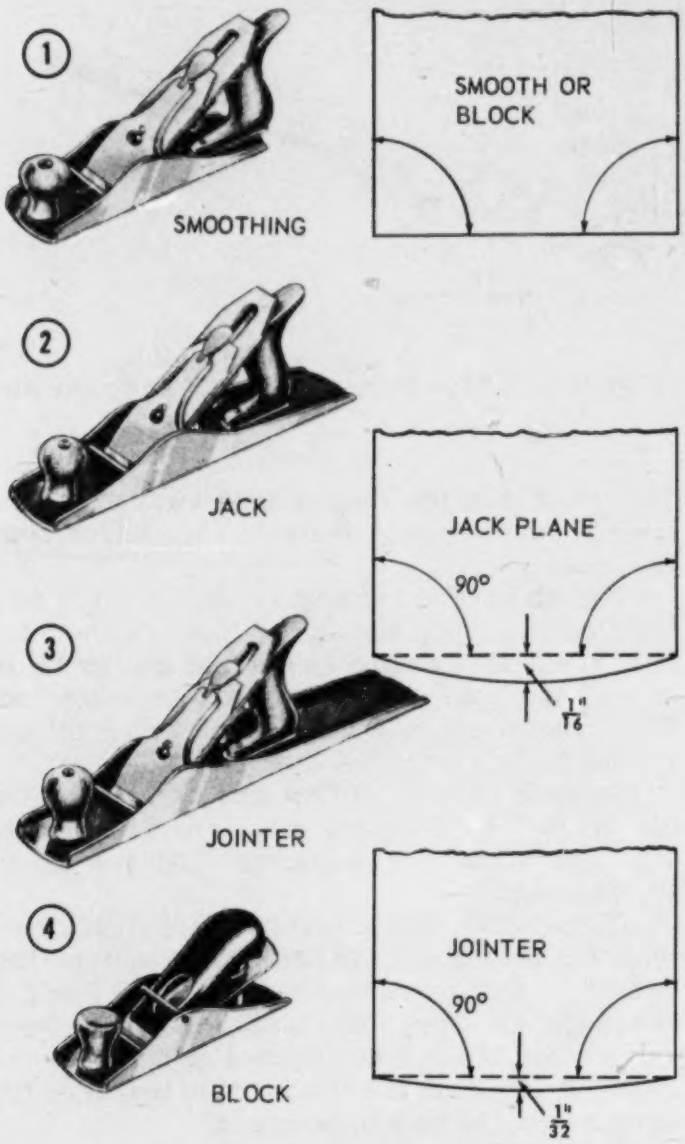

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Figure 1-1-48.—Types of bench planes and block plane.

The block plane, which is usually held at an angle to the work, is used chiefly for cross-grain squaring of end-stock. It is also useful, however, for smoothing all plane surfaces on very small work.

There are a great variety of special-purpose planes, only a few of which can be mentioned here. The RABBET-AND-FILLISTER plane is used to plane a RABBET (a groove cut on the edge or end of a piece of board) on an edge, as shown in figure 1-1-50. A FILLISTER is simply a rabbet which has been planed into the outer edge of a window sash bar. Before planing set the WIDTH GAGE on the plane to the desired width of the rabbet, and the DEPTH GAGE to the desired depth. To use this plane, set it on the edge with the width gage against the face of the board, and plane down until the further progress of the plane is stopped by the depth gage. The side edge of the plane iron must be set exactly flush with the side edge of the sole on the plane. The SPUR breaks trail, as it were, for the plane iron. Many rabbet-and-fillister planes do not have the spur.

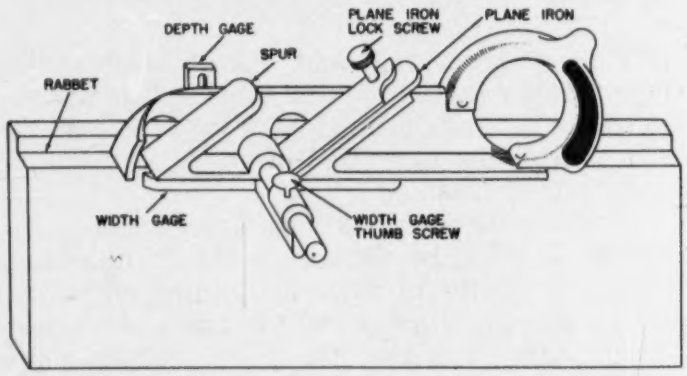

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Figure 1-1-50.—Rabbit-and-fillister plane.

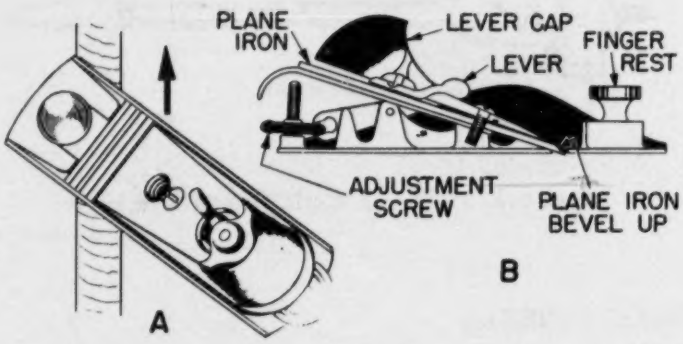

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Figure 1-1-49.—Block plane nomenclature.

The ROUTER plane (fig. 1-1-51) is used to smooth the bottom of a groove that has been roughed out with a chisel. The way the plane works is evident in the illustration.

A BULL-NOSE plane is a small one-hand plane with the mouth located near the forward edge of the sole and the iron flush with one or both sides of the sole; it is used for planing close into corners. A PLOW plane uses irons of different widths. A UNIVERSAL plane is a complicated tool which is equipped with cutters of various shapes for planing moldings. A MATCHING PLANE cuts a groove on one piece and a tongue to "match" it on another.

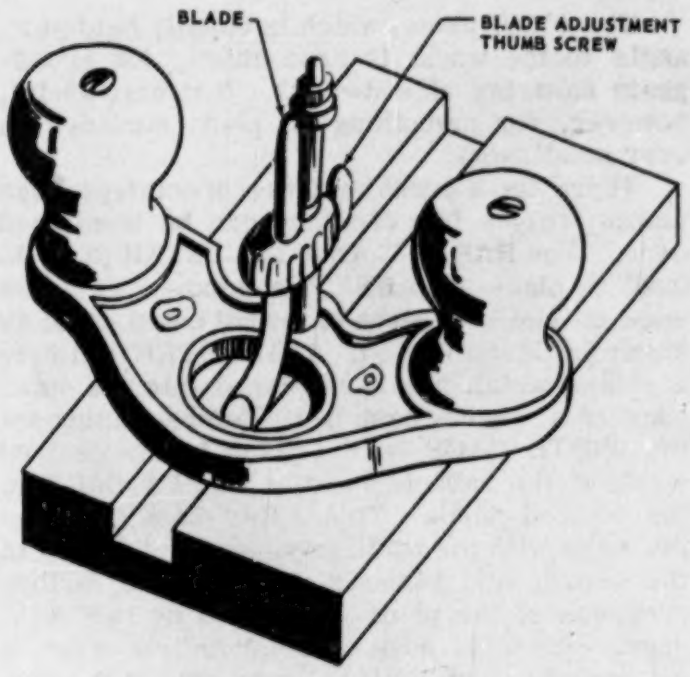

Figure 1-1-51.—Router plane.

AUGER BITS

The woodworking and metal trades distinguish sharply between bits and drills and between boring and drilling. A woodworker never says that a hole is drilled in wood, but uses the term "bored" instead.

Bits are used for boring holes for screws, dowels, and hardware, as an aid in mortising (cutting a cavity in wood for joining members) and in shaping curves and for many other purposes. Like saws and planes, bits vary in shape and structure with the type of job to be done. Some of the most common bits are described in this section.

AUGER bits are screw-shaped tools consisting of six parts: the cutter, screw, spur, twist, shank, and tang. (See fig. 1-1-52.) The twist ends with two sharp points called the spurs, which score the circle, and two cutting edges which cut shavings within the scored circle. The screw centers the bit and draws it into the wood. The threads of the screw are made in three different pitches: steep, medium, and fine. The steep pitch makes for quick boring and thick chips, and the fine or slight pitch makes for slow boring and fine chips. For end-wood boring, a steep- or medium-pitch screw bit should be used because end wood is likely to be forced in between the fine screw threads, and that will prevent the screw from taking hold.

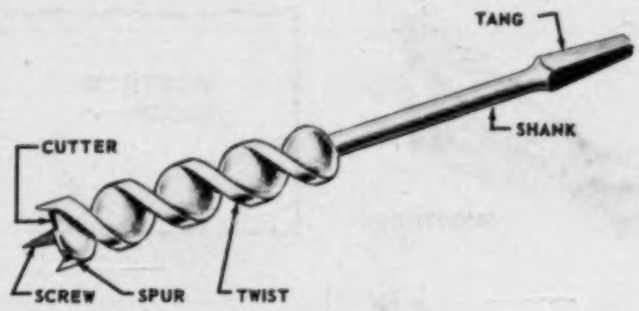

Figure 1-1-52.—Nomenclature of an auger bit.

The twist carries the cuttings away from the cutters and deposits them in a mound around the hole.

The sizes of auger bits are indicated in sixteenths of an inch and are stamped on the tang. A number 10 stamped on the tang means 10/16 or 5/8 in.; number 5 means 5/16 in. and so on. The most common woodworkers auger bit set ranges in size from 1/4 to 1 in.

Ordinary auger bits up to 1 in. in diameter are from 7 to 9 inches long. Short auger bits that are about 3 1/2 inches long are called DOWEL bits.

EXPANSIVE auger bits have adjustable cutters, for boring holes of different diameters (fig. 1-1-53.) Expansive bits are generally made in two different sizes. The largest size has three cutters and bores holes up to 4 inches in diameter. A scale on the cutter blade indicates the diameter of the hole to be bored.

More will be said on the maintenance, and the use of auger bits for specific jobs in a later section of this book.

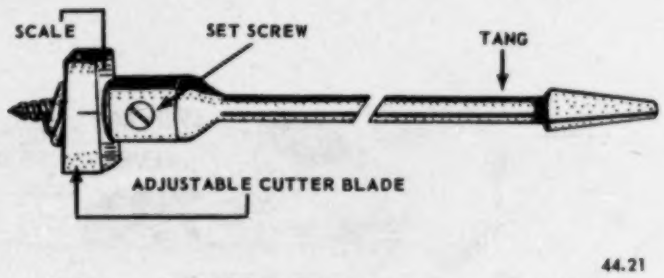

Figure 1-1-53.—Expansion auger bit.

WOOD CHISELS

After a board has been sawed and planed to size, the next operation usually is to join it to

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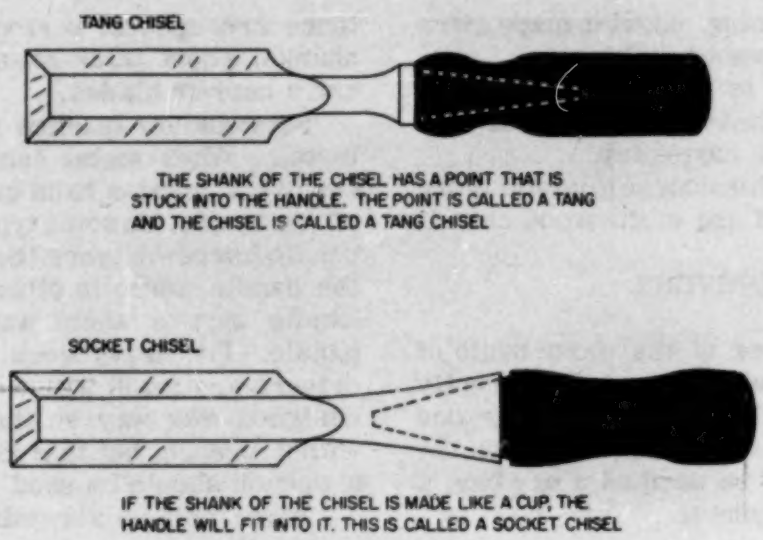

Figure 1-1-54.—Tang and socket wood chisels.

another board or part of a structure. A wood chisel, figure 1-1-54, in conjunction with other tools, is indispensable when making most joints by hand.

A wood chisel is a steel tool fitted with a wooden or plastic handle. It has a single beveled cutting edge on the end of the steel part, or blade. According to their construction, chisels may be divided into two general classes: TANG chisels, in which part of the chisel enters the handle, and SOCKET chisels, in which the handle enters into a part of the chisel. (See fig. 1-1-54.)

A socket chisel is designed for striking with a wooden mallet (never a steel hammer), while a tang chisel is designed for hand manipulation only.

Wood chisels are also divided into types, depending upon their weights and thicknesses, the shape or design of the blade, and the work they are intended to do.

The shapes of the more common types of wood chisels are shown in figure 1-1-55. The FIRMER chisel has a strong, rectangular-cross-section blade, designed for both heavy and light work. The blade of the PARING chisel is relatively thin, and is beveled along the sides for the fine paring work. The BUTT chisel has a short blade, designed for work in hard-to-get-at places.

The butt chisel is commonly used for chiseling the GAINS (rectangular depressions) for the BUTT hinges on doors; hence the name. The MORTISING chisel has a narrow blade, designed for chiseling out the deep, narrow MORTISES for mortise-and-tenon joints. This work requires a good deal of levering out of chips;

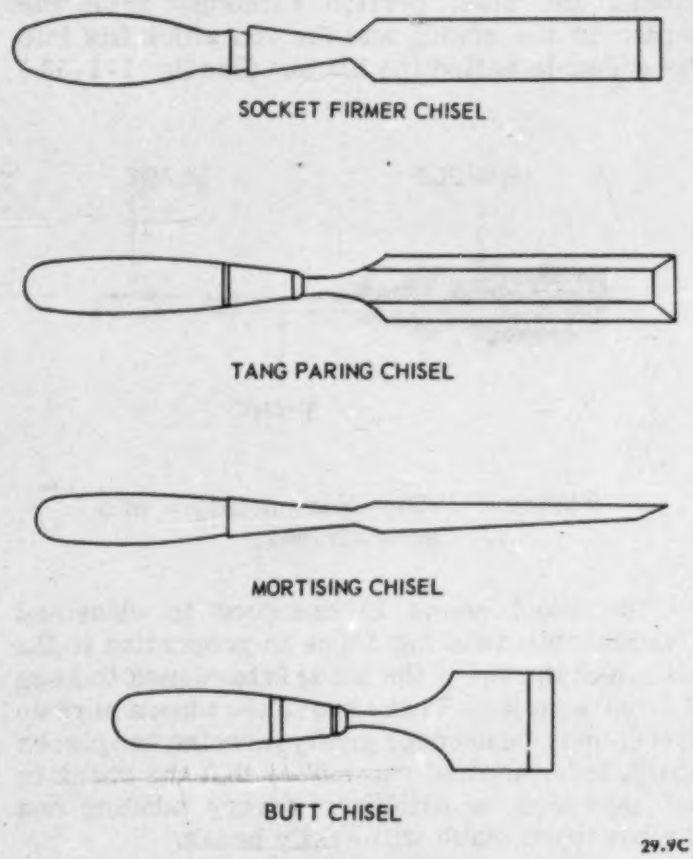

Figure 1-1-55.—Shapes of common types of wood chisels.

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consequently, the mortising chisel is made extra thick in the shaft to prevent breaking.

A FRAMING chisel is shaped like a firmer chisel, but has a very heavy, strong blade, designed for work in rough carpentry.

Sections 5 and 6 of this course give you more on the maintenance and use of the wood chisel.

SCREWDRIVERS

A screwdriver is one of the most basic of basic handtools. It is also the most frequently abused of all handtools. It is designed for one function only—to drive and remove screws. A screwdriver should not be used as a pry bar, a scraper, a chisel, or a punch.

STANDARD SCREWDRIVER

There are three main parts to a standard screwdriver. The portion you grip is called the handle, the steel portion extending from the handle is the shank, and the end which fits into the screw is called the blade. (See fig. 1-1-56.)

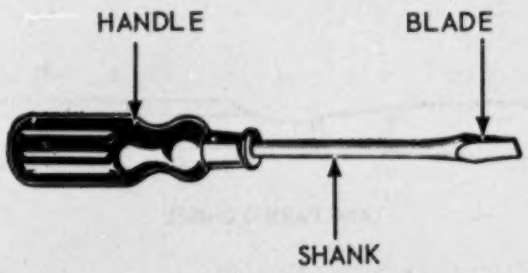

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Figure 1-1-56.—Nomenclature of a screwdriver.

The steel shank is designed to withstand considerable twisting force in proportion to its size, and the tip of the blade is hardened to keep it from wearing. There are times when a screwdriver may be used for gently levering two pieces apart, but you must remember that the shank is not designed to withstand severe bending and the hardened blade will easily break.

Standard screwdrivers are classified by size, according to the combined length of the shank and blade. The most common sizes range in length from 2 1/2 in. to 12 in. There are many screwdrivers smaller and some larger for special purposes. The diameter of the shank, and the width and thickness of the blade are generally proportionate to the length, but again there are special screwdrivers with long thin shanks, short thick shanks, and extra wide or extra narrow blades.

Screwdriver handles may be wood, plastic, or metal. When metal handles are used, there is usually a wooden hand grip placed on each side of the handle. In some types of wood- or plastic-handled screwdrivers the shank extends through the handle, while in others the shank enters the handle only a short way and is pinned to the handle. For heavy work, special types of screwdrivers are made with a square shank. They are designed this way so that they may be gripped with a wrench, but this is the only kind on which a wrench should be used.

When using a screwdriver it is important to select the proper size so that the blade fits the screw slot properly. This prevents burring the slot and reduces the force required to hold the driver in the slot.

PHILLIPS SCREWDRIVER

Recessed-head screws are now available under various trade names. These have a cavity of special shape formed in the head and require a specially shaped screwdriver. The most common type found is the Phillips head screw that requires a Phillips-type screwdriver. (See fig. 1-1-57.)

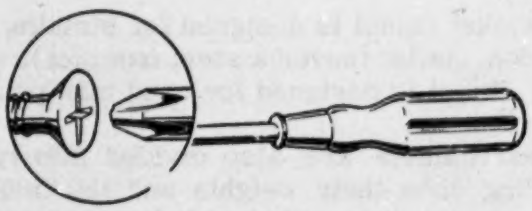

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Figure 1-1-57.—Phillips-head screwdriver.

The head of a Phillips-type screw has a four-way slot into which the screwdriver fits. This prevents the screwdriver from slipping. Three standard sized Phillips screwdrivers handle a wide range of screw sizes. Their ability to hold helps to prevent damaging the slots or the work surrounding the screw. It is a poor practice to try to use a standard screwdriver on a Phillips screw because both the tool and screw slot will be damaged.

OFFSET SCREWDRIVER

The offset screwdriver is a handy tool for use in a tight spot. It is somewhat difficult to handle because the bit has a tendency to jump out of the slot and to burr the screw or surrounding work, if you are not careful. The offset screwdriver has one blade forged in line with the shank or handle and the other blade at right angles to the shank. (See fig. 1-1-58.) With such an arrangement, when the swinging space for the screwdriver is limited, you can change ends after each swing and thus work the screw in or out of the threaded hole. This type screwdriver is to be used when there is not sufficient space to use a standard screwdriver.

1.14.8

Figure 1-1-58.—Offset screwdriver.

RATCHET SCREWDRIVER

For fast easy work the ratchet screwdriver is extremely convenient, as it can be used one-handed and does not require the bit to be lifted out of the slot after each turn. It may be fitted with either a standard type bit or a special bit for recessed heads. The ratchet screwdriver is most commonly used by the woodworker for driving screws in soft wood.

A WORD OF CAUTION

You should never use a screwdriver to check an electrical circuit where the amperage is high. The current may be strong enough to arc and melt the screwdriver blade. And, never try to turn a screwdriver with a pair of pliers.

Do not hold work in your hand while using a screwdriver—if the point slips it can cause a bad cut. Hold the work in a vise, with a clamp, or on a solid surface. If that is impossible, you will always be safe if you follow this rule: NEVER GET ANY PART OF YOUR BODY IN FRONT OF THE SCREWDRIVER BLADE TIP. That is a good safety rule for any sharp or pointed tool.

The maintenance and repairing of screwdrivers is discussed in section 5 of this book.

PLIERS

The word PLIERS is a plural name for a single tool. Pliers are made in many styles and sizes and are used to perform many different operations. There is a definite field of usefulness for pliers, but they are emphatically not a substitute for a wrench. Pliers are used for holding and gripping small articles in situations where it may be inconvenient or impossible to use hands.

SLIP-JOINT PLIERS

Slip-joint pliers (fig. 1-1-59) are pliers with straight, serrated (grooved) jaws, and the screw or pivot with which the jaws are fastened together may be moved to either of two positions, in order to grasp small- or large-sized objects better.

To spread the jaws of slip-joint pliers, first spread the ends of the handles apart as far as possible. The slip-joint, or pivot, will not move to the open position. To close, again spread the handles as far as possible, then push the joint back into the closed position.

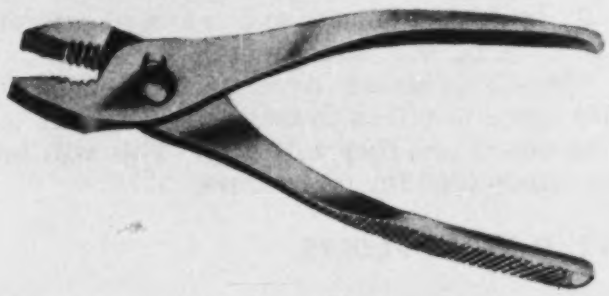

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Figure 1-1-59.—Slipjoint pliers.

Slip-joint combination pliers (fig. 1-1-60) are pliers similar to the slip-joint pliers just described, but with the additional feature of a side cutter at the junction of the jaws. This cutter consists of a pair of square cut notches, one on each jaw, which act like a pair of shears when an object is placed between them and the jaws are closed.

The cutter is designed to cut material such as soft wire and nails. To use the cutter, open

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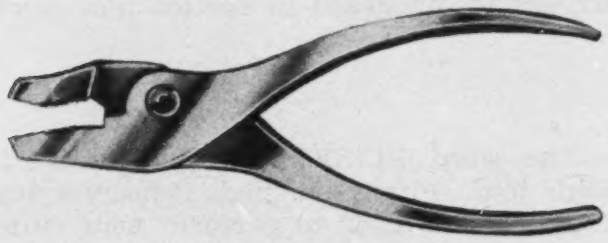

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Figure 1-1-60.—Slipjoint combination pliers.

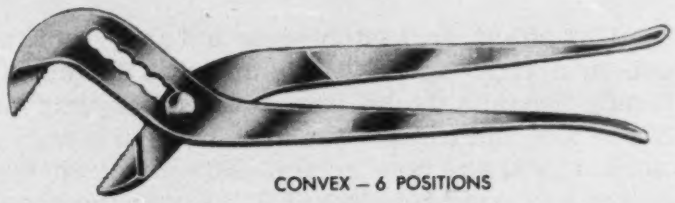

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Figure 1-1-61.—Water pump pliers.

the jaws until the cutter on either jaw lines up with the other. Place the material to be cut as far back as possible into the opening formed by the cutter, and squeeze the handles of the pliers together. Do not attempt to cut hard material such as spring wire or hard rivets with the combination pliers. To do so will spring the jaws; and if the jaws are sprung, it will be difficult thereafter to cut small wire with the cutters.

VISE-GRIP PLIERS

Vise-Grip pliers (wrenches) can be used for holding objects regardless of their shape. A screw adjustment in one of the handles makes them suitable for several different sizes. The jaws of Vise-Grips may have standard serrations such as the pliers just described or may have a clamp-type jaw. The clamp-type jaws are generally wide and smooth and are used primarily when working with sheet metal.

Vise-Grip pliers have an advantage over other types of pliers in that you can clamp them on an object and they will stay. This will leave your hands free for other work.

WATER-PUMP PLIERS

Water-pump pliers were originally designed for tightening or removing water pump packing nuts. They were excellent for this job because they have a jaw adjustable to seven different positions. Water-pump pliers (fig. 1-1-61) are easily identified by their size, jaw teeth, and adjustable slip joint. The inner surface of the jaws consists of a series of coarse teeth formed by deep grooves, a surface adapted to grasping cylindrical objects.

Another version of the water-pump pliers is called Channel-Lock pliers. They are shaped approximately the same as the pliers just described, but the jaw opening adjustment is effected differently. Channel-Lock pliers have grooves on one jaw and lands on the other. The adjustment is effected by changing the position of the grooves and lands. The Channel-Lock pliers are less likely to slip from the adjustment setting when gripping an object.

DIAGONAL PLIERS

Diagonal cutting pliers (fig. 1-1-62) are used for cutting small, light material, such as wire and cotter pins in areas which are inaccessible to the larger cutting tools. Also, since they are designed for cutting only, larger objects can be cut than with the slip-joint pliers.

As the cutting edges are diagonally offset approximately 15 degrees, diagonal pliers are adapted to cutting small objects flush with a surface. The inner jaw surface is a diagonal straight cutting edge. Diagonal pliers should never be used to hold objects, because they exert a greater shearing force than other types of pliers of a similar size. The sizes of the diagonal cutting pliers are designated by the overall length of the pliers.

SIDE CUTTING PLIERS

Side-cutting pliers (sidecutters) are principally used for holding, bending, and cutting thin materials or small gage wire. Sidecutters vary in size and are designated by their overall length. The jaws are hollowed out on one side just forward of the pivot point of the pliers. Opposite the hollowed out portion of the jaws are the cutting edges.

When holding or bending light metal surfaces, the jaw tips are used to grasp the object. When holding wire grasp it as near one end as possible because the jaws will mar the wire. To cut small diameter wire the side cutting edge of the jaws near the pivot is used. Never use sidecutters to grasp large objects, tighten nuts, or bend

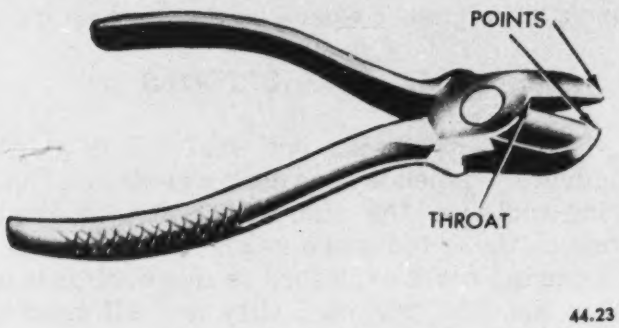

Fig. 1-1-62.—Diagonal-cutting pliers.

heavy gage metal, since such operations will spring the jaws.

Sidecutters are often called electrician or lineman pliers. They are used extensively for stripping insulation from wire and for twisting wire when making a splice.

MAINTENANCE OF PLIERS

Nearly all sidecutting pliers and diagonals are designed so that the cutting edges can be reground. Some older models of pliers will not close if material is ground from the cutting edges. When grinding the cutting edges never take any more material from the jaws than is necessary to remove the nicks. Grind the same amount of stock from both jaws.

NOTE: When jaws on pliers do not open enough to permit grinding, remove the pin that attaches the two halves of the pliers so that the jaws can be separated.

The serrations on the jaws of pliers must be sharp. When they become dull, the pliers should be held in a vise and the serrations recut by using a small 3-corner file.

Pliers should be coated with light oil when they are not in use. They should be stored in a toolbox in such a manner that the jaws cannot be injured by striking hard objects. Keep the pin or bolt at the hinge just tight enough to hold the two parts of the pliers in contact and always keep the pivot pin lubricated with a few drops of light oil.

PUNCHES

A hand punch is a tool that is held in the hand and struck on one end with a hammer. There are many kinds of punches designed to do a variety of jobs. Most punches are made of tool steel. The part held in the hand is usually octagonal shaped, or it may be knurled. This prevents the tool from slipping around in the hand. The other end is shaped to do a particular job. Figure 1-1-63 shows some of the most commonly used metal punches.

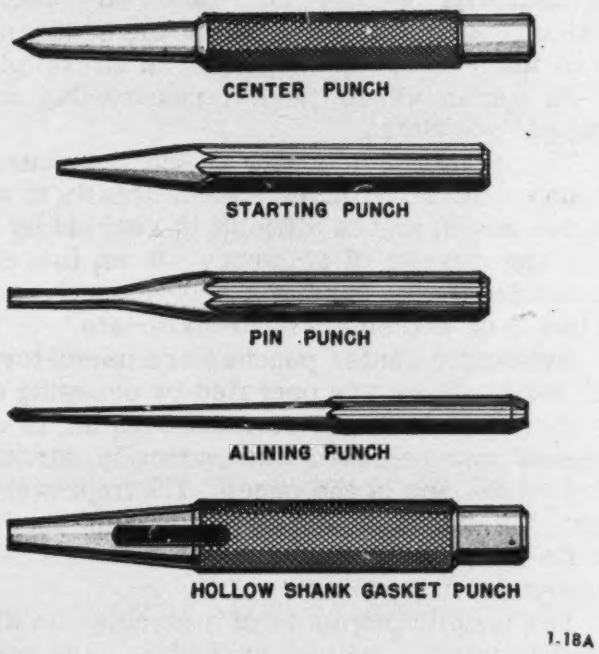

Figure 1-1-63.—Commonly used punches.

METAL PUNCHES

DRIFT punches, sometimes called "starting punches," have a long taper from the tip to the body. They are made that way to withstand the shock of heavy blows. They may be used for knocking out rivets after the heads have been chiseled off, or for freeing pins which are "frozen" in their holes.

After a pin has been loosened or partially driven out, the drift punch may be too large to finish the job. The followup tool to use is the PIN PUNCH. It is designed to follow through the hole without jamming. Always use the largest drift or pin punch that will fit the hole. These punches usually come in sets of three to five assorted sizes. Both of these punches will have flat points, never edged or rounded.

To remove a bolt or pin that is extremely tight, start with a drift punch that has a point diameter that is slightly smaller than the diameter of the object you are removing. As soon as it loosens, finish driving it out with a pin punch.

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Never use a pin punch for starting a pin because it has a slim shank and a hard blow may cause it to bend or break.

Another punch you will use a lot is the center punch. As the name implies, it is used for marking the center of a hole to be drilled. If you try to drill a hole without first punching the center, the drill will "wander" or "walk away" from the desired center. Another use of the center punch is to make corresponding marks on two pieces of an assembly to permit reassembly in the original positions.

The point of a center punch is accurately ground central with the shank, usually at a 60-degree angle, and is difficult to regrind by hand with any degree of accuracy. It is, therefore, advisable to take care of a center punch and not to use it on extremely hard materials.

Automatic center punches are useful for layout work. They are operated by pressing down on the shank by hand. An inside spring is compressed and released automatically, striking a blow on the end of the punch. The impression is light, but adequate for marking, and serves to locate the point of a regular punch when a deeper impression is required.

For assembling units of a machine an alinement (alining) punch is invaluable. It is usually about 1 foot long and has a long gradual taper. Its purpose is to line up holes in mating parts.

Hollow metal cutting punches are made from hardened tool steel. They are made in various sizes and are used to cut holes in light gage sheet metal.

Other punches have been designed for special uses. One of these is the soft-faced drift. It is made of brass or fiber and is used for such jobs as removing shafts, bearings, and wrist pins from engines. It is generally heavy enough to resist damage to itself, but soft enough not to injure the finished surface on the part that is being driven.

GASKET PUNCHES

You may have to make gaskets of rubber, cork, leather, or composition materials. For cutting holes in gasket materials a hollow shank gasket punch may be used. Gasket punches come in sets of various sizes to accommodate standard bolts and studs. The cutting end is tapered to a sharp edge to produce a clean, uniform hole. To use the gasket punch, place the gasket material to be cut on a piece of hard wood or lead so that the cutting edge of the punch will not be damaged. Then strike the punch with a hammer, driving it through the gasket where holes are required.

MEASURING TOOLS

The ability to lay out work and to measure accurately depends upon the correct use of measuring tools and the ease with which the graduations on these tools are read. While each of the measuring tools explained in this section is used for a specific purpose, they are all graduated according to the same system of linear measure.

There are many different types of measuring tools in use in the Navy. Where exact measurements are required a micrometer caliper (mike) is used. Such a caliper when properly used, gives measurements to within .0001 of an inch accuracy. The common rule or tape will suffice for most measurements that you will need.

RULES AND TAPES

Figure 1-1-64 shows some of the types of rules and tapes commonly used in the Navy. Of all measuring tools, the simplest and most common is the steel rule. This rule is usually 6 or 12 inches, although other lengths, such as 4 in., 18 in., and longer, are available. Steel rules may be flexible or nonflexible, but the thinner the rule, the easier it is to measure accurately because the division marks are closer to the work.

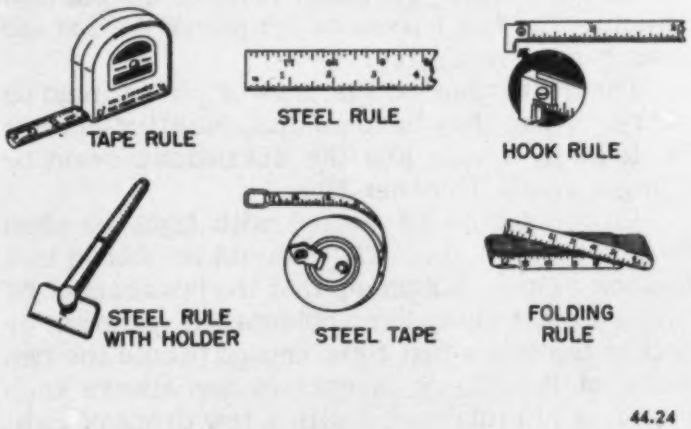

Figure 1-1-64.—Some common types of rules.

Generally a rule has four sets of graduations, one on each edge of each side. The longest lines represent the inch marks. On one edge, each inch is divided into 8 equal spaces; so each space represents 1/8 in. The other edge of this side

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is divided into sixteenths. The 1/4-in. and 1/2-in. marks are commonly made longer than the smaller division marks to facilitate counting, but the graduations are not, as a rule, numbered individually, as they are sufficiently far apart to be counted without difficulty. The opposite side is similarly divided into 32 and 64 spaces per inch, and it is common practice to number every fourth division for easier reading.

There are many variations of the common rule. Sometimes the graduations are on one side only, sometimes a set of graduations is added across one end for measuring in narrow spaces, and sometimes only the first inch is divided into 64ths, with the remaining inches divided into 32nds and 16ths.

For measuring lengths greater than 18 in., folding steel, wood, or aluminum rules can be used. These are called folding rules and are usually 2 to 6 feet long. The folding rules cannot be relied on for extremely accurate measurements because a certain amount of play develops at the joints after they have been used for a while.

Steel tapes are made from 6 to about 100 ft. in length. In the shorter lengths, these are frequently made with a curved cross section so that they are flexible enough to roll up, but remain rigid when extended. Long, flat tapes require support over their full length when measuring, or the natural sag will cause an error in reading.

The flexible-rigid tapes are usually contained in metal cases into which they wind themselves when a button is pressed, or into which they can be easily pushed. A hook is provided at one end to hook over the object being measured so one man can handle it without assistance. On some models, the outside of the case can be used as one end of the tape when measuring inside dimensions.

Rules and tapes should be handled carefully and kept lightly oiled to prevent rust. Never allow the edges of measuring devices to become nicked by striking them with hard objects. They should preferably be kept in a wooden box when not in use.

To avoid kinking tapes, pull them straight out from their cases—do not bend them backward. With the windup type, always turn the crank clockwise—turning it backward will kink or break the tape. With the spring-wind type, guide the tape by hand. If it is allowed to snap back, it may be kinked, twisted, or otherwise damaged.

SIMPLE CALIPERS

Simple calipers are used in conjunction with a scale to measure diameters. The calipers most commonly used in the Navy are shown in fig. 1-1-65.

Outside calipers for measuring outside diameters are bow-legged; those used for inside diameters have straight legs with the feet turned called firm-joint calipers. These calipers are adjusted by pulling or pushing the legs to open or close them. Fine adjustment is made by tapping one leg lightly on a hard surface to close them, or by turning them upside down and tapping on the joint end to open them. A variant of the firm-joint has a small screw for making fine adjustments.

Spring-joint calipers have the legs joined by a strong spring hinge and linked together by a screw and adjusting nut.

For measuring chamfered cavities, or for use over flanges, transfer calipers are available. They are equipped with a small auxiliary leaf attached to one of the legs by a screw. (See fig. 1-1-65.) The measurement is made as with ordinary calipers; then the leaf is locked to the leg. The legs may be opened or closed as needed to clear the obstruction, then brought back and locked to the leaf again, thus restoring them to the original setting.

A different type of caliper is the hermaphrodite, sometimes called odd-leg caliper. This has one straight leg ending in a sharp point, sometimes removable, and one bow leg. The hermaphrodite caliper is used chiefly for locating the center of a shaft, or for locating a shoulder.

Keep calipers clean and lightly oiled, but do not overoil the joint of firm joint calipers or you may have difficulty in keeping them tight. Do not throw them around or use them for screwdrivers or pry bars. Remember they are measuring instruments and must be used only for the purpose for which they are intended.

CALIPER SQUARE

The main disadvantage to ordinary calipers is that they do not give a direct reading. It is necessary to measure across the points of a caliper with an ordinary scale to get the measurement. To overcome this, the caliper square, (fig. 1-1-66) sometimes called a slide caliper, is available.

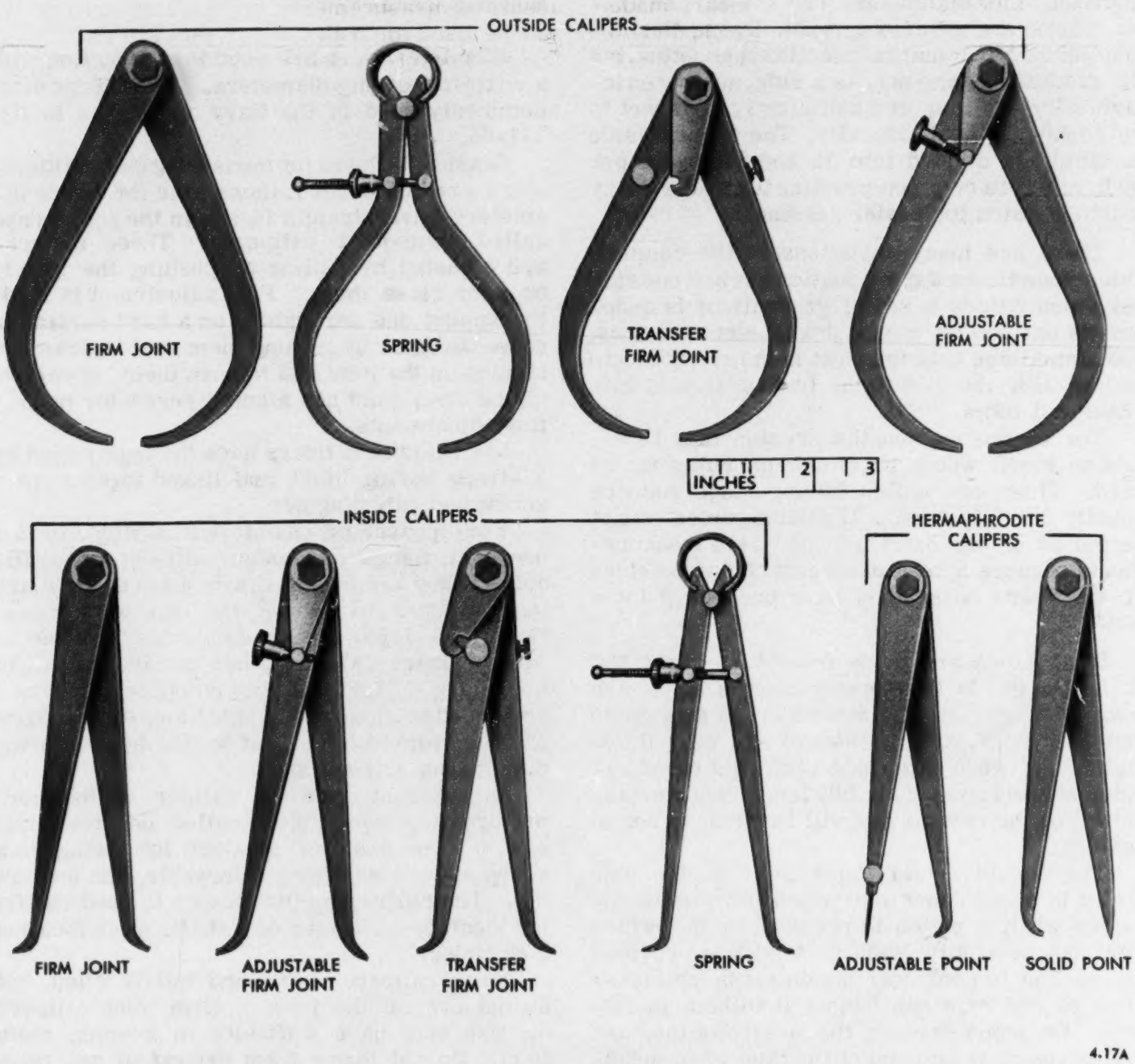

Figure 1-1-65.—Simple calipers—noncalibrated.

Slide calipers can be used for measuring outside, inside, and other dimensions. One side of the caliper is used as a measuring rule, while the scale on the opposite side is used in measuring outside and inside dimensions. Graduations on both scales are in inches and fractions thereof. A locking screw is incorporated to hold the slide caliper jaws in position during use. Stamped on the frame are two words, "IN" and "OUT," to be used in reading the scale while making inside and outside measurements, respectively.

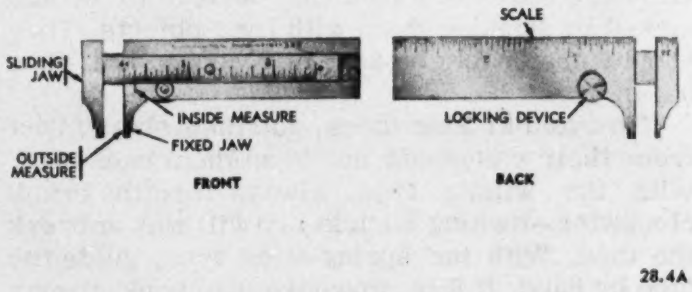

Figure 1-1-66.—Caliper square (slide caliper).

Pocket slide calipers are commonly made in 3-in. and 5-in. sizes and are graduated to read in 32nds and 64ths. Pocket slide calipers are valuable when extreme precision is not required. They are frequently used for duplicating work when the expense of fixed gages is not warranted.

VERNIER SCALE

When extreme accuracy and close tolerances are needed, measuring tools that incorporate a vernier scale may be used.

The fundamental idea behind the vernier scale is to divide a line of known length into equal parts, and to compare the length of each part with those on a line the same length as the first one, but divided into one less part.

Figure 1-1-67 shows a bar 1 inch long divided by graduations into 40 parts so that each graduation indicates one-fortieth of an inch (0.025 inch). Every fourth graduation is numbered; each number indicates tenths of an inch (4X0.025 inch). The vernier, which slides along the bar, is graduated into 25 divisions which together, are as long as 24 divisions on the bar. Consequently, each division of the vernier is 0.001 inch smaller than each division on the bar. Verniers that are calibrated as just explained are known as English-measure verniers. The metric-measure vernier is read the same, except that the units of measurement are in millimeters, and the fractions are all decimal fractions.

One of the most common applications of the vernier scale is the vernier caliper.

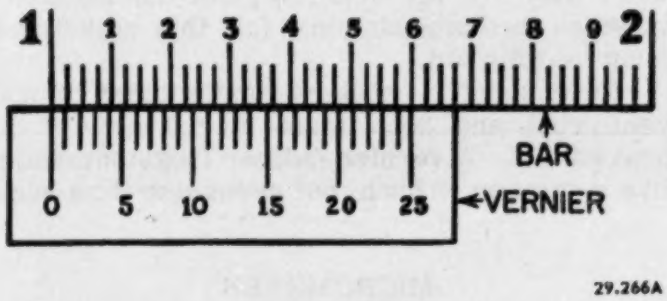

Figure 1-1-67.—English-measure vernier scale.

VERNIER CALIPER

Perhaps the most distinct advantage of the vernier caliper is the ability to provide very accurate measurements over a large range. It can be used for both internal and external surfaces. Pocket models usually measure from zero to 3 in., but sizes are available all the way to 4 ft.

A vernier caliper (fig. 1-1-68) consists of an L-shaped member with a scale engraved on the long shank. A sliding member is free to move on the bar and carries a jaw which matches the arm of the L. The vernier scale is engraved on a small plate that is attached to the sliding member.

READING A VERNIER CALIPER

Figure 1-1-69 A illustrates the English measure vernier caliper. Figure B shows an enlarged view of the vernier used. As you can see in this figure, when the zero on the vernier coincides with the 1-inch mark, no other lines coincide until the 25th mark on the vernier. Now count the division on the inch rule. There are only 24 such divisions (each equal to 1/40 inch) opposite the 25 divisions on the vernier. This means that the vernier divisions are a little narrower than those on the rule. Since each of the 24 spaces on the rule equals 1/40" the whole vernier scale is 24 X 1/40" or 24 X 0.0025 = 0.600". Thus one division on the vernier equals 1/25 of 0.300", or 0.24". So, the difference between a division on the vernier and on the rule is 0.025" - 0.024" = 0.001". When measuring, therefore, for each division on the vernier, count from its zero point to the line which coincides with a line on the rule, and to the reading on the rule at this point, add 0.001".

To read the caliper in figure 1-1-69C, write down in a column the number of inches (1.000"), of tenths of an inch (0.400"), and of thousandths of an inch the zero mark on the vernier is from the zero mark on the rule. Because the zero mark on the vernier is a little past a 0.025" mark, write down the 0.025" and then note the highest number on the vernier where a line on the vernier concides with one on the rule. In this case (fig. 1-1-69C) it is at the 0.011" line on the vernier, so you also write the 0.011" in the column which will then look like this:

1.000"
.400"
.025"
.011"
———
1.436"

9135

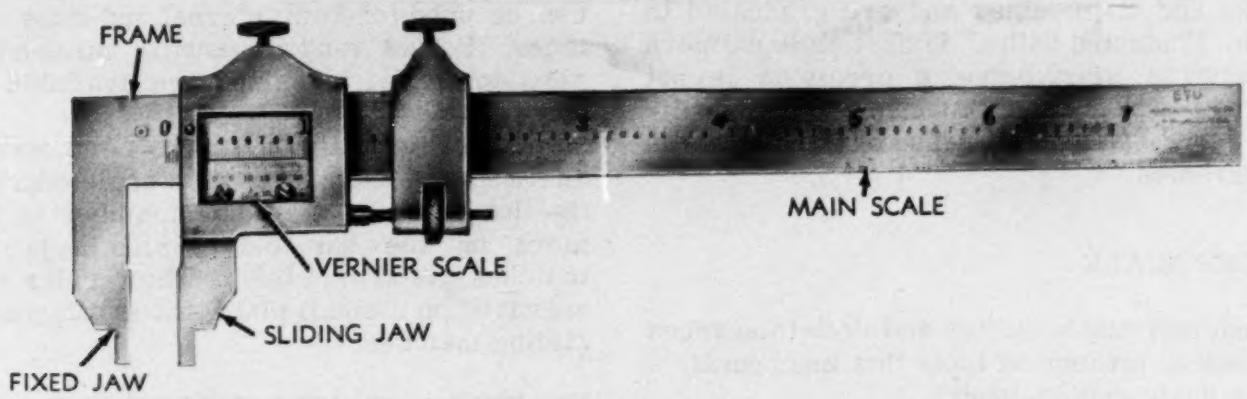

Figure 1-1-68.—Vernier caliper.

The reading on the caliper shown in figure 1-1-69 C is 1.436", and was obtained by adding four separate "readings." After a little practice you will be able to make these calculations mentally.

Now try to read the settings of the two verniers shown in figure 1-1-69 D. Follow the above procedure. You should read 2.350" on the first setting and 2.368" on the second one.

To read a metric-measure vernier, note the number of millimeters, and the 0.25 millimeter if the setting permits, that the zero on the vernier has moved from the zero on the scale. Then add the number of hundredths of a millimeter indicated by the line on the vernier that coincides with a line on the scale.

For example, figure 1-1-70 A shows the zero graduation on the vernier coinciding with a 0.5-mm. graduation on the scale. This indicates that 0.08 mm. should be added to the scale reading. The reading in figure 1-1-70 B equals 38.00 mm. + 0.50 mm. + 0.08 mm. = 38.58 mm.

If a vernier caliper is calibrated in either English measure or in metric measure, usually one side will be calibrated to take outside measurements and the other to take inside measurements directly. The vernier plate for inside measurements is set to compensate for the thickness of the measuring points of the tools. But if a vernier caliper is calibrated for both English and metric measure, one of the scales will appear on one side and one on the other. Then it will be necessary, when taking inside measurements over the measuring points, to add certain amounts to allow for their thickness; for example, the following table shows the amounts to be added for various sizes of vernier calipers:

Measuring Point Allowances

Size of Caliper	English Measure	Metric Measure
6" or 150 mm .	Add 0.250"...	Add 6.35 mm.
12" or 300 mm .	.300"...	7.62 mm.
24" or 600 mm .	.300"...	7.62 mm.
36" or 600 mm .	.500"...	12.70 mm.

CARE OF THE VERNIER CALIPER

The inside faces of the jaws and the outside of the tips must be treated with great care. If they become worn, or the jaws bent, the tool will no longer give accurate readings. The accuracy of vernier calipers should be checked periodically by measuring an object of known dimension. Vernier calipers can be adjusted when they are not accurate, but the manufacturer's recommendations for this adjustment must be followed.

Keep vernier calipers lightly oiled to prevent rust and keep them stored away from heavy tools. A vernier caliper looks something like a monkey wrench, but never use it as such.

MICROMETER

In much wider use than the vernier caliper is the micrometer commonly called the "mike." It is important that a person who is working with machinery or in a machine shop thoroughly understand the mechanical principles, construction, use, and care of the micrometer. Figure 1-1-71 shows an outside micrometer caliper

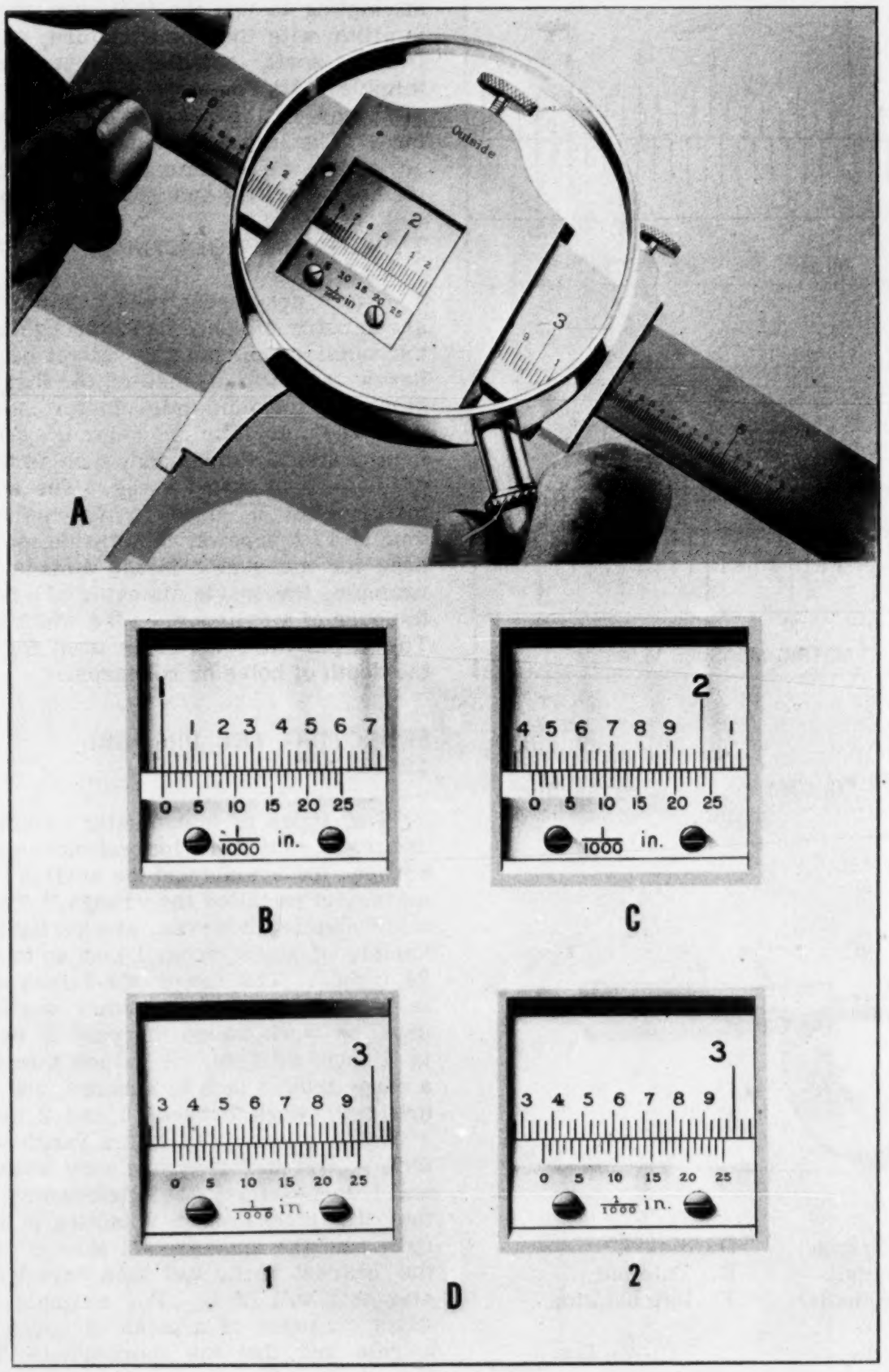

Figure 1-1-69.—Vernier caliper.

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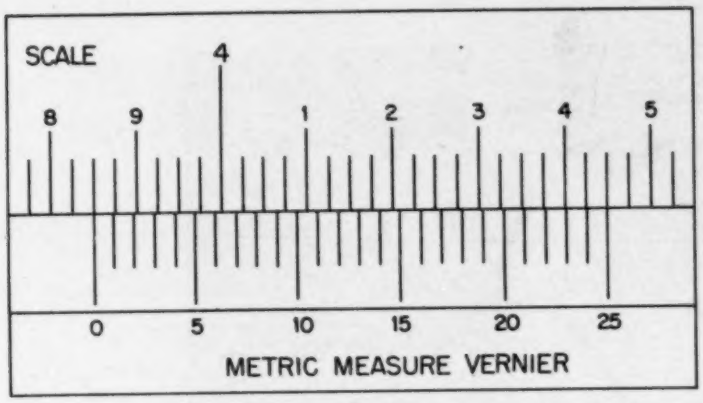

A

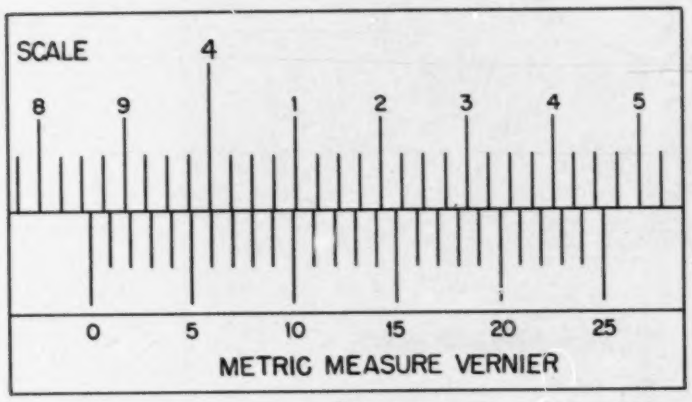

B

29.266C

Figure 1-1-70.—Metric-measure vernier scales.

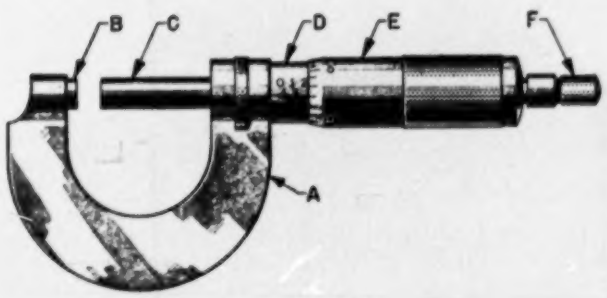

A. Frame
B. Anvil
C. Spindle
D. Sleeve
E. Thimble
F. Ratchet stop

4.20.1A

Figure 1-1-71.—Nomenclature of an outside micrometer caliper.

with the various parts clearly indicated. Before attempting to use the tool, you should become familiar with the nomenclature, especially the frame, anvil, spindle, sleeve (barrel), and thimble. Micrometers are needed to measure distances to the nearest one thousandth of an inch. The measurement is usually expressed or written as a decimal; so you must know the method of writing and reading decimals.

TYPES OF MICROMETERS

There are three types of micrometers that are most commonly used throughout the Navy: the outside micrometer caliper (including the screw thread micrometer), the inside micrometer, and the depth micrometer. (See fig. 1-1-72.) The outside micrometer is used for measuring outside dimensions, such as the diameter of a piece of round stock. The screw thread micrometer is used to determine the pitch diameter of screws. The inside micrometer is used for measuring inside dimensions, as for example, the inside diameter of a tube or hole, the bore of a cylinder, or the width of a recess. The depth micrometer is used for measuring the depth of holes or recesses.

SELECTING THE PROPER MICROMETER

The types of micrometers commonly used are made so that the longest movement possible between the spindle and the anvil is 1 inch. This movement is called the "range." The frames of micrometers, however, are available in a wide variety of sizes, from 1 inch up to as large as 24 inches. The range of a 1-inch micrometer is from 0 to 1 inch; in other words, it can be used on work where the part to be measured is 1 inch or less. A 2-inch micrometer has a range from 1 inch to 2 inches, and will measure only work between 1 and 2 inches thick; a 6-inch micrometer has a range from 5 to 6 inches, and will measure only work between 5 and 6 inches thick. It is necessary, therefore, that the mechanic in selecting a micrometer first find the approximate size of the work to the nearest inch, and then select a micrometer that will fit it. For example, to find the exact diameter of a piece of round stock; use a rule and find the approximate diameter of the stock. If it is found to be approximately 3 1/4 inches, a micrometer with a 3- to 4-inch range would be required to measure the

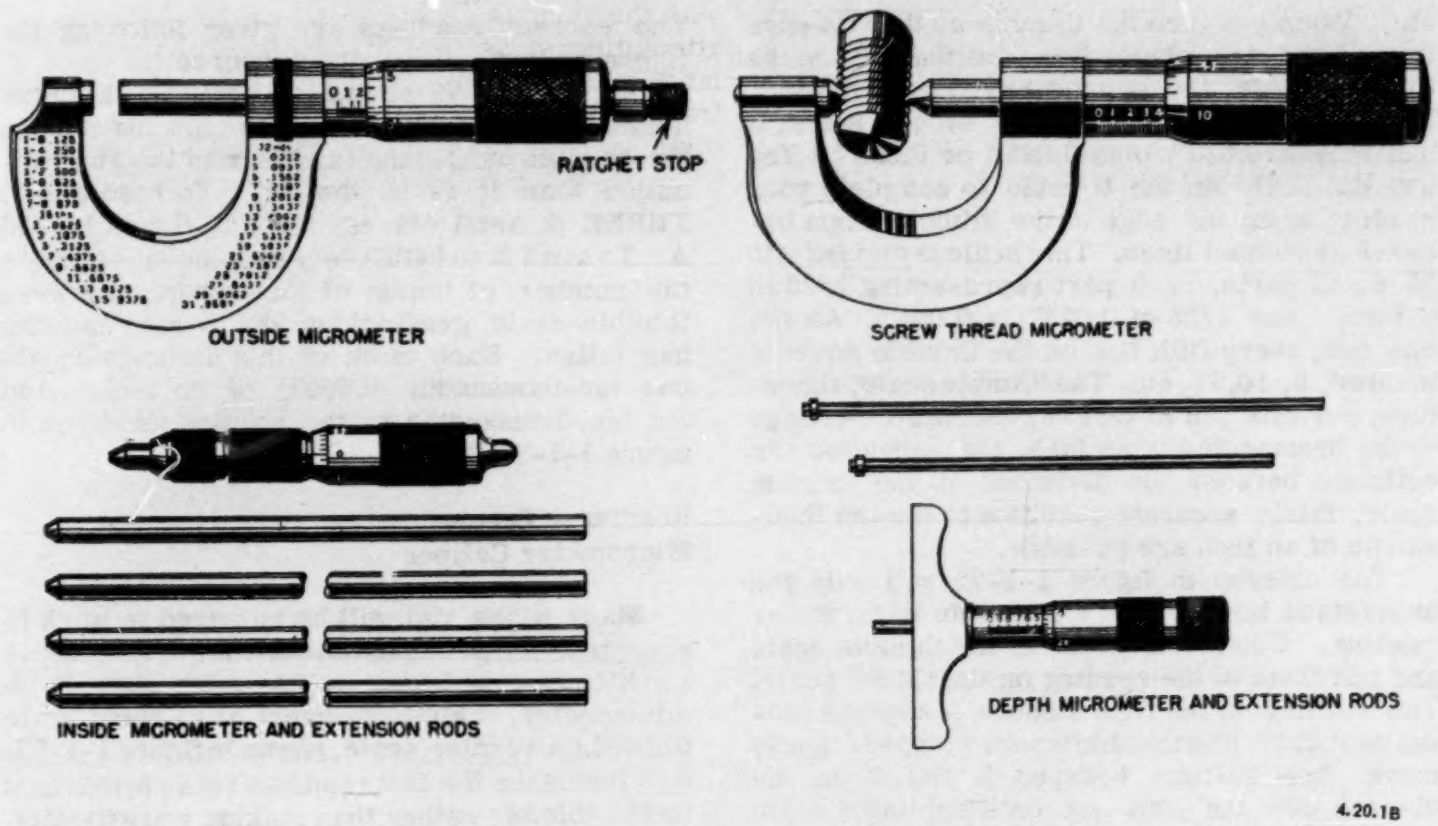

Figure 1-1-72.—Common types of micrometers.

exact diameter. Similarly, with inside and depth micrometers, rods of suitable lengths must be fitted into the tool to get the approximate dimension within an inch, after which the exact measurement is read by turning the thimble. The size of a micrometer is given as the size of the largest work it will measure.

READING A MICROMETER CALIPER

The spindle and the thimble of the micrometer caliper illustrated in figure 1-1-71, which shows the parts of a 1-inch micrometer caliper, are in one piece. The spindle is moved toward or away from the anvil by turning the thimble.

The sleeve and thimble scales of the micrometer caliper have been enlarged in figure 1-1-73. To understand these scales, you need to know that the threaded section on the spindle, which revolves, has 40 threads per inch. Therefore, every time the thimble completes a revolution, the spindle advances or recedes 1/40" (0.025").

Notice in figure 1-1-73 that the horizontal line on the sleeve is divided into 40 equal parts per inch. Every fourth graduation is numbered 1, 2, 3, 4, etc., representing 0.100", 0.200",

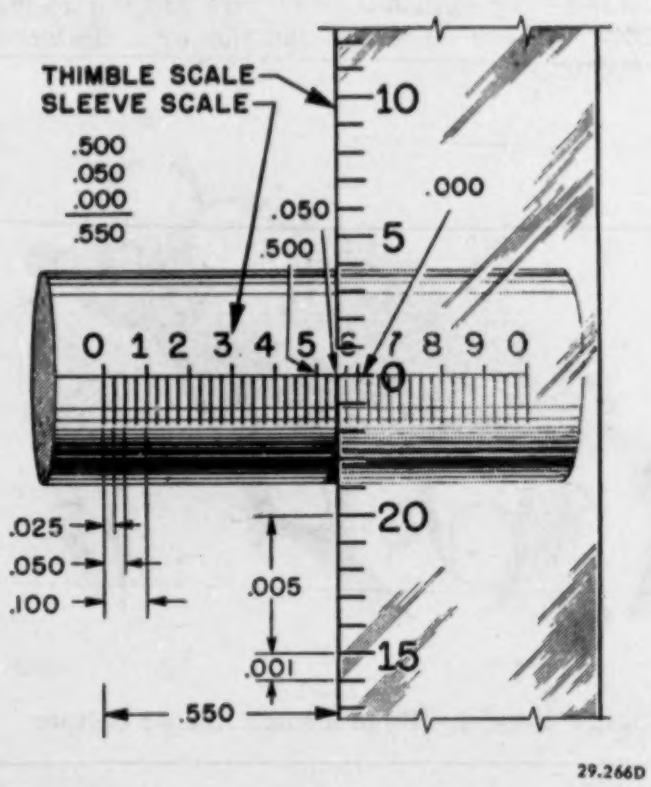

Figure 1-1-73.—Sleeve and thimble scales of a micrometer (enlarged).

etc. When you turn the thimble so that its edge is over the first sleeve line past the "0" on the thimble scale, the spindle has opened 0.025". If you turn the spindle to the second mark, it has moved 0.025" plus 0.025" or 0.050". You use the scale on the thimble to complete your reading when the edge of the thimble stops between graduated lines. This scale is divided into 25 equal parts, each part representing 1/25 of a turn. And 1/25 of 0.025" is 0.001". As you can see, every fifth line on the thimble scale is marked, 5, 10, 15, etc. The thimble scale, therefore, permits you to take very accurate readings to the thousandths of an inch, and, since you can estimate between the divisions on the thimble scale, fairly accurate readings to the ten thousandth of an inch are possible.

The closeup in figure 1-1-74 will help you understand how to take a complete micrometer reading. Count the units on the thimble scale and add them to the reading on the sleeve scale. The reading in the figure shows a sleeve reading of 0.250" (the thimble having stopped slightly more than halfway between 2 and 3 on the sleeve) with the 10th line on the thimble scale coinciding with the horizontal sleeve line. Number 10 on this scale means that the spindle has moved away from the anvil an additional 10 X 0.001" or 0.010". Add this amount to the 0.250" sleeve reading, and the total distance is 0.260".

4.20.2

Figure 1-1-74.—Read a micrometer caliper.

Read each of the micrometer settings in figure 1-1-75 so that you can be sure of yourself when you begin to use this tool on the job. The correct readings are given following the figure so that you can check yourself.

Figure 1-1-76 shows a reading in which the horizontal line falls between two graduations on the thimble scale and is closer to the 15 graduation than it is to the 14. To read this to THREE decimal places, refer to figure 1-1-76 A. To read it to FOUR decimal places, estimate the number of tenths of the distance between thimble-scale graduations the horizontal line has fallen. Each tenth of this distance equals one ten-thousandth (0.0001) of an inch. Add the ten-thousandths to the reading as shown in figure 1-1-76 B.

Reading a Vernier Micrometer Caliper

Many times you will be required to work to exceptionally precise dimensions. Under these conditions it is better to use a ten-thousandth micrometer. This instrument has a third scale which is a vernier scale, shown in figure 1-1-77, that furnishes the fine readings between the lines on the thimble rather than making you estimate. The 10 spaces on the vernier are equivalent to 9 spaces on the thimble. Therefore, each unit on the vernier scale is equal to 0.0009" and the difference between the sizes of the units on each scale is 0.0001".

When a line on the thimble scale does not coincide with the horizontal sleeve line, you can determine the additional space beyond the readable thimble mark by finding which vernier mark coincides with a line on the thimble scale. Add this number, as that many ten-thousandths of an inch, to the original reading. In figure 1-1-78 see how the second line on the vernier scale coincides with a line on the thimble scale.

This means that the 0.011 mark on the thimble scale has been advanced an additional 0.0002" beyond the horizontal sleeve line. When you add this to the other readings, the reading will be 0.200 + 0.075 + 0.011 + 0.0002 or 0.2862", as shown.

CARE OF MICROMETERS

Keep micrometers clean and lightly oiled. Make sure they are placed in a case or box when they are not in use. Anvil faces must be protected from damage and must not be cleaned with emery cloth or other abrasive.

If a 1 inch micrometer caliper does not read zero when the spindle touches the anvil, and both are clean at the point of contact, the zero

9140

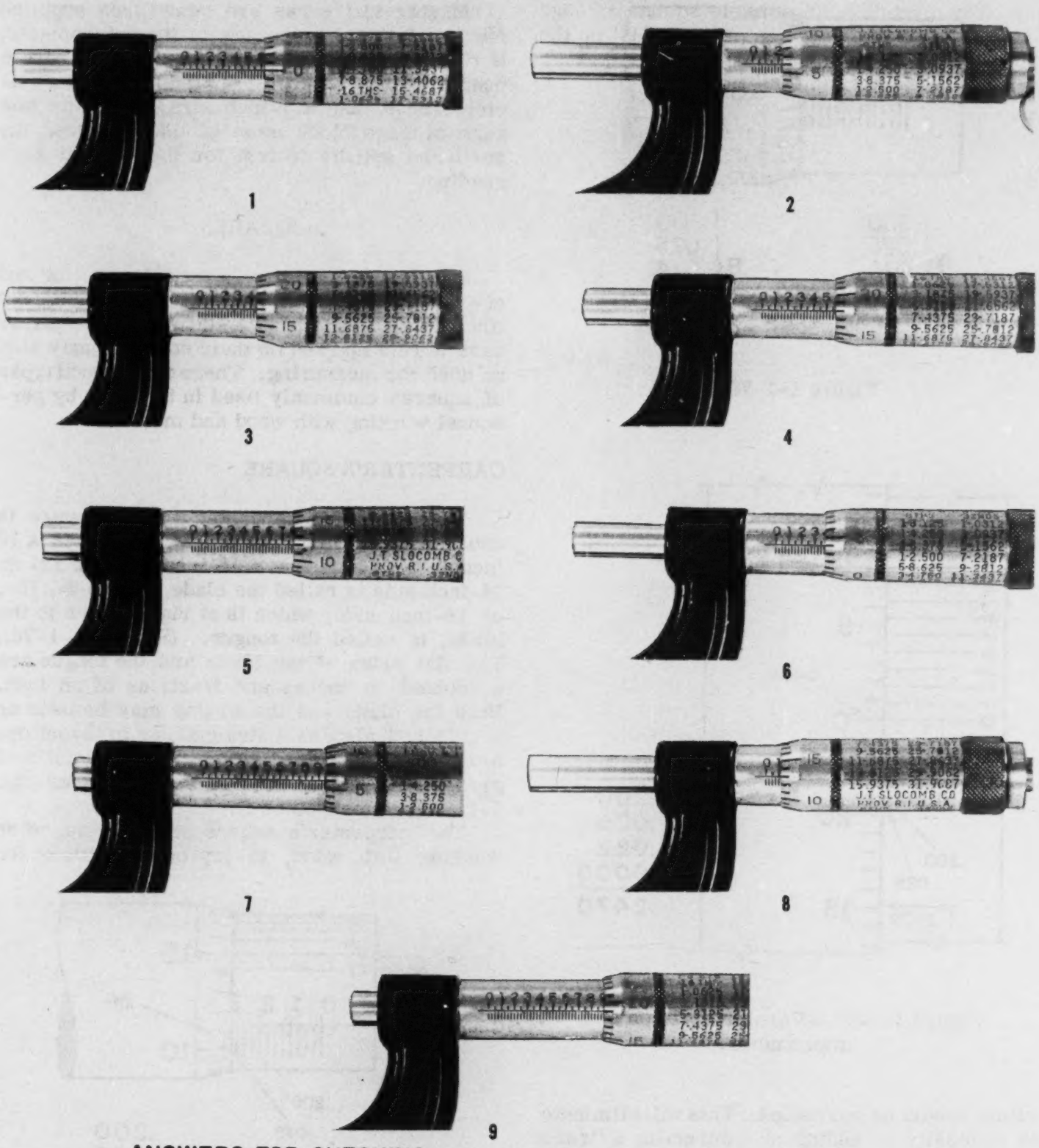

ANSWERS FOR CHECKING—

(1) 0.625	(4) 0.568	(7) 0.956
(2) 0.231	(5) 0.787	(8) 0.113
(3) 0.442	(6) 0.379	(9) 0.894

29.266E

Figure 1-1-75.

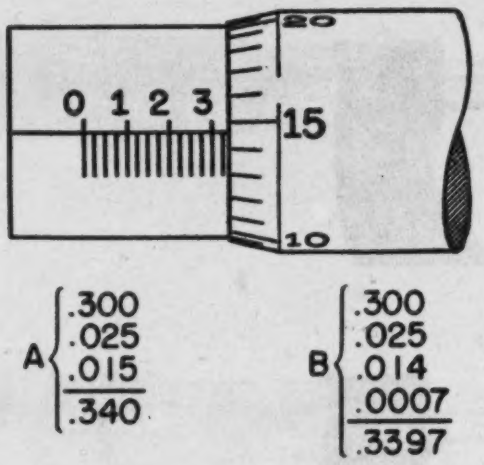

Figure 1-1-76.

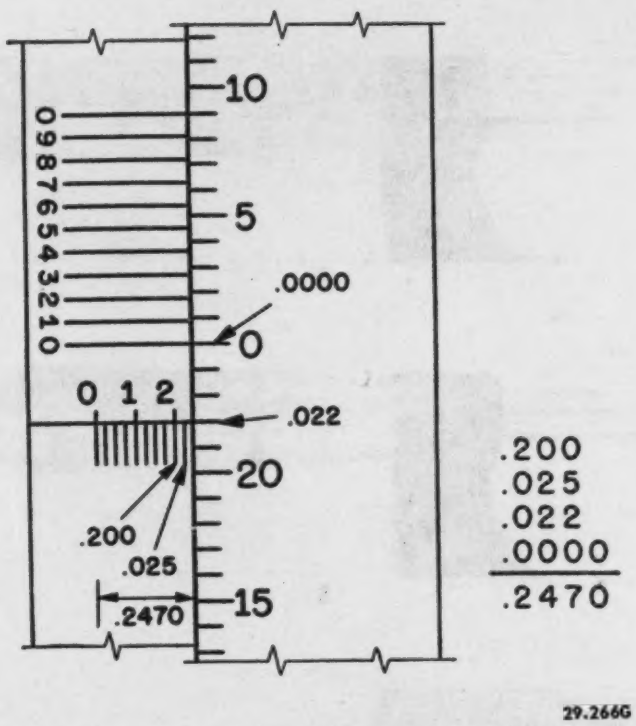

Figure 1-1-77.—Vernier scale on a micrometer.

setting should be corrected. This will eliminate the necessity of adding or subtracting a "zero correction" numerically to each reading as would otherwise be necessary if this adjustment were not made.

The zero setting on all micrometers is not made in exactly the same way. Refer to either the instructions that come with the micrometer or to the manufacturer's catalog for specific directions for a particular tool.

Master test gages are sometimes supplied for checking the accuracy of the micrometer. If these are not available, gage blocks can be used for this purpose. To adjust a micrometer larger than a 1-inch size, a master test gage or gage block must be used between the anvil and spindle to test for the correct zero reading.

SQUARES

Squares are primarily used for testing and checking trueness of an angle or for laying out lines on materials before cutting. Most squares have a rule marked on their edge and may also be used for measuring. There are several types of squares commonly used in the Navy by personnel working with wood and metal.

CARPENTER'S SQUARE

The size of a carpenter's steel square is usually 12 inches x 8 inches, 24 inches x 16 inches, or 24 inches x 18 inches. The 12- or 24-inch side is called the blade and the 8-, 16-, or 18-inch side, which is at right angles to the blade, is called the tongue. (See fig. 1-1-78.) The flat sides of the blade and the tongue are graduated in inches and fractions of an inch. Both the blade and the tongue may be used as a rule and also as a straightedge in layout operations. Besides the inch and fractional graduations on the square, several tables (fig. 1-1-79) are marked on it.

The carpenter's square enables you, when working with wood, to lay out guidelines for

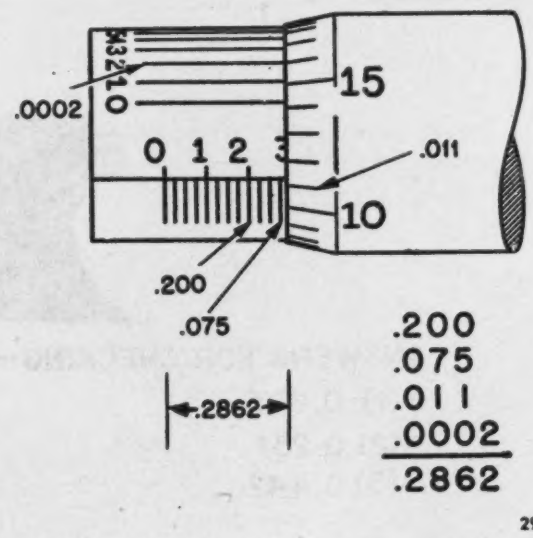

Figure 1-1-78.—Read a vernier micrometer caliper.

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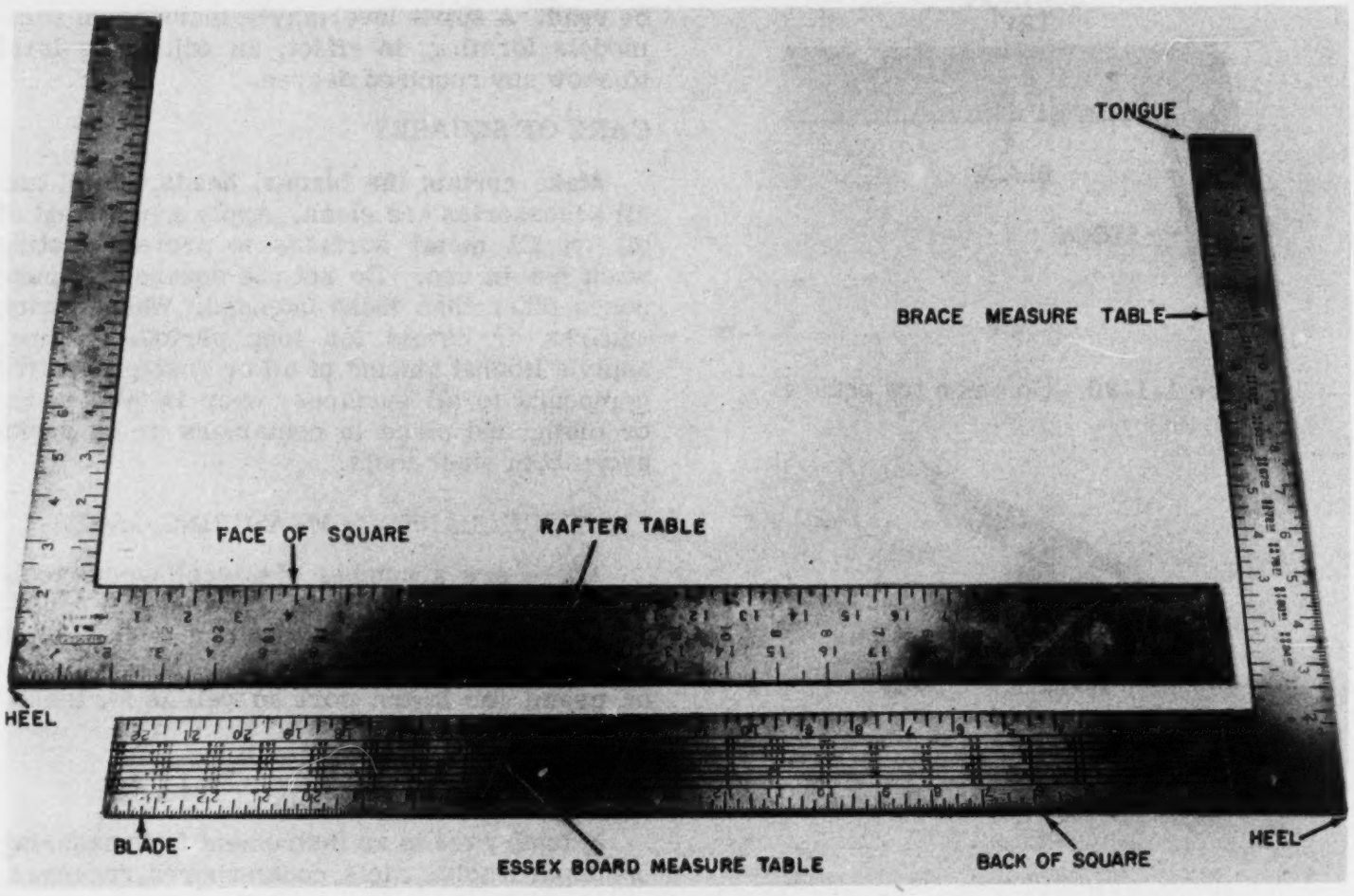

29.23A

Figure 1-1-79.—Carpenters square.

cutting rafters, oblique joints, stairs, and so forth. You can perform many calculations with the aid of the tables and graduations marked on the blade and tongue of the square. The most common uses for this square are laying out and squaring up large stock and large patterns, and for testing the flatness and squareness of large surfaces by placing the square at right angles to adjacent surfaces and observing if light shows between the work and the square.

TRY SQUARE

The try square (fig. 1-1-80) consists of two parts at right angles to each other; a thick wood or iron stock and a thin, steel blade. Most try squares are made with the blades graduated in inches and fractions of an inch. The blade length varies from 2 inches to 12 inches. This square is used for setting or checking lines or surfaces which have to be at right angles to each other. The carpenter's square can be used for the same purpose, but is often too large to use accurately.

SLIDING T BEVEL

The sliding T-bevel (fig. 1-1-81) is an adjustable try square with a slotted beveled blade. Blades are normally 6 or 8 inches long. The sliding T-bevel is used for laying out angles other than right angles, and for testing constructed angles such as bevels. These squares are made with either wood or metal handles.

COMBINATION SQUARE

A combination square that is equipped with a SQUARE HEAD, PROTRACTOR HEAD, and a CENTER HEAD is the most versatile layout tool that is used by Navy personnel. As its name implies, it combines the functions of several

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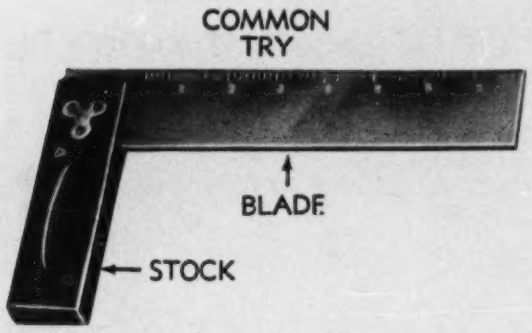

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Figure 1-1-80.—Common try square.

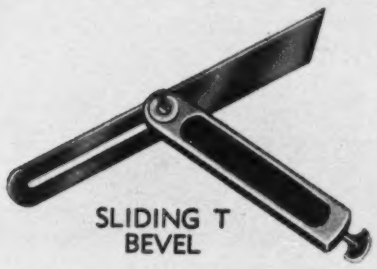

44.26

Figure 1-1-81.—Sliding T-bevel.

tools, and serves a wide variety of purposes. It consists of a hardened steel scale and the movable heads. (See fig. 1-1-82.)

The SQUARE HEAD may be adjusted to any position along the scale and clamped securely, or may be removed entirely. It can thus serve as a depth gage, height gage, or scribing gage. Two of the faces of the head are ground at right angles to each other, and a third face at 45 degrees. A small spirit level is built into the head for checking whether surfaces are plumb, and a small scriber is housed in a hole in the end of the head for marking layout lines.

The CENTER HEAD can be slid on to the blade in place of the stock head. This is a V-shaped member so designed that the center of the 90 degree V will lie exactly along one edge of the blade. This attachment is useful when locating the exact center of round stock.

The PROTRACTOR HEAD, commonly called a bevel protractor, can be attached to the scale, adjusted to any position on it, and turned and locked at any desired angle. Some types have a shoulder on only one side of the blade, others have it extending on both sides. Angular graduations usually read from 0 to 180 degrees both ways, permitting the supplement of the angle to be read. A spirit level may be included on some models forming, in effect, an adjustable level to show any required degree.

CARE OF SQUARES

Make certain the blades, heads, dials, and all accessories are clean. Apply a light coat of oil on all metal surfaces to prevent rusting when not in use. Do not use squares for purposes other than those intended. When storing squares or bevels for long periods of time, apply a liberal amount of oil or rust-preventive compound to all surfaces, wrap in oiled paper or cloth, and place in containers or on racks away from other tools.

MISCELLANEOUS MEASURING GAGES

There are a number of miscellaneous tools that are called gages and may be used for measuring or testing and setting distances. Some of the gages that will be discussed here will also be useful for layout work as well as for measuring.

DEPTH GAGE

A depth gage is an instrument for measuring the depth of holes, slots, counterbores, recesses, and the distance from a surface to some recessed part. The RULE DEPTH GAGE and the MICROMETER DEPTH GAGE are the most commonly used in the Navy. (See fig. 1-1-83.)

The rule depth gage is a graduated rule with a sliding head designed to bridge a hole or slot, and to hold the rule perpendicular to the surface on which the measurement is taken. This type has a measuring range of 0 to 5 inches. The sliding head has a clamping screw so that it may be clamped in any position. The sliding head has a flat base which is perpendicular to the axis of the rule and ranges in size from 2 to 2 5/8 inches in width and from 1/8 to 1/4 inch in thickness.

The micrometer depth gage consists of a flat base attached to the barrel (sleeve) of a micrometer head. These gages have a range from 0 to 9 inches, depending on the length of extension rod used. The hollow micrometer screw (the threads on which the thimble rotates) itself has a range of either 1/2 or 1 inch. Some are provided with a ratchet stop. The flat base ranges in size from 2 to 6 inches. Several extension rods are normally supplied with this type of gage.

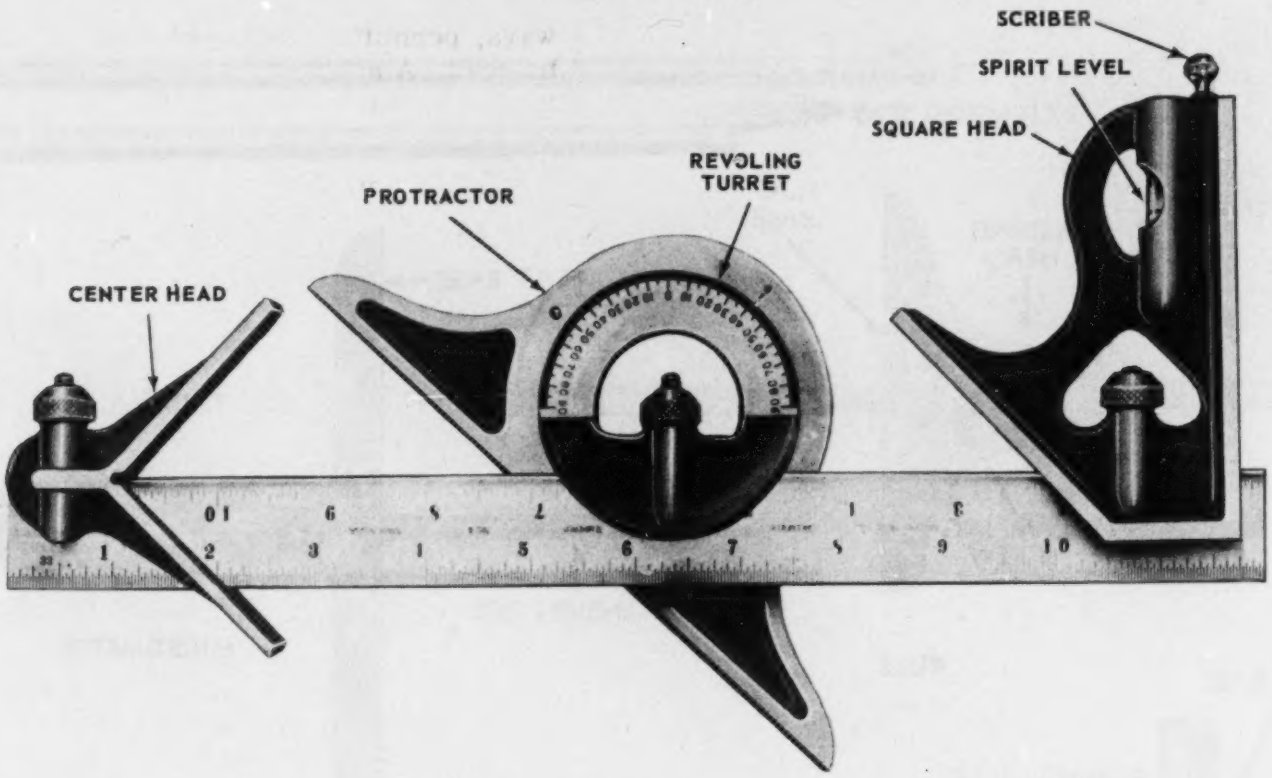

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Figure 1-1-82.—Combination square set.

SURFACE GAGE

A surface gage is a measuring tool generally used to transfer measurements to work by scribing a line, and to indicate the accuracy or parallelism of surfaces.

The surface gage (fig. 1-1-84) consists of a base with an adjustable spindle to which may be clamped a scriber or an indicator. Surface gages are made in several sizes and are classified by the length of the spindle, the smallest spindle being 4 inches long, the average 9 or 12 inches long and the largest 18 inches. The scriber is fastened to the spindle with a clamp. The bottom and the front end of the base of the surface gage have deep V-grooves cut in them, which allow the gage to measure from a cylindrical surface.

The spindle of a surface gage may be adjusted to any position with respect to the base and tightened in place with the spindle nut. The rocker adjusting screw provides for the finer adjustment of the spindle by pivoting the spindle rocker bracket. The scriber can be positioned at any height and in any desired direction on the spindle by tightening the scriber nut. The scriber may also be mounted directly in the spindle nut mounting, in place of the spindle, and used where the working space is limited and the height of the work is within range of the scriber.

SURFACE PLATE

A surface plate provides a true, smooth, plane surface. It is a flat-topped steel or cast iron plate that is heavily ribbed and reinforced on the under side. (See fig. 1-1-85.) It is often used in conjunction with a surface gage as a level base on which the gage and part to be measured are placed to obtain accurate measurements.

The surface plate can also be used for testing parts that must have flat surfaces. Before using the plate for testing smear a thin film of Prussian blue, or some other color pigment, on its surface; then rub the flat surface to be tested over the plate and the color pigment will stick to the high spots.

The surface plate should be covered when not in use to prevent scratching, nicking, and denting. It must be handled carefully to prevent warping (twisting). Never use the surface plate

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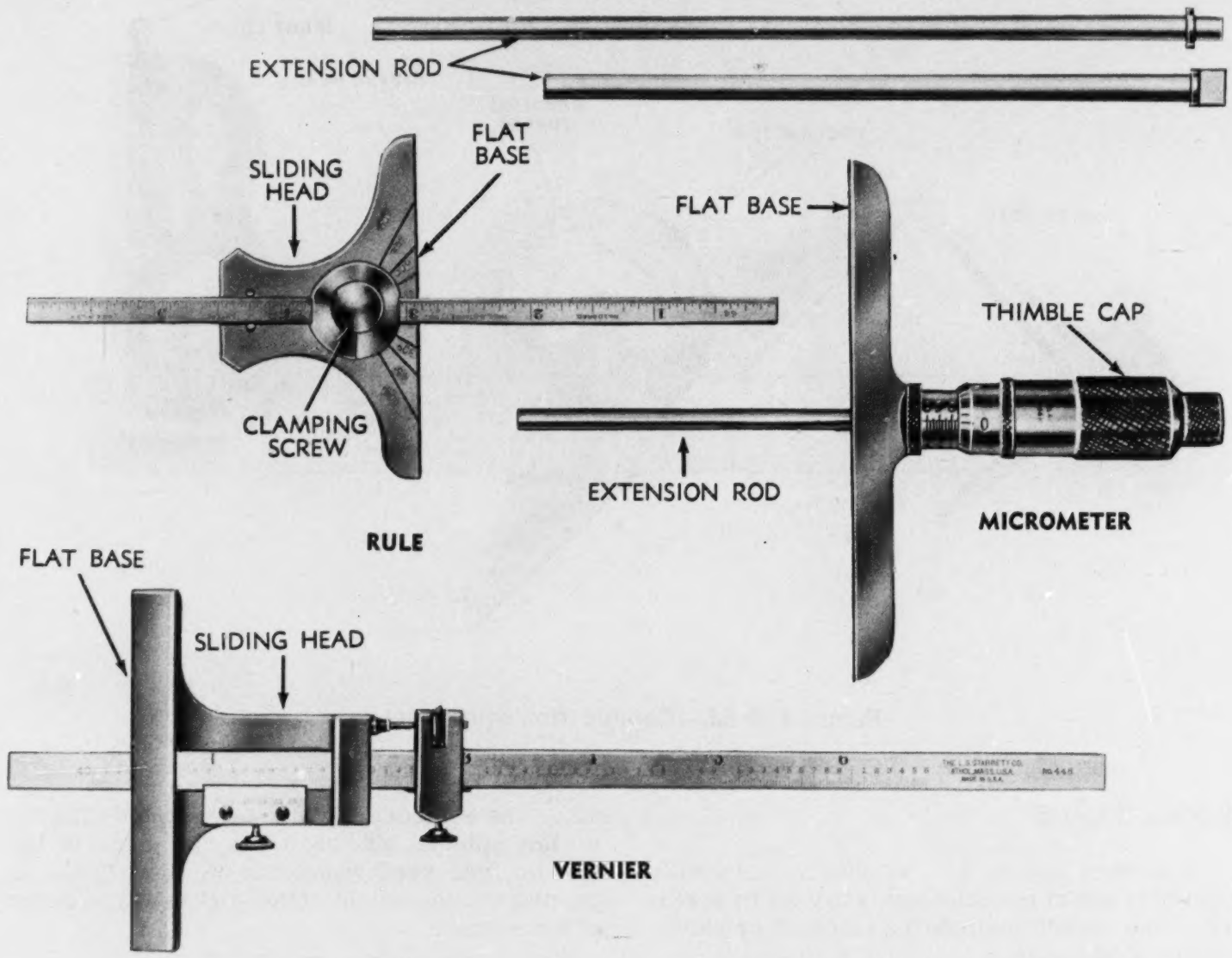

Figure 1-1-83.—Types of depth gages.

44.27

as an anvil or workbench—except for precision layout work (marking and measuring).

THICKNESS (FEELER) GAGE

Thickness (feeler) gages are fixed in leaf form, to permit the checking and measuring of small openings such as contact points, narrow slots, and so forth. They are widely used to check the flatness of parts in straightening and grinding operations and in squaring objects with a try square.

Thickness gages are made in many shapes and sizes; usually 2 to 26 blades are grouped into one tool and graduated in thousandths of an inch. (See fig. 1-1-86.) Most thickness gage blades are straight, while others are bent at the end at 45 and 90 degree angles. Some thickness gages are grouped so that there are several short and several long blades together. Thickness gages are also available in single blades and in strip form for specific measurements. For convenience, groups of thickness blades are equipped with a locking screw in the case that locks the blade to be used in the extended position.

THREAD GAGE

Thread gages (screw-pitch gages) are used to determine the pitch and the number of threads

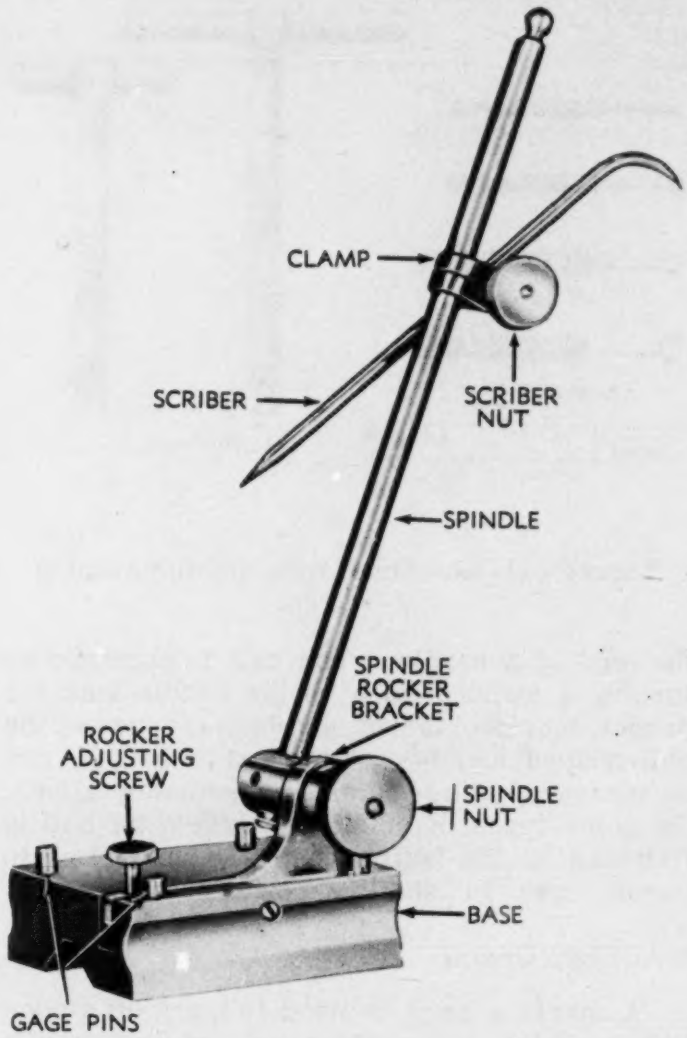

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Figure 1-1-84.—Surface gage.

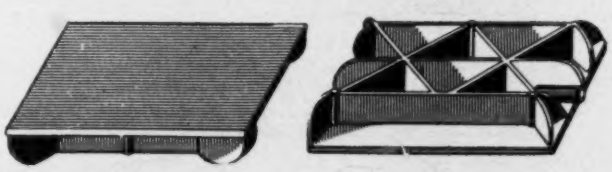

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Figure 1-1-85.—Surface plate.

per inch. (See fig. 1-1-87.) They consist of thin leaves whose edges are toothed to correspond to standard thread sections.

To measure the pitch of a thread, compare it with the standards of the gage, holding a gage leaf to the thread being gaged until you find an exact fit. If possible, look at the fit toward a source of light, since a difference of one thread

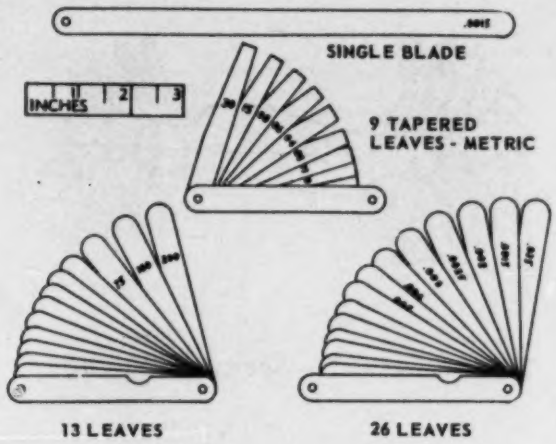

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Figure 1-1-86.—Thickness (Feeler) gages.

per inch, in the finer threads, is not easily detected.

The number of threads per inch is indicated by the numerical value on the blade which is found to fit the threads. Using this value as a basis, correct sizes of nuts, bolts, tap cutters, and die cutters are selected for use on the threads.

If the number of threads per inch on a nut equal the number of threads per inch on a bolt, the nut can be successfully applied without danger of stripping the threads on either.

WIRE GAGE

The wire gage (fig. 1-1-88) is used for gaging metal wire, and a similar gage is used to check the size of hot and cold rolled steel, sheet and plate iron, and music wire. The wire gage is circular in shape with cutouts in the outer perimeter. Each cutout gages a different size wire from 0 to 36 of the English Standard Wire Gage. A different gage is used for American Standard wire, and still another for U.S. Standard sheet and plate iron and steel.

TELESCOPING GAGE

Telescoping gages are used for measuring the inside size of slots or holes up to 6 inches in width or diameter. They are T-shaped tools in which the shaft of the T is used as a handle, and the crossarm used for measuring. (See fig. 1-1-89.) The crossarms telescope into each other and are held out by a light spring. To use the gage the arms are compressed, placed in the hole to be measured, and allowed to expand. A twist of the locknut on top of the handle locks the

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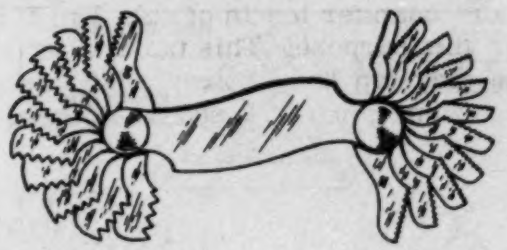

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Figure 1-1-87.—Screw pitch gage.

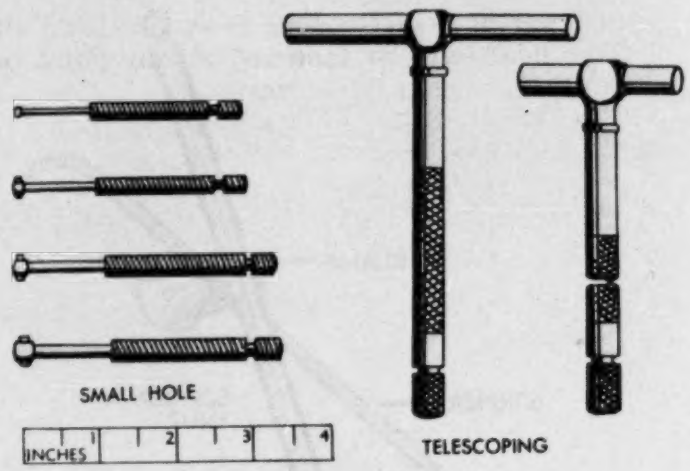

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Figure 1-1-89.—Small hole and telescoping gages.

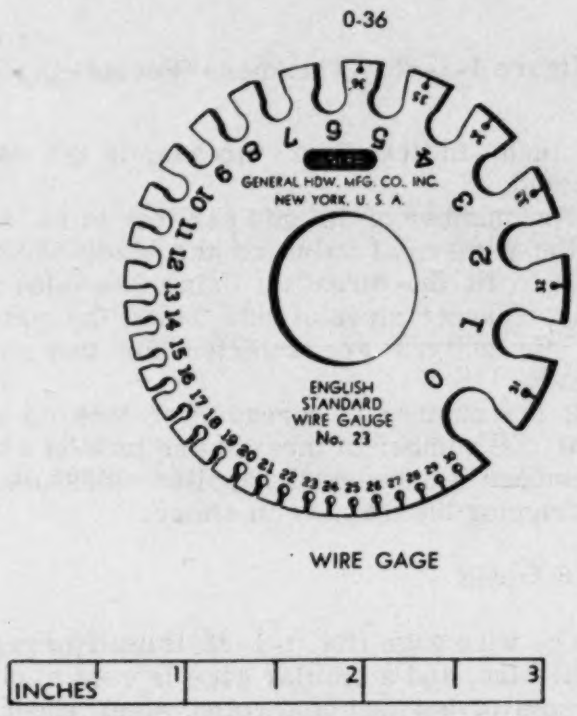

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Figure 1-1-88.—English standard wire gage.

arms. The tool may then be withdrawn and the distance across the arms measured.

These tools are commonly furnished in sets, the smallest gage for measuring distances from 5/16 to 1/2 inch, and the largest for distances from 3 1/2 to 6 inches.

SMALL HOLE GAGE

For measuring smaller slots or holes than the telescoping gages will measure, small hole gages can be used. These gages come in sets of four or more and will measure distances of approximately 1/8 to 1/2 inch.

The small hole gage (fig. 1-1-89) consists of a small, split, ball-shaped member mounted on the end of a handle. The ball is expanded by turning a knurled knob on the handle until the proper feel is obtained, and then the size of the ball-shaped member on the end of the gage can be measured with an outside micrometer caliper. On some types of small hole gages, the ball is flattened at the bottom near the centerline to permit use in shallow holes and recesses.

MARKING GAGES

A marking gage is used to mark off guidelines parallel to an edge, end, or surface of a piece of wood or metal. It has a sharp spur or pin that does the marking.

Marking gages (fig. 1-1-90) are made of wood or steel. They consist of a graduated

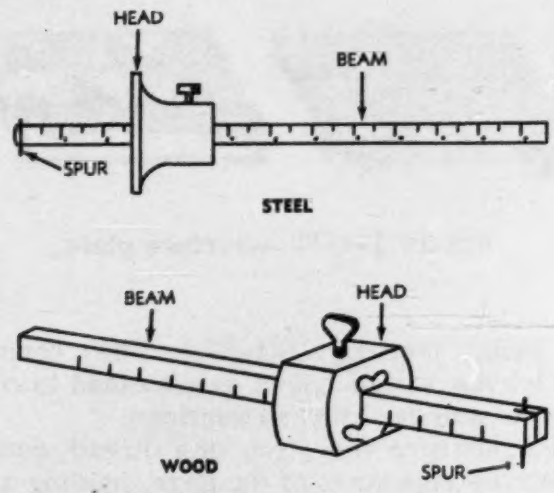

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Figure 1-1-90.—Marking gages.

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beam about 8 inches long on which a head slides. The head can be fastened at any point on the beam by means of a thumbscrew. The thumbscrew presses a brass shoe tightly against the beam and locks it firmly in position. The steel pin or spur that does the marking projects from the beam about 1/16 inch.

TAPS AND DIES

Taps and dies are used to cut threads in metal, plastics, or hard rubber. The taps are used for cutting internal threads, and the dies are used to cut external threads. There are many different types of taps. However, the most common are the taper, plug, bottoming, and pipe taps. (See fig. 1-1-91.)

The taper (starting) hand tap has a chamfer length of 8 to 10 threads. These taps are used when starting a tapping operation and when tapping through holes.

Plug hand taps have a chamfer length of 3 to 5 threads and are designed for use after the taper tap.

Bottoming hand taps are used for threading the bottom of a blind hole. They have a very short chamfer length of only 1 to 1 1/2 threads for this purpose. This tap is always used after the plug tap has already been used. Both the taper and plug taps should precede the use of the bottoming hand tap.

Pipe taps are used for pipe fittings and other places where extremely tight fits are necessary. The tap diameter, from end to end of threaded portion, increases at the rate of 3/4 inch per foot. All the threads on this tap do the cutting, as compared to the straight taps where only the nonchamfered portion does the cutting.

Dies are made in several different shapes and are of the solid or adjustable type. The square pipe die (fig. 1-1-92) will cut American Standard Pipe Thread only. It comes in a variety of sizes for cutting threads on pipe with diameters of 1/8 inch to 3 inches.

A rethreading die (fig. 1-1-92) is used principally for dressing over bruised or rusty threads on screws or bolts. It is available in a variety of sizes for rethreading American Standard Coarse and Fine threads. These dies are usually hexagon in shape and can be turned with a socket, box, open-end, or any wrench that will fit. Rethreading dies are available in sets of 6, 10, 14, and 28 assorted sizes in a case.

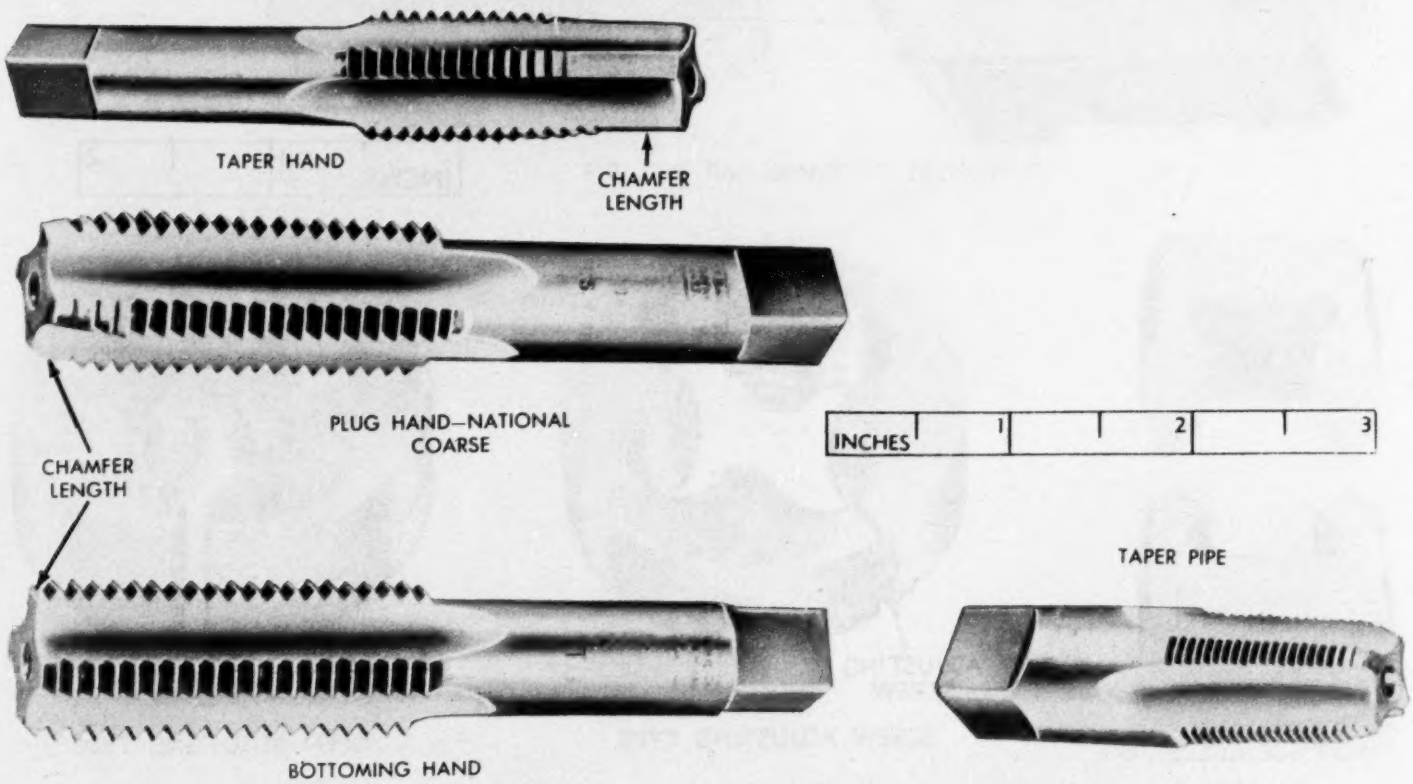

Figure 1-1-91.—Types of common taps.

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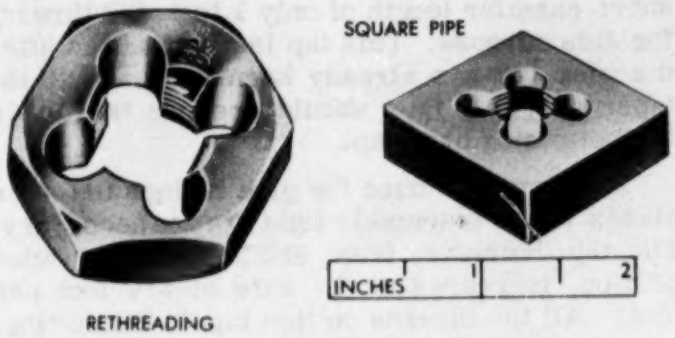

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Figure 1-1-92.—Types of solid dies.

Round split adjustable dies (fig. 1-1-93) are called "Button" dies and can be used in either hand diestocks or machine holders. The adjustment in the screw adjusting type is made by a fine-pitch screw which forces the sides of the die apart or allows them to spring together. The adjustment in the open adjusting types is made by means of three screws in the holder, one for expanding and two for compressing the dies. Round split adjustable dies are available in a variety of sizes to cut American Standard Coarse and Fine threads, special form threads, and the standard sizes of threads that are used in Britain and other European countries. For hand threading, these dies are held in diestocks (fig. 1-1-94). One type die stock has three pointed screws that will hold round dies of any construction, although it is made specifically for open adjusting-type dies.

Two piece collet dies (fig. 1-1-93) are used with a collet cap (fig. 1-1-94) and collet guide. The die halves are placed in the cap slot and are held in place by the guide which screws

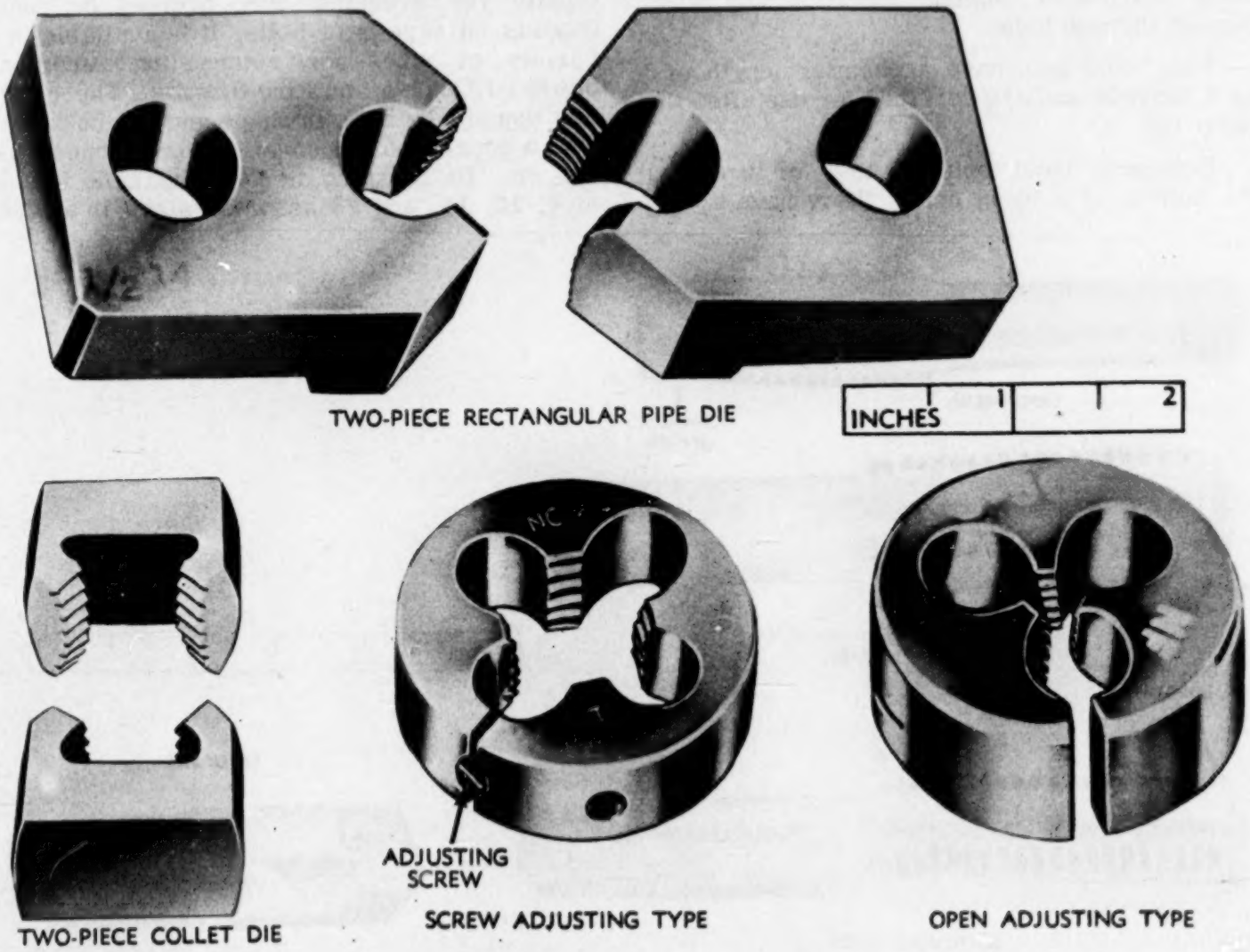

Figure 1-1-93.—Types of adjustable dies.

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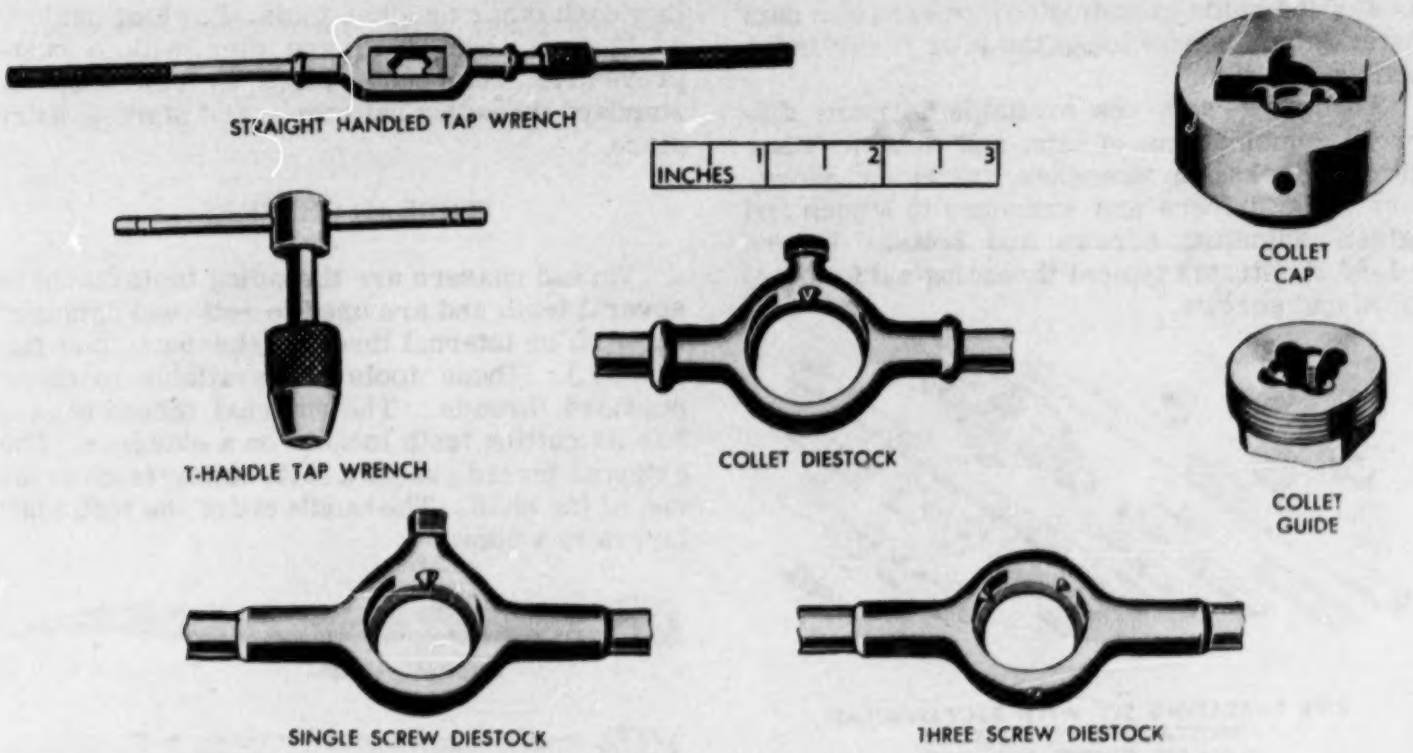

Figure 1-1-94.—Diestocks, diecollet, and tap wrenches.

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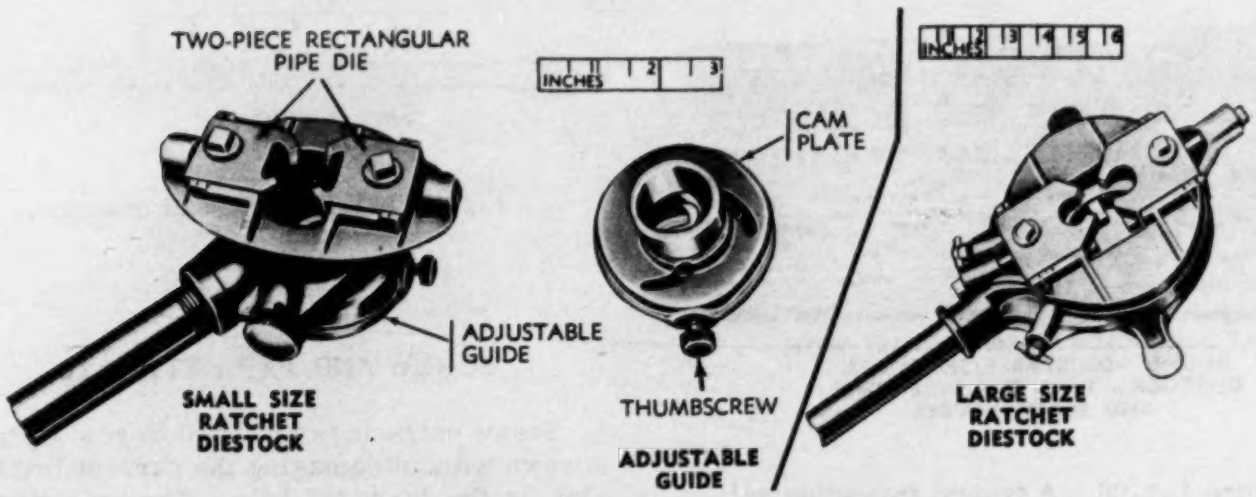

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Figure 1-1-95.—Adjustable die guide and ratchet diestocks.

into the underside of the cap. The die is adjusted by means of setscrews at both ends of the internal slot. This type of adjustable die is issued in various sizes to cover the cutting range of American Standard Coarse and Fine and special form threads. Diestocks to hold the dies come in three different sizes.

Two-piece rectangular pipe dies (fig. 1-1-93) are available to cut American Standard Pipe threads. They are held in ordinary or ratchet-type diestocks. (See fig. 1-1-95.) The jaws of the dies are adjusted by means of setscrews. An adjustable guide serves to keep the pipe in alinement with respect to the dies. The smooth

9151

jaws of the guide are adjusted by means of a cam plate; a thumbscrew locks the jaws firmly in the desired position.

Threading sets are available in many different combinations of taps and dies, together with diestocks, tap wrenches, guides and necessary screwdrivers and wrenches to loosen and tighten adjusting screws and bolts. Figure 1-1-96 illustrates typical threading set for pipe, bolts, and screws.

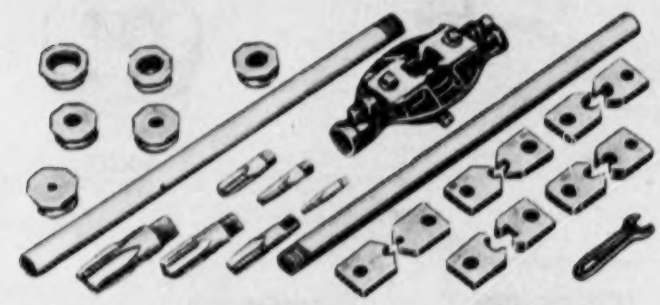

PIPE THREADING SET WITH RECTANGULAR ADJUSTABLE DIES, DIESTOCK, WRENCH, GUIDES AND TAPS

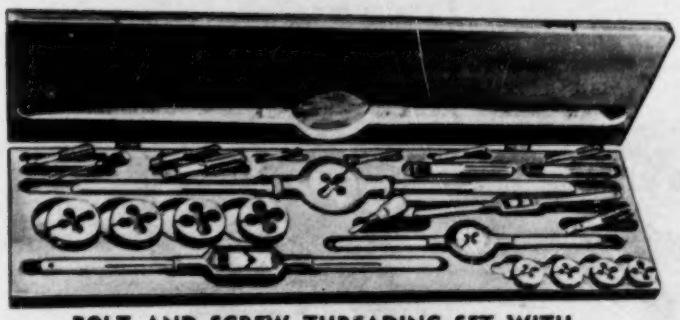

BOLT AND SCREW THREADING SET WITH ROUND ADJUSTABLE SPLIT DIES, DIESTOCKS, TAPS, TAP WRENCHES, AND SCREWDRIVERS

44.32

Figure 1-1-96.—A typical threading set.

Never attempt to sharpen taps or dies. Sharpening of taps and dies involves several highly precise cutting processes which involve the thread characteristics and chamfer. These sharpening procedures must be done by experienced personnel in order to maintain the accuracy and the cutting effectiveness of taps and dies.

Keep taps and dies clean and well oiled when not in use. Store them so that they do not contact each other or other tools. For long periods of storage, coat taps and dies with a rust-preventive compound, place in individual or standard threading set boxes, and store in a dry place.

THREAD CHASERS

Thread chasers are threading tools that have several teeth and are used to rethread damaged external or internal threads (chasing). (See fig. 1-1-97.) These tools are available to chase standard threads. The internal thread chaser has its cutting teeth located on a side face. The external thread chaser has its cutting teeth on the end of the shaft. The handle end of the tool shaft tapers to a point.

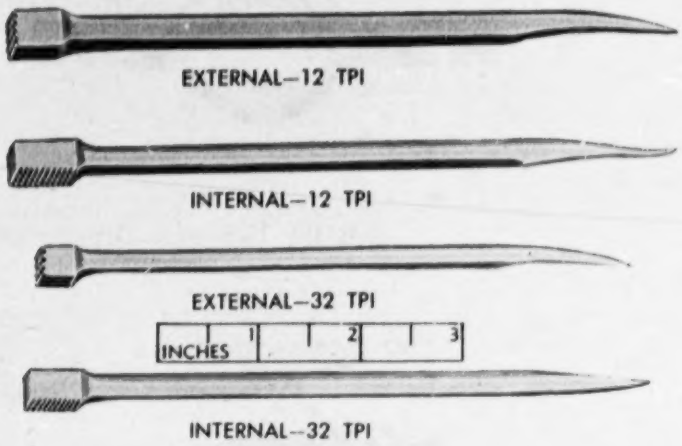

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Figure 1-1-97.—Thread chasers.

SCREW AND TAP EXTRACTOR

Screw extractors are used to remove broken screws without damaging the surrounding material or the threaded hole. Tap extractors are used to remove broken taps.

Some screw extractors (fig. 1-1-98) are straight, having flutes from end to end. These extractors are available in sizes to remove broken screws having 1/4 to 1/2 inch outside diameters. Spiral tapered extractors are sized to remove screws and bolts from 3/16 inch to 2 1/8 inches outside diameter.

Most sets of extractors include twist drills and a drill guide. Tap extractors are similar to the screw extractors and are sized to remove taps ranging from 3/16 to 2 1/8 inches outside diameter.

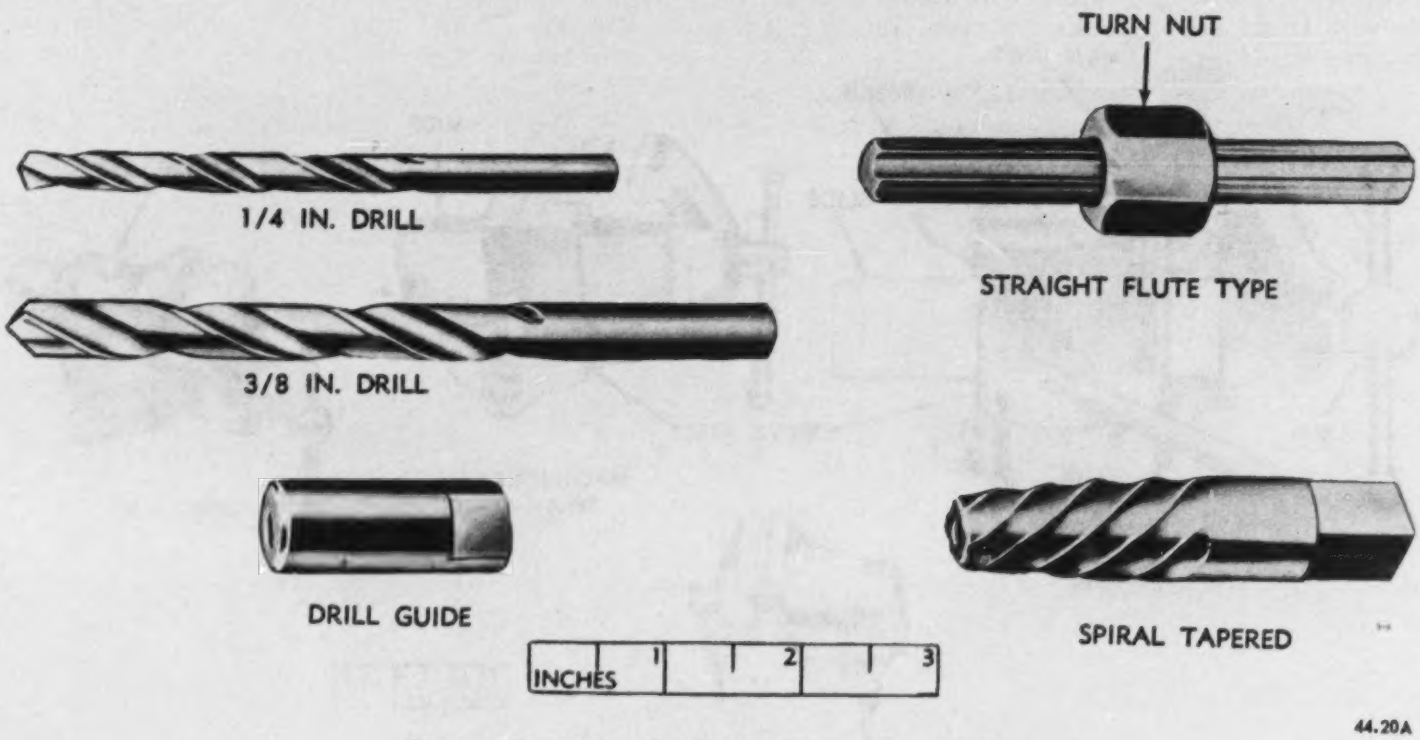

Figure 1-1-98.—Screw and tap extractors.

VISES AND CLAMPS

Vises are used for holding work when it is being planed, sawed, drilled, shaped, sharpened, or riveted, or when wood is being glued. Clamps are used for holding work which because of its shape and size cannot be satisfactorily held in a vise, or when a vise is not available. Clamps are generally used for light work.

Figure 1-1-99 shows the most common bench vises that are used throughout the Navy.

A MACHINIST'S BENCH VISE is a large steel vise with rough jaws that prevent the work from slipping. Most of these vises have a swivel base with jaws that can be rotated, while others cannot be rotated. A similar light duty model is equipped with a cutoff. These vises are usually bolt-mounted onto a bench.

THE BENCH AND PIPE VISE has integral pipe jaws for holding pipe from 3/4 inch to 3 inches in diameter. The maximum working main jaw opening is usually 5 inches, with a jaw width of 4 to 5 inches. The base can be swiveled to any position and locked. These vises are equipped with an anvil and are also bolted onto a workbench.

The CLAMP BASE VISE usually has a smaller holding capacity than the machinist's or the bench and pipe vise and is usually clamped to the edge of a bench with a thumbscrew. These type vises can be obtained with a maximum holding capacity varying between 1 1/2 in. and 3 in. These vises normally do not have pipe holding jaws.

The BLACKSMITH'S VISE (fig. 1-1-100) is used for holding work that must be pounded with a heavy hammer. It is fastened to a sturdy workbench or wall, and the long leg is secured into a solid base on the floor.

The PIPE VISE (fig. 1-1-100) is specifically designed to hold round stock or pipe. The vise shown has a capacity of 1 to 3 inches. One jaw is hinged so that the work can be positioned and then the jaw brought down and locked. This vise is also used on a bench. Some pipe vises are designed to use a section of chain to hold down the work. Chain pipe vises range in size from 1/8- to 2 1/2 inch pipe capacity up to 1/2- to 8-inch pipe capacity.

A C-CLAMP (fig. 1-1-101) is shaped like the letter C. It consists of a steel frame threaded to receive an operating screw with a swivel head. It is made for light, medium, and heavy service in a variety of sizes.

A HAND SCREW CLAMP (fig. 1-1-101) consists of two hard maple jaws connected with two operating screws. Each jaw has two metal inserts into which the screws are threaded. The

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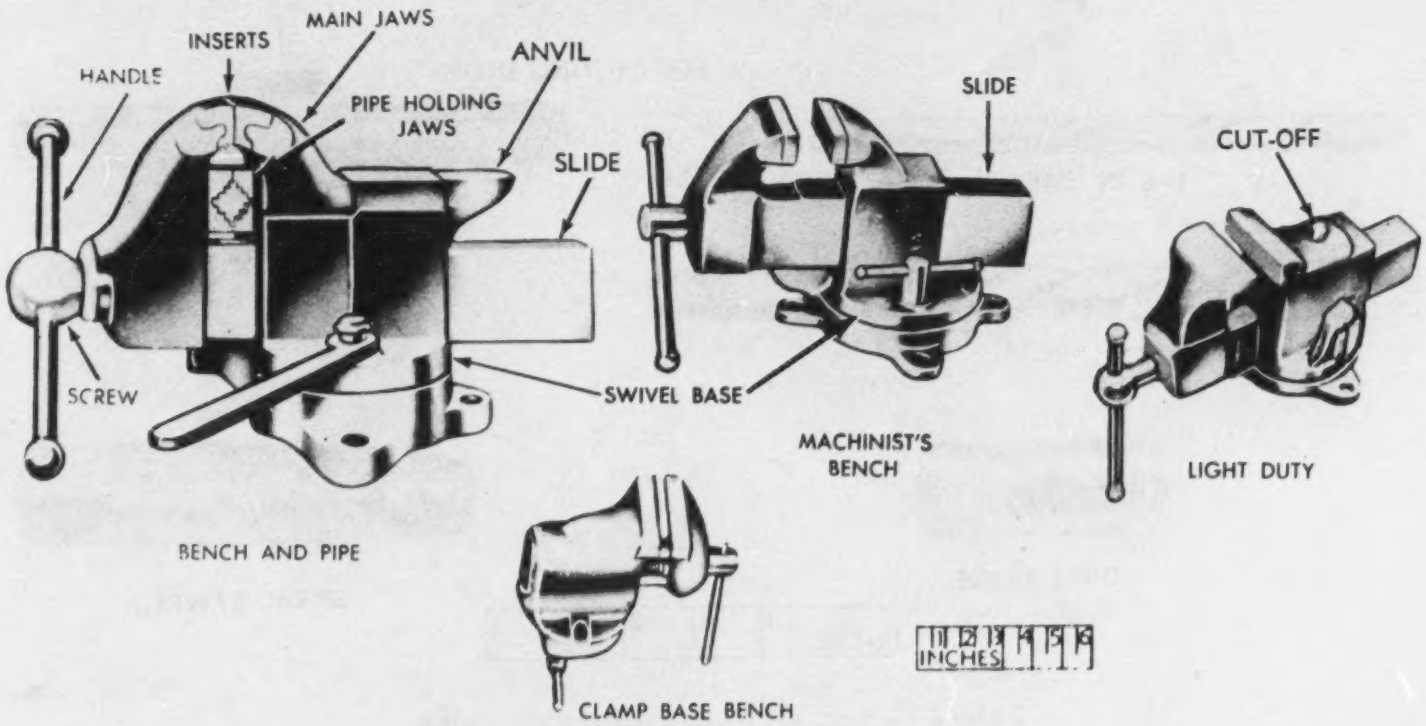

Figure 1-1-99.—Common types of bench vises.

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hand screw clamp is also issued from supply in a variety of sizes.

CARE OF VISES AND CLAMPS

Keep vises clean at all times. They should be cleaned and wiped with light oil after using. Never strike a vise with a heavy object and never hold large work in a small vise, since these practices will cause the jaws to become sprung or otherwise damage the vise. Keep jaws in good condition and oil the screws and the slide frequently. Never oil the swivel base of swivel jaw joint; its holding power will be impaired. When the vise is not in use, bring the jaws lightly together or leave a very small gap and leave the handle in a vertical position.

Threads of C-clamps must be clean and free from rust. The swivel head must also be clean, smooth, and grit free. If the swivel head becomes damaged, replace it as follows: pry open the crimped portion of the head and remove the head from the ball end of the screw (fig. 1-1-102). Replace with a new head and crimp. For short storage, wipe down the clamps with a light coat of engine oil and then hang them on racks or pins, or carefully place them in a toolbox. For long storage, apply a rust-preventive compound to the C-clamp.

The screw of hand screw clamps may break or become damaged, the inserts may become worn, or the wooden jaws may split or warp. When it is necessary to replace any of these parts, disassemble the clamp (fig. 1-1-103). Remove handles from screws by filing off peened end of attaching pins. Drive out pins. Turn both screws from the inserts and remove the inserts from the jaws. Replace damaged screws, inserts and handles. Install inserts in jaws and turn the screws into position in the two jaws. Turn new screws into handle or old screw into new handle, depending on which part is being replaced. Aline holes and tap in a new pin. Peen end of pin to secure handle on screws. Keep screws lubricated with a few drops of light oil. Apply a light coat of linseed oil to wood surfaces to prevent them from drying out. If the finish of wooden jaws is worn and bare wood is exposed, coat jaws with varnish. Hang clamps on racks or pins, or carefully place them in a toolbox, to prevent damage when not in use. Wipe clean before storing.

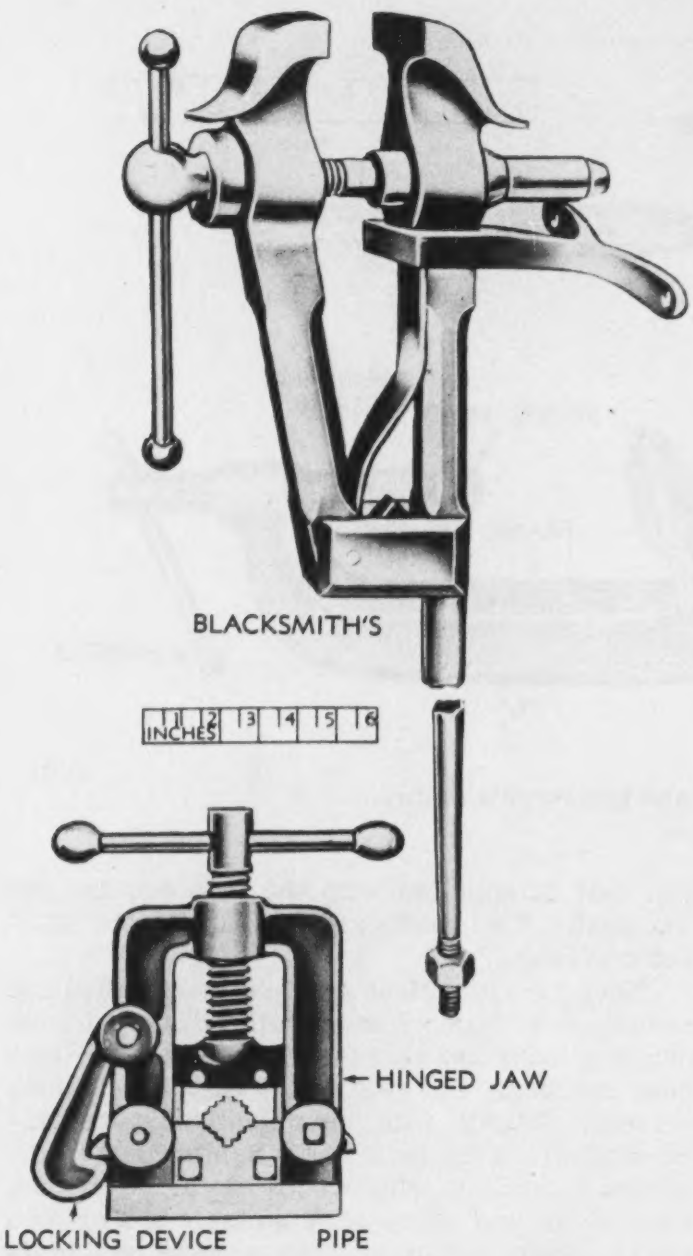

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Figure 1-1-100.—Blacksmith's and pipe vises.

SAFETY PRECAUTIONS

When closing the jaw of a vise or clamp, avoid getting any portion of your hands or body between the jaws or between one jaw and the work.

When holding heavy work in a vise, place a block of wood under the work as a prop to prevent it from sliding down and falling on your foot.

Do not open the jaws of a vise beyond their capacity, as the movable jaw will drop off, causing personal injury and possible damage to the jaw.

SOLDERING IRONS

Soldering is joining two pieces of metal by adhesion. The soldering iron is the source of heat for melting solder and heating to the proper temperature the parts to be joined.

There are two general types of soldering irons in use by the Navy. They are the electrically heated and the nonelectrically heated. The essential parts of both types are the tip and the handle. The tip is made of copper.

The electric soldering iron (fig. 1-1-104) transmits heat to the copper tip after the heat is produced by electric current which flows through a self-contained coil of resistance wire, called the heating element. Electric soldering irons are rated according to the number of watts they consume when operated at the voltage stamped on the iron. There are two types of tips on electric irons: plug tips which slip into the heater head and, which are held in place by a setscrew, and screw tips which are threaded, and which screw into or on the heater head. Some tips are offset and have a 90-degree angle for soldering joints that are difficult to reach (not illustrated). A nonelectric soldering iron (fig. 1-1-104) is sized according to its weight. The commonly used sizes are the 1/4-, 1/2-, 3/4-, 1-, 1 1/2-, 2-, and 2 1/2-pound irons. The 3-, 4-, and 5-pound sizes are not used in ordinary work. Nonelectric irons have permanent tips and must be heated over an ordinary flame, or with a blowtorch.

Electric iron tips must be securely fastened in the heater unit. The tips must be clean and free of copper oxide. Sometimes the shaft oxidizes and causes the tip to stick in place. Remove the tip occasionally and scrape off the scale. If the shaft is clean, the tip will not only receive more heat from the heater element, but it will facilitate removal when the time comes to replace the tip. After use, hang soldering irons on a rack or place on a shelf. Do not throw irons into a toolbox. When storing irons for long periods of time, coat the shaft and all metal parts with rust-preventive compound and store in a dry place.

GRINDERS AND SHARPENING STONES

A hand bench grinder (fig. 1-1-105) is an axially mounted abrasive wheel with a handcrank

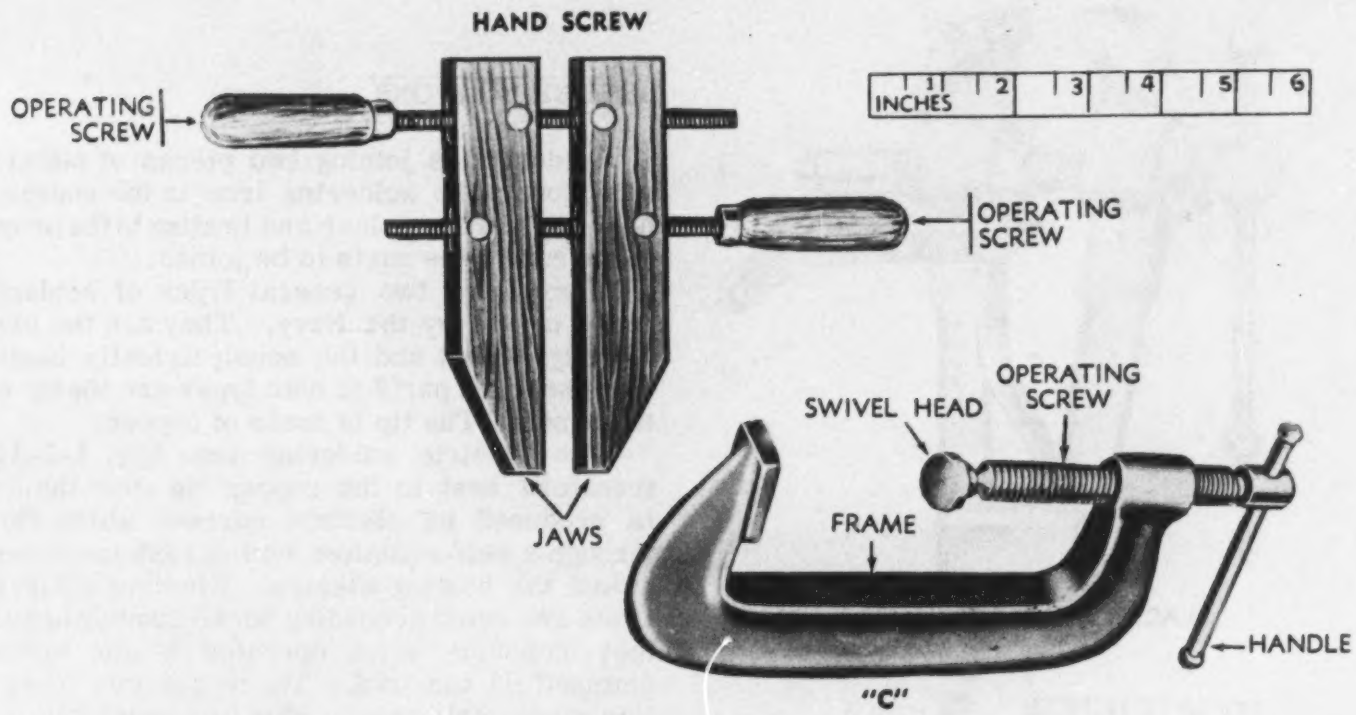

Figure 1-1-101.—C-Clamp and handscrew clamp.

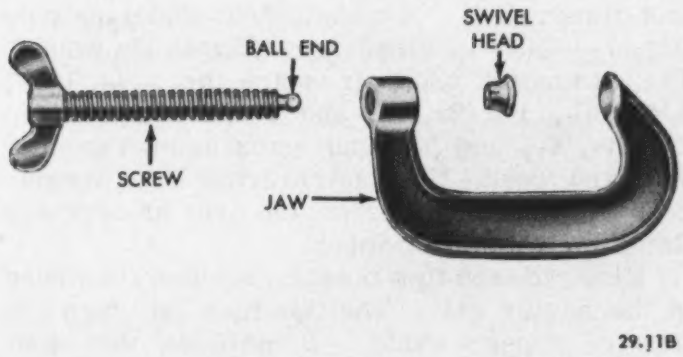

Figure 1-1-102.—C-Clamp, exploded view.

that permits turning the wheel. The grinder is geared so that the wheel spins faster than the crank. This type grinder is clamped onto a bench and is equipped with a rest for alinement of the work when grinding.

The hand valve grinder (fig. 1-1-105) is used to lap engine valves to their seats. It consists of pinion gearing enclosed in a heavy machined cast iron housing. An external crank handle drives the gears, which rotate a shaft. The end of the shaft is designed to hold any one of three driving blades for use on slotted valves. Non-slotted valves can be driven by a rubber suction cup that is supplied with the grinder, that fits the shaft. Two shafts are furnished: one short and one long.

Keep grinders clean and make certain housing screws are tight. Periodically, drain oil from bench grinder and regrease valve grinder. Flush gear housings and gears with suitable cleaning solvent. Refill with manufacturer's recommended grade of lubricant. Remove rust from external surfaces with crocus cloth. After use, wipe clean and store in a suitable box or on a rack. Make certain all nuts, screws, and bolts are tight. For long periods of storage, lubricate and spread a rust-preventive compound on all metal parts. Wrap grinder in oil-soaked cloth and store in a dry place.

Sharpening stones are divided into two groups, natural and artificial. Some of the natural stones are oil treated during and after the manufacturing processes. The stones that are oil treated are sometimes called oilstones. Artificial stones are normally made of silicone carbide or aluminum oxide. Natural stones have very fine grains and are excellent for putting razorlike edges on fine cutting tools. Most sharpening stones have one coarse and one fine face. Some of these stones are mounted, and the working face of some of the sharpening stones is

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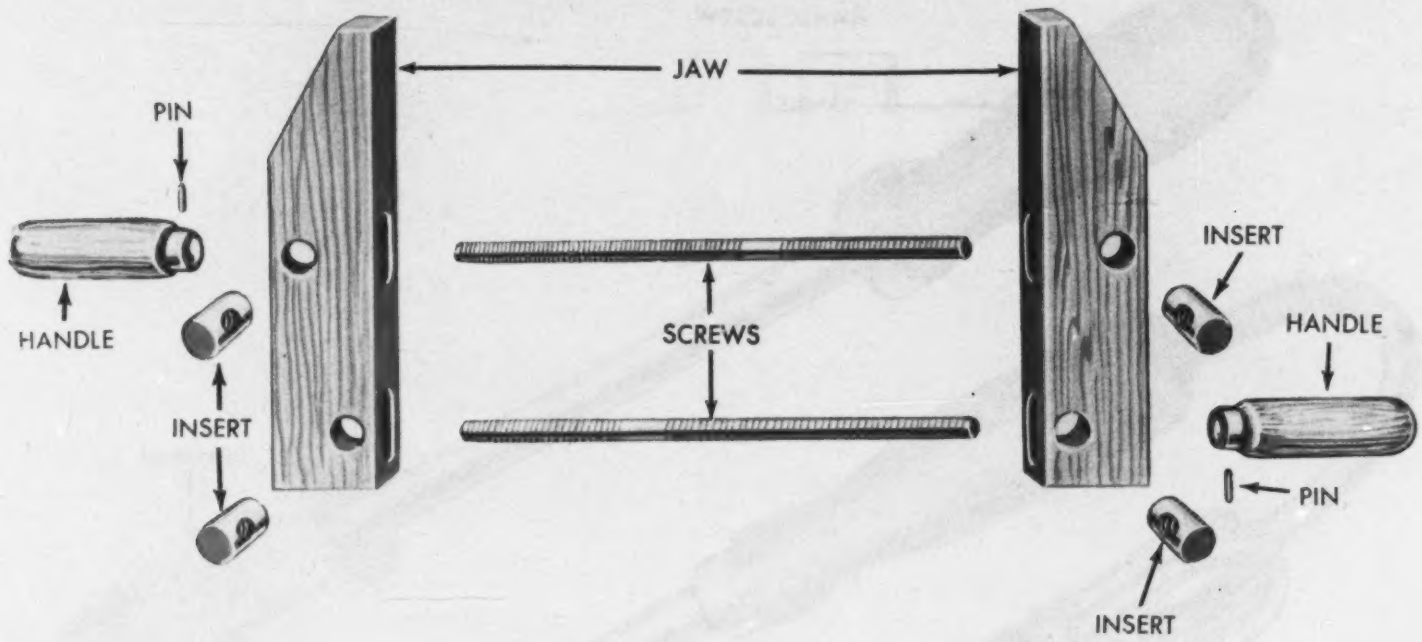

Figure 1-1-103.—Handscrew clamp, exploded view.

29.11C

a combination of coarse and fine grains. Stones are available in a variety of shapes, as shown in figure 1-1-106.

A fine cutting oil is generally used with most artificial sharpening stones, however, other lubricants such as kerosene may be used. When a tool has been sharpened on a grinder or grindstone, there is usually a wire edge or a feather edge left by the coarse wheel. The sharpening stones are used to hone this wire or feather edge off the cutting edge of the tool. Do not attempt to do a honing job with the wrong stone. Use a coarse stone to sharpen large and very dull or nicked tools. Use a medium grain stone to sharpen tools not requiring a finished edge, such as tools for working soft wood, cloth, leather, and rubber. Use a fine stone and an oilstone to sharpen and hone tools requiring a razorlike edge.

Prevent glazing of sharpening stones by applying a light oil during the use of the stone. Wipe the stone clean with wiping cloth or cotton waste after each use. If stone becomes glazed or gummed up, clean with aqueous ammonia or drycleaning solvent. If necessary, scour with aluminum oxide abrasive cloth or flint paper attached to a flat block.

At times, stones will become uneven from improper use. True the uneven surfaces on an old grinding wheel or on a grindstone. Another method of truing the surface is to lap it with a block of cast iron or other hard material covered with a waterproof abrasive paper, dipping the stone in water at regular intervals and continuing the lapping until the stone is true.

Stones must be carefully stored in boxes or on special racks when not in use. Never lay them down on uneven surfaces or place them where they may be knocked off a table or bench, or where heavy objects can fall on them. Do not store in a hot place.

PIPE AND TUBING CUTTERS AND FLARING TOOLS

Pipe cutters (fig. 1-1-107) are used to cut pipe made of steel, brass, copper, wrought iron, and lead. Tube cutters (fig. 1-1-107) are used to cut tubing made of iron, steel, brass, copper, and aluminum. The essential difference between pipe and tubing is that tubing has considerably thinner walls. Flaring tools (fig. 1-1-108) are used to make single or double flares in the ends of tubing.

Two sizes of hand pipe cutters are generally used in the Navy. The No. 1 pipe cutter has a cutting capacity of 1/8 to 2 inches, and the No. 2 pipe cutter has a cutting capacity of 2 to 4 inches.

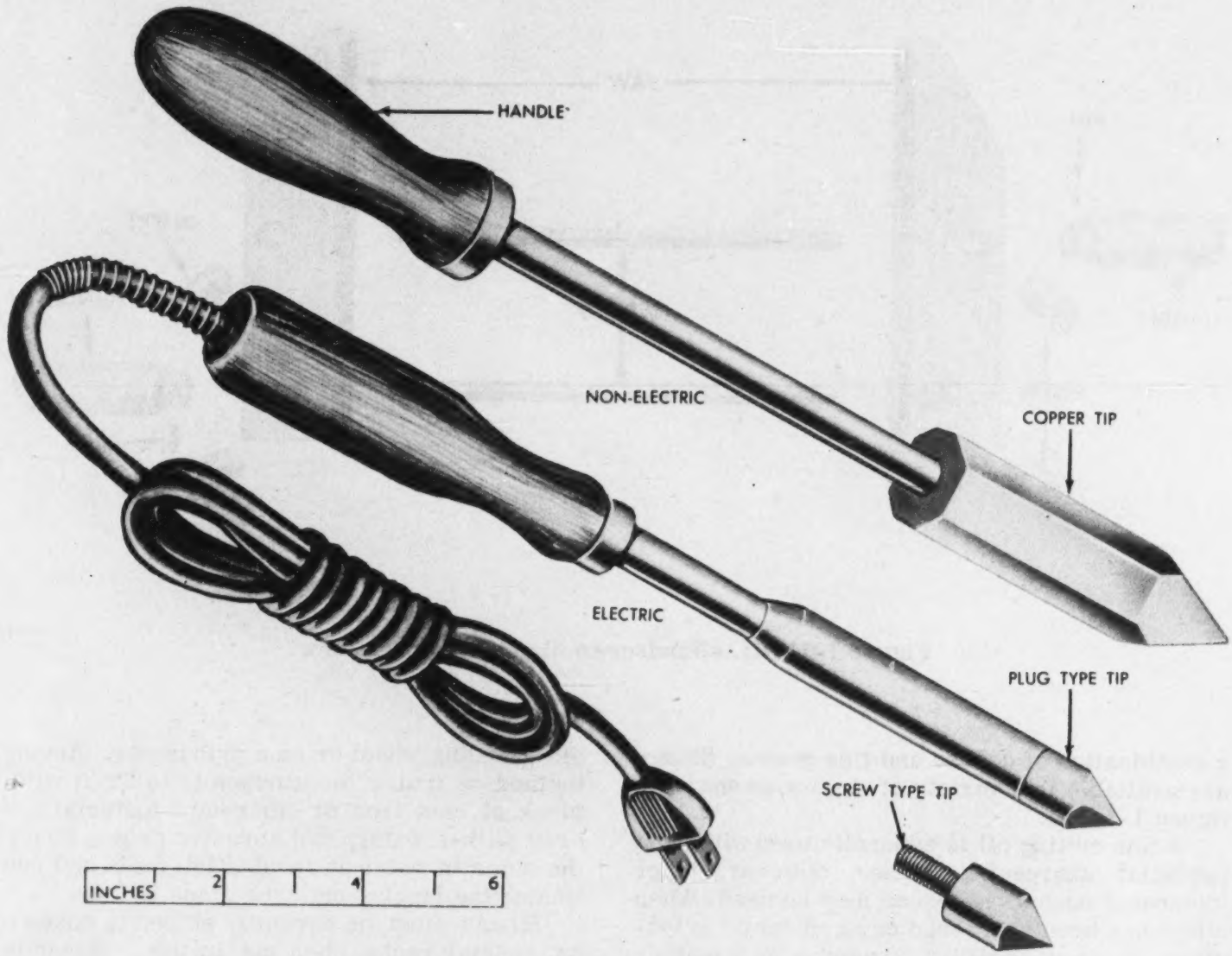

Figure 1-1-104.—Soldering irons.

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The pipe cutter (fig. 1-1-107) has a special alloy-steel cutting wheel and two pressure rollers which are adjusted and tightened by turning the handle.

Most TUBE CUTTERS closely resemble pipe cutters, except that they are of lighter construction. A hand screw feed tubing cutter of 1/8-inch to 1 1/4-inch capacity (fig. 1-1-107) has two rollers with cutouts located off center so that cracked flares may be held in them and cut off without waste of tubing. It also has a retractable cutter blade that is adjusted by turning a knob. Other types of tube cutters shown are designed to cut tubing up to and including 3/4 and 1 inch outside diameter. Some cutters have the feed screw covered to protect the threads against dirt and damage.

FLARING TOOLS (fig. 1-1-108) are used to flare soft copper, brass, or aluminum to make 45° flare joints. The single flaring tool consists of a split die block that has holes for 3/16-, 1/4-, 5/16-, 3/8-, 7/16-, and 1/2- inch o.d. tubing, a clamp to lock the tube in the die block, and a yoke that slips over the die block and has a compressor screw and a cone that forms a 45° flare or a bell shape on the end of the tube. The screw has a T-handle. A double flaring tool has the additional feature of adapters that turn in the edge of the tube before a regular 45° double flare is made. It consists of a die block with holes for 3/16-, 1/4-, 5/16-, 3/8-, and 1/2-inch tubing, a yoke with a screw and a flaring cone, plus five adapters for different size tubing, all carried in a metal case.

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MISCELLANEOUS TOOLS

Tools described under the heading "miscellaneous tools" are tools that cannot properly be listed under such headings as "metal-cutting tools" or "woodworking tools." Instead, they are tools that are likely to be used by all men in the Navy sometime during their careers.

The miscellaneous tools are not likely to be found in any particular toolkit, but will be stored in a central toolroom to be checked out when they are needed. You will find many of these tools mentioned several times throughout the text. This section will give you some tips on nomenclature, where the tools can be used, how they are used, and some safety precautions to be observed when using the tools.

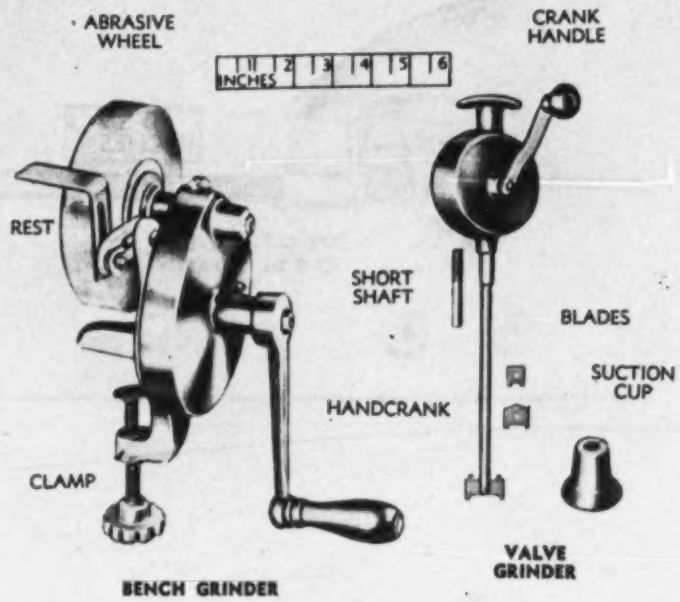

Figure 1-1-105.—Hand grinders.

ADZ

The adz (fig. 1-1-109) consists of a hardened steel head which has a square eye at the top and a curved blade at one end. The blade is 3 1/2 to 4 1/2 inches wide. It has a wooden handle, which is curved to give balance and to provide the proper angle for cutting.

The adz is used for cutting, shaping, and smoothing of logs when a large amount of wood is to be removed.

Securely block the timber which is to be worked on, to prevent it from slipping, sliding, or rolling. Keep the area being cut clear of chips, because they may deflect the blade and cause it to injure your foot or leg.

To use the adz, the timber to be worked on should be straddled. Grip the handle of the adz with the hands about 12 to 15 inches apart with the tool in front of the body. Make short, chopping strokes by swinging the adz downward and toward the body.

The head of the adz must be removed from the handle for sharpening. Remove the nicks from the edge of the blade by moving the edge back and forth across the wheel of a grindstone.

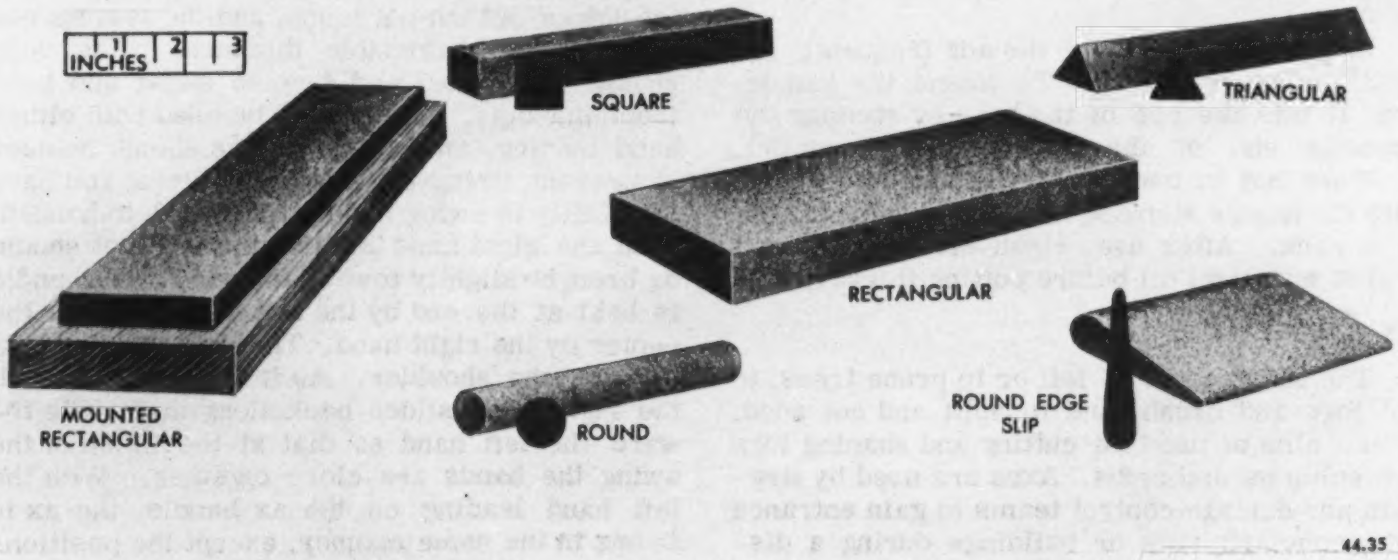

Figure 1-1-106.—Shapes of sharpening stones and oilstones.

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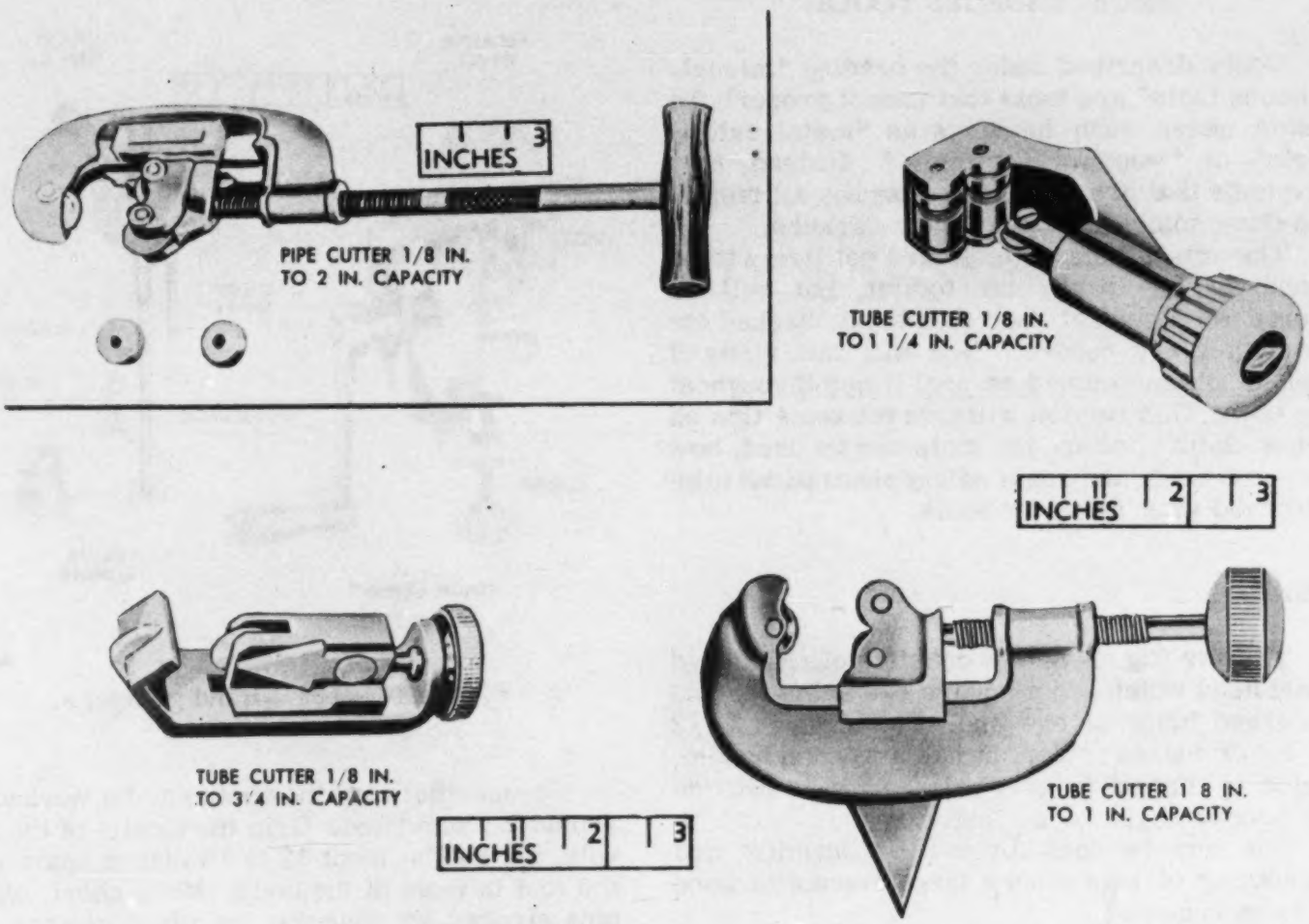

Figure 1-1-107.—Pipe and tubing cutters. 44.36

Then restore the bevel edge to its original shape. Keep the edge square (at a right angle) with the head.

Inspect the handle of the adz frequently for split or broken wood. To insert the handle, seat it into the eye of the head by striking the opposite end of the handle with a mallet.

When not in use, place the adz on its head with the handle standing upward, or hang the adz in a rack. After use, clean the adz head and coat it with light oil before putting it away.

AX

The ax is used to fell or to prune trees, to cut logs and brush, and to split and cut wood. It can also be used for cutting and shaping logs for columns and cribs. Axes are used by fireman and damage control teams to gain entrance into compartments or buildings during a disaster.

In using the ax (fig. 1-1-110), the body weight should be distributed evenly on both legs, with the knees set but not tense, and the feet spread apart at a comfortable distance. The body should be relaxed and free to swing and bend from the hips. The ax may be used with either hand leading, and both positions should be used to prevent tiring provided, of course, you have the ability to swing right-handed or left-handed. With the right hand leading, the left foot should be brought slightly toward the work. The handle is held at the end by the left hand and near the center by the right hand. The ax is then brought up over the shoulder. As it is swung forward, the right hand slides back along the handle toward the left hand so that at the finish of the swing the hands are close together. With the left hand leading on the ax handle, the ax is swung in the same manner, except the positions are reversed.

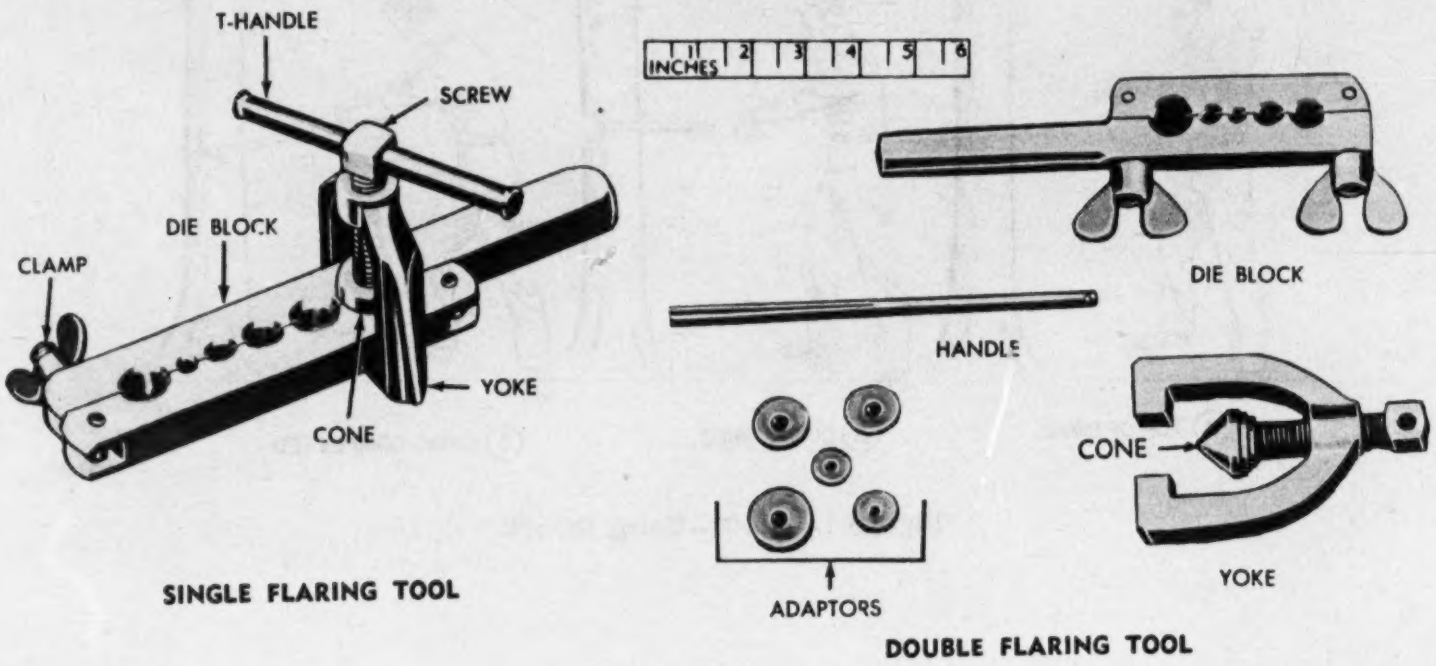

44.37

Figure 1-1-108.—Flaring tools.

44.39

Figure 1-1-109.—The adz.

Before swinging an ax, make sure no one is in the way of your swing. Clear away any branches, twigs, or other obstruction that might tend to deflect the blade from the target. Keep the blade sharp. A dull blade may be deflected and injure the foot or leg. Keep the blade clear of chips which may deflect the blade. If you are using an ax to cut used timbers make sure that all nails have been removed from the area that is being cut.

It is not necessary to remove the ax handle for sharpening the ax blade. (See fig. 1-1-111.) First remove nicks by moving the edge of the blade back and forth across a grindstone. Then restore the bevel by holding first one side then the other against the stone. The ax bevel should be slightly convex, or "rolled off." The edge is slightly curved, or fan-shaped, instead of straight across the head of the blade.

When grinding an ax, a wet grindstone should be used. Dip the ax in water frequently to keep it from overheating. Start to grind 2 or 3 inches back from the cutting edge and grind to within about 1/2 inch from the edge. Using a hone or whetstone, sharpen the remaining 1/2 inch and remove all scratches from the area which has been ground. A scratch left on highly tempered steel can cause it to break where it is scratched.

After an ax is used, it should be cleaned, sharpened, and coated with a light film of oil. Store it in a place where it will not fall and injure anyone and so as not to damage the sharp edge.

HATCHET

The half-hatchet, commonly called hatchet, is a chopping and driving tool similar in some respects to a hammer. It is used for light cutting, trimming, and hewing, and (because it is heavier than a hammer) for driving large nails and spikes. (See fig. 1-1-112.) It has a wooden handle and a steel head composed of a hammerhead, and eye, and a blade. Some hatchets have a notch in the blade for pulling nails. Hatchets

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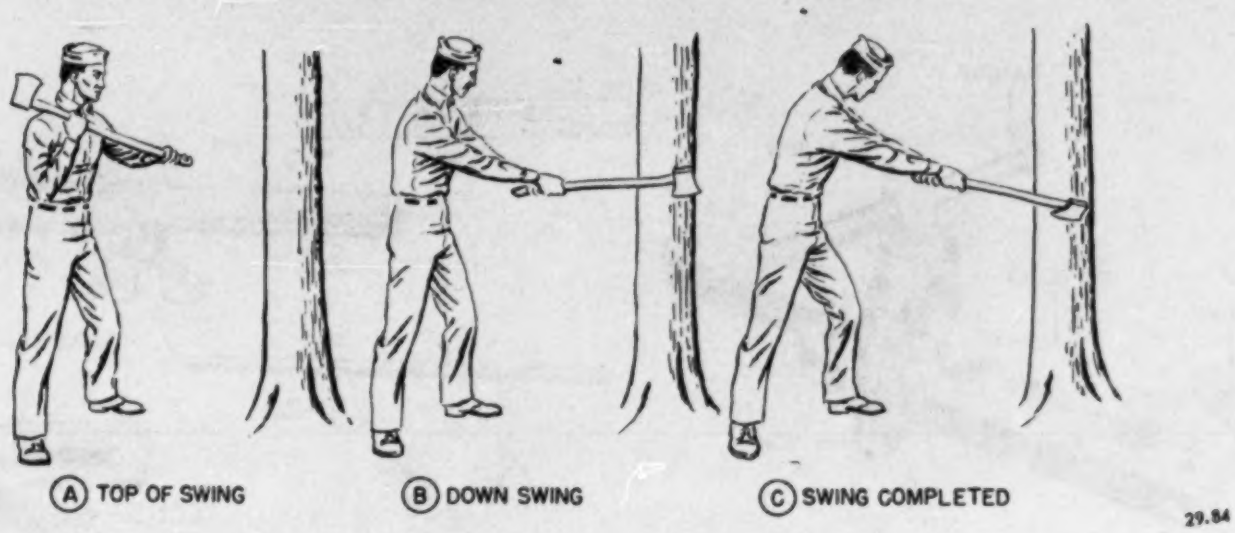

Figure 1-1-110.—Using the Ax.

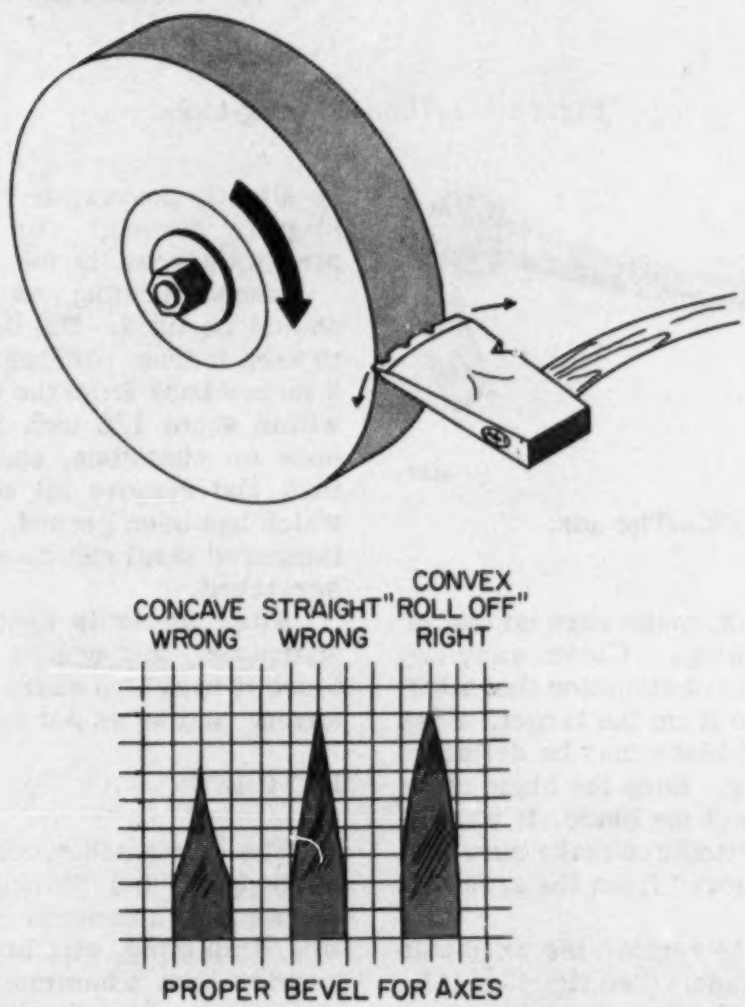

Figure 1-1-111.—Sharpening the Ax.

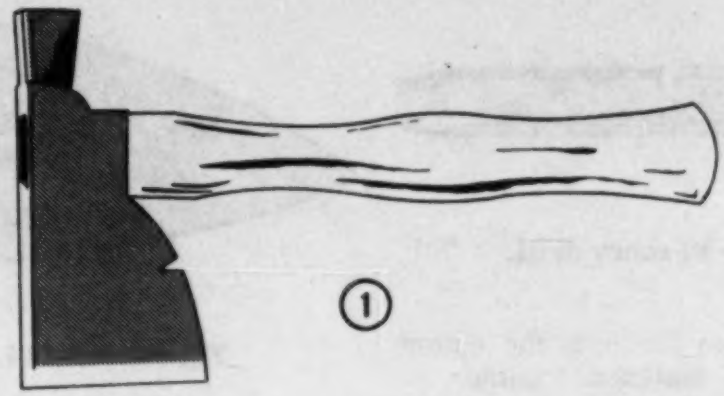

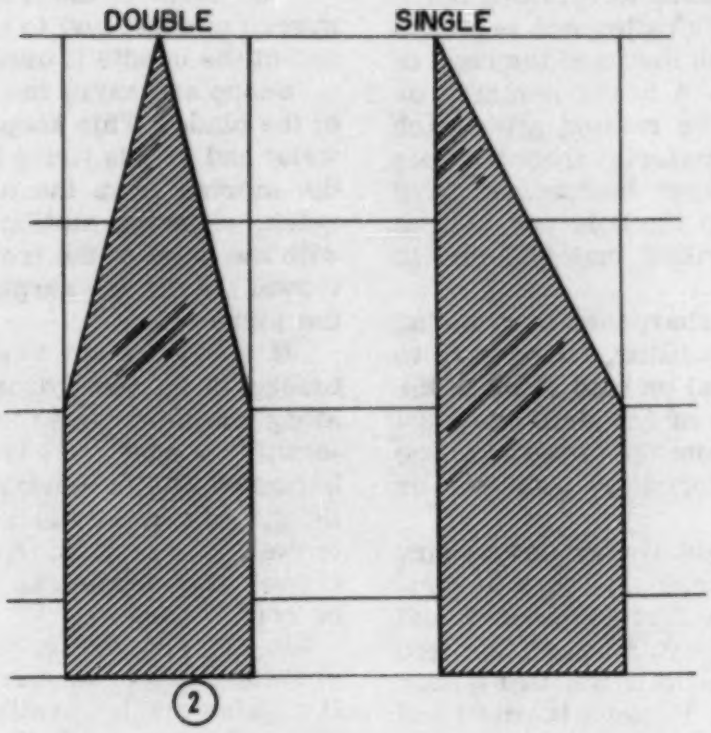

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Figure 1-1-112.—Half-hatchet.

are made with two types of cutting edge (fig. 1-1-112): the single bevel and the double bevel. The double bevel is the more common. The single bevel hatchet is ideal for cutting to a line.

To make heavy strokes with the hatchet, grasp the handle with one hand near its end; for light strokes, hold the handle close to the head. The hatchet is used principally to hew to a line with the grain of the wood. To do so, set the wood being hewn on edge and make a series of small, closely spaced cuts at an angle of about 45 degrees across the grain and near the line. Cut away the notched segments by striking with the grain along the line. In making the scoring cuts, when the grain is irregular, change the direction of the blow to cut across the grain with every stroke.

The care, the maintenance, and the safety rules to be followed when using a hatchet are the same as previously described for the ax.

MASONRY DRILLS

Masonry drills (fig. 1-1-113) frequently called star drills, are shafts of steel with a cutter at one end and a flat face on the other.

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Figure 1-1-113.—Masonry drill. 44.42

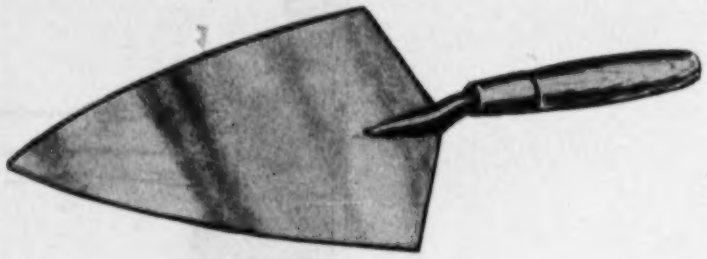

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Figure 1-1-114.—Brick trowel.

Looking at the drill from the end, the cutter resembles four chisels fastened together at their edges. Masonry drills are made in various sizes up to 1 3/4 inches in diameter and 18 to 48 inches in length.

The masonry drill is used for drilling holes in concrete or stone. The cutter end is placed where the hole is to be drilled and the head of the drill is struck with a heavy hammer or sledge. The drill must be rotated after each blow to clear the drilled material from the hole and to keep the drill from binding. In hard stone it is useful to keep the hole wet, both to help clear the hole of drilled material and to keep the drill cool.

The cutting edges are sharpened by grinding on a grinding wheel or by filing, taking care to maintain the original bevel on both sides of the cutting edges. The head of the drill may become burred or broken from the blows from the hammer; it can be restored by grinding or filing.

Always wear goggles when using the masonry drill. Bits of rock or concrete, and rock or concrete dust, will sometimes fly from the material being drilled and may injure your eyes if they are not protected. Keeping the hole wet will lessen the amount of dust raised. Because the drill and the hammer or sledge are both of steel, bits of this material may be broken off from the head of the drill and cause injury.

When holding a masonry drill for another person to strike with a sledge or hammer, always stand at one side of his swing, instead of directly in front of him. This will lessen the danger of injury should the hammer or sledge slip from his grasp or the head of the hammer or sledge come loose.

TROWELS

The BRICK trowel (fig. 1-1-114) is a pointed steel blade about 5 inches wide at the heel and 10 inches long. At the wide end, a wooden handle is fastened to the blade by means of a tang. The tang is bent upward slightly, so that the handle is slightly above the blade in use.

The blade of the trowel is used to scoop and spread mortar, and to chip and cut bricks. The end of the handle is used to tap bricks into place.

Scoop and carry the mortar on the wide part of the blade. This keeps the weight close to the wrist and avoids tiring the hand and wrist. Dump the mortar from the side of the trowel with a quick, chopping motion. Spread it into position with the point of the trowel. With the edge of the trowel cut off any surplus mortar coming out of the joint.

If a beveled or V-shaped joint between the bricks is desired, draw the point of the trowel along the joint, thus forcing the mortar into the joint. The edge of the trowel may be used to chip hardened bits of mortar or other material from the surface of the bricks. To cut a brick with a trowel, strike it sharply with the edge of the trowel at the point where you wish the brick to be cut.

In chipping brick, goggles should be worn to prevent chips or dust from getting into the eyes. If goggles are not available, hold the brick to be cut well away from the face. Do not hold the brick with your hand close to where the cut is being made. You may chop your finger instead of the brick.

The CEMENT trowel (fig. 1-1-115) is a flat rectangular blade about 4 inches wide and 14 inches long. A wooden handle is fastened to the back of the blade in its middle by means of a metal tang and strap.

The cement trowel is used for finishing concrete surfaces. While the concrete is still wet, it may be pushed into place and uneven spots leveled by moving the cement with the edge of the trowel.

To get a smooth surface on the concrete, wait until the concrete has partly set. Then dip the trowel in water and use it much as you would use a flat iron in ironing clothes to smooth out all

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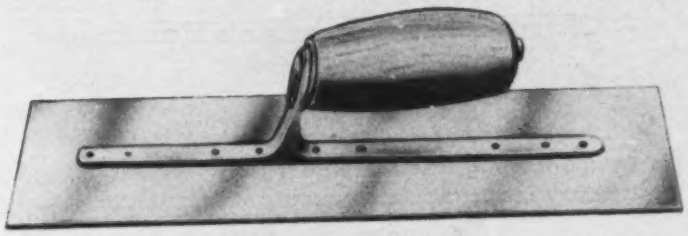

Figure 1-1-115.—Cement trowel. 29.164A

coarse appearing parts of the surface, taking care that the edge of the trowel does not gouge into the surface. The trowel must be kept wet by dipping it into water. Additional water can be brought to the surface of the concrete by slapping the surface with the flat of the trowel while finishing.

Clean all mortar from the trowel, including the handle, by washing it in water after use. If mortar hardens on the blade the trowel becomes useless until it is chipped or cleaned off. Mortar left to harden on the handle will scratch the hands when the trowel is next used. Oil the trowel lightly after it is used and before it is put away.

After working with mortar or cement, wash all cement dust from the skin and remove dirty clothing. The lime in the mortar or cement may burn the skin.

PICKS

The pick (fig. 1-1-116) is a tool that is designed for digging in hard earth. It consists of a steel head set on a wooden handle, which is inserted through an eye in the middle of the head. One end of the head tapers to a sharp point; the other end is chisel shaped.

The pick is used for loosening hard clay or rocky earth so that it may be removed with a shovel. A small amount of prying may be done with a pick; for heavy prying, a bar should be used.

Do not use a pick in extremely cold weather without first warming the head. Steel becomes brittle in extreme cold, and the head may be broken if used for very heavy blows while it is cold. To sharpen the pick, the head should be removed from the handle. The pick is then sharpened on a grinding machine in the same way as an ax. In the field, where a grinding machine is not available, a coarse file may be used to sharpen the points of a pick.

Observe the same safety precautions when using a pick as you do when using an ax.

SHOVELS

The shovel is a steel blade set on a wooden handle, and is used for moving earth or other material. The blades of some shovels are slightly pointed for easier cutting of earth and the back of the blade is cut off square so that the foot may be used to force the tool into the ground.

There are many types of shovels for various uses. The types generally found in the Navy are the D-handled round point and the long-handled round point (fig. 1-1-117).

The D-handled round point shovel is designed for light work or for digging in cramped spaces. It has a short handle (about 3 feet in length), at

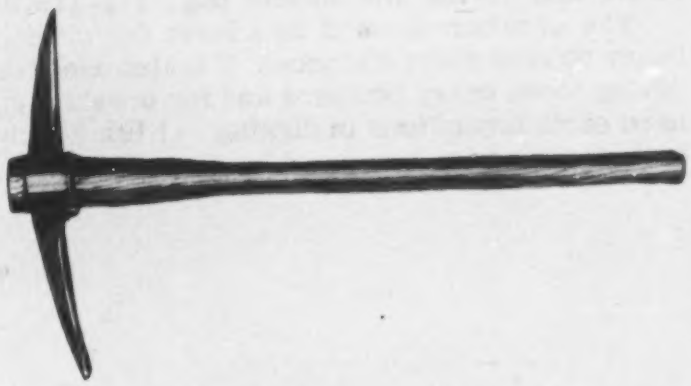

Figure 1-1-116.—Pick. 44.44

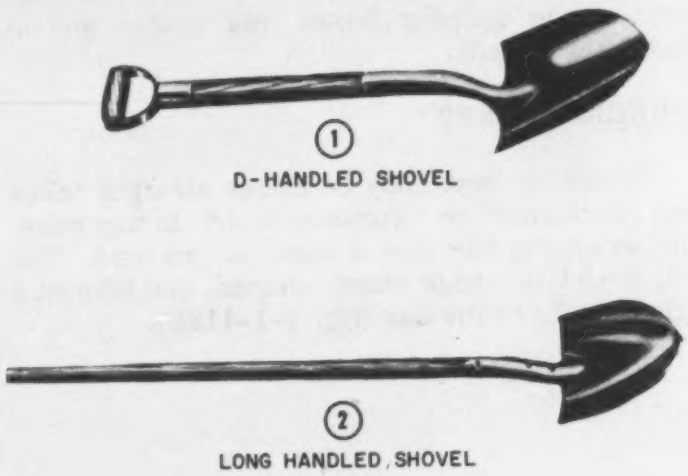

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Figure 1-1-117.—Types of shovels commonly used in the Navy.

the top of which is a D-shaped metal strap, into which is set a short wooden crosspiece for a hand grip.

The long-handled round point shovel is the best for most kinds of heavy work, such as digging trenches or any other digging in which there is sufficient room to swing it. This shovel has no hand grip. Instead the handle is a long (about 5 feet), round pole.

Shovels should not be used for heavy prying; this may break the handle or bend the blade. After use, shovels should be cleaned and oiled. To sharpen the blade after it has been worn, first hammer it into proper shape on a piece of hard wood or an anvil. Then file the point.

To replace the handle on a shovel, cut or grind off the heads of the rivets which hold the blade to the handle. Drive out the rivets and pull the handle from the socket. Insert a new handle and drill rivet holes through it. Drive in and peen the new rivets. If the handle has been broken off close to the socket, it may be necessary to bore the handle out of the socket.

When using a shovel, be sure your working space is free, so that you will not injure another worker when you swing the shovel. Try to throw the material where it will not have to be moved a second time and where it will do no harm.

PINCHBAR

The pinchbar is a steel rod, usually made of 3/4-inch bar stock, with one pointed end and one chisel, or wedge-shaped end. The wedge end is set at a slight angle to the bar. (See fig. 1-1-118A.) The pinchbar is generally used for prying, such as in opening boxes and crates and in loosening boards.

WRECKING BARS

Wrecking bars may be either straight "claw and pinchpoint" or "goosenecked." In any case, the wrecking bar has a claw at one end. The other end is wedge chisel shaped, and bent at a slight angle to the bar (fig. 1-1-118B).

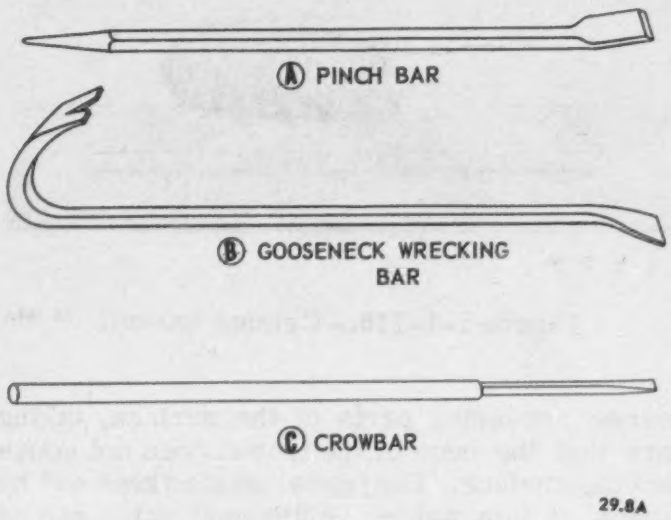

Figure 1-1-118.—Bars.

The wrecking bar is used for prying boards loose and for removing large nails or spikes from boards. The wedge-shaped end is inserted between boards to be removed, and the boards pried loose by exerting leverage on the other end of the bar. The claw is used in the same manner as is the claw on a claw hammer.

The gooseneck bar is usually of lighter weight than the straight wrecking bar. Large spikes should be drawn with the straight bar instead of with the gooseneck, as the lighter gooseneck bar may be bent out of shape in trying to draw too heavy a spike.

CROWBAR

The crowbar is a heavy steel bar about 5 feet in length. One end is square in cross section, and has a wedge-shaped point. The rest of the bar is round and forms the handle (fig. 1-1-118C).

The crowbar is used as a lever for moving heavy objects short distances. It is also used for prying loose heavy boulders and for breaking up hard earth formations in digging. It is a sturdy tool, designed for heavy and hard usage.

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PART I

Section 2

COMMON POWER TOOLS

Power tools can be either electrically or pneumatically powered and are hand-operated. They are becoming so commonplace in the Navy that men in nearly all ratings will have a need to use some power tools at one time or another. This section of Basic Handtools will acquaint you with the more common types of power tools and equipment. It will also discuss safety precautions, general operating practices, and the necessary care and maintenance of your machines.

Safety cannot be overemphasized when discussing power tools. There are several general rules that will help guide you. Before using a power tool or piece of equipment, remove all loose tools or other objects from it, and make all necessary adjustments. Use only sharp-edged cutting tools, since dull tools are safety hazards.

While operating a power tool, give it full attention. Keep all safety guards in position, and use safety shields or goggles when necessary. Fasten all loose sleeves, neckties, and aprons. Do not disturb or in any way distract another man while he is operating a power tool.

After using a power tool, turn off the power, and clean the tool. Remove all waste and scraps from the deck around it.

PORTABLE ELECTRIC POWER TOOLS

Portable electric power tools are tools that can be easily moved from place to place with a minimum of effort. These are probably the most used of all power tools. Some of the most common portable electric power tools that you will use in the Navy are drills, hammers, sanders, grinders and saws.

When using any electric power tool make sure the source of power is of the correct voltage. If an electric tool is designed to operate on 115 volts never plug it into any other power source. The switch on the tool must be in the "OFF" position before it is plugged in. Make sure the cord and plug are in good condition and that the tool is properly grounded before using it. Check appendix III for detailed instructions on grounding.

DRILLS

The portable electric drill is probably the most frequently used portable power tool in the Navy. It is especially designed for drilling holes in wood or metal with speed and ease. But today the electric drill has practically developed into a motorized shop that you can hold in one hand. There are so many different types of electric drills with so many diversified accessories that you can add, that they can be used for many different jobs. Sanding, sawing, buffing, polishing, screw-driving, wire brushing, paint mixing—these are samples of possible uses.

Portable electric drills commonly used in the Navy have capacities for drilling holes in steel from 1/16 inch up to 1 inch in diameter. The sizes of portable electric drills are classified by the maximum size straight shank drill it will hold. That is, a 1/4 inch electric drill will hold a straight shank drill up to and including 1/4 inch.

Figure 1-2-1 shows two popular types of spade handle electric drills. The handles may also be in the shape of a pistol grip. Some of the heavy duty type drills have a provision for an additional projecting bar which can be mounted for applying added feed pressure. Most important when choosing a drill for a job are the revolutions per minute (rpms) and power it will deliver. You will find that the speed of the drill motor decreases with an increase in size, primarily because the larger units are designed to turn larger cutting tools or to drill in heavy

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Figure 1-2-1.—Portable electric drills.

materials, and both these factors rule for slower speed.

If you are going to do heavy work, such as drilling in masonry or steel, then you would probably need to use a drill with a capacity of 3/8 inch or 1/2 inch. If most of your drilling will be forming holes in wood or small holes in sheet metal, then a 1/4-inch drill will probably be adequate.

The chuck is the clamping device into which the drill is inserted. Nearly all electric drills are equipped with a three-jaw chuck. Some of the drill motors have a hand-type chuck that you tighten or loosen by hand but most of the drills used in the Navy have gear-type, three-jaw chucks which are tightened and loosened by means of a chuck key, shown in figure 1-2-2. Never leave the chuck key in the chuck at any time. Always remove the key IMMEDIATELY after you use it. Otherwise the key will fly loose when the drill motor is started and may cause serious injury to you or one of your shipmates. The chuck key is generally taped on the cord of the drill; but if it is not, make sure you put it in a safe place where it will not get lost.

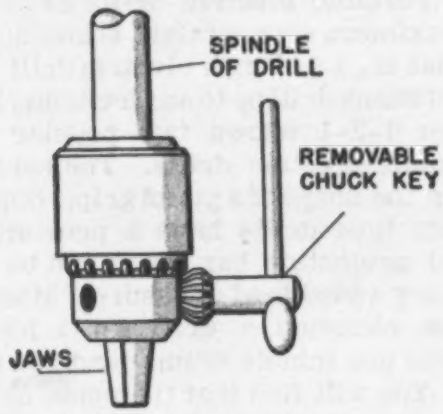

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Figure 1-2-2.—Three jaw chuck and chuck key.

All electric drills used in the Navy have some sort of a system for grounding. Make sure that the ground connection is properly made before turning on the drill motor. Proper grounding will prevent injury to you in the event that the internal wiring becomes shorted to the motor housing. Figure 1-2-3 shows one type of ground connection, however, a three prong plug and receptacle should be used when available.

If you must use a portable electric drill at some distance from the source of power make sure you use an extension cord of proper size to prevent excessive voltage drop. You can check with the electricians in the electric shop for this information.

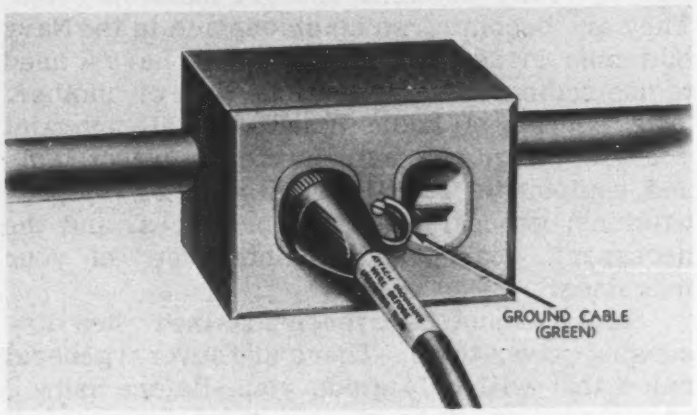

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Figure 1-2-3.—Proper grounding of portable electric tool.

All portable electric drills used in the Navy have controls similar to the ones shown on the 1/4-inch drill in figure 1-2-4. This drill has a double pole momentary contact trigger switch located in the pistol grip handle. The switch trigger is squeezed to start the electric drill and released to stop it.

The trigger latch is a button in the bottom of the drill handle. It is pushed in, while the switch trigger is held down, to lock the trigger switch in the "ON" position. The trigger latch is released by squeezing and then releasing the switch trigger.

SANDERS

Portable sanders are tools designed to hold and operate abrasives for sanding wood, plastics and metals. Power sanders have made the finishing of wood and metal surfaces easy and fast. Power sanders are widely used in the Navy to

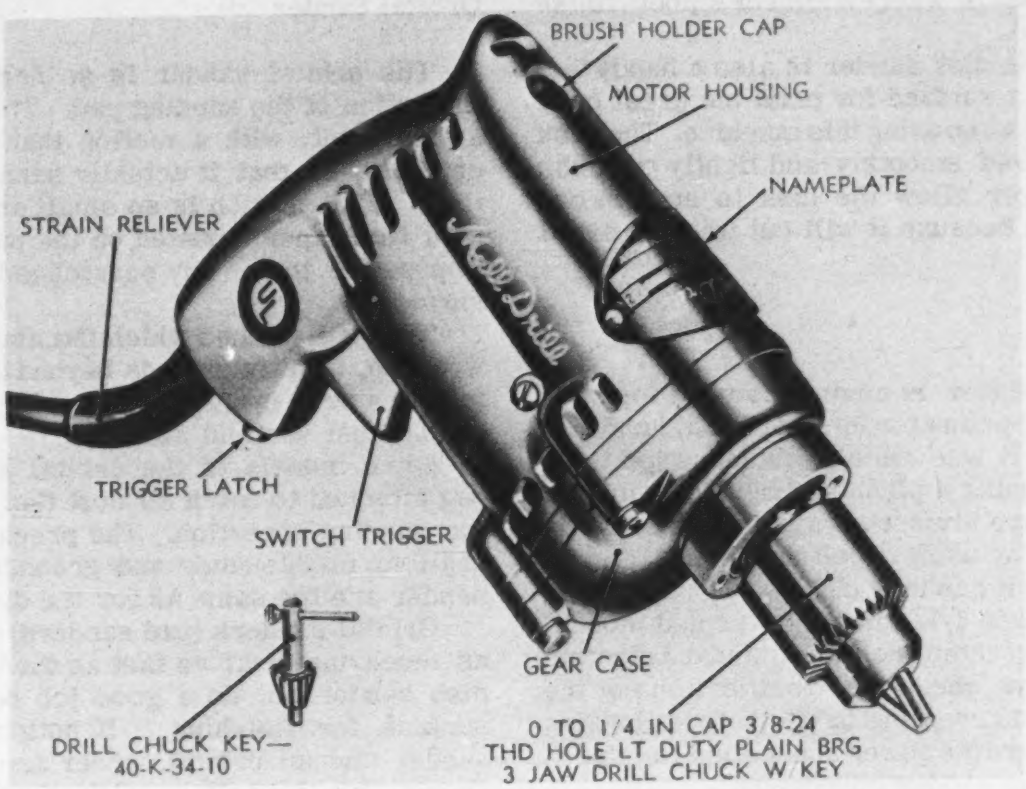

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Figure 1-2-4.—1/4-inch portable electric drill.

prepare surfaces for paint. The most common types found in the Navy are the DISK sander, BELT sander and RECIPROCATING ORBITAL sander.

The safety precautions to be observed while operating electric sanders are much the same as for the portable electric drill. That is, make sure the tool is properly grounded and in good operating condition prior to operation.

Safety goggles must be worn when operating any tool where dust and flying particles are produced. When sanding some materials, for example, reinforced plastics, respiratory precautions must be observed.

Disk Sander

The disk sander (fig. 1-2-5) is much like a portable drill with an abrasive disk attached. It has a straight type rear grip and a detachable side handle. The straight type rear handle has a slide button switch located on top. The disk sanders come in many different sizes but the most common ones found in the Navy will accommodate a 6- or 7-inch sanding pad.

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Figure 1-2-5.—Portable electric sander

Electric disk sanders are especially useful on work where a large amount of material is to

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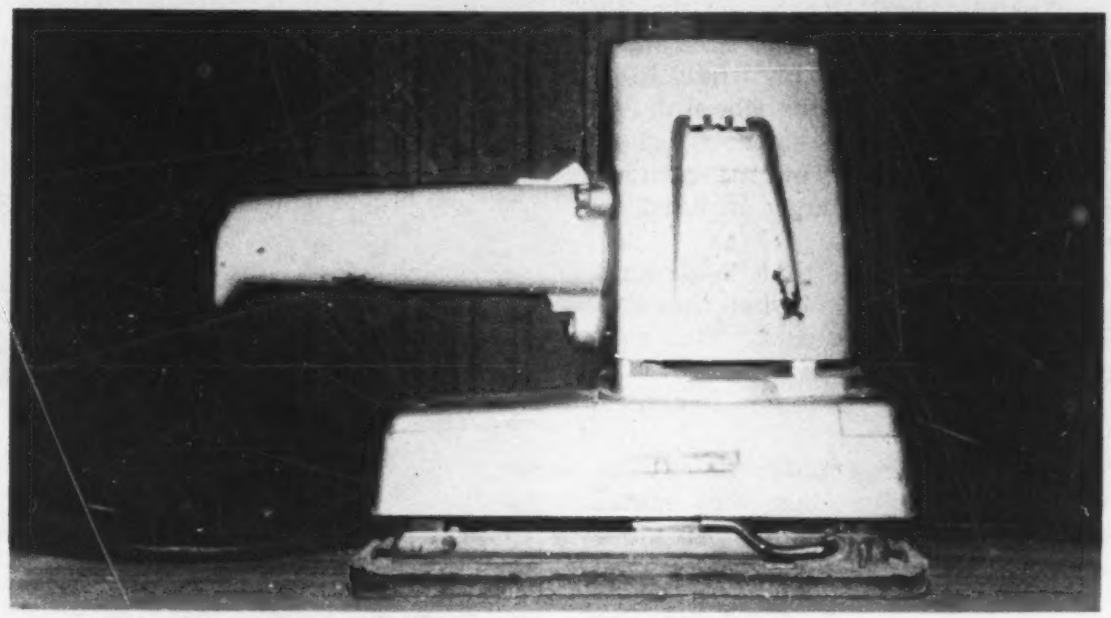

Figure 1-2-7.—Orbital sander.

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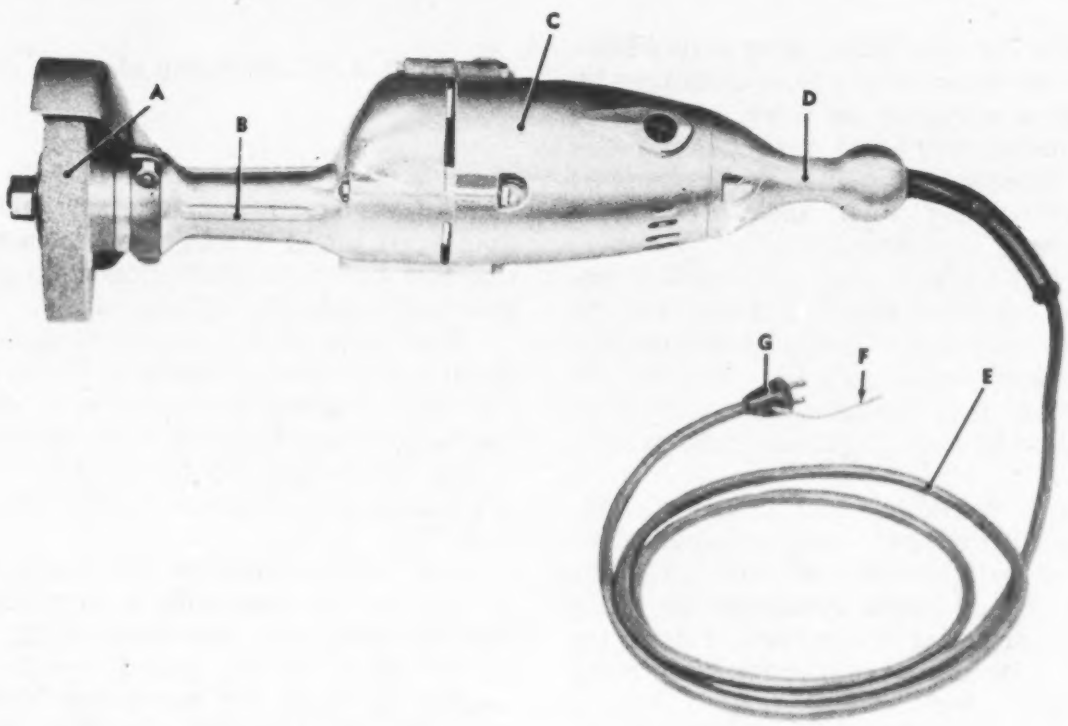

Figure 1-2-8.—Portable grinder.

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either AC or DC current which makes it adaptable to use on either shore stations or aboard ship.

The nameplate for the portable grinder is attached to the top of the motor housing. It contains the following data: manufacturer's name and address, model number, no-load rpm, serial number, AC cycles per second, amperage, number of AC phases, voltage, type of current required, and a warning concerning the need for grounding the grinder when in use.

There is a flexible shaft attachment that is available for most portable grinders. This shaft is attached by removing the grinding wheel then attaching the shaft to the grinding wheel drive spindle. The grinding wheel can then be attached to the end of the flexible shaft. This attachment is invaluable for grinding surfaces in hard to reach places.

It is particularly important that the ground conductor be connected to ground when there is presence of water in the work area. This will prevent possible injury to you in the event that the internal wiring of the grinder becomes shorted to the field case.

The wheel guard on the grinder should be positioned so that abrasive dust and metal particles will be deflected away from your face.

Before you turn the grinder on, make sure the abrasive grinding wheel is properly secured to the grinder spindle and not cracked or damaged.

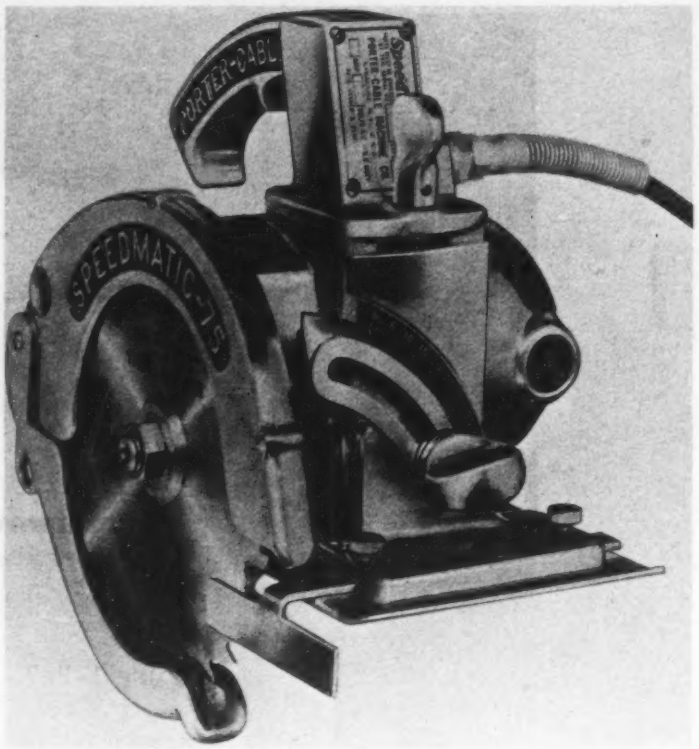

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Figure 1-2-9.—Portable electric circular saw.

PORTABLE CIRCULAR SAW

The portable circular saw, often called Skilsaw, is one of the most used power machines by people who have occasion to work with wood. They are becoming more and more popular because of the time and labor they save, the precision with which they work, and their ease of handling and maneuverability.

Because of the many types of portable circular saws in the Navy supply system, and the changes being made in the design of these saws, only general information will be given in this section. Information concerning a particular saw can be found by checking the manufacturer's manual.

The sizes of portable electric saws range from one-sixth horsepower with a 4-inch blade to one-and-one half horsepower with a 14-inch blade. They are so constructed that they may be used as a carpenter's handsaw, both at the job site or on a bench in the woodworking shop.

The portable electric saw (fig. 1-2-9) is started by pressing a trigger inserted in the handle and stopped by releasing it. The saw will run only when the trigger is held.

Most saws may be adjusted for crosscutting or for ripping. The rip saw guide is shown at (A, fig. 1-2-9). In this illustration it is turned up out of the way since the saw is being used as a crosscut saw. A guideline for crosscutting may be marked across the board as at B or the crosscut guide (F, fig. 1-2-9) may be used. When one straight side of this guide is held against the edge of the board, the other straight side will be at a right angle to this edge. The base plate of the saw can then slide along this guide and the saw will produce a square cut.

The depth of the cut is regulated by the adjusting thumbscrew shown at C. The adjustment for angle cutting is shown at D. This permits the base to be tilted in relation to the saw. A rapid adjustment may be made by the use of the graduated scale marked in degrees on the quadrant (E).

The bottom plate of the saw is wide enough to provide the saw with a firm support on the lumber being cut. The blade of the saw is protected by a spring guard which opens when lumber is being cut but snaps back into place when the cut is finished. Many different saw blades may be placed on the machine for special kinds of sawing. By changing blades almost any building material from slate and corrugated metal sheets to fiberglass can be cut.

Most portable electric saws are equipped with universal motors that will operate on either AC or DC current and require 115 volts. As with other portable electric tools, they must be grounded before they are turned on.

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The portable electric saw is one of the most dangerous power tools in existence when it is not properly used. Make sure the board you are sawing is properly secured so it will not slip or turn. After making a cut be sure the saw blade has come to a standstill before laying the saw down.

When using an electric saw remember that all the blade you can normally see is covered; the portion of the blade that projects under the board being cut is not covered. The exposed teeth under the work are dangerous and can cause serious injury if any part of your body should come into contact with them.

Make sure the blade of a portable circular saw is kept sharp at all times. The saw blade will function most efficiently when the rate of feed matches the blade's capacity to cut. You will not have to figure this out—you will be able to feel it. With a little practice you will know when the cut is smooth and you will know when you are forcing it. Let the blade do its own cutting. The tool will last longer and you will work easier because it is less fatiguing.

SABER SAW

The saber saw (fig. 1-2-10) is a power driven jigsaw that will let you cut smooth and decorative curves in wood and light metal. Most saber saws are light duty machines and are not designed for extremely fast cutting. About the same safety precautions must be observed when using the saber saw as for any other portable power tool.

There are several different blades designed to operate in the saber saw and they are easily interchangeable. For fast cutting of wood, a blade with coarse teeth may be used. A blade with fine teeth is designed for cutting metal.

The best way to learn how to handle this type of tool is to use it. Before trying to do a finished job with the saber saw, clamp down a piece of scrap plywood and draw some lines to follow, curved ones as well as straight ones. You will develop your own way of gripping the tool, and this will be affected somewhat by the particular tool you are using. On some tools, for example, you will find guiding easier if you apply some downward pressure on the tool as you move it forward. If you are not firm with your grip, the tool will tend to vibrate excessively and this will roughen the cut. Do not force the cutting faster than the design of the blade allows or you will break the blade. If this happens do not blame the tool.

ELECTRIC IMPACT WRENCH

The electric impact wrench (fig. 1-2-11) is a portable hand-type reversible wrench. The one shown has a 1/2-inch square impact driving anvil over which 1/2-inch square drive sockets can be fitted. Wrenches also can be obtained that have impact driving anvils ranging from 3/8

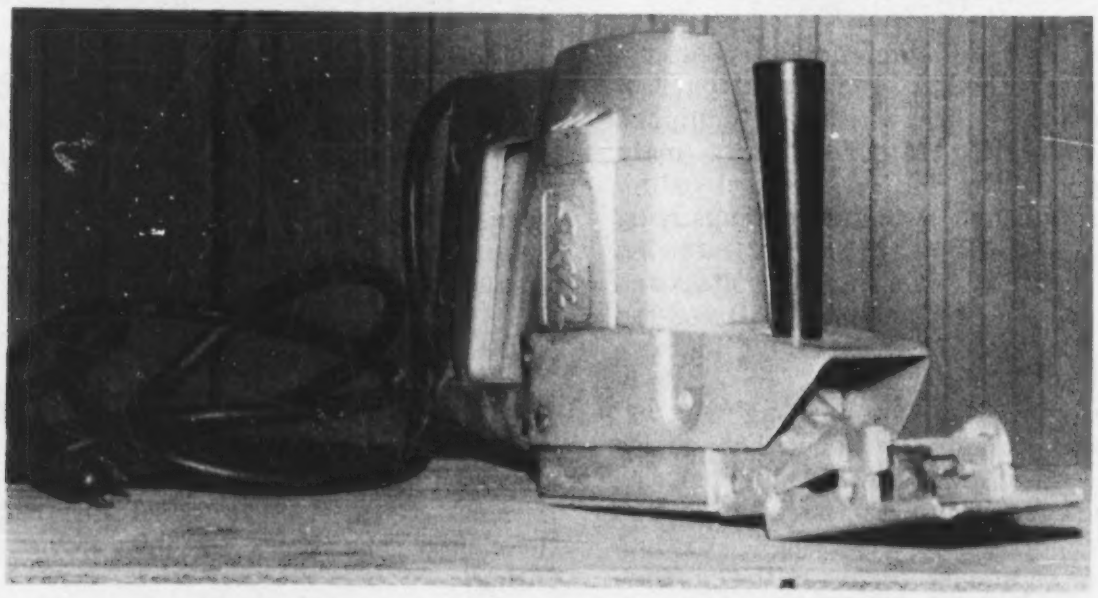

Figure 1-2-10.—Portable electric saber saw.

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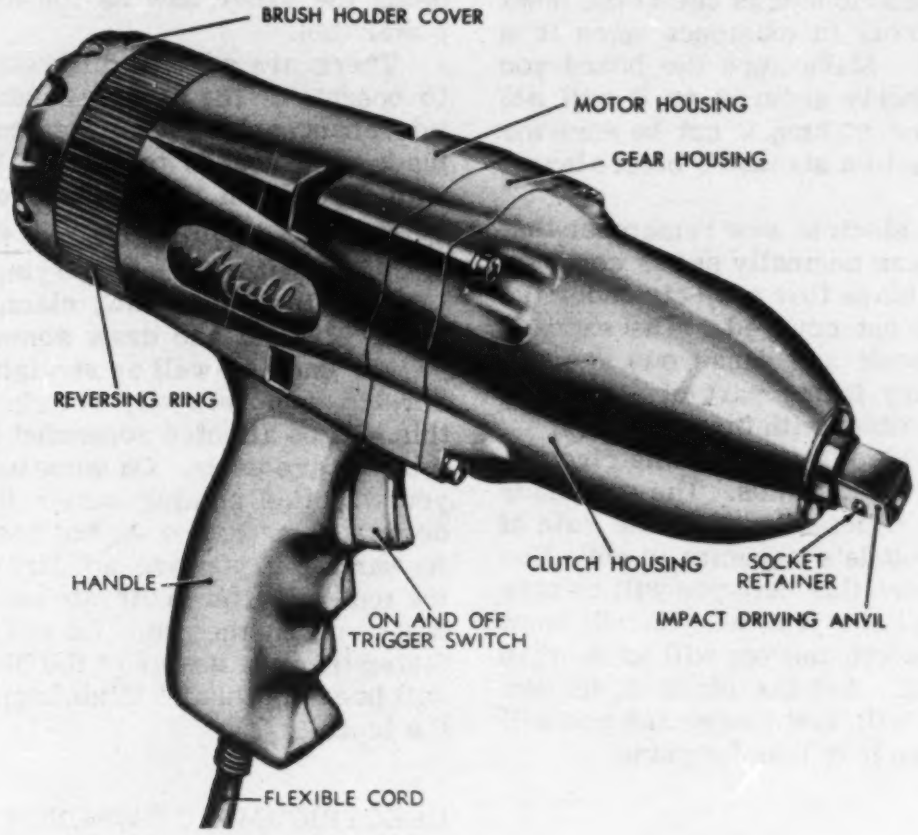

Figure 1-2-11.—Reversible electric impact wrench.

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inch to 1 inch. The driving anvils are not interchangeable, however, from one wrench to another. The reversing ring, located on the rear of the motor housing, is held in place by a brush holder cover.

A pistol-grip handle, which contains the on-and-off trigger switch, is an integral part of the motor housing. The wrench is equipped with a three-cable flexible cord having a male contact plug connector and one ground cable.

The electric wrench with its accompanying equipment (fig. 1-2-12) is primarily intended for applying and removing nuts, bolts, and screws. It may also be used to drill and tap metal, wood, plastics, etc., and drive and remove socket-head, Phillips-head, or slotted-head wood, machine, or self-tapping screws.

When you use an electric wrench that you are not completely familiar with, first check the voltage specifications and make sure the source of power is correct. After connecting the wrench to a suitable power source, depress the on-and-off trigger switch and allow the electric wrench to operate a few seconds, noting carefully the direction of rotation. Release the trigger switch to stop the wrench. Turn the reversing ring located at the rear of the tool; it should move easily in one direction (which is determined by the current direction of rotation). Depress the on-and-off trigger again to start the electric wrench. The direction of rotation should now be reversed. Continue to operate for a few seconds in each direction to be sure that the wrench and its reversible features are functioning correctly. When you are sure the wrench operates properly, place the suitable equipment on the impact driving anvil and go ahead with the job at hand.

SOLDERING GUNS

The soldering gun (fig. 1-2-13) is an induction-type soldering iron. This is not mechanical in the sense that it does not have any moving parts, but is becoming widely used throughout the Navy by men in nearly every rating.

The soldering gun operates on any standard electrical outlet and is rated in size by the number of watts it produces. The guns used

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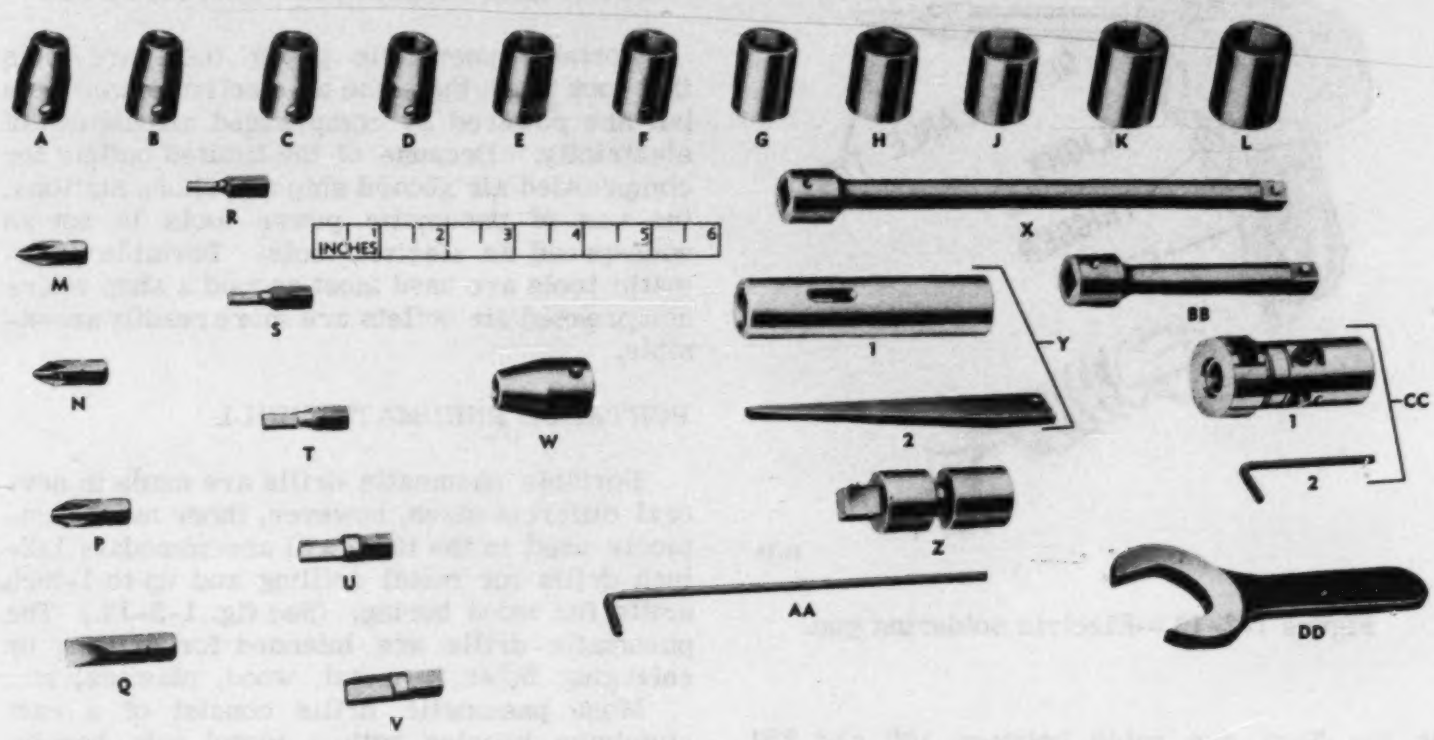

Heavy duty industrial type 6 point 1/2-inch, sq-drive (detachable socket wrenches

A 3/8-in. opng
B 7/16-in. opng
C 1/2-in. opng
D 9/16-in. opng
E 5/8-in. opng
F 11/16-in. opng
G 3/4-in. opng
H 13/16-in. opng
J 7/8-in. opng
K 15/16-in. opng
L 1-in. opng

Recessed screw (Phillips) screwdriver bits

M No. 2 point 5/16-in. sq-shk
N No. 3 point 5/16-in. sq-shk
P No. 4 point 5/16-in. sq-shk
Q 5/16-in. blade 5/16-in. sq-shk slotted head screw screwdriver bit

Hollow-head set or cap screw screwdriver bits

R 3/16-in. hex 5/16-in. sq-shk
S 7/32-in. hex 5/16-in. sq-shk
T 1/4-in. hex 5/16-in. sq-shk
U 5/16-in. hex 5/16-in. sq-shk
V 3/8-in. hex 5/16-in. sq-shk
W 5/16-in. sq-opng 1/2-in. sq-drive bit holder
X 10-in. long 1/2-in. sq-drive hv-duty industrial type extn socket wrench bar
Y 1/2-in. sq-drive No. 2 Morse taper socket w/drift
  1 1/2-in. sq-drive No. 2 Morse taper socket
  2 Drill (for No. 2 Morse taper socket)
Z 1/2-in. sq-drive hv-duty industrial type univ socket wrench joint
AA No. 10 and 12 cap screw 5/16-in set-screw 5/32-in. hex reg long arm series plug type hex (hollow-hd) set or cap screw wrench
BB 5-in. long 1/2-in. sq-drive hv-duty industrial type extn socket wrench bar
CC 3/16 to 3/8-in. cap 1/2-in. sq-drive collet type chuck (for rd shank tools) w/wrenches
  1 3/16 to 3/8-in. cap 1/2-in. sq-drive collet type chuck (for rd shank tools)
  2 No. 10 and 12 cap screw 5/16-in. set screw 5/32-in. hex reg short arm series plug type hex (hollow-hd) set or cap screw wrench
DD Size of opng 1-5/16-in. carb-s single open end angle 15° engrs wrench.

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Figure 1-2-12—Equipment used with the electric impact wrench.

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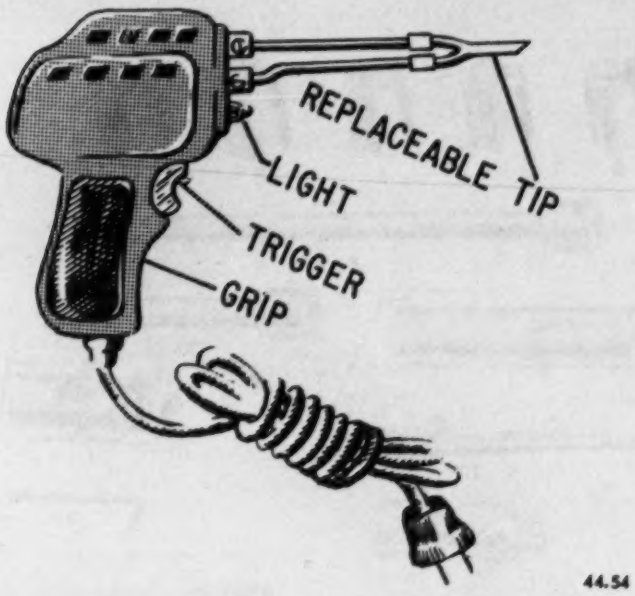

Figure 1-2-13.—Electric soldering gun.

in the Navy are rated between 100 and 250 watts. All good quality soldering guns operate in a temperature range of 500 to 600° F. The important difference in gun sizes is not the temperature, but the capacity of the gun to generate and maintain a satisfactory soldering temperature while giving up heat to the joint soldered.

Soldering guns contain a stepdown transformer in their bodies. The transformer secondary output current flows through the tip, causing it to heat. The tip heats only when the trigger is depressed, and then very rapidly. These guns afford easy access to cramped quarters, because of their small tip. Most soldering guns have a small light that is focused on the tip working area.

To prevent damage to the soldering gun, never subject it to heavy mechanical abuse. For instance, if the gun is dropped, or used as a hammer or a pry, the heating element may be broken or shorted or the tip may become bent. Always make certain that the cord does not come in contact with the tip where it can be burned.

The tip of a soldering gun should be removed occasionally to permit cleaning away the oxide scale which forms between the tip and metal housing. Removal of this oxide increases the heating efficiency of the gun. If for any reason the tip does become damaged, replaceable tips are available.

PORTABLE PNEUMATIC POWER TOOLS

Portable pneumatic power tools are tools that look much the same as electric power tools but are powered by compressed air instead of electricity. Because of the limited outlets for compressed air aboard ship and shore stations, the use of pneumatic power tools is not as widespread as electric tools. Portable pneumatic tools are used most around a shop where compressed air outlets are more readily accessible.

PORTABLE PNEUMATIC DRILL

Portable pneumatic drills are made in several different sizes, however, those most commonly used in the Navy will accommodate 1/2-inch drills for metal drilling and up to 1-inch drills for wood boring. (See fig. 1-2-14.) The pneumatic drills are intended for drilling or enlarging holes in metal, wood, plastics, etc.

Most pneumatic drills consist of a cast aluminum housing with a pistol-grip handle. There is a built-in air reservoir, a centrifugally actuated governor, a removable air strainer, a reduction gear case, and a rotor having a splined shaft mounted on ball bearings.

For proper operation, pneumatic drills require air pressure from 70 to 90 psi. Check the specifications on the drill you have and make sure you have the proper air pressure.

The air motor requires clean air and lubrication. Care should be taken to ensure clean couplings and air hose. In extremely dusty, humid, and cold regions, air compressor air filters and/or moisture traps are required to ensure that compressed air is dry and free from foreign matter. You should make sure that the air filters and moisture traps are cleaned periodically as suggested by the manufacturer's manual.

The only control required for operation of the pneumatic drill is the trigger (fig. 1-2-15). To start the drill the trigger is depressed. When the trigger is fully depressed it locks in the "ON" position. To release the locked trigger, the button end (left side of the pistol-grip handle) of the lock pin is depressed. The trigger will be released and will return to the "OFF" position.

Before operating a pneumatic drill inspect the air hose and check for any leaks and damage. Blow air through the air hose to free it of foreign material before connecting it to the

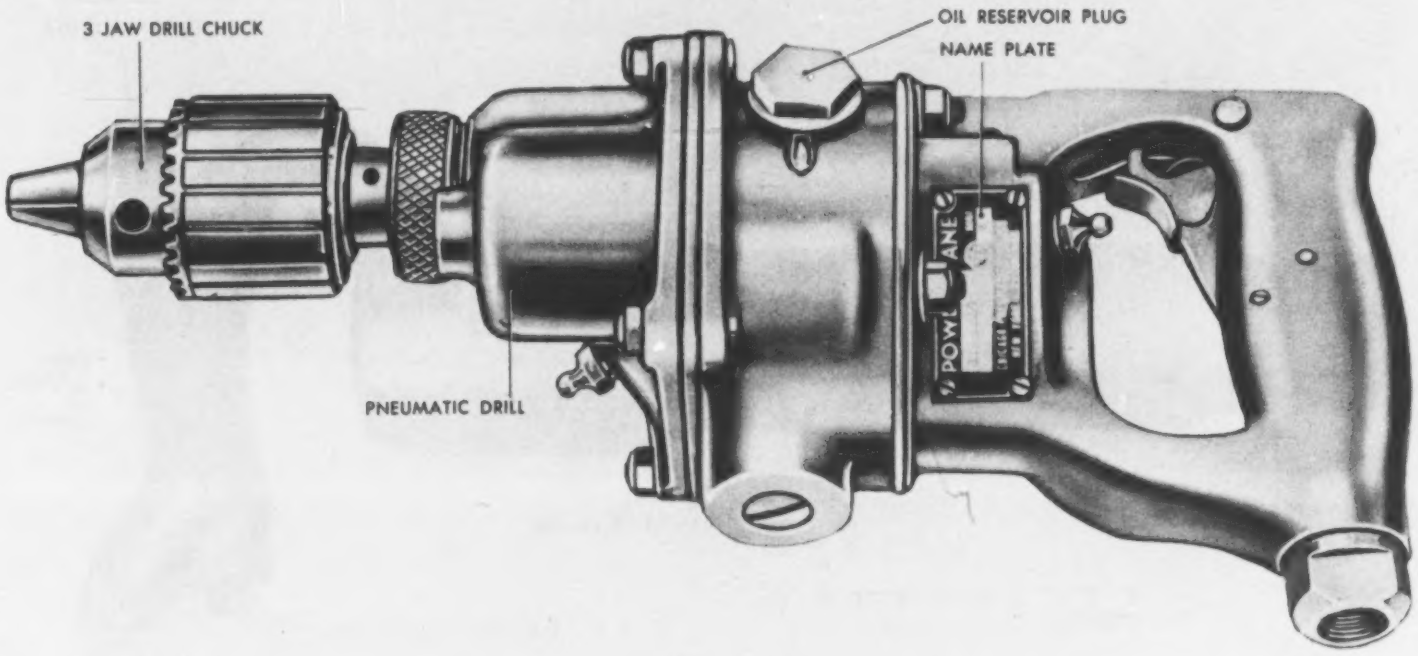

Figure 1-2-14.—Portable pneumatic drill.

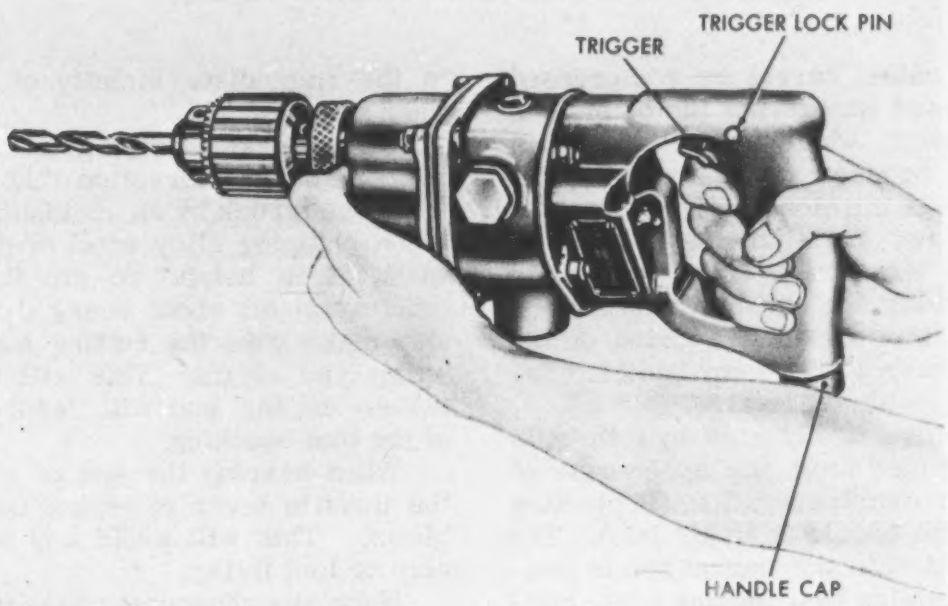

Figure 1-2-15.—Controls of a pneumatic drill. 1.25.2B

drill. Keep air hose clean and free from lubricants.

Make certain the tool being used in the chuck is properly secured and check the operation of the trigger to make sure it is working properly. Check the pneumatic drill for evidence of exterior damage. Tighten all loose fittings, nuts and bolts. Make sure the drill motor has been properly lubricated in accordance with the manufacturer's specifications.

PNEUMATIC CHIPPING HAMMER

The pneumatic chipping hammer (fig. 1-2-16) consists basically of a steel piston which is reciprocated (moved backward and forward

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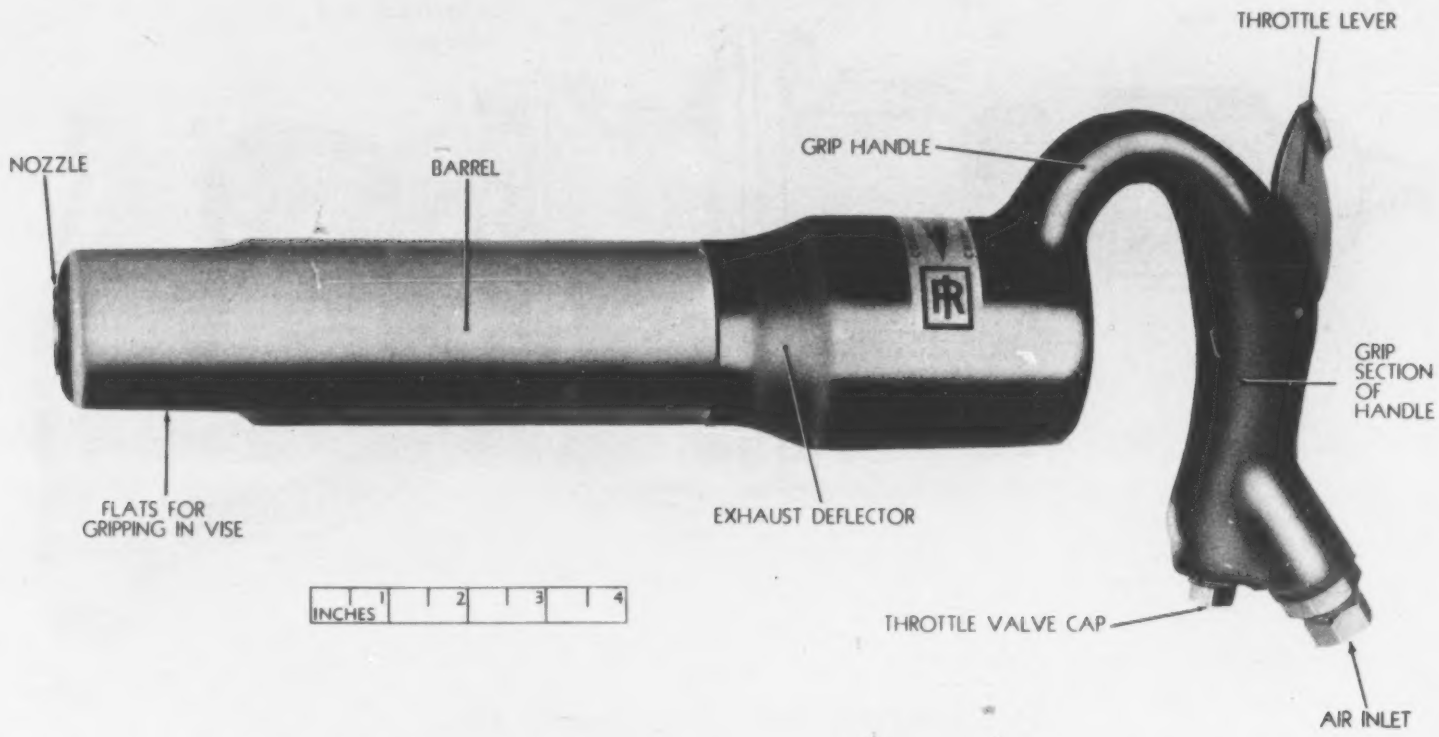

Figure 1-2-16.—Pneumatic chipping hammer.

alternately) in a steel barrel by compressed air. On its forward stroke the piston strikes the end of the chisel, which is a sliding fit in a hexagon nozzle pressed into the barrel. The rearward stroke is cushioned by compressed air to prevent any metal-to-metal contact. Reciprocation of the piston is automatically controlled by a valve box assembly located on the rear end of the barrel. Located on the rear end of the barrel is a grip handle, containing a poppet-type throttle valve.

The throttle valve is actuated by a throttle lever which protrudes from the upper rear of the grip handle for thumb operation. Projecting from the butt of the handle is an air inlet. The handle is threaded onto the barrel and is prevented from unscrewing by a locking ring. Surrounding and retaining the locking ring is an exhaust deflector. This deflector may be located in any of four positions around the barrel in order to throw the stream of exhaust air in the desired direction.

The pneumatic hammer may be used for beveling, calking or beading operations, and for drilling in brick, concrete, and other masonry. The chipping hammer is especially useful for preparing metal surfaces for painting.

Chipping hammers should not be operated without safety goggles and all other persons in the immediate vicinity of the work should wear goggles.

While working never point the chipping hammer in such a direction that other personnel might be struck by an accidentally ejected tool. When chipping alloy steel or doing other heavy work, it is helpful to dip the tool in engine lubricating oil about every 6 inches of the cut and make sure the cutting edge of the tool is sharp and clean. This will allow faster and easier cutting and will reduce the possibility of the tool breaking.

When nearing the end of a cut, ease off on the throttle lever to reduce the intensity of the blows. This will avoid any possibility of the chip or tool flying.

If for any reason you have to lay the chipping hammer down, always remove the tool from the nozzle. Should the chipping hammer be accidentally started when the tool is free, the blow of the piston will drive the tool out of the nozzle with great force and may damage equipment or injure personnel.

PORTABLE PNEUMATIC IMPACT WRENCH

The portable pneumatic impact wrench (fig. 1-2-17) is designed for installing or removing

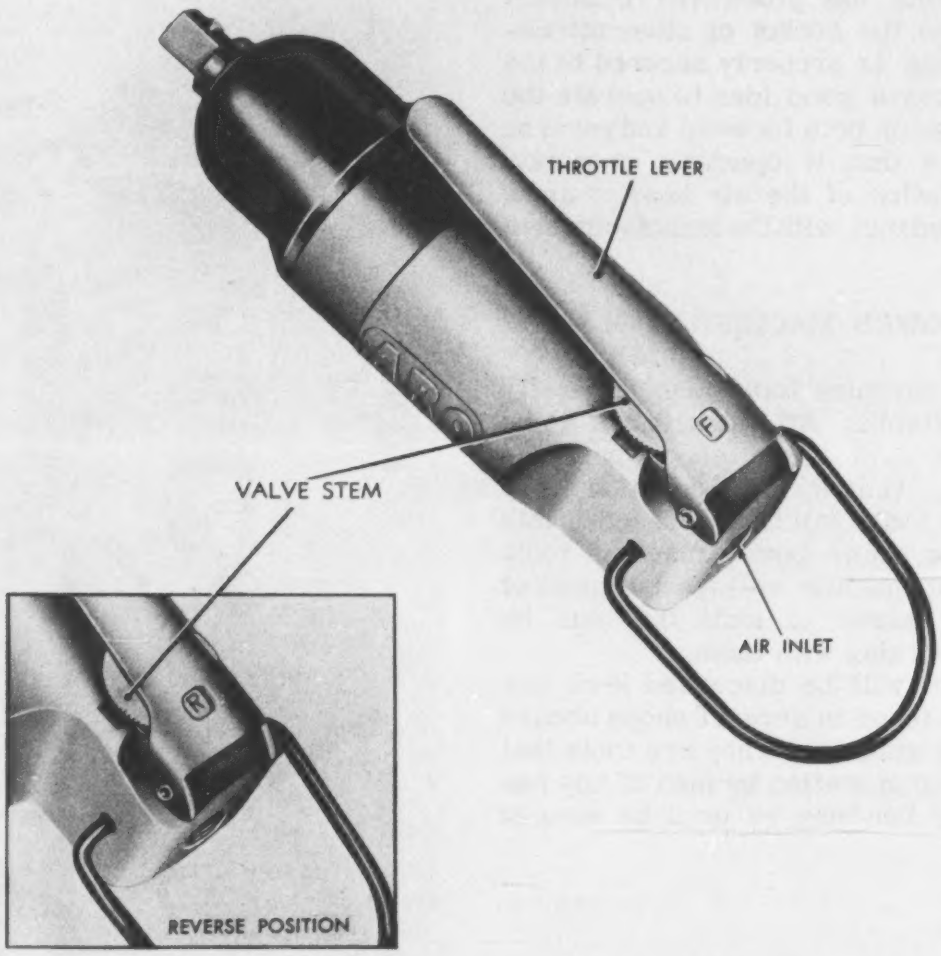

Figure 1-2-17.—Portable pneumatic impact wrench. 44.56

nuts and bolts. The wrench comes in different sizes and is classified by the size of the square anvil on the drive end. The anvil is equipped with a socket lock which provides positive locking of the socket wrenches or attachments. The wrench has a built-in oil reservoir and an adjustable air valve regulator which adjusts the torque output of the wrench. The torque regulator reduces the possibility of shearing or damaging threads when installing nuts and bolts to their required tension.

Nearly all pneumatic wrenches operate most efficiently on an air pressure range of 80 to 90 psi. A variation of plus or minus 5 pounds is serious. Lower pressure causes a decrease in the driving speeds while higher pressure causes the wrench to overspeed with subsequent abnormal wear of the motor impact mechanisms.

The throttle lever located at the rear of the pneumatic wrench provides the means for starting and stopping the wrench. Depressing the throttle lever starts the wrench in operation. Upon release, the lever raises to its original position stopping the wrench.

The valve stem is seated beneath the pivot end of the throttle lever. Most wrenches have a window cut in the throttle lever so that the markings on the upper surface of the valve stem will be visible. Two letters, "F" and "R," have been engraved on the head of the valve stem to indicate the forward (clockwise) and reverse (counterclockwise) rotation of the anvil. To change from forward to reverse rotation, or vice versa, turn the valve stem 180° until the desired marking is visible through the window in the throttle lever. When the valve stem is in proper position, the valve stem pin engages a recess on the under side of the valve stem, preventing accidental turning of the stem.

The air valve regulator is located at the bottom and towards the rear of the wrench. Using a screwdriver and altering the setting of the air regulator up to 90°, either to the right or left, reduces the torque from full power to zero power.

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Before operating the pneumatic impact wrench make sure the socket or other attachment you are using is properly secured to the anvil. It is always a good idea to operate the wrench free of load in both forward and reverse directions to see that it operates properly. Check the installation of the air hose to make sure it is in accordance with the manufacturer's recommendation.

COMMON POWER MACHINE TOOLS

Small power machine tools are, generally speaking, not portable. All work that is to be done must be brought to the shop where the machine is set up. Only the most common types of power machine tools will be discussed in this text. There are many power machine tools used by people of specific ratings but most of them require a degree of skill that can be learned only by working with them.

The tools that will be discussed here are tools that may be found in several shops aboard ship or on shore stations. They are tools that are not confined to operation by men of any one particular rating but may be used by men of several ratings.

DRILL PRESS

The drill press is an electrically operated power machine that was originally designed as a metal-working tool. As such its applications would be limited in the average shop. Available accessories, plus jigs and special techniques, now make it a versatile wood-working tool as well.

There are two basic types of drill presses used in the Navy. They are the bench-type drill press (fig. 1-2-18) and the upright-type drill press (fig. 1-2-19). These two types drill presses are basically the same, the difference being in the mounting. As the names suggest, the bench-type drill press is mounted on a work bench and the upright-type drill press is mounted on a pedestal on the floor.

Drill presses are manufactured in a number of sizes, however, only the small size drill press will be discussed in this text. The drill presses most commonly found in shops in the Navy have a capacity to drill holes in metal up to 1 inch in diameter. The driving motors range in size from 1/3 hp to 3 hp.

The motor is mounted to a bracket at the rear of the head assembly and designed to permit V-belt changing for desired spindle speed without removing the motor from its mounting bracket. Four spindle speeds are obtained by locating the V-belt on any one of the four steps of the spindle-driven and motor-drive pulleys.

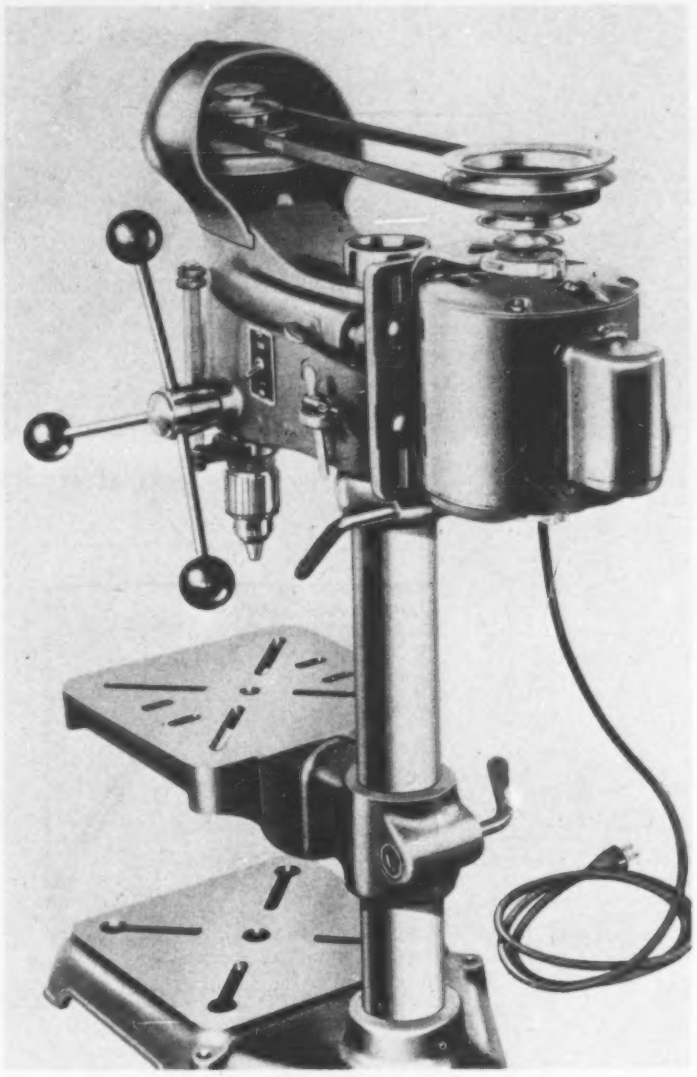

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Figure 1-2-18.—Bench-type drill press.

The controls of drill presses are all similar. The terms "right" and "left" are relative to the operator's position standing in front of and facing the drill press. Forward applies to movement toward the operator. Rearward applies to movement away from the operator.

The toggle switch (fig. 1-2-20) is located on the right side of the head assembly. The switch is single-pole single-throw. Start the

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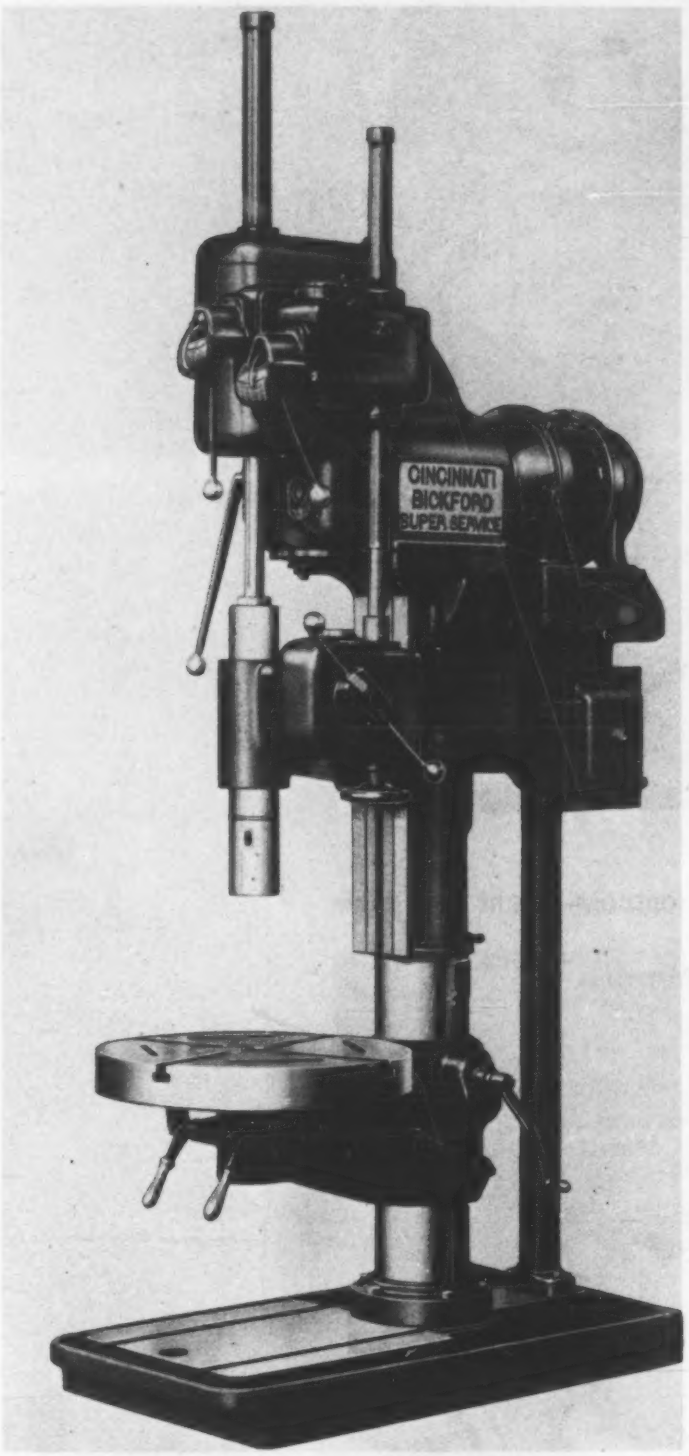

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Figure 1-2-19.—Upright-type drill press.

motor by placing the switch in the "ON" position.

The spindle and quill feed handles (fig. 1-2-20) radiate from the spindle and quill pinion feed hub which is located on the lower right-front side of the head assembly. Pulling forward and down on any one of the three spindle and quill feed handles, which point upward at the time, moves the spindle and quill assembly downward. Release the feed handle and the spindle and quill assembly will return to the retracted or upper position by spring action.

The quill lock handle (fig. 1-2-21) is located at the lower left-front side of the head assembly. Turn the quill lock handle clockwise to lock the quill at a desired operating position. Release the quill by turning the quill lock handle counterclockwise. However, in most cases, the quill lock handle will be in the released position.

The head lock handle (fig. 1-2-21) is located at the left-rear side of the head assembly. Turn the head lock handle clockwise to lock the head assembly at a desired vertical height on the bench column. Turn the head lock handle counterclockwise to release the head assembly. When operating the drill press, the head lock handle must be tight at all times.

The head collar support lock handle (fig. 1-2-20) is located at the right side of the head collar support and below the head assembly. The handle locks the head collar support, which secures the head vertically on the bench column, and prevents the head from dropping when the head lock handle is released. Turn the head collar support lock handle clockwise to lock the support to the bench column and counterclockwise to release the support. When operating the drill press, the head collar support lock handle must be tight at all times.

The tilting table lock handle (fig. 1-2-20) is located at the left-rear side of the tilting table bracket. Turn the tilting table lock handle counterclockwise to release the tilting table bracket so it can be moved up and down or around the bench column. Lock the tilting table assembly at desired height by turning the lock handle clockwise. When operating the drill press, the tilting table lock handle must be tight at all times.

The tilting table lockpin (S, fig. 1-2-22) is located below the tilting table assembly (T, fig. 1-2-22). The lockpin secures the table at a horizontal or 45° left or right from the horizontal position. To tilt the table left or right from its horizontal position, remove the lockpin and turn the table to align the lockpin holes. Insert the lockpin through the table and bracket holes after desired position is obtained.

The depth gage rod adjusting and locknuts (BB and CC (fig. 1-2-22) are located on the depth gage rod (Z, 1-2-22). The purpose of the

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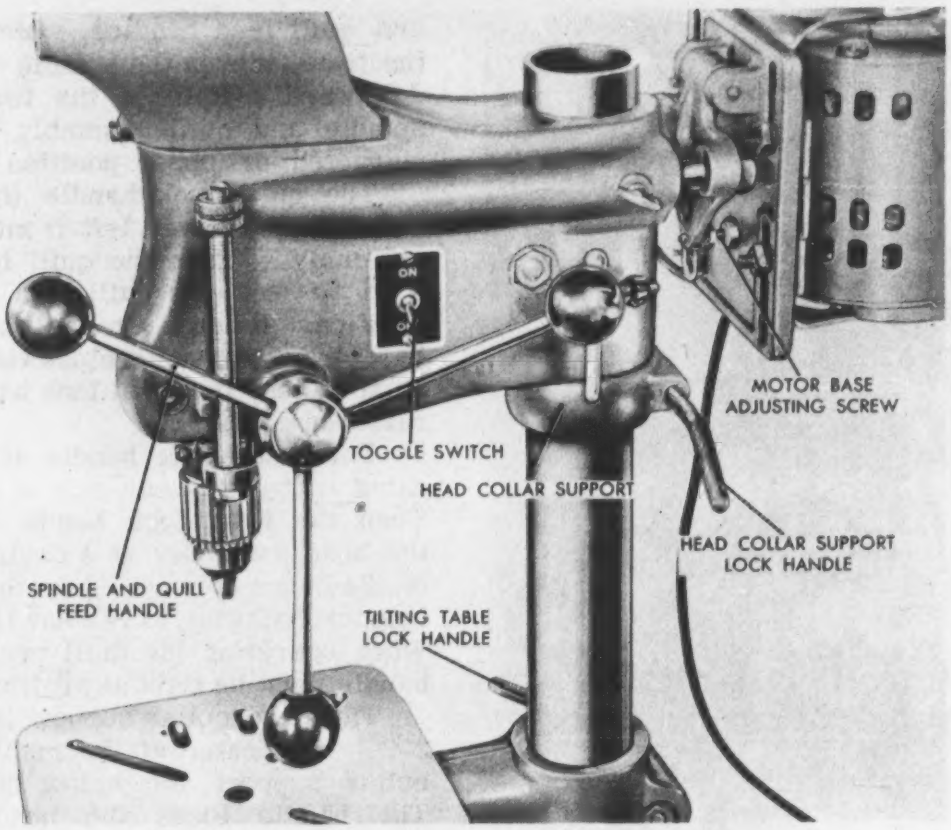

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Figure 1-2-20.—Drill-press controls—right side view.

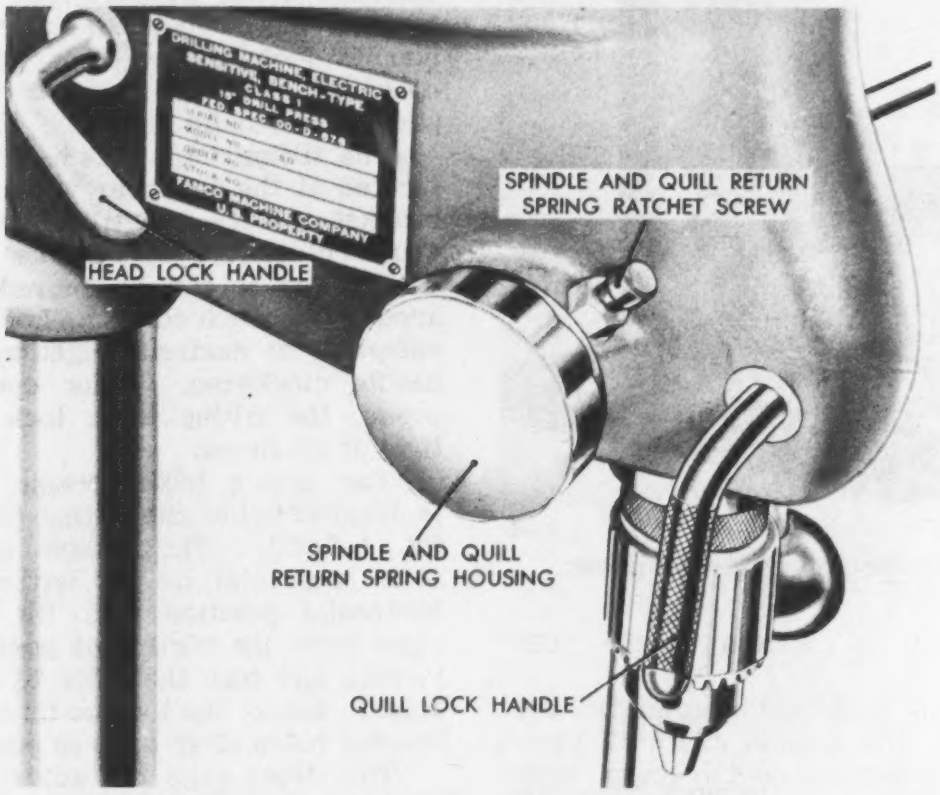

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Figure 1-2-21.—Drill press controls—left side view

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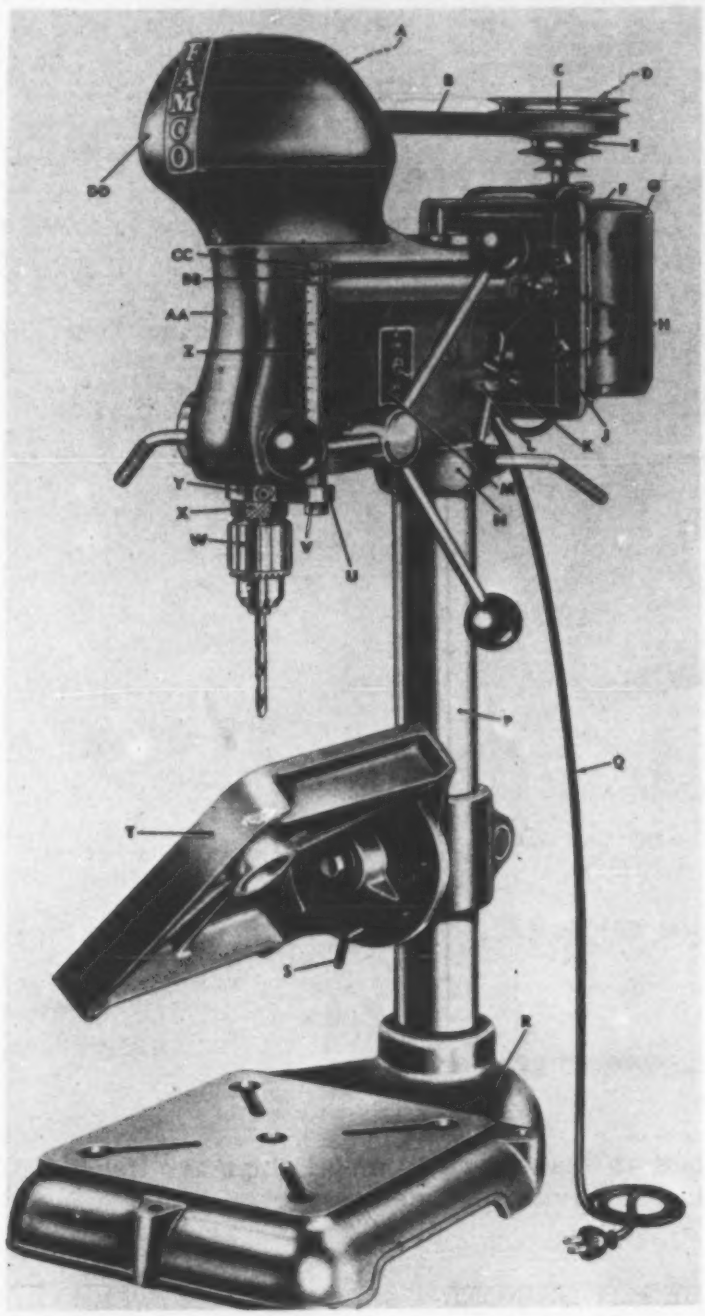

A Spindle driven pulley
B V-Belt
C Motor drive pulley
D 1/8 sq x 1 sq-end key
E No 10-24 x 5/8 hdls set screw
F Motor bracket stud thumbscrew
G Motor
H Motor base and bracket assy
J 1/4-20NC 2 x 1 sq-neck rd-hd carriage bolt and 1/4-20NC-2 sq nut
K Drill chuck key
L Drill chuck key bracket
M Toggle switch plate
N Head collar support
P Bench column
Q Cord
R Bench base
S Tilting table lockpin
T Tilting table assy
U Depth gage rod bracket
V Hex nut
W Drill chuck
X Chuck knockout collar
Y Spindle and quill assy
Z Depth gage rod
AA Head assy
BB Depth gage rod adjusting nut
CC Depth gage rod locknut
DD Spindle driven pulley guard

44.59B

Figure 1-2-22.—Drill press nomenclature.

adjusting and locknuts is to regulate depth drilling. Turn the adjusting and locknut clockwise to decrease the downward travel of the spindle. The locknut must be secured against the adjusting nut when operating the drill press.

When operating a drill press make sure the drill is properly secured in the chuck and that the work you are drilling is properly secured in position. Do not remove the work from the tilting table or mounting device until the drill press has stopped.

Operate the spindle and quill and feed handles with a slow, steady pressure. If too much pressure is applied, the V-belt may slip in the pulleys, the twist drill may break, or the starting switch in the motor may open and stop the drill press. If the motor should stop because of overheating, the contacts of the starting switch will remain open long enough for the motor to cool, then automatically close to resume normal operation. Always turn the toggle switch to "OFF" position while the motor is cooling.

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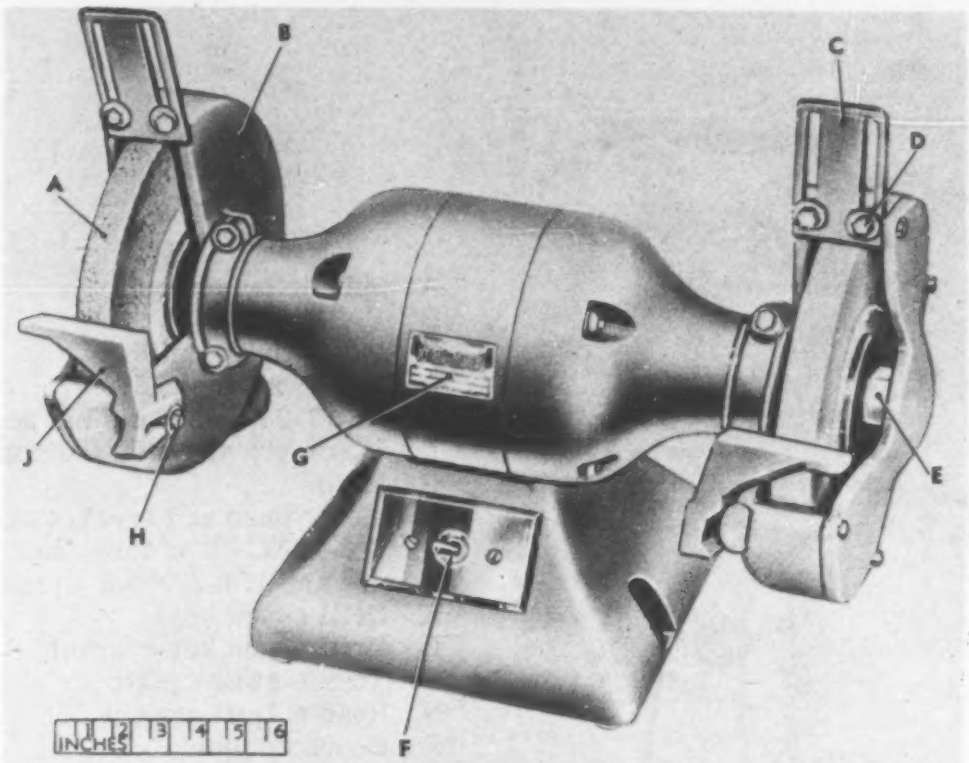

A—GRINDING ABRASIVE WHEEL
B—LEFT HAND WHEEL GUARD ASSY
C—EYE SHIELD
D—5/16-24NF-2 X 7/8 HEX-HD CAP SCREW
E—RIGHT HAND WHEEL CLAMP NUT
F—TOGGLE SWITCH
G—NAME PLATE
H—5/16-24NF-2 X 1 HEX-HD CAP SCREW
J—LEFT HAND TOOL REST

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Figure 1-2-23.—Electric powered grinder.

Check occasionally to make sure all locking handles are tight, and that the V-belt is not slipping.

Before operating any drill press, visually inspect the drill press to determine if all parts are in the proper place, secure, and in good operating condition. Check all assemblies, such as the motor, head, pulleys, and bench for loose mountings. Check adjustment of V-belt and adjust as necessary in accordance with the manufacturer's manual. Make sure the electric cord is securely connected and that the insulation is not damaged, chafed, or cracked.

While the drill press is operating, be alert for any sounds that may be signs of trouble, such as squeaks or unusual noise. Report any unusual or unsatisfactory performance to the petty officer in charge of the shop.

After operating a drill press, wipe off all dirt, oil, and metal particles. Inspect the V-belt to make sure no metal chips are imbedded in the driving surfaces.

BENCH GRINDER

The electric bench grinder (fig. 1-2-23) is designed for hand grinding operations, such as sharpening chisels or screw drivers, grinding drills, removing excess metal from work, and smoothing metal surfaces. It is usually fitted with both a medium grain and fine grain abrasive wheel; the medium wheel is satisfactory for rough grinding where a considerable quantity of metal has to be removed, or where a smooth finish is not important. For sharpening tools or grinding to close limits of size, the fine wheel should be used as it removes metal slower, gives the work a smooth finish and does not generate enough heat to anneal the cutting edges.

When a deep cut is to be taken on work or a considerable quantity of metal removed, it is often practical to grind with the medium wheel first and finish up with the fine wheel. Most bench grinders are so made that wire brushes, polishing wheels, or buffing wheels can be substituted for the removable grinding wheels.

To protect the operator during the grinding operation, an eye shield and wheel guard are provided for each grinding wheel. A tool rest is provided in front of each wheel to rest and guide the work during the grinding procedure. The rests are removable, if necessary, for grinding odd-shaped or large work.

When starting a grinder, turn it on and stand to one side until the machine comes up to full speed. There is always a possibility that a wheel may fly to pieces when coming up to full speed. Never force work against a cold wheel; apply work gradually to give the wheel an opportunity to warm. You thereby minimize the possibility of breakage.

Handle grinding wheels carefully. Before replacing a wheel always check it for cracks. Make sure that a fiber or rubber gasket is in place between each side of the wheel and its retaining washer. Tighten the spindle nut just enough to hold the wheel firmly; if the nut is tightened too much the clamping strain may damage the wheel. When selecting a replacement wheel, ascertain that the grinder will not exceed the manufacturer's recommended speed for the wheel.

When grinding, always keep the work moving across the face of the wheel; grinding against the same spot on the wheel will cause grooves to be worn into the face of the wheel. Keep all wheel guards tight and in place. Always keep the tool rest adjusted so that it just clears the wheel and is at or just below the center line of the wheel, to prevent accidental jamming of work between tool rest and wheel.

Wear goggles, even if eye shields are attached to the grinder. Keep your thumbs and fingers out of the wheel.

CUT-OFF SAW

The cut-off saw is a circular saw that is mounted on a radial arm. This arrangement is sometimes called a RADIAL ARM SAW. This machine is comparatively easy to move and is generally found on any woodworking job where there is quite a bit of sawing to do. The cut-off saw was primarily designed to cut boards off square but because of its versatility it can be used for ripping, cutting on an angle, dadoing, and many other wood cutting operations.

There are different types of cut-off saws available. The DeWalt (fig. 1-2-24) is commonly used in the Navy and is representative of what a cut-off saw is generally pictured to be. Its motor is incased in a yoke which is carriaged to travel to and fro in an overhead arm. The arm turns on a rigid column and can be adjusted up or down. Since the motor, too, can be turned and tilted, the whole relationship of components affords a flexibility of movement that will take care of nearly all woodworking operations.

Some of the latest models of cut-off saws have a built-in variable speed changer so you can select a suitable speed for the job being done. Some of them have an automatic brake so the saw blade stops in a few seconds when the switch is turned off.

Before you operate a radial arm saw, clean all dust and dirt from the blade, arbor face, and collar. The normal position of the blade is for the straight cut-off, where the blade is pulled from the rear to the front across the wood. The wood is placed on the table top with one side resting against the guide strip. For other operations where the cut is greater than that permitted in crosscutting, the wood is placed flat on the table against the guide and is moved by hand to the blade.

The arm may be pushed at any desired angle for angle cutting. For ripping and ploughing, the blade may be pulled out to the end of the arm and locked in position between the guide strip and the motor. In this operation, the wood is pushed along the guide strip from the side opposite the guard into the blade. For beveling, shaping, and routing, the motor may be tilted and locked at any angle.

The most important operating precautions for the cut-off saw are:

1. The electrical current being used should agree exactly with the specifications on the motor.
2. All clamp handles should be properly tightened before you operate the machine.
3. Before starting to cut, be sure that the wood rests against the guide strip in the cut-off position.
4. Before changing any setup, stop the saw.
5. For all operations, adjust the blade guard down to the material.

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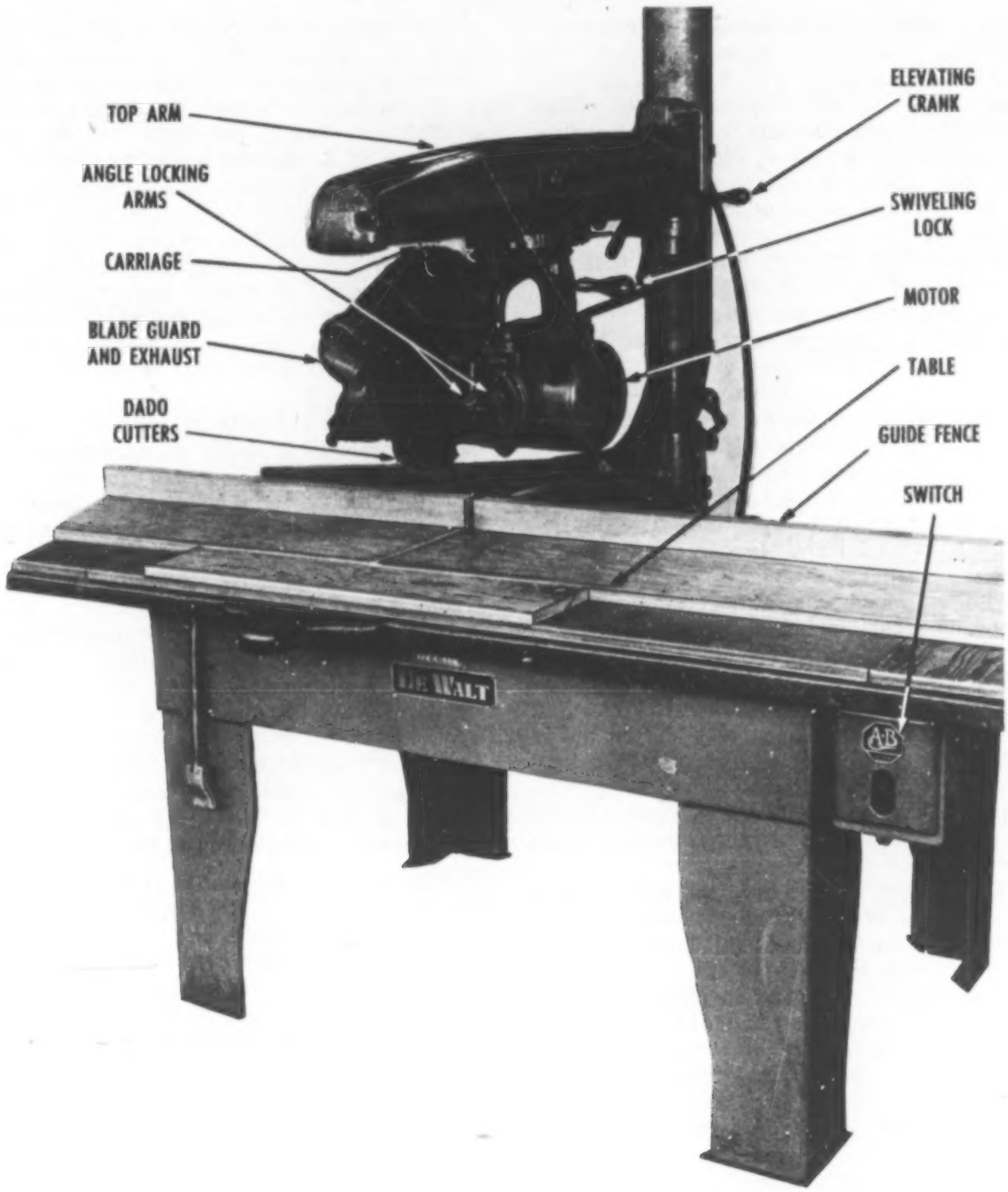

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Figure 1-2-24.—Cut-off saw (radial arm saw).

Periodical cleaning, greasing, and oiling of all moving parts are necessary. This should be done in accordance with the manufacturer's manual and is generally controlled by the petty officer in charge of the shop in which the saw is installed. Each morning before starting operations with the cut-off saw, you should clean the tracks inside the arm by wiping. Occasionally, clean these tracks with an approved cleaning fluid to remove grease and dirt.

PART I

Section 3

FASTENING DEVICES

Fastening devices are not tools; however, you will be using tools to install and remove them on any job that requires assembly or disassembly of equipment or structures.

Fastening devices, such as bolts, nuts, screws, and nails should be known by their names, sizes, and shapes. They are usually kept in storerooms or tool cribs and are issued when needed. When getting a fastener, you should know what you want so you can get the correct item in a minimum of time.

WOODWORKING FASTENERS

Before the development of nail-making, screw-making, and bolt-making machines, wooden members were held together by various types of interlocking joints that were reinforced with glue and wooden dowels. A dowel is a cylindrical hardwood pin which is driven into a hole bored to receive it, and which serves much the same purpose as a nail. Glued joints and joints fastened with wooden dowels are now confined mainly to furniture. Metal dowels are still used to fasten joints in window sashes, door members, and the like.

NAILS

Figure 1-3-1 shows the more common types of wire nails. The BRAD and the FINISH NAIL both have a DEEP COUNTERSINK head that is designed to be "set" below the surface of the work. The CASING nail has a FLAT COUNTERSINK head, which may be driven flush and left that way or which may also be "set." The other nails shown are all FLAT-HEADED nails. The COMMON nail is the one most widely used in general wood construction. Nails with LARGE FLAT heads are used for nailing roofing paper, plaster board, and similar thin or soft materials. DUPLEX or DOUBLE-HEADED NAILS are used for nailing temporary structures, such as scaffolds, which are eventually to be dismantled. A duplex nail has an upper and lower head. The nail is driven to the lower head; it can be easily drawn by setting the claw of a hammer under the upper head.

Besides nails with the usual type of shank (round) there are various more or less special-purpose nails with shanks of other types. Nails

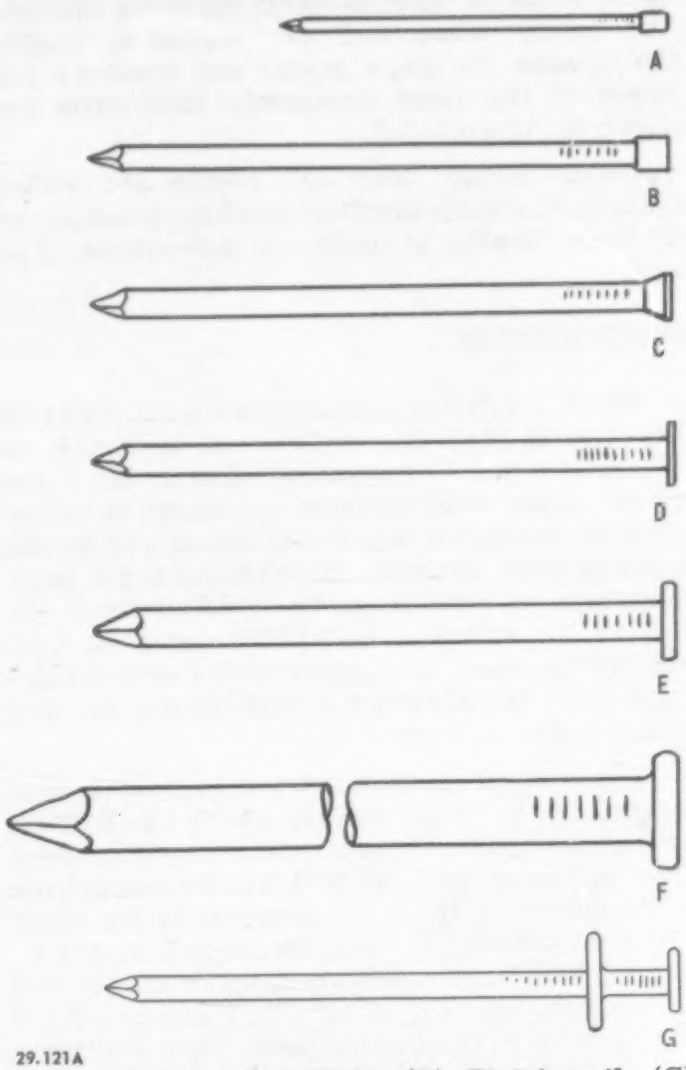

Figure 1-3-1.—(A) Brad, (B) Finish nail, (C) Casing nail, (D) Box nail, (E) Common nail, (F) Spike (larger than 60d), (G) Duplex head nail.

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with SQUARE, TRIANGULAR, LONGITUDINALLY GROOVED, and SPIRALLY GROOVED shanks have a much greater holding power than wire nails of the same size. CONCRETE and MASONRY nails, designed to be driven into concrete or masonry, are hardened-steel nails which sometimes have longitudinally grooved shanks. A spirally grooved nail is called a SCREW nail.

The lengths of the most commonly used nails are designated by the PENNY system. This system originated in England, where the abbreviation for the word "penny" is the letter d (from DENARIUS, the Latin name of a Roman coin). Thus, the expression "a 2d nail" means "a twopenny nail." The thickness of a nail increases with the penny size and the number of nails per pound decreases. A box or casing nail of the same common nail penny size is thinner, and it takes more of them to weigh the same amount. The penny sizes and corresponding length, thicknesses (in gage sizes) and numbers per pound of the most commonly used nails are shown in figure 1-3-2.

Nails larger than 60d (which are called spikes), and nails smaller than 2d are designated by their lengths in inches or in fractions of an inch.

WOOD SCREWS

Wood screws are designated as to types by the type of head (fig. 1-3-3) and material, as "flathead brass," "roundhead steel or blue" and so on. Most wood screws are made of either steel or brass, but there are copper and bronze wood screws as well. To distinguish the ordinary type of head from the Phillips head, the former is called a SLOTTED head. A LAG screw is a heavy iron screw with a square bolt-type head; lag screws are used mainly for fastening heavy timbers.

The size of an ordinary wood screw is designated by the length and the BODY DIAMETER (unthreaded part) of the screw. Body diameters are designated by GAGE NUMBERS running from 0 (for about a 1/16-in. diameter) to 24 (for about a 3/8-in. diameter). Lengths range from 1/4 in. to 5 in. The length and gage number are printed on the box, as "1 1/4-9." This means a No. 9 gage screw 1 1/4-inches long. Note that for a nail, a large gage number means a small nail; but for a screw, a large gage number means a large screw.

BOLTS

A BOLT is distinguished from a wood screw by the fact that it does not thread into the wood, but goes through and is held by a NUT threaded onto the end of the bolt. Figure 1-3-4 shows the four common types of bolts used in woodworking. STOVE bolts are rather small, ranging in length from 3/8 in. to 4 in., and in body diameter from 1/8 in. to 3/8 in. CARRIAGE AND MACHINE bolts run from 3/4 in. to 20 in. long, and from 3/16 in. to 3/4 in. in diameter. The carriage bolt has a square section below the head, which is imbedded in the wood to prevent turning as the nut is drawn up. The machine bolt has a square head which is held with a wrench to prevent it from turning.

METAL FASTENING DEVICES

Many mechanisms and devices are held together with metal fasteners. Only the more commonly used fasteners will be discussed here so you will know when, where and how they should be used. If a flat point setscrew was used where specifications called for a cone point an important installation might fail at a crucial moment.

Metal parts can be fastened together with various fastening devices, such as rivets, bolts, screws, etc. Rivets and riveting are explained in another section. Bolts and screws are made in many shapes and sizes. Only the more common ones will be discussed in this course. ROUGH and SEMIFINISHED bolts and screws are pressed, hammered, or punched out of cold or hot metal. FINISHED bolts and screws are cut out of a bar of steel by machine.

Bolts and screws are used to fasten together parts that may have to be taken apart later. A bolt is used where you can get at both sides of the work with wrenches. A screw is used where only one side can be reached with a wrench or screwdriver.

STANDARDIZED

At one time each manufacturer made as many threads per inch on bolts, screws, and nuts as suited his own particular needs. For example, one made 12 threads per inch on 1/2" bolts while another might put on 13 or 15 threads per inch. Thus the bolts of one manufacturer would not fit the nuts made by another. The NATIONAL SCREW THREAD COMMISSION was

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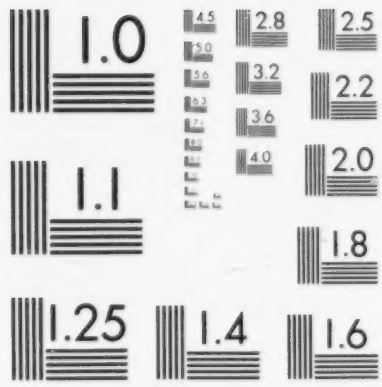

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

COMMON WIRE NAILS

Size	Length	Gage	Approx. No. to Lb.
2D	1 In.	No. 15	876
3D	1-1/4	14	568
4D	1-1/2	12-1/2	316
5D	1-3/4	12-1/2	271
6D	2	11-1/2	181
7D	2-1/4	11-1/2	161
8D	2-1/2	10-1/4	106
9D	2-3/4	10-1/4	96
10D	3 In.	No. 9	69
12D	3-1/4	9	63
16D	3-1/2	8	49
20D	4	6	31
30D	4-1/2	5	24
40D	5	4	18
50D	5-1/2	3	14
60D	6	2	11

FLOORING BRADS

Size	Length	Gage	Approx. No. to Lb.
6D	2 In.	No. 11	157
7D	2-1/4	11	139
8D	2-1/2	10	99
9D	2-3/4	10	90
10D	3	9	69
12D	3-1/4	8	54
16D	3-1/2	7	43
20D	4	6	31

FINISHING NAILS

Size	Length	Gage	Approx. No. to Lb.
2D	1 In.	No. 16-1/2	1351
3D	1-1/4	15-1/2	807
4D	1-1/2	15	584
5D	1-3/4	15	500
6D	2	13	309
7D	2-1/4	13	238
8D	2-1/2	12-1/2	189
9D	2-3/4	12-1/2	172
10D	3	11-1/2	121
12D	3-1/4	11-1/2	113
16D	3-1/2	11	90
20D	4	10	62

CASING NAILS

Size	Length	Gage	Approx. No. to Lb.
2D	1 In.	No. 15-1/2	1010
3D	1-1/4	14-1/2	635
4D	1-1/2	14	473
5D	1-3/4	14	406
6D	2	12-1/2	236
7D	2-1/4	12-1/2	210
8D	2-1/2	11-1/2	145
9D	2-3/4	11-1/2	132
10D	3	10-1/2	94
12D	3-1/4	10-1/2	87
16D	3-1/2	10	71
20D	4	9	52
30D	4-1/2	9	46

SMOOTH & BARBED BOX NAILS

Size	Length	Gage	Approx. No. to Lb.
2D	1 In.	No. 15-1/2	1010
3D	1-1/4	14-1/2	635
4D	1-1/2	14	473
5D	1-3/4	14	406
6D	2	12-1/2	236
7D	2-1/4	12-1/2	210
8D	2-1/2	11-1/2	145
9D	2-3/4	11-1/2	132
10D	3	10-1/2	94
12D	3-1/4	10-1/2	88
16D	3-1/2	10	71
20D	4	9	52
30D	4-1/2	9	46
40D	5	8	35

29.122

Figure 1-3-2.—Sizes of most commonly used nails.

established to study this problem and suggest a solution. This committee decided to standardize on a two-thread series, one called the NATIONAL COARSE THREAD SERIES (NC) and the other the NATIONAL FINE THREAD SERIES (NF). The SOCIETY OF AUTOMOTIVE ENGINEERS decided to standardize on some EXTRA FINE (EF) threads to be used in airplanes, automobiles, and other places where extra fine threads are needed. Figure 1-3-5 shows the number of threads per inch for NC, NF, and EF thread sizes up to 1 inch in diameter.

There have been four classes of fits established by the National Screw Thread Commission. They are: Class I, loose fit; Class II, free fit; Class III, medium fit; and Class IV, close fit.

The loose fit is for threaded parts that can be put together quickly and easily even when the threads are slightly bruised or dirty, and when

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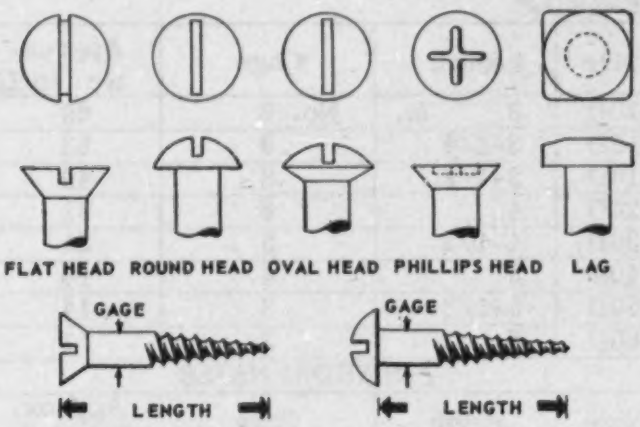

Figure 1-3-3.—Common types of wood screws.

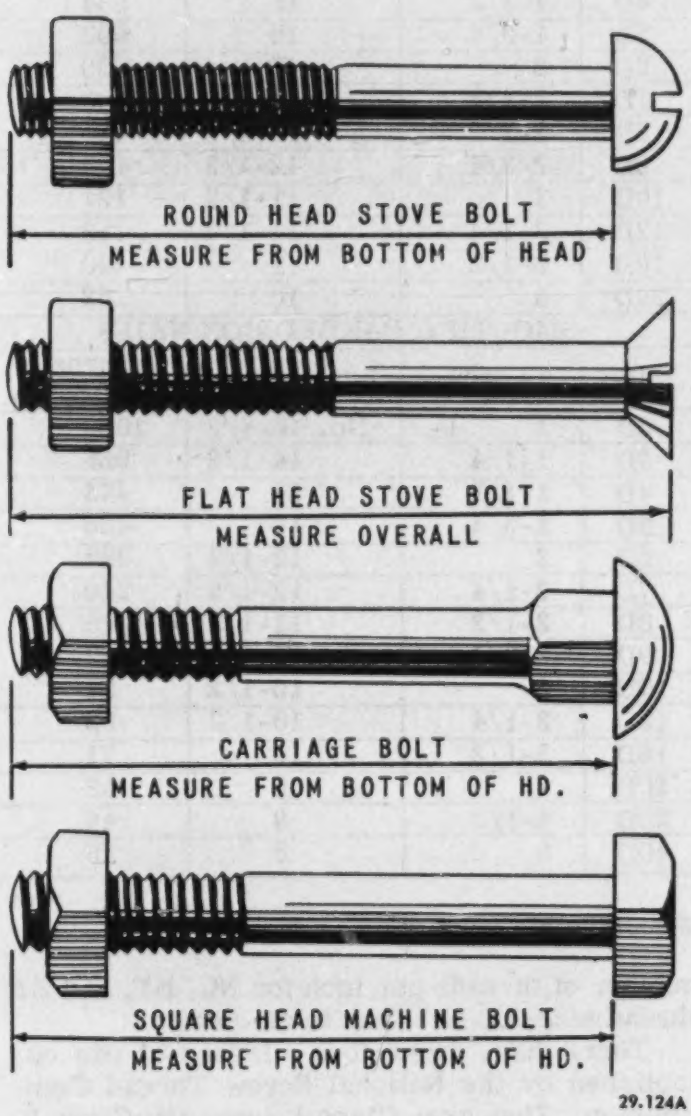

Figure 1-3-4.—Common types of bolts.

a considerable amount of shake or looseness is not objectionable. The free fit is for threaded parts that are to be put together nearly or

Diameter		Threads Per Inch			
No.	Inch	Decimal Equivalent	NC	NF	EF
0	----	.0600	---	80	---
1	----	.0730	64	72	---
2	----	.0860	56	64	---
3	----	.0990	48	56	---
4	----	.1120	40	48	---
5	----	.1250	40	44	---
6	----	.1380	32	40	---
8	----	.1640	32	36	---
10	----	.1900	24	32	40
12	----	.2160	24	28	---
---	1/4	.2500	20	28	36
---	5/16	.3125	18	24	32
---	3/8	.3750	16	24	32
---	7/16	.4375	14	20	28
---	1/2	.5000	13	20	28
---	9/16	.5625	12	18	24
---	5/8	.6250	11	18	24
---	3/4	.7500	10	16	20
---	7/8	.8750	9	14	20
---	1	1.0000	8	14	20

Figure 1-3-5.—Screw threads per inch.

entirely with the fingers and a little shake or looseness is not objectionable. This includes most of the screw thread work. The medium fit is for the higher grade of threaded parts. It is the same as free fit, except that the fit is somewhat closer. The close fit is for the finest threaded work where very little shake or looseness is desirable and where a screwdriver or wrench may be necessary to put the parts together. The manufacture of threaded parts belonging to this class requires the use of fine tools and gages. This fit should, therefore, be used only where requirements are exacting or where special conditions require screws having a fine, snug fit.

MACHINE SCREWS

The term "machine screw" is the general term used to designate small screws used in tapped holes for the assembly of metal parts. Machine screws may be used with nuts, but usually they are screwed into holes that have been tapped with matching threads.

Most machine screws are made of steel or brass. They may be plated to help prevent corrosion. Special machine screws made of aluminum or stainless steel are obtainable; the

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latter are very strong and highly resistant to the corrosive action of salt water.

A great variety of diameters, lengths, and head shapes are manufactured. The complete description of machine screws must include the LENGTH in inches, THREAD-DIAMETER, HEAD SHAPE, MATERIAL from which made, and FINISH. Here is a typical example—"1/2 inch, 8-32, round head, brass, chromium plated, machine screw." The "8-32" means that the screw gage is No. 8 and that it has 32 threads per inch.

Machine screws are driven with a screwdriver or wrench, depending on the type of screw head.

Holes for FILLISTER-HEAD machine screws must be counterbored so that the heads will be flush with or below the surface.

Most of the time you will use the common types of machine screws shown in figure 1-3-6, but you may have occasion to use some of the special types shown in figure 1-3-7. Note that some of these special machine screws require special tools for driving and removing. These tools are usually included in a kit that comes with the machine or installation on which the screws are used.

Nuts are seldom used on machine screws, but square or hex nuts may be. When a nut is needed, make sure the threads of the bolt and nut are the same gage and pitch.

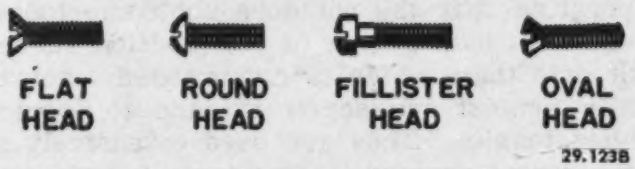

Figure 1-3-6.—Common types of machine screws.

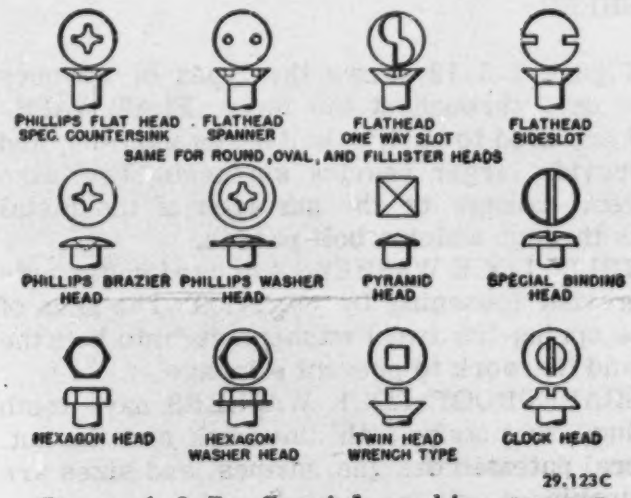

Figure 1-3-7.—Special machine screws.

CAPSCREWS

Capscrews (fig. 1-3-8) are usually used without nuts, to hold parts of machines and engines together. They are screwed into tapped holes, and are sometimes referred to as tap bolts. Threads may be either NF or NC. Capscrews perform the same functions as machine screws, but come in larger sizes for heavier work. Sizes range up to 1 inch in diameter and 6 inches in length.

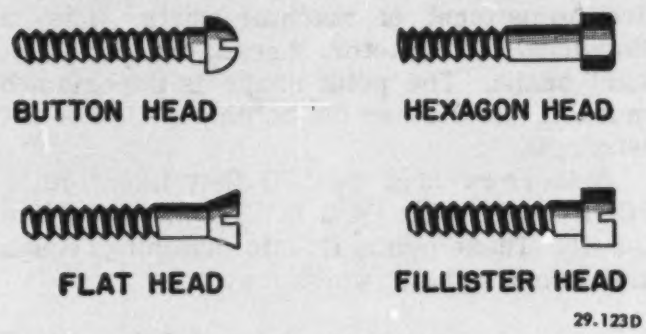

Figure 1-3-8.—Capscrews.

Capscrews may have square, hex, flat, button, or fillister heads. Fillister heads are best for use on moving parts because such heads are sunk into counterbored holes. Hex heads are usually used where the metal parts do not move.

The strongest capscrews are made of alloy steel, and can withstand great stresses, strains, and shearing forces. Capscrews made of stainless steel are often specified on machinery that is exposed to salt water.

Some capscrews have small holes through their heads. A wire, called a SAFETY WIRE, is run through the holes of several capscrews to keep them from coming loose.

STUDS

Studs might be called headless bolts. Both ends are threaded, one to screw into a tapped hole and the other to take a nut. (See fig. 1-3-9.)

Figure 1-3-9.—Studs.

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One important use of studs is to hold down the cylinder heads of boat and automobile engines. An important advantage of a stud over a bolt is that the nut can still be removed, even if the end screwed into the casting is "frozen". The end of the stud that screws into the casting usually has NC threads.

SETSCREWS

Setscrews are used to secure small pulleys, gears, and cams to shafts, and to provide positive adjustment of machine parts. They are classified by diameter, thread, head shape, and point shape. The point shape is important because it determines the holding qualities of the setscrew.

Setscrews hold best if they have either a CONE POINT or a DOG POINT, shown in figure 1-3-10. These points fit into matching recesses in the shaft against which they bear.

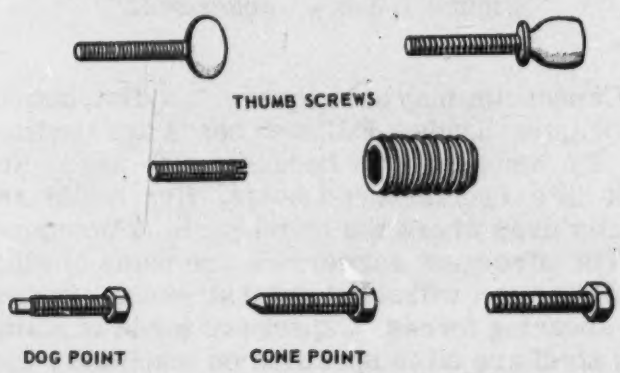

Figure 1-3-10.—Set screws and thumb screws.

HEADLESS SETSCREWS—slotted, Allen or Bristo types—are used with moving parts because they do not stick up above the surface. They are threaded all the way from point to head. COMMON SETSCREWS, used on fixed parts, have square heads. They have threads all the way from the point to the shoulder of the head.

THUMB SCREWS are used for setscrews, adjusting screws, and clamping screws. Because of their design they can be loosened or tightened without the use of tools.

NUTS

SQUARE and HEXAGONAL nuts are standard but they are supplemented by special nuts. (See fig. 1-3-11.) One of these is the JAM NUT, used above a standard hex nut to lock it in position. It

Figure 1-3-11.—Common kinds of nuts.

is about half as thick as the standard hex nut, and has a washer face.

CASTELLATED nuts are slotted so that a COTTER KEY may be pushed through the slots matching a hole in the bolt. This provides a positive method of preventing the nut from working loose. For example, you will see these nuts used with the bolts that hold the two halves of an engine connecting rod together. They are usually used with machine bolts.

WING NUTS are used where frequent adjustment is required. CAP, or ACORN nuts, are used where appearance is an important consideration. They are usually made of chromium plated brass. THUMB NUTS are knurled, so they can be turned by hand for easy assembly and disassembly.

ELASTIC STOP NUTS are used where it is imperative that the nut does not come loose. These nuts have a fiber or composition washer built into them which is compressed automatically against the screw threads to provide holding tension. They are used extensively on radio, sound equipment, fire control equipment and on aircraft.

WASHERS

Figure 1-3-12 shows the types of washers most used throughout the Navy. FLAT WASHERS are used to back up bolt heads and nuts, and to provide larger bearing surfaces. They also prevent damage to the surfaces of the metal parts through which a bolt passes.

SPLIT LOCK WASHERS are used under nuts to prevent loosening by vibration. The ends of these spring-hardened washers dig into both the nut and the work to prevent slippage.

SHAKEPROOF LOCK WASHERS have teeth or lugs that grip both the work and the nut. Several patented designs, shapes, and sizes are obtainable.

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Figure 1-3-12.—Washers.

KEYS AND PINS

COTTER KEYS (fig. 1-3-13) are used to secure castellated nuts on bolts and rods. They are also used as stops and holders on shafts and rods. SQUARE KEYS and WOODRUFF KEYS are used to prevent hand wheels, gears, cams and pulleys from turning on a shaft. These keys are strong enough to carry heavy loads if they are fitted and seated properly.

TAPER PINS are used to locate and position matching parts. They are also used to secure small pulleys and gears to shafts. They usually have a taper of 1/4-inch per foot. Holes for taper pins must be reamed with tapered reamers so they will fit properly.

DOWEL PINS are used to position and align the units or parts of an assembly. They are used in assemblies that must be frequently disassembled and assembled. One end of a dowel pin is chamfered, and it is usually .001 to .002 inch greater in diameter than the specified size. This allows the hole for the pin to be reamed to ensure a close fit.

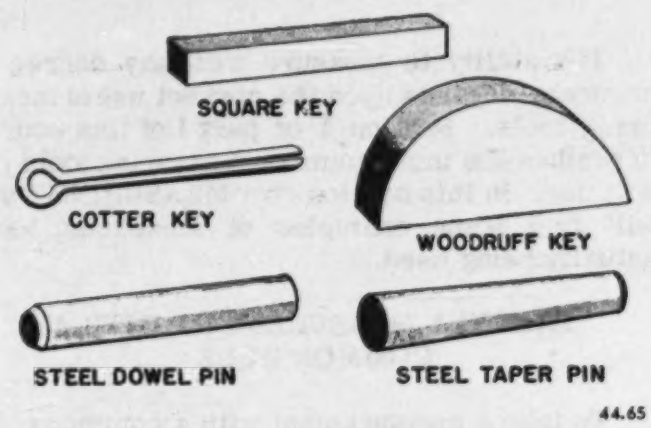

Figure 1-3-13.—Keys and pins.

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PART II

Section 1

MEASURING

The ability to measure with any degree of accuracy depends upon the correct use of measuring tools. Section 1 of part I of this course describes the most common measuring tools you will use. In this section on "MEASURING" you will find some examples of measuring tools actually being used.

TAKING A MEASUREMENT WITH A COMMON RULE

To take a measurement with a common rule, hold the rule with its edge on the surface of the object being measured. This will eliminate errors which might result due to the thickness of the rule. Except in tapes, this thickness causes the graduations to be a slight distance away from the surface of the object. Read the measurement at the graduation which coincides with the distance to be measured, and state it as being so many inches and fractions of an inch. (See fig. 2-1-1.) Always reduce fractions to their lowest terms, for example, 6/8 inch would be called 3/4 inch.

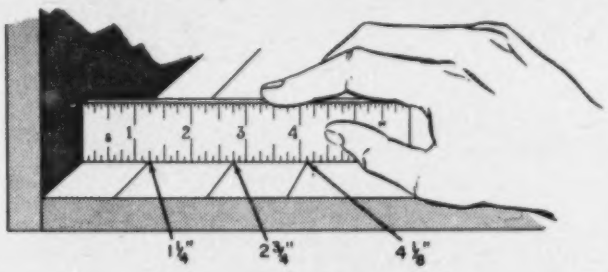

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Figure 2-1-1.—Measuring with and reading a common rule

MEASURING THE LENGTH OF A BOLT OR SCREW

The length of bolts and screws is best measured by holding them up against a rigid rule or tape. Hold both the bolt or screw to be measured and the rule up to your eye level so that your line of sight will not be in error in reading the measurement. As shown in figure 2-1-2, the bolts or screws with countersink type heads are measured from the top of the head to the opposite end, while those with other type heads are measured from the bottom of the head.

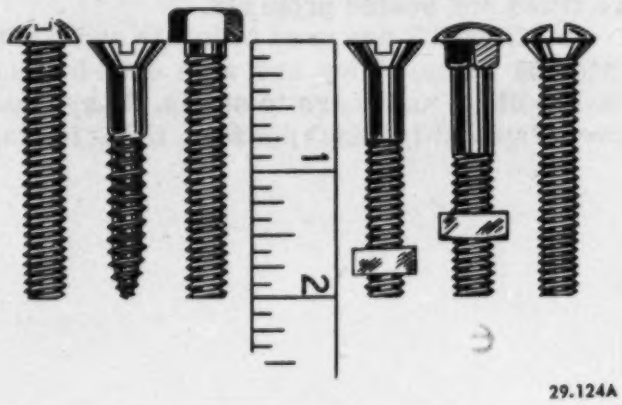

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Figure 2-1-2.—Measuring the length of a bolt or screw.

MEASURING THE OUTSIDE DIAMETER OF A PIPE

To measure the outside diameter of a pipe, it is best to use some kind of rigid rule. A folding wooden rule or a steel rule is satisfactory for this purpose. As shown in figure 2-1-3, line up the end of the rule with one side of the pipe, using your thumb as a stop. Then with the one end held in place with your thumb, swing the rule through an arc and take the maximum reading at the other side of the pipe. For most practical purposes, the measurement obtained by using this method is satisfactory. It is necessary that you know how to take this measurement as the outside diameter of pipe is the only dimension given on pipe specifications.

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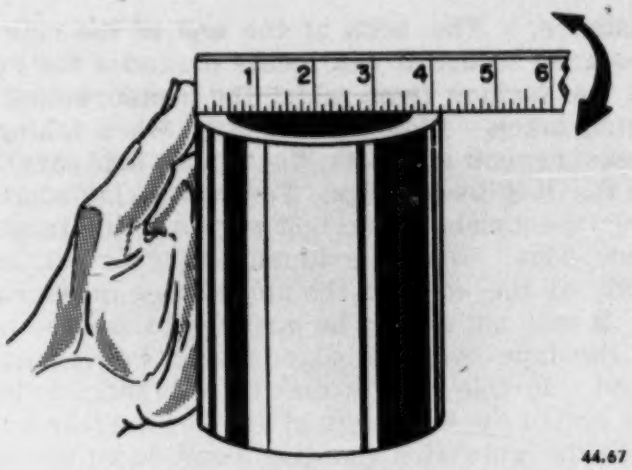

Figure 2-1-3.—Measuring the outside diameter of a pipe.

MEASURING INSIDE DIAMETER OF PIPE WITH A RULE

To measure the inside diameter of a pipe with a rule, as shown in figure 2-1-4, hold the rule so that one corner of the rule just rests on the inside of one side of the pipe. Then, with one end thus held in place, swing the rule through an arc and read the diameter across the maximum inside distance. This method is satisfactory for an approximate inside measurement.

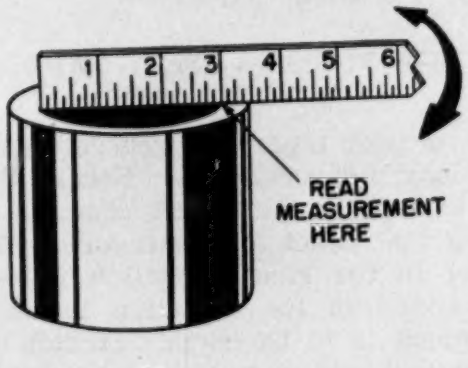

Figure 2-1-4.—Measuring the inside diameter of a pipe.

MEASURING THE CIRCUMFERENCE OF A PIPE

To measure the circumference of a pipe, a flexible type rule that will conform to the cylindrical shape of the pipe must be used. A web tape rule or a steel tape is adaptable for this job. When measuring pipe, make sure the tape has been wrapped squarely around the axis of the pipe (i.e., measurement should be taken in a plane perpendicular to the axis) to ensure that the reading will not be more than the actual circumference of the pipe. This is extremely important when measuring large diameter pipe.

Hold the rule or tape as shown in figure 2-1-5. Take the reading, using the 2-inch graduation, for example, as the reference point. In this case the correct reading is found by subtracting 2 inches from the actual reading. In this way the first 2 inches of the tape, serving as a handle, will enable you to hold the tape securely.

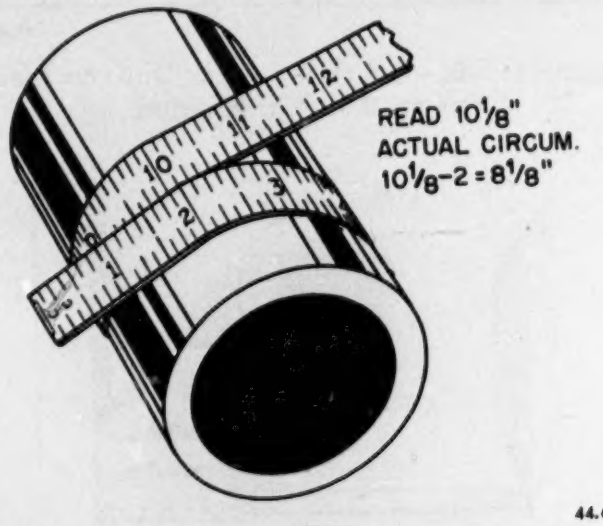

Figure 2-1-5.—Measuring the circumference of a pipe with a tape

MEASURING AN INSIDE DIMENSION USING A FOLDING RULE

To take an inside measurement, such as the inside of a box, a folding rule that incorporates a 6- or 7-inch sliding extension is one of the best measuring tools for this job. To take the inside measurement, first unfold the folding rule to the approximate dimension. Then extend the end of the rule and read the length that it extends, adding the length of the extension to the length on the main body of the rule. (See fig. 2-1-6.) In this illustration the length of the main body of the rule is 13 inches and the extension is pulled out 3 3/16 inches. In this case the total inside dimension being measured is 16 3/16 inches.

MEASURING AN INSIDE DIMENSION USING A TAPE RULE

In figure 2-1-7 notice in the circle that the hook at the end of the particular rule shown is

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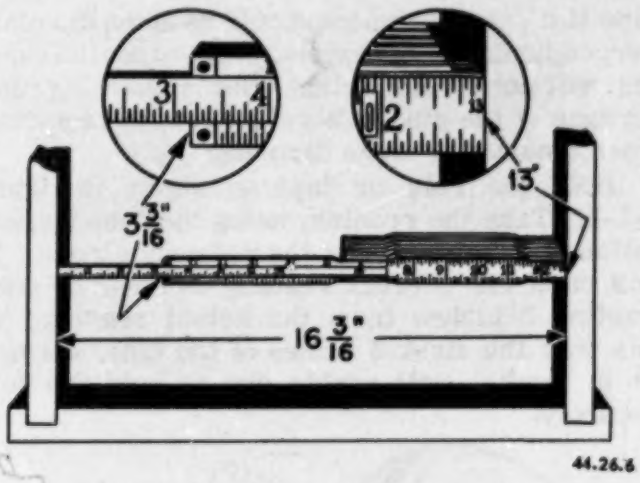

Figure 2-1-6.—Using a folding rule to measure an inside dimension.

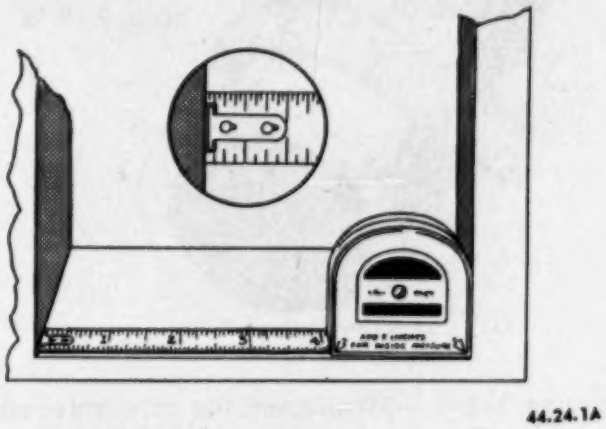

Figure 2-1-7.—Measuring an inside dimension with a tape rule.

attached so that it is free to move slightly. When an outside dimension is taken by hooking the end of the rule over an edge, the hook will locate the end of the rule even with the surface from which the measurement is being taken. By being free to move, the hook will retract away from the end of the rule when an inside dimension is taken. To measure an inside dimension using a tape rule, extend the rule between the surfaces as shown, take a reading at the point on the scale where the rule enters the case, and add 2 inches. The 2 inches are the width of the case. The total is the inside dimension being taken.

MEASURING AN OUTSIDE DIMENSION USING A TAPE RULE

To measure an outside dimension using a tape rule, hook the rule over the edge of the stock. Pull the tape out until it projects far enough from the case to permit measuring the required distance. The hook at the end of the rule is designed so that it will locate the end of the rule at the surface from which the measurement is being taken. (See fig. 2-1-8.) When taking a measurement of length, the tape is held parallel to the lengthwise edge. For measuring widths, the tape should be at right angles to the lengthwise edge. Read the dimension of the rule exactly at the edge of the piece being measured.

It may not always be possible to hook the end of the tape over the edge of stock being measured. In this case it may be necessary to butt the end of the tape against another surface or to hold the rule at a starting point from which a measurement is to be taken.

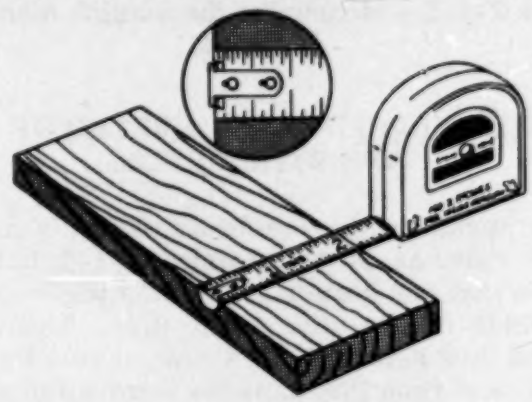

Figure 2-1-8.—Measuring an outside dimension using a tape rule.

HOW TO USE A STEEL TAPE OR WEB TAPE

Steel or web tapes are generally used for making long measurements. Secure the hook end of the tape to the outside edge, or corner, or end of the object to be measured. Hold the tape reel in the hand and allow it to unwind while walking in the direction in which the measurement is to be taken. Stretch the tape with sufficient tension to overcome sagging. At the same time make sure the tape is parallel to an edge or the surface being measured. Read the graduation on the tape by noting which line on the tape coincides with the measurement being taken.

MEASURING THE THICKNESS OF STOCK THROUGH A HOLE

To measure the thickness of stock through a hole with a hook rule, insert the rule through the hole, hold the hook against one face of the stock, and read the thickness at the other face. (See fig. 2-1-9.)

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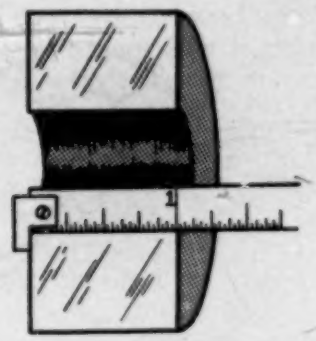

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Figure 2-1-9.—Measuring the thickness of stock through a hole.

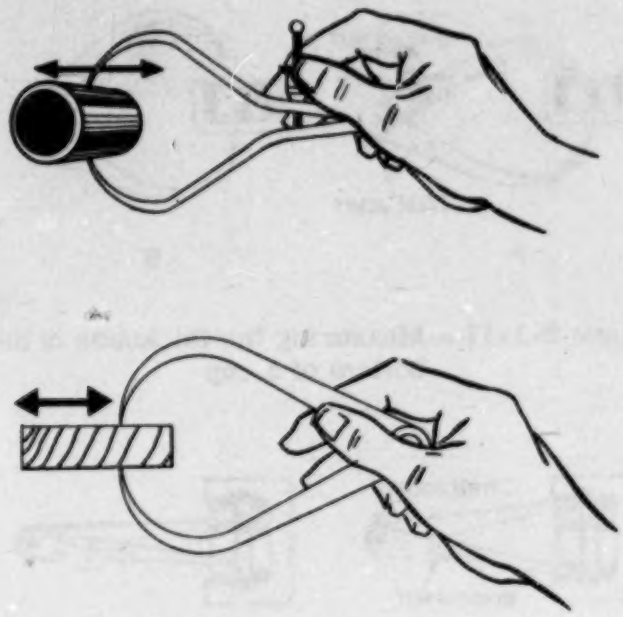

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Figure 2-1-10.—Using an outside caliper.

USING CALIPERS

A caliper is usually used in one of two ways. Either the caliper is set to the dimension of the work and the dimension transferred to a scale or the caliper is set on a scale and the work machined until it checks with the dimension set up on the caliper. To adjust a caliper to a scale dimension, one leg of the caliper should be held firmly against one end of the scale and the other leg adjusted to the desired dimension. To adjust a caliper to the work, open the legs wider than the work and then bring them down to the work. A sense of "feel" must be acquired to use calipers properly. This comes through practice and care in using the tool to eliminate the possibility of error. Always position the caliper properly on the axis of the work.

NOTE: Never set a caliper on work that is revolving in a machine.

The contact of one leg of a caliper on a revolving surface will tend to draw the other leg over the work because of the friction between the moving surfaces. Only a slight force is necessary to spring the legs of a caliper so that other measurements made with it are never accurate.

MEASURING THE DIAMETER OF ROUND STOCK OR THE THICKNESS OF FLAT STOCK USING AN OUTSIDE CALIPER

To measure the diameter of round stock, or the thickness of flat stock, adjust the outside caliper so that you feel a slight drag as you pass it over the stock. (See fig. 2-1-10.) After the proper "feel" has been attained, measure the setting of the caliper with a rule. Sight over the leg of the caliper after making sure the caliper is set squarely with the face of the rule.

MEASURING HARD TO REACH DIMENSIONS WITH A CALIPER

To caliper an almost inaccessible outside dimension such as the thickness of the bottom of a cup, use an outside transfer firm-joint caliper as shown in figure 2-1-11. When the proper "feel" is obtained, tighten the lock joint. Note that with the joint locked the auxiliary arm will remain in place. Loosen the binding nut and open the caliper enough to remove it from the cup. Close the caliper again and tighten the binding nut to seat in the slot at the end of the auxiliary arm. The caliper is now at the original setting, representing the thickness of the bottom of the cup. The caliper setting can now be measured with a rule.

To measure a hard to reach inside dimension, such as the internal groove shown in figure 2-1-12, a lock-joint inside caliper should be used. The procedure followed for measuring a hard to reach outside dimension is used.

MEASURING THE DISTANCE BETWEEN TWO SURFACES WITH AN INSIDE CALIPER

To measure the distance between two surfaces with an inside caliper, first set the caliper

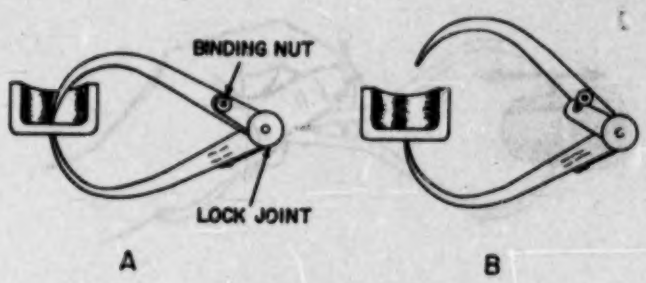

Figure 2-1-11.—Measuring the thickness of the bottom of a cup

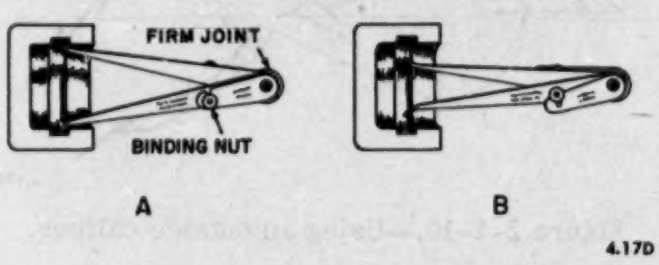

Figure 2-1-12.—Measuring a hard to reach inside dimension with an inside caliper.

to the approximate distance being measured. Hold the caliper with one leg in contact with one of the surfaces being measured. (See fig. 2-1-13.) Then as you increase the setting of the caliper, move the other leg from left to right. Feel for the slight drag indicating the proper setting of the caliper. Then measure the setting with a rule.

MEASURING THE DIAMETER OF A HOLE WITH AN INSIDE CALIPER

To measure the diameter of a hole with an inside caliper, hold the caliper with one leg in contact with one side of the hole (fig. 2-1-14) and, as you increase the setting, move the other leg from left to right and in and out of the hole. When you have found the point of largest diameter, measure the caliper setting with a rule.

MEASURING THE LENGTH OF A CURVE

To measure the length of a curve with dividers, step off the curve as you would step off a straight line. (See fig. 2-1-15.) First set the dividers to any small, even part of an inch. In setting a divider to a dimension on a scale,

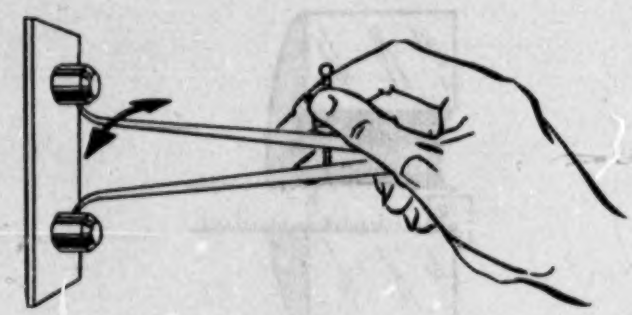

Figure 2-1-13.—Measuring the distance between two surfaces with an inside caliper.

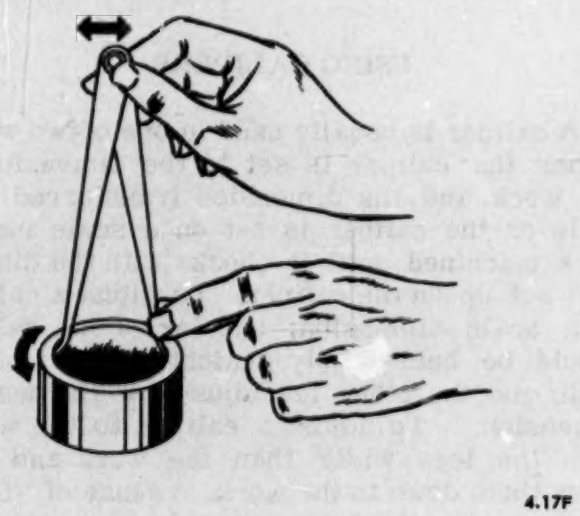

Figure 2-1-14.—Measuring an inside diameter with an inside caliper.

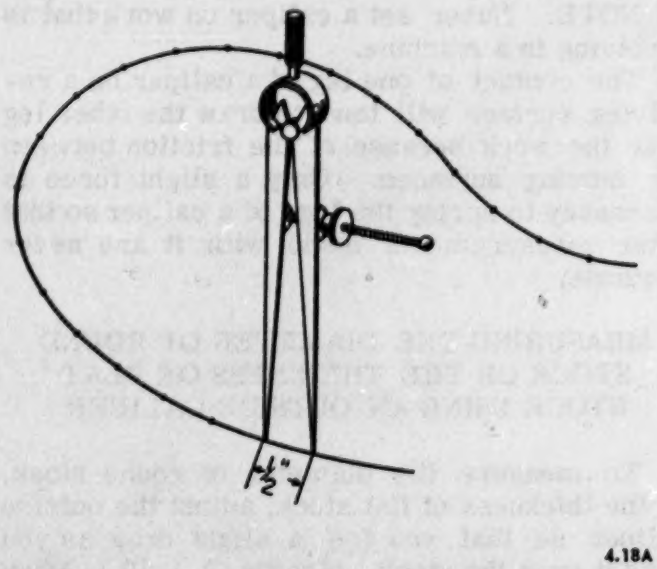

Figure 2-1-15.—Using a divider to measure the length of a curve.

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the usual procedure is to locate one point in one of the inch graduations of the rule and to adjust the divider so that the other point falls easily into the correct graduation. Make certain the points of the divider are not blunt. Extreme care is necessary in this setting because any error will be a cumulative error which increases as the length of the curve being measured increases. Then step off the curve, counting the number of "steps." This number, multiplied by the setting of the divider, will be only the approximate length of the curve, because you are stepping off a straight-line distance along a curved line, and a straight line is the shortest distance between two points. Therefore, the actual distance, or the length of the curve, will be a little greater than your totaled measurements. The accuracy of the totaled measurements will increase as the setting on the divider decreases.

MEASURING INSIDE AND OUTSIDE DIAMETERS WITH POCKET SLIDE CALIPERS

To measure the outside diameter of round stock, or the thickness of flat stock, with a pocket slide caliper, move the jaws of the caliper into firm contact with the surface of the stock. Read the measurement at the reference line stamped OUT. (See fig. 2-1-16.)

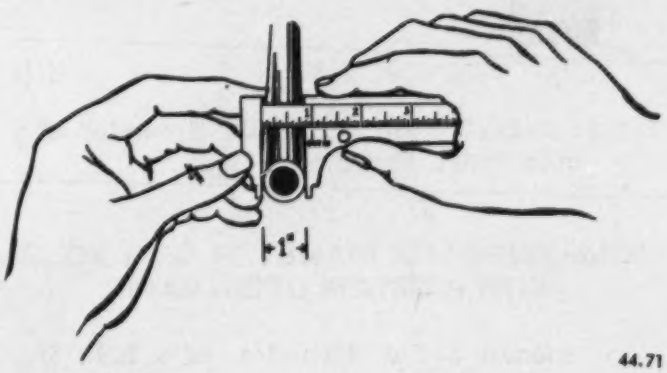

Figure 2-1-16.—Measuring an outside dimension with a pocket slide caliper.

To measure the inside diameter of a hole, or the distance between two surfaces, using a pocket slide caliper, insert only the rounded tips of the caliper jaws into the hole or between the two surfaces. (See fig. 2-1-17.) Read the measurement on the reference line stamped IN.

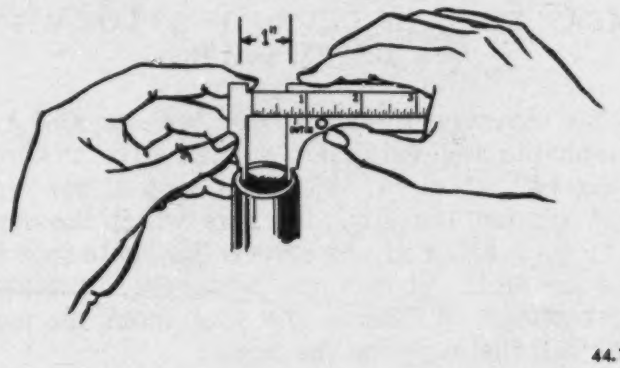

Figure 2-1-17.—Measuring an inside dimension with a slide caliper.

Note that two reference lines are needed if the caliper is to measure both outside and inside dimensions, and that they are separated by an amount equal to the outside dimension of the rounded tips when the caliper is closed.

MEASURING THE DEPTH OF A SLOT WITH A COMBINATION SQUARE

When using a combination square for measuring the depth of a slot, rest the squaring head on the surface of the work. (See fig. 2-1-18.) Loosen the blade friction screw and extend the blade to the bottom of the slot or shoulder, and retighten the screw to maintain the setting. Read the depth of the slot on the scale.

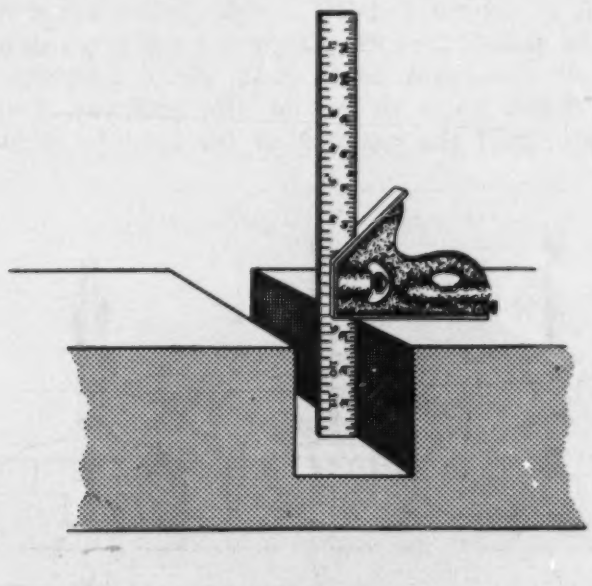

Figure 2-1-18.—Measuring the depth of a slot with a combination square.

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MEASURING THE DEPTH OF A SLOT WITH A DEPTH GAGE

To measure the depth of a hole or slot with reasonable accuracy, use a depth gage as shown in figure 2-1-19 A. Hold the body of the depth gage against the surface from which the depth is to be measured and extend the scale into the hole or slot. Tighten the setscrew to maintain the setting. Withdraw the tool from the work and read the depth on the scale.

To measure the depth of a hole or slot with more accuracy than is possible with an ordinary depth gage, place a vernier depth gage over the slot as shown in figure 2-1-19 B. Notice the clamping screws are at X and Y; the horizontal adjusting screw nut is at Z. With X and Y loose, slide the scale down into the slot being measured until it is almost in contact. Then tighten X to make Z operative. With Z, adjust the scale to the "proper feel" and secure the setting with Y. By proper feel we mean the adjustment at which you first notice contact between the end of the scale and the bottom of the slot. Then read the setting as described under "Reading a vernier scale" in part I section 1 of this course.

To set the vernier depth gage to a particular setting, loosen both setscrews at X and at Y and slide the scale through the gage to the approximate setting. Tighten the setscrew at X, turn the knurled nut at Z until the desired setting is made, and tighten the setscrew at Y to hold the setting.

To measure the depth of a hole or slot, as shown in figure 2-1-19 C, with more accuracy than is possible with either an ordinary depth gage or a vernier depth gage, place a micrometer depth gage over the slot and adjust the thimble until the contact of the spindle causes the ratchet stop to slip. Remove the micrometer from the work and read the micrometer. Remember, if extension rods are used, the total depth reading will be the sum of the length of the rods plus the reading on the micrometer.

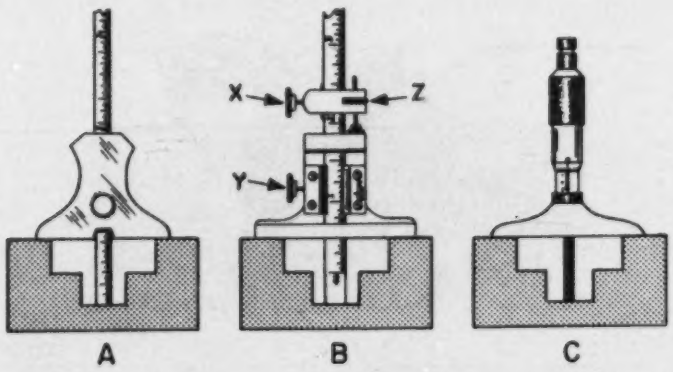

Figure 2-1-19.—Using depth gages.

MEASURING THE DIAMETER OF A HOLE WITH A SMALL HOLE GAGE

To measure the diameter of a hole from 1/8" to 1/2" in diameter, use a small-hole gage. (See fig. 2-1-20.) The four gages in a set cover this range of hole sizes so you must choose the proper gage for the size hole you are measuring. Insert the gage into the hole and adjust it to the hole size by turning the knurled tip of the handle. When you can feel the slight drag of the ball end on the sides of the hole, withdraw the gage. The size of the hole can then be determined by measuring the ball end of the gage with a micrometer caliper. Check part I, section 1 of this course if it is necessary to refresh your memory on how to read a micrometer.

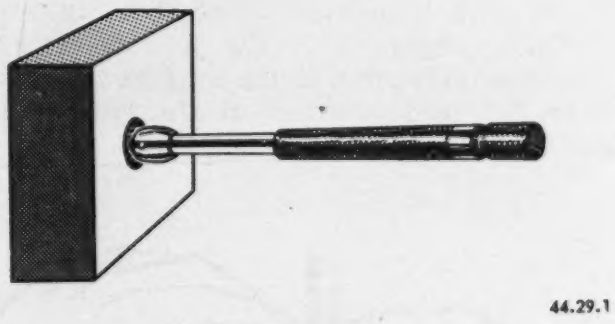

Figure 2-1-20.—Measuring the diameter of a hole with a small hole gage.

MEASURING THE DIAMETER OF A HOLE WITH A TELESCOPING GAGE

To measure the diameter of a hole from 1/2" to 6" in diameter, select from a set of telescoping gages the one whose range includes the size you need. Loosen the knurled nut at the end of the handle, and telescope the adjustable end of the gage to a size slightly smaller than the hole and retighten the nut. Insert the gage into the hole as shown in figure 2-1-21, loosen the nut to permit the spring-loaded adjustable end to expand to the hole diameter, and tighten the nut. The spring loaded contact of the adjustable end will assure proper contact. Make sure, however, that the gage is held with the

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Figure 2-1-21.—Using a telescoping gage.

telescoping end at right angles to the axis of the hole to measure the true, maximum diameter. Remove the gage and measure the setting with an outside micrometer caliper.

MEASURING THE DIAMETER OF A HOLE WITH AN INSIDE MICROMETER CALIPER

To measure the diameter of small holes from 0.2" to 1" in diameter, an inside micrometer caliper of the jaw type as shown in figure 2-1-22A may be used. Note that, in the inset the figures on both the thimble and the barrel are reversed, increasing in the opposite direction from those on an outside micrometer caliper, because this micrometer reads inside measurements. As you turn the thimble clockwise on this micrometer, the measuring surfaces move farther apart and the reading increases. On an outside micrometer caliper, as you turn the thimble clockwise, the measuring surfaces move closer together and the reading decreases.

For holes from 2" up to several feet in diameter, select the inside micrometer having measuring rods whose range includes the required dimension. The extension rod marked "6-7," for example, when inserted into the head of the micrometer, will measure inside diameters from 6" to 7". The soulder on the rod must seat properly to ensure a correct reading. Figure 2-1-22B shows that, for large measurements, both hands are used to set the micrometer for checking a diameter. Hold one end in place with one hand as you "feel" for the maximum possible setting by moving the other end from left to right, and in and out of the hole with the other hand. When no left-to-right movement is possible, and a slight drag is noticed on the in-and-out swing, take the reading.

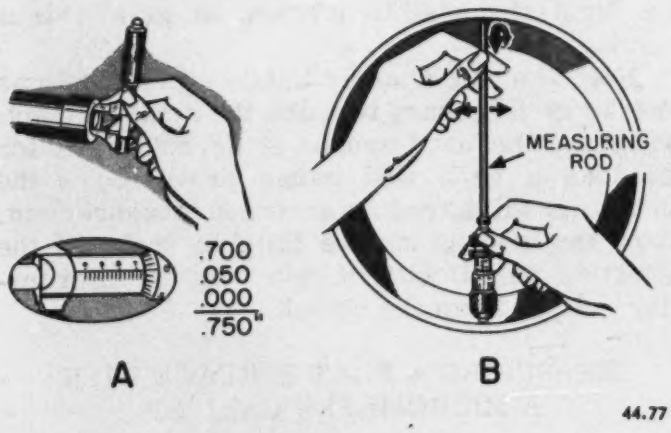

Figure 2-1-22.—Measuring an inside diameter with an inside caliper.

MEASURING THE DISTANCE BETWEEN OUTSIDE SURFACES WITH A VERNIER CALIPER

To measure the distance between outside surfaces or the outside diameter of round stock with a vernier caliper, steady the stock with one hand and hold the caliper in the other as shown in figure 2-1-23. In the figure the clamping screws are at A and B; the horizontal adjusting screw nut is at C. With A and B loose, slide the movable jaw toward the piece being measured until it is almost in contact. Then tighten A to make C operative. With C, adjust the movable jaw to the proper feel and secure the setting with B. The reading can then be taken as explained in part I section 1 of this course.

MEASURING THE DISTANCE BETWEEN INSIDE SURFACES WITH A VERNIER CALIPER

To measure the distance between inside surfaces, or the inside diameter of a hole, with a vernier caliper, use the scale marked "inside." Figure 2-1-24 shows the measuring points in place. Remember that if you are using a vernier caliper with both metric and English scales, the scales appear on opposite sides of the caliper and apply only to outside measurements. Then, to get correct inside measurements, you add to the actual reading the measuring point allowance for the size of caliper you are using. Take this allowance from the table given in part I section 1 or the manufacturer's instructions. The actual measurement in this case is made in the same manner as taking an outside measurement.

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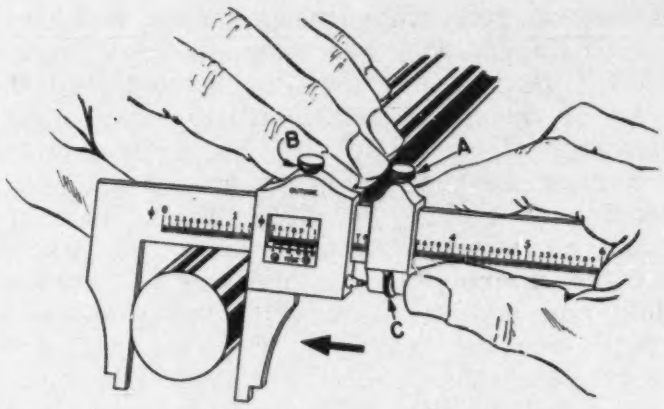

Figure 2-1-23.—Measuring an outside diameter with a vernier caliper.

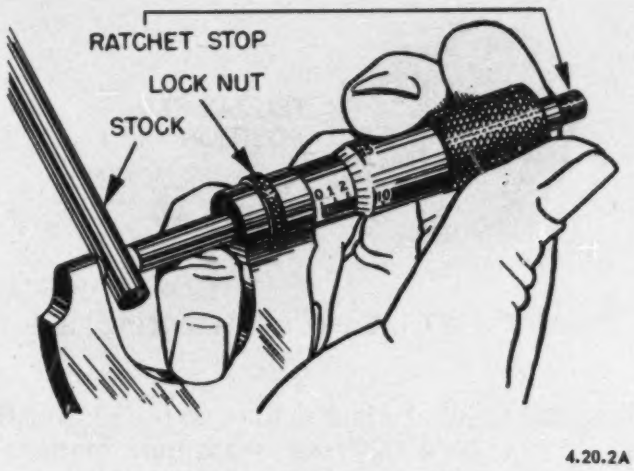

Figure 2-1-25.—Measuring round stock with a micrometer caliper.

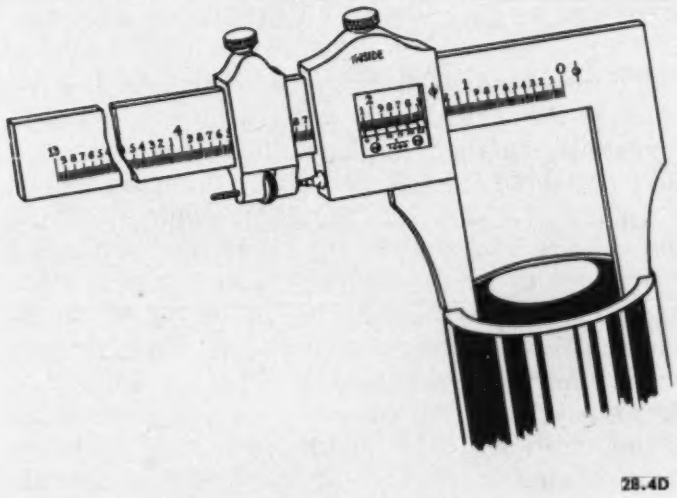

Figure 2-1-24.—Measuring an inside diameter with a vernier caliper.

MEASURING ROUND STOCK WITH A MICROMETER

When measuring the diameter of a small piece of round stock, hold the stock to be measured in one hand. Hold the micrometer in the other hand so that the thimble rests between the thumb and the forefinger. (See fig. 2-1-25.) The third finger is then in a position to hold the frame against the palm of the hand. The frame is supported in this manner and makes it easy to guide the work over the anvil. The thumb and forefinger are in position to turn the thimble either directly or through the ratchet and bring the spindle over against the surface being measured.

Turn the spindle down to contact by "feel," or else use the ratchet stop. Your feel should produce the same contact pressure and therefore the same reading as that produced when the ratchet stop is used. Develop your "feel" by measuring a certain dimension both with and without the aid of the ratchet stop. When you have the correct feel, you will get the same readings by both methods.

In measuring round stock the feel must be very light because there is only a line contact between the spindle and the stock and the anvil and the stock. Therefore the contact area is exceptionally small, causing a proportionally high contact pressure per unit of area. This would tend to give a reading smaller than the true reading unless the light feel is used. In measuring a ball from a ball bearing, the contact is at only two points, so the contact area is very small, indicating a tremendous pressure per unit of area. This condition requires only the lightest possible contact to give a true reading.

Hold the micrometer lightly and for only as long as is necessary to make the measurement. Wrapping the hand around it or holding it for too long a time will cause expansion of the metal and will introduce errors in measurement. Read the setting on the thimble scale (if the object is small) without removing the micrometer caliper from the object.

MEASURING A FLAT SURFACE WITH A MICROMETER CALIPER

When measuring a flat surface with a micrometer caliper, the entire area of both the

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anvil and the spindle is in contact with the surface being measured. This causes a proportionally low contact pressure per unit of area. Therefore the "feel" should be slightly heavier than when measuring round stock.

On large flat work, it is necessary to have the work stationary and positioned to permit access to the micrometer. The proper method of holding a micrometer when checking a part too large to be held in one hand is shown in figure 2-1-26. The frame is held by one hand to position it and to locate it square to the measured surface. The other hand operates the thimble either directly or through the ratchet. A large flat surface should be measured in several places to determine the amount of variation. It is good practice to lock the spindle in place with the locknut before removing the micrometer from the part being measured. After doing this the measurement indicated on the thimble scale can then be read.

To retain a particular setting, in cases where several pieces are to be gaged, lock the spindle in place with the locknut. When a piece is "gaged" with a micrometer with its spindle locked to a setting, the piece can quickly be identified as oversize, correct size, or undersize.

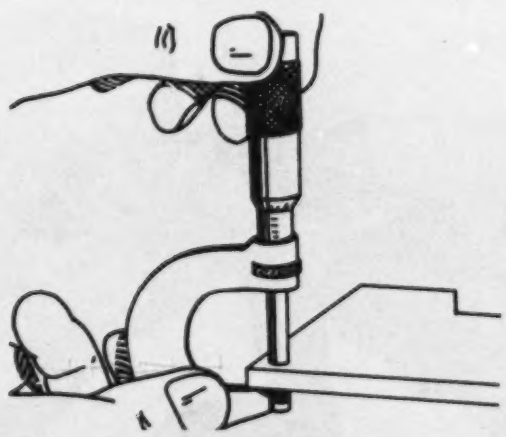

Figure 2-1-26.—Measuring flat stock with a micrometer caliper.

CORRECT MICROMETER ZERO SETTING

If an outside micrometer caliper does not read zero when the spindle touches the anvil, and both are clean at the point of contact, the zero setting should be corrected. This will eliminate the necessity of adding or subtracting a "zero correction" numerically to each reading as would otherwise be necessary if this adjustment were not made.

The zero setting on all micrometers is not made in exactly the same way. Refer to either the instructions that come with the micrometer or to the manufacturer's catalog for specific directions for a particular tool.

For example, The Brown & Sharpe Manufacturing Co. includes with each micrometer the instructions which follow, with an illustration of each step.

1. Carefully clean the measuring surfaces by pulling a piece of soft paper between the surfaces while the anvil and spindle are in light contact with the paper. Do not use hard paper. (See fig. 2-1-27A.)

2. With the anvil and spindle apart, unlock thimble cap with spanner wrench; then tighten cap lightly with fingers to bring light tension between thimble and spindle. (See fig. 2-1-27B.)

3. Bring anvil and spindle together by turning spindle and set zero line on thimble to coincide with line on sleeve. (See fig. 2-1-27C.)

4. Move spindle away from anvil by turning spindle and not by turning thimble. (See fig. 2-1-27D.)

5. Holding thimble only, tighten cap with fingers. Do not touch frame. (See fig. 2-1-27E.)

6. Lock cap with wrench, still holding thimble only, and the adjustment is complete. (See fig. 2-1-27F.)

It is IMPORTANT that you grip the micrometer as shown in each figure when making that particular adjustment. After completing the adjustment, check zero setting and make sure it is correct.

MEASURING THE PITCH OF A THREAD

The screw pitch gage has teeth which correspond to standard thread sections. To measure the pitch of a thread, compare it with the standards of the screw pitch gage by holding a gage

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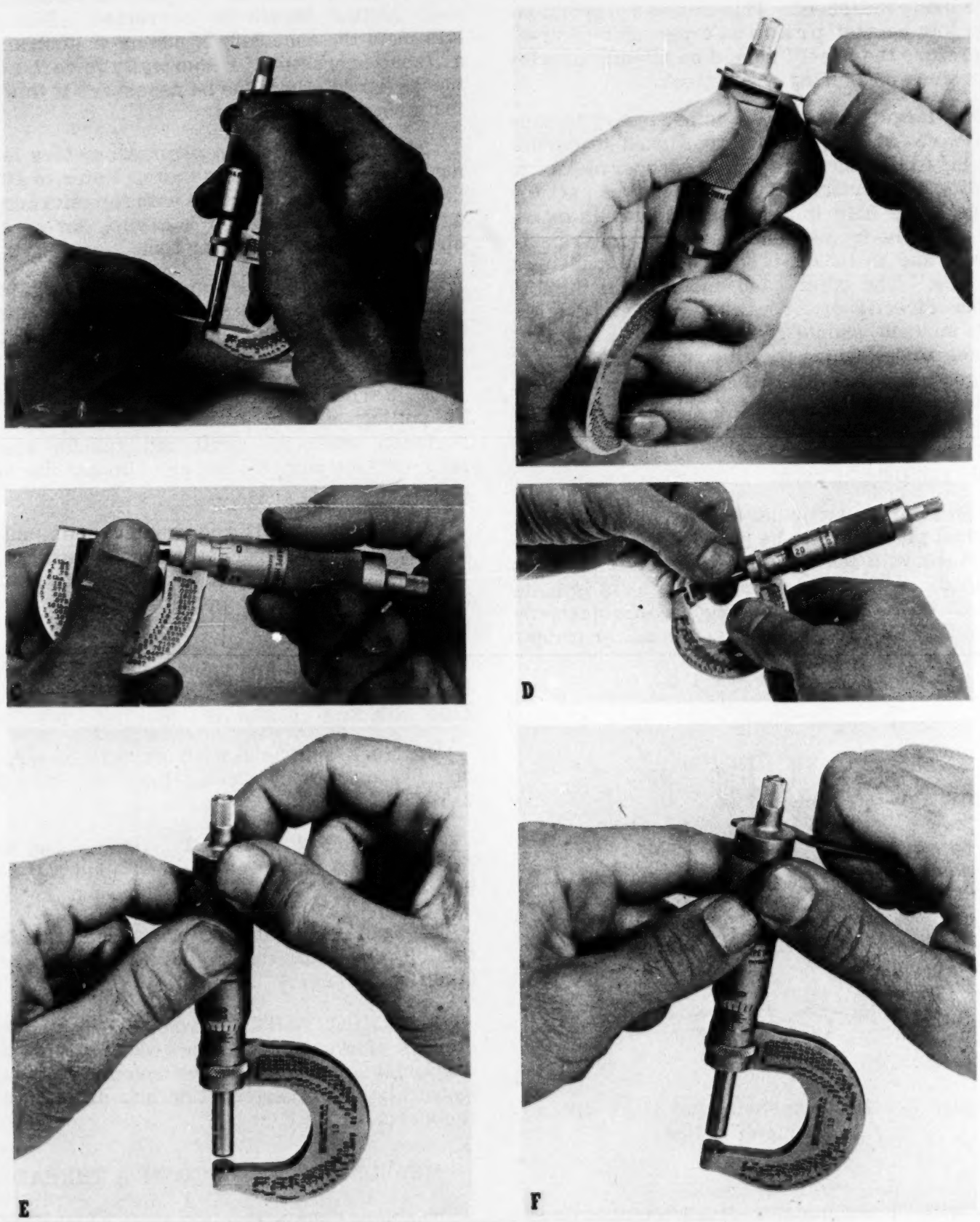

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Figure 2-1-27.—Correcting zero setting on a micrometer.

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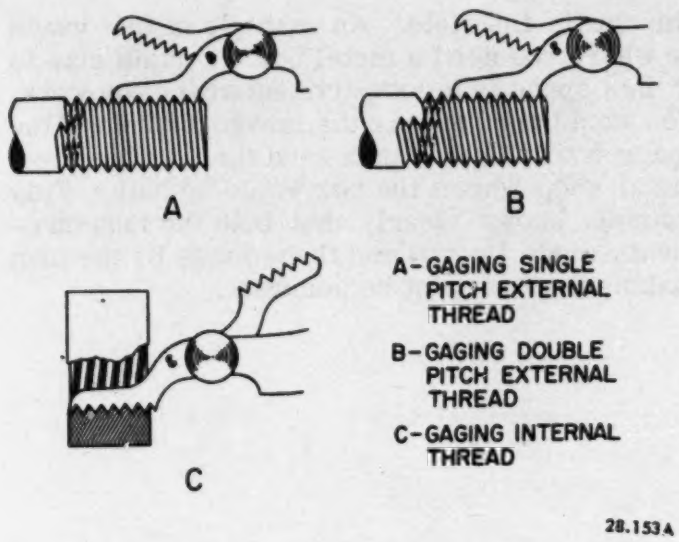

Figure 2-1-28.—Using a screw pitch gage.

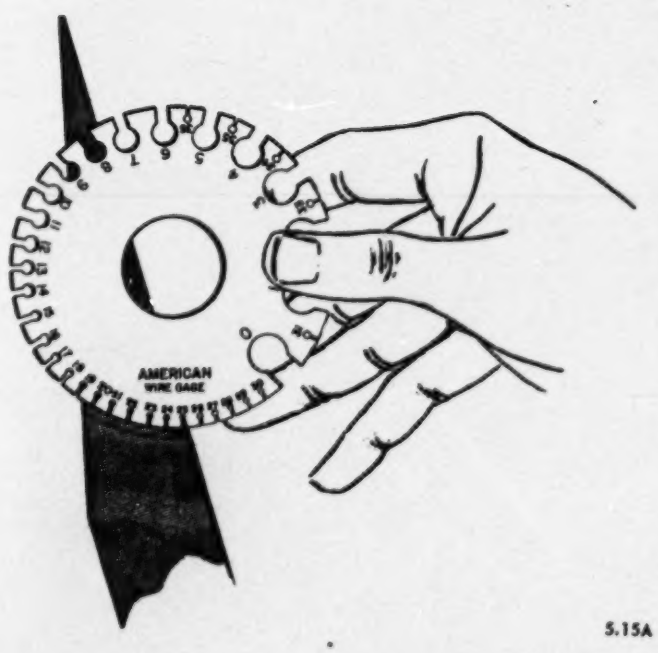

Figure 2-1-29.—Using a wire gage to measure sheet metal.

leaf to the thread being gaged until you find an exact fit. If possible, look at the fit toward a source of light, as a difference of one thread per inch, in the finer threads, is not easily detected.

As shown in figure 2-1-28, single and multiple threads can be gaged. The thread at A is single pitch, as the travel is one thread per revolution as shown by the dotted lines. The thread at B is a double pitch thread as shown by its dotted lines, and the travel is two threads per revolution. In this figure you see that the gage fits a certain thread, whether it be single or double pitch, internal or external thread.

MEASURING THE GAGE OF SHEET METAL

To measure the gage of a piece of sheet metal, first remove any burr from the place where you will apply the sheet metal gage.

The gage shown in figure 2-1-29 is used for gaging nonferrous sheet and wire. This gage, and others similar to it, are listed in the "Tables of useful information" under wire and sheet metal gages. Select, from the five gages listed in this table, the one that applies to the sheet of metal or wire you want to gage. For instance, column 2 of the above mentioned table tells you that the American Wire Gage shown in figure 2-1-29 is the one to use for nonferrous sheet and wire. Notice that usually each of the five gages has its own decimal equivalent for a particular gage number. If you have a piece of iron wire that is 0.016" in diameter, its correct identification is 0.016" diameter iron wire, B.W.G. (British Wire Gage) No. 27. If you have a piece of steel music wire that is 0.016" in diameter, you identify it as 0.016" diameter steel music wire, Music Wire Gage No. 6.

After the right gage has been selected, apply the gage to the wire, or to the edge of the sheet as shown in figure 2-1-29. The number opposite the slot that fits the wire or sheet is its gage number. The decimal equivalent is stamped on the opposite face of the gage.

To eliminate errors that might occur due to using the wrong gage, or if gages are not available, take a micrometer reading in decimal fractions of an inch and state the name of the material such as 0.014" hot rolled sheet steel, 0.010" brass wire, etc. Then to find the gage number, you can refer to the table on Wire and Sheet Metal Gages and find the material, the name of the proper gage, and the gage number corresponding to the decimal fraction obtained by taking a micrometer reading.

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THE IMPORTANCE OF ACCURATE MEASUREMENTS

In the performance of many jobs during your Navy career, accurate measurements of objects or material will be required.

More and more it is becoming common practice to fabricate parts and material for jobs in a shop for installation elsewhere on the ship or in the field. An example of this would be where you need a metal box a certain size to fit in a space in a compartment where you work. You would need to take the measurements of the space available and then send them to the sheet metal shop where the box would be built. This example shows clearly that both the measurements made by you and those made by the man making the box must be accurate.

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PART II

Section 2

LAYING OUT

Laying out work is the careful measuring and marking of stock prior to cutting and shaping the work. Close attention to details in layout is necessary to ensure successful progress on a job. The layout tools should be selected and used with care to ensure accurate layout work.

The plan for laying out a job may be taken from a blueprint or a sketch. The important thing to remember is to plan the layout to avoid delays in getting the job done and avoid waste of material.

Wood and metal are two common materials you will work with in the Navy. A marking awl or scriber is recommended for marking metal. An old saw file ground to a fine point makes a very good scriber if a commercial type scriber is not available. A center punch, or prick punch that is ground to a fine point, is valuable for marking locations for drill holes, bends, saw cuts, etc. To lay out lines on wood, pencils or a knife may be used for marking. To lay out rough work, a heavy carpenter's pencil may be used. To lay out lines for finish carpentry, a regular lead pencil sharpened to a conical point is used. For extremely accurate work, use a knife line for layout work.

The operations that are explained in this section are operations that you will perform when laying out lines on stock material prior to cutting and shaping the work.

SQUARING A LINE ON STOCK WITH A COMBINATION SQUARE

To square a line on stock with a combination square, place the squaring head on the edge of the stock, as shown in figure 2-2-1, and draw the line along either edge of the blade. The line will be square with the edge of the stock against which the squaring head is held; that is, the angle between the line and the edge will be 90 degrees.

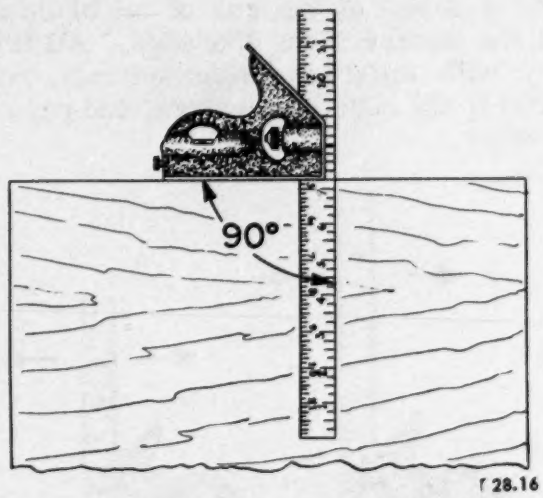

Figure 2-2-1.—Squaring a line on stock with a combination square.

LAYING OUT A 45° ANGLE ON STOCK WITH A COMBINATION SQUARE

To lay out a 45° angle on stock, using a combination square, place the squaring head on the edge of the stock, as shown in figure 2-2-2, and draw the line along either edge of the blade. The line will be at 45° with the edge

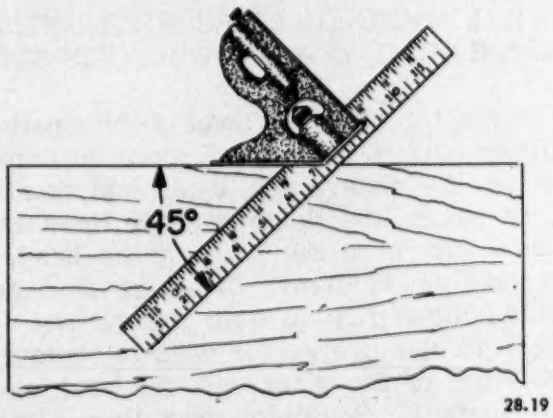

Figure 2-2-2.—Using a combination square to lay out a 45° angle.

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of the stock against which the squaring head is held.

DRAWING LINES PARALLEL TO AN EDGE WITH A COMBINATION SQUARE

To draw lines parallel to an edge, using a combination square, extend the blade from the squaring head a certain distance, such as the 2 inches shown in figure 2-2-3. Secure the blade at this position. Make a line parallel to the edge of the stock by holding the scratch awl or a pencil at the end of the blade as you move the square along the edge. All lines so made, with different blade settings, will be parallel to the edge of the stock, and parallel to each other.

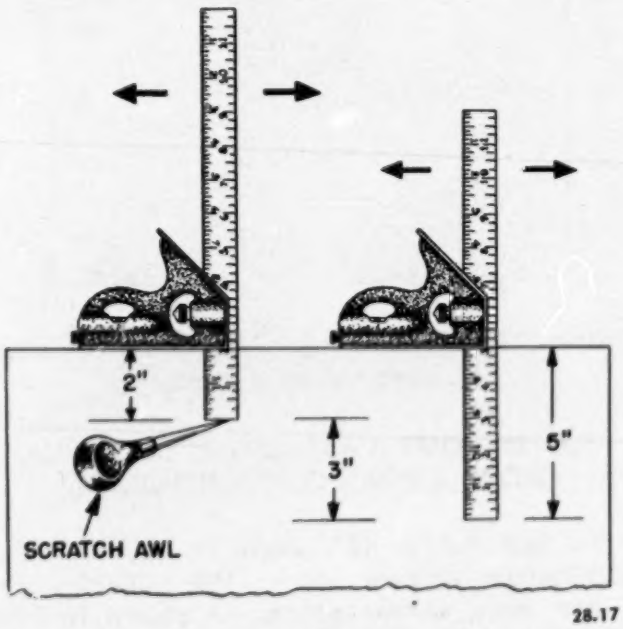

Figure 2-2-3.—Drawing parallel lines with a combination square.

DRAWING ANGULAR LINES WITH THE PROTRACTOR HEAD OF A COMBINATION SQUARE

Remove the squaring head of the square and install the protractor head. Loosen the adjusting screw of the protractor head and rotate the blade to where the desired angle lines up with the index mark on the body of the head. The setting shown in figure 2-2-4 is 60 degrees. Retighten the screw to hold the setting. Hold the body of the protractor head in contact with a true edge of the work with the blade resting on the surface. Scribe or draw lines along the edge of the blade on the surface of the work. The angle set on the scale determines the angle

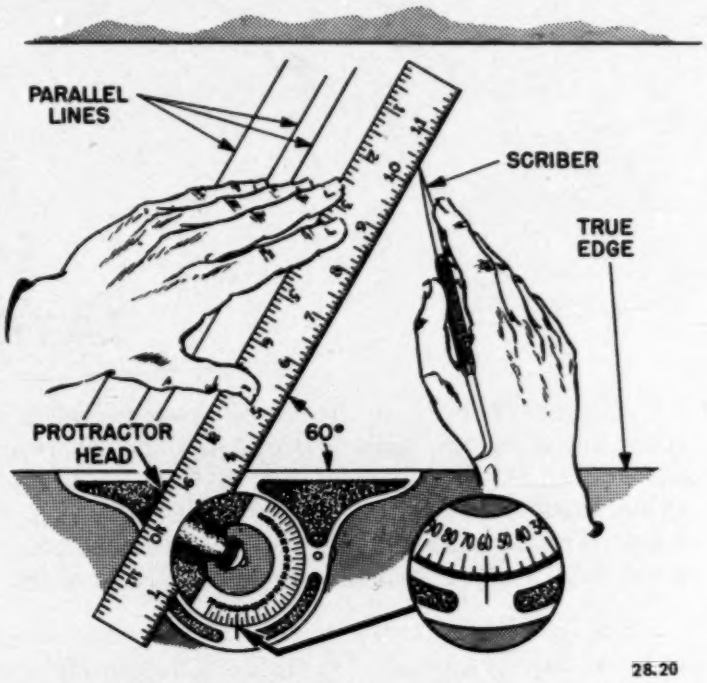

Figure 2-2-4.—Drawing angular lines with a combination square.

laid out on the work. All lines drawn with the same setting, and from the same true edge of the work, will be parallel lines.

FINDING THE CENTER OF ROUND STOCK

To locate the center of round stock, one of three tools is commonly used: the combination square, the hermaphrodite caliper, or a surface gage.

To use the combination square set for finding the center of round stock, remove the square head and protractor head by loosening their clamping nuts and withdrawing the rule. After removing these two heads, hold the center head firmly in place on the end of the shaft, as shown in figure 2-2-5, so that the shaft rests in the V of the center head and is in contact with the back of the rule. This will locate the one edge of the rule so that it passes through the center of the shaft. Scribe a line along this edge. Then relocate the center head at about 90° from this first line and scribe a second line. The intersection of these two lines will be the center of the end of the shaft.

Figure 2-2-6 shows the hermaphrodite caliper being used for locating the center of the end of a shaft. Hold the curved leg of the caliper against the shaft with one hand as you swing the arc holding the joint of the caliper with the other hand. The four points around

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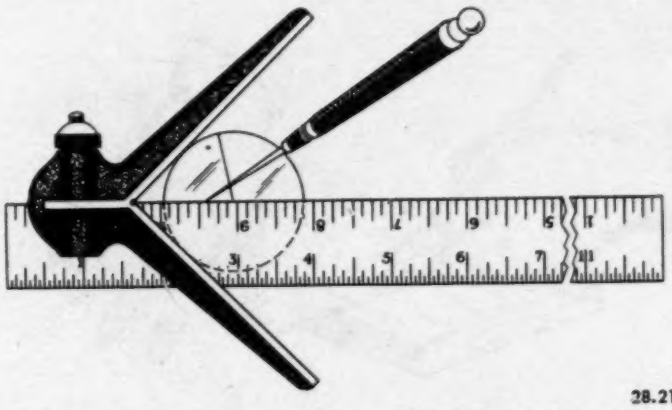

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Figure 2-2-5.—Locating a shaft center with a combination square.

the shaft where the curved leg is to be held are located approximately 90° apart. Any of the three patterns of scribed lines shown in figure 2-2-6 will serve as a guide to enable you to punch the center of the end of the shaft.

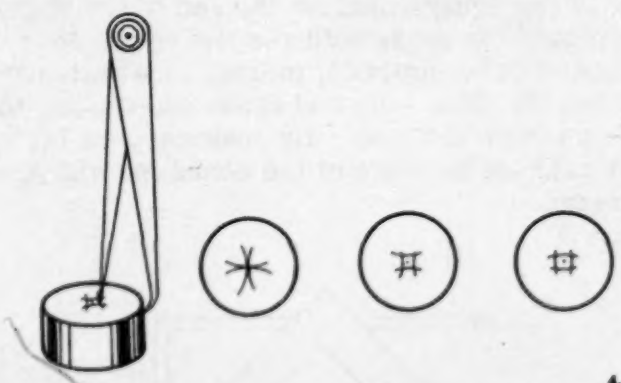

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Figure 2-2-6.—Locating the center of a shaft with hermaphrodite calipers.

The method for finding the center of a shaft by using a surface gage, vee-block, and a surface plate or similar true surface, is shown in figure 2-2-7. The vee-block holds the shaft at a fixed distance from the plate. The surface gage holds a scriber at a selected fixed distance from the plate. To locate the center on the end of the shaft, scribe a line that will be near the center. Rotate the shaft about 90° about its axis as it rests in the vee-block and scribe another line. When four lines have been scribed, they will serve as a guide to punching the center of the shaft. Do not move the setting of the scriber on the surface gage while making these layout lines.

When using a hermaphrodite caliper or a surface gage for finding the center of round stock, the methods shown will only give you an approximate center. The exact center can

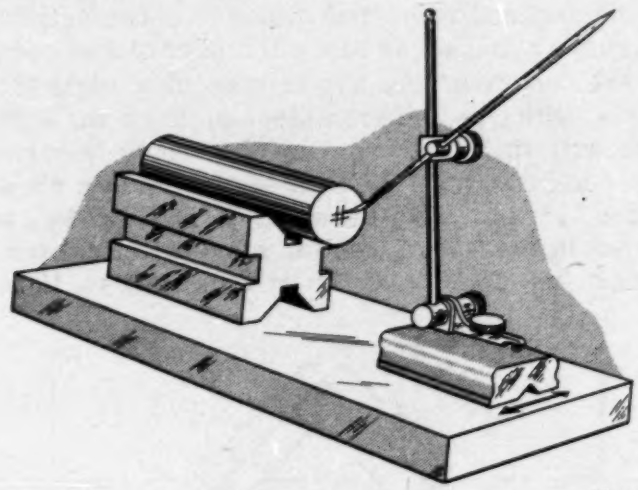

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Figure 2-2-7.—Locating the center of a shaft with a surface gage.

be found by drawing lines diagonally across the patterns scribed. Where the diagonal lines cross will be the exact center of the shaft.

When using any of the methods described for locating the center of a shaft, make sure the end of the shaft is reasonably square and clean. The use of layout dye or chalk, to emphasize the layout lines, will make them easier to see.

SOLVING BASIC PROBLEMS WITH THE FRAMING SQUARE

Of all the layout tools in the woodworker's kit, the framing square is far and away the most generally useful. The problems that can be solved when laying out work with the square are so many and varied that whole books have been written on the square along. Only a few of the most common uses of the square can be presented in this course.

The framing square is used most frequently to find the length of the hypotenuse (longest side) of a right triangle when the lengths of the other two sides are known. This is the basic problem involved, for example, in laying out or determining the length of a roof rafter, a brace, or any other member which forms the hypotenuse of an actual or an imaginary right triangle.

Figure 2-2-8 shows you how the framing square is used to determine the length of the hypotenuse of a right triangle with the other sides, each 12 in. long. Plane a true, straight edge on a board, and set the square on the board so as to bring the 12-in. mark on the tongue and the 12-in. mark on the blade even with the edge of the board. Draw the pencil marks shown

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in the second view. The distance between these marks, as measured along the edge of the board, is the length of the hypotenuse of a right triangle with the other sides each 12 in. long. You will find that the distance, which is called the BRIDGE DISTANCE, measures just a shade under 17 in. To be exact it is 16.97 in., as shown in the figure, but for most practical purposes the 16.97 may be rounded off to 17 in.

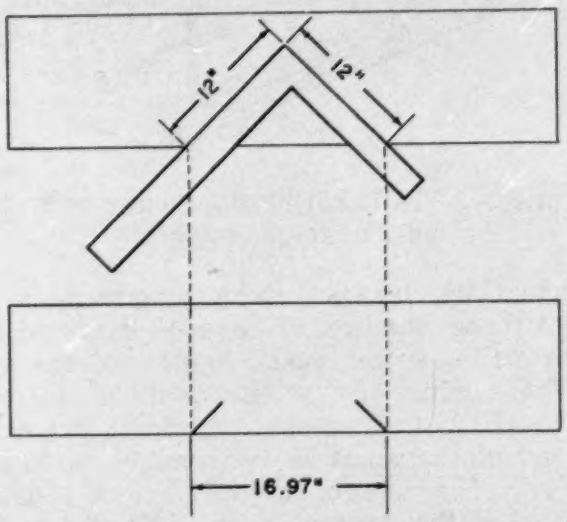

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Figure 2-2-8.—Basic problem solved by the framing square.

In figure 2-2-8 the hypotenuse of the triangle is horizontal. In most practical situations, however, the triangle in question has one of the shorter sides horizontal and the other vertical. When this is the case, the length of the horizontal shorter side is called the RUN and the length of the vertical shorter side is called the RISE.

LAYING OUT 90° AND 45° ANGLES WITH A FRAMING SQUARE

In laying out 90° and 45° angles with a framing square, the lumber you work with will nearly always have to be squared on the ends. This will make it necessary to lay out a line at a 90° angle with respect to the edge of the board. This line should be as close to the end of the board as possible to avoid undue waste of material. When doing this job with a framing square, place the blade of the square along one edge of the board, and mark along the outside edge of the tongue, as shown in figure 2-2-9.

Ninety degree mitered corners are made by placing two 45° cuts together. To lay out a 45°

44.79

Figure 2-2-9.—Laying out a 90° angle with a framing square.

angle for making the cuts, place the framing square on the face of the board with an equal number of graduations on the tongue and blade as shown in figure 2-2-10, and mark along the edge of the square nearest the end of the board. If you want the angle with respect to the edge of the board to be opposite, merely turn the square over on its other side and again mark along the edge nearest the end. By making your layout lines nearest the edge of the board you will save material.

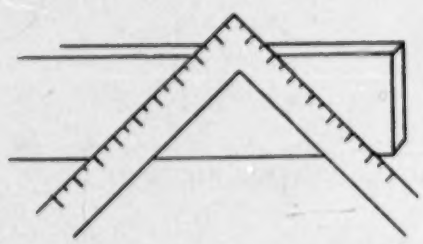

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Figure 2-2-10.—Laying out a 45° angle with a framing square.

LAYING OUT ROUNDED CORNERS ON SQUARE STOCK

To lay out a rounded corner on square stock, you will need a square and a set of dividers. Find the center of the arc (fig. 2-2-11) by measuring from the corner of the stock along the adjacent sides, a distance equal to the radius of the arc (A-A). Use a square and square in from points (B-B). The intersection of these lines will locate the center of the arc (C).

Set the dividers to a measurement equal to the distance of the radius of the arc (C-B).

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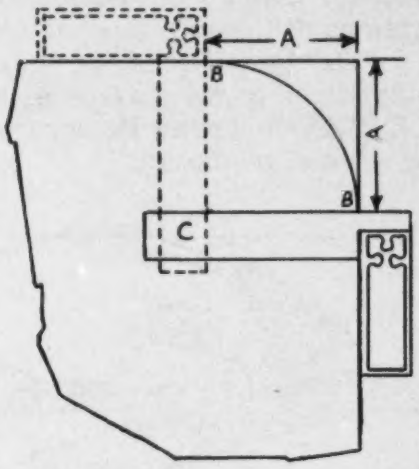

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Figure 2-2-11.—Laying out a rounded corner on square stock.

Place one leg of the dividers at C, (fig. 2-2-11), and rotate the dividers around this point as a center, allowing the other leg to scratch lightly the surface of the stock. This arc should fall in line with the edges of the board at points (B-B).

FASTENING PAPER TO A DRAWING BOARD TO DRAW LINES

To fasten paper to a drawing board, place it on the board about an inch from the left-hand edge and near the top. (See fig. 2-2-12.) Placing the paper near the top of the board will keep the head of the T-square from running off the edge when you are working near the bottom of the paper.

Then true up the paper with the T-square blade, and secure it with thumbtacks or drafting tape at the upper corners only. The paper will then lie flat on the board.

To draw parallel horizontal lines, hold the head of the T-square to the edge of the board and draw lines as shown in figure 2-2-13.

To draw lines with a triangle and T-square, refer to figure 2-2-14 and note the directional arrows. Experience has shown that the best speed and accuracy are obtained by drawing your lines in these ways, provided of course, you are right handed; this applies to the 30°-60° triangle as well as the 45° shown in figure 2-2-14.

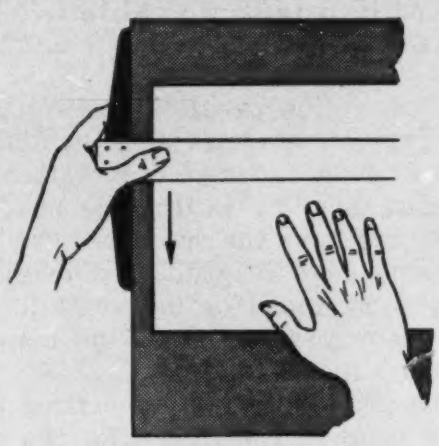

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Figure 2-2-12.—Squaring paper on a drawing board with a T-square.

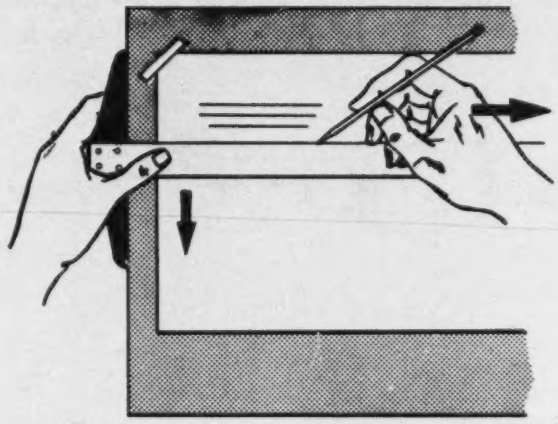

29.275C

Figure 2-2-13.—Drawing horizontal lines with a T-square.

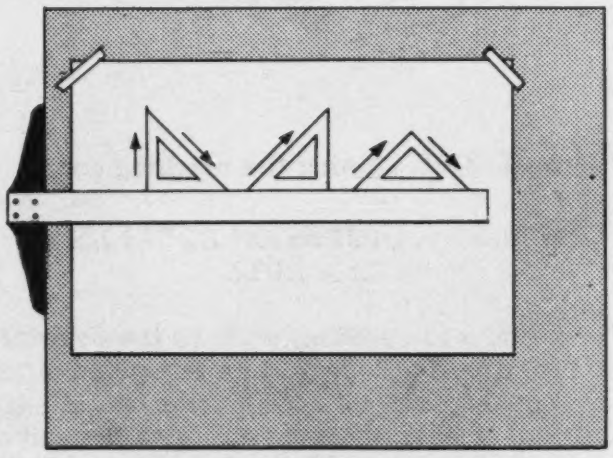

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Figure 2-2-14.—Drawing lines at an angle with a T-square and triangles.

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DRAWING A LINE PARALLEL TO AN EDGE WITH A MARKING GAGE

To draw a line parallel to an edge with a marking gage, first determine the distance the line must be from the edge of the stock. Adjust the marking gage by setting the head the desired distance from the spur. Although the bar of a marking gage is graduated in inches, the spur may work loose or bend. If this occurs, accurate measurement should be made with a rule between the head and spur. (See fig. 2-2-15A.) To draw a line after setting the gage, grasp the head of the gage with the palm and fingers as shown in figure 2-2-15B; extend the thumb along the beam towards the spur. Press the head firmly against the edge of the work to be marked, and with a wrist motion tip the gage forward until the spur touches the work. Push the gage along the edge to mark the work, keeping the head firmly against the edge of the work.

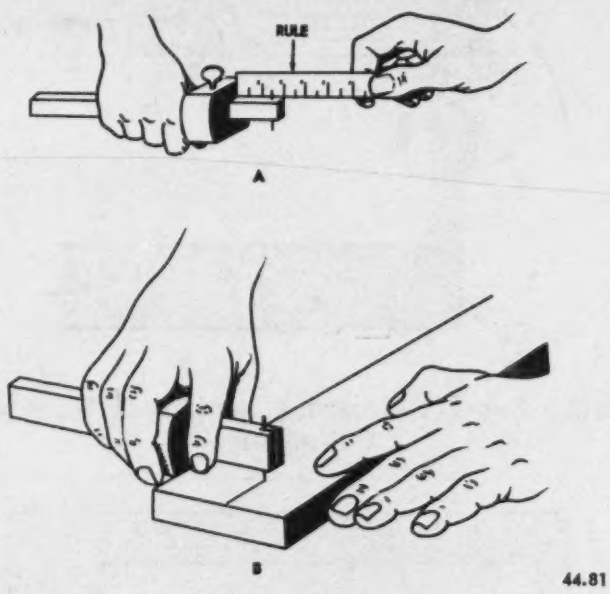

Figure 2-2-15.—Using the marking gage.

DIVIDING A DIMENSION EQUALLY WITH A RULE

To divide a dimension, such as the 4" width of the board in fig. 2-2-16, into any given number of equal parts, place a rule on its edge across the face of the board. With the end of the rule at one edge of the board, adjust the rule at an angle to the other edge so that an inch graduation falls on the other edge. The 9" graduation would give nine equal divisions at the inch lines. The 6" graduation would give 6 equal divisions at the inch lines, or 3 by marking at the 2- and 4-inch lines, as shown. Then mark the divisions on the surface with a sharp pencil (fig. 2-2-16) and draw lines parallel with the working edge of the board.

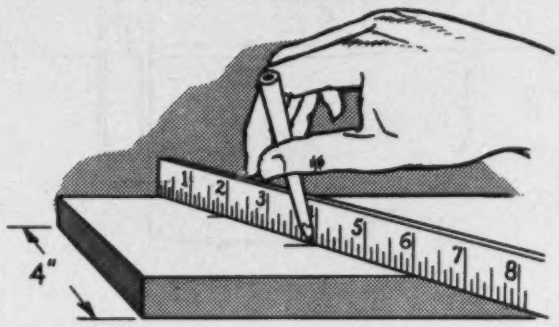

Figure 2-2-16.—Dividing a dimension equally with a rule.

DIVIDING A LINE INTO EQUAL SEGMENTS WITH A DIVIDER

To divide a line equally with a divider, step it off in any size steps, as shown in figure 2-2-17, working from one end of the line to the other. When the end is reached, you will probably have a division which is smaller than the rest. This is a trial-and-error method; so either increase or decrease the setting on the divider until you obtain the required number of equal divisions.

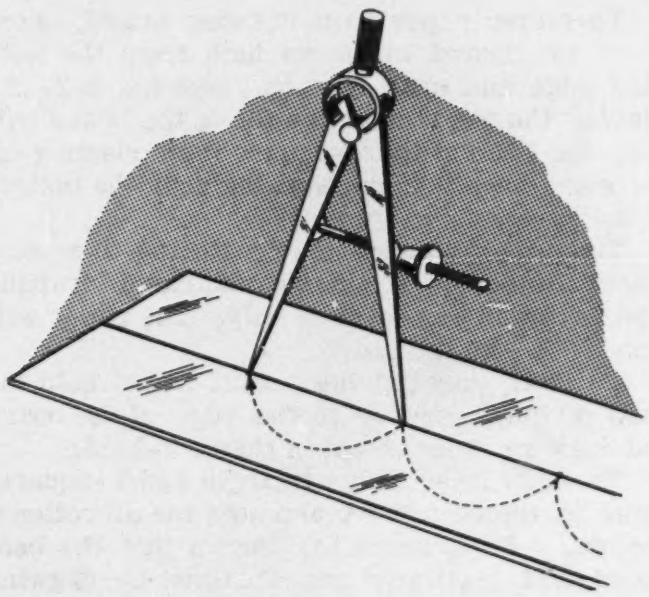

Figure 2-2-17.—Dividing a line into equal segments with a divider.

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SCRIBING A LINE TO A SURFACE WITH A DIVIDER

Scribing a line to a surface is a skill used when doing such jobs as fitting linoleum into corners or curves, or fitting a piece of stock, as shown in figure 2-2-18, to a curved surface. In figure 2-2-18A, you see the complete fit. In 2-2-18B the divider has scribed a line from left to right. When scribing horizontal lines, the legs of the divider must be kept plumb (one above the other). When scribing vertical lines, the legs must be kept level. Therefore, to scribe a line to a surface, set the divider so that one leg will follow the irregular surface, and the other leg will scribe a line on the material that is being fitted to the irregular surface. (See fig. 2-2-18B.)

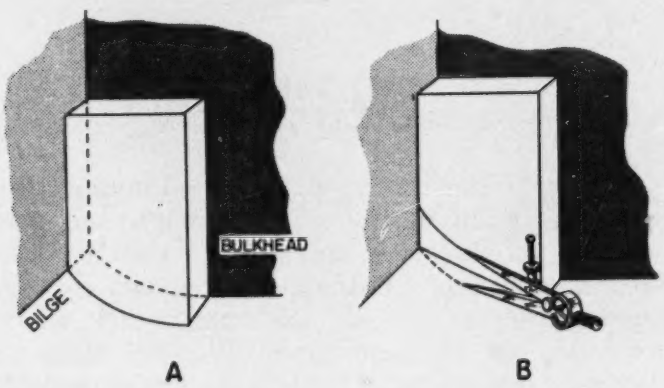

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Figure 2-2-18.—Scribing a line to a surface.

When scribing a line on a level surface, as in fitting linoleum to a curved bulkhead, figure 2-2-19, keep the line joining the points of the divider perpendicular to the straight bulkhead from which you start to scribe.

LAYING OUT A PERPENDICULAR FROM A POINT TO A LINE

As shown in figure 2-2-20, to lay out a perpendicular from a point to a line using a divider, lightly prick punch the point, C, then swing any arc from C which will intersect the line AB, and prick punch the intersections D and E as shown in the figure. With D and E as centers, scribe two arcs, which intersect at a point such as F. Place a straightedge on points C and F. The line drawn along this straightedge from point C to line AB will be perpendicular (90°) to the line AB.

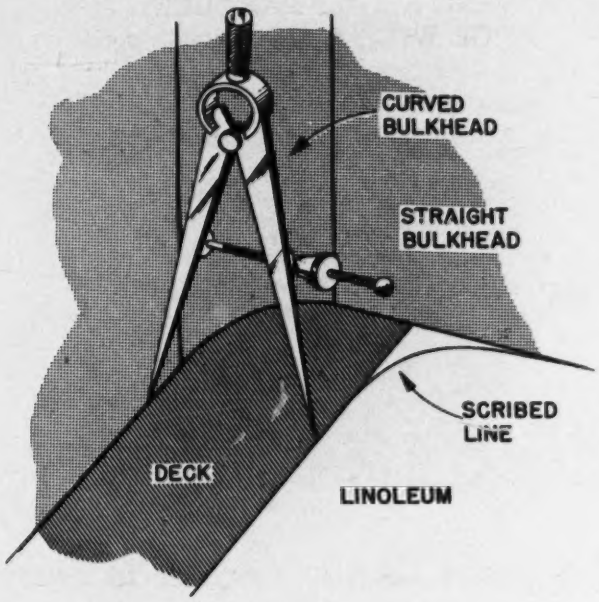

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Figure 2-2-19.—Scribing a line to fit linoleum to a curved surface.

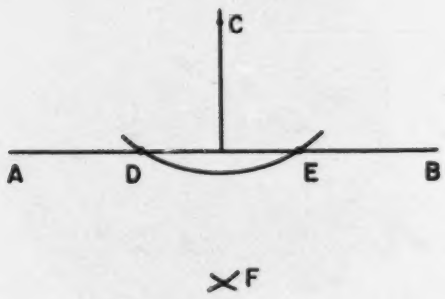

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Figure 2-2-20.—Laying out a line perpendicular to a line.

LAYING OUT A CIRCLE WITH A DIVIDER OR WITH TRAMMEL POINTS

To lay out a circle with a divider, set the divider at the desired radius, using a rule as shown in figure 2-2-21. Note that the 3-inch radius being set here is being taken away from the end of the rule. This reduces the chance of error, as each point of the dividers can be set on a graduation.

Place one leg of the divider at the center of the proposed circle, lean the tool in the direction it will be rotated, and rotate it by rolling the knurled handle between your thumb and index finger (fig. 2-2-22).

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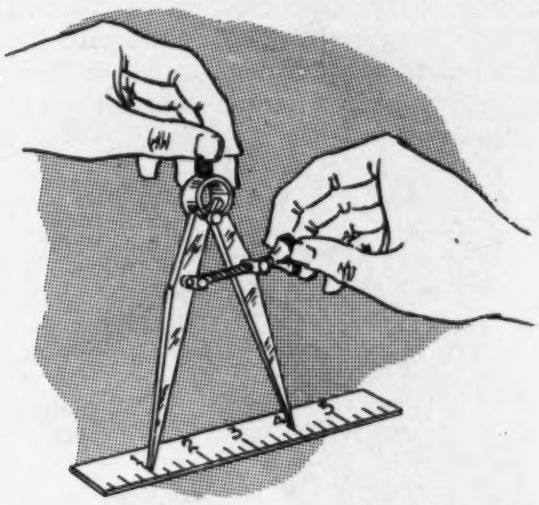

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Figure 2-2-21.—Setting a divider to a desired radius.

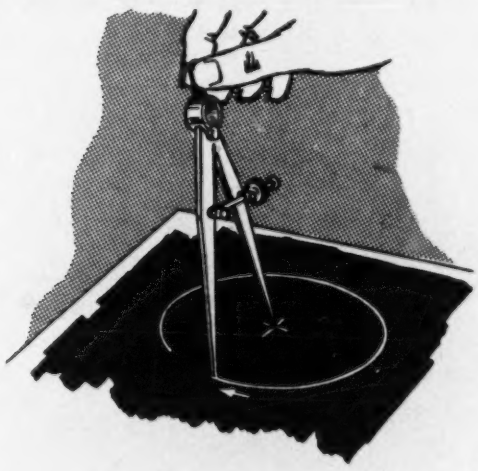

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Figure 2-2-22.—Scribing a circle with a divider.

When setting trammel points, shown in figure 2-2-23, follow the same directions as for a divider, but use a steel tape or rule long enough to provide the larger radii that the trammel points can handle.

To lay out a circle with trammel points, hold one point at the center, lean the tool in the direction you propose to move the other point, and swing the arc or circle as shown in figure 2-2-23.

To transfer a distance measurement with trammel points, hold one point as you would for laying out a circle, and swing a small arc with the other point opened to the desired distance.

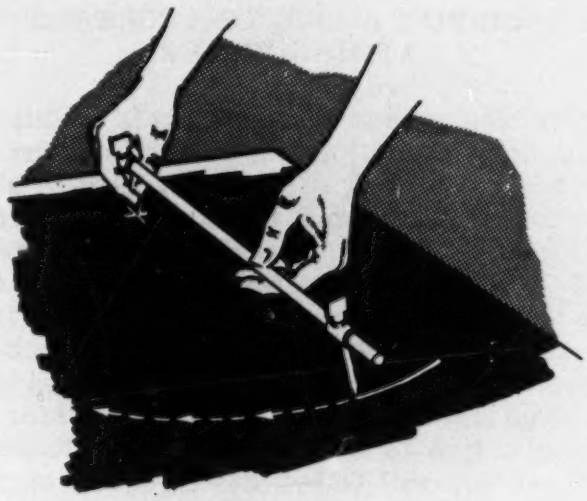

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Figure 2-2-23.—Scribing a circle with trammel points.

PRICK PUNCHING THE INTERSECTION OF TWO LAYOUT LINES

To make the intersection of two layout lines, bring the point of the prick punch to the exact point of intersection and tap the punch lightly with a hammer. If inspection shows that the exact intersection and the punchmark do not coincide, as at A in figure 2-2-24, slant the punch as shown at B and again strike with the hammer, thus enlarging the punchmark and centering it exactly. When the intersection has been correctly punched, finish off with a light blow on the punch held in an upright position. C shows the corrected punchmark.

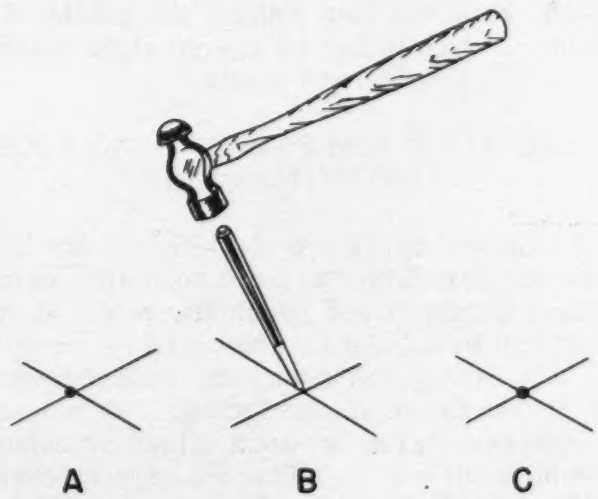

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Figure 2-2-24.—Marking the intersection of lines with a prick punch.

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LAYOUT WITH DIVIDER AND PRICK FOR A LARGE HOLE

Where exactness is required in locating a hole for drilling, make a layout and drill a pilot hole to pilot or guide the final size drill. In general, as drill sizes increase and the thickness of the web at the point of the drill increases, a pilot hole becomes more of a necessity. The web of a drill, as shown at (A) in figure 2-2-25, is the solid center of the point extending the length of the flutes. As the web does not actually drill and remove chips, a pilot hole is necessary for accurate drilling, both to remove the metal in this area, and to provide a true path for the larger drill to follow. (See fig. 2-2-25B.) The accuracy with which the pilot hole is located and drilled determines, in part, the accuracy of the location of the final or "size" hole.

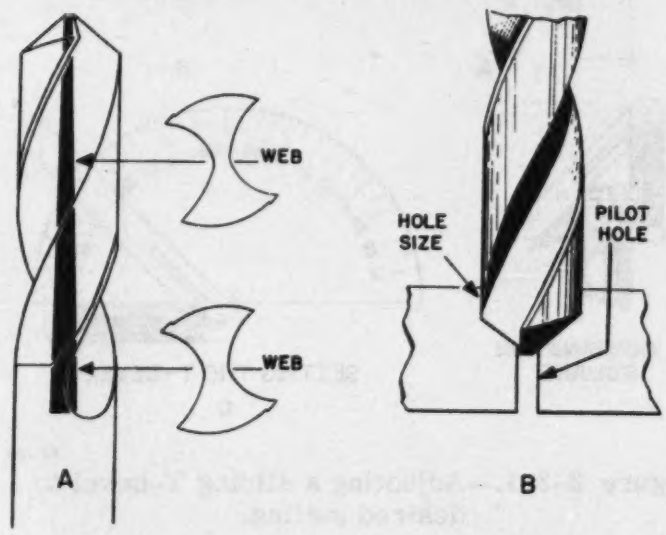

Figure 2-2-25.—Drilling a large hole.

To lay out a hole for accurate drilling, first apply layout dye sparingly to the surface to be laid out. Then place one leg of the divider in the prick punchmark which located the center of the hole and scribe a circle the size of the hole to be drilled. With the same center, scribe another smaller circle (called the pilot-hole proof circle), the diameter of which is equal to the diameter of the pilot drill. (See fig. 2-2-26A.) In figure 2-2-26, the size of the pilot hole has been greatly exaggerated compared to the pilot-hole size which would actually be used for the final-hole size shown. This is done only to clarify the illustration. Then, as shown in figure 2-2-26B prick punch both circles along their circumferences to complete the layout. In figure 2-2-26C, the pilot hole has been drilled to its layout line as indicated by the half prick punchmarks that remain on the pilot-hole proof circle.

PUNCH MATING PARTS WITH A CENTER PUNCH FOR REASSEMBLY

Before taking a mechanism apart, make a pair of center punchmarks in one or more places to help in reassembly. To do this, select places, staggered as shown in figure 2-2-27, where matching pieces are joined. First clean the places selected. Then scribe a line across the joint and center punch the line on both sides of the joint, with single and double marks as shown to eliminate possible errors. In reassembly, refer first to the sets of punchmarks to determine the approximate position of the parts. Then line up the scribed lines to determine the exact position.

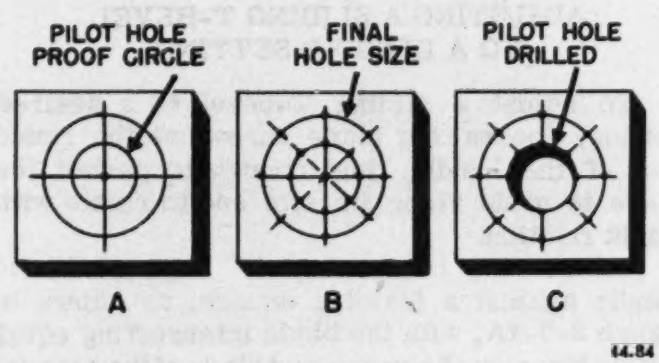

Figure 2-2-26.—Laying out a hole for accurate drilling.

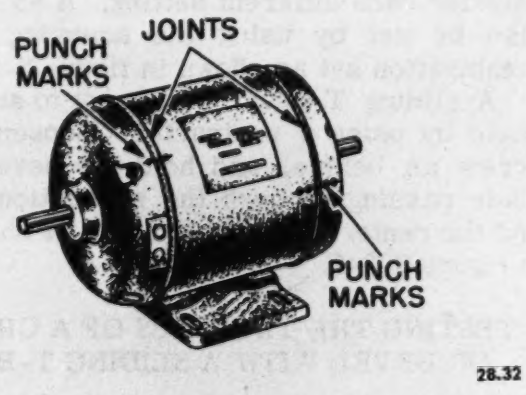

Figure 2-2-27.—Prick-punching mating parts of a mechanism.

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PART II

Section 3

TESTING, CHECKING AND SETTING

Many of the measuring and layout tools used by mechanics in the Navy also are used for inspecting a finished product or partly finished product. Inspection operations consist of testing, checking, and setting of a piece of work. This is accomplished by comparing the dimensions or shape of a piece of work with the required dimensions given on a drawing or sketch. There are many specialized tools especially made for checking certain jobs. It is not the purpose however, of this section to give detailed explanations of special tools, but rather to show how to use some of the more common handtools for testing, checking, and setting.

ADJUSTING A SLIDING T-BEVEL TO A DESIRED SETTING

To adjust a sliding T-bevel to a desired setting, loosen the blade screw, at the round end of the handle, just enough to permit the blade to slide along its slot and to rotate with slight friction.

To set the blade at a 45° angle, hold the handle against a framing square, as shown in figure 2-3-1A, with the blade intersecting equal graduations on the tongue and blade of the square. Or: hold the bevel against the edges of a 45° drafting triangle as shown in figure 2-3-1B. When using drafting triangles for setting a sliding T-bevel, different size triangles must be used for each different setting. A 45° angle can also be set by using the squaring head of a combination set as shown in figure 2-3-1C.

A sliding T-bevel can be set to any desired angle by using a protractor. Loosen the blade screw as before, and hold the bevel with its blade passing through the graduation selected, and the center of the protractor as shown at (D) in figure 2-3-1.

TESTING THE TRUENESS OF A CHAMFER OR BEVEL WITH A SLIDING T-BEVEL

To test a chamfer or bevel for trueness, set the T-bevel to the required angle, and hold the handle to the working face of the stock being tested. Face a source of light, and with the blade brought into contact with the surface to be tested, pass the blade along the length of the surface. (See fig. 2-3-2.) The appearance of light between the blade and the surface of the stock indicates where the angle is not correct. Figure 2-3-2 indicates the checking of a bevel, but testing the trueness of a chamfer is accomplished in the same way.

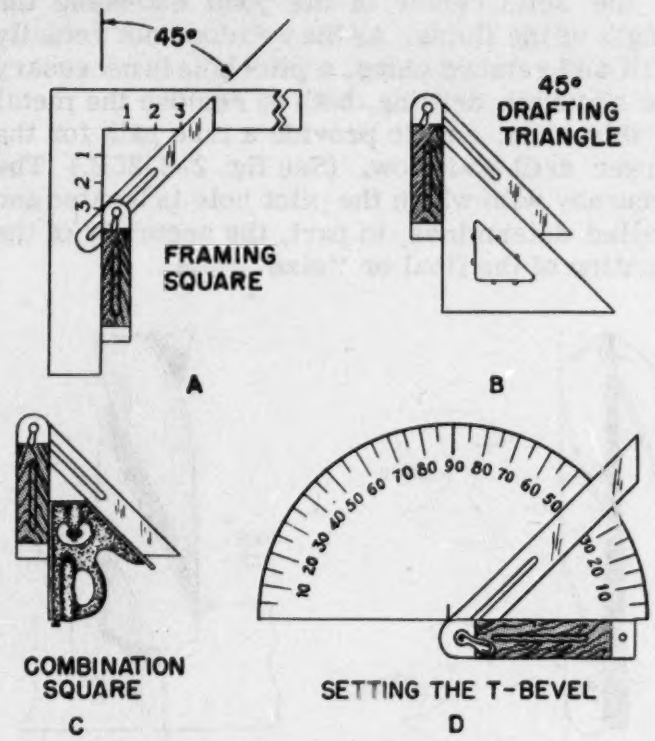

Figure 2-3-1.—Adjusting a sliding T-bevel to a desired setting.

TESTING TRUENESS OF A 45° ANGLE WITH A COMBINATION SQUARE

To test trueness of 45° angles with a combination square, hold the body of the square in contact with one surface of the 45° angle, and move the blade into contact with the other. (See

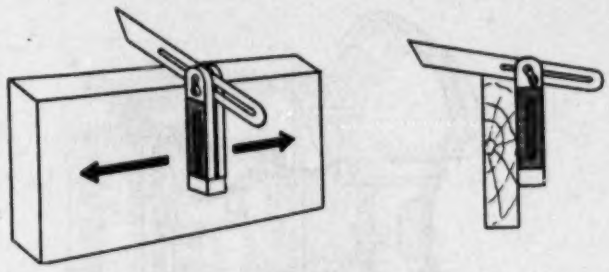

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Figure 2-3-2.—Testing the trueness of a bevel.

fig. 2-3-3.) In making this test, have the square between yourself and the source of light. If the angle is a true 45° angle, no light will be visible between the blade and the surface of the work.

TESTING TRUENESS OF A 90° ANGLE WITH A COMBINATION SQUARE

To test trueness of 90° angles with a combination square, hold the body of the square in contact with one surface of the 90° angle and bring the blade into contact with the other. (See fig. 2-3-4.) In making this test, have the square between yourself and a good source of light. If the angle is a true 90° angle, no light will be visible between the blade and the surface of the work.

SETTING A SURFACE GAGE FOR HEIGHT

To set a surface gage for height, first wipe off the top of a layout table or surface plate and the bottom of the surface gage. Use either a combination square or a rule with rule holder to get the measurement. A rule alone cannot be held securely without wobbling and consequently an error in setting generally results. Because a combination square is generally available, its use for setting a surface gage is explained in this section.

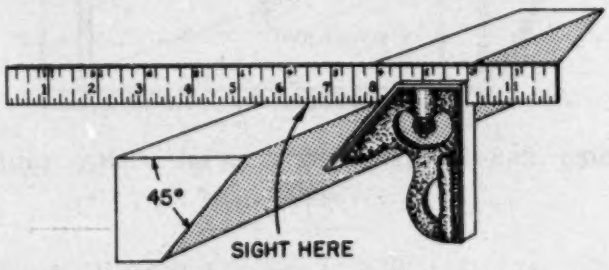

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Figure 2-3-3.—Testing the trueness of a 45° angle with a combination square.

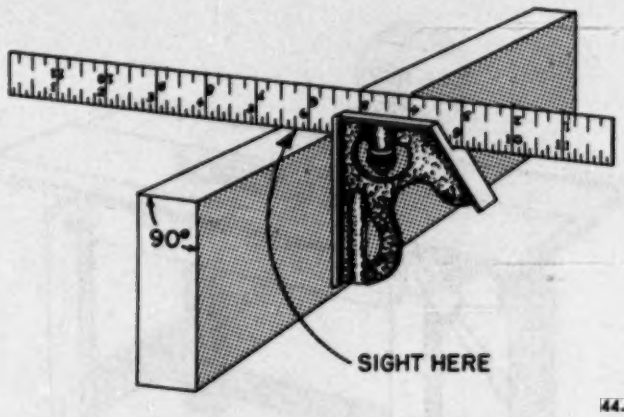

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Figure 2-3-4.—Testing the trueness of a 90° angle.

Place the squaring head of a combination square on a flat surface as shown in figure 2-3-5, and secure the scale so that the end is in contact with the surface. Move the surface gage into position and set the scriber to the approximate height required, using the adjusting clamp that holds the scriber onto the spindle. Make the final adjustment for the exact height required (4 1/2 inches in this case) with the adjusting screw on the base of the gage.

LEVELING AND PLUMBING EQUIPMENT WITH A CARPENTER'S LEVEL

To level a piece of equipment, such as the workbench in figure 2-3-6, set a carpenter's level on the bench top parallel to the front

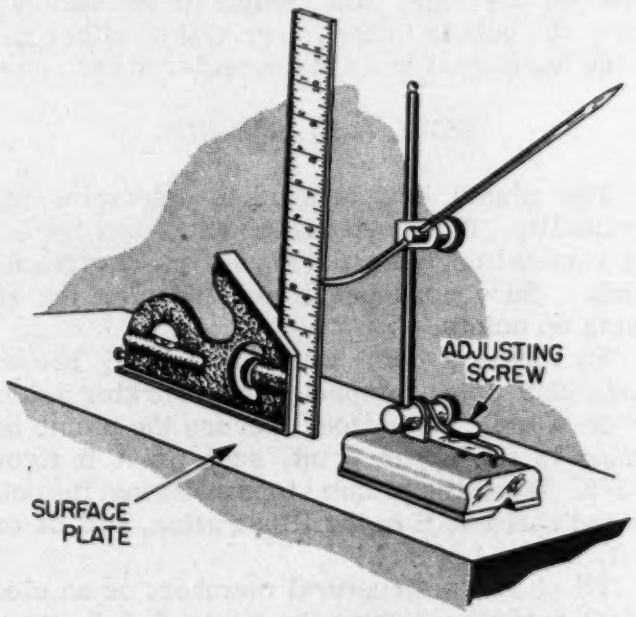

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Figure 2-3-5.—Setting a surface gage to height.

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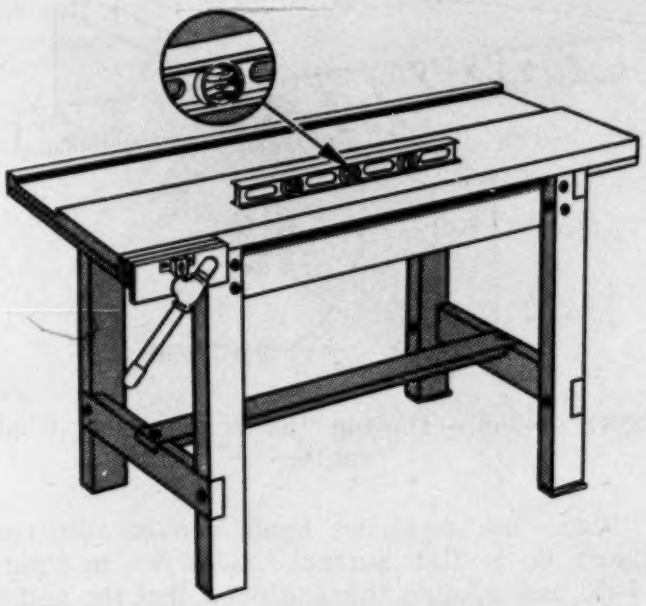

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Figure 2-3-6.—Leveling a bench.

edge of the bench. Notice that the level may have as many as three or more pairs of glass vials. Regardless of the position of the level, always watch the bubble in the bottom vial of a horizontal pair. Shim or wedge up the end of the bench that will return that bubble to the center of its vial. Recheck the first position of the level before securing the shims or wedges.

To plumb a piece of equipment, such as the drill press shown in figure 2-3-7, place the level on the side and on the front of the main column of the press. Figure 2-3-7 shows the level on the side. Use shims as necessary to bring the bubble in the lower vial of either pair of the horizontal vials to the center in each case.

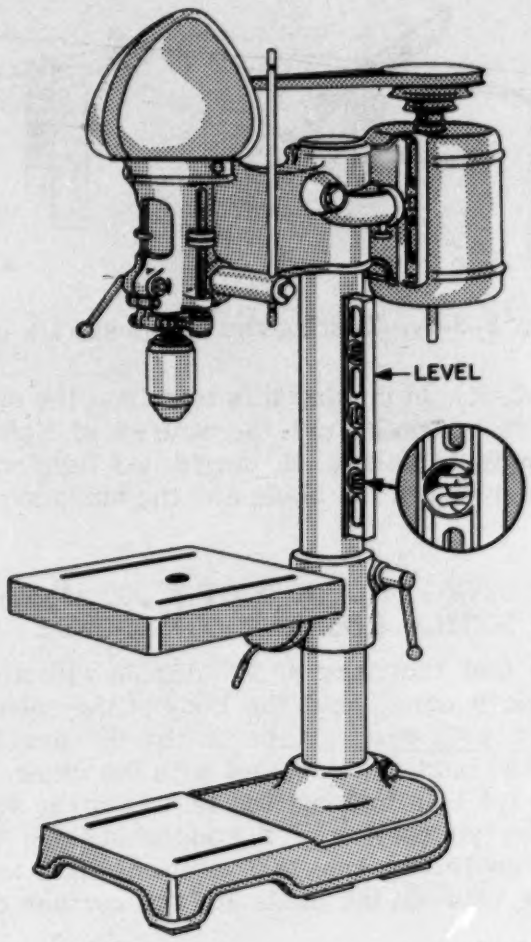

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Figure 2-3-7.—Plumbing a piece of equipment with a level.

USING A PLUMB BOB

The plumb bob is used to determine true verticality. It is used in carpentry when erecting vertical uprights and corner posts of framework. Surveyors use it for transferring and lining up points.

To locate a point which is exactly below a particular point in space, when working ashore or on a ship in drydock, secure the plumb bob string to the upper point, such as A in figure 2-3-8. When the plumb stops swinging, the point as indicated at B in the illustration, will be exactly below A.

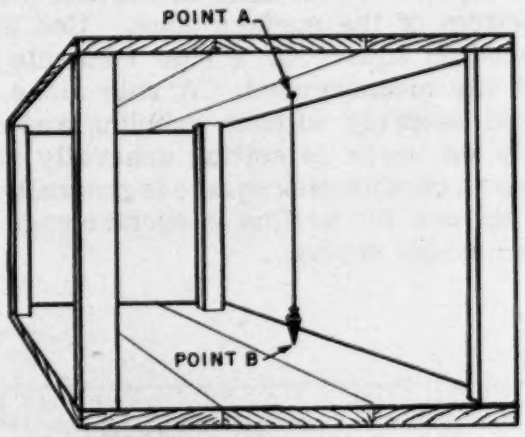

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Figure 2-3-8.—Locating a point with a plumb bob.

To plumb a structural member, or an electrical conduit, as shown by figure 2-3-9, secure the plumb line A so that you can look at both the line and piece behind the line. Then, by sighting, line up the member or conduit with the plumb line.

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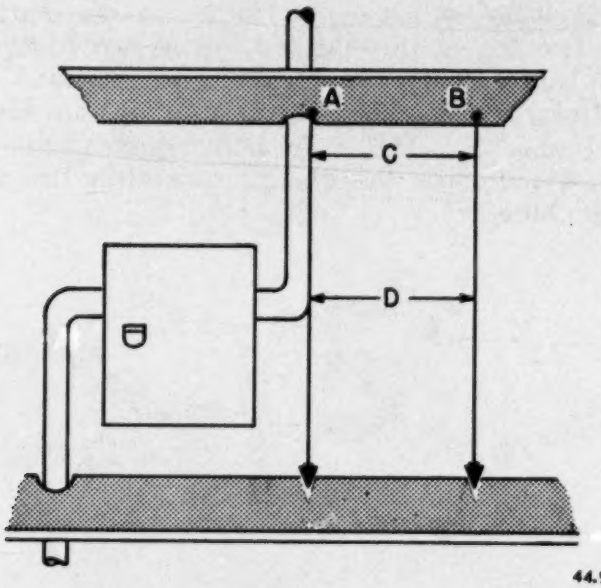

Figure 2-3-9.—Plumbing a structural member with a plumb bob.

If this cannot be done, it may be necessary to secure the plumb line at some point such as B, and then measure the offset from the line to the piece at two places so that, for example, C and D in figure 2-3-9 are equal. If the distances between C and D are not equal, adjust the structural member or conduit until they are.

USING A THICKNESS GAGE FOR CHECKING CLEARANCE BETWEEN SURFACES

To check clearance between surfaces, first clean the surfaces where the check will be made. Then insert blades of the thickness gage (fig. 1-1-86) into the clearance between the surfaces until a blade is found that enters with a slight drag. Then read the gage as follows.

In figure 2-3-10, the thickness gage leaf and the piston ring will both fit into the ring groove in the piston at the same time. Therefore, the number that appears on that leaf of the gage represents the number of thousandths of an inch of clearance there is between the piston ring and the side of the groove in the piston. All thickness gages have the thickness given on each leaf as a decimal part of an inch, such as 0.003", or 0.025". When necessary, two or more leaves can be used together for larger clearances. Keep the leaves clean and handle them with care so as not to cause damage to their edges or polished surfaces.

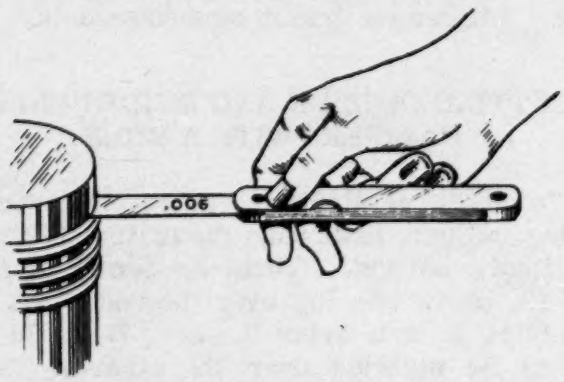

Figure 2-3-10.—Checking piston ring clearance with a thickness gage.

TESTING A SURFACE FOR FLATNESS

To test a surface for flatness, carefully clean it and remove all burrs. Then place the surface of the object on a flat area such as the surface plate in figure 2-3-11. Any rocking motion that is apparent will indicate a variance from flatness of the piece being tested.

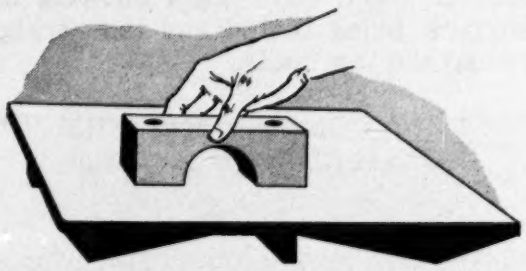

Figure 2-3-11.—Testing a surface for flatness.

To determine how much variation there is from flatness—and where it is—you can insert leaves of a thickness gage to determine the amount of variation of flatness. Remember to add the thickness of all leaves together to get the total variation. (See fig. 2-3-12.)

For very fine work, lightly coat the surface plate with prussian blue (bearing blue) and move the piece being tested across the blue surface. (See fig. 2-3-13.) The low spots on the surface

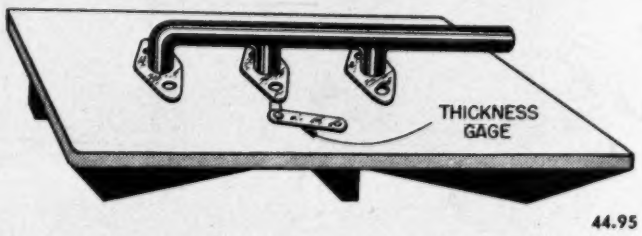

Figure 2-3-12.—Checking the conformity of a flat surface.

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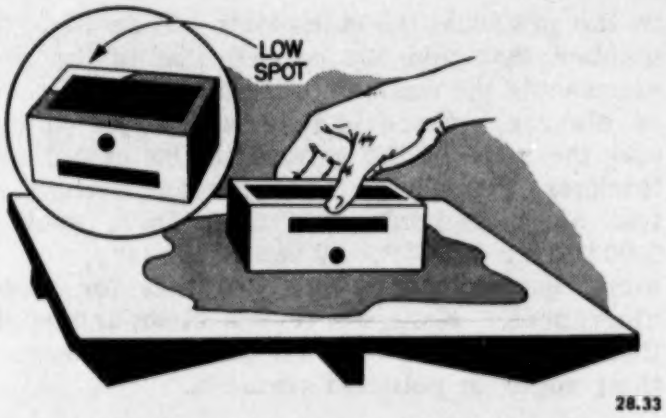

Figure 2-3-13.—Using prussian blue to aid in testing a flat surface.

being tested will not take the blue; the high spots will. See insert in figure 2-3-13.

A surface also may be tested for flatness with a straightedge. To do this, clean the surface thoroughly and hold the straightedge on the surface in several places as you look toward a source of light. The light showing between the surface being tested and the straightedge will reveal the low spots.

SETTING A COMBINATION FIRM JOINT CALIPER WITH A RULE

To set a combination firm joint caliper with a rule, when the legs are in position for outside measurements, grasp the caliper with both hands, as shown in figure 2-3-14A, and adjust both legs to the approximate setting. By adjusting both legs, the shape of the tool will be approximately symmetrical. Thus it will maintain its balance and be easier to handle.

Check this approximate setting and subsequent adjustments to the setting, as shown in 2-2-14B by resting one leg on the end of the rule. Sight squarely across the other leg at the graduations on the rule to get the exact setting required.

Figure 2-3-14.—Setting a combination firm joint caliper.

If it is necessary to decrease the setting, tap one leg of the caliper, as shown in figure 2-3-15A. If it is necessary to increase the setting, tap one leg of the caliper, as shown in figure 2-3-15B. In both illustrations the arrow indicates the change in setting that will take place.

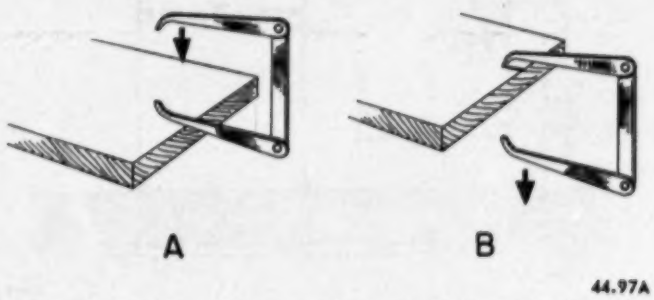

Figure 2-3-15.—Decreasing and increasing the setting of a firm joint caliper.

When the caliper is set for inside measurements, the same directions for adjusting the setting apply. Figure 2-3-16 shows how the end of the rule and one leg of the caliper are rested on the bench top so that they are exactly even with each other when the reading is taken.

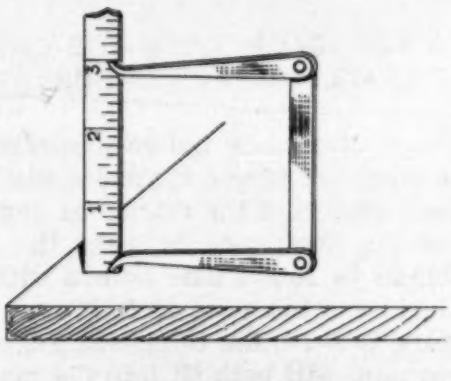

Figure 2-3-16.—Setting a combination firm joint caliper for inside measurements.

SETTING OUTSIDE AND INSIDE SPRING CALIPERS WITH A RULE

To set a particular reading on an outside spring caliper, first open the caliper to the approximate setting. Then, as shown in figure 2-3-17, place one leg over the end of the rule, steadying it with index finger. Make the final setting by sighting over the other leg of the caliper, squarely with the face of the rule at the reading, and turning the knurled adjusting nut until the desired setting is obtained. To

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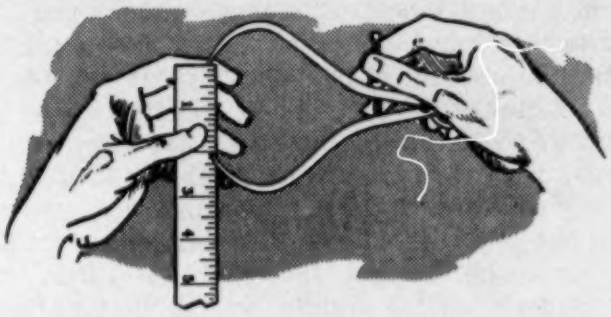

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Figure 2-3-17.—Setting an outside spring caliper.

set an inside spring caliper to a particular reading, place both caliper and rule on a flat surface as shown in figure 2-3-18. The rule must be held squarely or normal (90° in both directions) to the surface to ensure accuracy. Adjust the knurled adjusting nut, reading the setting on the rule with line of sight normal to the face of the rule at the reading.

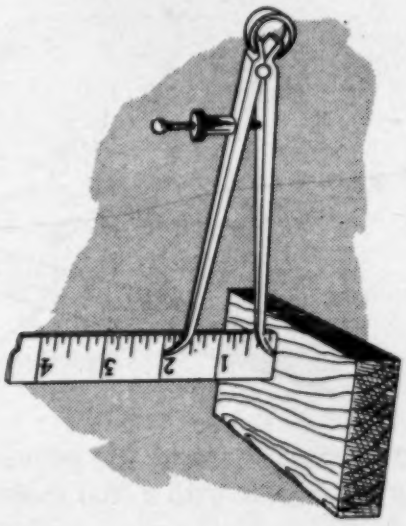

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Figure 2-3-18.—Setting an inside spring caliper.

TRANSFERRING MEASUREMENTS FROM ONE CALIPER TO ANOTHER

To transfer a measurement from one spring caliper to another, hold the calipers as shown in figure 2-3-19. Note that one of the man's fingers is extended to steady the point of contact of the two lower caliper legs. In this figure the inside caliper is being adjusted to the size of the outside caliper. As careful measurements with calipers depend on one's sense of touch, which is spoken of as "feel," calipers are best

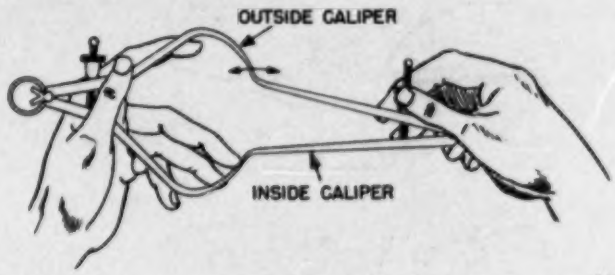

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Figure 2-3-19.—Transfering a measurement from an outside to an inside caliper.

held lightly. When you notice a slight drag, the caliper is at the proper setting.

SETTING A DIVIDER TO REQUIRED DIMENSIONS

In setting a divider to a dimension on a scale, the usual procedure is to locate one point in one of the inch graduations of the rule and turn the knurled adjusting nut or screw so that the other point falls easily into the desired graduation. (See fig. 2-3-20.) Make certain the points of the divider are not blunt.

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Figure 2-3-20.—Setting a divider using a rule.

Most vernier calipers, except the larger sizes, have two center points similar to prick punchmarks. These are particularly useful in setting a divider to exact dimensions. One center point will be found near the zero end of the scale on the rule. The other point is in line with the first and to the left of the zero on the vernier scale. (See fig. 2-3-21.)

Set and secure the desired setting on the vernier caliper and adjust the divider until both points readily enter the center points on the vernier caliper as in figure 2-3-21.

TRANSFERRING A MEASUREMENT TO AN OUTSIDE MICROMETER

To transfer a measurement from an inside spring caliper, a telescoping gage, or an inside

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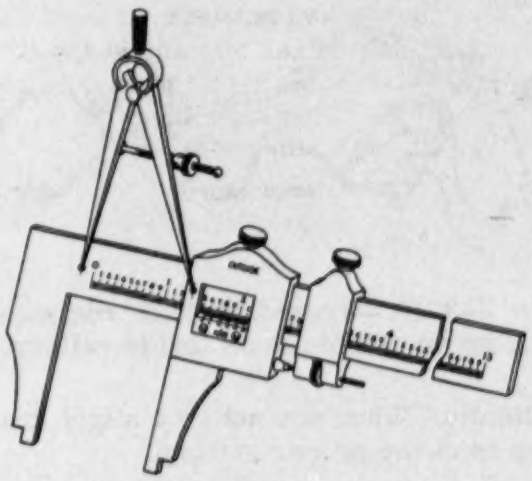

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Figure 2-3-21.—Setting a divider with a vernier caliper.

micrometer caliper to an outside micrometer caliper as shown in figure 2-3-22, proceed as you would to measure the outside diameter of round stock. In effect, you are simply measuring the setting of one of these tools with the outside micrometer. You proceed as you would in calipering round stock because the contact area is small and the contact pressure on the micrometer must be kept at a minimum. Use the ratchet stop, if the micrometer has one, to provide the correct pressure.

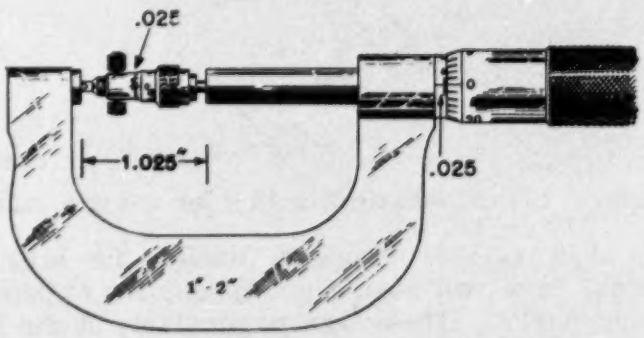

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Figure 2-3-22.—Transfering a measurement from an inside to an outside micrometer caliper.

The transfer of a measurement from the inside to the outside micrometer calipers can be a check on their accuracy, as both readings should be exactly the same. If they are not, first check the zero setting on each according to the manufacturer's instructions and make any necessary corrections. Then take a reading on a known dimension with the outside caliper such as on a gage block. This gage block must be somewhere between 1" and 2" in size, since the micrometer shown has a 1" to 2" range. If this reading does not check out, the threads on the spindle and in the sleeve of the outside micrometer are probably worn. This requires returning the micrometer to the manufacturer for repairs.

If the gage test shows the outside micrometer caliper to be correct, the trouble is likely with the threads on the inside micrometer caliper. It, also, must be sent to the manufacturer for repairs.

CHECKING HEIGHT WITH A DIAL INDICATOR

To check height with a dial indicator, support the indicator with a surface gage, as shown in figure 2-3-23. This figure shows the surface

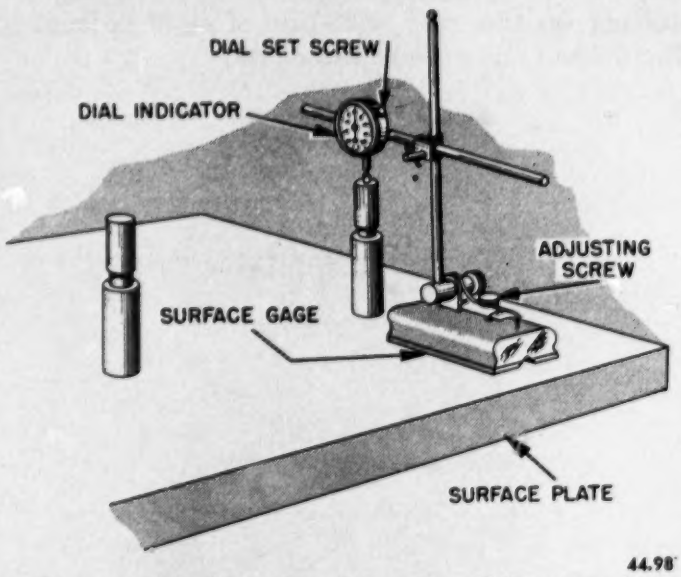

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Figure 2-3-23.—Checking the difference in heights of objects with a dial indicator.

gage and two objects resting on a surface plate. With the adjusting screw on the surface gage, move the indicator down into contact with the first object and secure the setting when the hand has moved about five-thousandths on the dial. Release the dial setscrew that is at the edge of the dial, rotate the dial to aline the zero with the hand, and retighten the setscrew. Then, without changing any of the adjustments, carefully slide the surface gage along the surface plate to take a dial indicator reading on the other object, or move the other object under the spindle of the dial indicator. The plus or minus reading on the dial will indicate the number of thousandths of an inch that the two objects differ in height.

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If the second object being checked is more than five-thousandths of an inch shorter than the first, reset the dial indicator lower to get the difference reading.

TESTING THE TRUENESS OF SHAFTS AND WHEELS WITH A DIAL INDICATOR

To test the trueness of a shaft between centers (fig. 2-3-24), set up a dial indicator on a surface

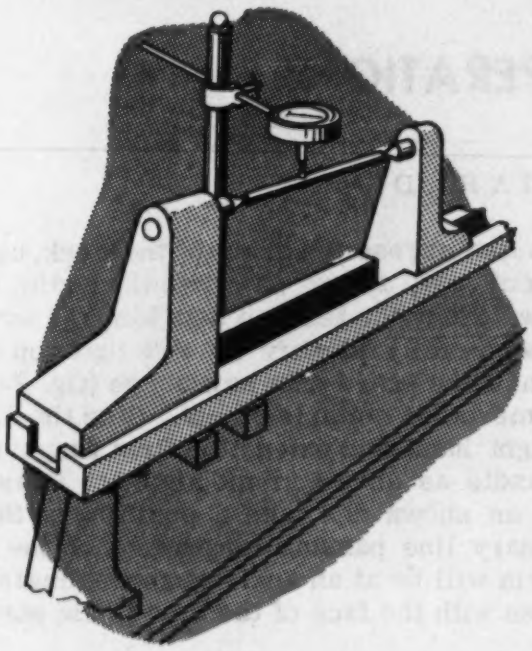

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Figure 2-3-24.—Testing the trueness of a shaft between centers.

gage so that the contact point of the spindle rests on the shaft near the middle. Now turn the shaft slowly as you watch the needle on the dial. A bent shaft, as it turns, will cause the spindle to move up or down. This motion is registered on the dial which is calibrated in one-thousandths of an inch. To read the total "runout" of the shaft, which means the amount it is bent out of line, loosen the dial setscrew that secures the rim of the indicator case and adjust the dial so that the zero coincides with the needle at one end of its travel. Then turn the shaft and take the reading at the other end of the needle's travel. This reading will indicate the number of thousandths of an inch the shaft is out of true, and it will enable you to find the high side as the shaft rotates.

To test the trueness of a wheel, gear, or sheave, set up the dial indicator so that its spindle is parallel to the shaft on which the wheel is mounted, and so that the tip of the spindle bears on the side of the wheel near its outer edge. As the wheel is rotated, the needle will indicate the runout in thousandths of an inch and enable you to find the place where it is at the maximum. (See fig. 2-3-25.)

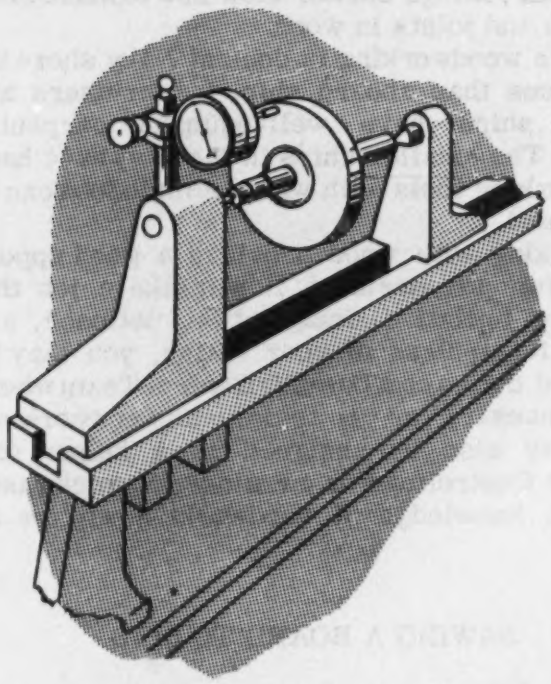

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Figure 2-3-25.—Testing the trueness of a wheel.

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PART II

Section 4

WOODCUTTING OPERATIONS

Although Navy ships are now made largely of steel and other metals, there are still plenty of woodcutting operations to be performed. Men in nearly all ratings should know how to make simple cuts and joints in wood.

More woodworking is done at Navy shore installations than aboard ship, but cruisers and larger ships have well-equipped carpenter shops. The smaller ships in the Navy have hand woodworking tools with which simple jobs can be performed.

Working with wood provides a good opportunity for advancement if you like a job that calls for initiative, imagination, patience, and skill. Regardless of your rating, you may be assigned duties on a Damage Control Team where it is necessary for you to do some woodworking. You may also be assigned as a helper to a Damage Controlman or a Builder; in which cases a basic knowledge of woodworking will be an asset.

SAWING A BOARD TO SIZE

One of the most important operations you will perform with wood is the proper laying out and cutting of stock lumber. Laying out is explained in part II, section 2, of this course.

It is important to determine at the beginning that the quality of stock fits your needs. Examine the stock for knots and checks, and lay out the job so that the imperfections will be cut away or will appear on the back side or underneath side where they will not be seen.

Check the stock to be certain that it is of proper size to ensure the required thickness and width of the piece you need. When laying out the job, keep in mind that there should be as little waste of material as possible.

USING A HAND SAW

To saw across the grain of the stock, use the crosscut saw, and to saw with the grain, use a ripsaw. Study the teeth in both kinds of saws so you can readily identify the saw that you need.

Place the board on a saw horse (fig. 2-4-1), or some other suitable object. Hold the saw in the right hand and extend the first finger along the handle as shown in the figure. Grasp the board as shown and take a position so that an imaginary line passing lengthwise of the right forearm will be at an angle of approximately 45 degrees with the face of the board. Be sure the

Figure 2-4-1.—Proper position for sawing a board to size.

side of the saw is plumb or at right angles with the face of the board. Place the heel of the saw on the mark. Keep the saw in line with the forearm and pull it toward you to start the cut.

To begin with, take short, light strokes, gradually increasing the strokes to the full length of the saw. Do not force or jerk the saw. Such procedure will only make sawing more difficult. The arm that does the sawing should swing clear of your body so that the handle of the saw operates at your side rather than in front of you.

Use one hand to operate the saw. You may be tempted to use both hands at times, but if your saw is sharp, one hand will serve you better. The weight of the saw is sufficient to make it cut. Should the saw stick or bind, it may be because the saw is dull and is poorly "set." The wood may have too much moisture in it, or you may have forced the saw and thus have caused it to leave the straight line.

Keep your eye on the line rather than on the saw while sawing. Watching the line enables you to see just the moment that the saw tends to leave the line. A slight twist of the handle, and taking short strokes while sawing, will bring the saw back. Blow away the sawdust frequently so you can see the layout line.

Final strokes of the cut should be taken slowly. Hold the waste piece in your other hand so the stock will not split when taking the last stroke.

Short boards may be placed on one sawhorse when sawing. Place long boards on two sawhorses, but do not saw so your weight falls between them or your saw will bind. Place long boards so that your weight is directly on one end of the board over one sawhorse while the other end of the board rests on the other sawhorse.

Short pieces of stock are more easily cut when they are held in a vise. When ripping short stock it is important that you keep the saw from sticking, so it may be necessary to take a squatting position. The saw can then take upward direction and thus work easily. When ripping long boards it will probably be necessary to use a wedge in the saw kerf to prevent binding (See fig. 2-4-2.)

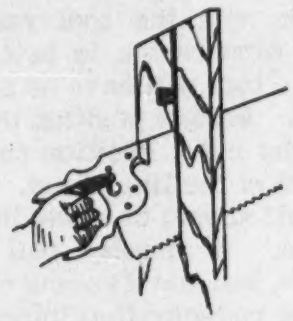

44.102

Figure 2-4-2.—Using a wedge in a saw kerf to prevent binding.

USING PORTABLE CIRCULAR SAW

When you use a portable electric circular saw for cutting stock to size, make layout lines the same as if you were using a hand saw. Adjust the depth of the saw cut, never allowing more than 1/4 inch of the saw blade to protrude through the material. When crosscutting (across the grain) turn the ripping guide up out of the way. Start the saw by pressing the switch in the handle. Allow the saw to run for a few seconds to see that it is operating properly.

NOTE: You should never use a power saw unless you have been instructed in its use by a proficient operator.

Place the stock to be cut on sawhorses or other support in such a way that it will not change its position while being cut. Accidents might occur when the power saw is used to cut short pieces that might slip or that are hard to hold. Hold the board with one hand, and guide the saw along the layout line with the other.

Somewhere at the front of the shoe of the saw is a line which tells you the cut line of the saw blade. By keeping this line traveling on the pencil mark you will know the cut will be true. If you find that you are traveling off the line, do not attempt to force the blade back into line again. It is best to back out the blade and make a new approach.

At the start of the cut, be sure the blade is not making contact with the work. Rest the tool on the work, line up the cut guide with the layout line, and when the blade has attained full speed, start cutting. Wood does not have uniform density, therefore, the cut will be easier in some places than in others. This is especially true when you are cutting through a knot in the wood. If at any time the saw begins to labor, slow up the feed pressure. It is not advisable to release the switch when the blade stalls or approaches a stall; instead, back the blade out from the cut until the saw resumes full speed, and continue the cut. Ease up on the feed pressure to compensate for the additional density through which you are cutting.

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Never work with the tool resting on the portion of the work which is being cut off. If you do this, the tool will have no support at the end of the cut. Always position the tool on the main side of the cut. Position yourself where your body is out of the line of cut.

The cut itself should be made just outside of the layout line. Remember that the saw cut (kerf) has width, and that if you cut exactly on the line, you will be reducing the dimension you need by at least half the width of the kerf.

When ripping a board with a saw that is equipped with a rip guide, it is not necessary to make a layout line. Set the rip guide to the desired width of the board as shown in figure 2-4-3. Feed the saw into the material in the same manner as when crosscutting. Push the saw forward so that the ripping gage will slide along the edge of the board. Observe the same precautions in handling the saw as in crosscutting.

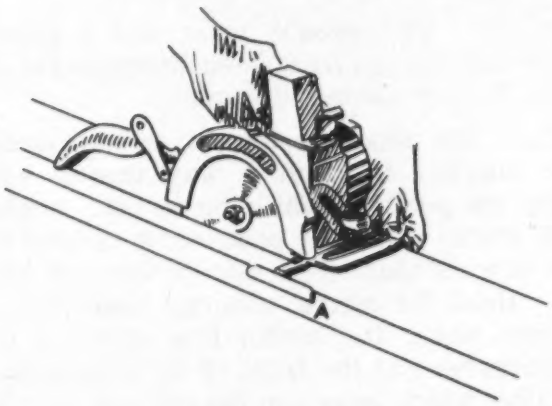

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Figure 2-4-3.—Ripping with a portable circular, using a ripping guide.

USING A RADIAL ARM SAW (CUT OFF)

When using a radial arm saw for cutting stock to size, it is important that you follow the manufacturer's manual in making the adjustments of the saw and securing the locks. Review the information of radial arm saws in section I part 2 of this course if you have any doubt as to what adjustments must be made. While the relationship of parts is basically the same on all saws, adjustment procedures may vary, so study the literature that comes with the machine you are operating.

To cut a board to size, first do the crosscutting that is necessary. Make the layout lines the same as for any other job. Before placing the board on the table of the saw, start the saw and let it come up to operating speed, and pass the saw back and forth through the line of cut to make sure it operates properly.

Place the board to be cut on the saw table against the guide fence and make sure the layout line is in line with the line of cut of the saw. Place your left hand to the left of the saw blade travel. (See fig. 2-4-4.) Turn on the switch and pull the blade gradually through the work. Then return the blade to the starting position.

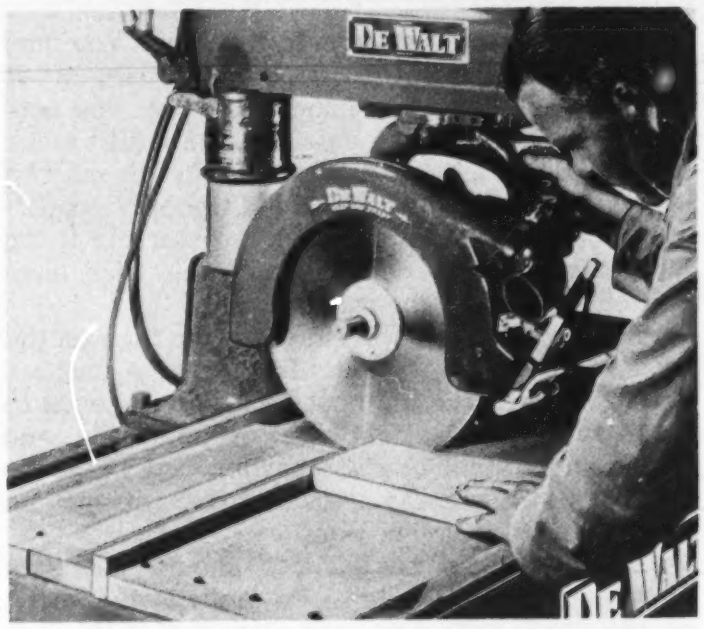

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Figure 2-4-4.—Crosscutting, using a radial arm saw.

The cut is complete when the blade has passed across the board width, but the operation is not complete until you have returned the blade to the rear of the arm travel. This is important: ALWAYS RETURN THE BLADE TO THE STARTING POSITION.

When ripping a board to size, push the work into the blade rather than pull the blade through the work. Set the saw blade parallel to the guide fence. Set the blade a distance from the guide fence equal to the width of the cut that you wish to make and lock the saw in position. (See fig. 2-4-5.)

Never feed the work in the direction of rotation of the blade. You must always feed against the rotation. Most saws are marked with arrows and warnings to help you remember correct feed direction for rip cuts.

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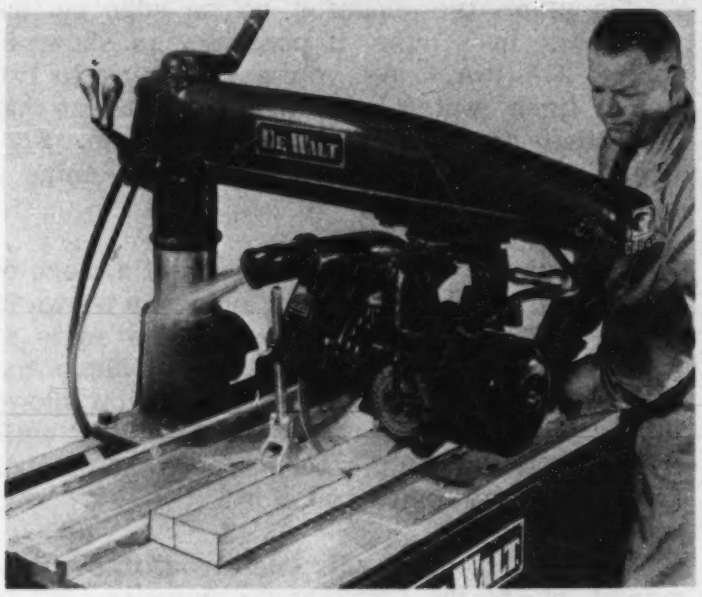

Figure 2-4-5.—Ripping, using a radial arm saw.

One edge of the work rides against the fence so it is important that the blade (in rip position) and the fence be parallel. If binding occurs it is a good sign that the blade is not in parallel alignment with the fence.

Feed the work into the saw at a moderate speed, but not so fast that the saw will stall. Keep your hand that is doing the feeding well away from the cutting area. Use push sticks (fig. 2-4-6) to feed the work into the saw when you near the end of the cut. When the cut is complete, turn off the switch, then remove the work from between the blade and fence. Never do this while the blade is turning.

ASSEMBLING AND ADJUSTING A PLANE FOR CUTTING

Part I, section 1, of this course has given a complete description of the different types of planes that you are likely to use in the Navy. It may be necessary to refer to that section occasionally to refresh your memory as to the relationship and names of the parts that will be mentioned in this section.

To assemble the plane iron or blade and the plane iron cap for cutting, first hold the cap and blade as shown in figure 2-4-7A. Notice that the bevel on the blade is on the side opposite the cap side. When the head of the cap screw has dropped through the hole in the blade, slide it down the slot in the blade to the position shown

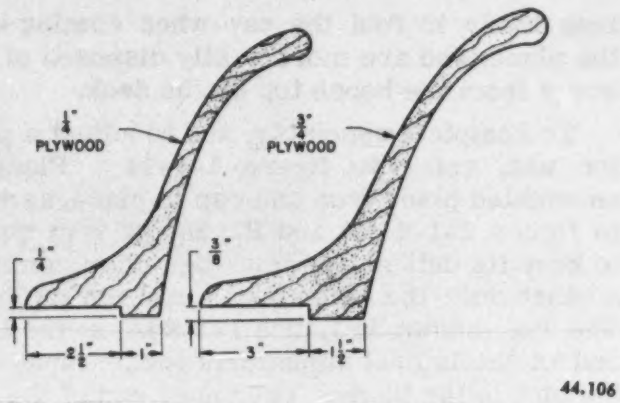

Figure 2-4-6.—Push stick for ripping.

in figure 2-4-7B. Then rotate the cap to the position shown in figure 2-4-7C, keeping the curved end of the cap well away from the cutting edge of the blade. Now slowly and carefully move the cap toward the cutting edge of the blade until it is about 1/32" away from the cutting edge as shown in figure 2-4-7D.

In part I section 1 figure 1-1-45A you will see the 1/32" setback from the end of the blade to the cap. The purpose of the cap is to curl the chips as they are cut off the wood by the cutting edge of the blade. This cap is sometimes called a chip breaker. The cap is fitted properly to the blade in figure 1-1-45A. Figure 1-1-45B shows a cap which has been improperly ground and therefore does not fit correctly. This will cause chips to become lodged between the blade and the cap. The improper fit may be corrected by filing or grinding the cap just behind its forward edge. In figure 1-1-45C the chip is being properly curled by the cap. Chips are curled so that they take a minimum of room, tend to break off as they increase in size, are

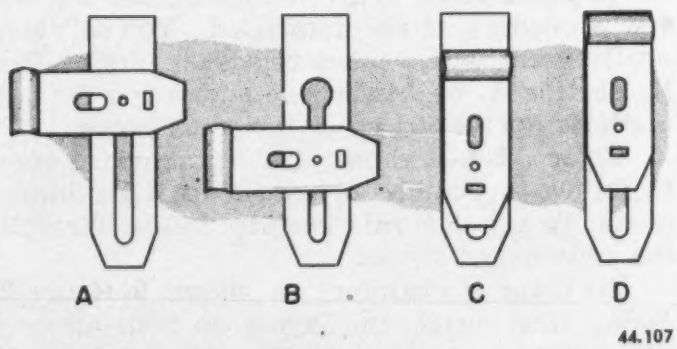

Figure 2-4-7.—Assembling a plane iron and cap for cutting.

less likely to foul the cap when coming out of the plane, and are more easily disposed of when swept from the bench top or the deck.

To complete assembly, and to adjust a plane for use, refer to figure 1-1-44. Place the assembled plane iron and cap in place, as shown in figure 1-1-44 (A and B), and be very careful to keep its delicate cutting edge from coming in contact with the other metal parts of the plane. The lug, shown in figure 1-1-44A, at the lower end of the lateral adjustment lever, must enter the slot in the blade. The upper end of the "Y" adjustment must enter the rectangular hole in the plane iron cap. The lever cap screw shown in figure 1-1-44C is used for adjusting the tension of the lever cap bearing on the plane iron cap. When the lever cap lever is down, as shown in 1-1-44C, and the lever cap is loose in its place, tighten the lever cap screw a quarter or a half turn at a time until the looseness disappears.

To adjust the plane for use (which means having the blade protruding through the bottom of the plane the proper amount, and having its edge parallel to the bottom of the plane), refer to figures 1-1-46 and 1-1-47. As you sight along the bottom of the plane, turn the adjusting nut until you can just barely see the blade protruding through the bottom of the plane. Figure 1-1-46 (B and C) shows you (greatly exaggerated) what to look for. The three views in figure 1-1-47 indicate how either one corner or the other of the plane iron can be withdrawn by moving the lateral adjusting lever from left to right. The final position of the lateral adjusting lever is not important. What is important is to have the blade protruding evenly across the width of the bottom of the plane.

PLANING STOCK TO GIVEN DIMENSIONS

To plane stock to given dimensions, a standard procedure is recommended. You will generally start with a piece of square stock. Part II, section 3, of this course shows you the best methods for testing stock for squareness.

Figure 2-4-8 shows the six standard steps to follow in planing any stock to given dimensions; to get accurate results, follow carefully the procedures shown.

To plane a chamfer, as shown in figure 2-4-9A, first make the layout on both sides of the corner to be chamfered. Figure 2-4-9 (B and C) show these layout lines being made with a marking gage.

To plane the chamfer on an edge secure the stock in a vise, if possible, as shown in figure 2-4-10A. As you are planing to two layout lines, watch both lines carefully so that both lines are reached at the same time. Figure 2-4-10B shows an end view of planing a chamfer on an edge.

To plane a chamfer on the end of a piece of stock, secure the stock and plane as shown in figure 2-4-11. Notice carefully the angle at which the plane is being held. Move the plane according to the directional arrow shown in the figure, and work from left to right until the entire width of the stock has been chamfered. Layout lines are used as before.

To plane a bevel only one layout line is required due to the fact that the opposite edge of the stock serves as the other layout line. Plane the bevel as you would plane a chamfer, holding the stock in a vise.

To plane across end grain, figure 2-4-12A, hold the block plane at an angle so that the blade will make a shearing cut. Block-plane adjustments are basically the same as those for smoothing and jack planes. See figure 2-4-12B. To assemble a block plane, which has a cap similar to the lever cap on a smoothing plane but has no plane iron cap, insert the blade carefully into the body with the bevel up. This position of the plane iron is just opposite to the plane iron position in planes with lever caps. A block plane has a very low blade angle to facilitate planing across grain. If the plane-iron bevel were down, its heel would not permit the cutting edge to come into contact with the surface of the work.

To see how to prevent splitting the edge of the stock when planing across its end, refer to figure 2-4-13. At (A) the presence of the layout line indicates that the board has not yet been planed to its required width. The splitting that occurs is therefore in the scrap area. At (B) the end is first planed from one edge toward the middle and then from the other. No splitting ever takes place when the plane enters the cut, but does occur when it leaves the cut at the edge of the work. In this method it does not leave the cut at the edge. At (C) a bar clamp holds a piece of scrap stock in place to back up the job at one edge. Again splitting occurs, but in the scrap stock.

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1. WORK FACE

PLANE ONE BROAD SURFACE SMOOTH AND STRAIGHT. TEST IT CROSSWISE, LENGTHWISE, AND FROM CORNER TO CORNER. MARK THE WORK FACE X.

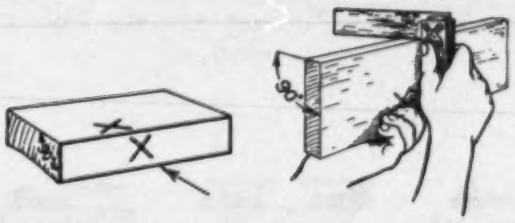

2. WORK EDGE

PLANE ONE EDGE SMOOTH, STRAIGHT AND SQUARE TO THE WORK FACE. TEST IT FROM THE WORK FACE. MARK THE WORK EDGE X.

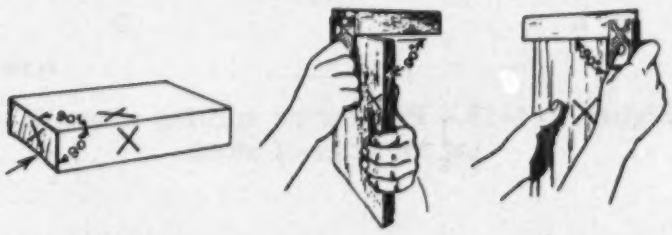

3. WORK END

PLANE ONE END SMOOTH AND SQUARE. TEST IT FROM THE WORK FACE AND WORK EDGE. MARK THE WORK END X.

4. SECOND END

MEASURE LENGTH AND SCRIBE AROUND THE STOCK A LINE SQUARE TO THE WORK EDGE AND WORK FACE. SAW OFF EXCESS STOCK NEAR THE LINE AND PLANE SMOOTH TO THE SCRIBED LINE. TEST THE SECOND END FROM BOTH THE WORK FACE AND THE WORK EDGE.

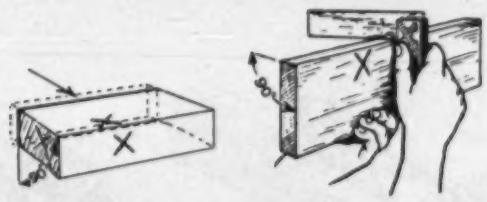

5. SECOND EDGE

FROM THE WORK EDGE GAUGE A LINE FOR WIDTH ON BOTH FACES. PLANE SMOOTH, STRAIGHT, SQUARE AND TO THE GAUGE LINE. TEST THE SECOND EDGE FROM THE WORK FACE.

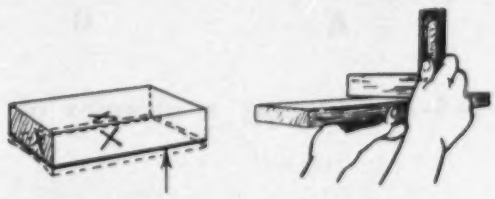

6. SECOND FACE

FROM THE WORK FACE GAUGE A LINE FOR THICKNESS AROUND THE STOCK. PLANE THE STOCK TO THE GAUGE LINE. TEST THE SECOND FACE AS THE WORK FACE IS TESTED.

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Figure 2-4-8.—Steps to follow in planing any stock to a given size.

USING A DRAWKNIFE (DRAWSHAVE) FOR ROUGHING OUT A CURVE

A drawknife is useful for roughing out a curve or any irregular surface in lumber. This is especially true where a large amount of waste material must be removed.

To use a drawknife, first make the layout lines on the stock material where they are needed. Clamp the stock in a vise or otherwise hold it securely. The drawknife is always pulled toward the operator with both hands and since, in most cases, you will be cutting both with and across the grain of the stock, it is advisable to work first on one side of the cut then the other. This procedure will lessen the chances of splitting the stock. Keep the bevel side of the blade up for ordinary work, and move one end of the blade slightly ahead of the other to give an oblique or sliding cut. This gives better control of the tool and enables you to cut to the layout line more easily.

After you have removed most of the excess material from the cut, use a wood rasp or sandpaper to smooth the cut even with the layout lines.

BORING HOLES IN WOOD

Boring holes is frequently necessary when working with wood. It is important, therefore, that you know the proper procedures and the tools that are used for this job.

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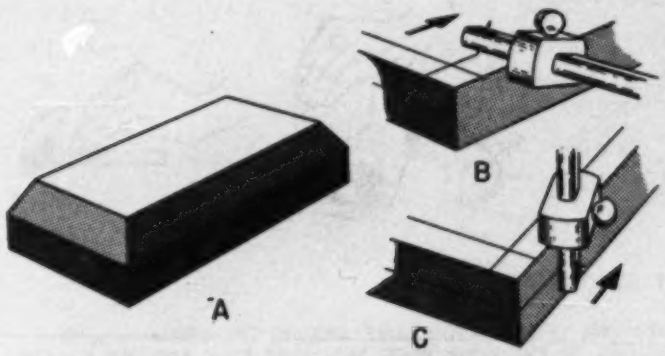

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Figure 2-4-9.—Laying out for planing a chamfer.

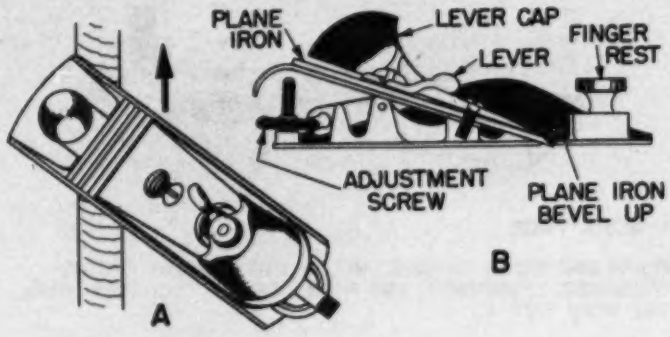

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Figure 2-4-12.—Planing across end grain of wood.

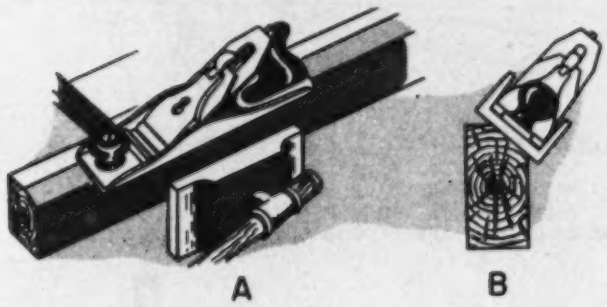

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Figure 2-4-10.—Planing a chamfer on stock.

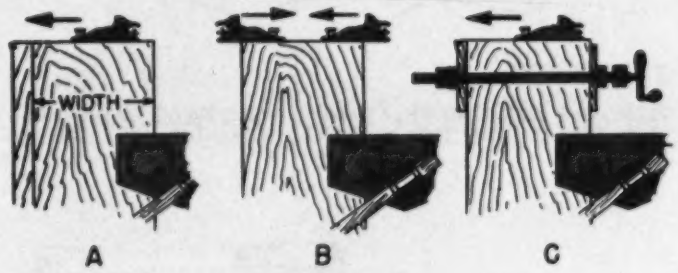

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Figure 2-4-13.—Preventing spliting when planing the edge of stock.

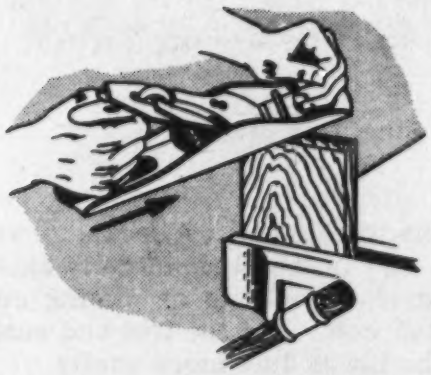

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Figure 2-4-11.—Planing a chamfer on the end of a piece of stock.

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Figure 2-4-14.—An auger bit file.

The auger bit is the tool that actually does the cutting in the wood; however, it is necessary that another tool be used to hold the auger bit and give you enough leverage to turn the bit. The tools most often used for holding the bit are the carpenter's brace, breast drill, push drill, and the drill press. All of these tools have been introduced in part I of this course.

For accurate boring, first mark the location for the center of the hole by the intersection of two cross lines, or by a small hole made with an awl or other sharp-pointed tool. As the auger starts boring, be careful to keep it perpendicular to the surface (unless you are boring the hole at an angle). To see that the auger is boring square with the surface, step back a little, steadying the brace or drill with one hand, and sight; then move around and sight in another direction about at right angles to the first direction of sighting. A square may also be used to see if the bit is going straight. It is

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In sharpening this screw, follow the original twist and thread pattern, removing the small nicks and sharpening the crest or top of the spiral thread. Rather than risk damaging the feed screw when large nicks are present, just touch up the rough edges of the nick so they will not tear the fibers of the wood when a hole is bored. A large nick treated in this way will put back into service a bit which otherwise might have to be surveyed. See figure 2-4-18.

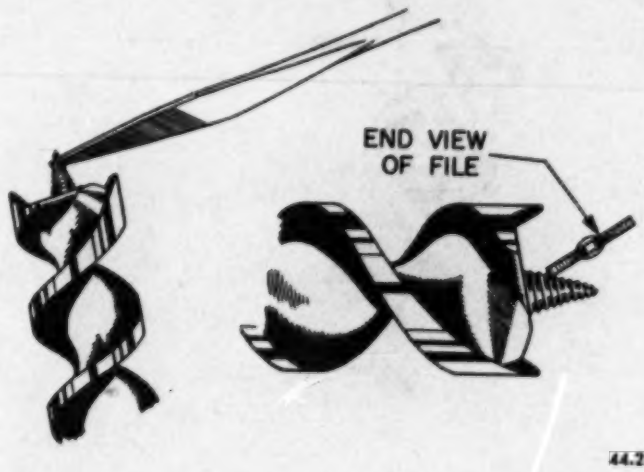

Figure 2-4-18.—Sharpening an auger bit feed screw.

SHARPENING AN EXPANSIVE BIT

To sharpen an expansive bit, sharpen the feed screw just as you would for an auger bit. This will be necessary only if the screw has been damaged by striking nails or being dropped on a hard surface. The three edges of the bit which normally require sharpening are identified in figure 2-4-19 as blade spur, blade-cutting edge, and body-cutting edge. An expansive bit may also have a body spur which would be sharpened as an auger bit spur is sharpened.

To sharpen the cutting edge of the blade, remove the blade from the body and hold it in the vise as shown in figure 2-4-20A. The removable soft jaws will protect the blade from damage. Using an auger bit file, file toward the cutting edge. Maintain angle A by filing the entire surface behind the cutting edge. Note that in figure 2-4-20A the file is in contact with the entire surface.

As filing progresses, a burr will form along the blade-cutting edge on the hollow face of the

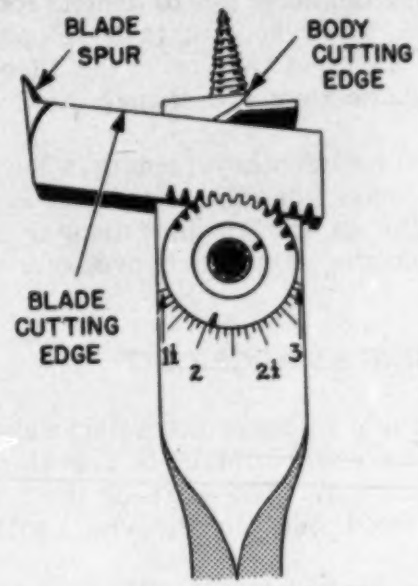

Figure 2-4-19.—Points to be sharpened on an expansive bit.

blade. Remove this with a round edge slip stone, holding the blade in one hand and the stone in the other. See figure 2-4-20.

To sharpen the spur, while the blade is in the vise, proceed as you would to sharpen the spur on an auger bit. This is illustrated in figure 2-4-16.

To sharpen the body-cutting edge, first note its cutting-edge angle and its clearance angle shown in figure 2-4-21A.

Maintain this original shape to provide strength behind the cutting edge. File toward the cutting edge, steadying the bit on the edge of the bench as shown in figure 2-4-21B.

A burr will form on the side opposite the one you have filed. To remove this burr, hold the bit as shown in figure 2-4-21C and file toward the cutting edge, holding the file flat on the surface of the metal behind the cutting edge.

BORING THROUGH HOLES IN WOOD

To bore a through hole in wood with an auger bit, first select the proper fit. Note the figure stamped on or near the square tang. This figure indicates the size, in 16ths of an inch, of the hole that the bit will bore. See figure 2-4-22.

To chuck the bit, hold the shell of the chuck (fig. 2-4-23A) as you turn the handle to open the jaws. When the jaws are apart far enough to take the square tang of the bit, insert it

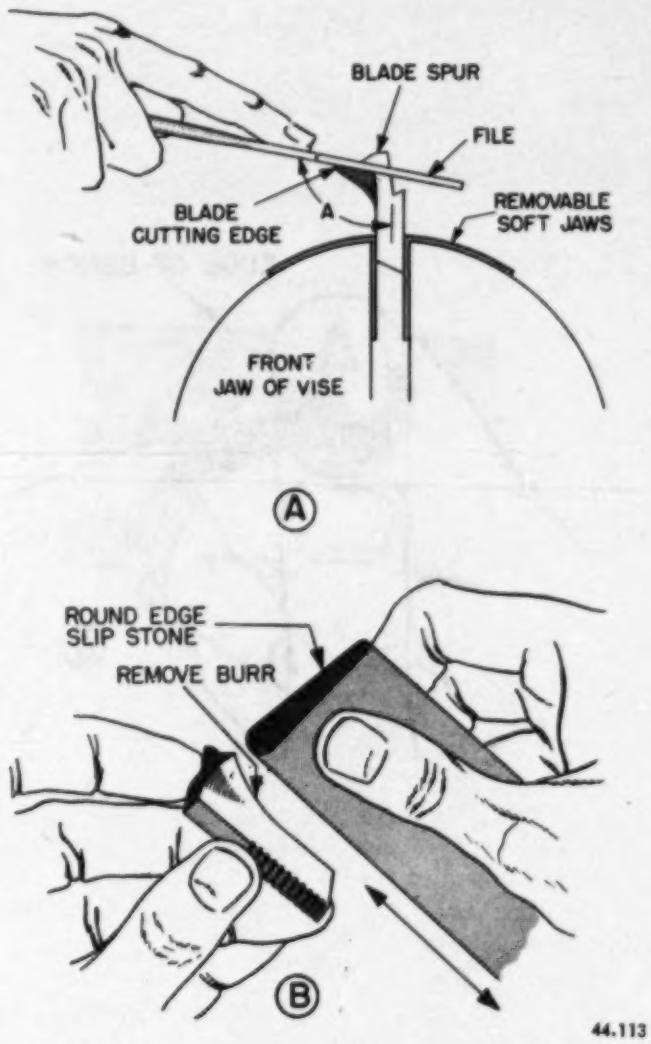

Figure 2-4-20.—Sharpening the cutting blade of an expansive bit.

(fig. 2-4-23B) until the end seats in the square driving socket at the bottom of the chuck. Then tighten the chuck by turning the handle to close the jaws and hold the bit in place.

With a chuck having no driving socket (a square hole which is visible if you look directly into the chuck), additional care must be taken to seat and center the corners of the tapered shank in the V grooves of the chuck jaws. See figure 2-4-23C. In this type of chuck the jaws serve to hold the bit in the center and to prevent it from coming out of the chuck.

After placing the point of the feed screw at the location of the center of the hole you will bore, steady the brace against your body, if possible, with the auger bit square with the surface of the work.

To bore a horizontal hole in stock held in the bench vise, hold the head of the brace with one hand, steadying it against your body, while turning the handle with the other hand. Scrap stock behind the job will prevent splintering. See figure 2-4-24.

When it is not possible to make a full turn with the handle of the bit brace, turn the cam ring, shown in figure 2-4-23A, clockwise until it stops. This will raise one of the two ratchet pawls affording clockwise ratchet action for rotating the bit. For counterclockwise ratchet action, turn the cam ring counterclockwise as far as it will go.

To bore a vertical hole in stock held in a bench vise, hold the brace and bit perpendicular to the surface of the work. Placing a trysquare near the bit, alternately in the two positions shown in figure 2-4-25, will help you sight it in.

Another way to bore a through hole without splitting out on the opposite face is to reverse the bit one or two turns when the feed screw just becomes visible through this opposite face (fig. 2-4-26A). This will release the bit. Remove the bit while pulling it up and turning it clockwise. This will remove the loose chips from the hole. Finish the hole by boring from the opposite face. This will remove the remaining material which is usually in the form of a wooden disk held fast to the feed screw. See figure 2-4-26B.

To bore through holes with an expansive bit, you must first clamp a piece of scrap stock behind the job as shown in figure 2-4-27. Then bore through the job and into the scrap stock a few turns, thus leaving a clean cut on the job itself. This method is, of course, also satisfactory when using auger bits. However, boring from both faces, as shown in figure 2-4-26 with an auger bit, does not work well with an expansive bit.

BORING HOLES IN WOOD TO A REQUIRED DEPTH

To bore a hole to a certain depth, especially when several holes of the same depth are needed, use a bit gage. This tool, shown in figure 2-4-28, will fit auger bits up to 1 inch and is clamped onto the bit as shown. When the two flats on the bottom of the gage come into contact with the surface of the board into which the hole is being bored, the feed screw cannot function. The hole will remain at that particular depth even though the bit is kept turning. The depth setting will be the distance the gage flats are set from the cutting edges of the bit.

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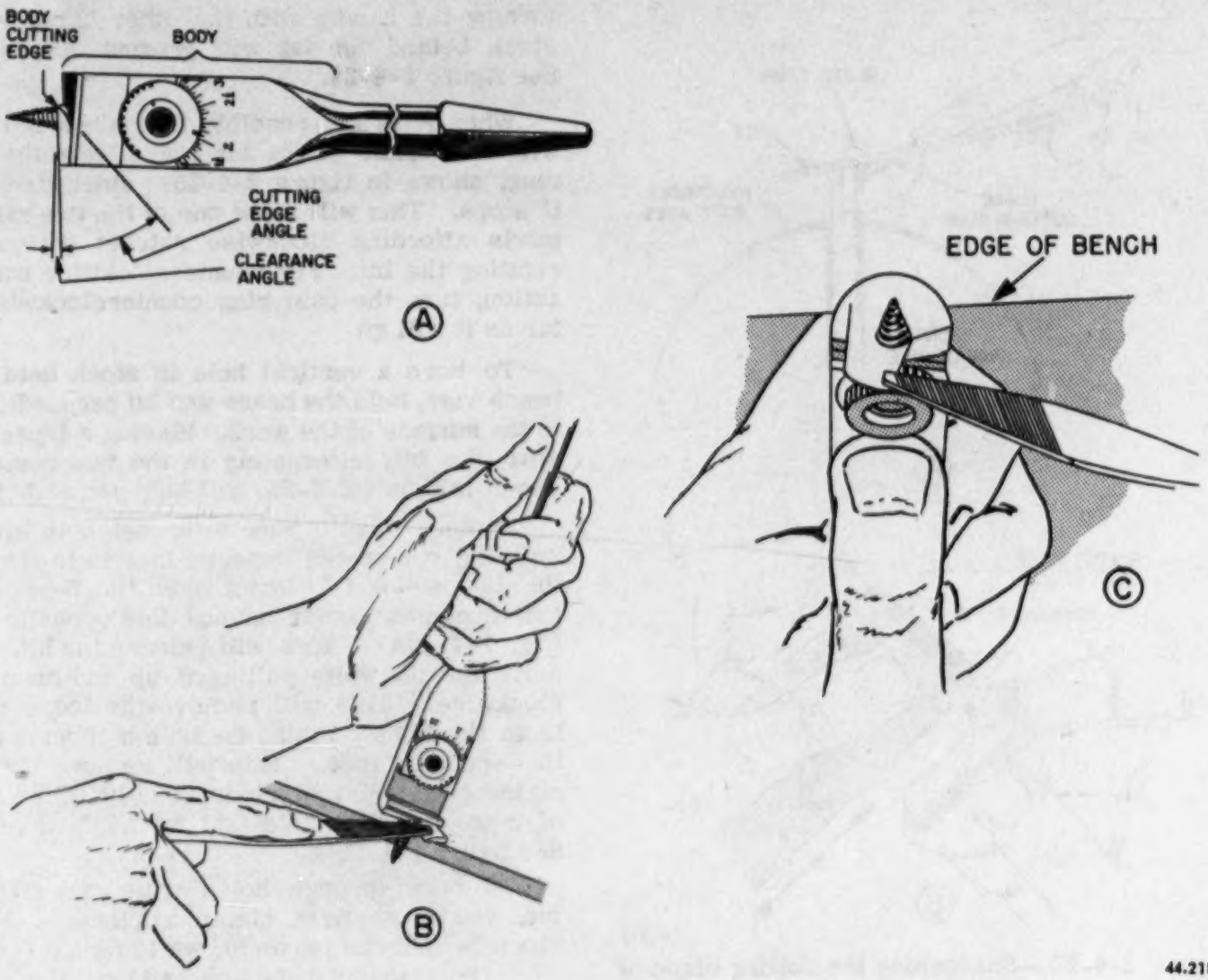

Figure 2-4-21.—Sharpening the body cutting edge of an expansive bit.

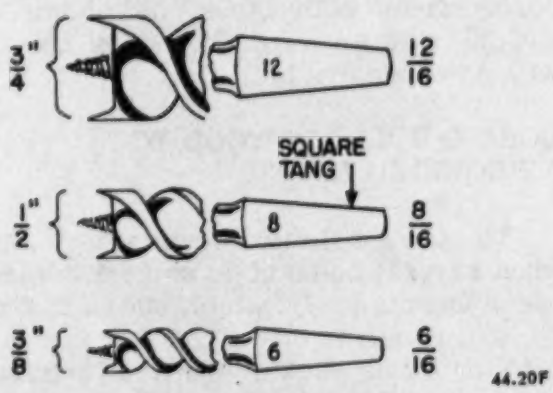

Figure 2-4-22.—Size markings on auger bits.

A block of wood, with a hole bored lengthwise through it, can be used as a depth gage. Cut the block to whatever length will provide the desired depth setting. See figure 2-4-29 on how to use it.

To bore a hole to a given depth without any type of gage, turn the bit until the cutting edges just start to cut. Then measure the distance, with your rule, from the surface of the wood to the bottom face of the chuck. As you bore the hole, this measurement will decrease. The amount of decrease is the depth of the hole. As an example, if the initial measurement was 5 inches, and after boring for several turns of the auger bit the measurement is 4 inches, the hole will be 1 inch deep. (See figure 2-4-30 (A and B).)

When accuracy is not important, you can measure from the cutting edges of the bit a distance equal to the required depth of the hole and put a mark on the twist of the bit. Bore the hole until this mark, which might be a

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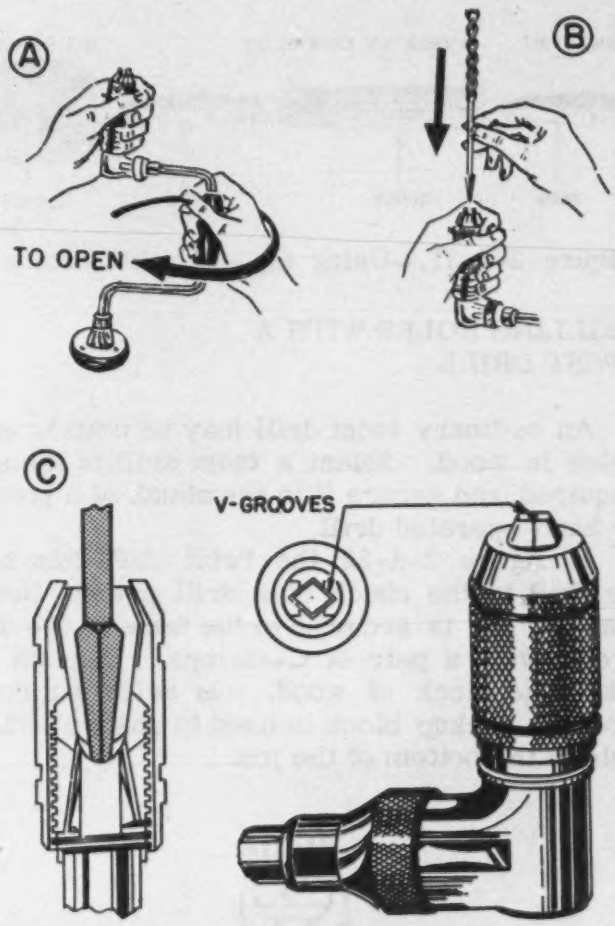

Figure 2-4-23.—Placing an auger bit in a chuck.

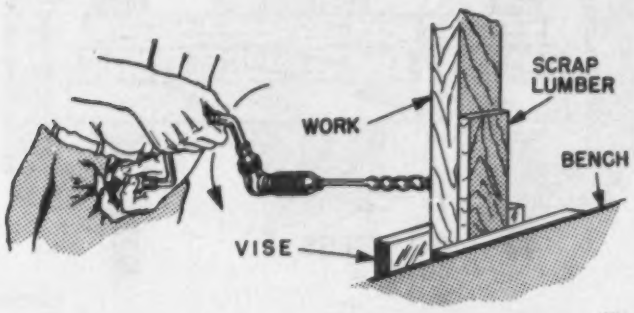

Figure 2-4-24.—Using scrap lumber to prevent splintering when boring.

crayon or pencil mark, reaches the surface of the wood. A piece of friction or scotch tape will serve as a marker, too. (See figure 2-4-30C.) These latter two methods of boring a hole to a certain depth are used when only one hole is to be bored to that depth.

To bore a deep hole, chuck an auger bit in an auger-bit extension and chuck the auger-bit extension in the bit brace.

The effective length of the auger bit will be increased by about the length of the extension,

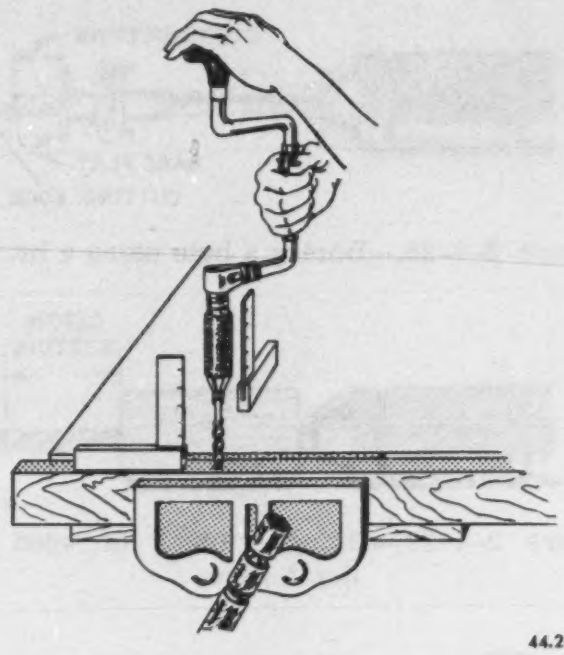

Figure 2-4-25.—Method of sighting in for perpendicular hole.

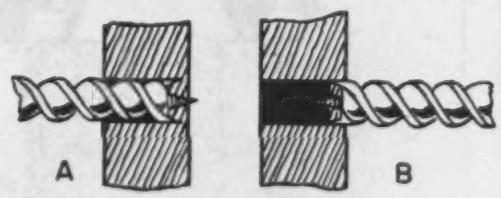

Figure 2-4-26.—Boring a through hole by reversing direction.

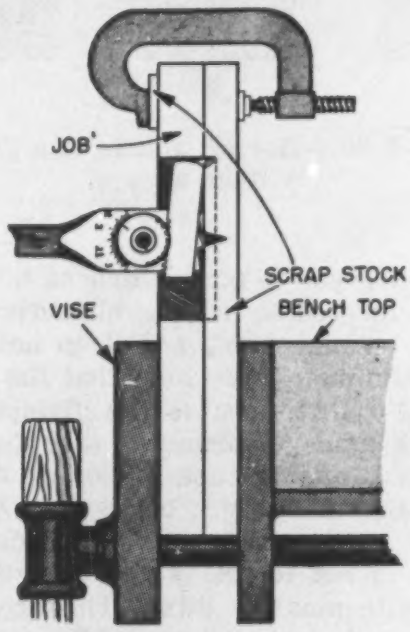

Figure 2-4-27.—Drilling a through hole with an expansion bit.

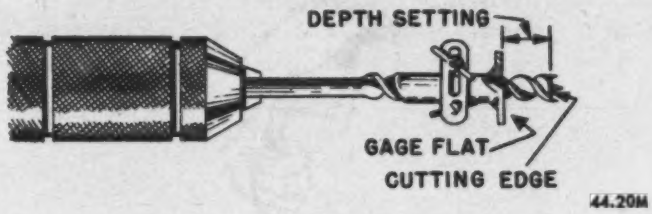

Figure 2-4-28.—Boring a hole using a bit gage.

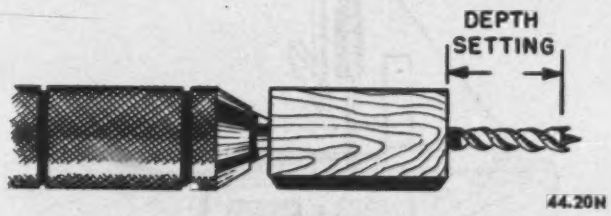

Figure 2-4-29.—Using a block of wood as a depth gage.

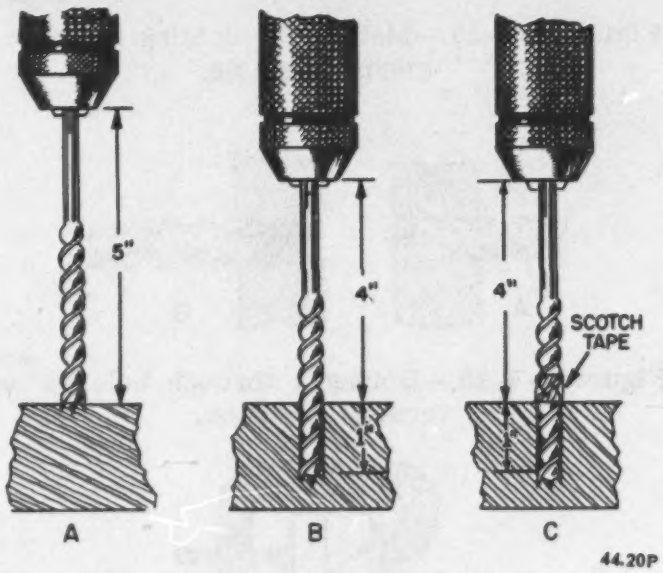

Figure 2-4-30.—Boring a hole to a given depth without a gage.

thus enabling you to bore overhead holes, holes which are located so that the bit and brace alone could not reach them, and deep holes. Note that the minimum-size hole that the extension itself will follow into is the diameter of the chuck plus some clearance. (See figure 2-4-31.) This limits its use in boring deep holes to that size or larger, but does not limit its use in boring in hard-to-reach places. If the extension is not to follow into the hole, it may be used with smaller bits. The auger-bit extension is not designed to handle sizes larger than 1" which take more turning force than it will stand. (See figure 2-4-31.)

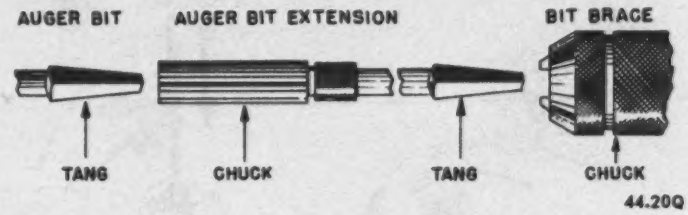

Figure 2-4-31.—Using an auger bit extension.

DRILLING HOLES WITH A TWIST DRILL

An ordinary twist drill may be used to drill holes in wood. Select a twist drill of the size required and secure it in the chuck of a power- or hand-operated drill.

In figure 2-4-32 the twist drill has been chucked in the chuck of a drill press. Notice that the job is secured to the table of the drill press with a pair of C-clamps. Beneath the job is a block of wood. In drilling through wood, a backup block is used to ensure a clean hole at the bottom of the job.

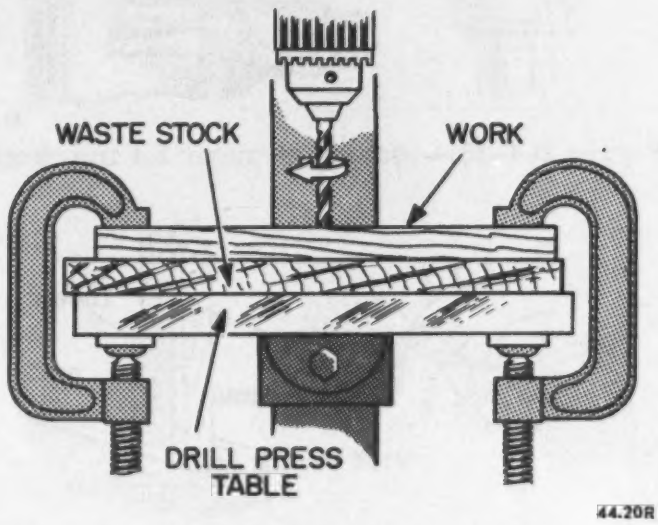

Figure 2-4-32.—Drilling a hole in wood with a twist drill.

An electric hand drill secured in a drill stand will serve in a limited way to take the place of a drill press. However, only the one speed is available and must be used for small and large twist drills alike. When the electric drill is used in a drill stand, rather than offhand, less effort is necessary to feed the drill into the metal. Also, because the drill is rigidly mounted, less drill breakage is to be expected. In addition, holes will be drilled at right angles to the surface of the work in either

the drill stand or the drill press more easily than if the electric drill is held by hand.

Figure 2-4-33 shows a hole being drilled with a breast drill. Turn the crank handle with one hand as you hold the side handle with the other hand. This will steady the breast drill while feed pressure is applied by resting your chest on the breast plate shown in figure 2-4-33. Notice, in figure 2-4-33, that the breast drill has a high or a low speed available, according to the setting of the speed selector nut. When drilling a horizontal hole, apply feed pressure by resting your body against the breast plate.

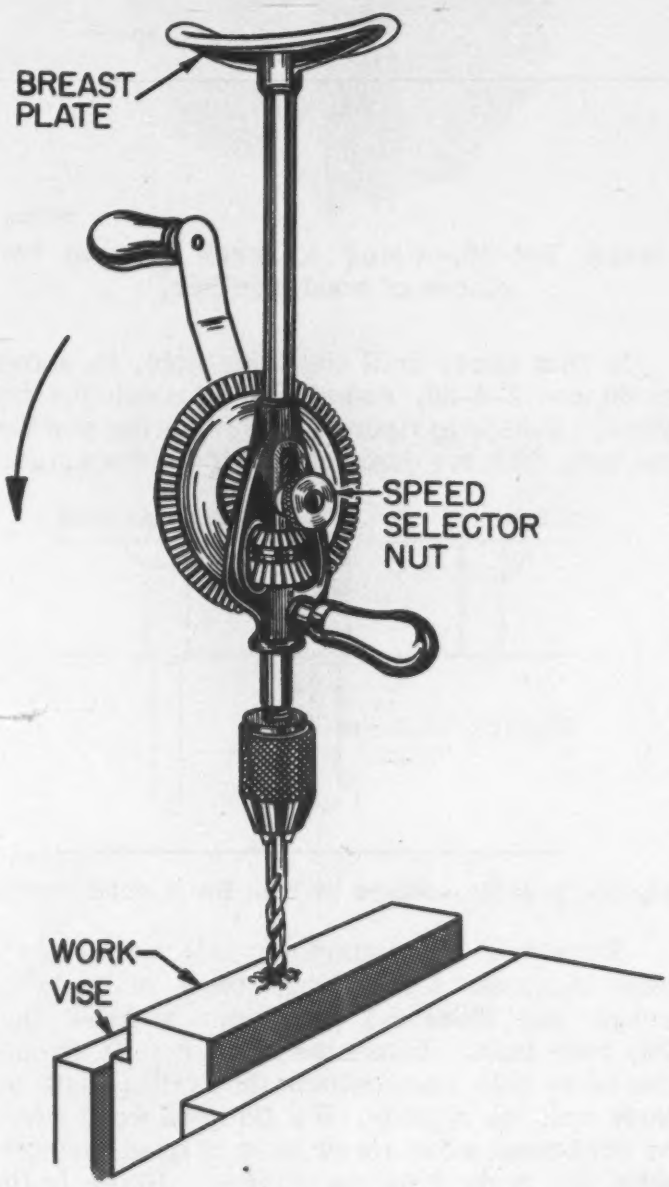

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Figure 2-4-33.—Drilling a hole with a breast drill.

In drilling a horizontal hole with the hand drill shown in figure 2-4-34, operate the crank with the right hand and with the left hand guide the drill by holding the handle which is opposite the chuck end of the drill. Get additional feed pressure, if necessary, by carefully leaning against the hand drill with your body.

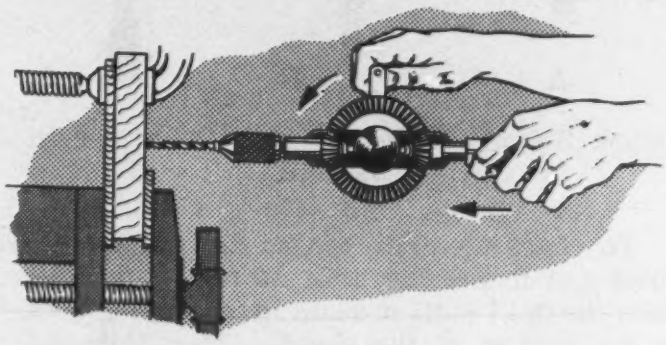

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Figure 2-4-34.—Drilling a hole with a hand drill.

DRILLING HOLES WITH A "PUSH" DRILL

Figure 2-4-35A shows the Stanley "Yankee" automatic drill which is often called a "push" drill. This drill can be used to drill either horizontal or vertical holes when the accuracy of the right angle with the work is not critical.

The drill point used in push drills (fig. 2-4-35B) is a straight flute drill. Sharpen its point on the grinder and provide only slight clearance behind the cutting edge. It will drill holes in wood and other soft materials.

To select a drill for use in a push drill, hold the handle of the drill in one hand and release the magazine by turning the knurled screw as shown in figure 2-4-36A. This will permit you to drop the magazine. Figure 2-4-36B shows the drill magazine lowered to expose the drills from which the proper size can be selected.

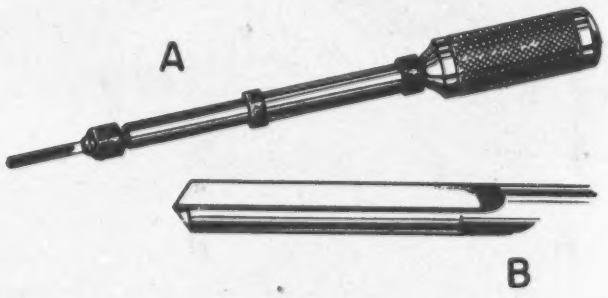

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Figure 2-4-35.—Push drill and drill point.

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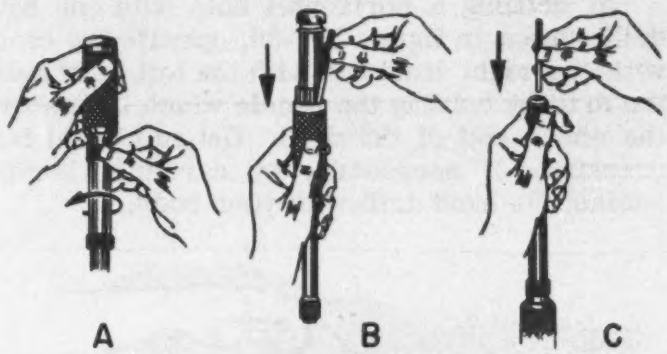

Figure 2-4-36.—Selecting a drill for use in a push drill.

To chuck the drill, loosen the chuck several turns and insert the drill as far as it will go. Turn the drill until it seats in the driving socket in the bottom of the chuck. Then tighten the chuck to hold the drill in place. See figure 2-4-36C.

To drill a vertical hole with this drill (fig. 2-4-37A), place the job on a flat surface and operate the push drill with alternate strokes up and down. If it is necessary to hold the work in place while it is being drilled, use some mechanical means if you can. If you must hold the job with your hand, grasp the material as far as possible from where the drill is drilling.

In drilling horizontal holes with the push drill, as in figure 2-4-37B, secure the job in a vise. The back-and-forth strokes rotate the drill, advancing it into the work on the forward stroke as the drilling proceeds. The index finger, extended along the body of the tool, will help guide the drilling at right angles to the work.

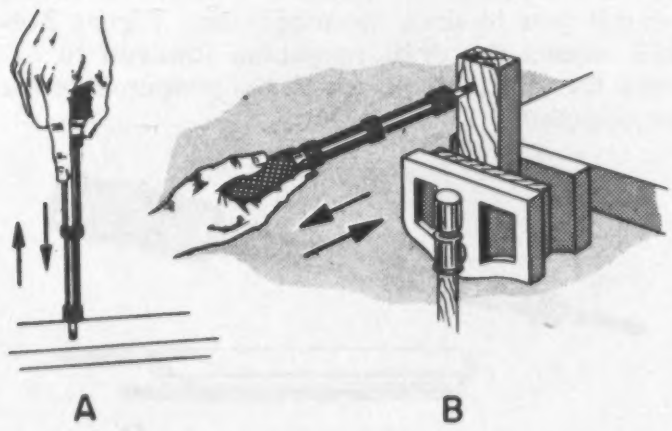

Figure 2-4-37.—Drilling horizontal and vertical holes with a push drill.

DRILLING HOLES FOR WOOD SCREWS

To drill a hole for a wood screw which is used to hold two pieces of hard wood together, as shown in figure 2-4-38, two different sized holes are usually necessary. The wood screw simply passes through the hole in the top piece and the threads take hold in the bottom piece.

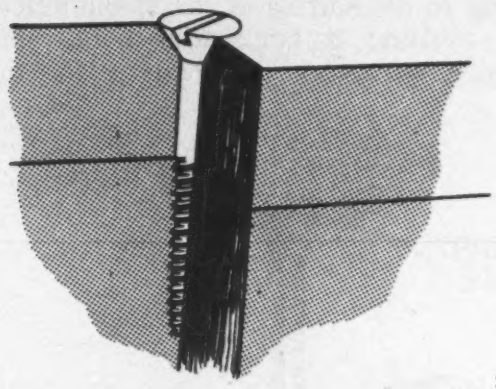

Figure 2-4-38.—Using a screw to hold two pieces of wood together.

In this case, drill the body hole, as shown in figure 2-4-39, completely through the top piece. Notice in figure 2-4-39 that the point of the body drill has just entered the bottom piece.

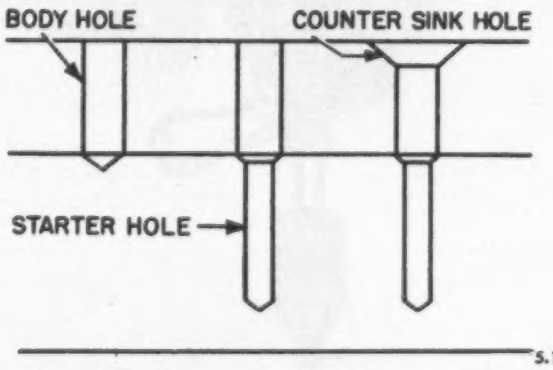

Figure 2-4-39.—Shape of hole for a wood screw.

Then drill the "starter" hole which is the root diameter (or a little less) of the wood screw and therefore somewhat smaller than the body hole. Insert the starter drill through the body hole and continue the drilling with the body hole as a guide. If a flathead wood screw or oval-head wood screw is to be used, countersink the body hole as shown. (Refer to fig. 2-4-43 on how to countersink holes in wood.)

Select the drill sizes according to the dimensions of the wood screw. The names of these dimensions are given in figure 2-4-40.

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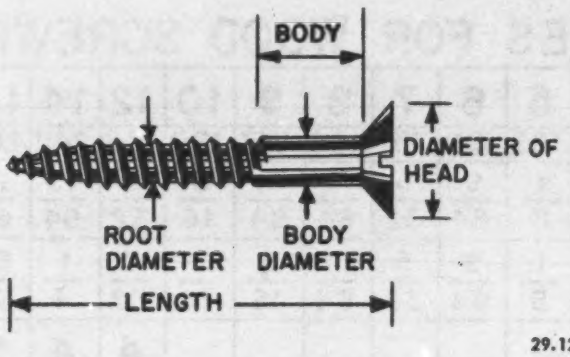

Figure 2-4-40.—Nomenclature of a wood screw.

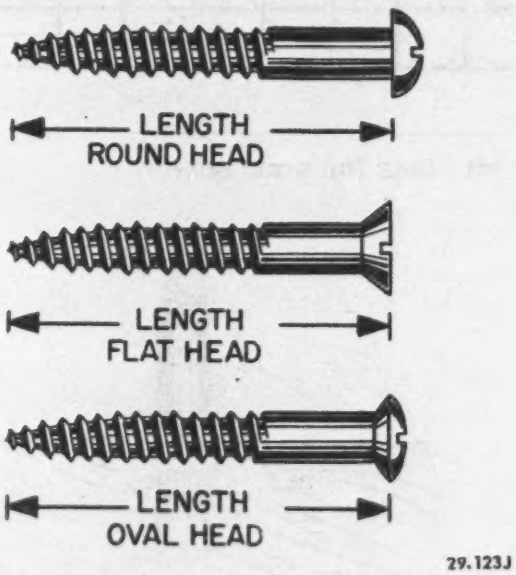

Figure 2-4-41.—Types of wood screws.

Figure 2-4-41 shows the three most common types of wood screws. Notice that the length is always measured from the point to the greatest diameter of the head. As a general rule, the length of the wood screw should be such that the body shown in figure 2-4-40 extends through the piece being screwed down so that the threaded portion will then enter the piece of wood beneath it.

Determine the size of the body hole by holding the body of the screw in front of the graduations on a rule and taking a reading. Then determine the size of the root diameter hole by using the same method and measuring at about the middle of the threaded portion of the screw. Neither of these measurements is critical. Another way to find out what size drills to use for the body hole and the starter hole, when you know the size number of the wood screw you are using, is to refer to the chart shown in figure 2-4-42. To do this, find the proper column according to the size number of the screw, such as No. 14 for instance. Reading down the column you will find that the decimal diameter of its shank is 0.242", or 15/64" stated in a common fraction. You will also find the the body hole should be drilled with a 1/4" twist drill or bored with a No. 4 auger bit, and that the starter hole should be drilled with a 5/32" twist drill. Where no figure is given in the chart for bit size, use the recommended twist drill size. A No. 4 auger bit is the smallest size (1/4") generally available. Because a No. 1 screw is so small, no starter hole is required and therefore no drill or bit sizes are given.

COUNTERSINKING HOLES IN WOOD

To countersink a hole in wood, use a countersink, three types of which are shown in figure 2-4-43. Any one of these will do the job. Turn the countersink at slow speed to ensure a smooth surface on the countersunk portion of the hole.

Countersink deeply enough so that the major diameter of the screwhead is at or just slightly below the surface of the work. Figure 2-4-44 shows one way of determining the proper depth of the countersunk portion of the hole. If many holes are to be countersunk on the drill press, set the depth stop when the proper setting has been determined.

USING WOOD CHISELS

A wood chisel should always be held with the flat side or back of the chisel against the work for smoothing and finishing cuts. Whenever possible, it should not be pushed straight through an opening, but should be moved laterally at the same time that it is pushed forward. This method ensures a shearing cut, which with care, will produce a smooth and even surface even when the work is cross-grained. On rough work, use a hammer or mallet to drive the socket-type chisel.

On fine work, use your hand as the driving power on tang-type chisels. For rough cuts, the bevel edge of the chisel is held against the work. Whenever possible, other tools such as saws and planes should be used to remove as much of the waste as possible, and the chisel used for finishing purposes only.

There are a few basic precautions that you should observe at all times when using a chisel.

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DRILL AND AUGER BIT SIZES FOR WOOD SCREWS

SCREW SIZE NUMBER		1	2	3	4	5	6	7	8	9	10	12	14	16	18
NOMINAL SCREW BODY DIAMETER		.073	.086	.099	.112	.125	.138	.151	.164	.177	.190	.216	.242	.268	.294
		5/64	3/32	3/32	7/64	1/8	9/64	5/32	11/64	11/64	3/16	7/32	15/64	17/64	19/64
BODY HOLE	DRILL SIZE	5/64	3/32	7/64	7/64	1/8	9/64	5/32	11/64	3/16	3/16	7/32	1/4	17/64	19/64
	BIT SIZE											4	4	5	5
STARTER HOLE	DRILL SIZE		1/16	1/16	5/64	5/64	3/32	7/64	7/64	1/8	1/8	9/64	5/32	3/16	13/64
	BIT SIZE														4

44.119

Figure 2-4-42.—Drill and auger bit sizes for wood screw.

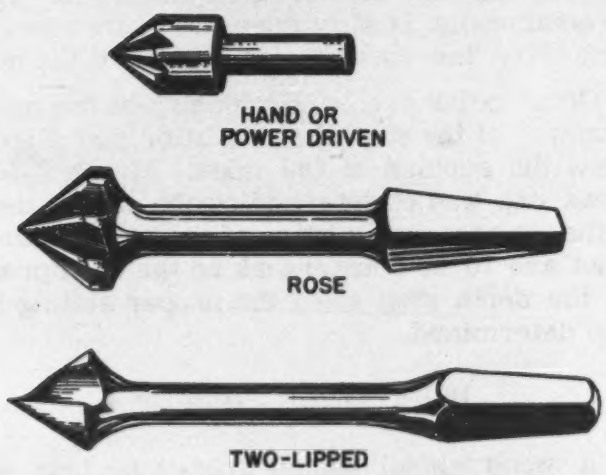

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Figure 2-4-43.—Types of wood countersinks.

a. Secure work so that it cannot move.

b. Keep both hands back of the cutting edge at all times.

c. Do not start a cut on a guideline. Start slightly away from it, so that there is a small amount of material to be removed by the finishing cuts.

d. When starting a cut, always chisel away from the guideline toward the waste wood, so that no splitting will occur at the edge.

e. Never cut towards yourself with a chisel.

f. Make the shavings thin, especially when finishing.

g. Examine the grain of the wood to see which way it runs. Cut with the grain. This severs the fibers and leaves the wood smooth. Cutting against the grain splits the wood and leaves it rough. This type of cut cannot be controlled.

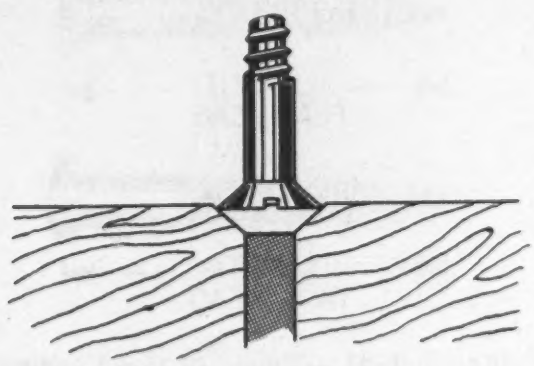

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Figure 2-4-44.—Checking countersink portion of hole for size.

CHISELING HORIZONTALLY WITH THE GRAIN

To chisel horizontally with the grain, grasp the chisel handle in one hand with the thumb extended towards the blade (fig. 2-4-45). The cut is controlled by holding the blade firmly with the other hand, knuckles up and the hand well back of the cutting edge. The hand on the chisel handle is used to force the chisel into the wood. The other hand pressing downward on the chisel blade regulates the length and depth of the cut.

The chisel will cut more easily and leaves a smoother surface when the cutting edge is held at a slight diagonal to the direction of the

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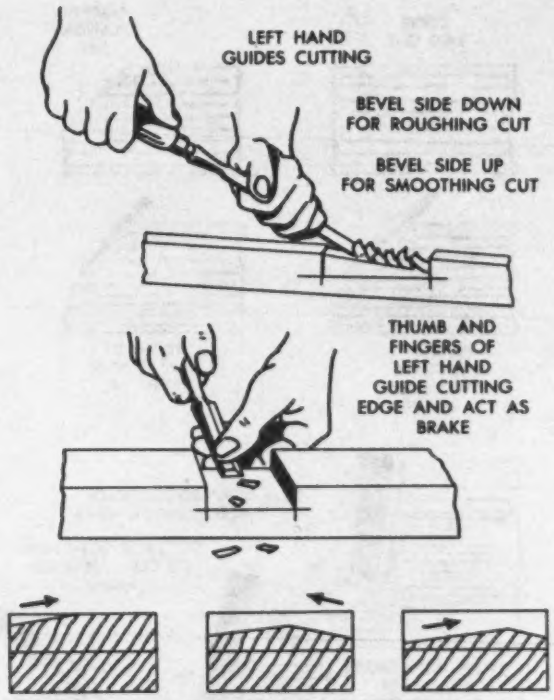

Figure 2-4-45.—Chiseling horizontally across the grain.

cut, or is given a slight lateral sliding motion. This is done by holding the tool at a slight angle and moving it to one side as it is pushed forward, or by moving it slightly from left to right at the same time you push it forward. With cross-grained wood, it is necessary to work from both directions to avoid splitting the wood at the edges. Do not hurry. Cut only fine shavings. If thick shavings are cut, the tool may dig in and split off a piece of wood which was never intended to be removed.

CHISELING HORIZONTALLY ACROSS THE GRAIN

To chisel horizontally across the grain, hold the work so that it does not move. Remove most of the waste wood by using the chisel with the bevel held down. On light work, use hand pressure or light blows on the end of the chisel handle with the palm of the right hand. On heavy work, use a mallet. To avoid splitting at the edges, cut from each edge to the center and slightly upward so that the waste wood at the center is removed last (fig. 2-4-45). Make finishing cuts with the flat side of the chisel down. Never use a mallet when making finishing cuts, even on large work. One-hand pressure is all that is necessary to drive the chisel which is guided by the thumb and forefinger of the other hand. Finish cuts should also be made from each edge toward the center. Do not cut all the way across from one edge to the other or the far edge may split.

CHISELING DIAGONALLY ACROSS THE GRAIN

To chisel diagonally across the grain, such as making a straight slanting corner, remove as much waste wood as possible with a saw. (See fig. 2-4-46.) Hold the work so the guideline is horizontal. Use the chisel as in cutting horizontally with the grain. It is necessary to chisel with the grain and to hold the chisel so that the cutting edge is slightly diagonal to the direction of the cut.

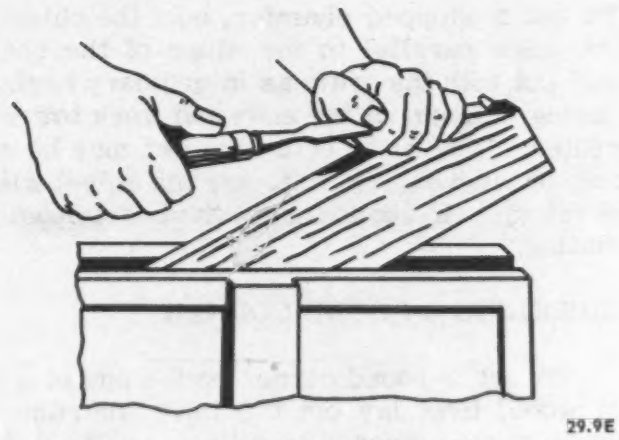

Figure 2-4-46.—Chiseling diagonally across the grain.

CHAMFERING WITH A CHISEL

A chamfer is made by cutting off and flattening the sharp corner which exists between two surfaces which are at right angles to each other. A plain chamfer runs the full length of the edge and is usually made with a plane. A stopped chamfer does not run the full length of the edge. If a stopped chamfer is long enough, part of it can be planed and the ends finished with a chisel. A short stopped chamfer must be made entirely with a chisel. A chamfer is usually made symmetrically at 45°. Mark guidelines with a pencil; the guidelines for a 45° chamfer will be the same distance back from the edges on both surfaces of the wood (fig. 2-4-47).

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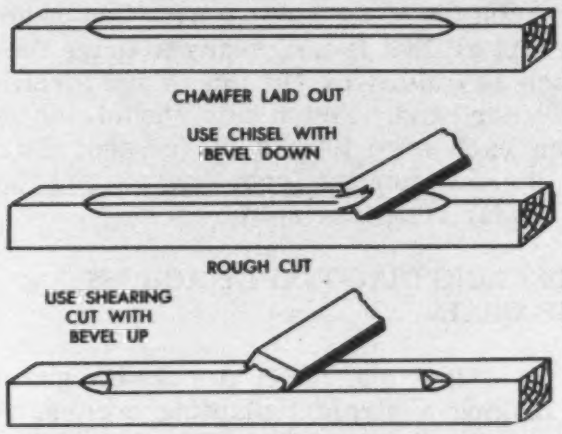

Figure 2-4-47.—Chamfering with a chisel.

NOTE: Do not use a marking gage, scratch awl, or knife to make guidelines, since they leave marks in the wood which are difficult to remove.

To cut a stopped chamfer, hold the chisel with the edge parallel to the slope of the chamfer and cut with the grain as in ordinary horizontal paring. Begin at the ends and work toward the center. The ends of a chamfer may be either flat or curved. If flat, use the chisel with the bevel up. If curved, keep the bevel down when cutting.

CHISELING A ROUND CORNER

To cut a round corner on the end of a piece of wood, first lay out the work and remove as much waste as possible with a saw (fig. 2-4-48). Use the chisel with the bevel side down to make a series of straight cuts tangent to the curve. Move chisel sideways across the work as it is moved forward. Finish curve by paring with the level side up. Convex curves are cut in the same manner as a round corner.

CUTTING A CONCAVE CURVE

When cutting a concave curve with a chisel, remove most of the waste wood with a coping saw or a compass saw. Smooth and finish the curve by chiseling (fig. 2-4-48) with the grain, holding the chisel with the bevel side down. Use one hand to hold the chisel against the work. Press down on the chisel with the other hand, and, at the same time, draw back on the handle to drive the cutting edge in a sweeping curve. Care must be used to take only light cuts or the work may become damaged.

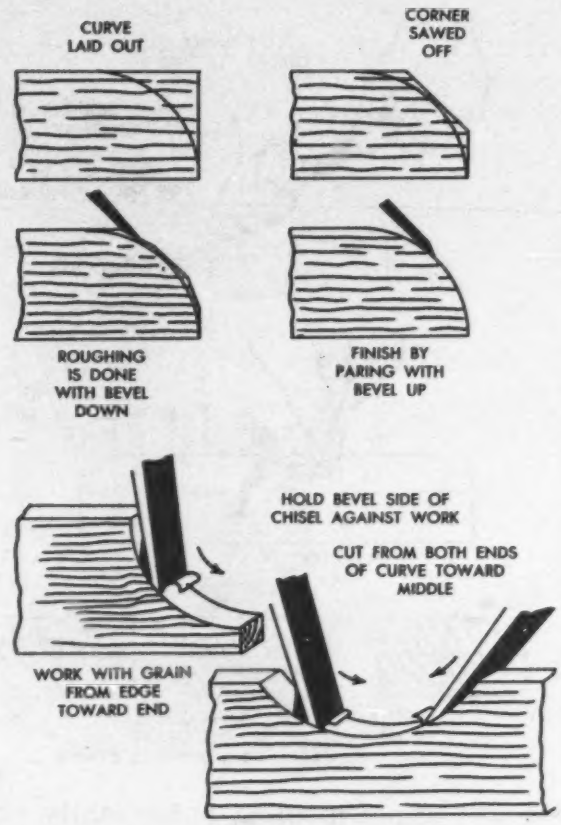

Figure 2-4-48.—Chiseling corners and curves.

VERTICAL CHISELING

Vertical chiseling (fig. 2-4-49) means cutting at right angles to the surface of the wood which is horizontal. Usually it involves cutting across the wood fiber, as in chiseling out the ends of a mortise or making a gain on stopped dado joints. When vertically chiseling across the grain, a mallet may be used to drive the chisel. A mallet is necessary when chiseling hardwood. Use a shearing cut in cutting across the grain.

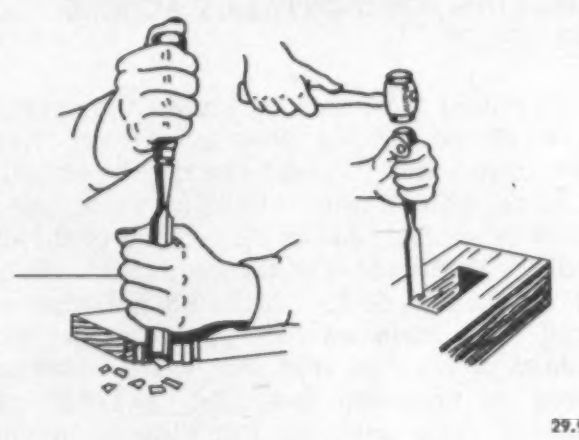

Figure 2-4-49.—Vertical chiseling.

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Always cut with the grain whenever possible, so that the waste wood will easily split away from the guidemarks. When chiseling on the ends of wood, remove as much waste wood as possible with a saw. Observe direction of grain and start to cut at an edge to avoid splitting the wood. Use a shearing cut and make the shavings thin. Thin shavings can be made without the use of a mallet. Grasp the handle of the chisel in one hand with the thumb pressing down on top of the handle, as shown in figure 2-4-49. Use the other hand to guide the tool, and to likewise supply some of the driving force if much pressure is required to do the job.

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PART II

Section 5

GRINDING AND FILING OPERATIONS

To keep hand tools in the best usable condition, cutting edges must be sharpened frequently and certain other tools trued or shaped for special purposes. Chisels, punches, drills, tinsnips, screwdrivers, and other hand tools are shaped or sharpened on an abrasive grinding wheel.

Grinding may be defined as the act of shaping or wearing down a surface or sharpening an edge by means of the cutting action of thousands of abrasive grains on the surface of the grinding wheel. Excessive grinding shortens the useful life of a tool.

A variety of grinding machines are in use in the Navy. Many of them are special machines used in tool and die making or machines used for other special purposes. The bench grinder, explained in part I, section 2, of this text, is the type of grinder most often found in general use in the Navy. Nearly all mechanical shops in shore installations or aboard ship will have a bench grinder.

ABRASIVE WHEELS

In any grinding operation, the selection of the proper abrasive wheel is of primary importance. Selection of the right wheel involves such factors as the material of the wheel, the material of the work, the amount of material to be removed from the work, and the nature of the finish required.

COMPOSITION

The abrasives are held together by a bonding agent. The strength with which the bonding agent holds the abrasive grains is known as the grade. Grade might also be described as the relative hardness of the wheel. The grade has considerable effect upon the grinding characteristics of a wheel. Spaces between grains (structure) also affect the result; if these spaces are too small, they may become clogged with metal particles from the work, and the wheel becomes "loaded." A loaded wheel will not grind properly and is likely to mar the work surface.

The standard markings given to grinding wheels by their manufacturers consist of a sequence of symbols. See fig. 2-5-1.

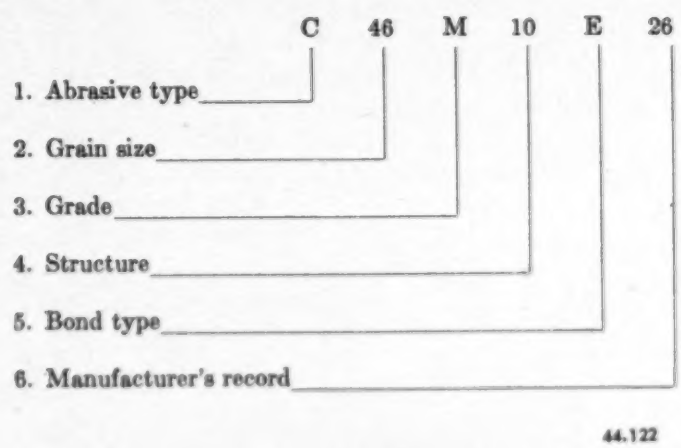

Figure 2-5-1.—Standard markings given to grinding wheels.

1. Abrasive type. The letter C is used for silicon carbide, and the letter A for aluminum oxide.

2. Grain size. The series 10, 12, 14, 16, 20, 24, 30, 36, 46, 54, 60, 70, 80, 90, 100, 120, 150, 180, and 220 is commonly used, with the low numbers representing coarse grain and the high ones a very fine grain size. A manufacturer may add a number and additional symbol to indicate a special grain combination for special purpose grinding.

3. Grade. This is indicated by a letter of the alphabet, A to Z—soft to hard.

4. Structure. Use of a structure symbol is optional. The general range is from 1 to 15,

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with the higher numbers indicating less density and wider grain spacing.

5. Bond type. These are indicated as follows: V, vitrified; E, shellac or elastic; S, silicate; R, rubber; B, resinoid; O, oxychloride.

6. Manufacturer's record. The symbol used here has reference to the manufacturer's factory records.

Although the markings given above are standardized, it is nevertheless a fact that wheels with identical markings may have different grinding actions if they are the output of different manufacturers. This is an important point to bear in mind when it becomes necessary to replace a wheel.

Typical wheels required for sharpening cutters and for other types of grinding are illustrated in figure 2-5-2. Reading from left to right the wheels are used as follows: (1) for cutting off Stellite, high-speed tool steel, tubing, etc.; (2) for grinding end mills, staggered tooth slotting cutters, reamers; (3) for cylindrical as well as surface grindings; (4) for face mills; (5) the straight cup, for flat forming tools such as lathe and planer cutter bits; (6) for internal grinding; (7) the flaring cup, for face and end mills, helical mills, slotting cutters, reamers; (8) for internal grinding; (9) the dished wheel, for gear cutters, formed cutters, taps.

STORAGE

Proper inspection and proper storage of grinding wheels are important. Wheels should be carefully inspected as soon as they are received, since there is always a possibility of the wheel being damaged in transit. To inspect for cracks, suspend the wheel and then tap it with some light implement, such as the wooden handle of a screwdriver. In doing this, make sure that the wheels are dry and free from sawdust. Vitrified and silicate wheels should emit a clear, metallic ring; wheels of other bonds give a different type of ring.

The detection of any cracks in a wheel is most important. When revolving at high speed, a cracked wheel may fly apart and cause serious injury.

Wheels should always be stored in a dry place. To prevent any shifting of the wheels, use pegs to support them in the storage racks.

DRESSING AN ABRASIVE WHEEL

An abrasive wheel often gets "out-of-round" and the peripheral surface gets out of shape. When this happens it is time to dress or true the wheel.

A dressing tool is provided for dressing an abrasive wheel. The wheel dresser shown in

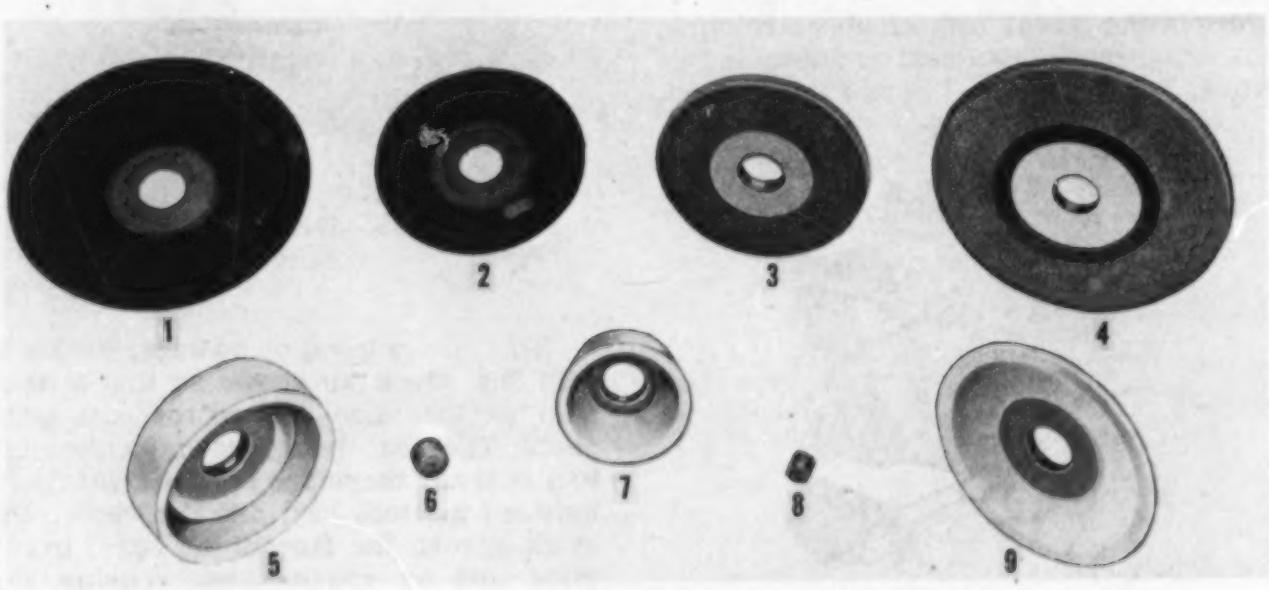

Figure 2-5-2.—Types of grinding wheels.

figure 2-5-3 is the kind usually found in most shops and is very simple to use. Notice that the tool rest has been secured close to the wheel. The "feet" on the bottom of the dresser ride on the tool rest and the cutters touch the wheel.

Figure 2-5-3.—Dressing an abrasive wheel with a wheel dresser.

To dress the wheel, start the grinder and, when the wheel is up to speed, move the handle of the dresser ahead to bring the cutters into firm contact with the rotating wheel. Then move the dresser back and forth across the face of the wheel until the surface is clean and approximately square with the sides. This is an eye-hazardous operation. WEAR YOUR GOGGLES.

To dress the wheel with an abrasive stick, rest the stick on the tool rest as shown in figure 2-5-4. When the wheel comes up to speed, hold the stick against the rotating wheel firmly enough to remove the imbedded particles from the surface of the wheel. Move the stick back and forth across the face of the wheel until the surface is clean and approximately square with the sides. This also is an eye-hazardous operation. WEAR YOUR GOGGLES.

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Figure 2-5-4.—Dressing an abrasive wheel with an abrasive stick.

GRINDING METAL STOCK

To grind a straight edge on metal stock (figure 2-5-5,) adjust the tool rest so that it just clears the wheel and is approximately at the center line of the wheel. Then, keeping the edge of the stock parallel with the center line of the grinder shaft, pass the stock across the face of the wheel. Grind across the entire width of the piece, using medium pressure which will keep the wheel cutting but will not appreciably decrease its speed. Grinding across the entire width of the piece and the wheel wears the wheel evenly and helps prevent overheating.

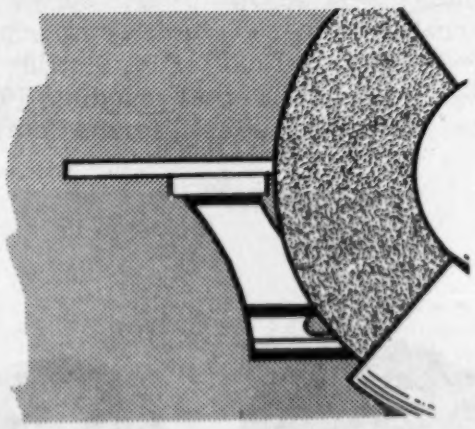

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Figure 2-5-5.—Grinding a straight edge on metal stock.

To grind a bevel on an edge, (figure 2-5-6,) hold the stock as shown so that it is resting both on the wheel and on the edge of the tool rest. The edge being ground is away from the tool rest and therefore is not liable to get caught between the tool rest and the wheel. Pass the stock across the face of the wheel from left to right just as you do when grinding a square edge.

To grind a radius, set the tool rest at the center line of the wheel. With one hand, hold the end of the stock being ground so that you can

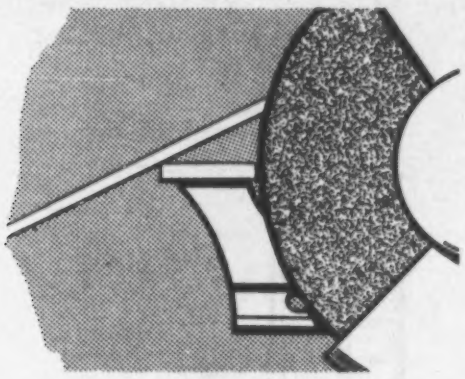

Figure 2-5-6.—Grinding a bevel on metal stock.

move it from left to right, across the face of the wheel, as shown by the small double-headed arrow in figure 2-5-7, and also hold it down firmly on the tool rest. With the other hand swing the arc shown by the longer curved double-headed arrow at the opposite end of the stock. The motion indicated by the curved arrow will produce the rounded edge on the stock. The travel indicated by the short straight double-headed arrow will prevent the wearing of a groove in the wheel which would have to be removed by dressing.

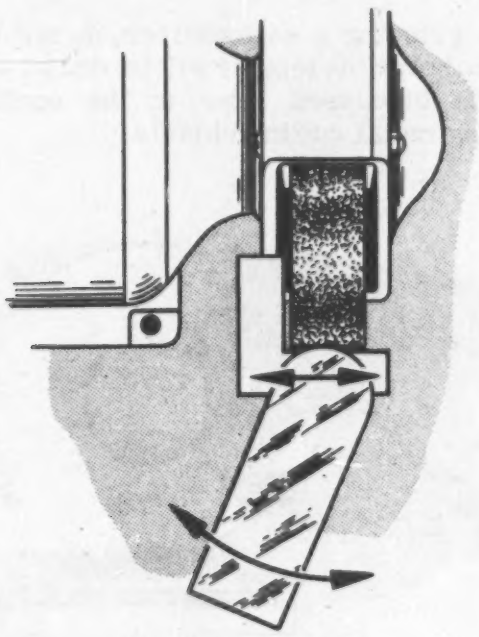

Figure 2-5-7.—Grinding a rounded edge on metal stock.

DRESSING TOOLS

The dressing of tools is an important part of hand tool maintenance. Dressing generally includes grinding the tools when they have become dulled or out of shape, or shaping the tools for specific jobs. There are some power grinders that are designed especially for tool grinding. However, these are not readily available in most small shops in the Navy. Therefore, most of the tool dressing operations must be done by holding the tool in your hand and grinding it with a bench grinder.

SHARPENING A CENTER PUNCH

To sharpen a center punch, cradle the end of the punch between the index finger and thumb of one hand, as shown in figure 2-5-8, resting that hand on the tool rest of the grinder. Move the punch into light contact with the rotating wheel of the grinder with the center line of the punch forming about a 45° angle with the face of the wheel. This will give the approximate 90° included angle required for a center punch. With the thumb and index finger of the other hand rotate the punch as shown by the directional arrow in figure 2-5-8. Keep the point cool by using only light pressure on the wheel and by frequently dipping the punch in a can of cooling water. Sharpen a prick-punch in the same

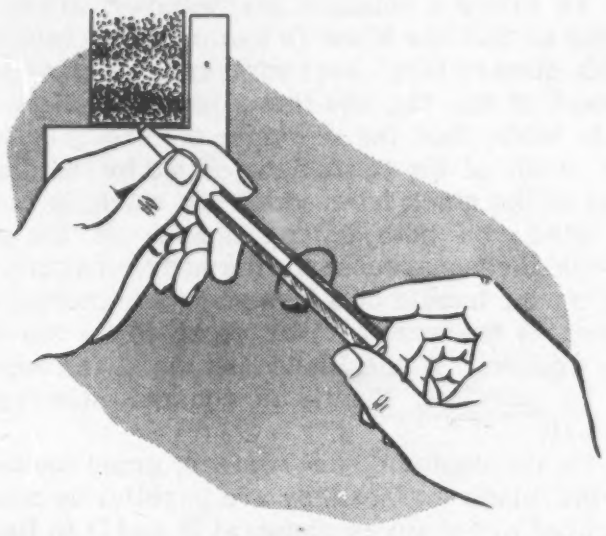

Figure 2-5-8.—Dressing a center punch with a bench grinder.

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way with the exception that, since the included angle should be 30° rather than 90°, the angle between the center line of this punch and the wheel should be about 15°.

DRESSING A SCREWDRIVER TIP

To see how to dress the tip of a screwdriver, refer to figure 2-5-9. Figure 2-5-9, parts A and B, are the front and side views of a common screwdriver; 2-5-9 C and 2-5-9 D are the front and side views of what is usually called an electrician's screwdriver.

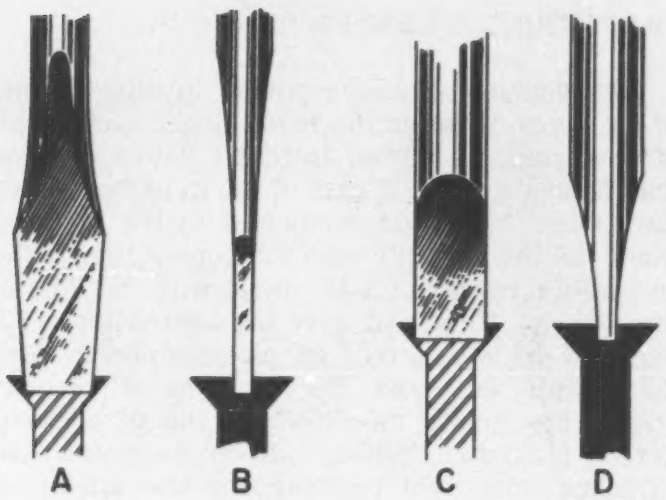

Figure 2-5-9.—Shapes of screwdrivers when properly dressed.

To dress a common screwdriver, dress the sides so that the blade is symmetrical in shape. With electricians' screwdrivers, which are not forged at the tip, and therefore do not have the wide blade that the common screwdriver has, the width of the tip is determined by the diameter of the stock from which the shank is made.

Then, on both types, square off the end. Check the squareness of the end by resting the tip on the handle of a trysquare and moving the shank of the screwdriver close to the blade of the square. If the blade and the shank appear to be parallel, the tip is square. See figure 2-5-10.

On the common screwdriver, grind the faces of the blade so that they are parellel or nearly parallel at the tip as shown at B and D in figure 2-5-9. The thickness of the blade at the tip should be such that the tip will just enter the slot of the screws you intend to turn. With such

Figure 2-5-10.—Checking the squareness of the end of a screwdriver.

a tip thickness, and the sides parallel or nearly so, the screwdriver will have the least tendency to climb out of the screw slot when the screw is being turned home.

The electrician's screwdriver (or cabinet screwdriver) shown in 2-5-9 D has been ground by resting it flat against the grinding wheel. A 6-inch wheel produces about the right grind on a screwdriver used for small screws. Hold the blade high on the circumference of the wheel and rest the shank on the tool rest. See figure 2-5-11.

When grinding a screwdriver, do not let the tip get too hot or the temper will be drawn—overheating is discussed later in the section on sharpening metal cutting chisels.

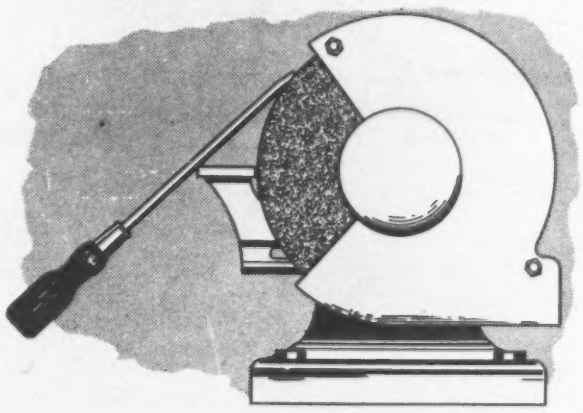

Figure 2-5-11.—Grinding a screwdriver tip with a bench grinder.

SHARPENING TIN SNIPS

To sharpen tin snips on a grinder, open the snips as shown in figure 2-5-12, resting the blade on the tool rest. Hold the handle of the blade being ground level and the handle of the other blade level or slanting downward at whatever angle is necessary to grind the cutting edge to an included angle of 80° to 85°. Holding the blade lightly against the rotating wheel, move it from left to right across the face of the wheel. Sharpen first one blade of the snips and then the other. While sharpening one blade, be careful to keep the other blade from coming into contact with the side of the wheel. Sharpening tin snips requires close and careful attention; improper techniques may result in wrecking the snips or even in serious injury.

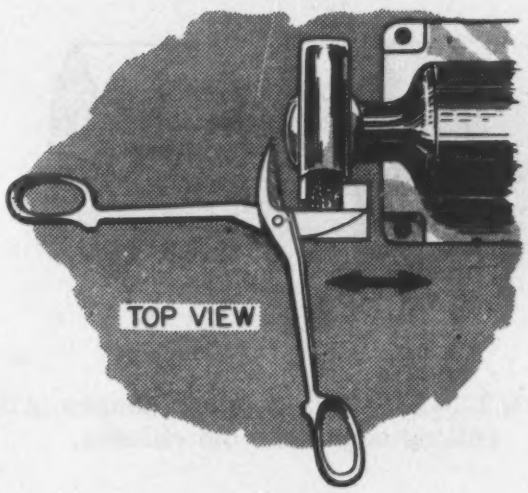

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Figure 2-5-12.—Sharpening snips on a grinder.

GRINDING THE HEADS OF CHISELS

The mushroom head on the chisel shown in figure 2-5-13B is very dangerous. When struck with a hammer, chips may break off and injure you or others.

Remove the ragged edges of such a head by grinding them off. One way to do this is to hold the head against the wheel as shown in figure 2-5-14.

Turn the chisel with one hand as you apply pressure with the other. Grind across the entire face of the wheel to keep it flat. In figure 2-5-13 A you will see a properly ground head. Keep it that way by frequent grinding before it begins to mushroom as shown in figure 2-5-13 B.

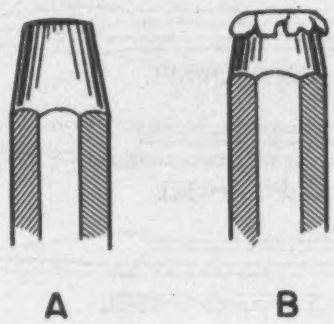

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Figure 2-5-13.—Good and bad shaped chisel heads.

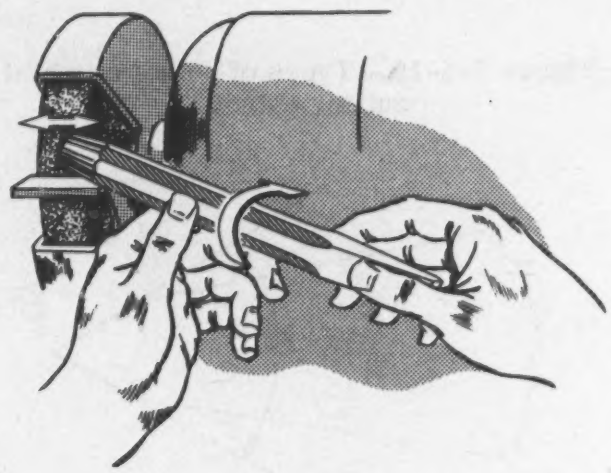

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Figure 2-5-14.—Grinding a chisel head with a bench grinder.

SHARPENING METAL CUTTING CHISELS

Metal cutting chisels, types of which are shown in figure 2-5-15, are sharpened by grinding. These chisels are designed to cut cold metal, and the cold chisel is the most common type. The general term "cold chisel" is often used when referring to any one of the chisels shown. The angle of 60°, shown on the cold chisel in figure 2-5-16, is for a general-use cold chisel. Increase this angle somewhat for cutting harder metals and decrease it for those that are softer.

To sharpen a metal-cutting chisel, hold the chisel to the wheel, resting it on the tool rest.

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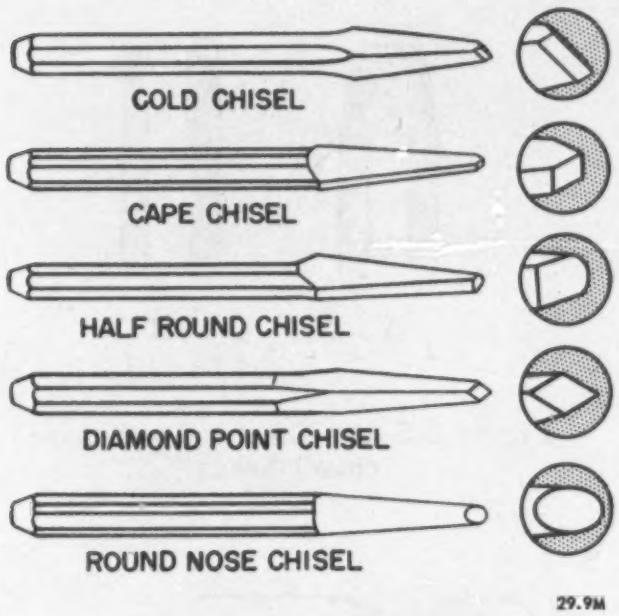

Figure 2-5-15.—Types of points on metal cutting chisels.

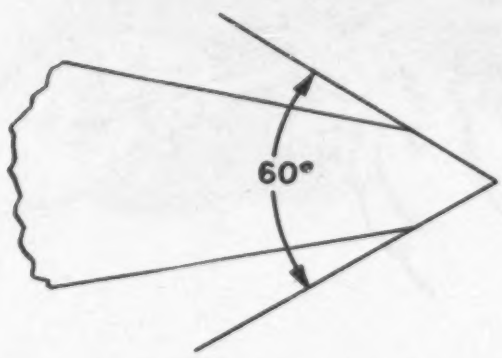

Figure 2-5-16.—Proper angle for general use cold chisel.

(See figure 2-5-17.) Notice that the index finger, curved beneath the chisel, rides against the front edge of the tool rest. This affords good control of the chisel and will help you to grind a single, equal bevel on each side.

Figure 2-5-18 A shows a cold chisel ground with a slight radius, and figure 2-5-18 B shows a straight cutting edge. Both types of edges are used. The radius (fig. 2-5-18 A) is ground by swinging either end of the chisel slightly from left to right as the two faces of the cutting edge are being ground.

For shearing metal in a vise the chisel with the straight edge may be better. The chisel with the slight radius will probably work better when you are cutting metal on a flat plate.

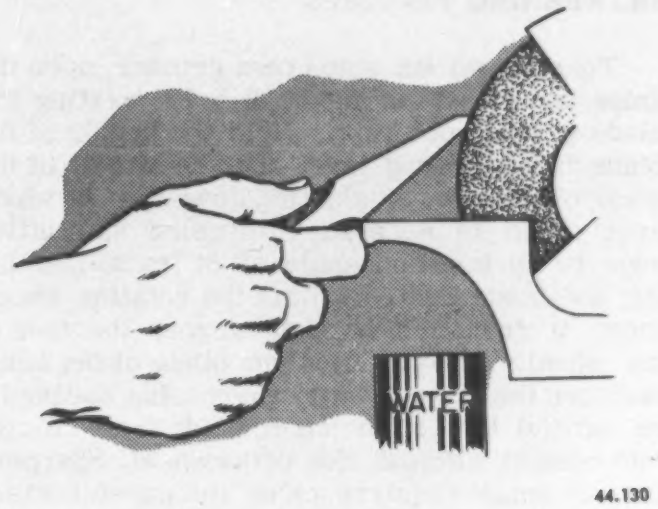

Figure 2-5-17.—Sharpening a chisel with a grinder.

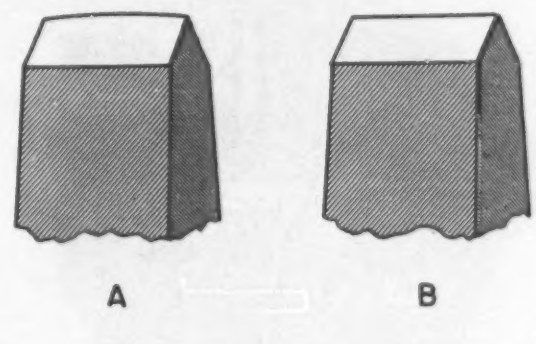

Figure 2-5-18.—Two common shapes of the cutting edges of cold chisels.

Notice, in figure 2-5-17, that a container of cooling water is near the tool rest. Let the chisel rest only lightly against the wheel when grinding. Less heat will be developed and, because the speed of the wheel is reduced only slightly, the air currents created by the wheel will have the maximum cooling effect. If the temperature of the cutting edge rises to the point where the metal begins to turn blue in color, the temper has been drawn, the cutting edge has been softened, and the edge will not stand up in use. The cutting edge will have to be rehardened, drawn to the proper temper (hardness), and the sharpening continued. As long as you can touch the cutting edge you are grinding with your bare hand and keep it there, you are in no danger of drawing the temper. Notice that it is the temperature of the cutting edge that is important. This means the very tip of the chisel where the bevel is being ground.

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The chisel at a point an inch or less from the cutting edge may be cool, while the cutting edge itself turns blue from overheating. Check this carefully while grinding.

SHARPENING TWIST DRILLS

The following requirements are of greatest importance in twist-drill grinding: (1) equal and correctly sized drill-point angles, (2) equal-length cutting lips, (3) correct clearance behind the cutting lips, and (4) correct chisel-edge angle. All four are equally important when grinding either a regular point (fig. 2-5-19) which is used for general purposes, or a flat point (fig. 2-5-20) which is used for drilling hard and tough materials.

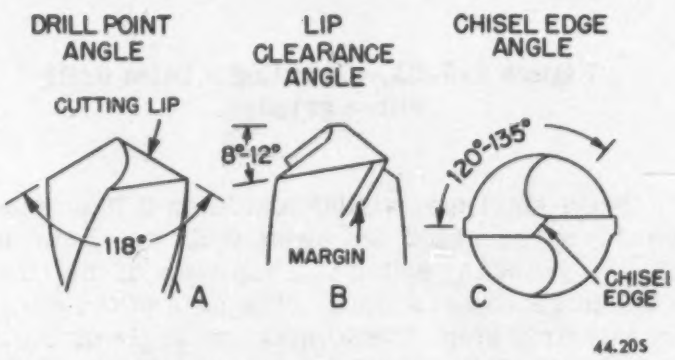

Figure 2-5-19.—Specifications for grinding a regular point twist drill.

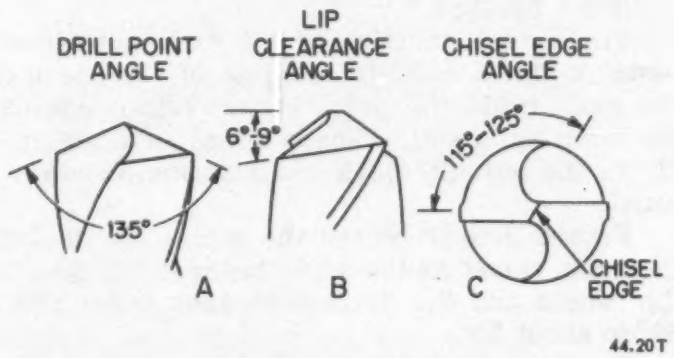

Figure 2-5-20.—Specifications for grinding a flat point twist drill.

Figure 2-5-21 shows what is meant by the two halves, A1 and A2, of the drill point angle, as well as the two equal-length cutting lips, L1 and L2.

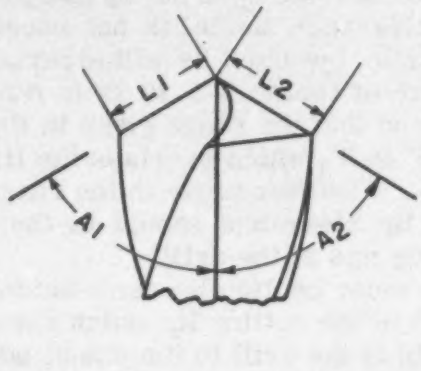

Figure 2-5-21.—Halves and cutting lips of a twist drill.

Figure 2-5-22 shows a drill being checked during grinding. The drill-point gage is being held against the body of the drill and has been brought down to where the graduated edge of the gage is in contact with one cutting edge. In this way, both the drill-point angle and the length of the cutting edge (or lip) are checked at the same time. The process is repeated for the other side of the drill.

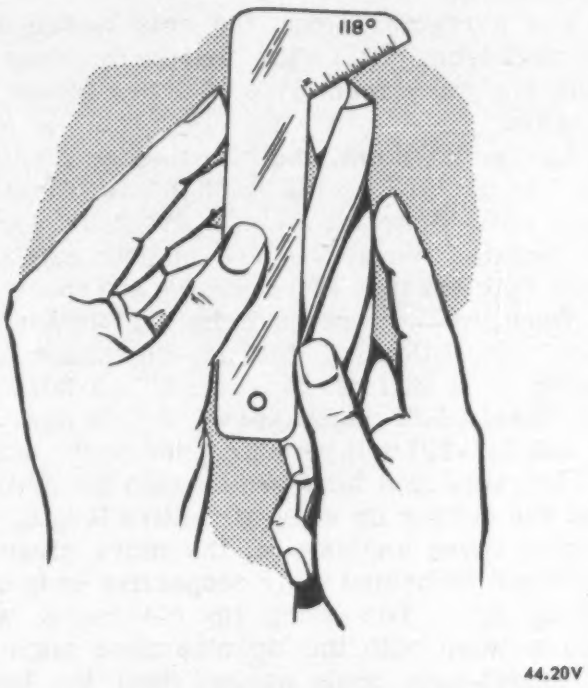

Figure 2-5-22.—Checking the drill point angle and cutting edge.

Lip clearance behind the cutting lip at the margin is determined by inspection. This means that you look at the drill point and approximate the lip-clearance angle (see figs. 2-5-19B and 2-5-20B), or compare it to the

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same angle that has been set up on a protractor. The lip-clearance angle is not necessarily a definite angle, but must be within certain limits. Notice that in figure 2-5-19 B it ranges from 8° to 12° and that the range given in figure 2-5-20 B is 6° to 9°, which overlaps the first range somewhat. Whatever angle in the range is used, however, lip clearance should be the same for both cutting lips of the drill.

There must be lip clearance behind the entire length of the cutting lip which extends from the margin of the drill to the chisel edge. This means that there must be "relief" behind the cutting lip along its entire length.

Whereas the lip clearance at the margin is measured by inspection, as shown in figures 2-5-19B and 2-5-20B, lip clearance at the other end of the cutting lip (at the chisel edge) is measured by inspection of the chisel-edge angle. The clearance behind the cutting lip at the chisel edge is greater than at the margin. The chisel-edge angle indicates how much clearance there is behind the cutting lip where it meets the chisel edge. As you grind more clearance behind the cutting lip near the chisel edge, the chisel-edge angle will get larger.

For a regular point, the chisel-edge angle can vary from 120° to 135° and the lip-clearance angle can vary from 8° to 12°. See figure 2-5-19 again.

For a flat point, the chisel-edge angle can vary from 115° to 125° and the lip-clearance angle from 6° to 9°. See figure 2-5-20 again. The greater the angles are in both cases, the more lip clearance there will be, and vice versa.

When lip clearance is being "ground into" a drill, inspection of the lip-clearance angle (shown at B in figs. 2-5-19 and 2-5-20) and of the chisel-point angle (shown at C in figs. 2-5-19 and 2-5-20) will be your guide to the amount of clearance you have ground into the drill behind the cutting lip along its entire length. The greater these angles are, the more clearance there will be behind their respective ends of the cutting lip. Too much lip clearance, which occurs when both the lip-clearance angle and the chisel-edge angle exceed their top limits, weakens the cutting edge or lip by removing too much metal directly behind it. Too little or no lip clearance, prevents the cutting edge from producing a chip, or cutting, and the drill will not drill a hole.

To SHARPEN TWIST DRILLS, first get the grinder ready. If necessary, dress the face of the wheel so that it is clean, a true circle, and square with the sides. Before starting the grinder, readjust the tool rest to 1/16" or less from the face of the wheel. This is an important safety measure which will help keep work from wedging between the tool rest and the face of the wheel.

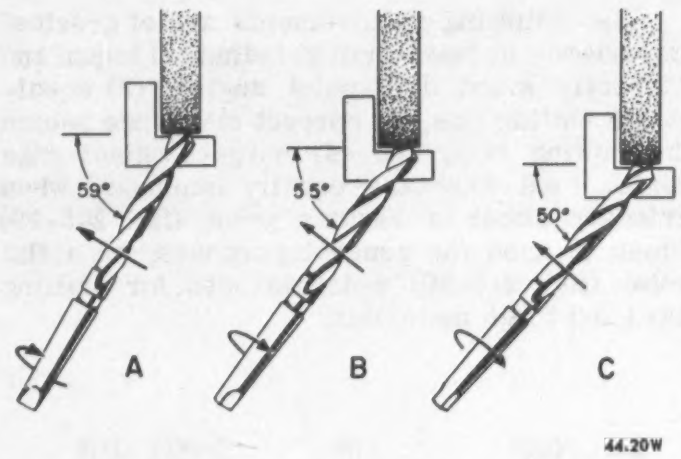

Figure 2-5-23.—Grinding a twist drill with a grinder.

Now, start the grinder and when it has come up to speed, hold the twist drill as shown in figure 2-5-23A, which is a top view of the first step in grinding a drill. The axis of the drill, in the first step, should make an angle of about 59° (half of the drill-point angle in fig. 2-5-23A) with the face of the wheel. The cutting lip should be horizontal.

Figure 2-5-24 is an actual photograph, side view, of the same drill position which is shown in figure 2-5-23A.

The actual grinding of the drill point consists of three definite motions of the shank of the drill while the point is held lightly against the rotating wheel. These three motions are: (1) to the left, (2) clockwise rotation, (3) downward.

Figure 2-5-23 shows the motion to the left in three views as the angle between the face of the wheel and the drill decreases from about 59° to about 50°.

In figure 2-5-23 the clockwise rotation is indicated by the advance of the rotation arrows in A, B, and C. Rotation is also pictured by the change in position of the cutting lip as well as that of the tang.

Because figure 2-5-23 is a top view, the third (downward) motion is not noticeable. However, all three motions are apparent when an actual photograph of the final position of the

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Figure 2-5-24.—Grinding a twist drill with a grinder.

drill in figure 2-5-25 is compared to the initial position in figure 2-5-24. All three motions taking place at the same time combine to produce the important requirements mentioned before (1) equal and correctly sized drill-point angles (2) equal-length cutting lips, (3) correct clearance behind the cutting lips, and (4) correct chisel-edge angle. Checking by means of a drill-point gage, figure 2-5-22, and by inspection will show when these four requirements have been met.

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Figure 2-5-25.—Grinding a twist drill with a grinder.

SHARPENING A TWIST DRILL FOR DRILLING BRASS

To grind a drill for drilling brass (fig. 2-5-26 A) hold the cutting lip against the right side of the wheel as shown in figure 2-5-26 B. Grinding the flute slightly flat, in line with the axis of the drill, greatly reduces the included angle of the cutting lip. This will give the drill a scraping action, necessary for brass, rather than the cutting action used for steel. This scraping action will prevent the tendency, that invariably occurs with drills not ground for brass, to stick in the hole being drilled. This sticking is troublesome especially when drilling through a pilot hole.

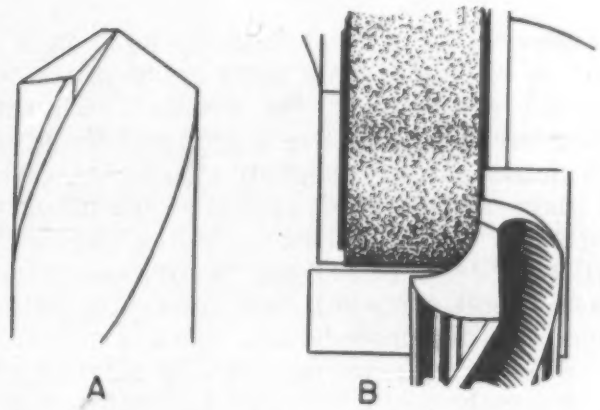

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Figure 2-5-26.—Grinding a twist drill for brass.

THINNING THE WEB OF A TWIST DRILL

Repeated sharpening, which shortens the drill, or the fact that the remaining length of a broken drill has been resharpened, results in an increase in the web thickness at the point. This may require web thinning. Correct web thinning, when it becomes necessary, is important for satisfactory drilling.

To thin the web of a drill, hold the drill lightly to the face of a round-faced wheel, as shown in figure 2-5-27A, thinning the web for a short distance behind the cutting lip and into the flutes. This is shown in figure 2-5-27B. Notice that the cutting lip is actually (but only slightly) ground back, reducing its included angle only a very little and not enough to affect the operation of the drill.

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Figure 2-5-27.—Thinning the web of a twist drill.

SHARPENING TWIST DRILL BY MACHINE

Sharpening a twist drill by hand is a skill that is mastered only after much practice and careful attention to the details. Therefore, whenever possible, use a tool grinder in which the drills can be properly positioned, clamped in place and set with precision for the various angles. This machine grinding (fig. 2-5-28) will enable you to sharpen the drills accurately. As a result, they will last longer and will produce more accurate holes.

Whether you are sharpening a drill by hand or by machine, it is very necessary that the temperature at the point be kept down. As the point gets hot, it approaches the temperature at which the temper of the steel will be drawn. To draw the temper means to remove the hardness.

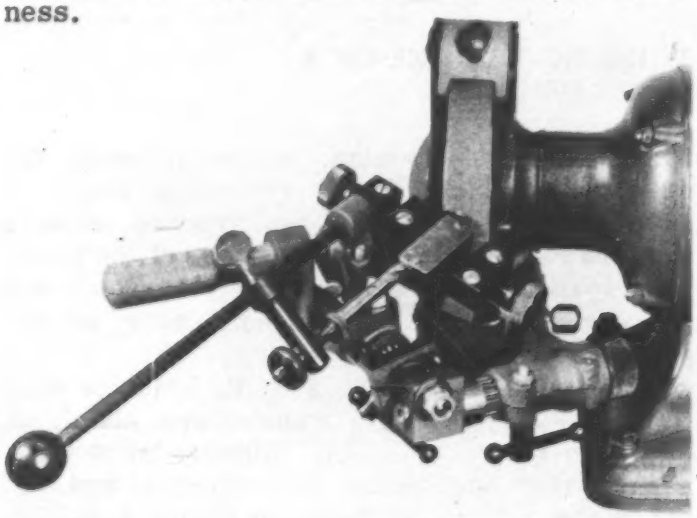

Figure 2-5-28.—Sharpening a twist drill with a tool grinder.

Keep the point cool enough to be held in your bare hand. Do this by making a few light passes over the grinding wheel, take a few seconds to let the point cool and repeat alternate grinding and cooling. With only slight pressure against the wheel, less heat is developed and the speed of the wheel is maintained. Wheel speed creates air currents which also help to keep the point cool.

Once you notice the appearance of a blue temper color at the point, it is too late. You have drawn the temper and the steel is now too soft to hold a cutting edge. Then the only thing you can do is to continue the sharpening process, first one lip and then the other, until you have finally ground away the soft tip of the drill. This means that you must grind away all that portion of the tip which is blue. As the blue color indicates softness throughout the entire point of the drill, and not only on the blue surface, resharpening must be continued until all of the blue-colored metal has been ground away.

This operation must be done very slowly and carefully, keeping the point cool to prevent continual bluing of the metal.

FILING OPERATIONS

Using a file is an operation that is nearly indispensable when working with metal. Filing is done when a small amount of metal is to be removed. To better understand this section, you may need to review the section on "files" in part I, section 1, of this course.

When you have finished using a file it may be necessary to use an abrasive cloth or paper to finish the product. Whether this is necessary depends on how fine a finish you want on the work.

FILING MILD STEEL

Figure 2-5-29 shows a piece of mild steel being crossfiled. This means that the file is being moved across the surface of the work in approximately a crosswise direction. For good results, keep your feet spread apart to steady yourself as you file with slow full-length steady strokes. The file cuts as you push it—ease up on the return stroke to keep from dulling the teeth. Keep your file clean.

Figure 2-5-30 shows the alternate positions of the file when an exceptionally flat surface is required. Using either one position or the

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1.20A

Figure 2-5-29.—Crossfiling a piece of mild steel.

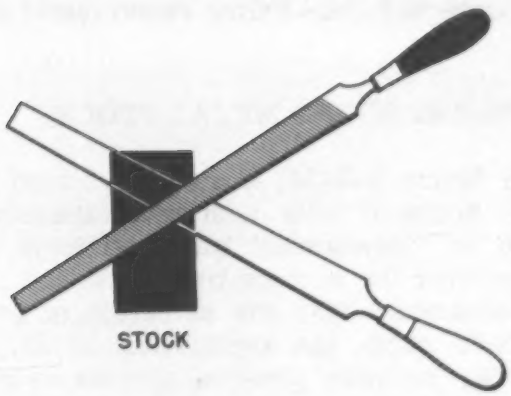

1.20B

Figure 2-5-30.—Alternating positions when filing.

other first, file across the entire length of the stock. Repeat this until the entire surface has had metal removed by the file. Then, using the other position, file across the entire length of the stock again. Because the teeth of the file pass over the surface of the stock from two directions, the high spots and low spots will readily be visible after filing in both positions. Continue filing first in one position or direction and then the other until the surface has been filed flat. Test the flatness with a straight edge or with prussian blue and a surface plate.

Draw filing produces a finer surface finish and usually a flatter surface than crossfiling. Small parts, as shown in figure 2-5-31, are best held in a vise. Hold the file as shown in the figure; notice that the arrow indicates that the cutting stroke is away from you when the handle of the file is held in the right hand. If the handle is held in the left hand, the cutting stroke will be toward you.

Lift the file away from the surface of the work on the return stroke. When draw filing will no longer improve the surface texture, wrap a piece of abrasive cloth around the file and polish the surface as shown in figure 2-5-32.

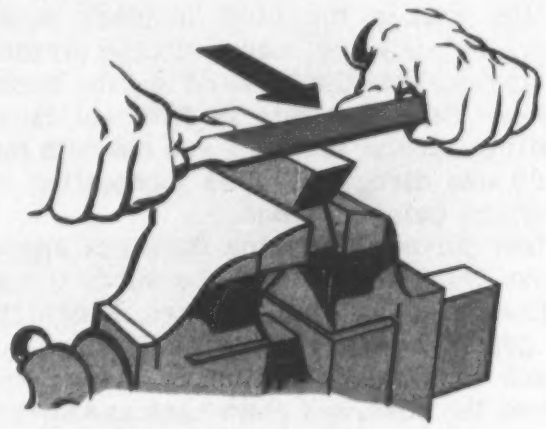

1.20C

Figure 2-5-31.—Drawfiling a small part.

Always keep the file clean, whether you're filing mild steel or other metals. Use chalk liberally when filing nonferrous metals.

POLISHING A FLAT METAL SURFACE

When polishing a flat metal surface, first draw file the surface as shown in fig. 2-5-31.

Then, when the best possible draw filed surface has been obtained, proceed with abrasive cloth, often called emery cloth. Select a grade of cloth suited to the draw filing. If the draw filing was well done only a fine cloth will be needed to do the polishing.

If your cloth is in a roll, and the job you are polishing is the size that would be held in a vise, tear off a 6" or 8" length of the 1" or 2" width. If you are using sheets of abrasive cloth, tear off a strip from the long edge of the 8" by 11" sheet.

Wrap the cloth around the file (fig. 2-5-32) and hold the file as you would for draw filing.

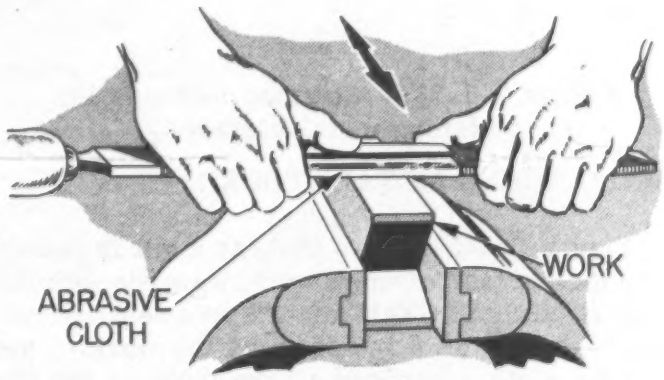

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Figure 2-5-32.—Polishing metal with abrasive cloth wrapped around a file.

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Hold the end of the cloth in place with your thumb. In polishing, use a double stroke with pressure on both the forward and the backward strokes. Note that this is different from the drawfiling stroke in which you cut with the file in only one direction. Use lubricating oil on the surface being polished.

When further polishing does not appear to improve the surface, you are ready to use the next finer grade of cloth. Before changing to the finer grade, however, reverse the cloth so that its back is toward the surface being polished.

Work the reversed cloth back and forth in the abrasive-laden oil as an intermediate step between grades of abrasive cloth. Then, with the solvent available in your shop, clean the job thoroughly before proceeding with the next finer grade of cloth. Careful cleaning between grades helps to ensure freedom from scratches.

For the final polish, use a strip of crocus cloth—first the face and then the back—with plenty of oil. When polishing is complete, again carefully clean the job with a solvent and protect it, with oil or other means, from rusting.

Figure 2-5-33A shows another way to polish in which the abrasive cloth is wrapped around a block of wood. In figure 2-5-33B, the cloth has simply been folded to form a pad from which a worn, dull surface can be removed by simply tearing it off to expose a new surface.

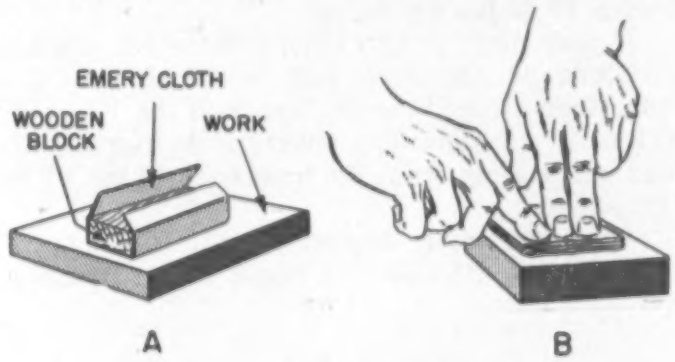

Figure 2-5-33.—Alternate methods for polishing metal surfaces.

FILING ROUND METAL STOCK

Figure 2-5-34 shows that, as a file is passed over the surface of round work, its angle with the work is changed. This results in a rocking motion of the file as it passes over the work. This rocking motion permits all the teeth on the file to make contact and cut as they pass over the work's surface, thus tending to keep the file much cleaner and thereby doing better work.

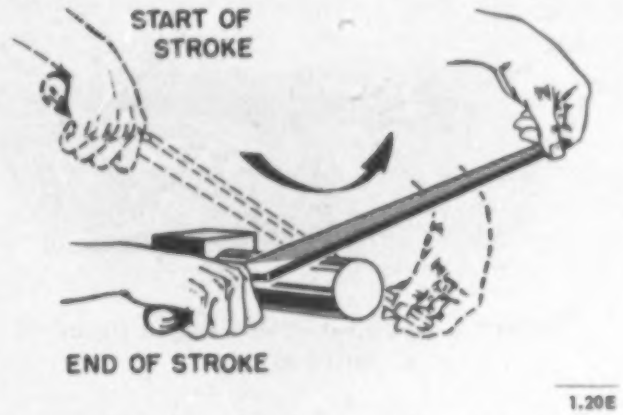

Figure 2-5-34.—Filing round metal stock.

POLISHING ROUND METAL STOCK

In figure 2-5-35, a piece of round stock is being polished with a strip of abrasive cloth which is "seesawed" back and forth as it is guided over the surface being polished.

Remember that the selection of grades of abrasive cloth, the application of oil, and the cleaning between grades, applies to polishing regardless of how the cloth is held or used.

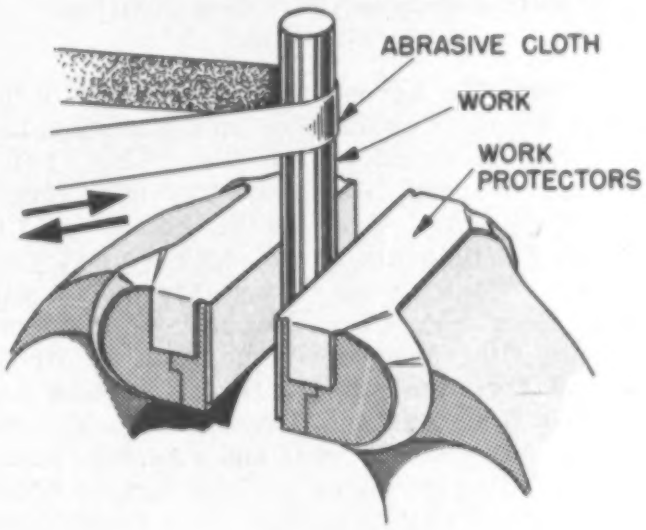

Figure 2-5-35.—Polishing round metal stock.

TESTING METAL FOR HARDNESS

A quick and practical test for hardness can be made with an ordinary mill file. Hold a piece of stock in a vise, or firmly against the edge of the bench, and pass the file over its surface, preferably at an edge or at a corner. If the file will take hold and cut the surface of the metal,

it indicates that the metal is softer than the file itself and can therefore be filed, drilled or cut with a hacksaw. If the file seems to slide over the surface of the metal, then its teeth are not cutting, and the metal cannot be drilled with twist drills or cut with a hacksaw. In this case, other methods of cutting will have to be employed. Among these methods are grinding, abrasive wheel cutting, and torch cutting.

USING SHARPENING STONES

Sharpening stones are often used for final dressing of edged tools. When a tool is ground with a grinder there is often a wire edge that should be removed. This can be done by honing the edge of the tool with a sharpening stone. There are many times when the sharp edge of a tool is dulled but is not damaged to the extent that it needs grinding. In these cases honing with a sharpening stone is all that is necessary to restore the keen edge to the tool. Do not grind a tool unless it is necessary, as it will wear away metal unnecessarily and may distort the original shape of the tool.

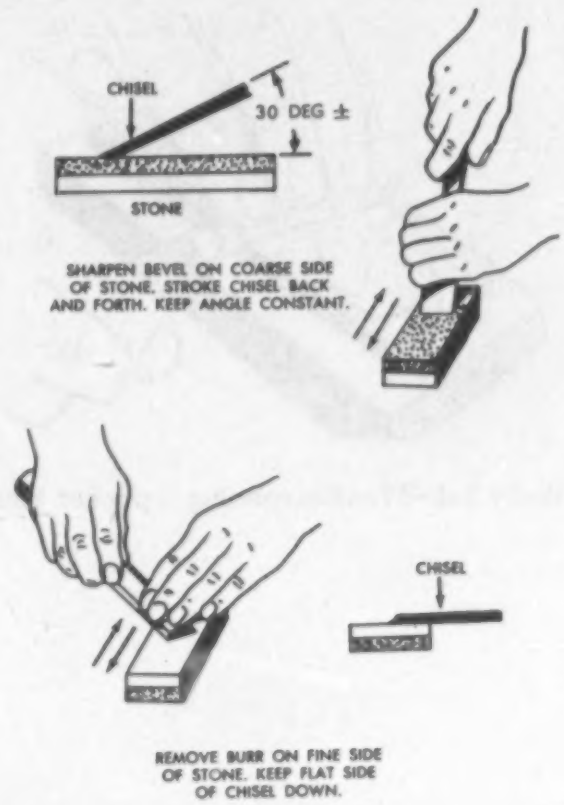

Figure 2-5-36.—Sharpening a woodworker's chisel.

SHARPENING A CHISEL ON A SHARPENING STONE

To sharpen a wood chisel with a sharpening stone, use a common oilstone that has coarse grit on one side and fine grit on the other. (See fig. 2-5-36.) Make sure the stone is firmly held so that it cannot move. Cover the stone with a light machine oil so that the fine particles of steel ground off will float and thus prevent the stone from clogging.

Hold the chisel in one hand with the bevel flat against the coarse side of the stone. Use the fingers of your other hand to steady the chisel and hold it down against the stone. Using smooth even strokes, rub the chisel back and forth parallel to the surface of the stone (fig. 2-5-36). The entire surface of the stone should be used to avoid wearing a hollow in the center of the stone. Do not rock the blade. The angle of the blade with the stone must remain constant during the whetting process.

After a few strokes, a burr, wire edge, or feather edge is produced. To remove the burr, first take a few strokes with the flat side of the chisel held flat on the fine grit side of the stone. Be careful not to raise the chisel even slightly; avoid putting the slightest bevel on the flat side, for then the chisel must be ground until the bevel is removed.

After whetting the flat side on the fine grit side of the stone, turn the chisel over and place the bevel side down and hold it at the same angle as used when whetting on the coarse side of the stone. Take two or three light strokes to remove the burr.

To test the sharpness of the cutting edge, hold the chisel where a good light will shine on the cutting edge. A keen edge does not reflect light in any position. If there are no shiny or white spots it is a good edge.

SHARPENING A POCKET KNIFE ON A SHARPENING STONE

Most pocket knives may be sharpened on a medium or fine grade sharpening stone with a few drops of oil spread on the surface. Hold the handle of the knife in one hand and place the blade across the stone. Press down with the fingers of the other hand and stroke the blade following a circular motion as shown in figure 2-5-37.

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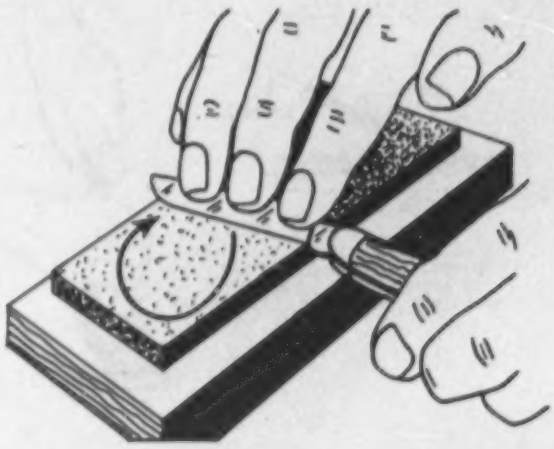

Figure 2-5-37.—Sharpening a pocket knife.

After several strokes, reverse blade and stroke opposite side, following the same type of motion. Use a light even pressure. A thin blade overheats quickly and can lose its temper. The wire edge or burr that may be left on a knife blade after whetting may be removed by stropping both sides on a soft wood block, canvas or leather.

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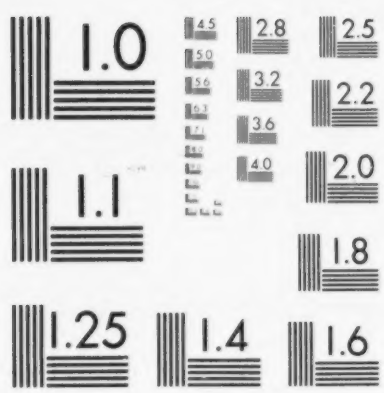

MICROCOPY RESOLUTION TEST CHART

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PART II

Section 6

METAL CUTTING OPERATIONS

The cutting of metal can, in some instances, be a simple operation where accuracy is not important. However, in most cases the cutting of metal is an important and precise job. A large number of tools, both power and hand, have been designed to make metal-cutting operations speedy, economical, and accurate in all kinds of material.

As you advance in your Navy career you will find that there are many special tools designed to do specific jobs. This is true in all ratings but especially true when the rating requires working with metal. Only the skills that require the use of common and versatile metal cutting tools will be discussed in this section.

METAL CUTTING WITH CHISELS

One of the earliest methods of shaping a piece of metal was to chip away the unwanted material with a hammer and chisel. This practice is still common for jobs that are done at the workbench, and where it is not practical to do the work on a machine. The different shapes and sizes of metal cutting chisels were discussed, in part I, section 1, of this course.

CUTTING METAL ON A FLAT SURFACE

To cut metal on a flat plate, place the metal on a heavy bench plate or similar surface that will serve as backing for the hammer blows. Hold the cold chisel firmly in the cut and slanting slightly away from the direction in which it is cutting. (See fig. 2-6-1). Advance the chisel along the scrap side of the layout line after each hammer blow. Cut through on the first blow for the lighter gages of metal. Heavier gages will require a second or third blow.

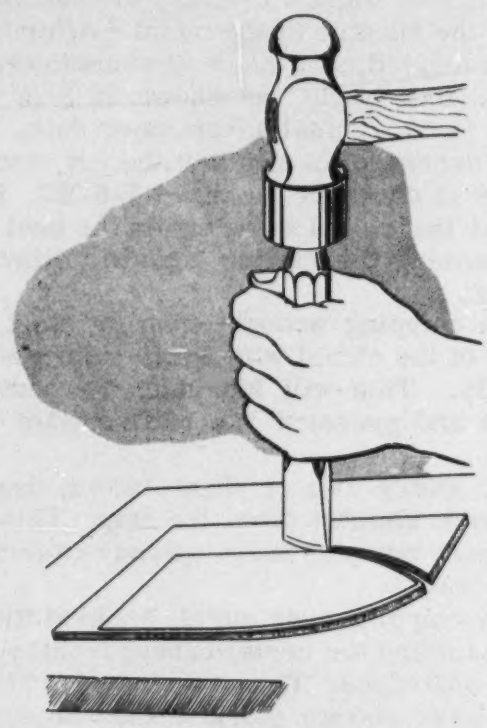

Figure 2-6-1.—Cutting metal on a flat surface.

CHIPPING METAL WITH A CHISEL.

"Chipping" is a term applied to the removal of metal with the cold chisel and hammer. The degree of accuracy required varies.

Secure the work in a vise with a block under the work to prevent it from slipping. Place canvas or some other type of chipping guard in front of the work to keep flying chips from hitting men working in front of you. Wear goggles to protect your eyes.

For most ordinary chipping with a 3/4-inch chisel, use a 1-pound hammer. Use a lighter hammer for a smaller chisel. Always use a well-sharpened chisel.

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Grasp the chisel with one hand, holding the cutting edge to the work and striking the other end of the chisel with the hammer. Keep your eyes on the cutting edge of the chisel to watch the progress of the work. The bevel side of the chisel is the guiding surface, and is held at a very slight angle with the finished part of the work which the cutting edge is touching. Raising or lowering the shank of the chisel increases or decreases the inclination of the guiding bevel and causes the chisel to take a heavier or lighter cut.

To start the chip, the angle 1 in figure 2-6-2A must be great enough to cause the cutting edge to enter the surface of the metal. After the cut has been started, and the desired depth reached, decrease this angle, as shown at 2 in figure 2-6-2B, as the chisel advances or cuts. If you want to decrease the depth of the cut, decrease the angle as shown at 3 in figure 2-6-2C. Notice here that the chisel is riding on the heel of the bevel, causing the cutting edge to "climb out" of the cut.

When chipping wrought iron or steel, wipe the edge of the chisel with an oil-saturated cloth frequently. This will lubricate the contacting surfaces and preserve the cutting edge of the chisel.

After every two or three blows, draw the chisel back slightly from the chip. This tends to ease your muscles and gives you better control over the job.

When chipping case metal, begin at the ends and chip toward the center to keep from breaking corners and edges. Take cuts from 1/16 to 1/32 inch. Leave enough stock so that the surfaces may be finished with a file.

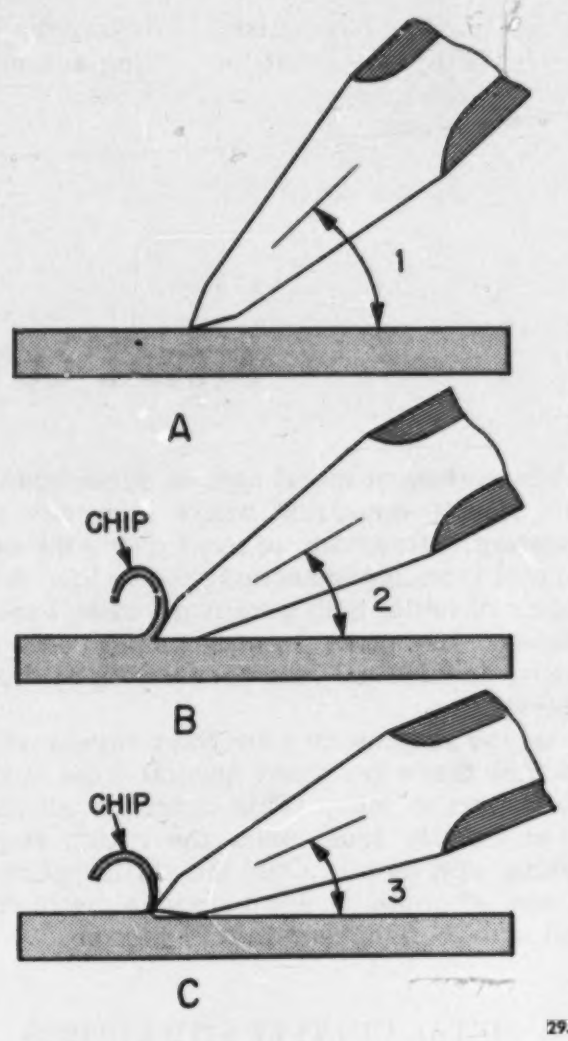

Figure 2-6-2.—Chipping metal with a chisel.

CUTTING WIRE OR ROUND STOCK

When a suitable hacksaw is not available to cut round stock, the chisel may be used.

Mark off a guideline on the stock and place the work on the top face of an anvil or other suitable working surface. Place the cutting edge of the chisel on the mark in a vertical position and lightly strike the chisel with a hammer. Check the chisel mark for the desired cut. Continue to strike the chisel until the cut is made. The last few blows of the hammer should be made lightly to avoid damage to the anvil, supporting surface, or to the chisel.

Heavy stock is cut in the same manner except that the cut is made halfway through the stock; the work is then turned over and the cut finished from the opposite side.

SHEARING METAL IN A VISE

To shear metal in a vise, hold the metal in the bare vise jaws (fig. 2-6-3) in order to provide a shearing action between the rear jaw of

Figure 2-6-3.—Shearing metal with a chisel.

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the vise and the cold chisel. Advance the chisel after each blow so that the cutting action takes place in about the center of the cutting edge of the cold chisel. If you are shearing to a line, hold the metal so that the line is just concealed by the front jaw of the vise. After cutting, it will then be visible along the sheared edge to serve as a guide for grinding or filing.

To cut an internal hole by shearing, hold the metal in the vise as you do for plain shearing. Notice that the cut is being made from a to b in figure 2-6-4A, and that the cutting has stretched the metal at the jaws of the vise. When ab has been cut, hold the metal in the vise along the other lines and cut bc, cd, and da. (See fig. 2-6-4B.)

On the second cut, from b to c, as well as on the next two cuts, the metal will curl back and away from the cut as the cutting proceeds. At the end of the fourth cut, to a point a, which was also the starting point, the scrap will fall away. Then raise the metal in the vise just enough to see the layout line in the clear and dress each sheared edge with a file down to the line. See figure 2-6-4C.

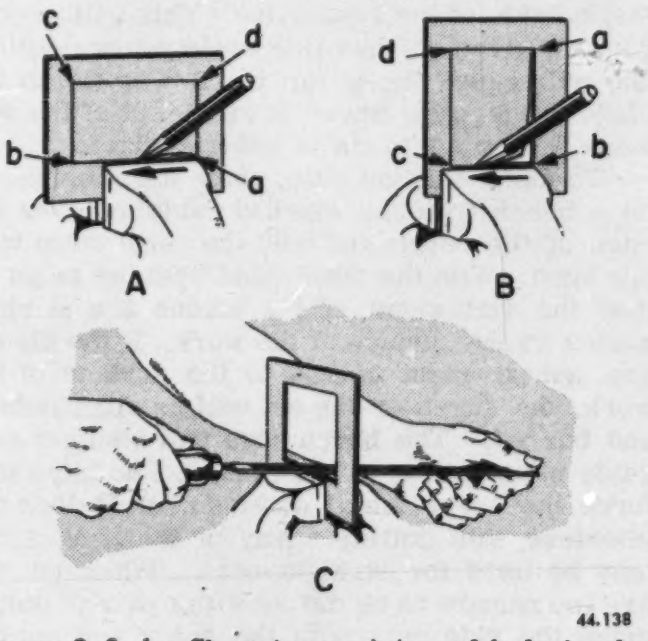

Figure 2-6-4.—Shearing an internal hole in sheet metal.

CUTTING OFF A RIVET OR BOLT HEAD

To cut off a rivet or bolt head with a chisel, hold the job in a heavy vise or secure it some other way so that the work will not move. (See fig. 2-6-5A.) Hold the cold chisel with one face of the bevel flat on the surface of the job. Strike the head of the chisel with the hammer as you loosely hold and guide the chisel.

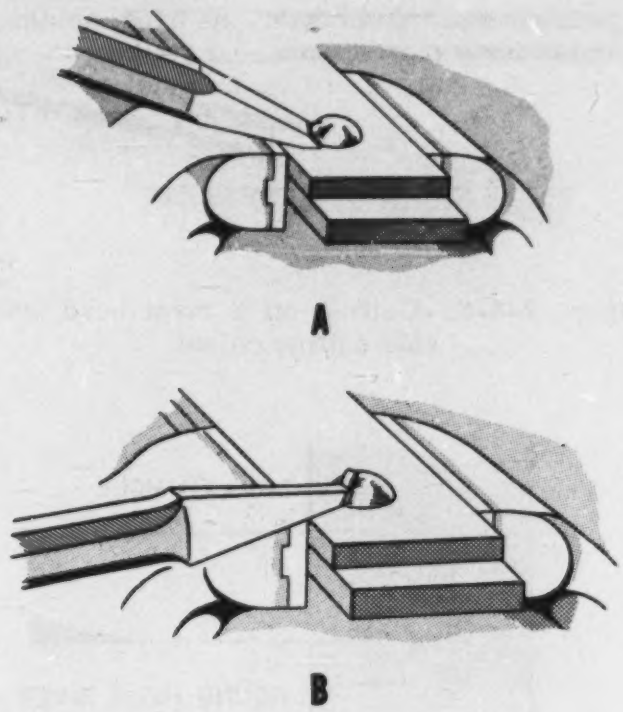

Figure 2-6-5.—Cutting off a rivet head with a chisel.

To cut off a rivet head with a cape chisel, select a chisel of about the same size as the diameter of the rivet. Cut through the center of the rivet head, holding one face of the bevel flat on the surface of the job, and then sever the center of the head from the shank or body, as shown in figure 2-6-5B.

To cut off a rivet head with a side cutting chisel, commonly called a rivet buster, place the chisel nearly flat on the surface of the work with its single bevel upwards. (The main difference between a rivet buster and a common cold chisel is that the rivet buster has only one bevel.) Drive the cutting edge under the edge of the rivet head just as you would if you were using a cold chisel. (See fig. 2-6-6A). Notice in figure 2-6-6B that the cutting edge of the chisel has a slight radius which will tend to prevent the corners from cutting undesirable grooves in the surface of the work.

To remove a rivet head (fig. 2-6-7) when there is not room enough to swing a hammer with sufficient force to cut the rivet, first drill a hole about the size of the body of the rivet in and almost to the bottom of the rivet head. Then cut off the head with a cold chisel.

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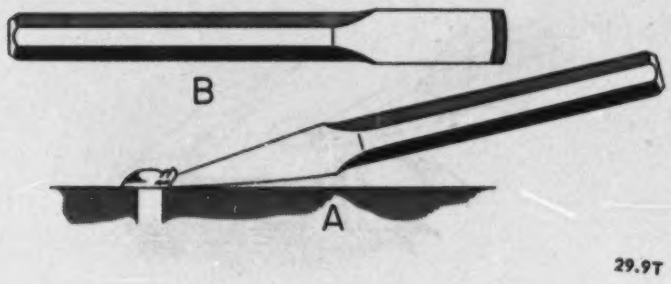

Figure 2-6-6.—Cutting off a rivet head with a side cutting chisel.

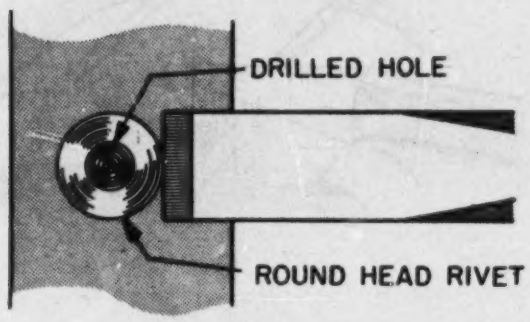

Figure 2-6-7.—Removing a rivet head in a hard to reach position.

CUTTING A GROOVE IN METAL

To cut a groove in metal (fig. 2-6-8), select a half-round chisel the size of the required groove. For small grooves, a round-nose chisel may be used.

As the chisel is driven forward, it will roll a chip ahead of the cutting edge (fig. 2-6-8), cutting a groove in the surface. You can control the depth of the groove by raising or lowering the handle of the chisel. When the handle is lowered, the chisel will tend to "ride out" of the cut on the heel—the part of the chisel just behind the cutting edge.

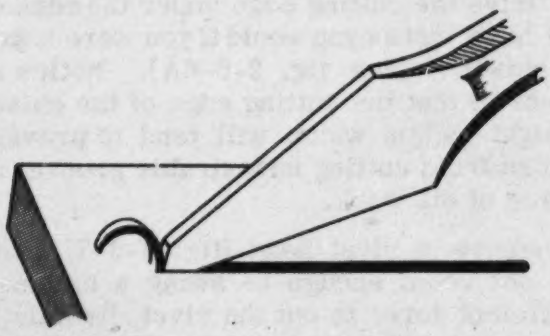

Figure 2-6-8.—Cutting a groove in metal.

CUTTING SHEET METAL WITH SNIPS

To cut large holes in the lighter gages of sheet metal, start the cut by punching or otherwise making a hole in the center of the area to be cut out. With an aviation snips, as shown in figure 2-6-9, or some other narrow-bladed snips, make a spiral cut from the starting hole out toward the scribed circle and continue cutting until the scrap falls away.

Figure 2-6-9.—Cutting an inside hole with snips.

To cut a disk in the lighter gages of sheet metal, use a combination snips or a straight blade snips as shown in figure 2-6-10. First, cut away any surplus material outside of the scribed circle leaving only a narrow piece to be removed by the final cut. Make the final cut just outside of the layout line. This will permit you to see the scribed line while you are cutting and will cause the scrap to curl up below the blade of the snips where it will be out of the way while the complete cut is being made.

To make straight cuts, place the sheet metal on a bench with the marked guideline over the edge of the bench and hold the sheet down with one hand. With the other hand hold the snips so that the flat sides of the blades are at right angles to the surface of the work. If the blades are not at right angles to the surface of the work, the edges of the cut will be slightly bent and burred. The bench edge will also act as a guide when cutting with the snips. The snips will force the scrap metal down so that it does not interfere with cutting. Any of the hand snips may be used for straight cuts. When notches are too narrow to be cut out with a pair of snips, make the side cuts with the snips and cut the base of the notch with a cold chisel.

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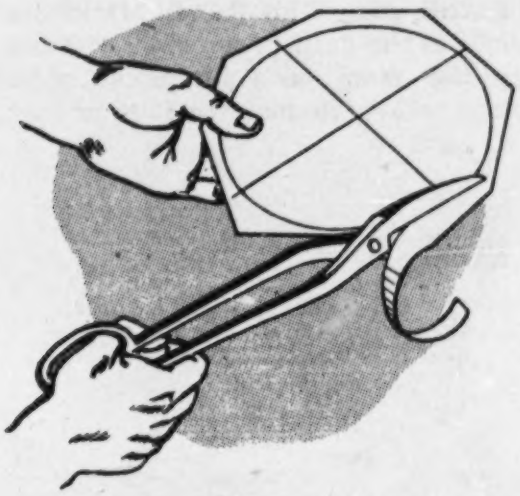

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Figure 2-6-10.—Cutting a disk out of sheet metal.

CUTTING HOLES IN METAL WITH PUNCHES

When using a hollow punch to cut holes in metal you should make layout lines on the stock metal. Use a center punch to mark the center of the hole. Scribe the desired circle with a pair of dividers.

When using either a hollow punch (fig. 2-6-11A) or a solid punch, (fig. 2-6-11B), place the stock sheet metal on top of a lead or wooden block. Strike the punch with a hammer to drive it through the metal. The lead or wood block keeps the punch from being damaged.

DRILLING HOLES IN METAL

Before drilling any material, even wood, it is a good idea to center-punch the exact location of the hole. This forms a seat for the drill point and assures accuracy. It is especially important in metal since, without the mark, the drill could "walk off" before it begins to cut into the material.

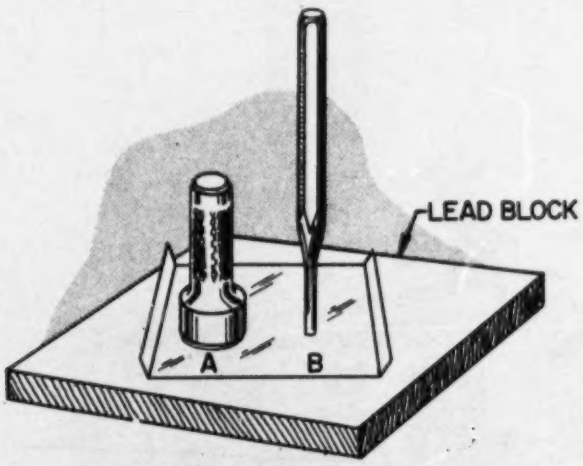

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Figure 2-6-11.—Cutting holes in metal with punches.

When drilling sheet metal, place the sheet on a flat surface to prevent the pressure you apply from buckling the sheet. The material you are drilling must be securely clamped.

Always apply pressure on a line which goes straight through the axis of the twist drill. Keep the drill steady and apply enough pressure to keep it cutting. Too much pressure will overload the motor; too little pressure will merely cause the drill to "polish" instead of cut. This will quickly dull the cutting edges of the drill. You will know the pressure is correct when the drill bites continuously without loading the drill motor.

Once you have lined up the drill with the hole, keep the drill straight. Side pressure or swaying off the line will enlarge the hole and can break the twist drill.

When drilling large holes, do it in stages, especially if you are using a low-power drill. A pilot hole is a good idea, since it serves as a guide for the larger drill and helps to increase accuracy. Above all, keep the drills sharp.

It is necessary to use a cutting oil to lubricate and cool the drill when drilling steel and wrought iron. Cast iron, aluminum, brass and other metals may be drilled dry, although at high drilling speeds it is advisable to use some medium to cool these metals. Compressed air may be used for cast iron; kerosene for aluminum; oleic acid for copper; sulfurized mineral oil for Monel metal; and water, lard, or soluble oil and soda water for ferrous metals (the soda water reduces heat, overcomes rust, and improves the finish).

HOLDING WORK FOR DRILLING

Most work is held for drilling by some mechanical means such as a clamp, vise, or pliers. When drilling small holes in fairly large pieces of work, it is permissible to hold the work with the bare hands to keep it from turning when the drill begins to cut. Under these conditions, a small drill will break in case it grabs, and the work will not be dangerously spun around at drill speed.

To drill small holes in small pieces with a hand drill or an electric drill, hold the work in

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a vise so that the axis of the drill is horizontal. See figure 2-6-12A and B. This position provides better control of the drilling and will tend to ensure a hole which will be square with the surface of the work.

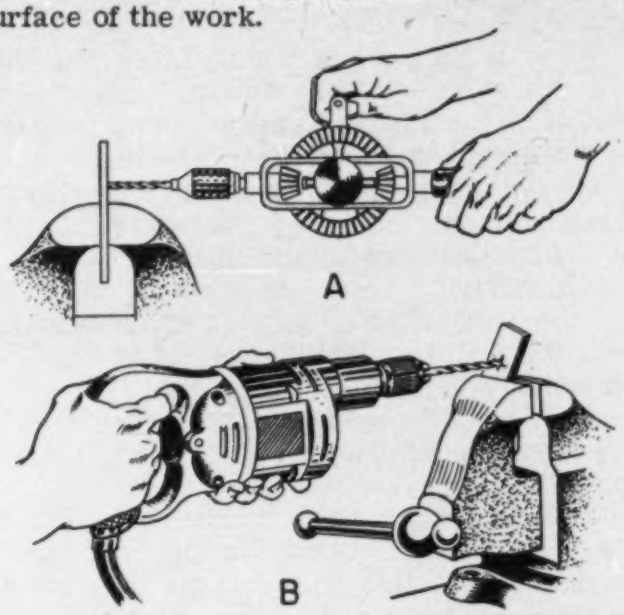

Figure 2-6-12.—Holding small pieces in a vise for drilling.

To drill small holes in small pieces with a drill press, hold the work either with a monkey wrench (fig. 2-6-13), in a drill press vise (fig. 2-6-14), with pliers or locking pliers (fig. 2-6-15), or between V blocks (fig. 2-6-16).

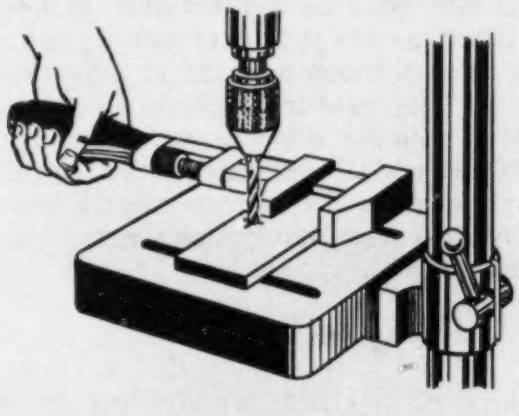

Figure 2-6-13.—Holding work with a monkey wrench.

To drill holes in the end of round stock, place the stock in one of the V-grooves in the stationary jaw of the drill vise as shown in figure 2-6-17. These V-grooves will hold the work so that it is square with the table of the drill press. The drilled hole will then be parallel with the axis of the round stock.

To drill small holes in long pieces (fig. 2-6-18), hold the stock in your left hand and feed the drill with your right hand. Drill over the center hole in the drill press table, if it has one, or place the stock on a flat piece of wood to protect the table. Reduce the feed pressure as

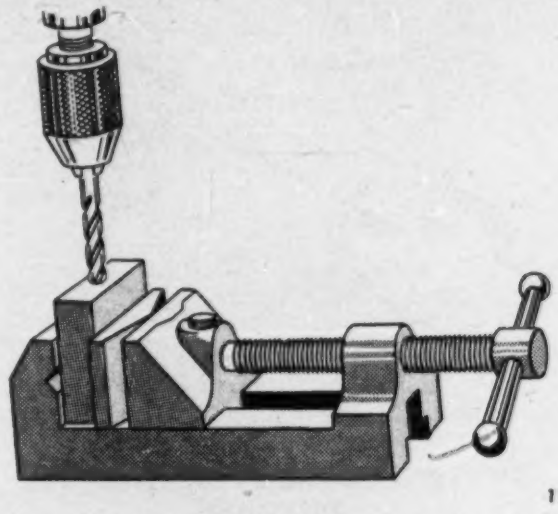

Figure 2-6-14.—Holding work with a drill press vise.

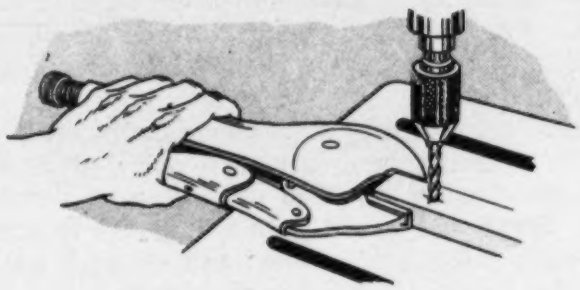

Figure 2-6-15.—Holding work with a pair of locking pliers.

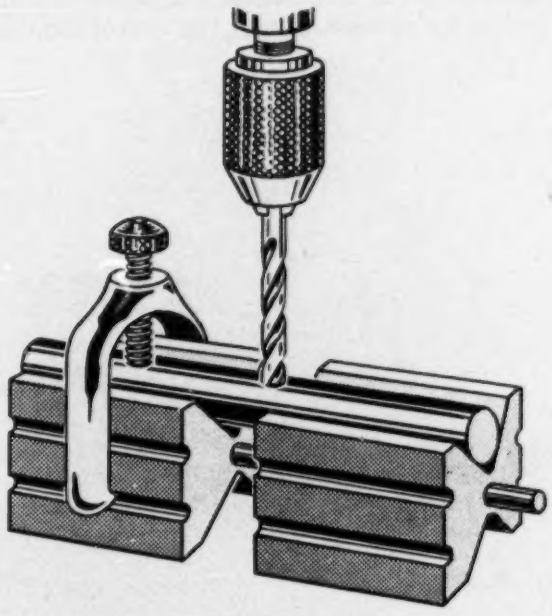

Figure 2-6-16.—Holding work in V-blocks.

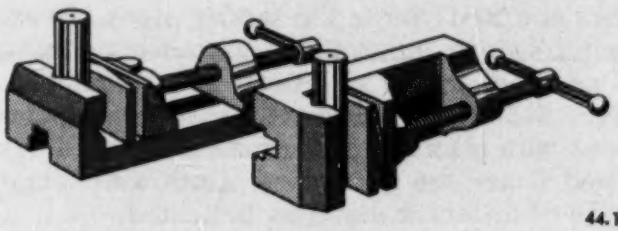

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Figure 2-6-17.—Holding work to drill holes in end of round stock.

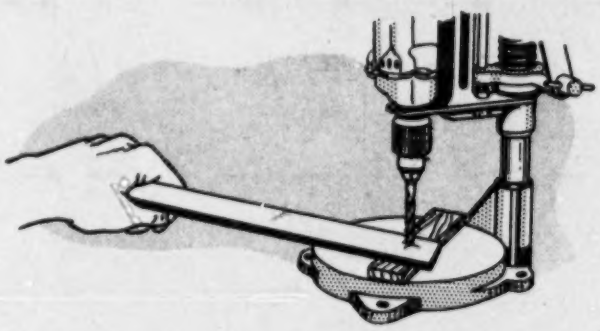

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Figure 2-6-18.—Holding a long piece for drilling a small hole.

the drill reaches the end of its cut to prevent drill breakage.

To drill large holes in large pieces, hold the work by using a step block and clamps, some types of which are shown in figure 2-6-19. Often pieces of metal of the proper thickness are substituted for a step block. A piece of metal with a hole drilled near one end makes a satisfactory substitute for a clamp.

To hold work with clamps and step blocks, the gooseneck clamp may be used, as in figure 2-6-20, to provide clearance for such obstructions as the nut below the overhang on the job shown. Notice that the body of the clamp is approximately parallel with the surface of the drill press table and that the bolt is held close

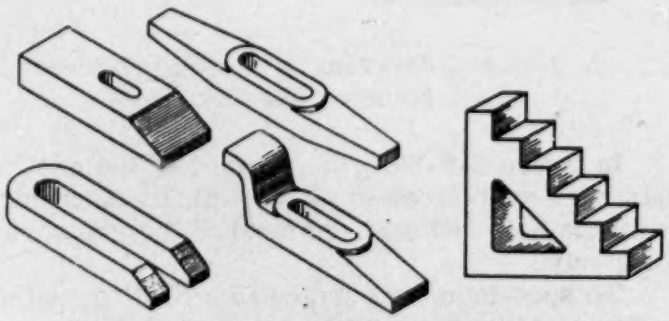

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Figure 2-6-19.—Step block and clamps.

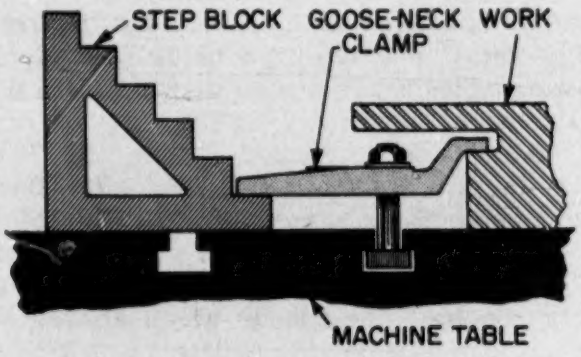

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Figure 2-6-20.—Holding work with step block and clamp for drilling.

to the work rather than close to the step block. This provides the most favorable mechanical advantage. Usually two or more clamps are used on each setup.

To hold thin metal for drilling, place it on a block of wood to provide support directly beneath the hole. This will help minimize drill breakage when the feed pressure is applied. Then secure the C-clamp as shown in figure 2-6-21, and drill through the metal and into the wood. Stop drilling when wood chips appear so as not to damage the drill press table. Some tables have no center hole, or, if there is a center hole, it may not be lined up directly below the drill.

SPEED AND FEED FOR DRILLING

The SPEED of a drill is the distance the drill would roll if it were placed on its side and rolled at a given rpm for 1 minute. This speed is usually expressed in feet per minute (fpm). The correct cutting speed for a job depends upon the

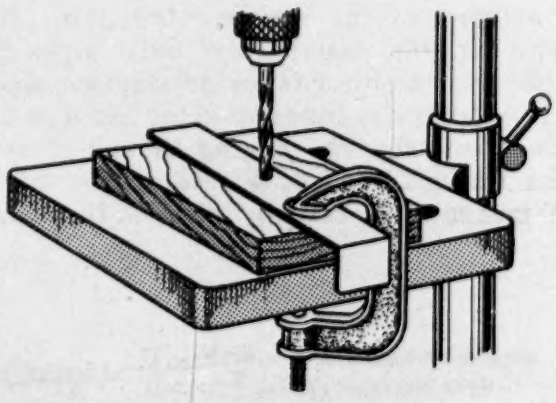

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Figure 2-6-21.—Holding thin gage metal for drilling.

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degree of hardness of the metal, the impurities in the metal, and the type of drill used. The following speeds are recommended when using high-speed drills.

Alloy steel	50-70 fpm
Machine steel	70-100 fpm
Cast iron	70-150 fpm
Brass	200-300 fpm

Carbon steel drills should be run at approximately one-half the speeds given above. With practice, you will be able to determine for yourself the correct speed for each piece of work.

The speed of the drill press is given in rpm. Tables giving the proper rpm at which to run a drill press for a particular metal are usually available in the machine shop, or they may be found in machinists' handbooks.

The FEED of a drill is the rate of entry into the work during each revolution. Feed is expressed in thousandths of an inch per revolution. In general, the larger the drill, the heavier the feed that may be used.

COUNTERBORING HOLES IN METAL

Counterboring is the operation of boring a second hole, larger in diameter than the first but concentric with it. A tool known as a counterbore is used for this operation. (See fig. 2-6-22.) The small diameter on the end of the tool, known as a pilot, keeps the counterbore concentric with the original hole. Pilots of different sizes are interchangeable to fit various sizes of holes.

Counterbores are also used for spot facing. In this operation, usually performed on castings, the objective is to remove enough material to provide a flat surface around a hole to accommodate the head of a bolt, nut or screw.

Counterbores for screw holes in metal are available in the usual twist drill sizes from 1/4" to 3", in either taper or straight shanks. They are generally made in sets, and a set may include counterbores ranging in size from 1/4 inch to 1 inch by 16ths. Pilots will be included which increase in size by 32ds in the smaller sizes and by 16ths in the larger sizes. Because the pilots are removable, various combinations of counterbores and pilots are possible. In figure 2-6-23A and B are the same size counterbores with pilots of different sizes as indicated. B and C are the same size pilots with counterbores of different sizes as indicated.

Figure 2-6-22.—Counterboring tool with pilot.

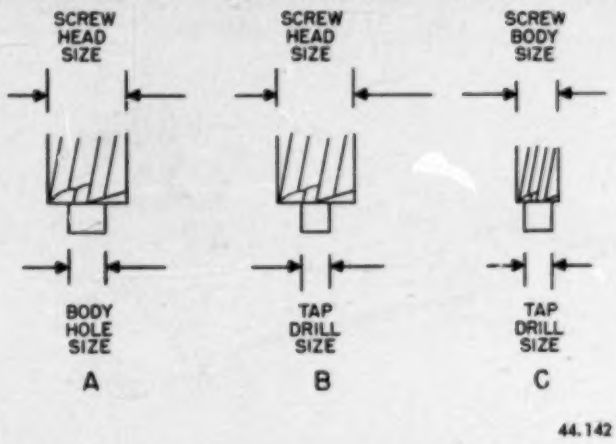

Figure 2-6-23.—Various combinations of counterbores and pilots.

A counterbore can be used to counterbore, or to spot-face, or to drill holes in metal which is too thin to drill with a twist drill.

Figure 2-6-24 is a drawing of a counterbored hole for a 3/8" fillister head or an internal chucking head screw. Here the pilot size is 3/8", which is the body hole size, and the body size of the counterbore is equal to the nominal diameter of the head of the screw.

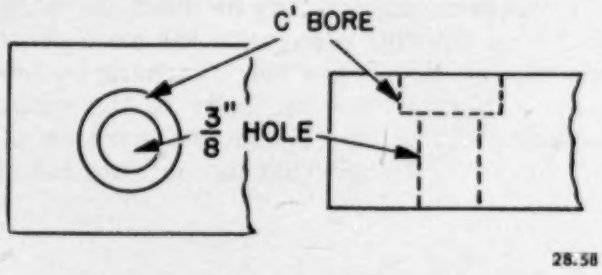

Figure 2-6-24.—Drawing of a counterbored hole for a filluster head screw.

In figure 2-6-25A, the surface of the casting has been spot-faced to make it clean and square with the hole and seat the head of the cap screw properly.

To spot-face the surface of a casting, select a counterbore that will be larger than the greatest diameter of the head of the cap screw. This is necessary so that the entire bottom of the

screw head will rest on the spot-faced surface. See figure 2-6-25B. Then select a pilot the size of the screw body hole, insert it in the counterbore, and proceed with the counterboring until the seating surface is cleaned up.

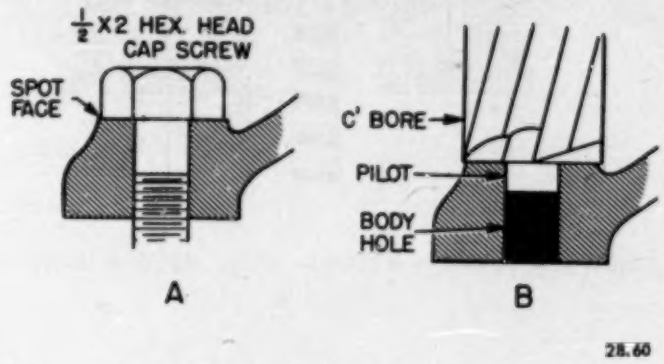

Figure 2-6-25.—Spot facing a surface on a casting.

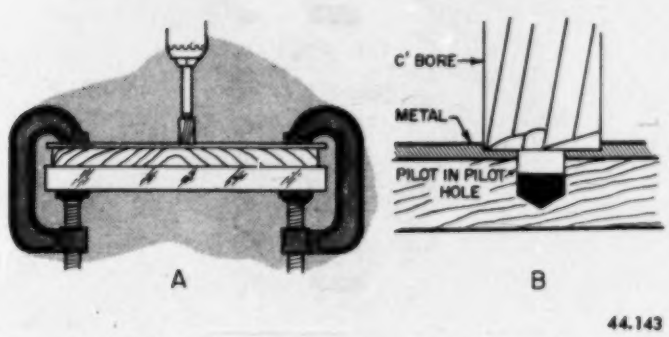

Figure 2-6-26.—Counterboring a hole in thin metal.

Figure 2-6-26 shows how a piloted counterbore is used to bore holes in thin metal. Secure the stock over a block of wood on the drill press table, as shown in figure 2-6-26A, and drill the pilot hole through the metal and into the wood. Then follow up with the counterbore, using a pilot to fit the pilot hole, and bore with the counterbore until the larger hole has also been bored through the metal and into the wood. (See fig. 2-6-26B.)

THREADS AND THREAD CUTTING

Threads are helical ridges cut into screws, nuts, bolts, or the walls of a hole, so that the action of turning the screw, nut, or bolt gives it endwise as well as rotary motion.

There are many types of threads, each designed for a specific type of work. The most common type of bolt threads in use today, however, is the American National form of threads of which there are two series: coarse thread series and fine thread series. The fine threads are of the same general shape as the coarse ones, but they are smaller and there are more of them per inch. Nuts with fine threads may be drawn up tighter than those with coarse threads, and they will not shake loose so easily.

Machine screw threads are of the same general shape as bolt threads, but they are much smaller. Machine screws are used in small machines and apparatus such as small motors, electric fans, and carburetors.

Pipe threads are used on pipe and pipe-and-tubing connections on engines, motors, and other machines. Pipe threads have a taper of 1/16 inch per inch of length. Since the threaded end of a pipe is tapered, the farther it is screwed into a fitting, the tighter the joint becomes. This makes it possible to make a tight joint without having any tension or end pull on the pipe. Since bolt and machine threads are straight they do not tighten until they are drawn up against the part being held.

Because of the system of indicating pipe sizes, pipe threads are much larger than the corresponding size of bolt threads. The size of pipe is designated by its inside diameter. A 1/2-in. bolt die cuts threads on the outside of a rod or bolt whose outside diameter is 1/2-in.; a 1/2-in. pipe die cuts threads on the outside of a pipe whose inside diameter is 1/2-inch. The pipe die, therefore, is much larger.

It is common practice to indicate the size of a bolt thread by two numbers, the first being the diameter of the bolt and the second the number of threads per inch. For example, a 3/8—16 thread would be for a 3/8-in. bolt which has 16 threads per inch. The size of a machine-screw thread, or a tap or die for cutting it, is designated by two numbers in the same manner as bolt threads, the first number being the size of the screw and the second the number of threads per inch. For example, an 8—32 thread is for a No. 8 screw which has 32 threads per inch.

DETERMINING THE PROPER SIZE TAP DRILL FOR PARTICULAR TAPS

If a threaded hole is to be made in a piece of metal, a hole of suitable size must first be drilled. The hole must be somewhat smaller than the size of the bolt to be screwed into it, usually 1/16 in. smaller for bolts 1/4 to 1/2 in. in size.

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The best method to determine the exact size of tap drill to use is to refer to the American National Form Threads chart in appendix II of this course. A chart similar to this generally is included with a set of taps and dies.

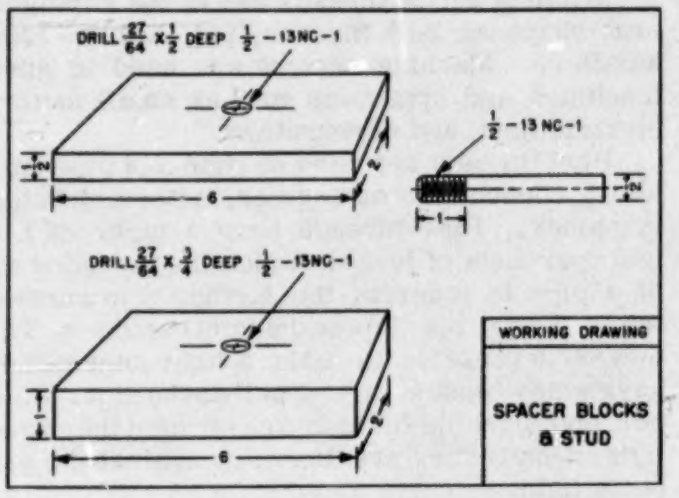

Figure 2-6-27.—A working drawing for tapping and cutting threads.

The working drawing shown in figure 2-6-27, specifies a 1/2 in. 13 National Coarse (NC) thread to be tapped in a through hole in one part (1/2 in. deep hole in 1/2 in. stock). The same thread is to be tapped in a blind hole in another part (3/4 in. deep hole in 1 in. stock). The 1/2 in. round stock is to be threaded with this same thread to fit the tapped holes.

Refer to the chart in appendix II and run down the first two columns until you locate 1/2—13 N.C. Follow this line to the right until you come to the tap drill size, 27/64 in. which will produce approximately a 75 percent full thread. Use the 27/64 in. drill to drill a through hole in the 1/2 in. block and a hole 3/4 in. deep in the 1-in. block as required by the working drawing.

When the tap hole is the right size, it is a little larger than the root diameter of the tap as shown in figure 2-6-28. The tap will cut a thread in the work which is only 75 percent as deep as the thread on the tap. The other 25 percent of the depth of thread on the tap provides clearance between the tap hole and the root diameter of the tap. (See fig. 2-6-28.) This makes tapping easier.

If the tap drill selected is oversize, the tap hole will be oversize, and the tap can cut only shallow threads in the work. (See fig. 2-6-29.)

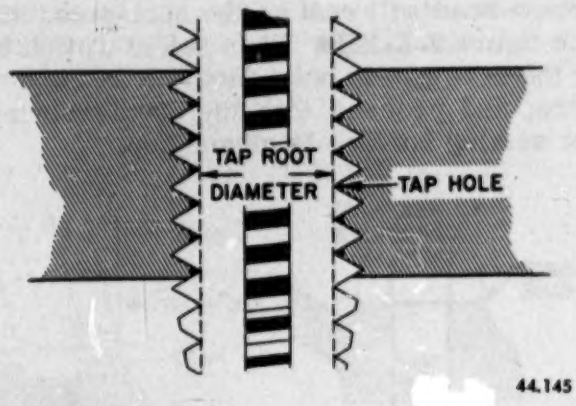

Figure 2-6-28.—Proper size drilled hole for tapping.

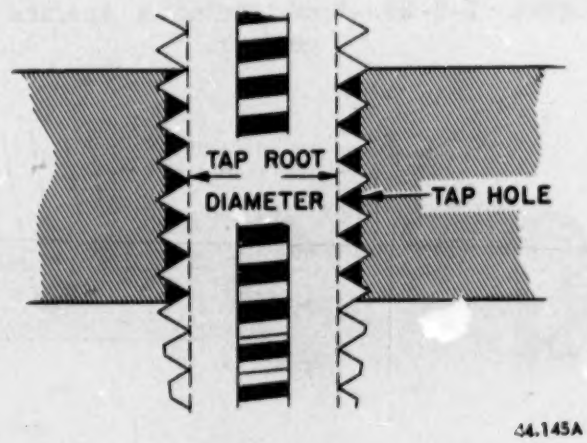

Figure 2-6-29.—Oversize drilled hole for tapping.

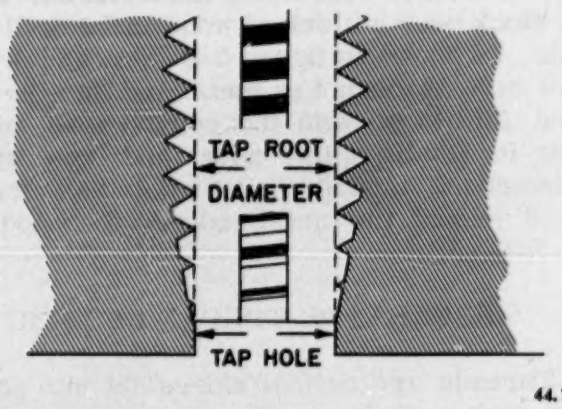

Figure 2-6-30.—Undersize drilled hole for tapping.

With less than a full 75 percent depth of thread, stud or capscrew threads usually strip.

If the tap drill selected is undersize, the tap hole will be undersize, being perhaps equal to the

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root diameter of the tap as shown in figure 2-6-30. Then there will be no clearance, and the tap will turn hard, tear the threads, and probably break.

CUTTING MACHINE THREADS WITH TAPS

A 50-50 mixture of white lead and lard oil, applied with a small brush, is highly recommended as a lubricant when tapping in steel. When using this lubricant, tighten the tap in the tap wrench and apply the lubricant to the tap. Start the tap carefully with its axis on the center line of the hole. The tap must be square with the surface of the work, as shown in figure 2-6-31.

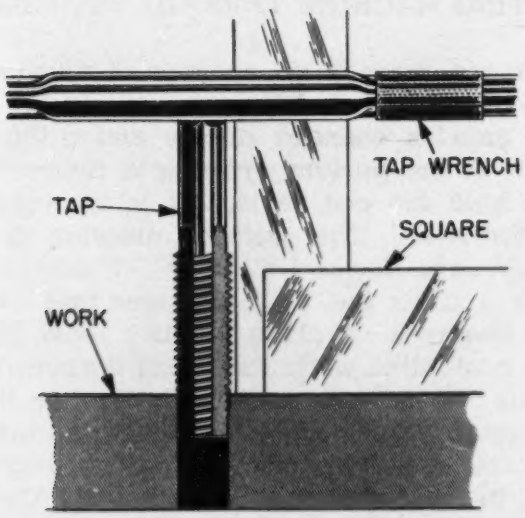

Figure 2-6-31.—Using a square to ascertain a tap is square with the work.

To continue tapping, turn the tap forward two quarter turns, back it up a quarter turn to break the chips, and then turn forward again to take up the slack. Continue this sequence until the required threads are cut. Lard oil alone is sometimes used for lubrication, and is conveniently applied from an oil can. After you cut for the first 2 or 3 full turns, you no longer have to exert downward pressure on the wrench. You can tell by the feel that the tap is cutting as you turn it. Don't permit chips to clog the flutes or they will prevent the tap from turning. When the tap won't turn and you notice a springy feeling, stop trying immediately. Back the tap up a quarter turn to break the chips, clean them out of the flutes with a wire as shown in figure 2-6-32,

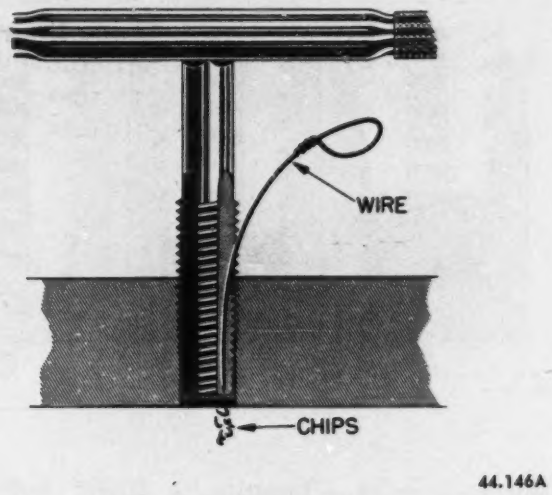

Figure 2-6-32.—Using a wire to clear chips from flute of a tap.

add some more lubricant, and continue tapping. When the tap has cut threads through the hole, the tap will turn with no resistance.

To tap a blind hole, start with the taper tap. For a blind hole you will need all three types—the taper, plug, and bottoming taps. Be sure they are the size and thread series you need, and that the tap hole is the size called for by the working drawing and the chart in appendix II.

Begin with the taper tap. Handle it as described and shown before. Figure 2-6-33A shows the taper tap just starting to cut. In figure 2-6-33B it has cut a little farther. In figure 2-6-33C it has bottomed in the hole after having cut several full threads near the top of the hole. This completes the work to be done with the taper tap.

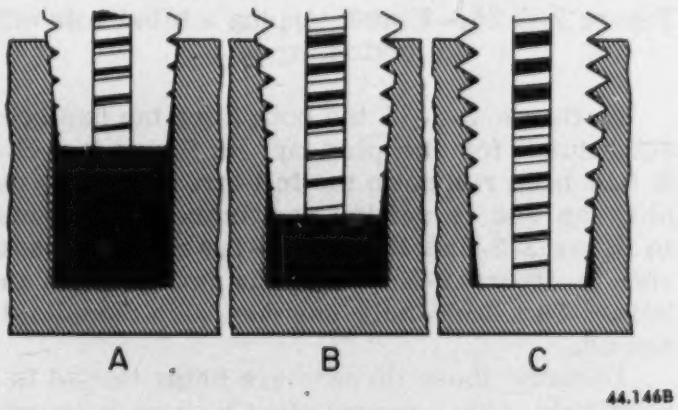

Figure 2-6-33.—Tapping a blind hole with a taper tap.

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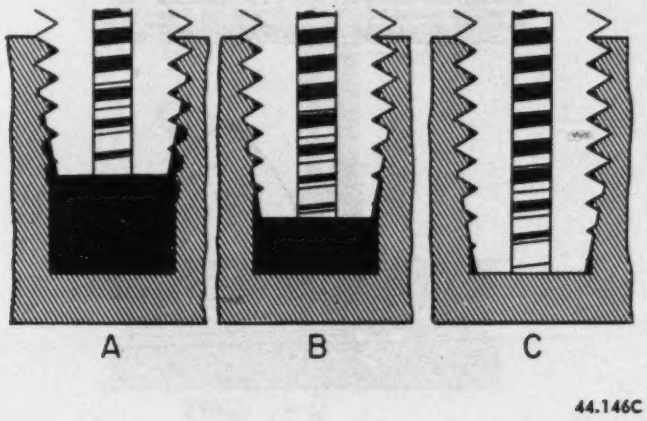

Figure 2-6-34.—Tapping a blind hole with a plug tap.

In figure 2-6-34A the plug tap has entered the few full threads cut by the taper tap. At figure 2-6-34B it has continued these threads a little farther down into the hole. At figure 2-6-34C it has bottomed in the hole. This is all the work that you can do with the plug tap. It has cut full threads about halfway down the tap hole before bottoming.

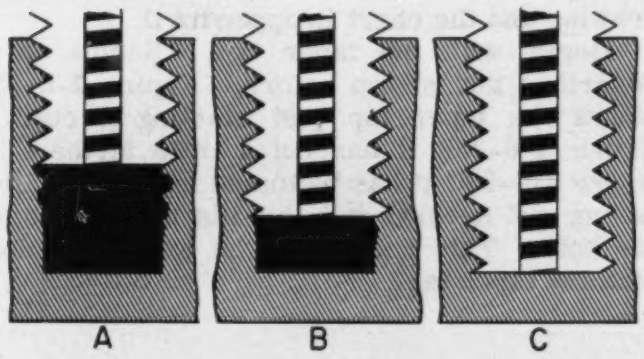

Figure 2-6-35.—Finish tapping a blind hole with a bottoming tap.

In figure 2-6-35 the bottoming tap has been substituted for the plug tap. In figure 2-6-35A it has been run down the full threads cut by the plug tap and is ready to cut more full threads. In figure 2-6-35B it has cut a few more threads, and in figure 2-6-35C it has bottomed in the hole. The blind hole has now been completely tapped.

Because these threads are being tapped in a blind hole, chip removal must be done differently. To remove chips, back the tap completely out of the hole very frequently, invert the stock, if possible, and jar out the chips or work them out of the hole with a wire while the stock is in the inverted position. If the work cannot be inverted, blow out the chips with air. Chip removal in tapping blind holes is much more difficult to do and is very important because chips will fall ahead of the tap through the flutes and accumulate in the bottom of the blind hole. Until these chips are removed, none of the three taps can complete its work. In tapping blind holes alternate with tapping and chip removal until each of the three taps bottom in the blind hole.

When you have finished using the three taps, brush the chips out of their teeth, oil them well with lubricating oil, wipe off the surplus oil, and replace them in the threading set.

CUTTING MACHINE THREADS WITH DIES

To cut threads on a piece of round stock—1/2—13 N.C. on a 1/2-inch rod in this case—first grind a chamfer on the end of the rod as shown in the working drawing in figure 2-6-27. Then hold the rod vertically in the vise to cut the threads. The working drawing in figure 2-6-27 calls for a 1/2-13N.C.-1 thread. The figure 1 after the N.C. indicates that a class 1 fit is required. A class 1 fit is a loose fit. The fit is controlled while threading the round stock. We tap the threads in the hole first as there is no way to adjust a tap. However, as threading dies are usually adjustable, we can control the fit of the threaded rod in the tapped hole by adjusting the threading die.

The adjustable round split die shown in figure 2-6-36 has an adjusting screw at A. By

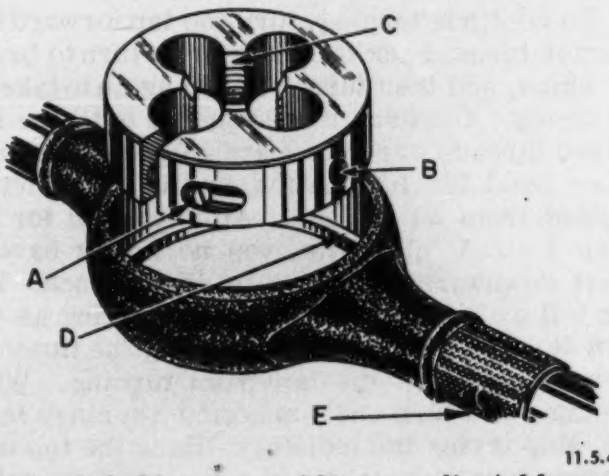

Figure 2-6-36.—Assembling an adjustable round split die to diestock.

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tightening this screw and spreading the die slightly, it will cut less deeply into the rod and the fit in the tapped hole will be tighter. The shallow hole at B is placed in the die stock opposite the adjustable handle E and serves as a drive hole. Also, when the adjustable handle is tightened, it holds the split die together and against the adjusting screw to maintain the setting while the die is cutting. The threads or cutting teeth of the die are chamfered or relieved at C to help start the die squarely on the round stock. The die is put into the die stock with the face with the unchamfered teeth against the shoulder, D.

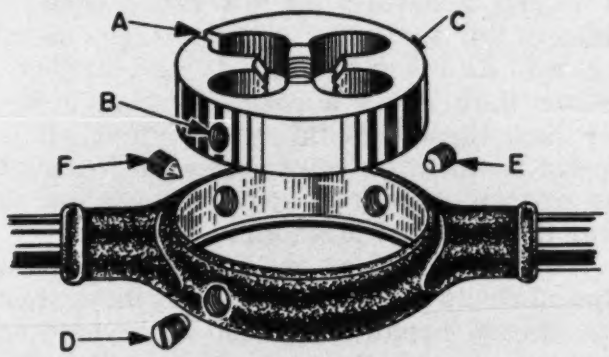

Figure 2-6-37.—Assembling a plain round split die to diestock.

Figure 2-6-37 is a plain round split die and die stock. At A, where the die is split, there is no adjusting screw. There are shallow holes at B and C, on both sides of the split, opposite which there are setscrews in the die stock at D and E. F is the adjusting screw which is pointed and enters the split A in the die. D and E are the holding setscrews. They have flat points and are tightened after the setting is made with F. D and E hold the adjustment and furnish the drive as they enter the shallow holes B and C shown in figure 2-6-37.

Figure 2-6-38 shows a section of the die in the die stock and its relation to the chamfer on the end of the work. The taper on the face of the die will accept the chamfer on the end of the work to start the threads square with the common center line.

To thread the work, brush some 50-50 white lead and lard oil on the rod. Start the die square with the work. Hold one handle with each hand, apply downward pressure, and turn clockwise until you feel the thread has been started. When the die has started to cut, rotate the die stock

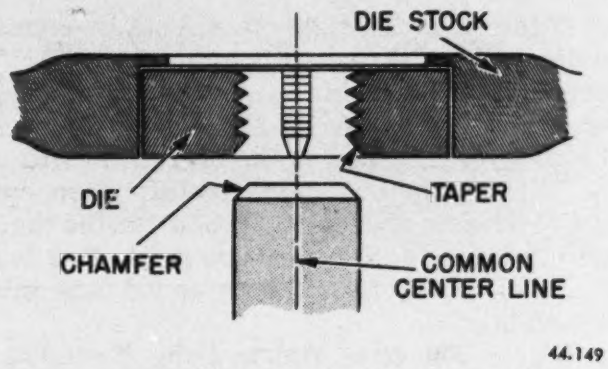

Figure 2-6-38.—Position of diestock in relation to chamfer on end of work.

two quarter turns, back it off one quarter turn to break the chips, and repeat the cutting (see fig. 2-6-39). When you have cut enough threads so that the rod comes through the back of the die, remove the die and try the rod in the tapped hole.

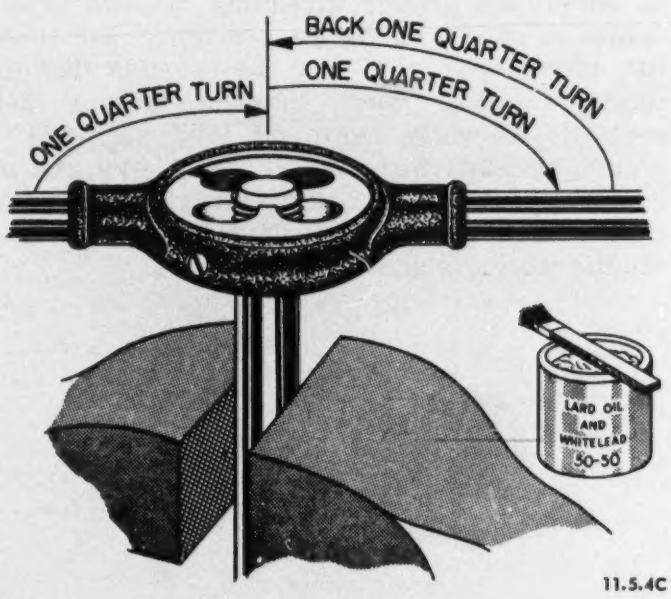

Figure 2-6-39.—Cutting outside threads on round stock.

Adjusting a threading die to produce a thread of the proper fit is a trial-and-error procedure. This was a trial run. If the fit is too loose, cut off and discard the portion of the rod that you threaded. Then expand the die by tightening the pointed setscrews (or the adjusting screw) so that the die will cut shallower threads on the rod and produce a tighter fit.

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If the fit is too tight, it will not be necessary to discard the threaded portion of the rod. Contract the die by backing off (loosening) the pointed setscrew (or the adjusting screw) to decrease the size of the split in the die. This will cause the die to remove more metal, when cutting, and produce a looser fit. Then run the die down the cut threads that were too tight. Now test the fit again by turning the threaded end into the tapped hole.

When you have finished the threading job, remove the die from the die stock, carefully clean out all the loose chips, and apply plenty of oil. Wipe off the surplus oil and put the die and die stock away in the threading set where they will be protected and ready for the next job.

RECONDITIONING MACHINE THREADS

To recondition machine threads, when the damage is not serious, the general practice is to select the proper threading die, one type of which is shown in figure 2-6-40A. Put it in a die stock, and run over the threads that are damaged. For steel, lubricate with a 50-50 mixture of white lead and lard oil, lard oil alone, or lubricating oil if the others are not available. Use no lubricant for brass and copper. Start the die with the chamfered face of the die which is shown in the figure.

A B

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Figure 2-6-40.—Two thread reconditioning tools.

The screw and bolt rethreading die, shown in figure 2-6-40B, is designed especially for reconditioning threads. The six sets of cutting teeth, in place of the customary four sets on a threading die, provide better alignment while the die is recutting damaged threads. Turn this rethreading die with any type of wrench or hold the die in a vise and turn the threaded piece through it.

Figure 2-6-41.—Thread restorer.

When only the first thread or the first 2 or 3 threads are damaged, and a perfect thread is not absolutely necessary, a three-square file can be used to touch up the tops of the damaged threads. A knife file will get down a little deeper into the threads when necessary.

The thread restorer shown in figure 2-6-41 resembles a square file. Each face is designed to match a certain pitch-screw thread. Two sizes of this tool are available, each one covering eight different machine-thread pitches. Together they cover a range of from 9 threads per inch through 32 threads per inch. Use this thread restorer as you would a file, maintaining the proper angle (that of the threads) as you go over the damaged threads.

Tools of this type are available for external pipe threads as well as for machine threads. The thread restorer for internal pipe threads, however, is similar to a tap. This type of thread restorer, whether internal or external, removes metal. Therefore, the thread that remains as a restored thread will not be a perfect or full thread. Where the crest of the original thread was battered over, the crest of the restored thread will be noticeably flat. Threads restored in this manner are, for practical purposes, as strong as new threads. They will again enter a nut or tapped hole.

Another type of thread restorer is shown in the 2" to 4" size in figure 2-6-42. This tool is not designed to cut new threads, but only as a maintenance and repair tool. Its action is a reforming action and not a cutting action. Therefore no metal is removed from the thread that is being forced back to its original shape. Only four sizes of this tool are necessary to cover thread diameters from one-quarter inch to 6 inches. A fifth size takes all diameters from 6 to 12 inches, inclusive. Each size will fit any pitch, left- or right-hand threads, standard pipe or machine thread, within the size limits specified, and no change of blades or dies is necessary. This restorer will not work on Acme threads.

To operate this thread restorer, simply slip it over the threads with the arrow on top, or toward you. Then tighten the jaws or blades

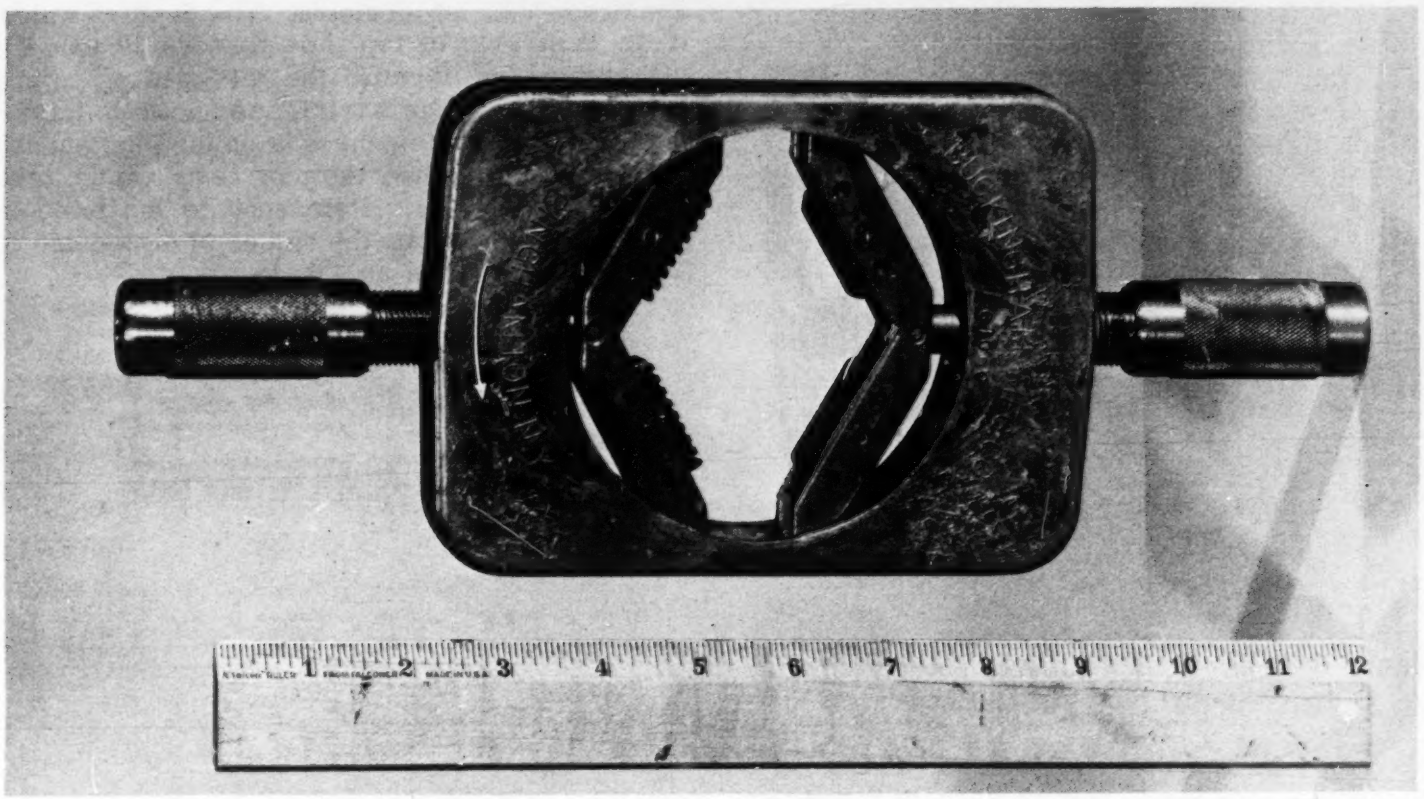

Figure 2-6-42.—Adjustable type thread restorer.

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to a snug fit into the threads close to the back of the thread where no damage has been done. Then, just as you would remove a nut, turn the tool counterclockwise in the direction of the arrow on right-hand threads. To restore left-hand threads, first flop the tool over so that the face of the tool having the arrow is away from you. Then, after bringing the jaws up snug, run the tool off of the left-hand threads by turning it clockwise so that it will move toward you. Notice that this type of thread restorer normally works from the bottom or back of the thread out toward the end, restoring the threads as it progresses.

In most cases, restorers slide easily over key ways and milled flats on threaded parts. It may be found that the milled flat is rather wide on large-diameter jobs. In such cases threads can still be restored and the tool will negotiate the flat if you will clamp a half round piece of soft wood on the flat and operate the tool as directed. When this is necessary, it is usually on work of 2-inch diameter or larger. When used on studs or bolts having cotter pin holes, a small wooden plug in the hole will avoid breaking teeth. Keep the restorer clean and well oiled both in use and in storage.

CUTTING INTERNAL PIPE THREADS

Pipe threads are tapered threads to provide an airtight and liquidtight joint. A 3/8" machine thread tap and a 3/8" pipe thread tap are compared in figure 2-6-43 to show their differences. The 3/8" machine thread tap will cut machine threads in a hole so that a 3/8" cap screw, having the same thread, can be screwed into the hole. The 3/8" pipe thread tap will cut pipe threads in a hole so that a 3/8" threaded pipe can be screwed into the hole. Because pipe diameters are measured and given as inside diameters, and the wall thickness of the pipe must be taken into consideration, the 3/8" pipe thread tap in figure 2-6-43 is noticeably larger than the 3/8" machine thread tap. It should also be noted that the pipe thread tap is tapered, but the machine thread tap is not.

The N. P. T., which formerly stood for National Pipe Thread, is still used as a carryover and now refers to the new name for the same thread, American Standard Taper Pipe Thread. This standard taper is 3/4" per foot.

To select the proper tap drill for the pipe tap that you will use to tap a hole to take a

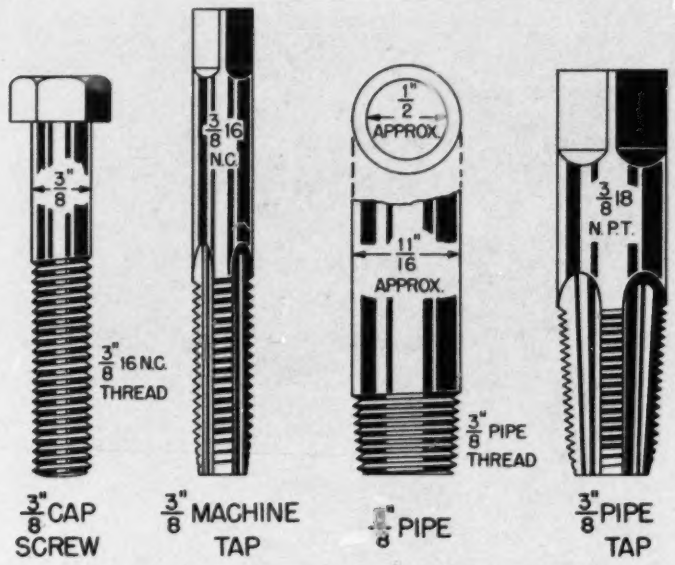

Figure 2-6-43.—Comparison of machine thread tap and pipe thread tap.

given size of threaded pipe, refer to figure 2-6-44. For example, if you want to drill and tap a hole to take a 3/8" pipe thread, find the 3/8" pipe tap in the Pipe Tap Size column. Opposite this, in the Tap Drill Size column, is 19/32", the proper tap drill to use for a 3/8" pipe tap.

Pipe Tap Size	Tap Drill Size	Pipe Tap Size	Tap Drill Size
1/8	11/32	2	2 3/16
1/4	7/16	2 1/2	2 5/8
3/8	19/32	3	3 1/4
1/2	23/32	3 1/2	3 3/4
3/4	15/16	4	4 1/4
1	1 5/32	4 1/2	4 3/4
1 1/4	1 1/2	5	5 5/16
1 1/2	1 23/32	6	6 3/8

Figure 2-6-44.—American Standard pipe tap drill sizes.

To cut internal pipe threads, drill a tap hole in the stock to be tapped and, following the suggested procedure for tapping machine threads given elsewhere in this book under the heading Cutting Machine Threads With Taps, run the pipe tap into the tap hole. Notice that the first few threads on the pipe tap are ground away. This makes starting easier. Plenty of lard oil is the standard lubricant for steel. Tap copper and brass with no lubricant. The depth to which it is desirable to tap pipe threads is usually determined by turning the threaded pipe into the tapped hole for a trial. As shown in figure 2-6-45, the last few threads on the pipe should still be visible when the pipe is drawn up tight in the tapped hole. Reference to the table in figure 2-6-46 shows the values of dimension A for various sizes of pipe up to 12".

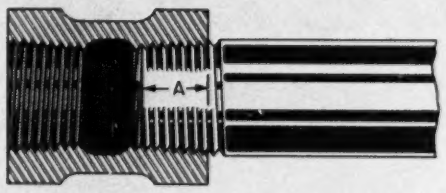

Size of Pipe, Inches	Dimension A, Inches	Size of Pipe, Inches	Dimension A, Inches	Size of Pipe, Inches	Dimension A, Inches
1/8	1/4	1 1/2	11/16	5	1 1/4
1/4	3/8	2	3/4	6	1 5/16
3/8	3/8	2 1/2	15/16	7	1 3/8
1/2	1/2	3	1	8	1 7/16
3/4	9/16	3 1/2	1 1/16	9	1 1/2
1	11/16	4	1 1/8	10	1 5/8
1 1/4	11/16	4 1/2	1 3/16	12	1 3/4

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Figure 2-6-45.—Length of thread on pipe required to make a tight joint.

Nominal Size	Outside Diameter	Nominal Size	Outside Diameter
1/8	13/32	3 1/2	4
1/4	17/32	4	4 1/2
3/8	11/16	4 1/2	5
1/2	27/32	5	5 9/16
3/4	1 1/16	6	6 5/8
1	1 5/16	7	7 5/8
1 1/4	1 21/32	8	8 5/8
1 1/2	1 29/32	9	9 5/8
2	2 3/8	10	10 3/4
2 1/2	2 7/8	11	11 3/4
3	3 1/2	12	12 3/4

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Figure 2-6-46.—Approximate O.D. of standard wrought iron pipe.

The general practice in tapping holes for pipe threads is to drill the proper size tap hole and then start the pipe tap right into the tap hole. Some men recommend using a pipe reamer, especially when large deep holes are to be

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tapped. A pipe reamer has the same 3/4" per foot taper as a pipe tap. A reamed pipe tap hole would have the same shape as the pipe tap, and therefore would make tapping easier and reduce wear on the tap.

CUTTING EXTERNAL PIPE THREADS

Usually, both ends of a pipe are threaded with external pipe threads. Notice, in all the figures showing pipe threads, that they are V-shaped. The standard 3/4" taper per foot of pipe threads is equal to 1/16" per inch. Therefore, the taper of the threads on each side of the pipe is 1/32" taper per inch. This taper cannot be changed. This produces a tight joint. The angle between sides of the threads is 60°, and several threads on the end of the pipe are perfect threads. The next few have V-bottoms but flat tops, and the last few threads have both flat tops and bottoms. Each size of pipe has a certain number of threads per inch, built into the pipe taps and dies.

Adjustable pipe dies have a reference mark on each die which, when lined up with the corresponding reference mark on the die stock, will give a standard-size thread. You adjust the dies one way or the other from the reference mark to cut a thread with the fit you want.

To cut external threads on iron pipe, first determine its nominal size. Nominal size means the "name size" of the pipe such as 1/8", 3/4", and so on. Except in the sizes below 1", nominal sizes correspond closely to inside diameters. For 1" pipe and larger, measure the I.D. with your rule, to the closest 1/32", and you will have nominal size. For sizes below 1", you can determine nominal size by measuring the O.D. to the nearest 1/32" and reading the corresponding nominal size on the chart in figure 2-6-46. This method can also be employed for sizes 1" and above in lieu of the I.D. measurement.

To begin cutting, put the die stock on the pipe so that the pipe passes through the guide and enters the tapered face of the pipe die. Turn the die stock clockwise for right-hand threads, applying pressure only when starting. It is not necessary to turn the die back and forth as you do when cutting machine threads. Pipe-threading dies can cut continuously because they cut only as many threads on the pipe as there are on the die itself and because there is plenty of room in a pipe die for the chips to escape. After the die has taken hold, it will feed itself. When cutting threads on steel pipe, apply lard oil to the pipe and die where the cutting is actually taking place. Continue turning until the end of the pipe has gone through the die and is flush with the near face. See figure 2-6-47.

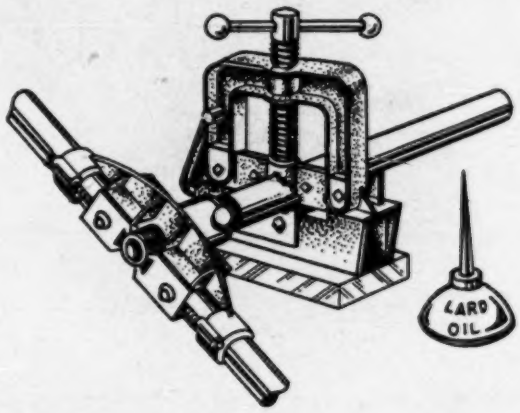

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Figure 2-6-47.—Threading an external pipe thread with a pipe die.

This will give you the length of thread called for in the table in figure 2-6-45. Notice that, in the assembled pipe joint in figure 2-6-45, several threads remain on both pipe and fitting to permit further tightening should a leak develop. Dimension A in figure 2-6-45 is the length of thread on pipe required to make a tight joint.

REAMING OPERATIONS

Reaming operations are jobs that smoothly enlarge drilled holes to an exact size and finish the hole at the same time. A hole that has been made by drilling is usually slightly oversize. This is quite satisfactory for holes in which bolts or rivets are placed. When greater accuracy and a smooth finish are required, the hole is first drilled undersize and then finished by reaming. Reamers are also used to remove burrs from the inside diameters of pipe and drilled holes.

Most reaming operations are done by hand-turning the reamer; however, some reamers are designed for operation on power machines. Never use a reamer that is designed for hand-reaming on a power machine as the handreamers cannot withstand the higher speeds.

REAMING A HOLE WITH A SOLID STRAIGHT REAMER

A solid straight-hole reamer is used for most work, since it is the most accurate and rugged

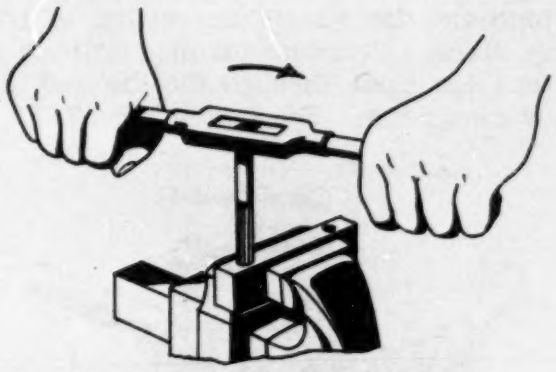

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Figure 2-6-48.—Using a tap wrench to turn a hand reamer.

of the straight-hole reamers. The straight-hole handreamer is turned by means of a tap wrench that is tightened on the square end of the reamer shank. (See fig. 2-6-48.) Secure the work in a vise so that the hole to be reamed is perpendicular to the top of the vise jaws. Position the reamer at the top of the hole (fig. 2-6-49). Straight-hole reamers have a slight taper at the end so that they will fit into the hole easily. Turn the wrench clockwise very slowly until the reamer is centered in the hole.

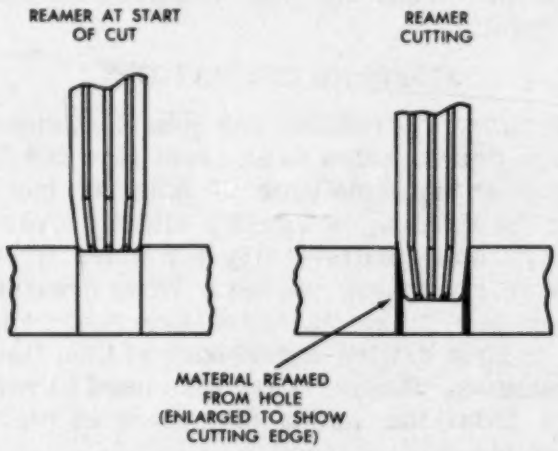

44.159

Figure 2-6-49.—Reaming a hole with a straight hole reamer.

After the reamer is centered in the hole, turn the wrench clockwise with a steady firm pressure until the reamer has been turned all the way through the hole. When reaming steel, use cutting oil or machine oil to lubricate the tool. When reaming soft iron, do not lubricate the tool. To remove the reamer from the hole turn the wrench clockwise and raise the reamer simultaneously.

NOTE: Turning the wrench too fast or too slowly will cause the reamer to chatter, producing an unevenly reamed hole.

INSTALLING A TAPER PIN

To install a tapered pin, refer to the blueprint or drawing for the proper size of pin to use. The size will be given as a number and length in inches (see the table in figure 2-6-50.) For instance, a No. 3 pin 1 3/4" long might be specified. Then, when you have the proper pin, measure the diameter of its small end and drill a hole of that size through for example, the hub of a flange and a shaft while the flange is in place on the shaft. (See fig. 2-6-51.) Then select the same number of tapered pin reamer, a No. 3 in this case.

No. of Pin	Diameter at Large End		Max. Length
	D	D	L
00000	0.094	3/32	3/4
0000	.109	7/64	7/8
000	.125	1/8	1
00	.141	9/64	1 1/8
0	.156	5/32	1 1/4
1	.172	11/64	1 1/2
2	.193	3/16	1 3/4
3	.219	7/32	1 3/4
4	.250	1/4	2
5	.289	19/64	2 1/4
6	.341	11/32	3
7	.409	13/32	3 3/4
8	.492	1/2	4 1/2
9	.591	19/32	5 1/4
10	.706	23/32	6
11	.860	55/64	7 1/4
12	1.032	1 1/32	9
13	1.241	1 15/64	11
14	1.523	1 33/64	13

44.160

Figure 2-6-50.—Chart for Standard taper pins.

Figure 2-6-52 shows specifications of various sizes of reamers. The specifications given opposite the reamer numbers in the left-hand column of the table in figure 2-6-52 are the dimensions of the reamers. The small end of the reamer should just enter the hole you drill and, if the proper size of reamer has been selected, the pin will fit exactly. Turn the tapered pin reamer with a tap wrench

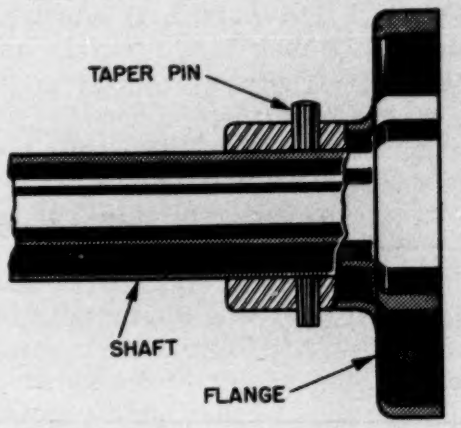

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Figure 2-6-51.—A tapered pin installed in a shaft and flange.

No. of Taper Pin Reamer	Diameter at Large End of Reamer	Diameter at Small End of Reamer	Length of Flute
7/0	0.0666	0.0497	13/16
6/0	0.0806	0.0611	15/16
5/0	0.0966	0.0719	1 3/16
4/0	0.1142	0.0869	1 5/16
3/0	0.1302	0.1029	1 5/16
2/0	0.1462	0.1137	1 9/16
0	0.1638	0.1287	1 11/16
1	0.1798	0.1447	1 11/16
2	0.2008	0.1605	1 15/16
3	0.2294	0.1813	2 5/16
4	0.2604	0.2071	2 9/16
5	0.2994	0.2409	2 13/16
6	0.3540	0.2773	3 11/16
7	0.4220	0.3297	4 7/16
8	0.5050	0.3971	5 3/16
9	0.6066	0.4805	6 1/16
10	0.7216	0.5799	6 13/16

44.162

Figure 2-6-52.—Chart for diameters and length of taper reamers.

slowly and in a clockwise direction only, lifting it out of the hole to clean away the chips while it is still turning. If you reverse the direction of the reamer, chips may be wedged behind its cutting edges, causing them to break. Ream brass dry but apply cutting oil liberally when reaming steel. Try the taper pin in the hole several times as the reaming progresses. Stop reaming when the pin protrudes the same amount on both sides of the hub of the gear.

REMOVING BURRS WITH A PIPE REAMER

After a piece of pipe has been cut, the ends should be reamed to remove the burr that is left on the inside of the pipe. This burr, if not removed, will restrict the flow of fluid in the pipe. Besides the reamer to trim the burr inside the pipe you will need a vise to hold the pipe steady. After making sure the pipe is held firmly in the vise, insert the reamer in the end of the pipe and turn the handle. (See fig. 2-6-53.) Rotate the handle of the reamer

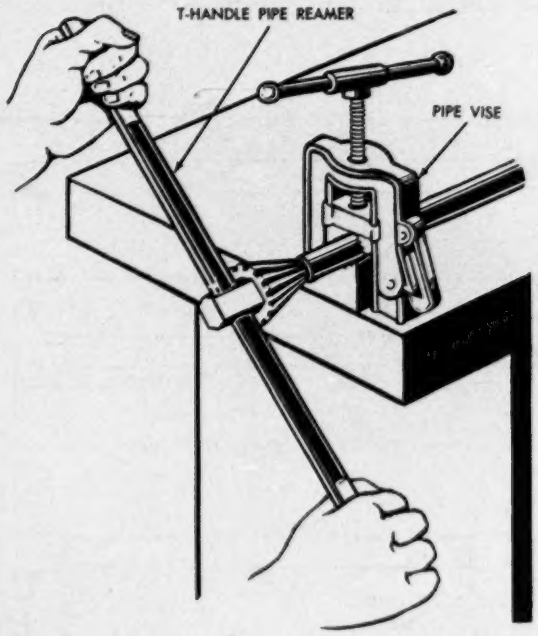

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Figure 2-6-53.—Using a pipe reamer to remove burrs from pipe.

clockwise in short even strokes until the burrs inside the cut piece of pipe are completely removed. Remove the reamer from the pipe by rotating it clockwise.

CUTTING PIPE AND TUBING

In nearly all ratings in the Navy, it will be necessary to cut pipe and/or tubing from time to time. The tools for doing this are generally kept in a tool room instead of in an individual mechanic's tool kit.

Pipe cutters are used to cut pipe made of steel, brass, copper, wrought iron, and lead. Tube cutters are used to cut tubing made of

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iron, steel, brass, copper, and aluminum. The essential difference is that tubing has considerably thinner walls than piping. A cold chisel and hammer are used to cut pipe that is made from cast iron. If a pipe or tubing cutter is not available, a hacksaw may be used to cut either pipe or tubing.

CUTTING IRON PIPE TO LENGTH WITH A PIPE CUTTER

Before you cut pipe, make certain the required correct length is determined. There are three methods of measuring threaded pipe, and you must understand these methods if the pipe is to be cut to the correct length. (See fig. 2-6-54.)

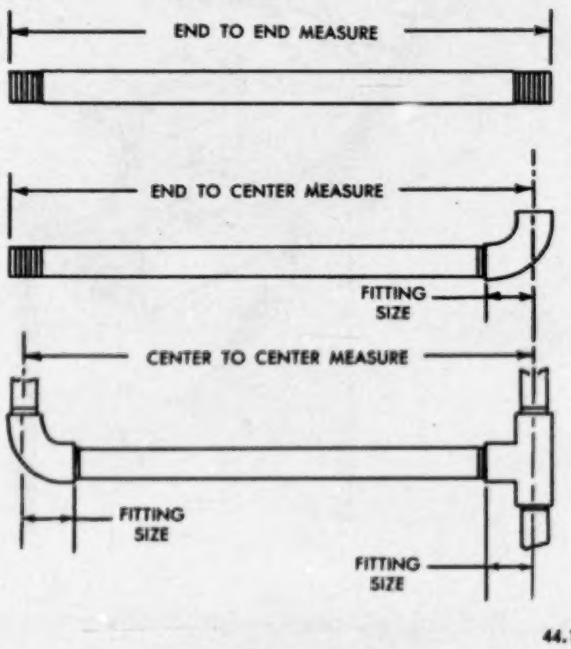

Figure 2-6-54.—Proper methods for measuring pipe to desired lengths.

The end-to-end method includes measuring the threaded portions of the pipe and measuring the pipe from end to end. The end-to-center method is used on a section of pipe that has a fitting screwed on one end only; measure from the free end of the pipe to the center of the fitting at the other end of the pipe. The center-to-center method is used when both ends of the pipe have fittings; measure from the center of one fitting to the center of the other fitting at the opposite end of the pipe.

The approximate length of thread on 1/2- and 3/4-inch wrought iron or steel pipe is 3/4 inch. On 1-, 1 1/4-, and 1 1/2-inch pipe, it is approximately 1 inch long. On 2- and 2 1/2-inch pipe, the length of thread is 1 1/8 and 1 1/2 inches respectively.

To determine the length of pipe required, take the measurement of installation such as center to center of the pipe requiring two fittings. Measure the size of the fittings as shown in figure 2-6-54. Subtract the total size of the two fittings from the installation measurement. Multiply the approximate thread length by 2 and add the result to the length obtained. This will give the length of pipe required.

After the length of the pipe has been determined, measure the pipe and mark the spot where the cut is to be made with a scriber or crayon. Lock the pipe securely in a pipe vise.

Inspect the cutter to make sure that there are no nicks or burrs in the cutting wheel. Open the jaws of the cutter by turning the handle counterclockwise. Position the cutter around the pipe at the marked point. Make sure the cutting wheel is exactly on the mark and close the jaws of the cutter lightly against the pipe by turning the cutter handle clockwise. After making contact, turn the cutter handle clockwise one-fourth of a turn more. This will put a bite on the pipe.

Grasp the cutter handle and rotate the cutter as a whole one complete revolution, swinging it around the pipe in the direction indicated in figure 2-6-55. Turn the cutter handle clockwise

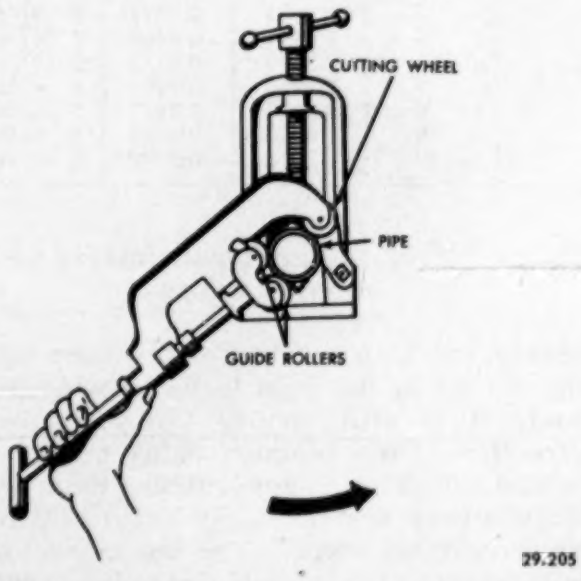

Figure 2-6-55.—Cutting pipe with a pipe cutter.

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one-fourth of a turn more to take another bite on the pipe and rotate the cutter another complete revolution. Keep the cutter perpendicular to the pipe at all times or the wheel will not track properly. Repeat this operation until the pipe is cut. Remove the small shoulder on the outside of the pipe with a file and remove the burr on the inside with a reamer.

CUTTING METALLIC TUBING WITH A TUBE CUTTER

Copper tubing is one of the most generally used kinds of metallic tubing readily cut with a tube cutter. This cutter works the same as a pipe cutter but is smaller. To cut tubing, place the tube cutter with the cutting wheel on the mark where the cut is to be made. Move the cutting wheel into light contact with the tubing. See step 1 in figure 2-6-56. Then swing the handle around the tubing as you feed

Figure 2-6-56.—Steps in cutting tubing with a tube cutter.

the cutting wheel a little for each revolution by turning the screw adjustment. Different wall thicknesses, kinds, and diameters of metallic tubing require different feeds. Step 2, figure 2-6-56 indicates the direction of rotation. The feed pressure is correct when it keeps the wheel cutting but does not flatten the tubing.

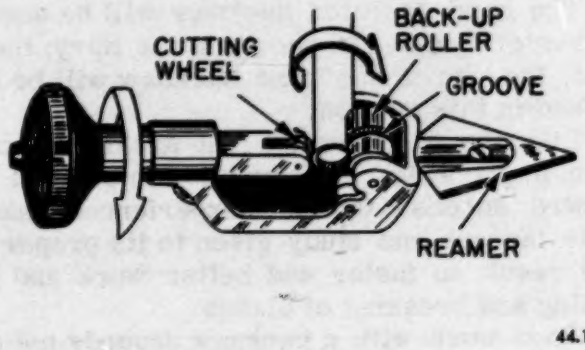

Figure 2-6-57.—Cutting tubing close to the base of a flare.

The design of some tubing cutters will permit cutting off a flared end close to the base of the flare. In figure 2-6-57, notice the groove in the backup roller. Place the flare in this groove so that the cutting wheel rides at the base of the flare. Then cut off the flare as you would cut tubing.

Burrs that form may be similar to those formed when cutting pipe. Remove the inside burr with the reamer attached to the tubing cutter opposite the handle. See figure 2-6-58.

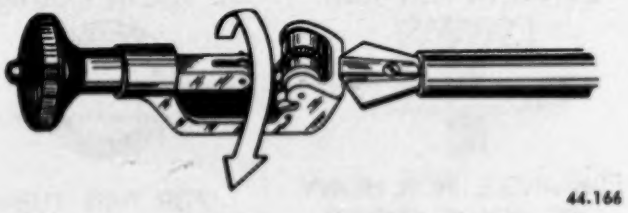

Figure 2-6-58.—Reaming the burrs from a piece of tubing.

In some cases a three-cornered scraper, pocketknife blade, or round file may work better than the reamer. After reaming clean out the chips. Then remove any outside burr with a mill file.

USING HACKSAWS

Hacksaws are among the most useful tools for cutting metal. They may be either hand-operated or powered by electricity. The power hacksaw is a great time-and-labor saver in a shop where much metalwork is done. It will cut much faster and more accurately than can usually be done by hand. When cutting heavy bars, the power hacksaw can be started and allowed to run by itself while other work is being done in the shop.

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The hand-operated hacksaw will be used by a greater number of people in the Navy; therefore, the use of the hand hacksaw will be discussed in this section.

Like the file, however, the hacksaw is often used improperly. Although it can be used with limited success by an inexperienced man, a little thought and study given to its proper use will result in faster and better work and less dulling and breaking of blades.

Good work with a hacksaw depends not only upon the proper use of the saw, but also upon the proper selection of the blades for the work to be done. Figure 2-6-59 will help you select the proper blade to use when sawing metal with a hacksaw. Coarse blades with fewer teeth

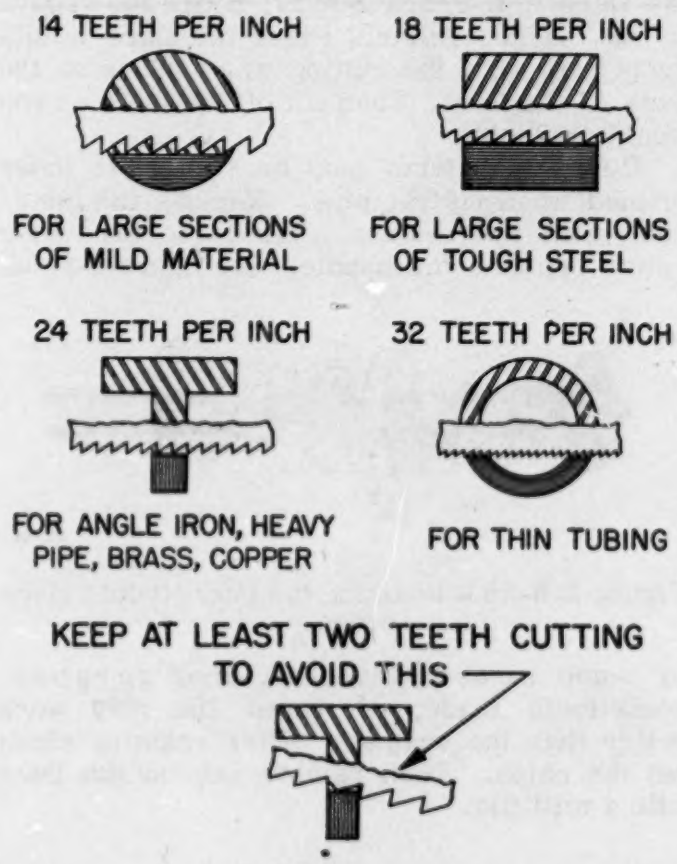

Figure 2-6-59.—Selecting the proper hacksaw blade.

per inch cut faster and are less liable to choke up with chips. However, finer blades with more teeth per inch are necessary when thin sections are being cut. The selection should be made so that, as each tooth starts its cut, the tooth ahead of it will still be cutting.

To make the cut, first install the blade in the hacksaw frame (fig. 2-6-60) so that the

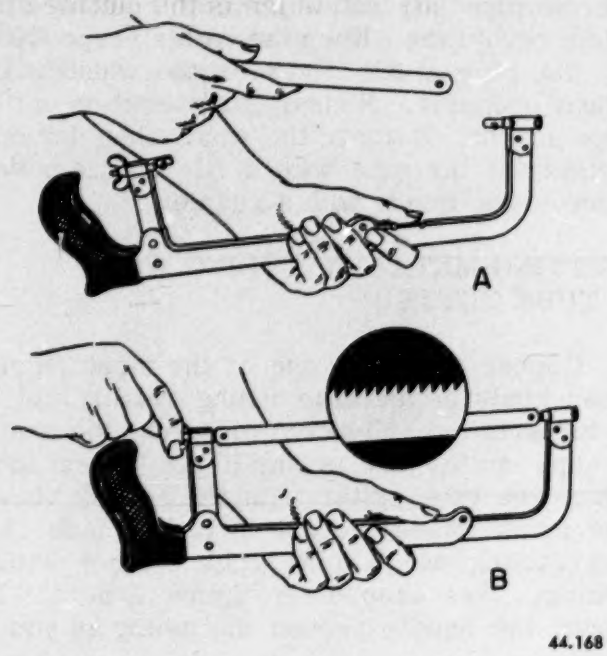

Figure 2-6-60.—Installing a hacksaw blade.

teeth point away from the handle of the hacksaw. Hand hacksaws cut on the push stroke, whereas power hacksaws cut on the pull stroke. Tighten the wingnut so that the blade is definitely under tension. This helps make straight cuts.

Hold the job in a vise with a minimum of overhang. This will reduce vibration, give a better cut, and lengthen the life of the blade. Have the layout line outside of the vise jaw so that the line is visible while you work. The index finger of the right hand, pointed forward, aids in guiding the frame. (See fig. 2-6-61.)

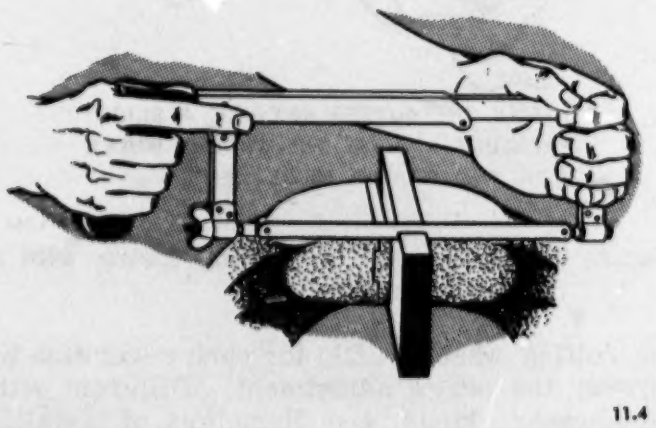

Figure 2-6-61.—Proper way to hold a hacksaw.

A stroke is one forward-and-back movement of the hacksaw frame. Let your body sway ahead

and back with each stroke. Apply pressure on the forward stroke, which is the cutting stroke, but not on the return stroke. From 40 to 50 strokes per minute is the usual speed. Long, slow, steady strokes are much preferred.

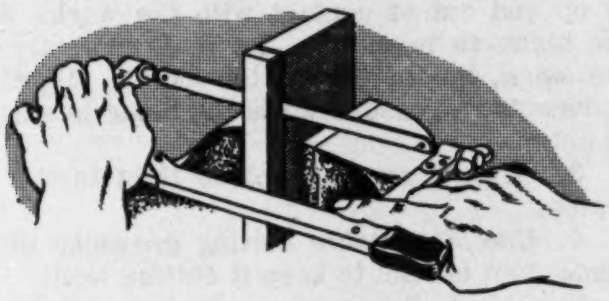

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Figure 2-6-62.—Making a long cut near the edge of stock.

For long cuts (fig. 2-6-62) rotate the blade in the frame so that the length of the cut is not limited by the depth of the frame. Hold the work with the layout line close to the vise jaws, raising the work in the vise as the sawing proceeds.

Saw thin metal as shown in figure 2-6-63. Notice the long angle at which the blade enters the saw kerf. This permits several teeth to be cutting at the same time.

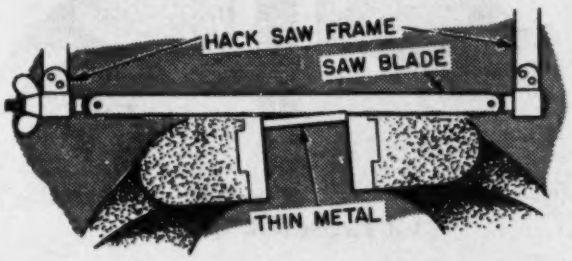

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Figure 2-6-63.—Cutting thin metal with a hacksaw.

Metal which is too thin to be held, as shown in figure 2-6-63, can be held between blocks of wood, as shown in figure 2-6-64. As shown in figure 2-6-64A, the wood provides support for several teeth as they are cutting. Without the wood, as shown at B in figure 2-6-64, teeth will be broken due to excessive vibration of the stock and because individual teeth have to absorb the full power of the stroke.

Cut thin metal with layout lines on the face by using a piece of wood behind it. (See fig.

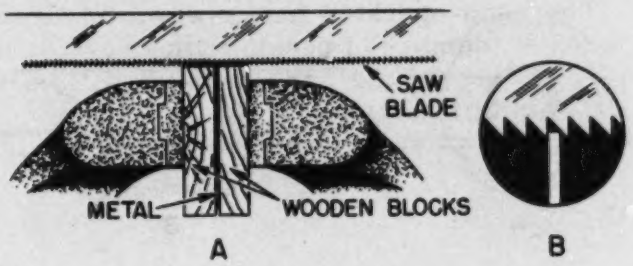

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Figure 2-6-64.—Cutting thin metal between two wooden blocks.

2-6-65.) Hold the wood and the metal in the jaws of the vise, using a C-clamp in addition when necessary. The wood block helps support the blade and produces a smoother cut. Using the wood only in back of the metal permits the layout lines to be seen.

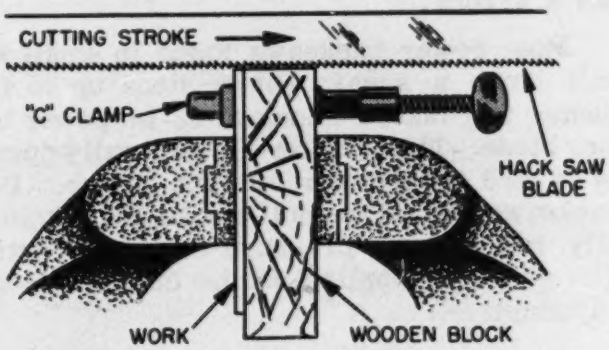

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Figure 2-6-65.—Cutting thin metal using wood block with layout lines.

To remove a frozen nut with a hacksaw, saw into the nut as shown in figure 2-6-66, starting the blade close to the threads on the bolt or stud and parallel to one face of the nut as shown in figure 2-6-66A. Saw parallel to the bolt until the teeth of the blade almost reach the lockwasher. Lockwashers are hard and will ruin hacksaw blades, so do not try to saw them. Figure 2-6-66B shows when to stop sawing. Then, with a cold chisel and hammer, remove this one side of the nut completely by opening the saw kerf. Put an adjustable wrench across this new flat and the one opposite, and again try to remove the frozen nut. As very little original metal remains on this one side of the nut, the nut will either give or break away entirely and permit its removal.

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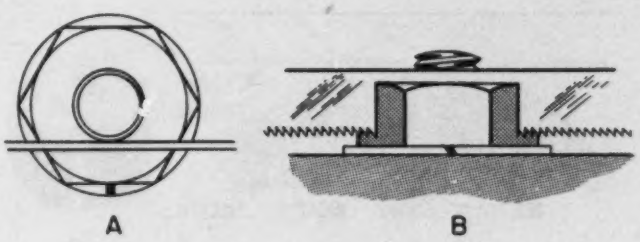

Figure 2-6-66.—Removing a frozen nut with a hacksaw.

To saw a wide kerf in the head of a cap screw or machine bolt, fit the hand hacksaw frame with two blades side by side, and with teeth lined up in the same direction. With slow, steady strokes, saw the slot approximately one-third the thickness of the head of the cap screw as shown in figure 2-6-67. Such a slot will permit subsequent holding or turning with a screwdriver when it is impossible, due to close quarters, to use a wrench.

Most power hacksaws found in small shops will make a square cut in stock up to 4 by 4 inches and take a standard 12-in. power hacksaw blade. This size saw is generally operated by a 1/3 horsepower electric motor. Power hacksaws cut on the pull stroke and automatically release the pressure on the backstroke. The pressure applied on the cutting stroke is adjustable.

As with hand hacksaws the blades should be selected according to the kind of sawing to be done. Blades with 18 teeth per inch are recommended for cutting thin sections like angle iron, pipe, and tubing, and are generally quite satisfactory for general work in the shop. Coarser toothed blades with 14, or even 10 teeth per inch, may be used for faster cutting in heavy stock.

Some of the main points to remember when operating a power hacksaw are:

1. Always clamp the work securely in the saw vise.
2. Before starting the saw, be sure the blade is up and out of contact with the work. After the blade is in motion, let it down gently onto the work, holding up on the handle slightly to reduce the pressure while the blade is starting to cut.
3. Always keep the blade tight in the saw frame.
4. Use a suitable cutting pressure on the blade, just enough to keep it cutting well.
5. Clamp the work so that the blade will not have to cut straight across thin sections.
6. Be sure to insert the blades so that the teeth will point in the direction of cutting.
7. Clamp the angle irons with the ridge up. Two or more may be cut at the same time by nesting them.
8. Do not push down on the saw to add pressure to the blade. The teeth can cut only as fast as their size will permit.
9. Run the saw at the speed recommended by the manufacturer.

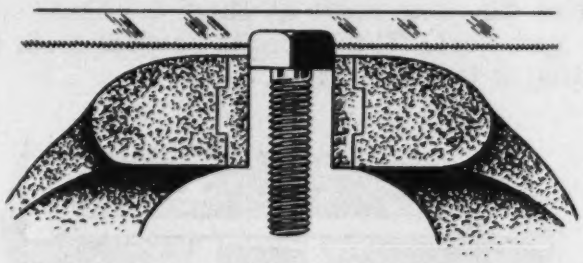

Figure 2-6-67.—Cutting a wide kerf in the head of a capscrew or bolt.

PART II

Section 7

MISCELLANEOUS SKILLS

A number of miscellaneous skills that are common throughout the Navy cannot be properly categorized in any of the foregoing sections. For example, skills introduced in this section may require the use of tools that are not used in such operations as cutting, grinding, measuring, etc. To accomplish some of these skills, a combination of particular materials, tools, and work methods is needed.

GLASSCUTTING

Two glasscutters are generally available for use in the Navy. One is the single wheel, general purpose type (fig. 2-7-1), while the other is a 2-to 24-inch circular capacity type incorporating a graduated beam (not illustrated).

A glasscutter actually does not cut glass; it splits it. If the wheel is sharp and it is drawn over the glass at the right speed and pressure, it makes a fine score or groove by slightly crushing or pulverizing the glass under the edge of the wheel. The beveled sides of the wheel act as wedges which push against the sides of the groove and pry the glass apart so that a crack is started. If a crack fails to start in the cutting, tap the scratch or score with the ball end of the glasscutter to start a crack.

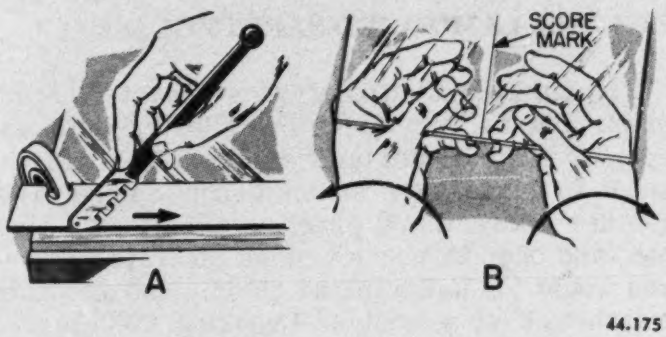

Figure 2-7-1.—Using a glasscutter.

Before trying to make a finish cut in a piece of glass, get a scrap piece and make several cuts on it. This helps you discover the proper speed and pressure that are required to get a smooth edge.

Ordinary window glass comes in two thicknesses, single light and double light. Single light is thinner and easier to cut. Plate glass up to 1/4 inch in thickness can be cut in the same manner as ordinary window glass. Safety glass, which consists of two or more glass sheets cemented together by a transparent plastic, requires special cutting equipment.

MAKING STRAIGHT CUTS IN ORDINARY GLASS

To make straight cuts in glass, follow the steps shown in figure 2-7-1. In scoring the glass, hold the glasscutter as you would a pencil. Draw the glasscutter toward you over the surface of the glass.

To break a small piece of glass, grasp the piece in both hands with the score mark up. Then push upward with your fingers beneath the score mark, and downward with your thumbs. The glass will break almost instantaneously along the entire score mark.

Straight cuts can also be made with the use of a straightedge. The straightedge must be held firmly in place, however. Figure 2-7-2 shows a straightedge held in place with a pair of C clamps. Other means of holding the straightedge in place are also acceptable. In placing the straightedge, make allowance for the fact that the wheel of the glasscutter must pass through the centers of the locating marks. Therefore, the score mark when made will be a slight distance from the straightedge itself.

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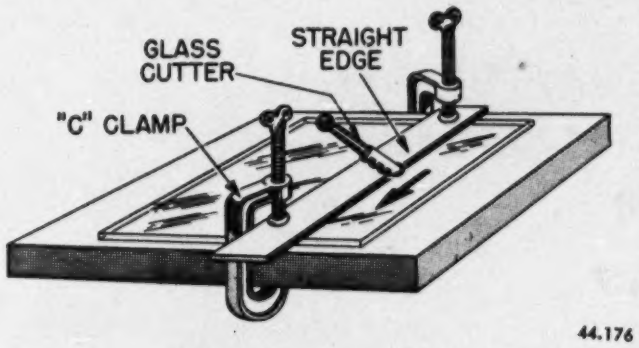

Figure 2-7-2.—Using a straightedge when cutting glass.

Dip the end of the glasscutter in kerosene before drawing it across the surface of the glass. Apply only light or medium pressure for glass that is about 1/8-inch thick. Too much pressure will tend to chip the glass along both sides of the score mark. The score mark should be only one barely visible line on the surface of the glass extending the entire distance from edge to edge. Make it in one pass. To go over it a second time may cause an uneven break.

For breaking large sheets of glass by scoring, lay the glass as shown in figure 2-7-3A, with the score mark on the top surface. Then tap the bottom surface just under the score mark, using the handle of the glasscutter. This will "start" the break at that point although the start may not be visible.

Then lay a piece of chalk line, or similar cord, on the bench top to raise the glass slightly, and place the score mark right over it. (See fig. 2-7-3B.) (In all glass work, the score mark is kept on the top face of the work.) Carefully apply downward pressure at points B and C, figure 2-7-3B, on both sides of the score mark. The crack that you started by tapping beneath one end of the score mark from the bottom surface of the glass will then almost instantly follow the score mark across the width of the sheet leaving the two pieces of glass in the clear. When pressure at points B and C starts the crack on its way from A to D, but the crack does not reach D, then apply pressure progressively toward D, but always slightly behind the point to which the crack has run. For short breaks, a matchstick can be substituted for the cord.

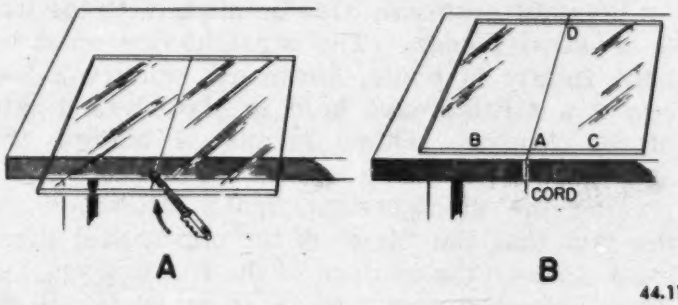

Figure 2-7-3.—Cutting large sheets of glass.

Figure 2-7-4 shows a break that did not follow the score mark. When this happens, grasp the remaining piece with glass pliers right up to the score mark and carefully apply pressure downward away from the score mark. A glass pliers is a broad-nosed pliers. If you do not have glass pliers, use ordinary pliers. It may be necessary to "nibble" off whatever scrap glass remains if the first break fails to follow the entire width of the glass.

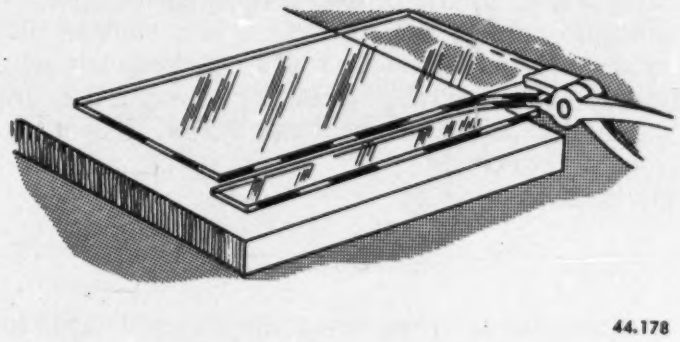

Figure 2-7-4.—Using pliers to aid in separating glass.

CUTTING GLASS TO A PATTERN

To cut glass to a pattern, first lay out a full size drawing on paper, making certain the outline is heavy and distinct. Place the drawing under the pane of glass to be cut. Cut circles, ovals, and curves by tracing them through the glass with the cutter wheel. For straight lines, use a guide such as a woodstrip or a yardstick.

CUTTING LAMINATED SAFETY GLASS

To cut laminated safety glass, make the score mark just as you would for ordinary glass and open or snap the cut on one side. Then turn the sheet of glass over on the bench top and make another score mark exactly opposite the first one, and open this score mark separately just as you would for unlaminated glass. Use a cord or matchstick to assist in breaking the glass if necessary.

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When both glass faces of the laminated safety glass have been scored and cut or snapped, secure the glass to the bench top as shown in figure 2-7-5. Then pull horizontally with glass pliers or common pliers, with pads of rubber to protect the surface of the glass from the jaws. When the cut is opened up in this way, cut the layer of plastic with a razor blade as shown. Pulling horizontally prevents chipping the edges of the glass on the bottom side which is what would happen if the top of the cut were opened up by bearing down on the pliers rather than pulling horizontally.

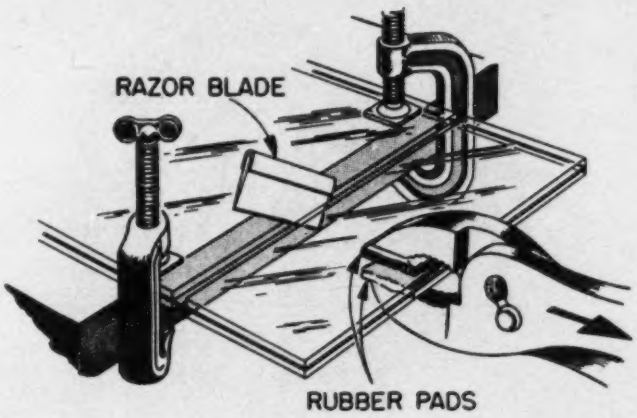

Figure 2-7-5.—Cutting laminated safety glass.

For satisfactory cutting, laminated safety glass must be at a temperature of between 75° and 110° F. However, to facilitate stretching the plastic so that it can be cut with a razor blade, it may be necessary to raise the temperature above this. After the glass has been scored and snapped, heat the plastic by immersing the whole sheet of glass in hot water (160° to 170° F) for a short period not to exceed a minute. Cut the plastic membrane clear through immediately upon removing the glass from the hot water. Then wipe the plate dry and stand it on its edge until it has cooled to almost room temperature. Do not attempt to hurry the cooling with a fan or other means.

CUTTING GLASS TUBING

One way to cut glass tubing, as shown in figure 2-7-6, is to score the surface with one forward stroke of a three-cornered file. The corner of a mill file will also work well in the absence of a three-cornered file. Make the score mark at right angles to the center line of

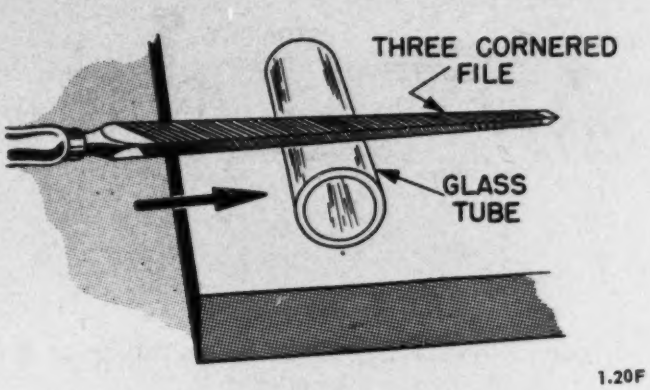

Figure 2-7-6.—Cutting glass tubing with a three-cornered file.

the tube so that the tube will snap squarely across. To snap the tube, place it on the bench top with a matchstick or toothpick directly beneath the score mark. Then, holding one end securely, press down on the other end and the snap will be immediate.

If possible, cut glass tubing with the gage glasscutter shown in figure 2-7-7. Set the stop collar to permit the cutting wheel to be inserted the required distance into the end of the tubing to make the cut where you want it. The backup shoe will ride on the outside surface of the tube exactly opposite the cutting wheel. If the glass is pyrex glass, it may be necessary to use a new, sharp cutting wheel for each gage glass that is to be cut, because pyrex glass is extremely hard. Apply pressure on the handles of the gage glasscutter with one hand and rotate the glass with the other. The score mark will be on the inside of the tube.

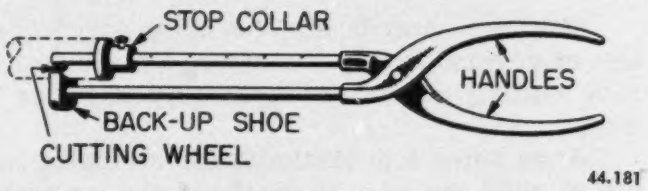

Figure 2-7-7.—Using a gage glasscutter for cutting glass tubing.

To break the glass tubing at the score mark, hold the glass in both hands with your thumbs at the mark. (See fig. 2-7-8.) Then pull against your thumb pressure and away from the score mark. On some glass tubing this method may be more satisfactory than using a matchstick.

To remove the sharp corners at the fresh cut, hold the glass at the edge of the bench as shown in figure 2-7-9, then, with a piece of

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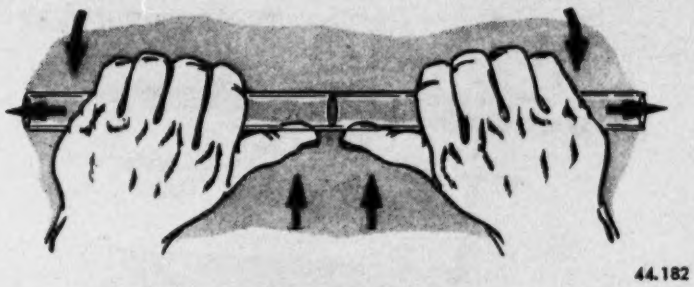

Figure 2-7-8.—Breaking glass tubing at the scored mark.

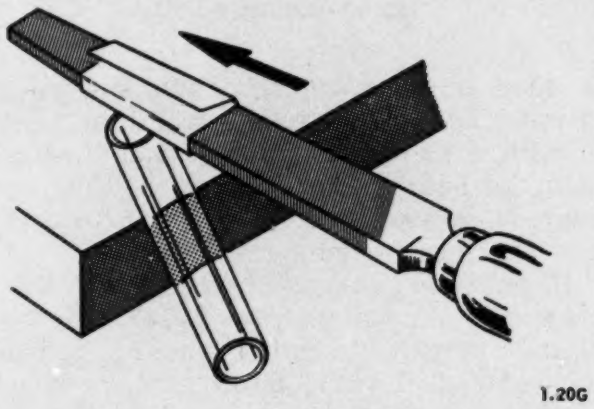

Figure 2-7-9.—Smoothing the cut edge of glass tubing.

emery cloth wrapped around a file, work your way around the entire circumference of the tube with forward strokes.

STRIPPING INSULATED WIRE

Insulation may be stripped from wire by using one of several tools. However, a pocketknife or side cutting pliers are generally used for this work.

When using a pocketknife for stripping insulation, hold the wire in one hand and the knife in the other. Use your thumb to roll the wire over the blade of the knife to cut the insulation almost to the wire itself. (See figure 2-7-10A.) Then pull off or "strip" the short piece of insulation from the end of the wire. Because any nick in the wire will eventually cause a break, it is important not to cut clear through the insulation. By not cutting completely through the insulation, the blade of the knife never comes into contact with the wire itself, thus preventing any possible injury to the surface of the wire. However, cutting nearly through the insulation weakens it sufficiently so that the insulation can be stripped from the wire. This method is not recommended for stranded wire.

Another way to perform this operation is, while holding the wire in one hand and the pocketknife in the other, hold the wire against the knife blade with your thumb and cut the insulation off with several strokes of the blade, working around the wire with each successive stroke. (See fig. 2-7-10B.) Notice that the blade is held almost flat against the insulation. This low angle prevents the blade from cutting into the wire itself. This method is not recommended for stranded wire.

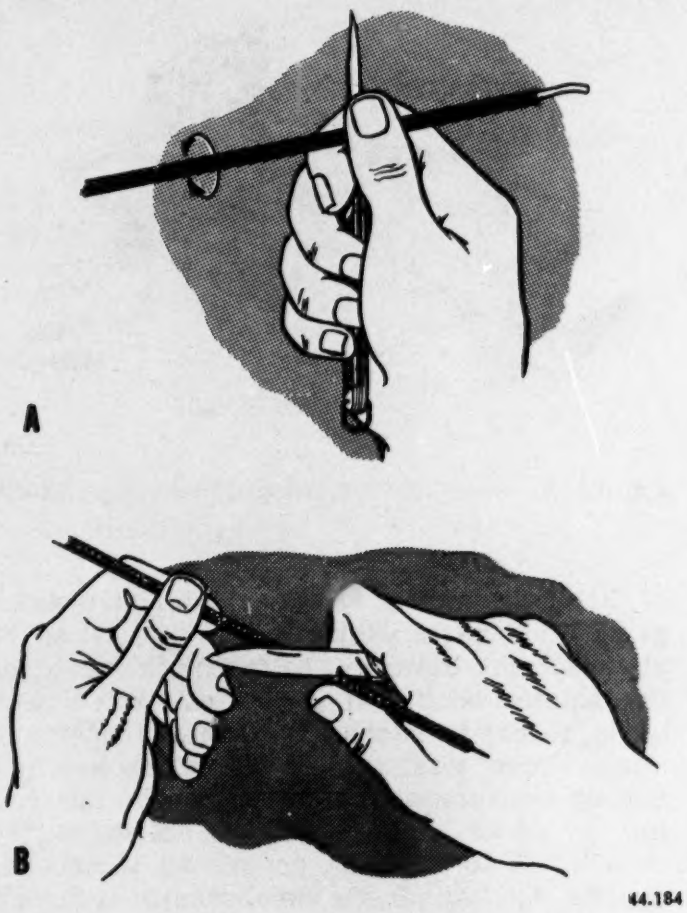

Figure 2-7-10.—Stripping insulated wire with a pocket knife.

Insulated wire can be stripped with the side cutting pliers, as shown in figure 2-7-11, by nicking the insulation all around, being careful not to break through to the wire itself, and stripping the short length of insulation off the end of the wire. Notice that, in figure 2-7-11A, the man's index finger is wedged between the handles of the pliers close to the joint. This affords better control over the cutting edges so that there

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is less chance that the insulation will be broken completely through. When the nick has been made all around the wire, press your thumb against the side of the pliers to break the insulation at the nick and, without changing the grip of the pliers, strip it off the end. (See fig. 2-7-11B.) Care must be exercised to avoid cutting too far through the insulation and nicking the wire.

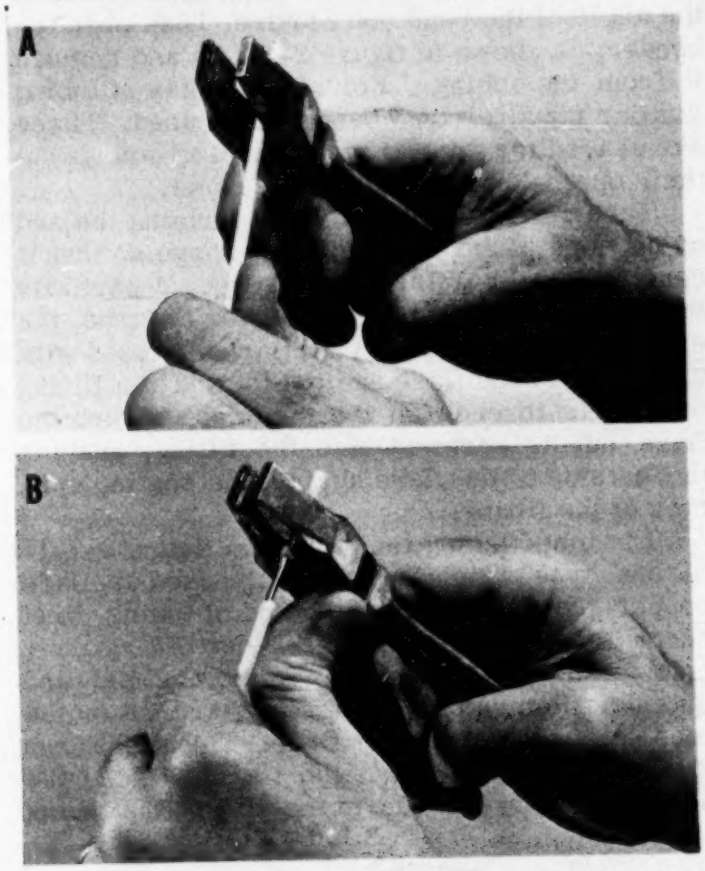

1.21.8A

Figure 2-7-11.—Stripping insulated wire with side cutting pliers.

Insulated solid wire can also be stripped as shown in figure 2-7-12. Starting at the end of the wire, grip and crush the insulation between the flat places on the inside of the handles close to the hinged joint. In figure 2-7-12A, the insulation has been crushed and the wire exposed. Then, as shown in figure 2-7-12B, grasp the insulation close to the end of the crushed portion and tear it off. Although this method leaves a rather ragged appearing end on the remaining insulation, there is no possibility of damaging the wire.

BENDING AND FLARING METALLIC TUBING

External spring-type benders, shown in figure 2-7-13A, come in sizes to bend 1/4",

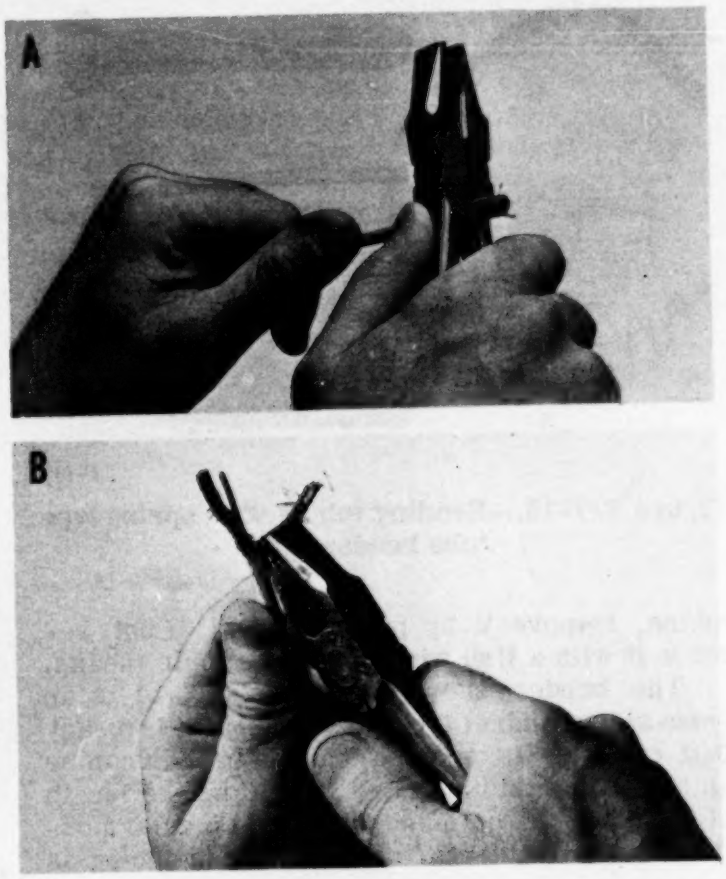

1.21.8B

Figure 2-7-12.—Stripping insulated wire with side cutting pliers.

5/16", 3/8", 7/16", 1/2", and 5/8" outside-diameter soft copper, aluminum, and other soft metallic tubing. To bend tubing with this type of bender, first select the size that will just slip over the size of tubing you want to bend. Then slip it over the tubing so that it centers at the middle of the proposed bend. Grasp the bender with both hands and make the bend. (See fig. 2-7-13B.) The restraining action of the bender will prevent the tubing from collapsing at the bend and will produce a smooth curve. To remove the bender, grasp the belled end and pull it off the tubing.

Internal spring-type benders, shown in figure 2-7-13C, come in sizes to bend 3/8", 1/2", and 5/8" outside diameter tubing. This type can be used when both ends of a length of tubing are flared and the external type cannot be applied. To bend tubing with an internal spring-type bender, select the proper size bender and slip it inside of the tubing. Insert it so that the center of its length is at the center of the proposed bend. Grasp the tubing with both hands and make the bend. If the bender sticks out of the end of the

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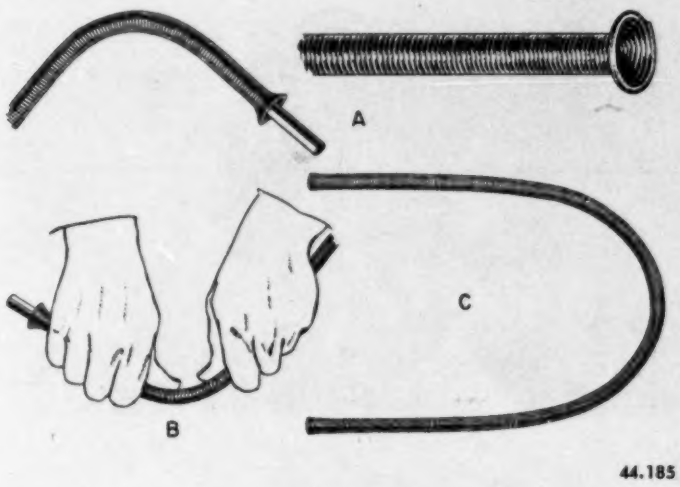

Figure 2-7-13.—Bending tubing with spring type tube benders.

tubing, remove it by pulling it out. If not, remove it with a fish wire or other simple means.

The bender shown in figure 2-7-14 is an open-side mandrel type. By open-side is meant that one side is open so that the bender can be placed on the tubing at any point along the length of the tubing. The mandrel is the circular portion of the bender around which the tubing is formed or bent. This type of bender is furnished in 3/16", 1/4", 5/16-, 3/8", and 1/2" sizes. Place the bender on the tubing at the point where the bend is required. Figure 2-7-14A, shows the zero line on the bender which indicates the start of the bend. Then close the bender, as shown in figure 2-7-14B, and by bringing your two hands toward each other, bend the tubing around the mandrel until the index line on the arm indicates the angle of the bend you require. Then open the bender, as shown in figure 2-7-14A and remove it from the tubing. For larger sizes of tubing similar mandrel-type benders are used. These are geared for greater mechanical advantage but their operation is basically the same.

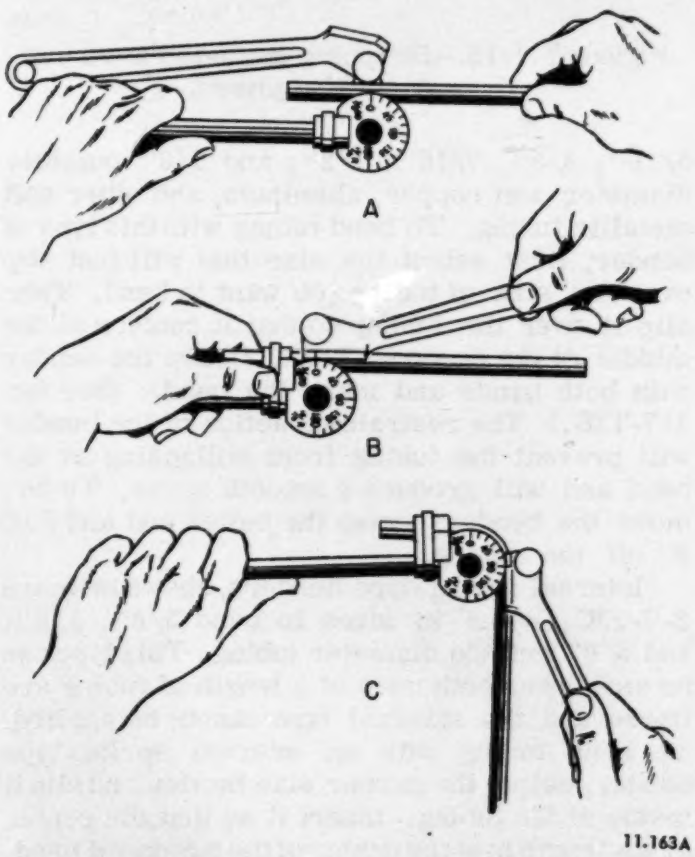

Figure 2-7-14.—Bending tubing with an open-side mandrel type bender.

Tube flaring is a method of forming the end of a copper tube into a funnel shape so that it can be held by a threaded fitting. A partially threaded flare nut is slipped over the tube, the end of the tube is flared, the flare is seated with the inside of the flare against the end of a fitting which has threads on the outside, and then the flare nut is screwed onto the fitting, pushing the outside of the flare against the seating surface of the fitting.

The tube-flaring tool shown in figure 2-7-15 is one type which is commonly used to flare copper tubing. To flare the end of tubing, first check to see that it has been cut off squarely and has the burrs removed from both inside and outside. Remember to slip the flare nut on the tube before you make the flare. Then, as shown in figure 2-7-15A, open the flaring tool at the die which corresponds to the size of the tubing

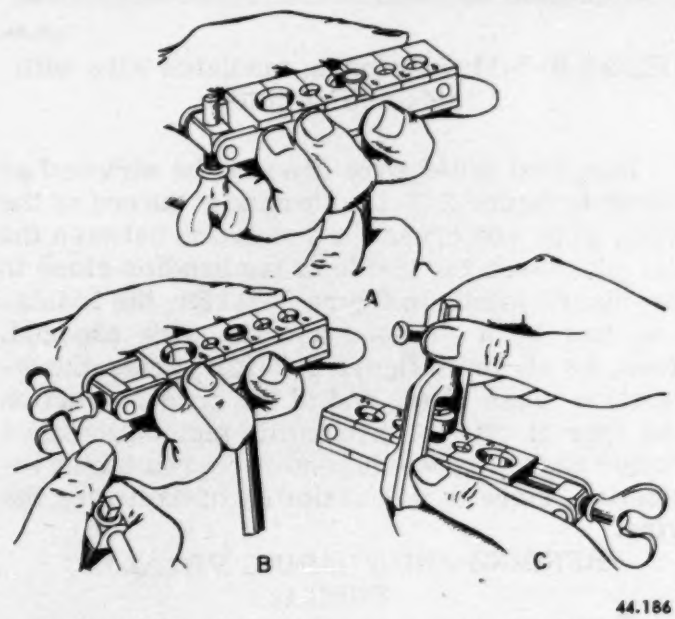

Figure 2-7-15.—Flaring metallic tubing.

being flared. Insert the end of the tubing to protrude slightly above the top face of the die blocks. The amount by which the tubing extends above the blocks determines the finished diameter of the flare. The flare must be large enough so that it will seat properly against the fitting, but small enough so that the threads of the flare nut will slide over it. You determine the correct size by trial-and-error. Then as shown in figure 2-7-15B, close the die block and secure the tool with the wing nut. Use the handle of the yoke to tighten the wing nut. Then place the yoke over the end of the tubing (fig. 2-7-15C), and tighten the handle to force the cone into the end of the tubing. The completed flare should be slightly visible above the face of the die blocks.

REMOVING BROKEN BOLTS AND STUDS

When the removal of a broken bolt or stud from work is required, use plenty of oil to flood the part being worked on. Penetrating oil is the most effective. Time permitting, soak the area for several hours or overnight. A week's soaking may loosen a bolt which would otherwise have to be drilled out.

If enough of the broken piece protrudes from the job, take hold of it with locking pliers, as shown in figure 2-7-16, and carefully try to ease it out. The smaller sizes of bolts are very liable to twist off. If the bolt cannot be turned, further soaking with penetrating oil may help. Or try removing the pliers and jarring the bolt with light hammer blows on the top and around the sides. This may loosen the threads so that the bolt can then be removed with the locking pliers.

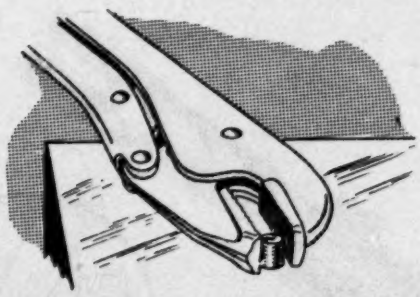

1.21C

Figure 2-7-16.—Removing a broken stud with locking pliers.

If a bolt has been broken off flush with the surface of the job, as shown in figure 2-7-17, it is sometimes possible to back it out of the hole with light blows of a prick punch or center punch.

44.188

Figure 2-7-17.—Removing a broken bolt with a prick punch.

However, if the bolt was broken due to rusting, this method will not remove it. If it cannot be removed by careful punching first on one side and then the other, a screw and bolt extractor may remove it. (See fig. 2-7-18B.)

When using this extractor, file the broken portion of the bolt to provide a smooth surface at the center for a punch mark, if possible. Then carefully center punch the exact center of the bolt (See fig. 2-7-18A.)

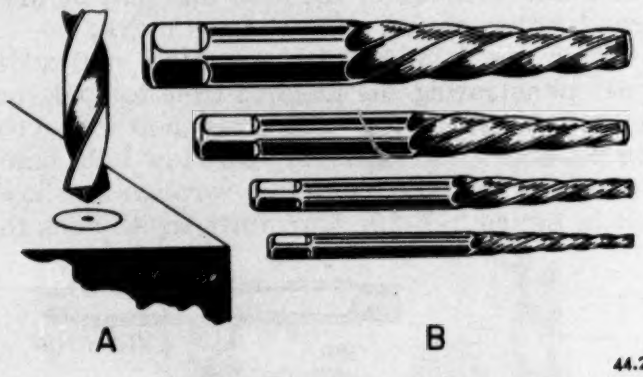

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Figure 2-7-18.—Screw and bolt extractors for removing broken studs.

Refer to figure 2-7-19 to select the proper drill size to use according to the size of the broken bolt that you are trying to remove. If possible, drill through the entire length of the broken bolt. Then carefully work some penetrating oil through this hole so that it fills the cavity beneath the bolt and has a chance to work its way upwards from the bottom of the bolt.

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Extractor		Used For—		Use Drill Size Dia., Inches
Size No.	Overall Length, Inches	Nominal Screw And Bolt Size, Inches	Nominal Pipe Size, Inches	
1	2	3/16 - 1/4	--------	5/64
2	2 3/8	1/4 - 5/16	--------	7/64
3	2 11/16	5/16 - 7/16	--------	5/32
4	3	7/16 - 9/16	--------	1/4
5	3 3/8	9/16 - 3/4	1/4	17/64
6	3 3/4	3/4 - 1	3/8	13/32
7	4 1/8	1 - 1 3/8	1/2	17/32
8	4 3/8	1 3/8 - 1 3/4	3/4	13/16
9	4 5/8	1 3/4 - 2 1/8	1	1 1/16
10	5	2 1/8 - 2 1/2	1 1/4	1 5/16
11	5 5/8	2 1/2 - 3	1 1/2	1 9/16
12	6 1/4	3 - 3 1/2	2	1 15/16

Figure 2-7-19.—Chart for screw and bolt extractor.

The more time you let the penetrating oil work from both ends of the broken bolt, the better are your chances of removing it.

When drilling a hole in a stud which has broken off below the surface of the piece which it was holding, as shown in figure 2-7-20A, a drill guide will center the drill and may be preferred rather than a center punch mark.

When the hole has been drilled, and additional penetrating oil has had time to soak, put the spiral end of the screw and bolt extractor into the hole. Set it firmly with a few light hammer blows and secure the tap wrench as shown at B in figure 2-7-20. Carefully try to back the broken bolt out of the hole. Turn the extractor counterclockwise. This type of extractor is designed for right hand threads only.

A screw and bolt extractor can sometimes be used to remove a socket-head capscrew, also called an Allen head capscrew, when the socket has been stripped by the Allen wrench. (See fig. 2-7-21.) When attempting this removal, carefully grind off the end of the extractor so that it will not bottom before the spiral has had a chance to take hold. Figure 2-7-21B shows this end clearance. In doing this grinding operation,

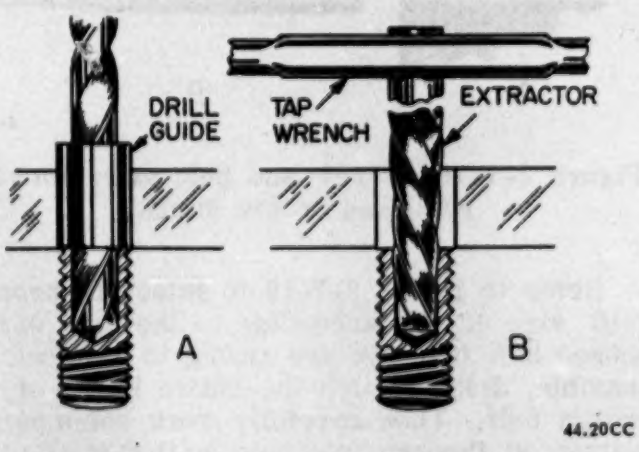

Figure 2-7-20.—Removing a stud broken off below the surface.

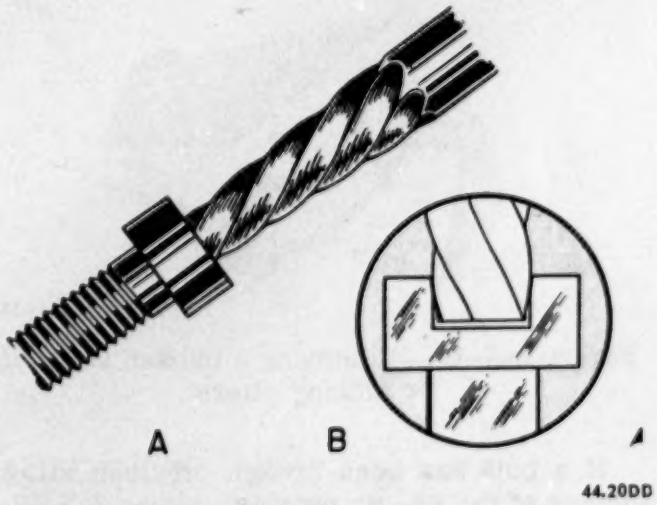

Figure 2-7-21.—Removing an Allen head capscrew with a bolt extractor.

great care must be taken to keep the temperature of the extractor low enough so that the tip can be handled with the bare hands. If the hardness is drawn from the tip of the extractor by overheating during the grinding, the extractor will not take hold.

REMOVING A BROKEN BOLT AND RETAPPING HOLE

To remove a broken bolt and retap the hole, file the bolt smooth, if necessary, and center-punch it for drilling.

Then select a twist drill which is a little less than the tap-drill size for the particular bolt that has been broken. As shown in figure 2-7-22, this drill will just about but not quite touch the crests of the threads in the threaded hole or the roots of the threads on the threaded bolt. Carefully start drilling at the center punch mark, crowding the drill one way or the other as necessary so that the hole will be drilled in the exact center of the bolt. The drill in figure 2-7-22 has almost drilled the remaining part of the bolt away and will eventually break through the bottom of the bolt. When this happens, all that will remain of the bolt will be a threaded shell. With a prick punch or other suitable tool, chip out and remove the first 2 or 3 threads, if possible, at the top of the shell. Then carefully start a tapered tap into these several clean threads and continue tapping until the shell has been cut away and the original threads restored.

In cases where the identical size of capscrew or bolt is not necessary as a replacement, center-punch and drill out the old bolt with a drill larger than the broken bolt, as shown in figure 2-7-23A. Tap the hole first, and then finish it with a bottoming tap as shown in figure 2-7-23B. Replace with a larger size capscrew or stud.

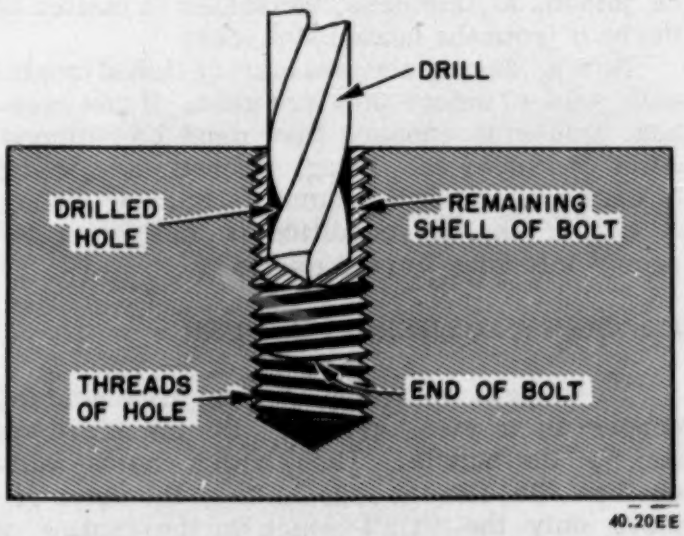

Figure 2-7-22.—Removing a broken bolt and retapping hole to same size.

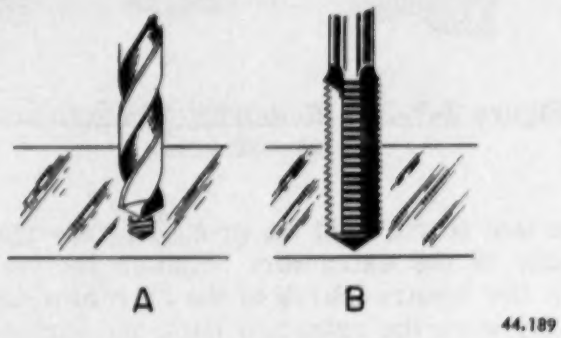

Figure 2-7-23.—Removing broken bolt and retapping hole to larger size.

REMOVING A BROKEN TAP FROM A HOLE

To remove a broken tap from a hole, generously apply penetrating oil to the tap, working it down through the four flutes into the hole. Then, if possible, grasp the tap across the flats with locking-type pliers. This operation is shown in figure 2-7-24. Carefully ease the tap out of the hole, adding penetrating oil as necessary.

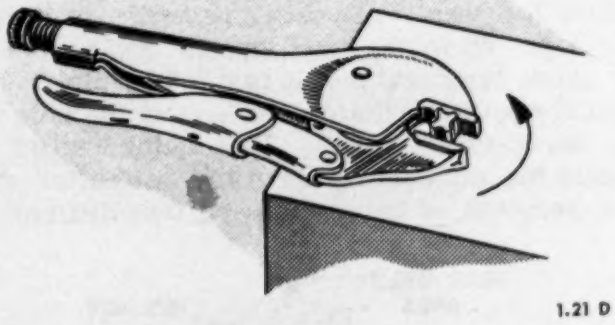

Figure 2-7-24.—Removing a broken tap with locking pliers.

If the tap has broken off at the surface of the work, or slightly below the surface of the work, the tap extractor shown in figure 2-7-25 may remove it. Again, apply a liberal amount of penetrating oil to the broken tap. Place the tap extractor over the broken tap and lower the upper collar to insert the four sliding prongs down into the four flutes of the tap. Then slide the bottom collar down to the surface of the work

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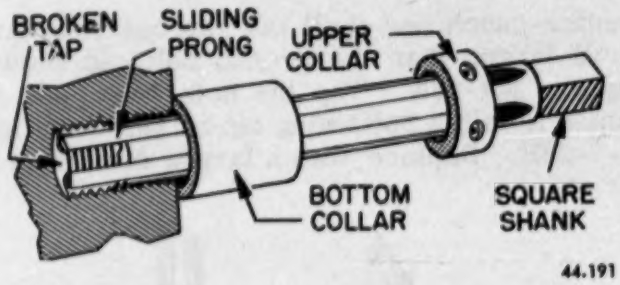

Figure 2-7-25.—Removing a broken tap with a tap extractor.

so that it will hold the prongs tightly against the body of the extractor. Tighten the tap wrench on the square shank of the extractor and carefully work the extractor back and forth to loosen the tap. It may be necessary to remove the extractor and strike a few sharp blows with a small hammer and pin punch to jar the tap loose. Then reinsert the tap remover and carefully try to back the tap out of the hole.

Each size of tap will require its own size of tap extractor. Tap extractors come in the following sizes: 1/4", 5/16", 3/8", 7/16", 1/2", 9/16", 5/8", 3/4", 7/8", and 1".

When a tap extractor will not remove a broken tap, it is often possible to do so by placing a hex nut over the tap (fig. 2-7-26), and plug welding the nut to the tap with an arc welder. Notice that the hole in the nut must be somewhat smaller than the tap to reduce the possibility of welding the nut and the tap to the job itself. Allow the weld to cool before trying to remove the tap. When the nut, tap, and job have come to room temperature, it is often helpful to heat quickly the immediate area around the hole with an oxyacetylene torch. This quick heating expands the adjacent metal of the work after which the removal of the tap may be less difficult. If

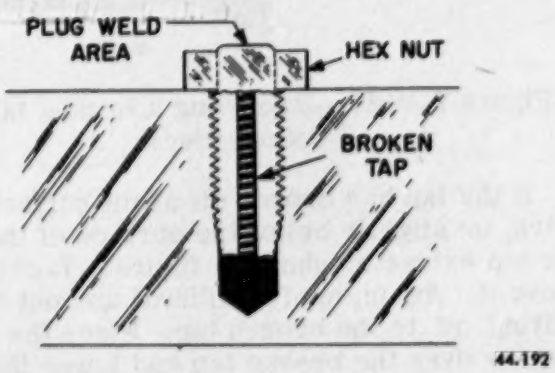

Figure 2-7-26.—Using a plug weld to remove a broken tap.

the heating is too slow, the tap will expand with the adjacent metal of the work and there will be no loosening effect.

SOLDERING

Soldering is used to join metallic surfaces such as copper, iron, nickel, lead, tin, zinc, and aluminum. It is particularly useful for securing electrical connections, joining sheet metal, and sealing seams against leakage. Soldered joints are not as strong as welded joints, and so are not used where any great mechanical strength is required. Electric soldering irons or guns are widely used for electrical connections, but soldering may also be done with coppers which do not have an electrical heating element.

Soldering requires relatively little equipment. For most soldering jobs, you will need only a source of heat, soldering coppers, solder and a flux. There are several different types of solder and solder fluxes used in the Navy. It is important that you understand which solder and flux to use when doing soldering jobs of any kind.

SOURCES OF HEAT

The sources of heat used for soldering with a copper vary according to the method used and the equipment that is available. Welding torches, blowtorches, forges, gas ovens, furnaces, and other heating devices may be used to heat soldering coppers which are used, in turn, to heat the metal being soldered and thus melt the solder. However, the heating devices are sometimes used for direct heating of the surfaces to be joined, in this case, the solder is melted by the heat from the heated surfaces.

New soldering coppers must be tinned (coated with solder) before they are used. If you overheat soldering coppers they must be retinned. After continued use, filing, and retinning, the tip of the copper tends to become too blunt or stubby. A copper in this condition is ineffective and requires forging to reshape its tip.

FORGING A SOLDERING COPPER

To forge a soldering copper, first hold the copper in a vise, gripping the copper itself and not the handle. Then, with a coarse well-chalked file, file the four faces of the tip to remove only the "tin" which is the coating of solder. The chalk on the file helps to keep bits of solder and copper from fouling the file teeth.

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The coating of solder is removed before the subsequent heating for forging, because it would otherwise cause deep pits to form in the surface of the copper when the copper is brought up to forging temperature. To forge, heat the copper to a dull-red heat by whatever means you have available, noting the color under a shaded light. If heated to a dull-red as viewed in sunlight or other bright light, it will have been overheated to a degree which will cause undesirable pitting of the surface.

Then, referring to figure 2-7-27, forge the copper to approximately the taper that is shown. Too long a taper causes the tip to cool too fast in use. Too short a taper does not produce enough surface area to transfer heat quickly from the copper to the work.

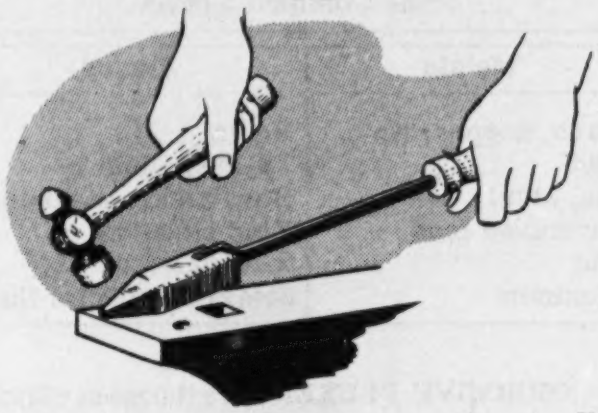

Figure 2-7-27.—Forging a soldering copper.

TINNING A SOLDERING COPPER

If a soldering copper is new or has just been forged, it will need to be tinned. To do so hold it in the vise and "dress" the point with a well-chalked file. By "dressing" is meant filing to remove hammer marks resulting from the forging process and to round off the sharp corners slightly. This is not always required when a tinned copper is to be retinned. Inspection will reveal if it is necessary. Then heat the copper hot enough so that it will readily melt solder. This temperature will be far below the dull-red forging temperature. Try melting solder with the copper frequently as it is being heated, and as soon as it will melt solder, it is ready for tinning.

To tin the copper, first quickly dip it into a jar of dipping solution as shown in figure 2-7-28. Dipping solution is made by dissolving a half

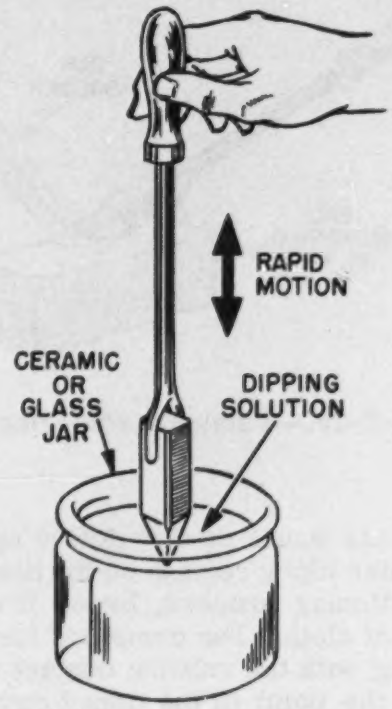

Figure 2-7-28.—Cleaning a soldering copper.

ounce of powdered sal ammoniac in a quart of clean water. If none is available in powdered form, scrape enough off a sal ammoniac block. Dip the copper quickly—in and out—and only an inch deep. This quick dip produces a puff of steam which, along with the chemical action of the solution, "blows off" any dirt and oxides present on the surface of the pointed end of the copper. Notice that the handle of the copper is held between the thumb and index finger with the copper hanging vertically downward. This affords good wrist action to assure a quick dip to remove the oxides without appreciably cooling the copper.

Then, with the copper cleaned (and still hot because it was dipped quickly into the dipping solution), rub each of its four faces on the sal ammoniac block as shown in figure 2-7-29, adding solder from a roll of solid wire solder or from a bar as indicated in this figure. The sal ammoniac will cause the solder to flow over the faces of the copper and tin them (coat them with solder). The coating is bright and shiny and very thin. It enables the copper, when in use, to pick up beads of solder which will adhere to its surface for transfer to the surface of the work being soldered. Another important function of this tinned surface is to aid in the rapid transfer of heat from the copper, through the tinning, to the work.

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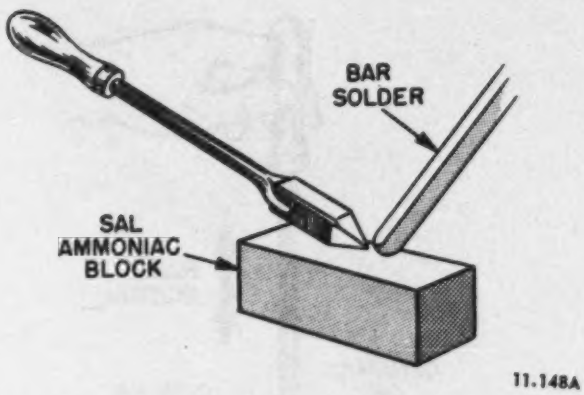

Figure 2-7-29.—Tinning a soldering copper.

Should any scum or dirt picked up from the sal ammoniac block remain on the tinned copper after the tinning process, brush it off with a damp pad of cloth. The damp pad forms steam which, along with the rubbing contact of the pad, will leave the point of the tinned copper bright and clean and ready for use.

SOLDERS

Most soft solders are alloys of tin and lead. Occasionally antimony, silver, arsenic, or bismuth are added to give special properties to the solders. Solders used for joining aluminum are usually alloys of tin and zinc or of tin and cadmium. As mentioned before, soft solders have melting points below 800° F and below the melting points of the metals being joined. The melting points of most tin-lead solders range from about 360° F to about 465° F.

Tin-lead solders are usually identified by numbers which indicate the percentage of tin and the percentage of lead. The first number gives the percentage of tin, the second gives the percentage of lead. For example, a 30/70 solder is an alloy of 30 percent tin and 70 percent lead. A 50/50 solder (sometimes called half-and-half solder) is an alloy of 50 percent tin and 50 percent lead. A 15/85 solder is an alloy of 15 percent tin and 85 percent lead. Solders containing a high percentage of tin are more expensive than those containing a high percentage of lead. In general, the solders which contain a high percentage of tin have lower melting points than those which contain a high percentage of lead.

Solders are available in various forms, including bars, wires, ingots, and powders. Wire solder is available with or without a flux core.

FLUXES

To make a satisfactory joint, both the metal to be joined and the solder must be free of dirt, grease, oxides, and other foreign matter which would keep the solder from adhering to the metal. Fluxes are used to clean the joint area, to remove the oxide film which is normally present on any metal, and to prevent further oxidation. Fluxes also decrease the surface tension of the solder and thus make the solder a better wetting agent. Table 2-7-1 shows the fluxes that are generally used with some common metals.

Fluxes are generally classified as corrosive, mildly corrosive, and noncorrosive.

Table 2-7-1.—Fluxes Used for Soldering Some Common Metals.

Metals	Fluxes
Brass, copper, tin	Rosin
Lead	Tallow, rosin
Iron, steel	Borax, sal ammoniac
Galvanized iron	Zinc chloride
Zinc	Zinc chloride
Aluminum	Stearine, special flux

CORROSIVE FLUXES have the most effective cleaning action. However, any trace of corrosive flux that remains on the work will cause subsequent corrosion of the metal. Therefore corrosive fluxes are not used for soldering electrical connections and for other work in which subsequent corrosion would present a serious problem.

The most commonly used corrosive fluxes are sal ammoniac (ammonium chloride) and zinc chloride. These fluxes are frequently used in solution or in paste form. The solvent is evaporated as the work is heated, leaving a layer of solid flux on the work. At the soldering temperature, this layer of flux melts and partially decomposes, liberating hydrochloric acid. The hydrochloric acid dissolves the oxides from the surface of the work and from the solder.

Zinc chloride (sometimes called CUT ACID or KILLED ACID) should be made up in small amounts, as required for use. To prepare zinc chloride, pour a small amount of muriatic acid (the commercial form of hydrochloric acid) into a container. Then add pieces of zinc to the muriatic acid until the liquid no longer boils and bubbles when the zinc is added. The zinc and the

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SOLDERING SHEET METAL

One way to solder sheet metal is shown in figure 2-7-30. In figure 2-7-30A, you see flux being applied to a lapped seam with a small bristle brush. The flux is applied to both surfaces that are to come into contact, and both surfaces often must be mechanically cleaned first. This means that they must be filed, scraped, or cleaned with abrasive cloth until they are bright. The flux then cleans them chemically to remove oxides. In addition to cleaning the surface, the flux will retard further oxidation and help the solder to flow over the surfaces being joined. The usual flux for tinplate is rosin applied as a powder to be sprinkled on or as the core of rosin core wire solder. The usual flux for sheet metal having a coating of zinc (often called galvanized iron) is zinc chloride. This is an acid sometimes called "cut acid" or "killed acid" and is made by adding zinc, a little at a time to hydrochloric acid, until the acid stops working chemically on zinc. The acid is then said to be "cut" or "killed." A few extra pieces of zinc are usually added to be sure the action is completely stopped. After standing overnight, the liquid is poured through a rag to strain out the residue before it is used as a flux. Hydrochloric acid is known commercially as muriatic acid and sometimes as "raw acid."

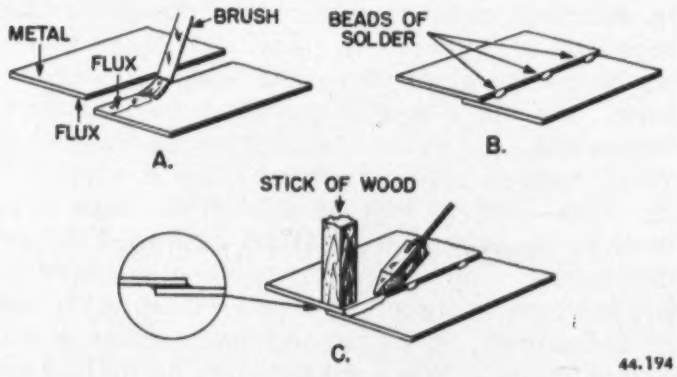

Figure 2-7-30.—Soldering sheet metal.

If galvanized metal is being soldered, cut hydrochloric acid (zinc chloride) may be used as a flux only if the soldering is for the purpose of making the seam air- and water-tight. The mechanical strength of such a seam must be obtained by riveting or other means such as grooving the seam before the soldering is done. Soldering adds little to the strength of the seam because it adheres only to the coating of zinc (the galvanizing) which itself has very limited adherance to the base metal of the sheet. When strength is necessary, and mechanical means cannot be used, use muriatic acid instead of zinc chloride as a flux before applying the solder. This acid will remove the coating of zinc on the galvanized iron so that the solder can adhere directly to the base metal of the sheet and give a strong bond. Be very careful not to splatter muriatic acid on your clothing or on the job. If a drop of acid gets on the job where it should not be, it will remove the protective coating of zinc at that place. If this happens, be sure to flow a little solder over the metal to tin the area and restore the protection. Similarly, when using muriatic acid, be sure that you flow solder over the entire area of the base metal where the galvanizing has been eaten away to restore the protection to the metal. This is done while soldering, and means you sometimes must flow more solder on the base metal than would actually be needed for the seam.

When flux has been applied to both surfaces, put them together as shown in figure 2-7-30B. Place beads of solder along the joint by melting them off the end of a bar of solder right onto the joint or by melting them on the sal ammoniac block and putting them in place, after they have cooled, with your fingers. These drops or beads of solder will flow into the seam when the metal is heated.

Then, as shown in figure 2-7-30C, hold the metal together with a stick of wood (which is a good heat insulator) and place the heated copper with one face flat on the seam. The entire face must be in contact to provide the greatest possible flow of heat from the copper to the work. Hold it there until the nearest bead of solder begins to melt and flow, as it will, into and through the joint, forming a small fillet, as shown in the inset of figure 2-7-30, on both sides of the seam. In the insert the metal is shown as separated a bit only to indicate that the solder is continuous through the entire lapped seam. Then, maintaining contact with the metal, slowly draw the copper along the length of the seam at the speed necessary for it to melt the beads of solder. When the solder near the stick of wood freezes (solidifies), it will hold the joint and the stick can be moved ahead. Reheat the copper, or take another heated copper, when it no longer melts the solder readily.

Remember that the hot copper heats the metal which in turn melts the solder which

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then flows through the entire seam. Dropping solder along the seam by holding the copper against a bar of solder in the air a few inches above the seam is not good soldering. However, feeding the solder to the heated metal (heated with the hot copper) which you are soldering, from a coil of wire solder or a bar of bar solder, rather than placing beads along the seam, is another correct way of soldering.

A thorough washing with soda and water after the soldering is completed will remove any remaining flux and prevent corrosion that would otherwise occur.

SOLDERING AN ELECTRICAL CONNECTION

To solder electrical connections, figure 2-7-31, use rosin core solder. The reason for this is that acid core solder, or acid applied with a brush, is usually difficult or impossible to wash off electrical gear. Any acid flux that remains from the soldering operation causes subsequent corrosion which cannot be tolerated. When new wire is being soldered, no mechanical cleaning, such as scraping, is necessary. Old wire, which may have a heavy coating of oxide on its surface, or from which the insulation does not strip off cleanly, may need to be scraped with a knife until it is bright and clean.

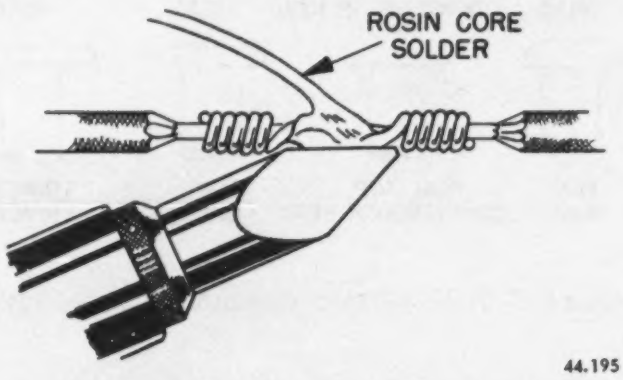

Figure 2-7-31.—Soldering an electrical connection.

To solder electrical connections, hold the soldering iron (copper) beneath the splice being soldered with as much mechanical contact as possible to permit maximum heat transfer. Apply the rosin core solder to the splice. The tinning on the soldering iron aids the transfer of heat to the spliced wire which, when hot enough, will melt the solder. Before this temperature is reached the rosin core will have melted and run out over the wire to flux the splice. When the solder has coated the splice completely, the job is finished. No extra solder is needed.

NOTE.—The term "soldering iron" is used here because, when this tool is electrically heated with its own heating element, it is usually called an "iron" rather than a "copper." This type is generally used on electrical gear. However, both "iron" and "copper" are sometimes used interchangeably for the tool used for soldering.

TORCH SOLDERING

Torch soldering is often used for small jobs or for work which is relatively hard to reach. A gasoline blowtorch or an alcohol torch may be used for torch soldering.

The general procedure for torch soldering is to play the flames from the torch on to the surfaces to be joined and then apply cold solder in bar or wire form. The heated surfaces will melt the solder. As the solder melts, any excess solder should be wiped off with a damp cloth before it completely hardens.

SOLDERING BY SWEATING

Soldering by sweating is frequently used for making electrical connections. To make a sweated joint, clean and flux each surface to be joined. Then tin each surface. Hold the pieces firmly together and heat the joint with a soldering copper or with a torch until the solder melts and begins to run out. Remove the source of heat and hold the parts firmly in position until the solder completely hardens.

SOLDERING ALUMINUM ALLOYS

Soldering aluminum alloys is more difficult then soldering many other metals. The difficulty arises largely from the fact that aluminum alloys are always covered with a layer of oxide, the thickness of the layer depending on the type of alloy and the conditions to which it has been exposed.

Many aluminum alloys can be successfully soldered, however, if the proper techniques are used. Wrought aluminum alloys are usually—although not always—easier to solder than cast aluminum alloys. Heat-treated aluminum alloys are extremely difficult to solder, as are aluminum alloys containing more than 1 percent magnesium.

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The solders used for soldering aluminum alloys are generally tin-zinc or tin-cadmium alloys; they are usually referred to as ALUMINUM SOLDERS. Most of these solders have higher melting points than the tin-lead solders used for ordinary soldering. Both corrosive and noncorrosive fluxes are used for soldering aluminum.

The first step in soldering aluminum is to clean the surfaces completely and remove the layer of oxide. If a thick layer of oxide is present, remove the main part of it mechanically by filing, scraping, sanding, or wirebushing. A thin layer of oxide can often be removed by using a corrosive flux; the flux, of course, must be completely removed from the joint after the soldering is finished.

After cleaning and fluxing the surfaces, tin the surfaces with aluminum solder. Apply flux to the work surfaces and to the solder. You can tin the surfaces with a soldering copper or with a torch. If you use a torch, do not apply heat directly to the work surfaces, to the solder, or to the flux. Instead, play the torch on a nearby part of the work and let the heat be conducted through the metal to the work area. Do not use any more heat than is necessary to melt the solder and tin the surfaces. Work the aluminum solder well into the surfaces. After the surfaces have been tinned, the parts may be sweated together.

A procedure that is sometimes used for soldering aluminum alloys is to tin the surfaces with an aluminum solder and then to use a regular tin-lead solder to actually join the tinned surfaces. This procedure may be used when the shape of the parts prevents the use of the sweating method or when a large amount of solder is required to join the parts. When using tin-lead solder with aluminum solder, it is not necessary to use a flux.

Another method of soldering aluminum is by "friction soldering." In this method, a molten pool of solder is deposited on the aluminum. The surface of the aluminum underneath the molten pool is scratched so that the oxide coating is abraded and broken up. The oxide floats to the surface of the solder puddle. The solder then tins the bare aluminum surface from which the oxide has been removed. After such tinning, two aluminum surfaces can easily be joined by applying heat to melt additional solder on the tinned area to form a fillet or to fill the joint.

Although mill files, soldering rods, soldering copper points, and other tools or devices may be used to abrade the oxide film and remove it from the surface of the aluminum, the best device for this purpose is a glass fiber brush. The brush is very easy to use and is more effective than other tools in breaking up the oxide film. When a glass fiber brush is used, the friction soldering process produces better soldered joints than are produced by any other aluminum soldering process.

RIVETING METAL

After metal has been cut and formed, it must be joined together. Most sheet metal seams are either locked or riveted, although some are joined by brazing or welding. This section deals only with joining sheet metal seams by riveting.

SELECTING THE PROPER RIVET

Rivets are available in all of the common metals, in many lengths and in many diameters. Some of the standard head types are shown in figure 2-7-32.

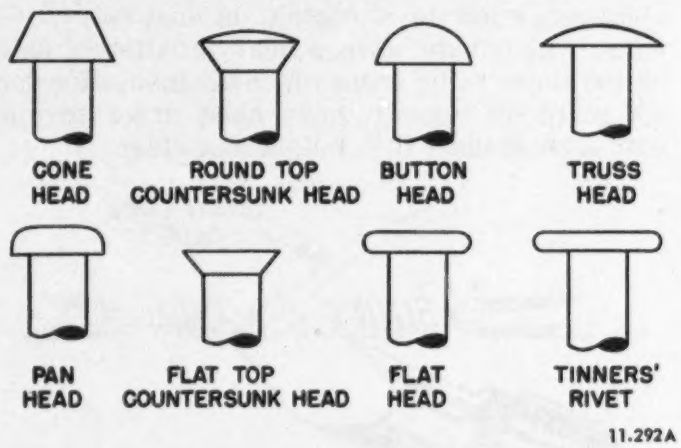

Figure 2-7-32.—Some common types of rivets.

The proper length of rivet to use for a particular job is determined by adding to the grip one and one-half times the rivet diameter. (See fig. 2-7-33C.) This will provide enough metal to form a second "head" at the end of the rivet (fig. 2-7-33A) or to fill the countersunk portion of the hole for flush surfaces as shown in figure 2-7-33B. The grip, as shown in figure 2-7-33, is always measured from face to face of the work, regardless of the type of rivet.

To rivet metal, select the rivet of the proper metal, type of head, and length for the job, and the right diameter.

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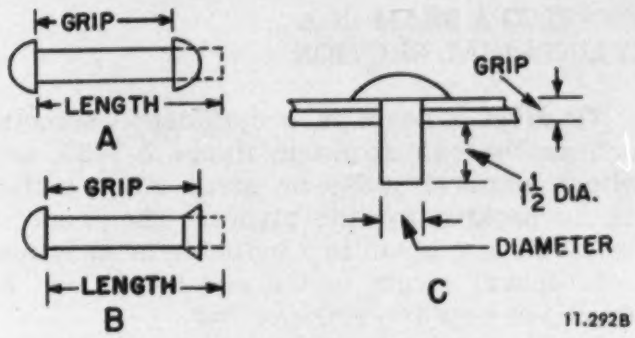

Figure 2-7-33.—Showing what is meant by "grip" of a rivet.

Table 2-7-2.—Guide for Selecting Rivet Size for Sheet Metal Work.

Gage of sheet metal	Rivet size (weight in pounds per 1000 rivets)
26	1
24	2
22	2 1/2
20	3
18	3 1/2
16	4

RIVETING SHEET METAL

For sheet metal work, you will probably use tinners' rivets more than any other kind. Tinners' rivets vary in size from the 8-ounce rivet to the 16-pound rivet. This size designation indicates the weight of 1000 rivets; thus, if 1000 rivets weigh 8 ounces, each rivet is called an 8-ounce rivet. As the weight per 1000 rivets increases, the diameter and length of the rivets also increase. For example, the 8-ounce rivet has a diameter of 0.089 inch and a length of 5/32 inch, while the 12-pound rivet has a diameter of 0.259 inch and a length of 1/2 inch. For special jobs that require fastening several layers of metal together, special rivets with extra long shanks are used. Table 2-7-2 is a guide for selecting rivets of the proper size for sheet metal work.

Rivet spacing is usually given on the blueprint or drawing that you are working from. If the spacing is not indicated, space the rivets according to the service conditions the seam must withstand. For example, if the seam must be watertight, you will need many more rivets per inch than if the seam does not need to be watertight. No matter how far apart the rivets are, there must be a distance of at least 2 1/2 times the rivet diameter between the rivets and the edge of the sheet, as measured from the center of the rivet holes to the edge of the sheet.

After you have determined the size and spacing of the rivets, mark the location of the centers of the rivet holes. Then pierce the metal by punching or drilling a small hole. The hole must be slightly larger than the diameter of the rivet to provide a slight clearance.

Riveting involves three operations: drawing, upsetting, and heading. These are illustrated in figure 2-7-34. A rivet set and a riveting hammer are used to perform these operations. The procedure for riveting sheet metal is as follows:

1. Select a rivet set that has a hole slightly larger than the diameter of the rivet.

2. Insert the rivets in the holes and rest the sheets to be joined on a stake or on a solid

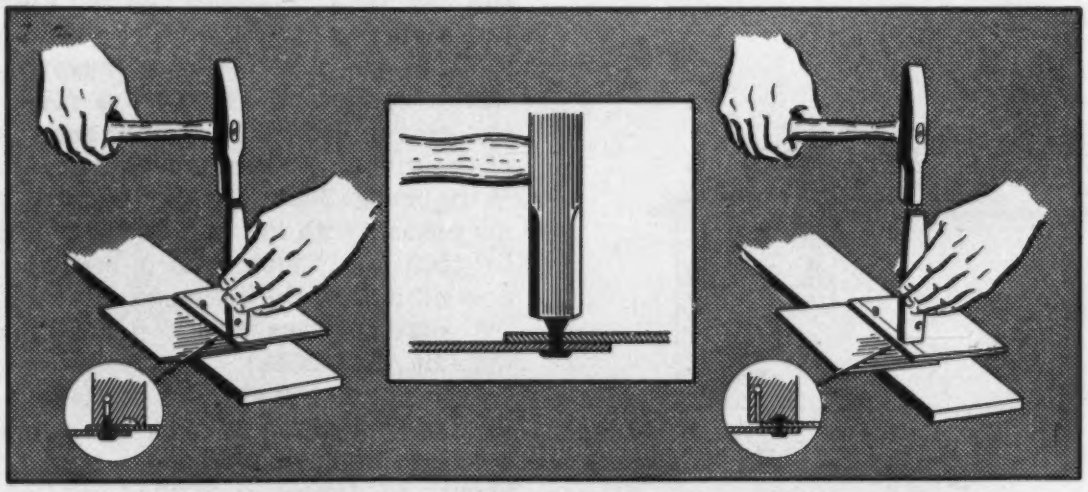

Figure 2-7-34.—Drawing, upsetting, and heading a rivet. 11.295

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bench top, with the rivet heads against the stake or bench top.

3. Draw the sheets together by placing the deep hole of the rivet set over the rivet and striking the head of the set with a riveting hammer. Use a light hammer for smaller rivets, a heavier hammer for larger rivets.

4. When the sheets have been properly drawn together, remove the rivet set. Strike the end of the rivet LIGHTLY with the riveting hammer, to upset the end of the rivet. Do not strike too hard a blow, as this would distort the metal around the rivet hold.

5. Place the heading die (dished part) of the rivet set over the upset end of the rivet and form the head. One or two hammer blows on the head of the rivet set will be enough to form the head on the rivet.

A correctly drawn, upset, and headed rivet is shown in the top part of figure 2-7-35. The lower part of this illustration shows the results of incorrect riveting.

When it is necessary to rivet a seam in such a position that you cannot use a stake or a bench top to back up the rivet, a hand dolly may be used as shown in figure 2-7-36.

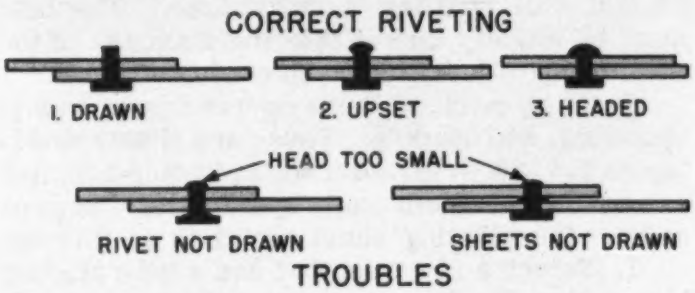

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Figure 2-7-35.—Correct and incorrect riveting.

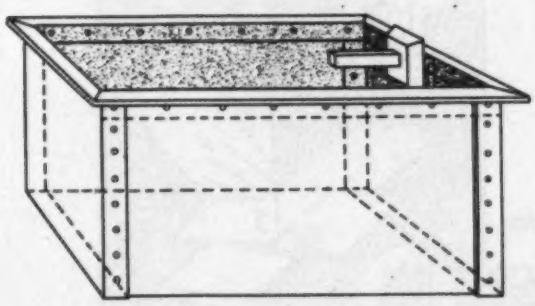

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Figure 2-7-36.—Using a hand dolly to back up rivets.

RIVETING A SEAM IN A CYLINDRICAL SECTION

To rivet a seam in a cylindrical structure such as the one shown in figure 2-7-37, use a hollow mandrel stake or some other suitable bar as backing for the rivets. The procedure for riveting a seam in a cylinder is as follows:

1. Insert rivets in the end holes, and slip the pieces over the stake or bar.

2. Draw the seams together and upset the end rivets enough to hold the structure together.

3. Insert the center rivet. Draw, upset, and head this rivet.

4. Complete the seam by riveting from the center to one end and then to the other end. Complete the drawing upsetting, and heading of each rivet as you work along the seam.

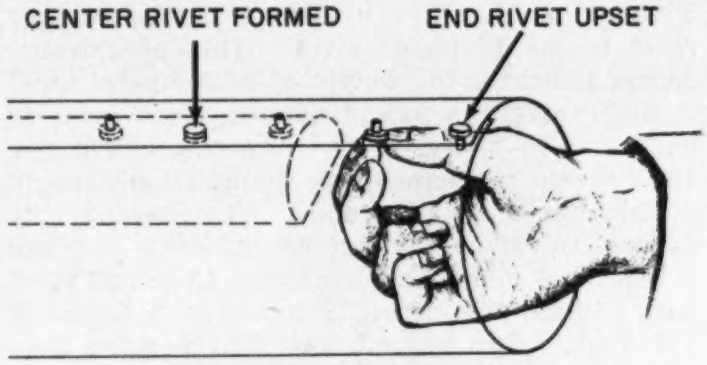

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Figure 2-7-37.—Riveting a seam in a cylindrical section.

RIVETING METAL, USING LARGE RIVETS

To rivet metal with rivets too large to permit the use of a rivet set, set the rivet by striking the metal around the rivet with a hammer (fig. 2-7-38) or by striking a punch (fig. 2-7-38B) while working it around the rivet to force the two pieces of metal together and against the head of the rivet. Then mushroom the rivet, as shown in figure 2-7-38C, using several flat blows if necessary with the face of the hammer. Finally, to give the mushroom a rounded form, work around it with the ball peen of the hammer, striking angled blows until a second head is formed (See fig. 2-7-38D.)

To upset (mushroom or flatten) rivets when the second head is to be a countersunk head, countersink the stock and insert the rivet as shown in figure 2-7-39A. After setting the

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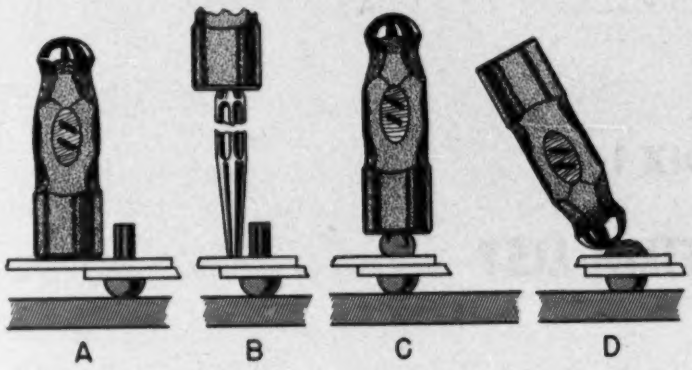

Figure 2-7-38.—Riveting metal, using large rivets.

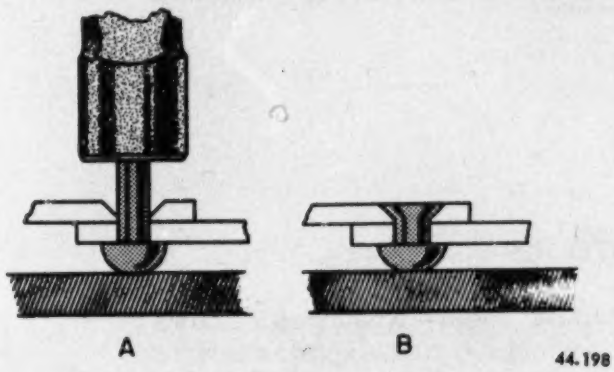

Figure 2-7-39.—Upsetting a rivet that is countersunk.

rivet, either with or without a rivet set, strike the rivet with the face of the hammer to force the metal into the countersunk hole. In figure 2-7-39B the rivet was just the right length to fill the countersunk hole. A too-short rivet will not fill the countersunk hole and a too-long rivet can be left slightly high or be filed, round, or otherwise cut flush with the surface if necessary.

STAMPING LETTERS AND FIGURES ON METAL

To stamp letters and figures on ferrous metal (cast iron or steel), first test it with a sharp mill file. If a sharp mill file will "take hold" and cut the metal, this indicates that the surface is soft enough to stamp without damaging the steel letters and figures used for stamping. Nonferrous metals are safe to stamp without testing. They are—even when heat treated—softer than the steel letters and figures.

Draw a guideline on the job and follow it as you stamp each letter and figure just above the line (See fig. 2-7-40.) Hold the steel letter or figure between your thumb and two fingers and strike only one blow for each impression. To determine how hard to strike the tool with the hammer, make a trial run on a test piece of the same metal.

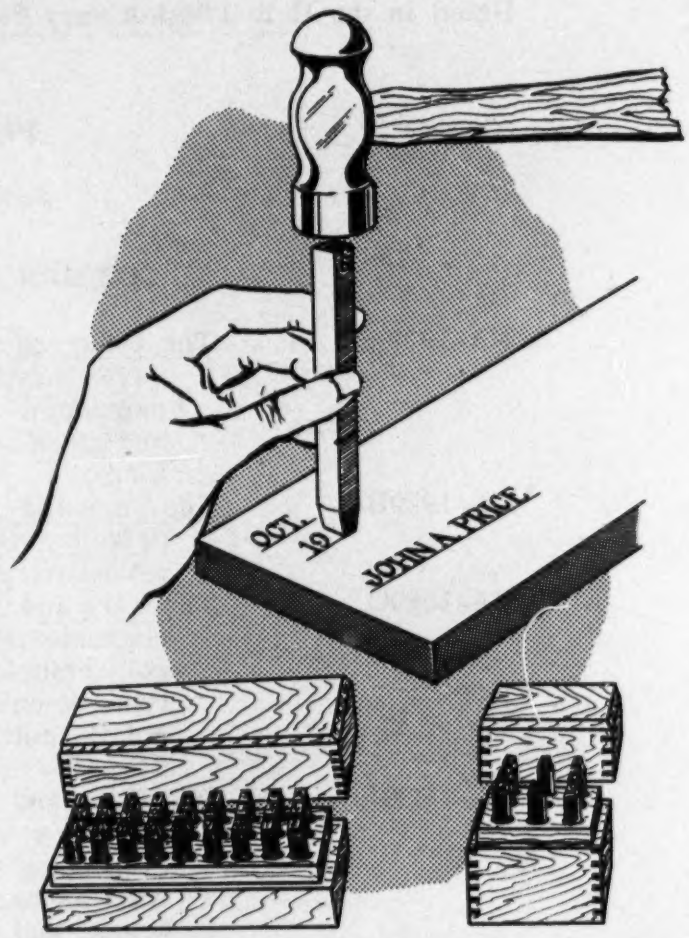

Figure 2-7-40.—Stamping letters and rivets on metal.

APPENDIX I

TRAINING FILM LIST

Training films that are directly related to the information presented in this training course are listed below. Under each chapter number and title, the training films are identified by Navy number and title and are briefly described. Other training films that may be of interest are listed in the United States Navy Film Catalog, NavPers 10000 (revised).

PART I

Section 1

COMMON HANDTOOLS

MA-1929A — The Care and use of Hand Tools—Wrenches. Shows various types of wrenches, and explains how to use them. Stresses necessity for care of tools and gives some rules for best results when using them.

MA-1929B — The Care and use of Hand Tools—Pliers and Screwdrivers. Shown are uses, as well as misuses of pliers and screwdrivers.

MA-1929C — The Care and use of Hand Tools—Chisels. Explains characteristics of the various types and sizes of cold chisels. Demonstrates correct use of each type of chisel and cautions against dullness of points, cutting too deep, and improper care and use.

MA-1929D — The Care and use of Hand Tools—Hammers. Demonstrates various uses of the claw, ballpeen, crosspeen, and sledge hammers (which are classified as hard) and plastic wooden mallet, lead, brass, and rawhide type (which are classified as soft).

MA-1929E — The Care and use of Hand Tools—Punches, Drifts, and Bars. Describes and explains the use of: (1) Bars (crow, wrecking, pinch or pry); (2) Punches and drifts, (prick punch, center punch, tapered punch or drift pin, solid or starting punch, pin punch).

MA-1929F — The Care and use of Hand Tools—Hacksaws. Explains construction and function of hacksaws.

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PART I

Section 2

COMMON POWER TOOLS

MN-142 — Drilling in Metal, Wood, and Plastics. Points out six basic steps in drilling, and demonstrates how to lay out wood and plastics with drill press, electric drill, and hand drill.

MA-2087A — Hand Measuring and Power Tools—Operation and Care of Portable and Bench Grinders. Describes uses and shows operation of a bench grinder and a portable grinder. Precautions to be observed and stressed.

MA-2087B — Hand Measuring and Power Tools—The Portable Electric Drill. Demonstrates how to assemble and how to use 3/4" portable electric drill, and stresses importance of its care. Both straight photography and animation are used.

PART II

Section 1

MEASURING

ME-239A — Precision Measuring—The Steel Rule. Steel rule and its common divisions (1/64, 1/32, 1/16, 1/8 inch) is shown in its 6-inch type and in such special forms as hook rule, flexible rule, depth gauge, and combination square.

ME-239B — Precision Measuring—The Micrometer. Identifies parts of the outside micrometer caliper (frame, anvil, barrel with graduated scale, internal barrel screw, spindle), and explains its operation. Examples of various measurements are given, and importance of getting the "feel" of the micrometer is stressed.

ME-239D — Precision Measuring—Vernier Scale. Principle of the vernier is explained in detail, and use of the vernier on the micrometer caliper is demonstrated. Explained is the vernier caliper in sizes from 6 to 24 inches. Treatment of fine tools as a matter of professional pride is brought out.

PART II

Section 2

COMMON POWER TOOLS

MN-142 — Drilling in Metal, Wood, and Plastics. Points out six basic steps in drilling, and demonstrates how to lay out wood and plastics with drill press, electric drill, and hand drill.

MA-2087A — Hand Measuring and Power Tools—Operation and Care of Portable and Bench Grinders. Describes uses and shows operation of a bench grinder and a portable grinder. Precautions to be observed and stressed.

MA-2087B — Hand Measuring and Power Tools—The Portable Electric Drill. Demonstrates how to assemble and how to use 3/4" portable electric drill, and stresses importance of its care. Both straight photography and animation are used.

PART II

Section 6

METAL CUTTING OPERATIONS

ME1051A — Cutting Threads with Taps and Dies. Demonstrates hand cutting of internal threads with a tap, and hand cutting of external threads of a stud with a die. Discusses choice of drill, drilling hole, use of the three taps (taper, plug, and bottoming), removing a broken tap.

ME1051D — Reaming with Straight Hand Reamers. Demonstrates correct techniques for using straight fluted, spiral fluted, adjustable hand reamers for work on a two bearing shaft (cast iron) and timing gear (steel) with keyway. Explains chattering and its elimination. Shows difference between machine reamer and hand reamer. Shows how to measure reamer with a micrometer.

ME1051E — Reaming with Taper Hand Reamers. Demonstrates recommended techniques for reaming taper holes necessary when a taper pin is used to fasten a collar to a shaft, and other work of a similar nature. Explains how taper is determined and shows straight fluted and spiral fluted reamers.

ME1051H — Fundamentals of Filing. Describes importance of files and filing in work of the machinist. Stresses physical movements of the files and machinist's body in filing techniques. Shows various types of files (fine, bastard cut, medium, rough, single cut, and double cut). Demonstrates use of file card to remove chips from teeth of the file.

MA1929C — Chisels. Explains characteristics of the various types and sizes of cold chisels. Demonstrates correct use of each type of chisel and cautions against dullness of points, cutting too deep, and improper care and use.

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MA1929F	Hacksaws. Explains construction and function of hacksaws. Discusses many types, sizes, and uses of frames and blades and demonstrates correct procedure for sawing metal with the hacksaw. Set of the teeth in various blades is illustrated.
ME7296A	Cutting and Threading Pipe by Hand. How to use pipe cutter and pipe reamer, select and insert proper type in stock, thread pipe by hand, test threads for fit, prepare fitted pipe for delivery, and the care of hand tools. SB7296B is an accompanying film strip for this film.

APPENDIX II

TABLES OF USEFUL INFORMATION

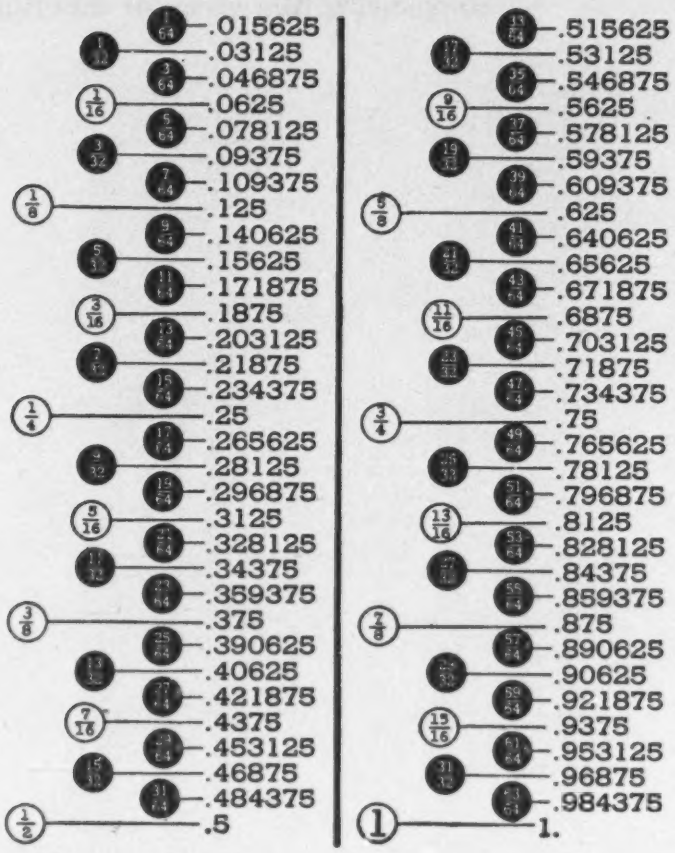

Table II-1.—Fractions and Decimal Equivalents.

Millimeters	Inches	Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
1	0.039370	26	1.023622	51	2.007874	76	2.992126
2	0.078740	27	1.062992	52	2.047244	77	3.031496
3	0.118110	28	1.102362	53	2.086614	78	3.070866
4	0.157480	29	1.141732	54	2.125984	79	3.110236
5	0.196850	30	1.181102	55	2.165354	80	3.149606
6	0.236220	31	1.220472	56	2.204724	81	3.188976
7	0.275591	32	1.259843	57	2.244094	82	3.228346
8	0.314961	33	1.299213	58	2.283465	83	3.267717
9	0.354331	34	1.338583	59	2.322835	84	3.307087
10	0.393701	35	1.377953	60	2.362205	85	3.346457
11	0.433071	36	1.417323	61	2.401575	86	3.385827
12	0.472441	37	1.456693	62	2.440945	87	3.425197
13	0.511811	38	1.496063	63	2.480315	88	3.464567
14	0.551181	39	1.535433	64	2.519685	89	3.503937
15	0.590551	40	1.574803	65	2.559055	90	3.543307
16	0.629921	41	1.614173	66	2.598425	91	3.582677
17	0.669291	42	1.653543	67	2.637795	92	3.622047
18	0.708661	43	1.692913	68	2.677165	93	3.661417
19	0.748031	44	1.732283	69	2.716535	94	3.700787
20	0.787402	45	1.771654	70	2.755906	95	3.740157
21	0.826772	46	1.811024	71	2.795276	96	3.779528
22	0.866142	47	1.850394	72	2.834646	97	3.818898
23	0.905512	48	1.889764	73	2.874016	98	3.858268
24	0.944882	49	1.929134	74	2.913386	99	3.897638
25	0.984252	50	1.968504	75	2.952756	100	3.937008

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Table II-2.—Conversion Chart—Millimeters to Inches.

Feet	Meters	Feet	Meters	Feet	Meters
1	0.3048	35	10.6680	68	20.7264
2	0.6096	36	10.9728	69	21.0312
3	0.9144	37	11.2776	70	21.3360
4	1.2192	38	11.5824	71	21.6408
5	1.5240	39	11.8872	72	21.9456
6	1.8288	40	12.1920	73	22.2504
7	2.1336	41	12.4968	74	22.5552
8	2.4384	42	12.8016	75	22.8600
9	2.7432	43	13.1064	76	23.1648
10	3.0480	44	13.4112	77	23.4696
11	3.3528	45	13.7160	78	23.7744
12	3.6576	46	14.0208	79	24.0792
13	3.9624	47	14.3256	80	24.3840
14	4.2672	48	14.6304	81	24.6888
15	4.5720	49	14.9352	82	24.9936
16	4.8768	50	15.2400	83	25.2984
17	5.1816	51	15.5448	84	25.6032
18	5.4864	52	15.8496	85	25.9080
19	5.7912	53	16.1544	86	26.2128
20	6.0960	54	16.4592	87	26.5176
21	6.4008	55	16.7640	88	26.8224
22	6.7056	56	17.0688	89	27.1272
23	7.0104	57	17.3736	90	27.4320
24	7.3152	58	17.6784	91	27.7368
25	7.6200	59	17.9832	92	28.0416
26	7.9248	60	18.2880	93	28.3464
27	8.2296	61	18.5928	94	28.6512
28	8.5344	62	18.8976	95	28.9560
29	8.8392	63	19.2024	96	29.2608
30	9.1440	64	19.5072	97	29.5656
31	9.4488	65	19.8120	98	29.8704
32	9.7536	66	20.1168	99	30.1752
33	10.0584	67	20.4216	100	30.4800
34	10.3632				

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Table II-3.—Conversion Chart—Feet to Meters.

Gage No.	Birmingham wire gage (B.W.G.) or Stubs iron wire gage, for iron wires, hot and cold rolled sheet steel	American wire gage, or Brown & Sharpe (for non-ferrous sheet and wire)	U.S. Standard gage for sheet and plate iron and steel	Steel wire gage, or the W & M (Washburn & Moen) for steel wire	Music wire gage for steel music wire
6/0	.....	0.5800	0.4687	0.4615	0.004
5/0	0.500	.5165	.4375	.4305	.005
4/0	.454	.4600	.4062	.3938	.006
3/0	.425	.4096	.3750	.3625	.007
2/0	.380	.3648	.3437	.3310	.008
1/0	.340	.3249	.3125	.3065	.009
1	.300	.2893	.2812	.2830	.010
2	.284	.2576	.2656	.2625	.011
3	.259	.2294	.2500	.2437	.012
4	.238	.2043	.2343	.2253	.013
5	.220	.1819	.2187	.2070	.014
6	.203	.1620	.2031	.1920	.016
7	.180	.1443	.1876	.1770	.018
8	.165	.1285	.1718	.1620	.020
9	.148	.1144	.1562	.1483	.022
10	.134	.1019	.1406	.1350	.024
11	.120	.0907	.1250	.1205	.026
12	.109	.0808	.1093	.1055	.029
13	.095	.0719	.0937	.0915	.031
14	.083	.0640	.0781	.0800	.033
15	.072	.0570	.0703	.0720	.035
16	.065	.0508	.0625	.0625	.037
17	.058	.0452	.0562	.0540	.039
18	.049	.0403	.0500	.0475	.041
19	.042	.0359	.0437	.0410	.043
20	.035	.0319	.0375	.0348	.045
21	.032	.0284	.0343	.0317	.047
22	.028	.0253	.0312	.0286	.049
23	.025	.0225	.0281	.0258	.051
24	.022	.0201	.0250	.0230	.055
25	.020	.0179	.0218	.0204	.059
26	.018	.0159	.0187	.0181	.063
27	.016	.0142	.0171	.0173	.067
28	.014	.0126	.0156	.0162	.071
29	.013	.0112	.0140	.0150	.075
30	.012	.0100	.0125	.0140	.080
31	.010	.0089	.0109	.0132	.085
32	.009	.0079	.0101	.0128	.090
33	.008	.0071	.0093	.0118	.095
34	.007	.0063	.0085	.0104	.100
35	.005	.0056	.0078	.0095	.106
36	.004	.0050	.0070	.0090	.112

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Table II-4.—Wire and Sheet Metal Gages.

Size	Decimal equivalents	Size	Decimal equivalents	Size	Decimal equivalents
½	0.5000	C	0.2420	30	0.1285
31/64	.4844	B	.2380	⅛	.1250
15/32	.4687	15/64	.2344	31	.1200
29/64	.4531	A	.2340	32	.1160
7/16	.4375	No. 1	.2280	33	.1130
27/64	.4219	2	.2210	34	.1110
Z	.4130	7/32	.2187	35	.1100
13/32	.4062	3	.2130	7/64	.1094
Y	.4040	4	.2090	36	.1065
X	.3970	5	.2055	37	.1040
25/64	.3906	6	.2040	38	.1015
W	.3860	13/64	.2031	39	.0995
V	.3770	7	.2010	40	.0980
⅜	.3750	8	.1990	41	.0960
U	.3680	9	.1960	3/32	.0937
23/64	.3594	10	.1935	42	.0935
T	.3580	11	.1910	43	.0890
S	.3480	12	.1890	44	.0860
11/32	.3437	3/16	.1875	45	.0820
R	.3390	13	.1850	46	.0810
Q	.3320	14	.1820	47	.0785
21/64	.3281	15	.1800	5/64	.0781
P	.3230	16	.1770	48	.0760
O	.3160	17	.1730	49	.0730
5/16	.3125	11/64	.1719	50	.0700
N	.3020	18	.1695	51	.0670
19/64	.2969	19	.1660	52	.0635
M	.2950	20	.1610	1/16	.0625
L	.2900	21	.1590	53	.0595
9/32	.2812	22	.1570	54	.0550
K	.2810	5/32	.1562	55	.0520
J	.2770	23	.1540	3/64	.0469
I	.2720	24	.1520	56	.0465
H	.2660	25	.1495	57	.0430
17/64	.2656	26	.1470	58	.0420
G	.2610	27	.1440	59	.0410
F	.2570	9/64	.1406	60	.0400
E ¼	.2500	28	.1405		
D	.2460	29	.1360		

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Table II-5.—Twist Drill Sizes.

(Thread and Tap Drill Sizes)

Nominal size	Thr'd series	Major diameter, inches	Root diameter, inches	Tap drill to produce approx. 75% full thread	Decimal equivalent of tap drill
0–80	N. F.	.0600	.0438	3/64	.0469
1–64	N. C.	.0730	.0527	53	.0595
72	N. F.	.0730	.0550	53	.0595
2–56	N. C.	.0860	.0628	50	.0700
64	N. F.	.0860	.0657	50	.0700
3–48	N. C.	.0990	.0719	47	.0785
56	N. F.	.0990	.0758	45	.0820
4–40	N. C.	.1120	.0795	43	.0890
48	N. F.	.1120	.0849	42	.0935
5–40	N. C.	.1250	.0925	38	.1015
44	N. F.	.1250	.0955	37	.1040
6–32	N. C.	.1380	.0974	36	.1065
40	N. F.	.1380	.1055	33	.1130
8–32	N. C.	.1640	.1234	29	.1360
36	N. F.	.1640	.1279	29	.1360
10–24	N. C.	.1900	.1359	25	.1495
32	N. F.	.1900	.1494	21	.1590
12–24	N. C.	.2160	.1619	16	.1770
28	N. F.	.2160	.1696	14	.1820
¼–20	N. C.	.2500	.1850	7	.2010
28	N. F.	.2500	.2036	3	.2130
5/16–18	N. C.	.3125	.2403	F	.2570
24	N. F.	.3125	.2584	I	.2720
⅜–16	N. C.	.3750	.2938	5/16	.3125
24	N. F.	.3750	.3209	Q	.3320
7/16–14	N. C.	.4375	.3447	U	.3680
20	N. F.	.4375	.3726	25/64	.3906
½–13	N. C.	.5000	.4001	27/64	.4219
20	N. F.	.5000	.4351	29/64	.4531
9/16–12	N. C.	.5625	.4542	31/64	.4844
18	N. F.	.5625	.4903	33/64	.5156
⅝–11	N. C.	.6250	.5069	17/32	.5312
18	N. F.	.6250	.5528	37/64	.5781
¾–10	N. C.	.7500	.6201	21/32	.6562
16	N. F.	.7500	.6688	11/16	.6875
⅞– 9	N. C.	.8750	.7307	49/64	.7656
14	N. F.	.8750	.7822	13/16	.8125
1– 8	N. C.	1.0000	8376	⅞	.8750
14	N. F.	1.0000	9072	15/16	.9375

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Table II-6.—American National Form Threads.

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Nominal Size Inches	No. of Threads per Inch	Pitch Diameter		Length		Pipe O. D. D Inches	Depth of Thread Inches	Tap Drills for Pipe Threads	
		A Inches	B Inches	L2 Inches	L1 Inches			Minor Diameter Small End of Pipe	Size Drill
1/8	27	.36351	.37476	.2638	.180	.405	.02963	.33388	R
1/4	18	.47739	.48989	.4018	.200	.540	.04444	.43294	7/16
3/8	18	.61201	.62701	.4078	.240	.675	.04444	.56757	31/64
1/2	14	.75843	.77843	.5337	.320	.840	.05714	.70129	23/32
3/4	14	.96768	.98887	.5457	.339	1.050	.05714	.91054	59/64
1	11 1/2	1.21363	1.23863	.6828	.400	1.315	.06957	1.14407	1 5/32
1 1/4	11 1/2	1.55713	1.58338	.7068	.420	1.660	.06957	1.48757	1 1/2
1 1/2	11 1/2	1.79609	1.82234	.7235	.420	1.900	.06957	1.72652	1 47/64
2	11 1/2	2.26902	2.29627	.7565	.436	2.375	.06957	2.19946	2 1/32
2 1/2	8	2.71953	2.76216	1.1375	.682	2.875	.10000	2.61953	2 5/8
3	8	3.34062	3.38850	1.2000	.766	3.500	.10000	3.24063	3 1/4
3 1/2	8	3.83750	3.88881	1.2500	.821	4.000	.10000	3.73750	3 3/4
4	8	4.33438	4.38712	1.3000	.844	4.500	.10000	4.23438	4 1/4

44.206

Table II-7.—American National Pipe Thread Dimensions and Tap Drill Sizes.

DRILL SPEEDS IN R. P. M.

Diameter of Drill	Soft Metals 300 F.P.M.	Plastics and Hard Rubber 200 F.P.M.	Annealed Cast Iron 140 F.P.M.	Mild Steel 100 F.P.M.	Malleable Iron 90 F.P.M.	Hard Cast Iron 80 F.P.M.	Tool or Hard Steel 60 F.P.M.	Alloy Steel Cast Steel 40 F.P.M.
1/16 (No. 53 to 80)	18320	12217	8554	6111	5500	4889	3667	2445
3/32 (No. 42 to 52)	12212	8142	5702	4071	3666	3258	2442	1649
1/8 (No. 31 to 41)	9160	6112	4278	3056	2750	2445	1833	1222
5/32 (No. 23 to 30)	7328	4888	3420	2444	2198	1954	1465	977
3/16 (No. 13 to 22)	6106	4075	2852	2037	1833	1630	1222	815
7/32 (No. 1 to 12)	5234	3490	2444	1745	1575	1396	1047	698
1/4 (A to E)	4575	3055	2139	1527	1375	1222	917	611
9/32 (G to K)	4071	2712	1900	1356	1222	1084	814	542
5/16 (L, M, N)	3660	2445	1711	1222	1100	978	733	489
11/32 (O to R)	3330	2220	1554	1110	1000	888	666	444
3/8 (S, T, U)	3050	2037	1426	1018	917	815	611	407
13/32 (V to Z)	2818	1878	1316	939	846	752	563	376
7/16	2614	1746	1222	873	786	698	524	349
15/32	2442	1628	1140	814	732	652	488	326
1/2	2287	1528	1070	764	688	611	458	306
9/16	2035	1357	950	678	611	543	407	271
5/8	1830	1222	856	611	550	489	367	244
11/16	1665	1110	777	555	500	444	333	222
3/4	1525	1018	713	509	458	407	306	204

Figures are for High-Speed Drills. The speed of Carbon Drills should be reduced one-half. Use drill speed nearest to figure given.

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Table II-8.—Drill Speeds in r.p.m.

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APPENDIX III

ELECTRICAL SAFETY PRECAUTIONS

(Articles 60-21 through 60-45 of BuShips Technical Manual)

SECTION II. ELECTRICAL SAFETY PRECAUTIONS

60-21. NEED FOR SAFETY PRECAUTIONS

(1) Safety precautions must always be observed by persons working around electric circuits and equipment to avoid injury from:

(a) Electric shock.

(b) Short circuits caused by accidentally placing or dropping a metal tool, ruler, flashlight case, or other conducting article across an energized line. The arc and fire which can be so started on even relatively low voltage circuits may cause extensive damage to equipment and serious injury to personnel.

(2) That the danger of shock from the 450-volt a.c. ship's service system is reasonably well recognized by operating personnel is shown by the relatively few reports of serious shock received from this voltage despite its widespread use. On the other hand, a number of shipboard fatalities have been reported due to contact with 115-volt circuits. Despite a fairly widespread but totally unfounded popular belief to the contrary, low voltage (115 volts and below) circuits are very dangerous and can cause death where the resistance of the body is lowered by moisture and especially when current passes through the chest. Shipboard conditions are particularly conductive to severity of shock because the body is likely to be in contact with the ship's metal structure and the body resistance may be low because of perspiration or damp clothing. Extra care is therefore needed.

60-22. SAFETY

Electrical safety is an all-hands job. For this reason, it is essential that all personnel understand the lethal nature of the hazard and be made familiar with the electrical safety precautions and safe practices. Articles 60-21 through 60-40 should be required study material for all hands.

After an accident has happened, investigation almost invariably shows that it could have been prevented by the exercise of simple safety precautions which are then posted for future guidance, but which never undo the consequences of the accident that has gone before. Always observe safety precautions and keep accidents from happening. Always remember that:

(1) Electricity strikes without warning.

(2) Hurrying reduces caution and invites accidents.

(3) Taking time to be careful saves time in the end.

(4) Taking chances is an invitation to trouble.

(5) If you do not know the safe way, it pays to find out before exposing yourself to danger.

(6) Every electrical circuit, with but insignificant exceptions which definitely do not include circuits even as low as 35 volts and possibly even lower, is a potential source of danger and MUST BE TREATED AS SUCH.

(7) Except in cases of emergency, never work on an energized circuit. It must be considered that the circuit is energized until a personal check has been made to see that the switch is opened and tagged (See art. 60-36), and the circuit has been tested with a voltmeter, or voltage tester. (See art. 60-30).

(8) Energized switchboards are a great source of danger. No work shall be undertaken on switchboards (energized or deenergized) without first obtaining the approval of the Electrical or Engineer Officer. The Commanding Officer's approval shall be obtained prior to the commencement of work on an energized switchboard.

(9) Records show that seven out of ten victims of electric shock were revived when artificial respiration was started in less than 3 minutes after the shock. After 3 minutes the chances of revival decrease rapidly.

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All shipboard personnel should be made aware of the fact that a victim rendered unconscious by electric shock should receive artificial respiration and that it should be started in a matter of seconds rather than minutes. To this end the person nearest the victim should start the resuscitation without delay and call or send others for assistance and medical aid. The only logical permissible delay is that required to free the man from his contact with the electricity in the quickest, safest way. This step, while it must be taken quickly, must be done with great care, otherwise there may be two victims instead of one. This should be done in the case of a portable electric tool, light, appliance, equipment, or portable outlet extension by turning off the bulkhead supply switch or by removing the plug from its bulkhead receptacle. If the switch or bulkhead receptacle cannot be quickly located, the suspected electric device may be pulled free of the victim by grasping the insulated flexible cable to the device and carefully withdrawing it clear of its contact with the victim. Other persons arriving on the scene must be clearly warned not to touch the suspected equipment until it is unplugged. Aid should be enlisted to unplug the device as soon as possible. Where the victim is in contact with stationary equipment such as a bus bar or the contacts on a machine, he should be pulled free if the equipment cannot be quickly deenergized, or if considerations of military operation or ship survival prevent immediate shutdown of the circuits. The man can be quickly and safely cleared from his contact with the electricity by carefully applying the following procedures:

In pulling him free, the principles reflected by the safety instructions of article 60-37 must be kept in mind. To save time, however, the equivalent of the protective insulation for the rescuer must be improvised. For example, instead of taking time to hunt for a pair of rubber gloves for use in grasping the victim, the victim can be safely pulled free if conditions are dry by grasping him by slack in his clothing or by the leather of his shoes. Instead of hunting for a rubber mat on which to stand, such nonconducting materials as deck linoleum, a pillow, blanket, mattress, dry wood, or coil of rope will suffice. In no case during the rescue should any part of the rescuer's person directly touch hull metal or metal structure or furniture.

(10) Additional information on safety is to be found in "Electric Shock—Its Causes and Its Prevention," NavShips 250-660-42.

60-23. GROUNDED CIRCUITS A HAZARD

Keep electrical circuits which are not intentionally grounded clear of accidental grounds. When a man makes contact with the ungrounded side of a grounded circuit, a current can flow from the ungrounded side through the man to ground and back to the grounded side of the circuit. If neither side of the circuit is grounded, a man who makes accidental contact with a bare conductor on one side of a circuit will be in series with the insulation resistance on the other side of the circuit and the danger of receiving a severe shock will be less when the insulation resistance is high than when it is lowered by the presence of accidental grounds. The insulation on the other side of the circuit should not, however, be relied upon as a protection against shock, and great care should always be exercised to avoid contact with bare conductors. When circumstances make it necessary to work on live conductors or equipment, be sure to observe the precautions of article 60-37.

60-24. GROUNDING OF METAL PARTS AS A SAFETY MEASURE

Metal enclosing cases, bases, frames, and structural parts of electrical equipment which are not intended or expected to operate at potentials above ground potential should be grounded. Normally on steel-hull vessels such grounds are inherently provided because the metal enclosing cases or frames are in contact with one another and the metal structure of the vessel. Where such inherent grounding is not provided by the mounting arrangements, for instance, equipment supported on shock mounts which insulate it from the hull, and on wooden hull vessels, ground connections should be provided to ground the frame, enclosure, or support of all permanently installed electrical equipment and of all semiportable equipment which is normally used at a fixed location in the vessel. For the grounding of portable equipment, see articles 60-25 to 60-27 and 60-29. If enclosing cases and similar parts are not grounded, a breakdown of insulation may raise them to line voltage and create a hazard which is the more serious because it is unexpected. Such breakdowns from a circuit or machine to an ungrounded metal object will not be shown by ground tests or measurements of insulation resistance. They will be if the metal object is grounded.

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60-25. GROUNDED TYPE PLUGS AND RECEPTACLES FOR PORTABLE TOOLS AND EQUIPMENT

Navy specifications for portable tools require the electric cord for the tool to be provided with a distinctively marked grounding conductor in addition to the conductors for supplying power to the tool. Except for a few cases in which black was used in the cords for some items of portable equipment, past practice was to use red for the grounding conductor in three-conductor cables for portable tools and equipment, and green in four-conductor cables. Revised specifications require that green be used for the grounding conductor in cables for all new portable tools and equipment. The end of the grounding conductor which is within the tool should be connected to the metal housing; the other end should be grounded, that is, connected to the ship's metal structure. In order to provide a convenient means of connecting the grounding conductor to ground, the Bureau has standardized on the use of grounded type plugs and receptacles which automatically make this connection when the plug is inserted in the receptacle. The installation of grounded type receptacles has been authorized for all power outlets in surface vessels and for submarines. Where the grounded type receptacles have been installed, they should be used in conjunction with grounded type plugs (art. 60-27) to ground portable tools and equipment.

60-26. INSTALLATION AND TESTING OF GROUNDED RECEPTACLES

(1) General. If grounded receptacles have not yet been installed, the proper receptacles should be selected from the Navy Stock List of Shipboard Electrical Items and requisitioned through the cognizant symbol A supply system. See article 62-17 for information on the proper type of receptacle to obtain and the locations where receptacles should be installed.

(2) Making connection to ground. The types of grounded receptacles listed in article 62-17 have metal cases which are connected internally to the ground terminal of the receptacle. Grounding the case of the receptacle will ground the grounded terminal. There are still in use, however, some grounded receptacles with plastic cases. All such grounded receptacles should be inspected to make sure that the conductor used to connect the grounded terminal to ground has a cross section greater than the cross section of the line conductors which carry power to the receptacle. When this inspection is made, the receptacle should also be tested in accordance with article 60-26(5). An entry should be made in a record book kept for grounded receptacles giving the date when the inspection and test were made.

(3) Precautions to ensure alinement. It is dangerous to insert a grounded plug in a grounded receptacle in any way but the right way. For this reason, grounded plugs and receptacles are so designed that the plug must be rotated to the correct position before it can be inserted into the receptacle. The inside of the first types of grounded receptacles installed on board ship contained a phenolic polarity pin located to match with a groove in the plug and prevent the insertion of the plug in any but the correct position. In time, however, these phenolic polarity pins may become damaged or loosened to such an extent that they no longer perform their function. When the plug is badly worn or the polarity pin is loose or missing, an inexperienced operator can force a grounded plug into a grounded receptacle in the wrong position. The ground contact on the plug will then touch a live contact in the receptacle. The result is that the metal casing of the tool or equipment becomes a live conductor and sets up the possibility of a serious electric shock when the operator touches the equipment. In 1950 an improved alinement feature was designed for grounded plugs and receptacles to overcome this weakness. A guide to match the cross section of the plug, molded of insulating material, was placed in the receptacle opening in the cover of the receptacle. A sturdy metal polarity tab shaped to match the groove in the plug was brazed inside the metal cover to reinforce the molded guide in the receptacle opening. This improved cover design ensures that the plug is properly alined before it reaches the interior fittings of the receptacle, saving the wear and tear on the polarity pin that was previously encountered. All Navy stocks of plugs, receptacles, and receptacle covers were modified to incorporate the improved features. In 1950, authorizations were issued to ships to modernize shipboard plugs and equipment with the new parts. To make the improved grounded plugs and receptacles fully effective as a safety measure, the following precautions must be observed:

(a) The plug must be correctly connected to the tool or equipment.

(b) The receptacle cover must be placed so that the pointed metal polarity tab brazed

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to the cover is superimposed over the phenolic polarity pin within the receptacle.

(c) The phenolic plug-guide insert in the aperture of the receptacle must be firmly in place. If a plug-guide is missing from the aperture of a receptacle, the plug of a portable electric tool or equipment can be incorrectly inserted. If inadvertently inserted when rotated 90° from its normal alinement with the contacts inside the receptacle, the grounding contact on the plug tip can touch a live contact in the receptacle. Since the grounding conductor in the tool cord provides a direct connection between the metal housing of the tool and the grounding contact on the plug, line voltage would be placed on the shell of the tool or equipment, thereby exposing the operator to possible electric shock. Receptacles should be inspected to make sure that the plug-guide inserts are neither missing nor loose to the extent that they can be pulled out manually. Where the inserts are missing, the entire cover should be replaced. Loose inserts in receptacle covers in use or drawn from stock should be corrected by cementing.

(4) Interim safety measures. If the grounded plugs and receptacles on a ship have not yet been modernized with the positive plug positioning features described above, the following interim precautions should be observed:

(a) Personnel should be instructed that before they insert a plug in a receptacle, they must make sure that the plug is rotated to such a position that its groove is alined with the polarity pin inside the receptacle. To facilitate carrying out this instruction, suitable markings may be painted on the plug tip and receptacle cover to show when the plug is properly alined.

(b) Inspections should be carried out to make sure that polarity pins in receptacles are not missing, bent, or worn, and that plugs are in good condition.

(c) The preceding precautions apply to any electrically operated equipment with metal case, such as a coffee percolator, which is plugged into a receptacle.

(5) Test at installation. A test to determine whether the connections are correct should be made whenever a grounded receptacle is installed, repaired, or modified in any way. This test should be made as follows:

a. Receptacles-Navy Type - Drawings 9-S-4223-L (Modified), 9000-S6202-73310, 9000-S6202-73312, 9000-S6202-74026, and 9000-S6202-74068.

(1) Deenergize circuit, test to make sure that the receptacle is deenergized, and adopt all necessary precautions to make sure that it will stay deenergized until all tests at the receptacle, including (5) and (6) below, have been completed.

(2) Remove box cover and examine for the following:

(a) Correct type (see drawing numbers) having ground contact and diamond shaped polarity pin opposite. Replace if not of the proper type; see article 62-17 (1) through (10) for guide in recognizing obsolete types.

(b) Correct wiring.

(c) Secure terminal screws.

(d) Clean ground contact.

(3) Using a volt-ohmmeter, test the resistance from ships hull to face of ground contact (must be less than one ohm).

(4) Replace cover in proper relation to polarity and index pin.

(5) Insert type D-2-G Navy plug attached to an equipment or an adaptor, drawing 815-1197085. If an adapter is used, insert a commercial plug attached to an equipment into adaptor receptacle.

(6) Using a volt-ohmmeter, test resistance from housing of equipment to ships hull (must be less than one ohm).

b. Receptacles — Bladed —single outlet (used in lighting fixtures) and double outlet, drawings 9000-S6202-73274 and 9000-S6202-74263 and single, watertight outlet 9000-S6202-74456.

(1) Deenergize circuit, test to make sure that the receptacle is deenergized, and adopt all necessary precautions to make sure that it will stay deenergized until all tests at the receptacle, including (5) and (6) below, have been completed.

(2) Remove box cover and examine for the following:

(a) Correct type having two parallel slots and one U-shaped ground hole. Receptacle unit (drawing 9000-S6202-73274) having a blade type ground contact shall be replaced with duplex receptacles unit (FSN G-5935-283-4003). Single receptacle unit is installed in lighting fixtures shall have two parallel slots and one U-shaped ground hole. Replacements should be purchased from local suppliers.

(b) Correct wiring.

(c) Secure terminal screws.

(d) Clean ground contacts

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(e) Corrosion protection caps authorized for use in crew's heads and showers.

(3) Using a volt-ohmmeter, test the resistance from ships hull to the face of the ground contact (must be less than one ohm).

(4) Replace cover..

(5) Insert commercial grounded plug attached to equipment.

(6) Using a volt-ohmmeter, test resistance from housing of equipment to ships hull (must be less than one ohm).

(6) Test of grounded receptacles. To ascertain whether vibration, corrosion, or some other cause has made a grounded receptacle unsafe, each grounded receptacle on a ship should be inspected and tested in accordance with article 60-26 (5). These tests should be performed as follows:

a. Receptacles

(1) Detailed procedures. It is recommended that the detailed procedures as outlined in article 60-26 (5) regarding receptacles be performed once on each ship, and thereafter be repeated only following an overhaul or other period during which derangement of these receptacles could have occurred.

(2) Abbreviated procedure:

(a) It is recommended that the following procedure be employed in making a routine ground continuity of each installed receptacle at least once a month.

1. Plug in any small 115 volt portable electric tool into the receptacle to be tested.

2. Secure one ohmmeter lead to the metal of the tool housing and the other lead to the ships hull.

3. The ohmmeter reading must be less than one ohm to indicate a satisfactory grounding circuit from the equipment housing through the plug and receptacle to the ships hull.

(b) Unsatisfactory receptacles should be immediately repaired or be tagged to indicate that they must not be used.

(c) A record book should be kept on each ship giving the location of all grounded receptacles and the dates when they have been tested.

60-27. PLUGS AND CORDS

(1) Cords for use with grounded plugs. Some of the portable tools now in use on Naval vessels may not yet be provided with the grounded type plug. In addition, there is a wide range of miscellaneous portable electric equipment that may be issued without being provided with a cord that has a grounding conductor and a grounded plug. This equipment includes galley equipment (fruit juice extractors, food-mixing machines, coffee pots, toasters); office equipment (adding machines, addressograph machines); shop equipment (key duplicating machines, valve grinders, mica undercutters, hot plates); medical equipment (infrared lamps, ultra-violet lamps, sterilizers); barber shop equipment (hair clippers); laundry equipment (flatirons); and others. Except as indicated in article 60-27 (2) and (3):

(a) All 115-volt or 230-volt single phase a.c. and all 115-volt or 230-volt two-wire d.c. electrically operated equipment now on board ship which does not have a cord with a grounding conductor and grounded plug, and all such equipment subsequently issued to the ship without a cord which has a grounding conductor and grounded plug, should be provided with a three-conductor flexible cable with standard grounded plug. The three-conductor flexible cable should be type SO or ST color coded black, white and green, as listed in the Navy Stock List of General Stores, Group 61. For general use, the plug should be the bladed type with "U"-shaped grounding prong. These are stocked for small and large diameter cords under numbers G5935-280-2380 and GS935-280-2381. Stub-type plugs which can be made watertight when in use, formerly designated as type D-2-G, drawing 9-S-440-L, are now furnished with plastic shell. They are identified by Bureau of Ships drawing 815-1197805, and the symbol numbers 701.1 or 720 for small and large diameter cords respectively.

(b) All 115-volt 3-phase electrically operated portable equipment now on board ship or subsequently issued, which does not have a cord with a grounding conductor and grounded plug, should be provided with a type FHOF four-conductor flexible cable color coded black, white, red, and green, with standard Navy grounded plug, type EEE-125, shown on Bureau of Ships plan 9-S-4861-L.

(c) The length of the cord for portable tools should be 25 feet. The length of the cord for such equipment as heaters should be as required. Extension cords (shown on Bureau of Ships plan 9000-S6202-73448) for use with portable tools and equipment are authorized for inclusion in the ship's allowance. These extension cords consist of 25 feet of three-conductor flexible

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cable (which includes the grounding wire) with a grounded plug attached to one end and a grounded type portable receptacle suitable for receiving the grounded type tool or equipment plug on the other end.

(2) No change to be made just for the sake of color coding. No change should be made in equipment now on board ship or subsequently issued which has a cord with a grounding conductor color coded in conformity with past practice. Such equipment should be used in accordance with past practice until cord replacement becomes necessary. Replacement cable should be type SO or SI for three-conductor cords, and type FHOF for four-conductor cords. The green conductors should be used for the grounding conductor. The plugs for three-conductor and four-conductor flexible cable are provided with a gland nut and packing which grips the cord securely and should prevent the cord from being pulled out of the plug under most conditions of rough usage.

(3) Cords not to be replaced on equipment that is adequately grounded. The cords need not be replaced on apparatus that is positively and adequately grounded through its mounting, nor on portable lights and other equipment having no exposed metal parts that may become energized. A two-conductor flexible cable and a plug suitable for use with the grounded type receptacle should be provided for such equipment. In addition, a check should be made to make sure that the natural grounding of the equipment is not blocked off in any way. For example, it was found that in one type of 8 1/2-inch bracket fans used on submarines and smaller surface ships, the fan motor case is insulated from the fan base by a vibration mount. All fans of this type should be provided with a stranded ground connection from the motor case to the mounting bracket. Be sure to unplug all equipment grounded by direct contact with mountings or by a ground connection to mountings, before removing the equipment from mountings or disconnecting the ground connection; otherwise the ground is lost while the equipment and its case may still be a dangerous potential. Another method of ground consists of replacing the two-conductor cable from the base to the motor with a three-conductor cable. Two of the conductors are for carrying power to the motor; the third should be connected to the motor case at one end and to the mounting bracket at the other end. Electric shavers may be grounded where feasible and if desired by the owner.

(4) Connecting cords and plugs. In connecting the cord and plug, the grounding conductor of the cord should be connected to the ground contact of the plug at one end, and to the metal equipment casing at the other. Extreme care must be exercised to see that the ground connection is made correctly. If the grounding conductor which is connected to the metallic equipment casing is inadvertently connected to a line contact of the plug, a dangerous potential will be placed on the equipment casing. This might easily result in a fatal shock to the operator. To guard against this danger, the connections should be tested after they have been made as described in article 60-27 (5).

(5) Tests of plug connections. Before using portable electrical equipment for the first time, check the plug connections of the equipment for correct wiring. The following tests of portable equipment should be conducted in a workshop equipped with a nonconducting surface workbench and diamond tread rubber deck covering. Electricians making the tests should wear rubber gloves during tests.

(a) Plug—NAVY TYPE.—Drawing 9-S4440-L, Type D-2-G, or 815-1197085 symbols 701.1 and 720.

1. Examine and make sure that insulation and contacts are in good condition.

2. Examine and make sure that conductors are properly secured under terminal screws.

3. Examine to determine that the plug is clean and that all contacts are free of hangover fringes of moulding material that would prevent making good contact. Particular attention should be given to the ground contact.

4. Using a volt-ohmmeter, test resistance from ground contact to equipment housing (must be less than one ohm). Move or "work" cable with a bending or twisting motion. A change of resistance will indicate broken strands in the grounding conductor. If this is found, the cable must be replaced.

Check type D-2-G plug on equipment and extension cord. Using a megohmmeter, measure insulation resistance between brass shell and each contact on plug. Move or work cable with a push-pull, bending and twisting motion while taking reading. If resistance is less than one megohm, check for twisted bare wires in plug. Rewire defective plug and replace brass shell with nylon shell. If excessive wear and tear requires a plug to be replaced, accomplish by renewal of plug tip and replacing brass shell

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of plug with nonconducting plastic (nylon) plug shell. Do not re-use brass shells. Nylon plug shall is identified as drawing NR815-1,197,085, stock number H5935-678-8520 for cables up to 0.425-inch diameter, and H5935-732-1841 for 0.560-inch diameter cables. If nylon plug shell is not in stock, rewire and retest brass-shell type plug for temporary use until nylon plug shell is available.

(b) Plug—Bladed.—Round or U-shaped contact.

1. Examine to determine that insulation and contacts are in good condition.

2. Examine and make sure that conductors are properly secured under terminal screws.

3. Using a volt-ohmmeter, test the resistance from ground contact to equipment (must be less than one ohm). Move or "work" cable with a bending or twisting motion. A change of resistance will indicate broken strands in the grounding conductor. If this is found, the cable must be replaced.

(6) Workmanship in connecting cords to plugs, tools and extension receptacles. The cord conductors must be fastened securely and in a workmanlike manner to the terminals of the plug, tool, or extension receptacle. There must be no loose conducting strands which might make accidental contact with metal parts they should not touch. Sucy loose strands, if present, might place line potential on the metal shell of the plug when the plug is partially inserted in an energized receptacle. A fatal hand-to-hand electric shock can result if the receptacle is on the end of an energized extension cord and has its metal case raised to line potential (of opposite polarity to that on the shell of the plug) by loose conducting strands at the cord connection to the receptacle. The following precautions should be observed:

(a) The cord conductors must terminate in a standard crimp or solder type wiring terminal. Where the standard terminal is not practical, each conductor must be twisted tightly together and formed into an eyelet, (or a hook where the terminal screw is not removable, and dipped in or coated with solder to hold all strands tight.)

(b) Connections to all cords should be examined to make sure that they comply with paragraph (a), preceding. Nonconforming devices should be taken out of service until corrected.

(c) The connections to the cord on each portable tool, equipment, or extension receptacle repaired on board or delivered to the ship should be examined for compliance with the preceding requirements before the equipment is used. The tests on the individual devices prescribed in article 60-27(4)(a) do not reveal this defect when the devices are tested individually.

(7) Precautions in use of extension cords. Because a metal hull ship is a hazardous location, personnel who must use portable electric devices connected to extension cords should take the time to plug the device into the extension cord before the extension cord is inserted into a live bulkhead receptacle. Likewise, the extension cord should be unplugged from the bulkhead receptacle before the device is unplugged from the extension cord. Only approved extension cords of the type described in paragraph (1) (c) shall be used.

(8) Portable equipment and associated extension cords. Prior to issue of any portable electrical equipment, the attached cable with plug (including extension cords, when used) should be examined visually to assure satisfactory condition. (Tears, chafing, exposed insulated conductors, and damaged plugs are causes for cable or plug replacement.) Prior to issue of any portable electrical equipment, the item, with associated extension cords connected, should be plugged into a dummy (or deenergized) receptacle and tested for resistance from equipment housing to ship's structure, using a volt-ohmmeter (must be less than one ohm). Move or "work" cable with bending or twisting motion. A change in resistance will indicate broken strands in the grounding conductor. If this is found, the cable must be replaced. It is further suggested that, at the discretion of the Commanding Officer, a list be established of portable equipment requiring testing more or less often than once a month depending on conditions in his ship, and that the following items be considered for inclusion:

(a) Portable hand held electric tools that are permanently charged out, or are on loan to other shipboard departments or divisions should be tested once a week.

(b) Electrical equipment which is frequently touched, such as hot plates, coffee makers, toasters, portable (115 volt) vent sets, and movie projectors should be tested once a week.

(c) Electric equipment which is frequently touched such as bulkhead mounted (115

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volt) fans energized from receptacles, should be tested once a year.

(d) Electric equipment which gives a reading through the grounding circuit higher than 1 ohm should not be used until repaired. In addition the following tests shall be made:

NOTE: While testing portable equipment, frames are to be installed from ship's hull during test.

Insulation resistance. For this test a megohmmeter shall be used with one lead of the instrument connected to the metal can of the tool, and the other to one line terminal of the plug. Measure the resistance when the switch of the tool is ON and also when it is OFF. Repeat the tests with the instrument lead connected between the metal case of the tool and the other line terminal of the plug. In all cases, the measured resistance will be the normal insulation resistance (usually well in excess of one megohm) if the connections are correct.

(9) Reenforcement of flexible cable at junction with portable equipment. Reenforcement usually consists of a molded rubber sleeve. Examine to insure that sleeve is sound and free of cracks. Reenforcement consisting of coiled metal spring is dangerous since it can conceal broken cable insulation and exposed conductors. Replace spring coil with rubber or other suitable nonconducting sleeve.

(10) Extension cords, 25-foot, single outlet and 6-outlet (drawings 9000-S6202-73448 and 9000-S6202-74163). Check each extension in accordance with the procedures listed for plugs, receptacles and cables in articles 60-26(5)(a); 60-27(5)(a) (except 3) and 60-27(3).

60-28. PERSONAL EQUIPMENT - RADIOS, TELEVISION SETS, RECORD PLAYERS, WIRE OR TAPE RECORDERS, ELECTRIC SHAVERS, LIGHTS, FANS, TOOLS, AND HOBBY EQUIPMENT

(1) Personal radios, television sets, record players, and wire or tape recorders having metal cases or metal back or bottom are a safety hazard in many cases. In much of such equipment the chassis forms a part of the circuit and the exposed metal parts are energized, thereby creating the danger of shock to personnel touching them. Moreover, grounding these metal parts to the ship's structure would place a ground on the 115-volt lighting system contrary to the safety instructions. Consequently, the use of such equipment on board ship should not be permitted unless the equipment meets the requirements of article 60-28(5), and also unless it satisfies one of the following conditions:

(a) The equipment has a built-in power transformer which completely insulates the primary or line side of the transformer from the secondary or equipment side. The isolation of the primary and secondary sides of the transformer must never be inferred merely from the presence of the power transformer but must be checked by measuring the insulation resistance from each line terminal of the transformer to the chassis and exposed metal parts of the equipment. If the insulation resistance is of the order of several megohms, the equipment should be provided with a grounded plug and suitable cord, the grounding conductor of the cord being connected to the chassis and exposed metal parts of the equipment at one end and to the ground contact of the plug at the other end. This arrangement will ground the chassis and exposed metal parts of the equipment but will not ground the power supply.

(b) If the equipment does not have a power transformer which isolates the primary and secondary sides as described above, an isolation transformer must be installed (at the owner's expense) to perform this function. A grounded plug and suitable cord should be used with the grounding conductor of the cord connected to the chassis and the power conductors of the cord connected to the primary of the isolation transformer.

(2) Electric shavers. In general, the molded housing on an electric shaver is a nonconducting plastic material, and the cutting blades are isolated from any contact with the electrical components within the shaver. For this reason, 3-prong grounding plugs are not required on electric shavers. For safe use aboard ship, your electric shaver should have a completely insulating housing and isolated cutting blades, and the housing and cord must be free of cracks. If in doubt whether your electric shaver complies, have it checked by the electric shop. If your electric shaver falls in a wash bowl of water, let it go. Do not touch it without first unplugging the cord from its receptacle connector. Do not try to energize it. Take it to the electric shop for a safety check first.

(3) Personally owned electric lights, fans, tools. Personally owned or non-Navy standard electric lights, fans, and tools are not justified. They are generally a shock hazard because of inferior insulation, leakage currents, and flimsy

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structure. Periodic inspections should be made to eliminate them from the ship. Adequate numbers and types of Navy lights, fans, and tools are available to meet all needs.

(4) Hobby Equipment. Personally owned hobby equipment such as hand-held, motor-driven carving tools are frequently found to be of flimsy construction and unsafe for use aboard ship. Such equipment may be retained aboard ship as an exception to article 60-28(3) subject to the following precautions:

(a) Prior to permitting use of portable, electrically operated hobby devices aboard ship, they should be inspected and tested by the electrical gang. Equipments which pass this inspection should be tagged as safe, giving date of inspection. This equipment should be frequently reinspected, at least once each 6 months.

(b) At any time that the hobby tool is damaged or is obviously defective, that is, if molded housing, cords, or plugs contain cracks or breaks or if the cord insulation breaks when sharply bent, the tool must not be used until repaired and reinspected by the electrical gang.

(5) No personal electrical equipment, such as radios, television sets, record players, wire or tape recorders, or other personal appliances as listed above, shall be used aboard ship without the Engineering Officer's tag of approval. Periodic inspection should be made to enforce this vital safety regulation.

60-29. GROUNDING PORTABLE TOOLS AND EQUIPMENT WHERE GROUNDED TYPE PLUGS AND RECEPTACLES ARE NOT INSTALLED

If the grounded type receptacles have not yet been installed in the spaces where the tool or equipment is to be used, other types of plugs and receptacles may be used if the grounding conductor in the tool or equipment cord is connected to the ship's metal structure by other methods; for example, by means of a spring clip or by securing the grounding conductor to a convenient screw or bolt. In those cases where the tool or equipment cord does not include an extra conductor for grounding, an additional conductor should be obtained and connected between the metal housing of the tool or equipment and the ship's metal structure. The additional conductor used to ground the case of the equipment must be of ample cross-sectional area and current-carrying capacity in order to be effective. It should have a cross section ay least equal to the cross section of the power conductors in the tool or equipment cord, and preferably greater. If the tool or equipment housing has two or more metallic parts which are not electrically connected, each should be connected to the grounding conductor. Care should be taken to secure a good contact between the grounding conductor and the metal to which it is connected, by scraping any paint away and scratching a clean surface. The ground connection should be made before inserting the power supply connecting plug, and the plug should be removed before removing the ground connection. Frequent inspection and check of the connections within portable electric tools and equipment should be made to insure that the supply cord and its connections are suitably insulated and that the ground connection is intact.

60-30. TESTING LEADS TO SEE IF ALIVE

All electrical leads are to be considered as being alive until it is positively proved that they are dead. To check a circuit, test the live side with a voltmeter or voltage tester, then test the dead side with the same device and retest the live side. This is to make sure the testing device is in good condition. Opening a switch to kill the power circuit does not always kill associated meter or remote control circuits. Always test such circuits in addition to testing the power circuit.

60-31. NEVER TAKE A SHOCK INTENTIONALLY

Intentionally taking a shock from any voltage is always dangerous and should not be done. Whenever it is necessary to check a circuit to see if it is alive, a voltmeter, voltage tester, or other suitable indicating device shall be used.

60-32. NEVER IMPLICITLY TRUST INSULATION

Never implicitly trust the insulation on live circuits when considering personnel safety. Insulation may look perfect, yet still not prevent a shock. Sufficient leakage current may be present to cause a fatal shock.

60-33. PORTABLE CABLES

(1) Portable cables should be carefully selected and maintained. They should be of the proper length and cross-sectional area. Spliced portable cables are extremely dangerous and should not be used unless an emergency warrants the risk involved.

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(2) Always support portable cables above decks, floor plates, and gratings. Never place them where they can be damaged by falling objects, by being walked on, or by contact with sharp corner or projections in the ship's hull or other objects. Where portable cables are passed through doorways or hatches, stops should be provided to protect the cables from being pinched by a door or hatch cover.

60-34. REPLACEMENT OF FUSES

(1) Fuses are safety devices and should be used as such. When a fuse blows, it should be replaced with a fuse of the same rated voltage and ampere capacity. Never short out a fuse.

(2) Fuse pullers made of insulating material should be used for the removal or replacement of fuses, except where, as is usually the case on I.C. and F.C. switchboards, the fuses are mounted in plug-type fuse holders. These fuses are removed by unscrewing the plugs.

(3) Only fuses of 10-ampere rated capacity or less should be removed from or replaced in energized circuits.

(4) Fuses larger than 10-ampere rated capacity should be removed or replaced only when the circuit is completely deenergized. After the replacement, the circuit should be energized only when the cover over the fuses is closed. Neglect of this precaution has led to injuries caused by explosion of a fuse when the circuit was energized.

60-35. SAFETY PRECAUTIONS WHEN SWITCHING

(1) Circuit breakers and switches should be operated with care for the safety of the operator and other personnel. Before closing any circuit breaker or switch, be sure that:

(a) The circuit is ready with all equipment connected to it in condition to be energized.

(b) Men working on the circuit are clear and are notified that it is to be energized.

(c) All circuit protective devices (fuses, circuit breakers, etc.) are in good working condition.

(2) When operating a circuit breaker or switch:

(a) Use only one hand except where the operating arrangements specifically provide for the use of both hands. Keep the other hand clear. Metal parts of circuit breakers may be at circuit potential.

(b) For manually operated knife switches, etc., make the closing or opening motion positive and rapid.

(3) In the case of switches enclosed in watertight cases, for example, snap switches and multipole rotary switches, the chief precaution required is to make sure that the switch has been operated to the position actually intended. Several reports have been received indicating that the switch handle was not operated far enough when the operator intended to transfer a circuit from one control station to another. Consequently, the switch contacts were left in an in-between position and the circuit was actually opened, thus leading to the possibility of serious casualty. The trouble was traced to the fact that gland rings in the switches had been tightened to a point where the friction on the switch shaft was so great that the action of the switch detent mechanism was no longer evident to the operator, with the result that he had no definite guide to ensure the proper positioning of the switch handle. The Bureau is studying this problem and is endeavoring to take corrective action as soon as possible by using improved types of packing and a type of construction which will ensure that the switch is watertight and that the amount of fraction on the shaft cannot be made excessive. In the meantime, all switches should be examined periodically to make sure that the shafts turn freely and the packing is the latest type specified by the Bureau. Personnel should be cautioned to make sure that switch handles are operated to the proper positions and that the switch is not sticking in an in-between position.

60-36. DEENERGIZE AND TAG CIRCUITS

(1) Work should not be done on any energized circuit, switchboard, controller, or other piece of electrical equipment unless the urgency of the work, together with the vital importance of the equipment concerned, dictates its necessity. Circuits to be overhauled or repaired should be deenergized by opening all switches through which the power could be supplied, and the circuit should be tested with a voltmeter or voltage tester (see art. 60-30). These switches should be tagged: "WARNING. Do not change position of switch except by direction of NAME. . . . . RATE/RANK." Warning tag NAVSHIPS 3950(5-51) may be used for this purpose. In case more than one repair party is engaged in repair work on an electrical circuit, a tag for each party should be placed on the supply switches. After

the work has been completed, each party should remove its own tag but no other.

(2) As a further precaution, metal locking devices are available that can be attached to the switch handles to prevent accidental operation. These locking devices can be obtained through the Ships Parts Segment of the Navy Supply System.

Breaker size	Navy stock no.
50 ampere	H5925-254-4920
100 ampere	H5930-669-7524
225 ampere	H5930-669-7572

All breaker handles are now provided with a 3/32-inch hole permitting fastening the locking device with a standard cotter pin. On earlier breakers it may be necessary to drill a 3/32-inch hole in the handle, using the locking device as a drilling guide. The warning tags can be attached to the eye of the cotter pin.

(3) When checking to see whether circuits are deenergized, never forget to check metering and control circuits as well as power circuits. In many cases metering and control circuits are connected to the supply side of a circuit breaker. A check of power circuits on the load side of a circuit breaker may show that they are dead after the circuit breaker is opened, but such a check gives no assurance whatsoever that associated metering and control circuits are dead. They may or may not be, and MUST be checked to make sure.

(4) No work shall be undertaken on switchboards without first obtaining the approval of the Electrical or Engineer Officer. (See art. 60-37 (10)).

60-37. SAFETY PRECAUTIONS WHEN WORKING ON LIVE CIRCUITS OR EQUIPMENT

When military considerations require that electrical repair or maintenance work be performed, but prohibit deenergizing the circuits involved, extreme measures of precaution must be used. The work should be accomplished only by adequately supervised personnel fully cognizant of the dangers involved. Every care should be taken to insulate the person performing the work from ground and to use all practicable safety measures. The following precautions should be taken when applicable:

(1) Provide ample illumination.

(2) The person doing the work should not wear wrist watch, rings, watch chain, metal articles, or loose clothing which might make accidental contact with live parts or which might accidentally catch and throw some part of his body into contact with live parts. Clothing and shoes should be as dry as possible.

(3) Insulate the worker from ground by means of insulating material covering any adjacent grounded metal with which he might come in contact. Suitable insulating materials are dry wood, rubber mats, dry canvas, dry phenolic material, or even heavy dry paper in several thicknesses. Be sure that any such insulating material is dry, has no holes in it, and no conducting materials embedded in it. Cover sufficient areas so that adequate latitude is permitted for movement by the worker in doing the work.

(4) Cover working metal tools with insulating rubber tape (not friction tape) as far as practicable.

(5) Insofar as practicable, provide insulating barriers between the work and any live metal parts immediately adjacent to the work to be done.

(6) Use only one hand in accomplishing the work, if practicable.

(7) A rubber glove should be used on the hand not used for handling tools. If the work being done permits, rubber gloves should be worn on both hands.

(8) Have men stationed by circuit breakers or switches, and telephone manned if necessary, so that the circuit or switchboard can be deenergized immediately in case of emergency.

(9) A man qualified in first aid for electric shock should be immediately available while the work is being done.

(10) Energized switchboards are a great source of danger. No work shall be undertaken on energized switchboards without first obtaining the approval of the Commanding Officer.

60-38. KEEP COVERS CLOSED

Covers for all fuse boxes, junction boxes, switch boxes, and wiring accessories in general should be habitually kept closed when not required to be open for a specific reason.

60-39. DISCHARGE MACHINES TO GROUND

The electrical charge retained by electrical machinery when secured is, in certain cases, sufficient to cause a severe shock. This must be considered before touching the terminals of an apparently dead machine. Be safe: discharge it to ground by momentarily connecting the terminal to ground using an insulated portable wire or a tool with an insulated handle.

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60-40. DISCHARGE CAPACITORS

Capacitors are used in radio interference suppression accessories and for other purposes in electric power and lighting equipment, in interior communication and firecontrol equipment, and in electronics equipment. Prior to touching a capacitor which is connected to a deenergized circuit, or which is disconnected entirely, short circuit the terminals.

60-41. USE OF ALCOHOL

Use of alcohol for cleaning electrical equipment should be avoided and it should never be used on energized equipment or near electrical equipment from which a spark is possible.

60-42. WORKING WITH VOLATILE LIQUIDS

When working with volatile liquids such as insulating varnish, paint, lacquer, turpentine, kerosene, and others from which inflammable vapors may be obtained, they should be considered as dangerous, and ample ventilation to prevent accumulation of fumes provided.

60-43. PRECAUTIONS IN USE OF INFLAMMABLE CLEANING FLUIDS

Gasoline, benzine, ether, and similar inflammable cleaning fluids should never be used on electrical apparatus, even though deenergized. See article 60-413 for the cleaning fluids to be used.

60-44. DEENERGIZING CIRCUITS IN COMPARTMENTS CONTAINING INFLAMMABLE VAPORS

If open-type electrical apparatus is in operation when the presence of explosive vapor is detected, the apparatus should be deenergized by means of switches located outside the contaminated space.

60-45. FIRES

In case of an electrical fire proceed as follows:

(1) Deenergize the circuit or equipment affected and shift the load to stand-by circuits or equipment. In case no stand-by circuit or equipment is available, deenergize the circuit or equipment affected by the fire except in extreme emergency when the need for uninterrupted power is considered to be of such paramount importance as to outweigh the risk incurred by leaving it energized.

(2) Report the fire.

(3) Extinguish the fire with carbon dioxide. Care must be taken to avoid high concentrations of carbon dioxide in confined spaces, as this is dangerous to personnel (See ch. 38). In electrical fires, remember that quick action is most needed for deenergizing the circuit. When this has been done, stop, look, and think, and then act fast to extinguish the fire before it spreads.

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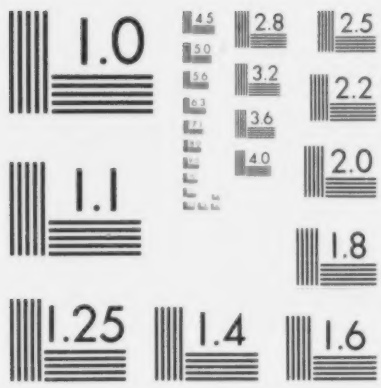

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ABSTRACT - Prepared to assist the Fireman Apprentice to qualify and to advance to Fireman in the Navy, this training course for enlisted men was developed by the Training Publications Division of the Navy. Chapters are: (1) Preparing for Advancement, (2) Engineering Department, (3) Engineering Fundamentals, (4) Ship Propulsion, (5) Basic Steam Cycle, (6) Boilers, (7) Steam Turbines, (8) Auxiliary Machinery and Equipment, (9) Instruments, (10) Pumps, Valves, and Piping, (11) Shipboard Electrical Equipment, (12) Internal Combustion Engines, and (13) Engineering Watches. Numerous illustrations are provided, and a training film list and glossary are appended. (GB)

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FIREMAN

VT012757

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10520-C

PREFACE

This training course has been prepared to assist the Fireman Apprentice to qualify and to advance to Fireman. Study of this training course should be combined with practical experience, with study and review of other applicable Navy Training Courses, and with study of manufacturers' technical manuals, Bureau of Ships Technical Manual, and other applicable material.

As one of the Navy Training Courses, Fireman has been prepared by the Training Publications Division, Naval Personnel Program Support Activity, Washington, D. C., for the Bureau of Naval Personnel. Information provided by numerous manufacturers, publishers, and associations is gratefully acknowledged. Technical assistance has been provided by the Bureau of Ships and the Service School Command, Great Lakes.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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READING LIST

Basic Handtools (Part I, Section 1), NavPers 10085-A

CHAPTER 1

PREPARING FOR ADVANCEMENT

Study of this training course will start you on your way to the time when you will wear a rating badge which will signify that you belong to one of the Engineering and Hull ratings. (See fig. 1-1.) This training course is one of several which will help you meet the technical requirements for advancement.

As a member of the engineering department aboard ship, you know that you are assigned to the heart of the ship. It is through your efforts and the efforts of every other member of the department that your ship becomes alive and is able to meet its commitments anywhere on the oceans of the world.

RATE OF FIREMAN

A Fireman is basically an engineering trainee and must perform a wide variety of tasks. Some of these tasks may seem quite unnecessary and yet there is a very distinct reason for the tasks you will be required to perform. The reason, even though sometimes it may be somewhat obscure, is to increase the operational readiness of the ship and to further your training. Everyday, throughout your Navy career, you will learn something new. This will increase your store of knowledge and thus will make you more valuable to yourself and to the Navy.

You must be able to serve as a competent assistant to the petty officers holding any of the 11 ratings in the engineering department. (These ratings are discussed in chapter 2 of this training course.) You will learn how to operate pumps, motors, and turbines; read gages and thermometers; maintain and clean engines, machinery, and compartments; and identify refrigeration equipment, anchor windlasses, distilling plants, and compressors. You will also stand security and fire watches in engineering spaces, act as a boat engineer, take part in drills, and perform the duties of damage control repair party telephone-talker and messenger.

You may ask yourself the question, "How am I ever going to learn to do all these jobs?" In the beginning, you will work with the petty officer who is responsible for seeing that a specific job is done properly. He will show you exactly how every detail of each operation should be performed. Then he will have you do the job under his supervision. Finally, when he has confidence in you and your ability to do the job, he will give you the opportunity to perform it on your own. This general procedure will be observed throughout your entire period as a striker.

In addition to meeting these requirements, you will also be required to have a basic knowledge of mathematics and blueprint reading. Sources of information which will be useful in learning about these subjects are listed later in this chapter.

ADVANCEMENT AND ELIGIBILITY REQUIREMENTS

Before you can advance in rate, you must fulfill certain military and professional requirements.

Military requirements for advancement are those general qualifications applicable to all enlisted personnel, such as watch standing, first aid, and military conduct. You must show that you are proficient in each of the military qualifications specified for the next higher pay grade. These are discussed in Basic Military Requirements, NavPers 10054-B.

Professional requirements for advancement are technical qualifications that are directly related to the work of each rating.

Both the military requirements and the professional requirements are divided into subject matter groups. These subject matter groups are further subdivided into practical factors and knowledge factors. Practical factors are things that you must be able to do. The knowledge factors are the minimum things you must know in order to perform your duties.

The professional and military requirements just [illegible]d are listed in the Manual of

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Qualifications for Advancement in Rating, NavPers 18068 (with changes). This manual provides the minimum requirements for advancement to each pay grade within each rating.

The qualifications for Fireman form the basis for this course, and they were current at the date of this printing. But the qualifications change occasionally, and the questions in the advancement examinations for all pay grades are based on the latest revision. Consequently, long before taking an examination for advancement, you should check for revisions and assure yourself that your knowledge covers all the latest qualifications.

A special form known as the Record of Practical Factors, NavPers 760, is used to keep

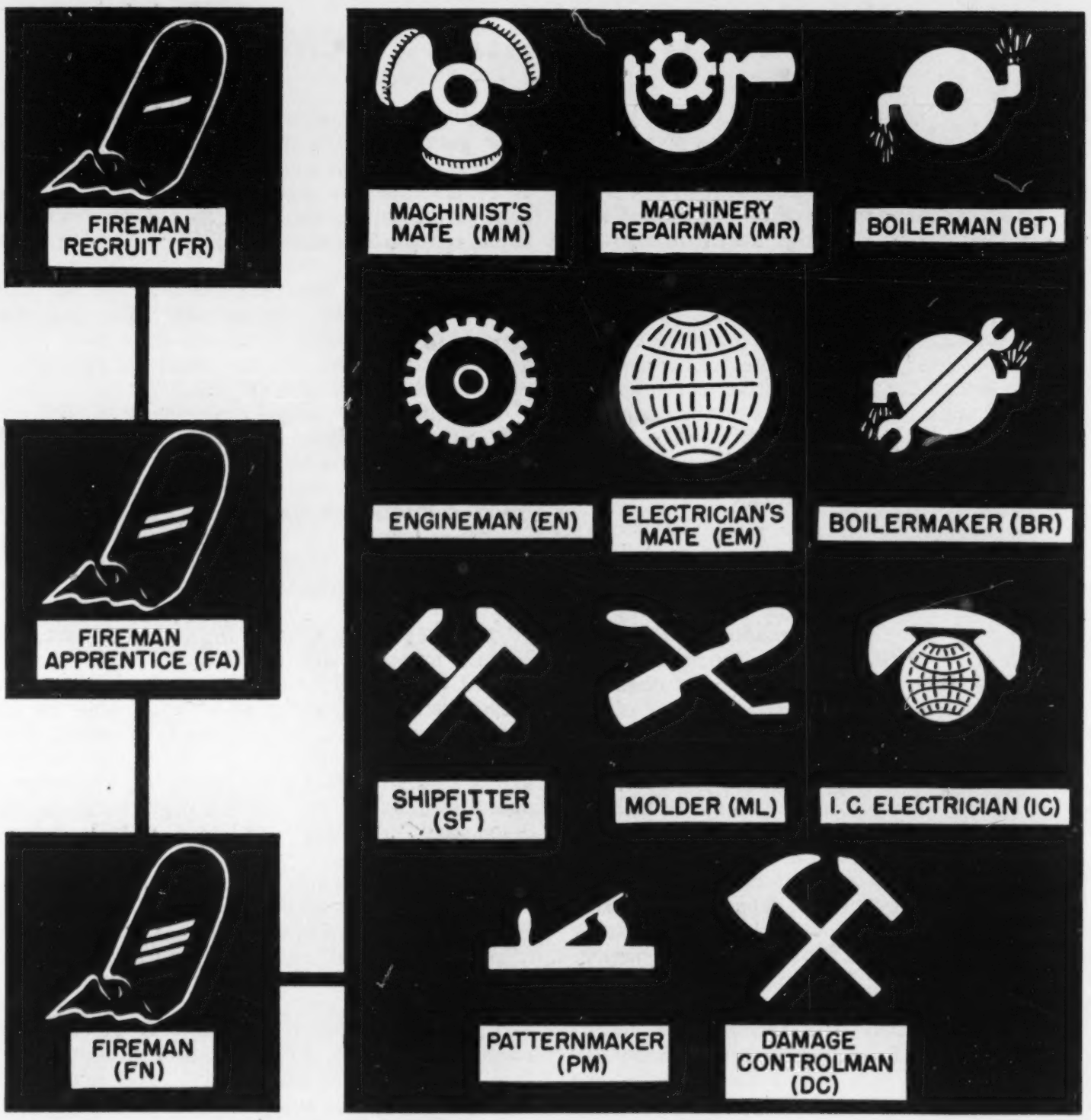

Figure 1-1.—Engineering and Hull Ratings. 3.10

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a record of your practical factor qualifications. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns by the division officer or your supervising petty officer.

Since changes are made periodically to the Manual of Qualifications for Advancement in Rating, revised forms of NavPers 760 are provided when necessary. Extra space is provided on the Record of Practical Factors for entering additional practical factors as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 760 form is forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

The Navy has established certain requirements that must be met before you are eligible to take the examination for advancement. You must—

First: Meet basic requirements, such as length of service in pay grade and total service.

Second: Have a statement in your service record that you satisfactorily performed the practical factors for the next higher pay grade.

Third: Have a statement in your service record that you successfully completed the training course for the next higher level of advancement.

Fourth: Be recommended by your commanding officer.

When you satisfy all of these enumerated requirements, you are eligible to participate in the examination. If you pass the examination with a high enough score, your commanding officer has the authority to advance you in rate.

SOURCES OF INFORMATION

The Navy has set definite limits on the material for which you are accountable on the examination. The sources from which examination items are taken are listed in a bibliography called Training Publications for Advancement in Rating, NavPers 10052. This bibliography is available on your ship or station. It is revised annually, so be sure to consult the current edition. It provides the titles of publications and sections of publications that you should study when preparing for the examination. The publications listed contain material covering all the qualifications listed in the Quals Manual. An asterisk (*) identifies the training course or courses that you must complete before you can be eligible to take the examination for advancement.

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to know to perform your duties. Basic training courses which will be helpful to you as you prepare for advancement are listed here. Your petty officers will assist you in obtaining other sources of information.

Basic Handtools, NavPers 10085-A
Basic Hydraulics, NavPers 16193
Blueprint Reading and Sketching, NavPers 10077-B
Basic Electricity, NavPers 10086-A
Basic Machines, NavPers 10624-A
Mathematics, Vol. I, NavPers 10069-B

REWARDS OF ADVANCEMENT

Each time you advance, you receive many rewards. These rewards include higher pay and allowances, together with additional pension benefits when you retire. But the really important gains are opportunities for more interesting and challenging assignments, increased respect from your superiors as well as from the men you supervise or help, and the chance for greater fulfillment of your abilities. Above all, you are afforded the opportunity to serve your command, your Navy, and your country at a higher level of responsibility in a more important job.

As a member of the United States Navy, you have the satisfaction of knowing that, as you advance, you are serving your country in a most important way. Do your job well at all times, and take pride in what you do and how you do it. Service to your country is a special privilege. You must make every endeavor to serve with honor.

Tradition, valor, and victory are the Navy's heritage. The long history of outstanding achievements and noble service of the Navy provides an inspiration and a challenge to you and your shipmates. It is up to you to help maintain and enlarge the prestige and the traditions of the naval service.

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CHAPTER 2

ENGINEERING DEPARTMENT

The functions of the engineering ratings cover all phases of operation, maintenance, and repair of machinery and equipment under the cognizance (control) of the engineering department. In order to fully understand the nature of your new assignments as a Fireman, you must understand the organization of the engineering department and be familiar with the scope of each Group VII (Engineering and Hull) Rating.

This chapter discusses the administrative and operational functions of the engineering department and the Group VII Ratings.

ORGANIZATION OF ENGINEERING DEPARTMENT

The organization of the engineering department is designed for the efficient operation, maintenance, and repair of the ship's propulsion plant, auxiliary machinery, and piping systems. In addition, the engineering department is responsible for (1) the control of damage, (2) the operation and maintenance of electric generators and distribution systems, (3) repair to the ship's hull, and (4) making general shipboard repairs.

The organization of the engineering department is established by the ship's organization book. This organization is made up of a number of divisions whose functions are discussed later in this chapter.

The organization of the department will vary according to the size of the ship and the engineering plant. Forces afloat, which are primarily concerned with repairs, will have a repair department consisting of many of the engineering ratings, in addition to an engineering department which will be concerned with the operation and maintenance of the propulsion plant of the repair ship or tender. Smaller ships, because of the smaller number of engineering ratings aboard, will combine many ratings into a single division.

Figure 2-1 shows the organization structure of the engineering department aboard a large ship and the functions of the various divisions of the department. Remember that this organization does not represent a particular type or class of ship. It should be noted that the administrative assistant, the department training officer, and the special assistants are aides to the engineer officer and these responsibilities are often assigned as additional duties to officers functioning in other capacities at any of the levels in the direct chain of command.

The three principal assistants to the engineer officer are the main propulsion assistant, the damage control assistant, and the electrical officer. Each of these assistants, in turn, administers those divisions assigned as indicated on the organization chart.

The division officer is responsible for the organization of his division. The Watch, Quarter, and Station Bill reflects the organization of the division by sections and shows the assignments for all emergency drills. The billets assigned depend upon the complement of the division and the capability of personnel assigned to the division.

ENGINEER OFFICER

The head of the engineering department is known as the engineer officer. In addition to the duties of a department head, the engineer officer is responsible for the operation, care, and maintenance of all propulsion and auxiliary machinery; the control of damage; and the accomplishment of repairs within the capacity of the shops in the engineering department.

Detailed information concerning the duties and responsibilities of the engineer officer are given in U. S. Navy Regulations, and in your Ship's Organization and Regulations Manual.

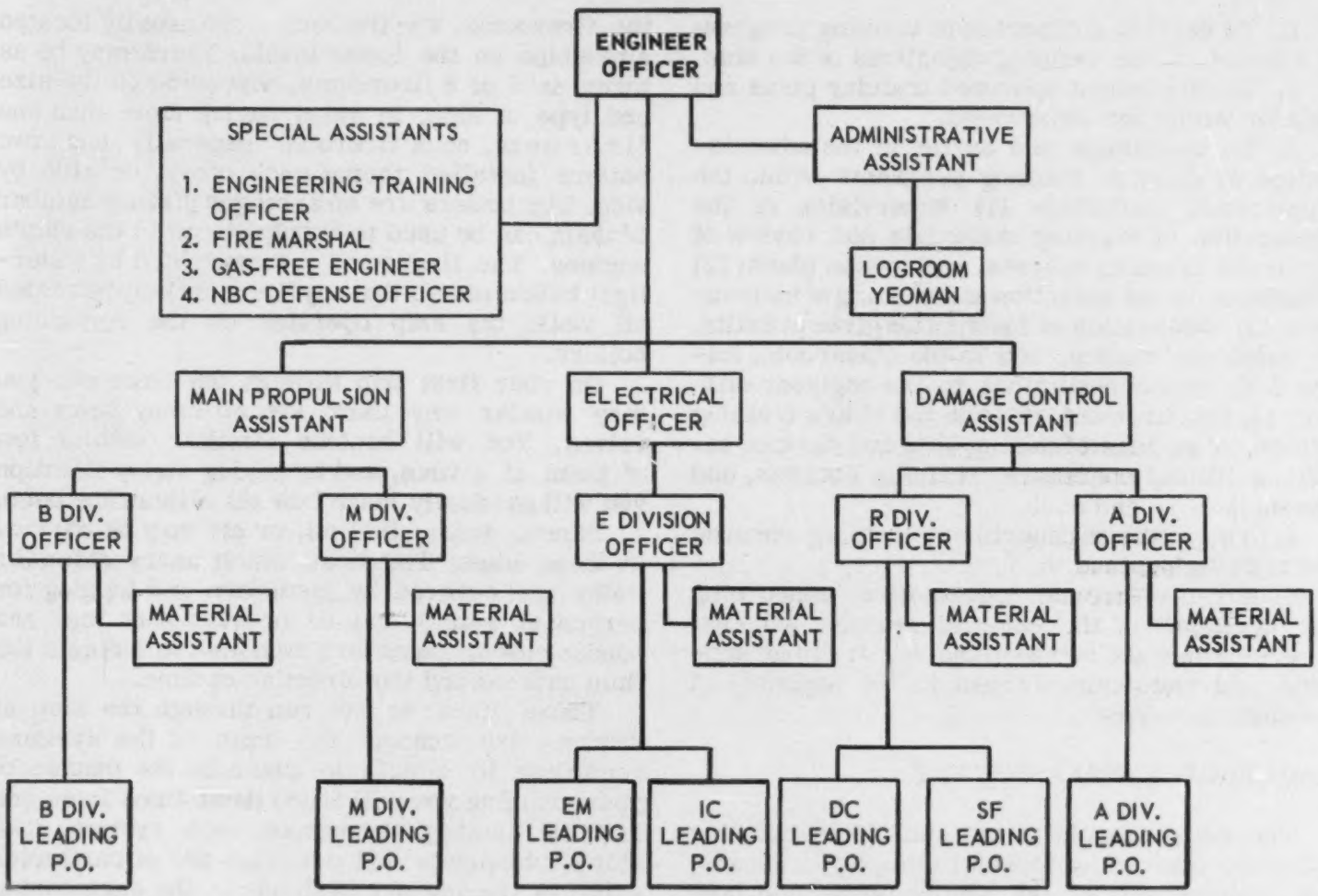

Figure 2-1.—Typical engineering department organization. 27.2

DEPARTMENT ADMINISTRATIVE ASSISTANT

The department administrative assistant functions as an aide to the engineer officer in the details of administration. His responsibilities and duties are as follows:

1. To supervise the operation of the department administrative office, ensuring the maintenance of assigned office spaces and the care and upkeep of office equipment.
2. To train, supervise, and direct the department Yeomen.
3. To screen all incoming correspondence routed to the engineer officer and initiate required action when appropriate; to screen and ensure correct preparation of all outgoing correspondence.
4. To assist in the preparation of all department directives and, following release by the engineer officer, exercise control over their issuance.
5. To supervise the maintenance of department records and maintain a tickler file on all required reports.
6. To coordinate the preparation of the department in-port daily watch bill.
7. To assign tasks to, and evaluate the performance of department Yeoman and other enlisted personnel assigned to the department office.

In an engineering department where an administrative assistant billet is not provided within the framework of the ship's organization, the engineer officer may delegate the duties of such a billet to any competent person.

DEPARTMENT TRAINING OFFICER

The duties of a department training officer are generally performed by the engineer officer, or an assistant to the engineer officer. Some of these duties are:

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1. To develop a department training program in support of the training objectives of the ship.

2. To implement approved training plans and policies within the department.

3. To coordinate and assist in the administration of division training programs within the department, including: (1) supervision of the preparation of training materials and review of curricula, training courses, and lesson plans; (2) assistance in the selection and training of instructors; (3) observation of instruction given at drills, on watch, on station, and in the classroom, followed by recommendations to the engineer officer; (4) procurement, through the ship's training officer, of required training aids and devices including films, projectors, training courses, and books.

4. To maintain department training records and training reports.

5. To disseminate information concerning the availability of fleet and service schools.

6. To initiate requisitions for training supplies and materials, subject to the approval of the engineer officer.

MAIN PROPULSION ASSISTANT

The main propulsion assistant is responsible under the engineer officer, for the operation, care, and maintenance of the ship's propulsion machinery and related auxiliaries. He has cognizance over the care, stowage, and use of fuels and lubricating oils. The preparation and care of the Engineering Log and Bell Book are the responsibility of the main propulsion assistant, as is the preparation of operation and maintenance records and procedures.

Machinery Division

If you are assigned to the M division, you will probably work in one of the enginerooms. Normally, there is one engine for each of the ship's propellers. On ships with two or more enginerooms, the enginerooms are generally located immediately aft of the firerooms which supply them with steam. In an emergency, any engineroom can be isolated while the ship continues underway on the remaining engines.

Boiler Division

The B division operates the boilers and the auxiliary fireroom machinery. If you are assigned to this division, your duty station may be one of the firerooms. The firerooms are usually located amidships on the lower levels. There may be as many as 6 or 8 firerooms, depending on the size and type of ship. In ships having more than one fireroom, each fireroom generally has two boilers installed facing each other, or side by side. The boilers are so arranged that any number of them can be used to supply steam to the ship's engines. The firerooms are separated by watertight bulkheads so that any fireroom may be sealed off while the ship operates on the remaining boilers.

On your first trip through the fireroom you may wonder why there are so many lines and valves. You will become familiar with a few of them at a time, and by paying strict attention you will gradually learn how all of them are used.

Steam, water, fuel oil, or air may be carried in these lines. The lines which carry steam or water are covered by insulation and lagging for personnel safety and to prevent heat loss and condensation. Lines are stenciled to indicate the fluid carried and the direction of flow.

These lines do not run through the ship at random, but connect the units of the systems according to a definite plan. In the course of your training you will trace these lines from one unit to another throughout each system. The ship's blueprints and drawings are of particular value in tracing out systems in the engineering plant.

DAMAGE CONTROL ASSISTANT

The damage control assistant is responsible, under the engineer officer, for the prevention and control of damage, including control of stability, list, and trim. Conditions of closure, watertight integrity, and compartment testing are carried out under his supervision. The damage control assistant (DCA) administers the training of the ship's personnel in damage control, firefighting, emergency repair work, and nonmedical defensive measures against NBC warfare. The carpenter shop, shipfitter shop, machine shop, hull shop, and damage control shop are under the cognizance of the DCA. In these shops, all necessary repairs to the hull and the ship's boats, within the shop's capacities are made by the assigned personnel.

Auxiliary Division

Personnel of A division operate the refrigeration plant, air compressors, emergency fire

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pumps, emergency diesel generators, and the ventilation and air conditioning systems. They are the boat engineers in small boats and maintain the ship's steering engines. If you are assigned to this division, you may be stationed in the auxiliary spaces or in any other part of the ship where the auxiliaries under A division are located.

The refrigeration plant, similar in many respects to the home refrigerator, preserves the supply of fresh foods and provides ice for general shipboard use. The air compressors supply compressed air for pneumatic tools, for cleaning parts of machinery, for diesel engine air starting systems, and for various other purposes. The equipment assigned to the A division is located throughout the ship.

Repair Division

The R division is responsible for maintaining the watertight integrity of the ship. The R division consists of the shipfitter, carpenter, and damage control shops. If you are assigned to this division you will work in one of these shops.

All damage control and firefighting equipment aboard ship is maintained by the R division. Much of the training of personnel in damage control is carried on by R division personnel.

ELECTRICAL OFFICER

The electrical officer is responsible, under the engineer officer, for the operation, maintenance, and repair of the electrical machinery and systems throughout the ship. The maintenance of the ship's power and lighting systems are the primary concern of the electrical officer. Repair shops are provided on larger ships for extensive repairs to electrical equipment. The IC systems, under the electrical officer, is a part of the E division.

The E division has charge of generators, gyrocompasses, intercommunications, and other electrical equipment. The generators in the enginerooms provide electricity for power and light. The steam turbines which drive the generators are operated by the M division. On electric-drive ships, the E division also operates the main generators and main electric motors which turn the shaft. If assigned to this division, you might work in the main motor rooms, the enginerooms, the electric repair shop, or in the IC rooms.

NBC DEFENSE OFFICER

Since nuclear, biological, and chemical (NBC) warfare defense procedures are classified and subject to frequent modification, it is best to refer to current OpNav Instructions for a detailed description of the NBC defense officer's duties. In general, the NBC defense officer (collateral duty of the damage control assistant) is responsible for the training of shipboard personnel in defense against NBC warfare. He is also responsible for the procurement, distribution, and maintenance of NBC warfare defense equipment. In addition, he must ensure decontamination of personnel, equipment, and the ship; and the management and transportation of NBC casualties with the advice and assistance of the medical officer.

FIRE MARSHAL

The fire marshal, under the engineer officer and the damage control assistant, is responsible for the maintenance and readiness for use of the ship's firefighting equipment. He is also responsible for the prevention and elimination of fire hazards in the ship.

GAS-FREE ENGINEER

The duties and responsibilities of the gas-free engineer are given in chapter 9920(92) of BuShips Technical Manual. Briefly, the gas-free engineer tests and analyzes the air in compartments or voids that have been closed and are being opened for inspection, to determine whether or not such spaces are safe for personnel to enter without danger of poisoning or suffocating. He also determines whether or not it is safe to perform "hot work" (welding or cutting) within, on the exterior boundaries, or in the way of such spaces without danger of fire or explosion. (The person designated as the gas-free engineer must have the qualifications set forth by BuShips.)

DIVISION OFFICERS

In addition to the duties as set forth in U.S. Navy Regulations, the Ship's Organization and Regulations Manual generally prescribes that a division officer shall:

1. Direct the operation of his division through leading petty officers, as prescribed in the division organization.

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2. Assign personnel to watches and duties within the division (develop rotation programs for battle stations, watches, and general duties, to ensure the training and proficiency of assigned personnel).

3. Ensure that division personnel receive indoctrination, and military and professional training.

4. Prepare enlisted performance evaluation sheets for personnel of his division.

5. Maintain a division notebook containing personnel data cards, training data, a space and equipment responsibility log, the watch and battle stations to be manned, and such other data as may be useful for the orientation of an officer relieving him, and for ready reference.

6. Be responsible for all forms, reports, and correspondence originated or maintained by his division.

7. Establish and maintain a division organization manual and other directives which may be necessary for the administration of his division.

8. Ensure that prescribed security measures are strictly observed by personnel of his division.

9. Make recommendations for personnel transfers and changes in the division allowance to his department head.

10. Forward requests for leave, liberty, and special privileges, and make recommendations for their disposition.

11. Conduct periodic inspections and exercises, and musters to evaluate the performance and discipline of his division and to initiate disciplinary action, when he deems it necessary, in accordance with the Uniform Code of Military Justice and other regulatory directives.

TECHNICAL ASSISTANTS

The duties of technical assistants (LDO, Warrant Officer, E-8, and E-9 personnel) vary with the different specialties. In general, a technical assistant's duties and responsibilities apply to the operation, maintenance, and repair of machinery, equipment, and systems under the cognizance of the division to which the technical assistant is assigned.

ENLISTED PERSONNEL

In addition to the general ratings for enlisted personnel of the engineering department, there are specific billets or assignments which require special mention. Three of these billets are the oil and water king, the movie operator, and the boat engineer.

Oil and Water King

On a large ship, the billet for oil and water king is usually divided into two billets—one for the fuel oil details, and the other for potable (fresh) water and feed water.

The oil and water king is a Boilerman on steam-driven ships and is generally an Engineman on diesel-driven ships. He has the following responsibilities:

1. Supervising the operation of all valves of the fuel oil system, the transfer and booster pumps, fuel oil manifolds, fuel oil heating coils as necessary, and the fresh water system as prescribed by the casualty control bills for those systems.

2. Properly maintaining fuel oil service tanks, and shifting suction among service tanks.

3. Maintaining the distribution of fuel oil and water so that the ship will remain on an even keel and with proper trim.

4. Preparing fuel and water reports.

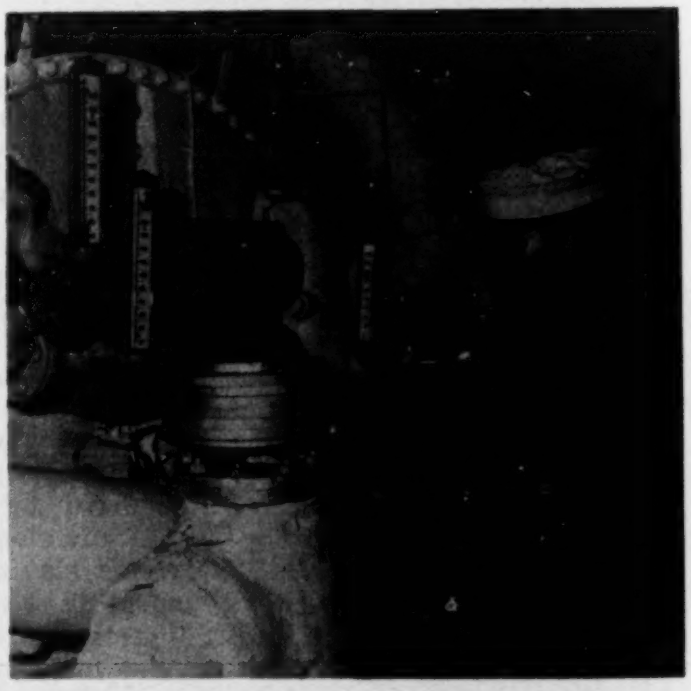

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Figure 2-2.—Machinist's Mate recording evaporator readings.

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5. Testing and recording the alkalinity, chloride content, hardness, and other properties of feed and boiler water, and making required tests of fuel oil. Detailed information concerning such tests can be obtained from BuShips Technical Manual, chapter 9550 (55) for oil tests and chapter 9560 (56) for water tests.

Movie Operator

Movie operators are generally graduates of a sound motion picture school or duly qualified by competent authority. Provision is generally made to have a sufficient number of operators to accommodate the ship's needs.

Boat Engineer

Firemen, Enginemen, or Machinist's Mates from the A division are detailed as boat engineers. Boat engineers operate, clean, and inspect the parts of the boats assigned to them. Boat engine repairs are undertaken by Enginemen assigned to that duty.

ENGINEERING DEPARTMENT RATINGS

After serving as a Fireman for the required length of time, you may strike for a third class petty officer's rating. But first, you must make an important decision. You may choose any of 11

139.2

Figure 2-3.—Engineman standing watch on a diesel engine.

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different ratings. The decision you make will determine largely the kind of work you will be doing throughout the balance of your Navy career.

In general, the engineering department ratings require an aptitude for things mechanical, a degree of proficiency in mathematics and physics, and some experience in repair work. A knowledge of mechanical drawing is also desirable. Navy Training Courses and Correspondence Courses are available, covering many aspects of basic engineering. Self-reliance, ingenuity, and resourcefulness are particularly important to any man striking for an engineering rating.

Schools for engineering ratings are available to those who can qualify. The various types of schools are covered in Basic Military Requirements, NavPers 10054-B. A list of all schools and their requirements is given in the Catalog of U.S. Naval Training Activities and Courses, NavPers 91769 (Revised).

The titles and job descriptions of the various engineering department ratings are given in the sections which follow.

MACHINIST'S MATE (MM)

Machinist's Mates operate and maintain the propulsion turbines, reduction gears, condensers, air ejectors, and such miscellaneous auxiliary equipment in the engineering spaces as pumps, air compressors, generators, evaporators,

Figure 2-4.—Machinery Repairman operating a milling machine. 139.3

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valves, oil purifiers, oil and water heaters, governors, and propeller shafts. Figure 2-2 shows a Machinist's Mate recording readings from an evaporator.

Engineman (EN)

Enginemen operate and maintain power plants used to operate shipboard auxiliaries, and to propel boats and ships. In addition to working with internal combustion engines (diesel and gasoline), Enginemen must know how to operate, maintain, and repair many kinds of shipboard auxiliary equipment. Such equipment includes refrigeration and air conditioning systems, pumps, air compressors, and various kinds of hydraulic equipment. Figure 2-3 shows an Engineman standing watch on a diesel engine.

MACHINERY REPAIRMAN (MR)

Machinery Repairmen make all types of machine shop repairs on shipboard machinery. This work requires the skillful use of lathes, milling

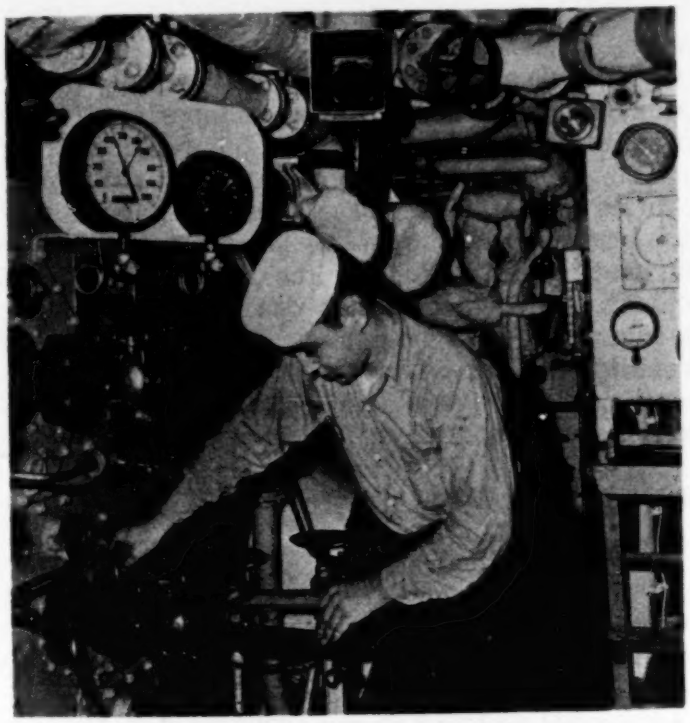

Figure 2-5.—A Boilerman removing an atomizer from a burner. 139.4

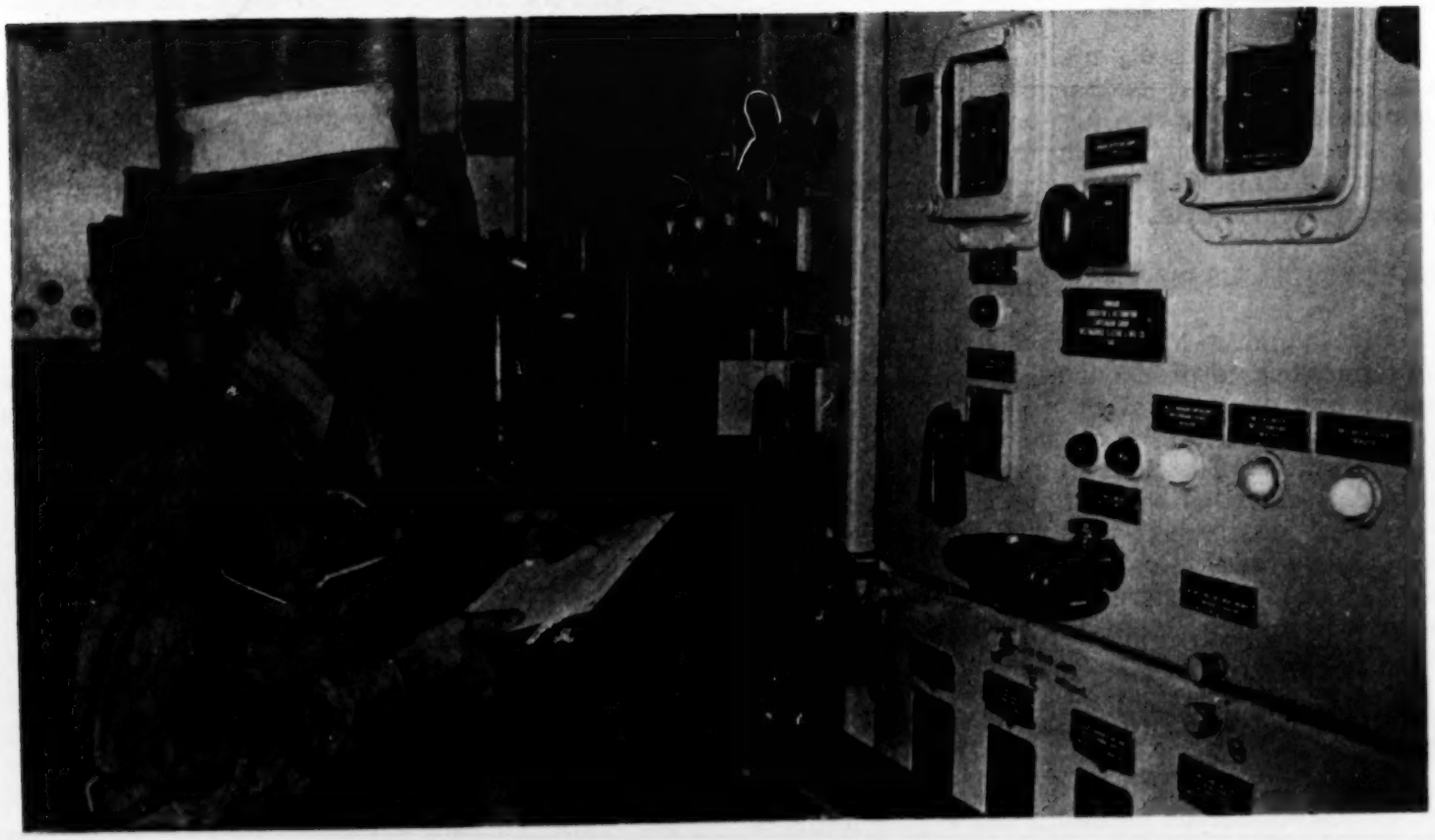

Figure 2-6.—An Electrician's Mate taking readings on main switchboard. 139.5

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machines, boring mills, grinders, power hacksaws, drill presses, and other machine tools, as well as all handtools and measuring instruments usually found in a machine shop. The job of restoring machinery to good working order, ranging as it does from the fabrication of a simple pin or link to the complete rebuilding of an intricate gear system, requires skill of the highest order. Often, in the absence of dimensional drawings or other design information, a Machinery Repairman must depend upon his ingenuity and know-how to successfully machine a repair part. Figure 2-4 shows a Machinery Repairman operating a milling machine.

BOILERMAN (BT)

Boilermen operate all types of marine boilers and fireroom machinery (pumps and forced draft blowers): Boilermen transfer, test, and take soundings of fuel and feed water tanks. Boilermen also maintain and repair boilers, pumps, and associated machinery. Figure 2-5 shows a Boilerman removing an atomizer from a burner.

BOILERMAKER (BR)

Boilermakers test, maintain, and repair marine boilers, heat exchangers, and associated equipment; inspect boilers and effect corrective measures; perform electric arc and oxyacetylene welding in boiler repairs; and maintain records and reports.

ELECTRICIAN'S MATE (EM)

Electrician's Mates stand watch on generators, motors, switchboards, and control equipment; operate searchlights and other electrical equipment; maintain and repair power and lighting circuits, electrical fixtures, motors, generators, distribution switchboards, and other electrical equipment; test for grounds of other casualties; and repair and rebuild electrical equipment in an electrical shop. Figure 2-6 shows an Electrician's Mate taking readings at the main switchboard.

INTERIOR COMMUNICATIONS ELECTRICIAN (IC)

I.C. Electricians maintain and repair interior communications (IC) systems, gyrocompass systems, amplified voice systems, alarm and warning systems, and related equipment; and stand IC and gyrocompass watches. (An I.C. Electrician may be responsible for maintaining motion picture equipment aboard ship.)

139.6

Figure 2-7.—Shipfitter preparing to weld.

SHIPFITTER (SF)

Shipfitters plan, supervise, and perform tasks necessary for fabrication, installation, and repair of metal structures. They install and maintain shipboard and shore base plumbing, and high and low pressure piping systems. Shipfitters organize, supervise, and train personnel in maintenance and repair duties. Figure 2-7 shows a Shipfitter preparing to weld two pieces of angle iron together.

The rating of Shipfitter, established in 1958, replaced the Pipefitter and Metalsmith ratings as follows: one general rating of Shipfitter on the first class and chief levels; two service ratings of Shipfitter P (Pipefitter) and Shipfitter M (Metalsmith) on the third and second class levels. (A general rating reflects the qualification in all aspects of an occupational field and assures a

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Figure 2-8.—Damage Controlmen recharging fire extinguishers. 139.7

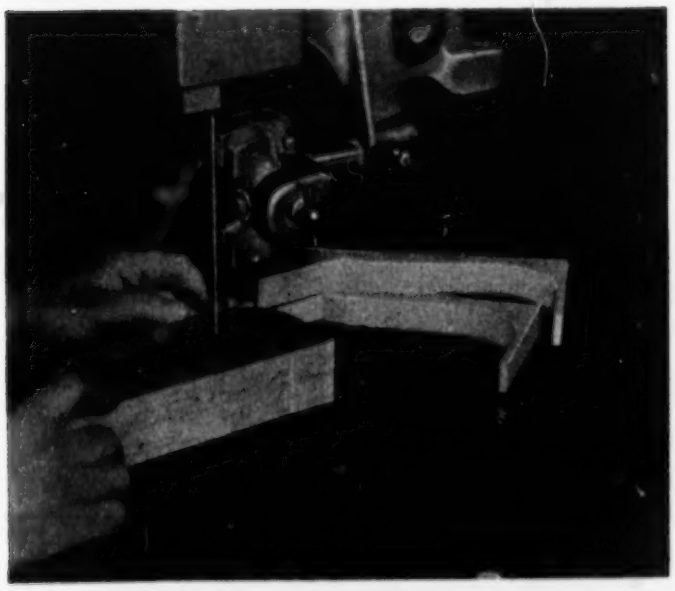

Figure 2-9.—Sawing a pattern. 29.137D

Figure 2-10.—A Molder finishing a core. 68.124

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broadly qualified petty officer. A service rating reflects the qualification in some aspects of an occupational field and provides specialization where deemed desirable.)

DAMAGE CONTROLMAN (DC)

Damage Controlmen are qualified in the techniques, skills, and use of equipment of damage control, carpentry, firefighting, and nuclear, biological, and chemical (NBC) warfare defense. Damage Controlmen are responsible for maintaining and repairing damage control equipment and for preserving watertight integrity by such means as adjusting dogs and renewing gaskets on watertight doors, hatches, scuttles, etc. Figure 2-8 shows two Damage Controlmen recharging fire extinguishers.

PATTERNMAKER (PM)

Patternmakers make wooden, plaster, and metal patterns, and other equipment used by Molders in a Navy foundry. They mount patterns on match plates and on follow boards for production molding. Patternmakers make master patterns; make full scale layouts of wooden patterns, core boxes, and templates; and index and store patterns. Figure 2-9 illustrates a Patternmaker sawing a pattern.

MOLDER (ML)

Molders operate foundries aboard ship and at shore stations; make molds and cores, rig flasks, prepare heats, and pour castings of ferrous, nonferrous, and alloy metals; shake out and clean castings; and pour bearings. Figure 2-10 illustrates a Molder finishing a core.

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CHAPTER 3

ENGINEERING FUNDAMENTALS

This chapter is designed to acquaint you with various laws and phenomena of nature. Included is information pertaining to matter and energy, force and motion, heat and temperature, pressure, combustion, the laws of perfect gases, and some fundamental information about metals. The information provided here is general in nature; but it has been included to give you a better understanding of how or why engineering machinery operates or produces work. As you study this chapter, remember that anything that occupies space and has weight is called MATTER.

PHYSICS

The forces of physics and the laws of nature are at work in every single piece of machinery or equipment aboard ship. It is by these forces and laws that the machinery and equipment produce work.

MASS, WEIGHT, AND INERTIA

The physical principles of mass and inertia are involved in the design and operation of the heavy flywheels and bull gears that are at work in the ship's engineering plant. The great mass of the wheel tends to keep it rotating once it has been set in motion. The high inertia of the wheel keeps it from responding to small fluctuations in speed and thus helps to keep the engine running smoothly.

The mass and the weight of an object are not the same. The mass of an object is the quantity of matter which the object contains. The weight of the object is equal to the gravitational force with which the object is attracted to the earth. Inertia is that physical property which causes objects that are at rest to remain at rest, unless they are acted upon by some external force; and which causes objects moving at a constant velocity to continue moving at this constant velocity, and in the same direction, until acted upon by some external force.

FORCE

Force is what makes an object start to move, or speed up, or slow down; or keep moving against resistance. This force may be either a push or a pull. You exert a force when you push against a truck, whether you move the truck, or only try to move it. You also exert a force when you pull on a heavy piano, whether you move the piano, or only try to move it. Forces produce or prevent motion, or have a tendency to do so.

A tendency to prevent motion is the frictional resistance offered by an object. This frictional resistance is called frictional force. While it can never cause an object to move, it can check or stop motion. Frictional force wastes power, creates heat, and causes wear. Although frictional force cannot be entirely eliminated, it can be reduced by using lubricants.

SPEED, VELOCITY, AND ACCELERATION

Speed is defined as the distance covered per unit of time. Velocity is speed in a certain direction. Acceleration is the rate at which velocity changes. If, for example, the propeller shaft rate of rotation increases from stop to 100 revolutions per minute (rpm) in 20 minutes, the acceleration is 5 rpm. In other words, the velocity has increased 5 revolutions per minute, during each minute, for a total period of 20 minutes. A body with uniform motion has no acceleration. When the velocity of an object changes by the same amount each second or minute, you have uniform acceleration. Uniform deceleration is obtained when the decrease in velocity is the same each second or minute.

ENERGY

Energy may be described as the ability to do work. In the physical sense, work is done when a force acts on matter and moves it. We use heat energy to turn a steam turbine, and electric energy to drive motors. The mechanical energy

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of the pistons in an automobile engine is transmitted to the wheels by the crank shaft, transmission, drive shaft, differential gears, and rear axles. Nuclear energy is used to generate electric power and to drive naval ships.

Perhaps the most common definition of energy is given as "the capacity for doing work." However this is not quite a complete statement because energy can produce other effects which could not be considered as work. For example, heat can flow from one object to another without doing any work; yet heat is a form of energy and the process of heat transfer produces an effect. Therefore, a better definition of energy states that energy is the capacity for producing an effect.

Energy is normally classified according to the size and nature of the objects or particles with which it is associated. So we say that mechanical energy is the energy associated with large objects—usually things that are big enough to see—such as pumps and turbines. Thermal energy is energy associated with molecules. Chemical energy is energy that arises from the forces which bind the atoms together in a molecule. Chemical energy is released whenever combustion or any other chemical reaction takes place. Electrical energy, light waves, and radio waves are examples of energy that are associated with particles smaller than atoms. Nuclear energy is obtained from splitting the atoms. Each of these types of energy (mechanical, thermal, etc.) must also be classified as either (1) stored energy, or (2) energy in transition.

Stored energy is thought of as energy that is actually contained in or stored in an object. There are two kinds of stored energy: potential energy and kinetic energy. Potential energy is energy in an object waiting to be released; while kinetic energy is energy that has been released. For example, potential energy exists in a rock resting on the edge of a cliff, water behind a dam, or steam behind a turbine throttle valve.

Kinetic energy exists because of the velocities of two or more objects. If you push the rock, open the gate of the dam, or open the turbine throttle valve, something will move. The rock will fall, the water will flow, and the steam will jet through the turbine nozzle valves. Thus the potential energy is converted to kinetic energy.

Energy in transition exists when the rock hits the ground, the water hits the bottom of the dam or the paddles of a water wheel, or when the steam hits the blades of the turbine rotor.

In the examples just discussed, an external source of energy was used to get things started. External energy was used to push the rock, open the gate of the dam, or to open the throttle valve. Thus you can see that one energy system affects another energy system. There is a tremendous amount of chemical energy stored in fuel oil; but it will not raise the steam in the boiler until some external energy has been expended to start the oil burning.

Energy can be measured. The most common measurement of expended energy is in work units of foot-pounds. When an object has been moved through a resisting force, work has been done.

WORK

The turbines and other power equipment used aboard ship are important because they do work. WORK is defined as the result of force moving through distance. The unit of measure for work is the FOOT-POUND (ft-lb). The two parts of this unit are the POUND OF FORCE and the FOOT OF DISTANCE.

Force is measured in pounds. The gravitational pull on an object weighing 1 pound is a force of 1 pound. If you lift a 1-pound weight from ground level to a height of 1 foot, you exert a force of 1 pound through a distance of 1 foot—and 1 foot-pound of work is done in the process. A force of 100 pounds is required to raise a 100-pound anvil; if you lift it to the top of a 30-inch bench, the work done is 2 1/2 ft x 100 lb = 250 ft-lb. Work (in foot-pounds), therefore, equals the force (in pounds) times the distance (in feet).

Now suppose you want to move the anvil across the deck without lifting it. It will take a considerable force to slide the anvil—let us say 60 pounds. If you slide it 10 feet, you do 600 foot-pounds of work. Here the force of 60 pounds is required to overcome the resisting force of friction between the anvil and the deck. A great deal of the work done by any machine is the overcoming of the many frictional forces which resist the motion of the parts.

POWER

The ship's main engines are frequently called the POWER PLANT; and they are commonly rated according to how much power they can develop. For example, it might take one man 10 hours to load 20,000 pounds of ammunition on a truck, whereas a crane could do the same job in 5 minutes. The amount of work done is the same, but the crane is much more powerful than

the man. It can do the work faster. POWER, then, relates to work and time. It is the TIME RATE of doing WORK. If we assume that the ammunition is raised an average height of 6 feet, the work done is equal to 6 ft x 20,000 lb or 120,000 ft-lb. Considering the man also as a machine, the power of each of the two machines is found by dividing this amount of work by the time required in each case. Expressing 10 hours in minutes, the man would work at the rate of 120,000 ft-lb ÷ 600 min = 200 ft-lb per min. The computed power of the crane would be 120,000 ft-lb ÷ 5 min = 24,000 ft-lb per min or 400 ft-lb per sec.

The most common unit of power is known as the HORSEPOWER. One horsepower is equivalent to 550 ft-lb per second, or 33,000 ft-lb per minute. Thus, if a lifting machine raises a weight of 100 pounds at the rate of 250 ft-lb per second, the machine is exerting only 0.454 of a horsepower (250 ft-lb ÷ 550 ft-lb = 0.454 hp).

If a crane hoists 2,000 pounds of cargo to a height of 30 feet in 5 seconds, how much horsepower is developed? Here is how to get the answer:

$$\text{Power} = \frac{\text{work}}{\text{time}} = \frac{2{,}000 \text{ lb} \times 30 \text{ ft}}{5 \text{ sec}}$$

$$= 12{,}000 \text{ ft-lb per sec}$$

$$\text{Horsepower} = \frac{12{,}000 \text{ ft-lb per sec}}{550 \text{ ft-lb per sec}} = 21.8$$

Or suppose a turbine has a known horsepower of 37,500 at rated capacity, and you want to know how much work it does. You find out by multiplying the developed horsepower by the hours in operation. This gives HORSEPOWER-HOURS, which is a measure of work for main propulsion machinery.

LAWS OF GASES

The energy transformation of major interest in the shipboard engineering plant is the transformation from heat to work. To see how this transformation occurs, we need to consider the pressure, temperature, and volume relationships which hold true for gases. In the middle of the 17th century, an English scientist, Robert Boyle, made some interesting discoveries concerning the relationship between the pressure, the temperature, and the volume of gases. In 1787, Jacques Charles, a Frenchman, proved that all gases expand the same amount when heated one degree if the pressure is kept constant. The relationships that these two men discovered are summarized as follows:

1. When the temperature is held constant, increasing the pressure on a gas causes a proportional decrease in volume. Decreasing the pressure causes a proportional increase in volume.

2. When the pressure is held constant, increasing the temperature of a gas causes a proportional increase in volume. Decreasing the temperature causes a proportional decrease in volume.

3. When the volume is held constant, increasing the temperature of a gas causes a proportional increase in pressure. Decreasing the temperature causes a proportional decrease in pressure.

Suppose we have a boiler in which steam has just begun to form. With the steam stop valves still closed, the volume of the steam remains constant while the pressure and the temperature are both increasing. When operating pressure is reached, and the steam stop valves are opened, the high pressure of the steam causes the steam to flow to the turbines. The pressure of the steam thus provides the potential for doing work; the actual conversion of heat to work is done in the turbines.

PRESSURE AND VACUUM

Because pressure is very important to the engineering plant, it is necessary that you understand the relationships between gage pressure, atmospheric pressure, vacuum, and absolute pressure. These relationships are indicated in figure 3-1.

Gage Pressure

Gage pressure is the pressure actually shown on the dial of a gage which registers pressures at or above atmospheric pressure. Gage pressure is usually shown in pounds per square inch (psi); but it may be shown in inches of water, mercury, or other liquid. A reading of 1 inch of water means that the exerted pressure is able to support a column of water 1 inch high, or that a column of water in a U-tube would be displaced 1 inch by the pressure being measured. Similarly, a gage pressure reading of 12 inches of mercury means that the measured pressure is able to support a column of mercury 12 inches high. Gages are calibrated in inches of water

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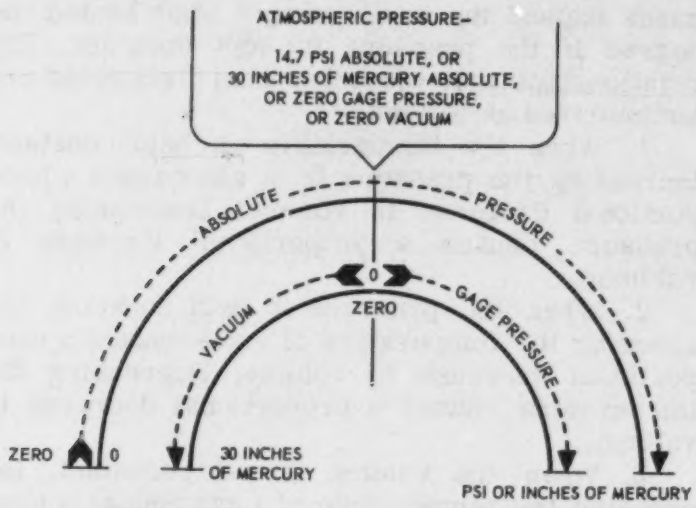

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Figure 3-1.—Relationships between vacuum, gage pressure, absolute pressure, and atmospheric pressure.

when they are to be used for the measurement of very low pressures. Inches of mercury may be used when the range of pressures to be measured is somewhat higher, since mercury is about 14 times as heavy as water.

Note that a gage pressure reading of zero means that the pressure being measured is exactly the same as the existing atmospheric pressure. A gage reading of 50 psi means that the pressure being measured is 50 psi IN EXCESS OF the existing atmospheric pressure.

Atmospheric Pressure

Atmospheric pressure, or the pressure exerted by the weight of the air in the atmosphere, is measured with a BAROMETER (fig. 3-2). A barometer is similar to a manometer (see chapter 9), except that the indicating tube is sealed at the top. A barometer may be made by filling a tube with mercury and then inverting it so that the open end rests in a container of mercury which is open to the atmosphere. The absence of pressure at the closed end of the tube permits atmospheric pressure, acting upon the surface of the mercury in the open container, to hold the mercury in the tube at a height which corresponds to the pressure being exerted.

Normally, at sea level, atmospheric pressure will hold the column of mercury at a height of approximately 30 inches. Since a column of mercury 1 inch high exerts a pressure of 0.49 pounds per square inch, a 30-inch column of mercury exerts a pressure which is equal to (30 x 0.49) 14.7 pounds per square inch. Thus we can say that atmospheric pressure (zero gage pressure) at sea level is 14.7 psi, or 14.7 pounds per square inch absolute (psia). Notice, however, that this figure of 14.7 psi is the STANDARD for atmospheric pressure. Since fluctuations from this standard are shown on the barometer, the term BAROMETRIC PRESSURE is used to describe the atmospheric pressure which exists at any given moment. As a rule, you can use the term ATMOSPHERIC PRESSURE and the value 14.7 psi in place of the actual barometric pressure; but there may be times when it will be important to know the ACTUAL (barometric) pressure, in order to make precise measurements of gage pressure or vacuum.

Vacuum

A space in which the pressure is LESS than atmospheric pressure is said to be under VACUUM. The amount of vacuum is expressed in terms of the difference between the pressure in the space and the existing atmospheric pressure. Vacuum is measured in inches of mercury—that is, the number of inches a column of mercury in a U-tube would be displaced by a pressure equal to the DIFFERENCE between the pressure in the vacuum space and the existing atmospheric pressure.

Vacuum gage scales are marked from 0 to 30. When a vacuum gage reads zero, the pressure in the space is the same as the existing atmospheric pressure—or, in other words, there is no vacuum. A vacuum gage reading of 30 inches of mercury would indicate a nearly perfect vacuum. In actual practice, it is impossible to obtain a perfect vacuum; and the highest vacuum gage readings are seldom over 29 inches of mercury.

Absolute Pressure

Absolute pressure is atmospheric pressure PLUS gage pressure, or atmospheric pressure MINUS vacuum. For example, if gage pressure is 300 psi, absolute pressure is 314.7 psi; or if the measured vacuum is 10 inches of mercury, absolute pressure is approximately 20 inches of mercury. It is important to note that the amount of PRESSURE in a space under vacuum can be expressed only in terms of absolute pressure.

Sometimes it is necessary to convert a reading from inches of mercury to pounds per square inch. Figure 3-1 gives you all the information you need to make this conversion. Since atmospheric pressure is equal to 14.7 psi or to 30 inches of mercury, it is easy to see that 1 inch

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correct the reading, you must ADD the weight of the column of water—that is, you must add 0.433 psi to the gage reading for each foot of rise.

For example, assume that a water pressure gage is connected 5 feet ABOVE the point at which the pressure is being measured. The gage reading is 30 psi. To obtain the actual pressure at the point of measurement, you must add (5 x 0.433 psi) 2.17 psi to the gage reading. Thus the actual pressure is 32.17 psi.

PRINCIPLES OF HYDRAULICS

The word hydraulics is derived from the Greek word for water (hydōr) plus the Greek word for flute (aulos). The term "hydraulics" originally covered a study of the physical behavior of water at rest and in motion. However, the meaning of the term "hydraulics" has been broadened to cover the physical behavior of all liquids, including the oils that are used in present day hydraulic systems.

During the period before World War I, the Navy began to apply hydraulics extensively to naval mechanisms. Since that time, naval applications have increased to the point where many ingenious hydraulic devices are used in the solution of problems of gunnery, navigation, and aeronautics. Aboard ship today the applications of hydraulics include anchor windlasses, power cranes, steering gear, remote controls, power drives for the elevating of guns and training of mounts and turrets, powder and projectile hoists, recoil systems, gun rammers, and airplane catapults.

The foundations of modern hydraulics began in 1653 when Pascal discovered that "pressure set up in a liquid acts equally in all directions." This pressure acts at right angles to the containing surfaces.

In figure 3-3 if the liquid standing on a square inch (A) at the bottom of the tank weighs 8 pounds, a pressure of 8 pounds is exerted in every direction at A. The liquid resting on A will push equally downward and outward. But the liquid on every other square inch of the bottom surface is also pushing downward and outward in the same manner.

When we apply a force to the end of a column of confined liquid, the force is transmitted not only straight through to the other end, but also equally in every direction throughout the column—forwards, backwards, and sideways—so that the containing vessel is literally filled with pressure. This is the reason that a flat fire hose takes on

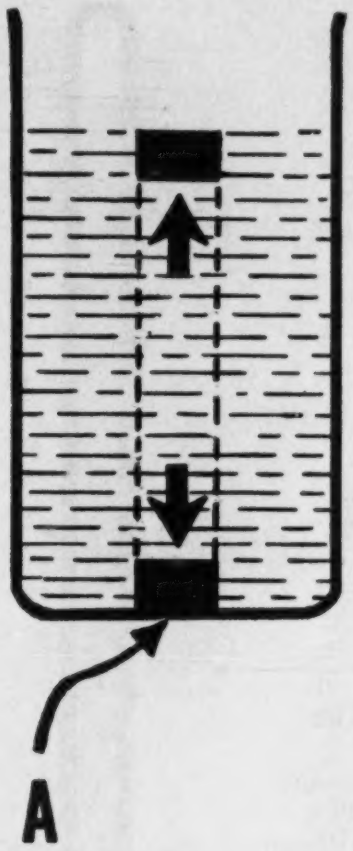

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Figure 3-3.—Illustration showing principle of Pascal's law.

a circular cross-section when it is filled with water under pressure. The outward push of the water is equal in every direction. Water will leave the hose at the same velocity, through leaks, regardless of where the leaks are in the hose.

Let us now consider the effect of Pascal's law in the system shown in figure 3-4. If the force at piston A is 100 pounds and the area of the piston is 10 square inches, then the pressure in the liquid must be 10 pounds per square inch (psi). This pressure is transmitted to piston B—so that for every square inch of its area, piston B will be pushed upward with a force of 10 pounds. In this example we are merely considering a liquid column of equal cross-section so that the areas of the pistons are equal. All we have done is to carry a 100-pound force around a bend; however, the principle illustrated is the basis for practically all mechanical hydraulics.

The same principle may be applied where the input piston is much smaller than the output piston or vice versa. Assume that the area of the input piston is 2 square inches and the area of the output piston is 20 square inches. If you

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apply a pressure of 20 pounds to the smaller piston, the pressure created in the liquid will again be 10 pounds per square inch because the force is concentrated on a smaller area. The upward force on the larger piston will be 200 pounds—10 pounds for each of its 20 square inches. Thus you can see if two pistons are used in a hydraulic system, the force acting on each piston will be directly proportional to its area, and the magnitude of each force will be the product of the pressure and the area of the piston.

PRINCIPLES OF PNEUMATICS

Pneumatics is that branch of mechanics that deals with the mechanical properties of gases. Perhaps the most common application of these properties, used in the Navy today, is the use of compressed air. Compressed air is used to transmit pressure, according to Pascal's principle, in a variety of applications. For example, in tires and air cushioned springs, compressed air acts as a cushion to absorb shock. Air brakes on locomotives and large trucks contribute greatly to the safety of railroad and truck transportation. In the Navy, compressed air is used in numerous ways. For example, tools such as riveting hammers and pneumatic drills are air operated. Automatic combustion control systems utilize compressed air for the operation of the instruments. Compressed air is also used in diving bells and diving suits. Perhaps a brief discussion on the use of compressed air as an aid in the control of submarines will best explain the theory of pneumatics.

Submarines are designed with a number of tanks that may be used for the control of the ship. These tanks may be flooded with water to submerge; or they may be filled with compressed air to surface.

The compressed air for the pneumatic system is maintained in storage tanks (called banks) at a pressure of 4,500 psi. When surfacing, the pneumatic system delivers compressed air to the desired control tanks. Since the pressure of the air is greater than the pressure of the water, the water is forced out of the tank. As a result, the weight of the ship is decreased; it becomes more buoyant, and thus it will tend to rise to the surface.

HEAT

You undoubtedly know from experience that heat and temperature are related; however, they are not the same. Water from a water main feels cool until it has been over a fire a few minutes. It evidently must have received something from the fire. If you place two pennies together, one of which was heated by being held in the flame of a match, in a short time the two pennies will be equally warm. Again something passed into the cooler object and made it hot. That something is called heat.

Many forms of mechanical action also produce considerable quantities of heat. For example, you rub your hands together to warm them when they are cold. Matches are ignited by rubbing them on a rough surface. A Shipfitter can notice heat in a piece of metal after hammering it; and the head of a nail is heated when the nail is driven into wood.

The molecules in the nail (as in all matter) are in continual motion. The blow on the nail increases the molecular motion. The molecules in the top layer receive the impulse from the hammer, and vibrate with greater violence. The increased vibration and energy of motion is passed on to layer after layer of molecules. Thus the effect of the blow is to produce a general increase in the motion of the molecules. This energy of molecular motion is called heat.

Because molecules are constantly in motion, they exert a pressure on the walls of the pipe, boiler, cylinder, or other object in which they are contained. Also, the temperature of any substance arises from and is directly proportional to the activity of the molecules. Therefore, every time you read thermometers and pressure gages you are finding out something about the amount of internal energy contained in the substance. High pressures and temperatures indicate that the molecules are moving rapidly and that the substance therefore has a lot of internal energy.

HEAT is a more familiar term than internal energy, yet one that may actually be more difficult to define correctly. The important thing to remember is that heat is THERMAL ENERGY IN TRANSITION—that is, it is thermal energy that is moving from one substance or system to another.

An example will help to illustrate the difference between heat and internal energy. Suppose there are two equal lengths of pipe, made of identical materials and containing steam at the same pressure and temperature. One pipe is well insulated, the other is not insulated at all. From everyday experience you know that more heat will flow from the uninsulated pipe than from the insulated pipe. When the two pipes are first filled with steam, the steam in one pipe contains exactly as much internal energy as the steam in the other

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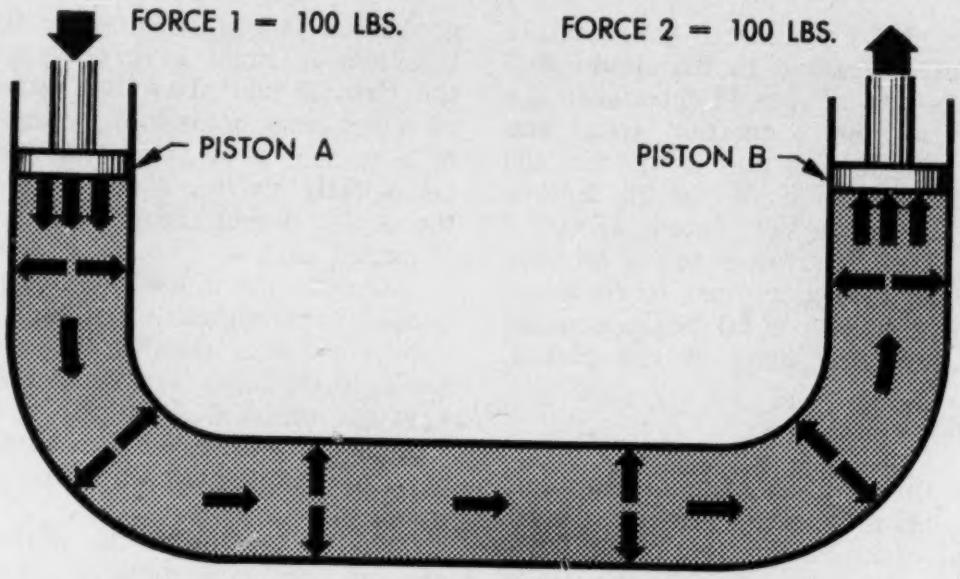

Figure 3-4.—Principle of mechanical hydraulics. 5.181

pipe. We know this is true because the two pipes contain equal volumes of steam at the same pressure and at the same temperature. After a few minutes, the steam in the uninsulated pipe will contain much less internal energy than the steam in the insulated pipe, as we can tell by measuring the pressure and the temperature of the steam in each pipe. What has happened? Stored thermal energy—internal energy—has moved from one place to another, first from the steam to the pipe, then from the uninsulated pipe to the air. The MOVEMENT or FLOW of thermal energy is what should be called heat.

Units of Measurement

Both internal energy and heat are usually measured using the unit called the BRITISH THERMAL UNIT (Btu). For most practical engineering purposes, 1 Btu is defined as the amount of thermal energy required to raise the temperature of 1 pound of water through 1°F.

When large amounts of thermal energy are involved, it is usually more convenient to use multiples of the Btu. For example, 1 kB is equal to 1,000 Btu, and 1 mB is equal to 1,000,000 Btu.

Another unit in which thermal energy may be measured is the CALORIE, the amount of heat required to raise the temperature of 1 gram of water 1°C. One Btu equals 252 calories.

Sensible Heat and Latent Heat

The terms SENSIBLE HEAT and LATENT HEAT are often used to indicate the effect that the flow of heat has on a substance. The flow of heat from one substance to another is normally reflected in a temperature change in each substance—the hotter substance becomes cooler, the cooler substance becomes hotter. However, the flow of heat is NOT reflected in a temperature change in a substance which is in the process of changing from one physical state (solid, liquid, or gas) to another. When the flow of heat is reflected in a temperature change, we say that SENSIBLE HEAT has been added to or removed from the substance. When the flow of heat is NOT reflected in a temperature change but IS reflected in the changing physical state of s substance, we say that LATENT HEAT has been added or removed.

Does anything bother you in this last paragraph? It should. Here we are, talking about adding and removing heat. And, furthermore, we are talking about sensible heat and latent heat as though we had two different kinds of heat to consider. As noted before, this is common (if inaccurate) engineering language. So keep the following points clearly in mind: (1) heat is the flow of thermal energy; (2) when we talk about adding and removing heat, we mean that we are providing temperature differentials so that thermal energy can flow from one substance to another; and (3) when we talk about sensible heat and latent heat, we are talking about two different kinds of EFFECTS that can be produced by heat, but not about two different kinds of heat.

The three basic physical states of all matter are SOLID, LIQUID, and GAS (or vapor). The physical state of a substance is closely related

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to the distance between molecules. As a general rule, the molecules are closest together in solids, farther apart in liquids, and farthest apart in gases. When the flow of heat to a substance is not reflected in a temperature change, we know that the energy is being used to increase the distance between the molecules of the substance and thus to change it from a solid to a liquid or from a liquid to a gas. You might say that latent heat is the energy price that must be paid for a change of state from solid to liquid or from liquid to gas. The energy is not lost; rather, it is stored in the substance as internal energy. The energy price is "repaid," so to speak, when the substance changes back from gas to liquid or from liquid to solid, since heat flows FROM the substance during these changes of state.

Figure 3-5 shows the relationship between sensible heat and latent heat for one substance, water, at atmospheric pressure. (The same kind of chart could be drawn up for other substances; however, different amounts of thermal energy would be involved in the changes of state.)

If we start with 1 pound of ice at 0°F, we must add 16 Btu in order to raise the temperature of the ice to 32°F. We call this adding SENSIBLE HEAT. To change the pound of ice at 32°F to a pound of water at 32°F, we must add 144 Btu (the LATENT HEAT OF FUSION). There will be no change in temperature while the ice is melting. After all the ice has melted, however, the temperature of the water will be raised as additional heat is supplied. If we add 180 Btu—that is, 1 Btu for each degree of temperature between 32°F and 212°F—the temperature of the water will be raised to the boiling point. To change the pound of water at 212°F to a pound of steam at 212°F, we must add 970 Btu (the LATENT HEAT OF VAPORIZATION). After all the water has been converted to steam, the addition of more heat will cause an increase in the temperature of the steam. If we add about 44 Btu to the pound of steam which is at 210°F, we can superheat it to 300°F.

The same relationships apply when heat is being removed. The removal of 44 Btu from the pound of steam which is at 300°F will cause the temperature to drop to 212°F. As the pound of steam at 212°F changes to a pound of water at 212°F, 970 Btu are given off. When a substance is changing from a gas or vapor to a liquid, we usually use the term LATENT HEAT OF CONDENSATION for the heat that is given off. Notice, however, that the latent heat of condensation is exactly the same as the latent heat of vaporization. The removal of another 180 Btu of sensible heat will lower the temperature of the pound of water from 212° F to 32° F. As the pound of water at 32° F changes to a pound of ice at 32° F, 144 Btu are given off without any accompanying change in temperature. Further removal of heat causes the temperature of the ice to decrease.

TEMPERATURE

The temperature of an object is a measure of how hot or cold the object is; and it can be measured by thermometers and read on their temperature scales.

The TEMPERATURE SCALES employed to measure temperature are the Fahrenheit scale and the centigrade scale. In engineering and for practically all purposes in the Navy, the Fahrenheit scale is used. It may, however, be necessary for you to convert centigrade readings to the Fahrenheit scale, so both scales are explained here.

The FAHRENHEIT SCALE has two main reference points—the boiling point of pure water at 212°, and the freezing point of pure water at 32°. The size of the Fahrenheit degree is 1/180 of the total temperature change from 32° to 212°. And the scale can be extended in either direction—to higher temperatures without any limits, and (by using MINUS degrees) to lower temperatures down to the lowest temperature theoretically possible, the so-called ABSOLUTE ZERO. This temperature is -460°, or 492° below the freezing point of water.

In the CENTIGRADE SCALE, the freezing point of pure water is 0° and the boiling point of pure water is 100°. Therefore, 0°C and 100°C are equivalent to 32°F and 212°F, respectively. Each centrigrade degree is larger than a Fahrenheit degree (since there are only 100 centigrade degrees between the freezing and boiling points of water, while this same temperature change requires 180 degrees in the Fahrenheit scale). Therefore the centrigrade degree is 180/100 or 1.8 Fahrenheit degrees. In the centrigrade scale absolute zero is -273°.

Figure 3-6 shows the two temperature scales in comparison. This figure also introduces the simplest of the temperature measuring instruments, the liquid-in-glass THERMOMETER. The two thermometers shown are exactly alike in SIZE and SHAPE, the only difference being in the outside markings or SCALES on them. Each thermometer is a hollow glass tube which has a mercury-filled bulb at the bottom, and which is sealed at the top. Mercury, like any liquid, expands on being heated, and it will rise in the

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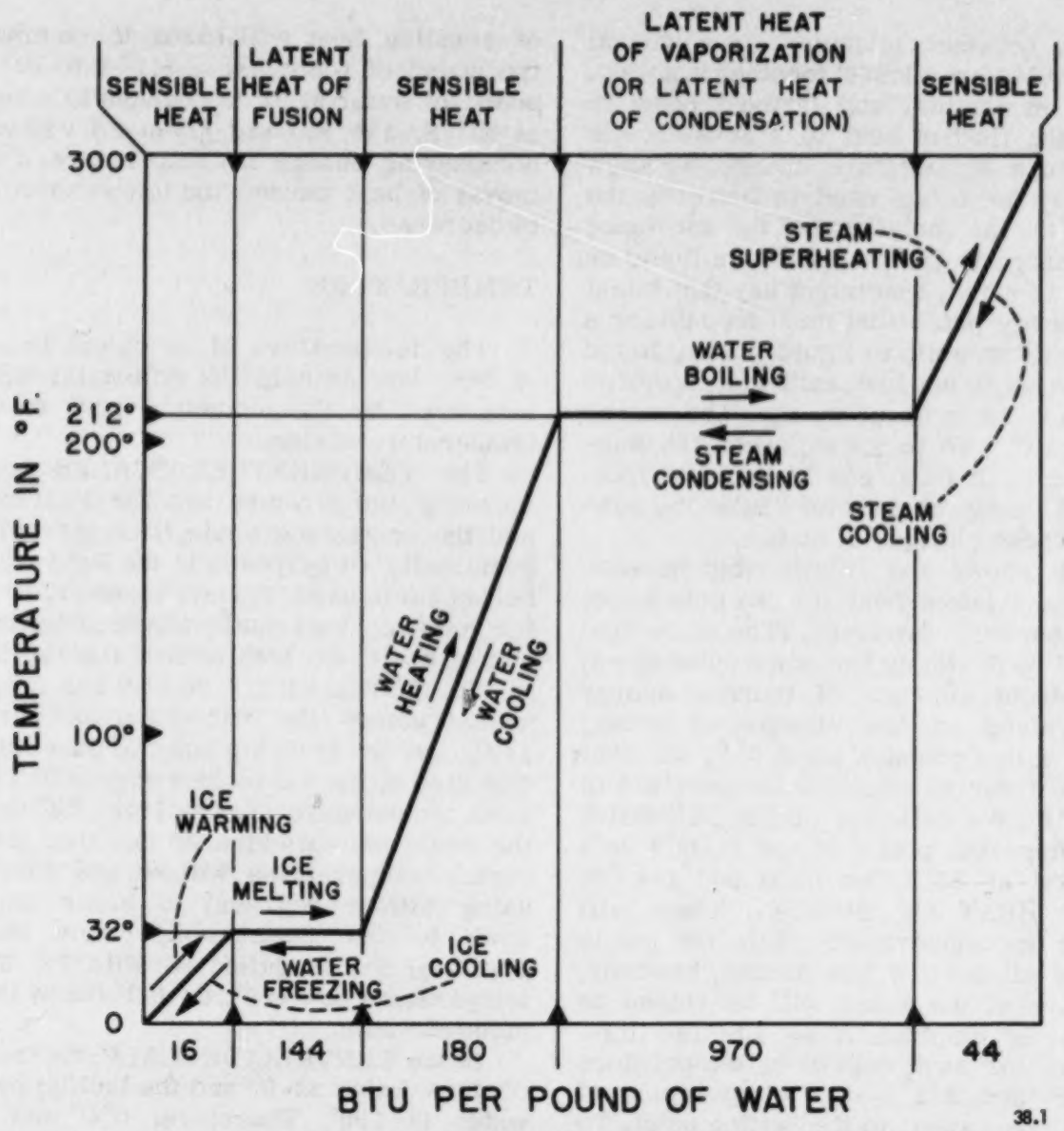

Figure 3-5.—Relationship between sensible heat and latent heat for water at atmospheric pressure.

hollow tube. The illustration shows the Fahrenheit thermometer with its bulb standing in ice water (32°F), while the centigrade thermometer is in boiling water (100°C).

The essential point to remember is that the level of the mercury in a thermometer depends only on the temperature to which the bulb is exposed. If you were to exchange the thermometers, the mercury in the centigrade thermometer would drop to the level at which the mercury now stands in the Fahrenheit thermometer, while the mercury in the Fahrenheit thermometer would rise to the level at which the mercury now stands in the centigrade thermometer. The temperatures would be 0°C for the ice water and 212°F for the boiling water.

If you place both thermometers in water containing lumps of ice, the Fahrenheit thermometer will read 32° and the centigrade thermometer will read 0°. Heat the water slowly. The temperature will not change until the ice in the water has completely melted (a great deal of heat is required just to melt the ice), then both mercury columns will begin to rise. When the mercury level is at the +10° mark in the centigrade thermometer, it will be at the +50° mark in the Fahrenheit thermometer. The two columns will rise together at the same speed, and when the water finally boils they will stand at 100°C and 212°F, respectively. The same temperature change—that is, the same amount of heat transferred to the water—has raised the temperature 100

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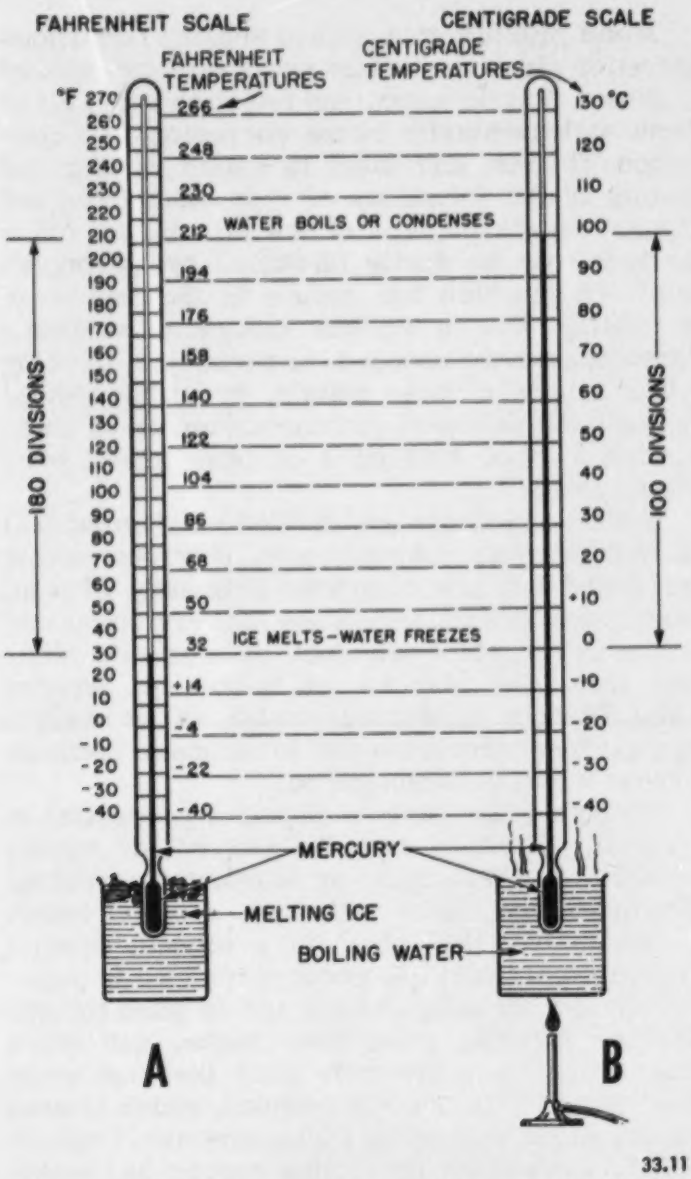

Figure 3-6.—Temperature scales: A. Fahrenheit scale. B. Centrigrade scale.

centigrade degrees and 180 Fahrenheit degrees, but the actual change in heat energy is EXACTLY THE SAME.

COMBUSTION

The term "combustion" refers to the rapid chemical union of oxygen with the fuel. The perfect combustion of fuel should result in carbon dioxide, nitrogen, water vapor, and sulphur dioxide. The oxygen furnished to the fuel, in order to burn it, is obtained from the air. Air is a mechanical mixture containing by weight 23.15 percent oxygen and 76.85 percent nitrogen. The oxygen only is used in combustion of the fuel; the nitrogen, being an inert gas, has no chemical effect upon the combustion.

The chemical combination obtained during combustion results in the liberation of heat energy, a portion of which is used to propel the ship. Actually, what happens is a rearrangement of the atoms of the chemical elements into new combinations of molecules. In other words, as the temperature of the fuel oil in the presence of oxygen is increased to the ignition point, the various chemical elements in the fuel begin to separate from each other and unite with certain amounts of oxygen, to form entirely new substances, which give off heat energy in the process. A good fuel has a high speed of combustion, thus producing a large amount of heat in a short time.

PERFECT COMBUSTION cannot as yet be achieved in either a boiler or the cylinders of an internal combustion engine, but this is the objective. Theoretically, it is simple. It consists of bringing each particle of the fuel (heated to its ignition temperature) into contact with the correct amount of oxygen. The following factors are involved:

1. Sufficient air must be supplied.
2. The air and fuel particles must be thoroughly mixed.
3. Temperatures must be high enough to maintain combustion.
4. Enough time must be allowed to permit completion of the process.

What is known as COMPLETE COMBUSTION, however, can be achieved. This is accomplished by supplying more oxygen to the process than would be required if perfect combustion were possible. The result is that some of the excess oxygen appears in the combustion gases.

STEAM

Steam is water to which enough heat has been added to convert it from the liquid to the gaseous state. When heat is added to water in an open container, steam forms, but it quickly mixes with air and cools back to water that is dispersed in the air, making the air more humid. If you add the heat to water in a closed container, the steam builds up pressure. If you add exactly enough heat to convert all the water to steam at the temperature of boiling water, you get saturated steam. SATURATED STEAM is steam saturated with all the heat it can hold at the boiling temperature of water.

The boiling temperature of water becomes higher as the pressure over the water becomes higher. Steam hotter than the boiling temperature of water is called SUPERHEATED STEAM. When steam has 250°F of superheat,

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the actual temperature is the boiling temperature plus 250°F. At 600 psi the boiling temperature of water is 489°F. So if steam at 600 psi has 250°F of superheat, its actual temperature is 739°F. WET STEAM is steam at the boiling temperature, but still containing some water particles. DESUPERHEATED STEAM is steam which has been cooled by being passed through a pipe extending through the steam drum; in the process the steam loses all but about 20° or 30° of its superheat. The advantage of desuperheated steam is that it is certain to be dry, and yet it is not so hot that special alloy steels would be required for the construction of the piping that carries the desuperheated steam about the ship.

METALS

As you look around, you can see that not only is your ship constructed of metal, but that the boilers, piping system, machinery, and even your bunk and locker are constructed of some type of metal. No one type of metal can serve all the needs aboard ship, so many types of metals or metal alloys must be used. For some parts of a ship a strong metal must be used and on other parts a lightweight metal is needed. Some areas require special metal that can be shaped or worked very easily.

The physical properties of some metals or metal alloys make them more suitable for one use than for another. Various terms are used in describing the physical properties of metals. By studying the following explanations of these terms you should have a better understanding of why certain metals are used on one part of the ship's structure and not on another part.

STRENGTH refers to the ability of a metal to maintain heavy loads (or force) without breaking. Steel, for example, is strong, but lead is weak.

HARDNESS refers to the ability of a metal to resist penetration, wear, or cutting action.

MALLEABILITY is a property of a metal that allows it to be rolled, forged, hammered, or shaped, without cracking or breaking. Copper is a very malleable metal.

BRITTLENESS—any metal that will shatter easily is brittle. Metals such as cast iron or cast aluminum, and some very hard steels are brittle.

DUCTILITY refers to the ability of a metal to stretch or bend without breaking. Soft iron, soft steel, and copper are ductile metals.

TOUGHNESS—metal that will not tear or shear (cut) easily and that will stretch without breaking has the property of toughness.

Metal preservation aboard ship is a continuous operation since the metals are constantly exposed to fumes, water, acids, and moist salt air; all of these will eventually cause corrosion. The corrosion of iron and steel is called rusting and results in the formation of iron oxide (iron and oxygen) on the surface of the metal. Iron oxide (or rust) can be easily identified by its reddish color. (A blackish hue occurs in the first stage of rusting, but is seldom thought of as rust.) Corrosion can be reduced, or prevented, by using better grades of base metals, by adding special metals such as nickel and chromium, or by coating the surface with paint or other metal preservatives.

Metals and alloys are divided into two general classes: ferrous and nonferrous. Ferrous metals are those that are composed primarily of iron. Nonferrous metals are those that are composed primarily of some element or elements other than iron. One way to tell a common ferrous metal from a nonferrous metal, is by using a magnet; most ferrous metal is magnetic and nonferrous metal is nonmagnetic.

To obtain the desired physical properties of a metal, elements must be alloyed (or mixed) together. For example, by alloying (or mixing) chromium and nickel with iron, a metal known as special treated steel is produced. Special treated steel (STS) has great resistance to penetrating and shearing forces and is used for gun shields, turrets, protective decks, and other vital areas. A nonferrous alloy that has many uses aboard ship is copper-nickel, which is used extensively in salt water piping systems. Copper-nickel is produced by mixing copper and nickel together. There are many other different metals and alloys used aboard ship that will not be discussed here.

With all the different types of metals used aboard ship, some way of identifying these metals in the storeroom must be used. At the present time the Navy utilizes two systems of identifying metals: the continuous identification marking system and the color marking system. These systems have been designed so that even after a portion of the metal has been removed, the identifying marks are still visible.

In the continuous identification marking system, the identifying information is actually painted on the metal with a heavy ink. This marking appears at specified intervals over the length of the metal. The marking contains the producer's trademark and the commercial designation of the metal. The marking also indicates the physical

condition of the metal such as "cold drawn," "cold rolled," "seamless," and others.

In the color marking system, a series of color symbols with a related color code is used to identify metals. The term "color symbol" refers to a color marking actually painted on the metal. The symbol is composed of one, two, or three colors and is painted on the metal in a conspicuous place. These color symbols correspond to the elements of which the metal is composed.

For further information on the metals used aboard ship, the properties of these metals, and the identification systems used, refer to the Navy Training Course Shipfitter 3 & 2, NavPers 10595-A.

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CHAPTER 4

SHIP PROPULSION

The primary function of any marine engineering plant is to convert the chemical energy of a fuel into useful work, and to utilize that work in the propulsion of the ship. A propulsion unit consists of the machinery and equipment, including their controls, that are mechanically, electrically, or hydraulically connected to a propulsion shaft.

This chapter contains information on the principles of ship propulsion, and in addition acquaints you with some of the different types of ship propulsion units, which include the geared-turbine drive, the turbine electric drive, diesel electric (d-c) drive and the straight diesel engine drive.

PRINCIPLES OF SHIP PROPULSION

A ship is propelled through the water by means of some device which imparts velocity to a column of water and moves it in the direction opposite to the direction in which it is desired to move the ship. A reactive force (thrust) is thereby developed against the velocity-imparting device, and this thrust, when transmitted to the ship, causes the ship to move through the water. All propelling devices—oars, paddle wheels, and propellers—are designed to move a column of water in order to build up a reactive force sufficient to move the ship.

The screw-type propeller is the propulsion device used on practically all naval ships. The thrust developed on the propeller is transmitted to the ship's structure by the shaft through the thrust bearing. On most steam-driven ships, the mechanical energy required to turn the propeller is provided by the turbines. Reduction gears are used on practically all steam-driven ships to connect the turbine to the shaft in a manner that allows the turbines to operate at high rotational speeds while the propellers operate at lower rotational speeds, thus allowing most efficient operation of both turbines and propellers.

The general principle of ship propulsion is illustrated in figure 4-1.

TYPICAL PROPULSION UNITS

Propulsion units with various types and designs of prime movers are currently in use in naval ships. The prime movers of a propulsion unit may be a geared turbine, turbine and a

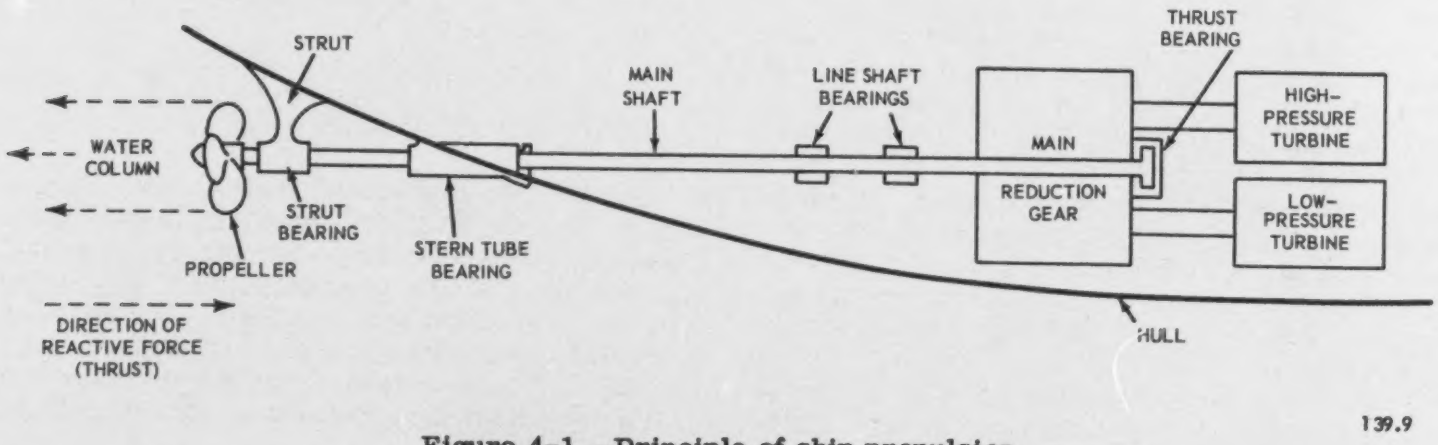

Figure 4-1.—Principle of ship propulsion.

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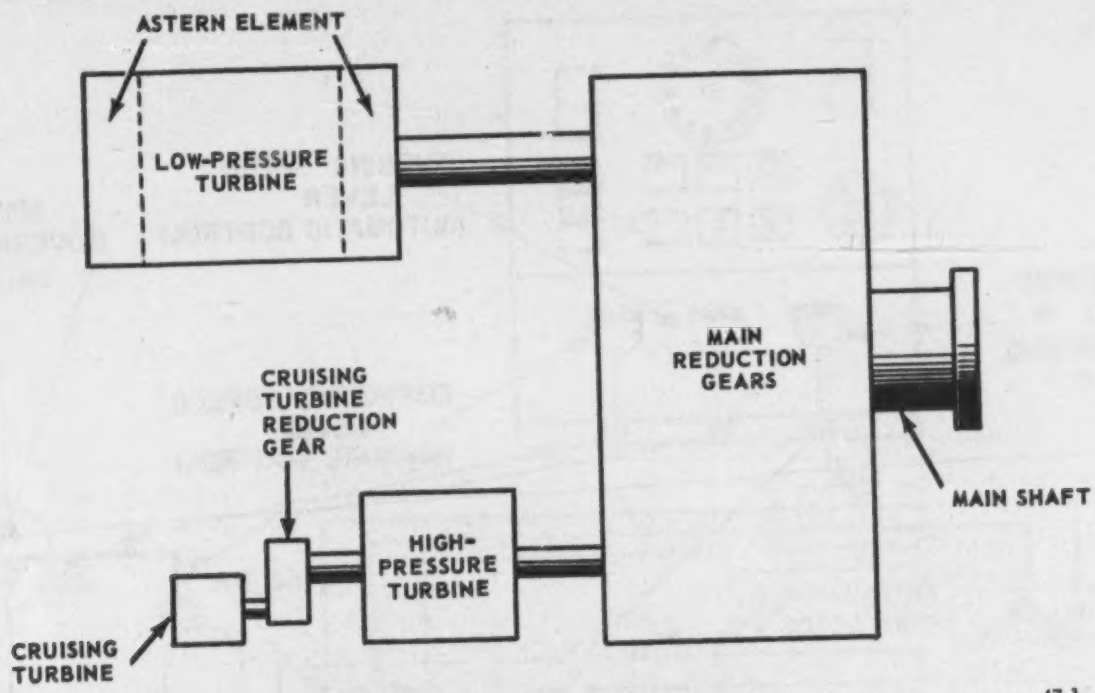

Figure 4-2.—Geared-turbine propulsion unit. 47.1

generator, a diesel engine and a generator, or a straight diesel engine. These are the most common types of prime movers of propulsion units and the ones with which we are most concerned.

GEARED-TURBINE DRIVE

In the geared-turbine drive, the unit parts or sections which make up the individual propulsion units consist of the main turbines and the reduction gear.

Figure 4-2 shows the general arrangement of the turbines and gears in a geared-turbine propulsion unit. Not all geared turbine plants have the cruising turbine which is included in the diagram. Ordinarily, cruising turbines will be found in only the older destroyers.

In a typical destroyer propulsion plant, the speed reduction ratio between the cruising turbine shaft and high pressure turbine shaft is approximately 1.8 to 1. The speed ratio between the high pressure turbine shaft and propeller shaft is 16 to 1, and the ratio between the low pressure turbine and propeller shaft is 13 to 1. In other words, in operation, if the propeller shaft is revolving at 100 rpm, the cruising turbine will be revolving at 2,880 rpm (1.8 x 16 x 100), the high pressure turbine at 1,600 rpm (16 x 100), and the low pressure turbine at 1,300 rpm (13 x 100).

Figure 4-2 shows two astern elements, one at each end of the low pressure turbine. This arrangement is typical for combatant type ships; auxiliary type ships usually have one astern element instead of two, and that one invariably is located at the forward end of the low pressure turbine (the end farthest from the reduction gear).

THE PROPULSION SHAFT, which extends from the main gear (low speed) shaft of the reduction gear to the propeller, is supported and held in alignment by the SPRING BEARINGS, the STERN TUBE BEARINGS, and the STRUT BEARING. The axial thrust, acting on the propulsion shaft as a result of the pushing effect of the propeller, is absorbed in the MAIN THRUST BEARING. In most ships, the main thrust bearing is located at the forward end of the main shaft, within the reduction gear casing. In some very large ships, however, the main shaft thrust bearing is located farther aft in a machinery space or a shaft alley.

TURBINE ELECTRIC DRIVE

Turbine electric drive installations have a single turbine unit for each installed shaft. Figure 4-3 shows the diagrammatic arrangement of a turbine electric propulsion unit. As you can see, the propulsion unit includes a turbine, main generator, propulsion motor, and a propulsion control board, a direct current generator for supplying rotor field current to the propulsion

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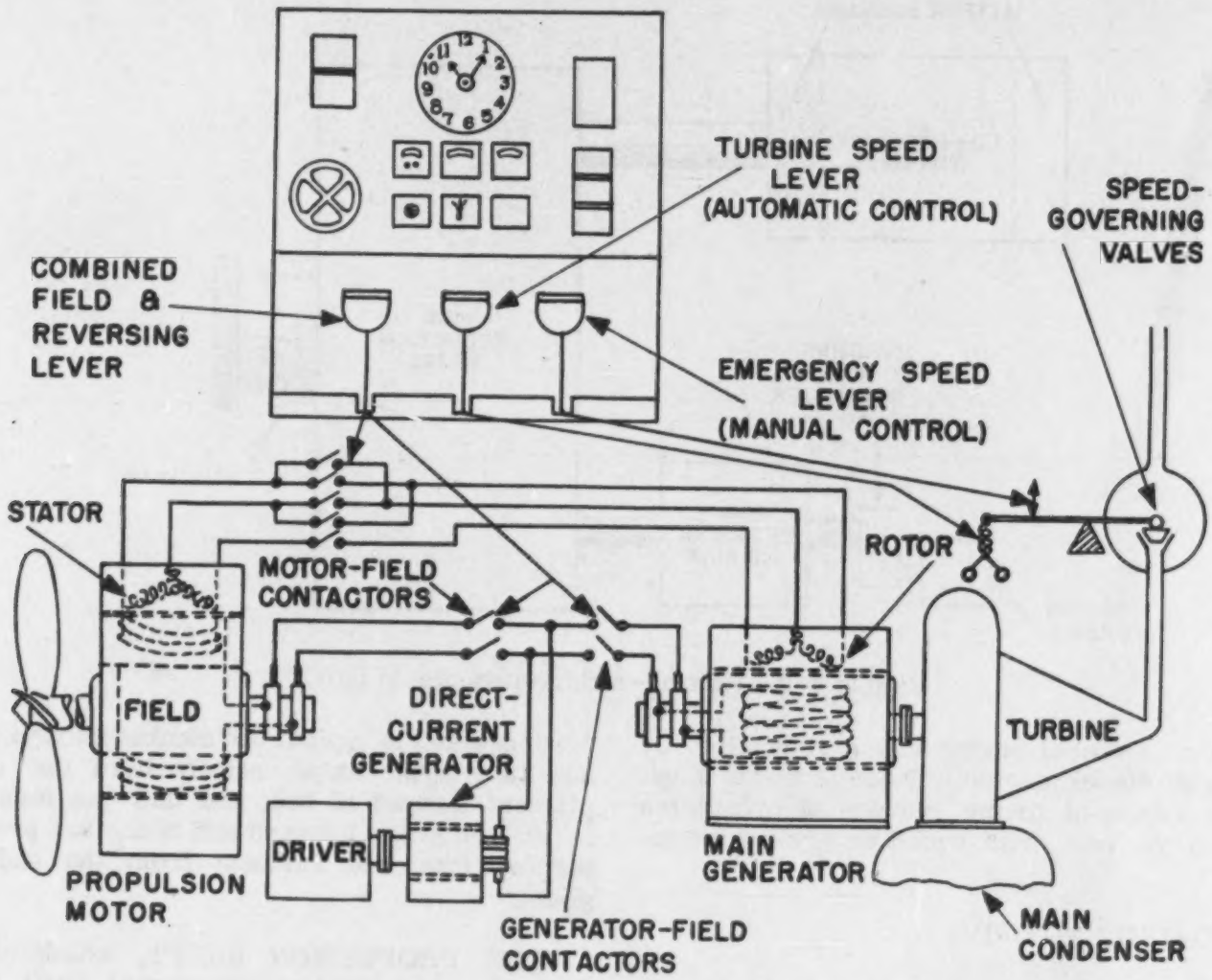

Figure 4-3.—Diagram of the turbo-electric drive. 47.2

motor and excitation current to the generator. Figure 4-4 is an illustration of a typical control board.

The speed reduction ratio between turbine and propeller in the turbo-electric drive is approximately the same as in the geared-turbine drive and is brought about electrically. For example, in one class of turbo-electric drive type destroyer escort, the normal operating range fixed speed ratio between the turbine-generator set and the propulsion motor is 14 to 1.

One of the outstanding differences between geared drive and electric drive is that the latter does not have an astern turbine element. In the electric drive, the direction of rotation of the propulsion motor, and consequently the propeller, is controlled by the electrical switch setup. Therefore, there is no need to reverse turbine rotation for astern operation.

DIESEL (D-C) ELECTRIC DRIVE

Diesel d-c electric drive is best suited to ships in the low or medium horsepower range up to about 6,000 shaft horsepower. It has been installed in approximately 175 escort ships and 500 surface ships and craft of other types, including minesweepers, submarine tenders, older submarines, fleet and harbor tugs, fuel oil tankers and barges, rescue and salvage craft and miscellaneous unclassified craft.

Figure 4-5 shows one of the main propulsion diesel engines aboard an oceanographic research ship. Figure 4-6 shows the main propulsion switchboard operating station aboard the same ship.

The propulsion equipment for a fleet tug that utilizes diesel d-c drive consists of four diesel-engine d-c generators furnishing power to one propulsion motor rated at 3,000 horsepower

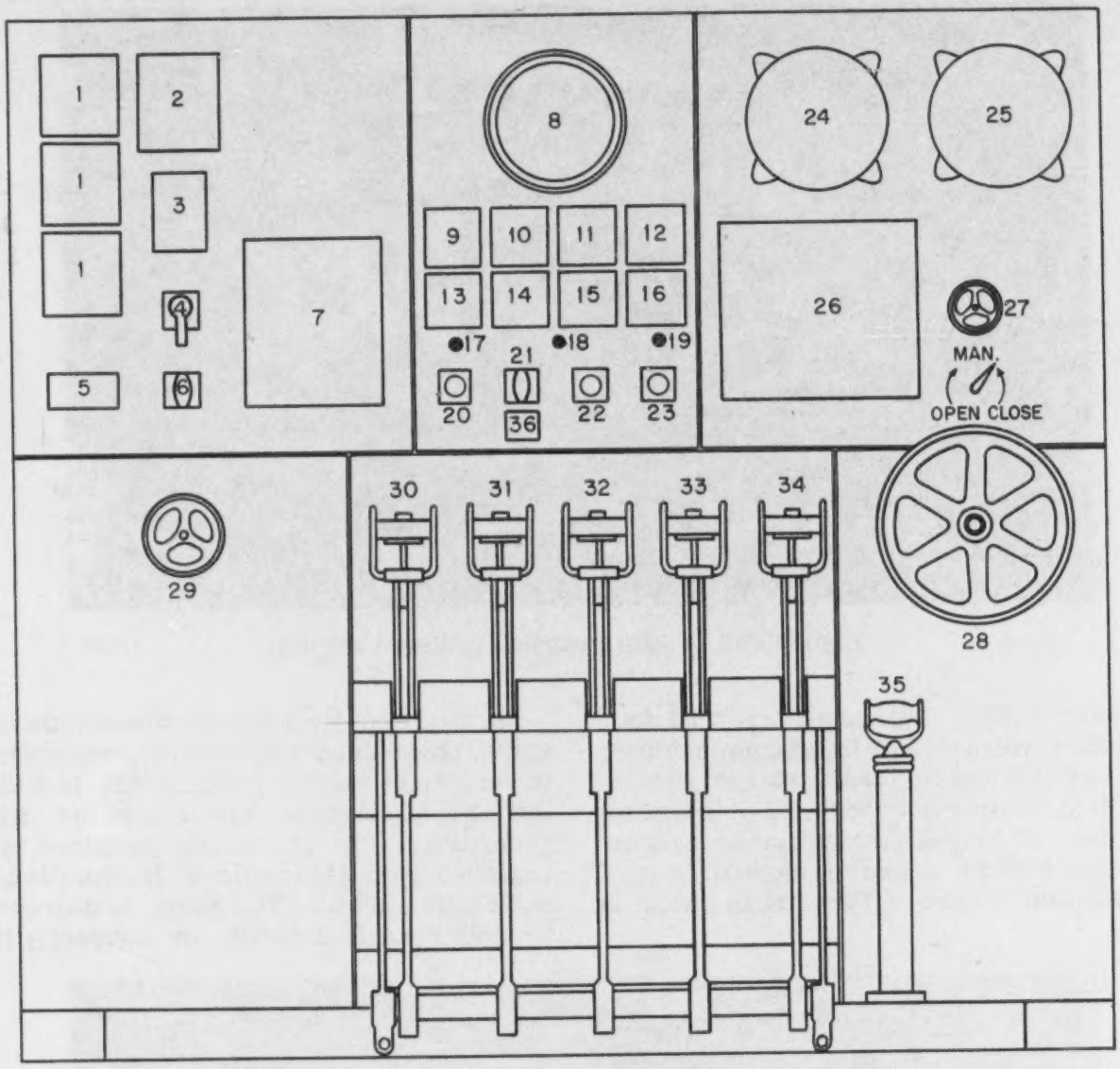

1. PHASE BALANCE RELAYS
2. GROUND PROTECTIVE RELAY
3. NAMEPLATE FOR GEN FIELD AMP
4. EXCITATION SET STARTING SWITCH
5. TEST BLOCK
6. STANDBY EXCITER CONTROL SWITCH
7. ENGINE ROOM TELEGRAPH
8. CLOCK
9. GENERATOR FIELD AMMETER
10. TURBINE SPEED INDICATOR
11. GENERATOR INDICATING WATTMETER
12. MOTOR FIELD AMMETER
13. EXCITER AND GROUND DETECTOR VOLTMETER
14. GENERATOR AMMETER
15. GENERATOR VOLTMETER
16. STATOR COIL TEMPERATURE INDICATOR
17. INDICATING LAMP CONTROL BUS
18. INDICATING LAMP WRONG DIRECTION INDICATOR
19. INDICATING LAMP HEATER
20. EXCITER VOLTMETER AND GROUND DETECTOR SWITCH
21. CONTROL SWITCH
22. MOTOR STATOR TEMPERATURE INDICATOR SWITCH
23. GENERATOR STATOR TEMPERATURE INDICATOR SWITCH
24. SHAFT RPM INDICATOR AND REVOLUTION COUNTER
25. SHAFT RPM INDICATOR AND REVOLUTION INDICATOR
26. RPM TELEGRAPH
27. LOAD LIMIT CONTROL RELEASE
28. LOAD LIMIT CONTROL HANDWHEEL
29. EXCITER FIELD RHEOSTAT
30. MOTOR SET UP LEVER
31. FIELD LEVER
32. REVERSER LEVER
33. GOVERNOR CONTROL LEVER
34. EMERGENCY LEVER
35. TURBINE TRIP HANDLE
36. NAMEPLATE FOR EMERGENCY OPERATION

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Figure 4-4.—Propulsion control equipment—DE-51 class.

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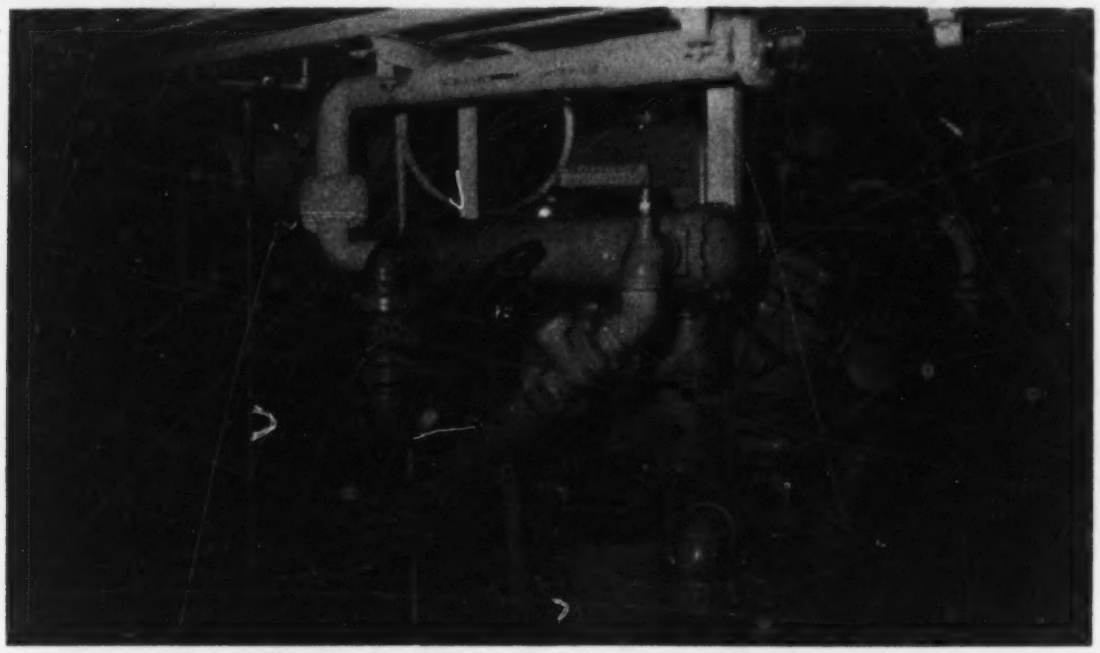

Figure 4-5.—Main propulsion diesel engine. 139.10

which, in turn drives the propeller. The four generating units are normally located amidships—two on the port side and two on the starboard side.

The control of direction (forward or reverse) and the speed of propeller rotation is accomplished at the control board. A typical control board installation aboard a fleet tug is shown in figure 4-7.

In the propulsion plants of some diesel-driven ships, there is no mechanical connection between the engine(s) and the propeller(s). In such plants, the diesel engines are connected directly to generators. The electricity produced by such an engine-driven generator is transmitted, through cables, to a motor. The motor is connected to the propeller shaft directly, or indirectly through a

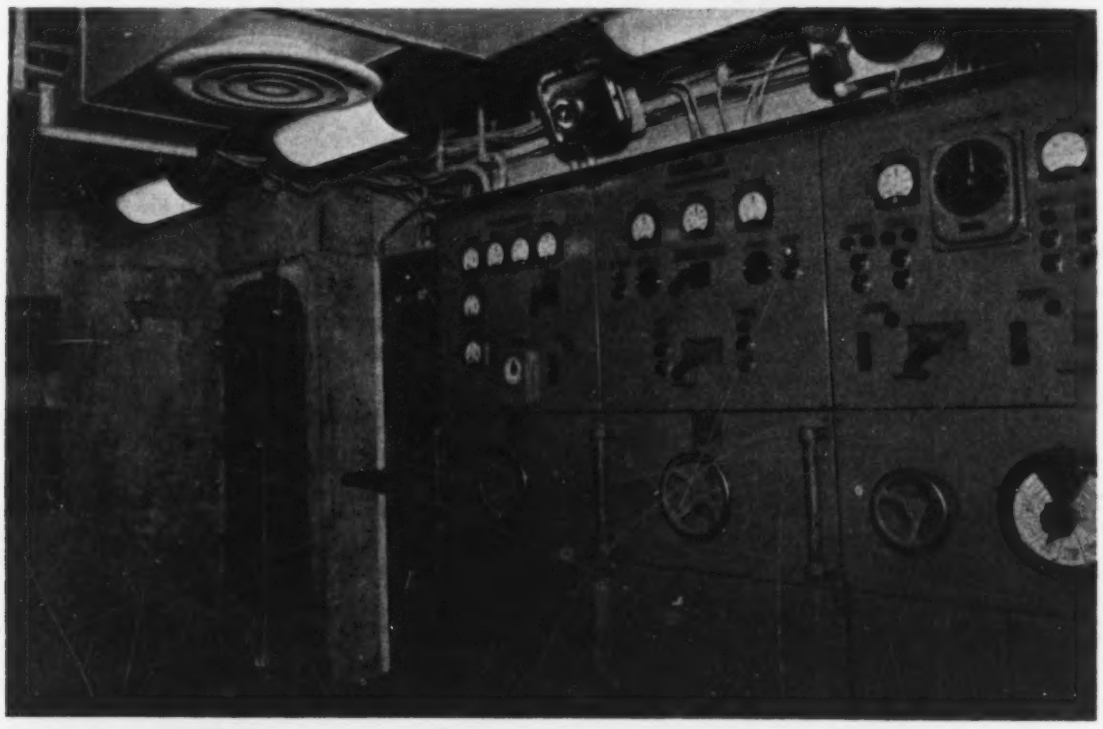

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Figure 4-6.—Main propulsion switchboard, enclosed operating station.

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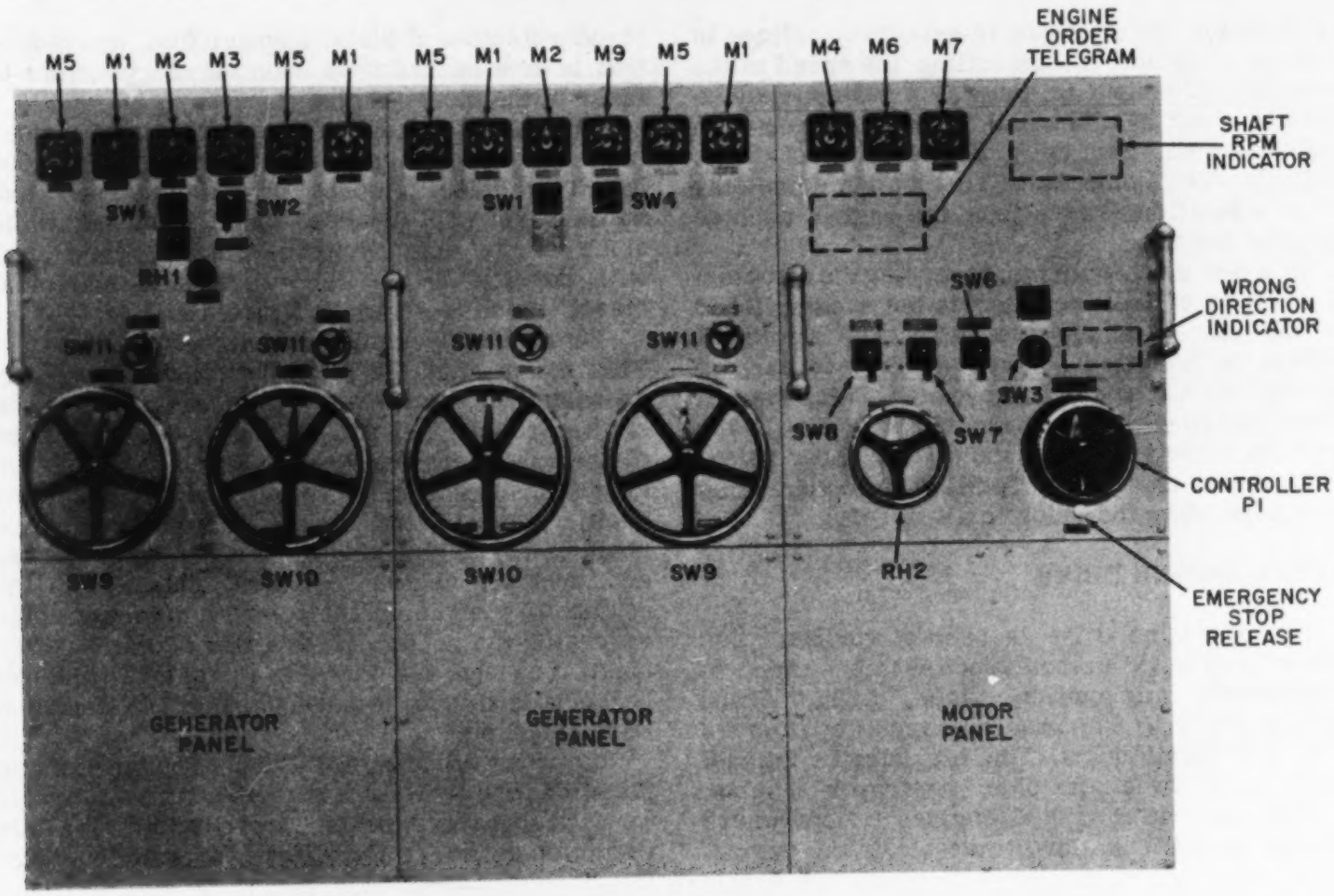

M1-GENERATOR VOLTMETER, 500-0-500
M2-EXCITER AND GROUND DETECTOR VOLTMETER, 100-0-100
M3-AUXILIARY POWER AMMETER, 0-2000
M4-MOTOR AND GROUND DETECTOR VOLTMETER, 1000-0-1000
M5-ENGINE SPEED INDICATOR, 0-1000
M6-MOTOR FIELD AMMETER, 0-150
M7-MOTOR AMMETER, 3000-0-3000
M8-PILOT HOUSE MOTOR AMMETER, 3000-0-3000 (NOT SHOWN)
M9-EXCITATION VOLTMETER (SHIP'S SERVICE), 0-300
SW1-EXCITER VOLTMETER AND GROUND DETECTOR TRANSFER SWITCH
SW2-AUXILIARY POWER GENERATOR FIELD CONTROL SWITCH
SW3-MOTOR VOLTMETER AND GROUND DETECTOR TRANSFER SWITCH
SW4-EXCITER VOLTMETER AND GENERATOR FIELD GROUND DETECTOR TRANSFER SWITCH
SW5-ENGINE SPEED-EXCITER FIELD SWITCH ON GENERATOR SET-UP SWITCH (NOT SHOWN)
SW6-ENGINE SPEED CONTROL SWITCH
SW7-EXCITATION CONTROL SWITCH
SW8-PILOT HOUSE-ENGINEROOM TRANSFER SWITCH
SW9-10-GENERATOR SET-UP SWITCHES
SW11-GENERATOR CONTROL SWITCH
RH1-AUXILIARY POWER GENERATOR FIELD RHEOSTAT
RH2-MOTOR FIELD RHEOSTAT
P1-ENGINEROOM CONTROLLER

Figure 4-7.—Propulsion control equipment—fleet tug. 27.100

reduction gear. When a reduction gear is included in a diesel electric drive, the gear is located between the motor and the propeller.

The generator and the motor of a diesel electric drive may be of the alternating current (a-c) type or of the direct current (d-c) type; almost all diesel electric drives in the Navy, however, are of the direct current type. Since the speed of a d-c motor varies directly with the voltage furnished by the generator, the control system of an electric drive is so arranged that the generator voltage can be changed at any time.

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An increase or decrease in generator voltage is used as a means of controlling the speed of the propeller. Changes in generator voltage may be brought about by electrical means, by changes in engine speed, and by a combination of these methods. The controls of an electric drive may be in a location remote from the engine, such as the pilot house.

In a d-c electric drive, reversing the direction of rotation of the propeller is not accomplished by the use of a reverse gear. The electrical system is arranged so that the flow of current through the motor can be reversed. This reversal of current flow causes the motor to revolve in the opposite direction. Thus, the direction of rotation of the motor and of the propeller can be controlled by manipulating the electrical controls.

DIESEL ENGINE DRIVE

Diesel engine drive is used on various types of auxiliary ships and craft such as minesweepers, subchasers, ammunition ships, patrol craft, landing ships (LST), and numerous other yard craft and small boats. You may also find diesel drive on a few of the older destroyer escorts.

The Navy uses diesel engines except where special conditions favor the gasoline engine. Standardization of fuels, cheaper fuel, and reduction in fire hazard have been the chief factors in favor of the diesel engine.

The diesel engine used in some of the older destroyer escorts developed approximately 6,000 hp. The diesel engines of minesweepers and subchasers will develop about 1,800 hp; while some of the engines in the smaller yard craft will develop from 190 to 225 hp. A typical diesel engine is shown in figure 4-8.

Some diesel engines are directly reversible. This means that the propeller shaft is directly connected to the diesel engine, so that the speed of the propeller shaft is controlled by the speed of the diesel engine. When it becomes necessary to change direction of rotation of the propeller shaft the diesel engine must be stopped, the cam shaft of the engine shifted for reverse rotation, and then the engine restarted. This allows the engine to operate in the opposite direction; thus reversing the rotational direction of the propeller shaft. You can see that this would take time and be very hard to do if sudden changes in direction were required.

In order to eliminate this stopping-starting situation, and to make a smoother transition from forward to reverse in less time, reverse-reduction gears, clutches, and hydraulic couplings

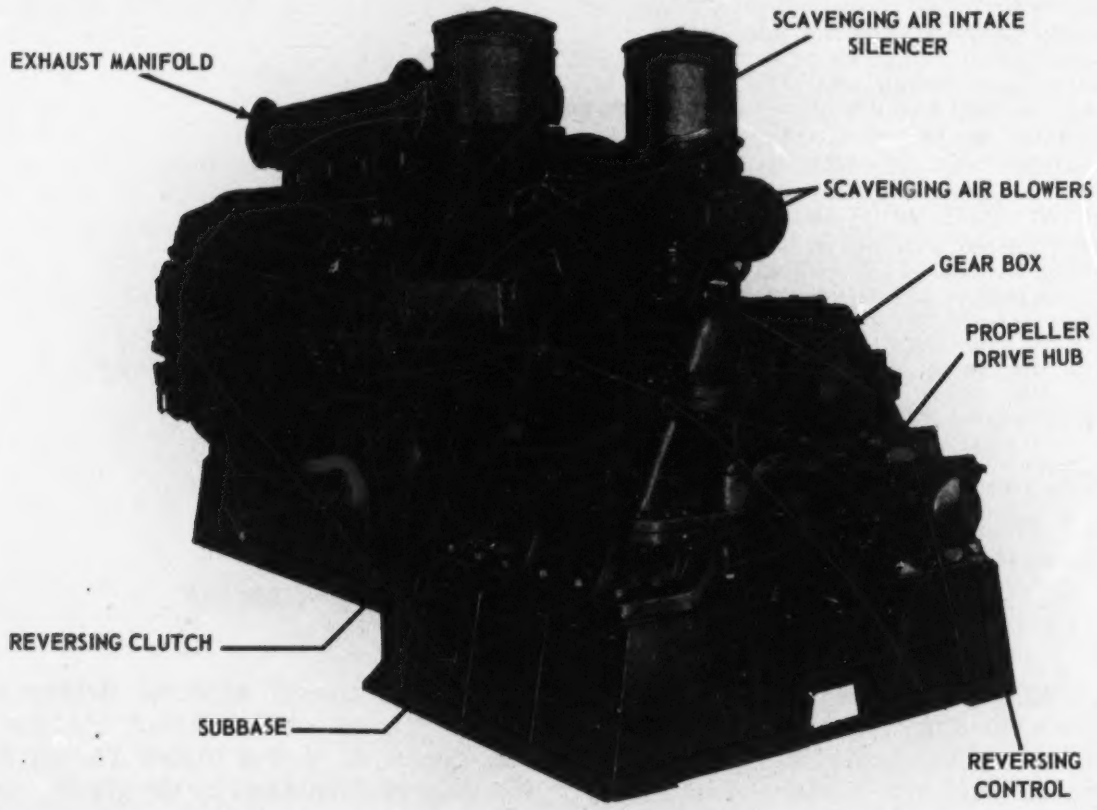

Figure 4-8.—Typical diesel engine and reduction gear. 75.44X

are used. (These are discussed in the following sections of this chapter.)

CONVERTING POWER TO DRIVE

The basic characteristics of a propulsion unit make it necessary, in most instances, for the drive mechanism to change both the speed and the direction of shaft rotation. In order that both the engine and the propeller may operate efficiently, the engine in many installations includes a device which permits a speed reduction from the engine to the propeller shaft. This device, which is a combination of gears and which effects the speed reduction, is called a reduction gear.

REDUCTION GEARS

Turbines must operate at relatively high speeds for maximum efficiency, whereas propellers must operate at lower speeds for maximum efficiency. Reduction gears are used, therefore, to allow both the turbine and the propeller to operate within their most efficient rpm ranges. A typical reduction gear installation is shown in figure 4-9.

The use of reduction gears is by no means limited to ship propulsion. Other steam turbine-driven machinery, such as ship's service generators, and various pumps also have reduction gears. In these units of machinery as well as in shipboard propulsion units, turbine operating efficiency requires a higher rpm range than that suitable for the driven unit.

Reduction gearing in many current combatant ships makes use of double helical gears. The use of double helical gears produces a smoother action of the reduction gearing and avoids tooth shock. Since the double helical gear has two sets of teeth at complementary angles to each other, the end thrust, such as developed in single helical gears, is thereby eliminated.

Reduction gears are classified by the number of steps used to bring about the speed reduction and the arrangement of the gearing. A gear mechanism consisting of a pair of gears, or a small gear (pinion) driven by the turbine shaft, which drives a large (bull) gear on the propeller shaft directly, is called a SINGLE REDUCTION GEAR. In this type of arrangement, the ratio of speed reduction is proportional to the diameter of the pinion and the gear. For example, in a 2-to-1 single reduction gear, the diameter

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Figure 4-9.—Typical reduction gear installation on upper level of an engine room.

of the driven gear is twice that of the driving pinion; and in a 10-to-1 single reduction gear, the diameter of the driven gear is 10 times that of the driving pinion.

Ships built since 1935 have DOUBLE REDUCTION PROPULSION GEARS. In this type of gear, a high-speed pinion, connected to the turbine shaft by a flexible coupling, drives an intermediate (first reduction) gear which is connected by a shaft to the low-speed pinion; this, in turn, drives the bull gear (second reduction) mounted on the propeller shaft. For example, a 20-to-1 (6000-300) speed reduction might be accomplished by having a ratio of 2 to 1 (6000-3000) between the high-speed pinion and the first reduction gear, and a ratio of 10 to 1 (3000-300) between the low-speed pinion on the first reduction shaft and the second reduction gear on the propeller shaft ($6000 \div 2 = 3000 \div 10 = 300$).

For a typical example of a double reduction application, let us consider the main reduction gear installation on a DD-692 class destroyer, shown in figure 4-10.

The cruising turbine is connected to the high pressure turbine through a single reduction gear. The cruising turbine rotor carries with it a pinion which drives the cruising gear (coupled to the high pressure turbine shaft). The cruising turbine rotor and pinion are supported by three bearings, one at the forward end of the turbine and one on each side of the pinion in the cruising reduction gear case.

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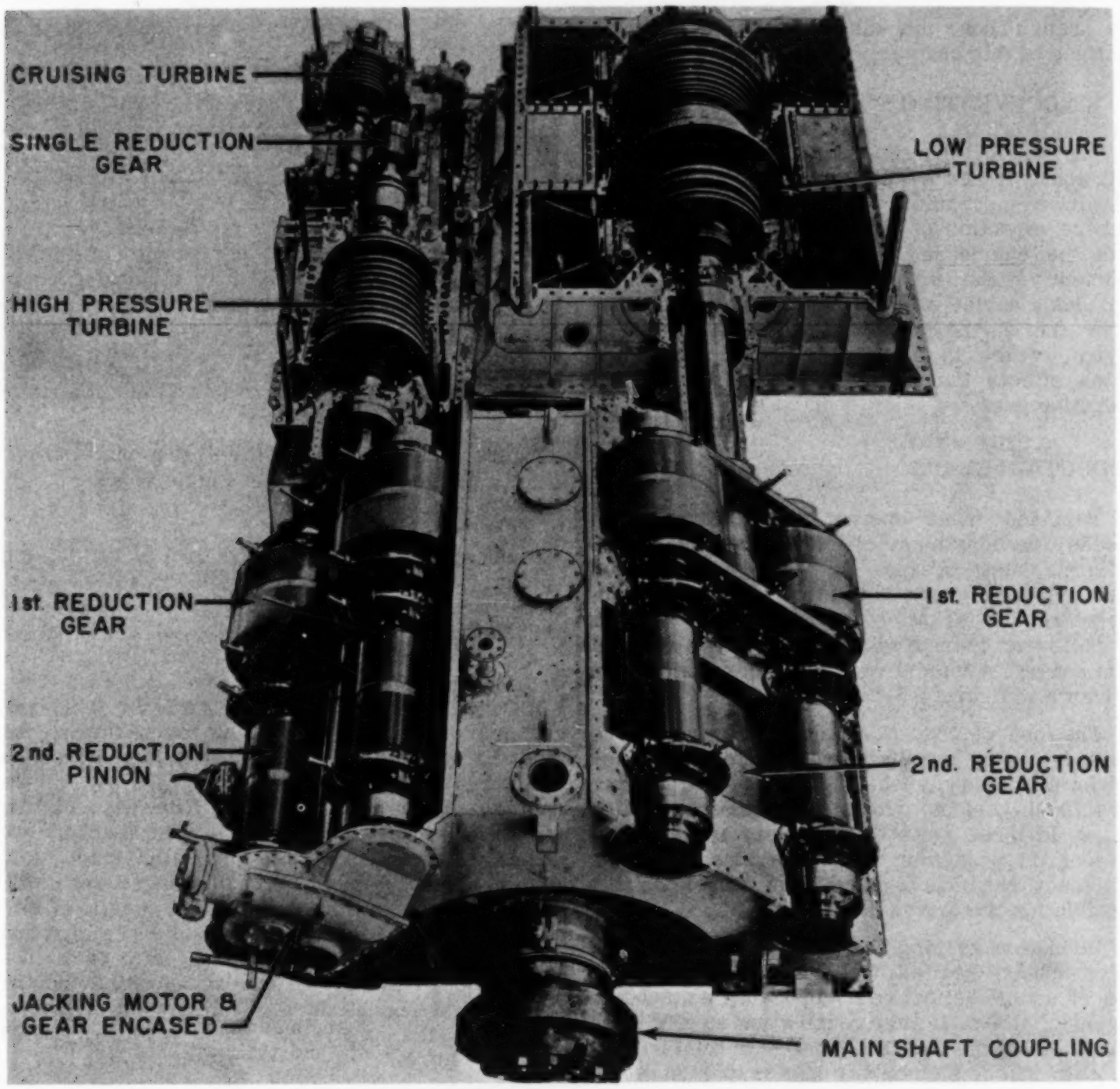

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Figure 4-10.—Turbine and locked train double reduction gearing installed on a DD-692 class destroyer.

The high pressure and low pressure turbines are connected to the propeller shaft through a locked-train type double reduction gear, shown in figure 4-11. (Note: This type of reduction gear is used aboard many naval combatant ships.) First reduction pinions are connected by flexible couplings to the turbines. Each of the first reduction pinions drives two first reduction gears. Attached to each of the first reduction gears by a quill shaft and flexible couplings is a second

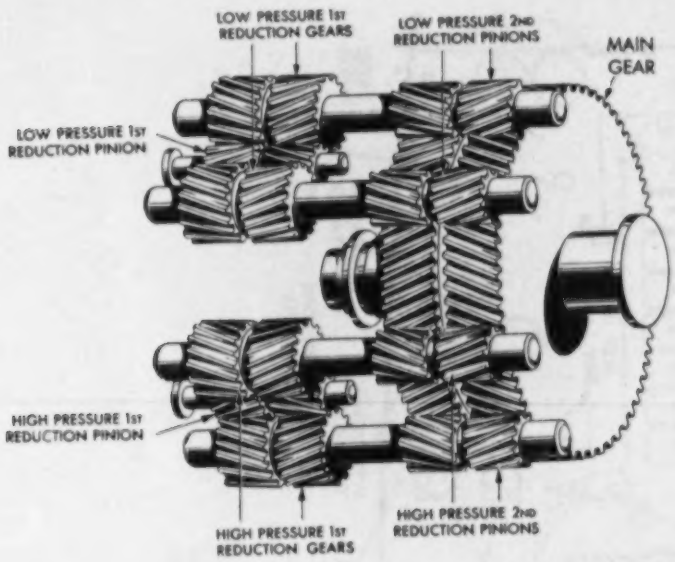

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Figure 4-11.—Locked train type gearing.

reduction (slow speed) pinion. These four pinions drive the second reduction (bull) gear which is attached to the propeller shaft.

CLUTCHES AND REVERSE GEARS

Clutches are normally used on direct-drive propulsion engines to provide a means of disconnecting the engine from the propeller shaft. In small engines, clutches are usually combined with reverse gears and used for maneuvering the ship. In large engines, special types of clutches are used to obtain special coupling or control characteristics, and to prevent torsional (twisting) vibration.

Reverse gears are used on marine engines to reverse the direction of rotation of the propeller shaft, when maneuvering the ship, without changing the direction of rotation of the engine. They are used principally on relatively small engines. If a high-output engine has a reverse gear, the gear is used for low-speed operation only, and does not have full-load and full-speed capacity. For maneuvering ships with large direct-propulsion engines, the engines are reversed.

Diesel propelling equipment of a boat or a ship must be capable of providing backing-down power as well as power forward. There are a few ships and boats in which backing down is accomplished by reversing the pitch of the propeller; in most ships, however, backing down is accomplished by reversing the direction of rotation of the propeller shaft. In mechanical drives, reversing the direction of rotation of the propeller shaft may be accomplished in one of two ways; by reversing the direction of engine rotation; or by the use of REVERSE GEARS.

More than reducing speed and reversing the direction of shaft rotation is required of the drive mechanism of a ship or a boat. It is frequently necessary to allow an engine to operate without power being transmitted to the propeller. For this reason, the drive mechanism of a ship or boat must include a means of disconnecting the engine from the propeller shaft. Devices which are used for this purpose are called CLUTCHES.

The arrangement of the components depends upon the type and size of the installation. In some small installations, the clutch, the reverse gear, and the reduction gear may be combined in a single unit; in other installations, the clutch and the reverse gear may be in one housing and the reduction gear in a separate housing attached to the reverse gear housing.

In large engine installations, the clutch and the reverse gear may be combined; or they may be separate units, located between the engine and a separate reduction gear; or the clutch may be separate and the reverse gear and the reduction gear may be combined.

In most geared-drive, multiple propeller ships, the propulsion units are independent of each other. An example of this type of arrangement is illustrated in figure 4-12.

In some installations, the drive mechanism is arranged so that two or more engines drive a single propeller. This is accomplished by having the driving gear, which is on—or connected to—the crankshaft of each engine, transmit power to the driven gear on the propeller shaft. In one type of installation, each of two propellers is driven by four diesel engines (quad power unit). The arrangement of the engines, the location of the reduction gear, and the direction of rotation of the crankshaft and the propeller shaft in one type of "quad" power unit are illustrated in figure 4-13.

The drive mechanism illustrated includes four clutch assemblies (one mounted to each engine flywheel) and one gear box. The box contains two drive pinions and the main drive gear. Each pinion is driven by the clutch shafts of two engines, through spines in the pinion hubs. The pinions drive the single main gear, which is connected to the propeller shaft.

Friction clutches are commonly used with smaller, high-speed engines, up to 500 hp. However, certain friction clutches, in combination with a jaw type clutch, are used with engines up

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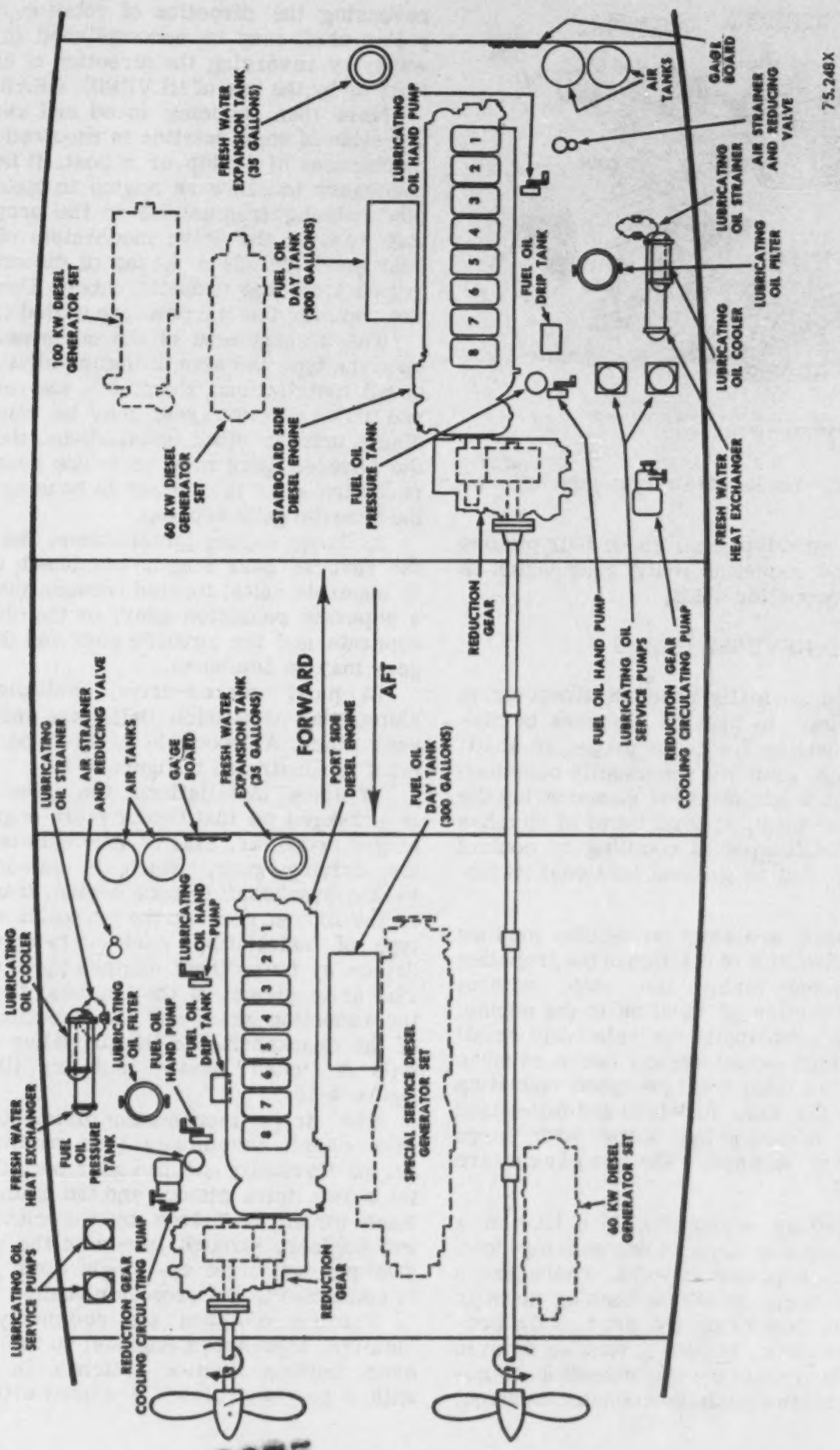

Figure 4-12.—Example of independent propulsion units.

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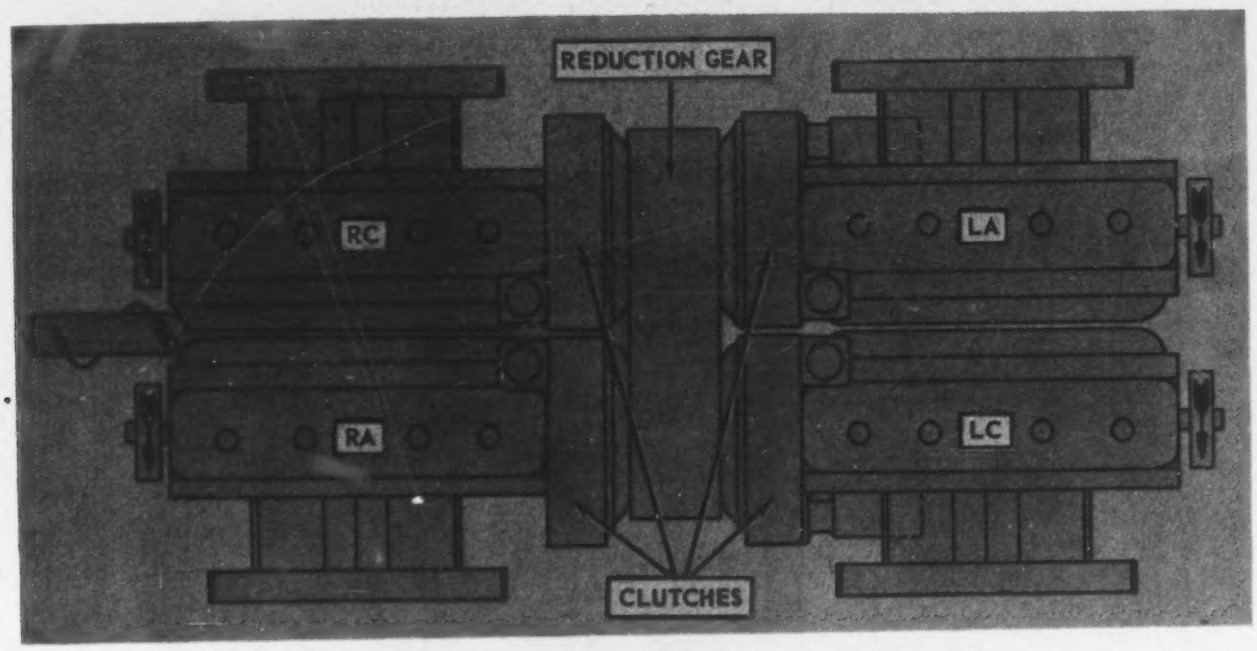

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Figure 4-13.—Four engines (quad unit) arranged to drive one propeller (GM 6-71).

to 1,400 hp; and pneumatic clutches, with a cylindrical friction surface, with engines up to 2,000 hp.

Friction clutches are of two general styles; the DISK and the BAND styles. In addition, friction clutches can be classified into dry and wet types, depending upon whether the friction surfaces operate with or without a lubricant. The designs of both types are similar, except that the wet clutches require a large friction area because of the reduced friction coefficient between the lubricated surfaces. The advantages of wet clutches are smoother operation and less wear of the friction surfaces. Wear results from slippage between the surfaces not only during engagement and disengagement, but also, to a certain extent, during the operation of the mechanism. Some wet type clutches are filled with oil periodically; in other clutches the oil, being a part of the engine-lubricating system, is circulated continuously. Such a friction clutch incorporates provisions which will prevent worn-off particles from being carried by the circulating lubricating oil to the bearings, gears, etc.

The friction surfaces are generally constructed of different materials, one being of cast iron or steel; the other is lined with some asbestos-base composition or bronze for dry clutches, and bronze, cast iron, or steel for wet clutches. Cast iron surfaces are preferred because of their better bearing qualities and greater resistance to scoring or scuffing.

The application of force-producing friction to engage the friction clutches can be obtained either by mechanically jamming the friction surfaces together by some toggle-action linkage, or through stiff springs (coil, leaf, or flat-disk type). The operation of friction clutches is discussed in the paragraphs which follow.

TWIN-DISK CLUTCH AND GEAR MECHANISM.—One of the several types of transmissions used by the Navy is the Gray Marine transmission mechanism. Gray Marine high-speed diesel engines are generally equipped with a combination clutch, and reverse and reduction gear unit—all contained in a single housing, at the after end of the engine.

The CLUTCH ASSEMBLY of the Gray Marine transmission mechanism is contained in the part of the housing nearest the engine. It is a dry type, TWIN-DISK clutch with two driving disks. Each disk is connected, through shafting, to a separate reduction gear train in the after part of the housing. One disk and reduction train is for reverse rotation of the shaft and propeller; the other disk and reduction train is for forward rotation.

JOE'S CLUTCH AND REVERSE GEAR.—A typical gear mechanism found on many power boats is Joe's clutch and reverse gear, shown

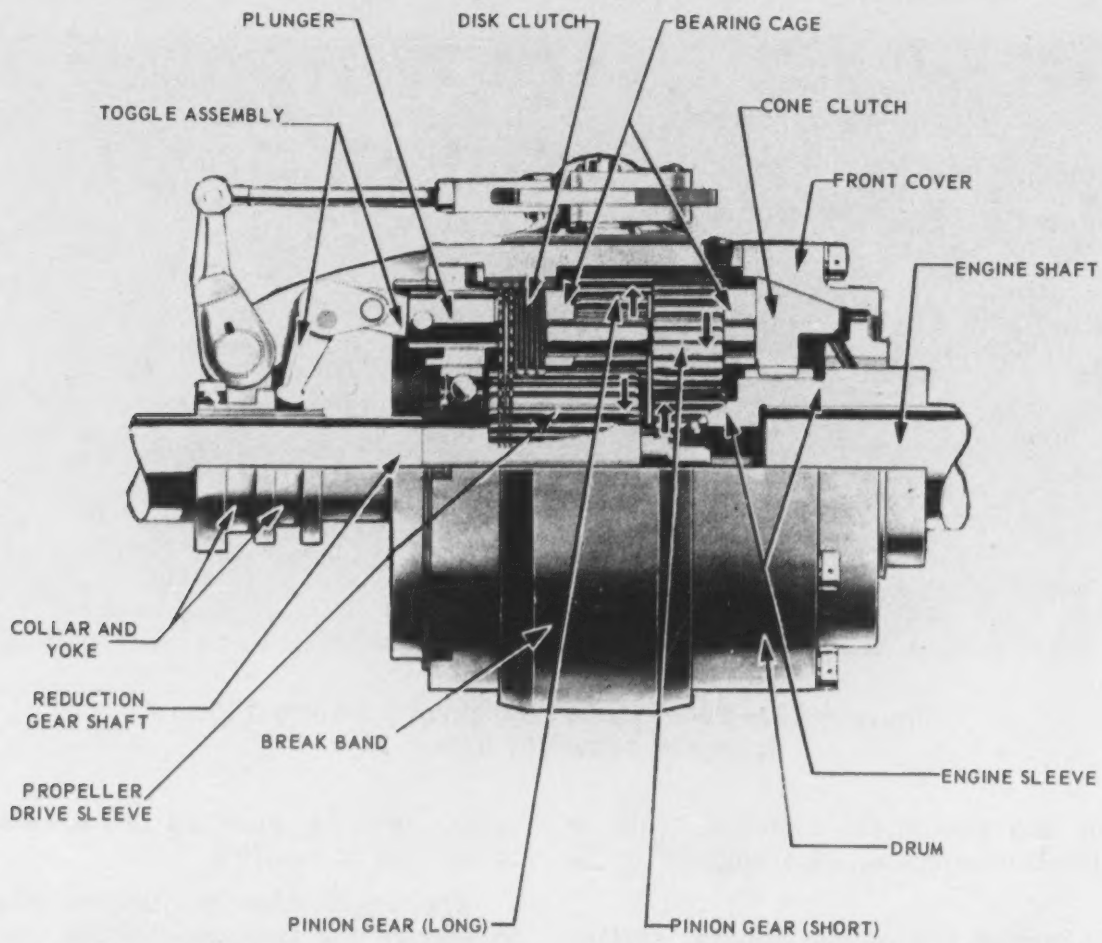

Figure 4-14.—Cutaway view of Joe's clutch and reverse gear. 75.254

in figure 4-14. The drive from the engine crankshaft is taken into the clutch and reverse gear housing by an extension of the crankshaft drive gear. The crankshaft rotation is transmitted to the reduction gear shaft through the clutch and the reverse gear unit.

AIRFLEX CLUTCH AND GEAR ASSEMBLY.—On the larger diesel-propelled ships, the clutch, reverse, and reduction gear unit has to transmit an enormous amount of power. To maintain the weight and size of the mechanism as low as possible, special clutches have been designed for large diesel installations. One of these is the AIRFLEX CLUTCH and gear assembly used with General Motors 12-567A engines on LST's.

A typical airflex clutch and gear assembly, for AHEAD and ASTERN rotation, is shown in figure 4-15. There are two clutches, one for forward rotation and one for reverse rotation. The clutches, bolted to the engine flywheel, both rotate with the engine at all times, and at engine speed. Each clutch has a flexible tire (or gland) on the inner side of a steel shell. Before the tires are inflated, they will rotate out of contact with the drums, which are keyed to the forward and reverse drive shafts. When air under pressure (100 psi) is sent into one of the tires, the inside diameter of the clutch decreases. This causes the friction blocks on the inner tire surface to come in contact with the clutch drum, locking the drive shaft with the engine.

HYDRAULIC CLUTCHES OR COUPLINGS.—The fluid clutch (coupling) is widely used on Navy ships. The use of a hydraulic coupling eliminates the need for a mechanical connection between the engine and the reduction gears. Couplings of this type operate with a minimum of slippage.

Some slippage is necessary for operation of the hydraulic coupling, since torque is transmitted because of the principle of relative motion between the two rotors. The power loss resulting from the small amount of slippage is transformed into heat which is absorbed by the oil in the system.

Compared with mechanical clutches, hydraulic clutches have a number of advantages. There is no mechanical connection between the driving

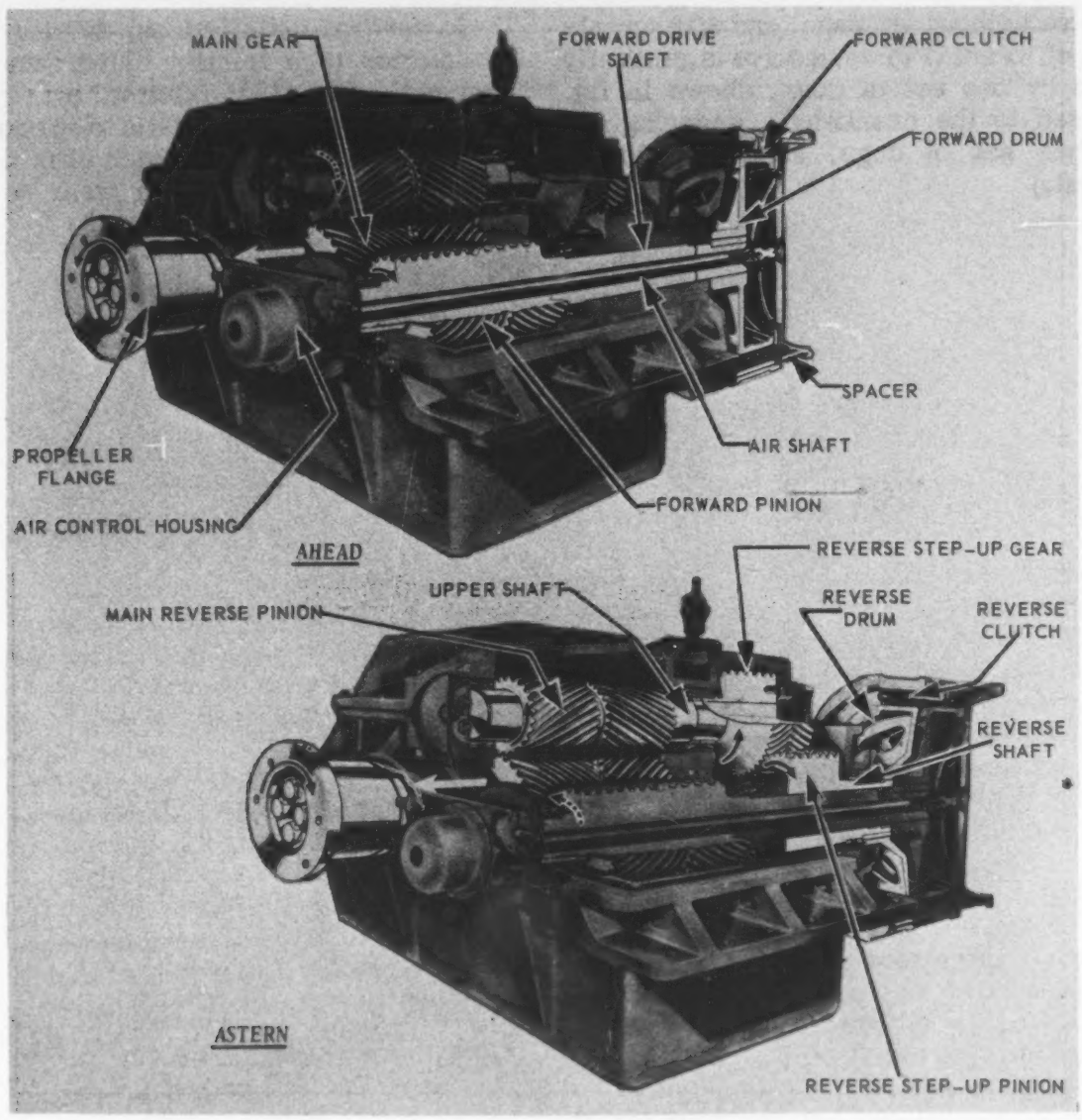

Figure 4-15.—Clutch and reverse-reduction gear assembly. 75.247

and driven elements of the hydraulic coupling. Power is transmitted through the coupling very efficiently (97 percent) without transmitting torsional vibrations, or load shocks, from the engine to the reduction gears. This protects the engine, the gears, and the shafting from sudden shock loads which may occur as a result of piston seizure of fouling of the propeller. The power is transmitted entirely by the circulation of a driving fluid (oil) between radial passages in a pair of rotors. In addition, the assembly of the hydraulic coupling will absorb or allow for slight misalignment.

DOG CLUTCHES.—Dog type clutches perform much the same function as the friction type in that they allow the engine shaft to be disconnected from the propeller shaft. The dog clutch ensures

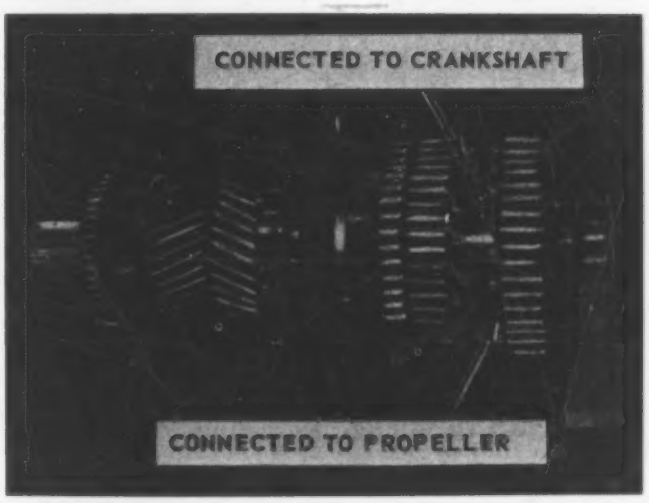

Figure 4-16.—Dog clutches. 75.264

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a positive drive without slippage, and with a minimum amount of wear. (Forward drive is generally accomplished by one set of dogs, shown in fig. 4-16, connected to the crankshaft, engaging and turning another set of dogs, connected to the propeller shaft.)

In several installations, the dog clutch is used in addition to a friction clutch; the dog clutch is engaged after the friction (or synchronizing) clutch brings the two shafts to an equal speed. The engagement of the dog clutch eliminates slippage, and holds friction clutch wear to a minimum.

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CHAPTER 5

BASIC STEAM CYCLE

In addition to knowing how steam is generated you must know what happens to steam after it leaves the boiler. One of the best ways to learn about the steam plant on your own ship is to trace the path of steam and water throughout its entire cycle of operation. Figure 5-1 is a diagrammatic representation of the basic steam cycle. The water and the steam circulate throughout the entire cycle of operation without ever being exposed to the atmosphere.

This chapter discusses the steam cycle in four basic areas of operation: (1) generation, (2) expansion, (3) condensation, and (4) feed. (Feed is the term used to describe the water supplied to the boiler for the generation of steam.)

GENERATION

To generate steam, it is first necessary to heat water to its boiling point and then add a sufficient amount of heat to change (convert) the boiling water into steam. The heat required to change boiling water into steam, at any given temperature of the boiling water, is called the LATENT HEAT OF VAPORIZATION. When steam condenses back to water (at the boiling point), an equal amount of heat is given off; it is called the LATENT HEAT OF CONDENSATION. The amount of heat required to convert boiling water to steam, or the amount of heat given off when steam is condensed back to water at its boiling temperature, varies with the pressure under which the

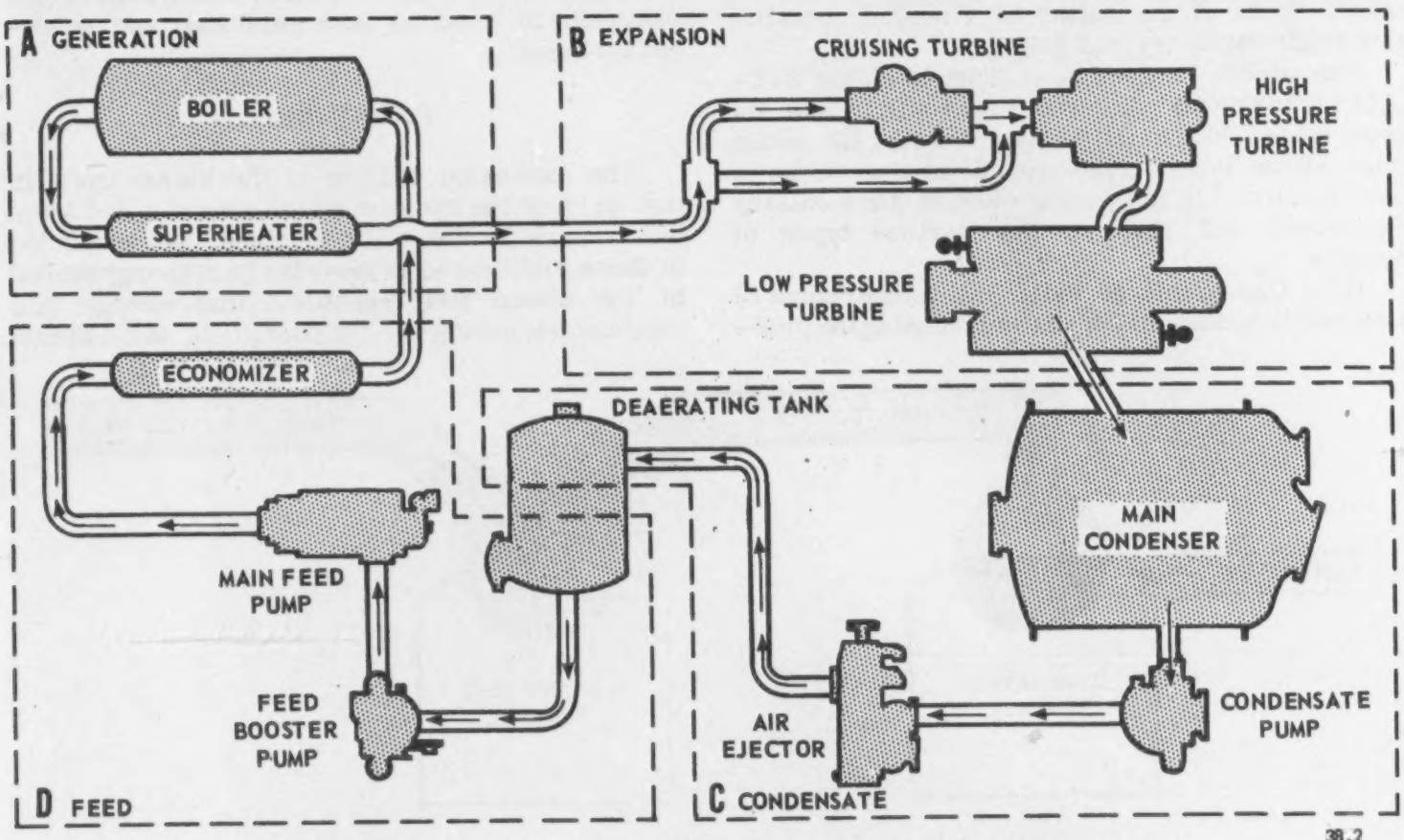

Figure 5-1.—Diagrammatic arrangement of the steam cycle.

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process takes place. Part A of figure 5-1 illustrates the generation area of the cycle.

There are definite pressure-temperature relationships involved in the generation of steam. The boiling point of water is 212°F at sea level, where the atmospheric pressure is 14.7 psi. At higher altitudes, where atmospheric pressure is reduced, water boils at a lower temperature. If the pressure is increased, the boiling temperature of water will also be increased. In a boiler operating under a pressure of 600 psig, water must be heated to approximately 489°F to make it boil. In boilers operating under a pressure of 1000 psig, water must be heated to approximately 544°F to make it boil. Therefore, the boiling point of water is determined by the pressure.

It is important to note that the temperature of steam is determined by the temperature at which the water boils, as long as the process is taking place in a closed vessel or in a closed system such as a boiler. As long as the pressure remains constant, steam in contact with the water from which it is being formed must remain at the same temperature as the boiling water. Therefore, in a boiler operating under a pressure of 600 psig, the temperature of the steam in the steam drum must be approximately 489°F— the same temperature as the boiling water. (The steam drum of the boiler is a sealed chamber that holds the water and steam.)

The steam in the steam drum is called SATURATED STEAM—this is steam which has not been heated above the temperature of the water from which it was generated. Saturated steam is used aboard ship to operate most of the auxiliary equipment and also in the various types of heaters.

It is impossible to raise the temperature of saturated steam without also increasing the pressure as long as the steam is in contact with the water from which it is formed. However, the steam can be heated above its saturation temperature if it is first drawn off into another vessel, where it is no longer in contact with the water, and additional heat is applied. Steam which has been heated above its saturation temperature is known as SUPERHEATED STEAM. The device which allows this extra heat to be added to the steam is known as a SUPERHEATER. Figure 5-2 shows a simple form of both a boiler and a superheater.

Most naval propulsion boilers are equipped with superheaters. Superheated steam has many advantages over saturated steam for use in propulsion machinery. Because the steam is dry, it causes relatively little corrosion or erosion of piping and machinery. In addition, superheated steam does not conduct heat as rapidly as saturated steam, therefore, it does not lose heat as rapidly. The use of superheated steam for propulsion purposes greatly increases the overall efficiency of the engineering plant; this increased efficiency results in large savings in fuel consumption, and in space and weight requirements.

Since most auxiliary machinery is designed to operate on saturated steam, naval boilers are designed to produce both saturated and superheated steam.

EXPANSION

The expansion portion of the steam cycle is that part of the cycle in which steam is led from the boilers to the main turbines, and expanded in those turbines to remove the heat energy stored in the steam and transform that energy into mechanical energy of rotation. The main steam

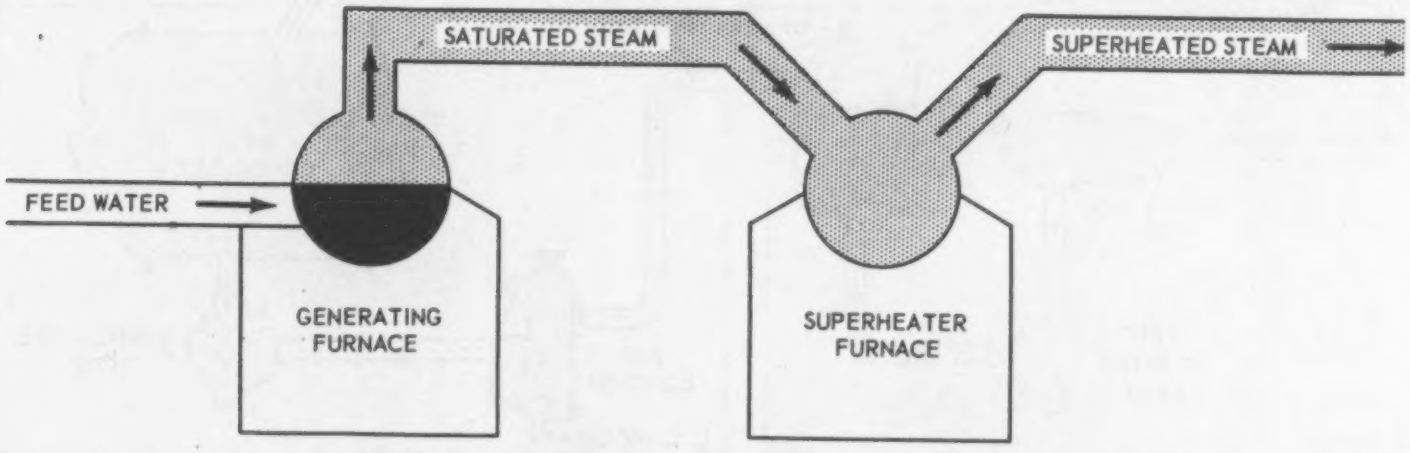

Figure 5-2.—Elementary boiler and superheater. 38.3

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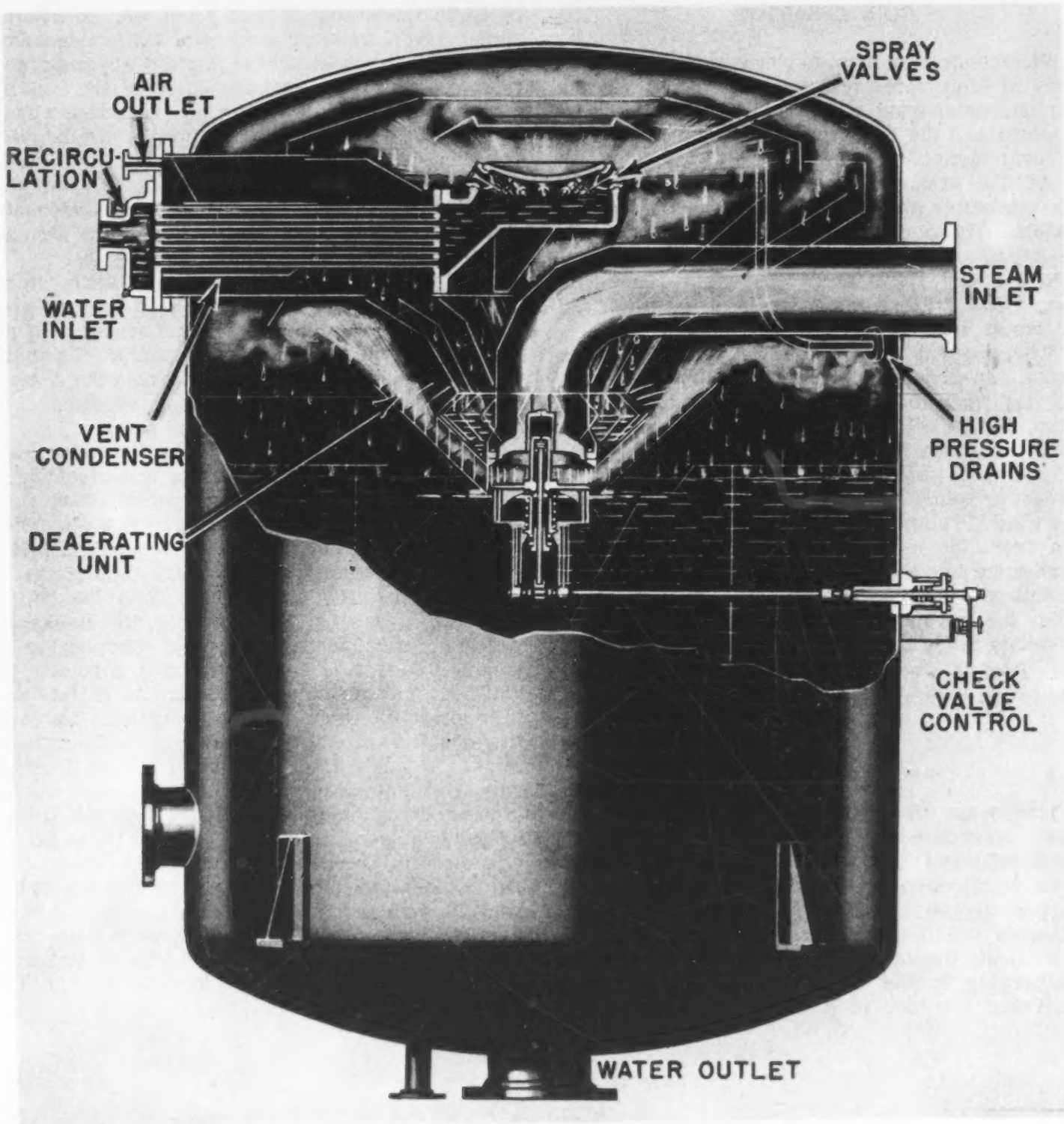

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Figure 5-3.—Deaerating feed tank.

system is the piping system which leads the steam from the boilers to the main turbines.

The main turbines generally consist of the cruising turbine, high pressure turbine, and the low pressure turbine. The steam may flow into the cruising turbine, then to the high pressure turbine, and on into the low pressure turbine; or the cruising turbine may be bypassed. Some main turbine installations do not have a cruising turbine. Part B of figure 5-1 illustrates the expansion portion of the steam cycle; it contains the cruising turbine, high pressure turbine, and low pressure turbine.

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CONDENSATION

Since each ship must produce sufficient quantities of feed water for the boilers and since a marine engineering plant must be as efficient as is possible, the feed water must be used over and over again.

As the steam leaves or exhausts from the low pressure turbine, it enters the condensate system. The condensate system is that part of the steam cycle in which the steam condenses to water and flows from the main condenser toward the boilers while it is being prepared for use as feed water.

The several components of the condensate system, in order, from the low pressure turbine are (1) main condenser, (2) main condensate pump, and (3) the main air ejector. These components are shown in part C of figure 5-1.

The main condenser receives the steam from the low pressure turbine and condenses the steam into water. The main condensate pump takes suction from the main condenser and delivers the condensate into the condensate piping system and through the main air ejector. As its name implies, the air ejector removes the air that was picked up in the main condenser. The condensate, after passing through the air ejector enters the deaerating feed tank.

FEED

The deaerating feed tank (fig. 5-3) is sometimes considered as the dividing line between condensate and feed water. This tank has three basic functions: (1) to free the condensate of all trapped oxygen and air, (2) to heat the water to a degree which will allow the economizer to introduce all the remaining necessary heat before discharging to the boiler, and (3) to act as a reservoir in which to store water to take care of rapid increases in feed needs and to absorb sudden increases or surges of the condensate.

As the condensate enters the deaerating feed tank it is sprayed into the dome of the tank by nozzles. Here it is discharged in a fine spray throughout the steam filled top or preheater. Breaking up the condensate into a fine spray releases the trapped oxygen and air from the condensate. The air-free, oxygen-free condensate falls to the bottom of the tank, while the air and oxygen are exhausted from the tank.

The condensate that is collected in the storage section of the deaerating feed tank is now called feed water and becomes a source of supply for the main feed booster pump. The main feed booster pump takes suction from the deaerating feed tank and maintains a constant discharge pressure to the main feed pump.

The main feed pump picks up the water (delivered from the booster pump) and discharges it into the main feed piping system. Part D of figure 5-1 illustrates the path of the water from the deaerating feed tank to the economizer. The discharge pressure of the main feed pump is usually about 150 psi greater than the boiler operating pressure. For example, the discharge pressure of a main feed pump, discharging to a boiler operating at 600 psi, will normally be 750 psi. The discharge pressure is maintained throughout the main feed piping system; however the quantity of water discharged to the economizer is controlled by a feed stop and check valve or automatic feed water regulator valve.

The economizer is positioned on the boiler to perform one basic function; that is, to act as a preheater. The gases of combustion flow around the economizer tubes which absorb some of the heat of combustion and the economizer in turn heats the water that is flowing through the economizer tubes. As a result the water is approximately 100°F hotter as it flows out of the economizer to the boiler.

CHAPTER 6

BOILERS

This chapter is designed to provide you with basic information on boilers and their operating principles. It includes a discussion on boiler construction and the major parts and their functions. It lists numerous fireroom safety precautions which must be observed when boilers are being fired.

BOILER ASSEMBLY

A boiler is defined as that part of a steam generator in which water is converted into steam. The boiler consists of metal drums, headers and tubes, and accessories that will assist the operator in controlling steam pressure and temperature and other aspects of boiler operation.

You will also find a furnace with casing and uptake; steam and water drums; generating, circulation, and water screen tubes; a superheater; and an economizer; and the necessary piping and accessories to ensure an ample supply of fuel, water, and air.

In the following sections on boiler assembly assume that you are assembling a boiler similar to the one shown in figure 6-1.

The Steam Drum (fig. 6-2) is cylindrical in shape and is located at the top of the boiler. The steam drum runs lengthwise from the front of the boiler to the back. The steam drum provides a space for the accumulation of steam generated in the tubes and for the separation of moisture from the steam. It also serves as a storage space for boiler water, which is distributed from the steam drum to the downcomer tubes. (During normal operation, the steam drum is kept about half full of water.) In addition to these basic functions, the steam drum either contains or is connected to many of the important controls and fittings required for the operation of the boiler.

At the bottom of the boiler you will find another drum and a header, as shown in figure 6-3. The largest drum is the water drum and the other is the header. Both are smaller than the steam drum. They are used to equalize the distribution of water to the generating tubes, and provide a place for the accumulation of loose scale and other solid matter that may be present in the boiler water. Each drum and header is provided with a blowdown valve. When the valve is opened, some of the water is forced out of the drum or header and carries the loose scale, sediment, or dirt with it.

At each end of the steam drum a number of large tubes are installed (fig. 6-4) that lead to the water drum and the sidewall header. These tubes are called downcomers and are utilized to ensure a downward flow of water from the steam drum to the water drum and header. The downcomers range in diameter from 3 to 8 inches.

A great number of other tubes are also installed linking the steam drum to the water drum and the steam drum to the header. These tubes are called generating tubes and are illustrated in figure 6-5. The generating tubes are arranged in the furnace so that the gases and the heat of combustion flow around them. The large arrows in figure 6-5 show the direction of flow of the combustion gases.

The generating tubes are made of steel that is strong enough to withstand the high pressures and temperatures within the boiler. In most boilers the water tubes are from 1 to 2 inches in diameter. These small tubes present a large surface area to absorb the heat in the furnace. Note that a 2" (ID) tube has twice the surface area of a 1" tube, but 4 times the volume. A 3" tube has three times the surface area of a 1" tube but 9 times the volume. The smaller the diameter of the tube, the higher is the ratio of absorption surface to the volume of water.

Normally there is only one row of tubes between the steam drum and the sidewall header. This single row of tubes is used to provide a cooling effect that protects the side wall of the furnace.

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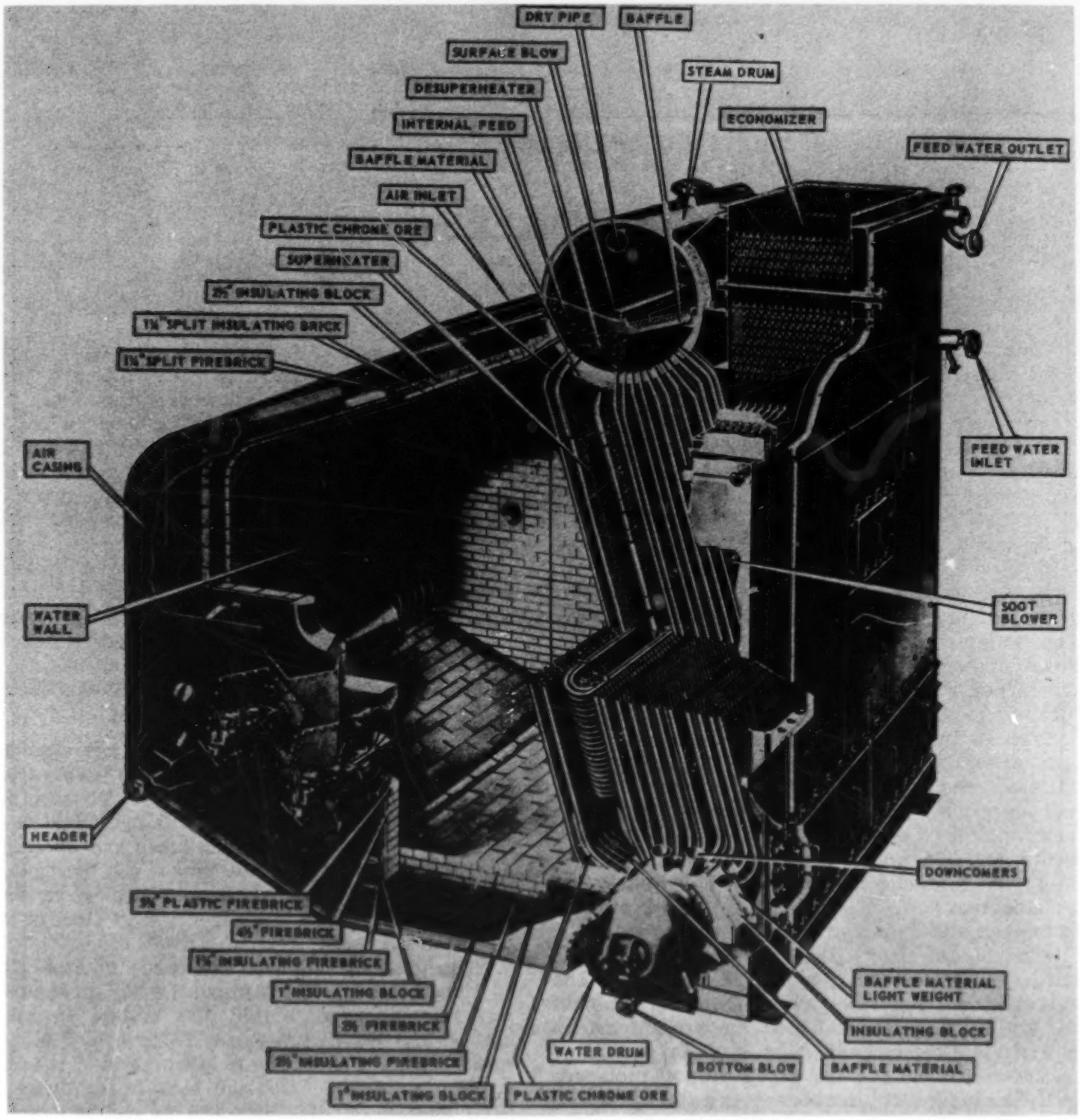

Figure 6-1.—Cutaway view of a D-type boiler (older type). 38.40

So far we have assembled the drums, header, downcomers, and the generating tubes. Before going any further with the assembly trace the path of the water through the boiler. The water flows out of the steam drum down through the downcomers into the water drum and the side-wall header. As the water is heated it forms a vapor (steam) that is lighter than the water in

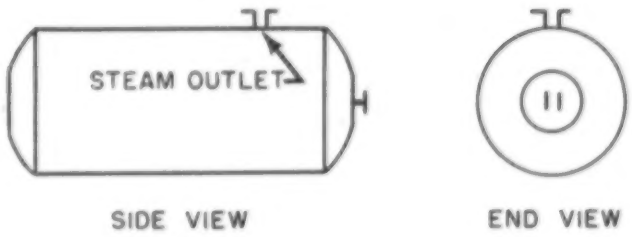

Figure 6-2.—Steam drum. 139.13

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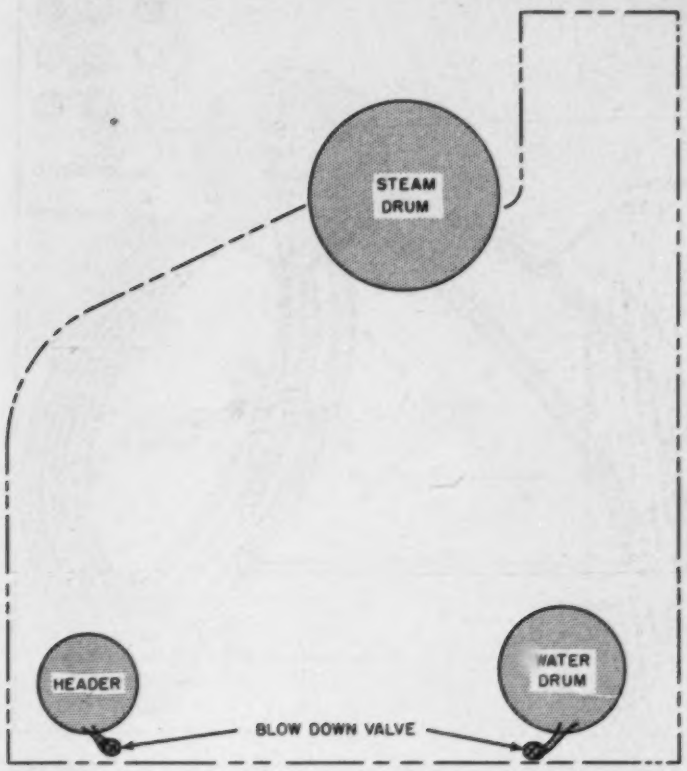

Figure 6-3.—Steam drum, water drum and header. 139.14

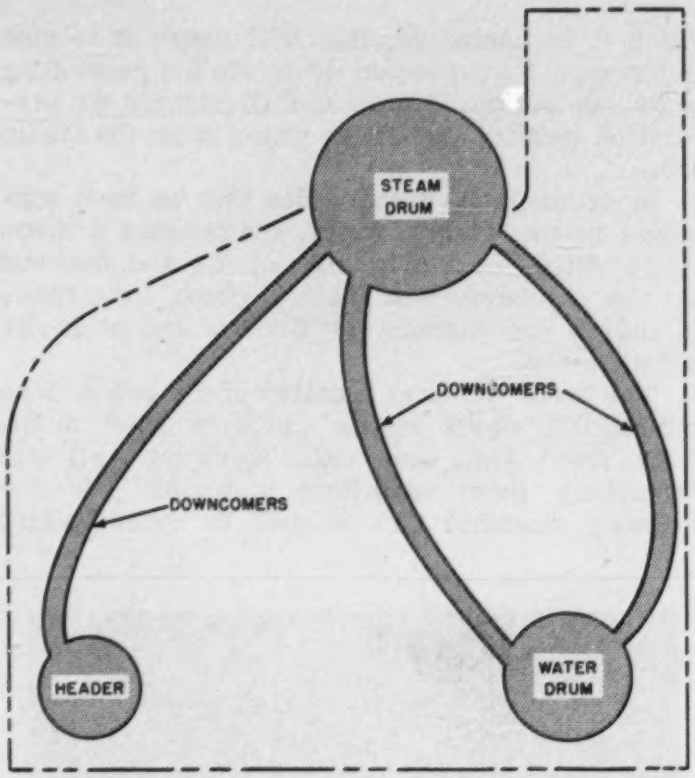

Figure 6-4.—Addition of downcomer tubes. 139.15

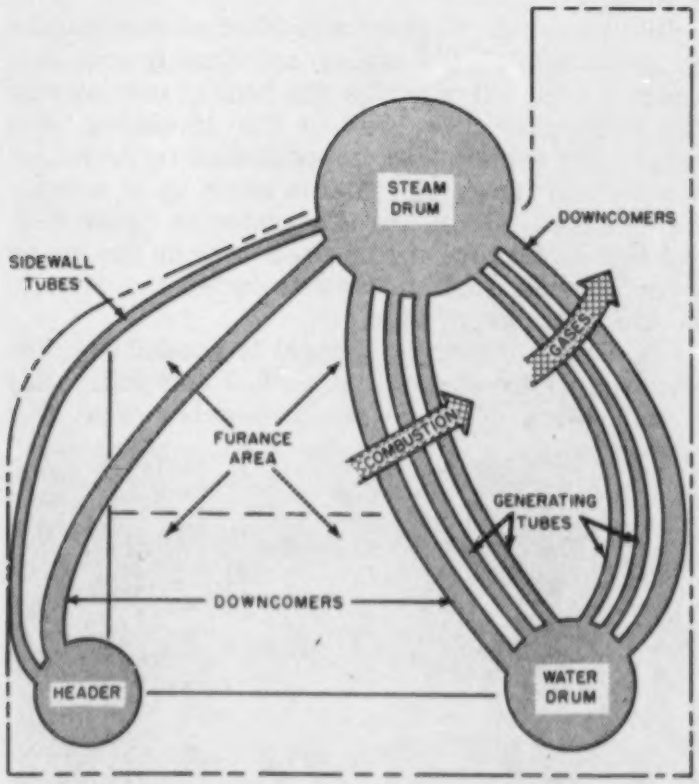

Figure 6-5.—Adding generating tubes and furnace area. 139.16

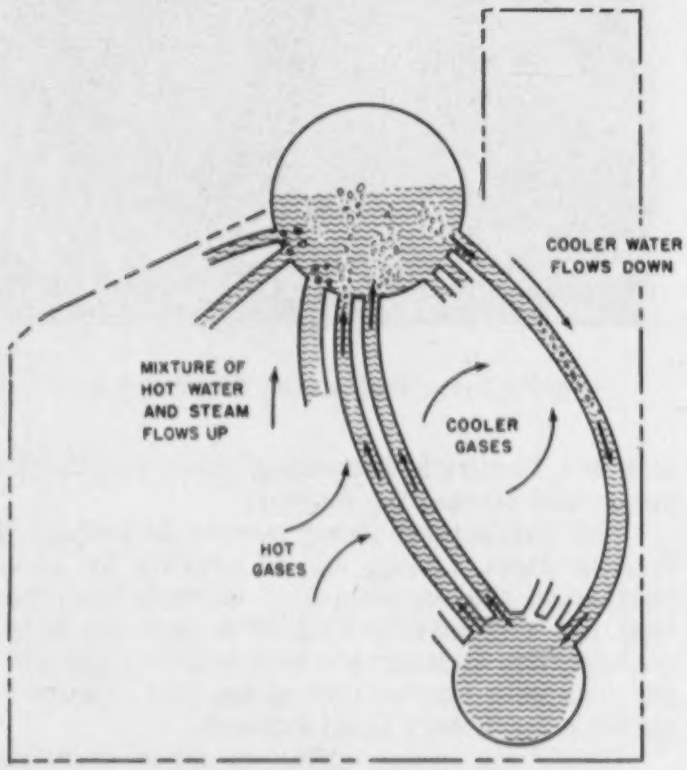

Figure 6-6.—Natural circulation (accelerated type). 139.17

which it is contained; this will cause it to rise and return to the steam drum via the generating tubes, as steam. Figure 6-6 illustrates the circulation path of the boiler water from the steam drum.

In order to heat the water that we have contained in the drums, tubes, and headers a space is provided for the mixing of air and fuel and for the combustion of the fuel (fire). This space is called the furnace or firebox and is shown in figure 6-5.

The boiler furnace consists of a more or less rectangular steel casing which is lined on the floor, front wall, side walls and rear wall with refractory (heat resisting) material. The refractory material that is used in naval boilers

38.40

Figure 6-7.—Refractory lined furnace.

includes firebrick, insulating brick, plastic firebrick, and air-setting mortar.

The refractory lining serves to protect the furnace steel casing, and to prevent the loss of heat from the furnace. The refractories retain heat for a relatively long time and thus help to maintain the high furnace temperatures necessary for complete combustion of the fuel. Figure 6-7 shows a refractory lined furnace.

There are many different types of refractories; but their use is determined by their physical and chemical properties and specific location within the furnace. Some refractory materials can withstand greater temperatures than others

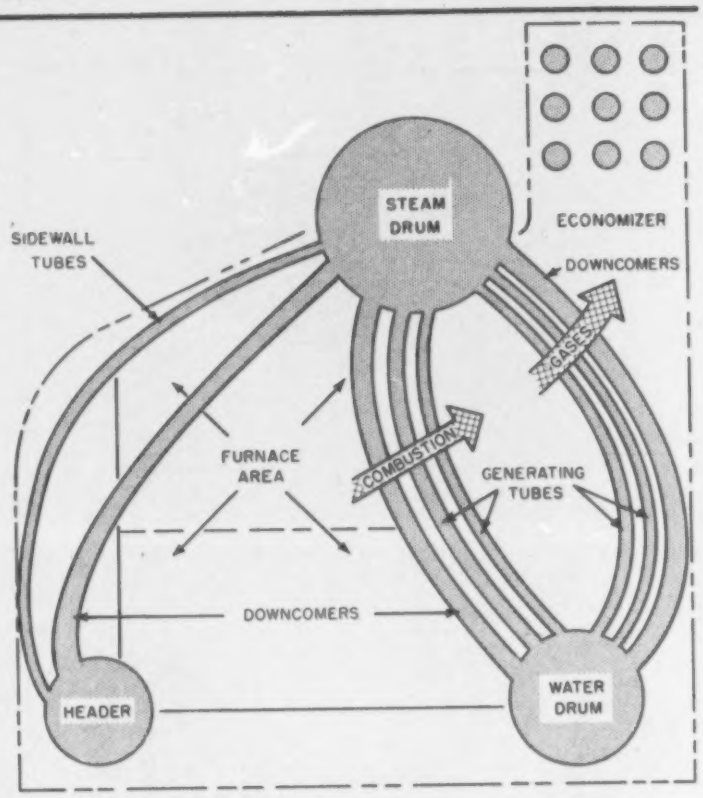

139.18

Figure 6-8.—Relative position of economizer.

and will be positioned nearer to the intense heat of the fire.

In chapter 5 you discovered that an economizer is positioned on the boiler and that it acts as a heater in that it absorbs the heat of combustion and transmits this heat to the incoming feed water. The economizer is positioned on the boiler as shown in figure 6-8, and is made up of a number of tubes which are illustrated in figure 6-9. The fins on the tube absorb the heat from the gases of combustion and in turn transfer the heat to the incoming feed water.

One more basic component is needed to complete the water-steam flow path. From your study of the steam cycle do you remember what that

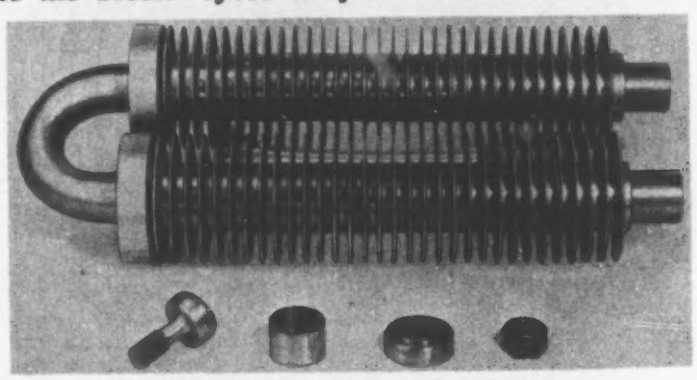

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Figure 6-9.—U-bend economizer tube with aluminum gill rings.

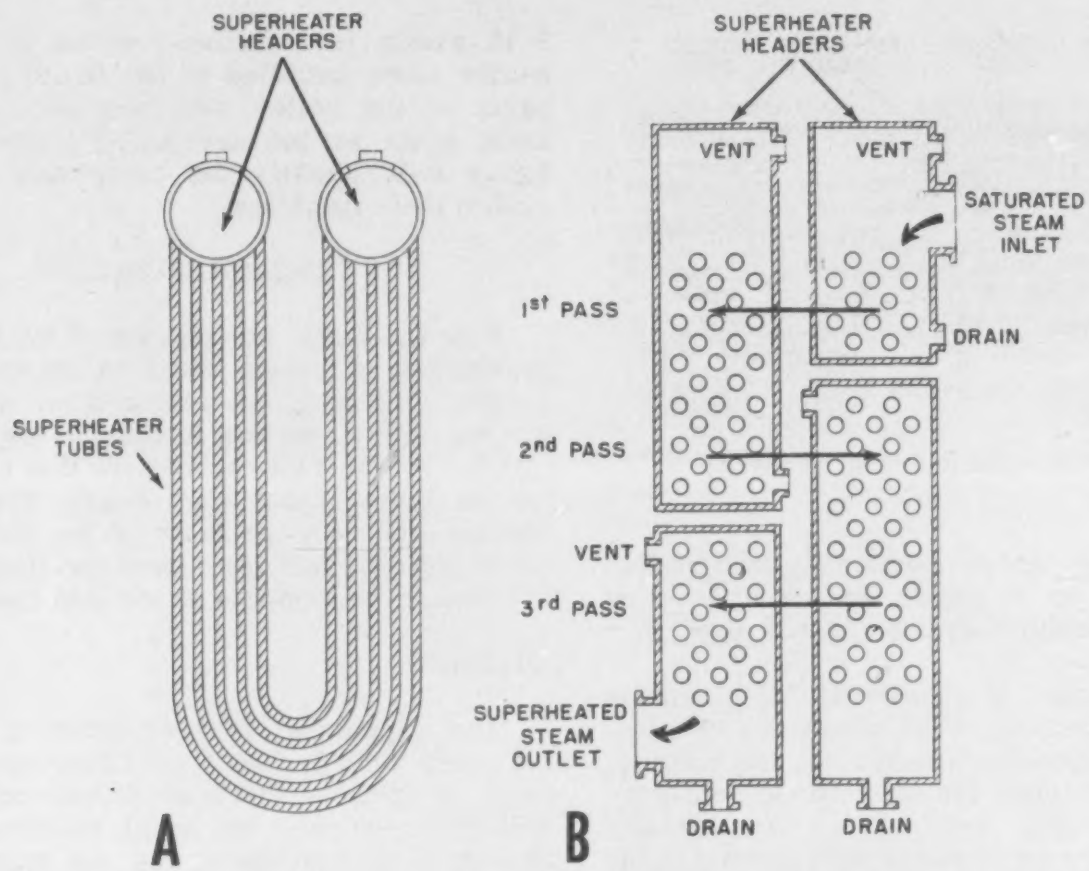

Figure 6-10.—Diagrammatic arrangement of superheater. 38.23

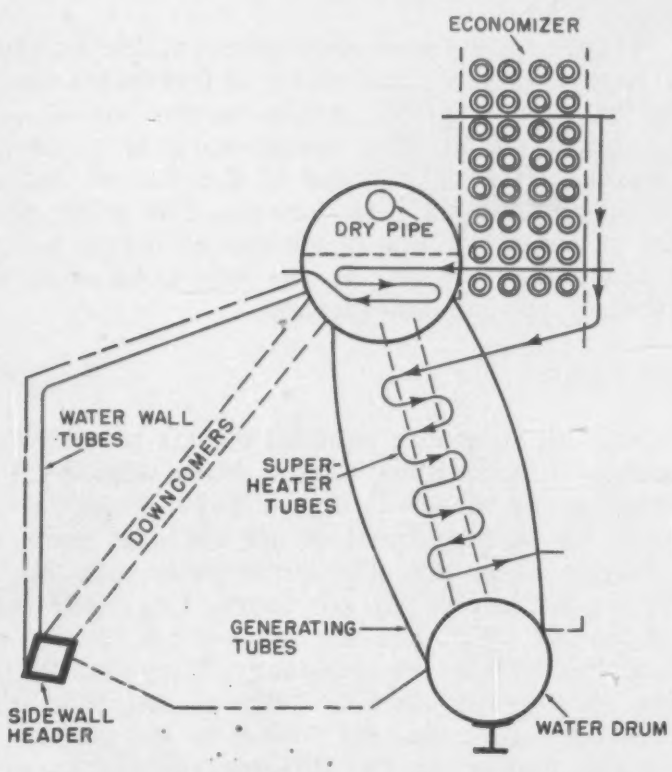

Figure 6-11.—Relative position of superheater tubes. 38.39

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Figure 6-12.—Babcock and Wilcox Carolina-type fuel oil burners installed on a boiler front.

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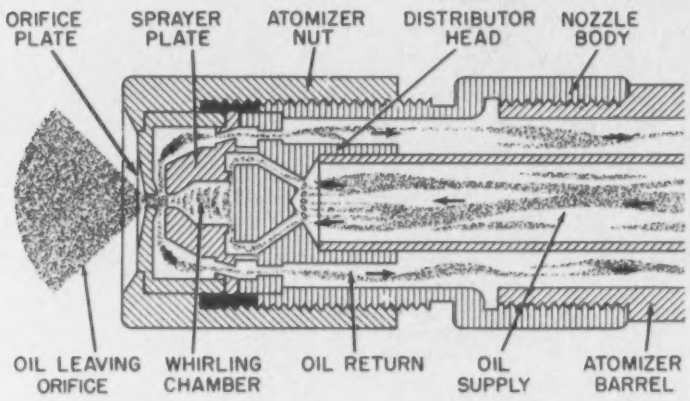

Figure 6-13.—Return-flow atomizer. 38.75

component might be? In chapter 5 you were told that the steam, as it leaves the steam drum on its way to the main turbines, passes through a superheater.

The superheater is constructed of a number of U-shaped tubes (fig. 6-10) which are installed horizontally projecting forward into the furnace. The superheater tubes are connected to the superheater headers (fig. 6-10) which are installed vertically at the rear of the boiler; one end of the tube enters one header and the other end of the tube enters the other header. (Some superheaters are of the vertical type with horizontal headers.)

The superheater tubes are positioned in the boiler so that they are surrounded by the generating tubes and where the hot gases of combustion will flow over and around them. Figure 6-11 shows the relative position of the superheater tubes installed in the boiler. The major parts of the boiler have now been assembled. Look again at the assembled boiler shown in figure 6-1, identify the component parts, and review their functions.

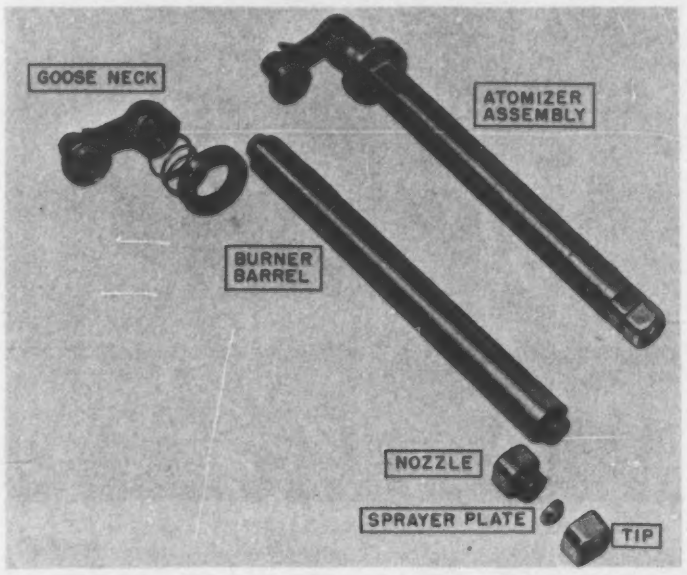

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Figure 6-14.—Parts of a straight-through-flow atomizer assembly.

FUEL OIL BURNERS

With the major components of the basic boiler assembled, a means must be provided for the proper mixing of the fuel and air and to allow for the entry into the furnace. This is accomplished by the fuel oil burners that are mounted on the boiler front (fig. 6-12). The complete burner assembly consists of the atomizer, the air registers, and the valves and fittings needed to connect the atomizer to the fuel line.

ATOMIZERS

The atomizers divide or break up the fuel oil into very fine particles as illustrated in figure 6-13. At present there are three major types of atomizers in use on naval boilers. Straight-through-flow atomizers are the most common. The return-flow atomizers (fig. 6-13) are used on many of the newer ships; you may also find steam-assist atomizers on some of the newer ships.

Figure 6-14 shows an atomizer of the straight-through-flow type. It consists of five major parts; the tip, sprayer plate, nozzle, burner barrel, and the goose neck. The nozzle-sprayer plate-tip assembly fits on the end of the burner barrel which projects into the furnace. The goose neck fits on the outer end of the burner barrel where it provides a means for the fuel oil to enter the atomizer and into the furnace.

AIR REGISTERS

The air register permits the air to enter the furnace in such a way that it mixes with the fine oil spray as shown in figure 6-13. Figure 6-15 shows the arrangement of air register parts in a burner assembly. The air register consists of three main parts: (1) air doors, (2) a diffuser, and (3) air foils. The air doors serve to open or close the register as necessary. They are usually kept either fully open or fully closed. When the air doors are open, air rushes in and is given a whirling motion by the diffuser plate. The diffuser plate causes the air to mix evenly with the atomized oil, in such a way as to prevent the flame from being blown away from the atomizer.

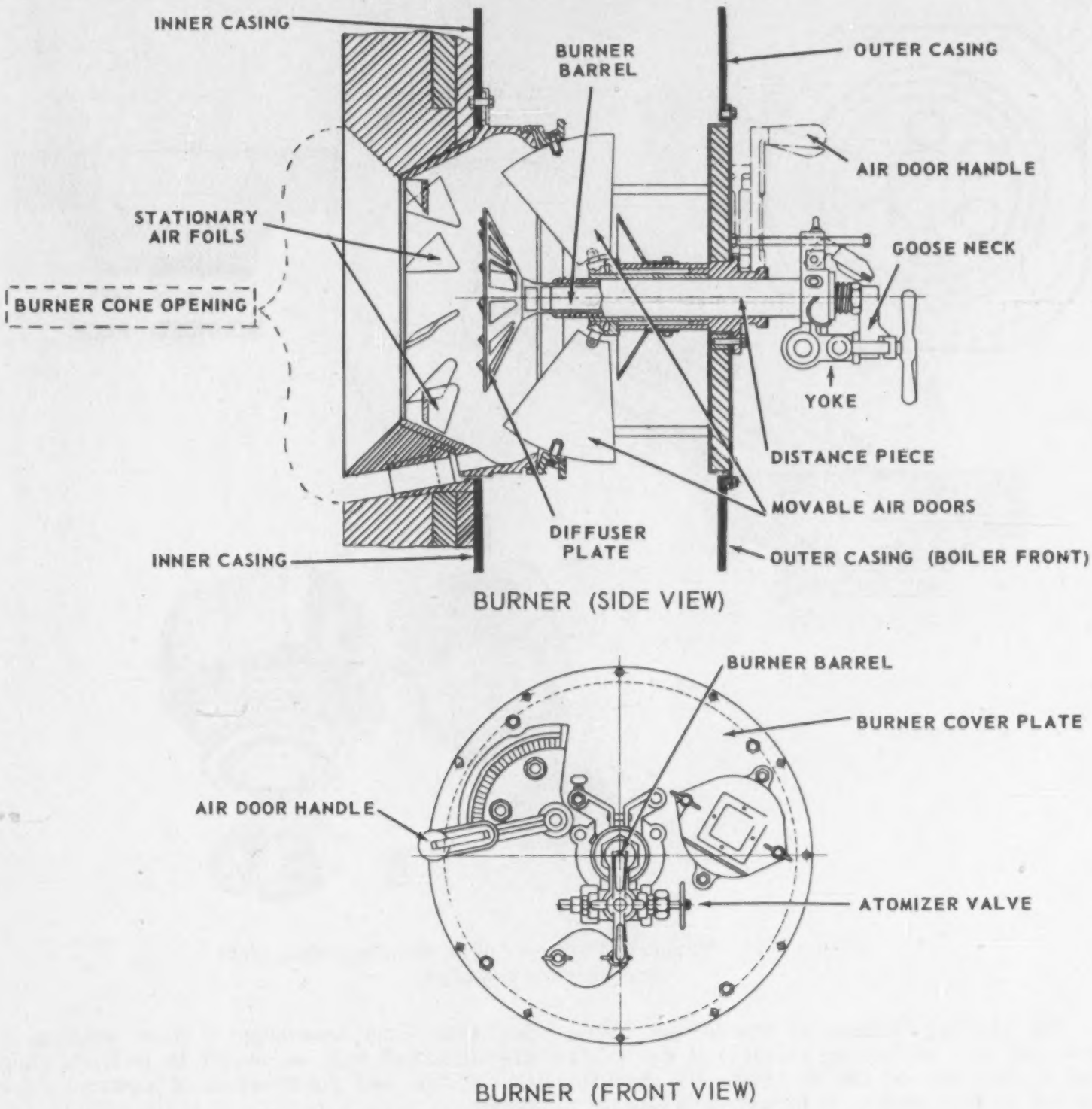

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Figure 6-15.—Cross-sectional view of Babcock and Wilcox Carolina-type fuel oil burner with straight-through-flow atomizer.

The air foils guide the major quantity of air and cause it to mix with the larger particles of oil spray beyond the diffuser.

Oil is forced under pressure through the burner barrel. It goes through the holes in the nozzle (part A of fig. 6-16) into the tangential slots of the rear side of the sprayer plate (part B of fig. 6-16). These slots are so shaped that the oil is given a high rotational velocity as it discharges into a small cylindrical "whirling chamber" in the center of the sprayer plate (part B of fig. 6-16).

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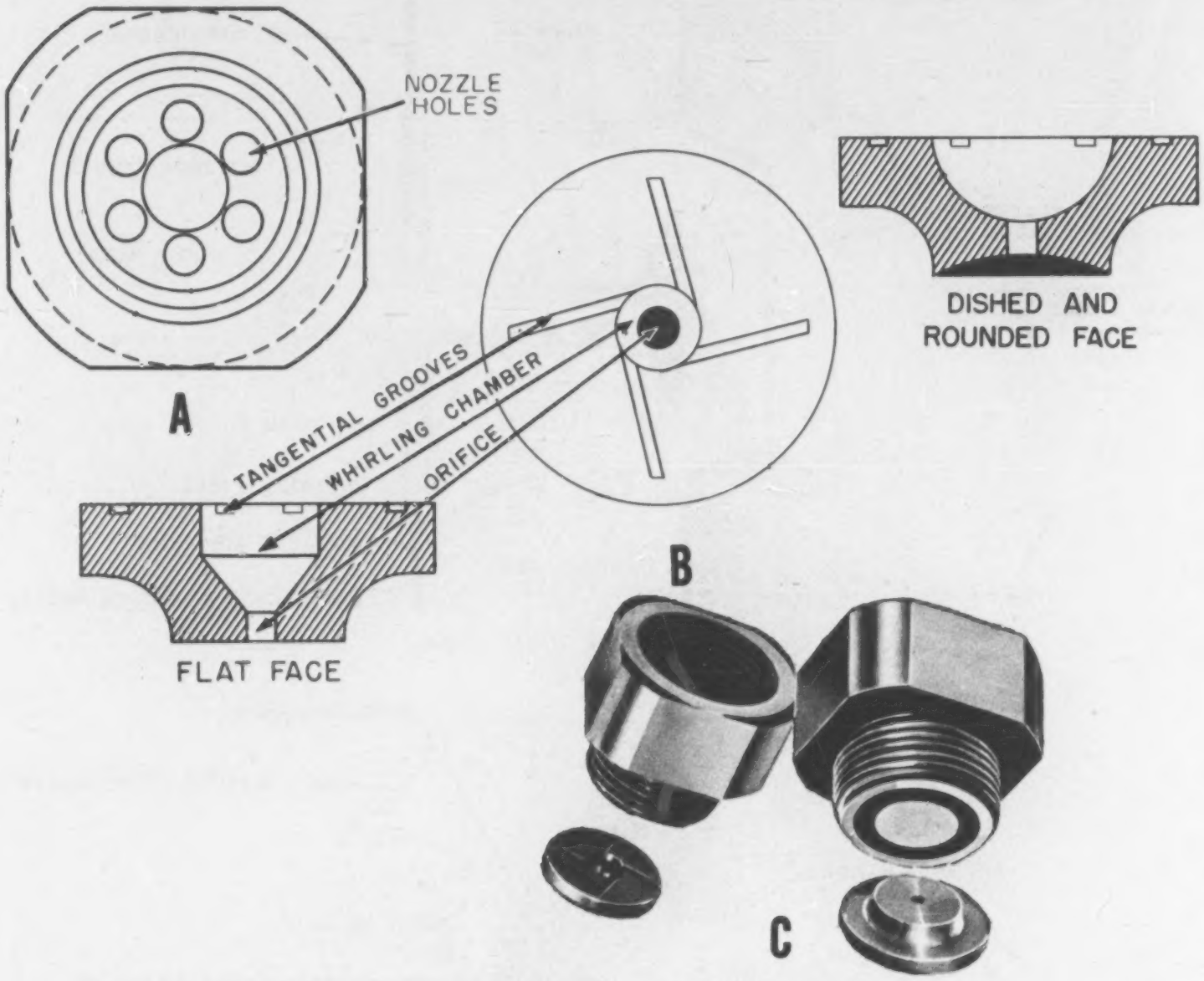

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Figure 6-16.—Nozzle and sprayer plate showing holes, slots and whirling chamber.

The whirling chamber is cone-shaped at the end, and has an opening (orifice) at the small end of the cone. As the oil leaves the chamber by way of this orifice, it is broken up into very fine particles which form a cone-shaped fog-like spray. A strong blast of air, which has been given a whirling motion in its passage through the register, catches the oil fog and mixes with it. The mixture of air and oil enters the furnace, where combustion takes place.

CLASSIFICATION OF BOILERS

Naval boilers may be classified in a number of different ways, according to various design features. Some knowledge of these methods of classification will be useful in understanding the design and construction of modern naval boilers.

LOCATION OF FIRE AND WATER SPACES

First of all, boilers are classified according to the relative location of their fire and water spaces. By this method of classification, all boilers may be divided into two groups: FIRE-TUBE BOILERS and WATER-TUBE BOILERS. In fire-tube boilers, the gases of combustion flow through the tubes and heat the surrounding water. In water-tube boilers, the water flows

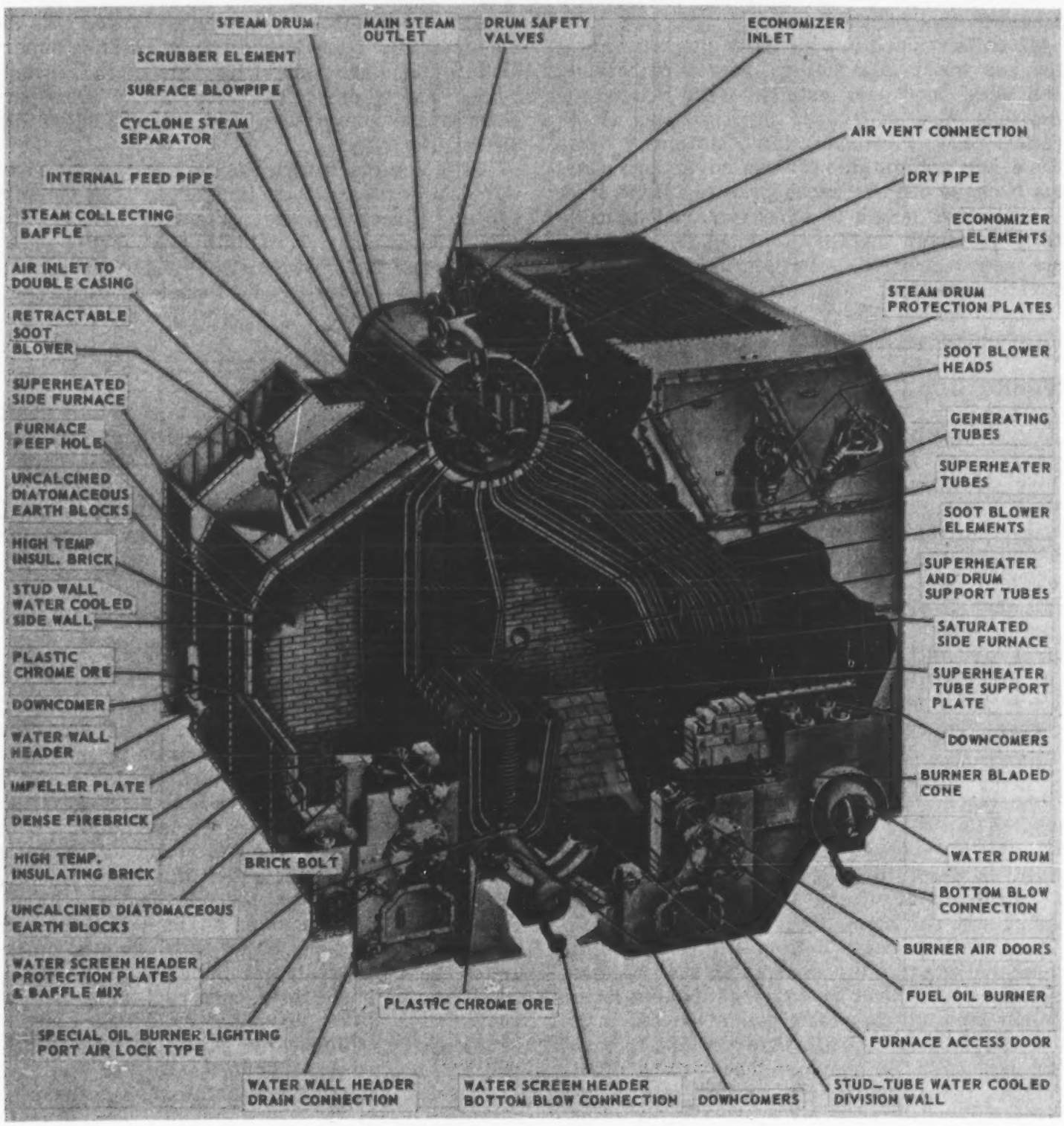

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Figure 6-17.—Cutaway view of M-type divided furnace boiler.

through the tubes and is heated by the gases of combustion that fill the furnace.

All boilers used in propulsion plants of naval ships are water-tube boilers. Fire-tube boilers, which were once used extensively in marine installations, are still used in propulsion plants of some older merchant ships. However, these boilers are not suitable for use on modern naval ships because of their excessive weight and size, the excessive length of time required to raise steam, and their inability to meet demands for rapid speed changes. Auxiliary boilers are not generally used on steam-driven ships because all steam for auxiliary service is taken from the propulsion-plant boilers.

TYPES OF CIRCULATION

Water-tube boilers are also classified according to the type of circulation. Natural circulation boilers are those in which the circulation of water depends upon the difference in density between an ascending mixture of hot water and steam, and a descending body of relatively cool and steam-free water. The difference in density occurs because the water expands as it is heated, thus becoming less dense. There are two types of natural circulation—FREE and ACCELERATED.

In FREE circulation boilers, the tubes which connect the lower and upper drums or headers are only slightly inclined; this allows the lighter hot water and steam to rise while the heavier and cooler water descends. Installing the generating tubes at a greater angle of inclination increases the rate of water circulation. Therefore, boilers in which the tubes slope more steeply between the water drums or headers and the steam drum are said to have ACCELERATED natural circulation.

Most modern naval boilers are designed for accelerated natural circulation. In such boilers, large tubes (3 inches or more in diameter) are installed between the steam drum (located at the top of the boiler) and the water drums (located at the bottom of the furnace). These large tubes, known as downcomers, are located outside the furnace and away from the heat of combustion, thereby serving as pathways for the downward flow of relatively cool water. The small tubes (generating tubes) then carry the steam and water upward.

TYPE OF SUPERHEATER

On practically all boilers currently used in the propulsion plants of naval ships, the superheater tubes are protected from radiant heat by water screen tubes. These tubes absorb the intense radiant heat of the furnace, and the superheater tubes are heated by convection currents rather than by direct radiation. Hence, the superheaters are referred to as CONVECTION-TYPE SUPERHEATERS.

On some older boilers, the superheater tubes were not screened by water screen tubes but were exposed directly to the radiant heat of the furnace. Superheaters of this type are called RADIANT-TYPE SUPERHEATERS. Although this type of superheater is uncommon at the present time, it may be used again in future boiler designs.

FURNACE ARRANGEMENT

All natural circulation boilers now in naval use may also be classified according to the furnace arrangement. By this classification, boilers are either SINGLE-FURNACE BOILERS or DOUBLE-FURNACE BOILERS. Double-furnace boilers are also referred to as DIVIDED-FURNACE BOILERS.

OTHER NAVAL BOILERS

There are many different kinds of boilers used in naval ships. Earlier in this chapter you studied and assembled the 600 psi D-type boiler. Some of the other boilers used in naval ships are the 600 psi M-type divided-furnace boiler shown in figure 6-17 and the 1200 psi boiler shown in figure 6-18. Notice that the boiler shown in figure 6-18 is very similar to the boiler shown in figure 6-1. However the boiler in 6-18 has some special operating and design features which make it different from the one shown in figure 6-1. On some older ships you may find the sectional header boiler, which is illustrated in figure 6-19. A relatively new boiler that is presently installed on some new construction of the DE 1040 class is the pressure fired boiler shown in figure 6-20. Since the pressure fired boiler is used for propulsion only, those ships that have a pressure fired boiler installed, also have an auxiliary boiler.

In addition to the boilers that are used for main propulsion there are also auxiliary boilers. The term auxiliary boilers is used to include a wide variety of small boilers which are used in diesel-driven ships to supply steam or hot water for distilling plants, space heating, galley and laundry services. Auxiliary boilers are equipped with the accessories and controls necessary for their operation as a complete self-contained

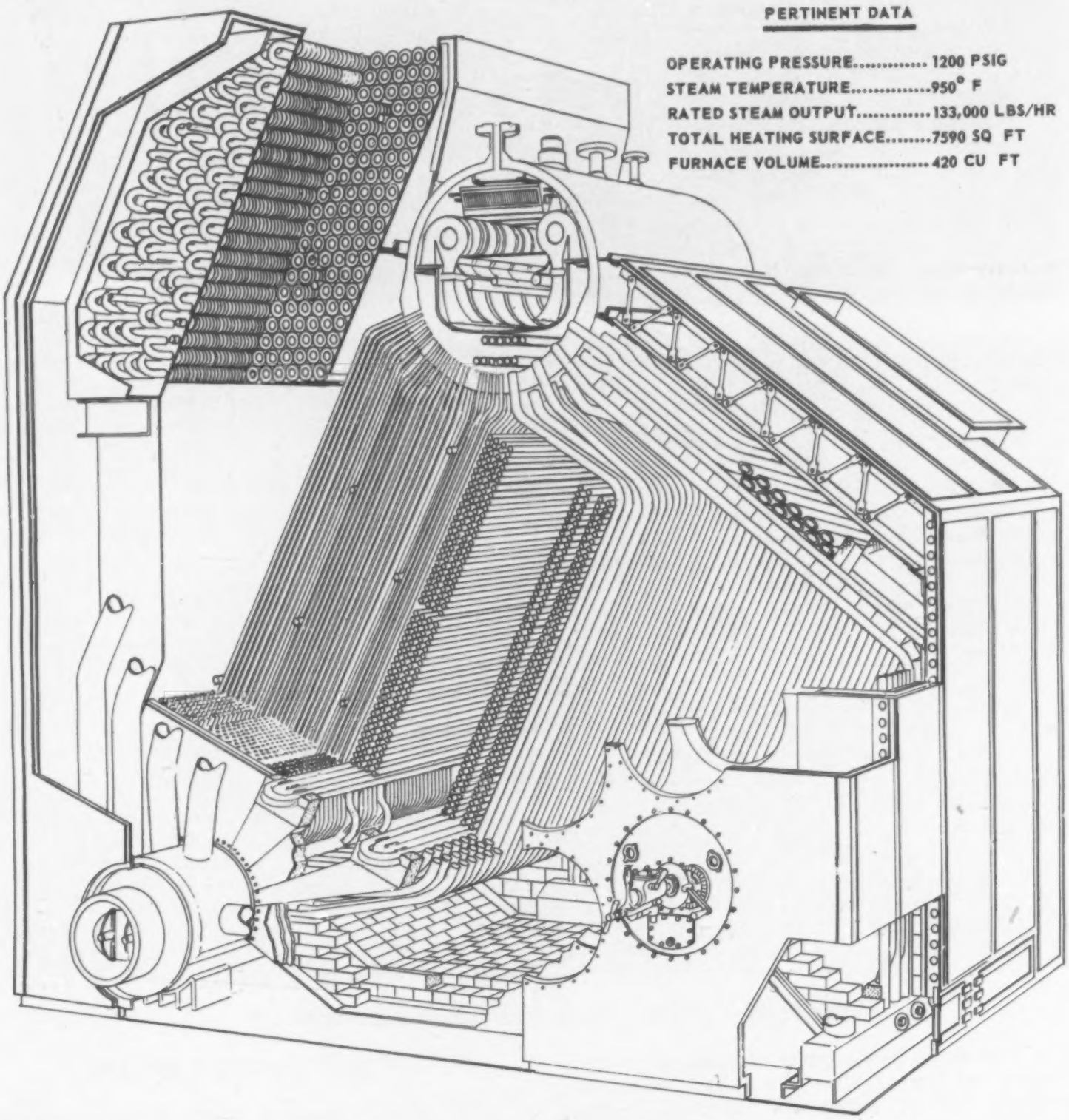

Figure 6-18.—1200 psi single-furnace boiler.

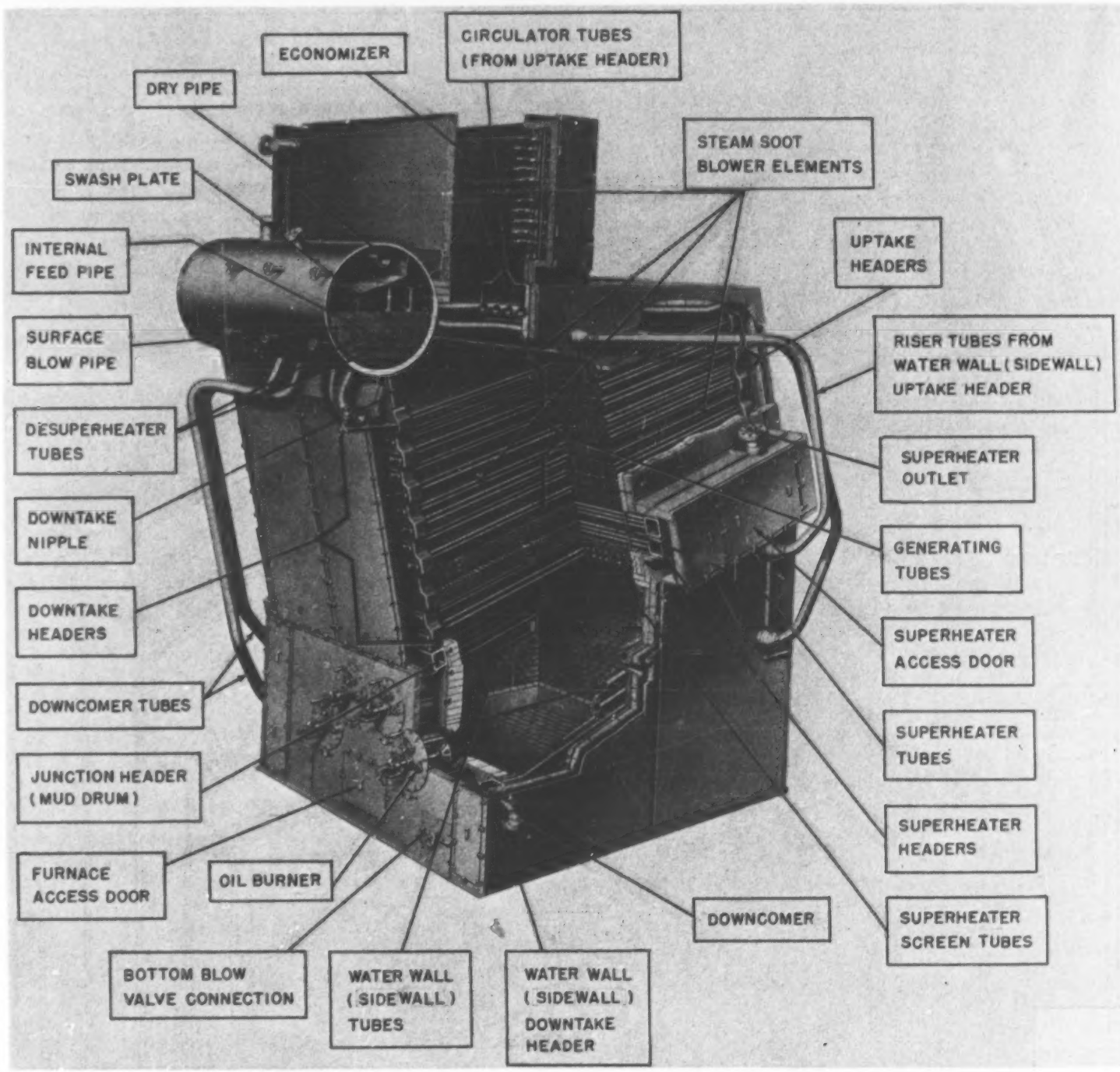

Figure 6-19.—Cutaway view of a sectional header boiler. 38.33X

unit. The three basic types of auxiliary boilers in naval use are: (1) fire-tube boilers, illustrated in figure 6-21, (2) water-tube boilers with natural circulation, shown in figure 6-22, and (3) water-tube boilers with forced circulation, as shown in figure 6-23.

Generally, operating pressures of auxiliary boilers range from 50 psi to 125 psi. Most operating and maintenance procedures for main propulsion boilers are also applicable to auxiliary boilers.

NEW HIGH PRESSURE BOILERS

The modern trend in boiler design is toward higher pressures and temperatures. High pressure boilers have the advantage of being smaller, lighter, and more economical of fuel for any given shaft horsepower than boilers which operate at lower pressures and temperatures. Boilers operating at 4500 psi and above are now in use in some stationary steam power plants. For naval propulsion boilers, such pressures are

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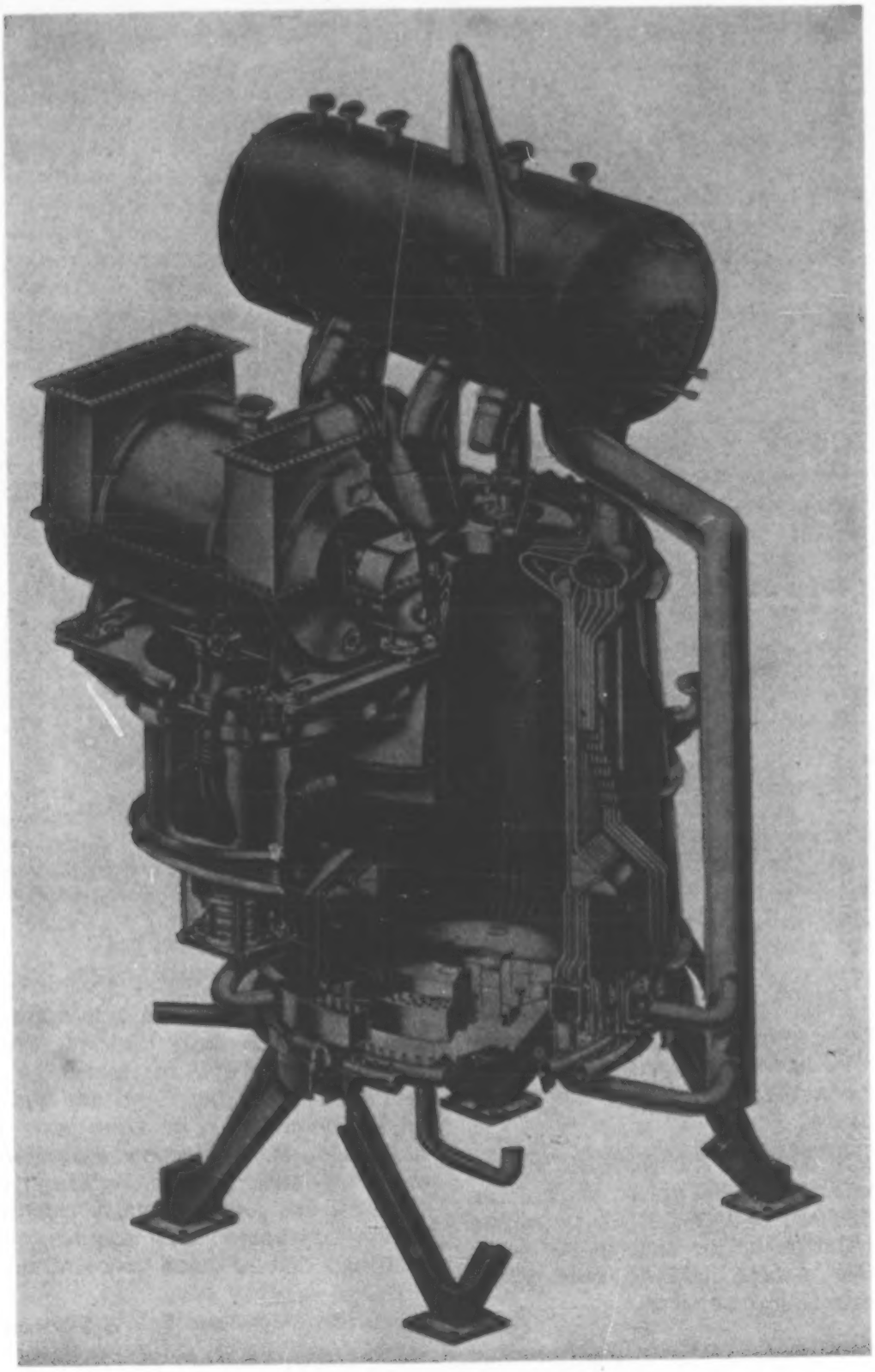

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Figure 6-20.—Pressure fired boiler.

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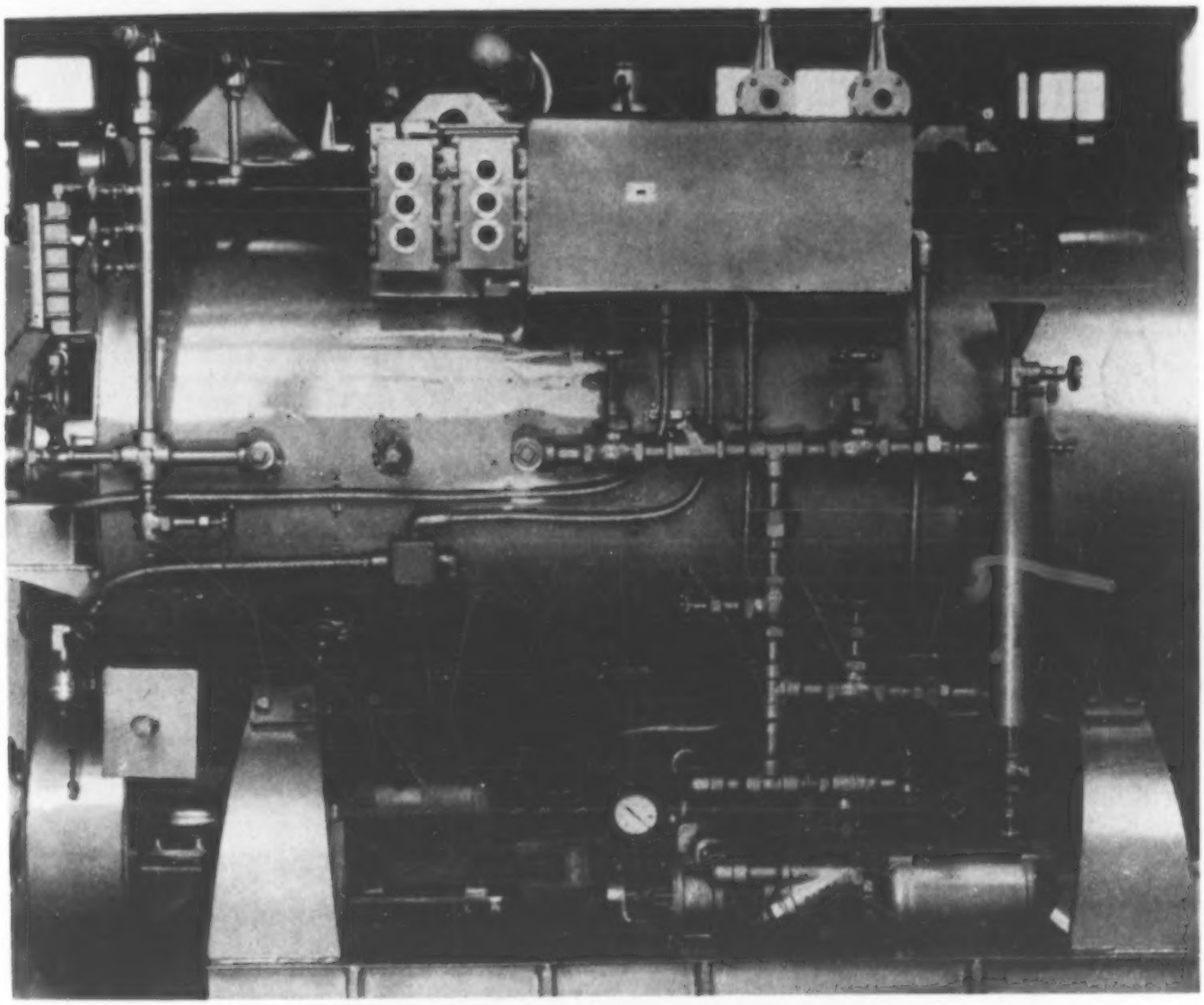

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Figure 6-21.—Fire tube auxiliary boiler.

not practicable at the present time. However, a number of boilers, operating at 1200 psi pressure and at 950°F, have been installed on new naval ships; increasing use will probably be made of these boilers.

The term HIGH PRESSURE BOILER refers to any boiler operating at 700 psi or above. The term HIGH PRESSURE, D-TYPE BOILER refers to a natural circulation boiler that is the same as the D-type boiler, except that it has been modified for higher operating pressures.

FIREROOM SAFETY PRECAUTIONS

Safety precautions are for your protection as well as for the protection of the machinery and equipment. When working in a steaming fireroom you should be fully clothed. The valves, pipes and exposed metal in firerooms are always hot and will burn the flesh and leave a scar. It is advisable not only to keep your shirt on; but to keep the shirt sleeves rolled down. Whenever you are assisting in lighting off or securing boilers, or just generally working in the fireroom, pay strict attention to posted safety precautions and to those precautions that your petty officers will tell you.

A few important safety precautions are listed here; your petty officers will instruct you in many more:

1. Do not open or close any valve whose purpose you do not understand and which you were not told to open or close.

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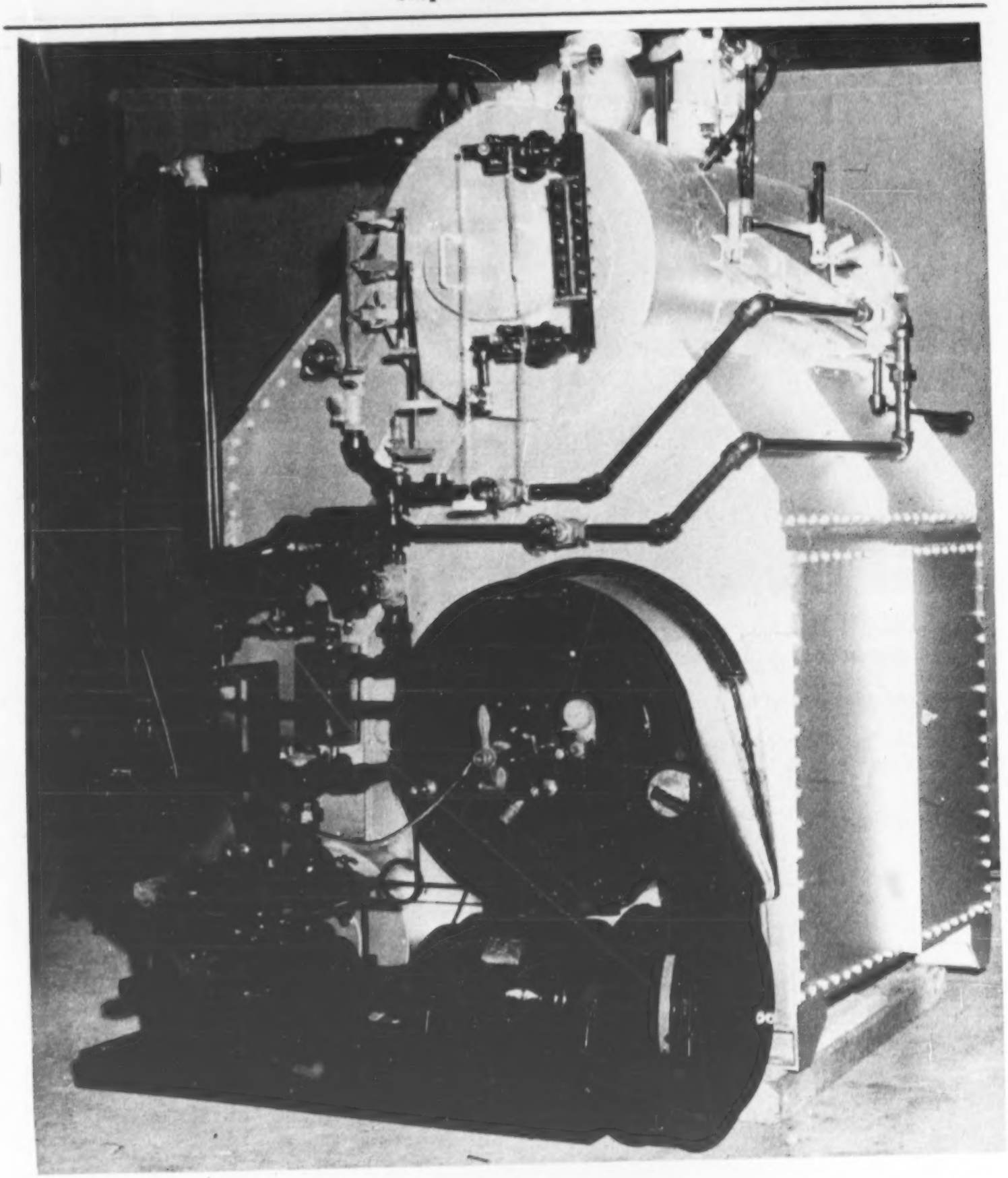

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Figure 6-22.—Assembly view, water tube auxiliary boiler (natural circulation).

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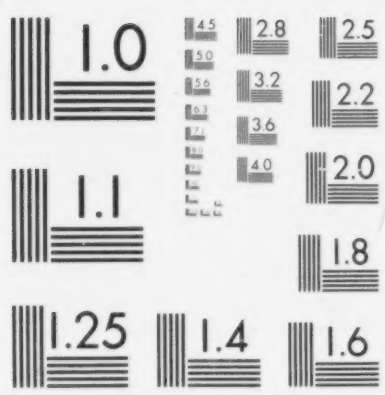

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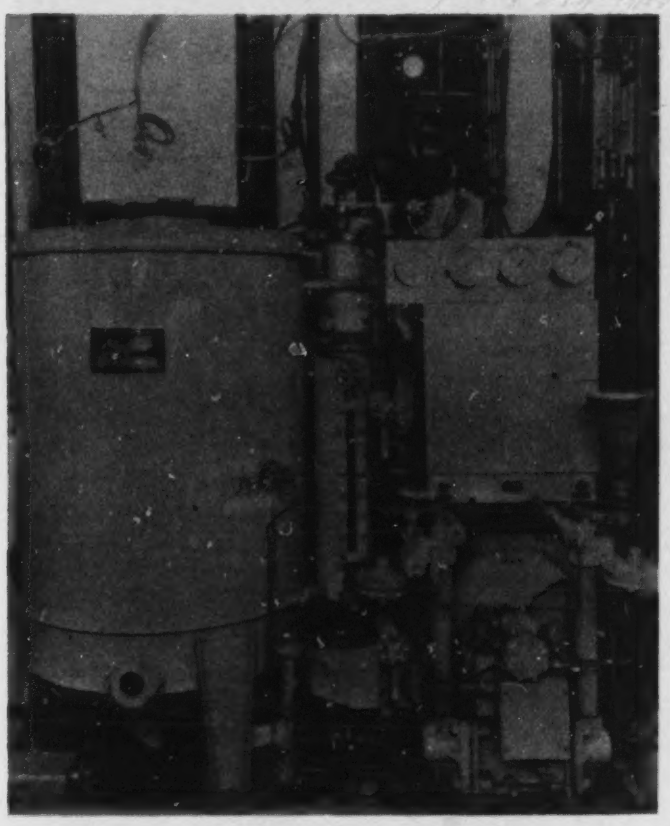

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Figure 6-23.—Assembly view of a forced circulation auxiliary boiler.

2. Do not play games of any kind in the fireroom.

3. Do not leave tools lying around the fireroom; always return them to their proper stowage.

The following precautions should be observed when lighting off a boiler:

1. Run the water level down until it is below lighting off level and then add water with the emergency feed pump until it is at lighting off level.

2. Always purge the furnace before lighting off the first saturated burner.

3. Stand well clear when inserting and withdrawing the torch.

The following precautions should be observed during boiler operation.

1. Never leave disconnected atomizers in place.

2. Keep the atomizer root valves to secured burners closed, except during maneuvering.

3. Test the drain from the oil heater once each hour.

4. Blow through the gage glasses once each watch.

5. Poke through the burner drain holes once each watch.

6. Wipe up spilled oil at once.

The following safety precautions apply to securing a boiler:

1. In shutting down a fireroom, do not close the master oil valve until the fuel oil pump is secured.

2. Remove atomizers from registers as soon as possible after securing.

3. Close all openings to the furnace as soon as all atomizers have been extinguished.

4. Pump the water level to three-fourths of a glass on cutting out a boiler.

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CHAPTER 7

STEAM TURBINES AND REDUCTION GEARS

Earlier chapters of this training course presented the basic steam cycle and various turbine propulsion units. This chapter will lift the cover from the turbines and the reduction gears so that you may obtain a basic understanding of how the stored energy (heat) in steam is transformed into the mechanical energy (work) of rotation.

TURBINES

The development of steam power was built around the reciprocating engine; however, the earliest steam engine operated on the TURBINE principle. Almost 2,000 years ago a Greek mathematician named Hero built a small steam turbine and demonstrated the feasibility of steam power (fig. 7-1). Hero's turbine consisted of a hollow sphere which carried four bent nozzles. The sphere was free to rotate on the tubes that carried steam from the boiler. Steam generated in the boiler passed up the tubes into the sphere and out through the nozzles. The action of the steam leaving the nozzles caused the sphere to rotate rapidly.

139.23

Figure 7-1.—Hero's steam turbine.

Down through the ages the turbine principle has been applied to many different types of machines. The water wheel that was used to operate the flour mills of colonial times, the common windmill used for pumping water, and the two-bladed windmill used for charging batteries are all examples of applications of the turbine principle. In these examples the power is derived from the effect of the wind or a stream of water on a set of blades attached to a wheel. In the steam turbine, steam under pressure serves the same purpose as the wind or the flowing water in the other types.

CLASSIFICATION OF TURBINES

Turbines may be classified in four ways:

1. The manner in which the steam causes the turbine rotor to rotate.
2. The type of staging and compounding of steam pressure and velocity.
3. The division of the steam flow.
4. The direction of the steam flow.

Under each of these classifications, there are several types of turbines, some of which are described briefly in the following paragraphs.

Impulse Turbines

The energy to rotate an impulse turbine is derived from the kinetic energy of a steam jet or some other rapidly moving fluid. The term "impulse" infers that the force which turns the turbine is derived from the impact of the

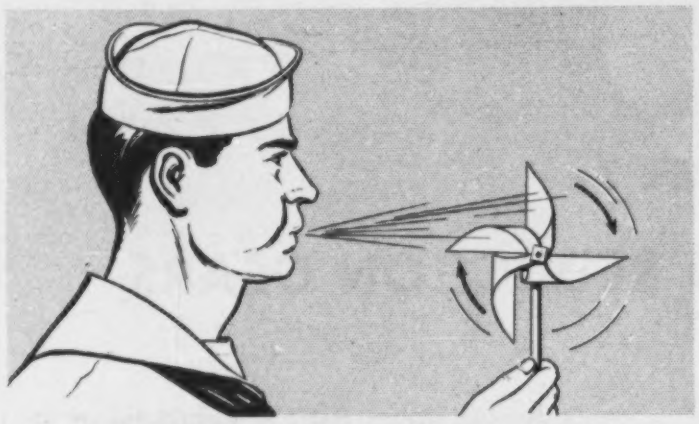

Figure 7-2.—The toy pinwheel operates on the impulse turbine principle. 139.24

fluid. The toy pinwheel (fig. 7-2) can be used to study some of the basic principles of turbines. When you blow on the rim of the wheel, it spins rapidly. The harder you blow, the faster it turns. The steam turbine operates on the same principle, except that it uses the high pressure steam from the ship's boiler.

The impulse turbine consists essentially of a rotor or spindle mounted on a shaft that is free to rotate in a set of bearings. The outer rim of the spindle carries a set of curved blades, and the whole assembly is enclosed in an air-tight case. Several nozzles direct the steam against the blades and turn the spindle (fig. 7-3).

STEAM NOZZLES are connected to the line that caries high pressure steam from the boiler. As the steam passes through each nozzle, its pressure is reduced, but its velocity is greatly increased. The potential energy of the steam under pressure is converted to kinetic energy in the high-speed jets emerging from the nozzles. These jets are directed against the nozzles. These jets are directed against the turbine blades and turn the spindle. To be more explicit, the velocity of the steam is reduced in passing over the blades, and some of its kinetic energy is transferred to the blades as a force that is utilized to turn the spindle. The modern impulse turbine operates on the same general principle as the model just described, but it has many refinements.

COMPOUND TURBINES have several rows of revolving blades with stationary nozzles or blades mounted between each row. As the steam passes through the first stage, it speeds up in the nozzles and slows down while going through the moving blades. The second set of nozzles speeds it up again, making additional kinetic

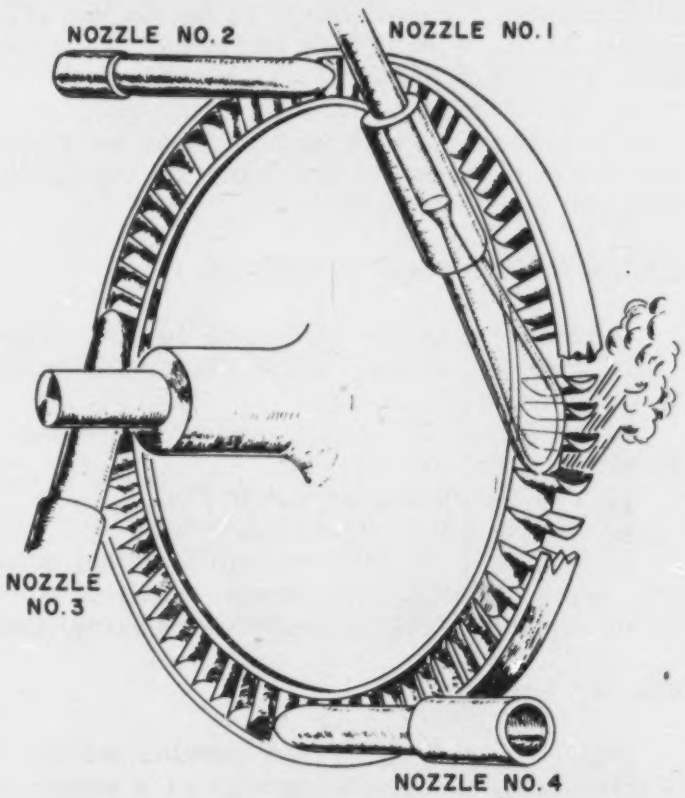

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Figure 7-3.—A simple impulse turbine.

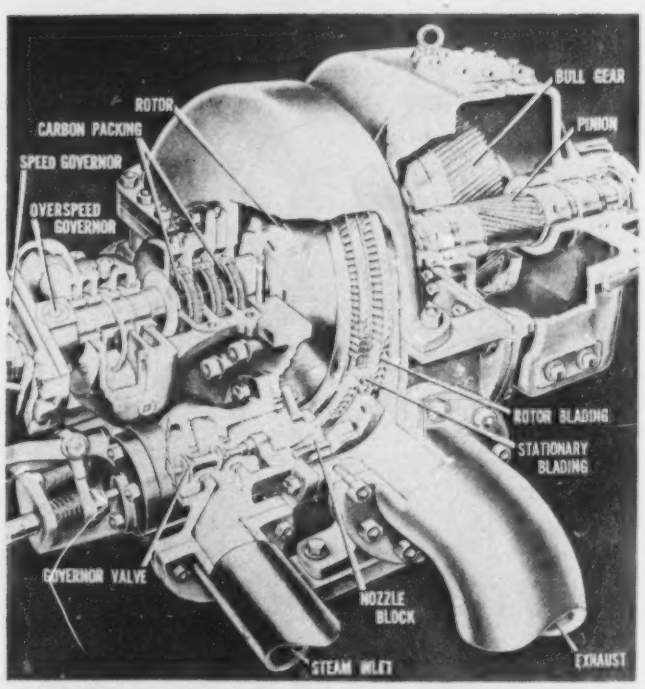

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Figure 7-4.—A velocity compound impulse turbine with a reduction gear.

9401

energy available for the second row of moving blades. This sequence continues through all of the successive stages until the pressure is reduced to the point where it would not be feasible to extract any more energy from it.

The velocity compound impulse turbine shown in figure 7-4 has two rows of moving blades. Steam enters through the inlet, flows through the governor valve, and passes through the stationary nozzles. There is a large pressure drop and a large velocity increase out of the nozzles. The steam enters the first row of moving blades attached to the spindle where there is a decrease in velocity. It then flows through the stationary blades or guide blades. There is neither a pressure drop nor a velocity increase while the steam goes through the stationary blades; they merely provide a reversal of steam flow prior to entering the next row of moving blades. The steam then enters the second row of moving blades where there is also a decrease in velocity. The velocity is reduced so that by the time the steam reaches the exhaust, most of the energy has been utilized to turn the spindle.

The shaft of the spindle revolves in bearings supported by the turbine casing. Carbon packing rings keep the steam from escaping through the shaft bearing. The reduction gear (discussed later in the chapter) consists of a pinion attached to the spindle shaft and a much larger bull gear. Because of its larger diameter, the bull gear rotates much more slowly than the high-speed turbine.

Impulse turbines are used in the Navy to drive the forced draft blowers and most of the feed water and fuel pumps. They have few moving parts, are lightweight, do not take up much space, and run with very little vibration.

In an impulse turbine, a STAGE is defined as one set of nozzles and the succeeding row or rows of moving and fixed blades. Another way of defining a stage is to say that it includes the nozzles and blading in which only one pressure drop takes place. (In an impulse turbine, remember, the only pressure drop takes place in the nozzles. Therefore, the number of sets of nozzles in an impulse turbine indicates the number of stages.)

Figure 7-5 shows a SIMPLE IMPULSE TURBINE. This turbine has one stage, consisting of one set of nozzles and one row of moving blades mounted on the rotor. Simple impulse turbines do not completely utilize the velocity of the steam, and are therefore not very efficient.

One way to increase the efficiency of a single stage impulse turbine is to add another row (or even two more rows) of moving blades to the rotor wheel. Figure 7-6 shows a turbine which has two rows of moving blades. This type of turbine is called a VELOCITY-COMPOUNDED IMPULSE TURBINE because the residual velocity of the steam leaving the first row of moving

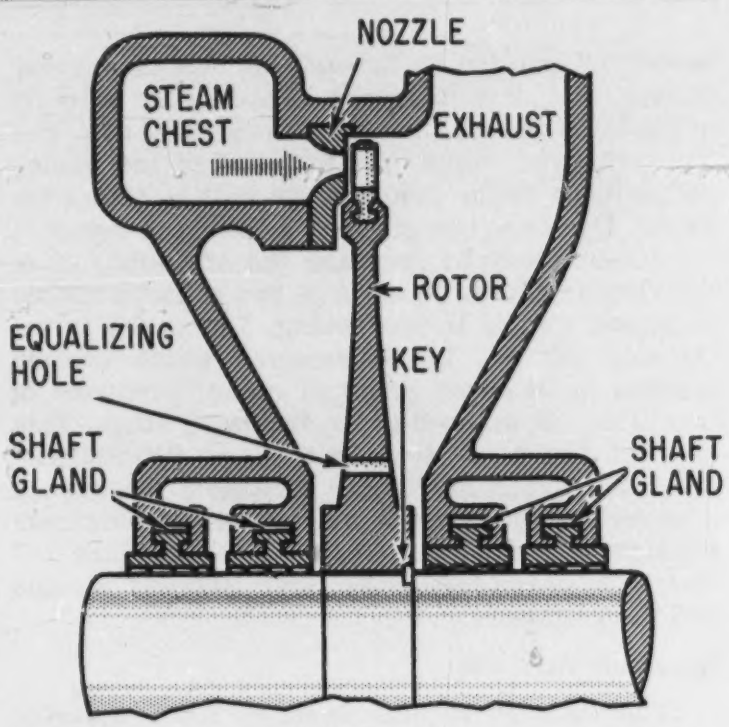

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Figure 7-5.—Simple impusle turbine.

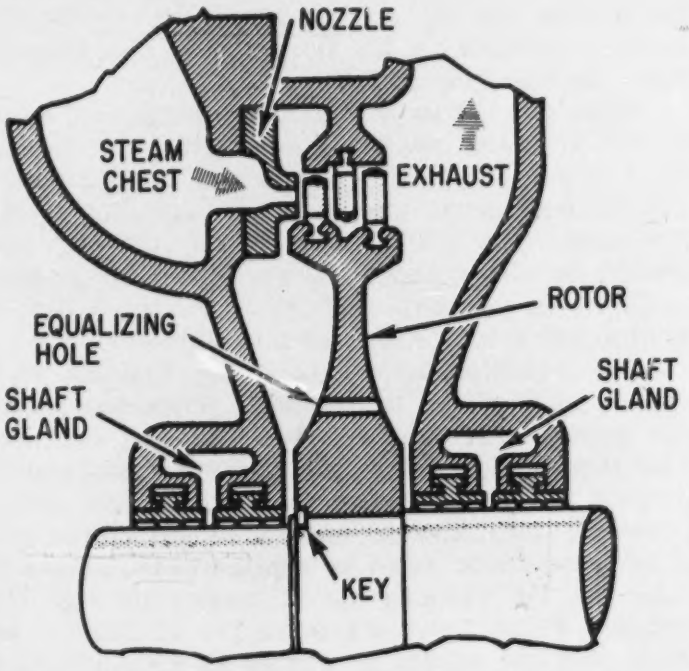

Figure 7-6.—Velocity-compounded impulse turbine. 38.79X

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blades is utilized in the second row of moving blades; and, if a third row is added, the velocity of the steam is utilized again in the third row. The fixed blades, which are fastened to the casing rather than to the rotor, serve only to direct the steam from one row of moving blades to another.

Another way to increase the efficiency of an impulse turbine is to arrange two or more simple impulses stages in one casing. The casing is internally divided by diaphragms which contain nozzles so that the residual steam pressure of one stage is utilized in the following stage. This type of turbine is known as a PRESSURE-COMPOUNDED IMPULSE TURBINE because a pressure drop occurs in each stage, as the steam expands through each set of nozzles. Figure 7-7 shows a pressure-compounded impulse turbine with four stages.

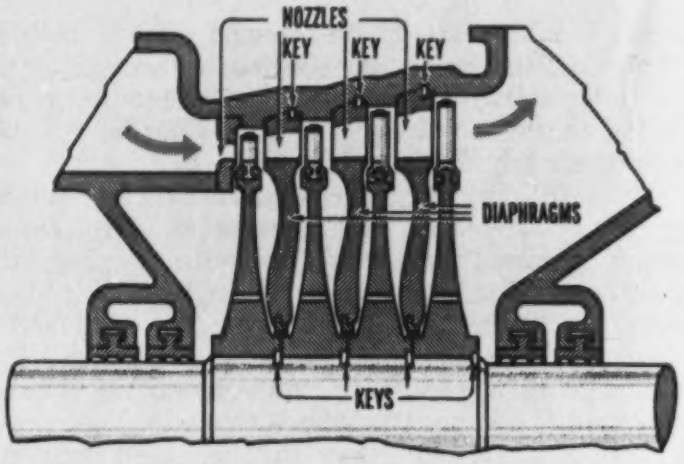

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Figure 7-7.—Pressure-compounded impulse turbine.

Reaction Turbines

The ancient turbine built by Hero operated on the reaction principle. Hero's turbine was invented long before Newton's time, but it was a direct application of Newton's third law of motion which states: FOR EVERY ACTION THERE MUST BE AN EQUAL AND OPPOSITE REACTION. On first thought, you may find it difficult to accept this statement on its face value. However, an examination of a few common examples should make you realize that it is true.

If you set an electric fan on a roller skate, it will take off across the table (fig. 7-8). The fan pushes the air and sets up a breeze; the air is also pushing on the fan with an equal force, but in an opposite direction.

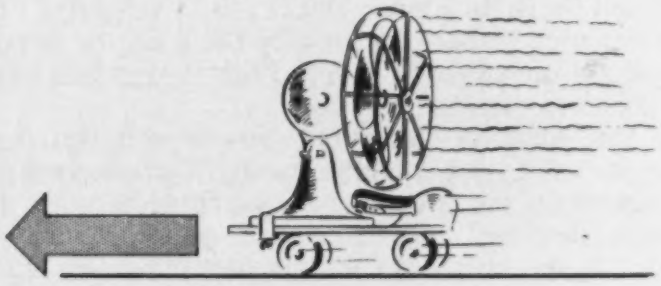

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Figure 7-8.—The reaction of the air on the blades rolls the electric fan across the table.

When you try to push a car, you may not know it but you are pushing back with your feet as hard as you are pushing forward with your hands. Try it sometime when you are standing on an icy road. With a little thought on your part you should be able to come up with enough examples to prove to yourself that Newton's third law of motion holds true under all circumstances.

The reaction turbine uses the reaction of a steam jet to drive the spindle. When discussing the impulse turbine, we explained that the nozzles increased the velocity of the steam and transformed the potential energy of the steam under pressure into kinetic energy in the steam jet. A forward force must be applied to the steam to increase its velocity as it passes through the nozzle. From Newton's third law of motion we know that the steam jet exerts an equal reactive force on the nozzle and on the turbine blades, but in the opposite direction; this is the force that drives the turbine.

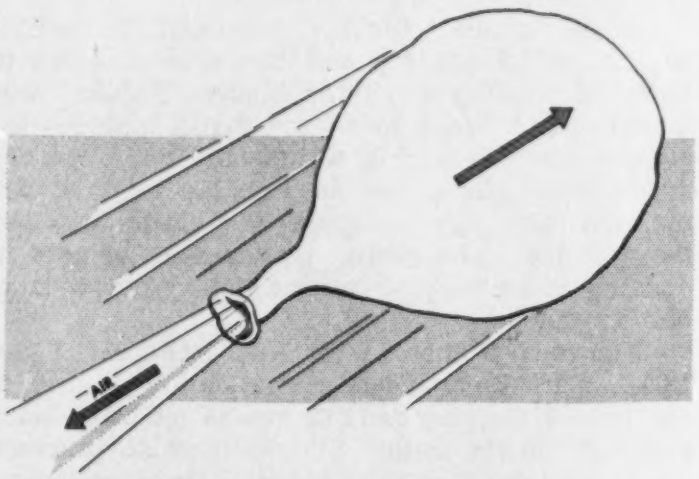

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Figure 7-9.—A toy balloon demonstrates the "kickback" or reaction principle.

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In the reaction turbine, stationary blades attached to the turbine casing act as nozzles and direct the steam to the moving blades. The moving blades are mounted on the rotor. Most reaction turbines have several stages, with alternate rows of stationary and moving nozzle blades.

The "kickback" or reaction force generated by the nozzle blades can be demonstrated by a toy balloon. Blow up the balloon and toss it into the air. The air will rush out through the opening and the balloon will shoot off in the opposite direction (fig. 7-9).

When the balloon is filled with air, we have potential energy by virtue of the increased air pressure inside. The air that escapes is speeded up as it passes out through the small opening; this represents a transformation from potential to kinetic energy. The force applied to the air to speed it up is accompanied by a reaction in the opposite direction. This reactive force propels the balloon forward through the air.

You probably think that the propelling force comes from the jet of air blowing against the air in the room, but this is not so. It is the reaction of the force required to increase the velocity of the air as it passes out through the opening. The balloon would travel even faster if it were in a vacuum.

The reaction type turbine (fig. 7-10) has all the advantages of the impulse type turbine, plus a slower operating speed and greater efficiency. The several stages through which the steam passes gradually reduce the steam pressure until practically all of the energy has been converted to power. When operated in conjunction with a condenser, the exhaust pressure of the turbine is only a small fraction of the normal atmospheric pressure. The steam gradually expands as it passes through the successive stages. The additional volume of the steam due to this expansion is taken care of by increasing the diameter of the spindle in each stage.

In the REACTION TURBINE, the steam pressure successively drops in each row of blades (whether fixed or moving). The combination of a row of fixed blades with a row of moving blades in these turbines is sometimes referred to as a DOUBLE STAGE (also known as a single REACTION STAGE).

The PRESSURE-COMPO)NDED REACTION TURBINE (all reaction turbines are pressure compounded) employs alternate rows, or stages, of fixed and moving blades which compound the total pressure drop into as many steps as there are rows of such blades. This pressure staging lowers the steam velocity in each stage.

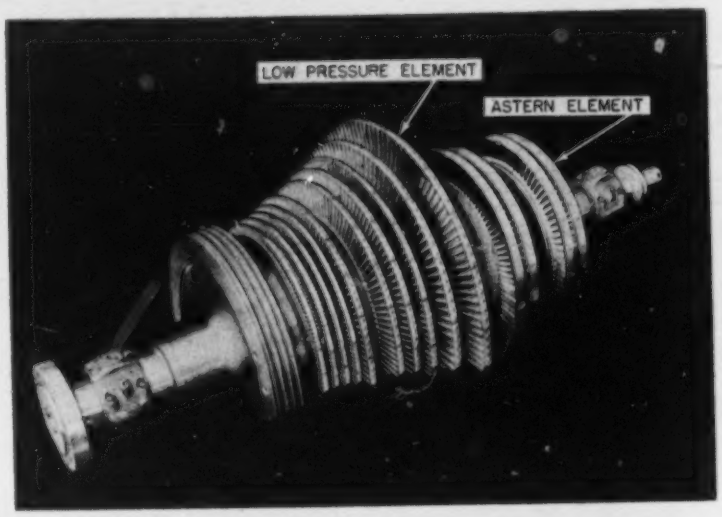

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Figure 7-10.—A low pressure reaction turbine with the upper half of the case removed.

CONSTRUCTION OF TURBINES

Exclusive of the controls, the turbine parts which are common to impulse and reaction turbines include foundations, casings, mozzles (or stationary blades), wheels and rotors, blading, bearings, shaft glands, and gland seals.

Foundations

Turbine foundations are built up from strength members in the hull so as to provide a rigid supporting base. All turbines are subject to varying degrees of temperature—from that existing during a secured condition to that existing during full power operation. Some means must therefore be provided to allow for expansion and contraction.

Normally the after end of the turbine is firmly secured to the structural foundation. The bolts have shanks which are fitted to the exact size of the holes in which they are placed. The tight fit thus prevents motion of any kind.

At the forward end of the turbine, freedom of movement is accomplished by one of two methods. Either elongated boltholes or grooved sliding seats may be used to allow the forward end of the turbine to move fore and aft, as expansion and contraction take place.

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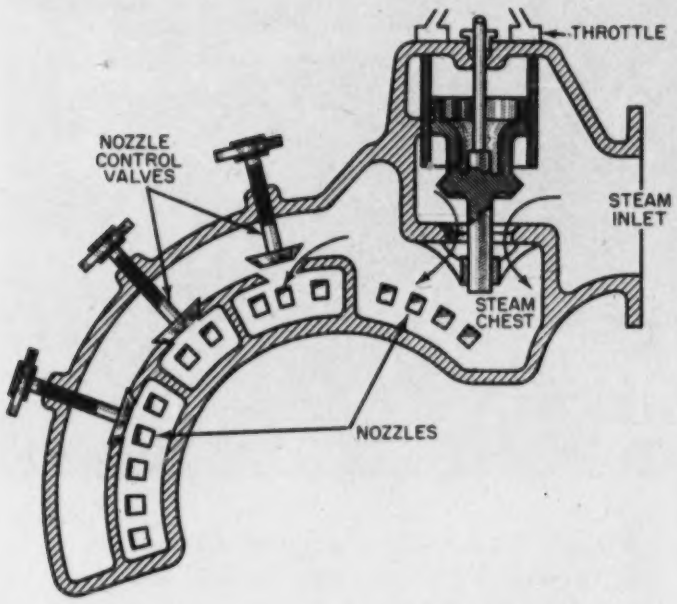

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Figure 7-11.—Diagram of a nozzle group.

Casings

Turbine casings are generally constructed of cast carbon steel; however for the turbines utilizing superheated steam with temperature above 650°F, the casings are generally cast or fabricated from carbon molybdenum steel or chromium molybdenum steel. Each casing has a steam chest which receives the incoming high pressure steam and delivers the steam to the first set of nozzles or blades.

Nozzles

The primary function of the nozzle is to convert the thermal energy of steam into kinetic energy. The secondary function of the nozzles is to direct the steam against the blades. In most modern turbines the nozzles are made up in groups or blocks with each group being controlled by a separate nozzle control valve. The quantity of steam delivered to each stage thus becomes the function of the number of nozzles and nozzle control valves in use. A diagrammatic arrangement of a nozzle group is shown in figure 7-11.

Turbine Rotors

The rotors (forged wheels and shaft) are made of carbon steel for use with steam of relatively low temperatures; however if the temperature of the steam to be used is greater than 650°F then the rotors are made of carbon molybdenum or some other creep- resistant alloy. The primary purpose of the rotor is to carry the moving blades which receive the energy from the steam and turn the turbine shaft. A rotor without the blades is shown in figure 7-12.

Blading

The blades are secured to the turbine casings and rotors by various methods. Some of the methods of securing turbine blading are illustrated in figure 7-13, parts A through D. The straight circumferential dovetail (part A) is primarily used for securing rotor blades. The inverted circumferential dovetail (part B) is used to secure blading in most impulse turbines. The side-locking key piece method, (part C) which is used only on casing blades, consists of driving a locking key piece between the blade root and a groove in the casing. The sawtooth serration method (part D) is used for both rotor and casing blades.

Other component parts of construction or assembly such as the turbine bearings, shaft glands, and the gland sealing system are discussed in the following sections of this training course.

TURBINE BEARINGS

The rotor of every turbine must be supported in bearings, which serve the double purpose of carrying the weight of the rotor and maintaining the correct radial clearance between rotor and casing. All main turbines, and most auxiliary units, have a bearing at each end of the rotor.

Bearings are of two classes: sleeve bearings and antifriction bearings. The latter, which include ball and roller bearings, are used on some small auxiliary units. All propulsion and most auxiliary turbine installations are equipped with

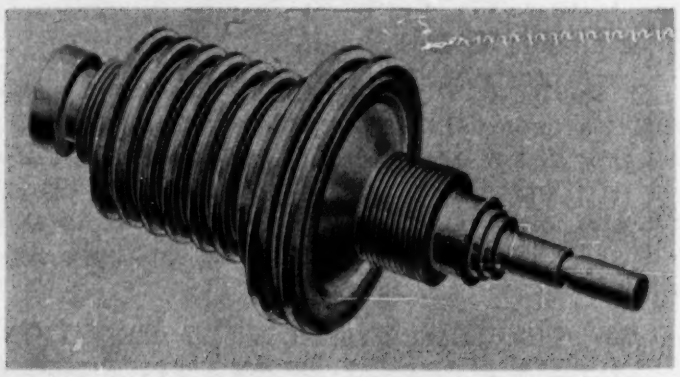

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Figure 7-12.—Turbine rotor without blades.

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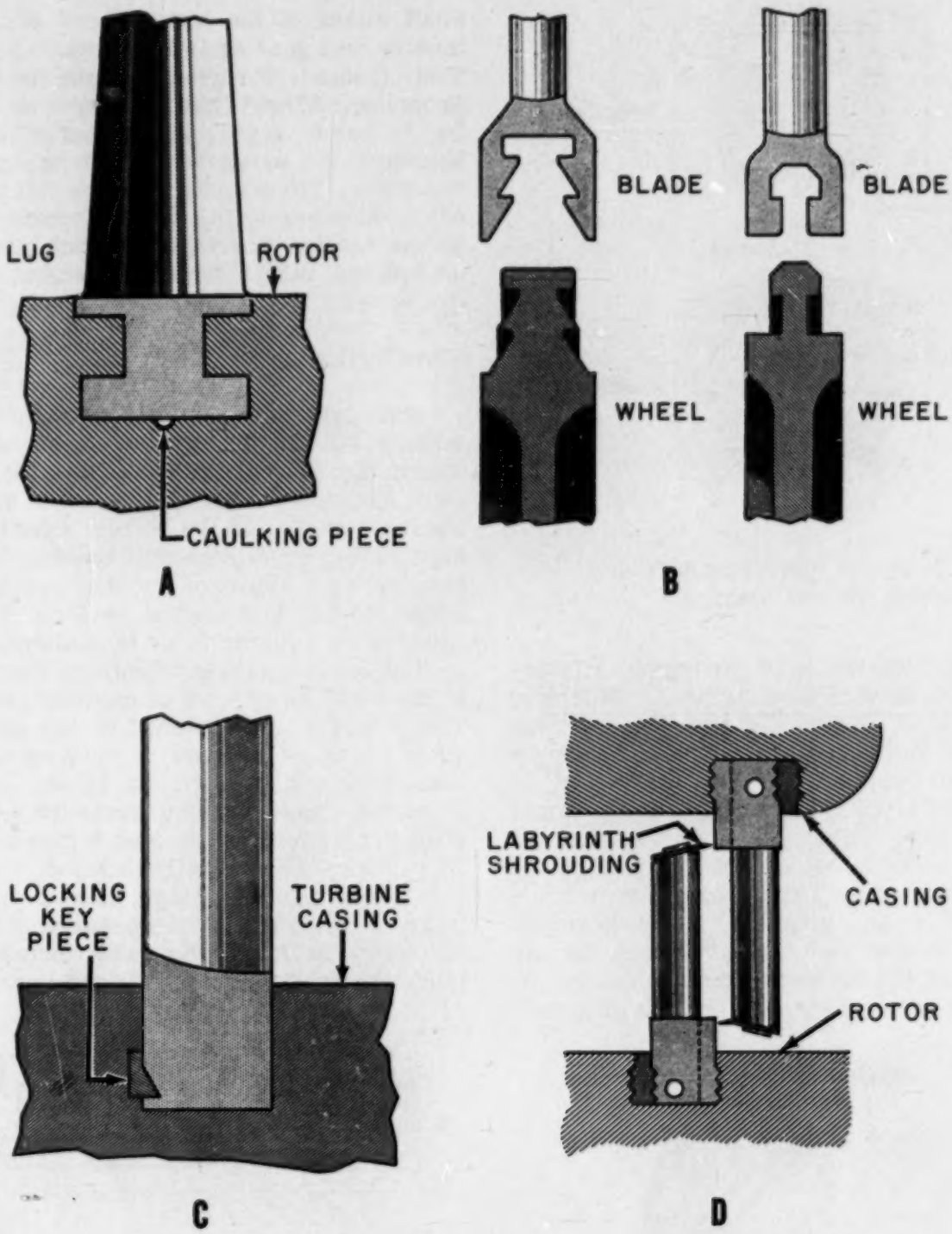

Figure 7-13.—Methods of securing turbine blading. 47.16X

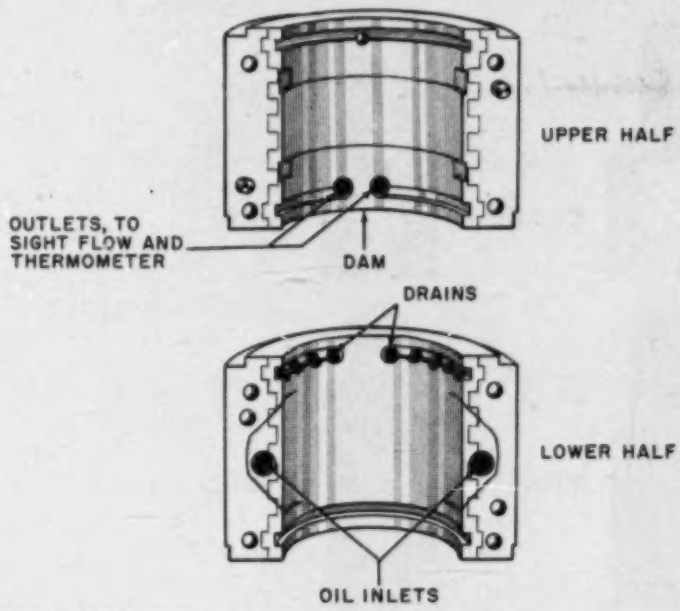

Figure 7-14.—A typical propulsion turbine journal bearing.

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sleeve bearings, which are of two types: cylindrical and spherical-seated. A typical cylindrical journal bearing is shown in figure 7-14. Notice that the upper half and the lower half fit snugly together around the shaft.

THRUST BEARINGS take care of any axial thrust which may exist in a turbine rotor and also hold the turbine rotor within certain definite axial clearances. Thrust bearings are installed on all main turbines. These bearings are installed on one end of the turbine, usually just forward of the forward turbine bearing. A thrust bearing is also installed on the propeller shaft either at the forward end of the main reduction bull gear or in the propeller line shafting abaft (behind) the gear, to take the thrust of the propeller. Except that the propeller thrust bearing is much larger, the design of turbine thrust bearings and propeller thrust bearings is much the same. Thrust bearings are lubricated by the same lubricating oil system which supplies oil to the turbine bearings and reduction gears. An assembled thrust bearing element is shown in figure 7-15.

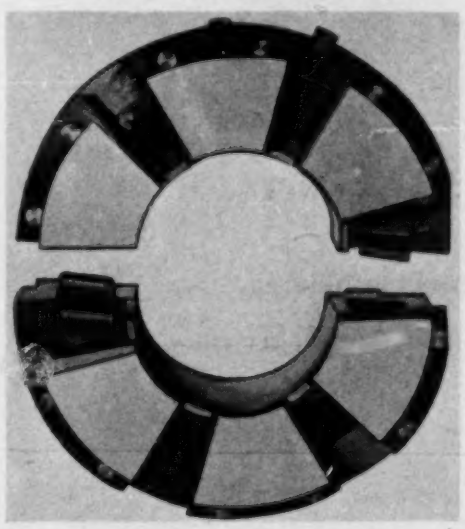

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Figure 7-15.—Assembled thrust bearing element.

SHAFT GLANDS

Shaft glands are used to keep steam from leaking out of the turbine casing at the points where the shaft extends through the casing. The shaft glands on auxiliary turbines have a gland housing which may be either a part of the turbine casing or a separate housing bolted to the casing. Two types of packing are used— labyrinth packing and carbon packing. They may be used either separately or in combination.

Labyrinth packing, shown in part A of figure 7-16, consists of rows of metallic strips or fins. These strips are fastened to the gland liner in such a way as to make a very small clearance between the strips and the shaft. As the steam from the turbine casing leaks through the small spaces between the packing strips and the shaft, its pressure is gradually reduced.

Carbon packing rings, shown in part B of figure 7-16, restrict the passage of steam along the shaft in much the same manner as do the labyrinth packing strips. They are mounted around

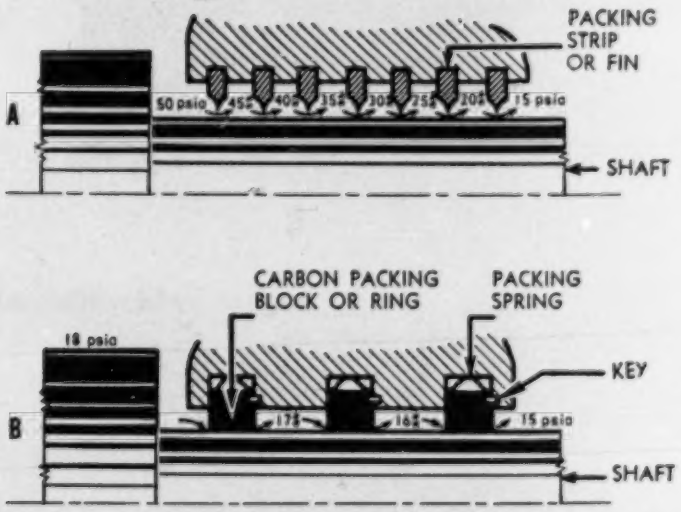

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Figure 7-16.—Turbine rotor shaft glands: A. Labyrinth packing gland. B. Carbon packing gland.

the shaft and held in place by springs. Three or four carbon rings are generally used in each gland. Each ring is fitted into a separate compartment of the gland housing, and each ring consists of two, three, or four segments which are butt-joined to each other. Lugs or stop pins are used to keep the carbon rings from rotating with the shaft. The outer carbon ring compartment is connected to a drain line.

Carbon packing is suitable only for relatively low pressures and temperatures. Therefore, when both types of packing are used in one gland, the labyrinth packing is used at the initial high-pressure area and the carbon packing is used at the low pressure area.

GLAND SEALING SYSTEM

In order to seal the glands of the turbines and prevent air from being drawn into the condenser, steam is passed into the glands. The low pressure turbine, which operates at all times with a vacuum in its casing, must have steam admitted at all times to the glands, from some external source. This steam is led from the auxiliary exhaust line, passes through a cutout valve, then through a weight-loaded pressure regulating valve, and finally to the turbine glands.

Figure 7-17.—A turbine steam sealing gland.

The weight-loaded pressure regulating valve operates at all times to maintain a pressure of about 2 psi (17 pounds absolute) to the turbine glands (fig. 7-17). In high pressure and cruising turbines at higher speeds, the pressure on the turbine end of the forward glands will be so great that steam will bleed out through these glands, automatically sealing them. Since these glands may at times seal themselves, it is necessary to have a separate system for the cruising and high pressure turbines.

REDUCTION GEARS

Chapter 4 of this training course discussed the main propulsion locked-train type, double

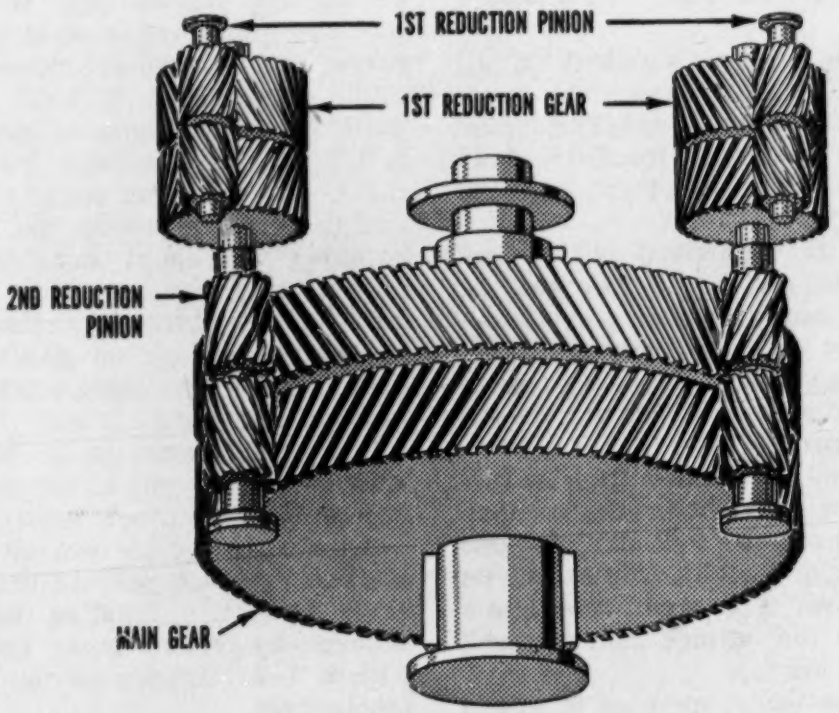

Figure 7-18.—Articulated type of double reduction gearing. 47.28

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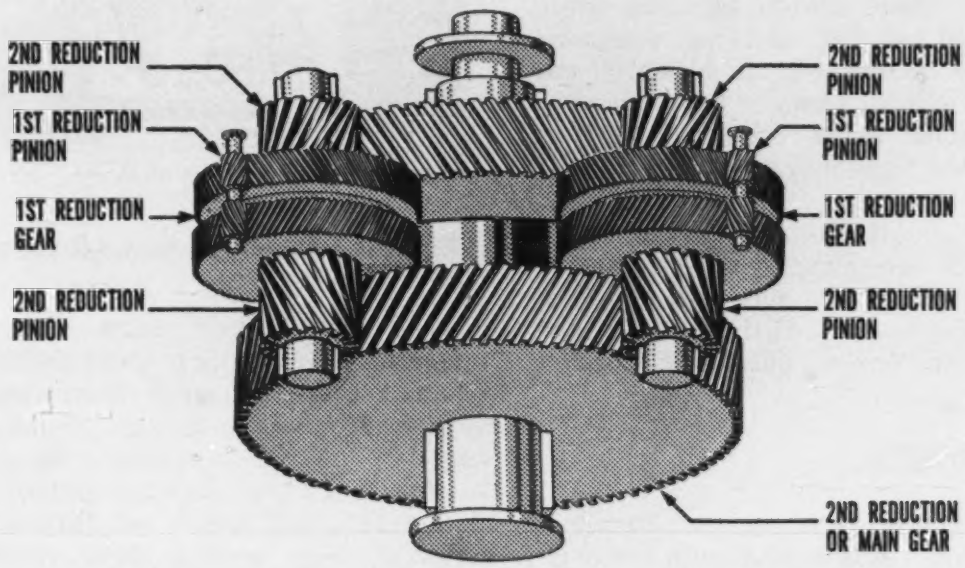

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Figure 7-19.—Nested type of double reduction gearing.

reduction gearing used in the DD-692 class destroyer. There are two other types of main propulsion double reduction gearing in use—the articulated gearing and the nested gearing.

The articulated gearing, shown in figure 7-18, has more bearings and occupies more longitudinal space in a ship than the nested or locked-train type reduction gearing. This type is seldom used in the Navy; it is not used on combatant ships.

The nested gearing is the simplest of all double reduction gears. It uses a minimum number of bearings and flexible couplings. The nested type gearing is illustrated in figure 7-19. This type is used on most auxiliary ships; it is not used on combatant ships.

The gearing used in shipboard pumps and auxiliary machinery is not as complicated as the reduction gearing used for main propulsion. Figure 7-20 illustrates common forms of gears used in shipboard machinery. Probably one of the simplest types of reduction gearing is the worm gear shown in figure 7-20.

Worm gears are used for transmitting motion between shafts that are at right angles to each other. The worm consists of a cylinder with one or more threads (single, double, triple) cut on the outside like a screw. The worm wheel is a gear with teeth cut on the outside rim to mesh with the threads on the worm.

The function of the worm gearing is speed reduction. A complete turn of the worm turns the wheel ahead the distance of one tooth on the wheel. A double thread worm will revolve the gear twice as fast as a single thread worm.

REDUCTION GEAR CONSTRUCTION

The gears in a main reduction gear unit such as the main gears and the pinion gears, must be capable of transmitting tremendous power loads. The pinion gear is the smaller of two meshing gears and is used mainly for decreasing speed and increasing power. Since even very slight unevenness of tooth contour and spacing would cause the gears to operate noisily, or even fail, special precautions are taken to manufacture the gears to exact dimensions. The gears are cut in a room where the temperature and the humidity are kept constant. This eliminates expansion and contraction and oxidation of the metal during cutting operations.

Almost all pinion gears in main reduction gearing are completely machined out of specially heat-treated nickel steel forgings. The gear wheels are generally of built-up construction, with the teeth cut in forged steel bands which are welded to steel webs. The first reduction gears are generally welded on their respective shafts. The bull gear is usually pressed on the shaft against a locating shaft shoulder and is, secured by one or more keys and a locking nut. Figure 7-21 illustrates the key and locking nut mechanism.

The gear casings can be divided into three major parts. The lower part (the base section)

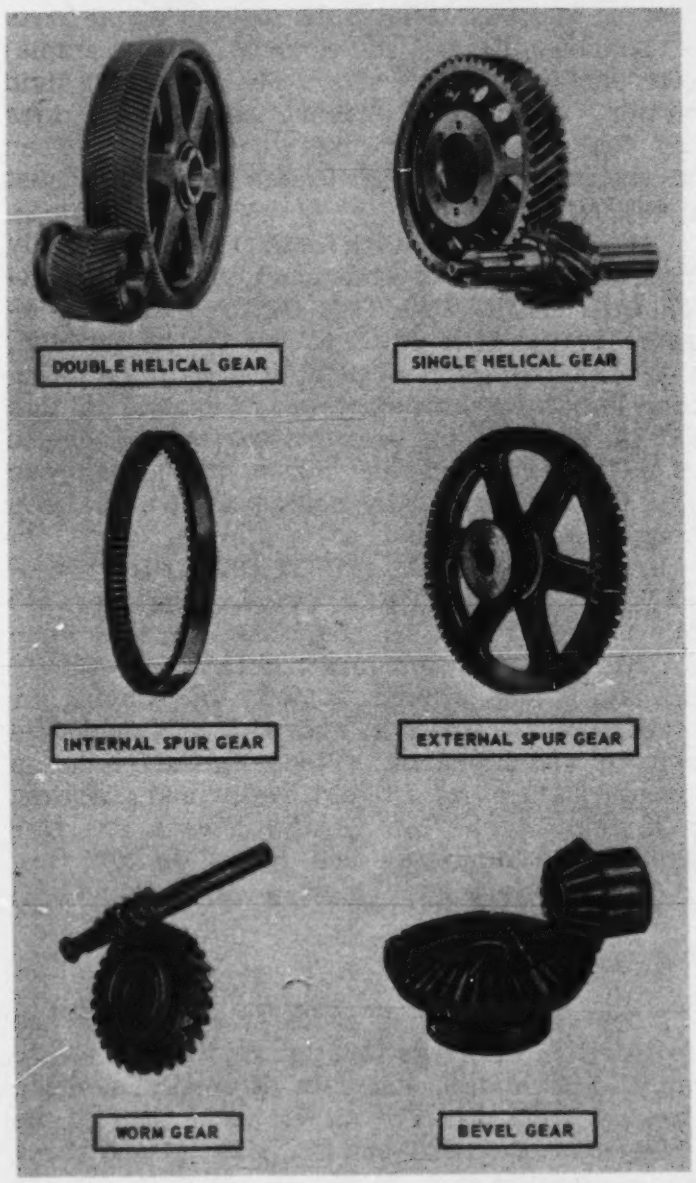

Figure 7-20.—Types of gears found in shipboard machinery. 5.22

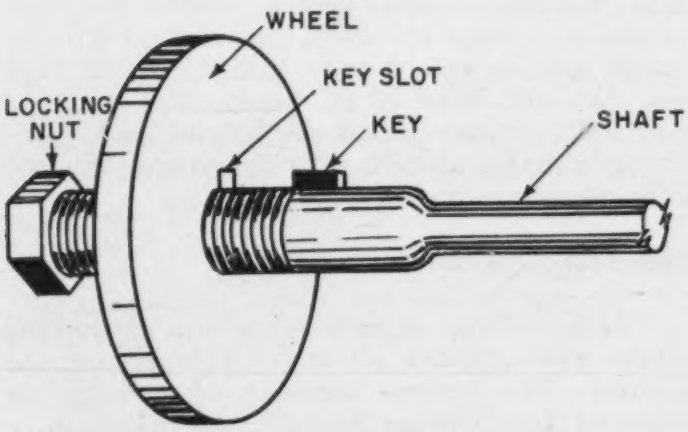

Figure 7-21.—Key and locking nut. 139.30

is used to support the bull gear, main thrust bearing, and the high speed parts of the reduction gear. The lower section also serves as the sump or storage tank for the lubricating oil in the system. The intermediate section of the casing supports the bearing housing for the intermediate speed pinions and gears as well as the high speed pinions. The other part of the gear casing is the main cover which is divided into two sections which have inspection ports that are located so that the teeth of any pinion or gear can be examined without removing the main cover sections. The inspection ports are covered by easily opened hinged covers.

Reduction gearing for pumps and other auxiliary machinery is constructed slightly different than the main reduction gearing just discussed. In the ship's service generator, the pinion is forged together with the shaft as one whole part. One end of the pinion shaft is flanged and bolted rigidily to the turbine shaft. The gear wheel is pressed and keyed onto the shaft.

In main circulating pumps the pinion is a solid forging, while the gear is constructed by welding a forged hub and a forged rim together. The gear hub is bolted to a plate which is keyed to the gear shaft.

The reduction gear of a turbine-driven condensate pump, shown in figure 7-22, which is a worm shaft and a worm wheel, reduces the turbine speed of approximately 5500 rpm to the pump speed of approximately 1100 rpm. The worm is cut in a solid, low-carbon, nickel-steel forging. The worm wheel is a solid nickel-bronze casting which is pressed onto a forged steel shaft. The gear casing is of cast steel designed to form rigid support for the rotating elements and is split horizontally to allow assembly and disassembly.

LUBRICATION

All moving surfaces must receive a steady and adequate supply of oil of proper quality at the correct temperature and free of any foreign matter. In addition, a means must be provided for impurities from the lubrication system and for maintaining a reserve supply of good clean oil.

To understand the principles of lubrication you should know the purposes of a lubricant. Lubricants reduce friction between moving parts. Friction may be defined as the resistance to motion offered by the surfaces of two bodies in contact. When this frictional resistance is overcome, and motion takes place, heat is generated. There are three kinds of friction:

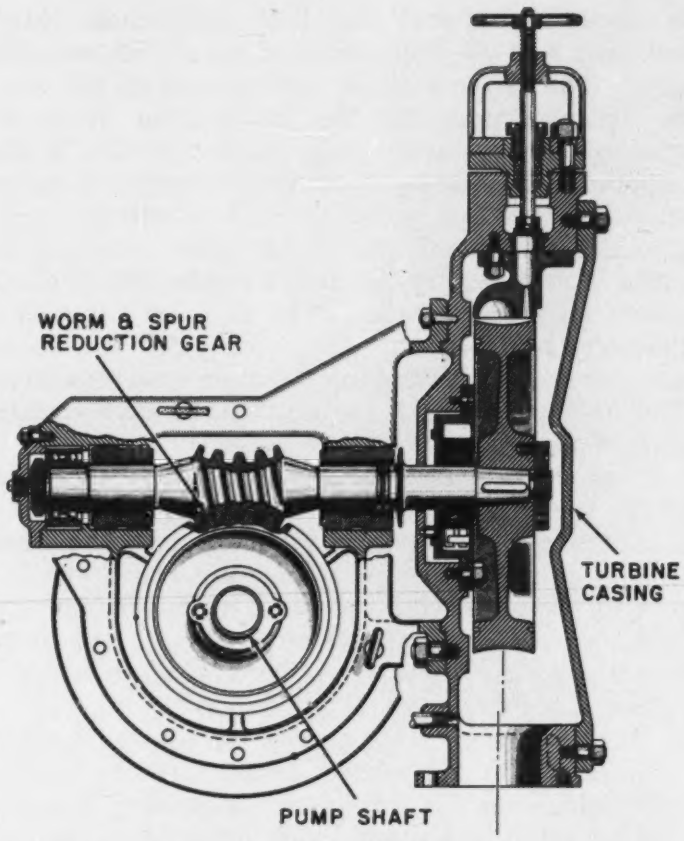

Figure 7-22.—Main condensate pump reduction bearing. 47.38

1. SLIDING FRICTION—between two solids whose opposing surfaces slide over each other.
2. ROLLING FRICTION—between two solids, one (or both) of which is rolling on the other.
3. FLUID FRICTION—between the molecules or particles of a fluid, or between two films of fluid.

Since liquid lubricants can be readily circulated, they are universally used for internal lubrication. Lubricating oils are mineral oils obtained from petroleum. In theory, fluid lubrication is based on the actual separation of the surfaces so that no metal-to-metal contact occurs. As long as an oil film remains unbroken, sliding or rolling friction is replaced by the fluid friction (internal friction) of the lubricant itself. Under such ideal conditions, friction and wear are held to a minimum.

Purpose of Lubrication

The primary purpose of lubricating oil and grease is to substitute fluid friction for either of the other types of friction. This means that a lubricant of sufficient quantity and consistency must be provided to keep the moving metal parts (of bearing, lining, and journal, for example) from contacting each other. The remaining fluid friction, within the lubricant itself, is far less than that which would otherwise occur between the solids, but it also generates heat which must be removed.

This brings you to the secondary but highly important purpose of a lubricant, that of ABSORBING AND REMOVING THE HEAT which is generated by the fluid friction and the heat which, in steam turbines, is conducted along the shafting from the steam-heated rotors. Removal of this heat by the lube oil prevents serious damage to the machinery parts and makes it necessary to have the oil repeatedly cooled as it circulates about the mechanisms.

In general, BOTH FRICTION AND OPERATING TEMPERATURES in bearings increase with a greater unit bearing pressure; with thinner films of the lubricant, if below a definite minimum; with a high velocity of rubbing or rotation of the journal; and with a higher viscosity of the lubricant. (Viscosity refers to the flowing qualities of a liquid. Water and gasoline, or liquids which flow freely, have a low viscosity. Cold molasses and honey do not flow freely; therefore they have a high viscosity.)

Bearing Lubrication

Most of the moving parts of a machine are supported in bearings that permit them to rotate freely. Lubrication consists of supplying these bearings with oil. The oil forms a film on the surfaces of the shaft and the bearing, and keeps them separated (fig. 7-23). An oil must be selected that has enough body to keep the metal surfaces from touching each other under ALL operating conditions.

Bearings that carry a heavy load are sometimes lubricated with grease. These bearings are equipped with standard grease cups or zerk fittings like those on an automobile. The cups must be kept filled at all times. The shafts of some rotary water pumps are lubricated by permitting a small amount of water to leak through the bearings and moisten the packing.

Lubricating Systems

Each turbine is provided with a lubricating system that supplies oil under pressure to the bearings. The system consists of a sump or reservoir for storing the oil, an oil pump, a strainer, a cooler, temperature and pressure

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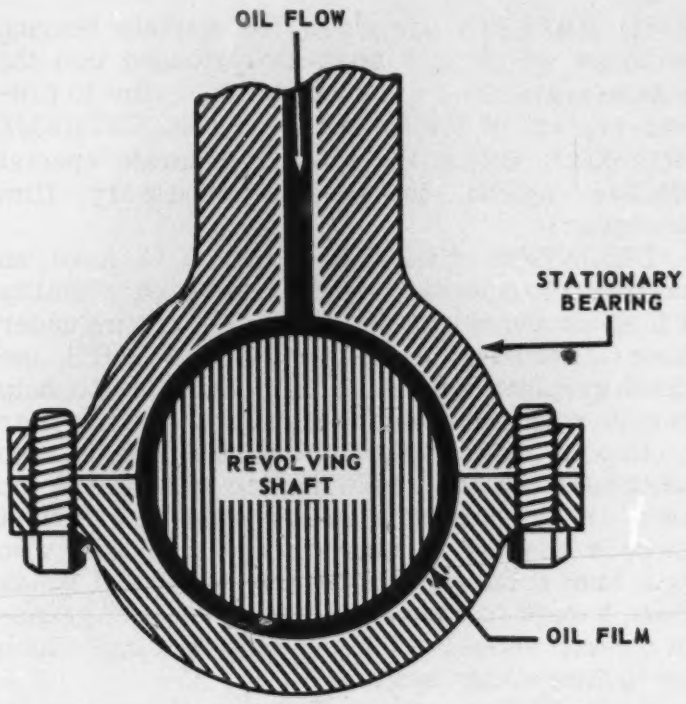

Figure 7-23.—The oil film (exaggerated view) separates the rotating shaft from the bearing.

gages, and the necessary piping to carry the oil to the bearings and back to the sump. The location and arrangement of these parts vary with each make and type of turbine.

The lube oil pump is generally a positive-displacement rotary pump. A definite pressure is maintained in the oil feed lines. A pressure relief valve allows excess oil to recirculate back to the suction side of the pump.

Quite often dual strainers are connected in the line so that the system can operate on one strainer while the other one is being cleaned. The tube-in-shell type of cooler is generally used with sea water circulating through the tubes and the oil flowing around them. The temperature of the oil is controlled by adjusting the valve that regulates the amount of sea water flowing through the tubes.

Oil must circulate through the turbine bearings at the prescribed pressure and within certain temperature limits. A pressure gage installed in the feed line and a thermometer installed in the return line indicate whether the oil system is functioning properly. Thermometers are often installed in the bearings to serve as a warning against overheating. If there is a decided drop in oil pressure, the engine should be shut down immediately; even a moderate rise in the oil temperature should be investigated. An oil-level float gage indicates the amount of oil in the sump.

Lubricating Oil and Greases

Many different kinds of lubricating materials are in use, each of them filling the requirements of a particular set of conditions. Animal and vegetable oils and even water have good lubricating qualities, but they cannot withstand high temperatures. It has been found that mineral oils, similar to the oils used in an automobile engine, are the best type of lubricant for modern machinery operating at high speeds and high temperatures. Some heavy-duty bearings are lubricated with grease in about the same way that the spring shackles and steering gear of your car are greased.

Mineral lubricating oils are derived from crude oil in the same process which produces gasoline, kerosene, and fuel oil. They vary according to the type of crude oil and the refining methods used. The same type of oil is usually made in several grades or weights. These grades correspond to the different weights of oil for an automobile varying from light to heavy.

Oils used in the Navy are divided into 9 classes, or series, depending upon their use. Each type of oil has a symbol number that indicates its class and viscosity. For example, symbol 2190 oil is a number 2 class of oil with a viscosity of 190 Saybolt Seconds Universal. The viscosity number represents the time in seconds that is required for 60 cubic centimeters (cc) of the oil, at a temperature of 130°F, to flow through a standard size opening in a Saybolt viscosimeter (fig. 7-24).

A 2190TEP oil is used for all propulsion turbines and reduction gears. The letters TEP indicate that the oil has been treated to give it water-protecting and corrosion-resisting properties, and extra load carrying capacity. This oil is also used in the turbines that drive the various kinds of pumps and blowers, except those that are driven through a worm gear. These pumps use a Navy sumbol 3080 oil.

Lubricating greases are mixtures of soap and lubricating oil. Fillers, such as graphite, are also added to some greases to make the greases more effective for certain lubrication requirements.

The soaps used in the common SOAP AND OIL GREASES are chemical compounds formed by fats or fatty acids reacting with various alkaline materials such as lime, soda, aluminum, zinc, barium, lithium, lead, and potassium.

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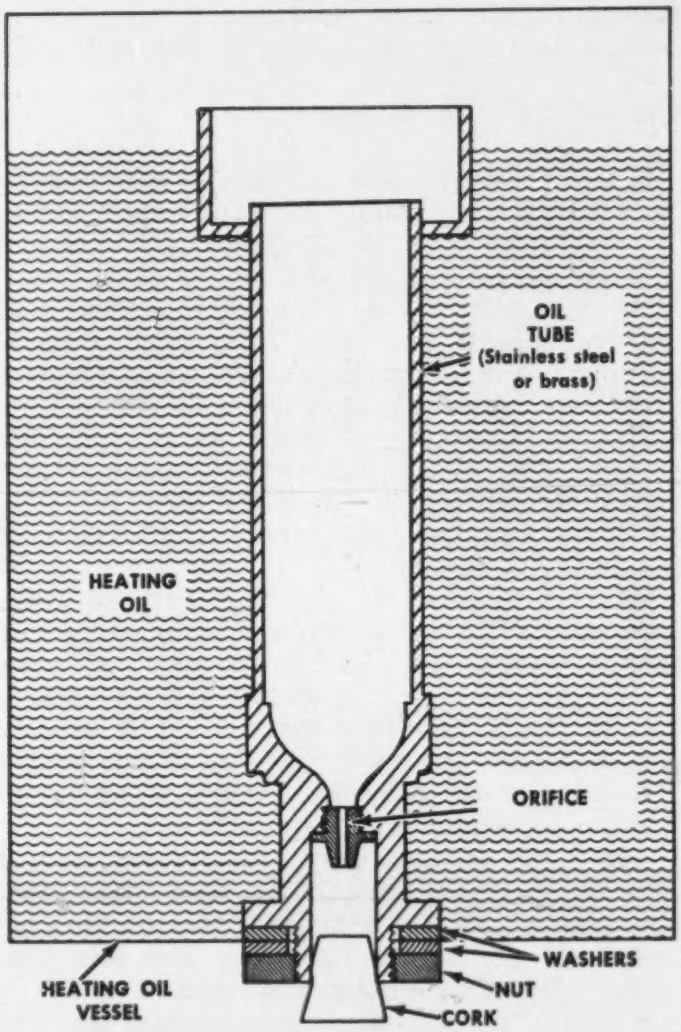

Figure 7-24.—Details of the viscosimeter tube.

The common SODA SOAP GREASES are used for applications where no water is present and where operating temperatures approach 200°F. The common LIME SOAP GREASES do not absorb moisture or emulsify as readily as the soda soap greases, but have lower melting points. They are used as general purpose greases for light load applications at ordinary operating temperatures. These two types of greases will satisfactorily lubricate the majority of machinery.

Certain lubricating greases contain additives. These SPECIAL ADDITIVE GREASES are identified by the additive. For example, LEAD OLEATE SOAP GREASES are used for certain bearing surfaces which are so heavily loaded that the ordinary grease will not maintain a film to prevent contact of the rubbing surfaces. EXTREME PRESSURE GREASES also incorporate special additive agents to provide necessary film strength.

OXIDATION INHIBITOR GREASES have an additive incorporated to ensure better stability at high temperatures and to prevent rusting under these conditions. In GRAPHITE GREASES, the added graphite acts as a mild abrasive to help smooth roughened surfaces, and acts as a filler to smooth over unequal surface spots. It also substitutes its own low friction for that of the metal it covers; this is especially important where a bearing is exposed to temperatures so high that ordinary grease or oil would break down. Except for such high temperatures, graphite grease should not be used in bearings which are in first-class condition.

Each of these several types of greases is supplied in three grades: soft, medium, and hard. The SOFT GRADES are used at high speeds under light pressure; the MEDIUM GRADES are used at medium speeds under medium pressure; and the HARD GRADES are used at slow speeds under heavy pressure.

Standard Navy Lubrication

Always be sure that you are using the specified lubricant for the individual machinery part, unit, or system you are responsible for operating or maintaining.

Most ships make up LUBRICATING CHARTS for quick reference on this information. These charts generally contain a line diagram of the unit or system, point of lubrication, symbol of lubricant, quantity, and interval of supply—along with applicable general instructions, operating hints, and possible casualties. The charts are generally posted in machinery compartments.

The manufacturer's technical manual for each unit of machinery is the basic reference for the correct lube oil, if no lubrication chart (based on manufacturer's instructions) is available. In addition, the TABLE OF RECOMMENDED OILS can be found in chapter 9450 (45) of BuShips Technical Manual.

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CHAPTER 8

AUXILIARY MACHINERY AND EQUIPMENT

In addition to the propulsion machinery and equipment you will become acquainted with a number of other units of machinery. These include refrigeration equipment, air conditioning equipment, and distilling plants. You will also become acquainted with the steering gear, the anchor windlass and capstan, lube oil purifiers, laundry equipment, galley equipment, air compressors, cranes, elevators and winches. The information provided in this chapter will be general in nature and will deal primarily with the location and the function of the auxiliary machinery and equipment mentioned.

REFRIGERATION EQUIPMENT

There are two basic types of mechanical refrigeration systems used in the Navy; the steam-jet refrigeration system and the vapor compression refrigeration system. The steam-jet system is used on some naval ships for air conditioning and on some merchant type ships for large area, moderate temperature refrigeration. The vapor compression system, which is the most common, may be adapted for use on naval ships in various applications including refrigerated ship's stores, refrigerated cargo, and unitary (self contained) refrigeration (as ship's service store equipment).

Ship's stores spaces are refrigerated for the preservation of food supplies. The insulated compartments for cold storage spaces are of the walk-in type. The equipment selected for cooling these spaces is designed to maintain certain temperatures: on ships designed before 1950, the meat room at 15°F, fruit and vegetable rooms at 40°F, butter and egg rooms at 32°F; and for ships designed since 1950, the freeze room at 0°F and the chill room at 33°F.

Refrigerated cargo spaces are provided on auxiliary ships for the stowage of perishable food that is intended for the forces afloat and advanced bases. The temperatures of the refrigerated cargo spaces are such that approximately 30 to 60 percent of the total refrigerated area is maintained at a temperature of 0°F (-5°F for latest design ships). The remainder of the refrigerated area is maintained at a temperature of 33°F to 35°F.

Unitary refrigeration systems are of two types—remote and self-contained. The remote type is a complete unit except that the source of refrigeration is located separately and is not contained within the unit cabinet. Equipment of this type includes soda fountains and ice cream hardening machines.

The self-contained units, which have the refrigeration source within the unit cabinet, include drinking water coolers, refrigerators, and frozen food cabinets.

Other refrigeration equipment includes two types of ice-making machines. One type is a self-contained unit and makes ice cubes. The other is the tank type and makes large slabs of ice. The tank type of ice machine is normally located in a separate machinery room which is identified as the ice machine room. This type has been installed on auxiliary ships such as tenders and repair ships.

AIR CONDITIONING EQUIPMENT

Air conditioning is installed on naval ships for certain spaces where personnel efficiency, health, safety, or operation of equipment could be endangered by high temperatures or high humidity.

There are two basic types of air conditioning equipment used aboard ship. One type uses chilled water for the cooling medium; the other uses a refrigerant, R-12 to carry away the heat. Most of the air conditioning equipment used aboard Navy ships uses the refrigeration equipment for the removal of heat from the circulating water or refrigerant. The removal of the heat is accomplished by the cooling coils of the refrigeration equipment. There are also some smaller self-contained units used aboard ship, like the ordinary window type used in homes.

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Some of the spaces that might be air conditioned include the radio and radar control spaces, sick-bay areas, and living and berthing spaces. The radio and radar control spaces are usually air conditioned because of the high heat given off by the equipment. This heat, especially in combination with high humidity, could be dangerous to the operator and the equipment. Air conditioned sick-bay areas have proved advantageous in that they help to speed recovery. The living and berthing spaces are often air conditioned, both to provide comfort for the crew and because air conditioning helps to increase personnel efficiency.

DISTILLING PLANTS

The two basic types of distilling plants installed on naval ships are the vapor compression distilling plant and the steam distilling plant. The main difference between the two types of distilling plants comes from the method used for applying heat to the sea water. In the vapor compression plant, the source of heat is obtained from electrical energy.

The vapor compression type distilling plant was first developed primarily for submarine service, where the absence of steam made it necessary to supply another form of heat energy. This type of plant is currently used on small diesel-driven ships and on ships where the daily demand for fresh water is less than 4,000 gallons per day (gpd). The vapor compression plant consists of three main components, the evaporator, the compressor, and the heat exchanger.

Steam operated distilling plants are classified as coil, submerged tube, vertical basket, and flash types. The coil type is found on a few older auxiliaries; while the submerged tube type is found on most older ships. The vertical basket and flash types are newer designs, and have been installed on some combatant ships constructed in the last 10 years. Some submerged tube types have also been installed during this period.

In the vertical basket type, low pressure steam flows into a corrugated basket that is surrounded by sea water. Here the steam gives up its heat to boil the sea water and is then condensed. The fresh water vapor from the boiling sea water is condensed and then removed as distillate (fresh water).

In the flash type, preheated feed water is discharged into a vacuum chamber where a portion of the water vaporizes (flashes into steam). The remaining water passes into a second flash chamber where further vaporization takes place. Any number of flash chambers, where vaporization takes place, can be installed. Each stage has a condenser in which the fresh water vapor is condensed.

There are three basic types of submerged-tube type distilling plants: soloshell double-effect (fig. 8-1), the triple-effect, and the two-shell double-effect. The principal difference between the triple-effect plant and the two-shell double-effect plant is the number of stages of evaporation. In the double-effect plant evaporation takes place in two stages while in the triple-effect plant evaporation takes place in three stages.

The most commonly used 20,000 gpd two-shell double-effect plant is built with two horizontal cylinder evaporator shells mounted parallel to each other. The triple-effect distilling plant is similar to the two-shell double-effect plant except that the triple-effect plant has an intermediate evaporating stage. A standard triple-effect, 20,000 gpd plant is illustrated in figure 8-2.

Almost all low pressure distilling plants up to and including the 12,000 gpd capacity plant are of the soloshell double-effect type. This type consists of a single shell that is designed with a vertical partition which divides the shell into two evaporator shells.

One type of 20,000 gpd capacity, soloshell double-effect plant was installed on light and heavy cruisers. Where it was necessary to furnish 40,000 gpd, two such plants were installed. Some older destroyers (2200 ton) are equipped with two soloshell evaporator plants—one, located in the forward engineroom, has a capacity of approximately 12,000 gpd; while the other, in the aft engineroom, has a capacity of approximately 4,000 gpd. The 2100 ton destroyers have only one 12,000 gpd plant; it is located in the forward engineroom.

STEERING GEARS

There are three basic types of steering mechanisms in use in the Navy. The first type is the steam steering gear, used only on a few naval auxiliary ships. The second type is the electromechanical type, used extensively on small noncombatant ships. The third and most common type is the electrohydraulic steering gear.

The steam steering gear consists of a pair of reversible, reciprocating steam engines which

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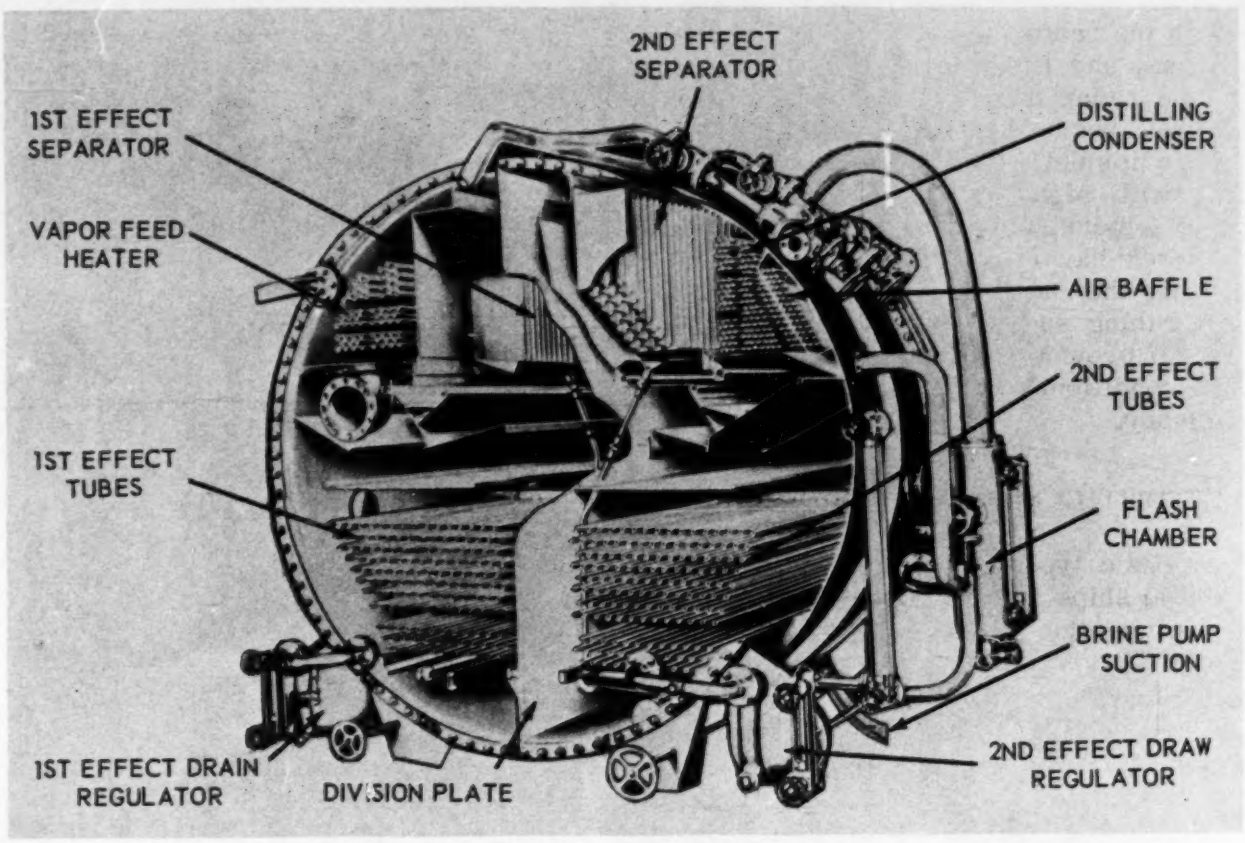

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Figure 8-1.—Soloshell double-effect distilling plant.

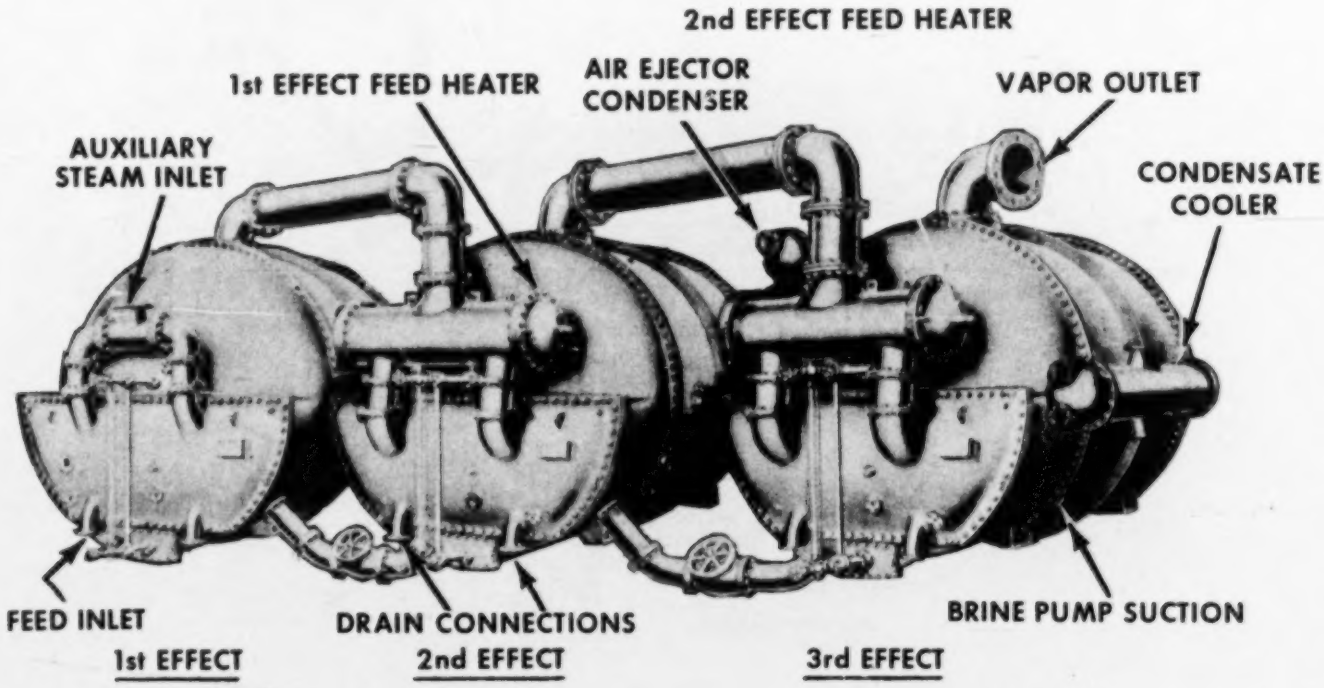

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Figure 8-2.—20,000 GPD triple-effect distilling plant.

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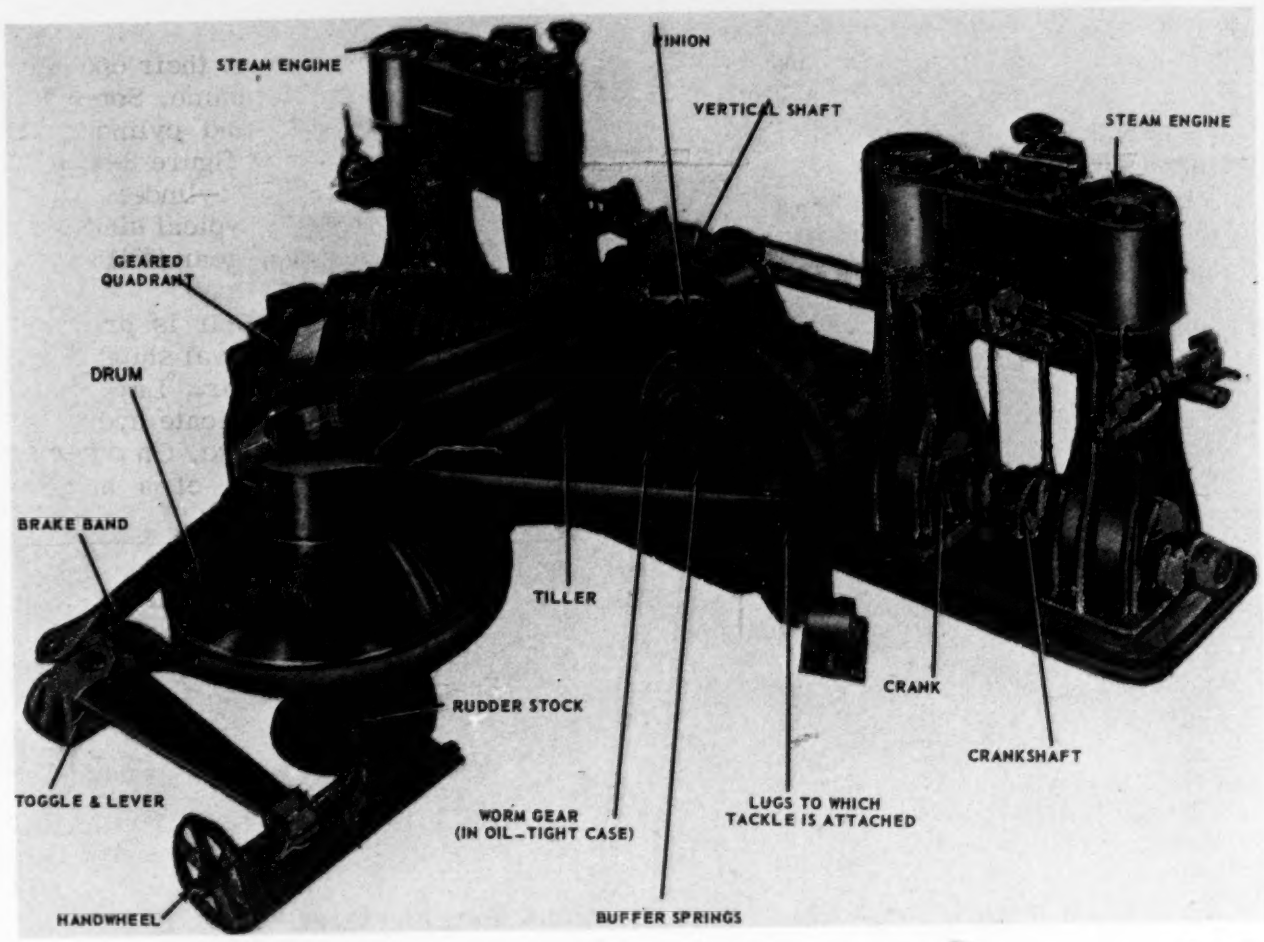

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Figure 8-3.—Steam-driven steering gear.

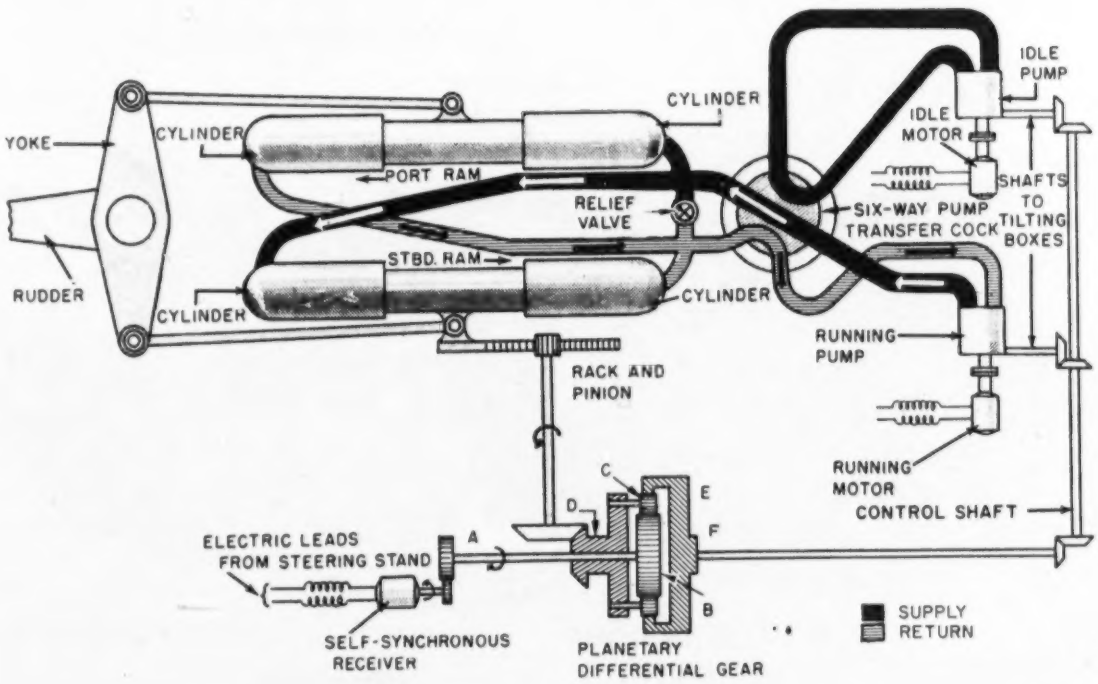

Figure 8-4.—Diagrammatic arrangement of a double-ram electrohydraulic steering gear.

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drive a geared quadrant which is attached to the rudder stock. (See fig. 8-3) Emergency steering for this type is accomplished by attaching wire ropes to a hand winch.

Electromechanical steering gear includes the steam steering gear plus an electric motor. The electric motors on steam steering gears were first introduced to provide for emergency steering in the event of steam failure. Later the electric motor became the prime mover and the steam steering system was kept in reserve for emergency use.

With the electrohydraulic type of steering gear, movement of the rudder is obtained from hydraulic rams operating in cylinders that are connected to variable delivery pumps. The development of this type was prompted by the large electrical power requirement necessary to steer ships of large displacement and high speeds.

The electrohydraulic steering gear provided some distinct advantages over the steam and the electromechanical types of steering gears. These advantages include: (1) little friction between moving parts, (2) immediate responses to movement of the steering wheel, (3) requires small deck space and head room, (4) savings in weight, and (5) flexibility and dependability.

There are various types of electrohydraulic steering gears in use, but their operating principles are basically the same. Some ships have double hydraulic rams and cylinders mounted fore and aft, as shown in figure 8-4; while other ships employ a double cylinder, single-ram, mounted athwartships. A typical single-ram electrohydraulic steering gear is illustrated in figure 8-5.

Emergency steering gear is provided on all combatant and auxiliary naval ships having electrohydraulic steering gear. Large combatant ships generally have a duplicate hydraulic steering gear for emergency use. On other ships the emergency gear consists of a hand-operated hydraulic pump.

ANCHOR WINDLASSES AND CAPSTANS

The term windlass refers to a piece of deck machinery used primarily for paying-out and heaving-in on anchor chain. A wildcat (drum), fitted with whelps to engage the anchor chain may be mounted vertically or horizontally at the end of the windlass shaft. (A whelp is any one of the ribs or ridges on the drum of a windlass. It looks much like the sprocket wheel of a chain fall.)

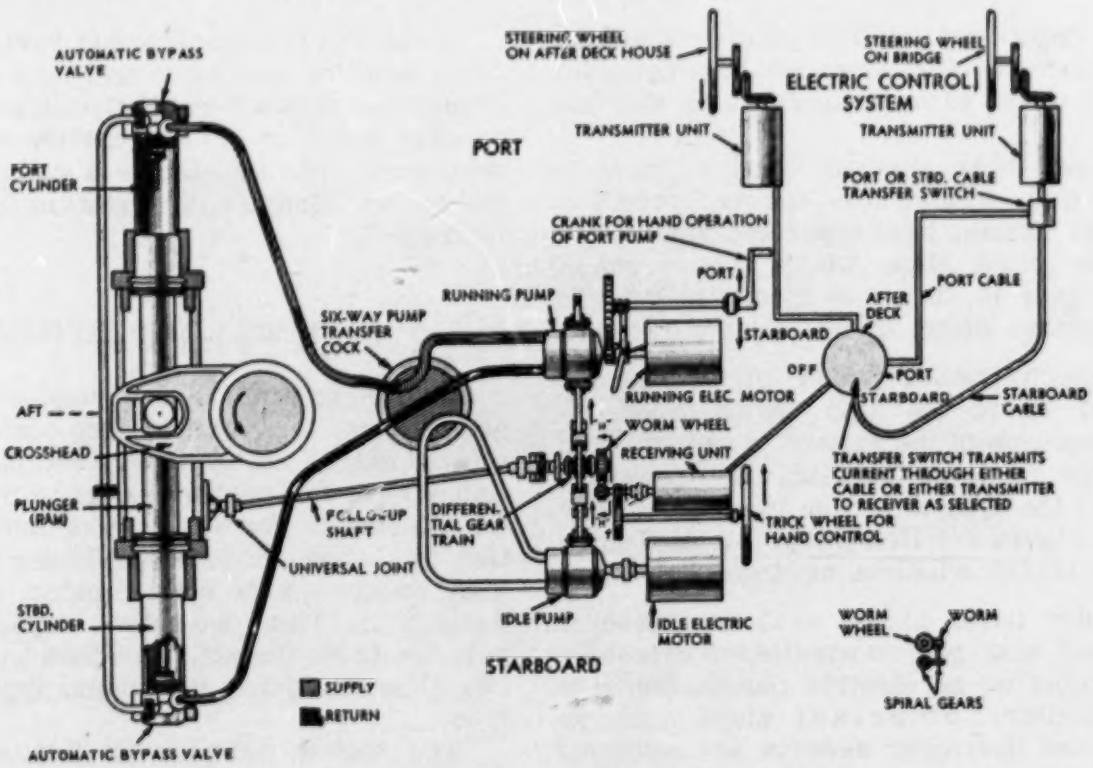

Figure 8-5.—Diagram of typical single-ram electrohydraulic steering gear system. 27.83X

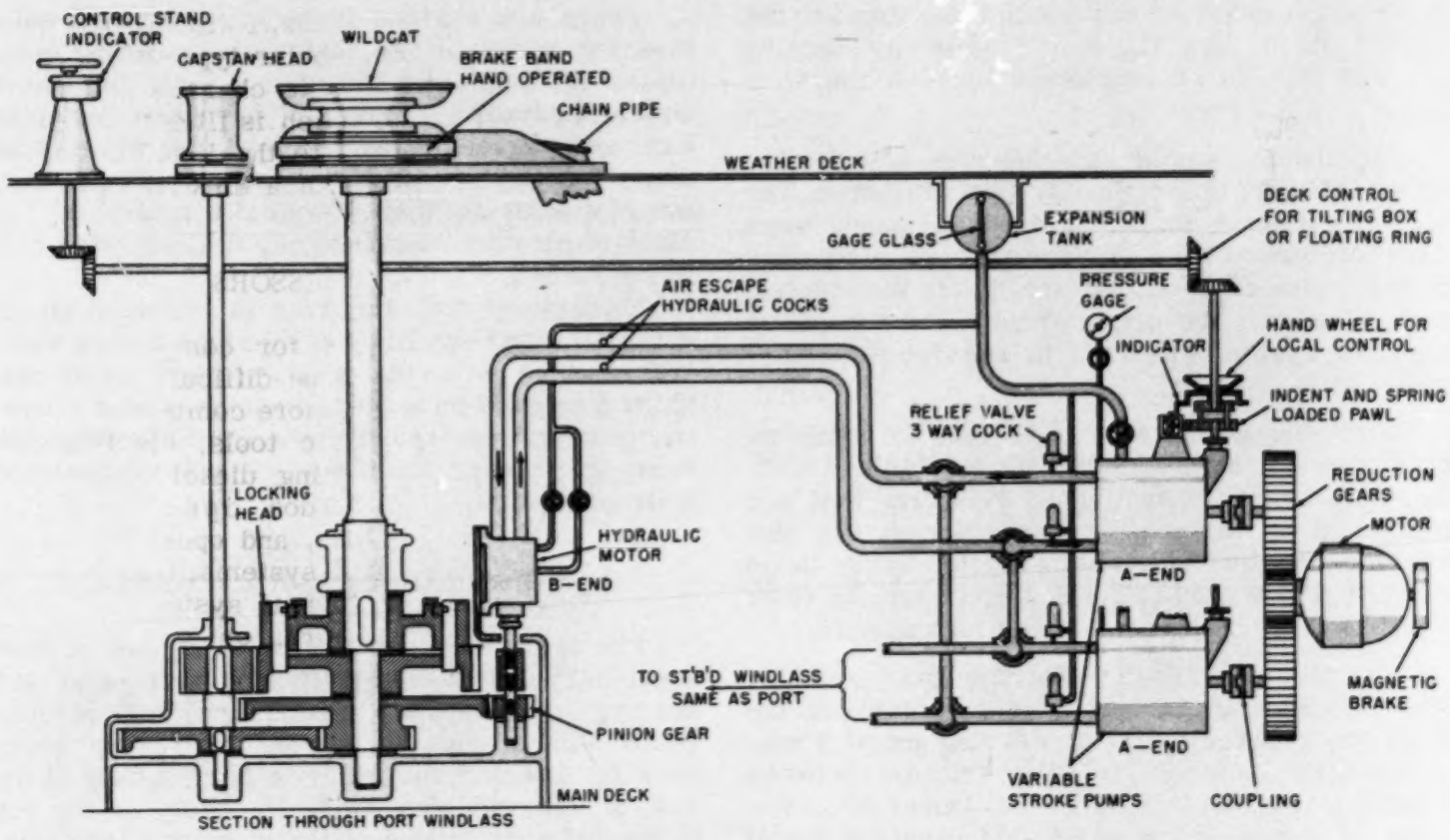

Figure 8-6.—Typical electrohydraulic anchor windlass arrangement.

General requirements of the anchor windlass are that it must be simple, rugged, and reliable. It must be capable of reversal and have suitable brakes.

There are three general types of power-driven anchor windlasses: electrohydraulic, electric, and steam. Hand-operated windlasses are used on small ships where the weight of the anchor gear is such that it can be handled without excessive effort by operating personnel.

The electrohydraulic anchor windlasses are advantageous where the load varies through a wide range because of the amount of anchor chain payed out, the force of the wind, the strength of the tide, and the type of bottom in which the anchor is set. Figure 8-6 illustrates a typical electrohydraulic anchor windlass arrangement.

Some older naval ships, such as cruisers, were equipped with geared windlasses driven by a steam engine or an electric motor. Some of the new smaller combatant ships such as destroyers and destroyer escorts are equipped with the electric motor type. Figure 8-7 illustrates an electric windlass of a modern destroyer.

A capstan is a spool shaped, vertically mounted drum used for heaving in on heavy mooring lines. Figure 8-8 shows a vertical shaft anchor windlass capstan which is normal topside equipment on a destroyer. The capstan is a component part of the anchor windlass, as shown in figures 8-6 and figure 8-7.

LUBE OIL PURIFIERS

Purifiers, which are normally located in the engineroom, are used to free contaminated lube oil or diesel oil of water, sediment and other impurities. The purifiers used in the naval service operate on the principle of centrifugal force; that is, a bowl or hollow cylinder is revolved at high speeds while contaminated oil is passed through it. This procedure separates the impurities from the oil. Purifiers are divided into two classifications, the tubular type and the disk type.

The hollow cylinder or tubular type is of relatively small diameter and is operated at high speed. The cylinder is fitted with a device known as a three-wing, that functions to keep the liquid

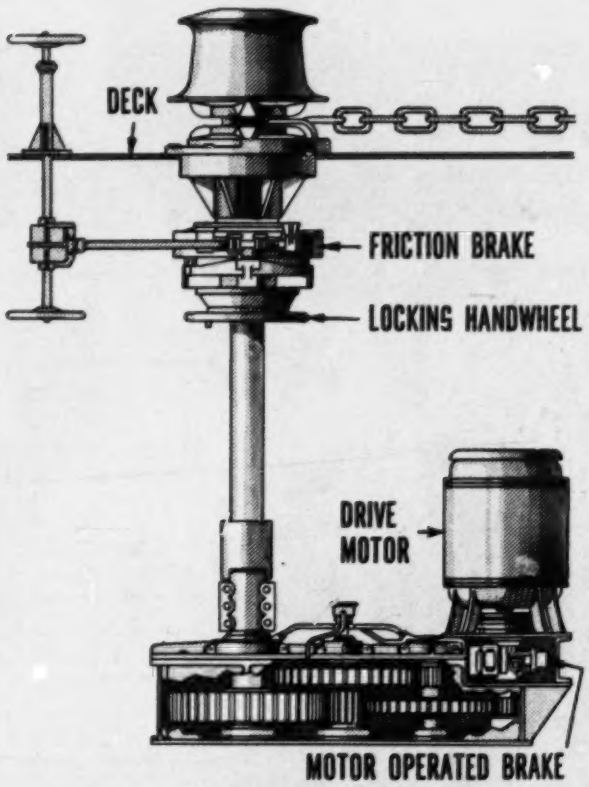

Figure 8-7.—Electric windlass. 3.224X

rotating at the speed of the bowl without slippage. Figure 8-9 shows the tubular type of purifier.

The disk type purifier is characterized by a larger diameter bowl, which is fitted with a series of disks that separate the liquid into thin layers. A sectional view of a disk type purifier is shown in figure 8-10.

AIR COMPRESSORS

There are many uses for compressed air aboard ship and it would be difficult to mention all of them. Some of the more common uses include: operating pneumatic tools, ejecting gas from ship's guns, starting diesel engines, charging and firing torpedos, operating gun counterrecoil mechanisms, and operating automatic combustion control systems. Compressed air is supplied to the various systems by high pressure, medium pressure, or low pressure air compressors, as appropriate. Reducing valves reduce a higher pressure to a lower pressure for a specific system. Air compressors are classified in a number of ways. A compressor may be single-acting (compression on one end of the stroke), double-acting (compression on each end of the stroke), single stage (one cylinder),

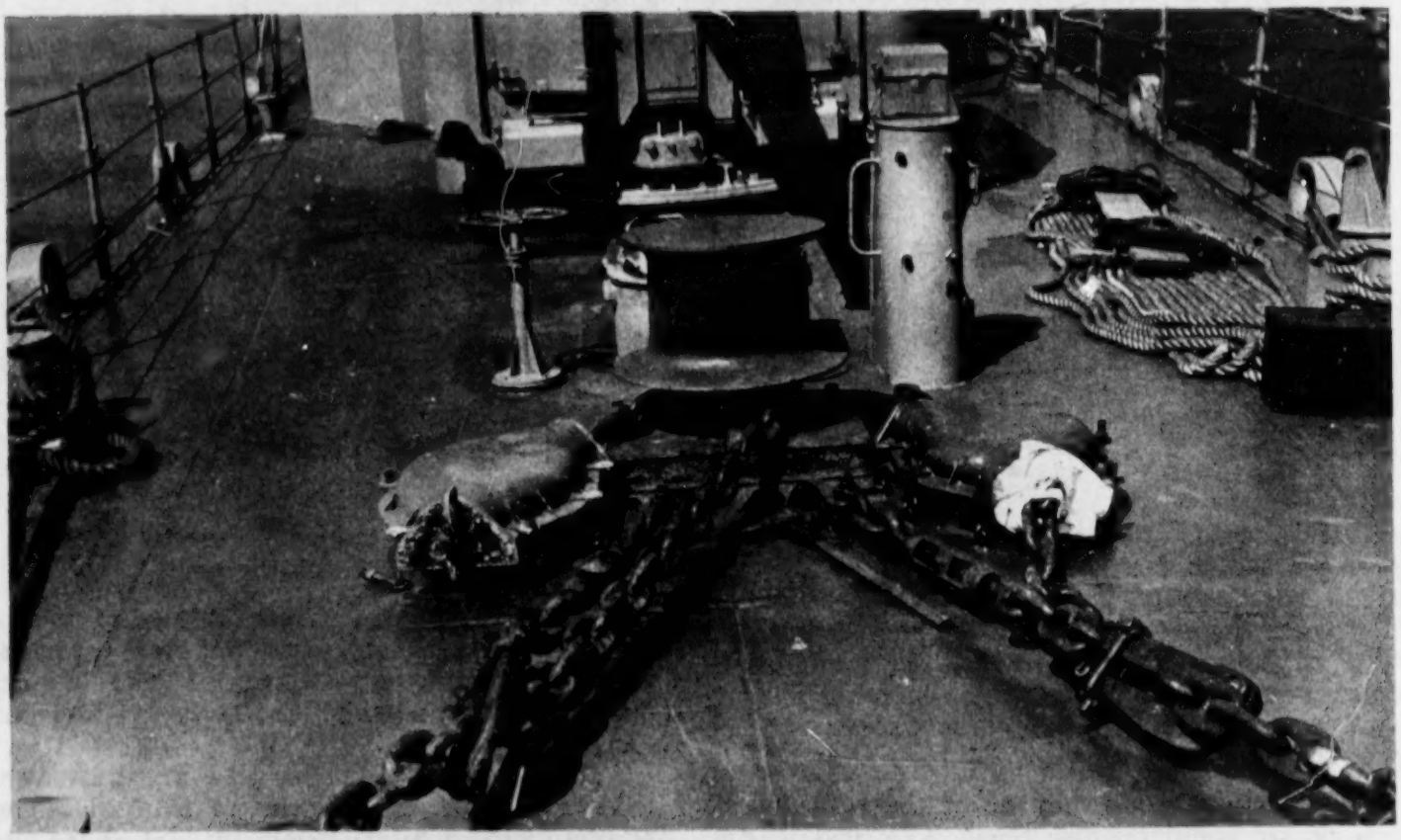

Figure 8-8.—Vertical shaft anchor windlass capstan head. 47.146

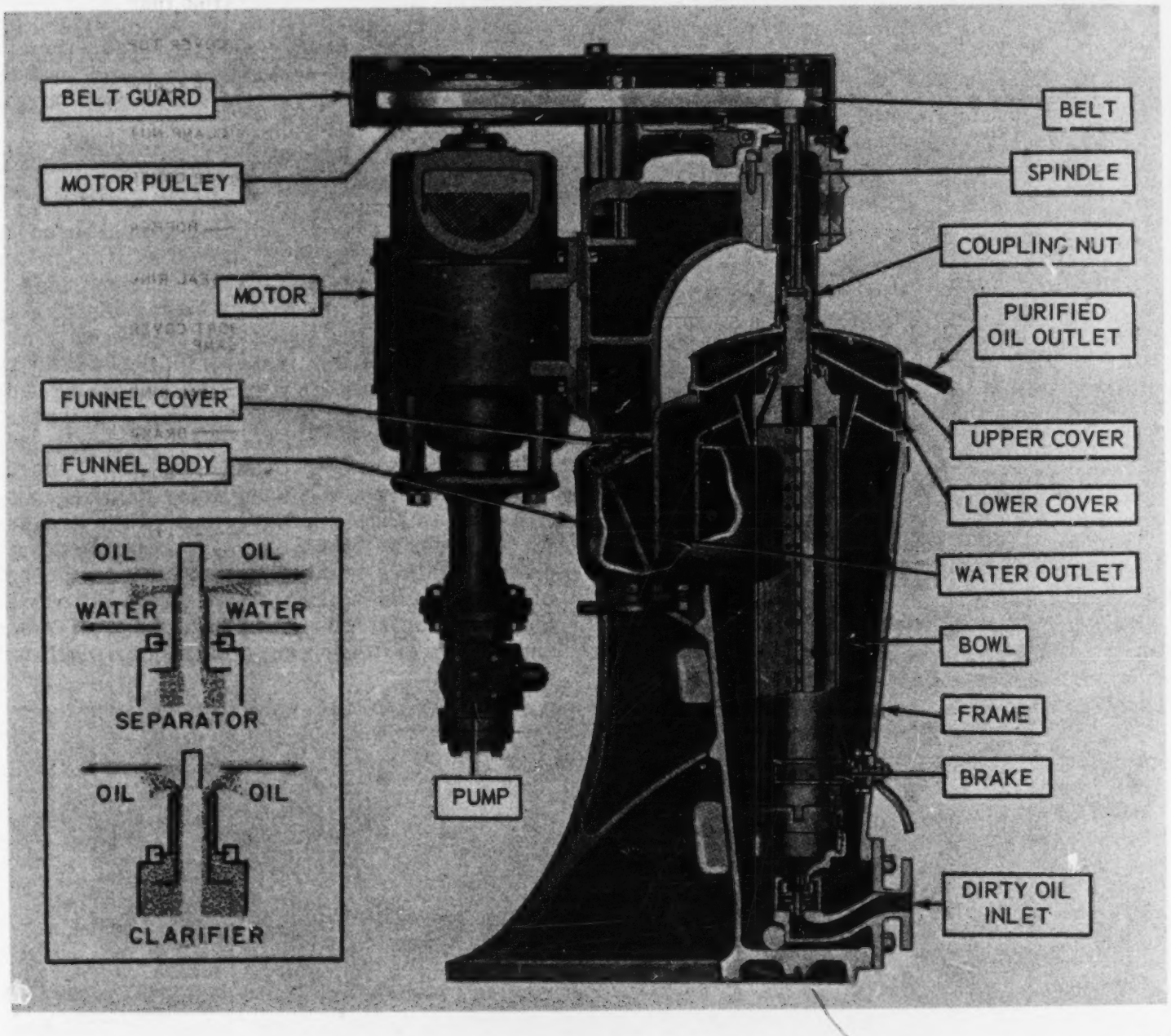

Figure 8-9.—Tubular type centrifugal purifier (Sharples).

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multistage (more than one cylinder) and the compressor design may be such that the pistons operate horizontally, vertically, or at an angle. Compressors are also classified according to the type of compressing element, the source of driving power, the method by which the driving unit is connected to the compressor, and the pressure that is developed.

Air compressors may be of the centrifugal, rotary, or reciprocating types. The type used is determined by the volume and pressure of air desired. Most of the compressors used in the Navy are of the reciprocating type.

Compressors are driven by electric motors, internal combustion engines, steam turbines, or reciprocating steam engines. The air compressors used most in the Navy are driven by electric motors.

Low pressure compressors are those which have a discharge pressure of 150 psi or less. Medium pressure compressors are those which have a discharge pressure of 151 psi to 1000

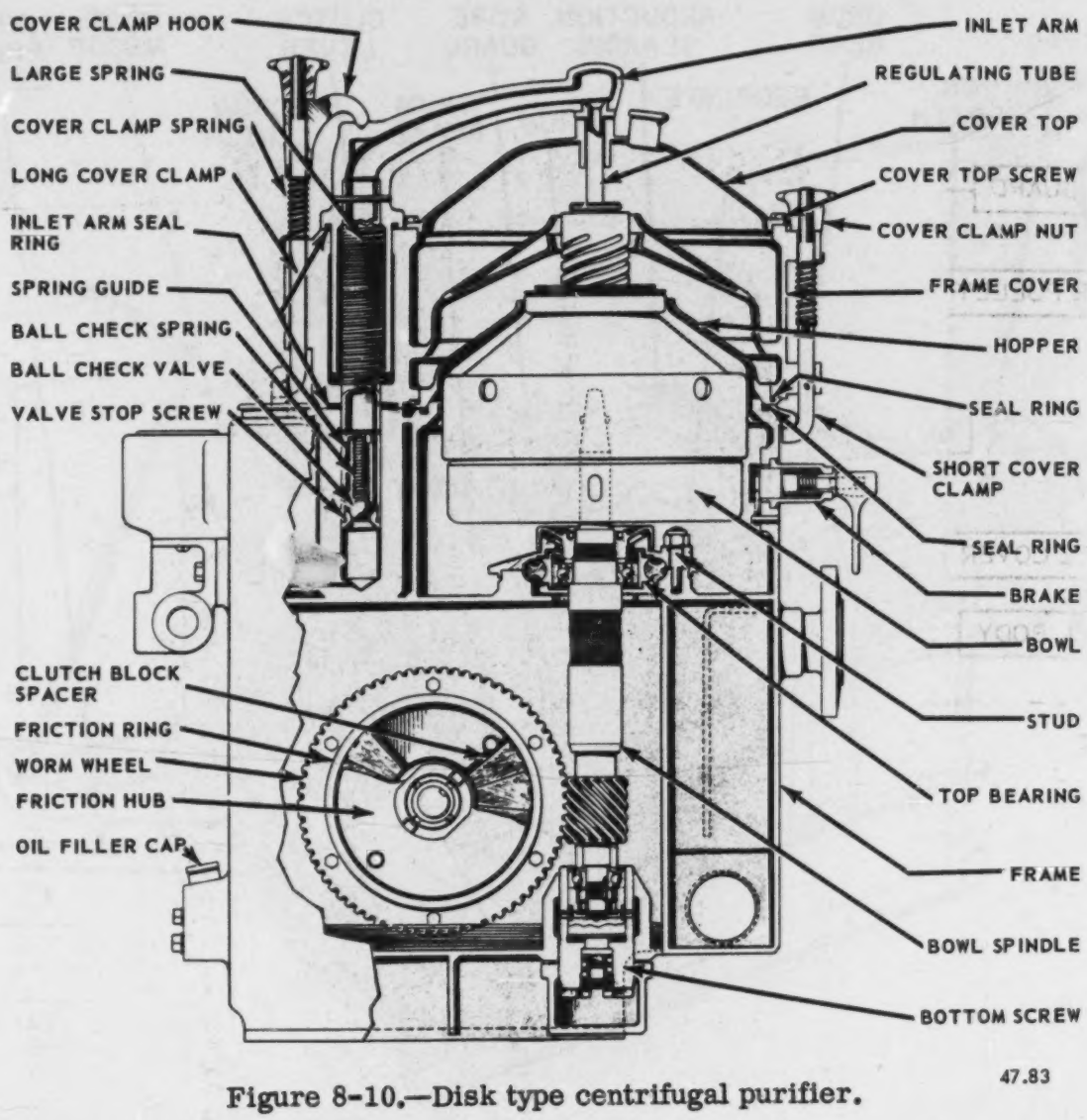

Figure 8-10.—Disk type centrifugal purifier.

psi. Compressors which have a discharge pressure above 1000 psi are classified as high pressure air compressors.

CRANES

Cranes are designed for raising a load, lowering it, and moving it in horizontal directions. You will find cranes installed on carriers, cruisers, and auxiliaries. Cranes are used for handling airplanes, boats, bombs, torpedoes, mines, sweep gear, missiles, trucks, and stores. Some submarines are also equipped with cranes for handling missiles.

In general, cranes may be electrically driven, engine driven, or hand driven. Cranes constructed for very heavy loads (lifting heavy aircraft, boats, or missiles) are usually electrohydraulic.

Detailed information concerning shipboard cranes can be obtained from applicable manufacturers' technical manuals.

ELEVATORS

Many Navy ships are equipped with elevators which are used to handle bombs, airplanes, freight, torpedoes, and ammunition. Shipboard elevators may be divided into two general classes: electrohydraulic and electromechanical elevators.

ELECTROHYDRAULIC elevators may be divided into two general types: the direct plunger lift and the plunger-actuated cable lift.

The platform of the DIRECT PLUNGER LIFT elevator is raised or lowered by one or more hydraulic rams, which are located under the platform. During the hoisting of a platform, hydraulic oil is pumped into the ram from a high pressure tank (approximately 950 psi). Lowering of the platform is performed by discharging the oil from the rams into a low pressure tank, which is under an approximate pressure of 230 psi.

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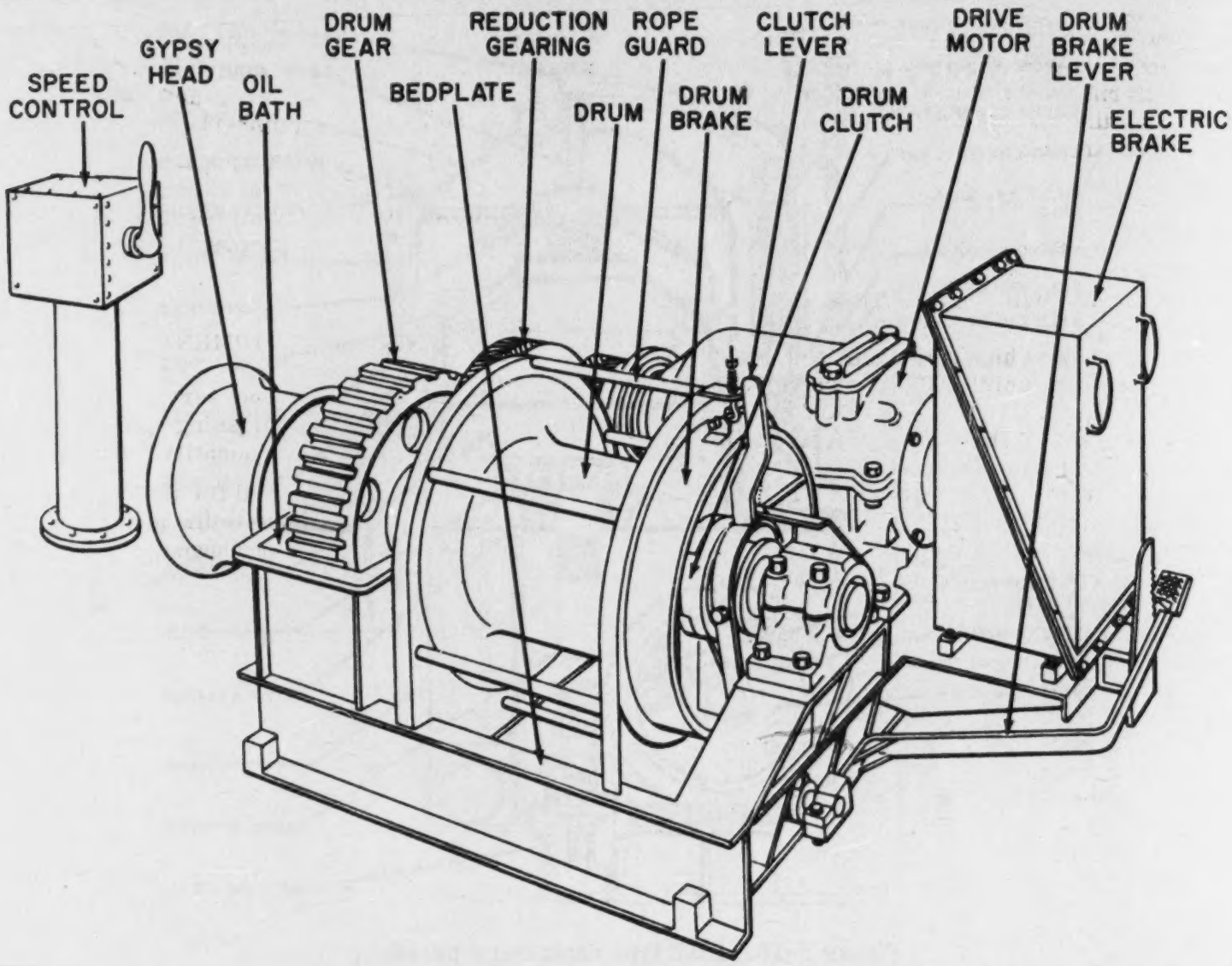

Figure 8-11.—Units of an electromechanical winch.

80.149

Pressure is maintained in the high pressure tank by means of two hydraulic pumps (variable stroke), which take suction from the low pressure tanks. Special control valves, located in the pressure and exhaust lines, regulate elevator speeds by varying the amount of hydraulic oil admitted to, or discharged from the rams. Mechanical locks allow the platform to be locked and held in position at deck level. Automatic quick-closing valves in the oil line prevent an unrestricted fall of the elevator.

The platform of the PLUNGER-ACTUATED CABLE LIFT elevator is raised by wire rope fastened to the platform at either two or four points. Most hydraulic airplane elevators are of this type. The wire ropes in an airplane elevator are operated through a series of pulleys, by a horizontal hydraulic ram located below the hangar deck. Special safety devices, provided to engage the guide rails of the elevators, stop the fall and hold the platform when one group of wire ropes fails.

ELECTROMECHANICAL elevators are used for freight, bombs, and stores. In elevators of this type, the platform is raised and lowered by one or more wire ropes which pass over pulleys and wind or unwind on hoisting drums. Hoisting drums are driven through a reduction gear unit by an electric motor. An electric brake is provided to stop and hold the platform. The motor has two speeds (full speed and low, or one-sixth speed). Control arrangements are such that the elevator starts and runs on high speed. Low speed is used for automatic deceleration as the elevator approaches the selected level. The platform travels on two or four guides. Hand-operated

9423

CHAPTER 9

INSTRUMENTS

Measurement is, in a very real sense, the language of engineers. The shipboard engineering plant has many instruments that indicate, to operating personnel, conditions existing within a piece of machinery or a system. By proper interpretation of the readings of the instruments, operating personnel can determine if the machinery, or the system, is operating within the prescribed range.

Recorded instrument readings are used as a means of ensuring proper operating procedures and also for determining the operating efficiency of the plant. The instruments provide information for the hourly, daily, and weekly entries for operating records and reports. The data entered in the records and reports must be accurate since the engineer officer studies the records and reports to keep up with the condition of the plant. Remember that accurate data entered on the records and reports can only be obtained by reading the instruments carefully.

The instruments, indicators, and alarms discussed in this chapter are included not only because of the relative importance in the engineering plant; but also to give you an idea of the wide range and type of instruments, indicators, and alarms that are used in the engineering plant aboard a naval ship.

Engineering measuring instruments may be classified into the following five groups:

1. Pressure gages.
2. Thermometers and pyrometers.
3. Liquid level indicators.
4. Fluid flow meters.
5. Revolution counters and indicators.

PRESSURE GAGES

Pressure gages include a variety of Bourdon tube gages, bellows and diaphragm gages, and manometers. The Bourdon tube gages are generally used for measuring pressure of 15 pounds per square inch (psi) and above. The bellows and diaphragm gages and manometers are generally used for measuring pressures below 15 psi.

BOURDON TUBE GAGES

The most common Bourdon tube gages used in the Navy include (1) simplex, (2) vacuum, (3) compound, and (4) duplex gages. They operate on the principle that pressure in a curved tube will have a tendency to straighten out the tube. The tube is made of bronze for pressures under 200 psi, and of steel for pressures over 200 psi. Figure 9-1 shows a Bourdon tube installed in a gage case.

The Bourdon tube is in the shape of a C and is welded or silver-brazed to the stationary base. The free end of the tube is connected to the indicating mechanism by a linkage assembly. The threaded socket, welded to the stationary base, is the pressure connection. When pressure enters the Bourdon tube, the tube straightens out slightly and moves the link connected with the toothed gear sector. The teeth on the gear sector mesh with a small gear on the pinion to which the pointer is attached. Thus when pressure in the tube increases, the gear mechanism pulls the pointer around the dial and registers the amount of pressure being exerted in the tube.

The simplex gage, shown in figure 9-2, may be used for measuring the pressure of steam, air, water, oil, and similar fluids or gases.

The Bourdon tube vacuum gage commonly used for indicating vacuum, in inches of mercury, on auxiliary condensers, is illustrated in figure 9-3. Vacuum gages indicate pressure below atmospheric pressure whereas pressure gages indicate pressure above atmospheric pressure.

The compound Bourdon tube gage (fig. 9-4) uses a single Bourdon tube of such great elasticity that it can measure vacuum to the left of the zero point and pressure to the right of the zero point. When the pointer is to the right of

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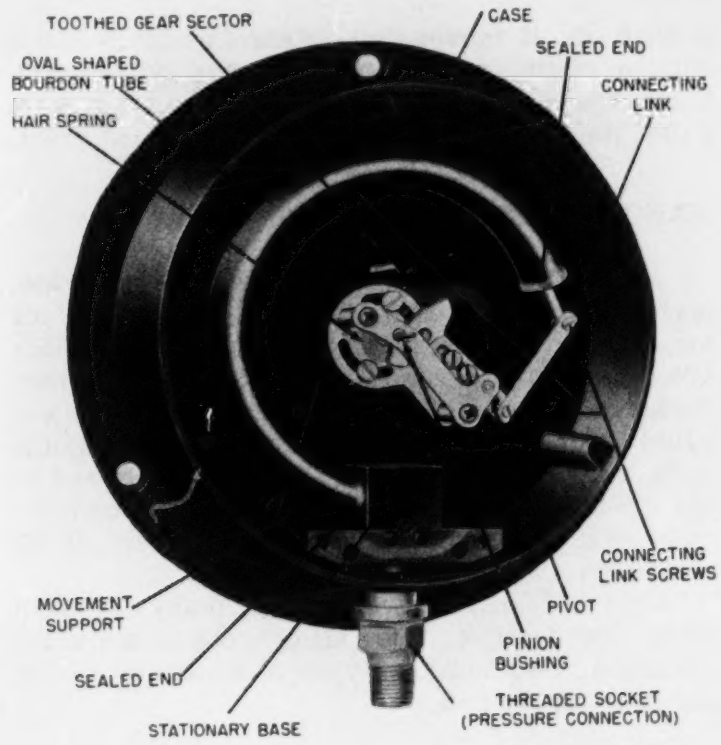

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Figure 9-1.—Bourdon tube installed in a gage case.

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Figure 9-2.—Simplex Bourdon tube pressure gage.

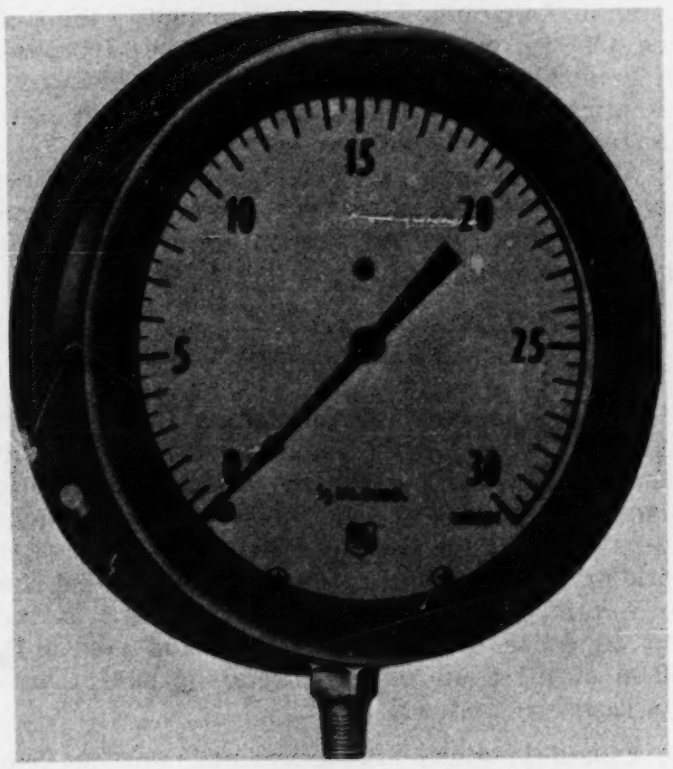

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Figure 9-3.—Bourdon tube vacuum gage.

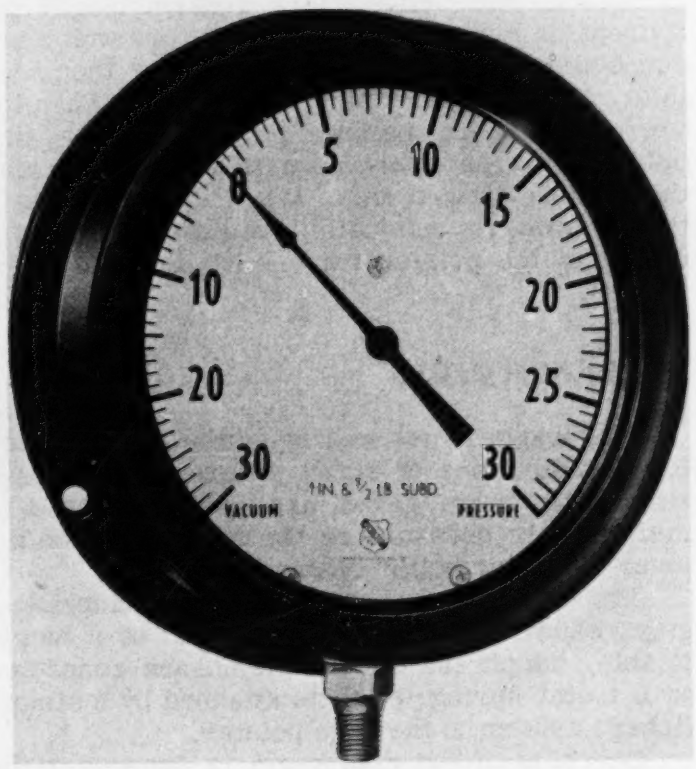

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Figure 9-4.—Compound Bourdon tube gage.

the zero point, it measures pressure in pounds per square inch (psi).

The duplex Bourdon tube gage illustrated in figure 9-5 has two separate gear mechanisms within the same case. A pointer is connected to the gear mechanism of each tube. Each pointer operates independently of the other pointer. Duplex gages are commonly used for such purposes as showing the pressure drop between the inlet side and the outlet side of lube oil strainers. If the pressure reading for the inlet side of the strainer is much greater than the pressure reading for the outlet side, it is very likely that the strainer is very dirty, and is thus restricting the flow of lube oil through the strainer.

BELLOWS GAGES

A bellows gage is generally used to measure pressures below 15 psi. Some types are satisfactory for measuring draft pressures and for general low pressure measurements. The bellows of the gage is made of stainless steel, brass, beryllium-copper, Monel, or phosphor bronze. A bellows is shown in a gage case in figure 9-6.

When pressure in the line to a bellows gage increases, the bellows increases in length and operates a system of gears and levers which are connected to the pointer. The pointer then registers the higher reading on the dial. When the pressure to the bellows gage decreases, the bellows returns to its normal length, returning the pointer toward zero. When the pressure to the bellows is completely removed, the hairspring of the pointer returns it all the way back to zero.

DIAPHRAGM GAGES

Diaphragm gages are sensitive and give reliable indications of small differences in pressure. Diaphragm gages are generally used to measure air pressure in the space between the inner and outer boiler casings.

The indicating mechanism of a diaphragm gage, shown in figure 9-7, consists of a tough, pliable, neoprene rubber membrane connected to a metal spring which is attached by a simple linkage system to the gage pointer.

One side of the diaphragm is exposed to the pressure being measured, while the other side is exposed to the atmosphere. When pressure is applied to the diaphragm, it moves upward and pushes the metal spring ahead. As the spring is pushed up, it moves the pointer, connected to it with a chain, to a higher reading on the dial. When the pressure is lowered the diaphragm pulls the pointer back toward the zero point.

MANOMETERS

A manometer is perhaps the most accurate, least expensive, and simplest instrument for measuring low pressure, or low pressure differentials. A manometer, in its simplest form consists of a glass U-tube of uniform diameter, filled with a liquid. The most common liquids used are water, oil, and mercury. One end of the U-tube is open to the atmosphere and the other end is connected with the pressure to be measured.

Manometers are available in many different sizes and designs. They all operate on the same principle. Two common types of manometers are shown in figure 9-8.

THERMOMETERS AND PYROMETERS

A thermometer is an instrument which measures temperature. The temperature measured may be that of steam to the main engines, brine in an ice machine, oil and bearings in the main engines, or substances in many other locations. In general a thermometer measures changes in temperature by utilizing the effect of heat on the expansion of a liquid or a gas.

Thermometers are designed as (1) direct reading, liquid-in-glass type, (2) bimetallic type, or (3) distant reading, indicating dial type thermometers.

LIQUID-IN-GLASS THERMOMETERS

Liquid-in-glass thermometers are filled with mercury, ethyl alcohol, benzine, water, or some other liquid suitable for the temperature range involved. Most of the liquid-in-glass thermometers used in the engineering spaces are filled with mercury. When a thermometer is exposed to a temperature to be measured, heat causes the liquid in the bulb to expand and rise in the glass stem. Cold, or the absence of heat, causes the liquid to contract.

Liquid-in-glass thermometers are designed so that the face will be in the best position for reading when the thermometer is installed. Some thermometers with different angles are shown in figure 9-9.

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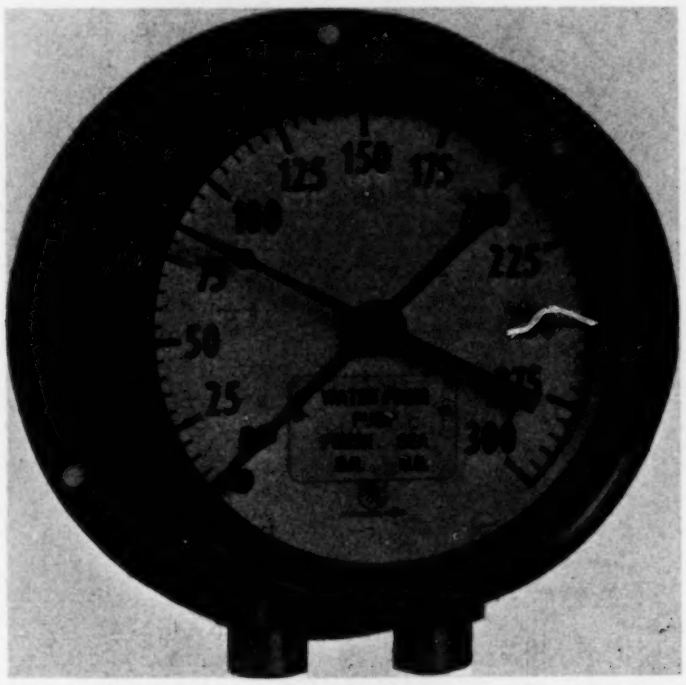

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Figure 9-5.—Duplex Bourdon tube gage.

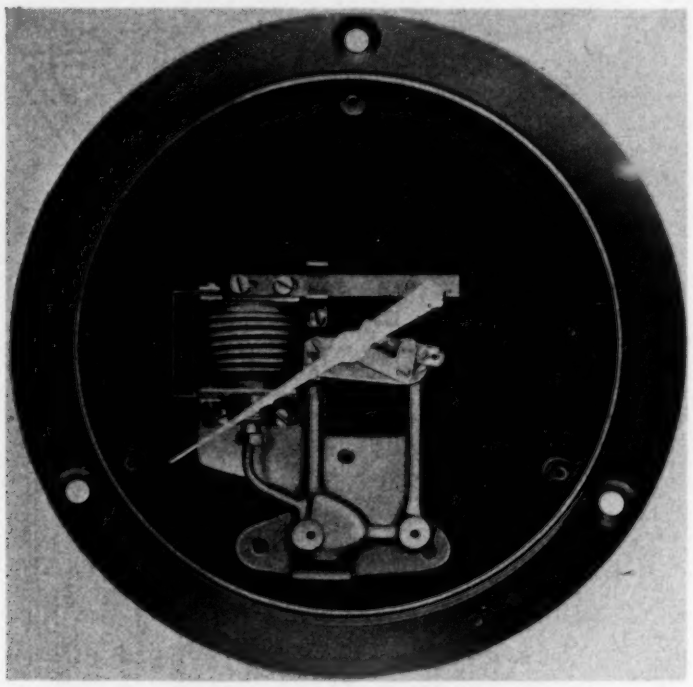

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Figure 9-6.—Indicating mechanism of a bellows pressure gage.

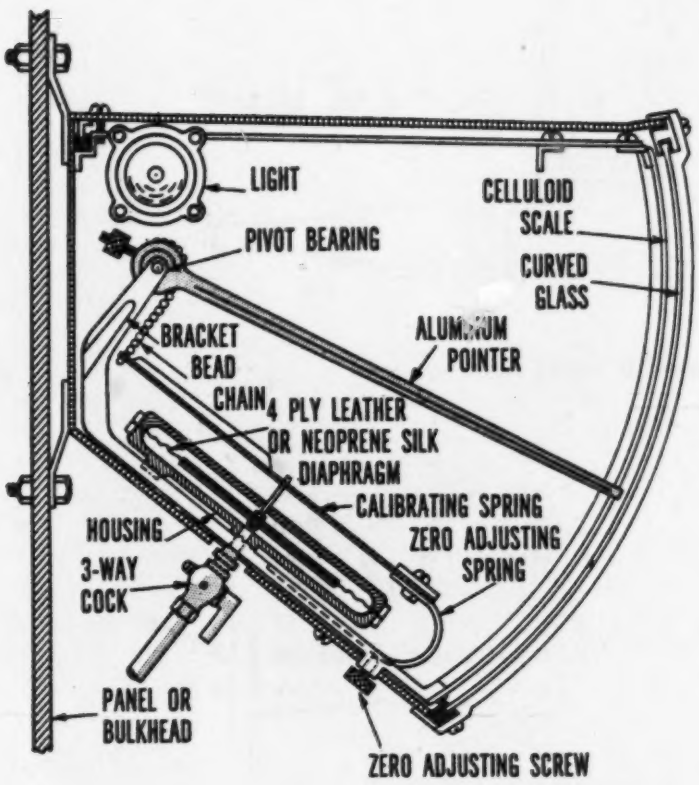

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Figure 9-7.—Diaphragm air pressure gage.

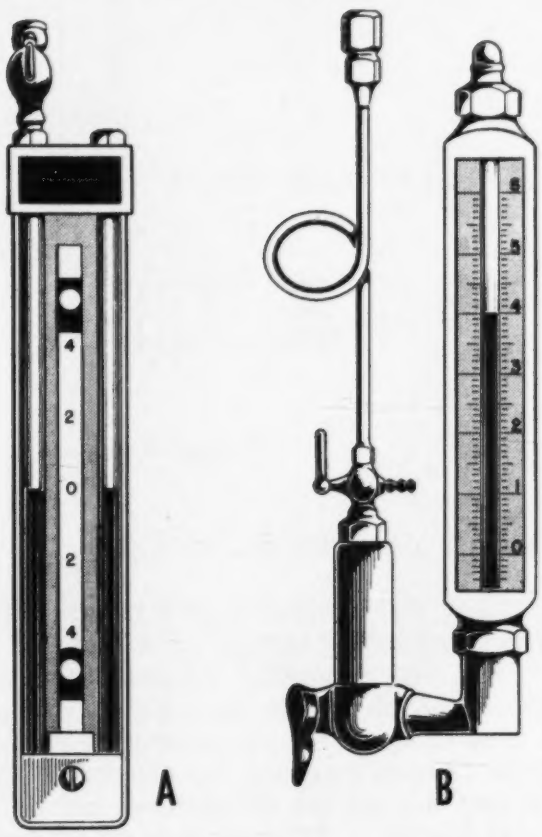

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Figure 9-8.—A Standard U-tube manometer. B. Single tube manometer.

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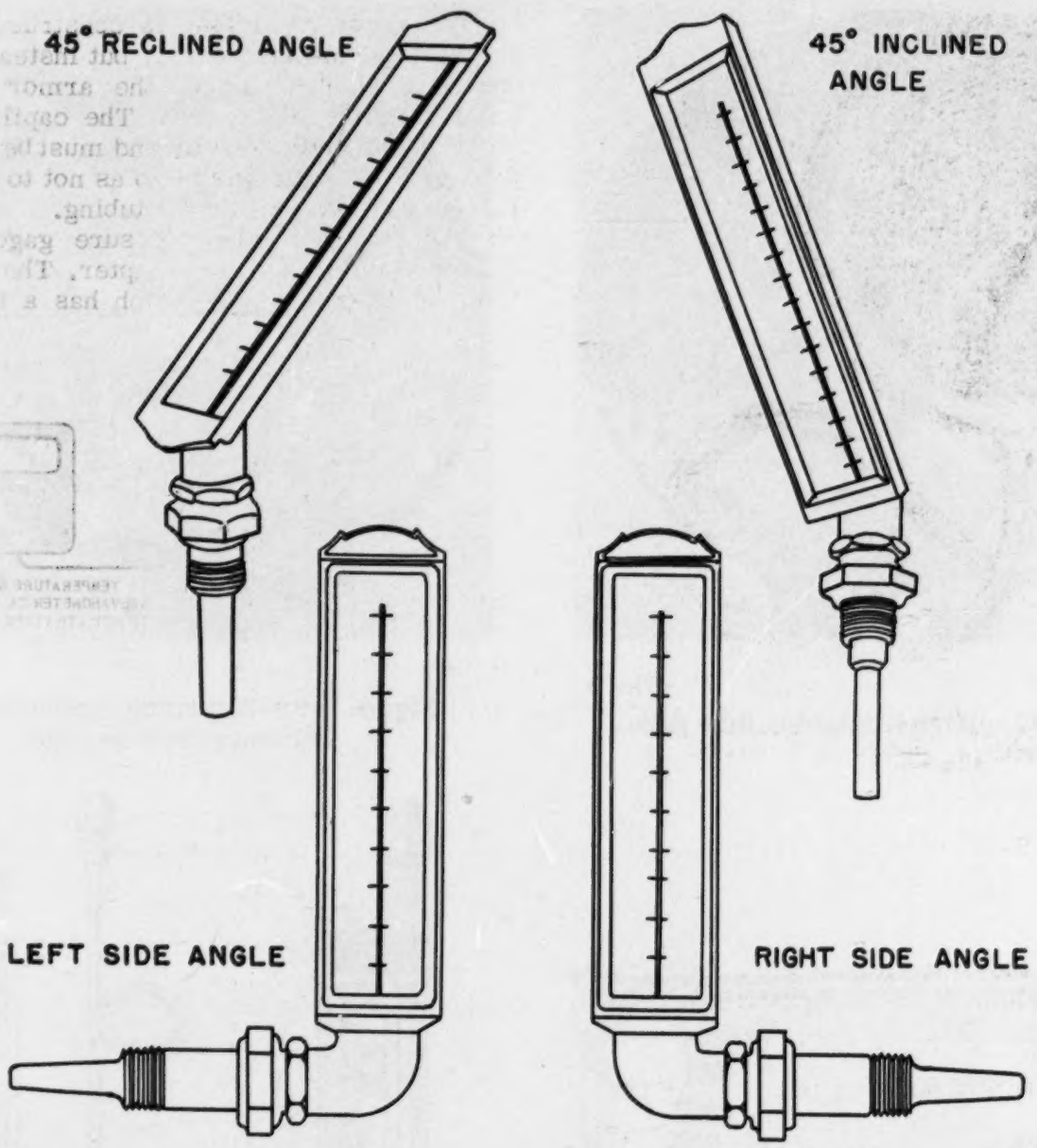

Figure 9-9.—Thermometers with angle sockets.

BIMETALLIC DIAL THERMOMETERS

Bimetallic dial thermometers use a bimetal element for indicating temperature changes on a circular dial. The bimetallic actuator is a single-helix coil fitted closely to the inside of the stem tube. A rise in temperature causes the actuating element to expand. Because the element is composed of two thin strips of different metals with each metal having a different rate of expansion, the element expands by unwinding instead of by expanding against the sides of the tube. The pointer shaft is secured to the free end of the element and thus registers the amount of element

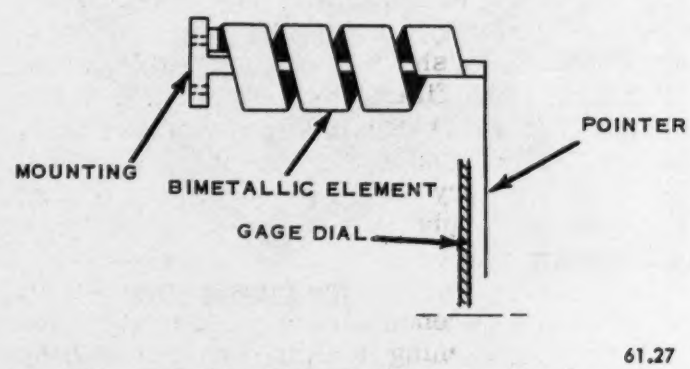

Figure 9-10.—Bimetallic actuator for a thermometer.

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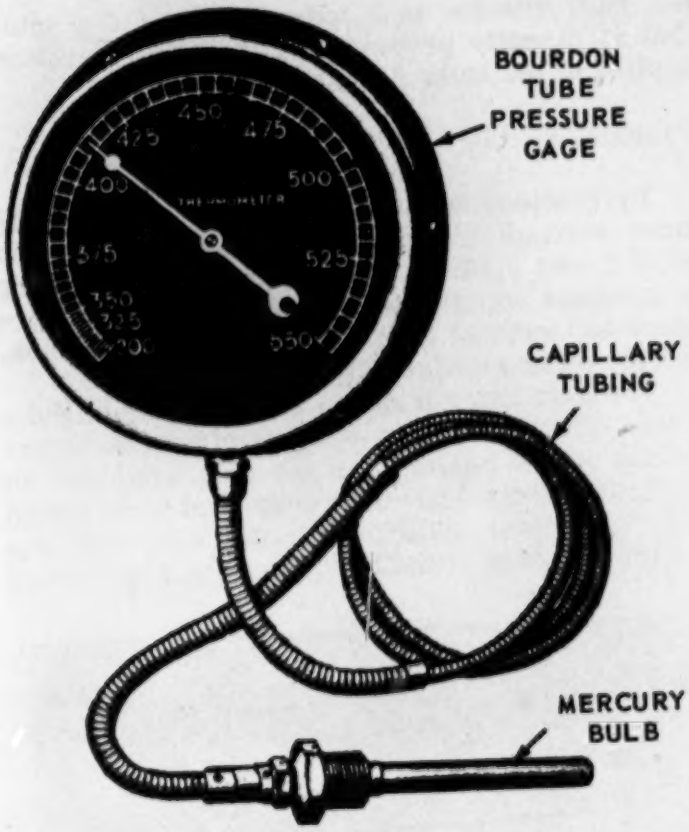

61.28X

Figure 9-11.—Distant reading dial thermometer.

movement on the dial face. Figure 9-10 shows the actuating element of a bimetallic thermometer.

DISTANT READING DIAL THERMOMETERS

Distant reading dial thermometers are used when indicating portions of the instrument must be placed at a distance from where the temperature is being measured. The mercury filled, distant reading thermometer, shown in figure 9-11, is the most common type used aboard ship. There are other types, but they are not commonly used aboard ship and will not be discussed.

The mercury filled, distant reading thermometer (fig. 9-11) consists of a mercury bulb, capillary tubing, and a Bourdon tube pressure gage. The mercury bulb, the capillary tubing, and the Bourdon tube in the pressure gage are all filled with mercury.

The mercury bulb is the sensing element. It is inserted and fastened securely (either threaded or bolted) in an opening in a pipe or turbine pump casing, for instance, where a temperature measurement is desired.

The capillary tubing is constructed similar to armored electric cable, but instead of having wires or cables inside, the armor contains a small flexible metal tube. The capillary tubing must be handled carefully and must be maintained free of kinks and twists, so as not to disrupt the mercury column within the tubing.

The Bourdon tube pressure gage was discussed earlier in this chapter. The gage contains a Bourdon tube which has a tendency to

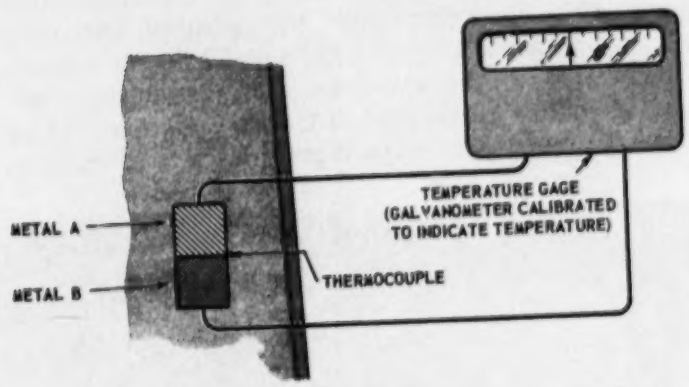

61.34X

Figure 9-12.—Diagrammatic arrangement of a thermocouple.

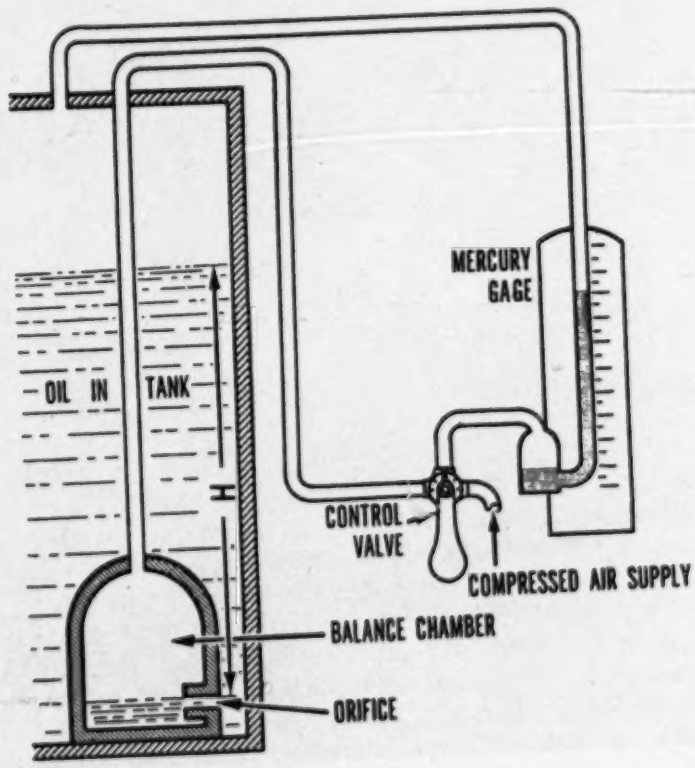

61.5X

Figure 9-13.—Static head gaging system.

9430

straighten out, as the pressure in the Bourdon tube increases.

Putting the three major units of the distant reading thermometer (mercury bulb, capillary tubing) and the pressure gage) together, let us see what happens. Remember that all three of these units are filled with mercury. Now when the temperature rises, the increase causes the mercury in the bulb to expand. The expansion of the mercury in the bulb causes a pressure to be built up in the capillary tubing. This same pressure is transmitted through the capillary tubing into the Bourdon tube in the pressure gage. The Bourdon tube straightens out and, through an assembly of gears and levers, causes a pointer to move around a dial, which has previously been calibrated to show corresponding temperatures. The expansion of the mercury in the bulb results in a movement of the pointer that is directly proportional to the temperature applied to the bulb.

PYROMETERS

Pyrometers are used for measuring temperatures through a wide range, generally between -300°F and 3,000°F. They are used aboard ship to measure temperatures in heat treatment furnaces and exhaust temperatures of diesel engines, and for other similar purposes.

The pyrometer includes a thermocouple and a meter. The thermocouple, made of two dissimilar metals joined together at one end, produces an electric current when heat is applied at its joined end. The meter, calibrated in degrees, indicates the temperature at the thermocouple. Figure 9-12

Figure 9-14.—Boiler gage glass installed on a boiler.

139.32

illustrates the operating principle of the thermocouple of the pyrometer.

LIQUID LEVEL INDICATORS

In the engineering plant, aboard ship, it is frequently necessary for operating personnel to know the level of various liquids in various locations. The level of the water in the ship's boilers is an example of a liquid level that must be known at all times. Other liquid levels that must be known are the level of the fuel oil in storage tanks and service tanks, the level of the water in the deaerating feed tank, and the level of the lubricating oil in the oil sumps and reservoirs of pumps and other auxiliary machinery.

Liquid level indicators, other than sounding rods and tapes, have been constructed in various designs and sizes; some are simple and some are relatively complex. Some indicators measure liquid level directly by measuring the height of a column of liquid.

TANK GAGING SYSTEM

One of the more complex liquid level indicators is shown in figure 9-13. This type of indicator or system is generally used for measuring the liquid level in fuel oil storage tanks aboard ship. It is called a static head gaging system; it balances a head of liquid in the tank against a column of liquid in a manometer. In this system a mercury manometer is used. The balance chamber is located so that its orifice (opening) is near the bottom of the tank; a line connects the top of the balance chamber to the mercury filled bulb of the indicator gage, and another line connects the space above the mercury column to the top of the tank. Since the height of the liquid in the tank has a definite relationship to the pressure exerted by the liquid, the scale can be calibrated to show the height (or liquid level). When the height of the liquid in the tank is known, the measurement of height can be readily converted to volume (gallons).

GAGE GLASSES

The gage glass is one of the simplest kinds of liquid level indicators. Gage glasses are used on boilers, on deaerating feed tanks, on inspection tanks, and on other shipboard machinery. Gage glasses vary in design and construction depending upon pressure or other service conditions.

The liquid level in the gage glass is the same as the liquid level in the container; and the liquid level can be determined by visual observation. A typical boiler gage glass installed on a boiler is shown in figure 9-14.

In addition to the gage glasses, some boilers have been equipped with remote water level indicators. The remote water level indicators are generally installed on the operating level of the boilers to provide the petty officer in charge with a readily obtainable reading of the water level in the steam drum of the boilers. Figure 9-15 illustrates one type of remote water level indicator.

FLUID METERS

Fluid meters are used on board ship to measure the flow rate of fuel oil, diesel oil, water, gasoline, and other liquids. Accurate measurement of the rate of flow of a liquid through a meter is not meaningful unless the recorded amount is correctly read. Some different types of dials used on fluid meters are shown in figures 9-16 and 9-17. The dial readings are generally in U.S. gallons unless otherwise specified on the dial face. The dial faces shown in figure 9-16 are for the straight reading type meter; the dial faces shown in figure 9-17 are for a round reading meter.

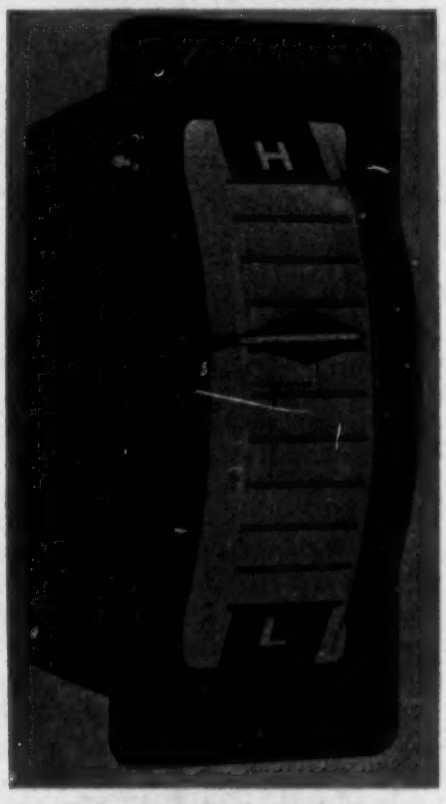

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Figure 9-15.—Remote water level indicator.

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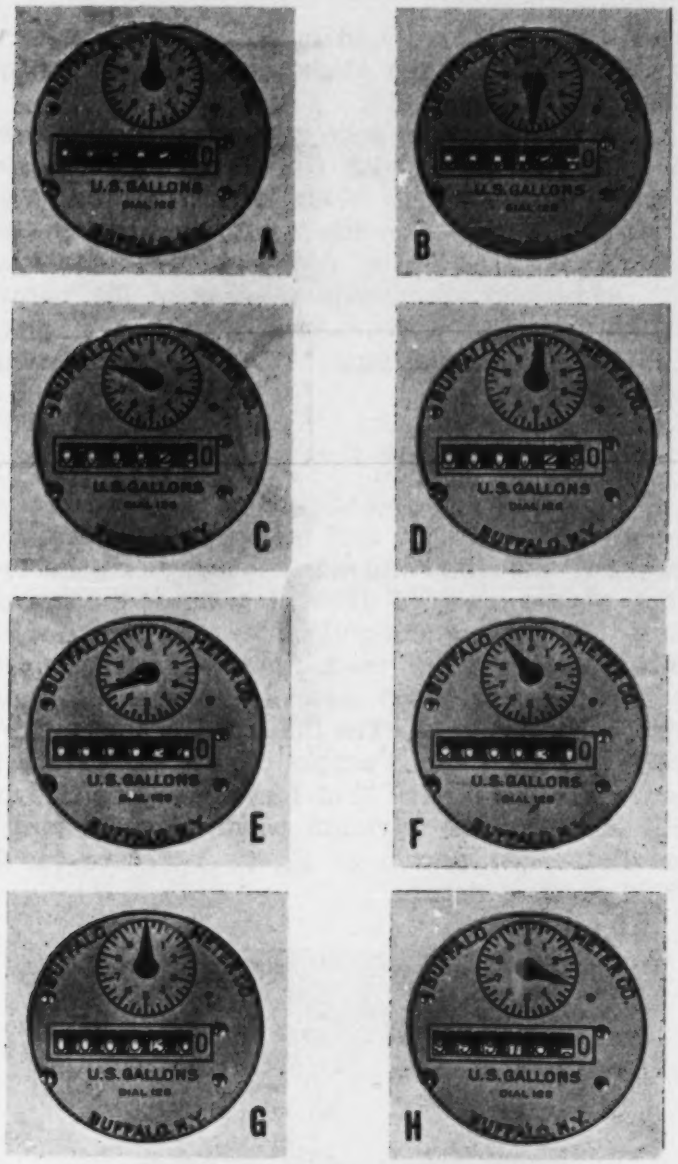

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Figure 9-16.—Straight reading registers.

To read the straight reading meter, read from left to right and add the number indicated by the small pointer above. For example in part A of figure 9-16 the reading is 0000280. Part B shows the reading to be 0000285. As the pointer turns, so does the right-hand, numbered roller. Even though the next higher number is partly exposed always read the lesser number, which is the number disappearing from sight. When the small pointer is at 0 all the numbers in the straight reading dial will be centrally aligned, as shown in part A and part G of figure 9-16. When the small pointer is at 8 or 9 (part C of fig. 9-16), the next larger number on the numbered roller is almost completely exposed, but the lesser number must be read. The dial in part C of figure 9-16 reads 288 gallons, not 298 gallons.

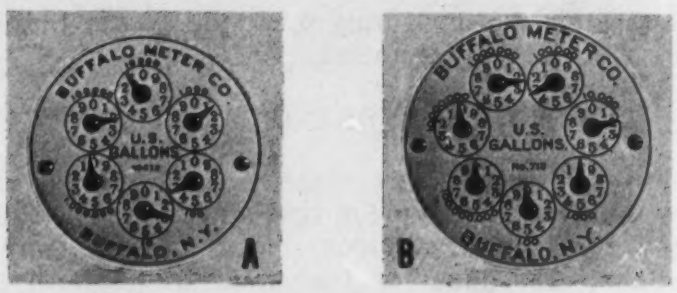

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Figure 9-17.—Round reading registers.

To read the round reading dial face (fig. 9-17) take the lesser number of the two between which the hand points in each circle. Notice that each circle indicates tens, hundreds, thousands, tens of thousands, etc. Place the number taken from the circle marked "tens" in the units position, place the number taken from the circle marked "hundreds" in the tens place; and continue similarly for the remaining circles. Each division of any circle stands for one-tenth of the whole number indicated by that circle. If a hand is on or near a number, read that number instead of the next lower number when the hand in the next lower circle is on or past 0.

REVOLUTION COUNTERS AND INDICATORS

Measurements of rotational speed are necessary for the operation of the pumps, forced

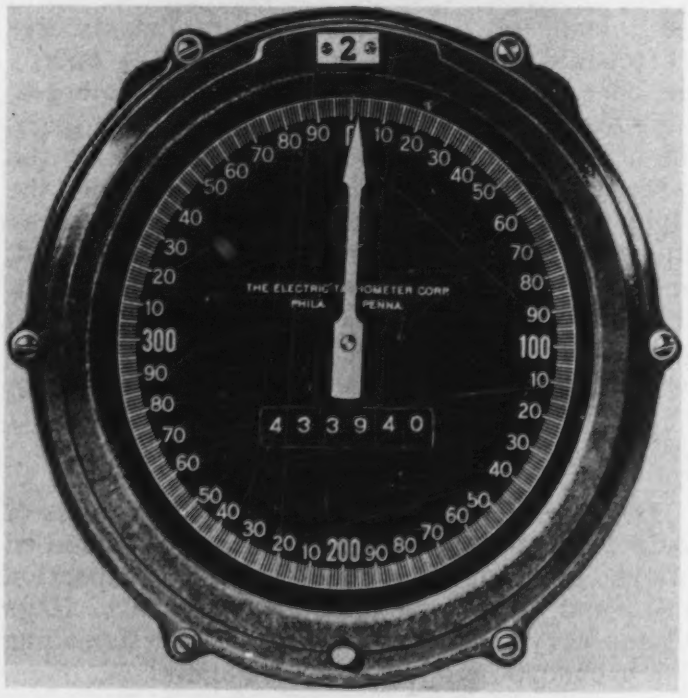

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Figure 9-18.—Revolution counter.

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SCAC

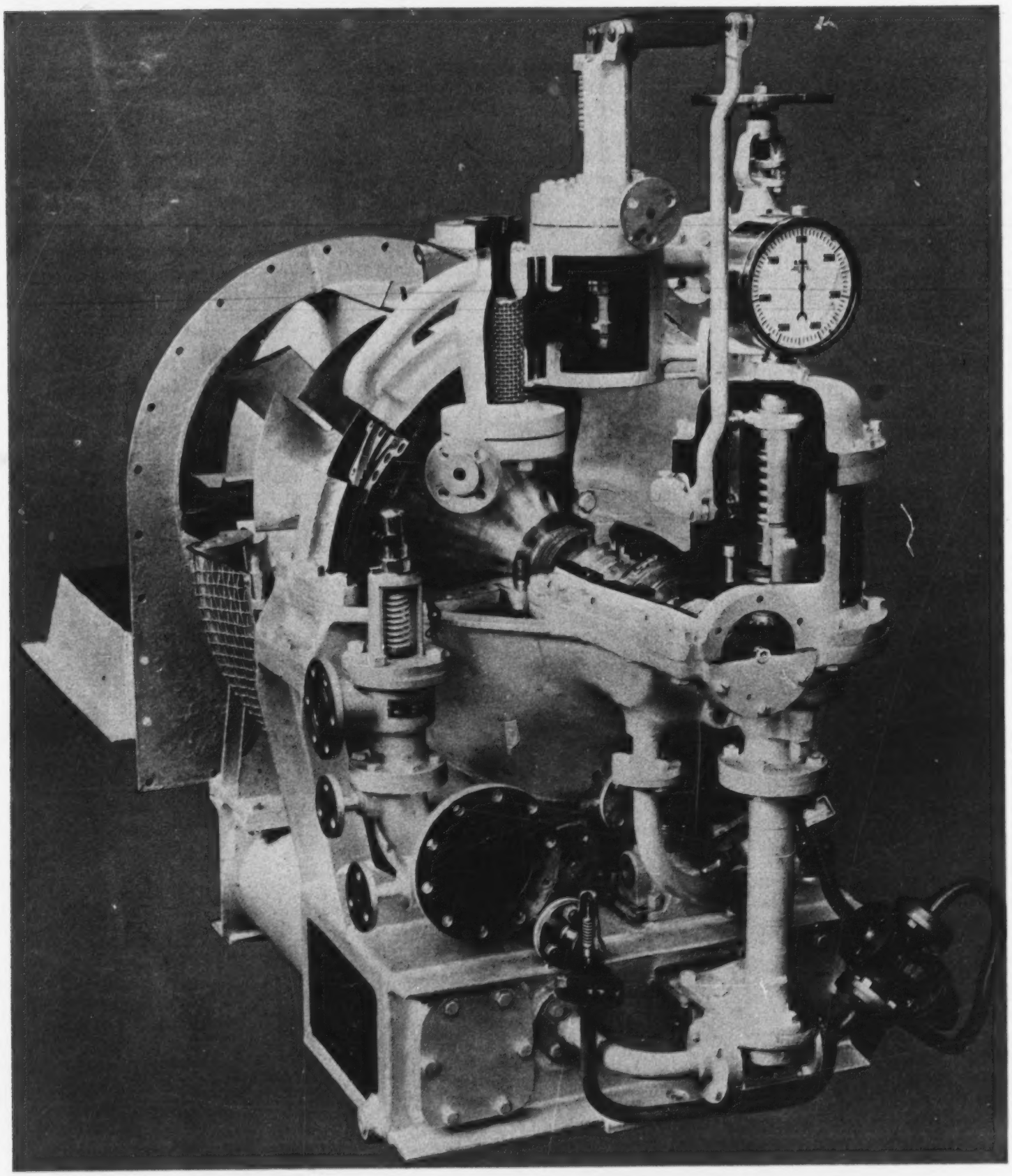

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Figure 9-19.—Permanently mounted centrifugal type tachometer on a forced draft blower.

draft blowers, main engines, and other machinery or equipment of the engineering plant. As a result, various instruments are used to indicate the shaft speed or to count the total number of turns a shaft makes. One type of instrument, the revolution counter, which is mounted on the throttleboard in the engineroom, counts the total number of turns that are made by a main propulsion shaft. These counters are similar to the speedometer of an automobile. A typical revolution counter is shown in figure 9-18.

The most common instrument used in the engineering plant aboard ship, for the measurement of rotational speed, is the tachometer. For most shipboard machinery, rotational speed is expressed in revolutions per minute (rpm). The tachometers generally used aboard ship are of three main types: the centrifugal type, the chronometric type, and the resonant type.

The CENTRIFUGAL tachometer may be either portable (single and multiple range) or permanently mounted. The portable multi-range tachometer has three ranges: low (50 to 500 rpm), medium (500 to 5,000 rpm), and high (5,000 to 50,000 rpm).

Normally, permanently mounted centrifugal tachometers operate off the governor or speed limiting assembly. The tachometer continuously records the actual rotational speed of the machinery shaft. A permanently mounted centrifugal tachometer is illustrated in figure 9-19.

A portable centrifugal tachometer has a small shaft protruding from its case, which is applied manually to a depression or projection on the end of a rotating shaft of a pump, motor, or other machinery. The rotating movement of the machinery shaft is converted to instantaneous values of speed on the dial face of the tachometer. Figure 9-20 shows a portable multi-range centrifugal tachometer.

The portable CHRONOMETRIC tachometer, shown in figure 9-21, is a combination watch and revolution counter. It measures the average number of revolutions per minute of a motor shaft, pump shaft, etc. The mechanism of this tachometer is such that its outer drive shaft runs free when applied to a rotating shaft, until a starting button is depressed to start the timing element. Note the starting button beneath the index finger in figure 9-21. The chronometric tachometer retains readings on its dial after its

Figure 9-20.—Multi-range centrifugal tachometer. 61.17X

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2.66X

Figure 9-21.—Portable chronometric tachometer.

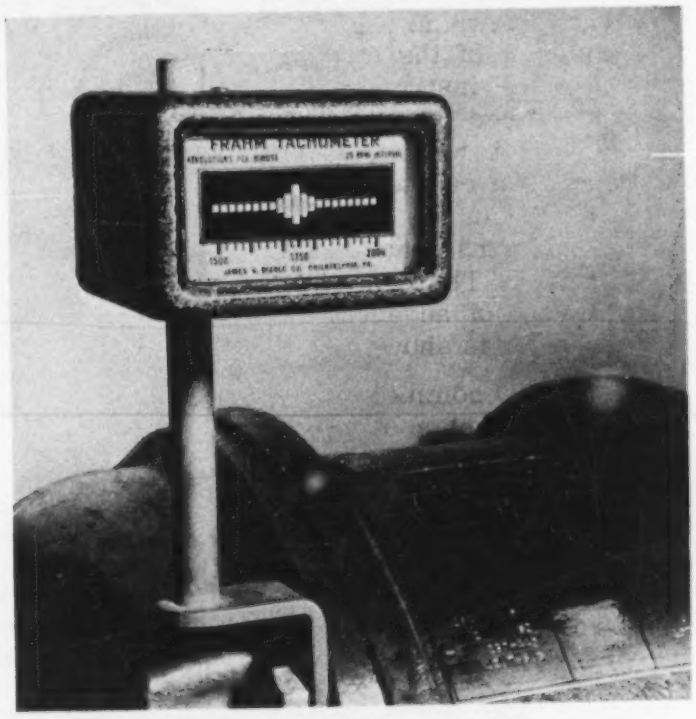

61.16X

Figure 9-22.—Mounted resonant reed tachometer.

drive shaft has been disengaged from a rotating shaft, until the pointers are returned to zero by the reset button (usually the starting button). The range of a chronometric tachometer is usually from 0 to 10,000 rpm, and from 0 to 3,000 feet per minute (fpm).

Each portable centrifugal or chronometric tachometer is supplied with a small rubber covered wheel and a number of hard rubber tips. The appropriate tip or wheel is fitted on the end of the tachometer drive shaft, and held against the shaft to be measured. Portable tachometers of the centrifugal or chronometric type are used for intermittent readings only, and are not used for continuous operation.

The RESONANT REED tachometer, illustrated in figure 9-22, is particularly useful for measuring high rotational speeds such as those that occur in turbines and generators. This type of tachometer is particularly suitable where it is practically impossible to reach the moving ends of the machinery shafts. This instrument gives continuous readings and is capable of making very rapid, instantaneous adjustments to rotational speed.

Resonance is the quality of an elastic body which causes it to vibrate vigorously when subjected to small, rhythmic impulses at a rate equal to its natural frequency, or nearly so. In a resonant reed tachometer, resonance provides a simple but accurate means for measuring speed and rate of vibration.

A resonant reed tachometer consists of a set of consecutively tuned steel reeds mounted in a case with a scale to indicate rpm of the shaft and vibrations per minute (vpm) of the reeds. This tachometer has no pointer—only a set of accurately tuned reeds— and it operates without direct contact with a moving part under test. It has no gears or couplings, and it requires no oiling and practically no maintenance.

OTHER ENGINEERING INSTRUMENTS

There are a great number of additional instruments and indicators used in the engineering plant. This section attempts to acquaint you with those additional instruments that you most likely will be seeing or working with in the engineering department. These additional instruments include superheater temperature alarms, superheater steam flow indicators, smoke indicators, salinity indicators, lube oil pressure alarms, engine order telegraph, and many others.

SUPERHEATER TEMPERATURE ALARMS

Superheater temperature alarms are installed on most boilers to warn operating personnel of

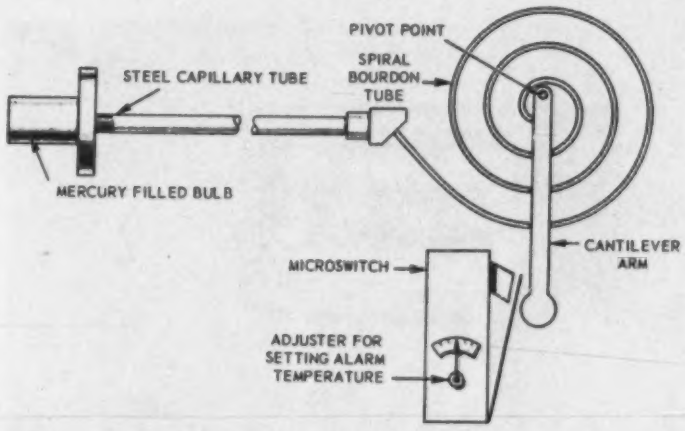

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Figure 9-23.—Superheater temperature alarm.

dangerously high temperatures in the superheater of the boilers. Some superheater temperature alarms operate similarly to the Bourdon tube pressure gage. As heat is applied, the mercury in the spiral wound Bourdon tube expands, causing the Bourdon tube to move a cantilever arm toward an electric microswitch. As the preset alarm temperature is reached, the cantilever arm engages the microswitch, setting off a warning howl or buzzer. The warning signal continues until the superheater temperature has been lowered to about 10° or 15°F below the preset alarm temperature. The signal or alarm stops because the mercury in the Bourdon tube contracts, moving the Bourdon tube, which in turn causes the cantilever arm to move away from the microswitch, shutting off the alarm. A diagrammatic arrangement of one type of superheater alarm is shown in figure 9-23.

STEAM FLOW INDICATOR

Steam flow indicators are used to show the rate of flow of steam through the superheater

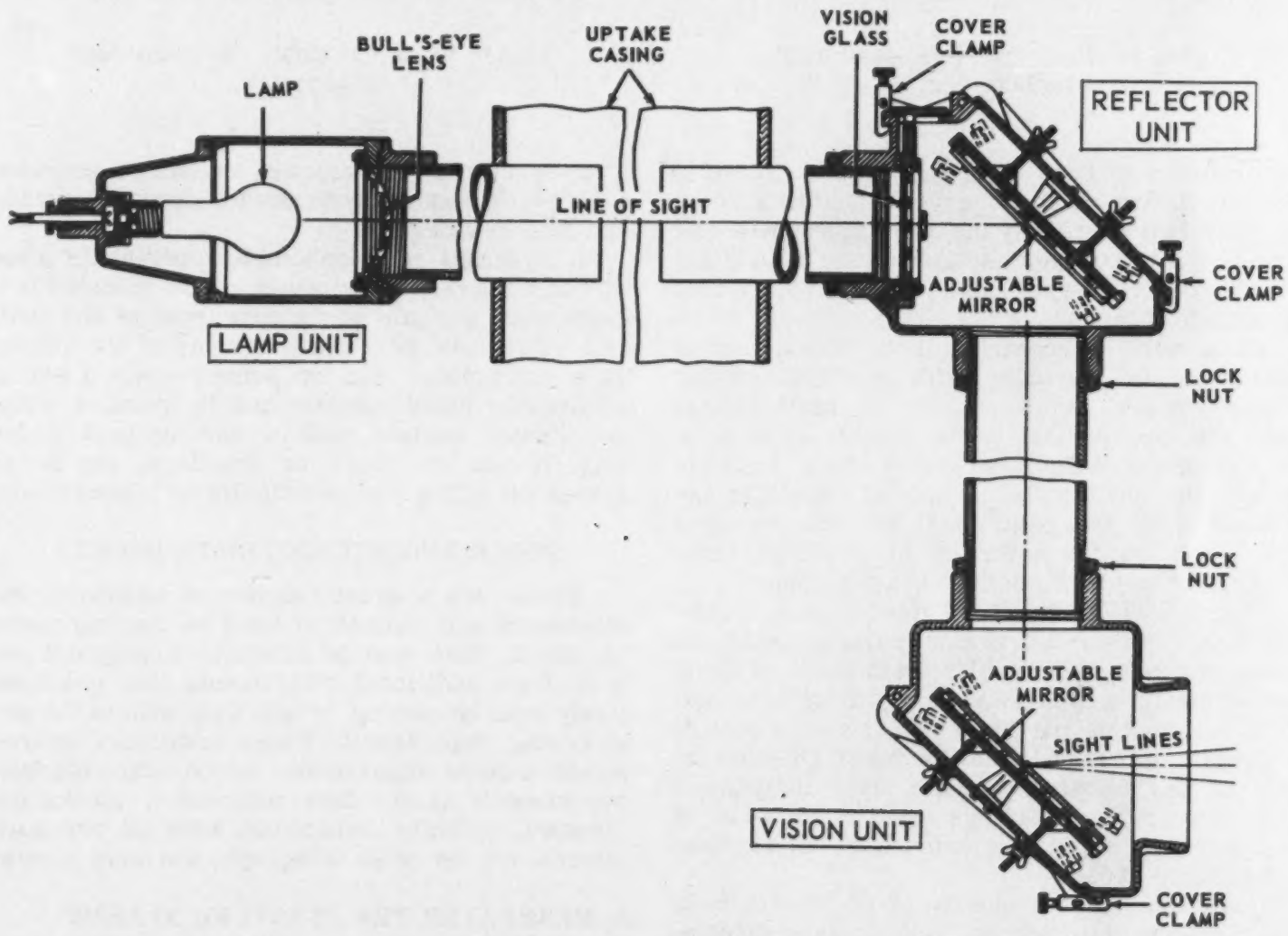

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Figure 9-24.—Smoke indicator.

of double-furnace boilers. Before fires are lighted in the superheated side of double-furnace boilers, the operator must ensure that a sufficient flow of steam is passing through the superheater. The flow of steam is necessary to carry off the heat of combustion in the superheated side of double-furnace boilers in order to prevent overheating of the superheater tubes, drums, and headers.

The steam flow indicator is calibrated in inches and is normally set at 2 inches as the minimum low. In other words, fires should not be lighted in the superheated side of double-furnace boilers until the pointer on the steam flow indicator has reached the 2-inch mark, which is an indication of sufficient flow of steam.

SMOKE INDICATOR

Smoke indicators (periscope type) are used to provide the boiler operator with visual indications of conditions in the stack above the furnace area. A smoke indicator is shown in figure 9-24.

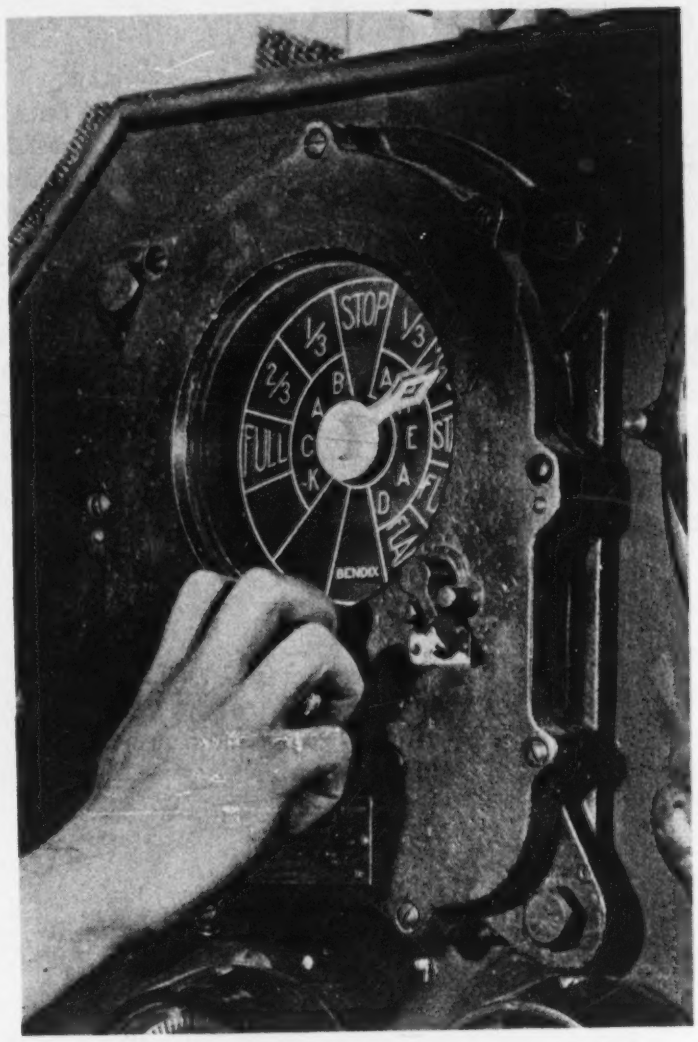

Figure 9-26.—Engine order telegraph. 139.49

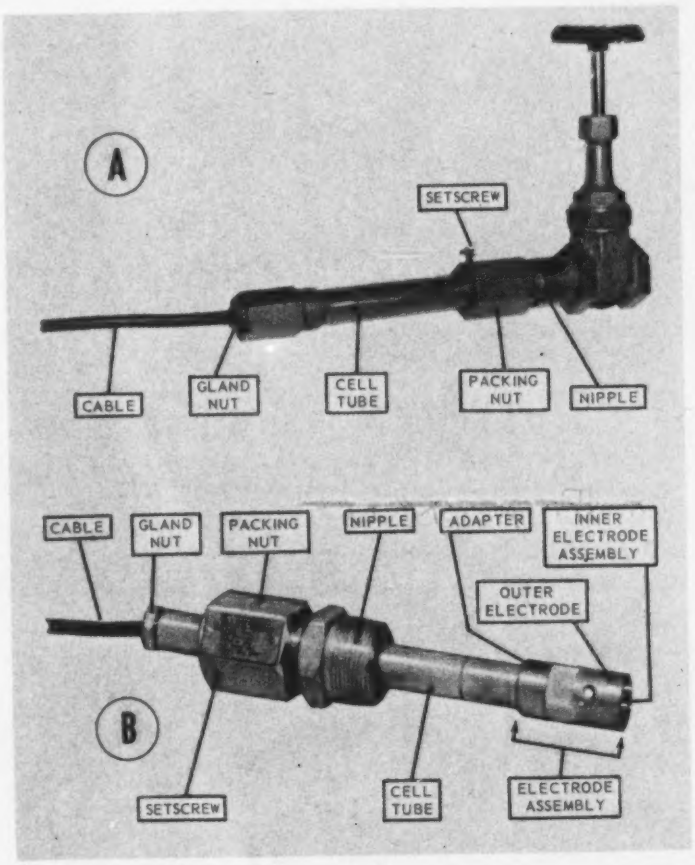

Figure 9-25.—Salinity cell and valve assembly. 7.150

SALINITY INDICATOR

Electrical salinity indicating cells (fig. 9-25) are installed throughout distilling plants to maintain a constant check on the distilled water. An electrical salinity indicator consists of a number of salinity cells in various locations in the plant; for example, in the evaporators, condensate pump discharge, and the air-ejector condenser drain. These salinity cells are all connected to a salinity indicator panel.

Since the electrical resistance of a solution varies according to the amount of ionized salts in solution, it is possible to measure salinity by measuring the electrical resistance. The salinity indicator panel is equipped with a meter calibrated to read directly in either equivalents per million (epm) or in grains per gallon (gpg). The newer type salinity indicators are calibrated in epm.

LUBE OIL PRESSURE ALARM

Lube oil pressure alarms are installed on all generators and main propulsion engines to provide the operator with a signal indicating that the lube oil pressure to the bearings is dangerously low. Low lube oil pressure could cause a number of casualties that would impair the operating condition of the machinery involved. The lube oil pressure alarm, which is either a rapidly ringing bell or loud siren, receives its signal from the bearing that is the most remote from the lube oil pump. When the alarm is sounded the affected machinery must be stopped immediately, the cause determined, and corrective measures taken.

ENGINE ORDER TELEGRAPH

The engine order telegraph (speed indicator), shown in figure 9-26, relays the speed, requested by the officer of the deck while underway, to the throttleman in the engineroom. The engine order telegraph is generally mounted on the throttleboard adjacent to the throttle valves, so that it is readily visible to the throttleman. The following table lists speed changes which may be indicated via the engine order telegraph.

AHEAD	STOP	ASTERN
1/3		1/3
2/3		2/3
I - Standard		Full
II - Full		
III - Flank		

The wrong direction alarm is connected to the engine order telegraph and the main engine throttle valves. If the engine order telegraph indicates "ahead" and the throttleman attempts to open the astern throttle valve, a loud signal or alarm is sounded.

CHAPTER 10

PUMPS, VALVES, AND PIPING

As a Fireman, you should have a general knowledge of the basic operating principles of the various types of pumps used by the Navy. Pumps are used to move any substance which flows or which can be made to flow. When thinking of the term pumping, you probably think of moving water, oil, air, steam, and other common liquids and gases. Substances such as molten metal, sludge, and mud are also fluid and can be pumped with specially designed pumps.

A pump is essentially a device which uses an external source of power to apply a force to a fluid in order to move the fluid from one place to another. A pump transforms energy from the external source (such as an electric motor or steam turbine) into mechanical kinetic energy, which is revealed by the motion of the fluid. This kinetic energy is then used to do work: to raise a liquid from one level to another, as when lifting water from a well; to transport a liquid through a pipe, as in an oil pipeline; to move a liquid against some resistance, as when filling a boiler under pressure; or to force a liquid through a hydraulic system against various resistance.

Aboard ship, pumps are used for a number of essential services. Pumps supply water to the boilers, draw condensate from the condensers, supply sea water to the fireman, circulate cooling water for coolers and condensers, pump out bilges, transfer fuel oil, supply sea water to the distilling plants, and serve many other purposes. The operation of the ship's propulsion plant and of almost all the auxiliary machinery depends upon the proper operation of pumps. Pump failure may cause failure of an entire power plant.

If a system has a pump, it must also contain devices for controlling the volume of flow, the direction of flow, or the operating pressure of the system. A device that performs one or more of these control functions is called a VALVE.

In addition to pumps and valves, this chapter will discuss piping which is a vital part of the ship's engineering plant.

PUMPS

Pumps are classified in accordance with design and operational features. Pumps may be classified, according to the type of movement that causes the pumping action (reciprocating, rotary, centrifugal, propeller, or jet pumps). Pumps are also classified by the rate of speed, the rate of discharge, and the method of priming. Some pumps run at variable speed; others at constant speed. Some pumps have a variable capacity; others discharge at a constant rate. Some pumps are self-priming; others require a positive pressure on the suction (intake) side before they can begin to move a liquid.

Regardless of classification, a pump must have a POWER END and a FLUID END. The power end may be a steam turbine, a reciprocating steam engine, a steam jet, or an electric motor. In steam driven pumps, the power end is often called the STEAM END. The fluid end is generally called the PUMP END; but it may be called the LIQUID END, the WATER END, the OIL END, or the GAS END, to indicate the nature of the fluid substance being pumped.

Pumps can be divided into groups according to the principles on which they operate. Most pumps fall into five main types: reciprocating, rotary, centrifugal, propeller, and jet. Each type of pump is especially suited for some particular kind of work.

RECIPROCATING PUMPS

The hand water pump commonly used on farms is a good example of the reciprocating pump. The reciprocating pump derives its name from the back and forth or up and down movement of the piston or plunger inside a cylinder. These pumps are used on modern ships as emergency feed water pumps and as fire and bilge pumps. Reciprocating pumps are used for emergency purposes because they are easy to operate and can be started safely by relatively inexperienced

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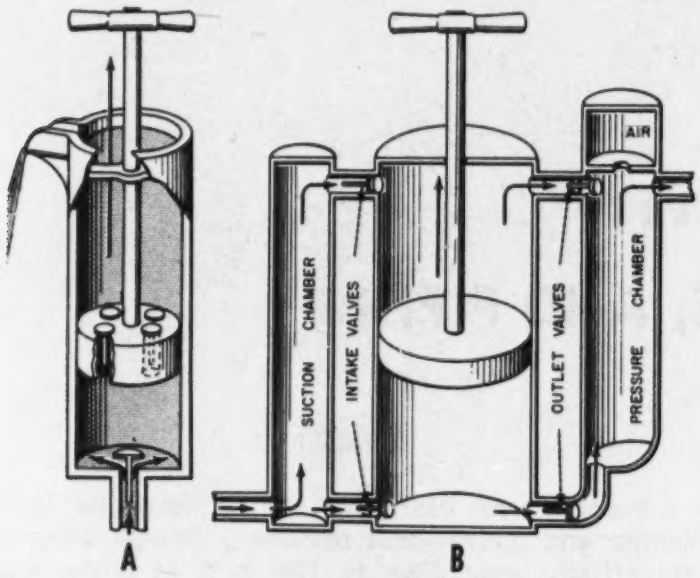

139.34

Figure 10-1.—Operating principle of two types of reciprocating pumps.

personnel. These pumps are also reliable for starting under cold conditions.

A single-acting pump is one which takes a suction on one stroke only, known as the suction stroke. On the return stroke—called the discharge stroke—the liquid is forced out of the cylinder. Figure 10-1 (A) illustrates the operating principle of a single-acting reciprocating pump.

The principal parts of a single-acting reciprocating pump are a cylinder, a piston, and a valve system. The piston fits snugly in the cylinder and is moved up and down in it by the pump shaft. Most of these pumps are steam driven. The pump shaft is a continuation of the piston rod of the steam cylinder.

On the down stroke, the valves in the bottom of the cylinder are closed and the water in the lower part of the cylinder is forced up through the valves in the piston. On the up stroke, the weight of the water above the piston closes the piston valves. As the piston moves upward, it draws the water from the suction line into the cylinder through the cylinder valves. The water above the piston leaves the pump through an outlet line or a spout.

The double-acting pump shown in (B) of figure 10-1 is designed to deliver a steady stream of water under high pressure. Double-acting pumps are also steam driven. The pump is connected directly to the piston rod of the steam cylinder. These pumps have the same general parts and operate on the same general principle as the single-acting type. The valve system is arranged differently and an air chamber is added to maintain the pressure when the piston is at the top and bottom of each stroke.

A stream of water is forced out of the double-acting pump on both the up and the down strokes. On the up stroke, the water above the piston is forced out through the upper outlet valve. At the same time, water is being drawn into the space below the piston through the lower inlet valve. On the down stroke, the water below the piston is forced out of (discharged from) the cylinder through the lower outlet valve and a new charge of water is drawn into the top of the cylinder through the upper inlet valve.

Reciprocating pumps are often called POSITIVE DISPLACEMENT pumps—that is, each discharge stroke displaces a definite amount of liquid, regardless of the resistance against which the pump is operating. A relief valve must be installed in the discharge line to relieve any excess pressure.

The operation of the reciprocating pump generally depends upon a valve system that directs the steam first into one end of the cylinder and then into the other end. The steam is allowed to escape from the cylinder after it has served its purpose. Steam to and from the cylinder passes through two ports (openings), one in each end of the cylinder. This arrangement is quite similar to the manner in which the water passes through the double-acting water pump described previously.

One valve design consists of a D-SHAPED SLIDE VALVE (D-valve) that is actuated by a linkage attached to the piston rod. (See fig. 10-2.) The steam chest which is attached to the cylinder is connected through a stop valve to the auxiliary steam line. When the piston reaches the top of its stroke, the valve-operating mechanism moves the valve down to the position shown in (A) of figure 10-2. The port connecting the steam chest

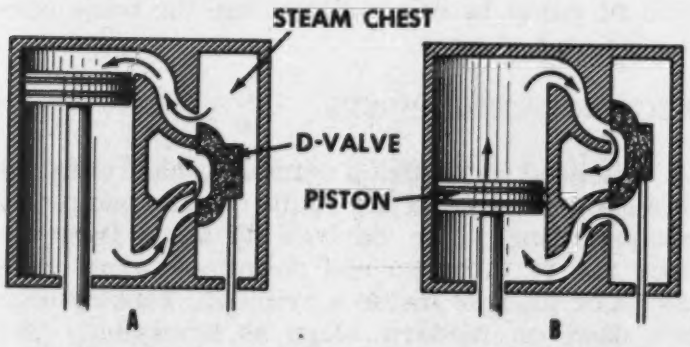

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Figure 10-2.—Operating principle of D-shaped slide valve of a reciprocating pump.

to the space in the top of the cylinder is uncovered. Steam from the chest flows through this port, exerts a pressure on the top of the piston, and forces it downward.

At the same time, the space below the piston is connected with the exhaust port through a recess in the back of the valve. As the piston moves downward, the steam that fills this space is forced out through the exhaust port.

As the piston nears the bottom of its stroke, the valve mechanism moves the D-valve to the position shown in (B) of figure 10-2. This movement uncovers the lower port. Steam from the chest now flows into the lower part of the cylinder and pushes the piston upward. The upper cylinder port is connected to the exhaust port through the back of the valve. As the piston rises, it pushes the exhaust steam out of the top of the cylinder through the exhaust port.

Figure 10-3 shows the piston valve gear commonly used aboard ship. It performs the same function as the D-valve, but the movement of the valve is controlled by the difference between the inlet and the outlet steam pressure. The piston valve gear consists of a main piston-type slide valve and a pilot slide valve. Since the rod from the pilot valve is connected to the pump rod by a valve-operating assembly, the position of the pilot valve is controlled by the position of the piston in the steam cylinder. The pilot valve furnishes actuating steam to the main piston valve; this in turn admits steam to the top or to the bottom of the steam cylinder at the proper time.

Regardless of the type of valve used, the continued operation of the pump consists of feeding steam into one end of the cylinder and exhausting it from the other end. The direction of steam flow (in and out of the cylinder ports) is reversed at the end of each stroke of the piston.

Starting a reciprocating pump is quite simple. First, open the proper valves in the suction and discharge lines before starting the pump. Next, open the exhaust valve and the cylinder drains. Then, open the throttle valve slightly, or "crack" it to feed enough steam into the cylinder to warm it. (See fig. 10-4.) Adjust the throttle to operate the pump at a slow speed until live steam begins to come out of the drains. Now close the drains and adjust the throttle to operate the pumps at the desired speed.

When securing a reciprocating pump, close the throttle first, and then close the exhaust valve. Next open the cylinder drains and close the valves in the suction and discharge lines.

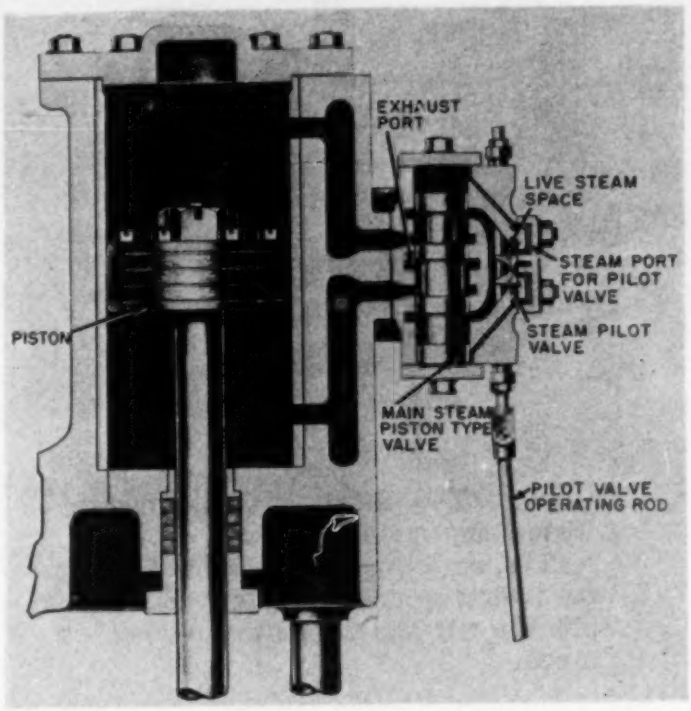

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Figure 10-3.—Piston-type valve gear for steam end of reciprocating pump.

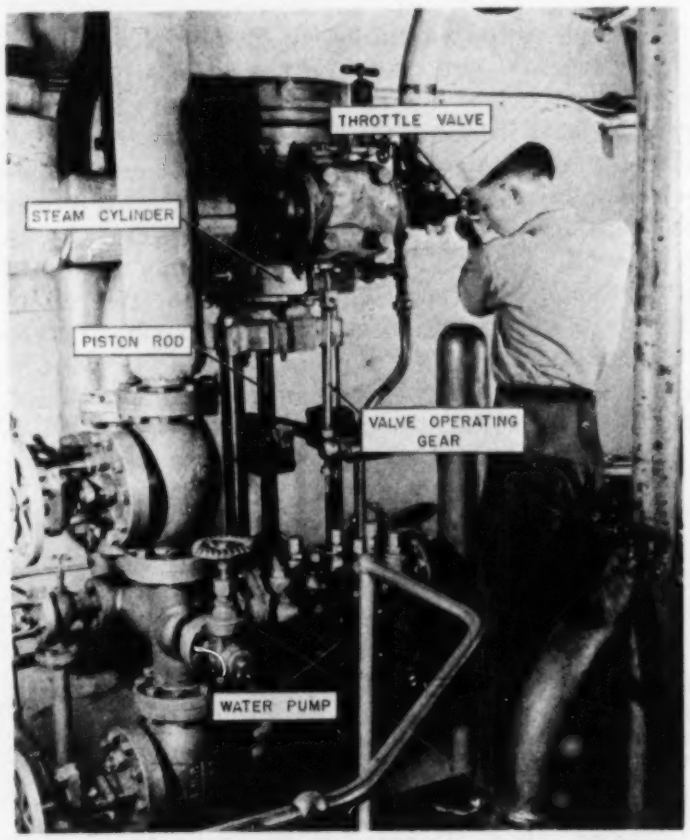

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Figure 10-4.—Starting a reciprocating pump.

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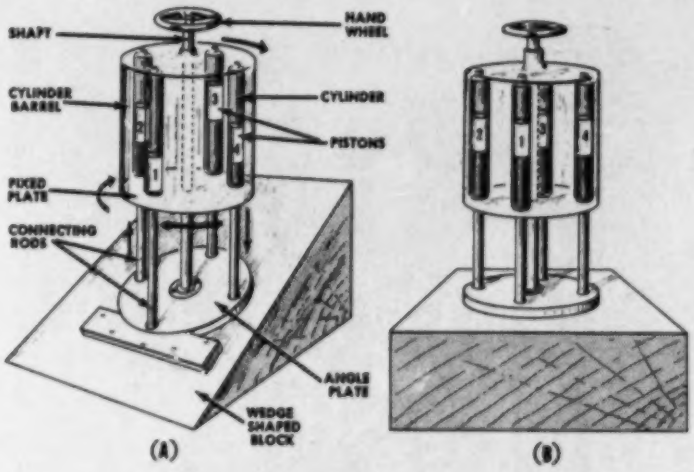

Figure 10-5.—Operating principle of a Waterbury variable-volume pump. A. The angle plate is tilted and moves the piston up and doen. B. The angle plate is flat and the pistons do not move. 139.37

After the steam cylinder has drained, close the drain valves.

VARIABLE STROKE PUMPS

Aboard ship, variable stroke pumps (positive displacement) are largely used on electrohydraulic steering gear, elevators, cranes, and anchor windlasses. In these applications, the variable stroke pump is referred to as the A-end of the drive system; and the hydraulic motor which is driven by the A-end is referred to as the B-end. By controlling the pumping action of the A-end, you can run the motor (B-end) in either direction and vary the speed from zero to the maximum rate. Variable stroke pumps are also used on some naval ships as in-port and cruising fuel oil service pumps.

Although variable stroke pumps are often classified as rotary pumps, they are actually reciprocating pumps. They operate on a principle similar to that of a single-acting reciprocating pump. A rotary motion is imparted to a cylinder barrel or cylinder block in the pump by means of a constant-speed electric motor, but the actual pumping is done by a set of pistons reciprocating inside a set of cylinders. The means by which the rotary motion is changed to reciprocating motion is explained and illustrated in the discussion which follows.

Figure 10-5 illustrates the operating principle of a Waterbury variable-volume pump. This pump is used as a variable-speed power transmission in the steering gear and the gun-training mechanism aboard ship. It is also used in those systems where it is necessary to control the pump output within very narrow limits.

In the Waterbury pump the pumping is done by a set of pistons that move back and forth within close-fitting cylinders. The oil enters and leaves the cylinders through ports or passages in the cylinder heads. The pistons are operated by the cam action of an angle plate. This method of changing rotary motion to reciprocating (back and forth) motion is demonstrated by the device shown in figure 10-5.

This demonstrator consists of a cylinder barrel and an angle plate attached to a shaft, as illustrated in (A) of figure 10-5. The angle plate is fastened to the shaft by a universal joint that permits it to tilt in any direction. The connecting rods (piston rods) rest in sockets in the angle plate and are attached to pistons that slide up and down in the cylinders. When the handwheel is turned the complete assembly turns with it.

When you place the demonstrator on a sloping surface the angle plate will tip or tilt and assume the same angle as the block. The pistons on the low slide will be drawn down in the cylinders, and those on the high side will be pushed up. In (A) of figure 10-5, the number 1 piston is in the lowest position; number 3 is in the highest.

Now turn the handwheel to the right, and see what happens. As the far side of the angle plate moves up along the surface of the block, the connecting rods and pistons on the side will be raised. The near side of the plate is moving down along the block surface and the pistons on this side will move down in the cylinders. The operation is continuous. Each piston moves up during half of each revolution around the shaft, and moves down during the other half.

The stroke of the pistons (the distance that they move up and down during each revolution of the shaft) depends on the slope or tilt of the angle plate. In (B) of figure 10-5 the demonstrator is resting on a level surface, and the angle plate is parallel with the bottom of the cylinder barrel. When you turn the handwheel now, the angle plate does not move up and down, and the pistons remain in the same position in the cylinders.

So far, the demonstrator has been used to show that the pistons will move up and down in the cylinders when the shaft is turned with the angle plate tilted. The device can be converted into an oil pump by adding an adjustable tilting box to control the tilt of the angle plate and

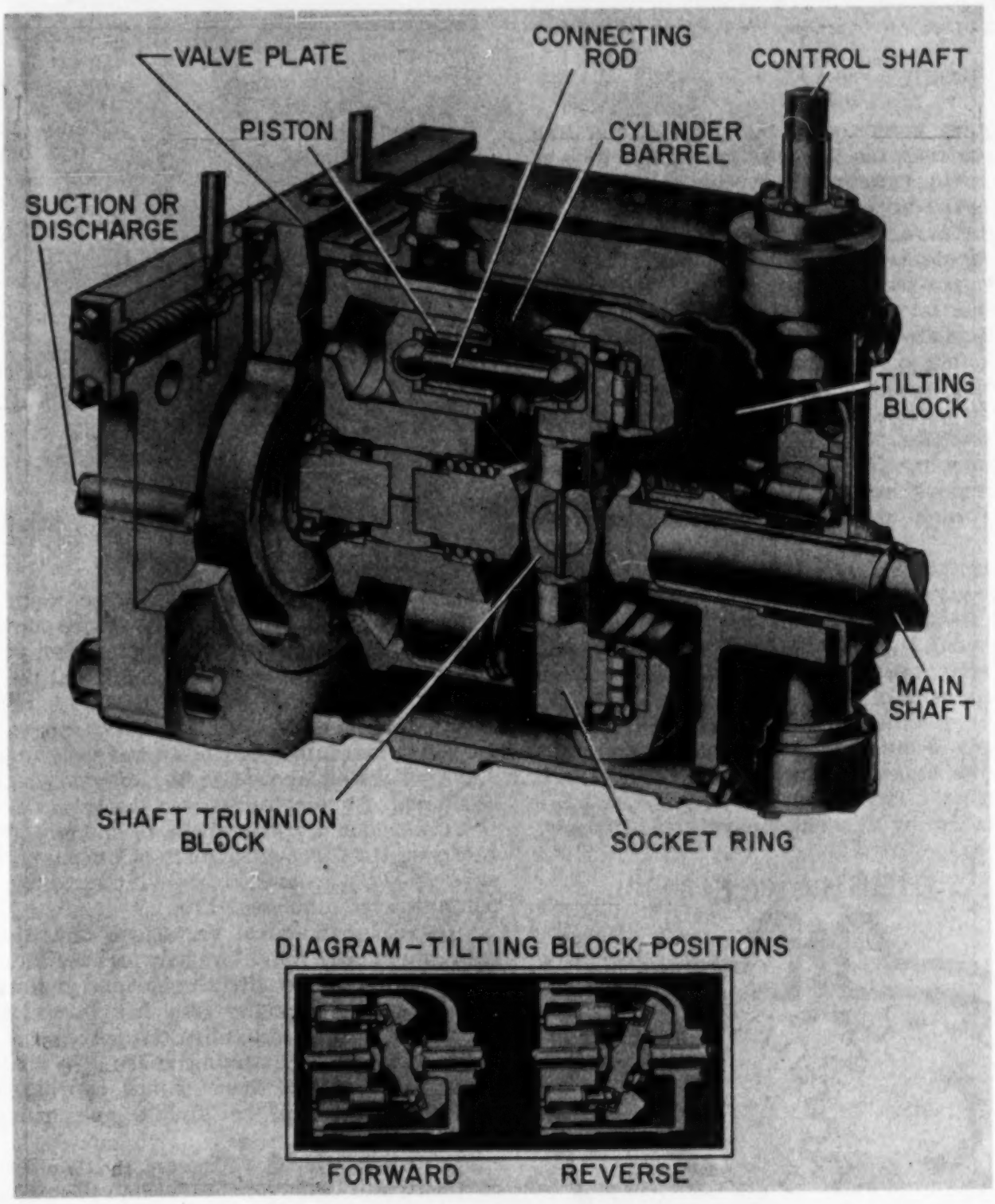

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Figure 10-6.—Variable stroke axial piston pump.

placing a valve plate on top of the cylinder barrel. The valve plate has two elongated ports that allow the oil to flow into the cylinders on one side of the pump and out on the other side. When the tilt of the angle plate is increased, the stroke of the pistons is increased and more oil passes through the pump. Tilting the angle plate in the opposite direction reverses the direction of the oil flow.

The Waterbury variable-volume pump has the same principal parts as the demonstrator just described. (Fig. 10-6.) the moving parts are enclosed in a pump case that is kept filled with oil. These pumps are mounted in a

9444

horizontal position and are usually driven by an electric motor.

ROTARY PUMPS

All rotary pumps work by means of rotating parts which trap the liquid at the suction side of the pump casing and force it through the discharge outlet. Gears, screws, lobes, vanes, and cam-and-plunger arrangements are commonly used as the rotating elements in rotary pumps.

Rotary pumps (positive displacement) are most useful for pumping oil and other heavy viscous liquids. They are also used for non-viscous liquids, such as water or gasoline, where the pumping problem involves a high suction lift. Rotary pumps are used for fuel oil service, fuel oil transfer, and lubricating oil service. These pumps are self-priming, because they are able to remove air from the suction lines and produce a high suction lift (or a satisfactory vacuum).

The simple GEAR PUMP, shown in figure 10-7 is frequently used in the lubricating systems of fuel oil and water pumps, forced draft blowers, and other auxiliary machinery. This type of pump has two spur gears which mesh together and rotate in opposite directions; one is the DRIVING *GEAR and the other is the DRIVEN GEAR. The* driving gear is attached to the shaft of the electric motor or steam turbine that drives the pump; the driven gear is in mesh with the driving gear and is driven by it. The gears must fit very closely within the case to keep the liquid from leaking back to the suction side of the pump. The parts are lubricated by the liquid being pumped.

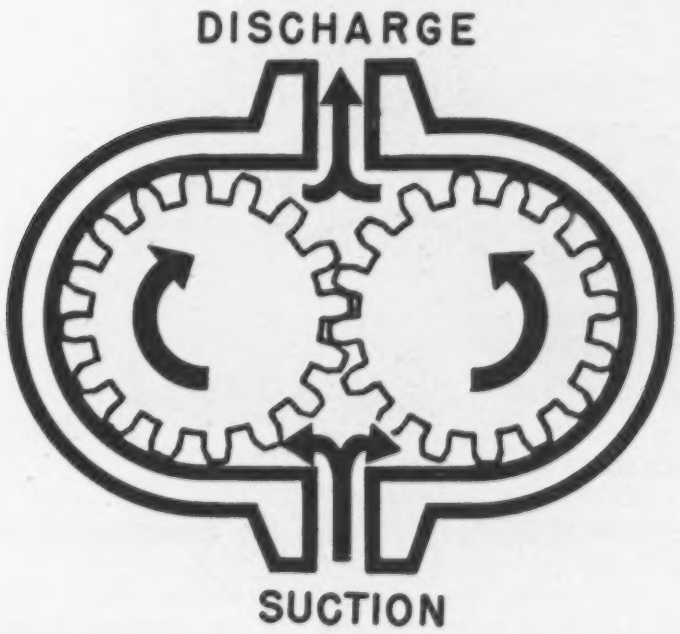

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Figure 10-7.—Action of simple gear pump.

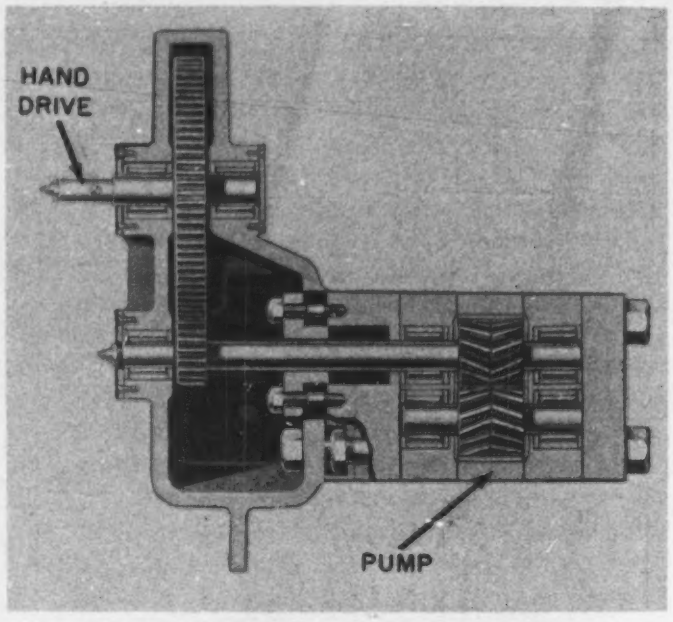

Figure 10-8.—Herringbone gear pump.[38.104]

At first glance you might think that the liquid passes between the two gears. This is not true. *As the gears rotate, the liquid is trapped in the* spaces between the gear teeth and the pump case, and is carried around to the discharge side of the pump. As the teeth come in mesh, the liquid is squeezed out of these spaces and is kept from returning to the suction side of the pump. Pressure is built up and forces the liquid out of the pump into the discharge line.

There are several variations of the simple gear pump. One kind has herringbone teeth (fig. 10-8) which make little noise and maintain an even pressure. Another kind has three lobes on each gear instead of teeth. Lobe pumps and some helical pumps have timing gears that rotate the pump parts. All of these pumps operate on the same principle as the simple gear pump just described.

SCREWS PUMPS represent still another type of positive displacement rotary pumps. In the screw pump, the liquid is trapped and forced through the pump by the action of rotating screws. Screw pumps have few moving parts and no valves to get out of order. They are widely used aboard ships as fuel oil and lubricating oil service pumps. They may have two or three screws, and are divided into high pitch and low pitch types.

The triple screw pump (high-pitch) illustrated in figure 10-9 has three screws or rotors that

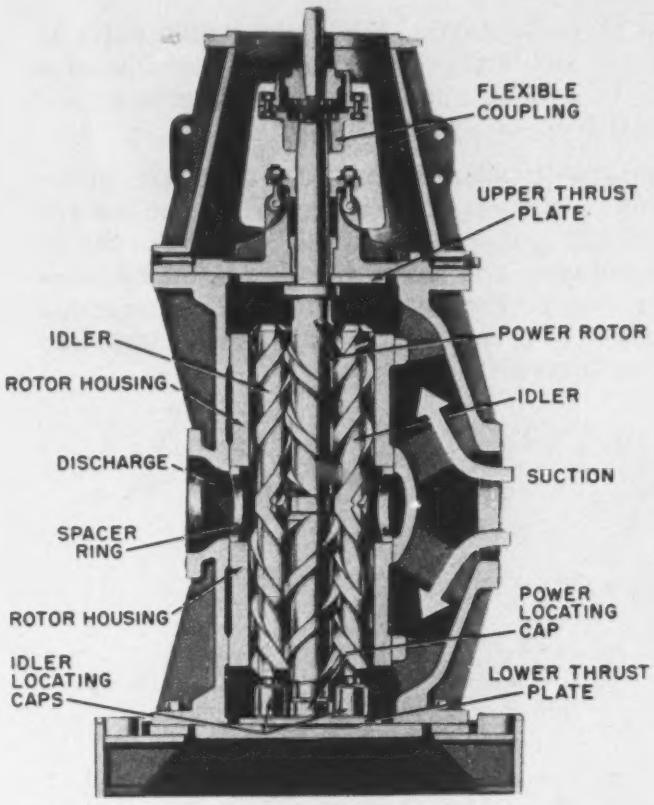

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Figure 10-9.—Cutaway view of triple screw, high pitch pump.

revolve within a close-fitting housing. The power rotor in the center is in mesh with (and drives) the two idling rotors (idlers).

The suction line is connected to the pump intake, which in turn opens into the chambers at the ends of the rotors. As the rotors turn, the liquid flows in between the threads at the outer end of each pair of screws. At the end of the first turn, a spiral-shaped slug of the liquid is trapped when the ends of the threads come in mesh again. The threads carry the liquid along within the housing toward the center of the pump, and to the discharge opening.

CENTRIFUGAL PUMPS

Centrifugal pumps are used in the feed, fresh water, and firemain systems of the engineering plant. There are many types of centrifugal pumps (feed water booster, condensate, and fire), but all operate on the same principle. Centrifugal pumps can handle large quantities of a liquid and deliver it at a high pressure. These pumps may be driven by a steam turbine, an electric motor, or a diesel engine. They do not operate on the positive displacement principle, but depend on centrifugal force to move the liquid through the pump and maintain the desired pressure. (See fig. 10-10.)

When a body revolves in a curved path, it exerts a force called "centrifugal force" upon the arm, level, casing, or whatever means is used to restrain it from moving in a straight (tangential) line. For example, centrifugal force is the force that holds the water in a pail when you swing it in a circle over your head. If there happens to be a hole in the bottom of the pail, the water will squirt out, even when the pail is upside down.

The simple centrifugal pump shown in figure 10-10 has only one main moving part. A wheel called an impeller is connected to the drive shaft and rotates within the pump casing. The casing has the same spiral shape as a snail's shell. The water enters the pump through the inlet pipe, which empties into the center of the casing. The location of the outlet passage corresponds to the opening in the snail's shell through which the snail emerges.

The suction connection is so designed that the liquid is guided from the suction chamber of the casing to the center or "eye" of the impeller. As the impeller rotates, it carries the water around with it. The centrifugal force resulting from this rotation pushes the water away from

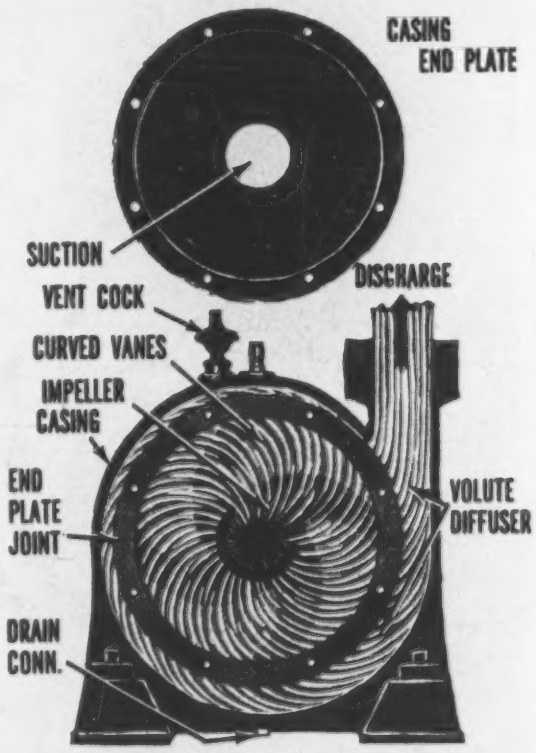

139.38X

Figure 10-10.—Operating principle of a centrifugal pump.

the center and holds it against the inside of the pump casing. As the water flows along the inside of the spiral-shaped casing, it is diverted through the outlet opening and passes into the discharge line.

Centrifugal pumps are not self-priming; they should never be run while empty. The impeller fits very closely into the sides of the casing and depends on the liquid being pumped to supply the necessary coolant. This type of pump is usually installed below the level of the tank from which suction is to be taken. When the intake valve is opened the liquid flows into the pump and primes it. The vent cock should be opened until all air is purged from the pump casing.

A single-impeller pump will maintain pressures up to 150 psi. Where higher pressures are required the pump is designed with from two to six impellers. The pressure is raised by successive stages. The outlet from the first impeller is connected to the inlet of the second impeller and so on through all the stages.

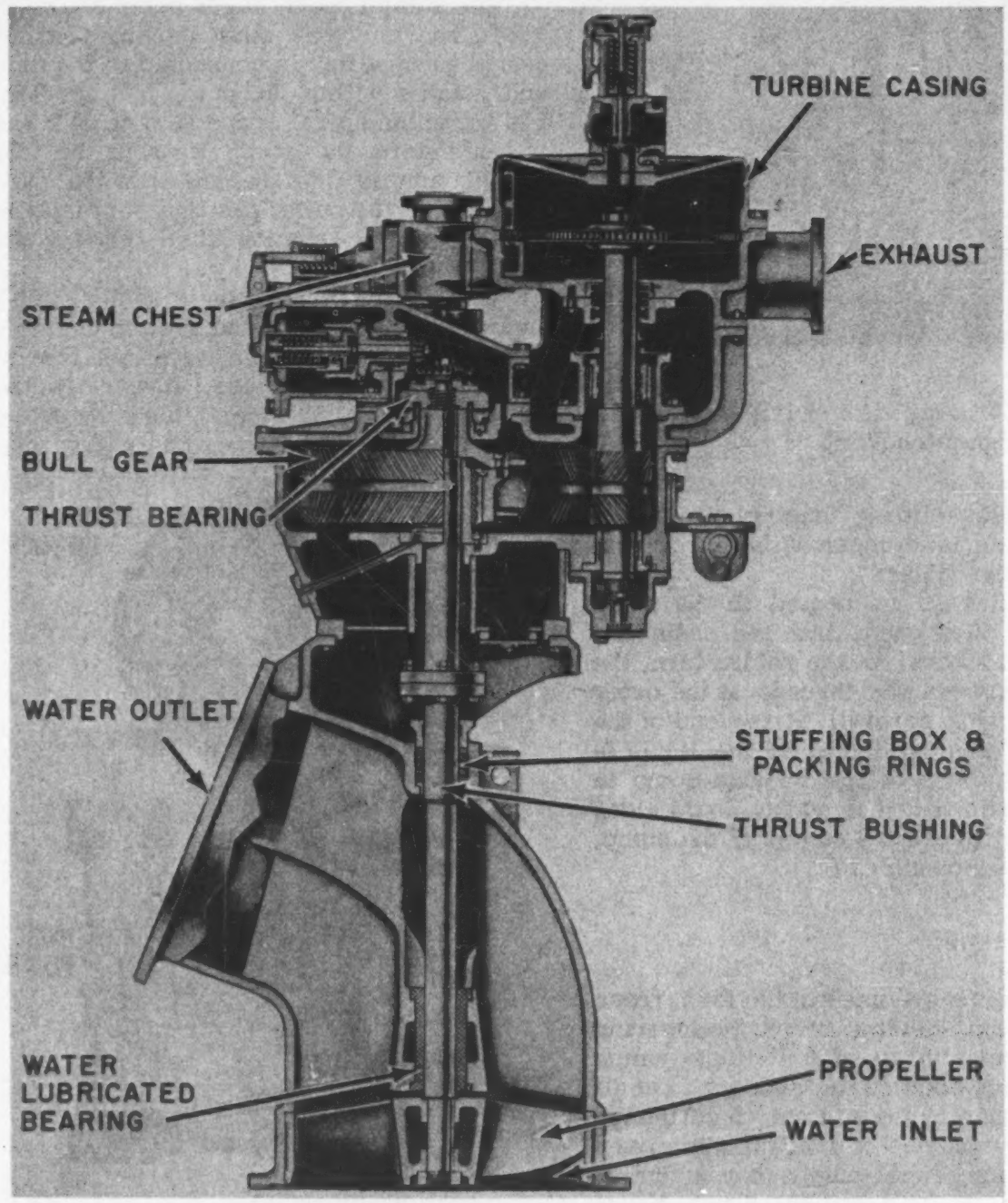

47.37

Figure 10-11.—Main condenser circulating pump (showing reduction gearing).

PROPELLER PUMPS

Propeller pumps are used on some ships as circulating water pumps (fig. 10-11). Although they are often classified as centrifugal pumps, this classification is incorrect because propeller pumps do not actually use centrifugal force for their operation.

A propeller pump has a propeller closely fitted into a tubelike casing. The propeller pumps the liquid by pushing it in a direction parallel to the shaft.

Propeller pumps must be located either below or only slightly above the surface of the liquid to be pumped, since they cannot operate with a high suction lift.

JET PUMPS

All the pumps previously described require motors or turbines to drive them. However, jet pumps have no moving parts. The flow through the pump is maintained by a jet of water or steam that passes through a nozzle at a high velocity.

Jet pumps are generally classified as EJECTORS (which use a jet of steam to entrain, and transport air, water, or other fluid) and EDUCTORS (which use a flow of water to entrain and pump fluids.) The basic principles of operation of these two devices are identical.

A simple jet pump of the ejector type is shown in figure 10-12. In this pump, steam under pressure enters the chamber (C) through a pipe (A) which is fitted with a venturi-shaped nozzle (B) having a reduced area which increases the velocity of the steam. The fluid in the chamber at point F, in front of the nozzle, is driven out of the pump through the discharge line (E) by the force of the steam jet. The size of the discharge line increases gradually beyond the chamber, in order to decrease the velocity of the discharge. As the steam jet forces some of the fluid from the chamber into the discharge line. pressure in the chamber is lowered and the pressure on the surface of the supply fluid forces the fluid up through the inlet (D) into the chamber and out through the discharge line. Thus, pumping action is established.

Jet pumps of the ejector type are occasionally used on board ship to pump small quantities of drainage overboard. Their primary use on naval ships is to remove air and other noncondensable gases from the main and auxiliary condensers.

Figure 10-13 shows a portable eductor of the type found in damage control lockers. The principle of operation is the same as that described for the ejector type of jet pump; but water is used instead of steam. All the water which enters the large end of the jet must go out through the small end. Since the exit end is smaller than the entrance end, the water leaving the jet will have a greater velocity than it had upon entering the jet. The venturi-shape of the diverging nozzles causes a low pressure area, creating suction which draws water through the strainer and entrains it through the diverging nozzle. This ensures a constant flow.

Eductors may also be used for salvage work and with fog or foam equipment. Eductors will operate when entirely submerged in a flooded compartment and will discharge against a moderate pressure.

Although fire and bilge pumps are still being installed in new ships, fixed-type eductors are the principal means of pumping water overboard through the drainage system. By the use of eductors, centrifugal fire pumps can serve as drainage pumps without having to run the risk of fouling the pump with debris present in the bilges; this is especially useful when there has been battle damage to a ship.

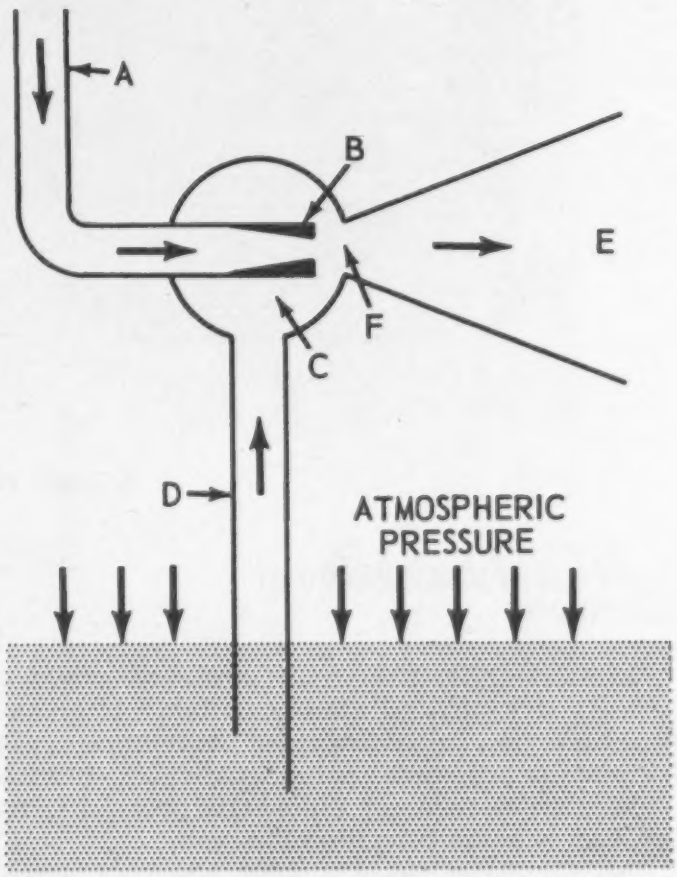

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Figure 10-12.—Jet pump (ejector type).

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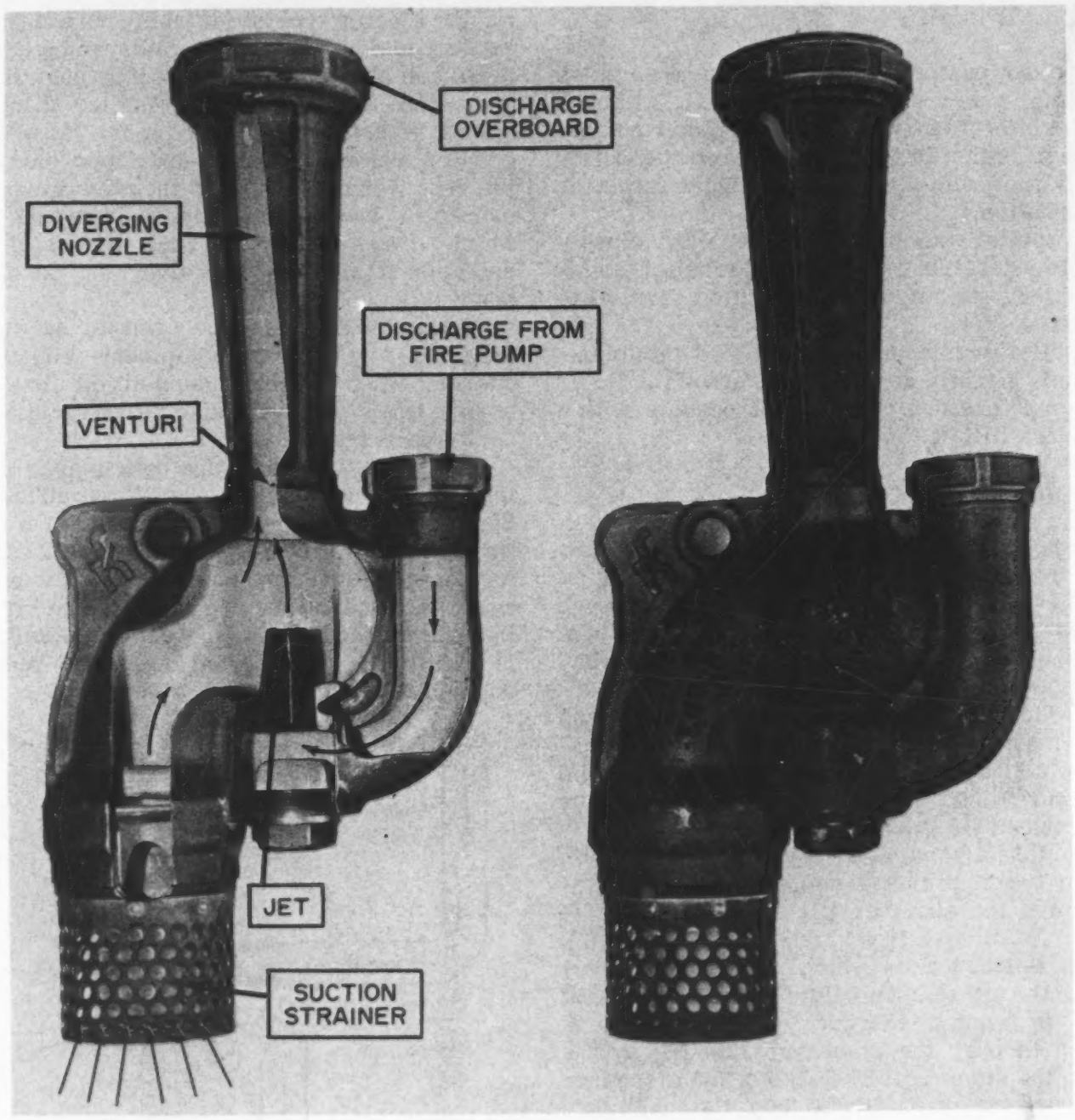

Figure 10-13.—Eductor.

47.48

CONSTANT-PRESSURE PUMP GOVERNORS

Constant-pressure pump governors used in the Navy are applied almost entirely to steam-driven pumps, both rotary and centrifugal types. A constant-pressure pump governor operates to maintain a constant discharge pressure, regardless of pump capacity or output.

The constant-pressure pump governor (sometimes referred to as pressure regulating) consists essentially of an automatic throttling valve installed in the steam supply line to the pump's driving unit. A pipeline connects the governor to the pump's discharge line. Variations in discharge pressure, or in pressure differential, actuate the governor, causing it to regulate the pump speed by varying the flow of steam to the driving unit.

A constant-pressure pump governor for a lubricating oil service pump is shown in figure 10-14. The governors used on fuel oil service pumps and on main feed pumps are of the same type. The size of the upper diaphragm and the

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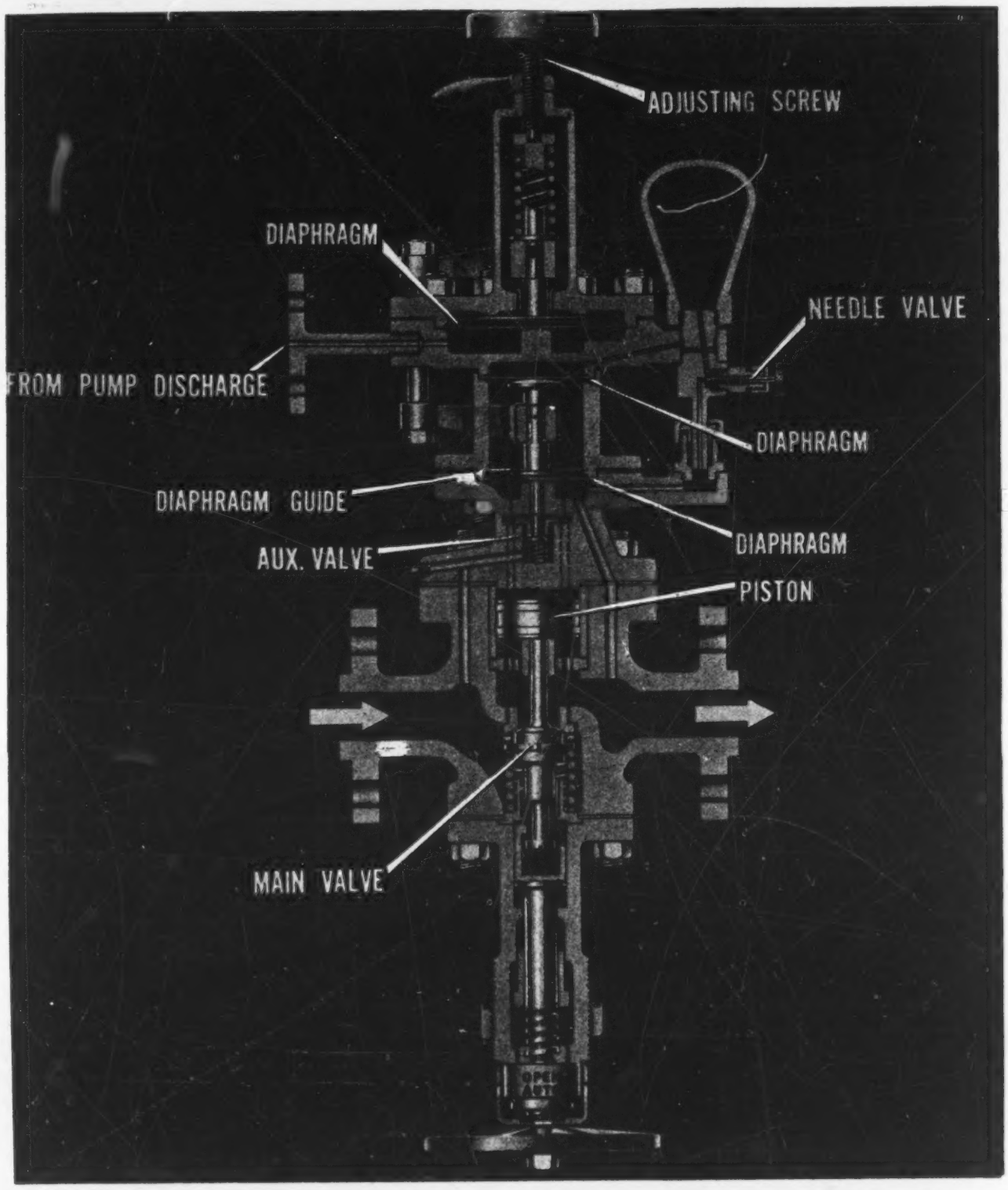

38.90

Figure 10-14.—Constant-pressure pump governor.

amount of spring tension vary on governors used for different services. Detailed information concerning the operation and adjustment of governors can be obtained from chapter 9470 (47) of BuShips Technical Manual.

VALVES

Most of the equipment in the engineering spaces is operated by either opening or closing the valves. A valve is a device for stopping and

controlling the flow of a fluid (liquid or gas) through a pipe or an opening. Valves are installed in every piping system aboard ship. You will find them in the fuel line, the feed water pipes, and the steam lines. In addition to the large valves which control the flow of fluid in the lines, there are small valves which pipe the flow around the larger ones. These valves are called by-pass valves, and are used to equalize the pressures.

Valve designs vary greatly to meet service demands. Most valves may be classified as being either stop valves (globe, gate, plug, piston, and needle valves) or check valves, or combination stop-check valves.

STOP VALVES

Stop valves are used to close off a pipe or opening so that the contained fluid cannot pass through. Some valves can be closed partially to cut down or regulate the flow of fluid.

The typical stop valve consists of the body, an opening (port) through which the fluid flows, a movable disk for closing this port, and some mechanical means for raising and lowering the disk. In the closed position, the disk fits snugly into the port, closing it completely. When the valve is open, the disk uncovers the port, allowing the fluid to pass through. Each type of stop valve has a different mechanical arrangement for closing the port in the valve.

Globe Valves

Globe valves generally derive their name from their body shape. (Other types of valves may also have globular bodies; hence, the name may tend to be misleading.) A cross-sectional view of a globe stop valve is shown in figure 10-15. Globe valves are widely used throughout the engineering plant for a variety of services. These valves may be used partly open as well as fully open or fully closed, and are suitable for use as throttling valves.

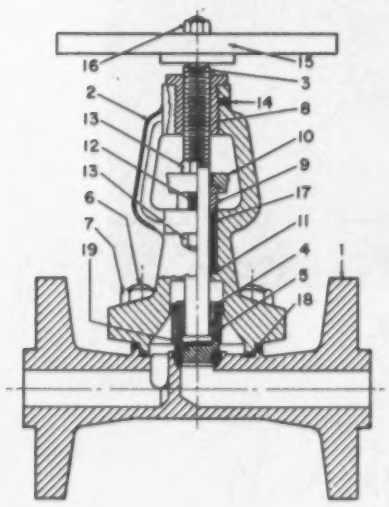

LIST OF PARTS	
PART NO.	NAME OF PART
1	VALVE BODY
2	BONNET
3	STEM
4	DISK NUT
5	DISK
6	BONNET STUD
7	BONNET STUD NUT
8	BONNET BUSHING
9	GLAND
10	GLAND FLANGE
11	PACKING STOP RING
12	GLAND STUD
13	GLAND STUD NUT
14	SET SCREW
15	HANDWHEEL
16	HANDWHEEL NUT
17	PACKING
18	BONNET GASKET
19	DISK WASHER

38.117

Figure 10-15.—Cross-sectional view of globe stop valve.

The moving parts of a globe valve consist of a disk, valve stem, and a handwheel. The stem, which connects the handwheel and the disk, is threaded and fits into threads in the valve bonnet. When you turn the handwheel the stem moves up or down in the bonnet, carrying the disk with it. The valve is closed by turning the handwheel clockwise.

The valve should never be jammed in the open position. After a valve has been fully opened, the handwheel should be turned toward the closed position one-half turn. Unless this is done, the handwheel is likely to freeze in the open position, and it will be difficult to close the valve. Many valves have been damaged in this manner. Another reason for not leaving globe valves fully open is that it is sometimes difficult to tell if a valve is open or closed. If a valve is jammed in the open position, the stem may be damaged or broken by someone who thinks that the valve is closed, and tries to force it open. Valves that are exceptions to the above rule are called BACK SEATING valves. Sometimes the operation of a back seating valve will require that it be fully opened. Whenever this is so, special instructions to that effect will be given. These valves are designed so that when fully open, the pressure being controlled cannot reach the valve stem packing, therefore eliminating possible leakage past the packing.

The edge of the port where the disk touches it is called the valve seat. The edge of the disk and the seat are machined and ground together to form a tight seal. The rate at which the fluid flows through the valve is regulated by the position of the disk. When the valve is closed, the disk fits firmly against the valve seat. When it is open, the fluid flows through the space between the edge of the disk and the seat.

Packing is placed in the stuffing box or space that surrounds the valve stem, and is held in place by a packing gland. With continued use of the valve, the stem will gradually wear the packing away and a leak may develop. You can generally stop a slow leak by tightening the gland a turn or two. If this fails, pressure should be removed from the valve, and the packing renewed.

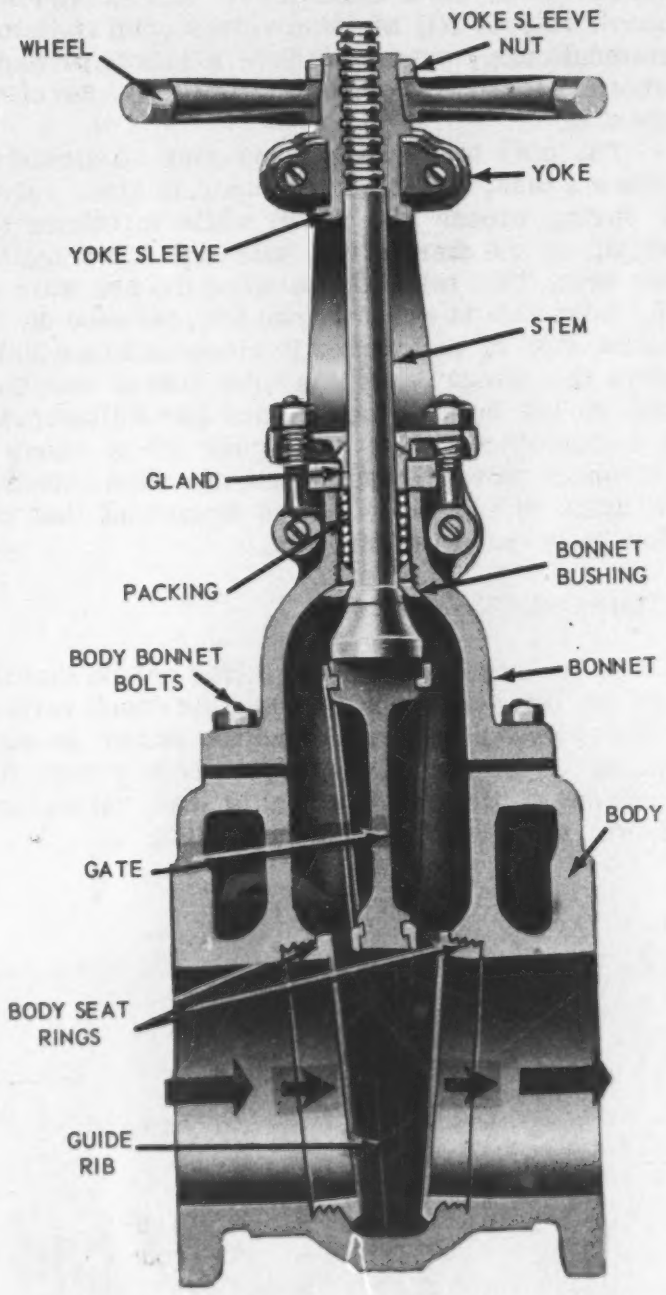

Figure 10-16.—Cutaway view of gate stop valve (rising stem type).

Gate Valves

Gate valves operate on the same principle as the globe valve, but have a gate (fig. 10-16) instead of a disk. The port is the full size of the pipe, and extends straight through the valve. The gate is connected to the valve stem and is raised and lowered by turning the handwheel. When the valve is in closed position, the wedge-shaped gate blocks off the port; in open position, the gate is drawn up into a recess in the top of the valve. (See fig. 10-16.)

Gate valves are used where a straight-line flow through the valve is desirable. They do not work well as throttles because they tend to chatter, and are therefore usually operated in the fully open or shut position. They are often used in water lines.

Plug Valves

Plug valves (sometimes referred to as plug cocks) are frequently used in gasoline and oil feed pipes as well as in water drain lines. The ordinary petcock is a good example of this valve.

The body of a plug valve (fig. 10-17) is shaped like a cylinder with holes or ports in the cylinder wall in line with the pipes in which the valve is mounted. Either a cone-shaped or a cylindrical plug, attached to the handle, fits snugly in the valve body. A hole bored through the plug is in line with the ports in the valve body. Turning the plug valve handle (which is in line with the hole in the plug) lines up the hole in the plug with the ports in the valve body, so fluid can pass through the valve. The flow can be stopped by turning the plug 90° (a quarter-turn) from the open position.

Some plug valves are designed as three-way or four-way selector valves. Three or more pipes are connected to a single valve in line with the same number of ports in the cylinder wall. Two or more holes drilled in the plug provide a variety of passages through the valve. When a valve of this kind is located in a fuel line, the liquid may be drawn from any one of two or three tanks be setting the handle in different positions.

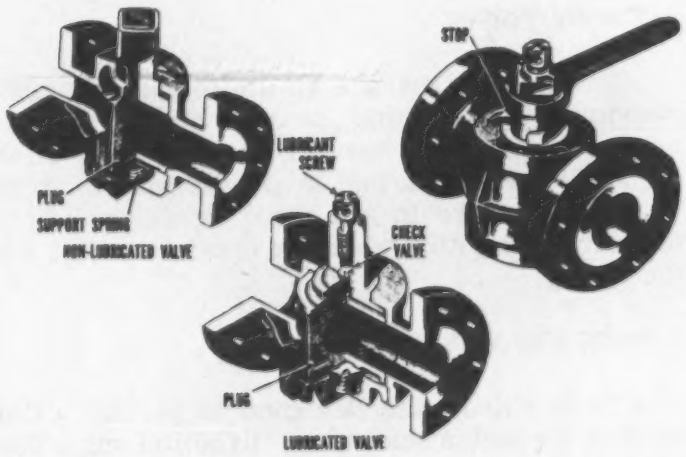

Figure 10-17.—Plug valves.

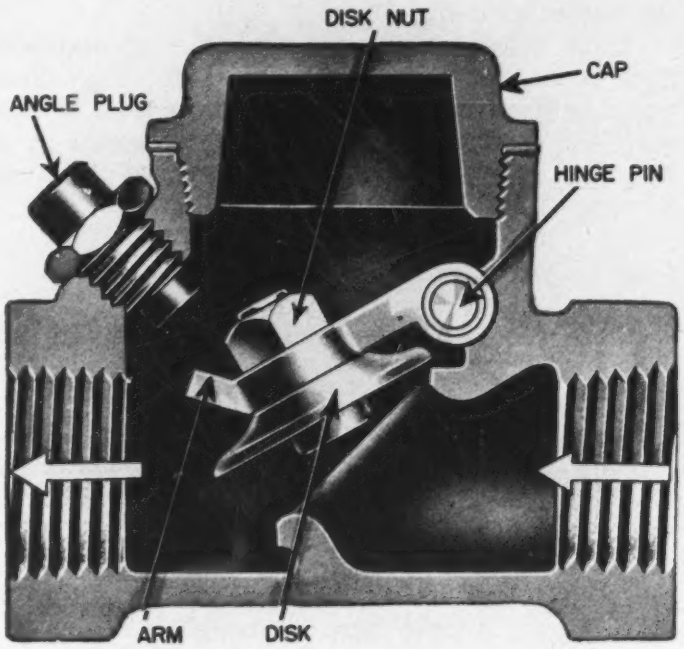

Figure 10-18.—Swing-check valve. 11.319X

Needle Valves

Needle valves are used for making relatively fine adjustments in the flow of fluid. A needle valve has a long tapered point at the end of the valve stem. This needle acts as a disk. Because of the long taper, part of the needle passes through the opening in the valve seat before the needle actually seats. This arrangement permits a very gradual increase or decrease in the size of the opening, and thus allows more precise control of flow than can be obtained with an ordinary globe valve.

Butterfly Valves

Butterfly valves are in limited use for liquid service only. The disk in this type valve is flat, and is operated by turning the hand lever on the stem. When the lever is positioned 90° to the piping, the valve is full open; the valve is in the full closed position when the lever is in line with the piping.

CHECK VALVES

Check valves are designed to permit a fluid to flow through a line in one direction only. They have many uses, both aboard ship and ashore. The air valves in automobile tires, the valves in an ordinary water pump, and the feed water check valves on a steam drum are examples of check valves. All of these valves open and close automatically, but some have a handle or handwheel to lock them closed or limit the size of the opening.

The port in a check valve may be closed by either a disk, a ball, or a plunger. In some valves a spring closes the valve, while in others the weight of the disk or ball holds the valve against the seat. The valve opens when the pressure on the inlet side is greater than the pressure on the outlet side of the valve. It closes automatically when the pressure on the inlet side is less than that on the outlet side. Figure 10-18 illustrates a swing-check valve and figure 10-19 shows a lift-check valve. These valves are often installed in drain lines, where it is important that the flow be in one direction only.

STOP-CHECK VALVES

As we have seen, most valves can be classified as being either stop valves or check valves. Some valves, however, function either as stop valves or as check valves, depending upon the position of the valve stem. These valves are known as STOP-CHECK VALVES.

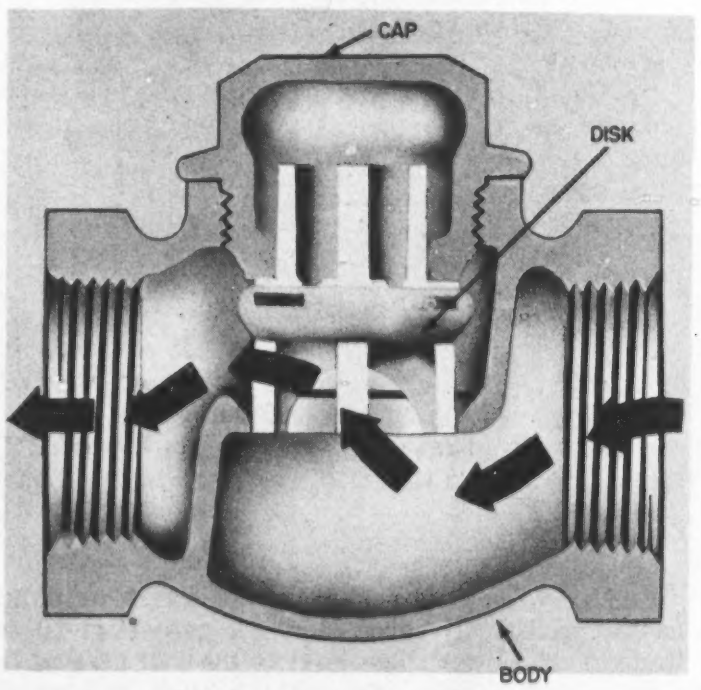

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Figure 10-19.—Cutaway view of lift-check valve.

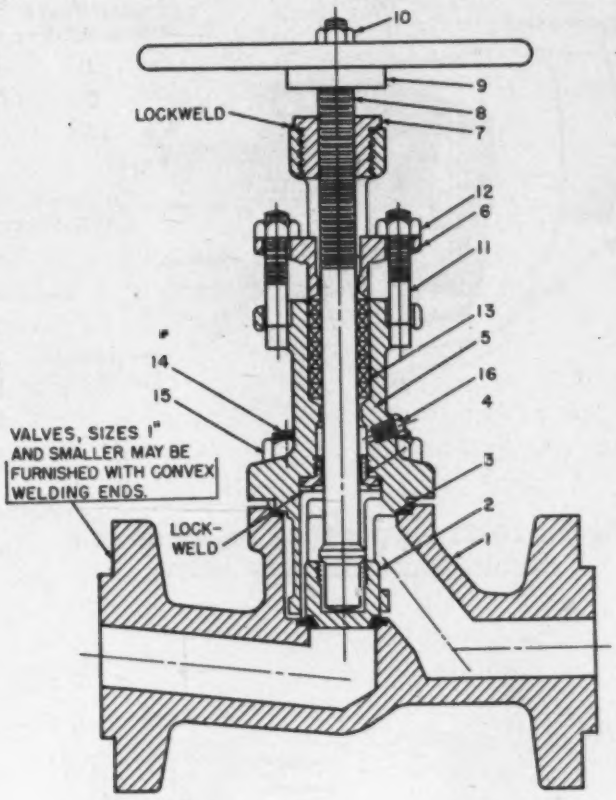

LIST OF PARTS	
PART NO.	NAME OF PARTS
1	BODY
2	DISK
3	GASKET
4	STEM BUSHING
5	BONNET
6	GLAND
7	YOKE BUSHING
8	STEM
9	HANDWHEEL
10	HANDWHEEL NUT
11	GLAND BOLT
12	GLAND BOLT NUT
13	PACKING
14	BONNET STUD
15	BONNET STUD NUT
16	RELIEF PLUG
17	SEAT RING
18	SPACER
19	GLAND FLANGE
20	YOKE BUSHING SET SCREW
21	JAMB NUT

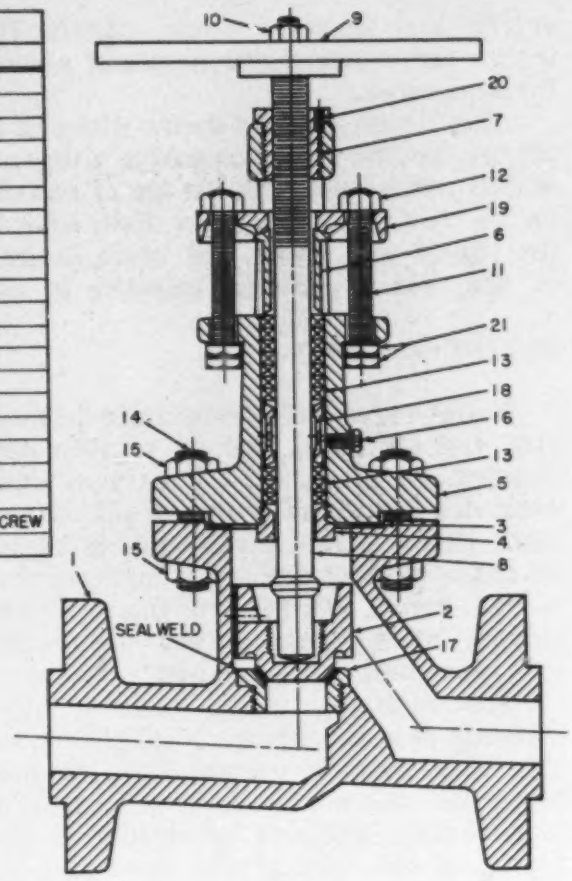

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Figure 10-20.—Stop-check valves.

Two similar stop-check valves are shown in cross section in figure 10-20. As you can see, this type of valve looks very much like a lift-check valve. However, the valve stem is long enough so that when it is screwed all the way doen it holds the disk firmly against the seat, thus preventing any flow of fluid. In this position, the valve acts as a stop valve. When the stem is raised, the disk can be opened by pressure on the inlet side. In this position, the valve acts as a check valve, allowing the flow of fluid in only one direction. The MAXIMUM lift of the disk is controlled by the position of the valve stem. Therefore, the position of the valve stem can limit the amount of fluid passing through the valve even when the valve is operating as a check valve.

Stop-check valves are used in various locations throughout the engineering plant. Perhaps the most familiar example is the so called boiler feed check valve, which is actually a stop-check valve rather than a true check valve. Stop-check valves are used in many drain lines; on the discharge side of many pumps; and as exhaust steam valves on auxiliary machinery.

THROTTLE VALVES

A throttle valve is installed in the MAIN STEAM LINE just ahead of the engine. It is operated by a handwheel and can be opened or closed quickly for starting and stopping. These valves can also be set in any in-between position to regulate the speed of the engine. Unlike check valves, they are installed so that the steam pressure tends to close rather than open them.

The pressure in the main steam lines of some installations is 600 psi. The disk of a throttle valve 6 inches across has an area of about 28 square inches. Therefore, the force exerted on the valve disk tending to keep it closed is 16,800 pounds (600 x 28). Throttle valves are designed to equalize this force, so that they can be opened easily.

A double-poppet throttle valve is two valves in one. It has two ports and two disks attached to a single stem. Both valves open or close at the same time when the handwheel is turned. The ports and the disks are designed in such a way that the steam tends to close one of the disk

valves and open the other. Figure 10-21 illustrates the operating principle of a double-poppet throttle valve.

The forces exerted on the disks of the double-poppet throttle valve resemble a tug-of-war. The steam pushes down on the top of one disk, and up on the bottom of the other disk. Like the rope in the tug-of-war game, the stem keeps the disks in the same position relative to each other.

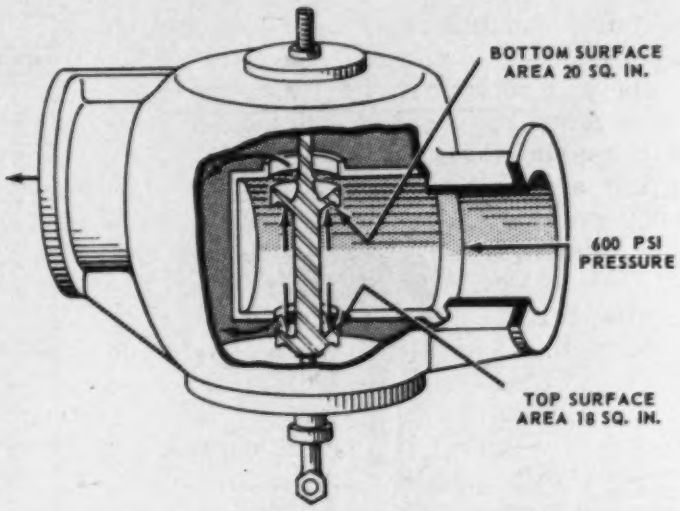

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Figure 10-21.—Operating principle of a double-poppet throttle valve.

RELIEF VALVES

Relief valves are installed in the steam, water, air, and oil lines, and on various units of machinery aboard ship. They open automatically when the pressure within the line becomes too high. Relief valves protect piping much the same as fuses protect electrical equipment and wiring in the home. There are many types of relief valves; most relief valves have either a disk or a steel ball acting against a coil spring.

The disktype relief valve in figure 10-22 consists of a valve body, a valve disk, and a stem. The steel spring pushes down on the disk and keeps the valve closed. The force of the spring is generally adjusted by setting an adjusting nut on top of the spring. The inlet side of the valve is connected to the system to be protected.

When the force on the bottom of the disk, exerted by the pressure of the fluid in the line, becomes greater than the compression of the spring, the disk is pushed off the seat, opening the valve. The valve outlet may be opened to the atmosphere in compressed air or steam lines. When the valve is used to protect a pump, its outlet is connected to the suction line leading to the pump; the excess fluid passes through the relief valve, and back to the inlet side of the pump.

The ball-type relief valve shown in figure 10-22 operates on the same principle as the disk valve. The ball valve is generally used on lube oil lines. The operating pressure is regulated by adjusting the threaded plug (not illustrated) which holds the spring in place.

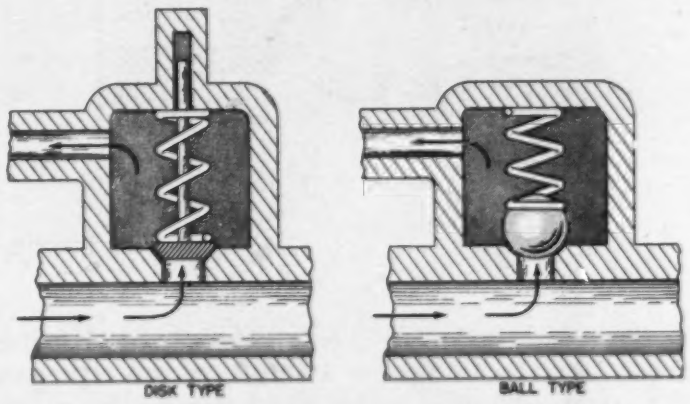

Figure 10-22.—Relief valves.

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REDUCING VALVES

The heating system and the galley operate on low pressure steam. The source of steam for these systems is the boilers, which are under high pressures. Reducing valves are installed in the steam lines to these systems to reduce the pressure. These valves will hold a constant pressure in the delivery lines even if the boiler pressure varies over a wide range.

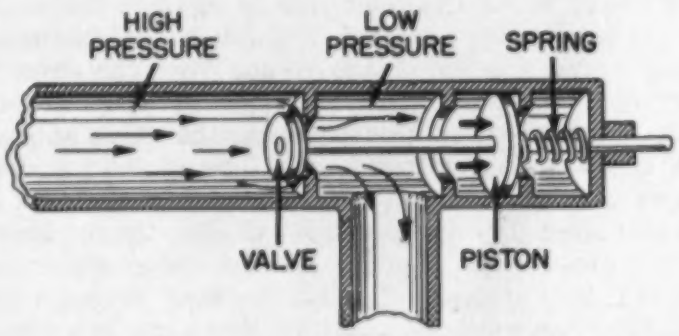

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Figure 10-23.—The operating principle of a simple reducing valve.

Most reducing valves depend on a balance between the outlet or operating pressure and the pressure of a spring or compressed air in a sealed chamber. Although some of these valves

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are quite complicated, the principle on which they operate is easily understood.

The simplified reducing valve in figure 10-23 has a main valve, a piston, and a spring. The compression of the spring pushes the piston to the left and opens the valve. When the steam is turned on, it passes through the open valve and builds up pressure in the outlet chamber. When the force exerted on the piston becomes greater than the force exerted by the spring, the piston moves to the right and closes the valve.

During operation, the outlet steam pressure and spring force remain in ballance with the valve partly open. Any slight variation in outlet pressure will upset this balance. The piston will move and increase or decrease the size of the valve opening and restore the original outlet pressure.

In some valves the spring is replaced by a sealed chamber containing compressed air. The air pressure acts on a diaphragm instead of on a piston. The valve can be set to maintain any desired pressure by adjusting the air pressure in the sealed chamber. Sometimes the diaphragm is located between two chambers, one of them opened to the inlet and the other to the outlet steam. The action of the diaphragm operates a valve which in turn regulates the steam pressure on a piston connected to the main valve. In all reducing valves, the outlet pressure is used to control the rate at which the inlet steam is permitted to pass through the valve.

SAFETY VALVES

Each boiler is fitted with safety valves which allow steam to escape from the boiler when the pressure rises above specified limits. The capacity of the safety valves installed on a boiler must be great enough to reduce the steam drum pressure to a specified safe point when the boiler is being operated at a maximum firing rate with all steam stop valves completely closed. Safety valves are installed on the steam drum and at the superheater outlet.

Several different types of safety valves are used on naval boilers, but all are designed to open completely (POP) when a specified pressure is reached and to remain open until a specified pressure drop (BLOWDOWN) has occurred. Safety valves must close tightly, without chattering, and must remain tightly closed after seating.

It is important to understand the difference between boiler safety valves and ordinary relief valves. The amount of pressure required to lift a relief valve increases as the valve lifts, since the resistance of the spring increases in proportion to the amount of compression. Therefore a relief valve opens slightly at a specified pressure, discharges a small amount of fluid, and closes at a lower pressure which is very close to the pressure that caused it to open.

Can you see why relief valves would not do for boilers? If the valves were set to lift at anything close to boiler pressure, the valves would be constantly opening and closing, pounding the seats and disks and causing early failure of the valves. Furthermore, relief valves would not rapidly discharge the large amount of steam that must be discharged quickly to bring the boiler pressure down to a safe point, since the relief valves would reseat very soon after they opened. (Fig. 10-24 shows a typical safety valve.)

PIPING

Piping is used throughout the engineering spaces. One piping system carries the fuel from the service tanks to the furnace. A second piping system supplies the boiler with feed water. A third piping system carries the steam from the boiler to the engines and other points where it is needed. Still other systems are used aboard ship to carry salt water, fresh water, gasoline, compressed air, and certain gases. The nature of the substances carried in the pipes, as well as the nature of the services performed, makes it necessary to use a variety of materials, sizes, and designs of piping and attached fittings.

PIPING DEFINITIONS

In routine operations aboard ship there is frequent misuse of the terms PIPE, TUBING, and PIPING by strikers and inexperienced naval personnel. As a step toward correcting the misuse of these three terms, the following definitions are offered.

1. A pipe is made of metal such as cast iron, wrought iron, steel, copper, or brass and designated for size by its nominal inside diameter (ID) in accordance with standard IRON PIPE SIZE (IPS), expressed in inches or fractions of an inch from 1/8 inch to 12 inches. Pipe is designated in three grades or weights of wall thickness as STANDARD, EXTRA STRONG, or DOUBLE EXTRA STRONG. The outside diameters (OD) are the same for each of the three wall thicknesses of any pipe with a given IPS dimension, while the actual ID of these three pipes will differ. When the ID measures more than 12 inches, the pipe is designated by its OD.

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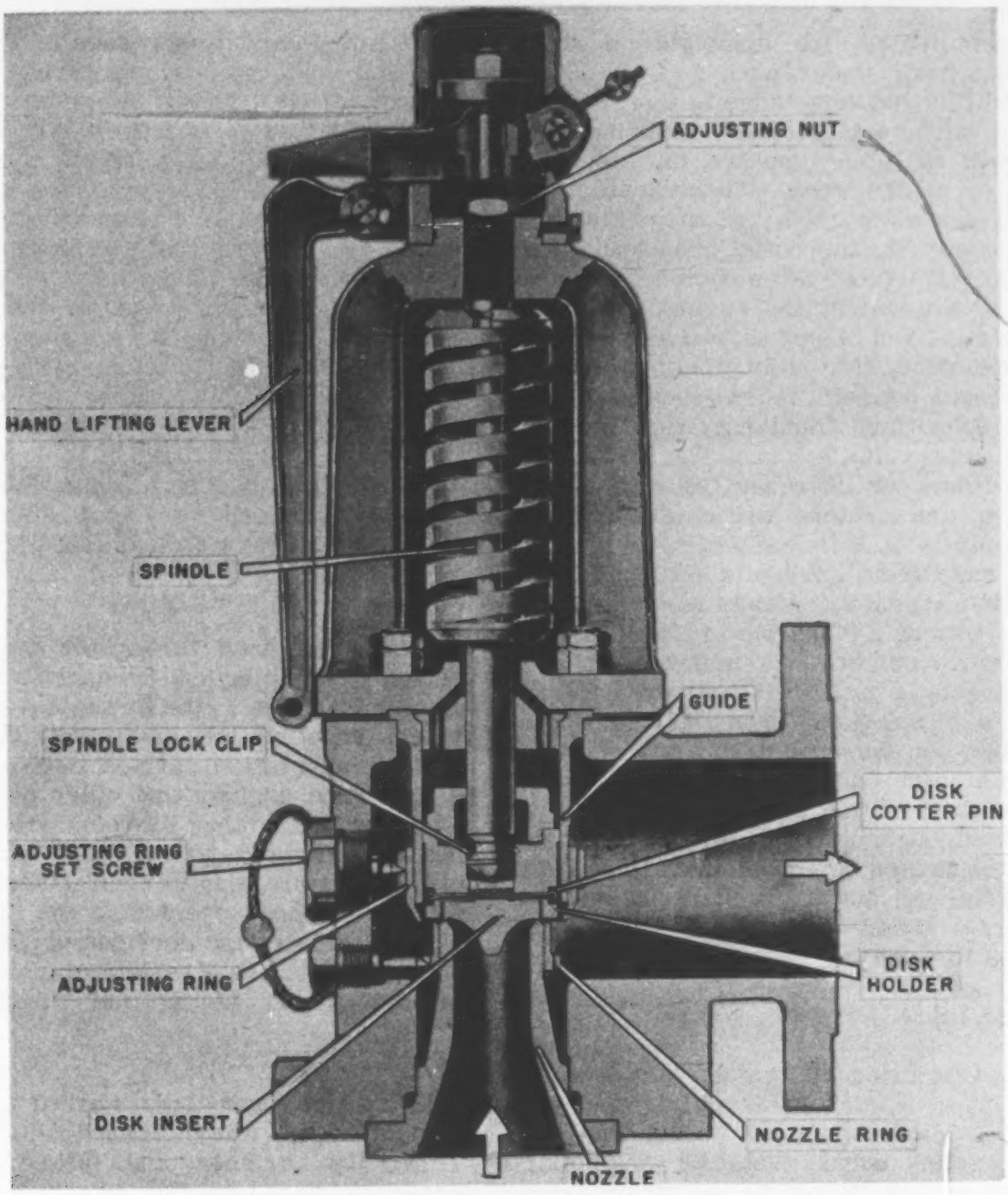

Figure 10-24.—Steam drum safety valve (nozzle reaction type). 29.219

For example, a 1-inch standard pipe will have an ID slightly over 1 inch, while 1-inch extra stong and 1-inch double extra strong pipes will have lesser ID's due to their greater wall thicknesses. The identical OD's permit standardization in pipe dies and taps.

2. TUBING, unlike pipe, is designated for size by its nominal OD dimension; specified for wall thickness in decimals of an inch; and joined by such methods as flanging, welding, soldering, or brazing. Because it has thinner walls, tubing is much more flexible than the thicker-walled pipe. Refrigeration piping systems are examples of shipboard use of tubing.

3. PIPING is an assembly of pipes or tubing, and fittings, forming a whole or composite part of a system designed for transferring fluids (water, steam, gas, and oil).

PIPING MATERIALS

Most of the piping systems aboard ship are made of steel, copper, brass, or a copper-nickel alloy. Steel is used for the steam and fuel oil lines. Copper tubing may be used for piping that carries fresh water, lube oil, and other materials. Nickel-alloy tubing has exceptional resistance to corrosion, and is used where resistance to

9457

corrosion, is an important consideration, such as in salt water and fresh water lines.

You will often hear the term "alloy" used in connection with the various kinds of metals. A metal is said to be an alloy when it contains other metals in addition to the principal one. A chrome-nickel-steel alloy is made by adding chromium and nickel to the molten steel while it is being manufactured. Stainless steel used aboard ship is a steel alloy that contains chromium and nickel. The alloys of steel, aluminum, and copper are widely used throughout the Navy.

The piping materials MUST be carefully selected from specified standards approved by BuShips—not according to appearance. For example, the 7-inch steel tubing employed for transferring 400 psi, 650°F steam may look the same to you as the 7-inch steel tubing employed for transferring 600 psi, 850°F steam. But the material of the first may be carbon steel; whereas that of the second MUST be molybdenum alloy steel, capable of resisting high temperature and pressure.

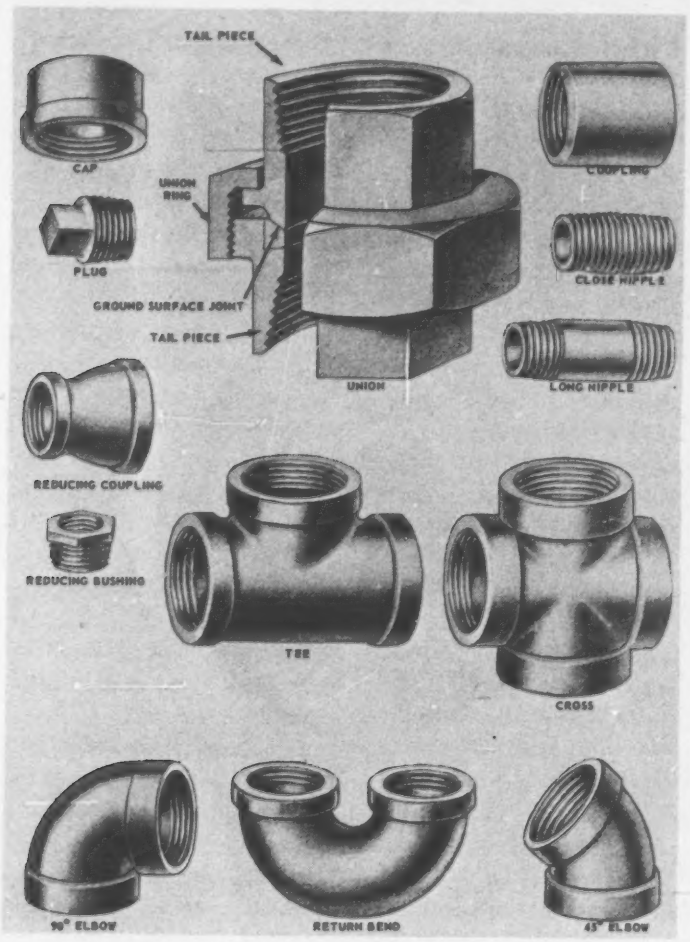

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Figure 10-25.—Standard threaded pipe fittings.

PIPE FITTINGS

A piping system can be made up by joining individual lengths of pipe with unions, couplings, elbows, or other threaded fittings. Piping systems may also be made up by bolted flanges, welding soldering, or by flared couplings.

The water pipes in a home, and some of the low pressure pipes on a ship, are fastened together by THREADED fittings. Standard threaded pipe fittings are shown in figure 10-25.

In high pressure steam lines the lengths of steel pipe are welded together into sections. A flange is welded to the ends of the sections. A suitable gasket is inserted between flanges, and they are drawn tightly together by stud bolts that pass through the holes in the outer edges of the connection. (See fig. 10-26.) Tubing is usually connected by flared couplings (fig. 10-27) or by soldering.

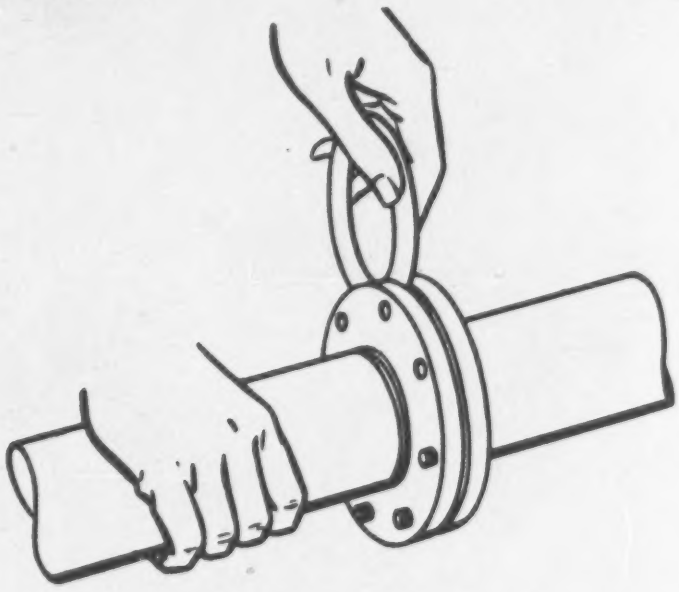

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Figure 10-26.—Gasket insertion.

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Figure 10-27.—Tee for flared tubing.

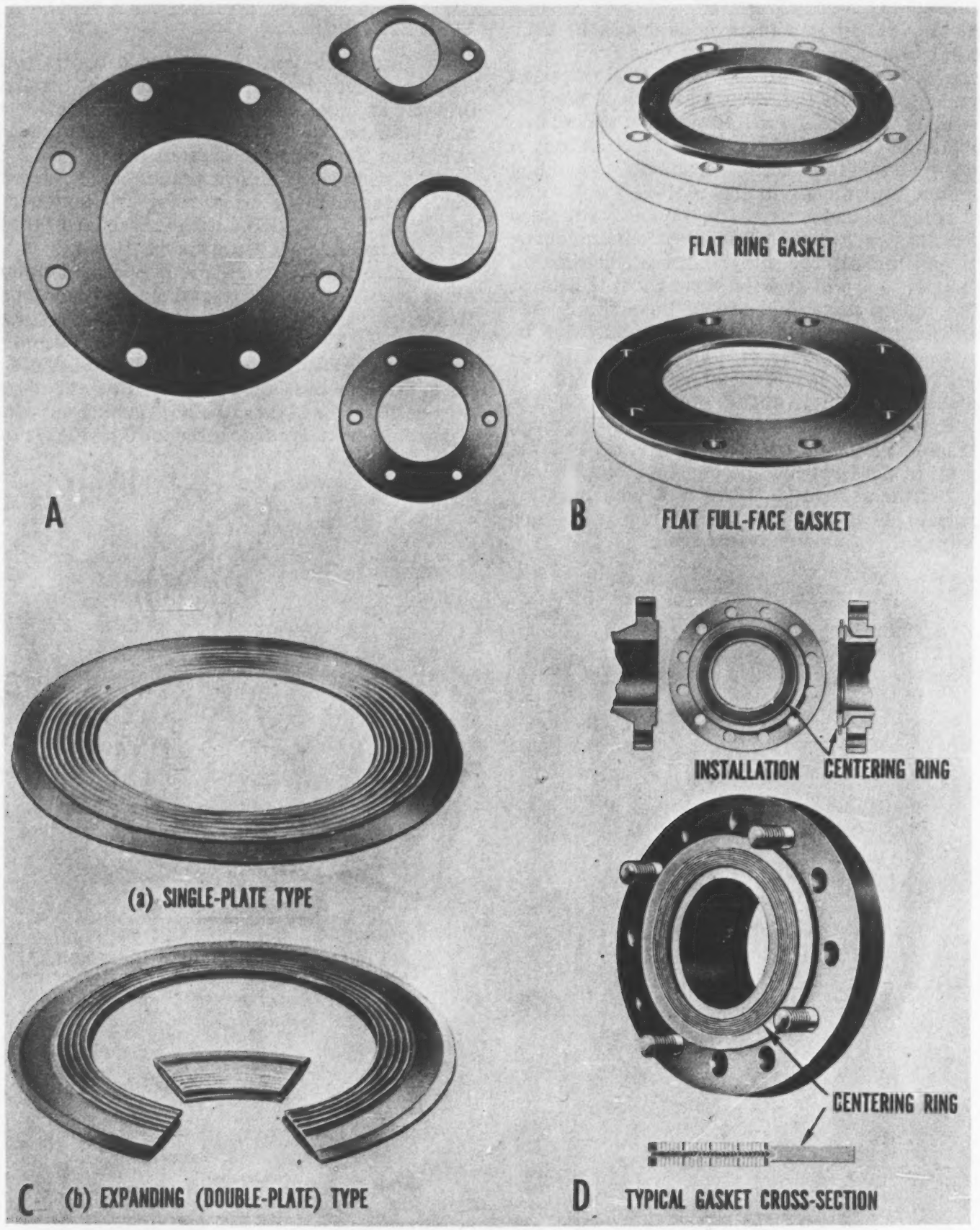

Figure 10-28.—Fixed joint gaskets: A. Sheet asbestos gaskets. B. Plain-faced metal gaskets. C. Serrated-faced metal gaskets. D. Spiral-wound, metal asbestos gaskets. 28.36X

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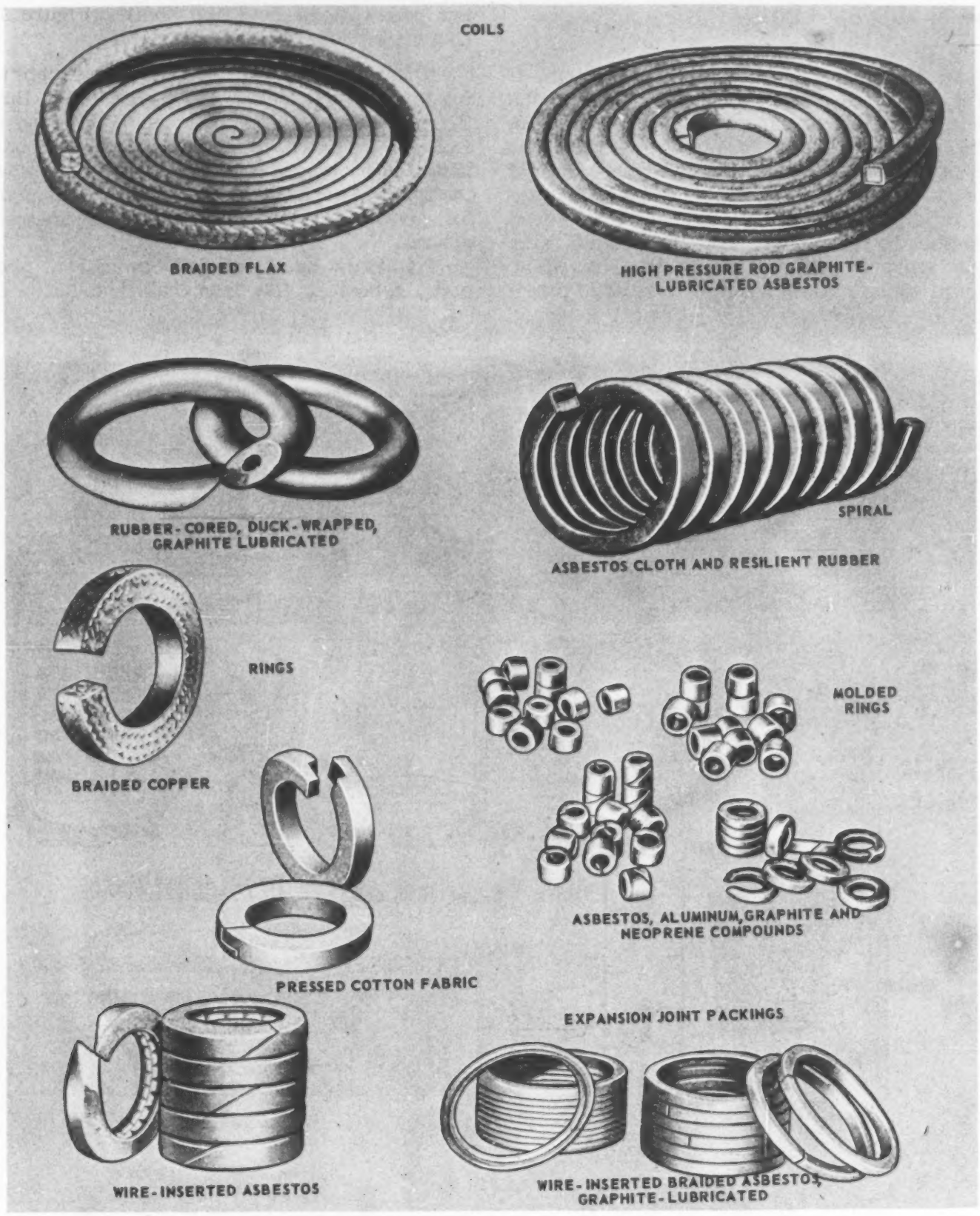

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Figure 10-29.—Types of packing.

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GASKETS AND PACKING

When leakage occurs in a piping system, it usually occurs at one of the joints. Many methods and materials are used to keep joints from leaking. Flanged joints in piping systems are made up with gaskets in order to make a tight seal and thus prevent leakage. (When the coupling is tightened, the gasket is compressed and seals the joints.) Figure 10-28 illustrates various types of gaskets. Connections in which there are sliding or rotating parts require packing material to seal the joints. Figure 10-29 illustrates several kinds of packing.

It is important that the proper gasket or packing material be used in each application. BuShips Technical Manual, chapter 9950 (95), and other BuShips publications contain information on gaskets and packings. On board ship, tables showing the types of gasket and packing materials approved for various services are posted in the engineering spaces.

Materials used for gaskets include pressed cork, asbestos, soft iron, Monel, metallic cloth,

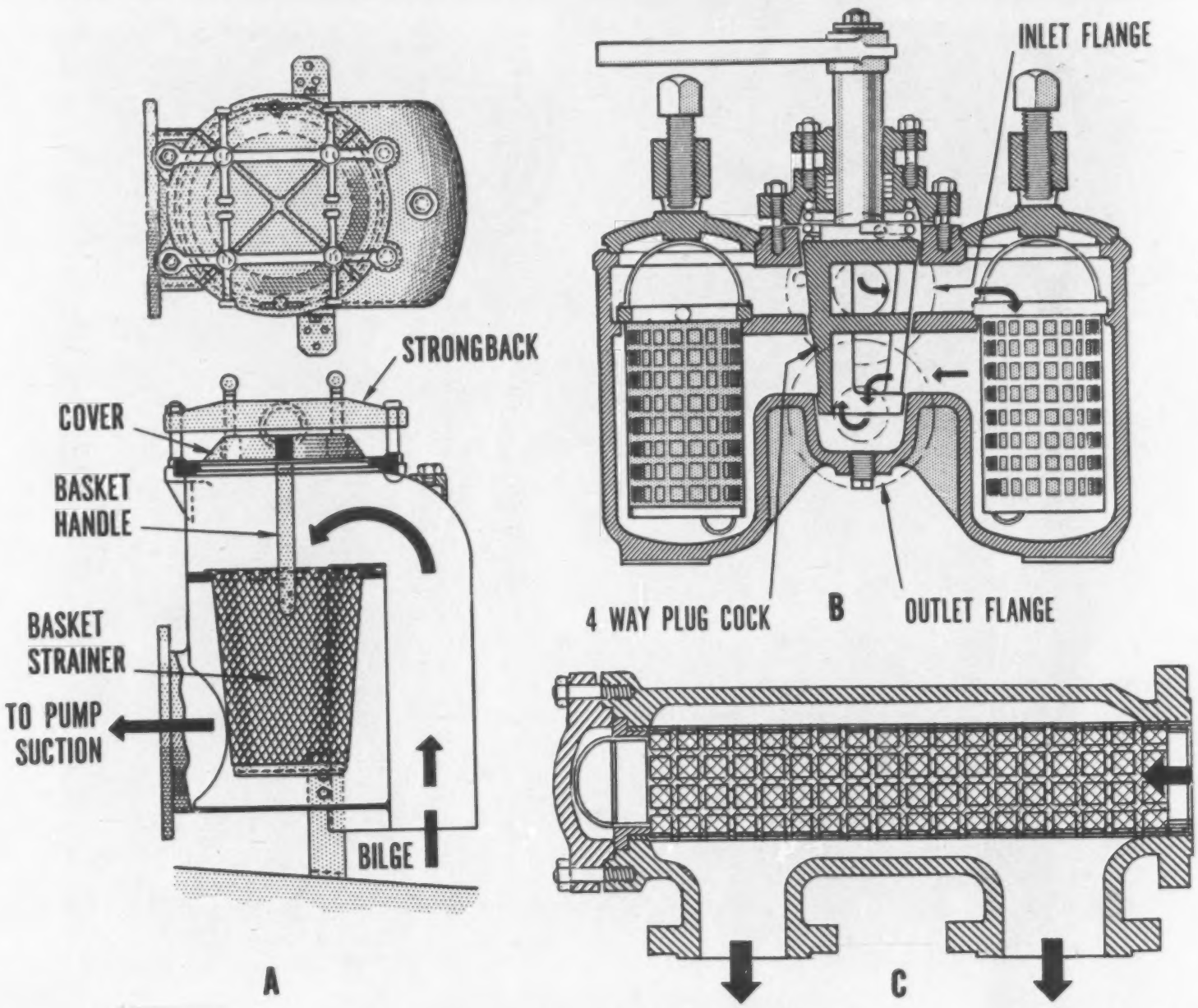

Figure 10-30.—A. Bilge suction strainer. B. Duplex oil strainer. C. Manifold steam strainer.

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and hard fiber sheets. The type of gasket to be used depends upon the pressures and temperatures to which it will be subjected, and in some cases on the nature of the fluid being carried in the piping system.

Packing is used to seal the joints around revolving shafts and valve stems. These units are designed with a space which surrounds the shaft or stem, called a stuffing box. When the packing has been placed in the stuffing box, it is compressed by tightening a gland or nut that screws up against it. Such an arrangement can be seen when taking an ordinary water faucet apart. The packing serves to keep the water from flowing up around the valve stem.

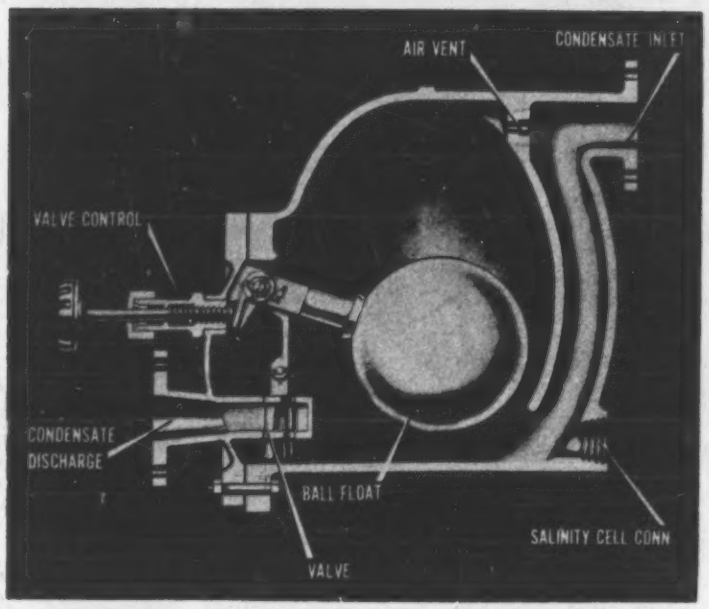

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Figure 10-31.—A mechanical steam trap.

Packing materials in common use include woven asbestos and rubber; anti-friction metal woven with cotton thread and graphite; spun yarn; and soft metal, flax, and rayon combinations. The type of packing to be used depends upon the service requirements.

STRAINERS

Strainers are installed in almost all piping lines to prevent the passage of foreign matter which might cause damage to machinery. For example, wire mesh basket-strainers are installed on the suction side of many pumps; steam strainers (part C of fig. 10-30) are installed in main and auxiliary steam lines (just ahead of most auxiliary turbines); and duplex strainers (part B of fig. 10-30) are fitted into most lubricating oil and fuel lines so that one strainer may be removed and cleaned without disturbing the flow of oil. A bilge suction strainer is shown in part A of figure 10-30. As you can see, the basket strainer keeps foreign matter from going to the bilge pump suction.

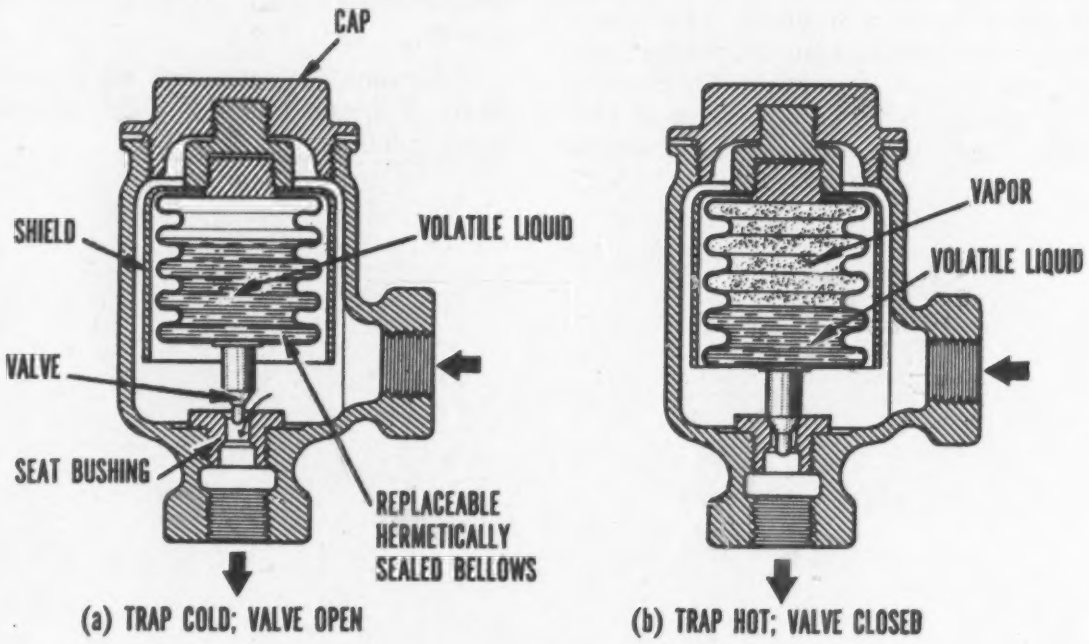

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Figure 10-32.—Thermostatic steam trap.

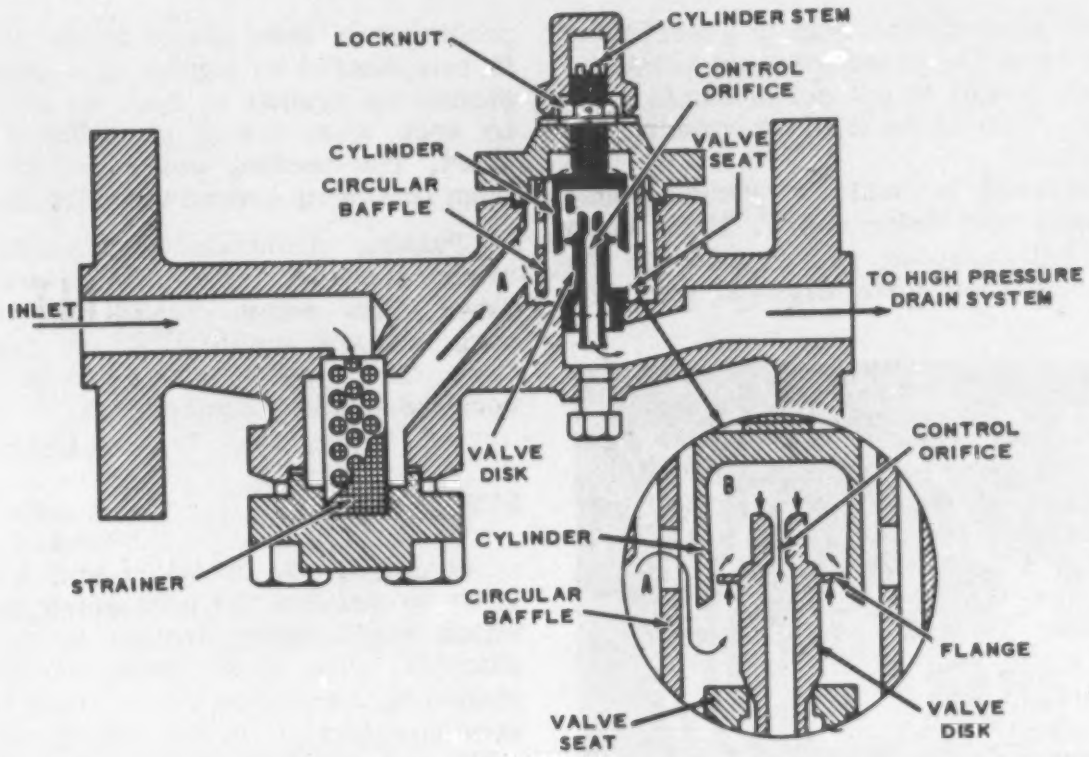

Figure 10-33.—Impulse steam trap.

STEAM TRAPS AND DRAINS

Steam traps are installed in steam lines to remove condensate. Some steam traps are suitable for high pressure use, and others for low pressure use. In general, a steam trap consists of a valve and some device or arrangement which will cause the valve to open or close, when necessary, to drain the condensate from the line without allowing the escape of steam. Steam traps are installed at the low point of a system or below a machinery unit that has to be drained. Drains are used to remove condensate while steam lines and steam-driven machinery are being warmed up. A drain usually consists of a section of piping and one or more valves.

There are several types of steam traps in use on naval ships: mechanical (fig. 10-31), thermostatic (fig. 10-32), and impulse (fig. 10-33).

Additional information on steam traps can be obtained from chapter 9480 (48) of the Bureau of Ships Technical Manual.

CHAPTER 11

SHIPBOARD ELECTRICAL EQUIPMENT

On modern naval ships, much auxiliary machinery and equipment is run by electricity. Regardless of rate or rating, every man assigned to a ship will operate some electric device in performing his duties. As a Fireman, you will probably use or operate portable lights, electric drills and grinders, electric heaters, ventilation blowers and fans, electric-driven pumps, and other electrical equipment. Therefore, you should know and observe all applicable safety precautions when working with or around electrical appliances and equipment.

It is beyond the scope of this training course to discuss the theories of basic electricity in detail. This chapter contains information to familiarize you with the different electrical equipment aboard ship, and with what the equipment is designed to do.

Additional information on the basic principles of electricity may be obtained in the Navy training course Basic Electricity, NavPers 10086-A.

INTRODUCTION TO ELECTRICITY

The various techniques and equipment developed from applying the principles of electricity require some degree of theoretical knowledge, as well as practical experience and skill, for safe operation.

Electric cable carries the electric energy produced by the generators to the electric motors where it is expended in performing work.

All materials will conduct electricity but some of them offer more resistance than others. Metals such as silver, copper, aluminum, and iron offer little resistance and are called CONDUCTORS.

In contrast to good conductors, some substances, such as wood, paper, porcelain, rubber, mica, and plastics offer a high resistance to an electric current and are known as INSULATORS. Electric circuits throughout the ship are made up of copper wires covered with rubber or some other insulator. The wire offers little resistance to the current while the insulation keeps the current from passing to the steel structure of the ship.

Definite units have been established to measure electrical properties of conductors and characteristics of electric currents. A brief review of these fundamentals of electricity is given in the sections which follow.

ELECTRIC CURRENT

Current is the rate at which electricity flows through a conductor or circuit. The practical unit, called the AMPERE, specifies the rate at which the electric current is flowing. The term AMPERE (I) is a measure of the intensity or the number of electrons passing a point in a circuit each second. (The flow of current can be compared to the flow of water through a pipe.)

ELECTROMOTIVE FORCE

Before an electric current can flow through a wire there must be a source of electric "pressure" just as there must be a pump to build up water pressure before the water will flow through a pipe. This electric pressure (E) is known as ELECTROMOTIVE FORCE (emf) or VOLTAGE (v); the source may be GENERATOR or a BATTERY.

If you increase the pressure on the electrons in the conductor, a greater current will flow, just as an increased pressure on water in a pipe will increase the flow.

RESISTANCE

Electrical resistance is that quality of an electric circuit that opposes the flow of current through it. The unit of resistance, known as the OHM, is usually expressed as R.

WATT

Power (P) is the rate of doing work. In a direct-current (d-c) circuit, power is equal to

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the product of current times voltage, or P = E x I. The practical unit of power is the WATT or KILOWATT (WATTS x 1000).

GENERATOR TYPES AND DRIVES

The generator is the heart of the ship's electrical system. On board any ship, a large amount of electricity is required for the proper provision of air, water, and food. Communications between the various parts of a ship depend largely upon the availability of electric current to operate the ship's announcing system. Radio, radar, and lighting systems, and the training and firing of guns depend upon electricity.

Since a generator runs at greatest efficiency when generating or producing its full rated current output, it is not practicable to have one large generator frequently running at part load. Therefore, two to eight small generators are installed aboard ship, depending upon the specific type ship.

Another reason for installing two or more generators aboard ship is to ensure that, in the event of damage to a generator, there will be enough power and lights available until the defective generator has been repaired. In addition, generators are installed throughout the engineering spaces of a ship so that the electrical plant cannot be destroyed by one or two enemy shells or bomb hits.

Alternating current (a-c) is used aboard the Navy's comtatant ships. The advantages of a-c installations are lower cost, smaller units, and less maintenance. Direct-current (d-c) generators are found on cargo ships, and personnel transports. The d-c motors may be run at variable speeds and are used to run the ship's winches.

D-C GENERATORS AND EXCITERS

A d-c generator is a rotating machine that changes mechanical energy to electrical energy. The essential parts of a d-c generator are the yoke and field windings, which are stationary, and the armature which rotates. In a-c generators, called alternators, the field rotates and the armature is stationary. In order to avoid confusion, the rotating members of d-c generators are called armatures and in a-c generators they are called ROTORS.

There is no difference between d-c generators and exciters. The exciter is a d-c generator which supplies direct current for an a-c generator. In the past, d-c ship's service generators were used aboard ship. At present, practically all ships have 450-volt (60 cycle) a-c ship's service and emergency generators. The d-c generators used in Navy installations for ship's service, or for exciters, are designed to operate at 120

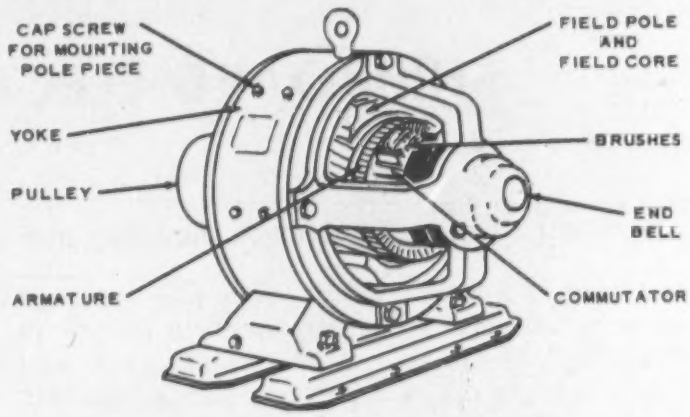

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Figure 11-1—A d-c generator.

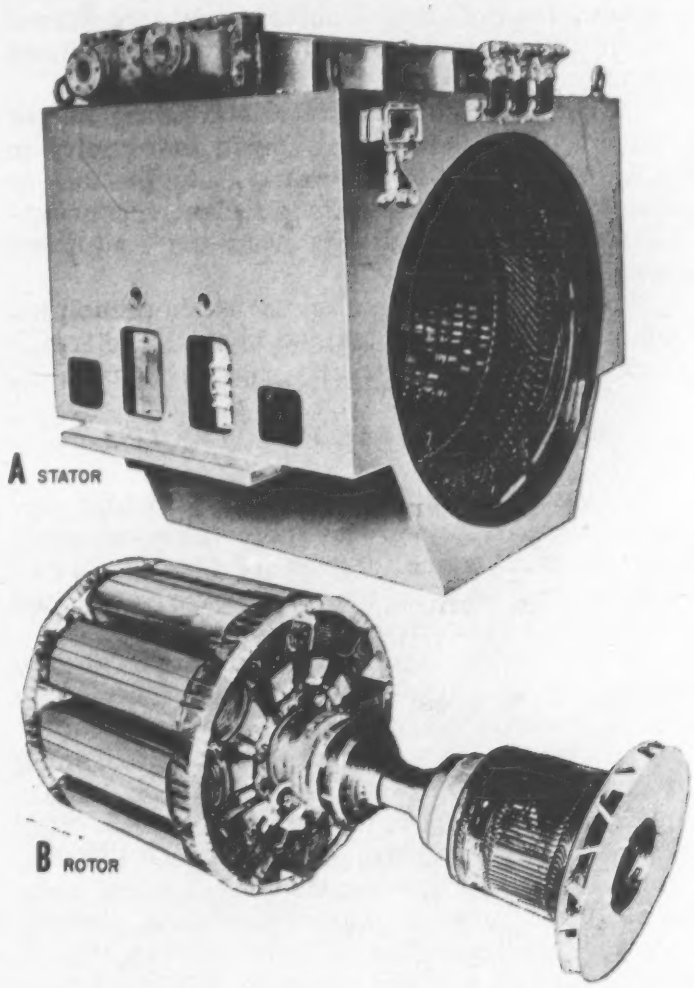

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Figure 11-2.—Low speed engine-driven alternator. A. Stator. B. Rotor.

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or 240 volts. The amount of current depends upon the size and design of the d-c generator.

A typical d-c generator is illustrated in figure 11-1. The armature is supported on ball bearings, and the field coil windings create a magnetic field through which the armature windings are rotated. This induces a voltage in the armature windings. The current driven by the induced voltage is circulated through the commutator (on the armature shaft) and carried by the brushes (which ride on the commutator) to the external circuit. Part of the armature current is forced through the field winding to increase and maintain the magnetic strength.

A-C GENERATORS

The general construction of a-c generators is somewhat simpler than that of d-c generators. The heavy current on a d-c generator has to pass through the commutator and brushes. A-c generators do not have a commutator. The heavy current on a-c generators is taken from the stationary part or stator windings. A-c generators have two slip rings which carry a relatively small direct current that is supplied by the exciter to the d-c field winding of the rotor.

A-c generators, like d-c generators, have magnetic fields and an armature. In small a-c generators the armature revolves, the field is stationary, and no commutator is required. In large a-c generators the field revolves and the armature is wound on the stationary member, or stator.

The principal advantages of the revolving-field generators over the revolving-armature generators are as follows:

1. The load current from the stator is connected directly to the external circuit without using slip rings.
2. Only two slip rings are necessary to supply excitation to the revolving field.
3. The stator winding is not subjected to mechanical stresses that are due to centrifugal force.

The a-c generators, or alternators, used in the Navy are divided into two classes: (1) low speed engine-driven alternators, and (2) high speed turbine-driven alternators.

The low speed engine-driven alternator (fig. 11-2) has a large diameter revolving field, with many poles, and a stationary armature. The stator (fig. 11-2A) contains the armature windings. The rotor (fig. 11-2B) consists of salient, or protruding, poles on which are mounted the d-c field windings.

The high speed turbine-driven alternator (fig. 11-3) is connected either directly or through gears to a steam turbine. The enclosed metal structure is part of a forced ventilation system that carries away the heat by circulation of air through the stator (fig. 11-3A) and rotor (fig. 11-3B).

SHIP'S SERVICE TURBINE-DRIVEN GENERATORS

Ship's service generators are so named because they furnish electricity for the service of the ship. Aboard most steam-driven ships of the Navy, these generators are driven by turbines. Large ships may have as many as six or eight ship's service generators.

Destroyers have four turbine-driven ship's service generators (two in the forward engineroom and two in the after engineroom), and two smaller diesel-driven emergency generators.

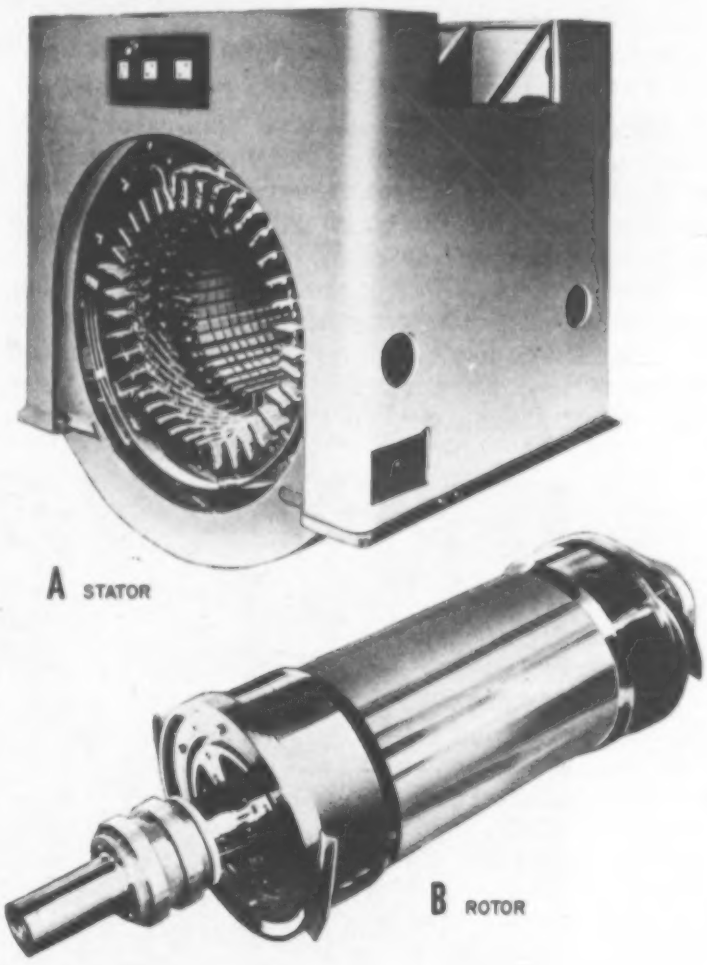

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Figure 11-3.—High speed turbine-driven alternator. A. Stator. B. Rotor.

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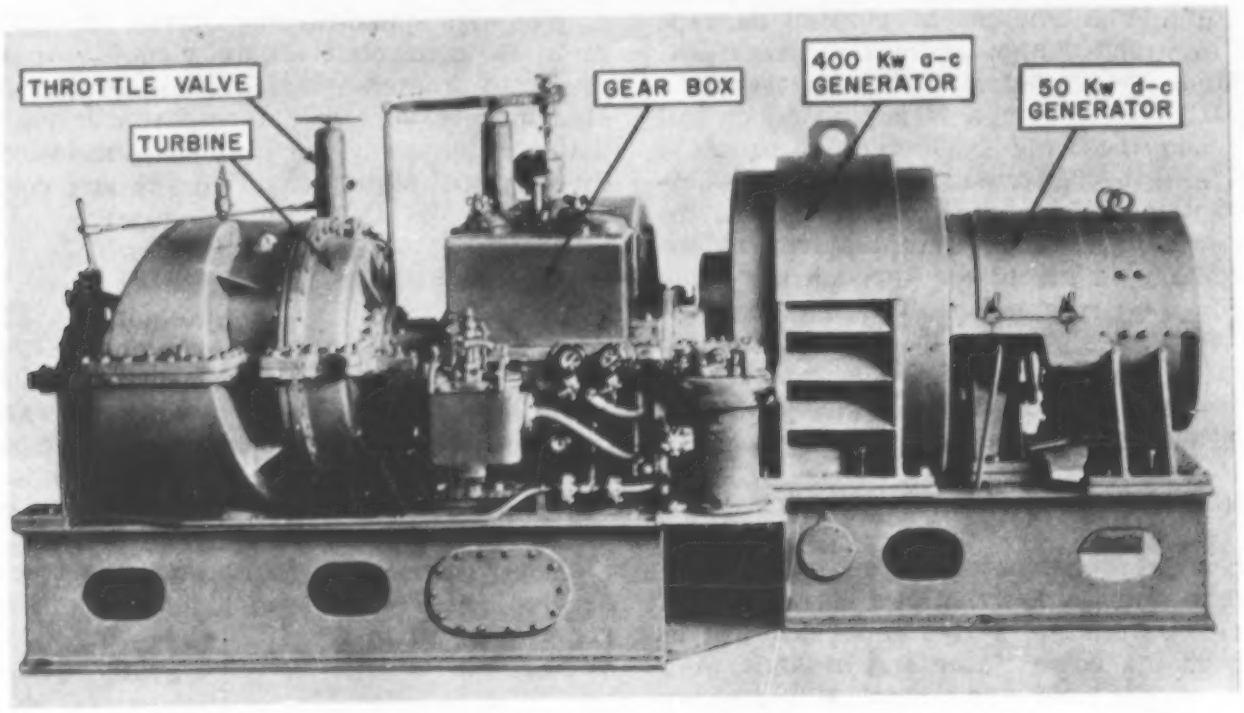

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Figure 11-4.—A turbine-driven generator set.

The type of ship's service generator commonly used aboard ships of the Navy is illustrated in figure 11-4. Although generator sets (turbogenerators) may be built differently, all have the same arrangement of major parts.

Turbines used for driving the ship's service generators differ from other auxiliary turbines in that they usually operate on superheated steam. These turbines are usually of the axial-flow, multistage, geared type. The turbine exhausts to a separate auxiliary condenser which has its own circulating pumps, condensate pumps, and air ejectors. Cooling water for the condenser is provided by the auxiliary circulating pump, through separate injection and overboard valves.

Provision is made for supplying superheated steam to the ship's service generator turbine from either the main steam line or a special turbogenerator line led directly from the boiler.

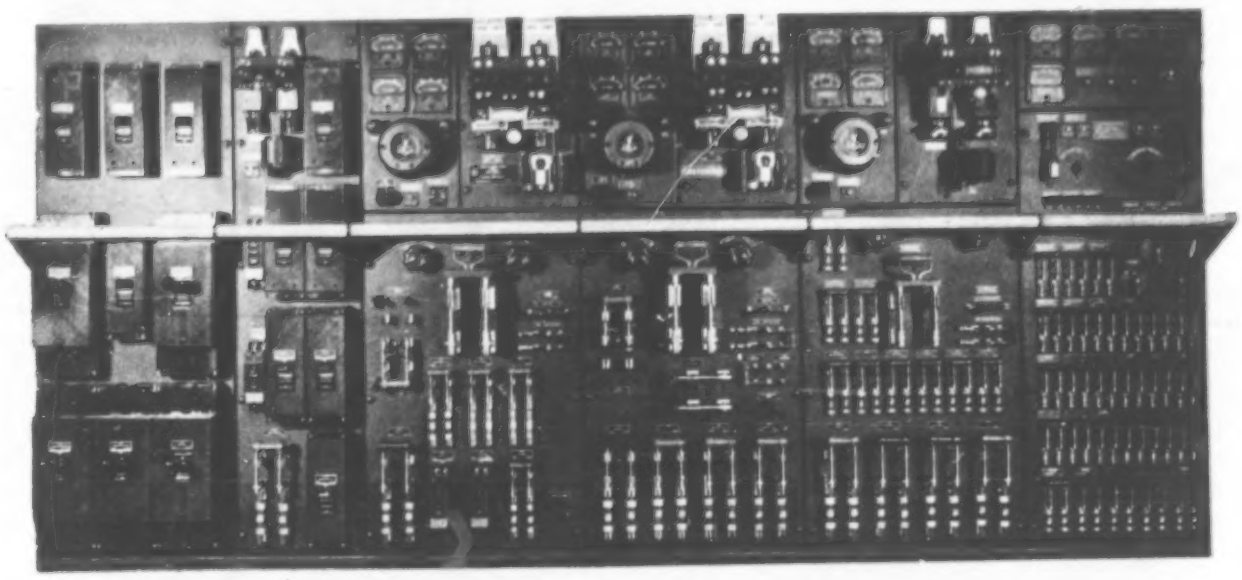

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Figure 11-5.—Generator and distribution switchboard—live front.

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On some ships, the turbine may—in the event of condenser casualty—be discharged directly to the atmosphere, or to the main condenser when the main plant is in operation.

Because the ship's service generator must supply electricity at a constant voltage and frequency, the turbine must run at a constant speed even though the load will vary greatly. Constant speed is maintained through the use of a speed regulating governor. This turbine also has an overspeed trip, which closes the throttle if the turbine overspeeds and the speed regulating governor fails to function; a back-pressure trip, which closes the throttle if excessive exhaust pressure is built up; and a manual trip which may be used to close the throttle quickly when damage to the turbine or to the generator occurs. The shaft glands of the ship's service generator turbine are supplied with gland-sealing steam; the system is similar to that used for main propulsion turbines. Other auxiliary turbines in naval use are seldom, if ever, provided with gland-sealing systems.

DIESEL-DRIVEN GENERATORS

Practically all Navy ships are equipped with diesel-driven emergency generators. Diesel engines, rather than turbines and reduction gears, are most suitable for this application because of their quick starting ability. Emergency generators furnish power directly to the radio, radar, gunnery, and vital machinery equipment.

The typical shipboard plant consists of two diesel emergency generators, one forward and one aft, in spaces outside the enginerooms and firerooms. Each emergency generator has its individual switchboard and switching arrangement for control of the generator and for distribution of power to certain vital auxiliaries and to a minimum number of lighting fixtures in vital spaces.

The capacity of the emergency unit varies with the size of the ship on which the unit is installed. Regardless of the size of the installation, the principle of operation is the same.

Detailed information concerning the operation of diesel-driven generators can be obtained from appropriate manufacturers' technical manuals.

SWITCHBOARDS

Switchboards consist of panels for mounting the various measuring instruments, indicating devices, and protective and regulating apparatus required for controlling the operation of the generators and the distribution of electric power. A distribution switchboard is provided for each generator or group of generators.

Most Navy ships have from two to four ship's service generator switchboards; small ships, such as destroyers, have two switchboards, whereas large ships may have as many as four switchboards.

Most switchboards have the equipment grouped to form a number of units, each complete with a separate front panel. These panels include the generator unit, bus tie unit, power distribution unit, and lighting distribution unit. (New ships have transformers throughout the ship with lighting distribution panels instead of lighting distribution units.) A number of these units mounted on a common base comprise a section. A switchboard may consist of a single section or of several sections, each complete in itself but connected by cables to form a switchgear group. This arrangement of several small sections lessens the danger of shock, localizes damage from fire, and provides for easy removal of damaged sections for repairs or replacement.

The two types of switchboard construction are live front and dead front. The live front switchboard, shown in figure 11-5, is found only on very old ships where low-voltage and d-c distribution systems are used, and as interior communication switchboards. The dead front switchboard, shown in figure 11-6, is used for all a-c distribution systems and for d-c systems on all new ships. (NOTE: The terminals are accessible on the live front type. In the dead front switchboard, the meters and operating handles are mounted on the panels, and all live parts are located behind the panels.)

GENERATOR AND DISTRIBUTION SWITCHBOARDS

Ship's service 450-volt, a-c switchboards are all of the dead front type. These switchboards are built to provide efficient and safe operation of the electrical system. A typical power distribution system in a destroyer consists of both a forward and after generator and distribution switchboard. All the necessary apparatus for controlling each generator and for distributing its power is incorporated in an associated switchboard.

The forward ship's service generator and distribution switchboard is the control switchboard. It is provided with instruments and controls for the after generator. These instruments

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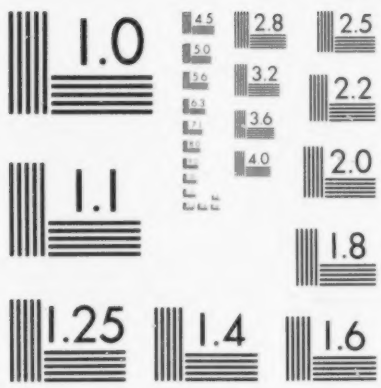

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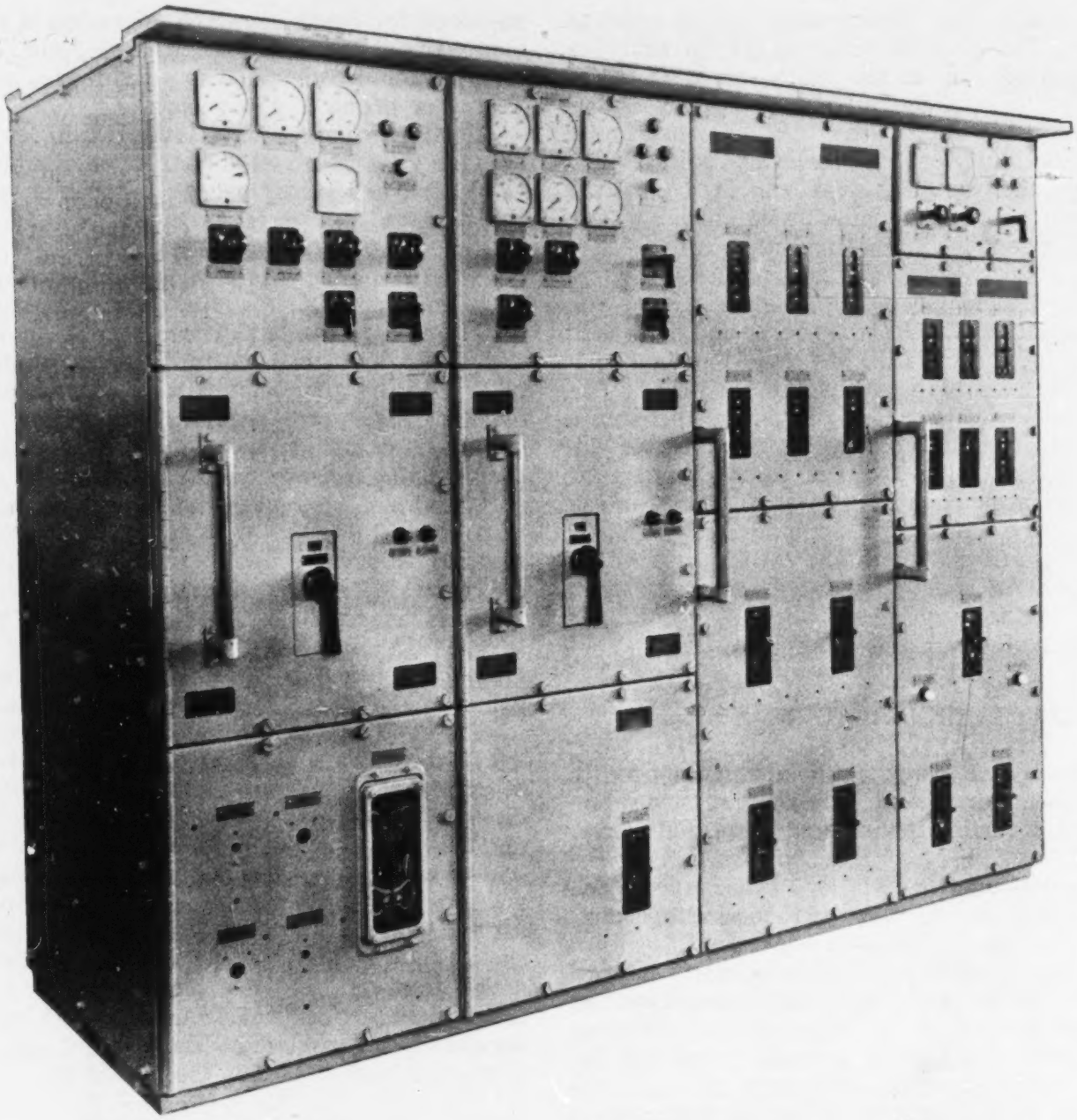

Figure 11-6.—Generator and distribution switchboard—dead front. 139.45

and controls are necessary to parallel the generators and equalize the load. An automatic voltage regulator is mounted on each switchboard to control the generator field excitation and to maintain a constant a-c generator voltage throughout the normal changes in load.

Two diesel emergency generator sets are provided to supply electric power for limited lighting and for vital auxiliaries in the event of failure of the ship's service power. One unit is located in the forward emergency generator room and the other unit is located in the after emergency generator room. The forward emergency switchboard is normally energized from the forward ship's service switchboard and the after emergency switchboard is energized from the after ship's service switchboard.

D-c power distribution systems are in use on some older ships that have large deck machinery loads. These systems, which consist of the ship's service generator and distribution switchboards, are similar to the a-c systems. On new ships, d-c power is provided at the load with rectifiers.

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COMPONENTS OF A SWITCHBOARD

Each switchboard includes one or more units, a bus tie unit, a power distribution unit, and lighting distribution units or transformers and lighting distribution panels. Large circuit breakers are used to connect ship's service and emergency generators to the power distribution system. They are also used on bus ties and shore connection circuits. In accordance with the electric load, smaller circuit breakers are also installed on switchboards and on distribution panels throughout the ship.

Circuit Breakers

Circuit breakers (see fig. 11-7), equipped with individual automatic tripping devices, are used to isolate faulty circuits, and to serve as overload protection. These circuit breakers are a part of the switchboard equipment. Circuit breakers are used in circuits that require large amounts of current, rather than fuses. They can be operated for an indefinite period, and their action can be controlled with greater accuracy.

Overload circuit breakers open automatically when the current (load) on the circuit exceeds a preset value for which the circuit breaker is set. Circuit breakers used with shipboard equipment are not susceptible to tripping under successive heavy shocks, such as those caused by gunfire. Circuit breakers are used on all rotating electrical machinery and feeders to vital loads. such as turrets and searchlights.

In addition to overload coils, reverse current trip coils are provided on d-c circuit breakers. These units are designed to open if the direction of current flow changes.

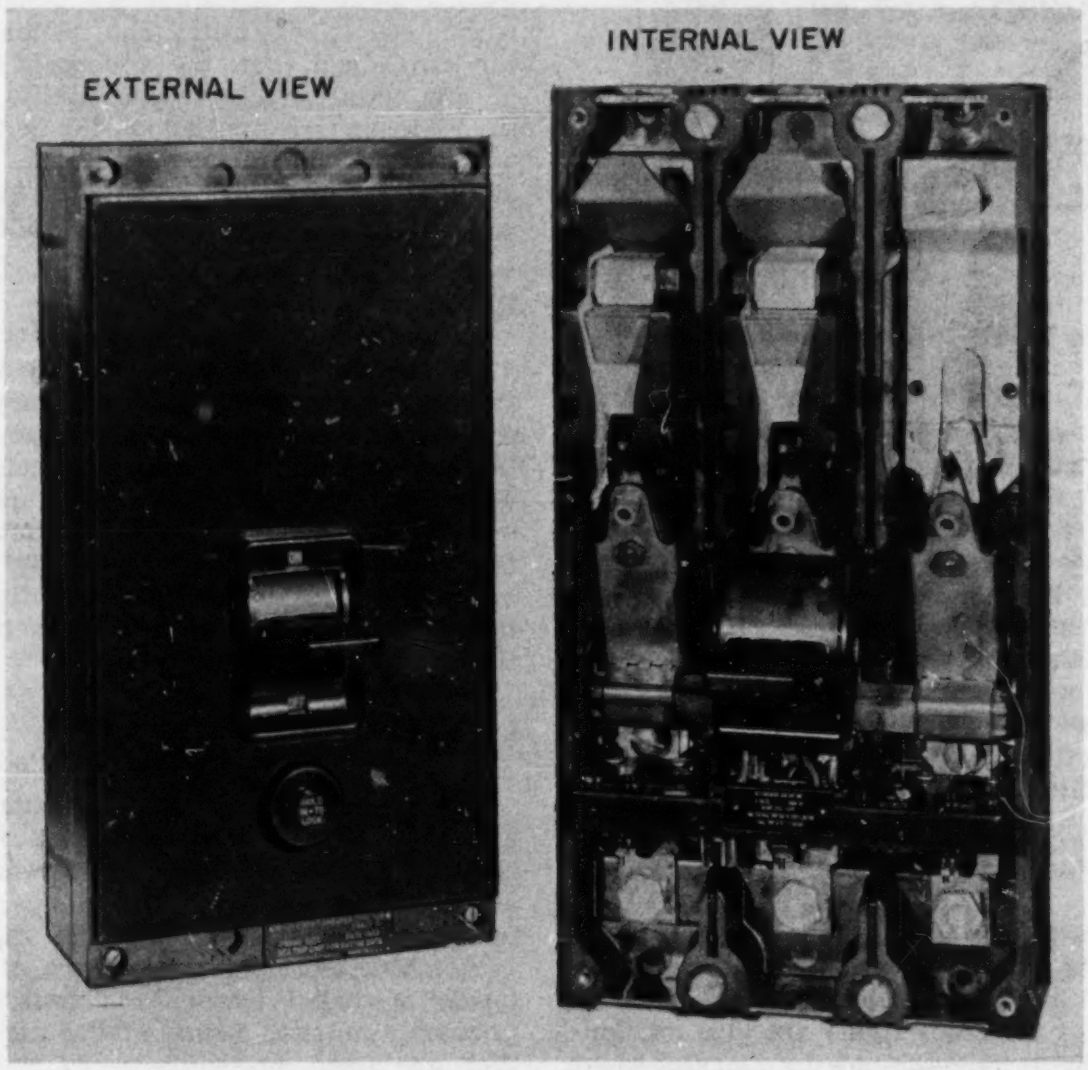

Figure 11-7.—Circuit breaker.

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Switches

A switch is a device for making or breaking an electric circuit. The KNIFE SWITCH, with the associated fuses, is used on small live front switchboards that distribute low voltage.

The ROTARY SNAP SWITCH, used mostly for lighting circuits, is a device that opens or closes a circuit widh a quick motion. A rotary snap switch, shown in figure 11-8, consists of

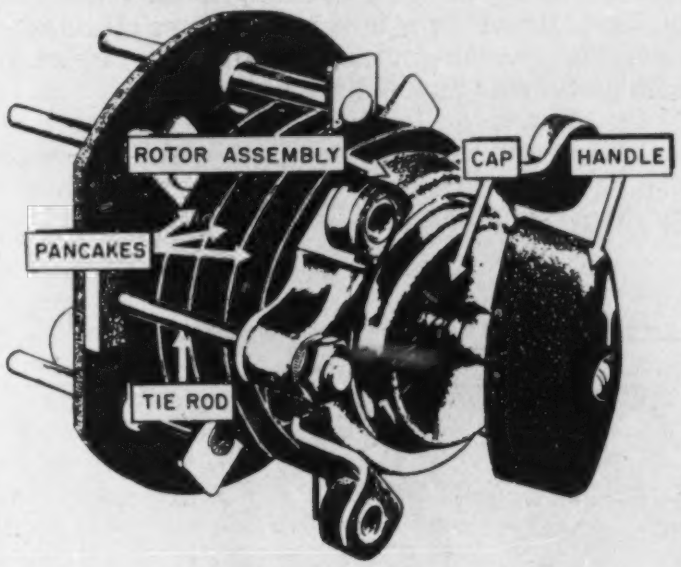

Figure 11-8.—Rotary snap switch. 12.69

one or more sections, each of which has a rotor and a stationary member. A shaft with a handle at one end extends through the center of the rotors. The rotors are snapped in and out of the stationary contacts on the "pancake" sections. When the handle is turned slightly, it winds a coil spring on the shaft. As the handle is turned farther the coil spring snaps the rotor contacts in or out of the stationary contacts. Snap switches are used extensively in the distribution sections of IC switchboards and in lighting circuits.

Indicator Lights

To provide information to the operator, small colored lights are usually installed on switchboards. The two most common colors used on older ships for indicator lights are blue and amber. Blue indicator lights show the operator which generator and bus tie circuit breakers are closed. When these circuit breakers are opened, the blue light will go off and the amber light will burn. On new ships, yellow is used instead of amber.

Light bulbs are also used on the switchboard for other pusposes. A set of lights is used when paralleling generators. These lights are called SYNCHRONIZING LAMPS. A meter (synchroscope) is generally used for paralleling generators. However, lights are installed on the board as a safety precaution.

White lights are used for checking grounds or low insulation of electrical circuits. These lights are known as GROUND-DETECTOR LIGHTS.

Voltage Regulators

Voltage regulators, installed on the associated switchboards, are used for a-c ship's service and emergency generators. The voltage regulator is used to maintain the generator voltage within specified limits. The switchboard operator can adjust (set) the voltage of the generator at any value within normal limits. When additional loads are applied on the generator, there will be a tendency for the voltage to drop. The automatic regulator keeps the voltage of the generator constant at different loads.

Rheostats

Rheostats are generally used on d-c panels to regulate the amount of current through the field windings of a generator. The rheostat contains resistors which are connected in series. The center part of the rheostat can be rotated so that movable electrical contacts select different amounts of resistance. By adjusting the amount of resistance in the circuit, it is possible to increase or decrease the current and control the voltage.

Indicating Meters

All the important switchboards aboard ship are provided with electrical meters of various types. Electrical meters, somewhat like gages and thermometers, show the operator what is taking place in the electrical machinery and systems. Electrical meters are of two general types: installed meters (on switchboards) and portable meters. Some of the common meters that are used on switchboards are voltmeters, ammeters, kilowatt meters, and frequency meters.

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ELECTRIC MOTORS

Electric motors are used aboard ship to operate guns, winches, elevators, compressors, pumps, ventilation systems, and other auxiliary machinery and equipment. There are many reasons for using electric motors; they are safe, convenient, easily controlled, and easily supplied with power.

A motor changes electrical energy, produced by the generators, into mechanical energy. There are important reasons for changing mechanical energy to electrical energy and then back to mechanical energy. One reason is that electric cables can be led through decks and bulkheads with less danger to watertight integrity than steam pipes or mechanical shafts. Another reason is that damage to a steam line could cause steam to escape, resulting in personnel injury. If an electric cable is used and a fault occurs, the circuit breaker protecting the cable opens automatically.

D-C AND A-C MOTORS

The a-c motor, smaller and requiring less maintenance than the d-c motor, is extensively used by the Navy. The d-c motor, which is built like a d-c generator, is used mostly on submarines, some auxiliary ships, and some small ships.

Most of the a-c motors used on board ship are three-phase 60 cycle, 440-volt motors. The induction motor is commonly used by the Navy. Although most a-c motors have one speed, a number of motors with two speeds, such as those on ventilation systems, are installed aboard ship.

MOTOR CONTROLLERS

Controlling devices are used to start, stop, speed up, or slow down motors. In general, these controllers are standard equipment aboard ship and are either manual, semiautomatic, or automatic. They are dripproof and shock resistant. In some installations the controllers are operated by remote control, with the switch located at a convenient place.

These motor control devices (controllers, master switches, and electric brakes) function to protect the equipment to which they are connected. Controllers are designed to provide protective and governing features for every type of shipboard auxiliary. To govern the controllers themselves, master switches of various types are installed. Electric brakes are used to bring a load to rest, or to hold it at rest, when electric power to the motor is cut off. Aboard ship, electric brakes are used primarily on hoisting and lowering equipment such as cranes, winches, and windlasses.

Most controllers function simply to start or to stop auxiliary machinery, but some controllers also provide for reversal of direction or two-speed control. Motor controllers, sometimes called starters, have overload protective devices to prevent the motor from burning out. Most controllers cut out automatically when the electric power fails, and have to be restarted at the controller.

BATTERIES

Aboard ship, batteries are one of the sources of electricity for emergency and portable power. Dry cell batteries are used primarily for flashlights, hand lanterns, and test equipment. Storage batteries are also used for emergency equipment on board ship and for ship's boats. (Boats, like automobiles, use batteries for starting and lighting.) The storage battery is used, as a source of electrical energy, for emergency diesel generators, gyrocompasses, and emergency radio.

Since you may act as a boat engineer, you should be familiar with safety precautions to be observed when working around batteries. Batteries must be protected from salt water, which can mix with the electrolyte (acid solution) and give off poisonous fumes. Salt water in the electrolyte also sets up a chemical reaction which will ruin the battery.

Storage batteries, when being charged, give off a certain amount of hydrogen gas. Battery compartments should be well ventilated. Flames or sparks of any kind, including lighted cigarettes, should never ba allowed in the vicinity of any storage battery that is being charged. When the battery is low or does not perform properly, the boat engineer should notify the Electrician's Mate (EM) so that the faulty condition can be corrected promptly.

PORTABLE EQUIPMENT

Aboard any ship there will be small electric powered equipment, such as portable electric drills, hand lanterns, small ventilation blowers, and handtools.

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HAND LANTERNS

Relay-operated hand lanterns, usually called battle lanterns, are powered by dry cell batteries. Hand lanterns are provided to give light when the lighting systems fail. These lanterns are placed in spaces where continual illumination is necessary, such as machinery spaces, control rooms, essential watch stations, battle dressing stations, and escape passages. The battle lantern should not be removed from its mounting bracket except in an emergency. Don't use it as a flashlight.

The relay control boxes for battle lanterns are connected to the emergency lighting supply circuit (or to the ship's service lighting circuit) in which the lantern is installed. If power in the circuit fails, the relay opens and the batteries light the lantern.

Hand (battle) lanterns are capable of operating for approximately 10 continuous hours (or the equivalent) before the light output ceases to be useful.

Similar hand lanterns, which are NOT connected to relays, are installed throughout the ship to provide illumination in stations which are manned occasionally. These lanterns are manually operated. When used in an emergency, these manually operated hand lanterns should always be RETURNED TO THEIR ORIGINAL LOCATION.

SEALED BEAM LIGHTS

Sealed beam lights, a type of flood lantern, are used to give high-intensity illumination in damage control or other emergency repair work. These units consist of a sealed beam light similar to that used for automobiles. The sealed beam light, powered by four small wet cell storage batteries, is mounted on the battery case, and fitted with a handle for convenience in carrying. A sealed beam lamp will operate for the equivalent of 3 continuous hours before the battery requires recharging. When the battery is at full charge, the beam has an intensity which is similar to that of the headlight of an automobile. At the end of 3 hours the light output will gradually drop to about one-half of its original brilliance.

PORTABLE EXTENSION LIGHTS

Portable extension lights are widely used aboard ship, especially in the engineering spaces. Adequate lighting is necessary when maintenance work is being done or when machinery repairs are being made.

The portable extension light and cord should be in good condition. The cord should be free from cuts or damaged areas. The light and cord should be free from moisture, oil, and grease.

Care should be taken to see that the extension light has the required metal wire guard. This metal wire guard is installed as a safety precaution; never remove the guard from the extension light. Unguarded electric light bulbs are dangerous as well as easily broken. Men have received fatal shocks from broken light bulbs.

Care should be taken not to lay extension cords across decks or other places where they may be damaged. If possible, cords should be run overhead and tied in place. Also, keep rubber cords away from hot steam piping as well as away from oil and paint. Avoid running an extension cord through a watertight hatch or door.

An extension light should be returned promptly to its proper stowage place after the work for which it was used has been finished. The light should be clean, dry, and in good condition. Defective extension lights (including lights without guards) should be brought to the electric shop for repairs immediately.

PORTABLE TOOLS

Proper care and precautionary measures should be taken in handling and working with portable tools such as electric drills and grinders. Protective goggles must always be worn while using tools such as wire brushes and grinders.

There is an inherent danger in the use of portable electric tools because of the possibility of electric shock. The Electrician's Mates are required to make routine tests of electrical tools to ensure that they are safe to use. Portable tools in use on Navy ships are provided with a grounded plug and a ground wire connected to the metal part of the tool. Grounded receptacles are installed throughout the ship. The cords for portable electric tools contain three conductors; the third conductor is used to ground the portable tool to the ship. These precautions are taken to prevent operators of portable tools from receiving a dangerous electric shock.

SHIPBOARD ELECTRICAL SYSTEMS AND CONNECTIONS

As a Fireman, you should be familiar with the power distribution systems, the lighting

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distribution systems, and shore power connections. These are described briefly in this course. Greater detail on this and other shipboard electrical equipment is available in chapter 9620(62), Bureau of Ships Technical Manual.

POWER DISTRIBUTION SYSTEMS

The power distribution system connects the generators, which furnish electric power, to the power-driven equipment installed throughout the ship. From the generator switchboards, a distribution system consisting of feeders, mains, submains, load center panels, distribution panels, and distribution boxes conveys power to every part of the ship. The most important auxiliaries are supplied with normal, alternate, and emergency feeders, each with a separate source of power. Casualty power systems are installed aboard ships in order to provide electrical connections when both ship's service and emergency electrical systems are damaged.

For loads near a switchboard, and for such large and important loads as steering gears, anchor windlasses, and turrets, power is supplied directly from the ship's service generator and the distribution switchboard. In large installations, power distribution to other loads is from the generator and distribution switchboards to load centers, then to distribution panels, and finally to the loads. Load centers are not provided in small installations.

LIGHTING DISTRIBUTION SYSTEMS

Lighting distribution systems are necessary not only for lighting the ship but also for assisting personnel controlling damage. Aboard combatant ships two lighting systems are installed: ship's service lighting and emergency lighting. The former normally supplies all lighting fixtures. Emergency lighting circuits are supplied to vital machinery spaces, the radio room, the combat information center, and other vital spaces. The emergency lighting system receives power from the ship's service generators, but if normal power is lost, the emergency system is automatically cut in on the emergency generators. Lighting distribution systems are similar to power distribution systems, except that they (1) are more numerous, (2) have lower voltages (117 v), and (3) have smaller panels and cables.

Lighting distribution requires a variety of panels and distribution boxes, for connecting loads with power supply. High-voltage feeders from switchboards are stepped down from 450 v to about 117 v by transformers when they are connected to distribution panels. Circuits emerging from distribution panels are connected to feeder distribution boxes. The feeder distribution box, which is similar to the distribution panel, only has a few branch circuits. The distribution boxes convey power directly to the actual load circuits.

SHORE POWER CONNECTIONS

Shore power connections are installed at or near suitable weather deck locations to which portable cables from the shore, or from a ship alongside, can be connected. Power can be supplied through these connections to the switchboard when ship's service generators are not in operation.

ELECTRICAL SAFETY PRECAUTIONS

There are certain safety precautions which should be observed when working with or around electrical appliances and equipment.

Some of the most common electrical safety precautions to be observed by personnel are as follows:

1. Do not attempt to maintain or repair electric equipment. Leave the electrical work to the Electrician's Mates and I.C. Electricians.
2. Observe and follow all pertinent instructions and electric warning signs on board ship.
3. Observe all safety precautions regarding portable electric lights and tools.
4. Remember that especially on board ship 117-volt electricity is very dangerous.
5. Do not touch or operate an electrical switch that has a warning tag attached to it.
6. Do not go behind electrical switchboards.
7. Do not touch live electric wires and fittings.
8. Never remove the wire metal guard from a portable extension light.
9. Do not remove steamtight globes from lighting fixtures.
10. Do not remove battle lanterns from their locations.
11. Do not use manually operated hand battle lanterns for unauthorized purposes. Each person should have his own flashlight.
12. Do not use electric cables for hoisting or supporting heavy weights, or the wireways for storage.
13. Prevent water from getting into electrical equipment.
14. Remember that a flame, spark, or lighted cigarette can cause a disastrous battery explosion.

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15. Remember that electrolyte from a storage battery can cause severe burns, and can damage equipment or clothing.

16. When repairing equipment that is driven by a motor, have an electrician disconnect the circuit and tag it as out of commission.

17. Do not start or operate electric equipment when flammable vapors are present.

18. Take time to learn the electrical safety precautions that are applicable to your assigned duties and duty station, whether it be the fireroom, engineroom, electric shop, or other duty or station assignment. (A thorough understanding of electrical safety precautions will help prevent injury to yourself and damage to equipment which you may be called upon to operate.)

19. If you are ever in doubt about the operating condition of electrical equipment, call an electrician.

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CHAPTER 12

INTERNAL COMBUSTION ENGINES

Most of the machinery and equipment of large Navy ships utilizes steam as the working fluid in the process of changing thermal (heat) energy to mechanical energy. This chapter deals primarily with internal combustion engines, in which a mixture of air and fuel serves as the working fluid.

Internal combustion engines are used extensively in the Navy, serving as propulsion units in a variety of installations such as ships, boats, airplanes, and automotive vehicles (trucks and buses). Internal combustion engines are also used as prime movers, or energizing units, for auxiliary machinery. In most shipboard installations, internal combustion engines are of the RECIPROCATING type. In relatively recent years, however, GAS TURBINE engines have been placed in Navy service as power units. Since the majority of the engines in service in the Navy are of the reciprocating type, the discussion which follows will deal primarily with reciprocating engines.

RECIPROCATING ENGINES

The internal combustion engines (diesel and gasoline engines) with which you will be working are machines that convert heat energy into mechanical energy. Diesel and gasoline engines are of the reciprocating type.

The general trend in Navy service is to install diesel engines rather than gasoline engines, unless special conditions favor the use of gasoline engines. Small boats are used in conjunction with airplane facilities are frequently powered with gasoline engines because the available fuel supply is gasoline. In addition, gasoline engines are used in many installations because of their small size or a lack of suitable diesel engines.

IGNITION PRINCIPLES

The gasoline and diesel engines differ principally in that the former has a carburetor and a spark ignition system. The fuel and air for the SPARK IGNITION (GASOLINE) ENGINE is mixed in the carburetor. This mixture is drawn into the cylinders where it is compressed and ignited by an electric spark.

The COMPRESSION IGNITION type engine is commonly known as a DIESEL ENGINE. The diesel engine takes in atmospheric air, compresses it, and then injects the fuel into the cylinders. The heat generated by compression ignites the fuel, hence the term "compression ignition" is used for diesel engines.

OPERATING CYCLE

All reciprocating engines have a definite cycle of operation. It is necessary to atomize the fuel, get into the cylinders, ignite and burn it, and dispose of the gases of combustion. All reciprocating internal combustion engines operate on either a 2-stroke or a 4-stroke cycle. A stroke is a single up or down movement of the piston, or the distance a piston moves between limits of travel. Each piston executes two strokes for each revolution of the crankshaft. The number of piston strokes occurring during any one series of operations (cycle) is limited to either two or four, depending upon the design of the engine.

In FOUR-STROKE-CYCLE engines, each piston goes through four strokes and the crankshaft makes two revolutions to complete one cycle. Each piston is delivering power during one stroke in four, or each piston makes one power stroke for each two revolutions of the crankshaft.

Let us use one cylinder of a diesel engine to trace its operation through the four strokes that make up a cycle. (See fig. 12-1.) The engine parts shown in this figure include only a cylinder, a crankshaft, a piston and connecting rod, and the inlet and exhaust valves. To simplify the diagrams (A thru D), the valve-operating mechanism and the fuel system have been omitted.

In part A of figure 12-1 the intake valve is open and the exhaust valve is closed. The piston

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is moving downward and drawing a charge of air into the cylinder through the open valve. This portion of the cycle during which the piston is moving downward is called the INTAKE STROKE.

When the crankshaft has rotated to the position shown in B of figure 12-1, the piston has moved upward, on the COMPRESSION STROKE, almost to the top of the cylinder. Both the intake and exhaust valves are closed during this stroke. The air which entered the cylinder during the intake stroke is compressed into the small space above the piston. The volume of this air may be reduced to less than 1/16 of what it was at the beginning of the stroke.

The high pressure which is a result of this great reduction in volume raises the temperature of the air far above the ignition point of the oil. When the piston nears the top of the compression stroke, the charge of fuel is forced into the cylinder through the injection valve. The air which has been heated by compression ignites the fuel.

During the POWER STROKE, indicated in C of figure 12-1, the inlet and exhaust valves are both closed. The increase in temperature resulting from the burning fuel greatly increases the pressure on top of the piston. This increased pressure forces the piston downward and rotates the crankshaft. This is the only stroke in which power is furnished to the crankshaft by the piston.

During the EXHAUST STROKE, shown in D of figure 12-1, the exhaust valve is open and the intake valve remains closed. The piston moves upward, forcing the burned gases out of the combustion chamber through the exhaust valve. This stroke, which completes the cycle, is followed immediately by the intake stroke of the next cycle, and the sequence of events continues to be repeated.

The 4-stroke-cycle gasoline engine operates on the same mechanical, or operational, cycle as the diesel engine. In the gasoline engine, the fuel and air are mixed in the carburetor and the mixture is drawn into the cylinders through the intake valve. The fuel-air mixture is ignited near the top of the compression stroke by an electric spark which passes between the terminals of the spark plug.

The principal difference in the cycles of operation for diesel and gasoline engines involves the admission of fuel and air to the cylinder. While this occurs as one event in the operating cycle of a gasoline engine, it involves two events in diesel engines. There are six main events taking place in the diesel cycle of operation (intake of air, compression of air, injection of fuel, ignition and combustion of charge, expansion of gases, and removal of burned gases), and five in the cycle of a gasoline engine (fuel is not injected in such an engine).

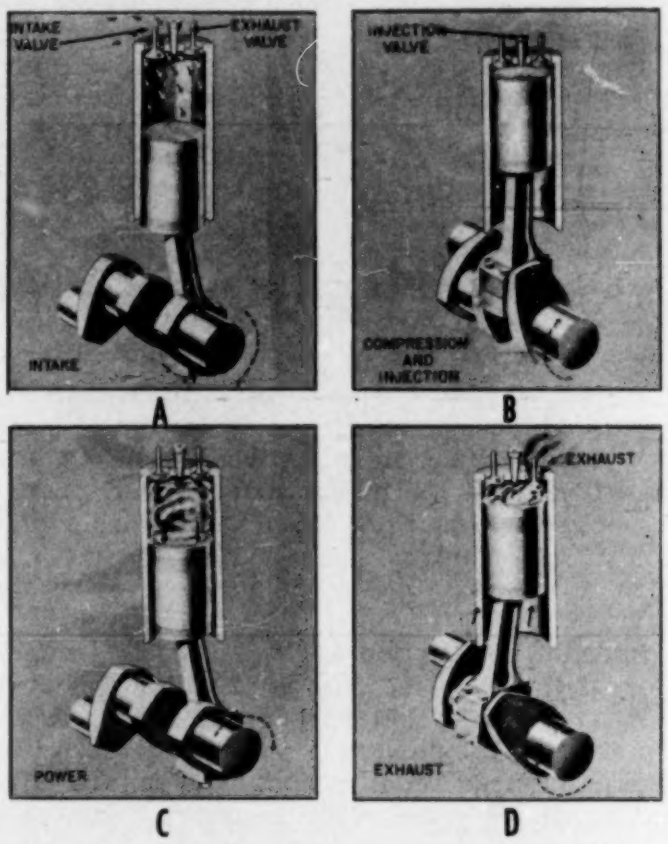

Figure 12-1.—The 4-stroke diesel cycle.

TWO-STROKE-CYCLE diesel engines are widely used by the Navy. The Navy uses some gasoline engines that operate on the 2-stroke cycle; they are used principally to drive portable pumps.

Every second stroke of a 2-stroke-cycle engine is a power stroke. The strokes between are compression strokes. The intake and exhaust functions take place rapidly near the bottom of each power stroke. With this arrangement there is one power stroke for each revolution of the crankshaft, or twice as many as in a 4-stroke-cycle engine.

The steps in the operation of a 2-stroke-cycle engine are shown in figure 12-2. The cylinder shown has an exhaust valve but no intake valve. (Other designs have both intake and exhaust ports and include no valves.) The air enters the combustion chamber through ports (openings) in the cylinder wall; these ports are uncovered by the piston as it nears the bottom of each stroke.

In A of figure 12-2, the piston is moving upward on the compression stroke. The exhaust valve and the intake ports are closed, and the

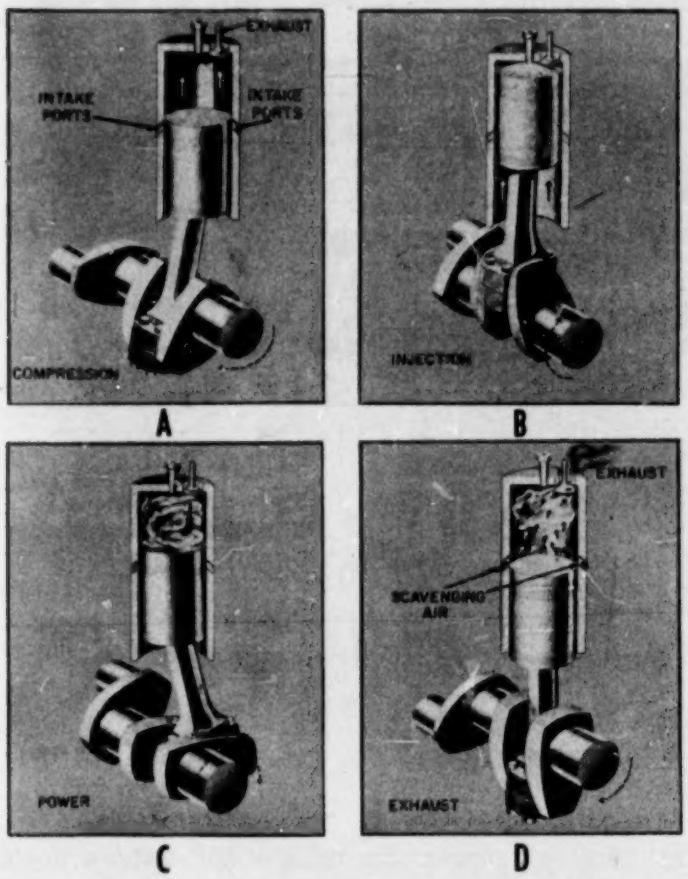

Figure 12-2.—The 2-stroke diesel cycle.[54.20]

piston is compressing the air trapped in the combustion chamber. At the top of the stroke, with the piston in the position shown in B of figure 12-2, fuel is injected (sprayed) into the cylinder and then ignited by the hot compressed air.

In C of figure 12-2, the piston is moving downward on the power stroke. The exhaust valve is still closed and the increased pressure, resulting from the burning fuel, forces the piston downward and rotates the crankshaft.

As the piston nears the bottom of the power stroke, shown in D of figure 12-2, the exhaust valve opens and the piston continues downward to uncover the intake ports. Air delivered under pressure by a blower or from the crankcase is forced into the cylinder through the intake ports, and the burned gases are carried out through the exhaust valve. This scavenging operation takes place almost instantly and corresponds to the intake and exhaust strokes of the 4-stroke cycle.

You might expect a 2-stroke-cycle engine to develop twice as much power as a 4-stroke-cycle engine; however, it does not because a certain percentage of the engine's power is required to drive the blower. Nevertheless, 2-stroke-cycle diesel engines give excellent service. Small gasoline engines operating on the 2-stroke-cycle principle operate satisfactorily, but the larger sizes are less popular.

DIESEL ENGINES

The diesel engines used in small boats look very much like the gasoline engine in an automobile. Each cylinder in the diesel engine is equipped with an ejector and an injector pump; this equipment injects fuel into the cylinder at the proper time. On the gasoline engine, the carburetor provides the proper mixture of gasoline and oil for the cylinder. Most boat engines have a sea water heat exchanger instead of the conventional radiator. Although different makes and models of diesels vary widely, they all have the same essential parts.

POWER SYSTEM

The main working parts of the engine transmit power from the cylinders to the driveshaft. These parts include the cylinders, pistons, connecting rod, and the crankshaft. The cylinders of most marine engines are contained in a single block or crankcase of iron. Each cylinder is lined with a special hardened steel sleeve called a cylinder liner. The upper end of the cylinder is covered by a cylinder head.

The pistons are connected to the crankshaft by connecting rods, which transmit power from the pistons to the crankshaft and convert their reciprocating motion to the rotary motion of the crankshaft. The rods are joined to the pistons by piston pins (wrist pins) and are connected to the crankshaft by connecting rod bearings. (See fig. 12-3.) A seal is provided between each piston and the cylinder wall. This is accomplished by rings on the pistons. As the piston moves up and down, the rings press against the cylinder wall, thus preventing the air or gases from passing down into the crankcase or the oil in the crankcase from working up past the rings.

The rotating force of the crankshaft is used to drive such items as reduction gears, propeller shafts, generators, and pumps. During three of the strokes of a 4-stroke-cycle engine, the rotary motion of the crankshaft is moving the piston up and down.

VALVE MECHANISM

The valves are opened by the action of a camshaft, driven by the crankshaft through a train

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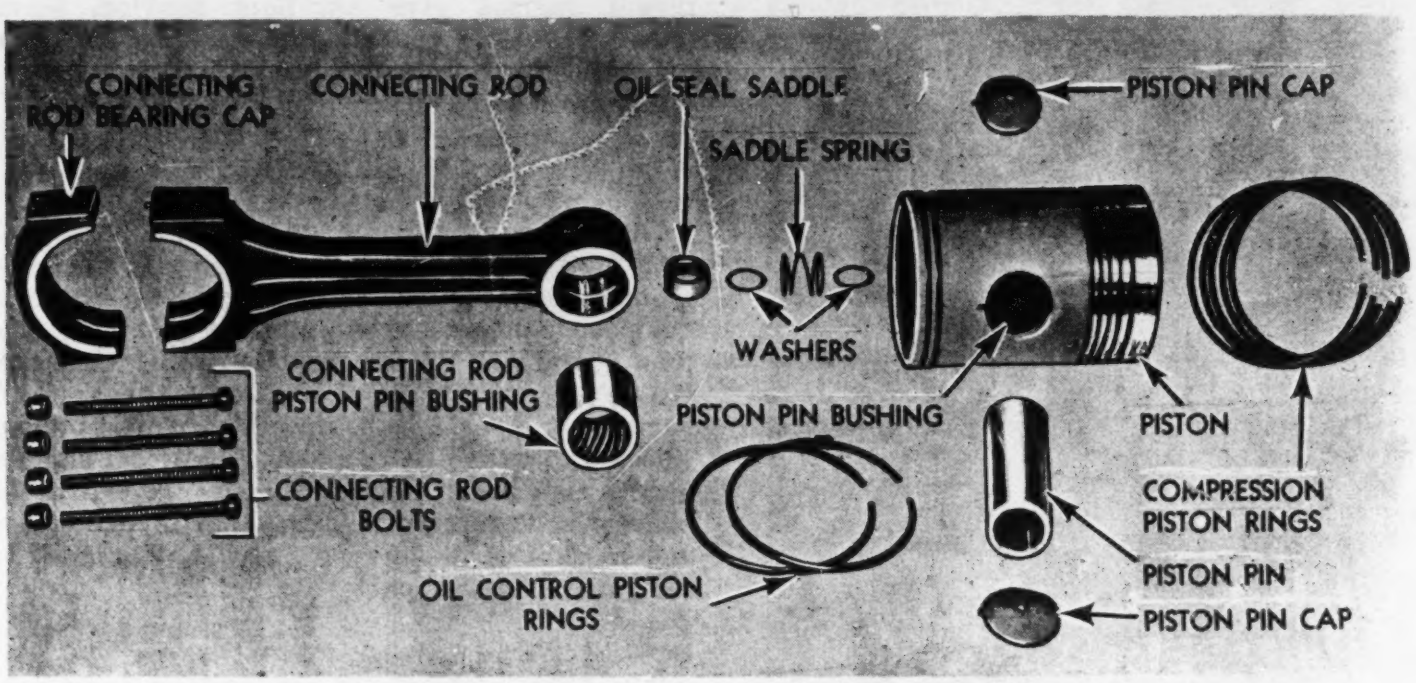

Figure 12-3.—Piston and connecting rod parts. 75.59X

of gears. The camshaft extends the length of the engine and carries one or more cams for each cylinder. The shaft is cylindrical with irregular shaped cams. Each cam is partly circular in outline but carries a LOBE (NOSE) which gives it an egg-shaped appearance as shown in figure 12-4. The circular part of the cam is called the CAM FLAT or base circle.

The camshaft functions to give an intermittent reciprocating motion, as it rotates. A cam follower or roller, riding on the rotating cam, is lifted each time the lobe or cam nose comes around.

The valve mechanism of a 2-stroke-cycle diesel engine is shown in the cutaway views that appear in figure 12-4. This engine has two exhaust valves that are opened at the same time by the action of a single cam. They make a tight fit in the exhaust openings (ports) in the cylinder head and are held in the closed position by the compression of the valve springs. The rocker arm and bridge transmit the reciprocating motions of the cam roller to the valves.

In A of figure 12-4, the cam roller is riding on the base circle of the cam and the valves are closed. As the camshaft rotates, the cam lobe or nose rides under the roller and raises it to the position shown in B of figure 12-4. When the roller is lifted, the arm rotates about the rocker shaft and the opposite end of the arm is lowered. This action pushes the bridge and valves down against the pressure of the valve springs and opens the valve passages.

On some types of engines, the camshaft is located near the crankshaft. In these designs the action of the cam roller is transmitted to the rocker arm by a push rod. In some engines, the valves are inverted and are located in recesses at the side of the cylinders. With this arrangement, the valve stems may ride directly on the cams or they may be separated by a short steel shaft and roller called a TAPPET assembly.

The camshaft must be timed with the crankshaft so that the lobes will open the valves in each cylinder at the correct instant in the operating cycle. In the 2-stroke cycle the exhaust valves are opened for only a short time near the bottom of the power stroke to permit the burned gases to escape. Since the cycle is completed in one revolution, the camshaft rotates at the same speed as the crankshaft.

The 4-stroke-cycle engine has an intake and an exhaust valve in every cylinder. Each valve is operated by a separate cam. The intake valve is held open during the intake stroke, and the exhaust valve is opened during the exhaust stroke. Since two revolutions of the crankshaft are necessary to complete a 4-stroke cycle, the camshaft of these engines turns only half as fast as the crankshaft.

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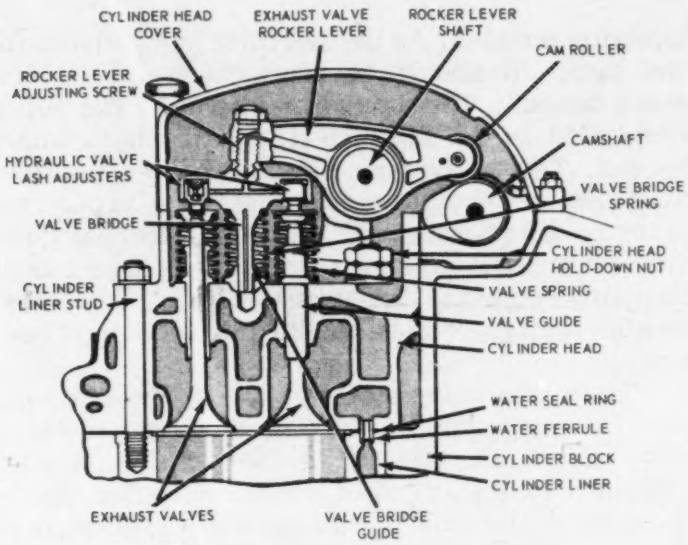

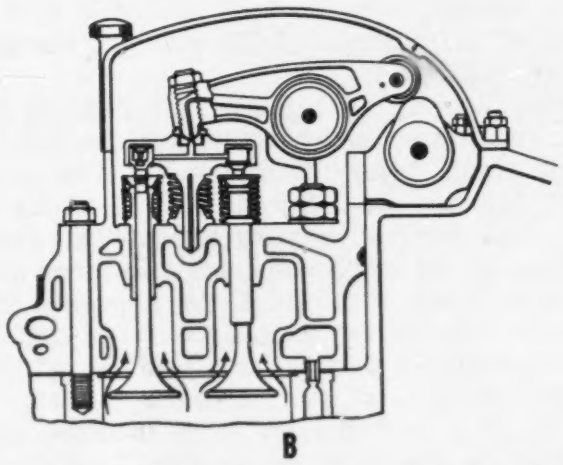

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Figure 12-4.—Cutaway of a cylinder head, showing the valve-operating mechanism.

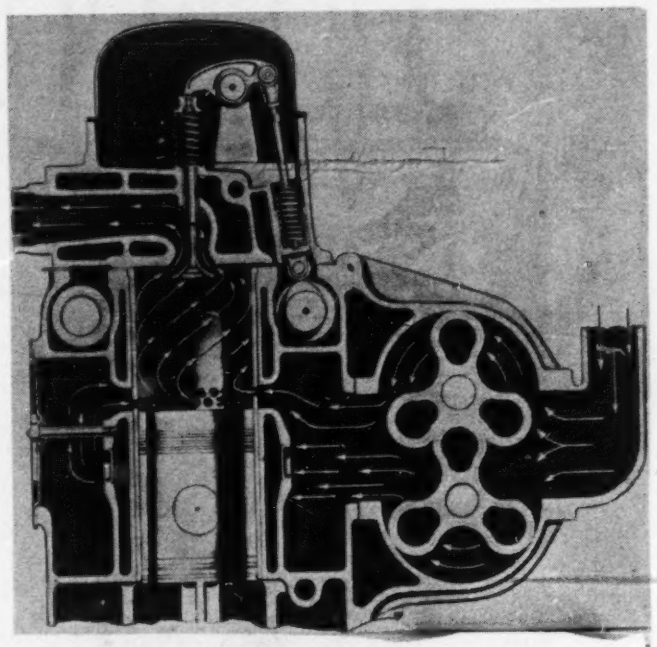

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Figure 12-5.—A 2-stroke-cycle engine cylinder with the piston at the bottom of the power stroke.

AIR SYSTEM

In the 4-stroke-cycle engine, the air enters the cylinders through the intake valve. As each piston moves downward on the intake stroke, the volume of the combustion chamber increases and the pressure decreases. The normal atmospheric pressure then forces the air into the cylinder through the intake valve.

Since the 2-stroke-cycle engine does not go through an intake stroke, a means must be provided to force air into the cylinders. The air enters through intake ports, uncovered when the piston approaches the bottom of the power stroke. (See fig. 12-5.) Since the exhaust valves are open when the intake ports are being uncovered, the incoming air forces the burned gases out through the exhaust valves and fills the cylinder with a supply of fresh air.

On the compression stroke, the exhaust valves are closed, the intake ports are covered, and the air is trapped in the cylinder. The rising piston compresses the air and raises its temperature. By the time the piston reaches the top of the stroke, the volume of the combustion chamber has been greatly reduced. The relation between the volume of the cylinder with the piston at the bottom of its stroke and the cylinder volume with the piston at the top of its stroke is called the COMPRESSION RATIO. Compressing the air to 1/16 of its original volume would represent a compression ratio of 16 to 1.

As the compression ratio is increased, the temperature of the air in the cylinder increases. Gasoline engines operate at compression ratios between 4 to 1 and 8 to 1, but compression ratios of diesel engines range between 12 to 1 and 16 to 1. This means that on the compression stroke of a diesel engine the air is compressed to a range of 400 to 600 psi; this results in a temperature ranging from 700° to 800°F. However, when the fuel is injected into the cylinder and begins to burn, the pressure may increase to more than 1500 psi and the temperature may rise as high as 1800°F.

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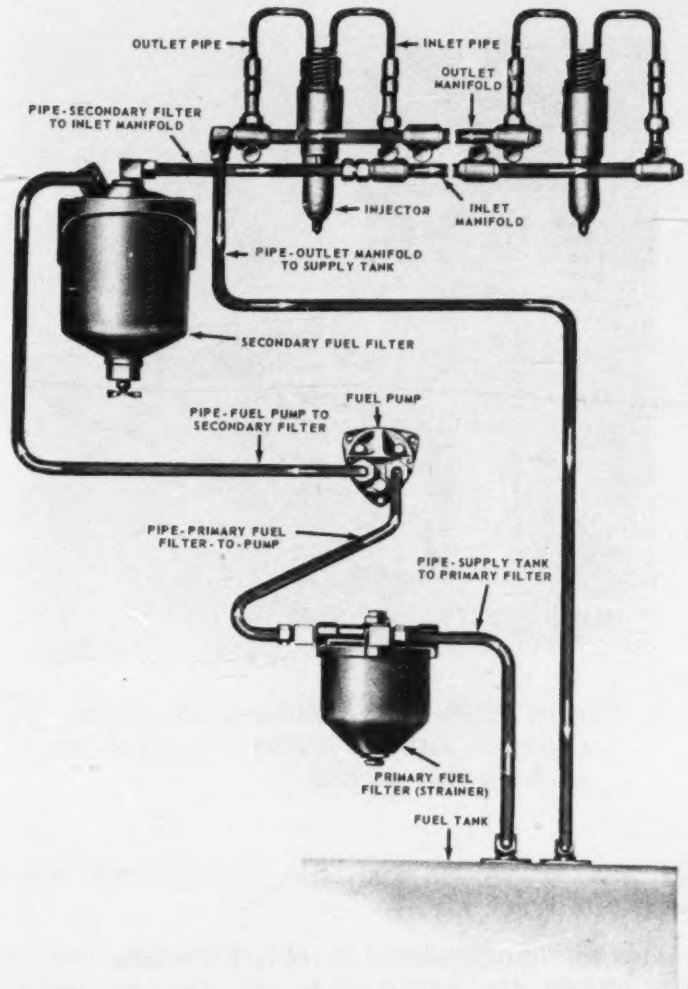

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Figure 12-6.—The fuel supply system of a General Motors portable diesel engine.

FUEL SYSTEM

The fuel system of the diesel engine draws fuel oil from the service tank and injects it into the engine cylinders. Figure 12-6 shows the units found in a typical fuel system of the unit injector type. The fuel pump draws the fuel oil from the tank through a primary filter and delivers it under low pressure to the injector by way of the secondary filter. The injector, operated by a rocker arm, meters, pressurizes, and atomizes the fuel as it is injected into the combustion chamber. The outlet line carries the excess fuel oil from the injector back to the fuel tank. In some installations, a transfer pump is installed between the tank and the primary filter. In other installations, the injection pump and injection nozzles are separate units instead of a combined unit as shown in figure 12-6.

A diesel engine will not operate efficiently unless clean fuel is delivered to the injector or injection nozzles. As the fuel oil is pumped into the fuel tanks, it should be strained through a fine mesh screen. The larger particles of the solids suspended in the fuel are trapped in the primary screen. The secondary filter separates the finer particles of foreign matter that pass through the primary filter screens. The final filtering takes place within the injector. Most filters have a drain plug for removing the water, sludge, and other foreign matter. The filter should be drained once a day.

There are many methods of fuel injection and just as many types of injection pumps and nozzles. The unit injector shown in figure 12-6 consists basically of a small cylinder and a plunger, and extends through the cylinder head to the combustion chamber. A cam, located on the camshaft adjacent to the cam that operates the exhaust valves, acts through a rocker arm and depresses the plunger at the correct instant in the operating cycle.

When the injector plunger is depressed, it discharges a fine spray of fuel into the cylinder, through small holes in the nozzle. The amount of fuel injected on each stroke of small boat engine fuel pumps is very small. The smooth operation of the engine depends to a large extent on the accuracy with which the plungers inject the same amount of fuel into every cylinder.

The amount of fuel injected into the cylinders on each stroke is controlled by rotating the plungers of a unit injector. The throttle, which regulates the speed of the engine, is connected to the injectors through a suitable linkage. Changing the throttle setting rotates the plungers and varies the amount of fuel injected into the cylinders on each stroke.

LUBRICATION SYSTEM

The lubrication system of an internal combustion engine is very important. If the lubricating system should fail, not only will the engine stop but many of the parts are likely to be damaged beyond repair. Therefore when lubrication failure occurs, the engine can seldom be run again without a major overhaul.

The lubricating system delivers oil to the moving parts of the engine to reduce friction and assist in keeping them cool. Most diesel and gasoline engines are equipped with a pressure lubricating system that delivers the oil under pressure to the bearings and bushings, and also lubricates the gears and cylinder walls. The oil usually reaches the bearings through passages drilled in the framework of the engine. The lubricating

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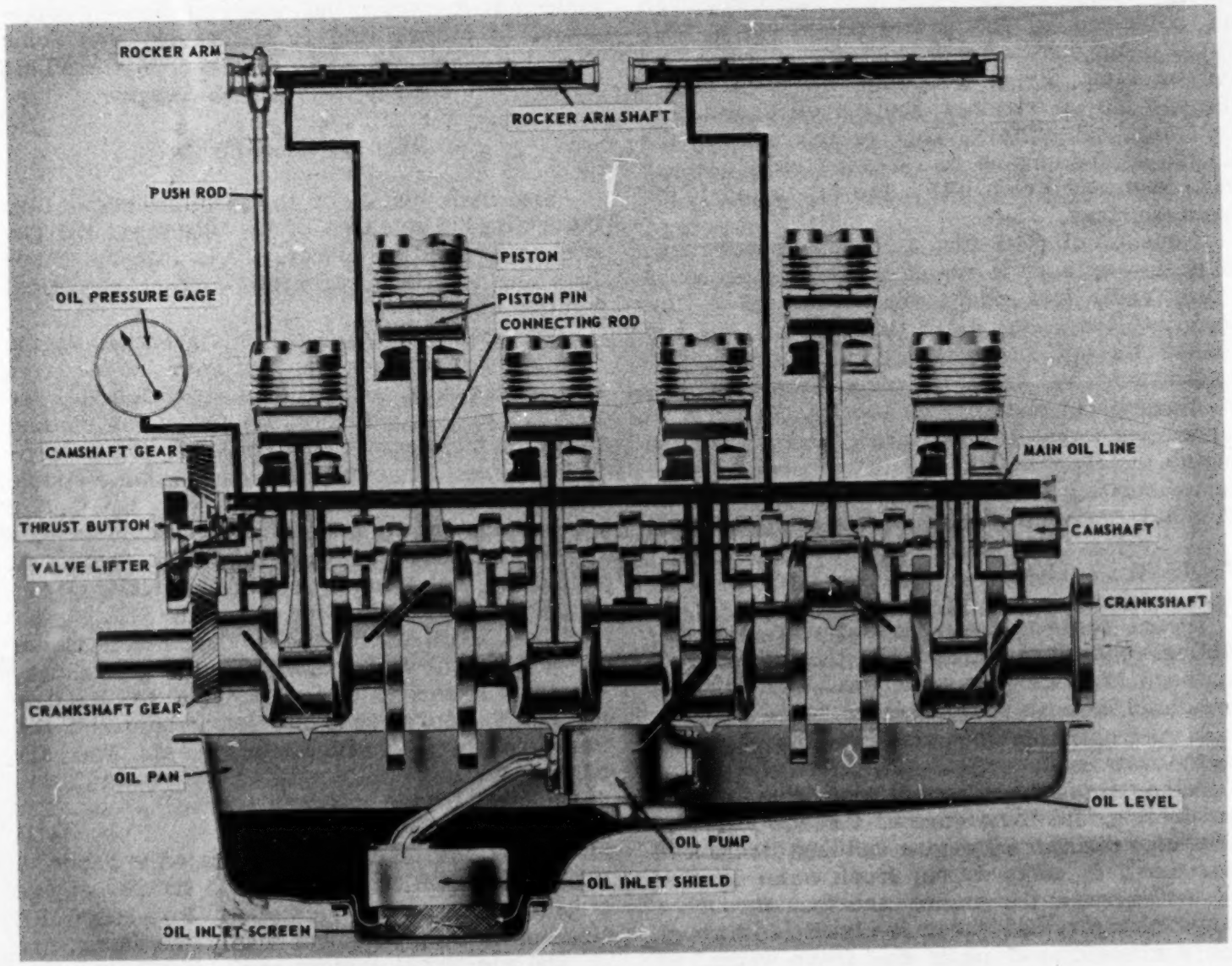

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Figure 12-7.—Basic units and oil passages of a pressure feed lubrication system.

system of a typical diesel engine is shown in figure 12-7.

Many methods of lubricating the individual parts of each type of engine are in use in the different engine models. Generally speaking, the oil is fed from the main gallery through individual passages to the main crankshaft bearings and one end of the hollow camshaft. All the other moving parts and bearings are lubricated by oil drawn from these two sources. The cylinder walls and the teeth of many of the gears are lubricated by oil spray thrown off by the rotating crankshaft. After the oil has served its purpose, it drains back to the sump to be used again.

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The oil pressure in the line leading from the pump to the engine is indicated on a Bourdon-type pressure gage. A temperature gage in the return line provides an indirect method for indicating variations in the temperature of the engine parts. Any abnormal drop in pressure or rise in temperature should be investigated at once. It is advisable to secure the engine until the trouble has been located and corrected.

All of the engine parts are lubricated with oil delivered by the gear-type oil pump. This pump takes suction through a screen from an oil pan or sump. From the pump, the oil is forced through the oil strainer and the oil cooler into the main oil gallery. This gallery extends the length of the engine and serves as a passage and reservoir from which the oil is fed to the main bearings.

Constant oil pressure, throughout a wide range of engine speeds, is maintained by the pressure relief valve that allows the excess oil to flow back into the sump. All of the oil from the pump passes through the strainer, unless the oil is cold and heavy, or the strainer (or oil cooler) is clogged. In such cases, the bypass valve is forced open and the oil flows directly to the engine. Part of the oil fed to the engine is returned through the filter, which removes flakes of metal, carbon particles, and other impurities.

COOLING SYSTEM

Diesel engines are equipped with a water-cooling system to carry away the excess heat produced in the engine cylinders. The water is circulated through water jackets in the cylinder walls and passages that surround the valves in the cylinder head.

Either fresh water or sea water may be used for cooling. In some engines the sea water is circulated through the engine and then discharged overboard. In other types, fresh water is circulated through the engine and then through a heat exchanger. Sea water is circulated through this exchanger and cools the fresh water. An advantage of the fresh water system is that it keeps the water passages cleaner and thus provides better cooling and allows the engine to operate at higher temperatures.

STARTING SYSTEM

The starting system of most small diesel engines follows the familiar gasoline engine design. It consists of a generator, an electric motor that serves as a starter, a suitable battery, and the necessary wiring. The generator keeps the battery charged and provides current for lights and other equipment. The charging rate of the generator is controlled by a voltage regulator, and a cut-out is provided to keep the battery from discharging through the generator at low speed.

When the starter button is pressed, the starter gear engages with the teeth on the flywheel and causes it to rotate; the rotary motion of the flywheel is transmitted to the crankshaft. Some diesel engines are started with compressed air or with a small auxiliary gasoline engine.

GASOLINE ENGINES

The main parts of the gasoline engine are quite similar to those of the diesel engine. The two engines differ principally in that the gasoline engine has a carburetor and an electrical ignition system.

The induction system of a gasoline engine draws gasoline from the fuel tank and air from the atmosphere, mixes them, and delivers the mixture to the cylinders. It consists of the fuel tank, the fuel pump, the carburetor, and the necessary fuel lines and air passages. Flexible copper tubing carries the fuel from the tank to the carburetor, while the intake manifold carries the fuel-air mixture from there to the individual cylinders. The fuel-air mixture is ignited by an electric spark.

The CARBURETOR is a device used for sending a fine spray of fuel into a moving stream of air as it moves to the intake valves of the cylinders. The spray is swept along, vaporized, and mixed (as a gas), with the moving air. The carburetor is designed to maintain the same mixture ratio over a wide range of engine speeds. The MIXTURE RATIO is the number of pounds of air mixed with each pound of gasoline vapor. A RICH MIXTURE is one in which the percentage of gasoline vapor is high, while a LEAN MIXTURE contains a low percentage of gasoline vapor.

The electrical system of the gasoline engine has the same units as the diesel engine, plus the ignition system. This system is designed to deliver a spark in the combustion chamber of each cylinder at a specific point in that cylinder's cycle of operation. A typical ignition system includes a storage battery, an ignition coil, breaker points, a condenser, a distributor, a spark plug in each cylinder, a switch, and the necessary wiring. (See fig. 12-8.)

There are two distinct circuits in the ignition system, called the primary and secondary. The

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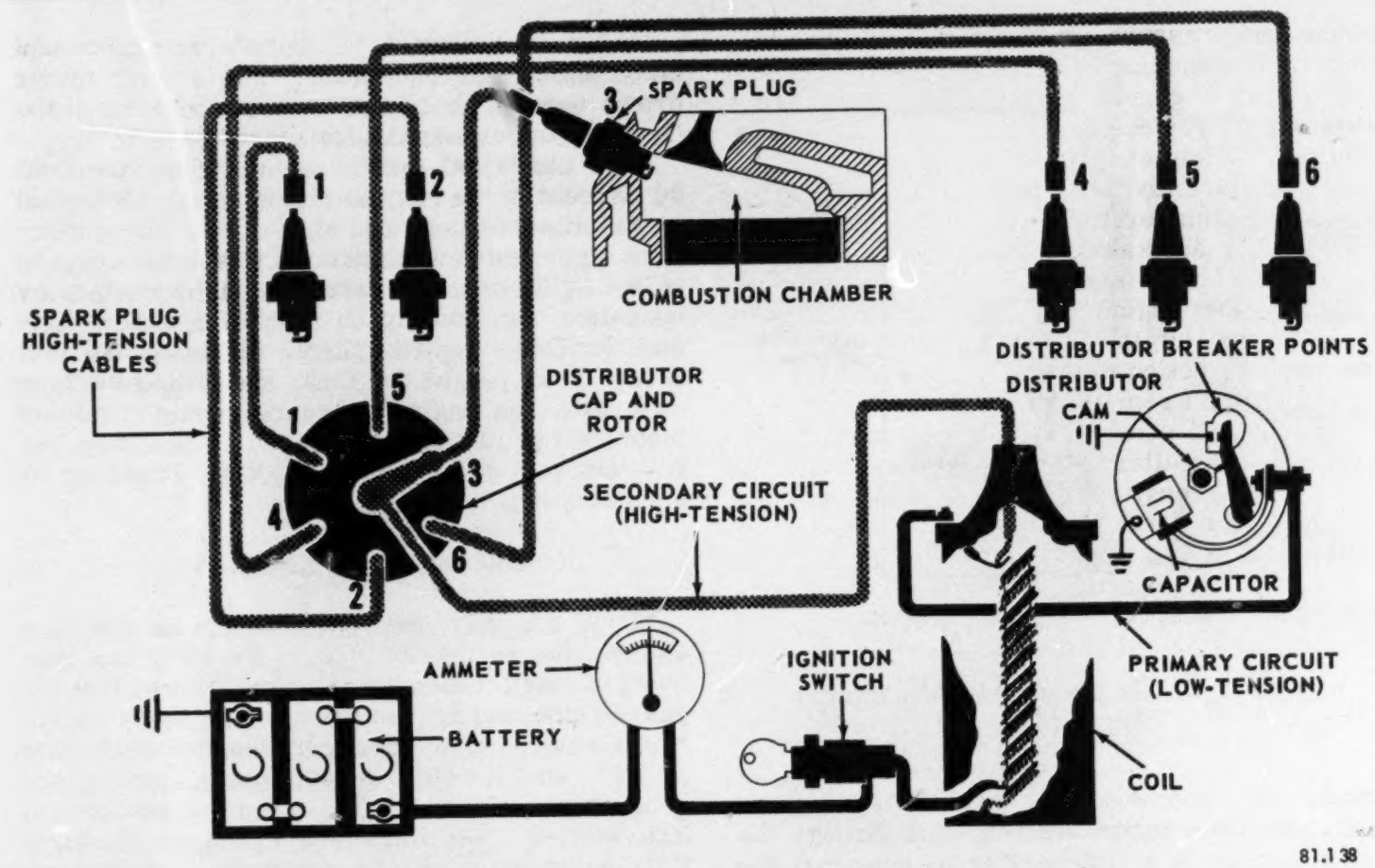

Figure 12-8.—Schematic wiring circuits of an ignition system.

primary circuit carries a low-voltage current, the secondary is a high-voltage circuit. The battery, the ignition switch, the ignition coil, and the breaker points are connected in the primary circuit. The secondary circuit, also connected to the ignition coil, includes the distributor and the spark plugs.

The STORAGE BATTERY is usually the 6- or 12-volt type. One terminal is grounded to the engine frame while the other is connected to the ignition system.

The IGNITION COIL is in many respects similar to an electromagnet. It consists of an iron core surrounded by the primary and secondary coils. The primary coil is made up of a few turns of heavy wire, while the secondary coil has a great many turns of fine wire. In both coils, the wire is insulated, and the coils are entirely separate from each other.

The BREAKER POINTS constitute a mechanical switch connected in the primary circuit. They are opened by a cam that is timed to break the circuit at the exact instant at which each cylinder is due to fire. A condenser is connected across the breaker points to prevent arcing and to provide a better high-voltage spark.

The DISTRIBUTOR, connected to the secondary or high-voltage circuit, serves as a selector switch that channels electric current to the individual cylinders. Although the breaker points are connected in the primary circuit, they are often located in the distributor case. The same drive shaft operates both the breaker points and the distributor.

The SPARK PLUGS, which extend into the combustion chambers of the cylinders, are connected by heavy insulated wires to the distributor. (See fig. 12-9.) A spark plug consists essentially of a metal shell that screws into the spark plug hole in the cylinder, a center electrode embedded in a porcelain cylinder, and a side electrode connected to the shell. The side electrode is adjusted so that the space between it and the center electrode is about 0.025 inch. When the plug fires, an electric spark jumps across this gap between the electrodes.

When the engine is running, the electric current in the primary circuit flows from the battery through the switch, the primary winding in the ignition coil, the breaker points, and then back to the battery. The high voltage is produced in the secondary winding in the ignition coil and flows

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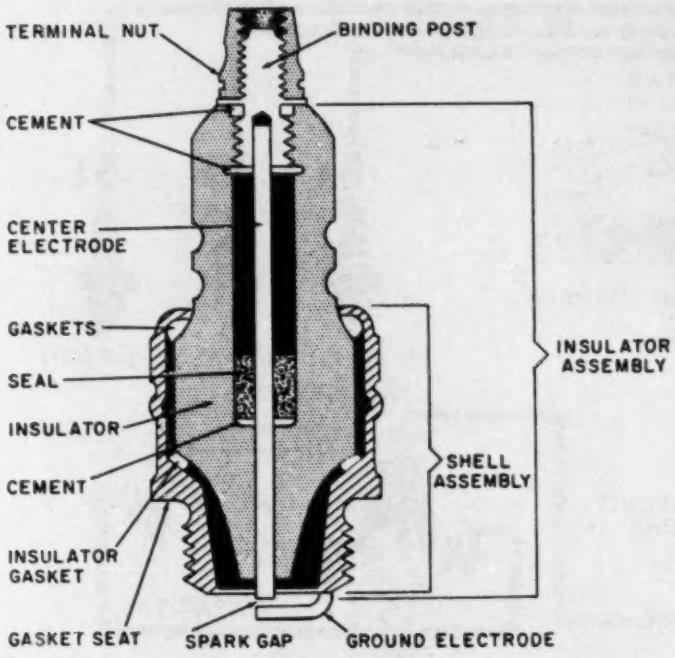

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Figure 12-9.—Sectional view of a typical spark plug.

through the distributor to the individual spark plugs and back to the ignition coil through the engine frame. It is interesting to note that the high voltage, which jumps the gap in the spark plugs, does not come from the battery but is produced in the ignition coil. (See fig. 12-8.)

The ignition coil and the condenser are the only parts of the ignition system that require an explanation. The soft iron core and the primary winding function as an electromagnet. The current flowing through the primary winding magnetizes the core. This same core and the secondary winding function as a transformer. Variations in the primary current change the magnetism of the core, which in turn produces high voltage in the secondary winding.

With the engine running and the breaker points closed, a low-voltage current flows through the primary circuit. When the breaker points open, this current is interrupted; this produces a high voltage in the secondary circuit. The electricity that would otherwise arc across the breaker points as they are separating, now flows into the condenser.

The principal purpose of the condenser is to protect the breaker points from being burned. The condenser also aids in obtaining a hotter spark.

The starting system of the gasoline engine is basically the same as that of the diesel engine. The generator keeps the battery charged and provides the current to operate the lights and other electrical equipment. The starter motor draws current from the battery and rotates the flywheel and crankshaft for starting.

The electrical system usually requires about 90 percent of the routine maintenance performed on gasoline engines. You should keep the connections tightened and the battery terminals covered with a light coating of petrolatum. Unsatisfactory operation can usually be traced to either dirty fuel or fouled spark plugs. Straining the fuel before it is put in the tank, and filling the tank each time the engine is secured would eliminate most of the fuel difficulties. A fouled plug can be removed and cleaned by wire brushing or sand blasting.

GAS TURBINE ENGINES

Until recently, the application of the gas turbine engine to marine use in the Navy has been experimental. Experiments have proved that the gas turbine engine can be used to power short-range ships, landing craft, high-speed craft such as PT and air-sea rescue boats, emergency generators, and portable firefighting equipment. The MSB-5 class minesweepers were the first U.S. naval ships to use gas turbine engines on an operational basis. Gas turbine installations aboard the MSB-5 class minesweepers supply power for the generators. Two gas turbine engines drive the generator through a combining reduction gear (see fig. 12-10). The output shafts of the engines are connected to the combining reduction gear by flexible couplings and overrunning clutches.

Additional marine applications of the gas turbine engine have been made on an operational basis; as service experience has been gained, the number of gas turbines in use has increased. Since both the number of installations and service experiences are limited at present, the following discussion deals with a comparison of gas turbines and reciprocating engines, the advantages and disadvantages of the gas turbine as a marine power plant, and the terminology and operating principles of gas turbine engines and their principal parts, or components.

COMPARISON OF GAS TURBINES AND RECIPROCATING ENGINES

The gas turbine is similar to reciprocating engines in that air is compressed, a fuel-air mixture is burned, and the gases of combustion are expanded to produce useful power. Engines

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comparable application. The gas turbine adjusts to varying loads more rapidly than other type engines.

The number of personnel required to operate and maintain a gas turbine engine, and the time required for the training of such personnel are much less than for engines of other types. Only one man is needed for starting and operating some gas turbine engines. The simplicity of the operating controls and the automatic safety devices used reduce the time required for training operators.

Compared to a diesel engine, the gas turbine has far fewer components and produces much less vibration at full power. The gas turbine engine has a significant advantage over the gasoline engine in the fuel used. The fuel used in gas turbines presents much less of a fire hazard than the highly volatile fuel used in gasoline engines.

Even though the gas turbine engine has some advantages over other types of internal combustion engines, it also has some disadvantages such as a higher rate of fuel consumption and larger components required for air inlet and exhaust.

COMPONENTS OF GAS TURBINE ENGINES

The gas turbine engine uses processes in its operation which are similar to those employed in other types of internal combustion engines. The engine components and the terms used to identify them are considerably different from the parts and terms which are common to the diesel and gasoline engines. The terms defined here and the operating principles and components discussed later are applicable to Boeing 502 two-stage engines. Although gas turbine engines vary in design and Navy installations include engines of other manufacturers, much of the discussion in the following section is applicable to all gas turbine engines.

The components of a gas turbine engine may be grouped as (1) parts of the basic engine, (2) engine accessories, and (3) engine systems. Figure 12-11 shows a 2-stage Boeing 502 engine.

Parts of the Basic Engine

The forward (compressor end) section of the engine, where a stream of hot expandable gases is created as a result of continuous compression and combustion, is called the gas producing section. This section consists principally of the compressor, burners, and first stage turbine wheel.

The COMPRESSOR is that part of the engine which draws in air and compresses it by centrifugal force (that force which tends to move something outward from a center of rotation). The compressor consists of a rotating impeller (a

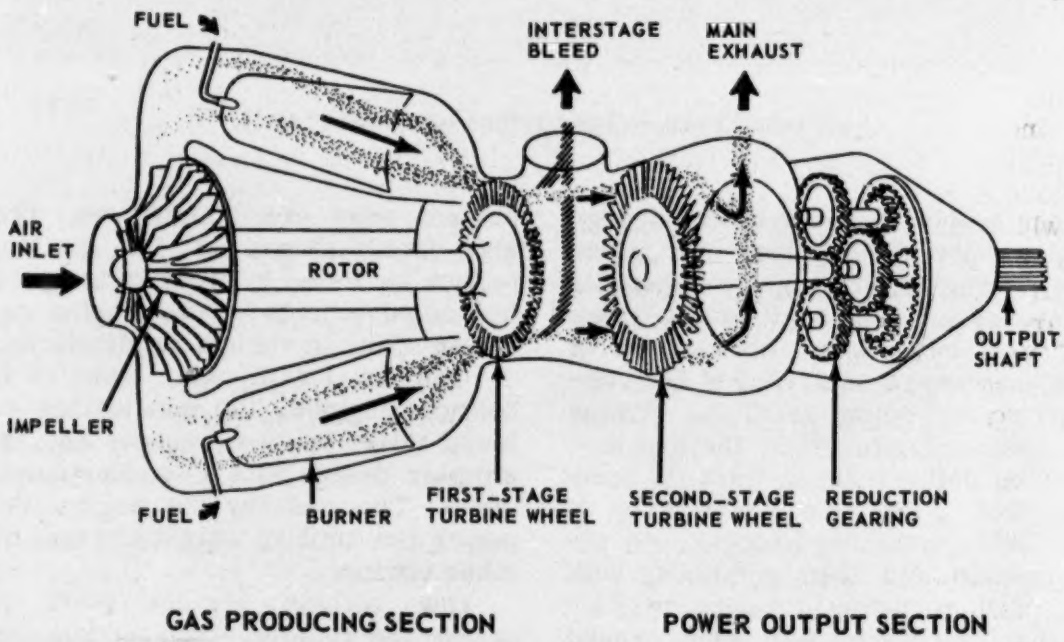

Figure 12-11.—Schematic illustration of a 2-stage gas turbine (Boeing 502).

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vaned disk) enclosed by a case which has diffusing vanes on its inner surface. The BURNER is that part of the engine in which combustion occurs. It consists of a cylindrical outer shell, perforated inner liner, fuel nozzle, and igniter plug. A metal chamber that collects combustion gases from the burners and directs them, through fixed vanes or nozzles, is called the NOZZLE BOX. The rotating assembly, consisting of the compressor impeller, an interconnecting shaft, and first stage turbine wheel, is called the ROTOR.

The section of the engine which changes energy into useful power is known as the power output section. The main parts of this section are the second stage turbine wheel, exhaust ducts, reduction gear, and output shaft.

The TURBINE WHEEL is a bladed disk which turns when the exhaust gas stream acts upon its blades. A circular metal duct, containing a ring of fixed vanes that form nozzles, which directs the gas flow from the first-stage turbine to the second-stage turbine is called the INTERSTAGE BLEED ASSEMBLY. The assembly also provides a means of releasing some of the combustion gases to the exhaust duct ahead of the second-stage turbine. A WASTE GATE (gate-type valve) in the interstage bleed duct controls the escape of combustion gases ahead of the second-stage turbine. An EXHAUST DAMPER (gate-type valve), in the turbine exhaust duct, controls the escape of gases aft of the second-stage turbine.

Engine Accessories

The main engine components discussed to this point are not the only ones required to make a complete engine. Like other types of internal combustion engines, the gas turbine engine includes various accessories.

The parts which constitute the engine accessory group are driven by the engine rotor or by the output shaft. The rotor-driven accessories include the gear-type FUEL PUMP, centrifugal fuel control GOVERNOR, and vane-type combination pressure-scavenge OIL PUMP. A centrifugal OVERSPEED SWITCH is driven by the output shaft.

Engine Systems

The principal systems of a gas turbine engine are those which supply fuel for combustion, oil for lubrication, and electricity or air for starting the engine and the operation of instruments and warning and safety devices. The engine accessories are usually considered as components of whichever system they affect.

OPERATION OF SMALL BOAT ENGINES

When a ship is at anchor, the officers and crew travel to and from the shore in small boats. As a Fireman, you may be assigned as an engineer on one of these small craft. A coxswain will be in charge of the boat. In some boats there may also be two seamen acting as bow and stern hooks.

You will be responsible for operating the boat's engine. You will receive your orders from the coxswain over the boat's bell system. You should know the bell signals; two sounds for neutral, one for slow ahead, three for reverse, and four calls for full speed in the direction in which you are going. The coxswain will expect you to comply with the bells instantly.

DIESEL-POWERED BOAT OPERATION

The actual operation of a small boat diesel might be considered as consisting merely of starting it, regulating the speed, and stopping it. However, there are other factors which should be considered. If you are going to depend on the engine to give reliable service, you must give it a lot of attention. Your first experience in getting stuck halfway between the ship and dock may leave a lasting impression on you, particularly if you happen to have the captain aboard.

When you are assigned to a boat, your first responsibility consists of inspecting the engine and warming it up. You should check the fuel supply, the lubricating oil, and the cooling system. When you are satisfied that everything is as it should be, you are ready to start the engine.

Starting a diesel engine ordinarily consists of CRACKING THE THROTTLE, or opening it part way, and pressing the starter button. The engine should start after the starter has turned it over a couple of times. It should be warmed up by running it at low speed until it is up to operating temperature.

While the engine is warming up, you will have a chance to find out whether or not it is in good running condition. Watching the instrument panel will help you determine the condition of the engine. (See fig. 12-12.) For example, if the oil gage fails to register any pressure, you should stop the engine immediately. The water temperature gage is used as an indirect indication of the temperature of the engine parts. The engine exhaust is usually cooled by sea

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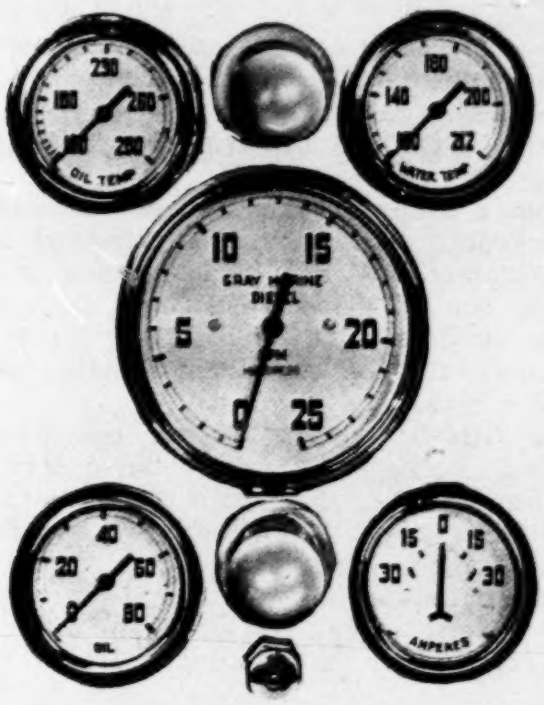

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Figure 12-12.—The instrument panel of a small diesel-powered boat.

water; the exhaust discharge should be inspected immediately after starting to determine if the water pump has suction. If the pump does not have suction, stop the engine and check the cooling system for such troubles as a clogged strainer and closed sea valves. You should check the idling speed by bringing the throttle back to the idling position. The engine should respond normally to changes in the throttle setting, and it should run smoothly after being brought up to operating temperature.

You should know where the fuel- and lube-oil strainer drains are located, so that you can get rid of any water that may accumulate in these systems. If lube oil must be added, see that the proper grade approved for that particular engine is used.

The engine can be stopped by merely closing the throttle. You should leave the engine compartment clean and orderly. A report calling attention to any abnormal operating condition that you may have noticed will be a help to the maintenance and servicing crew.

Another important part of your job is TROUBLESHOOTING. Diesel engine failure can usually be attributed either to the fuel system or to improper cooling or lubrication. If the fuel is not reaching the engine cylinders, you can often trace the trouble to an empty fuel tank or an accumulation of water in the strainers. A plugged vent in the fuel tank filler cap will cause a vacuum to form in the top of the tank, and the engine will stop for want of fuel. Overheating generally results from a lack of either oil or cooling water.

GASOLINE ENGINE OPERATION

The operation of a small boat gasoline engine is similar to that of a diesel engine. Since gasoline from a leak or an open container will vaporize quickly and may form an explosive mixture, additional precautions against fire must be taken. Adequate ventilation must be provided to rid the engine compartment of any combustable vapors which may accumulate. No smoking is permitted in small boats at any time, this is especially important in boats equipped with gasoline engines.

More gasoline engines stop because of ignition trouble than for any other reason. Defects in the ignition system can usually be detected by either hard starting or irregular firing of the cylinders. Hard starting can generally be traced to dirty and pitted breaker points, or too wide a gap between the points. A missing cylinder can usually be corrected by cleaning the faulty spark plug.

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CHAPTER 13

ENGINEERING WATCHES

Throughout the chapters of this training course you have become acquainted with the organization and ratings of the engineering department. You may be assigned to one of many different types of ships. On these ships you will find that the engineering spaces will vary in size and appearance. If you are assigned to a steam-driven ship, you may find the boilers, the main engines, and their associated equipment in one space; or you may find the boilers and their equipment in one space, and the main engines and their equipment in another space. Regardless of the number of boilers and main engines, many of the watches are basically the same. Therefore the information in this chapter is general in nature and does not apply strictly to any one ship.

This chapter contains information related to some of the watches and the duties that you will be required to perform, such as messenger of the watch, sounding and security watch, and cold-iron watch. As you progress and become acquainted with the fireroom or engineroom you will be required to stand other watches under the supervision and instruction of a petty officer. These watches include: (1) for the fireroom, burnerman, blowerman, and checkman and (2) for the engineroom, lower level watch, upper level watch, evaporator watch, shaft alley watch, and throttle watch.

MESSENGER OF THE WATCH

The messenger of the watch performs a number of important duties that involve a great deal of responsibility. The messenger is usually assigned as telephone talker on the engineering JV circuit, during close maneuvering conditions with other ships, when entering or leaving port, or when refueling or replenishing from another ship. Because the JV circuit is used to provide communications between all the engineering spaces, you must know proper telephone procedures; when you talk, speak slowly and in a very distinct manner pronouncing the syllables of each word very clearly. When you receive a message, or are given a message to transmit, be sure to repeat it word for word, exactly as it was given to you; do not engage in any idle chatter.

As the messenger on watch you will also perform such other duties as the petty officer of the watch may designate. This includes checking all operating machinery to see that it is operating properly, recording temperature and pressure readings in the appropriate logs, and calling the watch relief.

The operating log is an hourly record of operating pressures and temperatures of almost all operating machinery. The log readings include lube oil pressures and temperatures, boiler pressures and temperatures, pump suctions and discharge pressures, and other items of importance to the operation of the engineering plant. You should become acquainted with proper operating pressures and temperatures so that you will know when a piece of machinery or equipment is not operating properly.

SOUNDING AND SECURITY WATCH

As a Fireman, you will be required to stand sounding and security watches. While on this watch, your primary mission is to look for fire and flooding hazards. On most ships, this watch is stood from the end of the working day until 0800 the next morning and during holiday routine. The watch is particularly needed at these times because there are fewer personnel working aboard the ship and certain spaces that require frequent observation are not under the normal observation of personnel working in or near them. On some ships (particularly the larger ones), sounding and security watches are stood around the clock. In addition to looking for fire and flooding hazards, be sure no fresh water spigots are leaking or left running in heads, washrooms, galleys, and pantries. Another of your responsibilities while on watch is to maintain the proper condition

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of material readiness by checking all watertight air ports, doors, hatches, scuttles, and all other damage control fittings. Report any irregular condition (change in soundings, violations of material condition, fire hazards, etc.) to the officer of the deck.

SOUNDINGS

A sounding tube is usually made of 1 1/2-inch pipe. The lower end is fitted at a low point in the compartment, tank, or void which the tube serves. The upper end terminates in a flush deck plate which is usually located on the main or second deck; it is closed with a threaded plug or cap.

Tubes are made as straight as possible, but some are necessarily curved. Some sounding tubes, particularly those serving spaces under the enginerooms and firerooms, cannot be extended to the upper decks because of the construction of the ship. These tubes terminate in risers which extend approximately 3 feet above the compartment served; they have gate valve closures.

Soundings are taken with a sounding rod or sounding tape, whichever is provided for that purpose aboard ship. The sounding rod is normally about 6 feet long and is made of 12-inch lengths of 1/2-inch brass or bronze rods. It is lowered with a chain or line. The sounding tape is a steel tape, coiled on a reel suitable for holding while the tape is lowered. The tape is weighted at the end to facilitate lowering into the sounding tube.

HOW TO TAKE A SOUNDING

Before you take a sounding, dry the rod or tape thoroughly and coat it with white chalk. Water is relatively hard to see on a brass or bronze sounding rod; however, when the chalk becomes wet, it turns to a distinctly visible light brown color. For example, if there is 6 inches of water in a tank whey you take a sounding, the light brown color of the chalk will be distinctly visible up to the 6-inch mark; while the remainder of the sounding rod will still be covered with the white chalk. The chalk method is used only where water may be present.

When the sounding rod has been coated with chalk, lower it down the tube until it touches the bottom; immediately draw it back. Do not drop the rod or tape to the bottom, but lower it slowly so that it hits bottom without injuring the rod or tape. If the ship is rolling, try to lower and hoist the rod or tape while the ship is on an even keel. After you have taken the sounding, enter the reading in the sounding log.

COLD-IRON WATCH

When a ship moves alongside a repair ship or a tender, or into a naval shipyard, and is receiving power from these activities, a security and fire watch is usually set by each department. This watch is commonly called the COLD-IRON WATCH.

Each cold-iron watch makes frequent inspections of the area assigned to him, and looks for fire hazards or other unusual conditions throughout the area. He sees that no unauthorized persons are in his watch area, that all spaces are cleaned, and that no tools, rags, gear, and the like are left adrift. He keeps bilges reasonably free of water.

The watch makes hourly reports to the officer of the deck as to all existing conditions. Any unusual conditions that do exist are reported to the officer of the deck immediately so that the department responsible can be notified to take the necessary corrective measures.

In the event that welding or burning is going on in his area, the cold-iron watch sees that a fire watch is stationed. (The fire watch stands by with a CO_2 extinguisher.) if none has been stationed, he should have the work discontinued until the fire watch has been stationed. The cold-iron watch carries out all orders and special orders pertaining to the duties of that watch.

If the ship is in drydock, the watch must check all sea valves after working hours, to see that the valves are secure or are blanked off. He must see that no oil is pumped into the drydocks at any time. He will not allow any weights, such as fuel oil, feed water, or potable water, to be shifted without permission of the engineer officer.

The cold-iron watch is required to be familiar with all regulations, instructions, and safety precautions and must see that these are observed. He gives his relief all information regarding existing conditions, orders, and special orders. If the relieving watch is not satisfied with the conditions, he will not relieve him, but will report for instructions to the petty officer with the day's duty.

BURNERMAN

The burnerman maintains proper steam pressure by cutting in or out burners, or by regulating the fuel oil pressure at the burners. The steam pressure must be held at the working pressure, and as steady as possible. The burnerman

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must keep a close check for dirty atomizers, by observing their operation and condition of the fire. He changes the atomizers when authorized by the petty officer in charge of the watch.

The burnerman depends upon a steam pressure gage and a superheated steam temperature thermometer for information on conditions within the boiler. In most cases an engine order telegraph (annunciator) is located near the burner front so that the fireroom watch may know what main engine changes are being made.

As engine speed and steam conditions change, the burnerman must rapidly cut burners in or out as required to hold the steam pressure steady. During maneuvering in close contact with other ships, and when the ship is entering or leaving port, the burnerman must be constantly alert for large rapid changes in engine speed.

BLOWERMAN

The blowerman is responsible for operating the forced draft blowers that supply combustion air to the boiler. Although the air pressure in the double casings is affected by the number of registers in use and the extent to which each register is open, it is chiefly determined by the manner in which the forced draft blowers are operated. The opening, setting, or adjusting of the air registers is the BURNERMAN'S job. The control of forced draft blowers is the blowerman's job. It is important for the burnerman and the blowerman to cooperate with each other, since both are concerned with the combustion of the fuel oil.

CHECKMAN

The checkman is responsible for operating the feed stop valve and the feed check valve. The checkman has ONLY ONE JOB—that of maintaining the proper water level in the boiler. This job requires full attention at all times. When a boiler is being operated manually, the checkman must NEVER be given any other duties.

Some ships are equipped with fully automatic feed water controls. On these ships a checkman is not needed when the feed water is being controlled automatically. However if the automatic system fails or is swtiched to manual control, then a checkman must be immediately stationed on the checks.

THROTTLE WATCH

Being a throttleman at the main engines is a very important task. Orders from the bridge relative to movement of the propellers must be complied with immediately. To make correct adjustments for the required speed you have to keep a close watch on the rpm indicator on the throttle board, and open and close the throttle as required to attain or maintain the necessary rpm. In addition to handling the throttle itself, you may also have to operate various associated valves, accurately log all speed changes in the Engineer's Bell Book, visually check all gages (pressure, temperature, vacuum, etc.) installed on the throttle board, and keep the petty officer in charge informed of any abnormal gage readings.

You should become thoroughly familiar with all the gages, instruments, and indicators on the throttle board so that you will know what a normal reading is. There are steam pressure gages, steam temperature thermometers, a revolutions-per-minute (rpm) indicator, an engine order telegraph, feed water pressure gages, cooling water pressure gages, gages indicating the vacuum obtained in the main engine low pressure turbine, and others. Whenever an opportunity presents itself, study the throttle board and ask questions. Do not hesitate to ask the operator if those are normal readings and if they are the approximate readings you should always see there during steaming conditions. When you have learned the difference between a normal reading and an abnormal reading you may possibly help to prevent a major casualty by observing an abnormal reading and reporting it to the petty officer in charge of the watch.

LOWER LEVEL WATCHES

When you are assigned to the lower level to assist the lower level watch (pumpman) and to learn his duties and responsibilities, you will find a considerable number of pumps and other auxiliary machinery. Some of the pumps and equipment you will find are the main lube oil pumps and lube oil coolers, main condensate pumps and main condenser—and when installed in the engineroom—main feed pumps, main feed booster pumps, and fire pumps. In some installations you will also find air compressors on the lower level.

In addition to learning the proper procedures for starting, operating, and stopping the pumps and equipment, various routine checks must be made on the operating machinery. Some of the checks for the main feed pump, the lube oil pump, and the main condensate pump, are discussed in the sections that follow. Under the watchful

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eye of the pumpman you will learn how to make the following checks and perform the following duties.

MAIN FEED PUMP

In addition to complying with the posted instructions and safety precautions for the machinery and equipment at his station the pumpman performs the following duties:

1. Maintains main feed pump discharge pressure at a predetermined value by adjusting the constant pressure governor.
2. Keeps main feed pump bearings at the proper temperature by regulating the flow of water through the feed pump lube oil cooler.
3. Checks to ensure proper lube oil pressure to the bearings.
4. Keeps shaft packing glands adjusted properly. A small leakage is necessary for lubrication to prevent burning out the packing but an excessive amount of leakage wastes boiler feed water.
5. Checks and maintains proper lube oil level in the main feed pump sump tank.
6. Keeps valve packing glands tightened to prevent leakage.
7. Keeps his watch station clean; removes fire hazards by wiping up oil and picking up rags and other stray gear.
8. Is alert for unusual sounds, vibrations, temperatures, and pressures.
9. Keeps the standby pump ready for instant use.

LUBE OIL PUMP

1. Maintains the proper lube oil pump discharge pressure, by adjusting the constant pressure governor.
2. Keeps the standby pump on automatic standby, ready for instant use.
3. Shifts and cleans main lube oil strainers once a watch or more often if required.
4. Checks the lube oil system for leaks and maintains the proper oil level in the main engine sump tank.
5. Operates the lube oil purifier as ordered.
6. Checks the oil pressure to the lube oil service pump bearings and maintains the oil at the proper temperature by regulating the amount of water through the pump lube oil cooler.
7. Regulates the cooling water flow through the main lube oil cooler to maintain the correct oil outlet temperature.

MAIN CONDENSATE PUMP

1. Keeps the condensate in the condenser hot well at the proper level.
2. Frequently checks the exhaust trunk and main condenser overboard for abnormal temperatures.
3. Checks the main condensate pump bearings for proper oil pressure and temperature.
4. Keeps the main condenser vented.
5. Starts or secures an additional pump, as required, to keep the condensate level at the correct height.
6. Constantly checks for unusual conditions such as vibrations, sounds, and high or low temperatures or pressures.

All watchstanders should be constantly alert for signs of leakage in all parts of the steam and water systems. Some of the more common causes of feed water waste are as follows: (1) leaks in pipe fittings, flanges, valve and pump packing glands, pump housings and relief valves; (2) use of excessive gland sealing steam; and (3) failure to shift drains from the bilges to the appropriate drain system. Using an excessive amount of boiler feed water is an indication of a poorly operated plant and reflects on the ability of the watchstander.

UPPER LEVEL WATCH

When you are assigned to learn the duties of the upper level watch in the engineroom, you will record periodic temperature and pressure readings from the various gages on, or connected to, the upper level machinery; make required valve adjustments to correct conditions indicated by slight variations from the normal readings, and report unusual conditions to the petty officer in charge; maintain a normal water level in the deaerating tank, if it is in the engineroom, by adjustments of the excess and make-up feed valves; start and stop turbogenerators, and other upper level machinery, as ordered; and maintain an adequate gland seal pressure on the turbogenerator.

SHAFT ALLEY WATCH

Another main engine duty to which you may be assigned is that of keeping watch on the bearings of the propeller shafts leading from the reduction gears (or motors of a turbo-electric driven ship) to the ship's propellers. The SHAFT ALLEY WATCHSTANDER:

1. Checks all spring bearings for proper lubrication, including correct oil level, condition

of the oil, proper operation of self-oiling devices (ring or chain), and bearing temperature.

2. Checks and adjusts stern tube gland for correct amount of leak-off.

3. Is responsible for having the shaft alley bilge pumped.

4. Is to be especially alert during high speed to observe any abnormal rise in bearing temperature.

5. Reports hourly, by phone, to the control engineroom and at any time that abnormal conditions develop.

6. In ships which have the main thrust bearing in the shaft alley, is responsible for operation of the main thrust bearing lube oil system.

7. Performs any other additional duties which may be assigned.

EVAPORATOR WATCH

A ship requires a large amount of pure fresh water, daily, yet a ship can only store sufficient water to last a few days; therefore proper and careful watches must be maintained on the evaporators whenever they are in operation. Proper watchstanding requires the operator to constantly check pressures, temperatures, vacuum, and salt content of the distilled water. The ship cannot operate if the distilled water that is to be used for feed water contains more salt than the maximum allowable limits.

OTHER WATCHES OR ASSIGNMENTS

Each division officer prepares a Watch, Quarter, and Station Bill for his division. You will generally find the following information on this bill:

1. Organization of the division (i.e., sections and watches).

2. Listing of each man as to billet number, locker number, bunk number, compartment number, name, rating, and rate (actual and allowance).

3. Watch assignments for each man under various conditions of battle readiness.

4. Station each man will have and what he will provide for emergency situations such as Fire, Rescue and Assistance, and General Emergency.

5. Visit and search party, landing force, special sea detail, and other special duties and stations which each man is assigned.

The Watch, Quarter, and station Bill tells you where you fit into the ship's organizational picture: Check it frequently, for it is your duty to know where you belong under all conditions. There is NO EXCUSE FOR NOT KNOWING. The bills may be differently designed for different ships, but the stations and duties are always approximately the same.

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APPENDIX I

TRAINING FILM LIST

Certain training films that are directly related to the information presented in this training course are listed under the appropriate chapter numbers and titles. Unless otherwise specified, all films listed are black and white with sound, and are unclassified. For a description of these and other training films that may be of interest, see the United States Navy Film Catalog, NavPers 10000 (revised).

Chapter 3

ENGINEERING FUNDAMENTALS

MN-1730A	Elementary Hydraulics—Part 1. (16 Min.—1943.)
MN-1730B	Elementary Hydraulics—Part 2. (16 Min.—1943.)
MN-1730C	Elementary Hydraulics—Part 1. (12 Min.—1943.)
MN-1730D	Elementary Hydraulics—Part 2. (14 Min.—1943.)
MC-6932B	Force and Motion. (10 Min.—1950.)
SC-6933	The Atom. (56 frames—Color—Silent—1949.)

Chapter 4

SHIP PROPULSION

MN-47	Marine Diesel Engines for Power Boats. (16 Min.—1942.)
MN-2835B	Turbine-Electric AC Drive (Destroyer Escort). (15 Min.—1944.)

Chapter 5

BASIC STEAM CYCLE

MN-6732A	Naval Steam Turbines—The Steam Cycle. (17 min.—1951.)
MN-6903A	The Engine Room—Steam Cycle. (10 min.—1951.)

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MN-9223A Boilers and Their Operation—How Boilers Work. (15 min.—1955.)

MN-9356A Deaerating Feed Tanks—Theory of Operation. (16 min.—1955.)

Chapter 6

BOILERS

MN-7862A Boiler Repairs—Fire Side—Building Walls and Floors. (13 min.—1954.)

MN-9223E Boilers and Their Operation—Types of Naval Boilers. (14 min.—1956.)

MN-9223F Boilers and Their Operation—How Fuel Oil Burners Work. (11 min.—1956.)

Chapter 7

STEAM TURBINES AND REDUCTION GEARS

MN-6732B Naval Steam Turbines—How Turbines Work. (17 min.—1950.)

Chapter 8

AUXILIARY MACHINERY AND EQUIPMENT

MN-8208 Electro-Hydraulic Steering Gear. (15 min.—1956.)

MN-7489C Water Purification—Vapor Compression Distillation. (14 min.—Color—1953.)

MN-9343B High Pressure Air Compressors—Worthington Operation. (13 min.—1954.)

MN-3706A Distilling Plants—Low Pressure Type (Griscom-Russell) How It Works—Part I. (13 min.—1944.)

MN-3706B Distilling Plants—Low Pressure Type (Griscom-Russell) How It Works—Part II. (18 min.—1944.)

Chapter 10

PUMPS, VALVES, AND PIPING

MN-6741 Ships Pumps. (16 Min.—1951.)

MN-2505 Mechanical Packing Aboard Ship. (30 Min.—1945.)

MN-8428 Reseating Steam Valves in Place. (15 Min.—1956.)

SN-4057 Centrifugal Pumps Aboard Ship—Care and Repair. (14 Min.—1944.)

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Chapter 11

SHIPBOARD ELECTRICAL EQUIPMENT

SN-229A	Current Electricity - Part 1. (24 frames—Silent—1942.)
SN-229B	Current Electricity - Part 2. (27 frames—Silent—1942.)
SN-229C	Current Electricity - Part 3. (26 frames—Silent—1942.)
SN-233A	The Storage Battery - Part 1. (23 frames—Silent—1942.)
SC-793	Alternating Current - Basic Electricity Kit. (92 frames—Silent—1943.)

Chapter 12

INTERNAL COMBUSTION ENGINES

MN-43	The Construction of Diesel Engines. (15 min.—1942.)
MN-47	Marine Diesel Engines for Power Boats. (16 min.—1942.)
SG-1764A	The Four-Stroke Cycle Internal Combustion Engine—Part 1. (39 frames—Silent—1943.)
SG-2315	Reciprocating Engine Construction. (65 frames—Silent—1943.)
MN-7407A	Marine Gas Turbine Engine—Principles of Operation. (18 min.—Color—1952.)

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APPENDIX II

GLOSSARY—ENGINEERING TERMS

When a man enters a new occupation, he is faced with the necessity of learning the vocabulary of the trade in order to understand his fellow workmen, and make himself understood by them. Shipboard life requires that the Navyman learn a relatively new vocabulary—even new terms for many commonplace items. The reasons for this need are many, but most of them boil down to convenience and safety. Under certain circumstances, a word or a few words mean an exact thing or a certain sequence of actions, making it unnecessary to give a lot of explanatory details.

A great deal of the work of a Fireman is such that an incorrectly interpreted instruction could cause confusion, breakage of machinery, or even loss of life. Avoid this confusion and its attendant danger by learning the meaning of terms common to the Engineering Department.

This glossary is not all-inclusive, but it does contain many terms the meaning of which every Fireman should know. The terms given in this glossary may have more than one definition; only those definitions as related to engineering are given.

ABT (AUTOMATIC BUS TRANSFER): An automatic electrical device that supplies power to vital equipment. This device will shift from the normal power supply to an alternate power supply when the normal supply is interrupted.

ACETYLENE: A gas that is chemically produced from calcium carbide and water, used for welding and cutting.

ADAPTER: A coupling or similar device that permits fittings with different-sized openings (apertures) to be joined together.

AIR EJECTOR: A type of jet pump, used to remove air and other gases from the condensers.

AIR CHAMBER: A chamber, usually bulb-shaped, on the suction and discharge sides of a pump. Air in the chamber acts as a cushon and prevents sudden shocks to the pump.

AIR REGISTER: A device in the casing of a boiler, used for regulating the amount of air for combustion and to provide a circular motion to the air.

AISE: Association of Iron and Steel Engineers.

ALLOY: A mixture composed of two or more metals.

ALTERNATING CURRENT (A-C): Current that is constantly changing in value and direction at regular recurring intervals.

AMBIENT TEMPERATURE: The temperature of the surrounding area.

AMMETER: An instrument for measuring the rate of flow of electrical current in amperes.

ANNEALING: The softening of metal by heating and slow cooling.

ANNUNCIATOR: See ENGINE ORDER TELEGRAPH.

ARGON: An inert gas, slightly heavier than air, used in inert-gas shielded metal arc welding.

ARMORED CABLE: An electric cable that is protected on the outside by a metal covering.

ASTM: American Society for Testing Metals.

AUTOMATIC COMBUSTION CONTROL SYSTEM (ACC): A system that provides a means of automatically controlling the fuel and air mixture in a boiler.

BACK PRESSURE: The pressure exerted on the exhaust side of a pump or engine.

BDC (BOTTOM DEAD CENTER): The position of a reciprocating piston at its lowest point of travel.

BALLASTING: The process of filling empty tanks with salt water, to protect the ship from underwater damage and increase its stability. See DEBALLASTING.

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BLUEPRINTS: Reproduced copies of drawings (usually having white lines on a blue background.

BOILER: A strong metal tank or vessel composed of tubes, drums, and headers, in which water is heated by the gases of combustion to form steam.

BOILER CENTRAL CONTROL STATION: A centrally located station for directing the control of all boilers in the fireroom.

BOILER DESIGN PRESSURE: Pressure specified by the manufacturer, usually about 103% of normal steam drum operating pressure.

BOILER INTERNAL FITTINGS: All parts inside the boiler which control the flow of steam and water.

BOILER OPERATING PRESSURE: The pressure required to be maintained in a boiler while in service.

BOILER OPERATING STATION: A location from which boilers are operated.

BOILER RECORD SHEET: A NavShips form maintained for each boiler, which serves as a monthly summary of operation.

BOILER REFRACTORIES: Materials used in the boiler furnace to protect the boiler from heat of combustion.

BOILER ROOM: A compartment containing boilers but not containing a station for operating or firing the boilers. Refers specifically to bulkhead enclosed boiler installations.

BOILER TUBE CLEANER: A CYLINDRICAL brush that is used to clean the insides of boiler tubes.

BOILER WATER: Refers to the water actually contained in the boiler.

BRAZING: A method of joining two metals at high temperature with a molten alloy.

BRINE: A highly concentrated solution of salt in water, normally associated with the overboard discharge of distilling plants.

BRITTLENESS: That property of a material which causes it to fracture prior to any noticeable signs of deformation.

BURNERMAN: Man in fireroom who tends the burners in the boilers.

BUSHING: A renewable lining for a hole through which a moving part passes.

BYPASS: To divert the flow of gas or liquid. Also, the line that diverts the flow.

CALIBRATION: The comparison of any measuring instrument with a set standard.

CANTILEVER: A projecting arm or beam supported only at one end.

CAPILLARY TUBE: A slender thin-walled small-bored tube used with remote-reading indicators.

CARBON DIOXIDE: A colorless, orderless gas used as a fire extinguishing agent and for inflating liferafts and lifejackets.

CARBON PACKING: Pressed segments of graphite used to prevent steam leakage around shafts.

CASUALTY POWER SYSTEM: A means of using portable cables to transmit power to vital equipment in an emergency.

CHECK VALVE: A valve that permits a flow of liquid in one direction only.

CHILL SHOCKING: A method of removing scale from the tubes of a distilling plant, utilizing steam and cold water.

CHLORINE: A heavy gas, greenish-yellow in color used for water purification, sewage disposal, and in the preparation of bleaching solutions. Poisonous in concentrated form.

CIRCUIT BREAKER: An electrical device that provides circuit overload protection.

CLUTCH: A form of coupling which is designed to connect or disconnect a driving or driven member.

COMPARTMENT CHECKOFF LIST: A list of all damage control fittings, their location, and status for different ship conditions.

CONDENSER: A heat transfer device in which steam or vapor is condensed to water.

CONDUCTION: A method of heat transfer from one body to another when the two bodies are in physical contact.

CONSTANT PRESSURE GOVERNOR: A device that maintains a constant pump discharge pressure under varying loads.

CONTROLLER: A device used to stop, start, and protect motors from overloads, while they are running.

CORROSION: The process of being eaten away gradually by chemical action, such as rusting.

COUNTERSINK: A cone-shaped tool used to enlarge and bevel one end of a drilled hole.

CROSS-CONNECTED PLANT: A method of operating two or more plants as one unit, having a common steam supply.

CURTIS STAGE: A velocity-compounded impulse turbine stage having one pressure drop in the nozzles and two velocity drops in the blading.

DEAERATING FEED TANK (DA TANK): A unit in the steam-water cycle used to (1) free the condensate of dissolved oxygen, (2) heat the feed water, and (3) act as a reservoir for feed water.

DEBALLASTING: The process of emptying salt from tanks, to protect the ship from underwater damage and increase its stability.

DEGREE OF SUPERHEAT: The amount by which the temperature of steam exceeds saturation temperature.

DIATOMACEOUS EARTH: A light, crumbly silica material derived from algae and microscopic skeletons. It has relatively high absorption and filtering qualities.

DIATOMITE FILTERS: Filters made of a diatomaceous earth and asbestos filler.

DIRECT CURRENT (D-C): Current that moves in one direction only.

DIRECT DRIVE: One in which the drive mechanism is coupled directly to the driven member.

DISTILLATE: Fresh water produced in distilling plants.

DISTILLING PLANTS: Units commonly called evaporators (evaps) used to convert sea water into fresh water.

DRAWING: The plans used to show the fabrication and assembly details.

DRUM, STEAM: The large tank at the top of the boiler in which the steam collects.

DRUM, WATER: A tank at the bottom of a boiler; also called MUD DRUM.

DRY PIPE: A perforated pipe at the highest point in a steam drum to collect steam.

DUCTILITY: Property possessed by metals that allows them to be drawn or stretched.

ECONOMIZER: A heat transfer device on a boiler that uses the gases of combustion to preheat the feed water.

EDUCTOR: A jet type pump (no moving parts) used to empty flooded spaces.

EFFICIENCY: The ratio of the output to the input.

ELASTICITY: The ability of a material to return to its original size and shape.

ELECTRODE: A metallic rod (welding rod) used in electric welding that melts when current is passed through it.

ELECTROHYDRAULIC STEERING: A system having a motor-driven hydraulic pump that creates the force needed to actuate the rams to position the ship's rudder.

ELECTROLYSIS: A chemical action that takes place between unlike metals in systems using salt water.

ELECTROMOTIVE FORCE (EMF): A force that causes electrons to move through a closed circuit; expressed in volts.

ELEMENT: A substance which consists of chemically united atoms of one kind.

ENERGY: The capacity for doing work.

ENGINEER'S BELL BOOK: A legal record maintained by the throttle watch of all ordered main engine speed changes.

ENGINE ORDER TELEGRAPH: A device on the ship's bridge to give orders to the engineroom. Also called ANNUNCIATOR.

EPM (EQUIVALENTS PER MILLION): The number of equivalent parts of a substance per million parts of another substance. The word "equivalent" refers to the equivalent weight of a substance.

EXPANSION JOINT: A junction which allows for expansion and contraction.

FATIGUE: The tendency of a material to break under repeated strain.

FEED HEATER: A heat transfer device used to heat the feed water before it goes to the boiler.

FEED WATER: Fresh water, with the highest possible level of purity, made in EVAPORATORS for use in boilers.

FERROUS METAL: Metal with a high iron content.

FIREBOX: The section of a ship's boiler where fuel oil combustion takes place.

FIREMAIN: The salt water line that provides firefighting and flushing water throughout the ship.

FIRE TUBE BOILER: Boilers in which the gases of combustion pass through the tubes and heat the water surrounding them.

FLAREBACK: A backfire of flame and hot gases into a ship's fireroom from the firebox. Caused by a fuel oil explosion in the firebox.

FLASH POINT OF OIL: That temperature at which the oil vapor will flash into fire but the main body of the oil will not ignite.

FLEXIBLE I-BEAM: An I-shaped steel beam on which the forward end of a turbine is mounted; it allows for longitudinal expansion and contraction.

FLOOR PLATES: The removable deck plating of a fireroom or engineroom aboard ship.

FLUX: A chemical agent that retards oxidation of the surface, removes oxides already present, and aids fusion.

FORCE: Anything that tends to produce or modify motion.

FORCED DRAFT: A term used to describe air under pressure supplied to the burners in a ship's boiler.

FORCED DRAFT BLOWERS: Turbine-driven fans which supply air to the boiler furnace.

FORCED FEED LUBRICATION: A lubrication system that uses a pump to maintain a constant pressure.

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FORGING: The forming of metal by heating and hammering.

FRESH WATER SYSTEM: A piping system which supplies fresh water throughout the ship.

FUEL OIL MICROMETER VALVE: A valve installed at the burner manifold, which is used to control the fuel oil pressure to the burners.

FUEL OIL SERVICE TANKS: Tanks from which the fuel oil service pumps take suction for discharging oil to the burners.

FUSE: A protective device that is designed to open a circuit if the current flow exceeds a predetermined value.

GAGE GLASS: A device for indicating the liquid level in a tank.

GAS-FREE: A term used to describe a space that has been tested and found safe for hot work (welding & cutting).

GEARED-TURBINE DRIVE: A turbine that drives a pump, generator, or other machinery through reduction gears.

GROUNDED PLUG: A three pronged electrical plug used for grounding portable tools to the ship's structure. It is a safety device which always must be checked prior to using portable tools.

HAGEVAP SOLUTION: A chemical compound used in distilling plants, to prevent the formation of scale.

HALIDE LEAK DETECTOR: A device that is used to locate leaks in refrigeration systems.

HANDHOLE: An opening that is large enough for the hand and arm to enter the boiler for making slight repairs, and for inspection.

HANDY BILLY: A small portable water pump.

HARDENING: The heating and rapid cooling (quenching) of metal to induce hardness.

HARDNESS: The ability of a material to resist penetration.

HEAT EXCHANGER: Any device that is designed to allow the transfer of heat from one fluid (liquid or gas) to another.

HYDROGEN: A highly explosive, light, invisible, non-poisonous gas used for underwater welding and cutting operations.

HYDROMETER: An instrument used for determining the specific gravity of liquids.

HYDROSTATIC TEST: A pressure test using water to detect leaks in a boiler or other closed systems.

IGNITION, COMPRESSION: Ignition where the heat generated by compression in an internal combustion engine ignites the fuel (as in a diesel engine).

IGNITION, SPARK: Ignition where the mixture of air and fuel in an internal combustion engine is ignited by an electric spark (as in a gasoline engine).

IMPELLER: An encased, rotating element provided with vanes which draw in fluid at the center and expel it at a high velocity at the outer edge.

IMPULSE TURBINE: A turbine in which the major part of the driving force is received from the impulse of incoming steam.

INDIRECT DRIVE: A drive mechanism coupled to the driven member by gears or belts.

INERT: Inactive.

INJECTOR: A device which, by means of a jet of steam, forces water into the boiler, or as in the diesel engine—forces fuel into the cylinders.

INSULATION: A material used to retard heat transfer.

JACKBOX: Receptacle, usually secured to a bulkhead, in which telephone jacks are mounted.

JOB ORDER: The order issued by a repair activity to its own subdivisions, to perform a repair job in response to a WORK REQUEST.

JUMPER: Any connecting pipe, hose, or wire, normally for use in emergencies aboard ship, used to bypass damaged sections of a pipe, a hose, or a wire. (See BYPASS.)

JURY RIG: Any temporary or makeshift device.

LABYRINTH PACKING: Rows of metallic strips or fins used to prevent steam leakage along the shaft or a turbine.

LAGGING: A protective and confining cover placed over insulating material.

LIGHT OFF: Start, literally; "to start a fire in," as in "light off a boiler."

LOG BOOK: Any chronological record of events, such as an engineering watch log.

LOG, ENGINEERING: A legal record of important events and data concerning the machinery of a ship.

LOG ROOM: Engineer's office on board ship.

LUBE OIL PURIFIER: A unit that removes water and sediment from lubricating oil by centrifugal force.

MACHINABILITY: The term used to describe the ease with which a metal may be turned, planed, milled, or otherwise shaped.

MAIN CONDENSER: A heat exchanger which converts exhaust steam to feed water.

MAIN DRAIN SYSTEM: The system used for pumping bilges, consisting of pumps and associated piping.

MAKEUP FEED: Water of required purity intended for use in ship's boilers. It is the water needed to replace that lost in the steam cycle.

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MALLEABILITY: That property of a material which enables it to be stamped, hammered, or rolled into thin sheets.

MANIFOLD: A fitting with numerous branches used to convey fluids between a large pipe and several smaller pipes.

MECHANICAL ADVANTAGE (MA): The advantage (leverage) gained by the use of such devices as a wheel to open a large valve, chain falls and block and tackle to lift heavy weights, and wrenches to tighten nuts on bolts.

MECHANICAL CLEANING: A method of cleaning the firesides of boilers by scraping and wire-brushing.

MICROMHOS: Electrical units used with salinity indicators for measuring the conductivity of water.

MOTOR GENERATOR SET: A machine which consists of a motor mechanically coupled to a generator and usually mounted on the same base.

NAVY BOILER COMPOUND: A powdered chemical mixture used in boiler water treatment to convert scale-forming salts into sludge.

NAVY SPECIAL FUEL OIL (NSFO): The name applied to the grade of fuel oil that the Navy uses in combatant ships.

NIGHT ORDER BOOK: A notebook containing standing and special instructions by the engineer officer to the night engineering officer of the watch.

NITROGEN: An inert gas which will not support life or combustion. Used in recoil systems and other spaces requiring an inert atmosphere.

NONFERROUS METAL: Metals that are composed primarily of some element or elements other than iron.

OFFICER OF THE WATCH (OOW): Officer on duty in the engineering spaces.

OIL KING: A petty officer who receives, transfers, discharges, and tests fuel oil and maintains fuel oil records.

OIL POLLUTION ACTS: The Oil Pollution Act of 1924 (as amended) and the Oil Pollution Act of 1961 prohibit the overboard discharge of oil and water containing oil in port, in any sea area within 50 miles of land, and in special prohibited zones.

ORIFICE: A small opening.

OVERLOAD RELAY: An electrical protective device which automatically trips when a circuit draws excessive current.

OXIDATION: The process of various elements and compounds combining with oxygen. The corrosion of metals is generally a form of oxidation; rust on iron, for example, is iron oxide or oxidation.

PANT, PANTING: A series of pulsations caused by minor, recurrent explosions in the firebox of a ship's boiler. Usually caused by a shortage of air.

PERIPHERY: The curved line which forms the boundary of a circle (circumference), ellipse, or similar figure.

PITOMETER LOG: Device for indicating speed of ship and distance traveled by measuring water pressure on a tube projected outside the ship's hull.

PLASTICITY: That property which enables a material to be excessively and permanently deformed without breaking.

PNEUMERCATOR: A type of manometer used for measuring the volume of liquid in tanks.

PPM (PARTS PER MILLION): A comparison of the number of parts of a substance in a million parts of another substance. Used to measure the salt content of water.

PREHEATING: The application of heat to the base metal prior to a welding or cutting operation.

PRIME MOVER: The source of motion as a turbine, automobile engine, etc.

PUNCHING TUBES: The name applied to the mechanical means of cleaning the interiors of boiler tubes.

RADIATION, HEAT: The process of emitting heat in the form of heat waves.

REACH RODS: A length of pipe or back stock used as an extension on valve stems.

REACTION TURBINE: A turbine in which the major part of the driving force is received from the reactive force of steam leaving the blading.

REDUCER: Any coupling or fitting which connects a large opening to a smaller pipe or hose.

REDUCING VALVES: Automatic valves which are used to provide a steady pressure lower than the supply pressure.

REDUCTION GEAR: A set of gears used to transmit the rotation of one shaft to another at a slower speed.

REEFER: A provision cargo ship or a refrigerated compartment. An authorized abbreviation for refrigerator.

REFRIGERANT 12 (R-12): A nonpoisonous gas that is used in air conditioning and refrigeration systems.

REGULATOR (GAS): An instrument used to control the flow of gases from compressed gas cylinders.

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REMOTE OPERATING GEAR: Flexible cables attached to valve wheels which permit the valves to be operated from another compartment.

RISER: A vertical pipe leading off a larger one; e.g., fireman riser.

ROOT VALVE: A valve located where a branch line comes off the main line.

ROTARY SWITCH: An electrical switch which closes or opens the circuit by a rotating motion.

SAE: Society of Automotive Engineers.

SAFETY VALVES: An automatic, quick opening and closing valve which has a reseat pressure lower than the lift pressure.

SALINOMETER: A hydrometer that measures the concentration of salt in a solution.

SATURATION PRESSURE: The pressure corresponding to the saturation temperature.

SATURATION TEMPERATURE: The temperature at which a liquid boils under a given pressure. For any given saturation temperature there is a corresponding saturation pressure.

SCALE: Undesirable deposit, mostly calcium sulfate, which forms in the tubes of boilers.

SENTINEL VALVES: Small relief valves used primarily as a warning device.

SHAFT ALLEY: The long compartment of a ship in which the propeller shafts revolve.

SKETCH: A rough drawing indicating major features of an object to be constructed.

SLIDING FEET: A mounting for turbines and boilers to allow for expansion and contraction.

SLUDGE: The sediment left in fuel oil tanks.

SOLID COUPLING: A device used to join two shafts rigidly.

SOOT BLOWER: A soot removal device using a steam jet to clean the firesides of a boiler.

SPECIFIC HEAT: The amount of heat required to raise the temperature of one gram of a substance 1°C. All substances are compared to water which has a specific heat of 1.

SPEED-LIMITING GOVERNOR: A device for limiting the rotational speed of a prime mover.

SPEED-REGULATING GOVERNOR: A device that maintains a constant speed on a piece of machinery that is operating under varying load conditions.

SPLIT PLANT: A method of operating propulsion plants so that they are divided into two or more separate and complete units.

SPRING BEARINGS: Bearings positioned at various intervals along a propulsion shaft to help keep it in alignment and support its weight.

SPRINKLING SYSTEM: An automatic watering system used for cooling and flooding magazines and cargo spaces in case of fire.

STATIC: A force exerted by reason of weight alone, related to bodies at rest or in balance.

STEAM LANCE: A device for using low pressure steam inside of boilers to remove soot and carbon from boiler tubes.

STEERING ENGINE: The machinery that turns the rudder.

STERN TUBE: A watertight enclosure for the propeller shaft.

STRAIN: The deformation or change in shape of a material resulting from the applied load.

STRENGTH: The ability of a material to resist strain.

STRESS: Force producing or tending to produce deformation of a metal.

STUFFING BOX: A device to prevent leakage between a moving and a fixed part in a steam engineering plant.

STUFFING TUBE: A packed tube making a watertight fitting through a bulkhead for a cable or small pipe.

SUMP: A container, compartment, or reservoir; used as a drain or receptacle for fluids.

SUPERHEATER: A unit in the boiler that drys the steam and raises its temperature.

SWASH PLATES: Metal plates in the lower part of the steam drum that prevent the surging of boiler water with the motion of the ship.

SWITCHBOARD: A panel or group of panels with automatic protective devices, used to distribute the electrical power throughout the ship.

TANK TOP: Top side of tank section or double bottom of a ship.

TDC (TOP DEAD CENTER): The position of a reciprocating piston at its uppermost point of travel.

TEMPERING: The heating and controlled cooling of a metal to produce the desired hardness.

THIEF SAMPLE: A sample of oil or water taken from a ship's tank for analysis.

THROTTLEMAN: Man in the engineroom who operates the throttles to control the main engines.

THRUST BEARING: A bearing designed to limit the end play and absorb the axial thrust of a shaft.

TO BLOW TUBES: A procedure, using steam, for removing soot and carbon from the tubes of steaming boilers.

TOP OFF: To fill up, as a ship tops off in fuel oil before leaving port.

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TOUGHNESS: That property of a material which enables it to withstand shock, and to be deformed without breaking.

TRANSFORMER: An electrical device used to step up or step down an a-c voltage.

TRICK WHEEL: A steering wheel in the steering engineroom or emergency steering station of a ship.

TUBE EXPANDER: A tool used to expand replacement tubes into their seats in boiler drums and headers.

TURBINE: A multibladed rotor, driven by steam or hot gas.

TURBINE JACKING GEAR: A motor-driven gear arrangement used to slowly rotate idle propulsion shafts and turbines.

TURBINE STAGE: The term applied to one set of nozzles and the succeeding row or rows of moving blades.

UPTAKES (EXHAUST TRUNKS): Large enclosed passages for exhaust gases from boilers to the stacks.

VENT: A valve in a tank or compartment used primarily to permit air to escape.

VENTURI INJECTOR: A device used for washing the firesides of boilers.

VOID: A small empty compartment below decks.

VOLATILE: The term used to describe a liquid that vaporizes quickly.

VOLTAGE TESTER (WIGGINS): A portable instrument that is used to detect electricity.

WATER TUBE BOILER: Boilers in which the water flows through the tubes and is heated by the gases of combustion.

WATER WASHING: A method of cleaning the firesides of boilers to remove soot and carbon.

WELDING LEAD: The conductor through which the electrical current is transmitted from the power source to the electrode holder and welding rod.

WHELPS: Any of the ribs or ridges on the barrel of a capstan or windlass.

WIREWAYS: Passageways, between decks and on the overheads of compartments, that contain electric cables.

WORK REQUEST: Request issued to a naval shipyard, tender, or repair ship for repairs.

ZERK FITTING: A small fitting to which a grease gun can be applied to force lubricating grease into bearings or moving parts of machinery.

ZINC: A metal placed in salt water systems to counteract the effects of electrolysis.

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ABSTRACT - This 20-week experimental curriculum bulletin for intermediate and junior high schools was prepared by the New York City Bureau of Curriculum Development. A suggested program schedule outlines topics on Introduction to Flight, Support Systems, and Space and Rockets, including suggested projects, instructional content, and related information for each topic. Detailed information in the form of textual material and directions for making a wind tunnel and other student projects is provided for the Introduction to Flight topic. Additional project directions and information are appended. (SB)

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1

INDUSTRIAL ARTS AEROSPACE

for

Intermediate and Junior High Schools

Project No. 5511

These experimental materials were prepared as part of the Curriculum Workshop Program of the Bureau of Curriculum Development in cooperation with the Bureau of Industrial Arts.

August 1970

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Dr. Daniel A. Salmon, Assistant Director, Bureau of Curriculum Development, served as coordinator of the Curriculum Development Workshop Programs.

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These materials are being distributed to selected intermediate and junior high schools for tryout and evaluation. Suggestions for modification of the final publication are solicited and should be returned by June 1, 1972 to:

Dr. Daniel A. Salmon
Assistant Director
Bureau of Curriculum Development
131 Livingston Street
Brooklyn, New York 11201

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PREFACE

"After decompressuring the LM, Astronaut Neil A. Armstrong crawled onto the craft's front porch and into the airless vacuum of the moon. He carefully climbed down the lunar lander's steps, placed his right foot into the spaceship's landing pad and at 10:56 P.M. E.D.T., July 20, 1969 stepped from the Lunar Module to become the first earthling to ever set foot on the moon."[1]

This "...one small step for man, one giant leap for mankind"[2] was only the latest of a series of "giant leaps"by men and machines in man's quest of air and space that started some 1000 years ago. The Industrial Arts Junior and Intermediate School Aerospace Program is designed as an introductory course for our students in which they will explore and engage in meaningful activities to help them understand how we arrived at the Space Age on July 20, 1969.

[1]Man and Space, RCA Defense Electronic Products

[2]Astronaut Neil A. Armstrong from the moon

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The teachers who have limited experience and background in aerospace and model building should spend some time informing themselves and organizing their shops before embarking on the program. Skim through this publication and then reread sections and one or two books in each bibliography. Build a model or two in privacy and make several assembling or sanding fixtures. Build a wind tunnel and one or two instruments. Write to several sources listed and buy a magazine or two. Start decorating the shop with free industrial and government charts and illustrative materials related to aerospace. Ask your students who build models at home to bring them in and explain their hobby to the class. You may find some real experts in your students or even their parents.

If your school joins the National Aerospace Education Council you will receive five dollars worth of free educational materials. Send for a free film or film strip and review it with a colleague or one of your classes. When you have compiled enough material and prepared lesson plans and instruction sheets try a basic project with your best class or a small group of students who have completed their regular shop work. Alter your initial plans and note any additional preparation (if any) that would have been needed had you been conducting the full program.

Determine what changes will have to be made in your present shop organization for the storage of models, fixtures and special supplies. In your trial project work with the class, note the different tools the student will need. Are there changes needed on the tool board? Can your students handle the special wood, razor and knives and special cements and dope?

Try a few related lessons shop talks and see if your students would be interested in aerospace. They may be able to do the Flight and Rocket Sections but Weather and Navigation might be too advanced. Discuss the scientific and mathematical concepts that the academic

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teachers are covering in the school. Are there possibilities for coordinating your work with theirs? Use the information in this publication and contact some of the teachers and supervisors who helped prepare it for additional aids and suggestions. Have your assistant principal and principal evaluate your student's work to determine whether they could provide additional funds for a full term experiment with one class.

Prepare a list of tools and materials that would have to be purchased for one class to begin the program in the Spring term. Show the list and your models to the principal along with a suggested term plan, similar to the one in this manual. You may draw extensively from this publication or you may make up your own. By the beginning of the Spring term you should be ready to try the program with one or two of your best classes. Start with a new set of Safety Rules and a slightly different class organization. Make all your lesson plans and instruction sheets on rexograph stencils and don't be afraid to change them frequently. Give your students opportunities to experiment too as long as they use save and appropriate construction techniques. Keep a daily log of your lessons, students progress and an evaluative sheet on your successes and failures. We will ask you to evaluate this publication before the summer of 1971 to determine its value to you and your students.

GOOD FLYING.

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SUGGESTED PROGRAM SCHEDULE

WEEKS 4 periods/week	PROJECT CONSTRUCTION	INSTRUCTION	RELATED INFORMATION
		INTRODUCTION TO FLIGHT	
1	Introduction Models A. Soda Straw Jet B. Barnaby C. Dart	Program Orientation, Safety Class organization, Hobbies	Demonstration of models and wind tunnel. Films and industrial charts.
3	Basic Models A. Thermic 20 Glider B. Curtiss SBC-4 wind tunnel model C. The Patriot rubber power	Basic construction with balsa wood. Use of hand tools, finishing, testing. Wood and plastic fabrication. Student notebooks, and flight logs.	Development of Flight: principles and history. Comparison of flight characteristics. Commercial, General and Military Aviation, Civil Air Patrol.
5	Individual Models A. Thunderjet Whip U-Control B. Jet Glider C. Glow-Plug Engine U-Control Kit (1) Field Caddy	Advanced construction techniques. Use of machine tools. Reading commercial plans. Building assembling fixtures. Plastic injection molds. Internal combustion engine.	Flight contests. Careers and opportunities in aviation. Field trip - Control Tower, airport. Student research reports.
		SUPPORT SYSTEMS	
4	Weather, Navigation and Research Instruments A. Aneroid Barometer B. Weather Vane C. Sextant D. Anomometer E. Wind Tunnel	Basic wood, metal and electrical construction techniques. Calibrating instruments. Weather station orientation. Weather and flight maps.	Study of air and weather and their effect on flight. FAA air traffic controllers Field Trip - weather station

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SUGGESTED PROGRAM SCHEDULE

WEEKS 4 periods/week	PROJECT CONSTRUCTION	INSTRUCTION	RELATED INFORMATION
		SPACE AND ROCKETS	
3	Space and Astronomy A. Parallactic Displacement Ranging Instrument B. Astrolabe C. Constellarium	Advanced construction techniques, machine tools. Calculating with and calibrating of instruments. Astronomy: stars and planets.	Problems of space travel. Related Support Systems. Field Trip - Planetarium.
3	Rocket Models A. CO_2 Flight Model B. Rocket Launcher	Basic rocket construction: safety, materials, power, velocity and trajectory. Flight data record sheet	Development of Rocketry, principles and history. National Aeronautics And Space Administration (NASA) Mercury and Apollo Flights
1	Culminating Activities	Evaluation: craftsmanship, information. Assembly Program. Interpreting logs and determining corrective measures. Community Model Clubs.	Field Day: Contests, Exhibitions and Demonstrations. Opportunities for continued study in Aerospace.

Introduction To Flight

A review of the most familiar vehicle, the airplane, and an introduction to one of the least understood elements, air, can begin our study of aerospace. We hope to arrive at that point in time when the results of many thousands of men's efforts with countless machines produced the foot prints in moon's dust and brought the astronauts safely home. Constructing gliders, airplanes and rockets will help us understand the means of flight. The study of air, weather, navigation and space will be supplemented by the construction of measuring instruments related to flight and space travel.

Following a short introductory demonstration and exhibition by the teacher of models and projects, the students should construct their own paper gliders. The purpose of this activity is to learn basic nomenclature of an airplane and to demonstrate how control surfaces function.

Vocabulary

a. fuselage

b. wings

c. stabilizer

1. rudder

2. elevators

d. center of gravity

e. pitch

f. yaw

g. roll

Procedure:

1. Duplicate sheet of SODA-JETS (Appendix A) on 90 lbs. index.

2. Provide scissors, glue and masking tape to assemble parts on plastic straws.

3. Provide small balsa nose plugs and sandpaper. (Extra masking tape or paper clips may be used to balance the model.

4. Demonstrate assembling parts and identify parts. Adjust for dihedral angle.

5. Demonstrate the method of balancing the aircraft by adding or reducing nose weight.

Discuss and Demonstrate

1. The action of the gliders depend upon weight of fuselage, wings and stabilizers being balanced about the center of gravity. The wings of the glider are to provide the lift or resistance to the air to remain aloft. The stabilizers, vertical and horizontal provide the steadying surfaces to provide straight flight.

Fig. 1

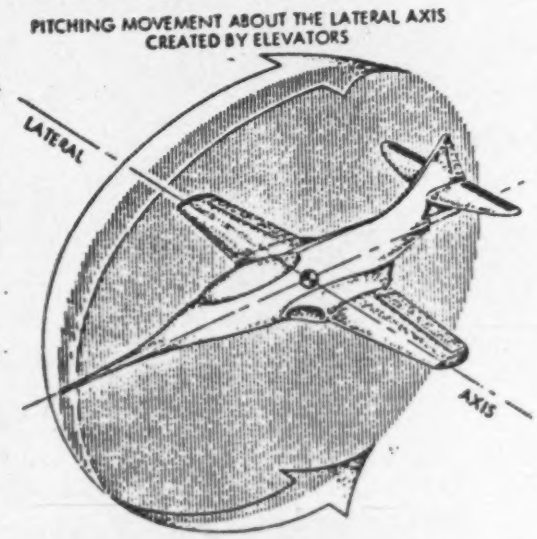

Elevator movements generate forces that cause pitching about the lateral axis.

Fig. 3

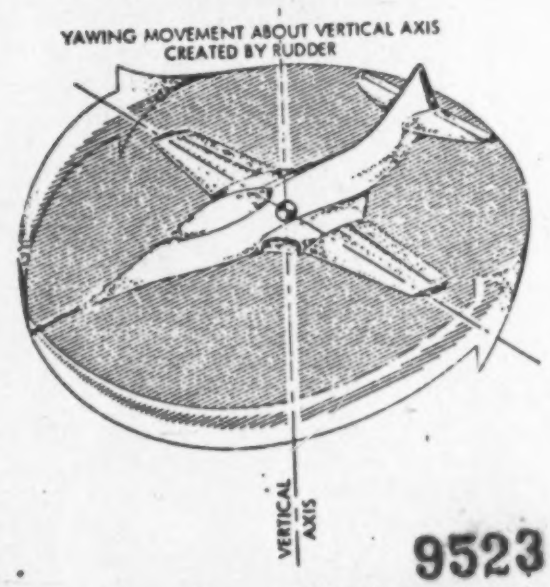

The rudder controls yawing movements about the vertical axis.

Fig. 2

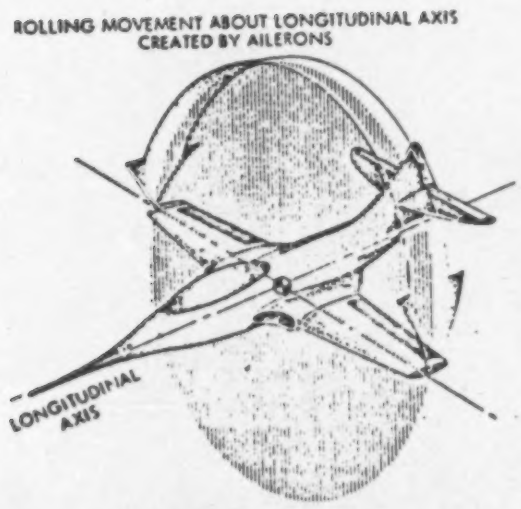

Manipulation of the ailerons varies forces so as to effect a rolling movement about the longitudinal axis.

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Fig. 4

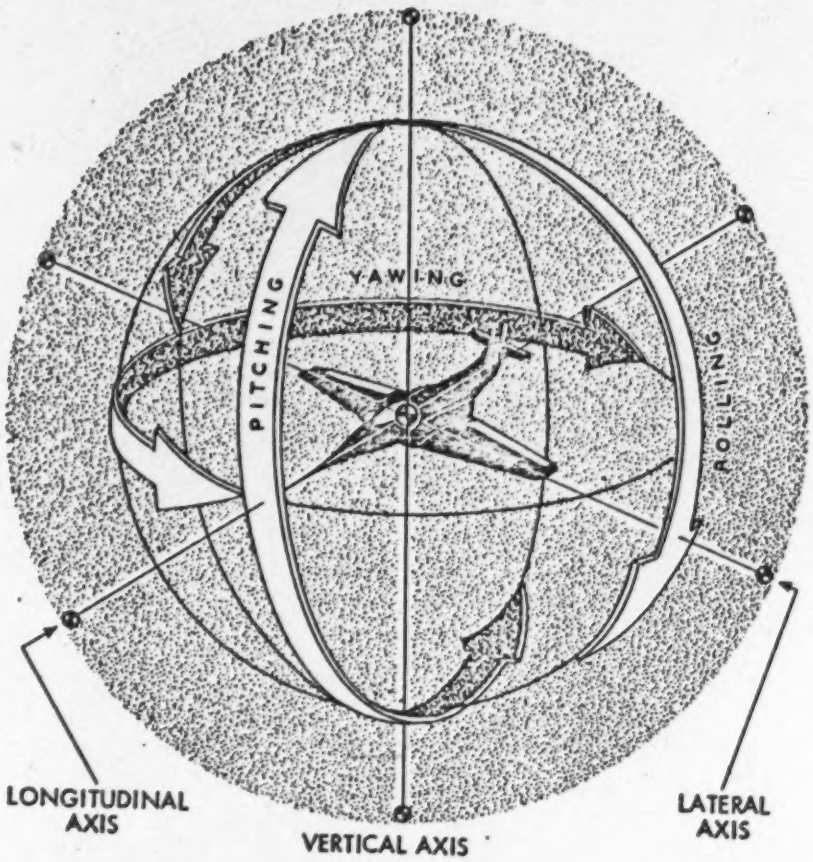

All movements take place about the axes of the aircraft. These axes all pass through a common point, the center of gravity.

Blacker, Robert D.

Basic Aeronautical Science
And Principles of Flight

Chicago, Ill., 1959

American Technical Society, pg. 119, 120

2. Control Surfaces are provided to permit the glider and an airplane to turn on its three axis.

   Ailerons - Longitudinal Axis - Rolling

   Rudder - Vertical Axis - Yawing

   Elevators - Lateral Axis - Pitching

   See Figures 1 - 4

3. Have students demonstrate their ability to fly the model straight, as well as any of the following maneuvers.

   a. climb

   b. dive

   c. roll

   d. climb-stall-dive

   e. climbing turn

   f. diving turn

   g. loop

   h. spin

Alternate models may be made from Model Aircraft Laboratory CAPP 33, Appendix B or "How to Build A Barnaby Model", Appendix C.

Try to identify as many parts of an airplane from Cessna's "How Well Do You Know Your Airplane?" Appendix D.

THE ATMOSPHERE

Although we have lived in the atmosphere about us, it is difficult to imagine since we cannot see, touch, smell, taste or hear it, except when the air is moving and working. Air may lift kits, paper and airplanes. We may feel its pressure or effects of a vacuum (the absence of air) when we stand in front of a window fan. Heated air warms us. We can hear it as the wind moves it out of the trees and around sharp corners. We can see its strength as it holds up cars or moves heavy lifts above the floor.

The properties of the air that affect flight are:

1. pressure or weight
2. density or humidity
3. movement

Air Pressure:

a. Atmosphere about earth to 4 mi. high

b. Troposphere 4-11 miles

c. Stratosphere 11-50 miles

The air pressure decreases as we go higher into the air. At sea level, it is measured as a barometric reading of 29.92 inches of Mercury or 14.7 lbs. per square inch at 59° F. Each factor of heat, altitude and humidity will affect flight as well as the barometric reading or pressure of the air.

The humidity or density of the air is the measure of the amount of moisture in the air in relation to the amount of moisture the air (at the temperature and altitude) can hold.

The speed and direction at which the air passes the glider or plane will determine the lifting power of the air and the altitude at which the plane may fly. The movement of the air about the plane is affected by many forces:

1. thrust of plane
   a. throwing by hand
   b. rubber band power
   c. small engine - propeller
   d. large engine - propeller
   e. jet
   f. ram jet

2. Lift
   a. size and shape of wing

3. Weight
   a. total weight of airplane

4. Drag
   a. resistance surfaces present to the air.

(See Figure 5)

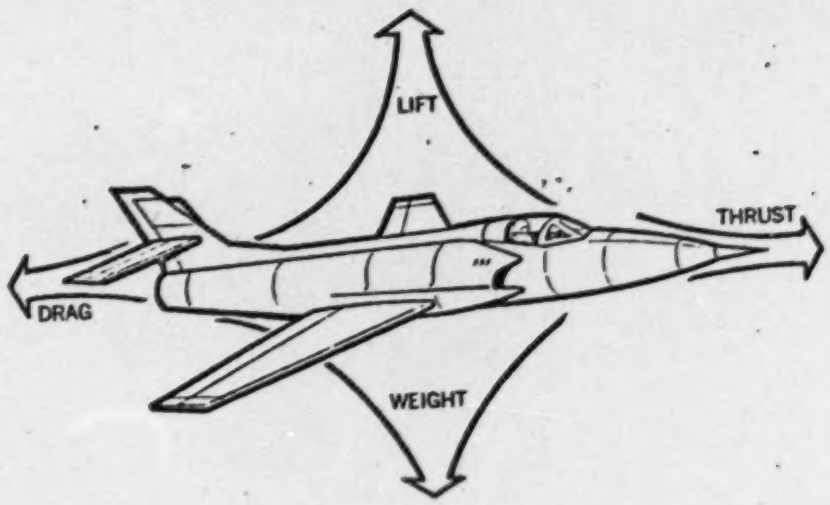

Figure 5

Indicate on Instrument Panel (Figure 6) the instruments related to air pressure, humidity and movement. On the ground air speeds are measured by an anemometer. This is important for each pilot to know the ground air speed befor he lands or takes off. Students may observe the action of a demonstration anemometer (Appendix E) and selected students may wish to make their own. The anemometer should be calibrated to operate with the wind tunnel demonstration. Students may also wish to build other instruments for a weather station. (See Weather Section). The New York Times Daily Weather Reports and Forecast may be used to calibrate and check shop made instruments. Barometric pressures, wind speeds and direction and temperatures and humidities are recorded each day.

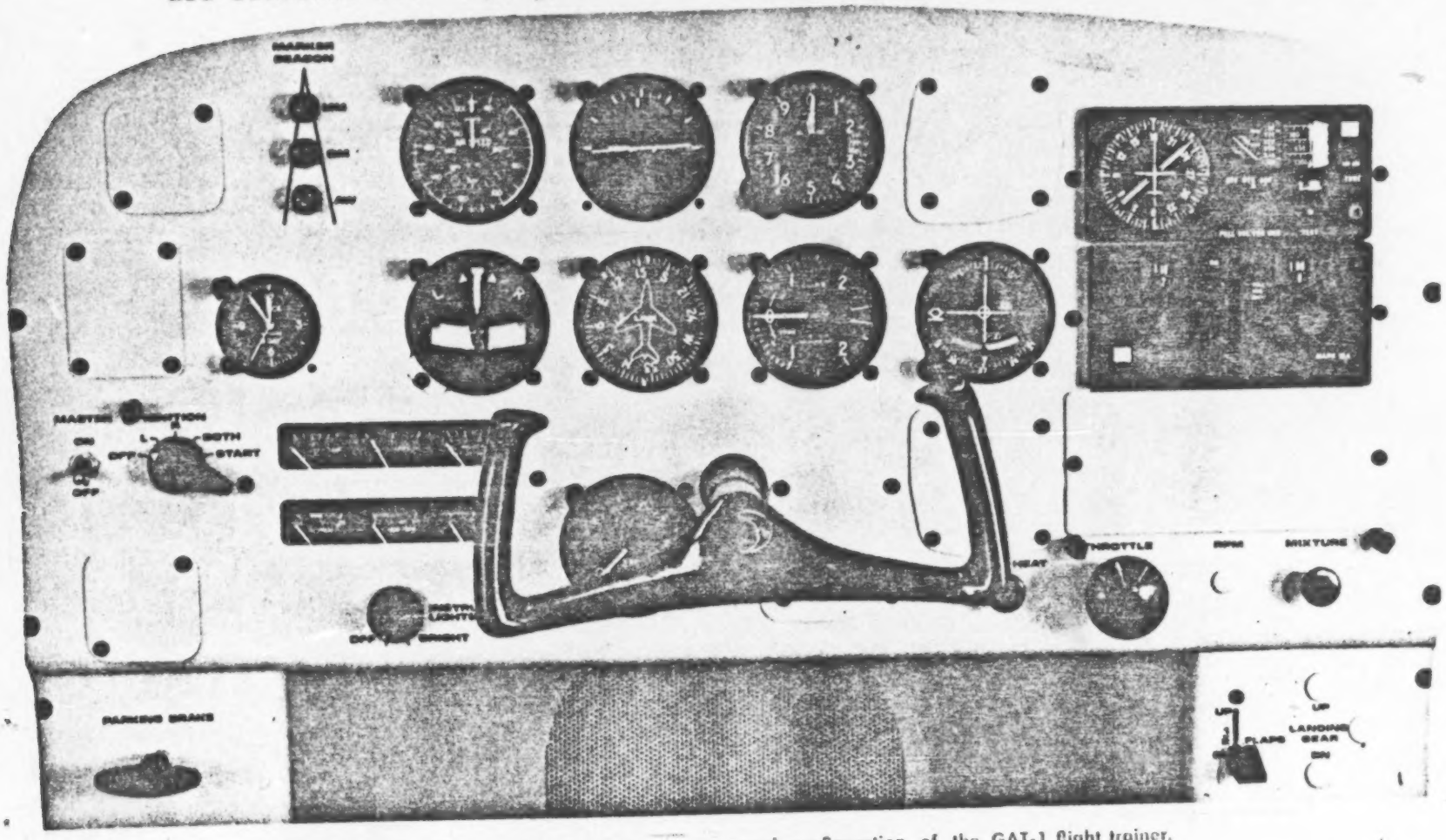

Typical single-engine, light-aircraft instrument panel configuration of the GAT-1 flight trainer.

(Figure 6)

A 30" x 40" Chart of A Piper Cherokee Panel is available from Piper Aircraft Corp., Lock Haven, Pa.

THE WIND TUNNEL

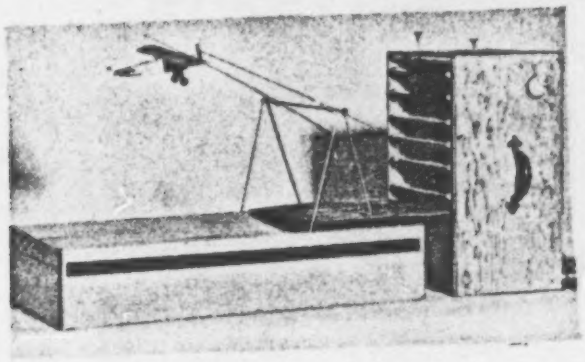

The wind tunnel, more than any other piece of equipment in the Aerospace Shop will enable the student to see, test and control air currents over a "flying" model. The unit (shown above) for this purpose was designed by the Aviation Development Council for their elementary school auditorium programs. It may now be seen at the Aerospace Education Resource Center, 86-50 109 Street, Richmond Hill, N.Y. Mr. Bernard Spar, Science Coordinator will demonstrate it as well as provide an interesting program for scheduled classes. Each teacher should make his own for testing and "flying" student made models. Students may wish to build their own for use at home. The unit is made around an 18" x 18" two speed window fan. The circulating air is straightened before it reaches the model by two sets of venetian blind slats built at right angles to each other.

(See Fig. 7)

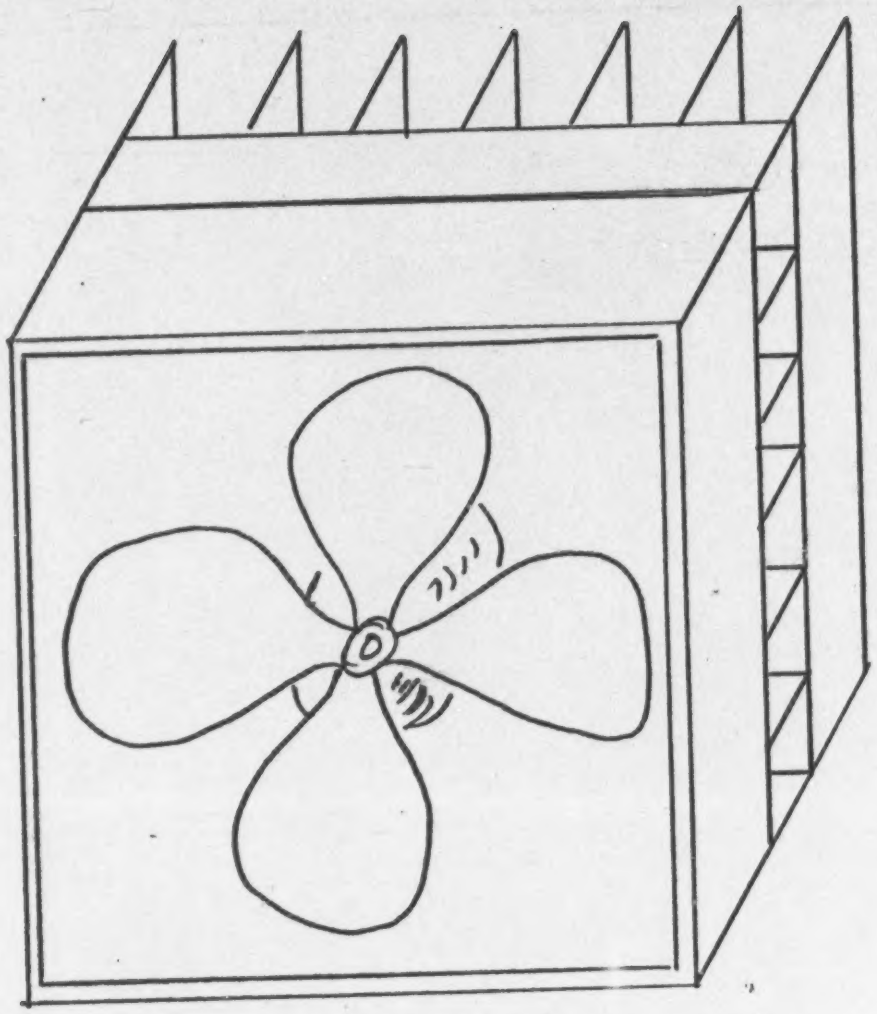

Fig. 7

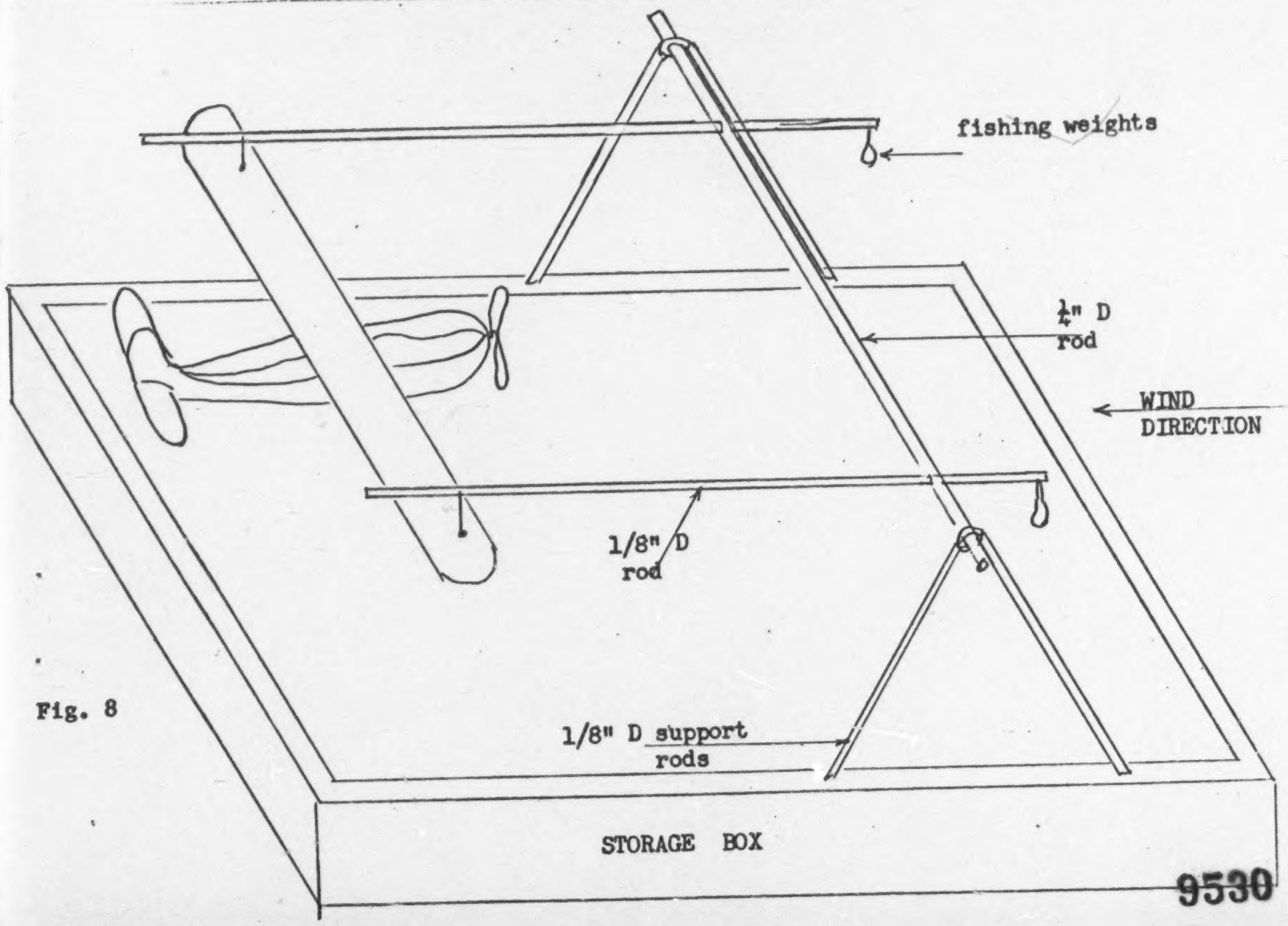
fishing weights
¼" D
rod
WIND
DIRECTION
1/8" D
rod
1/8" D support
rods
STORAGE BOX

Fig. 8

Control arms may be built into the horizontal slats to simulate elevator control on the model.

The model is suspended by pivots approximately 1/3 distance from the lead edge to trailing edge. It sould be balanced at this point prior to attaching it to the counter balance lever. (See Fig. 8) The fishing weights are adjustable to counter balance the weight of the model. This will permit the wind from the fan to provide the pressure differential over the cambered wing to lift the model for a test "flight".

This "tunnel" will only test and demonstrate a model's balance and lift. The construction of a tunnel and a measuring instrument for drag and lift characteristics of an airfoil for advance studies can be made from plans in Appendix F.

BASIC PROJECTS

The choice of the basic project may be among two or three models previously prepared and effectively demonstrated by the teacher.

1. Glider
2. Solid model
3. Rubber powered flying model

The choice may depend upon the age and maturity of the individual students. Each demonstration lesson should be readily adapted to any one of the models. Students should have provided detailed full size plans and/or templates and instructions. Variations for individual differences may be provided within limits of aerodynamic principles as well as finishes. (See Figure 9). Air foils, proportionate sizes and finishes may be altered without appreciably changing the flight capabilities of the craft. Alternate design procedures may be on instruction and information charts for reference by individual students. (See Appendix G).

The use of assembling and gluing fixtures prior to or following the partial finishing of wood surfaces should be demonstrated on the teacher's models. The chances of success of these initial efforts on the part of the student will be significantly improved by well made accurate and easily used fixtures. They should be in sufficient numbers for use by a student as the need arises. Appendix H describes a method for gluing the diehedral angle of a solid wing. Students should be encouraged to make their own fixtures so that they may persue this activity as a hobby at home. (Republic Thunderjet Project diagrams fixtures that can be made). The source of models and plans suitable for a first project can be found in numerous books and magazines. Those in this publication have been successfully used in experimental classrooms over the past year.

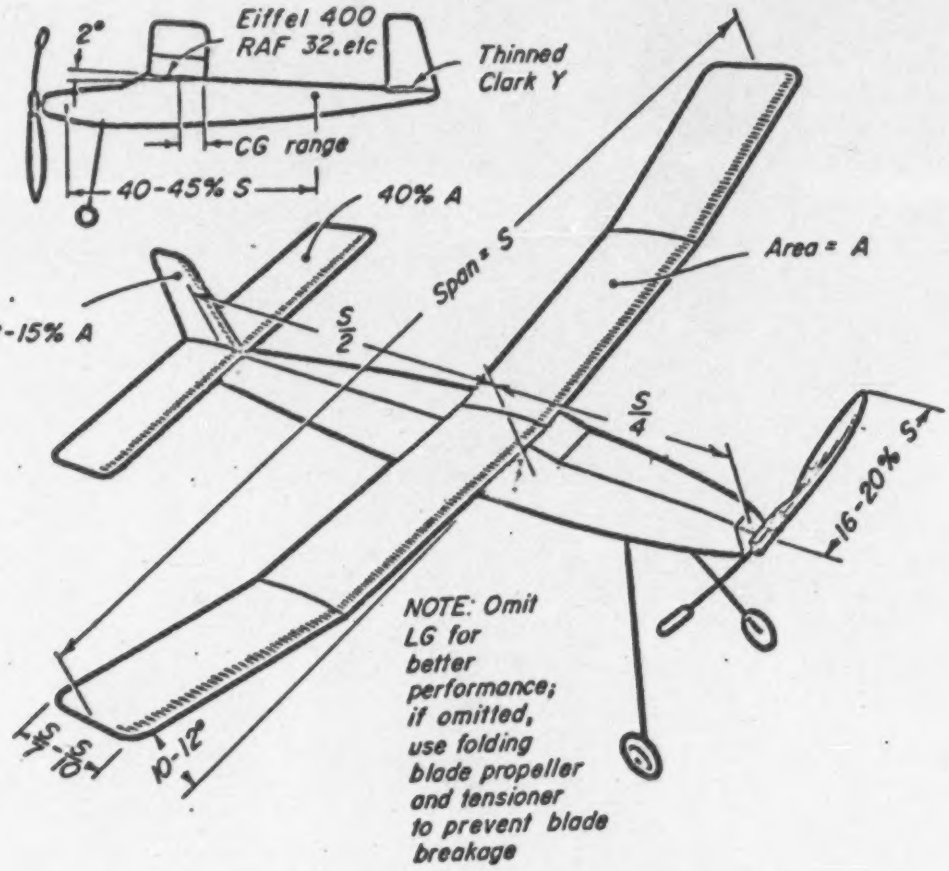

Sport Rubber Model Proportions

Fig. 9

Basic Demonstration Lessons

1. How to read plans

   a. getting out stock

2. Cutting and shaping balsa

   a. knives

   b. saws

3. Fuselages

   a. solid

   b. truss

   c. monocoque

4. Wings

   a. solid

   b. ribs

5. Empennage

   a. stabilizers

   b. rudder, fin

   c. elevators

6. Landing gears and wheels

   a. shaping

   b. string and glue

7. Finishing

   (See Appendix I)

8. Assembling

   a. fixtures

   b. glue, pins, toothpicks

9. Balancing

   a. (See Appendix J)

10. Wind Tunnel Tests

    or

    Flight Tests

    (See Appendix K & L)

11. Prepare student notebook and flight logs Appendix N

Related Information

1. Early flights and pilots
2. Aircraft Types
3. Reaction Principle
4. Bernoulli Theory

Alternate Group Demonstrations

1. Enlarging plans - graph method
2. Carving finishing and balancing propellers

   See Appendix M
3. Winding rubber power planes

BASIC GLIDER

"THERMIC 20" by: Jetco Models,

Brooklyn, New York

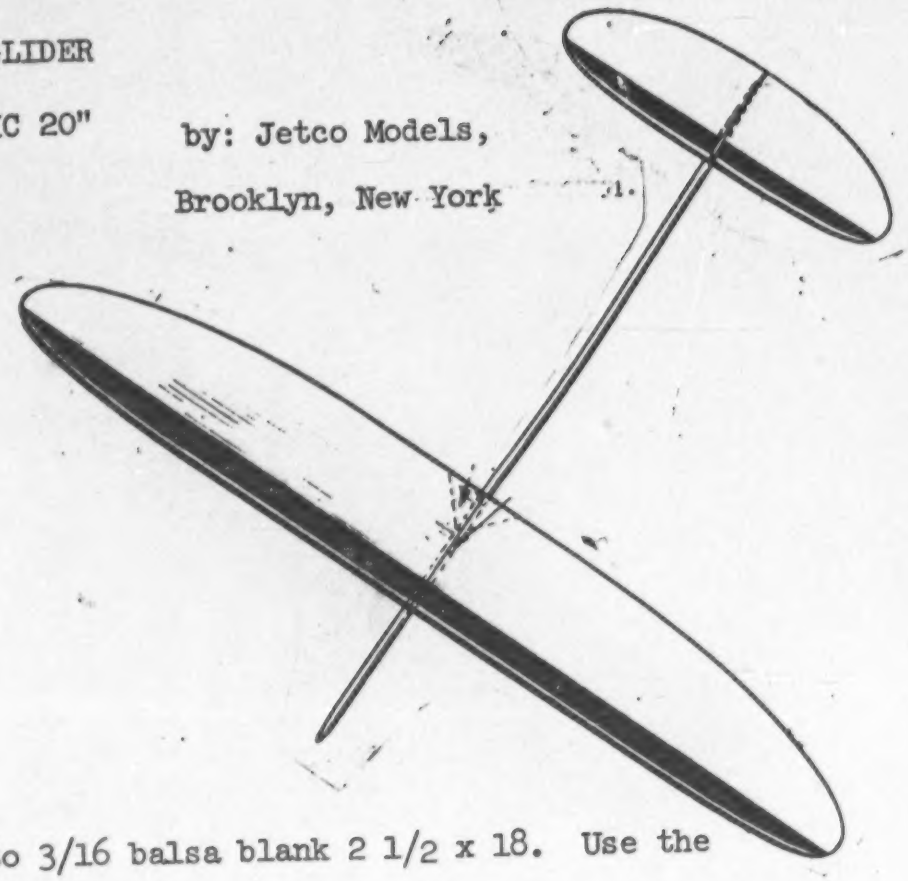

MATERIALS: Sheet Balsa

wing, 3/16 x 2 1/2 x 18

pod, 3/16 x 1 x 5 1/2

boom, 3/16 x 3/8 x 12

stabilizer, 1/16 x 2 x 7

fin, 1/16 x 2 x 2

CONSTRUCTION:

1. Transfer with pin wing template to 3/16 balsa blank 2 1/2 x 18. Use the half pattern on each side. (Figure 1)
2. Cut wing shape with knife and sand smooth wing camber. (Figure 2)
3. Apply two or three coats (allow each coat to dry) balsa filler. Sand smooth. (See Appendix I)
4. Cut out pod and boom from 3/16 stock.
5. Glue and pin (use Lance #2 T pin) and allow to dry. (Figure 3) Apply preliminary finishing after rounding the edges and sanding smooth. (Wing and stabilizer surfaces to remain flat.)
6. Transfer patterns for stabilizer, fin and finger rests to 1/16" balsa blank.
7. Sand airfoils on stabilizer and fin. (Figure 4)
8. Fill with balsa filler and sand smooth.
9. Cut wing in half and sand dihedral angle. (Figure 5) Be sure to keep top of the wing up on sanding fixture.
10. Weight one wing on wax paper and cement dihedral angle. (Figure 6) Use weight to hold down both wings until dry.
11. V-slot boom for the wings at the dihedral angle. (Figure 7)

12. Set fuselage into assembling and glueing fixture to hold all parts accurately and secure while the glue is setting. (Figure 8)

13. Glue finger rests under skin. (Figure 9)

BALANCE:

14. Stick pin in Balance Point (Figure 3) and suspend model with string. Balance with wire solder imbedded in the nose. Use clay for fine balance.

FINISH

15. Paint with clear or colored dope. Apply appropriate decals.

LAUNCHING

16. Hand launch. Add or decrease clay until model has smooth glide. (See Appendix J)

THERMIC 20

FIGURES

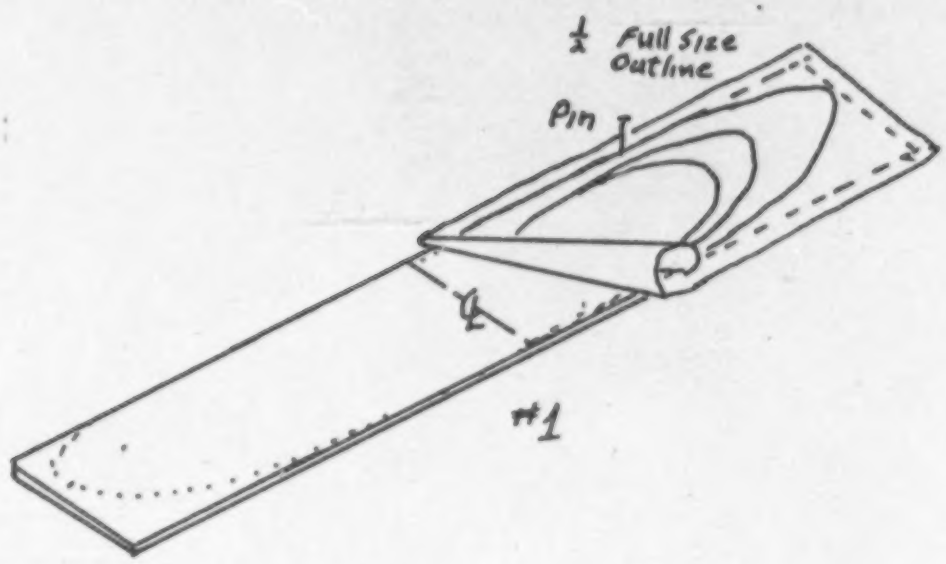

#1

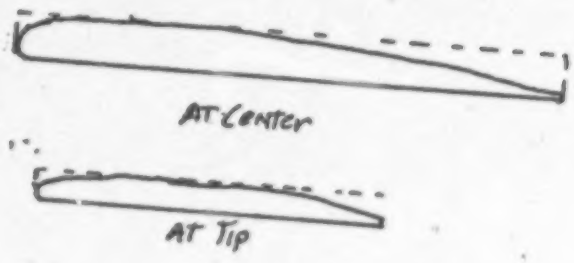

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#3

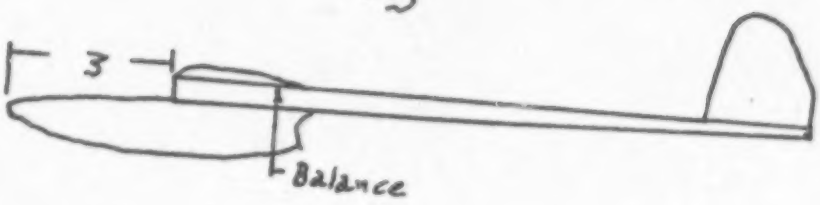

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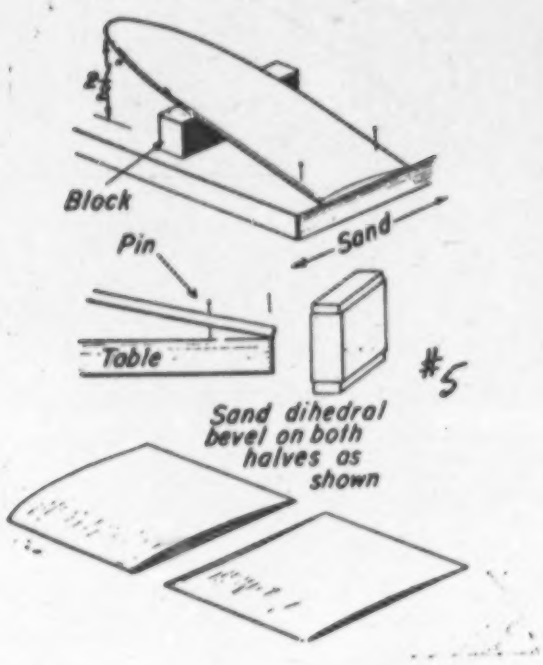
Block
Pin
Sand
Table
#5
Sand dihedral bevel on both halves as shown

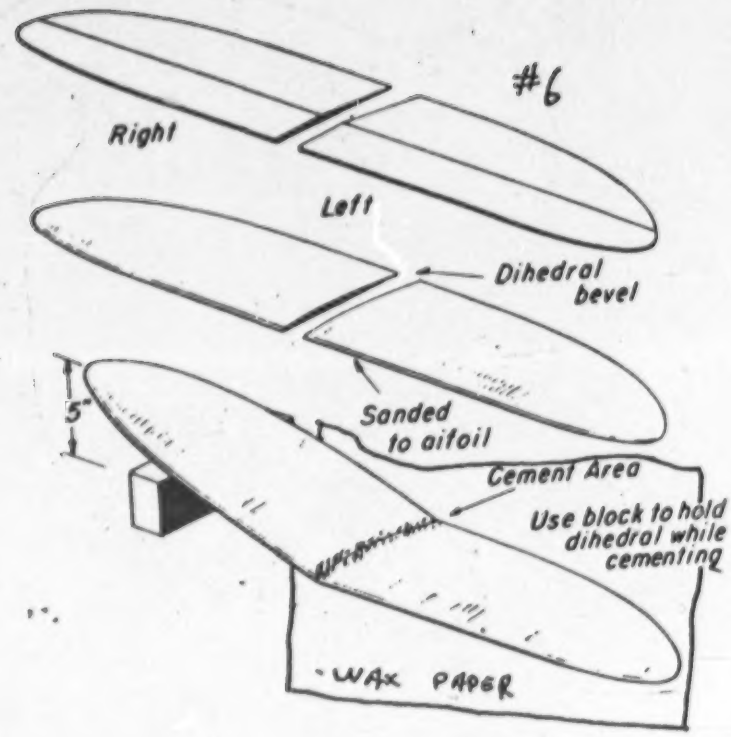
#6
Right
Left
Dihedral bevel
5"
Sanded to airfoil
Cement Area
Use block to hold dihedral while cementing
WAX PAPER

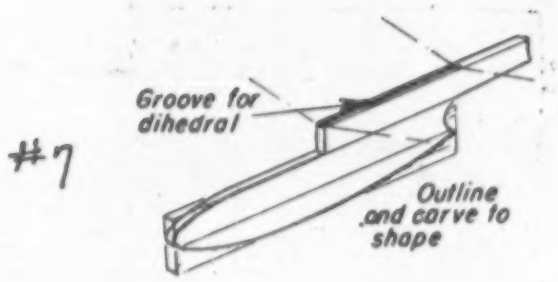
Groove for dihedral
#7
Outline and carve to shape

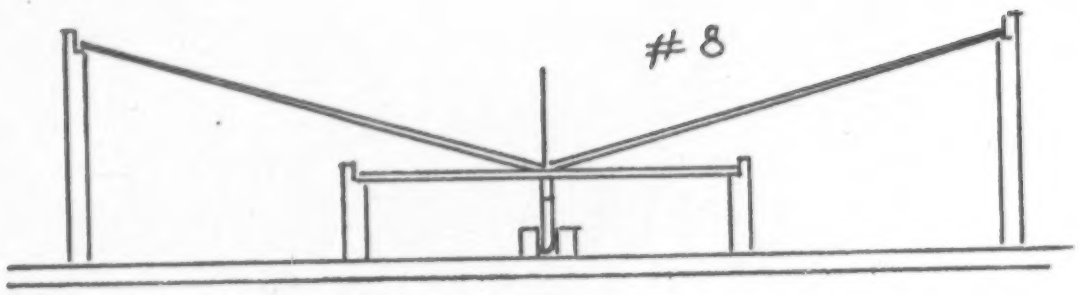
#8

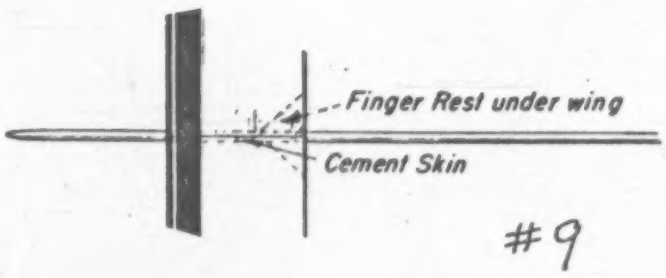
Finger Rest under wing
Cement Skin
#9

138 OF 327

ED

056 238

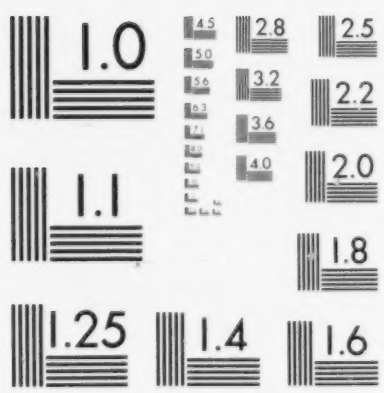

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

THERMIC 20

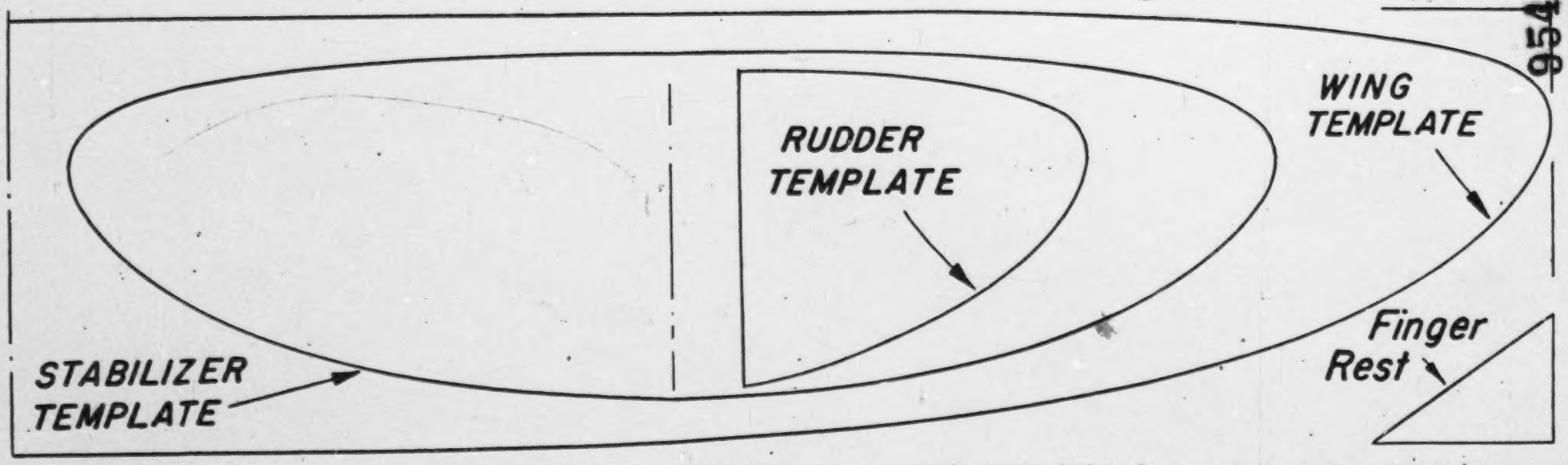

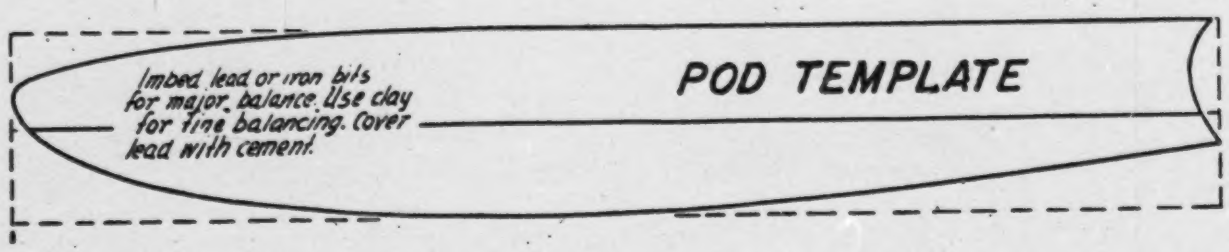

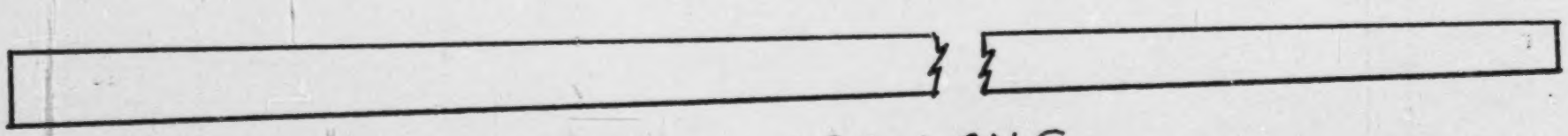

BOOM - 12" LONG

BLACK PORTION OF STRUTS FITS INTO HOLES MADE IN WING AND FUSELAGE.

SAND DOWEL TO SIZES SHOWN AND CUT TO LENGTH.

CABANE STRUTS
1/32" THICK. MAKE TWO OF EACH

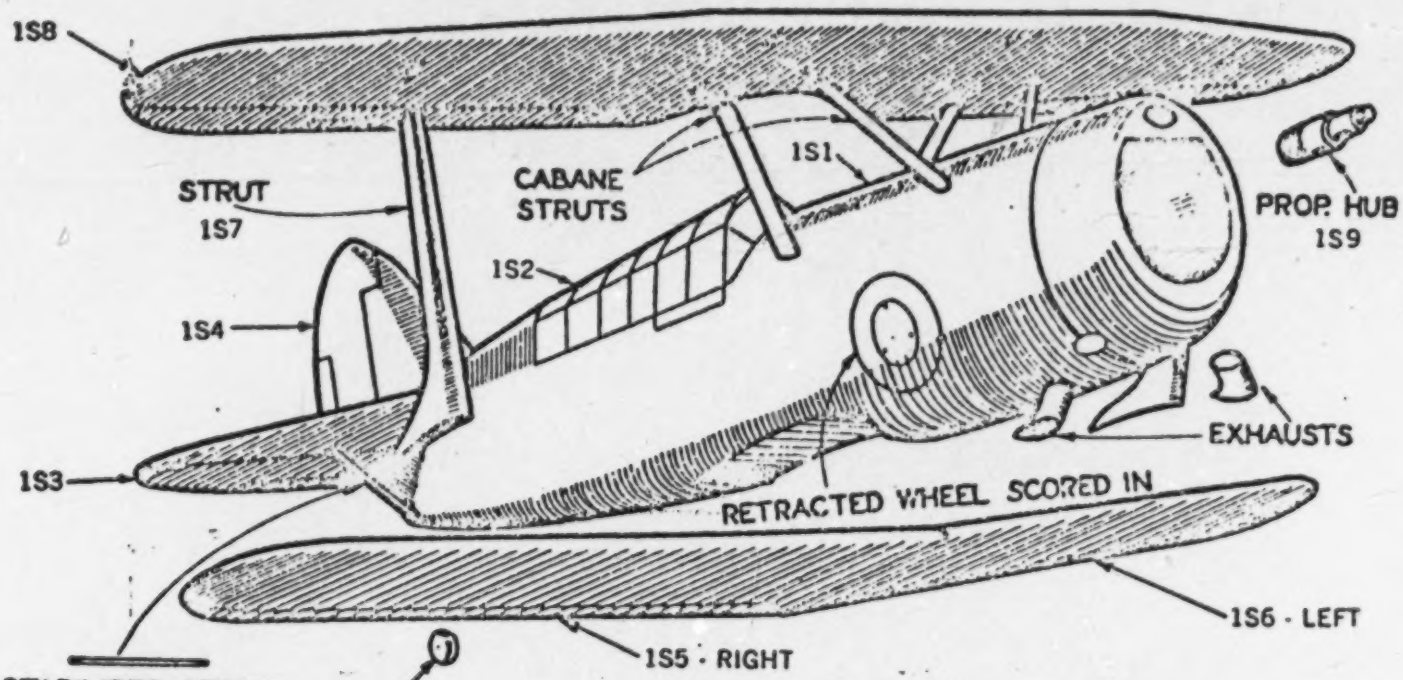

STABILIZER STRUT
FULL SIZE

SAND DOWEL AND CUT TO LENGTH.

TAILWHEEL
FULL SIZE
(1/16" THICK)

MAKE FROM VENEER SCRAP FROM 1S7 STRUT SHEET.

EXHAUST FULL SIZE.
MAKE TWO
(1/16" THICK)

MAKE FROM VENEER SCRAP FROM 1S7 STRUT SHEET.

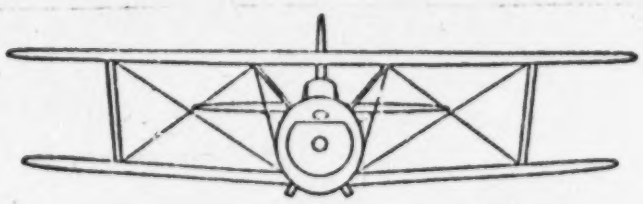

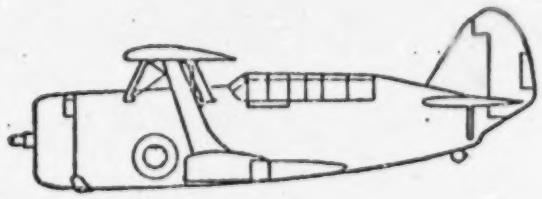

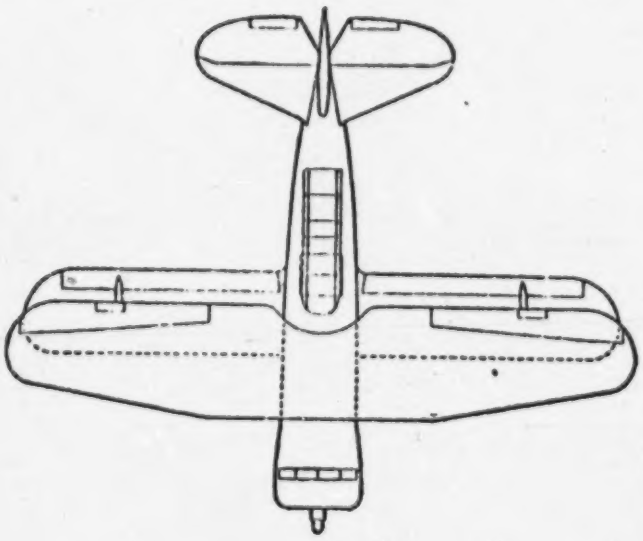

CURTISS SBC-4

U.S. NAVY SCOUT BOMBER

TEMPLATES AND ASSEMBLY INSTRUCTIONS

SPAN 5-21/32"		SCALE 1/72"

STROMBECK-BECKER MANUFACTURING CO.

9541

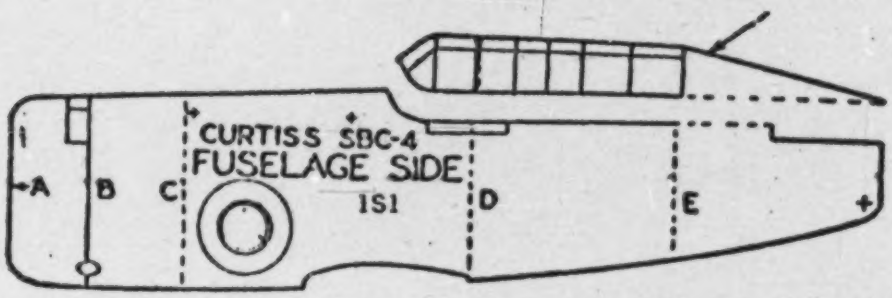

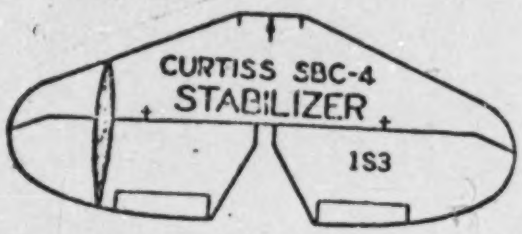

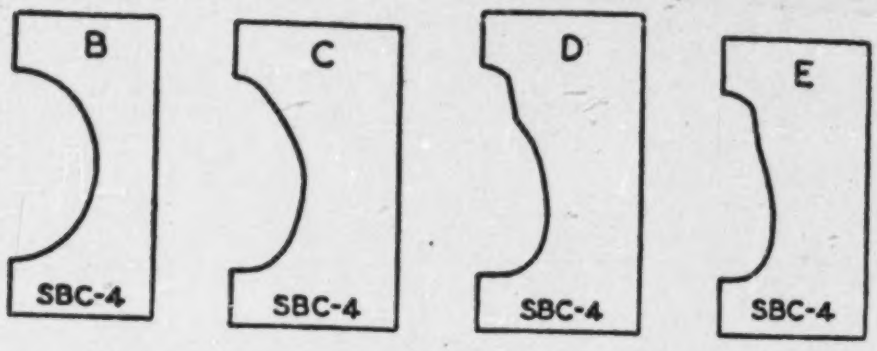

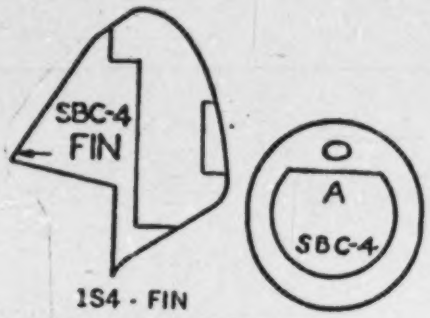

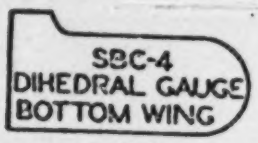

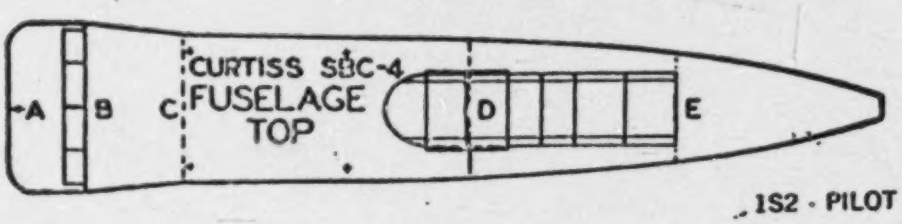

1S2 - PILOT CABIN

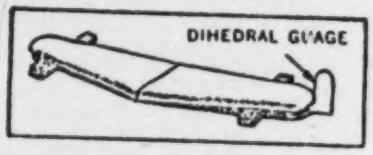

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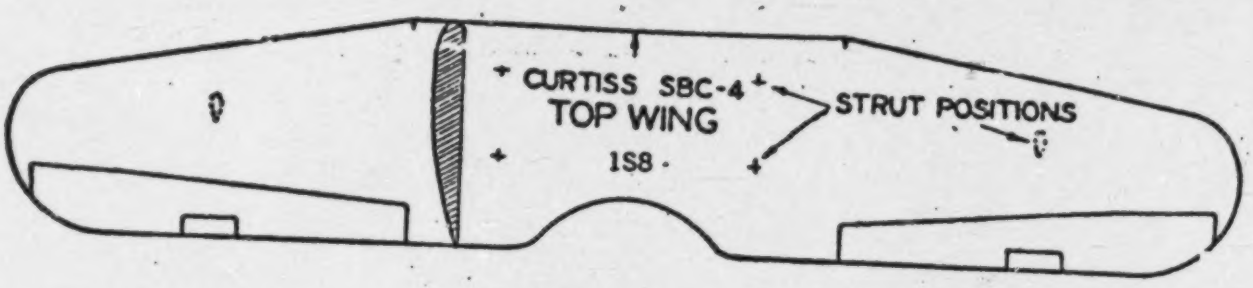

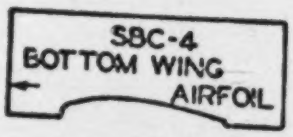

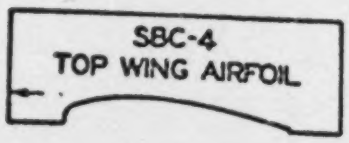

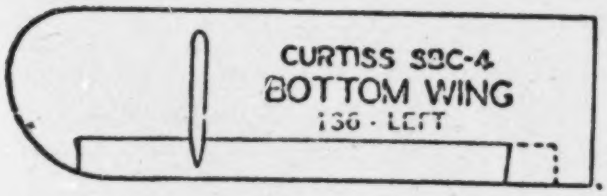

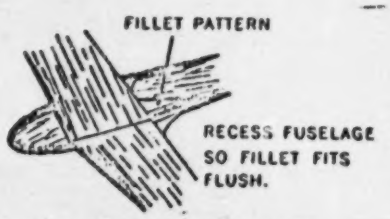

CUT FILLET PATTERN FROM CARDBOARD OF APPROXIMATELY POSTCARD WEIGHT. GLUE TO FUSELAGE AND WING AS SHOWN.

SHAPE WOOD FILLER (FURNISHED) TO FORM TOP OF FILLET AS SHOWN. SAND SMOOTH WHEN DRY.

CURTISS SBC-4 U.S. NAVY SCOUT BOMBER SPOTTER MODEL

INSTRUCTIONS FOR ASSEMBLING

Study the drawing and instructions carefully and thoroughly before starting construction. The quality of workmanship is important on these models. They must conform to the templates if they are to be true models, and although the parts are ready shaped there are some pieces that require sanding to exact shape so that templates will fit perfectly and all parts will conform with the drawing. Scoring of model as explained in Step 8 should be done after parts are sanded but before they are assembled. For some models it can be done after assembly, but on this particular model it should be done before assembly.

CAUTION: Trial assembly of pieces to check fit. alignment, etc. is always a good practice. Then adjustments can be made, if necessary, before pieces are actually glued in place.

Step 1: TEMPLATES

Cut out carefully (with scissors) the fuselage templates B, C, D, E, wing airfoil templates and dihedral gauge. Mount on stiff but light cardboard, using rubber cement, shellac or some adhesive that will not change the size of the template. Cut out, being careful not to cut away any outside lines of the template nor leave any paper visible outside the outline drawing.

Step 2: GLUE

Mix only a small quantity of glue at a time. Be careful to use just the right amount of water, adding a little at a time and mixing until the glue is creamy. No clamps needed.

Step 3: SANDPAPERING

Coarse sandpaper is furnished for sanding pieces down to the exact shape. The piece of garnet paper should be glued to the 1/8" x 1" x 5" piece of wood so it can be used as a file for tapering wings, rudder, elevator, etc. The fine sandpaper is to be used for getting all parts smooth after they are sanded to exact shape.

Step 4: FUSELAGE

Sand front end of pilot cabin (1S2) to shape shown on drawing. Glue to fuselage (1S1).

Sand fuselage so that templates B, C and D fit at points shown on drawing, blending in lines between these points. Use coarse sandpaper, if necessary, to remove surplus stock and then smooth entire fuselage with fine sandpaper.

Step 5: TAIL

The leading and trailing edges of the elevator (1S3) and rudder (1S4) must be sanded to shape (see sectional view) after being assembled to fuselage. Glue pieces in place, being careful to line them up properly. The leading edges should be rounded and the trailing edges gradually tapered to a near point. Blend in surface where fuselage and rudder meet.

Step 6: WING

Glue the two wing pieces (1S5 and 1S6) for bottom wing together. Edges are beveled so that correct dihedral will be obtained if pieces are glued together tightly. For accuracy, check with gauge. blocking up ends as shown on sketch.

When thoroughly dry, sand leading and trailing edges to get the proper airfoil. The leading edge should be rounded and the trailing edge gradually tapered to a near point. Use airfoil template to check shape. Glue in place, lining up carefully and let dry.

Cut out fillet patterns and mount on light but stiff cardboard. Glue to the fuselage and wing, leaving 1/4" between the fillets. Use wood filler provided to form top of fillet. Sand smooth when dry.

Sand top wing (1S8) to shape.

Break apart (1S7) struts from veneer sheet. Sand to shape to conform with template. Assemble struts to bottom wing, gluing into slots.

Glue on top wing and when dry sand struts to streamlined shape.

Step 7: OTHER PARTS

Cabin Struts

Dowels for cabin struts are to be cut to length from long dowel. Sand down to size shown on sketch before cutting to length. Glue in place. Holes in fuselage and wing mark position.

Stabilizer Strut

Sand dowel to size shown on drawing. Cut to length and glue in place.

Exhausts

Make two exhaust pieces from veneer scrap left from strut sheet. Cut to shape shown and glue in place. Round edge slightly.

Tailwheel

Cut from same material as used for exhausts. glue in place and round edges.

Glue propeller hub (1S9) in place.

Step 8: SCORING

On the spotter models it is necessary to score in the outlines representing hinged portion of ailerons, wing flaps, rudder, elevator and also all other surfaces as indicated on the template drawing such as nose turret, pilot cabin, etc.

For locating wing and tail marking, cut out templates and lay on surface, marking the locations with a pin. Score, using pin holes and a straight edge as a guide. A knife blade or glass cutter and hard lead pencil can be used for scoring.

Step 9: FINISHING

Models to be used for training and recognition are to be finished in dull black. Before applying any finish use wood filler to fill nicks or to close up any open joints where parts fit together. Be sure the model is smooth and apply two coats of clear lacquer. After each coat has thoroughly dried go over entire model with fine sandpaper. Apply two coats of dull black lacquer, sanding between coats.

THE PATRIOT

RUBBER-POWER FREE FLIGHT MODEL

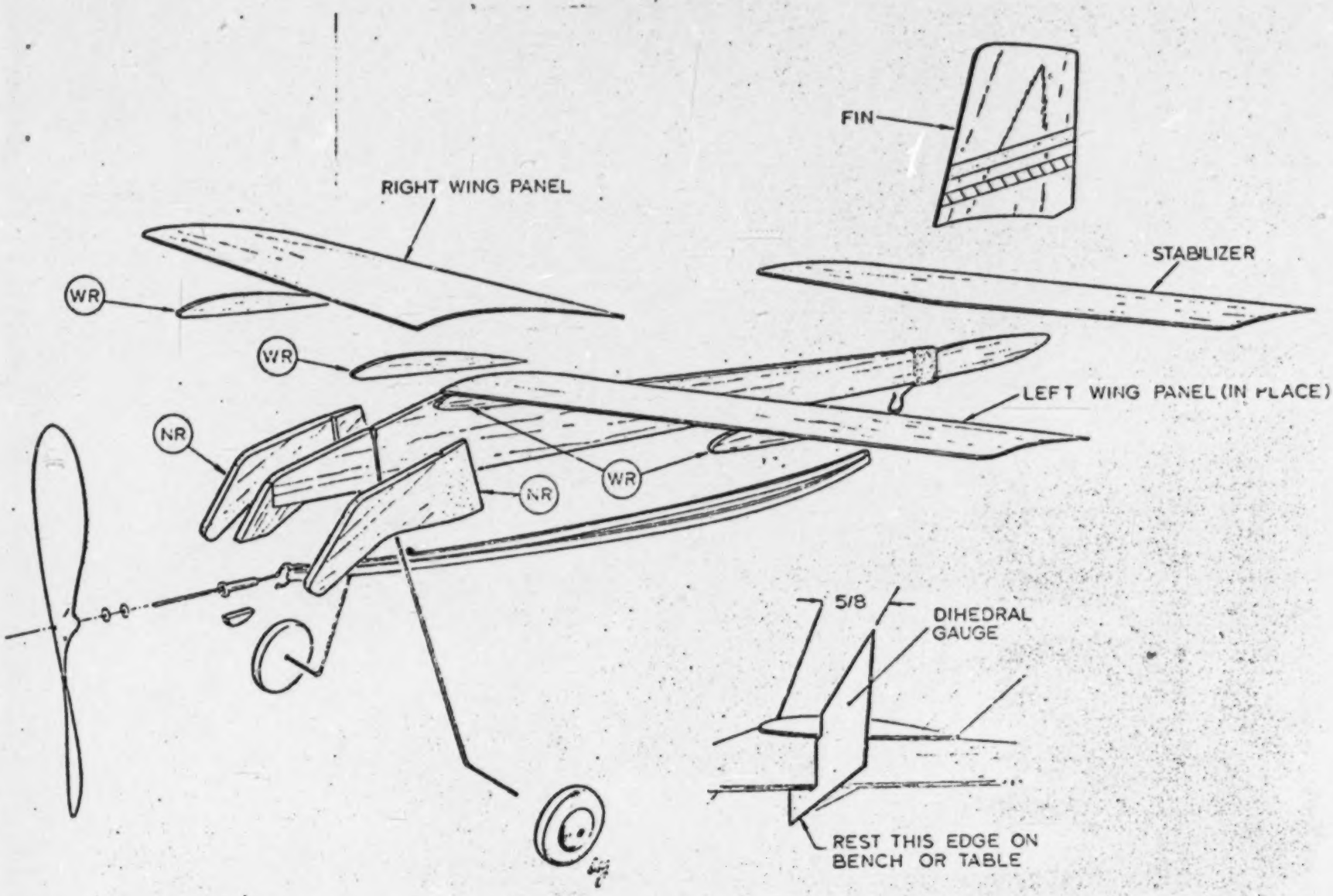

PARTS ASSEMBLY

LOCATION OF DIHEDRAL GAUGE

American Aircraft Modeler

December 1969

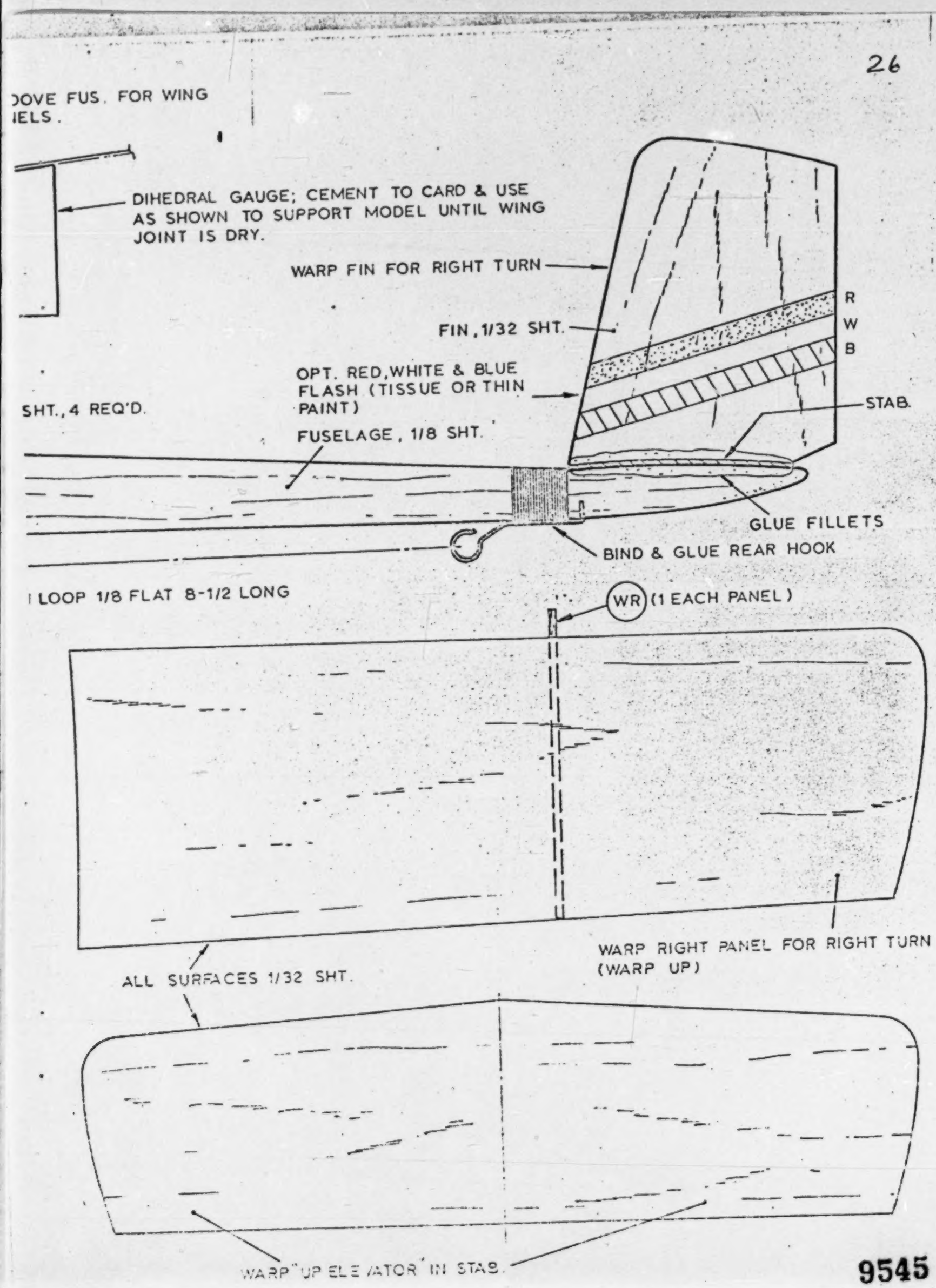
DOVE FUS. FOR WING
IELS.
DIHEDRAL GAUGE; CEMENT TO CARD & USE AS SHOWN TO SUPPORT MODEL UNTIL WING JOINT IS DRY.
WARP FIN FOR RIGHT TURN
FIN, 1/32 SHT.
R
W
B
OPT. RED, WHITE & BLUE FLASH (TISSUE OR THIN PAINT)
SHT., 4 REQ'D.
STAB.
FUSELAGE, 1/8 SHT.
GLUE FILLETS
BIND & GLUE REAR HOOK
1 LOOP 1/8 FLAT 8-1/2 LONG
WR (1 EACH PANEL)
WARP RIGHT PANEL FOR RIGHT TURN (WARP UP)
ALL SURFACES 1/32 SHT.
WARP "UP ELEVATOR" IN STAB.

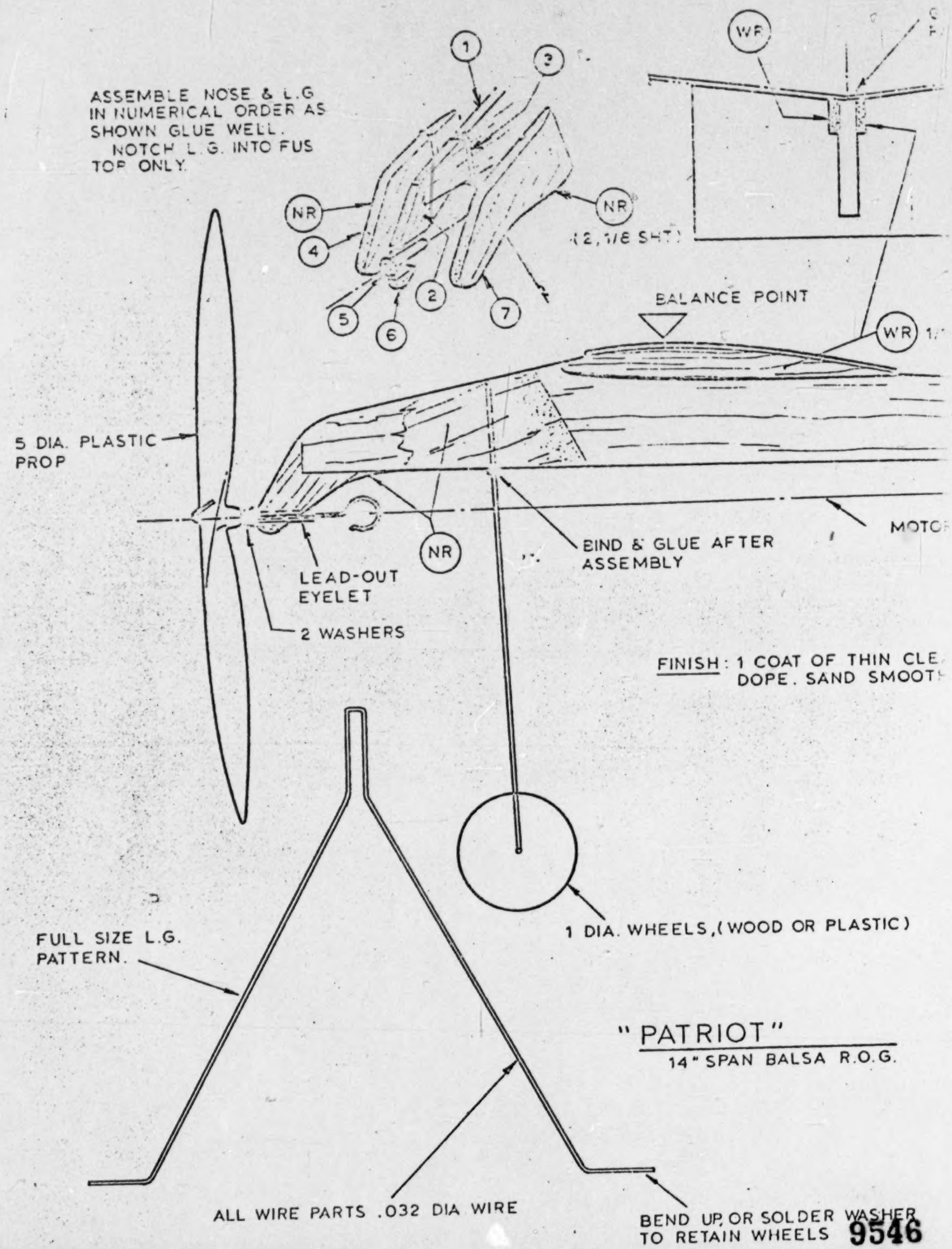
ASSEMBLE NOSE & L.G
IN NUMERICAL ORDER AS
SHOWN GLUE WELL.
NOTCH L.G. INTO FUS
TOP ONLY.
1
3
NR
4
5
6
2
7
NR
(2, 1/8 SHT)
WF
BALANCE POINT
WR
5 DIA. PLASTIC
PROP
NR
LEAD-OUT
EYELET
2 WASHERS
BIND & GLUE AFTER
ASSEMBLY
FINISH: 1 COAT OF THIN CLE
DOPE. SAND SMOOT
1 DIA. WHEELS, (WOOD OR PLASTIC)
FULL SIZE L.G.
PATTERN.
"PATRIOT"
14" SPAN BALSA R.O.G.
ALL WIRE PARTS .032 DIA WIRE
BEND UP, OR SOLDER WASHER
TO RETAIN WHEELS

THE PATRIOT

by David Garrett

from: American Aircraft Modeler
December 1969

MATERIALS:

Balsa Sheets

1 pc 1/32 x 3 x 36 wing, stabilizer and fin

1 pc 1/16 x 1/2 x 12 WR, 4 each

1 pc 1/8 x 3 x 13 fuselage, and nose parts

Miscellanous

1 pair 1" diamter wood or plastic wheels

2 each prop shaft washers

1 each plastic or wood propeller

1 each 1/2" long leadout eyelet

1 length rubber, 1/8" flat x 36

1 pc .032 dia. x 36 long spring 1 wire (landing gear and hooks)

CONSTRUCTION:

1. Cut out fuselage and nose pieces from 1/8" balsa sheet. Be sure to follow grain in diagrams.
   a. 2 each NR
   b. 1 each #s 1, 2, and six 6 (see nose assembly drawing)
2. Notch fuselage and NR for landing gear wire with sandpaper or file. File #2 and #6 for eyelet and glue it in place.
3. Bend landing gear wire from 1/32" wire.
4. Assemble nose pieces and glue in numerical order as shown in detail. Sand edges smooth after the glue is dry.
5. Bind and reglue landing gear wire below the fuselage.
6. Cut four WR ribs from the 1/16" balsa.

7. Glue two to the fuselage, one on each side of the wing mount. (give fuselage preliminary sanding and filling.)

8. Cut wings, stabilizer and fin from 1/32" balsa.

9. Cement two WR on each wing panel. (sand and give preliminary filling)

10. Cut and bend rear hook and propeller shaft. Bind and glue rear hook to fuselage. Do not extend binding under the stabilizer.

11. Cut V-slot in fuselage for wing at dihedral angle.

12. Construct dihedral fixture to hold fuselage and wings at designated angle. Apply glue fillets and allow to dry throughly.

13. Construct empannage fixture for assembly and gluing of the stabilizer and fin.

14. Attach wheels

15. Finish with one or more coats of dope or paint. Draw or apply appropriate decorations.

MOTOR AND PROPELLER

16. Purchase or carve and finish the propeller. (See Appendix M)

17. Assemble propeller, washers and prop shaft and bend wire as shown in diagram.

18. Make a 8 1/2" loop of the 1/8" rubber. Knot in the middle. Lubricate rubber for improved performance.

BALANCING:

19. Stick pin into balance point and suspend the model. Add weights (wire solder or lead) as needed.

INITIAL GLIDE TRIM

20. Warp slight up elevator into the stabilizer.

21. Warp appropriate aileron if model turns to left or right. (See Appendix J)

FLIGHTS

22. Initial flights may be made with 100 to 150 turns. Launch slightly nose down after letting prop go for a few turns.

23. Later flights with appropriate warping to adjust flight characteristics at 200 to 250 turns.

9548

WHIP-POWERED U-CONTROL

REPUBLIC F-84 G THUNDERJET

Designed by: Joe Wagner
American Aircraft Modeler
July 1970

CONSTRUCTION:

1. Cut out all parts from full scale drawings. Make wings in one piece. (Figure 1)

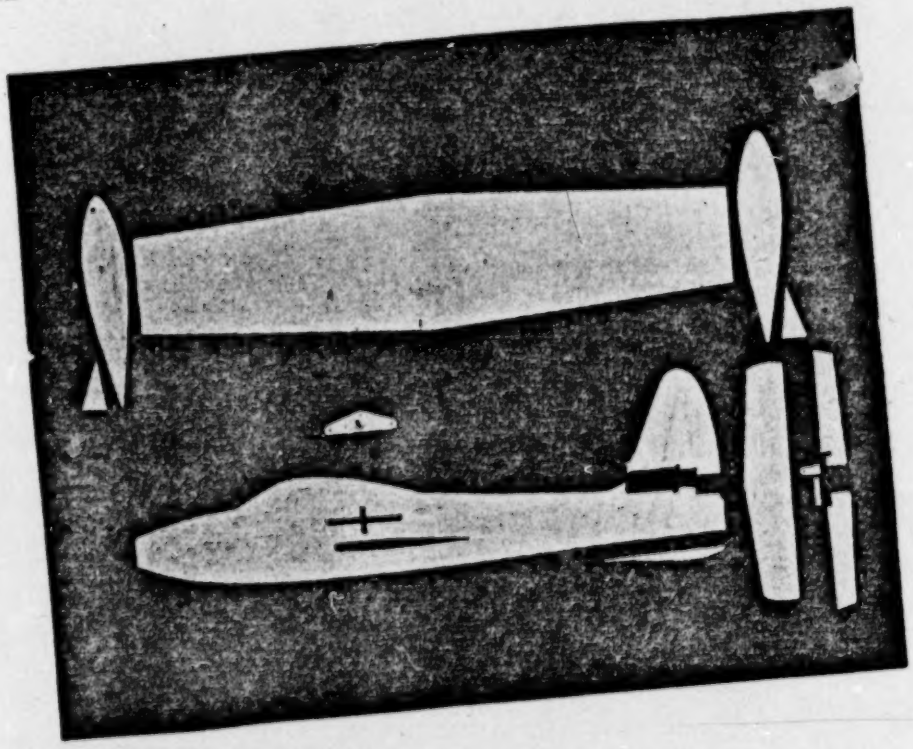

2. Sand all parts. Round outer edges. Camber wing and sand airfoil on stablizer elevators and on sanding board (Figure 2)

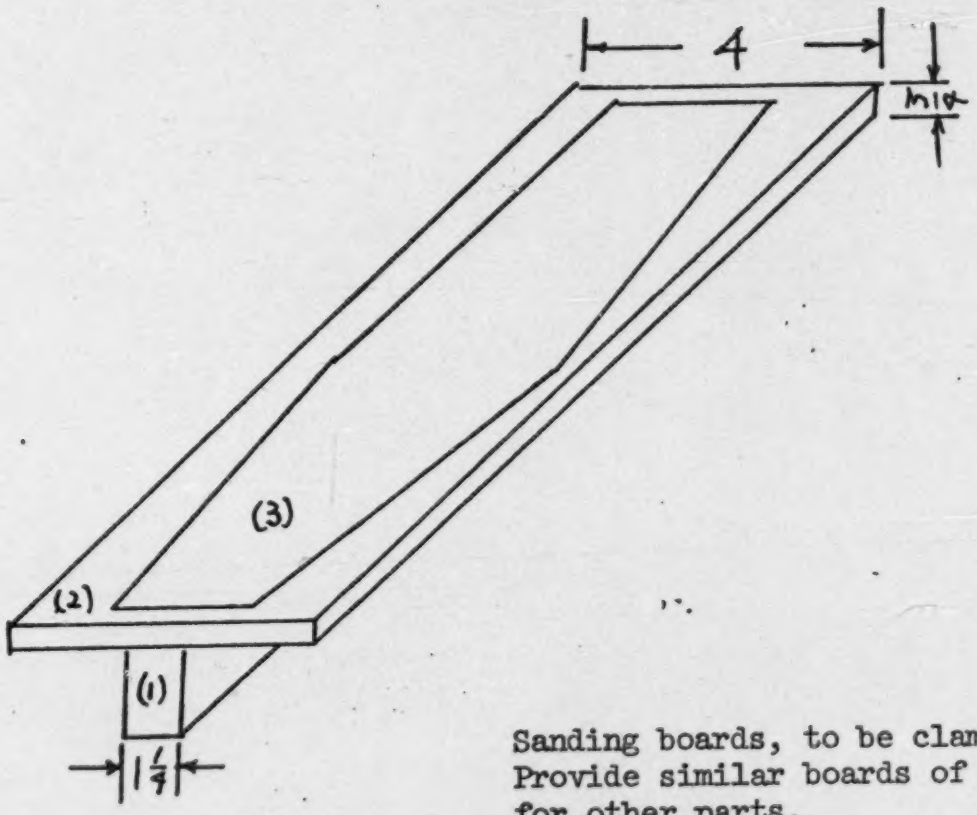

Sanding boards, to be clamped in vise.
Provide similar boards of appropriate sizes for other parts.
(1) 1 1/4 x 3 x 15
(2) 3/4 x 4 x 15
(3) wing shape

3. Use balsa filler on all wood parts (See Appendix I)

4. Set fuselage in assembly fixture and cement horizontal stabilizer and fin.

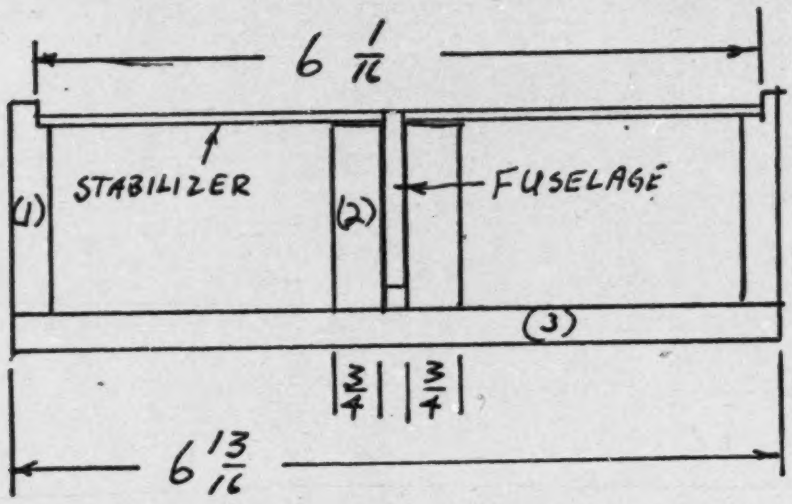

Empannage Fixture. Adjust fuselage with tail skid so that the stabilizer will be horizontal with the fixture and perpendicular to the fuselage.

(1) 3/4 x 2 7/8 x 4, 2 each end supports

(2) 3/4 x 1 3/8 x 4 2 each fuselage supports

(3) 3/4 x 4 X / 7 base

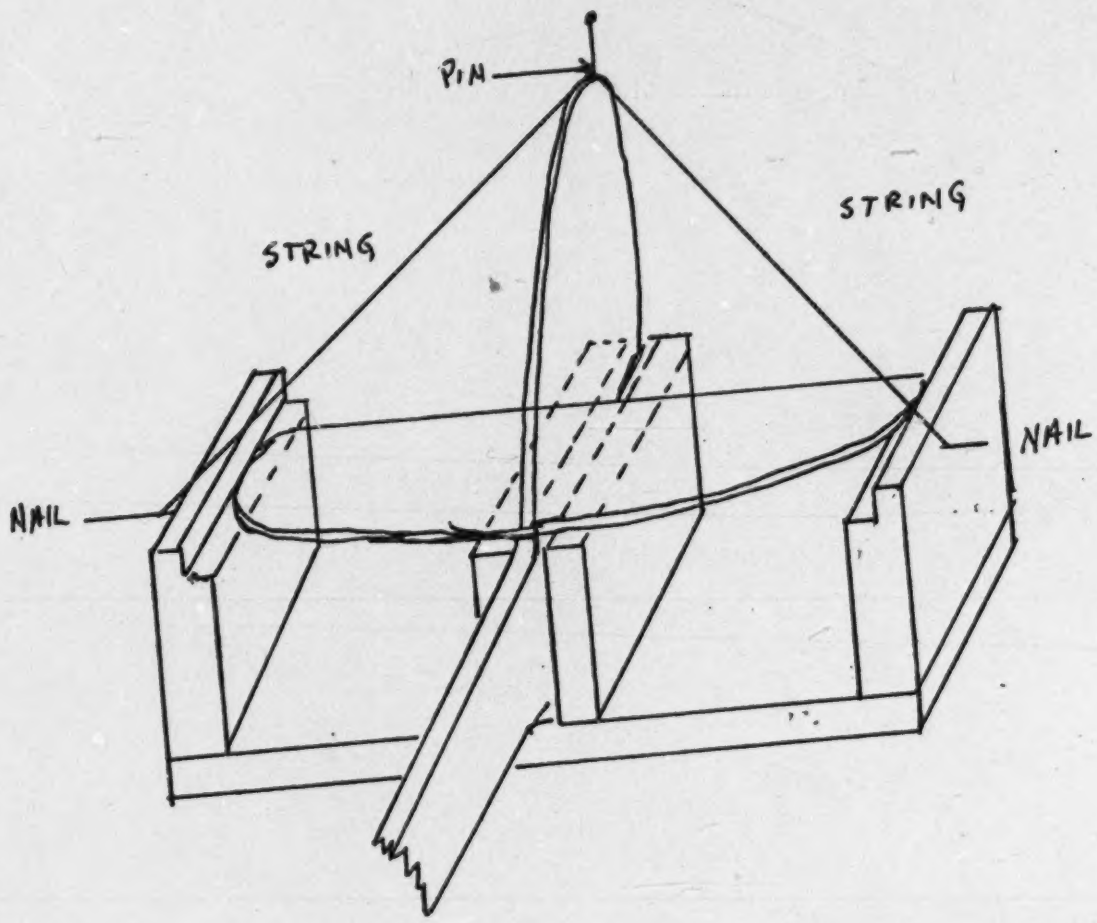

The empannage fixture shown above with fin in place. Stick pin in fin. String will hold it perpindicular to stabilizer until glue dries.

5. Cut wing in half. Sand dihedral angle (Figure 4)

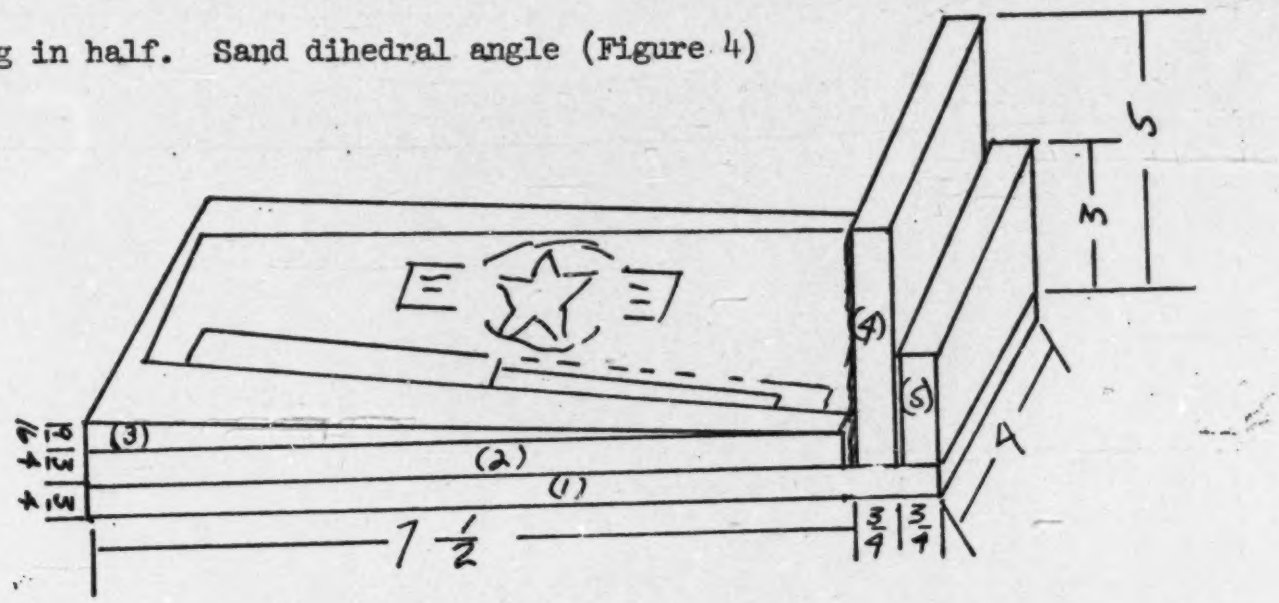

Dihedral Angle Sanding Fixture

The sliding sanding board has fine sandpaper glued to one side.

The wing is held steady as the board is moved back and forth.

(1)	3/4 x 4 x 9	base
(2)	3/4 x 4 x 7 1/2	wedge support
(3)	9/16 wedge x 4 x 7	dihedral angle
(4)	3/4 x 5 x 4	sliding sanding board
(5)	3/4 x 3 x 4	support bolock attached to base

6. Lay one half of the wing flat on a gluing board coverd with wax paper. Raise the other wing tip 1 1/8" off the surface. Cement wings at the dihedral angle. Weight both wings until glue is dry. (See Appendix H for alternate glueing method.)

7. Install bellcrank with 1/8" dowel and cement extra balsa scraps on both sides of the fuselage. Make sure the bellcrank is in the correct way and moves freely.

8. Sand wing slots in fuselage to receive wing.

9. Set fuselage in fixture and cement wings in place. Recement dihedral angle and glue fillets under and over wings (Figure 5)

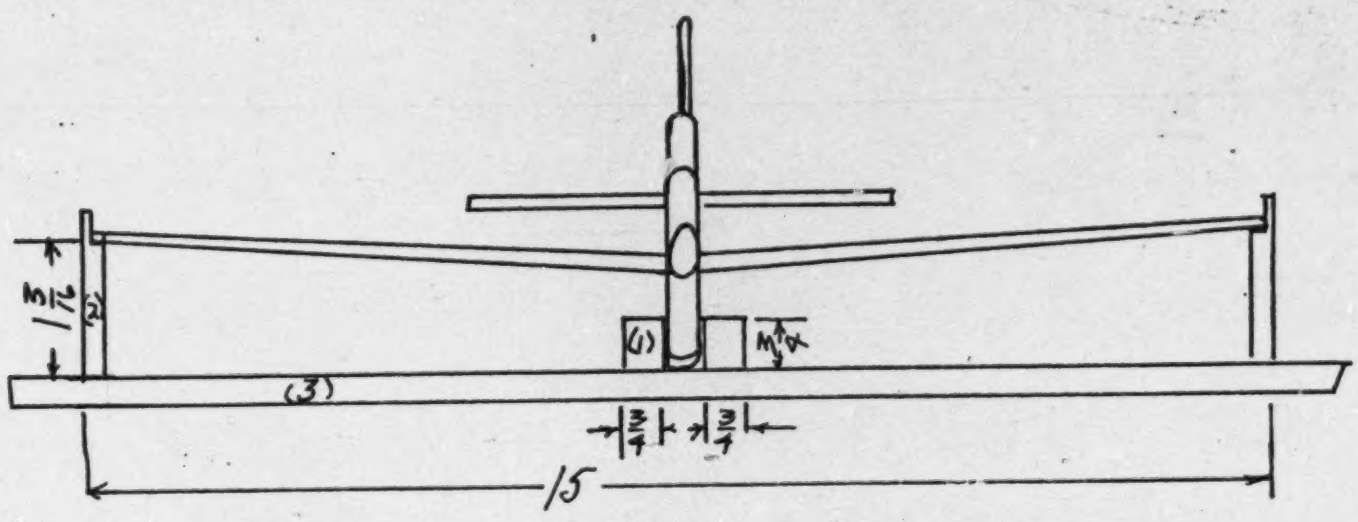

Wing-Fuselage Fixture

Check vertical and horizontal angles before the glue dries.

(1) 3/4 x 3/4 x 4	2 each fuselage supports
(2) 3/4 x 1 3/16 x 4	2 each wing supports
(3) 3/4 x 4 x 15	base

10. Secure fuselage in empannage fixture and sew on elevators. Attach elevator jointer and horn. Elevator must work easily within vertical stablizer.

11. Glue wing tip tanks and small fins to wings. Quick setting glue and pins may hold pieces in place until glue is dry.

12. Hollow out front of fuselage and fill with lead or clay to balance (See Appendix J)

13. Dope or paint model and apply appropriate decal decorations. (See Appendix I)

14. The canopy, rudder, ailerons and flap outlines may be drawn on model with felt pen.

15. Measure, bend and attach .045 dia. music wire rod between bellcrank and horn. Spot solder ends to prevent them from working loose in flight. Test bellcrank to operate elevators.

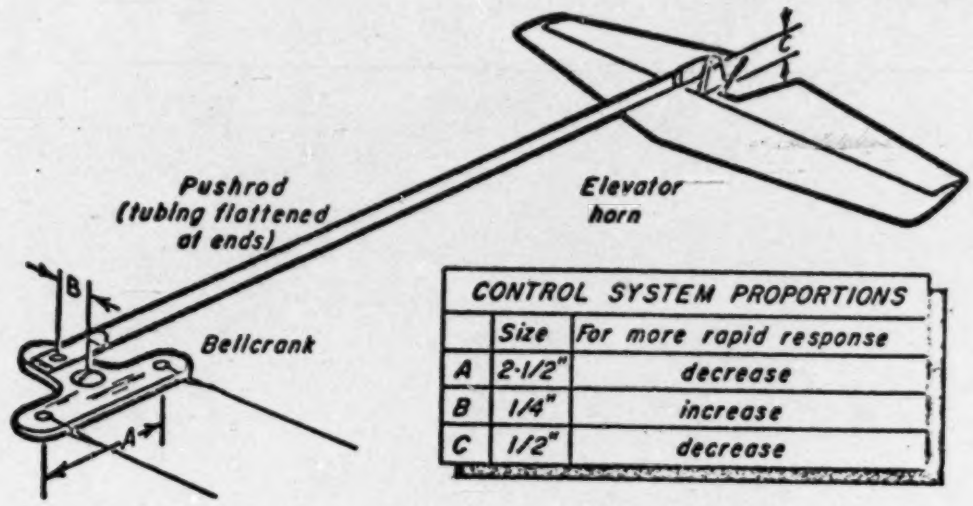

CONTROL SYSTEM PROPORTIONS		
	Size	For more rapid response
A	2-1/2"	decrease
B	1/4"	increase
C	1/2"	decrease

Fig. 11-6. Bellcrank and Linkage

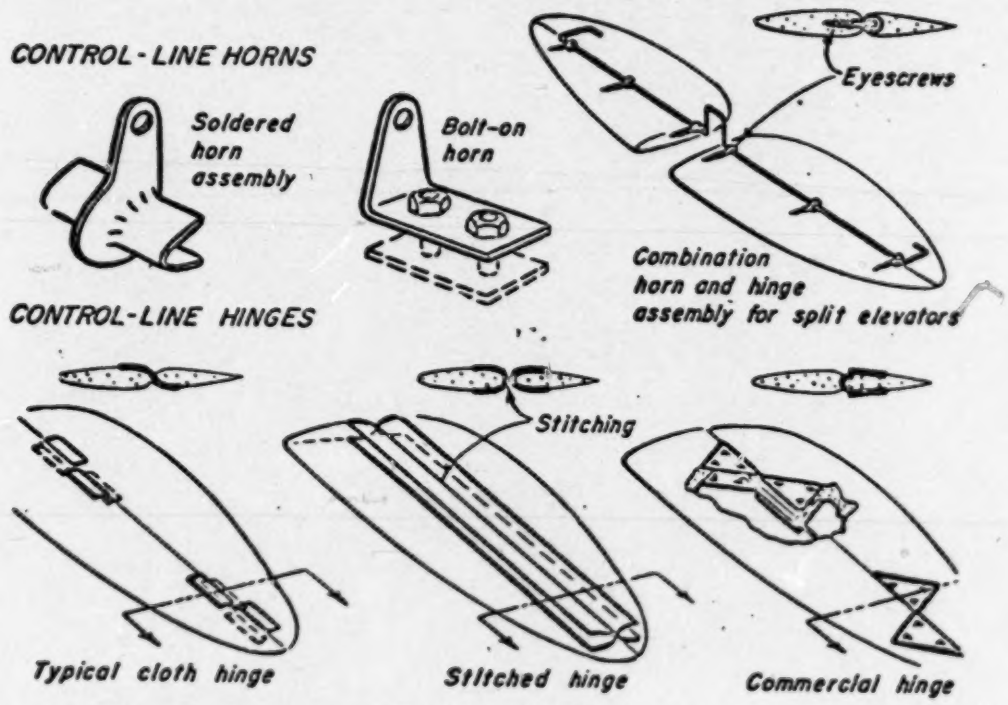

Horns and Hinges

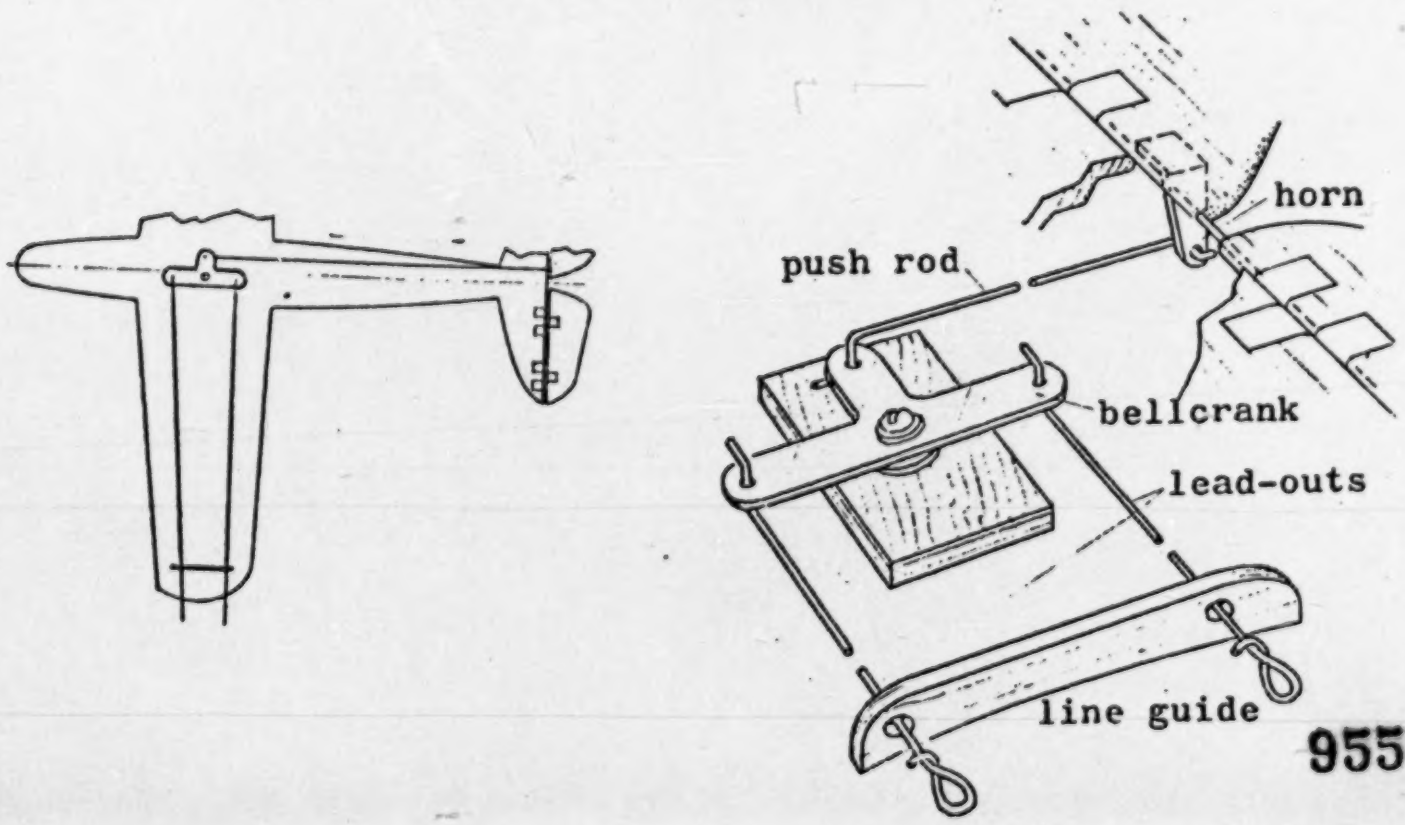

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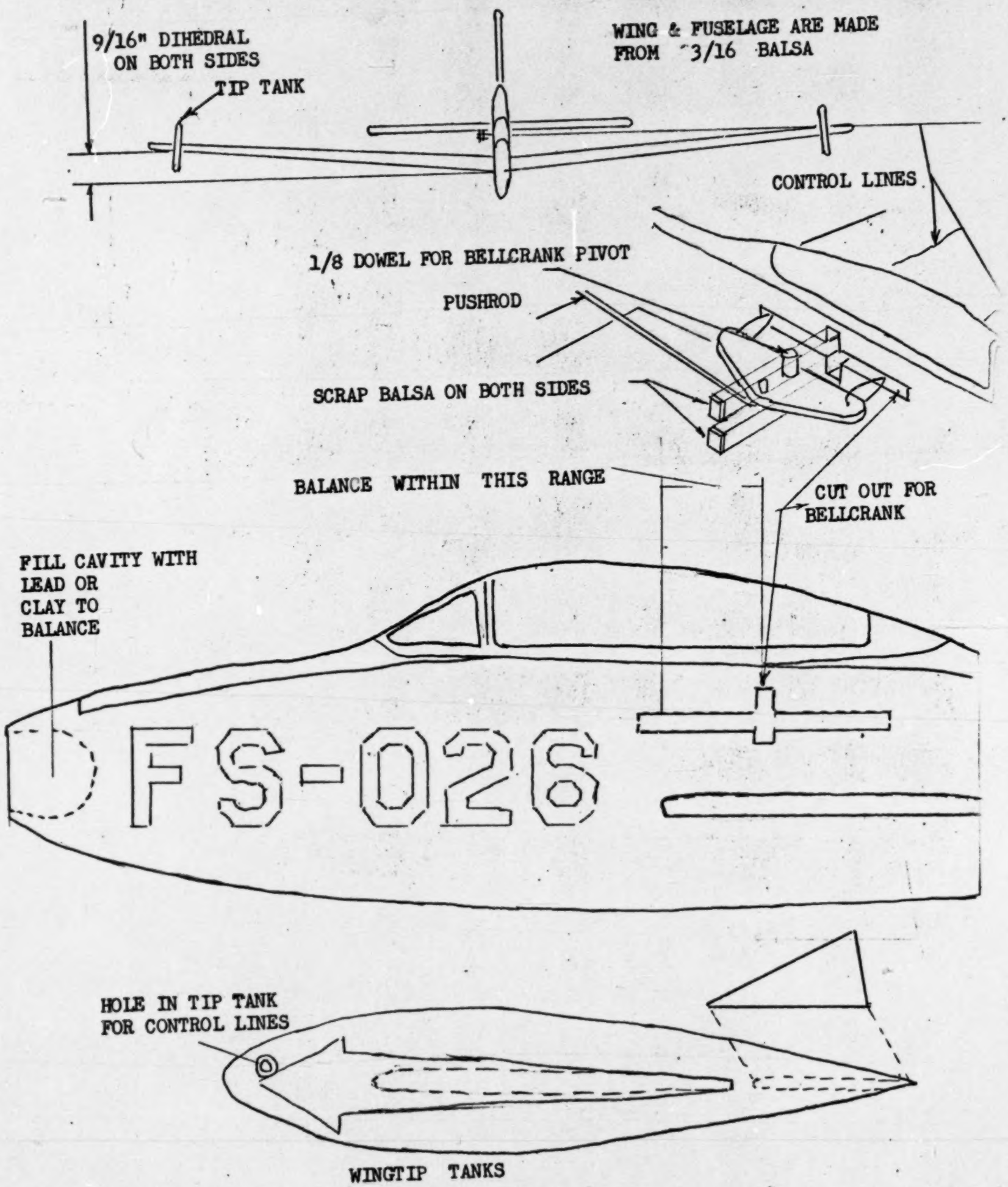
9/16" DIHEDRAL
ON BOTH SIDES
TIP TANK
WING & FUSELAGE ARE MADE
FROM 3/16 BALSA
CONTROL LINES
1/8 DOWEL FOR BELLCRANK PIVOT
PUSHROD
SCRAP BALSA ON BOTH SIDES
BALANCE WITHIN THIS RANGE
CUT OUT FOR
BELLCRANK
FILL CAVITY WITH
LEAD OR
CLAY TO
BALANCE
FS-026
HOLE IN TIP TANK
FOR CONTROL LINES
WINGTIP TANKS

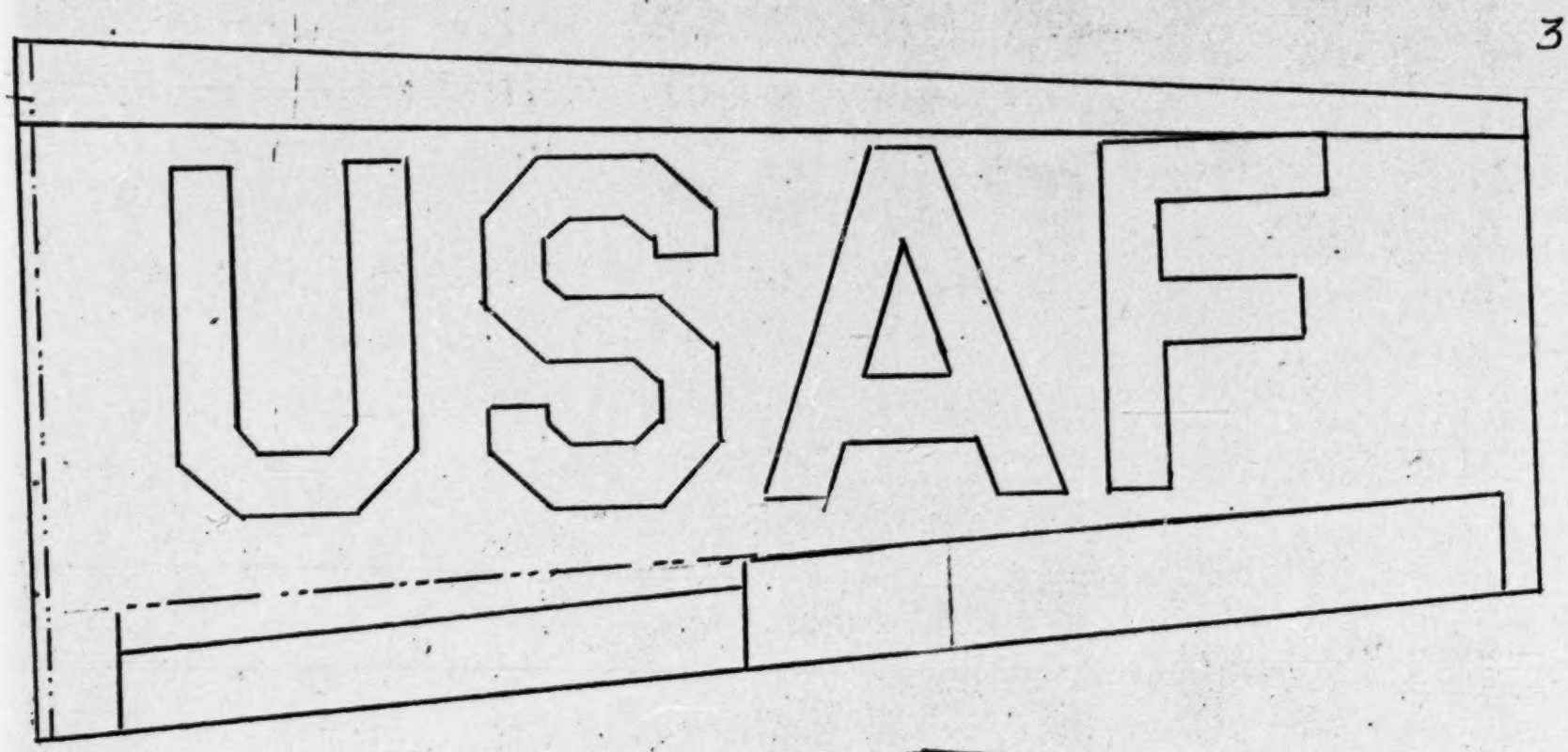

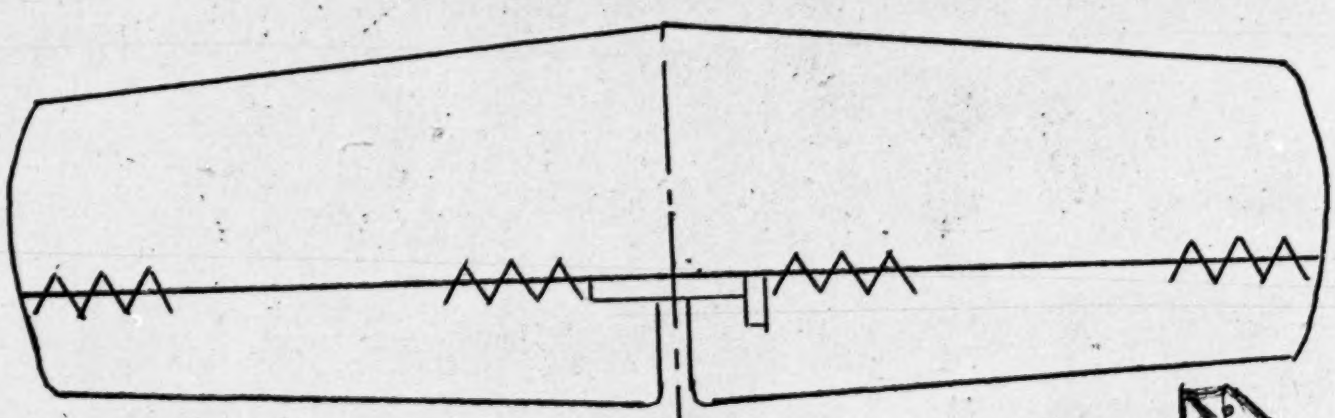

NYLON THREAD
BASEBALL
STITCH

3/32 PLYWOOD
BELLCRANK

L?*1/8" wood
ELEVATOR JOINT

METAL
CONTROL
HORN

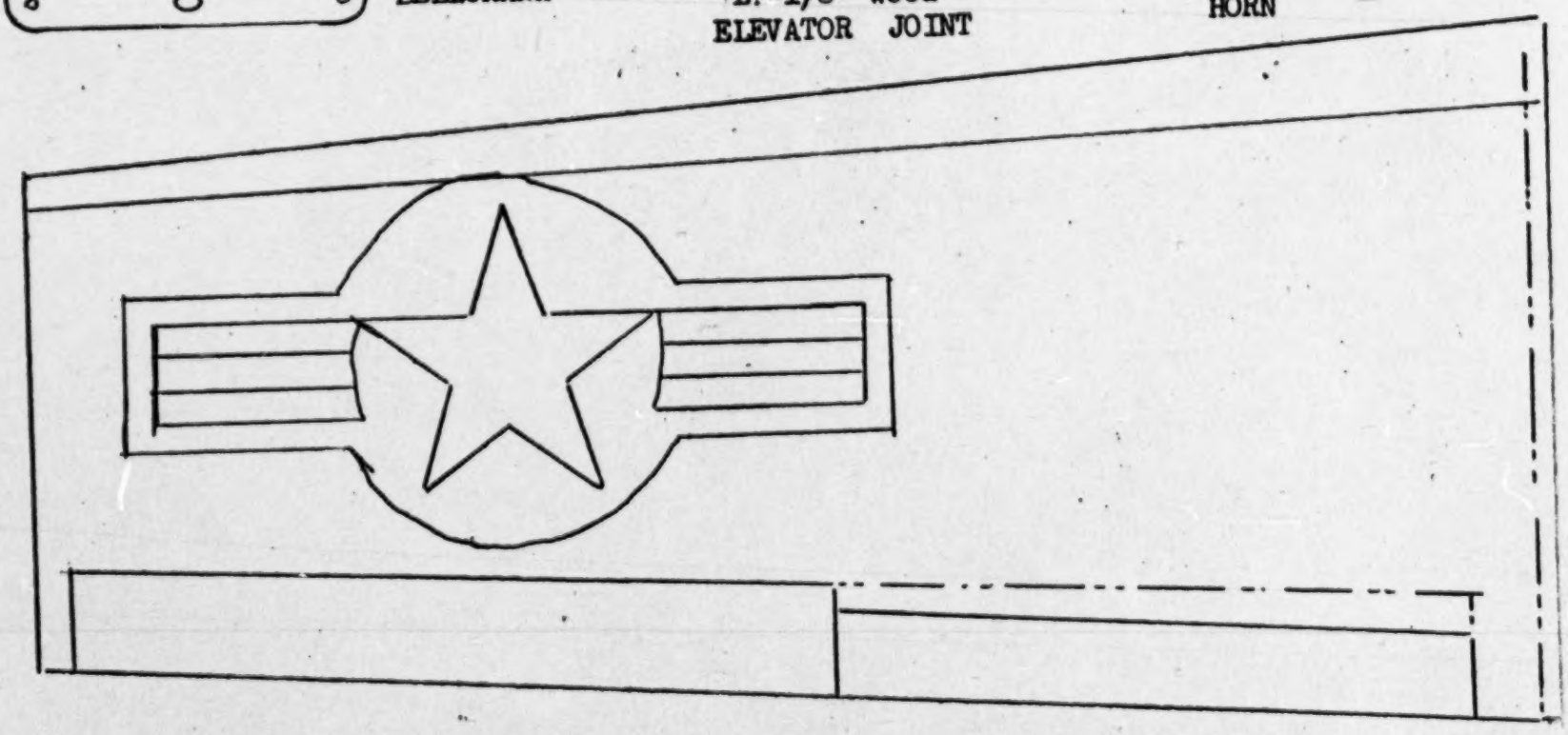

ALL TAIL SURFACES, WING TIPS, TANKS AND FINS ARE LIGHT 3/32 SHEET BALSA

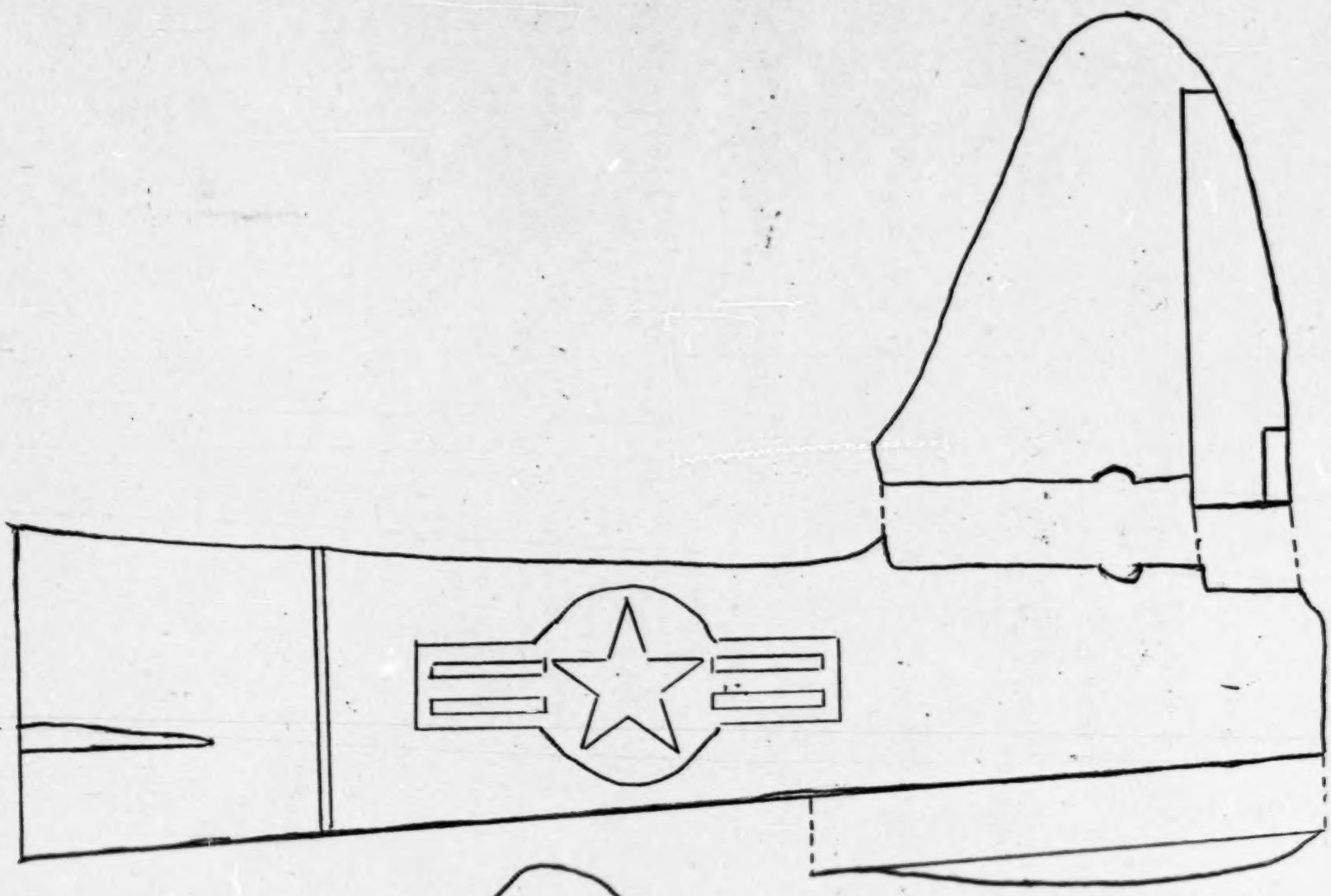

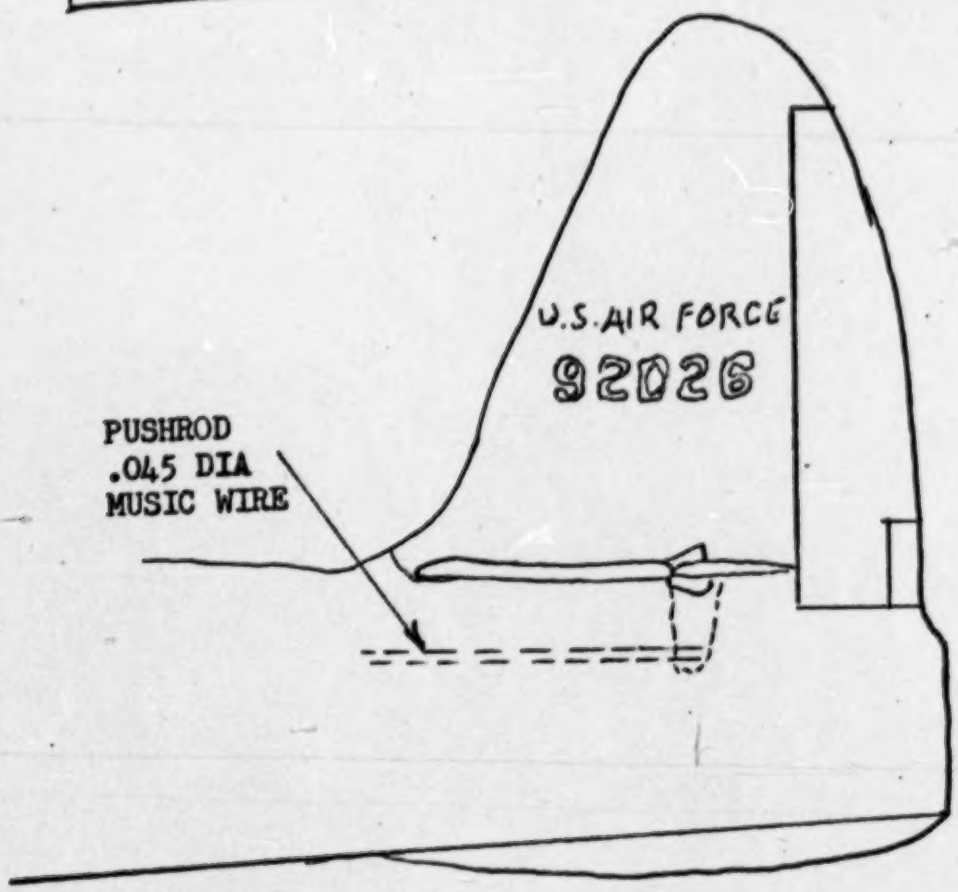
U.S. AIR FORCE
92026
PUSHROD
.045 DIA
MUSIC WIRE

JET POWER GLIDER

A full size blue print will be made available to teachers.

MATERIALS: BALSA SHEET:

1 pc 1 x 3/16 x 18	fuselage
1 pc 3 x 3/16 x 18	wings
1 pc 2 x 1/16 x 12	empennage

1 power pod

1 Jetex 50 engine

1 launcher

CONSTRUCTION:

1. Make full six size patterns from blue print.
2. Transfer patterns and cut out all parts.
3. Sand and partially finish all parts. See Appendix I
4. Construct empennage fixture suitable for model.
5. Assemble and glue stabilizer, fin and dorsal fin.
6. Cut wing in half and sand dihedral angle in sanding fixture.
7. Glue wings at dihedral angle. See Appendix H.
8. Secure model in second fixture and cement wings to fuselage. Apply cement fillets around joints.
9. Complete finishing and apply decals.
10. Attach Jetex engine to engine pod.
11. Balance model by adding weights until a smooth glide is achieved.
12. Construct launching devise.
13. Follow manufacturers directions for installation and ignition of the jet engine.
14. Review safety procedures with students regarding:
    a. installation of jet pellet
    b. placement of igniter
    c. lighting the igniter

d. clearing the area of lift off

e. procedure for misfire

f. following and recovery of the model.

STUDENT DESIGNS:

The relative simple design of this glider with a constant power element of the jet engine lends itself to student redesign and a study in research and development. The teacher should demonstrate and encourage redesign possibilities in any of the following areas:

a. variation in size and shape of the wings

b. changes in the empennage in size as well as position

c. increase and decrease in the dihedral angle

d. polyhedral, tip dihedral

See Appendix G

Testing, recording and evaluation of the flight characteristics may be evaluated in group and class sessions.

ENGINE
GLOW-PLUG/U-CONTROL KIT

1. Past experience indicates that the initial U-Control engine model might best be constructed from a commercial kit. The variables in this new venture would be measurably decreased for the student and the teacher. There are still sufficient educational experiences and adjustments that will be required of the novis student and the teacher who has had limited experiences in model making and flying.

2. Purchasing may be done via small value funds from a neighborhood Hobby Shop. At quantity purchases, some shops will give up to 40% school discount on kits, engines and accessories. The two models with which we have had the most success are the Sterling: Beginners Ringmaster, Kit #S 30, Wing Span 8" x 21", Engine .049 displacement and the Sterling Curtiss P-40 Tiger Shark, Kit #S-7, Wing Span 27 1/2", Engine .09 to .19 displacement. (See Figures #1 and #2) Both are profile fuselages. The Tiger Shark is built with a rib wing. Other suitable models are shown in Figure 3.

3. Construction of the models should follow instructions provided by the manufacturer with the kit. The construction of assembling and glueing fixtures by the teacher and or students will improve the appearance of the model as well as its flight characteristics. Fuel proof cements should be used on all parts. The fixtures will allow the parts ~~to~~ dry throughly while being held stationary. A special storage arrangement should be devised so that work can be held over from day to day. The teacher should provide extra balsa wood and fittings in the event parts are missing or broken during the construction operations. There are numerous opportunities for group or class lessons on finishing, soldering and wire bending as well as reading and following plans. The teacher may supply supplimentary

instruction sheets to those children who are able to follow diagrams and instructions by themselves. Figure 4 shows a diagram that may be included in covering the wing of the Tiger Shark.

4. The purchasing of the engine, gas tank, propellers, fuel, fuel lines batteries, battery clip, control handle and control lines might be made on an individual, group or class basis. Engines list in price from $5.47 for a .049 displacement and up. We have had some successes with the engines with built in spring starters. The automatic battery operated starters list for $24.95 without the battery. The Miniature Internal Combustion Engine Information Sheet (following) should be included in the instructional phase of the model building. Students may have their own or use the group or class engine. One advantage of fewer engines and control lines is that the organizational control by the teacher is simplified if he has to watch fewer flying models at one time.

5. The finishing of the models and the application of appropriate decals (See Figure 5) will do much to enhance its appearance.

6. Testing and flying in the school yard should be conducted with all necessary safety precautions and as many school aids as possible. Chalk the flying circle and spectator area. If students have test run their engines in the shop, there should be little difficulty in running the engine in the yard. Provide a table or have students field caddies on which to work. Assist the students in their initial flights since U-Control is not as simple as it appears, especially the first few times around.

7. Special note to the teacher: PRACTICE

GLOW-PLUG ENGINE U-CONTROL

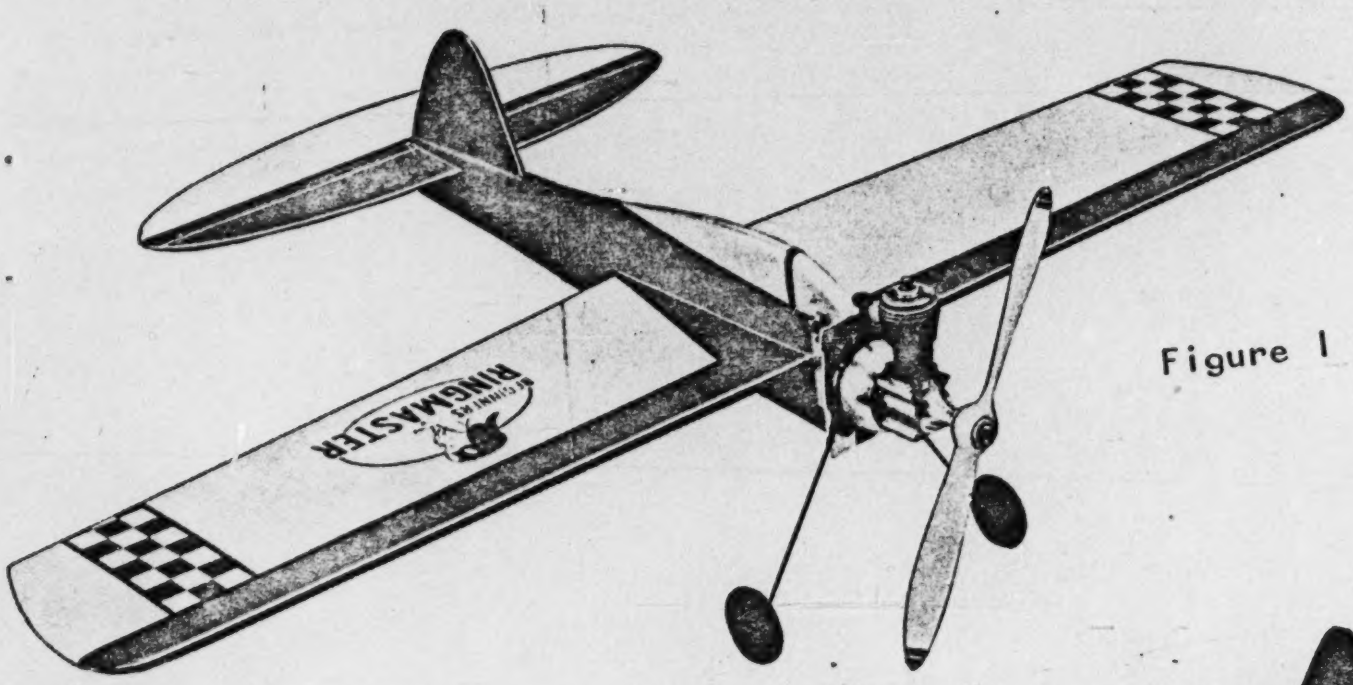

Figure 1

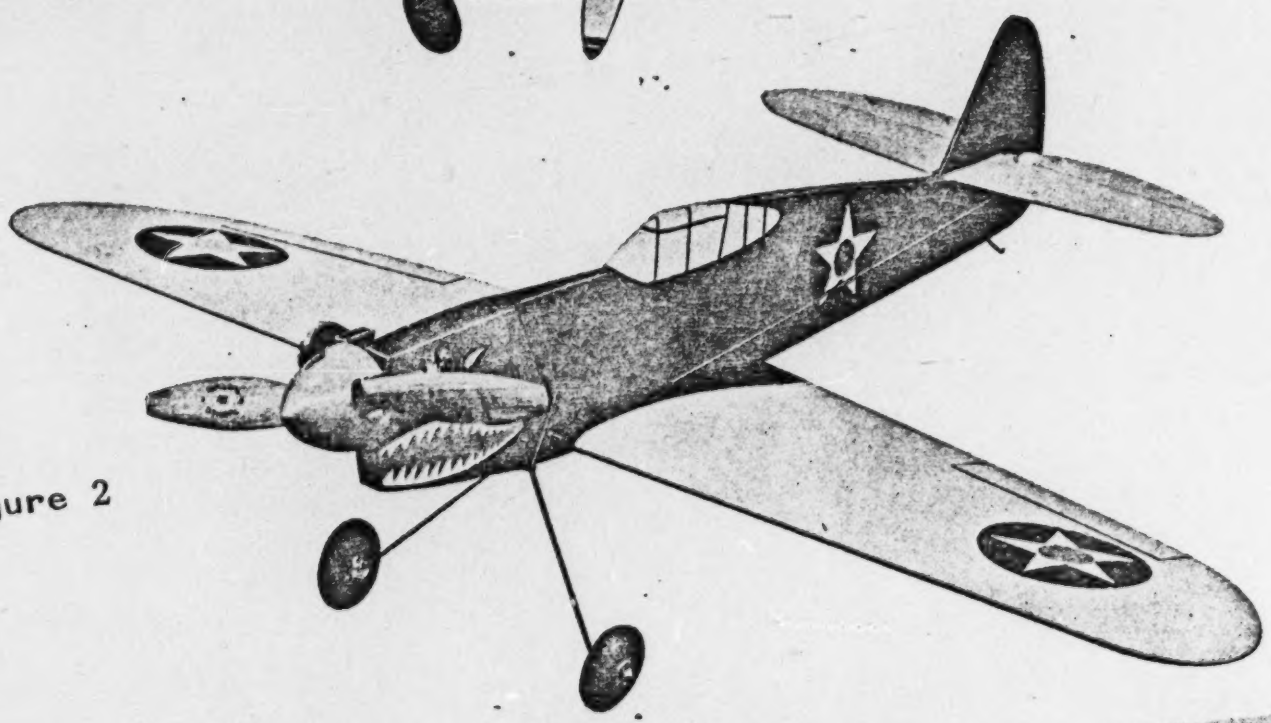

Figure 2

Figure 3

Kit 71 KINGPIN. 50 sq. in. wing Built-up wing, formed parts...$2.95

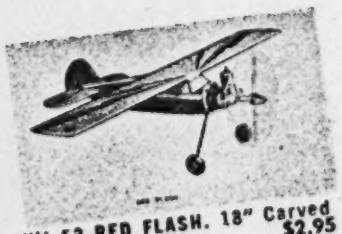

Kit 53 RED FLASH. 18" Carved body, shaped wing $2.95

Kit 140 BIG OTTO. 24" G bat Flyer .....

Kit 59 P-40 FLYING TIGER. 18" Carved body, shaped wing ..$3.95

Kit 8 PIPER CUB CRUISER 18" Carved body, shaped wing $3.95

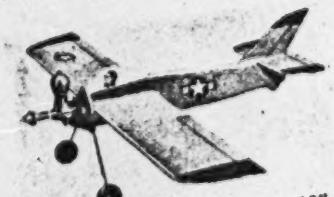

Kit 50 E-Z TRAINER (Profile). 18" Preshaped balsa wing $2.95

Kit 92 P-40 WARHAWK wing, formed cowl ...

9564

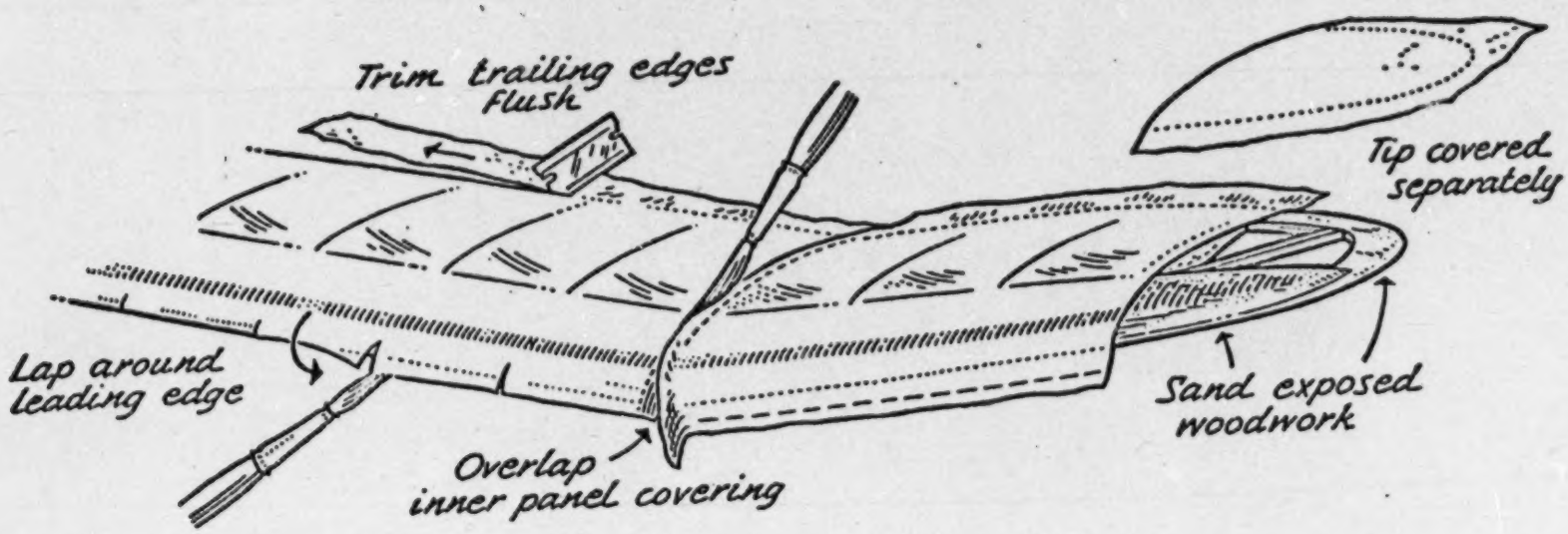

Figure 4

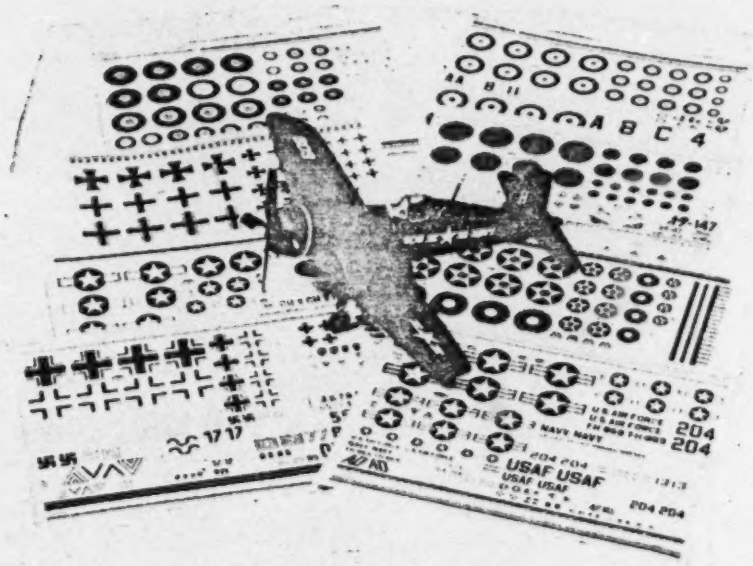

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Figure 5

MINIATURE INTERNAL-COMBUSTION ENGINE

1. Read the operating instructions of the manufacturer carefully.
2. Attach the proper size propeller.
3. Construct wooden break-in fixture and run the engine at least six different times, or six tank fulls before installing it in the model.

LESSON-DEMONSTRATIONS:

a. Construction and parts of a glow plug engine. Figure 1

b. Engine specifications

c. Demonstrate the operation of a four cycle automobile engine Figure 2.

d. Comparison and operation of the two cycle engine. Figure 3

e. Operation Procedures:

(Follow recommendations of the manufacturer)

1. Install engine in model with lock washers or airplane nuts.
2. Install tank and appropriate platic fuel lines.
3. Attach proper size propeller.
4. Observe special safety precautions when filling the fuel tank with manual or automatic pump.
5. Adjust needle valve and prim the engine.
6. Attach starting battery with glow plug clip.
7. Turn over engine. Trouble shoot if it is difficult to start.
8. Observe safety procedures when the engine starts:
   a. keep hands from propeller
   b. be sure back fire has not loosened the prop.
   c. adjust needle valve
   d. remove battery clip
   e. be sure ventilation is adequate if operation is indoors.
9. Adjust engine to run at maximum rpm.

McCOY® "19"

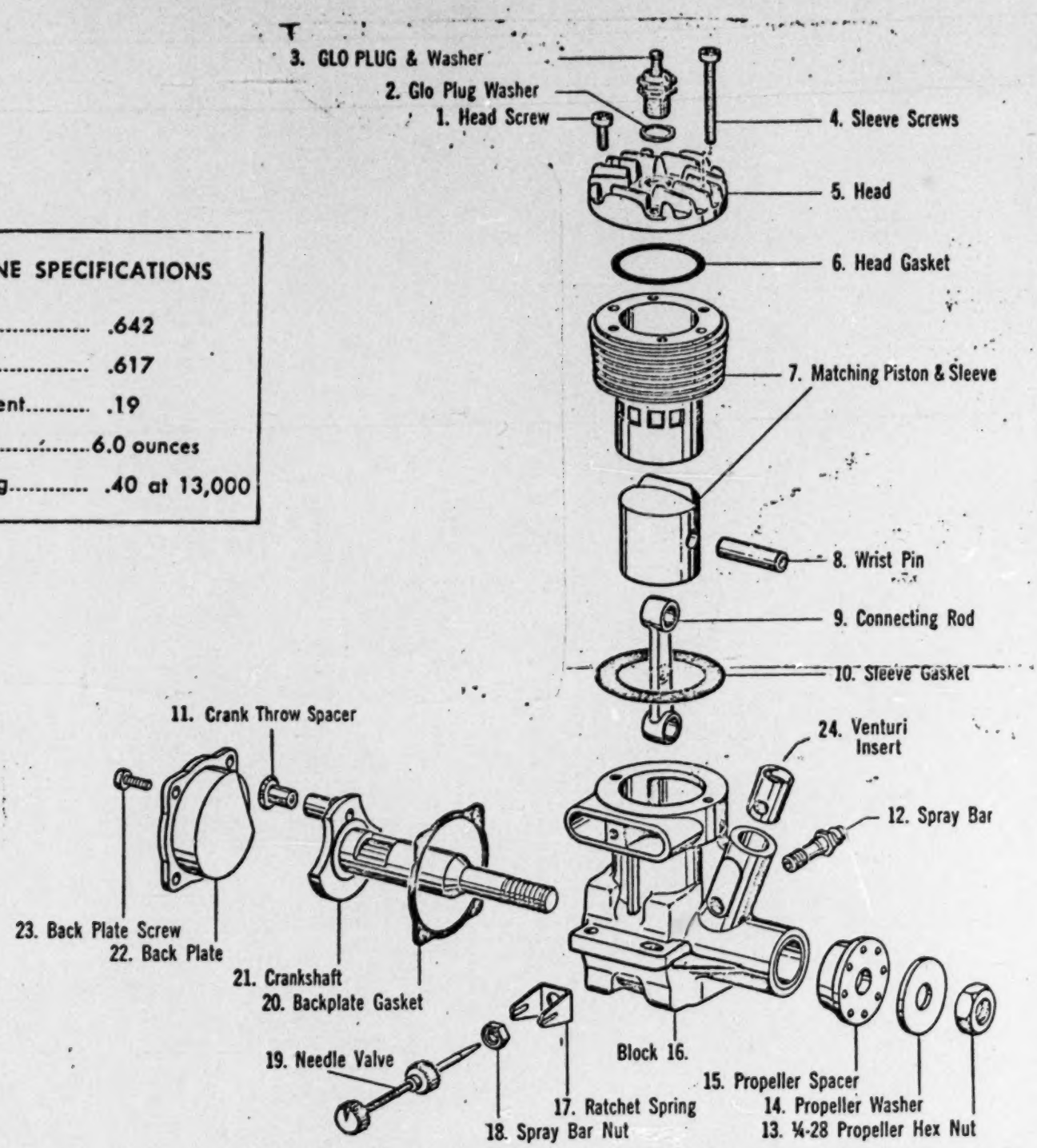

ENGINE SPECIFICATIONS

Bore	.642
Stroke	.617
Displacement	.19
Weight	6.0 ounces
H. P. Rating	.40 at 13,000

PROPELLER RECOMMENDATIONS

Free-Flight	9 x 4
P.A.A. or R.C.	10 x 4
Stunt	9 x 5
"	9 x 4
"	8 x 6
Speed	6 x 9

FIGURE 1

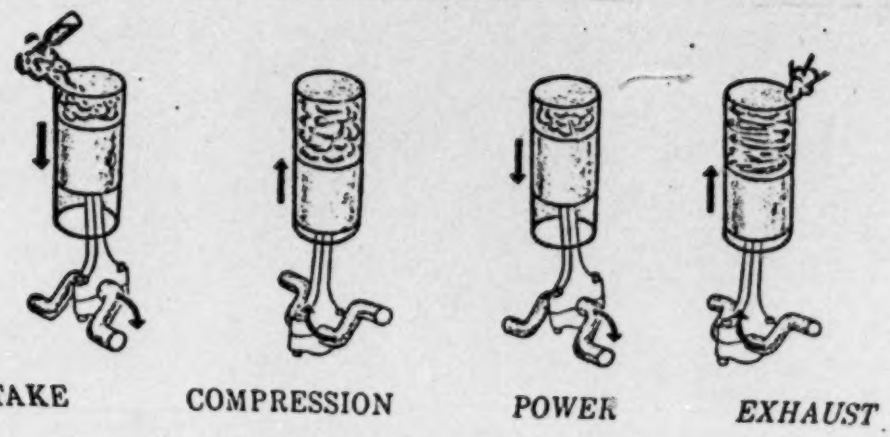

FIGURE 2

Miniature Internal-Combustion Engines

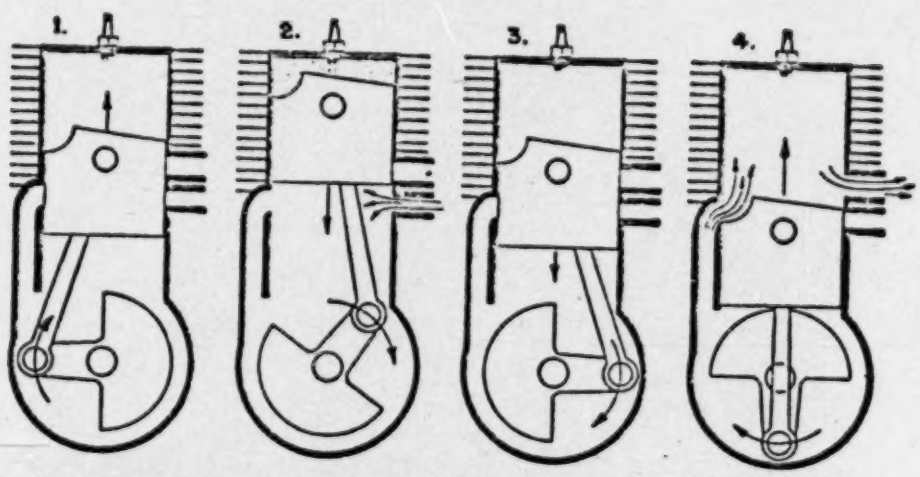

1. COMPRESSION STROKE – TURNING CRANKSHAFT FORCES PISTON UPWARD, COMPRESSING VAPORIZED GASOLINE IN CYLINDER. A PARTIAL VACUUM IS SIMULTANEOUSLY CREATED IN THE CRANKCASE.
2. POWER STROKE – INTAKE PORT IS OPENED, ALLOWING GAS VAPORS TO ENTER CRANKCASE. SPARK PLUG IGNITES GAS VAPORS IN CYLINDER, FORCING PISTON DOWNWARD.
3. EXHAUST STROKE – BURNING GASES FORCE PISTON DOWNWARD UNTIL THE EXHAUST PORT IS OPENED, LETTING BURNT GASES OUT.
4. INTAKE STROKE – GAS VAPORS IN CRANKCASE HAVE BEEN COMPRESSED DURING EXHAUST STROKE, AND WHEN PISTON UNCOVERS TRANSFER PORT, GASES RUSH IN, HELPING FORCE OUT THE EXHAUST GASES.

Two-Cycle Engine

FIGURE 3

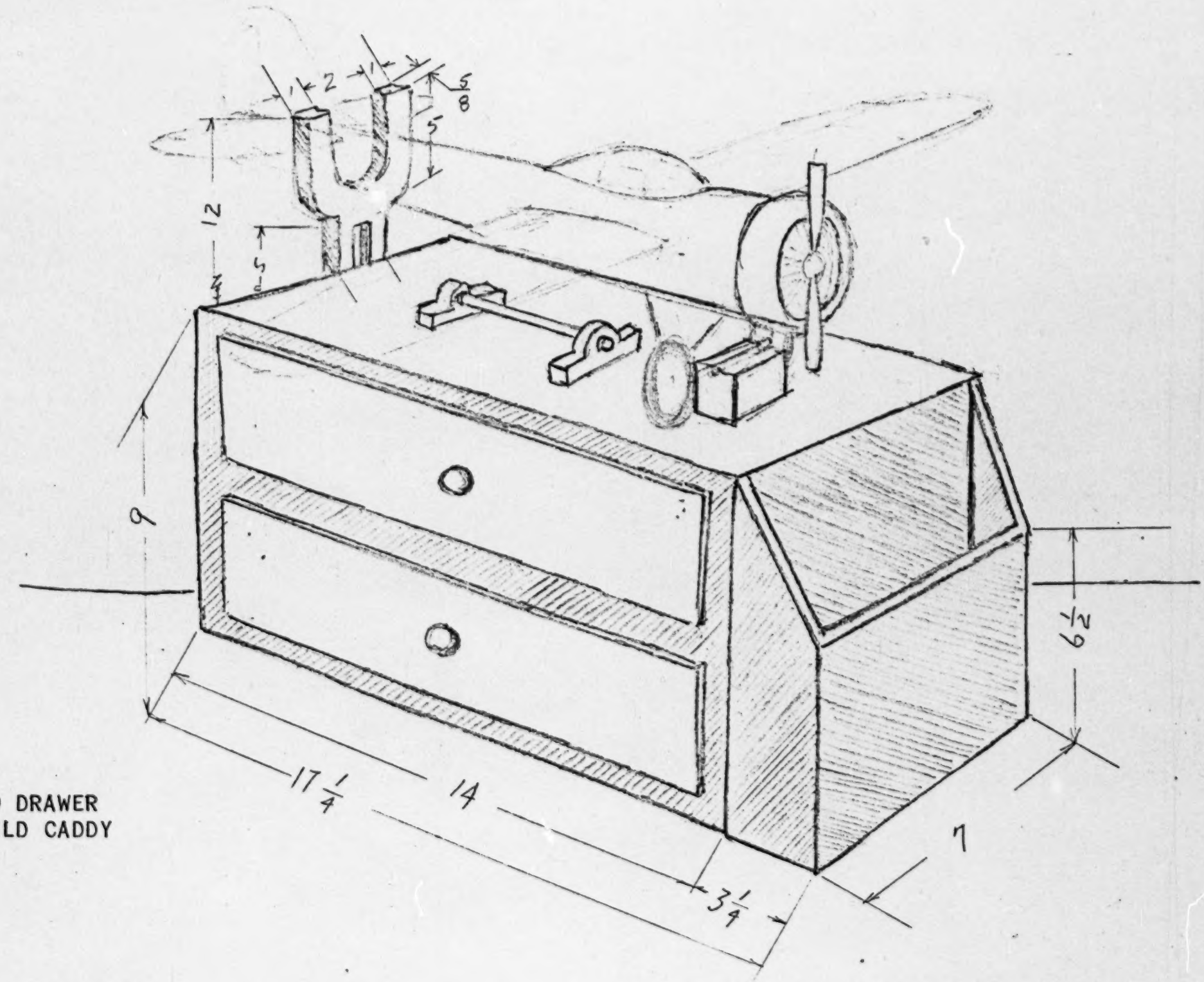

TWO DRAWER
FIELD CADDY

9569

APPENDIX TITLES

A	Soda Straw Jet
B	Model Aircraft Dart
C	How To Build A Barnaby Model
D	How Well Do You Know Your Airplane?
E	Electronic Anemometer
F	Return Type Wind Tunnel
G	Design Ideas
H	Procedure for Obtaining Dihedral Angle
I	Sanding And Sealing Balsa
J	Balancing For Flight
K	U-Control Power Flight
L	Glider Flight
M	Carving The Propeller
N	Sample Pages From Student's Flight Log
O	Individual Event Sheet
P	National Aerospace Educational Council Membership
Q	Magazine Subscriptions And Suppliers Cataloges
R	Demonstration And Experimentation
S	Cessna 150 Specifications
T	Cessna 150 Check List

Soda Jet–the Last Straw!

BILL HANNAN

SABRE "D"
(TWO STRAWS)

SAAB
"DRAKEN"

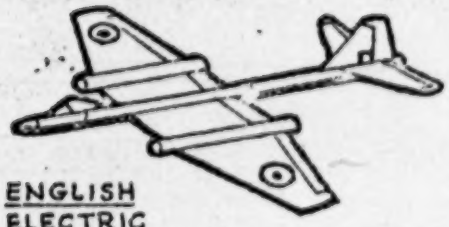

ENGLISH
ELECTRIC
"CANBERRA"

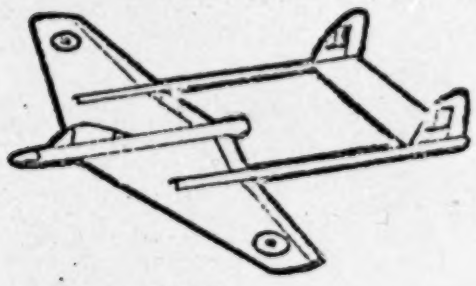

DE HAVILLAND
"VAMPIRE"

V-1 "BUZZ BOMB"

THOUGHT STARTERS

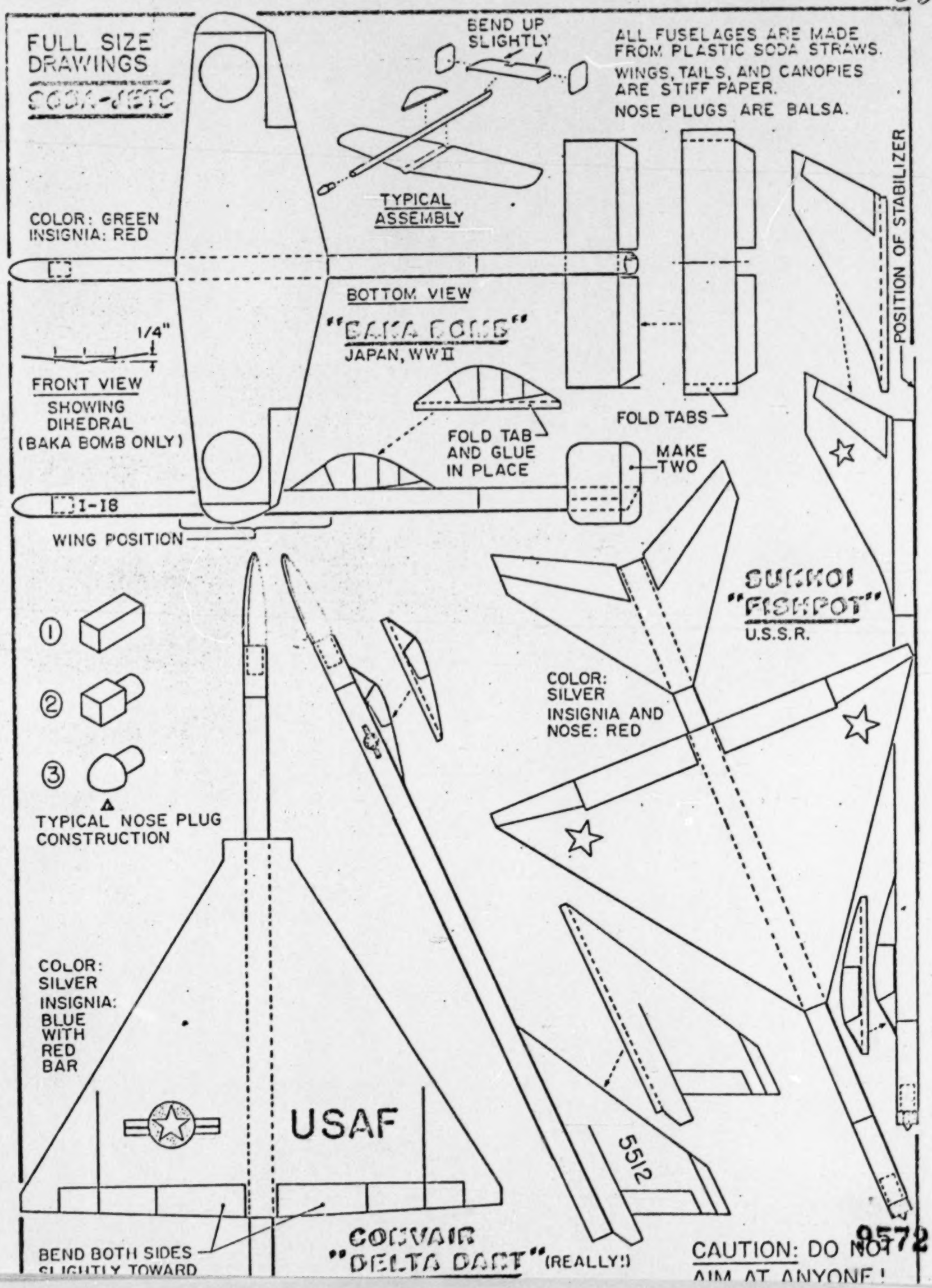
FULL SIZE DRAWINGS
SODA-JETS
BEND UP SLIGHTLY
ALL FUSELAGES ARE MADE FROM PLASTIC SODA STRAWS.
WINGS, TAILS, AND CANOPIES ARE STIFF PAPER.
NOSE PLUGS ARE BALSA.
TYPICAL ASSEMBLY
COLOR: GREEN
INSIGNIA: RED
POSITION OF STABILIZER
BOTTOM VIEW
"BAKA BOMB"
JAPAN, WW II
1/4"
FRONT VIEW
SHOWING DIHEDRAL (BAKA BOMB ONLY)
FOLD TABS
FOLD TAB AND GLUE IN PLACE
MAKE TWO
I-18
WING POSITION
SUKHOI "FISHPOT"
U.S.S.R.
COLOR: SILVER
INSIGNIA AND NOSE: RED
TYPICAL NOSE PLUG CONSTRUCTION
COLOR: SILVER
INSIGNIA: BLUE WITH RED BAR
USAF
5512
BEND BOTH SIDES SLIGHTLY TOWARD
CONVAIR "DELTA DART" (REALLY!)
CAUTION: DO NOT AIM AT ANYONE!

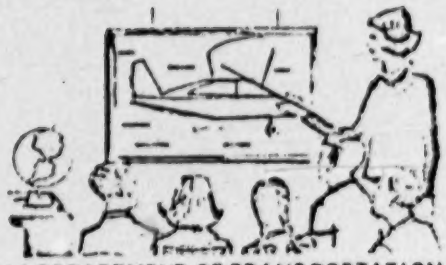

AVIATION EDUCATION

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WASHINGTON, D.C. 20590

MODEL AIRCRAFT

CAPP 33

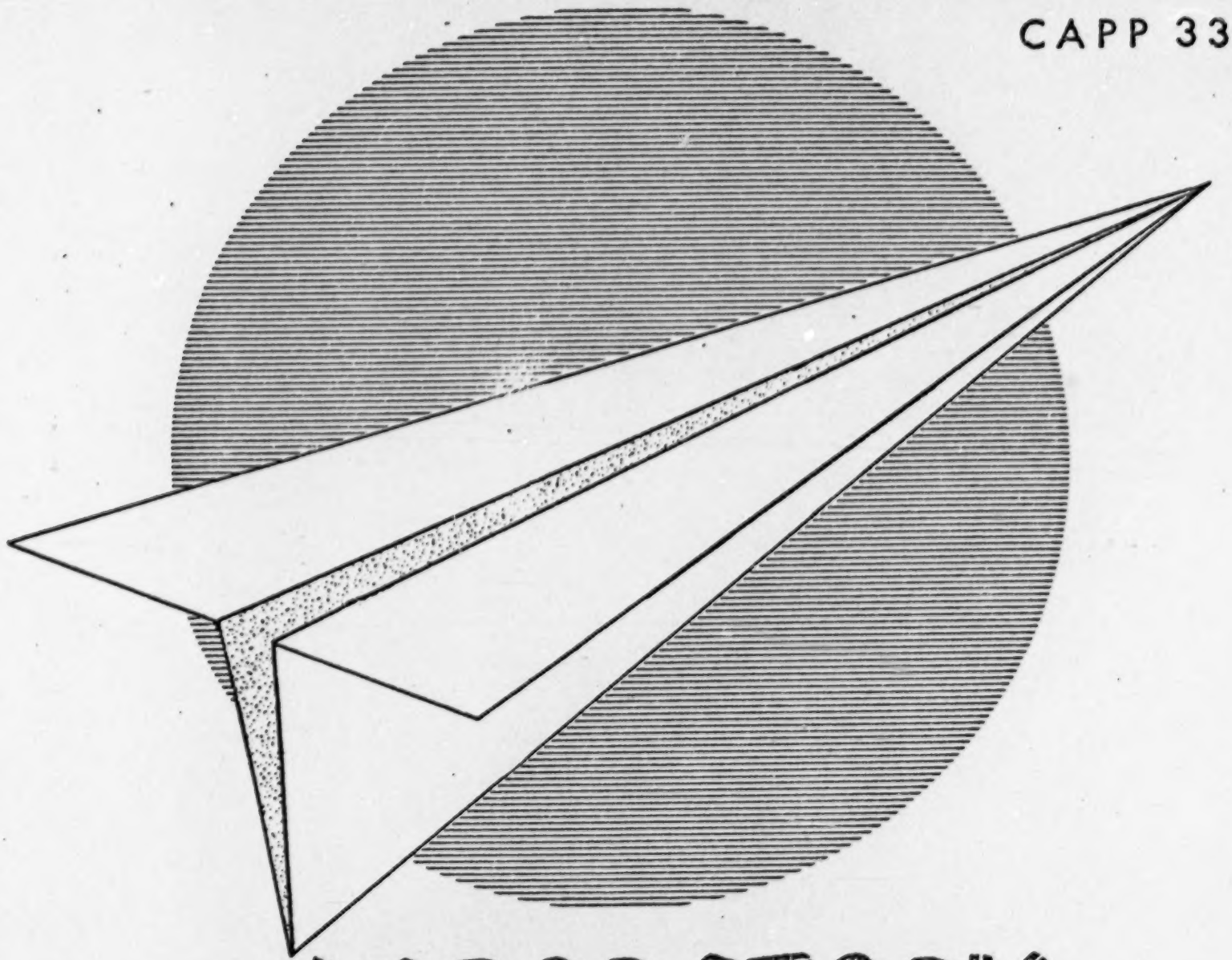

LABORATORY

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CIVIL AIR PATROL
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FEDERAL AVIATION ADMINISTRATION

GA-20-71

MODEL AIRCRAFT LABORATORY

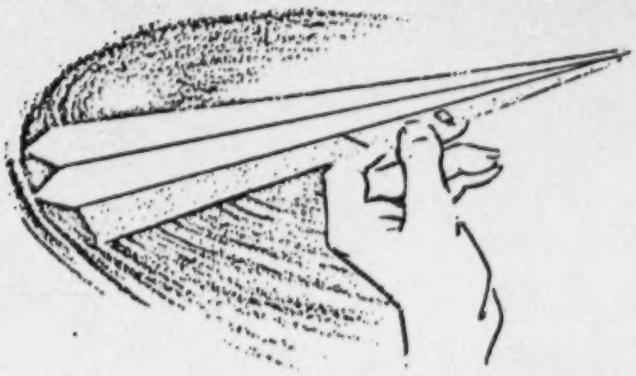

1. Purpose. The Model Aircraft Laboratory provides a controlled laboratory situation in which each individual participating in the CAP aerospace education program can demonstrate his knowledge of (1) the scientific principles of flight, (2) the characteristics of aircraft in flight, (3) the in-flight effects of primary control surfaces, and (4) the movements of an aircraft about its three axes. The Aerospace Education Officer is responsible for conducting the laboratory, and he must certify that each participant has successfully completed all of the requirements listed in paragraph 3 of this pamphlet. Satisfactory participation in the laboratory is a requirement for completion of the Wright Brothers Achievement in Phase II of the Civil Air Patrol Cadet Program. When the laboratory is completed by a CAP cadet, the Achievement Record on the individual's CAP Form 66, "CAP Cadet Master Record," will be properly annotated, and the completed checklist in this phamphlet placed in the cadet's master record.

2. How To Conduct the Laboratory:

a. Physical Layout:

(1) Obtain the use of a large area (room, gymnasium, ramp, etc.) sufficient to allow the flight and observation of paper and balsa gliders.

(2) On the floor of the laboratory area, construct (with chalk, tape, or string) a straight line 15 feet long with a 6-foot crossarm at one end, as shown in figure 1.

(3) Provide a table or other suitable flat working surface for use by personnel conducting and participating in the laboratory. The table should be located as shown in figure 1.

b. Aircraft. Each participant will bring two model aircraft to the laboratory.

(1) Aircraft "A" will be a paper aircraft constructed as shown in figure 2.

(2) Aircraft "B" will be an assembled, hand-launched balsa glider.

(3) Each participant will print his name on each side of the fuselage of each aircraft for identification purposes.

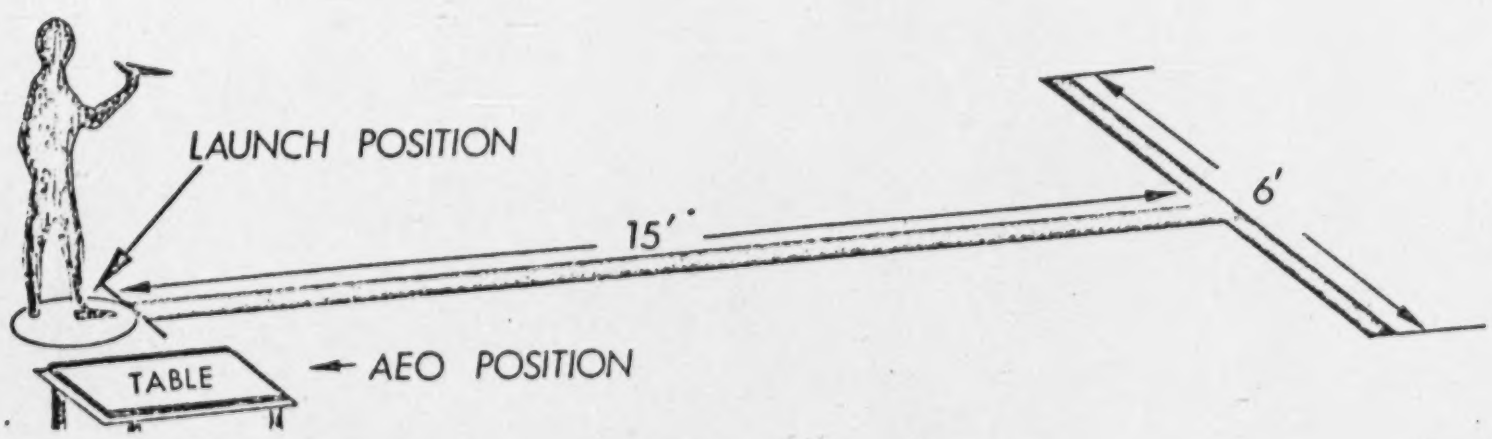

Figure 1.--Floor plan for Model Aircraft Laboratory flight area.

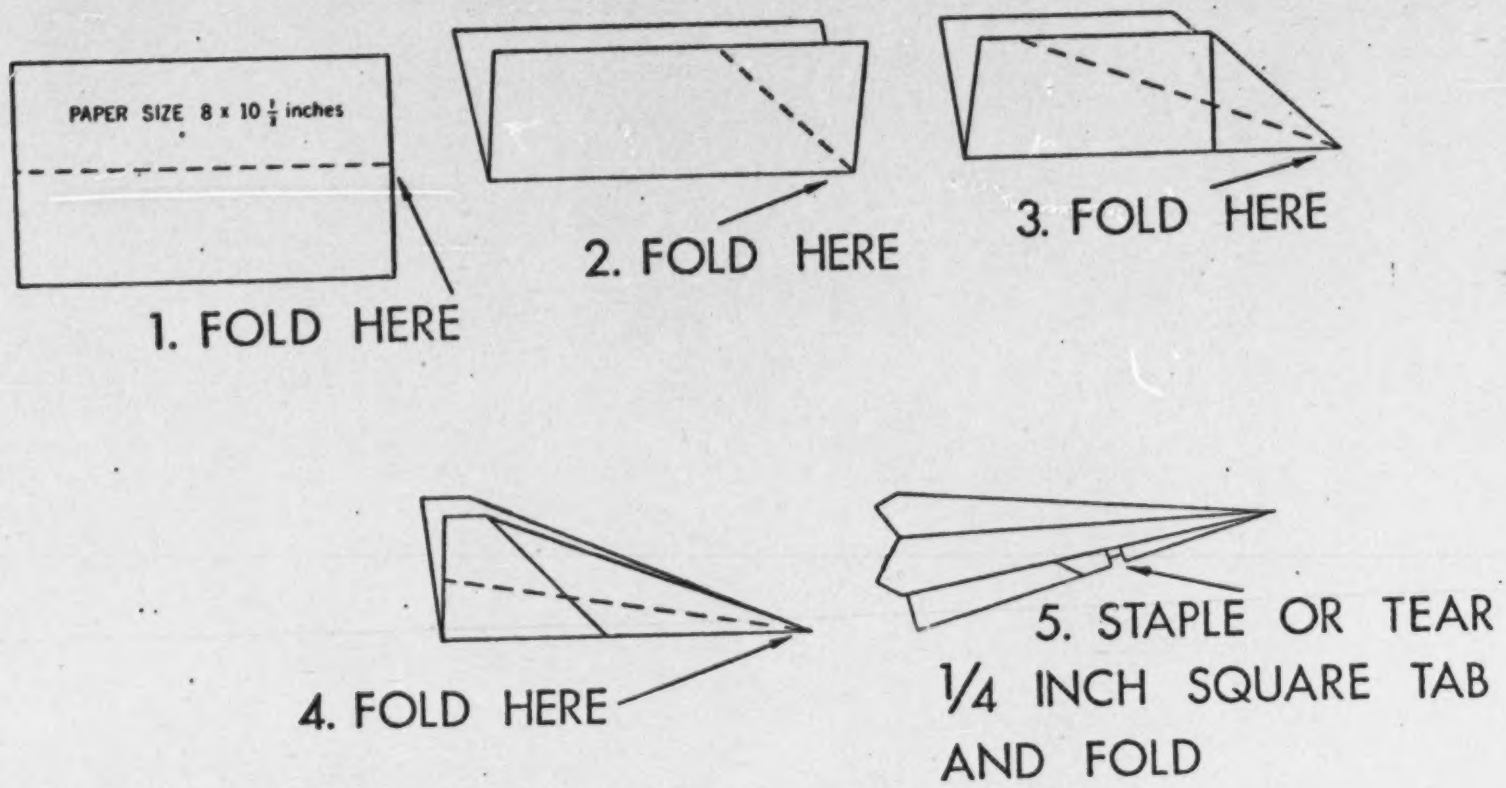

Figure 2.--Directions for constructing paper model Aircraft "A."

c. Procedures:

(1) Each participant will report to the laboratory flight area in the order directed by the Aerospace Education Officer.

(2) Each participant in the laboratory may not observe the exercise until his own performance has been evaluated.

(3) Each participant will report to the laboratory with the two aircraft described in paragraph 2b, assembled and ready to fly.

(4) When called, each participant will approach the laboratory flight area with both aircraft in his left hand. Each Civil Air Patrol cadet will report in a military manner to the assisting cadet officer as follows: "Cadet ___(grade)___ ___(last name)___ , ___(first name)___ , ready to fly, Sir."

(5) The Aerospace Education Officer or his assistant will announce each demonstration to be performed, all of which are contained in the Individual Checklist for the Model Aircraft Laboratory shown in paragraph 3. The participant will then demonstrate his knowledge, understanding, and/or abilities in each category of participation.

(6) The Aerospace Education Officer will observe each participant's performance and record on an individual checklist a "P" (for pass) or an "F" (for failure) in each step. The participant may progress from one checklist item to the next without achieving success; however, each item must be performed successfully before credit for satisfactory completion of the laboratory can be given.

(7) At the end of the checklist, the participant will be graded by the Aerospace Education Officer as a success or failure in the laboratory. If performance of any of the checklist items has been unsatisfactory, the areas of failure will be identified. An opportunity will be provided, outside the regular meeting schedule, for each individual with unsatisfactory ratings to satisfactorily complete the exercise. Once any item on the checklist is successfully completed, that item does not have to be reaccomplished.

(8) Upon completion of the laboratory period, which will take place during the first 50-minute instructional period of Meeting 6 in the Wright Brothers Achievement, the Aerospace Education Officer will report to the commander of the squadron the results of the laboratory and advise him of the time and place scheduled for a re-examination of individuals with unsatisfactory ratings.

3. Checklist To Be Completed. The Aerospace Education Officer, or his designee, will assure completion of the following checklist for each individual participating in the Model Aircraft Laboratory as follows: (1) Announce each checklist item in numbered order, (2) observe and evaluate the participant's performance on that item, and (3) enter an "X" in the appropriate block to denote pass (P) or failure (F).

INDIVIDUAL CHECKLIST FOR MODEL AIRCRAFT LABORATORY

PARTICIPANT'S NAME _____ DATE PASSED _____ AEO'S INITIALS _____

	AIRCRAFT "A"	AIRCRAFT "B"
1. AIRCRAFT NOMENCLATURE. IDENTIFY EACH OF THE FOLLOWING ITEMS BY POINTING TO THE CORRECT PART ON THE MODEL:		
TAIL	1. ☐ P ☐ F	7. ☐ P ☐ F
WINGS	2. ☐ P ☐ F	8. ☐ P ☐ F
FUSELAGE	3. ☐ P ☐ F	9. ☐ P ☐ F
ELEVATORS	4. ☐ P ☐ F	10. ☐ P ☐ F
AILERONS	5. ☐ P ☐ F	11. ☐ P ☐ F
RUDDER	6. ☐ P ☐ F	12. ☐ P ☐ F
2. DEMONSTRATIONS. ACCOMPLISH THE FOLLOWING ITEMS WITHOUT LAUNCHING THE MODEL:		
A. NAME EACH AXIS OF AN AIRCRAFT IN FLIGHT AND SHOW THE LOCATION OF THAT AXIS BY PLACING THE FINGERTIPS AT THE EXTREME ENDS OF THE AXIS:		
LONGITUDINAL	13. ☐ P ☐ F	
VERTICAL	14. ☐ P ☐ F	
LATERAL	15. ☐ P ☐ F	
B. NAME THE MOVEMENT OF AN AIRCRAFT ABOUT EACH OF ITS AXES AND ILLUSTRATE EACH BY MOVING THE MODEL IN THE PROPER DIRECTIONS:		
ROLL (LONGITUDINAL)	16. ☐ P ☐ F	
YAW (VERTICAL)	17. ☐ P ☐ F	
PITCH (LATERAL)	18. ☐ P ☐ F	
C. NAME AND IDENTIFY EACH OF THE PRIMARY CONTROL SURFACES ON THE MODEL AND DESCRIBE THE EFFECT OF EACH IN FLIGHT:		
ELEVATORS	19. ☐ P ☐ F	
AILERONS	20. ☐ P ☐ F	
RUDDER	21. ☐ P ☐ F	
D. DEMONSTRATE THE FOLLOWING MANEUVERS:		
CLIMB	22. ☐ P ☐ F	
DIVE	23. ☐ P ☐ F	
ROLL	24. ☐ P ☐ F	
CLIMB-STALL-DIVE	25. ☐ P ☐ F	
CLIMBING TURN		26. ☐ P ☐ F
DIVING TURN		27. ☐ P ☐ F
LOOP		28. ☐ P ☐ F
SPIN		29. ☐ P ☐ F
IMMELMANN TURN		30. ☐ P ☐ F
CHANDELLE		31. ☐ P ☐ F
SLOW ROLL		32. ☐ P ☐ F
3. FLIGHT PERFORMANCE. FACING THE CROSSARM FROM THE LAUNCH POSITION OF THE FLIGHT AREA (SEE FIGURE 1), LAUNCH THE MODEL TO PERFORM THE MANEUVERS LISTED BELOW. THREE LAUNCHES ARE ALLOWABLE FOR EACH MANEUVER.		
GLIDE STRAIGHT AHEAD A MINIMUM OF 15 FEET, STAYING WITHIN THE 6-FOOT CORRIDOR ABOVE THE CROSSARM	33. ☐ P ☐ F	38. ☐ P ☐ F
GLIDE WITH RIGHT TURN OF AT LEAST 90°	34. ☐ P ☐ F	39. ☐ P ☐ F
ROLL TO LEFT	35. ☐ P ☐ F	40. ☐ P ☐ F
CLIMB-STALL-DIVE	36. ☐ P ☐ F	
NOSE-HIGH SLOW FLIGHT	37. ☐ P ☐ F	
GLIDING SPIRAL TO LEFT		41. ☐ P ☐ F
GLIDING SPIRAL TO RIGHT		42. ☐ P ☐ F
LOOP FOLLOWED BY RIGHT TURN OF AT LEAST 90°		43. ☐ P ☐ F
PREDICT AND PERFORM ONE FLIGHT PROFILE THAT INCLUDES A MINIMUM OF TWO MANEUVERS (CLIMB, GLIDE, LOOP, ETC.): THE PROFILE SELECTED MAY NOT BE ALTERED AFTER ONCE STATED.		44. ☐ P ☐ F

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How To Build A Barnaby Model

Here's how to make a Barnaby model. Take a sheet of 8½-by-11-inch bond paper and fold it in half widthwise (Fig. 4–1*a*). Open it and lay it crease down on a hard flat surface. This crease will be the model's centerline.

Fold over a ¼-inch strip along one of the 11-inch edges. Do this in one operation, using the fingers of both hands. The fold must lie flat. Continue folding until at least one-half of the sheet has been folded up (*b*). Remember, each fold must be carefully flattened in a separate operation. Otherwise, you may build a twist into the leading edge. Later, when you try to adjust the model, the wings will not align.

Now bring the two rolled-up tips together and press again along the centerline. Hold the paper in this position and carefully cut or tear along the dotted line, as indicated in Fig. 4–1c. Spread the model out flat and turn up a quarter inch of each wingtip to make wing fins. These fins should be parallel to the centerline and perpendicular to the wings (*d*).

Next, fold *down* the outer portions of the tail surfaces to make rudders, following the angle made by the dashed lines in Fig. 4–1*e*. Note that these folds are not parallel to the centerline but toe in slightly toward the nose.

With thumb and index finger, bend up a small portion of the rolled-up leading edge at the centerline (*f*). This raised portion will act as a truss to stiffen the wings laterally and hold them at the proper angle.

Now camber the wings by scratching along their trailing edge (*g*), as you learned earlier. Hold the model by the tail, between the thumb and first two fingers with the index finger on top and check for symmetry (*h*). If necessary, add more camber to one wing or smooth one out until the two are identical.

Also, check for wingtip symmetry by viewing the model from the side. If the

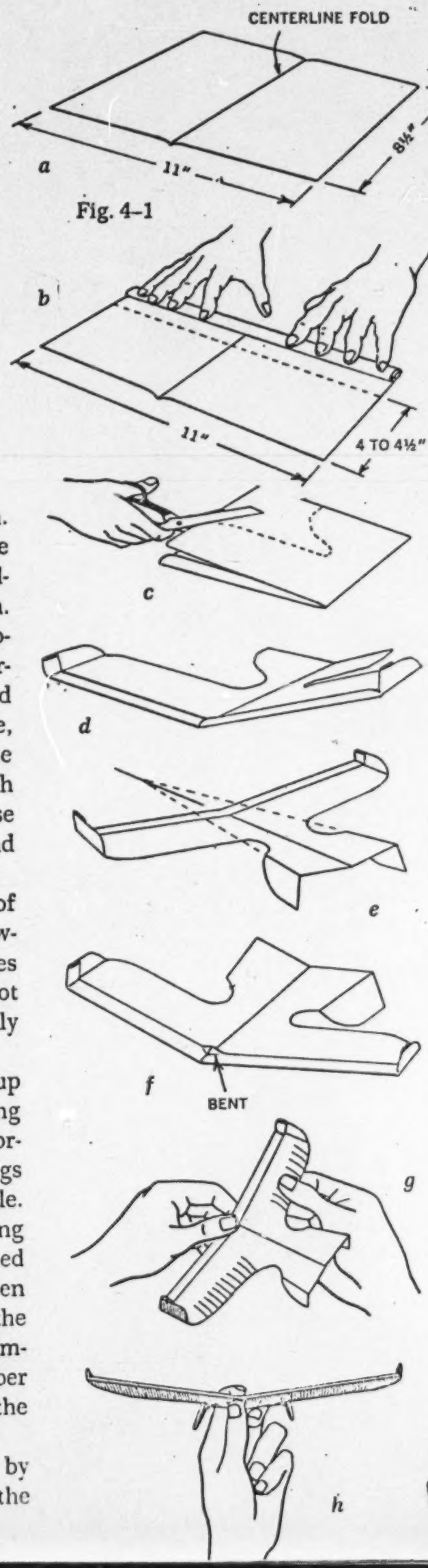

Fig. 4–1

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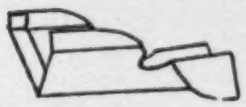

i

j

k

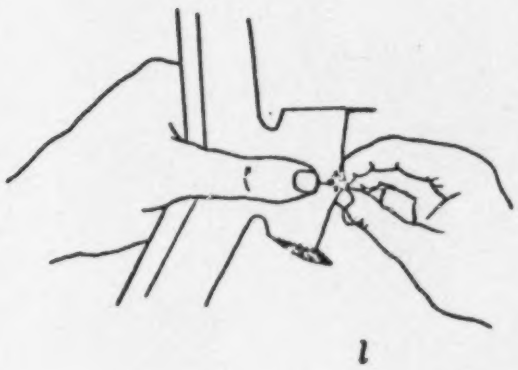

l

Fig. 4–1

Fig. 4–2

leading edge has been folded right, the creases of the wingtip fins will appear parallel to the centerline (*i*). If the leading edge has not been folded right, these fins may be twisted down (*j*), or one may be twisted down and the other up (*k*). It's practically impossible to get rid of such a fault once it has been folded into the model. It's easier to start over again with a fresh sheet of paper.

Finally, give the model a little up-elevator by pinching a bit of the center fold at the tail (*l*).

You are now ready for launch. Hold the model as shown in Fig. 4–2 and push it gently away from you on a slightly downward path. If you have correctly executed each step in construction, your model should glide along nicely. If not, adjustments must be made.

How to Make Adjustments

If the model dives into the ground, give it a little more up-elevator by cambering the trailing edge of the tail upward.

If the model follows an undulating path, it has too much up-elevator. Try flattening down the trailing edge of the tail. If this doesn't work, chances are your Barnaby is tail-heavy because you did not roll up enough paper in the leading edge. This can be corrected by adding a paper clip to the nose.

If the model glides all right but tends to

yaw, check again for symmetry. Make sure both wings have the same amount of camber. And make sure, too, that both rudders have the same amount of toe-in. If the airplane still tends to yaw, increase the camber on the side to which it turns. Then bend the trailing edge of the rudders toward the other side. Remember to keep your corrections small.

Perhaps you are wondering why I told you to toe in the rudders instead of making them parallel to the centerline. The aerodynamic explanation is quite complex, but the simple fact of the matter is the model flies better that way.

You may have noticed that most professional weather vanes are made with split surfaces at the rear (Fig. 4–3). It has been found that they make the arrow point more steadily into the wind with less wavering of the vane from side to side. The same is true of the toed-in rudders. They keep the glider on course and they keep it steady.

There is another way to loop the loop. Hold the model nose-up with the top surface away from you. Now pull the airplane straight up, releasing the model in front of your face. The airplane should loop away from you, then return so you can catch it in your hand.

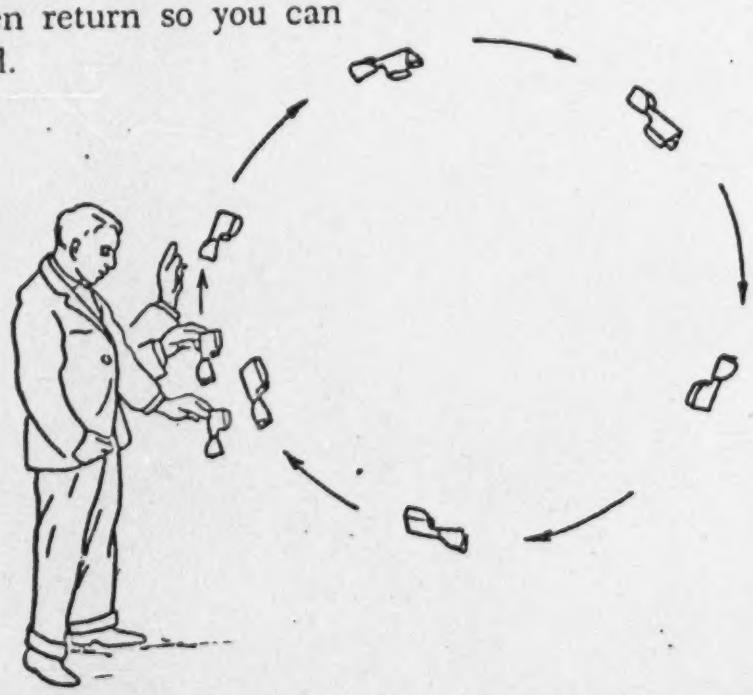

HOW WELL DO YOU KNOW YOUR AIRPLANE

APPENDIX D

Here's another quiz to test your knowledge of airplanes. On this page is an "exploded" view of a Cessna Model 180. You will note that parts are numbered 1 through 21. In the column to the right of the page, fill in the name of the parts, then check your answers (listed upside down in the lower right-hand corner).

NO FAIR PEEKING! A score of 18-21 is excellent, 15-17 good, 12-14 fair; below 12—looks like you'd better do some brushing up.

(Your Answers)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____

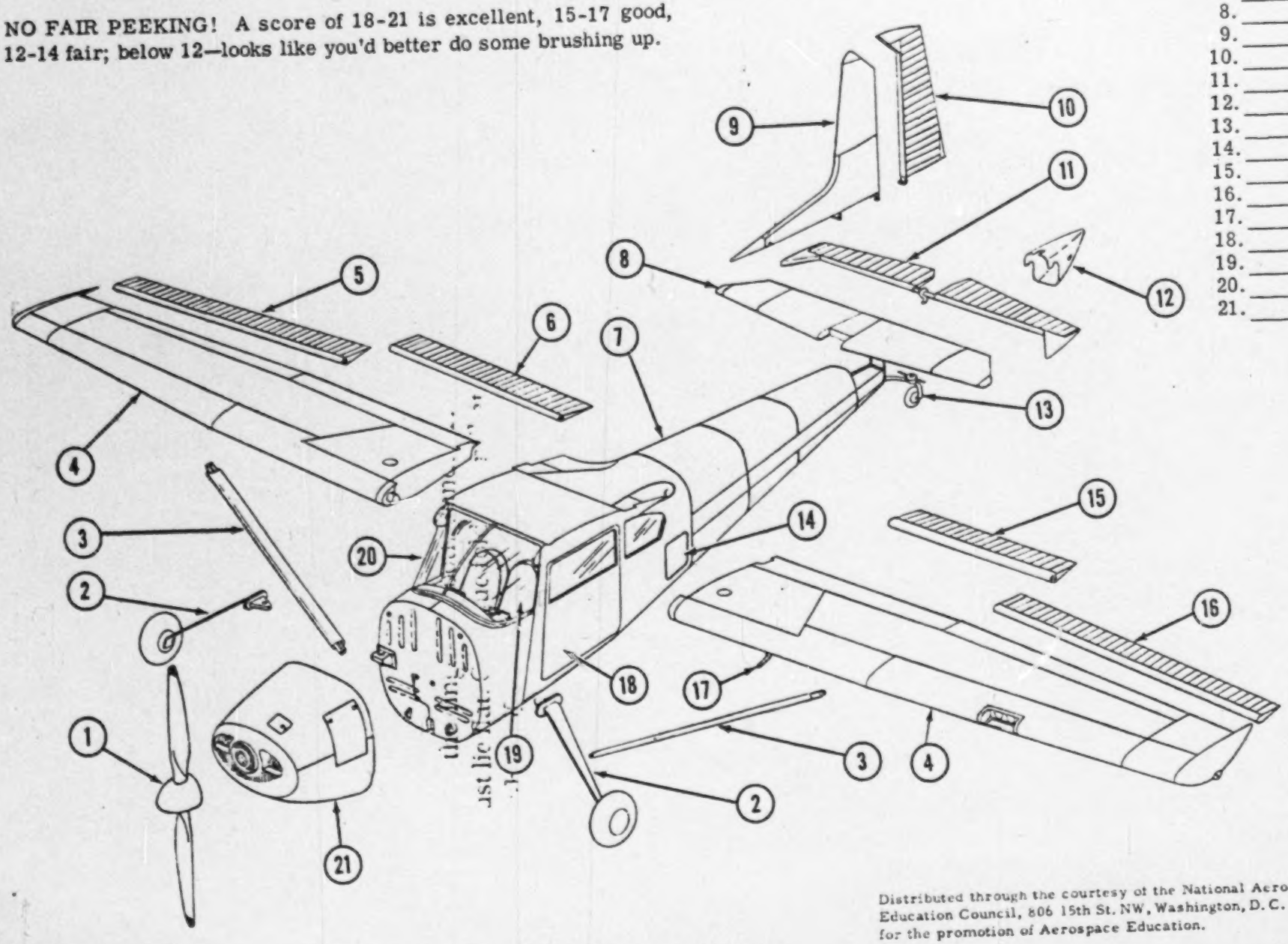

(Courtesy Cessna Aircraft Company)

(Answers)

1. Propeller
2. Landing Gear
3. Wing Strut
4. Wing
5. Right Wing Aileron
6. Right Wing Flap
7. Fuselage
8. Horizontal Stabilizer
9. Fin and Dorsal
10. Rudder
11. Elevator
12. Stinger
13. Tailwheel
14. Baggage Door
15. Left Wing Flap
16. Left Wing Aileron
17. Pitot
18. Door
19. Front Seat
20. Windshield
21. Engine Cowl

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09580

Developed by: Mr. E. Galland and Mr. K. Moynahan at the Carr Junior High School

ELECTRONIC ANEMOMETER

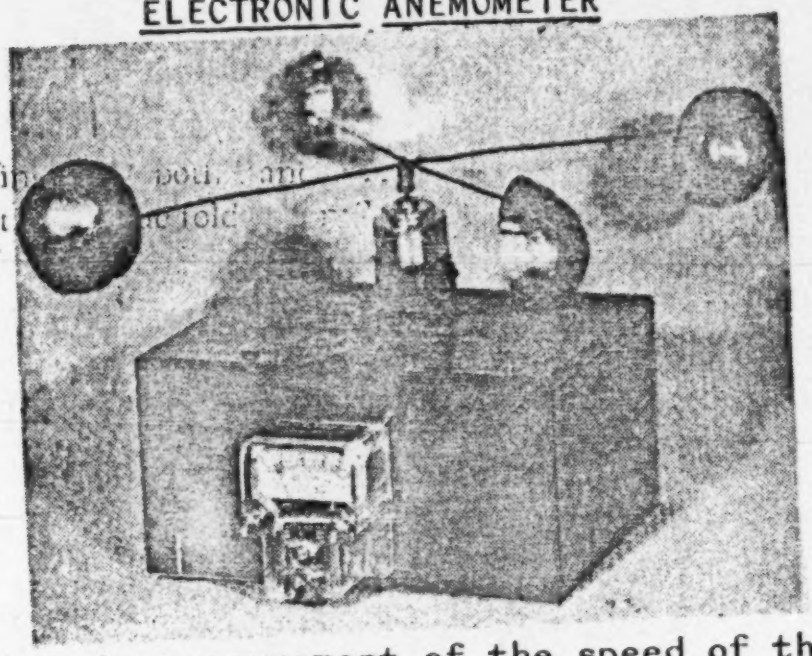

AIM:

The accurate measurement of the speed of the wind is of considerable importance in aerospace technology. The wind speed will determine the amount of power required by an airplane in take-offs and landings. The wind speed and its direction at the altitudes of the flight of the aircraft will determine the amount of the ground speed over the length of the flight. This in turn will determine the amount of fuel the plane must carry. Each airport must have an anemometer to measure the wind speed so that the information may be relayed to each pilot leaving and arriving.

INTRODUCTION

The construction of a simple electronic anemometer can be an introduction to the entire field of electronic and mechanical instrumentation. The students may also use this instrument as one of a series for a weather station. Others may include a wind direction indicator, rain and snow gages, barometers, thermometers and sling psychrometer. The model shown may be duplicated or adapted by the student and teachers for their particular use. The instrument may be mounted outside a window and the meter installed in a room.

CONSTRUCTION: METAL SHOP

1. Design and construct the metal container and motor support.

   a. shop sketches
   b. sheet metal layout
   c. transfer design to metal
   d. cutting and forming metals
   e. joining metals
   f. drilling holes for wiring and mounting of meter

2. Design and construct wind cups and holders

   a. forming copper - dieblocks and dapping punch
   b. soldering
   c. drilling motor shaft mount (set screw or key shafts)

3. Finishing

   a. painting on metals

CONSTRUCTION: ELECTRIC SHOP

4. Design electronic circuit

   a. principle of the generator
   b. principle of meters (microammeter)
   c. principle of capacitors
   d. soldering of electrical connections

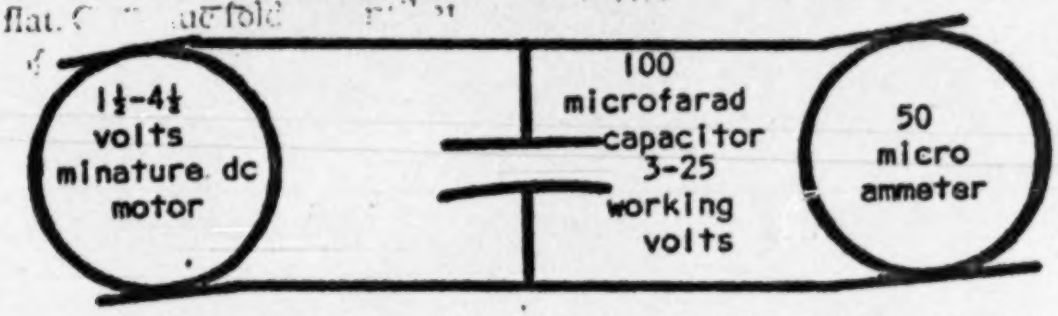

5. Mount motor and meter, wire capacitor and test unit.

6. Optional electronic construction: Use a 3 way switch for a variation of scale readings on the meter.

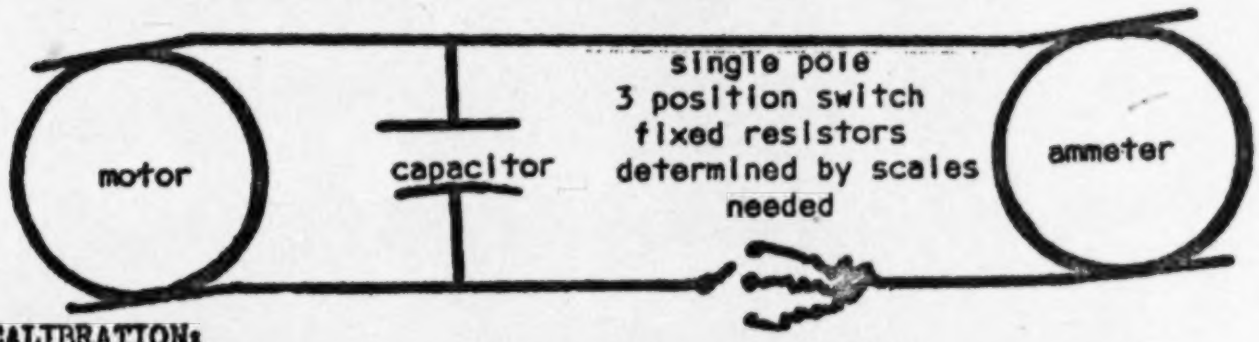

CALIBRATION:

1. Calibrate the anemometer with a commercial instrument.
2. Choose a relatively calm day. Extend the instrument out of a car window and calibrate with speedometer.
3. Substitute meter's scal for one of miles per hours or attach a conversion table to the side of the anemometer.

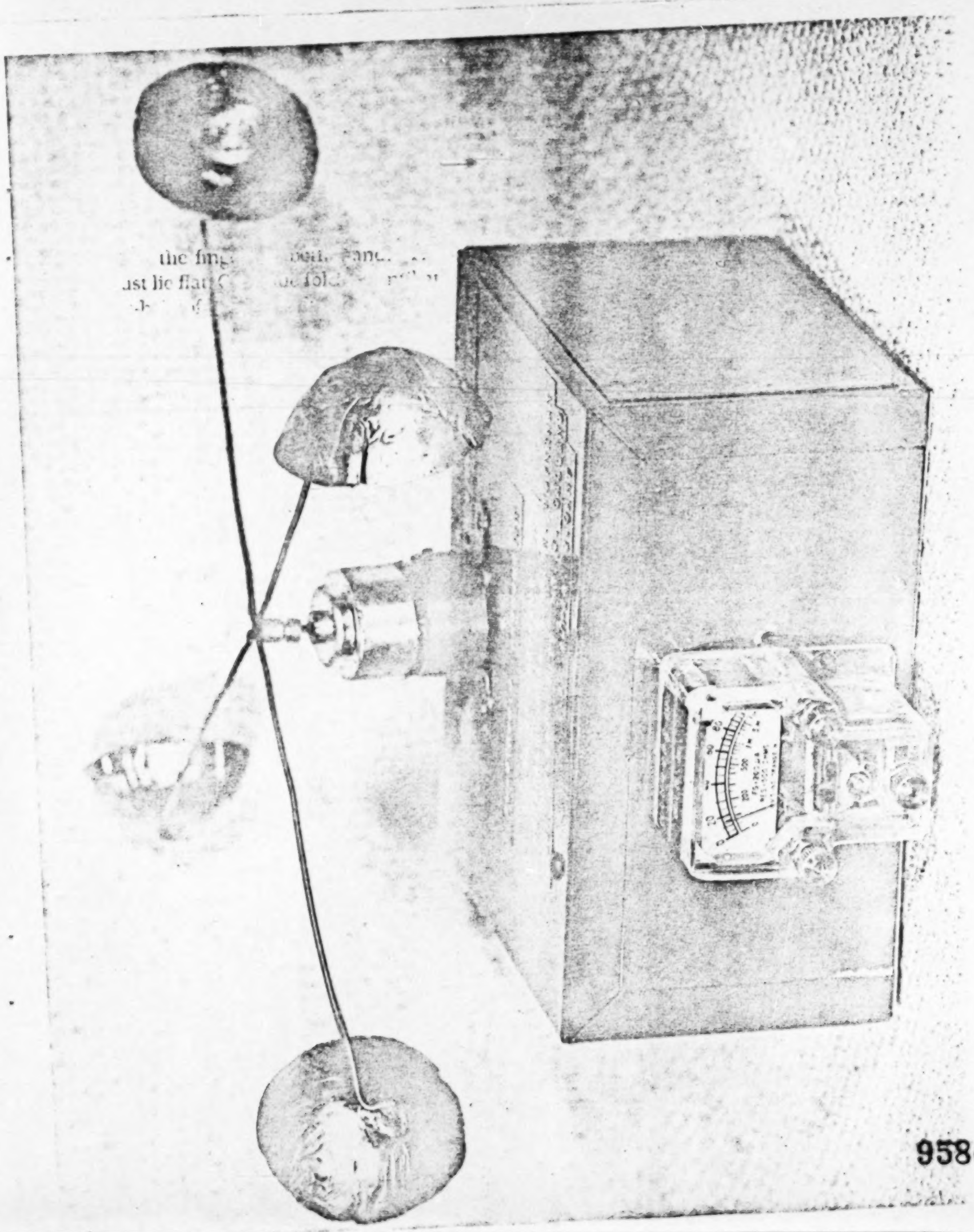

9584

A RETURN TYPE WIND TUNNEL

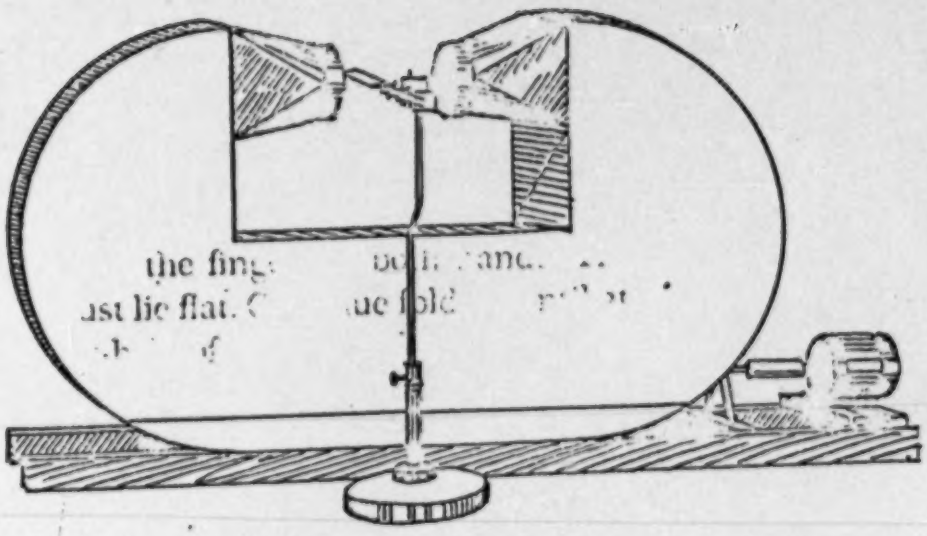

DESIGNED BY
H. ALLAN LACEY
GARDEN CITY HIGH SCHOOL
GARDEN CITY LONG ISLAND

The construction of a wind tunnel is an ideal industrial arts group project. The model illustrated was designed for use in aviation classes. It is an interesting and practical piece of equipment for the school shop and will stimulate the experimental work in aerodynamics outlined in this course.

Only basic dimensions for the tunnel are given. Slight changes can be made without destroying its effectiveness. Substitute materials can be used.

The lift and drag instrument is rugged in construction, yet sensitive in operation. Although the original model contains aluminum castings for the main and pivot frames, built-up frames would be equally satisfactory. Lift and drag arms also are of aluminum. However, any metal can be used. Wood could be used for these parts if suitable bearings were installed for the pivot screws. The instrument is mounted on a suitable heavy base such as a large brake drum. Because the unit is separate from the tunnel, it is easily accessible and can be moved when not in use.

The fan is driven by a half-horsepower motor. The fan shaft is connected to the motor shaft by a simple flexible coupling. The air speed is approximately 35 m.p.h.

Wooden test models of various airfoil cross-sections are five inches square. They are equipped with 1/8" pins for mounting on the end of the lift arm. Typical airfoil shapes are shown on pages 74 and 75. Other types of models can be used. The testing procedure is given on page 70.

RETURN TYPE WIND TUNNEL - DETAILS

RETURN TYPE WIND TUNNEL - DETAILS

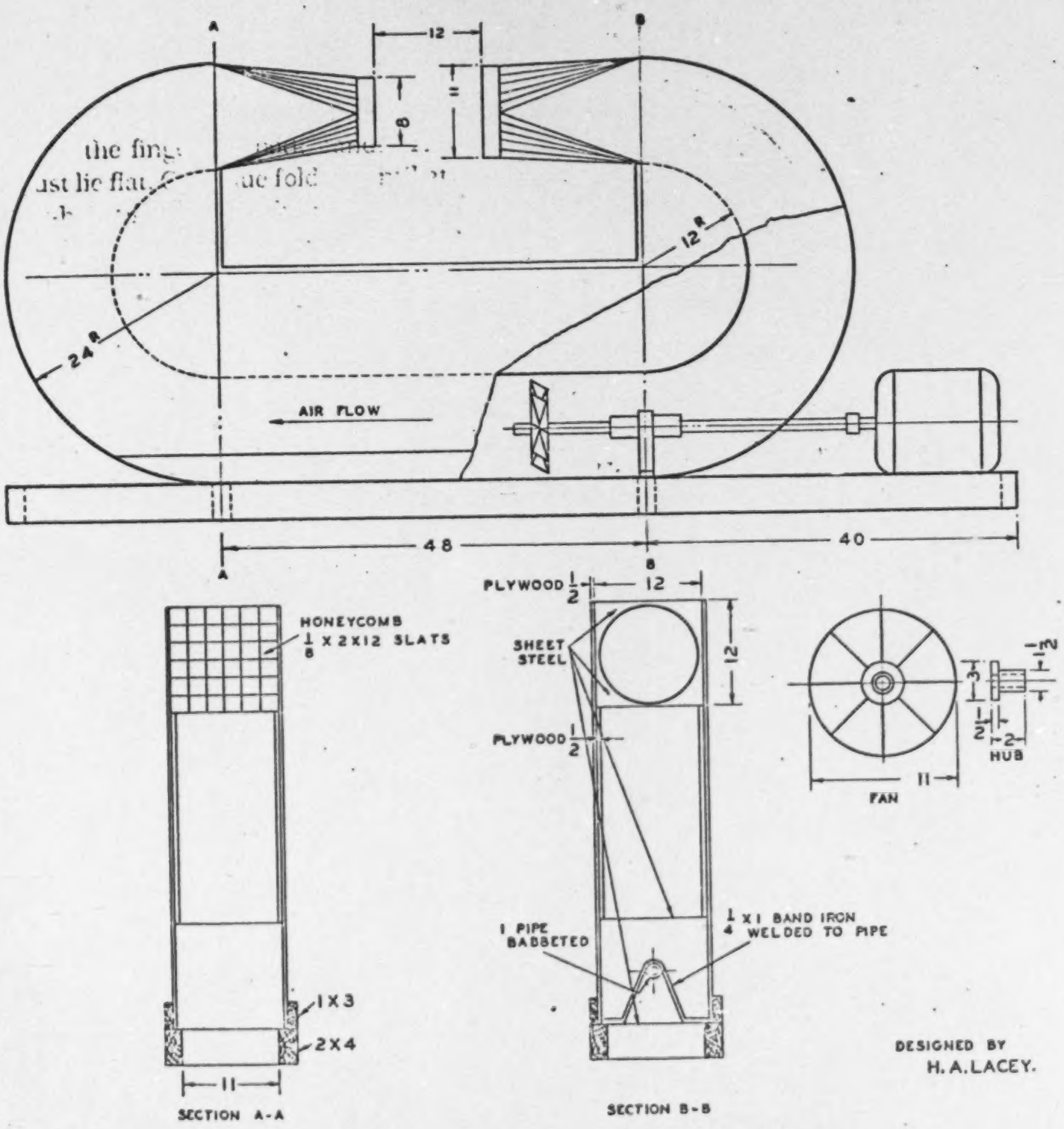

Additional equipment such as a wind speed indicator and various smoke testing devices utilizing dry ice will be valuable. Likewise, a small protractor mounted at the end of the lift arm will aid in setting the airfoil model at the desired angle of attack.

LIFT AND DRAG TESTING INSTRUMENT

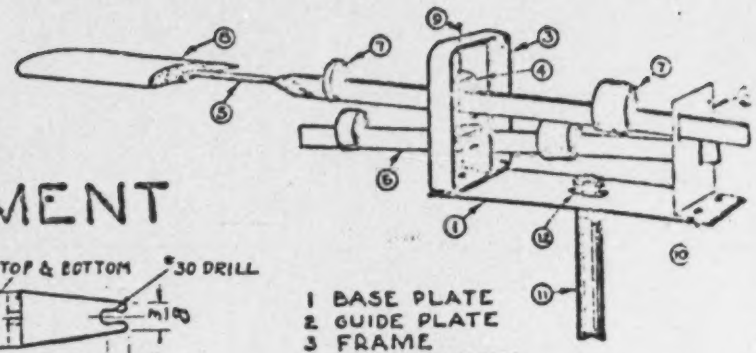

1 BASE PLATE
2 GUIDE PLATE
3 FRAME
4 PIVOT FRAME
5 LIFT ARM
6 DRAG ARM
7 WEIGHTS
8 AIRFOIL MODEL
9 PIVOT SCREW
10 STOVE BOLT
11 CONDUIT PIPE
12 PIPE NUT

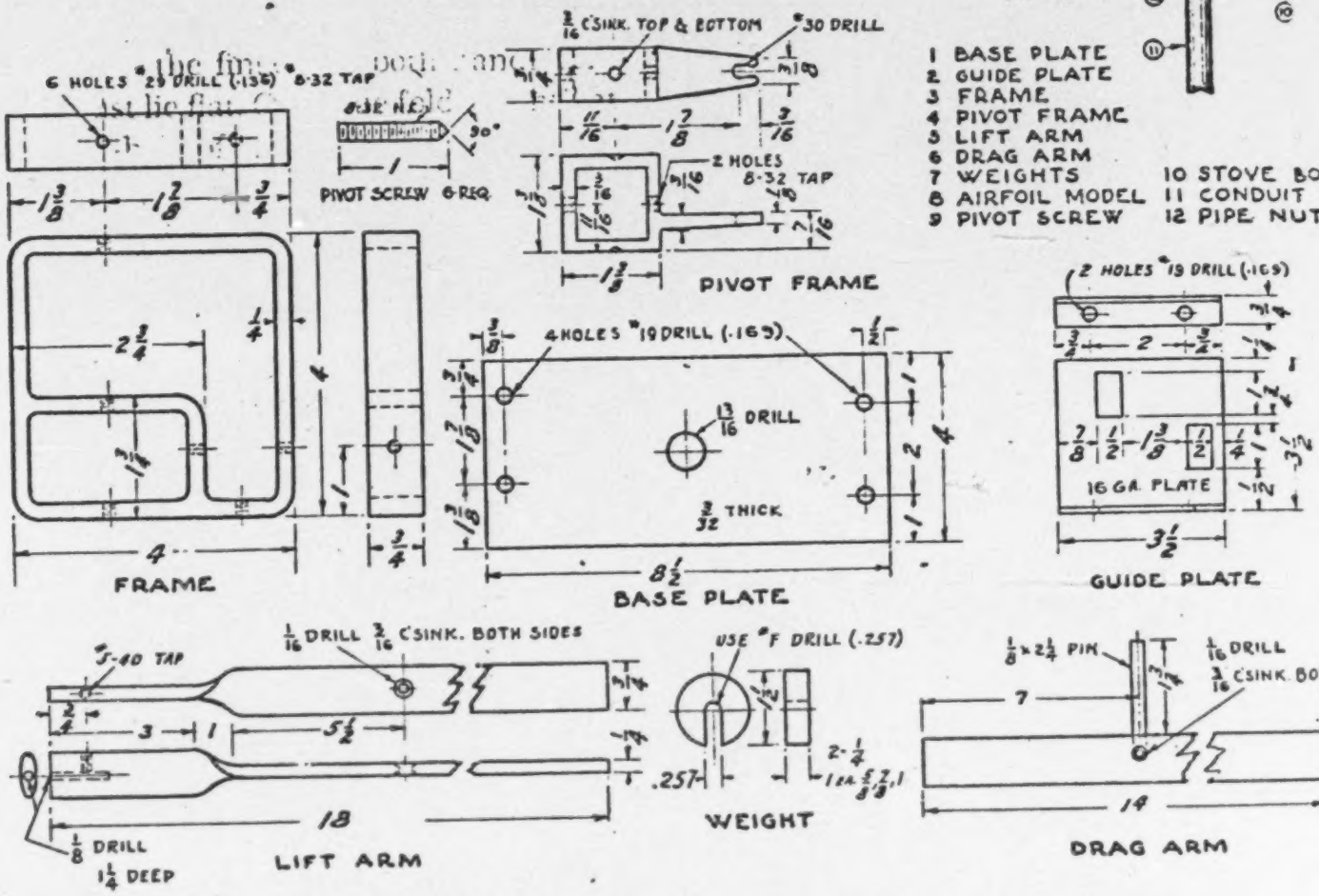

TESTING PROCEDURE

1. MOUNT AIRFOIL MODEL ON LIFT ARM. USE A PROTRACTOR HEAD WITH LEVEL TO SET AIRFOIL AT DESIRED ANGLE OF ATTACK. CENTER AIRFOIL BETWEEN TUNNEL OPENINGS.
2. COUNTERBALANCE AIRFOIL ON LIFT ARM BY ADJUSTING WEIGHTS. BALANCE DRAG ARM.
3. START MOTOR. BALANCE LIFT AND DRAG ARMS WHILE AIRFOIL IS SUBJECTED TO AIR STREAM.
4. SHUT OFF MOTOR. USE A GRAM OR OUNCE SPRING SCALE TO MEASURE LIFT. SEE LEFT HAND FIGURE BELOW. RECORD MEASUREMENT.
5. BALANCE LIFT ARM BEFORE MEASURING DRAG.
6. USE SPRING SCALE TO MEASURE DRAG. SEE RIGHT HAND FIGURE BELOW. RECORD MEASUREMENT.
7. CHANGE ANGLE OF ATTACK AND RETEST AIRFOIL.
8. COMPARE READINGS OF DIFFERENT AIRFOILS AT THE SAME ANGLE OF ATTACK.

NOTE: LIFT AND DRAG ARMS SHOULD FLOAT IN CENTER OF GUIDE PLATE HOLES WHEN BALANCED.

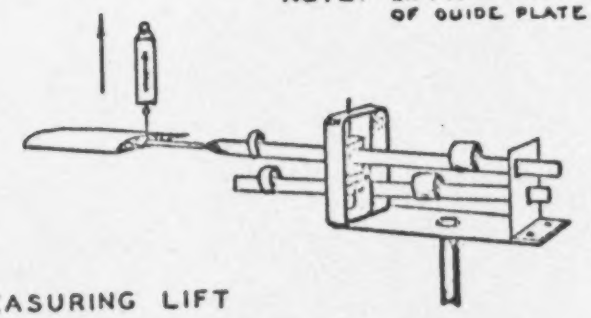

MEASURING LIFT

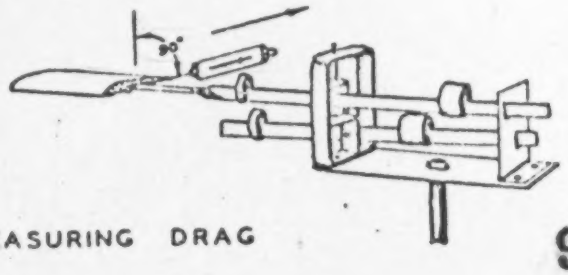

MEASURING DRAG

THE WINGS

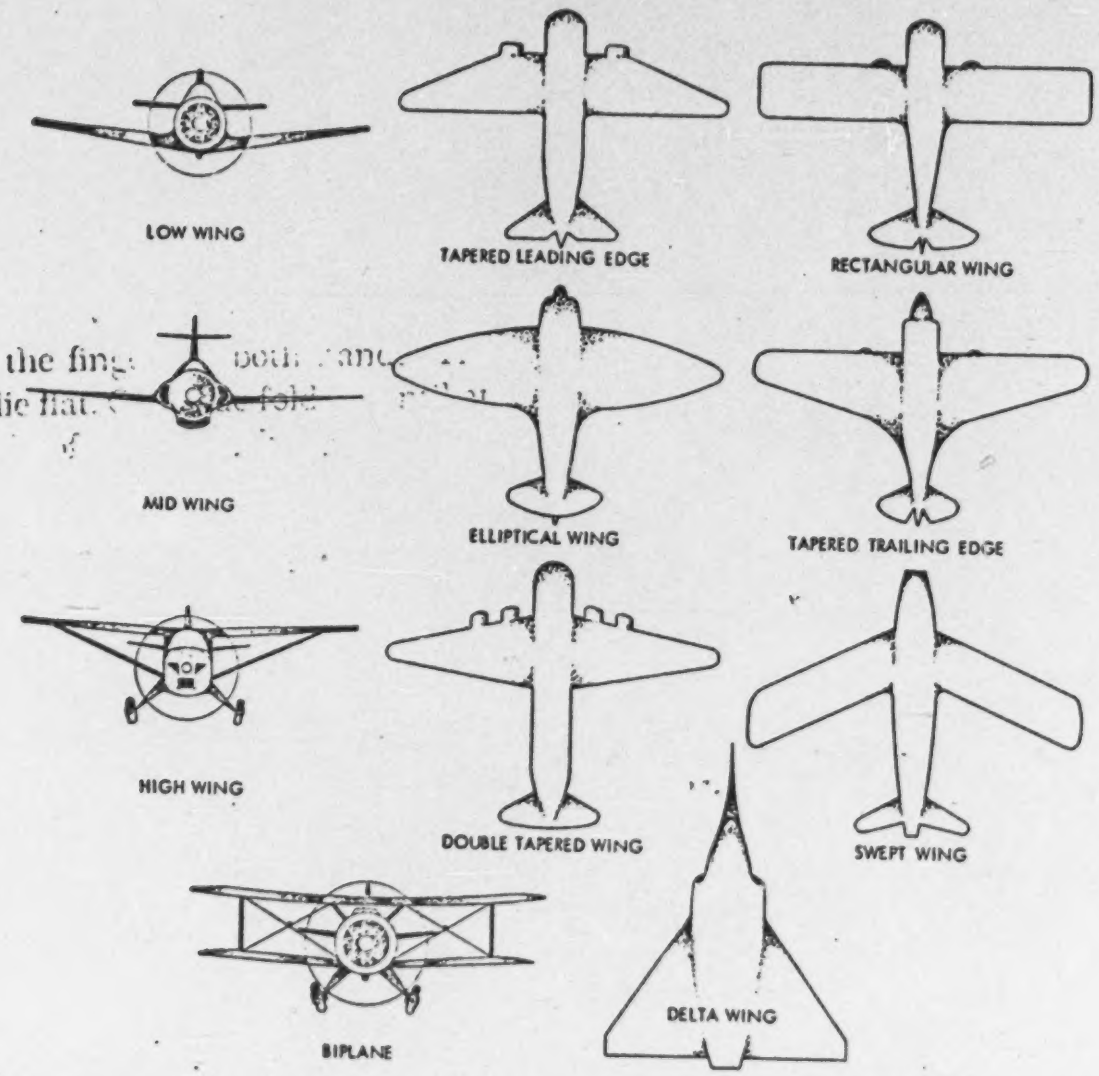

Various wing shapes and locations are designated in this illustration.

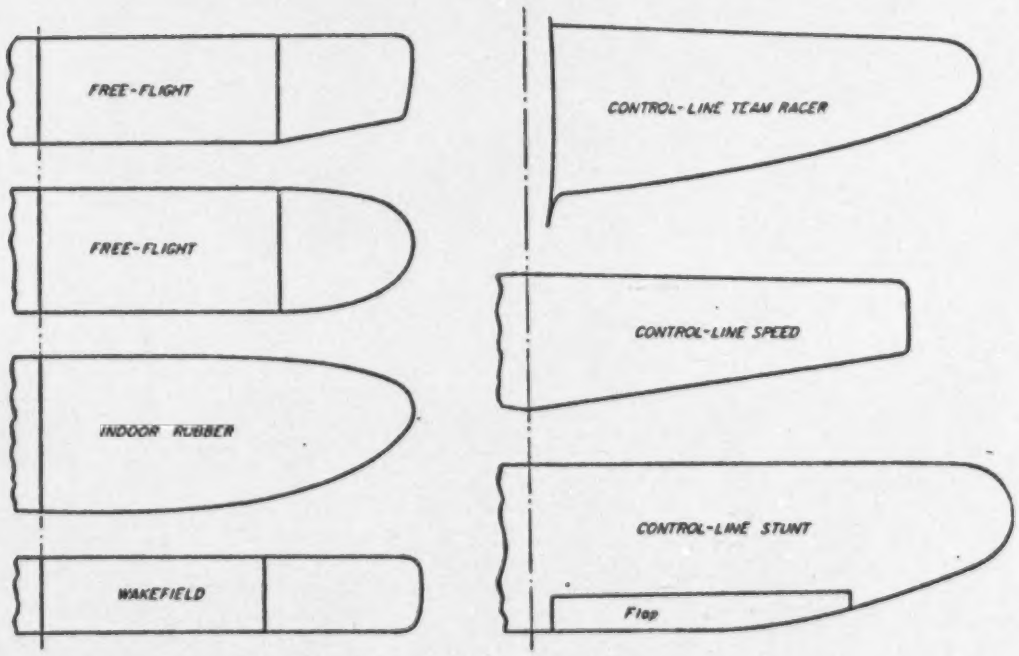

Representative Wing Planforms

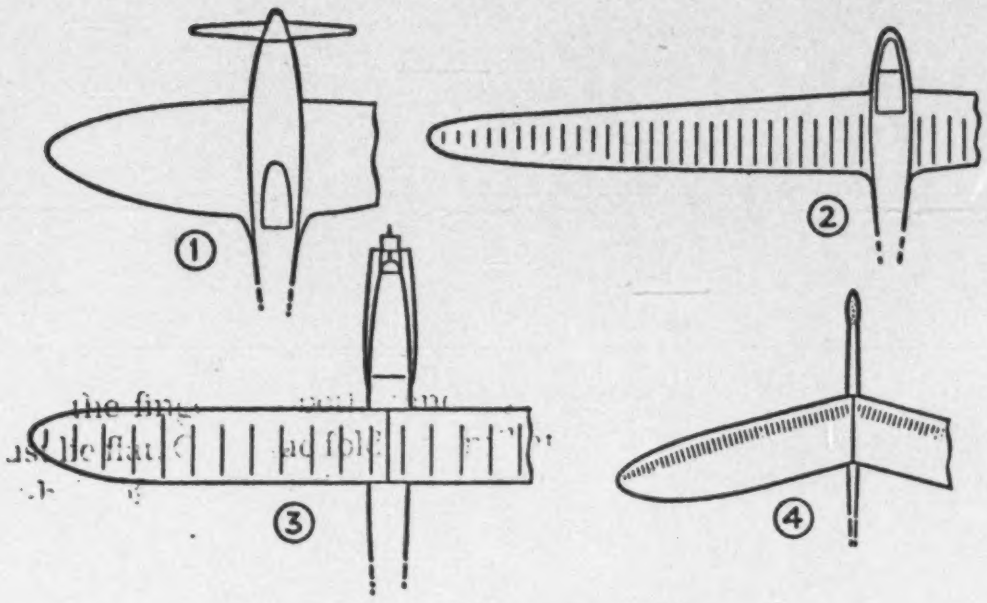

1. Control-line model 2. Sailplane
3. Rubber model 4. Hand-launched glider

Variations in Aspect Ratio

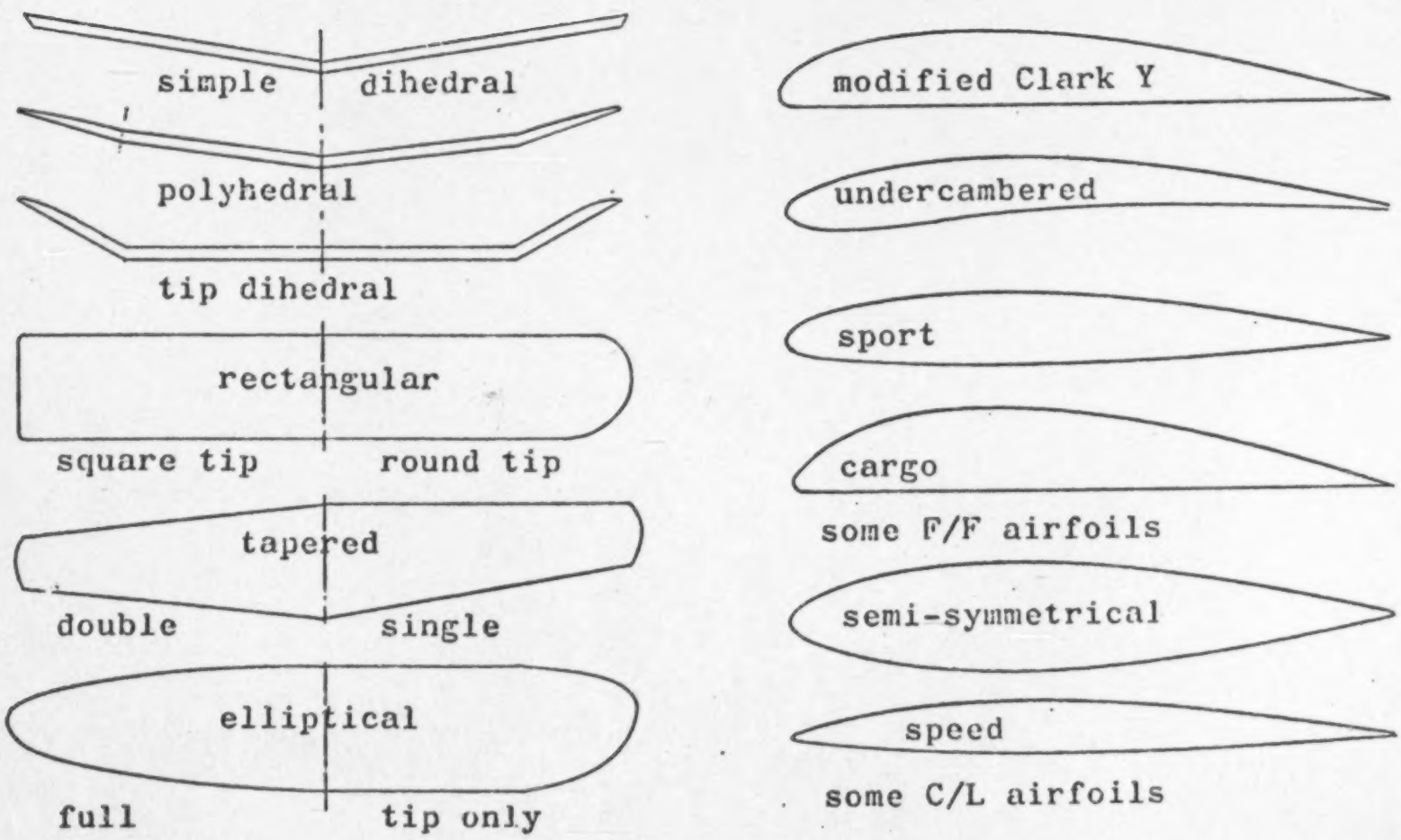

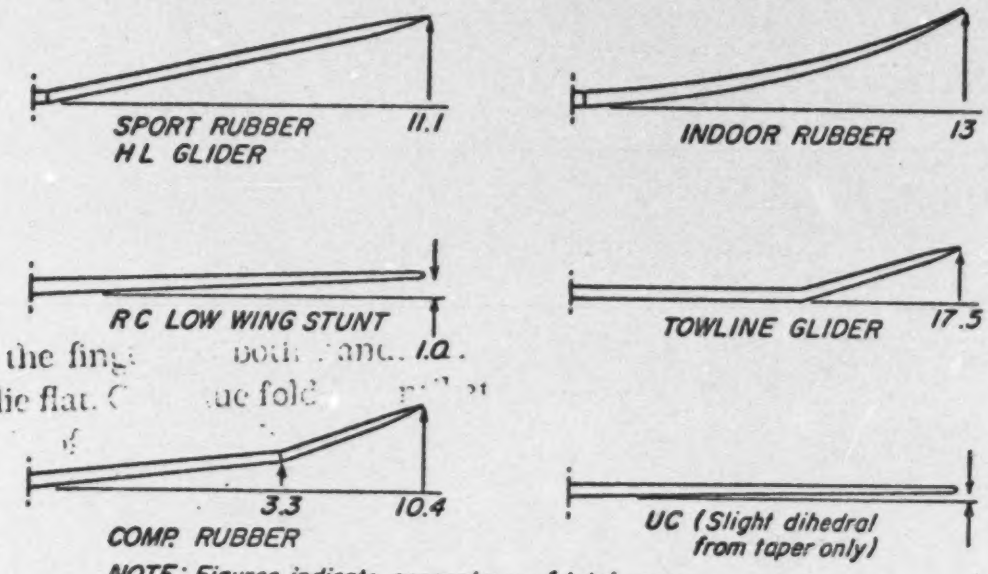

NOTE: Figures indicate percentage of total span

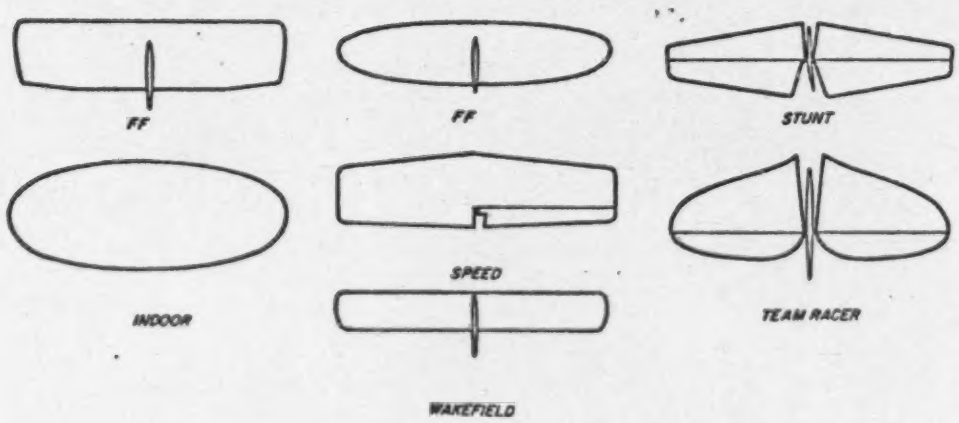

Representative Tail Planforms

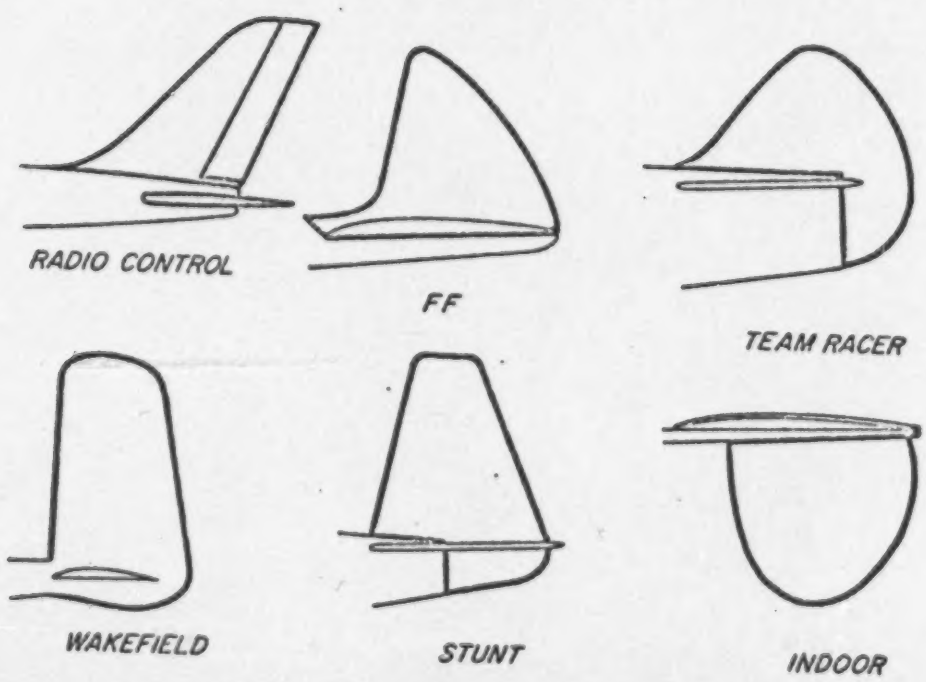

Representative Rudder Shapes

9590

APPENDIX H

PROCEDURE for OBTAINING DIHEDRAL ANGLE

1. Do not cut the wing completely in two. This makes it short and weak. The wing templates for the most part are already shorter than the wing span dimensions listed on the assembly sheet.

2. Cut the wing part way through with a dovetail saw or similar thin saw blade until it gives. Check dihedral angle. If more clearance is needed, bend and re-saw.

Cut until wing gives.

When saw cut does not give full dihedral angle--

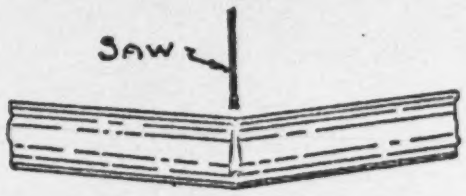

Bend and re-saw.

This method assures perfect alignment of each side.

3. Apply glue, set im simple jig to give proper dihedral and weight sufficiently.

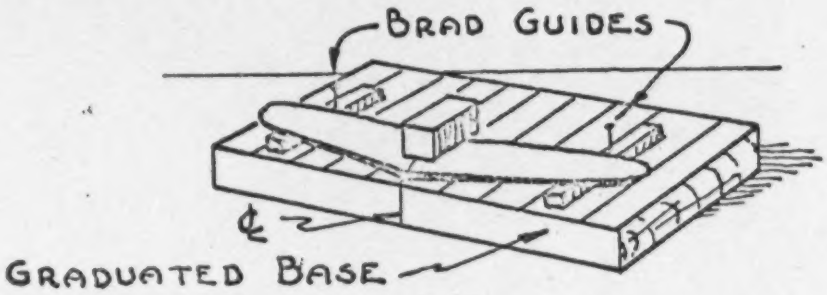

Note:--Place wax paper above and below the glue joint to keep the wing from sticking to the weight or base.

4. Press a few paper staples over the joint for added strength.

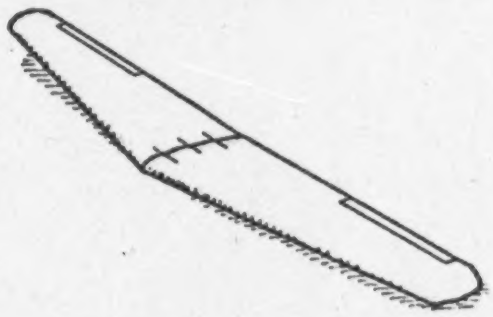

SANDING AND SEALING BALSA

Paints, lacquers and/or varnishes cannot replace sandpaper. If balsa surface is not sanded and sealed carefully, it is almost impossible to get a smooth paint finish. Start sanding the finished balsa with a fine sandpaper of 3/0 garnet. Give wood finished sanding with 5/0 garnet. (Fig. 1) Apply one coat of balsa sealer and allow to dry thoroughly, over night preferably. (Fig. 2) Sand with 5/0 or 320 grit or finer sandpaper until surface is smooth again. Apply more sealer and repeat drying and sanding until all pores are filled. (Fig. 3 and 4.)

BASE COAT PAINT

Once you feel the balsa surfaces are properly prepared you may give the wood its base coat of paint. This should be the lightest color to be used on the model. Apply light even coat of the base color (Fig. 5) and set model aside to dry on racks (Fig. 6). Always spray or brush thin coats. Sand with very fine or wet sandpaper and clean surface with rag before applying additional coats.

Second and third colors may then be painted over base color. Use masking tape to make even lines and protect edges. Final touches should be made with commercial decals.

9502

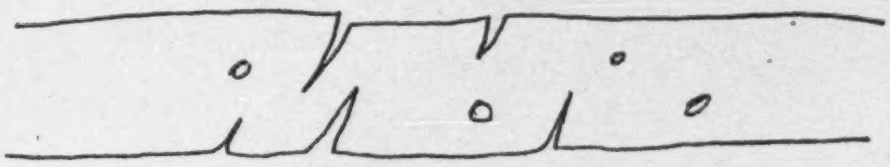

Fig. 1 Balsa Sanded Smooth But Unsealed

the fing[illegible] both [illegible]
ust lie flat. [illegible] ue fold [illegible]

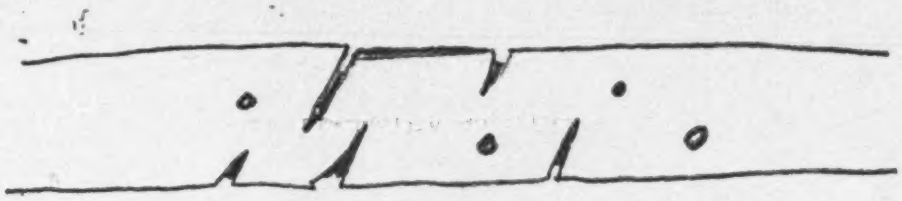

Fig. 2 1st Sealer Coat

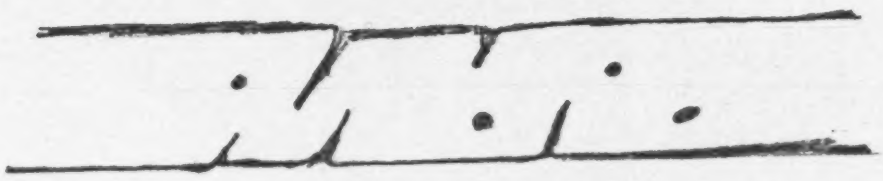

Fig. 3 2nd Sealer Coat

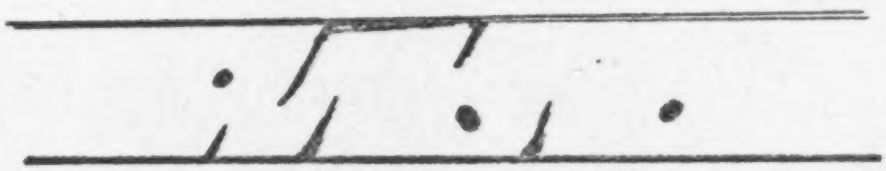

Fig. 4 3rd Sealer Coat

Fig. 5

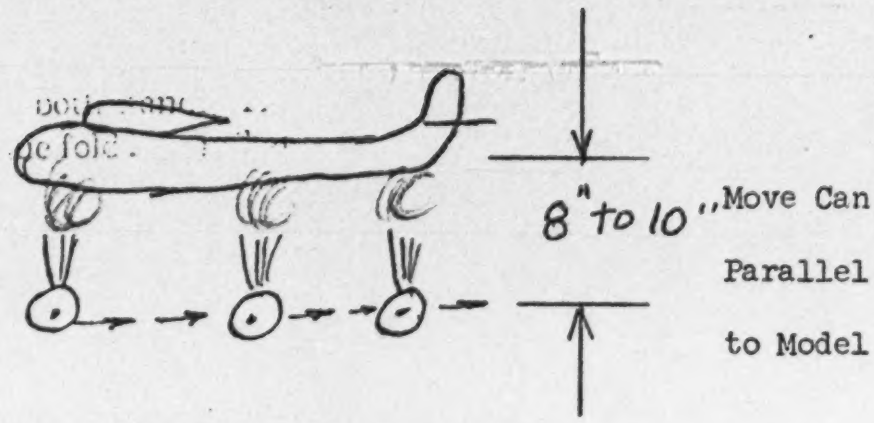

Suspend model at different angles

to cover all surfaces.

Fig. 6

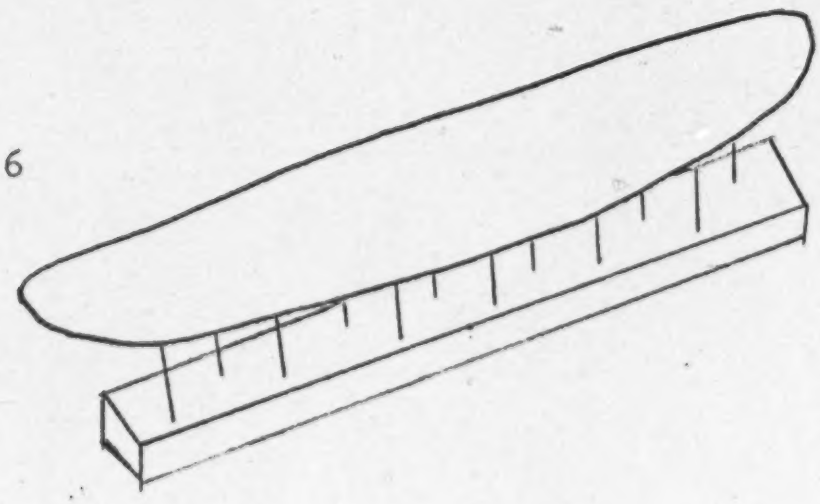

needle paint racks

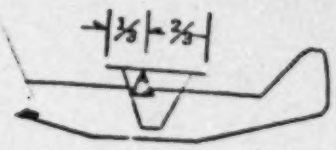

the fing[illegible] both [illegible]
ust lie flat. [illegible] ue fold [illegible]

BALANCING FOR FLIGHT

It is important to have your model properly balanced or it will not fly. Balance model on your finger, holding it ⅓ of the distance from the front edge of the wing to the rear edge. Add weight (clay, chewing gum, etc.) in the nose until the proper balance is attained. Make sure wings and tail surfaces are not warped.

Hold plane at eye level and throw straight out.

If plane dives too sharply, bend elevators up.

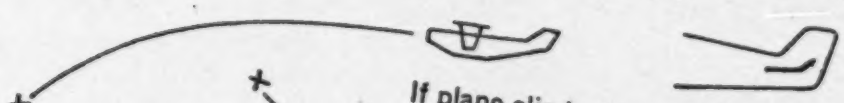

If plane climbs too sharply, bend elevators down.

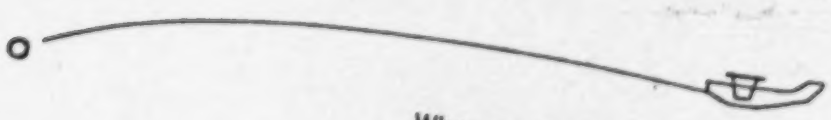

When properly balanced, plane should glide for about 50 feet.

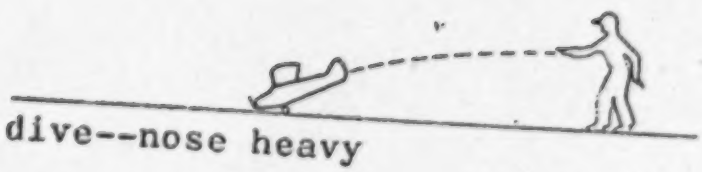

dive--nose heavy

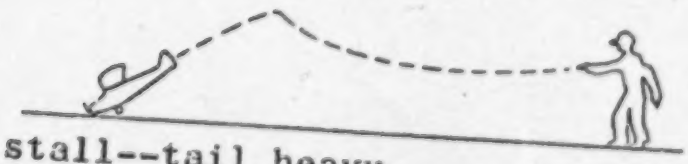

stall--tail heavy

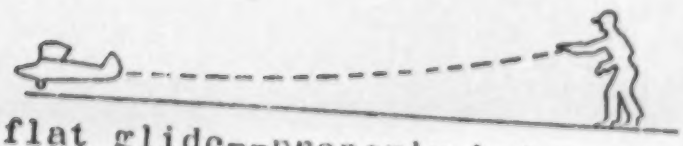

flat glide--properly bal[illegible]

9595

Winding and Launching

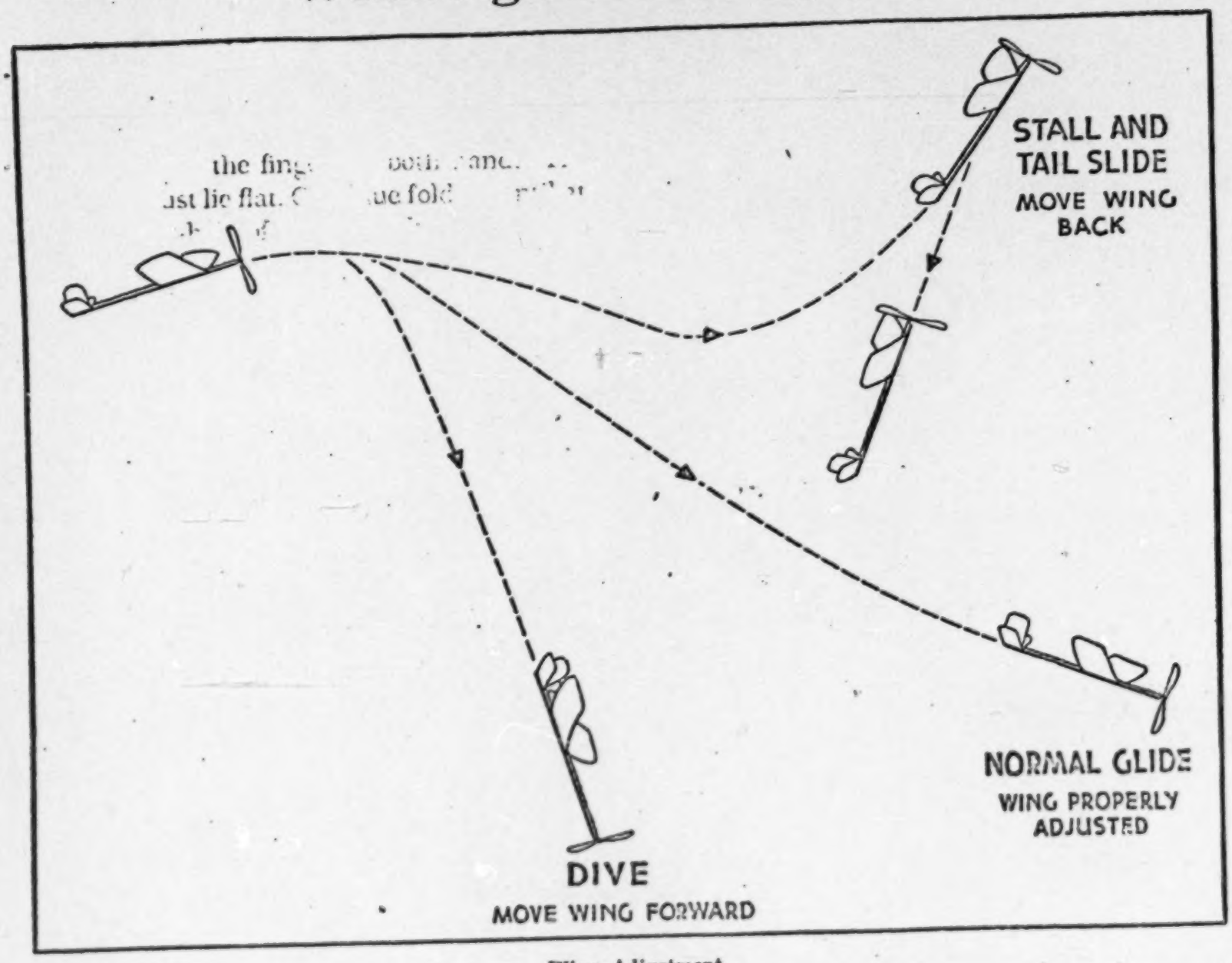

Wing Adjustment

U CONTROL POWER FLIGHT

Name _____

Address _____

PRE-FLIGHT INFORMATION

Name and Number of Plane _____

Date Completed _____

Color Scheme _____

Weight _____ Engine _____

Wing Shape _____

Dihedral Angle _____

Fuselage _____

Remarks _____

WEATHER INFORMATION

Wind Direction			
Wind Velocity			
Humidity			
Temperature			
Visibility			
Remarks			

	FLIGHT #1	FLIGHT #2	FLIGHT #3
Date			
Location			
No. of Flights			
Gr. Duration			
Av. Duration			
Stability Information			
Flight Performance			

9596

GLIDER FLIGHT DATA SHEET

Name _____

Address _____

PRE-FLIGHT INFORMATION

Name of Glider _____

Number of Glider _____

Date Completed _____

Weight _____

Fuselage _____

Wing Shape _____

Dihedral Angle _____

Color Scheme _____

Remarks _____

WEATHER INFORMATION

Wind Direction			
Wind Velocity			
Humidity			
Temperature			
Visibility			
Remarks			

	FLIGHT #1	FLIGHT #2	FLIGHT #3
Date			
Location			
Gr. Distance (ft.)			
Av. Distance			
Gr. Height))compt. ft.)			
Av. Height			
Gr. Duration			
Av. Duration			
Stability Information			
Flight Performance			

95598

THE PROPELLER

IN A MODEL PLANE, the propeller is a most important part. There are all types of propellers each designed for a special job, and in its finished form the propeller provides pulling or pushing power, speed or climb.

For the type of models shown throughout this booklet, the most efficient prop here illustrated is known as the STANDARD type. It is one of the easiest to carve.

A study of the various stages of carving a prop will convince you that without further hesitation, you can select your propeller block as specified by the plans of the model you've just built, use your X-ACTO knife and go to work.

The beginner builder would do well to follow the propeller design given when building a model from plans. It is assumed that the designer of the model has tested his craft thoroughly to get the best results with the propeller in question. Indoor models as a general rule are flown with propellers whose dimensions are about ½ the span of the wing. On outdoor models (excluding gas jobs) propeller sizes are about 1/3 the span and are designed for higher speed.

Carving the Prop

THE BLOCK of wood chosen for the prop is called a "blank". A properly dimensioned blank may be purchased at any model shop. First step is to draw diagonal lines across the face and back of the block. The "X" blank is then cut to shape with your X-ACTO knife or Hobbycraft Saw. Be sure the hub section is left fairly thick. The sketches illustrating the carving steps are simple to follow. Work easily and carefully across the face of the blade from hub outward in a gentle scooping out or concave motion. Do not attempt deep

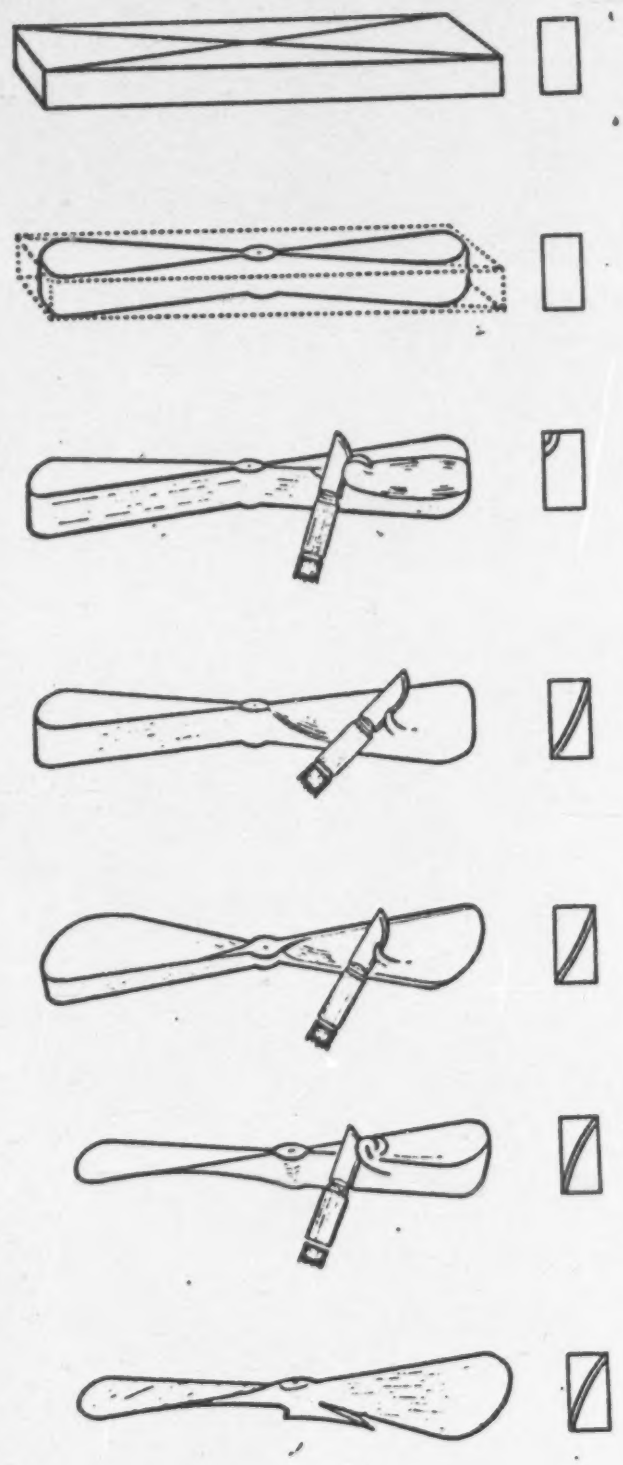

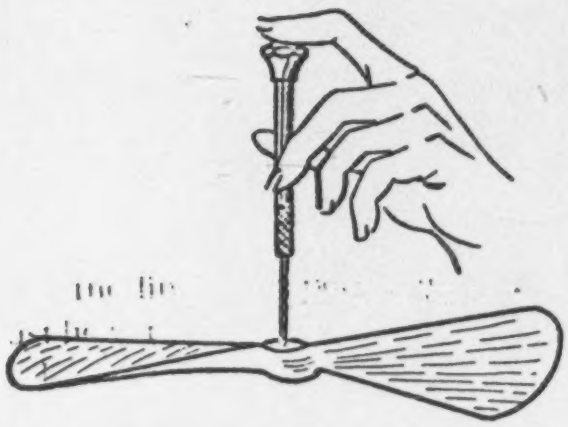

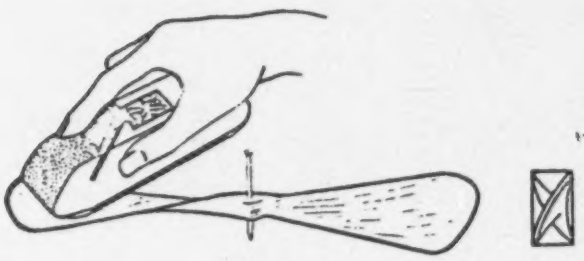

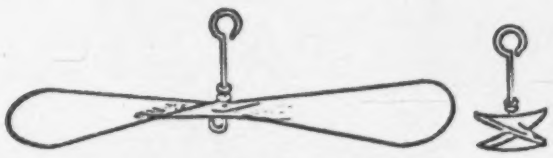

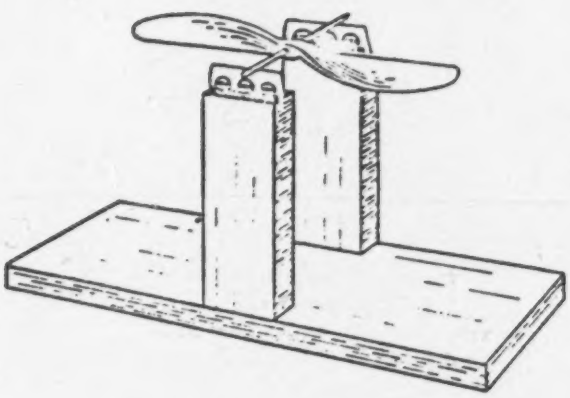

cuts and do not cut close to the outer edges. When one blade is semi-carved, work on the other blade in similar fashion.

Next turn the prop over and carve the CONVEX shape in the blades. Working out from the hub where it is thickest, remove the top surfaces in easy cuts until the blade has a tapered thickness at the edges of at least 1/8 of an inch. For the time being the hub should be the thickest part since strength is needed in the center portion because pressure is applied by the weight of carver's hand.

Sanding and Drilling

The next step is sanding the blades down smoothly. Using your fingers under the right hand blade (opposite if a "lefty") as a means of support, rub medium grade sandpaper over the surface to remove the rough spots. Finish with fine sandpapering. Round off the ends of the blades as shown in the sketches.

Now mark the center of the prop, drill a hole the same size of the wire prop shaft to be used and then balance horizontally. The heaviest side of the blade will naturally drop down. Sand lightly over the surface and balance again until the prop remains perfectly still in a horizontal position. (See sketch of prop balancer).

Cutting away a part of the hub at the rear of the prop in a scalloping effect, as illustrated in Step 7 makes for lightness and efficiency. Insert the prop shaft, bend the front end to shape and push firmly back into the face of the hub. Apply lots of cement over the joinings. Next, slip a few washers on the shaft before bending the rear end of the shaft into a hook. It is a good idea to cement one washer flush to the rear of the hub.

APPENDIX N

SAMPLE PAGES FROM STUDENT'S FLIGHT LOG

DATE _____ 19____

N _____ ENGINE _____ HP _____

MAKE AND MODEL _____

PRIVATE ☐ COMMERCIAL ☐ FLIGHT INSTRUCTOR ☐

INSTRUMENT ☐ X COUNTRY ☐ DAY ☐ NIGHT ☐

	DUAL		DUAL INST. FLIGHT		SOLO		PRE/POST FLIGHT	
FLIGHT TIME	HR.	MIN.	HR.	MIN.	HR.	MIN.	HR.	MIN.
THIS FLIGHT								
PREVIOUS TIME								
TOTAL TIME								

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Airplane equipment familiarization	Preflight procedures	Starting procedure	Taxiing and parking	Take offs and landings	Traffic pattern	Use of carburetor heat	Straight and level flight	Throttle elevator coordination	Turns	Climbs and glides	Coordination maneuvers	Series of stalls (power on and off)	Cross wind take offs and landings	Minimum controllable airspeed (slow flight)	Spins	Patterns and track flying	Emergencies and critical situations	Small soft & high alt. Temp field operations	High wind landings	Cross country flying	Radio communication	Radio orientation	Night flying	Transition to transportation airplane	Chandelles and lazy eights	Dragging area	Ability to instruct	Instrument flight, straight and level	Instrument flight, turns, climbs, descents	Instrument flight, spirals, stalls and recovery	Instrument flight, attitudes from unusual	Instrument flight, estimation of arrival times	Instrument flight, tuning radios	Instrument flight, orientation	Instrument flight, following a range leg or radial	Instrument flight, locating range stations	Instrument flight, approach procedures	Instrument flight, missed approach procedures	Instrument flight, air traffic control procedures	Progress check	Final check	FAA test for rating

SAMPLE

GRADES:	1 EXCELLENT	2 ABOVE AVERAGE	3 AVERAGE	4 BELOW AVERAGE	5 FAILURE

REMARKS: _____

ABOVE INSTRUCTION GIVEN: _____ ABOVE INSTRUCTION (OR SOLO) RECEIVED

(Instructor's Signature) (Cert. No.) (Rating) (Student's Signature)

DATE 8-7-70 19____

N 5879K ENGINE LYC HP 150

MAKE AND MODEL PIPER CHEROKEE

PRIVATE ☑ COMMERCIAL ☐ FLIGHT INSTRUCTOR ☐

INSTRUMENT ☐ X COUNTRY ☐ DAY ☐ NIGHT ☐

	DUAL		DUAL INST. FLIGHT		SOLO		PRE/POST FLIGHT	
FLIGHT TIME	HR.	MIN.	HR.	MIN.	HR.	MIN.	HR.	MIN.
THIS FLIGHT		50						15
PREVIOUS TIME	15	—			1	30	8	30
TOTAL TIME	15	50			1	30	8	45

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Airplane equipment familiarization	Preflight procedures	Starting procedure	Taxiing and parking	Take offs and landings	Traffic pattern	Use of carburetor heat	Straight and level flight	Throttle elevator coordination	Turns	Climbs and glides	Coordination maneuvers	Series of stalls (power on and off)	Cross wind take offs and landings	Minimum controllable airspeed (slow flight)	Spins	Patterns and track flying	Emergencies and critical situations	Small soft & high alt. Temp field operations	High wind landings	Cross country flying	Radio communication	Radio orientation	Night flying	Transition to transportation airplane	Chandelles and lazy eights	Dragging area	Ability to instruct	Instrument flight, straight and level	Instrument flight, turns, climbs, descents	Instrument flight, spirals, stalls and recovery	Instrument flight, attitudes from unusual	Instrument flight, estimation of arrival times	Instrument flight, tuning radios	Instrument flight, orientation	Instrument flight, following a range leg or radial	Instrument flight, locating range stations	Instrument flight, approach procedures	Instrument flight, missed approach procedures	Instrument flight, air traffic control procedures	Progress check	Final check	FAA test for rating
1	3	4	3	2	3	2	3	3	2	2	3		2																												

SAMPLE

GRADES:	1 EXCELLENT	2 ABOVE AVERAGE	3 AVERAGE	4 BELOW AVERAGE	5 FAILURE

REMARKS: Introduction to x wind landings (E)

ABOVE INSTRUCTION GIVEN: Gilgen Smart CFI 187.25 ABOVE INSTRUCTION (OR SOLO) RECEIVED John Dixon

(Instructor's Signature) (Cert. No.) (Rating) (Student's Signature)

9601

INDIVIDUAL EVENT SCORE SHEET

Contest Name

Place Held | Date | Time

Entries			Qualifiers		
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
7			7		
8			8		
9			9		
10			10		
11			11		
12			12		
13			13		
14			14		
15			15		
16			16		
17			17		
18			18		
19			19		
20			20		

Judging Staff

1	6
2	7
3	8
4	9
5	10

CONTEST WINNERS

PLACE	NAME	ADDRESS		

Weighing Factor

9602

APPENDIX P

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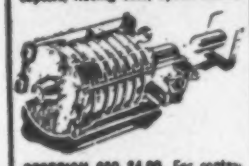

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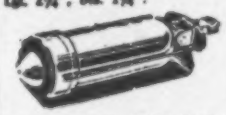

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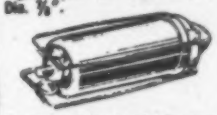

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19	Fuel Filter	.60
26	Cox tank ext.—.049 eng.	1.50
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33	RED HOT	$1.20
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No. 59	8x4/No. 60—8x6	.60c ea.
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No. 63	10x4	90c ea.
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61G	9x4 / 62G—9x6	1.00 ea.
63G	10x4 / 64G—10x6	1.10 ea.
65G	11x6 1.20 66G-11x7¾	1.20
	PROPS Fiber Glass, Metalized	
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61M	9x4 / 62M—9x6	1.60 ea.
63M	10x4 1.70 ea. 64M 10x6	1.70
65M	11x6 1.80 66M-11x7¾	1.80
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71	Aileron con. links adj.	.80
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APPENDIX R

TEACHER DISPLAY AND DEMONSTRATION APPARATUS

1. Wind Tunnel - Teacher Made
2. Air-cooled airplane engine from New York State Government Surplus Depot on special engine mount.
3. Airplane propeller from Government Surplus.
4. Control surface simulators - Teacher Made
   See photograph (Circa 1945)
5. Commercial Airline passenger plane models from Public Relations Department of the Airlines.

EXPERIMENTAL EXPERIENCES FOR TEACHER AND OR STUDENTS

1. Design wood molds and draw vacuum formed plastic canopies and cowls.
2. Make plastic injection molds of airplane wheels.
3. Make plaster of Paris molds of fuselage and lay up fiberglass. These may be used with styrofoam wings.
4. Cover teacher model truss fuselage and ribbed wings with transparent monokote to show construction.
5. Construction of Rocket Gantry.

APPENDIX S

CESSNA 150 SPECIFICATIONS

Gross Weight	1600 lbs.
Empty Weight	1010 lbs.
Useful Load	590 lbs.
Maximum Baggage	120 lbs.
Engine	Continental 0-200-A 10
Horsepower	100 HP @ 2750 RPM
Fuel Capacity	26 gallons
Useable Fuel	22.5 gallons
Fuel Grade	80/87 octane (min.)
Oil Capacity	6 quarts

Speeds	
Top speed–sea level	122 MPH
Cruise–75% power–7000 ft.	117 MPH
Take-off speed–normal	60 MPH
Approach speed–normal	65 MPH
Best Rate of Climb–sea level	70 MPH
Best Angle of Climb	60 MPH
Short Field Approach Speed	55 MPH

Stall speeds at Gross Weight	
Clean	48 MPH indicated
Flaps 20°	40 MPH indicated
Flaps 40°	39 MPH indicated

Range	
Cruise–75% power–7000 ft.	475 miles
Optimum range–10,000 ft.	565 miles

Performance	
Maximum rate of climb S.L.	670 FPM
Take-off ground run	735 ft.
Total Dist. over 50' obstacle	1385 ft.
Landing Roll	445 ft.
Total Dist. over 50' obstacle	1075 ft.
Service Ceiling	12,650 ft.

Fuel Consumption	65%	75%
2500 feet	4.8 gph	5.8 gph
5000 feet	4.8	5.6
7500 feet	4.8	5.5
10000 feet	4.8	–

Power Settings	50%	65%	75%
S.L.	2225	2375	2425
2500	2275	2450	2525
5000	2300	2500	2650
7500	2400	2600	2700
10000	2450	2675	–

Airspeed Limitations	
Maximum–Smooth Air	162 MPH
Caution Range	120-162 MPH
Normal Range	56-120 MPH
Flap Operating Range	49-100 MPH
Maneuvering Speed	109 MPH

APPENDIX T

AMITYVILLE FLYING SERVICE

ZAHN'S AIRPORT, AMITYVILLE, N.Y.

CESSNA 150 CHECK LIST

I. PREFLIGHT INSPECTION

1. Master switch on, check fuel quantity indicators, then turn master switch off.
2. Check ignition switch off
3. Check fuel valve handle on
4. Check oil level – 6 quarts
5. Check propeller and spinner for nicks and security
6. Check fuel tank vent opening for stoppage
7. Load within limits
8. No smoking
9. Seats and seat belts – adjust and lock
10. Brakes – test and set
11. Controls free
12. Cabin door locked
13. Radios off
14. Navigation and landing lights off
15. Altimeter and clock set

II. STARTING ENGINE

1. Carburetor heat control in full cold position
2. Mixture full rich
3. In cold weather up to six strokes of priming pump, warm temperatures with one or two strokes of the primer
4. Master switch and magneto switch on both
5. Throttle ¼ inch open
6. Propeller area clear
7. Pull starter handle
8. Check oil pressure, pressure indicated 30 seconds summer, one minute very cold weather
9. Release parking brake and check brakes

III. ENGINE WARM UP

1. 800 RPM – 2 minutes warm weather
   800 RPM – 4 minutes cold weather (below 70°F)
2. Since the engine is closely cowled for efficient inflight cooling, precautions should be taken to avoid overheating on the ground

IV. ENGINE RUN-UP

1. Parking brake set
2. Engine at 1700 RPM
3. Oil pressure 30 PSI to 60 PSI
4. Oil temperature min. 100°F
5. Generator checked for positive charge
6. Check magneto max. drop 75 RPM
7. Check carburetor heat drop
8. Idle engine, check magneto switch both off and then on
9. Radio check

V. BEFORE TAKE OFF

1. Controls free, unlocked, properly rigged
2. Oil temperature and pressure normal
3. Carburetor heat rechecked off
4. Altimeter set
5. Directional gyro set (check suction) 3.75 to 4.25" Hg.
6. Horizon checked for rigidity and set
7. Turn and bank checked
8. Gas on both
9. Mixture rich
10. Wing flaps checked (both) and set for take-off position
11. Trim tab set for take-off (neutral)
12. Engine checked for proper functioning and power
13. Safety belts fastened
14. Cabin door locked – no smoking
15. Accelerate to 50 to 60 MPH before take-off

VI. NORMAL CLIMB

1. Air speed – 75 MPH
2. Full power
3. Mixture rich unless engine is rough

VII. NORMAL CRUISE

1. Cruise 2430 RPM 65% rated power, 111 MPH, 4.8 GPH fuel consumption
2. Lean mixture as required
3. Use power chart when appropriate

VIII. BEFORE LANDING

1. Mixture rich
2. Carburetor heat on
3. Wing flaps as desired below 100 MPH
4. Airspeed 60 to 70 MPH flaps extended
5. Seat Belts fastened

IX. AFTER LANDING

1. Wing flaps up
2. Carburetor heat cold
3. Trim tab neutral

X. PARKING

1. Radios off
2. Navigation lights off if applicable
3. Mixture idle cut off
4. All switches off
5. Parking brake set (use chocks if available)

POWER PLANT EMERGENCY

1. Push mixture control to full rich
2. Apply carburetor heat
3. Check ignition switch
4. Check fuel valve
5. On damp days especially cloudy, foggy or hazy days, regardless of temperature, keep a sharp look-out for loss of power. If the engine begins to lose power, apply full heat and open the throttle. Fuel vaporization can be helped by using hot air when the outside temperatures are between 21° and 50°F. If ice is suspected from a drop in RPM and the air heater is turned on hot to melt the ice a slight additional drop will result. This is normal and if there is ice in the carburetor this slight drop in RPM will be regained as the ice melts.

4. Powered Flight

   a. Wright Brothers - Kitty Hawk

   b. Louis Bleriot - English Channel

   c. C. P. Rodgers - New York to California

5. World War I

   a. French Spad

   b. English - Sopwith Camel

   c. United States - Jenny

6. Charles A. Lindberg

   a. Solo from New York to Paris

7. Beginning of Commercial Aviation

   a. James H. Doolittle - instrument flight

   b. Early Commercial Service

8. World War II

   a. Advances in flight and navigation technology

9. Expansion of Commercial Aviation

   a. DC-3

   b. 707

   c. 747

   d. Boeing SST

   e. Air Ports

   f. F.A.A.

10. General Aviation

   a. Piper

   b. Cessna

   c. Flying Magazine

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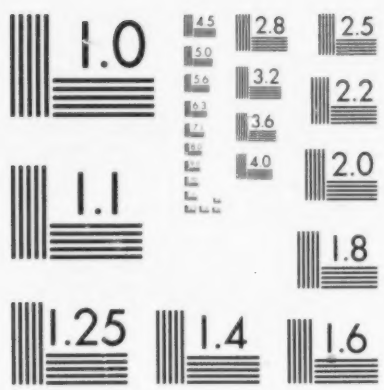

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

11. Civil Air Patrol

    a. organization

    b. search missions

    c. pilot training

12. Careers in Aviation

    a. pilot and flight crew

    b. ground support

    c. airline clerical

    d. manufacturing

    e. research and engineering

13. Early Rocket Experiments

    a. Goddard

    b. U-2 Buzz Bombs

    c. Sputnik I

    d. Vostok I

    e. Mercury

    f. Apollo

    g. Moon Landing

14. Aviation Careers

    a. Captain David E. Harris, American Airlines

    b. S. David Bailey, Private Pilot Instructor

    c. Clarence Powell, TWA First Officer

CAREERS IN AVIATION

First Officer, International Pilot, Clarence Powell

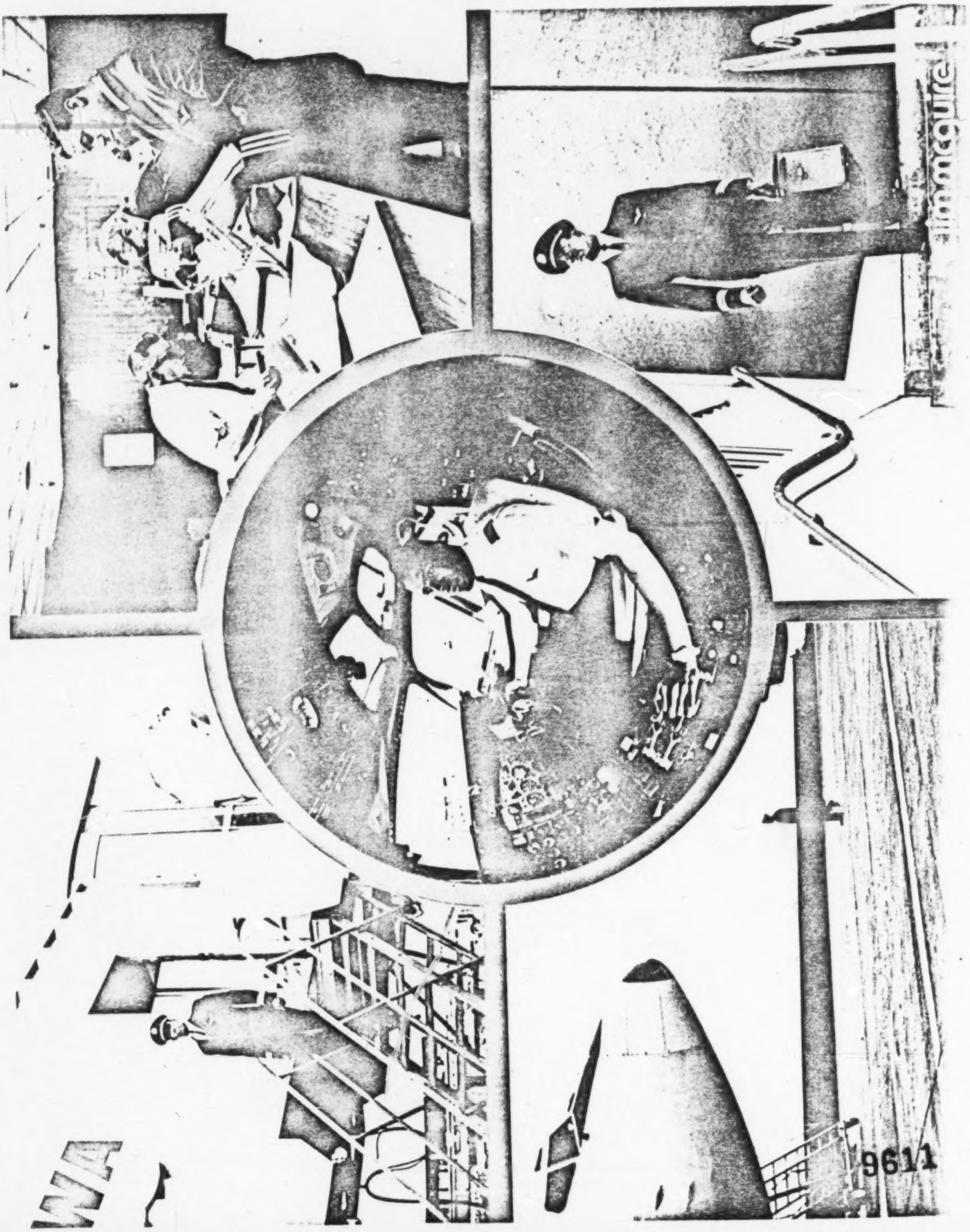

First Officer, International Pilot Clarence Powell has been with the Trans World Airlines since 1966. He is married and has just past his thirty-first birthday. He flew helicopters as a Chief Warrent Officer with the United States Army. He advanced to an Instructor Pilot before leaving the service for a commercial aviation career.

In order to qualify as a First Officer, Mr. Powell had to meet a rigorous training program and a satisfactory employment record as a Flight Engineer on TWA's jet fleet. His qualifications included two years of college at the University of Kansas and Troy State College of Alabama, a FAA commercial instructors rating, 500 hours of flight time and a first class FAA Medical Certificate.

After five years flying as a First Officer, International Pilot, he will be eligible to bid for the next vacancy as Captain.

SPECIAL SUPPLIES AND MATERIALS

1. Balsa wood is available from G-1 list. Special hard balsa would have to be bought from neighborhood or city hobby supply shops (see sources of supplies, below).
2. Laminated balsa may be made by glueing either plastic or brown paper between layers of wood.
3. Reenforce sheet balsa on landing farrings and wing struts by glueing on silk or nylon cloth.
4. Thin plywood - 1/8, 3 ply, is used for fire walls and bulkheads.
5. Bamboo wood can be used for extra strength for struts.
6. Lemon wood may be used for motor mounts.
7. Airplane model fuel-proof cements are required on all models that will have an engine. Rubber power gliders, whip u-control and solid models may be assembled adequately with "Titebond," a strong ready to use adhesive made by Franklin Glue Company.
8. Muscilage is handy for adhering paper covering.
9. Crinoline may be used to strengthen wing and stabilizer joints.
10. Japanese Tissues - available in assorted colors for covering truss fuselage and rib wings.
11. Sheet Plastic or celluloid are used for windows and canopys.
12. Monokote is a new gummed plastic, available in clear or opaque colors. It is used to cover engine - flying models. Can be applied easily with a hot iron. It is also fuel proof.
13. Dope is a special fuel proof lacquer that may be used with gliders as well as flying models. Special ventilation precautions should be taken. Be careful to use thinner recommended since there are different types and they are not interchangeable.

14. Balsa filler may be purchased or made by adding talcum powder or corn starch to clear-thinned dope.

15. Sandpaper is extremely important in preparing surfaces as well as finishes. Use garnet or aluminum oxide papers. Wet papers are used for high gloss finishes. Finger nail emery boards come in handy in tight spaces.

16. Use good paint brushes and keep them clean with appropriate thinning solutions.

17. Flight rubber for power should be lightly sprinkled with talcum powder and kept in a tightly covered tin can. Once installed in the plane, lubricate the rubber with glycerin, liquid soap or a commercial rubber lubricant for improved operation.

18. Assorted hardware:

    fish line and sinkers

    swivels

    glass beads

    cardboard

    very small screws and nuts

19. Metals: piano wire is used for push rods, hooks and skids. Copper wire is used to wrap joints that are to be soldered.

20. Lance #2 T pins are the best type of straight pin for all model work.

21. Single edge razor blades may be purchased from printing supply house.

HOBBY SUPPLY STORES

(School Discounts Available in Quantity Purchases)

American Hobby Center
146 West 22 Street
New York, N. Y.

Polk's Hobbies
314 Fifth Avenue
New York, N. Y.

Larry's Hobby Discount Center
115-13 Jamaica Avenue
Richmond Hill, N. Y.

Hobby Den
138-18 Northern Blvd.
Flushing, N. Y.

FIELD DAY

One or two effective field days per term with appropriate preparation, field organization and evaluation should be incorporated in each Aerospace Program. The application and measurement of students' craftsmanship and information will be put to as realistic a test as possible in a competitive spirit.

PREPARATIONS BY THE TEACHER:

1. The student's work, one class or selected individuals from several classes, should be evaluated sufficiently in advance so that the date of the trip will coincide within a week of the finishing of the models.

2. Arrangements must be made for bus, parents and para-professional aides as well as students' parental consent slips in accordance with school policy.

3. The teacher should make one or more trips to the prepared area to determine:

   a. permission to use public park or private area

   b. toilet and water facilities for the number of students

   c. sufficiently remote location from traffic, housing and pedestrians so that flights may be made

   d. appropriateness of the grounds for the activities and events

   e. availability of special apparatus and grounds

      1) U-Control surfaces

      2) wire attachments for CO 2 Rockets

   f. safety of students and adults

4. Each of the activities and events at the field day should be thoroughly planned with groups of students.

a. activity or contest

b. participants

c. schedule of activities

1) # of flights

2) type of flights

d. diagram of area

e. filing of official Flight Data Forms (Appendix K & L)

f. Compiling Individual Event Score Sheet (Appendix O)

g. listing of special equipment

1) measuring tape

2) scale

3) computation formulas

4) signs and charts

5) tables

5. Review all preliminary preparations with each group.

6. Designate group leaders and responsibilities.

7. Provide for emergencies and special displays.

a. teacher made models

1) U-control

2) radio control

3) guest demonstration by parent or flight club representative

8. Provide First Aid Kit for students and aircraft

9. Have alternative place in case of rain, once on the field

a. museum visit

b. Armory Hall for indoor contests

10. Arrange for lunch and supervised recreation area after lunch.

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11. Recheck bus, parents, para-professionals, parental and school approval one or two days before trip.

12. Discuss General Rules and Regulations for trips with students. See school regulations.

13. Requirements for carrying airplanes on bus

    a. shopping bags

    b. boxes

    c. field caddy

14. Prizes and Awards

Field Organizations

Constant attention and alert supervision are required at the field during the entire day on the part of all adults.

1. On the bus, check attendance and review Rules and Regulations with students.
2. Determine that each student's equipment and lunch is safely abroad.
3. Make sure all special equipment is on board.
4. Review Field Organization and distribute printed schedule and diagram of area. Indicate limits of students' use. Indicate safety factors and responsibility for public or private property. Be sure each student knows what he is to do, where he is to do it and when it is to be done.
5. At the field, organize first events and groups.
6. Provide tables (folding, bridge) for special equipment and judges.
7. Distribute prepared event sheets to judges and aides.
8. Distribute necessary equipment
9. Provide measured and calculated information

    a. weather

1) temperature

2) humidity

3) wind direction and speed

4) measuring sticks and tapes

5) stop watches

6) scales

7) pencils

10. Move from one event to another as soon as events are finished. More than enough events should be planned.

11. Check attendance periodically.

12. Provide First Aid for damaged craft.

a) quick setting glue

b) extra balsa parts

c) tape

d) staples and screws

e) strings

f) rubber bands

g) propellers

h) fuel and extra batteries

13. Following morning events, provide a shady area for quiet lunch - toilet facilities - beverage service.

14. Provide books, magazines and supervised free play area for some time after lunch.

15. Special exhibits by teacher or guests may follow lunch.

16. Activities after lunch should be short and of a special nature.

a. additional exhibits by special students

b. run offs of morning contests

c. repeat morning contests of particular interest or with different weather conditions

17. Provide opportunities for picture taking.

18. Check that all contests and events were held.

19. Have students police area.

20. Take attendance on bus before leaving area.

Evaluation

1. Review Flight Data Sheets and Individual Score Sheets for indications that will warrant review and discussion at following class session.

   a. finished models vs. rough wood

   b. craftsmanship compared to performances

   c. effects of weather on flights

   d. calculated and measured performances

2. Discuss and evaluate individual performances.

3. Determine causes of success and failure.

4. Direct students to corrective measures.

5. Award certificates and/or prizes.

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(15)"How To Books" from American Hobby Center

A1- Controline Model Plan Book

A2- ABC's of Model Building

A3- Free Flight Plans Book

A4- Guide to Radio Control

A5- Gas Model Construction

A6- Glo Engine Handbook

A7- Control Liner Book

A8- Data Handbook

A9- Control By Radio

A10-Jets and Rockets

A11-Building & Flying Model Airplanes

MAGAZINES

Nationally distributed (through hobby houses and on newstands) model-aviation and rocket publications are:

Aero Modeller (Model Aeronautical Press, Ltd., 13–35 Bridge St., Hemel Hempstead, Herts., England; distributed in U.S.A. by Eastern News Distributors, 155 West 15 St., New York, N.Y. 10011); all phases of model aviation, contains much material of interest to United States modelers.

American Aircraft Modeler (Potomac Aviation Publications, Inc., 1012 Fourteenth St., N.W., Washington, D.C. 20005); model aviation in all phases, model rocketry.

The Engine Collectors' Journal (bimonthly by the Model Museum, 1235 Xavier St., Denver, Colorado 80204); devoted principally to older model engines which are collectors' items; also some news of old-time model planes, usually termed "antiques."

Flying Models (Rajo Publications, Inc., 215 Park Ave. South, New York, N.Y. 10003) all phases of model aviation.

Model Airplane News (Air Age, Inc., 551 Fifth Ave., New York, N.Y. 10017); all phases of model aviation.

Model Rocket News (Estes Industries, Inc., Box 227, Penrose, Colorado 81240); sent free to customers of this large model-rocket maker; much information on all phases of model rocketry, including plans for successful rockets; concern also issues reports on technical matters of this field.

Radio Control Models and Electronics (Model Aeronautical Press, Ltd., London; available in U.S. from Polk's Model Craft Hobbies, 314 Fifth Ave., New York, N.Y. 10001); covers all sorts of radio-controlled models, much data on building RC equipment; contains much material of interest to United States modelers.

Radio Modeller (Radio Control Publishing Co. Ltd., 64 Wellington Rd., Hampton Hill, Middx., England; available in U.S. from Stanton Hobby Shop Inc., 4734 North Milwaukee Ave., Chicago, Ill. 60630); radio-control models of all types, considerable material on U.S. equipment.

R/C Modeler (R/C Modeler Corp., Box 487, Sierra Madre, California 91024); all phases of radio-control modeling—planes, boats, and so on.

Scale Modeler (Challenge, Inc., 7805 Deering Ave., Canoga Park, California); devoted to construction of nonflying scale models with heavy emphasis on planes and on plastic model construction.

Several of the model-plane and radio magazines presently issue (or have issued in the recent past) annuals covering a variety of subjects in the field. Issues of recent years are available from the same sources and will be found of much interest. Most of the model-plane magazines can provide full-size drawings for the vast variety of planes which have been featured in past issues; they offer free lists of the plans they can supply.

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Aviation Education Services and Resources

JFK International Airport, Jamaica, N.Y. 11430

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(4) National Aerospace Educational Council

806 15 St. NW

Washing DC

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Weather, climate, clouds etc.

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Loch Haven, Pa.

Large instruction charts of small airplane and airplane factory

(8) Cressna Aircraft Co.

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P.O. Box 1521

Wichita, Ka. 67201

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605 Third Avenue

N.Y. 10016

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Box 8776

Chicago, Ill. 60666

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Aviation Education Dept.

Wichita, Ka. 67201

(12) National Association of Rocketry

1239 Vermont Ave. N.W.

Washington, DC 20005

(13) Pan American World Airways

Pan Am Building

c/o Educational Services

N.Y. N.Y. 10017

VT 012 760
Powerplant Maintenance Technician Curriculum. An Experimental Program for Vocational and Technical High Schools.

New York City Board of Education, Brooklyn, N.Y. Bureau of Curriculum Development.
MF AVAILABLE IN VT-ERIC SET.
Project No. 7516A
PUB DATE - Jul69 88p.

DESCRIPTORS - *VOCATIONAL EDUCATION; *EXPERIMENTAL CURRICULUM; *CURRICULUM GUIDES; *MAINTENANCE; *AVIATION TECHNOLOGY; HIGH SCHOOLS; TECHNICAL EDUCATION; EXPERIMENTAL PROGRAMS; CURRICULUM

ABSTRACT - Intended for vocational and technical high schools, these experimental curriculum materials In powerplant maintenance were prepared by the City of New York Bureau of Curriculum Development in cooperation with the Bureau of Trade and Technical Education. Contents are: (1) Introduction, (2) Topical Outline, Year Level, and Time Allotment, (3) Curriculum Patterns, (4) Student Hours of Instruction, (5) General Notes, (6) Powerplant Maintenance Technician Curriculum, (7) Instructional Facilities, (8) Instructional Equipment, and (9) Teachers. The topics are presented in outline form according to subjects. (GB)

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CURRICULUM PROJECT REPORT

Limited Distribution

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POWERPLANT MAINTENANCE TECHNICIAN CURRICULUM

An Experimental Program

For

Vocational and Technical High Schools

Project No. 7516A

These experimental curriculum materials were prepared as part of the Curriculum Workshop Program of the Bureau of Curriculum Development in cooperation with the Bureau of Trade and Technical Education.

July 1969

BUREAU OF CURRICULUM DEVELOPMENT
BOARD OF EDUCATION • CITY OF NEW YORK
181 Livingston St., Brooklyn, New York 11201

VT012760

9625

_____ School _____ Date

_____ Principal

POWERPLANT MAINTENANCE TECHNICIAN CURRICULUM

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Amended Curriculum
Far 147.7

9629

_____ School _____ Date

_____ Principal

1. INTRODUCTION

The New York City Board of Education Curriculum Development Bureau submits the amended curriculums for Airframe, Powerplant and Airframe and Powerplant Maintenance Technician Ratings to the Department of Transportation, Federal Aviation Administration for approval in accordance with the revised F.A.R. Part 147. The individual curriculum projects are identified as follows:

1. Airframe Maintenance Technician Project 7515
2. Powerplant Maintenance Technician Project 7516
3. Airframe and Powerplant Maintenance Technician Project 7516A

These curriculums will be put to use in those Vocational and Technical High Schools that wish to provide the educational opportunities necessary for teaching the technologies and skills required by interested and motivated students in order to qualify for an F.A.A. Maintenance Technician Certificate of Competency with the Airframe, Powerplant or combined Airframe and Powerplant ratings.

The New York City School System has the following schools teaching F.A.A. Approved Maintenance Technician Curriculums:

1. Aviation High School
   Mr. Frank Woehr, Principal
   Queens Boulevard and 36 Street
   Long Island City, N.Y. 11101

   a) Airframe Maintenance Technician

   b) Powerplant Maintenance Technician

   c) Airframe and Powerplant Maintenance Technician

2. East New York Vocational and Technical High School
   Mr. Solomon Kantowitz, Principal
   1 Wells Street
   Brooklyn, New York, 11208

   a) Powerplant Maintenance Technician

Approval of these curriculums and the issuance of amended F.A.A. Maintenance Technician School Ratings for Aviation High School and East New York Vocational and Technical High School is hereby applied for:

_____
Principal

_____
School

_____
Date

_____ School _____ Date

_____ Principal

2. POWERPLANT MAINTENANCE TECHNICIAN

CURRICULUM TOPICAL OUTLINE, YEAR LEVEL AND TIME ALLOTMENT IN HOURS

10TH, 11TH, 12TH YEAR SHOPS AND RELATED TECHNOLOGY

I. GENERAL CURRICULUM SUBJECTS

	YEAR LEVEL				
	10	11	12	RT	TOTAL
A. BASIC ELECTRICITY	70	70	30	40	210
B. AIRCRAFT DRAWINGS	5	5	10	25	45
C. WEIGHT AND BALANCE			10	25	35
D. FLUID LINES AND FITTINGS		5	5		10
E. MATERIALS AND PROCESSES	5		5	40	50
F. GROUND OPERATION AND SERVICING			10	5	15
G. CLEANING AND CORROSION CONTROL	5			15	20
H. MATHEMATICS				20	20
I. MAINTENANCE FORMS AND RECORDS			5	10	15
J. BASIC PHYSICS				15	15
K. MAINTENANCE PUBLICATIONS			5	5	10
L. MECHANIC PRIVILEGES AND LIMITATIONS				5	5
SUB TOTAL: HOURS	85	80	85	200	450

School _____ Date _____

Principal _____

POWERPLANT CURRICULUM SUBJECTS

		YEAR LEVEL				
II.	POWERPLANT THEORY AND MAINTENANCE	10	11	12	RT	TOTAL
A.	RECIPROCATING ENGINES		70	160	30	260
B.	TURBINE ENGINES		15	30	15	60
C.	ENGINE INSPECTION		7	25	2	34
	SUB-TOTAL HOURS		92	215	47	354
III.	POWERPLANT SYSTEMS AND COMPONENTS					
A.	ENGINE INSTRUMENT SYSTEMS		10	15	10	35
B.	ENGINE FIRE PROTECTION SYSTEMS		8	5	2	15
C.	ENGINE ELECTRICAL SYSTEMS	90	60	50	50	250
D.	LUBRICATION SYSTEMS		10	20	5	35
E.	IGNITION SYSTEMS		40	30	20	90
F.	FUEL METERING SYSTEMS		30	45	45	120
G.	ENGINE FUEL SYSTEMS		10	15	15	40
H.	INDUCTION SYSTEMS		8	10	9	27
I.	ENGINE COOLING SYSTEMS		5	10	5	20
J.	ENGINE EXHAUST SYSTEMS		5	10	5	20
K.	PROPELLERS		7	30	25	62
	SUB-TOTAL HOURS	90	193	240	191	714
	POWERPLANT MAINTENANCE TECHNICIAN CURRICULUM TOTAL HOURS	175	365	540	438	1518

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School _____ Date _____

Principal _____

3. CURRICULUM PATTERN

All students enrolled in the FAA approved school curriculum, Airframe or Powerplant, follow the same course of instruction during the 10th and 11th school year.

The course content includes those subjects of common interest and importance to both the Airframe and Powerplant ratings. This pattern of instruction allows the student to acquire experience and training in both areas of the maintenance technician curriculum. He is then better prepared to select the technician rating curriculum. Specialization for either the airframe or powerplant rating takes place in the 12th year.

The FAA approved Airframe or Powerplant maintenance technician curriculum of the school provides 1518 hours of training and instruction for each course. The minimum hours of instruction required for either the Airframe or Powerplant approved curriculum as listed in FAR 147.21, is 1150 hours.

_____ School _____ Date

_____ Principal

4. HOURS OF INSTRUCTION

1) Student daily instruction time 6.75 Hours

	Daily	Term	Year
* Shop	3.00	270	540
* Related Technology	.45	67.5	135
** Math, Science, Drawing	.45	67.5	135
Academic	1.30	135.	270
Lunch	.45	--	--

* 3 Hours and 45 minutes per day for the FAA program during the 11th and 12th Year

** An additional 45 minutes of Math, Science and Drawing added to the FAA program in the 10th year.

2) School Term = 90 days

18 weeks - 5 days per week

3) School Year 180 days

36 weeks - 5 days per week

4) F.A.A. Curriculum hours

* 10th year - Shop, Related Technology, Mathematics, Science and Drawing	438 hours
* 11th year - Shop and Related Technology	405 hours
* 12th year - Shop and Related Technology	675 hours
Total Hours	1518

Maximum number of students enrolled is 900

9635

_____ School _____ Date

_____ Principal

5. GENERAL NOTES

A. Federal Air Regulations contained in Volumes I, II, III, IV, V, VI and IX and Parts 1, 11, 13, 21, 23, 25, 27, 29, 33, 35, 37, 39, 41, 43, 45, 47, 49, 65, 91 and 145 will be covered and taught throughout the Airframe, Powerplant, Airframe and Powerplant and the General Curriculum wherever they are deemed applicable.

B. The use and care of tools, equipment, materials, instruments and essential safety instructions will be taught at the appropriate time in conjunction with the demonstration and information lessons throughout the 10th, 11th and 12th year shops.

C. The basic references recommended and to be followed for the instructional and training program will include: AC65-2A - Airframe & Powerplant Mechanics Certification Guide, The General, Airframe and Powerplant Study Text Books now being prepared for sale by the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, and any other suitable text book that the individual teacher deems satisfactory. There will be no attempt to restrict or limit the use of texts, instruction sheets, job sheets, information sheets, assignment sheets, audio, visual or animated instructional aids.

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D. The instructional levels to be maintained are clearly defined in AC65-2A as follows:

Level 1. Know - basic facts and principles

Be able to - find information, follow directions and written instructions.

Knowledge of general principles but limited practical application with no development of manipulative skill.

Instruction by lecture, demonstration and discussion.

Level 2. Know and understand - principles, theories and concepts.

Be able to - find and interpret information and perform basic operations.

A high level of skill is not required.

Instruction by lecture, demonstration, discussion and limited practical application.

Level 3. Know, understand and apply - facts, principles, theories and concepts. Understand how to relate to the total operation and maintenance of aircraft.

Be able to - make independent and accurate judgements, perform all operations to a return to service standard

Practical application of general principles to a high degree and development of a sufficient manipulative skill to accomplish return to service.

Instruction by lecture, demonstration, discussion and a high degree of practical application.

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E. Testing of each student's technical knowledge and competence in performing manipulative skills will be conducted by a series of written examinations and practical performance projects. This testing and evaluation is indicated at the end of each section for each subject area in the curriculum. This program will consist of the following:

All level 1 learning - a written examination

All level 2 learning - a written examination and a practical project.

All level 3 learning - a written examination and a practical work project that must meet "return to service standard."

The curriculum lists the practical work projects that will be used to conduct the performance demonstrations.

A record of the examination grades and performance scores earned by each student, the practical projects completed by each student, will be kept by the school and made a part of each student's accumulative record. A work progress card will be maintained by the shop teacher, who will hold an FAA Maintenance Technician's Certificate of Competency, for each student that will show:

(a) each completed practical project

(b) grade earned for each project

(c) score earned for each written examination

(d) attendance and punctuality record

(e) character and personality ratings.

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F. The school will expect each student who satisfactorily completes the FAA Technician Certification Courses, Airframe or Powerplant, to score 70% or higher in the school administered Final Qualifying Examination to be given at the very end of the completed course of study. Failure to meet this standard will prevent a student from receiving the school FAA course completion graduation certificate. Provisions for continued education and training will be made available during the summer period so that interested and motivated students will be helped to meet the requirements for the FAA school course completion graduation certificate.

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6. POWERPLANT MAINTENANCE TECHNICIAN CURRICULUM

I. GENERAL CURRICULUM SUBJECTS

A. BASIC ELECTRICITY (10th, 11th, 12th Year and RT)

1. Measure capacitance and inductance (Level 1)

a) The effect of inductive reactance in an electrical circuit.

b) The interrelationship of capacitive and inductive reactance.

c) The term that describes the combined resistive forces in an A.C. electrical circuit.

d) The unit of measurement for capacitance and inductance.

A written examination appropriate to the above subject will be used to determine the degree of learning by the students.

2. Calculate and measure conductivity and electrical power (Level 2)

a) Determine the power furnished by a generator to an electrical system consisting of various electrical units having specific load ratings.

b) Determine the power required by an electric motor that is operating at a specified efficiency and load.

A written examination required and practical projects.

1) Find the power required of a generator supplying various units in an electric circuit.

2) Find the power required by an electric motor in an existing circuit under various load conditions.

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c) The current relationship in a electrical parallel circuitry.

d) The unit of measurement used to express electrical power.

e) The principles of electromagnetic induction.

f) The characteristics of magnets and magnetic lines of force.

g) The factors that effect the voltage drop in an electrical conductor.

h) Determine the resistance of an electrical device from the wattage and voltage valves specified.

i) Calculate the voltage drop across a resistor.

A written examination required and practical projects.

1) Determine the needs of, select, install, operate, and test an electrical circuit using a 24V supply consisting of the following units: bus, circuit breaker, switch, relay, lamps, and rheostat. The above project should reflect both series and parallel lamp circuits.

5. Read and interpret electrical circuit diagrams. (Level 3)

a) Trace electrical circuits using aircraft wiring diagrams.

b) Identify electrical system malfunctions by reference to circuit diagrams.

c) Identify the commonly used aircraft electrical symbols.

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3. Measure voltage, current, resistance, continuity, and leakage (Level 3).

   a) Use an ohmeter to check for open or short circuits.

   b) The test instruments used to check continuity.

   c) The basic operating principles of D.C. electrical instruments.

   d) The basic operating principles of a galvanometer.

   e) Connect voltmeters and ammeters into an electrical circuit.

   f) The purpose of a shunt resistor when used with an ammeter.

   g) The meaning of prefixes such as micro, mega, kilo, and milli as used in expressing electrical quantities.

   A written examination required and practical projects.

      1) Use an ohmmeter to check for short and open circuits in an existing electrical circuit.

      2) Connect an ammeter and a voltmeter in an existing electrical circuit. Use an ammeter requiring an external shunt.

4. Determine the relationship of voltage, current, and resistance in electrical circuits. (Level 3)

   a) Determine the current flow in an electrical circuit using variable resistance and voltage valves.

   b) Determine the power requirements of an electrical circuit when the voltage and resistance valves are specified.

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A written examination required and practical projects.

1) Wire an aircraft navigation and lighting system mock-up. Using an aircraft wiring diagram incorporate the following units into the lighting system: bus bar, circuit protecting devices, switches, lamps in parallel, variable resistance in series with cabin lamps.

6. Inspect and service batteries (Level 3).

a) Remove spilled electrolyte and treat all adjacent surfaces.

b) Remove and install a battery in the aircraft with a single wire electrical system.

c) Connect batteries to a constant current battery charger.

d) Determine the specific gravity of the battery electrolyte.

e) Perform a high-rate discharge condition test of batteries.

f) The design factors that affect battery voltage and capacity.

g) The factors that determine battery charging rate on a constant voltage source.

h) The indications of a shorted battery cell.

i) The significance of battery capacity ratings.

j) The effects of increased internal resistance on battery operation.

k) The effects of connecting battery cells in series or parallel.

l) The relative advantages of lead-acid and nickel-cadmium batteries for use in aircraft.

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m) The principles of battery construction.

n) Check battery electrolyte level.

o) The relationship between battery state of charge and the temperature at which the electrolyte will freeze.

p) The purpose of and requirements for ventilating batteries and battery compartments in civil aircraft.

q) The effect of excessive charging rates on batteries.

A written examination required and practical projects:

1) Remove, clean, service, charge and install batteries in an aircraft. (Use constant current and constant potential charger).

2) Clean and protect battery compartment in an aircraft and service spill-jar.

B. AIRCRAFT DRAWINGS (10th, 11th, 12th Year and RT)

1. Use drawings, symbols, and schematic diagrams. (Level 2)

a) Interpret the various types of lines employed in blueprints and schematics.

b) Use schematic diagrams to analyze system malfunctions.

c) Extract a specific electrical circuit from a system drawing.

d) Know why dimensions are used and how they are shown on aircraft drawings.

e) Use installation diagrams to locate and identify components.

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A written examination required and practical projects.

1) Install a rotating beacon on an aircraft using blueprints and wire chart as references.

2) Install wiring for a generating system using schematics, charts, and graphs.

3) Using wiring diagram of an aircraft engine instrument system, isolate a particular system, i.e., fuel pressure system, and proceed to correct fuel pressure system malfunction.

4) Rig a centersection on a biplane using specifications shown on a blueprint.

5) Layout a drawing to specifications. Transfer layout information to a piece of flat stock. Fabricate fitting.

2. Draw sketches of repairs and alterations (Level 3)

a) Illustrate a major repair or alteration.

b) Use dividers, compass, ruler, T-Square, etc. in the development of sketches of repairs and alterations.

c) Use standard drafting procedures.

A written examination required and practical projects.

1) Recover a control surface, complete form 337 and appropriate records.

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2) Repair damage to stressed skin area of fuselage, fill out form 337 and appropriate records.

3) Install an oil cooler on an engine other than that shown on data sheet, fill out form 337 and appropriate records.

3. Use blueprint information (Level 3).

a) The information presented in blueprint title blocks.

b) The common symbols used on aircraft blueprints.

c) Install and modify component parts by reference to blueprints.

d) Identify the changes made to a blueprint.

A written examination required and practical projects.

1) The drafting department curriculum provides adequate time and practice in areas a, b, and d above.

2) Modify a stringer installation by reference to blueprints.

3) Install an electrical oil pressure gauge using installation prints and specifications.

4. Use graphs and charts (Level 3).

a) Determine electric cable size and current carrying capacity.

b) Determine engine power requirements.

A written examination required and practical projects.

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1) By referring to the electrical cable chart in AC43.13-1 determine the size of an aluminum cable to replace a copper cable for the inverter.

2) During ground run use the manufacturer's manual to determine if the engine meets manufacturer's requirements.

C. WEIGHT AND BALANCE (12th Year and RT)

1. Weigh aircraft (Level 2)

a) Use aircraft specifications for weighing purposes.

b) Locate jacks and scales in the correct position.

c) Prepare aircraft for weighing.

A written examination required and practical projects.

1) Weigh an aircraft and record the scale readings.

2. Perform complete weight and balance check and record data. (Level 3)

a) Determine that the foreward or rearward center of gravity (C.G.) limit is not exceeded on a specified aircraft.

b) The point of reference for all weight and balance measurements.

c) The procedure for computing "minimum fuel."

d) Locate the information that should be known to compute weight and balance.

e) The method of expressing additions or removals of equipment for weight and balance purposes.

f) Determine the fully loaded center of gravity of an aircraft.

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g) Determine the "maximum authorized weight" of an aircraft.

h) The method of determining aircraft empty weight, when engine oil and hydraulic fluid are contained in supply tanks.

i) The effect on weight and balance of replacing a component with another of different weight and location.

j) Calculate the maximum cargo or baggage weight that can be carried by an aircraft.

k) The record requirements for weight and balance data.

l) The hazards of exceeding aircraft fore and aft center of gravity limits.

m) The critical conditions of helicopter load and balance.

n) Determine aircraft empty weight and empty weight center of gravity.

o) Define maximum gross weight.

p) Determine the moment of an item of equipment.

q) Account for tare weight when weighing an aircraft.

A written examination required and practical projects.

1) Compute new empty weight, empty weight center of gravity, and useful load. Complete appropriate record requirements.

2) Change or remove equipment from an aircraft, such as propeller, seats, gas tanks, etc. Compute new weight and balance, reflecting a corrected empty weight, empty weight center of gravity, useful load, fore and aft check and correction where necessary. This project must utilize such specifications and references as "Data Sheets" AC43.13-1, and equipment list.

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D. FLUID LINES AND FITTINGS (11th, 12th Year and RT)

1. Fabricate and install rigid and flexible fluid lines and fittings (Level 3)

a) Single and double-flare tubing.

b) Install military standard (MS) flareless fittings.

c) The significance of the identification stripes that appear on aircraft hose.

d) Fabricate and install beaded tubing.

e) Use lubricants and sealants in the assembly of lines and fittings.

f) Identify flexible hydraulic lines.

g) Install hose clamps.

h) Determine the bend radii for rigid tubing.

i) Fabricate aluminum tubing using standard AN flared tube fittings.

j) Route fluid lines in entryways and passenger, crew, or baggage compartments.

k) Repair metal tube lines.

l) Route fluid lines adjacent to electrical power cables.

m) Install rigid tubing.

n) Select tube flaring tools.

o) Identify AN fitting materials from color designators.

p) The maximum reduction in original outside diameter allowed when bending aluminum alloy hydraulic lines.

q) The procedure to follow if scratches are detected on an aluminum alloy tube.

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r) The storage requirements for hydraulic hose.

s) Install flexible hydraulic hose.

t) The lubricant used when assembling oxygen fittings.

A written examination required and practical projects.

1) Make up a replacement fluid line (rigid and flexible) and install the line in an aircraft or system mock-up. Use both AN and MS fittings.

2) Repair a rigid fluid line using a union.

E. MATERIALS AND PROCESSES (10th, 11th, 12th Year and RT)

1. Identify and select appropriate non-destructive testing methods (Level 1)

a) The use of radiography in aircraft and component inspection.

b) The use of ultrasonic inspection methods for detecting cracks.

c) The applicability of magnetic particle inspection methods to engine crankshafts.

d) The method for detecting surface cracks in aluminum castings and forgings.

e) The technique for locating cracks in materials when only one side of the material is accessible.

A written examination appropriate to the above subject will be used to determine the degree of learning by the students.

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2. Perform penetrant, chemical etching, and magnetic particle inspections. (Level 2)

   a) The general procedure for performing magnetic particle inspection.

   b) Demagnetize steel parts after magnetic particle inspection.

   c) Clean parts in preparation for penetrant inspection.

   d) The visual indications of a subsurface flaw or fracture during magnetic particle inspection.

   e) Locate cracks and blowholes in welded assemblies.

   f) The procedure for using dye penetrants.

   g) Distinguish between heat-treated and non-heat-treated aluminum alloys when the identification marks are not on the material.

A written examination required and practical projects.

   1) Using dye-penetrant method of inspection examine suspected areas of an aircraft engine power section.

   2) Using the magnetic particle type of inspection equipment inspect various engine parts, e.g., piston pin, connecting rod, crankshaft and welded assembly.

   3) Using acceptable trade practices distinguish between a heat treated and a non-heat treated piece of aluminum alloy.

   4) Inspect an aluminum propeller blade using the caustic soda etching method.

   5) Inspect a landing gear component by use of magnetic particle equipment.

   6) Inspect an aircraft and/or powerplant aluminum alloy part using the "zyglo" method of inspection.

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3. Perform basic heat-treating processes (Level 2)

a) The types of aluminum alloys considered to be heat treatable.

b) Anneal copper tubing.

c) The steps in heat treatment of aluminum alloys.

d) The effects of various forms of heat treatment.

e) The effect of incorrect heat treatment on the corrosion-resistant properties of aluminum alloys.

f) Identify the degree of temper for aluminum alloy products from code designators.

g) The effect of heating a metal slightly above its critical temperature, and then rapidly cooling it.

h) The effect of strain hardening on the tensile strength or aluminum alloy.

i) The relationship between tensile strength and metal hardness.

j) Anneal a welded steel part.

A written examination required and practical projects.

1) Remove a copper primer line, anneal, and reinstall.

2) Anneal a welded steel tubing joint or cluster.

3) Heat treat and form an aluminum alloy rib.

4) Heat treat a new machined center punch.

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4. Identify and select aircraft hardware and materials (Level 3)

a) Identify aluminum alloys from code designators.

b) Identify steel from code designators.

c) The identification markings of AN standard steel bolts.

d) Identify aircraft cable.

e) The characteristics of a material that affect its ability to be hammered, rolled, or pressed into various shapes.

f) The SAE system of identifying steel.

g) Determine wrought aluminum alloy composition and condition by referring to aluminum codes.

h) Install self locking nuts.

i) Determine the correct length bolt to use.

j) Determine correct torque valves for tightening aircraft nuts and bolts.

k) Determine rivet composition, condition, shape, and dimension by referring to rivet code.

l) Identify materials suitable for use for firewalls and exhaust shrouds.

m) Install castle nuts.

n) The strength characteristics of type "A" rivets.

o) The characteristic of aluminum alloy rivet material that causes some rivets to require several days to reach their ultimate strength.

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p) Determine that materials used in aircraft maintenance and repair are of the proper type and conform to the appropriate standards.

q) The characteristics of aluminum - clad sheet aluminum alloy.

A written examination required and practical projects.

1) Fabricate an aluminum alloy control surface.

2) During engine overhaul assemble cylinders and torque to proper valve.

3) Install an aircraft control surface using castellated nuts.

4) During engine overhaul install connecting rods using castellated nuts.

5) Replace an aircraft control cable in an aircraft.

6) Replace a propeller governor control cable.

7) Install bolts using self locking nuts during engine overhaul.

8) Install bolts using self locking nuts during replacement of components on aircraft.

9) Select steel and aluminum alloy using code designators in fabricating aircraft fittings and brackets.

10) Make stressed skin repair.

5. Inspect and check welds (Level 3)

a) The characteristics of a good weld.

b) The types of stress that welded joints can withstand.

c) The effect of welding over a previously brazed or soldered j

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A written examination required and practical projects.

1) Weld a steel tubing cluster.

2) Inspect a welded tube structure, i.e., welded tube engine mount, welded tube fuselage structure.

6. Perform precision measurements (Level 3).

a) Use a micrometer and a caliper to make precision measurements.

b) Measure a small hole using micrometer and a hole gauge.

c) Read and interpret a vernier micrometer scale.

d) Use a dial indicator, V Blocks, and a surface plate to check the alignment of a shaft.

A written examination required and practical projects.

1) During engine overhaul inspect various parts for wear and proper clearance.

2) During engine overhaul inspect a camshaft and/or crankshaft for runout.

F. GROUND OPERATION AND SERVICING (12th Year and RT)

1. Start, ground operate, move, service, and secure aircraft (Level 2).

a) The procedure for extinguishing fires in the engine induction system during starting.

b) Use hand signals to direct aircraft movement.

c) Select and use external auxiliary power units for engine starting.

d) Tie-down and secure aircraft for outside storage.

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e) Protect aircraft fuel system from contamination during fueling operations.

f) Connect and operate an external source of hydraulic power.

g) Start and operate an engine equipped with a float type carburetor.

h) Check a reciprocating engine for liquid lock.

i) Operate hand and electrical priming systems during engine starting.

j) Start and operate an engine equipped with a pressure injection carburetor.

k) Start and operate an engine equipped with an internal supercharger.

A written examination required and practical projects.

1) Move, tie-down, and store aircraft on hangar apron and in hangar.

2) Pre-start check a reciprocating engine including a check for liquid lock.

3) Start an aircraft engine using an A.P.U.

4) Start and run an aircraft engine with an internal supercharger.

5) Start and run an aircraft engine with a pressure injection carburetor.

6) Start and run an aircraft engine with a float type carburetor.

7) Service an aircraft engine with fuel and oil.

8) Operate aircraft actuating mechanisms with an external source of hydraulic power.

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A written examination required and practical projects.

1) Clean an engine in preparation for Disassembly.

2) Clean engine parts in preparation for inspection.

3) Clean an aircraft structure in preparation for painting.

4) Clean engine exhaust systems.

2. Perform aircraft cleaning and corrosion control (Level 3).

a) Protect tires and other rubber products from the deteriorating effects of cleaning materials.

b) The cause and corrective procedures for fretting corrosion.

c) Identify and control intergranular corrosion of heat treated aluminum alloy.

d) Protect structure against dissimilar metal corrosion.

e) Prevent and remove rust.

f) The effect of oily, dirty surfaces on the operation of high performance aircraft.

g) Protect interior surfaces of closed steel and aluminum tubing against corrosion.

h) The methods of protecting aluminum alloy parts against corrosion.

i) Clean and protect battery compartments and adjacent areas.

j) Remove corrosion products such as metal flake, scale powder, and salt deposits from aluminum.

k) Clean corrosion resistant parts by blast cleaning methods.

l) Use paints and similar organic coatings for corrosion protection purposes.

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2. Identify and select fuels (Level 2)

a) The effect of ethylene dibromide added to aviation gasoline.

b) The identifying color of various grades of aviation gasoline.

c) The characteristic of a fuel that affects its tendency to "vapor lock."

d) The significance of the numbers used to designate various grades of aviation gasoline.

e) The relative advantages of gasoline and kerosine for use as fuel for turbine engines.

f) Determine the types of fuel to be used with a specific aircraft.

g) The factors affecting the antiknock characteristics of fuel.

A written examination required and practical projects.

1) Refuel various aircraft requiring several grades of fuel.

G. CLEANING AND CORROSION CONTROL (10th, 11th, 12th Year and RT)

1. Identify and select cleaning materials (Level 3).

a) The effect of caustic cleaning products on aluminum structures.

b) The characteristics and use of chemical cleaners.

c) Clean aluminum and steel engine parts.

d) The type cleaner for use on high strength metals.

e) The methods for cleaning turbine engine compressor blades.

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A written examination required and practical projects.

1) Clean and protect a battery compartment on an aircraft.

2) Clean exhaust collectors and shrouds.

3) Cover tires of stored aircraft against oil and solvent drippings.

4) Remove rust from the exterior of spark plugs and paint.

5) Wash down aircraft.

6) Clean, zinc chromate, and paint aircraft fittings and brackets before installing.

7) Use par-al-ketone to protect exterior surfaces of engines in storage.

8) During fabrication of a control surface (aileron) use proper corrosion protection between dissimilar metals.

H. MATHEMATICS (10th, 11th, 12th Year and RT)

1. Extract roots and raise numbers to a given power (Level 1).
2. Determine areas and volumes of various geometrical shapes (Level 2).
3. Solve ratio and proportion and percentage problems (Level 3).
4. Perform algebraic operations involving addition, subtraction, multiplication, and division of positive and negative numbers (Level 3).

Students will demonstrate competency with this subject while performing practical projects and written examinations at appropriate times throughout the curriculum. Selected projects would include: weight and balance computations, flat pattern layout development, electric circuit computations, and calculating gear ratios and engine displacement.

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I. MAINTENANCE FORMS AND RECORDS (11th, 12th Year and RT)

1. Write descriptions of aircraft condition and work performed (Level 3).

   a) Describe the repairs made to an aircraft structure.

   b) State aircraft condition based upon inspection.

   A written examination required and practical projects.

      1) Make a log book entry describing repairs made to an aircraft and/or powerplant. Major and minor repairs.

      2) Perform a 100 hour inspection to an aircraft and/or powerplant and submit a completed inspection report and discrepancy list.

2. Complete required maintenance forms, records, and inspection reports (Level 3).

   a) Enter the required information in the permanent maintenance records when a minor repair has been performed.

   b) Prepare and properly dispose of FAA Form 337.

   c) The minimum information required to be entered in the maintenance records after maintenance or alteration of aircraft.

   d) Make record entries to indicate compliance with airworthiness directives.

   e) The definition of "Time in service" with respect to maintenance records.

   f) The record requirements for returning aircraft to service after 100 hour inspection.

   g) The requirement for maintaining a permanent record of aircraft maintenance.

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h) The definition of "repair" as related to aircraft maintenance.

i) The requirements for a permanent maintenance record.

A written examination required and practical projects.

1) Make a log book entry reflecting a major repair made to an aircraft and/or powerplant and execute an FAA Form 337.

2) Make a log book entry reflecting compliance with an airworthiness directive.

3) Make a log book entry reflecting return to service after completing a 100 hour inspection.

J. BASIC PHYSICS (10th, 11th, 12th Year and RT)

1. Use the principles of simple machines; sound, fluid, and heat dynamics (Level 2).

The course content includes classroom and laboratory experiments and demonstrations in the theory and application of the laws of physics as applied to aviation in the performance and operation of aircraft and powerplants and the functioning of its support systems. Examples: Charles Law, Boyles Law, Pascals Law, Bernoulli Theorum, Newtons Laws, Otto cycle, braden cycle are examples of the basic concepts incorporated in the curriculum.

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K. MAINTENANCE PUBLICATIONS (10th, 11th, 12th Year and RT)

1. Select and use FAA and manufacturer's aircraft maintenance specifications, data sheets, manuals, and publications, and related federal aviation regulations (Level 3).

   a) Determine the suitability of a propeller for use with a particular engine - airplane combination.

   b) Determine the minimum diameter of a propeller type and model when used with a particular engine.

   c) Locate aircraft leveline and weighing information.

   d) Determine engine/propeller speed ratios.

   e) The instrument markings required on a specified type and model aircraft.

   f) The purpose and applicability of technical standard orders.

   g) The purpose and applicability of supplemental type certificates.

   h) Identify the useful load and empty weight C.G. of an aircraft by reference to data.

   i) Use FAA specifications and type certificate data sheets.

   j) The applicability and requirements for aircraft airworthiness certificates.

   k) Determine the control surface movement limits of a specified aircraft.

   l) Determine seat locations of an aircraft using aircraft specifications.

   m) Use aircraft listing to find information about aircraft of limited production.

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k) Determine the maintenance classification (major repair, minor repair, preventive maintenance) of servicing landing gear shock struts.

l) Determine the repair classification (major repair, minor repair, preventive maintenance) of repairs to steel tubing structures by welding.

m) Determine the repair classification (major repair, minor repair, preventive maintenance) of replacing the fabric on fabric - covered parts such as wings, fuselages, stabilizers, and control surfaces.

n) The recency of experience requirements for certificated mechanics.

o) The privileges of a mechanic regarding return to service of aircraft after major repairs.

p) Determine the maintenance classification (major repair, minor repair, preventive maintenance) of the replacement of aircraft components with new, rebuilt, or repaired components of similar design.

A written examination is required and practical projects.

1) Service a wheel and tire assembly, and/or a controllable pitch propeller; establish authority to do the work necessary. Refer to Part 65. Classify the work required as to a major repair, minor repair, or preventive maintenance. Refer to Part 43.

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n) The purpose and applicability of FAA airworthiness directives.

o) Use "table of limits" to determine condition of parts.

A written examination as required and practical projects.

1) During the performance of a 100 hour inspection, determine from the aircraft data sheet that the powerplant and propeller combination is correct, also that the diameter of the propeller is within limits.

2) During the weighting of an aircraft make use of the aircraft data sheets to determine the identification of, and location of the leveling means, seat locations, and gross weight.

3) Check instrument marking and placards using aircraft and powerplant data sheets.

4) During engine overhaul make use of manufacturer's instruction manuals and table of limits.

5) Determine the airworthiness of various pieces of equipment by referring to technical standard orders.

6) During the performance of a 100 hour inspection, refer to summary of airworthiness directives for mandatory adherence data sheets for control surface travel.

2. Read technical data (Level 3)

a) Find specified information in technical reports and manuals.

A written examination required and practical projects will be combined with Item "L" Mechanic Privileges and Limitations.

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2) Service a landing gear shock strut and/or remove deep dents, cuts, scars or nicks on an aluminum propeller. Establish authority to do the work necessary. Refer to Part 65, and classify the work required as to a major repair, minor repair, or preventive maintenance. Refer to Part 43.

3) Repair a damaged steel tubing structure and/or overhaul a cylinder. Establish authority to do the work necessary. Refer to Part 65 and classify the work required as to a major repair, minor repair or preventive maintenance.. Refer to Part 43.

4) Recover a control surface and/or remove and service a set of spark plugs. Establish authority to do the work necessary. Refer to Part 65, and classify the work required as to a major repair, minor repair or preventive maintenance. Refer to Part 43.

5) Replace a landing gear shock strut and/or a rebuilt generator. Establish authority to do the work necessary. Refer to Part 65, and classify the work required as to a major repair, minor repair or preventive maintenance. Refer to Part 43.

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II. POWERPLANT THEORY AND MAINTENANCE

A. RECIPROCATING ENGINES (11th, 12th Year and RT)

1. Inspect and repair 14 cylinder or larger radial engine (Level 2).

a) The purpose and advantage of using propeller reduction gearing.

b) The characteristics of thrust bearings used in large radial engines.

c) The characteristics of crankshaft bearings used in large radial engines.

d) The construction characteristics of the crankshaft and rod assemblies for a twin-row radial engine.

e) The loads acting on the power case and nose case of the large radial engine during various conditions of operation.

f) The methods of classifying reciprocating engines.

g) The factors that affect the volumetric efficiency of an engine.

h) Determine the cylinder firing order for various types of engines.

A written examination required and practical projects.

1) Remove, inspect and replace a nose section.

2) Determine the firing order of various types of engines.

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2. Overhaul reciprocating engine (Level 2)

a) The purpose and operating principles of dynamic dampers used in aircraft engine.

b) The characteristics of various crankshaft designs.

c) The basic operating principles of four stroke cycle engines.

d) The characteristics of various piston pin and knuckle pin retention devices.

e) The processes used to harden cylinder bores.

f) The purpose and applicability of choke-type or taper-ground cylinders.

g) The wear characteristics of engine cylinder walls.

h) The purpose of valve overlap in some engines.

i) The effects of various poppet-type valve face angles.

j) The characteristics of various types of valve operating mechanisms.

k) The operating characteristics of zero-lash hydraulic valve lifters.

l) Time engine valves during engine assembly.

m) Install valve guides.

n) Grind and resurface valve and valve seats.

o) The purpose of using relatively large piston-to-cylinder wall clearances in aircraft engines.

p) The indications of failed or failing engine bearings.

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q) The result of operating an engine at high power settings before the lubricating oil has come up to operating temperature.

r) Check piston rings for correct end and side clearance.

s) Check valve stems for stretch.

t) Repair a scored aluminum piston.

u) Perform crankshaft "runout."

v) Prepare engine for disassembly before overhaul.

w) Measure inside diameter, taper, and out-of-round of a cylinder bore.

x) Install cylinders and tighten hold-down nuts.

y) The construction characteristics of air-cooled engine cylinders.

z) The construction characteristics and the operating principles of poppet-type engine valves.

aa) The construction of aircraft engine pistons.

bb) The types and arrangements of piston rings used in aircraft engines.

cc) The purpose of using more than one spring on aircraft engine valves.

dd) The operating principles and construction of spur and pinion-type and planetary type propeller reduction gearing.

ee) The principles of construction and operation of accessory gear drive trains on reciprocating engines.

ff) Inspect cast and forged engine crankcase assemblies.

gg) Remove and install studs in engine crankcase and accessory sections.

A written examination required and practical projects.

1) Overhaul a reciprocating engine.

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3. Inspect, check, service, and repair opposed and radial engines and reciprocating engine installations (Level 3).

   a) Check and adjust engine valve clearances.

   b) Determine the speed and direction of rotation of the cam ring in various radial engines.

   c) The effect of excessive or insufficient valve clearances on engine operation.

   d) The relationship between operating valve clearances and cold valve clearances.

   e) Perform cylinder compression tests.

   f) Perform an ignition system operational check.

   g) Determine the condition of cable-operated engine control systems.

   h) Check and adjust engine idling speed and mixture.

   i) Detect and determine the cause of a "cold" cylinder.

   j) The purpose of establishing one or more critical ranges for certain engine-propeller combinations.

   k) The operating indications of a worn or weak engine.

   l) The effect of a leaking oil dilution valve on engine operation.

   m) The effect of a low oil supply on engine operation.

   n) The indications of a correctly functioning engine oil system.

   o) The probable cause of oil being thrown out of the breather of wet-sump engine.

   p) Determine the source and cause of metallic particles found on the oil screen.

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q) The effect of an unbalanced propeller on engine operation.

r) The power setting most desirable for protracted engine operation.

s) Dilute engine oil in preparation for cold weather starting operations.

t) The purpose and operation principles of engine dynamic suspension systems.

u) Install and time a magneto.

A written examination required and practical projects.

1) Inspect, service, and repair opposed and radial engines.

2) Inspect, service and repair reciprocating engine installation.

3) Install reciprocating engine.

4. Install, troublesheet, and remove reciprocating engines (Level 3).

a) The effect of throttle position upon fuel-air.

b) Pre-oil an overhauled engine before starting.

c) Install air-cooled engine baffles.

d) The method of hoisting or lifting engines during removal and installation.

e) The effect of increased engine manifold pressure on master rod bearing load.

f) The effect of air density on engine power output.

g) The causes of engine backfire.

h) The basic operational sequence for increasing or reducing the power output of an engine equipped with a constant-speed propeller.

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i) The factors that affect an engine's tendency to detonate.

j) The effect of induction system air leaks on engine operation.

k) The indications of a leaking primer system during engine operation.

l) The effect of exhaust back pressure on engine power output.

m) The result of incorrect fuel-air mixture adjustments.

n) The indication and effect of carburetor icing.

o) Operate and adjust mechanical push-pull control system.

A written examination required and practical projects.

1) Install, troubleshoot, and remove reciprocating engine.

2) Operate installed powerplant, adjust controls, check performance to conform with operation manual.

B. TURBINE ENGINES (11th, 12th Year and RT)

1. Overhaul turbine engine (Level 2).

a) The relationship between rotor speed and total thrust of a turbine engine.

b) The relationship between turbine inlet temperature and thrust of a turbine engine.

c) The relationship between operating altitude and thrust of a turbine engine.

d) The operating characteristics of turbine engines equipped with two-spool or "split" compressors.

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e) The operating characteristics of fan and bypass turbine engines.

f) The relative gas pressures in various portions of a turbine engine.

g) The function of the nozzle diaphragm in a turbine engine.

h) The function of the exhaust cone in a turbine engine.

i) The operating characteristics and types of combustion chambers.

j) Remove and install outer combustion chamber case and liners.

k) The methods for disassembling compressor.

l) The function and location of fuel nozzles.

A written examination is required and practical projects.

1) Inspect nozzle diaphragm for cracks, distortion and failure.

2) Remove and inspect the exhaust cone for cracks, damage, or failure to welds and replace.

3) Remove combustion chambers from engine. Remove inner liner and inspect for cracks, burned areas and cross over tubes for excessive heat damage.

2. Inspect, check, service, and repair turbine engine installations. (Level 2)

a) The principles of operation of thrust reversing systems used with turbine engines.

b) The advantages of a gas turbine geared to a propeller.

c) The types of compressors most commonly used in turbine engines.

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d) The construction and operating characteristics of axial-flow compressors.

e) The advantages of the axial-flow compressor over the centrifugal compressor.

f) The function and location of the diffuser section.

g) The basic design of turbine blades.

h) The effect of high ambient temperatures on turbine engine operation.

i) The type failures to which turbine components are subject.

j) The results of excessive operating temperature.

A written examination is required and practical projects.

1) Remove upper compressor case and inspect for damaged blades, nicks and distortion.

2) Remove, install and connect engine controls in a jet aircraft.

3. Install, troubleshoot, and remove turbine engines (Level 2)

a) The operating principles of a turbine engine.

b) The effect of air density on the thrust of a turbine engine.

c) The effect of exhaust nozzle adjustments on turbine engine operation.

d) The method of controlling compressor surge.

e) The purpose and operation of fuel control devices.

f) The cause of hot spots on the outer combustion casing.

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g) The method of insuring ignition in combination chambers not equipped with igniter plugs.

h) Adjust turbine engine fuel controls.

A written examination is required and practical projects.

1) Install exhaust nozzle, check clearance between turbine blade tip and exhaust nozzle.

2) Remove, inspect, replace and adjust controls for fuel control unit. Trim engine.

C. ENGINE INSPECTION (11th, 12th Year and RT)

1. Perform powerplant conformity and airworthiness inspections (Level 3).

a) Determine that applicable airworthiness directives are complied with.

b) Determine that the powerplant conforms with the applicable FAA specification.

A written examination is required and practical projects.

1) Students will perform powerplant conformity and airworthiness inspection as part of the 100 Hour inspection.

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III. POWERPLANT SYSTEMS AND COMPONENTS

A. ENGINE INSTRUMENT SYSTEMS (11th, 12th Year and RT)

1. Troubleshoot, service, and repair fluid rate-of-flow indicating systems (Level 2).

a) The purpose and operating principles of a fuel-flow indicating system.

b) The relationship between fuel flow and the power output of an engine.

A written examination is required and practical projects.

1) Trace and troubleshoot the electrical wiring for a fuel flow indicating gauge and transmitter.

2. Inspect, check, service, troubleshoot, and repair engine temperature, pressure, and RPM indicating systems (Level 3).

a) The operating principles of thermo-couple-type temperature indicating systems.

b) The effect of a broken or leaking manifold pressure gauge line.

c) The operating principles of engine oil temperature indicating systems.

d) The purpose and operating principles of a manifold pressure indicating system.

e) The operating principles of engine oil temperature indicating systems.

f) Apply markings to the glass face of engine instruments.

g) Install tachometer drives.

h) Determine the reason for failure of an electric tachometer system.

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i) The requirements for a carburetor air temperature indicating system.

j) Determine the reason for an off-scale reading of a ratiometer-type indicating system.

k) Determine the cause of erratic indications when using a thermo-couple system.

l) The purpose and operating principles of fuel pressure warning systems.

m) The installation practices for thermo-couple leads.

n) The operation and use of synchronous motors.

o) Measure the resistance of thermocouple leads.

p) Determine the cause of an inverse reading in a thermocouple temperature indicating system.

q) Identify the types and application of thermocouples used to indicate turbine engine temperatures.

A written examination is required and practical projects.

1) Inspect, check, service, troubleshoot and repair engine temperature, pressure and tachometer (RPM) indicating systems.

B. ENGINE FIRE PROTECTION SYSTEMS (12th Year and RT)

1. Inspect, check, service, troubleshoot, and repair engine fire detection and extinguishing systems (Level 3).

a) Check continuity and resistance of the electrical circuit.

b) Determine the causes of system malfunction.

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c) The methods used to release the extinguishing agent.

d) The sensing devices used in the detection systems.

A written examination is required and practical projects.

1) Inspect, check, service, troubleshoot and repair engine fire extinguishing systems.

C. ENGINE ELECTRICAL SYSTEMS (10th, 11th, 12th Year and RT)

1. Repair engine electrical system components. (Level 2)

a) Check the condition of shunt and compound generator field circuits.

b) Locate and use overhaul information for electrical equipment.

c) The procedures for correcting generator brush arcing.

d) Check a motor or generator armature to determine that the windings are not grounded.

e) Smooth the commutator surface of a motor or generator armature.

f) Determine the cause of solder deposits on the armature cover plate of a generator.

g) The purpose of a ripple filter in a generator power circuit.

h) The type of electric motor used with direct-cranking engine starters.

i) The types of voltage regulators used with high output direct current generators.

j) The results of short or open circuits in a generator control circuit.

k) The effect of sticking points in a reverse-current cutout relay.

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l) The method of providing and controlling the field current of aircraft generators.

m) The methods of controlling parallel direct current generators.

n) The methods used to control output frequency and voltage of alternating current generators.

o) The methods of reducing armature reaction in aircraft generators.

p) The methods of controlling current and voltage output of compound direct current generators.

q) The operating principles of carbon-pile voltage regulators.

r) The operating characteristics of series-wound direct current electric motors.

s) The purpose and operation of reverse-current cutout relays in generator control circuits.

t) The general operating characteristics of vibrator-type current and voltage regulators.

u) Flash a generator field.

v) The effect of changes in speed and load on generator output.

w) The design factors that determine the number of cycles per revolution an alternating current generator will produce.

x) The factors that effect the torque produced by an electric motor.

y) The function of a commutator in a direct current electric motor.

z) Determine the output frequency of an alternating current generator.

aa) The methods used to protect armature shafts from overloads.

bb) Seat new or replacement generator brushes.

cc) The effect of incorrect generator brush spring tension on generator operation.

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dd) The speed and load characteristics of series, compound, and shunt-wound electric motors.

ee) The basic principles of electric generators.

ff) The basic internal electrical circuits of series, compound, and shunt-wound generators.

gg) The applicability and use of intermittent duty electric motors.

hh) The operating principles of magnetic clutches and brakes commonly used with electric motors.

ii) The requirements and methods for controlling a malfunctioning generator.

jj) The purpose and operation of reversible electric motors.

A written examination is required and practical projects.

1) Overhaul and functionally test a D.C. generator.

2) Remove and overhaul a flap actuator motor.

3) Install and perform an operational check of an alternator.

4) Troubleshoot and correct alternator failure.

5) Troubleshoot an inoperative inverter.

6) Troubleshoot output of a transformer rectifier unit.

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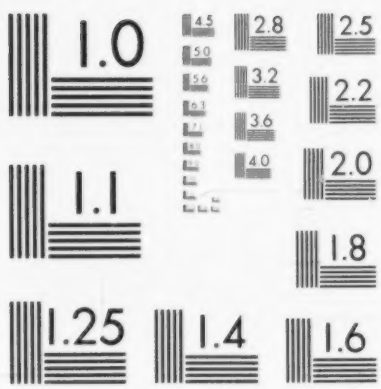

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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2. Install, check, and service engine electrical wiring, controls, switches, indicators, and protective devices. (Level 3)

   a) The purpose, applicability, and operation of electrical fuses and circuit breakers.

   b) The types of electrical switches and their operation.

   c) Install and wire electrical switches.

   d) Splice wiring in engine electrical systems.

   e) The characteristics of high-tension and low-tension electrical wiring.

   f) The purpose, applicability, and use of electrical wiring terminal strips.

   g) The criteria for selecting aluminum and copper electrical cables.

   h) Replace terminals on aircraft aluminum and copper electrical cables.

   i) Types of switches and circuits used to control reversible electric motors.

   j) Identify aircraft electric cables.

   k) Determine the current-carrying capacity of an electrical circuit.

   l) Install electrical wiring in conduits.

   m) Use electric cable selection chart for determining the correct cable to use in specified circumstances.

   n) The strength requirements for electric cable terminals.

   o) Select and install electrical bonding jumpers.

   p) The installation and wiring of solenoid operated switches.

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q) The characteristics of single-wire electrical systems.

r) The use of quick-disconnect electrical plugs and sockets.

s) The American Wire Gauge (A.W.G.) system of designating electrical wire sizes.

t) The cause and effect of solenoid switch chatter.

u) The method of providing direct current for battery charging on aircraft that operate only alternating current generators.

v) The maximum permissible continuous load on the electrical system.

w) The sources of alternating current power in aircraft that operate only direct current generators.

x) The operating principles and characteristics of transformers.

y) Determine the approximate continuous load on an aircraft electrical system.

A written examination is required and practical projects.

1) Wire A.C. and D.C. electrical system mock-up.

2) Inspect, service and trouble shoot A.C. and D.C. generator regulating system.

3) Inspect, service and troubleshoot an engine starting system.

4) Install and adjust the limit switches for various actuators; example: cowl flaps and oil cooler door actuators.

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5) Check 3 phase alternators for proper phasing in parallel installation on a bus.

6) Connect the alternator and adjust the voltage and frequency output.

D. LUBRICATION SYSTEMS (11th, 12th Year and RT)

1. Identify and select lubricants (Level 2)

a) The desirable characteristics for aircraft engine lubricating oils.

b) The meaning and importance of oil viscosity.

c) The meaning and significance of oil flash point.

d) The purpose of using synthetic lubricants for turbine engines.

e) The effect of heat on lubricants.

f) The grade designations for aviation oils.

g) The designations for synthetic turbine oil.

h) The results of operating an engine using an incorrect lubricant.

i) The functions of engine oil in addition to lubricating the engine.

A written examination is required and practical projects.

1) Service the lubricating system.

2) Adjust the oil pressure relief valve.

2. Repair engine lubrication system components (Level 2)

a) Clean and repair aluminum alloy external oil lines.

b) Clean external lubrication system components.

c) The function and location of an oil temprature regulator.

d) The size requirement for the oil inlet line.

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e) Clean and test oil tanks.

f) The purpose and operation of the oil cooler.

g) The operating principles of lubrication pumps.

A written examination is required and practical projects.

1) Clean and repair aluminum alloy external oil lines.

2) Clean and test oil tanks.

3) Install an oil line from the tank to the inlet of the pump.

4) Remove, disassemble, inspect, and replace the engine oil pump.

3. Inspect, check, service, troubleshoot, and repair engine lubrication systems (Level 3).

a) Determine source and cause of metallic particles in the lubricating oil.

b) The purpose and principles of operation of engine oil dilution systems.

c) The expansion space requirements for engine oil supply tanks.

d) The purpose for changing engine lubricating oil at specified intervals.

e) The type of lubrication system generally used in high volume reciprocating engines.

f) The factors that effect the oil consumption of a reciprocating engine.

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g) The method normally used to prevent excessive oil from accumulating in the cylinders of inverted engines or the lower cylinders of radial engines.

h) The method of controlling the oil film on cylinder walls.

i) The method of lubricating the valve-operating mechanism in an overhead-valve engine.

j) The venting requirements of dry-sump and wet-sump engine lubrication systems.

k) The effect of broken or leaking lines in various parts of the lubrication system.

l) The effect of engine wear on the operation of the lubrication system.

m) The operating indications of a low engine oil supply.

n) The method of maintaining a reserve supply of oil in the engine oil supply tank for use in propeller feathering.

o) The requirements for marking oil tank fillers.

p) The purpose and operating principles of the lubrication system pressure-relief valve.

q) The purpose and operation of the oil cooler bypass valve.

r) The effect of congealed oil in the heat exchange portion of an oil radiator.

s) The purpose, location, and operation of anti-sludge chambers in the lubrication system of a reciprocating engine.

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t) The purpose and operation of the bypass feature built into most engine oil filtering systems.

u) The operating principles of the stacked disc, edge filtration type of filter.

v) The characteristics and operating principles of dry-sump and wet-sump engine lubricating systems.

w) The purpose, location, and operation of the oil separator.

x) Adjust engine oil pressure.

y) The purpose of the restricted orifice in the oil pressure gage line.

z) The effect of obstructed rocker box inter-cylinder oil drain lines on engine operation.

aa) The characteristics and principles of operation of a radial engine oil scavenging system.

A written examination is required and practical projects.

1) Remove, clean, inspect and replace main oil screen and disc type filter.

2) Install and fit various ring combinations on pistons.

3) Placard engine oil tank fillers.

4) Adjust oil pressure relief valve.

5) Clean and service oil cooler and by-pass valve.

6) Fabricate an oil pressure gauge line and check snubber.

7) Clean oil sludge chambers in a crankshaft.

8) Disassemble, clean, inspect and measure a scavenger pump.

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E. IGNITION SYSTEMS (11th, 12th Year and RT)

1. Overhaul magneto and ignition harness (Level 2).

a) The construction characteristics of magneto main case housings.

b) The characteristics and construction materials of magneto pole shoes or coil core extensions.

c) The purpose and methods of ventilating aircraft magneto housings.

d) The materials used in the construction of magneto breaker points.

e) The purpose and use of "keepers" placed across the poles of a rotating magnet that has been removed from a magneto.

f) Check the strength of a rotating magnet installed in a magneto.

g) Internally time a magneto during assembly.

h) Determine the rotational speed of a magneto when installed on various types of engines.

i) The purpose and location of condensers in a magneto electrical circuit.

j) Determine the condition of magneto breaker points by visual indications.

k) Lubricate a magneto breaker cam.

l) The effect of cam-follower wear on pivot and pivotless type breaker point assemblies.

m) The meaning of the term "E-Gap Angle."

n) The characteristics of the rotating magnets commonly used in aircraft magnetos.

o) Install and adjust breaker points.

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p) The characteristics of cams used in aircraft magnetos to operate the breaker points.

q) The purpose of setting ignition cables in a plastic insulating material within some ignition harnesses.

r) Install high-tension ignition cables in a shielded ignition manifold.

s) The purpose and operation of impulse couplings used with aircraft magnetos.

t) The results of operating a magneto with a broken impulse coupling spring.

u) The methods used to secure ignition leads in harnesses and distributor blocks.

v) Measure breaker point spring tension.

A written examination is required and practical projects.

1) Overhaul, inspect and functionally test a magneto.

2. Repair engine ignition system components (Level 2).

a) The purpose and operation of magneto breaker points.

b) Measure the capacity of a condenser.

c) Check ignition coil windings for shorts or open circuits.

d) Locate and use data associated with ignition system components.

e) The effect of weak magnets on engine operation.

f) The effect of weak breaker point spring tension on engine operation.

g) Clean and inspect spark plugs and igniter plugs.

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h) Adjust spark plug electrodes.

i) The precautions to observe when working with high-energy ignition systems.

j) Determine that a distributor is internally timed.

k) The effect of high resistance in an ignition lead on engine operation.

l) The function and characteristics of ignition harnesses.

m) Determine the continuity of ignition wiring.

n) The construction and operation of a transformer coil for low-tension ignition systems.

A written examination is required and practical projects.

1) During magneto overhaul inspect and measure the capacity of a condenser.

2) During magneto overhaul locate and use data associated with ignition system components.

3. Inspect, check, service, troubleshoot, and repair reciprocating and turbine engine ignition systems. (Level 3).

a) The purpose of shielding aircraft engine ignition systems.

b) The purpose and principles of staggered ignition timing.

c) Install and time an ignition system distributor.

d) Recognize and interpret basic ignition analyzer patterns.

e) The purpose and operating principles of spark advance systems.

f) The effect of using condensers of incorrect capacity in an ignition system.

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g) The operating principles of low-tension ignition systems.

h) The effect a shorted primary winding in a low-tension ignition coil has on engine operation.

i) Install and test magneto ignition switches.

j) Test an ignition harness for electrical leakage.

k) The purpose and principles of compensated ignition timing.

l) The operating periods of turbine engine ignition systems.

m) The results of using a spark plug of incorrect heat range in an engine.

n) Install and remove spark plugs.

o) The meaning of "reach" as applied to spark plug design.

p) Inspect spark plugs for damaged insulation.

q) The cause and effect of various types of spark plug fouling.

r) The purpose and operation of an ignition booster system.

s) The purpose and operation of an induction vibrator.

t) Install and time a magneto equipped with an impulse coupling.

A written examination is required and practical projects.

1) Replace a defective wire in an ignition harness.

2) Clean, inspect and test a set of spark plugs.

3) Bench time a magneto.

4) Hi-potential test the ignition harness for shorts and continuity.

5) Install and time a distributor for a low and high tension ignition system.

6) Install and wire an ignition switch.

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7) Remove, inspect and install a set of spark plugs.

8) Install and time a magneto.

9) Remove, inspect and install a jet engine igniter.

F. FUEL METERING SYSTEMS (11th, 12th Year and RT)

1. Inspect, check and service water injection systems (Level 1).

a) The purpose and effect of injecting water or water-alcohol during periods of high engine power output.

b) The means used to prevent the freezing of the water or ADI liquid.

c) The effect of atmospheric humidity on engine power when using water injection.

d) The effect of exhausting the water supply during take off operations utilizing water injection.

e) The purpose and effect of the derichment valve in the water-alcohol injection system.

f) The results of detonation within an engine.

g) The procedure to follow when detonation occurs.

h) The factor that determines the amount of water flow during ADI operation.

i) The method for preventing corrosion of lines and fittings.

j) The purpose of the oil-pressure operated valve in the ADI system.

A written examination appropriate to the above subject will be used to determine the degree of learning by the students.

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2. Overhaul carburetor (Level 2).

a) The fuel metering forces of a conventional float-type carburetor and a pressure-type carburetor.

b) The relationship between carburetor venturi size and engine displacement volume.

c) The fuel-air mixture requirements of an engine during idling and during high power setting.

d) The operation of the idling system of a float type carburetor and a pressure-type carburetor.

e) The effect of a clogged main air bleed in a float-type carburetor on engine operation.

f) Check and adjust the float level of a float type carburetor.

g) The effect of an incorrectly adjusted float level on engine operation.

h) The effect of a worn or grooved needle valve and seat assembly in a float-type carburetor on engine operation.

i) The operating principles of a back-suction type mixture control.

j) The operating principles of an automatic mixture control.

k) The operating principles of economizer systems in float-type carburetors.

l) The effect of a ruptured diaphragm in a pressure-type carburetor on engine operation.

m) The basic function of a manual mixture control in an aircraft carburetor.

n) The location and operating of discharge nozzle used with pressure carburetor.

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A written examination required and practical projects.

1) Overhaul a float type carburetor.

2) Inspect and adjust the idle speed and mixture of a pressure carburetor.

3) Service and adjust various types of mixture controls.

3. Repair engine fuel metering system components (Level 2).

a) The operating principles of piston-type and single and double-diaphragm acceleration pumps.

b) The operating principles of direct fuel injection systems.

c) The purpose and operation of a venturi.

d) The function of a metering jet.

e) The purpose of an air bleed in a carburetor.

f) The purpose of an economizer valve in a carburetor.

g) Clean carburetor parts.

h) Repair a leaking float.

i) The adjustments that may be made on a pressure injection carburetor.

j) The effect of clogged impact tubes on engine operation.

k) The function of the synchronizer bar on fuel injection equipped engines.

l) The function and operation of the main and idling air bleed systems in a float-type carburetor.

A written examination required and practical projects.

1) Overhaul a float-type carburetor.

2) Perform a line maintenance inspection and adjustment to a pressure injection carburetor.

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4. Inspect, check, service, trouble-shoot, and repair reciprocating and turbine engine fuel metering systems (Level 3).

   a) Adjust idling speed and mixture.

   b) The principles of operation of an automatic fuel control unit used on a turbojet engine.

   c) Trim turbojet engine fuel control system.

   d) The effect of increased altitude on engine fuel air mixture.

   e) The relative burning rates of various fuel air mixtures.

   f) The fuel-air mixture requirements of a reciprocating engine at various power settings.

   g) The operating characteristics of engines with direct cylinder fuel injection systems.

   h) Install, remove, and adjust direct cylinder fuel injection system components.

   i) The difference between a fuel injection system and a fuel injection carburetor.

   j) The cause of lean mixtures in a conventional carburetor system.

   k) The effect an inoperative vapor vent in a pressure-type carburetor has on engine operation.

   l) The factors that affect the density of the air entering the carburetor.

A written examination required and practical projects.

   1) Adjust idling speed and mixture.

   2) Adjust fuel control linkage for positive fuel cut-off and idle position on a fuel control unit.

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3) Install, remove, and adjust direct cylinder fuel injection system components.

4) Check, and service a vapor separator on a pressure injection carburetor.

G. ENGINE FUEL SYSTEMS (11th, 12th Year and RT)

1. Repair engine fuel system components (Level 2)

a) The types of engine-driven fuel pumps generally used with large reciprocating engines.

b) The purpose and operation of a fuel pump bypass valve.

c) The purpose and operation of fuel boost pumps.

A written examination is required and practical projects.

1) Remove, inspect, install and adjust an engine driven fuel pump.

2) Use fuel booster pump for starting engine.

2. Inspect, check, service, trouble-shoot, and repair engine fuel systems. (Level 3).

a) The causes of fuel pressure fluctation.

b) The characteristics of centrifugal-type fuel boost pumps.

c) The fuel system requirements for aircraft certificated in the "standard" classification.

d) The usual sources of aircraft fuel system contamination.

e) The purpose and requirements for strainers in fuel tank outlets.

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f) Inspect aircraft fuel tank sumps and fuel strainers.

g) Adjust engine-driven fuel pump output pressure.

h) The location and operation of main fuel strainers.

i) The causes and effects of fuel system vapor lock.

j) The location and operation of fuel valves.

A written examination is required and practical projects.

1) Ground operate and service a reciprocating engine.

2) During run-up preflight a reciprocating engine.

3) Adjust engine driven fuel pump output pressure.

4) Remove, clean and inspect the fuel sump and strainers.

H. INDUCTION SYSTEMS (11th, 12th Year and RT)

1. Inspect, check, troubleshoot, service, and repair engine ice and rain control systems (Level 2).

a) The principles of alcohol injection to control induction system icing.

b) The effect of ice within the induction system on engine operation.

c) The operating principles of carburetor air heaters used to prevent or eliminate ice in an engine induction system.

d) The method used to prevent the entry of rain into the induction system of a reciprocating engine.

e) The operating principles of electrically heated inlet ducts.

f) The use of engine bleed air to control engine inlet icing.

g) The causes of carburetor and induction system icing.

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A written examination is required and practical projects.

1) Install and adjust a carburetor heat system.

2) Remove, clean, inspect and install induction system screen.

2. Inspect, check, service, and repair heat exchangers and superchargers (Level 2).

a) The effect of using heated air during periods of high engine power output.

b) The pressures present in various portions of the induction system of supercharged and unsupercharged reciprocating engines.

c) The principles of operation and control of turbo superchargers.

d) The principles of operation and control of integral superchargers.

e) The purpose and operation of the induction system impeller used in some radial engines.

A written examination is required and practical projects.

1) During ground operation of an engine operate the carburetor heat valve.

2) Inspect the impeller of a radial engine.

3) Remove, clean, inspect and install an intake pipe.

3. Inspect, check, service, and repair carburetor air intake and induction manifolds (Level 3).

a) The position of the carburetor heat control during engine starting.

b) The purpose and location of the induction system screen in a reciprocating engine.

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_____ Principal

c) The purpose and location of the "hot spot" heater in the induction system of some reciprocating engines.

d) The installation and operation of a multi-point priming system on a radial engine.

e) The purpose, location, and servicing requirements for carburetor air filters.

f) The purpose and operation of RAM air intake ducts on reciprocating engines.

A written examination is required and practical projects.

1) Functionally test an engine.

2) Remove, clean and inspect carburetor air filters.

3) Fabricate and install a primer line.

4) Remove, clean and inspect the RAM air intake ducts.

I. ENGINE COOLING SYSTEMS (11th, 12th Year and RT)

1. Repair engine cooling system components (Level 2)

a) The attachment of cylinder head baffles.

b) The material used in the construction of air baffles.

c) Reprofile cylinder fins.

d) The effect of valve adjustment on the heat rejection rate of an engine.

A written examination is required and practical projects.

1) Remove and replace intercylinder baffles.

2) Remove and replace head baffles.

3) Repair a broken cylinder head fin.

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2. Inspect, check, troubleshoot, service, and repair engine cooling system (Level 3).

   a) The operating principles of the cooling system of vertically installed air-cooled helicopter engine.

   b) The effects of excessive heat in an aircraft engine.

   c) The purpose of fins on engine cylinders.

   d) The effect of incorrectly installed baffles on engine operation.

   e) The function and operation of cowl flaps.

   f) The effect of fuel-air ratio on engine cooling.

   g) The purpose and operation of cooling air augmenting systems.

   h) The principles of "pressure baffling" used in cooling aircraft engines.

   i) The precautions necessary during ground operation of aircraft engines.

A written examination is required and practical projects.

1) Remove, inspect and service cowl flaps.

2) Remove, inspect, service and install accessory cooling augmenting systems.

3) During ground operation of aircraft engines perform the following precautions

   (a) Fire Protection

   (b) Fuel Handling

   (c) Propeller Guards

   (d) Chocks and Brakes

   (e) Control of Engine Temperature with use of cowl flaps and wind direction

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J. ENGINE EXHAUST SYSTEMS (11th, 12th Year and RT)

1. Repair engine exhaust system components (Level 2)

a) The construction characteristics of exhaust augmenter tubes.

b) The materials used in exhaust system components.

c) The technique for cleaning ceramic coated exhaust pipes.

d) Detect and repair cracks in stainless steel exhaust pipes.

e) The methods used to compensate for the unequal expansion rate of exhaust system components.

A written examination is required and practical projects.

1) Remove, inspect, service and install exhaust augmenter tubes.

2) Remove, inspect and repair stainless steel exhaust pipes, both ball joint and straight types.

2. Inspect, check, troubleshoot, service, and repair exhaust systems (Level 3)

a) Inspect exhaust systems that utilize an exhaust heat exchanger.

b) The purpose and operating principles of the turbines driven by the exhaust gases of a turbo-compound engine.

c) The function and location of exhaust augmenters.

d) The cause and effect of "frozen" ball joints in an exhaust system.

e) Clean and test exhaust-type heating muffs.

f) The methods for torquing exhaust system clamps.

g) The purpose and construction of exhaust gas noise suppressors.

h) The effect of exhaust gas leakage on system components.

i) The purpose and operation of engine thrust reversers.

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A written examination is required and practical projects.

1) Clean and test exhaust-type heating muffs.

2) Remove, clean, inspect and install exhaust collector rings.

3) Inspect exhaust system that utilize an exhaust heat exchanger.

K. PROPELLERS (11th, 12th Year and RT)

1. Inspect, check, service, and repair propeller synchronizing and ice systems (Level 1)

a) The purpose of slinger rings on some propeller installations.

b) The method of preventing ice formation on propeller spinners.

c) The operating principles of electrical de-icing systems for propellers.

d) The purpose of the governor step motor in the synchronizing system.

e) The purpose of propeller synchronizing systems.

f) The operating principles of synchronizing systems.

g) The operating principles of fluid anti-icing systems.

A written examination only is required.

2. Identify and select propeller lubricants (Level 2).

a) The principal requirements for propeller lubricants.

b) The factors to be considered in selecting an oil or grease for a particular application.

A written examination is required and practical projects.

1) Remove counterweights, clean (consult manufacturer's maintenance manual for proper grease) lubricate install.

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3. Balance propellers (Level 2).

   a) The effects of propeller unbalance on engine operation.

   b) Detect and correct vertical and horizontal unbalance in a two-blade propeller.

   c) Balance a two-blade propeller that uses a separate hub for mounting on the engine crankshaft.

   A written examination is required and practical projects.

   1) Balance a two-blade propeller that uses a separate hub for mounting on the engine crankshaft.

4. Repair propeller control system components (Level 2).

   a) Install oil control plugs in governors.

   b) Use manufacturer's data to repair components.

   c) The purpose and operation of a propeller governor.

   d) The forces acting on a governor to produce speed control.

   e) Determine the direction of rotation for which a propeller governor is set.

   A written examination is required and practical projects.

   1) Install oil control plugs in governor mock-up.

5. Inspect, check, service, and repair fixed pitch, constant-speed, and feathering propellers, and propeller governing systems (Level 3).

   a) The purpose and function of the parts of a propeller.

   b) The aerodynamic forces and loads acting on a rotating propeller blade.

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c) The operating principles of propeller controls used with turbine engines.

d) The meaning and significance of "static limits" as related to the installation of a fixed-pitch propeller.

e) The purpose of the metal tipping on a wood propeller.

f) Measure propeller blade angle.

g) The meaning of propeller blade "back" and "face."

h) The method of making changes in the speed and power output of an engine equipped with a constant-speed propeller.

i) The operation of the distributor valve assembly of a hydromatic propeller.

j) The normal position of a constant-speed propeller during take-off.

k) The effect on engine operation of changing propeller pitch settings before a steady oil pressure is obtained after engine starting.

l) The meaning and significance of "critical ranges" established for some engine-propeller combinations.

m) The operation of a propeller during the feathering cycle.

n) The operation of a propeller during the reversing cycle.

o) The purpose of placing a propeller in a specified position prior to stopping the engine.

p) The relationship between blade position, airspeed, and angle of attack of the propeller blades.

q) The operating principles of two-position and constant-speed counterweight propellers.

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r) The method of lubricating the pitch-changing mechanism of a hydromatic propeller.

s) The method of checking a steel propeller hub or blade for cracks.

t) The general procedure to be followed when using the chemical etching process to inspect aluminum alloy propeller blades.

u) Determine whether a bent aluminum alloy propeller blade can be repaired by cold straightening.

v) Clean and protect aluminum propeller blades.

w) The procedure for treating minor nicks and scratches on aluminum propeller blades.

x) Determine the blade pitch stop settings on a variable-pitch propeller.

y) The operating forces used to make blade pitch changes on various types of variable pitch propellers.

z) The location and purpose of propeller blade cuffs.

A written examination is required and practical projects.

1) Measure blade angle.

2) Place blades in high pitch and check condition of piston.

3) Remove nicks and scratches from the metal tip of a wood propeller.

4) Check the settings of the counterweights for maximum blade angle.

5) Remove the dome, inspect the pitch changing mechanism, lubricate, and install dome.

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6) During ground run-up operate propeller through complete range.

7) Magnaflux a steel propeller blade.

8) Using caustic soda, etch an aluminum propeller blade.

9) By reference to AC43.13-1 manual, determine if a blade of an aluminum propeller can be repaired.

6. Install, troubleshoot, and remove propellers (Level 3)

a) Perform an operational check of propeller feathering system.

b) Detect and correct front and rear cone bottoming of a propeller installed on a splined crankshaft.

c) The purpose and use of snap rings on propeller installations.

d) The purpose and use of propeller cones in some propeller installations.

e) Determine the amount of contact between a tapered crankshaft and the propeller hub.

f) Install and track a fixed-pitch and constant-speed propeller.

g) Detect and correct looseness in a cable-operated propeller control system.

h) The most likely indications of a damaged piston-to-dome seal in a hydromatic propeller.

i) The most likely cause of oil leakage around the rear cone of a hydromatic propeller.

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j) Perform an operational check of a propeller reversing system.

k) The constant-speed propeller setting used when checking ignition systems.

l) Adjust a propeller governor so that the propeller will operate within the correct range.

m) The purpose and significance of preloading the pitch-changing mechanism in a hydromatic propeller.

A written examination is required and practical projects.

1) Perform an operational check of propeller feathering system.

2) Remove a constant speed propeller, and check front and rear cones for proper seating.

3) Install and track a fixed pitch and constant-speed propeller.

4) Adjust governor control cable for proper stops and tension.

5) Remove hydromatic dome. Inspect condition of seal and replace dome.

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7. FACILITIES

POWERPLANT TECHNICIAN CURRICULUM

The following is a brief description of the powerplant facilities. Each shop is provided with sufficient working space and appropriate benches, part racks, etc. to enable each student to have unrestricted and uncrowded working conditions. Degreasing, washing and sandblasting equipment including air and water are provided. Sufficient engines, magnetos, starters, generators, carburetors, propellers, precision measuring tools, etc., are provided to enable each student to work under the proper student - equipment ratio. The powerplant equipment is complete enough to permit the actual overhaul of most powerplants and their accessories.

Suitable and separate space with either permanent, portable, or mobile test stands and test clubs for operating engines is provided.

All space, equipment, supplies, etc., exceed the amount required by the FAA.

Suitable storage facilities are available in each shop for tools, supplies, materials and equipment.

10TH YEAR POWERPLANT

ROOM 608) 1620 square feet each — 3240 sq. ft.

612) Electric Shop

School _____ Date _____

Principal _____

11TH YEAR POWERPLANT

ROOM 111)-	1620 Sq. ft. each	3240 Sq. ft.
115)-	Accessory Shop	
211)	1620 Sq. ft. each	3240 Sq. ft.
215)	Electric Shop	
311)	1620 Sq. ft. each	3240 Sq. ft.
315)	Machine Shop	
313	Maintenance Machine Shop	600 Sq. ft.
110)	1620 Sq. ft. each	3240 Sq. ft.
112)	Hydraulic Shop	
408)	1944 Sq. ft. each	7776 Sq. ft.
410)		
411)	Basic Powerplant	
415)		

12TH YEAR POWERPLANTS

B-10)	1944 Sq. ft. each	5832 Sq. ft.
B-12)	Advanced Powerplant	
412)		
B-11	Propeller Shop	1944 Sq. ft.
B-15	Jet Powerplant Shop	1944 Sq. ft.
B-1	Test Cell	1800 Sq. ft.
	TOTAL SHOP AREA	36,096 Sq. ft.

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MECHANICAL DRAWING

Room 534)	1500 Sq. ft. each	4500 Sq. ft.
536)		
538)		

BASIC SCIENCE

634)	1500 Sq. ft. each	4500 Sq. ft.
636)		
638)		

RELATED TECHNOLOGY

Ten (10) Rooms Used	15000 Sq. ft.
TOTAL RELATED TECHNICAL AREA	24000 Sq. ft.

Class rooms are separate from shops and fully enclosed.

School _____ Date _____

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8. INSTRUCTIONAL EQUIPMENT REQUIREMENTS

FAR PART NO. 147 SUBSECTION 147.17

The following is a list of powerplant instructional equipment presently being used in aviation high school. All equipment, etc. exceed the amount required by the FAA.

Amount	Name of Equipment				
8	Powerplant	Ranger	Model	No.	R 440
12	"	Continental	"	"	W 670
12	"	Jacobs	"	"	R 755
1	"	Curtiss Wright	"	"	R 3350
2	"	Pratt & Whitney	"	"	R 2800
32	"	" "	"	"	R 1340
7	"	" "	"	"	R 985
32	"	Lycoming	"	"	R 680
2	"	Continental	"	"	O
4	"	Lycoming	"	"	O 540
4	"	Franklin	"	"	O
3	Turbo Prop				
9	Turbo Jet				
2	Aircraft	Twin Beech Model D-18S (used for starting - run-up and stopping procedures)			
2	Powerplants Model R-985				
6	Propellers - Wood - (Sensenich - Flatrop - Hartzell)				
12	Propellers - Wood Test Clubs (Various Sizes) Sensenich				
4	Propellers - Metal - Fixed Pitch (McCauley - Sensenich)				

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School _____ Date _____

Principal _____

Amount	Name of Equipment
6	Propellers - Metal - Ground Adjustable (Hamilton Standard)
1	" " - Controllable (Beech)
2	" Plastic Controllable (Hartzell)
8	" Metal - Constant Speed (Hamilton Standard)
6	" " Hydromatic " "
2	" " Electric (Curtiss Wright)
4	" " Constant Speed (Automatic) (Aero Products)
4	" " Turbo Propellers
12	Propeller Governors (Hamilton Standard/Woodward)
120	High Tension Magnetos (Bendix - A.M.Bosch-Eiseman)
1	Low Tension Ignition System (Operational Mock-up)
120	Carburetors (Float Type) Various Makes
25	" (Pressure Injection) Various Makes
2	Fuel Injection Systems
80	Starters (Electric)
30	Fuel Pumps (Vane & Diaphragm)
2	Fuel System Mock-Up (Pressure Operational Models)
6	Electric Test Panels
10	Rectifiers
60	Electric Circuit Boards
2	Cut-Away (R-2800)
1	Cut-Away (R-440)

#7576

Central

AVIATION HIGH SCHOOL — Principal.
PERRY HOMES, PRINCIPAL

(Principal)

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MATERIALS, TOOLS AND SHOP EQUIPMENT

Maintenance and hand tools appropriate to the area of instruction are provided in sufficient quantity as is nece necessary to repair and maintain engines.

SUMMARY OF SHOP EQUIPMENT AND LOCATION

EQUIPMENT	LOCATION																	
	B1	B10	B11	B12	B15	111	115	211	215	311	313	315	408	410	411	415	608	612
Accessory Shops																		
Ignition Test Bench (Sprague)						1	1											
Ignition Analyzer						1	1											
Ignition Harness Tester						1	1											
Starter Test Bench						1	1											
Growler						1	1											
Time-Rite Indicator						4	4											
A.P.U.						1	1											
Spark Plug Cleaner and Tester						1	1											
Grinder (Pedestal)						1	1											
Lathe						1	1											
Arbor Press						1	1											
Drill Press ½"						1	1											
Condenser Tester						1	1											
Carburetor Float Test Bench						1	1											
Low Tension Ignition System (Mock-Up)						1												
Benches						6	6											
Storage Cabinet (Flammable)						1	1											
Electric Shops																		
Battery Charger								1	1		1	1						
Generator Test Stand								1	1		1	1						
Electric Test Bench								1	1		1	1						
D.C. Electric Mock-Up								1	1		1	1						
A.C. Electric Mock-Up								1	1		1	1						
Electric Distribution System Mock-Up								1	1		1	1						
Commutator Undercutter								1	1		1	1						
Benches						6	6	6	6									
Storage Cabinet (Flammable)											1	1						

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AVIATION-TECHNICAL SCHOOL
FRANKLINBURG, PENNSYLVANIA

Revised by
(Principal)

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SUMMARY OF SHOP EQUIPMENT AND LOCATION

EQUIPMENT	LOCATION																	
	B1	B10	B11	B12	315	111	115	211	215	311	313	315	408	410	411	415	608	612
Machine Shops																		
Drill Press										3	1	3						
Gas Furnace										1	1	1						
Grinder (Pedestal)										1	1	1						
Grinder (Surface)										1	1	1						
Grinder (Universal)											1							
Jig Borer											1							
Lathe										24	2	24						
Milling Machine										2	1	2						
Power Hack Saw										1	1	1						
Shaper										1	1	1						
Storage Cabinet (Flammable)										1	1	1						
Bench										1	1	1						
Powerplant Shops																		
Arbor Press		1	1	1	1	1	1						1	1	1	1		
Cylinder Hone		1																
Degreasing Tanks (Hot)		1		1	1													
Degreasing Tanks (Cold)		1		1	1								1	1	1	1		
Drill Press ½"		1		1	1								1	1	1	1		
Engine Parts Rack		6		6														
Engine Overhaul Stand		12		12									12	12	12	12		
Grinder (Pedestal)		1		1	1								1	1	1	1		
Lathe		1		1	1	1	1						1	1	1	1		
Electronic Drill		1																
Overhead Rail Block & Tackle		1		1	1								1	1	1	1		
Magnaflux Machine		1		1														
Sandblast Equipment		1		1														
Time-Rite Indicator		4		4		8	8						8	8	8	8		
Valve Refacing Machine		1		1									1	1	1	1		
Valve Seat Grinder		1		1														
Zyglow Equipment		1		1														
Benches		6		6	6								6	6	6	6		

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AVIATION HIGH SCHOOL
PLANT INVENTORY - TRANSCRIBE

Revised 4/68
(Initials)

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SUMMARY OF SHOP EQUIPMENT AND LOCATION

EQUIPMENT	LOCATION																	
	B1	B10	B11	B12	B15	111	115	211	215	311	313	315	403	410	[illegible]	415	603	612
Propeller Shops																		
Arbor Press			1															
Drill Press ½"			1															
Grinder (Pedestal)			1															
Hydraulic Press			1															
Hydromatic Prop. Test Stand			1															
Lathe			1															
Overhaul Rail Block and Tackle			1															
Propeller Assembly Stand			4															
Propeller Storage Rack			4															
Propeller Balancing Equipment			1															
Propeller Governor Test			1															
Protractor (Propeller)			2															
Bench			1															
Test Cell																		
APU (Rectifier)	1																	
Battery Charger	1																	
Engine Test Stands	8																	
Fuel Dispensing Pits	2																	
Grinder (Bench)	1																	
Harness Tester	1																	
Hoist (55 Gal. Drum)	1																	
Overhead Rail Block and Tackle	1																	
Time-Rite Indicator	4																	
Benches	4																	

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_____ Principal

9. TEACHERS

There will be at least one teacher for 25 students in each shop or laboratory. The teachers of shop subjects will hold the appropriate mechanic certificates and ratings issued by the FAA.

Specialized teachers, who are not certificated mechanics, can be used to teach mathematics, science and mechanical drawing as called for in the new curriculums.

Ref. 147.36

VT 012 761
Genes, H.F., And Others
Traffic Accident Investigation Teaching Guide.

North Carolina State Board of Education, Raleigh. Law Enforcement Training.
MF AVAILABLE IN VT-ERIC SET.
PUB DATE - Apr69 73p.

DESCRIPTORS - *TEACHING GUIDES; *TRAFFIC ACCIDENTS; *TRAFFIC REGULATIONS; *TRAFFIC SAFETY; LAW ENFORCEMENT; *POLICE

ABSTRACT - Prepared by officers of a North Carolina police department, this teaching guide is written in outline form and provides information concerning traffic accident investigation. Chapters cover: (1) classifications and definition of accidents, (2) what an accident investigation involves, (3) causes and factors involved in accidents, (4) planning an investigation, (5) steps in conducting and reporting an investigation, (6) driver, pedestrian, road, weather, and vehicle conditions, (7) speed and skidmarks, (8) hit and run investigation, and (9) legal responsibilities. (SB)

VT 012 761

TRAFFIC ACCIDENT INVESTIGATION

TEACHING GUIDE

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
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April, 1969

North Carolina State Board of Education
Department of Community Colleges
Special Education Division
Law Enforcement Training

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North Carolina State Board of Education
Department of Community Colleges
Special Education Division
Law Enforcement Training

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D. Paying for Ambulance Service
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CHAPTER XV

I. Case Preparation and Testifying
A.. How Cases Are Decided
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CHAPTER XVI

I. Assisting in Prosecution
A. Bringing Traffic Violators to Trial
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C. Assisting the Prosecutor
D. Adjudication and Penalization
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CHAPTER I

I. Classification and Definition

A. The traffic accident investigation is concerned chiefly with accidents which involve one or both of two elements: Motor vehicles and trafficways:

1. Trafficways: The entire width between boundary lines of every way or place of which any part is open to the use of the public for purposes of vehicular traffic as a matter of right or custom.

2. Roadway: That portion of a trafficway which is improved, designed or ordinarily used for vehicular travel.

3. Traffic Unit: Any person using a trafficway for travel, parking or other purpose as a pedestrian or driver, including any vehicle, other device, or animal which he is using.

a. Non-Contact Unit: A traffic unit which contributes to an accident, but strikes nothing and suffers neither damage or injury.

4. Motor Vehicle: Every device which is self-propelled and every vehicle which is propelled by electric power obtained from overhead trolley wires, but not operated upon rails.

5. Motor Vehicle Accident: Any event that results in unintended injury or property damage attributable directly or indirectly to the motion of a motor vehicle or its load.

a. Motor Vehicle Traffic Accident: Any motor vehicle accident occurring on a trafficway. (Automobiles or Collision on a Highway)

b. Motor Vehicle Non-Traffic Accident: Any motor vehicle accident which occurs entirely in any place other than a trafficway. (Private Property)

c. Non-Motor Vehicle Traffic Accident: Any accident occurring on a trafficway involving persons using the trafficway for transportation, but not involving a motor vehicle in motion. (Ex. Collision between pedestrian and bicyclist on a sidewalk)

d. Multi-Unit Traffic Accident: Traffic accident in which two or more traffic units are involved.

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NOTE: There must be property damage or personal injuries or there is no motor vehicle traffic accident, and it must be attributed to the motion of the vehicle.

II. Other Classifications of Accidents

A. Running off the road

1. Non-collision on the road

2. Collision on the road

III. Classification of Damage and Injury

A. Property damage

B. Personal injury

1. Non-visible

2. Minor visible

3. Serious visible

4. Fatal

a. Any death that occurs within twelve months of the motor vehicle accident.

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CHAPTER II

I. Accident Investigation, What It Is and Why It Is Important

A. Accidents are investigated for four main reasons:

1. Everyone involved is curious about causes and circumstances of the accident.

2. Police are also interested in finding out whether there is enough evidence of law violation in the accident to take enforcement action.

3. Claims attorneys and adjusters want to determine negligence on the part of the drivers involved in the accident so that claims can be properly adjusted.

4. Officers and others want specific information about accidents to know how to prevent them in the future.

B. Investigation enforcement results in citations or arrest by police, for law violations of any kind discovered in connection with the accident.

1. It may be for one of three different kinds of violations:

a. Violations which contributed to the accident such as failure to stop for a traffic signal.

b. Violations of other traffic laws discovered in the course of investigation but which did not contribute. (Ex. Driving without license.)

c. Violations not relating to traffic such as car theft or transporting narcotics.

C. Settlement of Claims

1. Perhaps half of all motor vehicle accidents involve possible claim settlements. A large percentage of these are settled out of court, but the remainder require some degree of investigation or study.

2. Police are nearly always in position to get the best first-hand information about the circumstances of a traffic accident.

3. Two good reasons why a police officer should gather accident information not needed by his department, so long as the equipment and time are available:

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a. Because it is important to the public, especially when an injured, ignorant, or confused person is unable to do it for himself.

b. Because an officer, when asked about it later, will appear incompetent if he has not made observations and measurements which he could easily have done.

D. Officials Who Want the Information:

1. The law makers would not know what laws to pass if they did not have sufficient information on why the accident happened.

2. Educators (drivers) would not know what to teach.

3. Engineers (road and car) would not know how to improve roads and traffic control devices.

4. Police administrators must have information on kinds of violations, times when violations are most likely to occur, and other circumstances of accidents. All this is necessary for intelligent planning of enforcement.

II. What Activities are Involved

A. Five kinds of activities are undertaken by traffic investigators:

1. Emergency measures to keep the accident from becoming worse, and to protect the scene from getting worse. This will be discussed in a later lesson.

2. Seeking facts

a. Ask questions

b. Listen to statements

c. Look at the results

d. Measure

e. Feel and smell

3. Recording information

a. Written

b. Sketch or diagram

c. Photograph

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4. Forming opinion about the accident

   a. Final step in accident investigation

   b. Most difficult part

   c. With facts you have

   d. Do not form opinions without facts to back you up.

5. Follow up

   a. Notify witnesses

   b. Cite or arrest

   c. Restore road conditions

   d. Testify

III. Reporting and Investigating Accidents

A. Accident reporting is getting and recording required information to establish exactly where and when the event took place, to identify who and what was involved, to describe how much injury or damage resulted.

1. Reporting tells what the overall accident situation is and whether it is getting better or worse.

2. It helps people who were injured and unable to do so at the time of an accident to find out who was involved.

3. It is used as a basis for directing traffic law enforcement and other safety activities.

B. Quality and Completeness

1. The accident report is the record of the accident used for official administrative purposes. Therefore, you should try to record all of the information required by the report form.

2. Identifying information

   a. This information should be exact because information relating to location of the accident is used in making spot maps.

   b. Information relating to drivers must be good enough so the licensing authorities may maintain accurate driver records.

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3. Activity cannot be considered investigation if it is merely:

   a. Receiving report, even required reports from one or more drivers.

   b. Taking information from drivers and recording it on official report forms.

   c. Securing additional information on names, addresses of drivers, owners, injured or witnesses.

   d. Visiting the scene only to give first aid, direct traffic, clear the roadway or obtain general information.

4. Complete investigation

   a. It is impossible. There can always be further refinement of data collection and analysis.

   b. No one expects you to find out all about any accident you work on. Yet, if you take the trouble to go to the scene of a traffic accident while people and vehicles involved are still there, you ought to be prepared to answer reasonable questions of fact about what you could have seen or heard.

IV. Accident Investigator

   A. Accident investigators are busy-bodies. They must be able to distinguish between circumstances connected with an accident and factors contributing to it. An intoxicated driver, for example, does not lead him automatically to conclude that intoxication contributed to the accident.

   B. Ability to testify

      1. If you go to the scene of an accident as an investigator, you can reasonably be expected to have some knowledge of the accident from your own observation and investigation. (Ex. An "Investigator" of an accident testified that there were skidmarks. When asked whether they were those of the front wheels, rear wheels, or both, he had to confess that he had not examined them closely enough to know.)

V. Legal Background for Police Traffic Accident Investigation

   A. Must have legal power to do certain things basic to the success of our traffic safety programs.

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1. Take charge at the scene. Usually there is a lot of confusion in connection with an accident. He must restore order, direct traffic.

2. Take enforcement action.

   a. Issue citations or make arrests, provided the evidence is sufficient to support such action.

3. Question witnesses and collect evidence. The police have the legal right to collect evidence pertaining to the condition of the driver or the vehicle, the wreckage, or clues at the scene.

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D. Trafficway condition

1. These attributes are such things as surface character, dimensions, traffic signals, controls and view obstructions, etc.

2. Modifiers are objects on the road. Road damages such as holes, ruts, wear and deterioration because of weather conditions.

II. Factors

A. Factors are any circumstances connected with a traffic accident. Without such, the accident could not have happened. These factors may be either actions or conditions. If a factor cannot, by itself, produce an accident, it should not be considered a cause. A true cause will produce the result. Therefore, cause is defined as a combination of factors and circumstances. Without either, the accident could not have occurred.

B. Operational factors: Operations which fail and lead to accidents are operational factors in those accidents.

1. Failure to obey traffic laws is a broad description of many but not all of the factors may be classified as operational.

2. Operational factors have been called "direct cause" of traffic accidents.

C. Contributing factors: Any circumstances connected with a traffic accident. Without such, the accident could not have occurred. These factors may be either actions or conditions.

D. Simultaneous factors

1. Factors which must be present at the same time to cause an accident.

2. Usually two are paired, such as road and driver. There could be more.

E. Speed as a "Cause of Accidents"

1. The rule of speed in traffic accidents is frequently debated. Without velocity, there would be no motion, and without motion, no accidents.

2. Adjusting speed is the most common strategy in driving. Speed is adjusted frequently.

3. Speed can put the driver beyond the point of no escape, at his point of perception.

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4. A safe speed is one adjusted to the potential or possible hazards of the road and traffic situation ahead.

5. Safe speed on a road is determined by the road rather than the particular driver or vehicle.

6. Safe speed is usually determined by such things as curves in the road and the marginal development along the road. Safe speed is affected by darkness, fog or smoke and slipperiness which is produced by water, snow or ice, etc.

F. Carelessness, negligence and recklessness

1. Carelessness is a breakdown of strategy or preparation and refers more often to decision than to recognition or performance.

   a. It can be an attribute of the individual. It is a general lack of alertness or vitality by which the traffic problem to be solved fails to get the attention it deserves.

2. Negligence - A more formal and legal way of expressing almost the same idea as carelessness. Negligence has become closely associated with law violation because law violations are generally prima facie negligence. Carelessness and negligence are about the same.

3. Recklessness - Having perceived a condition and not giving due caution and circumspection.

G. Law violations as causes of accidents

1. Many of us have been accustomed to thinking of law violations as causes of accidents. They are not. There are officially listed about 60 rules governing the behavior of vehicles and another 15 for pedestrians. These are written to decide exactly how people shall behave in using the highways so as to avoid accidents.

2. Violations of law in connection with an accident does not necessarily mean that the behavior or condition represented by the violation was a cause of the accident.

3. Driver intoxication is often a factor contributing to an accident. A driver may be guilty of driving while intoxicated without that circumstance being a contributing factor to his accident. (Ex. A drunk driver stopped at a light and is run into by a following car.)

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4. Failure to yield right of way cannot properly be considered more than a very far-fetched factor in an accident. Accidents involving failure to yield right of way permits us only to say that one traffic unit in a collision failed to take successful evasive action.

5. A vehicle, not being a person, cannot violate the law. It would, however, be possible to have vehicle behavior cause an accident against the will of the operator.

III. Traffic Accident Events

A. Chain of events

1. Hazard - Is a dynamic situation in which a crucial event will result if direction and acceleration of moving objects continued unchanged.

a. Perception and understanding of the hazard - perception of a hazard is seeing, feeling or hearing and understanding. The unusual or unexpected movement or condition could be taken as a sign of the accident about to happen.

b. Point of possible perception is the place and time at which the unusual or unexpected movement or condition could have been perceived by a normal person.

c. Maximum delay of perception occurs when the traffic unit does not sense a hazard until he hits it.

2. Encroachment

a. Moving into the path assigned to another traffic unit.

b. Crossing a barrier line or entering a crosswal when it is occupied.

c. Pedestrians can also encroach on a vehicle.

3. Start of evasive action - Is the first action taken by a traffic unit to escape from a collision course or otherwise avoid a hazard.

4. Leaving the roadway - moving off the roadway. That is the portion which is improved or designed or ordinarily used for vehicle traffic, excluding the shoulder.

5. Initial contact - The first accidental touching of an object collided with by a traffic unit in motion.

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6. Maximum engagement - Is the greatest collapse or overlap in a collision.

7. Disengagement - The separation of a traffic unit in motion from an object with which it has collided.

8. Stopping - Is coming to rest or stabilizing.

B. Key events

1. It determines the exact time, place and type of accident. It is wherever these three events occur first:

   a. Running off the road

   b. Non-collision on the road (overturning)

   c. Collision on the road

2. Repeated events - Sometimes occur in the same accident; for example, an accident may involve two or more collisions. (One striking fixed objects)

3. Results of an accident

   a. The damage to the vehicle and other property

   b. Injury to persons

   c. Marks on the road

   d. Final position of the vehicles or pedestrians

4. Study of results - Damage to cars often gives a clue as to what happened.

   a. The angle of collision can usually be determined.

   b. Some idea of the speed involved can be obtained.

   c. Results in terms of damage often effectively confirm or contradict the testimony of witnesses.

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CHAPTER IV

I. Preparation for Accident Investigation

A. Successful investigation takes special preparation

1. Investigating accidents is part of your job. It will pay you well to spend some time and effort in getting ready for this important activity.

a. The equipment is fairly easy to get ready. Not many things are necessary, but, like first aid equipment, they must be handy for use when you need them. (Forms, tapes, flares, jackets, crowbar, lights, etc.)

b. Training is necessary. You must have a clear idea of what you will have to do and how you are going to do it.

2. Know the general policies governing investigation.

a. What accidents to investigate. State statute states that an accident must be reported if damages are more than $100 or if there is an injury or fatality.

3. Objectives in investigation depend greatly upon departmental policy.

a. Knowing the necessary information that is required by your department and state

b. Extra duties that may arise in the investigation of an accident:

(1) Care for injury
(2) Fires or fire hazards
(3) Crowds
(4) Traffic

4. Habits - Have good habits in investigating accidents.

a. Be specific. Don't guess or estimate if you can measure.

b. Distinguish facts from opinions in what people tell you. Don't just have theories, conclusions or opinions.

c. See for yourself. Don't expect to learn all about the accident from what people tell you.

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d. Write information down at the time. Don't depend on memory. Write well enough so that you won't have to recopy later.

e. Grab at chances to get facts. Avoid the easy habit of thinking, "I'll get that later." Later is often too late.

5. Specific knowledge

a. Know your streets and highways. Know the short cuts to reach an accident scene quickly.

b. Maintenance of equipment. It is inexcusable for an investigator to be on a scene and not have the necessary equipment to make the investigation. It is poor public relations as well. So always check to see if you have beforehand all the necessary reports, pencils, tape measures, etc.

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CHAPTER V

I. Planning the Accident Investigation

NOTE: Many accident investigators wish many times they could go back and reinvestigate some accidents over. They failed to get some essential details. These and other mistakes usually result from a lack of planning.

A. Why planning is important

1. Definition of planning: Planning is laying out a course of action or method of accomplishing objectives.

a. This planning is necessary to accomplish the objectives.

b. The main objectives are to determine the cause, not to make a traffic arrest, only if there is a traffic violation.

2. In planning the investigation, officer must be guided by the objectives of the investigation. Any decision he makes should be based on attaining these objectives.

B. Principles of planning accident investigation

1. Flexibility is always necessary.

a. Too much organization can be just as harmful as disorganization.

b. Plan as far ahead as you can with the facts you have. Adjust and extend your plan as you work or as you receive more information.

2. Urgency is the basis of timing actions.

a.. Decisions based on urgency are intended to get things done first that you can least afford to put off.

b. Do the most important thing first, such as caring for injury, car catching on fire, or being hit by other cars, traffic and crowd control.

C. Six stages in accident planning

NOTE: Prepare yourself prior to learning of the accident. By that we mean all equipment such as tape, forms, lights and flares, etc.

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1. Upon learning of the accident, determine:

   a. Location of the accident. Know your area, reference to crowd, or if it happened on a busy street and need assistance.

   b. Type of accident. This is important due to types of vehicles such as gas trucks or other vehicles carrying inflammable material. This will probably be given to you by the dispatcher.

   c. Severity of accident. This means simply a fatality or severe injury or a possible fender-bender.

   d. Volume of traffic. If the highway is blocked - this goes right back to knowing your area.

   e. Need for assistance. You can have too much assistance at a small wreck.

   f. Division of work. If two men are answering the call, have one man in charge. Avoid having two officers testify on minor details of an accident. He can help you on skid-marks and testify with you.

   g. Where to park the patrol vehicle. Use it as a safety device and have the tools handy. (Any equipment which could be used in emergencies)

2. Upon arriving at the scene:

   a. Keep the accident from becoming more serious.

   b. Care for the injured.

   c. Handle fire hazards.

   d. Handle traffic hazards.

   e. Handle crowd control.

   NOTE: Handle the more serious first.

3. When emergencies have been handled:

   a. Start getting facts.

      (1) Get short-lived measurements and evidence.
      (2) Talk to witnesses fast before they leave.

   b. Locate drivers and witnesses.

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4. After getting short-lived evidence:

   a. Re-examine the scene.

   b. Determine causes of the accident.

5. After leaving the scene:

   a. Check injured parties at the hospital or doctor's office.

   b. Talk to witnesses at their home, office, etc. If possible, talk with them at the scene or as soon as possible thereafter.

6. Accident investigation follow-up: Prepare yourself for court. Be sure to have all the facts concerning the accident and the violation, if any. Do not base your decisions on opinions.

<u>NOTE</u>: Only move an injured person when the moving of this person would be less hazardous than leaving him at his present location. Avoid handling billfolds or ladies' handbags. Have a working agreement with the press on holding up publication in death or serious crimes until they check with you, especially on fatal injuries. The family must be notified.

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CHAPTER VI

I. Protecting the Accident Scene

A. Proceed to the accident scene quickly and safely.

1. Have sufficient information about the accident and drive accordingly.

a. Severity of traffic conditions may require more urgency on your part. Govern your driving according to the accident type.

2. Necessity to get there quickly but safely

a. To protect the scene from further accidents

b. To protect lives and render first aid

c. To protect the scene from possible theft

d. To protect and preserve physical evidence at the scene

B. Park your patrol car safely and properly.

1. Avoid creating congestion or destruction of evidence.

a. Do not park illegally if possible.

(1) It creates a hazard for other equipment on the scene.
(2) It encourages civilians to park the same way.
(3) It creates poor public relations which are very important.

2. Use of equipment in and on the patrol car

a. Use of equipment should help you determine where to park the patrol car. (Flares, first aid, tape, etc.)

C. Make the scene safe.

1. Evaluating and determining what to do about:

a. Personal injuries

b. Fire hazards

c. Traffic hazards

2. Fire prevention and control

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a. Fire under the hood

(1) Cut off the ignition.
(2) Cut off lights.
(3) Remove battery cables.

b. Use the fire extinguisher if available. If not, use sand or dirt or anything that can be used as a smothering agent.

c. The existence of leaking or spilled inflammables

(1) Keep the crowd away from the scene.
(2) May require movement of injured persons to a safer location.

D. Radioactive material requires special handling

1. Remove all injured persons and bystanders away from the scene as soon as possible.

2. Notify the nearest Atomic Energy Commission office or the State Highway Patrol which has a direct line to all monitoring. Give as much information on cargo and injured persons as possible.

3. Give information on wrecked vehicle such as trucks, trains and the exact location.

4. Advise them if there is a river nearby, the weather conditions and the nearest airport.

5. Clear the area of non-essential personnel of a distance not less than 1500 feet. Move them up wind if possible. In case of fire, try to avoid the smoke.

6. Do not attempt to move the vehicle until you are sure the cargo is not disturbed.

7. Arrange for heavy equipment to stand by the accident scene.

NOTE: The departmental policy is to move all personnel back 1500 feet and the department will contact State Highway Patrol.

E. Care for injured and their property

1. Evaluate the nature and extent of injuries.

a. Severe bleeding

b. Shock, pale looking, glaring eyes or semi-conscious

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c. Compound and simple fractures

d. Spinal and neck injuries

e. Asphyxiation or other toxic poison

2. Provide only immediate and temporary first aid. Do not play the role of a doctor.

3. Arrange for transportation by qualified persons.

F. Theft prevention - You are usually in command of activities at the accident scene and, therefore, responsible for protecting property from further damage or theft. Theft prevention is important but not the principal reason for your presence at the scene.

G. Police authority to remove vehicles

1. Police officer has the authority to move a vehicle involved in a traffic accident. He may move it to a safe place. He is also authorized to have it towed away by a towing service if the operator of the vehicle is incapacitated or when absent from the scene.

2. Decision to move the vehicles in emergencies

NOTE: Use your departmental policies on wrecker service.

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CHAPTER VII

I. Interviewing Driver and Witnesses

A. The most important sources of information are drivers and witnesses. As part of the investigation the police may question drivers and witnesses to get certain facts.

B. Police responsibility to obtain sufficient evidence to take enforcement action when necessary. Obtaining information for two reasons:

1. It adds to the total information obtained from all sources.

2. It can verify or disprove some opinions based on observations of physical evidence or statements made by other drivers and witnesses.

NOTE: Remember that obtaining statements from people is not a goal of accident investigation but a method.

C. Principles of getting information

1. Be objective

a. Overcome your feeling about a person's race or business. Avoid your dislike of foreigners or wise guys.

b. Attitude toward women drivers, interest in certain kinds of accidents, or other similar personal reactions can get in your way when you start to ask questions.

c. These feelings can easily show in the expression on your face and the manner of your speech.

d. The person whom you are addressing, more quickly and surely than you think, senses your feeling and responds accordingly.

e. Try to hide your feelings by being businesslike.

f. Keep yourself out of the situation. That is being objective.

2. Be positive

a. The way you approach the person to be questioned determines to a large degree how successful you will be.

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b. Let the drivers or witnesses know that you are aware that they have some information and that you intend to get it. Never be reluctant to ask questions but ask them in a straight-forward, clear manner.

3. Be specific

   a. To get useful answers, be certain that the driver or witness understands your questions.

   b. Make them as specific and clear as you would like the answers to be.

   c. Be sure you know what the answer really means.

4. Don't suggest answers - you must not thrust your own opinions on those you are questioning.

5. Avoid conflict

   a. Try to avoid conflict between drivers and witnesses.

   b. To keep yourself out of conflict, be objective.

6. Be adaptable

   a. Don't settle into a routine.

   b. Avoid asking a set list of questions.

   c. Adjust questions to the person.

7. Verify statements

   a. By comparing statements

   b. By physical evidence at the scene

8. Be especially careful to verify the driver's identity and ownership of the vehicle.

9. Be diplomatic and understanding.

10. Do not embarrass people.

II. Driver

A. Locating drivers is the first thing to do after handling emergency conditions at the scene.

   1. What influences driver in answering questions:

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a. People are affected by various physical and emotional factors which influence their ability to give accurate information.

b. The mere fact of a police officer asking questions is often enough to create tension or even fear. Most people cannot think and talk as well as usual when they are upset or injured.

c. Signs of emotional stress are usually present. Heavy breathing, trembling hands, stuttering or thick-tongued speech, fumbling with the hands and inability to follow a discussion. Some people may be this way all the time and others may not show signs of being nervous.

B. Personal problems

1. The driver's ability or willingness to answer questions accurately is influenced by what he considers to be very important personal problems which may have little or no bearing on the accident.

C. Rationalization

1. Few people like to admit having done something wrong. It always tends to be "the other person's fault." Many drivers will figure out logical reasons for behaving as they did.

2. It is a very convenient way to escape self-condemnation and feelings of guilt or remorse.

3. It is a normal human process but a process that seriously affects the ability of people to be truthful and objective.

D. Shock amnesia is the loss or impairment of memory due to shock.

1. Results from shock due to serious injuries, severe loss of blood and other conditions.

2. The period of unconsciousness after the accident will usually be the same as the blank period before the accident.

E. Evading responsibility

1. Some people will deliberately try to mislead you by giving inaccurate information to avoid punishment, small fines or to collect damages.

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2. Some people simply will not admit mistakes. If you detect a flaw in a story even if it seems unimportant, check the rest of the story carefully. It may be entirely inaccurate.

F. Failure to observe

1. Many people cannot give good information simply because they failed to observe or they see what interests them.

2. Check what they tell you by their position and time of accident.

G. When and where to question

1. Conditions at the scene

2. Emergency first

3. Collect physical evidence that might be removed.

4. Condition of drivers or witnesses

5. Question driver as soon as possible.

H. What information to seek from drivers, two kinds:

1. One kind of information is necessary for making routine accident reports.

2. The other is essential in discovering what happened and who was at fault.

NOTE: Getting the facts on how and why, the ability to think up the questions to ask. Ask them so as to get the best answers. This is one of the things which make the difference between investigation and a mere report.

III. Identification of driver and vehicle

A. Before asking for any other information, check driver's license and registration card. (He is required by law to show this to any police officer.) Do not handle wallet, purse or other papers unless absolutely necessary.

B. Sometimes a passenger will falsely claim to have been the driver because the actual driver may have been intoxicated, under age, or had a bad driving record. Check witness as to who was driving.

C. Events of accident

1. Exactly where were you when you first saw the car?

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2. What were you doing at the moment you first saw the other car?

   a. Movement

      (1) Speed
      (2) Direction
      (3) Slowing down
      (4) Speeding up

   b. Attention

      (1) Where had you been looking?
      (2) Had you been talking to anyone?
      (3) Where were you when you first realized you were in trouble? (Point of perception)
      (4) What were you doing at the moment you realized you were in trouble?
      (5) Exactly what did you do, if anything, to avoid the accident? (Evasive action)
      (6) Then what happened? (Let the driver describe the actual key event.)
      (7) Exactly where did the collision take place? (Do not ask if you know the answer from your own observations of physical evidence.)
      (8) Where did you stop after the collision? (Do not ask if you already know the answer with certainty.)
      (9) What is the first thing you remember after the accident?
      (10) If driver was unconscious, ask what is the last thing you remember clearly before the accident?
      (11) Who did you first see after the accident? (This may give a good clue to a witness.)
      (12) What did you say to him? (Object: to get an idea of what explanation of the accident the driver gave right afterward.)

IV. Witnesses

   A. Importance

      1. Vital in determining what happened in many cases

      2. Of value even if they did not see the accident happen

      3. Courts inclined to give particular attention to statement of impartial witnesses

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B. How to locate witnesses

1. With diplomacy they can be located even though people generally are reluctant to get involved.

2. Look for the gabby individuals. Persons talking and waving hands may lead you to important witnesses.

3. Watch for signs and statements that indicate that the person saw the accident.

4. Circulate quietly, not with a chip on your shoulder.

5. Don't ignore children.

6. Take license numbers of cars parked nearby.

7. Take license numbers of cars passing toward you from the scene, particularly if there is no one at the scene.

8. Try to locate the first person to reach the scene.

9. Usually best witnesses are bystanders who had nothing to do with the accident.

C. Handle witnesses properly when found.

1. Approach confidently if fairly certain person knows something about the accident.

2. Treat people decently. Never scold or bully.

3. Be patient with confused or mentally-low types.

4. Avoid use of expression "witness." Use "Tell me what you saw."

5. Request rather than order.

6. Use statement rather than question form. Use "What did you see?" not "Did you see it?"

D. Seek valid and reliable testimony.

1. Persons riding in involved cars usually side with their driver but may make good witnesses.

2. Be alert to detect friend who poses as a disinterested observer.

3. Watch out for imaginative person who fabricates, gives excessive variation of degrees of speed, size, color, etc.

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4. Some persons have a desire to be important.

5. Some have special prejudices, dislikes, etc., which color their interpretations.

6. Some cite opinions as though they were facts.

E. Written statement

1. Provides opportunity to cross examine later

2. May result in hesitancy of witness to change his story later

3. Need not be elaborate in form, but should contain essentials such as

a. Where was he standing?

b. What was he doing in vicinity?

c. What he can testify to

d. Name

e. Age

4. Write the statement for the witness if he will not write it for himself.

5. Use positive statement "Sign here." Don't appear resentful if witness will not sign.

V. Passengers

A. Be sure to question all passengers involved, especially in a serious or complicated accident.

B. Find out relationship of each passenger to the driver. (Help to determine if he will be biased)

C. Try to question each separately and then compare stories.

D. Ask seating positions to determine if he was able to see and what he was doing at the time of the accident.

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CHAPTER VIII

I. Driver and Pedestrian Condition

A. In general, the same personal conditions that make drivers have accidents also make pedestrians have accidents. Whether it is a pedestrian or a vehicle with its driver, it is called a traffic unit.

1. Behavior is what the driver or pedestrian does.

a. Behavior of the person is reflected in part by the behavior of the traffic unit.

b. In investigating an accident, we must try to discover driver or pedestrian's condition that produces behavior as well as discover the behavior itself.

2. Driver or pedestrian conditions

a. A single road or vehicle condition can sometimes cause an accident, but far more often, faulty driver conditions by themselves result in behavior that causes accidents.

b. Some driver conditions almost always contribute to an accident as a factor.

3. Personality in driver

a. It may be considered as all the qualities which can explain individual behavior.

b. We are particularly concerned with personality traits and qualities which set one person apart from another.

c. There are three aspects of personality related to traffic accidents.

(1) Natural mental and physical abilities
(2) Learn abilities and knowledge which the person has acquired by study and practice.
(3) Motives and attitudes which determine how and why a person thinks and feels about things

d. Personality is affected by many temporary driver conditions such as

(1) Intoxication
(2) Fatigue
(3) Medicine

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(4) Illness
(5) These may influence nearly every aspect of personality related to driving.

4. Distinguish factors from circumstances

   a. Ask yourself: Would the accident have happened if this condition had not been present?

   b. A driver may have some dangerous impairment and yet that condition may not have had anything to do with the accident.

5. Distinguish between driver conditions before and after an accident. We are interested primarily in prior conditions as possible factors.

   a. Ask youself "Did this driver condition contribute to this accident or did the accident create the condition?"

   b. Not only may driver conditions suggest why an accident happened, but clues from the accident may suggest the driver condition contributing to it. (Ex. Open whiskey bottle in car may indicate the possibility of intoxication and vomit in or on the car may indicate sickness.)

6. Expert help is sometimes needed

   a. Unfavorable road conditions are usually easy to see during investigation but

   b. Vehicle conditions are more difficult to detect.

   c. Driver conditions, especially attitudes and emotions, are most difficult of all to discover.

      (1) Sometimes certain experts can help determine what driver conditions might have contributed.
         (a) Doctors can discover conditions like heart ailments.
         (b) Psychologists can explain personality factors which may be involved.
      (2) Your job is to make such observations as you can of driver conditions and inquire concerning circumstances which might suggest or preclude certain possible conditions. Ask an expert for help if you need it.

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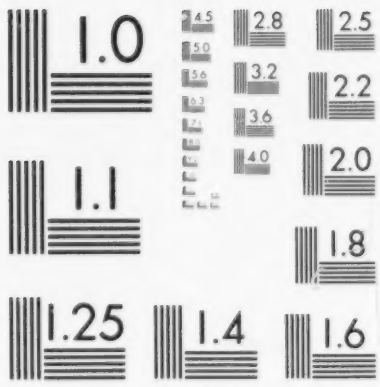

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

7. When police have proof of a driver's condition

   a. Take what action is appropriate regardless of whether the condition contributes to the accident.

   b. Arrest for operating intoxicated is the most common police action.

   c. Certain driver conditions are hazardous but not illegal. For such conditions, enforcement action is difficult. (Ex. Falling asleep or a heart attack while driving is very dangerous but, in most locations, does not break a specific law. If the driver could have anticipated them, a general charge of reckless operation could be made.)

   d. No one is expected to inquire into all driver conditions mentioned here in connection with every accident. It would be impossible. Only the most serious receive careful study.

   e. If you think a driver's condition is serious, such as the driver being an epileptic, and he has several unexplainable accidents, you should refer the case to a licensing official for further study.

8. Natural abilities

   a. Deficiency in natural abilities can contribute to accidents in several ways. We are speaking of relatively permanent conditions, not diseases.

   b. Some physical or mental defects or deficiencies with which the person may have been born. These deficiencies are in these three areas:

      (1) Sensory conditions, seeing and hearing, becoming aware of road or traffic conditions
      (2) Conditions of mind and nerves, understanding hazardous conditions and making proper decisions
      (3) Bone and muscle conditions, the prevention of the operation of the controls on the vehicle

   c. Vision - There are a dozen or more eye conditions that can handicap a driver.

      (1) Visual acuity or sharpness of seeing at a distance, such as road signs. This deficiency is usually correctable with glasses.

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(2) Night blindness is the inability to see objects of low contrast in low illumination, such as a pedestrian in dark clothing against a dark background 200 feet away. With low beam headlights, wearing sun glasses is bad. It cuts down vision.

(3) Glare blindness slows recovery from viewing dazzling lights at night. This is common with older people. (Ex. A person complains about being blinded by the headlights and runs off the road.)

(4) Narrow field of vision is the inability to see toward the sides. When the field is very narrow, it is called tunnel vision. It cannot be corrected with glasses. (Ex. People with one eye, sometimes car windows that are fogged by moisture or frost gives the effect of narrow field of vision.)
NOTE: Average is 160°. Some people have 180°.

(5) Depth perception is the ability to judge distance of nearby objects with both eyes. Lack of depth perception, using two eyes, cannot be corrected by glasses. People with one eye lack this ability but are able to judge distance by other means. This takes special equipment to determine depth perception.

(6) Color blindness is the inability to distinguish certain shades of red or green. Color blindness is probably not very important in accidents. It is not a common condition. More males are color blind. Rarely do you ever hear of a woman being color blind. This is sometimes suspected when a person swears that he had the green light when it was red, not the fact that he is being dishonest.

d. Hearing defects do not often contribute to accidents. You might suspect it when they failed to hear a horn or train whistle or even while you are talking to them. They are having trouble hearing you.
NOTE: If your windows are closed, radio on and air conditioner, etc. has same effect.

e. Very short drivers and those lacking limbs may have difficulty making the car do what they want it to.

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(1) Such deficiencies contribute to accidents in cases where high manipulative skill such as turning movements are necessary.
NOTE: May have restricted license.
(2) Vehicles have special equipment to handle handicapped persons and they have special training. Most of the time they can compensate for them.
(3) Such conditions may contribute when you notice the driver or pedestrian having such deficiencies.
(4) Over weight, low strength, stiff or painful joints all contribute to the accident.

NOTE: Licensed driver examiners have the authority to re-examine any licensed driver as to whether he may retain his license.

f. Personality

(1) Personality includes all the human traits or characteristics which explain behavior, physical and mental abilities, knowledge, skill, motives and attitudes.
(2) Motives and attitudes are useful in explaining personal causes of accidents.
(3) The fact that some people do not drive safely, though they have the ability and knowledge, is what necessitates traffic law enforcement.

g. Punishment or threat has little effect on persons who do not know what is expected of them or on their ability to drive as required.

(1) It may also stimulate the driver to learn about those things which cause him to be punished.
(2) The more legitimate role of punishment is for those drivers who know what should be done and yet intentionally do otherwise.

9. Motive

a. Motive is a psychological concept used to explain "why" behavior occurs.

b. In traffic accidents we are concerned with explaining why a driver behaved in a certain way. (Ex. Too much to drink. Why is he angry?)

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10. Attitudes may be defined as more or less parmanent ways of thinking and feeling about things.

    a. Attitudes are useful in explaining why drivers behave the way they do.

    b. Attitudes may be good or bad for driving, depending on whether they are in line with safe practices. There are several specific attitudes and motives that frequently account for unsafe driving:

        (1) Showing off - driving reckless, etc.
        (2) Inferiority - being inconsiderate with their driving
        (3) Risk taking - racing, playing chicken, etc. This demonstrates their "real men" effect.

11. Emotion

    a. Further concept which is useful for understanding driver behavior

    b. Emotions refers to the way we feel about something. There are many different kinds of emotions that can affect driving:

        (1) Anger - leads to reckless, aggressive behavior
        (2) Fear - causes hit and run driver to evade responsibility
        NOTE: Emotions, like the other psychological aspects of personality, are often difficult to relate to an accident.
        (3) Most all drivers are emotional after an accident, which is normal.
        NOTE: In attempting to investigate the emotions in an accident, inquire as to the events leading up to the accident and how the driver felt about them.

B. Reaction time

    1. This is the time after full perception of a situation that a person takes to decide what to do about it and start acting.
       NOTE: The average time is about 3/4 of a second.

    2. There are four kinds of reactions that are recognized, based on the amount of thinking necessary. The less thinking, the shorter the reaction.

        a. Reflex reactions

        b. Simple reactions

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c. Complex reactions

d. Discriminative reaction - less dangerous of possible action

3. Reaction time is affected by many things such as

a. Age

b. Strength of stimulus

c. Physical conditions

d. Habits

NOTE: Reaction is not a separate characteristic by itself. It depends on physical and mental conditions, knowledge, skill and attitude. Thus, reaction time includes the time required to comprehend the situation after it has been seen or heard.

4. Perception time

a. Is the interval between the moment when a movement or condition could have been perceived under normal conditions and actual perception

b. There must be perception before reaction is possible.

c. Perception time, as used here, includes time required to comprehend, understand or evaluate. (Ex. A person may be looking directly toward an object but may take some time to recognize it.)

5. Distractions

a. Something heard, felt or touched

b. Something that diverts or turns the mind and eyes away from something that close attention should be paid to

c. Distractions caused by minor emergencies and annoyances

(1) Demands from inside the vehicle
(2) Demands from the driver himself
(3) Distractions from outside the vehicle such as boy looking at girls

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(4) Preoccupation, day dreaming, any emotional thought. Anyone can be distracted, but you rarely can say positively that distraction was a factor because there usually is no permanent evidence of it.

d. Often distractions can be discovered by asking

(1) What were you doing just before the accident?

(2) What were you thinking about just prior to seeing you were in trouble? You must consider distractions as a possibility when there is a long perception time.

C. Poison, medicine, fatigue and illness

1. Effect - Various chemicals taken into the body, many diseases, and fatigue have some effect on most parts of personality that are important to safe driving.

a. Alcohol - It affects emotions and superficial attitudes more than anything else. There are many degrees of intoxication which affect a driver's ability to solve problems of the road and traffic and control his normal mental or physical faculty.

NOTE: Do not attribute all unusual actions on alcohol, as there are many other pathological reasons that give alcoholic symptoms.

b. Narcotics can seriously affect the driver's ability to drive safely, much the same effect as alcohol.

(1) Other drugs - stimulant drugs (Bennies, pep pills, etc.)

c. Carbon monoxide has, in the early stages, symptoms of alcohol, fatigue, etc.

d. Fatigue can produce almost every outward symptom of intoxication.

e. Illness - Do not confuse alcohol, drugs and medicine with illness such as heart, epilepsy, diabetes, shock or mental illness.

D. Legal requirements for drivers

1. This includes licensing.

2. In connection with investigation of accidents, you have an opportunity easily to discover if the driver has met the necessary legal requirements.

   a. Driving while under age

   b. Examine a license closely to determine whether it is valid.

   c. Examine the license for restrictions.

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CHAPTER IX

I. Road and Weather Conditions

A. Combination of causes

1. Road conditions

a. Definition: Includes roadway, trafficways and anything off the highway that might contribute to an accident

b. Unfavorable road driving, weather conditions at the time of the accident, are not always factors of the accident.

c. Road and weather conditions are only causes when they contribute to the accident.

d. Ask yourself if the accident would have happened if the conditions had been absent.

2. View obstructions

a. Horizontal

(1) Full
(a) Vehicle in the roadway
(b) Building
(c) Trees, shrubs
(d) Billboards, lighting
(2) Partial: can result in hasty glances

b. Vertical (Time, distance, relation)

(1) Such things as hillcrests and bridges

3. Reduced visibility

a. Darkness

b. Fog and smoke, dust storms

c. Rain and snow

d. Glare

(1) Headlights
(2) Back lighting and fixed lighting
(3) Sun

4. Surface conditions

a. Type of road surface

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(1) Slipperiness
(2) Wet
(3) Ice

b. Road surface material

(1) Concrete
(2) Asphalt
(3) Brick

c. Characteristics of roads

(1) Intersections - The different angles or sudden turns, an offset that you may encounter
(2) Width of road - The sudden narrowing, causing sudden changes in speed, likely to cause rear end accidents
(3) Alignment - The level and straight alignment of the roads. The angle of the roads. The failure of traffic engineers to properly warn drivers, by signs, of unusual alignment problems such as curves, etc., is a factor.

d. Constructions and faults

(1) Ruts
(2) Holes in the road
(3) Curbs
(4) Lips or drop offs
(5) Shoulders - types and condition, sandy, dirt or grass

e. Traffic control devices

(1) Types of devices
(a) Signs
(b) Signals
(c) Markings
(2) Conditions
(a) Visibility
(b) Operating
(c) Devices missing
(d) Devices not operating
(e) Decreased visibility
(f) Sign wording too small
(g) Driver's view of sign obscured

B. What to look for on the road after an accident

1. Debris

a. Accumulation of broken parts of vehicle, rubbish, dust or dirt and other materials left at the accident scene by the accident vehicles

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b. Underbody debris is debris that comes from beneath the car. May reveal:

(1) Location of key event
(2) Path vehicle followed after impact
(3) Direction of force
(4) Identification of vehicle
(5) Distance vehicle traveled after initial impact

c. Vehicle parts

d. Vehicle fluids

2. Damage to roadside objects (fixed objects, trees, posts, houses, etc.)

a. Path vehicle took after impact

b. May reveal the part of vehicle doing the damages

c. Sometimes it may determine the speed of the vehicle.

3. Imprints - any marks on the pavement or ground that are left without the sliding of tires or rotating wheels

4. Skidmarks

a. Tire marks left on the road by tires that are not free to rotate

b. Kind of skidmarks

(1) Pavement grinding, stone, gravel or grass
(2) Tire grinding on the pavement
(3) Smear of soft materials, snow or mud
(4) Smear of bituminous materials (tar and asphalt)
(5) Tire smears, melting of tires on road
(6) Furrow, the plowed depression made by sliding tire material piled up on each side and usually at the end
(7) Erasing or wiping of the pavement
(8) Squeegee marks or wiping of moisture from the pavement

5. Scuff marks - signs left on the road by tires that are sliding sideways, etc.

6. Scratches

a. Marks left on a road by sliding parts of vehicle other than tires

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b. There are two types

(1) Slight tearing
(2) Rubbing off of vehicle material

7. Gouges

a. Holes or grooves when material is dug out of the pavement by parts of the vehicle

b. There are three types

(1) Chip gouges
(2) Chop gouges
(3) Groove gouges

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CHAPTER X

I. Vehicle Conditions

A. Reasons for suspecting vehicle conditions contributing to the accident

1. When you find there is no evidence of the driver or road at fault, then it is safe to believe the vehicle is at fault.

2. Damaged or defective parts

3. Circumstances surrounding the accident

4. Great age of the vehicle (bad condition)

5. Size, weight and shape of load carried on the vehicle

6. Claims or statements of drivers and witnesses may cause you to suspect trouble with vehicle

7. Marks on the pavement prior to the key event (gouge, scratches or marks)

B. Parts of the vehicle likely to contribute to accident

1. Tires

2. Wheel suspension

3. Steering gear

4. Brakes

5. Engine and transmission

6. Accelerator sticking

7. Body of vehicle

8. Windshield and rear windows

9. Headlights

10. Tail lights

11. Miscellaneous equipment, horn, wipers, rear view mirror, etc.

II. Vehicle Damage and Conditions

A. What to look for

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1. It can tell how the accident happened.

2. It can tell why the accident happened.

B. Kinds of damage and defects

1. Preceding but not contributing to

2. Preceding and contributing to

3. Damage brought about during collision

4. Damage after collision and before final position

5. Damage brought about at the scene but following the accident (Ex. The wrecker causes damages.)

III. What the Vehicle Shows About How the Accident Happened

A. Body of car (bumpers, glass, doors, etc.) and what it may show

1. It will or may show the direction of travel and the extent of maximum engagement.

2. Suggestions for examination - study the damaged parts to find out which way they were pushed.

3. Examine the car for paint from other vehicles.

4. In pedestrian accidents, examine the damaged parts to determine the parts of pedestrian's clothes or body. (buttons, blood, flesh, hair, etc.)

B. Interior of the car

1. May show where each occupant was sitting prior to the accident

2. May show the direction from which the force came and who was driving

C. Tires

1. If the tire is cut or blown out, it can indicate the direction of force.

2. Also indicates movement of car before, after and during the collision

D. Gear position (especially trucks) - May give a clue to the possible speed of vehicle

E. Speedometer - May show the speed of vehicle at time of collision if it is in frozen position. (Variable factors influence position)

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F. Problems of investigation

1. Determine if driver imagined vehicle failed or if it really did.

2. Determine whether the broken part caused the accident or if the accident caused the broken part. (Check driver's statement against the broken parts)

3. Determine if the vehicle had continuing defects. (Brake lights or headlights, etc.)

G. Illegal condition discovered in accident investigation- When police discover an illegal condition of the vehicle in connection with an accident, whether the condition contributed to the accident or not, they should take appropriate law enforcement action.

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CHAPTER XI

I. Speed and Skidmarks

A. Introduction

Normal skids are those which occur on a flat, level surface of uniform slipperiness when all wheels are locked within perhaps a quarter of a second after brakes are applied. All wheels have tires of approximately the same kind.

1. Common errors in considering skidmarks

a. Courts are not informed on the evidence of skidmarks and not willing to accept them.

(1) Too complicated
(2) Too many variables such as size of tires, types of vehicles, etc.
(3) Never heard of speed formula

b. Skidmarks are misinterpreted.

2. Skidmarks occur when the following takes place:

a. Wheels slow down and begin to slide.

b. Locked wheels continue to slide, causing the following:

(1) It causes a grinding effect or causes the rubber to melt from the heat that is generated. Surface material may be displayed. This brings about a scraping or plowing effect.

NOTE: Temperature wise, surface tar will melt at 300° F., rubber at 600° F.

3. Skidmarks may show or indicate the following:

a. Position of car on roadway

b. Point of impact

c. It can also indicate the action of the drivers.

d. It can indicate the minimum speed the car was traveling.

B. Factors influencing skid distance

1. Speed (this is the principal factor)

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2. Pavement surface

   a. Slippery surface makes for longer slides.

   b. A number known as coefficient of friction describes the road surface or drag factor of the pavement.
      NOTE: Drag factor is the amount of drag that a pavement puts on a tire or tires on a wheel compared to the weight on that wheel. It is expressed by a number, usually a decimal fraction. (Ex. If a wheel presses down on the road with a force of 1000 lbs. and the road produces a horizontal force or drag on that wheel of 500 lbs., the drag factor is 500 divided by 1000 which equals 0.50. Ice can be 0.10 or very slick, while other surfaces may be as high as 1.20, which is very rough.

3. Grade or slope - Rise or fall in feet per 100 ft. plus or minus 5%.

   a. On a grade, less skid

   b. On a slope, more skid

C. Other factors having small effect

   1. Tires - All rubber tires are about equal in stopping resistance.

      a. Normal size tires have no effect. Air pressure has some but not much. You measure dual wheels as one.

      b. The weight of the vehicle will cancel itself out.

      c. Wind velocity makes no noticeable difference.

      d. Temperature of the air and pavement
         NOTE: Temperature of the air and road surface make some difference. In general, on ordinary pavements, hot weather produces longer stopping distance.

      e. The direction of the slide (backward, forward, etc.) will make some difference but not a noticeable amount

D. Identification and measurement of skidmarks

   1. Each wheel which skidded must be:

a. Measured separate as to length and position on roadway

b. Each wheel must be recorded properly on your field sketch or notes.

2. Beginning point - is critical and not always obvious

a. The shadow marks are important if you can identify them. You can see the shadow marks by looking low along the line of the skidmark.

b. Overlapping - When overlapping occurs, sometimes the beginning point must be assumed. The end of the rear wheel slides and the beginning of the front are obscured by the overlapping. If you look carefully, you can usually find the place where the rear wheel stopped. It is on top and usually a little off the side.

c. Identify the front and rear wheel skidmarks.

(1) Front wheels are normally indicated by dark smears on the outer edge of each.
(2) Rear wheel skidmarks are normally identified by a solid black smear.
(3) The ending point of a skidmark is usually clear and definite - ends abruptly.

3. Interruptions

a. Gaps are the distance between the releasing and reapplication of the brakes. You must include in your measurements, when you finish, deduct the total feet of gap. The gap is usually 10 ft. or more.

b. Skips are caused by bouncing or bumping over ruts, rails or holes in the road. Include the skips as part of the skid. They will usually run one (1) to three (3) feet.

4. Identification of skidmarks with the vehicle that made them

a. Witnesses and drivers

b. Skidmarks leading up to a certain car

c. If you have fresh marks and have probable cause, compare them with tires at the scene.

d. Photographs

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5. Road surface

   a. Composition of road surface should be recorded fully on accident reports. (Types of surface)

   b. Wet, dry or slipperiness

E. The drag factor or coefficient of friction is described as follows:

1. Description of road surface alone is not adequate to give drag factor.

   a. It can be estimated by experts. (Drag factor) However, there still is a margin for error.

   b. It may be the best you can do in some cases such as ice or wet roads.

2. Test skids are the "Best method for establishing the drag factor."

   a. The accident car is preferred if it is driveable, or a car as near like it as possible.

   b. The car should be driven at a predetermined speed, preferably 25 to 40 m.p.h.

   c. Note the m.p.h. you are driving. Apply your brakes hard and hold until car comes to a stop.

   d. Skidmarks are then measured carefully and recorded.

      (1) Add all four wheels together.
      (2) Divide by four (4) for your average length.

3. Formula for coefficient of friction: F minus or plus F equals 0.033 S2/d or F equals $\frac{S2}{30d}$

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CHAPTER XII

I. Hit and Run Investigation

A. Differences between hit and run and other accidents

1. Accident information is a fact finding operation with everyone accounted for.

a. Hit and run requires finding the driver evading responsibility.

b. Elements of the violation

(1) Prove who was driving at the time of the accident.
(2) Knowing that they were involved in an accident
(3) Left without satisfying legal obligations
(4) Make inquiries as soon as possible after a hit and run for description and investigation.

c. Importance of a hit and run investigation

(1) Criminal aspect
(2) The effects of public opinions
(3) The danger to the police officer

B. Directing the hit and run investigation at the scene

1. Determine if it is a hit and run - if drivers are not all there, find out where they are.

2. Guide for the investigating officers to follow:

a. Get the situation under control.

b. Obtain all the information you possibly can that relates to the identification of the hit and run vehicle and the other parts of the vehicle.

c. Transfer this information to the dispatcher to be put out to all units.

d. Search and collect evidence and preserve it.

e. Call for expert help if needed.

3. Standard operating procedures:

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a. Broadcast a description of the hit and run vehicle with information on vehicle, direction of travel, etc.

b. Dispatch special investigators, if possible.

c. Direct road blocks.

d. Check local files.

C. Clues useful in hit and run investigation

1. Reason for trying to find clues:

a. Show what kind of vehicle was involved in the accident.

b. Identify the particular vehicle when found as being in the accident.

c. Identify the person as the driver of the vehicle.

d. Verify or disprove the statement of other drivers and witnesses or theories as to what happened.

2. The material or evidence you discover at the scene very often will lead your investigation step by step to other evidence or conclusions of the greatest value.

3. Gathering materials for scientific examination

a. You may not be able to figure out the meaning of certain materials found at the scene.

b. You must preserve such materials for possible scientific examination.

c. When in doubt as to the connection, save all possible clues. It is much better to save materials found at the scene than to regret later that you didn't.

d. Any materials found at the scene which can't be explained at the moment as having any bearing on the investigation at hand shall be considered as physical evidence until the connection can be determined.

e. Actually what you are doing is substituting facts for guesses to find out who, what and why.

D. What to look for

1. Debris

   a. The accumulation of broken parts of vehicles, rubbish, dust and other materials left at the accident scene by a collision

   b. Debris samples can be collected and preserved but matched and analyzed by an expert to identify the vehicle or place it came from.

2. Parts of vehicles are the most important debris in a hit and run accident. When you match broken edges with parts still on the car they are positive identification. Even when they don't match, they may be able to identify the make, model, type or color and the extent of the damages.

   a. Again, if there is any question as to the material, collect, label and hold. Broken parts are more important than damaged parts. (Ex. Broken metal or a bent hub cap.)

   b. Parts of bodies of trucks are especially useful. They may identify a special type and make of truck. These may help you to locate particular vehicles.

3. Glass: Get the largest parts and several pieces if possible. You have a better chance of matching them with parts left on the vehicle.

4. Paint

   a. This is the most useful clue to the color of the hit and run vehicle.

   b. When paint is left from one vehicle to another or objects, samples can be scraped off and kept for scientific study.
      NOTE: Be careful not to scrape off paint from the object that was struck. This may contaminate the sample with the paint from the car on which it was found.

   c. Paint from chrome plated bumpers, head lamps, rims, door handles or any bright metal surface is best. It, too, is often easier to remove. Paint chips are especially good.

5. Things carried on a vehicle

   a. Evidence scattered or dropped at the scene of an accident may help to indicate where vehicles

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collided and where they came to rest and particularly clues for locating the vehicle after it has left the scene.

(1) Liquids of any type, location of accident and route
(2) Sand, gravel or other bulk materials which stay close to the area where they are dropped
(3) Rounded type materials generally scatter widely and are more helpful in identifying the vehicle than the collision point.
(4) Be careful not to assume they came from a hit and run vehicle, as they may have been dropped by another passing vehicle.

E. Pedestrian accidents

1. Fibers or hair

a. When a vehicle strikes a person, cyclist or large animal hard enough to cause death or injury, there usually is some bit of clothing or hair on the striking vehicle.

b. If it appears possible that the hit and run vehicle may have some evidence such as hair, clothing, etc., it would pay to get a sample from the hit and run victim for later identification. If the vehicle is located, this can later be scientifically matched.

c. In cases where there might be some quantity of blood on the hit and run vehicle, it would pay for the hospital to note on their records the victim's blood type.

d. Blood types can be scientifically matched to some extent from dried stains.

e. They will indicate if they are different or matched by type. You cannot say positively that they did come from the same person.

F. Collection and preservation of evidence

1. Cloth, hair, dirt, paint, glass, etc. should be placed in clean envelopes and sealed.

a. Avoid putting more than one kind of material in an envelope.

b. Label the envelopes or record the exact place it was found in respect to the road, vehicle or person. This will help you in reconstructing the accident.

c. The time, date, location, your name, etc. also will be able to prove identity of the material on the witness stand. (This can be done fairly easily by having the case number on the envelope.) The envelope will not be reopened for a chance of being tampered with.

d. Keep under lock until trial.

e. Chain of legal custody. Signed receipt or registered mail.

NOTE: In gathering evidence, do not advertise your findings as it may destroy your case. Word gets around.

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CHAPTER XIII

I. Recording Accident Information

A. Measurements to locate results of the accident

1. Reason for measurements

a. Careful measurements take the guess work out of locating things in your investigation. This will help you to testify with confidence and precision about your observations of where things were at the scene.

b. Aids in reconstruction

(1) Reconstruction will help you to find out how the accident happened. Without measurements, it is virtually impossible.
(2) Often a few measurements quickly and easily made will make photographs unnecessary and will reduce time needed to question drivers and witnesses later about positions of things at the scene.

NOTE: It is always better to have measurements that you never need than to need measurements that you do not have.

2. When to measure - Making measurements and sketches of most minor accidents is unnecessary. However, you expect to make urgent measurements in connection with:

a. All fatal accidents

b. All skidmarks

c. All accidents in which vehicle ran off road

d. Serious accidents where measurements may be needed for later prosecution

e. Accidents involving view obstruction outside of the vehicles. These are of special interest to traffic engineers.

f. Freak and serious accidents that you cannot explain

g. Accidents on the boundary lines of cities, counties or states and those partly on private property. This is to permit classifying the accident properly according to location.

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3. What needs measuring: To make a detailed accident diagram, you will need measurements for:

   a. Positions of vehicles where they come to rest after collision and vehicle parts

   b. The places where dead or injured persons lie after collision, in and out of vehicles. (Head injury can tell position)

   c. Point of collision or impact, running off pavement or shoulder

   d. Anything to show position of vehicle in road before collision. Tire marks, skidmarks and gouges are most common. (Skidmarks will show where vehicle came from.) If pictures are taken, know the position of the camera so the pictures can be compared with maps.

   NOTE: The purpose in measuring is to be able to relocate the position on the road if this becomes necessary.

4. Urgent measurements

   a. Some objects that you might want to measure will be moved or will disappear soon after the accident. Measurements will have to be taken.

   b. Some of these are temporary or short-lived.

      (1) Temporary - These actually last only minutes.
         (a) Skidmark shadows
         (b) Tire prints
         (c) Gasoline and water puddles
         (d) Debris or rubbish knocked from vehicles
         (e) Location of killed or injured
         (f) Location of damaged vehicle in traveled part of road

      (2) Short-lived - These may last several hours or even days.
         (a) Skidmark smears
         (b) Gouges on shoulders or banks
         (c) Oil and blood stains
         (d) Damage to fixed objects which will be repaired. (Ex. Signs)
         (e) Location of damaged vehicle off traveled part of road

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NOTE: Soon after getting to the accident, you must decide whether or not you will need measurements. Sometimes you will not be able to get measurements or temporary evidence right away. Some temporary evidence can be changed to short-lived by marking the position with a crayon. Don't neglect more urgent parts of an investigation just to make measurements.

B. Equipment - Only a few things are necessary to make satisfactory measurements in most accidents.

1. Tape measure at least 50 feet long

2. Pencil and yellow lumber marking crayon for writing on or marking pavement

3. Paper, preferably white, hard surfaced bond 8½" X 11" sheet padded. Knowledge and skill in using simple equipment is more important than additional equipment.

C. Precautions

1. Pacing is not very accurate but is much better than guessing.

2. Check tape and always keep it clean. Watch traffic when getting measurements.

3. When pacing, record your measurements as the number of steps.

4. Be careful when you are reading the tape.

D. Location measurements

1. You will need measurements to determine

a. The length, width, depth or height of something or to fix a location or position. In locating things accurately, you must measure from something permanent. Never measure from the point of impact. It is not a permanent object which can be found a week or a month later. Identify the position of object you measure from.

b. Small objects can be located well enough by measuring to their approximate centers.

(1) As bodies of persons, injured or killed, bicycles, gouges in the pavement, scrates, grooves, tire marks less than four feet long, piles of debris less than four feet across, parts of vehicles and damaged trees or posts

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(2) Vehicles
   (a) You will have to locate two points on each vehicle to fix its position.
   (b) Consider trailers and semitrailers as separate vehicles for this purpose.
(3) Long marks on the road surface are located by two or more points.
   (a) "If the mark is straight, one at each end is enough."
   (b) If the mark is curved, locate the center, if real long points, about every 20 feet.

E. Location by coordinates

1. Can be used to tie an object to a fixed point on or off the highway

2. One of these lines should be to a zero point.

3. Zero point is tied to a permanent point or landmark.

F. Location by triangulation

1. Can be used to tie an object to a fixed point on or off the highway

2. One of these lines should be to a zero point.

3. Zero point is tied to a permanent point or landmark.

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CHAPTER XIV

I. Legal Responsibilities

A. In connection with traffic accidents

1. A legal responsibility of a driver and others in connection with accidents differ considerably from state to state and city to city. It is important that you know what they are in your own community.

a. Almost every traffic accident has some legal implication. (Ex. The law requires that most all accidents be reported. Law suits for damages or injuries could be made.)

b. For most people, a traffic accident may be their first. Therefore, you can win genuine gratitude for yourself and respect for your organization simply by giving helpful information in a friendly manner.

2. Accident reporting by drivers

a. Calling police

(1) There are several reasons for rules requiring that the police be immediately notified in certain cases
(a) So the police can take immediate steps to handle the traffic problems that may develop
(b) To start an investigation before evidence and witnesses have disappeared
(c) So emergency vehicles can be sent (ambulance, fire trucks, tow trucks, etc.)

(2) In making out an accident report
(a) You are not sure of the amount of damage. Go ahead and fill it out to be on the safe side.
(b) Most states require the drivers to make reports (written) to the state for damages over certain amounts.
(c) Some states require separate reports for financial responsibility laws.
(d) A driver or owner is not required by law to notify his insurance company, but many companies have a clause in them. If the accident is not reported under certain conditions, the

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company will not pay a claim. Suggest to a driver that he should report it to his insurance company.

(e) Do not discuss civil liability or negligence in connection with suggestions to report to insurance companies.

B. Evading responsibility at scene

1. Every driver involved in an accident has a legal responsibility to do certain things.

   a. The first requirement of any driver involved in an accident resulting in personal injury, death or property damage is to stop as near as possible to the scene.

   b. Stay there until all his legal obligations have been fulfilled

   c. To be involved means that the driver is connected with the chain of events of the accident. It is not necessary for there to be actual contact for a driver to be involved. If he knows or should have known of the accident, he must stop and perform all the duties required by law.

NOTE: Help drivers meet responsibilities. When you investigate an accident at the scene, do everything you can to help the drivers fulfill their responsibilities.

2. Payment and punishment

   a. Perhaps the most annoying demand addressed to an investigator is from people who think someone else was responsible for the accident. They insist, "You've got to make him pay for my car."
      NOTE: You can't make anyone pay anything. Only courts can determine liability and assess damage. People think you can do everything. Only courts and insurance companies settle who pays.

   b. Demand to arrest - Often someone involved in an accident, and sometimes eye witnesses, will demand that you arrest a driver. Sometimes this is done in order to try to convince the officer or the driver's family and friends that he isn't wrong, as well as convincing himself.

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c. A person believes that if the driver is arrested, he will have to pay damages to keep out of jail. He confuses fines with civil damages and is only interested in someone else paying the bills.

C. Risk in trying to be helpful

1. Aid to injured - Are persons other than the driver involved required by law to give aid to the injured in an accident which occurs when they are present, or which they come upon shortly after it has happened?

a. "No one is required to assist a stranger." The fact that a person sees another person who is injured does not of itself impose on him any legal obligation to give relief or assistance.

b. North Carolina General Statute 20-166 (d) states no one can be responsible for injury resulting by trying to help in an accident scene as long as this injury is not a result of wanton conduct or intentional wrong doing.

D. Paying for ambulance service

1. In the event that you should call a doctor or ambulance to an injured person and he later cannot or will not pay for the service, you are not obligated.

a. In the absence of an agreement to pay, the one who calls on a doctor or ambulance to render services to another is not liable to pay. The same is true for a wrecker.

b. The mere fact of calling such service when the person calling is under no legal obligation to do so is no implication of promise to pay.

E. Charges for additional damages

1. Suppose in trying to get an injured person out of a car, put out a fire, or move the car out of the traffic, you damaged the car.

a. Would you have to pay?
(1) The same rule applies here as in the other questions. While there is no legal obligation for you to render assistance, you must exercise ordinary care in what you are doing or otherwise

you may render yourself liable for damages caused by begligence.

(2) Responsibility depends on who you are.

b. Does it make any difference to the foregoing question whether I am a police officer or insurance investigator, a relative or friend?

(1) Very much so.

(a) The ordinary person is under no legal obligation to render aid or assistance.

(b) However, an officer of the law, whose duty is to protect the public, does have an obligation. There may be such a duty on the part of a relative under certain circumstances.

(2) All should exercise ordinary care and are liable for further injury resulting from lack of proper care on his part.

c. When you are acting on someone's authority to remove vehicles, injured, etc., you will not be held liable for charges if you act in the best interest.

NOTE: The law imposes an obligation upon everyone who attempts to do something for another to use ordinary care and skill.

2. Duties of a police officer

a. Police have a general duty, nearly always specified by laws or ordinances, to enforce the law.

b. In connection with accidents, policemen must seek information to determine whether any law has been violated. If you believe a law has been violated, it is your duty as an officer of the law to get the evidence to prove the violation. It does not have to be a traffic violation - any kind of violation.

NOTE: References to laws: The exact responsibilities in connection with traffic accidents may be found in your state motor vehicle code or other additional requirements may be found in your city traffic ordinance.

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CHAPTER XV

I. Case Preparation and Testifying

A. How cases are decided

1. Respectable courts will not convict without sufficient evidence.

a. Do a thorough job of preparing case.

b. Bring in enough evidence to prove charges.

2. Trials are contests in persuasion with facts as weapons.

3. Cases of violations arising from accidents should be handled by qualified prosecutor.

a. Present all the facts to him.

b. Give him all available evidence.

c. See that all evidence is properly preserved for use in the trial.

d. Let him decide what to use in the case and what to leave out.

e. Evidence must be well presented to be effective.

4. Conferences with the prosecutor are most helpful in preparation of the case.

a. Regular meetings produce the best results when there are several cases.

b. Purpose of conferences is to insure that both of you have same understanding of case and are in agreement on strategy for presenting it.

c. In conferring, be entirely frank and honest with the prosecutor.

B. Testifying in court

1. Must know the rules of evidence

a. Can determine with the prosecutor what evidence is likely to be admitted

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b. Evidence must be well presented to be effective.

2. Must know how to conduct yourself

C. Common court situations - three kinds

1. Probable cause hearing

2. Trial without a jury

3. Jury trial

D. Appearance and behavior in court - Everyone in court forming an opinion of officer

1. General appearance

a. Well-groomed

b. Coat buttoned

c. Conservatively dressed

d. Sit properly, erect and relaxed

e. Bring only what you need in court (only notes on case in hearing) - notes should be where they are easily reached.

2. Manner - Dignified

3. Quality of voice

a. One reasonably understood

b. Clear and loud enough to be heard

4. Self control - Keep your wits and temper

5. Promptness of witness's reply

a. Answer questions as soon as you reasonably can.

b. Have a reasonably short period between question and answer.

c. If the question is not clear, ask that it be repeated.

6. Accuracy

a. Clearness of speech

(1) Short sentences
(2) Answer responsively to questions

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b. Brevity of statement - Do not make a speech

c. Selection of words - especially of descriptive phrase

7. Pronunciation - Speak clearly, watch slurring of words or running together.

8. Knowledge of subject

a. Have case properly prepared

b. Have clear, accurate notes

9. General statements

a. Look at defense council when he speaks to you.

b. Do not repeat perfectly audible statements.

c. Do not use affected nervous laughs.

d. Avoid unnecessary affected minute accuracy.

e. Stay away from the word "exactly" - use "similar".

E. Presenting your facts

1. Simply present facts.

2. Tell what you saw or discovered under permissible rules of evidence.

a. No case justifies departure from truth to obtain a conviction.

3. Be sincere and respectful.

4. Know courtroom procedure.

5. Be properly prepared.

a. Notes, reports, physical evidence, etc.

b. Do not try to memorize your testimony.

6. Look at the examiner when being questioned, but direct answer to judge or jury.

F. Cross examination

1. A legitimate and necessary part of any trial

2. The right to test the truth of witnesses' statements - One of the most important guarantees of our system of justice.

3. Purpose

   a. To search out the truth

   b. Expose ignorance or curruption

   c. Expose bias or malice on part of witness

   d. Without cross examination, the court would be forced to accept whatever any witness might choose to say with no means of checking the truth of the story or why the witness told it or if it should be believed.

4. Don't be aggressive or volunteer information not requested.

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CHAPTER XVI

I. Assisting in Prosecution

A. Bringing traffic violators to trial

1. Prosecution

a. The legal proceeding instituted in a court of law for determining the innocence or guilt of a person charged with an offense

(1) Citation
(2) Arrest
(a) On view
(b) Warrant

b. Successful prosecution requires:

(1) Good investigation
(2) Careful preparation

c. To penalize a violator may require efforts of:

(1) Police - to detect violator and cite or arrest violator to bring him into court
(2) Public prosecutor - the district or other official attorney who prosecutes the case in court
(3) Court - a judge and sometimes also a jury charged with the duty of deciding whether a violation has, in fact, been committed and what the penalty shall be

d. Responsibility of police officers for prosecution of violators:

(1) Essential assistance to prosecutor which is determined by
(a) How well you made investigation
(b) Power of observation
(c) Collecting and preservation of evidence
(d) Recording facts, reports, notes, etc.
(e) Knowledge, ability and presentation of testimony
(2) Understanding prosecutor's duties and something about the law under which violators are prosecuted will make it easier for you to do your part in bringing offenders to justice

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(a) Trial: A proceeding before a court governed by certain rules to determine the facts and insure that just verdicts are reached
   (1-1) two or more parties involved in disagreement
   (2-2) each has an opportunity to present evidence
(b) Parties to a trial
   (1-1) state or municipality on one side represented by prosecutor
   (2-2) defendant charged with a violation represented by defense attorney

(3) Duties of others involved in a trial
   (a) Judge: Primarily responsible for determining responsibility, for determining the correct application of the law and for seeing that trial proceedings are carried on in accordance with established rules
   (b) Jury: Responsible for weighing evidence and testimony presented in a trial
      (1-1) decide guilt or innocence of the defendant on this basis
      (2-2) without a jury, the judge has this responsibility
   (c) Prosecuting attorney: Represents the state or municipality in all criminal trials. He is responsible for presenting the state's evidence to the jury in such a manner that all available facts are known.
   (5) Defense attorney: Represents the defendant and has the obligation to make sure the defendant's rights and interests are protected during the trial
   (6) Witness: The "eyes and ears" of the judge and jury. He presents the facts within the rules established for court procedure.

B. Knowledge of law

1. Every officer needs a basic understanding of

   a. Traffic laws and rules

   b. Laws of arrest

   c. Rules of evidence

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2. Understanding helps you to

   a. Recognize violations more readily

   b. Prepare proper citations and charges

   c. Question witnesses properly

   d. Gather legally acceptable evidence

   e. Discuss case intelligently with prosecutor

   f. See a case to its proper conclusion in court

3. Elements of violation

   a. Traffic violations consist of a number of elements or parts which must be proven in court to convict

   b. Source of information for traffic violation elements

      (1) State motor vehicle code
      (2) City or municipal ordinances

   c. Example: Speeding elements

      (1) Accused must be driving a motor vehicle
      (2) Offense must take place on a public street, highway, public institution or place, providing parking space for customer
      (3) Vehicle must be in excess of stated limits or which is not reasonable and and prudent for existing conditions

C. Assisting the prosecutor - Establish a working relationship with prosecutor

   1. Present served cases for prosecutor to handle

   2. System for reporting facts to the prosecutor

   3. Make good quality arrests

   4. Remember the chain of evidence

   5. Know proper court procedure

   6. Be available for trial dates

   7. Keep prosecutor informed of the aims and objectives of program

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D. Adjudication and penalization

1. Make records available to court.

2. Maintain proper attitudes.

3. Realize that the judge is bound by law and legal principles.

4. Personal appearance

E. Other factors to consider which affect enforcement productivity

1. Must have adequate personnel

2. Must have adequate supervision to assure uniformity

3. Reporting of conditions

4. Departmental policies

5. Use of scientific aids

6. Working conditions and officer morale

7. Quality of all police activity

8. Nature and extent of inter-department cooperation

9. Public relations and public support

10. Adequate vehicles and equipment

11. Non-productive assignments

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ABSTRACT - Developed by the Training Publications Division of the Naval Personnel Program Support Activity, this study guide is for use by Navy and Naval Reserve personnel who are seeking advancement to the rate of Illustrator Draftsman Third Class or Illustrator Draftsman Second Class. The first chapter discusses the scope of the rating, and succeeding chapters provide information pertaining to: (1) mathematics, (2) machine, structural, mechanical, and electrical drawings, (3) lettering, (4) technical illustrations, (5) color, and (6) visual presentations. The material is illustrated by pictures and diagrams and a reading list and subject index are included. (GEB)

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PREFACE

This book is intended to serve as an aid for men who are seeking to acquire the theoretical knowledge and the operational skills required of candidates for advancement to the rate of Illustrator Draftsman Third Class or Illustrator Draftsman Second Class. As one of the Navy Training Courses, it was prepared by the Training Publications Division, Naval Personnel Program Support Activity, Washington, D.C., for the Bureau of Naval Personnel. Technical assistance was provided by the Illustrator Draftsman School, Port Hueneme, California.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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Creative Illustration, Andrew Loomis, Viking Press, 625 Madison Ave., New York, N.Y.

Screen Process Methods of Reproduction, Bert Zahn, Frederick J. Drake & Co., 9 S Clinton St., Chicago, Illinois

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CHAPTER 1

THE JOB AHEAD

This training course is designed to help you meet the qualifications for advancement to Illustrator Draftsman Third Class or Illustrator Draftsman Second Class. It presents information on the drawing techniques which you will be required to perform and the materials and instruments which you will use as a member of one of the Group VI ratings: the Illustrator Draftsman.

The first chapter deals with the scope of the Illustrator Draftsman rating, the enlisted rating structure, advancement in rating and administration pertaining to the Illustrator Draftsman. It is strongly recommended that you study this chapter carefully before beginning intensive study of the remainder of this training course.

Chapter 2 of this manual presents a general overview of the mathematics and mechanics used in drafting. Chapter 3 concerns the tools, instruments and equipment used in line drafting. Chapter 4 introduces you to the general drafting practices used in the rating. Chapter 5 covers the development of surfaces. Chapter 6 describes machine and structural drawing. Chapter 7 describes the systems drawings you will learn such as plumbing, heating, ventilation and electrical drawings. Chapter 8 describes the office machines and equipment most generally found in all graphic shops. Chapters 9 through 19 cover the more illustrating subjects such as lettering in chapter 9. Chapter 10 covers basic materials and how to use them. Chapter 11 shows how to draw the basic forms. Chapter 12 covers principles of drawing human figures. Chapter 13 describes composition and design in illustrating. Chapter 14 explains perspective for the illustrator. Chapter 15 covers advanced line and tonal painting. Chapter 16 introduces you to the principles of color. Chapter 17 describes shop procedures and production. Chapter 18 covers cartooning. Chapter 19 describes visual presentations.

THE ENLISTED RATING STRUCTURE

The two main types of ratings in the present enlisted rating structure, are general ratings and service ratings.

General ratings identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Service ratings identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

THE ILLUSTRATOR DRAFTSMAN RATING

The Illustrator Draftsman is a general rating at all levels.

SCOPE OF THE RATING

The scope of the Illustrator Draftsman rate is as follows: Illustrator Draftsmen design and prepare drawings and illustrations for presentation and reproduction; letter and sketch for illustration purposes; produce signs, posters, charts, graphs, training aids, and illustrations; demonstrate knowledge of media and methods of preparing art copy for reproduction; reproduce art copy by the silkscreen method; enlarge and/or reduce drawings using such aids as coordinates, pantographs, opaque and overhead projectors; operate reproduction machines; prepare, correct, edit, and file ship and aircraft,

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mechanical, electrical, electronic, and machine drawings, tracings, sketches, plans, blueprints, and statistical data from information provided; make computations required for the performance of illustration drafting to cover general mathematics, mensuration, and geometry. Cut, layout, and mount photography.

TYPES OF BILLETS

As an Illustrator Draftsman, you may expect to be assigned to duty both with units of the Fleet and at shore activities. The shore stations at which you will actually do your work may be at various locations around the world.

In the Atlantic area you may be assigned to duty in Italy, England, or Spain, to mention a few. You may work at some of the numerous bases on islands in the Caribbean group.

In the Pacific area you may be assigned to duties in Hawaii, Japan, Guam or the Philippines.

There are several units of the Fleet which utilize Illustrator Draftsmen, and many are assigned to the various Fleet staffs.

PRACTICAL LEADERSHIP ASPECTS

The principles of military and inspirational leadership for petty officers are covered in Military Requirements for PO 3 & 2, NavPers 10056-A. The practical leadership exercised by a PO3 or PO2 is that leadership which relates to his technical capacity--in fact it is on-the-job leadership.

This type of leadership requires, in the first place, a complete knowledge of the technical subject-matter. You must have this, not only to perform your own technical functions, but also to be able to give necessary technical instruction to the team which happens to be under your charge. In addition to a complete knowledge of technical subject-matter, you must have the capacity for breaking a given mission down into its logical subphases and for assigning these subphases to the team in accordance with individual ability and aptitude.

A principle which has large application in technical leadership might be called the responsibility principle. You must yourself develop a sense of responsibility for ensuring that everything necessary to successful completion of a mission is carried out, and you must develop a similar sense of responsibility in every member of the team.

Suppose, for example, that you are in charge of a job and you have a three-man crew in your shop. You have the ultimate responsibility for seeing that all of your equipment is in proper working order. You can't, of course spend all of your time making constant inspections on the equipment and still have time to perform your other functions. You can however, and you must, assign a particular man the responsibility of the upkeep and maintenance of a particular piece of equipment or category of items. This man must be made to realize the extent of his responsibility—must be shown, for example, the dire results of finding an indispensable item of equipment out of order when its use is absolutely essential for completion of a job.

ADMINISTRATION

Illustrating and line drafting in the Navy is done for such a variety of purposes and under so many difficult conditions that it is difficult to lay down any hard and fast rules about the organization of a drafting room. Many ships and shore activities have billets for only one or two Illustrator Draftsmen, and they become a part of one of the main divisions.

Maintenance of Graphic-Drafting Room

As a PO3 or PO2, you will assume the different jobs required to keep the graphic-drafting room and its equipment in shape to (1) get the job done quickly and (2) create habits of orderliness and cleanliness in the man. It is your job to assign these jobs and to see that things are kept up to snuff.

It is always important to see that equipment and instruments are kept in good condition and to impress this fact upon the men under you. Bad equipment and instruments mean inefficiency. Any Illustrator Draftsman worth his salt sets a high value on good work habits and care of equipment. Even as a striker you should have begun to feel a professional pride in keeping equipment clean and in good working condition.

Filing Systems

When a filing system is established, it should be one that is adopted to the needs of the activity using it. Therefore, no hard and fast rules can be laid down on filing. It is the responsibility of the PO in charge to establish

the filing system to be used at his activity and you may be the leading PO even at the 3rd or 2nd class level. The efficiency of the system will depend on your judgment. You will have the responsibility for seeing that the material is filed in the manner best adopted to the particular needs of your activity.

You may use a numerical or alphabetical sequence for your filing. A catalog containing a number or letter assigned the work and a brief description of the work and its location should be easily accessible. The files should be in the charge of one man, and all removals and returns should be made by him. It will also be his responsibility to keep track of all movements of the material in case another request is made for the same material. Once a piece of material is filed in the wrong place, it is the same as lost.

All files should be kept up to date. Old obsolete material should be destroyed to make room for newer up-to-date material.

Records and Correspondence

It is a good idea to maintain only as many records as you can conveniently keep up to date. A record that is not kept up to date is worse than useless. But, if you have a large section to supervise, you may need to keep a number of records and to delegate the responsibility for keeping some of them to others. Even if your section is small, you should keep a catalog book for locating material in your files, and some sort of record of material used so that they can be conveniently reordered.

A log book of drawing numbers usually consists of a list of numbers down the left side of the sheet. As each number is assigned, the title of the drawing is written on the same line. The date of the assignment and the name of the Illustrator Draftsman to whom the job is assigned may also be given. The log serves as a permanent record of the number given each drawing, so that there is less chance of a drawing being completed with the wrong number or of two drawings receiving the same number. A cross index may also be kept by drawing title or subject on 3 x 5 cards. However, if the cards are not kept up to date the system will soon fall into disuse.

The print record has several purposes. It is a means of keeping track of prints so that out-of-date prints can be quickly located and destroyed. It is also of value as a record of work performed. It may be kept as a log in which orders for prints are recorded, along with the name of the ordering activity, the drawing number and its title, the number of prints made, and the date of delivery. This same information can be kept in a card file instead, with cards filed by drawing number or by drawing title.

A drawing job sheet serves as a check on work progress. The following are suggested as headings for the sheet:

Drawing No.	Title	Started	By	Completed

When you are in charge of a drafting section one of your jobs may be the drafting of letters concerning drawings, prints, and so forth to be signed by your commanding officer or officer-in-charge. In this case, you should obtain the latest copy of the Navy Correspondence Manual, SECNAVINST 5216.5. It contains chapters and sections on typing practice and format, as well as chapters on writing practice.

Of special interest will be the chapter on developing a communication. In this chapter, you will find a discussion of the things to consider in planning a letter, with general outlines for letters which are intended to serve various purposes. Other valuable material in this chapter consists of sections on evaluating the letter, means of referring to a previous communication, and using abbreviations.

Supply

As a petty officer and Illustrator Draftsman, supply problems will affect you as it does nearly all departments of naval activities. For this reason, you should pay thorough attention to chapter 12, Military Requirements for Petty Officer 3 & 2, NavPers 10056-A. This chapter explains the types of material, how to identify parts or equipment, and the groups and classes to which different material is assigned.

In this supply chapter you will be given information on the different identification publications, COSAL, how to use the Federal Supply Catalog, procurement, forms to use in ordering supplies and surveying equipment no longer useable or needed. You are instructed in the proper custody and storage of material, and about the inventory of supplies.

Although normal channels of supply must be used whenever possible, some of the articles used in graphic-drafting shops cannot be acquired directly from all supply ships or supply depots, but will have to be ordered or purchased on the open market. For this reason, you should always anticipate your needs well in advance because it adds additional costs to buy on the open market.

In the area of making repairs of equipment, except for the very minor type of repairs, the maker of the equipment should be contacted, through the supply department, and the manufacturer's representative to make necessary repairs.

On any equipment where immediate repairs are necessary and the necessary repair parts are available, the repairs should be completed only after consulting the instruction book on the equipment. These instruction books supplied by the manufacturers are designed to aid you in making minor repairs and will also point out safety procedures necessary for your safety and the safety of the equipment.

ADVANCEMENT IN RATING

Some of the rewards of advancement in rating are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

But the advantages of advancing in rating are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating, you increase your value to the Navy in two ways. First, you become more valuable as a technical specialist in your own rating. And second, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy.

HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement in rating? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and professional training courses.
3. Demonstrate your ability to perform all the practical requirements for advancement by completing the Record of Practical Factors, NavPers 760.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Demonstrate your knowledge by passing a written examination on (a) military requirements and (b) professional qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your division officer or training officer to be sure that you know the most recent requirements.

Advancement in rating is not automatic. After you have met all the requirements, you are eligible for advancement. You will actually be advanced in rating only if you meet all the requirements (including making a high enough score on the written examination) and if the quotas for your rating permit your advancement.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement in rating? You must study the qualifications for advancement, work on the practical factors, study the required Navy Training Courses, and study other material that is required for advancement in your rating. To prepare for advancement, you will need to be familiar with (1) the Quals Manual, (2) the Record of Practical Factors, NavPers 760, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052, and (4) applicable Navy Training Courses. Figure 1-3 illustrates these materials; the following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

The Quals Manual

The Manual of Qualifications for Advancement in Rating, NavPers 18068B (with changes), gives the minimum requirements for advancement to each rate within each rating. This

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ACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	†E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service—or completion of recruit training.	6 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E-6.	36 mos. as E-7. 8 of 11 years total service must be enlisted. Must be permanent appointment.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training.		Class A for PR3, DT3, PT3. AME 3, HM 3			Class B for AGCA, MUCA, MNCA.		
PRACTICAL FACTORS	Locally prepared check-offs.	Records of Practical Factors, NavPers 760, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.	Counts toward performance factor credit in advancement multiple.						
EXAMINATIONS	Locally prepared tests.		Navy-wide examinations required for all PO advancements.				Navy-wide, selection board, and physical.	
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).					Correspondence courses and recommended reading. See NavPers 10052 (current edition).	
AUTHORIZATION	Commanding Officer		U.S. Naval Examining Center			Bureau of Naval Personnel		
	TARS attached to the air program are advanced to fill vacancies and must be approved by CNARESTRA.							

* All advancements require commanding officer's recommendation.
† 2 years obligated service required.

Figure 1-1.—Active duty advancement requirements.

INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS *		E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
	FOR THESE DRILLS PER YEAR								
TOTAL TIME IN GRADE	48	6 mos.	6 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
	24	9 mos.	9 mos.	15 mos.	18 mos.	24 mos.	36 mos.	36 mos.	24 mos.
	NON-DRILLING	12 mos.	24 mos.	24 mos.	36 mos.	48 mos.	48 mos.		
TOTAL TRAINING DUTY IN GRADE †	48	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
	24	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
	NON-DRILLING	None	None	14 days	14 days	28 days	28 days		
PERFORMANCE TESTS				Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION		Satisfactory participation as a member of a drill unit.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)		Record of Practical Factors, NavPers 760, must be completea for all advancements.							
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Completion of applicable course or courses must be entered in service record.							
EXAMINATION		Standard exams are used where available, otherwise locally prepared exams are used.						Standard EXAM, Selection Board, and Physical.	
AUTHORIZATION		District commandant or CNARESTRA					Bureau of Naval Personnel		

* Recommendation by commanding officer required for all advancements.

† Active duty periods may be substituted for training duty.

Figure 1-2.—Inactive duty advancement requirements.

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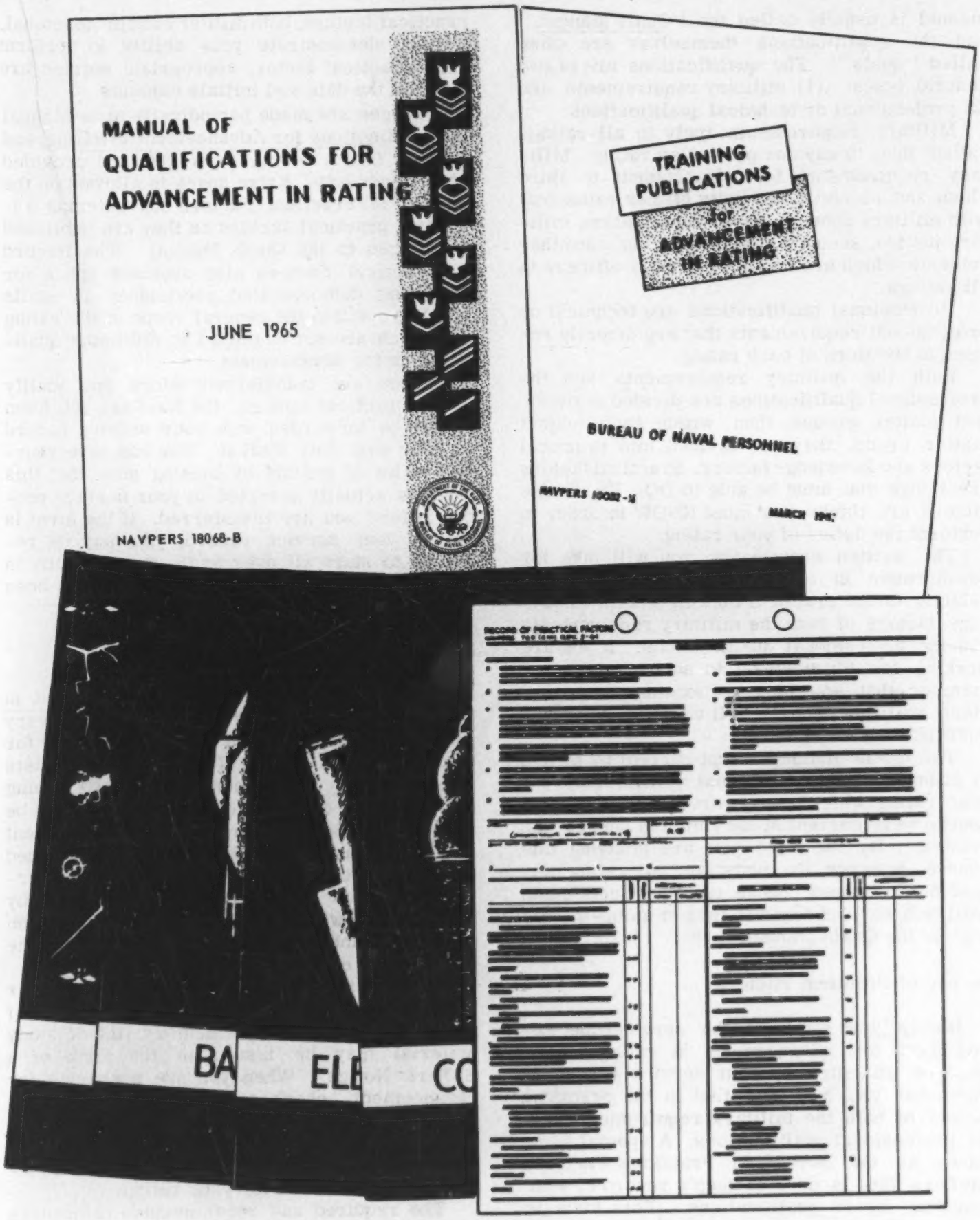

Figure 1-3.—Materials used in preparing for advancement.

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manual is usually called the "Quals Manual," and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) professional or technical qualifications.

Military requirements apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

Professional qualifications are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into practical factors and knowledge factors. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

The written examination you will take for advancement in rating will contain questions relating to the practical factors and the knowledge factors of both the military requirements and the professional qualifications. If you are working for advancement to second class remember that you may be examined on third class qualifications as well as on second class qualifications.

The Quals Manual is kept current by means of changes. The professional qualifications for your rating which are covered in this training course were current at the time the course was printed. By the time you are studying this course, however, the quals for your rating may have been changed. Never trust any set of quals until you have checked it against an up-to-date copy in the Quals Manual.

Record of Practical Factors

Before you can take the servicewide examination for advancement in rating, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the professional qualifications. A special form known as the Record of Practical Factors, NavPers 760, is used to keep a record of your practical factor qualifications. This form is available for each rating. The form lists all practical factors, both military and professional. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the date and initials columns.

Changes are made periodically to the Manual of Qualifications for Advancement in Rating, and revised forms of NavPers 760 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 760 form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

NavPers 10052

Training Publications for Advancement in Rating, NavPers 10052 (revised), is a very important publication for anyone preparing for advancement in rating. This bibliography lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be sure that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052 for your rating.

The required and recommended references are listed by rate level in NavPers 10052. If

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you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Navy Training Courses are marked with an asterisk (*). Any course marked in this way is mandatory—that is, it must be completed at the indicated rate level before you can be eligible to take the servicewide examination for advancement in rating. Each mandatory course may be completed by (1) passing the appropriate enlisted correspondence course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the training course; or (3) in some cases, successfully completing an appropriate Class A school.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military requirements for advancement. Personnel of ALL ratings must complete the mandatory military requirements training course for the appropriate rate level before they can be eligible to advance in rating.

The references in NavPers 10052 which are recommended but not mandatory should also be studied carefully. ALL references listed in NavPers 10052 may be used as source material for the written examinations, at the appropriate rate levels.

Navy Training Courses

There are two general types of Navy Training Courses. Rating courses (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the professional qualifications of one rating. Subject matter courses or basic courses give information that applies to more than one rating.

Navy Training Courses are revised from time to time to keep them up to date technically. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether any particular copy of a Navy Training Course is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists all current training courses and correspondence courses; you will find this catalog useful in planning your study program.)

Navy Training Courses are designed to help you prepare for advancement in rating. The following suggestions may help you to make the best use of this course and other Navy training publications when you are preparing for advancement in rating.

1. Study the military requirements and the professional qualifications for your rating before you study the training course, and refer to the quals frequently as you study. Remember, you are studying the training course primarily in order to meet these quals.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training course intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training course in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions: What do I need to learn about this? What do I already know about this? How is this information related to information given in other chapters? How is this information related to the qualifications for advancement in rating?

5. When you have a general idea of what is in the training course and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

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6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training course, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Navy Training Courses or on other appropriate texts. As mentioned before, completion of a mandatory Navy Training Course can be accomplished by passing an Enlisted Correspondence Course based on the Navy Training Course. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master the information given in the training course, and also helps you see how much you have learned.

10. Think of your future as you study Navy Training Courses. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCES OF INFORMATION

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional qualifications of your rating.

Some of the publications described here are subject to change or revision from time to time—some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you to do your work or to advance in rating; it is likely to be a waste of time, and may even be seriously misleading.

GOVERNMENT PUBLICATIONS

Military standards for engineering drawings and for illustrations of technical manuals are published with MIL-STD publication numbers. Current standards are listed in the Department of Defense Index of Specifications and Standards, the use of which is described in detail in chapter 4.

You should obtain a copy of those standards pertaining to the work done in your command and should request that all of the standards currently applying to illustrative drafting be obtained for use in studying.

TEXTBOOKS

There is a wealth of information for the Illustrator Draftsman in phamphlets, handbooks, and texts emanating from manufacturers, technical and professional societies and private publishing houses. Some of these are Commercial Art Techniques, by S. Ralph Maurello; Engineering Drawing, 8th edition, by French; Technical Drawing, by Giesecke, Mitchell, and Spencer; Creative Illustration, by Loomis; and Screen Process, by Zahn.

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CHAPTER 2

MATHEMATICS

As a draftsman, you must know how to measure distances accurately, scale distances on a drawing, reduce fractions to decimals, and find the area of a plane figure or the volume of a solid. This chapter includes a brief review of fractions and decimals, and gives a few of the basic formulas for finding area and volume. Unless you have a firm grasp of the basic operations of arithmetic, you cannot expect to be able to use mathematics successfully. If you can use numbers accurately and easily, you will find that mathematics is less difficult than you may have been led to suppose.

Mathematics is, as a matter of fact, very much like mechanical drawing in that, once you have a grasp of the principles, it becomes a matter of skill which can be acquired by practice. If you have never had occasion to use algebra, geometry, trigonometry, or logarithms, or have not had the occasion for some time, you will need to practice in order to develop the necessary skill. When you are using these tools steadily on the job, you will find that their use becomes almost second nature to you, so that problems which would otherwise be extremely complex can be solved quickly with a minimum of effort.

The Navy has prepared basic Navy Training Courses on mathematics. Two of these texts are Mathematics, Volume 1, NavPers 10069-B and Mathematics, Volume 2, 10071-A. These two texts cover all the mathematics required in the qualifications for advancement to DM3 and DM2. At the time of the writing of this DM 3&2 text, Mathematics, Volume 1, is undergoing revision and will be available several months after this text is published. Therefore, throughout this chapter, reference will be made to chapters in both the old NavPers 10069-B edition and the new NavPers 10069-C edition.

FRACTIONS AND DECIMALS

Any graduated instrument like a ruler is called a scale, although actually the set of graduations on it is the scale. When we speak of the scale of a drawing, we mean the ratio of the measurements on a drawing of an object to the same measurements on the object.

For example, suppose you are drawing an object which is 24 inches long, but there is only room on your paper for a drawing 12 inches long. If the object is drawn to scale in this space, 2 inches on the object will be represented by 1 inch on the drawing, and the drawing will be called a half-scale drawing. You could, of course, draw the object 6 inches long on the paper, and then 4 inches on the object would be represented by 1 inch on the drawing. The drawing would be called a quarter-scale drawing.

Notice that a half-scale drawing is not half the size of the object. It is only a quarter the size of the object, because the dimensions in each direction are halved. For the same reasons, a quarter-scale drawing is only 1/16 the size of the object.

A draftsman must deal with problems of scale constantly. When measuring distances with scales and when dimensioning drawings, you will use common fractions and decimal fractions. There will be times when, in order to determine the dimensions of a part, you must add, subtract, multiply, or divide fractions. Sometimes it will be necessary to change common fractions to decimal fractions (usually called decimals) and vice versa. Refer to figure 2-1 for a table of decimal equivalents to some

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common fractions. Keeping such a table on hand will save you time, but you should know how to perform these operations yourself.

If you have not used your arithmetic lately, especially working with fractions, review the appropriate chapters in Mathematics, Vol. 1. Common fractions are covered in chapter 3 of NavPers 10069-B or chapter 4 of NavPers 10069-C. Decimals, including percentage and the reduction of common fractions to decimals and vice versa, are covered in chapter 4 of NavPers 10069-B or chapter 5 of NavPers 10069-C.

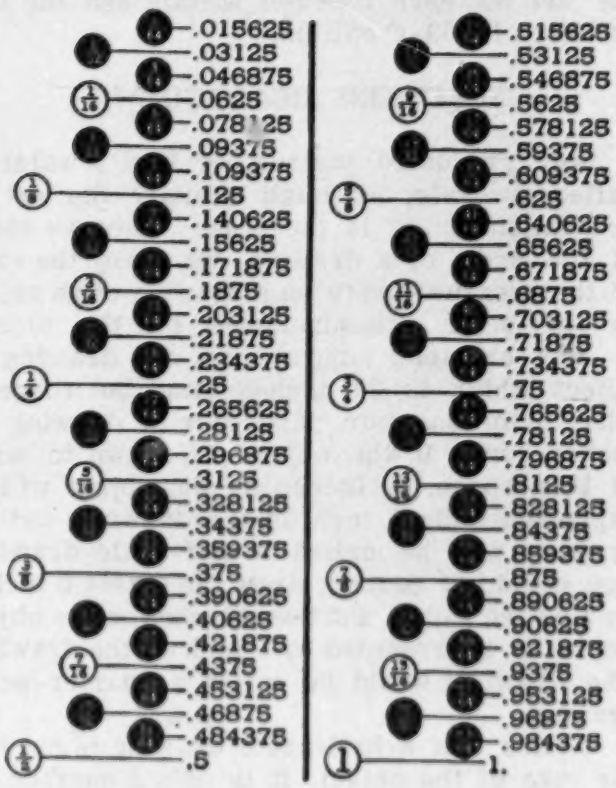

Figure 2-1.—Reduction table for fractions and decimals.

ALGEBRA

Algebra is an extension and completion of arithmetic. It does not involve an abrupt change into a distinctly new field, but rather provides a smooth transition into many branches of mathematics with a continuation of knowledge already gained in basic arithmetic. All the rules of algebra agree with those of arithmetic, and a great many of them are identical. Algebra enables us to write the rules of arithmetic, using symbols that are not only simpler and more concise but of a general nature rather than specific. Through algebra we are able to investigate the properties of numbers and to deal with their relations and combinations. Algebra also enables us to solve problems not even remotely possible by arithmetic means.

Study chapters 8 through 11 of Mathematics, Volume I NavPers 10069-B for details and practice problems in algebra. Or, refer to chapter 9 through 12 of NavPers 10069-C.

RATIO AND PROPORTION

Almost every computation which involves determining an unknown value on the basis of known values involves the solution of proportional equation. For example, if b represents the length of the base of a rectangle and h represents the height, then the formula for the area A is: A = bh. This is itself a proportional equation—that is, an equation showing two equal ratios, as: $\frac{A}{1} = \frac{bh}{1}$. It follows that, if $A = bh$, then $b = \frac{A}{h}$. This is likewise, of course, a proportional equation containing two equal ratios, as: $\frac{b}{1} = \frac{A}{h}$. It follows again that, if $A = \frac{b}{h}$, then $h = \frac{A}{b}$. This is, of course, again a proportional equation.

The whole of chapter 15 of NavPers 10069-B (chapter 13 in NavPers 10069-C) is devoted to an explanation of ratio and proportion, the solution of proportional equations, and the closely related subject of variation. In addition to this knowledge, you should develop the ability to recognize a computational situation as one that is solvable by proportional equation. Practically any problem involving the conversion of measurement expressed in one unit to the equivalent in a different unit is solvable by proportional equation. Similarly, if you know the quantity of a certain material required to produce a certain number of units of product, you can determine by proportional equation the quantity required to produce any given number of units.

In short, it is difficult to imagine any mathematical computation involving the determination of unknown values on the basis of known values that is not solvable by proportional equation.

Your knowledge of equations need not extend beyond that required to solve linear equations—

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that is, equations in which the unknown appears with no exponent higher than 1. The equation $4x \div 7 = \frac{15}{6}$ for example, is a linear equation because the unknown (technically known as the "variable") x appears to only the 1st power. The equation $x^2 \div 2x = -1$, however, is not a linear but a quadratic equation, because the variable x appears to the second power.

Chapter 10 of NavPers 10069-B (chapter 11 in NavPers 10069-C) is devoted to an explanation of linear equations in one variable. Chapter 11 of NavPers 10069-B (chapter 12 of NavPers 10069-C) is devoted to an explanation of linear equations in two variables.

CONVERSION OF WEIGHTS AND MEASURES

A unit of measurement is simply an arbitrary length, area, or volume, generally adopted and agreed upon as a standard unit of measurement. The basic standard for linear measurement, for example, is the meter, and the actual length of a meter is, in the last analysis, equal to 1,650,763.73 wavelengths of orange-red light of krypton-86.

As a DM, you will not be working with all the units described in this chapter, and therefore you need not attempt to memorize them all. Many are included simply to show that units are arbitrary and that there are many different kinds of units in use.

Units of Linear Measure

In the United States and most other English-speaking countries the most commonly used basic unit of linear measurement is the foot, a unit which amounts to slightly more than three-tenths of the international meter. In what is called "engineer's" measurement, the foot is subdivided decimally—that is, into tenths, hundredths, or thousandths of a foot. In what is called "carpenter's" measurement, the foot is subdivided into twelfths called inches, and the inch is further subdivided into even-denominator fractional parts, as: 1/2 in., 1/4 in., 1/8 in., 1/16 in., and so on.

Fractions or multiples of the basic 1-ft unit are used to form larger units of linear measure, as follows:

1 line	=	0.66 ft
1 yard	=	3.00 ft
1 rod, pole, or perch	=	16.50 ft
1 Gunter's chain	=	66.00 ft
1 engineer's chain	=	100.00 ft
1 statute mile U.S.	=	5280.00 ft
1 nautical mile (international)	=	6076.10 ft

A unit of linear measurement called a "vara," of Spanish and Portugese orgin, was formerly used to measure land boundaries in those areas of the U.S. which were at one time under Spanish control. The length of a vara varies in different parts of Arizona, California, Florida, New Mexico, and Texas from slightly less than 33 in. to slightly more than 33 in.

In many of the countries of the world the most commonly used basic unit of linear measure is the meter. The length of a meter was originally designed to equal (and does equal very nearly) one tenmillionth part of the distance, measured along a meridian, between the earth's Equator and one of the poles. A meter equals slightly more than 109 yd.

The big advantage of the metric system is the fact that it is a decimal system throughout—that is, the fact that the basic unit can be both subdivided into smaller units decimally and converted to larger units decimally, by simply moving the decimal point in the appropriate direction. Names of units smaller than the meter are indicated by the Latin prefixes deci- (one-tenth), centi- (one-hundredth), milli- (one-thousandth), and micro- (one-millionth), as follows:

1 decimeter	=	0.1 meter
1 centimeter	=	0.01 meter
1 millimeter	=	0.001 meter
1 micrometer	=	0.000001 meter

Names of units larger than the meter are indicated by the Greek prefixes deca- (ten), hecto- (one hundred), kilo- (one thousand), myria- (ten thousand), and mega- (one million), as follows:

1 decameter	=	10.00 meters
1 hectometer	=	100.00 meters
1 kilometer	=	1,000.00 meters
1 myriameter	=	10,000.00 meters
1 megameter	=	1,000,000.00 meters

Units of Area Measurement

In the English and metric systems, area is most frequently designated in units which consist of squares of linear units, as: square inches, feet, yards, miles; or square meters or kilometers. For land area measurements in the English system, however, other units have been

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developed in various ways. Some of these, with their equivalents in square feet, are as follows:

1 perch = 272.25 sq ft (this is the equivalent of a square rod or pole)
1 rood = 10,890 sq ft (this is the equivalent of 1/4 acre)
1 acre = 43,560.00 sq ft

An equilateral rectangular acre measures 208.71 ft on a side. There are 640 acres in a square mile.

Units of Angular Measurement

For DM purposes, an angle may be roughly defined as two straight lines which lie in the same plane and meet at a point. The point of meeting is called the apex of the angle, and the two straight lines are called the sides.

Again for DM purposes it may be said that the size of an angle is designated according to the size (measured in units of arc) of the arc (segment of the circumference of a circle with center at the apex) lying between the sides. (The circumference is the whole distance around a circle.)

According to this DM definition, the largest conceivable angle is the angle comprised in a single complete circle. Trigonometrically speaking, angles larger than this are conceivable.

The unit of arc most commonly used to measure angles in the English-speaking countries is the degree, representing a 360th part of the circumference of the total circle around the apex. A degree is subdivided into 60 minutes, each of which contains 60 seconds. Seconds are subdivided decimally into tenths, hundredths, and so on.

Angular measurement in grads is an aspect of the metric system of measurement, and is used mostly in those countries which make general use of the metric system. The circumference of the complete circle is divided into 400 equal intervals called grads, each of which is subdivided decimally into tenths, hundredths, thousandths, and so on. As there are 400 grads in 360 degrees, it follows that there are 400/4, or 100 grads in 90 degrees, and 1 grad therefore equals 0.9 degrees, which equals 54 minutes.

Angular measurement in mils is used principally for pointing and training guns in directing artillery fire. The circumference of the complete circle is divided into 6400 equal intervals called mils, and the mil is subdivided decimally into tenths, hundredths, and so on. As there are 6400 mils in 360 degrees, it follows that there are 1600 mils in 90 degrees, and that 1 mil equals 0.059 degrees, or an angle measuring about 0° 3' 36". The significance of this to gunnery lies in the fact that this is an angle which will subtend 1 yard at a range (target distance) of 1000 yds. Therefore, another common definition of mil is: the angle which subtends 1 yd at 1000 yds.

Units of Weight

The units of weight most frequently used in the U.S. for weighing all commodities except precious stones, precious metals, and drugs are the units of the so-called "avoirdupois" system. Avoirdupois units of weight are as follows:

437 1/2 grains (gr)	=	1 ounce (oz)
16 ounces (oz)	=	1 pound (lb)
100 pounds (lbs)	=	1 hundredweight (cwt)
2000 pounds (or 20 cwt)	=	1 ton (T)

Precious stones and precious metals are usually weighed in the U.S. by the system of "troy" weight, in which there are 12 rather than 16 oz in the pound. Drugs are weighed by "apothecaries" weight, in which there are also 12 oz in the pound.

In conjunction with the metric system of measure, there is a metric system of weight. The basic unit of this system is the "gram", which contains 15.432 grains. The grain was originally supposed to be equal to the weight of a single grain of wheat. The gram of 15.432 grains is also used in the avoirdupois, troy, and apothecaries' system of weights.

Multiples and subdivisions of the basic unit of the metric weight (the gram) are named in accordance with the usual metric system of nomenclature, as follows:

0.000001 gm	=	1 microgram
0.001 gm	=	1 milligram
0.01 gm	=	1 centigram
0.10 gm	=	1 decigram
10.00 gm	=	1 decagram
100.00 gm	=	1 hectogram
1000.00 gm	=	1 kilogram

A kilogram weighs about 2.2 lbs avg. A "metric ton" equals 1000 kilograms, which equals about 1.1 tons avg.

Board Measure

Board measure is a method of measuring lumber in which the basic unit is a board foot

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(bf). A board foot is an abstract volume 1 ft long by 1 ft wide by 1 inch thick. The chief practical use of board measure is in cost calculations; lumber is sold by the board foot just as sugar is sold by the pound.

There are several formulas for calculating the number of board feet in any given length of lumber of given section dimensions. Because lumber dimensions are most frequently given by length in feet and width and thickness in inches, the following formula is probably the most practical:

$$bf = \frac{\text{thickness in in. x width in in. x length in ft.}}{12}$$

Board measure is calculated on the basis of the nominal, not the actual, section dimensions. The actual section dimensions of (for example) 2 x 4 stock which is finished on all four surfaces (F4S) are about 1 5/8 in. thick by 3 5/8 in. wide. Nevertheless, the computation for the number of bf in (say) 300 ft of 2 x 4 would be as follows:

$$\frac{\overset{1}{\cancel{2}} \times \overset{2}{\cancel{4}} \times \overset{100}{\cancel{300}}}{\underset{\underset{\underset{1}{\cancel{3}}}{\cancel{6}}}{\cancel{12}}} = 200 \text{ bf}$$

Liquid Measure

In the U.S. the basic unit of liquid measure is the gallon, which has a volume of 231 cu in., or 1.6 cu ft. The gallon is subdivided into smaller units as follows:

1 gallon = 4 quarts
1 quart = 2 pints
1 pint = 4 gills

Units larger than the gallon in liquid measure are as follows:

1 barrel = 31.5 gallons
1 hogshead = 63 gallons or 2 barrels

For petroleum products the standard barrel contains 42 gals.

In the metric system the basic unit of liquid measure is the liter, equal in volume to a cubic decimeter, or about 61 cu in. There are 3.785 liters in a U.S. gallon.

Following the usual metric system of nomenclature, subdivisions and multiples of the liter are as follows:

0.000001 liter = 1 microliter
0.001 liter = 1 milliliter
0.01 liter = 1 centiliter
0.10 liter = 1 deciliter
10.00 liter = 1 decaliter
100.00 liter = 1 hectoliter
1000.00 liter = 1 kiloliter

Temperature Measure

Temperature is commonly measured in the U.S. by the Fahrenheit system devised by the German scientist Fahrenheit. In this system the freezing point of water is 32° F and the boiling point 212° F.

In many scientific pursuits the "centigrade" system is preferred. In this system (which was devised by the Swedish scientist Celsius, and is therefore sometimes called the Celsius system) the freezing point of water is 0° C and the boiling point 100° C. You can see that the centigrade system has a distant relationship to the metric system of measure.

Conversion of Units

To convert a measure expressed in terms of one unit to the equivalent in terms of a different unit is, when you know the ratio between the units, a simple proportional equation problem.

Let us suppose, for example, that you want to convert a linear distance in engineer's measure (feet and decimals of feet) to the equivalent in carpenters measure to the nearest 1/8 in. Suppose that the original distance is 12.65 ft. This means "12 ft and 65 hundredths of a foot." In carpenter's measure the foot is divided into inches, or twelfths of a foot. You want to determine first, then, how many twelfths of a foot there are in 65 hundredths of a foot. The original ratio is $\frac{12}{100}$. The proportional equation solution is:

$$\frac{x}{65} = \frac{12}{100}$$

$$x = \frac{12 \times 65}{100} = \frac{780}{100} = 7.8$$

Therefore there are 7.8 in. in 0.65 ft. The next step is to determine how many eights of an in. there are in 0.8 in., that is, in 8 tenths of an in. The initial ratio is $\frac{8}{10}$, and the proportional equation solution is:

$$\frac{x}{8} = \frac{8}{10}$$

$$x = \frac{8 \times 8}{10} = \frac{64}{10} = 6.4$$

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Therefore there are (rounded off) $\frac{6}{8}$ in., or $\frac{3}{4}$ in., in 0.8 in. In 12.65 ft, then, there are 12 ft 7 3/4 in. to the nearest $\frac{1}{8}$ in.

In converting from engineer's to carpenter's measure, or vice-versa, you may, when working to the nearest 0.01 ft or $\frac{1}{8}$ in., use the following tables of decimal equivalents of inches from 1 through 11 and decimal equivalents of the common carpenter's-measure subdivisions of the inch.

1 in. = 0.08 ft
2 in. = 0.17 ft
3 in. = 0.25 ft
4 in. = 0.33 ft
5 in. = 0.42 ft
6 in. = 0.50 ft
7 in. = 0.58 ft
8 in. = 0.67 ft
9 in. = 0.75 ft
10 in. = 0.83 ft
11 in. = 0.92 ft
1/8 in. = 0.01 ft
1/4 in. = 0.02 ft
1/2 in. = 0.04 ft
3/4 in. = 0.06 ft

Using these values, you can convert decimals of a foot to inches carpenter's measure, or inches carpenter's measure to decimals of a foot, very easily. To convert (for example) 0.37 ft. to inches carpenter's measure you have:

0.33 ft = 4 in.
0.04 ft = 1/2 in.
0.37 ft = 4 1/2 in.

To convert (say) = 7 3/8 in. carpenter's measure to engineer's measure you have:

7 in. = 0.58 ft
3/8 in. = (3 x 0.01) = 0.03 ft
7 3/8 in. = 0.61 ft

For a great many types of conversions there are tables in which you can find the desired values by inspection. Such tables may be found in drafting and engineering handbooks. These handbooks frequently also contain tables of constants, in which a large number of conversion factors are given. A conversion factor is a number which, multiplied by a value expressed in terms of one unit, will produce the equivalent value expressed in terms of a different unit. The factor for converting linear feet to miles, for instance, is 0.00019. If you multiply 5280 ft by 0.00019, you get 1.00 miles.

When you know the ratio between two different units, you can easily work out your own conversion factor. For example: you know that the ratio of degrees to mils is $\frac{9}{160}$. The conversion factor for converting degrees to mils is the number of mils in 1 degree, which is $\frac{160}{9}$, or 17.8 The conversion factor for converting mils to degrees is the number of degrees in a mil, which is $\frac{9}{160}$, or 0.0562. Some typical conversion factors are:

Lineal feet	x	0.00019	= miles
Lineal yards	x	0.0006	= miles
Square inches	x	0.007	= square feet
Square feet	x	0.111	= square yards
Square yards	x	0.0002067	= acres
Acres	x	4840.0	= square yards
Cubic inches	x	0.00058	= cubic feet
Cubic feet	x	0.03704	= cubic yards

Typical equivalents include the following:

U. S. gallons in 1 cubic foot	= 7.4805
Feet in 1 meter	= 3.280833
Inches in 1 meter	= 39.37
Square feet in 1 acre	= 43560.00

POWERS AND ROOTS

Raising a number to a power means multiplying the number by itself a certain number of times. Taking the root of a given number means determining what number must be multiplied by itself a certain number of times to result in the given number. Any number is a higher power of a given root; the number 9, for example, constitutes 3 raised to the second power, commonly called "3 squared," which is written 3^2. It follows that the square root of 9 is 3. A particular power is indicated by a small numeral called an exponent; the small 2 on 3^2 is an exponent. A particular root is indicated by the so-called radical sign $\sqrt{}$, together with a small numeral called the index of the root. The expression $\sqrt[3]{27}$, for example, means "the cube root of 27". For a square root, however, the index symbol is usually left off the radical sign.

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Powers, roots, exponents, radicals, and most of the significant arithmetical operations connected with the same are described in detail in chapter 5 of NavPers 10069-B (or in chapter 7 of NavPers 10069-C). Appendix D of NavPers 10069-B contains a table which gives the squares, cubes, square roots, and cube roots of numbers from 1 to 1000. The use of this table, then, will give you the square or cube root of any number containing not more than 3 digits. For numbers containing more than three digits, any roots or powers (including fractional roots and powers) may be obtained by the use of logarithms.

LOGARITHMS

The arithmetical operations of multiplication and division of numbers and the extraction of roots or the determination of powers of numbers, can be greatly simplified by the use of logarithms. There are two types of logarithms: "natural" (also called "Naperian") logs, and "common" logs. Natural logs are used mainly in higher mathematics. You will be working exclusively with common logs.

Common logs are explained in NavPers 10069-B, chapter 7, and 10069-C, chapter 8, and are also discussed in NavPers 10071-A, chapter 8. The logarithm of a given number is the exponent indicating the power to which another number called the base must be raised to produce the given number. For example: since $3^2 = 9$, 2 is the logarithm of 9 to the base 3. Common logs are logs to the base 10. Since $10^2 = 100$, 2 is the log of 100 to the base 10. When we write log 360 = 2.55630, we understand this to mean $10^{2.55630} = 360$.

GRAPHS

A graphical presentation can usually be grasped much more quickly and clearly than a table of figures. Graphs, which are sometimes called charts and sometimes called diagrams, are consistently used in engineering work and publications and as visual aids in Navy training programs.

There are many kinds of graphs. They may be divided roughly into two categories: engineering graphs and illustrative graphs. A draftsman in any of the engineering fields should know the basic types of coordinate paper, how to plot accurately, and how to draw curves. The illustrator should have this knowledge and these skills, and he should also know how to present the information in the form of visual aids to be used in briefings and training sessions.

This chapter introduces types of graph paper and the mathematics involved in plotting graphs. The use of French curves to draw graphs is covered in chapter 3. The illustrative aspects of charts and graphs are presented in chapter 19.

Coordinates

Coordinates are quantities which designate the position of point in relation to a given reference frame. Telling someone that the post office is "two blocks north of Main Street and three blocks east of Broadway" is using coordinates. Coordinates are often used in conjunction with a grid, which is a network of uniformly spaced straight lines intersecting at right angles. Figure 2-2 shows a grid. The reference frame consists of horizontal and vertical base lines. Each base line in this example is divided into units of measurement; each of the units is further divided into tenths. Call the direction of the vertical base line "North"; call the direction of the horizontal base line "East". The intersection of the base lines is called the origin and has coordinate values of zero-zero; that is, 0.0 North and 0.0 East.

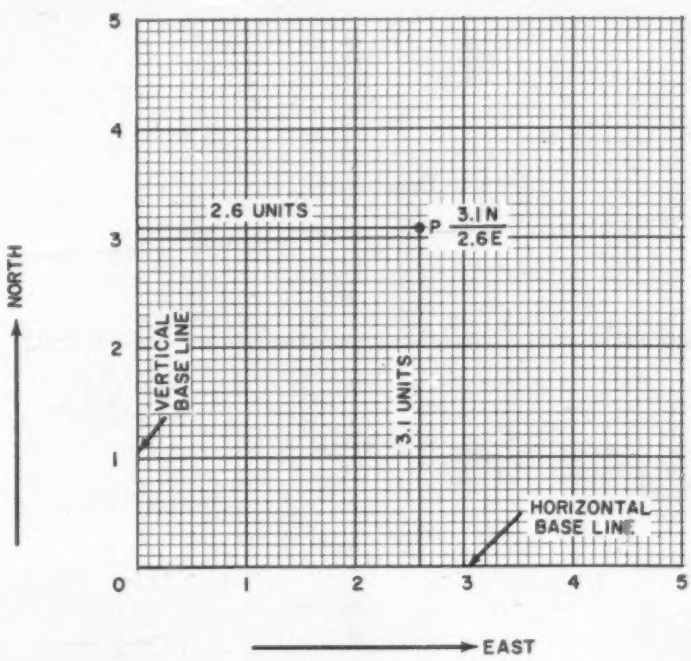

Figure 2-2.—Coordinates of a point on a grid.

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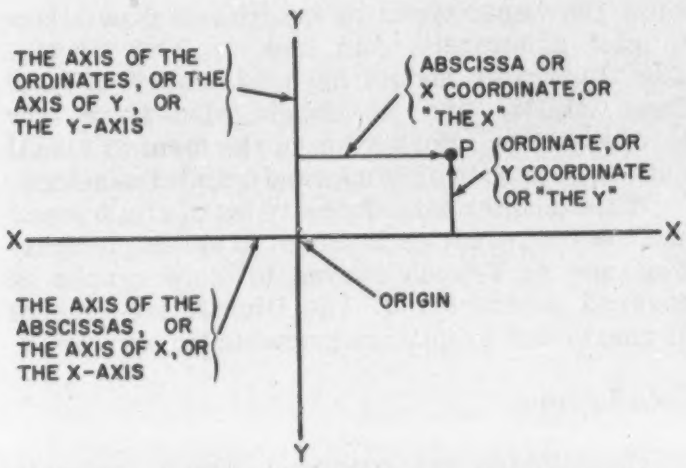

Figure 2-2a.—X and Y coordinate designations.

Point "P" is located 3 units plus one-tenth of a unit more, or 3.1 units, above the horizontal base line. P is also 2.6 units east of the vertical base line. The coordinates of P, therefore, are 3.1 North and 2.6 East.

On the grid shown in figure 2-2 the lines create rectangles; therefore grid coordinates are also called rectangular coordinates. There are various systems for designating the elements of grid coordinate system. Figure 2-2a shows the X and Y coordinate designation system in which x and y are the distances from the base lines to the coordinated point. It is customary to give the x value first and then the y value when identifying a point by x and y coordinates. The base lines divided the map into four areas or quadrants. Measurements up from and to the right of the origin are given positive, or plus, values; but measurements down and to the left are given negative, or minus, values (fig. 2-3). Therefore the x values and y values will be either positive or negative as shown in the illustration. For illustrative purposes, however, you would most likely be dealing only with positive quantities, therefore, the axes would be at the left and bottom, with only enough space left on the margins for the lettering. Generally the intersection of the axes is the zero point for both the vertical and horizontal axes, but on illustrative graphs, where paper saving is important, this is not always true.

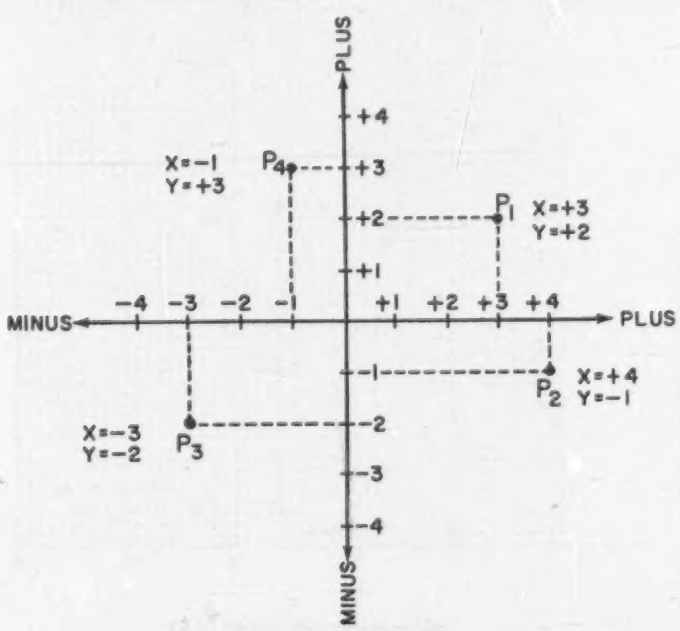

Figure 2-3.—Plus and minus coordinates.

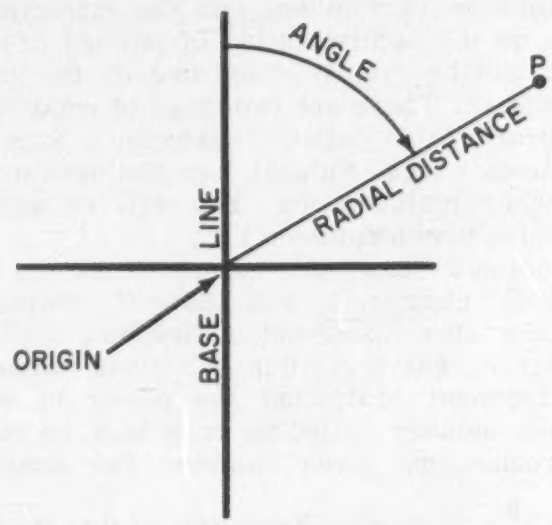

Figure 2-4.—Polar coordinates.

Since coordinates are any quantities which designate position, all coordinates are not necessarily grid coordinates; figure 2-4 illustrates a system of polar coordinates wherein point P is located by an angle and a distance.

Graph Paper

Coordinate paper is available with several types of printed grids, of which the most generally used are the rectangular, logarithmic, and semilogarithmic. (See fig. 2-5.) The rectangular coordinate paper (fig. 2-5a) is available in many different patterns of divisions; for example: 5, 8, 10, 16, or 20 spaces to the inch. The logarithmic paper (fig. 2-5b) is divided by the log scale on both axes; the semilog paper shown in figure 2-5c has equal divisions

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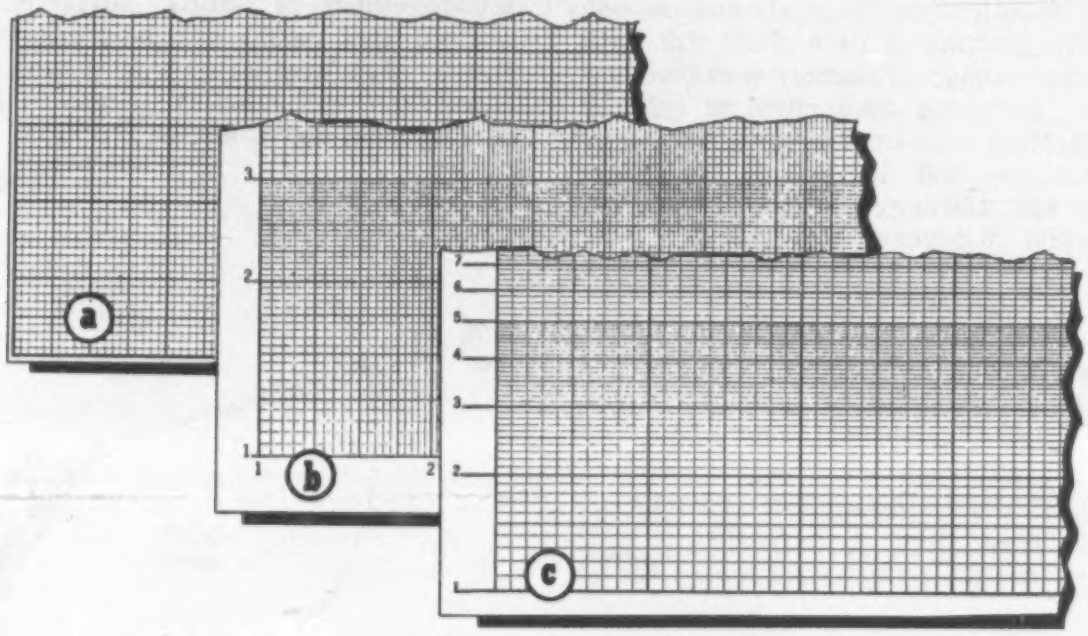

Figure 2-5.—Coordinate paper. A. Rectangular. B. Logarithmic. C. Semilogarithmic.

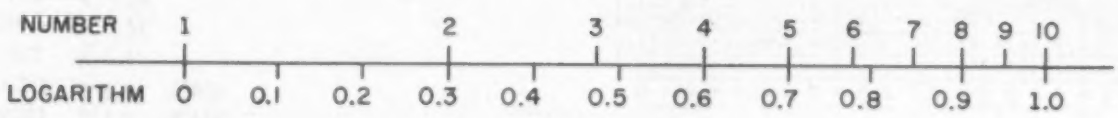

Figure 2-6.—Logarithms and corresponding members on a rule.

along the abscissa (horizontal) axis and log divisions along the ordinate axis. The mantissas of the logs of the numbers 1 through 10 have values from 0 to 1; this relationship is shown graphically in figure 2-6. Since only the characteristic changes for numbers less than 1 and greater than 10, the relationship pictured holds true for all of the tens groups; that is, 10 to 100, 100 to 1000, and so on. Note that the spaces between the numbers are not equal. On the graph paper, the number of ruled divisions between digits decreases as the digits get closer together. For example, note that along the ordinate in figure 2-5c there are 10 ruled divisions between 1 and 2 but only 5 spaces between 5 and 6; 1.5 is plotted 5 spaces above 1, but 5.5 is plotted 2 1/2 spaces above 5. Always carefully count the spaces when you plot values on log paper.

Plotting Graphs

Before you plot a graph, study the limits of the data to be plotted. Select a scale which is big enough to give you a meaningful picture but small enough so that the graph won't run off the paper. Figure 2-7 shows a graph on rectangular coordinate paper with labels indicating the terms used for the various elements.

In plotting the data on the graph locate each point with a dot and enclose each dot with a small circle, triangle, or square. Then draw a curve through the points. When the points do not fall so that they form a smooth curve, connect each point to the next with a straight line. Then draw a curve through these lines in such a way that the sum of the areas of the arcs formed by the lines on one side of the curve is approximately equal to the sum of the areas of the arcs on the other side.

The lettering on the graph should make the meaning clear to the reader. The grid lines should be broken out for lettering when this is possible, and when several curves are close together, leaders with captions should be used to distinguish the different lines.

The plotting of the conventional bar graph (fig. 2-8, for example) generally requires the

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knowledge of fractions or decimals and the use of a scale. The plotting of a pie chart (fig. 2-9) requires the knowledge of angular measure and the use of a protractor (described in chapter 3). Each individual item becomes a slice out of the pie. Since the 360 degrees of the circle equal 100 percent, 180 degrees equal 50 percent, 90 degrees equal 25 percent, and so on.

GEOMETRY

Geometry is that branch of mathematics which investigates the relations, properties, and measurement of solids, surfaces, lines, and angles; the theory of space and of figures in space. Mensuration is that branch of geometry concerned with finding length of lines, areas of surfaces, and volumes of solids.

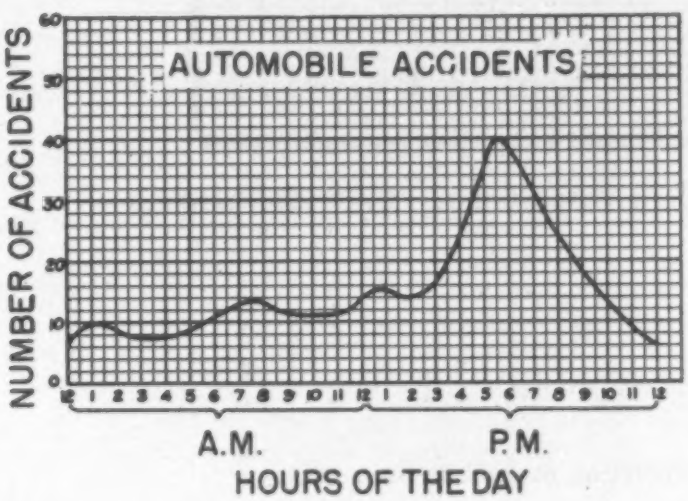

Figure 2-7.—Graph on rectangular coordinate paper.

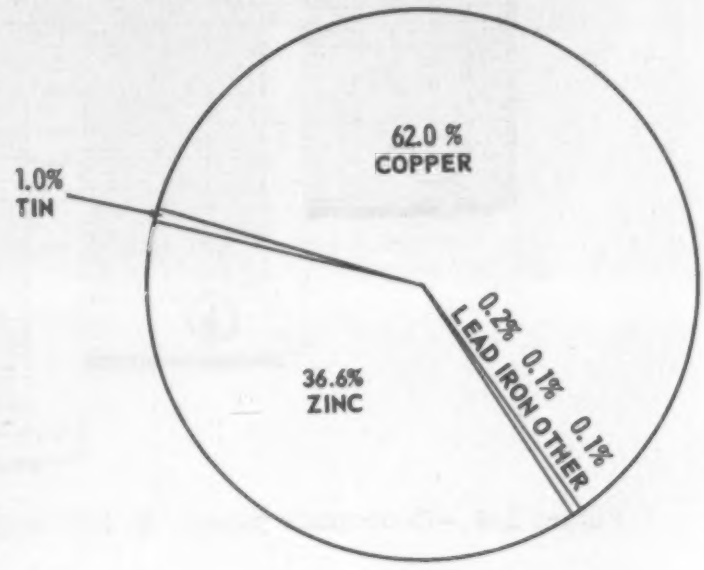

	62.0 %	COPPER
	36.6 %	ZINC
	1.0 %	TIN
MAX.	0.2 %	LEAD
MAX.	0.1 %	IRON
MAX.	0.1 %	OTHER
	100.0	TOTAL

Figure 2-9.—Pie chart.

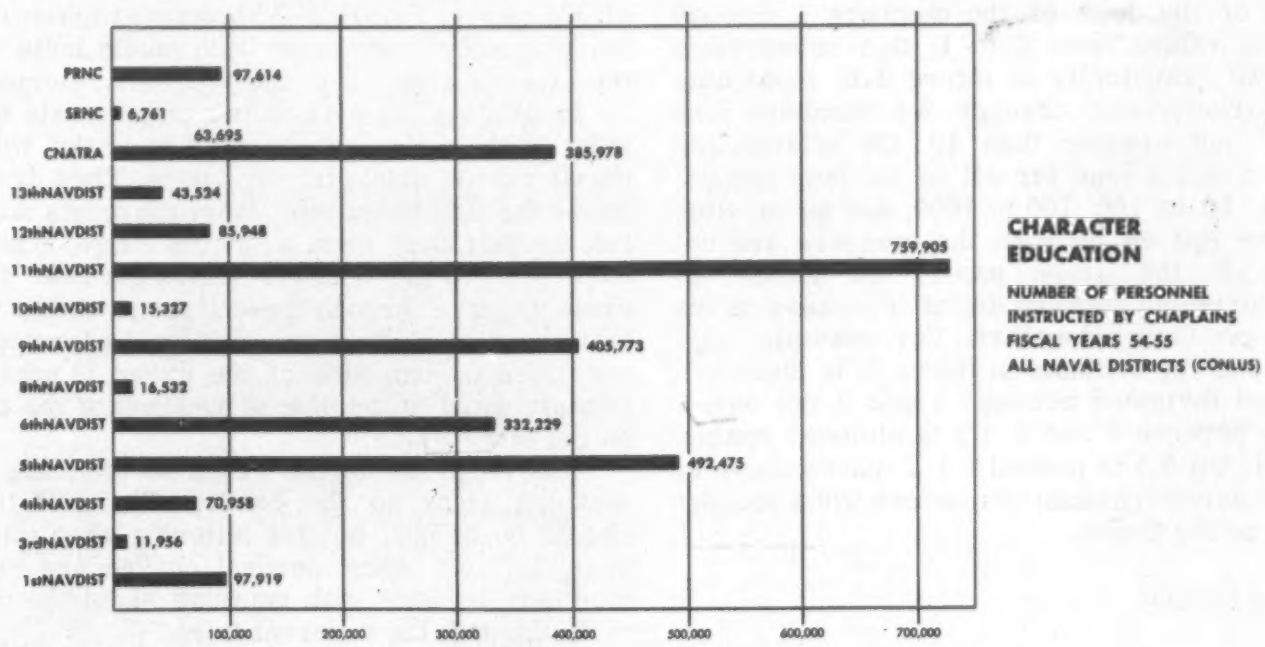

Figure 2-8.—Bar graph.

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As a draftsman you work with geometry constantly. Subsequent chapters in this book present porcedures for constructing geometrical figures with drawing instruments. This chapter identifies various plane and solid figures and explains how to compute areas and volumes.

Plane Figures

A geometrical surface has length and breadth. It has no thickness. A plane is a real or imaginary surface in which a straight line between any two points lies wholly in that surface. A plane surface is a surface on which every point lies in the same plane. Plane figures are plane surfaces bounded by either straight lines or curved lines.

Figure 2-10 shows some common plane figures. Refer to the illustration while you study the following terms, definitions, and statements relating to the plane figures depicted and indentified.

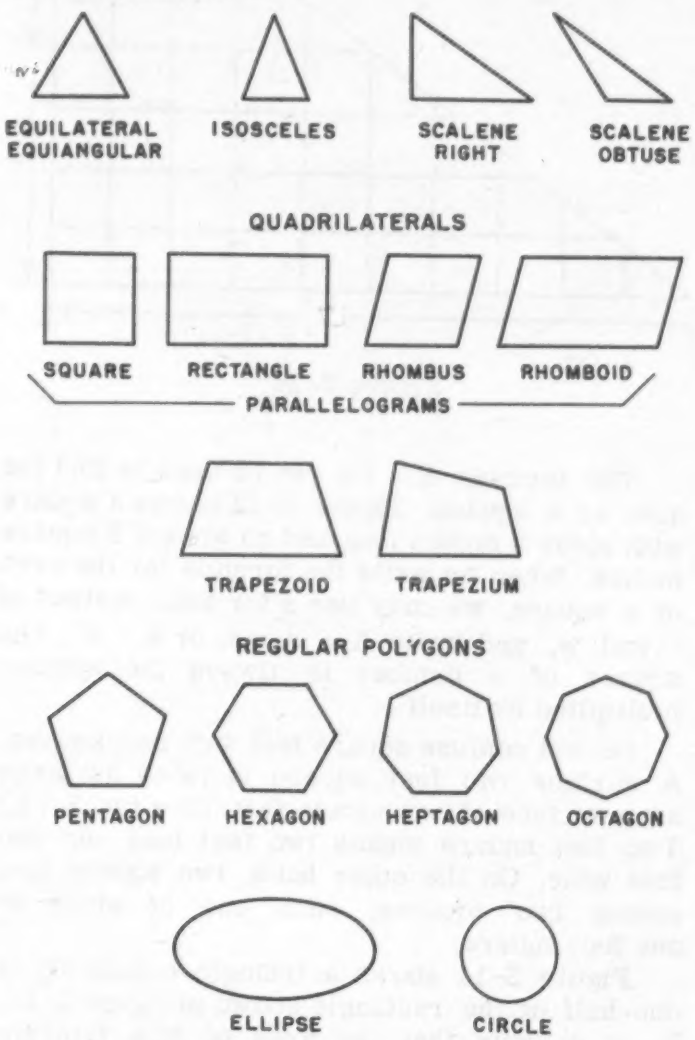

Figure 2-10.—Common plane figures.

A triangle is a three-sided figure.

A right triangle contains a right angle; that is, two of the sides are perpendicular—at right angles to one another.

A scalene triangle has unequal sides and angles.

An equilateral triangle has equal sides; the angles are also equal—therefore an equilateral triangle is also an equiangular triangle.

An isosceles triangle has two equal sides (and also two equal angles).

An obtuse triangle has an angle greater than 90°).

A quadrilateral is a four-sided figure.

A parallelogram has opposite sides which are equal and parallel (parallel lines are equally distant from each other at all points).

A square is a parallelogram whose sides are equal and perpendicular.

A rectangle is a parallelogram whose sides are perpendicular but unequal.

A rhombus is a parallelogram whose sides are equal but not perpendicular.

A trapezoid is a quadrilateral which has only two parallel sides.

A trapezium is a quadrilateral which has no parallel sides.

A polygon has many sides.

A regular polygon has equal sides.

A pentagon has five sides.

A hexagon has six sides.

A heptagon has seven sides.

An octagon has eight sides.

A circle is a closed curve every point of which is equally distant from a fixed point inside called the center.

Every point on an ellipse satisfies the following condition with respect to two fixed points which are called foci: the sum of the distances from a point on the curve to the foci is constant.

Areas of Plane Figures

Figure 2-11 shows a rectangle measuring 10 ft x 8 ft, divided up into units of area measure, each consisting of 1 square foot. If you counted the units, one after the other, you would count a total of 80 units. However, you can see that there are 8 rows of 10 units, or 10 rows of 8 units. Therefore, the quickest way to count the units is simply to multiply 10 by 8 or 8 by 10.

You could call the 10-ft dimension the length and the 8-ft dimension the width, in which case you would say that the formula

for determining area of a rectangle is $A = \ell w$, or $A = w\ell$. Or you could call the 10-ft dimension the base and the 8-ft dimension the altitude (meaning height), in which case your formula for area of a rectangle would be $A = ba$.

If the length of a rectangle is given as 4 feet and the width as 6 inches, convert the feet to inches before you substitute the numerical value for the letter in the formula. Since 4 feet equals 48 inches, the formula using the measurements will read: A = 48 in. x 6 in., or A = 288 square inches. Or, converting the 6 inches to 0.5 ft, A = 4.0 ft. x 0.5 ft = 2.0 square feet.

When you use a formula for area, like $A = \ell w$, the length and width must be expressed in the same units of measurement, and the area will be expressed in terms of square units of this measurement.

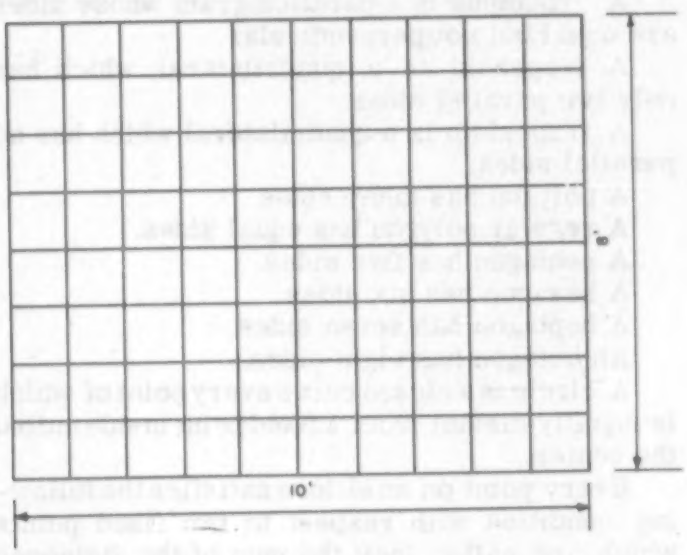

Figure 2-11.

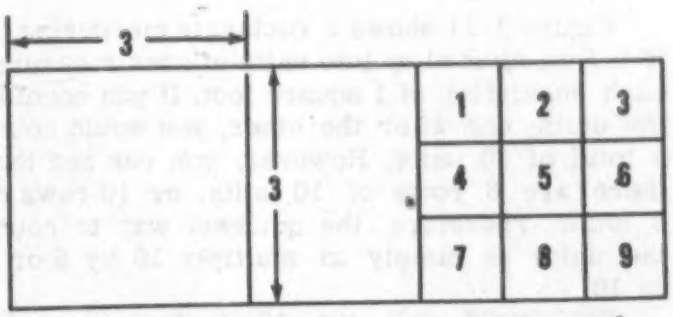

Figure 2-12.—Graphic illustration of the area of a square in terms of square units.

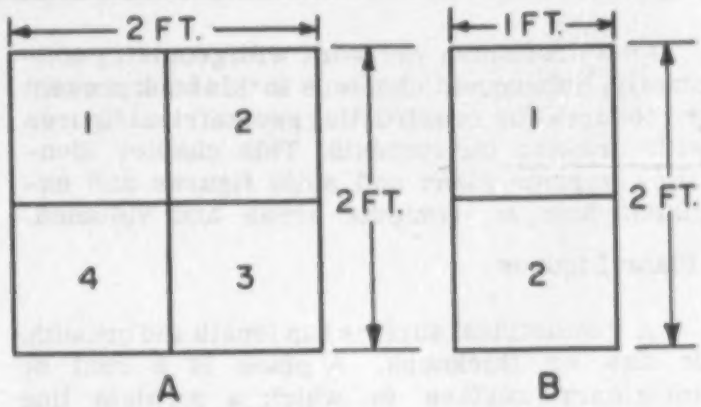

Figure 2-13.—Area A is two feet square. It contains four square feet. B is two square feet.

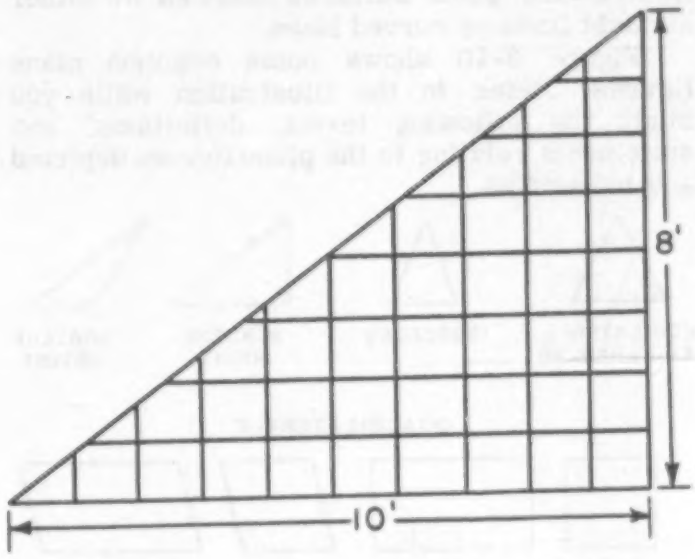

Figure 2-14.

The formula $A = \ell w$ can be used to find the area of a square. Figure 2-12 shows a square with sides 3 inches long and an area of 9 square inches. When we write the formula for the area of a square, we may use s for side, instead of ℓ and w, and write A = s x s, or $A = s^2$. The square of a number is always the number multiplied by itself.

Do not confuse square feet with feet square. A surface two feet square is twice as large as a surface of two square feet. (See fig. 2-13.) Two feet square means two feet long and two feet wide. On the other hand, two square feet means two squares, each one of which is one foot square.

Figure 2-14 shows a triangle consisting of one-half of the rectangle shown in figure 2-11. It is obvious that the area of this triangle must equal one-half of the area of the cor-

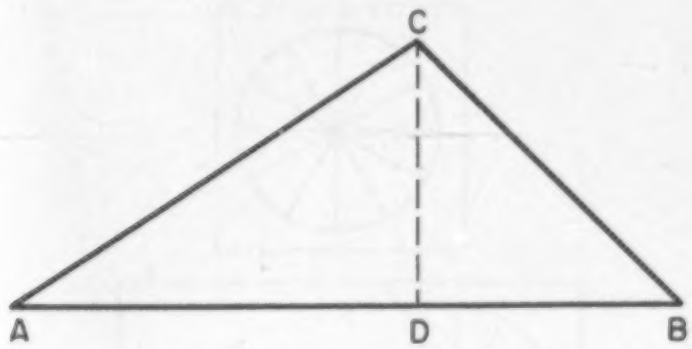

Figure 2-15.

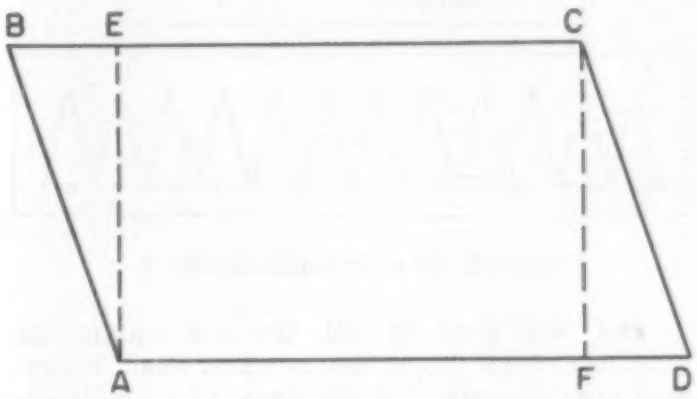

Figure 2-16.

responding rectangle, and the fact that it does can be demonstrated by geometrical proof. Therefore, since the formula for the area of the rectangle is A = ba, it follows that the formula for the triangle is A = 1/2ba.

The triangle shown in figure 2-14, because it is half of a corresponding rectangle, contains a right angle, and is therefore a right triangle. In a right triangle the altitude is the length of one of the sides. The triangle shown in figure 2-15, however, is an oblique triangle, so-called because all of the angles are oblique—that is, not right angles.

Now, a perpendicular DC drawn from the base AB to the apex of the angle at C divides the triangle into two right triangles, ACD and BCD. The area of the whole triangle equals the sum of the areas of ACD and BCD. The area of ACD equals 1/2 (AD) (DC), and the area of BCD equals 1/2 (DB) (DC). Therefore, the area of the whole triangle equals $\frac{AD}{2}(DC) + \frac{DB}{2}(DC)$, or $DC(\frac{AD + DB}{2})$. But since AD + DB = AB, it follows that the area of the whole triangle equals $DC(\frac{AB}{2})$. The length of AB is called the base (b), and the length of DC the altitude (a); therefore, your formula for determining the area of an oblique triangle is again A = 1/2ba.

Figure 2-16 shows a rhomboid ABCD. If you erect a perpendicular FC from AD to the apex of the angle at C, and another from BC to the apex of the angle at A, you will create the right triangles ABE and FCD, and the rectangle AECF. It can be shown geometrically that the right triangles are similar and equal.

You can see that the area of the rectangle AECF equals the product of AF x FC. The area of the triangle FCD equals 1/2(FD)(FC). Because the triangle ABE is equal and similar to FCD, the area of that triangle also equals 1/2(FD)(FC). Therefore, the total area of both triangles equals (FD)(FC). The total area of the rhomboid equals the area of the rectangle AECF.

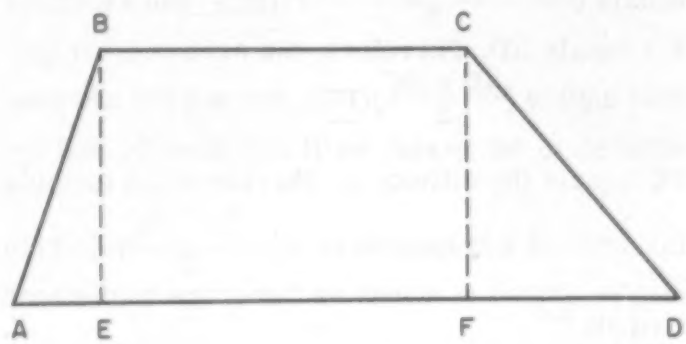

Figure 2-17.

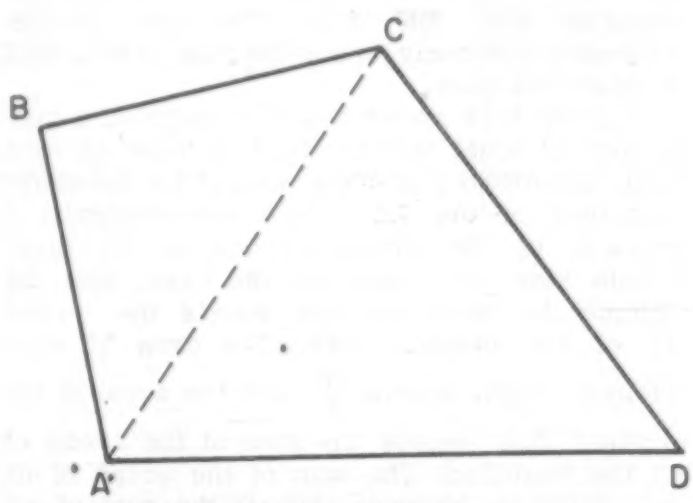

Figure 2-18.

The total area of the rhomboid equals (AF)(FC) + (FD)(FC), or (AF + FD)(FC). But AF + FD equals AD, the base. FC equals the altitude. Therefore, the formula for the area of a rhomboid is A = ba. Here again you must remember that the altitude in a rectangle corresponds to the length of one of the sides, but in a rhombus or rhomboid it does not.

Figure 2-17 shows a trapezoid ABCD. If you erect perpendiculars EB and FC from AD to B and C, you create the right triangles ABE and FCD and the rectangle EBCF. The area of the trapezoid obviously equals the sum of the areas of these figures. FC can be shown geometrically to be equal to EB.

The area of ABE equals 1/2(AE)(FC), the area of FCD equals 1/2(FD)(FC), and the area of EBCF equals (EF)(FC). Therefore, the area of the trapezoid equals $(\frac{AE}{2} + \frac{FD}{2} + EF)(FC)$, or $(\frac{AE + FD + 2EF}{2})(FC)$. However, 2EF equals EF + BC. Therefore, the area of the trapezoid equals $(\frac{AE + EF + FD + BC}{2})(FC)$. But AE + EF + FD equals AD. Therefore, the area of the trapezoid equals $(\frac{AD + BC}{2})(FC)$. AD and BC are considered to be bases; we'll call them b_1 and b_2. FC equals the altitude a. Therefore, the formula for area of a trapezoid is $A = (\frac{b_1 + b_2}{2})(a)$. This can be stated in words as "average base times altitude."

Figure 2-18 shows you how you can determine the area of area of a trapezium, or of any polygon, by reducing to triangles. The dotted line connecting A and C divides the figure into the triangles ABC and ACD. The area of the trapezium obviously equals the sum of the areas of these triangles.

Figure 2-19 shows how you could cut a disk up into 12 equal sectors. Each of these sectors would constitute a triangle, except for the slight curvature of the side which was originally a segment of the circumference of the disk. If this side is considered the base, then the altitude for each triangle equals the radius (r) of the original disk. The area of each triangle, then, equals $\frac{br}{2}$, and the area of the original disk equals the sum of the areas of all the triangles. The sum of the areas of all the triangles, however, equals the sum of all the b's, multiplied by r and divided by 2.

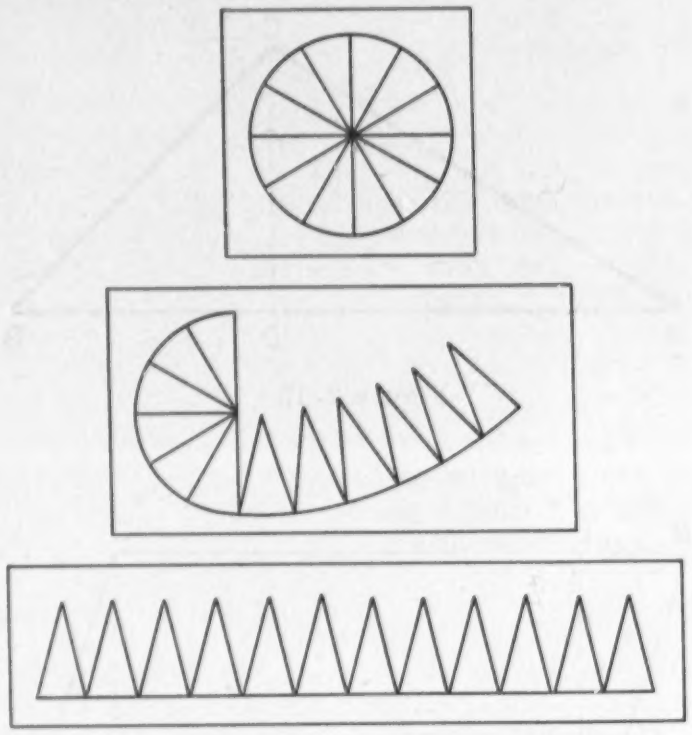

Figure 2-19.—Triangle sectors.

But the sum of all the b's equals the circumference (c) of the original disk. Therefore, the formula for the area of a circle can be expressed as $A = \frac{cr}{2}$. However, the circumference of a circle equals the product of the diameter times π (3.14159...). The diameter equals twice the radius; therefore, the circumference equals $2\pi r$. Substituting $2\pi r$ for c in the formula $A = \frac{cr}{2}$, we have $A = \frac{(2\pi r)(r)}{2}$,

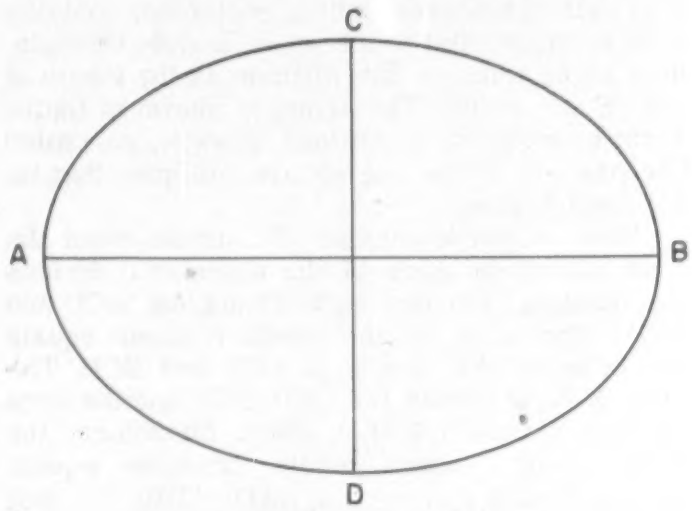

Figure 2-20.